H.E. Mills JADE Computer Note 82 June 6, 1985

MUTANA — A Simple Algorithm to find Tracks in the Muon Filter

Introduction.

The algorithm described here finds tracks in the muon filter. It is based upon the scheme used by the hardware of the T3 level trigger. It operates independently of other detector parts. The motivation to produce the algorithm was for the fast online filtering of cosmic background events in certain trigger sources.

The algorithm is implemented in the Nord-50 computer as part of JDAS and the results stored in the N50S bank. During offline analysis one may use the information in the N50S bank to select events with a track in the muon filter such as when looking for multihadronic events with a muon candidate. The algorithm may be run on the IBM computer for data taken before it was adopted online.

Early Developments.

The history of development is given here since it explains why certain decisions were taken.

The initial idea was to analyse by software the information available in the streets and groups of the T3 level trigger. The trigger hardware ORs together chambers in the barrel and endwalls of the muon filter and then the streets are ANDed. The streets point towards the interaction region and overlap so as not to lose efficiency. Thus a chamber may belong to one, two or even three groups. The layout of the T3 streets in the barrel of the muon filter is shown in Figure 1; that for the endwalls in Figure 2. The hardware of the T3 level trigger permits one of the five groups within a street to be inefficient.

Development started when the low energy neutral ("J.O.") trigger was installed. This trigger requires two low energy deposits in the lead glass barrel with TOF veto. The main background consists of cosmic particles outside the TOF timing gate but within that of the leadglass system. For this trigger (if no other trigger bits are on) it is possible to filter out events if there is a track in the muon filter. When scanning events triggered by this source it was clear that many cosmic particles do not go near the interaction region i.e. they slant across the detector. Such tracks would not be picked up by the T3 hardware. Thus the algorithm allows some overlapping between adjacent groups. Group 1 (the innermost layer) is excluded due to the fact that the chambers register additional hits due to other causes.

Tests showed that although the algorithm worked in general there were some problems. Tracks were being found where they did not exist due to some groups within the trigger being permanently set "ON" (due to known dead chambers). This is perfectly acceptable for a trigger but disastrous for a filtering algorithm where a few spurious hits could cause the event to be rejected.

The algorithm was also missing good tracks due to the fact that the T3 gate is shorter than the muon digitiser gate. Hits can be present in the muon filter chambers but not in the T3 trigger. This does not cause problems for in-time beam–beam events, such as muon pairs where the T3 level trigger is fully efficient, but for out-of-time cosmic particles (which

```
COMMON /CT3MU/ NMU,NMC(3),MUDEV,MUPOSN(5),MUQUAL(5)
      .
      .
CALL CLOC(IPMU,'MUEV',0)
IF(IPMU.LE.0) GOTO 999
LEN=IDATA(IPMU)*2 - 2
CALL MUNPK(IPMU,LEN)
CALL MU2T3
CALL MUTANA
```

The /CT3MU/ common block contains the results:—

NMU	total tracks found
NMC(1)	tracks found in barrel
NMC(2)	tracks found in −z endwall
NMC(3)	tracks found in +z endwall
MUDEV	not used
MUPOSN	position of up to 5 tracks
MUQUAL	quality of up to 5 tracks

The routines are written in FORTRAN 77 and are available in compiled form on library F22HEM.N50RED.L. If the calling program is written in FORTRAN then two FORTRAN 77 libraries must be included (SYS1.FT77LNKL and SYS1.FT77LIB).

Limitations of MUTANA.

The algorithm may fail to find a muon track in an event because of:—

1) A missing muon crate.

2) Dead chambers — no notice is taken of calibration information which specifies if a chamber is dead. Such chambers will just not have any hits. This is at least safe for online event filtering purposes.

3) Low energy tracks — if a muon track does not fully penetrate the filter then there may be insufficient hits for a track to be found in this way.

Since no attempt is made to ensure that any hits within a T3 street actually belong to a track, it is possible that a large number of random hits could satisfy the logic and hence cause a spurious track to be found.

Summary.

This algorithm is a fast way of counting tracks within the muon filter. It has performed well for several years as part of the Nord-50 online event filtering scheme and has been used offline during analysis of the width of the Eta decay[2].

References.

1. H.E. Mills, Online Event Filtering in the JADE Data Acquisition System, to be submitted to Nucl. Instr. Methods.

2. JADE Collaboration, A measurement of the η radiative width $\Gamma_{\eta\to\gamma\gamma}$, DESY 85-033.

29/4/80

T3 TRIGGER

ENDWALL STREET-MAP

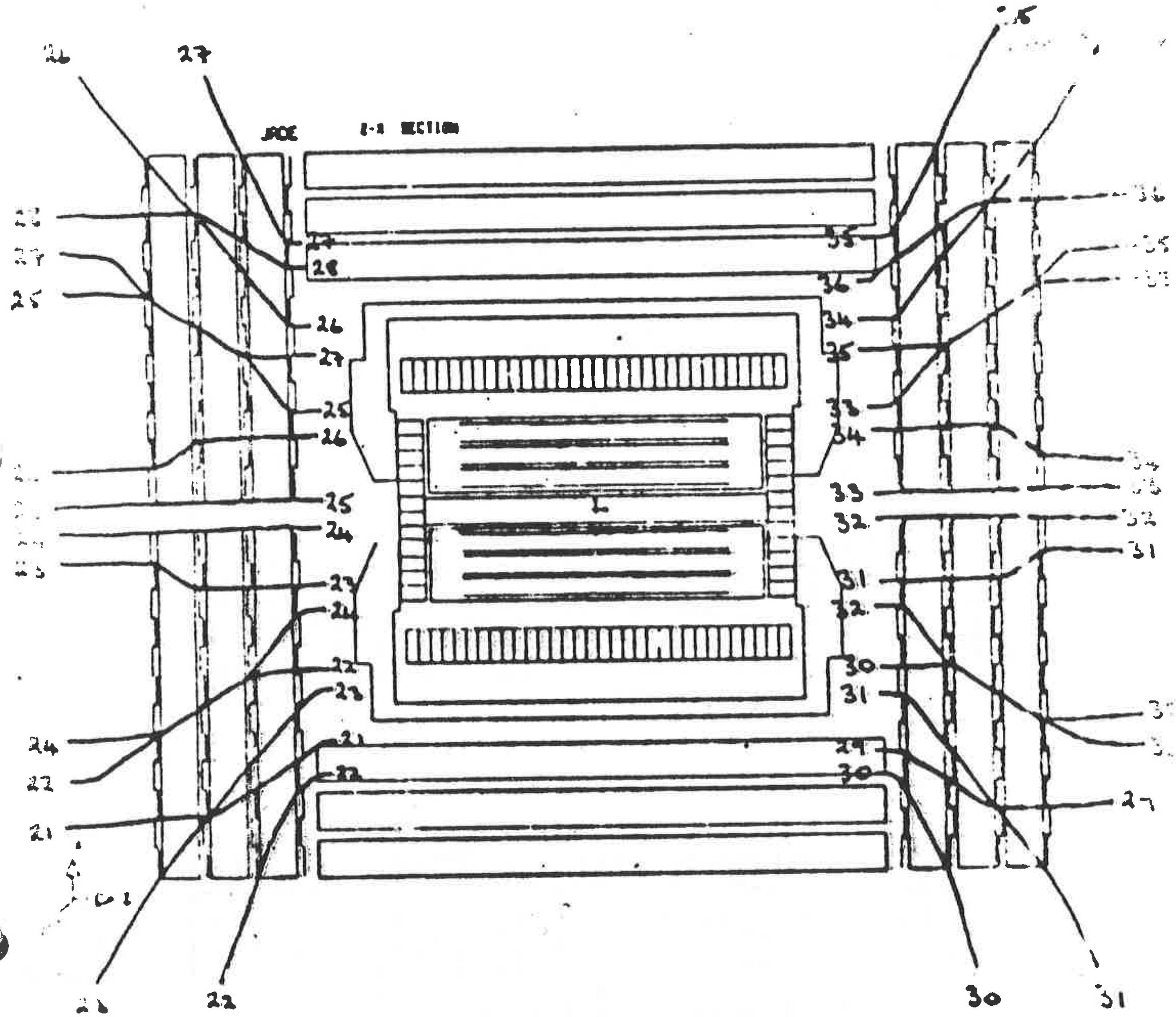

Figure 2

Olsson

24 June 1985

JADE COMPUTER NOTE No 83
Re-Analysis of Multihadronic Events

E.Elsen and K.H.Hellenbrand

The hadronic events taken up to the end of 1984 have been reTPed on the Heidelberg computer. The objective was to create uniform event result banks for the entire datataking of JADE. The so-called standard MH-datasets were processed and partly reanalysed over the years so that different and sometimes irreproducable result bank versions were available. This is usually of minor importance for the standard MH-user but hampers the detailed understanding that is needed for dE/dx and other purposes.

The list of datasets available is given at the end. The input to the analysis were MH-event candidates before E_{vis} and p_{bal}-cut. This was felt neccessary not to bias the event selection. It also makes the data usable for people looking for exotics. People interested in standard MH-events should call routine MCREDU to perform the neccessary reduction.

There is not always a one to one correspondance between the input datasets and the ones given in the TPSTATUS-list. The reason is that the origin of the event samples in the TPSTATUS-list sometimes is not very clear and some of the later occuring rearranging of event samples did not propagate into the TP-datasets. To the best of our knowledge the list below gives the complete sample of hadronic event candidates.

Before reanalysing the data were basically reduced to their original NORD format. The only banks kept were the ones created on the NORD: uncalibrated JETC etc. This made sure that no half-old information was used.

The important steps in the TP-program were

- JETC calibration
- Pattern Recognition (creates PATR 10,JHTL 10)
- JETC z-calibration (CALL ZSFIT(1))
- Helix fit (CALL RFEVFT) (creates PATR 9, JHTL 9)
- Refit of track with soft origin constraint (CALL PATRCO) using as input PATR 10, JHTL 10. Step creates PATR 8, JHTL 8. Note, however, that JHTL 8 is a mere copy of JHTL 10. The refit does not properly set the hit labels so that the input bank JHTL 10 is the best one has. Note also that with this fit it is perfectly possible that a track has more $r-z-$ than $r-\phi-$hits. (Ask P.Steffen for details).
- LG-calibration
- LG-clusterfinding
- Thrust calculation

In addition to the standard TP-banks the event records also contains a PHOT-bank, created with options LPAT=0, LZF=1 and LFIT=1 (see JADE Computer Note 75 by M.Kuhlen). This bank holds the information about candidates for converted photons.

All banks are kept on tape (The event length increases by a factor 6 from the raw format).

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Olsson

JADE Computer Note 84

Efficiency Corrections due to Online and Offline Event Filtering

H.E. Mills and J. Olsson

July 10, 1985

Normally overall detection efficiencies are obtained by generating 4-vector Monte Carlo events of the physics reactions studied, passing these through the JADE detector simulation ("including all known deficiencies of the apparatus") and applying all the cuts of the selection programs that were already used in selecting the data samples from the JADE data tapes, e.g. the REDUC1 tapes. Usually also some effects that are not included in the detector and trigger simulation will be corrected for, e.g. background affecting the rate of TOF counters and veto conditions in some triggers.

