NASA TECHNICAL MEMORANDUM NASA TM-75547

FAST PROCESSING OF DATA FROM SNEG-2MP EXPERIMENT

I.I. Dumer, G.I. Zabiyakin, A.V. Kuznetsov,
V.A. Krylov, A.N. Lutoshkin, O.A. Magarshak,
L.V. Onishchenko, V.M. Ol'khov, G.L. Pakhomov,
S.N. Rykovanov, Yu.S. Svirskiy, E.R. Cherkesova
and I.V. Estulin

Translation of "Ekspress-Obrabotka Informatsii
Eksperimenta Sneg-2MP",
Academy of Sciences USSR, Institute of
Space Research, Moscow, Report Pr-
391, 1978, pp. 1-15.

(NASA-TM-75547) FAST PROCESSING OF DATA
FROM SNEG-2MP EXPERIMENT (National
Aeronautics and Space Administration) 15 p
HC A02/MF A01 CSCL 05B

N78-32730
Unclas
G3/60 31631

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 SEPTEMBER 1978

STANDARD TITLE PAGE

1. Report No NASA TM-75547	2 Government Accession No.	3 Recipient's Catalog No
4. Title and Subtitle FAST PROCESSING OF DATA FROM SNEG-2MP EXPERIMENT		5. Report Date September 1978
		6. Performing Organization Code
7 Author(s) I.I. Dumer, G.I. Zabiyakin, et al. USSR Academy of Sciences, Institute of Space Research		8. Performing Organization Report No
		10 Work Unit No
9 Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063		11 Contract or Grant No. NASW-3199
		13. Type of Report and Period Covered Translation
12 Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C. 20546		14 Sponsoring Agency Code
15 Supplementary Notes Translation of "Ekspress-Obrabotka Informatsii Eksperimenta Sneg-2MP", Academy of Sciences USSR, Institute of Space Research, Moscow, Report Pr-391, 1978, pp. 1-15.		

16. Abstract

The following subjects are covered: basic stages during computer processing of data from "Sneg-2MP" instrument, basic modes during separation and fast processing (separation of data during satellite flight, separation of "burst" data segments, sampling and analysis of initial "burst" data segment). Experimental results obtained on the basis of fast processed data are reported.

17. Key Words (Selected by Author(s))		18. Distribution Statement Unclassified-Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

FAST PROCESSING OF DATA FROM SNEG-2MP EXPERIMENT

I.I. Dumer, G.I. Zabiyakin, A.V. Kuznetsov,
V.A. Krylov, A.N. Lutoshkin, O.A. Magarshak,
L.V. Onishchenko, V.M. Ol'khov, G.L. Pakhomov,
S.N. Rykovanov, Yu.S. Svirskiy, E.R. Cherkesova
and I.V. Estulin
USSR Academy of Sciences Institute of Space Research

The search experiment for gamma radiation bursts carried out aboard the "Prognoz-6" artificial satellite involved a fast processing stage during which data received from aboard the spacecraft were processed in the Data Processing Center of the Institute of Space Research of the USSR Academy of Sciences. The objective of this processing was to verify the operation of equipment aboard the satellite, including an evaluation of the operation of the instruments in the Earth's radiation belts and an analysis of data about the recorded events (bursts). /2*

The data for fast processing were separated from the entire data file arriving from aboard the satellite at the ground reception point and transmitted over the telephone channel to the USSR Institute of Space Research the received data were processed both during reception and after they were recorded on M-6000 computer magnetic tape. An elaborated method for displaying telemetered data on a graphic display screen was used.

The following subjects are covered: basic stages during computer processing of data from "Sneg-2MP" instrument, basic modes during separation and fast processing (separation of data during satellite flight, separation of "burst" data segments, sampling and analysis of initial "burst" data segment). Experimental results obtained on the basis of fast processed data are reported.

The search experiment for gamma radiation bursts carried out aboard the "Prognoz-6" aritificial satellite using the /3

*Numbers in the margin indicate pagination in the foreign text.

French "Sneg-2MP"[1] instrument involved a fast data processing stage during which data received from aboard the spacecraft were processed in the Data Processing Center of the Institute of Space Research of the USSR Academy of Sciences. The objective of the processing was to verify the operation of equipment on board, including an evaluation of the operation of the instrument in Earth's radiation belts and an analysis of data about the recorded events (bursts). An overall evaluation of the course of the experiment and of the data received from the spacecraft was made on the basis of fast processing, which allowed the subsequent carrying out of full systematic data processing and the workingout, on the basis of real data, the processing method immediately concurrently with the beginning of the experiment.

