

## General Disclaimer

### One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

CS84-BMDSC-0018

Contract No. T-9388 J  
CR 171 814  
C. 1

CS84-BMDSC-0018

(NASA-CR-171814) HISTORY OF ON-ORBIT  
SATELLITE FRAGMENTATIONS (Teledyne Brown  
Engineering) 344 p HC A15/MF A01 CSCL 22B

N84-34461

93  
00/15 Unclass  
23258

# HISTORY OF ON-ORBIT SATELLITE FRAGMENTATIONS

## August 1984



Prepared for  
Ballistic Missile Defense Systems Command  
Huntsville, Alabama 35807

THE VIEWS, OPINIONS, AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHOR(S) AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER OFFICIAL DOCUMENTATION.



 **TELEDYNE**  
**BROWN ENGINEERING**

1250 Academy Park Loop, Suite 240  
Colorado Springs, Colorado 80910

**Technical Report**

**History of On-Orbit Satellite Fragmentations**

by

N. L. Johnson

J. R. Gabbard

G. T. DeVere

E. E. Johnson

August 1984

Prepared for

**Ballistic Missile Defense Systems Command  
Huntsville, Alabama 35807**

**Contract No. DASC60-84-C-0005  
CDRL Item A029**

Prepared By

**Teledyne Brown Engineering  
Colorado Springs, Colorado 80910**

## INTRODUCTION

The phenomenon of on-orbit satellite fragmentation was first observed in June 1961 when the Transit 4A rocket body disintegrated into 261 detectable pieces of debris. Since that time there have been more than eighty similar events from 75 parent satellites accounting for over 5,200 cataloged pieces of debris. Today approximately 50% of all the objects currently being tracked by the NORAD Spacetrack Network originated from on-orbit fragmentations.

The causes of on-orbit fragmentations are varied and may be intentional or accidental. For example, a satellite may be deliberately destroyed by an explosive charge as part of a spacecraft test or a rocket stage may suffer a catastrophic propulsion failure. Unfortunately, the cause of many fragmentations remains unknown. While a few cases are currently under investigation as on-orbit collision candidates, man is directly responsible for the vast majority of artificial debris polluting the near-Earth space environment.

The magnitude of each fragmentation (i.e. the number of liberated pieces observed) may also vary substantially. Low altitude rocket stage explosions may result in hundreds of short-lived pieces of debris whereas only a few pieces may be observed in conjunction with much higher fragmented objects. It should be emphasized that the number of fragments listed with each event in this document represent only those debris officially cataloged by NORAD. At low altitude fragmentations many pieces are not cataloged as a result of their high drag rates and quick reentries. For example, although only 31 fragments were cataloged from the break-up of 1982-88A, at least 138 objects were detected by one NORAD radar shortly after the event. Likewise many small objects are believed to be orbiting at higher altitudes as the result of fragmentations above 600 km but are undetectable with the current SPACETRACK network. Finally, some spacecraft


eject several or tens of objects during their normal operational duties; however, these events do not qualify as fragmentations as defined in this document.

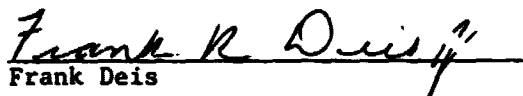
The data compiled in this document originated from several sources: NORAD archives, the Naval Space Surveillance System (NAVSPASUR), the Royal Aircraft Establishment, miscellaneous reports, and in-house technical analyses. Special thanks for their cooperation and guidance are extended to Mr. Preston Landry (Space Command, XPYS) and Mr. D. G. King-Hele (Royal Aircraft Establishment). Whenever possible, the data have been cross-checked. For instance, when a break-up time and location were provided by NAVSPASUR, satellite element sets and fragment distribution curves (Gabbard diagrams) were examined to verify the feasibility of this information. In this way many data base errors were discovered and corrected. Complete information is not available on all events due to the absence of archival data. Indeed documentation of some events is sparse or virtually non-existent.

Each known on-orbit satellite fragmentation is described within this document in module format. The first page is headed by the satellite's international designator, common name, and NORAD Space Surveillance Center (NSSC) control number. Also listed on this page will be pertinent characteristics of each fragmentation event. Page two of each module will contain comments regarding the nature of the satellite and additional details of the event(s) as well as the probable cause of the event. The remaining pages of each module contain plots of debris distributions on Gabbard diagrams and maps indicating the event orbit groundtrack and location of the satellite at the time of the events. The two large symbols on each Gabbard diagram indicate the apogee and perigee of the parent satellite. The reader is cautioned that all orbital parameters on the Gabbard diagrams are not referenced to a single epoch. In some cases when fragment element sets were developed several days or weeks after the event, the effects of atmospheric drag can be observed. Where the precise location of the event is known a satellite symbol on the orbit trace marks this position. In other cases,

only the orbit(s) on which the event probably occurred are provided.

This work was sponsored by the NASA Johnson Space Center with cooperation of USAF Space Command and the U.S. Army Ballistic Missile Command under Contract Number DASG60-84-C-0005.

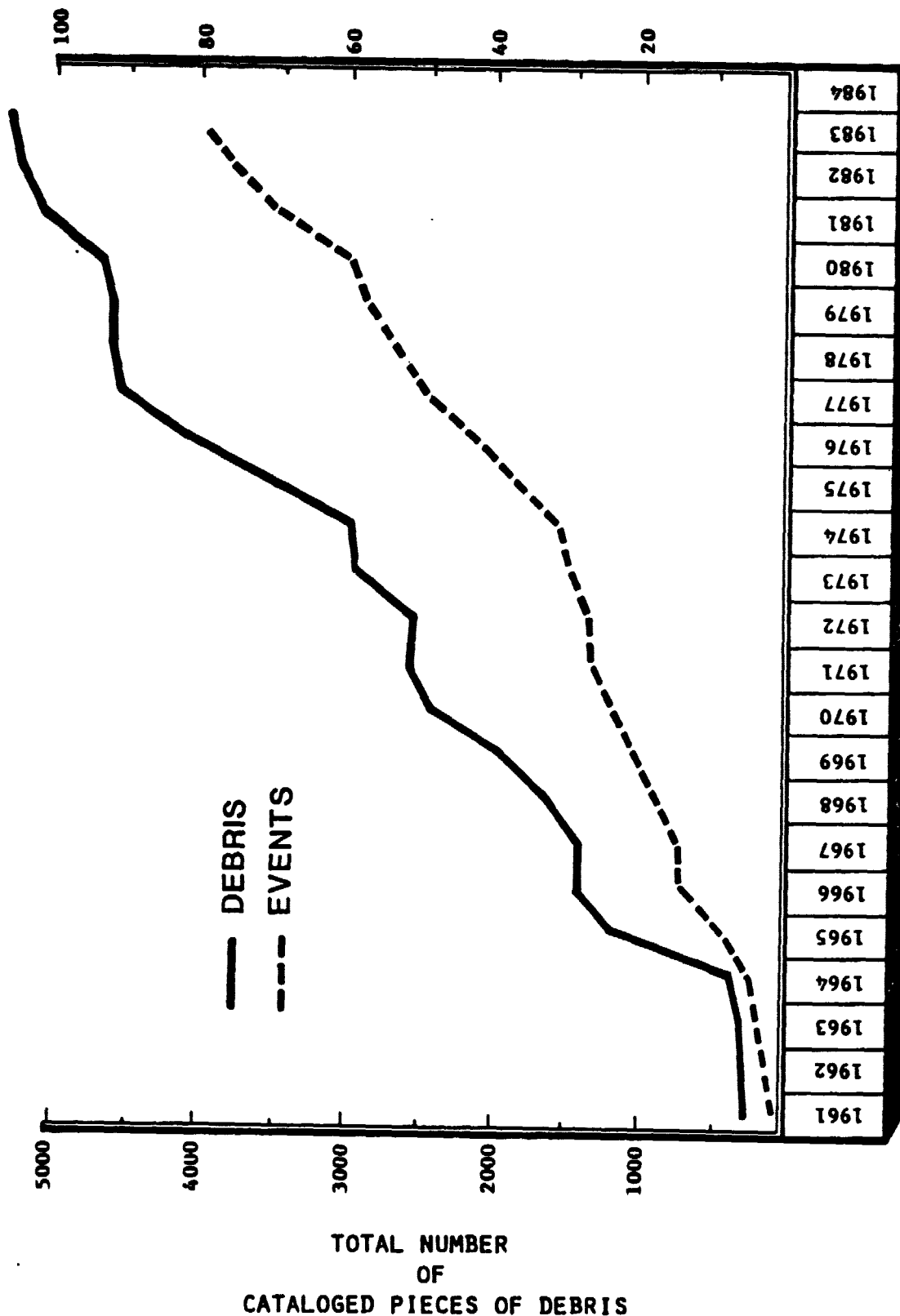
  
Nicholas L. Johnson  
Principal Technologist

  
Frank Deis  
Technical Director  
Colorado Springs Office

# HISTORY OF ON-ORBIT FRAGMENTATIONS

TOTAL NUMBER  
OF  
FRAGMENTATION EVENTS

ORIGINAL PAGE IS  
OF POOR QUALITY

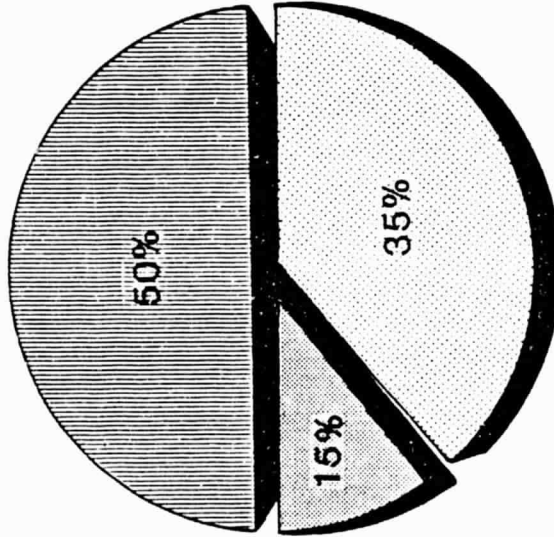


AS OF 1 JANUARY 1984

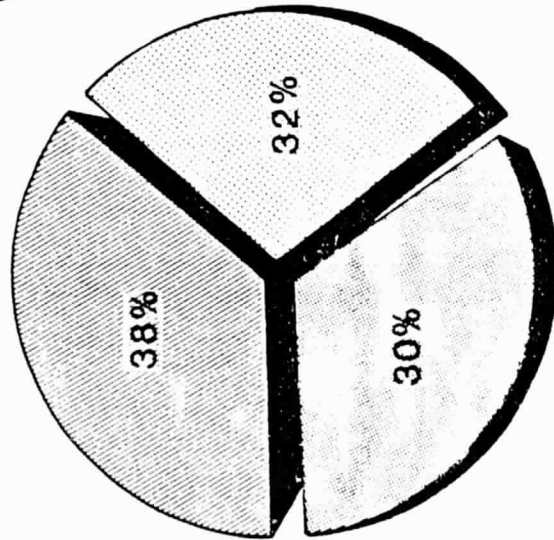
# CAUSES OF ON-ORBIT FRAGMENTATIONS AND DEBRIS

ORIGINAL PAGES  
OF POST 000077

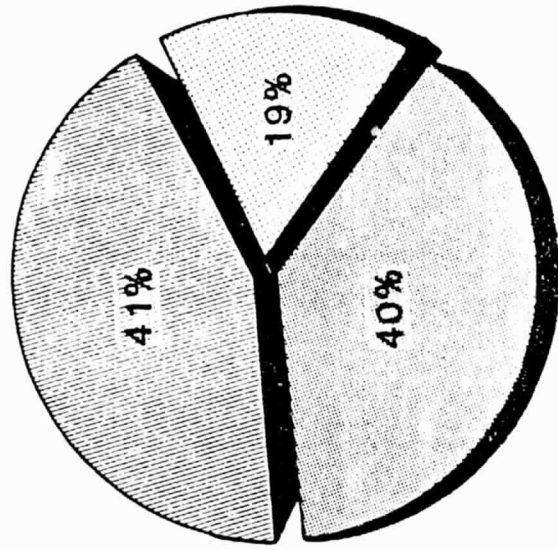
● CAUSES



● DEBRIS CREATED



● DEBRIS IN ORBIT





## Table of Contents

	<u>Page</u>
I. Satellite Fragmentations	1-1
Transit 4A	1-2
Sputnik-29	1-6
Atlas Centaur 2 Rocket	1-10
OPS 4412 R/B	1-14
Cosmos 50	1-18
Cosmos 57	1-22
Cosmos 61-63 Rocket	1-26
Titan 3C-4	1-30
Cosmos 95	1-34
OPS 3031	1-38
ATDA Rocket	1-42
Pageos 1	1-46
AS-203 R/B	1-54
USSR/Unknown 1	1-58
USSR/Unknown 2	1-62
Intelsat 2-F2 Rocket	1-66
Cosmos 248	1-70
Cosmos 249	1-74
Cosmos 252	1-78
Meteor 1/Rocket	1-82

## Table of Contents

	<u>Page</u>
Intelsat 3-F5 R/B	1-86
OPS 7613 R/B	1-90
Nimbus-4 R/B	1-94
Cosmos 374	1-98
Cosmos 375	1-102
Cosmos 397	1-106
Cosmos 462	1-110
Landsat 1 R/B	1-114
Salyut 2 R/B	1-118
Cosmos 554	1-122
NOAA-3 Rocket	1-126
Cosmos 686 R/B	1-130
NOAA-4 R/B	1-134
Cosmos 699	1-138
Landsat 2 Rocket	1-144
GEOS 3 Rocket	1-150
Cosmos 758	1-154
Cosmos 777	1-158
Cosmos 838	1-164
Cosmos 839	1-168
Cosmos 844	1-172
NOAA-5 R/B	1-176
Cosmos 862	1-180
Cosmos 880	1-184

## Table of Contents

	<u>Page</u>
Cosmos 886	1-188
Cosmos 903	1-192
Cosmos 917	1-196
Hinawari R/B	1-200
Cosmos 931	1-204
Cosmos 970	1-208
Landsat 3 R/B	1-212
Cosmos 1030	1-216
Cosmos 1094	1-220
Cosmos 1109	1-224
Cosmos 1124	1-228
Ariane V1	1-232
Cosmos 1167	1-236
Cosmos 1174	1-240
Cosmos 1191	1-244
Cosmos 1220	1-248
Cosmos 1247	1-254
Cosmos 1258	1-258
Cosmos 1260	1-262
Cosmos 1261	1-268
Cosmos 1275	1-272
Cosmos 1285	1-276
Cosmos 1286	1-280
Cosmos 1305	1-284

Table of Contents

	<u>Page</u>
Cosmos 1306	1-288
Cosmos 1317	1-294
Cosmos 1355	1-298
Cosmos 1405	1-306
Cosmos 1423	1-310
Cosmos 1456	1-316
Cosmos 1481	1-320
II. Satellite Fragmentation Summary Table	2-1
III. Other Anomalous Event Summary Table	3-1

**Section I**

**Satellite Fragmentations**

1961-Omicron

TRANSIT 4A ROCKET

116

LAUNCH DATE: 29.18 Jun 1961

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 29 Jun 1961 (DAY 180)

TIME: 060810.0 GMT

LOCATION: 28N, 254E

ALTITUDE: 950 KM

PIECES CATALOGED (1 JAN 84): 261

PIECES STILL IN ORBIT (1 JAN 84): 199

ORBIT CHARACTERISTICS:

INCLINATION: 66.81°

APOGEE: 998 km

PERIGEE: 880 km

PERIOD: 103.8 min

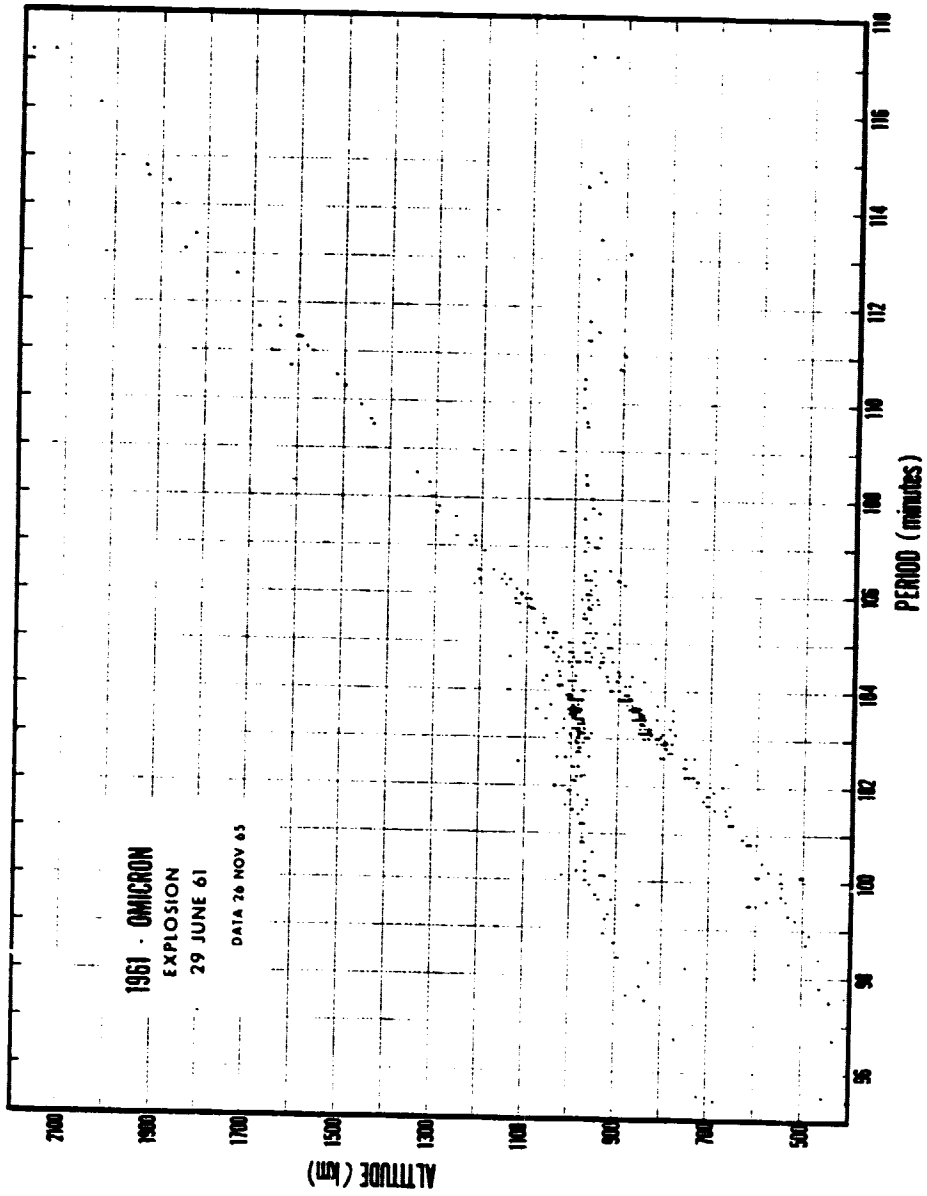
TRUE ANOMALY: 183°

- COMMENTS:
- The Ablestar rocket fragmented before it could be cataloged, therefore, no catalog number was assigned to the rocket.
  - The orbital information given is for one of the payloads, Transit 4A, satellite number 116.
  - No element set is available for the rocket but a "Moonwatch" team headed by Arthur Leonard of Davis, California observed the rocket ahead of the two payloads at 0605:12 GMT, 29 June 1961.
  - Separation between payloads and rocket at 0608:10 GMT was approximately 68 km.
  - The Organ Pass, New Mexico Baker-Nunn camera operated by the Smithsonian took a photograph at 0608:09 which showed three distinct objects which were judged to be the rocket and two payloads (2 of the 3 payloads did not separate). A subsequent frame at 0608:11 continued to show two payloads but in the area where the rocket should have been, a patchy and distributed image was apparent. The next frame at 0608:13 showed the two payloads and the patchy image slightly enlarged.
  - General shape of rocket; cylinder; length 4.8 m; dia. 1.4 m; weight 450 kg.

- CAUSE:
- Potential causes listed by Aerospace Corp., "Transit 4-A Abelstar Vehicle Fragmentation Study" para. 4 are:
    1. Propulsion system valve leakage.
    2. Abnormal electrical system operation.
    3. Meteoric impact.
    4. Command destruct activation.
    5. Other
  - Cited study on file at Teledyne Brown Engineering, Colorado Springs, Colorado.

1961-Omicron

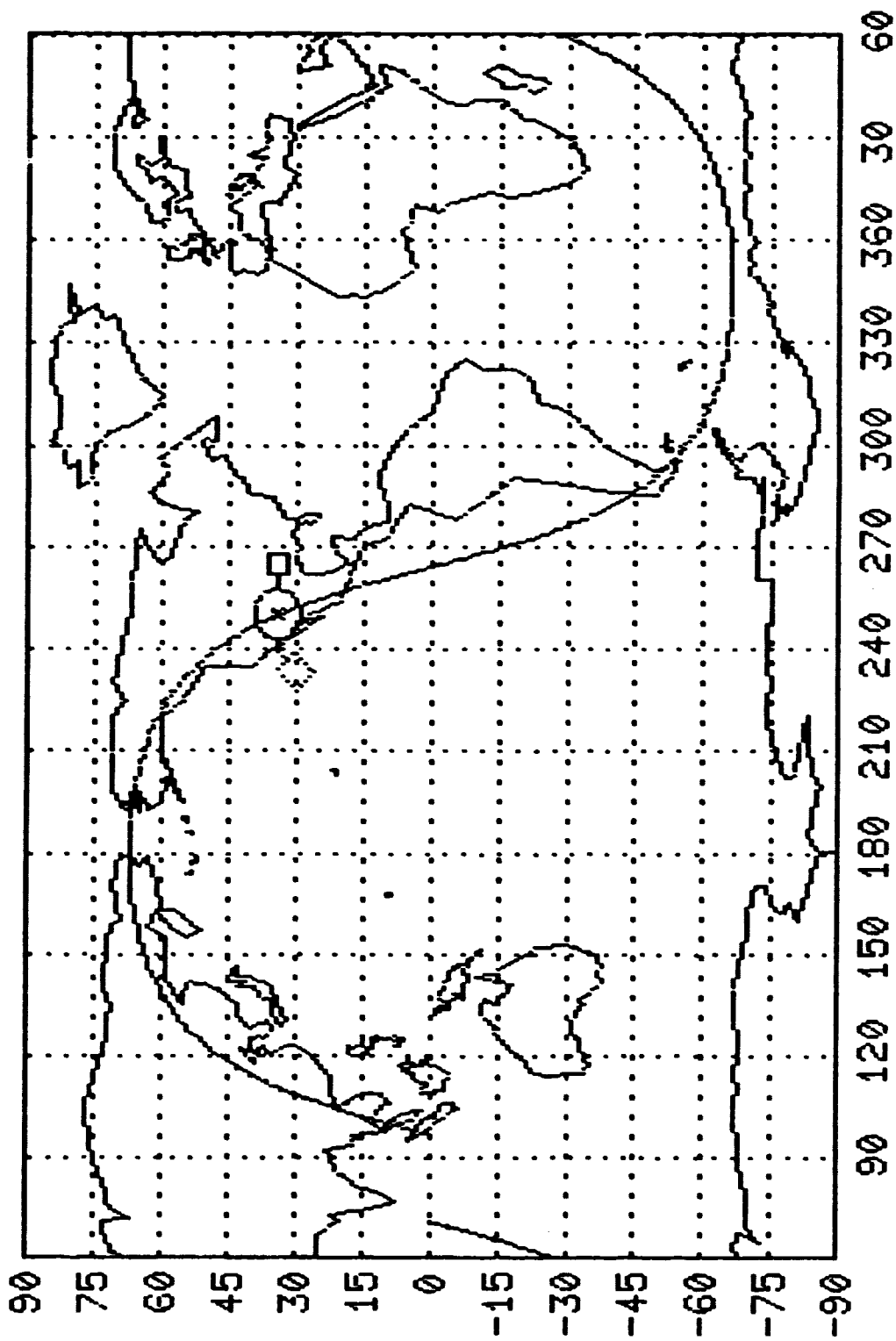
ORIGINAL PAGE IS  
OF POOR QUALITY



TRANSIT 4A R/B



ORIGINAL PAGE IS  
OF POOR QUALITY



TRANSIT 4A R/B

LAUNCH DATE: 24.(75?) Oct 1962

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 29 Oct 1962 (DAY 302)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 23

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.11°

APOGEE: 261 km

PERIGEE: 202 km

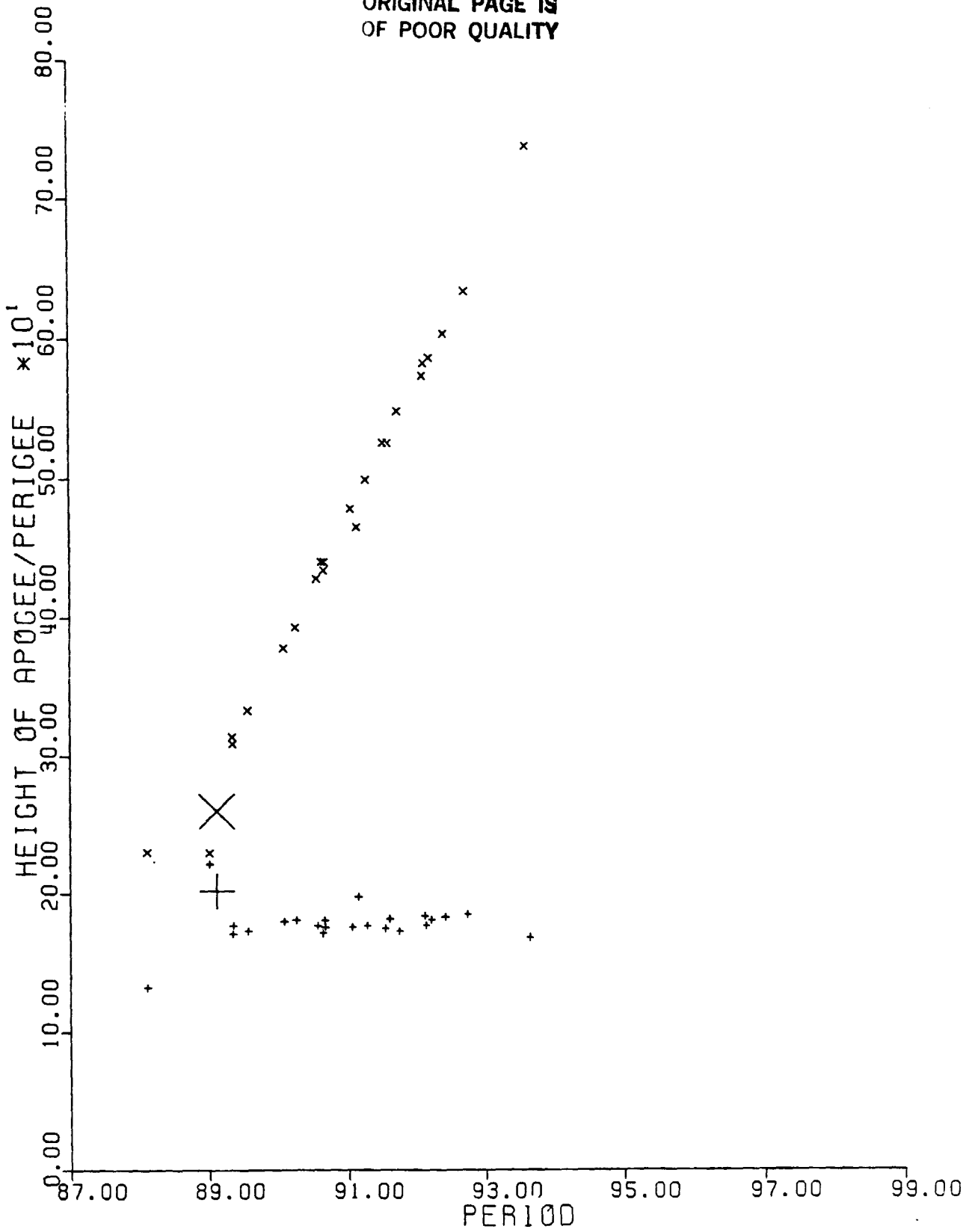
PERIOD: 89.1 min

TRUE ANOMALY:

- COMMENTS:
- Probable Mars probe failure.
  - This launch is also known as Sputnik 22. To-date the USSR has not acknowledged this launch.
  - Orbital characteristics derived from element set #1 of satellite 443.
  - General shape; cylinder; length 7m?; dia. 2m; weight full 6500 kg?
  - Insufficient data available to determine time and location of the event.

CAUSE: Probable propulsion failure during transfer orbit maneuver.

ORIGINAL PAGE IS  
OF POOR QUALITY



SPUTNIK 29

COMMENTS: • Insufficient data to show an appropriate ground track for  
Sputnik 29.

1962-B Iota

1963-47

ATLAS CENTAUR 2 ROCKET

694

LAUNCH DATE: 27.79 Nov 1963

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 27 Nov 1963 (DAY 331)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 14

PIECES STILL IN ORBIT (1 JAN 84): 12

ORBIT CHARACTERISTICS:

INCLINATION: 29.94°

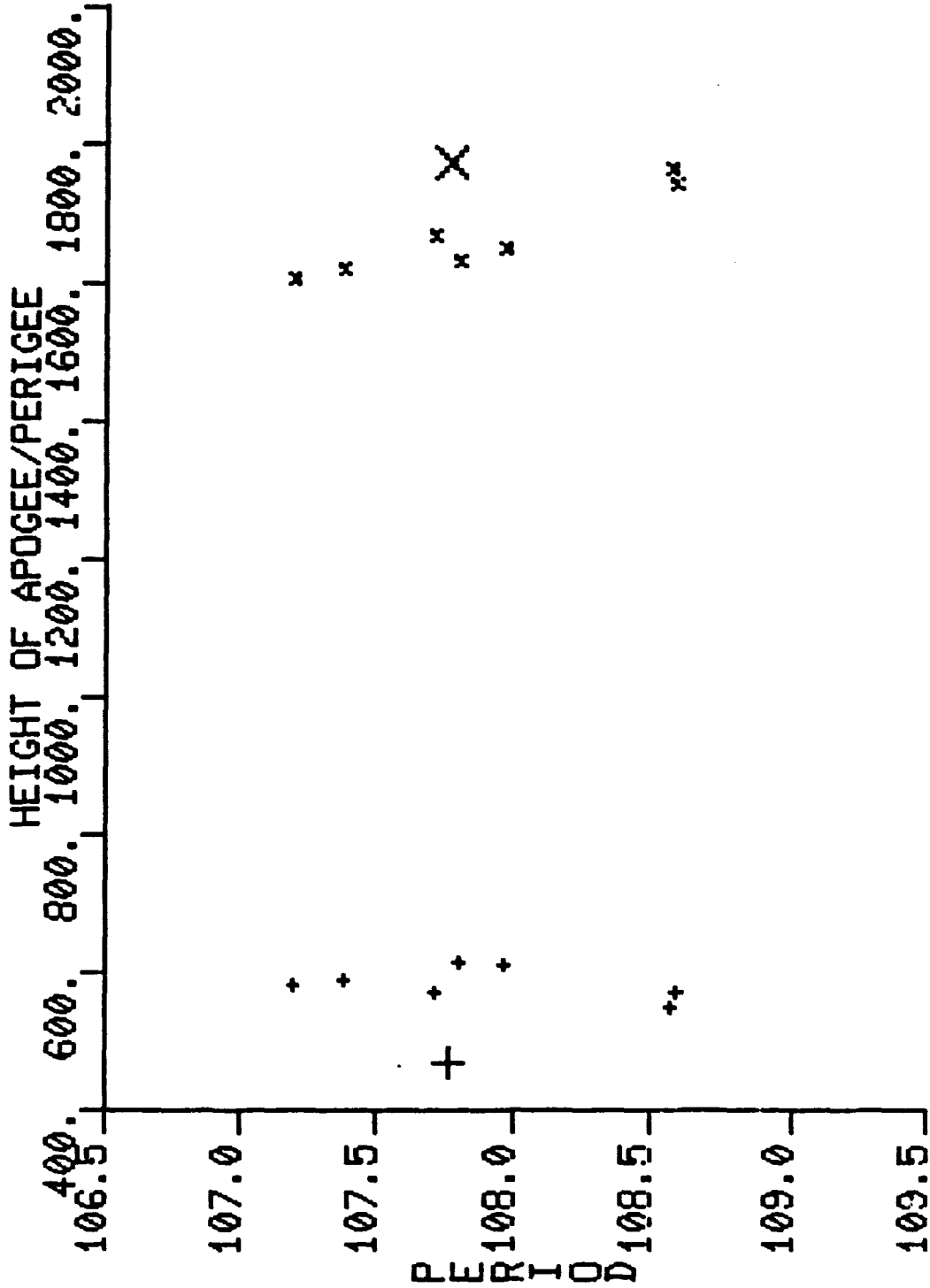
APOGEE: 1735 km

PERIGEE: 502 km

PERIOD: 107.7 min

TRUE ANOMALY:

ORIGINAL PAGE IS  
OF POOR QUALITY



ATLAS CENTAUR 2 ROCKET

COMMENTS:

- Centaur 2nd stage. Length 8.6m; Diameter 3 m. Propellants LH<sub>2</sub>/LOX pump fed. Thrust 13,500 kg total from 2 engines. Weight 4,590 kg empty.
- This satellite is listed as a payload in the NORAD catalog, however, this was the 2nd flight test of the Atlas Centaur and carried no payload. The 1st flight test failed 5-8-62.
- Element set #1 was developed 12 hrs. after launch resulting in an orbit with a period of 99.55 minutes and does not fit with the distribution of the orbits of fragments. Element set #2 results in an orbit with a period of 107.66 minutes and this orbit fits well with the distribution of the orbits of the fragments. Actual orbit manipulations have not been confirmed but is assumed the Centaur thrusted from the first to the second orbit and exploded. One of the fragments was then designated to continue as satellite 694. Element set #2 on 694 (a fragment) was used to develop the orbit characteristics shown.

CAUSE:

Unknown. Assume fuel leak/engine failure.



COMMENTS • Insufficient data available to determine an appropriate ground track for satellite 694.

1963-47

1964-26

OPS 4412 R/B

809

LAUNCH DATE: 4.16 Jun 1964

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: Jan-Feb 1966

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 11

PIECES STILL IN ORBIT (1 JAN 84): 3

ORBIT CHARACTERISTICS:

INCLINATION: 90.5°

APOGEE: 935 km

PERIGEE: 848 km

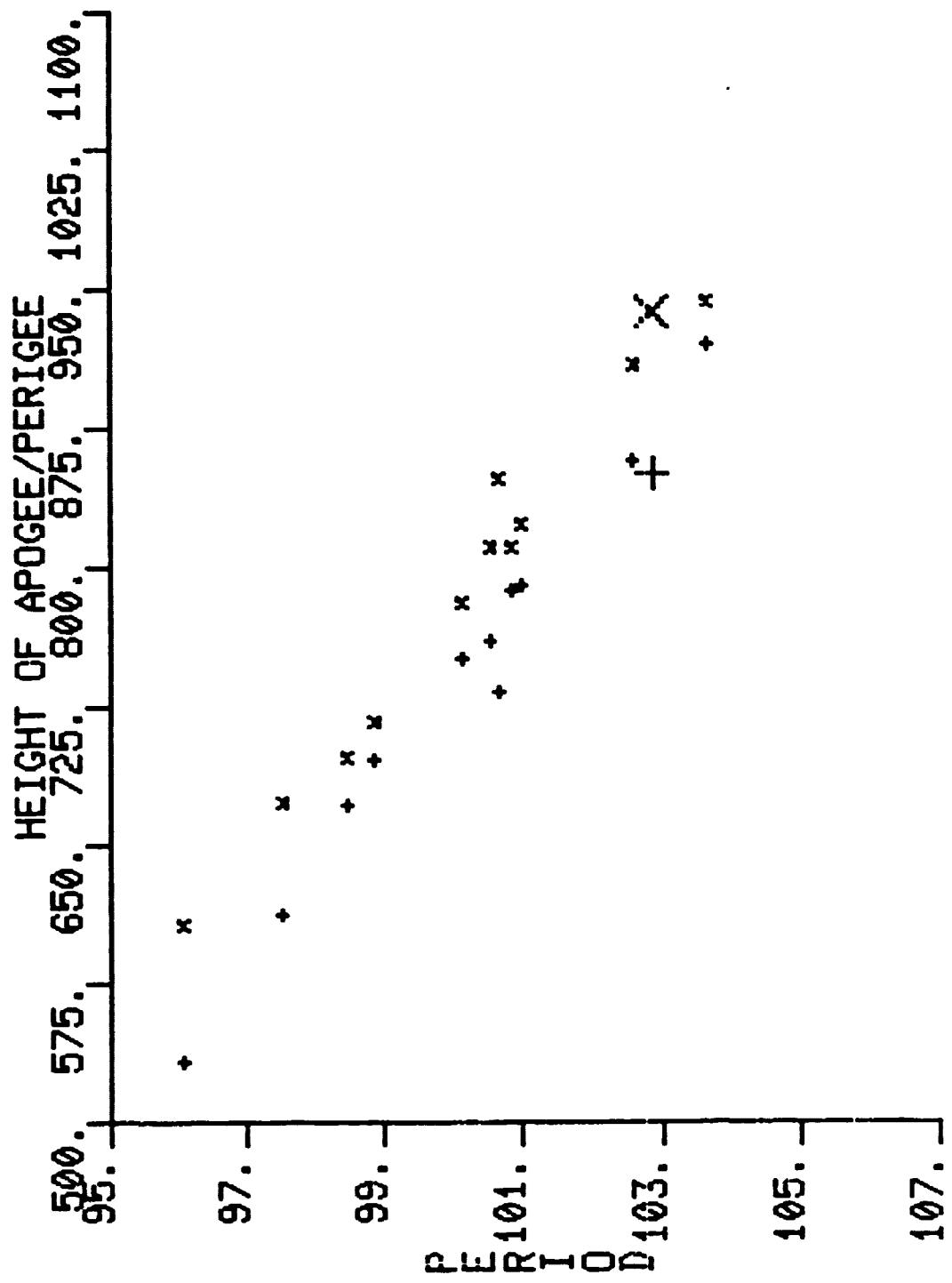
PERIOD: 102.8 km

TRUE ANOMALY:

- COMMENTS:
- Satellite 809 is an assumed parent. It was an Altair rocket; weight 24 kg; length 1.5 m; dia. 0.46 m.
  - Eleven small debris type objects were cataloged at various times among several launches that had taken place long before the small objects were found in space. The orbits of these objects were not in reasonable locations relative to the launches they were cataloged with. The only reasonable association was inclination. Plots of this debris shows systematic trending of the apogees/perigees and the trends fall very close to the payload and rocket of the 64-26 launch. Details leading to this assumed event are recorded in Technical Memorandum 81-6, Directorate of Analysis DCS/ Plans, Programs, Policy and Requirements, Headquarters NORAD/ADCOM, Peterston AFB, Colorado Springs, Colorado.
  - The eleven objects are: 1399, 2086, 2335, 3809, 4587, 5363, 6290, 6372, 7259, 7558, 8000
  - Insufficient data is available to determine the time and location of the assumed event.

CAUSE: Unknown

ORIGINAL PAGE IS  
OF POOR QUALITY



OPS 4412 ROCKET

COMMENTS: • Insufficient data available to determine an appropriate ground track for satellite 809, Ops. 4412.

1964-70

COSMOS 50

919

LAUNCH DATE: 28.45 OCT 1964

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 5 NOV 1964 (DAY 310)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 95

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 51.23°

APOGEE: 233 km

PERIGEE: 188 km

PERIOD: 88.7 min

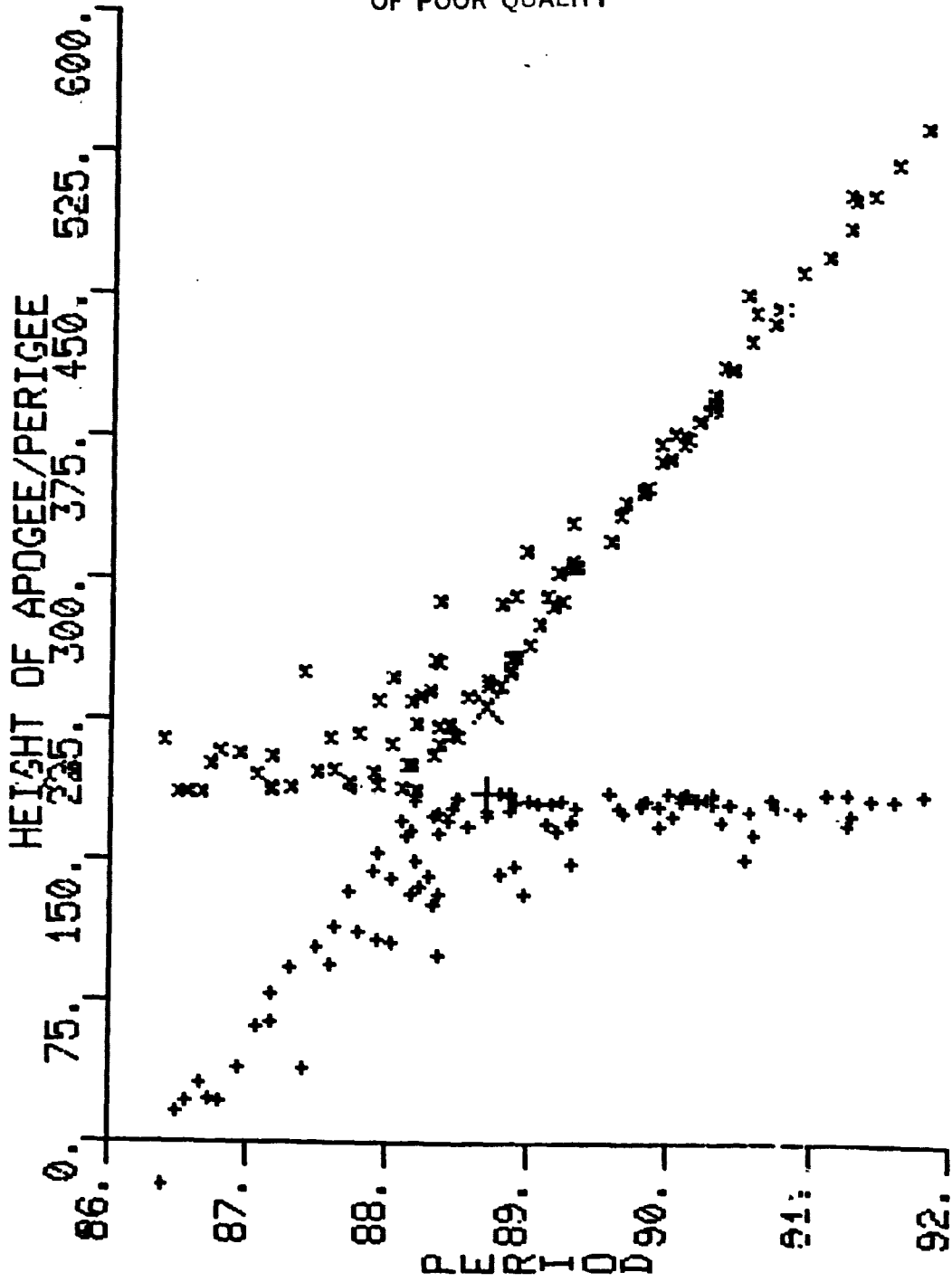
TRUE ANOMALY:

- COMMENTS:
- This payload had a general shape of a sphere-cylinder; length 4.3 m; dia. 2.4 m; weight 4750 kg?
  - The fragmentation was very low in altitude and orbital elements were not developed on any of the fragments. The piece count is an estimate made by the USAF.
  - The orbital data was developed from element set #3 of 919 which had an epoch of 30 Oct 1964. These are the elements nearest the event date that are available.
  - Fragment found in the Mzuzu area of Malawi. See Royal Aircraft Establishment Technical Report No. 65165, August, 1965.

CAUSE: Apparently intentionally detonated due to the failure of satellite 919 to respond to a signal to deorbit.

1964-70

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 50  
SIMULATION



COMMENTS: • Insufficient data available to show an applicable ground trace for satellite 919.

1964-70

1965-12

COSMOS 57

1093

LAUNCH DATE: 22.32 FEB 1965

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 22 Feb 1965 (DAY 53)

TIME: 0957 GMT

LOCATION: 64 S/284 E

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 166

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 64.8°

APOGEE:

PERIGEE:

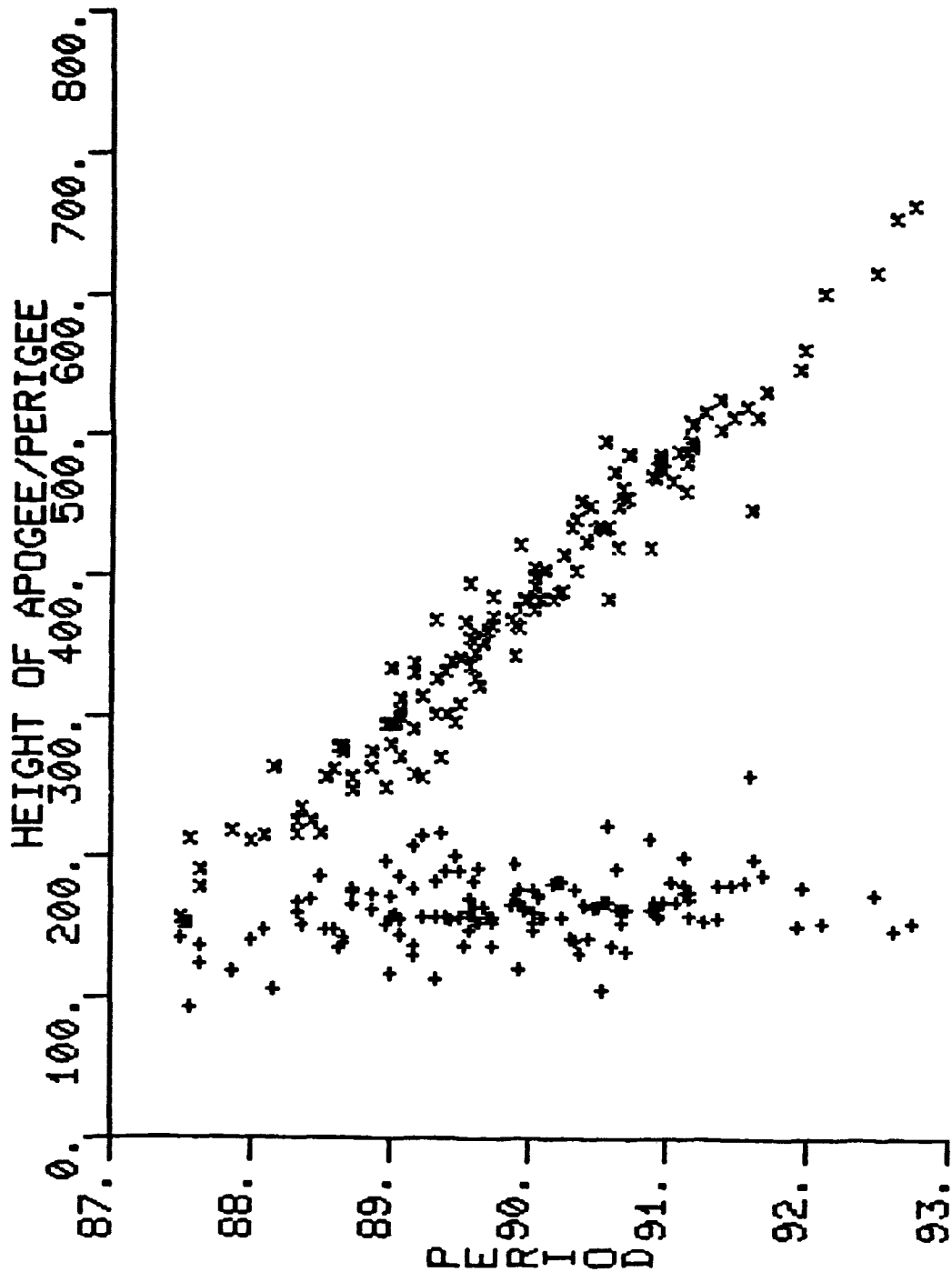
PERIOD:

TRUE ANOMALY:

- COMMENTS:**
- Payload had a general shape of spheric-cylinder; length 6 m; dia. 2.4 m; weight 5,500 kg?
  - This was an unmanned Voskhod test flight.
  - 34 of the cataloged objects were cataloged with "no initial elements." This count is an USAF estimate of very low orbiting pieces that could not be tracked enough to develop elements.
  - A "BMEWS-ADC Systems Engineering Memorandum," dated 16 June 1965, discusses this event. This document is on file at Teledyne Brown Engineering, Colorado Springs, Colorado office.
  - Satellite 1093 fragmented approximately  $1\frac{1}{2}$  revolutions after launch.
  - Orbit at the time of break-up is unknown as a result of maneuvers prior to the event.

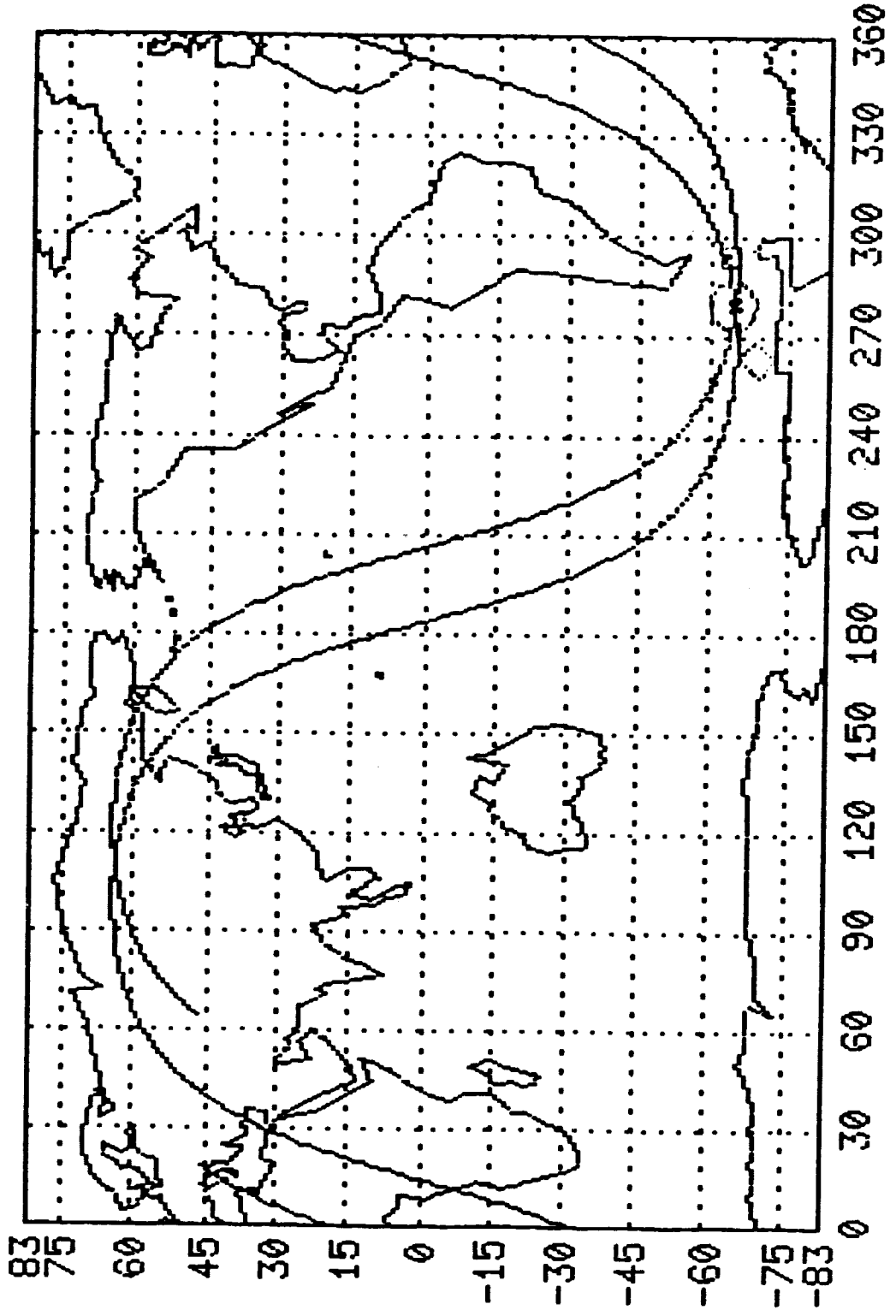
**CAUSE:** Unknown

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 57

ORIGINATOR'S NAME  
OF PROGRAM/PROJECT



COSMOS 57

1965-20

COSMOS 61- 63 ROCKET

1270

LAUNCH DATE: 15.46 Mar 1965

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 15 Mar 1965 (DAY 74)

TIME: 171350.0 GMT

LOCATION: 51 S/162 E

ALTITUDE: 1639 km

PIECES CATALOGED (1 JAN 84): 147

PIECES STILL IN ORBIT (1 JAN 84): 26

ORBIT CHARACTERISTICS:

INCLINATION: 56.05°

APOGEE: 1827 km

PERIGEE: 260 km

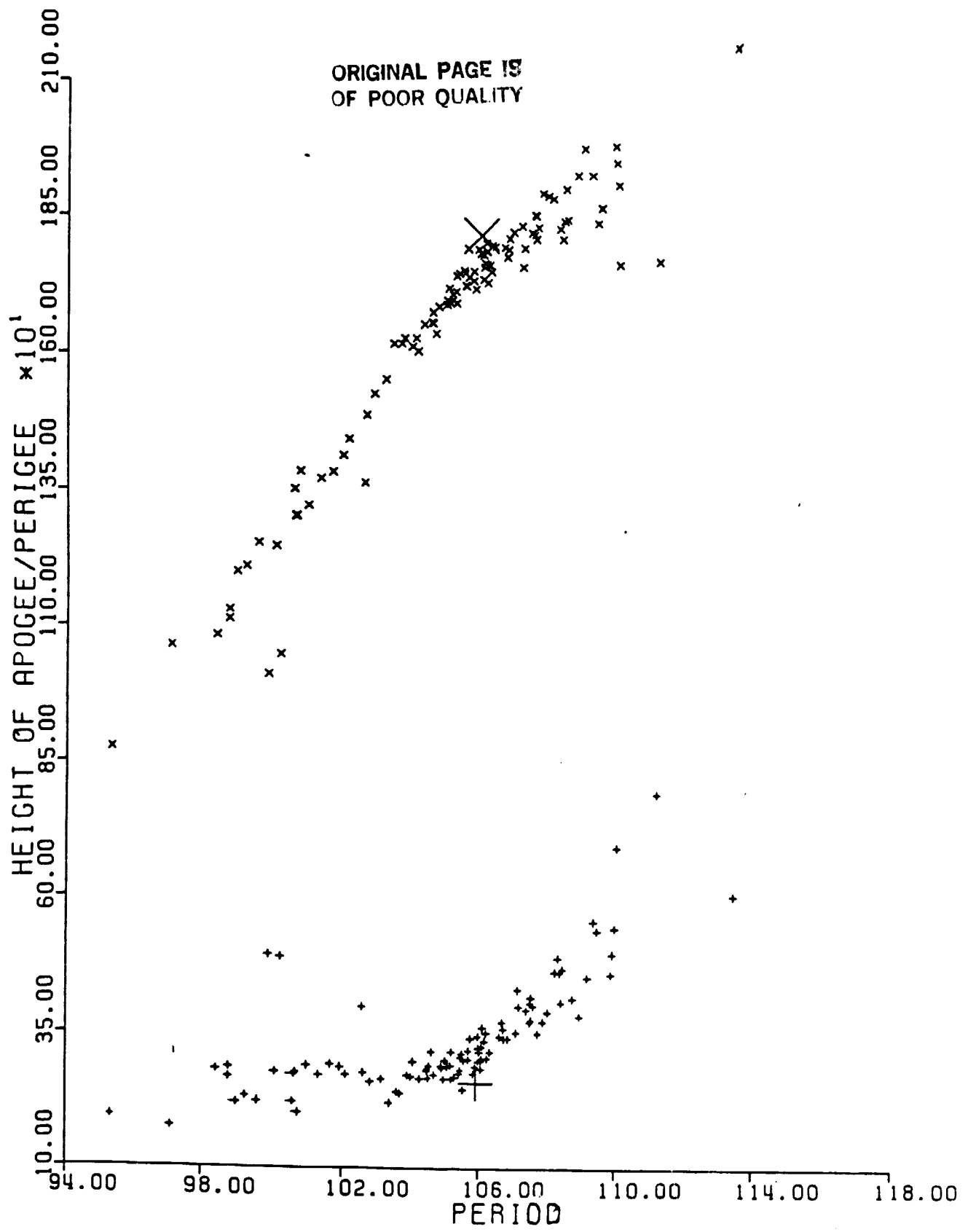
PERIOD: 106.0 min

TRUE ANOMALY: 143 °

- COMMENTS:**
- General shape was cylindrical; length 7.4 m; dia. 2.4 m; weight 2200 kg?
  - This was the third triple payload launch by the USSR. It was a communications satellite test launch.
  - Orbit characteristics were derived from element set #1 satellite 1270.

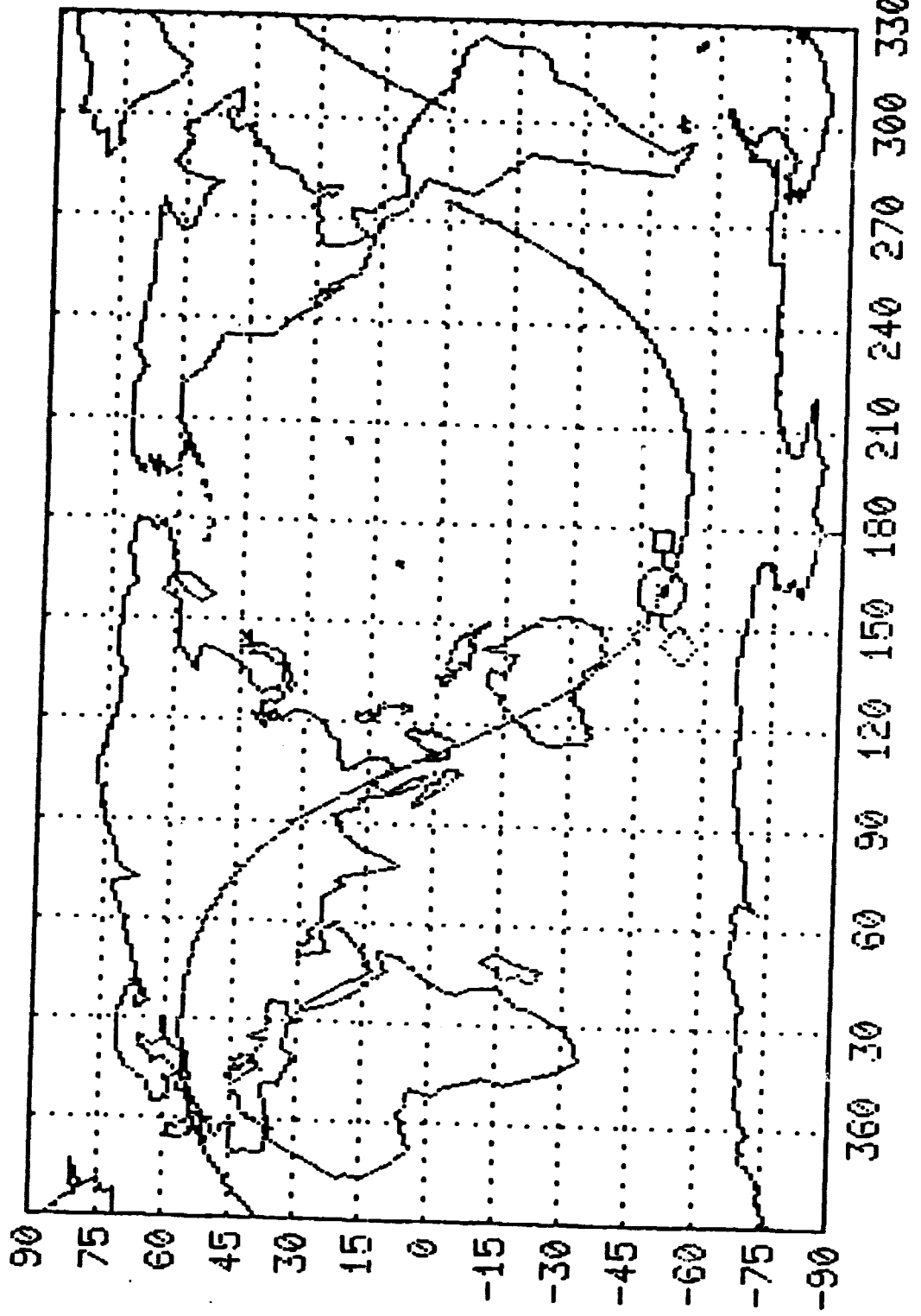
**CAUSE:** Unknown

1965-20





ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 61-63 R/B

1965-82

TITAN 3C-4

1640

LAUNCH DATE: 15.72 Oct 1965

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 15 Oct 1965 (DAY 288)

TIME: 1820 GMT

LOCATION: 2° S/108 E

ALTITUDE: 739 km

PIECES CATALOGED (1 JAN 84): 464

PIECES STILL IN ORBIT (1 JAN 84): 163

ORBIT CHARACTERISTICS:

INCLINATION: 32.6°

APOGEE: 791 km

PERIGEE: 708 km

PERIOD: 99.8 min

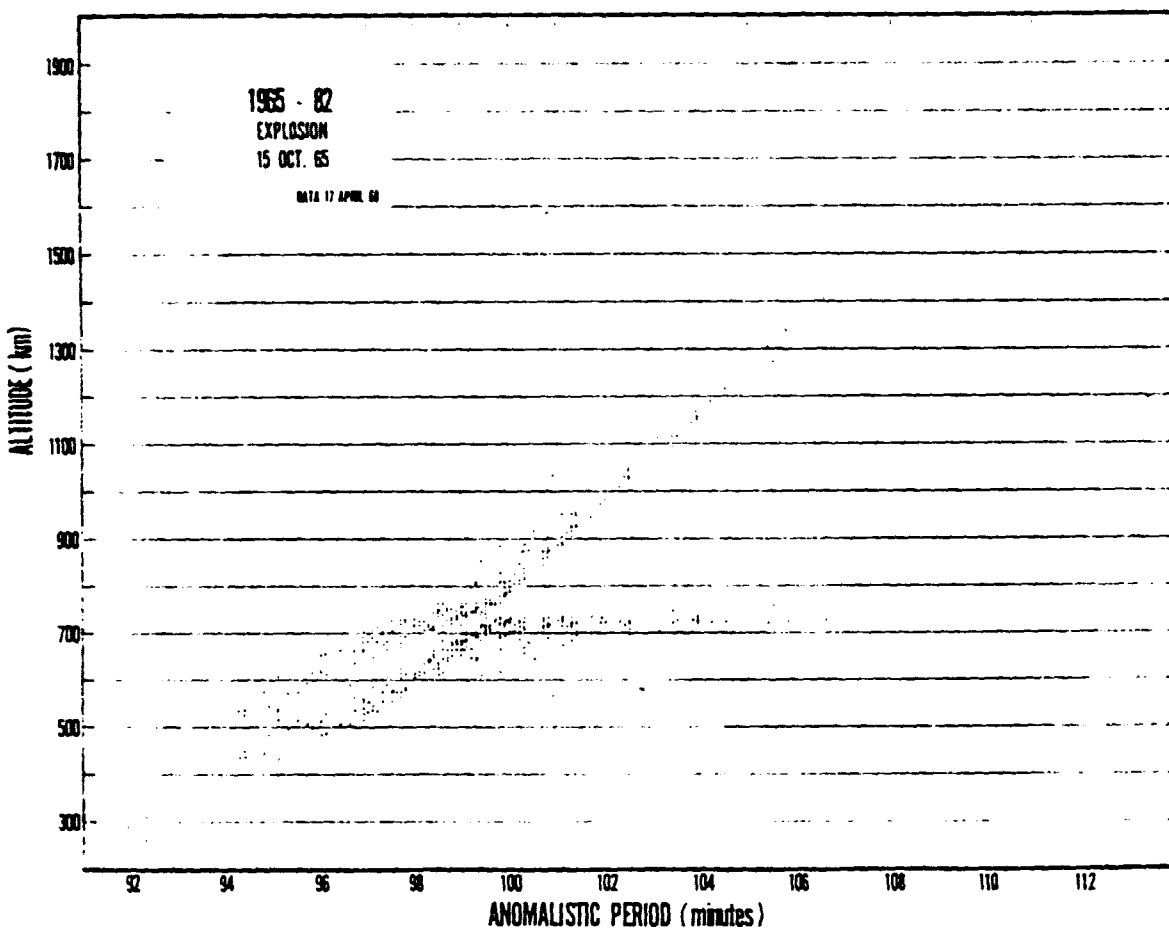
TRUE ANOMALY:

- COMMENTS:
- Transtage fragmented.
  - General shape was cylindrical; length 6 m; dia. 3 m; weight 1500 kg? Lester Sobel's Space: From Sputnik to Gemini indicates mass was 3764.5 kg but does not qualify the rocket as full or empty of fuel.
  - Payloads OV2-1 and LCS-2 did not separate from the transtage.
  - The restartable transtage employed one AJ10-138 engine with storable hypergolic propellants and produced 7,257.0 kg of thrust.
  - The orbit characteristics shown are from the initial elements on file for satellite 1624, the OV2-1, LCS-2 payloads.
  - The main body of OV2-1 was 23 in. square and 24 in. long. There were 4 solar panels. Total weight was 375 lbs. The LCS-2 was a highly polished rigid hollow sphere of 1/8 in. aluminum sheet and weighed 75 lbs.

CAUSE: Assume leak of hypergolic fuels.

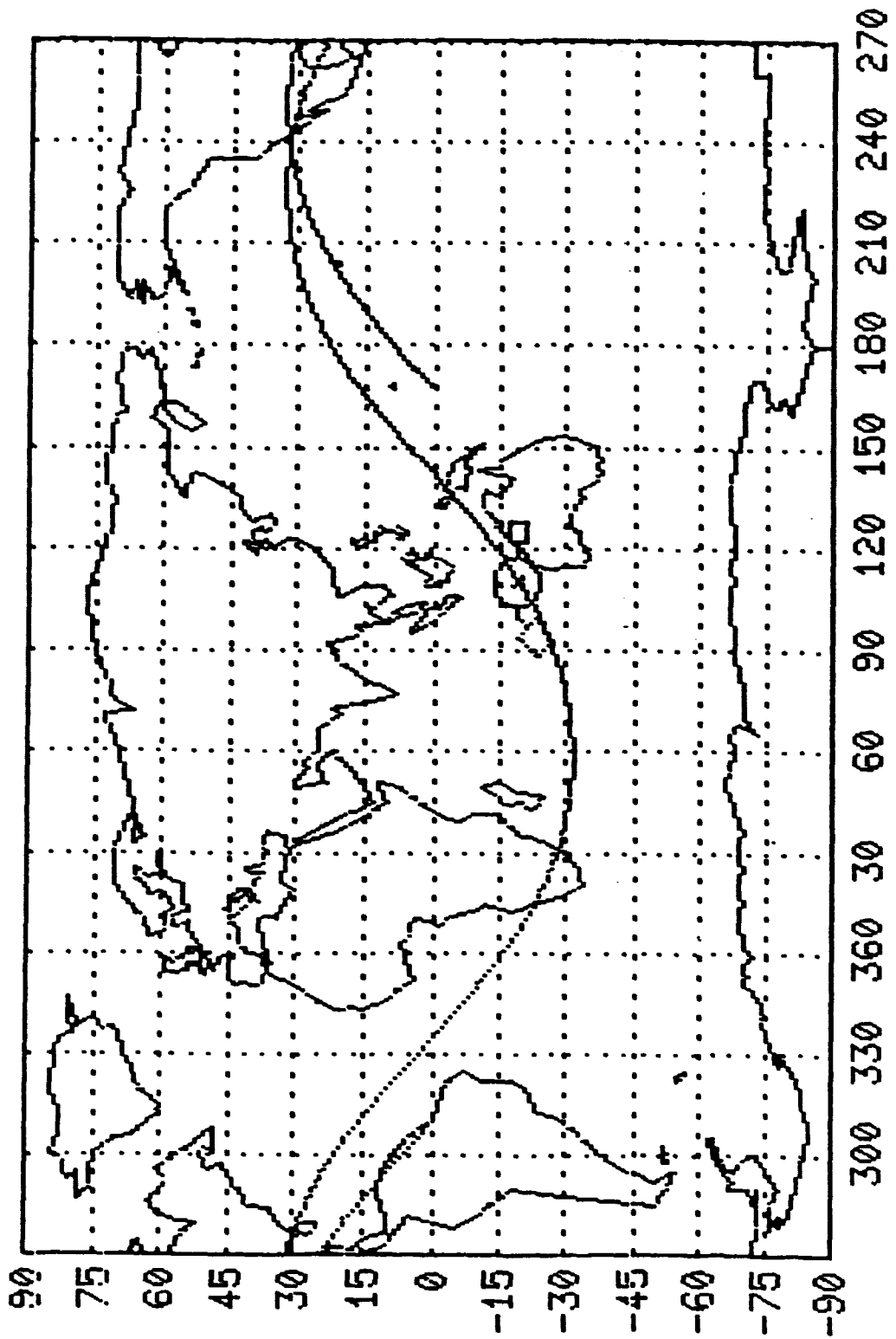
1965-82

ORIGINAL PAGE IS  
OF SUPERIOR QUALITY



TITAN 3C-4

ORIGINAL PAGE 19  
OF POOR QUALITY



TITAN 5C-4

1965-88

COSMOS 95

1706

LAUNCH DATE: 4.23 Nov 1965

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 4-15? Nov 1965 (DAY 308-319)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 21

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 48.44°

APOGEE: 521 km

PERIGEE: 211 km

PERIOD: 91.9 min

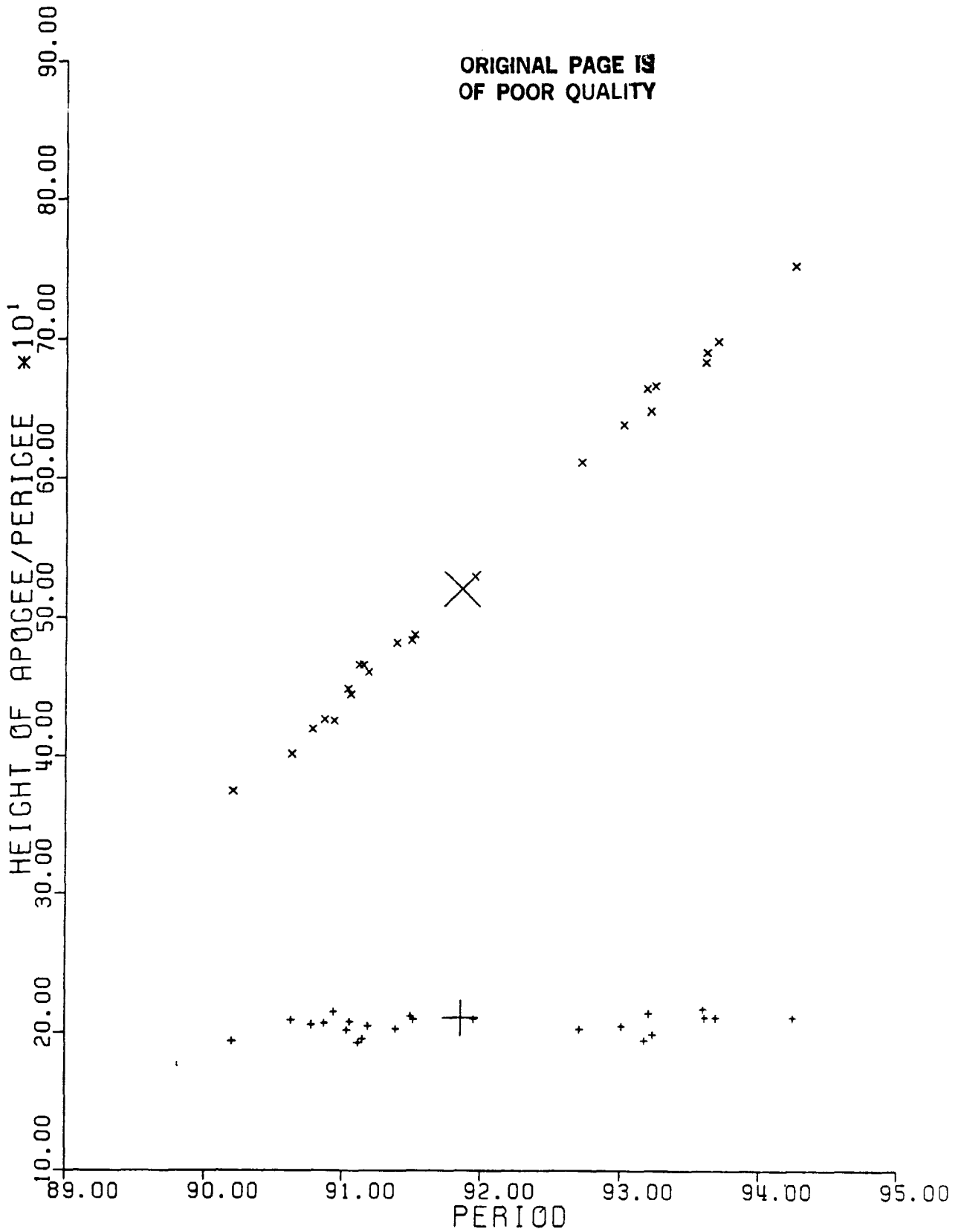
TRUE ANOMALY:

- COMMENTS:**
- The general shape of this payload was cylindrical; length 1.8 m; dia. 1.2 m; weight 400 kg?
  - The orbit characteristics were extracted from the initial element set generated for 1706 that remains on file in the USAF NSSC computer.
  - One fragment was cataloged near time of launch; two more between 19 and 20 Nov 1965; 19 cataloged between 27 and 29 Nov 1965.
  - Insufficient data is available to determine time and position for this event.

**CAUSE:** Unknown

1965-88

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 95



COMMENTS: ° Insufficient data available to show the applicable ground trace for satellite 1706.

1965-88

1966-12

OPS 3031

2015

LAUNCH DATE: 15.85 Feb 1966

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 15 Feb 1966 (DAY 46)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 37

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 96.5°

APOGEE: 268 km

PERIGEE: 147 km

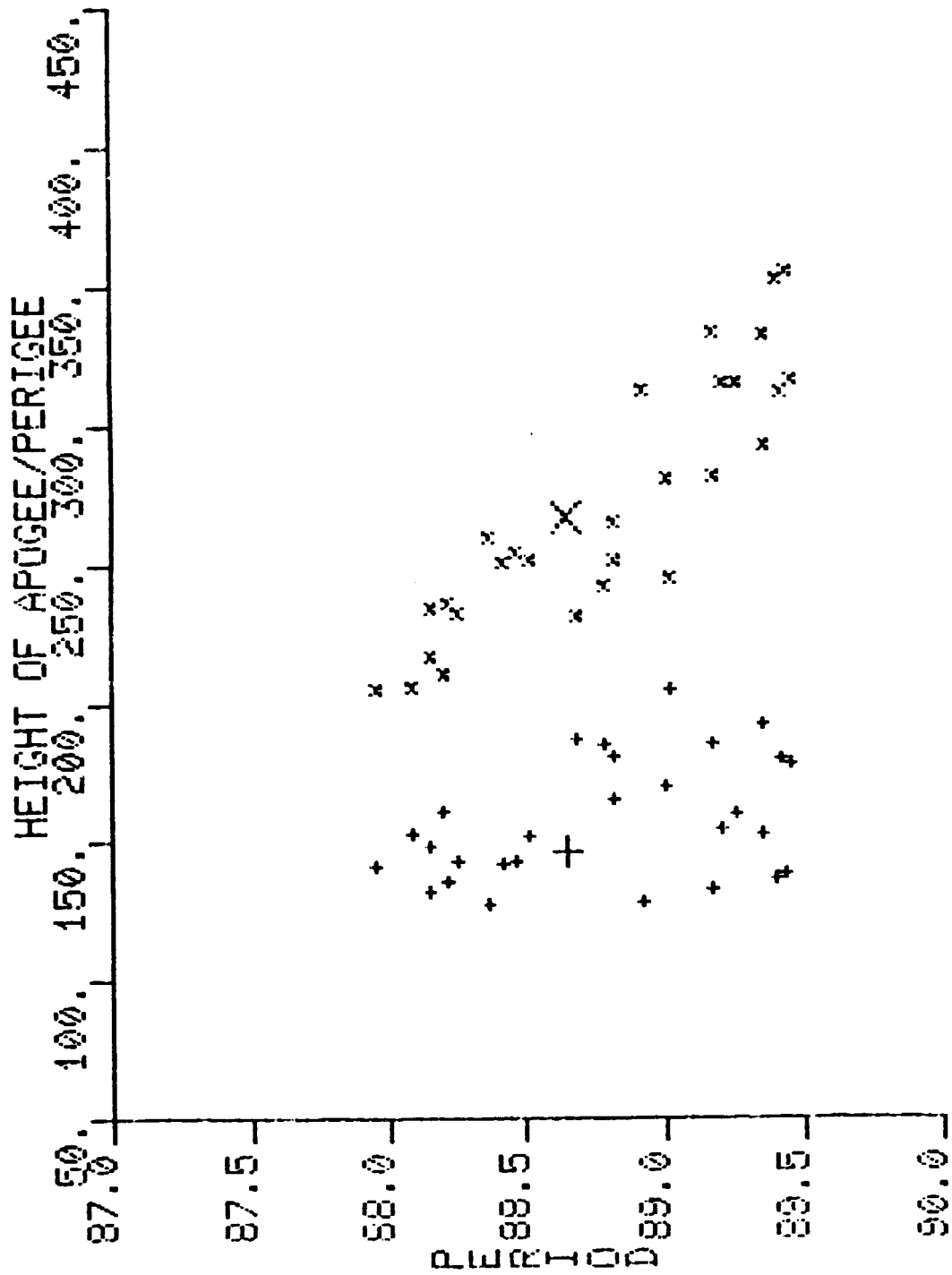
PERIOD: 88.6 min

TRUE ANOMALY:

- COMMENTS:**
- Satellite 2015 was an inflated sphere; dia. 3m; weight 4.1 kg.
  - There is no rocket cataloged with this launch. The launch hardware was an Atlas-Agena D. Three payloads launched.
  - NORAD cataloged the fragments with payload 2015, Ops 3031.
  - Payload 2014 was also an inflated sphere. 3 m in dia.; and payload 2012 was a capsule.
  - Orbit characteristics derived from initial element set on satellite 2015.
  - Parent identification tentative.
  - Insufficient data is available to determine time and position for this event.

**CAUSE:** Unknown

ORIGINAL PAGE IS  
OF POOR QUALITY



OPS 3031

COMMENTS: • Insufficient data available to show the applicable ground track for satellite 2015, Ops. 3031.

1966-12

1966-46

ATDA ROCKET

2188

LAUNCH DATE: 1.63 Jun 1966

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 21 Jun 1966

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 50

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 28.82°

APOGEE: 300 km

PERIGEE: 281 km

PERIOD: 90.3 min

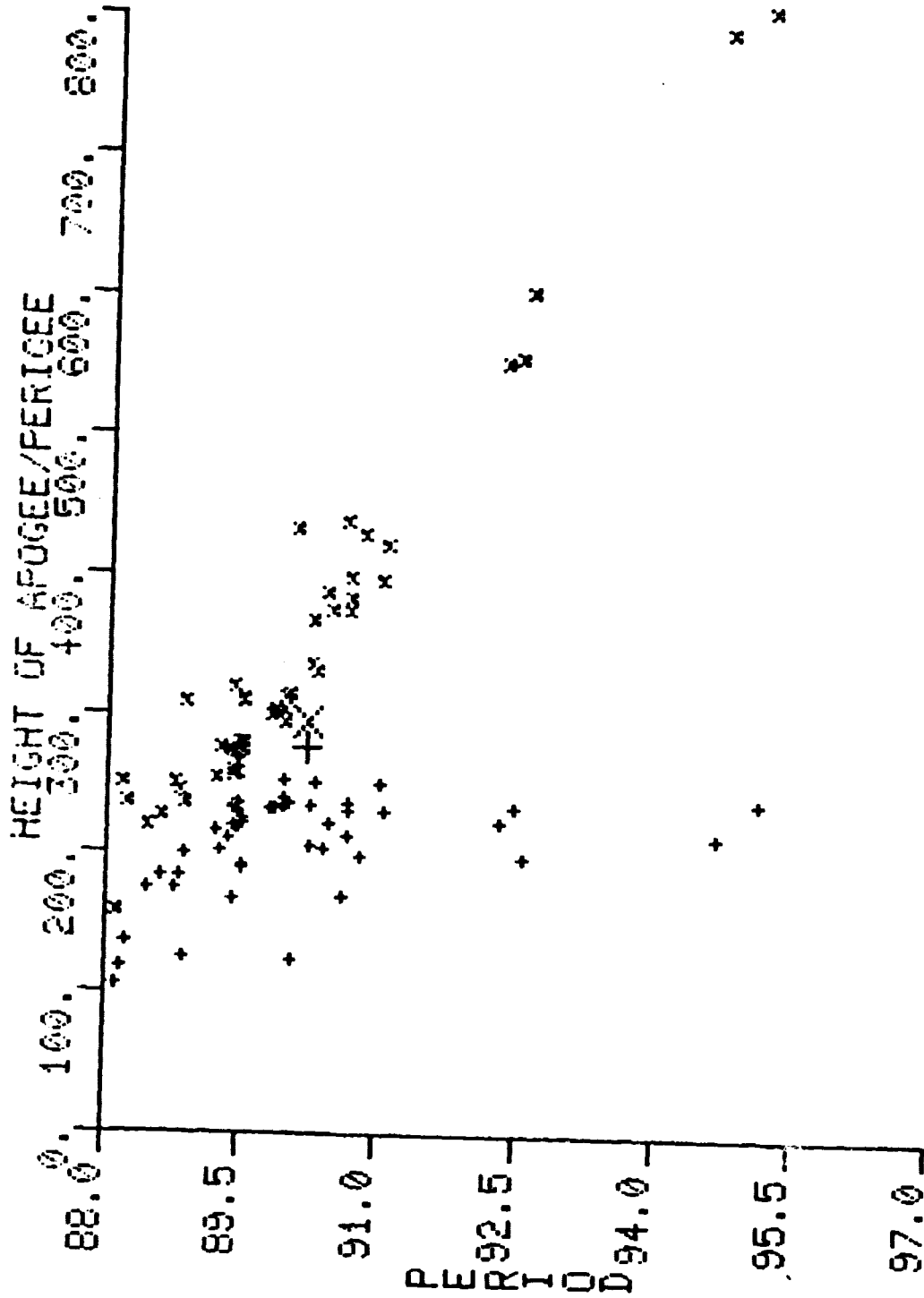
TRUE ANOMALY:

- COMMENTS:**
- This was the Atlas rocket that launched the Gemini rendezvous and docking Agena Target Vehicle #9; Augmented Target Docking Adaptor (ATDA).
  - The orbit characteristics were derived from element set #1 for satellite 2188.
  - General shape; cylinder; length 20 m; dia. 3 m; weight 3400 kg.

