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COMMISSION OF THE EUROPEAN COMMUNITIES

THE CBNM SATELLITE COMPUTER SYSTEM

Part I : The multiparameter system
user handbook

by

F. COLLING

1974

Joint Nuclear Research Centre
Geel Establishment - Belgium

Central Bureau for Nuclear Measurements - CBNM

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A p r i l 1974

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The numerous possibilities of the OFF-LINE system including up to 30 different routines are described in full detail. All routines can be called by a two-letter code. The OFF-LINE system is almost completely stored on the disk of the central computer and parts of the system are loaded automatically in an overlay area when needed by the user.

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KEYWORDS

IBM COMPUTERS
ON-LINE SYSTEMS
MEMORY DEVICES
ELECTRONIC EQUIPMENT
EFFICIENCY
COMPUTER CODES

Contents

1. INTRODUCTION

The integrated data processing system (Fig. 1) of the Central Bureau for Nuclear Measurements (CBNM) has mainly been installed for neutron cross section measurements at a 90 MeV electron linear accelerator and a 3 MV Van de Graaff.
The system is based on an IBM 1800 computer (64K, 2 μs cycle time, 4 disk drives, 3 magnetic tapes and floating point adapter) to which eleven data acquisition stations are connected by special interface units. Seven of these stations are equipped with multichannel analyser systems which are connected with the appropriate measuring facilities for the different types of experiments (scattering, capture gamma rays, capture, sigma total, fission, radioisotopes).
Four satellite computer systems are planned, one system is operational (GA-1) and the three others are being installed.
This report describes the running installation GA-1 equipped with the MULTIPARAMETER ON-LINE system. Excepted for the ON-LINE system, the basic software will be more or less the same for all satellite computer systems. (Display of data, transfer of data and programs, set of general utilities etc.).

- GA-1 is designed for monitoring up to four two parameter experiments at a time.
- GA-2 is intended to extend the sigma total measuring station.
- GA-3 is planned for monitoring the data acquisition of up to 16 different measurements on radioisotopes.
- GA-4 will be used for automatic control of an UF-6 spectrometer.

The memory capacities of the measuring stations are in principle only used as primary data buffers. The spectra are stored automatically or on manual request into large disk files at the central computer, which are used later on for interactive data reduction and numerical analysis with respect to interesting physical parameters.
The analysis of the experimental data is done in two steps: simple calculations are performed ON-LINE on the IBM 1800 by automatic requests from the interface units or by interface user intervention (interactive method). Complicated analysis problems are solved OFF-LINE on the IBM 1800 and on an IBM 370/165 at Ispra (Italy) by means of a teleprocessing system (1000 km).

The aim of this report is to present the main features of the CBNM satellite computer system and its multiparameter data acquisition possibilities. It contains all, we hope, information that enables the user to work with the satellite system. A second report describing the main system programs is intended for those who are interested in the internal structure and philosophy of the system.

The different sections to be treated are:
- the main reasons why a satellite system was chosen,
- the satellite computer system in general,
- the five data acquisition programs,
- the data storage area and its display facilities,
- the OFF-LINE facilities.

Programs supporting other features of the CBNM integrated data processing system, such as the analyser station servicing programs, the disk file management programs, off-line data reduction and analysis, are reported elsewhere (2), (4), (5), (6), (10).

2. THE MAIN REASONS WHY

When it was thought to extend and improve the measuring facilities at the linear accelerator by means of an on-line computer, the principle decision whether to install a stand-alone or a satellite system had to be taken. When we have chosen the second solution it was mainly due to the following reasons:

1. The large spectra files on the disk of the IBM 1800 computer were shared by 4 measuring stations and 3 other facilities were being installed:
   The computer should have a link with the central computer.
   The memory capacity of the station should be used as a primary data buffer in such a way that too many data transfers to the central computer are avoided.

2. The access to the spectra stored on disk had been strongly developped; routines to print, punch, plot, transfer to tape and read from tape or cards the spectra were available as well as the conversion routines into FORTRAN format:
   The basic format of the spectra should not be modified.

3. An opportunity offered to us was the existence of a small computer (GA 18/30) which granted full ASSEMBLER language compatibility with the IBM 1800 computer.

4. Certain peripherals such as disk, magnetic tape, card punch or line printer are expensive compared to a processor and should be avoided:
   This condition was fully accomplished because our satellite system can take profit of the peripherals of the central computer.
   Supplementary advantages of the satellite system are:

5. The disk capacity of the central computer is not only used for storage of spectra but also for the storage of programs. Thus the greatest part of the OFF-LINE MONITOR of the satellite system is stored on disk and parts of it are loaded upon call.

6. The programs can be assembled and listed on the IBM 1800 and the work with paper tape reader and punch can be avoided on the satellite. (Those who have already tried to assemble and list with paper tape and TELETYPE know what this means).

7. An absolute binary object deck punched on the central computer is directly executable in the satellite computer (which of course needs a card reader).

8. The card reader is indispensable only during the program debugging period, because even the initial load of the entire system can be effectuated from the disk of the central computer:
   The only needed peripherals for running the satellite system are a TELETYPE and a small DISPLAY to visualize the spectra.

Finally we had to convince the physicists that a specialized ON-LINE system based on a small computer without disk, tape or line-printer can only have a primitive standard OFF-LINE system. Therefore FORTRAN programs should be compiled on a computer with a convenient operating system and the corresponding peripherals i.e. on the central IBM 1800 computer.

3. THE SATELLITE COMPUTER SYSTEM

The satellite computer operating system is in principle the same for the 4 processors except that the ON-LINE MONITOR varies greatly in size according to the type of application and that the OVERFLOW AREA is only needed for multiparameter data acquisition (4.2.2.).
The memory lay-out given in Fig. 2 corresponds to the multi-parameter application to be described.

3.1. The Fixed Core

The fixed core is used for communication between the different programs of the system and contains all user introduced experiment parameters.

3.2. The Buffers

Where fast data input or output is required, a DATA CHANNEL is used. A DATA CHANNEL is a hardware facility to read in or out data at a rate determined by the external device without disturbing the current calculations of the computer. The computer cycles needed for data input or output are "stealed" delaying only slightly the execution of the current program. The data are always fed to or taken from a buffer. The end of data transmission is normally signified to the computer by an INTERRUPT . Only at this moment the computer can intervene, empty or fill the buffer and initialize the DATA CHANNEL again.

3.3. The Off-Line Monitor and Overlay Area

The control of the system is effectuated by the OFF-LINE MONITOR. The ON-LINE MONITOR, the DISPLAY and the TRANSFER MONITORS run only on interrupt request. The user is offered a set of utility programs (Section 6.) which are called into execution by selecting a two letter operation code (OP-CODE) on the TELETYPE. Most of these utilities are normally not core resident, they are stored on the disk of the central computer.
The OFF-LINE MONITOR loads the utility program which can perform the asked function into the OFF-LINE OVERLAY area (Fig. 2) and prints the day-time and the word "LOADED". The user should not get alarmed when the message of the computer is not delivered immediately after the introduction of the OPCODE, the central computer can be busy servicing requests from other stations. The time needed normally by the satellite computer to load a core load from disk is about 4 seconds.

3.4. The On-Line Monitor

The MULTIPARAMETER ON-LINE MONITOR controls the acquisition, reduction and storage of incoming digitized data originating from different experiments at the 90 MeV linear electron accelerator of the CBNM. The system is able to provide storage capacity for up to four users simultaneously. Each of the users can chose among five different routines to sort and merge data (section 4.). The absolute maximum number of experiment channels in the 16K STORAGE area is 128K (channels). The reserved count capacity per channel varies greatly according to the type of STORE-MODE and the effective upper limit is $65535(2^{16}-1)$.
The ON-LINE MONITOR assures automatic access to the disk files of the central computer in case the counting capacity in the satellite computer is exhausted.

3.5. The Transfer Monitor

The TRANSFER MONITOR supervises the transfer of spectra and programs to and from the host computer. The two computers exchange data in blocks of 170 words via a fast data link (DATA CHANNEL) and communicate with each other by means of two DEVICE STATUS WORDS. Before and after a data block each computer reads the STATUS of the other. The satellite computer always starts the operation by sending an interrupt request which is followed by one data block containing all information concerning the details of the transfer. (Direction, type of data, number of blocks...). Only the main computer can change the direction of the transfer, both computers can abort at any time the response. At the end of each transfer operation a message is printed out on the satellite computer user TELETYPE and on the typewriter reserved for "interface" messages at the central computer. Transmission errors are avoided by checking data before and after transmission and effectuating up to three trials with the same block in case of errors.

3.6. The Display Monitor

The DISPLAY MONITOR assures the updating of the IMAGE buffer according to the positions of the thumbwheel switches on the IMAGE CONDITIONS board (Fig. 5). The DISPLAY MONITOR allows the visualization of data stored either in TRUE or CODED form in any part of the USER AREA.

3.7. The System Engineer Area

An area which lies in the user field can be occupied by a program especially tailored for debugging. The SYSTEM ENGINEER CORE LOAD includes hexadecimal print and modify of memory words or zones and ON- and OFF-LINE traps (1). It is further possible

to delete an OFF-LINE OVERLAY program on disk and to replace it by the one loaded in the OFF-LINE OVERLAY AREA in memory. ATTENTION: The upper 1.2K of the USER AREA will be destroyed when this program is loaded; it is up to the user to save his data on disk.

4. THE DATA ACQUISITION SOFTWARE

For ON-LINE data acquisition, each user can chose among five different STORE MODES (Fig. 3). The choice will be determined by the type of experiment to be performed and by the Number of Experiment Channels (NECH).

4.1. Single Parameter Experiments

The STORE MODE-0 stands for a single parameter store program. The minimum number of channels is 256 or one BLOCK and can be increased in steps of one BLOCK up to 4096 channels (16 BLOCKS). The data are sorted and merged in an ON-LINE DISPLAY area and the maximum count capacity per channel is 65535. (1 channel = 1 memory word). If more capacity is needed the user can accumulate in AUTOMATIC (6. 5. 4.) i. e. as soon as the full count capacity of one channel of the spectrum is reached, the ON-LINE MONITOR adds the spectrum into a previously reserved disk space of the host computer, erases the spectrum in the memory and continues the measurement.

4.2. Two Parameter Experiments

For two parameter experiments (STORE MODE 1-4) the number of needed channels is given by the Number of CHannels of the first Parameter (NCHP1) times the Number of CHannels of the second Parameter (NCHP2)

$$NECH = NCHP1 * NCHP2$$

4.2.1. Normal Storage (STORE MODE-3, 4)

In case the number of needed channels (NECH) is smaller or equal to 4096 the data will be sorted into a normal ON-LINE DISPLAY area. (1 CHANNEL = 1 MEMORY WORD).
The minimum number of channels of the first parameter is 16 (4 BITS) and can be increased up to 256 (8 BITS) by multiplication of two (BIT BY BIT INCREASE).

- SMALL TWO PARAMETER (STORE MODE-4)
  Each channel of the second parameter is registered (TRUE or NORMAL two parameter) . To each channel of the second parameter corresponds a full size spectrum of the first parameter.
  SNECH = NCHP1 *NCHP2
- CONDITIONED MEDIUM TWO PARAMETER (STORE MODE-3)
  The second parameter is reduced to few channels by selection of regions of interest or WINDOWS (NWP2) and to each window corresponds a full size spectrum of the first parameter.
  SNECH = NCHP1 *NWP2

4.2.2. Coded Storage (STORE MODE-1, 2)

In case the Stored Number of Experimental CHannels (SNECH) exceeds 4096 i.e. in a conditioned large or medium two parameter experiment, a special store procedure (CODED STORAGE) provides a "virtual" STORAGE area which can contain up to 8 times as many channels as there are memory locations at the disposal of the user. This feature allows to monitor two parameter experiments (conditioned or not) of up to 64K channels in an 8K memory area.
For this purpose each computer word is splitting up into several channels with a reduced count capacity (CODED STORAGE). An intrinsic system of dynamically allocatable overflow zones allows to extend locally the count capacity up to 65535. If all overflow capacity of the system is exhausted, a transfer of the "overflowing" spectra to the disk files of the central computer is effectuated automatically, all transferred zones erased and the data input continued.

It would not have been realistic to choose the same count capacity per channel (i.e. number of channels per word) neither for all spectra nor for the whole range of each single spectrum. Provisions have been made to match the integral count rate within each quarter of each spectrum of the first parameter (CODED INTEGRAL FACTOR) and to provide overflow count capacity (CODED OVERFLOW FACTOR) according to the combined count rate of both parameters in this region. (For a detailed description it is referred to the second part of the report). (1)

A certain number of internal machine parameters have therefore to be set up before the start of the experiment. These parameters can either be introduced manually or can be calculated by the computer if the shape of both spectra and the window boundaries (STORE MODE-1 only) are at the computers disposal. The user should therefore make a TEST-RUN on both parameters and accumulate them as two independent single parameters into two ON-LINE display areas. In case the user disposes already of TEST spectra from previous runs on disk, he can load these spectra in two OFF-LINE display areas (6.4.2.). For a conditioned large two parameter type experiment the user has to set up the window boundaries of its regions of interest of the second parameter after the TEST-RUN. The STORAGE OPTIMIZATION program (6.2.6.) calculates the optimal machine factors based on the spectra of the TEST-RUN, the number of regions of interest and the user available memory space.
Fig. 4 tries to illustrate a typical two parameter experiment (STORE MODE-1). The CIDF of each quarter of each WINDOW SPECTRUM are computed in accordance to the relative weight factors within each quarter times the relative weight per window of the TEST-RUN. The weight factors per quarter is the mean count capacity per channel in the quarter (first parameter). The weight factor in the window is the mean count capacity per channel within the window boundaries (second parameter).