The purpose of this note is to point out a potentially important correction that often seems to be forgotten, namely correction for rejection losses in various online and offline filtering algorithms. The real events have gone through a number of filtering algorithms before making it onto a summary tape and all these algorithms of course carry the risk of occasionally rejecting good events, i.e. events arising from e^+e^- collisions. In order of appearance:

Online rejection in the Plessey Miproc–16

The details of the MIPROC–16 rejection can be found in JADE Computer Note 50. Only T2 Accept events are processed. Every 16th event ($\sim$ 6%) of a reject class (either T2ANA rejection or Z-vertex rejection) is kept and written to IBM or tape. The result of the MIPROC–16 analysis is added to the event in the bank MPRS and the Plessey Action word in the HEAD bank (word 25) provides the rejection information: if the event has been classified as reject but is kept as a 16th event, then either bit 12 or bit 13 is set. The reject bit 15 in this word is never set for events that are kept (i.e. written to IBM or tape). See also Supplement 5 to JADE Note 32.

Online rejection in the Nord–50

The details of Nord–50 rejection can be found in JADE Note 78 and its supplement. A large variety of event classes (trigger classes) are subjected to filtering, both T1 Accept and T2 Accept events. The results are also here added into the N50S bank. The Nord–50 action word in the HEAD bank (word 26) has bit 15 set if the event is rejected but kept as a 5% reject event. Note that this is a different convention as compared with the Plessey action word ("historical reasons"..).

Online rejection in the FAMP

At the time of writing this is still in the test phase. As in the case of the MIPROC–16 rejection, only T2 Accept events will be considered for rejection. Details can be found in JADE Notes 110 and 112 and in Supplement 5 to JADE Note 32. The FAMP Action Word in the HEAD bank (word 19) has bit 15 set for events that should be rejected. This bit will not be set for the 5% of rejected events that are to be kept. Bit 12 in the same word indicates that the event is a reject candidate.

JADE COMPUTER NOTE 85/D

JADEZ
THE JADE GRAPHICS PROGRAM

C. Bowdery, J. Olsson
21/10/86

ABSTRACT. This revised note describes how to use the JADE Graphics Program and is especially suited to beginners. Changed sections are marked in the margin.

1. What is the JADE Graphics Program?

The JADE Graphics Program is a tool to view JADE events and perform certain analysis operations on them if required. It drives Tektronix storage tube graphics terminals (and compatible types) allowing 2D monochrome graphics display. It is currently implemented on the DESY IBM computers, on several computers in the UK (MAGA, RLGB, RLIB), in Tokyo and in Maryland. Please note that the operating instructions given here apply to the DESY version of the program.

2. What preparation is needed before a graphics session?

The dataset with the events[1] to be viewed must be on an HSM-controlled volume or on MSS.[2] Tape datasets cannot be read. Thus if your selected events reside on tape, you must first copy them to a disk or MSS dataset. As a rule, multi-hadronic events occupy about 2 disk tracks and simpler events are somewhat shorter. Thus if you want to look at a large number of events, then space on the VTMP MSS volumes may be your best bet.

Assuming that your events are on a usable volume, you could either read this note all the way through first or go to a graphics terminal and follow the instructions as you go along. Remember, allow at least 15 minutes for a graphics session, since reading the calibration files can take some time. You will probably need a notebook and a pen, as well as this note, if you intend to scan events (rather than just casually looking). Finally, have you written down the name of the dataset which contains the events?

3. How is a graphics session started?

The recommended method of running the Graphics Program is with the so-called Graphical Attachment (GA) mode. This involves linking a graphics terminal to a TSO session. This allows the interactive dialogue with the program to take place at a TSO terminal and the graphical output to be sent to a (normally adjacent) graphics terminal. The alternative mode of usage is referred to here as Direct mode which only needs a graphics terminal.

---
[1] The events must have BOS format.
[2] See the DESY Computer Center User's Guide.

4. What happens during the 'first three minutes'?

After printing some mundane greetings and some general information, the graphics program then requests the name of a catalogued dataset which contains some JADE events to be viewed. While the dataset is being allocated, you can read the latest news about the program which is written in the box outlined with asterisks.

If the dataset does not exist or the name was mistyped, a message to that effect will be displayed. You can type in another dsname or press ENTER[1] on its own to end the program.[2] If the allocation is successful, the program then allocates the compact calibration dataset. (Currently this is F11LHO.AUPDAT1.) This will be adequate for most sessions, in which case, when the program responds with the ALLOCATION READY message, simply press ENTER. If however you plan to do LG analysis, the full calibration datasets will be needed, which include the 'spinning block numbers'. (Currently these are F11LHO.BUPDAT0 and F11LHO.BUPDAT1.) In this case, when the program responds with the ALLOCATION READY message, type any non-blank character key followed by ENTER. This will cause them to be allocated for the session.

The command screen is then cleared and the BOS start message is printed followed by some information about default settings of the graphics program. These will be explained later. The first event is then read in and the relevant calibration fetched. The CAMAC date and time of the event is written on the command screen.[3] Depending on the event date, the calibration datasets being used and the response time of the computer, you may have to wait between 30 seconds and 5 minutes before the event is drawn on the graphics screen (if it is real data).[4] Monte Carlo events do not need the calibration datasets so the waiting time is much less. However in this case, the program will print out the MC Smearing Constants and the Trigger Settings on the command screen.[5] This is usually of interest to experts only.

The default view of the event is the so-called RB view.[6] This shows the Central Detectors, the TOF hodoscope and the Lead Glass Shower Array in the R-ϕ projection. Other possible views of the event are explained later. The energies shown in the lead glass blocks are in MeV and represent the sum of all energies in the complete row of blocks along the Z direction.[7] The TOF times are displayed in nanoseconds with the counter numbers also shown.

The Jet Chamber (and, if shown, the Vertex Chamber) hits are drawn along with their mirror hits. You may also see hits in the Z Chamber which lies outside the Jet Chamber pressure tank. At the top left hand corner, the event number, run number and sequence number on the dataset are shown along with a brief summary of information from the main detectors. At the bottom left hand corner, the JADE coordinate axes are drawn to show the detector orientation.

You can now type in any command you like, to see the event in another view or superimpose the detector hardware on the current view or see results displays or perform additional analyses. A short overview of all the commands now follows. Where a synonym exists, it is

---

[1] In what follows, when the ENTER key is mentioned, the RETURN key applies in Direct mode.

[2] An emergency stop can be done at any time using the PA1 key or by pressing CONTROL+G .

[3] The format is seconds.minutes.hours day/month/year

[4] If you are using the AUPDAT1 dataset, a warning message will be printed on the command screen.

[5] See JADE Computer Note 66.

[6] Unless this has been altered with the DEFVIEW macro, as explained later in this note.

[7] In Z views, the LG energies are summed for each half ring.

— G E N E R A L —

HELP	Gives detailed information on all commands and macros.
MENU	Lists the available commands along with a 1 line description.
NEWS	Lists recent news about the JADE graphics program.

— V I E W S —

RA	Displays the Central Detectors and TOF counters in the R-ϕ view.
RB	Displays the Central Detectors, TOF counters and Barrel LG in the R-ϕ view.
RC	Displays the Central Detectors, TOF counters, Barrel LG and Muon Filter in R-ϕ.
ZXA	Displays the Central Detectors in the Z-X view.
ZXB	Displays the Central Detectors and the LG in the Z-X view.
ZXC	Displays the Central Detectors, the LG and the Muon Filter in the Z-X view.
ZXD	Displays the whole detector in the Z-X view, including the Forward Detector.
ZYA	Displays the Central Detectors in the Z-Y view.
ZYB	Displays the Central Detectors and the LG in the Z-Y view.
ZYC	Displays the Central Detectors, the LG and the Muon Filter in the Z-Y view.
ZYD	Displays the whole detector in the Z-Y view, including the Forward Detector.
FW	Displays the end-on views of the Forward Detector.
RU	Displays the rolled-out view of the Lead Glass and the Forward Detector.
ZC	Displays the rolled-out view of the Z Chamber (RZ).
VC	Displays the Vertex Chamber in the R-ϕ view.
CYL	Displays a perspective view of the Jet Chamber and the Barrel Lead Glass.
FWMU	Displays the Forward Muon Counters.
VRX	Displays the vertex region, R-ϕ view. (A cylinder centred at the origin, radius 5 mm.)
VRZX	Displays the vertex region, Z-X view.
VRZY	Displays the vertex region, Z-Y view.
STVW	Displays the current standard view. Needed if the view has a non-standard scale (S).

— R E S U L T S —

RES Displays ID and LG analysis results.

VRES Like RES but with vertex extrapolation. Recommended for all views.

MUPT Displays muon analysis results. (Re)analysis possible.

MUONS Displays 'good' muons.

TR Displays ID hits with various options. TR1 is useful to remove mirror and noise hits.

TRUE Displays the original 4-vectors in Monte Carlo events.

VX Displays vertex results with several options.

DEDX Displays dE/dx results with several options.

TOF Displays TOF results with several options.

AX Displays the event jet-axes with several options.

QP Displays Q-plots with several options.

ZV Displays Z vertex histogram (with your assistance).

FAMP Displays FAMP-found tracks.

ND50 Displays NORD 50-found tracks.

VAC Displays the amplitudes on signal wires in any one cell of the Vertex Chamber.

FADC Displays the Jet Chamber test wire Flash-ADC values (test data only).

ZTRG Displays the Z-trigger Flash-ADC values (test data only).

CLUS Displays Lead Glass energy clusters in the RU view. VRES is usually better.

MUR2 Like RES but displays full muon data in list form. For experts only.

— E X T R A S —

DET Displays the detector hardware on top of the current view.

PRO Displays projections of the other 2 orthogonal views.

EC Displays the End Cap LG hits in R-ϕ views.

FC Displays Tagging System hits in R-ϕ views.

TRLG Displays the T1 Lead Glass trigger conditions.

TRG2 Displays the T2 Track trigger conditions. See JN 31.

PL Displays 'dead', 'killed' and 'spinning' LG blocks. Other options exist too.

COM Adds a comment to the picture which will also appear on any hard copy made.

`VFIT` Performs vertex fit of chosen tracks (`GVTX`).

`SPVA` Users own command for private graphics modules ; no action in JADEZ.

`PRINT` Writes out a BOS bank on the graphics screen, usually in a readable format (`BW`).

`DELETE` Deletes BOS banks as requested (`BDLS`).

`DRAW` Invokes a drawing routine for circles, lines and points. Good for debugging.

`PICK` Returns the coordinates of the cross-hairs on the screen. Joystick is activated first.

`RECAL` Recalibrates the Lead Glass and JETC data (`NWCL`).

`EDIT` Invokes the PATREC editor subsystem. See JCN 28. Experts only!

`RET` Returns to the PATREC editor subsystem.

`SAVE` Saves PATREC /CWORK/ onto a scratch file.

6. How does the program handle event analysis and I/O?

The control commands will need some explanation here. The program has the JADE SUPERVISOR built into it so that it can analyse events. If the events you are looking at have had charged track pattern recognition and lead glass energy analysis done (which is normally the case), then what follows is not so important. It will be sufficient to know that command '`N`' fetches the next event. Otherwise some understanding of the actions of the SUPERVISOR is necessary.[1]

This routine coordinates the basic analysis steps between calls to a routine called USER. Each 'level' of the SUPERVISOR performs one step and then calls the USER routine at the corresponding level.[2] The graphics program's USER routine incorporates 'stop flags' at each level, which if set, cause a halt of the analysis to allow you to view the results so far.