Control of the space experiment based on the results of fast processing was an especially important factor in regard to method. Although no provisions wer made in the "Sneg-2MP" instrument for direct control of its operational modes from Earth, nonetheless control actions based on the results of fast processing of scientific data were applied during the space experiment.

1. Separation of Data for Fast Processing and Processing During Reception Over Communication Channel /4

Data for fast processing were separated from the entire data file arriving from aboard the spacecraft at the ground reception point and transmitted over the telephone channel to the Institute of Space Research of the USSR Academy of Sciences for processing (Fig. 1). The data were separated on

[1] M. Niel, K. Hurley, G. Vedrenne, I.V. Esthulin, A.S. Melioransky. Astrophys. Space Sci. 42, 99 1976.

the basis of formal criteria, for example the number of the telemetering channel, the satellite-flight time interval and also activation of the "burst" element in one of the three detectors in the "Sneg-2MP" instrument. The volume of separated data was limited by the time required for its transmission over the telephone channel to the Institute of Space Research. The data transmission rate over the channel was relatively low--1200 band. The time available to us for data transmission did not exceed 1.5-2 hours. Because of this only a part of the channels assigned to scientific instruments aboard the satellite were sampled for fast processing. The "Sneg-2MP" instrument occupied a privileged position in the entire arrangement; data from all nine channels of this instrument were transmitted to the Institute of Space Research for fast processing. Besides instrument data, a series of auxiliary parameters used in processing scientific data was also transmitted (0 and 100 per cent of the telemetry scale, time on board, orientation data, reception time at station, etc.).

The telephone channel over which the data were transmitted to the Institute of Space Research was interfaced with an M-6000 electronic computer which was used as a communications computer and also as the fast data processing computer. Received data were processed immediately during reception over the telephone channel and after they were recorded on magnetic tape they were structured so as to ensure reliability of received data without subsequent repeated transmissions of these /5 data.

Data processing during reception over the communication channel included monitoring the structure of telemetered data and an evaluation of certain characteristic instrument parameters. Data arriving at the Institute of Space Research preserved the telemetry structure aboard the satellite, i.e. data were arriving according to the switching sequence aboard the satellite (the operational cycle of the switch was retained). Machine verification of this structure as well as verification of the structure of data files transmitted over the telephone channel ensured correct sampling of telemetered data for fast processing which was executed at the reception point. It also confirmed the correct operation of the entire system for the transmission of data to the Institute of Space Research, including the proper operation of the telephone communication channel and communication computers. Received data were interpreted simultaneously with verification of their structure. Characteristic parameters of telemetered data were processed, and the results were printed on a numeric printer and displayed on a screen.

The newly elaborated method of scanning telemetered data on a display turned out to be very effective. The method, named "running parameter", involved displaying several telemetered parameters in the form of continuously moving graphs on the screen of a display. Display on the screen of values from channels over which 0 and 100 per cent of the telemetry scale was transmitted provided a clear idea about the stability or malfunction of these reference telemetering parameters. The operational modes of the three detectors in the "Sneg-2MP" instrument (1L, 2L, S) were also checked on the basis of values from three telemetering channels displayed on the screen of a display. Inferences could be made about the character of events giving rise to malfunctions of "burst" elements of the instrument, which in a number of cases considerably reduced subsequent processing of received data pertaining to "false bursts."

A photograph of the secreen of the display (Fig. 2) provides an idea about the capabilities of the display method. /6

Along with telemetered data, auxiliary data were also displayed on the screen (serial number of displayed data frame, recording time at station, number of communication session, number of record on magnetic tape where data displayed on the screen were recorded etc.), which allowed the assigning of telemetered data to the station time and number of record on magnetic tape in which the data were recorded.

2. Verification and Processing of Received Data

All data received over the telephone channel were recorded on M-6000 magnetic tape. The basic operational mode was a mode which ensured the verification of received data described above, a restoration of the telemetry structure of data after their transmission over the telephone channel (data frame structure aboard satellite) and recording of data processed in this manner on computer magnetic tape (tape 2, Fig. 1).

