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# COMPUTER CONTROL OF BIS SPECTROMETER

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ABSTRACT

This paper has the purpose first to familiarize the interested reader with the computer control of the BIS spectrometer, and then to help him to use the Control Program.

Аннотация

Контроляная системэма была выработана для спэктромэтра БИС-а, работающэго на линии с ЭВМ ТРА-1.

KIVONAT

Ez a leirás a BIS spektrométer számitógépes ellenőrzésével ismerteti meg az olvasót, és egyben segitséget nyujt a felhasználóknak a Control Program használatához.

CONTENT

## 1. INTRODUCTION

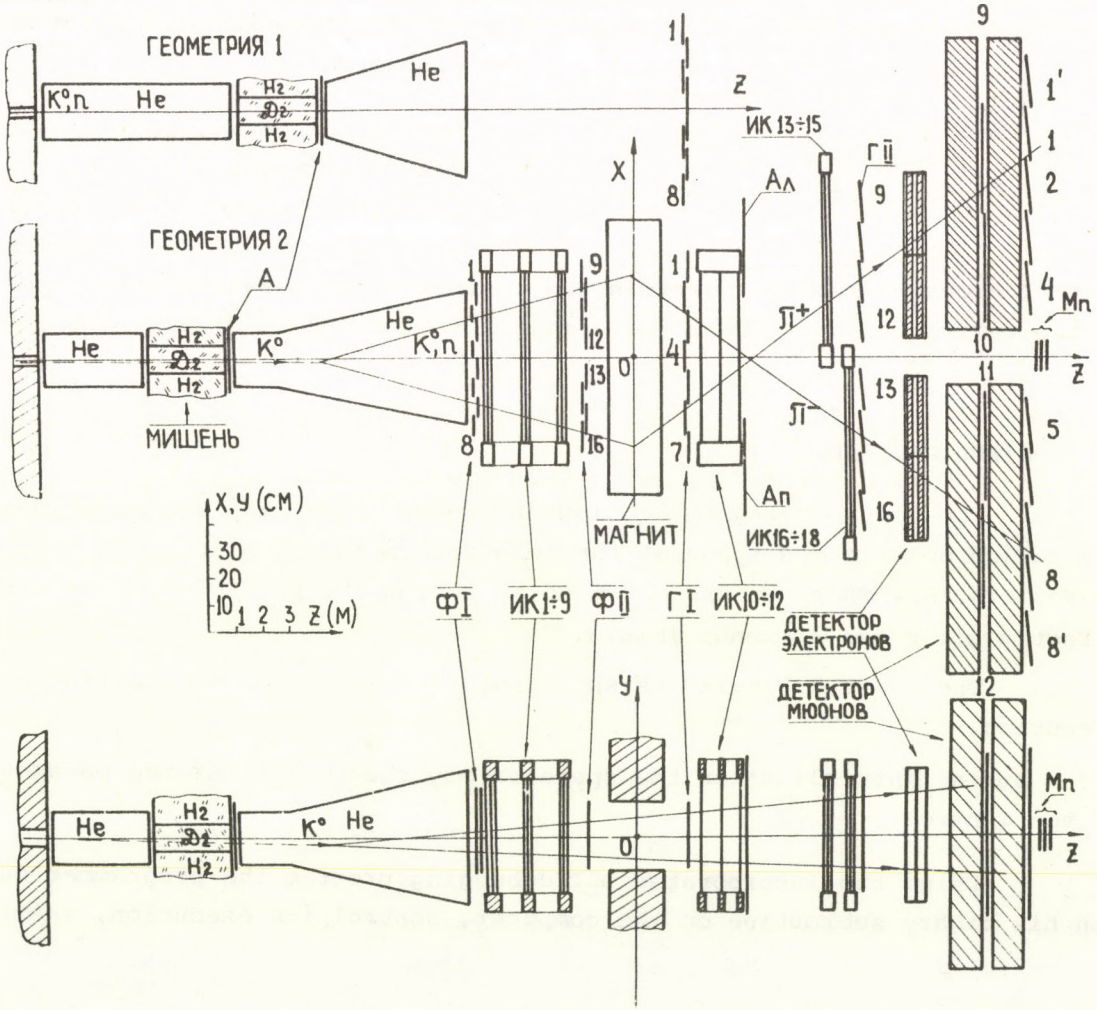
The computer control of the BIS spectrometer allows to recognize and to repair the defects of the spectrometer easily. Such a way expensive proton synchrotron time is saved and statistics of events may be collected for experiments in a minimal time.

