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MONTE CARLO SIMULATION OF DIFFRACTION DISSOCIATION EXPERIMENTS WITH THE BIS-2 SPECTROMETER

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I. INTRODUCTION

GEANT /1/, a general program for the Generation of Events ANd Tracks in electronic experiments, has been written at CERN for use in a variety of such experiments.

For each experiment a special user package is necessary to realize the set-up geometry, the properties of given reactions and others (see, for instance, NA4SIMUL/2/).

For the user of GEANT some familiarity is requested with the following program packages:

- HBOOK /3/ for histogramming and related topics
- ZBOOK /4/ for the management of the dynamical data bank structure
- FFREAD /5/ for format free data card input.

In the simplest case the existing program package MCBISDD/GEANT can be used as a black box only knowing the data and control cards for MCBISDD and GEANT as well as the elementary principles of GEANT. In order to introduce some new physics and/or histograms it is required already some knowledge of MCBISDD and the corresponding elements of HBOOK. The creation of new data cards is possible only knowing the principles of FFREAD.

The advances user, who wants to manipulate with the contents of memory banks, has to know the principles of ZBOOK.

A considerable knowledge of GEANT is required to write a completely new user package for any other experiment.

II. GENERAL STRUCTURE OF MCBISDD

MCBISDD is a GEANT user subprogram package for the event simulation which is used to prepare or to analyze experiments with the spectrometer BIS-2 /6/.

BIS-2 has been set up to search for charmed particles at the 76 GeV/c Serpukhov accelerator.

The package MCBISDD has been written to simulate events for a planned experiment on coherent and diffractive neutron dissociation/7/ with the BIS-2 spectrometer.

Before reading the documentation, the reader is referred to the GEANT documentation/1/ to get a rough understanding of the principle of GEANT.

MCBISDD/GEANT is working on the Dubna CDC-6500 computer.

As a convention, all GEANT User subprograms start with the letters "GU", the corresponding GEANT subprograms with the letter "G". No special convention exists for the names of the subprograms which are called from the "GU..."-routines.

The main tasks of all MCBISDD elements are summarized in the following table:

Initial stage

GUINIT	- Initialization of MCBISDD
LBCMZB	- Definition of the blanck common length
GUREAD	- Definition of special data cards for MCBISDD
SETDAT	- Setting of default values
GUPRIN	- Without own action
FLOINT	- Type transformation for input data
POSPC	- Definition of positions for MWPC's
POSSC	- Definition of positions for counters
GUGEOM	- Submission of geometrical information on MWPC's and counters
GEOPC	- Preparation of geometrical information for MWPC's
GEOSC	- Preparation of geometrical information of counters
GUBOOK	- Organization of histogram booking
BOOKY	- Booking of special user dependent histograms
XMSQKL	- Calculation of squared mass distribution
EXPTPP	- Calculation of four-momentum transfer distribution

Working stage

STEP 1: Kinematics

GUGET	- Not used in MCBISDD at present
GUKINE	- Control of the generation of events according to the physics reaction chosen by data cards
BEAM	- Generation of the actual beam momentum
GNGAU	- from a given gaussian
HISTIN	- from a read in histogram
TRGCU/TRG	- Generation of vertex coordinates in a cubic/ cylindrical target, respectively
KINEDD	- Kinematics of the reaction $n+\{ {p \atop C} \} \rightarrow K^{\circ}+\Lambda+\{ {p \atop C} \}$
BACKKI	- Organization of the background reaction kinematics

DALKIN - Three-body decay kinematics [9]

STEP 2: Tracking

GUDCAY - Decay kinematics of different particles (Λ , K° , $\pi^{\pm}$, π°)

DECAY - Two-particle decay; the momenta of decay particles are given in the parent rest system

GUMED - Calculation of the medium number for given space point within the spectrometer geometry

GUFLD - Calculation of the field value and the medium number for a given space point in the spectrometer magnet

GULOSS - Calculation of the energy loss for particles of given momenta in a given medium

GUHALT - Possible drop of the processing of the current event

GUTRA - Unconditional stop of the processing of non-complete events, filling of histograms after tracking, print of one-line summary for each good event

STEP 3: Hits on Detectors

GUHITS - Not used in MCBISDD

STEP 4: Digitization

GUDET - Digitization for scintillator hodoscopes (non-standard detectors in the context of GEANT)

GUEFF - Efficiency calculation for single elements of detectors

GUBKD - Not used at present

GUDIGI - Print out of HBOOK displays of generated events in two projections as seen by the detectors

Reinitialization

GUTRIG - Finalization of the event (e.g. updating of all internal counters)

Final Stage

GULAST - Finalization of MCBISDD/GEANT (print out of histograms and counters, EOF on output tapes)

BISERR - Error recovery subprogram

Peripheral Data Transfer

EDITY	- Output of user-dependent histograms on disk
FILLY	- Filling of user dependent histograms
GUGET/GUSAVE	- Not used at present
OUTTP	- Write-out of information in a compressed user dependent format

III. CONTROL CARDS FOR MCBISDD/GEANT

III.1. Single Module Loading Version

A typical joblisting, as shown in fig.1a, is explained as follows:

1. The MCBISDD subprograms to be modified are updated and compiled. The UPDATE input is taken from a special file (UBISNG, UPPI,...).
2. The main program of GEANT is compiled together with some GEANT subprograms modified for special tasks of MCBISDD. The UPDATE input is taken from the file BGEANT. Some print-out inside GEANT can be activated if the corresponding UPDATE input is added to the file BGEANT.

```
MENH1,T200,P20.   NOWAK, HANNA  (LHP)
ACCOUNT,PLVEN.
COMMENT.
COMMENT.      ******************
COMMENT.      *  MCBISDD/GEANT  *
COMMENT.      ******************
COMMENT.
REDUCE.
ATTACH,OLDPL,NOWAKMCBIS2SOURCE62807,ID=LVEBIS,MR=1.
ATTACH,USIGMA,NOWAKUSIGMA62807,ID=LVEBIS,MR=1.
UPDATE,I=USIGMA,L=1.
FTN,I=COMPILE,L=0.
RETURN,USIGMA,OLDPL,COMPILE.
COMMENT.----------------------------------------
ATTACH,OLDPL,NOWAKGEANTSOURCE62807,ID=LVEBIS,MR=1.
ATTACH,BGEANT,NOWAKBGEANTNEW62807,ID=LVEBIS,MR=1.
UPDATE,Q,I=BGEANT,L=0.
FTN,I=COMPILE,L=0.
RETURN,BGEANT,OLDPL,COMPILE.
COMMENT.----------------------------------------
ATTACH,GEANT,NOWAKNONOVGEANTLIB62807,ID=LVEBIS,MR=1.
ATTACH,BISLIB,NOWAKBISLIB62807,ID=LVEBIS,MR=1,PW=BIS.
LIBRARY,GEANT,BISLIB.
ATTACH,TAPE5,NOWAKDSBISDD62807,ID=LVEBIS,MR=1.
ATTACH,BISDD,NOWAKMCBISDDBIN62807,ID=LVEBIS,MR=1.
COMMENT.========================================
LOAD,LGO,BISDD.
EXECUTE.
EXIT.
COMMENT.========================================
LIST
READ  5  LOGICAL UNIT FOR DATA CARDS
STOP
```