**CAUSE:** Unknown

1966-46

ORIGINAL PAGE IS  
OF POOR QUALITY



ATDA R/B



COMMENTS: ° Insufficient data available to show applicable ground trace for satellite 2188.

1966-46

LAUNCH DATE: 24.01 Jun 1966

COUNTRY OF ORIGIN: US

EVENT DATA:	1.	2.	3.
DATE:	12 Jul 1975 (DAY 193)	20 Jan 1976 (DAY 20)	Jun 78
TIME:	224757.9 GMT	013000.0 GMT ± 3 hrs.	
LOCATION:	67 N/135 E		
ALTITUDE:	5144 km		
PIECES CATALOGED (1 JAN 84):	75		
PIECES STILL IN ORBIT (1 JAN 84):	13		

ORBIT CHARACTERISTICS:

INCLINATION:	85.28°	85.07°	84.6°
APOGEE:	5169 km	5424 km	5750 km
PERIGEE:	3201 km	2934 km	2629 km
PERIOD:	180.1 min	179.9 min	180.1 min
TRUE ANOMALY:	192°		

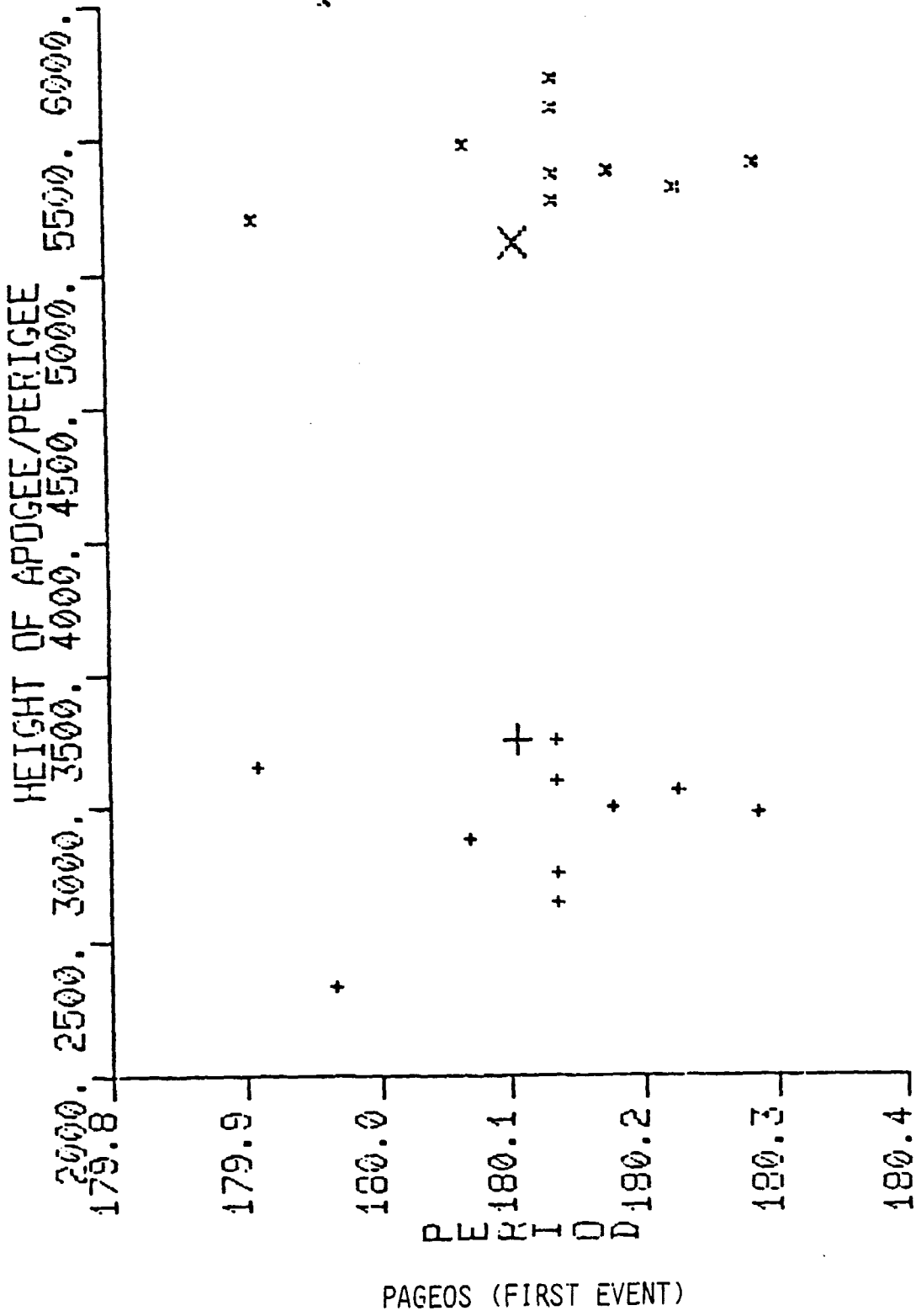
- COMMENTS:**
- Payload 2253 was a 30.48 m alumized mylar balloon.
  - See NORAD Technical Memorandum 81-6 for details of this fragmentation.
  - 45 pieces were cataloged with no initial elements and 30 with elements.
  - The RAE Table of Earth Satellites indicated a fragment of Pageos fragmented into 44 pieces on 20 Jan 1976. NORAD had a provisional satellite number of 82130 for that fragment. This 2nd group of fragments was observed by King-Hele and P. Neirinick.
  - The time of the 2nd breakup was calculated by P. Neirinick based on optical observations.
  - A 3rd breakup was detected by optical observations from Dubai & Invercargill, England and North Canton, Ohio. Its epoch appears to be mid June 1978.

**CAUSE:** Unknown for the 1st event, collision appears to be a more elevated possibility than for many other fragmentation cases.

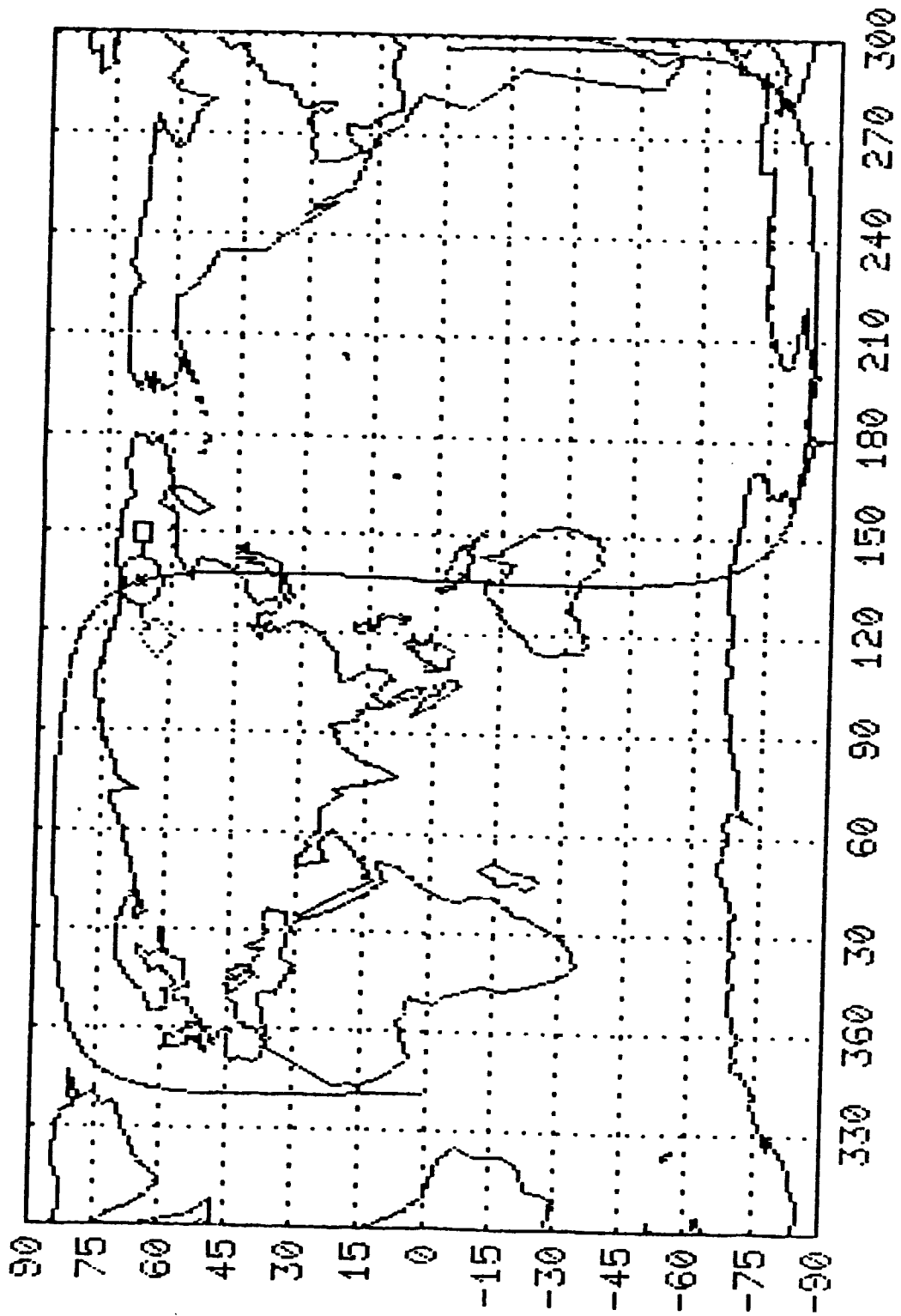
The Science Research Council, Appleton Laboratory, England has shown a general correlation between event time and object spin-up as the object moves to the position where its orbit grazes the earth shadow. Their data follows:

<u>Spin Up</u>	<u>Max. Spin</u>	<u>Shadow Grazing</u>	<u>Break-up</u>
?	?	2 Jul 75	12 Jul 75
?	?	11 Dec 75	20 Jan 76
2 Jun 78	22 Jun 78	5 Jul 78	19? Jun 78

ORIGINAL PAGE IS  
OF POOR QUALITY



ORIGINAL PAGE IS  
OF POOR QUALITY

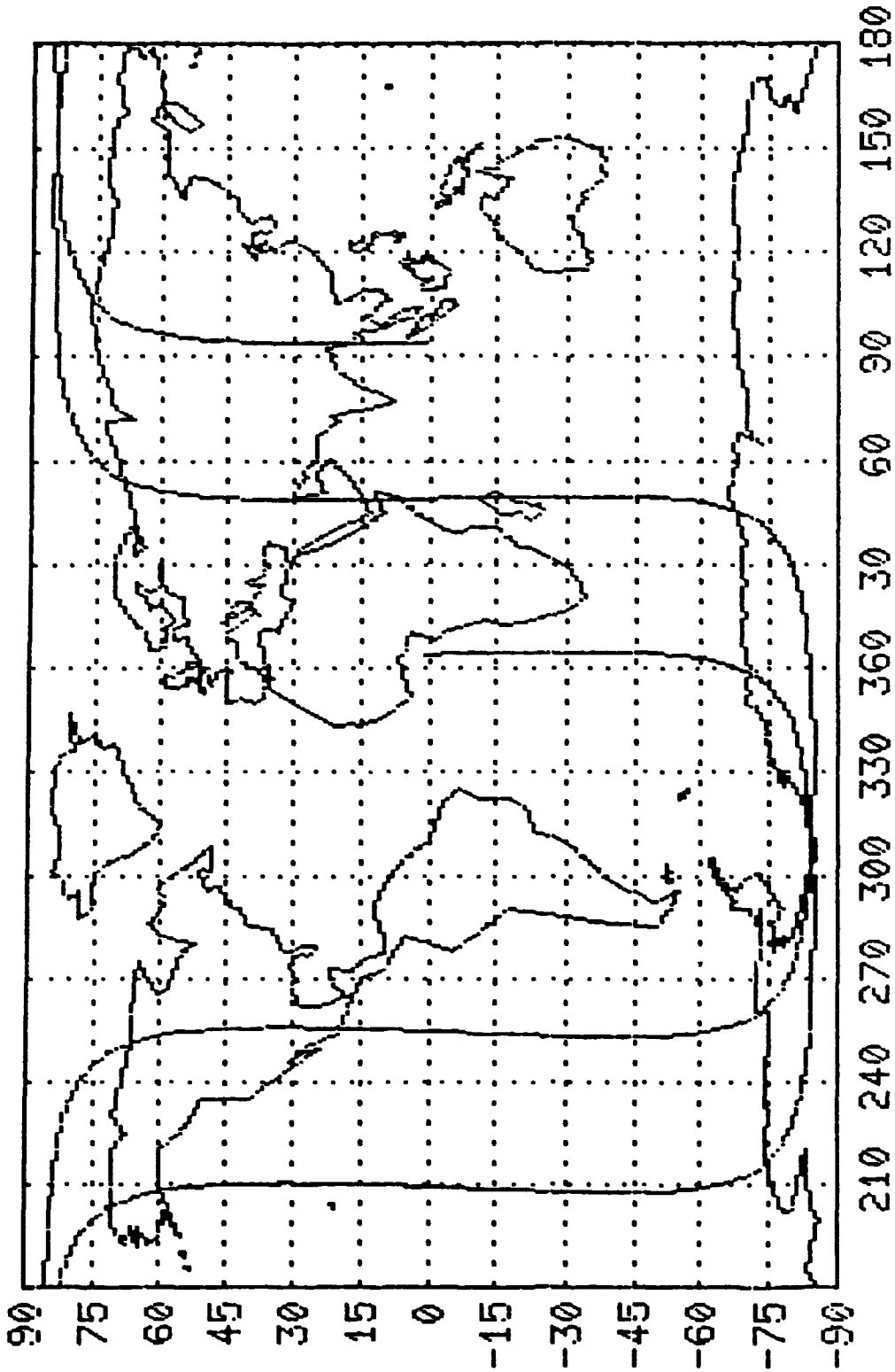


PAGEOS, EVENT 1

COMMENTS: • Insufficient data to identify debris associated with the Second Event, therefore, an orbit distribution plot is not provided.

1966-56

ORIGINAL PAGE IS  
OF POOR QUALITY



PAGEOS (EVENT 2)

COMMENTS: • Insufficient data to identify debris associated with the Third Event, therefore, an orbit distribution plot is not provided.



COMMENTS: • Insufficient data to show applicable ground track for satellite 2256, Third Event.

1966-56

1966-59

SA-203 R/B

2289

LAUNCH DATE: 5.62 Jul 1966

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 5 Jul 1966 (DAY 186)

TIME: 211100.0 GMT

LOCATION: 20 N/277 E

ALTITUDE: 204 KM

PIECES CATALOGED (1 JAN 84): 33

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 31.98°

APOGEE: 214 km

PERIGEE: 185 km

PERIOD: 88.5 min

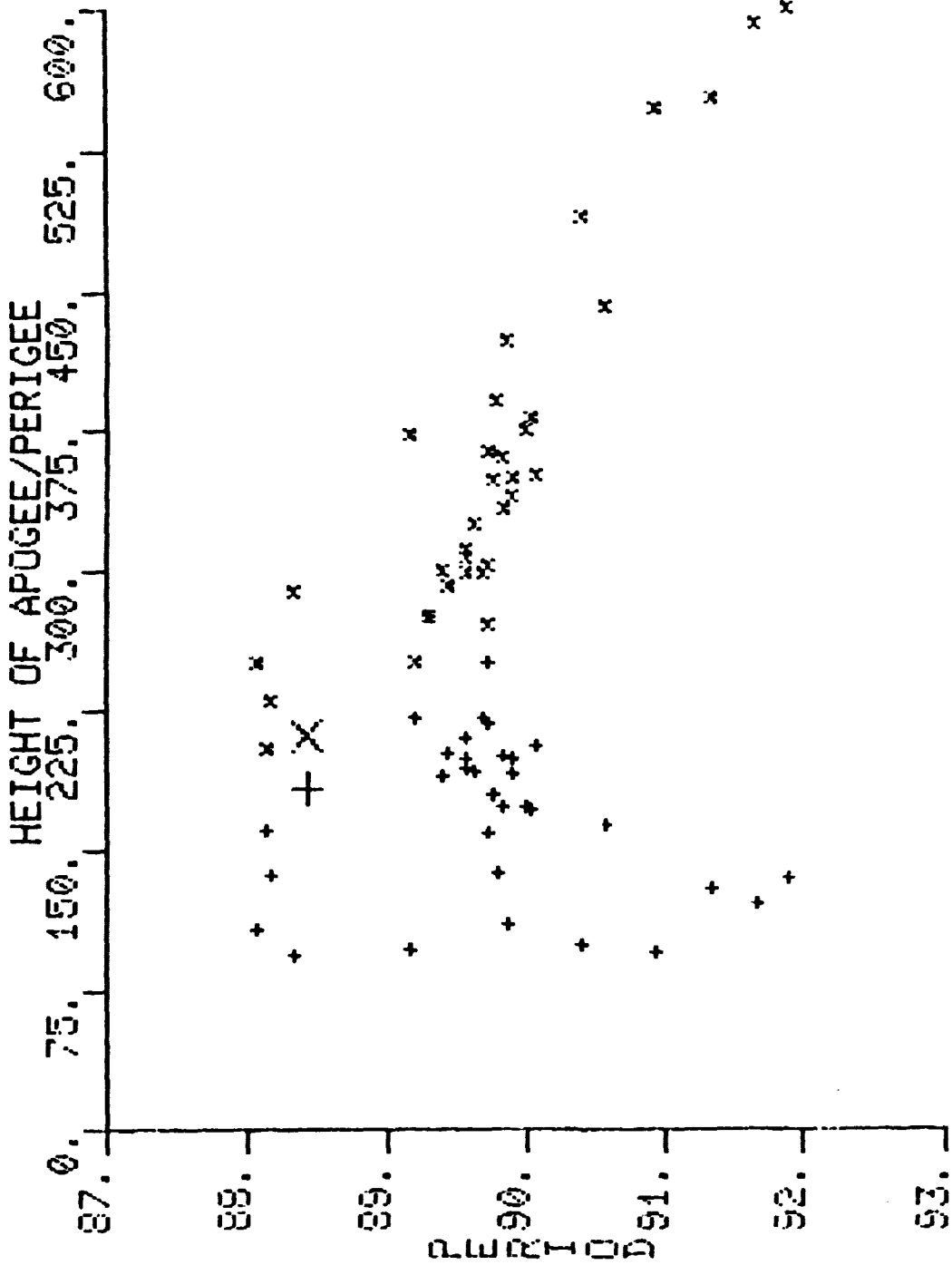
TRUE ANOMALY: 140°

- COMMENTS:
- This was a Saturn 1B launch associated with the Apollo program.
  - The NORAD catalog carries the common name AS-203 and other documents refer to it as SA-203.
  - The orbit characteristics were derived from element set #1 for satellite 2289.
  - NORAD was unable to catalog the S-IVB stage prior to its fragmentation. Its length was 28.3 m; dia. 6.6 m; weight 26552 kg.
  - This launch tested venting and restart of the S-IVB stage after a coast period. Later in the flight this stage was allowed to build pressure for a structures test which then exploded the S-IVB stage in orbit.

CAUSE: Planned structures test.

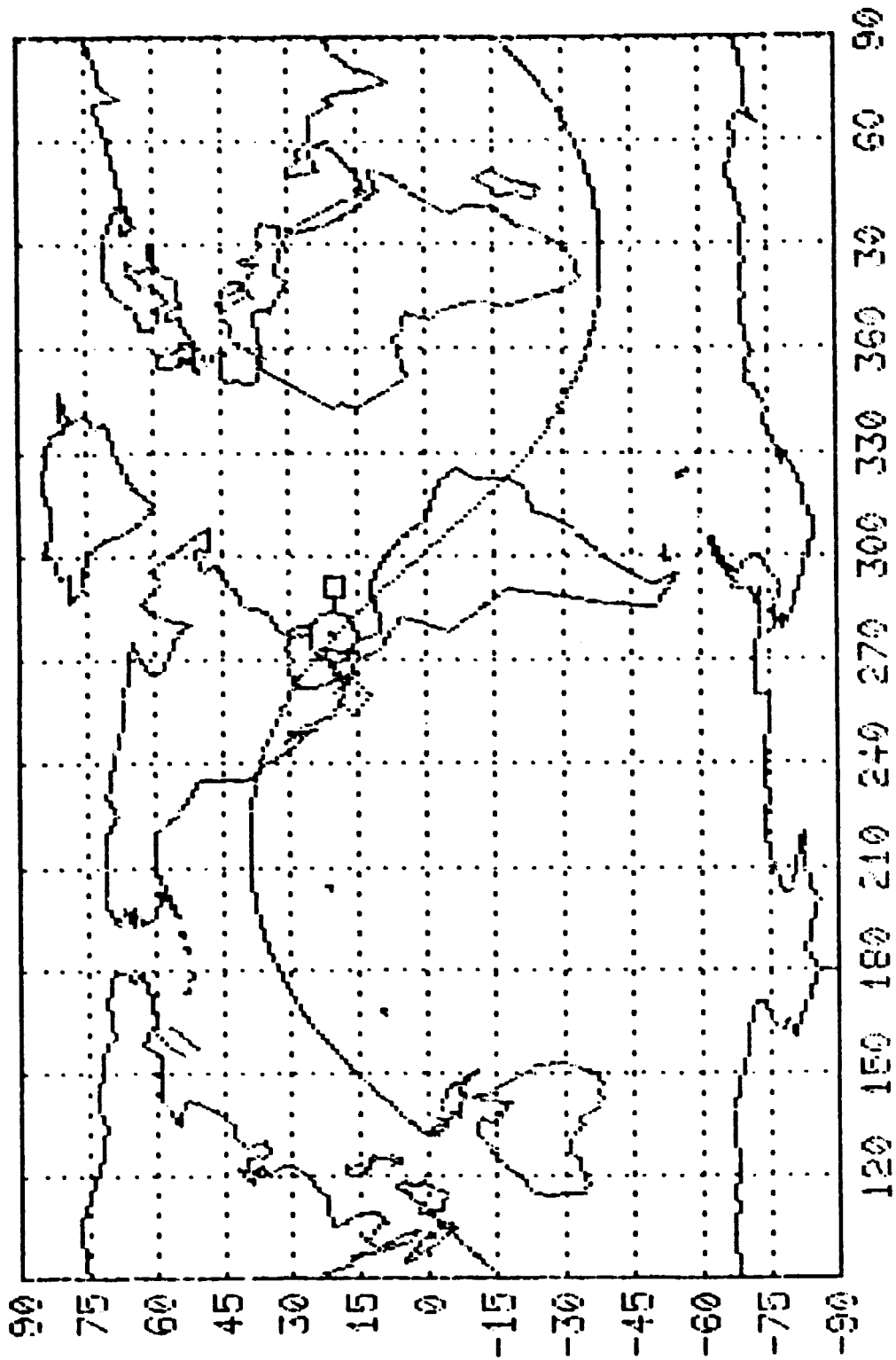
1966-59

ORIGINAL PAGE IS  
OF POOR QUALITY



S/A 203 R/B

ORIGINAL PAGE IS  
OF POOR QUALITY



S/A 203 R/B

1966-88

USSR/Unknown 1

2437

LAUNCH DATE: 17.94 Sep 1966

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 17 Sep 1966 (DAY 260)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 54

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 49.6°

APOGEE: 792 km

PERIGEE: 138 km

PERIOD: 93.9 min

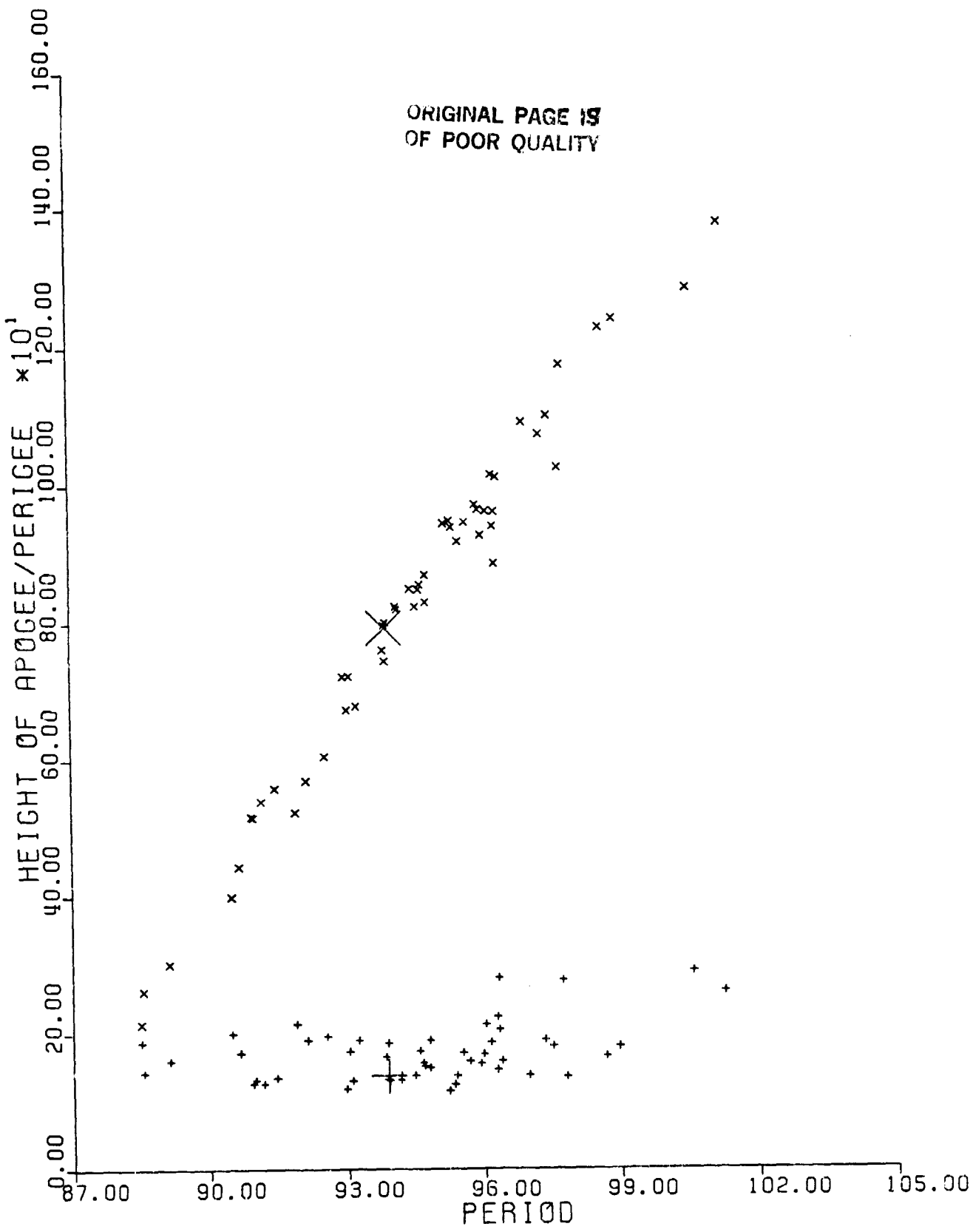
TRUE ANOMALY:

- COMMENTS:
- Alleged Fractional Orbit Bombardment System (FOBS) test.
  - This launch was between Cosmos 128 and 129 and was not acknowledged by the USSR.
  - Only debris was cataloged and satellite 2437 was the first piece cataloged.
  - No elements are in the archives for 2437. The orbit characteristics were taken from the initial element set for 2437 which is saved on file in the NORAD computational system.
  - General shape was cone-cylinder; length 6 m? dia. 1.5 m?
  - Probably fragmented on first revolution.

CAUSE: Unknown

1966-88

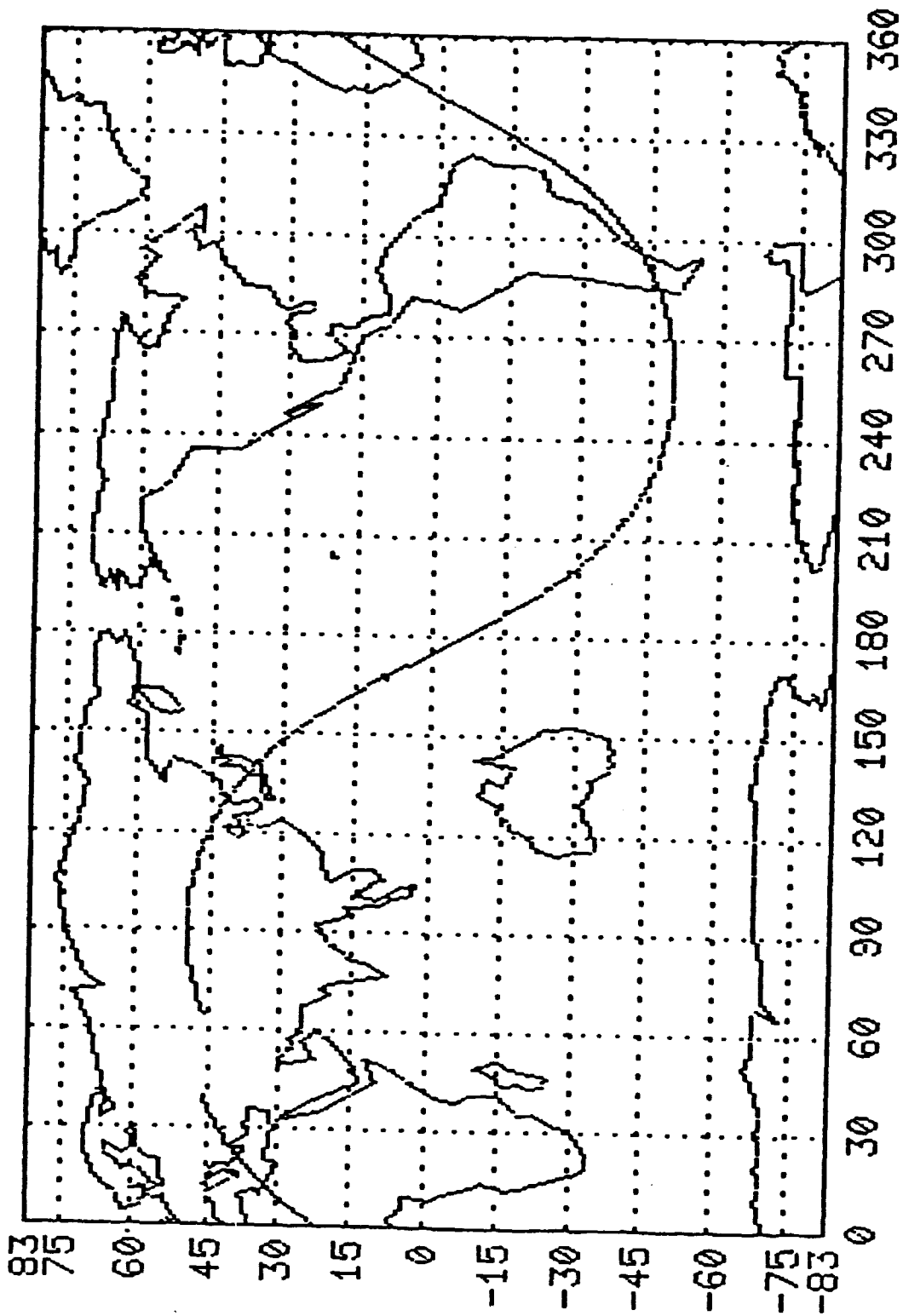
ORIGINAL PAGE IS  
OF POOR QUALITY



1966-88 FOBS



ORIGINAL PAGE IS  
OF POOR QUALITY



1966-88 FOBS

1966-101

USSR/Unknown 2

2536

LAUNCH DATE: 2.03 Nov 1966

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 2 Nov 1966 (DAY 306)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 40

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 49.7°

APOGEE: 651 km

PERIGEE: 188 km

PERIOD: 92.9 min

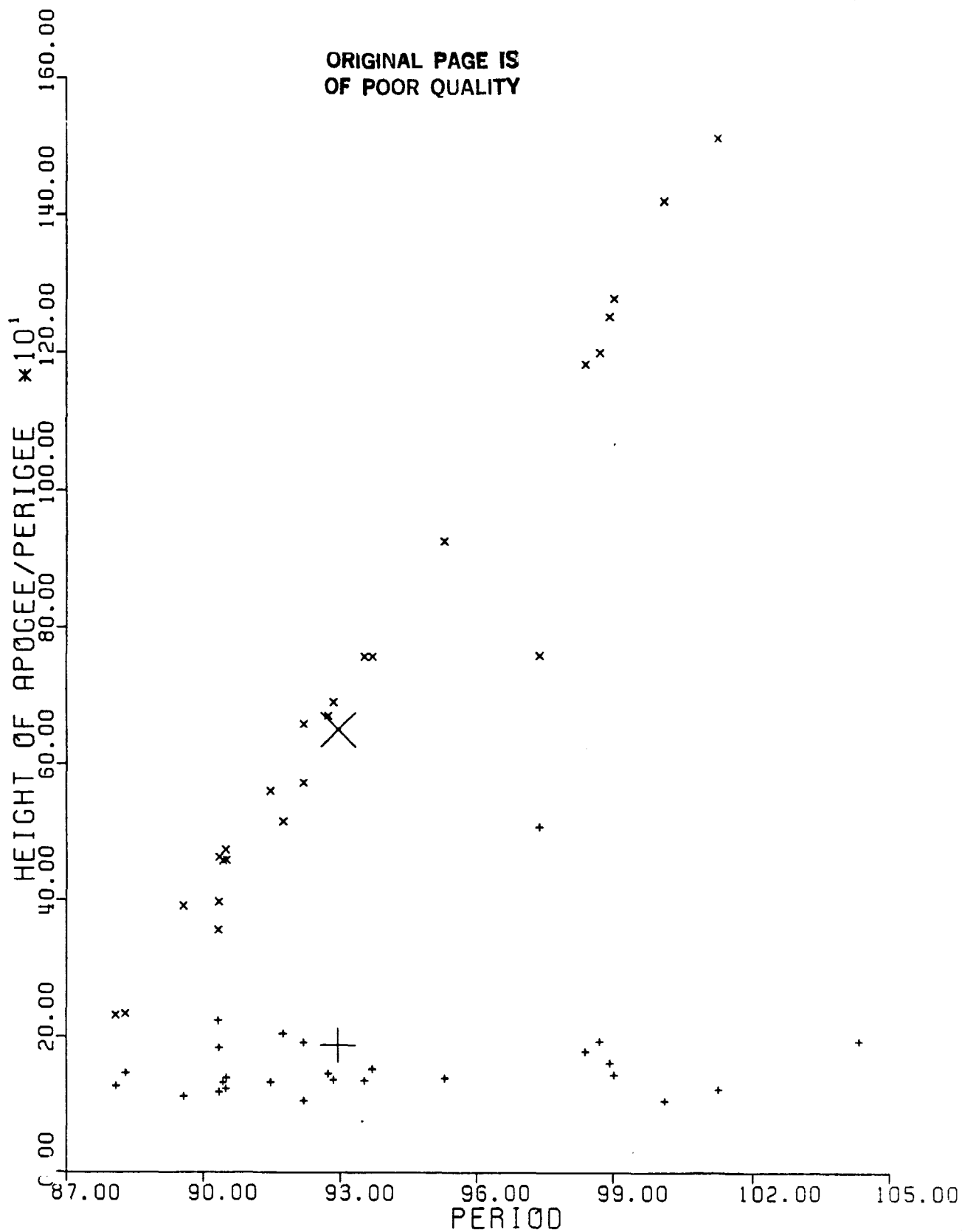
TRUE ANOMALY:

- COMMENTS:
- Alleged Functional Orbit Bombardment System (FOBS) test.
  - Only debris cataloged.
  - Satellite 2536 is the first piece of debris cataloged.
  - No elements are in the archives for 2536. The orbit characteristics were taken from the initial element set for 2536 which is saved on file in the NORAD computational system.
  - This launch was not acknowledged by the USSR.
  - General shape was cone-cylinder; length 6 m?; dia. 1.5 m?
  - Probably fragmented on first revolution.

CAUSE: Unknown

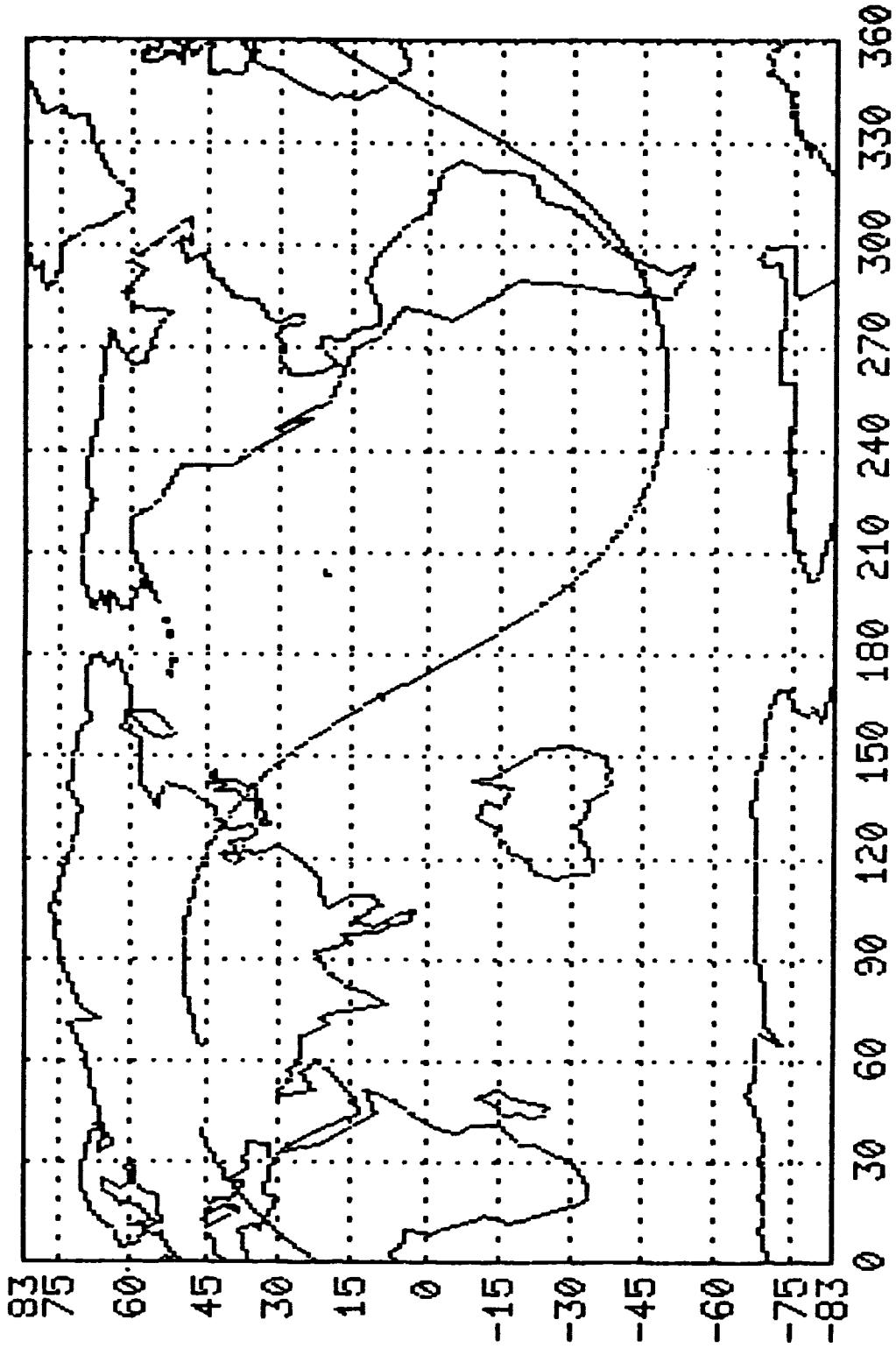
1966-101

ORIGINAL PAGE IS  
OF POOR QUALITY



1966-101 FOBS

ORIGINAL PAGE IS  
OF POOR QUALITY



1966-101 FOBS

1967-01

INTELSAT 2-F2 ROCKET

2640

LAUNCH DATE: 11.45 Jan 1967

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE:

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 23

PIECES STILL IN ORBIT (1 JAN 84): 4

ORBIT CHARACTERISTICS:

INCLINATION: 28.73°

APOGEE: 589 km

PERIGEE: 253 km

PERIOD: 93.6 min

TRUE ANOMALY:

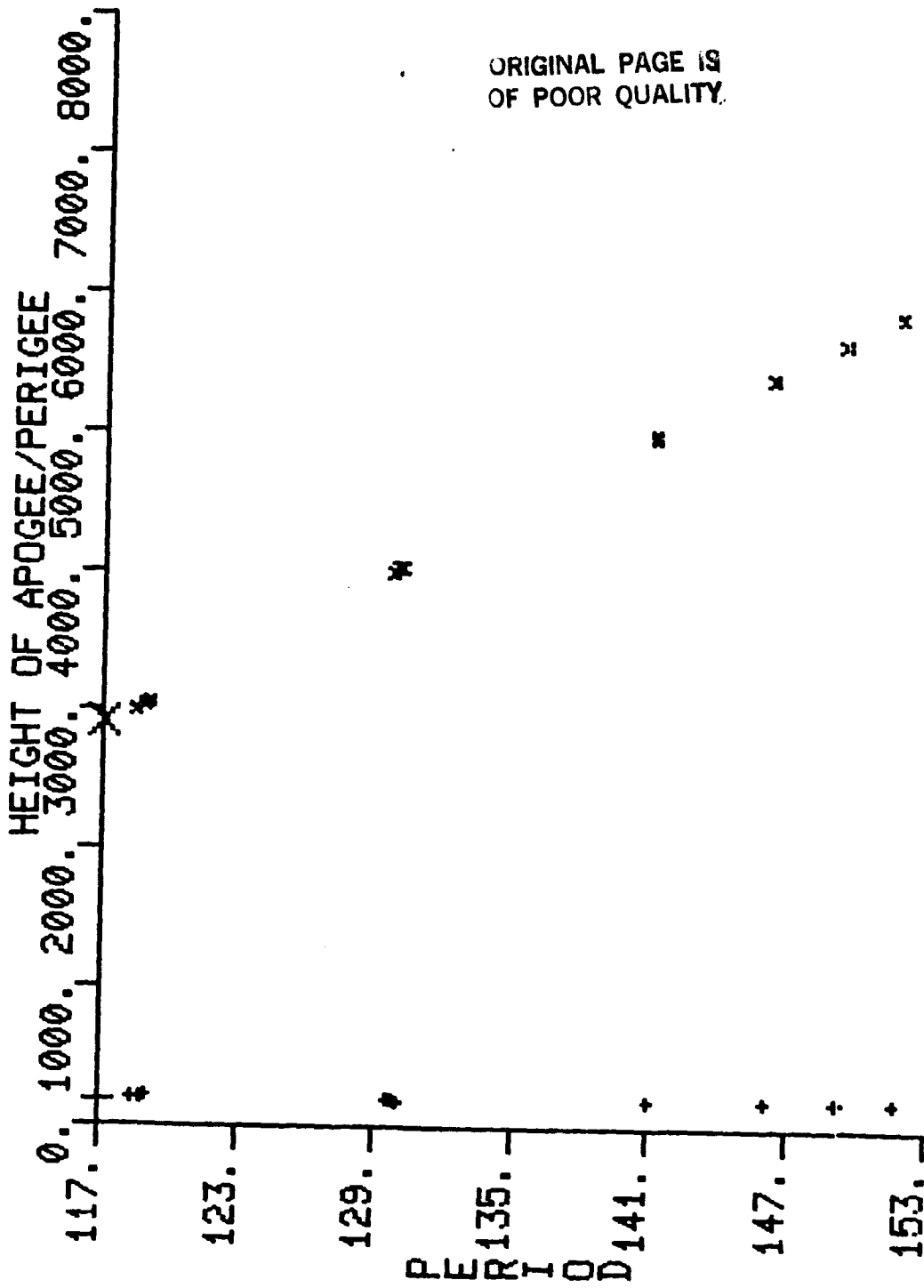
- COMMENTS:
- Due to the low inclination of this launch and severe sensor limitations on low inclination orbits information on this event is sparse. Inconsistent observation of debris in the region between 2,800 and 6,000 km was experienced. Attempts to maintain elements on this debris were largely unsuccessful.
  - The identification of this debris with this launch is provisional.
  - Orbit characteristics developed from element set #1 on satellite 2640. However, the characteristics of the orbits of the debris indicates the event most likely occurred during a transfer maneuver.
  - Insufficient data is available to determine time and location of the event for satellite 2640.
  - Launch vehicle was a thrust augmented Delta (TAD). Payload was placed in planed orbit.

CAUSE: Unknown.

1967-01

1-67

ORIGINAL PAGE IS  
OF POOR QUALITY.



INTELSAT 2-F2 ROCKET



COMMENTS: • Insufficient data is available to show the applicable ground track for satellite 2640, Intelsat 2-F2 rocket.

1967-01

1968-90

COSMOS 248

3503

LAUNCH DATE: 19.18 Oct 1968

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 1 Nov 1968 (DAY 306)

TIME: 041205.7 GMT

LOCATION: 55 N/104 E

ALTITUDE: 542 km

PIECES CATALOGED (1 JAN 84): 4

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 62.25°

APOGEE: 543 km

PERIGEE: 473 km

PERIOD: 94.8 min

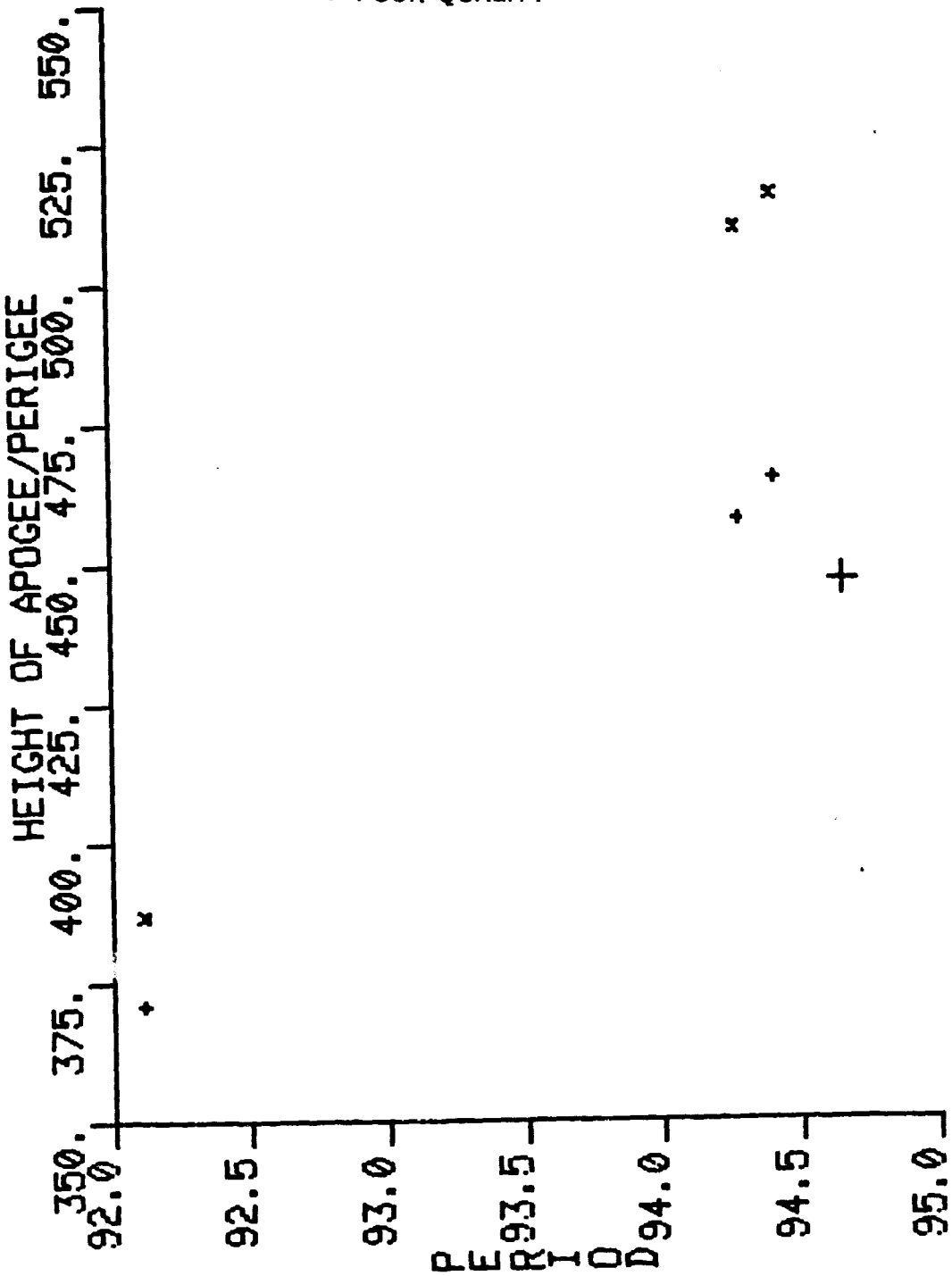
TRUE ANOMALY: 172°

- COMMENT:
- Alleged anti-satellite test target.
  - Orbit characteristics derived from element set #5 on satellite 3503, epoch 30 Oct 68.
  - General shape was cylinder?; length 4 m? dia. 2 m?

CAUSE: Pieces detected after second alleged ASAT test which involved the interceptor, Kosmos 252. This is the only alleged Soviet ASAT target which has experienced fragmentation immediately after an alleged ASAT test.

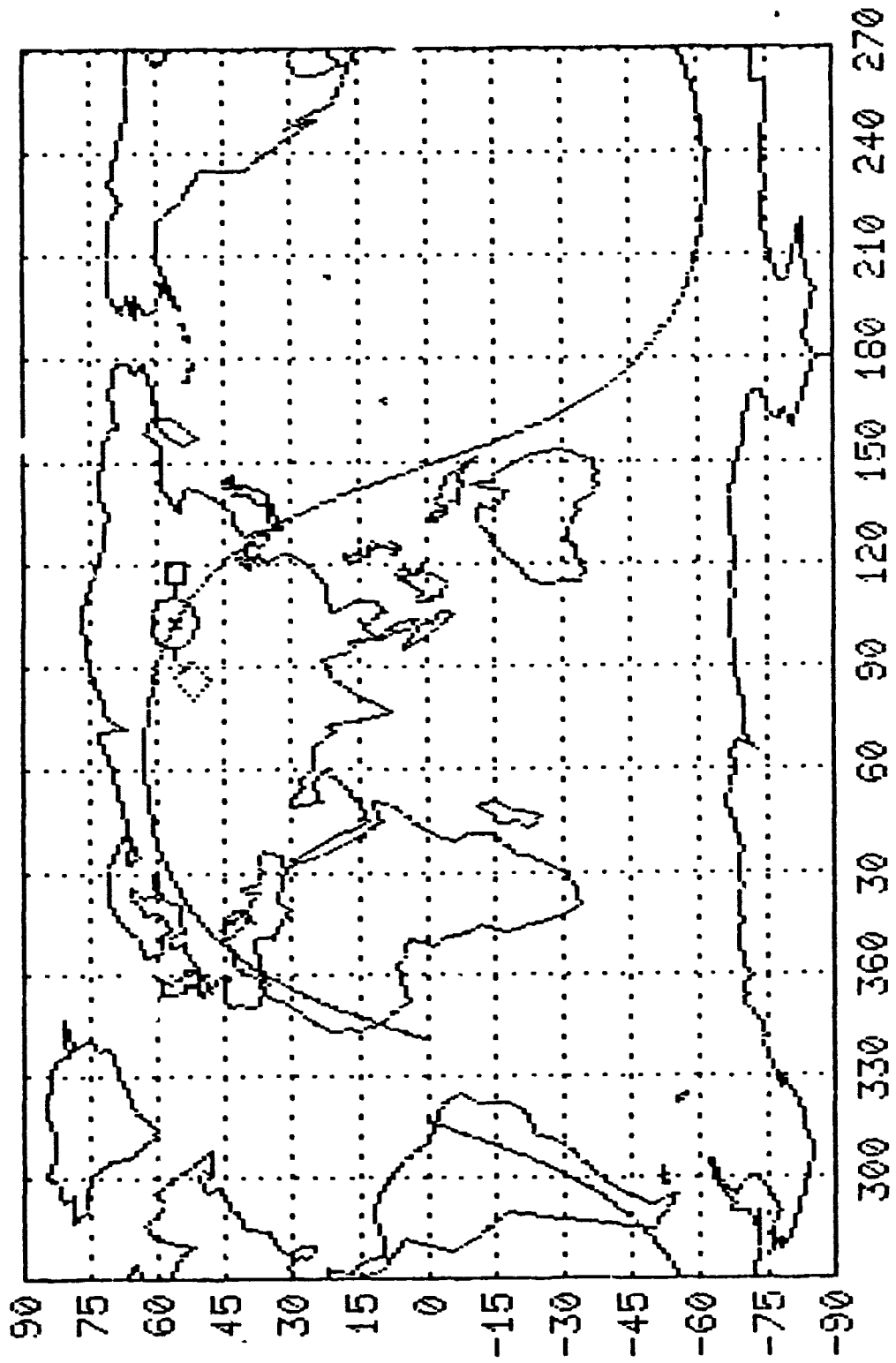
1968-90

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 248

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 248

1968-91

COSMOS 249

3504

LAUNCH DATE: 20.17 Oct 1968

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 20 Oct 1968 (DAY 294)

TIME: 142708.9 GMT

LOCATION: 57 S/181 E

ALTITUDE: 1994 km

PIECES CATALOGED (1 JAN 84): 91

PIECES STILL IN ORBIT (1 JAN 84): 55

ORBIT CHARACTERISTICS:

INCLINATION: 62.33°

APOGEE: 2159 km

PERIGEE: 496 km

PERIOD: 112.2 min

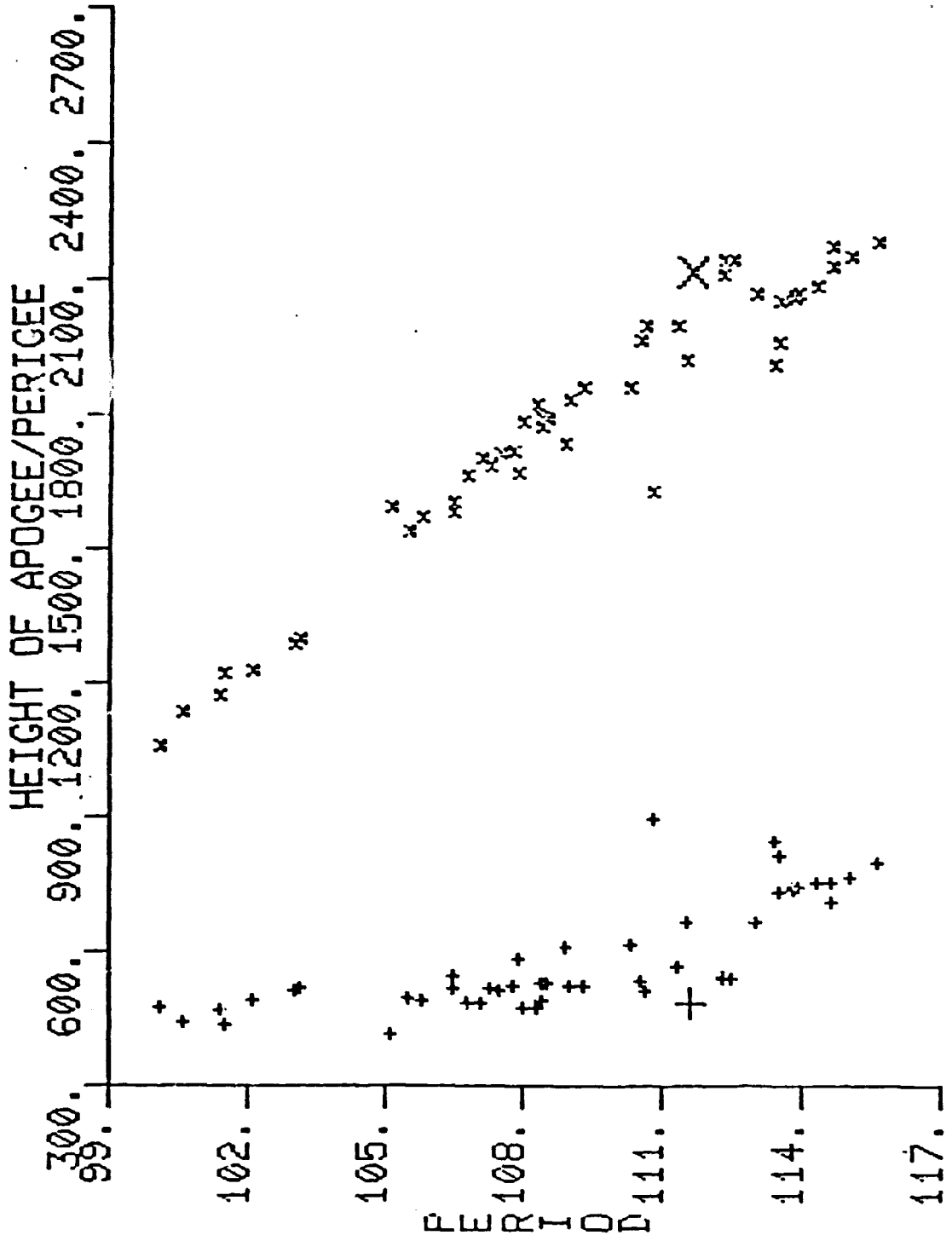
TRUE ANOMALY: 214°

- COMMENTS:**
- General shape was cylinder?; length 4 m?; dia. 1.5 m?
  - This was the 1st alleged USSR ASAT test.
  - The distribution of debris suggests 2 separate fragmentation events.
  - The break-up events did not occur near the target satellite (Kosmos 248).

**CAUSE:** Planned fragmentation as part of an alleged USSR ASAT test.

1968-91

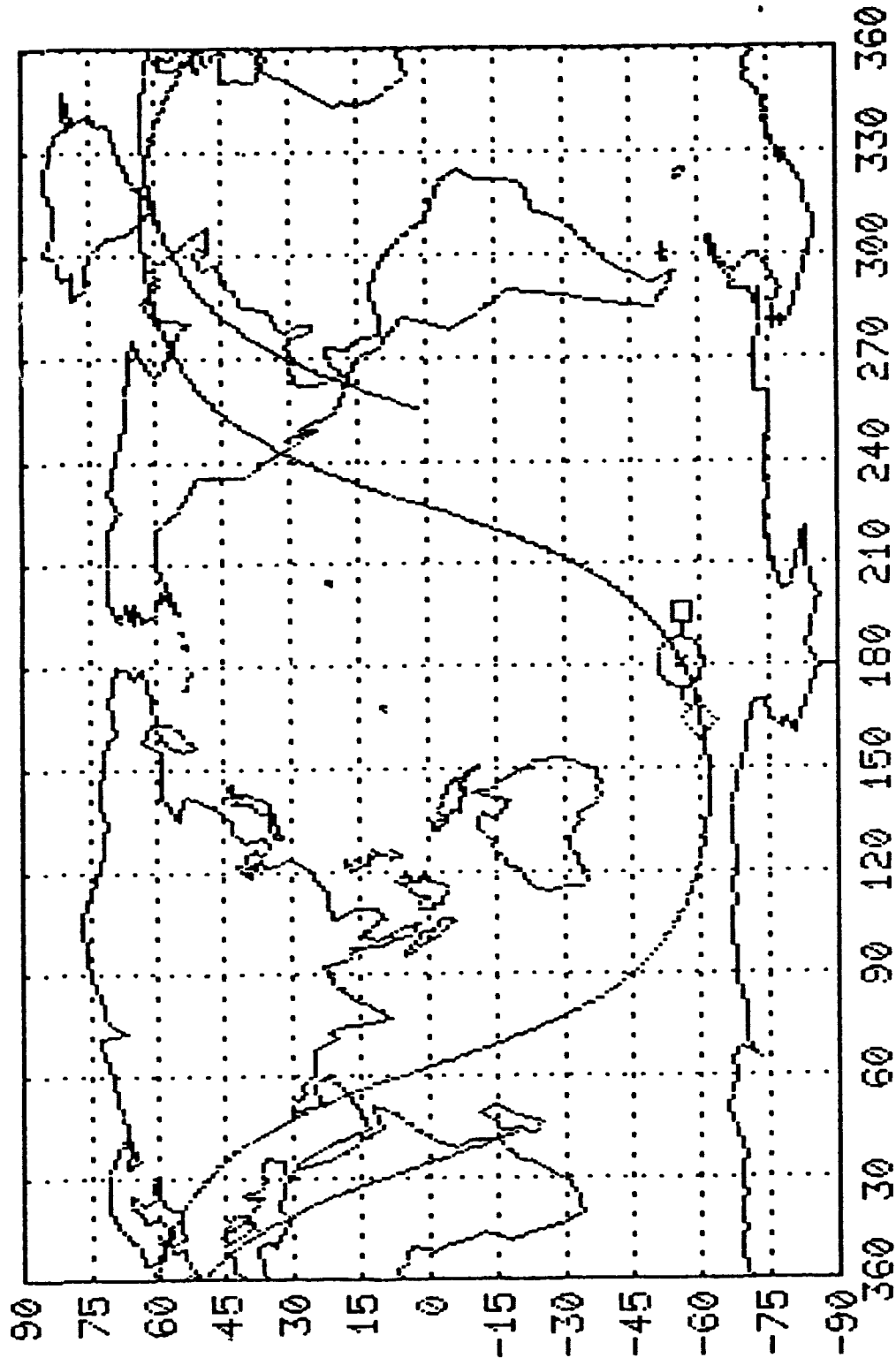
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 249



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 249

1968-97

COSMOS 252

3530

LAUNCH DATE: 1.02 Nov 1968

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 1 Nov 1968 (DAY 306)

TIME: 040159.3 GMT

LOCATION: 58 N/34 E

ALTITUDE: 534 km

PIECES CATALOGED (1 JAN 84): 122

PIECES STILL IN ORBIT (1 JAN 84): 55

ORBIT CHARACTERISTICS:

INCLINATION: 62.34°

APOGEE: 2139 km

PERIGEE: 534 km

PERIOD: 112.4 min

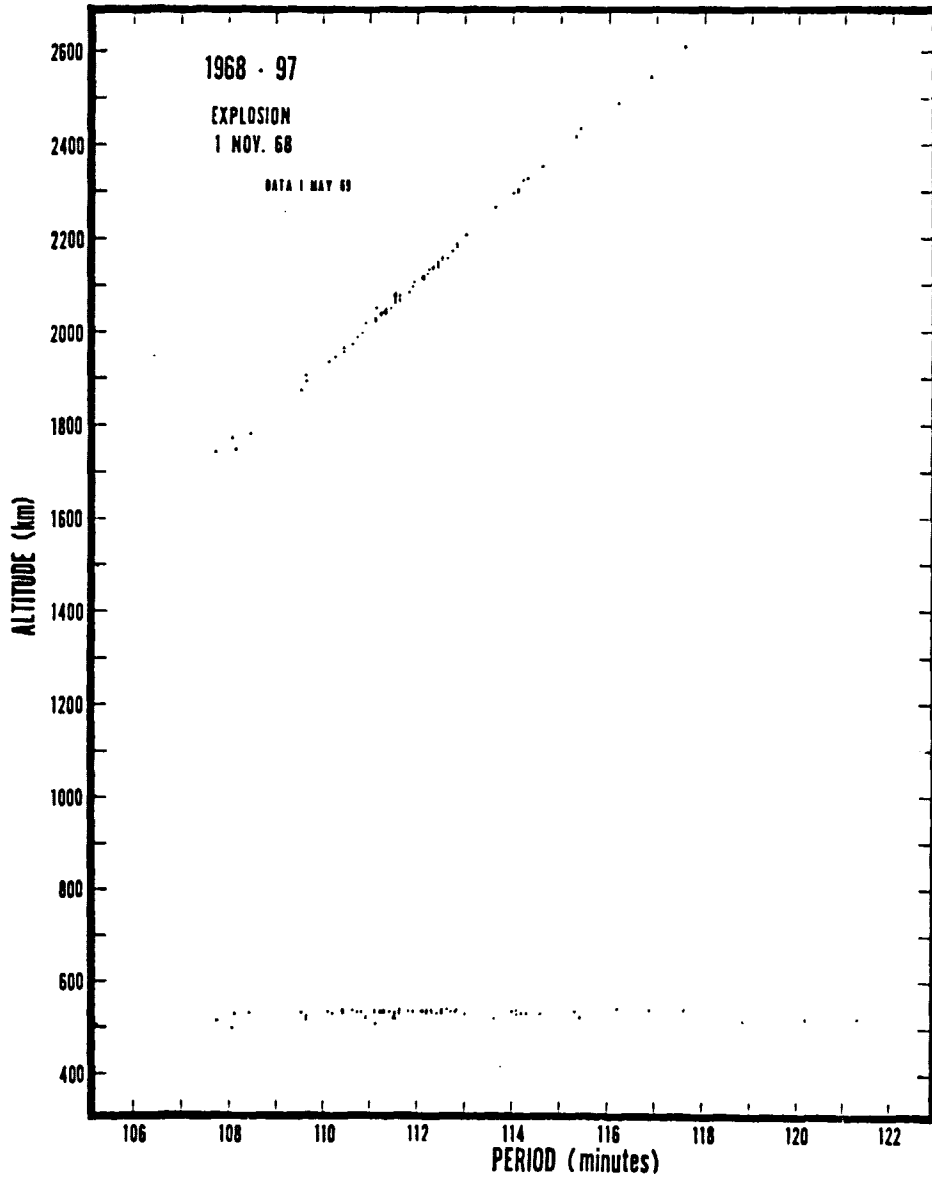
TRUE ANOMALY: 360°

- COMMENTS:
- Alleged 2nd USSR ASAT test.
  - Orbit data derived from element set #2 satellite 3530.
  - General shape was cylinder?; length 4 m.?; dia. 2 m?
  - Break-up occurred at perigee in the vicinity of the target satellite (Kosmos 248).

CAUSE: Planned fragmentation as part of an alleged USSR ASAT test.

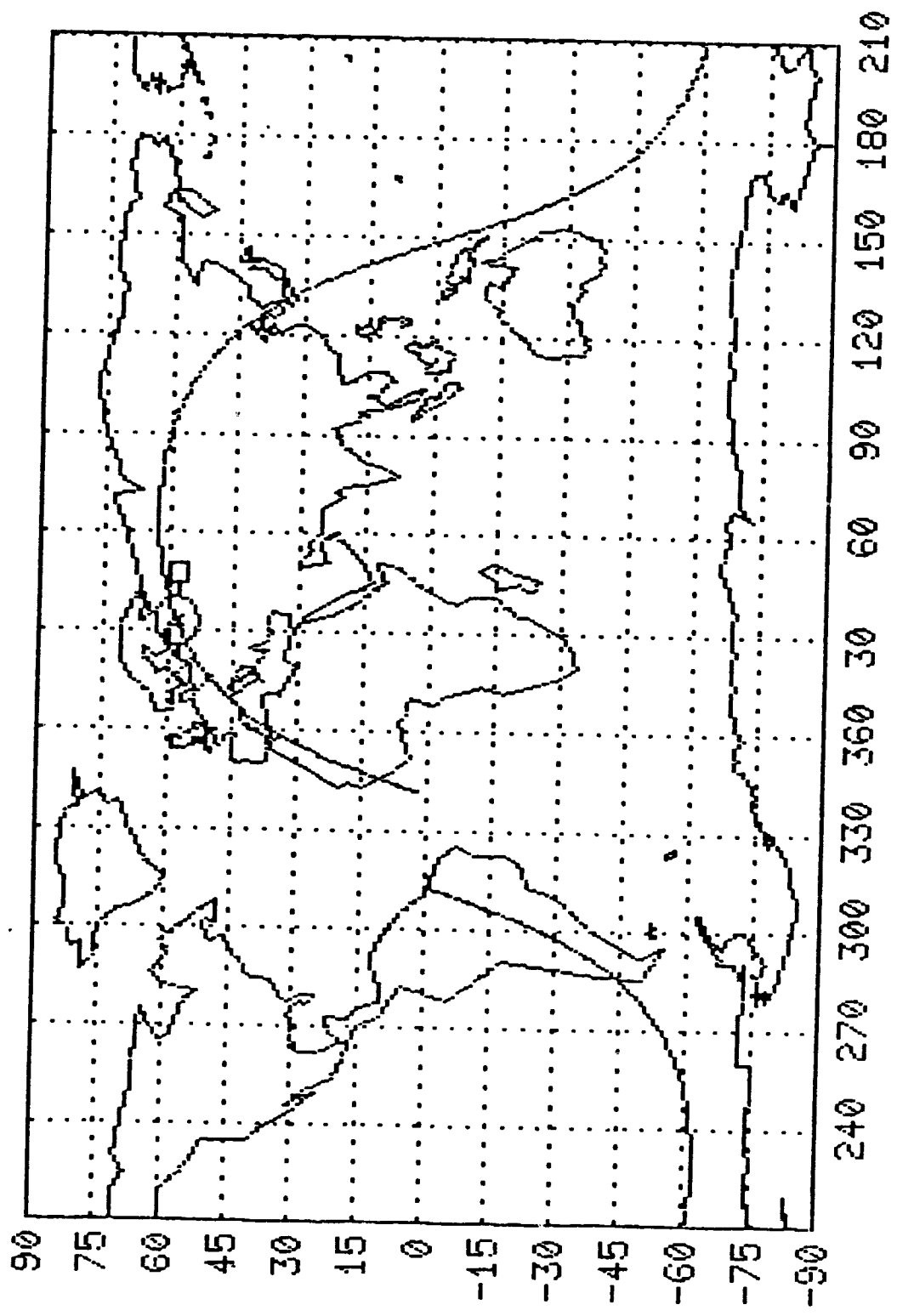
1968-97

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 252

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 252

1969-29

METEOR 1/ROCKET

3836

LAUNCH DATE: 26.52 Mar 1969

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 28 Mar 1969 (DAY 87)

TIME: 184431.52

LOCATION: 59 N/91 E

ALTITUDE: 554 km

PIECES CATALOGED (1 JAN 84): 36

PIECES STILL IN ORBIT (1 JAN 84): 2

ORBIT CHARACTERISTICS:

INCLINATION: 81.17°

APOGEE: 851 km

PERIGEE: 462 km

PERIOD: 97.9 min

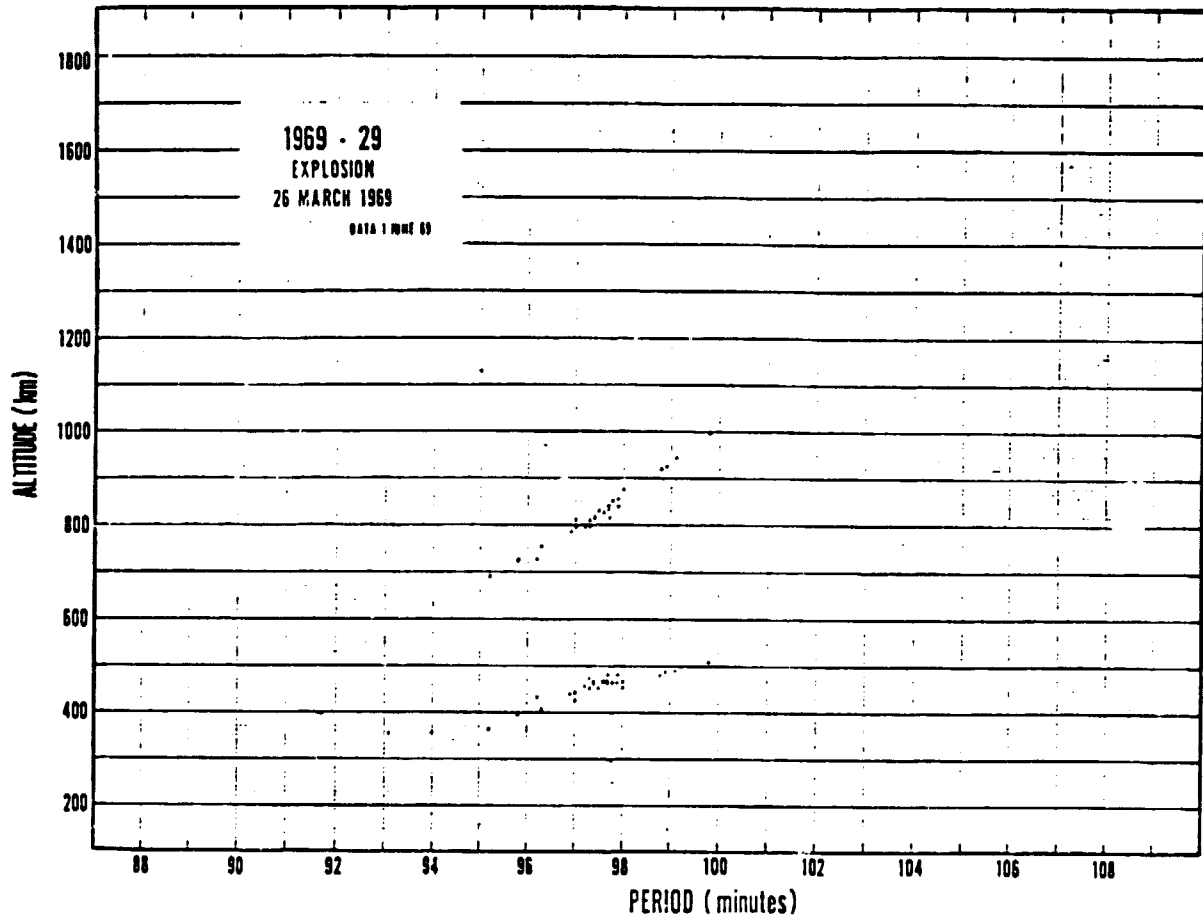
TRUE ANOMALY: 300°

- COMMENTS:
- General shape was cylinder; length 3.8 m; dia. 2.6 m; weight 1440 kg.
  - Orbit data derived from element set #2 (Epoch = 69087.213) of payload satellite 3835. (Identity of payload and rocket had been switched in element data).

CAUSE: Unknown

1969-29

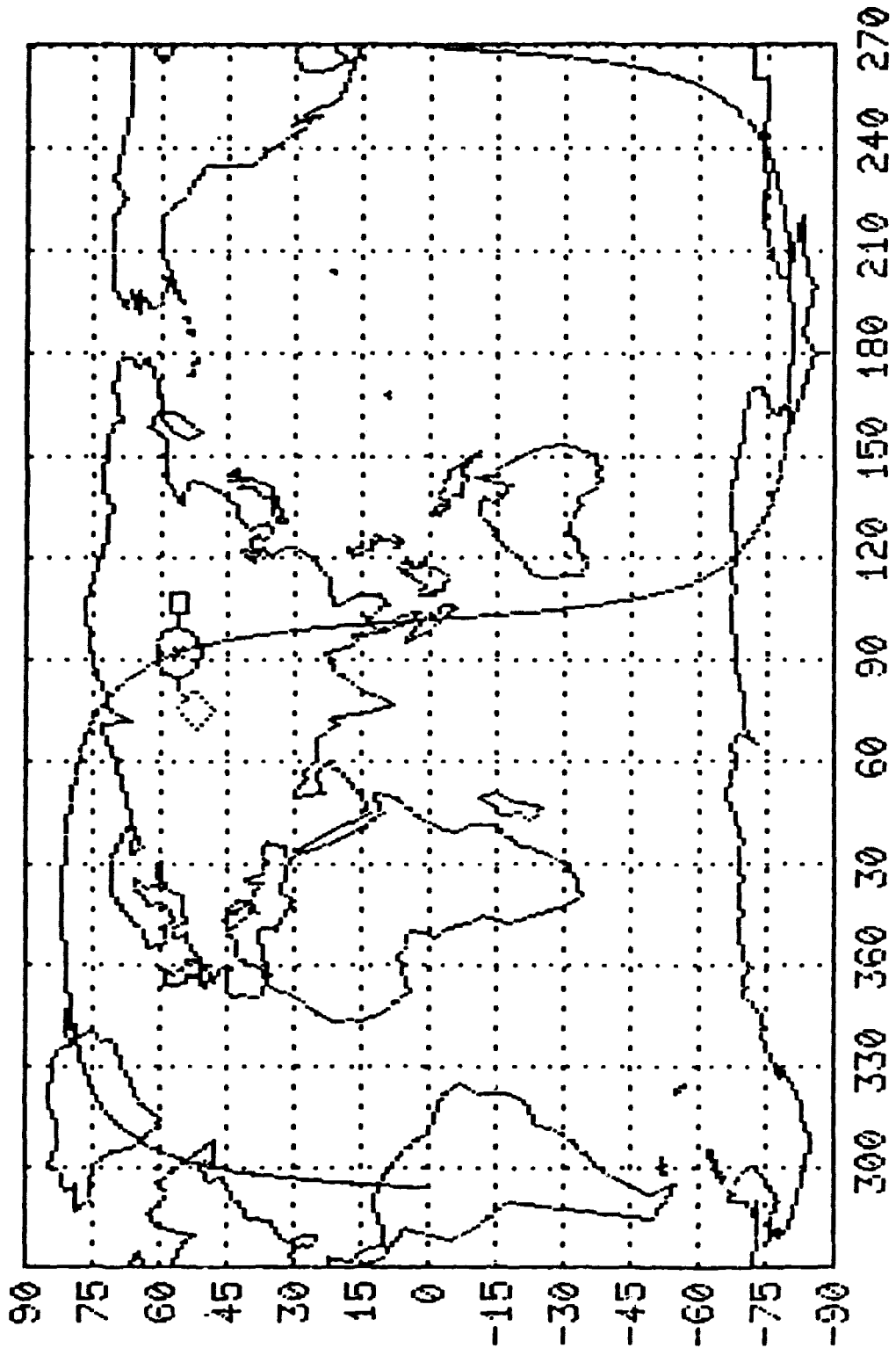
ORIGINAL PAGE IS  
OF POOR QUALITY



METEOR 1/ROCKET



ORIGINAL PAGE IS  
OF POOR QUALITY



METEOR 1 R/B

1969-64

INTELSAT 3-F5 R/B

4052

LAUNCH DATE: 26.09 Jul 1969

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 26 Jul 1969 (DAY 207)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 24

PIECES STILL IN ORBIT (1 JAN 84): 4

ORBIT CHARACTERISTICS:

INCLINATION: 30.37°

APOGEE: 5445 km

PERIGEE: 271 km

PERIOD: 147.2 min

TRUE ANOMALY:

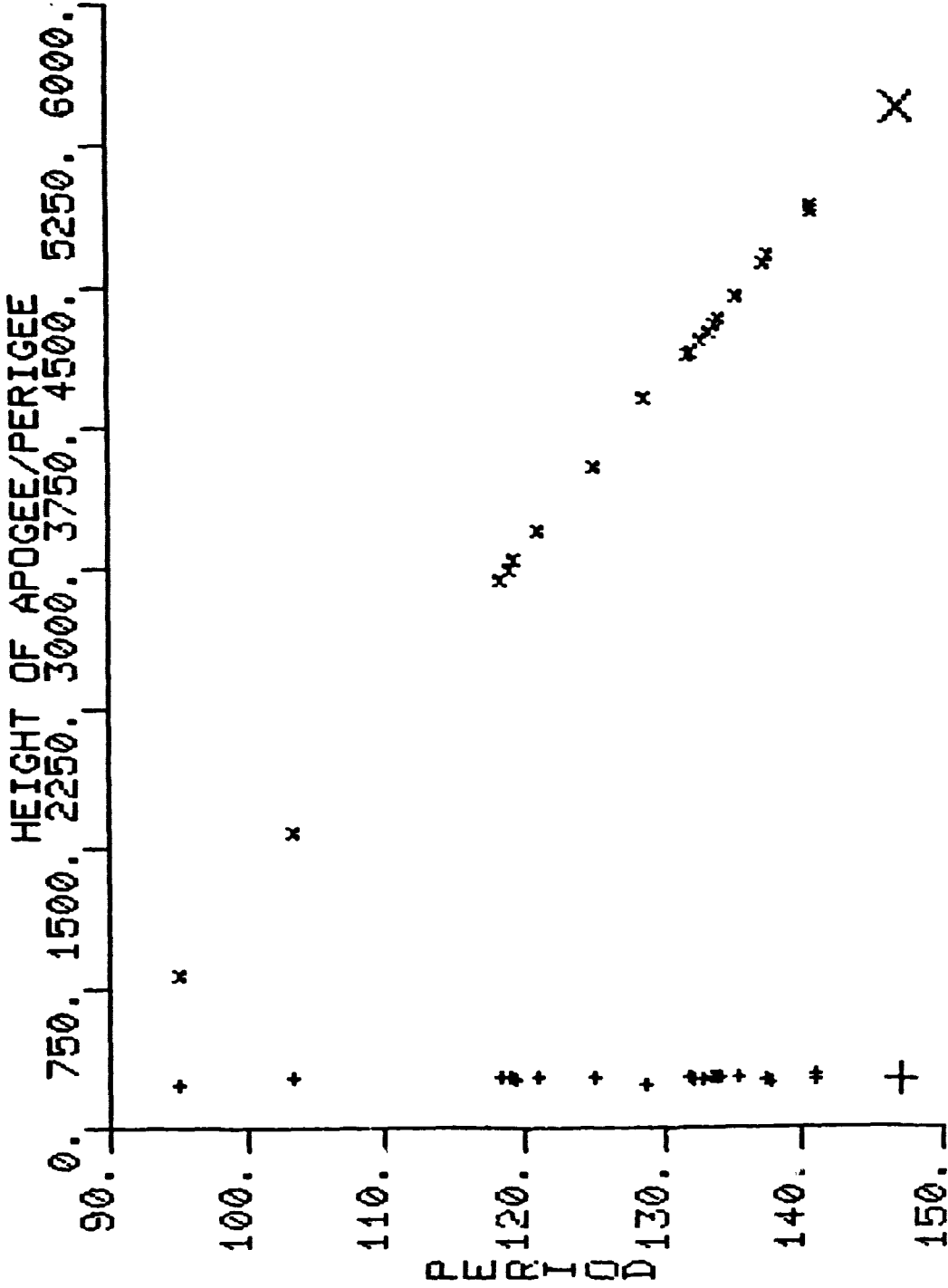
- COMMENTS:
- Orbit data derived from element set #1 on satellite 4052.
  - The launch vehicle was a LTTA-Delta rocket.
  - General shape was sphere-cone; length 1.32 m; dia. 94 m; weight 66 kg.
  - This launch attained orbit, however, the payload was unusable because a 3rd stage malfunction placed it into an incorrect orbit.
  - Four cataloged debris not from this event; satellites 5309, 13913, 13914 and 13915. They are not plotted on the following orbit distribution plot.