The described control system allows to change the BIS spectrometer from one experiment to the other easily.

## II. BIS SPECTROMETER

Several important experiments were carried out with the BIS spectrometer at the 76 GeV proton synchorotron of the high energy laboratory ИФВЭ* in Serpukhov. The most important experiments are the measurement of $K^0$-regeneration, the investigation of $K_S \to \mu\mu$ decay and the search for charmed particles.

The BIS spectrometer/Fig.1./ consists of magnets, spark chambers, proportional chambers, scintillator counters, μ-detectors and electron--detectors.




* Институт Физики Высоких Энэргий

The spectrometer works on line to a BESM-3 computer. This computer records the events onto magnetic tapes. These recorded tapes are evaluated off-line on computers: BESM-6, CDC-62oo etc.

## III. CONTROL EQUIPMENT

The BIS spectrometer is on line to a TPAi small computer too /Fig.2./

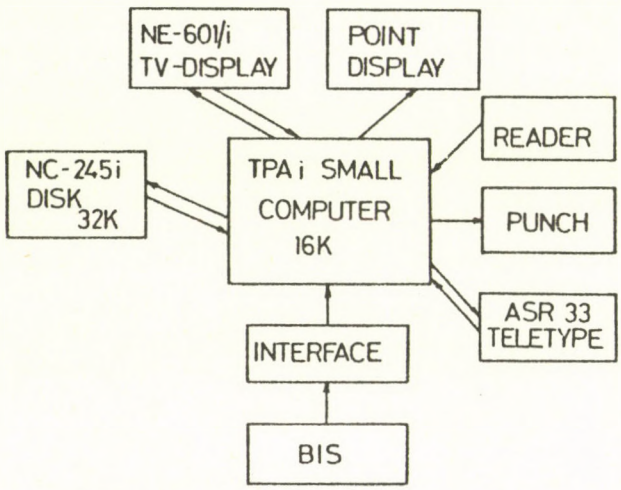



*Fig.2.*

The installed TPAi computer consists of a 16K core memory, 32K NC-245i Disc Unit, PERFOMOM 30 punch, FS 1501 reader, ASR33 Teletype and NE-601/i TV-display.

There is an interface with 256 12-bit word buffer memory between the spectrometer and the TPAi small computer, Less than 0.3 msec is needed to fill up the buffer memory. The interface drives a point display too.

During the measurement the data are transferred from the BIS spectrometer via the buffer memory into the computer core memory. The Control Program selects, controls and evaluates the measured data according to the commands given. There are commands to type or to display the results.

## IV. CONTROL PROGRAM

The Control Program consists of program segments. The program segments are called by commands typed at the Teletype in the form of maximum four characters. All commands are executed by typing the RETURN key or a comma directly after the commands /Fig.3./.

The Control Program is split into two sections: initialization and execution.

a./ During initialization the operator may change the desired parameters of the Control Program.

Using the incorporated ODT debugging program the programmer can run his binary subroutine on the computer, control its execution, examine

