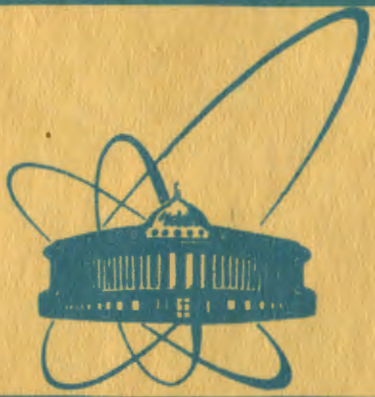

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PROGRAM PACKAGE FOR DATA PREPARATION OF RISK EVENTS.

Part I. The Description of Program SMHV

1980

I. INTRODUCTION

Photos obtained from the RISK chamber[1] are measured by collaboration's members with different measuring devices. Two of them are the measuring tables SAMET and ПУОС[2], half-automatic devices widely used in Dubna. Another one is the automatic scanning and measuring device HEVAS[3], developed in Berlin. These devices supply digitized coordinates of tracks and vertices of events for further geometrical reconstruction - but in a different format.

Program SMHV (from SaMet to HeVas) is designed for transforming the data obtained from SAMET and ПУОС to such a format as if they are obtained from HEVAS. This makes possible to use one input processor for geometry program independently of the measuring device and to interchange the measured data between collaboration members.

The track and vertex coordinates digitized by SAMET or ПУОС are recorded on a magnetic tape by means of the on-line computer БЭСМ-4. We will call this tape "SAMET tape", its format "SAMET format". The SAMET tape will be one of the inputs of SMHV program.

The SAMET format was not originally planned for RISK events but for measuring events from a 2 meter propane chamber. This makes its characteristics differ significantly from the peculiarities of RISK events.

Differences between SAMET format and RISK event's characteristics:

	SAMET format	RISK events
Maximum number of views	3	8
Maximum number of fiducials/view	6	14
Maximum number of tracks/view	16	>16
Vertex coordinates	No possibility to measure	Secondary interactions and neutral decays seen in the chamber
Maximum number of rolls handled by the device	3	Photos from the same event are on 4 different rolls

Because of these differences we need special measuring instructions on SAMET and ПУОС units for RISK event measuring. On these devices there is no possibility to measure all of the views of one frame simultaneously. The operator measures only two views (one stero-pair) regarded as a sub-event. This sub-event we call a flex. An event having tracks through the whole chamber has 4 flexes. The flexes of an event are measured at different time, may be with different devices. We only assume that all of the flexes of a given event are on the SAMET tape. The program SMHV gathers these flexes and forms out of them one event in HEVAS format. It may happen that one view contains more than 16 tracks. In this case operator measures it in two (or more) flexes, and this event will have more than 4 flexes.

The program uses the following input/output streams of data (see fig.1):

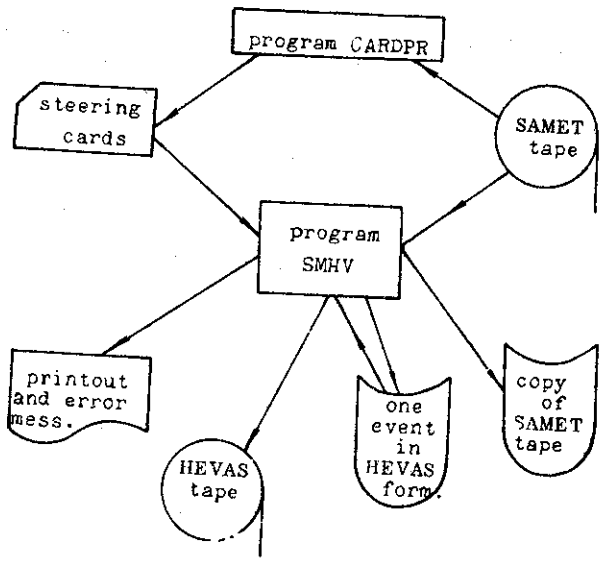

Fig.1. The input/output data streams of the program SMHV.

- Steering cards (generally from card reader), to tell to the program which events from the SAMET tape to process, and what is the topology of these events. If we want to process all events from the SAMET tape (maximum 50 events can be processed in one program run) and if the operator sends to the SAMET tape the description of topology then program

CARDPR, an auxiliary program to SMHV, prepairs these steering cards. The logical unit number for this file is a parameter of the program.

- The SAMET tape (logical unit number = 31).
- Intermediate files for SAMET tape copy and for events ready in HEVAS format (LUN = 11, LUN = 41).
- The HEVAS tape (LUN = 21).
- Printout (LUN = 2).
- Error messages (LUN = 99).

II. MEASURING INSTRUCTIONS

In case we use the program SMHV to get the measurement result in HEVAS format, the measuring operator must follow the following instructions during the measurement on SAMET or ПУОС.