By default, the 'stop flags' at levels 2 and 6 are set. This means that when an event is read in, there is a 'stop' at level 2 (that is, before any analysis is attempted). If pattern recognition and lead glass energy analysis is to be done, then the SUPERVISOR can be continued with the '`C`' command until the next 'stop' occurs at level 6. Using the '`C`' command again, takes you through the SUPERVISOR to level 11 where the event is either discarded or (if the '`WRIT`' command has been issued once already) the current event is written out. A new event is then read in and processing continues up to and including level 2.

As stated above, the SUPERVISOR will do nothing at a given level if the appropriate results banks already exist.[3] By using the '`LEVELS`' command, you can examine and set the 'stop flags' as you wish. (Should you ever need to skip a certain analysis level, then '`JUMP`' will do this. Please note that this command does not change the 'stop flags' so the SUPERVISOR will just continue onwards at the requested level.)

Finally, command '`WRIT`', as its name suggests, explicitly writes out an event. (The first time this command is given, the output dataset is allocated. This dataset must be existing

[1] See JADE Computer Note 73 for full details.

[2] A short description of each level is given in Appendix 2 of this note.

[3] Except at levels 7 and 9 (graphics program only) in the SUPERVISOR.

If the sequential dataset already exists, use ALLOC OLD to allocate the filename COPY to it before the COPY operation. Please note that the macro definitions are only checked when they are executed. If a mistake has been made, you can edit the erroneous macro inside the graphics program. Later on, you should correct the Profile to prevent the error occurring again.

If your Profile contains a macro called `DEFVIEW`, it will be automatically executed at the start of the graphics program in order to set up the standard view. The macro must contain one valid view command only. An optional non-zero argument will be interpreted as a command to draw the detector whenever the standard view is drawn. The standard view can be changed at any time with the `CSTV1` command after the required view has been selected. (A more general 'auto-execute' macro facility may be available later.)

8. Anything else to be remembered?

There are a number of miscellaneous points:

a) Many commands have options which can usually be given as numerical arguments. Spaces between a command and its first argument are optional. If a second argument can be given, this must be separated by spaces or a comma. Some commands prompt for arguments if they are not given, but not all do this. Full information about the meaning of the arguments is given in the HELP system.

b) If the program asks a question which needs a 'yes' or 'no' answer, the following are understood as affirmative replies:

```
YES   YE  Y     JA   JAWOHL   J      HAI   HA   H
```

Anything else, e.g. just ENTER, is treated as `NO`.

c) For scanning purposes, drawing speeds can be increased by flipping the drawing flags 6 and 26. To do this, type:

```
OPT 6; OPT 26
```

d) If the side projections are active with a magnified main view, only Jet Chamber hits visible in the main view will be drawn in the projections.

e) The Z views of the Jet Chamber can be drawn in one of 2 modes: project or rotate. Project mode shows a projection of the 3 dimensional coordinates onto the screen whereas rotate mode shows the hits rotated into the plane of the screen. Thus rotate mode is a 'top-bottom split' R-Z display mode. Drawing flag 9 controls which mode is to be used and can be changed with `OPT 9`. The current mode is also written near the top of the graphics screen in Z views. Note that in muon filter views, project mode is selected automatically and no permanent change is made to flag 9.

f) In rotate mode for the Z views, no Jet Chamber mirror hits are shown to avoid confusion unless `OPT 10` is ON. The hits are drawn at the mean position of the left and right ambiguities. In project mode, both ambiguities are shown unless the mirror hits have been suppressed using the `TR1` command.

g) To produce pictures suitable for showing in public, it is recommended to resolve

2	ON	Display of the Lead Glass
3	ON	Display of the Muon Filter
4	OFF	Display of the Jet Chamber walls
5	ON	Display of the Jet Chamber wires
6	ON	Crosses drawn for Jet Chamber hits instead of short lines
7	OFF	Logarithmic histogram display of Lead Glass energies
8	OFF	Full muon hit symbols. See JCN 52
9	ON	Rotate mode (not project mode) for Jet Chamber hits in Z views
10	OFF	Draw both hit ambiguities rather than an 'average hit' in rotate mode
11	OFF	Automatic T2 trigger display in R-ϕ views. See JN 31
12	ON	Track numbers for Jet Chamber tracks with the `RES` command
13	ON	Track list printout with results display
14	ON	Obsolete. Do not change!
15	OFF	Dashed line display of the Lead Glass in `RU` and `CYL` views.
16	OFF	Automatic results display (= `RES`)
17	OFF	Automatic display of the 2 orthogonal projections on the right
18	OFF	Automatic T3 trigger display
19	OFF	Extrapolation of Jet Chamber tracks to the closest approach to the beam line
20	ON	Jet Chamber hit display in side projections
21	ON	Jet Chamber hit display in main view
22	OFF	Muon hit number display
23	OFF	Extrapolation of Jet Chamber tracks to inner surface of LG in R-ϕ views
24	OFF	Automatic display of muon hits in other planes
25	OFF	Unused at present
26	OFF	Suppression of the odd layer hits in the Jet Chamber. (Saves time)
27	OFF	Automatic display of the main vertex
28	ON	Photons displayed in commands `RES` and `VRES`. Overridden by flag 29
29	OFF	Charged tracks suppressed but photons displayed in commands `RES` and `VRES`
30	OFF	Display of the Forward Muon Counter TOF values
31	ON	Display of track numbers with the `TR` command

7 LG clusters have been (re)linked with ID tracks.

8 Nothing further has been done.

9 Muon analysis has been done or repeated.

10 Nothing further has been done.

Olsson

ADDENDUM TO JADE COMPUTER NOTE 85

C. Bowdery
21/10/86

Please note that the NEWLIB member which contains your macros should be unnumbered before the contents are copied to the `yourid.GRAPHICS.PROFILE.MACROS` dataset. Otherwise the line numbers will be copied into columns 73 to 80 which will later on confuse JADEZ and lead to a `Bad Macro Name` error.

Unnumbering a member can be done by issuing the NEWLIB command `RENUM 0`. This command should always be used before copying members into sequential datasets unless the contents are FORTRAN statements (or JCL). Users of TEX will probably be aware that unnumbered members are always used for TEX source.

JADE COMPUTER NOTE 86

TAGGING SYSTEM MONTE CARLO

A.J.FINCH 19/10/85

ABSTRACT

This note describes a new package of routines for simulating the JADE tagging system as part of the MCJADE program.

Introduction.

The current JADE Monte Carlo program (MCJADE) uses a program called FWDDET to do tagging sytem tracking. This routine is old and obsolete as it only simulates the 1979/80 (Mark I) tagger. The new package of routines simulates all the different flavours of tagging system (see Table 1) that have existed to date.

Using the program.

Assuming for the moment that one has a new version of MCJADE with the new routines installed, the user must take care of certain control parameters, in order to insure that the program works as required.

The simulation currently recognises 4 different 'flavours' of tagging system, as described in the table below:

DATE	'MARKMC'	MARK (as used by TAGAN)	COMMENTS
YEAR < 1981	1	0	mark I apparatus
1981 & MONTH < 7	2	1	mark II apparatus : no lead snouts
1981 & MONTH > 6	3	1	lead snouts
1982	3	1	" "
YEAR > 1982	4	2	mark III apparatus

Table 1

The program decides which value of 'MARKMC' to use on the basis of a date which it reads from the common 'TODAY'. This is the same scheme as is used in the muon routines. The format of the common is:-

```
INTEGER*2 HDATE
COMMON/TODAY/HDATE(6)
```

where :

HDATE(1) = second
HDATE(2) = minute
HDATE(3) = hour
HDATE(4) = day
HDATE(5) = month
HDATE(6) = year

. . .

```
C
C                   INITIALIZE FWD LG BLOCKS
C
C           DO 30 I=1,96
C 30        IGG(I) = 0
C
C
            CALL MCTAGI
C
```

S T A T A G

Replace with new version, calling sequence from WRTMCB is unchanged.

NEW ROUTINES

The following new routines must be picked up by the link editor:

MCTAGF
MCTAGM
MCTAGI — 1 format error.
MCTAGC
MCTAGB
MCTAGS
MCTAGR
MCTAGE
TAGS2H⋆

MCTAG FY entry EØ

MCTAGZ

MCTAGE → EØ

Z

These currently reside on: NWT

SOURCE:	'F22FIN.MCTAG.S'
LOAD:	'F22FIN.MCTAG.L'

⋆ Except for TAGS2H which is one of the routines used by TAGAN, and is kept on: F11LHO.TAGG.S/L .

On 7/11/85 the routines will be copied on to F22ELS.JMC.S/L , and installed as standard according to the above scheme.

O Lsson

June 13, 1986

JADE Computer Note 87 A

Addendum and Update

J. OLSSON

The update of the Monte Carlo library F22ELS.JMC.S / L which was anticipated in JADE Computer Note 87 was implemented late afternoon, 10.6.1986. The errors reported in that note have now been corrected. As agreed in recent JADE meetings, also other changes were made to this libraries at the same time:

1) The update of the EGS shower simulation, known as K.-H. Meier leadglass simulation, for the combined SF5 / SF6 leadglass system, was made standardly available. The routines have been developed by N. Magnussen and will be described in a forthcoming note. Note that the tracking program decides automatically, based on the date in COMMON /TODAY/ HDATE(6), if the old version (SF5 only) or the new version (SF5 / SF6) should be used (HDATE is of course INTEGER*2 type, JADE standard). Note also that the original SF5 version of K.-H. Meier has been somewhat modified, based on the new EGS3 calculations of N. Magnussen. The use of this simulation is invoked by putting LFLAG(4)=.TRUE., in the COMMON /CFLAG/ LFLAG(10) (LFLAG is type LOGICAL*1). By default though, LFLAG(4)=.FALSE. and the default LG photon tracking uses 1-dimensional shower profiles for SF5, obtained using an old version of the EGS program, both for the old and the new leadglass setup in JADE.

2) The tracking simulation of the vertex chamber, as developed by J. Hagemann, C. Kleinwort and R. Ramcke and previously available on the libraries F22HAG.JMC.S / L is now standard on F22ELS.JMC.S / L. According to the date in COMMON /TODAY/, the use of these programs is enforced. The date of instalment of the vertexchamber is 1.5.1984, i.e., if /TODAY/ contains a later date, the vertex chamber geometry and tracking is automatically invoked.

3) The COMMON /TODAY/ HDATE(6) is now set in the JADE Block Data routine JADEBD (on F11LHO.JADEGS / L). The default date is HDATE(1-6) = 1,1,1,17,5,1985. As is easily seen, the array elements give second, minute, hour, day, month and year.

4) Minor errors were discovered (by J. Hagemann) in the Tables 1 and 2 in JCN 87, giving thickness of various absorber layers in the JADE detector. In Table 1, the thickness of Beam Pipe Counters should be 0.0238 X0 (not 0.0236 X0). In Table 2, the thickness of the Beam Pipe Chamber should be 0.0243 X0 (not 0.0228 X0). Please correct your copy of JCN 87. Corresponding changes in the routines TRKGAM and TRKGMV on F22ELS.JMC.S / L have been made.