CAUSE: Unknown

1969-64

C-2

ORIGINAL PAGE IS  
OF POOR QUALITY



INTELSAT 3-F5 R/B

COMMENTS: • Insufficient data to show applicable ground trace for satellite 4052.

1969-64

1-89

1969-82

OPS 7613 R/B

4132

LAUNCH DATE: 30.57 Sep 1969

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 4 Oct 1969 (DAY 277)

TIME: 155309.2 GMT

LOCATION: 54 N/178 E

ALTITUDE: 919 km

PIECES CATALOGED (1 JAN 84): 241

PIECES STILL IN ORBIT (1 JAN 84): 123

ORBIT CHARACTERISTICS:

INCLINATION: 70.0°

APOGEE: 940 km

PERIGEE: 907 km

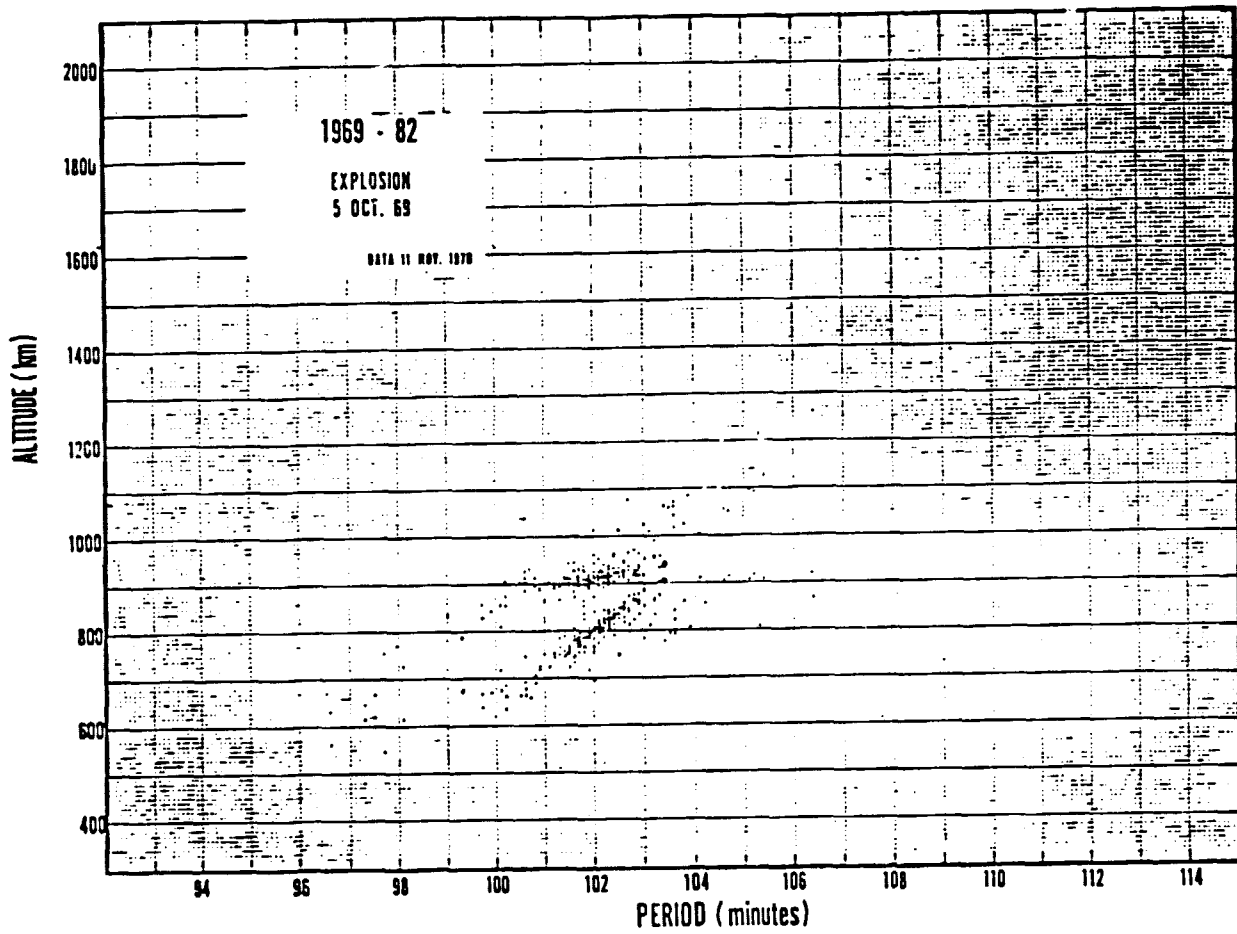
PERIOD: 103.4 min

TRUE ANOMALY: 11°

- COMMENTS:**
- Launched with Thorad-Agena D rocket. The rocket was not cataloged by NORAD for this launch because the rocket fragmented before its orbit could be developed.
  - NORAD cataloged the debris with a substitute parent: payload #9, Ops 7613, satellite 4132.
  - The orbital characteristics shown are from satellite 4132 and serve as an approximation of the unknown rocket orbit.
  - The ground trace was derived from the orbit of a large piece of debris and fits the rocket orbit at the point of fragmentation and approximates the actual rocket orbit for the remainder of the ground trace.

**CAUSE:** Unknown

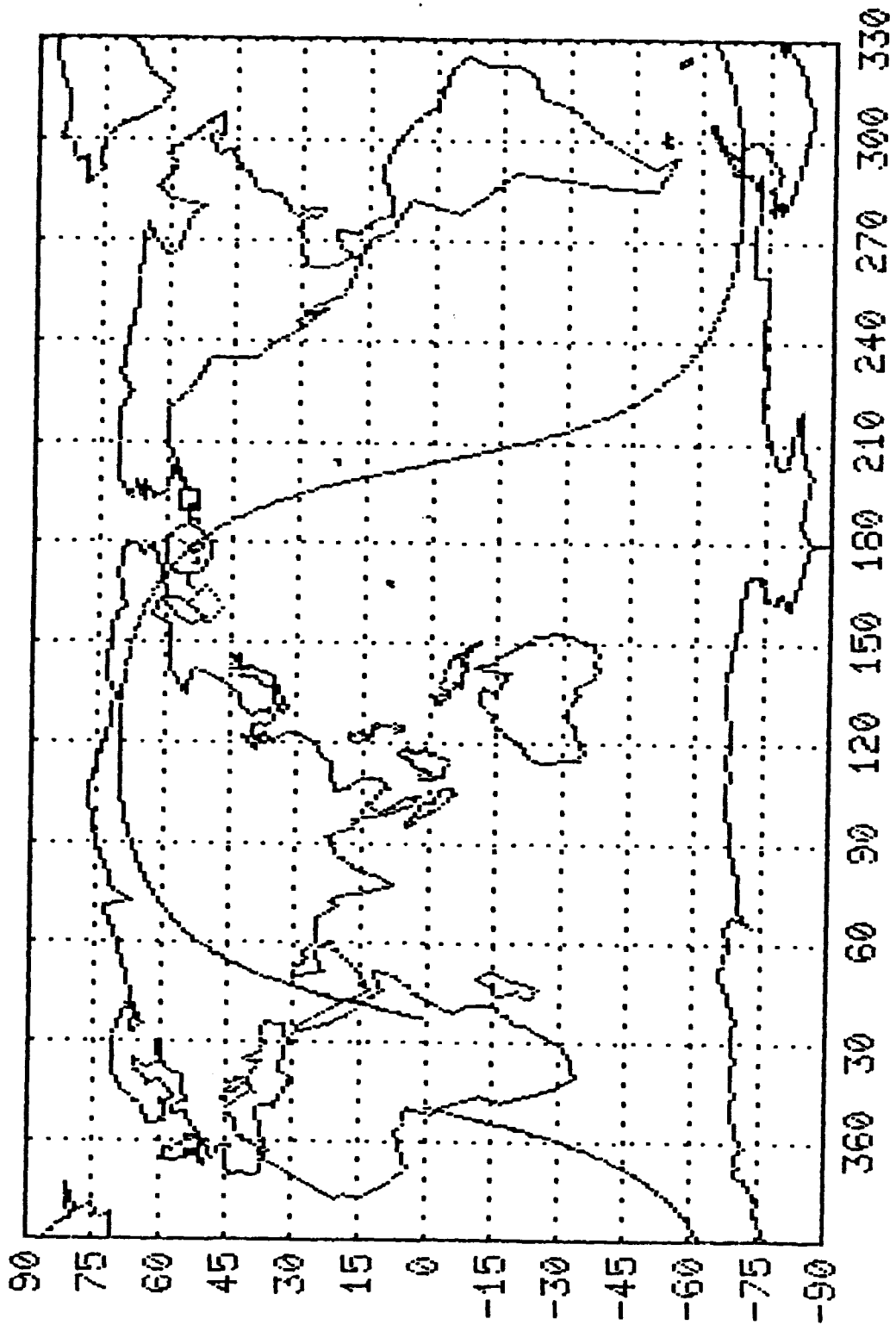
ORIGINAL PAGE IS  
OF POOR QUALITY



OPS 7613 R/B



ORIGINAL PAGE IS  
OF POOR QUALITY



OPS 7613 R/B

1970-25

NIMBUS-4 R/B

4367

LAUNCH DATE: 8.35 Apr 1970

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 17 Oct 1970 (DAY 290)

TIME: 031717.0 GMT

LOCATION: 50 S/142 E

ALTITUDE: 1076 km

PIECES CATALOGED (1 JAN 84): 330

PIECES STILL IN ORBIT (1 JAN 84): 282

ORBIT CHARACTERISTICS:

INCLINATION: 99.79°

APOGEE: 1094 km

PERIGEE: 1051 km

PERIOD: 106.7 min

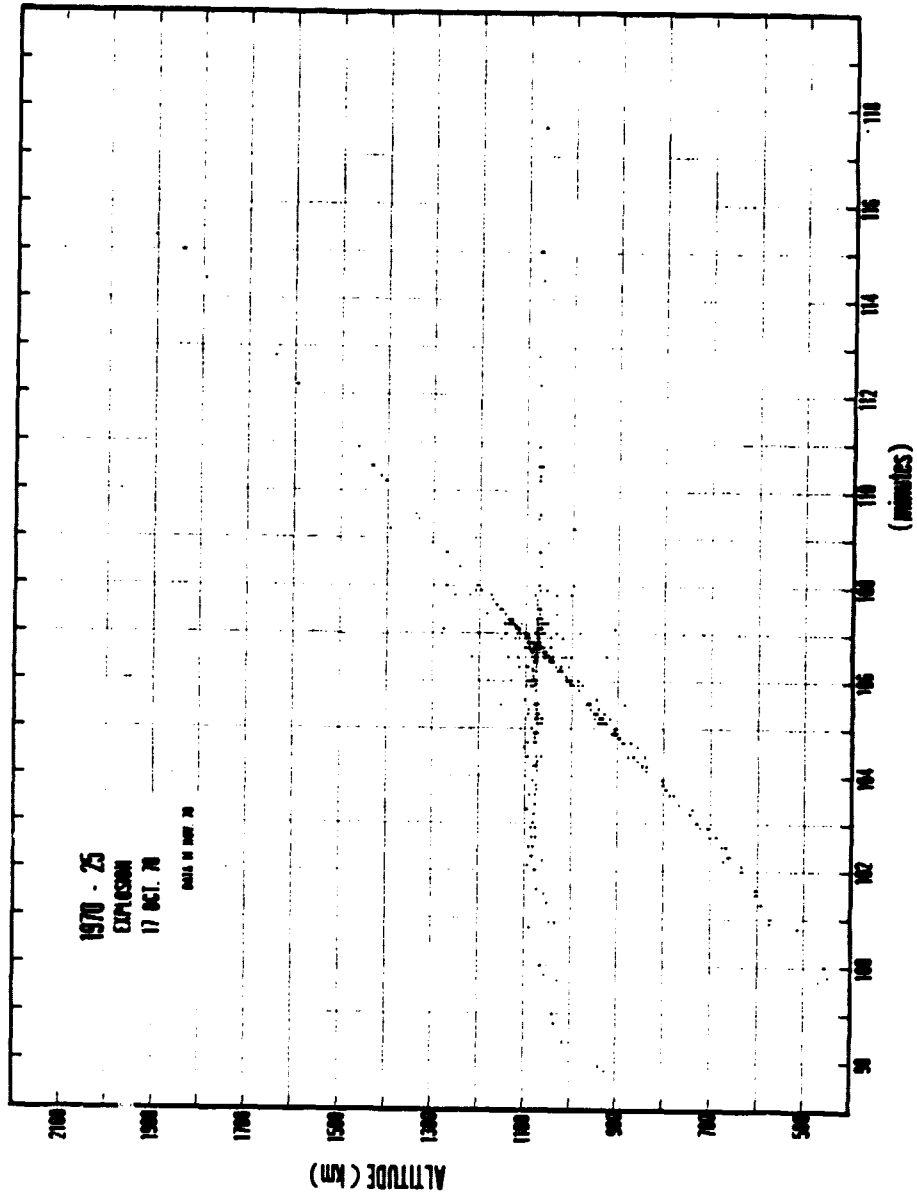
TRUE ANOMALY: 93°

**COMMENTS:**

- Launched with Thor-Agena D.
- General shape was cylinder; length 6 m; dia. 1.5 m; weight 700 kg?
- Orbit data derived from element set #966 for satellite 4367.

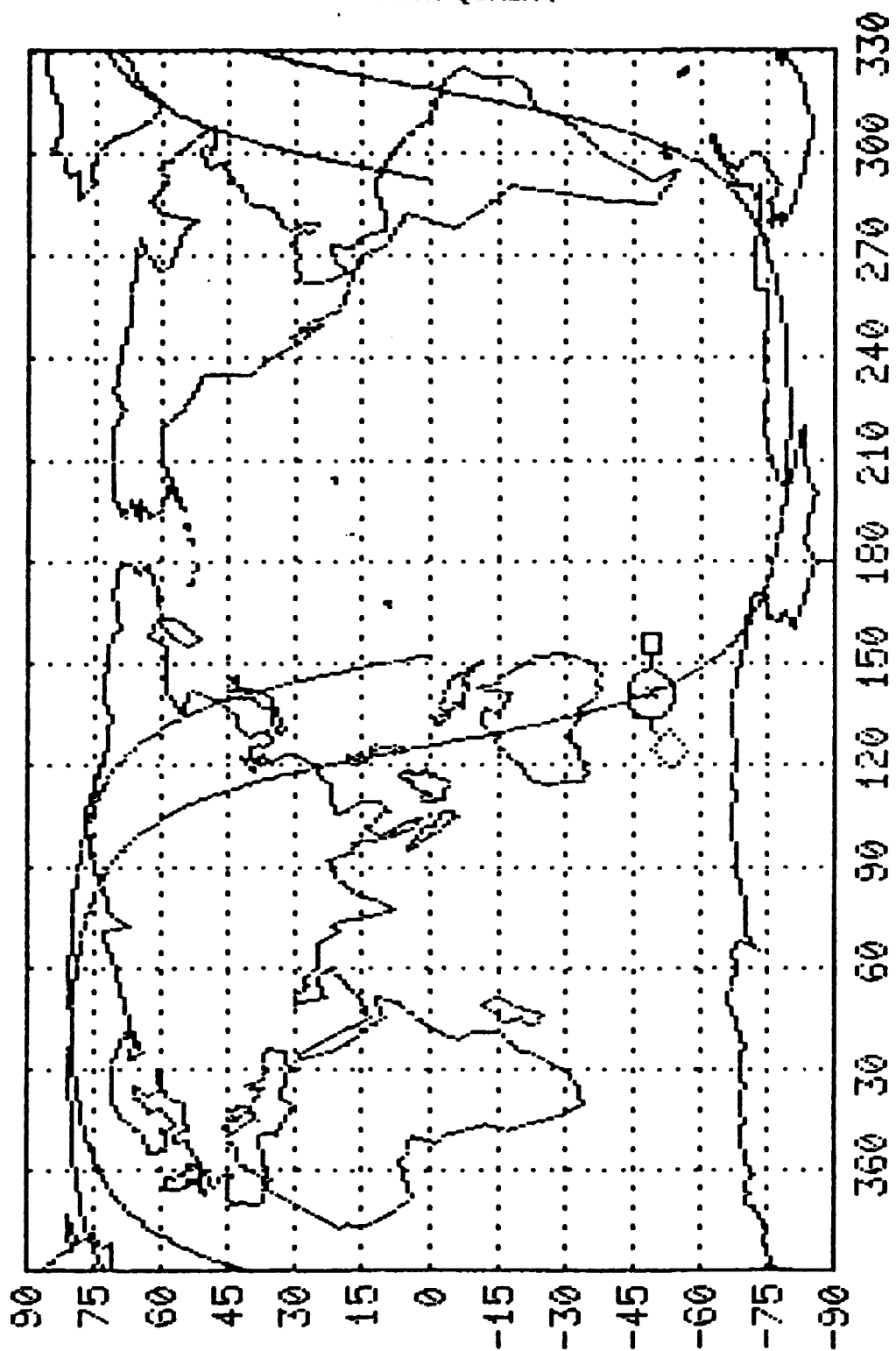
**CAUSE:** Unknown

ORIGINAL PAGE IS  
OF POOR QUALITY



NIMBUS-4 R/B

ORIGINAL PAGE IS  
OF POOR QUALITY



NIMBUS-4 R/B

1970-89

.COMSOS 374

4594

LAUNCH DATE: 23.18 Oct 1970

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 23 Oct 1970 (DAY 296)

TIME: 151323.6 GMT

LOCATION: 22 S/217 E

ALTITUDE: 1197 km

PIECES CATALOGED (1 JAN 84): 92

PIECES STILL IN ORBIT (1 JAN 84): 44

ORBIT CHARACTERISTICS:

INCLINATION: 62.94

APOGEE: 2132 km

PERIGEE: 529 km

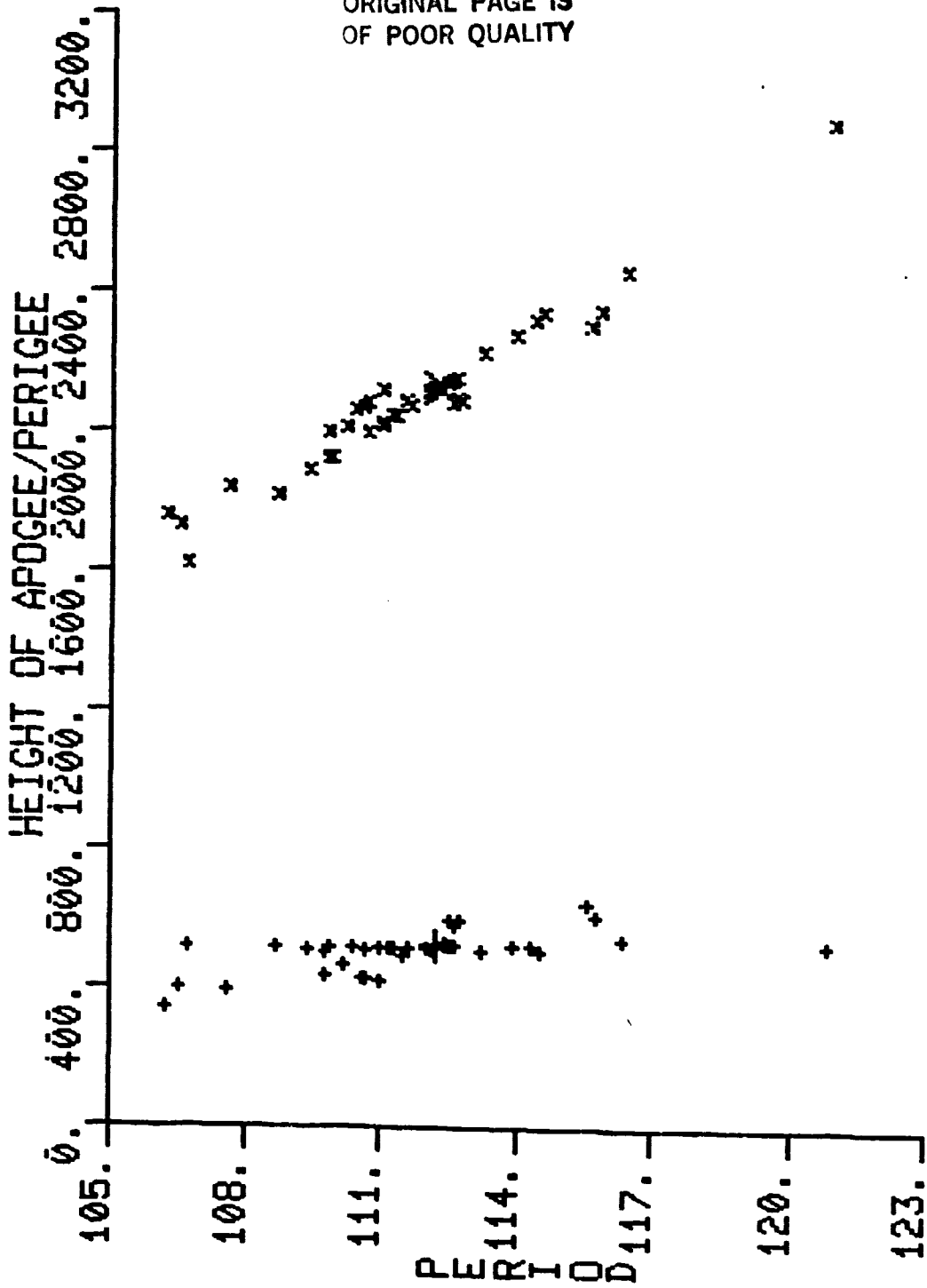
PERIOD: 112.3 min

TRUE ANOMALY: 273°

- COMMENTS:**
- Alleged Soviet ASAT test.
  - Orbit data derived from element set #2 for satellite 4594.
  - General shape was cylinder?; length 4 m?; dia. 2 m?
  - Break-up did not occur in the vicinity of the alleged target satellite (Kosmos 373).

**CAUSE:** Planned fragmentation as part of an alleged USSR ASAT test.

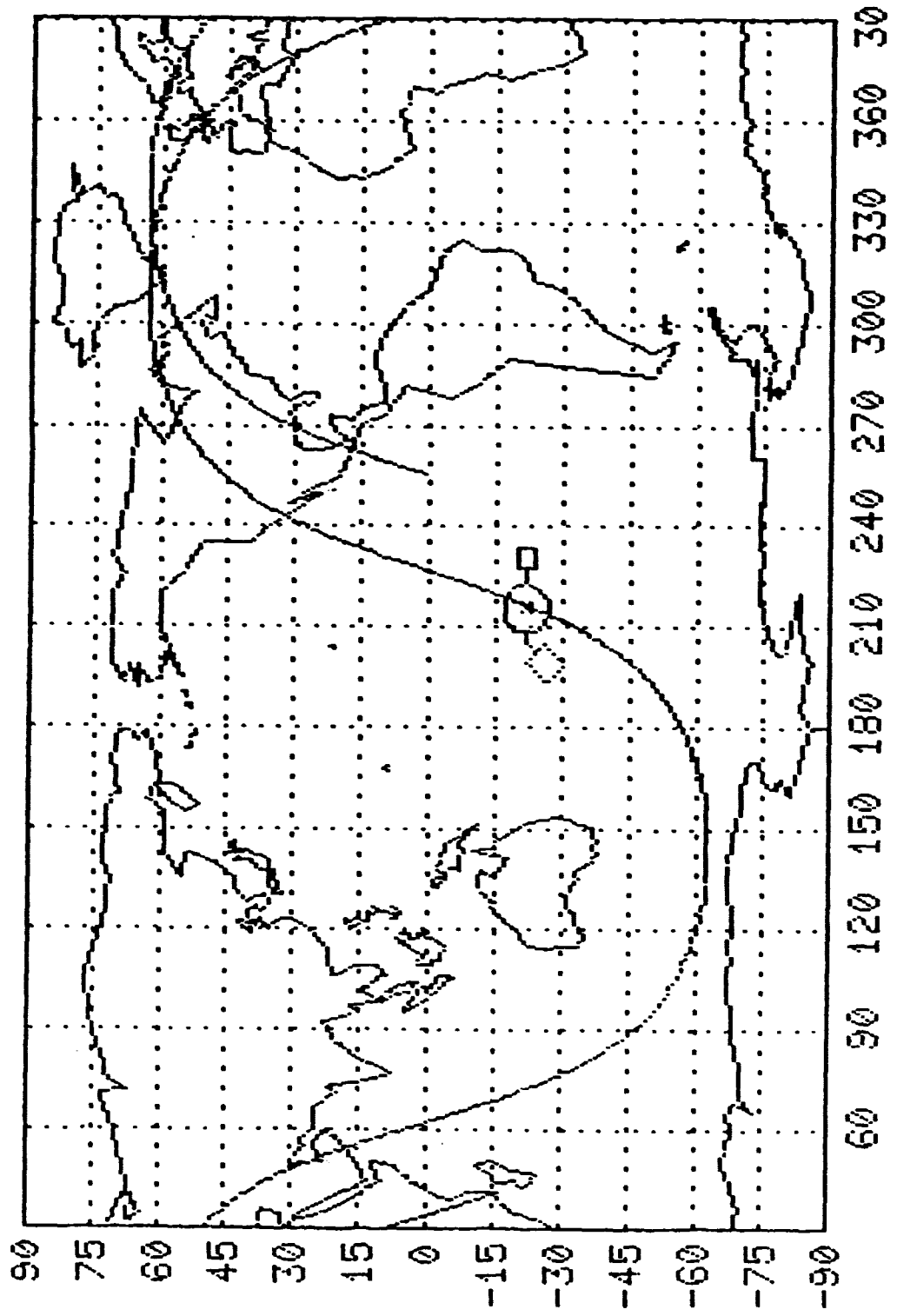
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 374



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 374

1970-91

COSMOS 375

4598

LAUNCH DATE: 30.09 Oct 1970

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 30 Oct 1970 (DAY 303)

TIME: 060003.77 GMT

LOCATION: 54 N/23 E

ALTITUDE: 565 km

PIECES CATALOGED (1 JAN 84): 41

PIECES STILL IN ORBIT (1 JAN 84): 31

ORBIT CHARACTERISTICS:

INCLINATION: 62.83°

APOGEE: 2186 km

PERIGEE: 464 km

PERIOD: 112.1 min

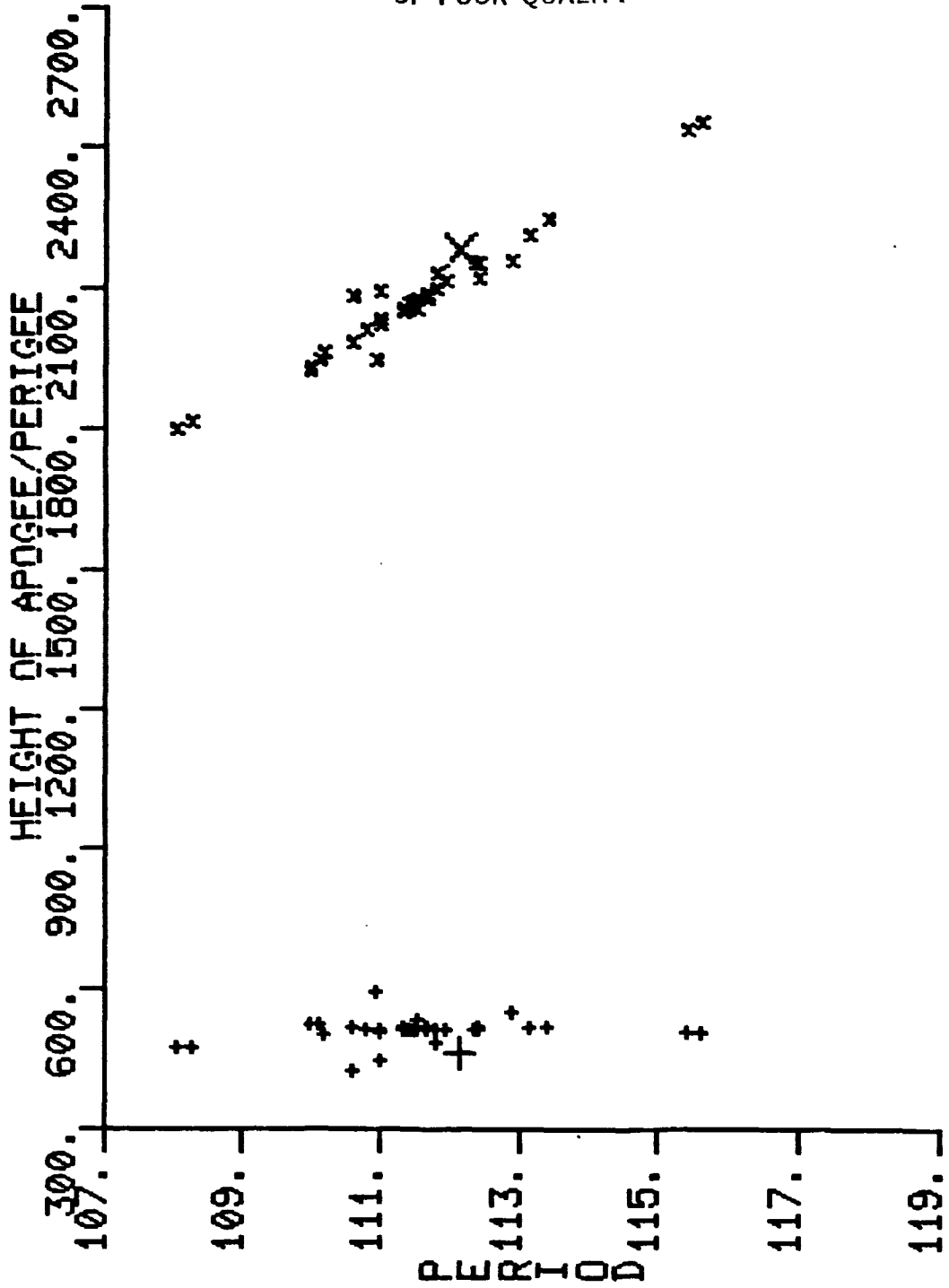
TRUE ANOMALY: 359°

- COMMENTS:**
- Alleged Soviet ASAT test.
  - Orbit data derived from element set #2 for satellite 4598.
  - General shape was cylinder?; length 4 m?; dai. 2 m?
  - Break-up occurred in the vicinity of the alleged target satellite (Kosmos 373).

**CAUSE:** Planned fragmentation as part of an alleged USSR ASAT test.

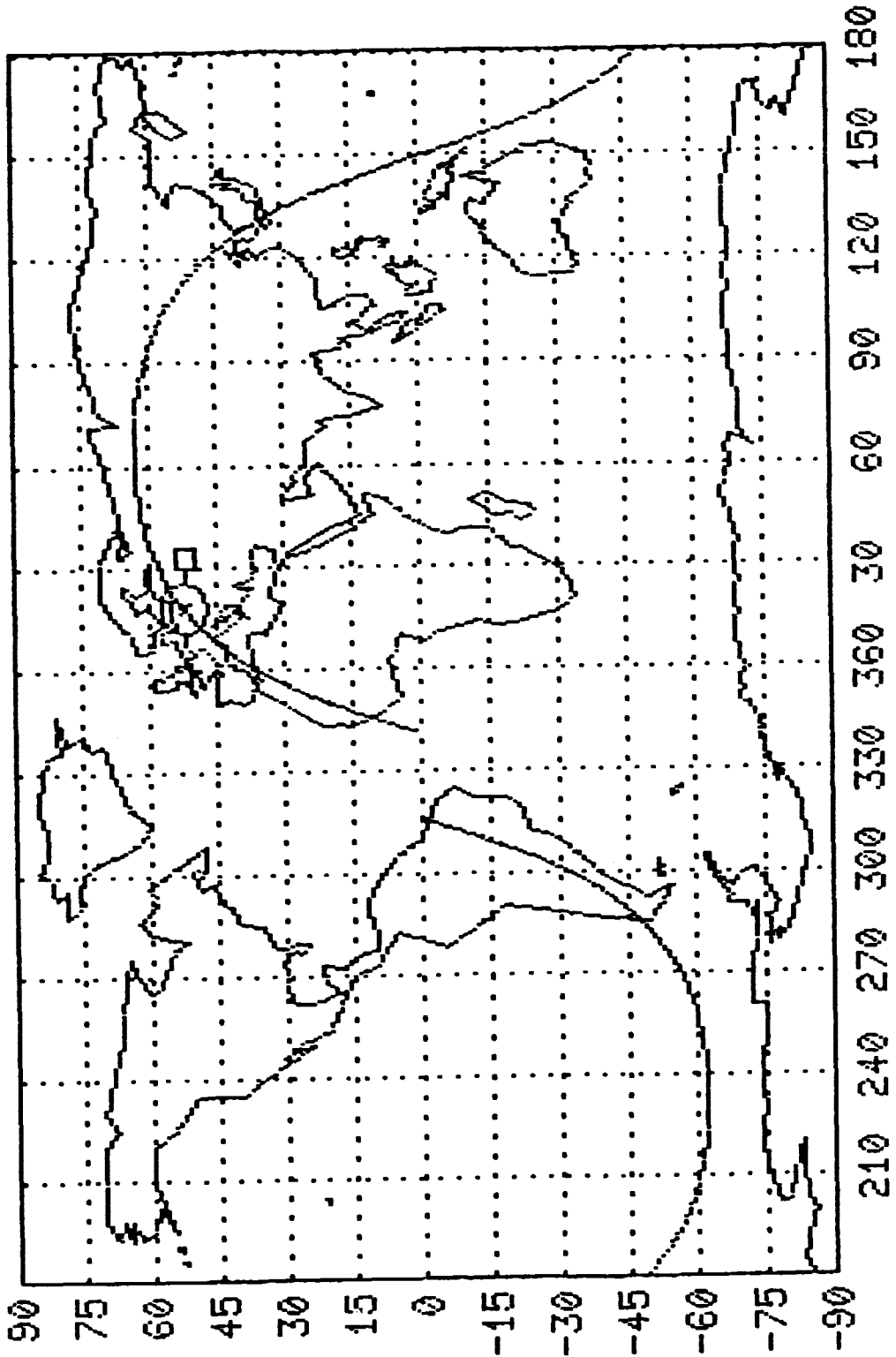
1970-91

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 375

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 375

1971-15

COSMOS 397

4964

LAUNCH DATE: 25.47 Feb 1971

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 25 Feb 1971 (DAY 56)

TIME: 143039.2 GMT

LOCATION: 54 N/21 E

ALTITUDE: 587 km

PIECES CATALOGED (1 JAN 84): 88

PIECES STILL IN ORBIT (1 JAN 84): 73

ORBIT CHARACTERISTICS:

INCLINATION: 65.76°

APOGEE: 2,200 km

PERIGEE: 575 km

PERIOD: 113.5 min

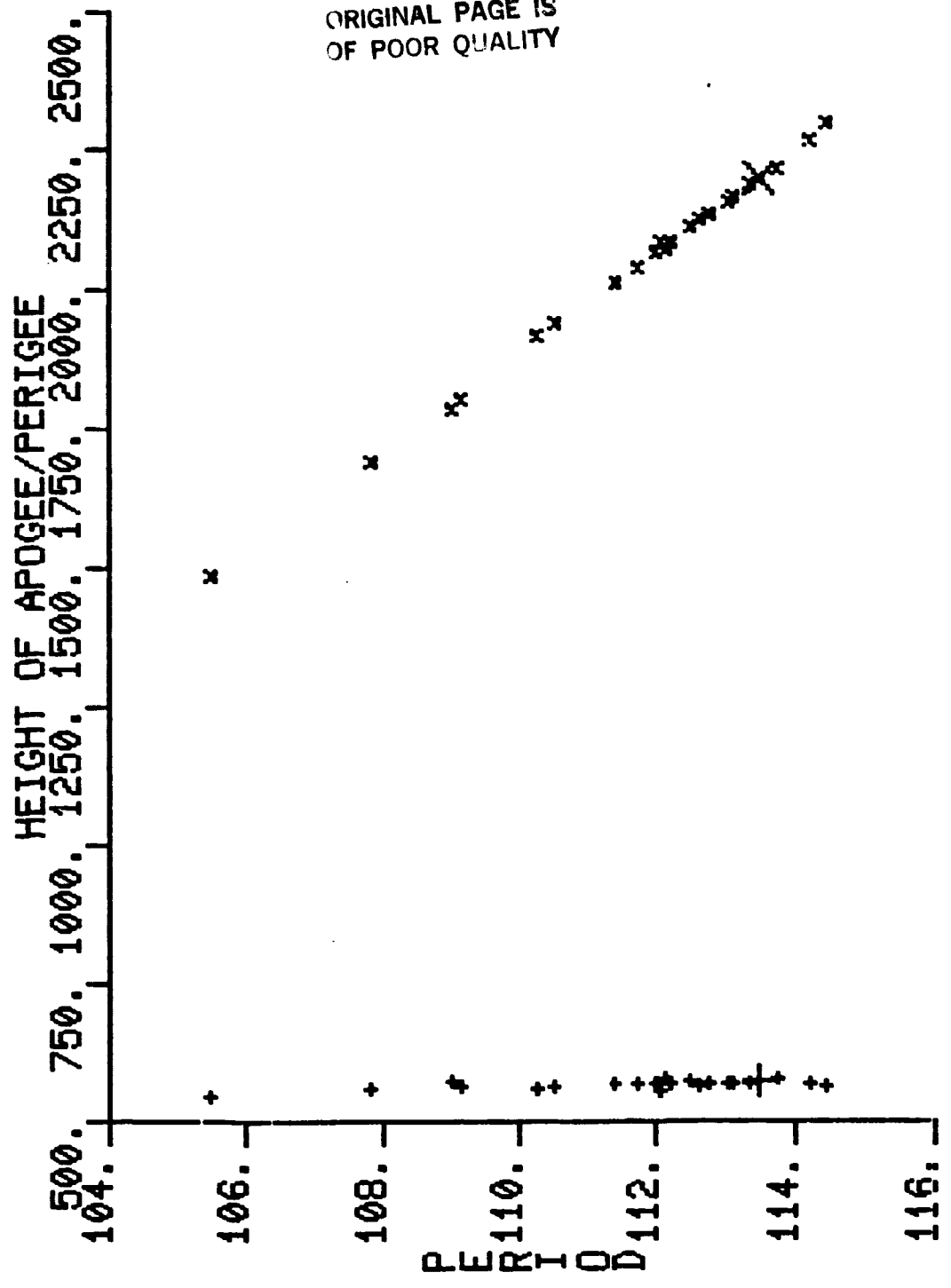
TRUE ANOMALY: 11°

- COMMENTS:**
- Alleged Soviet ASAT test.
  - General shape was cylinder; length 4 m?; dia. 2 m?
  - Orbit data derived from element set #2 for satellite 4964.
  - Break-up occurred in the vicinity of the alleged target satellite (Kosmos 394).

**CAUSE:** Planned fragmentation as part of an alleged USSR ASAT test.

1971-15

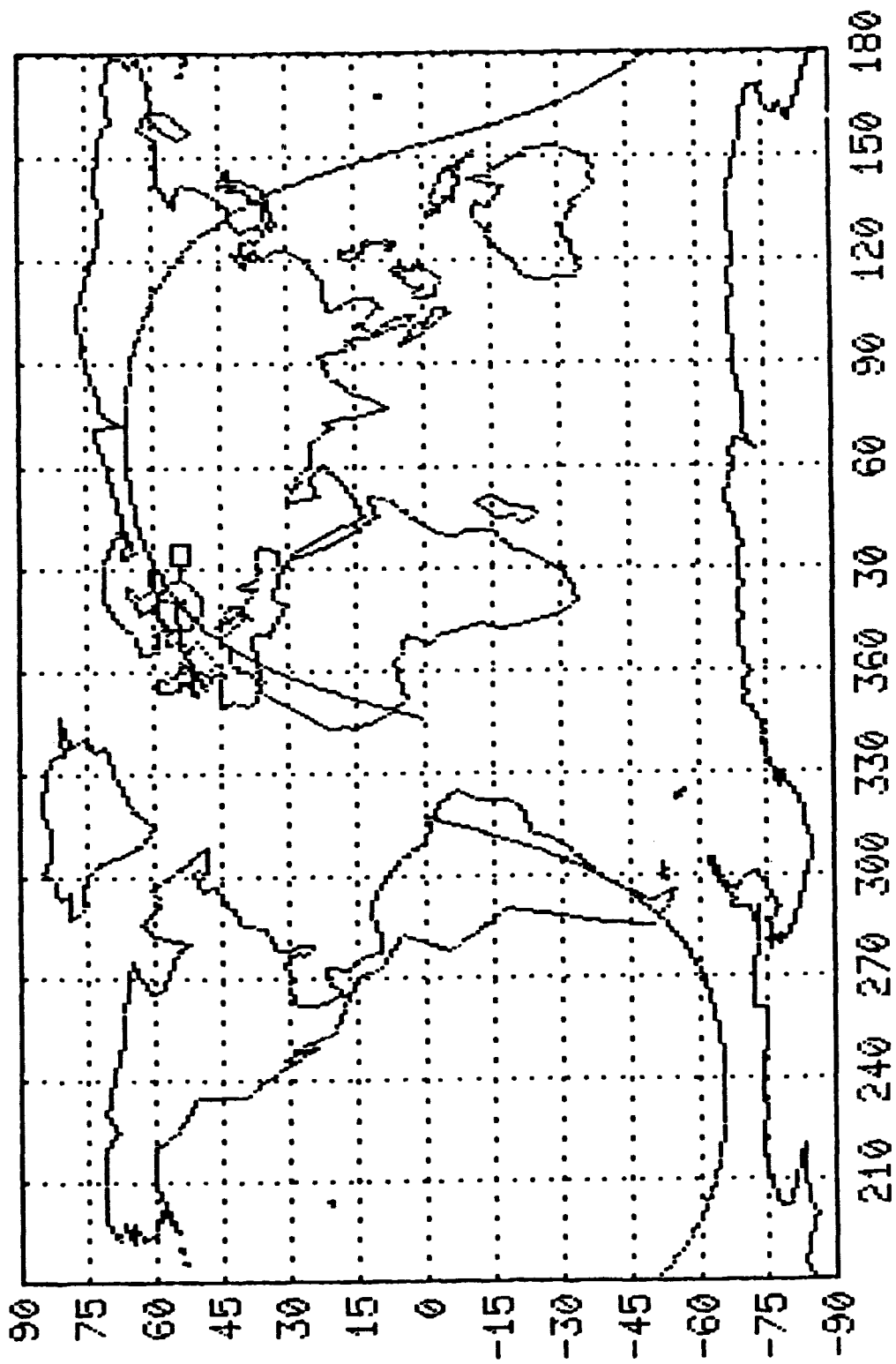
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 397



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 397

1971-106

COSMOS 462

5646

LAUNCH DATE: 3.55 Dec 1971

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 3 Dec 1971 (DAY 337)

TIME: 165102.2 GMT

LOCATION: 52 N/9 E

ALTITUDE: 231 km

PIECES CATALOGED (1 JAN 84): 27

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.88°

APOGEE: 1,654 km

PERIGEE: 231 km

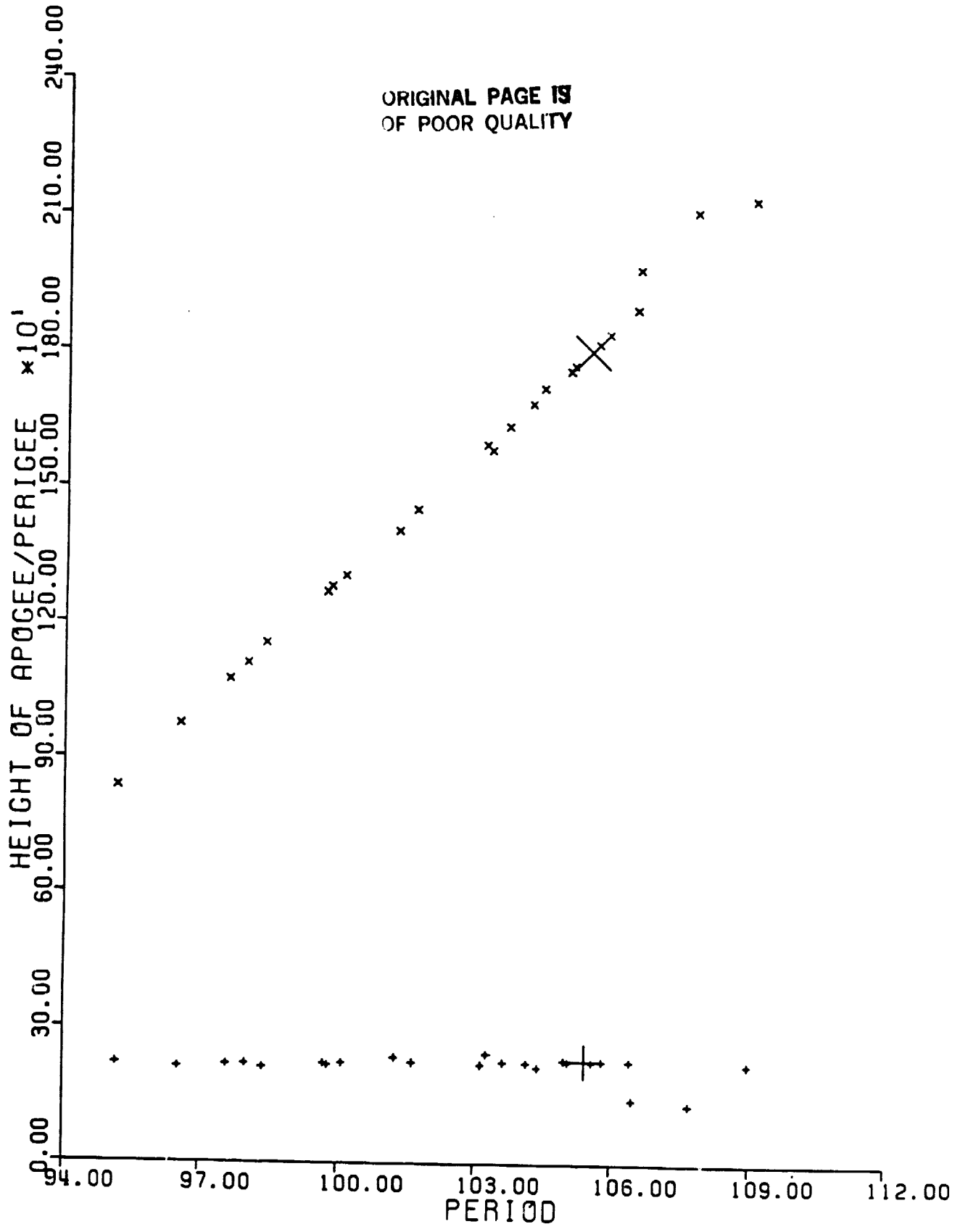
PERIOD: 103.8 min

TRUE ANOMALY: 359°

- COMMENTS:**
- Alleged Soviet ASAT test.
  - General shape was cylinder?; length 4 m?; dia. 2 m?
  - Orbit data derived from element set #1 for satellite 5646.
  - Break-up occurred at perigee in vicinity of the alleged target satellite (Kosmos 459).

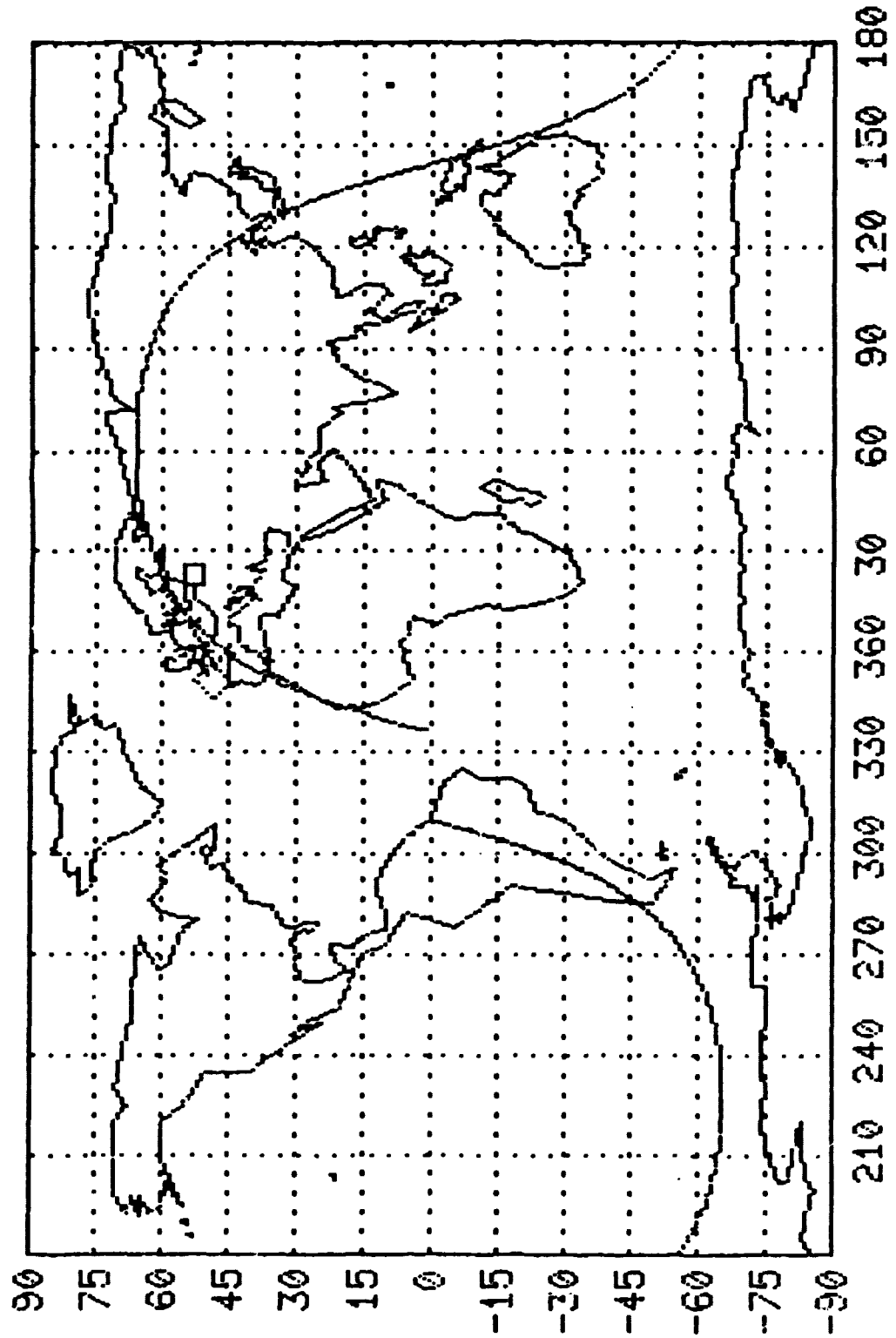
**CAUSE:** Planned fragmentation as part of an alleged USSR ASAT test.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 462

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 462

1972-58

LANDSAT 1 R/B

6127

LAUNCH DATE: 23.75 Jul 1972

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 22 May 1975 (DAY 142)

TIME: 182720.5 GMT

LOCATION: 34 S/46 E

ALTITUDE: 725 km

PIECES CATALOGED (1 JAN 84): 218

PIECES STILL IN ORBIT (1 JAN 84): 88

ORBIT CHARACTERISTICS:

INCLINATION: 98.34°

APOGEE: 909 km

PERIGEE: 633 km

PERIOD: 100.3 min

TRUE ANOMALY: 289°

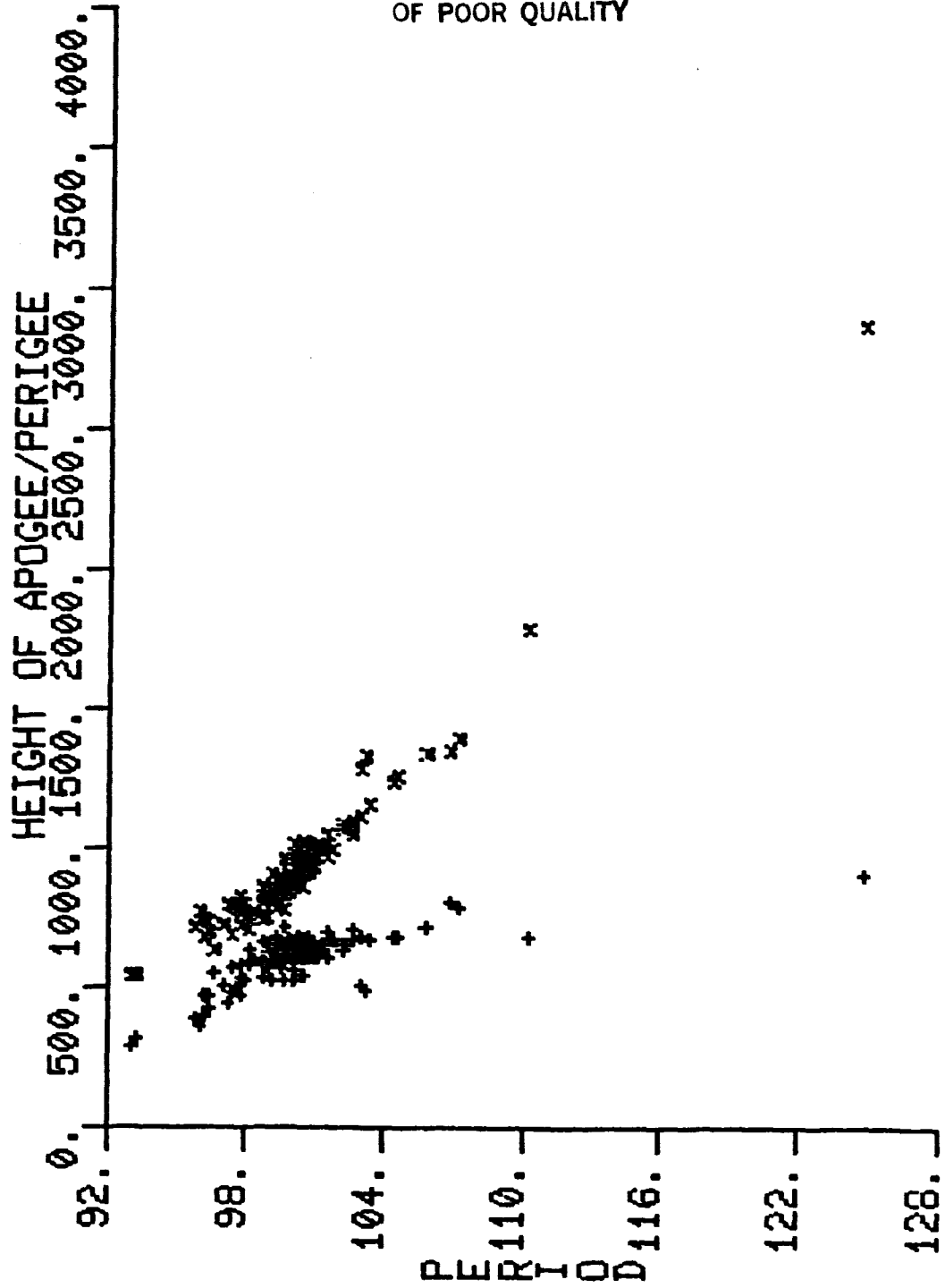
**COMMENTS:**

- Delta 2nd stage rocket.
- General shape was cylinder; length 4.9 m; dia. 1.43 m; weight 350 kg?
- Orbit data derived from element set #260 on satellite 6127.

**CAUSE:**

Hypergolic fuel ignition due to tank bulkhead rupture is the most probable cause.

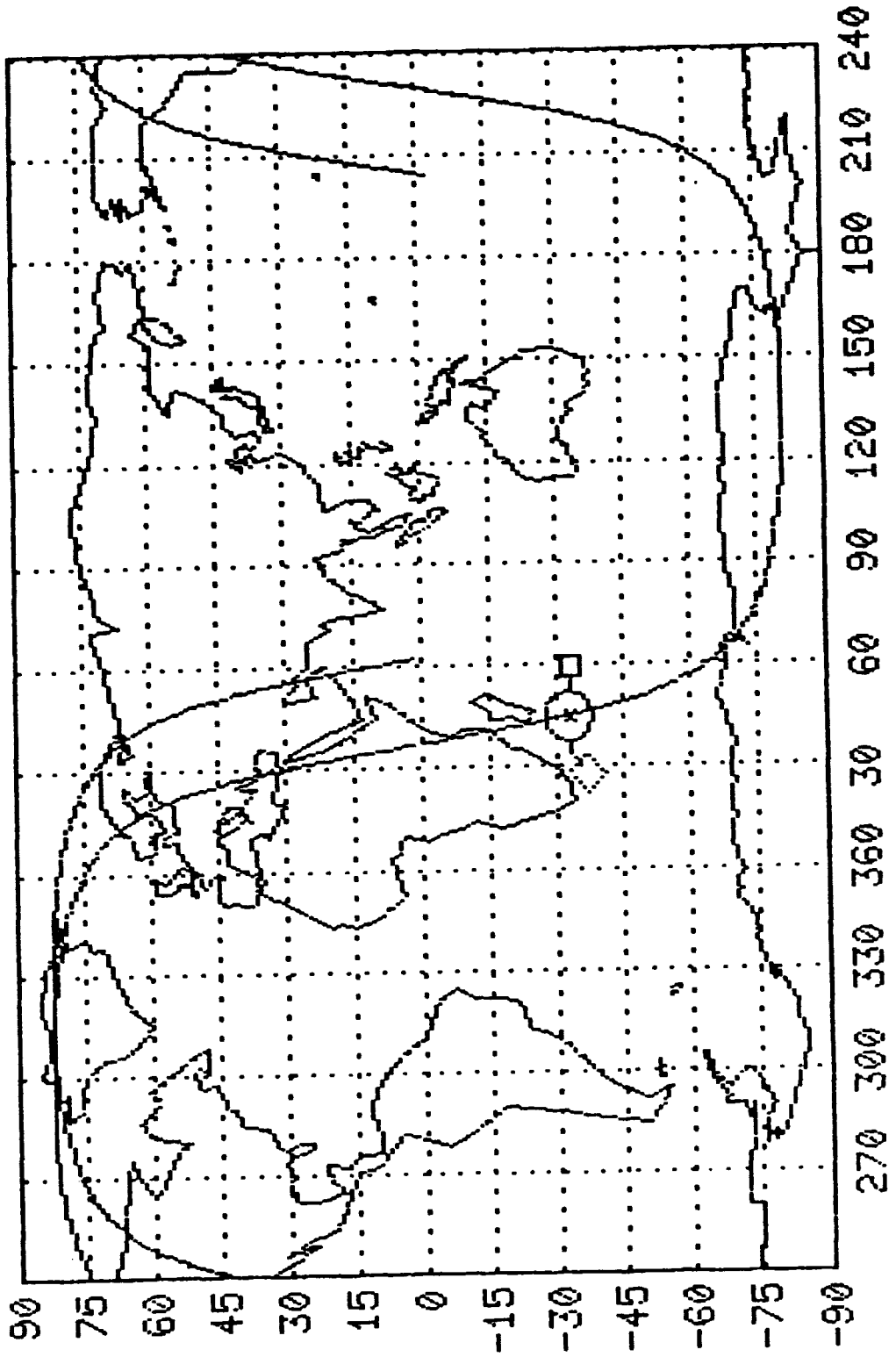
ORIGINAL PAGE IS  
OF POOR QUALITY



LANDSAT 1 ROCKET



ORIGINAL PAGE IS  
OF POOR QUALITY



1973-17

SALYUT 2 R/B

6399

LAUNCH DATE: 3.38 Apr 1973

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 3 Apr 1973 (DAY 93)

TIME: 223626.9 GMT

LOCATION: 45 N/290 E

ALTITUDE: 224 km

PIECES CATALOGED (1 JAN 84): 25

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 51.48°

APOGEE: 244 km

PERIGEE: 195 km

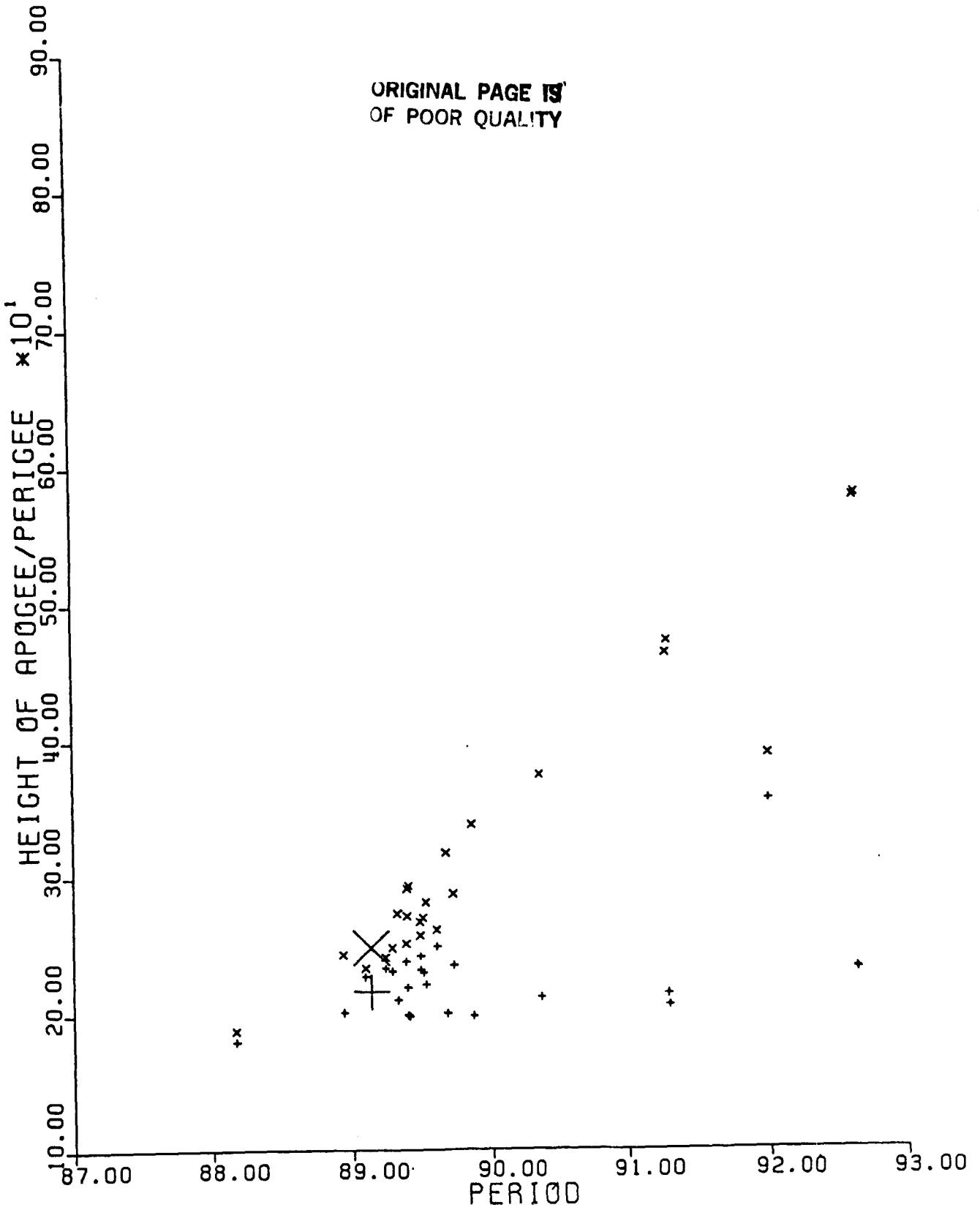
PERIOD: 88.9 min

TRUE ANOMALY: 112°

- COMMENTS:**
- General shape was cylinder; length 12 M?; dia. 4 m.?; weight 400 kg?
  - Orbit data derived from element set #1 for satellite 6399.

**CAUSE:** Unknown

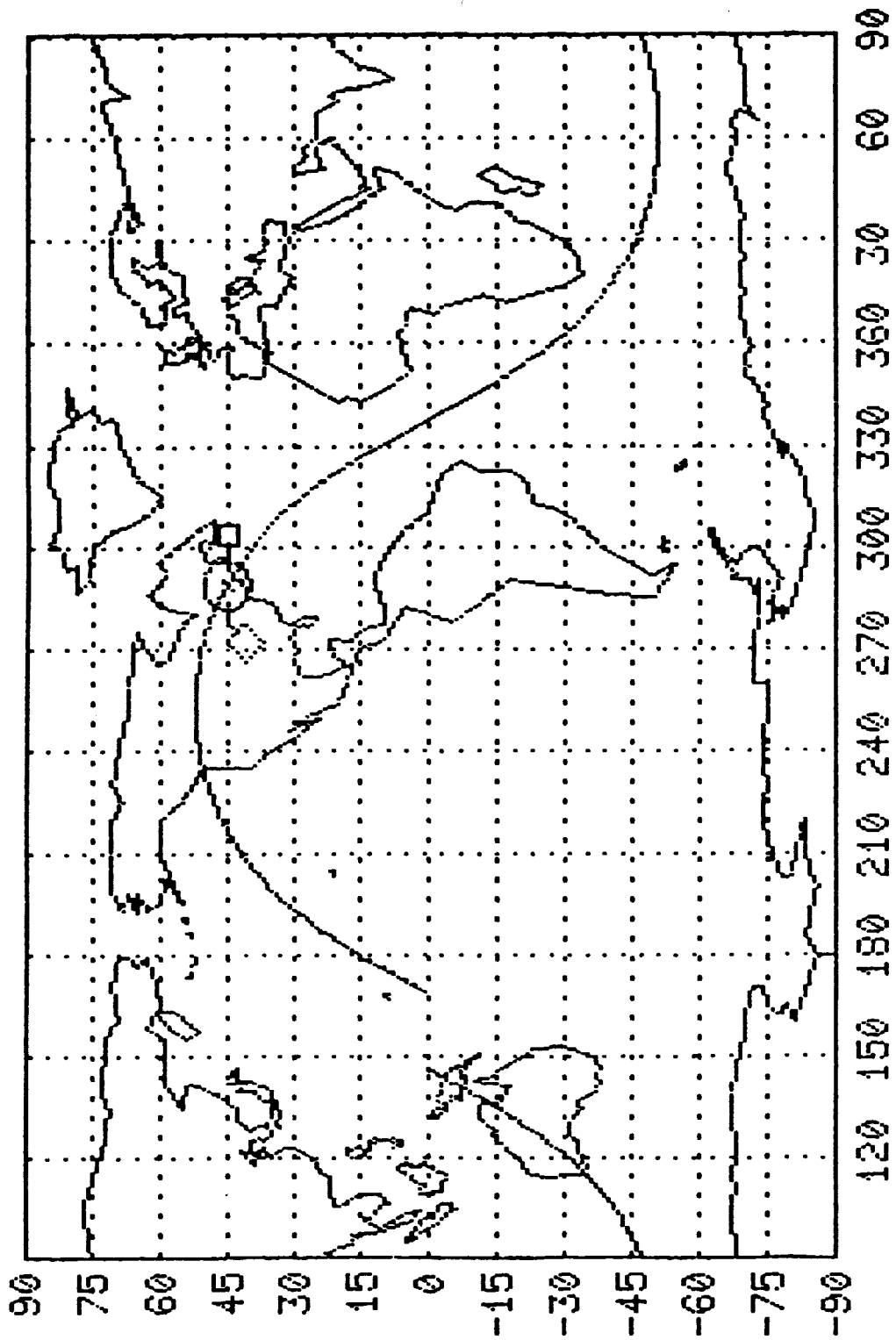
ORIGINAL PAGE IS  
OF POOR QUALITY



SALYUT 2 R/B

ORIGINAL PAGE IS  
OF POOR QUALITY

~~ORIGINAL PAGE IS  
OF POOR QUALITY~~



SALYUT 2 R/B

1973-21

COSMOS 554

6432

LAUNCH DATE: 19.38 Apr 1973

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 6 May 1973 (DAY 126)

TIME: 072333.0 GMT

LOCATION: 71 S/215 E

ALTITUDE: 309 km

PIECES CATALOGED (1 JAN 84): 196

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 72.85

APOGEE: 350 km

PERIGEE: 168 km

PERIOD: 89.7 min

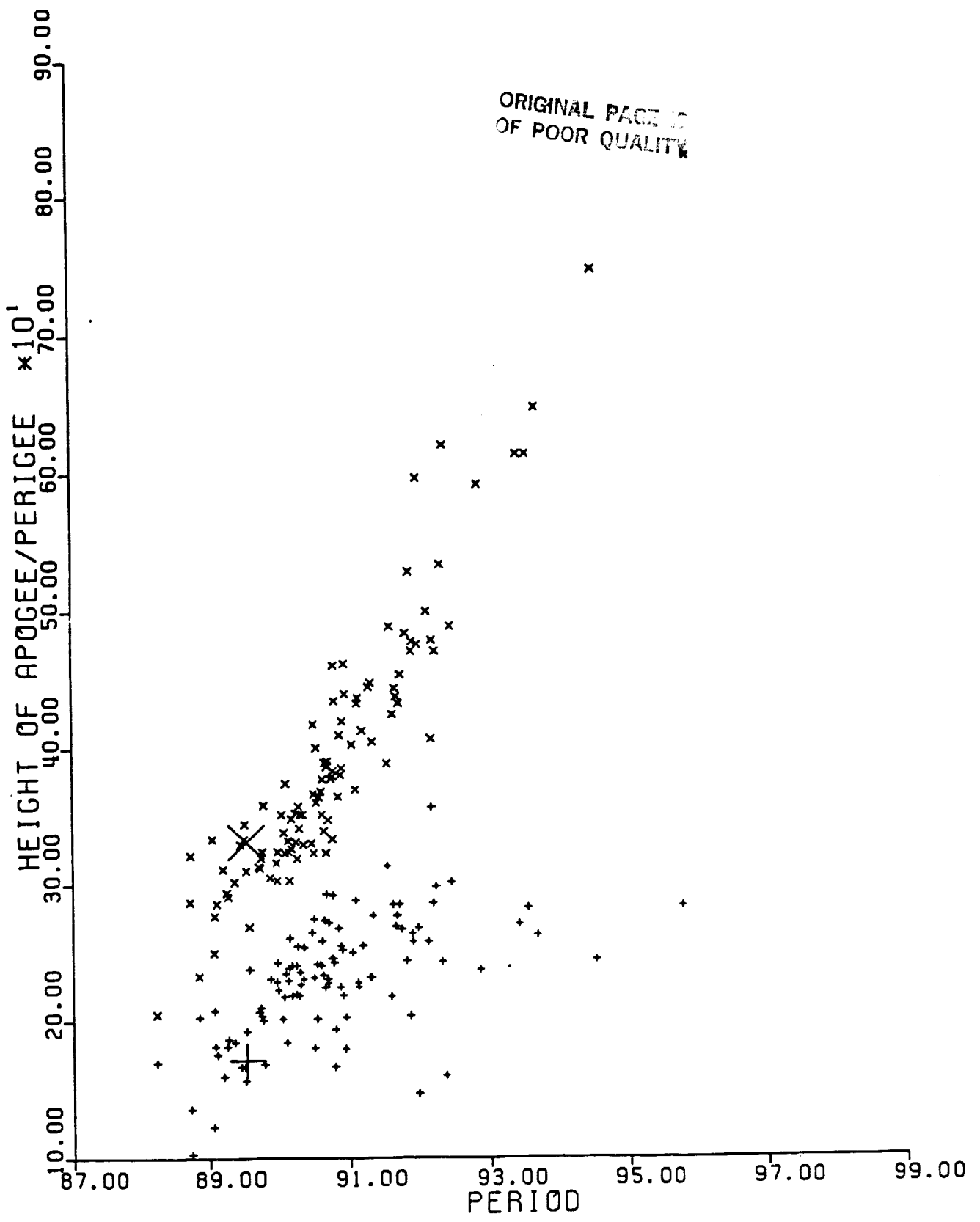
TRUE ANOMALY: 251°

- COMMENTS:**
- General shape was sphere-cylinder; length 5 m?; dia. 2 m?; weight 4000 kg?
  - 88 debris cataloged with "no initial elements." This count is contained in "pieces cataloged" count.

**CAUSE:** Intentionally destroyed by USSR

1973-21

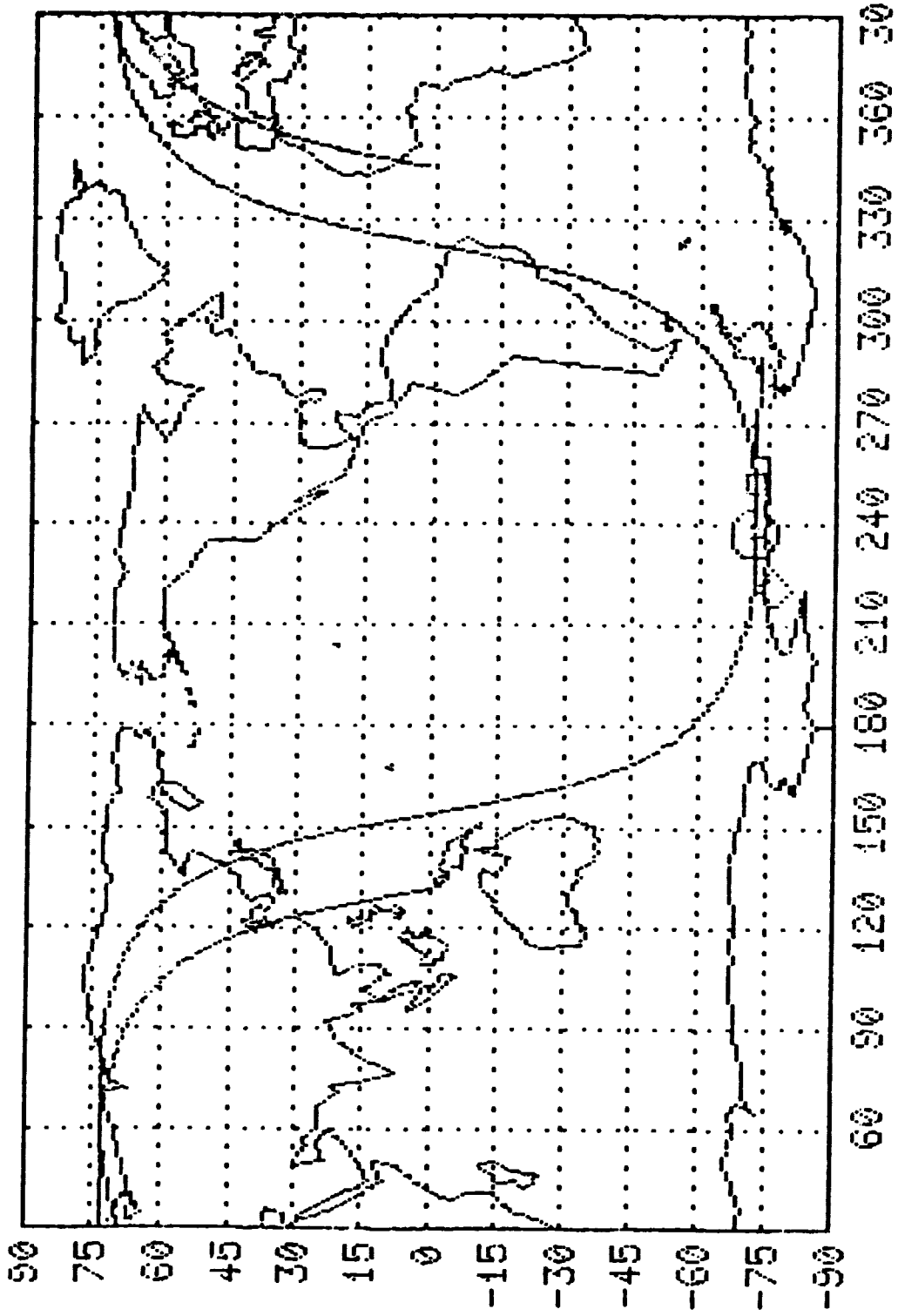
1-123



COSMOS 554



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 554

1973-86

NOAA-3 ROCKET

6921

LAUNCH DATE: 6.71 Nov 1973

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 28 Dec 1973 (DAY 362)

TIME: 090800.0 GMT

LOCATION: 26 S/176 E

ALTITUDE: 1513 km

PIECES CATALOGED (1 JAN 84): 180

PIECES STILL IN ORBIT (1 JAN 84): 168

ORBIT CHARACTERISTICS:

INCLINATION: 102.05°

APOGEE: 1513 km

PERIGEE: 1504 km

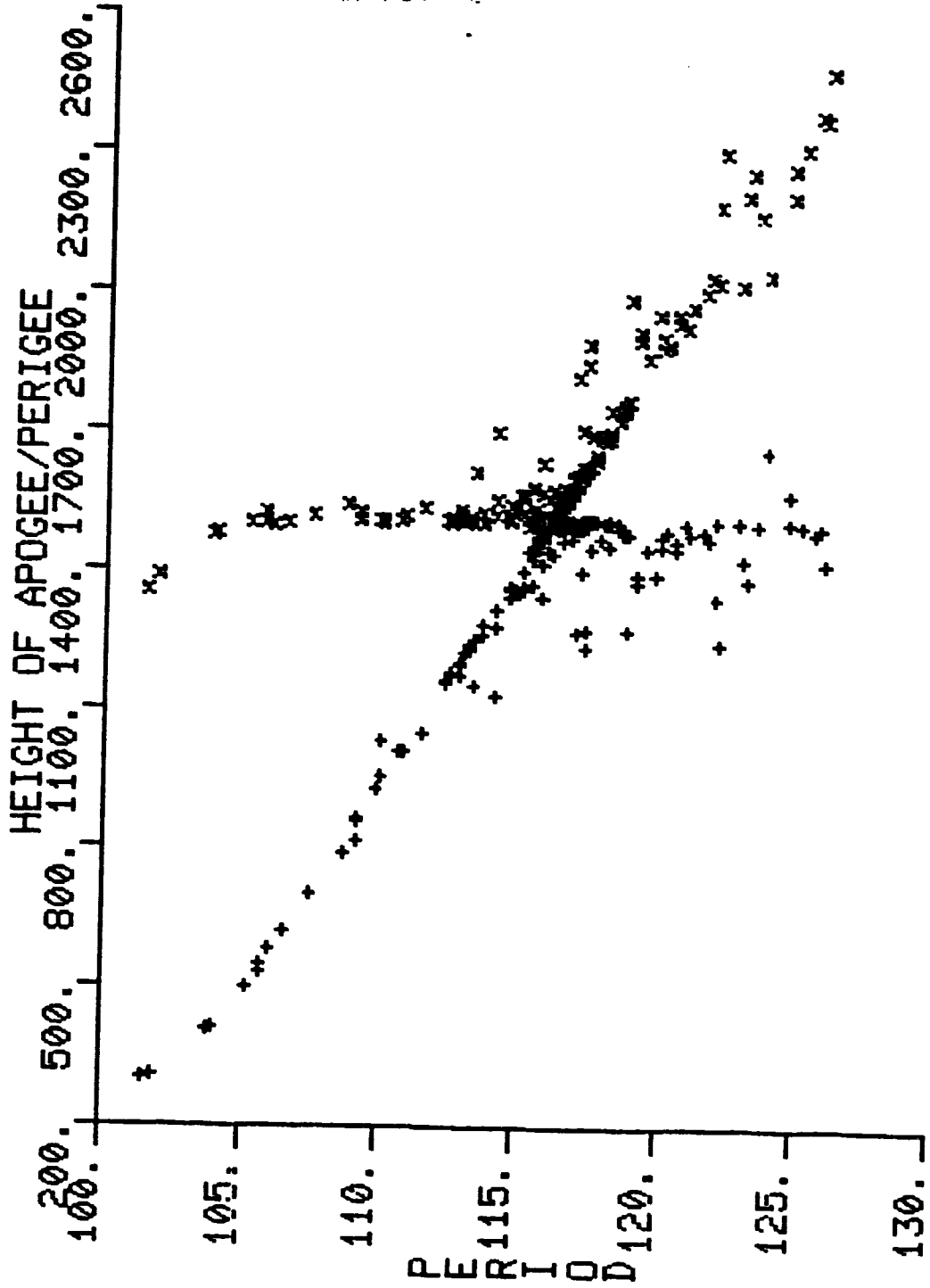
PERIOD: 116.2 min

TRUE ANOMALY: 181°

- COMMENTS:**
- Delta 2nd stage rocket
  - General shape was cylinder; length 4.9 m; dia. 1.43 m; weight 350?
  - Orbit data derived from element set #15 for satellite 6921.
  - Time and location of this event taken from analysis of NOAA-3 (ITOS-F) rocket body breakup by R. R. Dasenbrock, B. Kaufman and W. B. Heard and reported in AAS/AIAA paper No. AAS-75-040.

