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ANTENNA EVALUATION STUDY
FOR THE
SHUTTLE MULTISPECTRAL RADAR:
PHASE I

FINAL REPORT

by

Edgar L. Coffey, III
Keith R. Carver

prepared for

NASA Johnson Space Center
Houston, Texas

Contract No.
NAS 9-95469

December 1976

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1.0 INTRODUCTION

This report presents the results of the first phase of the Antenna Evaluation Study for the Shuttle Multispectral Radar (SMR). The original goals of Phase I were to make preliminary indentification of those critical parameters of the Shuttle Multispectral Radar Antenna (SMRA) which most affect antenna performance and to write a first draft of specifications for the subarrays which will be analyzed in Phases III and IV. During the course of this research it was decided to expand the scope of Phase I to include the development of a preliminary mathematical model describing SMRA performance under the influence of various physical and environmental factors. This was necessary to identify those key antenna parameters and environmental conditions which might degrade SMRA performance. This has allowed more time in Phase II for the simulation and study of critical factors which may create or influence these error-causing conditions.

1.1 Some Projected User Needs

A key and as yet not completely answered question is the instrumentation requirement of the rather nebulously defined user community. Studies by Hughes Aircraft Co. and JPL have suggested L and X-bands as a dual-frequency choice best suited to the needs of potential users, yet realizable in terms of development. In addition, dual polarization capability has been specified along with three incidence angles and various swath widths.

Space radars with imaging capabilities have a considerable potential applicability in the following areas:

1. Soil moisture determination
2. Flood area monitoring
3. Crop discrimination
4. Crop yield estimates
5. Plant biomass
6. Mineral and petroleum exploration
7. Sea and lake ice mapping
8. Iceberg monitoring

These application areas have been discussed in two Active Microwave Workshops (Fall, 1974 and Fall, 1976 at NASA/JSC) along with an additional October, 1976 Shuttle Multispectral Radar Applications Meeting held at NASA/JSC. These meetings have also pointed out that L and X-bands are not optimum for some prime application areas. For example, C-band and K_u-band are optimum for soil moisture measurement and vegetation classification, respectively. At the time of this writing, the user groups have not been able to agree on two optimum frequencies best suited for the broadest range of application; this has imposed additional delays on detailed specification of optimum incidence angles, registration of cross-band beams, etc. For example, it has been shown that soil moisture determination is best carried out at about 4.5 GHz and for incidence angles in the 7^o - 12^o range, whereas crop classification is optimally accomplished at 14 GHz and with a 40^o - 50^o incidence angle range.

This situation of uncertainty requires that the present antenna study incorporate frequencies ranging from 1.2 - 14.5 GHz as well as a consideration of incidence angles from near-nadir to nearly 50^o. In fact, one of the eventual goals of this project is to provide simulated performance data at a variety of frequencies, incidence angles, etc.; this may impose additional hardware-related restrictions on finalized choices of SMR design parameters.

1.2 The Need For A Comprehensive and Independent Antenna Evaluation Study

The Shuttle Multispectral Radar Antenna, being an electrically large radiator, has several characteristics that require a thorough analysis. Preliminary studies indicate that the SMRA must be a large structure, on the order of 12 m by 3 m which can operate in a space environment. The determination of its electrical behavior (gain, beamshape, pointing accuracy, etc.) is vital to the calibration of the overall SAR system and thus to the success of the mission itself. Since the antenna development cost is by far the largest system development budget item, it is economically imperative that critical antenna parameters and potential calibration problems be identified early in order to avoid costly mechanical and electrical redesign phases which might otherwise be required. In effect, a macro developmental and simulation exercise such as described herein seeks to clearly identify at a very early stage those most likely technological problem areas which invariably accompany the development of a state-of-the-art instrument such as the Shuttle Multispectral Radar; this not only helps to avoid costly development errors but also permits a realistic prediction of the performance of the instrument itself and thus allows design/performance tradeoffs to be made at a much earlier stage of development.

The huge electrical size of the total antenna structure suggests that conventional techniques for measurement of important electrical parameters will be of little use and that novel calibration schemes must be devised. In addition, electrical and mechanical tolerance errors, particularly systematic ones, are more likely to seriously degrade the performance of a large antenna. In preliminary investigations by Hughes Aircraft Co. and Ball Brothers Research Corp., the antenna configuration and size was specified, but no bounds were placed on tolerance errors or performance indices. These bounds should be determined as soon as possible to avoid the expense of constructing either an antenna whose parameters are overly restricted or an antenna whose performance will be inadequate for the desired applications.

In addition to determining antenna performance in an idealized environment, it is also necessary to predict in situ performance and to devise means for assurance of calibration stability. This prediction requires an adequate mathematical model which describes the SMRA performance including space environmental factors such as thermal gradient effects on electrical flatness, beam pointing stability, material stability in a near-vacuum environment, and effects of multiple scatter from the shuttle bus itself.

Although the effect of the SAR processor on the synthetic antenna performance has not been considered in this report, it will be discussed in subsequent reports. The quality of the image processors currently being considered may have little effect on the image if the antenna performance is significantly degraded by external factors, or vice versa. A related consideration is the study of realistic system calibration techniques. System development must be planned with calibration as an integral part of the design process; calibration must not be an afterthought. Since the SMR can only be calibrated to within a specified uncertainty, the antenna should not be overspecified to a level which cannot even be measured. For example, it should be possible to answer the question, "What level of antenna cross-polarization rejection is actually necessary in light of: 1) user requirements, and 2) ability to calibrate cross-polarized performance?"

1.3 A Two-Path Approach To The Antenna Study Problem

An answer to the questions in the last section requires the development of both mathematical techniques and computer programs to analyze random and systematic electrical and mechanical SMRA errors, and a method of measuring and testing antennas representing the competing approaches. This dual approach has been followed in Phase I and will continue to be used in subsequent phases.

The mechanical model and computer simulation relate electrical and mechanical tolerances to performance indices. The model is being designed to that tradeoffs can be made between the quality of performance and the expense of tight tolerances. It is also capable of predicting SMRA performance under various space environmental conditions. Finally, through analysis of the results of several simulations, the model is able to flag any possible problems that one of the competing designs might incur. In Phase I antenna parameters have been identified which are critical to both antenna and system performance. Furthermore, a preliminary mathematical model and a computer program have been developed and tested. Subsequent phases will deal with refinement of the model and the simulation of a number of scenarios.

The measurement/testing problems can be alleviated by performing appropriate tests on macro model subarray antennas representing the competing design approaches. These measurements will include near-field and far-field electrical performance tests and thermal cycling tests with mechanical flatness measurements. The results of these tests will be entered into the SMRA simulation model to predict the performance of the full size array. In Phase I, those parameters which must be measured have been identified.

1.4 Scope of Work

This report presents the results of several activities associated with the development of the mathematical model, the computer program, and the subarray panel requirement. These activities were:

1. A review of the antenna designs from the definition phase.
2. An identification of critical SMRA performance parameters.
3. An identification of conditions which may degrade SMRA performance.
4. An identification of factors which may create or influence error-causing conditions.
5. The development of a preliminary SMRA mathematical model.
6. The organization of the SMRA computer simulation program.
7. A demonstration of the flexibility of the SMRA computer program.
8. The identification of requirements and specifications for the subarray panels.
9. The development of an interface data tape for the University of Texas Applied Research Laboratory image processor simulation program.

The prinicpal results obtained to date are:

1. A cause-effect relationship for various environmental and physical factors on the antenna electrical and mechanical behavior.
2. A baseline mathematical model for the electrical and mechanical behavior of the SMRA in a space environment.
3. A compilation of results of the simulation of the baseline designs for both competing approaches and several sample scenarious demonstrating the flexibility of the mathematical simulation.

2.0 IDENTIFICATION OF IMPORTANT PARAMETERS, THEIR EFFECT ON SMR SYSTEM PERFORMANCE AND POSSIBLE TRADEOFFS

2.1 A Review Of The Antenna Designs From The Definition Phase

A review of the candidate SMR system approaches and synthetic aperture techniques was conducted early in Phase I in order to establish a familiarity with both the antennas themselves and the interaction between the antenna and the image processor. It was found that although preliminary specifications had been placed on some of the antenna parameters, there was not a tolerance budget (or rationale for one) for each major component of the overall system. Because the performance of the overall system is set by both the antenna and the image processor, and because these cannot be designed independently, it is our opinion that further refinement of antenna performance parameters be withheld pending dual simulation of antenna and processor. To this end, we have developed an auxiliary computer program which generates real antenna pattern data for use by the Applied Research Laboratories (University of Texas) in their image processor simulations.

Both Hughes and JPL have suggested in independently conducted studies that the SMR antenna be a large, planar array of approximately three meters by twelve meters. The twelve meter azimuth dimension was predicated upon the resolution requirement. The three meter elevation dimension was based upon the swath width requirement, space required for both L- and X-band antennas, and payload weight/size restrictions. Both designs would use uniform illumination and would achieve three different elevation beamwidths by switching between two panels. The angle of incidence would be controlled by the attitudes of the shuttle. Hughes proposed to use crossed dipoles at L-band and waveguides slots at X-band, whereas Ball Brothers (under contract to JPL) would use microstrip elements at both frequencies. For launch and boost, the antenna would be folded twice in the azimuth dimension and stowed within the shuttle payload compartment. After orbit insertion, the antenna would be deployed to its nominally flat shape. A comparison of the Hughes and JPL/Ball Brothers antenna specifications is given in Table 1. More detailed information can be found in the Hughes report to NASA/JSC of October 1975 and the JPL report to NASA/JSC of March 1976.

TABLE 1. A comparison of JPL/Ball Brothers and Hughes antenna specifications.

Specification	JPL/BB						HUGHES					
	L-band			X-band			L-band			X-band		
Frequency, GHz	1.302			8.33			1.04			9.00		
Polarization	HH,HV,VH,VV			HH,HV,VH,VV			HH,HV,VH,VV			HH,HV,VH,VV		
Azimuth dimension, m	12			12			12			12		
Azimuth Peak-to-Null beamwidth, deg	1.1			0.172			1.287			0.153		
Efficiency, %	70			70			---			---		
Peak power rating, KW	6			20			6.8			17		
Pointing accuracy, deg	±0.5			± 0.5			---			---		
Peak sidelobe level, dB	13.5			13.5			13			13		
Element type	microstrip			microstrip			crossed dipoles			waveguide slots		
Off-nadir angle, deg	25	38	50	25	38	50	10 - 60			10 - 60		
Peak gain, dB.	32	36	38	41	45	46	29*	32*	34*	38*	42*	43*
Elevation dimension, m[†]	0.65	1.55	2.2	0.12	0.24	0.36	0.81	1.62	2.53	0.094	0.188	0.282
Elevation Peak-to-Null beamwidth, deg.	20.8	8.5	6.0	17.45	8.63	5.74	18.87	9.44	6.29	18.87	9.44	6.29

*Gain figures include 2.4 dB system loss

[†] The two panels are combined to form the narrow beam panel

The similarity of the two designs makes it possible to model both antennas with the same algorithm and computer program. The only significant electrical difference is the element type, and this may be handled with only a minor change in one subprogram.

2.2 Critical Antenna Parameters

Six antenna electrical parameters have been identified as being critical to the SMR performance. They are:

1. Antenna gain and efficiency.
2. Main beam shape.
3. Side lobe level.
4. Polarization purity.
5. Beam pointing accuracy.
6. Cross-band and cross-polarization beam coincidence.

For each of these parameters, both static errors and dynamic errors must be considered. In many cases, static errors, or those errors which do not change during a mission, can be compensated. On the other hand, dynamic errors whose effect on performance may change during a mission, are quite difficult to handle. For example, the shape of the main beam will modulate the data. If the beam shape is known, this effect may be processed out of the final image. But if the beam shape changes during flight, as it may due to thermal distortion of the antenna structure, it may be impossible to compensate for the time-varying modulation without real-time knowledge of the antenna pattern.

In the following, each of the above six parameters will be discussed considering both types of errors and possible tradeoffs with other system components.

Antenna Gain & Efficiency -- Static errors will affect the system signal-to-noise ratio (SNR). Tradeoffs are with transmitter power, receiver sensitivity, and minimum detectable scattering cross section. Slow changes in the antenna gain or efficiency over a period of hours or days cause instability in the system calibration.

Main Beam Shape -- The azimuth beam shape does not affect the system as much as the elevation beam shape, since each resolution cell "sees" the entire azimuth beam but only sees a portion of the elevation beam. As mentioned above, the static antenna gain pattern weights the amplitude of the data, but this effect can be compensated by using the appropriate (in elevation) processor demodulation algorithm. However, dynamic changes in the beam (e.g., caused by thermal deformations related to changing sun angle) are largely uncorrectable and lead to a degradation in image quality.

Side Lobe Level (SLL) -- The prinicpal impact of the side lobe level on the overall system is one of ambiguities within the processed image. Uniform illumination of the SMRA will produce a theoretical SLL of -13.3 dB (one-way), but this level may rise due to panel folding/unfolding errors, mechanical and thermal distortions, etc. However, azimuth ambiguities can be suppressed further by proper choice of the Doppler processing bandwidth and the pulse repetition frequency (PRF). Range ambiguities are the result of ground point returns that are outside the desired image swath width which arrives at the receiver simultaneously with the return from a point which lies within the desired swath width. Unfortunately, their control is provided almost exclusively by the antenna elevation pattern. Consequently, any rise in the side lobes, static or time-varying, will decrease the imaged signal-to-ambiguity ratio. Furthermore, an increase in the SLL indicates that the antenna gain has decreased, degrading the SNR as well. Elevation side lobes are the most critical since no compensation can be performed on the processed image.

Another quality criterion is that of total peak to total side lobe power ratio. Even though all side lobes may fall below some relative level (for example, -20 dB), the integrated SLL power level may completely mask the presence of a fairly strong point target.

One obvious, but expensive, solution to the ambiguities problem would be to overdesign the range pattern of the SMRA by tapering the range excitation amplitude to produce an even lower side lobe level. There are two other tradeoffs to be considered. First, the SMRA would be more susceptible to errors induced by mechanical and thermal distortions since tighter control on magnitude and phase excitation tolerances is necessary to obtain the low side lobe pattern. Secondly, the three required beamwidths could not be obtained simply by switching between the two subarrays as in the case of uniform illumination.

Polarization Purity -- No adequately substantiated performance guideline for polarization purity has yet been announced. However, it is felt that this parameter will be important to the scientific community and should be considered. In theory, the presence of any cross-polarized field at the antenna output will degrade the quality of the data. However, the cross-polarization level performance actually required depends on the intended use of the data and the sophistication of the σ^0 classification models. For example, in the X-band GEMS SAR, most users feel that a -20 dB cross-polarization level is quite adequate. The level of this unwanted component can be controlled to some degree by the selection of the array element type and the fabrication of a supporting structure that will allow little, if any, deviation of the array surface from mechanical flatness. The principal tradeoffs are against expense and technical risk. It is conceivable that any static purity problems might be compensated in the processing hardware, but certainly, time-changing instabilities would be uncontrollable.

Beam Pointing Accuracy -- The items basic to the subject of antenna pointing are: 1) The position of the antenna beam relative to the zero Doppler plane; and 2) The rate of change of that position. Both of these items must be considered when attempting to locate the plane of zero Doppler for the processor. In the process of forming the synthetic aperture, it is necessary to sense any changes in the position of the antenna beam relative to the isodops (surfaces of constant Doppler frequency) so that the resulting image may be compensated. One way of doing this is to monitor in real time the average Doppler shift of the radar data and use this information to keep the beam centered about the required isodop. Unfortunately, this requires precise control of the beam pointing direction, and any errors, static or dynamic, will tend to invalidate this approach.

A second approach would be to monitor the data and dynamically adjust the processor to compensate for deviations in beam position as well as orbit eccentricity and angular velocity (combined pitch, roll, and yaw velocities) of the spacecraft. Using this approach, the antenna requirements are reduced (at the expense of increased processor complexity) to placing limits on the angular excursions of the combined antenna electrical/mechanical beam pointing directions and on the rate of change of this angular motion.

The following antenna pointing and stability limits have been recommended[†]:

± 0.5 degrees in pitch, roll and yaw.

0.01 degrees per second maximum in pitch, roll, and yaw rates.

In summary, a tradeoff exists between processor complexity and antenna beam pointing requirements.

Cross-Band and Cross-Polarization Beam Coincidence -- No information is yet available on beam coincidence requirements. Obviously, the closer the coincidence of footprint registration, the more meaningful the cross-band and cross-polarization data becomes. Again, the intended uses of the SMR data must be considered in attempting to qualify beam coincidence requirements. Two major projected uses are: 1) Crop classification, and 2) Soil moisture measurement, with the high frequency being most useful for (1) and the lower frequency most useful for (2). Thus, in specifying the cross-band beam coincidence, one must ask how the data are to be used in an interpretive model. See Section 1.1.

It is conceivable that any static errors could be compensated by increasing the processor complexity. However, dynamic changes in beam coincidence seem to be undetectable and hence uncompensatable.

2.3 Conditions Which May Degrade Antenna Performance

The six critical antenna parameters of the last section are directly affected by both random and systematic errors in the electrical excitation and/or mechanical construction and orientation of the SMR array. This section

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[†] J.G. Mehlis, Shuttle Synthetic Aperture Radar Implementation Study, Vol. 1, Jet Propulsion Laboratory Document 750-73, Pasadena, California, March 8, 1976, p. 2-42.

discusses the effect of various types of errors upon the performance of the antenna.

2.3.1 Electrical Errors

Electrical errors are classified into two types, random and systematic. While both classes will be discussed, it is felt that the effects of systematic errors on SMRA performance will be the more important consideration in the performance of the real antenna since the overall effect of small random errors diminish as the size of the array increases due to an averaging effect. It should be pointed out that random errors do affect the performance of the synthesized antenna pattern (e.g., synthetic beam pointing errors caused by phase decorrelation due to random phase errors), but the extent to which these errors degrade overall system performance cannot be predicted without further study and a knowledge of the image processor operation.

Random electrical errors may be divided into three catagories:

1. Amplitude errors.
2. Phase errors.
3 Errors in the individual element patterns.

Random amplitude errors will cause a loss of gain, a broadening of the main beam, a reduction in null depths, and to a lesser extent, a rise in the side lobe level. Random phase errors affect the real beam pointing direction and SLL, as do errors in the characteristics of the individual element patterns. These errors arise from the manufacturer-controlled tolerances placed on the antenna which are the result of element-to-element variations in the feed arrangement, power dividers, waveguide slot width and placement, etc. A given random error will affect X-band performance more than L-band performance since phase tolerances are relative to wavelength.

Systematic electrical errors are much more difficult to analyze than random errors since the more important systematic errors depend upon the antenna structure and geometry. Consequently, little a priori information is available for the systematic errors which may influence the performance of the SMRA. The more common (and most easily analyzed) errors are:

1. Linear phase errors.
2. Quadratic phase errors.
3. Cubic phase errors.
4. Periodic errors.

A systematic linear phase shift across the array will change the beam pointing direction, broaden the main beam, decrease the gain, increase the SLL, and degrade polarization purity. Quadratic phase errors tend to raise the null depths between side lobes, widen the main beam, reduce gains, and increase the level of the near-in side lobes. However, the beam direction remains unchanged. Cubic phase errors will shift the beam position, decrease the gain, and produce asymmetrical side lobes. Periodic errors create two additional side lobes and a loss of gain, but no beam pointing errors.

Errors which cannot be classified into one of the above categories must be analyzed separately. The only efficient method of tackling this problem is to simulate the effect of such errors on a digital computer. In this way, information concerning footprint shape, gain, etc., can be obtained for a large class of systematic errors.

The mathematical algorithms for the simulation will be analyzed in Section 3, the organization of the computer program will be discussed in Section 4, and the source listing for the computer program is given in the appendix.

2.3.2 Mechanical Errors

Both random and systematic mechanical errors arise from manufacturer-induced tolerances; space environmental effects on the antenna and its supporting structure induce additional systematic departures from flatness. Systematic mechanical errors will likely be more detrimental to SMRA performance than random errors.

The most significant mechanical error problems will be concerned with deviations of the array from nominal flatness. The effect of this error on performance will be the same as a systematic electrical phase error since the change in element path-length distance introduced by this distortion can be viewed as an electrical phase difference. Hence, a mechanical distortion will exhibit the same effects as the phase distortions of the last section. These include beam defocusing, gain reduction, an SLL increase, and polarization purity degradation.

Another source of mechanical errors is the random and systematic errors in the element locations. Translational errors will change the beam shape, raise the side lobe level, and may introduce other lobes. The effect of rotational errors would be to destroy the polarization purity and to decrease the gain. As with electrical errors, the only efficient method for determining the effect of mechanical errors to devise a suitable computer algorithm. One such algorithm is described in Sections 3 and 4.

2.3.3 Other Sources of Errors

One source of error that should not be ignored is the multipath effects caused by reflection from the Shuttle body and/or other experiments. A ray-optics treatment of the problem should be sufficient to identify any possible problems, and to suggest ways of reducing multipath effects to a minimum.

Another consideration to the overall performance of the antenna is the degradation of materials due to the space environment and exhaust envelopes of the Shuttle engines. This could become important for the dielectric used in a microstrip antenna element.

2.3.4 Summary of Errors

The effects of various electrical and mechanical errors on SMRA performance is summarized in Table 2.

2.4 Summary

The four cause-effect relationships discussed in Section 2 are graphically portrayed in Figure 1. Briefly, manufacturing, environmental, and deployment

TABLE 2. The effects of electrical and mechanical errors on SMRA performance.

Error Type	Gain	Beam Shape	Sidelobe Level	Polarization Purity	Beam Pointing	Beam Coincidence
Electrical						
Random Amplitude	X	X	X			
Random Phase			X		X	X
Linear Phase Shift	X	X	X	X	X	X
Quadratic Phase	X	X	X			
Cubic Phase	X	X			X	X
Periodic Errors	X		X		X	X
Mechanical						
Deviation from Surface Flatness	X	X	X	X	X	X
Translational Errors in Element Location		X	X			
Rotational Errors in Element Location	X			X		

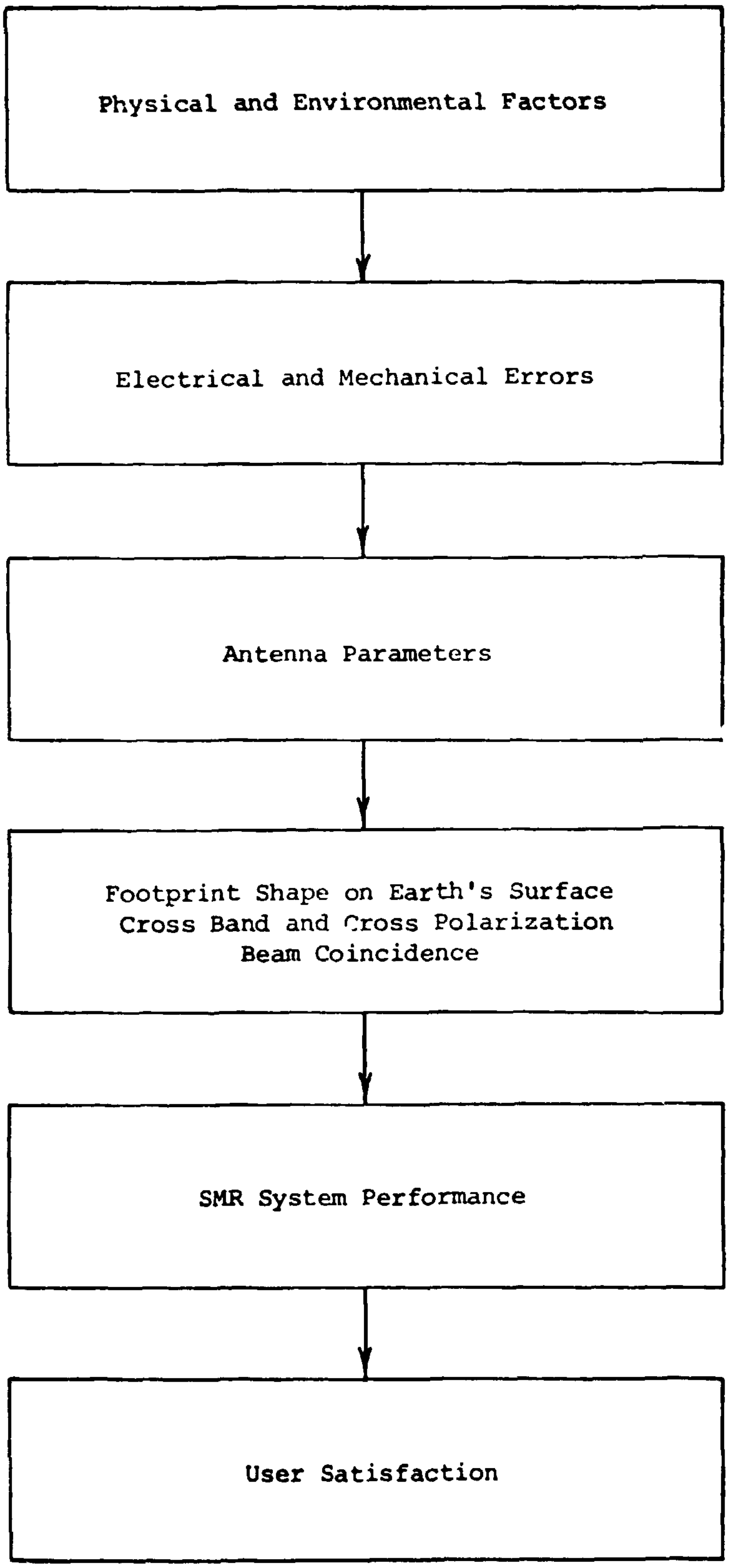


Figure 1. Cause-effect relationships for the SMR Antenna.

factors will create electrical and mechanical errors. These errors in turn affect the performance of the SMR antenna which then changes the characteristics of the ground footprint. Finally, the footprint shape is a major determinant of quality of the overall system.

3.0 THE DEVELOPMENT OF A PRELIMINARY SMRA MATHEMATICAL MODEL

To obtain predictions of the behavior of the Shuttle Multispectral Radar Antenna under a wide variety of electrical, mechanical, and environmental conditions, a number of algorithms simulating the SMRA were developed. Emphasis was given to developing mathematical models that would predict the effect of systematic departures from mechanical and electrical flatness on beam pointing accuracy, beam efficiency, etc. Later phases of this work will add to the initial model additional algorithm modules that will take into account the results from thermal, mechanical and electrical tests.

The theory and practical considerations behind the PSL approach to large-scale array modeling was presented in Section 2.2 of the Phase I Interim Report. This method has been expanded upon and implemented in the computer program discussed in Section 4 of this report. The results from a few selected examples are given in Section 5.

3.1 Antenna Electrical and Mechanical Characteristics

A flat uniformly excited rectangular electrically large array of equally-spaced elements lying in the (x, y)-plane will produce a far-field radiation pattern of the form:

$$E = E_0 \frac{\sin M\psi_x/2}{M \sin \psi_x/2} \cdot \frac{\sin N\psi_y/2}{N \sin \psi_y/2} \qquad (3\text{-}1)$$

where: E_0 = constant

M = number of array elements in azimuth (x)

N = number of array elements in elevation (y)

$\psi_x = \beta d_x u + \alpha_x$

$\psi_y = \beta d_y v + \alpha_y$

$\beta = 2\pi/\lambda$ = wave number

d_x = x-axis interelement spacing

d_y = y-axis interelement spacing

u = cosine of pointing direction with respect to the x-axis

v = cosine of pointing direction with respect to the y-axis

α_x = x-axis interelement phase shift

α_y = y-axis interelement phase shift

However, the presence of random and systematic electrical and mechanical errors in the array structure requires a much more general model. Three mechanical and electrical models were considered in the Phase I Interim Report. In essence, each model incorporated an approximation of the electrical and mechanical surfaces. The three varying degrees of approximation are described below.

1. The array factor is the sum of the patterns of each individual element, each of which has its own location, orientation, and excitation. (No approximation)
2. The electrical/mechanical deformation of the array is approximated by a function or sum of functions whose closed-form array factor(s) can be found.
3. The electrical/mechanical deformation of the array is approximated by piecewise bilinear error-minimizing rectangular sections.

The first two of these were either too time-consuming or unable to model adequately severe systematic errors. The third alternative was considered to be the best compromise, especially if the number of subarray sections could be varied to reflect the severity of the distortion.

The geometry of the approximated antenna surface is explained in Figure 2, while Figure 3 shows an individual subarray unit in local coordinates.

3.1.1 The Antenna Radiation Pattern Algorithm

Consider an array antenna composed of M x N subarray sections. The antenna is nominally located in the z=0 plane and it is centered about the z-axis as illustrated in Figure 4. The far-field radiation pattern of such an antenna may be written as the weighted sum of the contributions from each subarray.

$$\overline{E}(r,\theta,\phi) = \frac{j\beta\eta}{4\pi} \frac{e^{-j\beta r}}{r} \sum_{m=1}^{M} \sum_{n=1}^{N} a_{mn} e^{j\phi_{mn}} \overline{g}_{mn}(u,v) \exp\left[j\psi\right]$$

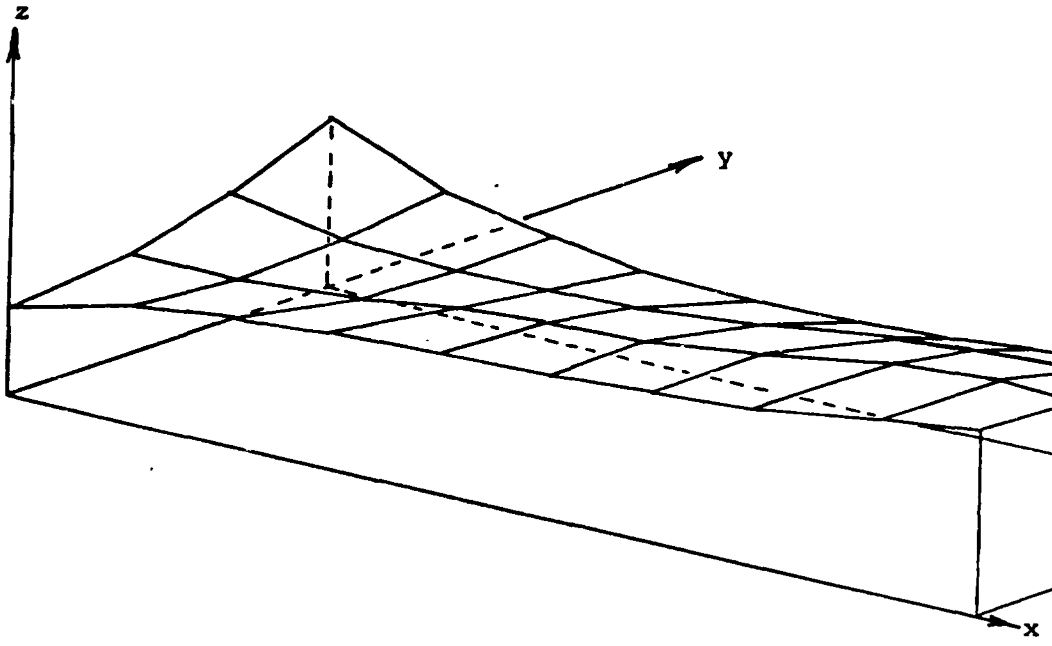


Figure 2. Geometry of the approximated antenna surface.

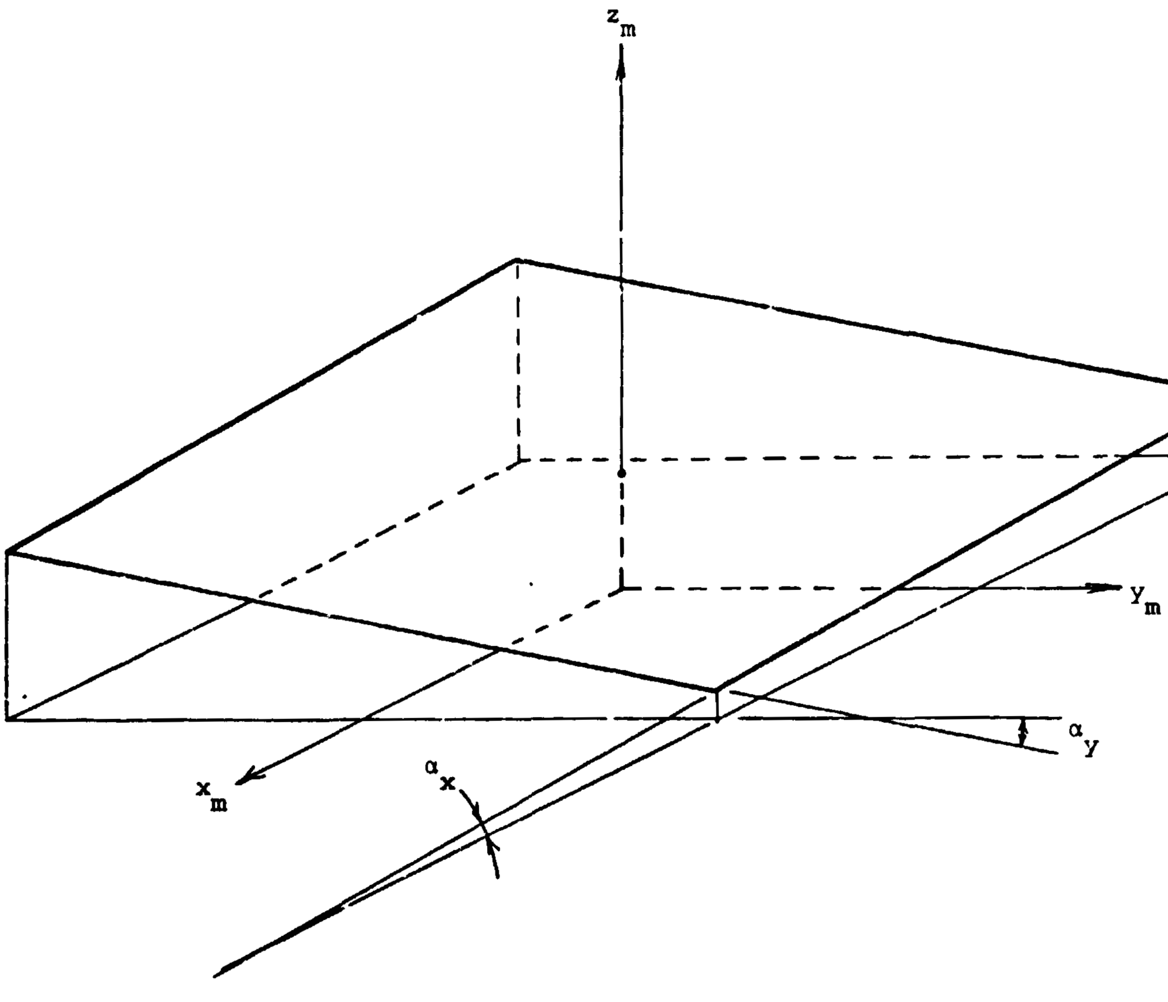


Figure 3. Single subarray section in local coordinates.

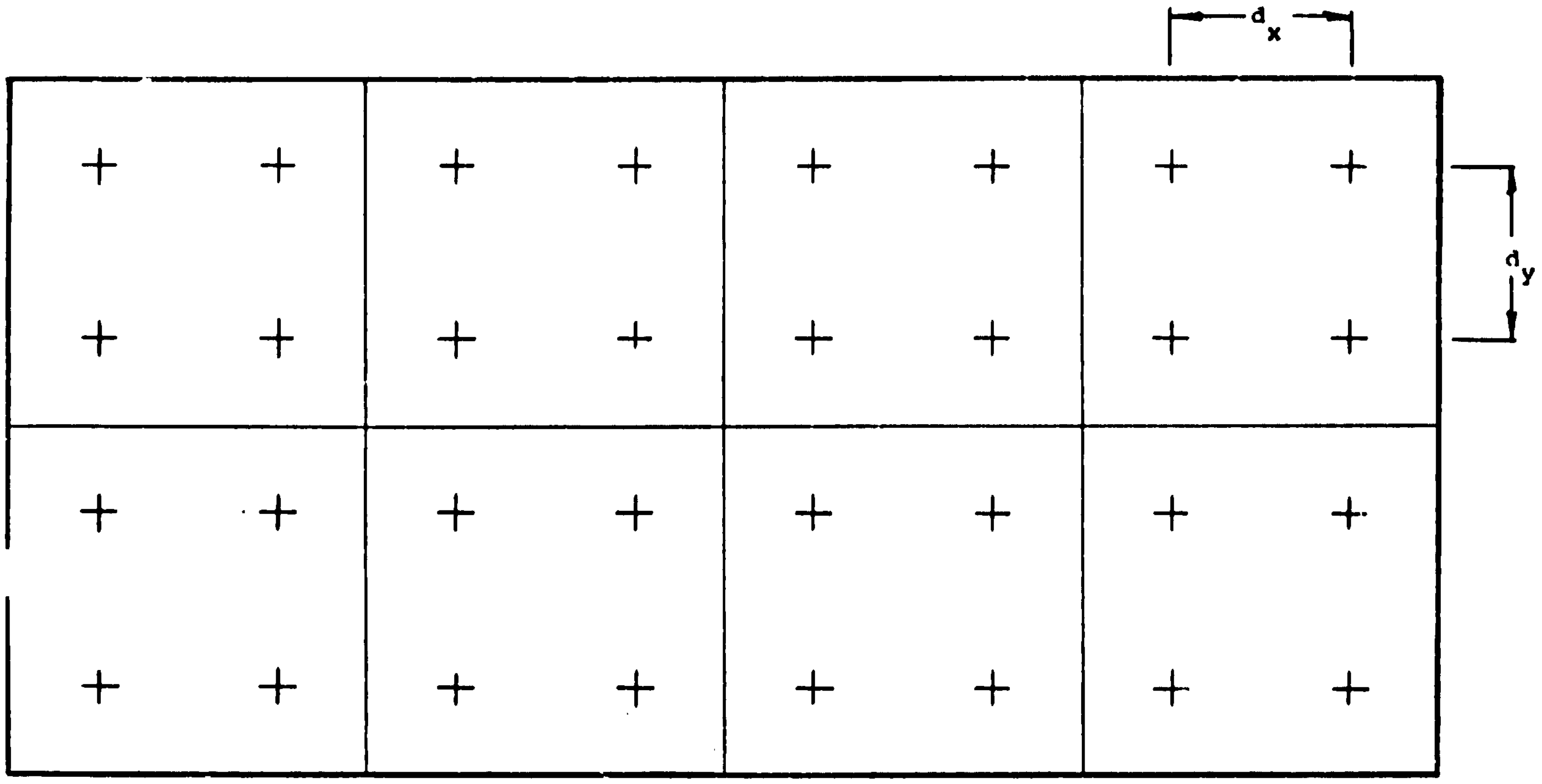


Figure 4. An array antenna of 8 x 4 elements divided into 4 x 2 subarrays. The element spacings d_x and d_y are indicated.

where: $a_{mn}e^{j\phi_{mn}}$ = the complex excitation of the mnth subarray.

(u, v, w) = $(\sin\theta\cos\phi, \sin\theta\sin\phi, \cos\theta)$, the cosines of the beam pointing direction with respect to the x, y, and z axes.

$\beta=2\pi/\lambda$ = wave number of the source.

$\eta=\sqrt{\frac{\mu}{\epsilon}}$ = intrinsic impedance of the medium.

$\bar{g}_{mn}(u, v)$ = vector array factor of the mnth subarray.

ψ = $(x_{mn}u + y_{mn}v + z_{mn}w)$

(x_{mn}, y_{mn}, z_{mn}) = location of the center of the mnth subarray.

For rectangular sections with dipole elements, the vector "subarray factor" has the form:

$$\bar{g}_{mn}(u,v) = \frac{\sin N_x\psi_x/2}{N_x \sin\psi_x/2} \; \frac{\sin N_y\psi_y/2}{N_y \sin\psi_y/2} \begin{cases} \dfrac{\cos\frac{\pi}{2}u}{\sqrt{1-u^2}} & \hat{x} \text{ Horizontal Polarization} \\[2ex] \dfrac{\cos\frac{\pi}{2}v}{\sqrt{1-v^2}} & \hat{y} \text{ Vertical Polarization} \end{cases} \qquad (3\text{-}3)$$

where: N_xN_y = number of elements in the subarray.

ψ_x = $\beta d_x\cos(\cos^{-1}u - \alpha_x) + \phi_x$

ψ_y = $\beta d_y\cos(\cos^{-1}v - \alpha_y) + \phi_y$

d_x, d_y = interelement spacing.

ϕ_x, ϕ_y = interelement phase shift.

α_x, α_y = the x-axis and y-axis angular tilt of the section.

The (m,n) subscripts have been dropped for clarity.

Notice that for a given linear polarization, $|\bar{g}_{mn}|$ may be written as:

$$|\bar{g}_{mn}(u,v)| = f_1(u)\, f_2(v)$$

This separability allows one to precalculate $f_1(u)$ and $f_2(v)$ so that $\bar{g}_{mn}$ may be calculated using a table look-up algorithm, greatly reducing the numbers of operations and function calculations. Since all subarray sections are identical except for orientation, the same f_1 and f_2 tables may be used for each. The total far-field radiation pattern is then obtained by vectorally summing the contributions from each subarray.

3.2 Antenna Position and Orientation

The spacecraft position and orientation are specified by its altitude and three angles. These angles (YAW, TILT, are TWIST) are defined by Figure 5. While it is true that only two angles are needed to specify any possible (static) orientation of the antenna, three angles are used to enable the user to picture clearly the antenna pointing direction. The antenna subsatellite point is assumed here to be 0° Longitude, 0° Latitude as shown in Figure 6.

The matrices for the three rotations are:

$$\text{YAW:}\quad \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} \cos(\text{YAW}) & \sin(\text{YAW}) & 0 \\ -\sin(\text{YAW}) & \cos(\text{YAW}) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} \tag{3-4}$$

$$\text{TILT:}\quad \begin{bmatrix} x'' \\ y'' \\ z'' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos(\text{TILT}) & -\sin(\text{TILT}) \\ 0 & \sin(\text{TILT}) & \cos(\text{TILT}) \end{bmatrix} \begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} \tag{3-5}$$

$$\text{TWIST:}\quad \begin{bmatrix} x''' \\ y''' \\ z''' \end{bmatrix} = \begin{bmatrix} \cos(\text{TWIST}) & \sin(\text{TWIST}) & 0 \\ -\sin(\text{TWIST}) & \cos(\text{TWIST}) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x'' \\ y'' \\ z'' \end{bmatrix} \tag{3-6}$$

In practice, the YAW, TILT, and TWIST matrices would be multiplied together and stored as a single 3x3 matrix.

3.3 Coordinate Transformation To Produce The "Footprint" On The Earth's Surface

There are two transformations involved:

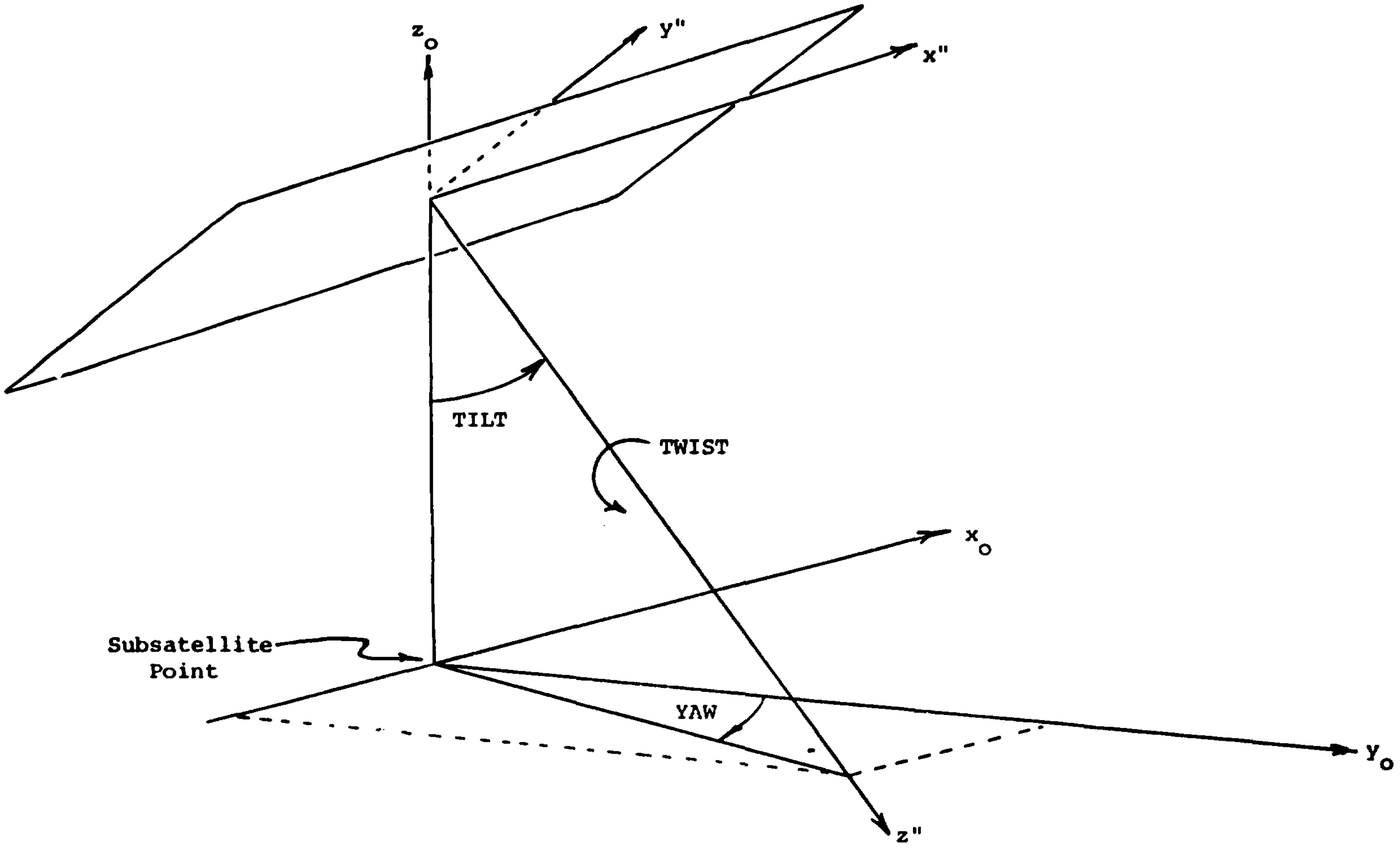


Figure 5. Orientation angles and geometry for the SMR antenna.

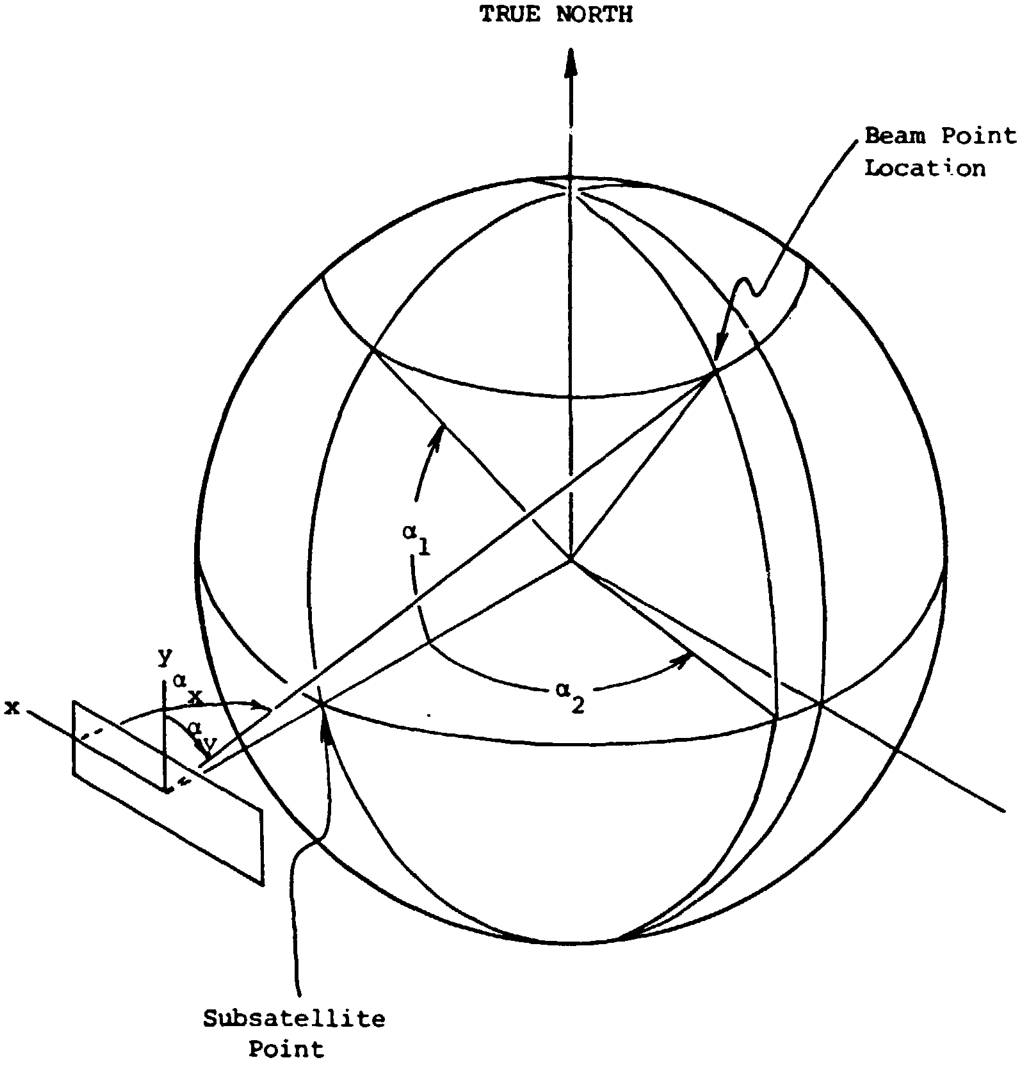


Figure 6. SMRA antenna above a spherical earth. The subsatellite point is at 0° latitude, 0° longitude. The beam is pointed at [α_1 (latitude), α_2 (longitude)].

(1) What point, i.e., with latitude (α_1) and longitude (α_2), on the earth's surface corresponds to a given beam direction (u,v)?

(2) What antenna beam direction (u,v,) corresponds to a specified latitude and longitude location?

The first transformation is used to predict the location of the beam center. The second is necessary to determine the "footprint" contours of the antenna.

3.3.1 Latitude and Longitude From Beam Direction

For an unrotated antenna pointing to a nadir of (0°, 0°), the following formulas may be derived:

$$\alpha_r = \sin^{-1}\left[\frac{R_e+\mathrm{Alt}}{R_e}\right]\sin\theta \; - \theta \quad (\alpha_r>0)$$

$$\phi_r = \phi - \frac{\pi}{2} \qquad (3\text{-}7)$$

$$\text{Range} = R_e \cdot \alpha_r$$

where: R_e = radius of the (spherical) earth.

Alt = antenna altitude in same units as R_e.

(θ,ϕ) = pointing direction of unrotated antenna.

α_r = range angle.

ϕ_r = heading angle.

Then:

$$\alpha_2 = \tan^{-1}(\sin\phi_r/\tan\alpha_r)$$
$$\alpha_1 = \cos^{-1}(\cos\alpha_r/\cos\alpha_2) \qquad (3\text{-}7a)$$

If $\alpha_1>90^\circ$, $\alpha_1 = \alpha_1 - 180^\circ$.

Example, let R_e = 6400 km, Alt = 200 km, and $(\theta,\phi) = (60^\circ, 120^\circ)$. Then:

$\alpha_r = 3.263975^\circ$ $\qquad$ $\phi_r = 30^\circ$

$\alpha_2 = 1.6333^\circ$ $\qquad$ $\alpha_1 = 2.8263^\circ$

Range = 364.56 km.

3.3.2 Beam Direction From Latitude and Longitude

Given α_1 and α_2 we may invert eqns. (3-7a) to find:

$$\begin{aligned} \alpha_r &= \cos^{-1}(\cos\alpha_1 \cdot \cos\alpha_2) \\ \phi_r &= \sin^{-1}(\cos\alpha_1 \cdot \cos\alpha_r \cdot \sin\alpha_2) \end{aligned} \qquad (3\text{-}8)$$

Then:

$$\begin{aligned} \phi &= \phi_r + 90^{c} \\ z &= (R_e + \text{Alt}) - R_e \cos\alpha_1 \cos\alpha_2 \\ x &= -R_e \cos\alpha_1 \sin\alpha_2 \\ y &= R_e \sin\alpha_1 \\ r &= \sqrt{x^2+y^2+z^2} \\ \theta &= \cos^{-1}(z/r) \end{aligned} \qquad (3\text{-}9)$$

Example, let $R_e = 6400$, Alt = 200 km, $\alpha_1 = 2.82631^{\circ}$, and $\alpha_2 = 1.6333^{\circ}$. Then:

$\alpha_r = 3.263975^{\circ}$ $\quad x' = -182.19476$ km.

$\phi_r = 29.9997 \approx 30^{\circ}$ $\quad y' = 315.5738$ km.

$\phi = 120^{\circ}$ $\quad r' = 420.764$ km.

$z' = 210.382$ km. $\quad \theta = 60^{\circ}$

3.4 Data Handling Techniques and Data Reduction

With the vast amounts of data generated by this algorithm, it was clear that in order to obtain usable results, the data must be reduced to pictoral form. Five modes of presentation were developed. These are:

1. Printer profile plots of "principal planes."
2. Printer contour plot of the entire region of interest.
3. Plotter profile plots of "principle planes."
4. Plotter contour plots of the entire region.
5. Plotter three-dimensional plots of the entire region.

The printer plots provide a quick and inexpensive preview of the results of the simulation. If satisfactory results are obtained, then the Calcomp plotter is used to draw more detailed plots.

When the Tektronix 4051 interactive graphics terminal is made operational, many of the data presentation problems will be greatly simplified. It will be then possible to quickly draw a complete contour "footprint" from any data set. If a permanent copy is desired, a hard copy or photograph may be taken.

3.5 Areas For Further Development

The mathematical model discussed here is preliminary in nature and its algorithms will be refined and expanded during Phase II.

The most significant addition to the model will be the incorporation of data gathered from near-field and far-field electrical measurements, thermal measurements, and mechanical tests of the subarray panels. These data, to be taken during Phase IV, will be used by the model to predict the performance of the full-size SMR antenna. It is planned to add these modules to the algorithm during Phase III.

The other important addition to the model will be the inclusion of a module to accept arbitrary array elements and/or total antenna type. With this change, other antenna types, such as reflector antennas, other aperature antennas, and traveling wave antennas, can be simulated as well as arrays of antennas with arbitrary elements.

3.6 Summary and Block Diagram Of The Simulation Algorithm

The operation of the SMRA mathematical model can be summarized by the block diagram shown in Figure 7. Only those modules presently implemented are shown.

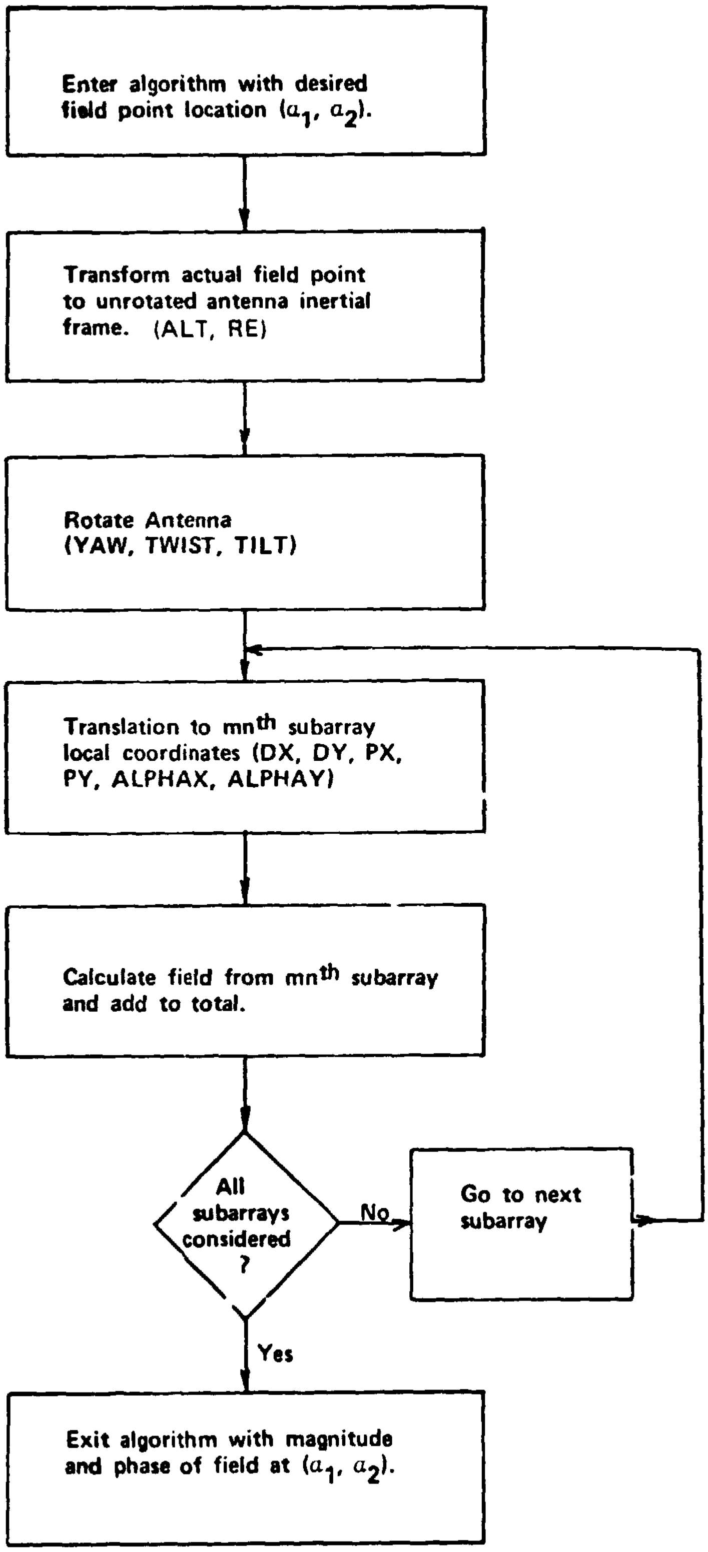


Figure 7. Operation of the SMRA mathematical model.

4.0 THE SMRA SIMULATION PROGRAM

A computer program was written to implement the simulation algorithms of Section 3. It produces line printer plots and Calcomp plotter plots of the anteann footprint on the earth's surface. The organization of the program is shown in Figure 8, and a description of each program segment is given in Section 4.1.

4.1 Program Description

MAINPGM - Performs mostly housekeeping chores and calls other routines according to user input commands. It calculates the "YAW-TILT-TWIST" array, predicted beam center location, plot normalization factor (pattern value at predicted beam center location), increments beam pointing angle to cover entire "footprint" region and initiates profiles along lines of constant latitude and longitude intersecting the predicted beam center.

ANTENA - Inputs and calculates appropriate antenna parameters: number of elements, spacing, phase shift, number of subarrays, polarization, and element type. After calculations have been performed, a summary is printed.

MECH - Calculates mechanical deformation data based on the inputs from STRESS, THERML, and MISC. For each subarray, MECH calculates the average displacement ZAVG, the tilt angles, ALPHAX and ALPHAY, and the error coefficient of the bilinear approximations. A summary is printed after execution.

STRESS - Determines the warpage of the array that is due to mechanical considerations.

THERML - Will determine the warpage of the array due to thermal gradients across and through the array structure. (Not Yet Implemented)

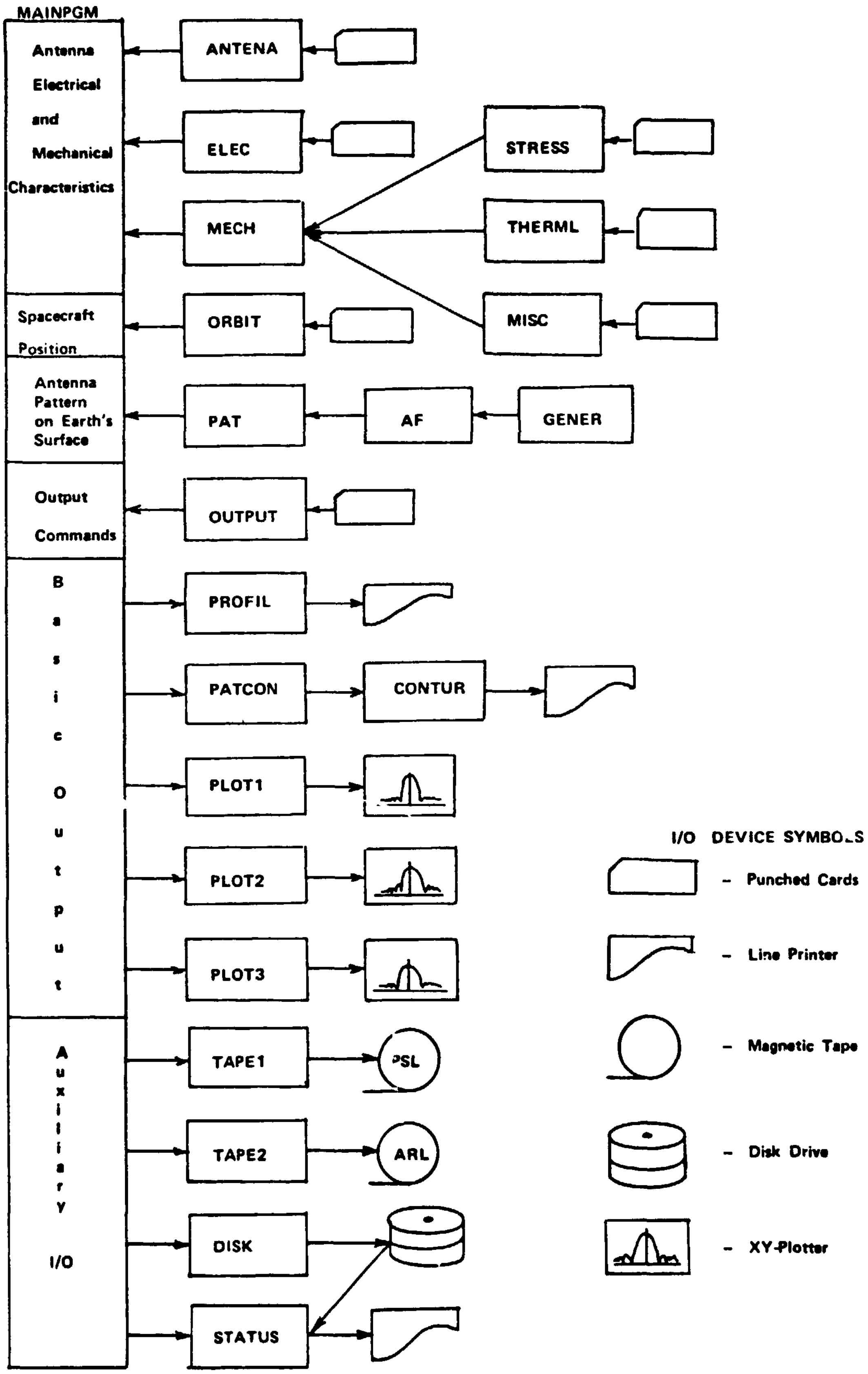


Figure 8. Organization of the SMRA Simulation Program.

MISC - Inputs any other deformation data not covered by STRESS and THERML.

ELEC - Inputs the amplitude, phase, and linear phase gradients of each subarray. This information is passed to PAT via common block ELCTRC, and a summary is printed.

ORBIT - Inputs orbital parameters and antenna YAW, TILT, and TWIST, then prints a summary.

PAT - Is the basic pattern subprogram. Given latitude-longitude coordinates on the earth's surface, it performs all translations and rotations to determine the beam pointing angle (u,v). It then calls AF to find the subarray factor and finally computes the sum of all subarrays.

AF - This function calculates the array factors of a subpanel by "table look-up" with linear interpolation if $|u| <$ UMAX and $|v| <$ VMAX. Otherwise, the AF is computed in the usual way.

GENER - This routine generates the table used by AF. Table length is 1001 words: UMAX and VMAX are chosen to include the main beam plus the first three side lobes.

OUTPUT - Translates user commands for printer and pattern output into logical switches for the program.

PROFIL - Is the printer profile plot routine. It will print a one-dimensional plot down the page for up to 501 data points. The exact values of both the abscissa and ordinate are printed with each data point, the ordinate also being printed in dB.

PATCON - Is chiefly a "bookkeeping" subroutine for CONTUR. It calls subroutine CONTUR three times to generate a complete 151 x 151 two-dimensional contour map.

CONTUR - Prints a 51 x 151 contour plot of the footprint. To obtain a complete 151 x 151 plot, this routine is called three times by subroutine PATCON. Then the three separate plots are pasted together to make the composite.

PLOT1 - Is the Calcomp one-dimensional plot routine. It is called twice by the main program, and it is used to generate the profile plots of the principal planes through the main beam.

PLOT2 - Is the Calcomp contour map routine. From the data used to generate the printer contour map, it draws a continuous contour plot of the antenna ground footprint over the rectangular region specified by the user.

PLOT3 - Is the Calcomp three-dimensional plot routine. It plots the magnitude (in dB) of the footprint pattern over rectangular region specified by the user.

TAPE1 - Will be used to store the pattern matrices and other important variables so that additional plots may be generated by other programs without recomputing the data. (Not Yet Implemented)

TAPE2 - Is the ARL data tape routine. It stores the antenna pattern as a function of u and v and is used whenever ARL requires a new antenna pattern for their processor modeling program. (At present, TAPE2 is a separate computer program.)

DISK - Will be used to store pattern data on a disk drive at PSL. (Not Yet Implemented)

STATUS - Will be used to determine what data has been stored by TAPE1 and DISK, to selectively erase any simulation run, and to reinitialize the entire storage area. (Not Yet Implemented)

4.2 Input/Output and Flexibility To The User

The program input data has been structured so that user knowledge of computer fundamentals is not required. Consequently, the program can be used by anyone desiring information concerning the footprint of a particular antenna configuration.

The input has been divided into six modules. These are:

1. Simulation Information
2. Antenna Position and Orientation
3. Output Commands and Parameters
4. Antenna Configuration
5. Antenna Mechanical Parameters
6. Antenna Electrical Parameters

By including input parameters in these six categories, it is possible for the user to simulate a wide range of electrical, mechanical, and physical scenarios. Furthermore, a change in the simulation does not require that the complete input deck be repunched. When related scenarios are being studied, only one of the six modules need be changed.

Examples of different simulations are deferred to Section 5.

4.2.1 Simulation Information

The simulation information consists of three entries: 1) the simulation number, 2) the date of the simulation, and 3) a short narrative describing the simulation. The simulation number and date provide bookkeeping reference information. The narrative is printed at the beginning of the computer output to allow quick identification of the program output and future dates.

4.2.2 Antenna Position and Orientation

The parameters used as input for this category are antenna altitude, yaw, tilt, twist, and frequency. Altitude is expressed in kilometers, the angles are expressed in degrees, and frequency is expressed in GHz. These parameters are more fully described in Section 3.2.

4.2.3 Output Commands and Parameters

Five logical switches are used to control the five output categories of Section 3.4. If a particular output is desired, the associated command switch is set to logical "1". In addition to the output commands, it is necessary to specify parameters for those output devices which have been turned on by the output commands.

The parameters needed for a particular simulation are governed by which logical switches have been previously engaged. If any output command is entered, then the latitude and longitude limits of the footprint must be entered. If a plotter contour map is desired tne contour level parameters are required. For a printer contour, the highest contour, lowest contour, and contour level interval must be entered. For any two- or three-dimensional plot, the plot resolution is necessary.

Some outputs do not require a command. The narrative described above and the summaries described in Section 3 have no command word; this information is always printed.

4.2.4 Antenna Configuration

This category contains all the parameters needed by subroutine ANTENA. These include the number of subarray sections, the number of elements, the interelement spacings in centimeters, the interelement phase shifts in degrees, the element type. and the element polarization.

4.2.5 Antenna Mechanical Information

Antenna mechanical information includes all the parameters needed by subroutines STRESS, THERML, and MISC. In this preliminary simulation model, the displacement of the antenna from nominal flatness (expressed in centimeters) is entered through subroutine MISC.

4.2.6 Antenna Electrical Parameters

All excitation information is entered through subroutine ELEC. The necessary parameters provide information concerning the excitation magnitude, phase, and any linear phase taper for each subarray section.

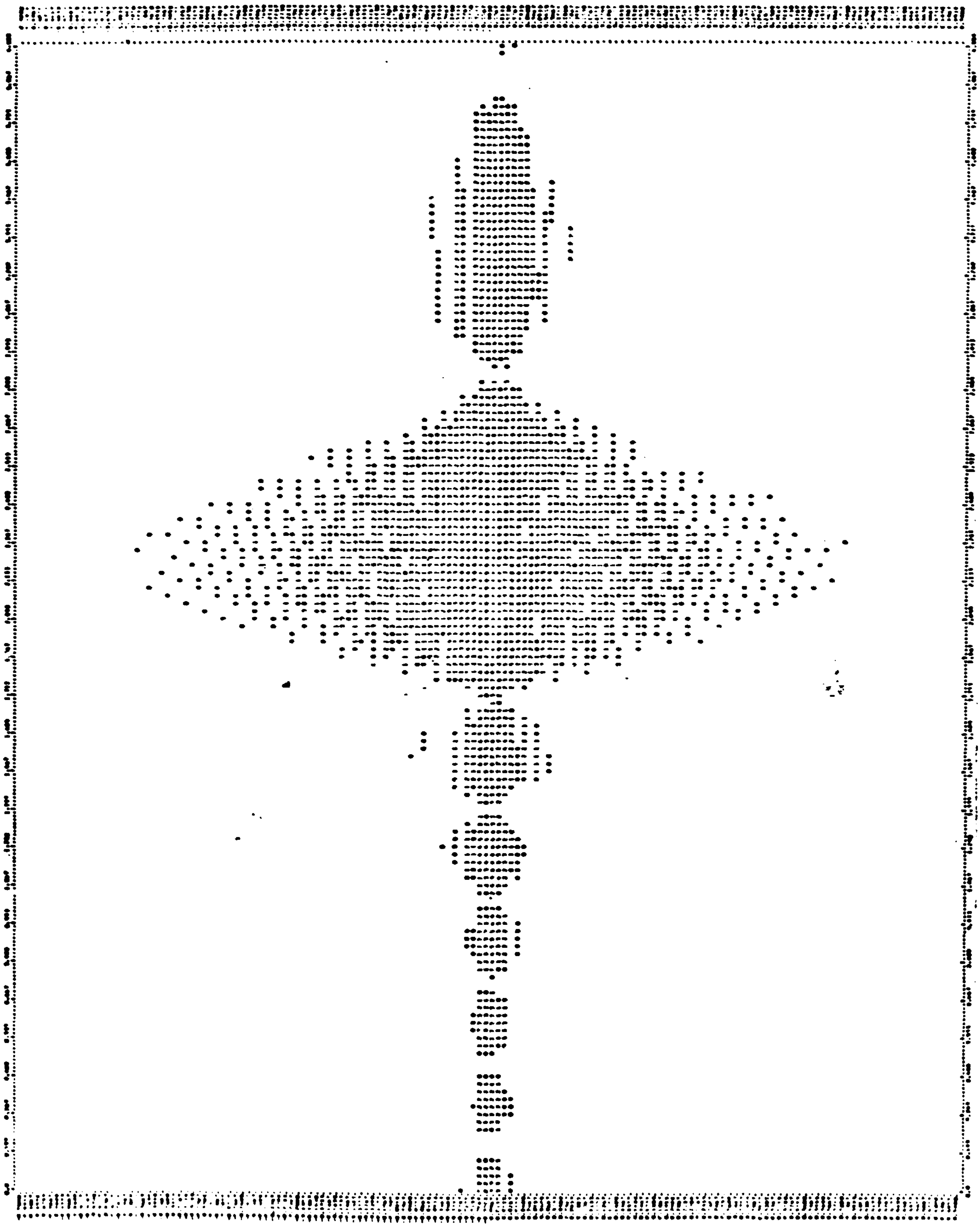
5.0 EXAMPLES OF COMPUTER SIMULATION RUNS

The following pages illustrate the actual line printer output from the Shuttle Multispectral Radar Antenna Simulation Program. The pages run in sequence; no attempt has been made to join the profile plot or contour map pages together. However, a photo-reduction of a typical composite contour map is shown in Figure 9.