1. The identification of the event (flex)

When starting the work the operator sends to the on-line computer the following information identifying the flex:

roll number
frame number
remeasurement number
first view number of the stereo-pair (e.g., if this flex belongs to stereo-pair 3-4, the first view number of the stereo-pair is 3)

2. Topology of the view

The description of the view topology must be sent by the operator only in case one wants to use the program CARDPR. Otherwise the topology must be described by steering cards. For information on event topology to be sent to the on-line computer see appendix A.

3. Fiducial measurements

The on-line program of SAMET and ПУОС devices accepts only 6 fiducial coordinates. Therefore the operator must measure only the first fiducial when the on-line program asks him for fiducial coordinates. If the first fiducial of the view is not seen then he measures the second one twice, if

it is not seen either then he measures the third one three times, etc.

The first track's place is used for the coordinates of fiducials. That is, when the online program asks for the measurement of the first track, the operator sends the coordinates of the fiducials, in the order shown by fig.2. If one fiducial is missing then the operator must measure the previous one twice, if two are missing one after the other, then he must measure the last one three times, etc.

There is a possibility in SMHV program which allows one to measure the fiducials in any order. If one uses the Patchy control card +USE, FIDUREC, then the program recognizes the fiducials by their coordinates.

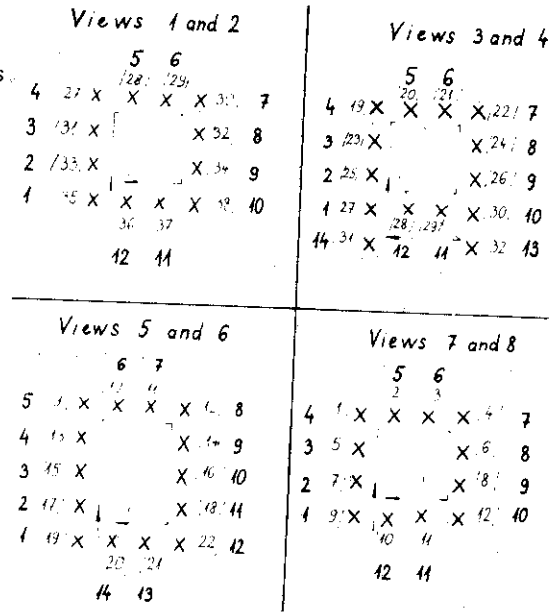

Fig.2. The measuring order of fiducials. Number outside the brackets means the measuring order, number in brackets stands for fiducial labels used in geometry program.

4. Vertex measurements

A vertex must be measured as a track having only one coordinate point.

5. Order of track and vertex measurements

According to the so-called "HEVAS measuring strategy" one must measure the tracks in the following order:

i. the beam track if any,
ii. tracks from the main apex if any, in any order and hanging tracks if any, in any order,
iii. vertices of secondary charged interactions just after the measurement of the decaying track,

iv. tracks from secondary charged (or neutral) interactions just after the measurement of its secondary vertex,

v. neutral secondary vertices with their tracks.

III. STEERING CARDS

The program SMHV needs the following two obligatory steering cards on logical unit:

i. INPCODE, in (I1) format.
This must be always 1 for the time being.

ii. INPLUN, in (I2) format.
This is the logical unit number of the further steering card input. It must be 50 if the cards are prepared by CARDPR.

If INPLUN = 1, then there follow 5 cards for every event to be processed by SMHV: one header card and 4 view-cards.

iii. The header card contains in
(2(I4,1X), I6, 1X,I3,1X,I1,1X,I2,1X,I4,1X,I1)
format the following data:
roll number,
frame number,
date of run,
trigger information,
beam type,
beam momentum,
run number,
end mark.

If the end mark $\neq 0$, the reading of cards stops.

iv. The view card can be empty (if the given view - pair is not measured) or it can contain in
(3(I1,1X),2(I2,1X),2I3,19(1X,I2))
format the following:
first view number of the stereo-pair,
remeasurement number,
number of flexes for this view-pair,
view numbers of this pair (e.g., 34 for views 3 and 4),
number of vertices,
number of tracks,
number of tracks from the main apex (this must be negative if the beam is included),
number of hanging tracks,
number of one-prong secondaries,
number of two-prongs secondaries,

number of γ's,
number of V^0 s,
one two digits number for every secondaries with more than two prongs (max.14 times).

For each secondary with more than two prongs there stands a code number (1 for charged, 2 for neutral secondary) together with the number of tracks. E.g., 24 stands for a 4-prongs neutral star.