5) As described in JCN 87, word 16 in the HEAD bank is now set to 1. This serves to mark the correction of the previous errors in photon conversion probabilities. In order to enable a user to see if the programs described under point 1 above had been used in generating a certain data set, word 17 in the HEAD bank is set to 1 in this case. In real data, word 17 is the miproc pattern word and was previously always zero in Monte Carlo events. In addition, word 18 is set to -1, if multiple scattering and energy loss has been disabled in the tracking process. This is normally not the case and is for experts only, but mentioned here for completeness of the description. Word 18 in the Head bank gives vertex chamber high tension value in real data and is normally zero in Monte Carlo events.

March 9, 1987

JADE Computer Note 87
Supplement 2

Further Errors in the Reconstruction of Photons in the JADE Detector

J. Olsson

During 1986 several errors were discovered in subroutines and functions which are concerned with Lead Glass calibration, reconstruction of photons and Monte Carlo simulation of photons. Most of these errors were reported in various JADE Meetings; they are summarized here for convenience and clarity.

The function ELGOBS and the subroutine LGECOR:

The function ELGOBS is used in the Monte Carlo tracking program to determine the amount of shower energy that reaches the lead glass blocks, after absorption loss in the material in front of the lead glass. ELGOBS uses for this purpose the subroutine ENGLOS, which for a given thickness of absorber and for a given shower energy calculates the loss. ENGLOS is also called in an iterative way by the subroutine LGECOR, which is used by LGCDIR to estimate the amount of correction energy to be added to a cluster in order to compensate for the absorption loss. ELGOBS and LGECOR thus are closely related.

Both ELGOBS and LGECOR have the absorber thicknesses (at 90°) explicitly stated in the program code and are not affected by any update of COMMON variables in a BLOCK DATA. Such an update was done in 1982, with a general revision of thicknesses of absorber in front of the lead glass, both for the Barrel part and the Endcap parts. The absorber thickness values are stored in COMMON/CGEO1/, which is BLOCK DATA set in the member JADEBD, on F11LHO.JADEGS/JADEGL. The updates were however only partly carried out in the system ELGOBS–LGECOR and the following sad situation resulted:

Absorber Thickness in front of the Lead Glass Barrel (X_0)			
Period	ELGOBS	LGECOR	Reality
1979–82	0.88	0.88	0.978
1982–84	0.88	0.97	0.978
1984–86	0.88	0.97	1.041
Absorber Thickness in front of the Lead Glass Endcaps (X_0)			
Period	ELGOBS	LGECOR	Reality
1979–82	0.0	0.0	1.17
1982–86	0.0	1.17	1.17

The periods in the table are understood to indicate real time, i.e. LGECOR was updated in 1982; when used after 1982 for data taken before 1982, it of course gave the updated thicknesses. Thus, for data from 1979–84, LGECOR has absorber thicknesses which are practically identical to reality values.

For the time 1984–86 there is a small systematic deviation in the Barrel region (due to the z–chamber). This has by purpose not been changed in LGECOR, since lots of data have been reconstructed already with the value 0.97 X_0 and the difference is only slight.

Since ELGOBS was forgotten in the update 1982, with absorber thicknesses which are $\sim$ 10 % too thin in the Barrel region and non–existent in the Endcap regions, loss and correction do not match in terms of absorber thickness, in particular for the Endcap parts. This clearly gives systematic deviations in corrected Monte Carlo photon and electron energies, severely so for the ones in the Endcap regions.

This bug has far–reaching consequences: Other programs for reconstruction of photon and electron energies have been optimized using the combination ELGOBS–LGECOR and may compensate these systematic errors by adjustment of internal scales and tuning variables. Thus the correction of ELGOBS with respect to LGECOR may necessitate new tuning of such programs. This is in particular true for the so called Meier–Magnussen SF5–SF6 program, which gives a fast 3–dim. simulation of EGS showers[1].

Calibration of Lead Glass Gain Constants:

The calibration of the lead glass gain constants is also affected by the bug in ELGOBS: In the calibration procedure (see Jade Note 86) deposited energy from Bhabha electrons is compared to the "expected" energy, which is calculated from the beam energy, using the function ELGOBS to subtract absorption losses. Since these losses are underestimated by ELGOBS, *the Gain Constants are systematically high.* This may again be compensated for by the leakage loss for high energy electrons, which is not considered in the calibration procedure.

In the reconstruction of cluster energies (photons) a third effect enters, namely the readout threshold: of all blocks which are hit by a shower only those with an energy above a certain threshold are actually read out in the raw data. This threshold was in 1979–1982 about 25 MeV, corresponding to 5 ADC–counts and an average gain constant of $\sim$ 5 MeV/count. In 1983–1986 this threshold was 6 ADC–counts, corresponding to 30–36 MeV, since the gains were also raised to cope with the higher beam energies at PETRA. This loss of energy is not compensated for in the reconstruction programs (and also not in the calibration procedure). Photon energies will therefore be systematically low, although the relative error will be smaller with higher photon energy. Note that this systematic effect is compensated (at least partly) by the too high gain constants!

In view of these effects it is clear that reconstructed photon energies will have systematic errors which vary with the photon energies. This is demonstrated by e.g. the absolute value of the π° peak in various data samples: with low energy photons dominating, the mass will be low (as seen in two–photon physics data), while with higher energy photons the mass will agree with the table value or even be higher (as seen in e.g. multi–hadronic annihilation events). This variation of the π° mass with photon energies is of course also present in Monte Carlo data, since the readout threshold is simulated. However, the agreement of the Monte

[1] EGS is a well known program for electromagnetic shower development (Electron Gamma Shower).

Carlo peaks with those in the real data is clearly a matter of luck!

Considering all of the above, the following corrections have been done: ELGOBS is given the same absorber thicknesses as LGECOR, i.e. 0.97 X_0 in the Barrel region and 1.17 X_0 in the Endcap region. LGECOR is left as it is. The corrected ELGOBS is effective since 19.1.1987.

The programs TRLGSH and TRLGS6:

These 2 program packages are also known as the Meier–Magnussen SF5–SF6 3–dim. shower simulation programs (see Jade Computer Note 70 and Jade Note 136). They are called in the standard Monte Carlo tracking program by the subroutine TRLGL, which handles the tracking of all particles in the lead glass system. For simulation of the period 1979–1982, the program TRLGSH is called (pure SF5 type of lead glass) and for 1983–1986 TRLGS6 is called (mixed SF5–SF6 setup). Although these programs are fast compared to the full EGS code, they are still rather slow compared with the standard 1–dim. simulation in the tracking program; therefore their usage is not default and has to be switched on by the logical flag LFLAG(4) (default .FALSE.).

Both programs suffered, since their introduction in the JADE software ($\sim$ 1982), from a couple of logical bugs, apart from the problem of the dependence on the systematic errors in the combination ELGOBS–LGECOR described above.

The outstanding bug was the fact that the position 3–vector for photons and electrons going into the Endcap regions was not properly updated. As a result these photons and electrons were tracked a second time, i.e. first a 3–dim. simulation in TRLGSH/TRLGS6 and then the standard 1–dim. simulation in TRLGL. The energy was thus deposited twice, with disastreous consequences for single photons (and electrons) and with strong bias in cuts which depends on the total lead glass energy (e.g. the Multihadron selection). This bug was corrected on 20.8.1986.

The other bug is more subtle. The block energies from each shower were multiplied by a correction factor in the program. This factor was calculated from the ratio of total shower energy to seen shower energy, the latter quantity being determined by the blocks with energy above the hardware readout threshold, which was fixed to 28 MeV in the program. The purpose of this factor was to compensate for the loss of shower energy due to the readout threshold; in a 3–dim. simulation this loss is much larger than in a simple 1–dim. simulation where only a few blocks are hit. This correction has no clear correspondence in reality and must be considered an artefact of the program; it has consequences for the trigger simulation, which works with the deposited (i.e. uncorrected) shower energies. Moreover, it is logically wrong when several showers hit the same block. Clearly, the readout threshold is effective only on the total energy of each block and not on the individual block contributions from each shower.

The correction of this logical error (by setting the correction factor to 1.) affects the internal normalization constants of TRLGSH/TRLGS6. The necessary new tuning of these constants has been performed during autumn 1986 but was complicated and delayed by the other errors in the combination ELGOBS–LGECOR described above. The final versions, without this artificial correction and with newly tuned internal constants, were introduced as standard versions on F22ELS.JMC.S/L on 19.1.1987, together with the corrected function

ELGOBS (on JADELG.SOURCE/LOAD)[1].

The subroutine LGCDIR:

This is the main steering routine for calculating energies and directions of the observed clusters in the lead glass. These clusters are stored in the banks ALGN and LGCL (see Jade Computer Note 14) and LGCDIR updates the latter bank. LGCDIR performs the task of energy correction, i.e. an amount of energy is added to the observed cluster energy in order to compensate for the absorption loss in the material in front of the lead glass (pressure vessel, magnet, heatshields, TOF counters, etc.). This is done for real data as well as for Monte Carlo data. In the latter case it is only done if a corresponding energy loss was imposed in the tracking of the Monte Carlo data. As is well known, this is steered by the LOGICAL*1 flag LFLAG(3) in COMMON /CFLAG/ LFLAG(10). Normally this flag is .TRUE., absorption is imposed and all is well in LGCDIR[1]. However, for certain studies one might switch this flag to .FALSE. and expects then no absorption corrections done by LGCDIR.

Due to faulty logic in LGCDIR absorption corrections were in this case nevertheless done, but not for all clusters. Affected were clusters nr. 5–8,13–16, 21–24, etc., and the others were correctly treated, i.e. got no absorption correction. The bug in LGCDIR was present since the beginning of JADE and was corrected on 3.9.1986.

[1] the old version is available as ELGOBS0, to be included if one needs it.

[1] LGCDIR knows about this via a marker in the bank descriptor word of the bank ALGN.

JADE Computer Note 88

How to Handle Lead Glass Clusters in Calculating the Visible Energy E_{vis}

author: Karl-H. Hellenbrand

10th July 1986

To calculate E_{vis} a summation is done over the momenta of the charged tracks and the energies of the lead glass clusters.

$$E_{vis} = \sum_i p_i + \sum_j E_j$$

In MCREDU, the routine which applies the cuts in E_{vis} and the momentum balance p_{bal}, the index j runs over all clusters in the 'LGCL' bank, neutral or charged [1]. In this case the mean value of E_{vis}/E_{cm} becomes nearly 1. This gives one the impression that the full amount of energy released in an e^+e^- annihilation is detected. You can imagine that this cannot be true because of particles escaping through holes in our detector or leaving the detector without any interaction like ν's or K_L^0's. Some people subtract 300...350 MeV for each charged track that is connected to a lead glass cluster. This is of course insufficient in cases where an electron hits the lead glass or a hadronic interaction takes place.

In this JADE note I present a method which handles these cases more adequately. Charged tracks with $p > 0.2\ GeV/c$ are extrapolated into the lead glass and the energies of the hit blocks are summed up. If this energy is lower than p, these blocks are deleted in the 'ALGN' bank. If the energy is bigger than p, an energy equal to p is subtracted from the energy of the hit blocks. After this is done for all charged tracks, the lead glass analysis is repeated for the modified 'ALGN' bank. The results are stored in the banks 'ALGN',2 and 'LGCL',2. The original banks 'ALGN',1 and 'LGCL',1 are restored.