The comments printed with the pattern output provide all the necessary information to visualize each scenario being simulated. All antennas have the following characteristics in common:

1. Frequency = 9.0 GHz
2. Tilt Angle = 50°
3. Altitude = 200 km
4. Polarization: Horizontal
5. Configuration: Both modules excited for minimum beam width
6. Number of elements: 504 x 12
7. Element spacing: 2.2966 x 2.3550 cm
8. Phase Shift: 0°

Pattern 100 is the simulation of the baseline design, with no electrical or mechanical errors. Pattern 101 illustrates pattern errors due to misalignment of the three panels. Pattern 102 shows the effect of a spherical bow in the antenna which might be induced by thermal gradients through the antenna surface. A systematic phase error is simulated by Pattern 103, and Pattern 104 provides information on errors caused by Shuttle attitude errors.



```
          EXAMPLE 1:
             BASELINE DESIGN FOR X-BAND SPACE SHUTTLE IMAGING RADAR (BOTH PANELS).



          SYSTEM INFORMATION:
               FREQUENCY =  9.000 GHZ.
               YAW =     0.0   DEGREES
               TILT =   50.000 DEGREES
               TWIST =     0.0   DEGREES
               ALTITUDE =  200.000 KM.


          ANTENNA PARAMETERS FOR SIMULATION NUMBER 100
               ELEMENT TYPE: HORIZONTAL DIPOLE
               NUMBER OF ELEMENTS (X,Y) = (504 ,  12)
               INTERELEMENT SPACING (CM.):  2.2966 ,  2.3550
               INTERELEMENT PHASE SHIFT (DEG.):  0.0     ,  0.0


          DEFORMATION DATA FOR SIMULATION 100:

  0.0       0.0


  0.0       0.0







          ELECTRICAL DATA FOR SIMULATION 100:

       ( 1, 1)   (
PHSX:      0.0
PHSY:      0.0
AMAG:      1.00
APHS:      0.0









          PRINT/PLOT INFORMATION:
               REQUESTED OUTPUT:
                    PRINTER PROFILE
                    PRINTER CONTOUR
               PLOT RESOLUTION: 151 X 151 POINTS


               STARTX =    -0.500
               STOPX =      0.500
               DELTAX =      0.007

               STARTY =      0.0
               STOPY =      4.000
               DELTAY =      0.027

          SUBARRAY DATA SUMMARY FOR PATTERN100:
AREA         XCENT          YCENT          ZAVG          ALPHAX          ALPHAY          AMAG          APHS          PHSX          PHSY
  1           0.0            0.0            0.0            0.0             0.0         1.0000          0.0           0.0           0.0


          PREDICTED BEAM CENTER:
               LATITUDE =     2.1945
               LONGITUDE =      0.0
               RANGE = [illegible]
               HEADING =      0.0
```

```
PLOT NORMALIZATION FACTOR =  -35.011 DB.
```

```
                 PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 100

       0.0       0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
        I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
-0.5000.
-0.4933.
-0.4867.
-0.4800.
-0.4733.
-0.4667.
-0.4600.
-0.4533.
-0.4467.
-0.4400.
-0.4333.
-0.4267.
-0.4200.
-0.4133.
-0.4067.
-0.4000.
-0.3933.
-0.3867.
-0.3800.
-0.3733.
-0.3667.
-0.3600.
-0.3533.
-0.3467.
-0.3400.
-0.3333.
-0.3267.
-0.3200.
-0.3133.
-0.3067.
-0.3000.
-0.2933.
-0.2867.
-0.2800.
-0.2733.
-0.2667.
-0.2600.
-0.2533.
-0.2467.
-0.2400.
-0.2333.
-0.2267.
-0.2200.
-0.2133.
-0.2067.
-0.2000.
-0.1933.
-0.1867.
-0.1800.
-0.1733.
-0.1667.
-0.1600.
-0.1533.
-0.1467.
-0.1400.
-0.1333.
-0.1267.
-0.1200.
-0.1133.
-0.1067.
-0.1000.
-0.0933.
-0.0867.
-0.0800.
-0.0733.
-0.0667.
-0.0600.
-0.0533.
-0.0467.
-0.0400.
-0.0333.
-0.0267.
-0.0200.
-0.0133.
-0.0067.
-0.0000.3 3 3 2 1    0 1 2 3 3 3 3 2 1     0 2 2 2 3 3 3 2 0     2 3 3 3 3 3 3 2 0   0 2 3 4 4 4 4 4 3 2 1
 0.0067.
 0.0133.
 0.0200.
 0.0267.
 0.0333.
 0.0400.
 0.0467.
 0.0533.
 0.0600.
 0.0667.
 0.0733.
 0.0800.
 0.0867.
```

```
0.0933.
0.1000.
0.1067.
0.1133.
0.1200.
0.1267.
0.1333.
0.1400.
0.1467.
0.1533.
0.1600.
0.1667.
0.1733.
0.1800.
0.1867.
0.1933.
0.2000.
0.2067.
0.2133.
0.2200.
0.2267.
0.2333.
0.2400.
0.2467.
0.2533.
0.2600.
0.2667.
0.2733.
0.2800.
0.2867.
0.2933.
0.3000.
0.3067.
0.3133.
0.3200.
0.3267.
0.3333.
0.3400.
0.3467.
0.3533.
0.3600.
0.3667.
0.3733.
0.3800.
0.3867.
0.3933.
0.4000.
0.4067.
0.4133.
0.4200.
0.4267.
0.4333.
0.4400.
0.4467.
0.4533.
0.4600.
0.4667.
0.4733.
0.4800.
0.4867.
0.4933.
0.5000.
         I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
        0.0      0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
```

```
PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 100

1.333     1.467     1.600     1.733     1.867     2.000     2.133     2.267     2.400     2.533     2.667
I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I

                                                      0 0 0 0 0
                                                        0 0 0 0 0 0 0 0
                                                            0 0 0 0 1 1 1 0 0 0 0
                                                                    0 0 0 0 0 0 0 0 0 0 0
                                          0 0 0 0 0 0 0                             0 0 0
                                        0 0 1 1 1 1 2 2 2 2 2 1 1 1 1 0 0
                                      0 0 1 1 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 2 2 2 2 1 1 0 0 0
                                      0 1 1 2 2 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 2 2 2 1 1
                                      0 1 1 2 3 3 3 4 4 4 4 4 5 5 5 5 5 5 5 5 5 5 4 4 4 4 4 4 3 3 3 2
  0 2 3 4 5 5 5 5 5 5 4 3 2   0 3 5 6 6 7 7 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 8 8 8 8 8 7 7 7 6 6 6 5
                                      0 1 1 2 3 3 3 4 4 4 4 4 5 5 5 5 5 5 5 5 5 5 4 4 4 4 4 3 3 3 2 2
                                      0 1 1 2 2 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 2 2 2 1 1
                                      0 0 1 1 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 2 2 2 2 1 1 0 0 0
                                        0 0 1 1 1 1 2 2 2 2 2 1 1 1 1 0 0
                                          0 0 0 0 0 0 0                             0 0 0
                                                                    0 0 0 0 0 0 0 0 0 0 0
                                                            0 0 0 0 1 1 1 0 0 0 0
                                                        0 0 0 0 0 0 0 0
                                                      0 0 0 0 0
```

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|.........|.........|.........|.........|.........|.........|.........|.........|.........|.........|
1.333     1.467     1.600     1.733     1.867     2.000     2.123     2.267     2.400     2.533     2.667


                                        CONTOUR LEVEL KEY

0: -0.2850000E 02 TO -0.2549998E 02   4: -0.1650000E 02 TO -0.1349999E 02   8: -0.4500000E 01 TO -0.1499990E 01
1: -0.2550000E 02 TO -0.2249998E 02   5: -0.1350000E 02 TO -0.1049999E 02   9: -0.1500000E 01 TO  0.1500010E 01
2: -0.2250000E 02 TO -0.1949998E 02   6: -0.1050000E 02 TO -0.7499990E 01    : -0.1000000E 51 TO -0.2850000E 02
3: -0.1950000E 02 TO -0.1649998E 02   7: -0.7500000E 01 TO -0.4499990E 01   +:  0.1500010E 01 TO  0.1000000E 51
```

```
                        PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 100

2.667     2.800     2.933     3.067     3.200     3.333     3.467     3.600     3.733     3.867     4.000
 |.........|.........|.........|.........|.........|.........|.........|.........|.........|.........|
                                                                                                       . -0.5000
                                                                                                       . -0.4933
                                                                                                       . -0.4867
                                                                                                       . -0.4800
                                                                                                       . -0.4733
                                                                                                       . -0.4667
                                                                                                       . -0.4600
                                                                                                       . -0.4533
                                                                                                       . -0.4467
                                                                                                       . -0.4400
                                                                                                       . -0.4333
                                                                                                       . -0.4267
                                                                                                       . -0.4200
                                                                                                       . -0.4133
                                                                                                       . -0.4067
                                                                                                       . -0.4000
                                                                                                       . -0.3933
                                                                                                       . -0.3867
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                                                                                                       . -0.3400
                                                                                                       . -0.3333
                                                                                                       . -0.3267
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                                                                                                       . -0.3133
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                                                                                                       . -0.2933
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                                                                                                       . -0.2267
                                                                                                       . -0.2200
                                                                                                       . -0.2133
                                                                                                       . -0.2067
                                                                                                       . -0.2000
                                                                                                       . -0.1933
                                                                                                       . -0.1867
                                                                                                       . -0.1800
                                                                                                       . -0.1733
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                                                                                                       . -0.1600
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                                                                                                       . -0.1267
                                                                                                       . -0.1200
                                                                                                       . -0.1133
                                                                                                       . -0.1067
                                                                                                       . -0.1000
                                                                                                       . -0.0933
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                                                                                                       . -0.0533
                                                                                                       . -0.0467
                                                                                                       . -0.0400
                                                                                                       . -0.0333
                                                                                                       . -0.0267
                                                                                                       . -0.0200
1 0 0                                                                                                  . -0.0133
2 2 1 0 0             0 0 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 0 0 0 0                            . -0.0067
9 5 4 3 2 1       0 1 2 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 3 3 2 2 2 2 1 1 1 0 0                    . -0.0000
2 2 1 0 0             0 0 0 1 1 1 1 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 0 0 0 0                            .  0.0067
1 0 0                                                                                                  .  0.0133
                                                                                                       .  0.0200
                                                                                                       .  0.0267
                                                                                                       .  0.0333
                                                                                                       .  0.0400
                                                                                                       .  0.0467
                                                                                                       .  0.0533
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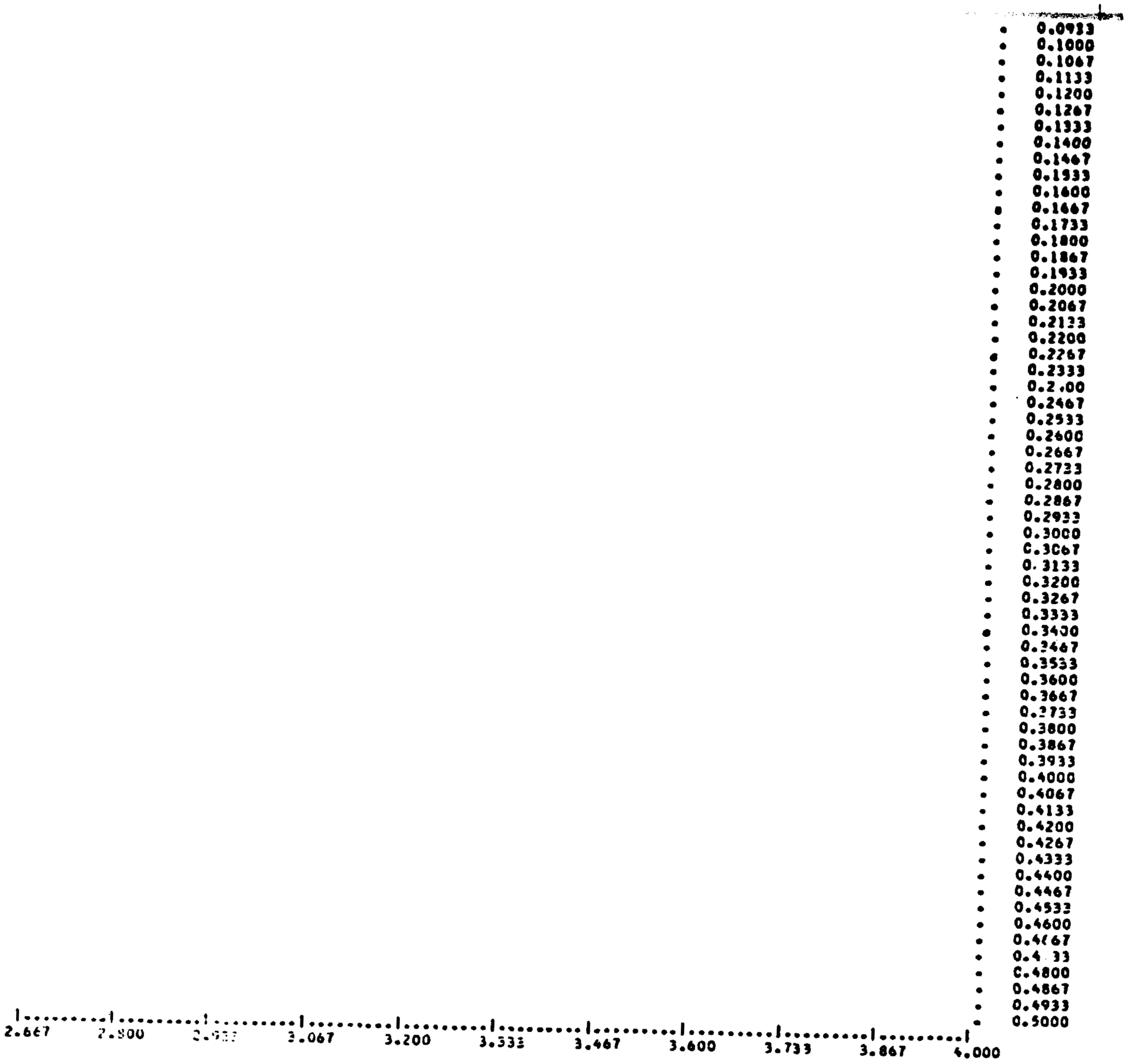
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0.1667
0.1733
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0.3267
0.3333
0.3400
0.3467
0.3533
0.3600
0.3667
0.3733
0.3800
0.3867
0.3933
0.4000
0.4067
0.4133
0.4200
0.4267
0.4333
0.4400
0.4467
0.4533
0.4600
0.4667
0.4733
0.4800
0.4867
0.4933
0.5000
2.667
2.800
2.933
3.067
3.200
3.333
3.467
3.600
3.733
3.867
4.000

```
                          B-AXIS PROFILE PLOT ALONG    2.194 DEGREES LATITUDE.
                          PATTERN NUMBER   100

                                                     SCALE FACTOR IS 10**-2

   DB.     REAL  99.9983         79.9988         59.9993         39.9998         20.0003          0.0008
 -46.59     0.468  I                                                                              *I    0.5000
 -45.83     0.511  I                                                                              *I    0.4980
 -50.60     0.295  I                                                                              *I    0.4960
 -62.74     0.073  I                                                                              *I    0.4940
 -47.81     0.407  +       +       +       +       +       +       +       +       +       +      *+    0.4920
 -45.41     0.537  I                                                                              *I    0.4900
 -48.08     0.394  I                                                                              *I    0.4880
 -65.99     0.050  I                                                                              *I    0.4860
 -49.82     0.323  I                                                                              *I    0.4840
 -45.45     0.534  I                                                                              *I    0.4820
 -46.47     0.475  I                                                                              *I    0.4800
 -55.30     0.172  I                                                                              *I    0.4780
 -53.10     0.221  +       +       +       +       +       +       +       +       +       +      *+    0.4760
 -45.94     0.505  I                                                                              *I    0.4740
 -45.48     0.522  I                                                                              *I    0.4720
 -50.84     0.287  I                                                                              *I    0.4700
 -59.39     0.107  I                                                                              *I    0.4680
 -46.94     0.450  I                                                                              *I    0.4660
 -44.96     0.565  I                                                                              *I    0.4640
 -48.17     0.390  I                                                                              *I    0.4620
 -77.03     0.014  +       +       +       +       +       +       +       +       +       +      *+    0.4600
 -48.56     0.373  I                                                                              *I    0.4580
 -44.86     0.572  I                                                                              *I    0.4560
 -46.42     0.478  I                                                                              *I    0.4540
 -57.29     0.137  I                                                                              *I    0.4520
 -51.12     0.278  I                                                                              *I    0.4500
 -45.15     0.553  I                                                                              *I    0.4480
 -45.27     0.545  I                                                                              *I    0.4460
 -51.87     0.255  +       +       +       +       +       +       +       +       +       +      *+    0.4440
 -55.44     0.169  I                                                                              *I    0.4420
 -45.85     0.510  I                                                                              *I    0.4400
 -44.58     0.590  I                                                                              *I    0.4380
 -48.76     0.365  I                                                                              *I    0.4360
 -65.79     0.051  I                                                                              *I    0.4340
 -47.03     0.445  I                                                                              *I    0.4320
 -44.27     0.611  I                                                                              *I    0.4300
 -46.72     0.462  +       +       +       +       +       +       +       +       +       +      *+    0.4280
 -62.98     0.071  I                                                                              *I    0.4260
 -48.85     0.361  I                                                                              *I    0.4240
 -44.31     0.609  I                                                                              *I    0.4220
 -45.31     0.542  I                                                                              *I    0.4200
 -54.21     0.193  I                                                                              *I    0.4180
 -51.66     0.261  I                                                                              *I    0.4160
 -44.68     0.583  I                                                                              *I    0.4140
 -44.38     0.604  +       +       +       +       +       +       +       +       +       +      *+    0.4120
 -50.19     0.310  I                                                                              *I    0.4100
 -56.48     0.150  I                                                                              *I    0.4080
 -45.43     0.535  I                                                                              *I    0.4060
 -43.82     0.644  I                                                                              *I    0.4040
 -47.59     0.417  I                                                                              *I    0.4020
 -70.25     0.031  I                                                                              *I    0.4000
 -46.61     0.467  I                                                                              *I    0.3980
 -43.57     0.663  +       +       +       +       +       +       +       +       +       +      *+    0.3960
 -45.79     0.514  I                                                                              *I    0.3940
 -60.69     0.092  I                                                                              *I    0.3920
 -48.36     0.382  I                                                                              *I    0.3900
 -43.61     0.660  I                                                                              *I    0.3880
 -44.52     0.594  I                                                                              *I    0.3860
 -53.34     0.215  I                                                                              *I    0.3840
 -51.00     0.282  I                                                                              *I    0.3820
 -43.95     0.635  +       +       +       +       +       +       +       +       +       +      *+    0.3800
 -43.64     0.657  I                                                                              *I    0.3780
 -49.54     0.334  I                                                                              *I    0.3760
 -55.39     0.170  I                                                                              *I    0.3740
 -44.59     0.589  I                                                                              *I    0.3720
 -43.08     0.702  I                                                                              *I    0.3700
 -47.04     0.445  I                                                                              *I    0.3680
 -65.01     0.051  I                                                                              *I    0.3660
 -45.60     0.525  +       +       +       +       +       +       +       +       +       +      *+    0.3640
 -42.78     0.726  I                                                                              *I    0.3620
 -45.27     0.545  I                                                                              *I    0.3600
 -62.73     0.073  I                                                                              *I    0.3580
 -47.07     0.443  I                                                                              *I    0.3560
 -42.73     0.730  I                                                                              *I    0.3540
 -43.97     0.633  I                                                                              *I    0.3520
 -54.07     0.198  I                                                                              *I    0.3500
 -49.20     0.347  +       +       +       +       +       +       +       +       +       +      *+    0.3480
 -42.93     0.714  I                                                                              *I    0.3460
 -43.03     0.705  I                                                                              *I    0.3440
 -49.86     0.321  I                                                                              *I    0.3420
 -52.45     0.238  I                                                                              *I    0.3400
 -43.37     0.678  I                                                                              *I    0.3380
 -42.37     0.761  I                                                                              *I    0.3360
 -47.14     0.439  I                                                                              *I    0.3340
 -58.31     0.121  +       +       +       +       +       +       +       +       +       +      *+    0.3320
 -44.10     0.674  I                                                                              *I    0.3300
 -41.95     0.799  I                                                                              *I    0.3280
 -45.70     0.550  I                                                                              *I    0.3260
 -90.01     0.001  I                                                                              *I    0.3240
 -45.16     0.552  I                                                                              *I    0.3220
```

```
-41.74    0.819  |                                                                                        *|    0.3200
-43.74    0.650  |                                                                                        *|    0.3180
-57.66    0.131  +        .        .        .        .        .        .        .        .        .       *+    0.3160
-46.66    0.465  |                                                                                        *|    0.3140
-41.73    0.819  |                                                                                        *|    0.3120
-42.63    0.739  |                                                                                        *|    0.3100
-51.70    0.260  |                                                                                        *|    0.3080
-48.77    0.365  |                                                                                        *|    0.3060
-41.92    0.801  |                                                                                        *|    0.3040
-41.79    0.813  |                                                                                        *|    0.3020
-48.21    0.388  +        .        .        .        .        .        .        .        .        .       *+    0.3000
-51.      0.252  |                                                                                        *|    0.2980
-42.33    0.765  |                                                                                        *|    0.2960
-41.18    0.873  |                                                                                        *|    0.2940
-45.82    0.512  |                                                                                        *|    0.2920
-57.76    0.129  |                                                                                        *|    0.2900
-42.97    0.711  |                                                                                        *|    0.2880
-40.76    0.917  |                                                                                        *|    0.2860
-44.01    0.630  +        .        .        .        .        .        .        .        .        .       *+    0.2840
******    0.001  |                                                                                         *    0.2820
-42.87    0.640  |                                                                                        *|    0.2800
-40.51    0.943  |                                                                                        *|    0.2780
-42.61    0.740  |                                                                                        *|    0.2760
-57.48    0.134  |                                                                                        *|    0.2740
-45.13    0.554  |                                                                                        *|    0.2720
-40.43    0.952  |                                                                                        *|    0.2700
-41.51    0.840  +        .        .        .        .        .        .        .        .        .       *+    0.2680
-51.35    0.271  |                                                                                        *|    0.2660
-46.86    0.454  |                                                                                        *|    0.2640
-40.51    0.943  |                                                                                        *|    0.2620
-40.64    0.929  |                                                                                        *|    0.2600
-47.76    0.409  |                                                                                        *|    0.2580
-49.35    0.341  |                                                                                        *|    0.2560
-40.75    0.918  |                                                                                        *|    0.2540
-39.96    1.005  +        .        .        .        .        .        .        .        .        .       *+    0.2520
-45.25    0.547  |                                                                                        *|    0.2500
-53.30    0.216  |                                                                                        *|    0.2480
-41.17    0.874  |                                                                                        *|    0.2460
-39.44    1.066  |                                                                                        *|    0.2440
-43.33    0.681  |                                                                                        *|    0.2420
-61.68    0.082  |                                                                                        *|    0.2400
-41.79    0.813  |                                                                                        *|    0.2380
-39.07    1.113  +        .        .        .        .        .        .        .        .        .       *+    0.2360
-41.82    0.811  |                                                                                        *|    0.2340
-64.42    0.060  |                                                                                        *|    0.2320
-42.65    0.737  |                                                                                        *|    0.2300
-38.83    1.145  |                                                                                        *|    0.2280
-40.59    0.935  |                                                                                        *|    0.2260
-53.61    0.209  |                                                                                        *|    0.2240
-43.84    0.643  |                                                                                        *|    0.2220
-38.71    1.160  +        .        .        .        .        .        .        .        .        .       *+    0.2200
-39.57    1.050  |                                                                                        *|    0.2180
-48.78    0.364  |                                                                                        *|    0.2160
-45.42    0.536  |                                                                                        *|    0.2140
-38.73    1.158  |                                                                                        *|    0.2120
-38.73    1.157  |                                                                                        *|    0.2100
-45.64    0.522  |                                                                                        *|    0.2080
-47.70    0.412  |                                                                                        *|    0.2060
-38.87    1.139  +        .        .        .        .        .        .        .        .        .       *+    0.2040
-38.03    1.254  |                                                                                      *  |    0.2020
-43.32    0.682  |                                                                                        *|    0.2000
-51.18    0.276  |                                                                                        *|    0.1980
-39.15    1.102  |                                                                                        *|    0.1960
-37.46    1.339  |                                                                                      *  |    0.1940
-41.47    0.845  |                                                                                        *|    0.1920
-57.96    0.127  |                                                                                        *|    0.1900
-39.60    1.048  +        .        .        .        .        .        .        .        .        .       *+    0.1880
-37.00    1.412  |                                                                                      *  |    0.1860
-39.95    1.006  |                                                                                        *|    0.1840
-68.60    0.037  |                                                                                        *|    0.1820
-40.22    0.975  |                                                                                        *|    0.1800
-36.65    1.471  |                                                                                      *  |    0.1780
-38.67    1.166  |                                                                                        *|    0.1760
-53.50    0.211  |                                                                                        *|    0.1740
-41.09    0.883  +        .        .        .        .        .        .        .        .        .       *+    0.1720
-36.39    1.515  |                                                                                      *  |    0.1700
-37.56    1.225  |                                                                                      *  |    0.1680
-48.05    0.396  |                                                                                        *|    0.1660
-42.22    0.774  |                                                                                        *|    0.1640
-36.22    1.545  |                                                                                      *  |    0.1620
-36.60    1.480  |                                                                                      *  |    0.1600
- 4.55    0.593  |                                                                                        *|    0.1580
   .81    0.645  +        .        .        .        .        .        .        .        .        .       *+    0.1560
  5.15    1.557  |                                                                                      *  |    0.1540
  5.75    1.631  |                                                                                      *  |    0.1520
-41.94    0.800  |                                                                                        *|    0.1500
-46.10    0.495  |                                                                                        *|    0.1480
-36.18    1.553  |                                                                                      *  |    0.1460
-35.01    1.777  |                                                                                      *  |    0.1440
-39.84    1.019  |                                                                                        *|    0.1420
-49.75    0.325  +        .        .        .        .        .        .        .        .        .       *+    0.1400
-36.31    1.529  |                                                                                      *  |    0.1380
-34.24    1.518  |                                                                                      *  |    0.1360
-38.06    1.250  |                                                                                        *|    0.1340
-57.49    0.134  |                                                                                        *|    0.1320
-36.96    1.445  |                                                                                      *  |    0.1300
-33.76    2.052  |                                                                                      *  |    0.1280
-36.51    1.492  |                                                                                      *  |    0.1260
-61.76    0.032  +        .        .        .        .        .        .        .        .        .       *+    0.1240
-36.95    1.420  |                                                                                      *  |    0.1220
-33.      2.180  |                                                                                      *  |    0.1200
-35.19    1.748  |                                                                                      *  |    0.1180
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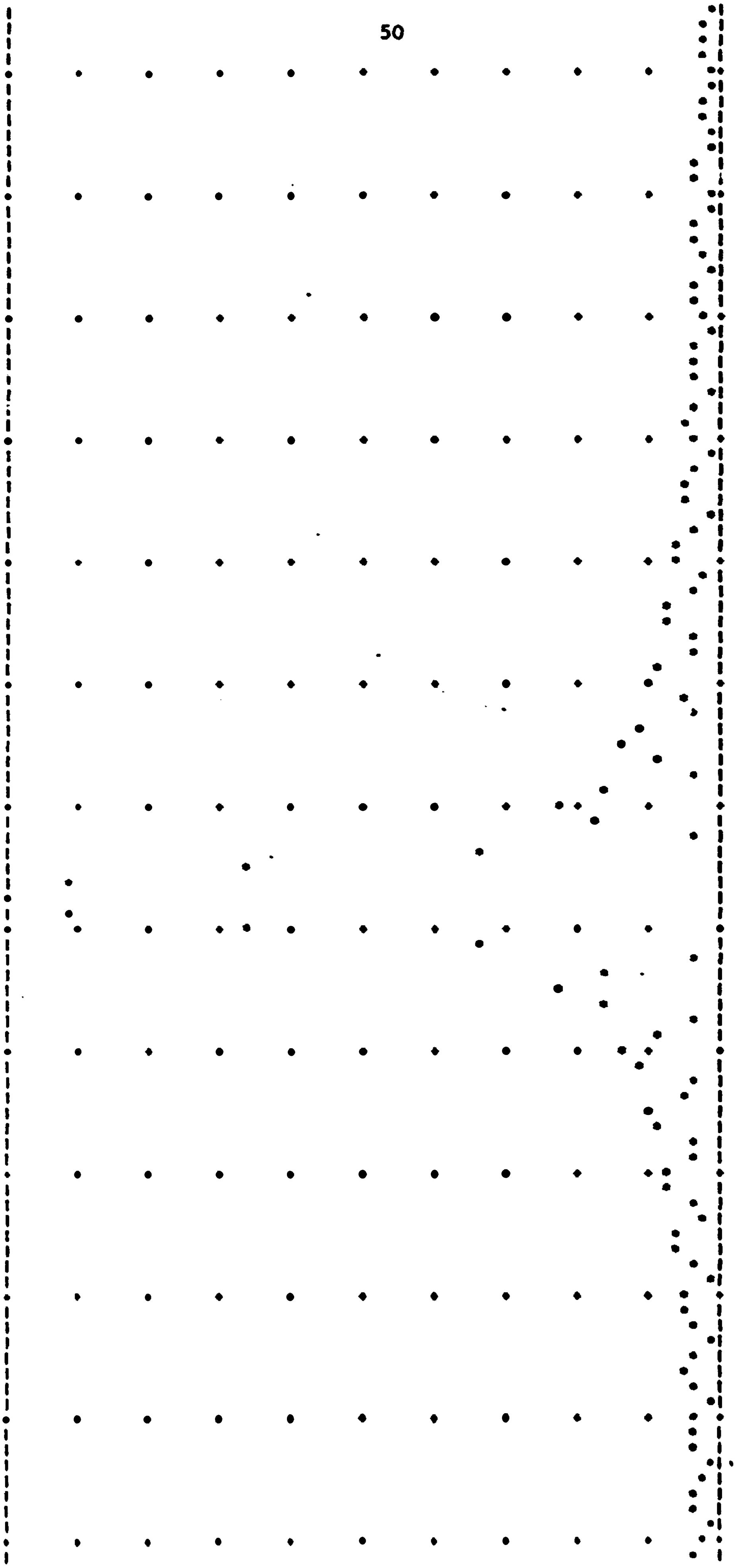


-49.81	0.322	0.1160
-37.51	1.221	0.1140
-37.74	2.301	0.1120
-33.40	2.018	0.1100
-44.52	0.594	0.1080
-38.31	1.214	0.1060
-32.35	2.414	0.1040
-37.74	2.306	0.1020
-40.90	0.902	0.1000
-39.42	1.067	0.0980
-31.98	2.519	0.0960
-31.65	2.616	0.0940
-30.09	1.244	0.0920
-41.05	0.886	0.0900
-31.65	2.616	0.0880
-30.59	2.953	0.0860
-35.69	1.642	0.0840
-43.61	0.460	0.0820
-31.36	2.704	0.0800
-29.56	3.326	0.0780
-33.55	2.101	0.0760
-48.45	0.378	0.0740
-31.11	2.753	0.0720
-28.53	3.746	0.0700
-31.56	2.441	0.0680
-49.55	0.033	0.0660
-30.89	2.853	0.0640
-27.47	4.232	0.0620
-29.65	3.292	0.0600
-47.73	0.411	0.0580
-30.72	2.910	0.0560
-26.35	4.815	0.0540
-27.73	4.108	0.0520
-40.12	0.586	0.0500
-30.58	2.959	0.0480
-25.12	5.547	0.0460
-25.73	5.171	0.0440
-35.05	1.768	0.0420
-30.48	2.994	0.0400
-23.71	6.523	0.0380
-23.55	6.644	0.0360
-30.76	2.896	0.0340
-30.40	3.020	0.0320
-22.00	7.941	0.0300
-21.04	8.874	0.0280
-26.61	4.672	0.0260
-30.41	3.015	0.0240
-19.75	10.291	0.0220
-17.38	12.769	0.0200
-21.97	7.970	0.0180
-30.51	2.581	0.0160
-16.38	15.174	0.0140
-13.29	21.646	0.0120
-15.72	16.376	0.0100
-30.98	2.824	0.0080
-9.72	32.650	0.0060
-3.72	65.179	0.0040
-0.89	90.368	0.0020
-0.00	99.598	0.0000
-0.03	90.849	-0.0020
-3.61	65.581	-0.0040
-9.4[illegible]	33.517	-0.0060
-29.[illegible]	3.467	-0.0080
-15.89	16.046	-0.0100
-13.28	21.678	-0.0120
-16.23	15.436	-0.0140
-29.59	3.315	-0.0160
-22.22	7.746	-0.0180
-17.90	12.741	-0.0200
-19.63	10 436	-0.0220
-29.81	3.232	-0.0240
-26.92	4.509	-0.0260
-21.08	8.828	-0.0280
-21.91	8.027	-0.0300
-29.98	3.170	-0.0320
-31.19	2.756	-0.0340
-23.62	6.592	-0.0360
-23.64	6.574	-0.0380
-30.13	.115	-0.0400
-35.62	1.656	-0.[illegible]420
-25.92	5.116	-0.[illegible]0
-25.07	5.578	-0.0[illegible]0
-30.30	3.054	-0.0480
-41.02	0.849	-0.0500
-27.84	4.053	-0.0520
-26.32	4.832	-0.0540
-30.50	2.986	-0.0560
-49.76	0.325	-0.0580
-29.79	3.239	-0.0600
-27.46	4.238	-0.0620
-30.72	2.511	-0.0640
-59.25	0.109	-0.0660
-31.75	2.586	-0.0680
-28.53	3.744	-0.0700
-30.96	2.820	-0.0720
-48.95	0.449	-0.0740
-33.78	2.047	-0.0760
-29.59	3.[illegible]	-0.0780
-31.24	2.742	-0.0800
-42.86	0.7[illegible]	-0.0820
-35.[illegible]	1.[illegible]	-0.0840
-3[illegible].81	[illegible]	-0.0860

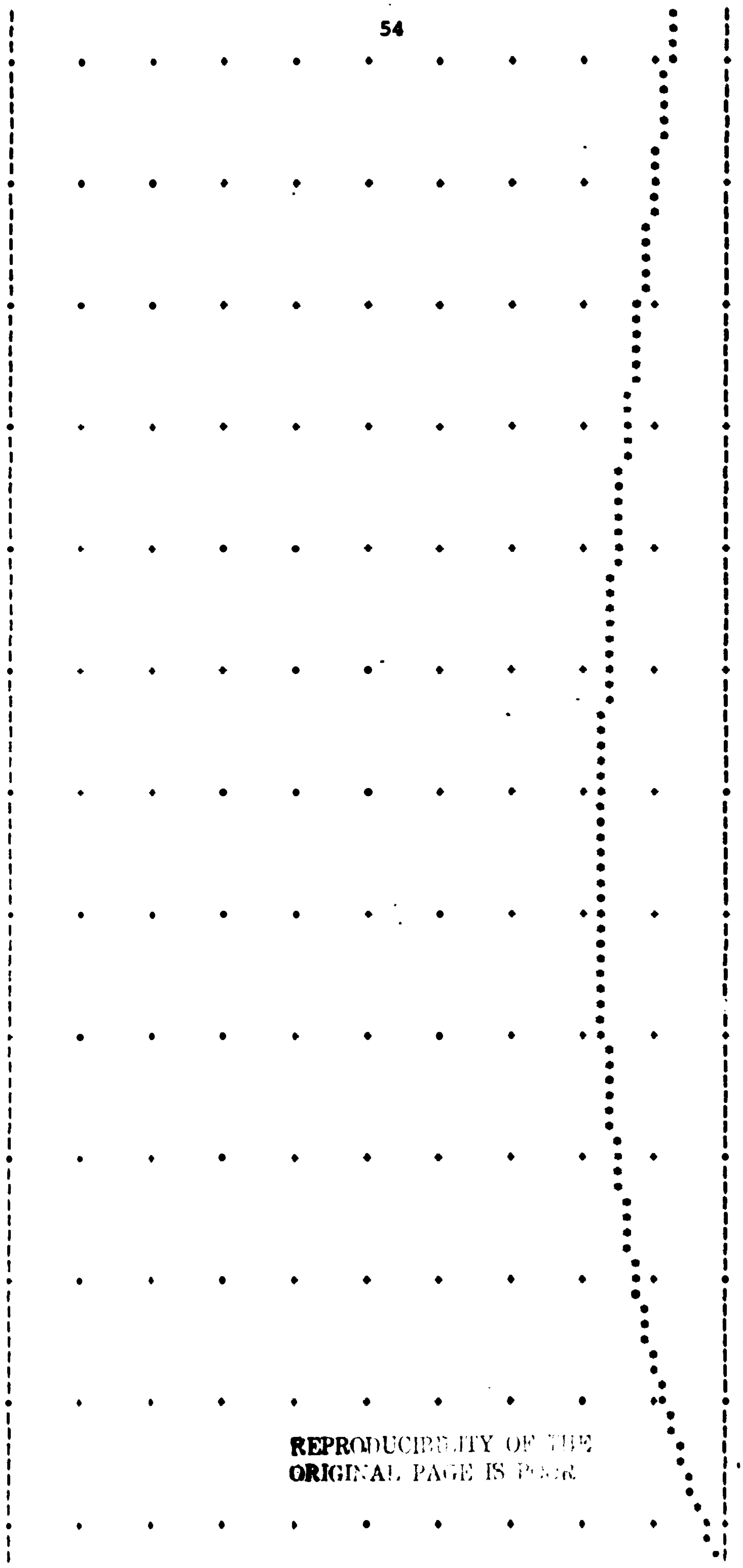
```
-31.45   2.645  |                              •   |  -0.0880
-40.55   0.937  |                                 •|  -0.0900
-37.43   1.178  |                                 •|  -0.0920
-31.71   2.599  |                              •   |  -0.0940
-31.93   2.541  |                              •   |  -0.0960
-39.64   1.117  |                                 •|  -0.0980
-41.38   0.853  • .  .  .  .  .  .  .  .  .       ••  -0.1000
-32.82   2.785  |                                • |  -0.1020
-32.79   2.427  |                                • |  -0.1040
-38.01   1.258  |                                • |  -0.1060
-45.70   0.550  |                                 •|  -0.1080
-34.00   1.974  |                                • |  -0.1100
-32.73   2.310  |                                • |  -0.1120
-37.28   1.247  |                                • |  -0.1140
-51.96   0.200  • .  .  .  .  .  .  .  .  .       ••  -0.1160
-35.28   1.722  |                                • |  -0.1180
-33.71   2.184  |                                • |  -0.1200
-36.76   1.453  |                                • |  -0.1220
-67.66   0.041  |                                 •|  -0.1240
-36.69   1.464  |                                • |  -0.1260
-33.76   2.052  |                                • |  -0.1280
-36.40   1.513  |                                • |  -0.1300
-55.22   0.173  • .  .  .  .  .  .  .  .  .       ••  -0.1320
-38.27   1.220  |                                 •|  -0.1340
-34.36   1.913  |                                • |  -0.1360
-36.18   1.552  |                                • |  -0.1380
-48.81   0.363  |                                 •|  -0.1400
-40.09   0.990  |                                 •|  -0.1420
-35.04   1.769  |                                • |  -0.1440
-36.08   1.571  |                                • |  -0.1460
-45.52   0.530  • .  .  .  .  .  .  .  .  .       ••  -0.1480
-42.26   0.771  |                                 •|  -0.1500
-35.81   1.620  |                                • |  -0.1520
-36.07   1.571  |                                • |  -0.1540
-43.42   0.674  |                                 •|  -0.1560
-44.99   0.563  |                                 •|  -0.1580
-36.68   1.466  |                                • |  -0.1600
-36.17   1.554  |                                • |  -0.1620
-41.93   0.801  • .  .  .  .  .  .  .  .  .       ••  -0.1640
-48.72   0.367  |                                 •|  -0.1660
-37.66   1.309  |                                • |  -0.1680
-36.35   1.522  |                                • |  -0.1700
-40.94   0.908  |                                 •|  -0.1720
-54.82   0.182  |                                 •|  -0.1740
-38.80   1.149  |                                 •|  -0.1760
-36.63   1.473  |                                • |  -0.1780
-40.04   0.595  • .  .  .  .  .  .  .  .  .       ••  -0.1800
-81.64   0.003  |                                 •|  -0.1820
-40.12   0.937  |                                 •|  -0.1840
-37.01   1.411  |                                • |  -0.1860
-39.45   1.065  |                                 •|  -0.1880
-56.32   0.152  |                                 •|  -0.1900
-41.68   0.624  |                                 •|  -0.1920
-37.49   1.335  |                                • |  -0.1940
-39.04   1.117  • .  .  .  .  .  .  .  .  .       ••  -0.1960
-50.44   0.301  |                                 •|  -0.1980
-43.60   0.661  |                                 •|  -0.2000
-38.08   1.247  |                                 •|  -0.2020
-38.78   1.159  |                                 •|  -0.2040
-47.23   0.435  |                                 •|  -0.2060
-46.01   0.501  |                                 •|  -0.2080
-36.80   1.149  |                                 •|  -0.2100
-38.66   1.165  • .  .  .  .  .  .  .  .  .       ••  -0.2120
-45.09   0.557  |                                 •|  -0.2140
-49.32   0.342  |                                 •|  -0.2160
-39.67   1.039  |                                 •|  -0.2180
-38.67   1.165  |                                 •|  -0.2200
-43.55   0.662  |                                 •|  -0.2220
-54.57   0.187  |                                 •|  -0.2240
-40.71   0.922  |                                 •|  -0.2260
-38.81   1.147  • .  .  .  .  .  .  .  .  .       ••  -0.2280
-42.47   0.752  |                                 •|  -0.2300
-68.23   0.029  |                                 •|  -0.2320
-41.98   0.796  |                                 •|  -0.2340
-39.07   1.113  |                                 •|  -0.2360
-41.64   0.829  |                                 •|  -0.2380
-59.82   0.102  |                                 •|  -0.2400
-43.54   0.665  |                                 •|  -0.2420
-39.46   1.064  • .  .  .  .  .  .  .  .  .       ••  -0.2440
-41.06   0.885  |                                 •|  -0.2460
-52.98   0.735  |                                 •|  -0.2480
-45.50   0.531  |                                 •|  -0.2500
-40.00   1.000  |                                 •|  -0.2520
-40.67   0.926  |                                 •|  -0.2540
-48.91   0.358  |                                 •|  -0.2560
-48.12   0.293  |                                 •|  -0.2580
-40.71   0.922  • .  .  .  .  .  .  .  .  .       ••  -0.2600
-40.45   0.950  |                                 •|  -0.2620
-46.56   0.470  |                                 •|  -0.2640
-51.88   0.755  |                                 •|  -0.2660
-41.60   0.832  |                                 •|  -0.2680
-40.39   0.956  |                                 •|  -0.2700
-44.42   0.568  |                                 •|  -0.2720
-58.99   0.118  |                                 •|  -0.2740
-42.73   0.720  • .  .  .  .  .  .  .     .       ••  -0.2760
-43.50   0.744  |                                 •|  -0.2780
-43.72   0.657  |                                 •|  -0.2800
-75.64   0.017  |                                 •|  -0.2820
-44.16   0.619  |                                 •|  -0.2840
-40.77   0.910  |                                 •|  -0.2860
[illegible] [illegible] |                         •|  [illegible]
[illegible] [illegible] |                         •|  [illegible]
```

```
-46.02   0.500  +    .    .    .    .    .    .    .    .    .   *+  -0.2920
-41.21   0.870  I                                                *I  -0.2940
-42.25   0.772  I                                                *I  -0.2960
-51.92   0.765  I                                                *I  -0.2980
-48.50   0.376  I                                                *I  -0.3000
-41.85   0.809  I                                                *I  -0.3020
-41.87   0.807  I                                                *I  -0.3040
-48.90   0.376  I                                                *I  -0.3060
-52.11   0.248  +    .    .    .    .    .    .    .    .    .   *+  -0.3080
-42.70   0.732  I                                                *I  -0.3100
-41.70   0.822  I                                                *I  -0.3120
-46.45   0.476  I                                                *I  -0.3140
-58.50   0.119  I                                                *I  -0.3160
-43.84   0.642  I                                                *I  -0.3180
-41.73   0.820  I                                                *I  -0.3200
-45.02   0.561  I                                                *I  -0.3220
-80.83   0.009  +    .    .    .    .    .    .    .    .    .   *+  -0.3240
-45.34   0.541  I                                                *I  -0.3260
-41.96   0.798  I                                                *I  -0.3280
-44.00   0.631  I                                                *I  -0.3300
-57.58   0.132  I                                                *I  -0.3320
-47.24   0.430  I                                                *I  -0.3340
-42.46   0.759  I                                                *I  -0.3360
-43.31   0.683  I                                                *I  -0.3380
-52.07   0.249  +    .    .    .    .    .    .    .    .    .   *+  -0.3400
-50.14   0.311  I                                                *I  -0.3420
-43.08   0.701  I                                                *I  -0.3440
-42.88   0.718  I                                                *I  -0.3460
-48.97   0.356  I                                                *I  -0.3480
-54.52   0.188  I                                                *I  -0.3500
-44.05   0.627  I                                                *I  -0.3520
-42.71   0.732  I                                                *I  -0.3540
-46.91   0.451  +    .    .    .    .    .    .    .    .    .   *+  -0.3560
-64.00   0.063  I                                                *I  -0.3580
-45.28   0.579  I                                                *I  -0.3600
-42.78   0.726  I                                                *I  -0.3620
-45.50   0.531  I                                                *I  -0.3640
-64.39   0.060  I                                                *I  -0.3660
-47.18   0.437  I                                                *I  -0.3680
-43.05   0.700  I                                                *I  -0.3700
-44.52   0.594  +    .    .    .    .    .    .    .    .    .   *+  -0.3720
-54.95   0.179  I                                                *I  -0.3740
-49.74   0.326  I                                                *I  -0.3760
-43.68   0.655  I                                                *I  -0.3780
-43.90   0.638  I                                                *I  -0.3800
-50.78   0.289  I                                                *I  -0.3820
-53.66   0.207  I                                                *I  -0.3840
-44.59   0.590  I                                                *I  -0.3860
-43.55   0.662  +    .    .    .    .    .    .    .    .    .   *+  -0.3880
-48.22   0.348  I                                                *I  -0.3900
-61.45   0.085  I                                                *I  -0.3920
-45.88   0.508  I                                                *I  -0.3940
-43.55   0.664  I                                                *I  -0.3960
-46.51   0.473  I                                                *I  -0.3980
-68.47   0.038  I                                                *I  -0.4000
-47.70   0.412  I                                                *I  -0.4020
-43.83   0.643  +    .    .    .    .    .    .    .    .    .   *+  -0.4040
-45.36   0.539  I                                                *I  -0.4060
-56.10   0.157  I                                                *I  -0.4080
-50.37   0.303  I                                                *I  -0.4100
-44.41   0.602  I                                                *I  -0.4120
-44.64   0.586  I                                                *I  -0.4140
-51.46   0.267  I                                                *I  -0.4160
-54.60   0.186  I                                                *I  -0.4180
-45.37   0.539  +    .    .    .    .    .    .    .    .    .   *+  -0.4200
-44.29   0.610  I                                                *I  -0.4220
-48.72   0.367  I                                                *I  -0.4240
-63.81   0.065  I                                                *I  -0.4260
-46.79   0.458  I                                                *I  -0.4280
-44.27   0.612  I                                                *I  -0.4300
-46.94   0.450  I                                                *I  -0.4320
-64.77   0.058  I                                                *I  -0.4340
-48.87   0.360  +    .    .    .    .    .    .    .    .    .   *+  -0.4360
-44.60   0.589  I                                                *I  -0.4380
-45.79   0.513  I                                                *I  -0.4400
-55.13   0.175  I                                                *I  -0.4420
-52.05   0.250  I                                                *I  -0.4440
-45.31   0.543  I                                                *I   0.4460
-45.11   0.555  I                                                *I  -0.4480
-50.97   0.233  I                                                *I  -0.4500
-57.64   0.131  +    .    .    .    .    .    .    .    .    .   *+  -0.4520
-46.47   0.473  I                                                *I  -0.4540
-44.84   0.572  I                                                *I  -0.4560
-48.47   0.377  I                                                *I  -0.4580
-81.30   0.009  I                                                *I  -0.4600
-48.25   0.387  I                                                *I  -0.4620
-44.97   0.564  I                                                *I  -0.4640
-46.88   0.452  I                                                *I  -0.4660
-59.07   0.112  +    .    .    .    .    .    .    .    .    .   *+  -0.4680
-50.96   0.283  I                                                *I  -0.4700
-45.50   0.531  I                                                *I  -0.4720
-45.91   0.507  I                                                *I  -0.4740
-52.93   0.226  I                                                *I  -0.4760
-55.53   0.167  I                                                *I  -0.4780
-46.52   0.472  I                                                *I  -0.4800
-45.45   0.535  I                                                *I  -0.4820
-49.77   0.327  +    .    .    .    .    .    .    .    .    .   *+  -0.4840
-66.83   0.046  I                                                *I  -0.4860
-48.15   0.391  I                                                *I  -0.4880
-45.41   0.517  I                                                *I  -0.4900
-47.75   0.410  I                                                *I  -0.4920
-62.28   0.077  I                                                *I  -0.4940
```

```
-50.71        C.292    |                                                                                                  •|    -0.4960
-45.84        0.510    |                                                                                                  •|    -0.4980
-46.*         0.470    •         •         •         •         •         •         •         •         •         •        ••    -0.5000
   CF         REAL 99.9903               79.9988             59.9993             39.9998             20.0003              0.0008
```

```
                                    Y-AXIS PROFILE PLOT ALONG   0.0  LONGITUDE.
                                    PATTERN NUMBER   100

   DP.       REAL     1.C035             0.8028              C.6022               0.4015              0.2009              0.C002
-32.99        0.022    |                                                                                                 • |     3.9999
-33.67        0.021    |                                                                                                 • |     3.9918
-34.42        0.019    |                                                                                                 • |     3.9839
-35.26        0.017    |                                                                                                 • |     3.9759
-36.19        0.015    •         •         •         •         •         •         •         •         •         •       • •     3.9679
-37.26        0.014    |                                                                                                 • |     3.9599
-38.50        0.012    |                                                                                                  •|     3.9519
-39.97        0.010    |                                                                                                  •|     3.9439
-41.76        C.008    |                                                                                                  •|     3.9359
-44.06        0.006    |                                                                                                  •|     3.9279
-47.24        0.004    |                                                                                                  •|     3.9199
-52.42        0.002    |                                                                                                  •|     3.9119
-67.60        0.000    •         •         •         •         •         •         •         •         •         •        ••     3.9039
-56.02        0.002    |                                                                                                  •|     3.8959
-48.86        C.004    |                                                                                                  •|     3.8879
-44.95        C.006    |                                                                                                  •|     3.8799
-42.23        0.008    |                                                                                                  •|     3.8719
-40.15        0.010    |                                                                                                  •|     3.8639
-38.45        0.012    |                                                                                                  •|     3.8559
-37.02        0.014    |                                                                                                 • |     3.8479
-35.78        0.016    •         •         •         •         •         •         •         •         •         •       • •     3.8399
-34.68        0.018    |                                                                                                 • |     3.8319
-33.70        0.021    |                                                                                                 • |     3.8239
-32.81        0.023    |                                                                                                 • |     3.8159
-31.99        0.025    |                                                                                                 • |     3.8079
-31.24        0.027    |                                                                                                •  |     3.7999
-30.54        0.030    |                                                                                                •  |     3.7919
-29.84        0.032    |                                                                                                •  |     3.7839
-29.28        0.034    •         •         •         •         •         •         •         •         •         •      •  •     3.7759
-28.71        0.037    |                                                                                                •  |     3.7679
-28.16        0.039    |                                                                                              •    |     3.7599
-27.65        0.041    |                                                                                              •    |     3.7519
-27.16        0.044    |                                                                                              •    |     3.7439
-26.70        0.046    |                                                                                              •    |     3.7359
-26.25        0.049    |                                                                                              •    |     3.7279
-25.83        0.051    |                                                                                             •     |     3.7199
-25.42        0.054    •         •         •         •         •         •         •         •         •         •   •     •     3.7119
-25.03        0.056    |                                                                                             •     |     3.7039
-24.65        0.059    |                                                                                             •     |     3.6959
-24.29        C.061    |                                                                                             •     |     3.6879
-23.94        0.064    |                                                                                            •      |     3.6799
```



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-23.61   0.066   3.6719
-23.24   0.069   3.6639
-22.97   0.071   3.6559
-22.67   0.074   3.6479
-22.38   0.076   3.6399
-22.09   0.079   3.6319
-21.82   0.081   3.6239
-21.55   0.084   3.6159
-21.29   0.086   3.6079
-21.04   0.089   3.5999
-20.80   0.091   3.5919
-20.56   0.094   3.5839
-20.33   0.096   3.5759
-20.11   0.099   3.5679
-19.89   0.101   3.5599
-19.68   0.104   3.5519
-19.48   0.106   3.5439
-19.28   0.109   3.5359
-19.09   0.111   3.5279
-18.90   0.113   3.5199
-18.72   0.116   3.5119
-18.55   0.118   3.5039
-18.37   0.121   3.4959
-18.21   0.123   3.4879
-18.05   0.125   3.4799
-17.89   0.127   3.4719
-17.74   0.130   3.4639
-17.59   0.132   3.4559
-17.45   0.134   3.4479
-17.32   0.136   3.4399
-17.18   0.138   3.4319
-17.06   0.140   3.4239
-16.93   0.142   3.4159
-16.82   0.144   3.4079
-16.70   0.146   3.3999
-16.59   0.148   3.3919
-16.49   0.150   3.3839
-16.39   0.152   3.3759
-16.29   0.153   3.3679
-16.20   0.155   3.3599
-16.11   0.156   3.3519
-16.03   0.158   3.3439
-15.95   0.159   3.3359
-15.88   0.161   3.3279
-15.81   0.162   3.3199
-15.75   0.163   3.3119
-15.69   0.164   3.3039
-15.63   0.165   3.2959
-15.59   0.166   3.2879
-15.54   0.167   3.2799
-15.50   0.168   3.2719
-15.47   0.169   3.2639
-15.44   0.169   3.2559
-15.42   0.170   3.2479
-15.40   0.170   3.2399
-15.39   0.170   3.2319
-15.39   0.170   3.2239
-15.38   0.170   3.2159
-15.38   0.170   3.2079
-15.39   0.170   3.1999
-15.41   0.170   3.1919
-15.44   0.169   3.1839
-15.47   0.169   3.1759
-15.51   0.168   3.1679
-15.55   0.167   3.1599
-15.61   0.166   3.1519
-15.67   0.165   3.1439
-15.74   0.163   3.1359
-15.82   0.162   3.1279
-15.90   0.160   3.1199
-16.00   0.158   3.1119
-16.11   0.157   3.1039
-16.22   0.154   3.0959
-16.35   0.152   3.0879
-16.49   0.150   3.0800
-16.65   0.147   3.0719
-16.81   0.144   3.0640
-17.00   0.141   3.0560
-17.19   0.138   3.0480
-17.41   0.135   3.0400
-17.64   0.131   3.0320
-17.89   0.128   3.0240
-18.16   0.124   3.0160
-18.46   0.119   3.0080
-18.78   0.115   3.0000
-19.13   0.111   2.9920
-19.51   0.106   2.9840
-19.92   0.101   2.9760
-20.38   0.096   2.9680
-20.89   0.090   2.9600
-21.44   0.085   2.9520
-22.06   0.079   2.9440
-22.75   0.073   2.9360
-23.53   0.067   2.9280
-24.43   0.060   2.9200
-25.46   0.053   2.9120
-26.67   0.046   2.9040
-28.11   0.039   2.8960
-29.95   0.032   2.8880
-32.14   0.024   2.8800
-35.74   0.016   2.8720
-41.78   0.008   2.8640
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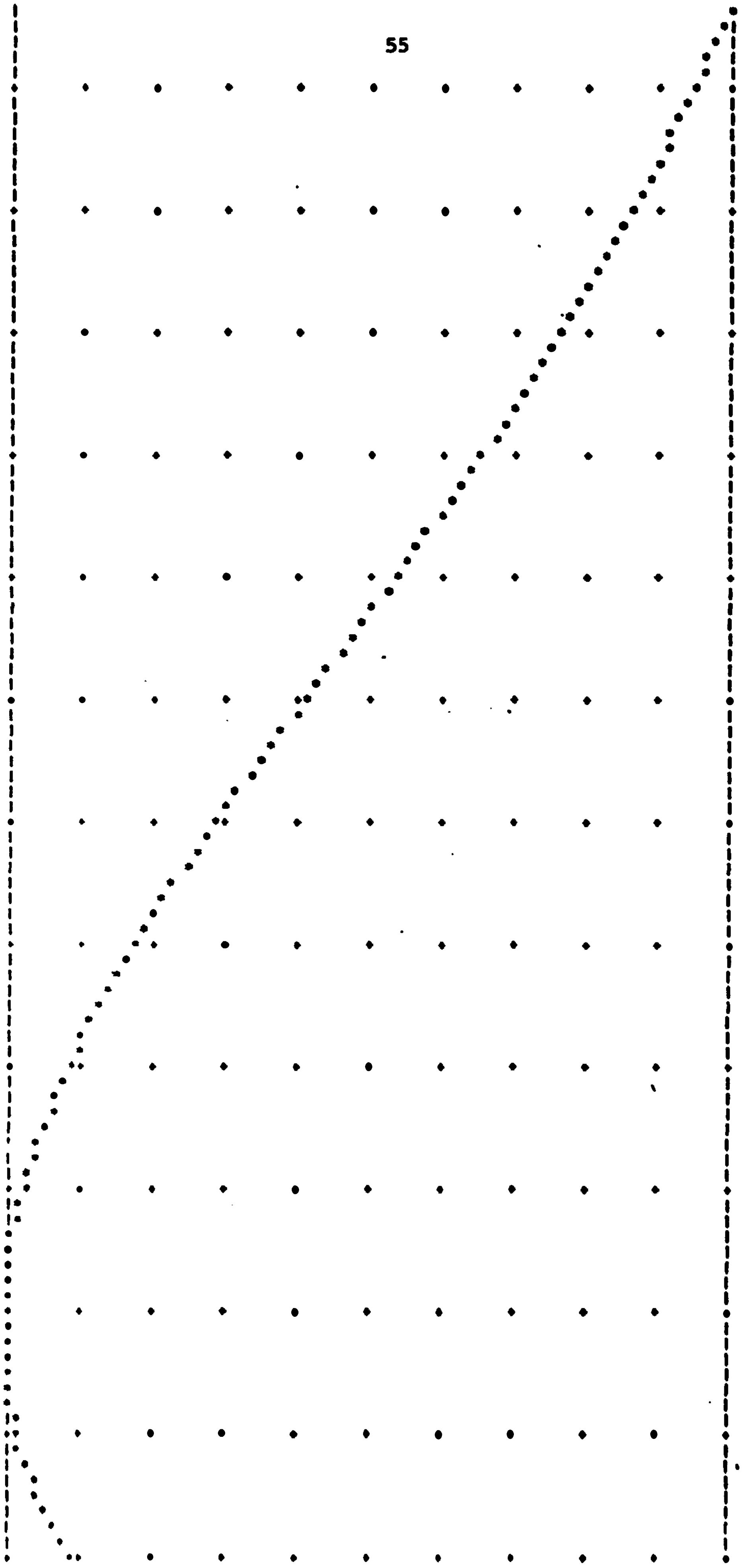

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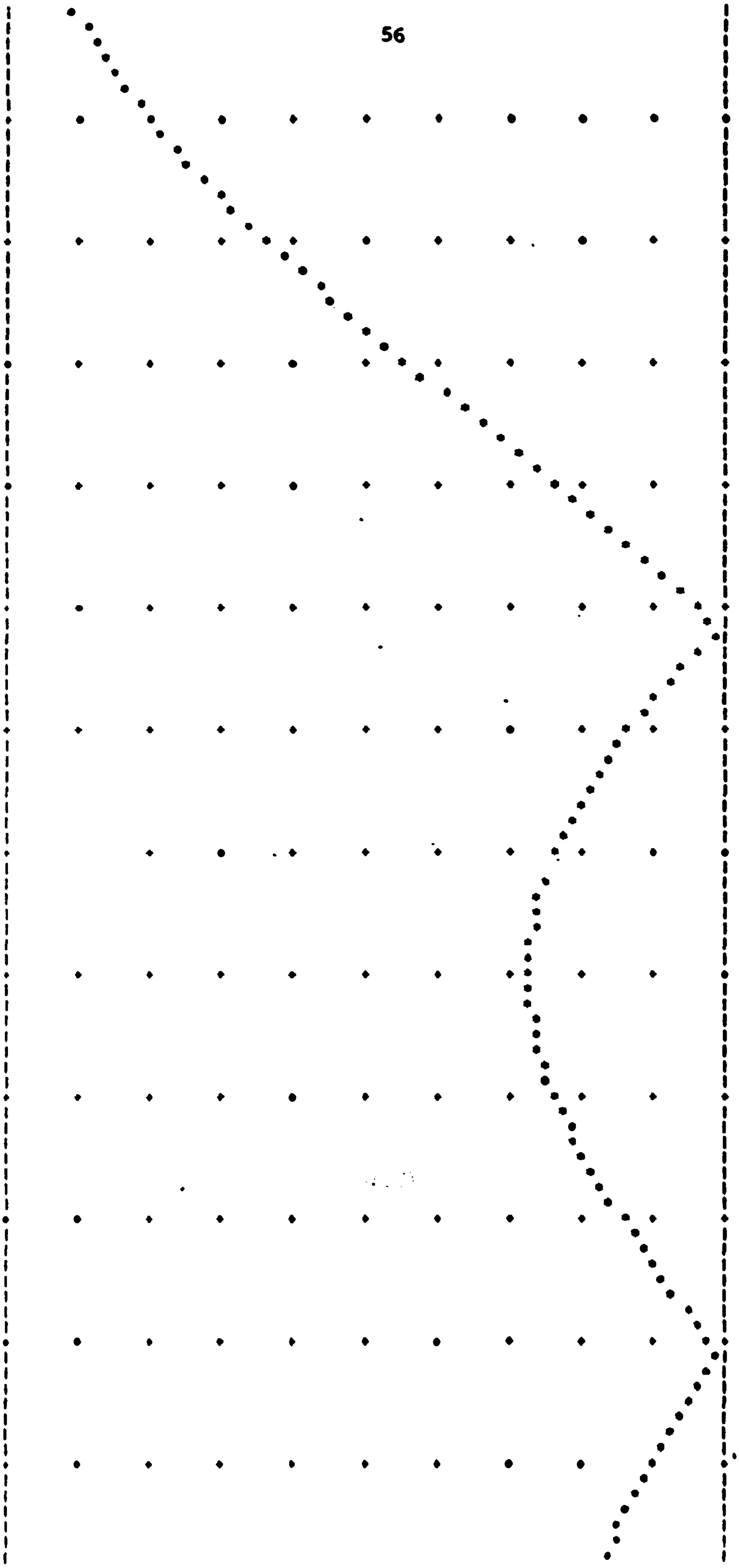
-73.56   0.000   2.8560
-41.11   0.009   2.8480
-35.67   0.018   2.8400
-31.47   0.027   2.8320
-28.87   0.036   2.8240
-26.83   0.046   2.8160
-25.14   0.055   2.8080
-23.70   0.065   2.8000
-22.43   0.076   2.7920
-21.30   0.086   2.7840
-20.28   0.097   2.7760
-19.35   0.108   2.7680
-18.50   0.119   2.7600
-17.70   0.130   2.7520
-16.96   0.142   2.7440
-16.26   0.154   2.7360
-15.61   0.166   2.7280
-14.98   0.178   2.7200
-14.40   0.191   2.7120
-13.84   0.203   2.7040
-13.30   0.216   2.6960
-12.79   0.229   2.6880
-12.30   0.243   2.6800
-11.83   0.256   2.6720
-11.38   0.270   2.6640
-10.94   0.284   2.6560
-10.53   0.298   2.6480
-10.12   0.312   2.6400
 -9.73   0.326   2.6320
 -9.35   0.341   2.6240
 -8.99   0.355   2.6160
 -8.63   0.370   2.6080
 -8.29   0.385   2.6000
 -7.96   0.400   2.5920
 -7.64   0.415   2.5840
 -7.32   0.430   2.5760
 -7.02   0.446   2.5680
 -6.73   0.461   2.5600
 -6.44   0.476   2.5520
 -6.16   0.492   2.5440
 -5.89   0.508   2.5360
 -5.62   0.523   2.5280
 -5.37   0.539   2.5200
 -5.12   0.554   2.5120
 -4.88   0.570   2.5040
 -4.65   0.586   2.4960
 -4.42   0.601   2.4880
 -4.20   0.617   2.4800
 -3.99   0.632   2.4720
 -3.78   0.647   2.4640
 -3.57   0.663   2.4560
 -3.38   0.678   2.4480
 -3.19   0.693   2.4400
 -3.00   0.709   2.4320
 -2.82   0.722   2.4240
 -2.65   0.737   2.4160
 -2.48   0.751   2.4080
 -2.32   0.766   2.4000
 -2.16   0.780   2.3920
 -2.01   0.793   2.3840
 -1.87   0.807   2.3760
 -1.73   0.820   2.3680
 -1.59   0.833   2.3600
 -1.46   0.845   2.3520
 -1.34   0.857   2.3440
 -1.22   0.869   2.3360
 -1.10   0.881   2.3280
 -0.99   0.892   2.3200
 -0.89   0.902   2.3120
 -0.79   0.913   2.3040
 -0.70   0.922   2.2960
 -0.61   0.932   2.2880
 -0.53   0.941   2.2800
 -0.45   0.949   2.2720
 -0.38   0.957   2.2640
 -0.32   0.964   2.2560
 -0.26   0.971   2.2480
 -0.20   0.977   2.2400
 -0.15   0.982   2.2320
 -0.11   0.987   2.2240
 -0.07   0.992   2.2160
 -0.04   0.995   2.2080
 -0.01   0.998   2.2000
  0.01   1.001   2.1920
  0.02   1.002   2.1840
  0.03   1.003   2.1760
  0.03   1.003   2.1680
  0.03   1.003   2.1600
  0.02   1.002   2.1520
 -0.00   1.000   2.1440
 -0.03   0.997   2.1360
 -0.06   0.994   2.1280
 -0.09   0.989   2.1200
 -0.14   0.984   2.1120
 -0.19   0.978   2.1040
 -0.25   0.972   2.0960
 -0.31   0.964   2.0880
 -0.39   0.956   2.0800
 -0.47   0.947   2.0720
 -0.56   0.937   2.0640
 -0.66   0.927   2.0560
 -0.77   0.915   2.0480
```



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 -1.29   0.862   2.0160
 -1.44   0.847   2.0080
 -1.61   0.831   2.0000
 -1.79   0.814   1.9920
 -1.97   0.797   1.9840
 -2.17   0.779   1.9760
 -2.38   0.760   1.9680
 -2.61   0.740   1.9600
 -2.85   0.720   1.9520
 -3.10   0.700   1.9440
 -3.37   0.678   1.9360
 -3.65   0.657   1.9280
 -3.95   0.634   1.9200
 -4.27   0.611   1.9120
 -4.61   0.588   1.9040
 -4.97   0.564   1.8960
 -5.35   0.540   1.8880
 -5.75   0.516   1.8800
 -6.18   0.491   1.8720
 -6.64   0.466   1.8640
 -7.13   0.440   1.8560
 -7.65   0.414   1.8480
 -8.21   0.389   1.8400
 -8.81   0.363   1.8320
 -9.45   0.337   1.8240
-10.15   0.311   1.8160
-10.91   0.285   1.8080
-11.74   0.259   1.8000
-12.66   0.233   1.7920
-13.67   0.207   1.7840
-14.81   0.182   1.7760
-16.11   0.156   1.7680
-17.62   0.132   1.7600
-19.41   0.107   1.7520
-21.64   0.083   1.7440
-24.57   0.059   1.7360
-28.91   0.036   1.7280
-37.61   0.013   1.7200
-41.00   0.009   1.7120
-30.36   0.030   1.7040
-25.83   0.051   1.6960
-22.96   0.071   1.6880
-20.88   0.090   1.6800
-19.27   0.109   1.6720
-17.97   0.126   1.6640
-16.89   0.143   1.6560
-15.98   0.159   1.6480
-15.21   0.174   1.6400
-14.55   0.187   1.6320
-13.98   0.200   1.6240
-13.48   0.212   1.6160
-13.06   0.222   1.6080
-12.69   0.232   1.6000
-12.38   0.240   1.5920
-12.12   0.248   1.5840
-11.91   0.254   1.5760
-11.74   0.259   1.5680
-11.61   0.263   1.5600
-11.52   0.265   1.5520
-11.47   0.267   1.5440
-11.46   0.267   1.5360
-11.49   0.267   1.5280
-11.55   0.265   1.5200
-11.64   0.262   1.5120
-11.78   0.258   1.5040
-11.95   0.253   1.4960
-12.17   0.246   1.4880
-12.42   0.239   1.4800
-12.72   0.231   1.4720
-13.06   0.222   1.4640
-13.46   0.212   1.4560
-13.90   0.202   1.4480
-14.41   0.190   1.4400
-14.98   0.178   1.4320
-15.63   0.165   1.4240
-16.36   0.152   1.4160
-17.20   0.138   1.4080
-18.15   0.124   1.4000
-19.25   0.109   1.3920
-20.55   0.094   1.3840
-22.10   0.079   1.3760
-24.01   0.063   1.3680
-26.49   0.047   1.3600
-29.98   0.032   1.3520
-35.88   0.016   1.3440
-64.90   0.001   1.3360
-36.63   0.015   1.3280
-30.52   0.030   1.3200
-27.04   0.044   1.3120
-24.62   0.059   1.3040
-22.79   0.073   1.2960
-21.34   0.086   1.2880
-20.14   0.098   1.2800
-19.15   0.110   1.2720
-18.31   0.121   1.2640
-17.60   0.132   1.2560
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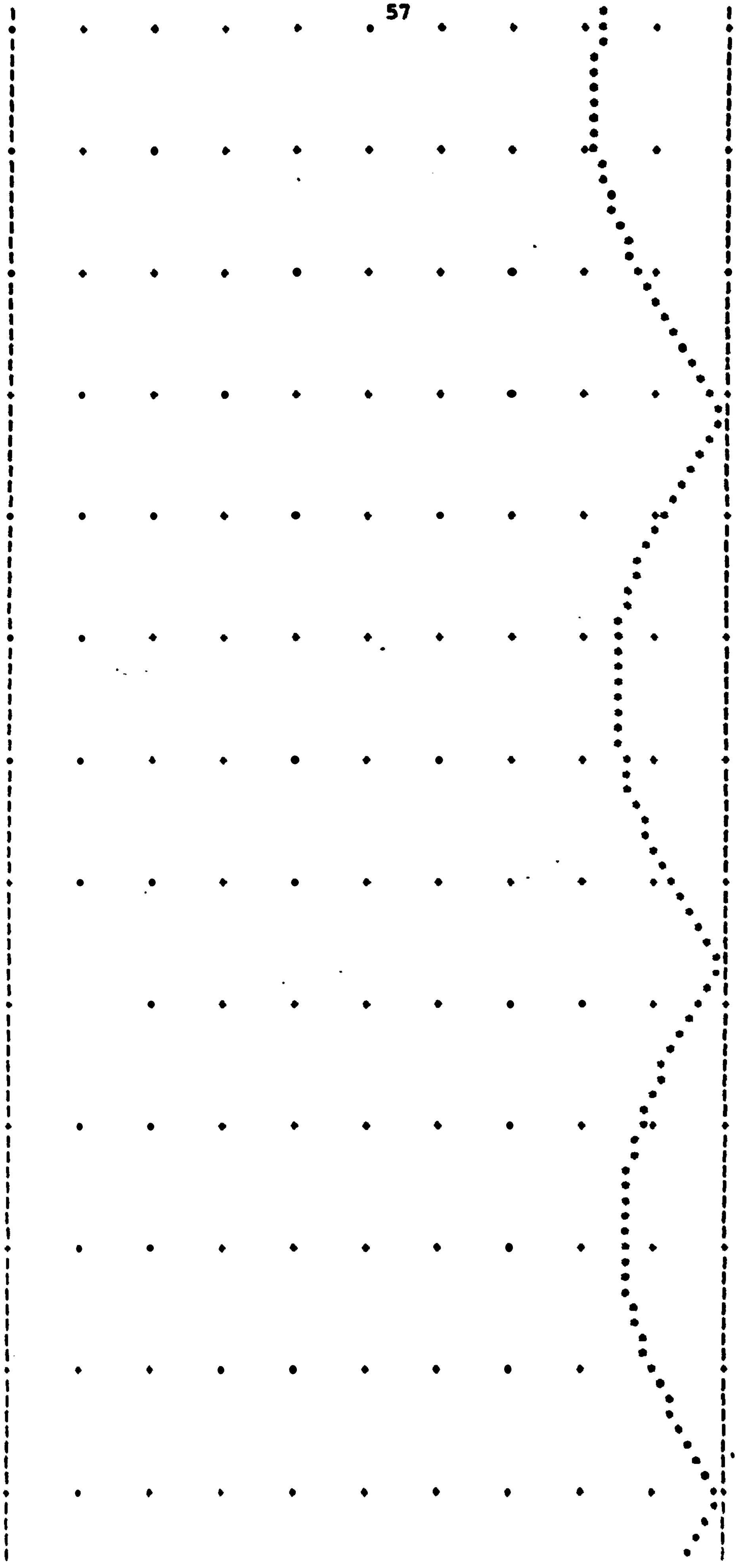
-16.48   0.150   1.2400
-16.04   0.158   1.2320
```



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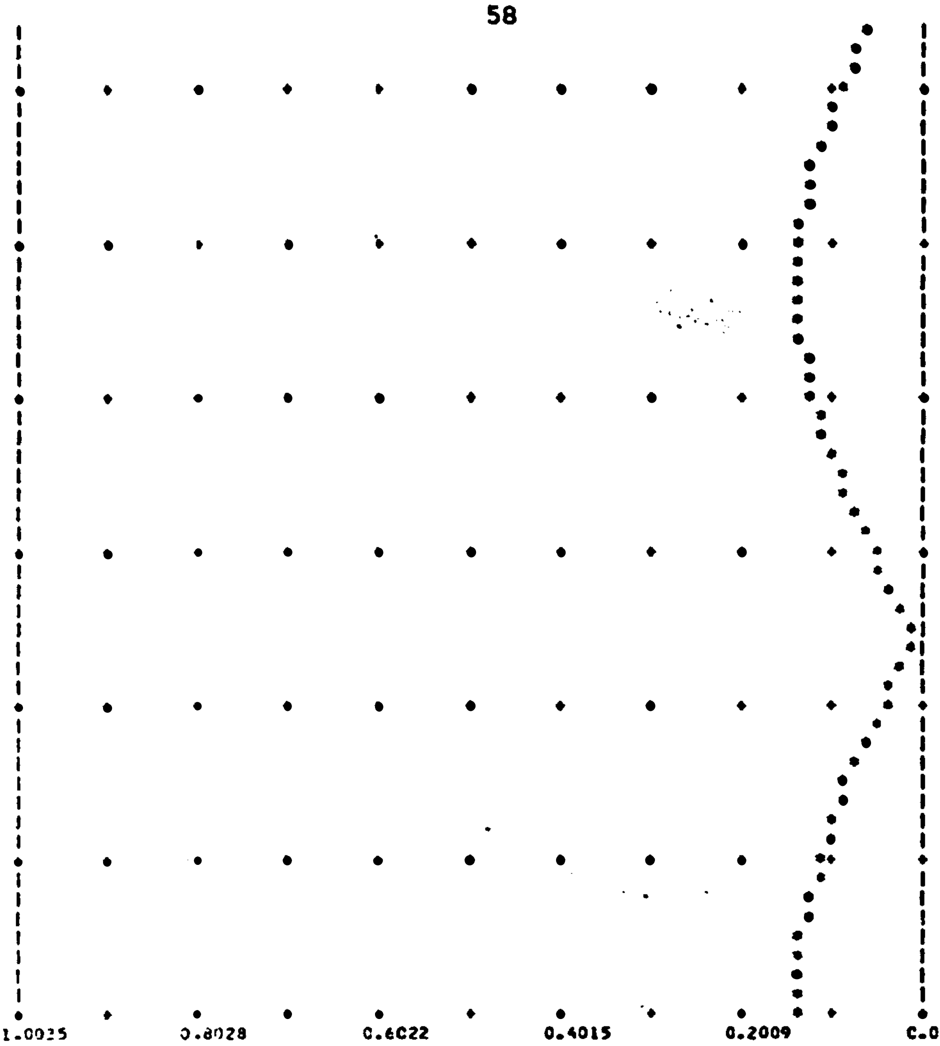
-14.90	0.178	1.2000
-14.86	0.181	1.1920
-14.79	0.182	1.1840
-14.78	0.182	1.1760
-14.81	0.182	1.1680
-14.91	0.180	1.1600
-15.05	0.177	1.1520
-15.25	0.173	1.1440
-15.51	0.168	1.1360
-15.83	0.162	1.1280
-16.21	0.155	1.1200
-16.67	0.147	1.1120
-17.20	0.138	1.1040
-17.83	0.128	1.0960
-18.56	0.118	1.0880
-19.41	0.107	1.0800
-20.40	0.095	1.0720
-21.58	0.083	1.0640
-23.01	0.071	1.0560
-24.76	0.058	1.0480
-27.02	0.045	1.0400
-30.14	0.031	1.0320
-35.11	0.018	1.0240
-47.97	0.004	1.0160
-40.45	0.009	1.0080
-32.83	0.023	1.0000
-28.89	0.036	0.9920
-26.26	0.049	0.9840
-24.30	0.061	0.9760
-22.76	0.073	0.9680
-21.51	0.084	0.9600
-20.49	0.095	0.9520
-19.63	0.104	0.9440
-18.91	0.113	0.9360
-18.31	0.122	0.9280
-17.80	0.129	0.9200
-17.39	0.135	0.9120
-17.06	0.140	0.9040
-16.81	0.144	0.8960
-16.63	0.147	0.8880
-16.51	0.149	0.8800
-16.46	0.150	0.8720
-16.47	0.150	0.8640
-16.55	0.149	0.8560
-16.70	0.146	0.8480
-16.91	0.143	0.8400
-17.20	0.138	0.8320
-17.56	0.132	0.8240
-18.00	0.126	0.8160
-18.54	0.118	0.8080
-19.18	0.110	0.8000
-19.94	0.101	0.7920
-20.84	0.091	0.7840
-21.92	0.080	0.7760
-23.23	0.069	0.7680
-24.83	0.057	0.7600
-26.88	0.045	0.7520
-29.65	0.033	0.7440
-33.82	0.020	0.7360
-42.26	0.008	0.7280
-46.10	0.005	0.7200
-35.13	0.018	0.7120
-30.49	0.030	0.7040
-27.54	0.042	0.6960
-25.40	0.054	0.6880
-23.75	0.065	0.6800
-22.42	0.076	0.6720
-21.35	0.086	0.6640
-20.45	0.095	0.6560
-19.71	0.103	0.6480
-19.09	0.111	0.6400
-18.58	0.118	0.6320
-18.16	0.124	0.6240
-17.84	0.128	0.6160
-17.59	0.132	0.6080
-17.42	0.135	0.6000
-17.33	0.136	0.5920
-17.30	0.136	0.5840
-17.35	0.136	0.5760
-17.47	0.134	0.5680
-17.66	0.131	0.5600
-17.92	0.127	0.5520
-18.27	0.122	0.5440
-18.70	0.116	0.5360
-19.23	0.109	0.5280
-19.87	0.102	0.5200
-20.63	0.093	0.5120
-21.54	0.084	0.5040
-22.64	0.074	0.4960
-23.97	0.063	0.4880
-25.62	0.052	0.4800
-27.74	0.041	0.4720
-30.64	0.029	0.4640
-35.13	0.018	0.4560
-45.09	0.006	0.4480
-42.87	0.006	0.4400
-34.75	0.018	0.4320
-30.46	0.030	0.4240
-27.65	0.041	0.4160



DB.	REAL	
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-21.65	0.083	0.3840
-20.77	0.092	0.3760
-20.03	0.100	0.3680
-19.42	0.107	0.3600
-18.91	0.113	0.3520
-18.50	0.119	0.3440
-18.17	0.123	0.3360
-17.92	0.127	0.3280
-17.74	0.130	0.3200
-17.64	0.131	0.3120
-17.60	0.132	0.3040
-17.62	0.132	0.2960
-17.71	0.130	0.2880
-17.87	0.128	0.2800
-18.10	0.124	0.2720
-18.40	0.120	0.2640
-18.78	0.115	0.2560
-19.24	0.109	0.2480
-19.80	0.102	0.2400
-20.46	0.095	0.2320
-21.24	0.087	0.2240
-22.16	0.078	0.2160
-23.27	0.069	0.2080
-24.60	0.059	0.2000
-26.24	0.049	0.1920
-28.35	0.039	0.1840
-31.20	0.028	0.1760
-35.56	0.017	0.1680
-44.87	0.006	0.1600
-45.57	0.005	0.1520
-35.83	0.016	0.1440
-31.39	0.027	0.1360
-28.52	0.037	0.1280
-26.42	0.048	0.1200
-24.78	0.059	0.1120
-23.45	0.067	0.1040
-22.36	0.076	0.0960
-21.44	0.085	0.0880
-20.66	0.093	0.0800
-19.95	0.100	0.0720
-19.43	0.107	0.0640
-18.96	0.113	0.0560
-18.56	0.118	0.0480
-18.23	0.123	0.0400
-17.97	0.126	0.0320
-17.76	0.129	0.0240
-17.61	0.132	0.0160
-17.52	0.133	0.0080
-17.47	0.134	0.0

```
          EXAMPLE 2:
             DEMONSTRATION OF FOOTPRINT DEGRADATION DUE TO ANTENNA PANEL
             UNFOLDING ERRORS.