IV. PROGRAM OPTIONS

The SMHV source program is stored on a pamfile, which has to be edited by the program YPATCHY /4/ before compilation. One has the following possibilities to select program options by Patchy steering cards:

1. Fiducial recognition

+USE,FIDUREC

This card forces Patchy to build in to the program SMHV the subroutines which find the standard order of fiducials measured in any order (only the first fiducial must be measured first). The fiducial coordinates are identified using the result of averaging a few hundred fiducial measurements. Averaging was done by the program KERTAV, stored on the SMHV pam-file. If the optical characteristics of RISK chamber or SAMET - ПУОС devices change by any reason, then averaging must be done again and data values for variables IFID1 and IFID2 must be updated in the subroutine FELISM.

The following two cards trigger the printout of fiducial recognition results:

+KEEP, FERPRNT.

DATA IDEBUG(i)

If i=1, results of successful fiducial recognition will be printed.
If i=2, only the unsuccessful recognitions are traced.
If i=3, the result of all fiducial recognition will be printed.

The recognition is successful if more than 6 fiducials are found and identified. This number can be also changed by a data statement in the SMHV main routine (variable MINFID).

The fiducial recognition slightly differs for SAMET and ПУОС devices. In case of ПУОС measurements one has to use the +USE,PUOC. Patchy steering card too.

2. Extended printout

+USE, PRINT.

With this card a lot of additional printout appears on the output listing:

- printout of steering cards
- extended error messages (only in Hungarian)
- printout of fiducial recognition results
- printout of found topology of each view (not the one described by the measuring operator, but the one really found by the program on the SAMET tape)
- printout of the full event on HEVAS format.

Each printout can be triggered separately by +KEEP cards, by the definition of the following sequences (in the order of the above list):

Z=FLPRNT,KIIRHIB,FELPRNT,KIIRTOPO,ATKPRNT2.

(For further details consult the listing of P=PRINT patch).

Patch PRINT triggers extended printout for SMHV auxiliary programs too.

3. Secondary vertex-track connections

In the HEVAS format the incoming and outgoing tracks of a secondary interaction have similar labels together with the secondary vertex. To realize which tracks are going to or coming from the same vertex the SMHV compairs the coordinates of the secondary vertex with the last point of the last track and with the first point of further tracks. If the distances between these points are less than $\sqrt{\text{SZIGMA2}}$, then the SMHV connects them to each other, that is, gives them the same HEVAS label. For the definition of variable SZIGMA2 one has to use the following Patchy cards:

+KEEP, SZIGMA2.

SZIGMA2 = ...

The default value is 800 (SAMET units)^2 (800 $(2.5\mu)^2$), that is, tracks are connected to vertex if for its first (last) coordinates and vertex coordinates there stands:

$$(X_{vx} - X_{tr})^2 + (Y_{vx} - Y_{tr})^2 < 800$$

4. HEVAS unit number

The SMHV produces the HEVAS tape as if it were measured on HEVAS unit number 1. This value can be changed by the redefinition of sequence Z=MHSZ.

5. Error messages

If the format of events on the SAMET tape is not correct or the topology of the view described on the steering cards

does not coincide with the measured one, error messages are printed. The error messages contain the error code, roll, event, view, remeasurement number of the view, SAMET unit number, measuring operator code and a short explanation in Hungarian (if Z=KIIRHIB is redefined). Here we list the error codes together with their explanation in English.

Error code	Explanation
2	Unrecognisable data on the SAMET tape
3,4,5,18,19	Number of fiducials in a continuation flex does not coincide with the same number in first flex of the view pair.
6	No fiducial measurement in the first flex.
7	No fiducial measurement in the continuation flex.
8	Fiducial recognition failed.
9	Identification of flex missing.
10,11	Not enough memory for this view.
12,13	Number of tracks or vertices is not the same with the one given on the steering cards.
14,15	Number of secondaries is not the same as on the steering cards.
16,17	Number of fiducials <MINFID (=6 as default), or more than 20.
20	V° or γ with one track.
21	Track from a secondary interaction without secondary vertex.

An error code * * * is generated together with error codes 12,13,14,15,20 and 21. There can occur such a situation when these codes do not appear between error messages. In this case the code * * * attracts attention to some debug in the SAMET tape.

APPENDIX A

Description of the SAMET format

Measuring information obtained with SAMET or ПУОС devices are first recorded to the drum of an on-line computer БЭСМ-4, then copied onto magnetic tape by means of a computer CDC-1600. The latest one has word length of 48 bits, therefore in the following description by a "word" we will mean a bit group of 48 bits. Bit positions are numerated from right to left.

The SAMET tape consists of records. The length of a record is 256 words at most. One flex may consist of one or more records. If the first word of a record is 0, it means that the flex is continued in the next record too. The measurement information starts from the second word of the records.

The information on the SAMET tape is coded in two different formats. The coordinate values of a point are written in normal binary format into some bits of a word. This coding will be marked by the letter B in the following description.