An example is shown in Fig. 1. The upper part shows the standard rolled out view of the lead glass. Numbers inside the blocks give the energy in MeV. The lower part shows the same view after modification of the 'ALGN' bank. Blocks hit by T3, T4, T6, T7, T11 and T20 are deleted. Some energy is subtracted from the blocks hit by T8 and T9.

Some checks are done. In Monte Carlo events it was checked whether neutral particles (γ, n, K_L^0) are lost because the blocks where they deposited their energy are deleted. Nearly all neutral particles are found unless there is a close overlap with a charged particle.

The total lead glass energy after modification E_2 (taken from 'LGCL',2) is compared to the expected lead glass energy E_e. All neutral particles (γ, n, K^0) which encounter the lead glass

[1] If a lead glass cluster is connected to one or more charged tracks it is called a charged one.

Table 1

	Monte Carlo		Data	
	mean	rms	mean	rms
E_1 (GeV)	13.7	4.5	14.2	4.3
E_2 (GeV)	8.1	4.4	8.6	4.3
E_e (GeV)	7.7	4.3		
$E_{vis}^{(1)}/E_{cm}$	0.94	0.19	0.94	0.20
$E_{vis}^{(2)}/E_{cm}$	0.78	0.15	0.77	0.16
$E_{vis}^{(3)}/E_{cm}$	0.86	0.18	0.85	0.19
$M_T^{(1)}$	4.36	1.63	4.22	1.70
$M_T^{(2)}$	3.81	1.41	3.71	1.49
$M_T^{(3)}$	3.68	1.37	3.60	1.43

Figure captions

Fig. 1: (a) Rolled out view of the lead glass
(b) The same after modification of the 'ALGN' bank

Fig. 2: (a) The lead glass energies E_1 (dotted line), E_2 (full line) and E_e (dashed line) for Monte Carlo events
(b) Comparison between Monte Carlo (full line) and data (dashed line) for E_2
(c) The same for E_1

Fig. 3: (a) $E_{vis}^{(1)}/E_{cm}$ (dashed line), $E_{vis}^{(2)}/E_{cm}$ (full line) and $E_{vis}^{(3)}/E_{cm}$ (dotted line) for Monte Carlo events
(b) Comparison between Monte Carlo (full line) and data (dashed line) for $E_{vis}^{(2)}/E_{cm}$
(c) The same for $E_{vis}^{(1)}/E_{cm}$

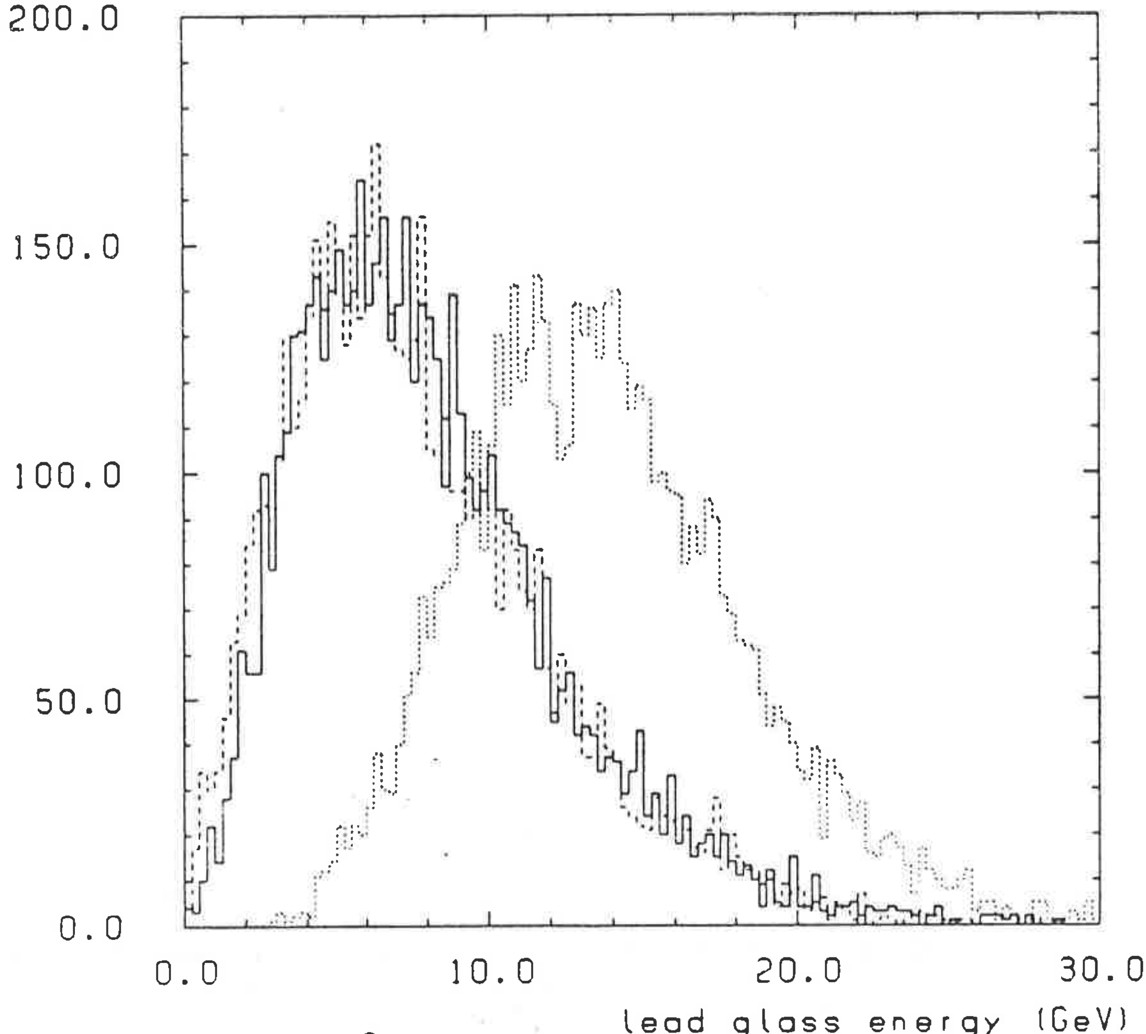


Fig. 2a

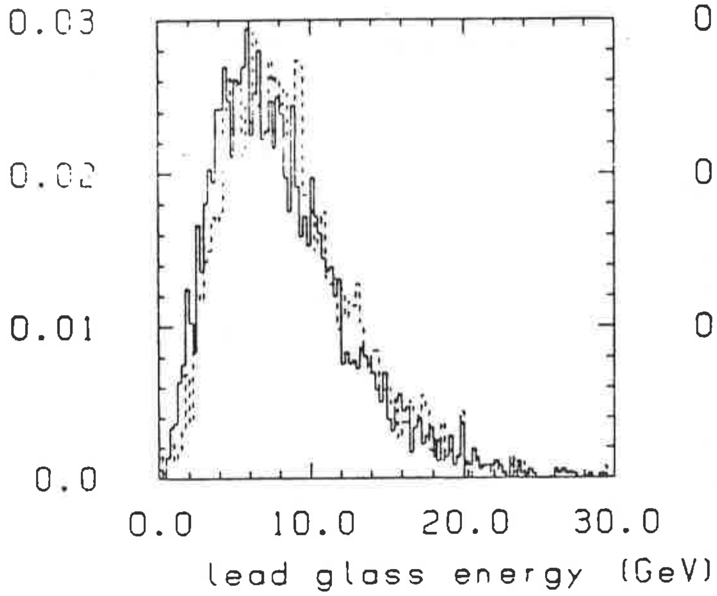


Fig. 2b

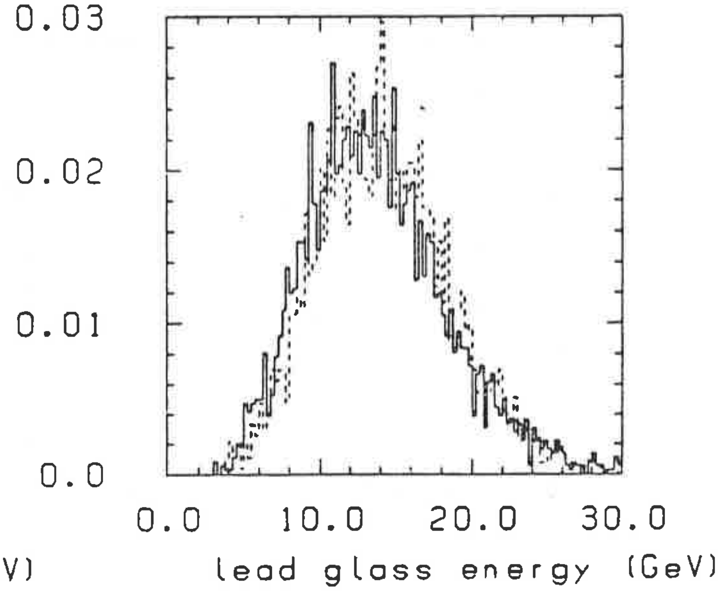


Fig. 2c

28 November 86

JADE Computer Note No 89

Calibration for 1986 REDUC1 and Status of Rutherford Tapes

E.Elsen and J.Olsson

The 1986 data taken have been routinely sent to Rutherford and analysed as in previous years, despite of expected changes due to the FADC installation for the Jet Chamber. Some precaution had been taken to adapt the calibration files to the best known constants known at the time. However, after analysing the data in detail some problems showed up which will be presented in this note.

Jet Chamber Constants

Four sets of constants for the Inner Detector calibration can be distinguished:

a) Global T0 (for each ring)	Subroutine JETCAL
b) Individual T0 (for each wire)	/CALIBR/ constants JTPL
c) z parameters (for each wire): 2 Pedestals, Relative Gain, Effective Wire Length	/CALIBR/ constants ZCAL, JTPL
d) Cell parameters (for each cell)	/CALIBR/ constants JTAB

Whereas the global T0 is kept in Data statement and applied in subroutine JETCAL the other constants are split over several locations in COMMON /CALIBR/. Depending on the run the COMMON /CALIBR/ is loaded from the calibration file F11LHO.BUPDAT0 or for the later runs from F11LHO.BUPDAT1. The files F11LHO.AUPDAT1 or F11LHO.KALWRK0 hold subsets of the data of the BUPDATx files as summarized below.

F11LHO.BUPDAT0/1 Complete set of calibration constants including the extensive list of "spinning" lead glass blocks, which changes from run to run. The file is long and time consuming to read. The noisy block list is needed whenever the leadglass data is calibrated, i.e. ALGN is created from ALGL. If one is not doing leadglass calibration, one usually prefers the shorter AUPDAT1 file.

F11LHO.AUPDAT1 Contains all calibration constants from BUPDAT0/1 except for the list of noisy lead glass blocks. Considerably shorter and faster to read.

F11LHO.KALWRK0 This file is a copy of the last run period of the BUPDAT1 file and used as a work file for the REFORM job, that continuously adds the information for the "spinning" lead glass blocks. Since during datataking only this file is up-to-date concerning the noisy leadglass blocks, it is the only file that can be used for the REDUC1 at Rutherford Lab. The current version of KALWRK0 is copied to every REFORM tape sent to Rutherford.