- CONDITIONED LARGE TWO PARAMETER (STORE MODE-1)

The smallest range for the first parameter is 256 channels and through BLOCK BY BLOCK increase extendable to 4096. The second parameter is only limited towards the upper end (4096 channels). The user can select up to 31 regions of interest or WINDOWS defined each by a lower channel (LCH) and an upper channel (UCH) within the range of the second parameter. To each WINDOW corresponds a full range first parameter spectrum (WINDOW SPECTRUM) (Fig. 4). Each WINDOW SPECTRUM is saved with a different identification number (ID. NR) on the disk.

- MEDIUM TWO-PARAMETER (STORE MODE-2)

Each channel of each parameter is stored. The different full range spectra of the first parameter are stored sequentially, the serial number is given by the channel number of the second parameter. The spectra are stored in groups of 4096 channels as a WINDOW SPECTRUM under the same identification number on the disk of the central computer . The OPTIMIZATION of the STORAGE OCCUPATION can also be effectuated upon request. The programs have been made in such a way that an experiment cannot be started if the system does not dispose of all parameters needed for the chosen STORE MODE.

4.3. Three Parameter Experiments

It is possible to make real or conditioned three parameter experiments with the STORE MODES 1 and 2 under special circumstances. The first and the third parameter are given a new combined address formed in the following way

COMBINED ADDRESS (P1) = ADDRESS(P3)*NCHP1+ADDRESS(P1)

When the experiment conditions are selected (OPCODE-IE) the user has to set up the range (NCHP1) of the first parameter to the value of the maximum combined channel no.

COMBINED NCHP1 = NCHP1 *NCHP3

For the second parameter, the user can either impose conditions (STORE MODE -1) or make a real three parameter experiment (STORE MODE -2).

The boundary values for the number of channels per parameter (NCHP) are:

- conditioned three parameter (STORE MODE -1)
  NCHP1* NCHP3 ≤ 4096
  NUWIN* OF P2 ≤ 31
- real three parameter (STORE MODE -2)
  NCHP1 *NCHP3 ≤ 4096
  NCHP1 *NCHP2 *NCHP3 ≤ 65536

The user has to notify with OPCODE-TP (6.2.9) to the ON-LINE MONITOR that a three parameter experiment is to be run.

The two ON-LINE DISPLAY areas reserved during the set-up of the experiment conditions (IE-OPCODE) are valid for the TEST RUN as well as for the STORAGE OPTIMIZATION procedure (6.2.6.).

The sequence and the characterization of the addresses of the three individu. l parameters are described in the ON-LINE HARDWARE section of the second report (1). All addresses which do not fulfil the specifications are rejected without error message during the ON-LINE data acquisition procedure.

4.4. Two Parameter Experiment with Windows on both Parameters

To facilitate the evaluation of the measured data provisions have been made to allow at the same moment the running of two acquisition procedures on the same data. Such a possibility has a sense only for STORE MODES 1 or 3, because for STORE MODES 2 and 4 anyhow all channels of both parameters are processed.

The user (U1) has first to select its experiment conditions (IE-OPCODE) and the correct STORE MODE (1 or 3). Then under another user number (U2) he has to select the experiment conditions which must respect the following rules.

NCHP1(U1) = NCHP2 (U2)
NCHP2(U1) = NCHP1 (U2)

It is possible to select different STORE MODES for both runs. (1-1, 1-3, 3-3, 3-1).
The link between both experiments is established by the OPCODE-BW (6.2.9.). The incoming data must be characterized with the first user number (U1). The ON-LINE MONITOR runs through the experiment conditions of both users during the data acquisition. For the second user the addresses of the two parameters will be interverted.

4.5. Error Messages of the OFF-LINE MONITOR

ERROR	CONDITION	RECOVERY	COMMENT
103	System incomplete for coded storage	Return to LC-OPCODE	You did not clear experim. conditions
104	illegal WINDOW NR	STOP EXPERIMENT IMMEDIATELY AND GO BACK TO IE-OPCODE	Clear always your old experiment conditions
9999	System error	Call System Engineer	Tel.:

5. THE DATA STORAGE AREA AND ITS DISPLAY FACILITIES

The DATA STORAGE are (Fig. 2) of 16K can be shared by up to 4 users simultaneously. The number of users and the size of the areas are defined at system load time (Section 7) and should not be modified during ON-LINE data acquisition. Each user is free, to utilize the STORAGE capacity of his USER AREA in his own way. For instance, the user can reserve part or the entire user field for the acquisition of one or several single parameter spectra of different size, or he can devote if for two parameter data acquisition in one of the four possible STORE MODES (Section 4). Besides such experiment or ON-LINE areas, i.e. areas into which the incoming data from experiments are sorted and merged, the user can define OFF-LINE areas for inspection of data he can load from the disk storage of the host computer.

The DISPLAY MONITOR permits the user to have visual access at any time to the data stored in any portion of each USER AREA. The display IMAGE is preserved in a 256 word buffer and the DISPLAY MONITOR assures about 20 images per second to allow proper inspection. The user can therefore display only one data BLOCK at a time in full detail. A survey of a greater zone is achieved by condensing several channels of one BLOCK into one IMAGE channel and by dividing the obtained channel count by the number of condensed channels i.e. the mean number of counts per channel is visualized.

5.1. Link between Storage Area and Image Buffer

The ON-LINE STORAGE areas are classified into two groups, CODED and TRUE areas and a special decode program (TRANSFER MONITOR) is required to display CODED spectra. The IMAGE updating for CODED spectra requires significantly more time than the updating for normal spectra.

- CODED spectra can be visualized by selecting the appropriate WINDOW on the IMAGE CONDITIONS board (Fig. 5).
- TRUE ON-LINE or OFF-LINE areas are selected on the DISPLAY switch of the IMAGE CONDITIONS. This fact implies that ON- or OFF-LINE NORMAL STORAGE areas are at the same time DISPLAY areas. The number of DISPLAY or NORMAL STORAGE areas is limited to ten shared by all users.

5.2. The Display Parameters

The 10 DISPLAY areas are defined by the following parameters: (6.3.10.)

- USER NO.
  is the number of the user to which this DISPLAY area belongs. One user is not allowed to delete an area of another user.

- PARAM. NO.
  is the number of the parameter (either first or second) for which this ON-LINE DISPLAY area is reserved. For OFF-LINE areas no PARAM. NO has to be defined.
- FIRST B.
  is the first block of the DISPLAY, the lowest possible is 1 and the highest is 16. (1 BLOCK = 256 CHANNELS). For OFF-LINE DISPLAY areas the FIRST B is always assumed to be one.
- N. BLOCK
  defines the number of blocks of the DISPLAY area.

The absolute limits for the TRUE ON-LINE and CODED ON-LINE areas of each user are defined during the INITIALIZE EXPERIMENT (6.2.1.) procedure, where the number of channels per parameters is set up and each ON-LINE area is checked to fall within these limits. The absolute limit of an OFF-LINE area is given by the maximum number of blocks allowed for a spectrum in the system (16 BLOCKS or 4096 channels). This limit is imposed by the disk storage programs of the central computer.

- EXPERIM. OR ON-LINE
  The user defines whether the DISPLAY is to be ON-LINE, i.e. linked to the experiment, or not. OFF-LINE areas are used to receive spectra stored on disk of the host computer.
- THRESHOLD
  An integral THRESHOLD to be subtracted from each channel content of the IMAGE buffer, can be selected on the TELETYPE. Together with the VERTICAL RANGE switch of the IMAGE CONDITIONS the THRESHOLD allows to magnify any count zone of the IMAGE.
- ID. NO.
  is the identification number under which the spectrum will be stored on disk in case the maximum count capacity is exceeded (6.4.5.).

5.3. The Image Conditions

The data limits of the IMAGE are to be selected on the IMAGE CONDITIONS board (Fig. 5). All conditions which do not fall within the previously defined limits (5.2.) are automatically corrected by the DISPLAY MONITOR and set to the boundary values, without ERROR MESSAGE. (IMAGE FORMAT: 10*8 cm)

- DISPLAY
  Selects the appropriate DISPLAY or TRUE STORAGE area within the USER areas (0 - 9).

- WINDOW (1 - 31)
  Selects the WINDOW SPECTRUM (4.2.2.) of the current OFF-LINE user (6.1.1.). In case no CODED spectrum of this user is in memory, the WINDOW setting is ignored, and the first DISPLAY area of this user will be loaded. If no DISPLAY area of this user is available, the first DISPLAY area (0 or DISPLAY) is loaded. In case no DISPLAY area at all is foreseen, the ERROR NR 310 is printed on the TELETYPE.
- FIRST BLOCK and NR. of BLOCKS
  are the first block and the number of blocks to be packed into the IMAGE buffer for 256 channels. Without an ERROR message the system corrects erroneous settings of both switches (5.2.).
- LOWER CHANNEL and UPPER CHANNEL
  Two channel contents can be intensified in the data visualized on the IMAGE by means of these switches. The DISPLAY MONITOR corrects out-of-range channels by intensifying the first or last channel of the IMAGE. In certain OFF-LINE utilities (integration, print out of channel contents and selection of WINDOW boundaries) the user can introduce the lower and upper channels into the computer via LOWER- and UPPER CHANNEL switches by pressing the "SPACE" key on the TELETYPE.
- VERTICAL RANGE
  The VERTICAL RANGE switch delimites the scale for the channel contents in the full range vertical deflection of the IMAGE. The resolution of the digital to analog converter is 10 bits and the 10 switch positions have been defined in the following way:

Vertical Range	Full Scale (No. of counts)	No. of Counts per cm
0	80	10
1	160	20
2	320	40
3	800	100
4	1600	200
5	3200	400
6	8000	1000
7	16000	2000
8	32000	4000
9	80000	10000

VERTICAL RANGE VERSUS FULL-SCALE DEFLECTION.

- THRESHOLD (5.2.)
  The THRESHOLD can be modified by the MT-OPCODE routine.

5.4. Display Examples

Several examples for the DISPLAY capabilities of the DISPLAY MONITOR are given in Fig. 6.

5.4.1. On-Line Coded Spectrum (STORE MODE-1)

The first user occupies 3744 with 6 WINDOW SPECTRA of 4096 each. The spectra are referred to by their WINDOW NO. CODED SPECTRA do not occupy an ON-LINE DISPLAY area, they are decoded by the TRANSFER MONITOR and use the TRANSFER BUFFERS as intermediate buffers before the real final IMAGE is moved into the IMAGE buffer. The illustrative example of the IMAGE conditions of Fig. 5 concern this example.

5.4.2. On-Line (True) Display Spectrum (STORE MODE-0)

This DISPLAY area occupies 256 memory positions and serves as ON-LINE control on the second parameter of the first user (1024 channels). A particularly important zone has been selected. It is to be emphasized that the IMAGE conditions refer to the DISPLAY CONDITIONS (6.3.5.) and NOT to the EXPERIMENT CONDITIONS (6.2.1.).

5.4.3. True Two-Parameter Spectrum (STORE MODE-4)

A 4096 channels area is used to make a small two parameter experiment. In one BLOCK 4 full range spectra of the first parameters are sorted and merged.
The LOWER and UPPER CHANNEL will refer to the current channels of the DISPLAY area and not of a parameter.

5.4.4. Off-Line Spectrum

The second user, with a USER area of 8K, can afford to dispose of another 4K area to load spectra stored on the disks of the main computer. The same user can consecutively control his ON-LINE data acquisition, perform OFF-LINE calculation with a spectrum stored in the OFF-LINE area and make the central computer execute manipulations of data stored on its disks, without stopping the ON-LINE data input stream.

6. THE OP-CODE FACILITIES

The OFF-LINE MONITOR offers to the user a set of utilities to be called into execution by a two letter operation-code (OP-CODE). By means of these utilities the user enters his experiment conditions, reserves and deletes display areas, controls the data acquisition, prints out experimental results or previously introduced parameters, stores and calls spectra on and from disk and effectuates interactive operations with data stored on disk.

The OFF-LINE MONITOR is divided into two parts, a fixed and a variable part at the upper core end (OVERLAY AREA IN FIG. 2). After introduction of the OP-CODE it is checked whether the asked routine is included in the fixed or variable part of the OFF-LINE MONITOR and in the latter case whether the correct variable part is in memory or not. In case the requested OP-CODE is not in core, the needed variable part is automatically fetched from the disk of the host computer, loaded into the OFF-LINE OVERLAY AREA and it is immediately brought into execution. Through this feature the user has practically at his disposal an OFF-LINE MONITOR of (1 + 5* 1,280)K = 7,4K in a memory space of 2.28K.