          SYSTEM INFORMATION:
               FREQUENCY =  9.000 GHZ.
               YAW =     0.0   DEGREES
               TILT =    50.000 DEGREES
               TWIST =     0.0   DEGREES
               ALTITUDE =  200.000 KM.


          ANTENNA PARAMETERS FOR SIMULATION NUMBER 101
               ELEMENT TYPE: HORIZONTAL DIPOLE
               NUMBER OF ELEMENTS (X,Y) = (504 ,  12)
               INTERELEMENT SPACING (CM.):  2.2966 ,  2.3550
               INTERELEMENT PHASE SHIFT (DEG.):  0.0     , 0.0


          DEFORMATION DATA FOR SIMULATION 101:

 -1.00       0.0        0.0        2.00


 -1.00       0.0        0.0        2.00




          ELECTRICAL DATA FOR SIMULATION 101:

       ( 1, 1)   ( 2, 1)   ( 3, 1)   (
 PHSX:   0.0       0.0       0.0
 PHSY:   0.0       0.0       0.0
 AMAG:   1.00      1.00      1.00
 APHS:   0.0       0.0       0.0
```

```
          PRINT/PLOT INFORMATION:
               REQUESTED OUTPUT:
                    PRINTER PROFILE
                    PRINTER CONTOUR
               PLOT RESOLUTION: 151 X 151 POINTS


               STARTX =    -0.500
               STOPX =     0.500
               DELTAX =     0.007

               STARTY =     0.0
               STOPY =     4.000
               DELTAY =     0.027

          SUBARRAY DATA SUMMARY FOR PATTERN101:
AREA          XCENT          YCENT          ZAVG          ALPHAX          ALPHAY          AMAG          APHS          PHSX          PHSY
  1          -385.83          0.0           -0.50          0.148           0.0            1.0000          0.0           0.0           0.0
  2             0.0           0.0            0.0           0.0             0.0            1.0000          0.0           0.0           0.0
  3           385.83          0.0            1.00          0.297           0.0            1.0000          0.0    '      0.0           0.0


          PREDICTED BEAM CENTER:
               LATITUDE =     2.1545
               LONGITUDE =      0.0
               RANGE = 243.978
```

```
HEADING =    0.0
```

```
PLOT NORMALIZATION FACTOR =  -46.325 DB.
```

PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 101

```
       0.0      0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
        |.........|.........|.........|.........|.........|.........|.........|.........|.........|.........|
-0.5000.
-0.4933.
-0.4867.
-0.4800.
-0.4733.
-0.4667.
-0.4600.
-0.4533.
-0.4467.
-0.4400.
-0.4333.
-0.4267.
-0.4200.
-0.4133.
-0.4067.
-0.4000.
-0.3933.
-0.3867.
-0.3800.
-0.3733.
-0.3667.
-0.3600.
-0.3533.
-0.3467.
-0.3400.
-0.3333.
-0.3267.
-0.3200.
-0.3133.
-0.3067.
-0.3000.
-0.2933.
-0.2867.
-0.2800.
-0.2733.
-0.2667.
-0.2600.
-0.2533.
-0.2467.
-0.2400.
-0.2333.
-0.2267.
-0.2200.
-0.2133.
-0.2067.
-0.2000.
-0.1933.
-0.1867.
-0.1800.
-0.1733.
-0.1667.
-0.1600.
-0.1533.
-0.1467.
-0.1400.
-0.1333.
-0.1267.
-0.1200.
-0.1133.
-0.1067.
-0.1000.
-0.0933.
-0.0867.
-0.0800.
-0.0733.
-0.0667.
-0.0600.
-0.0533.
-0.0467.                                                                                    0 0 0 0 0
-0.0400.
-0.0333                                                                                     0 0 0 0 0 0
-0.0267.  0                 0 0 0 0             0 0 0 0 0           0 1 1 1 1 0           0 1 1 1 1 1 1 0
-0.0200.  0 0               0 0 0 0               0 0 0
-0.0133.1 1 1 0         0 1 1 1 1 1 0         0 1 1 1 1 1 0       0 1 1 2 2 2 1 0       0 2 2 3 3 3 3 2 1
-0.0067.3 3 3 2 1     0 2 3 3 4 4 3 2 1     1 2 3 4 4 4 3 2 1   0 2 3 4 4 4 4 3 2 1   1 3 4 4 5 5 5 4 4 3 1
-0.0000.4 4 4 3 2 0   1 2 3 4 4 4 3 3 2     1 2 3 4 4 3 3 2 0   0 7 3 3 4 ● 4 3 2 0   0 2 3 4 4 4 4 4 3 2 1
 0.0067.5 5 ● 4 2 0   1 2 3 4 4 4 4 3 2     1 2 3 3 3 3 3 2 0     2 3 3 3 4 3 3 2 0   0 2 3 4 5 5 5 5 4 3 2
 0.0133.2 2 1 1 0       0 1 2 2 2 2 1 0     0 2 3 3 4 4 3 2 1   0 3 4 5 5 5 5 4 4 2   2 4 5 6 6 6 6 6 6 5 3
 0.0200.2 2 2 1 0       0 1 2 2 2 2 1 0     0 1 2 2 3 2 2 1 0     1 2 3 3 3 3 3 2 0   0 2 3 4 4 4 4 4 3 2 0
 0.0267.0 0 0             0 0 0 0 0 0           0 1 1 0 0           0 1 1 1 1 1 0       0 2 2 3 3 3 3 2 1
 0.0333.0 0 0             0 0 0 0 0             0 0 0 0                                     0 1 1 1 1 1 0
 0.0400.                                          0 0 0               0 0 0 0             0 1 1 1 1 1 0
 0.0467.                                                                                    0 0 1 1 0 0
 0.0533.
 0.0600.                                                                                        0 0
 0.0667.
 0.0733.
 0.0800.
 0.0867.
```

```
0.0933.
0.1000.
0.1067.
0.1133.
0.1200.
0.1267.
0.1333.
0.1400.
0.1467.
0.1533.
0.1600.
0.1667.
0.1733.
0.1800.
0.1867.
0.1933.
0.2000.
0.2067.
0.2133.
0.2200.
0.2267.
0.2333.
0.2400.
0.2467.
0.2533.
0.2600.
0.2667.
0.2733.
0.2800.
0.2867.
0.2933.
0.3000.
0.3067.
0.3133.
0.3200.
0.3267.
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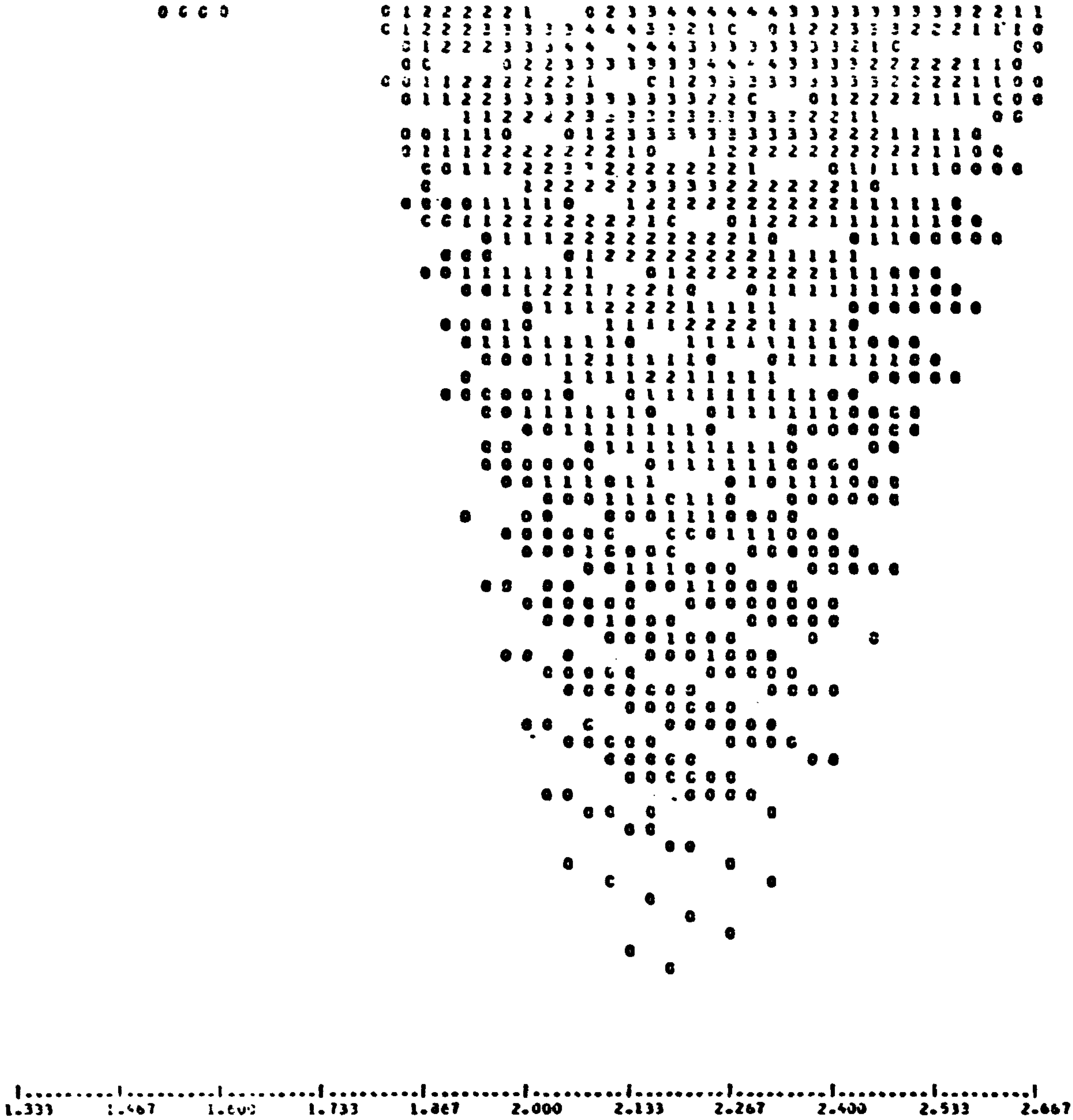
0.3400.
0.3467.
0.3533.
0.3600.
0.3667.
0.3733.
0.3800.
0.3867.
0.3933.
0.4000.
0.4067.
0.4133.
0.4200.
0.4267.
0.4333.
0.4400.
0.4467.
0.4533.
0.4600.
0.4667.
0.4733.
0.4800.
0.4867.
0.4933.
0.5000.
        I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
       0.0       0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
```

PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 101



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                                   CONTOUR LEVEL KEY

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1: -0.2550000E 02 TO -0.2249999E 02   5: -0.1350000E 02 TO -0.1049999E 02   9: -0.1500000E 01 TO  0.1500010E 01
2: -0.2250000E 02 TO -0.1949999E 02   6: -0.1050000E 02 TO -0.7499990E 01    : -0.1000000E 51 TO -0.2850000E 02
3: -0.1950000E 02 TO -0.1649999E 02   7: -0.7500000E 01 TO -0.4499990E 01   *:  0.1500010E 01 TO  0.1000000E 51
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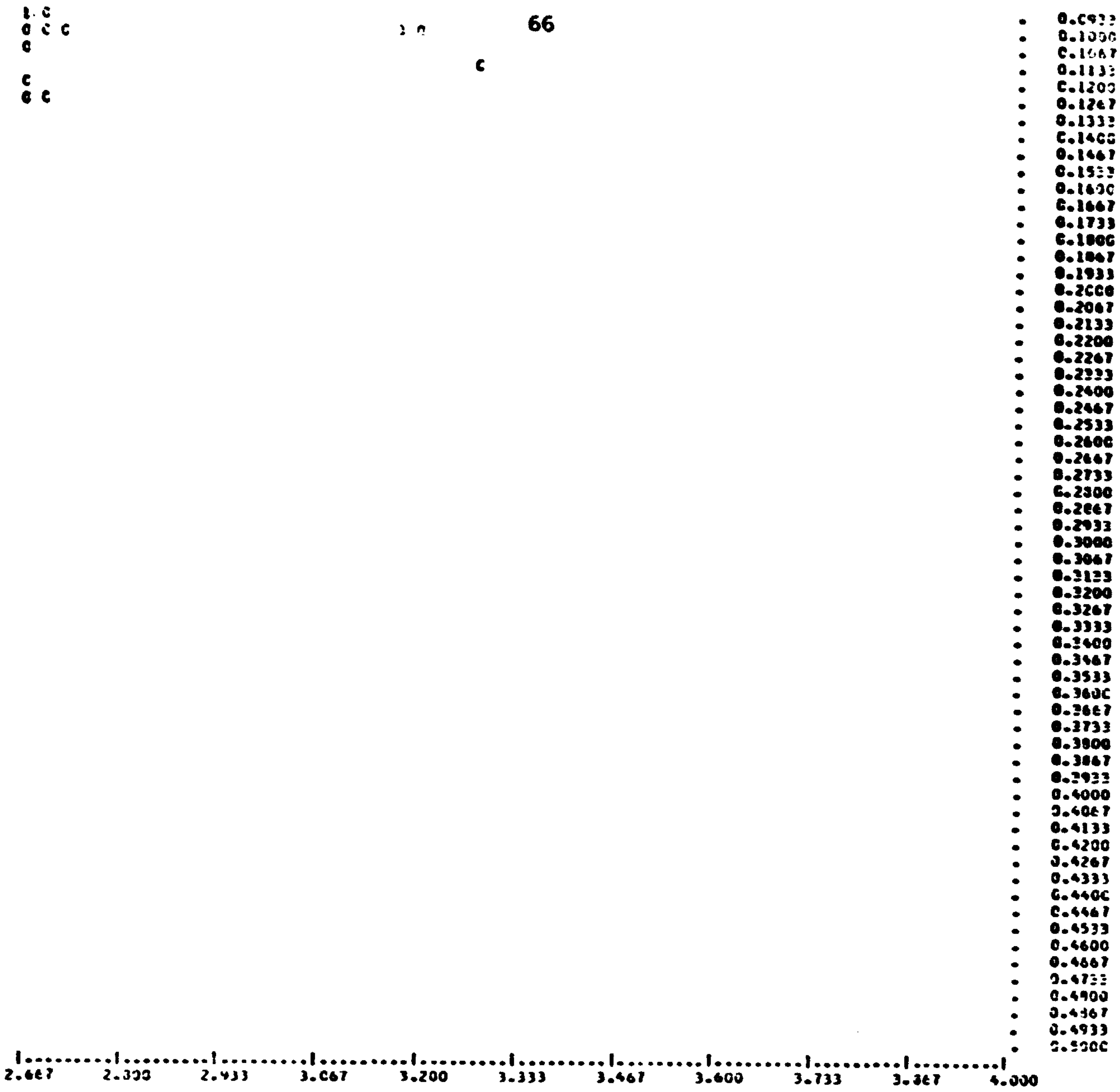
PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 101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0.1333
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0.1467
0.1533
0.1600
0.1667
0.1733
0.1800
0.1867
0.1933
0.2000
0.2067
0.2133
0.2200
0.2267
0.2333
0.2400
0.2467
0.2533
0.2600
0.2667
0.2733
0.2800
0.2867
0.2933
0.3000
0.3067
0.3133
0.3200
0.3267
0.3333
0.3400
0.3467
0.3533
0.3600
0.3667
0.3733
0.3800
0.3867
0.3933
0.4000
0.4067
0.4133
0.4200
0.4267
0.4333
0.4400
0.4467
0.4533
0.4600
0.4667
0.4733
0.4800
0.4867
0.4933
0.5000
2.667
2.800
2.933
3.067
3.200
3.333
3.467
3.600
3.733
3.867
4.000

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                      X-AXIS PROFILE PLOT ALONG    2.194 DEGREES LATITUDE.
                      PATTERN NUMBER   101

    DB.      REAL    2.3224          1.8588          1.3951          0.9314          0.4678          0.0041
  -40.95      0.009  |                                                                              *|    0.5000
  -32.78      0.023  |                                                                              *|    0.4980
  -30.47      0.030  |                                                                              *|    0.4960
  -30.29      0.031  |                                                                              *|    0.4940
  -29.95      0.032  +       .       .       .       .       .       .       .       .       .      *+    0.4920
  -28.59      0.036  |                                                                             * |    0.4900
  -28.59      0.037  |                                                                             * |    0.4880
  -29.39      0.034  |                                                                             * |    0.4860
  -30.43      0.030  |                                                                              *|    0.4840
  -30.17      0.031  |                                                                              *|    0.4820
  -30.03      0.032  |                                                                              *|    0.4800
  -32.24      0.024  |                                                                              *|    0.4780
  -40.42      0.010  +       .       .       .       .       .       .       .       .       .      *+    0.4760
  -39.46      0.011  |                                                                              *|    0.4740
  -32.01      0.025  |                                                                              *|    0.4720
  -29.94      0.032  |                                                                              *|    0.4700
  -29.79      0.032  |                                                                              *|    0.4680
  -29.44      0.034  |                                                                             * |    0.4660
  -28.43      0.038  |                                                                             * |    0.4640
  -28.13      0.039  |                                                                             * |    0.4620
  -29.03      0.035  +       .       .       .       .       .       .       .       .       .     * +    0.4600
  -29.98      0.032  |                                                                              *|    0.4580
  -29.62      0.033  |                                                                              *|    0.4560
  -29.65      0.033  |                                                                              *|    0.4540
  -32.30      0.024  |                                                                              *|    0.4520
  -42.05      0.008  |                                                                              *|    0.4500
  -37.28      0.014  |                                                                              *|    0.4480
  -31.05      0.028  |                                                                              *|    0.4460
  -29.37      0.034  +       .       .       .       .       .       .       .       .       .     * +    0.4440
  -29.31      0.034  |                                                                             * |    0.4420
  -28.81      0.036  |                                                                             * |    0.4400
  -27.80      0.041  |                                                                             * |    0.4380
  -27.68      0.041  |                                                                             * |    0.4360
  -28.72      0.037  |                                                                             * |    0.4340
  -29.45      0.034  |                                                                             * |    0.4320
  -29.02      0.035  |                                                                             * |    0.4300
  -29.35      0.034  +       .       .       .       .       .       .       .       .       .     * +    0.4280
  -32.72      0.023  |                                                                              *|    0.4260
  -45.29      0.005  |                                                                              *|    0.4240
  -35.03      0.018  |                                                                              *|    0.4220
  -29.99      0.032  |                                                                              *|    0.4200
  -28.78      0.036  |                                                                             * |    0.4180
  -28.78      0.036  |                                                                             * |    0.4160
  -28.07      0.039  |                                                                             * |    0.4140
  -27.14      0.044  +       .       .       .       .       .       .       .       .       .     * +    0.4120
  -27.29      0.043  |                                                                             * |    0.4100
  -28.44      0.038  |                                                                             * |    0.4080
  -28.91      0.036  |                                                                             * |    0.4060
  -28.40      0.038  |                                                                             * |    0.4040
  -29.22      0.035  |                                                                             * |    0.4020
  -32.75      0.021  |                                                                              *|    0.4000
  -46.25      0.005  |                                                                              *|    0.3980
  -32.69      0.023  +       .       .       .       .       .       .       .       .       .      *+    0.3960
  -28.92      0.036  |                                                                             * |    0.3940
  -28.21      0.039  |                                                                             * |    0.3920
  -28.15      0.039  |                                                                             * |    0.3900
  -27.23      0.044  |                                                                             * |    0.3880
  -26.48      0.047  |                                                                             * |    0.3860
  -26.95      0.045  |                                                                               |    0.3840
  -28.14      0.039  |                                                                               |    0.3820
  -28.21      0.039  +       .       .       .       .       .       .       .       .       .       *    0.3800
  -27.82      0.041  |                                                                             * |    0.3780
  -29.37      0.034  |                                                                             * |    0.3760
  -35.01      0.018  |                                                                              *|    0.3740
  -40.08      0.010  |                                                                              *|    0.3720
  -30.53      0.030  |                                                                              *|    0.3700
  -27.95      0.040  |                                                                             * |    0.3680
  -27.64      0.041  |                                                                             * |    0.3660
  -27.37      0.043  +       .       .       .       .       .       .       .       .       .     * *    0.3640
  -26.31      0.048  |                                                                             * |    0.3620
  -25.81      0.051  |                                                                             * |    0.3600
  -26.70      0.046  |                                                                             * |    0.3580
  -27.72      0.041  |                                                                             * |    0.3560
  -27.40      0.043  |                                                                             * |    0.3540
  -27.28      0.043  |                                                                             * |    0.3520
  -30.03      0.032  |                                                                              *|    0.3500
  -40.03      0.010  +       .       .       .       .       .       .       .       .       .      *+    0.3480
  -34.82      0.018  |                                                                              *|    0.3460
  -28.64      0.037  |                                                                             * |    0.3440
  -27.06      0.044  |                                                                             * |    0.3420
  -27.03      0.045  |                                                                             * |    0.3400
  -26.41      0.048  |                                                                             * |    0.3380
  -25.38      0.054  |                                                                             * |    0.3360
  -25.38      0.054  |                                                                             * |    0.3340
  -25.49      0.047  +               .       .       .       .       .       .       .       .     * +    0.3320
  -27.09      0.044  |                                                                             * |    0.3300
  -26.56      0.047  |                                                                             * |    0.3280
  -27.[illegible]  [illegible]  |                                                                             * |    0.3260
  -31.[illegible]  [illegible]  |                                                                              *|    0.3240
  -44.[illegible]  [illegible]  |                                                                              *|    0.3220
  -30.[illegible]  [illegible]  |                                                                              *|    0.3200
  -27.[illegible]  [illegible]  |                                                                             * |    0.3180
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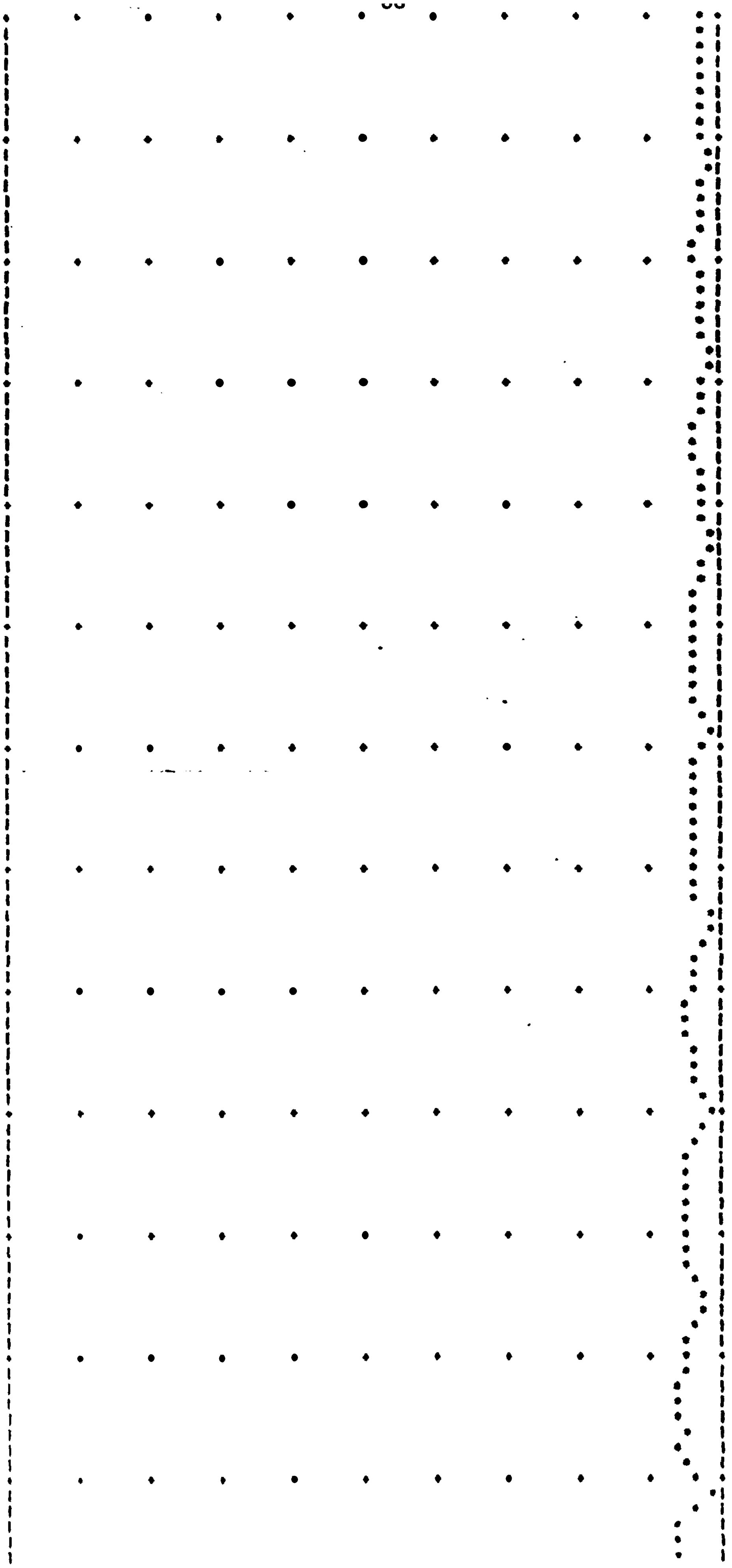

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-25.02   0.056   0.3080
-26.19   0.049   0.3060
-26.15   0.047   0.3040
-25.84   0.051   0.3020
-27.62   0.042   0.3000
-34.83   0.018   0.2980
-36.49   0.015   0.2960
-28.05   0.040   0.2940
-25.79   0.051   0.2920
-25.62   0.052   0.2900
-25.22   0.055   0.2880
-24.10   0.062   0.2860
-23.81   0.064   0.2840
-24.77   0.058   0.2820
-25.62   0.052   0.2800
-25.15   0.055   0.2780
-25.44   0.053   0.2760
-28.89   0.036   0.2740
-42.06   0.004   0.2720
-30.62   0.029   0.2700
-25.84   0.051   0.2680
-24.80   0.058   0.2660
-24.79   0.058   0.2640
-23.90   0.064   0.2620
-22.98   0.071   0.2600
-23.30   0.068   0.2580
-24.47   0.060   0.2560
-24.64   0.059   0.2540
-24.18   0.062   0.2520
-25.62   0.052   0.2500
-31.93   0.025   0.2480
-36.44   0.015   0.2460
-26.78   0.046   0.2440
-24.19   0.062   0.2420
-23.95   0.063   0.2400
-23.61   0.066   0.2380
-22.46   0.075   0.2360
-22.05   0.079   0.2340
-22.94   0.071   0.2320
-23.83   0.064   0.2300
-23.38   0.068   0.2280
-23.56   0.065   0.2260
-26.81   0.046   0.2240
-39.25   0.011   0.2220
-29.05   0.035   0.2200
-24.05   0.063   0.2180
-22.95   0.071   0.2160
-22.94   0.071   0.2140
-22.05   0.079   0.2120
-21.08   0.088   0.2100
-21.36   0.086   0.2080
-22.51   0.075   0.2060
-22.65   0.074   0.2040
-22.17   0.078   0.2020
-23.61   0.066   0.2000
-30.03   0.032   0.1980
-34.00   0.020   0.1960
-24.59   0.059   0.1940
-22.09   0.079   0.1920
-21.88   0.081   0.1900
-21.50   0.084   0.1880
-20.20   0.097   0.1860
-19.91   0.101   0.1840
-20.91   0.091   0.1820
-21.61   0.083   0.1800
-21.08   0.088   0.1780
-21.35   0.086   0.1760
-24.84   0.057   0.1740
-38.08   0.012   0.1720
-26.13   0.049   0.1700
-21.53   0.084   0.1680
-20.59   0.093   0.1660
-20.57   0.094   0.1640
-19.56   0.105   0.1620
-18.61   0.117   0.1600
-18.96   0.113   0.1580
-20.07   0.099   0.1560
-20.00   0.100   0.1540
-19.56   0.105   0.1520
-21.29   0.086   0.1500
-28.60   0.037   0.1480
-29.47   0.034   0.1460
-21.38   0.085   0.1440
-19.26   0.109   0.1420
-19.17   0.110   0.1400
-18.64   0.11[illegible]   0.1380
-17.39   0.135   0.1360
-17.10   0.140   0.1340
-1[illegible].04   0.1[illegible]5   0.1320
-18.59   0.113   0.1300
-17.94   0.127   0.1280
-18.49   0.120   0.1260
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-25.02   0.0[illegible]   0.1220
-21.91   0.081   0.1200
-17.99   0.12[illegible]   0.1180
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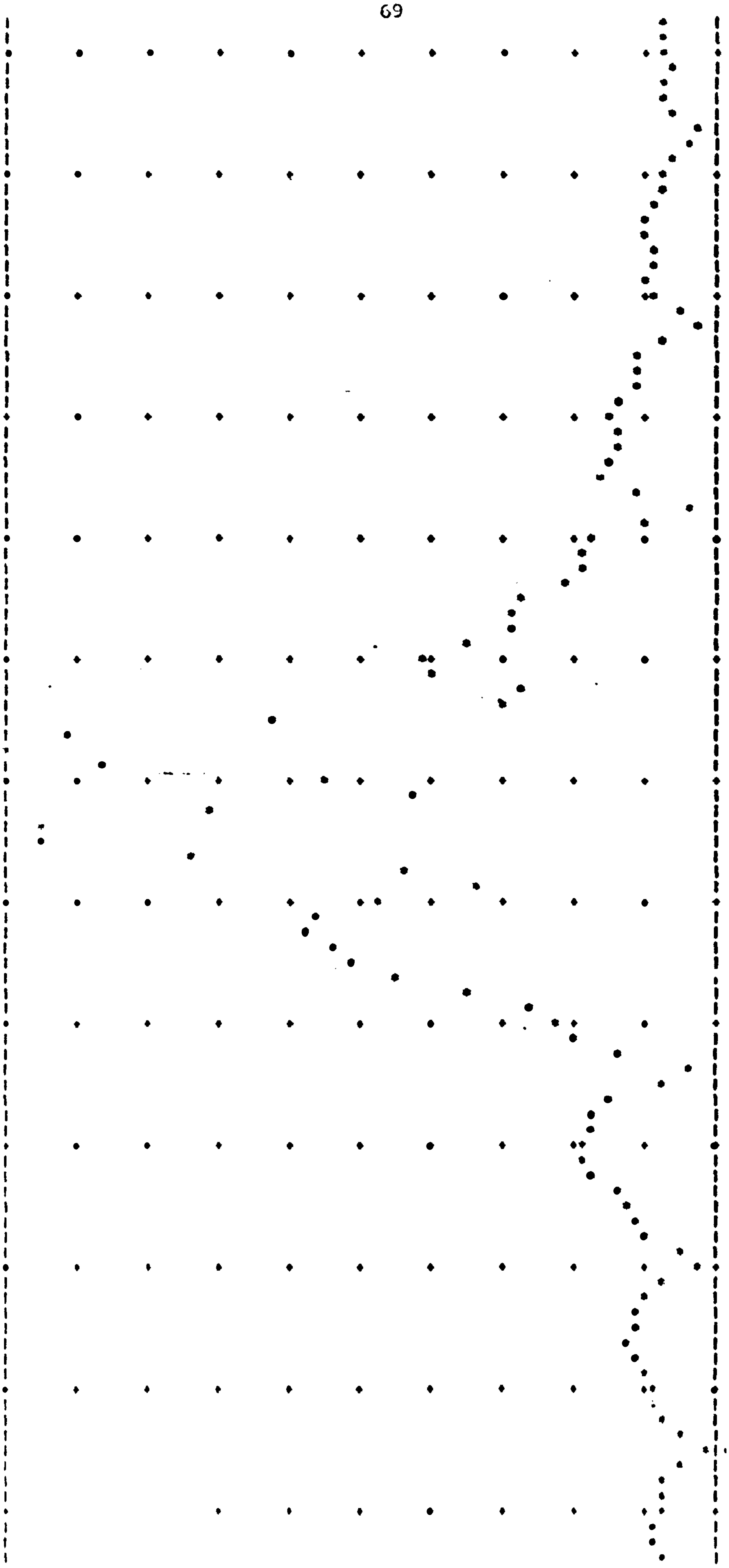

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-15.65	0.165	0.1080
-16.59	0.148	0.1060
-16.17	0.155	0.1040
-15.84	0.162	0.1020
-18.08	0.125	0.1000
-27.09	0.044	0.0980
-22.16	0.069	0.0960
-16.74	0.146	0.0940
-15.15	0.175	0.0920
-15.19	0.174	0.0900
-14.39	0.151	0.0880
-13.05	0.223	0.0860
-12.88	0.227	0.0840
-13.77	0.205	0.0820
-13.82	0.203	0.0800
-13.02	0.223	0.0780
-13.88	0.202	0.0760
-19.02	0.112	0.0740
-25.89	0.051	0.0720
-15.38	0.170	0.0700
-12.40	0.240	0.0680
-12.15	0.247	0.0660
-11.89	0.254	0.0640
-10.35	0.304	0.0620
-9.43	0.339	0.0600
-9.87	0.321	0.0580
-10.25	0.307	0.0560
-9.26	0.344	0.0540
-9.00	0.355	0.0520
-11.77	0.258	0.0500
-21.40	0.085	0.0480
-13.28	0.217	0.0460
-8.35	0.382	0.0440
-7.34	0.430	0.0420
-7.58	0.418	0.0400
-6.15	0.493	0.0380
-4.21	0.616	0.0360
-3.60	0.661	0.0340
-3.52	0.665	0.0320
-2.07	0.789	0.0300
-0.42	0.953	0.0280
-0.69	0.923	0.0260
-3.97	0.635	0.0240
-3.20	0.692	0.0220
3.07	1.425	0.0200
6.41	2.091	0.0180
7.22	2.322	0.0160
5.96	1.986	0.0140
1.97	1.255	0.0120
-0.22	0.975	0.0100
4.36	1.651	0.0080
6.79	2.186	0.0060
6.81	2.191	0.0040
4.60	1.698	0.0020
0.07	1.008	0.0300
-2.33	0.765	-0.0020
0.71	1.085	-0.0040
2.29	1.301	-0.0060
2.37	1.314	-0.0080
1.90	1.245	-0.0100
1.32	1.164	-0.0120
0.22	1.026	-0.0140
-1.81	0.811	-0.0160
-4.34	0.607	-0.0180
-5.81	0.512	-0.0200
-6.92	0.451	-0.0220
-10.41	0.302	-0.0240
-23.34	0.068	-0.0260
-15.19	0.174	-0.0280
-9.55	0.333	-0.0300
-8.16	0.391	-0.0320
-7.99	0.399	-0.0340
-7.59	0.417	-0.0360
-7.38	0.427	-0.0380
-8.27	0.386	-0.0400
-10.13	0.312	-0.0420
-11.32	0.272	-0.0440
-11.53	0.264	-0.0460
-13.42	0.213	-0.0480
-20.26	0.097	-0.0500
-25.56	0.053	-0.0570
-15.37	0.171	-0.0540
-12.84	0.228	-0.0560
-12.47	0.238	-0.0580
-12.15	0.247	-0.0600
-11.51	0.266	-0.0620
-11.69	0.260	-0.0640
-13.10	0.221	-0.0660
-14.55	0.187	-0.0680
-14.69	0.184	-0.0700
-15.45	0.169	-0.0720
-19.52	0.106	-0.0740
-37.21	0.014	-0.0760
-20.63	0.093	-0.0780
-16.37	0.152	-0.0800
-15.41	0.170	-0.0820
-15.27	0.172	-0.0840
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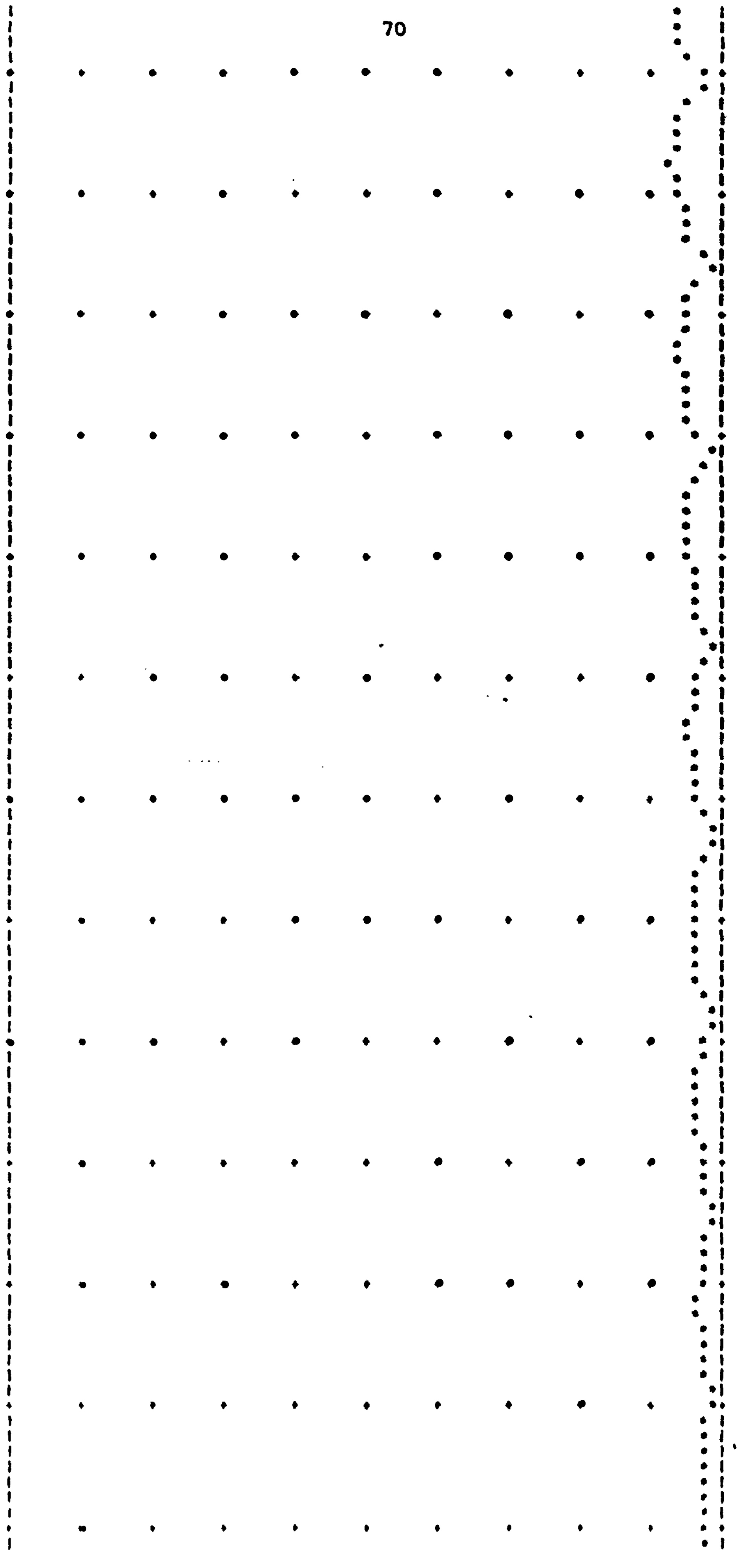

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-17.20   0.138   -0.0960
-19.52   0.106   -0.0980
-23.31   0.039   -0.1000
-26.59   0.045   -0.1020
-19.6[illegible]   0.105   -0.1040
-17.72   0.130   -0.1060
-17.54   0.133   -0.1080
-17.05   0.141   -0.1100
-16.30   0.152   -0.1120
-16.57   0.148   -0.1140
-17.99   0.126   -0.1160
-19.02   0.112   -0.1180
-18.87   0.114   -0.1200
-19.93   0.101   -0.1220
-24.57   0.056   -0.1240
-37.83   0.013   -0.1260
-23.28   0.069   -0.1280
-19.89   0.101   -0.1300
-19.29   0.108   -0.1320
-19.09   0.111   -0.1340
-18.25   0.122   -0.1360
-17.95   0.127   -0.1380
-18.94   0.113   -0.1400
-20.35   0.096   -0.1420
-20.48   0.095   -0.1440
-20.67   0.093   -0.1460
-23.52   0.067   -0.1480
-34.62   0.019   -0.1500
-28.22   0.039   -0.1520
-22.26   0.077   -0.1540
-20.80   0.091   -0.1560
-20.71   0.092   -0.1580
-20.08   0.099   -0.1600
-19.34   0.109   -0.1620
-19.74   0.103   -0.1640
-21.17   0.097   -0.1660
-21.90   0.080   -0.1680
-21.68   0.092   -0.1700
-23.05   0.071   -0.1720
-28.87   0.036   -0.1740
-36.66   0.014   -0.1760
-25.28   0.054   -0.1780
-22.38   0.076   -0.1800
-21.97   0.080   -0.1820
-21.70   0.082   -0.1840
-20.81   0.091   -0.1860
-20.59   0.093   -0.1880
-21.65   0.083   -0.1900
-22.93   0.071   -0.1920
-22.87   0.072   -0.1940
-23.17   0.069   -0.1960
-26.36   0.048   -0.1980
-38.99   0.011   -0.2000
-29.70   0.033   -0.2020
-24.25   0.061   -0.2040
-23.10   0.070   -0.2060
-23.02   0.071   -0.2080
-22.32   0.077   -0.2100
-21.[illegible]0   0.083   -0.2120
-22.05   0.079   -0.2140
-23.46   0.067   -0.2160
-24.04   0.063   -0.2180
-23.80   0.065   -0.2200
-25.26   0.055   -0.2220
-31.38   0.027   -0.2240
-37.90   0.013   -0.2260
-27.14   0.044   -0.2280
-24.38   0.060   -0.2300
-24.02   0.063   -0.2320
-23.74   0.065   -0.2340
-22.93   0.072   -0.2360
-22.60   0.074   -0.2380
-23.65   0.066   -0.2400
-24.82   0.057   -0.2420
-24.77   0.058   -0.2440
-25.04   0.056   -0.2460
-28.18   0.039   -0.2480
-40.44   0.009   -0.2500
-31.65   0.026   -0.2520
-26.22   0.049   -0.2540
-24.93   0.057   -0.2560
-24.65   0.057   -0.2580
-24.19   0.062   -0.2600
-23.43   0.067   -0.2620
-23.80   0.065   -0.2640
-25.17   0.055   -0.2660
-25.78   0.051   -0.2680
-25.49   0.053   -0.2700
-26.77   0.046   -0.2720
-32.39   0.024   -0.2740
-41.07   0.009   -0.2760
-29.17   0.035   -0.2780
-26.13   0.049   -0.2800
-25.[illegible]8   0.052   -0.2820
-25.46   0.053   -0.2840
-24.56   0.059   -0.2860
-24.21   0.062   -0.2880
-25.12   0.055   -0.2900
-26.4[illegible]   0.04[illegible]   -0.2920
-26.[illegible]   0.048   -0.2940
```

```
-26.45     0.049  I                                                                             * I   -0.2960
-29.07     0.035  I                                                                             * I   -0.2980
-39.04     0.011  I                                                                              *I   -0.3000
-34.58     0.019  I                                                                              *I   -0.3020
-28.14     0.039  I                                                                             * I   -0.3040
-26.49     0.047  I                                                                             * I   -0.3060
-26.40     0.048  +       +       +       +       +       +       +       +       +       +     * +   -0.3080
-25.86     0.051  I                                                                             * I   -0.3100
-25.00     0.056  I                                                                             * I   -0.3120
-25.15     0.055  I                                                                             * I   -0.3140
-26.42     0.048  I                                                                             * I   -0.3160
-27.25     0.043  I                                                                             * I   -0.3180
-26.93     0.045  I                                                                             * I   -0.3200
-27.72     0.041  I                                                                             * I   -0.3220
-32.10     0.025  +       +       +       +       +       +       +       +       +       +      *+   -0.3240
-46.83     0.005  I                                                                              *I   -0.3260
-31.81     0.026  I                                                                              *I   -0.3280
-27.86     0.040  I                                                                             * I   -0.3300
-27.07     0.044  I                                                                             * I   -0.3320
-26.98     0.045  I                                                                             * I   -0.3340
-26.17     0.049  I                                                                             * I   -0.3360
-25.57     0.053  I                                                                             * I   -0.3380
-26.19     0.049  +       +       +       +       +       +       +       +       +       +     * +   -0.3400
-27.54     0.042  I                                                                             * I   -0.3420
-27.82     0.041  I                                                                             * I   -0.3440
-27.59     0.042  I                                                                             * I   -0.3460
-29.30     0.034  I                                                                             * I   -0.3480
-36.07     0.016  I                                                                              *I   -0.3500
-39.94     0.010  I                                                                              *I   -0.3520
-30.52     0.030  I                                                                              *I   -0.3540
-27.99     0.040  +       +       +       +       +       +       +       +       +       +     * +   -0.3560
-27.69     0.041  I                                                                             * I   -0.3580
-27.42     0.043  I                                                                             * I   -0.3600
-26.58     0.047  I                                                                             * I   -0.3620
-26.25     0.049  I                                                                             * I   -0.3640
-27.23     0.043  I                                                                             * I   -0.3660
-28.41     0.038  I                                                                             * I   -0.3680
-28.27     0.039  I                                                                             * I   -0.3700
-28.40     0.038  +       +       +       +       +       +       +       +       +       +     * +   -0.3720
-31.15     0.028  I                                                                              *I   -0.3740
-41.46     0.008  I                                                                              *I   -0.3760
-36.18     0.016  I                                                                              *I   -0.3780
-29.97     0.032  I                                                                              *I   -0.3800
-28.36     0.038  I                                                                             * I   -0.3820
-28.28     0.039  I                                                                             * I   -0.3840
-27.76     0.041  I                                                                             * I   -0.3860
-26.90     0.045  +       +       +       +       +       +       +       +       +       +     * +   -0.3880
-26.99     0.045  I                                                                             * I   -0.3900
-28.21     0.039  I                                                                             * I   -0.3920
-29.07     0.035  I                                                                             * I   -0.3940
-28.72     0.037  I                                                                             * I   -0.3960
-29.33     0.034  I                                                                             * I   -0.3980
-33.21     0.022  I                                                                              *I   -0.4000
-47.75     0.004                                                                                  *   -0.4020
-34.37     0.019  +       +       +       +       +       +       +       +       +       +      *+   -0.4040
-29.85     0.032  I                                                                              *I   -0.4060
-23.82     0.036  I                                                                             * I   -0.4080
-28.79     0.036  I                                                                             * I   -0.4100
-28.09     0.039  I                                                                             * I   -0.4120
-27.36     0.043  I                                                                             * I   -0.4140
-27.75     0.041  I                                                                             * I   -0.4160
-29.06     0.035  I                                                                             * I   -0.4180
-29.58     0.033  +       +       +       +       +       +       +       +       +       +     * +   -0.4200
-29.21     0.035  I                                                                             * I   -0.4220
-30.31     0.031  I                                                                              *I   -0.4240
-35.33     0.017  I                                                                              *I   -0.4260
-46.79     0.005  I                                                                              *I   -0.4280
-33.47     0.021  I                                                                              *I   -0.4300
-29.58     0.032  I                                                                              *I   -0.4320
-29.32     0.034  I                                                                             * I   -0.4340
-29.24     0.035  +       +       +       +       +       +       +       +       +       +     * +   -0.4360
-28.43     0.038  I                                                                             * I   -0.4380
-27.26     0.040  I                                                                             * I   -0.4400
-28.47     0.038  I                                                                             * I   -0.4420
-29.77     0.032  I                                                                              *I   -0.4440
-30.02     0.032  I                                                                              *I   -0.4460
-29.73     0.033  I                                                                              *I   -0.4480
-31.25     0.027  I                                                                              *I   -0.4500
-37.23     0.014  +       +       +       +       +       +       +       +       +       +      *+   -0.4520
-43.74     0.006  I                                                                              *I   -0.4540
-33.13     0.022  I                                                                              *I   -0.4560
-30.25     0.031  I                                                                              *I   -0.4580
-29.81     0.032  I                                                                              *I   -0.4600
-29.66     0.033  I                                                                              *I   -0.4620
-28.80     0.036  I                                                                             * I   -0.4640
-28.36     0.038  I                                                                             * I   -0.4660
-29.11     0.035  +       +       +       +       +       +       +       +       +       +     * +   -0.4680
-30.37     0.030  I                                                                              *I   -0.4700
-30.44     0.030  I                                                                              *I   -0.4720
-30.24     0.031  I                                                                              *I   -0.4740
-32.06     0.025  I                                                                              *I   -0.4760
-38.94     0.011  I                                                                              *I   -0.4780
-42.37     0.005  I                                                                              *I   -0.4800
-33.15     0.022  I                                                                              *I   -0.4820
-30.60     0.029  +       +       +       +       +       +       +       +       +       +      *+   -0.4840
-30.29     0.031  I                                                                              *I   -0.4860
-30.08     0.031  I                                                                              *I   -0.4880
-29.21     0.035  I                                                                             * I   -0.4900
-28.64     0.036  I                                                                             * I   -0.4920
-29.67     0.033  I                                                                              *I   -0.4940
-30.[illegible]  0.029  I                                                                        *I   -0.4960
-30.[illegible]  0.029  I                                                                        *I   -0.4980
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                            Y-AXIS PROFILE PLOT ALONG   0.0  LONGITUDE.
                            PATTERN NUMBER   101

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  -32.73     0.023  I                                                                                  * I    3.9998
  -33.41     0.021  I                                                                                  * I    3.9918
  -34.16     0.020  I                                                                                  * I    3.9839
  -34.99     0.018  I                                                                                  * I    3.9759
  -35.93     0.016  +        +        +       +        +       +        +       +        +       +     * +    3.9679
  -37.00     0.014  I                                                                                  * I    3.9599
  -38.24     0.012  I                                                                                   *I    3.9519
  -39.71     0.010  I                                                                                   *I    3.9439
  -41.50     0.008  I                                                                                   *I    3.9359
  -43.81     0.006  I                                                                                   *I    3.9279
  -46.99     0.004  I                                                                                   *I    3.9199
  -52.16     0.002  I                                                                                   *I    3.9119
  -67.35     0.000  +        +        +       +        +       +        +       +        +       +      *+    3.9039
  -55.77     0.002  I                                                                                   *I    3.8959
  -48.61     0.004  I                                                                                   *I    3.8879
  -44.70     0.006  I                                                                                   *I    3.8799
  -41.95     0.008  I                                                                                   *I    3.8719
  -39.91     0.010  I                                                                                   *I    3.8639
  -38.21     0.012  I                                                                                   *I    3.8559
  -36.78     0.014  I                                                                                  * I    3.8479
  -35.54     0.017  +        +        +       +        +       +        +       +        +       +     * +    3.8399
  -34.44     0.019  I                                                                                  * I    3.8319
  -33.46     0.021  I                                                                                  * I    3.8239
  -32.57     0.024  I                                                                                  * I    3.8159
  -31.76     0.026  I                                                                                 *  I    3.8079
  -31.01     0.028  I                                                                                 *  I    3.7999
  -30.31     0.031  I                                                                                 *  I    3.7919
  -29.66     0.033  I                                                                                 *  I    3.7839
  -29.05     0.035  +        +        +       +        +       +        +       +        +       +    *  +    3.7759
  -28.48     0.038  I                                                                                 *  I    3.7679
  -27.94     0.040  I                                                                                *   I    3.7599
  -27.43     0.043  I                                                                                *   I    3.7519
  -26.94     0.045  I                                                                                *   I    3.7439
  -26.48     0.047  I                                                                                *   I    3.7359
  -26.03     0.050  I                                                                                *   I    3.7279
  -25.61     0.052  I                                                                               *    I    3.7199
  -25.21     0.055  +                 +       +        +       +        +       +        +       +  *    +    3.7119
  -24.82     0.057  I                                                                               *    I    3.7039
  -24.44     0.060  I                                                                               *    I    3.6959
  -24.08     0.063  I                                                                               *    I    3.6879
  -23.74     0.065  I                                                                              *     I    3.6799
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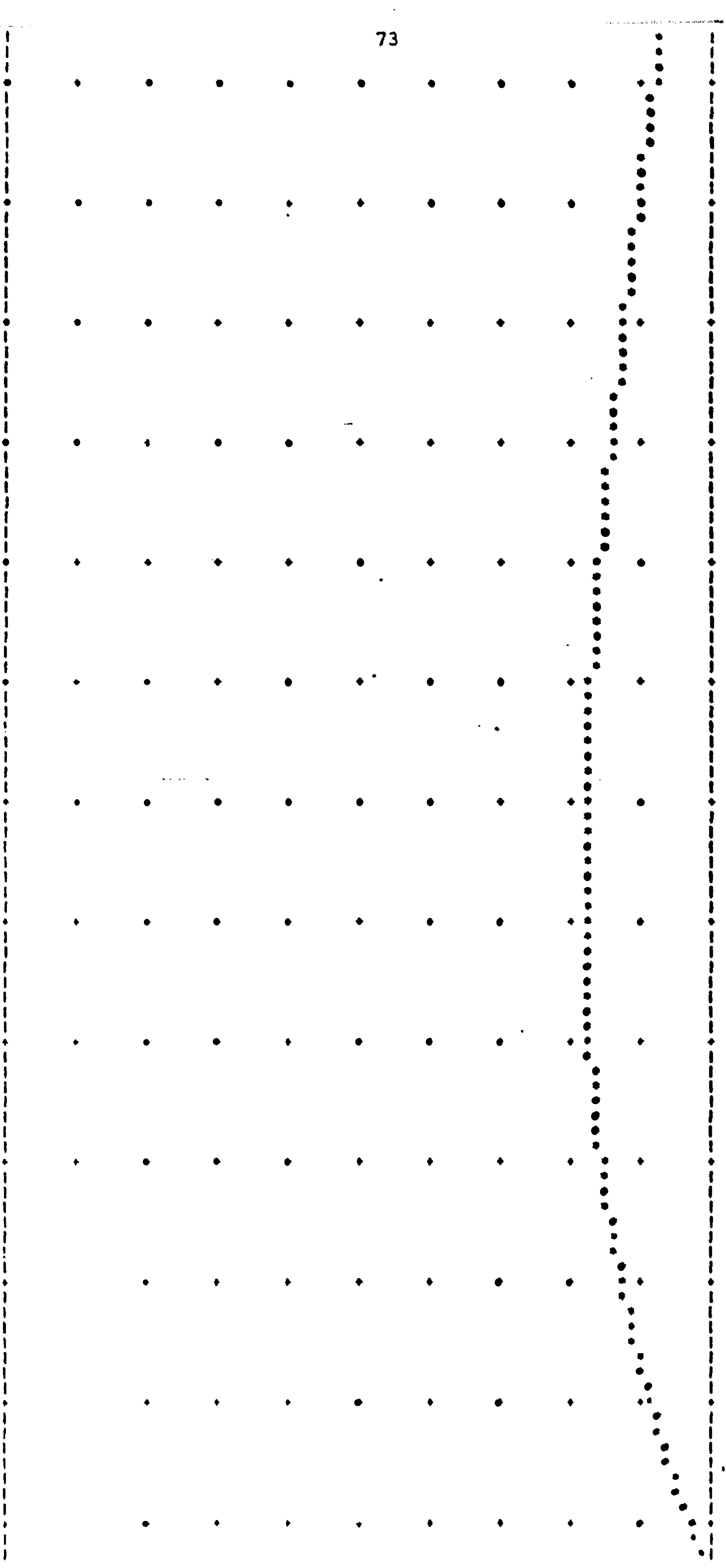

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-21.62	0.083	3.6239
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-21.10	0.088	3.6079
-20.65	0.091	3.5999
-20.61	0.093	3.5919
-20.37	0.096	3.5839
-20.14	0.098	3.5759
-19.92	0.101	3.5679
-19.71	0.103	3.5599
-19.50	0.106	3.5519
-19.30	0.108	3.5439
-19.10	0.111	3.5359
-18.91	0.113	3.5279
-18.72	0.116	3.5199
-18.54	0.118	3.5119
-18.37	0.121	3.5039
-18.20	0.123	3.4959
-18.04	0.125	3.4879
-17.88	0.128	3.4799
-17.72	0.130	3.4719
-17.57	0.132	3.4639
-17.43	0.134	3.4559
-17.29	0.137	3.4479
-17.15	0.139	3.4399
-17.02	0.141	3.4319
-16.90	0.143	3.4239
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-16.66	0.147	3.4079
-16.54	0.149	3.3999
-16.44	0.151	3.3919
-16.33	0.153	3.3839
-16.23	0.154	3.3759
-16.14	0.156	3.3679
-16.05	0.158	3.3599
-15.96	0.159	3.3519
-15.88	0.161	3.3439
-15.81	0.162	3.3359
-15.74	0.163	3.3279
-15.67	0.165	3.3199
-15.61	0.166	3.3119
-15.55	0.167	3.3039
-15.50	0.168	3.2959
-15.45	0.169	3.2879
-15.41	0.170	3.2799
-15.37	0.170	3.2719
-15.34	0.171	3.2639
-15.31	0.172	3.2559
-15.29	0.172	3.2479
-15.27	0.172	3.2399
-15.26	0.173	3.2319
-15.25	0.173	3.2239
-15.25	0.173	3.2159
-15.26	0.173	3.2079
-15.27	0.172	3.1999
-15.29	0.172	3.1919
-15.32	0.171	3.1839
-15.35	0.171	3.1759
-15.39	0.170	3.1679
-15.44	0.169	3.1599
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-16.55	0.149	3.0719
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-16.90	0.143	3.0560
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-17.80	0.129	3.0240
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-26.40	0.047	2.9040
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-29.85	0.032	2.8880
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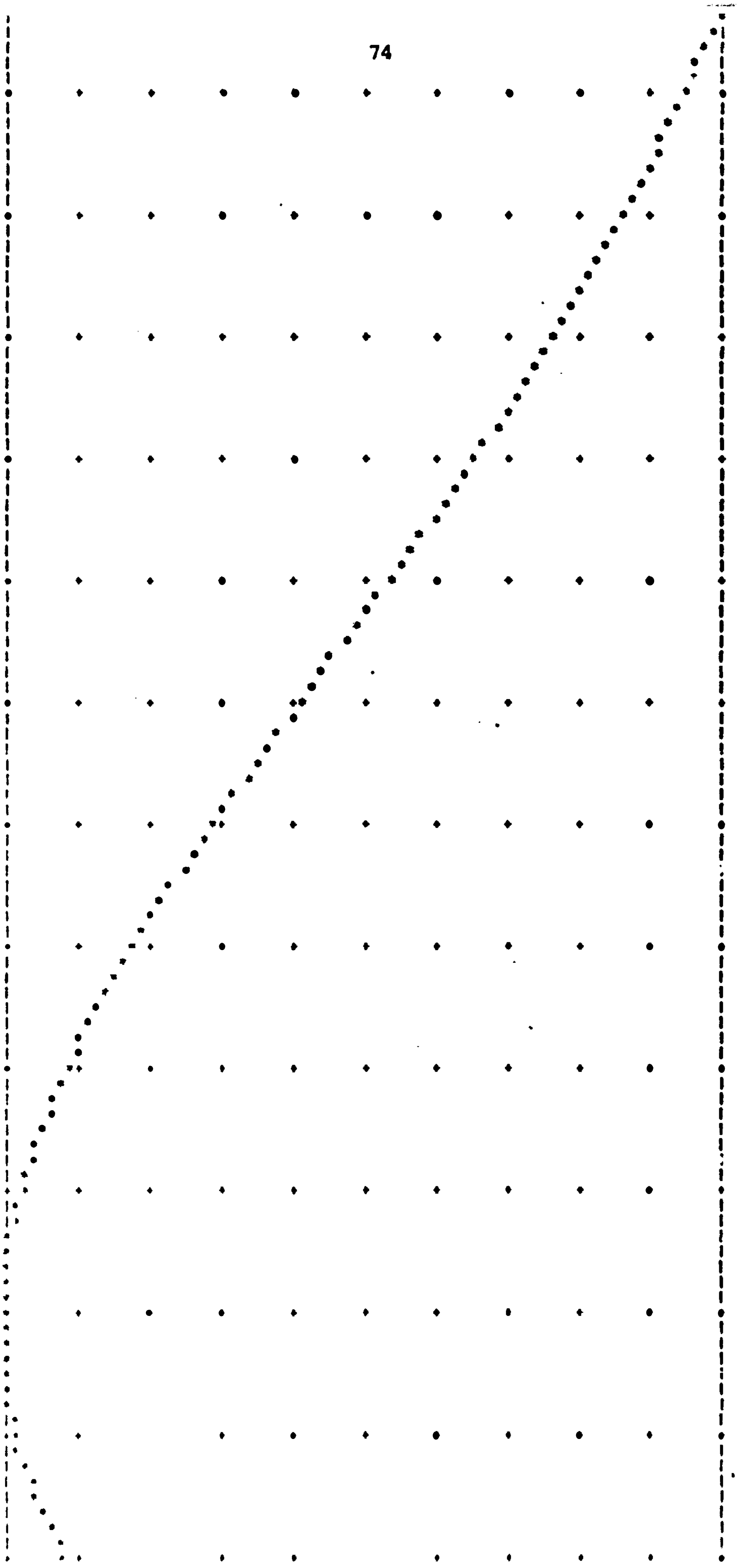

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-18.45	0.120	2.7600
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-16.91	0.143	2.7440
-16.22	0.155	2.7360
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-10.09	0.313	2.6400
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-8.26	0.386	2.6000
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-7.61	0.416	2.5840
-7.30	0.432	2.5760
-7.00	0.447	2.5680
-6.70	0.462	2.5600
-6.42	0.478	2.5520
-6.14	0.493	2.5440
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-5.61	0.524	2.5280
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-0.15	0.982	2.2320
-0.11	0.987	2.2240
-0.07	0.992	2.2160
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0.03	1.003	2.1680
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0.02	1.002	2.1520
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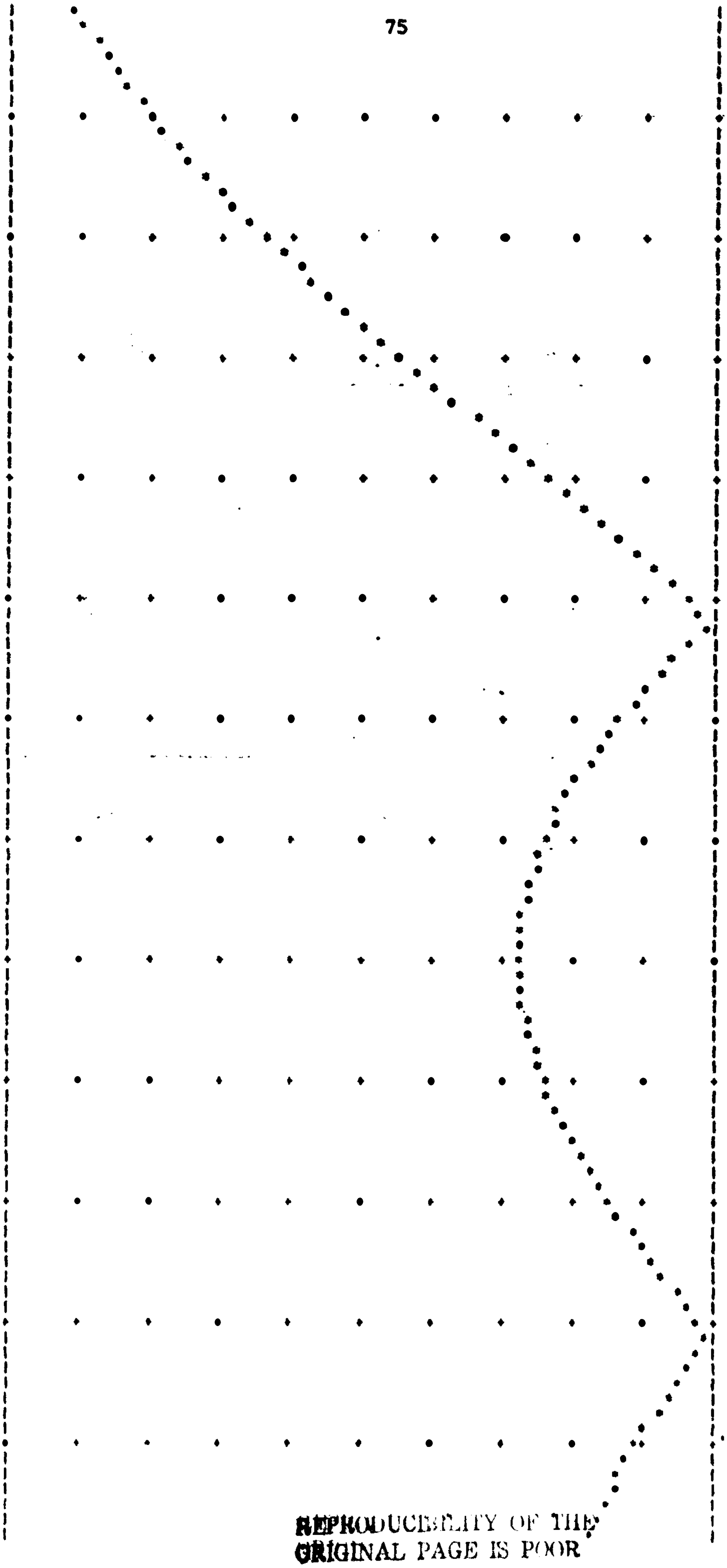

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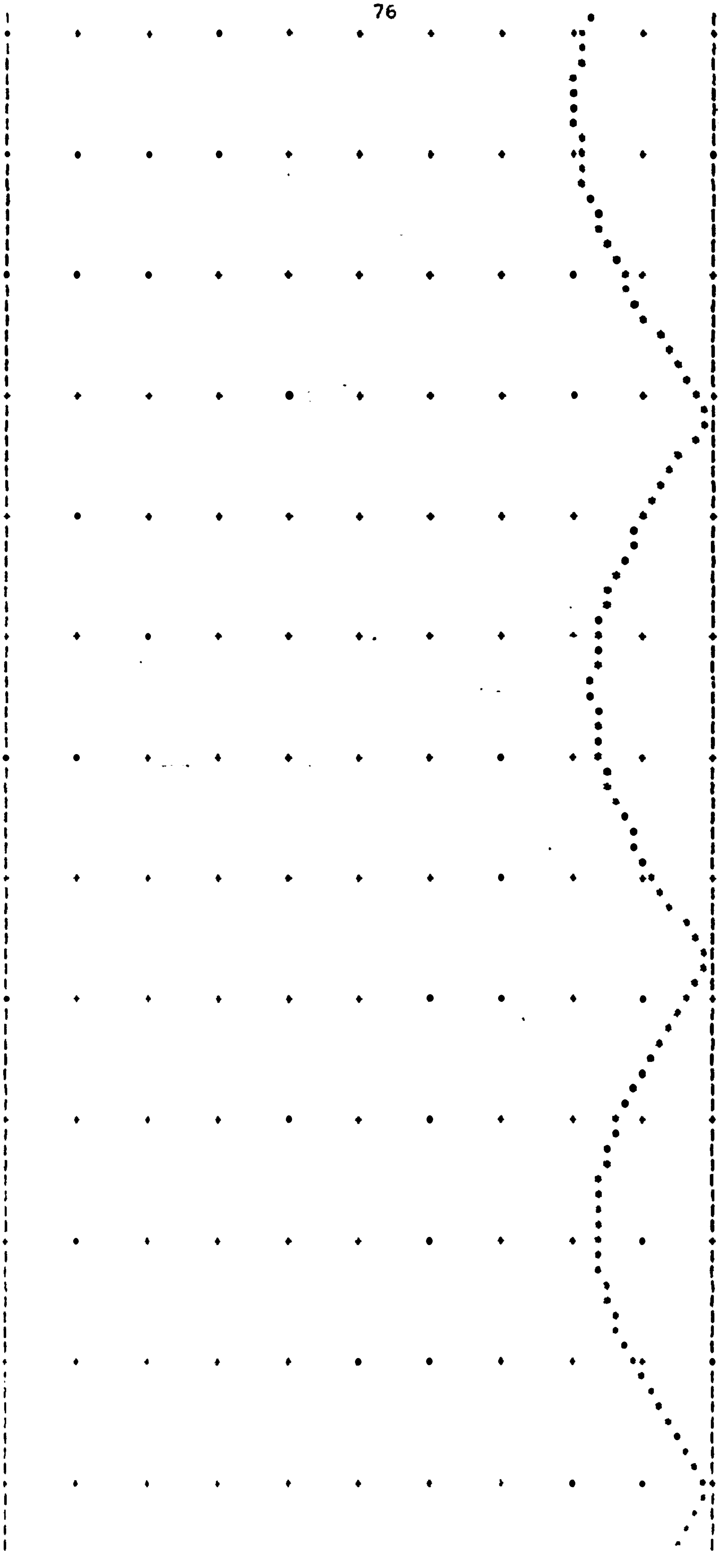
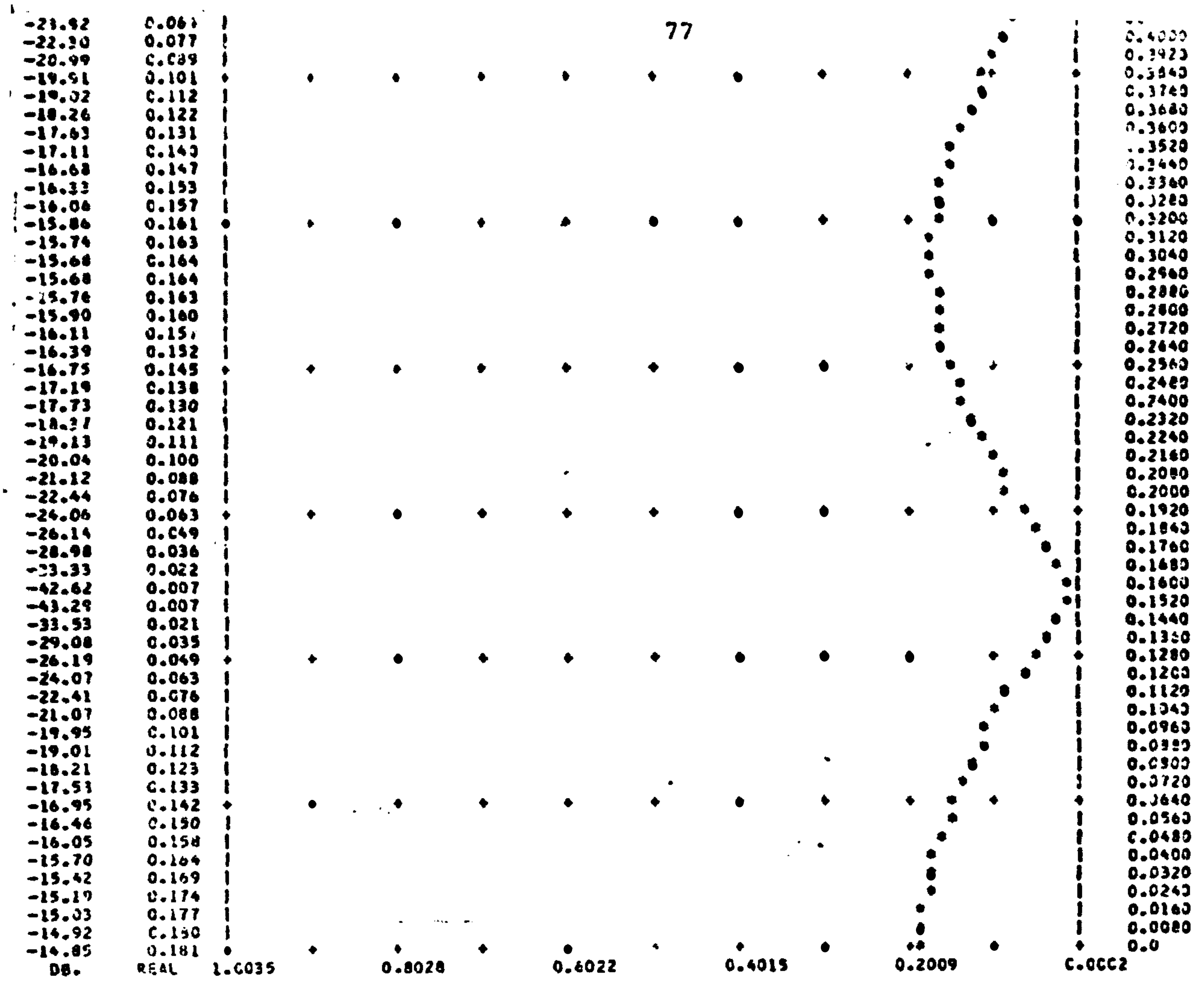
-3.35	0.680	1.9360
-3.64	0.658	1.9280
-3.94	0.636	1.9200
-4.25	0.613	1.9120
-4.59	0.589	1.9040
-4.95	0.566	1.8960
-5.33	0.542	1.8880
-5.73	0.517	1.8800
-6.16	0.492	1.8720
-6.61	0.467	1.8640
-7.10	0.442	1.8560
-7.62	0.416	1.8480
-8.18	0.390	1.8400
-8.77	0.364	1.8320
-9.42	0.338	1.8240
-10.12	0.312	1.8160
-10.87	0.286	1.8080
-11.70	0.260	1.8000
-12.61	0.234	1.7920
-13.63	0.208	1.7840
-14.77	0.183	1.7760
-16.06	0.157	1.7680
-17.57	0.132	1.7600
-19.36	0.108	1.7520
-21.59	0.083	1.7440
-24.52	0.059	1.7360
-28.85	0.036	1.7280
-37.55	0.013	1.7200
-40.94	0.009	1.7120
-30.29	0.031	1.7040
-25.76	0.052	1.6960
-22.89	0.072	1.6880
-20.81	0.091	1.6800
-19.19	0.110	1.6720
-17.89	0.128	1.6640
-16.81	0.144	1.6560
-15.90	0.160	1.6480
-15.12	0.175	1.6400
-14.46	0.189	1.6320
-13.88	0.202	1.6240
-13.39	0.214	1.6160
-12.96	0.225	1.6080
-12.59	0.235	1.6000
-12.28	0.243	1.5920
-12.01	0.251	1.5840
-11.80	0.257	1.5760
-11.63	0.262	1.5680
-11.49	0.266	1.5600
-11.40	0.269	1.5520
-11.35	0.271	1.5440
-11.33	0.271	1.5360
-11.35	0.271	1.5280
-11.41	0.269	1.5200
-11.50	0.266	1.5120
-11.63	0.262	1.5040
-11.80	0.257	1.4960
-12.01	0.251	1.4880
-12.26	0.244	1.4800
-12.56	0.236	1.4720
-12.89	0.227	1.4640
-13.29	0.217	1.4560
-13.73	0.206	1.4480
-14.23	0.194	1.4400
-14.80	0.182	1.4320
-15.44	0.169	1.4240
-16.17	0.155	1.4160
-16.99	0.141	1.4080
-17.94	0.127	1.4000
-19.04	0.112	1.3920
-20.33	0.096	1.3840
-21.88	0.081	1.3760
-23.79	0.065	1.3680
-26.26	0.049	1.3600
-29.74	0.033	1.3520
-35.63	0.017	1.3440
-64.65	0.001	1.3360
-36.38	0.015	1.3280
-30.26	0.031	1.3200
-26.77	0.046	1.3120
-24.35	0.061	1.3040
-22.51	0.075	1.2960
-21.05	0.089	1.2880
-19.85	0.102	1.2800
-18.85	0.114	1.2720
-18.00	0.126	1.2640
-17.29	0.137	1.2560
-16.65	0.147	1.2480
-16.15	0.156	1.2400
-15.71	0.164	1.2320



-15.34	0.171	1.2240
-15.04	0.177	1.2160
-14.80	0.182	1.2080
-14.61	0.186	1.2000
-14.49	0.189	1.1920
-14.41	0.190	1.1840
-14.39	0.191	1.1760
-14.42	0.190	1.1680
-14.50	0.189	1.1600
-14.64	0.185	1.1520
-14.83	0.181	1.1440
-15.08	0.176	1.1360
-15.29	0.170	1.1280
-15.77	0.163	1.1200
-16.22	0.155	1.1120
-16.74	0.145	1.1040
-17.36	0.136	1.0960
-18.08	0.125	1.0880
-18.92	0.113	1.0800
-19.91	0.101	1.0720
-21.08	0.088	1.0640
-22.49	0.075	1.0560
-24.24	0.061	1.0480
-26.49	0.047	1.0400
-29.60	0.033	1.0 20
-34.55	0.019	1.0240
-47.40	0.004	1.0160
-39.87	0.010	1.0080
-32.24	0.024	1.0000
-28.30	0.038	0.9920
-25.65	0.052	0.9840
-23.68	0.065	0.9760
-22.13	0.078	0.9680
-20.87	0.090	0.9600
-19.84	0.102	0.9520
-18.97	0.113	0.9440
-18.24	0.122	0.9360
-17.62	0.131	0.9280
-17.11	0.139	0.9200
-16.69	0.146	0.9170
-16.34	0.152	0.9040
-16.08	0.157	0.8960
-15.98	0.161	0.8880
-15.75	0.163	0.8800
-15.69	0.164	0.8720
-15.69	0.164	0.8640
-15.76	0.163	0.8560
-15.39	0.160	0.8480
-16.09	0.157	0.8400
-16.37	0.152	0.8320
-16.71	0.145	0.8240
-17.15	0.139	0.8160
-17.67	0.131	0.8080
-18.30	0.122	0.8000
-19.04	0.112	0.7920
-19.93	0.101	0.7840
-21.00	0.089	0.7760
-22.29	0.077	0.7680
-23.88	0.064	0.7600
-25.92	0.051	0.7520
-28.67	0.037	0.7440
-32.83	0.023	0.7360
-41.25	0.009	0.7280
-45.98	0.005	0.7200
-34.09	0.020	0.7120
-29.43	0.034	0.7040
-26.47	0.047	0.6960
-24.32	0.061	0.6880
-22.65	0.074	0.6900
-21.31	0.086	0.6720
-20.22	0.098	0.6640
-19.31	0.108	0.6560
-18.54	0.118	0.6480
-17.91	0.127	0.6400
-17.38	0.135	0.6320
-16.95	0.142	0.6240
-16.61	0.148	0.6160
-16.35	0.152	0.6080
-16.17	0.155	0.6000
-16.05	0.158	0.5920
-16.01	0.158	0.5840
-16.04	0.158	0.5760
-16.14	0.156	0.5680
-16.32	0.153	0.5600
-16.56	0.149	0.5520
-16.89	0.143	0.5440
-17.31	0.136	0.5360
-17.82	0.128	0.5280
-18.44	0.120	0.5200
-19.19	0.110	0.5120
-20.08	0.099	0.5040
-21.16	0.087	0.4960
-22.47	0.075	0.4880
-24.10	0.062	0.4800
-26.21	0.049	0.4720
-29.09	0.035	0.4640
-33.56	0.021	0.4560
[illegible]	0.007	0.4480
-42.27	[illegible]	0.4400
-35.13	[illegible]	0.4320
[illegible]	[illegible]	0.4240
[illegible]	[illegible]	0.4160



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 -23.92    0.063
 -22.30    0.077     0.4000
 -20.99    0.089     0.3920
 -19.91    0.101     0.3840
 -19.02    0.112     0.3760
 -18.26    0.122     0.3680
 -17.63    0.131     0.3600
 -17.11    0.140     0.3520
 -16.68    0.147     0.3440
 -16.33    0.153     0.3360
 -16.06    0.157     0.3280
 -15.86    0.161     0.3200
 -15.74    0.163     0.3120
 -15.68    0.164     0.3040
 -15.68    0.164     0.2960
 -15.76    0.163     0.2880
 -15.90    0.160     0.2800
 -16.11    0.157     0.2720
 -16.39    0.152     0.2640
 -16.75    0.145     0.2560
 -17.19    0.138     0.2480
 -17.73    0.130     0.2400
 -18.37    0.121     0.2320
 -19.13    0.111     0.2240
 -20.04    0.100     0.2160
 -21.12    0.088     0.2080
 -22.44    0.076     0.2000
 -24.06    0.063     0.1920
 -26.14    0.049     0.1840
 -28.98    0.036     0.1760
 -33.33    0.022     0.1680
 -42.62    0.007     0.1600
 -43.29    0.007     0.1520
 -33.53    0.021     0.1440
 -29.08    0.035     0.1360
 -26.19    0.049     0.1280
 -24.07    0.063     0.1200
 -22.41    0.076     0.1120
 -21.07    0.088     0.1040
 -19.95    0.101     0.0960
 -19.01    0.112     0.0880
 -18.21    0.123     0.0800
 -17.53    0.133     0.0720
 -16.95    0.142     0.0640
 -16.46    0.150     0.0560
 -16.05    0.158     0.0480
 -15.70    0.164     0.0400
 -15.42    0.169     0.0320
 -15.19    0.174     0.0240
 -15.03    0.177     0.0160
 -14.92    0.180     0.0080
 -14.85    0.181     0.0
   DB.     REAL   1.0035   0.8028   0.6022   0.4015   0.2009   0.0002
```

```
EXAMPLE 3:
   DEMONSTRATION OF THERMALLY INDUCED MECHANICAL DEFORMATIONS
   (SPHERICAL) ON THE FULL X-BAND HORIZONTAL ARRAY.
6



SYSTEM INFORMATION:
     FREQUENCY =  5.000 GHZ.
     YAW =     0.0   DEGREES
     TILT =   50.000 DEGREES
     TWIST =    0.0   DEGREES
     ALTITUDE =  200.000 KM.


ANTENNA PARAMETERS FOR SIMULATION NUMBER 102
     ELEMENT TYPE: HORIZONTAL DIPOLE
     NUMBER OF ELEMENTS (X,Y) = (504 ,  12)
     INTERELEMENT SPACING (CM.):  2.2966 ,  2.3550
     INTERELEMENT PHASE SHIFT (DEG.):  0.0     ,  0.0


    DEFORMATION DATA FOR SIMULATION 102:

5.00      3.47      2.22      1.25      0.55      0.14      0.0       0.14      0.55      1.25
2.22      3.47      5.00


5.00      3.47      2.22      1.25      0.55      0.14      0.0       0.14      0.55      1.25
2.22      3.47      5.00
```

```
    ELECTRICAL DATA FOR SIMULATION 102:

         ( 1, 1)   ( 2, 1)   ( 3, 1)   ( 4, 1)   ( 5, 1)   ( 6, 1)   ( 7, 1)   ( 8, 1)   ( 9, 1)   (10, 1)
(11, 1)  (12, 1)   (
  PHSX:    0.0      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
   0.0     0.0
  PHSY:    0.0      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
   0.0     0.0
  AMAG:    1.00     1.00      1.00      1.00      1.00      1.00      1.00      1.00      1.00      1.00
   1.00    1.00
  APHS:    0.0      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
   0.0     0.0




PRINT/PLOT INFORMATION:
     REQUESTED OUTPUT:
          PRINTER PROFILE
          PRINTER CONTOUR
     PLOT RESOLUTION: 151 X 151 POINTS


     STARTX =   -0.500
     STOPX =    0.500
     DELTAX =    0.007

     STARTY =    0.0
     STOPY =    4.000
     DELTAY =    0.027


    SUBARRAY DATA SUMMARY FOR PATTERN 102:
 AREA       XCENT       YCENT       ZAVG       ALPHAX       ALPHAY       AMAG       APHS       PHSX       PHSY
   1     [illegible]     0.0        4.29     [illegible]  [illegible]   1.0000      0.0        0.0        0.0
   2     [illegible]     0.0     [illegible]  -0.[illegible]            1.0000      0.0        0.0        0.0
```

```
  3      -337.60       0.0       1.74     -0.577      0.0       1.0000      0.0       0.0      0.
  4      -241.14       0.0       0.90     -0.413      0.000     1.0000      0.0       0.0      0.
  5      -144.69       0.0       0.35     -0.247      0.0       1.0000      0.0       0.0      0.
  6       -48.23       0.0       0.07     -0.082      0.0       1.0000      0.0       0.0      0.
  7        48.23       0.0       0.07      0.082      0.0       1.0000      0.0       0.0      0.
  8       144.69       0.0       0.35      0.247      0.0       1.0000      0.0       0.0      0.
  9       241.14       0.0       0.90      0.413      0.000     1.0000      0.0       0.0      0.
 10       337.60       0.0       1.74      0.577      0.0       1.0000      0.0       0.0      0.
 11       434.06       0.0       2.05      0.742      0.0       1.0000      0.0       0.0      0.
 12       530.51       0.0       4.24      0.908      0.0       1.0000      0.0       0.0      0.


          PREDICTED BEAM CENTER:
               LATITUDE =    2.1945
               LONGITUDE =     0.0
               RANGE = 243.978
               HEADING =    0.0



          PLOT NORMALIZATION FACTOR =  -51.369 DB.
```

```
                           PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 102

       0.0      0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
        I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
-0.5000.
-0.4933.
-0.4867.
-0.4800.
-0.4733.
-0.4667.
-0.4600.
-0.4533.
-0.4467.
-0.4400.
-0.4333.
-0.4267.
-0.4200.
-0.4133.
-0.4067.
-0.4000.
-0.3933.
-0.3867.
-0.3800.
-0.3733.
-0.3667.
-0.3600.
-0.3533.
-0.3467.
-0.3400.
-0.3333.
-0.3267.
-0.3200.
-0.3133.
-0.3067.
-0.3000.
-0.2933.
-0.2867.
-0.2800.
-0.2733.
-0.2667.
-0.2600.
-0.2533.
-0.2467.
-0.2400.
-0.2333.
-0.2267.                                                                                    0 0
-0.2200.                                                                                      0 0
-0.2133.
-0.2067.
-0.2000.                                                                                            0
-0.1933.                                                                                    0 0 0
-0.1867.
-0.1800.                                                                                      0 0 0 0
-0.1733.
-0.1667.                                                                0 0                         0
-0.1600.                                                                                    0 0
-0.1533.                                                                                    0 1 1 1
-0.1467.                                                                                      0 1 1 1 0
-0.1400.                                                            0 0                           0 0 0
-0.1333.0 0                                     0 0 0               0 0 0 0               0 0 0
-0.1267.0 0                                     0 0 0 0               0 0 0 0                 0 0 1 0 0
-0.1200.0 0                                     0 0 0 0                                   0 1 1 2 1 1 0
-0.1133.0 0 0                                                         0 1 1 1 0
-0.1067.                                        0 0 1 1 0                                     0 1 1 1 1 0
-0.1000.1 1 0 0           0 0 1 0 0                                       0 0 0           0 1 1 1 1 0 0
-0.0933.                                          0 0 0 0           0 0 0 0 0                         0
-0.0867.1 1 0 0           0 1 1 1 0                                                     0 1 2 2 2 2 1 0
-0.0800.                                              0 0         0 1 2 2 2 1 0           0 2 3 3 3 3 3 2 0
-0.0733.1 1 1 0         0 1 2 2 2 2 1 0       0 0 0               0 2 2 3 3 3 2 1         0 1 1 2 3 3 3 2 0
-0.0667.2 2 1 1 0       1 2 2 3 3 2 2 0     0 1 2 2 1 1 0         0 1 2 3 3 3 . 2 0     1 2 2 2 1 1 1 1 0
-0.0600.3 3 2 2 1     0 1 2 3 3 3 3 2 1     0 1 2 2 2 2 1 0       0 1 2 2 2 2 2 1       1 2 2 3 3 2 2 1 0
-0.0533.3 3 3 2 1     0 2 3 3 3 3 3 2 1     0 1 2 2 2 2 1 0         0 0 0 0               1 2 2 3 3 3 3 2 0
-0.0467.2 1 1 0           0 0 0 0 0           0 0 1 1 1 1 0       1 2 3 3 4 3 3 2 1   1 3 4 5 5 5 5 5 4 3 2
-0.0400.3 3 2 2 1     0 2 3 3 4 4 4 3 2     2 3 4 4 5 4 4 3 1   1 3 4 4 4 4 4 3 2 0     1 2 2 2 2 1 0
-0.0333.4 3 3 2 1     0 2 2 3 3 3 2 2 0         1 1 1 1 0           0 0 0 0                 0 1 2 2 2 2 2 0
-0.0267.4 4 3 3 1     0 2 2 3 3 3 2 2 1     0 2 3 3 4 4 3 3 1   1 3 4 5 5 6 5 5 4 2   2 4 5 6 6 7 7 6 6 5 3
-0.0200.4 4 4 3 2 0   1 3 4 4 5 5 4 4 2 0   2 3 4 4 4 4 3 2 1   0 2 3 3 3 3 3 2 1       1 2 2 3 3 3 3 2 1 0
-0.0133.5 5 5 4 3 0   1 3 4 4 4 4 4 3 1     0 2 2 2 2 2 1 0           0 0 0 1 0 0       1 3 3 4 4 4 4 4 3 2
-0.0067.5 5 5 4 3 1   2 4 5 6 6 6 6 5 4 1 0 3 4 6 6 6 6 6 5 3   3 5 6 6 6 6 6 6 5 3   3 5 6 6 7 7 7 6 6 5 3
-0.0000.6 6 5 5 4 1   2 4 5 5 5 5 5 4 3 0       4 4 4 4 4 3 1   0 2 3 4 4 4 4 3 2 0   0 2 3 4 4 4 4 4 3 2 1
 0.0067.5 5 5 4 3 1   2 4 5 6 6 6 6 5 4 1       6 6 6 6 6 . 3   3 5 6 6 6 6 6 6 5 3   3 5 6 6 7 7 7 5 6 5 3
 0.0133.5 5 5 4 3 0   1 3 4 4 4 4 4 3 1     0 2 2 2 2 2 1 0           0 0 0 1 0 0       1 3 3 4 4 . 4 4 3 2
 0.0200.4 4 4 3 2 0   1 3 4 4 5 5 4 4 2 0   2 3 4 4 4 4 3 2 1   0 2 3 3 3 3 3 2 1       1 2 2 3 3 3 3 2 1 0
 0.0267.4 4 3 3 1     0 2 2 3 3 3 2 2 1     0 2 3 3 4 4 3 3 1   1 3 4 5 5 6 5 5 4 2   2 4 5 6 6 7 7 6 6 5 3
 0.0333.4 3 3 2 1     0 2 2 3 3 3 2 2 0       0 1 1 1 1 0           0 0 0 0                 0 1 2 2 2 2 2 0
 0.0400.3 3 2 2 1     0 2 3 3 4 4 4 3 2     2 3 4 4 5 4 4 3 1   1 3 4 4 4 4 4 3 2 0     1 2 2 2 2 1 0
 0.0467.2 1 1 0           0 0 0 0 0           0 0 1 1 1 1 0       1 2 3 3 4 3 3 2 1   1 3 4 5 5 5 5 5 4 3 2
 0.0533.3 3 3 2 1     0 2 3 3 3 3 3 2 1     0 1 2 2 2 2 1 0         0 0 0 0               1 2 2 3 3 3 3 2 0
 0.0600.3 3 2 2 1     0 1 2 3 3 3 3 2 1     0 1 2 2 2 2 1 0       0 1 2 2 2 2 2 1       1 2 2 3 3 2 2 1 0
 0.0667.2 2 1 1 0       1 2 2 3 3 2 2 0     0 1 2 2 1 1 0         0 1 2 3 3 3 2 2 0     1 2 2 2 1 1 1 1 0
 0.0733.1 1 1 0         0 1 2 2 2 2 1 0       0 0 0               0 2 2 3 3 3 2 1         0 1 1 2 3 3 3 2 0
 0.0800.                                              0 0         0 1 2 2 2 1 0           0 2 3 3 3 3 3 2 0
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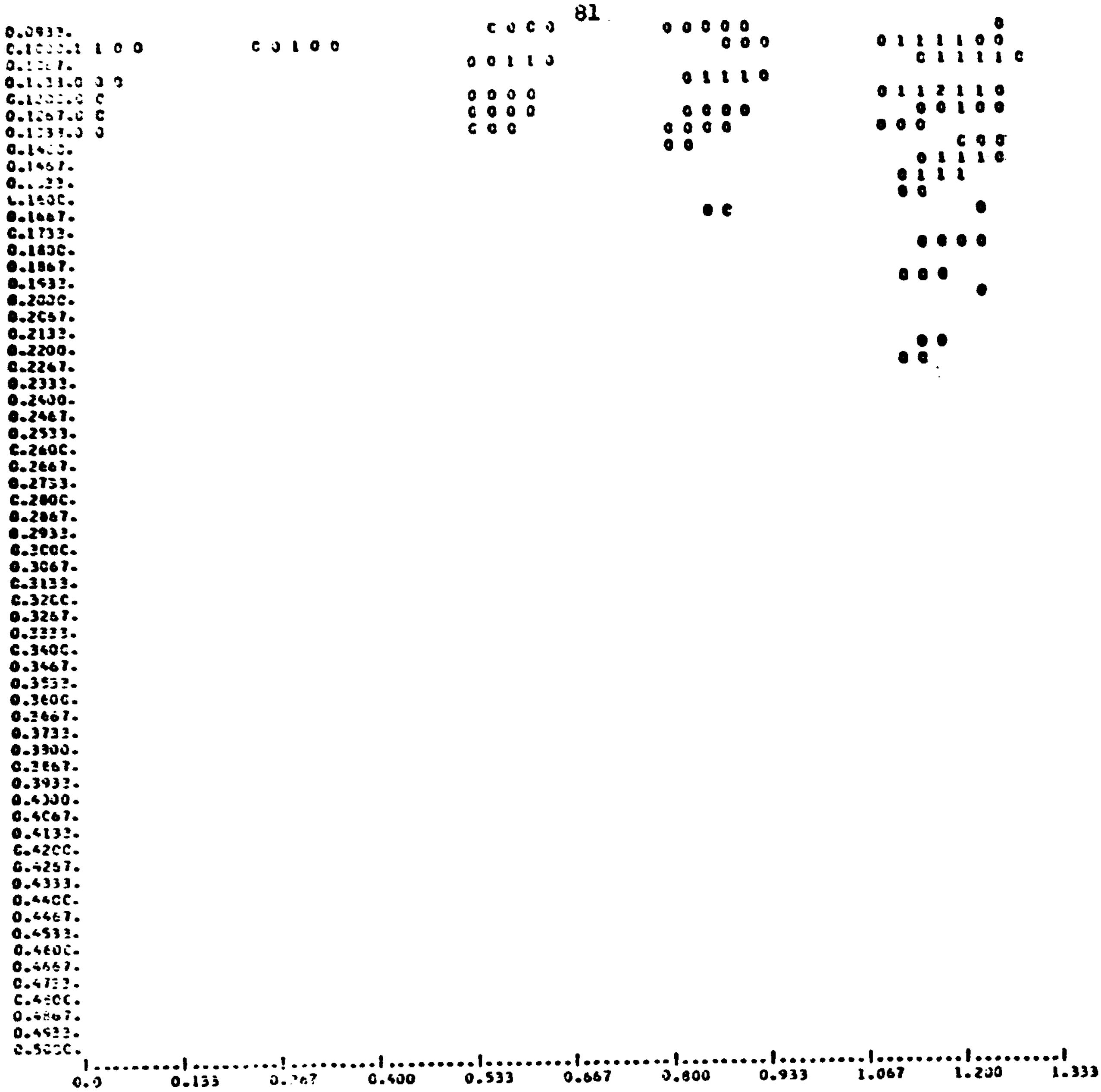
```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0.1667
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0.1800
0.1867
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0.2800
0.2867
0.2933
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0.3067
0.3133
0.3200
0.3267
0.3333
0.3400
0.3467
0.3533
0.3600
0.3667
0.3733
0.3800
0.3867
0.3933
0.4000
0.4067
0.4133
0.4200
0.4267
0.4333
0.4400
0.4467
0.4533
0.4600
0.4667
0.4733
0.4800
0.4867
0.4933
0.5000
0.0
0.133
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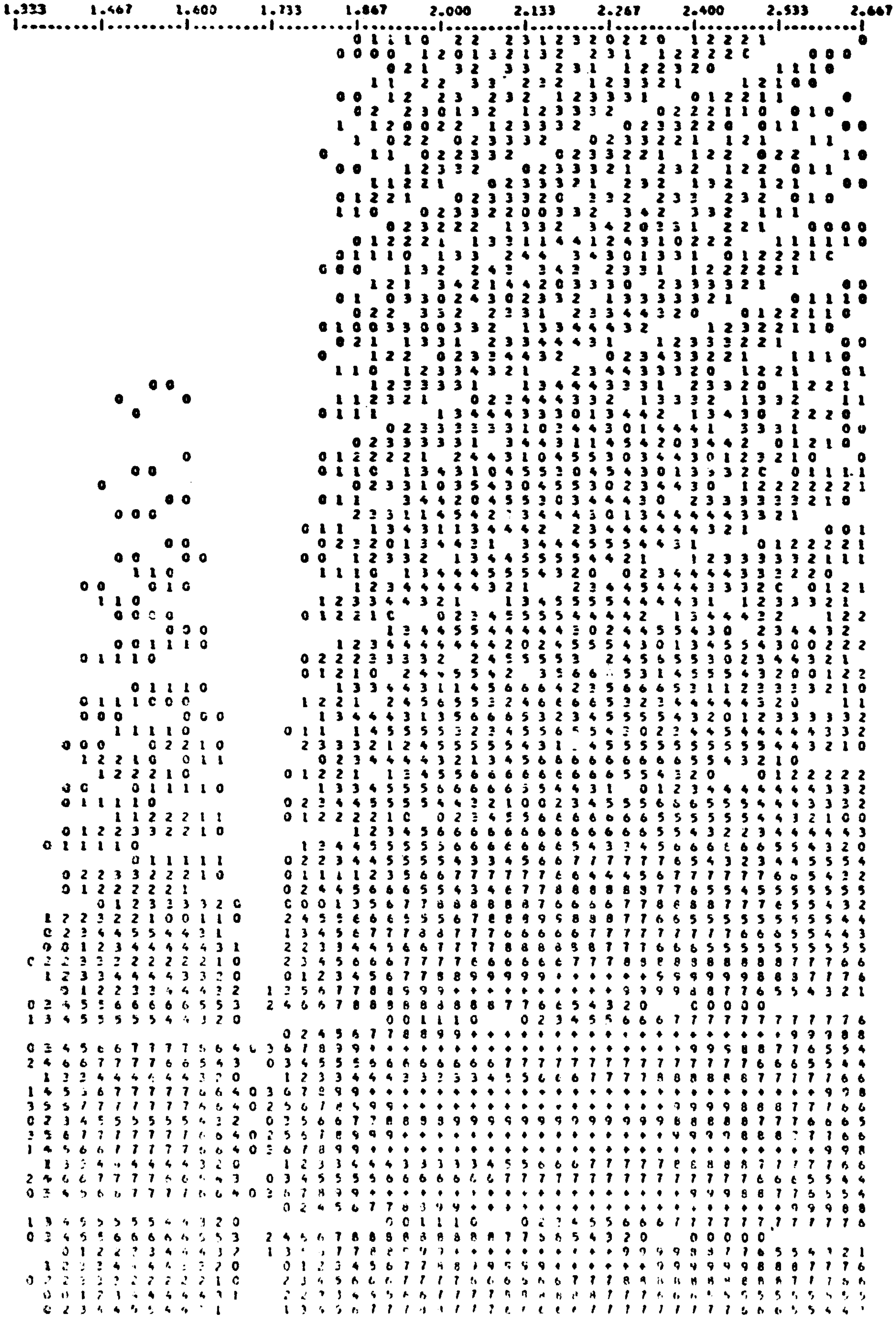
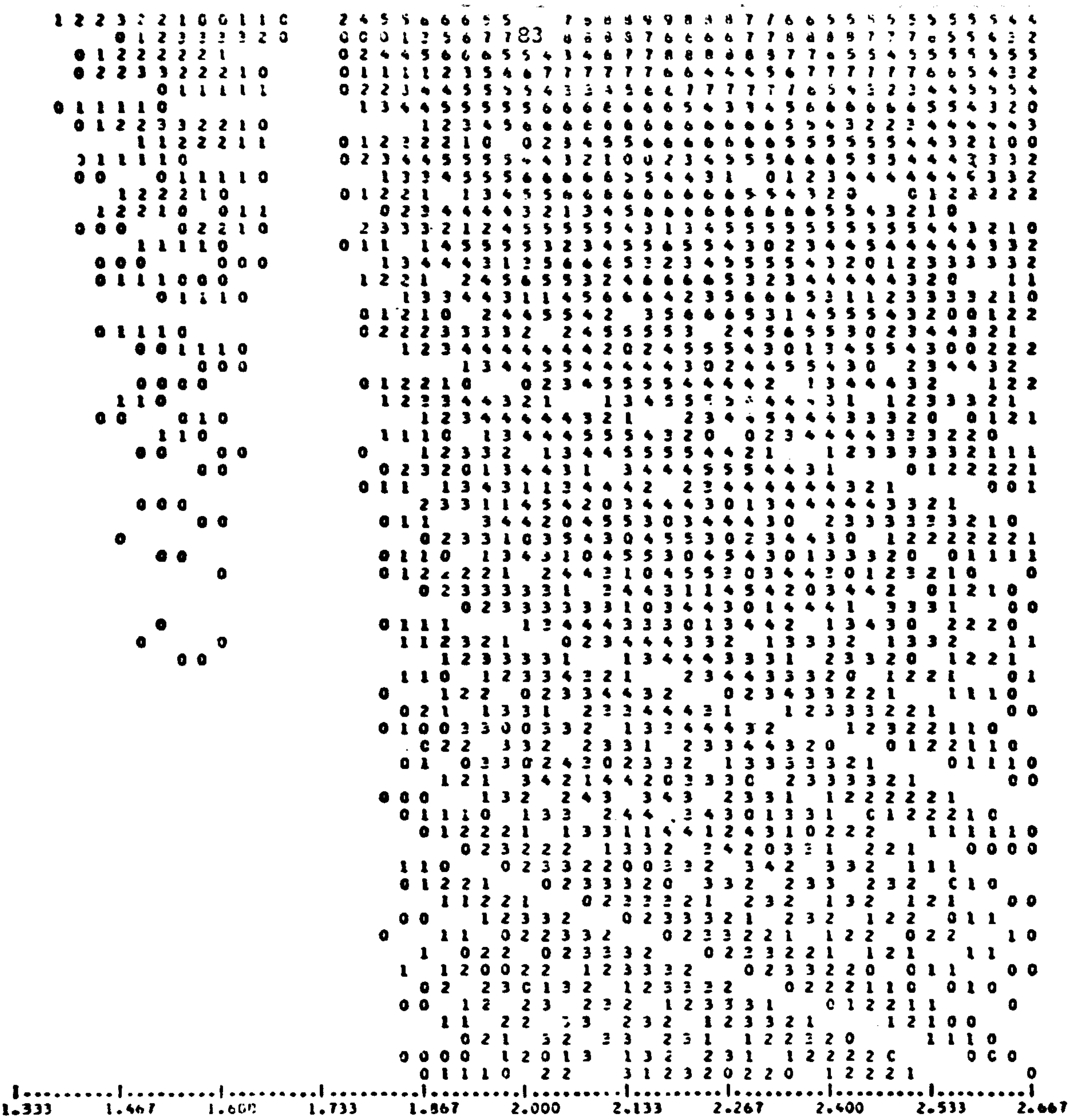
0.933
1.067
1.200
1.333

PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 102





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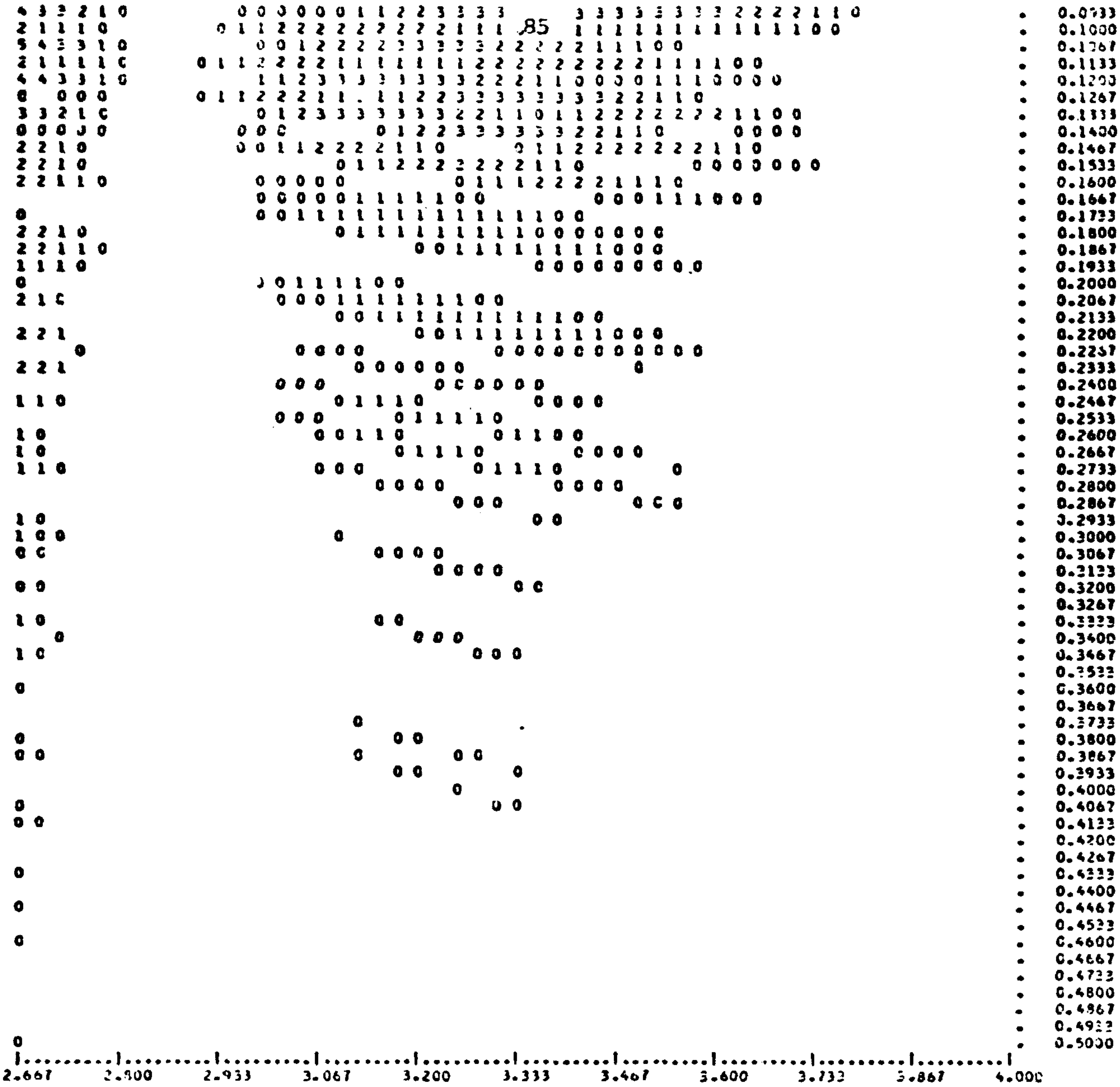
                                  CONTOUR LEVEL KEY

0: -0.2850000E 02 TO -0.2549999E 02   4: -0.1650000E 02 TO -0.1349999E 02   8: -0.4500000E 01 TO -0.1499990E 01
1: -0.2550000E 02 TO -0.2249999E 02   5: -0.1350000E 02 TO -0.1049999E 02   9: -0.1500000E 01 TO  0.1500010E 01
2: -0.2250000E 02 TO -0.1949999E 02   6: -0.1050000E 02 TO -0.7499990E 01    : -0.1000000E 51 TO -0.2850000E 02
3: -0.1950000E 02 TO -0.1649999E 02   7: -0.7500000E 01 TO -0.4499990E 01   +:  0.1500010E 01 TO  0.1000000E 51
```

PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 102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0.1200
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0.1333
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0.1467
0.1533
0.1600
0.1667
0.1733
0.1800
0.1867
0.1933
0.2000
0.2067
0.2133
0.2200
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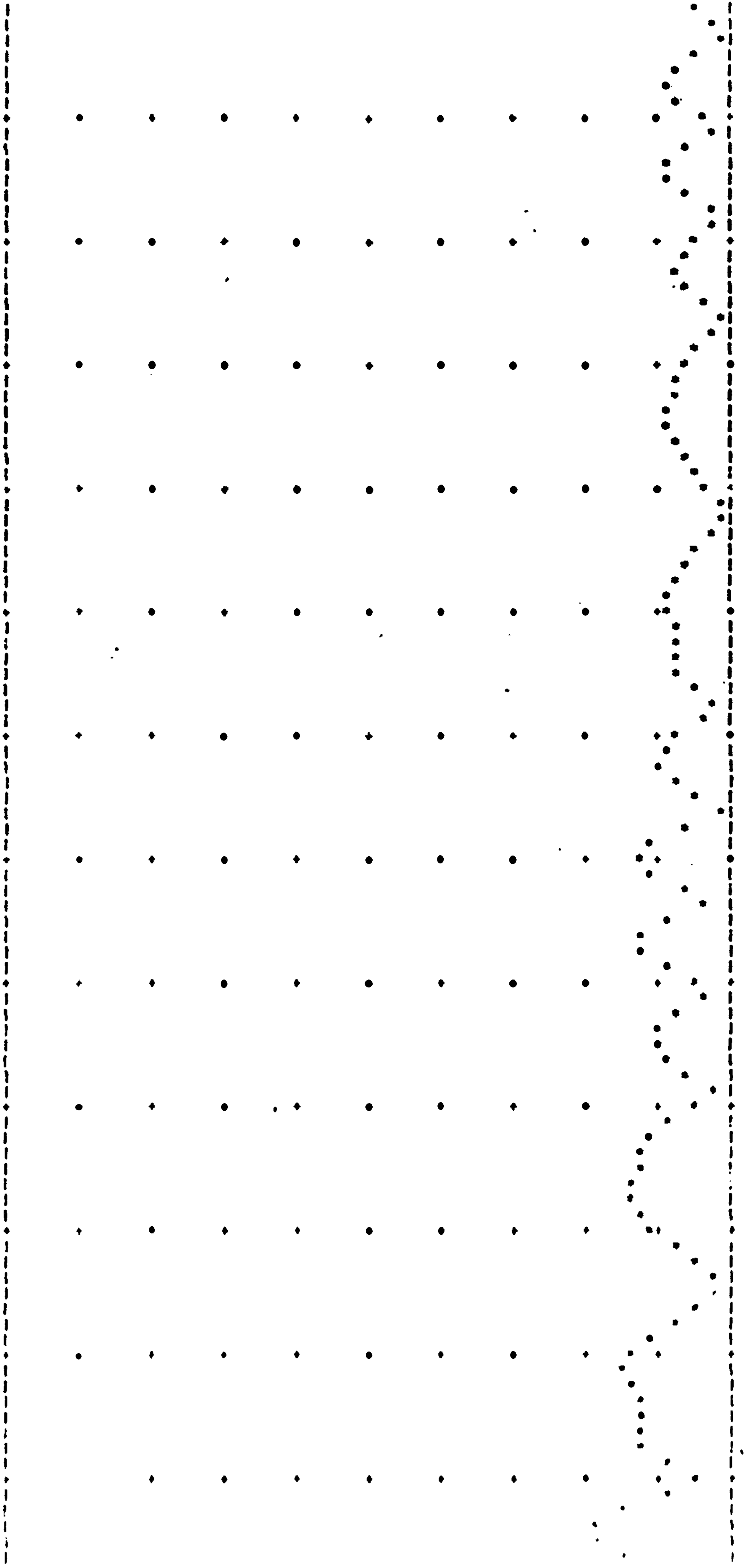
0.2333
0.2400
0.2467
0.2533
0.2600
0.2667
0.2733
0.2800
0.2867
0.2933
0.3000
0.3067
0.3133
0.3200
0.3267
0.3333
0.3400
0.3467
0.3533
0.3600
0.3667
0.3733
0.3800
0.3867
0.3933
0.4000
0.4067
0.4133
0.4200
0.4267
0.4333
0.4400
0.4467
0.4533
0.4600
0.4667
0.4733
0.4800
0.4867
0.4933
0.5000
2.667
2.800
2.933
3.067
3.200
3.333
3.467
3.600
3.733
3.867
4.000

```
                           X-AXIS PROFILE PLOT ALONG    2.194 DEGREES LATITUDE.
                           PATTERN NUMBER   102

     DB.      REAL  2.9574              2.3671              1.7768              1.1865              0.5963              0.0060
  -19.08   0.111  I                                                                                            *  I  0.5000
  -16.90   0.143  I                                                                                           *   I  0.4980
  -17.52   0.133  I                                                                                           *   I  0.4960
  -21.07   0.088  I                                                                                            *  I  0.4940
  -29.89   0.032  +         +         +         +         +         +         +         +         +         +        *+  0.4920
  -26.43   0.048  I                                                                                             * I  0.4900
  -20.90   0.090  I                                                                                            *  I  0.4880
  -18.99   0.112  I                                                                                            *  I  0.4860
  -18.93   C.113  I                                                                                            *  I  0.4840
  -20.45   0.095  I                                                                                            *  I  0.4820
  -24.28   0.061  I                                                                                             * I  0.4800
  -35.26   0.017  I                                                                                              *I  0.4780
  -29.79   0.032  +         +         +         +         +         +         +         +         +         +        *+  0.4760
  -23.03   0.C71  I                                                                                             * I  0.4740
  -20.60   0.093  I                                                                                            *  I  0.4720
  -19.73   0.103  I                                                                                            *  I  0.4700
  -19.07   0.111  I                                                                                            *  I  0.4680
  -18.07   0.125  I                                                                                           *   I  0.4660
  -17.36   C.136  I                                                                                           *   I  0.4640
  -17.37   0.135  I                                                                                           *   I  0.4620
  -18.52   0.119  +         +         +         +         +         +         +         +         +         +     *   +  0.4600
  -20.82   0.091  I                                                                                            *  I  0.4580
  -24.34   0.061  I                                                                                             * I  0.4560
  -29.64   0.033  I                                                                                              *I  0.4540
  -41.03   0.C09  I                                                                                              *I  0.4520
  -35.48   0.017  I                                                                                              *I  0.4500
  -27.20   C.044  I                                                                                             * I  0.4480
  -22.57   0.074  I                                                                                             * I  0.4460
  -19.53   C.106  +         +         +         +         +         +         +         +         +         +      *  +  0.4440
  -17.75   C.130  I                                                                                           *   I  0.4420
  -17.16   0.139  I                                                                                           *   I  0.4400
  -17.63   0.131  I                                                                                           *   I  0.4380
  -18.67   C.117  I                                                                                            *  I  0.4360
  -19.34   0.108  I                                                                                            *  I  0.4340
  -19.56   C.105  I                                                                                            *  I  0.4320
  -20.62   0.093  I                                                                                            *  I  0.4300
  -24.29   0.C61  +         +         +         +         +         +         +         +         +         +       * +  0.4280
  -36.78   C.014  I                                                                                              *I  0.4260
  -26.57   0.047  I                                                                                             * I  0.4240
  -20.41   0.095  I                                                                                            *  I  0.4220
  -17.83   0.123  I                                                                                           *   I  0.4200
  -17.25   0.137  I                                                                                           *   I  0.4180
  -18.42   C.120  I                                                                                           *   I  0.4160
  -22.65   C.074  I                                                                                             * I  0.4140
  -44.05   0.006  +         +         +         +         +         +         +         +         +         +        *+  0.4120
  -22.00   0.079  I                                                                                             * I  0.4100
  -16.60   0.148  I                                                                                           *   I  0.4080
  -14.94   C.179  I                                                                                          *    I  0.4060
  -15.99   0.159  I                                                                                          *    I  0.4040
  -20.96   0.090  I                                                                                            *  I  0.4020
  -34.11   C.C20  I                                                                                              *I  0.4000
  -19.40   C.107  I                                                                                            *  I  0.3980
  -15.43   0.168  +         +         +         +         +         +         +         +         +         +    *    +  0.3960
  -14.97   C.178  I                                                                                          *    I  0.3940
  -17.17   0.139  I                                                                                           *   I  0.3920
  -23.26   0.069  I                                                                                             * I  0.3900
  -28.67   0.C37  I                                                                                              *I  C.3880
  -20.68   0.093  I                                                                                            *  I  0.3860
  -17.61   C.132  I                                                                                           *   I  0.3840
  -16.83   C.144  I                                                                                           *   I  0.3820
  -17.66   0.131  +         +         +         +         +         +         +         +         +         +     *   +  0.3800
  -20.50   0.094  I                                                                                            *  I  0.3780
  -27.96   0.040  I                                                                                              *I  0.3760
  -30.99   0.028  I                                                                                              *I  0.3740
  -21.60   0.083  I                                                                                            *  I  0.3720
  -18.41   0.120  I                                                                                           *   I  0.3700
  -17.30   0.136  I                                                                                           *   I  0.3680
  -16.77   C.145  I                                                                                           *   I  0.3660
  -15.99   0.159  +         +         +         +         +         +         +         +         +         +    *    +  0.3640
  -15.26   C.173  I                                                                                          *    I  0.3620
  -15.24   0.173  I                                                                                          *    I  0.3600
  -16.27   0.154  I                                                                                          *    I  0.3580
  -18.44   0.120  I                                                                                           *   I  0.3560
  -21.82   0.081  I                                                                                            *  I  0.3540
  -26.85   0.045  I                                                                                             * I  0.3520
  -37.42   0.013  I                                                                                              *I  0.3500
  -33.14   0.022  +         +         +         +         +         +         +         +         +         +        *+  0.3460
  -24.84   0.057  I                                                                                             * I  0.3460
  -20.28   0.097  I                                                                                            *  I  0.3440
  -17.31   C.136  I                                                                                           *   I  0.3420
  -15.60   0.166  I                                                                                          *    I  0.3400
  -15.07   0.176  I                                                                                          *    I  0.3380
  -15.57   0.166  I                                                                                          *    I  0.3360
  -16.50   C.150  I                                                                                           *   I  0.3340
  -16.90   0.143  +         +         +         +         +         +         +         +         +         +     *   +  0.3320
  -16.99   C.141  I                                                                                           *   I  C.3300
  -18.24   0.122  I                                                                                           *   I  0.3280
  -22.55   0.075  I                                                                                             * I  0.3260
  -35.[illegible]   C.017  I                                                                                              *I  0.3240
  [illegible]   [illegible]  I                                                                                             * I  0.3220
  -17.10   C.140  I                                                                                           *   I  0.3200
  -15.11   C.176  I                                                                                          *    I  0.3180
```



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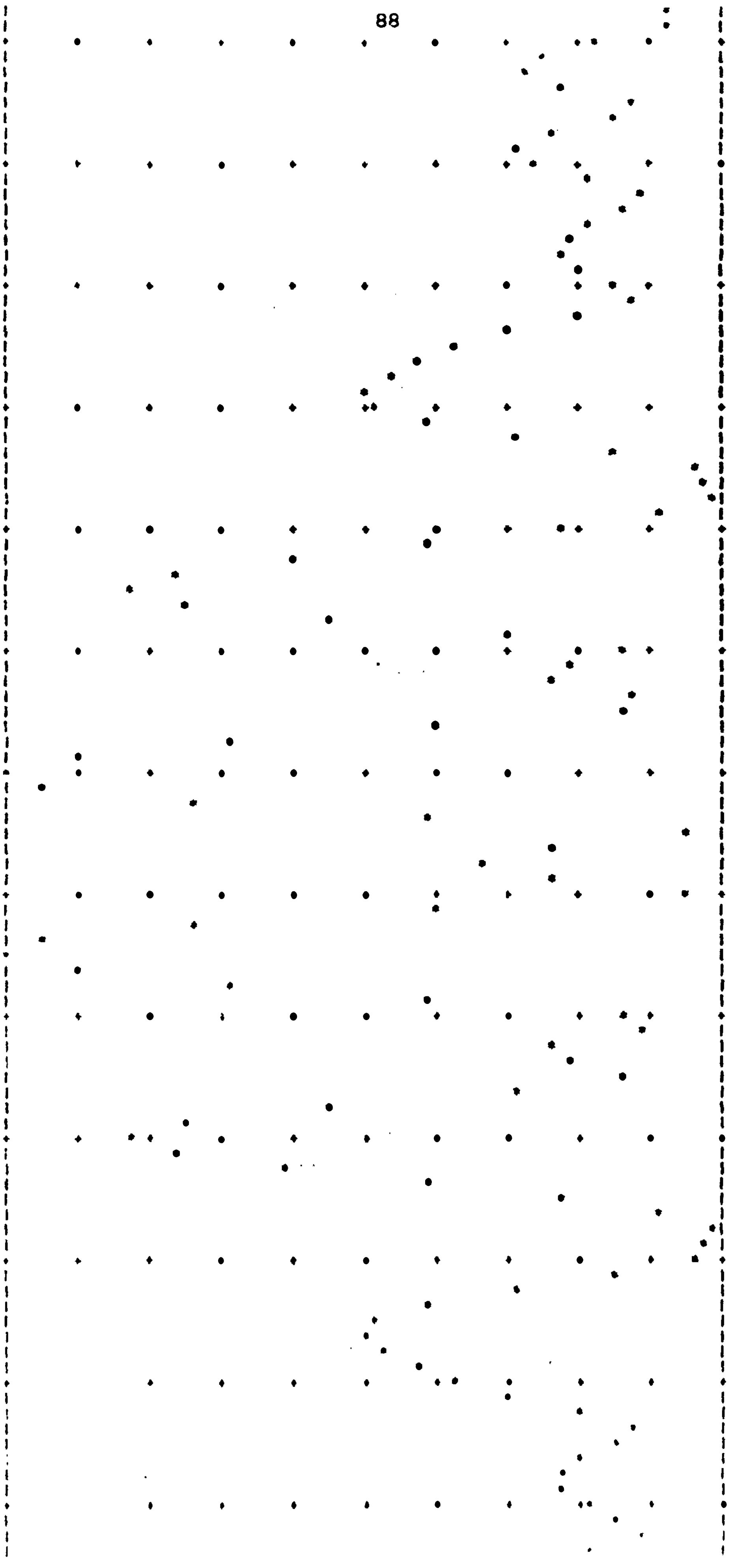
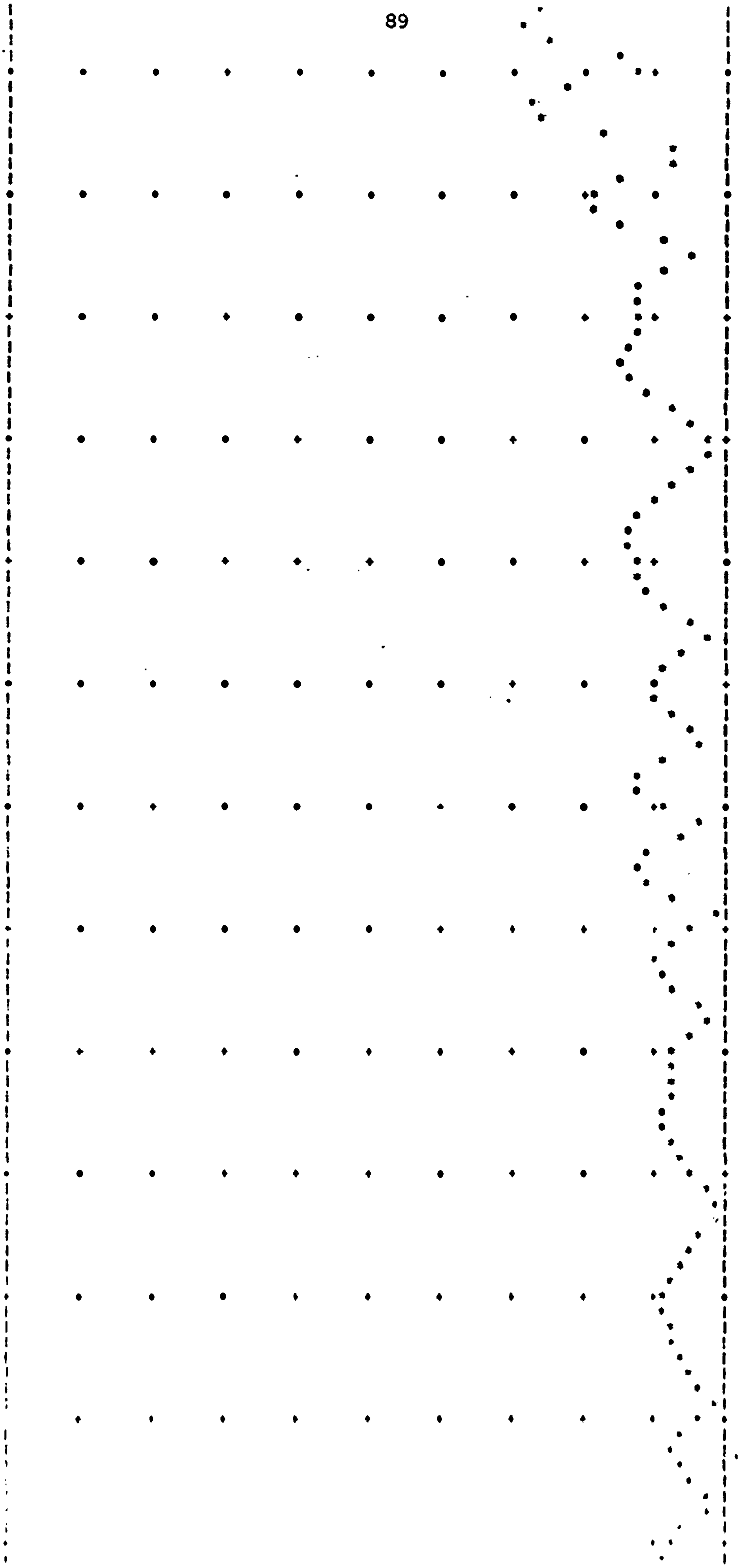
 -14.97    0.178    0.3160
 -16.85    0.144    0.3140
 -22.41    0.072    0.3120
 -30.65    0.029    0.3100
 -17.22    0.136    0.3080
 -13.29    0.216    0.3060
 -12.42    0.239    0.3040
 -14.37    0.171    0.3020
 -21.43    0.085    0.3000
 -23.79    0.065    0.2980
 -15.81    0.178    0.2960
 -12.44    0.239    0.2940
 -12.83    0.228    0.2920
 -16.09    0.157    0.2900
 -23.59    0.063    0.2880
 -22.39    0.076    0.2860
 -16.65    0.146    0.2840
 -14.59    0.187    0.2820
 -14.35    0.192    0.2800
 -15.79    0.162    0.2780
 -19.89    0.101    0.2760
 -31.68    0.026    0.2740
 -22.33    0.079    0.2720
 -16.56    0.149    0.2700
 -14.54    0.187    0.2680
 -13.86    0.203    0.2660
 -13.32    0.216    0.2640
 -12.61    0.234    0.2620
 -12.29    0.243    0.2600
 -12.87    0.227    0.2580
 -14.57    0.187    0.2560
 -17.41    0.135    0.2540
 -21.61    0.083    0.2520
 -28.76    0.036    0.2500
 -34.75    0.018    0.2480
 -23.82    0.054    0.2460
 -18.52    0.119    0.2440
 -15.15    0.175    0.2420
 -13.03    0.222    0.2400
 -12.22    0.245    0.2380
 -12.43    0.238    0.2360
 -13.27    0.215    0.2340
 -13.79    0.206    0.2320
 -13.62    0.208    0.2300
 -14.33    0.193    0.2280
 -17.49    0.134    0.2260
 -26.09    0.045    0.2240
 -20.20    0.097    0.2220
 -14.28    0.195    0.2200
 -11.81    0.257    0.2180
 -11.43    0.266    0.2160
 -13.00    0.224    0.2140
 -18.17    0.124    0.2120
 -29.79    0.032    0.2100
 -14.52    0.138    0.2080
  -9.93    0.317    0.2060
  -8.73    0.366    0.2040
 -10.23    0.308    0.2020
 -15.94    0.160    0.2000
 -20.52    0.094    0.1980
 -11.74    0.259    0.1960
  -8.34    0.362    0.1940
  -8.56    0.357    0.1920
 -11.03    0.276    0.1900
 -18.53    0.118    0.1880
 -18.67    0.117    0.1860
 -13.19    0.219    0.1840
 -10.96    0.283    0.1820
 -10.54    0.297    0.1800
 -11.74    0.259    0.1780
 -15.45    0.169    0.1760
 -24.22    0.061    0.1740
 -17.43    0.135    0.1720
 -12.10    0.248    0.1700
  -9.97    0.317    0.1680
  -9.14    0.347    0.1660
  -8.56    0.369    0.1640
  -8.03    0.396    0.1620
  -7.86    0.405    0.1600
  -8.57    0.373    0.1580
 -10.36    0.302    0.1560
 -13.32    0.216    0.1540
 -17.56    0.132    0.1520
 -24.12    0.060    0.1500
 -26.44    0.048    0.1480
 -18.10    0.125    0.1460
 -13.24    0.218    0.1440
 -10.11    0.312    0.1420
  -6.77    0.436    0.1400
  -7.67    0.413    0.1380
  -8.24    [illegible]    0.1360
  -9.23    [illegible]    0.1340
  -9.21    0.346    0.1320
  [illegible]    0.374    0.1300
  -9.12    0.353    0.1280
 [illegible]    [illegible]    0.1260
 -17.88    0.128    0.1240
 [illegible]    [illegible]    0.1220
 [illegible]    [illegible]    0.1200
 [illegible]    [illegible]    0.1180
 [illegible]    [illegible]    0.1160
 [illegible]    [illegible]    0.1140
```



[illegible]	[illegible]	0.1120
-13.22	[illegible]	0.1100
-5.23	[illegible]	0.1080
-2.60	[illegible]	0.1060
-1.95	[illegible]	0.1040
-3.84	0.643	0.1020
-8.58	0.372	0.1000
-7.70	0.412	0.0980
-3.07	0.702	0.0960
-1.40	0.851	0.0940
-2.23	0.774	0.0920
-5.53	0.529	0.0900
-9.78	0.324	0.0880
-7.79	0.408	0.0860
-5.09	0.557	0.0840
-3.97	0.633	0.0820
-3.83	0.644	0.0800
-4.74	0.579	0.0780
-7.33	0.430	0.0760
-9.19	0.347	0.0740
-4.92	0.567	0.0720
-1.26	0.865	0.0700
0.74	1.089	0.0680
1.88	1.241	0.0660
2.72	1.368	0.0640
3.26	1.456	0.0620
3.05	1.421	0.0600
1.62	1.205	0.0580
-1.55	0.836	0.0560
-7.48	0.423	0.0540
-20.13	0.099	0.0520
-23.06	0.070	0.0500
-30.30	0.031	0.0480
-12.63	0.234	0.0460
-3.81	0.645	0.0440
1.50	1.189	0.0420
4.96	1.771	0.0400
7.00	2.238	0.0380
7.67	2.417	0.0360
6.87	2.205	0.0340
4.23	1.628	0.0320
-1.20	0.871	0.0300
-8.23	0.388	0.0280
-4.14	0.621	0.0260
-3.43	0.674	0.0240
-9.29	0.343	0.0220
-3.52	0.675	0.0200
1.47	1.184	0.0180
6.03	2.002	0.0160
8.45	2.646	0.0140
9.41	2.955	0.0120
8.97	2.809	0.0100
6.78	2.182	0.0080
1.62	1.205	0.0060
-16.83	0.144	0.0040
-3.28	0.685	0.0020
-0.00	1.000	0.0000
-3.10	0.700	-0.0020
-13.42	0.120	-0.0040
1.42	1.178	-0.0060
6.70	2.162	-0.0080
8.94	2.798	-0.0100
9.42	2.957	-0.0120
8.49	2.658	-0.0140
6.11	2.021	-0.0160
1.62	1.205	-0.0180
-8.15	0.392	-0.0200
-9.60	0.331	-0.0220
-3.47	0.670	-0.0240
-4.06	0.627	-0.0260
-8.23	0.388	-0.0280
-1.38	0.853	-0.0300
4.14	1.611	-0.0320
6.83	2.195	-0.0340
7.67	2.417	-0.0360
7.03	2.246	-0.0380
5.03	1.785	-0.0400
1.66	1.210	-0.0420
-3.64	0.657	-0.0440
-12.34	0.241	-0.0460
-30.67	0.029	-0.0480
-22.94	0.071	-0.0500
-20.66	0.093	-0.0520
-7.67	0.414	-0.0540
-1.66	0.826	-0.0560
1.57	1.197	-0.0580
3.04	1.419	-0.0600
3.27	1.457	-0.0620
2.74	1.371	-0.0640
1.93	1.249	-0.0660
0.73	1.084	-0.0680
-1.29	[illegible]	-0.0700
-4.01	[illegible]	-0.0720
-9.14	[illegible]	-0.0740
-7.43	[illegible]	-0.0760
-4.79	[illegible]	-0.0780
-3.83	[illegible]	-0.0800
[illegible]	[illegible]	-0.0820
-5.05	[illegible]	-0.0840
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]



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 -2.23    0.769   -0.0920
 -1.39    0.852   -0.0940
 -2.94    0.709   -0.0960
 -7.56    0.419   -0.0980
 -8.71    0.367   -0.1000
 -3.92    0.637   -0.1020
 -1.96    0.79[illegible]  -0.1040
 -2.55    0.745   -0.1060
 -5.75    0.515   -0.1080
-12.94    0.224   -0.1100
-13.13    0.220   -0.1120
 -7.52    0.421   -0.1140
  5.45    0.534   -0.1160
 -5.41    0.536   -0.1180
 -7.23    0.435   -0.1200
-11.68    0.261   -0.1220
-17.84    0.123   -0.1240
-12.47    0.238   -0.1260
 -9.16    0.348   -0.1280
 -8.54    0.374   -0.1300
 -9.19    0.347   -0.1320
 -9.25    0.345   -0.1340
 -8.24    0.386   -0.1360
 -7.67    0.413   -0.1380
 -8.23    0.387   -0.1400
-10.05    0.315   -0.1420
-13.15    0.220   -0.1440
-17.95    0.127   -0.1460
-26.15    0.049   -0.1480
-24.60    0.059   -0.1500
-17.68    0.131   -0.1520
-13.42    0.213   -0.1540
-10.44    0.301   -0.1560
 -8.60    0.372   -0.1580
 -7.86    0.404   -0.1600
 -8.04    0.396   -0.1620
 -8.65    0.369   -0.1640
 -9.18    0.347   -0.1660
 -9.94    0.318   -0.1680
-12.01    0.251   -0.1700
-17.21    0.138   -0.1720
-24.42    0.060   -0.1740
-15.59    0.166   -0.1760
-11.80    0.257   -0.1780
-10.55    0.297   -0.1800
-10.93    0.294   -0.1820
-12.11    0.221   -0.1840
-13.48    0.119   -0.1860
-15.77    0.116   -0.1880
-11.94    0.253   -0.1900
 -8.97    0.355   -0.1920
 -8.81    0.363   -0.1940
-11.62    0.262   -0.1960
-20.21    0.098   -0.1980
-16.17    0.155   -0.2000
-10.33    0.305   -0.2020
 -8.74    0.366   -0.2040
 -9.92    0.319   -0.2060
-14.36    0.192   -0.2080
-29.0[illegible]   0.035   -0.2100
-18.28    0.121   -0.2120
-13.07    0.222   -0.2140
-11.44    0.268   -0.2160
-11.76    0.258   -0.2180
-14.11    0.197   -0.2200
-20.04    0.100   -0.2220
-27.30    0.044   -0.2240
-17.61    0.132   -0.2260
-14.34    0.192   -0.2280
-13.62    0.209   -0.2300
-13.73    0.204   -0.2320
-13.34    0.214   -0.2340
-12.50    0.237   -0.2360
-12.32    0.245   -0.2380
-13.05    0.223   -0.2400
-15.35    0.176   -0.2420
-18.42    0.120   -0.2440
-23.57    0.066   -0.2460
-34.2[illegible]   0.019   -0.2480
-29.3[illegible]   0.035   -0.2500
-21.7[illegible]   0.082   -0.2520
-17.44    0.134   -0.2540
-14.62    0.186   -0.2560
-12.9[illegible]   0.227   -0.2580
-12.2[illegible]   0.243   -0.2600
-12.40    0.2[illegible]   -0.2620
-13.31    0.216   -0.2640
-13.35    0.203   -0.2660
-14.92    0.18[illegible]   -0.2680
-16.56    0.150   -0.2700
-21.81    0.081   -0.2720
-31.69    0.025   -0.2740
-20.03    0.100   -0.2760
-19.84    0.161   -0.2780
-14.7[illegible]   0.191   -0.2800
-14.5[illegible]   0.167   -0.2820
-16.[illegible]   0.147   -0.2840
[illegible]   [illegible]   [illegible]
[illegible]   [illegible]   [illegible]
[illegible]   [illegible]   [illegible]
[illegible]   [illegible]   [illegible]
[illegible]   [illegible]   [illegible]
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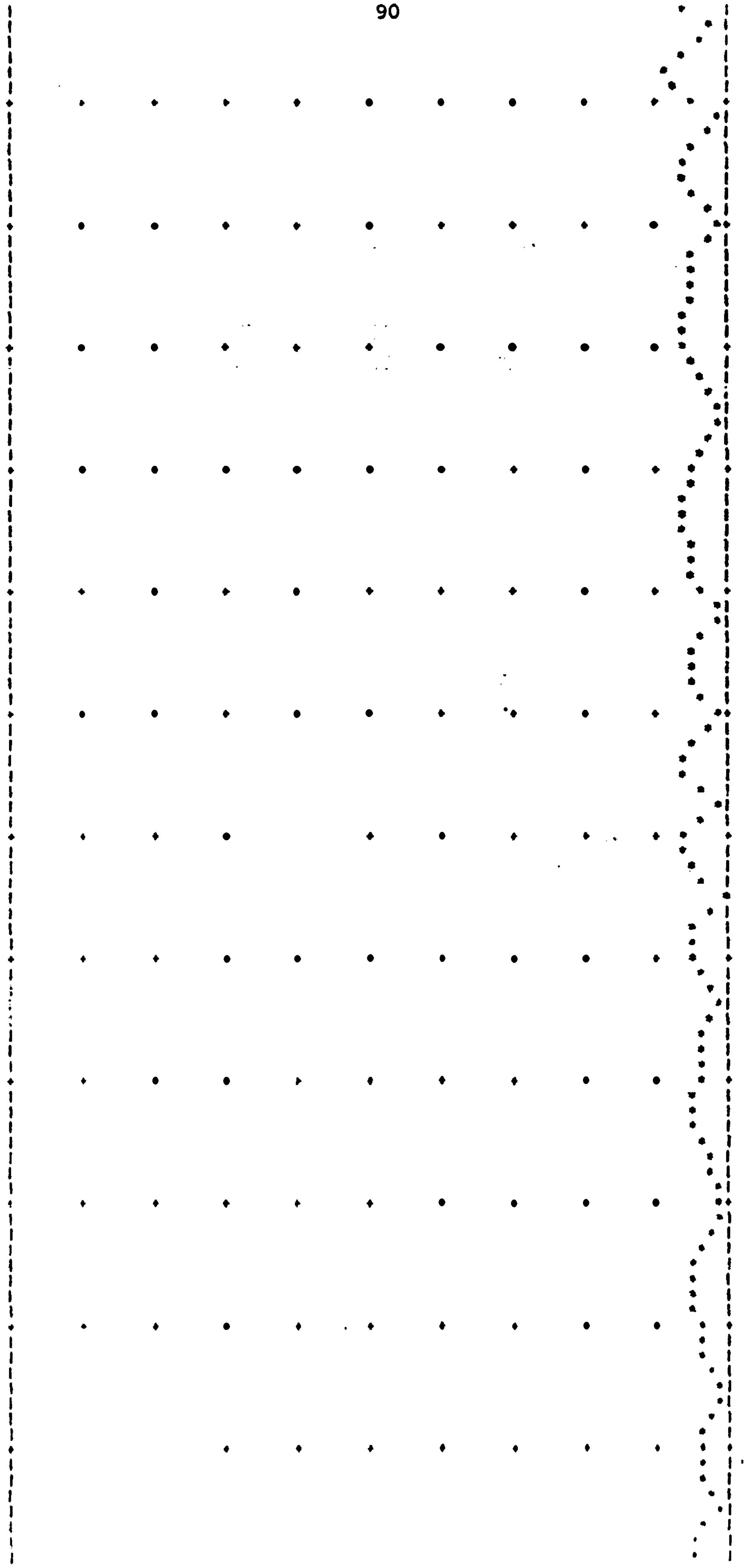

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-23.45	0.067	-0.2980
-21.61	0.082	-0.3000
-14.45	0.193	-0.3020
-12.43	0.239	-0.3040
-13.25	0.217	-0.3060
-17.20	0.138	-0.3080
-30.08	0.021	-0.3100
-23.11	0.070	-0.3120
-16.51	0.143	-0.3140
-14.99	0.178	-0.3160
-15.09	0.176	-0.3180
-17.04	0.141	-0.3200
-22.06	0.079	-0.3220
-35.25	0.017	-0.3240
-22.68	0.073	-0.3260
-18.29	0.122	-0.3280
-17.00	0.141	-0.3300
-16.40	0.143	-0.3320
-16.52	0.149	-0.3340
-15.59	0.166	-0.3360
-15.07	0.176	-0.3380
-15.58	0.166	-0.3400
-17.27	0.137	-0.3420
-20.22	0.098	-0.3440
-24.75	0.058	-0.3460
-32.92	0.023	-0.3480
-37.74	0.013	-0.3500
-27.09	0.045	-0.3520
-21.89	0.080	-0.3540
-18.49	0.119	-0.3560
-16.30	0.153	-0.3580
-15.25	0.173	-0.3600
-15.25	0.173	-0.3620
-15.98	0.159	-0.3640
-16.76	0.145	-0.3660
-17.29	0.137	-0.3680
-18.39	0.120	-0.3700
-21.52	0.084	-0.3720
-30.71	0.029	-0.3740
-29.17	0.029	-0.3760
-20.56	0.094	-0.3780
-17.69	0.131	-0.3800
-16.83	0.144	-0.3820
-17.58	0.137	-0.3840
-20.60	0.093	-0.3860
-26.51	0.038	-0.3880
-23.41	0.068	-0.3900
-17.22	0.128	-0.3920
-14.98	0.179	-0.3940
-15.45	0.169	-0.3960
-19.31	0.108	-0.3980
-33.79	0.020	-0.4000
-21.07	0.089	-0.4020
-16.02	0.158	-0.4040
-14.97	0.179	-0.4060
-16.56	0.149	-0.4080
-21.63	0.081	-0.4100
-44.47	0.006	-0.4120
-22.74	0.073	-0.4140
-18.45	0.120	-0.4160
-17.25	0.137	-0.4180
-17.86	0.128	-0.4200
-20.36	0.096	-0.4220
-26.45	0.048	-0.4240
-37.08	0.014	-0.4260
-24.36	0.061	-0.4280
-20.65	0.093	-0.4300
-19.56	0.105	-0.4320
-19.35	0.106	-0.4340
-18.68	0.116	-0.4360
-17.64	0.131	-0.4380
-17.16	0.139	-0.4400
-17.74	0.130	-0.4420
-19.50	0.105	-0.4440
22.52	0.075	-0.4460
-27.13	0.044	-0.4480
-35.34	0.017	-0.4500
-41.28	0.009	-0.4520
-29.72	0.022	[illegible]
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-20.55	0.091	-0.4580
-18.54	0.116	-0.4600
-17.34	0.135	-0.4620
-17.30	0.136	-0.4640
-18.06	0.125	-0.4660
-19.06	0.111	-0.4680
-19.72	0.102	-0.4700
-20.58	0.094	-0.4720
-23.00	0.071	-0.4740
-29.61	0.022	-0.4760
-35.44	0.017	-0.4780
-24.34	0.061	-0.4800
-20.47	0.095	-0.4820
-18.94	0.113	-0.4840
-18.95	0.112	-0.4860
-20.67	0.091	-0.4880
-26.14	0.048	-0.4900
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[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

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  -19.04     0.112  *       +       +        +       +        +       +       +        +       +    .  +  -0.5000
   DB.      REAL   2.9574          2.3671           1.7768           1.1865           0.5963           0.0050
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                                            -AXIS PROFILE PLOT ALONG   0.0  LONGITUDE.
                                           PATTERN NUMBER   102