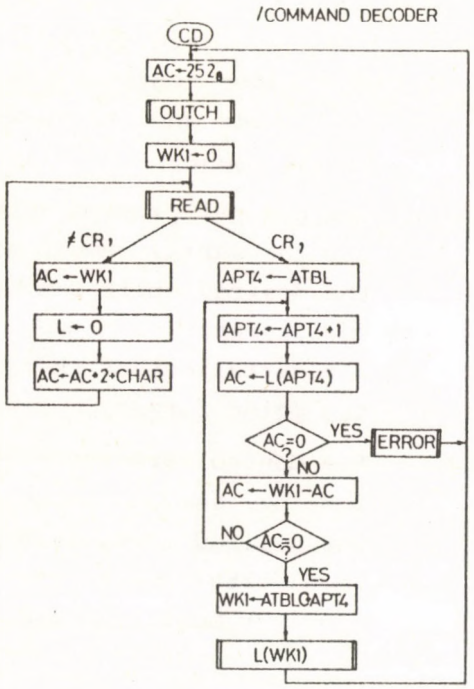



*Fig. 3.*

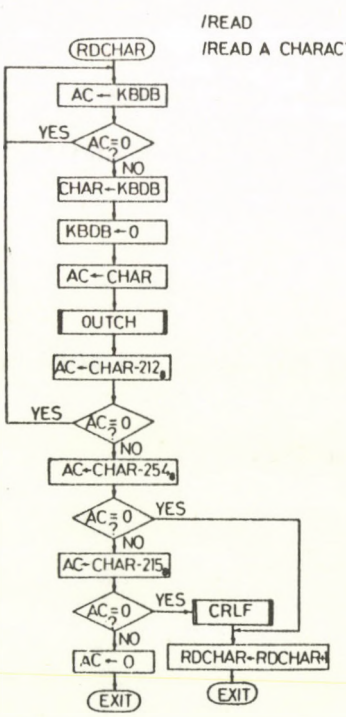



*Fig. 5.*

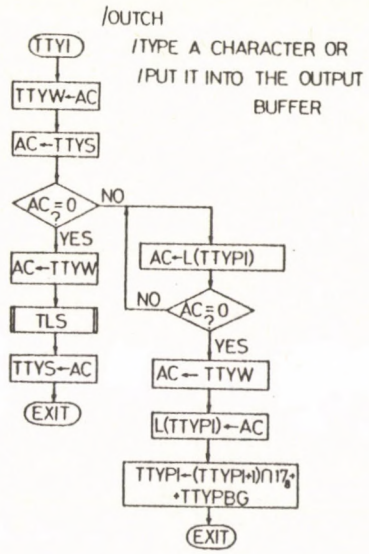



*Fig. 4.*

registers, change their contents and make alterations to his program by typing at the Teletype keyboard. The programmer may have the corrected program in binary. Finally he can incorporate his program into the Control Program. /The precise capabilities and commands of ODT are detailed in [2], [6] and Appendix A./

The Control Program may type its command set /Fig. 6 /.

b./ During execution the operator may direct the evaluation of the data by typing commands detailed below.

NOTE: The measured data overlay the command table and the ODT.

## V. COMMANDS

```
*CMND

COMMANDS:
KILL    CLEAR BUFFER
NCH     CHAMBER NO?
NEV     EVENT NO?
MRK     MARKER?
X       X VIEW
Y       Y VIEW
DHT     DISPLAY HISTOGRAM
DCH     DISPLAY CHAMBERS
S       STOP
C       CONTINUE
CLR     CLEAR DISPLAY
SLT     SELECT
FCL     START FOCAL
GO      START RUN
CMND    COMMANDS
ODT2    START ODT

*
```

*Fig. 6.*

KILL Clear the data buffer. The buffer contains the histograms and the views of the events.

NCH The Control Program waits for the serial number of the desired spark chamber. The operator must type the serial number in floating point format.

NEV The Control Program waits for the serial number of the desired event in a accelerator cycle. The operator must type the serial number in floating point format.

MRK The Control Program waits for the marker. The operator must type the place of the marker in floating point format.

X X view.

Y Y view.

DHT Display histogram according to the NCH, NEV, MRK, X and Y commands.

DCH Display the view of the event according to the NEV, X and Y commands.

S Stop execution.

C Continue execution.

CLR Clear the display buffer.

STL Select program to evaluate data. The user may write no more than 7 evaluating programs.

FCL Transfer control to the FOCAL on line interpreter.

CMND Type the command set /Fig. 6./.

ODT2 Transfer control to the ODT debugging program.

## VI. FOCAL

The Control Program contains the FOCAL on line interpreter./You may find detailed description of FOCAL in [3], [5], [10], and Appendix B./

Using FNEW function [7] FOCAL programs may read data from the core memory or may store data there in the form of one word fixpoint format.

The call of FNEW is as follows:

SET Z = FNEW /WR, F, LC,V/

Parameters:

WR = { 1 reading
     { -1 storing

F = The serial number of the field /4K/
LC = Decimal address of the word in field F
V = Value to store in case of writing

Any parameter may be a number, a variable or an expression.

The user may write programs in FOCAL to evaluate or to display [10] measured data.

The FCL command transfers the control to the FOCAL.

## VII. INPUT/OUTPUT

Information is transferred between peripherial devices and the TPAi small computer through program interrupt. The devices signal the computer when they are ready to transfer information, the program will then interrupt its normal flow and jump to a routine /SERV/ to process information, after which it will return to the point in the main program at which it was interrupted. Thus the transfers are device-initiated but under program control.

## VIII. DIAGNOSTIC MESSAGES

Error messages of FOCAL are described in [3] and [5].