A survey on all OP-CODES with a short indication of the values to be introduced, the messages printed and comments on the function is given in Fig. 7, 8, 9.
VALID FOR ALL OPCODES.

Any introduced parameter which exceeds the maximum allowed value causes an ERROR NR 600

ERROR	CONDITION	RECOVERY	COMMENTS
600	The introduced value exceeds absolute maximum	See OPCODE description for max. values	Parameter is set to zero.

The maximum number of decimal digits is prescribed for each value to be entered. A SPACE closes the digit string if less digits are introduced. If the maximum number of decimal digits is entered, no SPACE is required. All digits of any value can be renewed by pushing "R" on the keyboard as long as the last allowed digit has not been entered.

If a SPACE is entered as first character the momentary value of the parameter will be printed and no modification caused.

ADDING NEW OPCODE FUNCTIONS
On user request the system engineer can easily either include new OPCODES in an existing variable part or can build a completely new one. The new program is stored on the disk by means of a routine included in the SYSTEM ENGINEER CORE LOAD (1). The number of core loads that can be added is only limited by the size of the file reserved on the disk.

6.1. General Utility OP-CODES

6.1.1. Introduce User No.

OP-CODE: IU
MESSAGE: USER NO SET UP
INTRODUCE: 0 - 3
COMMENT: The USER NO remains the same during all OFF-LINE manipulations and is printed out each time an OP-CODE with user related data is asked. Certain OP-CODES are user protected like deleting of experiment conditions or display areas i.e. one user cannot delete data of another user.

NO ERROR MESSAGE.

6.1.2. Print Free Core

OP-CODE: PC
MESSAGE: USER NO FRE. CORE
PRINT: 0 - 3 0 - 16384
COMMENT: The free core is the part of the USER AREA allotted to this user which is not yet occupied for DISPLAY or CODED STORAGE.

NO ERROR MESSAGE.

6.2. Utilities in Connection with the Experiment

6.2.1. Initialize Experiment

OP-CODE: IE
MESSAGE: USER NO EXPERIM. SET UP
PRINTED: 0 - 3
MESSAGE: USER NO CLEAR EXPERIM.
PRINTED: 0 - 3
INTRODUCE: Y in case of YES, any other character in case of NO.
MESSAGE: NCH. AMP PARAM. N NCH. TOF STORE MD
INTRODUCE: 0-4096 0-1 0-4096 0-4
COMMENTS: It has been defined that the first in time arrived parameter is named TOF (TIME-OF-FLIGHT) and the second arrived is named AMP(AMPLITUDE), which is the case when a neutron capture γ-ray experiment is being monitored. (TOF for the flight time of the neutron and AMP for the energy of the γ-ray).
The multiparameter satellite computer ON-LINE MONITOR can accept two parameters defined in the following way:
PARAMETER-0 is the parameter which is analyzed (P1) channel per channel in ALL STORE MODES.

PARAMETER-1 is either conditioned (STORE MODES 1, 3) or also analyzed channel per channel (STORE MODE 2, 4) or is eliminated or not delivered from the experiment side (STORE MODE-0 single parameter experiment).
(P2)

For THREE PARAMETER experiments the ON-LINE MONITOR combines two of the three parameter addresses in the following way: (see also 4.3.)

COMBINED ADDRESS(P1)=ADDRESS(P3)* NCH. P1+ ADDRESS(P1)

ADDRESS(P2)=ADDRESS(P2)

Each user can define one type of experiment with either one, two or three parameters.

All users can define the same type of experiment.

Selected by the User				Defined in the ON-LINE MONITOR	
NCH. AMP	PARAM. N.	NCH. TOF	STORE MD	P1	P2
≤ 4096	0	0	0	AMP	---
0	1	≤ 4096	0	TOF	---
≤ 4096	0	≤ 4096	1	AMP	TOF
≤ 4096	0	≤ 4096	1	AMP1* AMP2	TOF
≤ 4096	1	≤ 4096	1	TOF	AMP
≤ 4096	1	≤ 4096	1	TOF* AMP2	AMP1
≤ 256(2096)	0	≤ 256 (16)	2	AMP	TOF
≤ 256(4096)	0	≤ 256 (16)	2	AMP1* AMP2	TOF
≤ 256(16)	1	≤ 256(4096)	2	TOF	AMP
≤ 256(16)	1	≤ 256(4096)	2	TOF* AMP2	AMP1
≤256	0	≤ 4096	3	AMP	TOF
≤ 4096	1	≤256	3	TOF	AMP
≤ 256	0	≤256	4	AMP	TOF
≤ 256	1	≤ 256	4	TOF	AMP

POSSIBLE PARAMETER COMBINATIONS

The program reserves automatically the following DISPLAY areas for each STORE MODE:

STORE MODE	SIZE OF AREAS	PURPOSE
0	NCHP1	Single par. ON-LINE display
1	NCHP1 NCHP2	For test run (T) For test run and selection of windows (T)
2	NCHP1 NCHP2	For test run (T) For test run (T)
3	NCHP2	Selection of windows (T)
4	NCHP1* NCHP2	True two parameter ON-LINE display

Before the experiment conditions are introduced the user can optionally clear all parameters of the preceding experiment. In case a new STORE MODE is selected the clear action is mandatory.

NCH.

It is the users responsibility to select the correct number of channels for his experiment. The number of channels is related to the number of bits connected from the digital to analog converter and the time of flight coders to the computer as follows.

NR. OF CONNECTED BITS	NR. OF CHANNELS
4	16
5	32
6	64
7	128
8	256
9	512
10	1024
11	2048
12	4096

STORE MODE

For the detailed explanation of the different STORE MODES the user is referred to SECTION 4 of this handbook.

NCHP1 = NR OF CHANNELS FOR FIRST PARAMETER
NCHP2 = NR OF CHANNELS FOR SECOND PARAMETER
T = FOR TEST PURPOSE ONLY.

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
210	No. of ch. for first par. greater 4096.	Start again with OP-CODE-IE.	Allowed values are given above.
212	No. of ch. for second par. greater 4096.	IDEM	IDEM
214	NCHP1*NCHP2 greater 4096	IDEM	Store mode 4 max. 4096 in true display area Store mode 2 for coded storage max. is 65536 channels.
216	NCHP1*NCHP2 greater 65 536	IDEM	

6.2.2. Start Test Run

OP-CODE: ST
MESSAGE: USER NO START TEST-RUN
PRINTED: 0-3
COMMENTS: A TEST-RUN can be started for STORE MODES 1, 2 and 3. If not yet initialized, the data acquisition is started. The TEST RUN can be stopped by the ABORT EXPERIMENT facility.

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
220	Boundaries of display area not correct.	List experiment conditions (PP) and display condition (PD) and compare	Only checked for STORE MODE 1+2
221	No. of reserved areas uncorrect.	Check display areas (PD)	STORE MODE-1(2) STORE MODE-2(2) STORE MODE-3 (1 or 2) (Display areas)
222	Wrong STORE-MODE	Check experiment conditions (PP)	STORE MODES 0 and 4 no test run possible.

6.2.3. Window Set Up on Image Condition Board

OP-CODE: WS
MESSAGE: USER NO WINDOW SET UP
PRINTED: 0 - 3

MESSAGE:	WINDOW	LO. CHANL	UP. CHANL
SET UP ON DISPLAY BOARD:	1 - 31	0 - 4095	0 - 4095

INTRODUCE: "SPACE" ON TELETYPE
PRINTED: VALUES ENTERED ON DISPLAY BOARD
COMMENTS: With each "SPACE" on the TELETYPE the values are entered and printed. To EXIT the routine, push "RETURN" on TELETYPE. The routine puts the greatest value into the location for the UPPER CHANNEL. The maximum number of windows per user is defined during the SYSTEM LOAD procedure (7.). (See also 6.2.4.).

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
230	Max. No. of windows exceeded.	You have to live with less windows.	If you can't call system engineer.
231	Illegal window No.	Check window Nr. on Display Board.	Window numbering starts with 1.

6.2.4. Print and Modify Windows

OP-CODE: PW
MESSAGE: USER NO WINDOW SET UP
PRINTED: 0 - 3
MESSAGE: WINDOW LO. CHANL UP. CHANL
PRINTED: 1 - 31 0 - 4096 0 - 4096
LO. CHANL. UP. CHANL.
INTRODUCE: NEW VALUE NEW VALUE
COMMENT: The current values of both the lower and the upper channel are printed. The user can either introduce the new values or leave the values unchanged by selecting the "SPACE" key on the TELETYPE. To exit the routine, select the "RETURN" key.

The correctness of all window boundaries is checked during the LC-routine (6.2.5.).

- The lower channel of window (N+1) must at least be by one channel greater than the upper channel of the window (N).

- The lower and the upper channel of a window can have the same values.

- The boundary channels are included in the window.

- The last window (N) is to be notified to the system by selecting the lower channel of window (N+1) equal to zero. If the maximum number of windows is selected this condition is fulfilled automatically. The first window (N = 1) can have a lower limit equal to zero.

ERROR: The same as for section 6.2.3.

6.2.5. Last Condition Introduced

OP-CODE: LC
MESSAGE: NO. OF BLOCKS DISPLAY (STORE MODE-1,2)
INTRODUCE: 0 - 16
COMMENTS:

STORE MODE-0: The routine checks if an ON-LINE DISPLAY area has been reserved (IE-OPCODE).

STORE MODE-1,3: The selected windows are checked and the number of effectively used windows is found. The search procedure to determine whether an address of the second parameter lies within a window or not requires a special form of the table where the boundaries are stored. All unused boundaries (Maximum number of windows of the user - number of used windows) are set to 32767.

STORE MODE-3: The correct ON-LINE DISPLAY area with NCHP1 * NUWIN channels is reserved.

STORE MODE-1,2: Having received the number of blocks the user wants to reserve for display purposes (or other) within his area, the programs give control to the STORAGE OPTIMIZATION routine (6.2.6.). If no space is reserved the OPTIMIZATION program will occupy the TOTAL area of the user for CODED STORAGE .

STORE MODE-4: It is checked if the correct ON-LINE DISPLAY area (NCHP1 * NCHP2) for two parameter storage has been reserved (IE-OPCODE).

In case no erronous values are detected, the routine exits with the following message for STORE MODES 0, 3 and 4.
ON-LINE READY ...
The user can proceed now to start the experiment (SE-OPCODE).

ERROR	CONDITION	RECOVERY	COMMENT
25WN	LL(WN)SM. or EQ. UL(WN-1)	Print and modify windows (PW-OPCODE)	WN is the two decimal window number.
26WN	LL(WN)GR. UL(WN)	IDEM	IDEM
27WN	UL(WN)GR. MAX. RANGE	IDEM	IDEM
28WN	UL(WN)GR or EQ LL(WN+1)	IDEM	IDEM
250	No ON-LINE display area reserved.	Return to "IE-OPCODE".	STORE MODE-0

ERROR	CONDITION	RECOVERY	COMMENT
251	No ON-LINE display area for two-parameter store reserved.	IDEM	STORE MODE-4
252	No windows are allowed.	Check your STORE MODE.	Only allowed for 1 and 3.
253	No windows are selected.	Return to PW or WS OPCODES.	You need windows for 1 and 3.
254	Too many windows have been chosen.	Cancel one or more windows.	STORE MODE-3 max. No. of channels = NUWIN * NCHP1.

6.2.6. Coded Storage Optimization Based on Test-Run

OP-CODE: SO
MESSAGE: USER STORAGE OPTIMIZATION
PRINTED: 0 - 3
MESSAGE: MANUAL?
INTRODUCE: Y in case of YES

MANUAL PROCEDURE:
PRINTED: CIDF (CODED INTEGRAL DENSITY FACTOR)
INTRODUCE: Hexadecimal configuration for each chosen window.
PRINTED: CODF (CODFD Overflow density factor)
INTRODUCE: Single value (0 - 3) for each window.

AUTOMATIC PROCEDURE:
MESSAGE: USER NO. FRE. CORE
PRINTED: 0 - 3 0 - 16384
MESSAGE: NO. WIND. NO. BLOC.
PRINTED: 1 - 32 1 - 16
MESSAGE: WINDOW COD. FAC CID. FACT

1	0 - 3	0 - 7	0 - 7 0 - 7 0 - 7
2	0 - 3	0 - 7	0 - 7 0 - 7 0 - 7
N	0 - 3	0 - 7	0 - 7 0 - 7 0 - 7

COMMENTS: In "MANUAL" the user has to introduce four CID factors (1 CIDF per quarter) and one COD factor for each selected window.
After the calculation of the memory lay-out, the remaining free core, which is the memory space that could not be occupied by the optimization program in automatic mode, is printed in "AUTOMATIC" mode.

The program further indicates the number of spaces for WINDOW spectra (NO. WIND.) and the size of the spectra (NO. BLOC.) that will be needed on disk.
A list of the calculated COD factors and the CID factors of all windows is printed (1).