   DB.      REAL   1.0035          0.6028           0.6022           0.4015           0.2009           0.0002
  -32.88     0.023  |                                                                                * |    3.9998
  -33.54     0.021  |                                                                                * |    3.9918
  -34.31     0.019  |                                                                                * |     .9933
  -35.15     0.017  |                                                                                * |    3.9759
  -36.09     0.016  +       +       +        +       +        +               +        +       +     * +    3.9679
  -37.16     0.014  |                                                                                * |    3.9599
  -38.40     0.012  |                                                                                 *|    3.9519
  -39.86     0.010  |                                                                                 *|    3.9439
  -41.66     0.008  |                                                                                 *|    3.9359
  -43.96     0.006  |                                                                                 *|    3.9279
  -47.15     0.004  |                                                                                 *|    3.9199
  -52.32     0.002  |                                                                                 *|    3.9119
  -67.51     0.000  +       +       +        +       +        +       +       +        +       +      *+    3.9039
  -55.53     0.002  |                                                                                 *|    3.8959
  -48.77     0.004  |                                                                                 *|    3.8879
  -44.86     0.006  |                                                                                 *|    3.8799
  -42.15     0.008  |                                                                                 *|    3.8719
  -40.06     0.010  |                                                                                 *|    3.8639
  -38.27     0.012  |                                                                                 *|    3.8559
  -36.94     0.014  |                                                                                * |    3.8479
  -35.70     0.016  +       +       +                +        +       +       +        +       +     * +    3.8399
  -34.60     0.019  |                                                                                * |    3.8319
  -33.62     0.021  |                                                                                * |    3.8239
  -32.71     0.023  |                                                                                * |    3.8159
  -31.91     0.025  |                                                                               *  |    3.8079
  -31.17     0.028  |                                                                               *  |    3.7999
  -30.47     0.030  |                                                                               *  |    3.7919
  -29.82     0.032  |                                                                               *  |    3.7839
  -29.21     0.035  +               +        +       +        +       +       +        +       +    *  +    3.7759
  -28.64     0.037  |                                                                               *  |    3.7679
  -28.10     0.039  |                                                                              *   |    3.7599
  -27.58     0.042  |                                                                              *   |    3.7519
  -27.10     0.044  |                                                                              *   |    3.7439
  -26.63     0.047  |                                                                              *   | .  3.7359
  -26.19     0.049  |                                                                              *   |    3.7279
  -25.77     0.051  |                                                                             *    |    3.7199
  -25.36     0.054  +               +        +       +        +       +       +        +       +  *    +    3.7119
  -24.97     [illegible]  |                                                                       *    |    [illegible]
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-22.04	0.079	3.6319
-21.77	0.082	3.6239
-21.51	0.084	3.6159
-21.25	0.08[illegible]	3.6079
-21.00	0.089	3.5999
-20.76	0.092	3.5919
-20.52	0.094	3.5839
[illegible]	0.096	3.5759
[illegible]	0.099	3.5679
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-19.45	0.107	3.5439
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[illegible]	0.111	3.5279
[illegible]	0.114	3.5199
-18.69	0.116	3.5119
-18.52	0.119	3.5039
-18.35	0.121	3.4959
-18.18	0.123	3.4879
-18.02	0.126	3.4799
-17.87	0.128	3.4719
-17.72	0.130	3.4639
-17.57	0.132	3.4559
-17.43	0.134	3.4479
-17.29	0.137	3.4399
-17.16	0.139	3.4319
-17.04	0.141	3.4239
-16.91	0.143	3.4159
-16.80	0.145	3.4079
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-16.47	0.150	3.3839
-16.3[illegible]	0.152	3.3759
-16.28	0.154	3.3679
-16.18	0.155	3.3599
-16.10	0.157	3.3519
-16.02	0.158	3.3439
-15.94	0.160	3.3359
-15.87	0.161	3.3279
-15.80	0.162	3.3199
-15.74	0.163	3.3119
-15.68	0.164	3.3039
-15.63	0.165	3.2959
-15.58	0.166	3.2879
-15.53	0.167	3.2799
-15.49	0.168	3.2719
-15.46	0.169	3.2639
-15.43	0.169	3.2559
-15.41	0.170	3.2479
-15.39	0.170	3.2399
-15.38	0.170	3.2319
-15.37	0.170	3.2239
-15.37	0.170	3.2159
-15.38	0.170	3.2079
-15.39	0.170	3.1999
-15.41	0.170	3.1919
-15.44	0.169	3.1839
-15.47	0.169	3.1759
-15.51	0.168	3.1679
-15.55	0.167	3.1599
-15.61	0.166	3.1519
-15.67	0.165	3.1439
-15.74	0.163	3.1359
-15.82	0.162	3.1279
-15.90	0.160	3.1199
-16.00	0.158	3.1119
-16.11	0.156	3.1039
-16.23	0.154	3.0959
-16.36	0.152	3.0879
-16.50	0.150	3.0800
-16.65	0.147	3.0719
-16.82	0.144	3.0640
-17.00	0.141	3.0560
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-17.41	0.135	3.0400
-17.64	0.131	3.0320
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[illegible]	[illegible]	[illegible]
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-28.14	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]
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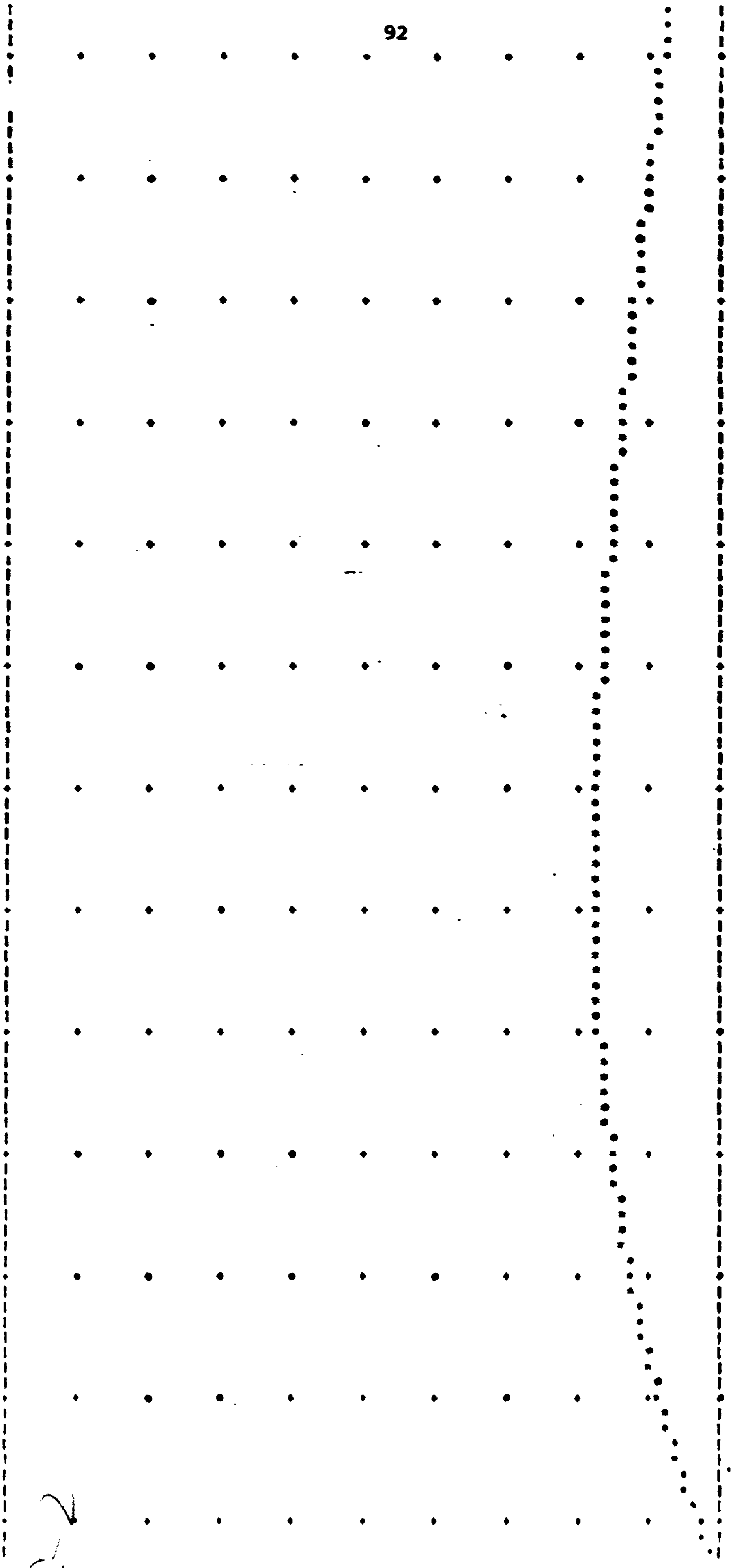

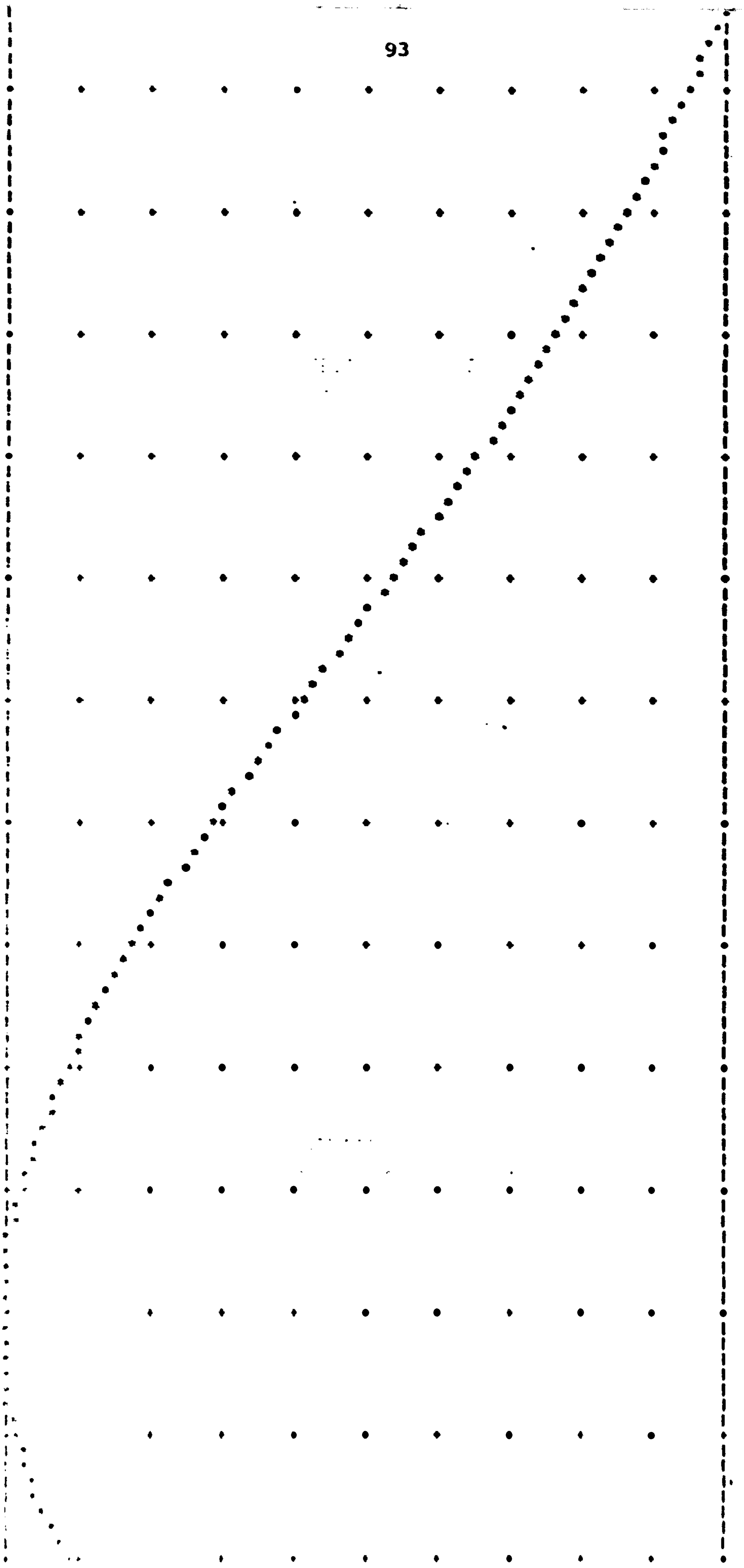

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-28.86   0.036   2.8240
-26.84   0.046   2.8160
-25.15   0.055   2.8080
-23.70   0.065   2.8000
-22.44   0.075   2.7920
-21.31   0.086   2.7840
-20.29   0.097   2.7760
-19.36   0.108   2.7680
-18.53   0.119   2.7600
-17.72   0.130   2.7520
-16.97   0.142   2.7440
-16.27   0.154   2.7360
-15.61   0.166   2.7280
-14.99   0.178   2.7200
-14.40   0.190   2.7120
-13.84   0.203   2.7040
-13.31   0.216   2.6960
-12.80   0.229   2.6880
-12.31   0.242   2.6800
-11.84   0.256   2.6720
-11.39   0.270   2.6640
-10.95   0.283   2.6560
-10.53   0.297   2.6480
-10.13   0.312   2.6400
 -9.74   0.326   2.6320
 -9.36   0.340   2.6240
 -8.99   0.355   2.6160
 -8.64   0.370   2.6080
 -8.30   0.385   2.6000
 -7.96   0.400   2.5920
 -7.64   0.415   2.5840
 -7.33   0.430   2.5760
 -7.03   0.445   2.5680
 -6.73   0.461   2.5600
 -6.44   0.476   2.5520
 -6.17   0.492   2.5440
 -5.90   0.507   2.5360
 -5.63   0.523   2.5280
 -5.38   0.538   2.5200
 -5.13   0.554   2.5120
 -4.89   0.570   2.5040
 -4.65   0.585   2.4960
 -4.43   0.601   2.4880
 -4.20   0.616   2.4800
 -3.99   0.632   2.4720
 -3.78   0.647   2.4640
 -3.58   0.662   2.4560
 -3.38   0.678   2.4480
 -3.19   0.693   2.4400
 -3.01   0.708   2.4320
 -2.83   0.722   2.4240
 -2.65   0.737   2.4160
 -2.49   0.751   2.4080
 -2.32   0.765   2.4000
 -2.17   0.779   2.3920
 -2.01   0.793   2.3840
 -1.87   0.806   2.3760
 -1.73   0.820   2.3680
 -1.59   0.833   2.3600
 -1.46   0.845   2.3520
 -1.34   0.857   2.3440
 -1.22   0.869   2.3360
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 -0.79   0.913   2.3040
 -0.70   0.922   2.2960
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 -0.52   0.941   2.2800
 -0.46   0.949   2.2720
 -0.38   0.957   2.2640
 -0.32   0.964   2.2560
 -0.26   0.971   2.2480
 -0.20   0.977   2.2400
 -0.15   0.982   2.2320
 -0.11   0.987   2.2240
 -0.07   0.992   2.2160
 -0.04   0.995   2.2080
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  0.01   1.001   2.1920
  0.02   1.002   2.1840
  0.03   1.003   2.1760
  0.03   1.003   2.1680
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  0.02   1.002   2.1520
 -0.00   1.000   2.1440
 -0.03   0.997   2.1360
 -0.06   0.994   2.1280
 -0.09   0.989   2.1200
 -0.14   0.986   2.1120
 -0.19   0.978   2.1040
 -0.25   0.972   2.0960
[illegible]  0.964   2.0880
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[illegible]  [illegible]  2.0560
[illegible]  [illegible]  2.0480
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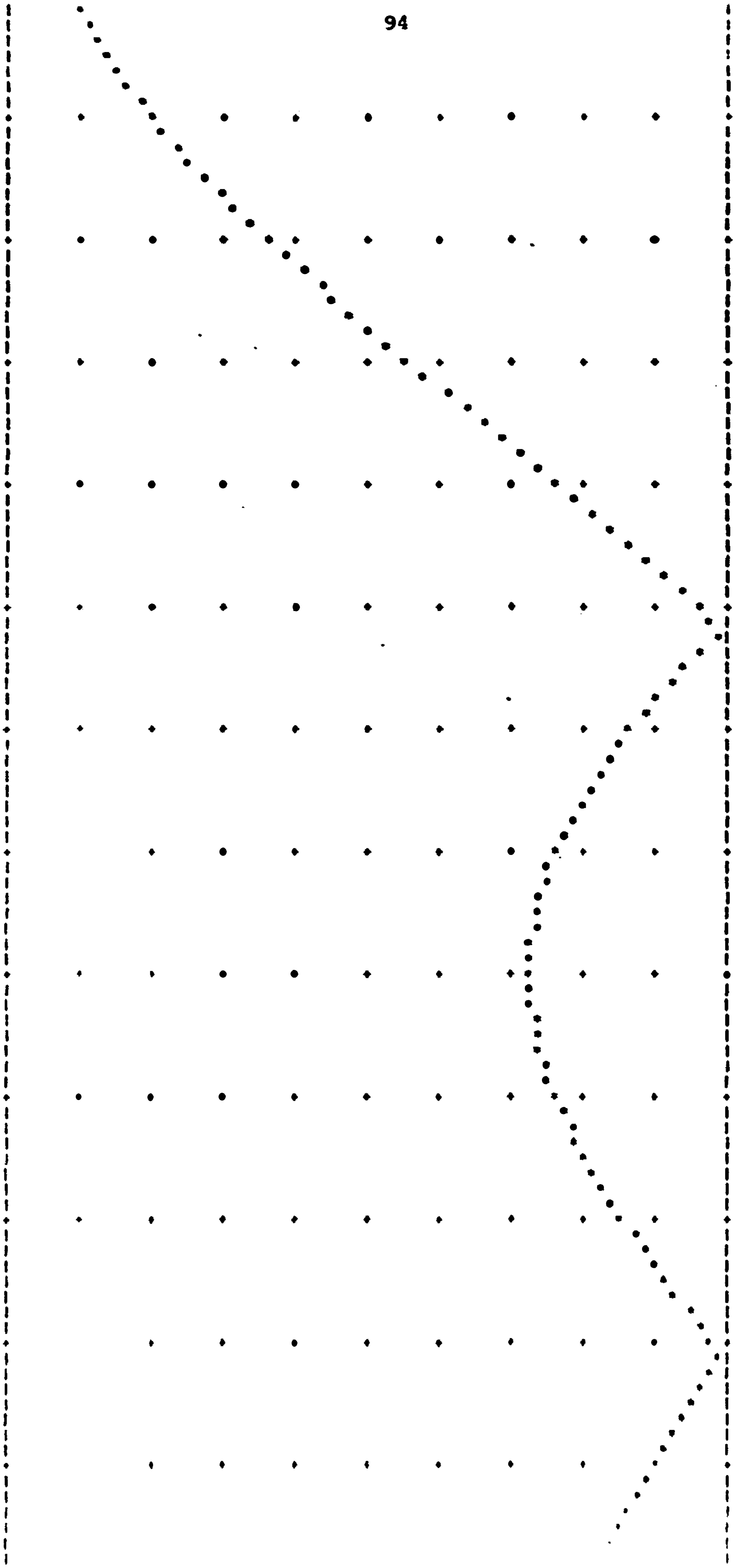

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 -3.11   0.699   1.9440
 -3.37   0.678   1.9360
 -3.66   0.656   1.9280
 -3.96   0.634   1.9200
 -4.28   0.611   1.9120
 -4.62   0.588   1.9040
 -4.98   0.564   1.8960
 -5.36   0.540   1.8880
 -5.76   0.515   1.8800
 -6.19   0.490   1.8720
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 -9.46   0.336   1.8240
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-12.66   0.233   1.7920
-13.68   0.207   1.7840
-14.82   0.182   1.7760
-16.12   0.155   1.7680
-17.63   0.131   1.7600
-19.42   0.107   1.7520
-21.65   0.083   1.7440
-24.58   0.059   1.7360
-28.92   0.035   1.7280
-37.62   0.013   1.7200
-41.01   0.009   1.7120
-30.37   0.030   1.7040
-25.84   0.051   1.6960
-22.97   0.071   1.6880
-20.89   0.090   1.6800
-19.23   0.109   1.6720
-17.98   0.125   1.6640
-16.90   0.143   1.6560
-15.99   0.159   1.6480
-15.22   0.173   1.6400
-14.55   0.187   1.6320
-13.98   0.200   1.6240
-13.49   0.212   1.6160
-13.06   0.222   1.6080
-12.70   0.232   1.6000
-12.38   0.240   1.5920
-12.12   0.248   1.5840
-11.91   0.254   1.5760
-11.74   0.259   1.5680
-11.61   0.263   1.5600
-11.52   0.265   1.5520
-11.47   0.267   1.5440
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-11.48   0.267   1.5280
-11.54   0.265   1.5200
-11.63   0.262   1.5120
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-17.15   0.139   1.4080
-18.10   0.124   1.4000
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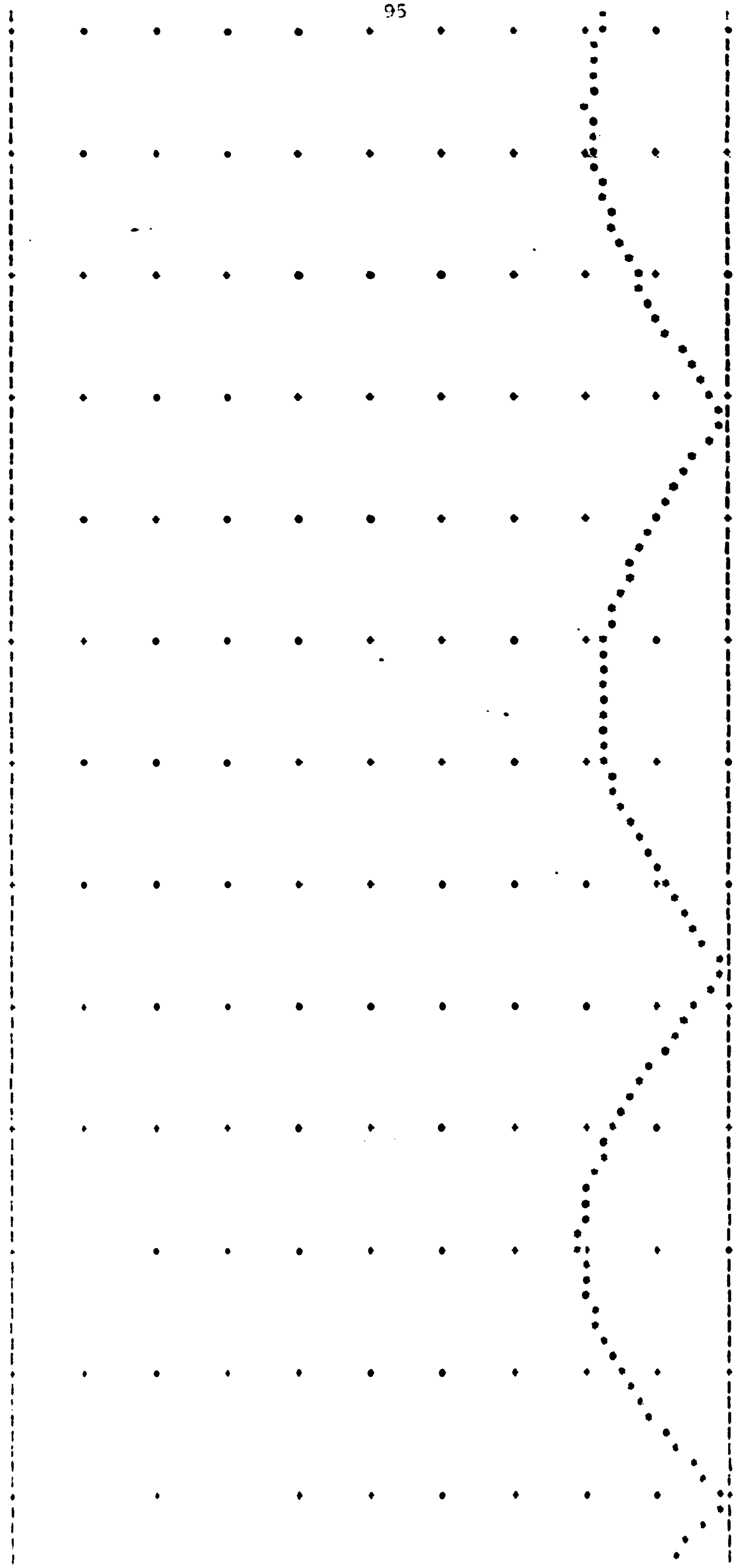
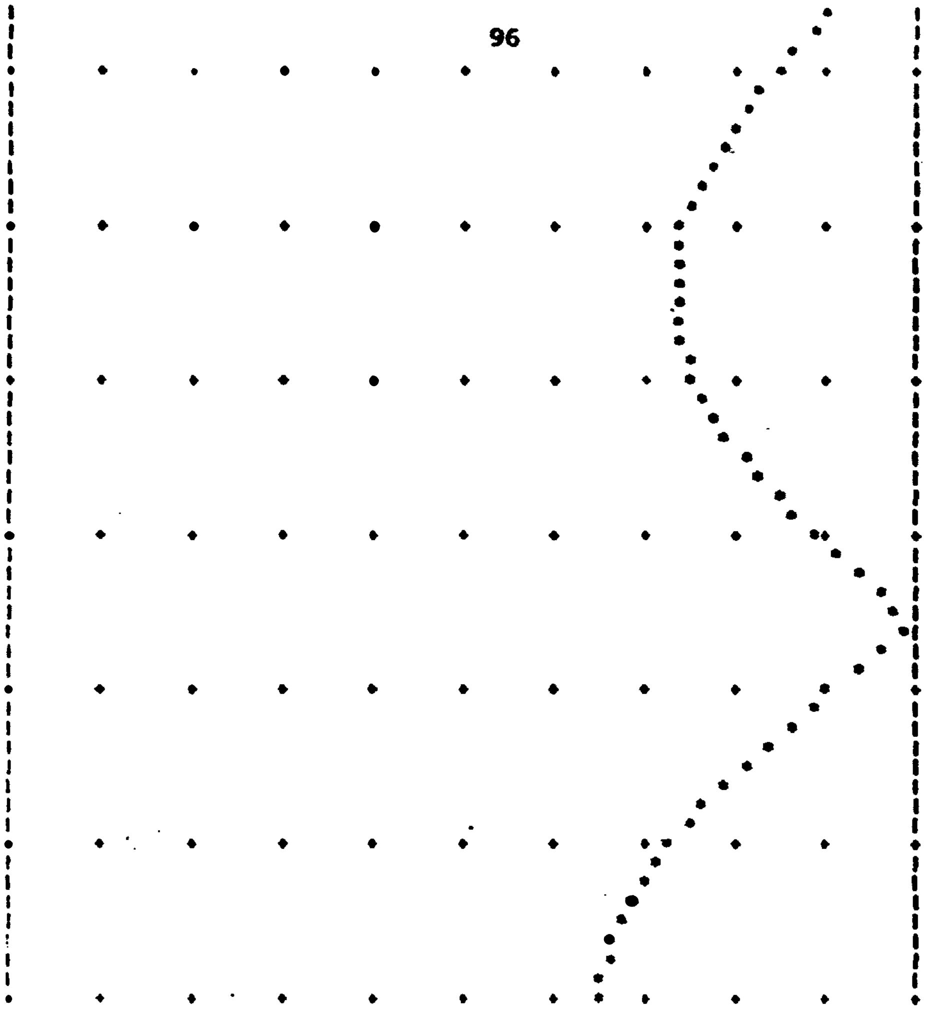
-20.49   0.095   1.3840
-22.03   0.079   1.3760
-23.94   0.064   1.3680
-26.42   0.048   1.3600
-29.90   0.032   1.3520
-35.79   0.016   1.3440
-64.81   0.001   1.3360
-36.53   0.015   1.3280
-30.47   0.030   1.3200
-26.93   0.045   1.3120
-24.50   0.060   1.3040
-22.66   0.074   1.2960
-21.20   0.087   1.2880
-20.03   0.100   1.2800
-19.00   0.112   1.2720
-18.15   0.124   1.2640
-17.4[illegible]   0.1[illegible]   [illegible]
[illegible]   [illegible]   [illegible]
[illegible]   [illegible]   [illegible]
[illegible]   [illegible]   [illegible]
```



```
[illegible]   [illegible]   1.2240
-15.16        0.175         1.2160
-14.92        0.180         1.2080
-14.73        0.183         1.2000
-14.59        0.186         1.1920
-14.51        0.188         1.1840
-14.49        0.189         1.1760
-14.51        0.188         1.1680
-14.59        0.186         1.1600
-14.72        0.184         1.1520
-14.90        0.180         1.1440
-15.14        0.175         1.1360
-15.44        0.169         1.1280
-15.81        0.162         1.1200
-16.25        0.154         1.1120
-16.76        0.145         1.1040
-17.37        0.135         1.0960
-18.08        0.125         1.0880
-18.91        0.113         1.0800
-19.88        0.101         1.0720
-21.04        0.089         1.0640
-22.44        0.076         1.0560
-24.17        0.062         1.0480
-26.41        0.048         1.0400
-29.50        0.033         1.0320
-34.44        0.019         1.0240
-47.77        0.004         1.0160
-39.73        0.010         1.0080
-32.08        0.025         1.0000
-28.12        0.039         0.9920
-25.45        0.053         0.9840
-23.46        0.067         0.9760
-21.89        0.080         0.9680
-20.61        0.093         0.9600
-19.55        0.105         0.9520
-18.66        0.117         0.9440
-17.90        0.127         0.9360
-17.27        0.137         0.9280
-16.73        0.145         0.9200
-16.28        0.153         0.9120
-15.91        0.160         0.9040
-15.62        0.166         0.8960
-15.39        0.170         0.8880
-15.24        0.173         0.8800
-15.14        0.175         0.8720
-15.11        0.175         0.8640
-15.15        0.175         0.8560
-15.25        0.173         0.8480
-15.42        0.169         0.8400
-15.66        0.165         0.8320
-15.97        0.159         0.8240
-16.37        0.152         0.8160
-16.86        0.144         0.8080
-17.45        0.134         0.8000
-18.16        0.124         0.7920
-19.01        0.112         0.7840
-20.04        0.100         0.7760
-21.29        0.086         0.7680
-22.84        0.072         0.7600
-24.84        0.057         0.7520
-27.55        0.042         0.7440
-31.66        0.026         0.7360
-40.04        0.010         0.7280
-43.83        0.006         0.7200
-32.79        0.023         0.7120
-28.09        0.039         0.7040
-25.08        0.056         0.6960
-22.88        0.072         0.6880
-21.17        0.087         0.6800
-19.79        0.102         0.6720
-18.64        0.117         0.6640
-17.69        0.131         0.6560
-16.87        0.143         0.6480
-16.19        0.155         0.6400
-15.61        0.166         0.6320
-15.13        0.175         0.6240
-14.74        0.183         0.6160
-14.43        0.190         0.6080
-14.19        0.195         0.6000
-14.02        0.199         0.5920
-13.93        0.201         0.5840
-13.91        0.202         0.5760
-13.95        0.201         0.5680
-14.07        0.198         0.5600
-14.27        0.193         0.5520
-14.54        0.187         0.5440
-14.91        0.180         0.5360
-15.36        0.171         0.5280
-15.93        0.160         0.5200
-16.62        [illegible]   0.5120
[illegible]   [illegible]   0.5040
[illegible]   [illegible]   0.4960
-19.72        [illegible]   0.4880
[illegible]   [illegible]   0.4800
[illegible]   [illegible]   0.4720
[illegible]   [illegible]   0.4640
[illegible]   [illegible]   0.4560
[illegible]   [illegible]   0.4480
[illegible]   [illegible]   0.4400
[illegible]   [illegible]   0.4320
[illegible]   [illegible]   0.4240
[illegible]   [illegible]   0.4160
```



```
-20.62   0.093   0.4080
-18.94   0.113   0.4000
-17.59   0.132   0.3920
-16.45   0.151   0.3840
-15.45   0.169   0.3760
-14.63   0.186   0.3680
-14.00   0.200   0.3600
-13.42   0.213   0.3520
-12.93   0.226   0.3440
-12.53   0.236   0.3360
-12.21   0.245   0.3280
-11.95   0.253   0.3200
-11.77   0.258   0.3120
-11.66   0.261   0.3040
-11.61   0.263   0.2960
-11.63   0.262   0.2880
-11.72   0.259   0.2800
-11.83   0.255   0.2720
-12.11   0.248   0.2640
-12.42   0.239   0.2560
-12.81   0.229   0.2480
-13.33   0.216   0.2400
-13.89   0.202   0.2320
-14.60   0.186   0.2240
-15.46   0.169   0.2160
-16.49   0.150   0.2080
-17.76   0.129   0.2000
-19.34   0.108   0.1920
-21.37   0.085   0.1840
-24.16   0.062   0.1760
-28.46   0.039   0.1680
-37.71   0.013   0.1600
-38.34   0.012   0.1520
-28.53   0.037   0.1440
-24.04   0.063   0.1360
-21.11   0.088   0.1280
-18.94   0.113   0.1200
-17.24   0.137   0.1120
-15.86   0.161   0.1040
-14.70   0.184   0.0960
-13.72   0.206   0.0880
-12.89   0.227   0.0800
-12.17   0.246   0.0720
-11.55   0.264   0.0640
-11.02   0.281   0.0560
-10.57   0.296   0.0480
-10.19   0.309   0.0400
 -9.87   0.321   0.0320
 -9.62   0.330   0.0240
 -9.42   0.338   0.0160
 -9.27   0.344   0.0080
 -9.18   0.347   0.0
  DB.    REAL    1.0035     0.8028     0.6022     0.4015     0.2009     0.0002
```

NORMAL TERMINATION

```
EXAMPLE 4:
   DEMONSTRATION OF SYSTEMATIC ELECTRICAL ERRORS IN THE FULL X-BAND
   HORIZONTAL ARRAY.



SYSTEM INFORMATION:
     FREQUENCY =  5.000 GHZ.
     YAW =     0.0   DEGREES
     TILT =   50.000 DEGREES
     TWIST =     0.0   DEGREES
     ALTITUDE =  200.000 KM.


ANTENNA PARAMETERS FOR SIMULATION NUMBER 103
     ELEMENT TYPE: HORIZONTAL DIPOLE
     NUMBER OF ELEMENTS (X,Y) = (504 ,  12)
     INTERELEMENT SPACING (CM.):  2.2966 ,  2.3550
     INTERELEMENT PHASE SHIFT (DEG.):  0.0    , 0.0


CEFORMATION DATA FOR SIMULATION 103:
0.0        0.0        0.0        0.0        0.0        0.0        0.0

0.0        0.0        0.0        0.0        0.0        0.0        0.0

0.0        0.0        0.0        0.0        0.0        0.0        0.0




ELECTRICAL DATA FOR SIMULATION 103:

         ( 1, 2)    ( 2, 2)    ( 3, 2)    ( 4, 2)    ( 5, 2)    ( 6, 2)    (
PHSX:      0.0        0.0        0.0        0.0        0.0        0.0
PHSY:      0.0        0.0        0.0        0.0        0.0        0.0
AMAG:      1.00       1.00       1.00       1.00       1.00       1.00
APHS:     15.00      10.00       5.00       0.0        0.0        0.0


         ( 1, 1)    ( 2, 1)    ( 3, 1)    ( 4, 1)    ( 5, 1)    ( 6, 1)    (
PHSX:      0.0        0.0        0.0        0.0        0.0        0.0
PHSY:      0.0        0.0        0.0        0.0        0.0        0.0
AMAG:      1.00       1.00       1.00       1.00       1.00       1.00
APHS:      0.0        0.0        0.0       -5.00     -10.00     -15.00




PRINT/PLOT INFORMATION:
     REQUESTED OUTPUT:
          PRINTER PROFILE
          PRINTER CONTOUR
     PLOT RESOLUTION: 151 X 151 POINTS

     STARTX =    -0.500
     STOPX =      0.500
     DELTAX =     0.007

     STARTY =     [illegible]
     [illegible]  [illegible]
     [illegible]  [illegible]
```

```
                       SUBARRAY DATA SUMMARY FOR PATTERN 103:
AREA        XCENT          YCENT        ZAVG        ALPHAX       ALPHAY       AMAG        APHS        PHSX         PHSY
  1       -482.29          -7.06         0.0         0.0          0.0        1.0000        0.0         0.0          0.0
  2       -289.37          -7.06         0.0         0.0          0.0        1.0000        0.0         0.0          0.0
  3        -96.46          -7.06         0.0         0.0          0.0        1.0000        0.0         0.0          0.0
  4         96.46          -7.06         0.0         0.0          0.0        1.0000       -5.00        0.0          0.0
  5        289.37          -7.06         0.0         0.0          0.0        1.0000      -10.00        0.0          0.0
  6        482.29          -7.06         0.0         0.0          0.0        1.0000      -15.00        0.0          0.0
  7       -482.29           7.06         0.0         0.0          0.0        1.0000       15.00        0.0          0.0
  8       -289.37           7.06         0.0         0.0          0.0        1.0000       10.00        0.0          0.0
  9        -96.46           7.06         0.0         0.0          0.0        1.0000        5.00        0.0          0.0
 10         96.46           7.06         0.0         0.0          0.0        1.0000        0.0         0.0          0.0
 11        289.37           7.06         0.0         0.0          0.0        1.0000        0.0         0.0          0.0
 12        482.29           7.06         0.0         0.0          0.0        1.0000        0.0         0.0          0.0


                       PREDICTED BEAM CENTER:
                            LATITUDE =   2.1945
                            LONGITUDE =    0.0
                            RANGE = 243.578
                            HEADING =    0.0



                       PLOT NORMALIZATION FACTOR =  -35.088 DB.
```

```
                         PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 103

       0.0      0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
        |.........|.........|.........|.........|.........|.........|.........|.........|.........|.........|
-0.5000.
-0.4933.
-0.4867.
-0.4800.
-0.4733.
-0.4667.
-0.4600.
-0.4533.
-0.4467.
-0.4400.
-0.4333.
-0.4267.
-0.4200.
-0.4133.
-0.4067.
-0.4000.
-0.3933.
-0.3867.
-0.3800.
-0.3733.
-0.3667.
-0.3600.
-0.3533.
-0.3467.
-0.3400.
-0.3333.
-0.3267.
-0.3200.
-0.3133.
-0.3067.
-0.3000.
-0.2933.
-0.2867.
-0.2800.
-0.2733.
-0.2667.
-0.2600.
-0.2533.
-0.2467.
-0.2400.
-0.2333.
-0.2267.
-0.2200.
-0.2133.
-0.2067.
-0.2000.
-0.1933.
-0.1867.
-0.1800.
-0.1733.
-0.1667.
-0.1600.
-0.1533.
-0.1467.
-0.1400.
-0.1333.
-0.1267.
-0.1200.
-0.1133.
-0.1067.
-0.1000.
-0.0933.
-0.0867.
-0.0800.
-0.0733.
-0.0667.
-0.0600.
-0.0533.
-0.0467.
-0.0400.
-0.0333.
-0.0267.
-0.0200.
-0.0133.
-0.0067.
-0.0000.3 3 3 2 1     0 1 2 3 3 3 2 1 0     1 3 3 3 3 3 3 2 0     1 2 3 3 3 3 2 1     1 3 4 4 4 4 4 4 3 2 1
 0.0067.
 0.0133.
 0.0200.
 0.0267.
 0.0333.
 0.0400.
 0.0467.
 0.0533.
 0.0600.
 0.0667.
 0.0733.
```

```
0.0533.
0.1000.
0.1067.
0.1133.
0.1200.
0.1267.
0.1333.
0.1400.
0.1467.
0.1533.
0.1600.
0.1667.
0.1733.
0.1800.
0.1867.
0.1933.
0.2000.
0.2067.
0.2133.
0.2200.
0.2267.
0.2333.
0.2400.
0.2467.
0.2533.
0.2600.
0.2667.
0.2733.
0.2800.
0.2867.
0.2933.
0.3000.
0.3067.
0.3133.
0.3200.
0.3267.
0.3333.
0.3400.
0.3467.
0.3533.
0.3600.
0.3667.
0.3733.
0.3800.
0.3867.
0.3933.
0.4000.
0.4067.
0.4133.
0.4200.
0.4267.
0.4333.
0.4400.
0.4467.
0.4533.
0.4600.
0.4667.
0.4733.
0.4800.
0.4867.
0.4933.
0.5000.
         I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
        0.0       0.133     0.267     0.400     0.533     0.667     0.800     0.933     1.067     1.200     1.333
```

PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 103

```
1.333     1.467     1.600     1.733     1.867     2.000     2.133     2.267     2.400     2.533     2.667
 I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I

                                                     0 0 0 0 0
                                                       0 0 0 1 1 1 0 0 0 0
                                                             0 0 0 0 0 0 0 0 0
                                                                   0 0 0 0 0 0 0 0 0 0
                                         0 0 0 0 0 0 0
                                       0 0 1 1 1 1 2 2 1 1 1 1 1 0 0 0
                                     0 1 1 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3 2 2 2 2 1 1 0 0 0
                                   0 1 1 2 2 3 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 2 2 1 1 0 0
                                     0 1 2 3 3 4 4 4 5 5 5 5 5 5 5 6 6 6 6 5 5 5 5 5 5 5 4 4 4 4 3 3 2
   0 2 3 4 5 5 5 5 5 4 3 2   0 2 4 5 5 7 7 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 8 8 8 8 8 7 7 7 6 6 6 5 4
                                             0 0 1 2 2 2 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 2 2 2 1
                                       0 1 1 2 2 3 3 3 3 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 2 2 2 2 1 1 0
                                       0 1 1 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 2 2 2 2 1 1 1 0 0
                                       0 0 1 1 2 2 2 2 2 2 2 2 2 2 1 1 1 1 0 0
                                       0 0 0 0 1 1 1 1 0 0 0
                                                                         0 0 0 0 0 0 0
                                                             0 0 0 1 1 1 1 1 1 0 0 0
                                                           0 0 0 0 0 0 0
                                                       0 0 0 0 0 0
```

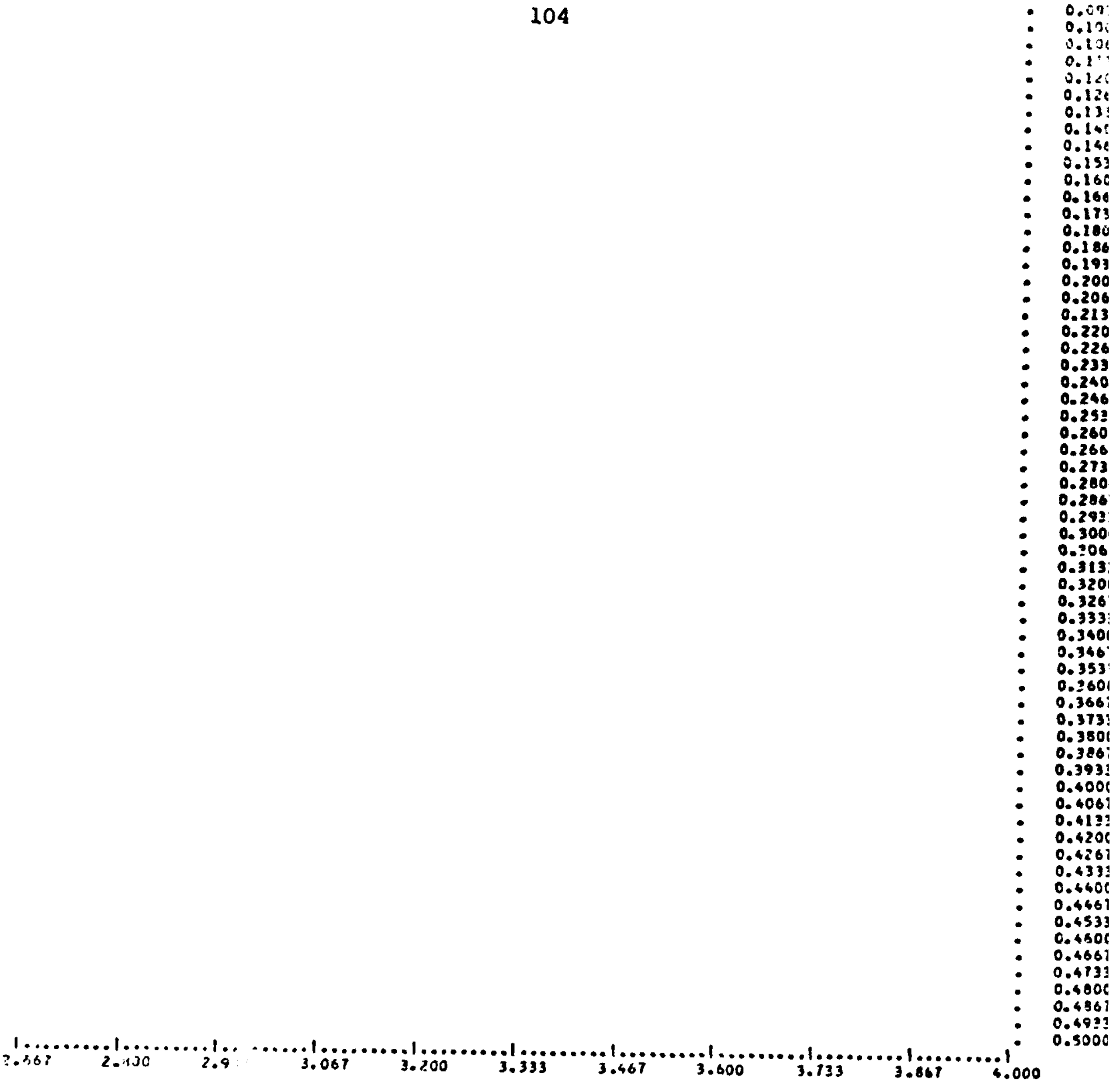
```
I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
1.333     1.467     1.600     1.733     1.867     2.000     2.133     2.267     2.400     2.533     2.667

                                  CONTOUR LEVEL KEY

0: -0.2850000E 02 TO -0.2549998E 02   4: -0.1650000E 02 TC -0.1349999E 02   8: -C.4500000E 01 TO -C.1499990E 01
1: -0.2550000E 02 TO -0.2249998E 02   5: -0.1350000E 02 TO -0.1049999E 02   9: -0.1500000E 01 TO  0.1500010E 01
2: -0.2250000E 02 TO -0.1949998E 02   6: -0.1050000E 02 TO -0.7499990E 01    : -0.1000000E 51 TO -0.2850000E 02
3: -0.1950000E 02 TO -0.1649998E 02   7: -C.7500000E 01 TO -0.4499990E 01   +:  0.1500010E 01 TO  0.1000000E 51
```

```
                          PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 103


2.667     2.800     2.933     3.067     3.200     3.333      .467     3.600     3.733     3.867     4.000
  I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
                                                                                                       .  -0.5000
                                                                                                       .  -0.4933
                                                                                                       .  -0.4867
                                                                                                       .  -0.4800
                                                                                                       .  -0.4733
                                                                                                       .  -0.4667
                                                                                                       .  -0.4600
                                                                                                       .  -0.4533
                                                                                                       .  -0.4467
                                                                                                       .  -0.4400
                                                                                                       .  -0.4333
                                                                                                       .  -0.4267
                                                                                                       .  -0.4200
                                                                                                       .  -0.4133
                                                                                                       .  -0.4067
                                                                                                       .  -0.4000
                                                                                                       .  -0.3933
                                                                                                       .  -0.3867
                                                                                                       .  -0.3800
                                                                                                       .  -0.3733
                                                                                                       .  -0.3667
                                                                                                       .  -0.3600
                                                                                                       .  -0.3533
                                                                                                       .  -0.3467
                                                                                                       .  -0.3400
                                                                                                       .  -0.3333
                                                                                                       .  -0.3267
                                                                                                       .  -0.3200
                                                                                                       .  -0.3133
                                                                                                       .  -0.3067
                                                                                                       .  -0.3000
                                                                                                       .  -0.2933
                                                                                                       .  -0.2867
                                                                                                       .  -0.2800
                                                                                                       .  -0.2733
                                                                                                       .  -0.2667
                                                                                                       .  -0.2600
                                                                                                       .  -0.2533
                                                                                                       .  -0.2467
                                                                                                       .  -0.2400
                                                                                                       .  -0.2333
                                                                                                       .  -0.2267
                                                                                                       .  -0.2200
                                                                                                       .  -0.2133
                                                                                                       .  -0.2067
                                                                                                       .  -0.2000
                                                                                                       .  -0.1933
                                                                                                       .  -0.1867
                                                                                                       .  -0.1800
                                                                                                       .  -0.1733
                                                                                                       .  -0.1667
                                                                                                       .  -0.1600
                                                                                                       .  -0.1533
                                                                                                       .  -0.1467
                                                                                                       .  -0.1400
                                                                                                       .  -0.1333
                                                                                                       .  -0.1267
                                                                                                       .  -0.1200
                                                                                                       .  -0.1133
                                                                                                       .  -0.1067
                                                                                                       .  -0.1000
                                                                                                       .  -0.0933
                                                                                                       .  -0.0867
                                                                                                       .  -0.0800
                                                                                                       .  -0.0733
                                                                                                       .  -0.0667
                                                                                                       .  -0.0600
                                                                                                       .  -0.0533
                                                                                                       .  -0.0467
                                                                                                       .  -0.0400
                                                                                                       .  -0.0333
                                                                                                       .  -0.0267
                                                                                                       .  -0.0200
                              0 0 0                                                                    .  -0.0133
  2 2 1 0           0 0 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 0 0 0                        .  -0.0067
  4 4 3 2 0     0 1 2 2 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 3 3 3 3 3 2 2 2 1 1 1 0 0                  .  -0.0000
  1 1 0                 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0                            .   0.0067
                        0 0 0 0 0 0 0 0 0 0 0 0 0 0                                                    .   0.0133
                                                                                                       .   0.0200
                                                                                                       .   0.0267
                                                                                                       .   0.0333
                                                                                                       .   0.0400
                                                                                                       .   0.0467
                                                                                                       .   0.0533
                                                                                                       .   0.0600
                                                                                                       .   0.0667
                                                                                                       .   0.0733
                                                                                                       .   0.0800
                                                                                                       .   0.0867
```


0.09
0.10
0.10
0.1
0.12
0.12
0.13
0.14
0.14
0.153
0.160
0.166
0.173
0.180
0.186
0.193
0.200
0.206
0.213
0.220
0.226
0.233
0.240
0.246
0.253
0.260
0.266
0.273
0.280
0.286
0.293
0.300
0.306
0.313
0.320
0.326
0.333
0.340
0.346
0.353
0.360
0.366
0.373
0.380
0.386
0.393
0.400
0.406
0.413
0.420
0.426
0.433
0.440
0.446
0.453
0.460
0.466
0.473
0.480
0.486
0.493
0.5000
2.667
2.800
2.9
3.067
3.200
3.333
3.467
3.600
3.733
3.867
4.000

```
X-AXIS PROFILE PLOT ALONG    2.144 DEGREES LATITUDE.
PATTERN NUMBER   103

                                              SCALE FACTOR IS 10**-2

   CR.        REAL  99.9427          79.9560        59.9653        39.9826        19.9959        0.0392
  -44.02       C.449  |                                                                        *|     0.5000
  -44.71       C.591  |                                                                        *|     0.4980
  -44.11       0.293  |                                                                        *|     0.4960
  -72.41       C.024  |                                                                        *|     0.4940
  -49.24       0.345  .       .       .       .       .       .       .       .       .       *.     0.4920
  -45.50       C.531  |                                                                        *|     0.4900
  -47.10       C.442  |                                                                        *|     0.4880
  -58.27       0.122  |                                                                        *|     0.4860
  -51.49       0.256  |                                                                        *|     0.4840
  -45.58       0.526  |                                                                        *|     0.4820
  -45.61       0.524  |                                                                        *|     0.4800
  -51.65       C.262  |                                                                        *|     0.4780
  -57.77       0.129  .       .       .       .       .       .       .       .       .       *.     0.4760
  -46.95       C.449  |                                                                        *|     0.4740
  -45.44       C.534  |                                                                        *|     0.4720
  -45.37       0.540  |                                                                        *|     0.4700
  -69.13       0.035  |                                                                        *|     0.4680
  -47.99       C.399  |                                                                        *|     0.4660
  -44.76       C.565  |                                                                        *|     0.4640
  -47.00       C.447  |                                                                        *|     0.4620
  -59.49       0.106  .       .       .       .       .       .       .       .       .       *.     0.4600
  -51.05       0.280  |                                                                        *|     0.4580
  -45.90       C.507  |                                                                        *|     0.4560
  -46.90       0.452  |                                                                        *|     0.4540
  -57.40       C.135  |                                                                        *|     0.4520
  -50.98       0.286  |                                                                        *|     0.4500
  -44.51       0.595  |                                                                        *|     0.4480
  -44.01       C.630  |                                                                        *|     0.4460
  -48.70       C.367  .       .       .       .       .       .       .       .       .       *.     0.4440
  -63.60       C.066  |                                                                        *|     0.4420
  -46.87       C.453  |                                                                        *|     0.4400
  -44.46       0.598  |                                                                        *|     0.4380
  -47.38       C.428  |                                                                        *|     0.4360
  -70.73       C.029  |                                                                        *|     0.4340
  -48.12       0.393  |                                                                        *|     0.4320
  -44.16       C.619  |                                                                        *|     0.4300
  -45.47       0.533  .       .       .       .       .       .       .       .       .       *.     0.4280
  -55.04       C.177  |                                                                        *|     0.4260
  -51.51       C.266  |                                                                        *|     0.4240
  -44.97       0.565  |                                                                        *|     0.4220
  -44.97       C.564  |                                                                        *|     0.4200
  -51.59       C.263  |                                                                        *|     0.4180
  -54.76       C.183  |                                                                        *|     0.4160
  -45.32       C.542  |                                                                        *|     0.4140
  -44.07       C.626  .       .       .       .       .       .       .       .       .       *.     0.4120
  -48.17       C.390  |                                                                        *|     0.4100
  -67.71       C.041  |                                                                        *|     0.4080
  -47.16       0.439  |                                                                        *|     0.4060
  -44.61       C.564  |                                                                        *|     0.4040
  -47.92       C.402  |                                                                        *|     0.4020
  -70.21       0.031  |                                                                        *|     0.4000
  -46.23       C.485  |                                                                        *|     0.3980
  -42.72       C.731  .       .       .       .       .       .       .       .       .       *.     0.3960
  -44.06       0.626  |                                                                        *|     0.3940
  -53.14       C.220  |                                                                        *|     0.3920
  -50.96       0.283  |                                                                        *|     0.3900
  -44.04       C.627  |                                                                        *|     0.3880
   43.95       0.634  |                                                                        *|     0.3860
  -50.41       0.302  |                                                                        *|     0.3840
  -54.02       0.199  |                                                                        *|     0.3820
  -44.38       0.604  .       .       .       .       .       .       .       .       .       *.     0.3800
  -42.08       C.782  |                                                                        *|     0.3780
  -47.15       C.439  |                                                                        *|     0.3760
  -66.24       0.049  |                                                                        *|     0.3740
  -45.92       C.505  |                                                                        *|     0.3720
  -43.27       C.686  |                                                                        *|     0.3700
  -45.98       0.533  |                                                                        *|     0.3680
  -67.79       0.041  |                                                                        *|     0.3660
  -46.90       0.452  .       .       .       .       .               .       .       .       *.     0.3640
  -42.91       C.716  |                                                                        *|     0.3620
  -44.30       C.609  |                                                                        *|     0.3600
  -54.90       C.189  |                                                                        *|     0.3580
  -49.84       0.321  |                                                                        *|     0.3560
  -43.63       0.657  |                                                                        *|     0.3540
  -44.69   [illegible]|                                                                        *|     0.3520
  -54.20       0.195  |                                                                        *|     0.3500
  -49.07   [illegible].       .       .       .       .       .       .       .       .       *.     0.3480
  -42.70       C.768  |                                                                        *|     0.3460
  -41.76       C.816  |                                                                        *|     0.3440
  -46.01       0.467  |                                                                        *|     0.3420
  -53.92   [illegible]|                                                                        *|     0.3400
  [illegible] [illegible] |                                                                    *|     0.3380
  -42.19       C.777  |                                                                        *|     0.3360
  -45.60   [illegible]|                                                                        *|     0.3340
  [illegible]  C.017  .               .       .       .       .       .       .       .       *.     0.3320
  -45.01   [illegible]|                                                                        *|     0.3300
  [illegible] [illegible] |                                                                    *|     [illegible]
  [illegible] [illegible] |                                                                    *|     [illegible]
  [illegible] [illegible] |                                                                    *|     [illegible]
  [illegible] [illegible] |                                                                    *|     [illegible]
```

REPRODUCIBILITY OF
ORIGINAL PAGE IS P

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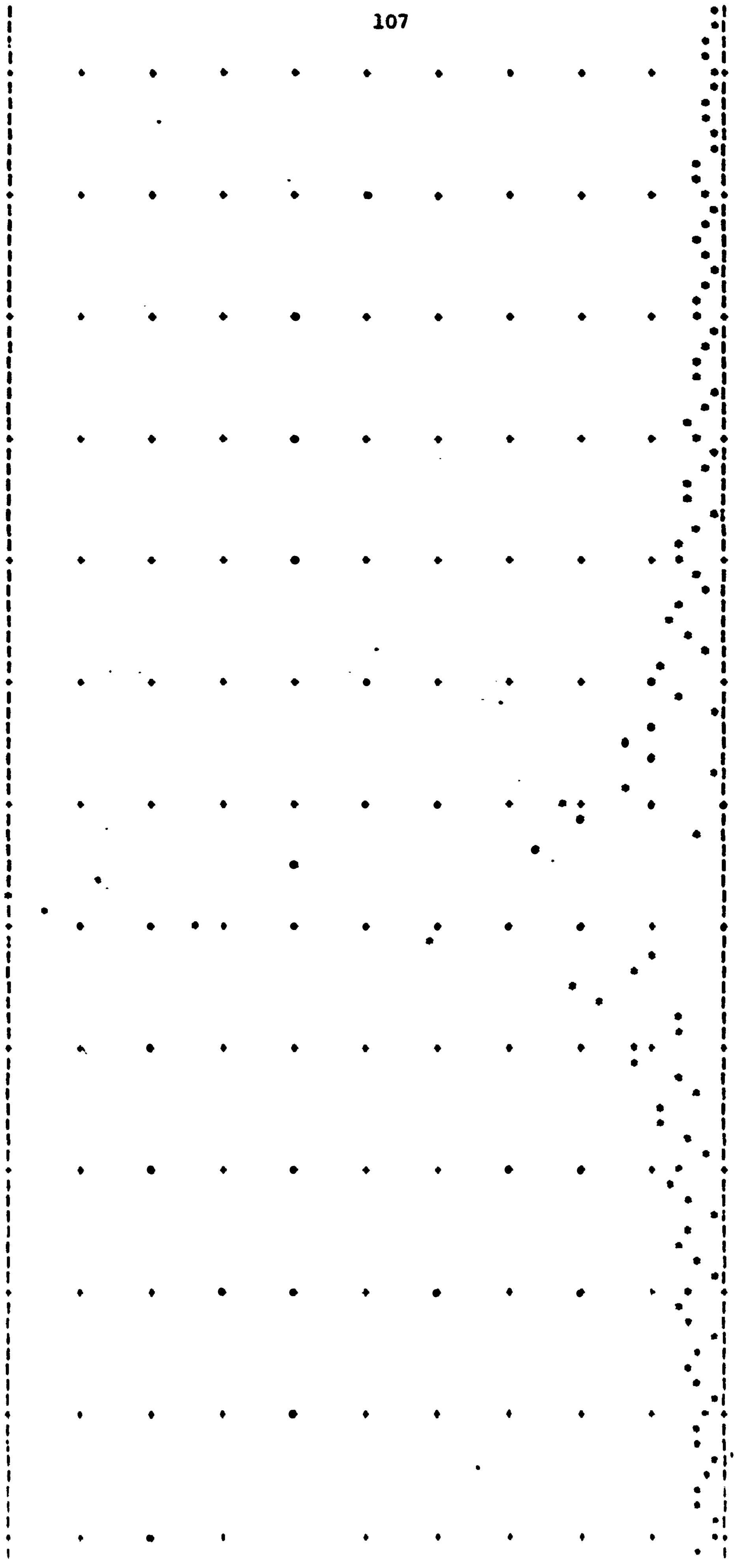
 -42.21   0.775  I                                                  *I   0.3200
 -43.17   0.695  I                                                  *I   0.3180
 -53.78   0.232  +    .    .    .    .    .    .    .    .    .     *+   0.3160
 -44.71   0.367  I                                                  *I   0.3140
 -42.13   0.782  I                                                  *I   0.3120
 -42.06   0.789  I                                                  *I   0.3100
 -44.36   0.382  I                                                  *I   0.3080
 -53.19   0.219  I                                                  *I   0.3060
 -43.28   0.686  I                                                  *I   0.3040
 -42.43   0.756  I                                                  *I   0.3020
 -48.43   0.379  +    .    .    .    .    .    .    .    .    .     *+   0.3000
 -51.83   0.256  I                                                  *I   0.2980
 -41.81   0.812  I                                                  *I   0.2960
 -43.11   0.548  I                                                  *I   0.2940
 -43.28   0.678  I                                                  *I   0.2920
 -68.99   0.636  I                                                  *I   0.2900
 -44.32   0.609  I                                                  *I   0.2880
 -40.79   0.913  I                                                  *I   0.2860
 -42.89   0.717  +    .    .    .    .    .    .    .    .    .     *+   0.2840
 -58.17   0.123  I                                                  *I   0.2820
 -45.16   0.552  I                                                  *I   0.2800
 -40.47   0.947  I                                                  *I   0.2780
 -41.46   0.845  I                                                  *I   0.2760
 -50.53   0.298  I                                                  *I   0.2740
 -47.86   0.405  I                                                  *I   0.2720
 -41.08   0.883  I                                                  *I   0.2700
 -41.14   0.977  +    .    .    .    .    .    .    .    .    .     *+   0.2680
 -45.31   0.384  I                                                  *I   0.2660
 -49.58   0.332  I                                                  *I   0.2640
 -41.06   0.885  I                                                  *I   0.2620
 -40.23   0.974  I                                                  *I   0.2600
 -45.26   0.546  I                                                  *I   0.2580
 -55.55   0.167  I                                                  *I   0.2560
 -42.25   0.772  I                                                  *I   0.2540
 -40.66   0.927  +    .    .    .    .    .    .    .    .    .     *+   0.2520
 -45.50   0.531  I                                                  *I   0.2500
 -53.20   0.219  I                                                  *I   0.2480
 -40.70   0.923  I                                                  *I   0.2460
 -36.44   1.196  I                                                  *I   0.2440
 -41.13   0.878  I                                                  *I   0.2420
 -58.39   0.120  I                                                  *I   0.2400
 -43.35   0.680  I                                                  *I   0.2380
 -39.14   1.059  +    .    .    .    .    .    .    .    .    .     *+   0.2360
 -40.82   0.910  I                                                  *I   0.2340
 -53.52   0.211  I                                                  *I   0.2320
 -44.10   0.674  I                                                  *I   0.2300
 -38.85   1.141  I                                                  *I   0.2280
 -39.52   1.057  I                                                  *I   0.2260
 -47.80   0.407  I                                                  *I   0.2240
 -46.81   0.456  I                                                  *I   0.2220
 -37.47   1.069  +    .    .    .    .    .    .    .    .    .     *+   0.2200
 -39.25   1.093  I                                                  *I   0.2180
 -46.00   0.501  I                                                  *I   0.2160
 -48.31   0.384  I                                                  *I   0.2140
 -39.31   1.083  I                                                  *I   0.2120
 -35.34   1.210  I                                                  *I   0.2100
 -43.72   0.690  I                                                  *I   0.2080
 -54.15   0.195  I                                                  *I   0.2060
 -40.39   0.956  +    .    .    .    .    .    .    .    .    .     *+   0.2040
 -38.74   1.157  I                                                  *I   0.2020
 -43.59   0.652  I                                                  *I   0.2000
 -51.08   0.279  I                                                  *I   0.1980
 -34.68   1.164  I                                                  *I   0.1960
 -36.46   1.504  I                                                 * I   0.1940
 -39.23   1.093  I                                                  *I   0.1920
 -57.81   0.129  I                                                  *I   0.1900
 -41.09   0.832  +    .    .    .    .    .    .    .    .    .     *+   0.1880
 -37.09   1.393  I                                                 * I   0.1860
 -38.50   1.135  I                                                  *I   0.1840
 -52.79   0.279  I                                                  *I   0.1820
 -41.17   0.825  I                                                  *I   0.1800
 -35.[illegible]1   1.474  I                                                 * I   0.1780
 -37.53   1.329  I                                                 * I   0.1760
 -46.57   0.469  I                                                  *I   0.1740
 -43.78   0.647  +    .    .    .    .    .    .    .    .    .     *+   0.1720
 -37.03   1.408  I                                                 * I   0.1700
 -37.16   1.287  I                                                 * I   0.1680
 -44.74   0.579  I                                                  *I   0.1660
 -44.73   0.560  I                                                  *I   0.1640
 -35.73   1.458  I                                                 * I   0.1620
 -36.13   1.562  I                                                 * I   0.1600
 -41.70   0.877  I                                                  *I   0.1580
 -49.89   0.259  +    .    .    .    .    .    .    .    .    .     *+   0.1560
 -37.56   1.374  I                                                 * I   0.1540
 -36.41   1.512  I                                                 * I   0.1520
 -42.16   0.780  I                                                  *I   0.1500
 -45.97   0.502  I                                                  *I   0.1480
 -35.66   1.649  I                                                 * I   0.1460
 -33.62   2.011  I                                                 * I   0.1440
 -37.57   1.[illegible]51  I                                                 * I   0.1420
 -77.35   0.614  +    .    .    .    .    .    .    .    .    .     *+   0.1400
 -37.76   1.374  I                                                 * I   0.1380
 -34.22   1.924  I                                                 * I   0.1360
 -37.93   1.445  I                                                 * I   0.1340
 -57.67   0.131  I                                                  *I   0.1320
 -37.[illegible]   1.111  I                                                 * I   0.1300
 -33.52   2.066  I                                                 * I   0.1280
 -35.17   1.744  I                                                 * I   0.1260
 -46.[illegible]   0.449  +    .    .    .    .    .    .    .    .    .     *+   0.1240
 -[illegible].1   1.105  I                                                  *I   0.1220
 [illegible]   2.[illegible]  I                                                 * I   0.1200
 -3[illegible]   1.[illegible]  I                                                 * I   0.1180
```