Fig.1a. Typical joblisting for a MCBISDD single module loading job.

```
11.59.55.ATTACH,OLDPL,NOWAKMCBIS2SOURCE62807,ID=L
11.59.55.VEBIS,MR=1.
11.59.56.PF CYCLE NO. = 001
11.59.59.ATTACH,UKLC,NOWAKUKLC62807,ID=LVEBIS,MR=
11.59.59.1.
12.00.01.PF CYCLE NO. = 001
12.02.48.UPDATE,I=UKLC,L=0.
12.05.57.LOCKIN.
12.06.04.UNLOCK,EXP.
12.06.29. UPDATE COMPLETE.
12.06.29.FTN,I=COMPILE,L=0.
12.08.38.     3.888 CP SECONDS COMPILATION TIME
12.08.39.RETURN,UKLC,OLDPL,COMPILE.
12.08.41.MAP,OFF.
12.08.41.-------------------------------------
12.08.41.ATTACH,OLDPL,NOWAKGEANTSOURCE62807,ID=LV
12.08.41.EBIS,MR=1.
12.08.42.PF CYCLE NO. = 001
12.08.42.ATTACH,BGEANT,NOWAKBGEANTNEW62807,ID=LVE
12.08.42.BIS,MR=1.
12.08.44.PF CYCLE NO. = 001
12.08.46.UPDATE,Q,I=BGEANT,L=0.
12.08.52. UPDATE COMPLETE.
12.08.53.FTN,I=COMPILE,L=0.
12.09.41.     4.124 CP SECONDS COMPILATION TIME
12.09.41.RETURN,BGEANT,OLDPL,COMPILE.
12.09.43.-------------------------------------
12.09.45.ATTACH,GEANT,NOWAKNONOVGEANTLIB62807,ID=
12.09.45.LVEBIS,MR=1.
12.09.46.PF CYCLE NO. = 001
12.09.49.ATTACH,BISLIB,NOWAKBISLIB62807,ID=LVEBIS
12.09.49.,MR=1,PW=*---*.
12.09.52.PF CYCLE NO. = 001
12.09.52.LIBRARY,GEANT,BISLIB.
12.09.53.ATTACH,TAPE5,NOWAKO2BISDD62807,ID=LVEBIS
12.09.53.,MR=1,CY=1.
12.09.55.ATTACH,BISDD,NOWAKMCBISDDBIN62807,ID=LVE
12.09.55.BIS,MR=1.
12.09.57.PF CYCLE NO. = 001
12.09.58.=====================================
12.09.58.LOAD,LGO,BISDD.
12.10.02.EXECUTE.
13.31.57.    STOP
13.31.57.  3600.925 CP SECONDS EXECUTION TIME
```

Fig.1b. Typical dayfile of such a job.

```
ATTACH,OLDPL,NOWAKMCBIS2SOURCE62807,ID=LVEBIS,MR=1.
ATTACH,UBISNG,NOWAKUBISNG62807,ID=LVEBIS,MR=1.
UPDATE,I=UBISNG,L=0.
FTN,I=COMPILE,L=0.
RETURN,OLDPL,UBISNG,COMPILE.
COMMENT.  ---------------------------
ATTACH,OLDPL,NOWAKGEANTSOURCE62807,ID=LVEBIS,MR=1.
ATTACH,MGEANT,NOWAKMGEANTNEW62807,ID=LVEBIS,MR=1.
UPDATE,I=MGEANT,L=0.
FTN,I=COMPILE,L=0.
RETURN,OLDPL,MGEANT,COMPILE.
COMMENT.  ---------------------------
ATTACH,GEANT,NOWAKNONOVGEANTLIB62807,ID=LVEBIS,MR=1.
ATTACH,BISDD,NOWAKMCBISDDBIN62807,ID=LVEBIS,MR=1.
LIBEDT,L=DUMMY.
RETURN,GEANT,BISDD,LGO,DUMMY.
COMMENT.  -----------------------------------------
ATTACH,BISLIB,NOWAKBISLIB62807,ID=LVEBIS,MR=1,PW=BIS.
LIBRARY,JOBLIB,BISLIB.
ATTACH,OVERLGO,NOWAKNEWGEANTOVERLGO62807,ID=LVEBIS,MR=1.
COMMENT.   ==================================
LDSET,MAP=X/DUMMY.
LOAD,OVERLGO.
NOGO.
VSN,TAPE3=91442.
REQUEST,TAPE3,NT,E,SV,RING.
REWIND,TAPE3.
ATTACH,TAPE5,NOWAKD10BISDD62807,ID=LVEBIS,MR=1,CY=1.
ATTACH,TAPE6,NOWAKPLOTSKLP62807,ID=LVEBIS,MR=1.
REQUEST,TAPE7,*PF.
GO.
CATALOG,TAPE7,NOWAKPLOTSKLP62807,ID=LVEBIS,MR=1,RP=999.
EXIT.
UNLOAD,TAPE3.
CATALOG,TAPE7,NOWAKPLOTSKLP62807,ID=LVEBIS,MR=1,RP=999.
LIBRARY(JOBLIB,NEW=2000)
OLDLIB(GEANT)
REPLACE(*,BISDD)
REWIND(LGO)
REPLACE(*,LGO)
FINISH.
ENDRUN.
LIST
READ    5  LOGICAL UNIT FOR DATA CARDS
```

Fig.2a. Typical joblisting for a MCBISDD overlay job.

3. The global library set is built up by two library files (prepared by LIBEDT)

   1. GEANT : all GEANT subprograms
   2. BISLIB : HBOOK, ZBOOK, FFREAD and all other service subprograms (see App.III)

4. The input data are read from the data card file TAPE5.

5. Loading subsequently the LGO file and the binary file MCBISDDBIN, only those subprograms are taken from MCBISDDBIN which are not modified in step 1.

The dayfile of such a job is shown in fig.1b. For the reaction $n+p \to K^0+\Lambda+p$ one gets the following time estimations, denoting the mean time for processing one good event by t_{proc} and the mean time to get this event by $t_{monitor}$ (having in mind the non-unity efficiency of the spectrometer)

$t_{proc} = 4.12$ sec.

$t_{monitor} = 1.24$ sec.