PRINCIPLE OF OPTIMIZATION

The program calculates the mean number of counts per channel within each window or region of interest (see also Fig. 4). The mean number of counts per channel in each quarter of the first parameter is also calculated. With the combination of both types of results, four weight factors for each window are obtained. These factors are a measure for the integral rate to be expected within each quarter of each window spectrum. Knowing the memory space at the user's disposal and the possible integral densities the ON-LINE MONITOR can handle, the program choses the coded integral density factors (CIDF) related to the weight factors in such a way that the storage occupation for coded spectra absorbs as many space within the user field as possible. The coded overflow density factors (CODF) are chosen in dependence of the total count in the windows.

ERROR	CONDITION	RECOVERY	COMMENT
260	One or both display areas missing.	Reserve areas and make test-run.	Test spectra can also be loaded from disk.
261	No windows have been selected.	Return to OPCODE PW.	Are you in STORE MODE 1 or 2?
262	Illegal window boundary.	Return to PW-OPCODE.	You skipped LC-OPCODE.
263	NCHP1*NCHP2 greater 65535 (STORE MODE-2)	Return to IE-OPCODE.	You skipped IE or YY OPCODE
264	User storage area too small.	Too many windows or too many channels per parameter.	See comment below.

The maximum gain in channels that cen be achieved is a factor of 8. This means that a STORAGE or USER area of N-16 bit words can accept 8*N experiment channels.

$NCHP1 * NUWIN * 8 \leq N$ (STORE MODE-1)
$NCHP1 * NCHP2 * 8 \leq N$ (STORE MODE-2)

6.2.7. Start Experiment

OP-CODE: SE
MESSAGE: USER NO. START EXPERIM.
PRINTED: 0 - 3
COMMENT: The program checks if all conditions needed for the type of experiment have been set up and connects the user to the data input stream. The experiment can be stopped momentarily by the ABORT EXPERIMENT feature (6.2.8.).

In STORE MODES-1 and -2 the following message is printed each time a "WINDOW" spectrum is transferred to the disk of the central computer.
SPECTRUM ADDED ID.NO NR.FIRST N.BLOC.

ERROR	CONDITION	RECOVERY	COMMENT
EXP.D. CH. with decimal number	Experiment data channel error.	To restart computer see "GA 18/30 industrial supervisory system"	call electronics engineer if no success.
270	Experiment conditions not complete.	Return to OPCODE-LC	Read requirements for each STORE MODE (Section 4.).

6.2.8. Three Parameter Experiment Set-Up

OP-CODE: TP
MESSAGE: USER NR THREE PARAM. EXPERIM.
PRINTED: 0 - 3
COMMENT: The user must previously have made an initialize experiment procedure (IE-OP-CODE) and defined the STORE MODE 1 or 2. It is the users responsibility to chose the correct number of channels for the combined first parameter (4.3.)

COMBINED NCHP1 = NCHP1*NCHP3

The ON-LINE MONITOR will form the combined address of the first parameter and sort and merge in the same way as for the two parameter case (STORE MODE 1 or 2)

COMBINED ADDRESS(P1)=ADDRESS(P2)*NCHP1+ADDRESS(P1)

The sequence and the characterization of the individual addresses of the three parameters as they have to send to the computer are described in the ON-LINE HARDWARE section of the second report.

ERROR	CONDITION	RECOVERY	COMMENT
280	Illegal STORE MODE	Return to IE-OPCODE	Only allowed for STORE MODE 1 or 2

6.2.9. Windows on Both Parameters

OP-CODE: BW
MESSAGE: USER NR
PRINTED: 0 - 3
MESSAGE: SECOND USER NO
INTRODUCE: 0 - 3
COMMENT: The user must previously have selected complementary experiment conditions under two different user numbers (4.4.).
The routine establishes the link between the two sets of experiment conditions. The user has to introduce the eventual window conditions for each parameter separately as well as the OPCODE-LC.

ERROR	CONDITION	RECOVERY	COMMENT
290	Illegal STORE MODES	Print parameter conditions (PP) and correct	Only STORE MODE 1 and 3 are allowed
291	Illegal parameter conditions	IDEM	See 4.4.
292	Illegal USER NO	Return to IE-OPCODE	USER NO = 0 not allowed as second user neither twice the same user.

6.2.10. Abort Experiment

OP-CODE: AE
MESSAGE: USER NO ABORT EXPERIM.
PRINTED: 0 - 3
COMMENT: The incoming data of this user will no more be sorted and merged. The OPCODE-SE (START EXPERIMENT) can be uses to resume the analysis of the incoming data.
NO ERROR MESSAGE.

6.2.11. Abort Data Input

OP-CODE: AI
MESSAGE: ABORT DATA-IN
COMMENT: The data input stream is topped for ALL ON-LINE users. Data input is started again for ALL ON-LINE users at a START EXPERIMENT selected by any user.

6.2.12. Clear Experiment Conditions

OP-CODE: YY
MESSAGE: USER NO. CLEAR EXPERIM.
PRINTED: 0 - 3
MESSAGE: REALLY?
INTRODUCE: Y if YES, any other character in case of NO.
COMMENT: All experiment conditions of the current OFF-LINE user are reset, all DISPLAY areas as well as eventual data of CODED SPECTRA are deleted and the situation at system load established. The CLEAR EXPERIMENT feature MUST be executed if the user changes the STORE MODE.
NO ERROR MESSAGE.

6.2.13. Print Experiment Parameters

OP-CODE: PP
MESSAGE: USER NO NCH. AMP NCH. TOF
0 - 3 0-4096 0-4096

STORE MD. ID. NO.
0 - 4 0 - 9999
COMMENT: The selected experiment conditions of the current user are listed. The message NCH. AMP. and NCH. TOF. are respectively the first and the second internal system parameters. The message is inverted if the user has defined NCH. TOF as first parameter (2.1.). The ID. NO. is only defined in the last stage of the RESERVE DISK SPACE procedure (6.4.3.).
NO ERROR MESSAGE.

6.3. Utilities Related with Display of Data

6.3.1. Start Display

OP-CODE: SD
MESSAGE: START DISPLAY
COMMENTS: The routine unmasks the DISPLAY interrupt level, causes an updating of the IMAGE buffer and initializes the DISPLAY DATA CHANNEL. The DATA CHANNEL assures 20 IMAGES per second and, at maximum, one updating of the IMAGE per second. In case the DISPLAY had been started already the program exits without error message.
ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
DSP. D. CH with decimal number	Display data channel error	To restart computer see "GA 18/30 industrial supervisory system"	Call electronics engineer if no success

ERROR	CONDITION	RECOVERY	COMMENT
310	No display area reserved at all	Reserve display area OPCODE RD (6.3.5.)	Function is not user related.

6.3.2. Abort Display

OP-CODE: AD
MESSAGE: ABORT DISPLAY
COMMENTS: Within at least one second the IMAGE will disappear, the DISPLAY interrupt level masked and the DATA CHANNEL stopped.
NO ERROR MESSAGE.

6.3.3. On-Line Display

OP-CODE: ON
MESSAGES: DISPLAY ON-LINE
COMMENTS: The IMAGE buffer with data originating from a WINDOW SPECTRUM or an ON-LINE DISPLAY area is updated every second so that the user gets an ON-LINE control on the incoming data stream. This option is very time consuming particularly for WINDOW SPECTRA and should be avoided in order to limit deadtime losses especially if several users are ON-LINE.
NO ERROR MESSAGE.

6.3.4. Off-Line Display

OP-CODE: OF
MESSAGES: DISPLAY OFF-LINE
COMMENTS: The ON-LINE DISPLAY areas as well as the DISPLAY of WINDOW SPECTRA are treated as OFF-LINE DISPLAY areas i.e. the IMAGE is only updated if one of the IMAGE CONDITIONS (Fig. 5) is modified.
NO ERROR MESSAGE.

6.3.5. Reserve Display Area

OP-CODE: RD
MESSAGES: USER NO DISPLAY SET UP
PRINTED: 0 - 3
MESSAGES: PARAM. FIRST B. N.BLOC EXPERIM.
INTRODUCE: 0 - 1 1 - 16 1 - 16 1 if YES, 0 if NO
PRINTED: DISP.NO.
PRINTED: 0 - 9
PRINTED: USER NO. FRE.CORE
PRINTED: 0 - 3 0 - 16384
COMMENTS: This routine allows to reserve a DISPLAY area in the user field of the USER area. The storage

in a DISPLAY area is always made in a true form i.e. 1 CHANNEL = 1 computer word and the count capacity per channel is 65535. (2**16-1).

The maximum number of DISPLAY areas for ALL users is limited to ten. The routine searches the next free DISPLAY area.

- PARAM. N
  For OFF-LINE DISPLAY areas the parameter must be zero.

- FIRST B
  For OFF-LINE DISPLAY areas to be filled with data from disk (EXPERIM=0) the FIRST BLOCK is assumed always to be 1 even if it is set up differently.

- N. BLOC.
  The sum of the FIRST BLOCK + NO OF BLOCKS is checked to fall within the initially set-up experiment conditions for areas linked to the experiment in STORE MODES 0 and 1.

- EXPERIM.
  An EXPERIMENT area can exclusively be utilized for ON-LINE data acquisition; an OFF-LINE area can be used for the DISPLAY of spectra stored on the disks of the central computer.

  N. B. The visualization of a WINDOW SPECTRA DOES NOT require an extra ON-LINE or OFF-LINE area but it is decoded directly into the IMAGE buffer.
  The remaining FREE CORE of the user and the number of the reserved DISPLAY area is printed at the end of a correct reservation.

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
350	All display areas are occupied.a	Delete one of your areas or ask another user to do so.	The last reserved area for the user is deleted.
351	Not enough memory space available.	Delete one of your display areas or get space in other user area.	The space per user cannot be modified by user.

ERROR	CONDITION	RECOVERY	COMMENT
352	Par. 1 or par. 2 boundaries out of range (EXPERIM. only)	Try again with same OPCODE.	The absolute boundaries are defined during experiment set up (2.1.).

6.3.6. Delete Display Area

OP-CODE: DD
MESSAGES: USER NO DISPLAY DELETE
PRINTED: 0 - 3
PRINTED: REALLY?
INTRODUCE: Y in case of YES, any other character in case of NO.
PRINTED: DISPLAY
PRINTED: 0 - 9
PRINTED: FRE. CORE
PRINTED: 0 - 16384
COMMENT: The LAST reserved DISPLAY area of the user is deleted and the new FREE CORE printed out. It is the users responsibility to store the contents of the area on disk (TS) if they have to be saved.

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
360	No display area reserved for user.	Check reserved display area (PD-OPCODE)	No free core is printed.

6.3.7. Print Lower or Lower to Upper Channel (Set Up on Image Condition Board)

OP-CODE: PL
PRINT: CHANNEL
EITHER
INTRODUCE: PUSH "SPACE" key of TELETYPE
PRINT: 0 - 4096 0 - 65535

OR
INTRODUCE: U
PRINT: LOWER CHANNEL CHANNEL CONTENT C.C. C.C. C.C. C.C.
LCH+5 C.C. C.C. C.C. C.C. C.C.
ETC

COMMENTS: Either "SPACE" or the letter "U" can be selected. For "SPACE" the contents of the LOWER CHANNEL of the DISPLAY CONDITIONS is printed, and for U the contents of all channels from LOWER to UPPER are printed in 5 contents per line. The current channel number is reproduced in the first column.
The routine corrects without ERROR MESSAGE
- the UPPER CHANNEL if it falls out of the range defined in the DISPLAY reservation and sets it to the highest channel.
- the UPPER CHANNEL if it is set to a smaller value than the LOWER CHANNEL. Only the LOWER CHANNEL is printed.
Both the LOWER and the UPPER CHANNEL are always referred to the first channel the DISPLAY area i.a. for EXPERIMENT areas the user has to calculate the correct effective channel number if the DISPLAY area does not start with the first block (3. 5.). To exit the routine select "RETURN" on the keyboard.

NO ERROR MESSAGES.

6.3.8. Integrate from Lower to Upper Channel (Set Up on Image Condition Board

OP-CODE:	IN		
MESSAGE:	INTEGRAL		
MESSAGE:	LO. CHAN	UP. CHAN	INTEGRAL
INTRODUCE:	"SPACE"		
PRINTED:	0-4095	0-4095	0-2 147 483 647 (2**31-1)

COMMENTS: The routine inverts without an ERROR MESSAGE LOWER to UPPER and UPPER to LOWER CHANNEL in case the UPPER CHANNEL is chosen smaller than the LOWER CHANNEL. Both limits are referred to the first CHANNEL of the DISPLAY area (3. 7.). The result of the integration is printed in double word precision. To exit, select "RETURN" on keyboard.

NO ERROR MESSAGES.

6.3.9. Modify Threshold

OP-CODE: MT
MESSAGE: DISP. NO.
PRINTED: 0 - 9
MESSAGE: THRESHLD
INTRODUCE: 0-65535
COMMENTS: To know the actual value of the THRESHOLD select "SPACE" on the keyboard. The THRESHOLD is subtracted from all channel contents loaded into the IMAGE buffer. The data stored in the DISPLAY area are not modified. Each DISPLAY area has its own THRESHOLD which is set to zero when the DISPLAY area is reserved.