The data received over the telephone channel, which were not processed, were recorded simultaneously on another tape (No. 1). In the latter case, only the correct operation of the reception-transmission equipment and telephone channel was verified. After reception was completed, the data on the /7 magnetic tape No. 1 could be converted to the format of magnetic tape No. 2.

The received data recorded on magnetic tape could again be scanned on the screen of a display at various scanning rates which allowed an improved accuracy of individual details, selection segments for subsequent processing and printing out selected data records. The program controlling the image on the screen of the display could be adjusted from the keyboard (selection of parameters, scale, identifiers, etc.).

To analyze telemetering channel malfunctions during transmission of data from aboard the satellite and malfunctions arising while recording these data on Earth, in particular on magnetic tape of the telemetry storage device (TS), the received data were analyzed statistically. The distribution of values was determined over each telemetering channel. A histogram of these values (telemetry scale 512 values) provided a clear idea about the character of malfunctions and allowed the location of the sources of errors in most cases (aboard satellite, telemetry, recording apparatus on Earth, etc.).

The above-mentioned stages involving reception and verification of telemetered scientific data controlled to a sufficient degree individual components of the complex space experiment, and allowed an operational evaluation of the course of this experiment, the operation of recording apparaus mounted aboard and on the ground, etc. The final fast processing stage, confirming the objective of the experiment, could only be sufficiently complete processing of instrument readings. For this purpose, some of the received data were processed on the computer taking into account the operational logic of the instrument aboard the satellite.

The "Sneg-2MP" instrument had a 16-position interval switch, as a result of which all data received from aboard the satellite had a cyclic character requiring preliminary segmentation by switching cycles (for all nine telemetering channels of the "Sneg-2MP" instrument) and also control of this cyclic character, which in case of a malfunction could result in loss of data from an entire cycle.

Segmentation of data into cycles, control of these cycles, and also decoding of data received over a special channel transmitting the time aboard the satellite was executed by a /8 separate program, providing as the resulting output a reference table (operational record of instrument), characterizing the operational modes of the instrument (burst in detector 2 or 1, recording of data from memory M9, M8, M7 or M1 of "Sneg-2MP" instrument in memory device aboard satellite), the time at which bursts were recorded, the time scale aboard the satellite and also the reliability of the cyclic data structure (Fig. 3).

This type of fast processing of "Sneg-2MP" instrument data together with certain auxiliary prameters (time aboard satellite, 0 and 100 per cent telemetry scale parameters) turned out to be extremely useful not only in evaluating the course of the experiment, but also in an analysis of unforeseen operational modes of instrumentation aboard the satellite and ground recording apparatus.

The concluding stage of the analysis of results was the processing of routine and burst mode "Sneg-2MP" instrument data. Telemetering channel data calibrated according to instrument reference levels were merged into instrument values, and separate algorithms were used to form files of "burst" and routine mode data during the operation of the instrument. The results were printed out in the form of tables.

The described fast processing method allowed the characterization of received telemetered data both during reception and after they were recorded on computer magnetic tape. Practically all mentioned modes were used in the fast processing of "Sneg-2MP" data.

3. Experiment, Fast Processing, Control /9

Data recorded by the "Sneg-2MP" instrument during its 26-hour operation were separated and transmitted to the

Institute of Space Research immediately after the satellite was launched into orbit and the instrument was switched on. Some of this time the satellite was located in the Earth's radiation belts. Fast processing allowed a conclusion to be drawn about the proper operation of the instrument as a whole and its behavior in radiation belts within 24 hours after the data were transmitted to Earth.

The "Sneg-2MP" instrument provided unreliable data in radiation belts. Under great loads along the input, the recording apparatus was overloaded. The amplitude of the output signal varied within 10 per cent limits at individual instants. During passage of the satellite near Earth (at a distance less than 60,000 km), where detector readings fluctuate considerably, the burst elements were actuated several times by charged particles. This switched the instrument over to the burst recording mode when in reality a false burst was being recorded. A decision was made not to separate henceforth data recorded in radiation belts for fast processing.

The conclusion was drawn on the basis of the results of fast processing that the "Sneg-2MP" and RGS instruments functioned correctly while operating jointly as envisaged by the flight program.