**CAUSE:** Hypergolic fuel ignition due to ruptured fuel tank bulkhead most probable cause.

ORIGINAL PAGE IS  
OF POOR QUALITY.



NOAA-3 ROCKET



1974-74

COSMOS 686 ROCKET

7448

LAUNCH DATE: 26.69 Sept 1974

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 26 Sept 1974 (DAY 269)

TIME: 213538.2 GMT

LOCATION: 26 N/94 E

ALTITUDE: 355 km

PIECES CATALOGED (1 JAN 84): 19

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 70.9°

APOGEE: 456 km

PERIGEE: 259 km

PERIOD: 91.7 min

TRUE ANOMALY:

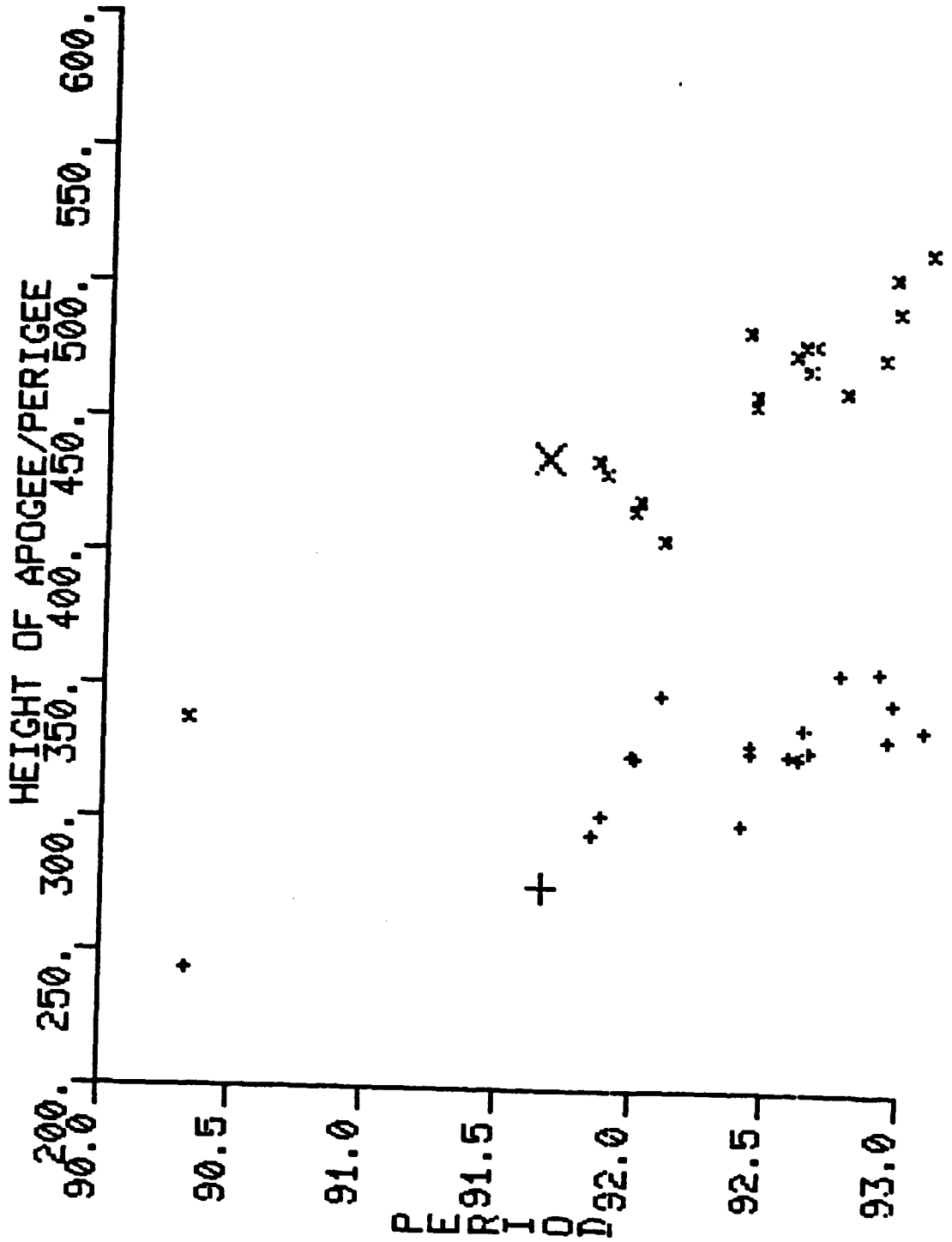
COMMENTS:

- Orbit data derived from element set #1 for satellite 7448
- General shape was cylinder; length 8 m; dia. 1.65 m; weight 1500 kg?
- All fragments were launched forward except one. This fragment was cataloged after it had decayed.

CAUSE: Unknown

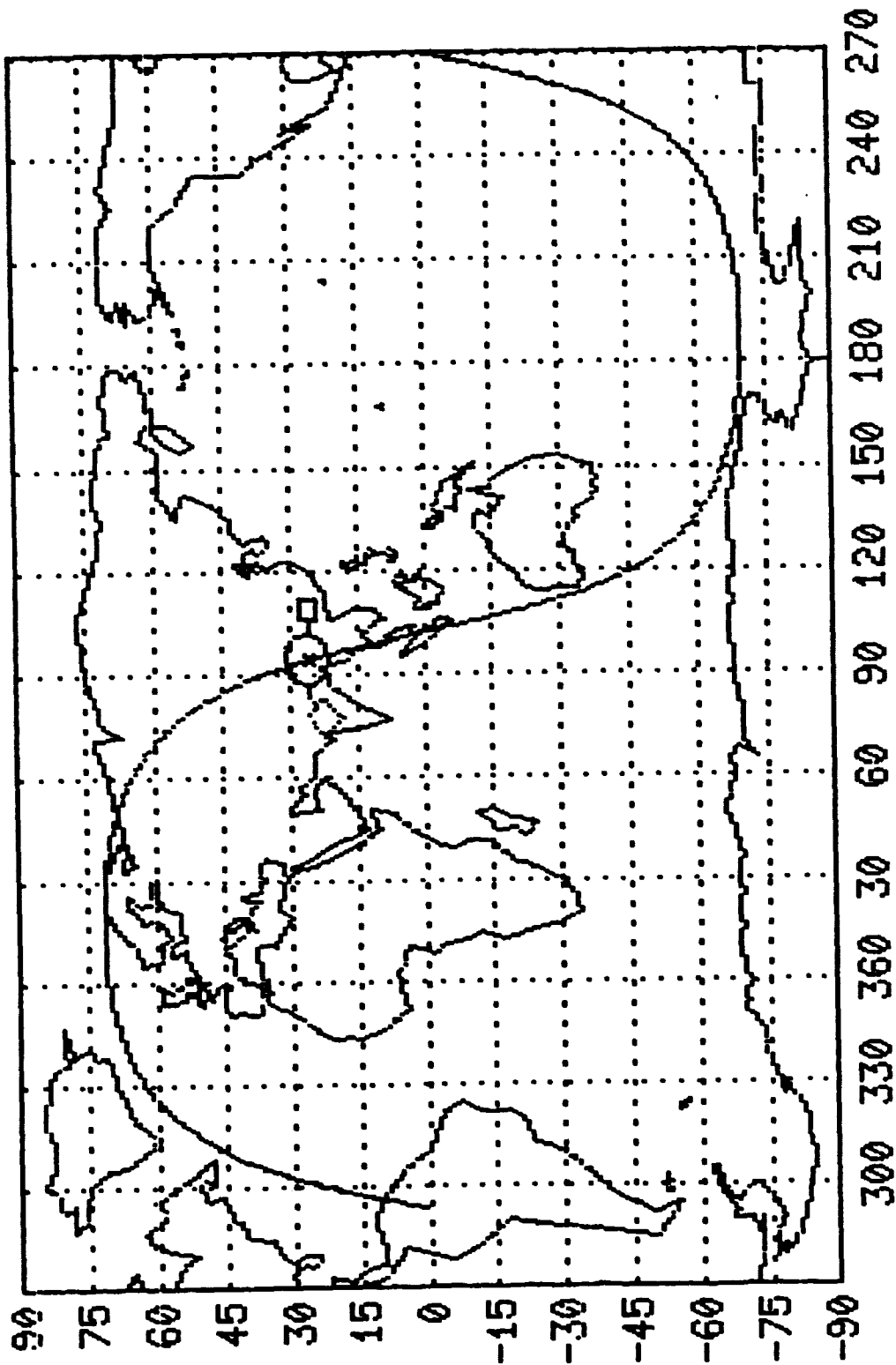
1974-74

ORIGINAL PAGE IS  
OF POOR QUALITY





ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 686

1974-89

NOAA-4 R/B

7532

LAUNCH DATE: 15.72 Nov 1974

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 20 Aug 1975 (DAY 232)

TIME: 130638.8 GMT

LOCATION: 52 S/278 E

ALTITUDE: 1460 km

PIECES CATALOGED (1 JAN 84): 132

PIECES STILL IN ORBIT (1 JAN 84): 124

ORBIT CHARACTERISTICS:

INCLINATION: 101.69°

APOGEE: 1460 km

PERIGEE: 1445 km

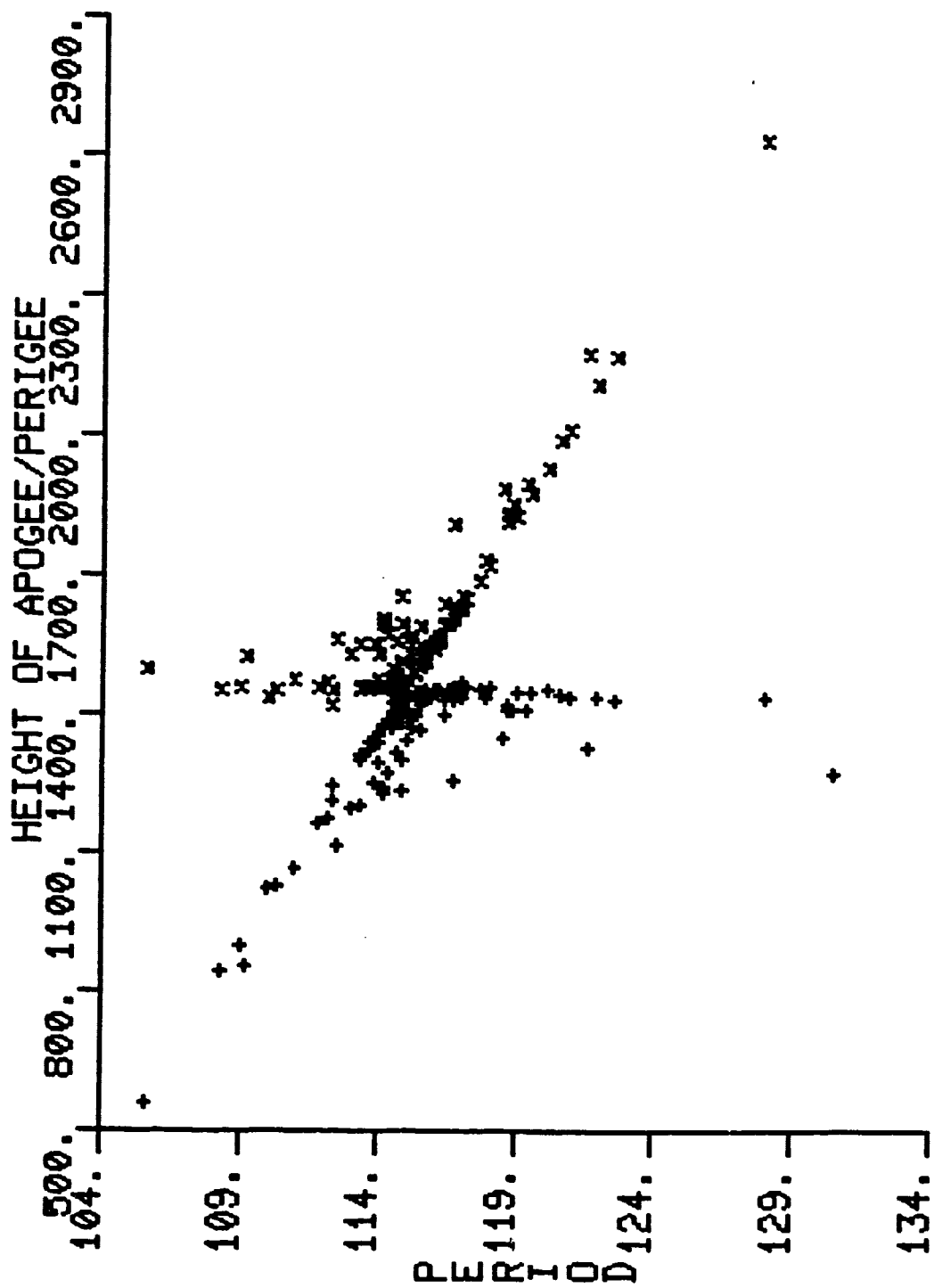
PERIOD: 114.9 min

TRUE ANOMALY: 185°

- COMMENTS:**
- Delta 2nd stage rocket.
  - General shape was cylinder; length 4.9 m; dia. 1.43 m; weight 350 kg?
  - Orbit data derived from element set #64 on satellite 7532.

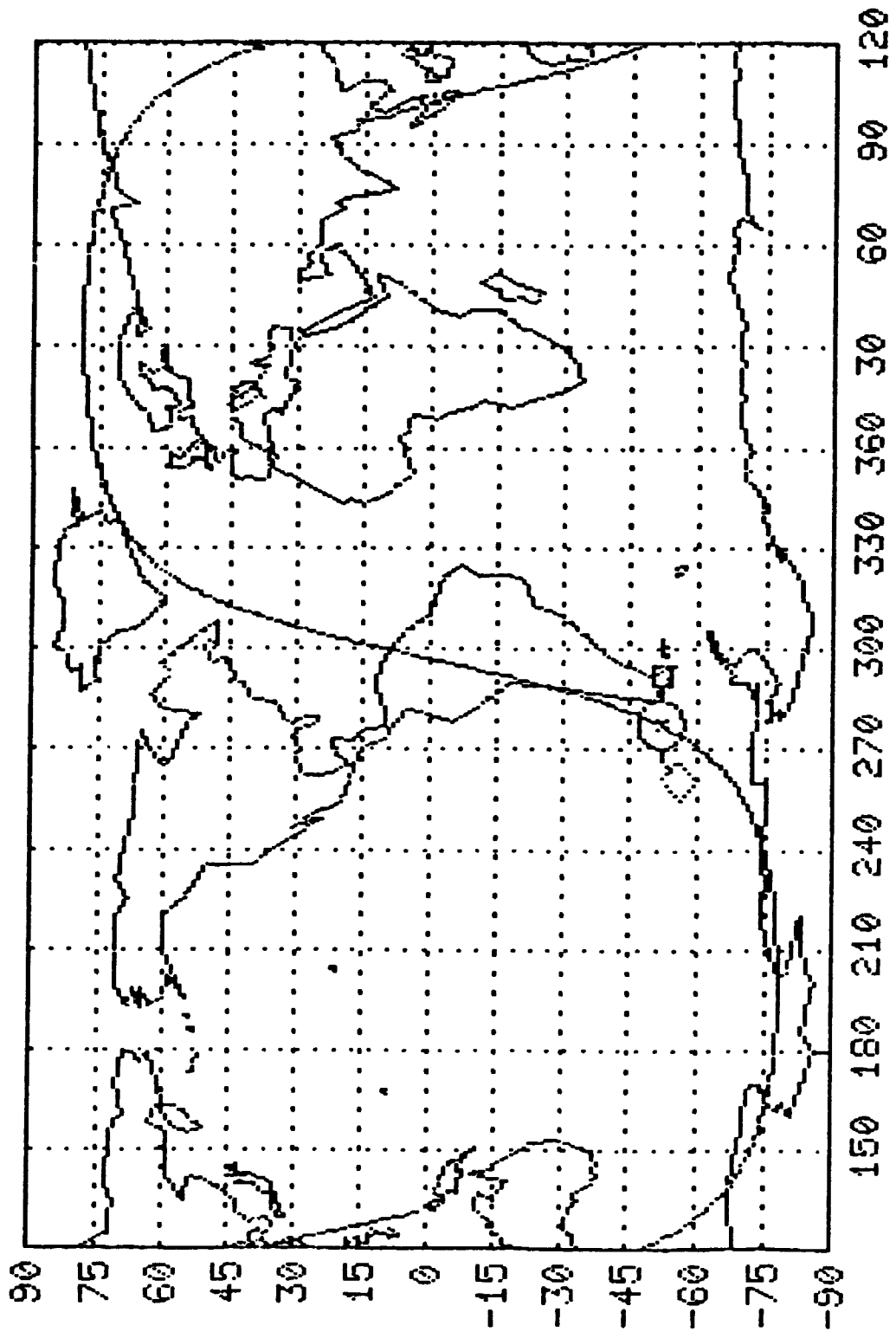
**CAUSE:** Hypergolic fuel ignition due to ruptured fuel tank bulkhead most probable cause.

ORIGINAL PAGE IS  
OF POOR QUALITY



NOAA-4 ROCKET

ORIGINAL PAGE IS  
OF POOR QUALITY



NOAA-4 R/B

1974-103

COSMOS 699

7587

LAUNCH DATE: 24.46 Dec 1974

COUNTRY OF ORIGIN: USSR

EVENT DATA:

1.

2.

DATE: 17 Apr 1975 (DAY 107)

2 Aug 1975 (DAY 214)

TIME: 214825.5

162310.0

LOCATION: 01 N/278 E

2 S/258 E

ALTITUDE: 437 km

433 km

PIECES CATALOGED (1 JAN 84): 50

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.04°

65.05°

APOGEE: 444 km

442 km

PERIGEE: 424 km

414 km

PERIOD: 93.3 min

93.1 min

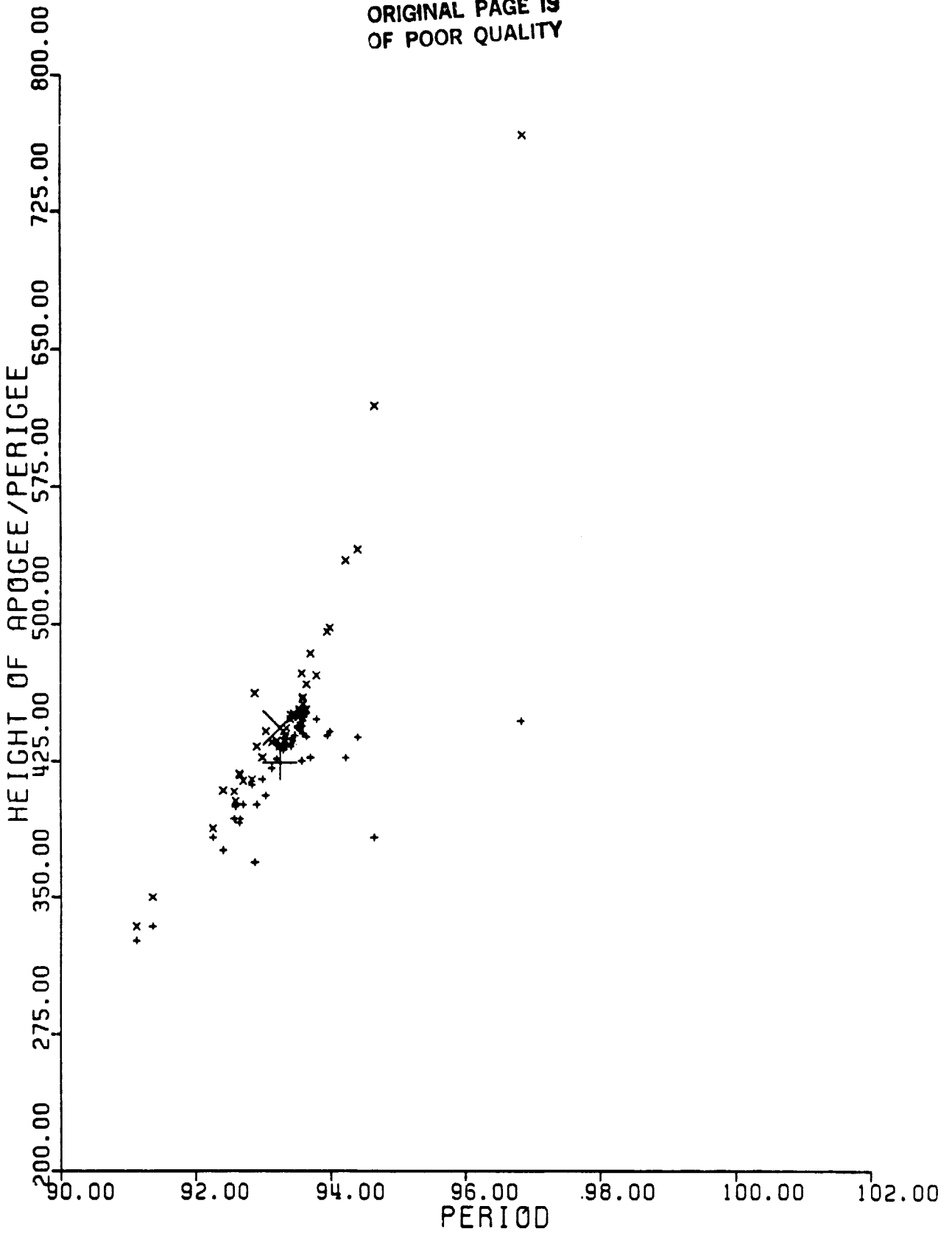
TRUE ANOMALY: 250°

250°

- Comments:
- Orbit data derived from element set #132 and #333 for satellite 7587; 1st and 2nd events respectively.
  - This event analyzed by William Heard of the Naval Research Laboratory. Report on file at Teledyne Brown Engineering, Colorado Springs, Colorado.
  - Debris highly unidirectional.
  - This was the first of a class of USSR satellites at 65° inclination and approximately 440 km altitude. The majority of the satellites in this class fragment.

CAUSE: Apparently deliberate fragmentation.

ORIGINAL PAGE IS  
OF POOR QUALITY



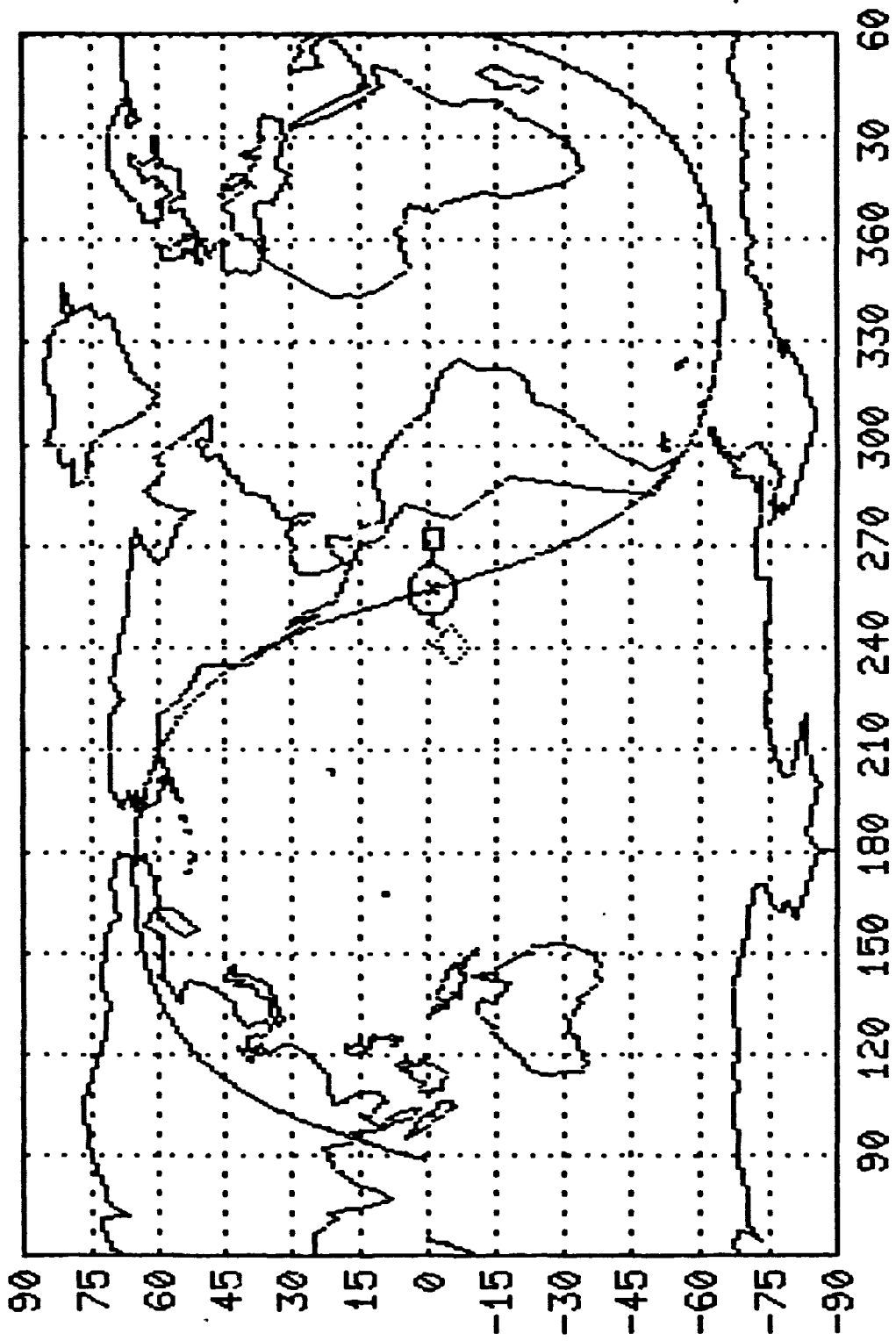




COMMENTS: • Unable to unambiguously identify debris associated with 2nd event, therefore, an orbit distribution plot is not provided.

1974-103

ORBITAL POSITION  
OF POOR QUALITY



COSMOS 699 (EVENT 2)

LAUNCH DATE: 22.75 Jan 1975

COUNTRY OF ORIGIN: US

EVENT DATA:

1.

2.

DATE: 9 Feb 1976 (DAY 40)

19 Jun 1976 (DAY 171)

TIME:

065916.6 GMT

LOCATION:

7 N/344 E

ALTITUDE:

751 km

PIECES CATALOGED (1 JAN 84): 14

183

PIECES STILL IN ORBIT (1 JAN 84): 54 (Both Events)

ORBIT CHARACTERISTICS:

INCLINATION: 97.78°

97.78°

APOGEE: 915 km

912 km

PERIGEE: 741 km

742 km

PERIOD: 101.5 min

101.4 min

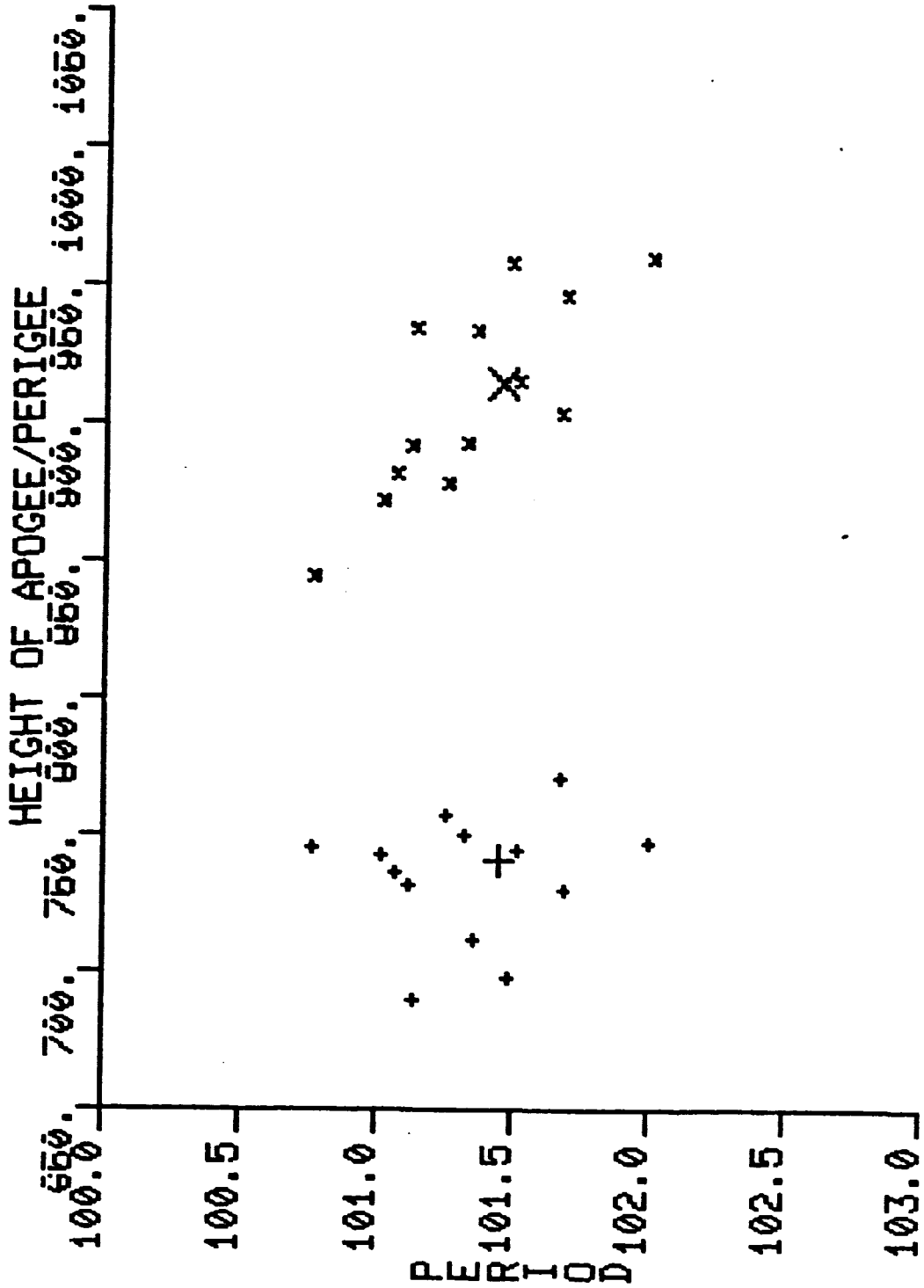
TRUE ANOMALY:

28°

- COMMENTS:**
- Delta 2nd stage rocket.
  - Orbit data derived from element set #127 for satellite 7616, for 1st event; #145 for 2nd event.
  - Two events. First event on 9 Feb 1976 was a small fragmentation resulting in only 14 pieces cataloged. The 2nd event followed the first by 131 days and was a far more forceful event.
  - General shape was cylinder-annulus; length 6.4 m and 1.52 m; dia. 2.44 m; weight 350 kg?

**CAUSE:** Hypergolic fuel ignition due to ruptured fuel tank bulkhead most probable cause for 2nd event. 1st event unknown cause.

ORIGINAL PAGE IS  
OF POOR QUALITY



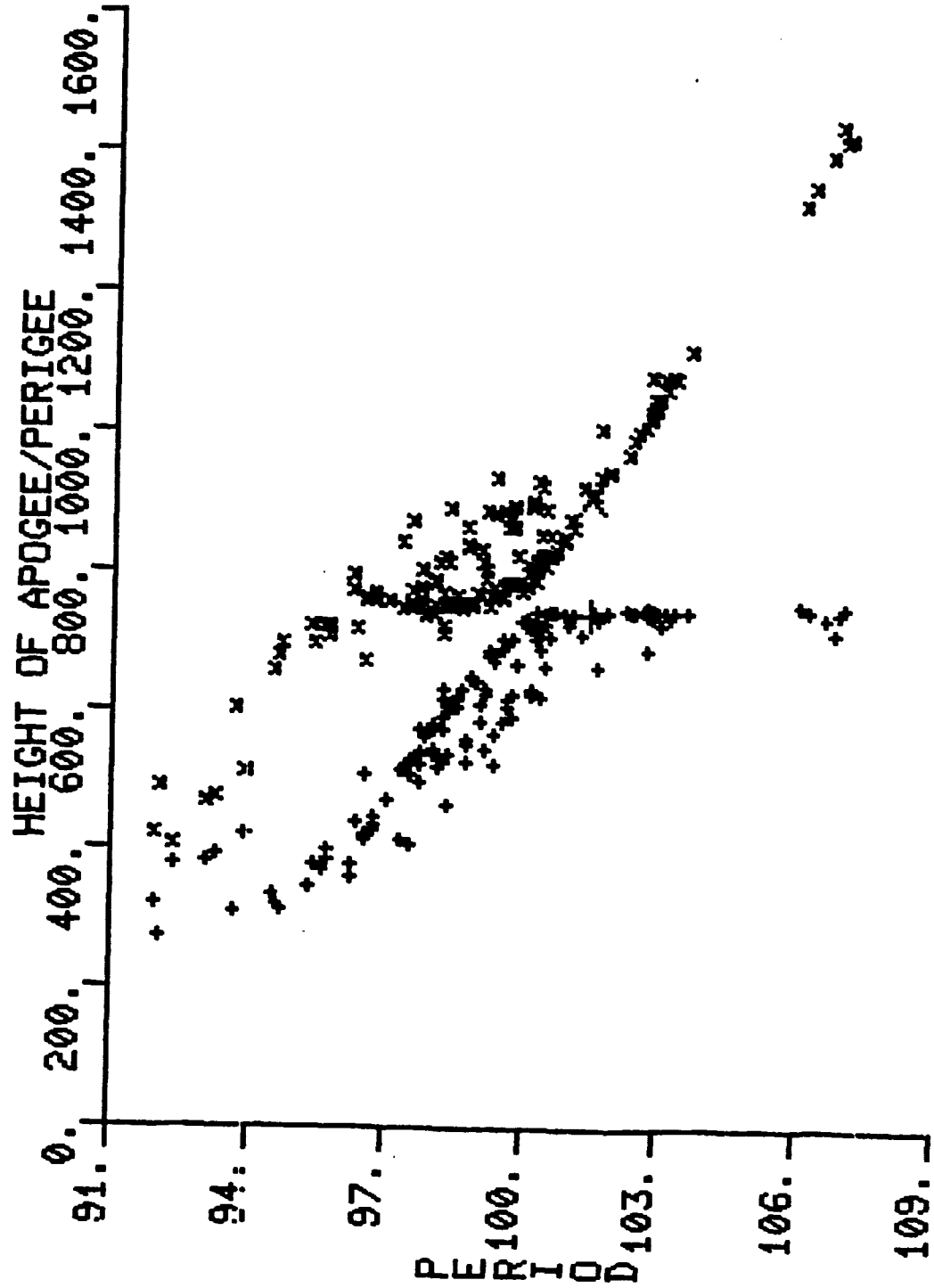
LANDSAT 2 ROCKET  
1st EVENT

COMMENTS • Insufficient data to show applicable ground trace for satellite  
7616, first event.

1975-04

1-147

ORIGINAL PAGE IS  
OF POOR QUALITY

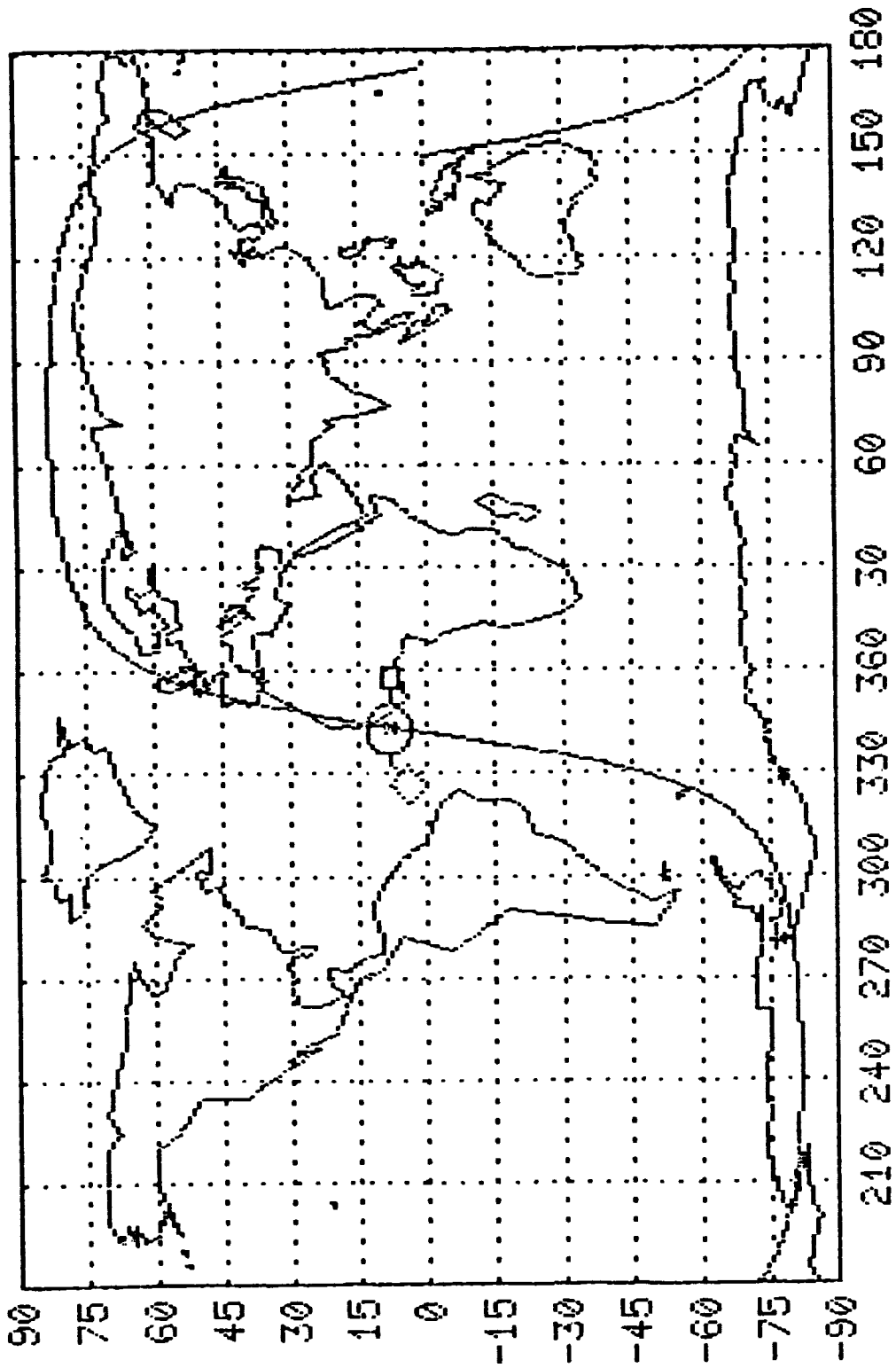


LANDSAT 2 ROCKET

2ND EVENT



ORIGINAL PAGE IS  
OF POOR QUALITY



LANDSAT 2 ROCKET

(EVENT 2)

1975-027

GEOS 3 ROCKET

7735

LAUNCH DATE: 10.00 Apr 1975

COUNTRY OF ORIGIN: US

EVENT DATA:

DATE: 12 Mar 1978 (DAY 71)

TIME: ~ 1200 GMT

LOCATION:

ALTITUDE: ~ 840 km

PIECES CATALOGED (1 JAN 84): 5

PIECES STILL IN ORBIT (1 JAN 84): 3

ORBIT CHARACTERISTICS:

INCLINATION: 114.99°

APOGEE: 844 km

PERIGEE: 837 km

PERIOD: 101.7 min

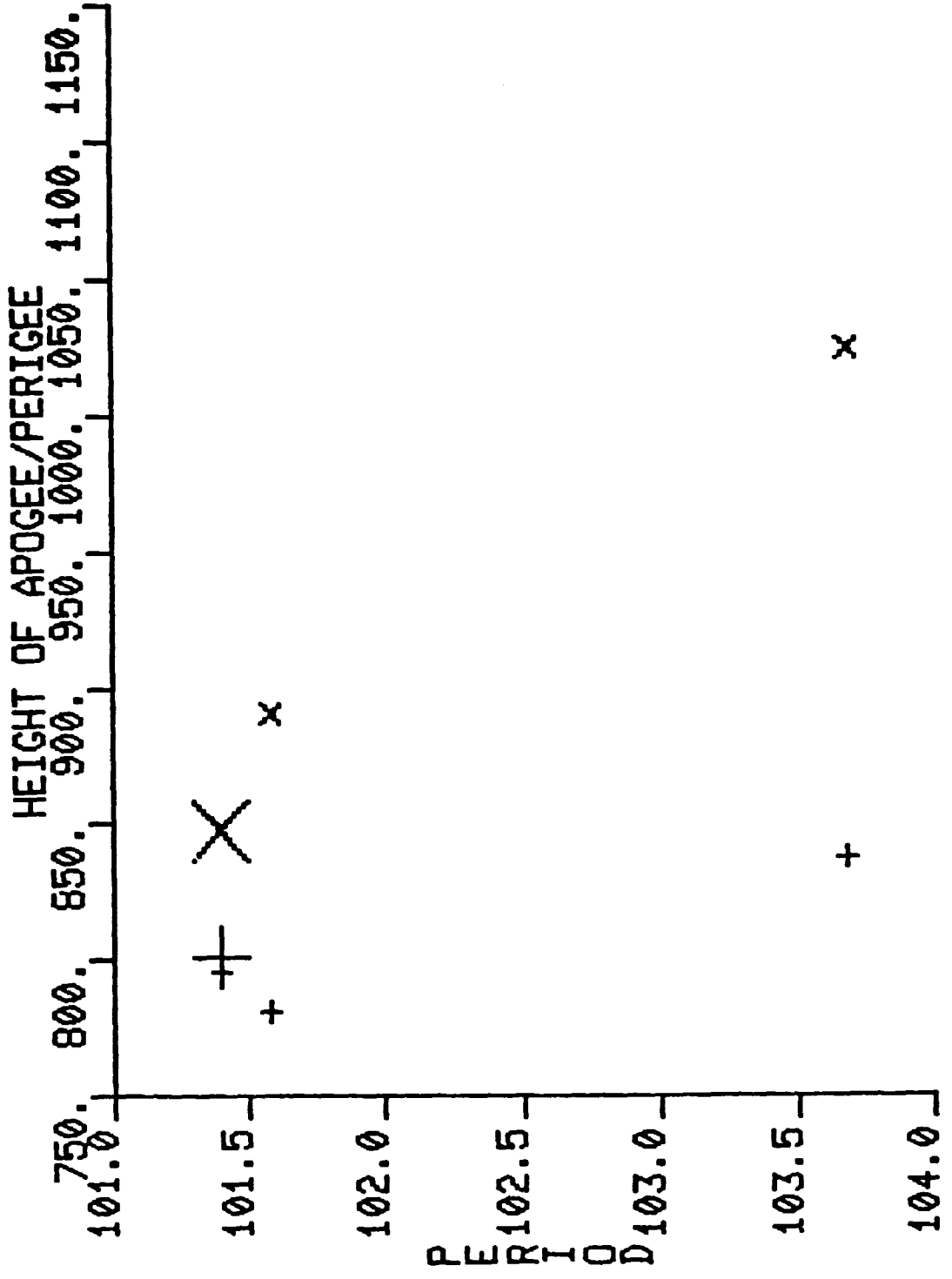
TRUE ANOMALY:

- COMMENTS:**
- Delta 2nd stage rocket.
  - No other event at this inclination.
  - This event was discovered when researching the NORAD satellite catalog for new objects cataloged with old launches.
  - Orbit data derived from 1 March 1978 element set on satellite 7735.
  - General shape was cylinder plus annulus; length 6.4 and 1.52 m; dia. 2.44 m; weight 350 kg?

**CAUSE:** Unknown; may not be related to the more violent mechanism which has plagued other Delta second stages.

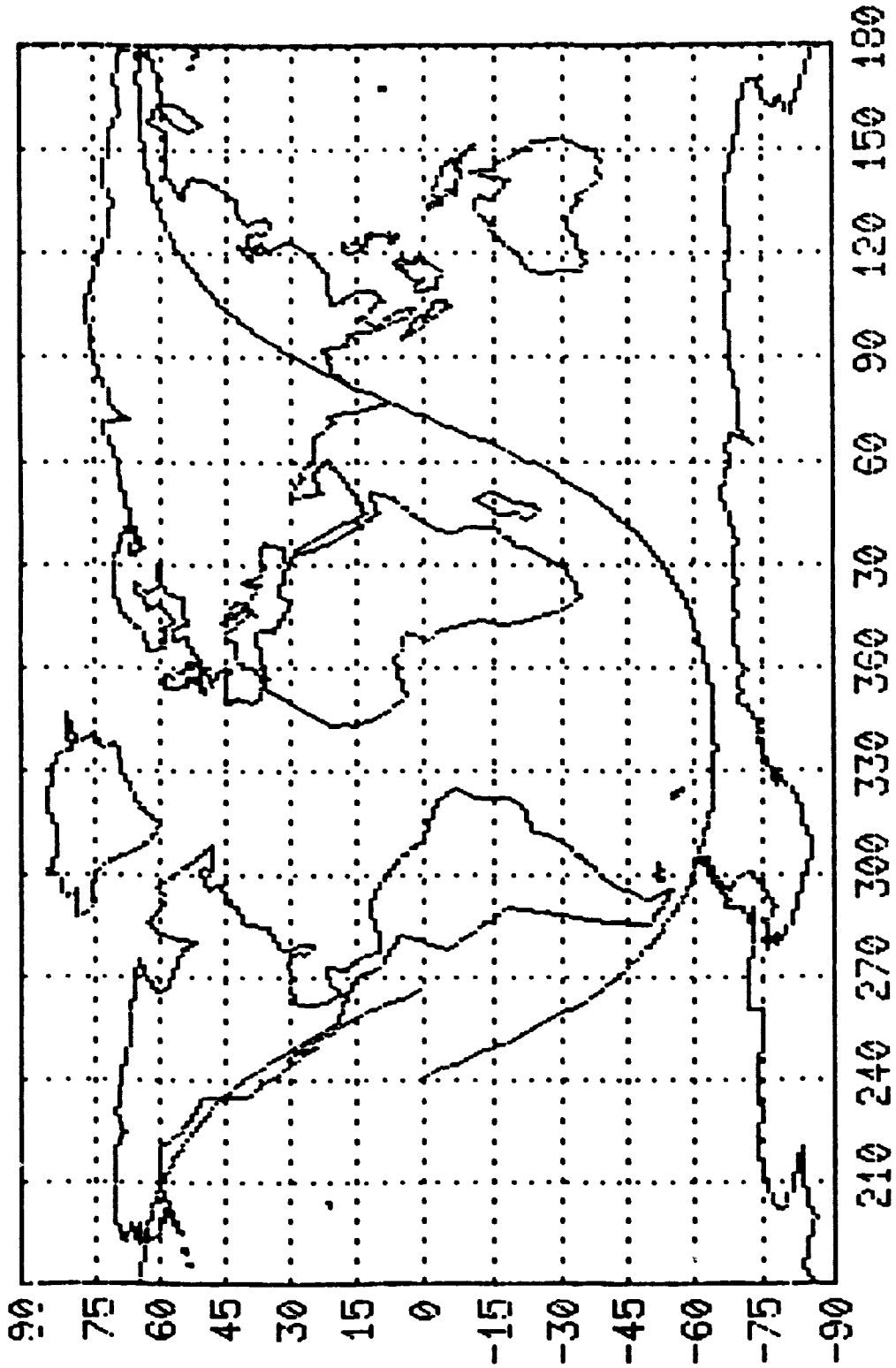
1975-27

ORIGINAL PAGE IS  
OF POOR QUALITY



GEOS 3 ROCKET

ORIGINAL PAGE IS  
OF POOR QUALITY



GEOS 3 ROCKET

1975-80

COSMOS 758

8191

**LAUNCH DATE:** 5.62 Sep 1975

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 6 Sep 1975 (DAY 249)

**TIME:** 190611.0 GMT

**LOCATION:** 32 N/293 E

**ALTITUDE:** 184 km

**PIECES CATALOGED (1 JAN 84):** 77

**PIECES STILL IN ORBIT (1 JAN 84):** 0

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 67.14

**APOGEE:** 324 km

**PERIGEE:** 173 km

**PERIOD:** 89.5 min

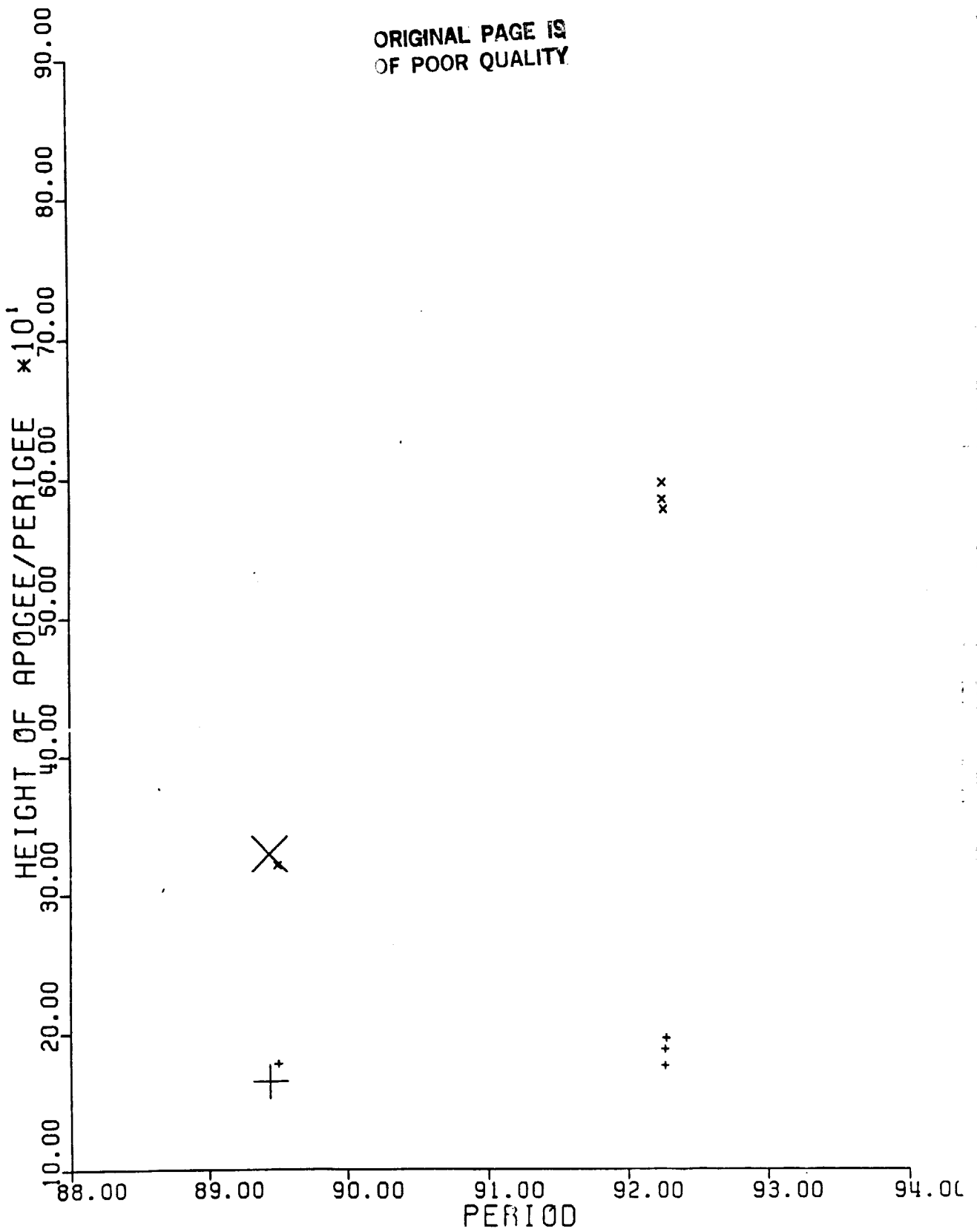
**TRUE ANOMALY:** 328°

- COMMENTS:**
- General shape was sphere-cylinder; length 7 m?; dia. 2.4 m; weight 670<sup>0</sup> kg?
  - Orbit data derived from element set #5 for satellite 8191.
  - 72 pieces of those counted under "pieces cataloged" were cataloged without elements.

**CAUSE:** Possibly deliberately detonated.

1975-80

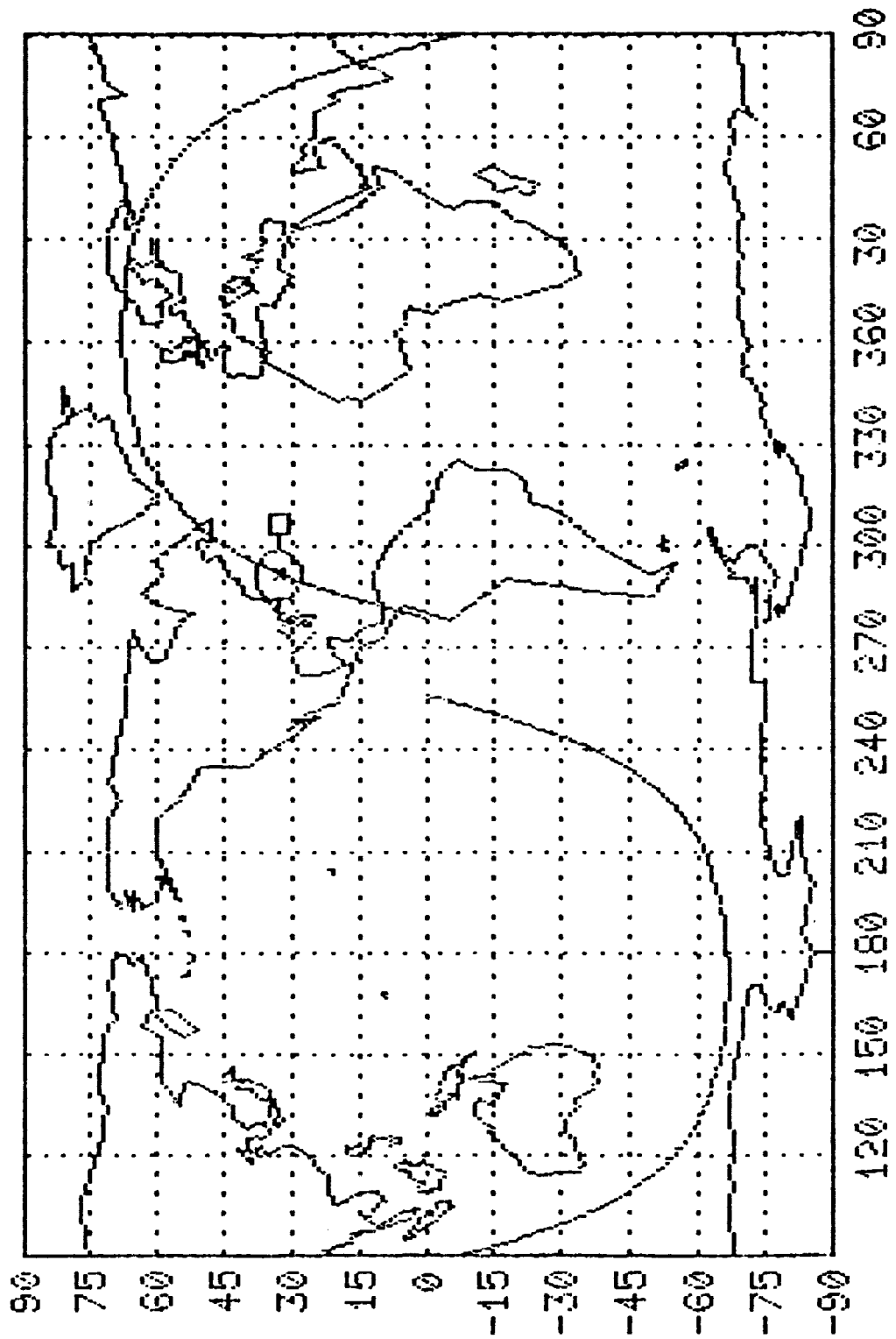
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 758



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 758

1975-102

COSMOS 777

8416

LAUNCH DATE: 29.46 Oct 1975

COUNTRY OF ORIGIN: USSR

EVENT DATA:

1.

2.

DATE: 25 Jan 1976 (DAY 25)

25 Jan 1976 (DAY 25)

TIME: 135941.1 GMT

152928.0 GMT

LOCATION: 53 N/7 E

42 N/331 E

ALTITUDE: 441 km

440 km

PIECES CATALOGED (1 JAN 84): 62

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.02°

66.02°

APOGEE: 442 km

442 km

PERIGEE: 430 km

430 km

PERIOD: 93.3 min

93.3 min

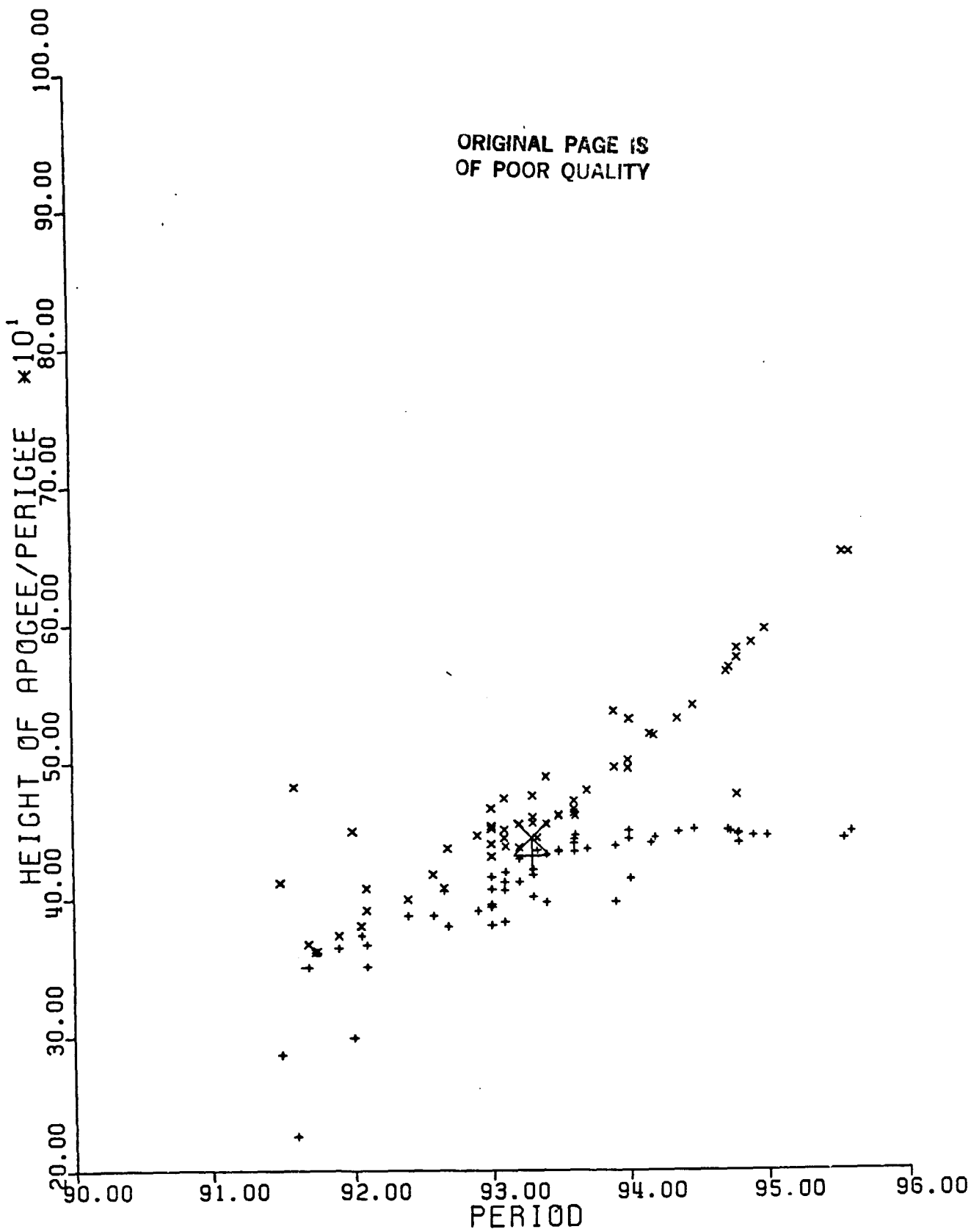
TRUE ANOMALY: 151°

138°

- COMMENTS:**
- Payload still active when it fragmented.
  - Orbit data derived from element set #96 for satellite 8416.
  - 2 events about 1 orbital revolution apart in time.
  - Member of Cosmos 699 class.

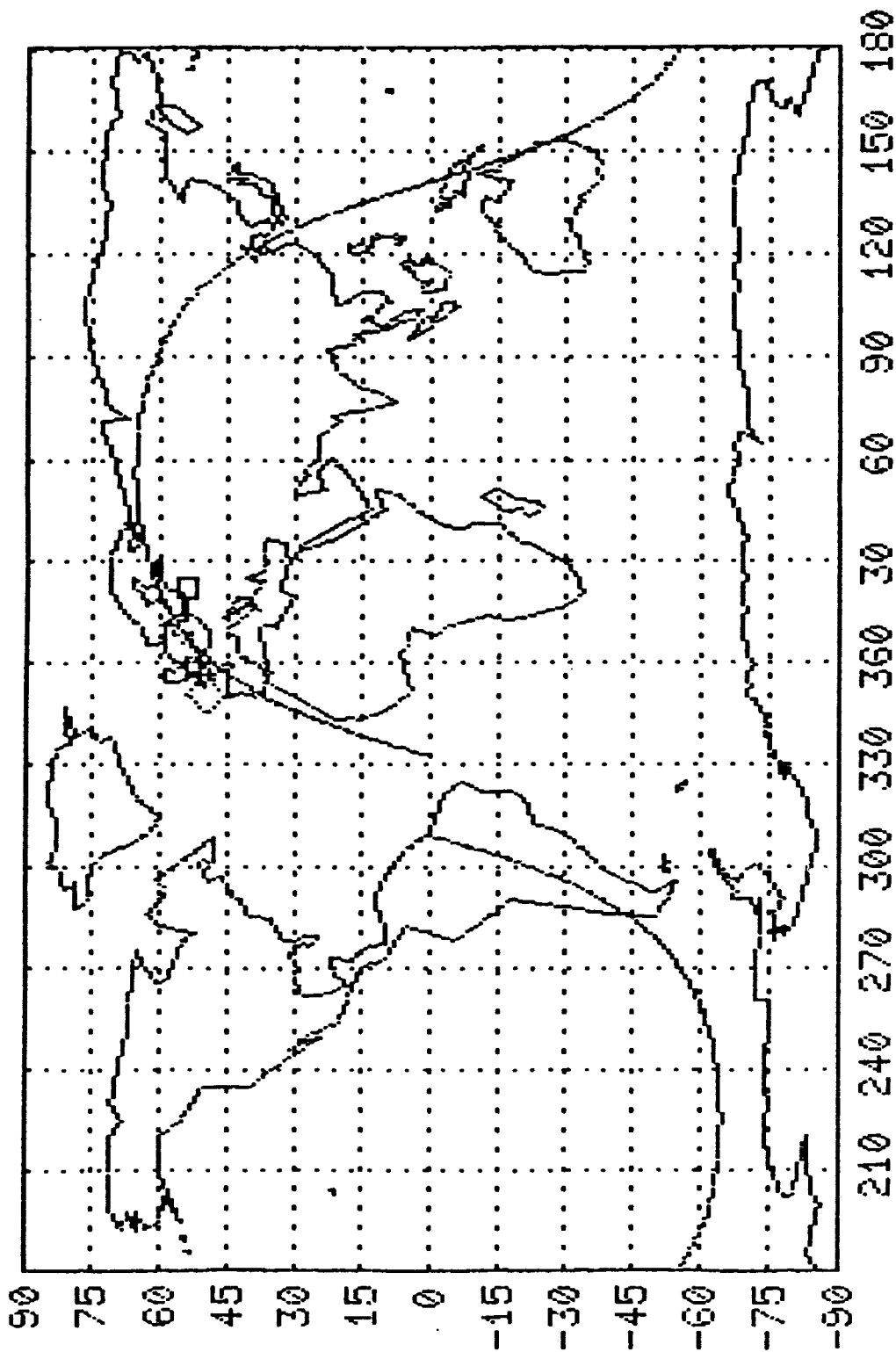
**CAUSE:** Apparently deliberate fragmentation.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 777

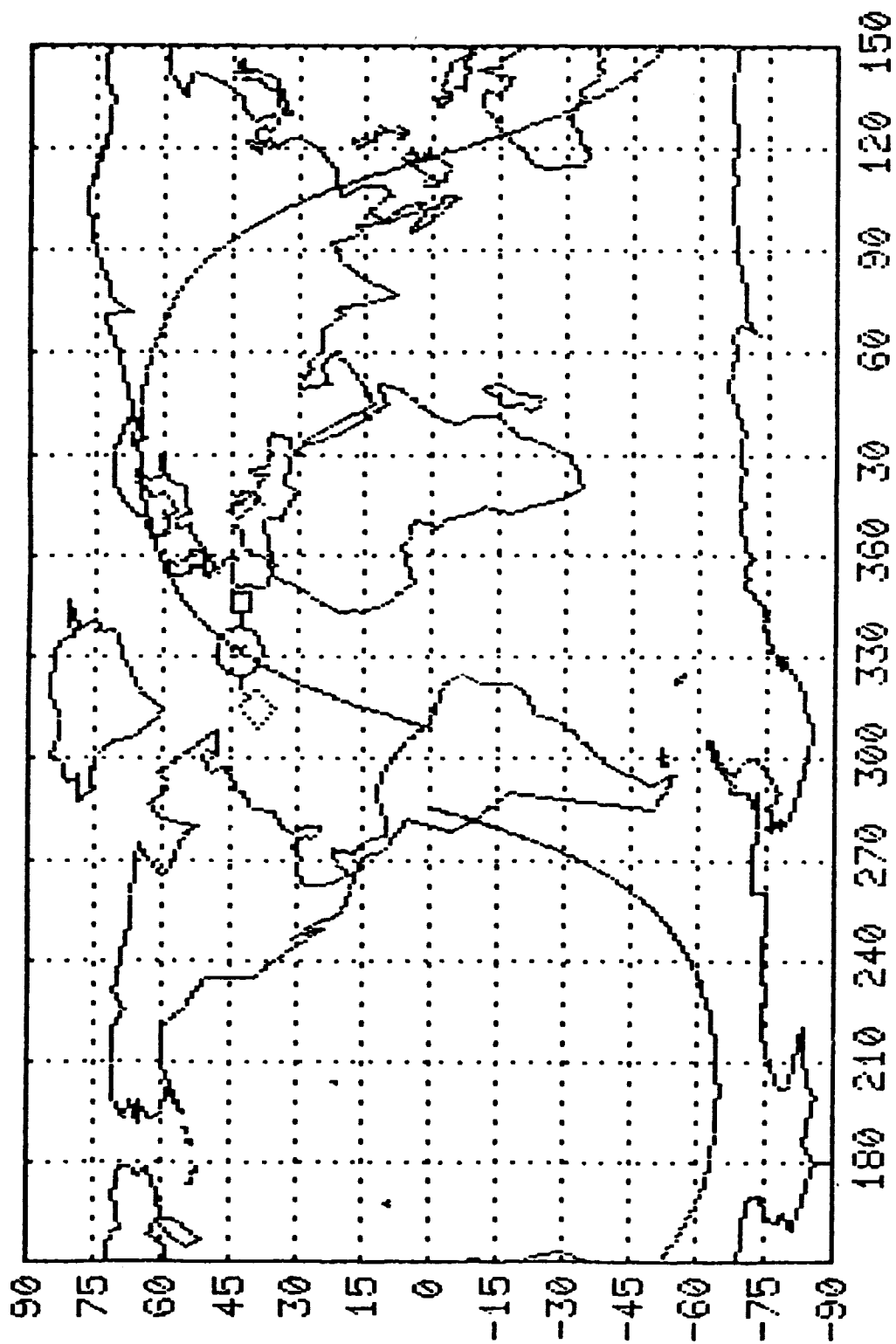
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 777 # 1

COMMENTS: • Unable to unambiguously identify debris associated with event 2, therefore, an orbit distribution plot is not provided for event 2.

ORIGINAL FACE IS  
OF POOR QUALITY



COSMOS 777 #2

1976-63

COSMOS 838

8932

**LAUNCH DATE:** 2.44 Jul 1976

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 17 May 1977 (DAY 137)

**TIME:** 101758.7 GMT

**LOCATION:** 9 S/284 E

**ALTITUDE:** 431 km

**PIECES CATALOGED (1 JAN 84):** 40

**PIECES STILL IN ORBIT (1 JAN 84):** 0

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.06°

**APOGEE:** 444 km

**PERIGEE:** 415 km

**PERIOD:** 93.2 min

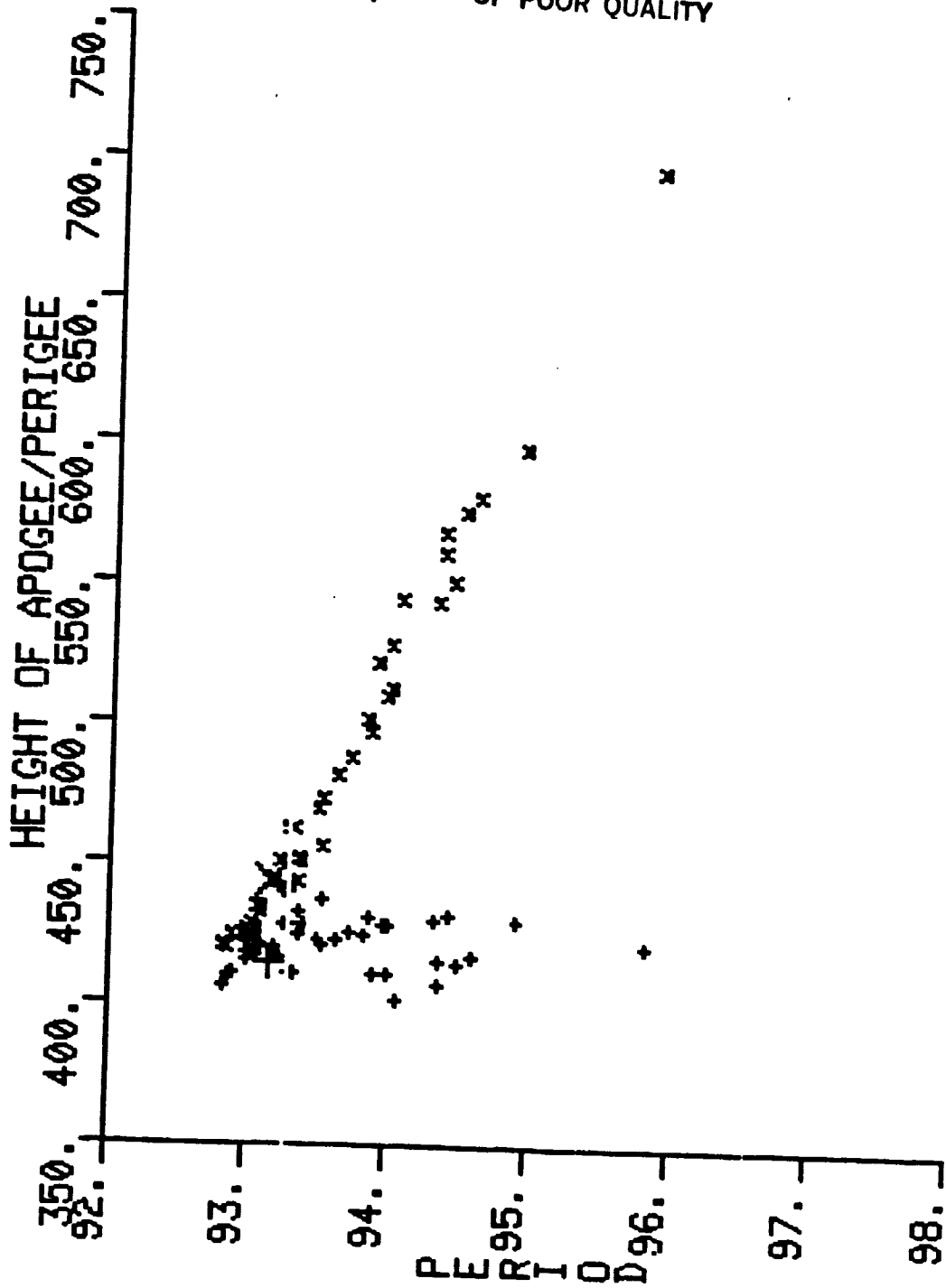
**TRUE ANOMALY:** 263°



- COMMENTS:**
- Orbit data derived from element set #250 on satellite 8932.
  - General shape; cylinder?
  - Member of Cosmos 699 class.

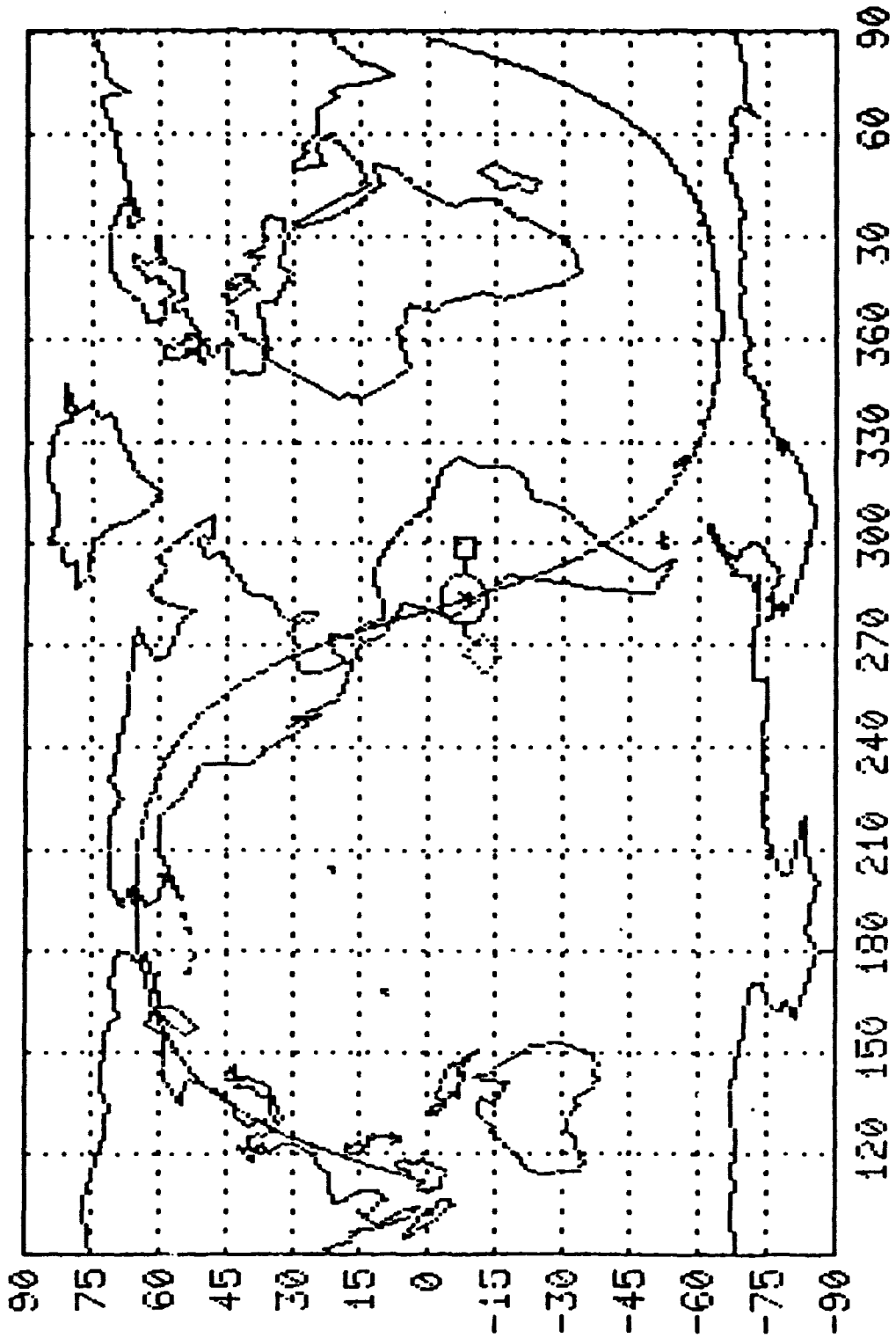
**CAUSE:** Apparently deliberate fragmentation.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 838

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 838

1976-67

COSMOS 839

9011

**LAUNCH DATE:** 8.88 Jul 1976

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 29 Sep 1977 (DAY 272)

**TIME:** 071647.3 GMT

**LOCATION:** 33 S/162 E

**ALTITUDE:** 1911 km

**PIECES CATALOGED (1 JAN 84):** 53

**PIECES STILL IN ORBIT (1 JAN 84):** 52

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.85°

**APOGEE:** 2100 km

**PERIGEE:** 981 km

**PERIOD:** 116.9 min

**TRUE ANOMALY:** 226°

**COMMENTS:**

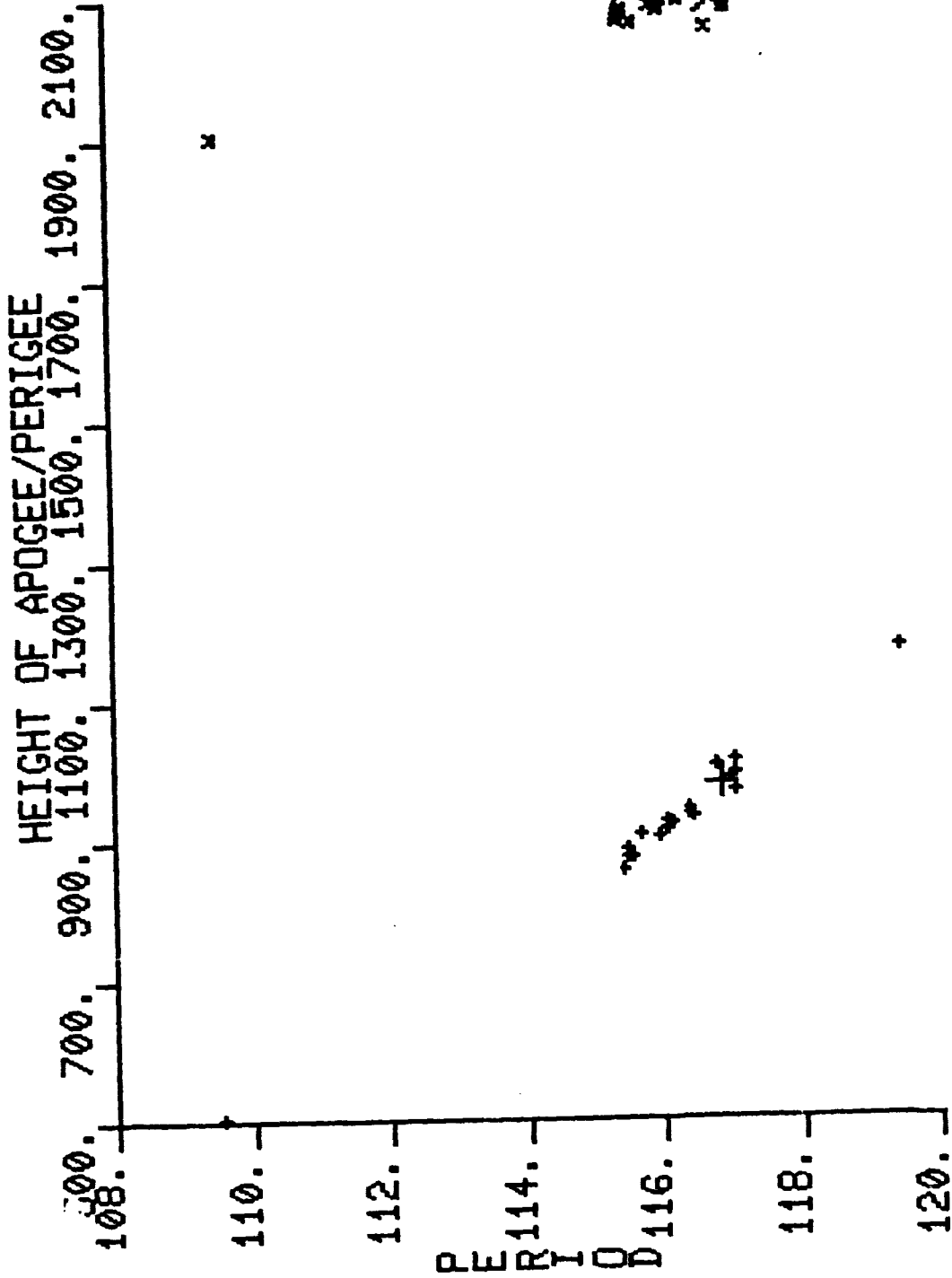
- Alleged Soviet ASAT target.
- General shape was cylinder?; length 4 m?; dia. 2 m?
- Did not break-up due to alleged ASAT test activity.
- Orbit data derived from element set #379 for satellite 9011.