III.2. Overlay Version

Production runs with a lot of histograms filled during the generation and tracking of events need more space than available on the Dubna CDC-6500 computer. This is the reason why an overlay version is available. A typical joblisting is given in fig.2a. Two main differences are to be noted. A new library JOBLIB is created summarizing the GEANT, BISDD and LGO files with the help of the CDC LIBEDT-procedure. The file OVERLGO contains all three overlays of the MCBISDD/GEANT package in binary form.

TAPE3 is for the user format output of tracked events.All histograms produced up to now and the last random generator are stored on TAPE6. At the end of the job the updated histograms and the new last random generator can be stored on TAPE7.

The dayfile of a typical overlay job is given in fig2b.

IV. CONFIGURATION OF THE SPECTROMETER BIS-2

The geometrical set-up of the BIS-2 spectrometer for an experiment on a search for charmed particles is explained in the proposal[6]. The set-up for a neutron diffraction dissociation experiment is nearly the same except an additional recoil proton detector [7]. The positions and dimensions of the target, the decay volume and the magnet gap are fixed in SUBROUTINE SETDAT.

```
  MFA   JINR-DUBNA CDC-6500 PSR 454   30 JUN 78
21.13.44.MENH195  FROM
21.13.44.IP  00000576 WORDS - FILE INPUT  , DC 00
21.13.44.MENH1,T1550,P20,MT1.    NOWAK HANNA (LVE)
21.13.47.
21.13.47.    ***********************************
21.13.47.    *  MGBISDJ/GEANT OVERLAY          *
21.13.47.    ***********************************
21.13.47.
21.13.47.REDUCE.
21.13.47.MAP,PART.
21.13.47.ATTACH,OLDPL,NOWAKMGBIS2SOURCE62507,ID=L
21.13.47.VEBIS,MR=1.
21.13.48.PF CYCLE NO. = 001
21.13.48.ATTACH,DBISNG,NOWAKDBISNG62507,ID=LVEBIS
21.13.48.,MR=1.
21.13.48.PF CYCLE NO. = 001
21.27.51.UPDATE,I=DBISNG,L=0.
22.52.49. UPDATE COMPLETE.
22.52.49.FTN,I=COMPILE,L=0.
23.52.33.       1.704 CP SECONDS COMPILATION TIME
23.52.33.RETURN,OLDPL,DBISNG,COMPILE.
23.52.36.   ----------------------------
23.52.36.ATTACH,OLDPL,NOWAKGEANTSOURCE62507,ID=LV
23.52.36.EBIS,MR=1.
23.52.37.PF CYCLE NO. = 001
23.52.37.ATTACH,MGEANT,NOWAKMGEANTNEW62507,ID=LVE
23.52.37.BIS,MR=1.
23.52.38.PF CYCLE NO. = 001
23.53.59.UPDATE,I=MGEANT,L=0.
23.54.10.DECK STRUCTURE CHANGED
23.54.13. UPDATE COMPLETE.
23.54.14.FTN,I=COMPILE,L=0.
00.03.47.       1.546 CP SECONDS COMPILATION TIME
00.03.47.RETURN,OLDPL,MGEANT,COMPILE.
```

```
00.03.46.ATTACH,GEANT,NOWAKNONOVGEANTL1362607,ID=
00.03.48.LVEBIS,MR=1.
00.03.48.PF CYCLE NO. = 001
00.03.49.ATTACH,B1SDD,NOWAKN0B1SDDB1N62607,ID=LVE
00.03.49.BIS,MR=1.
00.03.49.PF CYCLE NO. = 001
00.03.50.LIBEDT,L=DUMMY.
00.04.30.  USER EDITLIB HAS DETECTED
00.04.30.           35 ERROR CONDITIONS
00.04.30.  IN EXECUTION OF DIRECTIVES
00.04.31.RETURN,GEANT,B1SDD,LGO,DUMMY.
00.04.32.  -----------------------------------
00.04.32.ATTACH,BISLIB,NOWAKBISLIB62607,ID=LVEBIS
00.04.32.,MR=1,PW=*---*.
00.04.34.PF CYCLE NO. = 001
00.04.34.LIBRARY,JOBLIB,BISLIB.
00.04.34.ATTACH,OVERLGO,NOWAKNEWGEANTOVERLGO62607
00.04.34.,ID=LVEBIS,MR=1.
00.04.34.PF CYCLE NO. = 001
00.04.35.   ===================================
00.04.35.=
00.04.35.LDSET,MAP=X/DUMMY.
00.04.37.LOAD,OVERLGO.
00.04.37.NOGO.
00.06.10.VSN,TAPE3=91442.
00.06.13.REQUEST,TAPE3,NT,E,SV,RING.
00.06.14.( NT 050 ASSIGNED)
00.06.15.REWIND,TAPE3.
00.06.17.ATTACH,TAPE5,NOWAKD1031SDD62607,ID=LVEBI
00.06.17.S,MR=1,CY=1.
00.06.17.ATTACH,TAPE6,NOWAKPLOTSKLP62607,ID=LVEBI
00.06.17.S,MR=1.
00.06.18.PF CYCLE NO. = 001
00.06.19.REQUEST,TAPE7,*PF.
00.06.21.GO.
00.06.26.NT50 VOLUME SERIAL NUMBER IS  (91442
05.25.55.
05.25.57.NT50  BLOCKS WRITTEN -003841
05.25.59.       END  GMAIN
05.25.59.  3603.546 CP SECONDS EXECUTION TIME
```

Fig.2b. Typical dayfile of such a job.

The geometrical information on all MWPC's and counters is submitted by SR POSPC/POSSC.

All these values can be modified by changing the corresponding statements.

V. CHOICE OF THE REACTION

Events of different reactions can be simulated using the existing MCBISDD package. A main choice is made already on the UPDATE level using different correction sets [10]

UBISNG	for	$np \to K^\circ \Lambda p$
UBISBG	for	$np \to K^\circ \Lambda Z^+$
UPPI	for	$nA \to p \pi A'$
UPKOKM	for	$np \to pK^\circ K^- p$
USIGMA	for	$np \to K^\circ \Sigma^\circ p$

To study the diffraction dissociation of neutrons into $K^\circ \Lambda$, four different reactions are available by the data card REACTION I (I = 1,4).

REACTION	1:	$np \to K^\circ \Lambda p$
REACTION	2:	$np \to K^\circ \Lambda p \pi^\circ$
REACTION	3:	$np \to K^\circ \Lambda \pi^+ n$
REACTION	4:	$np \to K^\circ \Lambda p Z^\circ$

VI. DESCRIPTION OF DATA CARDS

All MCBISDD data cards are read from unit TAPE5 together with all data cards from GEANT.

All of them are optinal; the corresponding default values, as defined in SR SETDAT, are listed in the following table as well.