Subsequent fast processing of experimental data was directed toward a search of data segments in which activation of a "burst" element occurred. The "burst" segment data were separated from the entire recorded data file and transmitted to the Institute of Space Research for processing. There the /10 data were processed using the method described above. The somewhat larger than expected number of activations of "burst" elements in the "Sneg-2MP" instrument in one orbital revolution period (from 4 to 10 activations in 3 detectors) subsequently forced us to modify somewhat fast data processing management so as to reduce the volume of data and the transmission time to the Institute of Space Research. It turned out that the vast majority of activations of "burst" elements were background activations not carrying information about the "burst". In this connection, only data on the initial portion of a "burst" in a detector were transmitted to the Institute of Space Research and the values corresponding to this instant were transmitted over the remaining channels. The decision whether the "burst" was genuine was made on the basis of the initial portion of data about it (approximately one-fourth of the values in the memory of the detector which recorded the "burst"). "Interesting" events separated in this manner could then be completely transmitted to the Institute of Space Research.

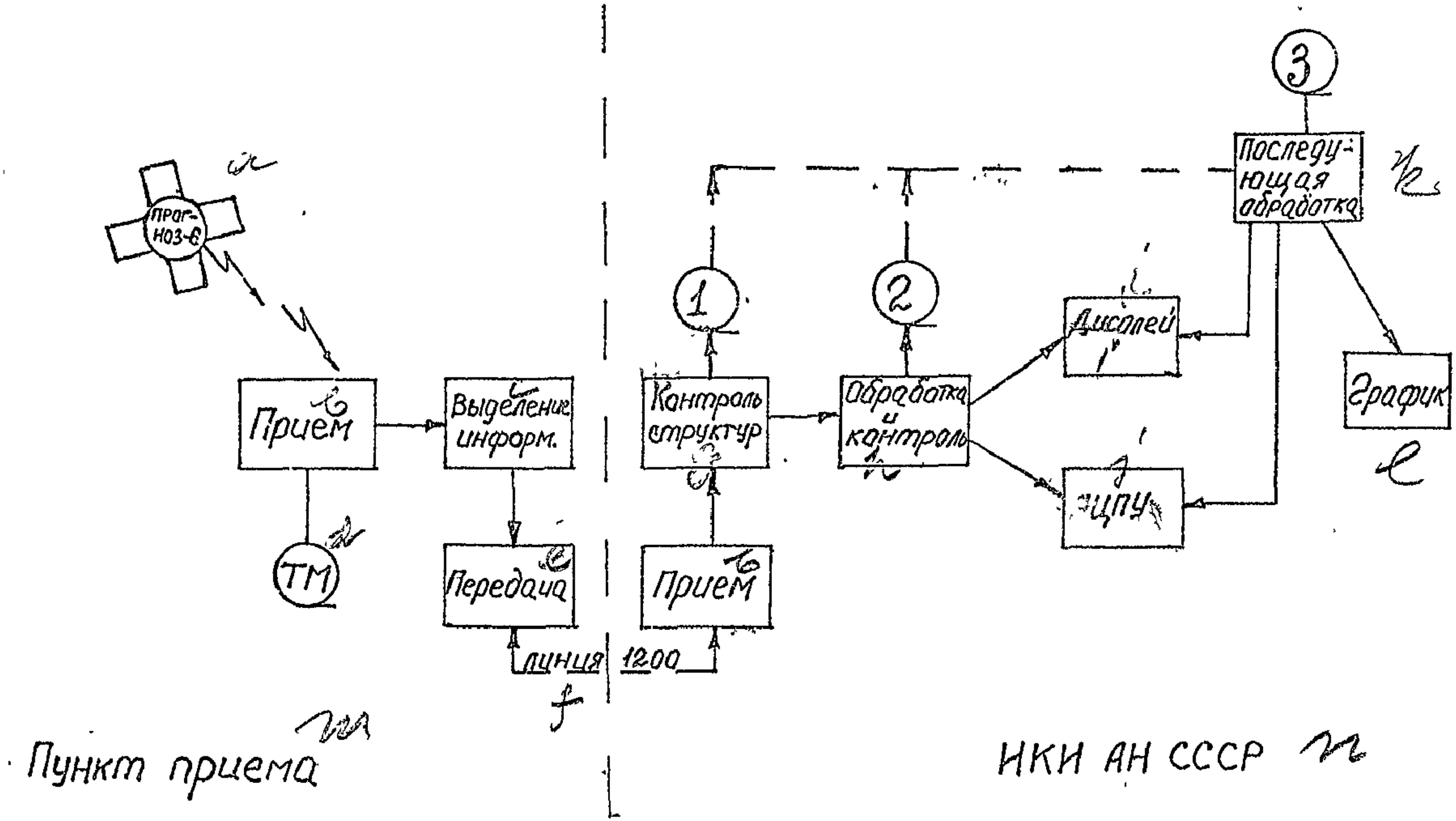
In approximately the one and a half month long flight of the satellite (from the end of September to 12 November 1977), data from 8 orbits were analyzed (duration of each orbit was 4 days). The fast data processing method taking into account real specific features of the experiment was evaluated during the first few orbits. Basic changes were introduced in the fast processing method because of the greater than expected number of activations of the element recording a "burst" in the instrument.