When an error occurs during program execution, error message is typed on the Teletype. The Control Program types the word ERROR AT and the location where the error is encountered /Fig.7./.

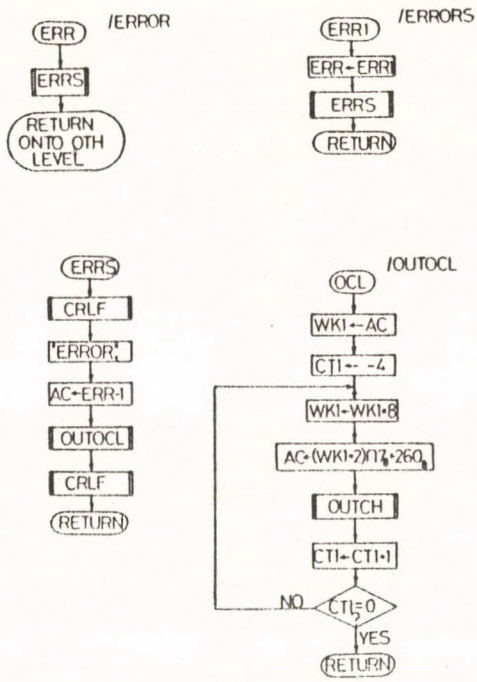



*Fig. 7.*

## IX. LITERATURE


[1] PDP8/e 1 PDP8/m Small Computer Handbook 1972. Digital Equipment Corporation, 1972, Massachusetts, USA

[2] Introduction to Programming, DEC, 1970

[3] Programming Languages, DEC, 1970

[4] Edusystem Handbook, DEC, 1973

[5] FOKAL, KFKI TPA-IY-01-MA, TPA-IY-02-MA, TPA-IY-03-MA

[6] ODT, KFKI 5114

[7] I.Manno: FOCAL in On-line Data Processing, 1975, DECUCOPE, Massachusetts

[8] I.Manno: SOFT, a Supervisor of both FOCAL and On-line Measuring Terminals, 1974, KFKI-74-53

[9] OS/8 Software Support Manual, DEC, 1973

[10] J.Eszenszki and I.Manno: Display-FOCAL, 1975, KFKI

# APPENDIX A

ODT COMMAND SUMMARY

| | |
|---|---|
| nnnn/ | Open location designated by the octal number nnnn. |
| / | Reopen last opened location. |
| RETURN key | Close previously opened location. |
| LINE FEED key | Close previously opened location and open the next sequential one for modification. |
| ↑ (SHIFT/N) | Close location, take contents of that location as a memory reference and open it. |
| ← (SHIFT/O) | Close location, open indirectly. |
| Illegal character | Current line typed by user is ignored, ODT, types ?(CR/LF). |
| nnnnG | Transfer program control to location nnnn. |
| nnnnB | Establish a breakpoint at location nnnn. |
| B | Remove the breakpoint. |
| A | Open the location in which the contents of AC were stored when the breakpoint was encountered for modification. |
| LINE FEED key | Open the location in which the contents of L were stored when the breakpoint was encountered for modification. |
| C | Proceed from a breakpoint. |
| nnnnC | Continue from breakpoint and iterate past the breakpoint nnnn times before interrupting the user's program at the breakpoint location. |
| M | Open the search mask. |
| LINE FEED key | Open the lower search limit. |
| LINE FEED key | Open the upper search limit. |
| nnnnW | Search one portion of core as defined by the upper and lower limits for the octal value nnnn using the mask. |
| T | Punch leader. |
| nnnn;mmmmP | Punch a binary core image defined by the limits nnnn and mmmm. |
| E | Punch checksum and trailer. |