Code	Max. No. of Elements	Default Values	Contents
1	2	3	4
BEAM	6	0.9396,0., 45.,10., 20.,70.	Mass, charge, mean value, variance, minimum, maximum momentum of the beam
DEFL	20	20*0	Activation of debugging for each event having the corresponding track quality non-zero flag

1	2	3	4
HIST	1	0	Histogram handling -1: initial booking and filling of histograms 0: no histogram handling 1: histograms are booked by fetching them from TAPE6, filled and stored on TAPE7
IMPA	1	0	Display of events, as seen by the detectors (XZ - and YZ-planes)
INIT	3	0.1,2., -6750.	Radius, length and z-coordinate of the beginning of the internal target
LACO	3	0.67,1.65 , -4610.	x,y,z coordinates of the last collimator
MAGN	7	45.,15.,75., 0.,0.,0., 12.	x,y,z of the magnet gap; coordinates at the center; magnetic field in kG
NOSU	1	0	Noncomplete events are also processed (no suppression)
PRFL	1	0	Print of track quality flags for each track
PRIN	4	4*0	Print of user dependent histograms at the end of the job
REAC	1	1	Choice of the reaction
RECM	1	5000	Maximum number of output records on user tape
ROTA	1	0	Rotation angle in degrees for MWPC's

1	2	3	4
SWIT	10	10*0	In addition to switches 1 to 4 (used by GEANT),there are 2 more switches.8"on": on-line summary for each good event, 9 "on": full printing of the user output record
TARG	5	0.9383,1., 2.5,5.,-495.	Mass and charge of the target particle radius, length and z-coordinate of the beginning of the target
TIME	1	3600	Internal time limit for MCBISDD/GEANT jobs in sec.
WRIT	1	-1	Activates output onto TAPE3 The number of events to be skipped has to be given here

```
KINEMATICS
TRACKING
HITS OF DETECTORS
DIGITIZATION

DROP BANKS AFTER STEP THREE
BOUNDARIES OF MEDIA GIVE ENTRY IN POINT BANKS

MEDIUM 4      AIR    AIR+FIELD POLYSTYROLE LEAD
FIELD          0        1          0         0      FIELD OR NOT
STMEDIUM      51       16          6         6      STEP FOR  SEARCH
STMAX         50       15          5         5      MAX STEP FOR  SEARCH
STRANK        50       15        0.5       0.5      STEP FOR POINTS
STMULT       1E5      1E5        0.5       0.5      STEP FOR MULT. SCAT.
STLOSS       1E5      1E5        0.5       0.5      STEP FOR ENERGY LOSS
RADLEN       3E4      3E4         44         6      RADIATION LENGHTS

DEBUGGING FOR TRIGGER  1  TO  1
SWITCH (LEVEL OF DEBUGGING)  1  0  1  1  8=1 0
...PLAY OF EVENTS IN PLANES 13(XZ) AND 23(YZ) (AFTER STEP TRACKING)
..PACT POINTS ON DETECTORS TO BE DISPLAYED (AFTER STEP DIGITIZATION)
SPECTROMETER LIMITS  -100  100  -50  50  -500  500

REACTION   1   (N + P ---> K0 + L  + P)
ROTATION OF CHAMBERS SIX AND EIGHT BY  10 DEGREES

HISTOGRAMS BOOKED INITIALLY (-1)
PRINT HISTOGRAMS AFTER KINEMATICS (STEP 1) AND (STEP 2 )
TRIGGER TO BE PROCESSED  200000
TIME LIMIT IN SECONDS     300

STOP
```

Fig.3. Typical data card file (TAPE5).

A typical data card file is shown in fig.3. Some comments are given now to illustrate the choice of data cards and corresponding values.

1. The GEANT data card BOUND is used to get points on all medium borders.

2. Step length for point storage into banks (GEANT data card STBANK):

In medium 1 (air without field, i.e., before and after the magnet) the value is

STBANK (1) = 50 cm

to save computer time and memory space.

In medium 2 (air with field, i.e., inside the magnet) a compromise has to be found between time and space requirements, on one hand, and the wanted final accuracy in x and y at the end of the spectrometer, on the other hand. This accuracy is determined by the number of points for the curved track in the magnet. It decreases with decreasing track momentum. Holding the accuracy for low-momentum tracks within the limits of half a wire spacing of the MWPC's (1 mm), the maximum step length inside the magnet is obtained to be

STBANK (2) = 15 cm

In medium 3 (target) the step length of point storage is chosen according to that for the calculation of multiple scattering and energy loss

STBANK (3) = 0.5 cm.

3. Step length for medium search (GEANT data card STMED) and its limitation (GEANT data card STMAX):

According to the tracking algorithm (SR GTRA and SR GNWMED), the step length for medium search and its corresponding limits should be chosen in the following manner:

STMED(I) = STBANK (I)
STMAX (I)= STBANK (I)

to avoid wasting computer time.

4. Adjustment of an important test in SR GTRA to eliminate event losses:

Due to the decay characteristics of K° and Λ, their corresponding track length (SDECAY) between the end of the target and their decay point is in general much smaller than STBANK(1), the step length for point storage into banks for air. This means that SDECAY will be often the length of the first and only tracking step after the target. Nevertheless, the entrance point in the decay volume must be stored in the point banks, otherwise all events with

SDECAY < STBANK(1)

would be lost.

Therefore the responsible test for point storage in GTRA must be ajusted to the distance between the target and the decay volume:

FACTOR * STBANK(1) = ZDEC1 - ZTARG2

Working with the above explained value of STBANK(1) and a distance of 10 cm between the target and the beginning of the decay volume

FACTOR = 0.2

must be used to get the wanted point for all tracks entering the decay volume.

VII. SHORT WRITE-UP'S OF MCBISDD SUBPROGRAMS

1. Initial Stage

1.1. GUINIT

GUINIT is an organization subprogram, which is required for the MCBISDD/GEANT overlay version, only. It forces user common blocks and dummy subprograms into the root of the program.

Structure: Subroutine subprogram
Called by: GEANT
Externals: LBCMZB
VZERO
RECOVR
Parameters: none
Comments: All user common blocks have to be included in SR. GUINIT. In addition to the above listed externals, some dummy GEANT and HBOOK subprograms are called to reduce the overall field length.

1.1.1. LBCMZB

LBCMZB gives the length of the blank common block.
Structure: Function subprogram
Called by: GUINIT
Externals: none
Parameters: one (dummy)
Comments: The CERN library version (Z 028), which gives the actually used length of the blank common block, is used in the single-module loading version. If

MCBISDD/GEANT works in the overlay version, LBCMZB has to be provided by the user, e.g.,

```
FUNCTION LBCMZB(I)
COMMON// B(14000)
LBCMZB = 13900
RETURN
END
```

1.1.2. BISERR

BISERR organizes the error recovery. Different versions are used for single-module and overlay loading, respectively.