**CAUSE:**

Unknown.

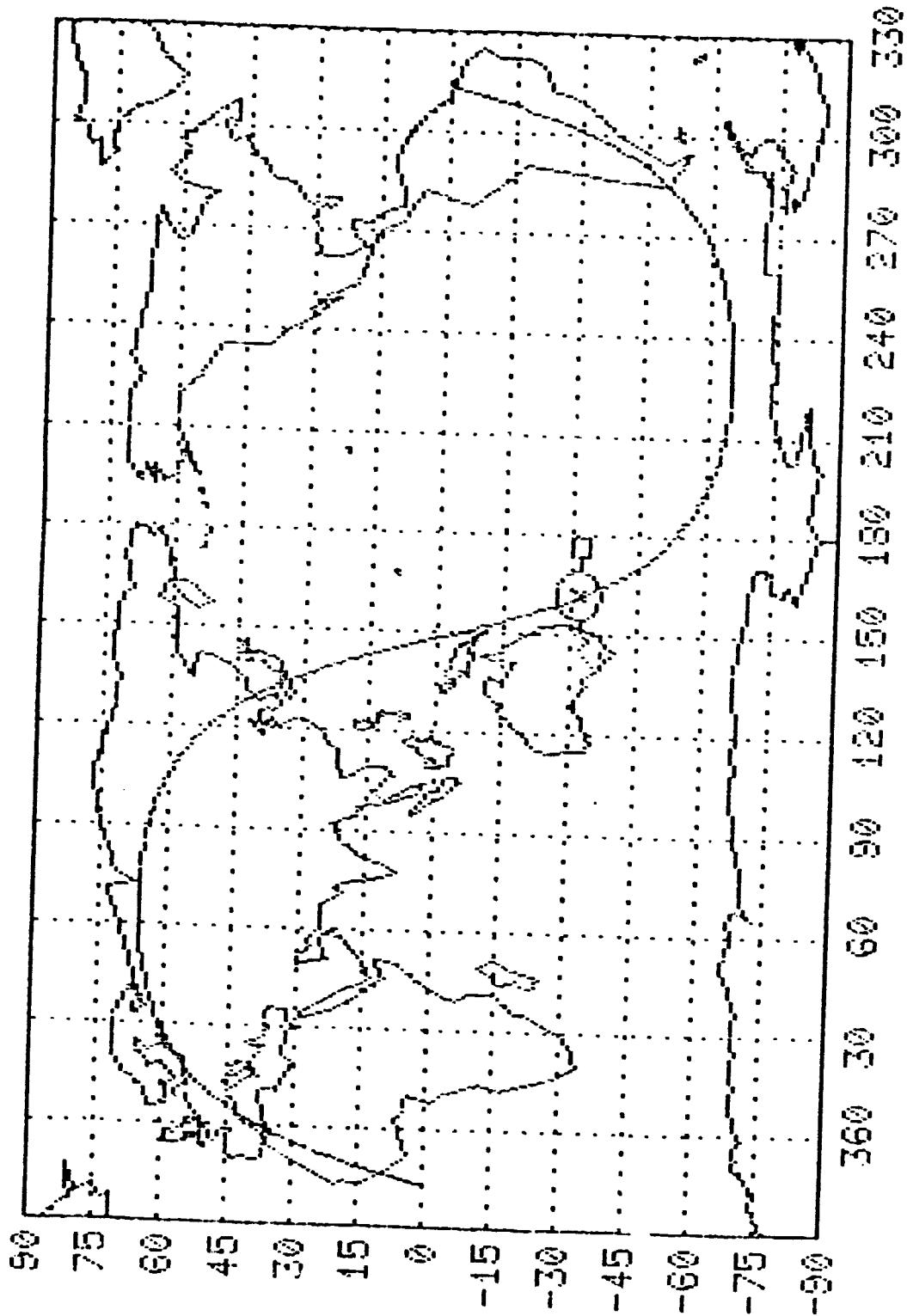
1976-67

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 839

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 839

1976-72

COSMOS 844

9046

**LAUNCH DATE:** 22.66 Jul 1976

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 25 Jul 1976 (DAY 207)

**TIME:** 171754.7 GMT

**LOCATION:** 49 N/100 E

**ALTITUDE:** 209 km

**PIECES CATALOGED (1 JAN 84):** 248

**PIECES STILL IN ORBIT (1 JAN 84):** 0

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 67.15

**APOGEE:** 353 km

**PERIGEE:** 172 km

**PERIOD:** 89.8

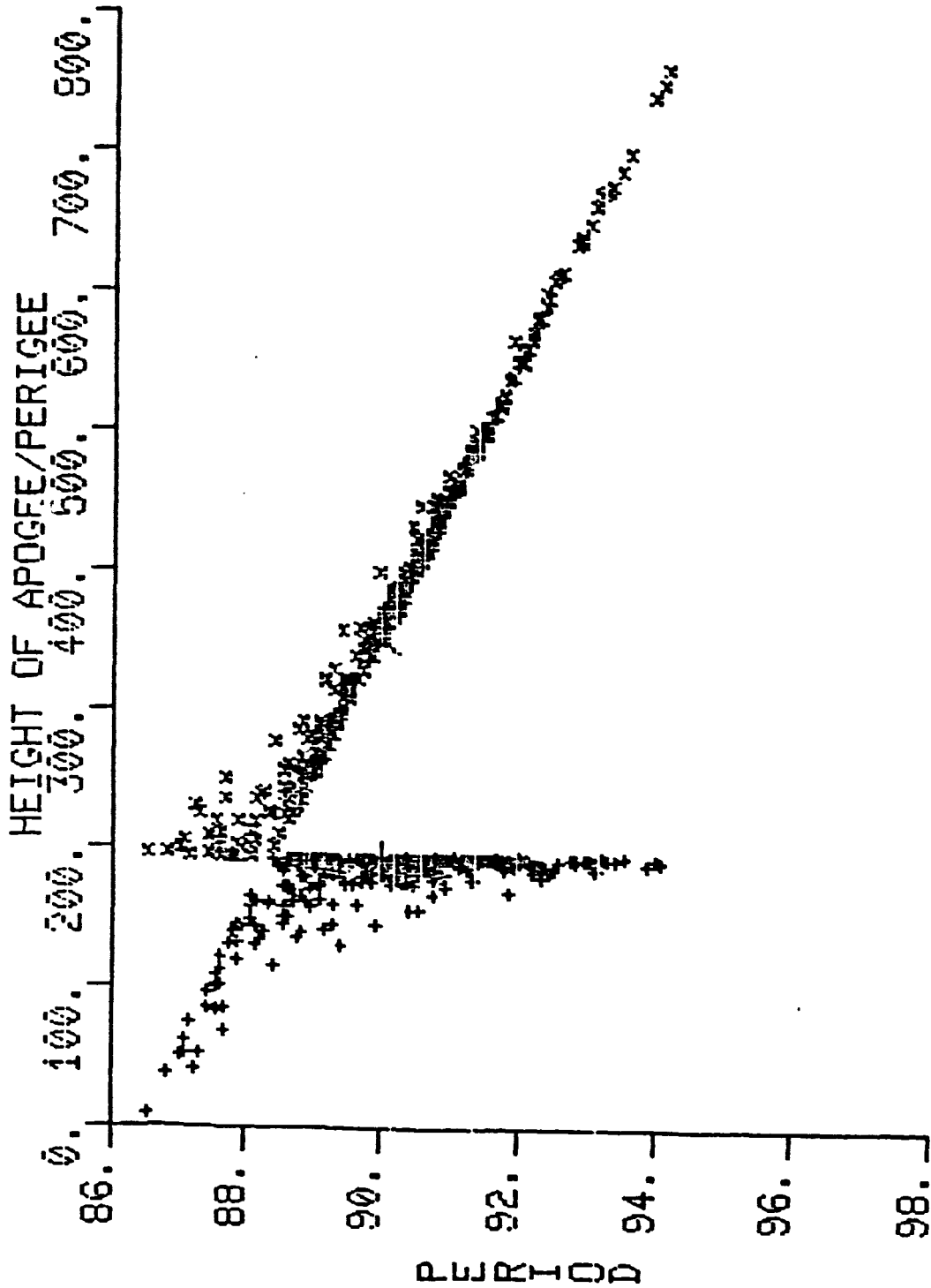
**TRUE ANOMALY:** 55°



- COMMENTS:**
- Orbit data derived from element set #8 for satellite 9046.
  - All debris decayed before elements could be developed. Piece count approximation determined from sensors; satellite numbers assigned and each piece was designated "decayed" when cataloged. This procedure has not been consistent over the years, other satellites have fragmented in low orbit and all debris decayed before it could be cataloged but the pieces were not cataloged.
  - General shape was sphere-cylinder; length 7 m?; dia. 2.4 m; weight 6700 kg?

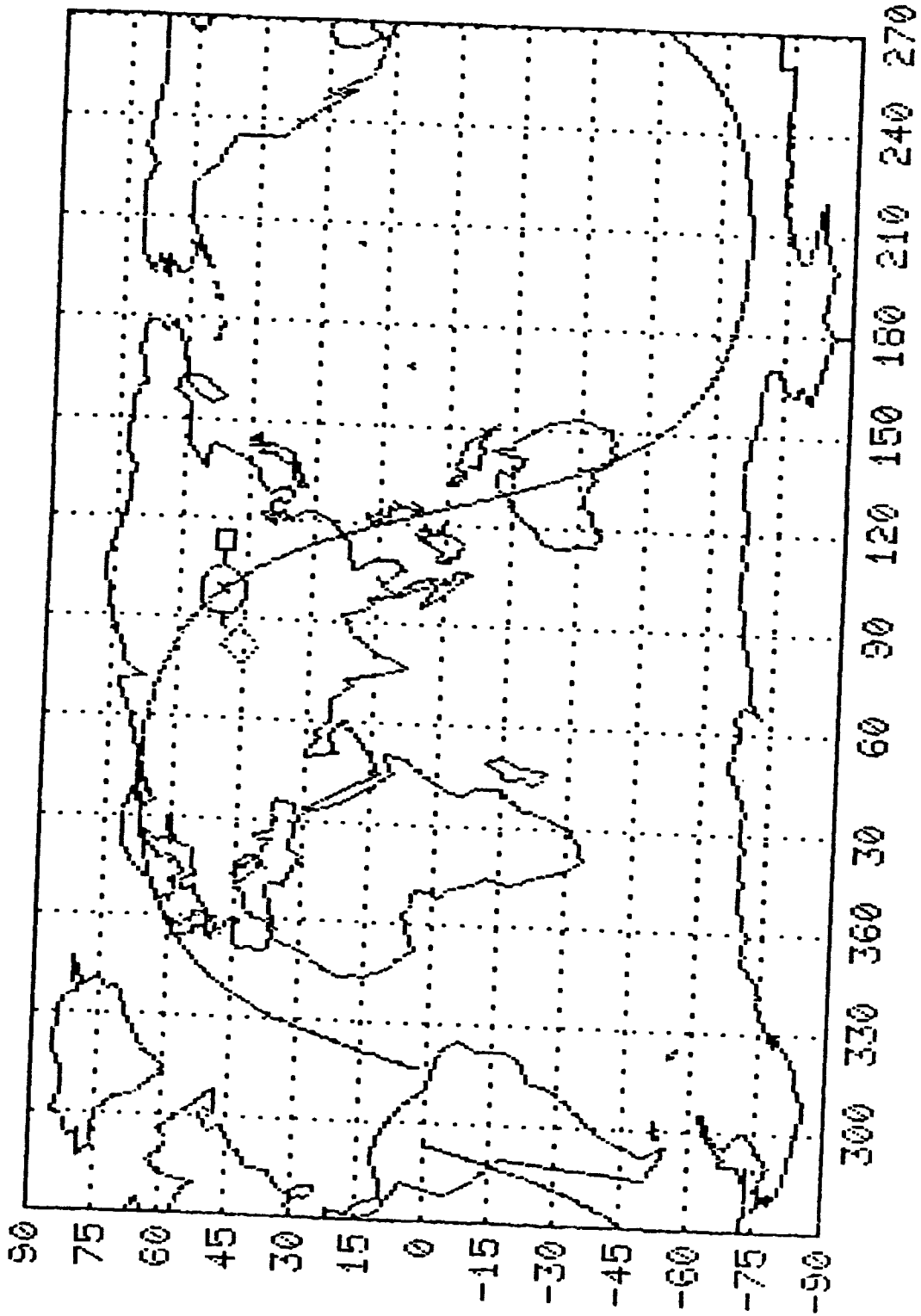
**CAUSE:** Probably deliberately detonated.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 844 SIMULATION

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 844

1976-77

NOAA-5 (ITOS-H) R/B

9063

**LAUNCH DATE:** 29.71 Jul 1976

**COUNTRY OF ORIGIN:** US

**EVENT DATA:**

**DATE:** 24 Dec 1977 (DAY 358)

**TIME:** 113324.7 GMT

**LOCATION:** 40 S/146 E

**ALTITUDE:** 1510 km

**PIECES CATALOGED (1 JAN 84):** 130

**PIECES STILL IN ORBIT (1 JAN 84):** 126

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 102.02°

**APOGEE:** 1521 km

**PERIGEE:** 1506 km

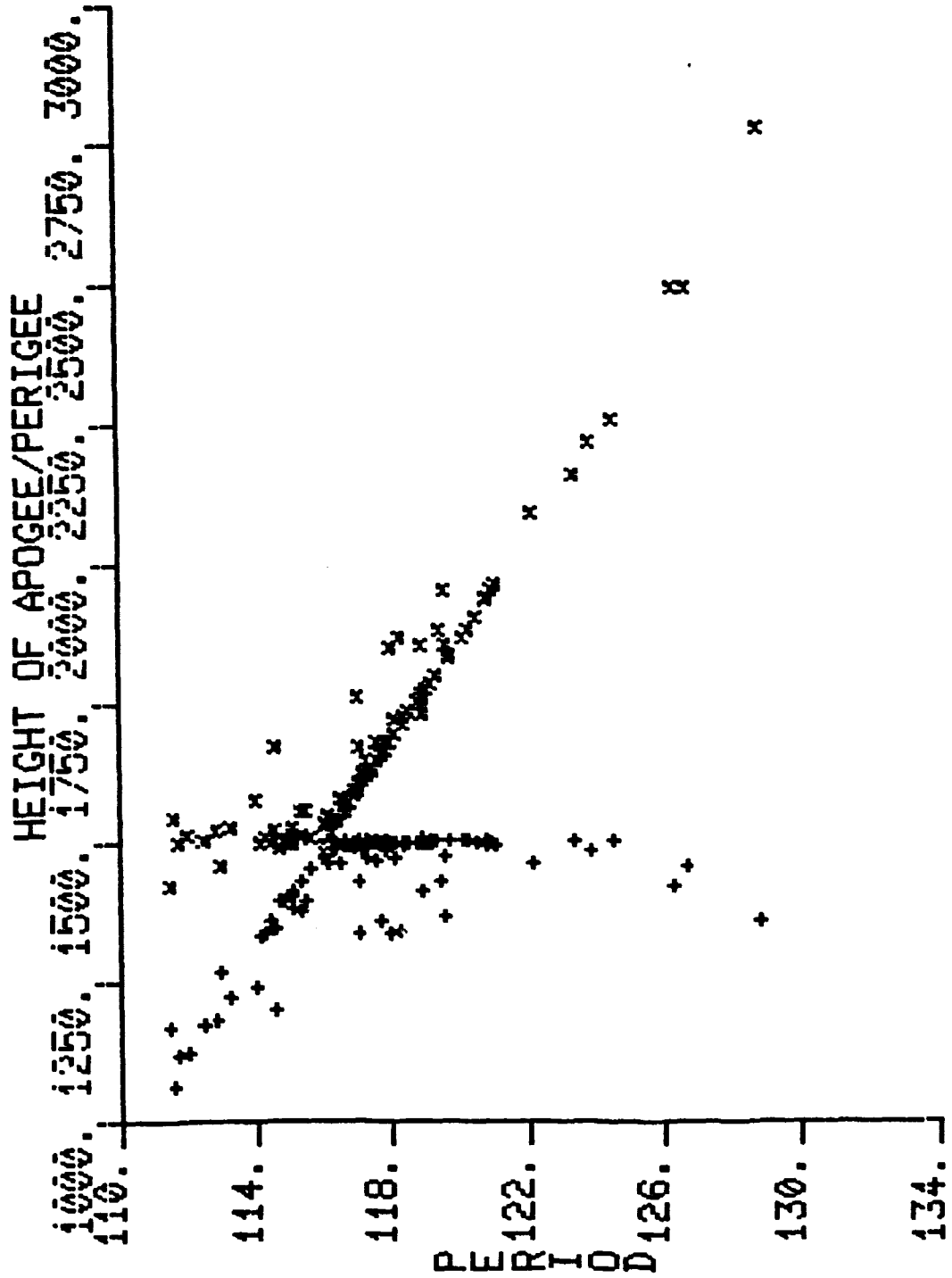
**PERIOD:** 116.3 min

**TRUE ANOMALY:** 298°

- COMMENTS:**
- Delta 2nd stage rocket.
  - Orbit data derived from element set #97 for satellite 9063.
  - General shape was cylinder plus annulus; length 6.4 m; dia. 1.52 and 2.44 m; weight 350 kg?

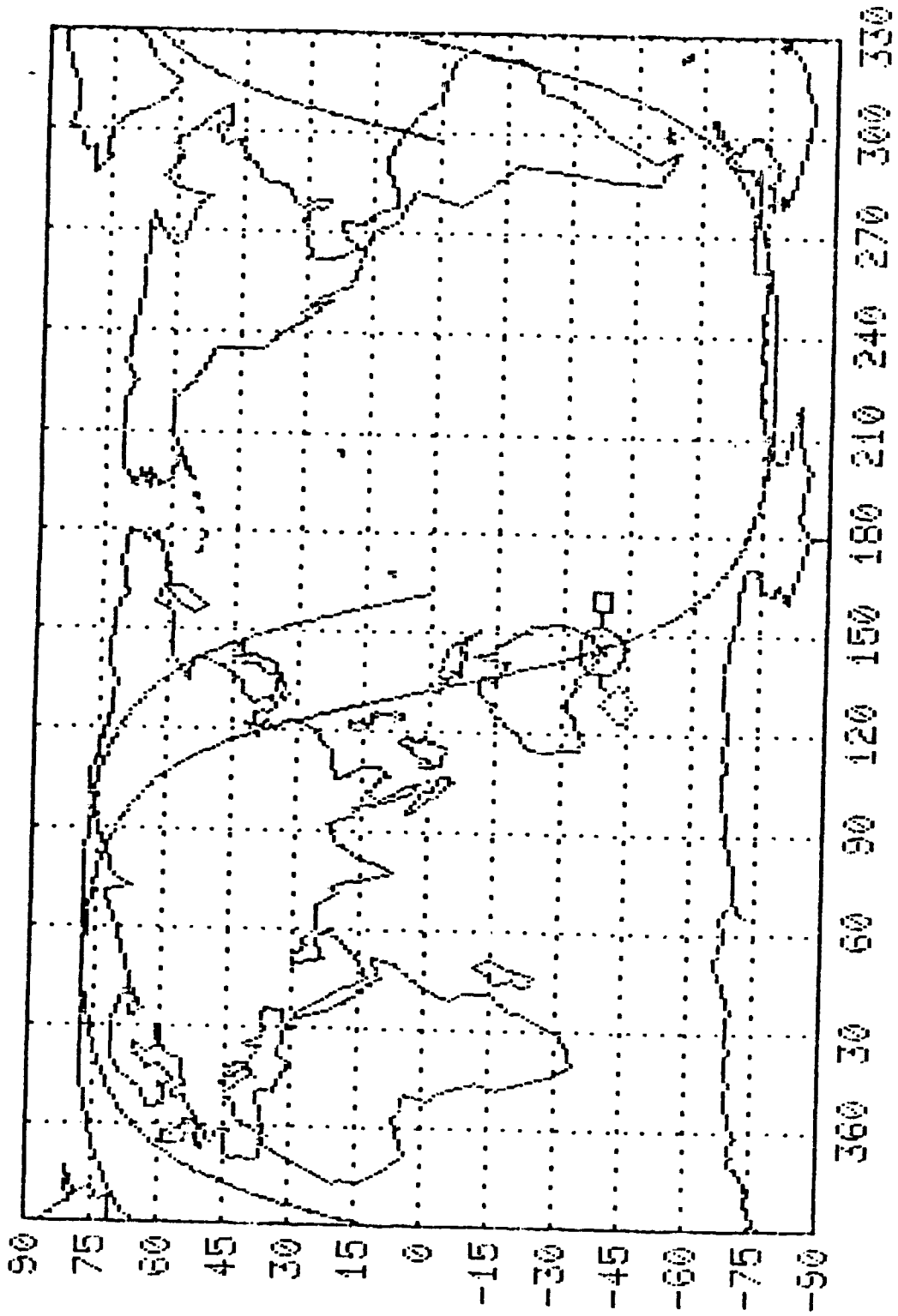
**CAUSE:** Hypergolic fuel ignition due to ruptured tank bulkhead most probable cause.

ORIGINAL PAGE IS  
OF POOR QUALITY



NOAA-5 ROCKET

ORIGINAL PAGE IS  
OF POOR QUALITY



NOAA-5 ITOS-H R/B

1976-105

COSMOS 862

9495

**LAUNCH DATE:** 22.39 Oct 1976

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 15 Mar 1977 (DAY 74)

**TIME:** 125626.1 GMT

**LOCATION:** 29 N/114 E

**ALTITUDE:** 5678 km

**PIECES CATALOGED (1 JAN 84):** 11

**PIECES STILL IN ORBIT (1 JAN 84):** 11

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 63.16°

**APOGEE:** 39644 km

**PERIGEE:** 1352 km

**PERIOD:** 718.9 min

**TRUE ANOMALY:** 88°

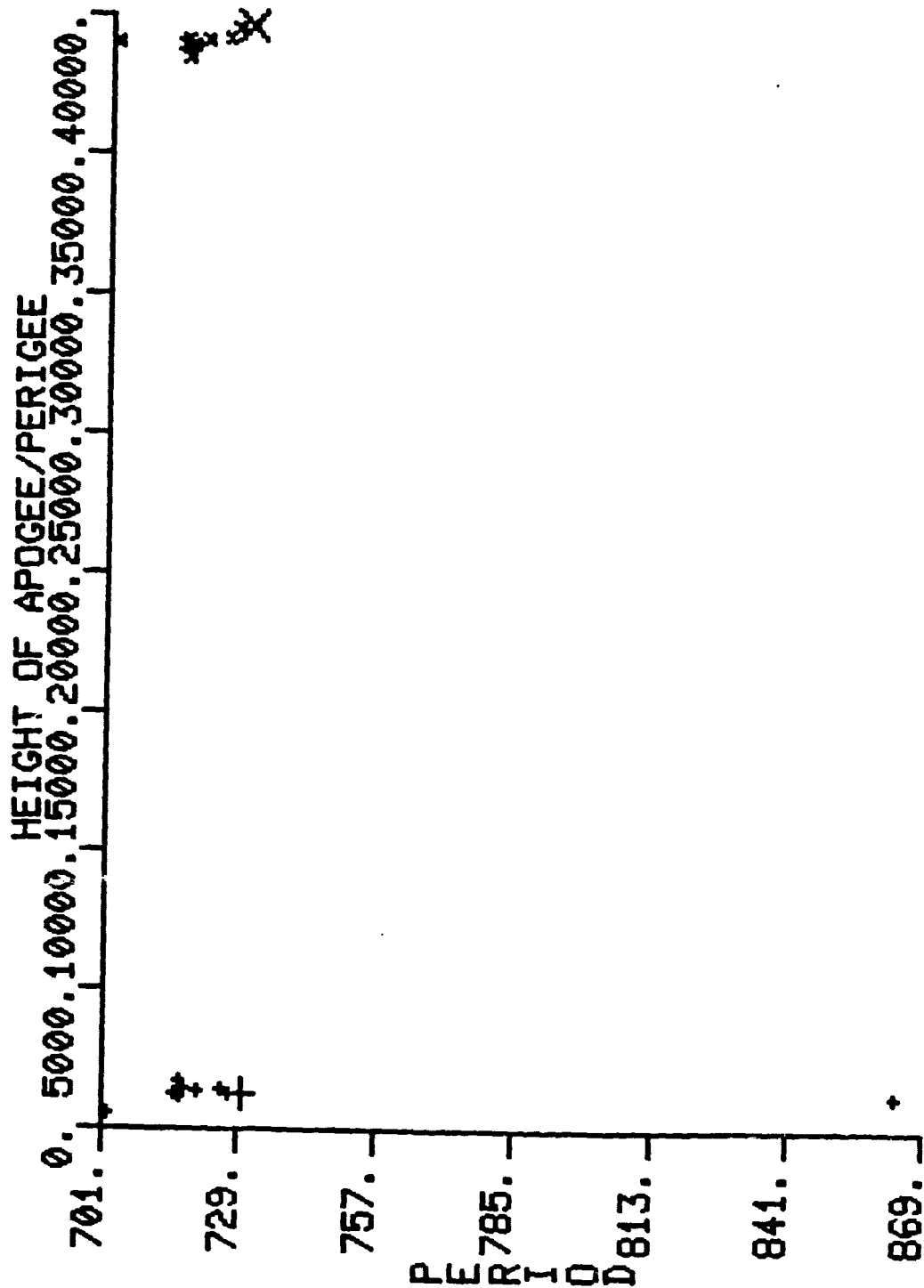


**COMMENTS:**

- Orbit data derived from element set #46 for satellite 9495.
- General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m?; weight 1250 kg?

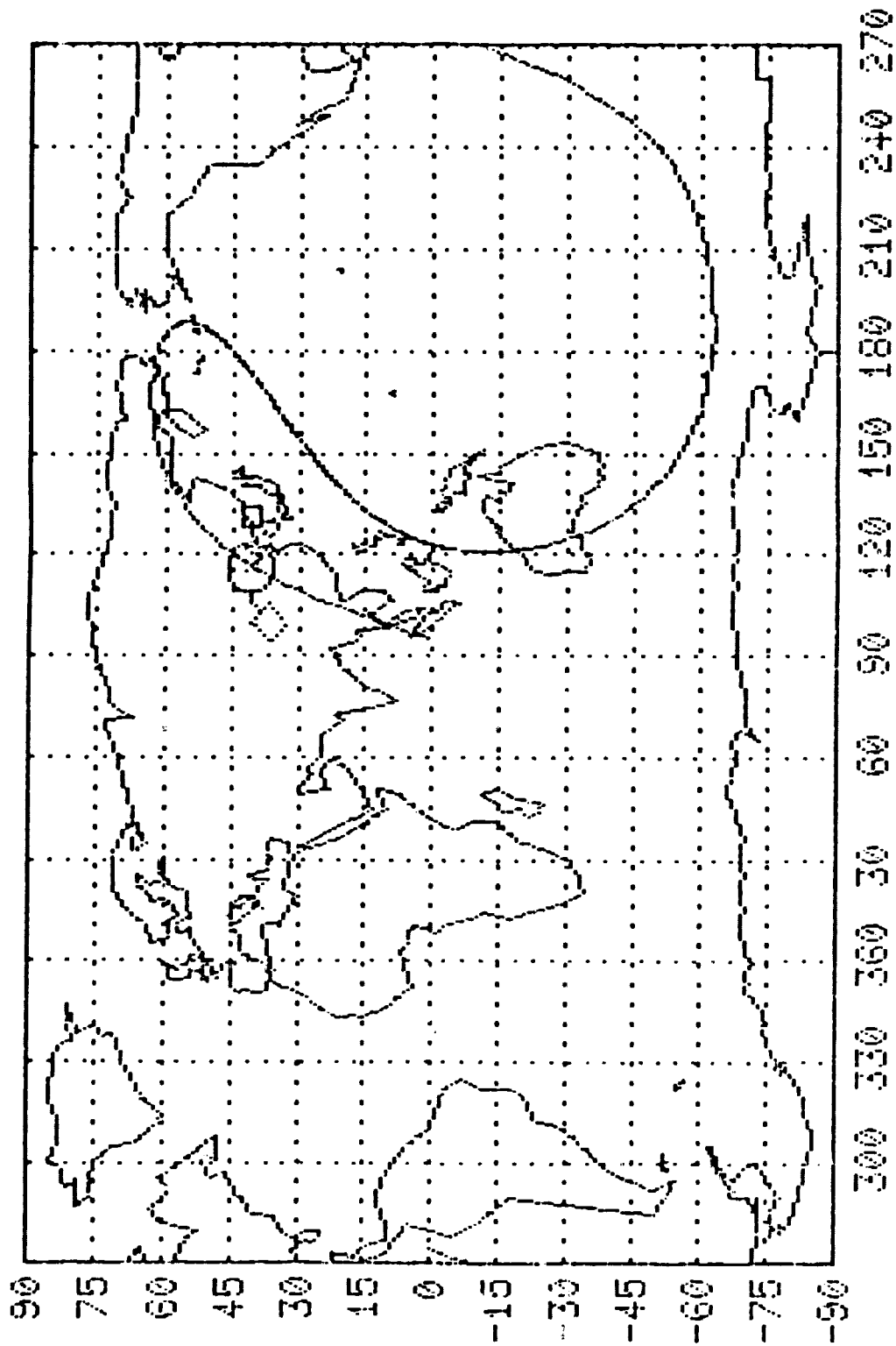
**CAUSE:** Unknown; first of many break-ups associated with this class of satellites.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 862

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 862

1976-120

COSMOS 880

9601

**LAUNCH DATE:** 9.84 Dec 1976

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 27 Nov 1978 (DAY 331)

**TIME:** 170248.3 GMT

**LOCATION:** 65 S/306 E

**ALTITUDE:** 559 km

**PIECES CATALOGED (1 JAN 84):** 50

**PIECES STILL IN ORBIT (1 JAN 84):** 13

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.84°

**APOGEE:** 621 km

**PERIGEE:** 551 km

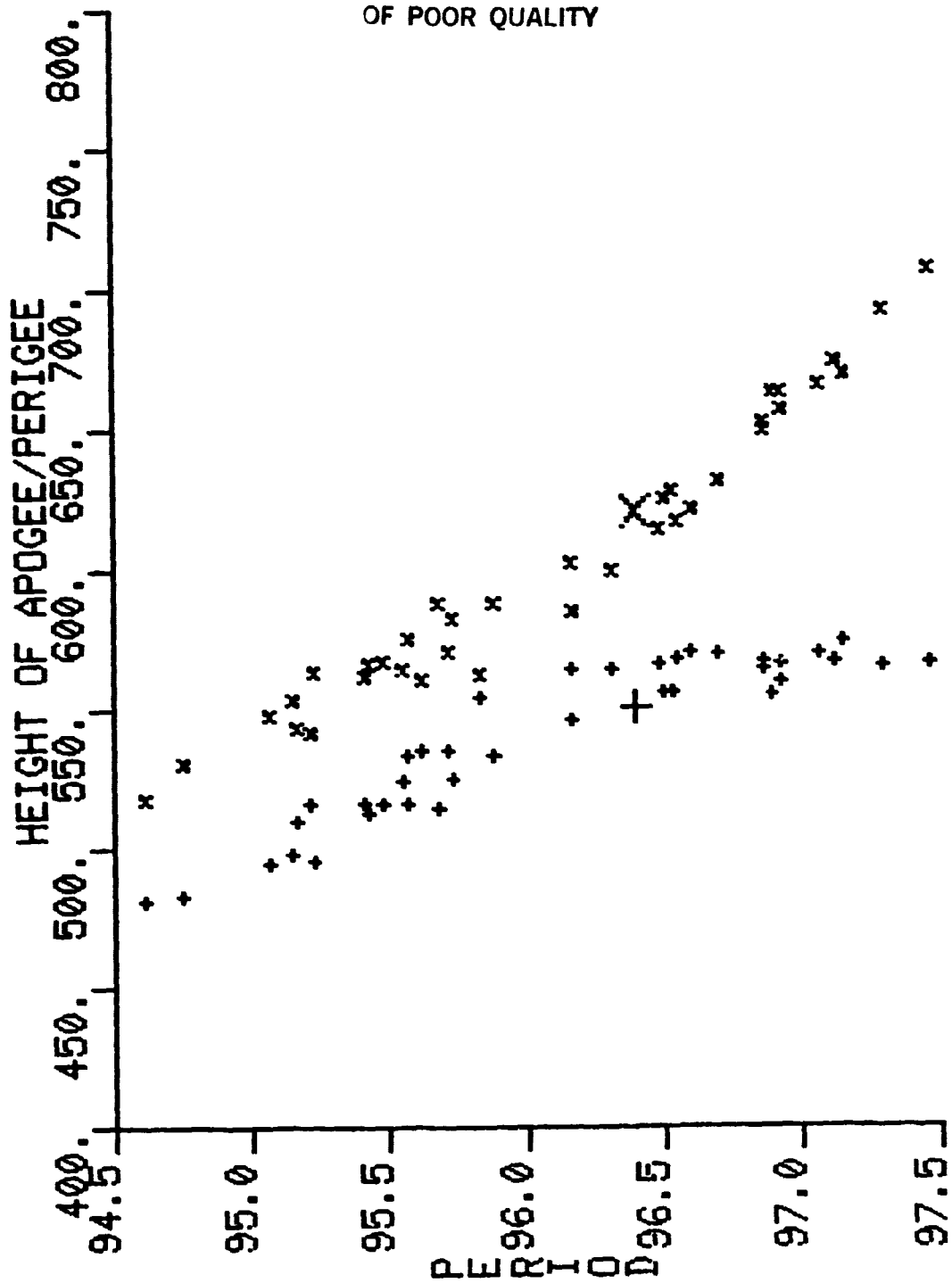
**PERIOD:** 96.4 min

**TRUE ANOMALY:** 321°

- COMMENTS:**
- General shape was cylinder?; length 4 m?; dia. 2 m?
  - Orbit characteristics derived from element set #403 for satellite 9601.
  - This apparent ASAT target did not fragment due to alleged ASAT test activity.

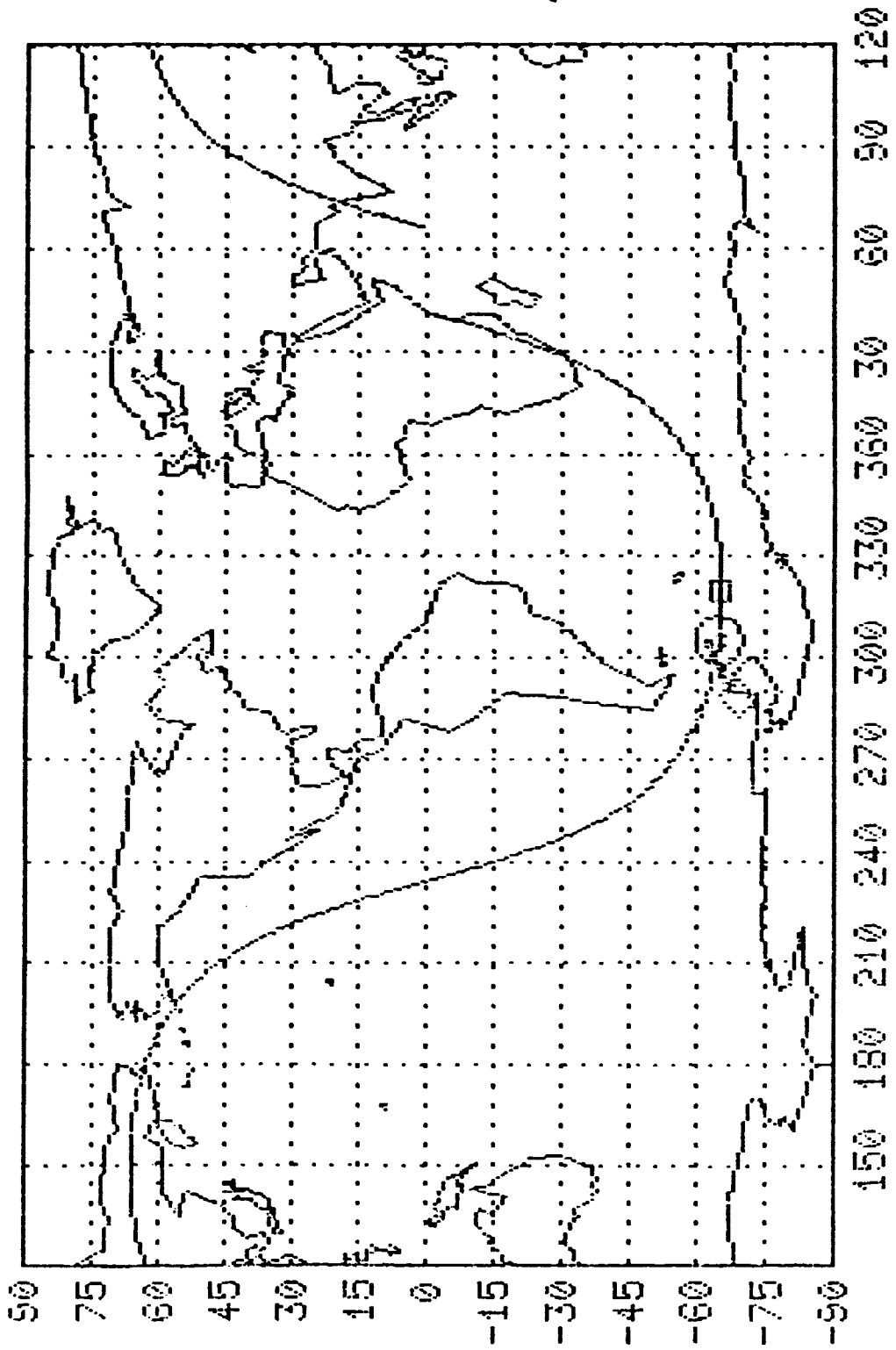
**CAUSE:** Unknown.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 880

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 880

1976-126

COSMOS 886

9634

**LAUNCH DATE:** 27.53 Dec 1976

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 27 Dec 1976 (DAY 362)

**TIME:** 183955.7 GMT

**LOCATION:** 65 S/211 E

**ALTITUDE:** 2088 km

**PIECES CATALOGED (1 JAN 84):** 57

**PIECES STILL IN ORBIT (1 JAN 84):** 51

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.84°

**APOGEE:** 2297 km

**PERIGEE:** 595 km

**PERIOD:** 114.8 min

**TRUE ANOMALY:** 217°

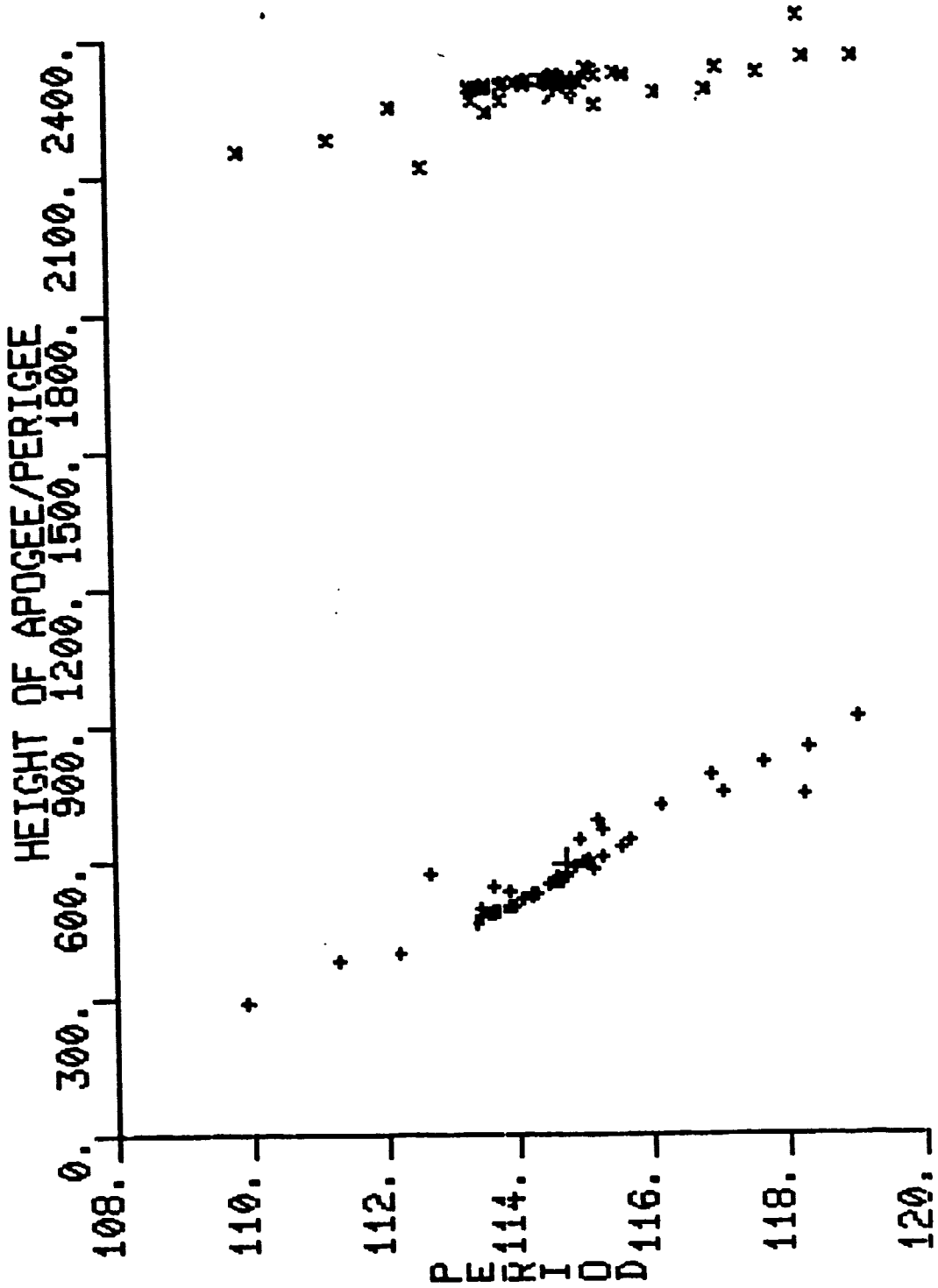


- COMMENTS:**
- Alleged Soviet ASAT test.
  - General shape was cylinder?; length 4 m?; dia. 2m?
  - Orbit data derived from element set #2 for satellite 9634.
  - Fragmentation did not occur near the alleged target satellite (Kosmos 880).

**CAUSE:** Fragmentation due to alleged ASAT test activity.

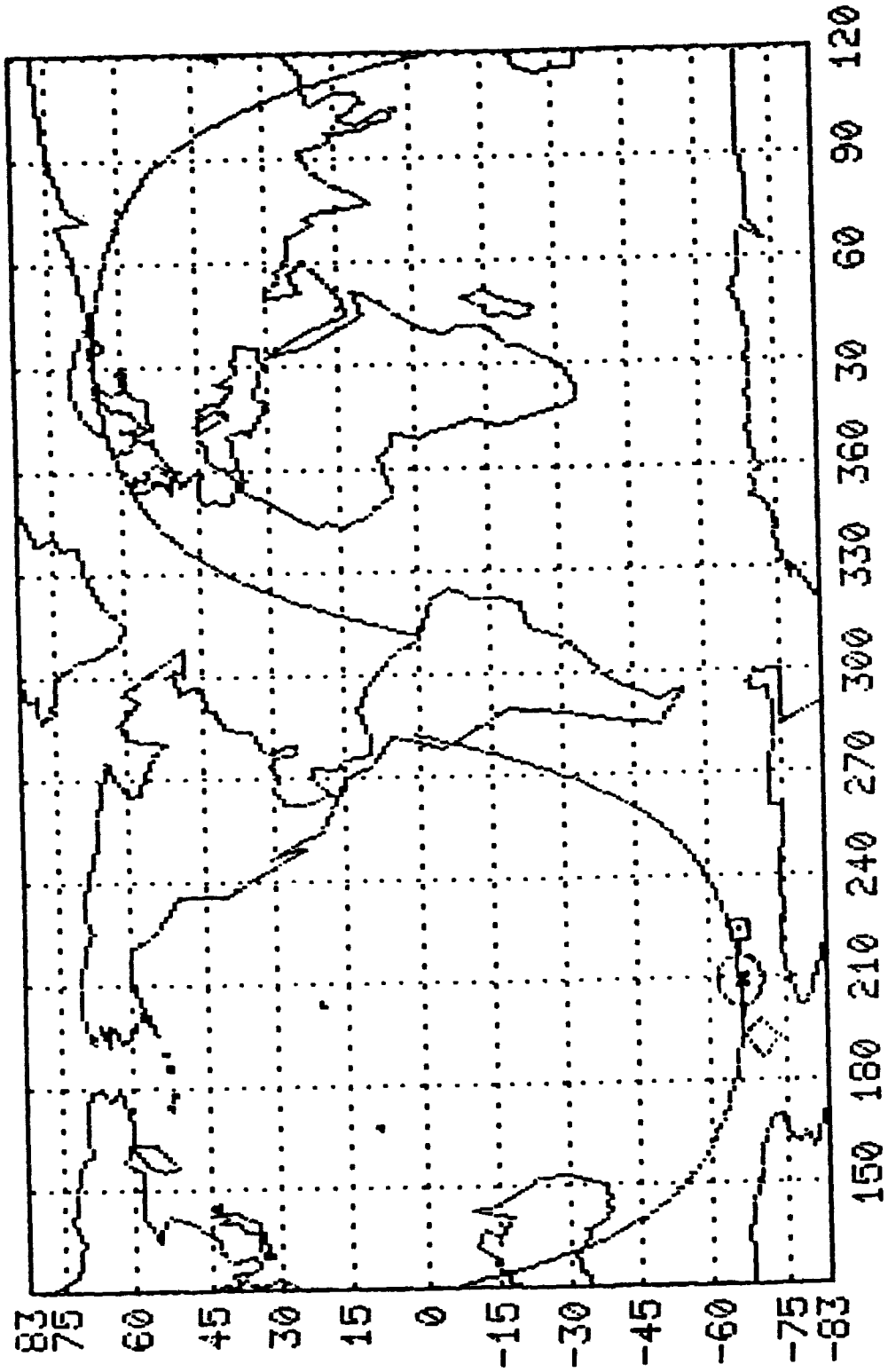
1976-126

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 886

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 886

1977-27

COSMOS 903

9911

**LAUNCH DATE:** 11.07 Apr 1977

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 8 Jun 1978 (DAY 159)

**TIME:**

**LOCATION:**

**ALTITUDE:**

**PIECES CATALOGED (1 JAN 84):** 2

**PIECES STILL IN ORBIT (1 JAN 84):** 2

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 63.15°

**APOGEE:** 39035 km

**PERIGEE:** 1323 km

**PERIOD:** 717.8 min

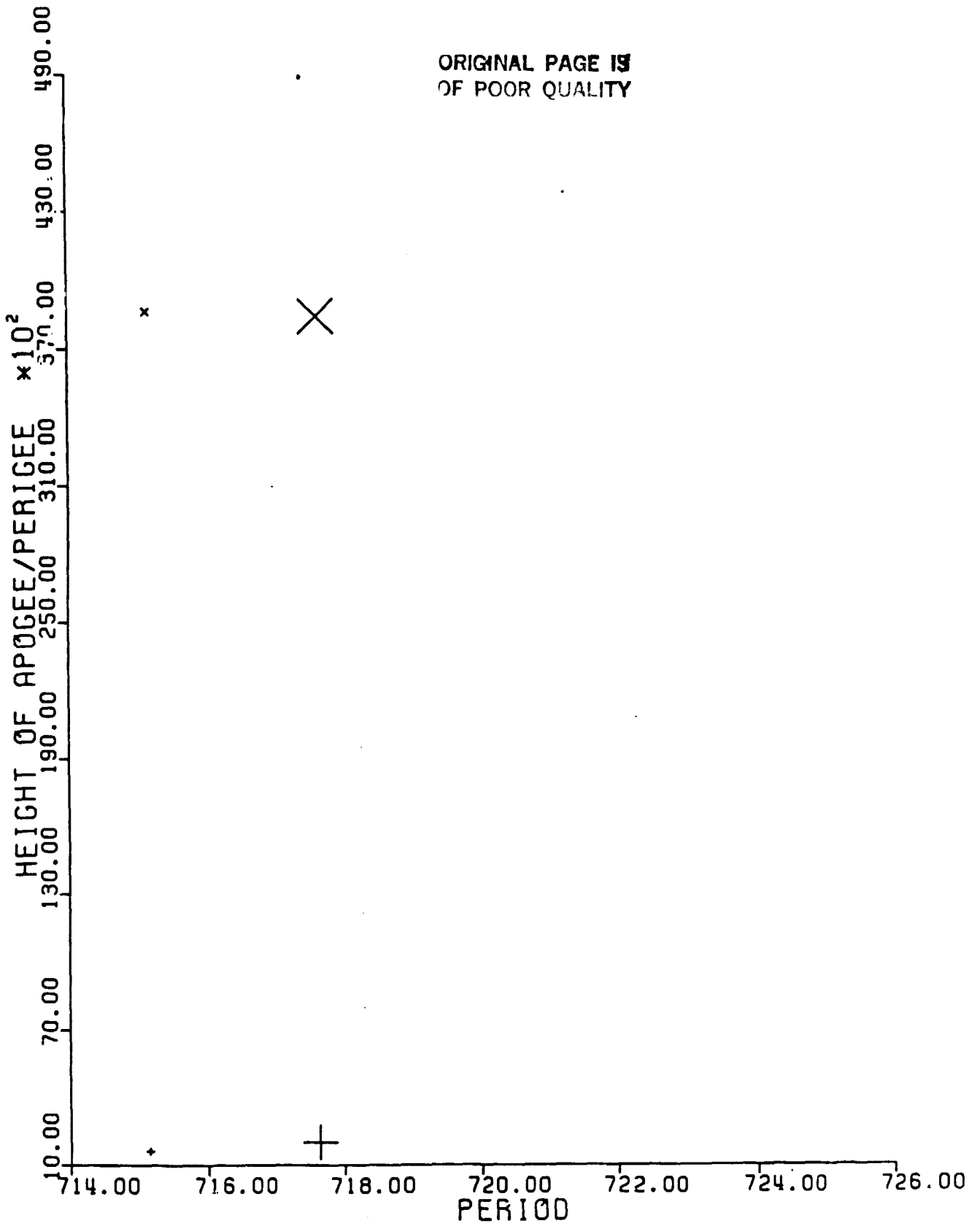
**TRUE ANOMALY:**

- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m?; weight 1250 kg?
  - Orbit data derived from element set #84 for satellite 9911.
  - Insufficient data is available to determine time and location for the satellite 9911 event.

**CAUSE:** Unknown.

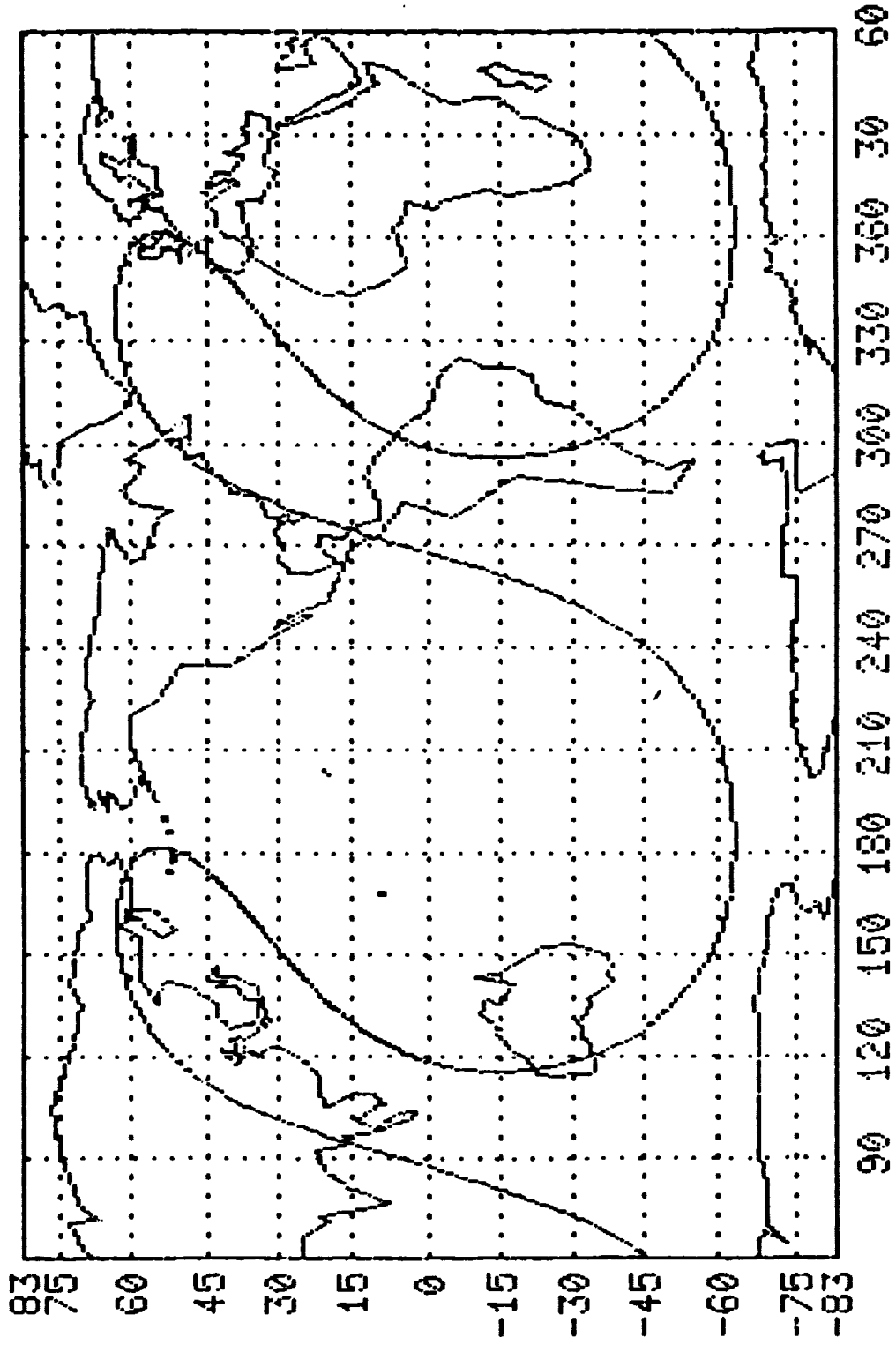
#77-27

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 903

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 903

1977-47

COSMOS 917

10059

**LAUNCH DATE:** 16.09 Jun 1977

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 30 Mar 1979 (DAY 89)

**TIME:** 154507.4 GMT

**LOCATION:** 63 S/O E

**ALTITUDE:** 3283 km

**PIECES CATALOGED (1 JAN 84):** 1

**PIECES STILL IN ORBIT (1 JAN 84):** 1

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 62.95°

**APOGEE:** 38723 km

**PERIGEE:** 1643 km

**PERIOD:** 718.0 min

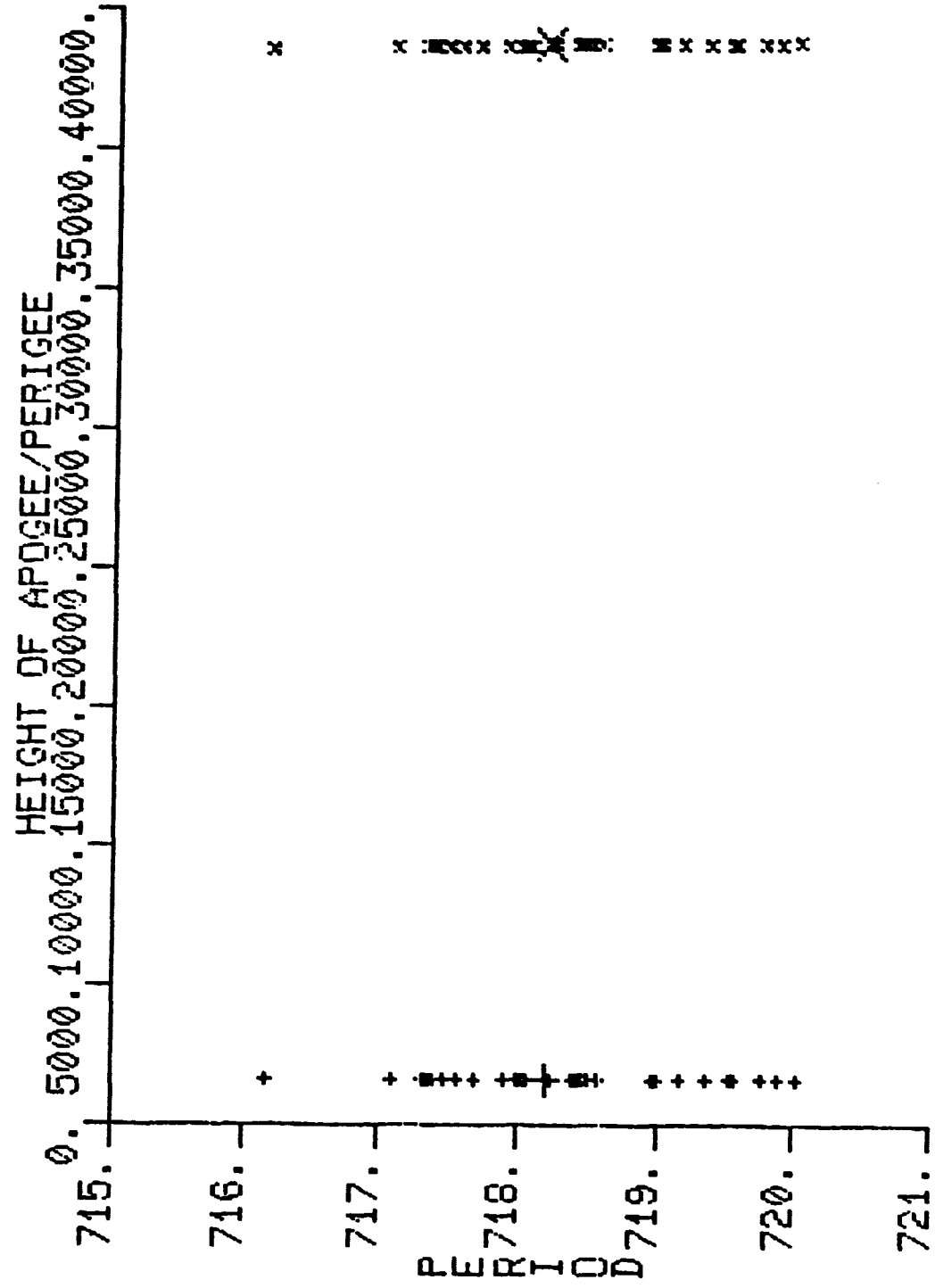
**TRUE ANOMALY:** 306°



- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m; weight 1250 kg?
  - Orbit data derived from element set #134 for satellite 10059.

**CAUSE:** Unknown.

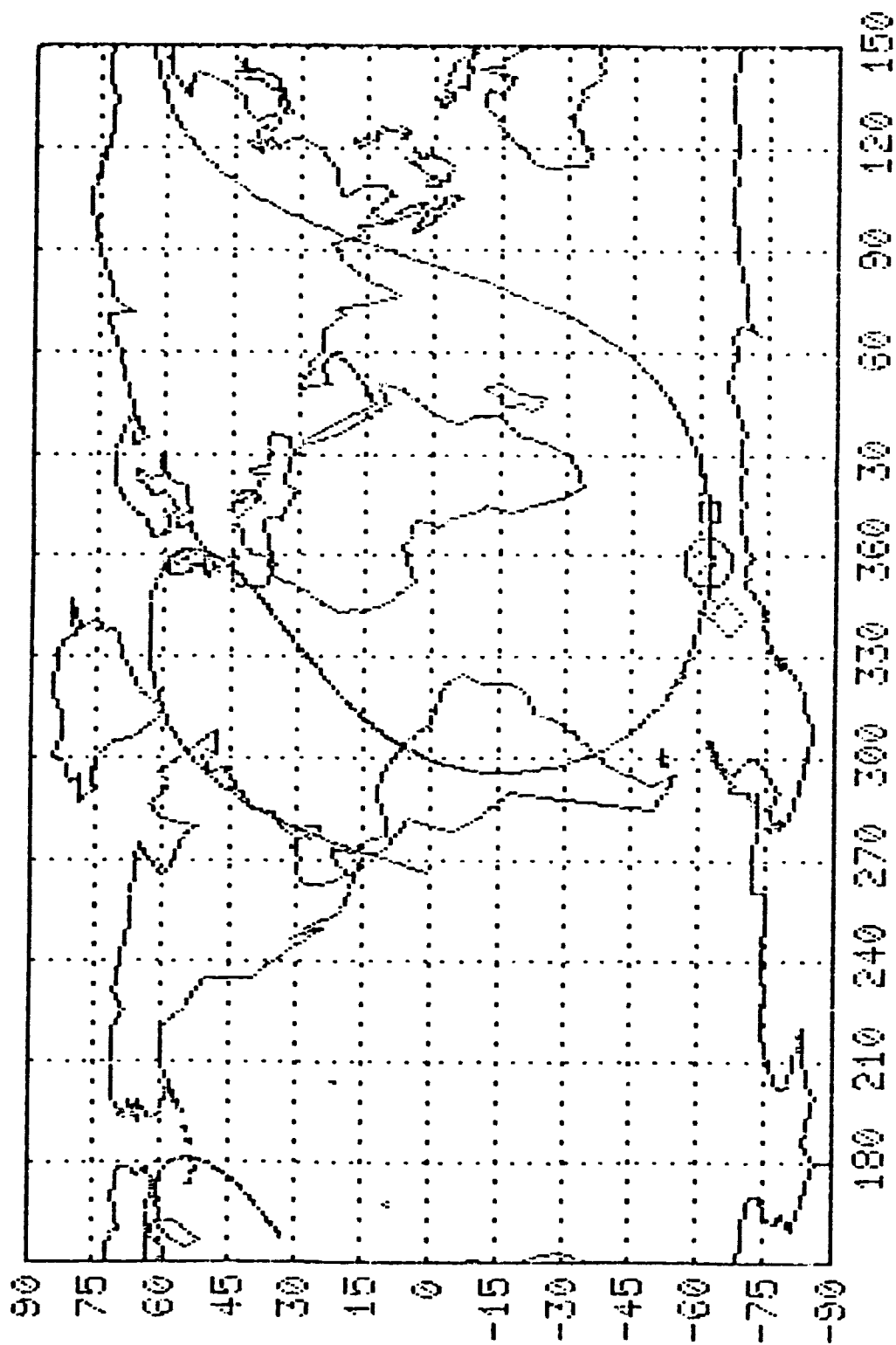
ORIGINAL PAGE IS  
OF POOR QUALITY



\* \* \* \* \*  
\* \* \* \* \*  
\* \* \* \* \*

COSMOS 917 SIMULATION

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 917

1977-65

HIMAWARI R/B

10144

**LAUNCH DATE:** 14.44 Jul 1977

**COUNTRY OF ORIGIN:** US

**EVENT DATA:**

**DATE:** 14 Jul 1977 (DAY 195)

**TIME:** 161155.1 GMT

**LOCATION:** 14 N/249 E

**ALTITUDE:** 1450 km

**PIECES CATALOGED (1 JAN 84):** 147

**PIECES STILL IN ORBIT (1 JAN 84):** 93

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 29.05°

**APOGEE:** 2027 km

**PERIGEE:** 536 km

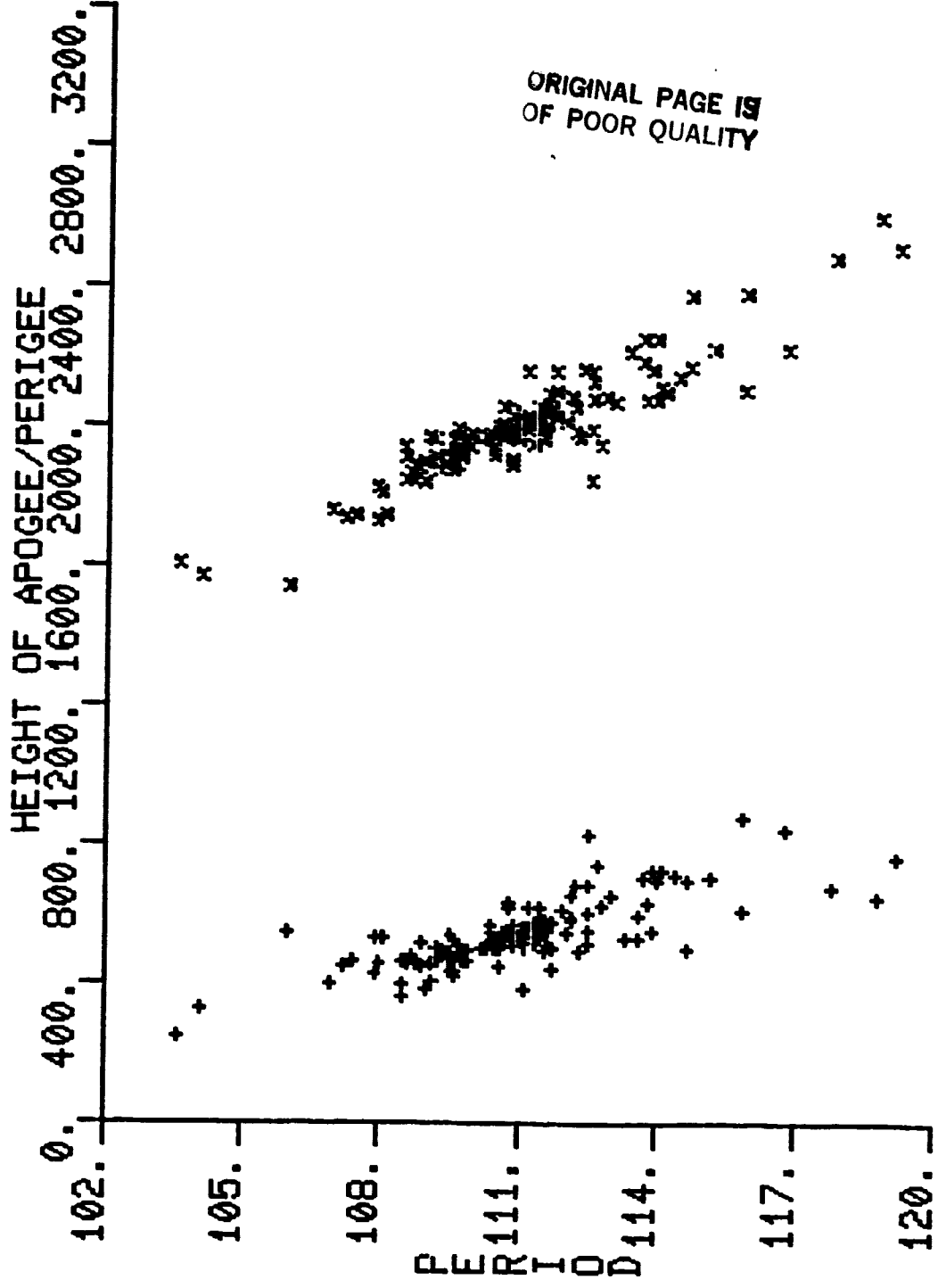
**PERIOD:** 111.2 min

**TRUE ANOMALY:** 108°

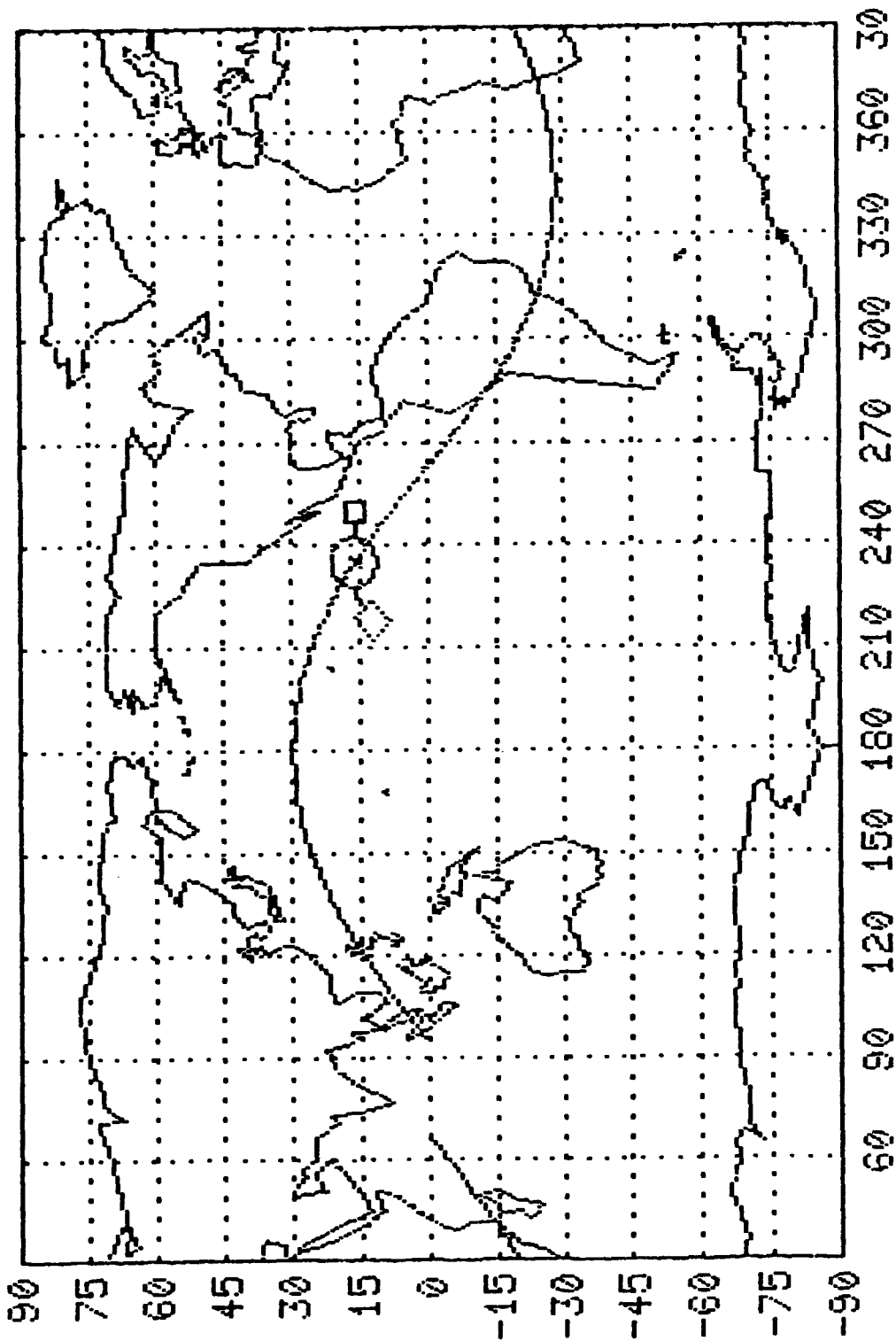
**COMMENTS:** • Delta 2nd stage rocket.

- Orbit data derived from element set #2 for satellite 10144.
- General shape was cylinder; length 3 m; dia. 2.1 m?; weight 670 kg full, 281 kg empty.

**CAUSE:** Hypergolic fuel ignition due to ruptured tank bulkhead most probable cause.



ORIGINAL PAGE 19  
OF POOR QUALITY



HIMAWARI R/B

1977-68

COSMOS 931

10150

**LAUNCH DATE:** 20.20 Jul 1977

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 24 Oct 1977 (DAY 297)

**TIME:**

**LOCATION:**

**ALTITUDE:**

**PIECES CATALOGED (1 JAN 84):** 4

**PIECES STILL IN ORBIT (1 JAN 84):** 2

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 62.94°

**APOGEE:** 39667 km

**PERIGEE:** 682 km

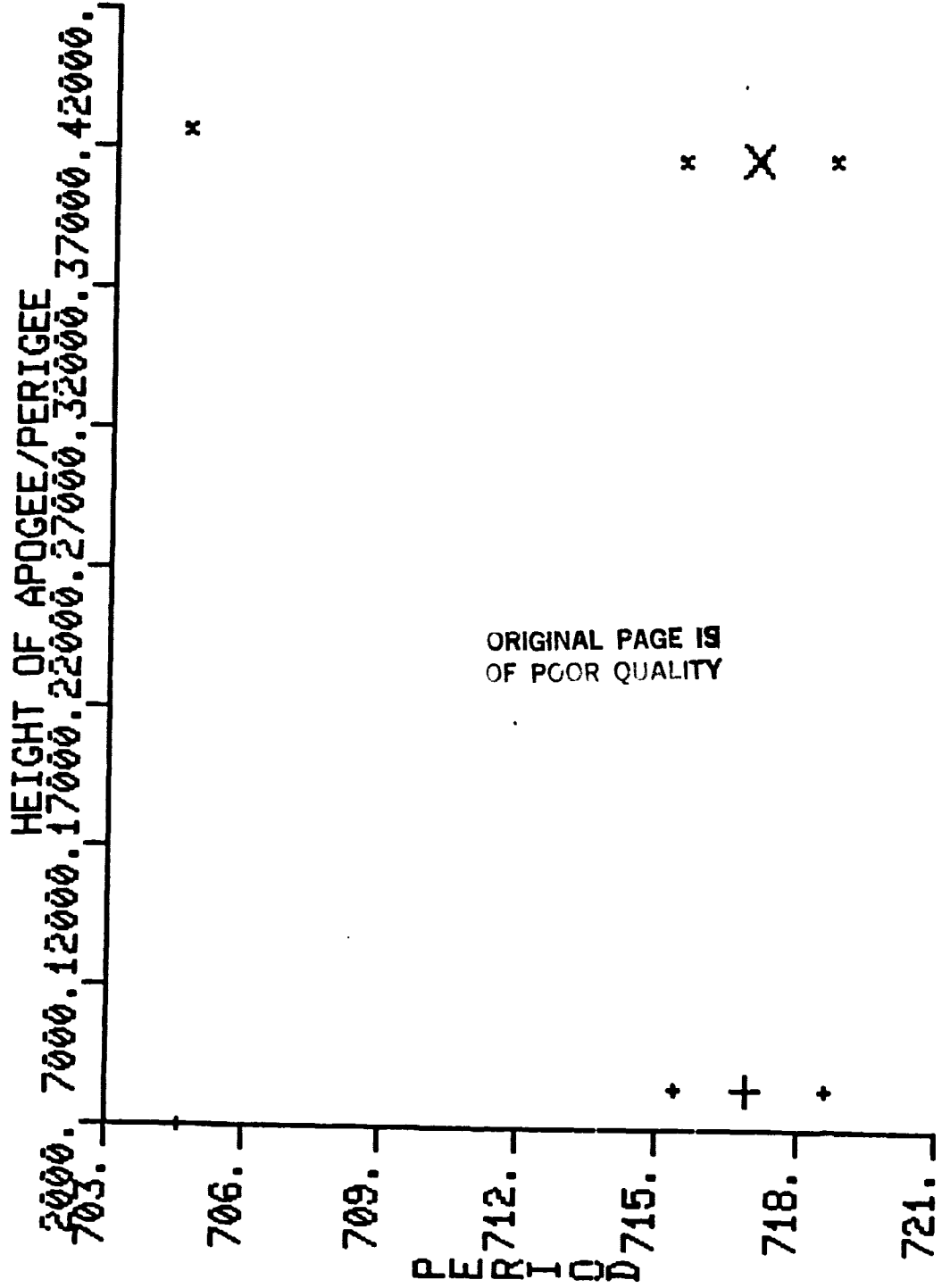
**PERIOD:** 717.7 min

**TRUE ANOMALY:**



- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m?; weight 1250 kg.
  - Orbit data derived from element set #16 for satellite 10150.

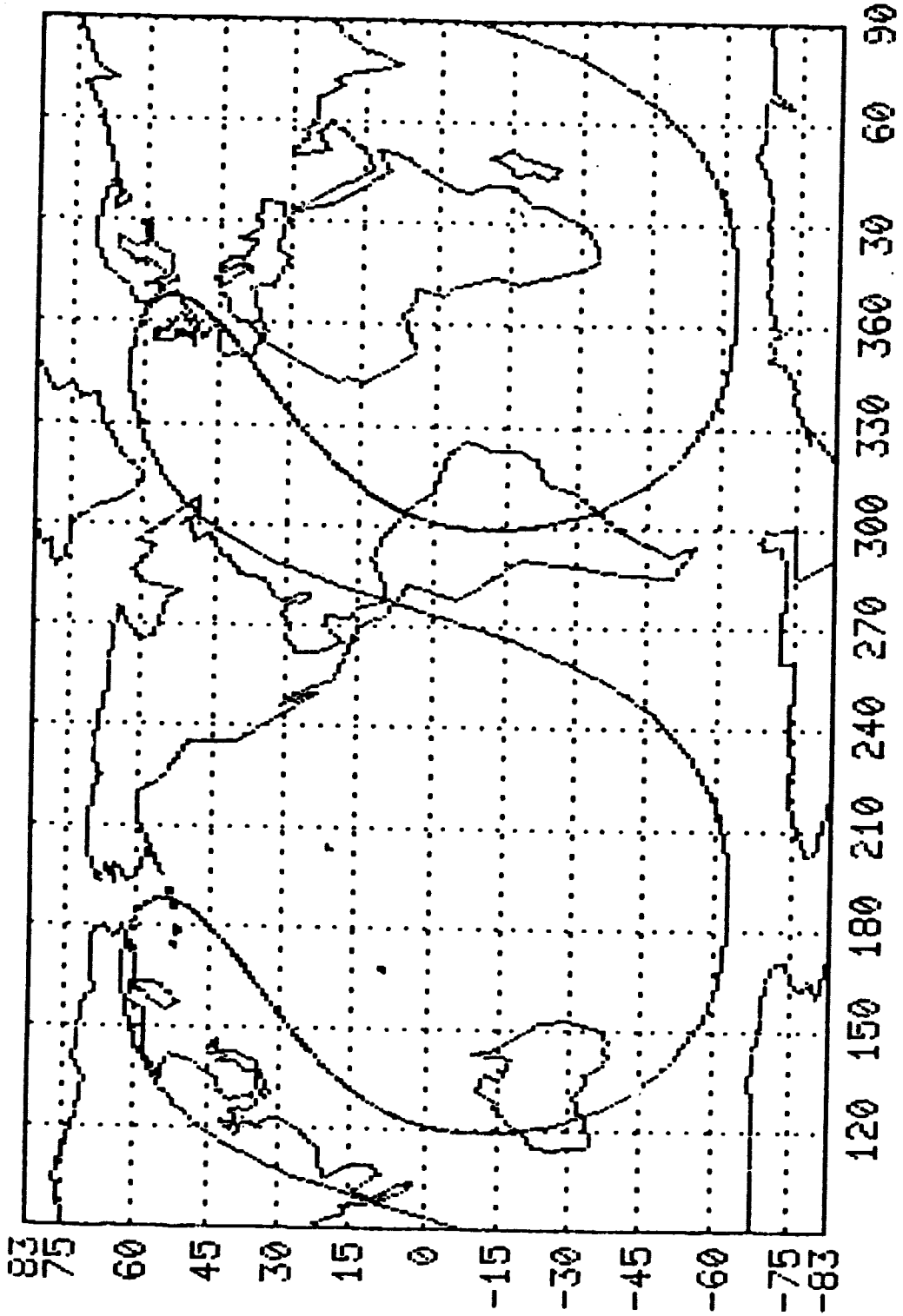
**CAUSE:** Unknown.