Clearly, since leadglass "spinning" block list is the only difference between these files, all other constants, in particular other leadglass constants and Jet Chamber constants should be the same on all files. This has not been the case during 1986.

Leadglass Constants

The leadglass constants consist of pedestals and gains for individual blocks as well as the run dependent list of noisy blocks. The latter is continuously being updated during the REFORM step. The data are initially kept in the calibration file F11LHO.KALWRK0, which has to be copied to F11LHO.BUPDAT1 occasionally. Gains and pedestals for the leadglass system are kept in the calibration in a similar way as for the Jet chamber. They are loaded into /CALIBR/ constants LGMA.

Jet Chamber Constants 1986

Before starting the 1986 REDUC1 the calibration constants for the Jet chamber were estimated. The biggest change was expected for the z-calibration, namely the ADC pedestals, which used to be around 50 for the DL8s and are 0 for the FADCs. Also, the relative gains in the system had no relation to the previous values (the corresponding electronics had been replaced), so that the relative gains were set to 1 and the pedestals to 0. These constants were implemented on the F11LHO.BUPDAT1 calibration file in the beginning of 1986. However, they were not copied to F11LHO.AUPDAT1 and F11LHO.KALWRKO, where they should have been in effect for the REDUC1 job in Rutherford. Instead, up to end of May 86 (run number is indicated in the table), the constants of the last update, namely the1983 calibration were used. With the update of KALWRKO end of May 86 the estimates of the Jet chamber parameters finally came into effect. At the same time the relative T0s changed from the values of 1983 to the values of 1984.
The global T0 was changed to the new values for the FADCs at about the same time, a shift of two DL8 clock counts. However, it showed up only now, that, due to a program bug, none of the global T0 applied since 1980, had any effect on the data. Instead of the correct value an undefined variable was used in subroutine JETCAL, the standard JETC calibration routine called by the supervisor routine. The subroutine JRECAL, which performs REcalibration of an existing Jet chamber bank, always used the correct code. This routine may optionally be called by the user, e.g. in the TP step. As a result, probably no global T0 correction was applied for REDUC1 or any recalibration using the standard SUPERV routine, since, most likely, unitialised variables are set to zero. In fact if the variable had been largely different from zero complete failure of pattern recognition would be expected.
The table below summarizes the parameters used for the two 1986 periods together with best values as they are known now after a more careful calibration. The additional change not yet mentioned is an increase in the parameter for the effective wire length by 4%. The numbers in parentheses indicate the year for which the constants were determined.

Jet Chamber Calibration Constants used for REDUC1 in Rutherford Lab

Parameter	< run 26372	≥run 26372	Best Values	Units
Global T0	? probably 0	? probably 0	4	DL8 clock cnts.
Gain	1 (1983)	1 (1986)	1	rel. units
Pedestal	50 (1983)	0 (1986)	0	DL8 ADC cnts.
rel. T0	0 (1983)	0 (1984)	0	DL8 clock cnts.
Eff. Wire length	1 (1983)	1 (1983)	1.04	rel. units

Leadglass Constants 1986

Together with the Jet chamber constants the leadglass gains and pedestals were left at the 1983 values for the first period and at the 1984 values for the second period in 1986. Since in 1984 the gains of the leadglass system were changed to account for the higher beam energy, the 1983 numbers still might be a better approximation of the 1986 values than the values from 1984. The final numbers for 1986 will not be known before an expert from Tokyo deals with the task of determining them.

Determination of Jet Chamber Constants 1986

For historical reasons, the JADE calibration scheme allows two versions of the z-constants to appear in the calibration blocks. Effective wire length, relative gain and two pedestals were originally regularly determined for each wire from a pulser calibration run and stored in the calibration block JTPL (together with a relative T0). The pulser calibration has been carried out for the last time in 1983 and since then all expert knowledge has disappeared. Still, these parameters will always be used when the standard pattern recognition is performed, especially in REDUC1.
In 1981, Peter Dittmann introduced the dedicated calibration block ZCAL in /CALIBR/ and also left us with a procedure to determine the constants, which again are effective wire length, relative gain and two pedestals. These constants are applied, whenever the subroutine ZSFIT is

JADE Computer Note No. 90

Jet Chamber Cell Inefficiencies in 198~~7~~6

Eckhard Elsen

January 13, 1987

Introduction The JADE Jet Chamber itself performed as efficient in 1986 as in previous years. Apparent inefficiencies are due to inefficiencies of the readout system or the way it was operated. The defects are shortly described below and their effect on the data is discussed.

Origin of Inefficiencies Immediately after the introduction of the Flash-ADC system the readout software had not been developed to its final form. Modifications had to be applied mainly to improve readout times. When the division of data between the 'virtual' DL8 crate boundaries was changed in this respect a bug was introduced that existed for the first few days of data taking and resulted in omitting some cells from the readout. The range of skipped cells did depend on the event configuration and thus was varying from event to event. This bug did exist up to and including run 24371 after which the software was corrected.

The second inefficiency originated from the SCANNER hardware module. This is the module that scans the Flash-ADC raw data for channels contents above a preset threshold value and thus triggers the microprocessor readout. If the SCANNER does not detect a hit the microprocessor will not read the Flash-ADC data, examine them for valid hits and determine times and amplitudes. In fact, there were predominantly two DL300 crates, where the SCANNER would hang under certain circumstances and a reset signal would have to be issued to that crate. Only later we learned how to reset the crate without losing the hit information. This hardware bug was corrected in the beginning of September 1986, i.e. from run 28365 on.

Effect on the Data The main effect on the track finding comes from cells missing in ring 2. For these cases the pattern recognition program has

DSN F22ELS.DL.REDUC2.G1244.G1273
R-FI SECTION

BEAM 17.500 GEV FIELD -4.8[illegible] KG TALC C879 DATE 12/01/87 TIME 12.24.
T1A 0802 [illegible] 4101 T2C 8089 CAMAC TIME 45.40.19 19/ 2/1986

24228 274 68
IDHITS 258
ELGTOT 32714
MUHITS 5
LGCYL 32714
LGCAPS 0 0
FWCAPS 240 0

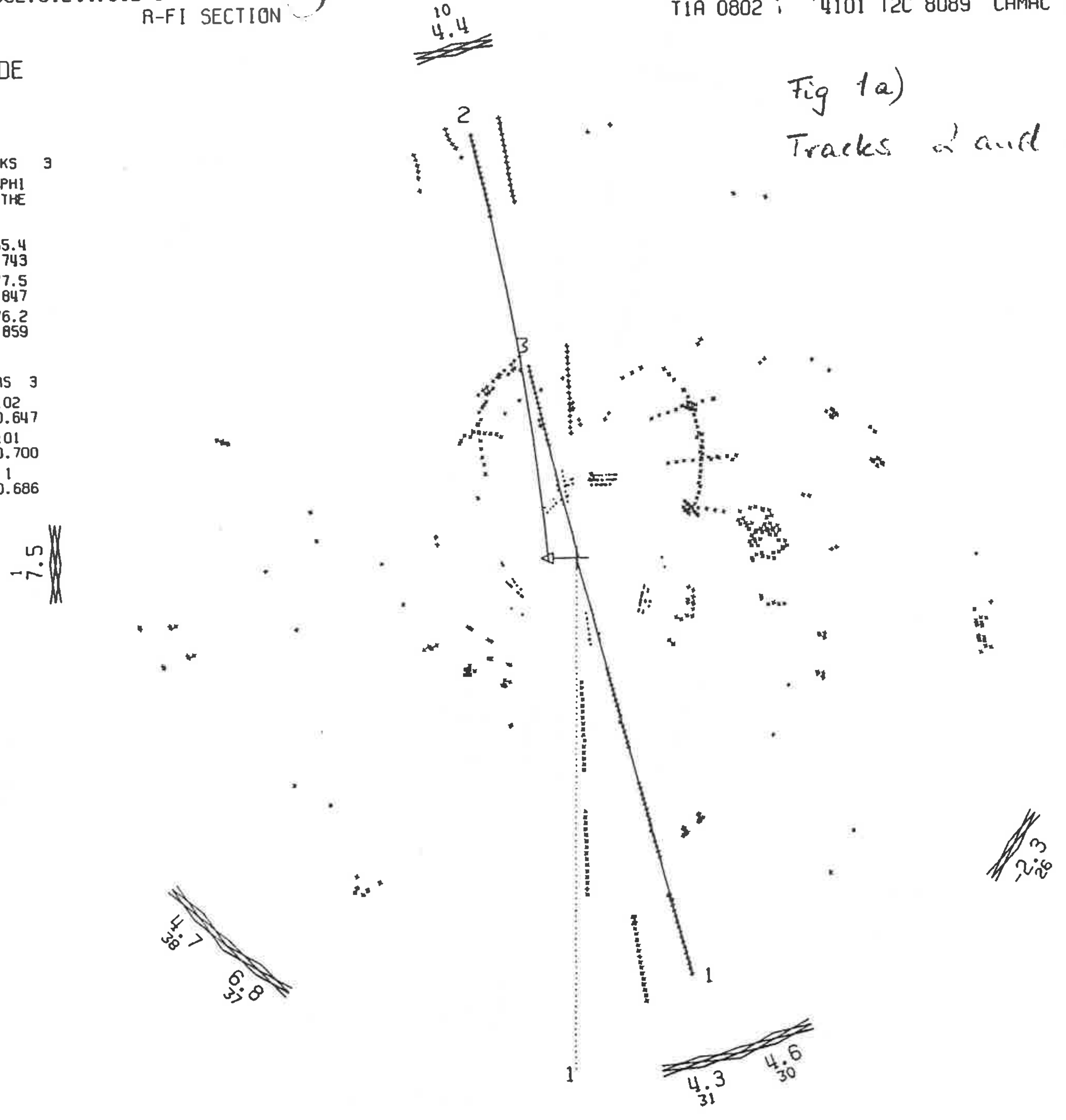
JADE

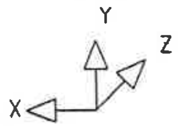
BANK PATR 9 NR OF TRACKS 3
NR +- RMSRFI RMSRZ/HIT PHI
PTOT PLONG PTRANS COSTHE

1 - 0.63/47 39.0/32 255.4
21.694 -16.128 14.510 -0.743
2 - 0.40/16 30.4/15 77.5
1.313 1.113 0.698 0.847
3 + 0.12/16 77.3/12 76.2
3.097 2.662 1.583 0.859

BANK LGCL 1 NR OF CLUSTERS 3
NR 1 BARREL CHARGE 102
E 17.682 FI 76.7 COST 0.647
NR 2 BARREL CHARGE 101
E 18.207 FI 255.0 COST-0.700
NR 3 BARREL PHOTON 1
E 0.928 FI 270.9 COST-0.686

Fig 1a)
Tracks 2 and 3 are separated





*** SUMS (GEV) *** PTOT 26.105 PTRANS 16.791 PLONG 19.903 CHARGE -1
TOTAL CLUSTER ENERGY 36.818 PHOTON ENERGY 0.928 NR OF PHOTONS 1

T-210

February 9, 1987

JADE Computer Note 91

Neutral Triggers on Tape

J. Olsson

In the shutdown period 1981 - 1982 the trigger electronics system of the JADE detector underwent a thorough modification and update. New trigger elements were introduced, in form of energy sums of the various subsections of the Lead Glass system: the so called Barrel Groups (BG), Septants, Endcap Quadrants (EQ) and the Endcaps and the Barrel by themselves (see Jade Note 69). At the same time, the various triggers of JADE were revised and updated and new ones were added (see Jade Note 82). Finally the Reduc1 program underwent an update and was adjusted to accept the new triggers and bank formats.