A large number of "background" activations was recorded (on the average 6-8 per orbit). One gamma radiation "burst" was detected which occurred on 10 November 1977 at 20 hours, 14 minutes.

Operational analysis of experimental data from the "Sneg-2MP" instrument allowed us to ascertain a regular shift of the calibration peak in the detector and automatic switching /11 of the apparatus to a higher threshold during sampling of "bursts." A decision was made to switch back the instrument to the original state by means of zeroing. Accordingly, an instruction to turn on the instrument was transmitted to the "Prognoz-6" satellite, and several hours later another instruction to turn it on again was sent.

The described method for fast processing of scientific data from instruments mounted aboard a satellite was also extended with some additions to ther instruments aboard the "Prognoz-6" satellite.

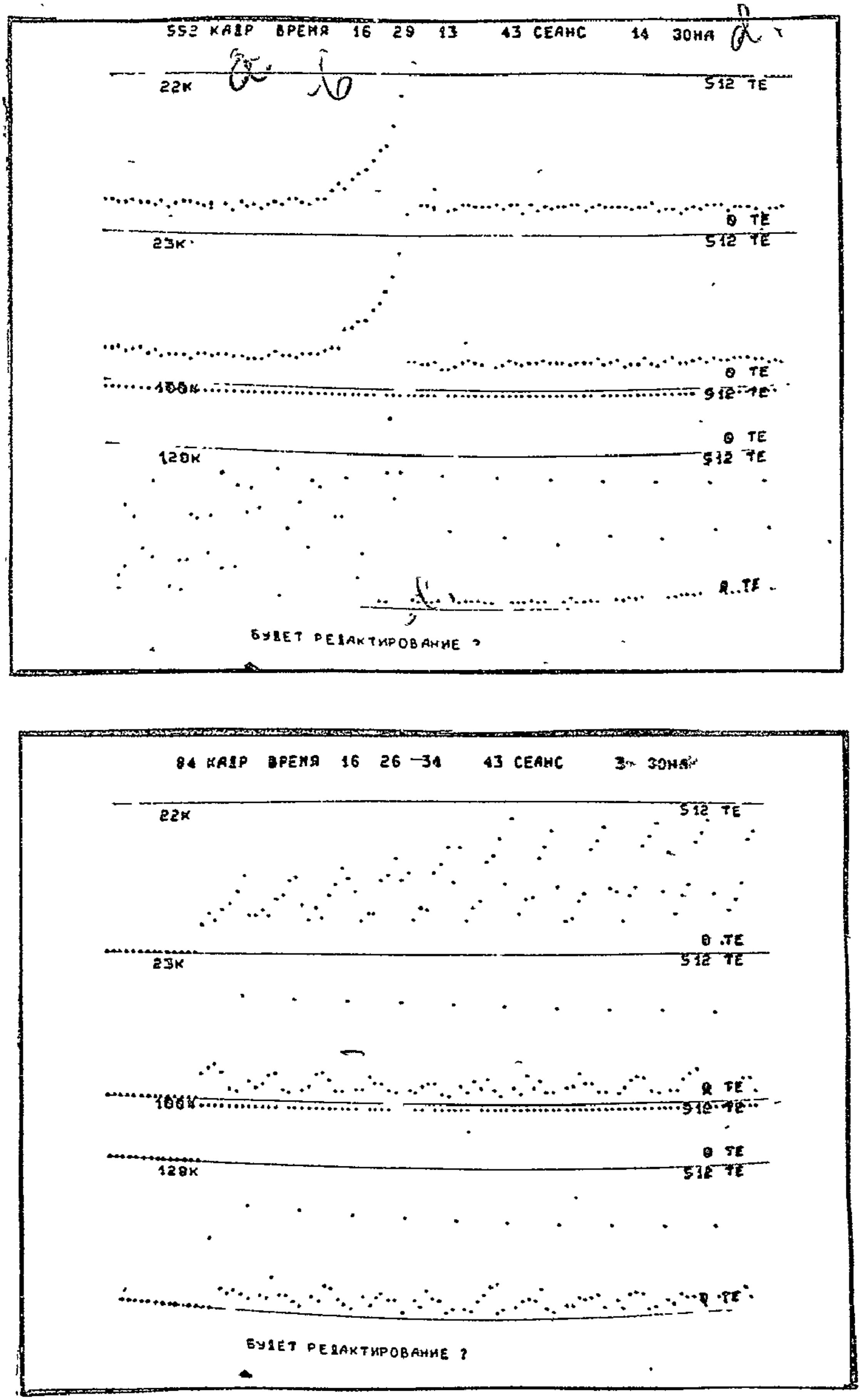
The following programs were used to execute the operations: data transmission programs written earlier for the M-6000 with the participation of L.S. Chesalin and V.I. Borisenko, programs converting codes to M-6000 code developed by Ye.D. Gernet, and display programs developed with the participation of Ye. P. Slobodnikova. V.V. Afanes'yev, A.A. Volkov and Yu.B. Shokin ensured the operation of hardware and equipment.