NO ERROR MESSAGES.

6.3.10. Print Selected Display Areas

OP-CODE: PD

MESSAGES:	DISPLAY	USER NO.	PARAM. N	LO. LEVL.
INTRODUCE:	0 - 9	0 - 3	0 - 1	0 - 4095
	UP. LEVL.	EXPERIM.	ID. NO.	THRESHLD.
	0-4095	0 - 1	0-9999	0 - 65535

COMMENTS: The conditions for the ten areas are listed. To interrupt the listing set the DATA SWITCH "0" on the computer console to "one".

NO ERROR MESSAGES.

6.3.11. Clear Display Area

OP-CODE: CD
MESSAGES: USER NO CLEAR DISPLAY
PRINTED: 0 - 3
MESSAGE: DISPLAY
INTRODUCE: 0 - 9
COMMENTS: The channel contents of all channels of the DISPLAY area are cleared. The DISPLAY area conditions remain the same (3.10.).

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
360	Display area does not belong to user.	Check display area No. (3.10.).	To prevent erase by inadvertence.
361	No area reserved for user.	Check USER NO.	Perhaps you really don't have an area.

6.4. Utilities Providing Access to the Spectra on Disk

6.4.1. Transfer Spectrum on Disk

OP-CODE: TS

MESSAGE: USER NO SPECTRUM TRANSFER

PRINTED: 0 - 3

MESSAGE:	DISP.NO.	STATION	ID.NO	FIRST B.	N.BLOC.
INTRODUCE:	0 - 9	5	0-9999	1 - 16	1 - 16

FINAL MESSAGE: SPECTRUM STORED ID.NO FIRST BL. NO. OF BLOCKS

COMMENT: The final message and the full text error messages are delivered by the central computer.

- DISP.NO. Number of the DISPLAY area in which the spectrum is stored. To transfer CODED SPECTRA it is referred to section 6.4.4.
- STATION The station number is fixed and cannot be modified by the user.
- ID.NO. The identification under which the spectrum is to be stored on disk.
- FIRST B. First block within the DISPLAY area where the spectrum to transfer starts. On disk the spectrum will ALWAYS be stored with the first block equal to one.
- N. BLOCKS Total number of blocks of the spectrum. To guarantee AUTOMATIC storage of spectra of a DISPLAY area on disk, i.e. if the maximum count capacity of a channel is reached, the user has to define the ID.NO. and the DISPLAY area with the AU-OPCODE (6.4.3.). After the transfer of a spectrum in AUTOMATIC mode the following message is printed:

  SPECTRUM ADDED ID.NO. FIRST BL. NO. OF BLOCKS

MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
410	First block below display condition.	Print display conditions (OPCODE-PD).	The conditions of the 10 areas are printed.
411	No. of blocks too great.	IDEM	To stop printing set data switch "0" of console to "1".

ERROR	CONDITION	RECOVERY	COMMENT
412	Display area does not belong to user.	IDEM	IDEM
No place for 4K spectrum in SI-PR. ID. F. BL. N. BL.		Delete an obsolete 4K spectrum.	Each user has a limited number of places on disk.
No place for 4K spectrum in DO-PR. ID. F. BL. N. BL.		You need two adjacent free places on disk.	Ask list of spectra ID. from operator.
No place for spectrum smaller 4K ID. F. BL. N. BL.		Delete an obsolete small spectrum.	The number of small spectra per user is not limited.
No place for overflow channels ID. F. BL. N. BL.		Delete an obsolete spectrum with overflow channels.	Ask list of spectra ID. NR. from operator.
Same ID. already on disk ID. F. BL. N. BL.		Chose other ID.	Make list of ID. for this station (IO-OPCODE-15)
ID. not on disk ID. F. BL. N. BL.		Reserve space with this ID. (6. 4. 3.)	Message possible in automatic store only.
Illegal store ID. F. BL. N. BL.		Compare stored and reserved N. BLOCK and FIRST BL.	First BLOCK + NR. OF BLOCKS exceed reserved space.

6.4.2. Get Spectrum from Disk

OP-CODE:	GS
MESSAGE:	USER NO SPECTRUM DISPLAY
PRINTED:	0 - 3
MESSAGE:	STATION ID. NO. FRST. B. N. BLOC.
INTRODUCE:	1 - 15 0-9999 1 - 16 1 - 16
	DISP. NO. FRST. B. DIVISION
	0 - 9 1 - 16 0 - 9999
COMMENT:	The full text error messages are delivered by the central computer.
- STATION	The station number is not fixed to allow the user to inspect spectra stored on disk by him from another station.
- ID. NO.	The identification number under which the spectrum is stored.

- FIRST B. If not equal to one indicates the first block to be loaded within the spectrum stored on disk.
- N. BLOCKS Total number of blocks to be loaded.
- DISP. NR. OFF-LINE DISPLAY area into which the spectrum is to be stored.
- FIRST BL. is the first block within the DISPLAY area where the first block of the spectrum is to be loaded.
- DIVISION the contents of all channels of the asked spectrum are divided by the division factor before being sent to the satellite computer. The maximum capacity per channel on disk is 2**31-1 and the maximum capacity per channel in the satellite computer is 2**16-1 (65535). A 0-division factor is replaced by a 1-division factor.

ERROR MESSAGES:

ERROR	CONDITION	RECOVERY	COMMENT
420	First bl. +nr. of blocks greater display area.	Compare display area conditions (PD) and selected conditions.	First BL. is First BL. in display area.
421	Area does not belong to user.	IDEM	If no space ask other user for OFF-LINE display area.
422	No display area with this number selected.	Correct display area Nr.	IDEM
423	Display area too small.	Lower No. of blocks.	You can examine block after block.
424	First block in area too high.	Lower first block.	First block above Nr. of blocks of display area.
425	This is an EXPERIMENT display area	Select OFF-LINE display area.	If we had done you would be sorry now.
ID. NR NOT ON DISK		Try again with corrected ID. NO.	Make list of your ID. NO. (IO-OP-CODE-15)
CHECK FIRST BLOCK		Correct first block.	Asked first block greater upper block Nr.

CHECK NO. OF BLOCKS	Correct No. of blocks	First block + No. of blocks greater No. of blocks on disk.

6.4.3. Reserve Space on Disk

OP-CODE: RS
MESSAGE: USER NO RESERVE DISK ROOM
PRINTED: 0 - 3
MESSAGE: STATION ID. NO. NO. BLOC. NO. WIND.
INTRODUCE: 5 0-9999 1 - 16 1 - 32

DB. PREC.
0 - 1

COMMENTS: ATTENTION
The ID. NO. selected with this routine is retained as ID. NO. of the ON-LINE EXPERIMENT (check with PP-OPCODE).
The ID. NO. entered during the AU-OPCODE will be assigned to the DISPLAY area (check with PD-OPCODE).

- STATION The station number cannot be modified by the user.

- ID. NO. The number of spaces reserved is given by the number of windows (NO. WIND). The spectra will be alloted an ID. NO. is ascending order i.e. The first window spectrum will be stored under the introduced ID. NO., the second under ID. NO+1, the third under ID. NO+2 etc.

- NO. BLOC. The size of the spaces to be reserved is indicated by the number of blocks. If the number of blocks is smaller than 7, the reservation will be made in the zone for small spectra, where the number of reservations is not restricted by user. For spectra with more blocks, a great spectrum is reserved.
N. B. Each user disposes only of a limited number of large spectra (OPCODE: I 0, -18).

- NO. WIND. The number of spaces to be reserved.
For STORE MODE 1 and 2 the number of windows and the size of the spaces is delivered by the STORAGE OPTIMIZATION (6.2.6.) routine. For AUTOMATIC storage of a spectrum accumulated in a display area only one space is needed on disk.

- DB. PREC. The user can reserve space for spectra either in single precision (0) or in double precision (1).

ERROR	CONDITION	RECOVERY	COMMENT
420	Illegal WINDOW NO.	Try with smaller window no. ; Zero is not allowed.	Maximum no. of windows is defined at system load.
CHECK OP-CODE ID/WIND		Serial number of ID. NO+WINDOW NO. exceeds 99	The serial number of the ID. NO. are the two last decimal digits.
SAME ID. NR ALREAY ON DISK		make list of your ID. NO. on disk.	IO-OPCODE-15 (6. 5. 3.)

ID. F. BLOC. N. BLOC.

6. 4. 4. Transfer all Window Spectra

OP-CODE: TA
MESSAGE: USER NO TRANSFER EXPERIM.
PRINTED: 0 - 3
MESSAGE: SPECTRUM ADDED ID. NO. N. FIRST N. BLOCK
COMMENTS: All window spectra of the user will be transferred consecutively on disk and one message will be printed for each transfer. The user can get a survey on all data processed by the computer up to this moment by calling back (OP-CODE-GS) the window spectra into an OFF-LINE DISPLAY area.

ERROR	CONDITION	RECOVERY	COMMENT
440	No window spectra for user.	Check your STORE MODE (OPCODE-PP)	Possible only for STORE MODE 1 and 2.

6. 4. 5. Automatic Transfer on Display Area

OP-CODE: AU
MESSAGE: USER NO AUTOMATIC DISPLAY TRANSFER
PRINTED: 0 - 3
MESSAGE: DISP. NO.
INTRODUCE: 0 - 9
COMMENT: The user can assure an automatic transfer of a DISPLAY area in case the maximum count capacity is reached in one channel of the DISPLAY area. After the successful completion of the transfer the entire DISPLAY area is cleared and the measurement is continued. The AUTOMATIC TRANSFER option is possible

for each of the ten DISPLAY areas with a different ID.NR. For this purpose control is automatically given to the DISK SPACE RESERVATION (6.4.3.) routine when the number of the DISPLAY area has been introduced. Only one space has to be reserved per DISPLAY area and the number of blocks can be obtained by the PD-OPCODE. N.BLOC. = (UP.LEVL+1-LO.LEVL)/256.

After a spectrum of an automatic DISPLAY area has been transferred to disk, the following message is printed:

SPECTRUM ADDED ID.NR. N.FIRST

N.BLOCK.

6.4.6. Call for System Engineer Routines

OP-CODE: ZY

COMMENT: For a detailed description of the SYSTEM ENGINEER routines, it is referred to the second part of this report.
The routines will be loaded into the 1280 words at the end of the USER AREA (Fig. 2). In case this zone is being reserved for storage of data, the OFF-LINE MONITOR will not load the routines: The user has to cancel the reservation (YY-OPCODE or DD-OPCODE). With OPCODE-OM the user can return from the SYSTEM ENGINEER ROUTINES to the OFF-LINE MONITOR.

ERROR	CONDITION	RECOVERY	COMMENT
500N	User N has reserved the memory space for the SYSTEM ENGINEER routines.	Cancel reservation (YY or DD-OP-CODES)	If needed save data on disk (TA or TS-OPCODES).

6.5. Interactive Operations with Data on Disk

OP-CODE: IO
MESSAGE: USER NO.
PRINTED: 0 - 3
MESSAGE: OPCODE
INTRODUCE: 12 - 30
COMMENT: All routines which are described in this section can also be called into the INTERFACE STATIONS (8) by manual request. A complete description of the routines and the values to be entered as well as the form under which the final result will be delivered can be found in the report: (10, pages 5 - 17). "IBM 1800 programs for data processing at the accelerators of the Central Bureau for Nuclear Measurements
Part 3: Programs for interactive data reduction" by H. Horstmann (EUR 4404e Part 3) 1972.
The satellite computer OFF-LINE MONITOR only facilitates the input of the values but the operations are executed by the same routines that handle requests from the INTERFACE STATIONS. In this section only the messages delivered by the satellite computer are reproduced.
The OPCODES 1-10 to store on read spectra to or from disk have not been included because they form part of the standard facilities to be called by two letter OPCODES (TS, GS, TA).
VALID FOR ALL VALUES TO BE INTRODUCED:
- A "SPACE" selected on the TELETYPE closes the character (or digit) string of a value.
- A "RETURN" on the TELETYPE skips the value or the remaining number of values of the same kind that can be introduced.
- As long as the "SPACE" or the maximum number of characters of a value have not yet been introduced, the value can be repeated (i.e. corrected) by pressing the "R" letter "REPEAT" on the TELETYPE.
- A REAL NUMBER can be introduced in one of the following forms
273. 32.741 1.667E-02 1.00E01
- The maximum number of decimal digits or characters per real number is limited to 8; the satellite computer does not check the correctness of the introduced values.

ERROR	CONDITION	RECOVERY	COMMENT
500	Illegal Opcode Number	SELECT NEW OPCODE NUMBER	Return with IO-OPCODE

6.5.1. Integration (Also OPCODE-IN)

OP-CODE: 12
MESSAGE: INTEGRAL
MESSAGE: ID. NO LO. LEVL UP. LEVL
INTRODUCE: (01-15)(0-9999) 0-4095 0-4095
MESSAGE: MULT. BY
INTRODUCE: UP TO 5 MULTIPLICATION FACTORS (REAL NUMBERS)
MESSAGE: DIV. BY
INTRODUCE: UP TO 4 DIVISION FACTORS (REAL NUMBERS)
FINAL MESSAGE: (10, Page 8).