Structure : Subroutine subprogram
Called by : RECOVR (as EXTERNAL)
Externals : GLAST for single-module loading
OVERLAY (2HGO,3,0) for overlay loading

1.2. GUREAD

GUREAD prepares arrays for reading user data cards in the framework of FFREAD.

Structure : Subroutine subprogram
Called by : GREAD
Externals : LOCF
SETDAT
Parameters: NKEY = number of user keywords
KEY = array containing the user keywords
LAD = array containing addressed of all common block cells, the contents of which are changed by the corresponding data cards
IL = maximum number of elements to be changed by the corresponding keyword.
Comments : see the description of FFREAD /5/.

1.2.1. SETDAT

SETDAT defines default values of all constants and calculates often used values.

Structure : Subroutine subprogram
Called by : GUREAD
Externals : VZERO
Parameters: none
Comments : The default values and special constants are specific for each reaction and set up. Therefore they are to be checked by the user carefully.

1.3. GUPRIN

At present GUPRIN is an organization subprogram only.
Structure : Subroutine subprogram
Called by : GPRIN
Externals : FLOINT
POSPC
POSSC
Parameters: none
Comments : none

1.3.1. FLOINT

FLOINT performs all necessary type transformations for input data according to FFREAD requirements.
Structure : Subroutine subprogram
Called by : GUPRIN
Externals : FLOARG
INTARG
Parameters: none
Comments : FLOARG and INTARG are explained in [5].

1.3.2. POSPC

In POSPC all geometrical values are defined for MWPC's in the forward part of the spectrometer.
Structure : Subroutine subprogram
Called by : GUPRIN
Externals : none
Parameters: none
Comments : none

1.3.3. POSSC

In POSSC all geometrical values are defined for scintillator hodoscopes.
Structure : Subroutine subprogram
Called by : GUPRIN
Externals : none
Parameters: none
Comments : none

1.4. GUGEOM

GUGEOM organizes the filling of banks with geometrical information for all types of detectors.

Structure : Subroutine subprogram
Called by : GEOM
Externals : GEOPC
GEOSC
GSETRO
UCOPY
VFILL
YBOOK
Parameters: N = Detector number
NID=Number of words in the bank
A,IA=Transfer array
IFLAG=Mode flag defining the detector type
Comments : none

1.4.1. GEOPC

GEOPC fills an array with geometrical information on a certain type of MWPC.

Structure : Subroutine subprogram
Called by : GUGEOM
Externals : VFILL
VZERO
Parameters: The same as in GUGEOM
Comments : The filling is performed according to the GEANT format requirements for the type 1 detectors (MWPC)

1.4.2. GEOSC

GEOSC fills an array with geometrical information on a certain type of scintillator hodoscope.

Structure : Subroutine subprogram
Called by : GUGEOM
Externals : VZERO
Parameters : The same as in GUGEOM
Comments : The filling is performed in a special MCBISDD format (see the listing of SR GEOSC).

1.5. GUBOOK

At present GUBOOK is an organization subprogram only.

Structure : Subroutine subprogram
Called by : GBOOK
Expernals : BOOKY
OUTTP

Parameters : none
Comments : none

1.5.1. BOOKY

BOOKY performs the user dependent booking of histograms. The actual coding depends on the special problems to be studied.

Structure : Subroutine subprogram
Called by : GUBOOK

Externals : EXTPP XMSQKL
HBFUN1 HBOOK1 HBOOK2 HBPRO
HTITLE HFETCH HEXIST HNOENT HUNPAK
Parameters: none
Comments : The booked histograms for a study of neutron diffraction dissociation into $K^\circ\Lambda$ are:

- Momentum of K°, Λ, and the $K^\circ\Lambda$ system, respectively
- Transverse momentum versus longitudinal one for K°, Λ, and the $K^\circ\Lambda$ system, respectively
- y versus x coordinate of the primary vertex
- z coordinate of the primary vertex
- y versus x for the decay vertex of K° and Λ
- z coordinate for the decay vertex of K° and Λ
- Effective mass of the $K^\circ\Lambda$ system
- Transverse momentum versus longitudinal one for the recoil particle
- Transverse momentum versus longitudinal one for beam particles

The work of SR BOOKY is controlled by the parameter IHIST:

IHIST $<$ 0 initial booking of histograms
IHIST= 0 no booking of histograms
IHIST $>$ 0 fetching of histograms from disk (including the last random generator)

1.5.2. EXPTPP, XMSQKL

The squared mass of the diffractive system (say, the $K^\circ\Lambda$ system), $M^2_{K^\circ\Lambda}$ and the four-momentum transfer, t_{pp}, are randomly distributed according to the functions

EXPTPP ~ $\exp(B \cdot t_{pp})$
XMSQKL ~ $M^{-2}_{K^\circ\Lambda}$

The slope B of the t_{pp} distribution strongly depends on the chosen reaction.

Structure : Function subprograms
Called by : HBFUN1 as EXTERNALS
Externals : none
Parameters: one: t_{pp} and M^2, respectively
Comments : HBFUN1 generates the corresponding distributions by many calls to EXPTPP and XMSQKL, respectively. The variables are obtained by calling HRNDM. For further explanations see[3].

2. Working Stage

2.1. Kinematics

2.1.1. GUKINE

GUKINE is mainly an organization subprogram controlling the generation of reaction kinematics.

Structure : Subroutine subprogram
Called by : GKINE
Externals : BEAM SECOND TRGCU
VZERO FILLY KINEDD
Parameters: none
Comments : According to the UPDATE correction set, a special version for the wanted reaction is generated (see chapter V)

2.1.1.1. BEAM, HISTIN, GNGAU

BEAM calculates the actual beam momentum.
Structure : Subroutine subprogram
Called by : GUKINE
Externals : ATG HFILL RNDM
GNGAU in the default version or
HISTIN for * DEFINE HISTIN
Parameters: none
Comments : In the default version the beam momentum is randomly obtained from a Gaussian (FU. GNGAU). If the UPDATE card * DEFINE HISTIN is used, a special histogram, which replaces the Gaussian, is read by SR. HISTIN.

HISTIN reads a one-dimensional histogram from cards.
Structure : Subroutine subprogram
Called by : BEAM for * DEFINE HISTIN
Externals : HBOOK1 HFILL
Parameters: ID = histogram identifier
Comments : Random values according to the read histogram are obtained by HRNDM. The read-in format is

1. NX, XLOW, XUP (I10, 2F10.5)
2. TITLE(7) (7A10)
3. Histogram contents NX values in (7F10.5)

GNGAU gives the beam momentum which is obtained randomly from a gaussian distribution.