ORIGINAL PAGE IS OF POOR QUALITY

Fig. 1. Operational block diagram for fast processing of Scientific data from "Prognoz-6" satellite.

Key:
a. "Prognoz'6"
b. Reception
c. Data separation
d. Telemetry storage device
e. Transmission
f. line
g. Verification of structures
h. Processing and control
i. Display
j. Numeric printer
k. Subsequent processing
l. Graph
m. Reception point
n. Institute of Space Research of USSR Academy of Sciences



Key:

a. Frame
b. Time
c. Communication session
d. Record
e. Editing

Fig. 2

```
   30    30  0  0  0  0  0  0  0  0   6.34. 505  6. 5. 510  17. 0. 569   714
   31    31  0  0  0  0  0  0  0  0   6.34. 505  6. 5. 510  14.16. 724   713
**ЗОНА ЦИКЛ  S 21 1L  R M9 M8 M7 M1  ВРЕМЯ_ РГС  ВРЕМЯ_  1L  ВРЕМЯ_ЦИКЛ  НОМЕР
   32    32  0  0  0  0  0  0  0  0   6.34. 505  6. 5. 510  11.32. 878   712
   33    33  0  0  0  0  0  0  0  0   6.34. 505  6. 5. 510   8.49.   8   711
   34    34  0  0  0  0  0  0  0  0   6.34. 505  6. 5. 510   6. 5. 163   710
   35    35  0  0  0  0  0  0  0  0   6.34. 505  6. 5. 510   3.21. 317   709
СБОЙ 118  КАДР= 12  ЦИКЛ=  36
   37    37  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   5.31. 382   218
   38    38  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   2.47. 537   217
NT=3         IT= 140
   39    39  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  17. 3. 691   216
   40    40  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  14.19. 846   215
   41    41  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  11.35.1000   214
   42    42  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   8.52. 131   213
   43    43  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   6. 8. 285   212
   44    44  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   3.24. 440   211
                  ВРЕМЯ= 63 11.50. 841     ЦИКЛ=  44     КАДР=  518
   45    45  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  16.40. 594   210
   46    46  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  13.56. 749   209
   47    47  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  11.12. 903   208
**ЗОНА ЦИКЛ  S 21 1L  R M9 M8 M7 M1  ВРЕМЯ_ РГС  ВРЕМЯ_  1L  ВРЕМЯ_ЦИКЛ  НОМЕР
   48    48  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   8.29.  34   207
   49    49  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   5.45. 188   206
   50    50  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510   3. 1. 343   205
                  ВРЕМЯ= 62 55.27. 744     ЦИКЛ=  50     КАДР=  614
   51    51  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  16.17. 497   204
   52    52  0  1  0  0  1  0  0  0   6.34. 505  6. 5. 510  13.33. 652   203
   53    53  0  1  0  0  0  0  0  0   6.34. 505  6. 5. 510  10.49. 806   202
```

Fig. 3

Key:
a. Record
b. Cycle
c. Malfunction
d. Frame
e. Time
f. Number