Another way of coding used on the SAMET tape is to write one decimal digit on four bits. E.g., number 11 in this coding looks like 0001 0001 (while in a binary coding would be 1011). We will call this coding "decimal format" and mark it by a letter D (the name of hexadecimal coding would be more precise, since in 4 bits one can represent 16 different values).

The structure of a flex is as follows:

Header information (5 words at least)
View header (1 word)
Track header (1 word)
Track coordinates (one word for each point) } repeated for each track measurement } Twice
.
.
Track trailer (2 words)
:
View trailer (1 word)
Flex trailer (3 words)

The header information:

Word number	Bit positions	Coding	Content
1	1÷48	B	Record counter. If 0, continuation records follow.
2	13÷24	B	Total length of the flex not counting this word and the record counter (s).
3	1÷12	D	Roll number.
	13÷28	D	Frame number.
	29÷32	D	Remeasurement number.
	33÷36	D	The smallest view number. E.g., for view 3 and 4 here stands 3.
4			Not used.
5	21÷28	D	Measuring table number.
	29÷36	D	Operator code.

6	1÷4	D	Number of vertices for this view pair.
	5÷12	D	Number of tracks for this view pair.
	13÷20	D	Number of tracks from the main apex (including beam), if the main apex is seen in this view pair.
	21÷28	D	Number of hanging tracks for this view pair.
	29÷33	D	Serial number of this flex in the view pair - 1. For continuation flexes bits 1÷28 are not used, only this serial number is requested.
7 and further words	1÷4	D	Label =0: no beam measured 1: beam measured 2: special tracks 3: charged secondary 4: neutral secondary
	5÷12	D	- for label 0 and 1: beam type (1 for Π^-, 2 for K^-, 3 for $\bar{p}$, 4 for $\bar{D}$) - for label 2: track type (1,2,3,4 as above and 5 for "black" tracks, 6 for electron or positron) - for label 3 and 4: vertex type (1 for V^0, 2 for γ, 3 for $V^\pm$, 4 for K_τ decay)
	13÷20	D	Target number (0÷10,20 for gas)
	21÷28	D	- for label 0 and 1 not used - for label 2: number of special tracks - for label 3 and 4: number of secondary tracks
	29÷32	D	Number of flexes for the total event. This is the only information concerning not one stereo-pair but the full event.

There is one such a word for the main apex (label 0 or 1) for every type of special tracks (label 2) and for every secondary interaction (label 3 or 4) seen on the given stereo-pair.

Words 1÷5 are used by the program SMHV, words 6 and further describe the view topology and are used only by program CARDPR, which prepairs steering cards for the SMHV.

The end of header information (beginning of view header) is marked by the first word after word 5 having non zero value on bit positions 33÷36.

The view header and trailer:

	Bit positions	Coding	Content
Header:	33÷36	B	View number
Trailer:	17÷20	B	3

The track header and trailer:

	Bit positions	Coding	Content
Header:	1÷8	B	Track serial number 0 means: fiducial measurements (only the first fiducial), 1 means: first track containing fiducial coordinates.
Trailer:			
Word 1.	1÷48	B	0
Word 2.	1÷48	B	0

Vertex is measured as a track with one pair of coordinates.

Track coordinates:

Bit positions	Coding	Content
1÷16	B	Y coordinate } in SAMET
21÷36	B	X coordinate } unit =2.5μ

Flex trailer: three zero words.

APPENDIX B

Deviations of HEVAS format produced by the SMHV from the standard one

The description of standard HEVAS format can be found in several papers, among others in refs./3,5/.

The program SMHV does not use all possibilities allowed in the HEVAS format. Since SMHV auxiliary programs can deal only with such a restricted format, we enumerate here these restrictions:

1. Length of header block is 40 TPA words (This is the smallest number of TPA words which can be read without word-

fraction by all of the computers TPA, IBM, ЕЭСМ-6, CDC). The words 3÷40 of header block contain 0.

2. For the length LRREAD of main block there stands:
   $LRREAD \leq 2040$ TPA words

and

   $mod\ (LRREAD, 40) = 0.$

3. The label LAB1 for fiducial data unit is always 6000B.
4. The following data units are not produced by SMHV:
   - ionization block: DU 2000,
   - road block : DU 3000,
   - topology block : DU 7040,
   - operator comments: DU 7001÷7004,
   - deletitions : DU 7021÷7023.
5. Order of data units in one frame:
   - DU 7015 in a separate main block,
   - DU 7010,
     DU 6000,
     DU's for track and vertices, according to HEVAS measuring strategy,
     DU 7030
     From DU 7010 to DU 7030 everything is in one main block (except if it would be longer than 2040 TPA words).
   - After the last view-event in a separate main block:
     DU 7031,
     DU 7050 (trigger information, new for SMHV),
     DU 7033.

6. In every data unit which needs the time of beginning and finishing of measurement there is zero instead of this information.

For SMHV auxiliary programs restrictions 1,2,5 are the most important.

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