# APPENDIX B

## FOCAL COMMAND SUMMARY

| Command | Abbreviation | Example of Form | Explanation |
|---|---|---|---|
| ASK | A | ASK X,Y,Z | FOCAL types a colon for each variable, the user types a value to define each variable. |
| COMMENT | C | COMMENT | If a line begins with the letter C, the remainder of the line will be ignored. |
| CONTINUE | C | CONTINUE | Dummy line |
| DO | D | DO 4.1 | Execute line 4.1; return to command following DO. |
| | | DO 4.0 | Execute all the lines beginning with 4. Return to the command following DO also when a RETURN is encountered |
| | | DO ALL | Execute the whole program |
| ERASE | E | ERASE | Erase the symbol table |
| | | ERASE 2.1 | Delete line 2.1 |
| | | ERASE 2.0 | Erase all the beginning with 2. |
| | | ERASE ALL | Delete all user input |
| FOR | F | FOR I=X,Y,Z;<br>/commands/ | Execute the commands following unless I is greater than Z. The initial value |
| | | FOR I=X,Z;<br>/commands/ | of I is X and at the end of each cycle Y is added to I. |
| GO | G | G | Start indirect program at the lowest line number |
| GO? | G? | GO? | Start at the lowest line number and trace entire indirect program until another ? is encountered or until the completion of program. |
| GOTO | G | GOTO 3.4 | Start indirect program /transfer control to line 3.4/ Must contain an argument. |
| IF | I | IF/X/Ln,Ln,Ln<br>IF/X/Ln,Ln<br>/commands/<br>IF/X/Ln<br>/commands/ | Where X is a defined identifier a value, or an expression, followed by one to three line numbers. If X is less than zero control is transferred to the first line number, if X is equal to zero to the second line number, if X is greater than zero to the third line number. |

| | | | |
|---|---|---|---|
| MODIFY | M | MODIFY 1.15 | Enables editing of any character on line 1.15. The (CTRL/L), (CTRL/BELL), RUBOUT, ← , LINE FEED and RETURN keys may be used, |
| QUIT | Q | QUIT | Return control to the user |
| RETURN | R | RETURN | Terminates DO subroutines, returns to the original sequence |
| SET | S | S A=5/B-C | Defines identifiers in the symbol table |
| TYPE | T | TYPE A+B-C | Evaluate expression and type out = and the result in current output format. |
| | | TYPE A-B,C/D | Compute and type each expression separated by commas. |
| | | TYPE "TEXT" | Types texts. May be followed by ! to generate new line, or # to generate carriage return. |
| WRITE | W | WRITE | FOCAL types out the entire indirect program. |
| | | WRITE ALL | |
| | | WRITE 1.0 | FOCAL types out all the lines beginning with 1. |
| | | WRITE 1.1 | FOCAL types out line 1.1 |

OPTIONS:

| | | | |
|---|---|---|---|
| OPTION | R | | High-speed reader input. |
| OPTION | K | | Keyboard input. |
| OPTION | P | | High-speed punch output. |
| OPTION | I | | Interpretive Input mode and Numeric Output mode. |
| OPTION | C | | Character Input/Output mode. |
| OPTION | X | | Suppress the colon printout. |
| OPTION | : | | Restore the colon printout. |
| OPTION | S | n | Set the number following "s" as the character code for an extra input terminator. Decimal value ASCII code. |
| OPTION | S | | Delete the special terminator. |
| OPTION | N | | No echo. |
| OPTION | E | | Restore the echo. |
| OPTION | M | | Start the Disk Monitor. |

# APPENDIX C

## LOADING PROCEDURE

There are two ways to load the Control Program.

a./ The Control Program is punched on two paper tapes in binary format. To load the paper tapes the FIELD LOADER must be in core.

Place binary tape 1 into the reader, set the switches to 7777 then press the LOAD ADDRess key, set the switches to 3777 then press the CLEAR and CONTinue keys in that order. When the tape has been read, the status of the accumulator lights will indicate any error in loading. If the lights are out, the loading was successful; if any lights are on, there was a checksum error and the tape must be reread. Repeat the described procedure with binary tape 2.

The Control Program starts at 200 in field 2.

b./ The user may load the Control Program using the Disc Monitor System. This procedure is shown on Figure 8.

```
.PIP
*OPT-L

*IN-S:

FE=0033

NAME  TYPE     ELK

AF
PALD.SYS (0) 0037
PIP .SYS (0) 0025
LOAD.SYS (0) 0011
.CL..SYS (0) 0007
EDIT.SYS (0) 0015
ASC .ASCII   0103
ODT .USER(2) 0004
FLTG.USER(2) 0011
FCL .USER(2) 0037
OL1 .USER(2) 0004
OL2 .USER(2) 0016

*OPT-
.CALL OL1
.CALL OL2
.CALL ODT
.CALL FLTG '
.CALL FCL
 *CMND

COMMANDS:
KILL   CLEAR BUFFER
NCH    CHAMBER NO?
NEV    EVENT NO?
MRK    MARKER?
X      X VIEW
Y      Y VIEW
DHT    DISPLAY HISTOGRAM
DCH    DISPLAY CHAMBERS
S      STOP
C      CONTINUE
CLR    CLEAR DISPLAY
SLT    SELECT
FCL    START FOCAL
GO     START RUN
CMND   COMMANDS
ODT2   START ODT

*GO
*FCL


C-FOKAL, 1971
*
```