Structure : Subroutine subprogram
Called by : BEAM
Externals : RANNOR
Parameters : P = beam momentum vector
Comments : Default values of the mean momentum and variance of the gaussian beam distribution can be modified by the BEAM data card.

2.1.1.2. TRGCU, TRG

Random calculation of target coordinates is performed, equally distributed inside a cylindrical (SR.TRG) or cubic (SR.TRGCU) target, respectively.

Structure : Subroutine subprogram
Called by : GUKINE
Externals : none
Parameters : XYZT = array of vertex coordinates
Comments : none

2.1.1.3. KINEDD

KINEDD organizes the generation of kinematical variables according to diffraction physics.

Structure : Subroutine subprogram
Called by : GUKINE
Externals : BACKKI DECAY GSTORE HRNDM LRTR
Parameters : S = center of mass energy squared
IBAD = flag for unphysical kinematics
Comments : According to the value of NREAC, given by the REAC data card, the kinematics of the following reactions can be calculated:

NREAC = 1	$np \rightarrow$	$K^0 \Lambda p$
NREAC = 2		$K^0 \Lambda p \pi^0$
NREAC = 3		$K^0 \Lambda n \pi^+$
NREAC = 4		$K^0 \Lambda p Z^0$

The reactions 2 to 4 are generated via SR BACKKI. All other reactions, prepared up to now can be generated with the corresponding correction set from UPDATE and NREAC = 1.

2.1.1.4. BACKKI

BACKKI calculates the kinematics of background reactions according to the data card REAC.
Structure : Subroutine subprogram
Called by : KINEDD

Externals : CMSLAB DALKIN DECAY GENONE
GSTORE HRNDM LRTR
Parameters: SB = center of mass energy squared
NREAC = reaction number
IBAD = flag for unphysical kinematical region
Comments : For NREAC = 4 the following "shower" decay of the Z° system is implemented: $Z^\circ \rightarrow 2\pi^+ 2\pi^- 2\pi^\circ$

2.1.1.5. DALKIN

The Dalitz decay for

SQ → XM(1) + XM(2) + XM(3)

is calculated assuming a given distribution of mass XM(1) and four-momentum transfer from the beam to this particle [9].
Structure : Subroutine subprogram
Called by : BACKKI
Externals : HRNDM
Parameters: SQ = CM-energy
XM = array of decay particle masses.
PA = } generated momenta of decay
PB = } particles in the c.m.s.
PC = }
EA = }
EB = } energies of decay particles in the c.m.s.
EC = }
XMB = mass of beam particle
XMT = mass of target particle
IBAD= flag for unphysical kinematical region
Comments : For a detailed description of the used method see [9].

2.1.1.6. TWOEM, THREM

These subprograms calculate the two- and three-particle effective masses, respectively.
Structure : Subroutine subprograms
Called by : FILLY
Externals : none

Paremeters: P1(3) = } particle momenta
[P2(3)] =
P3(3) =
XM1 = } particle masses
XM2 =
[XM3] =
XM = effective mass of the system

Comments : none

2.1.1.7. LRTR, CMSLAB

Both subroutines perform Lorentz transformations.
LRTR transforms from the resonance rest system to the laboratory system.
Structure : Subroutine subprogram
Called by : KINEDD BACKKI GUDCAY
Externals : none
Parameters: DP = momentum of the parent particle in the laboratory system
DM = mass of the parent particle
ECM = energy } of the decay particle in the
PCM = momentum } parent rest system
PLAB = momentum of the decay particle in the laboratory system
Comments : none
CMSLAB performs the transformation from the center-of-mass to the laboratory system.
Structure : Subroutine subprogram
Called by : BACKKI
Externals : none
Parameters: SQS = center-of-mass energy
ECM = energy } of particle in the c.m.s.
PCM = momentum }
PLAB = momentum in the laboratory system
Comments : none

2.2. Tracking

2.2.1. GUDCAY

GUDCAY calculates the decay kinematics of K°, Λ , $\pi^\pm$, π° and other particles depending on the actual experiment. It transmits all necessary information on decay particles to GEANT.
Structure : Subroutine subprogram
Called by : GTRA
Externals : DECAY GSTORE LOCATF
LRTR

Parameters: PKITRA = bank of kinematical information according to the conventions of GEANT
XMASS = mass of the decaying particle
NPART = number of tracks as given by GEANT

Comments : For all particles a check is made, whether the decay is inside the allowed region of the spectrometer. Using the default version of MCBISDD, the following decays are included: $\Lambda \rightarrow p\pi^-$, $K^o \rightarrow \pi^+\pi^-$, $\pi^\pm \rightarrow \mu^\pm \nu$, $\pi^o \rightarrow \gamma\gamma$

2.2.1.1. DECAY

DECAY performs a two-body decay of a particle in its own rest system.

Structure : Subroutine subprogram
Called by : GUDCAY KINEDD
Externals : none
Parameters: DM = mass of the decaying particle
AM = mass, AP = momentum, AE = energy — of the first decay particle
BM = mass, BP = momentum, BE = energy — of the second decay particle

Comments : The decay is assumed to be isotropical in the rest system of the decaying particle.

2.2.2. GUMED

GUMED calculates the medium number at a given space point.

Structure : Subroutine subprogram
Called by : GTRA
Externals : ATG
Parameters: X = three-dimensional coordinates of the current point from the tracking procedure
N = medium number to be returned

Comments : Based on the general structure of the spectrometer, five different regions are defined:
i) target region
ii) region of the recoil proton
iii) cone before magnet
iv) magnet region
v) cone after magnet.

The first reason for losing a track is given by a flag in the array IFLOUT (see GUHALT). The processing of an incomplete event is normally dropped.

2.2.3. GUFLD

GUFLD is analogous to GUMED but used for tracking inside the magnetic field, only.

Structure : Subroutine subprogram
Called by : GTRA
Externals : none
Parameters : X = three-dimensional coordinates of the current point from the tracking procedure
F = three-dimensional field vector at the current point
N = medium number to be returned
Comments : none

2.2.4. GULOSS

GULOSS calculates the energy loss of a particle having crossed a medium of certain thickness.

Structure : Subroutine subprogram
Called by : GTRA
Externals : none
Parameters : P = momentum of particle
NTRA = GEANT track number
S = thickness of the crossed material
N = medium number
ISTOP = flag for stopping this track
ISEN, PIN not used
Comments : The ordering in the array EL has to correspond to the GEANT data card STLOSS.

2.2.5. GUHALT

GUHALT drops the current event.

Structure : Subroutine subprogram
Called by : GTRA
Externals : UCOPY GUMED
Parameters : NTR = number of the current track
IHLT= dropping flag for the current event
Comments : Possible reasons for dropping a track are listed in appendix II.