6.5.2. Deleting Spectra on Disk

OP-CODE: 14
MESSAGE: SPECTRUM DELETE
MESSAGE: ID. NO.
INTRODUCE: UP TO 10 ID. NO. OF SPECTRA STORED ON DISK EACH SPECTRUM BEING DEFINED BY 6 DECIMAL DIGITS
MESSAGE: WARNING
INTRODUCE: D IF ALL ID. NO. ARE CORRECT.
GIVE TO STATION: Y if YES - STATION 01 - 15
FINAL MESSAGE: (10, page 9)

ERROR	CONDITION	RECOVERY	COMMENT
520	Error in delete procedure.	Try again with OPCODE-14	Message always provided if no delete transmitted.

6.5.3. Table of Identification Numbers

OP-CODE: 16
MESSAGE: ID. TABLE
MESSAGE: STATION
INTRODUCE: 01 - 15
FINAL MESSAGE: (10, pages 9 - 10)

6.5.4. Addition and Subtraction of Spectra

OP-CODE: 16
MESSAGE: SUM
MESSAGE: RESULT ID.
INTRODUCE: $\pm$ (01 - 15) (0 - 9999)
MESSAGE: ID. NO.
INTRODUCE: UP TO 9 ID. NO. OF SPECTRA
FINAL MESSAGE: (10, Pages 10 - 11)
COMMENT: An ID. NO. preceded by the + sign is added, an ID. NO. preceded by the - sign is subtracted. If no sign is given, addition is assumed.

6.5.5. Normalization of Spectra

OP-CODE: 17
MESSAGE: MULTIPLY
MESSAGE: ID.NO. RESLT.ID. MULT.BY
INTRODUCE:(01-15) (0-9999) (01-15) (0-9999) REAL VALUE
FINAL MESSAGE: (10, page 11)

6.5.6. Available Disk Storage

OP-CODE: 18
MESSAGE: DISK ROOM
FINAL MESSAGE; (10, Pages 11 - 12)

6.5.7. Shifting of Spectra

OP-CODE: 23
MESSAGE: SHIFT SPECTRUM
MESSAGE: ID.NO. CHANNEL
INTRODUCE:(01-15) (0-9999) 0 - 4095
FINAL MESSAGE: (10, Page 13)

6.5.8. Orders

OP-CODE: 26
MESSAGE: ORDERS
MESSAGE: ID.NO. FIRST BL. NR. BLOC.
INTRODUCE:(01-15) (0-9999) 01-16 01-16
MESSAGE: LIST BIN. CARD INT. LIST PLOT
INTRODUCE:1 IN CASE OF YES FOR EACH OPTION
IF PLOT WAS ASKED:
MESSAGE: X-AXIS Y-AXIS MAX. COUNT
INTRODUCE:0-1000 0-1000 REAL NUMBER
FINAL MESSAGE: (10, Pages 13, 14)

6.5.9. Cancellation of Orders

OP-CODE: 25
MESSAGE: DELETE ORDERS
MESSAGE: ID.NO.
INTRODUCE:(01-15) (0-9999)
FINAL MESSAGE: (10, 15)

6.5.10 Accordeon

OP-CODE: 24
MESSAGE: ACCORDEON
MESSAGE: ID.NO. FACTOR RESLT.ID.
INTRODUCE:(01-15) (0-9999) ± 2, ± 4 (01-15) (0-9999)
FINAL MESSAGE: 10, 15)

7. COLD START OF MULTIPARAMETER SYSTEM

The COLD START procedure actually is part of the experimental set-up. All users - by mutual arrangement - must split up the available free core (and windows) according to their experimental requirements, before they can initialize their experiments.

When the ON-LINE MONITOR is loaded with the card reader, control is directly given to the COLD START program. It enables the different runs to split up the USER AREA (Fig. 2) and share the windows. The routine calculates all parameters and fills in the appropriate tables needed later on by the ON-LINE MONITOR. The COLD START program lies in the USER AREA and will be erased when the first user either reserves a DISPLAY area (RD-OPCODE) or defines the experiment conditions (IE-OPCODE)

MESSAGE:	MPS COLD START FRE. CORE
PRINTED	TOTAL SIZE OF USER AREA
MESSAGE·	USER NO. SIZE WINDOWS COD. STOR.
PRINTED:	0 - 3
INTRODUCE	0-14898 0-31 0-1
MESSAGE:	USER NO. FRE. CORE
PRINTED :	4 TOTAL-RESERVED SIZE
COMMENT:	

- SIZE: The first FRE. CORE is the maximum size of the USER AREA and is to be shared by all users. The remaining free core after all users have chosen the size of their areas is printed at the end of the COLD START.
- WINDOWS: The total number of windows the sytem can can accept is 63, but the maximum number of windows has been limited to 31 for a single user. The COLD START program reserves either 7, 15 or 31 windows for reasons of internal system organization in case the user choses less than 7, 15 or 31 windows (STORE MODE 1 or 3).
- COD. STOR.: In case the user intents to run an experiment with more than 4096 channels (STORE MODE 1 or 2) the CODED STORAGE indicator has to be set to "1".

The routine gives control to the OFF-LINE MONITOR when correct values have been introduced for all four users. The only way to correct values is to reload the ON-LINE MONITOR via the card reader (or call the SYSTEM ENGINEER).

ERROR	CONDITION	RECOVERY	COMMENT
10	Sum of all size too great.	Select smaller size.	Maximum is listed under MPS COLD START message.
11	Too many windows.	Select less windows.	Absolute maximum is 63 See comment under "WINDOWS"
12	No coded storage possible.	Select less windows.	Coded storage tables are too small.

ERROR CODES

Error Codes	Op-Code	Error Condition
2	INTERNAL	Memory parity error
3	INTERNAL	Memory protect violation
4	INTERNAL	Data channel check error
5	INTERNAL	Opcode violation (execution of /0000)
10	COLD START	Size too great
11	COLD START	Too many windows
12	COLD START	No coded storage possible
100	OFF-LINE MON.	Specified core load not in CORE LOAD TABLE.
103	ON-LINE MON.	System incomplete for coded storage
104	ON-LINE MON.	Illegal window number
210	IE	Number of channels for first Par. >4096
212	IE	Number of channels for second par. > 4096
214	IE	NCHP1 *NCHP2>4096 (store mode 4)
216	IE	NCHP1 *NCHP2>65536 (store mode 2)
220	ST	Boundaries of display are incorrect
221	ST	Number of reserved areas incorrect
222	ST	Wrong Store-mode
230	WS	Max. number of windows exceeded
231	WS	Illegal window number
250	LC	No on-line display area reserved
251	LC	No on-line display area for two-par. store reserved
252	LC	No windows are allowed
253	LC	No windows are selected
254	LC	Too many windows have been chosen
260	SO	One or both display areas missing
261	SO	No windows have been selected

Error Codes	Op-Code	Error Condition
262	SO	Illegal window boundary
263	SO	NCHP1 *NCHP2 > 65536 (store mode-2)
264	SO	User storage area too small
270	SE	Experiment conditions not complete
280	TW	Illegal store mode
290	BW	Illegal store mode
291	BW	Illegal parameter conditions
292	BW	Illegal user number
310	SD	No display area reserved
350	RD	All display areas are occupied
351	RD	Not enough memory space available
352	RD	Par. 1 or Par. 2 boundaries out of range
360	DD-CD	Areas does not belong to user
361	DD-CD	No display area reserved for user
410	TS	First block below display condition
411	TS	Number of blocks too great
412	TS	Display area does not belong to user
420	GS	First block + number of blocks >display area
421	GS	Area does not belong to user
422	GS	No display area with this number selected
423	GS	Display area too small
424	GS	First block in area too high
425	GS	This is an on-line display area
430	RS	Illegal window number
440	TH	No window spectra for user
500	IO	Illegal OPCODE-number
520	IO	Error in DELETE procedure

Error Codes	Op-Code	Error Condition
600	All	Introduced value exceeds allowed maximum
25WN	LC	LL(WN) smaller or equal UL (WN-1)
26WN	LC	LL(WN) greater than UL (WN)
27WN	LC	LL(WN) greater
28WN	LC	UL(WN) greater or equal LL (WN+1)
5000+N	OFF-LINE MON.	System engineer core load overlays occupied data area of user N - 1
9999	ON-LINE MON.	System error
10000	SYST. ENG.	Trap without replacement

OPCODE	FUNCTION
AE	Abort experiment or test run
AD	Abort DISPLAY
AI	Abort Input of data
AU	Automatic transfer of display area linked to experiment
BW	Windows on both parameters
CD	Clear DISPLAY area
DD	Delete DISPLAY area
GG	Load GENERAL AUTOMATION G.U.S.
GS	Get Spectrum from disk
IE	Introduce experiment conditions
IN	Integrate from lower to upper channel
IO	Interactive operation with data stored on disk
IU	Introduce User number
LC	Last condition of experiment selected
MT	Modify Threshold
OF	Put DISPLAY OFF-LINE (no image updating)
ON	Put DISPLAY ON-LINE (update image)
PC	Print free core of user
PD	Print selected DISPLAY areas
PL	Print lower to upper channel
PP	Print selected experiment parameters
PW	Print and modify window boundaries
RD	Reserve DISPLAY area
RS	Reserve space on disk
SD	Start DISPLAY (image refreshing)
SE	Start experiment
SO	Storage optimization for coded storage

OPCODE	FUNCTION
ST	Start Test-run
TA	Transfer ALL window spectra on disk
TP	Three parameter experiment set-up
WS	Select WINDOW boundaries with lower and upper channel of image conditions board.
YY	Clear experiment condition of single user
ZY	Call for SYSTEM ENGINEER routines

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(9) De Keyser, A., de Jonge, S., van der Veen, T., ter Meer, P., EUR report in preparation.