ORIGINAL PAGE IS  
OF POOR QUALITY

COSMOS 931

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 931

1977-121

COSMOS 970

10531

**LAUNCH DATE:** 21.44 Dec 1977

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 21 Dec 1977 (DAY 355)

**TIME:** 170946.4 GMT

**LOCATION:** 38 S/274 E

**ALTITUDE:** 1133 km

**PIECES CATALOGED (1 JAN 84):** 54

**PIECES STILL IN ORBIT (1 JAN 84):** 54

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.85°

**APOGEE:** 1139 km

**PERIGEE:** 946 km

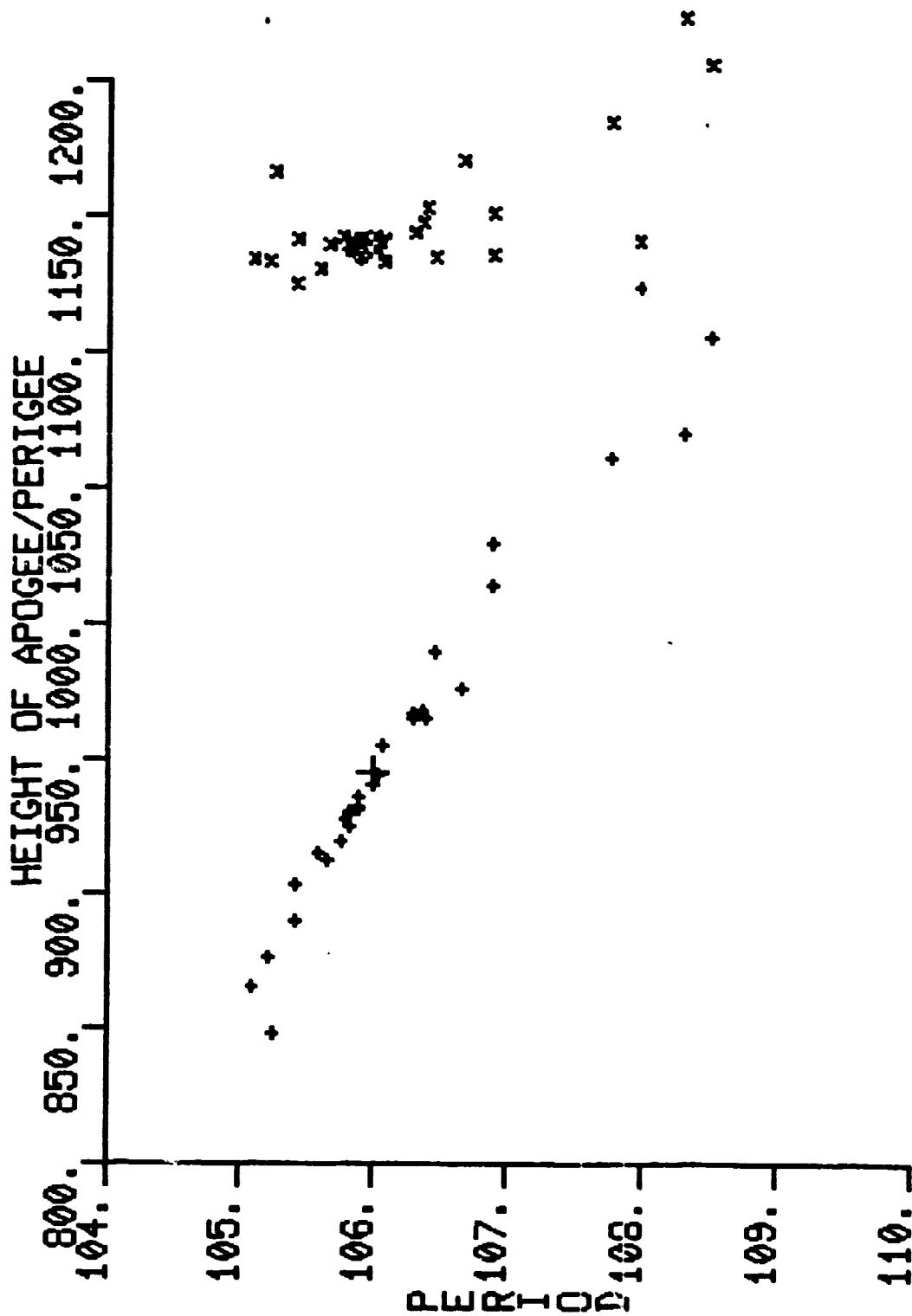
**PERIOD:** 106.0 min

**TRUE ANOMALY:** 201°

- COMMENTS:**
- Alleged Soviet ASAT test.
  - General shape was cylinder?; length 4 m; dia. 2m?
  - Orbit data derived from element set #6 for satellite 10531.

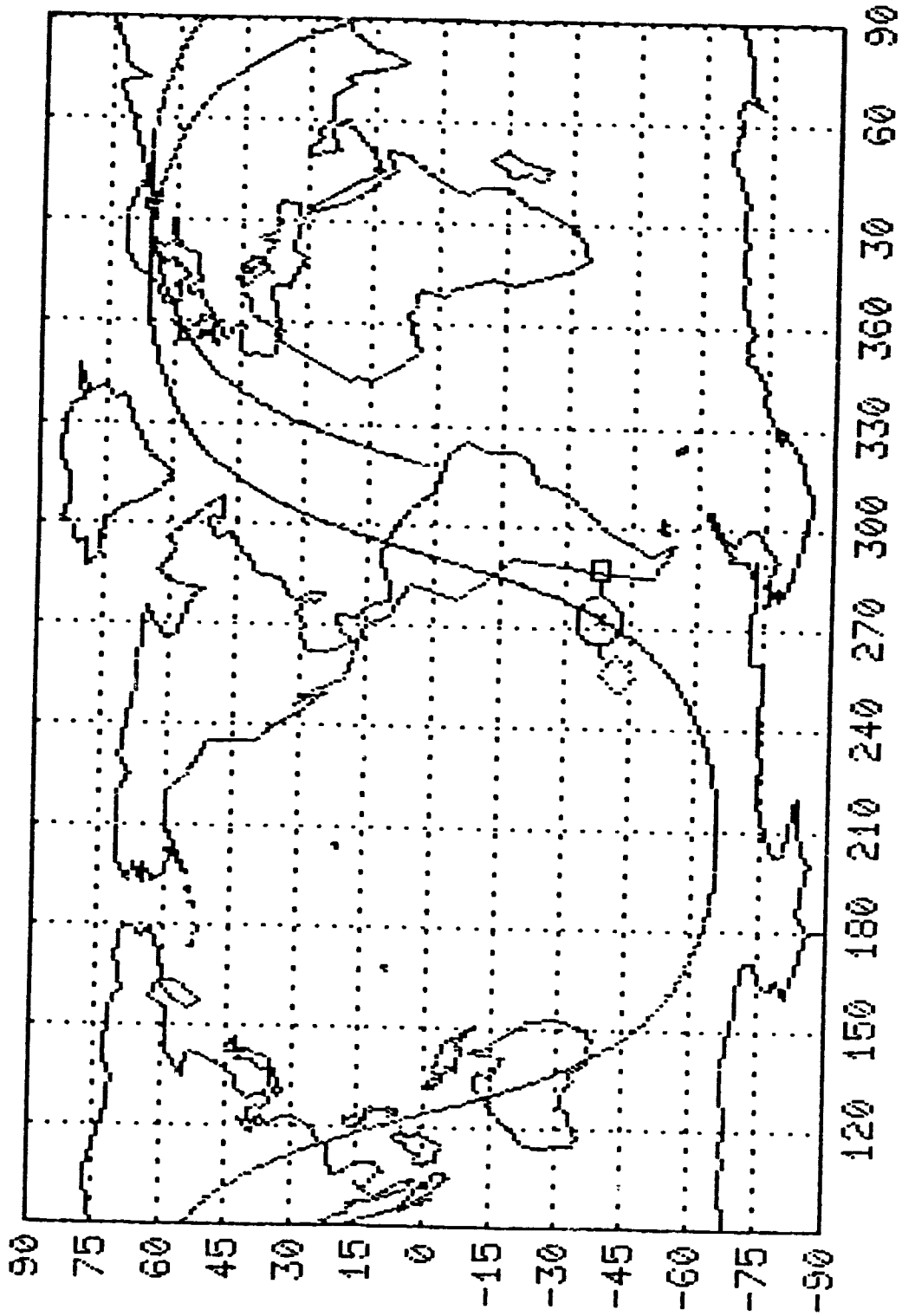
**CAUSE:** Fragmentation due to alleged ASAT test activity.

ORIGINAL PAGE IS  
OF POOR QUALITY



CGSMOS 970

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 970

1978-26

LANDSAT 3 R/B

10704

**LAUNCH DATE:** 5.75 Mar 1978

**COUNTRY OF ORIGIN:** US

**EVENT DATA:**

**DATE:** 27 Jan 1981 (DAY 27)

**TIME:** 043202.3 GMT

**LOCATION:** 80 S/301 E

**ALTITUDE:** 905 km

**PIECES CATALOGED (1 JAN 84):** 172

**PIECES STILL IN ORBIT (1 JAN 84):** 155

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 98.85°

**APOGEE:** 912 km

**PERIGEE:** 903 km

**PERIOD:** 103.1 min

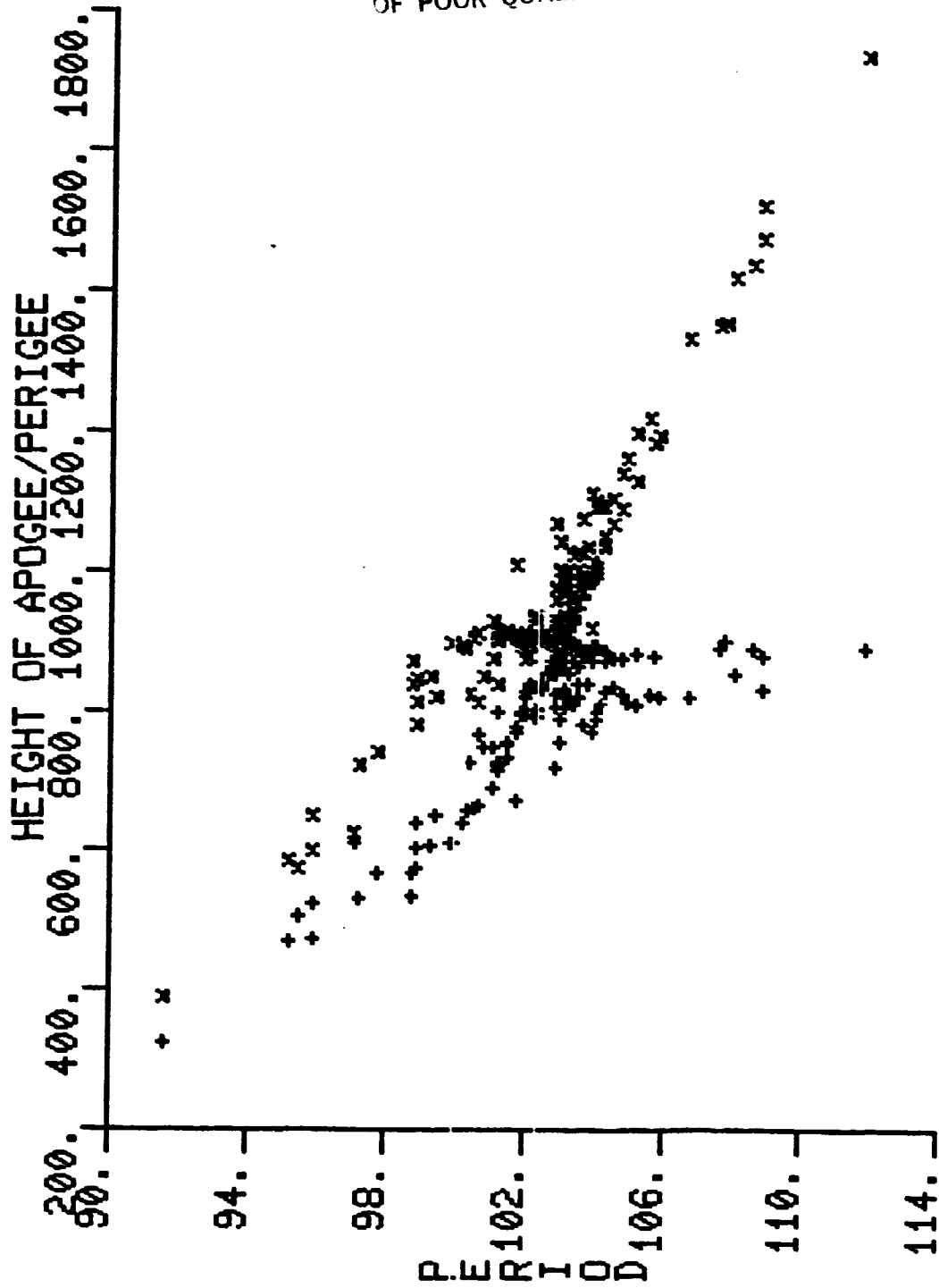
**TRUE ANOMALY:** 62°



- COMMENTS:**
- Delta 2nd stage rocket.
  - Orbit data derived from element set #569 for satellite 10704.
  - General shape was cylinder plus annulus; length 6.4 m; dia. 1.52 and 2.44 m; weight 350 kg?

**CAUSE:** Hypergolic fuel ignition due to ruptured tank bulkhead most probable cause.

ORIGINAL PAGE IS  
OF POOR QUALITY



LANDSAT 3 ROCKET



1978-83

COSMOS 1030

11015

LAUNCH DATE: 6.13 Sep 1978

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 10 Oct 1978 (DAY 283)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 4

PIECES STILL IN ORBIT (1 JAN 84): 3

ORBIT CHARACTERISTICS:

INCLINATION: 62.84°

APOGEE: 39760 km

PERIGEE: 666 km

PERIOD: 719.2 min

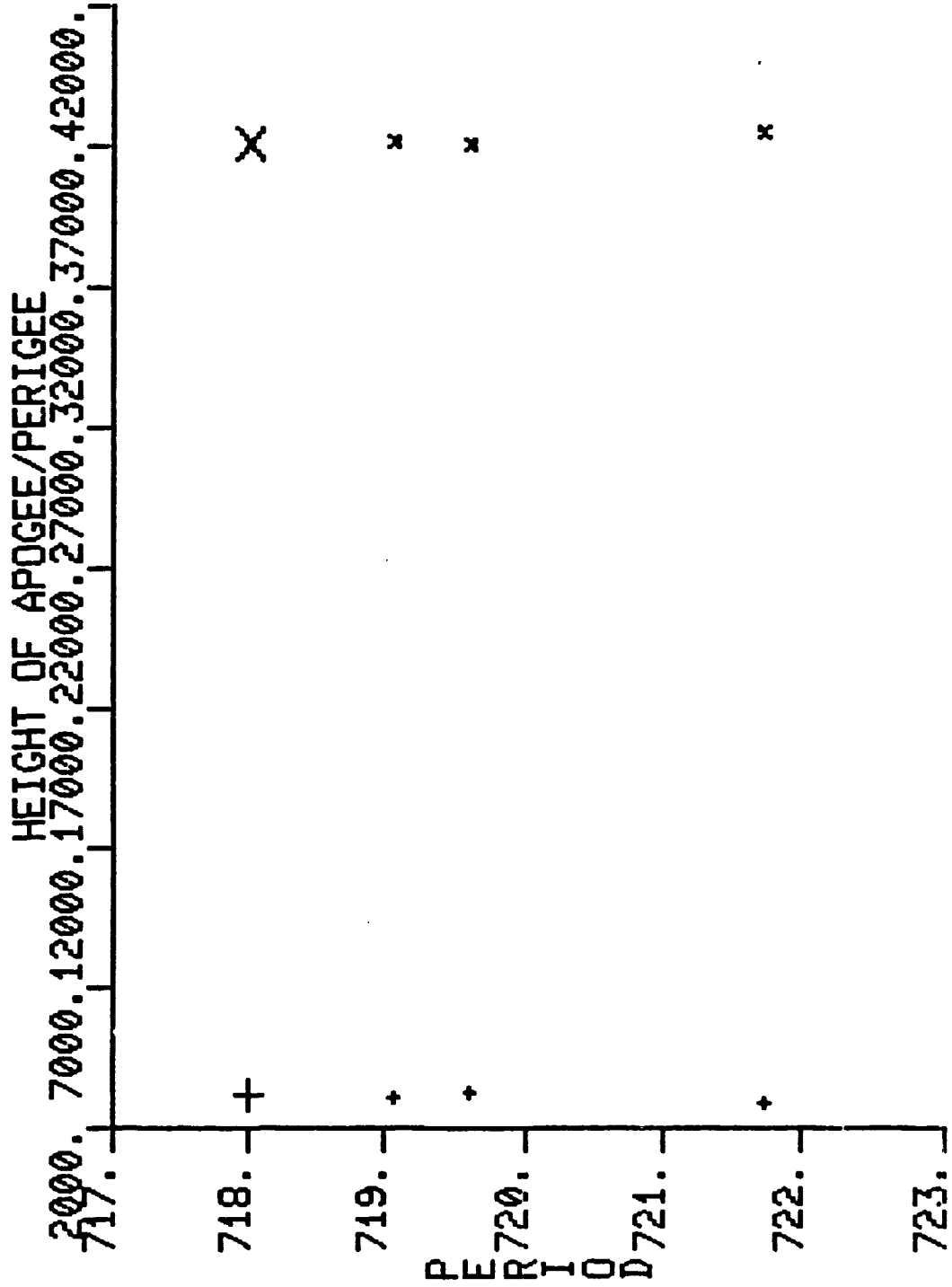
TRUE ANOMALY:

- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m; dia. 1.6 m?; weight 1250 kg?
  - Orbit data derived from element set #8 for satellite 11015.
  - Insufficient data available to determine time and location for the satellite 11015 event.

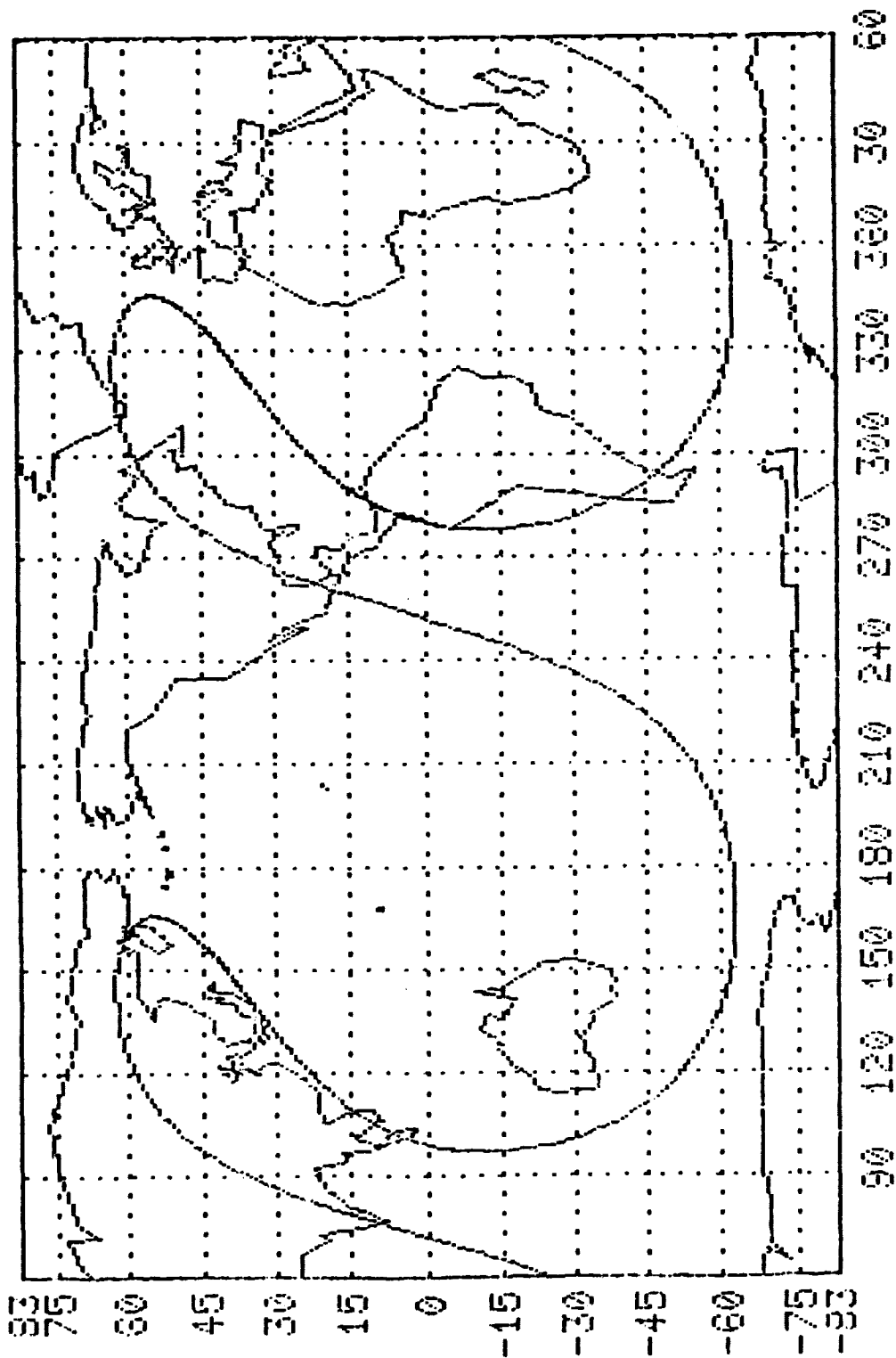
**CAUSE:** Unknown.

1978-83

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 1030



COSMOS 1030

1979-33

COSMOS 1094

11333

**LAUNCH DATE:** 18.50 Apr 1979

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 17 Sep 1979 (DAY 260)

**TIME:** 103906.0 GMT

**LOCATION:** 54 S/336 E

**ALTITUDE:** 403 km

**PIECES CATALOGED (1 JAN 84):** 2

**PIECES STILL IN ORBIT (1 JAN 84):** 0

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.03°

**APOGEE:** 405 km

**PERIGEE:** 382 km

**PERIOD:** 92.4 min

**TRUE ANOMALY:** 206°

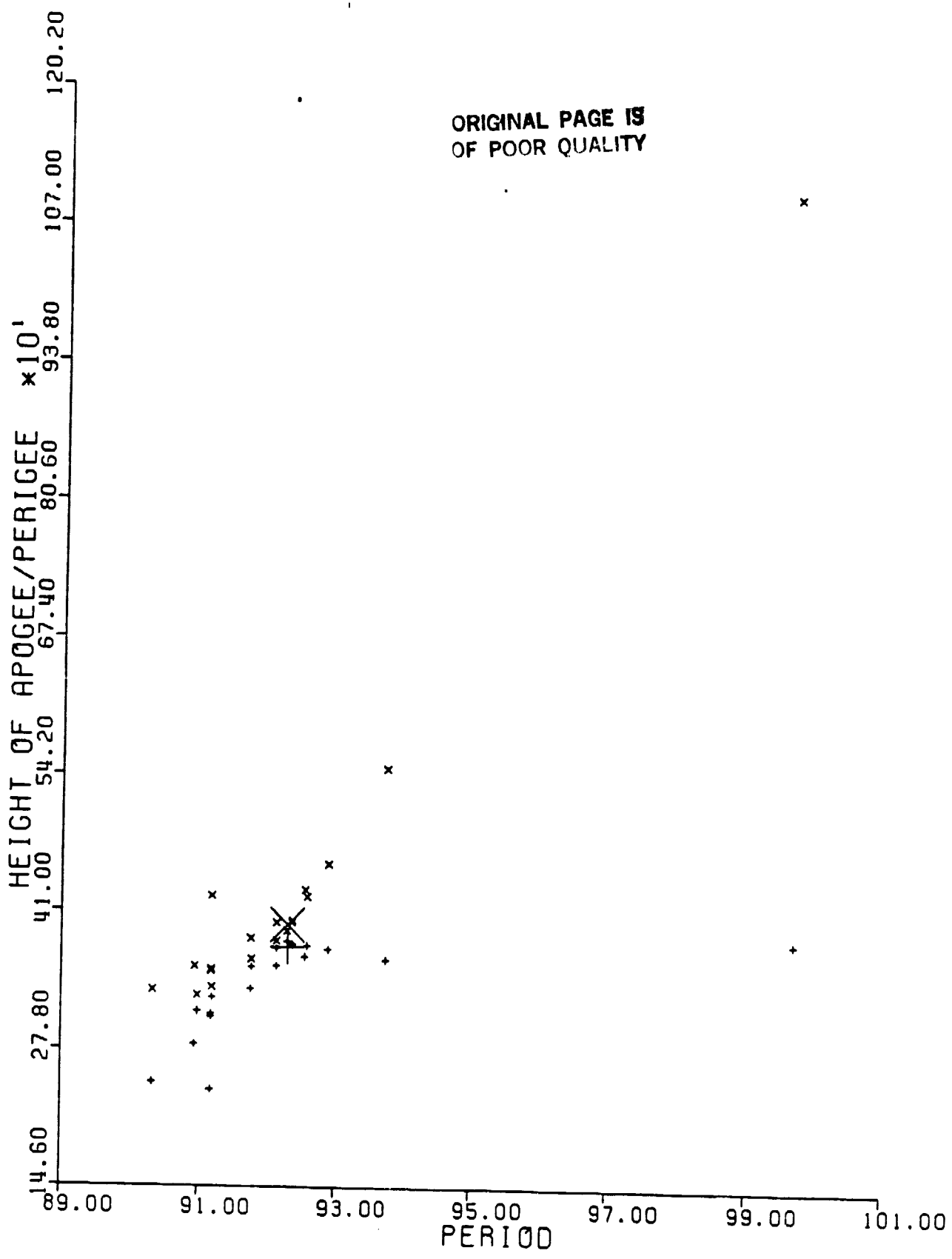


**COMMENTS:** • 23 known pieces decayed before they could be cataloged but provisional (8X,XXX) elements were developed.

- Member of Cosmos 699 class.

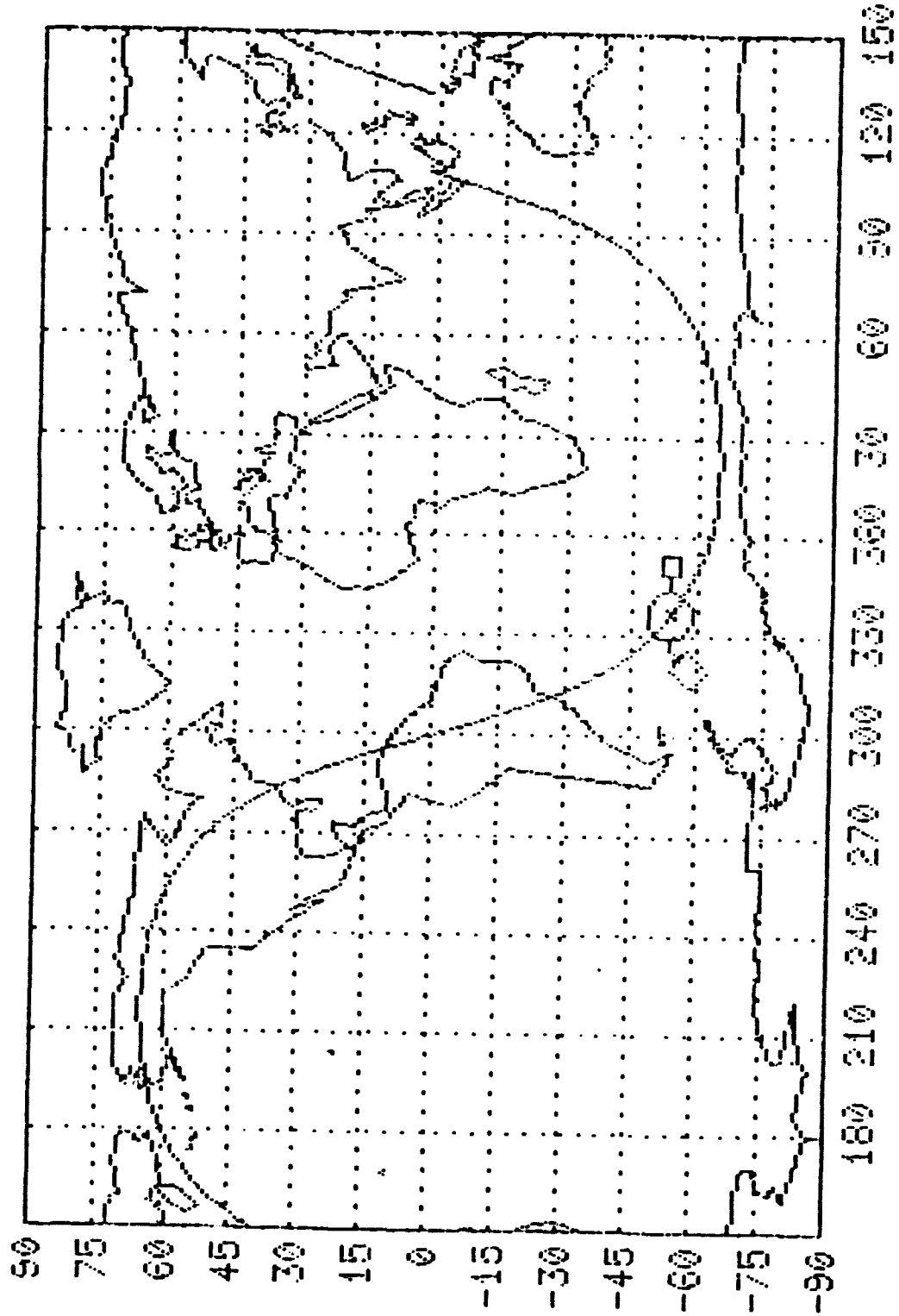
**CAUSE:** Apparently deliberate fragmentation.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1094

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1094

1979-58

COSMOS 1109

11417

**LAUNCH DATE:** 27.76 Jun 1979

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** Late Sep 1979

**TIME:**

**LOCATION:**

**ALTITUDE:**

**PIECES CATALOGED (1 JAN 84):** 4

**PIECES STILL IN ORBIT (1 JAN 84):** 4

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 62.86°

**APOGEE:** 39679 km

**PERIGEE:** 712 km

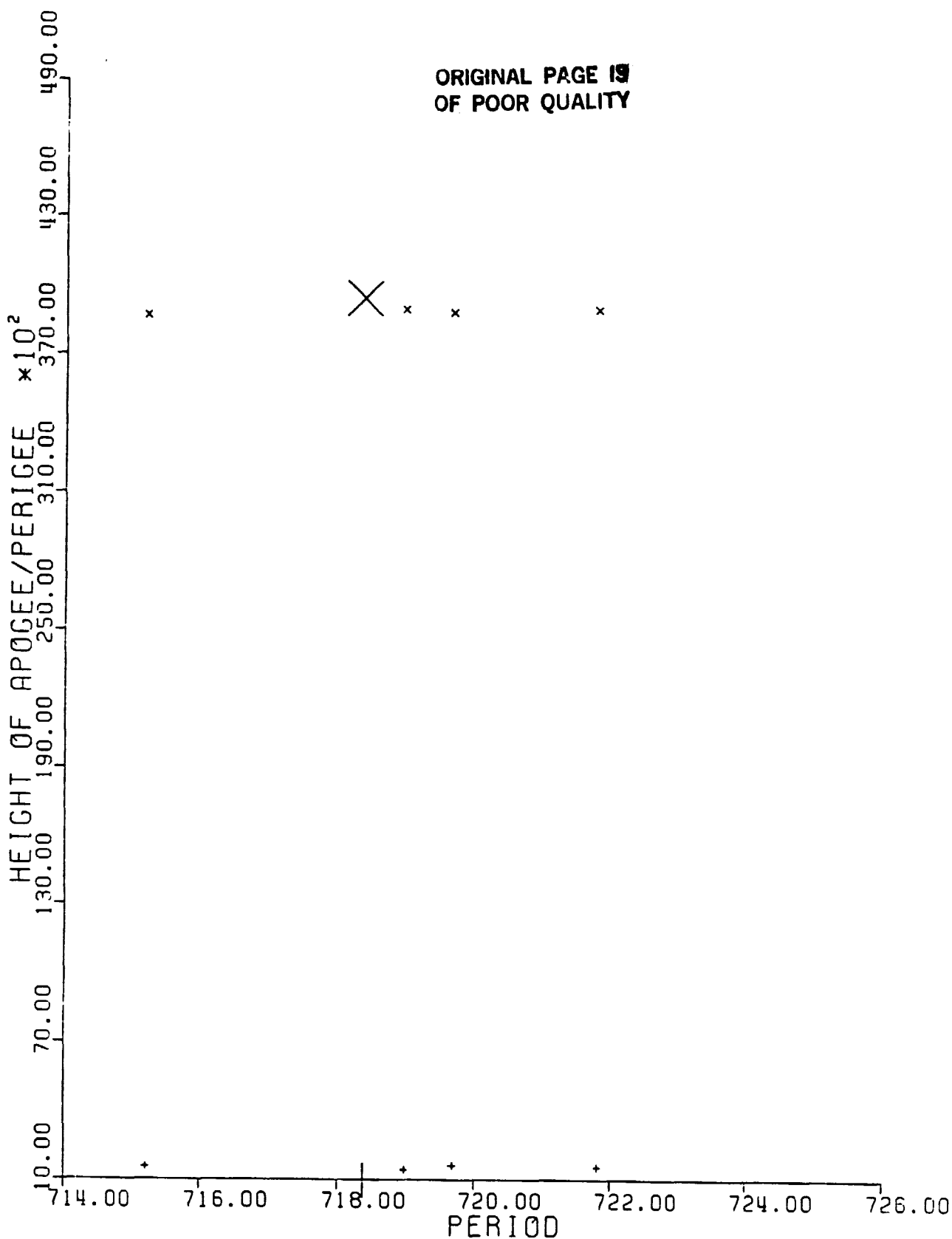
**PERIOD:** 718.5 min

**TRUE ANOMALY:**

- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m; dia. 1.6?; weight 1250 kg?
  - Orbit data derived from element set #7 for satellite 11417.
  - Insufficient data available to determine time and location for the satellite 11417 event.

**CAUSE:** Unknown.

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 1109

COMMENTS • Insufficient data was available to obtain a ground trace for 1979-58, COSMOS 1109.

1979-58

1-227

1979-77

COSMOS 1124

11509

LAUNCH DATE: 28.01 Aug 1979

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 9 Sep 1979 (DAY 252)

TIME: 022932.4 GMT

LOCATION: 52 N/304 E

ALTITUDE: 8100 km

PIECES CATALOGED (1 JAN 84): 5

PIECES STILL IN ORBIT (1 JAN 84): 5

ORBIT CHARACTERISTICS:

INCLINATION: 62.93°

APOGEE: 39754 km

PERIGEE: 574 km

PERIOD: 717.2 min

TRUE ANOMALY: 103°

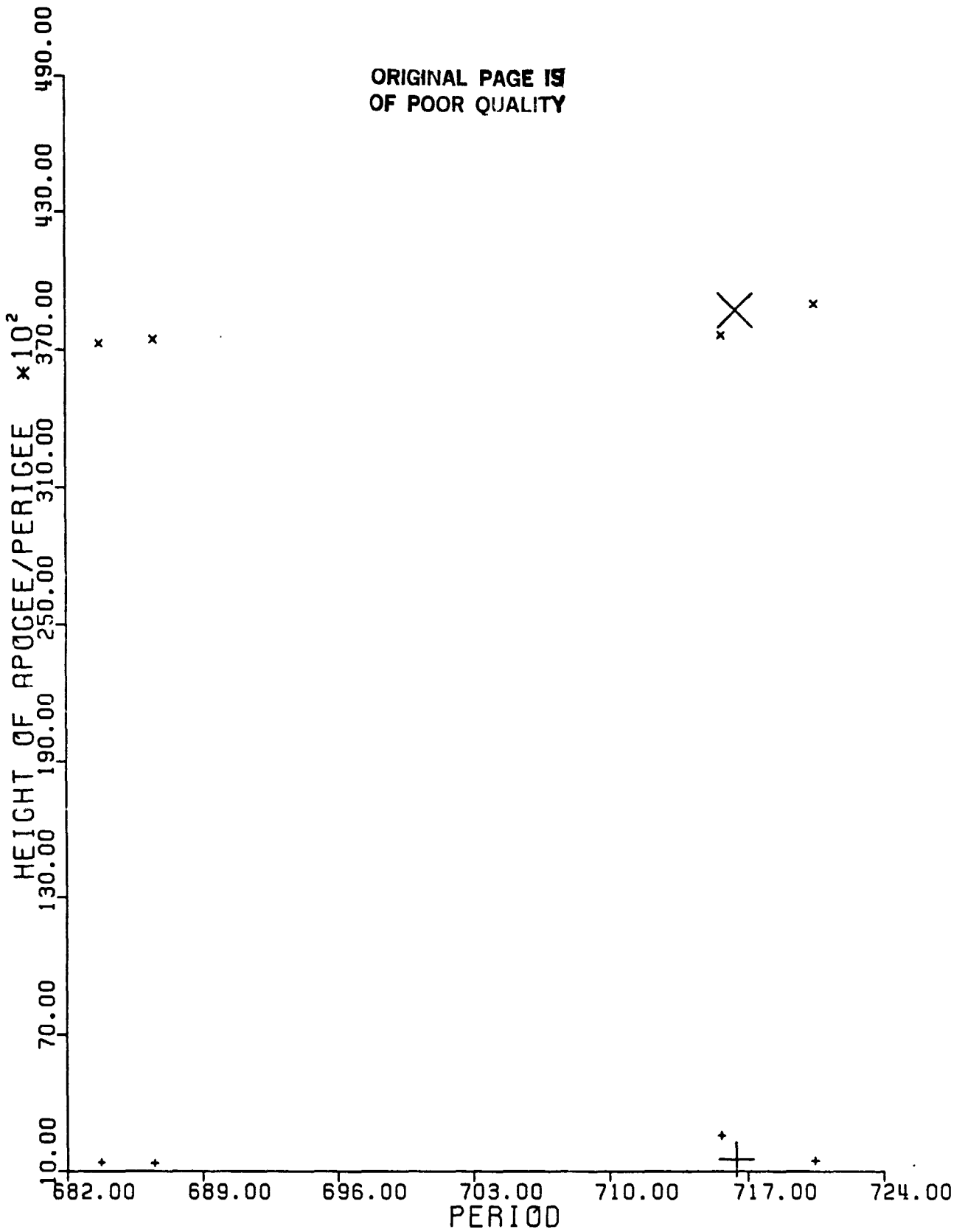


- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m; dia. 1.6 m?; weight 1250 kg?
  - Orbit data derived from element set with epoch 79249.09583699 for satellite 11509.

**CAUSE:** Unknown.

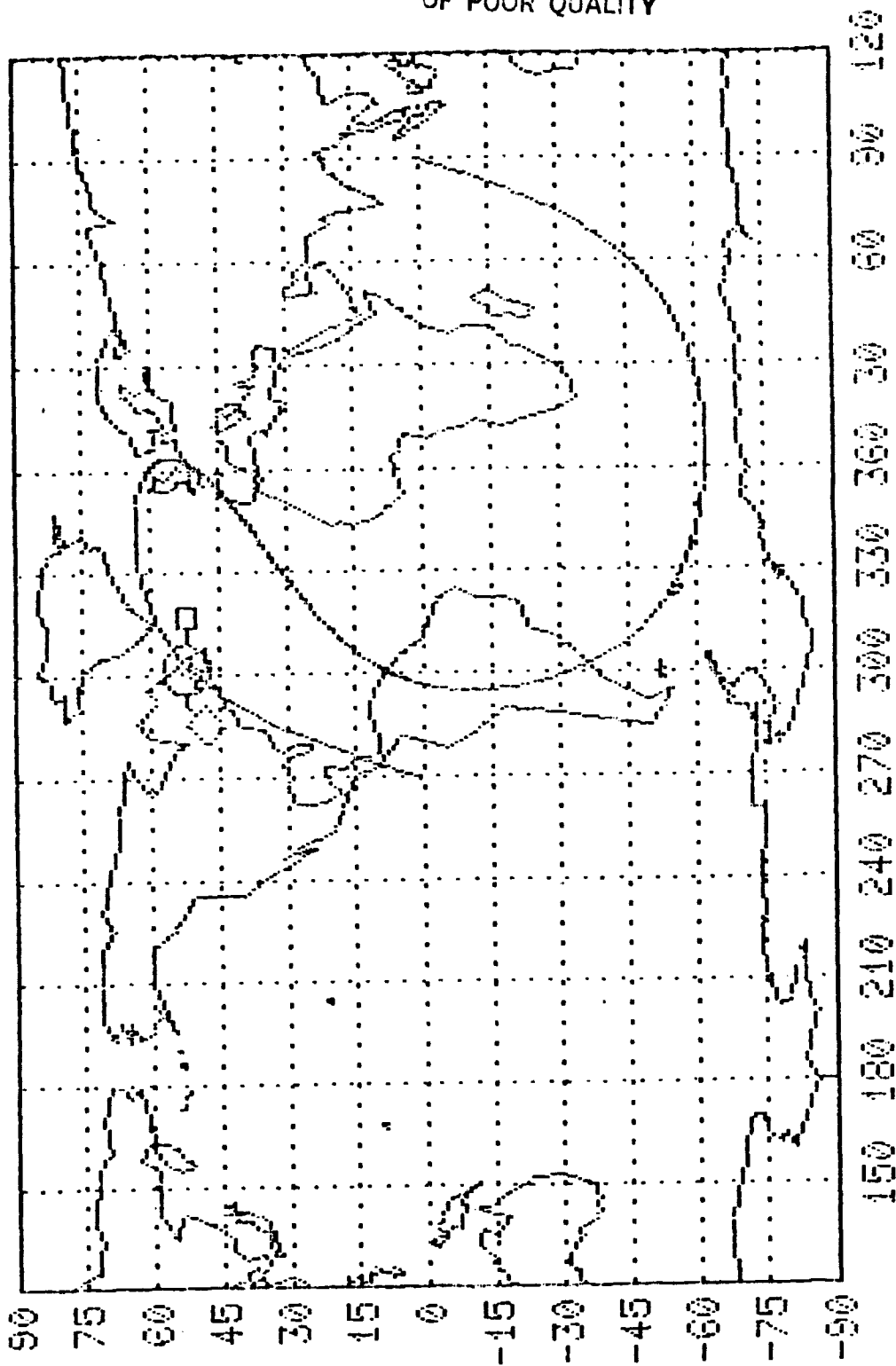
1979-77

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1124

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1124

1979-104

ARIANE V1

11659

LAUNCH DATE: 24.72 Dec 1979

COUNTRY OF ORIGIN: France

EVENT DATA:

DATE: Early 1980

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 1

PIECES STILL IN ORBIT (1 JAN 84): Est. at least 25

ORBIT CHARACTERISTICS:

INCLINATION: 17.6°

APOGEE: 35839 km

PERIGEE: 189 km

PERIOD: 631.9 min

TRUE ANOMALY:

- COMMENTS:**
- This event was discovered by analysis of the provisional (8X,XXX) elements in the NORAD catalog.
  - Only the payload and rocket of this launch have been cataloged. Due to inconsistent observation of the smaller low inclination, (17°) fragments they become alternately lost then found as the observable portion of the orbits moved within and then out of sensor coverages.
  - At any given time from 7 to 12 provisional elements are resident in the catalog.
  - General shape was a sphere; dia. unk; weight 217 kg capsule plus 1385 kg ballast.
  - Insufficient data available to determine the time and location for the satellite 11659 event.
  - Orbit data for satellite 11659 derived from element set #1.
  - Millstone radar team believes third stage blew-up approximately 90 days after launch.

**CAUSE:** Unknown.



COMMENTS • Insufficient data available to show applicable ground track for satellite 11659.

1979-104

1-235

1980-21

COSMOS 1167

11729

LAUNCH DATE: 14.45 Mar 1980

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 15 Jul 1981 (DAY 196)

TIME: 092049.7 GMT

LOCATION: 10 N/106 E

ALTITUDE: 437 km

PIECES CATALOGED (1 JAN 84): 12

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.31°

APOGEE: 450 km

PERIGEE: 357 km

PERIOD: 92.6 min

TRUE ANOMALY: 222°

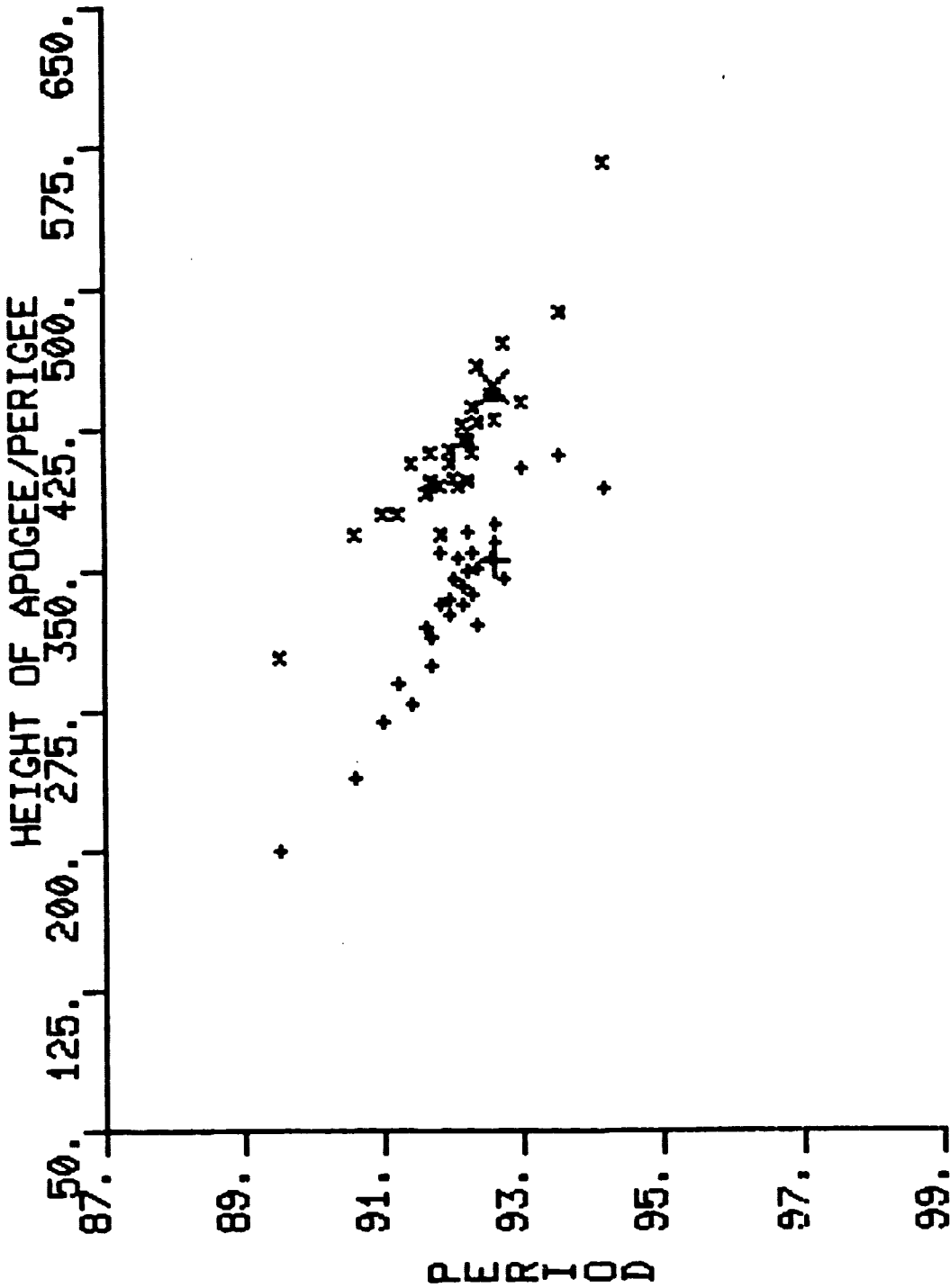


**COMMENTS:** • Orbit derived from element set #573 for satellite 11729.

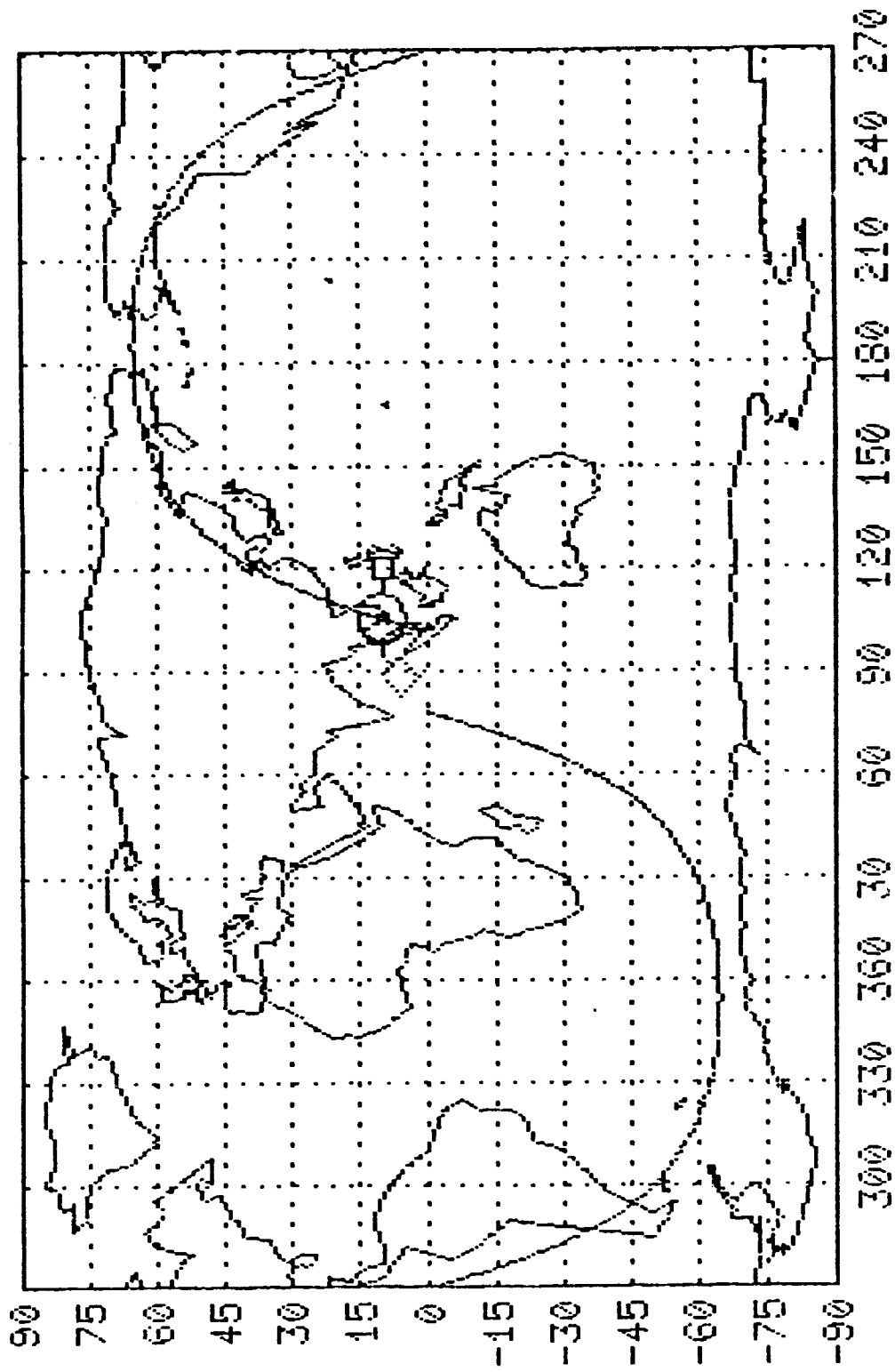
• Member of Cosmos 699 class.

**CAUSE:** Apparently deliberate fragmentation.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1167



COSMOS 1167

1980-30

COSMOS 1174

11765

**LAUNCH DATE:** 18.04 Apr 1980

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 18 Apr 1980 (DAY 109)

**TIME:** 072616.1 GMT

**LOCATION:** 47 N/322 E

**ALTITUDE:** 986 km

**PIECES CATALOGED (1 JAN 84):** 39

**PIECES STILL IN ORBIT (1 JAN 84):** 22

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 65.84°

**APOGEE:** 1025 km

**PERIGEE:** 362 km

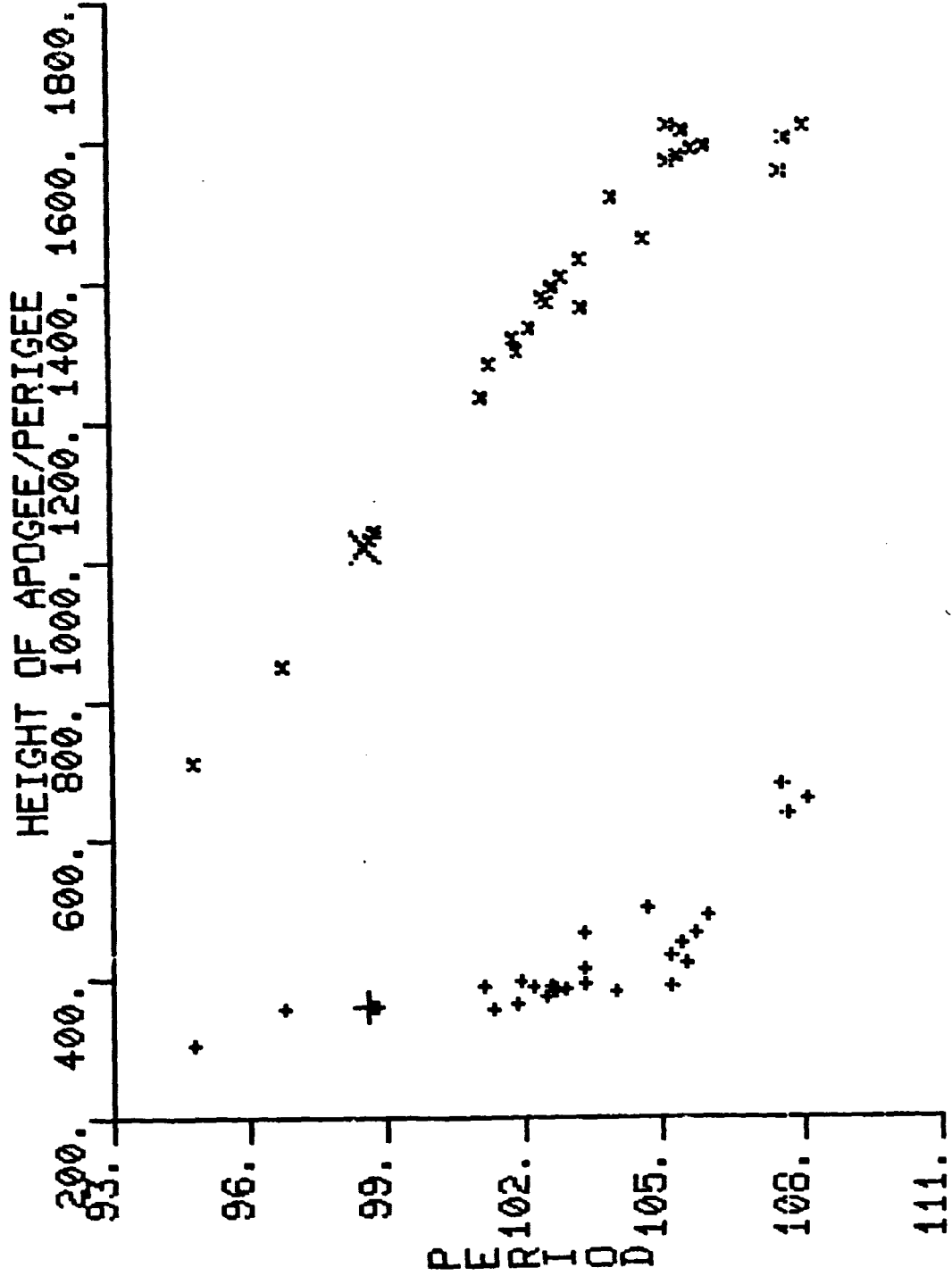
**PERIOD:** 98.6 min

**TRUE ANOMALY:** 154°

- COMMENTS:**
- Alleged Soviet ASAT test.
  - Orbit data derived from element set #2 for satellite 11765.
  - General shape; cylinder?

**CAUSE:** Fragmentation due to alleged ASAT test.

ORIGINAL PAGE IS  
OF POOR QUALITY





1980-57

COSMOS 1191

11871

LAUNCH DATE: 2.04 Jul 1980

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 14 May 1981 (DAY 134)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 2

PIECES STILL IN ORBIT (1 JAN 84): 2

ORBIT CHARACTERISTICS:

INCLINATION: 62.64°

APOGEE: 39283 km

PERIGEE: 1083 km

PERIOD: 718.0 min

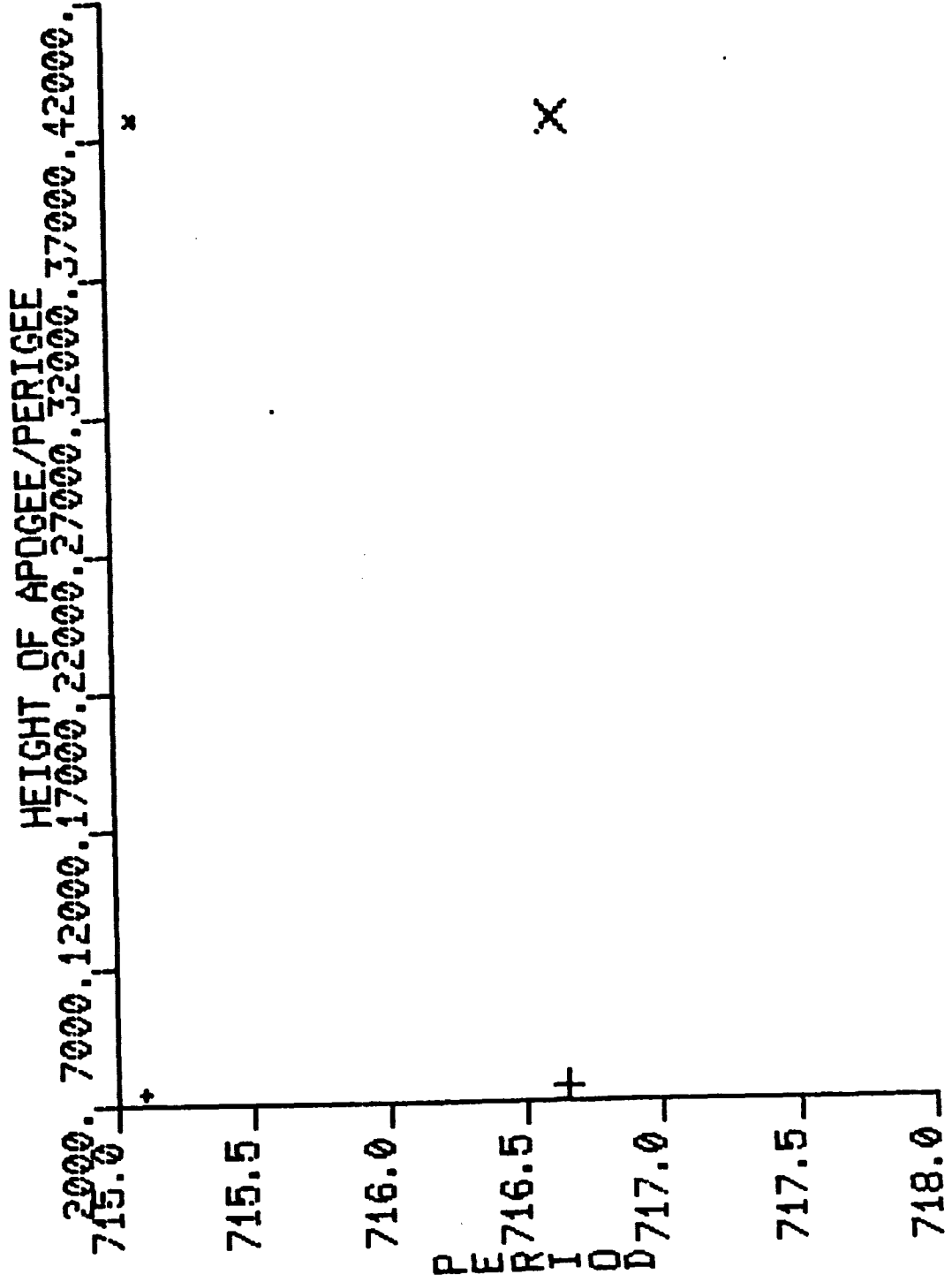
TRUE ANOMALY:



- COMMENTS:**
- This event uncovered after the fact by analysis of provisional (8X,XXX) elements being actively carried in the NORAD system.
  - The event date was determined by examination of the mean motion for satellite 11871 over a period of 2 years and correlating a significant change with the appearance of the provisional element sets.
  - Six 8X,XXX elements were in the system but only one was cataloged.
  - Orbit data derived from an element set with 14 March 1981 epoch for satellite 11871.
  - General shape was windmill plus 6 vanes?; length 4.2m?; dia. 1.6 m; weight 1250 kg?
  - Insufficient data available to determine time and location of the event for satellite 11871.

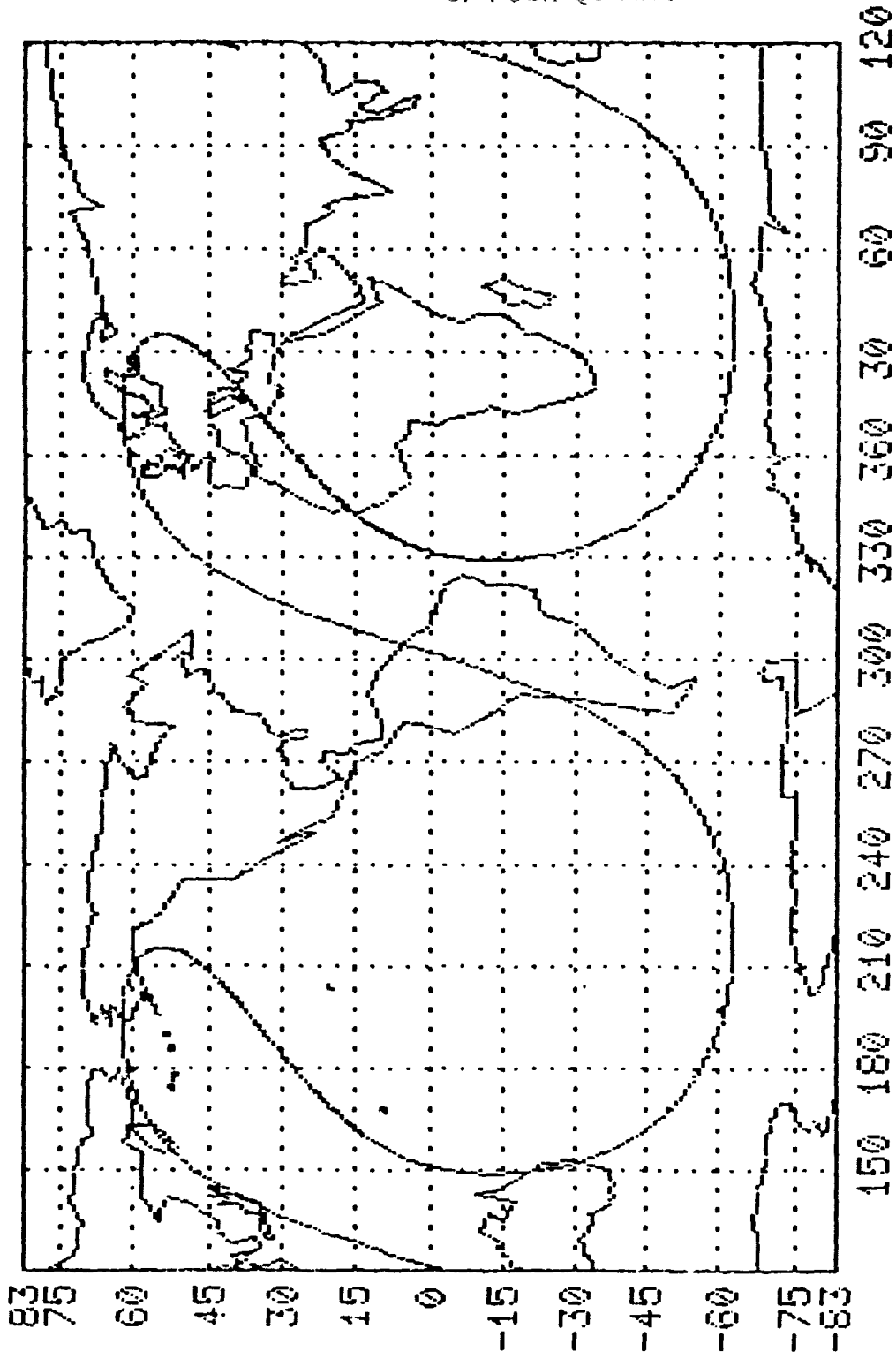
**CAUSE:** Unknown.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1191

ORIGINAL SOURCE  
OF POOR QUALITY



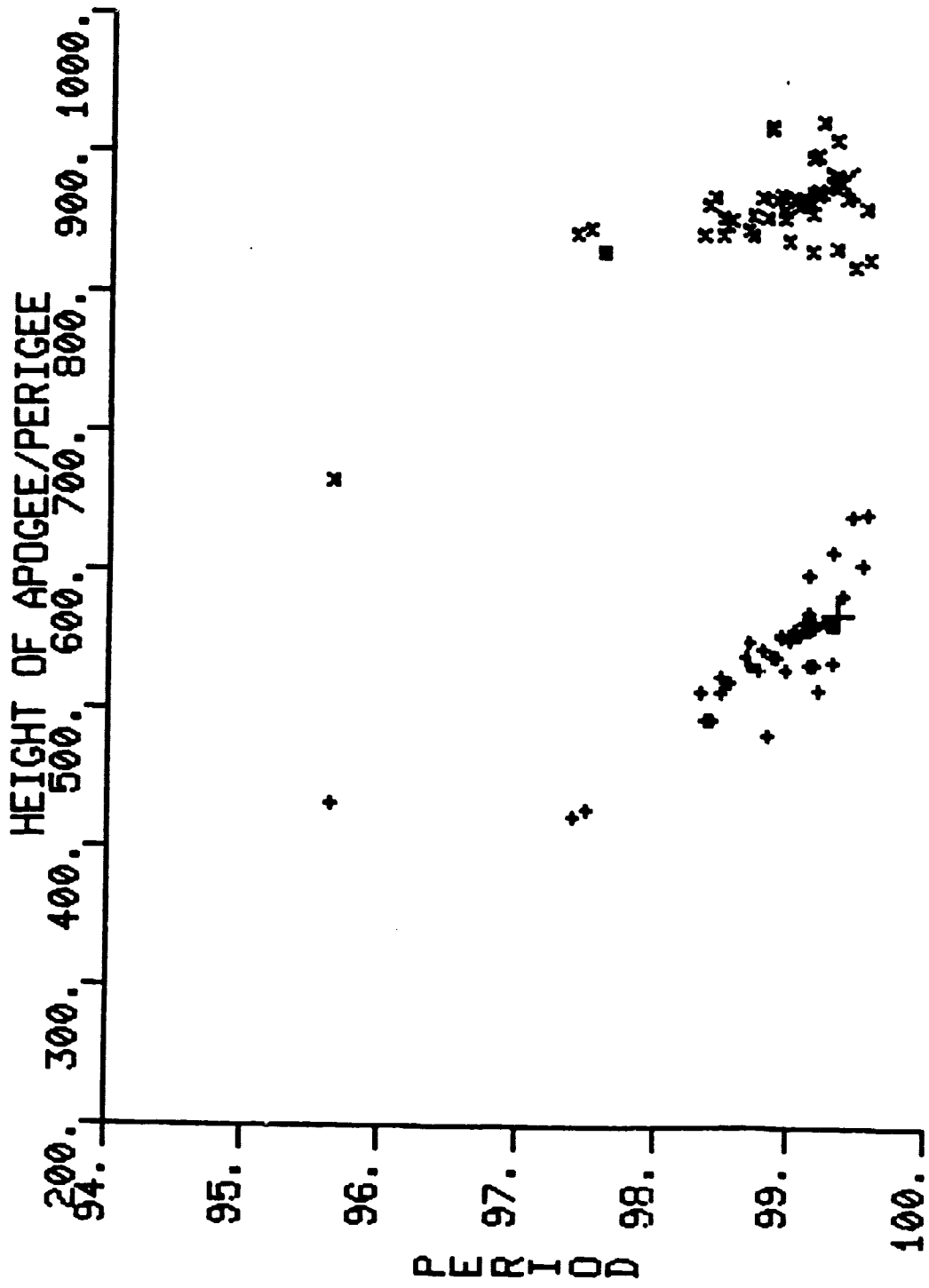
COSMOS 1191



- COMMENTS:**
- Orbit data derived from element set #656 for satellite 12054.
  - Eleven of the 63 pieces cataloged were cataloged after the 2nd event.
  - Member of Cosmos 699 class.

**CAUSE:** Apparently deliberate fragmentations.

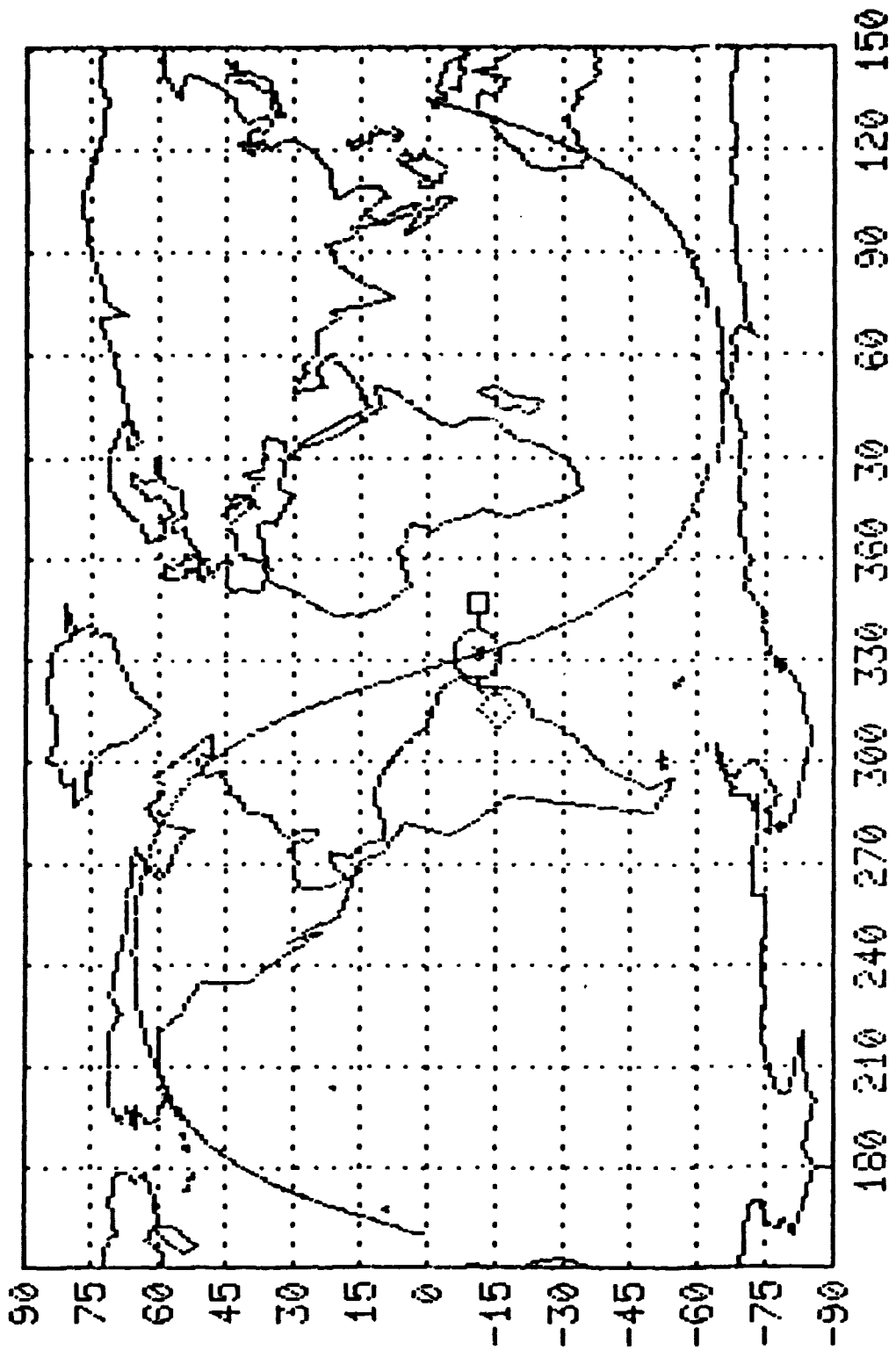
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1220

(EVENT 1)

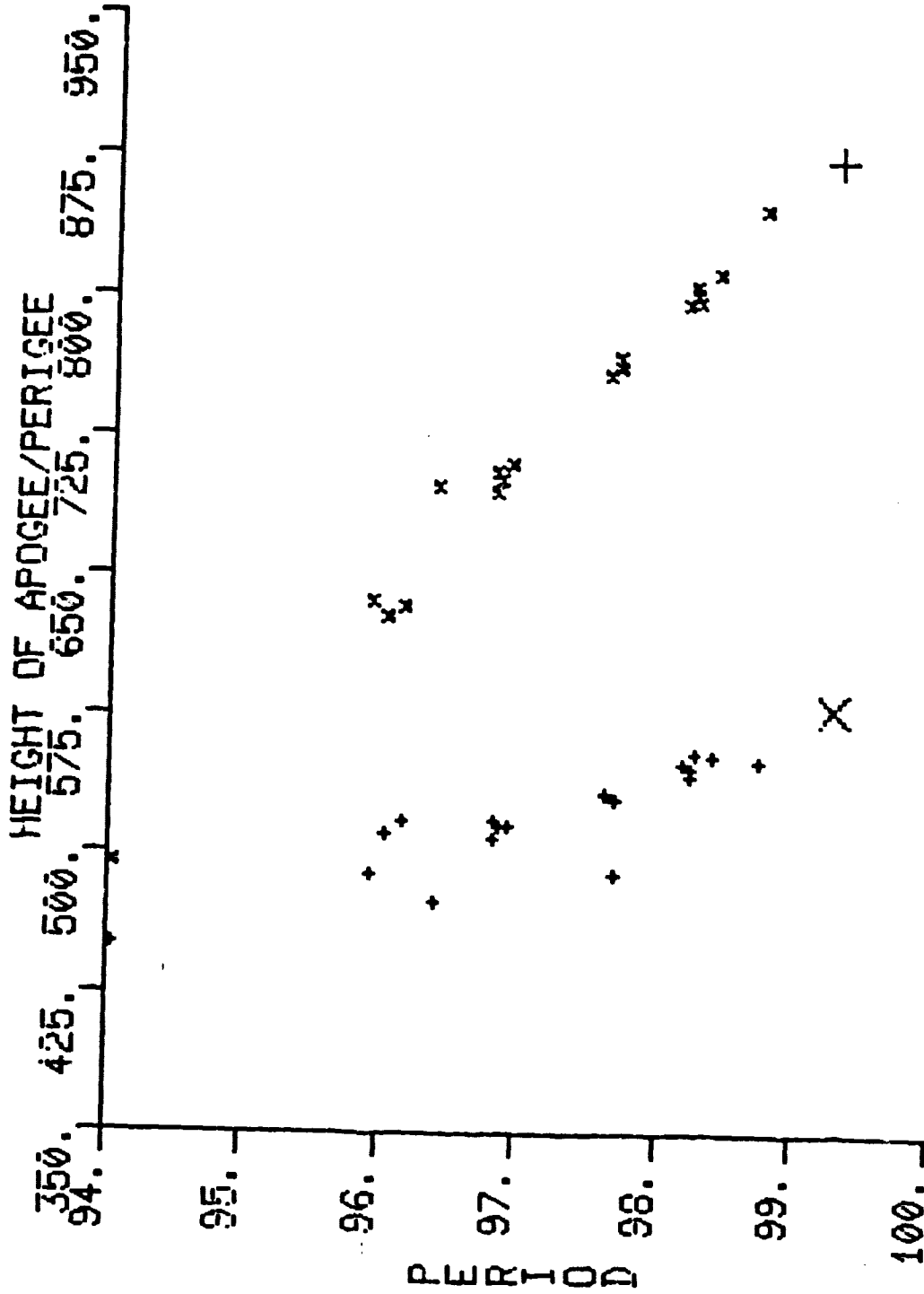
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1220

(EVENT 1)

ORIGINAL PAGE IS  
OF POOR QUALITY



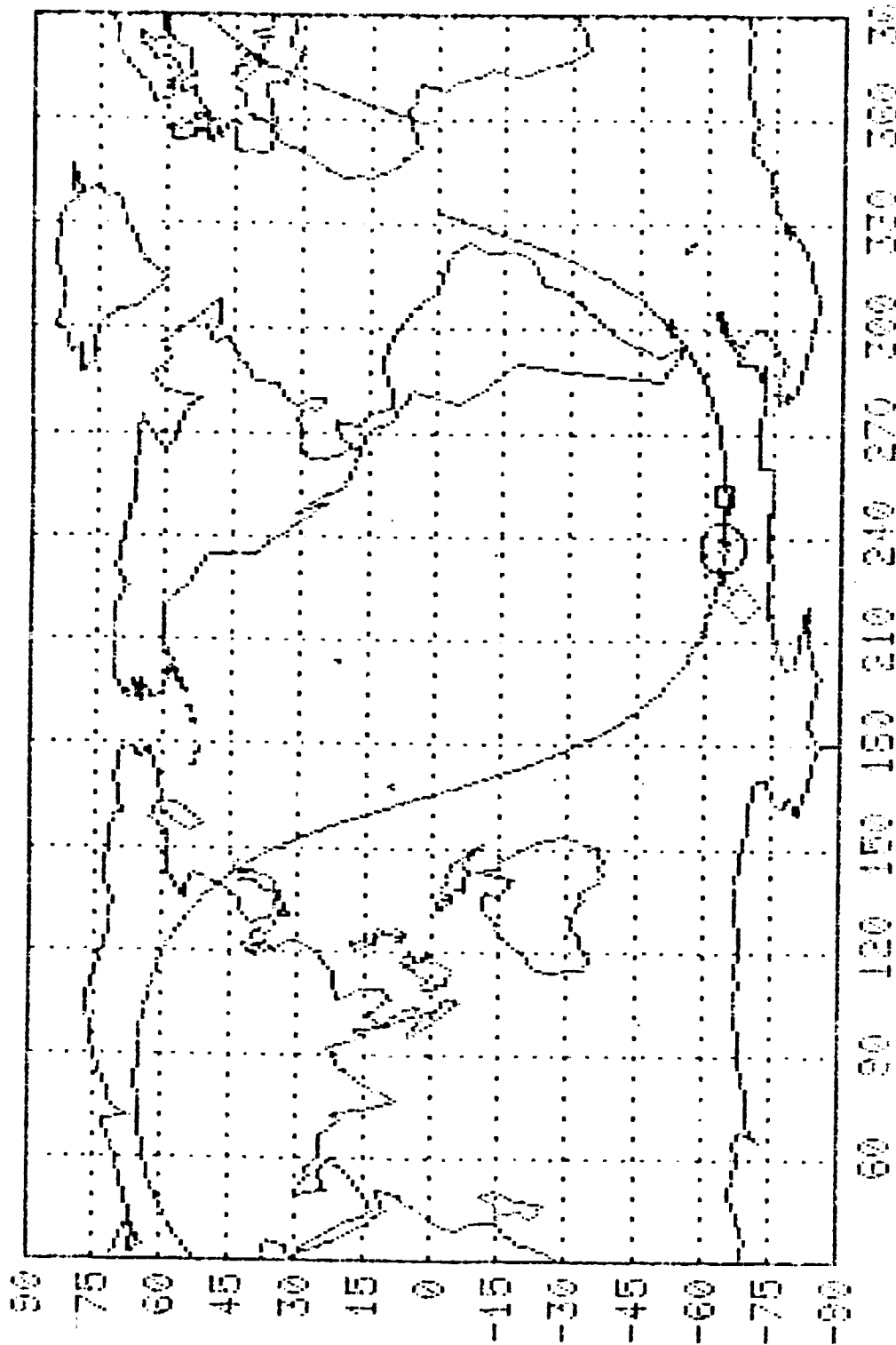
COSMOS 1220

(EVENT 2)

1-252



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1220  
(EVENT 2)

1981-16

COSMOS 1247

12303

**LAUNCH DATE:** 19.48 Feb 1981

**COUNTRY OF ORIGIN:** USSR

**EVENT DATA:**

**DATE:** 20 Oct 1981 (DAY 293)

**TIME:**

**LOCATION:**

**ALTITUDE:**

**PIECES CATALOGED (1 JAN 84):** 4

**PIECES STILL IN ORBIT (1 JAN 84):** 4

**ORBIT CHARACTERISTICS:**

**INCLINATION:** 62.97°

**APOGEE:** 39401 km

**PERIGEE:** 362 km

**PERIOD:** 717.9 min

**TRUE ANOMALY:**

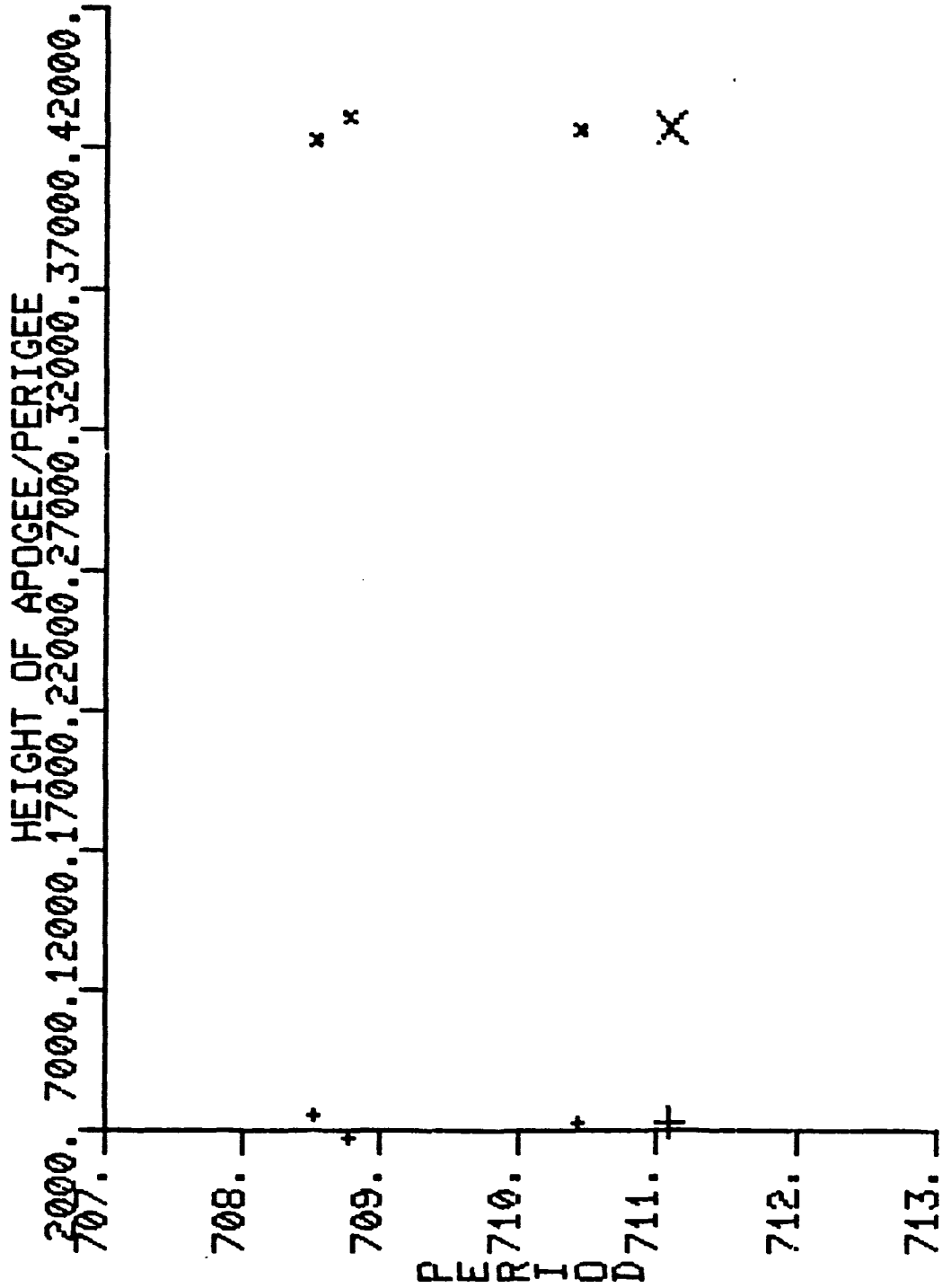
- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m; weight 1250 kg?
  - Best estimate of event date is mid October 1981 and the orbit data has been derived from a mid October element set #236 for satellite 12303.