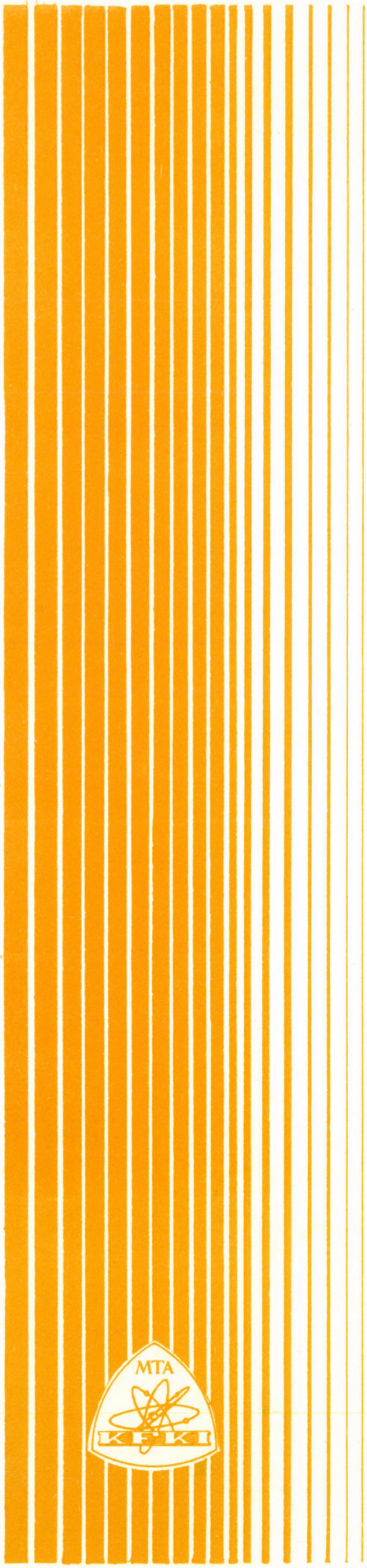
# APPENDIX D

EXAMPLE

BEAM DISTRIBUTION AT THE 1ST CHAMBER  Y VIEW
MEASURED BY THE BIS SPECROMETER
DATE: 16. V. 1975.  SERPUCHOV

BIN CONT  ENTRIES= .514000E+04  MEAN= .309813E+02

```
 1    1
 2    0
 3    2
 4    1
 5    1
 6    2
 7    5 X
 8    5 X
 9    5 X
10   14 XXX
11   24 XXXXXX
12   23 XXXXX
13   29 XXXXXXX
14   32 XXXXXXXX
15   43 XXXXXXXXXX
16   38 XXXXXXXXX
17   59 XXXXXXXXXXXXXX
18   79 XXXXXXXXXXXXXXXXX
19   91 XXXXXXXXXXXXXXXXXXXX
20  106 XXXXXXXXXXXXXXXXXXXXXXX
21  130 XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
22  139 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
23  160 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
24  171 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
25  187 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
26  193 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
27  216 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
28  227 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
29  231 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
30  239 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
31  240 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
32  237 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
33  238 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
34  219 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
35  218 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
36  199 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
37  185 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
38  176 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
39  143 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
40  135 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
41  128 XXXXXXXXXXXXXXXXXXXXXXXXXXXX
42  107 XXXXXXXXXXXXXXXXXXXXXXXX
43   77 XXXXXXXXXXXXXXXXXX
44   86 XXXXXXXXXXXXXXXXXXX
45   73 XXXXXXXXXXXXXXXXX
46   60 XXXXXXXXXXXXXXX
47   44 XXXXXXXXXX
48   28 XXXXXXX
49   31 XXXXXXX
50   22 XXXXX
51    9 XX
52    4 X
53    6 X
54    9 XX
55    5 X
56    4 X
57    3
```




Kiadja: a Központi Fizikai Kutató Intézet
Felelős kiadó: Pintér György, a KFKI
Részecske- és Magfizikai Tudományos
Tanácsának szekcióelnöke
Szakmai lektor: Telbisz Ferenc
Nyelvi lektor: Sebestyén Ákos
Példányszám: 450 Törzsszám: 75-972
Készült a KFKI sokszorosító üzemében
Budapest, 1975. augusztus hó