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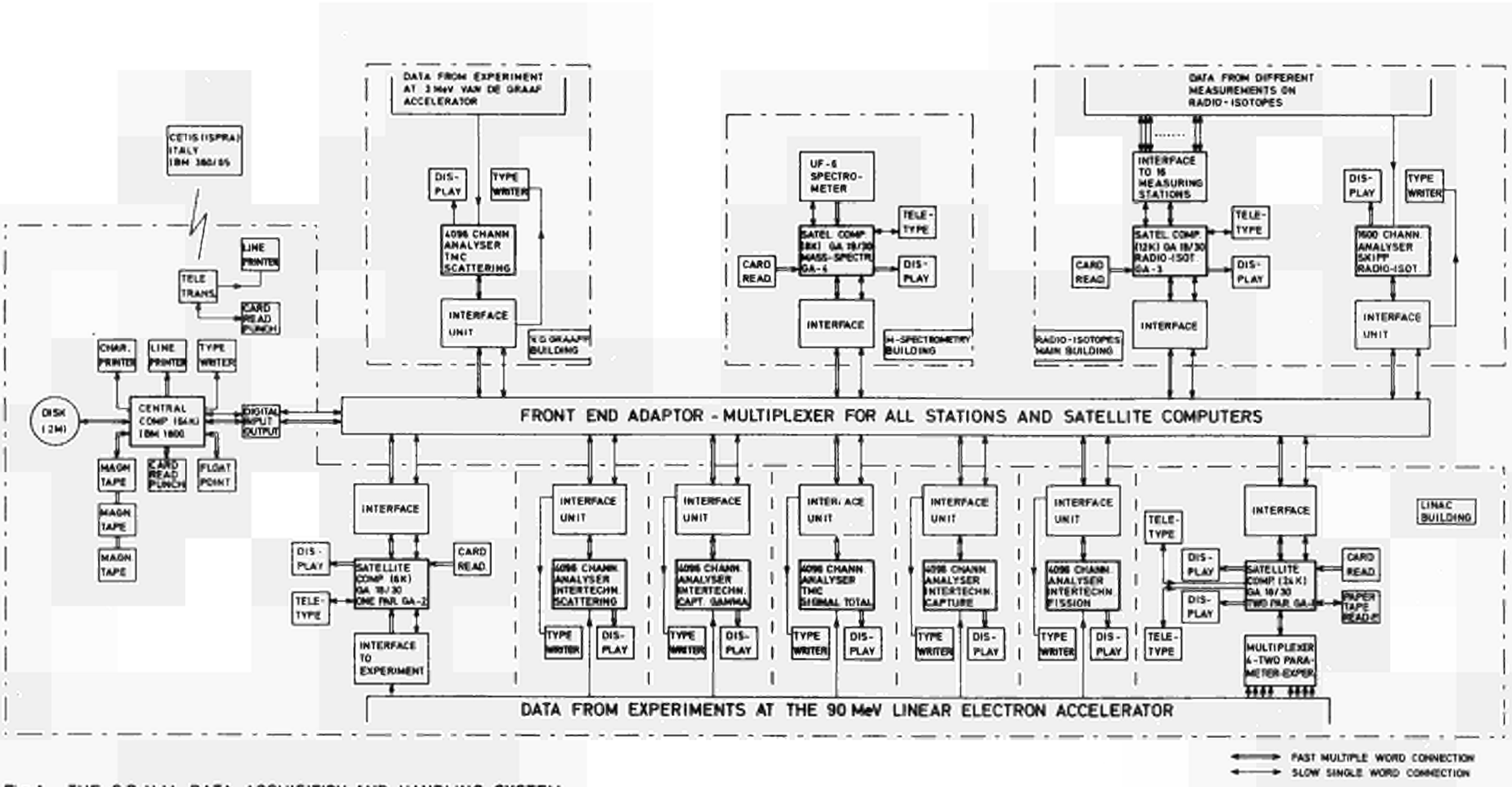
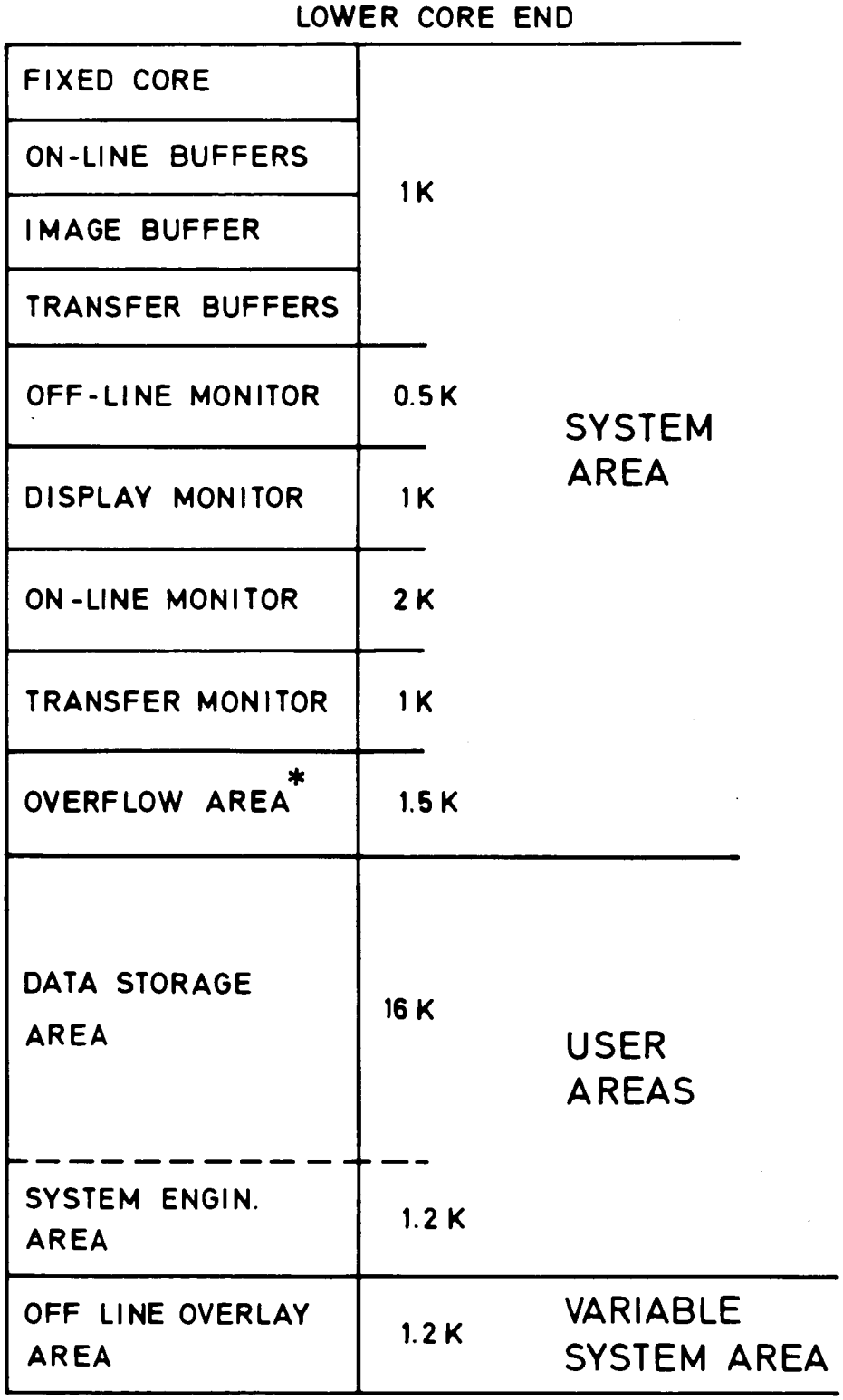


Fig.1 THE C.B.N.M. DATA ACQUISITION AND HANDLING SYSTEM



* ONLY MULTIPARAMETER CASE

Fig. 2 SATELLITE COMPUTER MEMORY LAY-OUT MULTIPARAMETER. DATA ACQUISITION APPLICATION

STORE MODE	FIRST PARAMETER (NR. OF CHANNELS)		SECOND PARAMETER (NR. OF CHANNELS)		CONDITIONS ON SECOND PARAMETER DEFINED EACH BY LOWER AND UPPER LEVEL	MAXIMUM NR. OF EXPERIMENT CHANNELS (NECH)	CORE OCCUPATION (16 BIT WORDS)	DENOMINATION OF SPECTRUM
0	256	4096				4096	4096	SINGLE PARAMETER
1	256	4096		4096	31	61.440 OUT OF 16.777.216	8192 CODED STORAGE	CONDITIONED LARGE TWO-PARAMETER
2	256			256		65.536	8192 CODED STORAGE	MEDIUM TWO-PARAMETER
		4096	16					
3	16	256		4096	31	4096 OUT OF 1.048.576	4096	CONDITIONED MEDIUM TWO-PARAMETER
4	16			256		4096	4096	SMALL TWO-PARAMETER
		256		16				
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	

Fig.3 THE FIVE BASIC STORE MODES

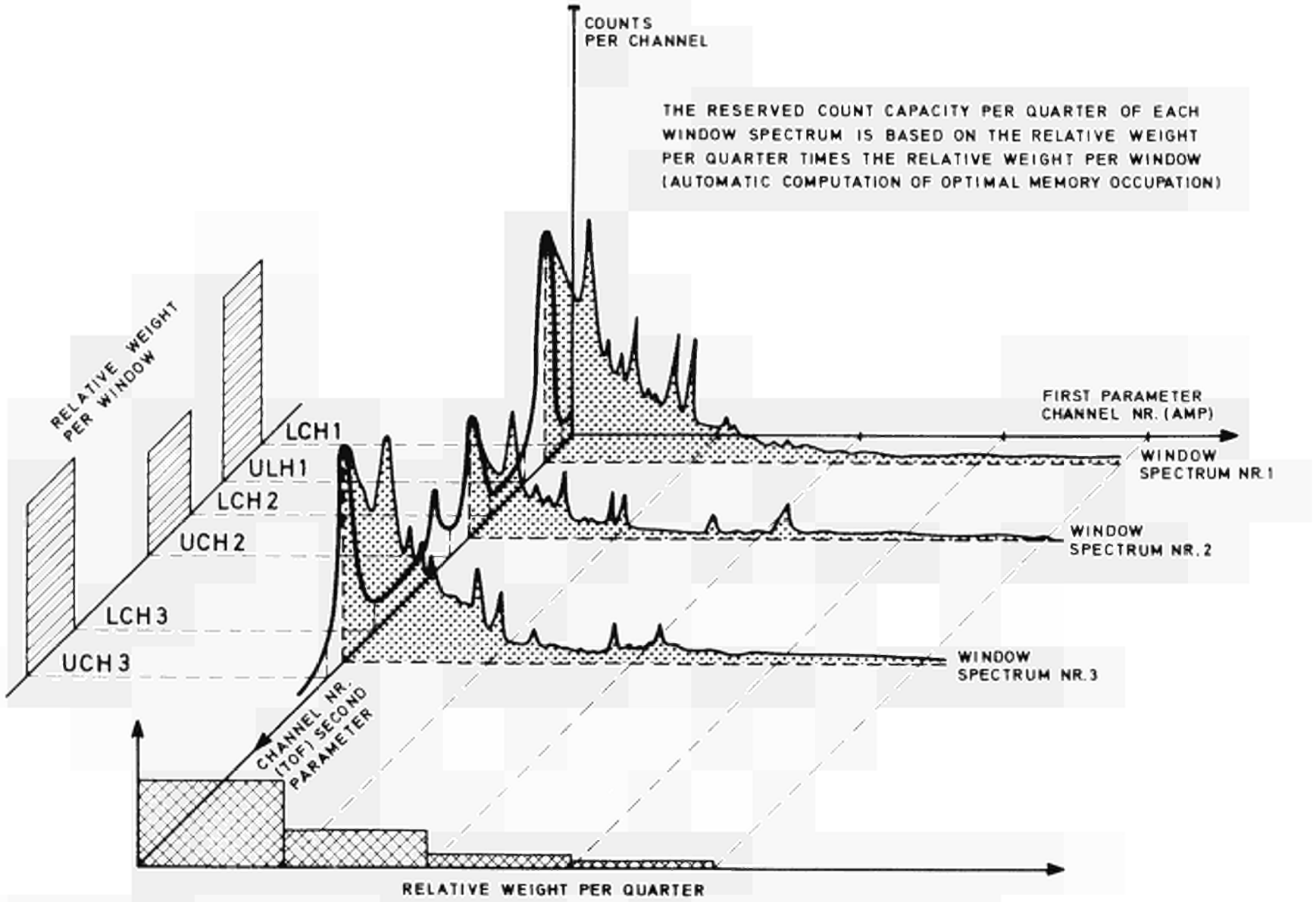


Fig.4 EXAMPLE FOR TWO PARAMETER DATA ACQUISITION (STORE-MODE-1)
(AMP) IS A TYPICAL NEUTRON CAPTURE γ-RAY SPECTRUM
(TOF) IS A TYPICAL TIME-OF-FLIGHT SPECTRUM

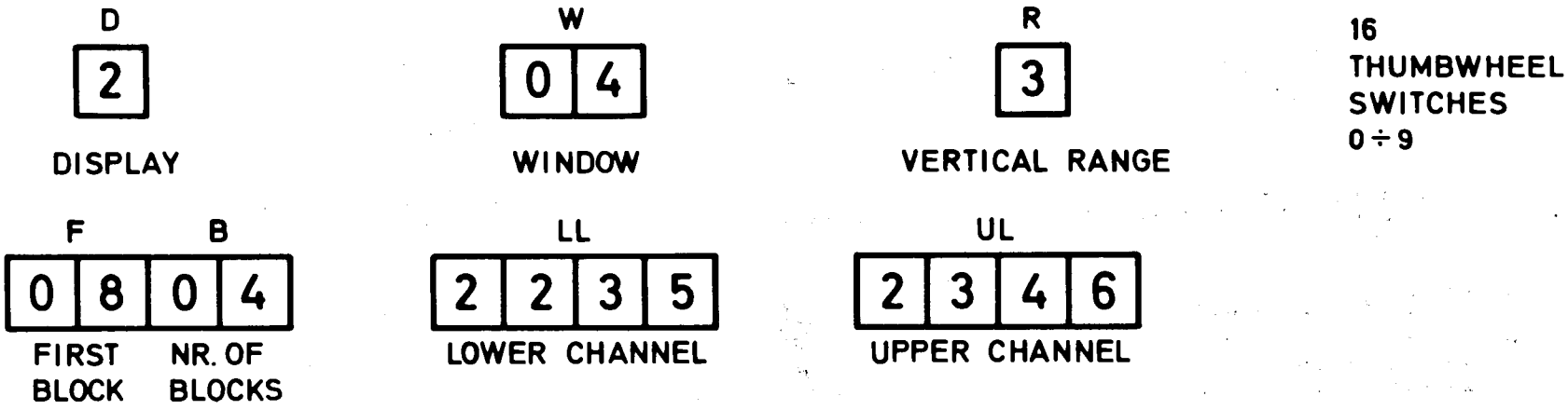


Fig. 5 IMAGE CONDITIONS BOARD (SEE ALSO FIG.6 - 5.4.1.)