-44.47	0.549	0.1160
-39.45	1.006	0.1140
-33.12	2.234	0.1120
-33.75	2.175	0.1100
-40.42	0.953	0.1080
-41.97	0.797	0.1060
-33.58	2.093	0.1040
-33.32	2.157	0.1020
-41.06	0.835	0.1000
-39.24	1.071	0.0980
-31.38	2.677	0.0960
-30.42	3.012	0.0940
-34.96	1.787	0.0920
-48.24	0.383	0.0900
-32.58	2.249	0.0880
-30.39	3.024	0.0860
-34.02	1.990	0.0840
-52.29	0.243	0.0820
-32.13	2.474	0.0800
-29.24	3.452	0.0780
-31.80	2.572	0.0760
-52.37	0.241	0.0740
-32.76	2.301	0.0720
-28.82	3.622	0.0700
-30.70	2.918	0.0680
-46.53	0.471	0.0660
-32.31	2.423	0.0640
-27.63	4.152	0.0620
-28.71	3.669	0.0600
-39.00	1.123	0.0580
-33.39	2.141	0.0560
-27.40	4.264	0.0540
-28.23	3.689	0.0520
-40.21	0.574	0.0500
-30.31	3.052	0.0480
-24.42	6.013	0.0460
-24.29	6.102	0.0440
-30.55	2.967	0.0420
-34.21	1.549	0.0400
-24.34	6.070	0.0380
-23.12	6.985	0.0360
-28.31	3.842	0.0340
-33.93	2.011	0.0320
-22.48	7.518	0.0300
-20.48	9.461	0.0280
-24.15	6.201	0.0260
-35.69	1.137	0.0240
-20.97	8.941	0.0220
-17.94	12.674	0.0200
-20.64	9.286	0.0180
-41.21	0.678	0.0160
-17.39	13.501	0.0140
-13.24	21.772	0.0120
-14.34	19.192	0.0100
-31.78	2.575	0.0080
-11.74	25.635	0.0060
-4.60	58.261	0.0040
-1.26	86.531	0.0020
-0.01	99.943	0.0000
-0.47	94.690	-0.0020
-2.78	72.596	-0.0040
-7.75	40.974	-0.0060
-20.22	9.747	-0.0080
-18.19	12.322	-0.0100
-13.62	20.835	-0.0120
-15.52	16.755	-0.0140
-25.26	5.455	-0.0160
-24.26	6.122	-0.0180
-18.10	12.439	-0.0200
-18.82	11.469	-0.0220
-25.93	5.026	-0.0240
-30.91	2.847	-0.0260
-21.56	7.979	-0.0280
-21.73	8.194	-0.0300
-27.87	4.043	-0.0320
-34.59	1.750	-0.0340
-24.32	6.030	-0.0360
-22.36	6.793	-0.0380
-28.04	3.945	-0.0400
-44.47	0.549	-0.0420
-27.44	4.247	-0.0440
-25.81	5.123	-0.0460
-30.59	2.956	-0.0480
-40.95	0.896	-0.0500
-27.39	4.270	-0.0520
-25.39	5.468	-0.0540
-28.33	3.832	-0.0560
-45.76	0.515	-0.0580
-31.24	2.710	-0.0600
-27.55	4.189	-0.0620
-29.63	3.260	-0.0640
-41.05	0.639	-0.0660
-33.07	2.215	-0.0680
-28.51	3.752	-0.0700
-29.81	2.211	-0.0720
-39.52	1.057	-0.0740
-35.33	1.517	-0.0760
-30.20	3.071	-0.0780
-30.01	2.992	-0.0800
[illegible]	[illegible]	-0.0820
[illegible]	1.217	-0.0840
[illegible]	2.717	-0.0860

```
-31.03  2.808  I                                             •  I  -0.0880
-37.98  1.252  I                                              • I  -0.0900
-42.92  0.714  I                                               •I  -0.0920
-33.05  2.225  I                                              • I  -0.0940
-32.52  2.365  I                                              • I  -0.0960
-39.24  1.091  I                                               •I  -0.0980
-41.23  0.868  •    •    •    •    •    •    •    •    •    •  ••  -0.1000
-32.28  2.433  I                                              • I  -0.1020
-31.16  2.768  I                                             •  I  -0.1040
-35.20  1.722  I                                              • I  -0.1060
-58.61  0.117  I                                               •I  -0.1080
-35.12  1.754  I                                              • I  -0.1100
-32.63  2.337  I                                              • I  -0.1120
-35.87  1.609  I                                              • I  -0.1140
-74.21  0.019  •    •    •    •    •    •    •    •    •    •  ••  -0.1160
-36.23  1.544  I                                              • I  -0.1180
-33.00  2.239  I                                              • I  -0.1200
-35.25  1.727  I                                              • I  -0.1220
-49.65  0.328  I                                               •I  -0.1240
-38.64  1.170  I                                               •I  -0.1260
-34.17  1.957  I                                              • I  -0.1280
-35.72  1.636  I                                              • I  -0.1300
-47.53  0.420  •    •    •    •    •    •    •    •    •    •  ••  -0.1320
-39.99  1.001  I                                               •I  -0.1340
-34.65  1.851  I                                              • I  -0.1360
-35.44  1.691  I                                              • I  -0.1380
-43.79  0.646  I                                               •I  -0.1400
-43.35  0.680  I                                               •I  -0.1420
-36.22  1.545  I                                              • I  -0.1440
-36.62  1.476  I                                              • I  -0.1460
-45.66  0.521  •    •    •    •    •    •    •    •    •    •  ••  -0.1480
-42.65  0.790  I                                               •I  -0.1500
-35.19  1.740  I                                              • I  -0.1520
-34.80  1.829  I                                              • I  -0.1540
-40.04  0.995  I                                               •I  -0.1560
-51.03  0.281  I                                               •I  -0.1580
-37.54  1.327  I                                              • I  -0.1600
-35.92  1.600  I                                              • I  -0.1620
-40.15  0.982  •    •    •    •    •    •    •    •    •    •  ••  -0.1640
-55.81  0.162  I                                               •I  -0.1660
-38.35  1.204  I                                               •I  -0.1680
-36.99  1.594  I                                              • I  -0.1700
-39.02  1.119  I                                               •I  -0.1720
-61.76  0.022  I                                               •I  -0.1740
-40.42  0.952  I                                               •I  -0.1760
-36.91  1.427  I                                              • I  -0.1780
-39.17  1.101  •    •    •    •    •    •    •    •    •    •  ••  -0.1800
-55.15  0.175  I                                               •I  -0.1820
-41.55  0.826  I                                               •I  -0.1840
-37.19  1.383  I                                              • I  -0.1860
-38.54  1.183  I                                               •I  -0.1880
-48.66  0.369  I                                               •I  -0.1900
-44.46  0.593  I                                               •I  -0.1920
-38.57  1.178  I                                               •I  -0.1940
-39.54  1.055  •    •    •    •    •    •    •    •    •    •  ••  -0.1960
-50.54  0.297  I                                               •I  -0.1980
-43.25  0.690  I                                               •I  -0.2000
-37.41  1.347  I                                              • I  -0.2020
-37.42  1.345  I                                              • I  -0.2040
-43.36  0.679  I                                               •I  -0.2060
-50.69  0.292  I                                               •I  -0.2080
-39.55  1.052  I                                               •I  -0.2100
-38.34  1.211  •    •    •    •    •    •    •    •    •    •  ••  -0.2120
-43.09  0.701  I                                               •I  -0.2140
-54.56  0.187  I                                               •I  -0.2160
-40.32  0.966  I                                               •I  -0.2180
-38.26  1.222  I                                               •I  -0.2200
-41.62  0.830  I                                               •I  -0.2220
-75.18  0.017  I                                               •I  -0.2240
-42.23  0.774  I                                               •I  -0.2260
-39.04  1.117  •    •    •    •    •    •    •    •    •    •  ••  -0.2280
-41.53  0.839  I                                               •I  -0.2300
-59.52  0.106  I                                               •I  -0.2320
-43.34  0.693  I                                               •I  -0.2340
-39.21  1.095  I                                               •I  -0.2360
-40.65  0.924  I                                               •I  -0.2380
-51.23  0.274  I                                               •I  -0.2400
-46.76  0.447  I                                               •I  -0.2420
-40.56  0.943  •    •    •    •    •    •    •    •    •    •  ••  -0.2440
-41.55  0.836  I                                               •I  -0.2460
-52.69  0.232  I                                               •I  -0.2480
-45.25  0.546  I                                               •I  -0.2500
-39.34  1.079  I                                               •I  -0.2520
-39.31  1.082  I                                               •I  -0.2540
-45.12  0.555  I                                               •I  -0.2560
-52.00  0.224  I                                               •I  -0.2580
-41.49  0.843  •    •    •    •    •    •    •    •    •    •  ••  -0.2600
-40.15  0.983  I                                               •I  -0.2620
-44.65  0.565  I                                               •I  -0.2640
-57.59  0.128  I                                               •I  -0.2660
-42.29  0.768  I                                               •I  -0.2680
-40.02  0.997  I                                               •I  -0.2700
-43.01  0.707  I                                               •I  -0.2720
-66.05  0.050  I                                               •I  -0.2740
-44.27  0.605  •    •    •    •    •    •    •    •    •    •  ••  -0.2760
-40.74  0.919  I                                               •I  -0.2780
-42.98  0.719  I                                               •I  -0.2800
-57.65  0.134  I                                               •I  -0.2820
-45.68  [illegible]  I                                         •I  -0.2840
[illegible]  [illegible]  I                                    •I  -0.2860
[illegible]  0.733  I                                          •I  -0.2880
[illegible]  [illegible]  I                                    •I  -0.2900
```

```
-44.11    0..50  +    +    +    +    +    +    +    +    +    +    *+   -0.2920
-42.37    0.762  I                                                 *I   -0.2940
-47.76    0.724  I                                                 *I   -0.2960
-51.[illegible]    0.261  I                                                 *I   -0.2980
-46.[illegible]    0.345  I                                                 *I   -0.3000
-41.24    0.867  I                                                 *I   -0.3020
-43.61    0.930  I                                                 *I   -0.3040
-45.27    0.[illegible]39  I                                                 *I   -0.3060
-59.58    0.104  +    +    +    +    +    +    +    +    +    +    *+   -0.3080
-43.67    0.554  I                                                 *I   -0.3100
-41.54    0.828  I                                                 *I   -0.3120
-44.95    0.566  I                                                 *I   -0.3140
-30.71    0.009  I                                                  *   -0.3160
-44.77    0.577  I                                                 *I   -0.3180
-41.52    0.843  I                                                 *I   -0.3200
-43.56    0.664  I                                                 *I   -0.3220
-56.47    0.150  +    +    +    +    +    +    +    +    +    +    *+   -0.3240
-47.45    0.424  I                                                 *I   -0.3260
-42.44    0.755  I                                                 *I   -0.3280
-43.44    0.673  I                                                 *I   -0.3300
-52.85    0.229                                                    *I   -0.3320
-49.44    0.337  I                                                 *I   -0.3340
-42.92    0.723  I                                                 *I   -0.3360
-42.76    0.729  I                                                 *I   -0.3380
-48.90    0.259  +    +    +    +    +    +    +    +    +    +    *+   -0.3400
-54.86    0.181  I                                                 *I   -0.3420
-44.49    0.597  I                                                 *I   -0.3440
-43.54    0.666  I                                                 *I   -0.3460
-49.20    0.347  I                                                 *I   -0.3480
-54.41    0.193  I                                                 *I   -0.3500
-43.55    0.664  I                                                 *I   -0.3520
-41.69    0.824  I                                                 *I   -0.3540
-44.65    0.586  +    +    +    +    +    +    +    +    +    +    *+   -0.3560
-62.78    0.073  I                                                 *I   -0.3580
-46.92    0.450  I                                                 *I   -0.3600
-42.90    0.716  I                                                 *I   -0.3620
-44.53    0.594  I                                                 *I   -0.3640
-56.15    0.156  I                                                 *I   -0.3660
-48.77    0.364  I                                                 *I   -0.3680
-42.19    0.693  I                                                 *I   -0.3700
-43.57    0.663  +    +    +    +    +    +    +    +    +    +    *+   -0.3720
-50.59    0.296  I                                                 *I   -0.3740
-53.48    0.212  I                                                 *I   -0.3760
-44.54    0.593  I                                                 *I   -0.3780
-43.74    0.650  I                                                 *I   -0.3800
-48.86    0.360  I                                                 *I   -0.3820
-58.44    0.120  I                                                 *I   -0.3840
-45.-C    0.537  I                                                 *I   -0.3860
-43.42    0.674  +    +    +    +    +    +    +    +    +    +    *+   -0.3880
-46.54    0.456  I                                                 *I   -0.3900
-71.37    0.027  I                                                 *I   -0.3920
-47.85    0.404  I                                                 *I   -0.3940
-44.45    0.599  I                                                 *I   -0.3960
-46.70    0.452  I                                                 *I   -0.3980
-68.49    0.036  I                                                 *I   -0.4000
-47.37    0.428  I                                                 *I   -0.4020
-43.07    0.702  +    +    +    +    +    +    +    +    +    +    *+   -0.4040
-43.87    0.644  I                                                 *I   -0.4060
-51.05    0.280  I                                                 *I   -0.4080
-53.98    0.202  I                                                 *I   -0.4100
-45.04    0.560  I                                                 *I   -0.4120
-44.24    0.614  I                                                 *I   -0.4140
-49.29    0.343  I                                                 *I   -0.4160
-59.45    0.107  I                                                 *I   -0.4180
-46.01    0.501  +    +    +    +    +    +    +    +    +    +    *+   -0.4200
-43.90    0.638  I                                                 *I   -0.4220
-45.55    0.452  I                                                 *I   -0.4240
-67.30    0.043  I                                                 *I   -0.4260
-48.52    0.375  I                                                 *I   -0.4280
-44.62    0.587  I                                                 *I   -0.4300
-46.23    0.488  I                                                 *I   -0.4320
-57.55    0.123  I                                                 *I   -0.4340
-50.70    0.292  +    +    +    +    +    +    +    +    +    +    *+   -0.4360
-45.45    0.566  I                                                 *I   -0.4380
-45.17    0.551  I                                                 *I   -0.4400
-51.67    0.251  I                                                 *I   -0.4420
-56.51    0.149  I                                                 *I   -0.4440
-46.69    0.463  I                                                 *I   -0.4460
-41.77    0.515  I                                                 *I   -0.4480
-51.70    0.275  I                                                 *I   -0.4500
-57.93    0.133  +    +    +    +    +    +    +    +    +    +    *+   -0.4520
-46.00    0.501  I                                                 *I   -0.4540
-43.86    0.641                                                    *I   -0.4560
-46.38    0.480                                                    *:   -0.4580
-60.14    0.09[illegible]  I                                                 *I   -0.4600
-50.69    [illegible]  I                                                 *I   -0.4620
-45.21    0.[illegible]49  I                                                 *I   -0.4640
-4[illegible].10    0.435  I                                                 *I   -0.4660
-56.[illegible]    0.195  +    +    +    +    +    +    +    +    +    +    *+   -0.4680
-51.15    0.220  I                                                 *I   -0.4700
-45.7[illegible]    0.514  I                                                 *I   -0.4720
-45.[illegible]    0.54[illegible]  I                                                 *I   -0.4740
-50.31    0.312  I                                                 *I   -0.4760
-62.[illegible]    0.07[illegible]  I                                                 *I   -0.4780
-47.7     0.41[illegible]  I                                                 *I   -0.4800
-45.[illegible]    [illegible]  I                                                 *I   -0.4820
[illegible]    [illegible]  +    +    +    +    +    +    +    +    +    +    *+   -0.4840
-72.[illegible]    0.02[illegible]  I                                                 *I   -0.4860
[illegible]    0.2[illegible]  I                                                 *I   -0.4880
[illegible]    [illegible]  I                                                 *I   [illegible]
[illegible]    [illegible]  I                                                 *I   [illegible]
[illegible]    [illegible]  I                                                 *I   [illegible]
```

```
[illegible]  0.203  I                                                                                                  *I   -0.4960
[illegible]  0.445  I                                                                                                  *I   -0.4980
-47.12       0.440  +         +         +         +         +         +         +         +         +         +        *+   -0.5000
  DB.        REAL  99.9427             79.9560             59.9693             39.9826             19.9959             0.0092
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```
                                  Y-AXIS PROFILE PLOT ALONG   0.0  LONGITUDE.
                                  PATTERN NUMBER   103

  DB.      REAL  1.0126            0.8102              0.6077              0.4053              0.2029             0.0004
-33.08    0.022  I                                                                                                * I   3.9998
-33.75    0.021  I                                                                                                * I   3.9918
-34.49    0.019  I                                                                                                * I   3.9838
-35.32    0.017  I                                                                                                * I   3.9759
-36.25    0.015  +         +         +         +         +         +         +         +         +         +      * +   3.9679
-37.31    0.014  I                                                                                                * I   2.9599
-38.54    0.012  I                                                                                                  *I   3.9519
-40.00    0.010  I                                                                                                  *I   3.9439
-41.79    0.008  I                                                                                                  *I   3.9359
-44.05    0.006  I                                                                                                  *I   3.9279
-47.26    0.004  I                                                                                                  *I   3.9199
-52.43    0.002  I                                                                                                  *I   3.9119
-67.64    0.000  +         +         +         +         +         +         +         +         +         +         *    3.9039
-56.01    0.002  I                                                                                                  *I   3.8959
-48.84    0.004  I                                                                                                  *I   3.8879
-46.02    0.006  I                                                                                                  *I   3.8799
-42.21    0.008  I                                                                                                  *I   3.8719
-40.12    0.010  I                                                                                                  *I   3.8639
-38.41    0.012  I                                                                                                  *I   3.8559
-37.17    0.014  I                                                                                                * I   3.8479
-35.72    0.016  +         +         +         +         +         +         +         +         +         +      * +   3.8399
-34.62    0.019  I                                                                                                * I   3.8319
-33.65    0.021  I                                                                                                * I   3.8239
-32.73    0.023  I                                                                                                * I   3.8159
-31.91    0.025  I                                                                                                * I   3.8079
-31.15    0.028  I                                                                                               *   I   3.7999
-30.54    0.030  I                                                                                               *   I   3.7919
-29.79    0.032  I                                                                                               *   I   3.7839
-29.17    0.035  +         +         +         +         +         +         +         +         +         +     *   +   3.7759
-28.63    0.037  I                                                                                               *   I   3.7679
-28.09    0.040  I                                                                                              *    I   3.7559
-27.62    0.042  I                                                                                              *    I   3.7519
-27.12    0.045  I                                                                                              *    I   2.7439
-26.65    0.047  I                                                                                              *    I   3.7359
-26.20    0.050  I                                                                                              *    I   3.7279
-25.86    0.052  I                                                                                             *     I   3.7199
[illegible] 0.055 +         +         +         +         +         +         +         +         +         +    *     +   3.7119
[illegible] 0.057 I                                                                                             *     I   [illegible]
[illegible] [illegible] I                                                                                       *     I   [illegible]
[illegible] [illegible] I                                                                                       *     I   [illegible]
[illegible] [illegible] I                                                                                      *      I   [illegible]
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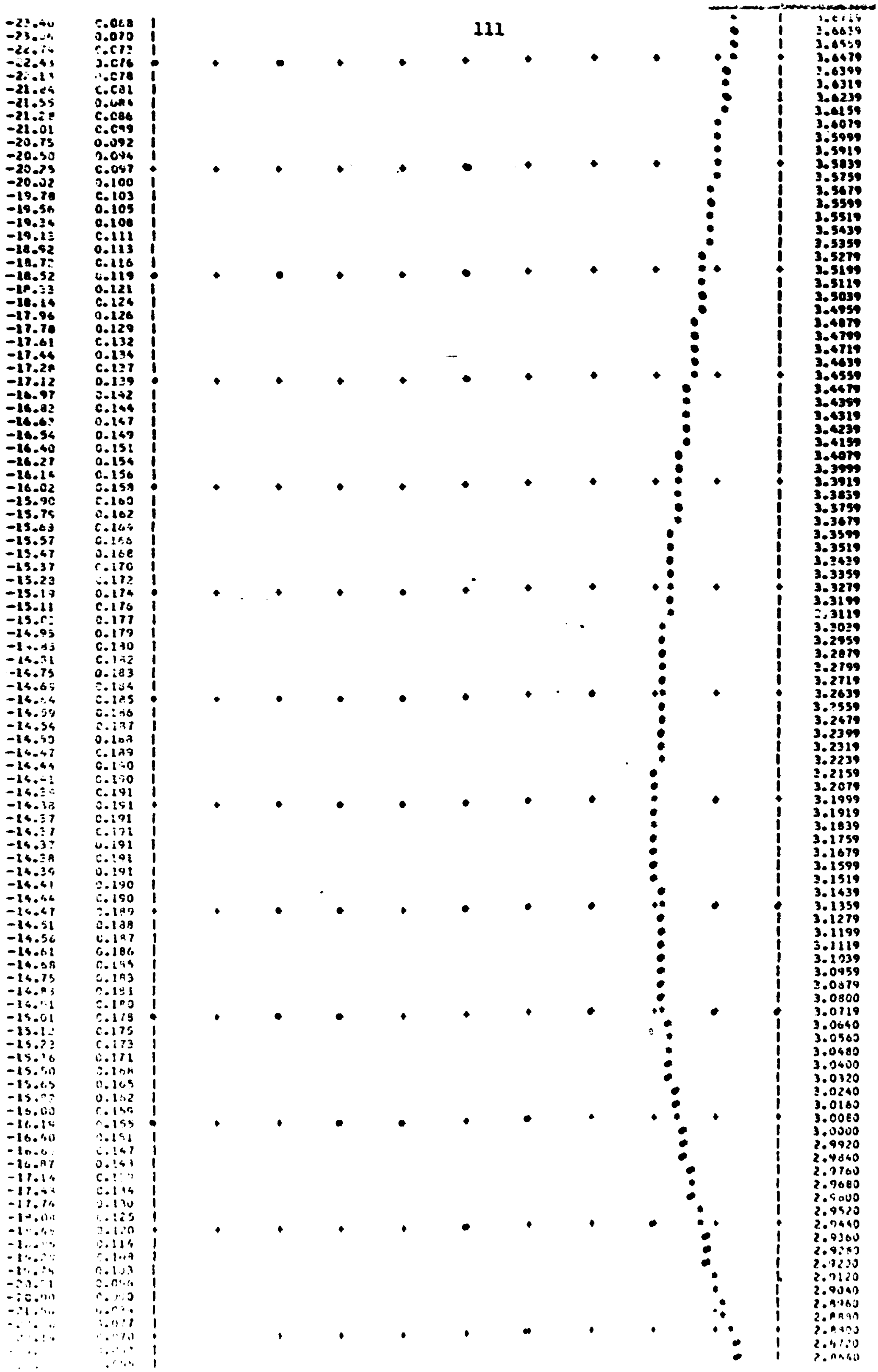
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-23.04 0.070 3.6639
-22.74 0.072 3.6559
-22.43 0.076 3.6479
-22.13 0.078 3.6399
-21.84 0.081 3.6319
-21.55 0.084 3.6239
-21.28 0.086 3.6159
-21.01 0.089 3.6079
-20.75 0.092 3.5999
-20.50 0.094 3.5919
-20.25 0.097 3.5839
-20.02 0.100 3.5759
-19.78 0.103 3.5679
-19.56 0.105 3.5599
-19.34 0.108 3.5519
-19.13 0.111 3.5439
-18.92 0.113 3.5359
-18.72 0.116 3.5279
-18.52 0.119 3.5199
-18.33 0.121 3.5119
-18.14 0.124 3.5039
-17.96 0.126 3.4959
-17.78 0.129 3.4879
-17.61 0.132 3.4799
-17.44 0.134 3.4719
-17.28 0.137 3.4639
-17.12 0.139 3.4559
-16.97 0.142 3.4479
-16.82 0.144 3.4399
-16.68 0.147 3.4319
-16.54 0.149 3.4239
-16.40 0.151 3.4159
-16.27 0.154 3.4079
-16.14 0.156 3.3999
-16.02 0.158 3.3919
-15.90 0.160 3.3839
-15.79 0.162 3.3759
-15.68 0.164 3.3679
-15.57 0.166 3.3599
-15.47 0.168 3.3519
-15.37 0.170 3.3439
-15.28 0.172 3.3359
-15.19 0.174 3.3279
-15.11 0.176 3.3199
-15.02 0.177 3.3119
-14.95 0.179 3.3039
-14.88 0.180 3.2959
-14.81 0.182 3.2879
-14.75 0.183 3.2799
-14.69 0.184 3.2719
-14.64 0.185 3.2639
-14.59 0.186 3.2559
-14.54 0.187 3.2479
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-14.47 0.189 3.2319
-14.44 0.190 3.2239
-14.41 0.190 3.2159
-14.39 0.191 3.2079
-14.38 0.191 3.1999
-14.37 0.191 3.1919
-14.37 0.191 3.1839
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-14.61 0.186 3.1119
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-14.75 0.183 3.0959
-14.83 0.181 3.0879
-14.91 0.180 3.0800
-15.01 0.178 3.0719
-15.12 0.175 3.0640
-15.23 0.173 3.0560
-15.36 0.171 3.0480
-15.50 0.168 3.0400
-15.65 0.165 3.0320
-15.82 0.162 3.0240
-16.00 0.159 3.0160
-16.19 0.155 3.0080
-16.40 0.151 3.0000
-16.63 0.147 2.9920
-16.87 0.143 2.9840
-17.14 0.139 2.9760
-17.43 0.134 2.9680
-17.74 0.130 2.9600
-18.08 0.125 2.9520
-18.45 0.120 2.9440
-18.85 0.114 2.9360
-19.28 0.109 2.9280
-19.74 0.103 2.9200
-20.21 0.096 2.9120
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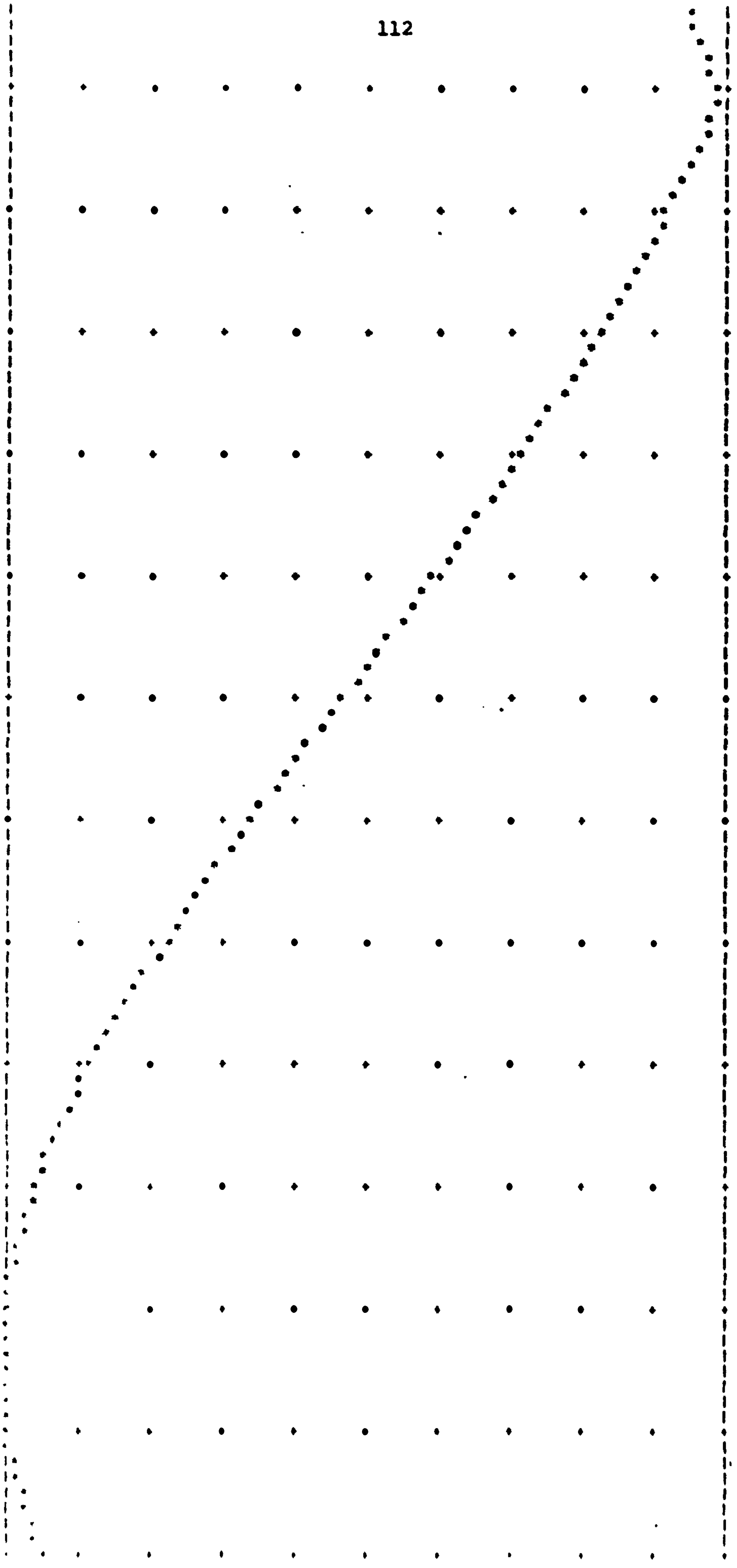
0.077 2.8880
0.070 2.8800
2.8720
2.8640



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-27.01        0.045         2.7760
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-23.62        0.066         2.7600
-22.28        0.077         2.7520
-21.05        0.088         2.7440
-20.03        0.100         2.7360
-19.06        0.111         2.7280
-18.17        0.122         2.7200
-17.35        0.136         2.7120
-16.59        0.148         2.7040
-15.88        0.161         2.6960
-15.21        0.174         2.6880
-14.57        0.187         2.6800
-13.98        0.200         2.6720
-13.41        0.214         2.6640
-12.86        0.227         2.6560
-12.35        0.241         2.6480
-11.85        0.255         2.6400
-11.38        0.270         2.6320
-10.92        0.284         2.6240
-10.49        0.299         2.6160
-10.07        0.314         2.6080
 -9.66        0.329         2.6000
 -9.27        0.344         2.5920
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 -7.18        0.438         2.5440
 -6.87        0.453         2.5360
 -6.57        0.469         2.5280
 -6.28        0.486         2.5200
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 -5.72        0.518         2.5040
 -5.45        0.534         2.4960
 -5.19        0.550         2.4880
 -4.94        0.566         2.4800
 -4.69        0.582         2.4720
 -4.45        0.599         2.4640
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 -3.37        0.678         2.4240
 -3.18        0.694         2.4160
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 -2.28        0.769         2.3760
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 -1.82        0.811         2.3520
 -1.67        0.825         2.3440
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 -1.40        0.851         2.3280
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 -1.03        0.888         2.3040
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 -0.8[illegible]   0.910    2.2880
 -0.7[illegible]   0.921    2.2800
 -0.62        [illegible]   2.2720
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  0.07        1.008         2.1760
  0.09        1.010         2.1680
  0.10        1.012         2.1600
  0.11        1.013         2.1520
  0.11        1.013         2.1440
  0.10        1.012         2.1360
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  0.01        1.001         2.1040
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 -0.07        0.992         2.0880
 -0.13        0.985         2.0800
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[illegible]   [illegible]   [illegible]
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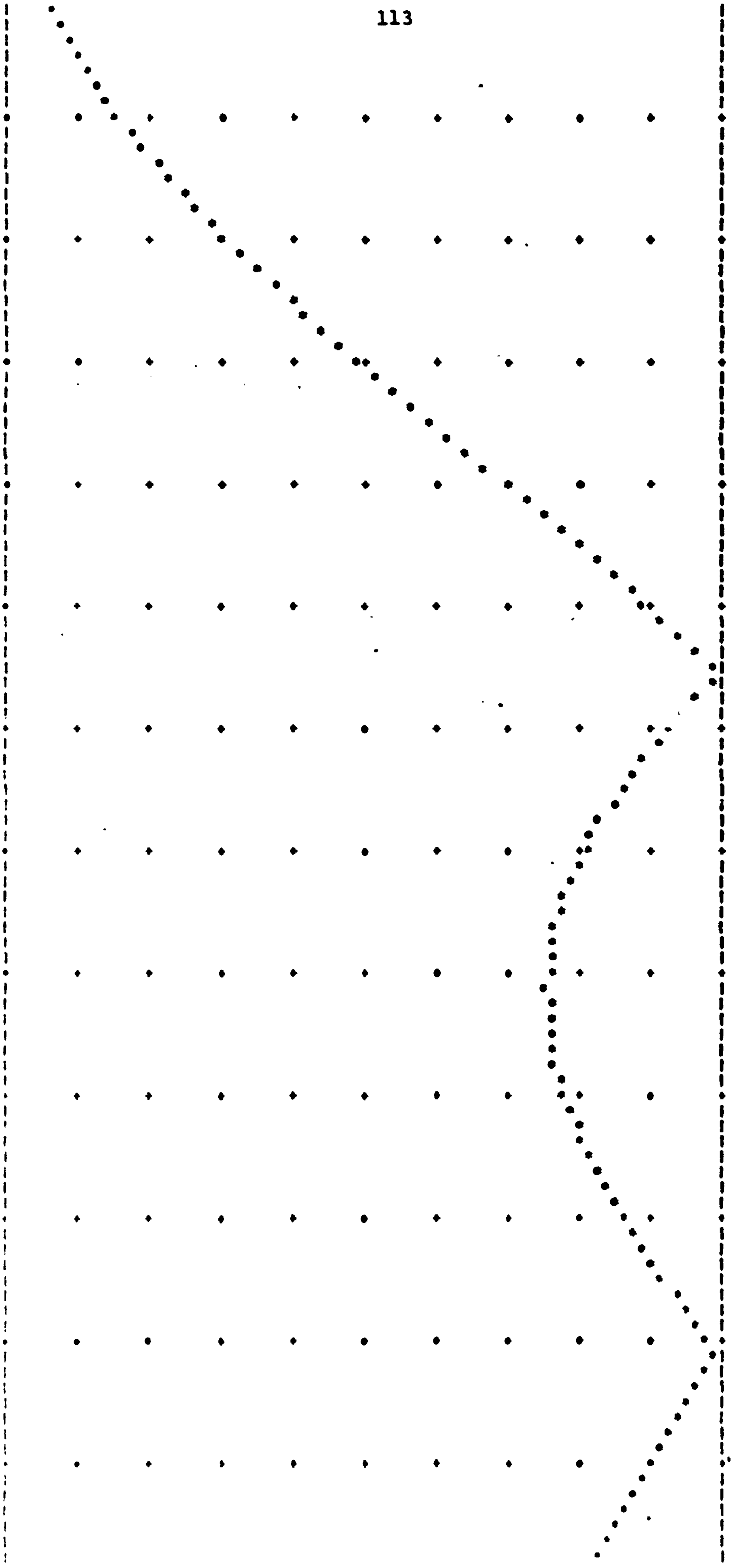

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 -1.27   0.864   1.9920
 -1.43   0.848   1.9840
 -1.60   0.832   1.9760
 -1.78   0.815   1.9680
 -1.97   0.797   1.9600
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 -2.40   0.759   1.9440
 -2.63   0.739   1.9360
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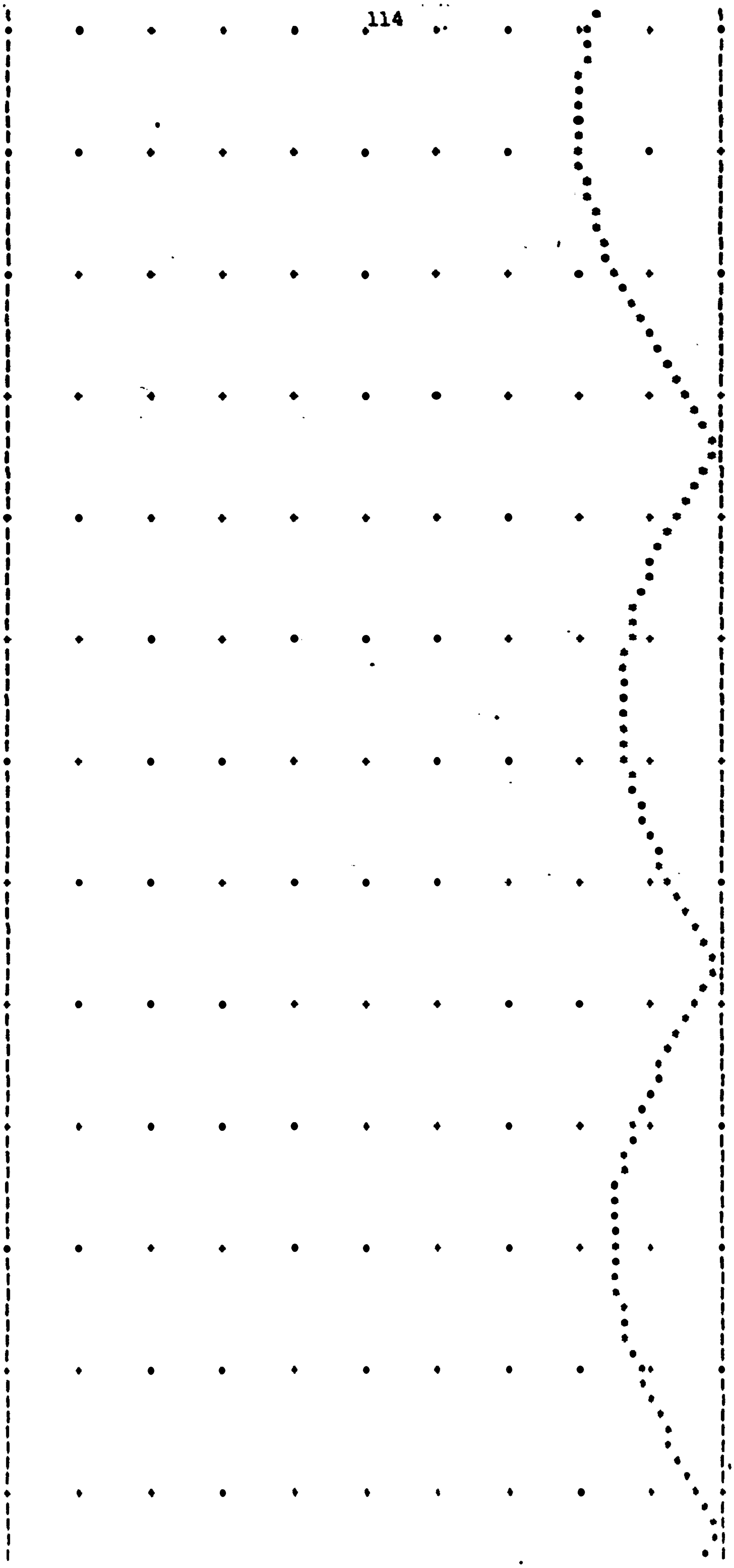
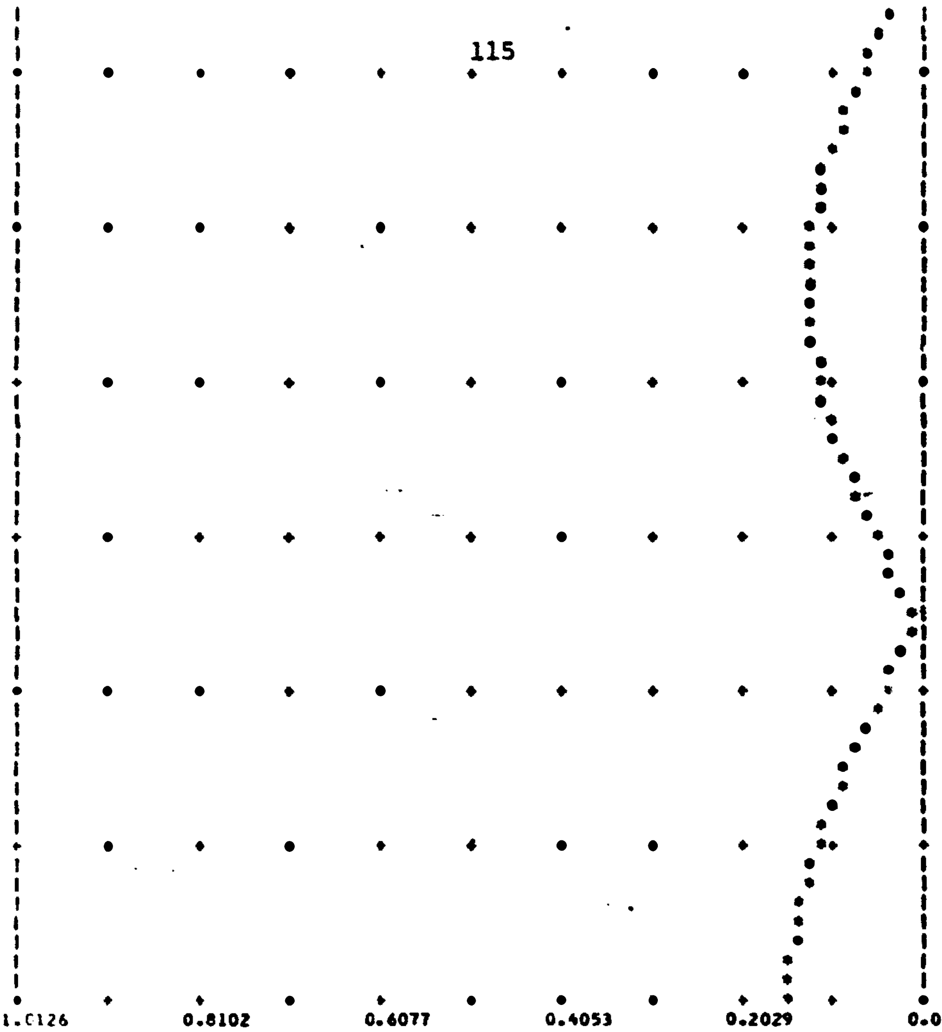
 -3.41   0.675   1.9120
 -3.70   0.653   1.9040
 -4.01   0.630   1.8960
 -4.34   0.607   1.8880
 -4.69   0.583   1.8800
 -5.05   0.559   1.8720
 -5.44   0.534   1.8640
 -5.86   0.509   1.8560
 -6.30   0.484   1.8480
 -6.77   0.459   1.8400
 -7.27   0.433   1.9320
 -7.80   0.407   1.8240
 -8.37   0.381   1.8160
 -8.98   0.355   1.8080
 -9.64   0.329   1.8000
-10.36   0.303   1.7920
-11.14   0.277   1.7840
-11.98   0.252   1.7760
-12.92   0.226   1.7680
-13.96   0.200   1.7600
-15.13   0.175   1.7520
-16.46   0.150   1.7440
-18.00   0.126   1.7360
-19.85   0.102   1.7280
-22.14   0.078   1.7200
-25.19   0.055   1.7120
-29.79   0.032   1.7040
-39.58   0.010   1.6960
-39.34   0.011   1.6880
-30.07   0.031   1.6800
-25.81   0.051   1.6720
-23.07   0.070   1.6640
-21.07   0.088   1.6560
-19.51   0.106   1.6480
-18.26   0.122   1.6400
-17.22   0.138   1.6320
-16.35   0.152   1.6240
-15.62   0.165   1.6160
-14.99   0.178   1.6080
-14.45   0.189   1.6000
-13.99   0.200   1.5920
-13.60   0.209   1.5840
-13.28   0.217   1.5760
-13.00   0.224   1.5680
-12.79   0.229   1.5600
-12.61   0.234   1.5520
-12.49   0.237   1.5440
-12.41   0.240   1.5360
-12.37   0.241   1.5280
-12.37   0.241   1.5200
-12.41   0.240   1.5120
-12.49   0.237   1.5040
-12.62   0.234   1.4960
-12.79   0.229   1.4880
-13.00   0.224   1.4800
-13.25   0.217   1.4720
-13.56   0.210   1.4640
-13.91   0.202   1.4560
-14.32   0.192   1.4480
-14.80   0.182   1.4400
-15.33   0.171   1.4320
-15.95   0.159   1.4240
-16.65   0.147   1.4160
-17.45   0.134   1.4080
-18.38   0.121   1.4000
-19.47   0.107   1.3920
-20.72   0.092   1.3840
-22.24   0.077   1.3760
-24.13   0.062   1.3680
-26.58   0.047   1.3600
-30.04   0.031   1.3520
-35.91   0.016   1.3440
-64.39   0.001   1.3360
-36.61   0.015   1.3280
-30.47   0.030   1.3200
-26.95   0.045   1.3120
-24.51   0.059   1.3040
-22.65   0.074   1.2960
-21.17   0.087   1.2880
-19.[illegible]   0.101   1.2800
-18.92   0.113   1.2720
-18.05   0.125   1.2640
-17.31   0.136   1.2560
-16.67   0.147   1.2480
-16.12   0.156   1.2400
-15.65   0.165   1.2320
```



```
  -15.26    0.172    1.2240
  -14.92    0.179    1.2160
  -14.65    0.185    1.2080
  -14.41    0.190    1.2000
  -14.27    0.193    1.1920
  -14.16    0.196    1.1840
  -14.09    0.197    1.1760
  -14.08    0.198    1.1680
  -14.11    0.197    1.1600
  -14.19    0.195    1.1520
  -14.32    0.192    1.1440
  -14.51    0.188    1.1360
  -14.74    0.183    1.1280
  -15.03    0.177    1.1200
  -15.38    0.170    1.1120
  -15.80    0.162    1.1040
  -16.28    0.153    1.0960
  -16.84    0.144    1.0880
  -17.49    0.133    1.0800
  -18.24    0.122    1.0720
  -19.11    0.111    1.0640
  -20.12    0.099    1.0560
  -21.31    0.086    1.0480
  -22.74    0.073    1.0400
  -24.49    0.060    1.0320
  -26.72    0.046    1.0240
  -29.76    0.032    1.0160
  -34.50    0.019    1.0080
  -45.60    0.005    1.0000
  -41.74    0.008    0.9920
  -33.41    0.021    0.9840
  -29.32    0.034    0.9760
  -26.62    0.047    0.9680
  -24.65    0.059    0.9600
  -23.11    0.070    0.9520
  -21.88    0.081    0.9440
  -20.87    0.090    0.9360
  -20.04    0.100    0.9280
  -19.25    0.108    0.9200
  -18.78    0.115    0.9120
  -18.31    0.121    0.9040
  -17.94    0.127    0.8960
  -17.65    0.131    0.8880
  -17.44    0.134    0.8800
  -17.31    0.136    0.8720
  -17.25    0.137    0.8640
  -17.26    0.137    0.8560
  -17.35    0.136    0.8480
  -17.50    0.133    0.8400
  -17.73    0.130    0.8320
  -18.05    0.125    0.8240
  -18.44    0.120    0.8160
  -18.94    0.113    0.8080
  -19.53    0.106    0.8000
  -20.25    0.097    0.7920
  -21.12    0.088    0.7840
  -22.16    0.078    0.7760
  -23.42    0.067    0.7680
  -24.99    0.056    0.7600
  -27.01    0.045    0.7520
  -29.74    0.033    0.7440
  -33.88    0.020    0.7360
  -42.28    0.008    0.7280
  -46.09    0.005    0.7200
  -35.08    0.018    0.7120
  -30.41    0.030    0.7040
  -27.42    0.043    0.6960
  -25.25    0.055    0.6880
  -23.57    0.066    0.6800
  -22.21    0.078    0.6720
  -21.09    0.088    0.6640
  -20.15    0.098    0.6560
  -19.37    0.107    0.6480
  -18.71    0.116    0.6400
  -18.16    0.124    0.6320
  -17.70    0.130    0.6240
  -17.33    0.136    0.6160
  -17.04    0.141    0.6080
  -16.82    0.144    0.6000
  -16.67    0.147    0.5920
  -16.58    0.148    0.5840
  -16.56    0.149    0.5760
  -16.61    0.148    0.5680
  -16.72    0.146    0.5600
  -16.89    0.143    0.5520
  -17.14    0.139    0.5440
  -17.46    0.134    0.5360
  -17.86    0.128    0.5280
  -18.34    0.121    0.5200
  -18.92    0.113    0.5120
  -19.61    0.105    0.5040
  -20.42    0.095    0.4960
  -21.37    0.085    0.4880
  -22.52    0.075    0.4800
  -23.90    0.064    0.4720
  -25.61    0.052    0.4640
  -27.80    0.041    0.4560
  -30.90    0.029    0.4480
  -35.47    0.017    0.4400
  [illegible]    0.005    0.4320
  [illegible]    0.007    0.4240
  [illegible]    0.019    0.4160
```



```
-30.36   0.030   0.4080
-27.47   0.041   0.4000
-25.69   0.052   0.3920
-24.13   0.062   0.3840
-22.90   0.072   0.3760
-21.89   0.080   0.3680
-21.06   0.089   0.3600
-20.37   0.096   0.3520
-19.81   0.102   0.3440
-19.35   0.108   0.3360
-19.99   0.112   0.3280
-18.71   0.116   0.3200
-18.52   0.119   0.3120
-18.40   0.120   0.3040
-18.36   0.121   0.2960
-18.38   0.120   0.2880
-18.48   0.119   0.2800
-18.66   0.117   0.2720
-18.91   0.113   0.2640
-19.24   0.109   0.2560
-19.66   0.104   0.2480
-20.17   0.098   0.2400
-20.79   0.091   0.2320
-21.53   0.084   0.2240
-22.42   0.076   0.2160
-23.48   0.067   0.2080
-24.78   0.058   0.2000
-26.35   0.048   0.1920
-28.46   0.038   0.1840
-31.28   0.027   0.1760
-35.61   0.017   0.1680
-44.89   0.006   0.1600
-45.55   0.005   0.1520
-35.78   0.016   0.1440
-31.32   0.027   0.1360
-28.41   0.038   0.1280
-26.23   0.049   0.1200
-24.61   0.059   0.1120
-23.25   0.069   0.1040
-22.12   0.078   0.0960
-21.17   0.087   0.0880
-20.35   0.096   0.0800
-19.66   0.104   0.0720
-19.06   0.111   0.0640
-18.55   0.118   0.0560
-18.11   0.124   0.0480
-17.74   0.130   0.0400
-17.44   0.134   0.0320
-17.19   0.138   0.0240
-17.00   0.141   0.0160
-16.85   0.144   0.0080
-16.76   0.145   0.0
  DB.     REAL   1.0126   0.8102   0.6077   0.4053   0.2029   0.0004


             NORMAL TERMINATION
```

```
PATTERN 104            SPACE SHUTTLE IMAGING RADAR ANTENNA SIMULATION PROGRAM            25 OCTOBER 19

          EXAMPLE 5:
             DEMONSTRATION OF THE EFFECT OF SHUTTLE ATTITUDE ERRORS ON FULL X-BAND
             HORIZONTAL ARRAY PERFORMANCE.



          SYSTEM INFORMATION:
               FREQUENCY =  9.000 GHZ.
               YAW =    2.000 DEGREES
               TILT =   52.000 DEGREES
               TWIST =    5.000 DEGREES
               ALTITUDE =  200.000 KM.


          ANTENNA PARAMETERS FOR SIMULATION NUMBER 104
               ELEMENT TYPE: HORIZONTAL DIPOLE
               NUMBER OF ELEMENTS (X,Y) = (504 ,  12)
               INTERELEMENT SPACING (CM.):  2.2966 ,  2.3550
               INTERELEMENT PHASE SHIFT (DEG.):  0.0    ,  0.0


          DEFORMATION DATA FOR SIMULATION 104:

    0.0        0.0


    0.0        0.0




          ELECTRICAL DATA FOR SIMULATION 104:

        ( 1, 1)   (
   PHSX:      0.0
   PHSY:      0.0
   AMAG:      1.00
   APHS:      0.0




          PRINT/PLOT INFORMATION:
               REQUESTED OUTPUT:
                    PRINTER PROFILE
                    PRINTER CONTOUR
               PLOT RESOLUTION: 151 X 151 POINTS


               STARTX =   -0.500
               STOPX =    0.500
               DELTAX =    0.007

               STARTY =    0.0
               STOPY =    4.000
               DELTAY =    0.027

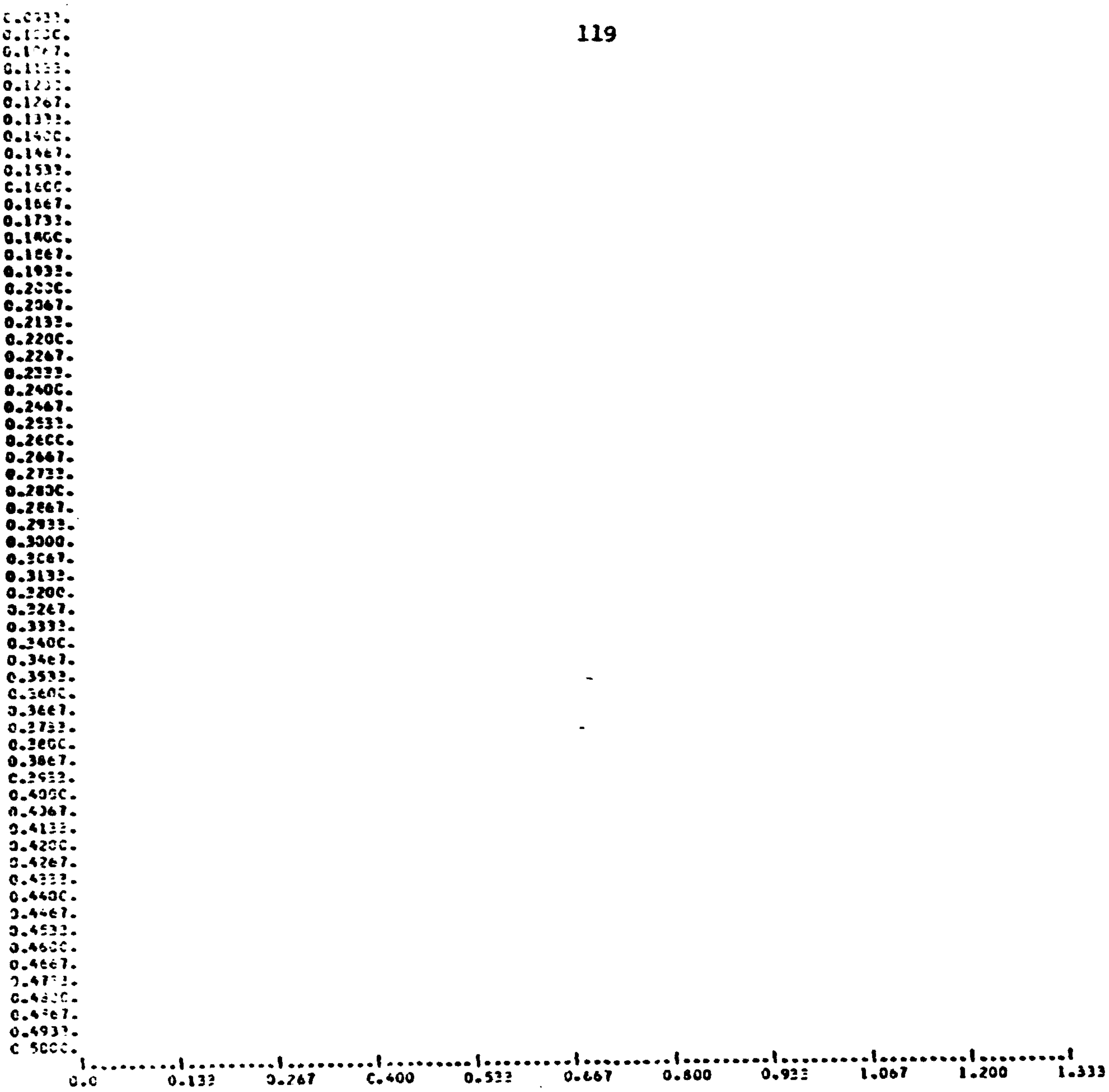
          SUBARRAY DATA SUMMARY FOR PATTERN104:
 AREA        XCENT        YCENT       ZAVG       ALPHAX        ALPHAY        AMAG        APHS        PHSX        PHS
   1          0.0          0.0         0.0        0.0           0.0         1.0000        0.0         0.0         0.


          PREDICTED BEAM CENTER:
               LATITUDE =    2.3647
               LONGITUDE =     0.0026
               RANGE = 262.612
               HEADING =     2.000
```

```
PLOT NORMALIZATION FACTOR =  -35.418 DB.
```

```
                 PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 104

       0.0      0.133     0.267     C.40C     0.533     C.667     0.800     0.923     1.067     1.200     1.333
        I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
-0.5000.
-0.4933.
-0.4867.
-0.4800.
-0.4733.
-0.4667.
-0.4600.
-0.4533.
-0.4467.
-0.4400.
-0.4333.
-0.4267.
-0.4200.
-0.4133.
-0.4067.
-0.4000.
-0.3933.
-0.3867.
-0.3800.
-0.3733.
-0.3667.
-0.3600.
-0.3533.
-0.3467.
-0.3400.
-0.3333.
-0.3267.
-0.3200.
-0.3133.
-0.3067.
-0.3000.
-0.2933.
-0.2867.
-0.2800.
-0.2733.
-0.2667.
-0.2600.
-0.2533.
-0.2467.
-0.2400.
-0.2333.
-0.2267.
-0.2200.
-0.2133.
-0.2067.
-0.2000.
-0.1933.
-0.1867.
-0.1800.
-0.1733.
-0.1667.
-0.1600.
-0.1533.
-0.1467.
-0.1400.
-0.1333.
-0.1267.2
-0.1200.  2 3 2
-0.1133.      0 3 3 0
-0.1067.              0
-0.1000.                    1 1
-0.0933.                        1 3 2
-0.0867.                              2 3 1
-0.0800.                                    0
-0.0733.                                          1 2 1
-0.0667.                                              1 3 3 1
-0.0600.                                                    2 3 1
-0.0533.
-0.0467.                                                                1 3 2
-0.0400.                                                                    0 3 4 2
-0.0333.                                                                          1 3 2
-0.0267.                                                                                      0
-0.0200.                                                                                      0 3 3 2   0
-0.0133.                                                                                            3 4 4 2
-0.0067.                                                                                                1 3 4
-0.0000.                                                                                                  0
 0.0067.
 0.0133.
 0.0200.
 0.0267.
 0.0333.
 0.0400.
 0.0467.
 0.0533.
 0.0600.
 0.0667.
 0.0733.
 0.0800.
 0.0867.
```


0.0933.
0.1000.
0.1067.
0.1133.
0.1200.
0.1267.
0.1333.
0.1400.
0.1467.
0.1533.
0.1600.
0.1667.
0.1733.
0.1800.
0.1867.
0.1933.
0.2000.
0.2067.
0.2133.
0.2200.
0.2267.
0.2333.
0.2400.
0.2467.
0.2533.
0.2600.
0.2667.
0.2733.
0.2800.
0.2867.
0.2933.
0.3000.
0.3067.
0.3133.
0.3200.
0.3267.
0.3333.
0.3400.
0.3467.
0.3533.
0.3600.
0.3667.
0.3733.
0.3800.
0.3867.
0.3933.
0.4000.
0.4067.
0.4133.
0.4200.
0.4267.
0.4333.
0.4400.
0.4467.
0.4533.
0.4600.
0.4667.
0.4733.
0.4800.
0.4867.
0.4933.
0.5000.
0.0
0.133
0.267
0.400
0.533
0.667
0.800
0.933
1.067
1.200
1.333

PRINTEF CONTCUR PLCT FOR SIPLLATICN NUPBER 104

```
1.333     1.467     1.600     1.733     1.867     2.000     2.133     2.267     2.400     2.533     2.667
 I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
























































































 4 3
   C 2 0
           0 2 3 1   1 0                                           0
               2 4 5 4 1   1                                     C       0 0
                   C 4 5 5 4 1   C                     0       0 0     0 0       0
                     1   1 4 5 4 3                   0 0     1 0     0 0     0 0
                         0 1   1 3 3 1       0 C   0 1 0   1 1     1 1     0 1 0     0 C
                               0         1 3 3 0 0 2 2   1 2 1   1 2 0   1 1 0     1 0       C
                                           1 4 5 6 5 2 1 2 2   2 3 2   1 2 1   0 1 1     0 0
                                               0 4 6 7 7 6 3 2 4 3   2 3 2   1 - 1     1 1       0
                                               0 2 0 3 6 7 8 0 6 3 3 4 4   2 3 2   0 7 1     0 1
                                                 0   2 3 C 4 7 8 5 8 7 3 2 5 4 0 1 3 2     1 1 0     0
                                                     1 0   3 4   5 0 9 9 8 7 1 1 5 4 C 1 2 2 0   1 1 0
                                                     C   1 2 C 2 4 4   6 4 9 9 8 7 2 3 4 4 0 C 2 2 C
                                                         1 C   2 2   1 5 4 2 7 5 9 5 8 6 2 3 4 3 0   1
```

```
121    0   0 2 0 0 3 2   4 9 3 3 7 8 9 9 8 6 2 2 3 3
           1 C   1 2   2 7 2 0 4 4 2 4 7 8 8 8 7 5 1
           0   C 1   0 2 1   2 3 0 2 4 4   4 7 8 8 7
               0 0   1 1   1 2 0 0 3 2   2 4 3   4 6
               C   0 1   0 1 0   2 2   1 3 2   2 3 2
                   0     1 0   1 1   0 2 1   1 2 0
                       0.0   0 1     1 C   1 1     1
                       0     0     0 C   0 1     1 0
                           0     0 0     0     0 C
                                 0     0     0
                                     C

     I.........I.........I.........I.........I.........I.........I.........I.........I.........I.........I
   1.333     1.467     1.600     1.733     1.867     2.000     2.133     2.267     2.400     2.533     2.667

                                        CCNTOLR LEVEL KEY

0: -0.2850000E 02 TO -0.2549999E C2   4: -0.1650000E 02 TC -0.1349999E 02   8: -C.4500000E 01 TO -C.1499990E 01
1: -0.2550000E 02 TO -0.2249999E 02   5: -C.1350000E C2 TO -0.1049999E 02   9: -0.1500000E 01 TC  C.1500010E 01
2: -0.2250000E 02 TO -0.1949998E 02   6: -0.1050000E 02 TC -0.7499990E 01    : -0.1000000E 51 TO -0.2850000E 02
3: -0.1950000E 02 TO -0.1649998E 02   7: -C.7500000E 01 TC -0.4499990E 01   +:  0.1500010E 01 TO  0.1000000E 51
```

PRINTER CONTOUR PLOT FOR SIMULATION NUMBER 104

```
2.667     2.800     2.933     3.067     3.200     3.333     3.467     3.600     3.733     3.867     4.000
  |.........|.........|.........|.........|.........|.........|.........|.........|.........|..... ...|
                                                                                                      .  -0.5000
                                                                                                      .  -0.4933
                                                                                                      .  -0.4867
                                                                                                      .  -0.4800
                                                                                                      .  -0.4733
                                                                                                      .  -0.4667
                                                                                                      .  -0.4600
                                                                                                      .  -0.4533
                                                                                                      .  -0.4467
                                                                                                      .  -0.4400
                                                                                                      .  -0.4333
                                                                                                      .  -0.4267
                                                                                                      .  -0.4200
                                                                                                      .  -0.4133
                                                                                                      .  -0.4067
                                                                                                      .  -0.4000
                                                                                                      .  -0.3933
                                                                                                      .  -0.3867
                                                                                                      .  -0.3800
                                                                                                      .  -0.3733
                                                                                                      .  -0.3667
                                                                                                      .  -0.3600
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                                                                                                      .  -0.3467
                                                                                                      .  -0.3400
                                                                                                      .  -0.3333
                                                                                                      .  -0.3267
                                                                                                      .  -0.3200
                                                                                                      .  -0.3133
                                                                                                      .  -0.3067
                                                                                                      .  -0.3000
                                                                                                      .  -0.2933
                                                                                                      .  -0.2867
                                                                                                      .  -0.2800
                                                                                                      .  -0.2733
                                                                                                      .  -0.2667
                                                                                                      .  -0.2600
                                                                                                      .  -0.2533
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                                                                                                      .  -0.2400
                                                                                                      .  -0.2333
                                                                                                      .  -0.2267
                                                                                                      .  -0.2200
                                                                                                      .  -0.2133
                                                                                                      .  -0.2067
                                                                                                      .  -0.2000
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                                                                                                      .  -0.1867
                                                                                                      .  -0.1800
                                                                                                      .  -0.1733
                                                                                                      .  -0.1667
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                                                                                                      .  -0.1267
                                                                                                      .  -0.1200
                                                                                                      .  -0.1133
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                                                                                                      .  -0.1000
                                                                                                      .  -0.0933
                                                                                                      .  -0.0867
                                                                                                      .  -0.0800
                                                                                                      .  -0.0733
                                                                                                      .  -0.0667
                                                                                                      .  -0.0600
                                                                                                      .  -0.0533
                                                                                                      .  -0.0467
                                                                                                      .  -0.0400
                                                                                                      .  -0.0333
                                                                                                      .  -0.0267
                                                                                                      .  -0.0200
                                                                                                      .  -0.0133
                                                                                                      .  -0.0067
                                                                                                      .  -0.0000
                                                                                                      .   0.0067
                                                                                                      .   0.0133
                                                                                                      .   0.0200
                                                                                                      .   0.0267
                                                                                                      .   0.0333
                                                                                                      .   0.0400
                                                                                                      .   0.0467
                                                                                                      .   0.0533
                                                                                                      .   0.0600
                                                                                                      .   0.0667
                                                                                                      .   0.0733
                                                                                                      .   0.0800
                                                                                                      .   0.0867
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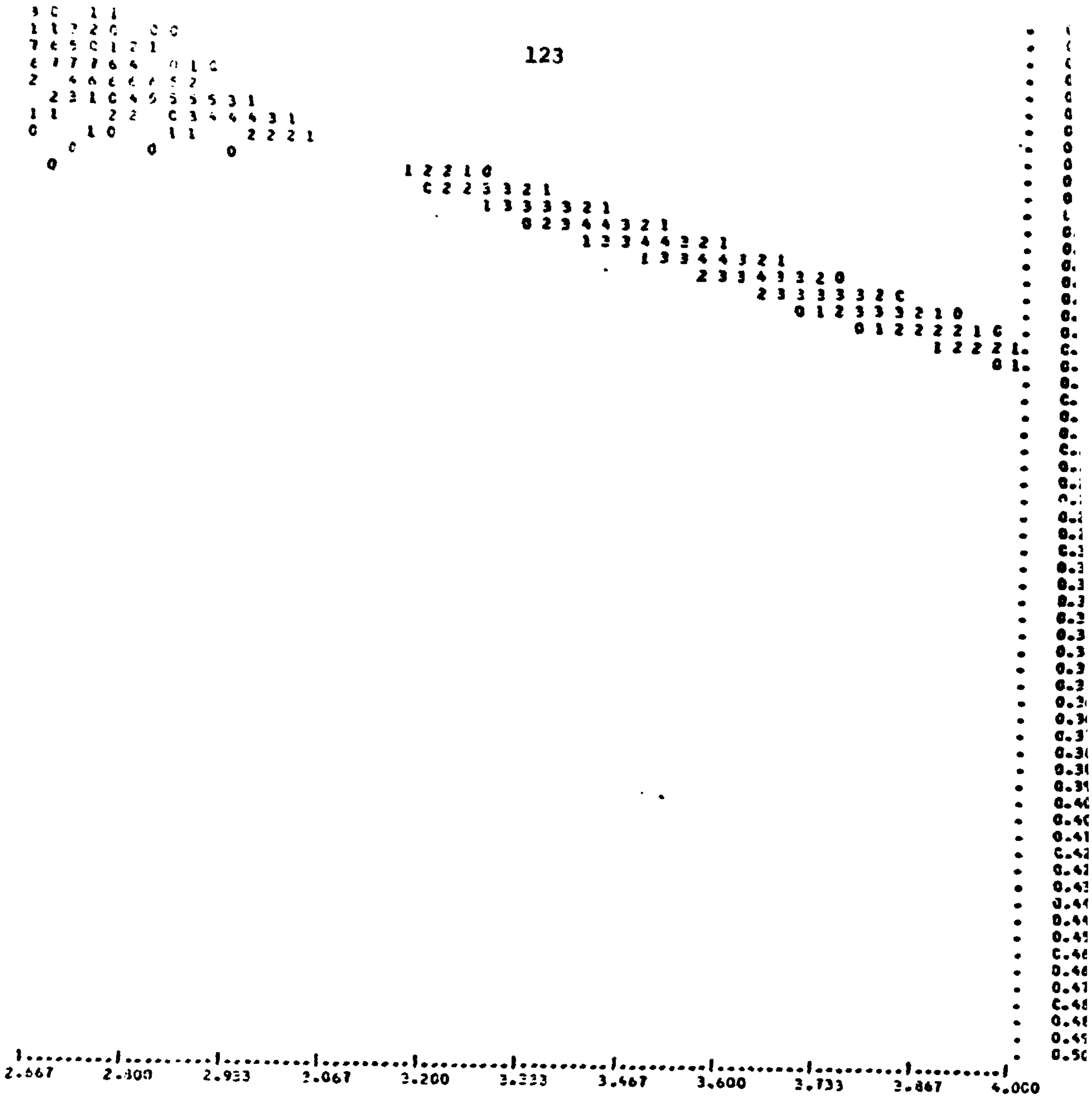
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2.800
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3.067
3.200
3.333
3.467
3.600
3.733
3.867
4.000
0.50

```
                           X-AXIS PROFILE PLOT ALONG    2.364 DEGREES LATITUDE.
                           PATTERN NUMBER   104

                                                     SCALE FACTOR IS 10**-2

    DB.     REAL  99.2487        79.3996         59.5506        39.7015         19.8525          0.0035
   -45.38   0.538   |                                                                            *|    0.5000
   -54.79   0.182   |                                                                            *|    0.4980
   -51.62   0.262   |                                                                            *|    0.4960
   -44.59   0.589   |                                                                            *|    0.4940
   -43.83   0.643   +       +       +       +      +       +       +       +       +      +      *+    0.4920
   -48.03   0.397   |                                                                            *|    0.4900
   -68.28   0.039   |                                                                            *|    0.4880
   -46.74   0.460   |                                                                            *|    0.4860
   -43.47   0.670   |                                                                            *|    0.4840
   -44.91   0.568   |                                                                            *|    0.4820
   -54.08   0.198   |                                                                            *|    0.4800
   -51.38   0.270   |                                                                            *|    0.4780
   -44.22   0.615   +               +       +      +       +       +       +       +      +      *+    0.4760
   -43.42   0.675   |                                                                            *|    0.4740
   -47.55   0.417   |                                                                            *|    0.4720
   -67.99   0.040   |                                                                            *|    0.4700
   -46.32   0.483   |                                                                            *|    0.4680
   -43.05   0.704   |                                                                            *|    0.4660
   -44.52   0.594   |                                                                            *|    0.4640
   -53.85   0.203   |                                                                            *|    0.4620
   -50.79   0.289   +       +       +       +      +       +       +       +       +      +      *+    0.4600
   -43.75   0.649   |                                                                            *|    0.4580
   -43.01   0.707   |                                                                            *|    0.4560
   -47.32   0.430   |                                                                            *|    0.4540
   -65.49   0.053   |                                                                            *|    0.4520
   -45.73   0.517   |                                                                            *|    0.4500
   -42.60   0.741   |                                                                            *|    0.4480
   -44.21   0.616   |                                                                            *|    0.4460
   -54.13   0.197   +       +       +       +      +       +       +       +       +      +      *+    0.4440
   -49.87   0.321   |                                                                            *|    0.4420
   -43.20   0.692   |                                                                            *|    0.4400
   -42.63   0.738   |                                                                            *|    0.4380
   -47.25   0.434   |                                                                            *|    0.4360
   -61.86   0.081   |                                                                            *|    0.4340
   -44.99   0.563   |                                                                            *|    0.4320
   -42.13   0.783   |                                                                            *|    0.4300
   -43.99   0.632   +       +       +       +      +       +       +       +       +      +      *+    0.4280
   -55.00   0.178   |                                                                            *|    0.4260
   -48.71   0.367   |                                                                            *|    0.4240
   -42.58   0.743   |                                                                            *|    0.4220
   -42.28   0.769   |                                                                            *|    0.4200
   -47.39   0.427   |                                                                            *|    0.4180
   -58.19   0.123   |                                                                            *|    0.4160
   -44.13   0.622   |                                                                            *|    0.4140
   -41.63   0.828   +       +       +       +      +       +       +       +       +      +      *+    0.4120
   -43.87   0.641   |                                                                            *|    0.4100
   -56.65   0.147   |                                                                            *|    0.4080
   -47.36   0.429   |                                                                            *|    0.4060
   -41.90   0.803   |                                                                            *|    0.4040
   -41.98   0.796   |                                                                            *|    0.4020
   -47.81   0.407   |                                                                            *|    0.4000
   -54.73   0.183   |                                                                            *|    0.3980
   -43.18   0.693   +       +       +       +      +       +       +       +       +      +      *+    0.3960
   -41.15   0.876   |                                                                            *|    0.3940
   -43.88   0.640   |                                                                            *|    0.3920
   -60.70   0.092   |                                                                            *|    0.3900
   -45.85   0.509   |                                                                            *|    0.3880
   -41.20   0.871   |                                                                            *|    0.3860
   -41.72   0.819   |                                                                            *|    0.3840
   -48.61   0.371   |                                                                            *|    0.3820
   -51.64   0.262   +       +       +       +      +       +       +       +       +      +      *+    0.3800
   -42.18   0.778   |                                                                            *|    0.3780
   -40.68   0.925   |                                                                            *|    0.3760
   -44.06   0.627   |                                                                            *|    0.3740
   -73.70   0.021   |                                                                            *|    0.3720
   -44.39   0.604   |                                                                            *|    0.3700
   -40.49   0.945   |                                                                            *|    0.3680
   -41.59   0.833   |                                                                            *|    0.3660
   -50.01   0.316   +       +       +       +      +       +       +       +       +      +      *+    0.3640
   -48.83   0.362   |                                                                            *|    0.3620
   -41.16   0.875   |                                                                            *|    0.3600
   -40.26   0.970   |                                                                            *|    0.3580
   -44.51   0.595   |                                                                            *|    0.3560
   -62.62   0.074   |                                                                            *|    0.3540
   -42.88   0.718   |                                                                            *|    0.3520
   -39.81   1.023   |                                                                            *|    0.3500
   -41.58   0.834   +       +       +       +      +       +       +       +       +      +      *+    0.3480
   -52.53   0.236   |                                                                            *|    0.3460
   -46.27   0.486   |                                                                            *|    0.3440
   -40.15   0.983   |                                                                            *|    0.3420
   -39.93   1.008   |                                                                            *|    0.3400
   -45.31   0.542   |                                                                            *|    0.3380
   -54.19   0.195   |                                                                            *|    0.3360
   -41.41   0.850   |                                                                            *|    0.3340
   -39.17   1.101   +               +       +      +       +       +       +       +      +      *+    0.3320
   -41.75   0.818   |                                                                            *|    0.3300
   -57.72   0.130   |                                                                            *|    0.3280
   -42.94   0.713   |                                                                            *|    0.3260
   -39.11   1.[illegible]   |                                                                            *|    0.3240
   -39.70   1.[illegible]   |                                                                            *|    0.3220
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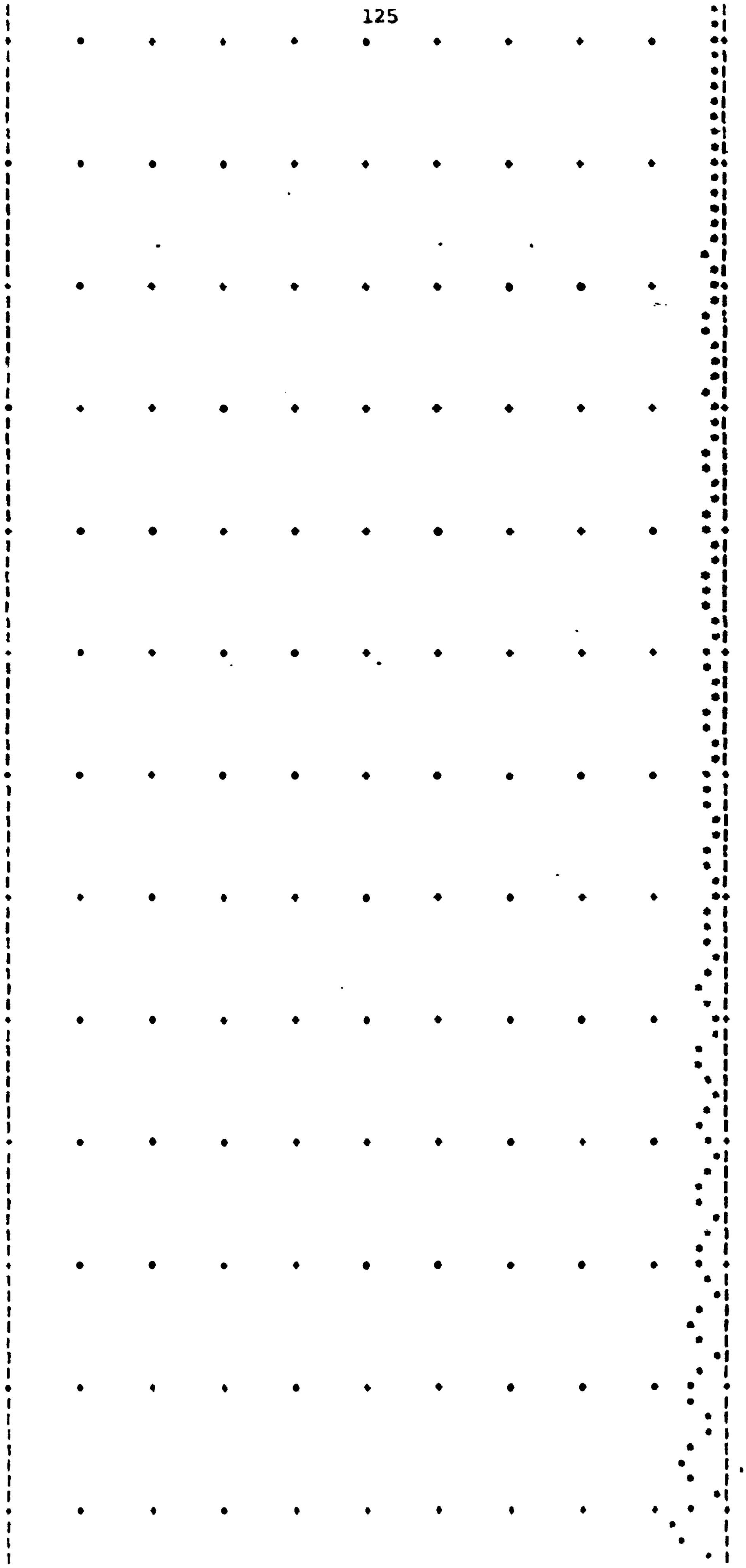

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-78.87	0.011	0.3100
-41.87	0.807	0.3080
-38.27	1.220	0.3060
-39.65	1.042	0.3040
-49.17	0.349	0.3020
-45.52	0.530	0.3000
-38.68	1.164	0.2980
-38.15	1.237	0.2960
-43.08	0.701	0.2940
-54.41	0.190	0.2920
-39.96	1.005	0.2900
-37.45	1.341	0.2880
-39.81	1.022	0.2860
-54.33	0.192	0.2840
-42.51	0.749	0.2820
-37.45	1.340	0.2800
-37.85	1.280	0.2780
-44.63	0.547	0.2760
-47.68	0.413	0.2740
-38.21	1.229	0.2720
-36.75	1.454	0.2700
-40.32	0.964	0.2680
-76.39	0.015	0.2660
-39.92	1.009	0.2640
-36.34	1.524	0.2620
-37.75	1.255	0.2600
-47.57	0.414	0.2580
-43.26	0.657	0.2560
-36.61	1.477	0.2540
-36.18	1.552	0.2520
-41.33	0.658	0.2500
-51.01	0.242	0.2480
-37.67	1.307	0.2460
-35.34	1.729	0.2440
-37.93	1.259	0.2420
-54.65	0.185	0.2400
-39.83	1.019	0.2380
-35.15	1.747	0.2360
-35.80	1.622	0.2340
-43.29	0.645	0.2320
-44.15	0.620	0.2300
-35.64	1.652	0.2280
-34.48	1.857	0.2260
-38.52	1.125	0.2240
-57.66	0.131	0.2220
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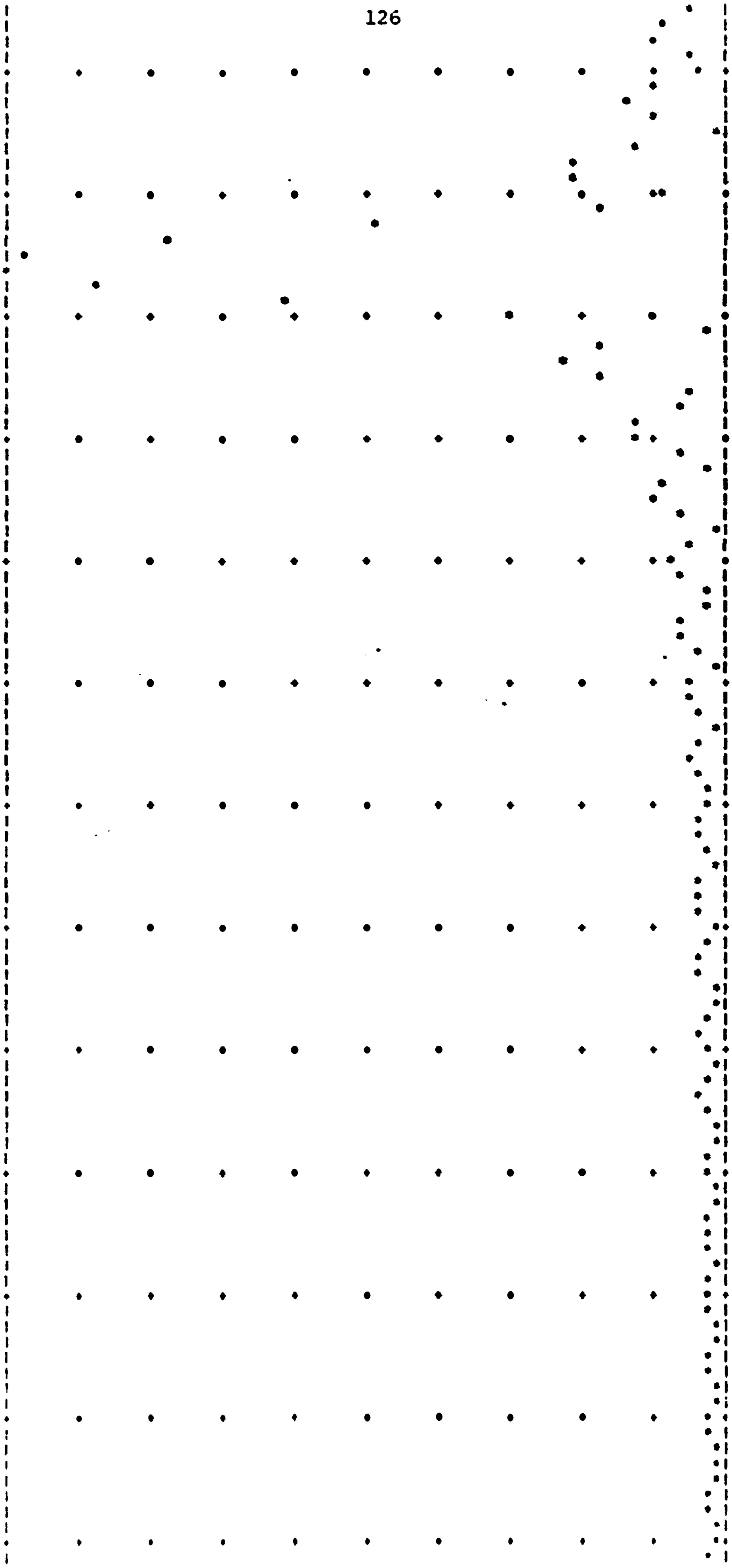