2.2.6. GUTRA

GUTRA organizes an unconditional stop of processing non-complete events.

Structure : Subroutine subprogram
Called by : GTRA
Externals : FILLY
Parameters : NTRACK = total number of tracks in the current event
Comments : none

2.3. Hits on Detectors

2.3.1. GUHITS

At present not used in MCBISDD.

2.4. Digitization

2.4.1. GUDET

GUDET performs the digitization for non-standard detectors in the context of GEANT.
At present only stripe scintillators are included.

Structure : Subroutine subprogram
Called by : GDIGI
Externals : GUBKD GUEFF UCOPY YBOOK
Parameters: ND = current detector number
Comments : The digitization is implemented by analogy with the GEANT standard digitization procedure GMWPC.

2.4.2. GUEFF

GUEFF calculates the efficiency of detectors at a given point.

Structure : Subroutine subprogram
Called by : GMWPC GUDET
Externals : none
Parameters: ID = current detector number
X = space point hit in the detector plane
IFIL = element number
EFFICA = efficiency from the bank JPOS
IFLAG = efficiency flag to be returned
Comments : statistical inefficiencies are taken into account for MWPC's; stripe scintillators are assumed to be of a 100% efficiency.

2.4.3. GUBKD

At present no additional background signals are assumed.

2.4.4. GUDIGI

GUDIGI generates and prints event displays (in both xz and yz projections), as seen by MWPC's.
Structure : Subroutine subprogram
Called by : GDIGI

Externals : HBCDI HFIL2N HPRINT HRESET UBLOW UBUNCH
Parameters: NT = total number of tracks for the current event
Comments : none

2.5. Reinitialization

2.5.1. GUTRIG

GUTRIG performs the finalization of an event as well as the counting of events and reasons for dropping them.
Structure : Subroutine subprogram
Called by : GTRIG
Externals : OUTTP
Parameters: none
Comments : none

2.6. Peripheral Data Transfer

2.6.1. GUGET

Not used in MCBISDD at present

2.6.2. GUSAVE

Used for counting good events only.

2.6.3. OUTPP

OUTPP organizes the user-dependent output of complete events, i.e., with all tracks remaining in the apparatus.
Structure : Subroutine subprogram
Called by : GUBOOK GUTRIG GULAST
Externals : OFORMAT YBOOKO ZPRINT
VZERO UCOPY
Parameters: ISTAGE = 1 - Skip of NEVSKP records on user tape. Note that NEVSKP is given by data card.
ISTAGE = 2 - Output of full records
ISTAGE = 3 - Output of the last (noncomplete) record and EOF.

Comments : If the number of records on user tape is larger than the maximum one (given by the user in SR SETDAT), OUTTP automatically terminates the generation of events. The job is finished normally.

2.6.3.1. OFORMAT

OFORMAT prepares the output vector for SR OUTTP. The format is reaction-dependent.

Structure : Subroutine subprogram
Called by : OUTTP
Externals : UCOPY
Parameters: ISTAGE = 1 - used in the first stage of SR. OUTTP; gives the number of words per event.
ISTAGE = 2 - used in the second stage of OUTTP prepares the output vector for one event.
Comments : none

2.6.4. FILLY

FILLY fills histograms after stage ISTEP of GEANT. The wanted steps are given by the data card HIST.

Structure : Subroutine subprogram
Called by : GUKINE GUTRA
Externals : HFILL
Parameters: ISTEP = the current working stage in GEANT
Comments : FILLY has also to be changed when changing BOOKY.

2.6.5. EDITY

EDITY writes plots including the last random generator onto tape or disk unit IHOUT if the data card HIST is present.

Structure : Subroutine subprogram
Called by : GULAST
Externals : HPAK HSTORE HDELET
Parameters: none
Comments : EDITY is reaction-independent. The last random generator is stored in histogram 99.

3. Termination Stage

3.1. GULAST

GULAST performs the finalization of the job including end-of-file writing on output files, print of histograms and run statistics.

Structure:	Subroutine subprogram
Called by:	GLAST
Externals:	HEXIST HDELET EDITY
	HINDEX HBLACK HPRINT
Parameters:	none
Comments :	none.

APPENDIX I

EXPLANATION OF COMMON BLOCK VARIABLES

1. COMMON /CBEAM/

XMB	=	mass
QB	=	charge
PM	=	mean value of momentum
SIGPM	=	variance of momentum
PMIN	=	lower limit
PMAX	=	upper limit
PB(3)	=	current beam momentum.

All values are given for the beam particle.

2. COMMON /CONES/

AXBEF, BXBEF, AYBEF, BYBEF, AXAFT, BXAFT, AYAFT, BYAFT — Parameters of straight lines $a_x + b_x$ and $a_y + b_y$, limiting the spectrometer acceptance cones before and after the magnet

3. COMMON /CONST/

PI, TWOPI — numerical values of π and 2π

4. COMMON /COUNPR/

NC	=	number of counters in the recoil proton detector
DPHI	=	azimuthal angle region of one counter
RCI	=	inner radius of the inner counter ring
RCI2	=	RCI squared
RCF	=	inner radius of the metallic filter
RCF2	=	RCF squared
DELTAF	=	thickness of the metallic filter

RCO = inner radius of the outer counter ring

RCO2 = RCO squared

DCIX = x, DCIY = y, DCIZ = z } size of one inner ring counter

DCOX = x, DCOY = y, DCOZ = z } size of one outer ring counter

RCI2O = outer radius squared of the inner ring

RCF2O = outer radius squared of the metallic filter

RCO2O = outer radius squared of the outer ring

5. COMMON /DECKKL/

XMPI = mass of charged pion

QM = its charge

TAUP = lifetime of the proton

TAUPI = lifetime of charged pion

PPIP(3) = π^+, PPIM(3) = π^- } laboratory momentum from K° decay

PPRO(3) = p, PPI(3) = π^- } laboratory momentum from Λ decay

6. COMMON /FLAGS/

NFL = number of flags used in IFLOUT

IFLOUT(20) = array of output flags for the current event

JDEFL = flag signing non-zero values in data card DEFL

KDEFL = flag signing that a debugging flag (in IDEFL) is on for a lost track

IDEFL(20) = debugging flags set by data card DEFL

NREAC = number of reaction

ILLTR = binary coded numbers of lost tracks

LFL = number of below flags to be zeroed (=9)