During 1982 and the following years thoughts were still given to other possibilities of using the new lead glass segmentation for triggering (see e.g. Jade Note 74), in particular for the purpose of triggering on low energy neutral (i.e. all photon) final states. Several such special purpose triggers were also installed, in 1982 and later years. Being intended for close-to-detection-threshold physics, at the time of installations little or nothing was known about the possibilites to reduce the data that were obtained with these new triggers. Therefore, no changes were made to the Reduc1 program to accomodate them, and as a consequence, the events are not present on the REDUCONE tapes, the program is designed to reject all events with "unknown triggers", unless they have also one of the old and known trigger bits set.

In order to study these special events, a collection onto summary tapes was done directly from the Reform tapes and the summary tapes were then subjected to the standard Reduc2 program, modified to perform special cuts on the new trigger type events. In the course of time, these cuts were modified, based on deeper knowledge about the physics content of the new events. This redoing was possible since the Reduc2 program was fast enough to repeat the reduction from the summary tapes with new cuts. However, from 1985 onwards, the "neutral" triggers contain also many events with charged tracks and repeating the reduction for 1985-1986 is costly, in terms of CPU-time.

Thus a new series of Reduc2 tapes appear, containing to a large extent events which are not present on the standard Reduc1 and Reduc2 tapes. This note describes the new triggers, the cuts that are performed in Reduc2 and it also gives the names of the tapes where the data can be found. However, it does not give details of energy thresholds of the various components, which were used in the triggering.

1. The Coplanar Septant Trigger, T1 Accept bit 13 (Z 2000).

This trigger[1] requires 2 opposite (coplanar) septants, i.e. 2 septants separated by 2 septants (e.g. septants 1–4, 1–5, 2–5, 2–6, etc., are valid configurations). Furthermore there is a veto on any TOF counter. It was introduced in 1982, at Run 10493. In the run period 10493 - 10817 exactly 2 septants were required, from Run 10818 this was loosened to ≤ 3 septants (2 of which must be in coplanar configuration) and from Run 20245 (beginning of 1985) no restriction on additional septants was made. The trigger is primarily designed to trigger on final states of $\gamma\gamma$ produced resonances decaying into either $\gamma\gamma$ or $\pi^0\pi^0$. A measurement of $\Gamma_{\eta\rightarrow\gamma\gamma}$ using this trigger has been published by the Jade Collaboration (Phys.Lett.160B(1985)421). A typical event is shown in Fig.1 (η' decaying into $\pi^+\pi^-\eta, \eta \rightarrow \gamma\gamma$).

2. The Tagged Septant Trigger, T1 Accept bit 14 (Z 4000).

This trigger[2] requires ≥ 1 septant, no TOF counter set and the Tagging condition. It was introduced in autumn 1982, at Run 12757. It is designed to trigger the same reactions as the previous trigger, but at larger Q^2, where the resonance decay is no longer expected to appear in a balanced and coplanar fashion. An event is shown in Fig.2.

[1] Also known as "First Olsson Trigger".
[2] Also known as "First Zorn Trigger".

F Coplanar Septant Trigger, T1 Postpone bit 10 (Z 400).

trigger[1] and the following can be seen as extensions of the previous ones, from the neutral final states can also contain charged tracks that do not reach the TOF counters) to final states which contain tracks that reach the TOF counters, as well as photons. The T1 Postpone triggering condition is here nar septants, just as in the T1 Accept case, and ≥ 1 TOF and < 6 TOF. The T2 Accept condition is k_{all}, with T2 coincidence bit 8 (Z 100). The trigger was permanently installed in spring 1985, at Run . As seen from the description, it is a "1–prong trigger". It contains interesting physics already at the t accessible charged track momentum. In order not to lose the events with tracks close to T2 triggering eshold, the filtering algorithm in the Plessey μ16 was changed, so that events with this trigger bit set were not rejected in the T2ANA part of the filter (the Z-vertex part of the filter was still allowed to reject). Similarly, the NORD–50 program (and also the FAMP) was modified so that the normal pattern recognition filtering did not apply to events with only this T2 coincidence bit. These changes were also active from Run 20300 onwards. In Fig.3 is shown a "typical" event (η' decaying into $\pi^+\pi^-\eta, \eta \rightarrow \gamma\gamma$).

4. The Tagged TOF Septant Trigger, T1 Postpone bit 11 (Z 800).

This trigger[2] requires ≥ 1 septant, ≥ 1 TOF and the Tagging condition as T1 Postpone condition. The T2 Accept condition is 1 Track_{all}, with T2 coincidence bit 9 (Z 200). Since no weak tracks were expected in is trigger, no special conditions were made for it in the online filtering algorithms. The trigger was installed 1985, at Run 22587. An event is shown in Fig.4 (η' decaying into $\pi^+\pi^-\eta, \eta \rightarrow \gamma\gamma$).

5. The Septant – Endcap Quadrant Trigger, T1 Accept bit 4 (Z 10).

This trigger[3] requires a coplanar condition between a septant on the one hand and an Endcap Quadrant on the other hand. No TOF counter is allowed and as a further veto only 1 (or 2 neighboring) EQ is allowed. Since there are 7 septants and 2 x 4 EQ, the coplanar condition is somewhat complicated. It is given by any of the following combinations (for the numbering convention, see Fig.5):

Endcap Quadrants	Septants
1, 5	5, 6
2, 6	2, 6, 7
3, 7	1, 2, 3
4, 8	3, 4, 5

The trigger was installed in autumn 1985, at Run 23739. An example of an event is shown in Fig.5 (again η' decaying into $\pi^+\pi^-\eta, \eta \rightarrow \gamma\gamma$).

Special Online Conditions
The special exceptions installed for the third trigger have already been described above. The main background in the first, third and fifth triggers above are cosmic muons. In order to reject such background events online, the NORD–50 filtering program was set up to perform a fast analysis of the muon filter and reject events of these triggers if a muon signal was found. Details are given in Supplement 2 of Jade Note 78. The first Zorn trigger has also been subjected to this cosmic muon filtering, although not strictly necessary, since both Zorn triggers had a low rate. At times a high rate in the first Zorn trigger was experienced; it was however due to noise and high background in the tagging apparatus, when running at the highest Petra beam energies.

The first, third and fifth of the just described triggers had at times quite high rate and in order to reduce deadtime in data taking, there have been periods when they were not active ("Reduced Triggers"). Since 1985, the information about active triggers was written into the HEAD bank in every event (see Jade Note 32, Supplement 5) and so it is possible to map these periods out with software methods, in order to calculate the integrated luminosity for any particular trigger.

[1] Also known as "Second Olsson Trigger".
[2] Also known as "Second Zorn Trigger".
[3] Also known as "Krehbiel Trigger".

Cuts in Reduc 2

The general description of the Reduc2 program is found in Jade Computer Note 43. As already mentioned, the program was modified in order to accomodate the new triggers and special cuts were installed for them. The 5 different triggers fall into 2 groups, namely the 2 T1 Postpone triggers and the 3 T1 Accept triggers. The T1 Postpone triggers are only considered as special if no other T2 triggering condition is fulfilled. The following simple treatment has been applied in the reduction:

The T1 Postpone triggers routinely undergo the MUTANA analysis and are rejected if a muon signal is found. Since MUTANA was running in the online NORD-50 filtering all the time, this is largely redundant.

The T1 Postpone triggers with at least one good track (p_t >100 Mev/c and $\geq$ 16 fitted hits in $r\phi$ and rz) undergo the normal track checks. Important is here that 1 good track is enough to fulfill the ratio condition used in Reduc2. In the Reduc1 filtering an event must have $\geq$ 1 track with p_t >600 Mev/c or $\geq$ 2 tracks with p_t >100 Mev/c.

The T1 Postpone triggers with no good track are accepted, unless they have a z-vertex with a quality flag > 1, outside the $\pm$ 350 mm limit.

The T1 Accept triggers with at least one good track (see above) undergo the normal track checks.

The T1 Accept triggers with no good track, but with tracks found by the pattern recognition program, are checked for the presence of at least 1 track originating in the fiducial cylinder with radius 30 mm and length $\pm$ 350 mm. In this case, there is no requirement on the number of fitted hits. If such a track is found, the event is accepted, otherwise rejected.

The T1 Accept triggers with no tracks found by the pattern recognition program, are checked for the presence of a muon signal. This check is done with 3 different programs, namely MUTANA (also run online), LGKOSM (also run online for other triggers) which searches for the so called "grazing cosmics", and finally with the subroutine FINCOS. FINCOS makes a combined search of the lead glass cluster situation and the hits in the inner detector, by laying a road between any pair of lead glass clusters and finding a minimum nr of hits in the inner detector, within this road (only in the $r\phi$ projection). Both barrel and endcap clusters are considered and the roads are linear as well as curved. The program catches those cosmic muons which for various reasons did not produce enough hits in the muon filter to be seen by MUTANA. If no muon signal is found in the three routines, the event is accepted, otherwise rejected. Note that the Halfworld Energy Balance is not checked for these triggers, as is the case for other neutral events.

Finally it is worthwhile to mention that all the above triggers are simulated in the JADE Monte Carlo programs, albeit with "step-function" thresholds for the various energy sums. For details, see Supplement 2 of Jade Computer Note 66.

Summary Tapes

As already mentioned, events with any of the above mentioned trigger bits set, were collected directly from the REFORM tapes onto special summary tapes. These tapes are kept in the archive and have the names:

F11OLS.NEUSUM.RAWDATA0

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F11OLS.NEUSUM.RAWD349

A summary of the tape names, run periods and nr of events can be found in the member

JADEPR.TEXT(NEUSUM)

The Reduc2 tapes resulting from running the Reduc2 program on these "Rawdata" tapes are named

F11OLS.RED2NEU.TAPE82E etc...

They are given in detail in the following tables and are also found in the member

JADEPR.TEXT(RED2NEU)

Several facts should be noted:

Similar to the standard Reduc1 and Reduc2 events, processing has been done at times when only preliminary calibration for inner detector and lead glass was available. For 1986, the reduction was done after the final

JETC calibration was available, i.e. it was done in late autumn 1986 and spring 1987. Thus the JETC and Pattern recognition corresponds to the status on the standard Reduc1 and Reduc2 tapes in 1986. The new lead glass calibration for 1986 was made standard in January 1987 and the later part of the data have been processed with this calibration, the spring and summer data however with the preliminary (1985) lead glass calibration.

Some events have old trigger bits set as well as the new ones. Such events are probably also present on the standard Reduc2 tapes as well, unless rejected by Reduc1. If data selection is done from the standard data as well as from the RED2NEU tapes, this has to be born in mind when merging the selected samples.

No particular care has been taken to avoid cosmic runs or other kind of junk runs in the selection. If such runs contained any of the above triggers, the events will be on the summary tapes and might cause a number of warning prints from various routines (e.g. RUNFIX, EBEAM).