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-31.23    2.743   0.1080
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-17.83   12.834   0.1040
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 -0.38   95.711   0.0840
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-13.27   21.697   0.0700
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-26.29    4.848   0.0660
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-41.03    0.658  -0.0140
-32.34    2.416  -0.0160
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-55.94    0.161  -0.0220
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-31.90    2.542  -0.0260
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-38.30    1.216  -0.0320
-32.45    2.221  -0.0340
-32.36    2.147  -0.0360
-40.04    0.955  -0.0380
-44.34    0.607  -0.0400
-34.61    1.550  -0.0420
-33.31    2.161  -0.0440
-37.13    1.291  -0.0460
-63.64    0.027  -0.0480
-37.05    1.464  -0.0500
-37.90    2.041  -0.0520
-35.51    1.658  -0.0540
-46.52    0.472  -0.0560
-40.50    0.912  -0.0580
-34.85    1.808  -0.0600
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-47.67    0.414  -0.0660
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-44.76    0.650  -0.0740
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[illegible]    [illegible]  [illegible]
[illegible]    [illegible]  [illegible]
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 -41.54    0.839  I                                                                            *I   -0.0900
 -51.55    0.265  I                                                                            *I   -0.0920
 -38.22    1.213  I                                                                            *I   -0.0940
 -36.23    1.543  I                                                                           * I   -0.0960
 -39.11    1.108  I                                                                            *I   -0.0980
 -57.12    0.139  +       .       .       .      .       .       .       .      .       .       *+   -0.1000
 -41.13    0.878  I                                                                            *I   -0.1020
 -36.83    1.441  I                                                                           * I   -0.1040
 -37.82    1.285  I                                                                           * I   -0.1060
 -45.98    0.502  I                                                                            *I   -0.1080
 -45.81    0.512  I                                                                            *I   -0.1100
 -38.04    1.252  I                                                                           * I   -0.1120
 -37.31    1.363  I                                                                           * I   -0.1140
 -41.91    0.803  +       .       .       .      .       .       .       .      .       .       *+   -0.1160
 -57.07    0.140  I                                                                            *I   -0.1180
 -40.04    0.995  I                                                                            *I   -0.1200
 -37.42    1.345  I                                                                           * I   -0.1220
 -39.76    1.028  I                                                                            *I   -0.1240
 -53.43    0.213  I                                                                            *I   -0.1260
 -43.21    0.691  I                                                                            *I   -0.1280
 -38.14    1.239  I                                                                            *I   -0.1300
 -38.64    1.169  +       .       .       .      .       .       .       .      .       .       *+   -0.1320
 -45.56    0.527  I                                                                            *I   -0.1340
 -48.84    0.361  I                                                                            *I   -0.1360
 -39.53    1.056  I                                                                            *I   -0.1380
 -38.27    1.221  I                                                                            *I   -0.1400
 -42.11    0.785  I                                                                            *I   -0.1420
 -70.89    0.029  I                                                                            *I   -0.1440
 -41.81    0.812  I                                                                            *I   -0.1460
 -38.53    1.185  +       .       .       .      .       .       .       .      .       .       *+   -0.1480
 -40.26    0.970  I                                                                            *I   -0.1500
 -50.71    0.285  I                                                                            *I   -0.1520
 -45.53    0.529  I                                                                            *I   -0.1540
 -39.42    1.069  I                                                                            *I   -0.1560
 -39.35    1.077  I                                                                            *I   -0.1580
 -45.06    0.558  I                                                                            *I   -0.1600
 -52.94    0.225  I                                                                            *I   -0.1620
 -41.05    0.886  +       .       .       .      .       .       .       .      .       .       *+   -0.1640
 -39.16    1.102  I                                                                            *I   -0.1660
 -42.21    0.776  I                                                                            *I   -0.1680
 -62.45    0.075  I                                                                            *I   -0.1700
 -43.75    0.650  I                                                                            *I   -0.1720
 -39.60    1.047  I                                                                            *I   -0.1740
 -40.67    0.926  I                                                                            *I   -0.1760
 -49.00    0.355  I                                                                            *I   -0.1780
 -48.38    0.381  +       .       .       .      .       .       .       .      .       .       *+   -0.1800
 -40.74    0.919  I                                                                            *I   -0.1820
 -40.00    1.000  I                                                                            *I   -0.1840
 -44.55    0.592  I                                                                            *I   -0.1860
 -60.13    0.099  I                                                                            *I   -0.1880
 -42.73    0.720  I                                                                            *I   -0.1900
 -40.03    0.997  I                                                                            *I   -0.1920
 -42.23    0.774  I                                                                            *I   -0.1940
 -55.07    0.176  +       .       .       .      .       .       .       .      .       .       *+   -0.1960
 -46.06    0.498  I                                                                            *I   -0.1980
 -40.73    0.920  I                                                                            *I   -0.2000
 -41.04    0.888  I                                                                            *I   -0.2020
 -47.47    0.423  I                                                                            *I   -0.2040
 -52.41    0.240  I                                                                            *I   -0.2060
 -42.15    0.777  I                                                                            *I   -0.2080
 -40.64    0.929  I                                                                            *I   -0.2100
 -44.06    0.626  +       .       .       .      .       .       .       .      .       .       *+   -0.2120
 -72.41    0.024  I                                                                            *I   -0.2140
 -44.69    0.583  I                                                                            *I   -0.2160
 -40.95    0.897  I                                                                            *I   -0.2180
 -42.25    0.771  I                                                                            *I   -0.2200
 -51.27    0.273  I                                                                            *I   -0.2220
 -49.09    0.351  I                                                                            *I   -0.2240
 -41.98    0.795  I                                                                            *I   -0.2260
 -41.42    0.849  +       .       .       .      .       .       .       .      .       .       *+   -0.2280
 -46.21    0.489  I                                                                            *I   -0.2300
 -59.70    0.104  I                                                                            *I   -0.2320
 -43.90    0.638  I                                                                            *I   -0.2340
 -41.35    0.856  I                                                                            *I   -0.2360
 -43.65    0.657  I                                                                            *I   -0.2380
 -56.56    0.142  I                                                                            *I   -0.2400
 -47.22    0.436  I                                                                            *I   -0.2420
 -42.00    0.794  +       .       .       .      .       .       .       .      .       .       *+   -0.2440
 -42.33    0.764  I                                                                            *I   -0.2460
 -48.75    0.365  I                                                                            *I   -0.2480
 -52.73    0.206  I                                                                            *I   -0.2500
 -43.43    0.670  I                                                                            *I   -0.2520
 -41.85    0.805  I                                                                            *I   -0.2540
 -45.22    0.549  I                                                                            *I   -0.2560
 -70.34    0.030  I                                                                            *I   -0.2580
 -46.09    0.496  +       .       .       .      .       .       .       .      .       .       *+   -0.2600
 -42.20    0.776  I                                                                            *I   -0.2620
 -43.36    0.679  I                                                                            *I   -0.2640
 -51.86    0.255  I                                                                            *I   -0.2660
 -50.86    0.286  I                                                                            *I   -0.2680
 -43.31    0.684  I                                                                            *I   -0.2700
 -42.54    0.747  I                                                                            *I   -0.2720
 -46.95    0.449  I                                                                            *I   -0.2740
 -64.26    0.061  +       .       .       .      .       .       .       .      .       .       *+   -0.2760
 -45.42    0.536  I                                                                            *I   -0.2780
 -42.53    0.747  I                                                                            *I   -0.2800
 -44.44    0.597  I                                                                            *I   -0.2820
 -55.82    0.162  I                                                                            *I   -0.2840
 -49.20    0.347  I                                                                            *I   -0.2860
 -42.31    0.742  I                                                                            *I   -0.2880
 -41.26    [illegible]  I                                                                      *I   -0.2900
```

```
-49.94   0.361  •     •     •     •     •     •     •     •     •     •    •+   -0.2920
-57.46   0.134  I                                                          •I   -0.2940
-45.05   0.559  I                                                          •I   -0.2960
-42.55   0.712  I                                                          •I   -0.2980
-45.66   0.521  I                                                          •I   -0.3000
-61.62   0.063  I                                                          •I   -0.3020
-48.18   0.390  I                                                          •I   -0.3040
-43.46   0.679  I                                                          •I   -0.3060
-44.03   0.627  •     •     •     •     •     •     •     •     •     •    •+   -0.3080
-50.90   0.265  I                                                          •I   -0.3100
-54.40   0.190  I                                                          •I   -0.3120
-44.88   0.570  I                                                          •I   -0.3140
-43.44   0.673  I                                                          •I   -0.3160
-46.86   0.454  I                                                          •I   -0.3180
-72.09   0.020  I                                                          •I   -0.3200
-47.56   0.419  I                                                          •I   -0.3220
-43.70   0.653  •     •     •     •     •     •     •     •     •     •    •+   -0.3240
-44.82   0.574  I                                                          •I   -0.3260
-53.06   0.222  I                                                          •I   -0.3280
-52.71   0.232  I                                                          •I   -0.3300
-44.88   0.570  I                                                          •I   -0.3320
-43.55   0.625  I                                                          •I   -0.3340
-48.05   0.396  I                                                          •I   -0.3360
-71.07   0.028  I                                                          •I   -0.3380
-47.24   0.435  •     •     •     •     •     •     •     •     •     •    •+   -0.3400
-44.06   0.631  I                                                          •I   -0.3420
-45.59   0.525  I                                                          •I   -0.3440
-55.31   0.172  I                                                          •I   -0.3460
-51.78   0.260  I                                                          •I   -0.3480
-44.98   0.564  I                                                          •I   -0.3500
-44.43   0.598  I                                                          •I   -0.3520
-49.16   0.348  I                                                          •I   -0.3540
-63.93   0.064  •     •     •     •     •     •     •     •     •     •    •+   -0.3560
-47.10   0.441  I                                                          •I   -0.3580
-44.34   0.607  I                                                          •I   -0.3600
-46.21   0.484  I                                                          •I   -0.3620
-57.49   0.133  I                                                          •I   -0.3640
-51.15   0.277  I                                                          •I   -0.3660
-45.16   0.552  I                                                          •I   -0.3680
-44.97   0.564  I                                                          •I   -0.3700
-50.16   0.310  •     •     •     •     •     •     •     •     •     •    •+   -0.3720
-61.16   0.068  I                                                          •I   -0.3740
-47.13   0.440  I                                                          •I   -0.3760
-44.70   0.582  I                                                          •I   -0.3780
-46.95   0.449  I                                                          •I   -0.3800
-59.50   0.106  I                                                          •I   -0.3820
-50.54   0.275  I                                                          •I   -0.3840
-45.41   0.537  I                                                          •I   -0.3860
-45.43   0.535  •     •     •     •     •     •     •     •     •     •    •+   -0.3880
-50.98   0.293  I                                                          •I   -0.3900
-60.01   0.100  I                                                          •I   -0.3920
-47.28   0.432  I                                                          •I   -0.3940
-45.05   0.559  I                                                          •I   -0.3960
-47.48   0.423  I                                                          •I   -0.3980
-60.94   0.090  I                                                          •I   -0.4000
-50.99   0.282  I                                                          •I   -0.4020
-45.70   0.519  •     •     •     •     •     •     •     •     •     •    •+   -0.4040
-45.83   0.511  I                                                          •I   -0.4060
-51.55   0.265  I                                                          •I   -0.4080
-59.72   0.103  I                                                          •I   -0.4100
-47.54   0.420  I                                                          •I   -0.4120
-45.40   0.527  I                                                          •I   -0.4140
-47.88   0.404  I                                                          •I   -0.4160
-61.59   0.083  I                                                          •I   -0.4180
-51.27   0.272  •     •     •     •     •     •     •     •     •     •    •+   -0.4200
-46.03   0.499  I                                                          •I   -0.4220
-46.17   0.491  I                                                          •I   -0.4240
-51.87   0.255  I                                                          •I   -0.4260
-60.23   0.097  I                                                          •I   -0.4280
-47.92   0.402  I                                                          •I   -0.4300
-45.73   0.517  I                                                          •I   -0.4320
-48.14   0.392  I                                                          •I   -0.4340
-61.31   0.086  •     •     •     •     •     •     •     •     •     •    •+   -0.4360
-51.86   0.257  I                                                          •I   -0.4380
-46.41   0.478  I                                                          •I   -0.4400
-46.45   0.476  I                                                          •I   -0.4420
-51.90   0.254  I                                                          •I   -0.4440
-61.53   0.083  I                                                          •I   -0.4460
-48.41   0.380  I                                                          •I   -0.4480
-46.05   0.493  I                                                          •I   -0.4500
-48.27   0.386  •     •     •     •     •     •     •     •     •     •    •+   -0.4520
-60.27   0.097  I                                                          •I   -0.4540
-52.59   0.235  I                                                          •I   -0.4560
-46.84   0.455  I                                                          •I   -0.4580
-46.66   0.465  I                                                          •I   -0.4600
-51.69   0.260  I                                                          •I   -0.4620
-64.10   0.062  I                                                          •I   -0.4640
-49.05   0.353  I                                                          •I   -0.4660
-46.39   0.480  •     •     •     •     •     •     •     •     •     •    •+   -0.4680
-48.73   0.386  I                                                          •I   -0.4700
-58.76   0.115  I                                                          •I   -0.4720
-53.75   0.205  I                                                          •I   -0.4740
-47.34   0.429  I                                                          •I   -0.4760
-46.83   0.455  I                                                          •I   -0.4780
-51.27   0.273  I                                                          •I   -0.4800
-69.83   0.042  I                                                          •I   -0.4820
-49.87   0.321  •     •     •     •     •     •     •     •     •     •    •+   -0.4840
-46.74   0.462  I                                                          •I   -0.4860
-49.20   0.339  I                                                          •I   -0.4880
-57.07   0.144  I                                                          •I   -0.4900
-55.42   0.174  I                                                          •I   -0.4920
-47.55   0.400  I                                                          •I   -0.4940
```

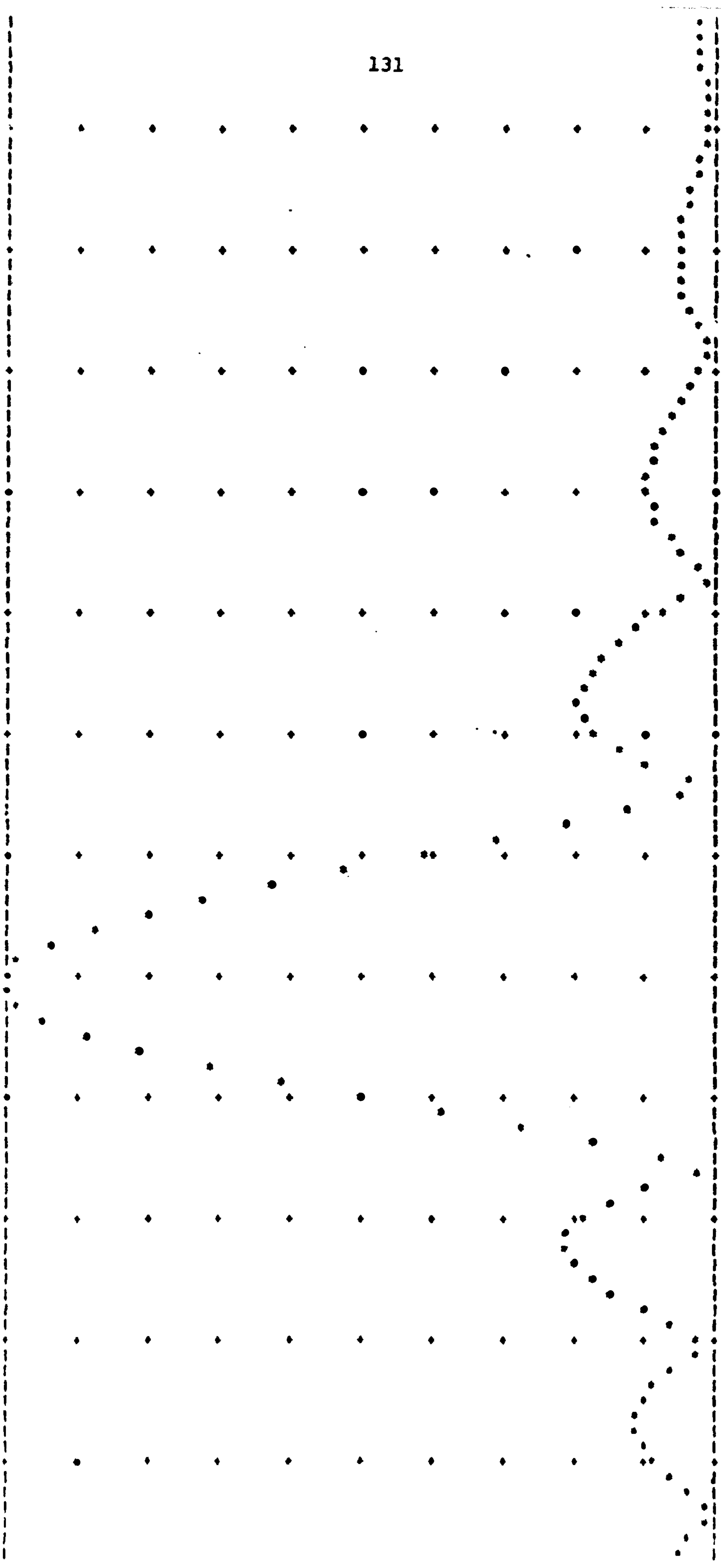
```
   [illegible]   0.[illegible]7   I                                                                         *I   -0.4960
  -5[illegible].73   0.2[illegible]   I                                                                     *I   -0.4980
  -[illegible].27   0.[illegible]   +      +      +      +      +      +      +      +      +      +          *    -0.5000
   DB.       REAL  99.2487         79.3996          59.5506          39.7015          19.8525          0.0035
```

```
                             Y-AXIS PROFILE PLOT ALONG   0.083LONGITUDE.
                             PATTERN NUMBER   104

                                                        SCALE FACTOR IS 10**-2

    DB.       REAL  99.8009          79.8408          59.8806          39.9204          19.9603          0.0001
  -56.81      0.144  I                                                                                  *I     3.9998
  -55.40      0.170  I                                                                                  *I     3.9918
  -54.21      0.195  I                                                                                  *I     3.9838
  -53.22      0.213  I                                                                                  *I     3.9759
  -52.39      0.240  +      +      +      +      +      +      +      +      +      +                   *+     3.9679
  -51.69      0.260  I                                                                                  *I     3.9599
  -51.12      0.278  I                                                                                  *I     3.9519
  -50.67      0.293  I                                                                                  *I     3.9439
  -50.33      0.304  I                                                                                  *I     3.9359
  -50.11      0.312  I                                                                                  *I     3.9279
  -49.99      0.317  I                                                                                  *I     3.9199
  -49.99      0.317  I                                                                                  *I     3.9119
  -50.10      0.312  +      +      +      +      +      +      +      +      +      +                   *+     3.9039
  -50.35      0.304  I                                                                                  *I     3.8959
  -50.74      0.290  I                                                                                  *I     3.8879
  -51.30      0.272  I                                                                                  *I     3.8799
  -52.05      0.250  I                                                                                  *I     3.8719
  -53.05      0.222  I                                                                                  *I     3.8639
  -54.39      0.191  I                                                                                  *I     3.8559
  -56.17      0.155  I                                                                                  *I     3.8479
  -59.73      0.116  +      +      +      +      +      +      +      +      +      +                   *+     3.8399
  -62.79      0.072  I                                                                                  *I     3.8319
  -71.11      0.028  I                                                                                  *I     3.8239
  -74.15      0.020  I                                                                                  *I     3.8159
  -63.19      0.069  I                                                                                  *I     3.8079
  -58.95      0.113  I                                                                                  *I     3.7999
  -55.45      0.169  I                                                                                  *I     3.7919
  -53.22      0.218  I                                                                                  *I     3.7839
  -51.60      0.263  +      +      +      +      +      +      +      +      +      +                   *+     3.7759
  -50.12      0.312  I                                                                                  *I     3.7679
  -49.0[illegible]    0.35[illegible]  I                                                                *I     3.7599
  -48.11      0.39[illegible]  I                                                                        *I     3.7519
  -47.[illegible]    0.4[illegible]7  I                                                                 *I     3.7439
  -46.8[illegible]   0.45[illegible]  I                                                                 *I     3.7359
  -46.4[illegible]   0.4[illegible]  I                                                                  *I     3.7279
  -46.1[illegible]   0.4[illegible]  I                                                                  *I     3.7199
  -4[illegible]      0.[illegible]1  +             +      +      +      +      +      +      +      +     *+     3.7119
  -4[illegible]      0.[illegible]  I                                                                   *I     3.7039
  -4[illegible]      0.[illegible]  I                                                                   *I     3.6959
```

```
 -46.41   0.478 I                                                         *I   3.6879
 -46.85   0.455 I                                                         *I   3.6799
 -47.43   0.422 I                                                         *I   3.6719
 -48.34   0.383 I                                                         *I   3.6639
 -49.47   0.336 I                                                         *I   3.6559
 -50.99   0.282 +     +     +     +     +     +     +     +     +     +   *+   3.6479
 -53.07   0.222 I                                                         *I   3.6399
 -56.09   0.157 I                                                         *I   3.6319
 -61.16   0.088 I                                                         *I   3.6239
 -76.20   0.015 I                                                         *I   3.6159
 -64.63   0.059 I                                                         *I   3.6079
 -57.47   0.134 I                                                         *I   3.5999
 -53.65   0.208 I                                                         *I   3.5919
 -51.08   0.279 +     +     +     +     +     +     +     +     +     +   *+   3.5839
 -49.18   0.347 I                                                         *I   3.5759
 -47.73   0.411 I                                                         *I   3.5679
 -46.60   0.468 I                                                         *I   3.5599
 -45.73   0.517 I                                                         *I   3.5519
 -45.07   0.558 I                                                         *I   3.5439
 -44.60   0.589 I                                                         *I   3.5359
 -44.30   0.609 I                                                         *I   3.5279
 -44.17   0.619 +     +     +     +     +     +     +     +     +     +   *+   3.5199
 -44.20   0.617 I                                                         *I   3.5119
 -44.39   0.603 I                                                         *I   3.5039
 -44.77   0.578 I                                                         *I   3.4959
 -45.34   0.541 I                                                         *I   3.4879
 -46.13   0.494 I                                                         *I   3.4799
 -47.21   0.436 I                                                         *I   3.4719
 -48.65   0.370 I                                                         *I   3.4639
 -50.59   0.295 +     +     +     +     +     +     +     +     +     +   *+   3.4559
 -53.34   0.215 I                                                         *I   3.4479
 -57.69   0.131 I                                                         *I   3.4399
 -67.27   0.043 I                                                         *I   3.4319
 -66.94   0.045 I                                                         *I   3.4239
 -57.60   0.132 I                                                         *I   3.4159
 -53.32   0.216 I                                                         *I   3.4079
 -50.60   0.295 I                                                         *I   3.3999
 -48.70   0.367 +     +     +     +     +     +     +     +     +     +   *+   3.3919
 -47.32   0.431 I                                                         *I   3.3839
 -46.30   0.484 I                                                         *I   3.3759
 -45.57   0.527 I                                                         *I   3.3679
 -45.09   0.557 I                                                         *I   3.3599
 -44.82   0.574 I                                                         *I   3.3519
 -44.76   0.578 I                                                         *I   3.3439
 -44.91   0.569 I                                                         *I   3.3359
 -45.25   0.546 +     +     +     +     +     +     +     +     +     +   *+   3.3279
 -45.82   0.512 I                                                         *I   3.3199
 -46.63   0.466 I                                                         *I   3.3119
 -47.72   0.411 I                                                         *I   3.3039
 -49.17   0.348 I                                                         *I   3.2959
 -51.10   0.279 I                                                         *I   3.2879
 -53.74   0.206 I                                                         *I   3.2799
 -57.65   0.131 I                                                         *I   3.2719
 -64.97   0.056 +     +     +     +     +     +     +     +     +     +   *+   3.2639
 -75.44   0.015 I                                                         *I   3.2559
 -61.80   0.081 I                                                         *I   3.2479
 -57.04   0.141 I                                                         *I   3.2399
 -54.35   0.192 I                                                         *I   3.2319
 -52.63   0.232 I                                                         *I   3.2239
 -51.64   0.262 I                                                         *I   3.2159
 -51.06   0.280 I                                                         *I   3.2079
 -50.86   0.286 +     +     +     +     +     +     +     +     +     +   *+   3.1999
 -51.01   0.281 I                                                         *I   3.1919
 -51.50   0.266 I                                                         *I   3.1839
 -52.33   0.242 I                                                         *I   3.1759
 -53.53   0.211 I                                                         *I   3.1679
 -55.18   0.174 I                                                         *I   3.1599
 -57.37   0.135 I                                                         *I   3.1519
 -60.31   0.097 I                                                         *I   3.1439
 -64.34   0.061 +     +     +     +     +     +     +     +     +     +   *+   3.1359
 -70.34   0.030 I                                                         *I   3.1279
 -81.66   0.008 I                                                         *I   3.1199
 -88.84   0.004 I                                                         *I   3.1119
 -89.27   0.003 I                                                         *I   3.1039
 -80.09   0.010 I                                                         *I   3.0959
 -69.61   0.037 I                                                         *I   3.0879
 -62.70   0.078 I                                                         *I   3.0800
 -57.69   0.130 +     +     +     +     +     +     +     +     +     +   *+   3.0719
 -54.26   0.194 I                                                         *I   3.0640
 -51.55   0.265 I                                                         *I   3.0560
 -49.38   0.340 I                                                         *I   3.0480
 -47.65   0.414 I                                                         *I   3.0400
 -46.30   0.484 I                                                         *I   3.0320
 -45.29   0.544 I                                                         *I   3.0240
 -44.62   0.588 I                                                         *I   3.0160
 -44.29   0.611 +     +     +     +     +     +     +     +     +     +   *+   3.0080
 -44.32   0.608 I                                                         *I   3.0000
 -44.80   0.575 I                                                         *I   2.9920
 -45.87   0.509 I                                                         *I   2.9840
 -47.81   0.407 I                                                         *I   2.9760
 -51.38   0.270 I                                                         *I   2.9680
 -60.34   0.095 I                                                         *I   2.9600
 -59.29   0.109 I                                                         *I   2.9520
 -49.35   0.341 +     +     +     +     +     +     +     +     +     +   *+   2.9440
 -44.52   0.594 I                                                         *I   2.9360
 -41.33   0.859 I                                                         *I   2.9280
 -35.99   1.127 I                                                         *I   2.9200
 -37.21   1.378 I                                                        * I   2.9120
 -35.06   1.610 I                                                        * I   2.9040
 -34.67   [illegible] I                                                  * I   2.8960
 [illegible] [illegible] I                                               * I   2.8880
 [illegible] [illegible] +     +     +     +     +     +     +     +     +   *  +   2.8800
```



```
 -33.83     2.034    2.8720
 -34.18     1.954    2.8640
 -34.97     1.784    2.8560
 -36.37     1.518    2.8480
 -38.73     1.157    2.8400
 -43.02     0.706    2.8320
 -53.02     0.177    2.8240
 -47.51     0.421    2.8160
 -39.47     1.065    2.8080
 -35.26     1.726    2.8000
 -32.44     2.387    2.7920
 -30.41     3.017    2.7840
 -28.93     3.575    2.7760
 -27.88     4.035    2.7680
 -27.21     4.362    2.7600
 -26.88     4.528    2.7520
 -26.92     4.509    2.7440
 -27.37     4.280    2.7360
 -28.32     3.837    2.7280
 -29.97     3.173    2.7200
 -32.80     2.291    2.7120
 -38.24     1.224    2.7040
 -78.35     0.012    2.6960
 -37.25     1.372    2.6880
 -31.07     2.795    2.6800
 -27.47     4.234    2.6720
 -25.03     5.605    2.6640
 -23.30     6.842    2.6560
 -22.09     7.868    2.6480
 -21.30     8.610    2.6400
 -20.92     8.997    2.6320
 -20.94     8.972    2.6240
 -21.43     8.489    2.6160
 -22.47     7.526    2.6080
 -24.34     6.065    2.6000
 -27.66     4.141    2.5920
 -35.00     1.779    2.5840
 -40.67     0.926    2.5760
 -28.21     3.887    2.5680
 -23.13     6.977    2.5600
 -19.96    10.050    2.5520
 -17.76    12.939    2.5440
 -16.21    15.466    2.5360
 -15.17    17.445    2.5280
 -14.57    18.692    2.5200
 -14.41    19.037    2.5120
 -14.74    18.332    2.5040
 -15.68    16.446    2.4960
 -17.53    13.292    2.4880
 -21.08     8.830    2.4800
 -30.18     3.096    2.4720
 -28.18     3.901    2.4640
 -18.40    12.019    2.4560
 -13.52    21.080    2.4480
 -10.22    30.819    2.4400
  -7.74    41.044    2.4320
  -5.78    51.403    2.4240
  -4.21    61.560    2.4160
  -2.95    71.167    2.4080
  -1.95    79.839    2.4000
  -1.18    87.323    2.3920
  -0.60    93.278    2.3840
  -0.22    97.459    2.3760
  -0.03    99.676    2.3680
  -0.02    99.801    2.3600
  -0.19    97.801    2.3520
  -0.56    93.732    2.3440
  -1.14    87.697    2.3360
  -1.94    79.959    2.3280
  -3.01    70.741    2.3200
  -4.37    60.461    2.3120
  -6.12    49.428    2.3040
  -8.38    38.099    2.2960
 -11.41    26.897    2.2880
 -15.79    16.229    2.2800
 -23.78     6.469    2.2720
 -33.71     2.064    2.2640
 -20.80     9.121    2.2560
 -16.74    14.550    2.2480
 -14.78    18.238    2.2400
 -13.90    20.190    2.2320
 -13.76    20.519    2.2240
 -14.25    19.347    2.2160
 -15.39    17.027    2.2080
 -17.24    13.747    2.2000
 -20.33     9.647    2.1920
 -24.90     5.686    2.1840
 -36.19     1.553    2.1760
 -32.96     2.248    2.1680
 -25.21     5.486    2.1600
 -21.98     7.958    2.1520
 -20.38     9.572    2.1440
 -19.76    10.290    2.1360
 -19.90    10.115    2.1280
 -20.75     9.174    2.1200
 -22.39     7.59[illegible]    2.1120
 -25.07     5.579    2.1040
 -29.58     3.320    2.0960
 -39.75     1.029    2.0880
 -39.15     1.1[illegible]    2.0800
 -[illegible]0.7[illegible]    [illegible].61[illegible]    2.0720
 -2[illegible].[illegible]5     4.[illegible]    2.0640
```

```
  -25.77   5.144  I                                          *     I   2.0560
  -25.23   5.461  +    .    .    .    .    .    .    .    .  *     +   2.0480
  -25.57   [illegible]  I                                          *     I   2.0400
  -26.68   4.636  I                                           *    I   2.0320
  -28.72   3.666  I                                            *   I   2.0240
  -32.08   2.490  I                                             *  I   2.0160
  -38.17   1.234  I                                               *I   2.0080
  -70.62   0.029  I                                               *I   2.0000
  -39.82   1.021  I                                               *I   1.9920
  -34. 7   1.827  +    .    .    .    .    .    .    .    .     *  +   1.9840
  -32.55   2.346  I                                             *  I   1.9760
  -31.82   2.564  I                                            *   I   1.9680
  -32.05   2.496  I                                            *   I   1.9600
  -33.18   2.193  I                                             *  I   1.9520
  -35.29   1.719  I                                             *  I   1.9440
  -38.74   1.156  I                                               *I   1.9360
  -44.78   0.577  I                                               *I   1.9280
  -65.78   0.051  +    .    .    .    .    .    .    .    .       *+   1.9200
  -48.76   0.365  I                                               *I   1.9120
  -43.83   0.644  I                                               *I   1.9040
  -42.20   0.776  I                                               *I   1.8960
  -42.23   0.774  I                                               *I   1.8880
  -43.51   0.668  I                                               *I   1.8800
  -46.04   0.499  I                                               *I   1.8720
  -50.13   0.311  I                                               *I   1.8640
  -56.64   0.147  +    .    .    .    .    .    .    .    .       *+   1.8560
  -68.62   0.037  I                                               *I   1.8480
  -91.79   0.003  I                                               *I   1.8400
  -70.72   0.029  I                                               *I   1.8320
  -58.61   0.117  I                                               *I   1.8240
  -52.55   0.236  I                                               *I   1.8160
  -49.10   0.351  I                                               *I   1.8080
  -47.35   0.429  I                                               *I   1.8000
  -47.08   0.443  +    .    .    .    .    .         .    .    .       *+   1.7920
  -48.50   0.376  I                                               *I   1.7840
  -52.89   0.227  I                                               *I   1.7760
  -80.66   0.009  I                                               *I   1.7680
  -52.12   0.248  I                                               *I   1.7600
  -45.91   0.507  I                                               *I   1.7520
  -42.78   0.726  I                                               *I   1.7440
  -41.22   0.869  I                                               *I   1.7360
  -40.87   0.905  +    .    .    .    .    .    .    .    .       *+   1.7280
  -41.71   0.821  I                                               *I   1.7200
  -44.13   0.622  I                                               *I   1.7120
  -49.62   0.330  I                                               *I   1.7040
  -75.62   0.017  I                                               *I   1.6960
  -48.67   0.370  I                                               *I   1.6880
  -43.24   0.691  I                                               *I   1.6800
  -40.69   0.903  I                                               *I   1.6720
  -39.96   1.005  +    .    .    .    .    .    .    .    .       *+   1.6640
  -40.27   0.970  I                                               *I   1.6560
  -41.90   0.804  I                                               *I   1.6480
  -45.45   0.532  I                                               *I   1.6400
  -54.22   0.195  I                                               *I   1.6320
  -56.00   0.158  I                                               *I   1.6240
  -46.47   0.475  I                                               *I   1.6160
  -42.97   0.711  I                                               *I   1.6080
  -41.58   0.834  +    .    .    .    .    .    .    .    .       *+   1.6000
  -41.60   0.832  I                                               *I   1.5920
  -42.94   0.713  I                                               *I   1.5840
  -46.02   0.500  I                                               *I   1.5760
  -52.61   0.234  I                                               *I   1.5680
  -67.63   0.042  I                                               *I   1.5600
  -50.97   0.283  I                                               *I   1.5520
  -46.84   0.455  I                                               *I   1.5440
  -45.37   0.539  +    .    .    .    .    .    .    .    .       *+   1.5360
  -45.51   0.530  I                                               *I   1.5280
  -47.09   0.442  I                                               *I   1.5200
  -50.45   0.300  I                                               *I   1.5120
  -57.35   0.136  I                                               *I   1.5040
  -75.14   0.017  I                                               *I   1.4960
  -57.42   0.135  I                                               *I   1.4980
  -54.00   0.200  I                                               *I   1.4800
  -53.52   0.211  +    .    .    .    .    .    .    .    .       *+   1.4720
  -54.98   0.178  I                                               *I   1.4640
  -58.40   0.120  I                                               *I   1.4560
  -64.57   0.059  I                                               *I   1.4480
  -76.93   0.014  I                                               *I   1.4400
  -94.62   0.002  I                                               *I   1.4320
  -77.66   0.013  I                                               *I   1.4240
  -65.73   0.051  I                                               *I   1.4160
  -60.31   0.096  +    .    .    .    .    .    .    .    .       *+   1.4080
  -57.77   0.129  I                                               *I   1.4000
  -57.57   0.132  I                                               *I   1.3920
  -60.37   0.096  I                                               *I   1.3840
  -73.71   0.021  I                                               *I   1.3760
  -61.79   0.081  I                                               *I   1.3680
  -55.43   0.169  I                                               *I   1.3600
  -51.19   0.276  I                                               *I   1.3520
  -49.93   0.317  +    .    .    .    .    .    .    .    .       *+   1.3440
  -50.41   0.302  I                                               *I   1.3360
  -51.99   [illegible]  I                                               *I   1.3280
  [illegible]   0.090  I                                               *I   1.3200
  -73.11   0.070  I                                               *I   1.3120
  -52.[illegible]   0.229  I                                               *I   1.3040
  -49.2[illegible]   [illegible]  I                                               *I   1.2960
  -48.01   [illegible]  I                                               *I   1.2880
  -49.51   [illegible]  +         .    .    .    .    .    .    .    .       *+   1.2800
  -51.09   0.279  I                                               *I   1.2720
  -57.83   0.12[illegible]  I                                               *I   1.2640
  [illegible]   [illegible]  I                                               *I   1.2560
  [illegible]   [illegible]  I                                               *I   1.2480
```

```
[illegible]  [illegible] |                                              *|  1.2400
-55.07  0.259 |                                                    *|  1.2320
-54.36  0.267 |                                                    *|  1.2240
-52.23  0.244 +    +    +    +    +    +    +    +    +    +   *+  1.2160
-59.29  0.107 |                                                    *|  1.2080
-63.53  0.034 |                                                    *|  1.2000
-55.65  0.161 |                                                    *|  1.1920
-52.47  0.233 |                                                    *|  1.1840
-51.83  0.256 |                                                    *|  1.1760
-53.20  0.219 |                                                    *|  1.1680
-56.92  0.143 |                                                    *|  1.1600
-65.91  0.051 +    +    +    +    +    +    +    +    +    +   *+  1.1520
-69.76  0.033 |                                                    *|  1.1440
-61.11  0.088 |                                                    *|  1.1360
-59.35  0.104 |                                                    *|  1.1280
-60.45  0.095 |                                                    *|  1.1200
-64.12  0.062 |                                                    *|  1.1120
-71.53  0.027 |                                                    *|  1.1040
-90.35  0.003 |                                                    *|  1.0960
******  0.000 +    +    +    +    +    +    +    +    +    +   *+  1.0880
-75.27  0.017 |                                                    *|  1.0800
-67.09  0.044 |                                                    *|  1.0720
-63.59  0.066 |                                                    *|  1.0640
-63.26  0.069 |                                                    *|  1.0560
-67.26  0.043 |                                                    *|  1.0480
-81.57  0.008 |                                                    *|  1.0400
-62.52  0.075 |                                                    *|  1.0320
-57.27  0.137 +    +    +    +    +    +    +    +    +    +   *+  1.0240
-55.20  0.174 |                                                    *|  1.0160
-55.40  0.170 |                                                    *|  1.0080
-58.40  0.120 |                                                    *|  1.0000
-69.52  0.033 |                                                    *|  0.9920
-63.05  0.070 |                                                    *|  0.9840
-55.70  0.164 |                                                    *|  0.9760
-53.07  0.222 |                                                    *|  0.9680
-52.68  0.227 +    +    +    +    +    +    +    +    +    +   *+  0.9600
-55.12  0.175 |                                                    *|  0.9520
-61.56  0.080 |                                                    *|  0.9440
-69.05  0.035 |                                                    *|  0.9360
-57.08  0.140 |                                                    *|  0.9280
-53.67  0.207 |                                                    *|  0.9200
-53.11  0.221 |                                                    *|  0.9120
-54.91  0.180 |                                                    *|  0.9040
-60.25  0.097 +    +    +    +    +    +    +    +    +    +   *+  0.8960
[illegible]  [illegible] |                                              *|  0.8880
-60.81  0.091 |                                                    *|  0.8800
-56.53  0.147 |                                                    *|  0.8720
-55.95  0.160 |                                                    *|  0.8640
-57.68  0.131 |                                                    *|  0.8560
-62.58  0.074 |                                                    *|  0.8480
-79.31  0.011 |                                                    *|  0.8400
-67.91  0.040 +    +    +    +    +    +    +    +    +    +   *+  0.8320
-63.54  0.067 |                                                    *|  0.8240
-63.60  0.066 |                                                    *|  0.8160
-65.69  0.045 |                                                    *|  0.8080
-73.69  0.021 |                                                    *|  0.8000
-91.45  0.003 |                                                    *|  0.7920
******  0.000 |                                                    *|  0.7840
-77.67  0.013 |                                                    *|  0.7760
-69.71  0.033 +    +    +    +    +    +    +    +    +    +   *+  0.7680
-66.57  0.046 |                                                    *|  0.7600
-67.37  0.043 |                                                    *|  0.7520
-75.42  0.017 |                                                    *|  0.7440
-71.41  0.027 |                                                    *|  0.7360
-62.42  0.076 |                                                    *|  0.7280
-59.00  0.112 |                                                    *|  0.7200
-58.35  0.121 |                                                    *|  0.7120
-60.53  0.094 +    +    +    +    +    +    +    +    +    +   *+  0.7040
-69.03  0.035 |                                                    *|  0.6960
-67.90  0.040 |                                                    *|  0.6880
-59.08  0.111 |                                                    *|  0.6800
-56.16  0.156 |                                                    *|  0.6720
-56.00  0.159 |                                                    *|  0.6640
-58.59  0.118 |                                                    *|  0.6560
-67.17  0.044 |                                                    *|  0.6480
-67.46  0.042 +    +    +    +    +         +    +    +    +   *+  0.6400
-58.74  0.116 |                                                    *|  0.6320
-56.14  0.156 |                                                    *|  0.6240
-56.35  0.152 |                                                    *|  0.6160
-59.29  0.109 |                                                    *|  0.6080
-68.14  0.039 |                                                    *|  0.6000
-69.32  0.034 |                                                    *|  0.5920
-60.85  0.091 |                                                    *|  0.5840
-58.70  0.116 +    +    +    +    +    +    +    +    +    +   *+  0.5760
-59.38  0.107 |                                                    *|  0.5680
-62.87  0.072 |                                                    *|  0.5600
-72.25  0.024 |                                                    *|  0.5520
-74.65  0.019 |                                                    *|  0.5440
-66.95  0.045 |                                                    *|  0.5360
-65.59  0.050 |                                                    *|  0.5280
-68.31  0.038 |                                                    *|  0.5200
-74.28  0.019 +         +    +    +    +    +    +    +    +   *+  0.5120
-89.12  0.004 |                                                    *|  0.5040
******  0.000 |                                                    *|  0.4960
-81.[illegible]  0.009 |                                              *|  0.4880
-72.71  0.023 |                                                    *|  0.4800
-69.31  0.035 |                                                    *|  0.4720
-68.[illegible]  0.036 |                                              *|  0.4640
-74.72  0.018 |                                                    *|  0.4560
-77.0[illegible]  0.014 +    +    +    +    +    +    +    +    +    +   *+  0.4480
[illegible].61  [illegible] |                                              *|  0.4400
-61.[illegible]  [illegible] |                                              *|  0.4320
```

```
-60.39     0.096  I                                                                               *I    0.4240
-61.88     0.081  I                                                                               *I    0.4160
-68.06     0.039  I                                                                               *I    0.4080
-74.53     0.018  I                                                                               *I    0.4000
-62.44     0.076  I                                                                               *I    0.3920
-58.66     0.117  •       •       •       •       •       •       •       •       •       •       *•    0.3840
-57.83     0.128  I                                                                               *I    0.3760
-59.47     0.106  I                                                                               *I    0.3680
-65.07     0.056  I                                                                               *I    0.3600
-80.23     0.010  I                                                                               *I    0.3520
-62.84     0.072  I                                                                               *I    0.3440
-58.79     0.115  I                                                                               *I    0.3360
-57.92     0.127  I                                                                               *I    0.3280
-59.41     0.107  •       •       •       •       •       •       •       •       •       •       *•    0.3200
-64.19     0.062  I                                                                               *I    0.3120
-86.13     0.005  I                                                                               *I    0.3040
-66.41     0.048  I                                                                               *I    0.2960
-61.62     0.083  I                                                                               *I    0.2880
-60.57     0.094  I                                                                               *I    0.2800
-61.89     0.080  I                                                                               *I    0.2720
-65.98     0.050  I                                                                               *I    0.2640
-77.00     0.014  •       •       •       •       •       •       •       •       •       •       *•    0.2560
-75.30     0.017  I                                                                               *I    0.2480
-68.92     0.036  I                                                                               *I    0.2400
-68.06     0.040  I                                                                               *I    0.2320
-70.15     0.031  I                                                                               *I    0.2240
-75.37     0.017  I                                                                               *I    0.2160
-86.41     0.005  I                                                                               *I    0.2080
*******    0.000  I                                                                                *    0.2000
-87.71     0.004  •       •       •       •       •       •       •       •       •       •       *•    0.1920
-76.46     0.015  I                                                                               *I    0.1840
-71.38     0.027  I                                                                               *I    0.1760
-69.55     0.033  I                                                                               *I    0.1680
-70.82     0.029  I                                                                               *I    0.1600
-78.61     0.012  I                                                                               *I    0.1520
-76.29     0.015  I                                                                               *I    0.1440
-64.86     0.045  I                                                                               *I    0.1360
-63.04     0.071  •       •       •       •       •       •       •       •       •       •       *•    0.1280
-61.67     0.083  I                                                                               *I    0.1200
-62.35     0.075  I                                                                               *I    0.1120
-65.80     0.051  I                                                                               *I    0.1040
-78.61     0.012  I                                                                               *I    0.0960
-69.35     0.034  I                                                                               *I    0.0880
-62.42     0.076  I                                                                               *I    0.0800
-59.70     0.103  I                                                                               *I    0.0720
-59.11     0.111  •       •       •       •       •       •       •       •       •       •       *•    0.0640
-60.39     0.096  I                                                                               *I    0.0560
-64.32     0.061  I                                                                               *I    0.0480
-77.23     0.014  I                                                                               *I    0.0400
-68.93     0.036  I                                                                               *I    0.0320
-62.71     0.073  I                                                                               *I    0.0240
-59.70     0.104  I                                                                               *I    0.0160
-59.23     0.109  I                                                                               *I    0.0080
-60.46     0.095  •       •       •       •       •       •       •       •       •       •       *•    0.0
  DB.      REAL  99.8009         79.8408         59.8806         39.9204         19.9603         0.0001

                 NORMAL TERMINATION
```

6.0 A SUMMARY OF OTHER AREAS OF ENDEAVOR

6.1 The Need For Integration of Antenna Studies With Processor Studies

The University of Texas at Austin Applied Research Laboratory has been developing a computer model of the SMR radar processor with the goal of specifying hardware requirements, data rates, etc., for the SMR system. Communication lines between ARL and PSL have been set up during the latter part of the Phase I contract period in order to integrate PSL's antenna model and ARL's processor model into a more realistic total SMR system simulation model which will eventually be capable of accurately predicting the performance of the overall system. Prior to this interchange of information, both ARL and PSL were using well-developed models of their respective subsystems, but both teams had made somewhat unrealistic assumptions about the quality of the other group's components. Both groups were assuming "perfect", ideal performance characteristics from the other's subsystem.

It is felt that a continuing exchange of ideas, results, and data will yield two important benefits in the shuttle study effort. First, the very act of exchanging data demands some familiarity with the roles which the antenna, radar, and processor play and the way they interact with each other and the rest of the system. Too often this understanding is lacking, resulting in a poorly designed system composed of independently well-designed subsystems. By "closing the loop" with a free exchange of information, it will be possible to provide NASA/JSC with information that will be able to predict accurately the total system performance. The ARL or PSL models standing alone cannot do this.

Secondly, any constraints upon the antenna imposed by the rest of the system can be identified, and vice versa. This will allow bounds to be set on optimum design requirements based on errors and uncertainties within other system components. For example, a user may desire a 25 meter ground cell resolution over a 100 km swath, but because of filtering problems in the range compressor, it may not be feasible to implement so fine a resolution. As a consequence of this radar restriction, it may be possible to relax beam pointing accuracy requirements. By exploring all such constraints it should be possible to "box in" a feasible region of acceptable operation. By making hypothetical tradeoffs within this region, the most cost-effective system can be specified.

Passing large amounts of data between two widely separated locations can become a formidable task unless computer compatible magnetic tapes or disks are used as the medium of communications. An auxiliary computer program was written to create data tapes from the output of the PSL antenna simulation program. The contents of these tapes is discussed in the next section.

6.2 The ARL SMRA Performance Data Tape

The details of the data tape contents, format, etc., are described in the Interface Control Document entitled, "The Shuttle Imaging Radar Antenna Computer Simulation Data Tape" of August 27, 1976. Hence, only a brief description will be given here.

The (one-way) far-field radiation pattern of an array antenna may be written as the product of three terms.

$$\overline{E}(r,\theta,\phi) = E_0(r)f(\theta,\phi)\,\overline{g}(\theta,\phi) \qquad (6\text{-}1)$$

$$E_0(r) = \frac{-j\omega\mu e^{-jkr}}{4\pi r} \qquad (6\text{-}2)$$

where:

$f(\theta,\phi)$ = antenna array factor

$\overline{g}(\theta,\phi)$ = vector element pattern factor

Only data for $|f\overline{g}|$ has been stored, since the $E_0(r)$ term may be calculated without regard to θ and ϕ. If polarization information is needed, it may be added quite easily.

A coordinate transformation has been performed to simplify calculations. Rather than store $|f(\theta,\phi)\,\overline{g}(\theta,\phi)|$, let

$$\begin{aligned} u &= \sin\theta\cos\phi \\ v &= \sin\theta\cos\phi \end{aligned} \qquad (6\text{-}3)$$

The advantage of storing f and g as functions of u and v is that more data points are clustered within the main beam. However, even in the (u,v)-coordinate system, the narrow azimuth beam width of the SMR antenna demands rather dense discretization. To minimize interpolation errors, at least twenty points on either side of the main beam (in both u and v) are needed. This requirement makes storage of the entire $(u,v,)$-space or, equivalently, (θ,ϕ)-space prohibitive. Therefore, only the main beam and first two side lobes have been included. (All other side lobes are nominally 20 dB or more below the main beam maximum.) Data may be recovered quite easily by using the procedure described in the ICD.

6.3 SMRA Subarray Preliminary Specifications

The purpose of constructing subarray panels is two-fold:

1. To produce realistic simulation and measurement of reduced-size array behavior and to extend this to a prediction of full-size array behavior.
2. To verify the ability of near-field antenna pattern measurement techniques to measure full-scale SMRA characteristics, particularly in gain, beam coincidence, and cross-polarization levels at X-band.

The specifications on these test panels are based on an estimate of the tests and measurements that will be required to obtain the above results.

Objective (1) may be achieved by measurement of antenna characteristics (such as beam shape, footprint coincidence, etc.) under laboratory-simulated thermal and mechanical stress. Phase I studies have shown this to be critical, particularly at X-band. Once this baseline simulation has been done, systematic errors in the mechanical flatness of the subarray can be induced by mounting the subarray in a standard rigid jig; antenna pattern would then be measured for the subarray under these simulated stress conditions, which would be used to verify the ability of the computer simulation mode (developed under Phases I and II) to <u>predict</u> the actual measured antenna pattern distortions. Finally, from the measured data and the verified computer simulation, it should be possible to predict the performance of the full-scale SMR antenna, under response to space condition thermal stresses, panel unfolding mechanism accuracy, etc.

To check the above mentioned near-field measurements, the near-field antenna patterns (measured at NBS) will be compared with the far-field measurements taken at PSL.

The measurement specifications and their justifications that are listed here are based on data presently available, and as such are only preliminary requirements. As more information regarding antenna behavior is obtained through interactive graphics simulations of various space environmental conditions, these specifications will be refined. Final specifications for the subarrays will be delivered at the close of Phase II.

6.3.1 Measurements Necessary to Obtain Desired Data

Both near-field and far-field pattern measurements should be performed to verify the baseline electrical performance of each subarray. Near-field tests will be conducted by NBS (Boulder), while conventional far-field testing will be done using the 3000' PSL antenna range. A carefully defined set of electrical performance tests will be issued early in Phase III. The purposes of using two independent tests are: 1) to compare conventional far-field testing techniques to the near-field techniques for the subarray and 2) to establish the testing accuracy and capability of the near-field technique, when used for measuring the full-scale SMRA.

Thermal tests will be performed on the subarrays, with measurements of mechanical flatness performed simultaneously. Ideally, the goal of the thermal tests would be to determine the expected thermal response of the full-size antenna plus support structure. However, it has been indicated that the design of a support structure that would replicate the performance of the full-size structure will increase the subarray cost to a prohibitively high level. Consequently, at this time it is felt that it would be more cost-effective to determine the thermal gradient - mechanical deformation relationships between each subarray and a common support structure. After this data has been analyzed, separate specifications can be made for the support structure.

To provide data on the effects of mechanical deformation on antenna pattern parameters, an instrumented jig for the subarrays should be obtained so that simulated random and systematic mechanical errors may be induced into the subarray surface. To obtain pattern data, these tests should be performed simultaneously with the NBS near-field measurements. In this way, the effects of mechanical deformations on antenna performance which were predicted by the computer simulation can be verified, and an extrapolation can later be made to the performance of the full-size SMRA.

The results of these tests will be entered into a more advanced version of the SMRA simulation model as representative of space environmental thermal effects, with predictions made of pattern degradation, beam pointing inaccuracy, etc. Consequently, consideration should be given to the form of measurement data storage. It is our opinion that the most efficient method of managing large amounts of numerical information is to generate computer compatable digital and/or analog magnetic tapes for each test result.

6.3.2 Requirements Imposed By Measurement Facilities

In preliminary discussions with Hughes and Ball Brothers, a 6' x 6' area subarray was used as an approximate size. This size estimation was made using the following criteria: 1) the area was electrically large enough to allow meaningful electrical and thermal tests which could with a computer simulation model, be used to predict full-size array performance, and 2) the antenna effective aperature was small enough to conveniently make pattern tests using both near-field and far-field techniques.

The principal concern of (1) is to minimize the edge effects of the smaller subarray so that a better prediction can be made for the full-size SMRA. There are some guidelines in the literature[†], but even by following these suggestions, the subarrays would still be too large for meaningful far-field measurements. Therefore, criterion (2) is the most restrictive.

[†] c.f. N. Amitay, V. Galindo, and C.P. Wu, Theory and Analysis of Phased Array Antennas, John Wiley and Sons Inc., (New York): 1972, pp. 426-430.

The rule-of-thumb used by many antenna engineers for pattern testing is that the separation between the source and test antenna be greater than $2D^2/\lambda$, where D is the test antenna maximum dimensions. This criterion corresponds to a $\lambda/16$ path length difference between the source antenna and the extrema of the test antenna. For precise measurement of null depths and side lobe levels, several times this distance may be necessary. The longest leg of the PSL antenna range is 3000', which corresponds to a maximum antenna dimension of 35' at 1.2 GHz and 12.27' at 9.8 GHz. Using four times the rule-of-thumb distance corresponds to 17.5' at 1.2 GHz and 6.135' at 9.8 GHz. This criterion $(8D^2/\lambda)$ should provide sufficient accuracy (equivalent to a 5.625° departure from planeness of the incident spherical wave) for all necessary measurements. Therefore, six feet is the upper bound on the maximum dimension (azimuth) of the X-band subarray.

Since the subarrays are to replicate the design approaches of the competing full-size arrays, the azimuth dimensions on the L-band section of the subarray should be 6' also. The elevation dimension of the arrays are open at this time, but for ease of handling, cost minimization, etc., it is proposed that it also be limited to six feet. This makes practical sense, because increasing the elevation dimension will not decrease the edge effects in the azimuth dimensions. Consequently, the most cost-effective design for the measurements which are necessary would be a square subarray.

The 6' x 6' subarray size can be accommodated by the other test facilities needed for the measurements described in Section 6.3.1. The near-field facility at NBS (Boulder, Colorado) can measure both gain and directivity of this size antenna with an uncertainty claim of better than 0.2 dB at the 3σ level, at both L- and X-bands. Facilities exist at NASA/JSC and elsewhere that can perform meaningful thermal and mechanical tests on a 6' x 6' structure.

6.3.3 A Summary of The Preliminary Specifications

The preliminary specifications for the SMRA test panels, based on the above considerations, are presented in Table 3.

TABLE 3. Preliminary specifications for the SMRA test panels.

1. The size shall not exceed 6' x 6'.
2. The weight shall not exceed 200 lbs.
3. The test panel shall operate at 1.5 GHz and 9.0 GHz.
4. Both horizontal and vertical polarization shall be available at each frequency.
5. The cross-polarized component shall not exceed -25 dB with respect to the principally-polarized component.
6. Two modules shall be present at both frequencies to demonstrate beamwidth switching.
7. This VSWR shall not exceed 1.3 in any mode of operation.
8. The maximum side lobe level shall not exceed 12 dB.
9. All array elements, feedlines, and the electrical design approach shall be the same as that which will be used on the full sized antenna.

APPENDIX

This appendix contains the computer listing of the Shuttle Multispectral Radar Antenna Simulation Program. This listing was obtained by compiling the program on the Physical Science Laboratory/New Mexico State University IBM 370/135 computer using DOS FORTRAN IV.

While the majority of this program can be run on any compatible IBM machine, the user is cautioned to examine all subprograms carefully for calls to functions and subroutines that may not be standard software items. Special attention is called to the subprograms PLOT, AXIS, LINE, and NUMBER.

```
            C*****************************************************************************
            C
            C        MAIN PROGRAM FOR SPACE SHUTTLE EARTH RESOURCES IMAGING RADAR ANTENNA
            C
            C        WRITTEN BY: E. L. COFFEY, SENIOR ENGINEER
            C                    PHYSICAL SCIENCE LABORATORY
            C                    ELECTROMAGNETICS SECTION
            C                    NEW MEXICO STATE UNIVERSITY
            C                    LAS CRUCES, NEW MEXICO  88001
            C                    PHONE: (505) 524 - 2851
            C
            C              DATE: 2 AUGUST 1976
            C           REVISED: 23 AUGUST 1976
            C
            C           VERSION 2.3
            C
            C*****************************************************************************
            C
 0001             REAL APLOT(151,151),CON(10),K,MU,XPRINT(501,2),YPRINT(501,2),
                 $XPLOT(501),YPLOT(501),ZAVG(24,12),ALPHAX(24,12),ALPHAY(24,12),
                 $ANGLE(3,3)
 0002             REAL KX,KY
 0003             REAL PHSX(24,12),AMAG(24,12),APHS(24,12),PHSY(24,12)
            C
 0004             COMPLEX AF,AF1,PAT,CEXP,J
            C
 0005             INTEGER NAM(80),DELIM,PR1,PR2,PR3,PL1,PL2,PL3,TP1,TP2
 0006             INTEGER DATE(5)
 0007             EQUIVALENCE (XPRINT(1,1),YPRINT(1,1)),(XPLOT(1),YPLOT(1))
            C
 0008             COMMON /ANG/ YAW,TILT,TWIST,CTW,STW,CT,ST,CYAW,SYAW
 0009             COMMON /IO/ PR1,PR2,PL1,PL2,PL3,TP1,TP2,NCON,CON,STARTX,STOPX,
                 $DELTAX,STARTY,STOPY,DELTAY,CONLOW,CONMAX,NPTSX,NPTSY,FLOOR,DASH
 0010             COMMON /ARRAY/ APLOT
 0011             COMMON /SYS/ REARTH,RE3,ALT,ALT3,ANGLE
 0012             COMMON /ANT/ MSECT,NSECT,MEL,NEL,SX,SY,PX,PY,IHV,K,OMU4PI,ZAVG,
                 $ALPHAX,ALPHAY,KX,KY,PXSECT,PYSECT
 0013             COMMON /ELCTRC/ PHSX,PHSY,AMAG,APHS
```

```
              C
 0014                DATA J/(0.,1.)/
 0015                DATA PI,MU,RADDEG/3.14159265E0,12.56637E-7,0.01745329E0/
 0016                DATA DELIM /'&'/
 0017                FLOOR=-30.0
              C
              C........INPUT USER PARAMETERS
 0018          1000 READ(1,1,END=9999) NUMPAT,DATE
 0019             1 FORMAT(I5,1X,5A4)
 0020                WRITE(3,2) NUMPAT,DATE
 0021             2 FORMAT(1H1,12X,'PATTERN ',I3,15X,'SPACE SHUTTLE IMAGING RADAR ANTE
                   $NNA SIMULATION PROGRAM',14X,5A4////)
 0022             9 IYES=0
 0023                READ(1,3) NAR
 0024             3 FORMAT(80A1)
              C........CHECK FOR DELIMITER
 0025                DO 10 I=1,80
 0026                IF(NAR(I).EQ.DELIM) GO TO 11
 0027            10 CONTINUE
 0028                IYES=1
 0029                I=81
 0030            11 I=I-1
 0031                WRITE(3,4) (NAR(JJ),JJ=1,I)
 0032             4 FORMAT(20X,80A1)
 0033                IF(IYES.EQ.1) GO TO 9
 0034                WRITE(3,5)
 0035             5 FORMAT(////)
              C........END OF NARRATIVE
 0036             6 FORMAT(8F10.0)
 0037             7 FORMAT(2I5)
 0038             9 FORMAT(5I1)
              C
              C          CALL SUBROUTINES FOR FURTHER OUTPUT CALCULATIONS
              C
 0039                CALL ORBIT(NUMPAT,FREQ)
 0040                CALL ANTENA(NUMPAT)
 0041                CALL MECH(NUMPAT)
 0042                CALL ELEC(MSECT,NSECT,NUMPAT)
```

```
0043             CALL OUTPUT(NUMPAT)
          C
          C........CALCULATE RUN PARAMETERS
          C
0044             K=2.*PI*FREQ/30.0
0045             OMEGA=2.*PI*FREQ*1E9
0046             OMU4PI=OMEGA*MU/(4.*PI)
0047             DXD=DELTAX/RADDEG
0048             DYD=DELTAY/RADDEG
          C
0049             WRITE(3,200) NUMPAT
0050         200 FORMAT(20X,'SUBARRAY DATA SUMMARY FOR PATTERN ',I3,':'/
                $1X,'AREA',8X,'XCENT',9X,'YCENT',9X,'ZAVG',8X,'ALPHAX',7X,
                $'ALPHAY',8X,'AMAG',9X,'APHS',9X,'PHSX',9X,'PHSY')
0051             IAREA=0
0052             DO 201 N=1,NSECT
0053             YCENT=SY*NEL*(N-FLOAT(NSECT+1)*0.5)
0054             DO 201 M=1,MSECT
0055             XCENT=SX*MEL*(M-FLOAT(MSECT+1)*0.5)
0056             IAREA=IAREA+1
0057             P1=ZAVG(M,N)
0058             P2=ALPHAX(M,N)*57.295
0059             P3=ALPHAY(M,N)*57.295
0060             P4=AMAG(M,N)
0061             P5=APHS(M,N)*57.295
0062             P6=PHSX(M,N)*57.295
0063             P7=PHSY(M,N)*57.295
0064             WRITE(3,202) IAREA,XCENT,YCENT,P1,P2,P3,P4,P5,P6,P7
0065         202 FORMAT(2X,I3,6X,F8.2,6X,F8.2,6X,F7.2,6X,F7.3,6X,F7.3,6X,F7.4,
                $6X,F7.2,6X,F7.2,6X,F7.2)
0066         201 CONTINUE
          C
          C........CALCULATE BEAM CENTER
          C
0067             KX=K*SX
0068             KY=K*SY
0069             CALL GENER
                 UP=-PX/KX
```

```
0071              VP=-PY/KY
0072              IF(UP.EQ.0. .AND. VP.EQ.0.) GO TO 20
0073              PHIP=ATAN2(VP,UP)
0074              GO TO 21
0075           20 PHIP=0.
0076           21 CONTINUE
0077              WP=SQRT(1.0-(UP*UP+VP*VP))
0078              THETAP=ARCOS(WP)
            C
            C........UNTWIST
            C
0079              PHIP=PHIP+TWIST
0080              XP=SIN(THETAP)*COS(PHIP)
0081              YP=SIN(THETAP)*SIN(PHIP)
0082              ZP=COS(THETAP)
            C
            C........"UNTILT"
            C
0083              X=XP
0084              Y=CT*YP+ST*ZP
0085              Z=-ST*YP+CT*ZP
            C
            C........"UNYAW"
            C
0086              XP=CYAW*X-SYAW*Y
0087              YP=SYAW*X+CYAW*Y
0088              ZP=Z
            C
            C........CALCULATE ANGLES
            C
0089              RP=SQRT(XP*XP+YP*YP+ZP*ZP)
0090              THETAP=ARCOS(ZP/RP)
0091              IF(XP.EQ.0. .AND. YP.EQ.0.) GO TO 22
0092              PHIP=ATAN2(YP,XP)
0093              GO TO 23
0094           22 PHIP=0.0
0095           23 CONTINUE
            C
```

```
             C........PREDICT LATITUDE AND LONGITUDE ON EARTH ASSUMING SUBSATELLITE
             C        POINT IS AT (0,0).
             C
 0096              ALPHAR=ARSIN(SIN(THETAP)/REARTH*(REARTH+ALT))-THETAP
 0097              PHIR=PHIP-PI/2.0
 0098              RANGE=REARTH*ALPHAR
             C
 0099              FLONG=ATAN(SIN(PHIR)*TAN(ALPHAR))
 0100              FLAT=ARCOS(COS(ALPHAR)/COS(FLONG))
 0101              IF(FLAT.GT.PI/2.) FLAT=FLAT-PI
 0102              FLATD=FLAT/RADDEG
 0103              FLONGD=FLONG/RADDEG
 0104              PHIRD=PHIR/RADDEG
 0105              WRITE(3,102) FLATD,FLONGD,RANGE,PHIRD
 0106          102 FORMAT(///20X,'PREDICTED BEAM CENTER:'/25X,'LATITUDE = ',F8.4/25X,
                  $'LONGITUDE = ',F9.4/25X,'RANGE = ',F7.3/25X,'HEADING = ',F8.3///)
             C
             C........NOW BEGIN POINT-BY-POINT CALCULATION OF PATTERN.
             C        FIRST CALCULATE AF AT BEAM CENTER.
             C
 0107              AF=PAT(FLONG,FLAT)
 0108              BIG1=CABS(AF)
 0109              IF(BIG1.LT.1E-10) BIG1=1E-10
 0110              BIG=20.0*ALOG10(BIG1)
             C
             C
 0111              WRITE(3,113) BIG
 0112          113 FORMAT(///20X,'PLOT NORMALIZATION FACTOR = ',F8.3,' DB.'////)
             C
             C
 0113              IF(PR2+PL2+PL3.EQ.0) GO TO 50
 0114              YR=STARTY-DELTAY
 0115              DO 40 NN=1,NPTSY
 0116              YR=YR+DELTAY
 0117              XR=STARTX-DELTAX
 0118              DO 40 MM=1,NPTSX
 0119              XR=XR+DELTAX
 0120              AF=PAT(XR,YR)
```

```
0121             IF(CABS(AF).LT.1E-10) AF=(1E-10,0.)
0122             APLOT(MM,NN)=20.*ALOG10(CABS(AF))-BIG
0123          40 CONTINUE
           C
0124             IF(PL2.EQ.1) CALL PLOT2(NPTSX,NPTSY,CON,NCON,NUMPAT,-1000.)
0125             IF(PR2.EQ.1) CALL PATCON(APLOT,CONLOW,CONMAX,STARTX/RADDEG,
                $STOPX/RADDEG,STARTY/RADDEG,STOPY/RADDEG,NUMPAT)
0126             IF(PL3.NE.1) GO TO 50
0127             DO 45 M=1,NPTSX
0128             DO 45 N=1,NPTSY
0129             IF(APLOT(M,N).LT.FLOOR) APLOT(M,N)=FLOOR
0130          45 CONTINUE
0131             CALL PLOT3(NPTSX,NPTSY,NUMPAT)
           C
           C........ONE DIMENSIONAL PLOTS
           C
0132          50 CONTINUE
0133             IF(PR1+PL1.EQ.0) GO TO 51
           C
           C        CALCULATE PROFILE ALONG X-AXIS AT Y=YC
           C
0134             DX=(STOPX-STARTX)/500.0
0135             YR=FLAT
0136             XR=STARTX-DX
0137             DO 60 MM=1,501
0138             XR=XR+DX
0139             AF=PAT(XR,YR)
0140             XPRINT(MM,1)=XR/RADDEG
0141             XPRINT(MM,2)=CABS(AF)/BIG1
0142             IF(XPRINT(MM,2).LT.1E-10) XPRINT(MM,2)=1E-10
0143          60 XPLOT(MM)=20.*ALOG10(XPRINT(MM,2))
0144             IF(PR1.NE.1) GO TO 63
0145             WRITE(3,114) FLATO
0146         114 FORMAT(1H1,25X,'X-AXIS PROFILE PLOT ALONG ',F8.3,' DEGREES LATITUD
                $E.')
0147             CALL PROFIL(XPRINT,501,NUMPAT)
0148          63 CONTINUE
0149             IF(PL1.NE.1) GO TO 64
```

```
 0150               CALL PLOT1(STARTX/RADDEG,STOPX/RADDEG,500,1,FLATD,NUMPAT,XPLOT)
 0151            64 CONTINUE
              C
              C.........CALCULATE PROFILE ALONG Y-AXIS AT X=FLAT
 0152               DY=(STOPY-STARTY)/500.0
 0153               XR=FLONG
 0154               YR=STARTY-DY
 0155               DO 70 MM=1,501
 0156               YR=YR+DY
 0157               AF=PAT(XR,YR)
 0158               YPRINT(MM,1)=YR/RADDEG
 0159               YPRINT(MM,2)=CABS(AF)/BIG1
 0160               IF(YPRINT(MM,2).LT.1E-10) YPRINT(MM,2)=1E-10
 0161            70 YPLOT(MM)=20.*ALOG10(YPRINT(MM,2))
              C
              C.........OUTPUT SEQUENCE
 0162               IF(PR1.NE.1) GO TO 80
 0163               WRITE(3,115) FLONGD
 0164           115 FORMAT(1H1,25X,'Y-AXIS PROFILE PLOT ALONG',F8.3,'LONGITUDE.')
 0165               CALL PROFIL(YPRINT,501,NUMPAT)
              C.........PLOTTER PLOTS
 0166            80 CONTINUE
 0167               IF(PL1.NE.1) GO TO 90
 0168               CALL PLOT1(STARTY/RADDEG,STOPY/RADDEG,500,2,FLONGD,NUMPAT,YPLOT)
 0169            90 CONTINUE
 0170            51 CONTINUE
 0171            95 CONTINUE
              C.........NEW SEARCH CODE
 0172               CALL PLOT(0.,0.,-3)
 0173               GO TO 1000
              C
              C
              C
 0174          9999 CONTINUE
 0175               WRITE(3,117)
 0176           117 FORMAT(20X,'NORMAL TERMINATION')
 0177               CALL PLOT(0.,0.,999)
 0178               STOP
```

```
      SUBROUTINE ORBIT(NUMPAT,FREQ)
      DATA RADDEG /0.01745329E0/
      REAL ANGLE(3,3)
      COMMON /ANG/ YAW,TILT,TWIST,CTW,STW,CT,ST,CYAW,SYAW
      COMMON /SYS/ REARTH,RE3,ALT,ALT3,ANGLE
      REARTH = 6370.0
      RE3=REARTH*1E3
      READ(1,6) FREQ
      READ(1,6) ALT
    6 FORMAT(8F10.0)
      ALT3=ALT*1E3
      READ(1,6) YAWD,TILTD,TWISTD
      TWIST=RADDEG*TWISTD
      TILT=RADDEG*TILTD
      YAW=RADDEG*YAWD
      CTW=COS(TWIST)
      STW=SIN(TWIST)
      CT=COS(TILT)
      ST=SIN(TILT)
      CYAW=COS(YAW)
      SYAW=SIN(YAW)
C
      ANGLE(1,1)=CTW*CYAW-SYAW*CT*STW
      ANGLE(1,2)=SYAW*CTW+CYAW*CT*STW
      ANGLE(1,3)=-ST*STW
      ANGLE(2,1)=-STW*CYAW-SYAW*CT*CTW
      ANGLE(2,2)=CYAW*CT*CTW-SYAW*STW
      ANGLE(2,3)=-ST*CTW
      ANGLE(3,1)=-SYAW*ST
      ANGLE(3,2)=CYAW*ST
      ANGLE(3,3)=CT
C
C........OUTPUT SYSTEM INFORMATION
C
      WRITE(3,100) FREQ
  100 FORMAT(20X,'SYSTEM INFORMATION:'/25X,'FREQUENCY = ',F6.3,' GHZ.')
      WRITE(3,101) YAWD,TILTD,TWISTD,ALT
  101 FORMAT(25X,'YAW = ',F8.3,' DEGREES'/25X,'TILT = ',F8.3,' DEGREES'/
```

```
                 $25X,'TWIST = ',F8.3,' DEGREES'/25X,'ALTITUDE = ',F8.3,' KM.'///)
           C
 0035              RETURN
 0036              END
```

```
 0001              SUBROUTINE ANTENA(NUMPAT)
             C
             C      THIS ROUTINE INPUTS AND CALCULATES APPROPRIATE ANTENNA PARAMETERS
             C      FOR THE SPACE SHUTTLE SYNTHETIC IMAGING RADAR ANTENNA.
             C
             C      FINALLY, ALL ANTENNA PARAMETERS ARE OUTPUTTED.
             C
             C
             C...............ANTENNA CONFIGURATION -- TWO-DIMENSIONAL ARRAY................C
             C
 0002              REAL ZAVG(24,12),ALPHAX(24,12),ALPHAY(24,12),K
 0003              REAL KX,KY
 0004              COMMON /ANT/ MSECT,NSECT,MEL,NEL,SX,SY,PX,PY,IHV,K,OMU4PI,ZAVG,
                  $ALPHAX,ALPHAY,KX,KY,PXSECT,PYSECT
             C
             C
 0005              READ(1,1) MSECT,NSECT
 0006              READ(1,1) NX,NY
 0007            1 FORMAT(8I5)
 0008              MEL=NX/MSECT
 0009              NEL=NY/NSECT
 0010              READ(1,2) SX,SY
 0011            2 FORMAT(8F10.0)
 0012              READ(1,2) PXD,PYD
 0013              PX=PXD*0.01745329E0
 0014              PY=PYD*0.01745329E0
 0015              READ(1,1)IHV
 0016              WRITE(3,3) NUMPAT
 0017            3 FORMAT(20X,'ANTENNA PARAMETERS FOR SIMULATION NUMBER ',I3)
 0018              IF(IHV.EQ.0) WRITE(3,100)
 0019              IF(IHV.EQ.1) WRITE(3,101)
 0020              IF(IHV.EQ.2) WRITE(3,102)
 0021          100 FORMAT(25X,'ELEMENT TYPE: ISOTROPIC')
 0022          101 FORMAT(25X,'ELEMENT TYPE: HORIZONTAL DIPOLE')
 0023          102 FORMAT(25X,'ELEMENT TYPE: VERTICAL DIPOLE')
 0024              WRITE(3,4) NX,NY
 0025            4 FORMAT(25X,'NUMBER OF ELEMENTS (X,Y) = (',I3,' , ',I3,')')
 0026              WRITE(3,5) SX,SY
```

```
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 0027                5 FORMAT(25X,'INTERELEMENT SPACING (CM.): ',F7.4,' , ',F7.4)
 0028                  WRITE(3,6) PXD,PYD
 0029                6 FORMAT(25X,'INTERELEMENT PHASE SHIFT (DEG.): ',F7.4,' , ',F7.4///)
 0030                  RETURN
 0031                  END
```

```
      SUBROUTINE MECH(NUMPAT)
      REAL ZAVG(24,12),ALPHAX(24,12),ALPHAY(24,12),K
      REAL A(3,3)
      REAL KX,KY
      REAL WARP(201)
      COMMON /SYS/ RE,RE3,ALT,ALT3,A
      COMMON /ANT/ MSECT,NSECT,MEL,NEL,SX,SY,PX,PY,IHV,K,OMU4PI,ZAVG,
     $ALPHAX,ALPHAY,KX,KY,PXSECT,PYSECT
C
C
      CALL MISC(MSECT,NSECT,WARP)
      WRITE(3,100) NUMPAT
  100 FORMAT(20X,'DEFORMATION DATA FOR SIMULATION ',I3,':'/)
      NSECT1=NSECT+1
      MSECT1=MSECT+1
      DO 50 II=1,NSECT1
      I=NSECT1-II+1
      II=(I-1)*MSECT1+1
      III=I*MSECT1
      WRITE(3,101) (WARP(IJ),IJ=II,III)
  101 FORMAT(10(3X,F7.2))
      WRITE(3,105)
  105 FORMAT(/)
   50 CONTINUE
      WRITE(3,104)
C
C
      PXSECT=MEL*PX
      PYSECT=NEL*PY
      XLEN=SX*MEL
      YLEN=SY*NEL
      DX2=0.5/XLEN
      DY2=0.5/YLEN
C
C
  104 FORMAT(////)
      IAREA=0
      DO 30 N=1,NSECT
```