IPRINT(4) = print flags from data card PRIN

INOSU = flag corresponding to data card NOSU

	IPRFL	= flag corresponding to data card PRFL
	IMPACT	= flag corresponding to data card IMPA
	IHIST	= flag corresponding to data card HIST
	IHALT	= MCBISDD flag for noncomplete events
7. COMMON /HIST/	IHIN = IHOUT =	} logical units for plot handling
8. COMMON /ICOUNT/	ICOUNT (25)	= summary array for run statistics
	MONEV	= monitor per completely tracked event
9. COMMON /INTAR/	RIT	= radius of the inner target
	ZLIT	= length of the inner target in z
	ZBIT	= z-coordinate of the beginning of the inner target in the spectrometer system
	DXCO = Δx DYCO = Δy	} size of the last collimator
	ZCO	= z-coordinate of the last collimator in the beam line
10. COMMON /KZLAM/	XMKL	= mass of the $K^\circ\Lambda$ system
	PKLABS = absolute value PKL(3) = array	} of the $K^\circ\Lambda$ momentum
11. COMMON /KZERO/	XMK = mass QK = charge TAUK = lifetime PK(3) = laboratory momentum	} of K°
12. COMMON /LAMBDA/	XML = mass QL = charge TAUL = lifetime PL(3) = laboratory momentum	} of Λ
13. COMMON /LIMITS/	TIMEXE	= maximum execution time for the job
	TIMPRE	= time already used for job preparation
	NRTA	= maximum number of records on user tape
	NWRECM	= maximum number of words per record

NEVSKP = number of events to be skipped on user tape
NWHEAD = number of header words per record
NWEV = number of words per event
NWREC = number of words per record
NWTOT = total number of words written onto user tape
NEVREC = number of events per record
NEVOUT = number of events written onto user tape
NREC = number of records written onto user tape
JBUFO1 = start adress of output buffer

14. COMMON /LOCPC/
PCL(5,2) = half size of efficient x and y plane region, respectively, for 5 different chamber types
XYPC(3,2)= shifts in x and y, respectively, with respect to the beam axis
ZPC(19) = z-coordinates of all chamber planes
GAP(19) = gap of all MWPC's
WSP = wire spacing
EPSPC = nominal efficiency
BGPC = nominal background
ALPHAY = angle between x and y wires
NWMAX(19)= maximum number of wires
EFFPC(19)= efficiency
JPRO(21) = flags signing x or y projection
ROTA = rotation angle for rotated chambers

15. COMMON /LOCSC/
ZG = z-coordinate of the counter G2
DXG = Δx } size of the counter elements
DYG = Δy }
CROSSG = overlapping region
NG = number of scintillator counters

16. COMMON /MAGN/
DXM = x } size of magnet gap
DYM = y }
DZM = z }
XM = 0 } coordinates of the center
YM = 0 } of the magnet = origin of
ZM = 0 } the coordinate system
H = magnetic field value in kG

17. COMMON /MASSES/	NRMASS	= number of decaying particles foreseen in SR GUDCAY
	ZMASS(10)	= array of particle masses in increasing order
18. COMMON /MUEL/	XMMU	= mass } of muon
	TAUMU	= lifetime } of muon
	XMEL	= mass } of electron
	TAUEL	= lifetime } of electron
19. COMMON/NPART/	XMN	= mass } of neutron
	TAUN	= lifetime } of neutron
	XMPIO	= mass } of neutral pion
	TAUPIO	= lifetime } of neutral pion
	PPN(3)	= laboratory momentum of neutral particle
20. COMMON/OVERLAY/	IOVER	= flag for overlay version
	IRECOV	= recovery flag
21. COMMON /PROTON/	XMP	= mass } of proton
	QP	= charge } of proton
	TP	= four-momentum transfer } of proton
	PHIMAX	= upper } limit of azimuthal angle
	PHIMIN	= lower } limit of azimuthal angle
	THMAX	= upper } limit of theta angle
	THMIN	= lower } limit of theta angle
	PHIFAC	= correction factor for efficiency calculations
	TH	= Θ } after tracking
	PHI	= ϕ } after tracking
22. COMMON /TARGET/	XMT	= target mass
	TR	= target radius (if cylindrical)
	TL	= target length
	ZT	= z -coordinate of target beginning
	TX	= Δx } (if cubic)
	TY	= Δy } (if cubic)
23. COMMON /VXPOINT/	VTX(3)	= coordinates of { vertex
	DCPL(3)	= coordinates of { Λ decay point
	DCPK(3)	= coordinates of { K decay point

24. COMMON /ZLIM/

ZTARG1	= begin	of target
ZTARG2	= end	
ZDEC1	= begin	of decay volume
ZDEC2	= end	
ZMAG1	= begin	of bending magnet
ZMAG2	= end	
ZEND	= end of spectrometer	

APPENDIX II

EXPLANATION OF TRACK QUALITY FLAGS FOR POSSIBLE SUPPRESSION OF NONCOMPLETE EVENTS

The processing of the current event is dropped if necessary track appears to be lost due to the following reasons

- IFLOUT(1) = 1 - decay point before decay volume
- IFLOUT(2) = - not used
- IFLOUT(3) = 1 - recoil proton out of phi-range
- IFLOUT(4) = 1 - recoil proton out of theta-range
- IFLOUT(5) = 1 - decay after decay volume
- IFLOUT(6) = 1 - out of x-cone before magnet
- IFLOUT(7) = 1 - out of y-cone before magnet
- IFLOUT(8) = 1 - out of x-range inside magnet
- IFLOUT(9) = 1 - out of y-range inside magnet
- IFLOUT(10) = 1 - out of x-cone after magnet
- IFLOUT(11) = 1 - out of y-cone after magnet
- IFLOUT(12) = 1 - charged pion decay
- IFLOUT(13) = 1 - recoil proton stops in target
- IFLOUT(14) = 1 - neutral pion decay
- IFLOUT(15) = 1 - recoil proton stops in filter
- IFLOUT(16) to IFLOUT(20) not used

APPENDIX III

SUBPROGRAMS FROM OTHER PACKAGES/LIBRARIES

All subprograms starting with the letter G are part of GEANT[1], those starting with H are part of HBOOK[3]. All starting with Y or Z are part of YBOOK or ZBOOK, respectively[4]. All subprograms taken from the general library BISLIB (mainly the CERN library) are given in the following table:

Name	Type	Action	CERN-Lib. Nr
1	2	3	4
ATG	SR	Arctangent defined over 2π	B101
LBCMZB	FU	Length of blank common	Z028
LOCATF	FU	Search for a given element in an ordered array	E106
RANNOR	SR	Random numbers in normal distributions	V100
UBLOW	SR	Concentration } of character strings	M409
UBUNCH	SR	Dispersion } of character strings	
UCOPY	SR	Copying an array	V301
VFILL	SR	Vector Filling with { a constant	
VZERO	SR	Vector Filling with { zero	F121

REFERENCES

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2. NA4SIMUL: CERN DD/EE/78-1.
3. HBOOK: CERN DD/77/9
4. ZBOOK: CERN DD/78/1.
5. FFREAD: CERN DD/EE/78-2.

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CONTENTS

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