**CAUSE:** Unknown.

1981-16

1-255

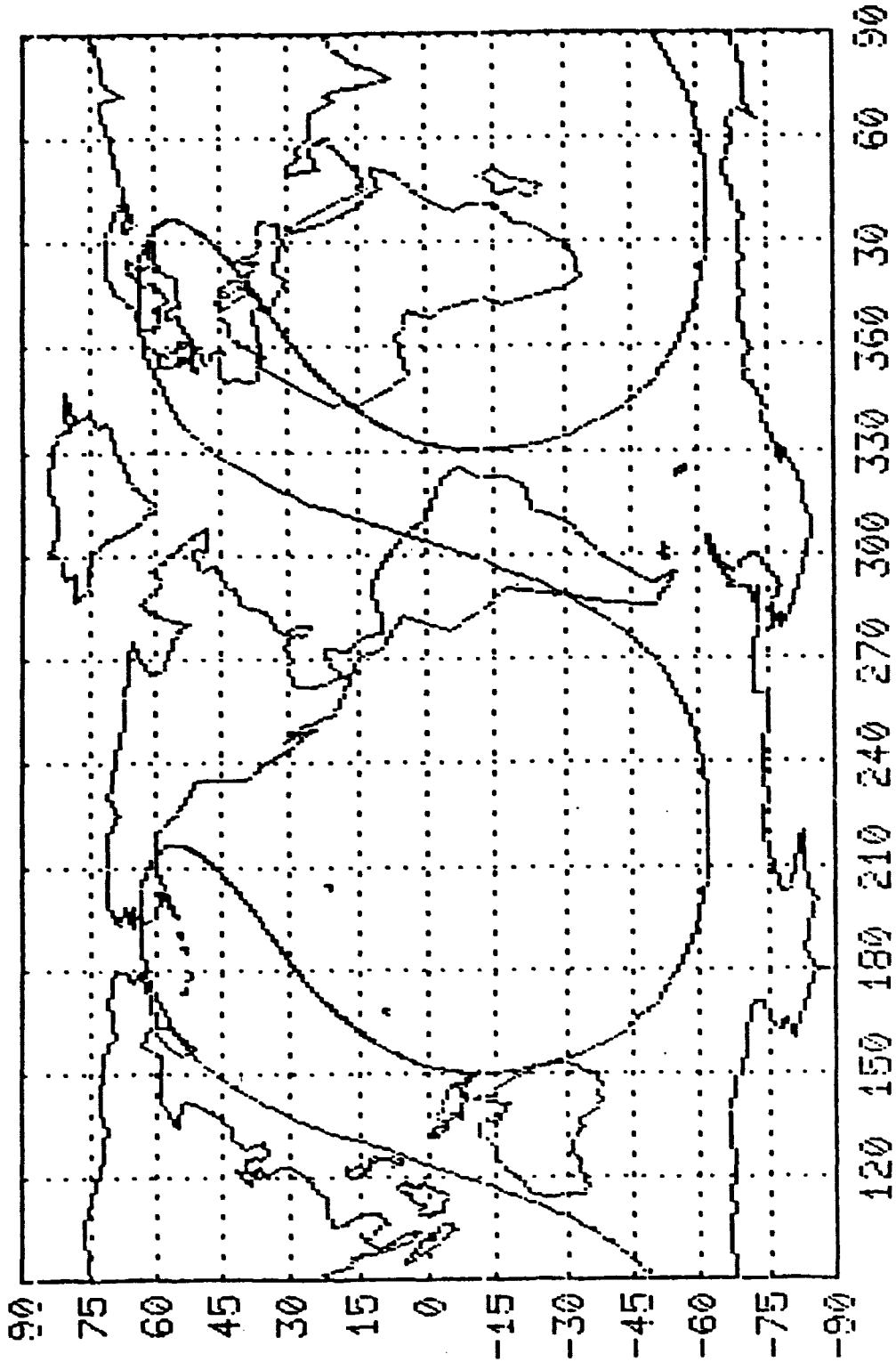
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1247

1-256

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1247

1981-24

COSMOS 1258

12337

LAUNCH DATE: 14.71 Mar 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 14 Mar 1981 (DAY 73)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 1

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.8°

APOGEE: 1024 km

PERIGEE: 301 km

PERIOD: 98.0 min

TRUE ANOMALY:

- COMMENTS:**
- Alleged Soviet ASAT test.
  - 12 to 18 pieces detected re-entering. No fragments were cataloged.
  - Insufficient data available to determine time and location of the event for satellite 12337.

**CAUSE:** Fragmentation due to alleged ASAT test activity.

1981-24

COMMENTS:

- A graph of the distribution of orbits of the fragments can not be presented because no fragments were cataloged. A simulation of the expected distribution of orbits could not be generated due to the uncertainty of the orbit at time of fragmentation.

1981-24



COMMENTS: • Insufficient data available to show applicable ground trace for satellite 12337.

1981-28

COSMOS 1260

12364

LAUNCH DATE: 21.00 Mar 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA: 1.

2.

DATE: 8 May 1982 (DAY 128)

10 Aug 1982 (DAY 222)

TIME: 044424.3 GMT

233513.4 GMT

LOCATION: 40 N/62 E

51 N/238 E

ALTITUDE: 557 km

752 km

PIECES CATALOGED (1 JAN 84): 65

PIECES STILL IN ORBIT (1 JAN 84): 37 (Event 1 & 2)

ORBIT CHARACTERISTICS:

INCLINATION: 65.02°

65.02°

APOGEE: 720 km

753 km

PERIGEE: 422 km

447 km

PERIOD: 96.1 min

96.7 min

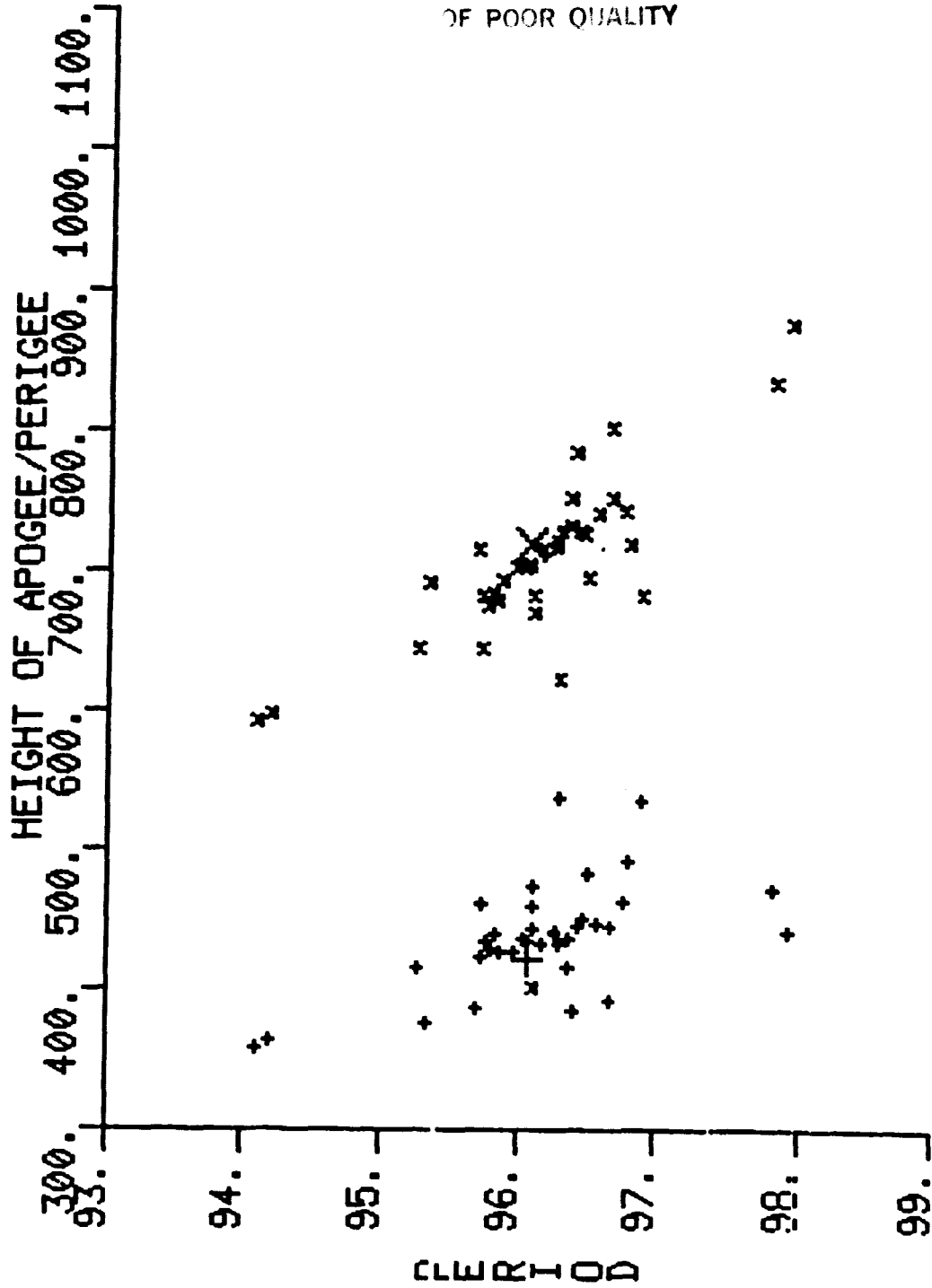
TRUE ANOMALY: 74°

186°

- COMMENTS:**
- Two separate events. The largest piece remaining after the first event was designated satellite 13183. Its orbit was a little higher than the original parent orbit. This piece fragmented on 10 Aug 1982.
  - Orbit data for satellites 12364 and 13183 was derived from element sets #483 and #47 respectively.
  - General shape; cylinder?
  - Member of Cosmos 699 class.

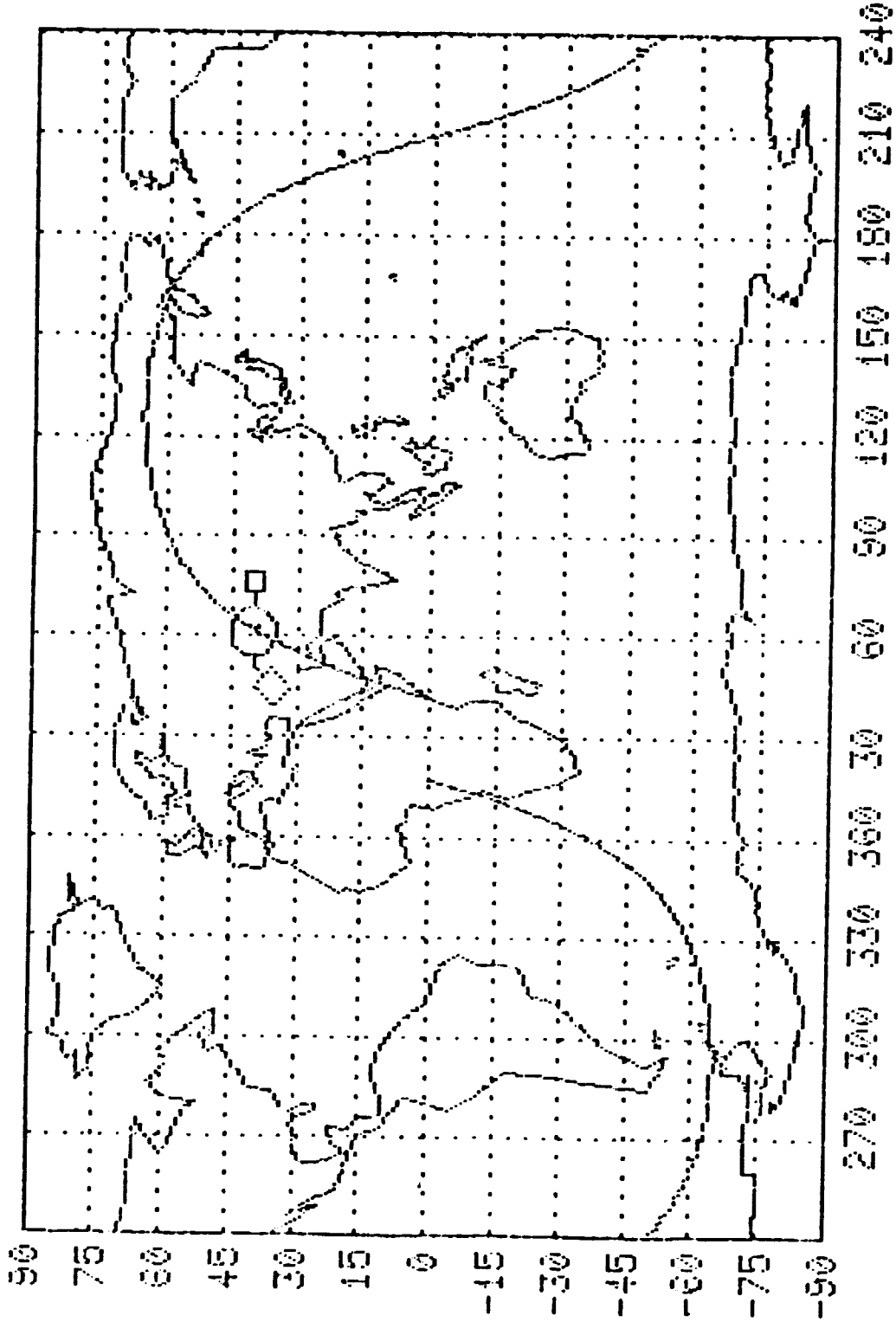
**CAUSE:** Apparently deliberate fragmentation.

ORIGINAL PAGE IS  
OF POOR QUALITY



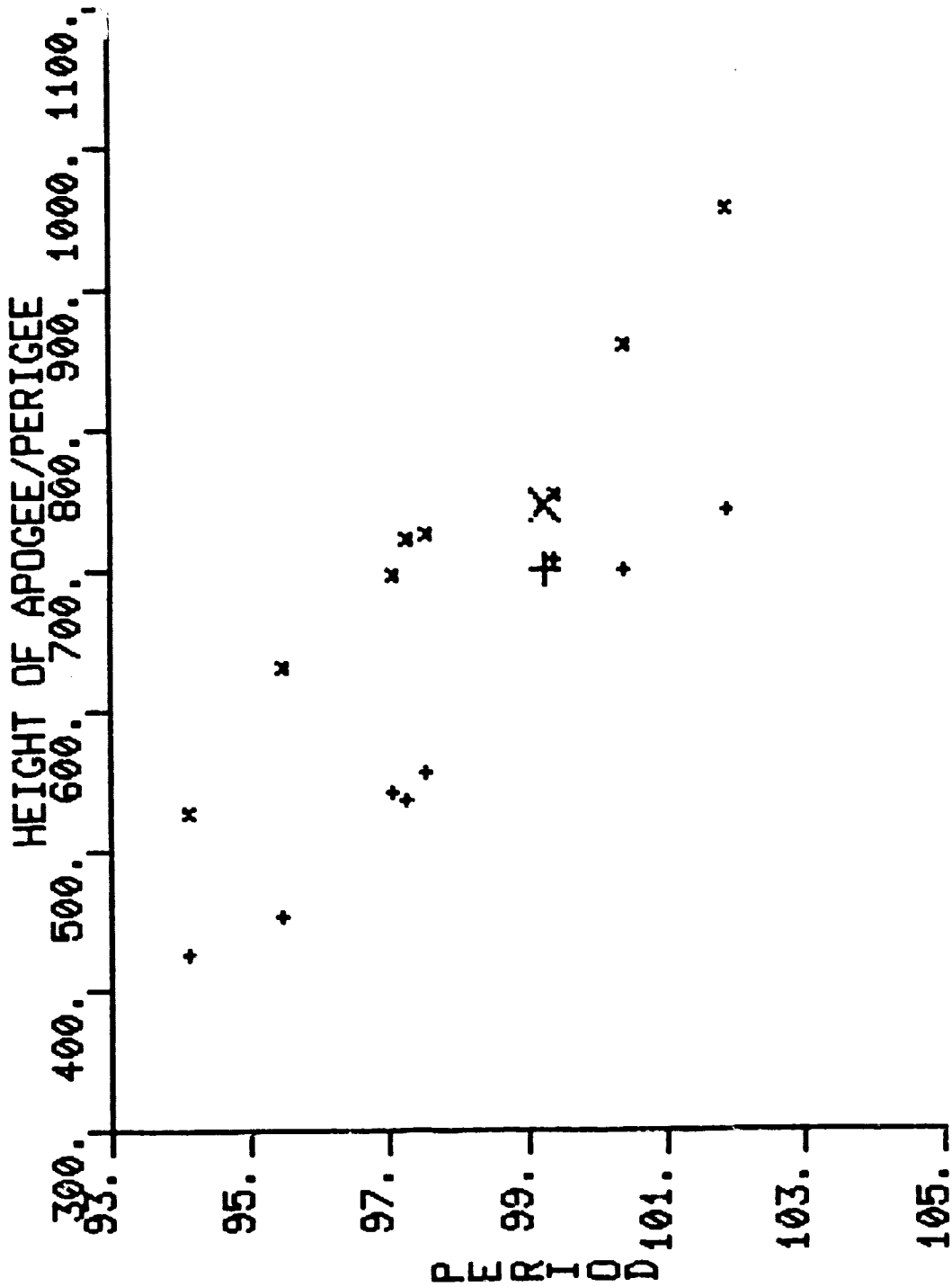
COSMOS 1260  
1ST EVENT

ORIGINAL PAGE IS  
OF POOR QUALITY



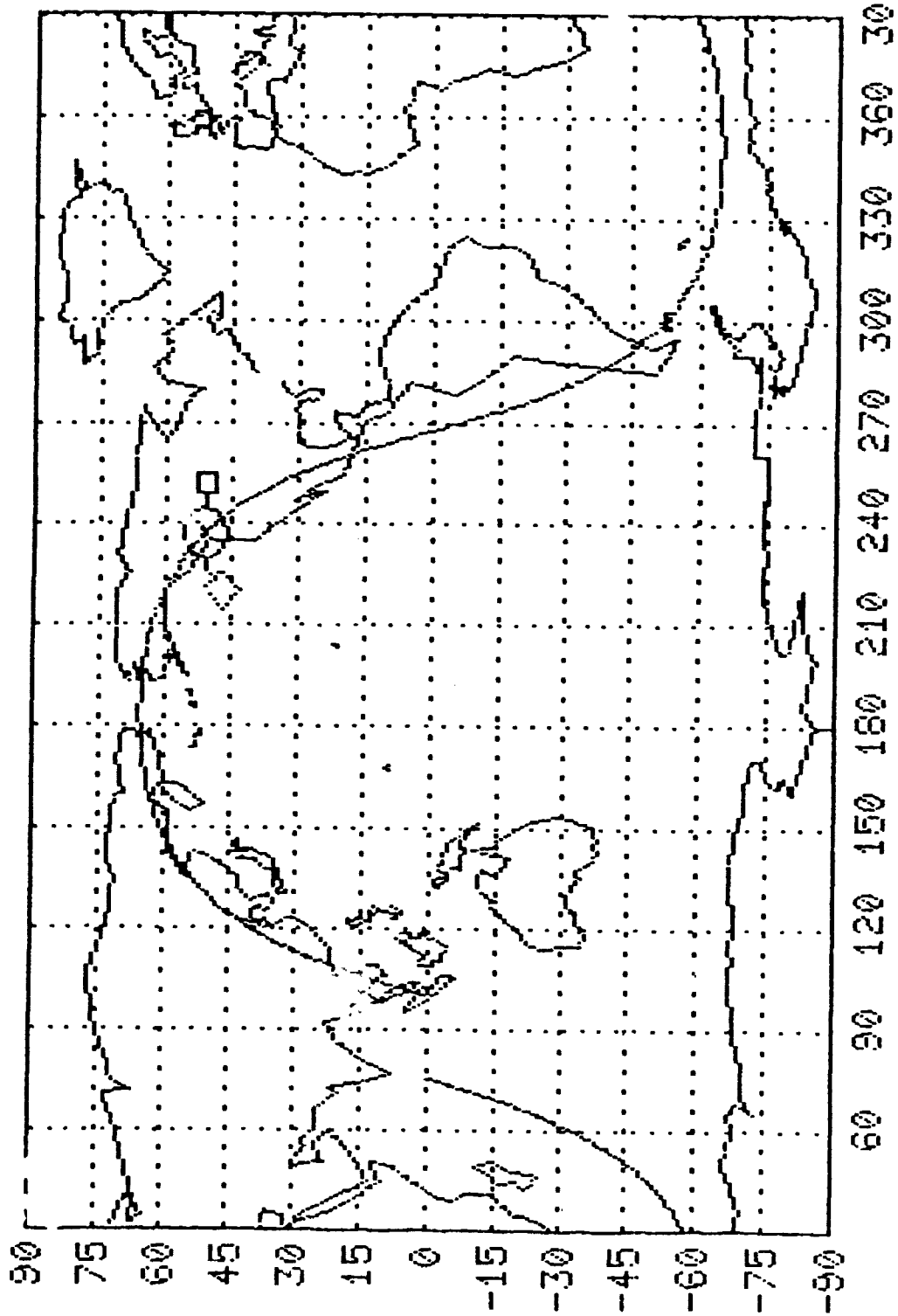
COSMOS 1260 (EVENT 1)

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1260  
2ND EVENT

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1260 (EVENT 2)

1981-31

COSMOS 1261

12376

LAUNCH DATE: 31.41 Mar 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 12 May 1981 (DAY 132)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 4

PIECES STILL IN ORBIT (1 JAN 84): 4

ORBIT CHARACTERISTICS:

INCLINATION: 63.04°

APOGEE: 39743 km

PERIGEE: 649 km

PERIOD: 718.5 min

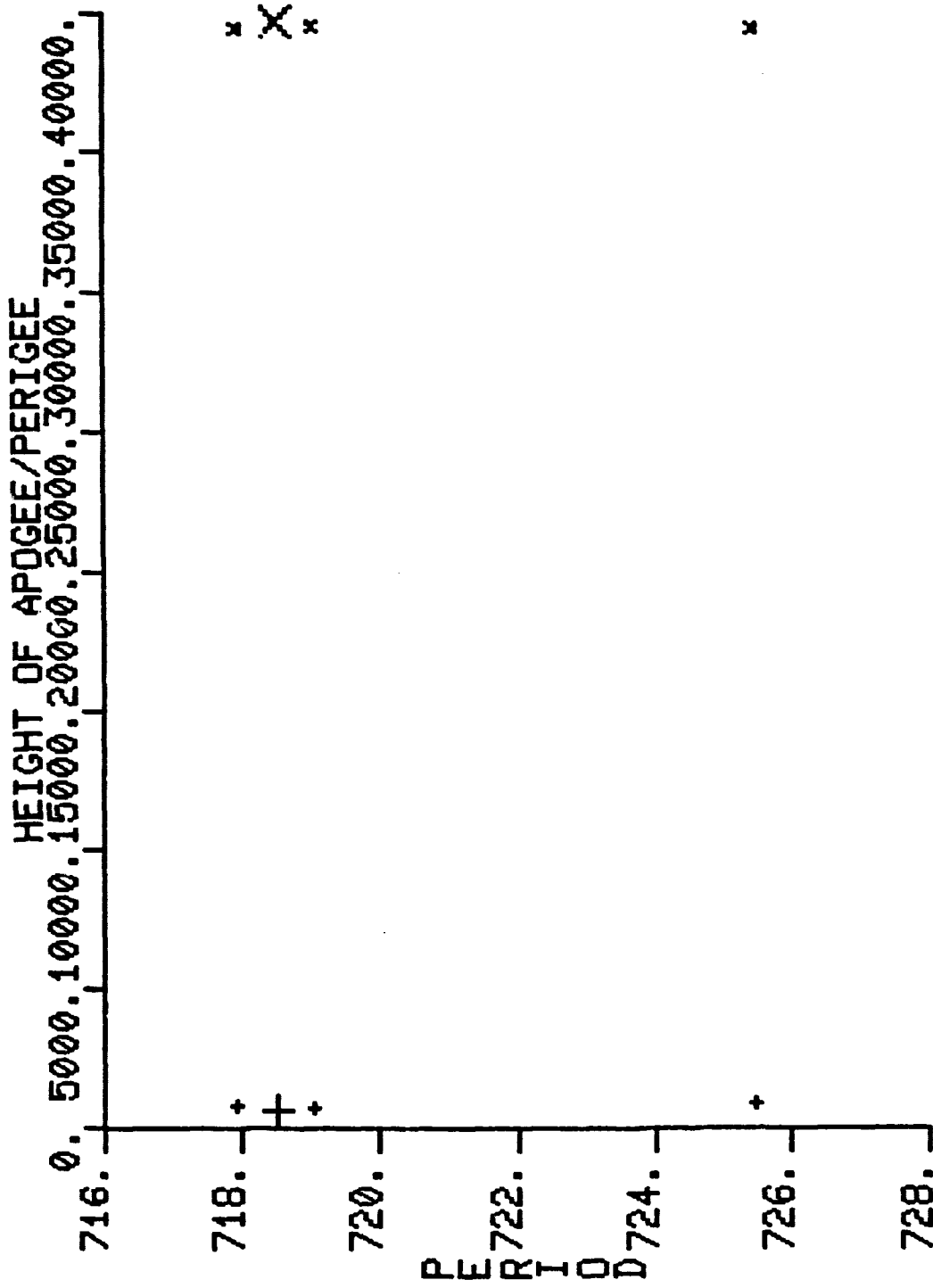
TRUE ANOMALY:



- COMMENTS:**
- Orbit data derived from element set #34 for satellite 12376.
  - General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m; weight 1250 kg?

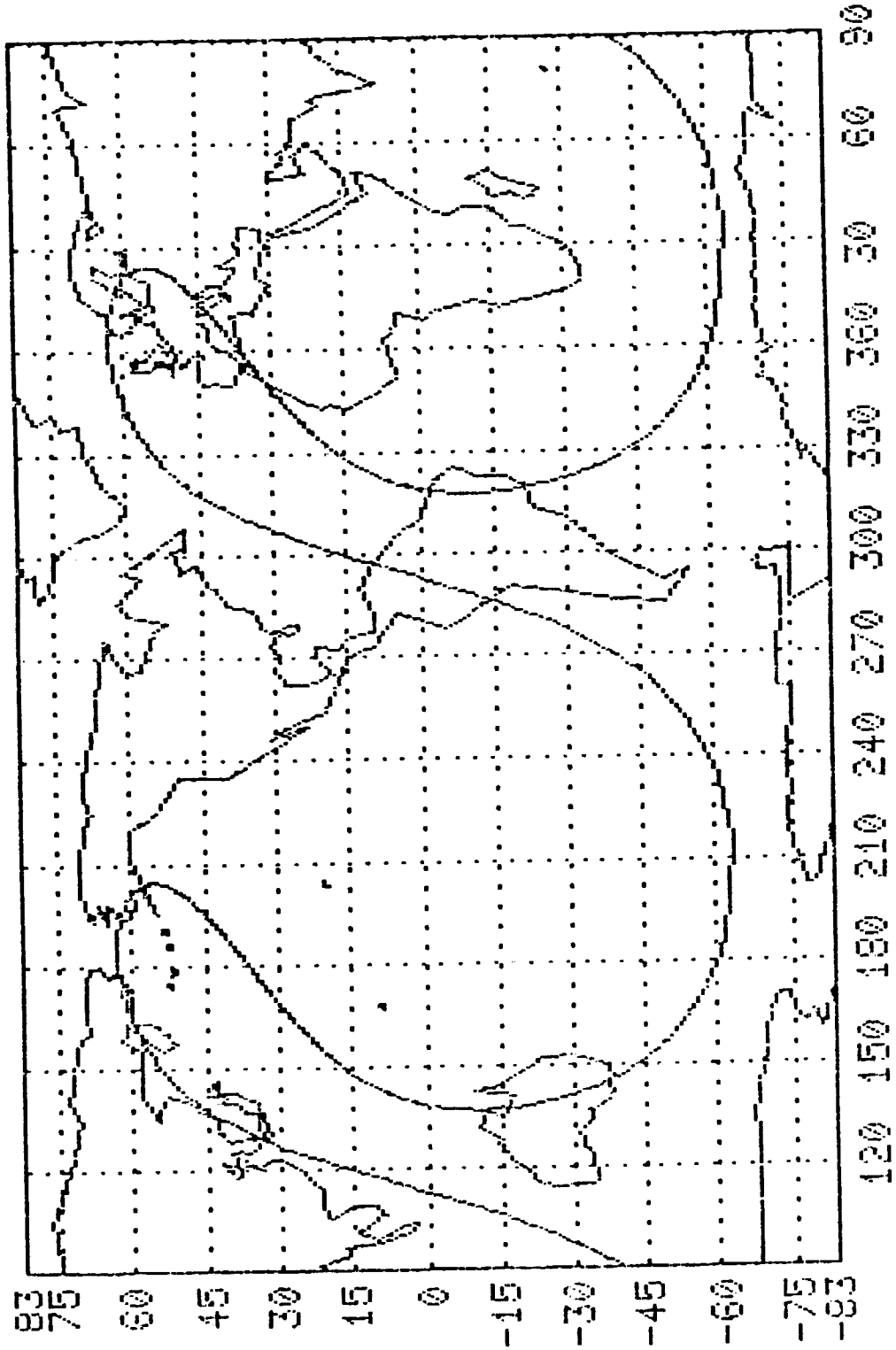
**CAUSE:** Unknown.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1261

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1261

1981-53

COSMOS 1275

12504

LAUNCH DATE: 4.65 Jun 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 24 Jul 1981 (DAY 205)

TIME: 235103.2 GMT

LOCATION: 68 N/197 E

ALTITUDE: 977 km

PIECES CATALOGED (1 JAN 84): 226

PIECES STILL IN ORBIT (1 JAN 84): 223

ORBIT CHARACTERISTICS:

INCLINATION: 82.96°

APOGEE: 1014 km

PERIGEE: 961 km

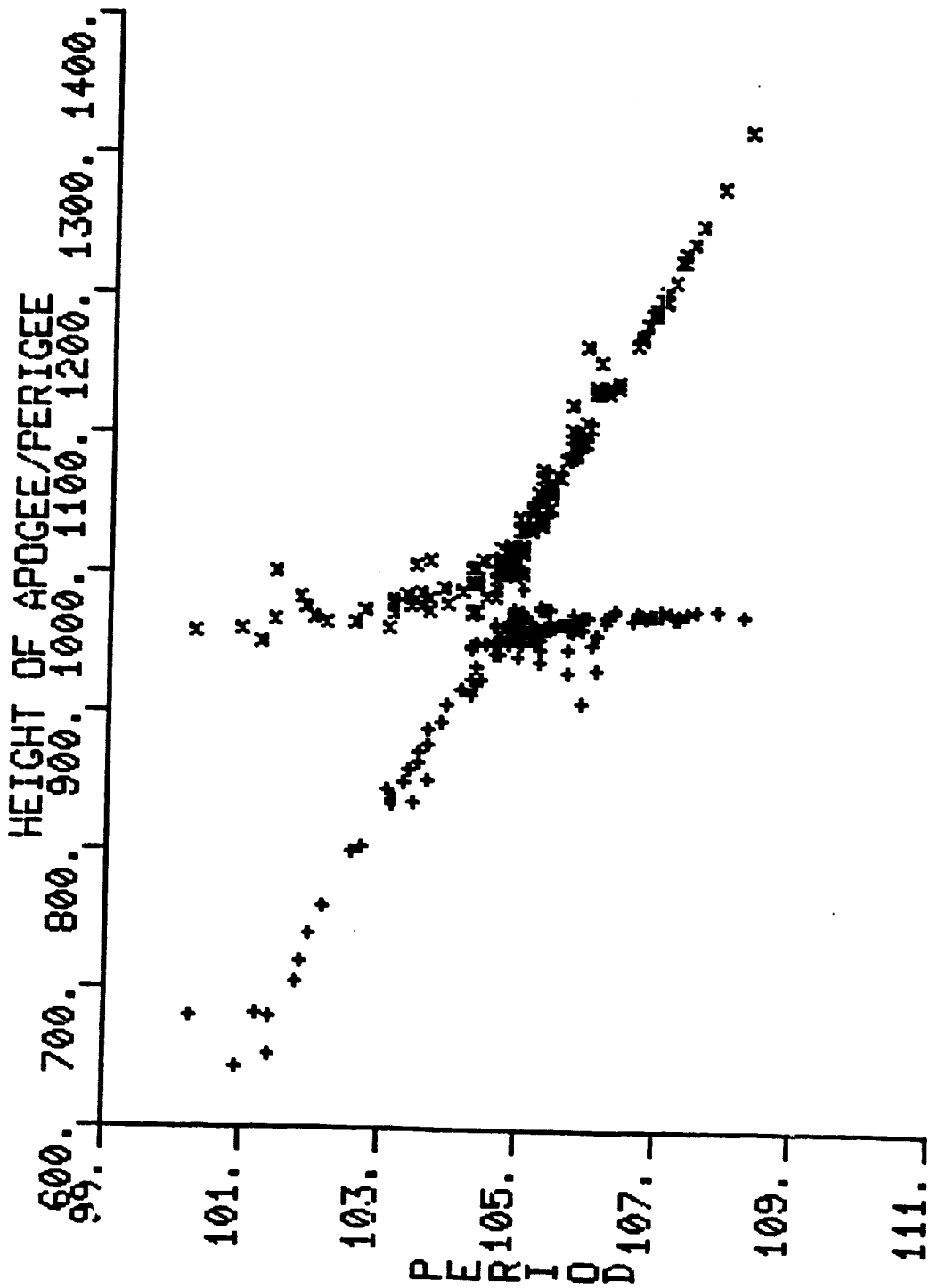
PERIOD: 104.8 min

TRUE ANOMALY: 292°

**COMMENTS:** • General shape was cylinder; length 1.3 m?; dia. 1.9 m?; weight 700 kg?

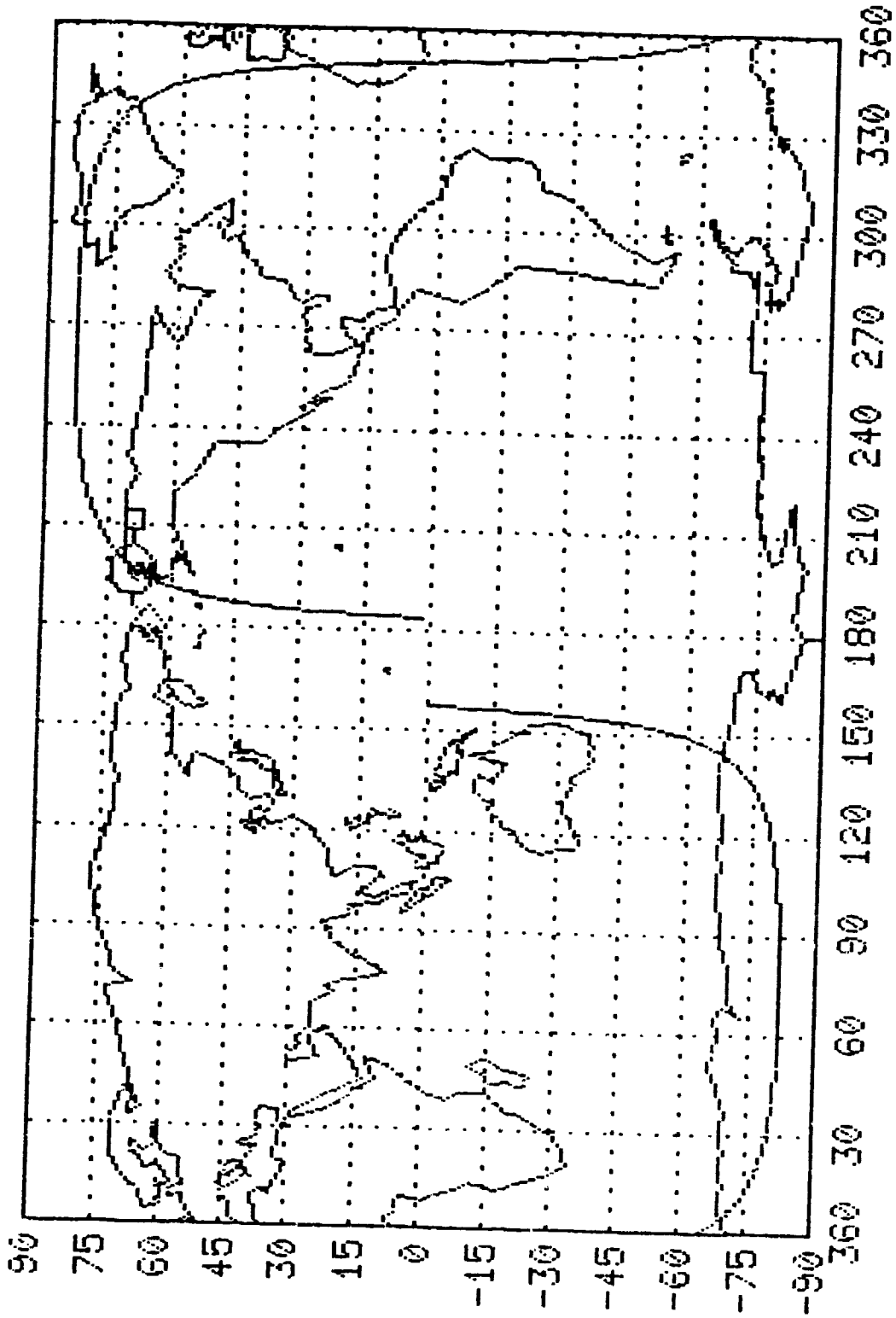
**CAUSE:** Unknown. See classified NORAD Technical Memorandum 81-5-3 for discussion. Title: "Fragmentation of USSR Satellites 11729 and 12504," dated May 1982. This document is on file at Teledyne Brown Engineering, Colorado Springs, Colorado.

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1275

ORIGINAL PRICE \$10  
OF POOR QUALITY



COSMOS 1275

1981-71

COSMOS 1285

12627

LAUNCH DATE: 4.01 Aug 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 21 Nov 1981 (DAY 325)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 3

PIECES STILL IN ORBIT (1 JAN 84): 3

ORBIT CHARACTERISTICS:

INCLINATION: 63.11°

APOGEE: 40109 km

PERIGEE: 721 km

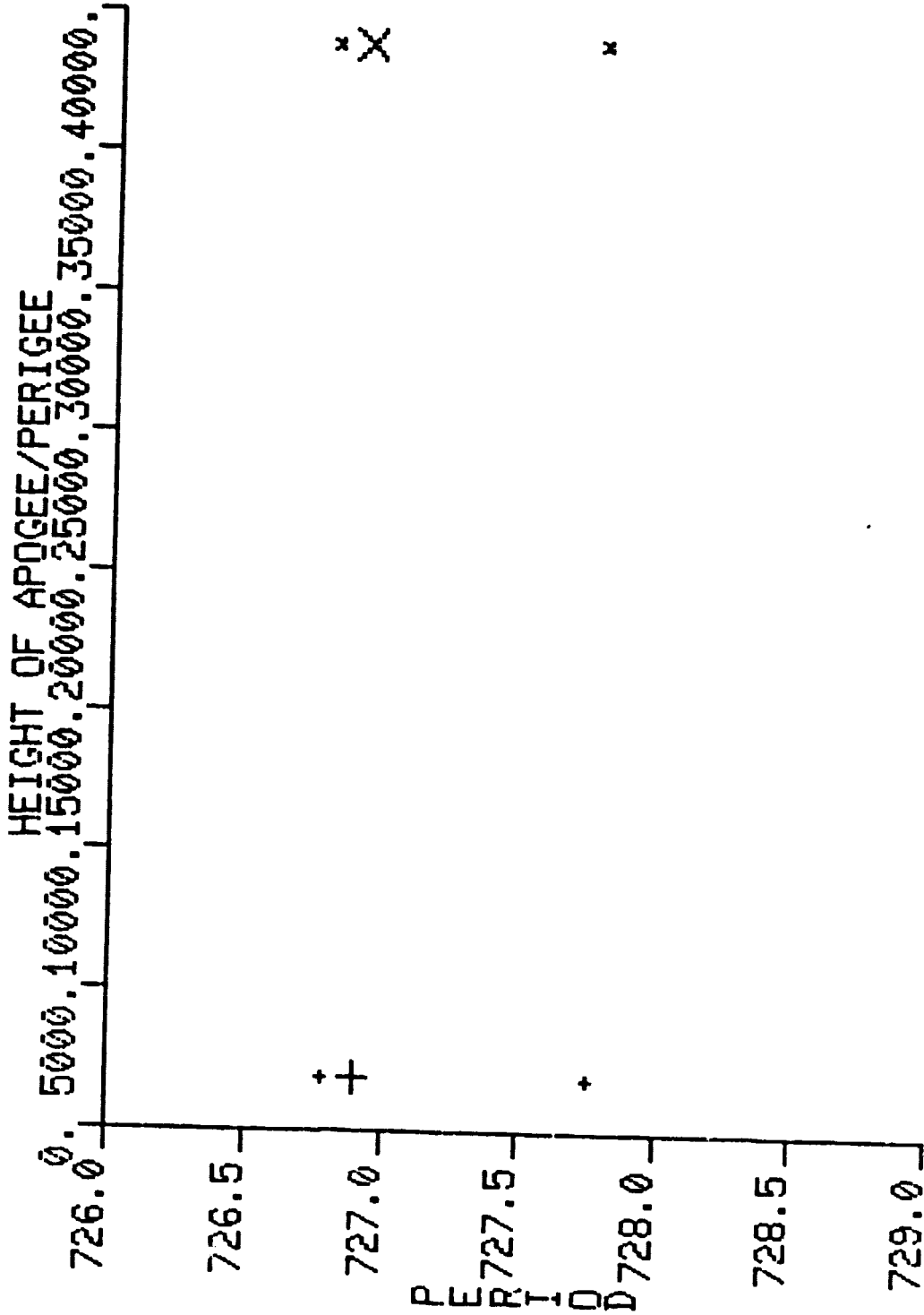
PERIOD: 727.4 min

TRUE ANOMALY:



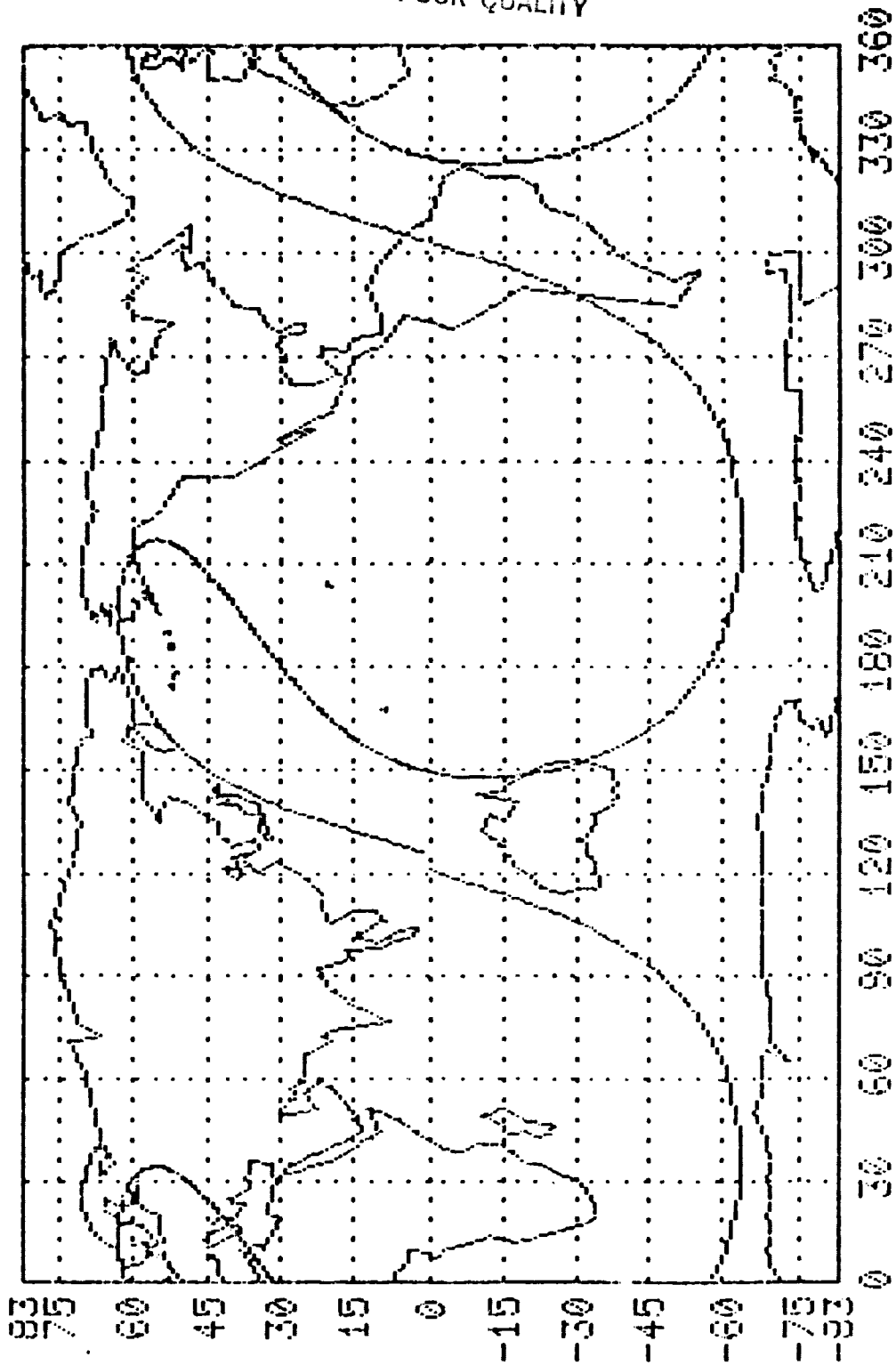
- COMMENTS:**
- General shape was windmill plus 6 vanes?; length 4.2 m; dia. 1.6 m?; weight 1250 kg?
  - Orbit data derived from element set #95 for satellite 12627.

**CAUSE:** Unknown



COSMOS 1285

ORIGINAL FILED  
OF POOR QUALITY



COSMOS 1285

1981-72

COSMOS 1286

12631

LAUNCH DATE: 4.35 Aug 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 29 Sep 1982 (DAY 272)

TIME: 051955.9 GMT

LOCATION: 51 N/80 E

ALTITUDE: 317 km

PIECES CATALOGED (1 JAN 84): 2

PIECES STILL IN ORBIT (1 JAN 84): 0

ORBIT CHARACTERISTICS:

INCLINATION: 65.21°

APOGEE: 328 km

PERIGEE: 305 km

PERIOD: 92.6 min

TRUE ANOMALY: 251°

- COMMENTS:**
- Orbit data derived from element set #581 for satellite 12631.
  - NORAD sensor personnel estimated 30 pieces but only one could be cataloged before decay.
  - Member of Cosmos 699 class.

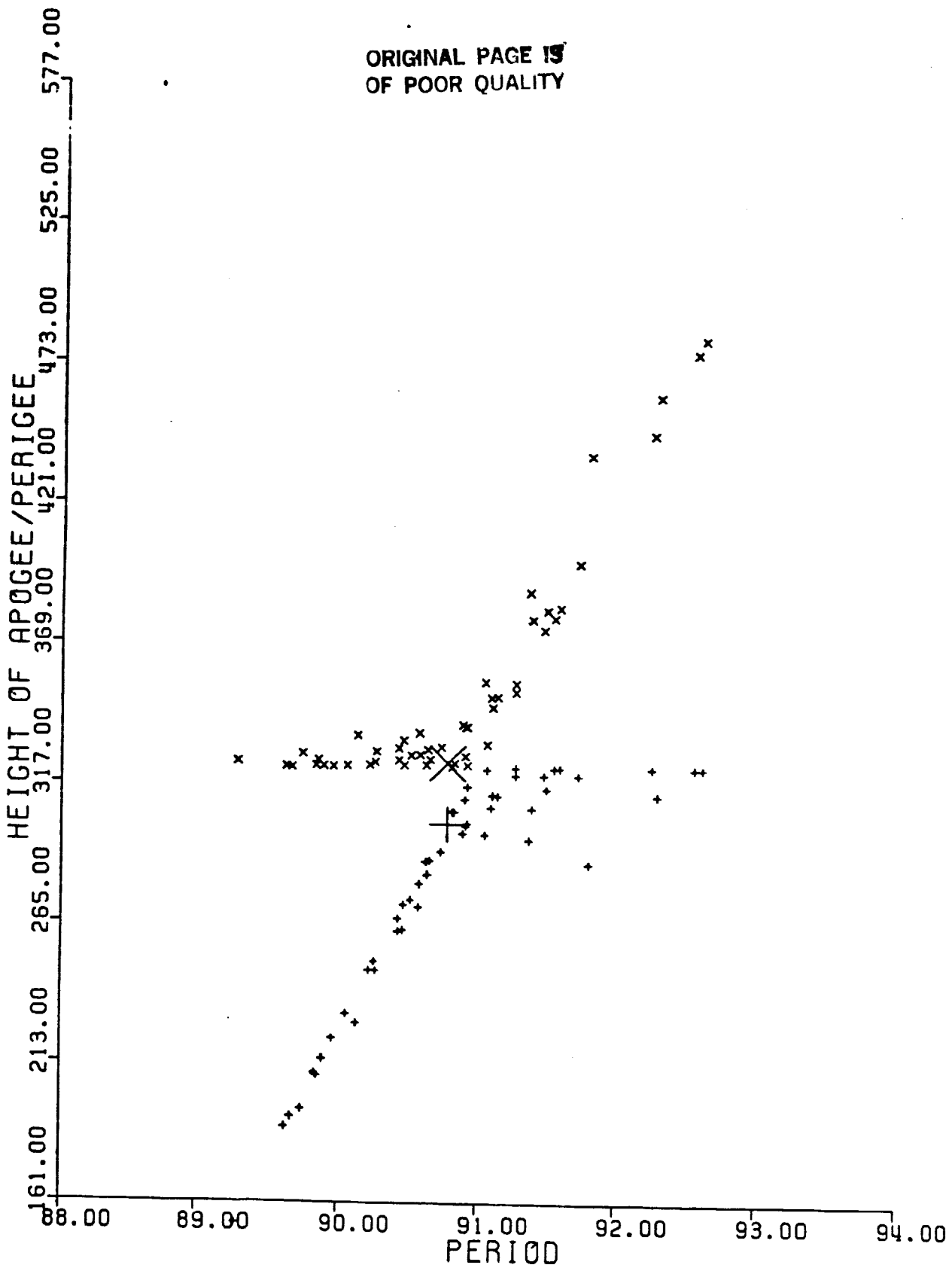
**CAUSE:** Apparently deliberate fragmentation.

1981-72

1-281

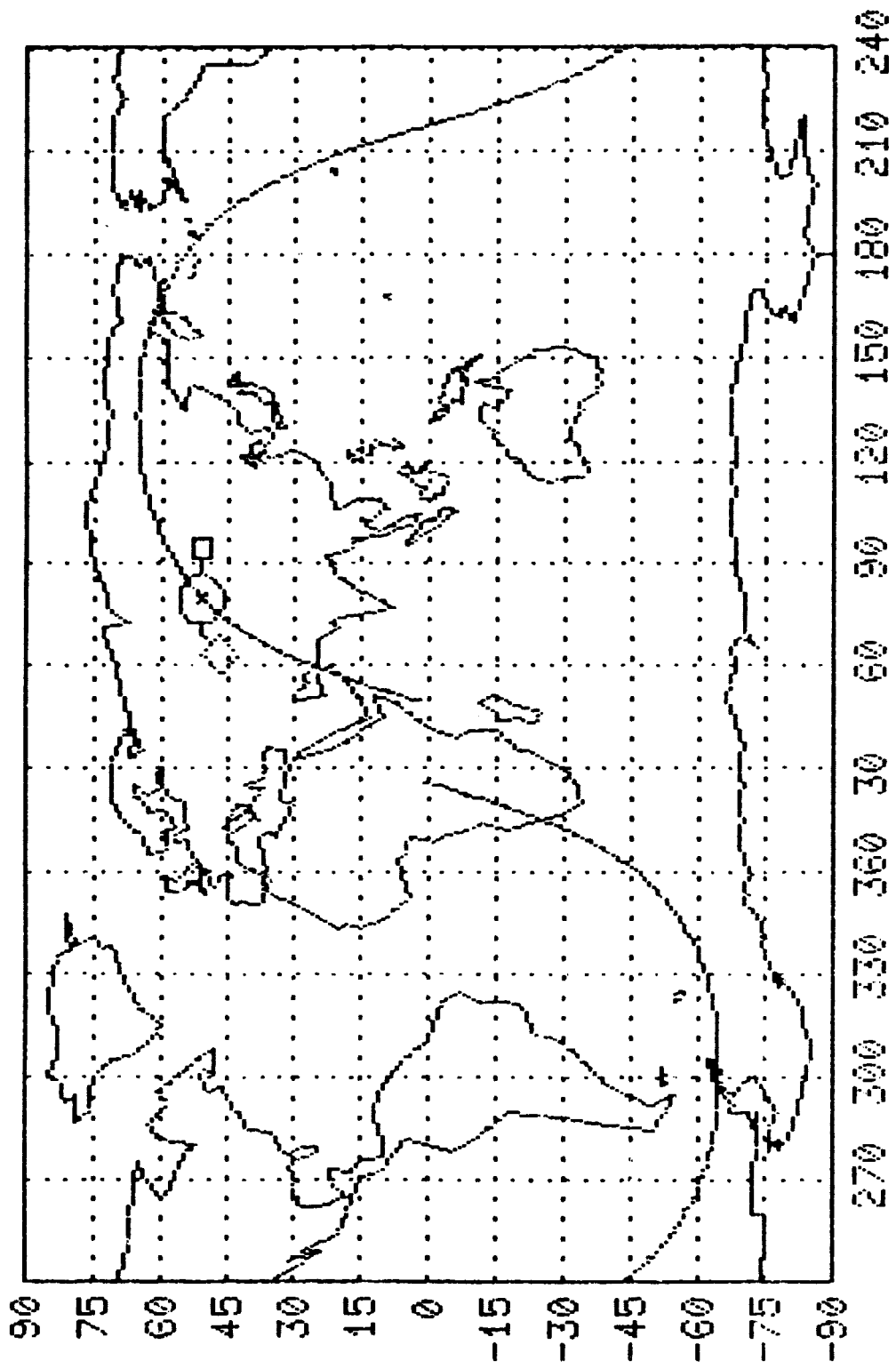
C-4

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 1286 SIMULATION

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1286

1981-88

COSMOS 1305

12818

LAUNCH DATE: 11.37 Sep 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 11 Sep 1981 (DAY 254)

TIME: 093631.1 GMT

LOCATION: 62 S/225 E

ALTITUDE: 649

PIECES CATALOGED (1 JAN 84): 2

PIECES STILL IN ORBIT (1 JAN 84): 2

ORBIT CHARACTERISTICS:

INCLINATION: 62.82°

APOGEE: 13864 km

PERIGEE: 626 km

PERIOD: 263.7 min

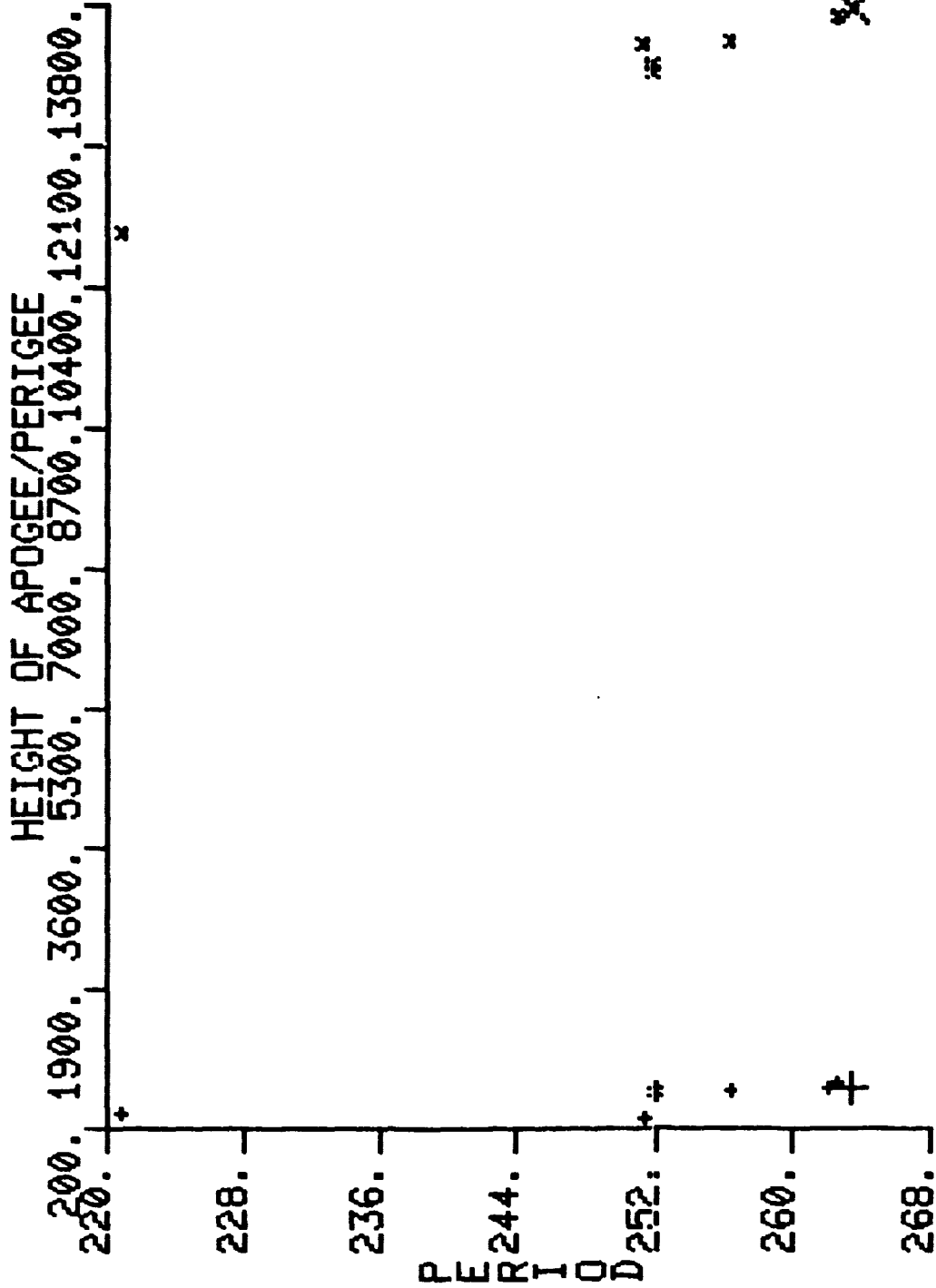
TRUE ANOMALY: 352



- COMMENTS:**
- Orbit data derived from element set #1 for satellite 12818.
  - Four additional pieces noted but not cataloged at this time.

**CAUSE:** Rocket malfunction during a transfer orbit attempt.

ORIGINAL PAGE IS  
OF POOR QUALITY

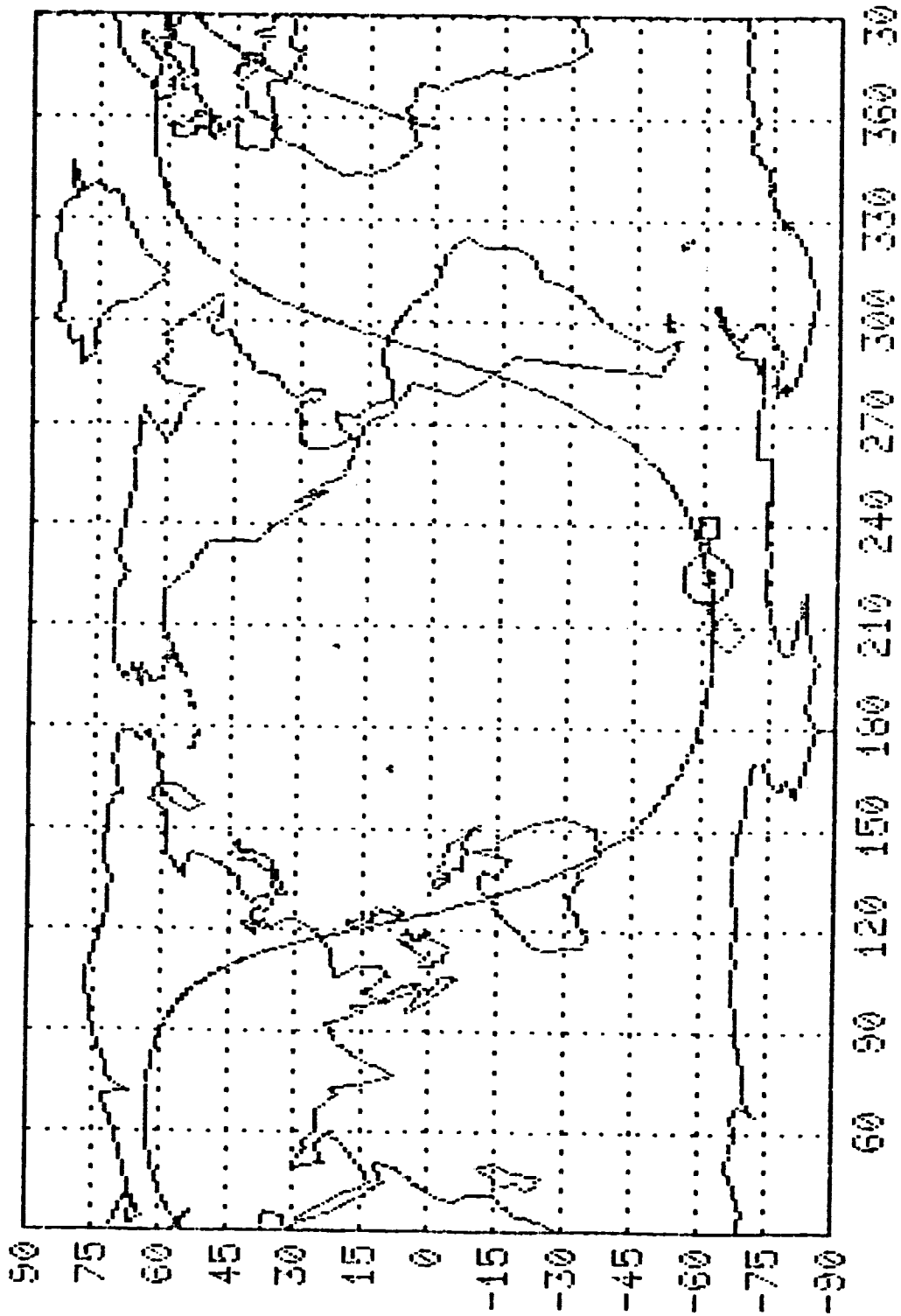


COSMOS 1305

1-286

INCLUDES 8XXXX  
PLUS 2 CATALOGED

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 1305

1981-89

COSMOS 1306

12828

LAUNCH DATE: 14.86 Sep 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA: 1.

2.

DATE: 12 Jul 1982 (DAY 193)

18 Sep 1982 (DAY 261)

TIME: 232436.0 GMT

170141.5 GMT

LOCATION: 65 S/40 E

32 N/293 E

ALTITUDE: 380 km

370 km

PIECES CATALOGED (1 JAN 84): 6

1

PIECES STILL IN ORBIT (1 JAN 84): 1

0

ORBIT CHARACTERISTICS:

INCLINATION: 64.94°

64.94°

APOGEE: 407 km

372 km

PERIGEE: 380 km

369 km

PERIOD: 92.4 min

92.0 min

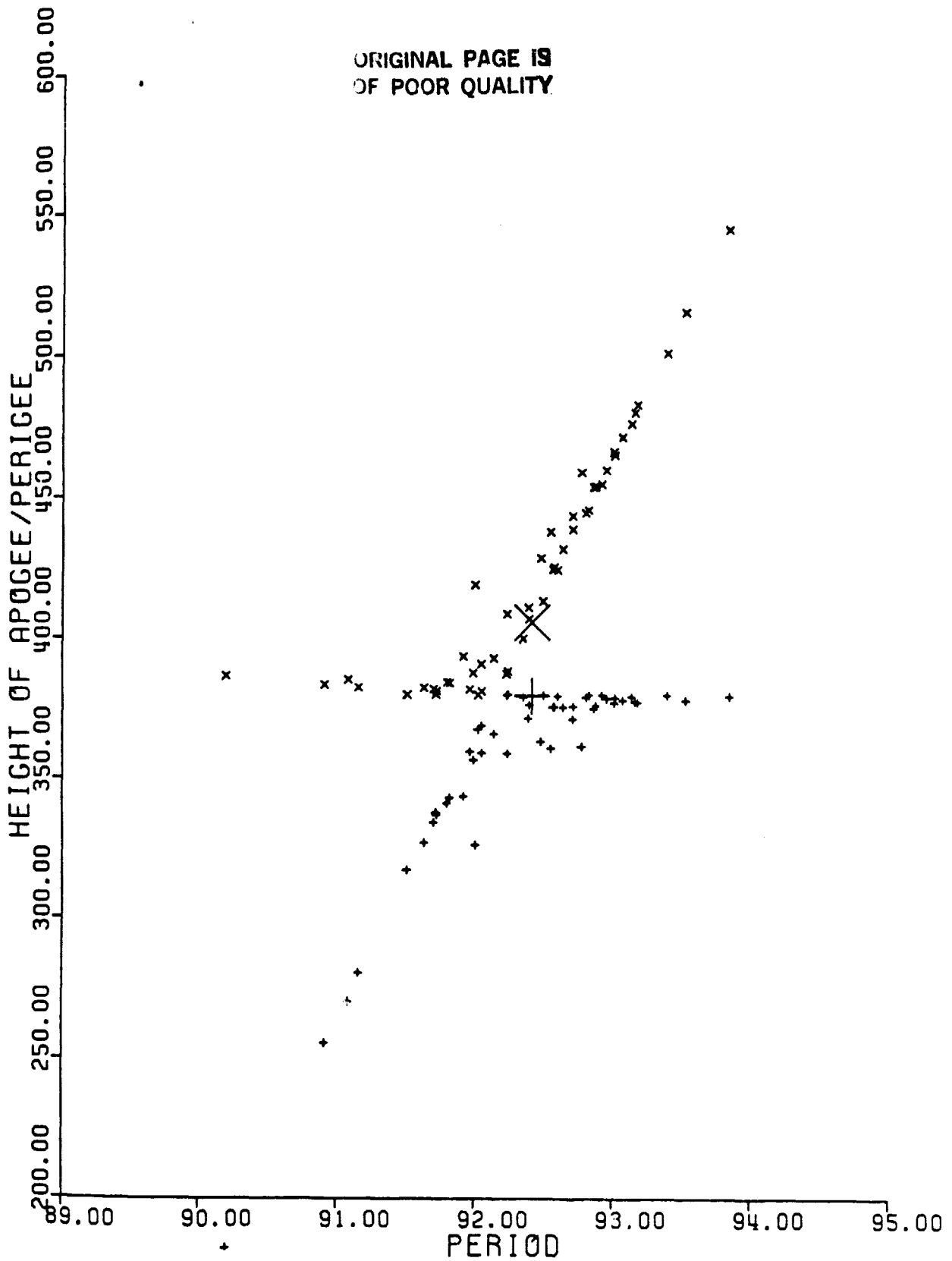
TRUE ANOMALY: 347°

81°

- COMMENTS:**
- Two fragmentation events.
  - For the first event NORAD sensor personnel counted 27 pieces but most decayed before they could be cataloged. A large fragment was given the number of the original parent, 12828, and it decayed 16 July 1982. One piece of debris from the first event, satellite 13369, fragmented 18 Sept 1982.
  - Four cataloged pieces from the 1st event had not decayed by time of 2nd event.
  - Orbit data derived from element sets #302 and #85 for satellites 12828 and 13369 respectively.
  - 25 provisional element sets were developed on fragments from these events.
  - Member of Cosmos 699 class.

**CAUSE:** Apparently deliberate fragmentations.

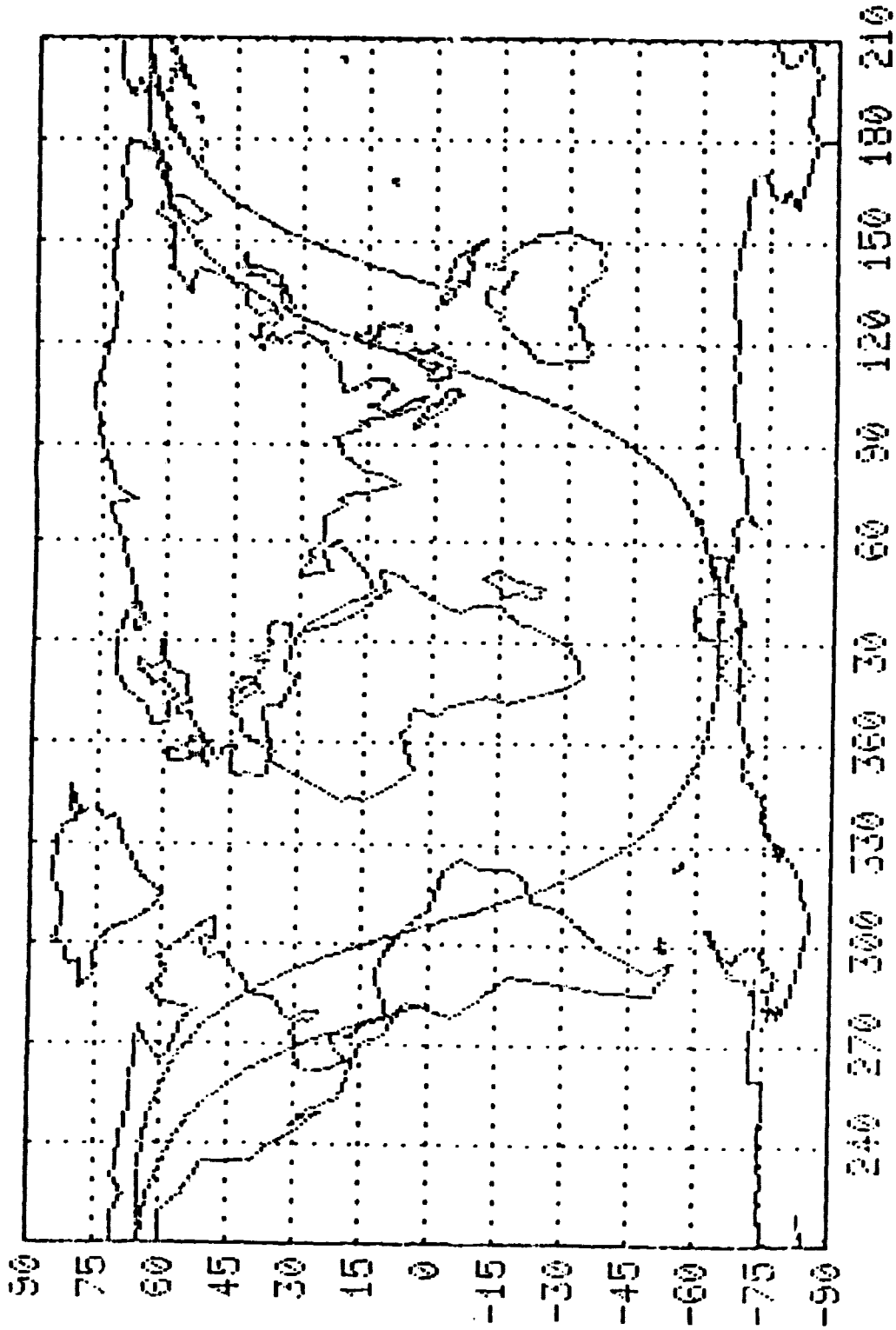
ORIGINAL PAGE IS  
OF POOR QUALITY



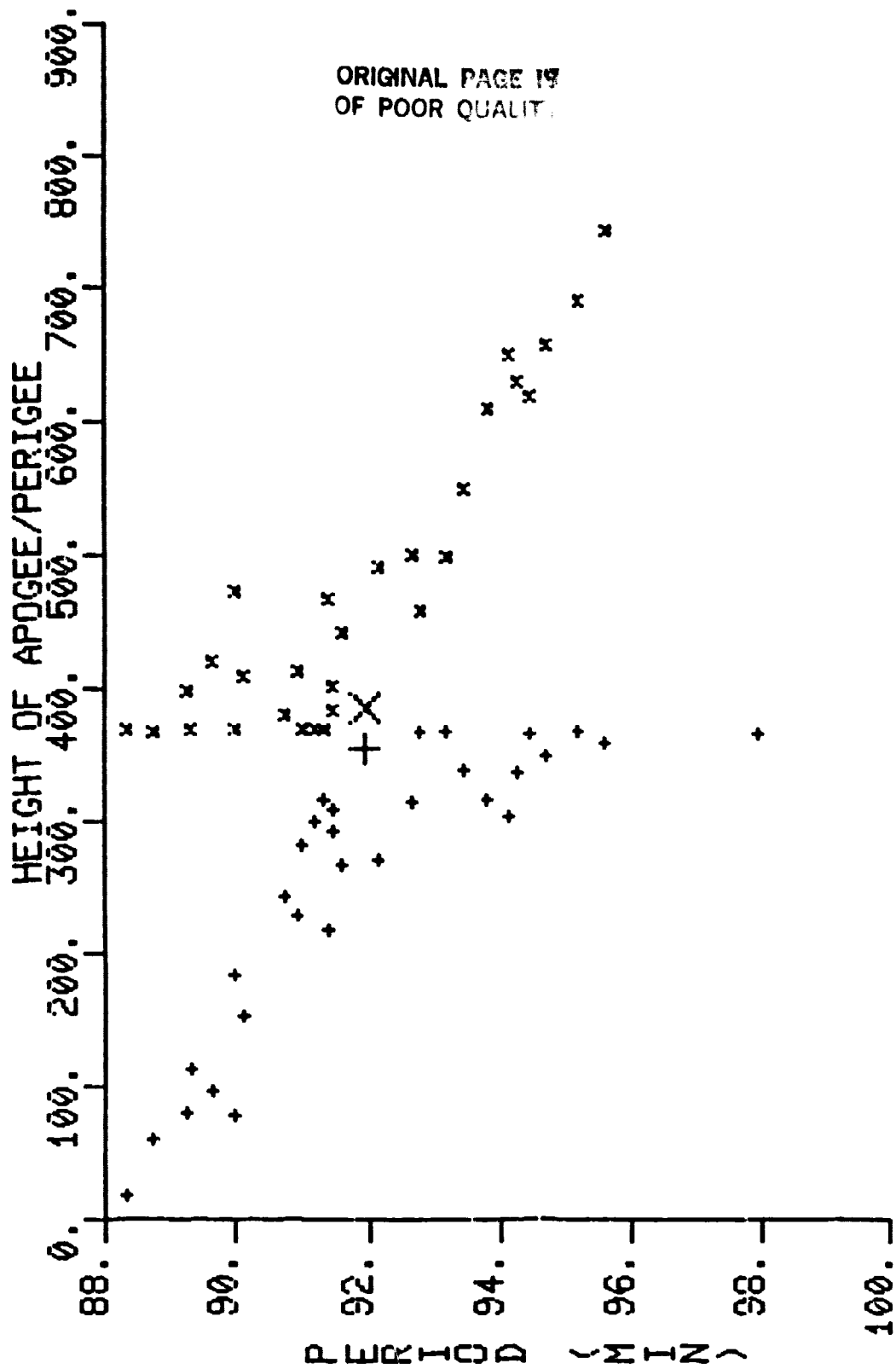
COSMOS 1306 SIMULATION

FIRST EVENT

ORIGINAL PAGE IS  
OF POOR QUALITY



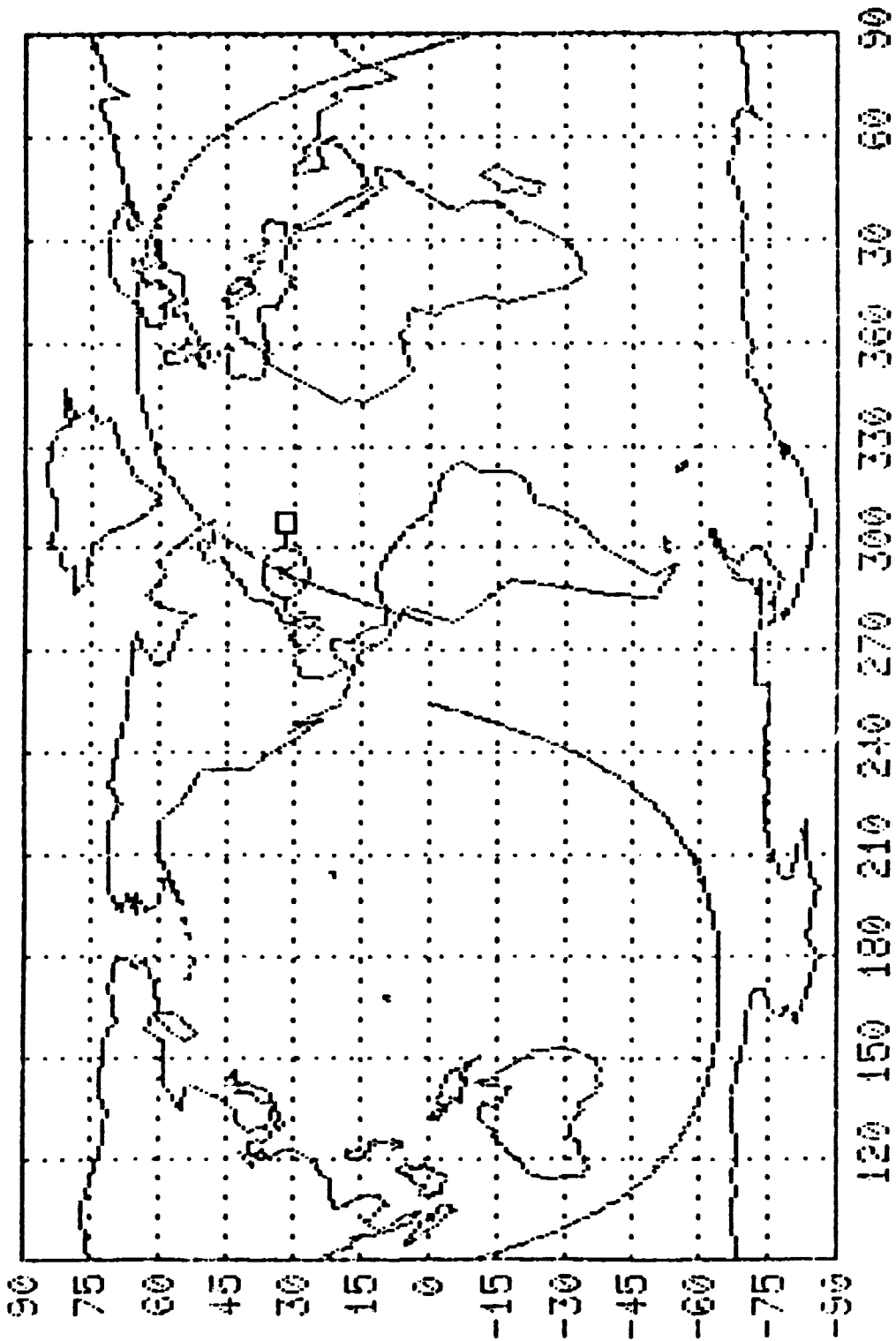
COSMOS 1306 (1ST EVENT)



COSMOS 1306 SIMULATION  
2ND EVENT



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1306 (2ND EVENT)

1981-108

COSMOS 1317

12933

LAUNCH DATE: 31.96 Oct 1981

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 25-28 Jan 1984 (Day 25-28)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 MAR 84): 6 (3 cataloged plus 3 more provisional)

PIECES STILL IN ORBIT (1 MAR 84): 6

ORBIT CHARACTERISTICS:

INCLINATION: 62.8°

APOGEE: 39085.2 km

PERIGEE: 1318.9 km

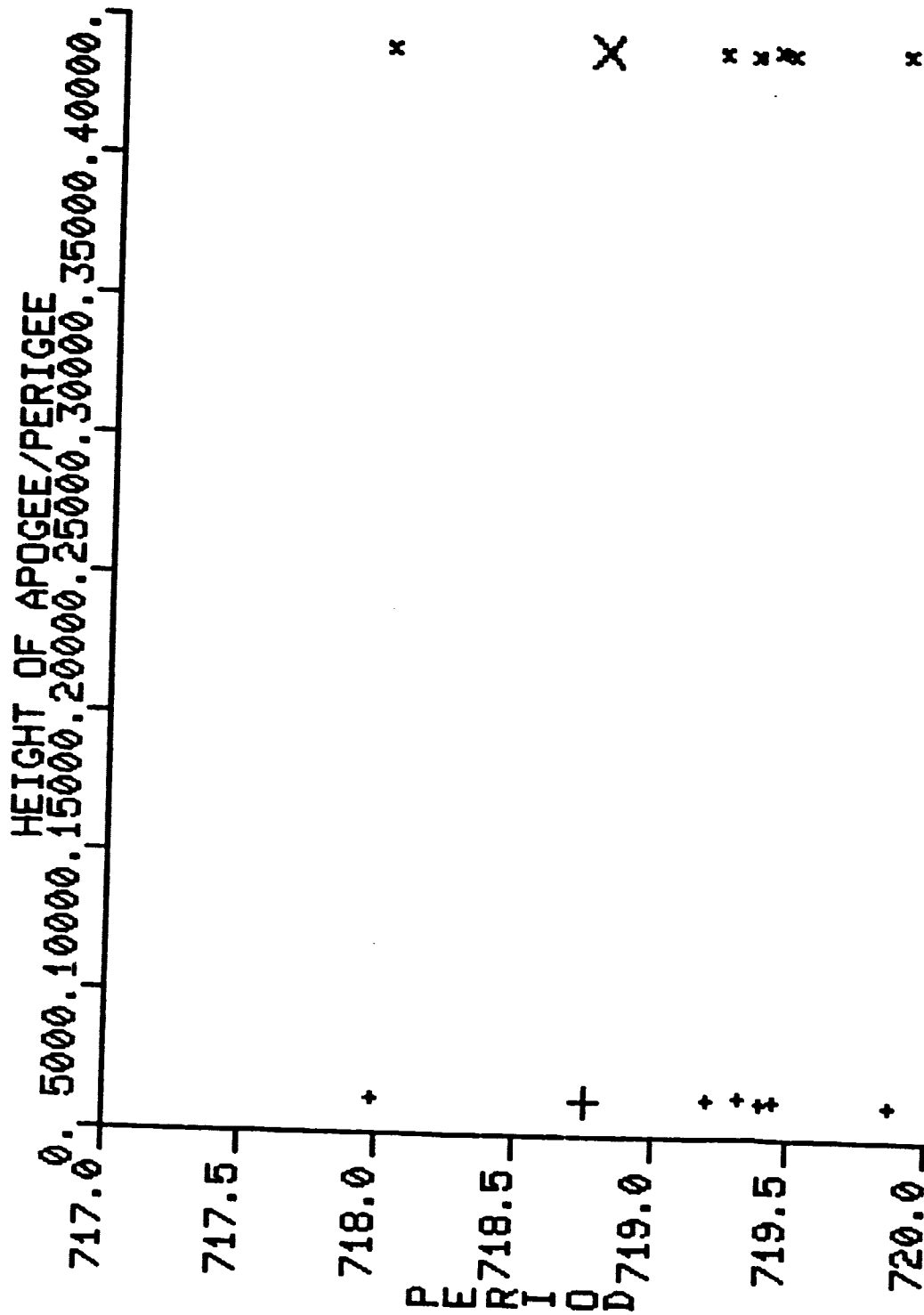
PERIOD: 718.8 min

TRUE ANOMALY:

- COMMENTS:
- General shape; windmill plus 6 vanes; 4.2 m long?; 1.6 m dia.; weight 1250? kg.
  - Element data derived from NSCC elements on satellite 12933 epoch 1984 day 26.45925295.