	FIRST USER AREA (4K)		SECOND USER AREA (8K)	
CORE ADDRESSES	/1000 - /1EFF 3840 WORDS	/1F00 - /1FFF 256 WORDS	/2000 - /2FFF 4096 WORDS	/3000 - /3FFF 4096 WORDS
EXPERIMENT TYPE	CONDITIONNED LARGE TWO-PARAMETER COMPOSED BY 6 WINDOW SPECTRA	ON-LINE DISPLAY AREA	SMALL TWO-PARAMETER	OFF-LINE DISPLAY AREA
STORAGE TYPE	CODED FIRST PARAMETER	PARTIAL TRUE SEC. PAR.	COMPLETE TRUE P1 * P2 IN ON-LINE DISPLAY AREA	FREE TRUE OFF-LINE DISPLAY AREA
EXPERIMENT CONDITIONS	P1 (4096 CHAN.) * P2 (1024 CHAN.)	256 CHAN. OF SEC. PAR.	P1 (64 CHAN.) * P2 (64 CHAN.)	4096 CH. AT USERS DISPOSAL
SECOND PAR. DATA TYPIFICATION	WINDOW 1 | 2 | 3 | 4 | 5 | 6	CHANNEL 512 - 767	CHANNEL 1, 2, 3 ..... 63, 64	FREE
DISPLAY EXAMPLES 256 WORDS DISPLAY BUFFER	5.4.1. W = 4 D (NOT USED) F = 8 B = 4 LL UL	5.4.2. W (NOT USED) D = 0 F = 1 B = 1	5.4.3. W (NOT USED) D = 1 F = 6 B = 1	5.4.4. W (NOT USED) D = 2 F = 1 B = 16
DISPLAY TYPE	PARTIAL DISPLAY OF WINDOW SPECTRUM NR.4 (SEE ALSO DISPLAY CONDITIONS)	ON-LINE MONITOR	4 TIMES 64 CHAN. OF FIRST PAR. CHAN. 21-24 OF SEC PART.	SURVEY ON A 4096 CHANNEL SPECTRUM

Fig.6 DISPLAY FACILITIES

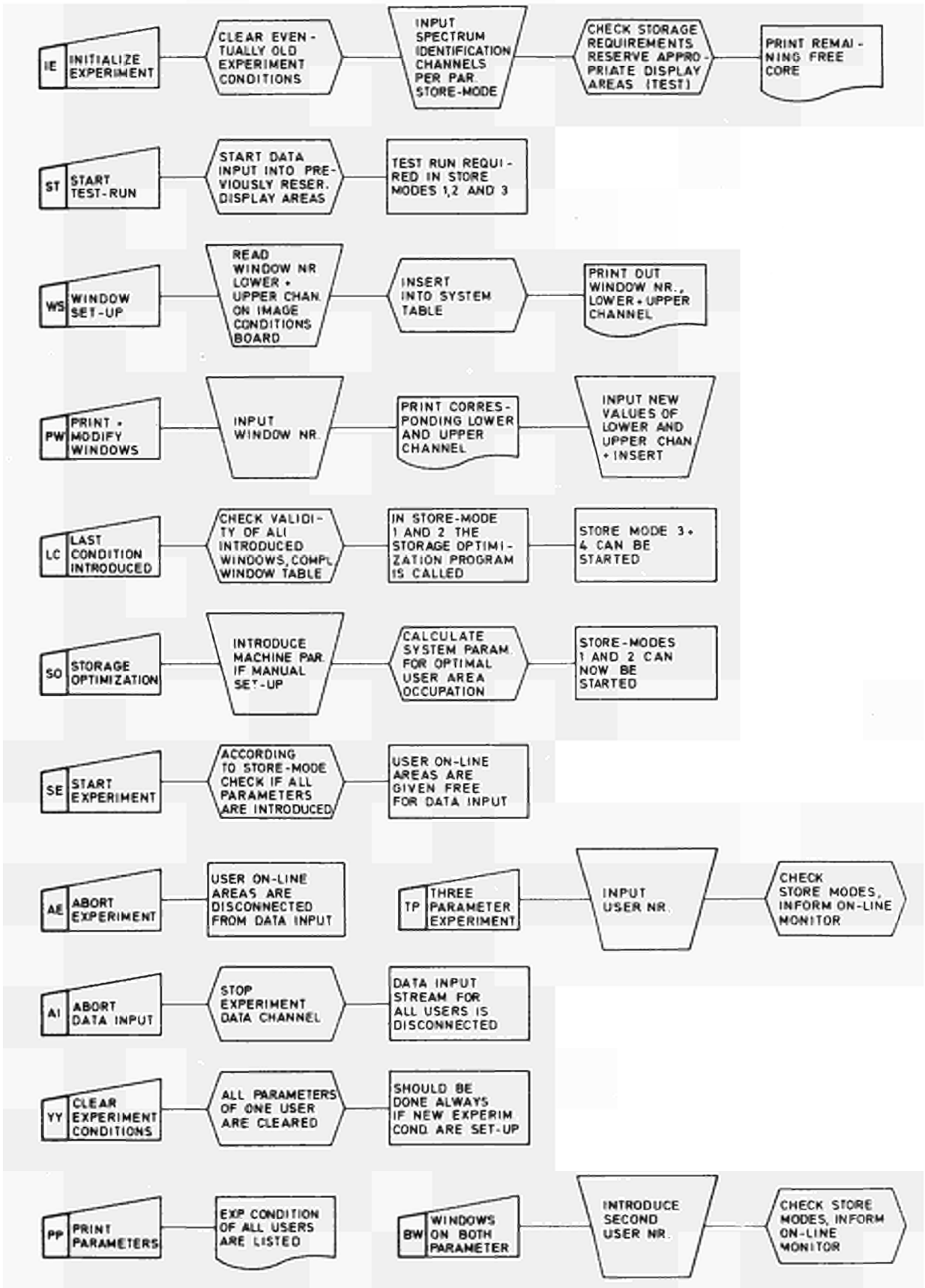


Fig.7 UTILITIES IN CONNECTION WITH EXPERIMENTS.

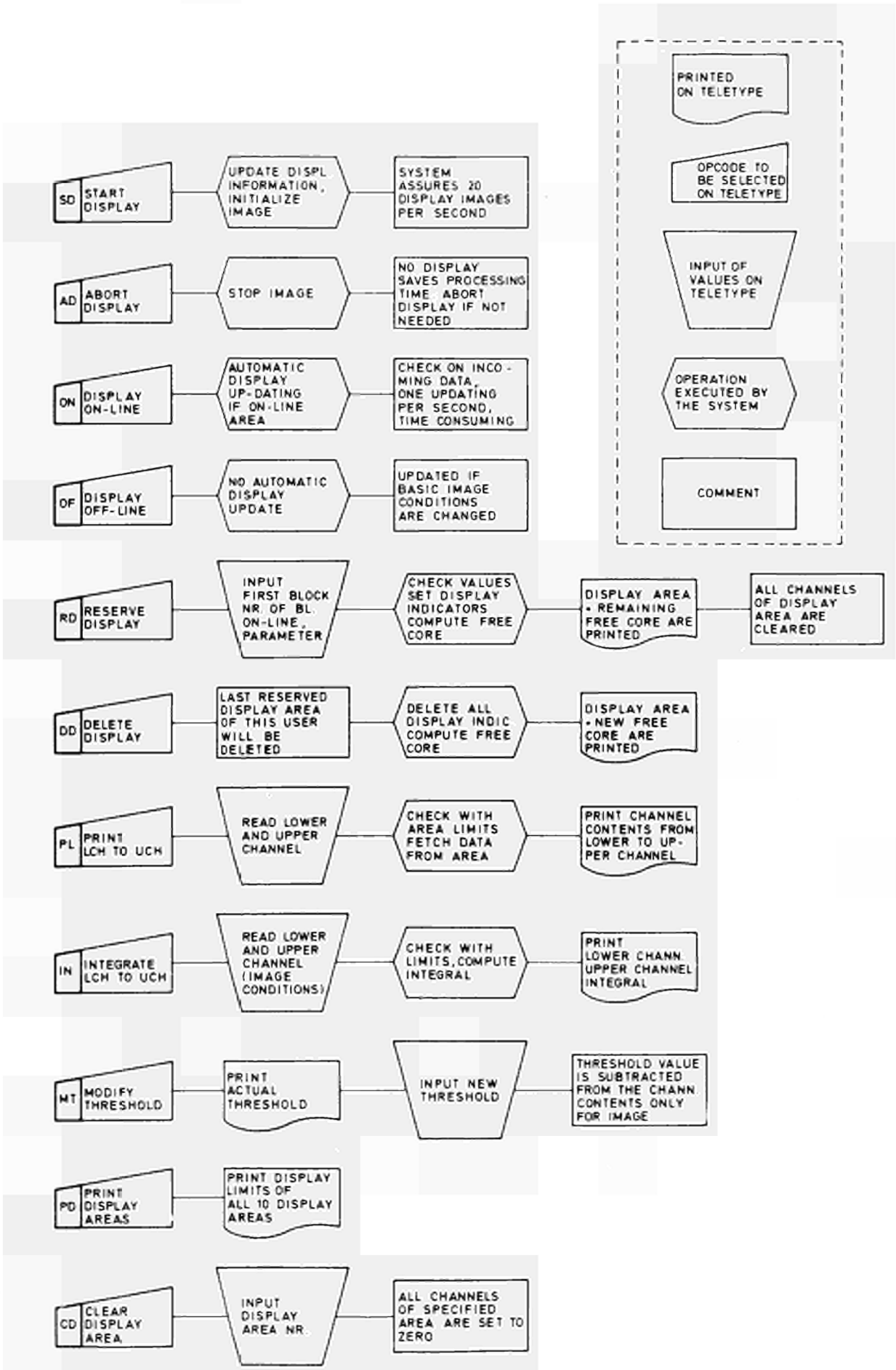


Fig. 8 DISPLAY UTILITY FUNCTIONS.

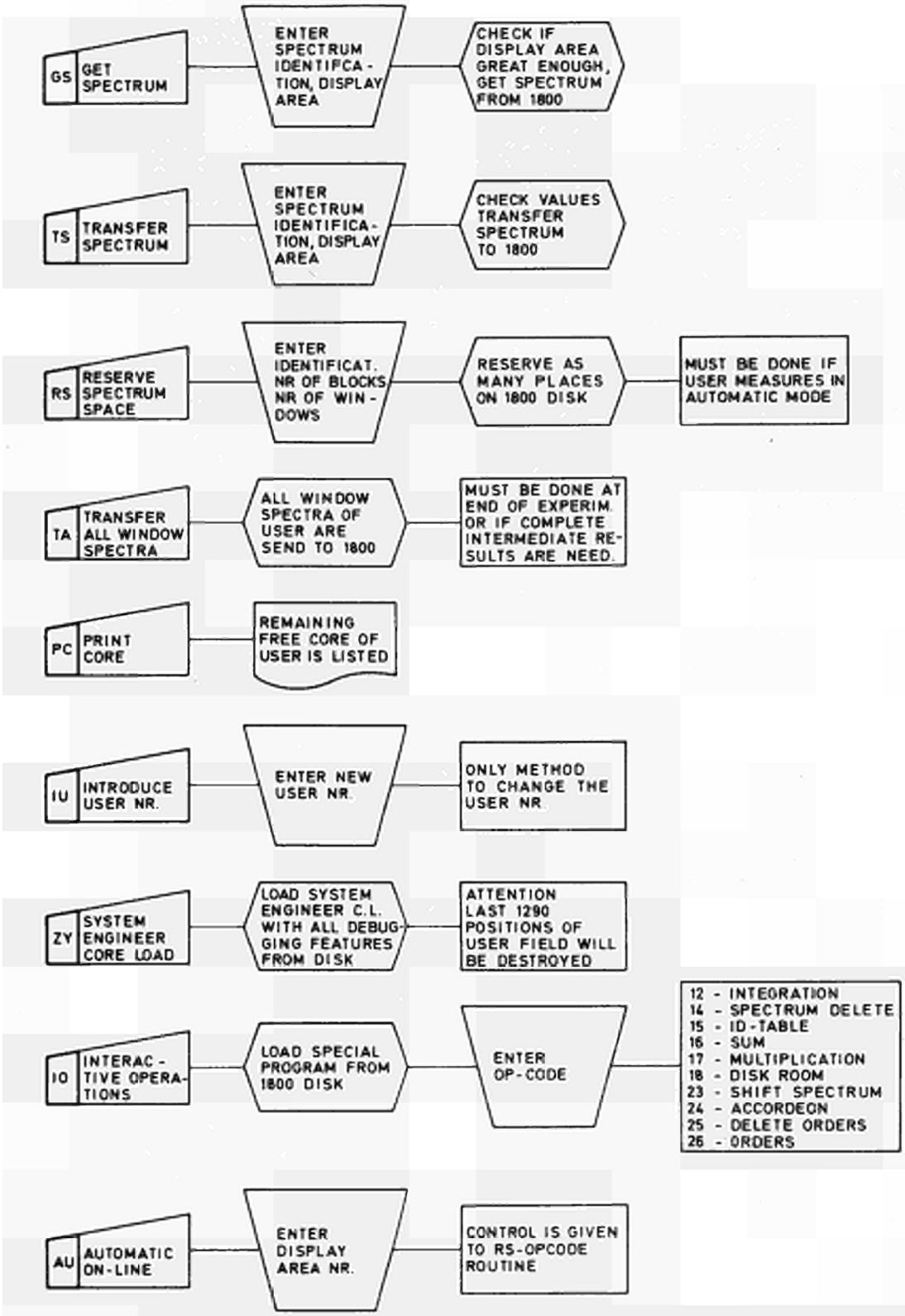


Fig.9 UTILITIES INVOLVING DATA TRANSFER BETWEEN 18/30 AND 1800

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