```
               YCENT=YLEN*(N-FLOAT(NSECT+1)*0.5)
               DO 30 M=1,MSECT
               XCENT=XLEN*(M-FLOAT(MSECT+1)*0.5)
               IAREA=IAREA+1
               NUM=(IAREA-1)+N
               A0=WARP(NUM)
               A1=WARP(NUM+1)
               A2=WARP(NUM+1+MSECT)
               A3=WARP(NUM+2+MSECT)
      C
               B0=(A0+A1+A2+A3)*0.25
               B1=DX2*(-A0+A1-A2+A3)
               B2=DY2*(-A0-A1+A2+A3)
               B3=DX2*DY2*4*(A0-A1-A2+A3)
      C
               ZAVG(M,N)=B0
               ALPHAX(M,N)=ATAN(B1)
               ALPHAY(M,N)=ATAN(B2)
            30 CONTINUE
               WRITE(3,104)
               RETURN
               END
```

```
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      SUBROUTINE MISC(MSECT,NSECT,WARP)
      REAL WARP(201)
      NWARP=(MSECT+1)*(NSECT+1)
      READ(1,2)  (WARP(I),I=1,NWARP)
    2 FORMAT(8F10.0)
      RETURN
      END
```

```
DOS FORTRAN IV 360N-FO-479 3-9          ELEC                DATE   12/17/76     TIME    09.17.17

           SUBROUTINE ELEC(MSECT,NSECT,NUMPAT)
           REAL PHSX(24,12),AMAG(24,12),APHS(24,12),PHSY(24,12)
           COMMON /ELCTRC/ PHSX,PHSY,AMAG,APHS
           MNSECT=(MSECT+1)*(NSECT+1)
           DO 10 J=1,NSECT
           DO 10 I=1,MSECT
        10 READ(1,11) PHSX(I,J),PHSY(I,J),AMAG(I,J),APHS(I,J)
        11 FORMAT(3F10.0)
     C
     C
           WRITE(3,12) NUMPAT
        12 FORMAT(20X,'ELECTRICAL DATA FOR SIMULATION ',I3,':'/)
           J=NSECT+1
           DO 20 JJ=1,NSECT
           J=J-1
           WRITE(3,25) (I,J,I=1,MSECT)
           WRITE(3,21) (PHSX(I,J),I=1,MSECT)
           WRITE(3,22) (PHSY(I,J),I=1,MSECT)
           WRITE(3,23) (AMAG(I,J),I=1,MSECT)
           WRITE(3,24) (APHS(I,J),I=1,MSECT)
           WRITE(3,104)
        20 CONTINUE
        21 FORMAT(5X,'PHSX:',10(3X,F7.2))
        22 FORMAT(5X,'PHSY:',10(3X,F7.2))
        23 FORMAT(5X,'AMAG:',10(3X,F7.2))
        24 FORMAT(5X,'APHS:',10(3X,F7.2))
        25 FORMAT(10X,10(3X,'(',I2,',',I2,')'))
           DO 30 J=1,NSECT
           DO 30 I=1,MSECT
           PHSX(I,J)=PHSX(I,J)*0.017453293E0
           PHSY(I,J)=PHSY(I,J)*0.017453293E0
           APHS(I,J)=APHS(I,J)*0.017453293E0
        30 CONTINUE
           WRITE(3,104)
       104 FORMAT(////)
           RETURN
           END
```

```
DOS FORTRAN IV 360N-FO-479 3-9          PAT                   DATE   12/17/76     TIME    09.17.29

0001             FUNCTION PAT(XR,YR)
           C
           C        PAT COMPUTES THE COMPLEX-VALUED PATTERN FROM A PIECEWISE
           C        BILINEAR RECTANGULAR ARRAY.
           C
           C       ANTENNA PARAMETERS ARE PASSED BY COMMON BLOCK ANT.
           C        OTHER SYSTEM PARAMETERS ARE PASSED BY COMMON BLOCK SYS.
           C
           C
           C        WRITTEN BY: E. L. COFFEY
           C              DATE:  26 JULY 1976
           C
           C
0002             COMPLEX PAT,CEXP,J
0003             COMPLEX AF2
0004             REAL ZAVG(24,12),ALPHAX(24,12),ALPHAY(24,12),K
0005             REAL KX,KY
0006             REAL PHSX(24,12),AMAG(24,12),APHS(24,12),PHSY(24,12)
0007             REAL A(3,3)
           C
0008             COMMON /SYS/ RE,RE3,ALT,ALT3,A
0009             COMMON /ANT/ MSECT,NSECT,MEL,NEL,SX,SY,PX,PY,IHV,K,OMU4PI,
                $ZAVG,ALPHAX,ALPHAY,KX,KY,PXSECT,PYSECT
0010             COMMON /ELCTRC/ PHSX,PHSY,AMAG,APHS
           C
           C
0011             DATA J/(0.,1.)/
           C
           C........TRANSLATION FROM EARTH SURFACE TO UNROTATED ANTENNA.
0012             CYR=COS(YR)
0013             XP=-RE3*SIN(XR)*CYR
0014             YP=RE3*SIN(YR)
0015             ZP=RE3*(1.-COS(XR)*CYR)+ALT3
           C
           C........ANTENNA YAW,TILT,TWIST
0016             XPP=A(1,1)*XP+A(1,2)*YP+A(1,3)*ZP
0017             YPP=A(2,1)*XP+A(2,2)*YP+A(2,3)*ZP
0018             ZPP=A(3,1)*XP+A(3,2)*YP+A(3,3)*ZP
```

```
0019              RPP=SQRT(XPP*XPP+YPP*YPP+ZPP*ZPP)
0020              U=XPP/RPP
0021              V=YPP/RPP
0022              ALPHA1=ARCOS(U)
0023              ALPHA2=ARCOS(V)
0024              AF1=OMU4PI/RPP
            C
            C......TRANSLATE TO CENTER OF SUBARRAY
            C
0025              DX=SX*MEL
0026              DY=SY*NEL
0027              AF2=(0.,0.)
0028              YCENT=-FLOAT(NSECT+1)/2.0*DY
0029              DO 10 N=1,NSECT
0030              YCENT=YCENT+DY
0031              XCENT=-FLOAT(MSECT+1)/2.0*DX
0032              DO 10 M=1,MSECT
0033              XCENT=XCENT+DX
0034              UP=COS(ALPHA1-ALPHAX(M,N))+PHSX(M,N)/KX
0035              VP=COS(ALPHA2-ALPHAY(M,N))+PHSY(M,N)/KY
0036              WP=SQRT(1.-(UP*UP+VP*VP))
0037              PHASE=K*(XCENT*UP+YCENT*VP+ZAVG(M,N)*WP)+M*PXSECT+N*PYSECT
                 $+APHS(M,N)
0038              AF2=AF2+AF1*CMPLX(COS(PHASE),SIN(PHASE))*AF(UP,VP)
                 $*AMAG(M,N)
0039           10 CONTINUE
            C
            C
0040              PAT=AF2
0041              RETURN
0042              END
```

```
DOS FORTRAN IV 360N-FO-479 3-9          GENER                DATE   12/17/76     TIME    09.17.43

 0001                SUBROUTINE GENER
 0002                REAL ZAVG(24,12),ALPHAX(24,12),ALPHAY(24,12),K
 0003                REAL KX,KY
 0004                REAL UARRAY(1001),VARRAY(1001)
 0005                COMMON /PATTRN/ UARRAY,VARRAY,UMAX,VMAX,DU,DV
 0006                COMMON /ANT/ MSECT,NSECT,MEL,NEL,SX,SY,PX,PY,IHV,K,DMU4PI,
                    $ZAVG,ALPHAX,ALPHAY,KX,KY,PXSECT,PYSECT
            C
            C........THIS ROUTINE GENERATES PATTERN DATA FOR THE ARRAYS UARRAY AND VARRAY.
            C
 0007                NULNUM=3
 0008                UMAX=6.28318531E0/K/(MEL*SX)*NULNUM
 0009                VMAX=6.28318531E0/K/(NEL*SY)*NULNUM
 0010                IF(UMAX.GT.1.0) UMAX=1.0
 0011                IF(VMAX.GT.1.0) VMAX=1.0
            C
 0012                DU=UMAX*1E-3
 0013                DV=VMAX*1E-3
            C
            C
 0014                DO 10 I=1,1001
 0015                U=(I-1)*DU
 0016                PSIX=KX*U+PX
 0017                PSIX2=0.5*PSIX
 0018                U1=1.0
 0019                IF(PSIX.NE.0.) U1=SIN(MEL*PSIX2)/(MEL*SIN(PSIX2))
 0020                IF(IHV.EQ.1.AND.ABS(U).NE.1.0)U1=U1*COS(1.570796E0*U)/SQRT(1.-U*U)
 0021                UARRAY(I)=U1
            C
 0022                V=(I-1)*DV
 0023                PSIY=KY*V+PY
 0024                PSIY2=0.5*PSIY
 0025                V1=1.0
 0026                IF(PSIY.NE.0.) V1=SIN(NEL*PSIY2)/(NEL*SIN(PSIY2))
 0027                IF(IHV.EQ.2.AND.ABS(V).NE.1.)V1=V1*COS(1.570796E0*V)/SQRT(1.-V*V)
 0028                VARRAY(I)=V1
 0029             10 CONTINUE
            C
```

```
               C
 0030                    RETURN
 0031                    END
```

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

```
0001              FUNCTION AF(U1,V1)
           C
           C........THIS FUNCTION CALCULATES THE ARRAY FACTOR OF A SUBPANEL BY
           C           "TABLE LOOK-UP" IF U < UMAX AND V < VMAX.   OTHERWISF, THE FUNCTION
           C           IS COMPUTFD IN THE USUAL WAY.
           C
           C           LINEAR INTERPOLATION IS USED IN THE TABLE LOOK-UP.
           C
0002              REAL ZAVG(24,12),ALPHAX(24,12),ALPHAY(24,12),K
0003              REAL KX,KY
0004              REAL UAPRAY(1001),VAPRAY(1001)
           C
0005              COMMON /PATTRN/ UARRAY,VARRAY,UMAX,VMAX,DU,DV
0006              COMMON /ANT/ MSECT,NSFCT,MEL,NEL,SX,SY,PX,PY,IHV,K,OMU4PI,
                 $ZAVG,ALPHAX,ALPHAY,KX,KY,PXSECT,PYSECT
           C
           C
0007              U=ABS(U1)
0008              V=ABS(V1)
           C
0009              IF(U.GT.UMAX) GO TO 10
           C........U IS IN RANGE
0010              FU=U/DU+1.0
0011              IFU=IFIX(FU)
0012              DIFF=FU-IFU
0013              UPAT=(1.0-DIFF)*UARRAY(IFU)+DIFF*UARRAY(IFU+1)
0014              GO TO 15
0015           10 CONTINUF
0016              PSIX2=(KX*U+PX)*0.5
0017              UPAT=SIN(MEL*PSIX2)/(MEL*SIN(PSIX2))
0018              IF(IHV.EQ.1) UPAT=UPAT*COS(1.570796E0*U)/SQRT(1.-U*U)
0019           15 CONTINUE
0020              IF(V.GT.VMAX) GO TO 20
           C........V IS IN RANGE
0021              FV=V/DV+1.0
0022              IFV=IFIX(FV)
0023              DIFF=FV-IFV
0024              VPAT=(1.0-DIFF)*VARRAY(IFV)+DIFF*VARRAY(IFV+1)
```

```
DOS FORTRAN IV 360N-FO-479 3-9          AF                 DATE   12/17/76     TIME    09.17.55

 0025                GO TO 25
 0026             20 CONTINUE
 0027                PSIY2=(KY*V+PY)*0.5
 0028                VPAT=SIN(NEL*PSIY2)/(NEL*SIN(PSIY2))
 0029                IF(IHV.EQ.2) VPAT=VPAT*COS(1.570796E0*V)/SQRT(1.-V*V)
 0030             25 CONTINUE
 0031                AF=UPAT*VPAT/(MSECT*NSECT)
 0032                RETURN
 0033                END
```

```
DOS FORTRAN IV 360N-FO-479 3-9          OUTPUT               DATE   12/17/76     TIME    09.18.06

0001                 SUBROUTINE OUTPUT(NUMPAT)
              C
              C
0002                 INTEGER BUFFER(1000),SYS13
0003                 REAL CON(10)
0004                 INTEGER PR1,PR2,PL1,PL2,PL3,TP1,TP2
0005                 DATA RADDEG/0.01745329E0/
              C
              C
0006                 COMMON /IO/ PR1,PR2,PL1,PL2,PL3,TP1,TP2,NCON,CON,STARTX,STOPX,
                    $DELTAX,STARTY,STOPY,DELTAY,CONLOW,CONMAX,NPTSX,NPTSY,FLOOR,DASH
              C
              C
0007                 READ(1,8) PR1,PR2
0008                 READ(1,8) PL1,PL2,PL3
0009                 READ(1,8) TP1,TP2
0010                 IF(PL1+PL2+PL3.EQ.0) GO TO 10
              C........INITIALIZE PLOT BUFFER
              C
0011                 NBUF=1000
0012                 SYS13=13
0013                 CALL PLOTS(BUFFER,NBUF,SYS13)
              C
0014              10 CONTINUE
0015                 READ(1,6) STRXD,STPXD
0016                 READ(1,6) STRYD,STPYD
0017                 STARTX=STRXD*RADDEG
0018                 STOPX=STPXD*RADDEG
0019                 STARTY=STRYD*RADDEG
0020                 STOPY=STPYD*RADDEG
0021                 IF(PL2.EQ.1) READ(1,7) NCON
0022                 IF(PL2.EQ.1) READ(1,6) (CON(JJ),JJ=1,NCON)
0023                 IF(PR2.EQ.1) [illegible]D(1,6) CONLOW,CONMAX
0024                 IF(PR2+PL2+[illegible].GE.1) READ(1,7) NPTSX,NPTSY
0025                 DELTAX=(STOPX-STARTX)/(NPTSX-1)
0026                 DELTAY=(STOPY-STARTY)/(NPTSY-1)
0027                 DXD=DELTAX*57.295
0028                 DYD=DELTAY*57.295
```

```
      C
      C........OUTPUT PRINT/PLOT INFORMATION
      C
            WRITE(3,103)
        103 FORMAT(////20X,'PRINT/PLOT INFORMATION:'/25X,'REQUESTED OUTPUT:')
            IF(PR1.EQ.1) WRITE(3,104)
            IF(PR2.EQ.1) WRITE(3,105)
            IF(PL1.EQ.1) WRITE(3,106)
            IF(PL2.EQ.1) WRITE(3,107)
            IF(PL3.EQ.1) WRITE(3,108)
        104 FORMAT(30X,'PRINTER PROFILE')
        105 FORMAT(30X,'PRINTER CONTOUR')
        106 FORMAT(30X,'PLOTTER PROFILE')
        107 FORMAT(30X,'PLOTTER CONTOUR')
        108 FORMAT(30X,'PLOTTER THREE-D')
      C
            IF(PL2.NE.1 ) GO TO 24
            WRITE(3,109) (CON(I),I=1,NCON)
        109 FORMAT(//25X,'CONTOURS TO BE PLOTTED: ',5(F6.2,3X)/49X,5(F6.2,3X))
         24 CONTINUE
            IF(PR2+PL2+PL3.GE.1) WRITE(3,110) NPTSX,NPTSY
        110 FORMAT(25X,'PLOT RESOLUTION: ',I3,' X ',I3,' POINTS'//)
            WRITE(3,111) STRXD,STPXD,DXD
        111 FORMAT(25X,'STARTX = ',F8.3/25X,'STOPX = ',F8.3/25X,'DELTAX = ',
           $F8.3/)
            WRITE(3,112) STRYD,STPYD,DYD
        112 FORMAT(25X,'STARTY = ',F8.3/25X,'STOPY = ',F8.3/25X,'DELTAY = ',
           $F8.3//)
          6 FORMAT(8F10.0)
          7 FORMAT(2I5)
          8 FORMAT(5I1)
            RETURN
            END
```

```
DOS FORTRAN IV 360N-FO-479 3-9          PROFIL              DATE   12/17/76     TIME    09.18.20

 0001               SUBROUTINE PROFIL(DATA,NPT,NUMPAT)
              C
              C      DATA = DATA INPUT (DESTROYED)
              C      NPT = NUMBER OF POINTS
              C      NUMPAT = PATTERN NUMBER
              C
 0002               INTEGER SF
 0003               INTEGER OUTPUT(81)
 0004               INTEGER BLANK,PLUS,SLASH,STAR
 0005               REAL DATA(501,2),BOUND(81)
 0006               DATA BLANK,PLUS,SLASH,STAR /' ','+','|','*' /
              C
              C        FIND THE RANGE OF DEPENDENT DATA AND SCALE IF NECESSARY
              C
 0007               IF(NPT.GT.501) GO TO 999
 0008               BIG=-1.E10
 0009               SMALL = 1.E10
 0010               DO 1 J=1,NPT
 0011               IF(DATA(J,2).LT.-60.0) DATA(J,2)=-60.0
 0012               IF(DATA(J,2).LT.SMALL) SMALL=DATA(J,2)
 0013               IF(DATA(J,2).GT.BIG) BIG=DATA(J,2)
 0014             1 CONTINUE
 0015               DIFF=ABS(BIG-SMALL)
 0016               SF = 0
 0017               IF(DIFF.LT.1.) GO TO 10
 0018               IF(DIFF.LT.100.)GO TO 21
 0019               DO 2 J=1,10
 0020               IF(DIFF*10.**(-J).GT.100.) GO TO 2
 0021               SF=J
 0022               GO TO 20
 0023             2 CONTINUE
 0024           400 WRITE(3,100)
 0025           100 FORMAT('0 YOUR DATA IS TOO LARGE FOR THIS PROGRAM.')
 0026               RETURN
 0027            10 DO 3 J=1,10
 0028               K=11-J
 0029               IF(DIFF*10**K.GT.100.) GO TO 3
 0030               SF=-K
```

```
              GO TO 20
            3 CONTINUE
              GO TO 400
           20 DO 4 J=1,NPT
            4 DATA(J,2) = DATA(J,2)*10.**(-SF)
      C
      C          CALCULATE BOUNDS
      C
           21 SCALE=DIFF/80.
              DO 5 J=1,81
              K=J-1
            5 BOUND(J)=(BIG-K*SCALE)*10.**(-SF)
              SFDB=20.*SF
      C
      C          PRINT TITLE
      C
              WRITE(3,640) NUMPAT
          640 FORMAT(26X,'PATTERN NUMBER ',I5//)
              IF (SF.EQ.0) GO TO 200
              WRITE(3,4004) SF
         4004 FORMAT(53X,'SCALE FACTOR IS 10**',I2/)
          200 WRITE(3,650) (BOUND(J),J=1,81,16)
          650 FORMAT(3X,'DB.',5X,'REAL',2X,6(F7.4,9X))
              DO 6 J1=1,NPT
              J=NPT+1-J1
              DO 50 K=1,81
           50 OUTPUT(K)=BLANK
              IF((J-1)/8*8-(J-1)) 62,61,62
           61 DO 40 K=1,81,8
           40 OUTPUT(K)=PLUS
              GO TO 87
           62 OUTPUT(1)=SLASH
              OUTPUT(81)=SLASH
           87 DO 7 K=1,80
              IF(DATA(J,2).GT.BOUND(K)) GO TO 7
              IF(DATA(J,2).LE.BOUND(K+1)) GO TO 7
              OUTPUT(K)=STAR
              GO TO 69
```

```
 0063           7 CONTINUE
 0064             OUTPUT(81)=STAR
 0065          69 IF(DATA(J,2).EQ.0.0) DATA(J,2) = 1.0E-6
 0066             DATADB=20.*ALOG10(ABS(DATA(J,2)))+SFDB
 0067         141 WRITE(3,4000) DATADB,DATA(J,2),OUTPUT,DATA(J,1)
 0068        4000 FORMAT(1X,F6.2,2X,F8.3,2X,81A1,1X,F9.4)
 0069             GO TO 6
 0070           6 CONTINUE
 0071             WRITE(3,650) (BOUND(J),J=1,81,16)
 0072             WRITE(3,651)
 0073         651 FORMAT(1H1)
 0074         999 RETURN
 0075             END
```

```
F 3S FORTRAN IV 360N-FO-479 3-9          PATCON              DATE   12/17/76      TIME     09.18.35

 0001              SUBROUTINE PATCON(A    ,CONLOW,CONMAX,STARTX,STOPX,STARTY,STOPY,
                  $NUMPAT)
            C
            C       THIS ROUTINE CALLS SUBROUTINE CONTUR THREE TIMES TO GENERATE A
            C       COMPLETE 151 X 151 TWO-DIM. PLOT.
            C
 0002              DIMENSION A(151,151)
 0003              DY=(STOPY-STARTY)/3.0
 0004              CALL CONTUR(A ,1,CONLOW,CONMAX,STARTX,STOPX,STARTY,STARTY+DY,
                  $NUMPAT)
 0005              CALL CONTUR(A ,2,CONLOW,CONMAX,STARTX,STOPX,STARTY+DY,STOPY-DY,
                  $NUMPAT)
 0006              CALL CONTUR(A ,3,CONLOW,CONMAX,STARTX,STOPX,STOPY--CY,STOPY,NUMPAT)
 0007              RETURN
 0008              END
```

```
          SUBROUTINE CONTUR(A,ICODE,CONLOW,CONMAX,STARTX,STOPX,STARTY,STOPY,
         $NUMPAT)
C
C          THIS ROUTINE PRINTS A  51 X 151 CONTOUR PLOT OF THE FOOTPRINT.
C          TO OBTAIN A COMPLETE 151 X 151 PLOT, THIS ROUTINE IS CALLED THREE
C          TIMES BY SUBROUTINE PATCON.  THEN THE THREE SEPARATE PLOTS ARE
C          JOINED TOGETHER TO MAKE THE COMPOSITE.
C
C
          REAL A(151,151),LOW(12),HIGH(12),AXIS(11)
          INTEGER OUTPUT(101),LEVEL(12),BLANK,DOT
C
C
          DATA LEVEL/'0','1','2','3','4','5','6','7','8','9',' ','+'/
          DATA BLANK /' '/
C
          WRITE(3,10) NUMPAT
       10 FORMAT(1H1,37X,'PRINTER CONTOUR PLOT FOR SIMULATION NUMBER ',I3//
         $///)
C
          DELTAX=(STOPX-STARTX)/150.0
          DELTAY=(STOPY-STARTY)/10.0
          NUMCON=10
          CONINT=(CONMAX-CONLOW)/FLOAT(NUMCON-1)
          DELCON=CONINT*0.5
          DO 71 J=1,NUMCON
          LOW(J)=CONLOW+(J-1)*CONINT-DELCON
          HIGH(J)=LOW(J)+CONINT+1E-5
       71 CONTINUE
          LOW(11)=-1E50
          HIGH(12)=1E50
          HIGH(11)=LOW(1)
          LOW(12)=HIGH(NUMCON)
C
          DO 40 I=1,11
       40 AXIS(I)=STARTY+(I-1)*DELTAY
          WRITE(3,42) (AXIS(I),I=1,11)
       42 FORMAT(6X,11(F8.3,2X)/10X,10('|.........'),'|')
```

```
      DO 50 N=1,151
      X=STARTX+(N-1)*DELTAX
      DO 51 K=1,101
   51 OUTPUT(K)=BLANK
C
      DO 60 M=1,51
      MM=2*M-1
      M1=M+50*(ICODE-1)
      F=A(N,M1)
      IF(F.LE.LOW(1)) GO TO 1001
      IF(F.GT.HIGH(NUMCON)) GO TO 1002
      DO 61 K=1,NUMCON
      IF(F.GT.LOW(K) .AND. F.LE.HIGH(K)) GO TO 62
   61 CONTINUE
 1002 OUTPUT(MM)=LEVEL(12)
      GO TO 60
 1001 OUTPUT(MM)=LEVEL(11)
      GO TO 60
   62 OUTPUT(MM)=LEVEL(K)
   60 CONTINUE
C
C........OUTPUT
C
      IF(ICODE.EQ.1) WRITE(3,1) X,OUTPUT
      IF(ICODE.EQ.2) WRITE(3,2) OUTPUT
      IF(ICODE.EQ.3) WRITE(3,3) OUTPUT,X
    1 FORMAT(1X,F8.4,'.',101A1)
    2 FORMAT(10X,101A1)
    3 FORMAT(10X,101A1,'.',1X,F8.4)
   50 CONTINUE
      WRITE(3,43) (AXIS(I),I=1,11)
   43 FORMAT(10X,10('|.........'),'|'/6X,11(F8.3,2X))
C
C
      IF(ICODE.NE.2) GO TO 80
      WRITE(3,44)
   44 FORMAT(///51X,'CONTOUR LEVEL KEY'//)
      DO 45 I=1,4
```

```
DOS FORTRAN IV 360N-FO-479 3-9          CONTUR            DATE   12/17/76      TIME    09.18.44

 0057             45 WRITE(3,46) (LEVEL(J),LOW(J),HIGH(J),J=1,12,4)
 0058             46 FORMAT(2X,3(A1,': ',E14.7,' TO ',E14.7,3X))
 0059             80 CONTINUE
 0060                RETURN
 0061                END
```

```
0001                SUBROUTINE PLOT1(PSTRT,PEND,IP,CODE,CONST,NUMPAT,PTS)
           C
           C
           C           PROFILE PLOT ROUTINE
           C
           C           WRITTEN BY: E. L. COFFEY
           C                 DATE: 22 JUNE 1976
           C
           C           INPUT:
           C        PSTRT= BEGINNING OF PLOT
           C        PEND= END OF PLOT
           C        IP= NUMBER OF POINTS TO BE PLOTTED
                    CODE= LABELLING CODE -- 1 FOR X-AXIS, 2 FOR Y-AXIS
           C        CONST= "OTHER" AXIS CONSTANT
           C        NUMPAT= PATTERN NUMBER...USER DEFINED
           C
           C
0002                INTEGER CODE
0003                DIMENSION PTS(501)
0004                CALL PLOT(8.,2.,23)
0005                CALL FACTOR(0.7)
0006                FNUM=NUMPAT
           C
           C           DRAW AXES AND LABEL THEM
           C
0007                Y=0.05
0008                DO 11 J=1,11
0009                X=-5.0+(J-1)*1.0
0010                CALL PLOT(X,-Y,3)
0011             11 CALL PLOT(X,Y,2)
0012                CALL PLOT(5.,0.,3)
0013                CALL PLOT(-5.,0.,2)
           C
0014                CALL PLOT(0.,5.5,3)
0015                CALL PLOT(0.,0.,2)
0016                X=0.05
0017                DO 10 J=1,6
0018                Y=0.5+(J-1)*1.0
```

```
0019                 CALL PLOT(-X,Y,3)
0020              10 CALL PLOT(X,Y,2)
           C
           C
0021                 CALL NUMBER(-5.25,-.75,0.125,PSTRT,0.,6)
0022                 PMID=(PSTRT+PEND)*0.5
0023                 CALL NUMBER(-.25,-.75,0.125,PMID,0.,6)
0024                 CALL NUMBER(4.75,-.75,0.125,PEND,0.,6)
0025                 CALL SYMBOL(-5.0,-1.5,0.125,7HPATTERN,0.,7)
0026                 CALL NUMBER(-3.5,-1.5,0.125,FNUM,0.,-1)
           C
0027                 IF(CODE.EQ.1) CALL SYMBOL(-2.0,-1.5,0.125,32HX-AXIS PROFILE ALONG
                    $LATITUDE = ,0.,32)
0028                 IF(CODE.EQ.2) CALL SYMBOL(-2.0,-1.5,0.125,33HY-AXIS PROFILE ALONG
                    $LONGITUDE = ,0.,33)
0029                 CALL NUMBER(2.0,-1.5,0.125,CONST,3)
0030                 CALL ZIP(1,3,18)
           C
           C            PLOT IT
           C
0031                 IF(PTS(1).LT.-50.) PTS(1)=-50.0
0032                 FS=PTS(1)/10.+5.5
0033                 CALL PLOT(-5.0,FS,3)
0034                 DELTA=10./FLOAT(IP-1)
0035                 DO 1 IWI=1,IP
0036                 X=-5.0+(IWI-1)*DELTA
0037                 Y=PTS(IWI)/10.+5.5
0038                 IF(Y .LT. 0.5) GO TO 1
0039                 CALL PLOT(X,Y,2)
0040               1 CONTINUE
0041                 CALL FACTOR(1.0)
0042                 CALL PLOT(8.0,-2.0,23)
0043                 CALL ZIP(3,3,18)
0044                 RETURN
0045                 END
```

```
DOS FORTRAN IV 360N-FO-479 3-9          PLOT2             DATE   03/02/77     TIME     10.01.01

0001              SUBROUTINE PLOT2(N,M,CONTUR,NCON,NUMPAT,DASH)
          C                                                                          00000240
          C       A= N BY M MATRIX OF DATA POINTS
          C       CONTUR= ARRAY OF CONTOURS TO BE PLOTTED
          C       NCON= NUMBER OF CONTOURS TO BE PLOTTED
          C       NUMPAT= PATTERN NUMBER SPECIFIED BY USER
          C       DASH= CONTOURS BELOW DASH ARE PLOTTED AS DASHED LINES
          C
          C                                                                          00000310
0002              DIMENSION A(151,151),RA(151),RB(151),X(151),Y(151)
0003              REAL CONTUR(10)
0004              COMMON /ARRAY/ A                                                   00000335
0005              CALL PLOT(8.,0.,23)
0006              CALL FACTOR (0.7)
0007              JJ=1
0008              MS=M                                                               00000340
0009              NS=N                                                               00000350
0010              RATIO=MS/NS                                                        00000360
0011              SCALE=10.
0012              ANM=AMAXO(N-1,M-1)                                                 00000380
0013              IF(RATIO-1.0)1,1,2                                                 00000390
0014            1 SX=ANM                                                             00000400
0015              SY=RATIO*ANM                                                       00000410
0016              GO TO 3                                                            00000420
0017            2 SX=1./RATIO*ANM                                                    00000430
0018              SY=ANM                                                             00000440
0019            3 SMAX=AMAX1(SX,SY)                                                  00000450
0020              SS=SX/SMAX                                                         00000460
0021              SYS=SY/SMAX                                                        00000470
0022              CALL PLOT(2.0,.25,3)
0023              DO 300 I=1,10
0024              CALL PLOT(FLOAT(I)+2.0,.25,2)
0025              CALL PLOT(FLOAT(I)+2.0,.5,2)
0026              CALL PLOT(FLOAT(I)+2.0,.25,2)
0027          300 CONTINUE
0028              DO 301 I=1,10
0029              YY=FLOAT(I)+.25
0030              CALL PLOT(12.,YY,2)
```

```
          CALL PLOT(11.75,YY,2)
          CALL PLOT(12.,YY,2)
      301 CONTINUE
          DO 302 I=1,10
          XX=12.-FLOAT(I)
          CALL PLOT(XX,10.25,2)
          CALL PLOT(XX,10.,2)
          CALL PLOT(XX,10.25,2)
      302 CONTINUE
          DO 303 I=1,10
          YY=10.25-FLOAT(I)
          CALL PLOT(2.,YY,2)
          CALL PLOT(2.25,YY,2)
          CALL PLOT(2.,YY,2)
      303 CONTINUE
          CALL PLOT(1.00,0.25,3)                                          00000660
          CALL PLOT(0.60,0.25,2)                                          00000670
          CALL PLOT(0.60,8.25,2)                                          00000680
          CALL PLOT(1.00,8.25,2)                                          00000690
          CALL PLOT(1.00,0.25,2)                                          00000700
          CALL SYMBOL (0.88,0.45,0.12,10HPATTERN = ,90.,10)
          FNUM=NUMPAT
          CALL NUMBER(0.88,2.075,0.12,FNUM,90.,-1)
          CALL ZIP(1,3,18)
C
C            SORT CONTOURS FROM SMALLEST TO LARGEST
C
          NCON1=NCON-1
          DO 200 I=1,NCON1
          I1=I+1
          DO 201 J=I1,NCON
          IF(CONTUR(I).LE.CONTUR(J)) GO TO 201
          TEMP=CONTUR(I)
          CONTUR(I)=CONTUR(J)
          CONTUR(J)=TEMP
      201 CONTINUE
      200 CONTINUE
C
```

```
                C
 0065          1125  YCONA=1.0/SMAX                                                   00000720
 0066                DELTAX=SX/FLOAT(N-1)                                             00000730
 0067                X(1)=0.0                                                         00000740
 0068                Y(1)=0.0                                                         00000750
 0069                RB(1) = A(1,1)                                                   00000760
 0070                DO 27 J=2,N                                                      00000770
 0071                 RB(J)=A(J,1)                                                    00000780
 0072            27  X(J)=X(J-1)+DELTAX                                               00000790
 0073                DELTAY=SY/FLOAT(M-1)                                             00000800
 0074                DO 28 J=2,M                                                      00000810
 0075            28  Y(J)=Y(J-1)+DELTAY                                               00000820
 0076                DO 118  K=2,M                                                    00000830
 0077                 DO 30 J=1,N                                                     00000840
 0078                 RA(J)=RB(J)                                                     00000850
 0079            30  RB(J)=A(J,K)                                                     00000860
 0080                DO 118  J=2,N                                                    00000870
 0081            35  ASSIGN 112 TO L                                                  00000880
 0082                RR=RA(J)                                                         00000890
 0083                XX=X(J)                                                          00000900
 0084                YY=Y(K-1)                                                        00000910
 0085            37 RL=RR                                                             00000920
 0086                XL=XX                                                            00000930
 0087                YL=YY                                                            00000940
 0088            39 IF(RL-RA(J-1))   41,40 ,40                                        00000950
 0089            40 IF(RL-RB(J))42,50 ,50                                             00000960
 0090            41 RL=RA(J-1)                                                        00000970
 0091                XL =X  (J-1)                                                     00000980
 0092                YL= Y(K-1)                                                       00000990
 0093                GO TO 40                                                         00001000
 0094            42 RL=RB(J)                                                          00001010
 0095                XL=X  (J)                                                        00001020
 0096                YL=Y(K)                                                          00001030
 0097                GO TO  50                                                        00001040
 0098            50 RS=RR                                                             00001050
 0099                XS=XX                                                            00001060
 0100                YS=YY                                                            00001070
 0101                IF(RS-RA(J-1)) 52, 52,53                                         00001080
```

```
0102          52 IF(RS-RB(J)) 60,60,54                                      00001090
0103          53 RS=RA(J-1)                                                 00001100
0104             XS=X (J-1)                                                 00001110
0105             YS =Y(K-1)                                                 00001120
0106             GO TO 52                                                   00001130
0107          54 RS=RB(J)                                                   00001140
0108             XS=X (J)                                                   00001150
0109             YS=Y (K)                                                   00001160
0110             GO TO 60                                                   00001170
0111          60 RM=RR                                                      00001180
0112             XM=XX                                                      00001190
0113             YM=YY                                                      00001200
0114             IF(RM-RS) 62, 62,61                                        00001210
0115          61 IF(RM-RL)70 ,62 ,62                                        00001220
0116          62 RM=RA(J-1)                                                 00001230
0117             XM=X (J-1)                                                 00001240
0118             YM=Y (K-1)                                                 00001250
0119             IF(RM-RS) 64,64,63                                         00001260
0120          63 IF(RM-RL) 70,64,64                                         00001270
0121          64 RM = RB(J)                                                 00001280
0122             XM=X (J)                                                   00001290
0123             YM=Y (K)                                                   00001300
0124          70 YCS=YS*YCONA                                               00001310
0125             YCM=YM*YCONA                                               00001320
0126             YCL=YL*YCONA                                               00001330
0127          71 YS=YS-SY                                                   00001340
0128             YM=YM-SY                                                   00001350
0129             YL=YL-SY                                                   00001360
0130          72  XCS=XS/SMAX                                               00001370
0131              XCM=XM/SMAX                                               00001380
0132              XCL=XL/SMAX                                               00001390
0133             JJ=1
0134          80 IF(JJ .GT. NCON) GO TO 110
0135             RC=CONTUR(JJ)
0136             IF ( RC .NE. RM ) GO TO 91                                 00001420
0137          81 IF ( RM .NE. RS ) GO TO 91                                 00001430
0138          82 IF ( RL .EQ. RM ) GO TO 100                                00001440
0139          91 IF(RC-RS)100,95,92                                         00001450
```

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DOS FORTRAN IV 360N-FO-479 3-9          PLOT2               DATE   03/02/77     TIME      10.01.01

 0140           92 IF(RC-RM)96,93,94                                                     00001460
 0141           93 XPA=XCM                                                               00001470
 0142              YPA=YCM                                                               00001480
 0143              GO TO 99                                                              00001490
 0144           94 IF(RC-RL)106,103,110                                                  00001500
 0145           95 Q=0.0                                                                 00001510
 0146              GO TO 97                                                              00001520
 0147           96 Q = (RC-RS)/(RM-RS)                                                   00001530
 0148           97 XPA = XCS-Q*(XCS-XCM)                                                 00001540
 0149              YPA = YCS-Q*(YCS-YCM)                                                 00001550
 0150           99 Q = (RC-RS)/(RL-RS)                                                   00001560
 0151              XPB = XCS-Q*(XCS-XCL)                                                 00001570
 0152              YPB = YCS-Q*(YCS-YCL)                                                 00001580
 0153              IF(RC-DASH) 10115,10115,10116
 0154        10115 XPB1=0.5*(XPA+XPB)                                                    00001600
 0155              YPB1=0.5*(YPA+YPB)                                                    00001610
 0156              IF(ABS (XPA-XPB1)-.001)5001,5002,5002                                 00001620
 0157         5001 IF(ABS (YPA-YPB1)-.001)100,5002,5002                                  00001630
 0158         5002 CALL PLOT(SCALE*XPA+2.,SCALE*YPA+0.25,3)
 0159              CALL PLOT(SCALE*XPB1+2.,SCALE*YPB1+0.25,2)
 0160              GO TO 100                                                             00001650
 0161        10116 IF(ABS (XPA-XPB)-.001)5003,5004,5004                                  00001660
 0162         5003 IF(ABS (YPA-YPB)-.001)100,5004,5004                                   00001670
 0163         5004 CALL PLOT(SCALE*XPA+2.,SCALE*YPA+0.25,3)
 0164              CALL PLOT(SCALE*XPB+2.,SCALE*YPB+0.25,2)
 0165          100 JJ=JJ+1
 0166              GO TO 80                                                              00001700
 0167          103 XPA = XCL                                                             00001710
 0168              YPA = YCL                                                             00001720
 0169              GO TO 99                                                              00001730
 0170          106 Q=(RC-RM)/(RL-RM)                                                     00001740
 0171              XPA=XCM-Q*(XCM-XCL)                                                   00001750
 0172              YPA=YCM-Q*(YCM-YCL)                                                   00001760
 0173              GO TO 99                                                              00001770
 0174          110  GO TO L,(112,118)                                                    00001780
 0175          112  ASSIGN 118 TO L                                                      00001790
 0176              RR   =RR(J-1)                                                         00001800
 0177              XX   =X (J-1)                                                         00001810
```

```
DOS FORTRAN IV 360N-FO-479 3-9          PLOT2                DATE   03/02/77     TIME     10.01.01

 0178             YY    =Y (K)                                                            00001820
 0179             GO TO 37                                                                00001830
 0180         118 CONTINUE                                                                00001840
 0181             CALL FACTOR(1.0)
 0182             CALL PLOT(SCALE+6.,0.,23)
 0183             CALL ZIP(3,3,18)
 0184              RETURN                                                                 00001860
 0185              END                                                                    00001870
```

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS PO

```
C          SUBROUTINE PLOT3
C
C          PURPOSE:  TO DRAW A PERSPECTIVE VIEW OF A CONTOURED SURFACE.
C
C
C          DESCRIPTION OF PARAMETERS AND IMPORTANT VARIABLES:
C
C          N         - NUMBER OF DATA POINTS ALONG FIRST AXIS.
C
C          M         - NUMBER OF DATA POINTS ALONG THE SECOND AXIS.
C
C          NUMPAT    - PATTERN NUMBER (FOR LABELLING).
C
C          K         - CODE THAT TELLS WHETHER TO DRAW THE GRID LINES:
C                            K=1: ALONG THE N-DIMENSION ONLY.
C                            K=2: ALONG THE M-DIMENSION ONLY.
C                            K=3: ALONG BOTH DIMENSIONS.
C
C          DISTS     - DISTANCE FROM SURFACE TO EYE WHEN PERSPECTIVE IS
C                      CALCULATED -- SDISTS > 6 USUALLY WONT'T SHOW ANY
C                      DISTORTION DUE TO PARALLAX.
C
C          YAW       - (IN DEGREES) HOW FAR THE OBJECT IS TURNED AWAY FROM
C                      THE VIEWER.
C
C          PITCH     - (IN DEGREES) HOW THE SURFACE IS LOWERED OR RAISED AT
C                      THE FRONT EDGE.  (POSITIVE PITCH TENDS TO EXPOSE THE
C                      TOP OF THE FIGURE).
C
C          SIZE      - (IN INCHES) THE SIZE OF THE CUBE THAT ENCLOSES THE
C                      FIGURE.
C
C          KODE      - "HIDDEN LINE" SWITCH.  IF KODE=0 DO NOT DRAW HIDDEN
C                      LINES...IF KODE=1, ALL HIDDEN LINES ARE PLOTTED.
C
C          MGN       - WHETHER TO DRAW THE OUTLINE OF THE CUBE TO HELP ORIENT
C                      THE VIEWER.  MGN=0: DO NOT DRAW ANY OUTLINE OF THE
C                      CUBE.  MGN=1:  DRAW THE OUTLINE OF THE CUBE SEPARATE
```

```
C                    FROM THE FIGURE.  MGN=2:  DRAW THE OUTLINE OF THE
C                    CUBE SUPERIMPOSED ON THE SURFACE PLOT.  MGN=3:  DRAW
C                    ONLY THE THREE EDGES OF THE CUBE THAT MEET AT THE
C                    ORIGIN, SUPERIMPOSED ON THE SURFACE PLOT.
C
C        SCALE    - HOW TALL TO MAKE THE SURFACE RELATIVE TO THE HEIGHT
C                    OF THE CUBE.  SCALE=0: DO NOT SCALE THE DATA AT ALL
C                    BUT TRUST THE USER THAT THE DATA IS NOT SO HIGH THAT
C                    IT RUNS OFF THE PAPER.  SCALE=1: SCALE THE DATA SO
C                    THE TOP OF THE DATA JUST TOUCHES THE TOP OF THE CUBE.
C                    SCALE=0.3: SCALE THE DATA SO THE TOP OF THE SURFACE IS
C                    THREE TENTHS AS HIGH AS THE CUBE.
C
C
C
C        REMARKS.
C
C     I. IT IS VERY EXPENSIVE TO DRAW OPAQUE SURFACES, BECAUSE THE
C        PROGRAM HAS TO DETERMINE THE VISIBILITY OF EVERY POINT, THE
C        COMPUTER TIME DOUBLES OR TRIPLES...DEPENDING ON HOW MANY LINE
C        SEGMENTS ARE PARTIALLY VISIBLE.
C
C    II. THE CONTENTS OF ARRAY A ARE DESTROYED IN COMPUTATION.
C
C
C        COMMON BLOCKS REQUIRED:
C
C              COMMON /ARRAY/ A
C              COMMON /THREE6/ ANGA,ANGB,HV,D,SH,SV
C              COMMON /THREE7/ SL,SM,SN,CX,CY,CZ,QX,QY,QZ,SD
C
C
C        SUBROUTINE AND FUNCTION SUBPROGRAMS REQUIRED:
C              THREE2
C              THREE3
C              THREE4
C              THREE5
C              PLOT
```

```
DOS FORTRAN IV 360N-FO-479 3-9          MAINPGM            DATE   03/02/77     TIME    10.01.24
               C          FACTOR
               C          SYMBOL
               C          NUMBER
               C
               C
               C
               C      REFERENCE:HOWARD JESPERSON, IOWA STATE UNIVERSITY.
               C
               C      MODIFIED FOR USE AT VPI BY:  ROBERT D. KEPHART.
               C                                   S. R. KAUFFMAN
               C                                   W. L. STUTZMAN
               C                                   F. L. COFFEY
               C
               C
               C
 0001                 SUBROUTINE PLOT3(N,M,NUMPAT)                                  00000320
               C                                                                    00000330
               C                                                                    00000370
 0002                 COMMON /ARRAY/ A                                              00000389
 0003                 COMMON /THREE6/ ANGA,ANGB,HV,D,SH,SV                          00000390
 0004                 COMMON /THREE7/ SL,SM,SN,CX,CY,CZ,QX,QY,QZ,SD                 00000400
 0005                 DIMENSION H(10),V(10),X(2),Y(2),Z(2),XP(8),A(151,151)         00000410
 0006                 K=3                                                           00000420
 0007                 SPISTS=6.0                                                    00000430
 0008                 PITCH=30.                                                     00000440
 0009                 YAW=45.                                                       00000450
 0010                 SIZE=10.
 0011                 KODE=0                                                        00000470
 0012                 MCN=0                                                         00000480
 0013                 SCALE=1.0
 0014                 CALL FACTOR(1.0)
 0015                 CALL PLOT(8.,.2,23)
 0016                 CALL PLOT(.4,0.,2)                                            00000510
 0017                 CALL PLOT(.4,8.,2)                                            00000520
 0018                 CALL PLOT(0.,8.,2)                                            00000530
 0019                 CALL PLOT(0.,0.,2)                                            00000540
 0020                 CALL ZIP(3,3,18)
 0021                 CALL SYMBOL(0.3,1.0  ,0.12,10HPATTERN = ,90.,10)
```

```
0022                FNUM=FLOAT(NUMPAT)
0023                CALL NUMBER(0.3,2.130 ,0.12,FNUM,90.,-1)
0024                CALL ZIP(1,3,18)
0025                CALL PLOT(1.5,-.2,23)
          C***** ********                                                00000570
0026                ANGA = (YAW+270.) * .0174532                         00000580
0027                ANGB = PITCH * .0174532                              00000590
0028                HV = SIZE                                            00000600
          C  DIRECTION COMPONENTS TO THE EYE.                            00000610
0029                 SL = -COS( ANGA ) * COS( ANGB )                     00000620
0030                 SM = -SIN( ANGA ) * COS( ANGB )                     00000630
0031                 SN = -SIN ( ANGB )                                  00000640
0032                     IF ( ABS( SN ) .NE. 1.0 ) GO TO 10              00000650
0033                   WRITE(  6       ,    20  )                        00000660
0034           20   FORMAT (  '1' , 20X,  20('*') , / '0', 'YOU ARE ATTEMPTING TO LO00000670
                 :K  STRAIGHT DOWN ( OR UP ) AT THE SURFACE ' )          00000680
0035                        GO TO 2150                                   00000690
0036           10  CONTINUE                                              00000700
0037                SD = 1.0 / SQRT( 1.0 - SN ** 2  )                    00000710
0038                 X(1) = 1                                            00000720
0039                 X(2) = N                                            00000730
0040                 Y(1) = 1                                            00000740
0041                 Y(2) = M                                            00000750
0042                T=MAX0(M,N)                                          00000760
          C  FIND THE DIAGONAL OF THE "CUBE".                            00000770
0043                 D = M ** 2  +  N ** 2  +  T ** 2                    00000780
0044                 D  =   SQRT ( D )                                   00000790
0045                 SCL = SDISTS * D                                    00000800
          C  COORDINATES OF YOUR EYE.                                    00000810
0046                 CX = -SL * SCL                                      00000820
0047                 CY = -SM * SCL                                      00000830
0048                 CZ = -SN * SCL                                      00000840
          C  COORDINATES OF THE PROJECTION PLANE.                        00000850
0049                 OX = CX + D * SL                                    00000860
0050                 OY = CY + D * SM                                    00000870
0051                 OZ = CZ + D * SN                                    00000880
          C          PPPPPPPPPPPPPPPPPPPPPPPPPP                          00000890
0052                 GO TO 2060                                          00000900
```

```
              C      WRITE(6,100) CX,CY,CZ                                    00000910
              C      WRITE(6,100) QX,QY,QZ                                    00000920
 0053         100   FORMAT(1X,3F15.3)                                         00000930
 0054          2060 Z(2)=A(1,1)
 0055               Z(1)=A(1,1)
 0056               DO 1000 J=1,N
 0057               DO 1000 K=1,M
 0058               Z(1)=AMIN1(Z(1),A(J,K))
 0059               Z(2)=AMAX1(Z(2),A(J,K))
 0060          1000 CONTINUE
 0061               RANGE= (Z(2)-Z(1))                                        00000950
 0062                DOL=1.0                                                  00000960
 0063                IF(SCALE.NE.0)  DOL=T/RANGE*SCALE                        00000970
              C   SCALE THE SURFACE TO MAKE A "CUBE".                         00000980
 0064                DO 30 I = 1 , N                                          00000990
 0065                DO 30 J = 1 , M                                          00001000
 0066                A ( I , J ) = ( A ( I , J ) - Z ( 1 ) ) * DOL            00001010
 0067            30 CONTINUE                                                  00001020
 0068                Z(1) = 0.0                                               00001030
 0069                Z(2) = T                                                 00001040
 0070          2080 CALL THREE2  ( X, Y, Z, XP , H , V ,KODE)                 00001050
 0071                DO 2130 I = 1 , 8                                        00001060
 0072                H( I ) = ( (XP(I) - QX ) * SM - (  H(I) - QY ) * SL ) * SD 00001070
 0073                V ( I ) = (  V( I ) - QZ ) * SD                          00001080
 0074          2130 CONTINUE                                                  00001090
 0075          2100 H(10)=H(1)
 0076               H(9)=H(1)
 0077               DO 1001 J=1,8
 0078               H(9)=AMIN1(H(9),H(J))
 0079               H(10)=AMAX1(H(10),H(J))
 0080          1001 CONTINUE
 0081          2120 V(9)=V(1)
 0082               V(10)=V(1)
 0083               DO 1002 J=1,8
 0084               V(9)=AMIN1(V(9),V(J))
 0085               V(10)=AMAX1(V(10),V(J))
 0086          1002 CONTINUE
 0087               IF( MGN .EQ. 0) GO TO 2140                                00001120
```

```
0088             S=HV                                                              00001130
0089             IF(MGN .EQ. 1) S=1.5                                              00001140
0090             SH = S/ (H(10)-H(9) )                                             00001150
0091             SV = S/ (V(10)-V(9) )                                             00001160
0092             SH = SIGN( AMIN1(SH,SV),SH )                                      00001170
0093             SV = SIGN(SH,SV)                                                  00001180
0094             IF(MGN .EQ. 1)CALL PLOT (0.,2.,-3)                                00001190
0095             CALL SYMBOL((H(1)-H(9))*SH,(V(1)-V(9))*SV,.14,'O',0.,1)           00001200
0096             CALL SYMBOL((H(3)-H(9))*SH,(V(3)-V(9))*SV,.14,'M',0.,1)           00001210
0097             CALL SYMBOL((H(2)-H(9))*SH,(V(2)-V(9))*SV,.14,'Z',0.,1)           00001220
0098             CALL SYMBOL((H(5)-H(9))*SH,(V(5)-V(9))*SV,.14,'N',0.,1)           00001230
0099              CALL PLOT(.03,.05,-3)                                            00001240
0100             CALL PLOT ( (H(1)-H(9))*SH, (V(1)-V(9))*SV,3)                     00001250
0101             CALL PLOT ( (H(2)-H(9))*SH, (V(2)-V(9))*SV,2)                     00001260
0102             CALL PLOT ( (H(1)-H(9))*SH, (V(1)-V(9))*SV,2)                     00001270
0103             CALL PLOT ( (H(3)-H(9))*SH, (V(3)-V(9))*SV,2)                     00001280
0104             CALL PLOT ( (H(1)-H(9))*SH, (V(1)-V(9))*SV,2)                     00001290
0105             CALL PLOT ( (H(5)-H(9))*SH, (V(5)-V(9))*SV,2)                     00001300
0106             IF( MGN .EQ. 3) GO TO 2139                                        00001310
0107             CALL PLOT ( (H(6)-H(9))*SH, (V(6)-V(9))*SV,2)                     00001320
0108             CALL PLOT ( (H(2)-H(9))*SH, (V(2)-V(9))*SV,2)                     00001330
0109             CALL PLOT ( (H(4)-H(9))*SH, (V(4)-V(9))*SV,2)                     00001340
0110             CALL PLOT ( (H(3)-H(9))*SH, (V(3)-V(9))*SV,2)                     00001350
0111             CALL PLOT ( (H(7)-H(9))*SH, (V(7)-V(9))*SV,2)                     00001360
0112             CALL PLOT ( (H(5)-H(9))*SH, (V(5)-V(9))*SV,2)                     00001370
0113             CALL PLOT ( (H(6)-H(9))*SH, (V(6)-V(9))*SV,2)                     00001380
0114             CALL PLOT ( (H(8)-H(9))*SH, (V(8)-V(9))*SV,2)                     00001390
0115             CALL PLOT ( (H(4)-H(9))*SH, (V(4)-V(9))*SV,2)                     00001400
0116             CALL PLOT ( (H(8)-H(9))*SH, (V(8)-V(9))*SV,2)                     00001410
0117             CALL PLOT ( (H(7)-H(9))*SH, (V(7)-V(9))*SV,2)                     00001420
0118        2139  IF(MG .NE. 1) GO TO 2140                                         00001430
0119             CALL PLOT (AINT((H(10)-H(9))*SH+2.),-2.05,23)                     00001440
0120        2140 CALL THREE3(X,Y,N,M,H,V,K,KODE)
0121        2150 CONTINUE                                                          00001460
0122               LL PLOT(16.,0.,23)
0123             CALL ZIP(3,3,18)
0124               RETURN                                                          00001470
0125             END                                                               00001480
```

```
0001                 SUBROUTINE THREE2 ( X, Y, Z, XP , H , V ,KODE)                 00001670
           C FIND THE CORNERS OF THE ROTATED CUBE.                                   00001680
           C                                                                         00001690
0002                  DIMENSION X(2),Y(2),Z(2),H(10),V(10),XP(8)                     00001700
           C                                                                         00001710
0003         050  L = 0                                                              00001720
0004         070  DO 180 I = 1, 2                                                    00001730
           C                                                                         00001740
0005         090   DO 170 J = 1, 2                                                   00001750
           C                                                                         00001760
0006         110    DO 160 K = 1, 2                                                  00001770
           C                                                                         00001780
0007         130    L = L + 1                                                        00001790
0008         140    CALL THREE4 ( X(I), Y(J), Z(K), XP( L ),                         00001800
               1      H(L) , V( L ),KODE )                                           00001810
0009         160 CONTINUE                                                            00001820
0010         170 CONTINUE                                                            00001830
0011         180 CONTINUE                                                            00001840
0012         190 RETURN                                                              00001850
0013              END                                                                00001860
```

```
DOS FORTRAN IV 360N-FO-479 3-9         THREE4             DATE   03/02/77     TIME    10.02.00

 0001                 SUBROUTINE THREE4 ( X, Y, Z, XP , YP , ZP ,KODE)                   00001870
            C  FIND THE LOCATION OF A POINT IN THE ROTATED CUBE.                           00001880
 0002                 COMMON /THREE6/ ANGA , ANGB , HV , D, SH,SV                          00001890
 0003                 COMMON /THREE7/SL , SM , SN , CX , CY , CZ , QX , QY , QZ , SD      00001900
 0004                 SK = D / (  (X - CX ) * SL + ( Y - CY ) * SM + ( Z - CZ ) *SN)      00001910
 0005                 XP = CX + SK * ( X - CX )                                            00001920
 0006                 YP = CY + SK * ( Y - CY )                                            00001930
 0007                 ZP = CZ + SK * ( Z - CZ )                                            00001940
 0008                          RETURN                                                      00001950
 0009                                       END                                            00001960
```

```
 0001               SUBROUTINE THREE3 (X,Y,N,M,H,V,K,KODE)                               00001970
          C  DRAW THE FIGURE.                                                            00001980
 0002                COMMON /THREE6/ ANGA , ANGB , HV , D, SH,SV                         00001990
 0003                COMMON /THREE7/S1,SM,SN,CX,CY,CZ,QX,QY,QZ,SD                        00002000
          C                                                                              00002010
 0004                DIMENSION X(2),Y(2),H(10),V(10),A(151,151)                          00002020
 0005                COMMON /ARRAY/ A                                                    00002025
 0006                INTEGER UP , DOWN , PEN , P , Q                                     00002030
 0007                  INTEGER P1 , P0                                                   00002040
          C                                                                              00002050
          C                                                                              00002070
 0008                     END = 1.0 / 16.0                                               00002080
          C  CAN USE 1 / 32 OR  1 / 64 FOR FINER INTERPOLATION                           00002090
          C                                                                              00002100
          C                                                                              00002110
 0009                UP   = 3                                                            00002120
 0010                DOWN = 2                                                            00002130
 0011                SH =  HV / ( H ( 10 ) - H ( 9 ) )                                   00002140
 0012                SV = HV / ( V ( 10 ) - V ( 9 ) )                                    00002150
 0013                SH = SIGN(AMIN1(SH,SV),SH)                                          00002160
 0014                SV = SIGN(SH,SV)                                                    00002170
 0015                 MM = M                                                             00002180
 0016                 NN = N                                                             00002190
          C 080 IF(K-1) 100,120,100
          C                                                                              00002210
          C 100 IF(K-3) 1110,120,1110
          C                                                                              00002230
          C  DRAW LINES ALONG THE Y-AXIS                                                 00002240
 0017         120 CONTINUE                                                               00002250
 0018                L = 0                                                               00002260
 0019                LD = 1                                                              00002270
 0020                  DD = 0.5 * LD                                                     00002280
          C                                                                              00002290
 0021         140  DO 1060 J = 1, M                                                      00002300
 0022                Q    = 0                                                            00002310
 0023                YJ = J                                                              00002320
 0024         160  DO 1030 I = 1, NN                                                     00002330
          C                                                                              00002340
```

```
              L = L + LD                                                 00002350
            XI = L                                                       00002360
           CALL THREE5 (    XI ,YJ , N , M , P ,KODE)                    00002370
            PEN = UP                                                     00002380
               IF ( P ) 510 , 520 , 530                                  00002390
      510 CONTINUE                                                       00002400
             IF ( Q ) 540 , 550 , 540                                    00002410
      520 CONTINUE                                                       00002420
             IF ( Q ) 610 , 1020 , 610                                   00002430
      530  CONTINUE                                                      00002440
             IF ( Q ) 540 , 550 , 540                                    00002450
      540  CONTINUE                                                      00002460
            PEN = DOWN                                                   00002470
           GO TO 170                                                     00002480
      550  CONTINUE                                                      00002490
              IF ( I .EQ. 1 ) GO TO 170                                  00002500
             DI = DD                                                     00002510
           TO = L - LD                                                   00002520
             T = TO + DI                                                 00002530
             P1 = P                                                      00002540
      560  IF (  ABS( DI )  .LT.  END  )  GO TO 570                      00002550
           CALL THREE5 (T,YJ,N,M,PO,KODE)
             DI = DI * 0.5                                               00002570
            IF ( PO  .EQ.  0  )  GO TO 565                               00002580
              TO = T                                                     00002590
             P1 = PO                                                     00002600
             T =  T - DI                                                 00002610
             GO TO 560                                                   00002620
      565  T = T + DI                                                    00002630
             GO TO 560                                                   00002640
      570  CONTINUE                                                      00002650
            T = TO                                                       00002660
           IF ( P1 * P  )  170 , 170 , 580                               00002670
      580 CONTINUE                                                       00002680
      590 CONTINUE                                                       00002690
           ZP = A(L-LD,J)+(T-L+LD)*(A(L,J)-A(L-LD,J))/LD                 00002700
           CALL  THREE4(T,YJ,ZP,XP,HH,VV,KODE)                           00002710
            HH = ( ( XP-OX)*SM- (HH - OY )*SL ) * SO                     00002720
```

```
0063              VV =  ( VV - OZ ) * SD                                         00002730
0064               HH = ( HH - H(9) ) * SH                                       00002740
0065               VV = ( VV - V(9) ) * SV                                       00002750
0066               CALL PLOT ( HH , VV , PEN )                                   00002760
0067        600   PEN = 5 - PEN                                                  00002770
0068              GO TO 170                                                      00002780
0069        610 CONTINUE                                                         00002790
0070                PEN = DOWN                                                   00002800
0071                 DI = DD                                                     00002810
0072               TO = L - LD                                                   00002820
0073              T = TO + DI                                                    00002830
0074                 P1 = Q                                                      00002840
0075        620   IF ( ABS( DI )  .LT.  END  )  GO TO 630                        00002850
0076             CALL THREE5 (T,YJ,N,M,PO,KODE)
0077              DI = DI * 0.5                                                  00002870
0078               IF ( PO  .EQ.  0  )  GO TO 625                                00002880
0079               TO = T                                                        00002890
0080              P1 = PO                                                        00002900
0081              T = T + DI                                                     00002910
0082               GO TO 620                                                     00002920
0083        625    T = T - DI                                                    00002930
0084                 GO TO 620                                                   00002940
0085        630    CONTINUE                                                      00002950
0086               T = TO                                                        00002960
0087                 IF (  P1 * Q )  600 , 600 , 590                             00002970
0088        170     CALL THREE4 ( XT , YJ , A( L, J ), XP , HH ,VV ,KODE)        00002980
0089              VV =  ( VV - OZ ) * SD                                         00002990
0090              HH = ( ( XP-QX)*SM- (HH - QY )*SL ) * SD                       00003000
0091        190     HH = ( HH - H(9) ) * SH                                      00003010
0092        200     VV = ( VV - V(9) ) * SV                                      00003020
0093              CALL PLOT (  HH , VV , PEN )                                   00003030
0094       1020   Q = P                                                          00003040
           C                                                                     00003060
           C                                                                     00003070
0095              L = L + LD                                                     00003080
0096       1030   CONTINUE                                                       00003050
0097              LD = -LD                                                       00003090
0098                 DD =-DD                                                     00003100
```

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              C                                                                         00003110
 0099          1060 CONTINUE                                                            00003120
              C                                                                         00003130
              C                                                                         00003140
              C1090 IF(K-3) 2060,1110,2060
              C                                                                         00003160
              C  DRAW LINES ALONG THE X-AXIS.                                           00003170
 0100          1110 CONTINUE                                                            00003180
              C                                                                         00003190
 0101               L = 0                                                               00003200
 0102               LD = 1                                                              00003210
 0103                 DD = 0.5 * LD                                                     00003220
 0104          1140 DO 2040 I = 1 , N                                                   00003230
 0105                    XI = I                                                         00003240
 0106                 Q = 0                                                             00003250
 0107          1160     DO 2020 J = 1 , MM                                              00003260
 0108                          L = L + LD                                               00003270
 0109                        YJ = L                                                     00003280
 0110               CALL THREES (XI,YJ,N,M,P,KODE)
 0111                 PEN = UP                                                          00003300
 0112                       IF ( P ) 1510 , 1520 , 1530                                 00003310
 0113          1510 CONTINUE                                                            00003320
 0114                    IF ( Q ) 1540 , 1550 , 1540                                    00003330
 0115          1520   CONTINUE                                                          00003340
 0116                   IF ( Q )  1610 , 2010 , 1610                                    00003350
 0117         1530   CONTINUE                                                           00003360
 0118                     IF ( Q ) 1540 , 1550 , 1540                                   00003370
 0119          1540   CONTINUE                                                          00003380
 0120                   PEN = DOWN                                                      00003390
 0121                  GO TO 1170                                                       00003400
 0122          1550       CONTINUE                                                      00003410
 0123                  IF ( J .EQ.  1  )  GO TO 1170                                    00003420
 0124                   DI = DD                                                         00003430
 0125               T0=L-LD
 0126                T = T0 + DI                                                        00003450
 0127                PI = Q                                                             00003460
 0128          1560  IF (  ABS( DI )  .LT.  END  )  GO TO 1570                          00003470
 0129               CALL THREES (XI,T,N,M,PO,KODE)
```

```
                DI = DI * 0.5                                                     00003490
              IF ( PO  .EQ.  0  )  GO TO 1565                                     00003500
                TO = T                                                            00003510
               PI = PO                                                            00003520
               T =  T - DI                                                        00003530
                GO TO 1560                                                        00003540
          1565 T = T + DI                                                         00003550
                 GO TO 1560                                                       00003560
          1570   CONTINUE                                                         00003570
               T = TO                                                             00003580
              IF ( PI * P  )  1170 , 1170 , 1580                                  00003590
          1580 CONTINUE                                                           00003600
          1590 CONTINUE                                                           00003610
              ZP=A(I,L-LD) + (T-L+LD) * (A(I,L) - A(I,L-LD))/LD                   00003620
                 CALL THREE4 ( XI , T , ZP , XP,HH,VV ,KODE)                      00003630
              HH = ( ( XP-OX)*SM- (HH - OY )*SL ) * SD                            00003640
              VV =  ( VV - OZ ) * SD                                              00003650
                HH = ( HH - H(9) ) * SH                                           00003660
                VV = ( VV - V(9) ) * SV                                           00003670
               CALL PLOT ( HH , VV , PEN )                                        00003680
          1600 PEN = 5 - PEN                                                      00003690
                GO TO 1170                                                        00003700
          1610  CONTINUE                                                          00003710
                 PEN = DOWN                                                       00003720
                  DI = DD                                                         00003730
                TO = L - LD                                                       00003740
               T = TO + DI                                                        00003750
                   PI = 0                                                         00003760
          1620  IF ( ABS( DI )  .LT.  END  )  GO TO 1630                          00003770
              CALL THREE5 (XI,T,N,M,PO,KODE)
                 DI = DI * 0.5                                                    00003790
                IF ( PO .EQ. 0 )  GO TO 1625                                      00003800
                 TO = T                                                           00003810
               PI = PO                                                            00003820
                T = T + DI                                                        00003830
                GO TO 1620                                                        00003840
          1625   T = T - DI                                                       00003850
                 GO TO 1620                                                       00003860
```

```
 0168        1630    CONTINUE                                                 00003870
 0169                 T = TO                                                  00003880
 0170                 IF ( PI * Q ) 1600 , 1600 , 1590                        00003890
 0171        1170   CALL THREE4 ( XI, YJ, A( I, L ), XP , HH ,VV ,KODE)       00003900
 0172               HH = ( ( XP-QX)*SM- (HH - QY )*SL ) * SD                  00003910
 0173               VV =  ( VV - QZ ) * SD                                    00003920
 0174        1180      HH = ( HH - H(9) ) * SH                                00003930
 0175        1190      VV = ( VV - V(9) ) * SV                                00003940
 0176                 CALL PLOT (  HH , VV ,  PEN  )                          00003950
 0177        2010   Q = P                                                     00003960
 0178        2020    CONTINUE                                                 00003970
            C                                                                 00003980
 0179               L = L + LD                                                00003990
 0180               LD = - LD                                                 00004000
 0181                  DD =-DD                                                00004010
 0182        2040   CONTINUE                                                  00004020
            C                                                                 00004030
 0183        2060 CONTINUE                                                    00004040
            C                                                                 00004050
 0184        2130   RETURN                                                    00004060
 0185                 END                                                     00004070
```

```
C
C
C          SUBROUTINE THREE5
C
C
C          PURPOSE: TO SEE IF A POINT ON THE PROJECTED THREE DIMENSIONAL
C          FIGURE IS VISIBLE.
C
C
C          USAGE:
C
C          CALL THREE5(XI,YJ,M,N,P,KODE)
C
C
C          DESCRIPTION OF PARAMETERS:
C
C
C          XI       - ABSCISSA OF THE PROJECTED POINT
C
C          YJ       - ORDINATE OF THE PROJECTED POINT
C
C          M        - NUMBER OF HORIZONTAL POINTS
C
C          N        - NUMBER OF VERTICAL POINTS
C
C          P        - PLOT CODE;  IF P = -1  INVISIBLE TO VISIBLE
C                                     1  VISIBLE TO INVISIBLE
C                                     0  VISIBLE TO VISIBLE OR
C                                        INVISIBLE TO INVISIBLE.
C
C          KODE     - HIDDEN LINE CODE  (SEE SUBROUTINE PLOT3)
C
C
C
C          COMMON BLOCKS REQUIRED:
C
C          COMMON /ARRAY/ A
C          COMMON /THREE6/ ANGA,ANGB,HV,D,SH,SV
```

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DOS FORTRAN IV 360N-FO-479 3-9          MAINPGM            DATE   03/02/77     TIME    10.02.30
          C         COMMON /THREE7/ SL,SM,SN,CX,CY,CZ,QX,QY,QZ,SD
          C
          C
          C         SUBROUTINE AND FUNCTION SUBPROGRAMS REQUIRED:NONE.
          C
          C
          C
                  SUBROUTINE THREE5 (XI,YJ,M,N,P,KODE)
                  DIMENSION Z(151,151)
                   COMMON /THREE6/ ANGA , ANGB , HV , D, SH,SV                      00004100
                  COMMON /THREE7/SL,SM,SN,CX,CY,CZ,QX,QY,QZ,SD                      00004110
                  COMMON /ARRAY/ Z
                   INTEGER  CUM , CNT , P                                           00004120
                     REAL I , J , II , JJ                                           00004130
                  IF( KODE .EQ. 1) GO TO 78                                         00004150
                  IR = XI                                                           00004160
                  JC = YJ                                                           00004170
                    ZB = Z ( IR , JC )                                              00004180
                  IF (  XI  .EQ.  IR  )  GO TO 2                                    00004190
                   ZB = Z(IR ,JC ) + ( XI - IR) * (Z(IR + 1 , JC ) - Z( IR ,JC))    00004200
                      GO TO 4                                                       00004210
                2  IF ( YJ .EQ.  JC )         GO TO 4                               00004220
                   ZB = Z(IR , JC) + (YJ-JC)*(Z(IR,JC+1) - Z(IR,JC ))               00004230
                4  CONTINUE                                                         00004240
                   XEND = 0.0                                                       00004250
                   DX = 0.0                                                         00004260
                   YMULT = 0.0                                                      00004270
                   ZMULT = 0.0                                                      00004280
                     IF (XI   .EQ.  CX  ) GO TO 10                                  00004290
                  YMULT = (YJ - CY ) /  (XI - CX )                                  00004300
                     ZMULT = ( ZB - CZ ) / ( XI - CX )                              00004310
                  DX = 1.0                                                          00004320
                    XEND = M + 1                                                    00004330
                    IF ( XI  .LT.  CX)  GO TO 10                                    00004340
                    DX = -1.0                                                       00004350
                   XEND = 0.0                                                       00004360
               10 CONTINUE                                                          00004370
                  YEND = 0.0                                                        00004380
```

```
0032                DY = 0.0                                                        00004390
0033                 XMULT = 0.0                                                    00004400
0034                 IF ( YJ  .EQ.  CY  )  GO TO 20                                 00004410
0035                XMULT = ( XI - CX ) / (YJ - CY )                                00004420
0036                 IF (  ZMULT  .EQ.  0.0  )  ZMULT=(ZB - CZ ) / ( YJ - CY )      00004430
0037                DY = 1.0                                                        00004440
0038                YEND = N + 1                                                    00004450
0039                IF ( YJ  .LT.  CY )  GO TO 20                                   00004460
0040                DY = -1.0                                                       00004470
0041                YEND = 0.0                                                      00004480
0042             20 CONTINUE                                                        00004490
0043                SUM = 0                                                         00004500
0044                CNT = 0                                                         00004510
0045                P = 0                                                           00004520
0046                 XB = XI                                                        00004530
0047                YB = YJ                                                         00004540
0048             30 CONTINUE                                                        00004550
0049                II = AINT( XB )                                                 00004560
0050                JJ = AINT( YB )                                                 00004570
0051                XSTEP = DX                                                      00004580
0052                YSTEP = DY                                                      00004590
0053                  IF ( XB  .EQ.  II )  GO TO 40                                 00004600
0054                  IF ( DX  .LT.  0.0 )  XSTEP = 0.0                             00004610
0055                GO TO 45                                                        00004620
0056             40  IF ( YB  .EQ.  JJ )  GO TO 45                                  00004630
0057                  IF ( DY  .LT.  0.0 )  YSTEP = 0.0                             00004640
0058             45 CONTINUE                                                        00004650
0059                  I = II + XSTEP                                                00004660
0060                  J = JJ + YSTEP                                                00004670
0061                  IF ( I  .EQ.  XEND )  GO TO 80                                00004680
0062                  IF ( J  .EQ.  YEND )  GO TO 80                                00004690
0063                XB = CX + XMULT * ( J - CY )                                    00004700
0064                YB = CY + YMULT * ( I - CX )                                    00004710
0065                  IF ( DX  .LT.  0.0 )  GO TO 55                                00004720
0066                  IF ( XB  .LT.  I  )  GO TO 60                                 00004730
0067             50 XB = I                                                          00004740
0068                 GO TO 65                                                       00004750
0069             55 IF ( XB  .LT.  I )  GO TO 50                                    00004760
```

```
     60 YB = J                                                                 00004770
     65  CONTINUE                                                              00004780
        ZB = CZ + ZMULT * ( XB - CX )                                          00004790
        IR = I                                                                 00004800
        JC = J                                                                 00004810
          IF ( YB  .NE.  J )  GO TO 70                                         00004820
         IDX = I - DX                                                          00004830
        ZS = Z( IR, JC ) - DX * ( XB - I ) * (Z(IDX,JC) - Z(IR,JC))            00004840
        GO TO 75                                                               00004850
 70     JDY=J-DY                                                               00004860
        ZS = Z( IR,JC ) - DY * ( YB-J ) * (Z( IR,JDY ) - Z( IR,JC ) )          00004870
     75 CONTINUE                                                               00004880
        SGN = 1                                                                00004890
        IF (  ZB  .LT.  ZS  )  SGN = -1                                        00004900
        CUM = CUM + SGN                                                        00004910
        CNT = CNT + 1                                                          00004920
        IF (  IABS ( CUM)  .EQ.  CNT  )  GO TO 30                              00004930
         GO TO 90                                                              00004940
  78    P=1                                                                    00004950
        GO TO 95                                                               00004960
     80 CONTINUE                                                               00004970
        P = 1                                                                  00004980
            IF ( CUM ) 84 , 86 , 90                                            00004990
     84 P = -1                                                                 00005000
               GO TO 90                                                        00005010
     86  CONTINUE                                                              00005020
                IF ( ZB  .LE.  CZ  )  GO TO 90                                 00005030
         P = -1                                                                00005040
     90  CONTINUE                                                              00005050
  95      RETURN                                                               00005060
        END
```