CAUSE: Unknown.

ORIGINAL PAGE IS  
OF POOR QUALITY.



COSMOS 1317

COMMENTS • Insufficient data available to show applicable ground trace for satellite 12933.

1981-108

1982-38

COSMOS 1355

13150

LAUNCH DATE: 29.42 Apr 1982

COUNTRY OF ORIGIN: USSR

EVENT DATA:

	<u>1.</u>	<u>2.</u>	<u>3.</u>
DATE:	8 Aug 1983 (DAY 220)	1 Feb 1984 (DAY 32)	21 Feb 1984 (DAY 52)
TIME:	233058.0 GMT	032157.1 GMT	
LOCATION:	32 S/310 E	4 S/200 E	
ALTITUDE:	364 km	317 km	
PIECES CATALOGED (1 JAN 84):	22		
PIECES STILL IN ORBIT (1 JAN 84):	3		

ORBIT CHARACTERISTICS:

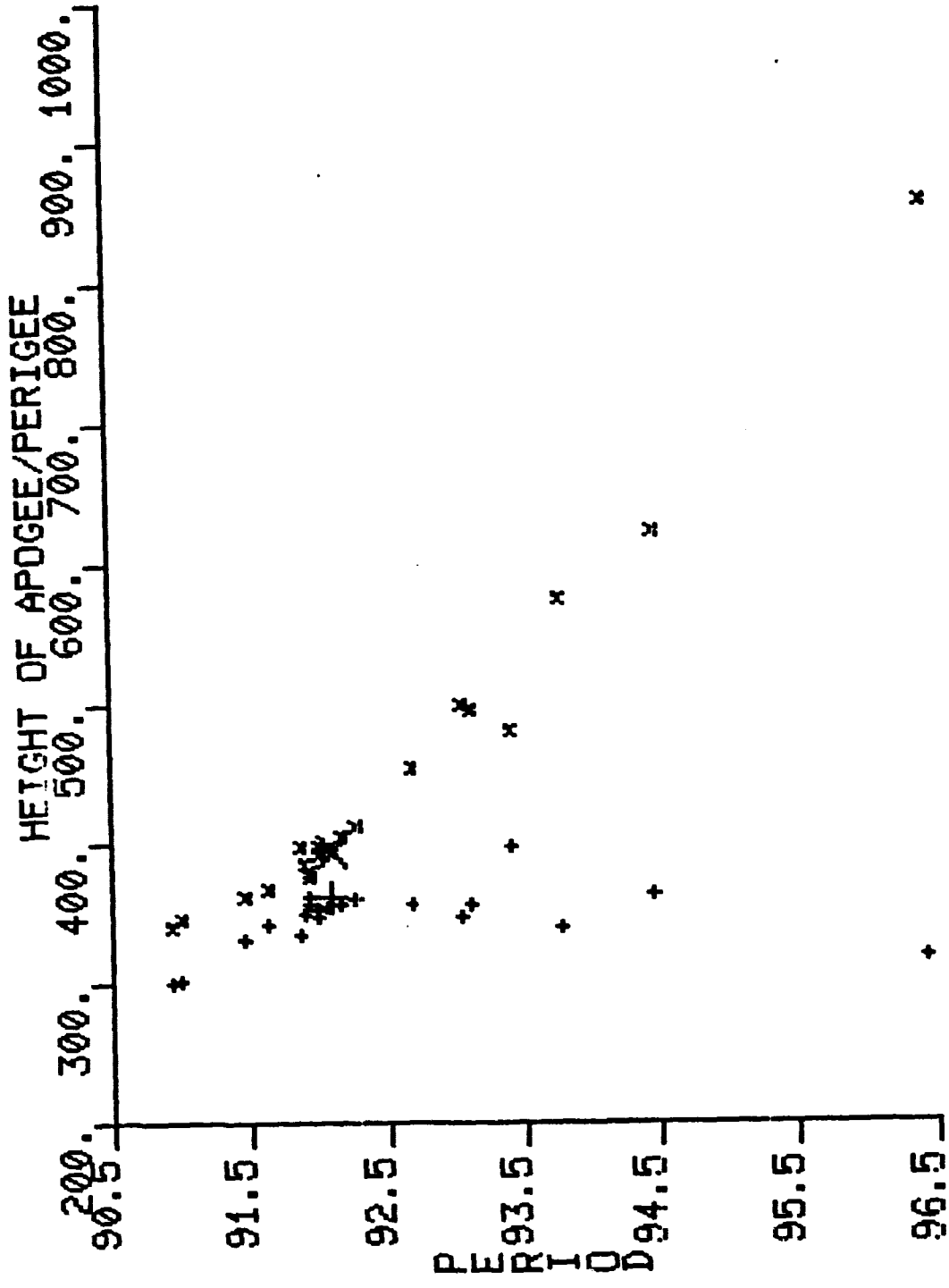
INCLINATION:	65.05°	65.04°	65.04°
APOGEE:	395 km	330 km	307 km
PERIGEE:	362 km	308 km	289 km
PERIOD:	92.1 min	90.9 min	90.5 min
TRUE ANOMALY:	32°	79°	

**COMMENTS:** • Orbit data derived from element set #632 for satellite 13150, 1st event; element set #242 for 2nd event, satellite 14275 and elements generated on day 51.19, Feb. 19, 1984 on satellite 13150 for the 3rd event.

- The 1st and 3rd fragmentation was satellite 13150 and the 2nd fragmentation was satellite 14275.
- Thirteen fragments were detected after 3rd event.
- Member of Cosmos 699 class.

**CAUSE:**      Apparently deliberate fragmentations.

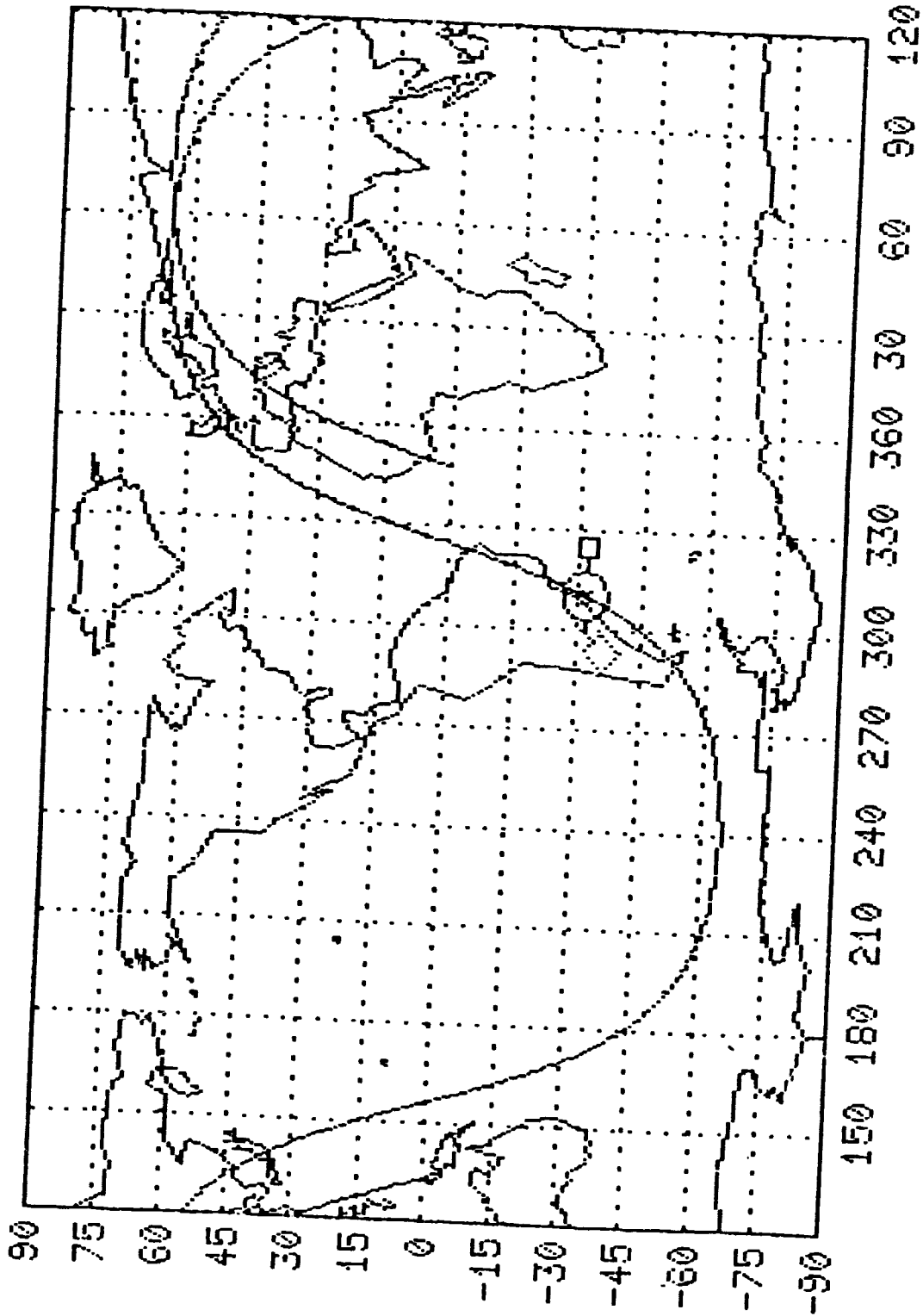
ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1355  
1st EVENT

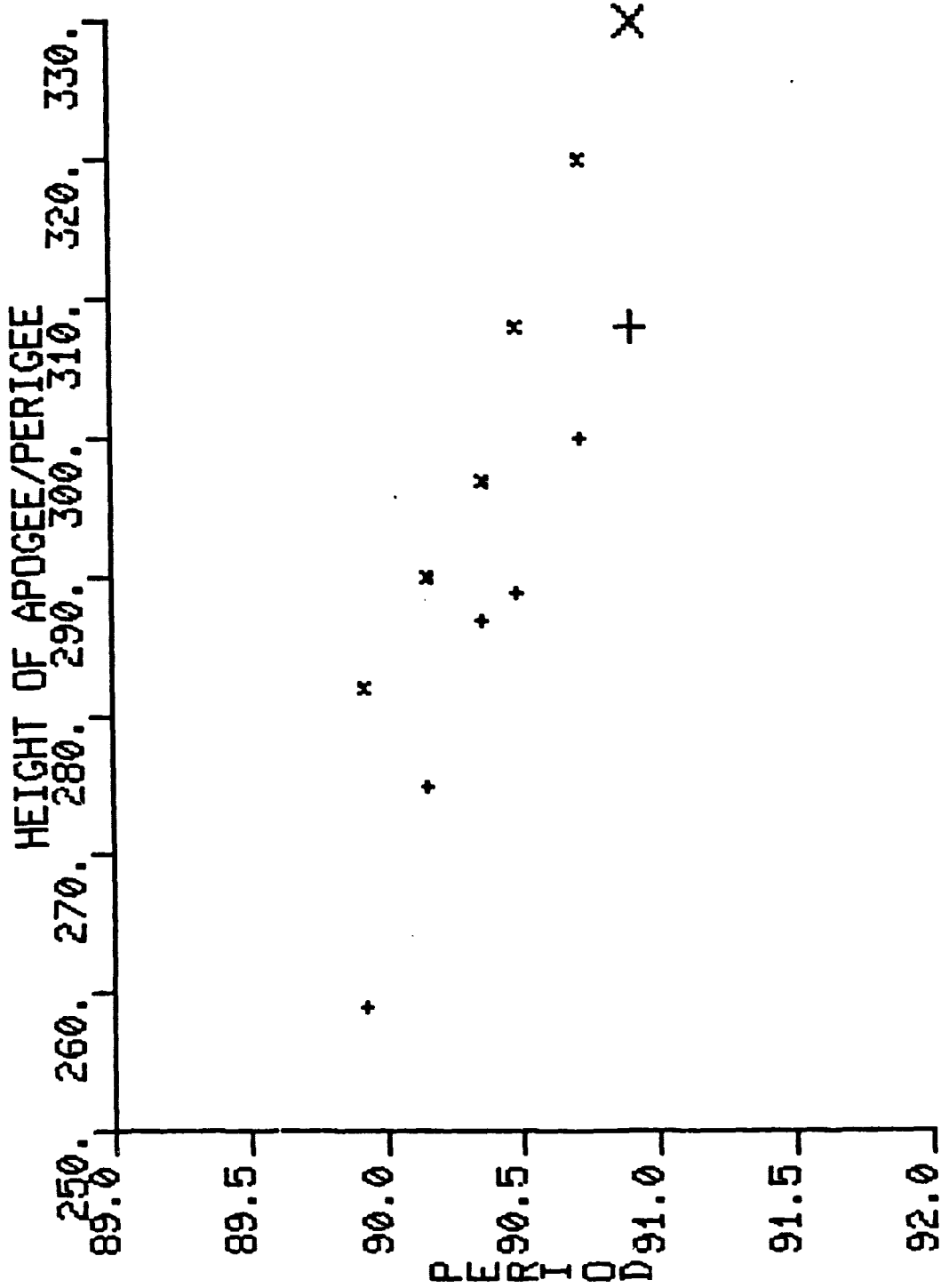


ORIGINAL PAGE IS  
OF POOR QUALITY



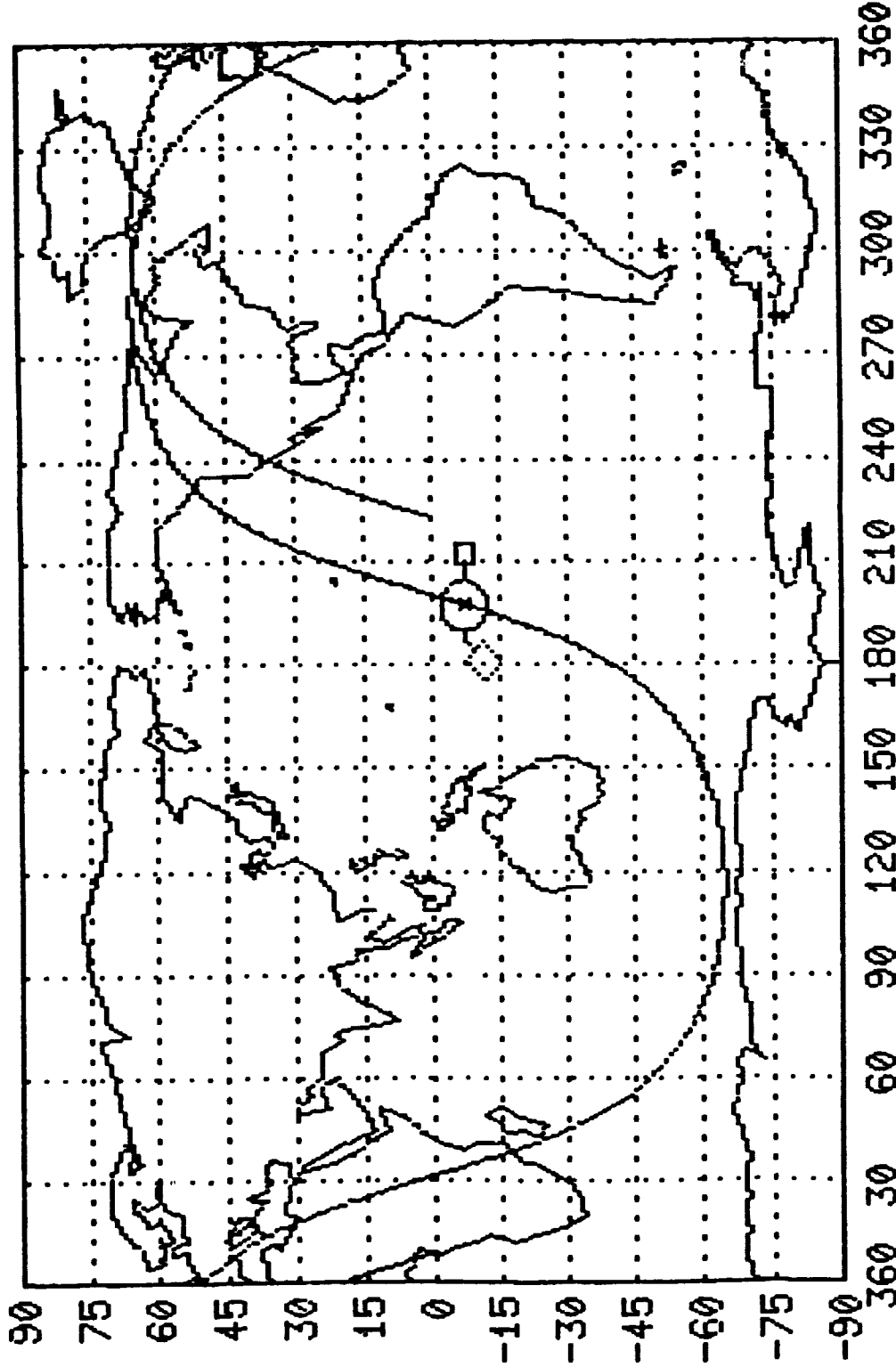
COSMOS 1355 (1ST EVENT)

ORIGINAL PAGE IS  
OF POOR QUALITY



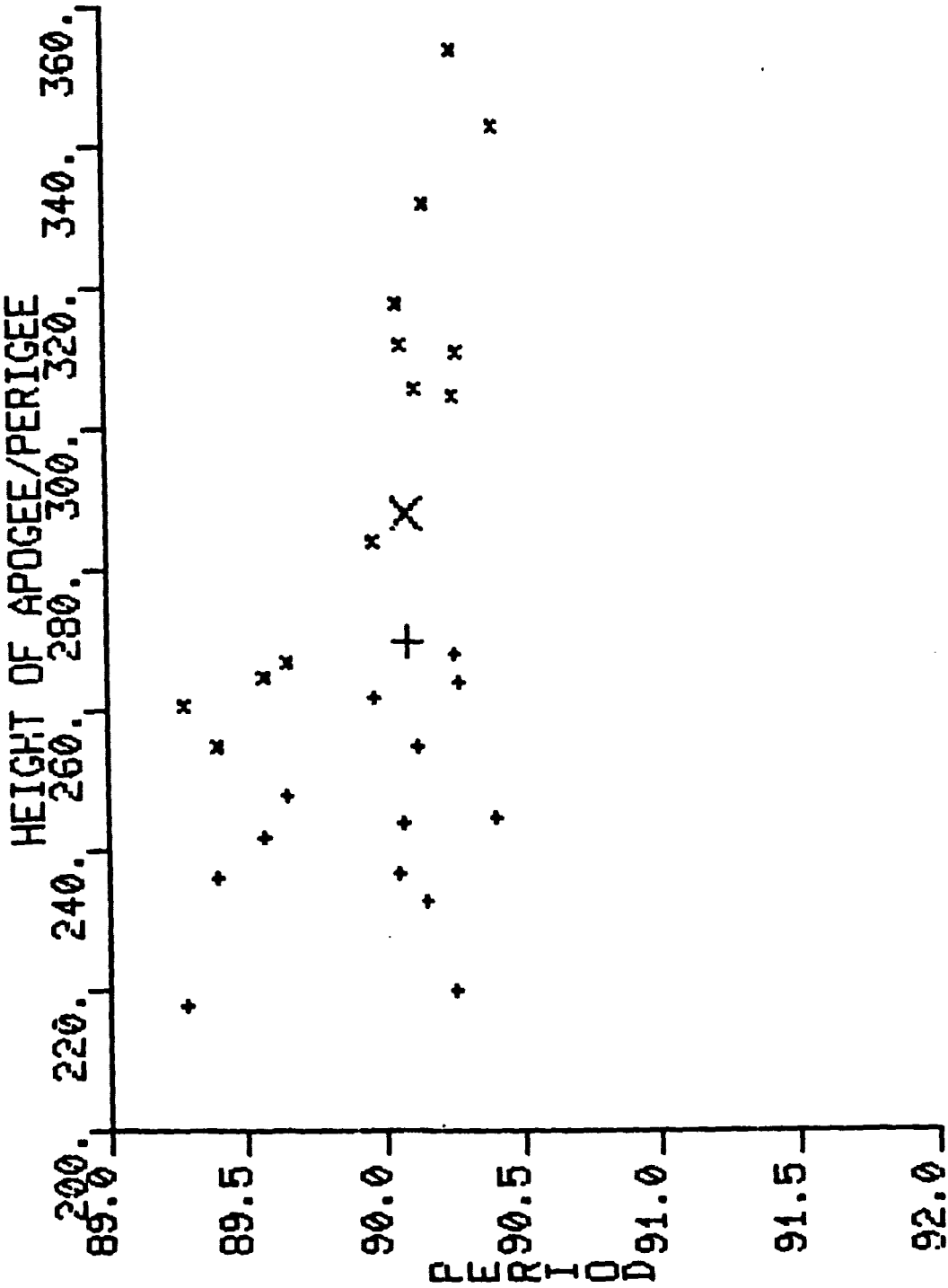
COSMOS 1355  
2ND EVENT

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1355 (2ND EVENT)

ORIGINAL PAGE 19  
OF POOR QUALITY



COSMOS 1355  
3RD EVENT

COMMENTS: • Insufficient data available to show applicable ground trace for COSMOS 1355 - 3rd event.

1982-38

1-305

1982-88

COSMOS 1405

13508

LAUNCH DATE: 4.74 Sep 1982

COUNTRY OF ORIGIN:

EVENT DATA:

DATE: 20 Dec 1983 (DAY 354)

TIME: 121434.0 GMT

LOCATION: 25 S/45 E

ALTITUDE: 333 km

PIECES CATALOGED (1 JAN 84): 5 (others cataloged after 1 Jan)

PIECES STILL IN ORBIT (1 JAN 84): 5

ORBIT CHARACTERISTICS:

INCLINATION: 65.00°

APOGEE: 342 km

PERIGEE: 315 km

PERIOD: 91.1 min

TRUE ANOMALY: 247°

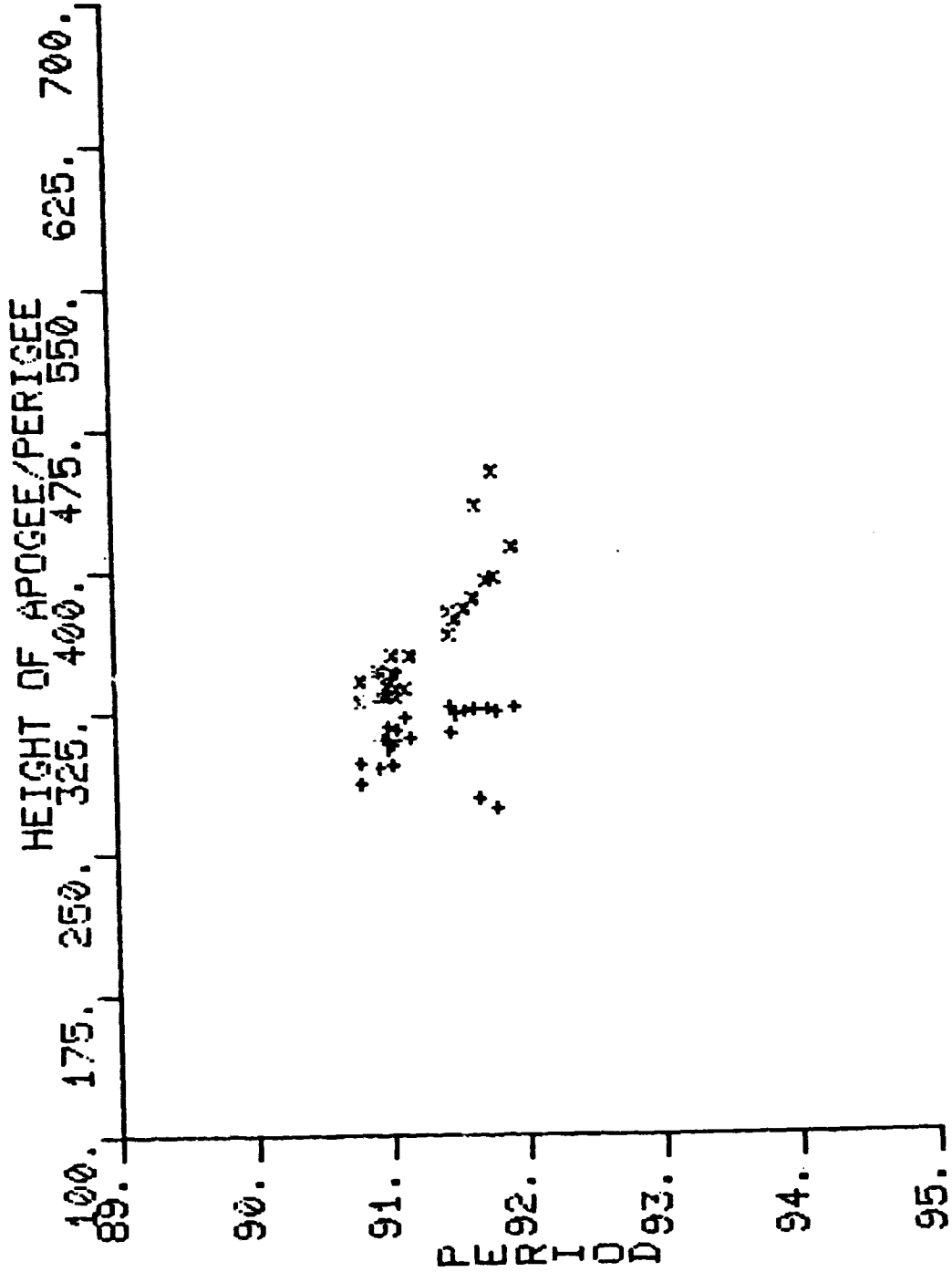
- COMMENTS:**
- Orbit data as of 16 Dec 1983
  - Total count of pieces by sensors was approximately 140.
  - Member of Cosmos 699 class.

**CAUSE:** Apparently deliberate fragmentation.

1982-88

1-307

ORIGINAL PAGE IS  
OF POOR QUALITY



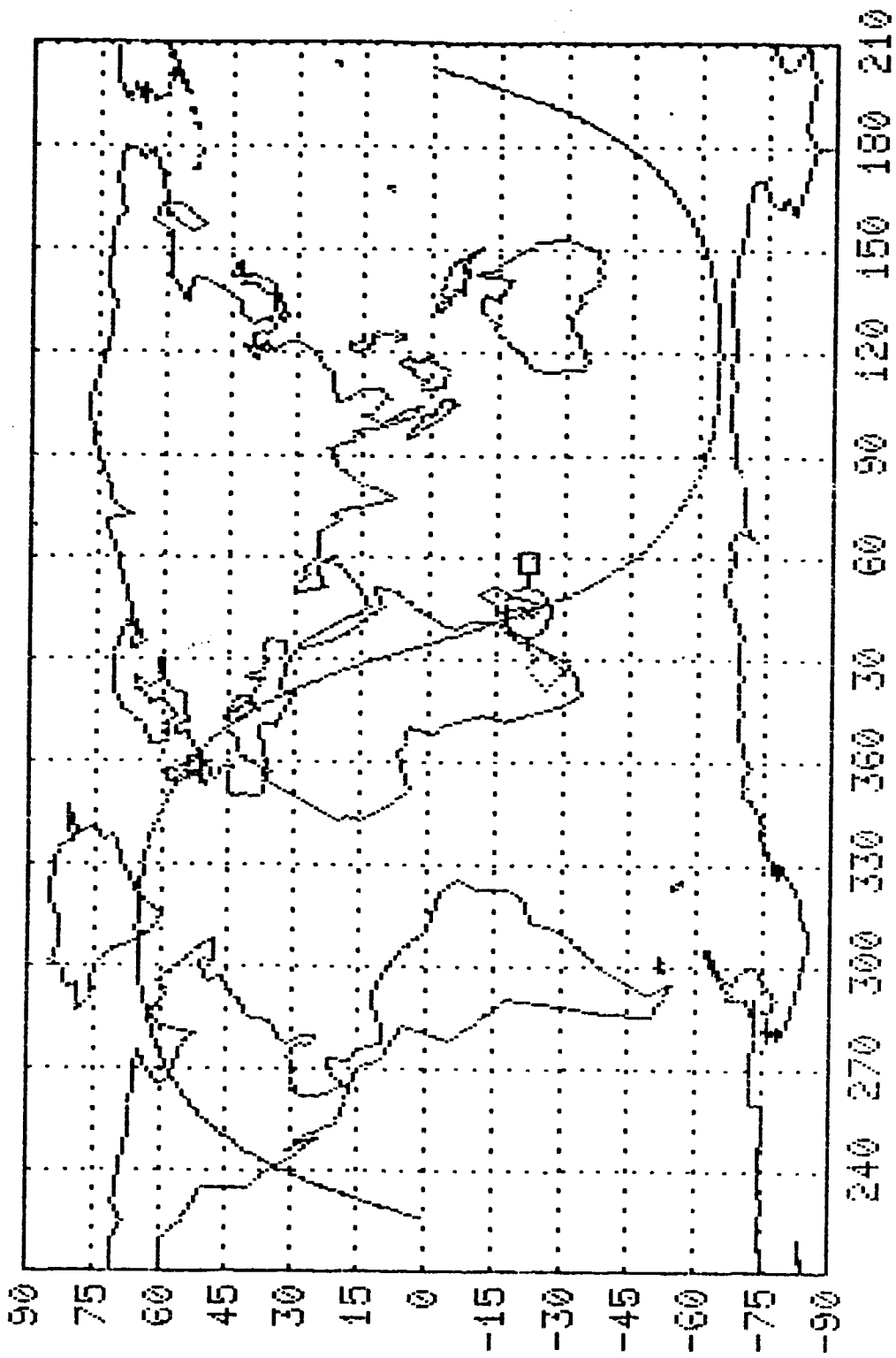
COSMOS 1405

1-308

Cataloged plus 8X,XXX  
provisional orbits



ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1405



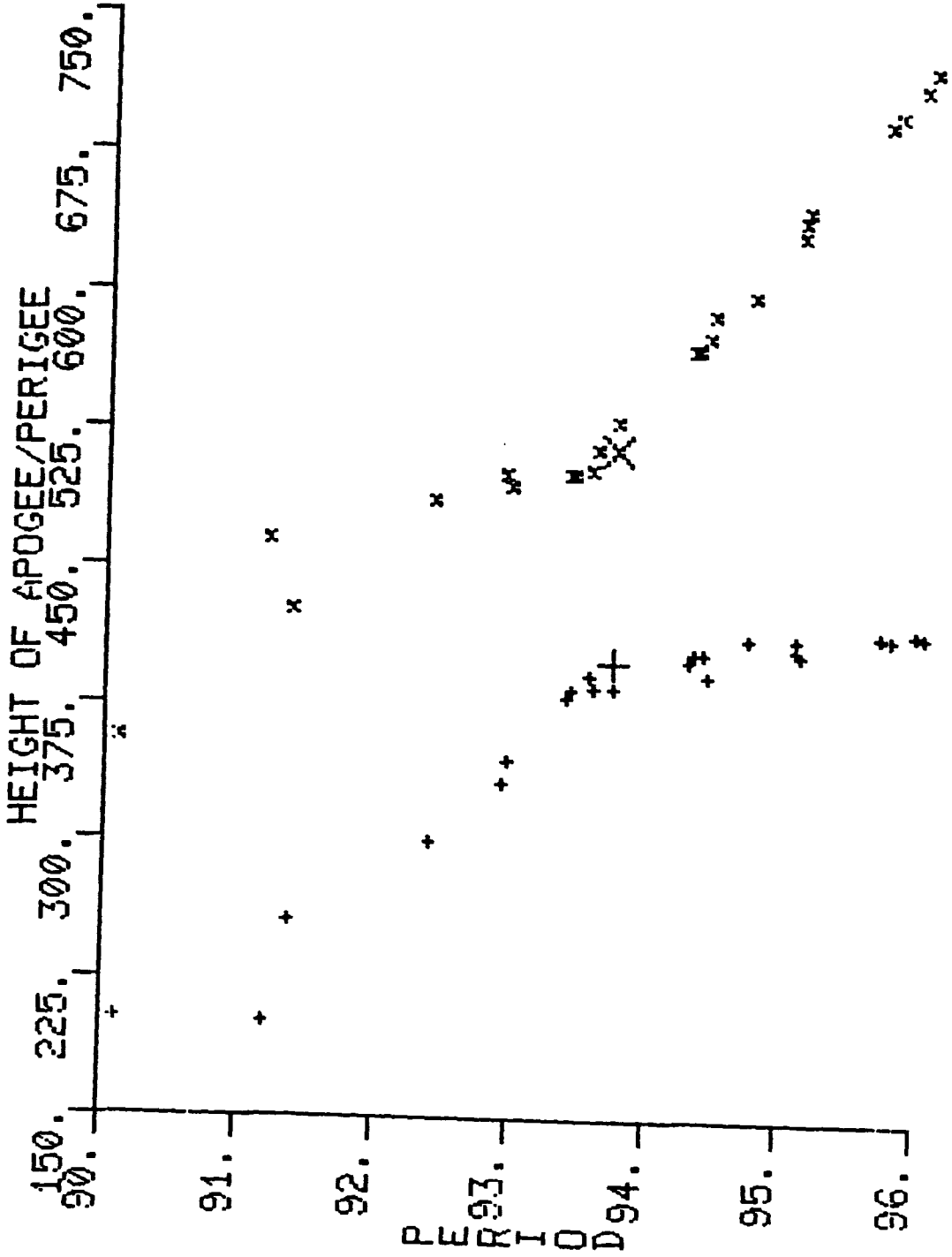
- COMMENTS:**
- General shape was windmill plus cylinder; length 6.2 m; dia. 1.6 m?; weight full, 6050 kg?
  - Failure during attempt to transfer payload to Molniya highly eccentric orbit.
  - 13685 fragmented twice.
  - 17 pieces counted by NORAD sensor for the 2nd fragmentation.

**CAUSE:** Upper stage engine failure.

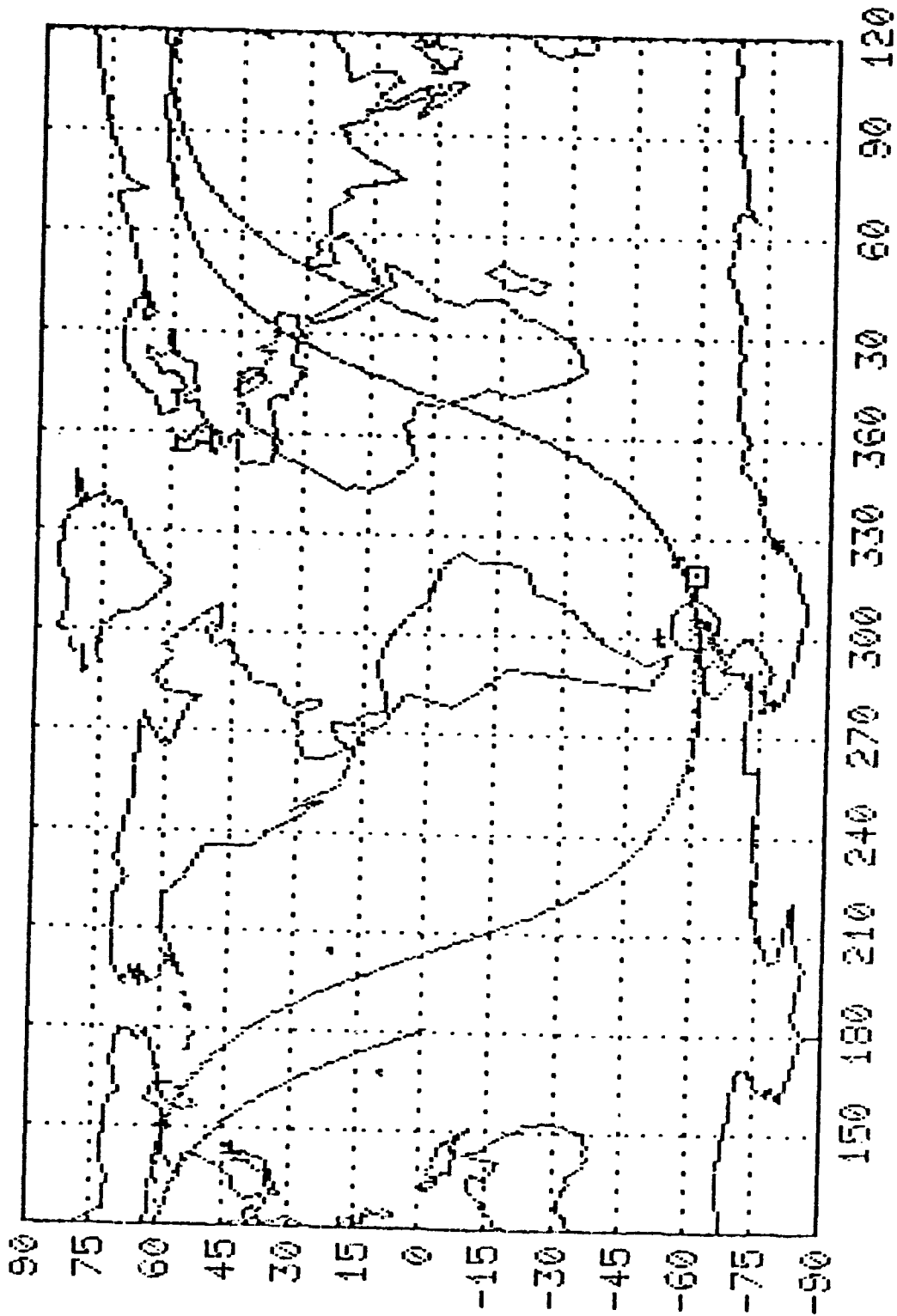
1982-115

1-311

ORIGINAL PAGE 19  
OF POOR QUALITY



ORIGINAL PAGE IS  
OF POOR QUALITY.



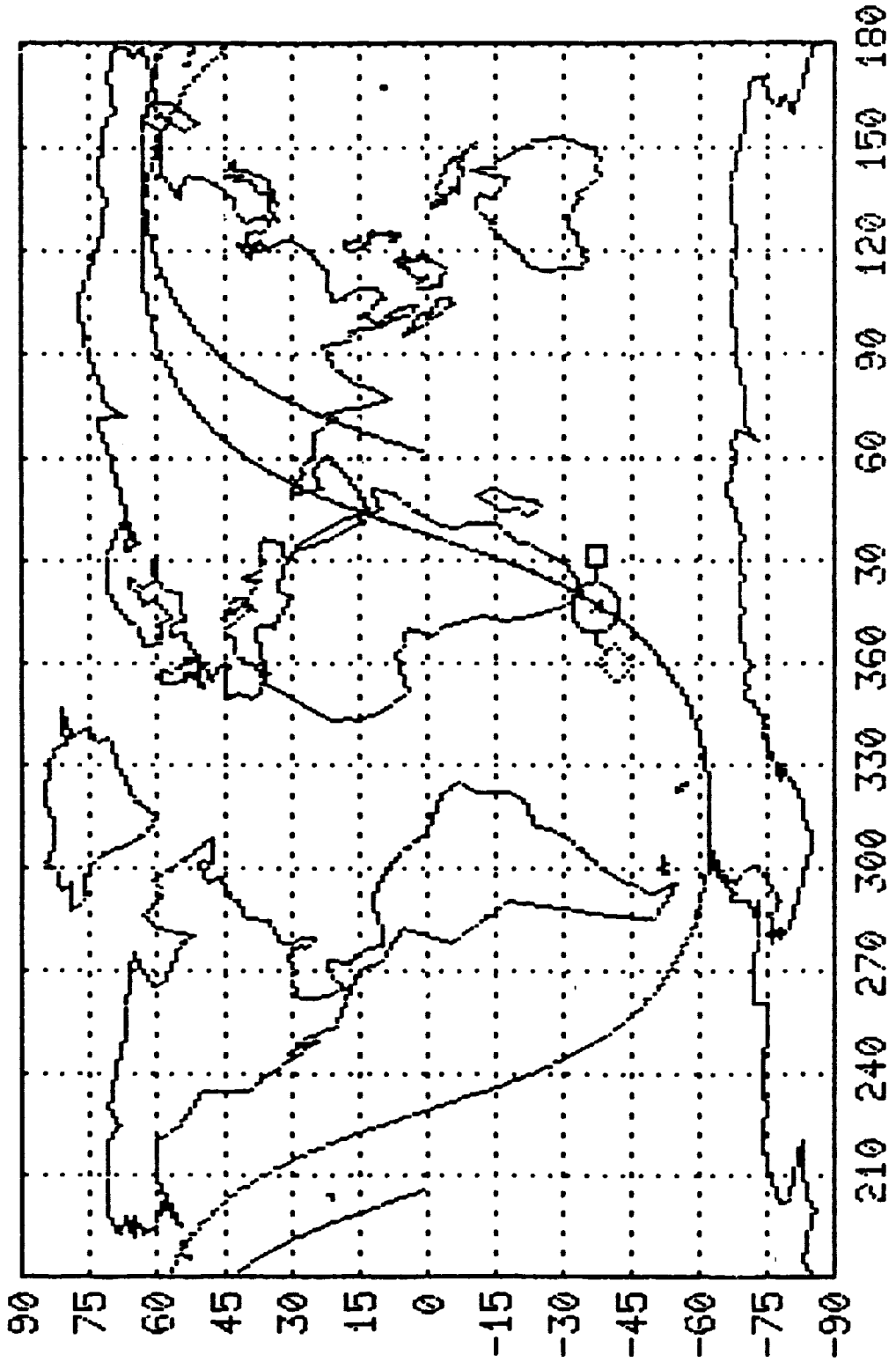
COSMOS 1423 (1ST EVENT)

COMMENTS

- Insufficient data was available to resolve the element set information for the two breakups, therefore no orbit distribution plot is provided for the second event.

1982-115

ORIGINAL PRINTING  
OF POOR QUALITY



COSMOS 1423  
(2ND EVENT)

1983-38

COSMOS 1456

14034

LAUNCH DATE: 25.60 Apr 1983

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 12 Aug 1983 (DAY 224)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 4

PIECES STILL IN ORBIT (1 JAN 84): 4

ORBIT CHARACTERISTICS:

INCLINATION: 63.29°

APOGEE: 39631 km

PERIGEE: 729 km

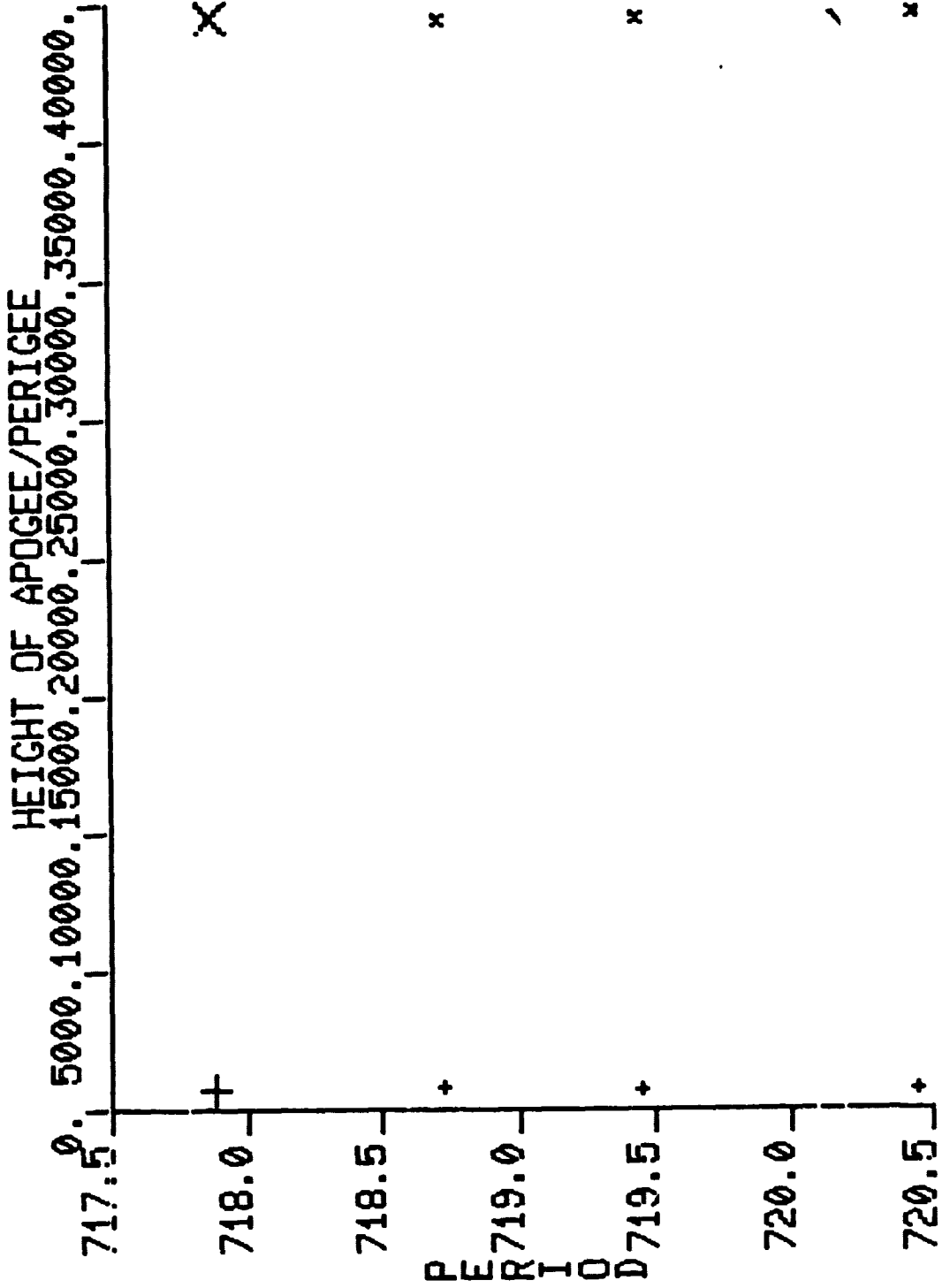
PERIOD: 717.9 min

TRUE ANOMALY:



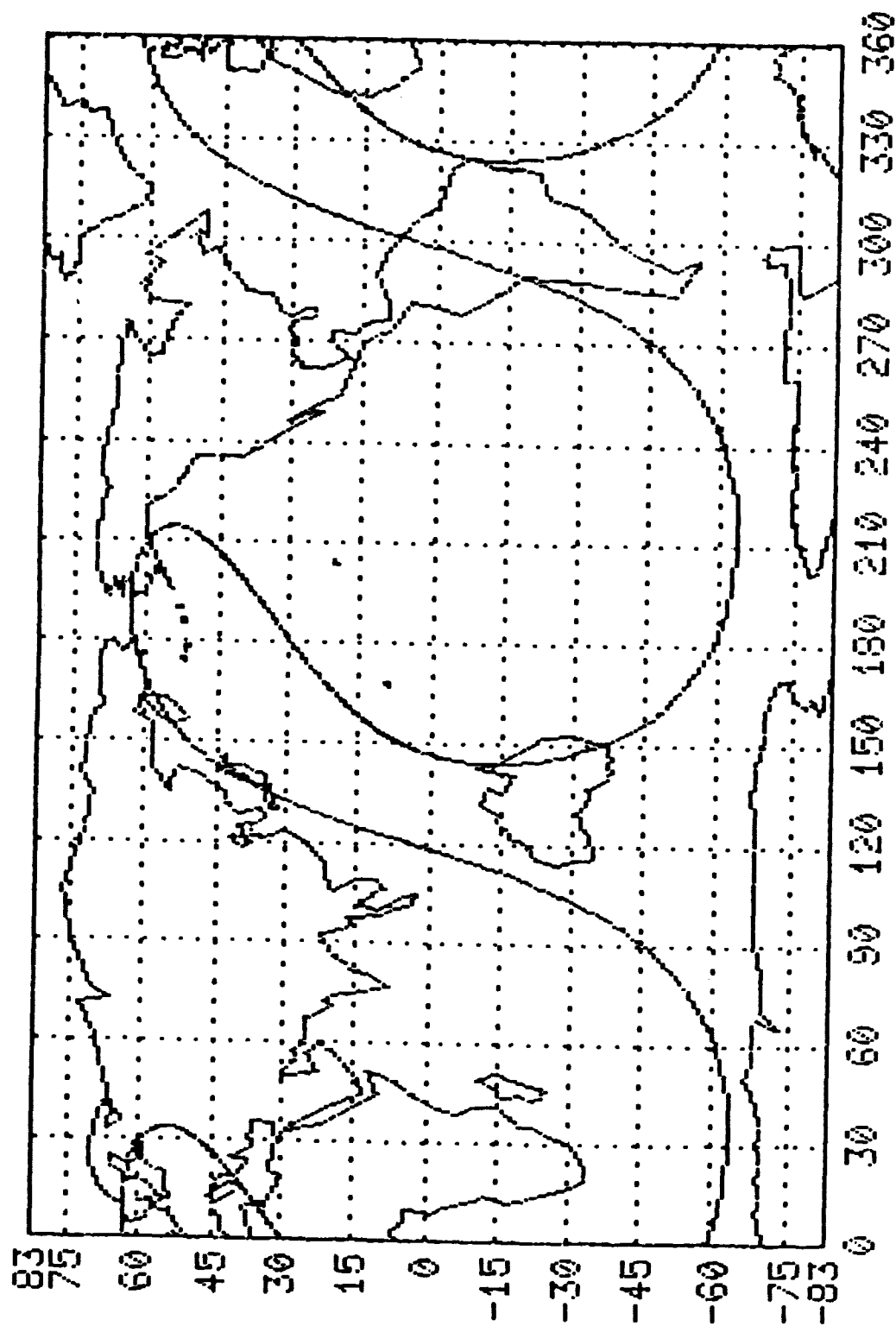
- COMMENTS:**
- Orbit data derived from element set #49 for satellite 14034.
  - General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6m; weight 1250 kg?
  - Five cataloged pieces in event orbit. One of the 5 is the 2nd rocket of this launch.
  - Ten objects cataloged with this international designator. These include objects in both the low transfer orbit and the high event orbit.

**CAUSE:** Unknown



COSMOS 1456

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1456

1983-70

COSMOS 1481

14182

LAUNCH DATE: 8.81 Jul 1983

COUNTRY OF ORIGIN: USSR

EVENT DATA:

DATE: 9 Jul? 1983 (DAY 150)

TIME:

LOCATION:

ALTITUDE:

PIECES CATALOGED (1 JAN 84): 2

PIECES STILL IN ORBIT (1 JAN 84): 2

ORBIT CHARACTERISTICS:

INCLINATION: 62.92°

APOGEE: 39199 km

PERIGEE: 642 km

PERIOD: 707.4 min

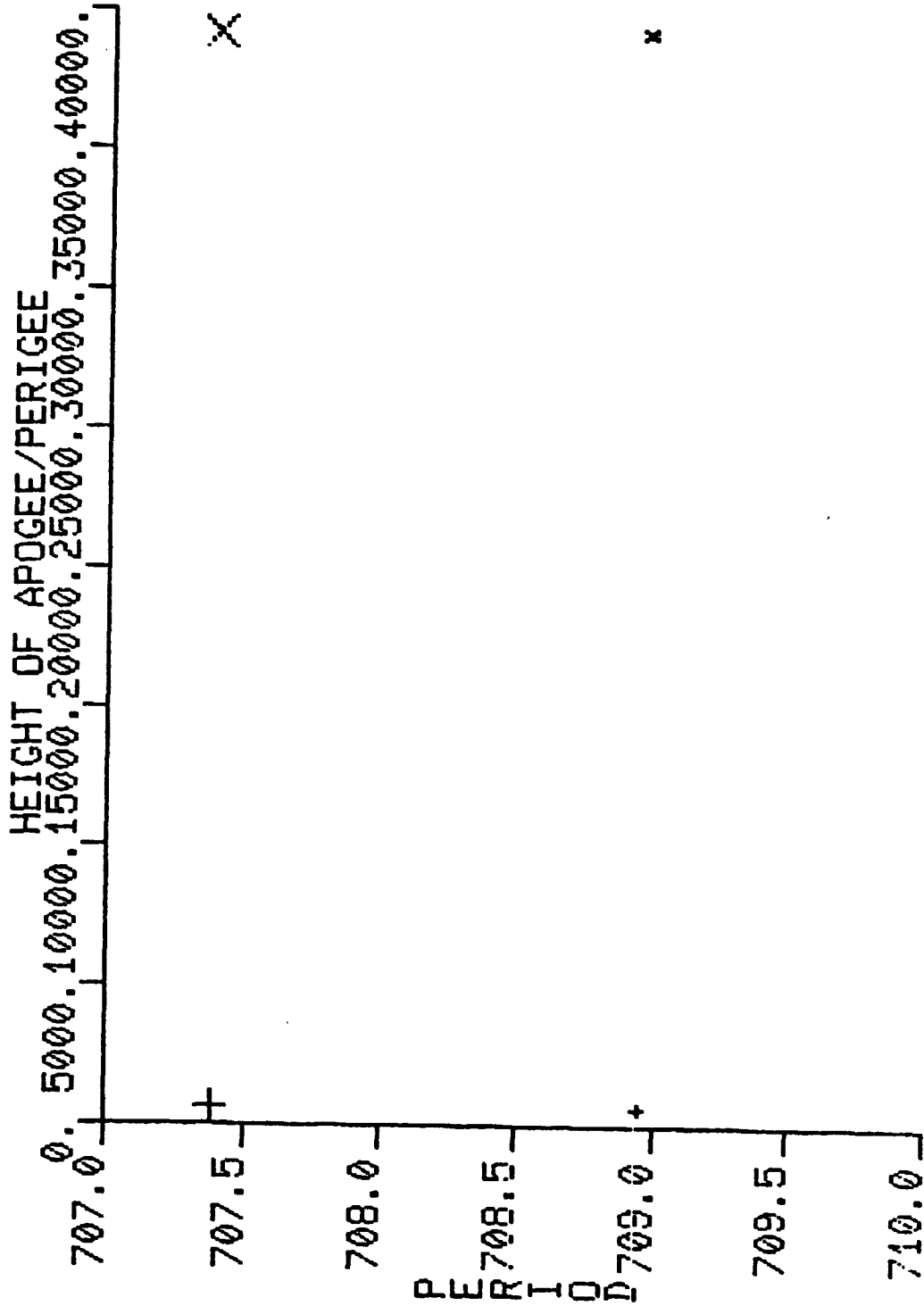
TRUE ANOMALY:

- COMMENTS:**
- Orbit data derived from element set #8 for satellite 14182.
  - General shape was windmill plus 6 vanes?; length 4.2 m?; dia. 1.6 m; weight 1250 kg?
  - Never attained planned orbit.
  - Pieces appeared the day after launch.
  - Two additional 8X,XXX pieces identified.

**CAUSE:** Unknown; possibly propulsion related.

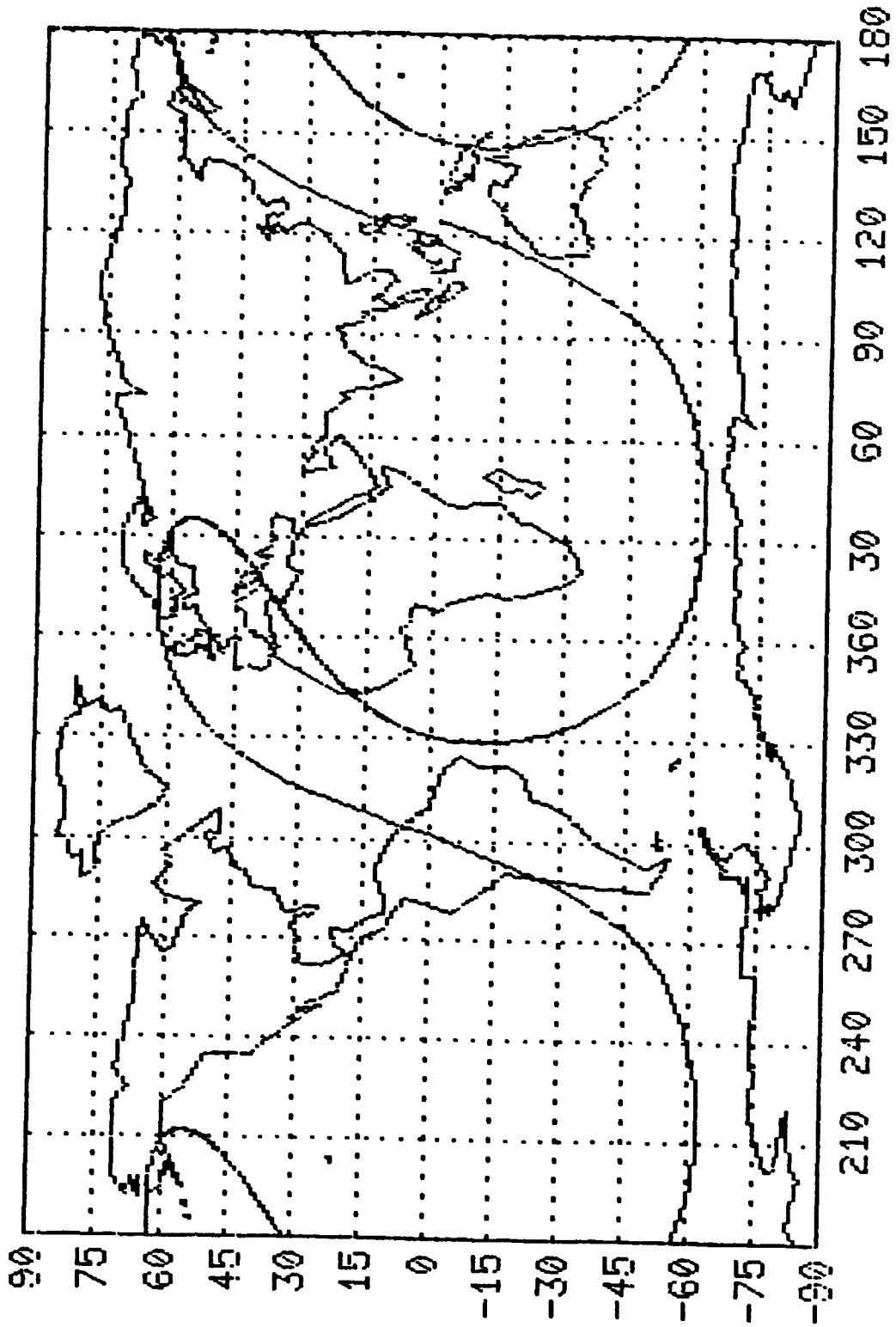
1983-70

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1481

ORIGINAL PAGE IS  
OF POOR QUALITY



COSMOS 1481

Section II

Satellite Fragmentation Summary Table  
Satellite Breakup Status as of 31 Dec 1983



SATELLITE BREAKUP STATUS AS OF 31 DEC 1983

INTERNATIONAL DESIGNATOR	LAUNCH	COMMON NAME	NSSC CATALOG NUMBER	LAUNCH DATE	DATE OF EVENT	SATELLITE DEBRIS			PARENT SATELLITE			REMARKS
						CATALOGED	IN ORBIT	INCL (°)	APOGEE (KM)	PERIGEE (KM)		
1961-Omicron		TRANSIT 4A	119	29 Jun	29 Jun	261	152	66.8	998	880	Able Star rocket	
1962-B Iota		SPUTNIK-29	443	24 Oct	29 Oct	23	0	65.1	361	202	Payload	
1963-47		Atlas Centaur 2	694	27 Nov	27 Nov	14	12	29.9	1735	502	More debris cataloged with 65-82. Rocket	
1964-26		Transit 9 (OPS 4412)	809?	4 Jun	Jan-Feb 66	11	10	90.5	935	848	809 most likely parent; some fragments cataloged with other launches	
1964-70		COSMOS 50	919	28 Oct	5 Nov	95	0	51.2	233	188	Payload	
1965-12		COSMOS 57	1093	22 Feb	22 Feb	166	0	64.8	708	159	Voskhod test flight	
1965-20		COSMOS 61-63	1270	15 Mar	15 Mar	147	26	56.0	1827	260	Rocket	
1965-82		Titan 3C-4	1640	15 Oct	27 Jul 66	464	163	32.6	791	708	Titan 3C-4 Transtage fragmented	
1965-88		COSMOS 95	1706	4 Nov	Mid Nov 65	21	0	48.4	521	211	Payload?	
1966-12		Bluebell 2 (OPS 3031)	2015	15 Feb	15 Feb	37	0	96.5	268	147	Inflated sphere	
1966-46		ATDA	2188	1 Jun	Jun	50	0	28.8	300	281	Atlas rocket	
1966-56		Pageos 1	2253	24 Jun	12 Jul 75	12		85.3	5169	3201	Balloon	
					20 Jan 76	63	13	85.1	5424	2934		
					Jun 78			84.6	5750	2629		
1966-59		AS-203	2289	5 Jul	5 Jul	33	0	31.9	214	185	Saturn rocket	
1966-88		USSR/Unk. 1	2437	17 Sep	17 Sep	54	0	49.6	792	138	Alleged FOBS test	
1966-101		USSR/Unk. 2	2536	2 Nov	2 Nov	40	0	49.7	651	188	Alleged FOBS test	
1967-01		INTELSAT 2-F2	2643	11 Jan	Early 1971?	23	4	28.7	589	253	Rocket; data indicates debris cataloged with this launch probably originated from another geosync flight.	

ORIGINAL PAGE 19  
OF POOR QUALITY

SATELLITE BREAKUP STATUS AS OF 31 DEC 1983

INTERNATIONAL DESIGNATOR	COMMON NAME	NSSC CATALOG NUMBER	LAUNCH DATE	DATE OF EVENT	SATELLITE DEBRIS			PARENT SATELLITE			REMARKS
					CATALOGED	IN ORBIT	INCL (°)	APOGEE (KM)	PERIGEE (KM)		
1968-90	COSMOS 248	3503	19 Oct	1 Nov	4	0	62.2	543	473	Alleged ASAT target	
1968-91	COSMOS 249	3504	20 Oct	20 Oct	91	55	62.3	2159	496	Alleged ASAT	
1968-97	COSMOS 252	3530	1 Nov	1 Nov	122	55	62.3	2139	534	Alleged ASAT	
1969-29	Meteor 1	3836	26 Mar	28 Mar	36	2	81.1	851	462	Rocket	
1969-64	INTELSAT 3-F5	4052	26 Jul	26 Jul	25	4	30.3	5445	271	Rocket. 4 objects not from 69-64	
1969-82	Ops 7613	4132	30 Sep	4 Oct	241	123	70.0	940	907	Payload	
1970-25	Nimbus 4	4367	8 Apr	17 Oct	330	282	99.8	1094	1051	Agona D Rocket	
1970-89	COSMOS 374	4594	23 Oct	23 Oct	92	44	62.9	2132	529	Alleged ASAT	
1970-91	COSMOS 375	4598	30 Oct	30 Oct	41	31	62.8	2186	464	Alleged ASAT	
1971-15	COSMOS 397	4964	25 Feb	25 Feb	88	73	65.8	2200	575	Alleged ASAT	
1971-106	COSMOS 462	5646	3 Dec	3 Dec	27	0	65.9	1654	231	Alleged ASAT	
1972-38	Landsat 1	6127	23 Jul	22 May 75	218	88	98.3	909	633	Delta second stage	
1973-17	Salyut 2	6399	3 Apr	3 Apr	25	0	51.5	244	195	Rocket	
1973-21	COSMOS 554	6432	19 Apr	6 May	196	0	72.8	350	168	Payload	
1973-86	NOAA 3	6921	6 Nov	28 Dec	180	168	102.0	1513	1504	Delta second stage	
1974-74	COSMOS 686	7448	26 Sep	26 Sep	19	0	70.9	456	259	Rocket	
1974-89	NOAA 4	7532	15 Nov	20 Aug 75	132	124	101.7	1460	1445	Delta second stage	
1974-103	COSMOS 699	7587	24 Dec	17 Apr 75 2 Aug 75	50	0	65.0 65.1	444 442	424 414	Two fragmentations one revolution apart	

ORIGINAL PAGE IS  
OF POOR QUALITY

SATELLITE BREAKUP STATUS AS OF 31 DEC 1983

INTERNATIONAL DESIGNATOR	LAUNCH	COMMON NAME	NSSC CATALOG NUMBER	LAUNCH DATE	DATE OF EVENT	SATELLITE DEBRIS			PARENT SATELLITE			REMARKS
						CATALOGED	IN ORBIT	INCL (°)	APOGEE (KM)	PERIGEE (KM)		
1975-04		Landsat 2	7616	22 Jan	9 Feb 76 19 Jun 76	197	54	97.8 97.8	915 912	741 742		Delta second stage; small fragmentation. Large fragmentation
1975-27		GEOS 3	7735	9 Apr	12 Mar 78	5	3	115.0	844	837		Delta second stage
1975-80		COSMOS 758	8191	5 Sep	6 Sep	77	0	67.1	324	173		Payload
1975-102		COSMOS 777	8416	29 Oct	26 Jan 76	62	0	65.0	442	430		Payload; two events one revolution apart
1976-63		COSMOS 838	8932	2 Jul	17 May 77	40	0	65.0	444	415		Payload
1976-67		COSMOS 839	9011	8 Jul	29 Sep 77	53	52	65.9	2100	981		Alleged ASAT target
1976-72		COSMOS 844	9046	22 Jul	25 Jul	248	0	67.1	353	172		Debris cataloged but no elements. Payload
1976-77		NOAA 5	9063	29 Jul	24 Dec 77	130	129	102.0	1521	1506		Delta second stage
1976-105		COSMOS 862	9495	22 Oct	15 Mar 77	11*	11	63.1	39644	1352		Payload
1976-120		COSMOS 880	9601	9 Dec	27 Nov 78	50	13	65.8	621	551		Alleged ASAT target
1976-126		COSMOS 886	9634	27 Dec	27 Dec	57	51	65.8	2297	595		Alleged ASAT target
1977-27		COSMOS 903	9911	11 Apr	8 Jun 78	2*	2	63.1	39035	1323		Payload
1977-47		COSMOS 917	10059	16 Jun	30 Mar 79	1*	1	62.9	38723	1643		Payload
1977-65		GMS (Himawari)	10144	14 Jul	14 Jul	147	93	29.0	2027	536		Delta second stage
1977-68		COSMOS 931	10150	20 Jul	24 Oct	4*	2	63.9	39667	682		Payload
1977-121		COSMOS 970	10531	21 Dec	21 Dec	54	54	65.8	1139	946		Alleged ASAT
1978-26		Landsat 3	10704	5 Mar	27 Jan 81	172	155	98.9	912	903		Delta second stage
1978-83		COSMOS 1030	11015	6 Sep	10 Oct	4*	3	63.0	39760	666		Payload

ORIGINAL PAGE IS  
OF POOR QUALITY

SATELLITE BREAKUP STATUS AS OF 31 DEC 1983

INTERNATIONAL DESIGNATOR	COMMON NAME	NSSC CATALOG NUMBER	LAUNCH DATE	DATE OF EVENT	SATELLITE DEBRIS		PARENT SATELLITE			REMARKS
					CATALOGED	IN ORBIT	INCL (°)	APOCEE (KM)	PERIGEE (KM)	
1979-33	COSMOS 1094	11333	18 Apr	17 Sep	2	0	65.0	405	382	Payload; 23 fragments decayed before being cataloged
1979-58	COSMOS 1109	11417	27 Jun	Sep ?	4*	4	62.9	39679	712	Payload
1979-77	COSMOS 1124	11509	28 Aug	9 Sep	5*	5	62.9	39754	574	Payload
1979-104	ARIANE VI	11659	24 Dec	Early 1980	1*	0	17.6	35839	189	Rocket; appears to have fragmented shortly after launch; at least 25 objects have been tracked
1980-21	COSMOS 1167	11729	14 Mar	15 Jul 81	12	0	65.3	450	357	Payload
1980-30	COSMOS 1174	11765	18 Apr	18 Apr	39	22	65.8	1025	362	Alleged ASAT
1980-57	COSMOS 1191	11871	2 Jul	14 May 81	2*	2	62.6	39283	1083	Payload
1980-89	COSMOS 1220	12054	4 Nov	20 Jun 82 25 Aug 82	63	57	{ 65.0 65.0	{ 883 873	{ 571 580	Payload Payload
1981-16	COSMOS 1247	12303	19 Feb	20 Oct	4*	4	63.0	39401	362	Payload
1981-24	COSMOS 1258	12337	14 Mar	14 Mar	1	0	65.8	1024	301	Alleged ASAT. 12-18 pieces detected reentering
1981-28	COSMOS 1260	12364	20 Mar	8 May 82 10 Aug 82	65	37	{ 65.0 65.0	{ 720 753	{ 422 447	Payload Fragment
1981-31	COSMOS 1261	12376	31 Mar	12 May	4*	4	63.0	39743	649	Payload
1981-53	COSMOS 1275	12504	4 Jun	24 Jul	226	223	82.9	1014	961	Payload
1981-71	COSMOS 1285	12627	4 Aug	21 Nov	3*	3	63.0	40109	721	Payload
1981-72	COSMOS 1286	12631	4 Aug	29 Sep 82	2	0	65.2	327	304	Payload; Est. 30 pieces decayed before they could be cataloged
1981-88	COSMOS 1305	13818	11 Sep	11 Sep	2*	2	62.8	13864	626	Rocket malfunction, other pieces detected, but not cataloged

ORIGINAL PAGE IS  
OF POOR QUALITY

SATELLITE BREAKUP STATUS AS OF 31 DEC 1983

INTERNATIONAL DESIGNATOR	LAUNCH	COSMOS NAME	NSSC CATALOG NUMBER	LAUNCH DATE	DATE OF EVENT	SATELLITE DEBRIS		PARENT SATELLITE			REMARKS
						CATALOGED	IN ORBIT	INCL (°)	APOGEE (KM)	PERIGEE (KM)	
1981-89		COSMOS 1306	12828	14 Sep	12 Jul 82	6	1	64.9	407	380	Payload; 27 pieces counted
			13369		18 Sep 82	1	0	64.9	372	369	Fragment; from 1st event
1982-38		COSMOS 1355	13150	29 Apr	8 Aug 83	22	3	65.1	395	362	Payload. (2 more events, 1984)
1982-88		COSMOS 1405	13508	4 Sep	20 Dec 83	5	5	65.0	342	315	Payload, Est. 30 pieces detected
1982-115		COSMOS 1423	13685	8 Dec	8 Dec 9 Dec	28	22	62.8 62.8	516 516	400 400	Payload fragmented twice
1983-38		COSMOS 1456	14034	25 Apr	12 Aug	9*	5	63.3	39631	729	17 pieces counted on 2nd event
1983-70		COSMOS 1481	14182	8 Jul	9 Jul	1*	1	62.9	39199	642	Payload
Total						5250	2497				

ORIGINAL PAGE IS  
OF POOR QUALITY

Total number of all cataloged satellites in orbit 1 Jan 84: 5064

\*Note: Fragments in highly elliptical, "deep-space" orbits are extremely difficult to track. Consequently, the number of pieces of debris cataloged with these orbits is very small and probably not representative of the true population.

Update: Cosmos 1317 fragmented between 25 & 28 January 1984, six pieces detected. Cosmos 1355 experienced two other fragmentation events; one on 1 February 1984 and one on 21 February 1984.

### Section III

#### Other Anomalous Event Summary Table

The space events in this section can not be classed as forceful fragmentations. However, small amounts of debris listed under "NSSC Debris Number" have been left in space due to unplanned events and the causes for most are unknown. Of particular interest are those old US payloads that spawn pieces at irregular intervals.

ANOMALOUS EVENTS

INTERNATIONAL DESIGNATOR	COMMON NAME	NSSC CATALOG NUMBER	LAUNCH DATE	INCL (°)	APOGEE (KM)	PERIGEE (KM)	PARENT SATELLITE ORBIT		EVENT	NSSC DEBRIS NUMBER	REMARKS
							AT DATE OF EVENT	DATE			
1964-014	WESTFORD NEEDLES	574	9 May	87.3	3694	3597		9 May 63	See Remarks		101 debris pieces cataloged, deployed as part of launch sequence but not expected
1964-26	OPS 4412	801	4 Jun	90.5	847	930		19 Dec 80		12142	Decayed 25 Oct 81
1965-16	GREB-6	1271	9 Mar	90.5	844	923		2 Jul 82		13360	
1965-27	SNAPSHOT	1314	3 Apr	70.1	1318	1273		26 Nov 80		12099	
				90.3	1319	1272		Late Nov 79		11631	Payload contains SNAP nuclear power supply
				90.3	1316	1272		6 Dec 80		12102	
				90.3	1319	1272		23 Aug 81		13131	
				90.3	1320	1271		19 Mar 83		14047	
								19 Mar 83		14048	
								19 Mar 83		14049	
				90.3	1320	1271		Late Aug 83		14715	
								Late Aug 83		14716	
								Late Aug 83		85577*	
								Late Aug 83		85632*	
1965-48	# TRANSIT 5B-6	1420	24 Jun	90.3	1320	1271		Late Nov 83		14717	
				89.9	1135	1025		22 Aug 80		11952	
				89.9	1135	1025		24 Aug 80		11953	
				89.9	1132	1021		Jun 81		12516	
								Jun 81		12582	
1966-05	OPS 1953	1952	28 Jan	89.8	1205	857		13 Aug 80		11990	Decayed 11 Jan 83
				89.8	1202	860		17 Sep 80		11991	
				89.7	1154	820		Jul 83		14226	Spawned from debris 11991

ORIGINAL SOURCE OF POOR QUALITY

ANOMALOUS EVENTS

INTERNATIONAL DESIGNATOR	COMMON NAME	NSSC CATALOG NUMBER	LAUNCH DATE	PARENT SATELLITE ORBIT AT DATE OF EVENT			EVENT		REMARKS
				INCL (°)	APOGEE (KM)	PERIGEE (KM)	DATE	NSSC DEBRIS NUMBER	
1966-24	OPS 1117	2119	26 Mar	89.9	1114	888	5 Jul 81	12856	
1967-92	OPS 4947	2965	25 Sep	89.3	1110	1036	Late Apr 81	12554	
1974-89	Debris (NOAA)	8138	15 Nov	101.6	1323	1135	Late Apr 81	12555	
1978-64	SEASAT 1	10967	27 Jun	108.0	782	780	17 Sep 81	13130	Radar cross section of parent $.3m^2$ ; 6 pieces noted; Only one cataloged
1978-98	CAMEO	11081	24 Oct	99.3	954	937	18 Jul 83	14244	Noticed on 18 Jul 83. Separation rate 16-17 seconds per day
1984-11	WESTAR 6	14688	3 Feb	27.7	457	303	6 May 81	88503**	The two pieces came off 11081 5 hours apart
							6 May 81	88504**	Decay rate extremely high on both pieces
							3 Feb 84	14698	Debris caused by PAM engine failure
								14765	
								thru	
								14773	

\*Satellites pending cataloging as of 1 Jan 84.  
 \*\*Satellites decayed before formally cataloged.  
 †Previously designated "OSCAR 4"

ORIGINAL PAGE IS  
OF POOR QUALITY