The large amount of data in 1985 and 1986 is mostly due to the relatively high rate of the third and fifth triggers described above. Also, 1985 and 86 correspond to about 110 pb^{-1}, the previous years gave less integrated luminosity.

Neutral Triggers on Tape 1982		
F110LS.RED2NEU.	Nr of Events	Run Period
TAPE82E	21424	10493 – 11754
TAPE82F	19573	11755 – 12384
TAPE82G	15222	12385 – 12948

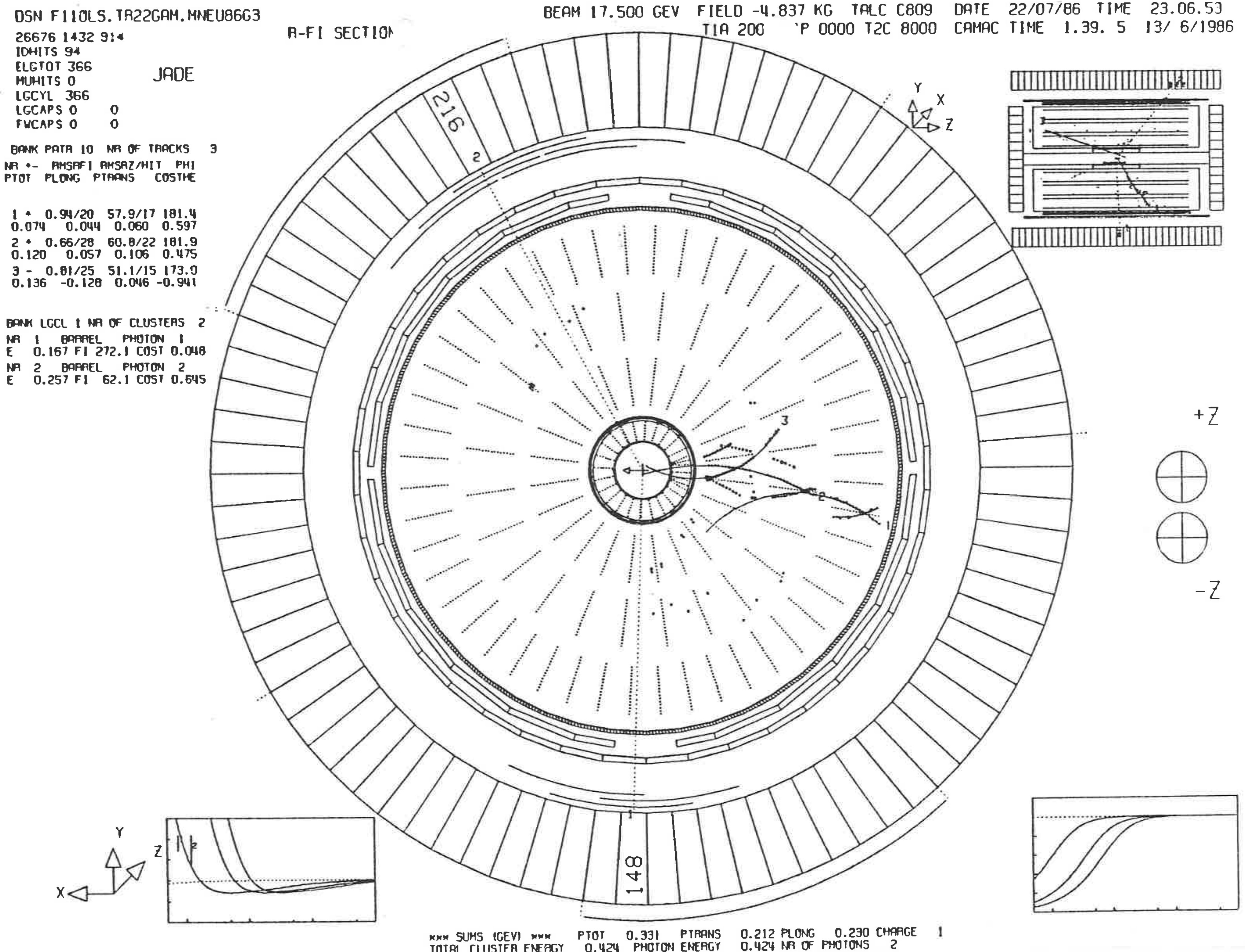
Neutral Triggers on Tape 1983		
F110LS.RED2NEU.	Nr of Events	Run Period
TAPE83A	24182	12959 – 13248
TAPE83B	26955	13249 – 13698
TAPE83C	21192	13699 – 14373
TAPE83D	17029	14374 – 14467
TAPE83E	20455	14468 – 14500
TAPE83F	17338	14501 – 14536
TAPE83G	16816	14537 – 14586
TAPE83H	16180	14587 – 14820
TAPE83I	16116	14821 – 15082
TAPE83J	16903	15083 – 15689
TAPE83K	2233	12959 – 15689

Neutral Triggers on Tape 1984		
F110LS.RED2NEU.	Nr of Events	Run Period
TAPE84A	15917	15693 – 16241
TAPE84B	13512	16236 – 16733
TAPE84C	850	15693 – 16733
TAPE84D	17044	16734 – 17733
TAPE84E	18095	17734 – 17953
TAPE84F	17292	17954 – 18310
TAPE84G	12799	18311 – 18627
TAPE84H	10580	18628 – 18880
TAPE84I	12094	18881 – 19018

Neutral Triggers on Tape 1985		
F11OLS.RED2NEU.	Nr of Events	Run Period
TAPE85A	14804	19019 – 20368
TAPE85B	13577	20369 – 20498
TAPE85C	14512	20499 – 20611
TAPE85D	13964	20612 – 20717
TAPE85E	14258	20718 – 20821
TAPE85F	13796	20822 – 20938
TAPE85G	15024	20939 – 21056
TAPE85H	14670	21057 – 21189
TAPE85I	14389	21190 – 21323
TAPE85J	12023	21324 – 21434
TAPE85K	12501	21435 – 21547
TAPE85L	13443	21548 – 21689
TAPE85M	11729	21690 – 21811
TAPE85N	10153	21812 – 21922
TAPE85O	13294	21923 – 22060
TAPE85P	12336	22061 – 22168
TAPE85Q	12892	22169 – 22284
TAPE85R	11979	22285 - 22403
TAPE85S	12986	22404 – 22521
TAPE85T	13789	22522 – 22625
TAPE85U	13062	22626 – 22712
TAPE85V	13074	22713 – 22799
TAPE85W	13371	22800 – 22888
TAPE85X	13284	22889 – 22982
TAPE85Y	13018	22983 – 23093
TAPE85Z	12561	23094 – 23182
TAPE85ZA	12734	23183 – 23257
TAPE85ZB	13192	23258 – 23354
TAPE85ZC	13398	23355 – 23418
TAPE85ZD	15906	23419 – 23497
TAPE85ZE	15697	23498 – 23568
TAPE85ZF	16868	23569 – 23654
TAPE85ZG	16927	23655 – 23732
TAPE85ZH	16759	23733 – 23789
TAPE85ZI	17108	23790 – 23840
TAPE85ZJ	17476	23841 – 23903
TAPE85ZK	19020	23904 – 23962
TAPE85ZL	19023	23963 – 24019
TAPE85ZM	19777	24020 – 24099
TAPE85ZN	17485	24100 – 24160
TAPE85ZO	9129	24161 – 24197

Neutral Triggers on Tape 1986 Part I		
F110LS.RED2NEU.	Nr of Events	Run Period
TAPE86DA	17803	24212 – 24434
TAPE86DB	15400	24435 – 24578
TAPE86DC	19621	24579 – 24755
TAPE86DD	19899	24756 – 24856
TAPE86DE	18035	24857 – 24907
TAPE86DF	18379	24908 – 24967
TAPE86DG	20888	24968 – 25031
TAPE86DH	20723	25032 – 25093
TAPE86DI	20447	25094 – 25165
TAPE86DJ	20728	25166 – 25219
TAPE86DK	20836	25220 – 25263
TAPE86DL	20937	25264 – 25315
TAPE86DM	21157	25316 – 25366
TAPE86DN	20945	25367 – 25429
TAPE86DO	21214	25430 – 25481
TAPE86DP	21489	25482 – 25539
TAPE86DQ	22593	25540 – 25598
TAPE86DR	23678	25599 – 25655
TAPE86DS	24120	25656 – 25713
TAPE86DT	23027	25714 – 25777
TAPE86DU	22888	25778 – 25835
TAPE86DV	18448	25836 – 25885
TAPE86DW	20132	25886 – 25942
TAPE86DX	21400	25943 – 26000
TAPE86DY	21946	26001 – 26051
TAPE86DZ	22960	26052 – 26105
TAPE86EA	22151	26106 – 26159
TAPE86EB	22701	26160 – 26212
TAPE86EC	23647	26213 – 26271
TAPE86ED	24056	26272 – 26354
TAPE86EE	23776	26355 – 26411
TAPE86EF	23904	26412 – 26468
TAPE86EG	23014	26469 – 26520
TAPE86EH	23251	26521 – 26579
TAPE86EI	23839	26580 – 26653
TAPE86EJ	24442	26654 – 26714
TAPE86EK	23929	26715 – 26772
TAPE86EL	23824	26773 – 26871
TAPE86EM	24518	26872 – 26955
TAPE86EN	23970	26956 – 27048
TAPE86EO	24789	27049 – 27153
TAPE86EP	24932	27154 – 27219
TAPE86EQ	24544	27220 – 27287
TAPE86ER	24914	27288 – 27393
TAPE86ES	24414	27394 – 27475
TAPE86ET	23856	27476 – 27553
TAPE86EU	24088	27554 – 27614
TAPE86EV	23547	27615 – 27664
TAPE86EW	24203	27665 – 27722
TAPE86EX	23867	27723 – 27780
TAPE86EY	23867	27781 – 27834
TAPE86EZ	24835	27697 – 27879

Neutral Triggers on Tape 1986 Part II		
F110LS.RED2NEU.	Nr of Events	Run Period
TAPE86FA	22861	27880 – 27950
TAPE86FB	20638	27951 – 28002
TAPE86FC	22070	28003 – 28046
TAPE86FD	19958	28047 – 28088
TAPE86FE	22396	28089 – 28132
TAPE86FF	23062	28133 – 28187
TAPE86FG	23075	28188 – 28227
TAPE86FH	23368	28228 – 28272
TAPE86FI	23358	28186 – 28321
TAPE86FJ	23605	28306 – 28364
TAPE86FK	24363	28365 – 28419
TAPE86FL	23793	28420 – 28474
TAPE86FM	23158	28475 – 28522
TAPE86FN	23348	28523 – 28581
TAPE86FO	21280	28533 – 28618
TAPE86FP	23086	28619 – 28656
TAPE86FR	20967	28699 – 28810
TAPE86FS	22399	28811 – 28894
TAPE86FT	23743	28895 – 28939
TAPE86FU	23427	28940 – 28987
TAPE86FV	20841	28988 – 29037
TAPE86FW	23771	29038 – 29082
TAPE86FX	23148	29083 – 29130
TAPE86FY	22975	29131 – 29173
TAPE86FZ	22663	29174 – 29217
TAPE86GA	23207	29218 – 29256
TAPE86GB	23205	29257 – 29302
TAPE86GC	23489	29303 – 29346
TAPE86GD	23325	29347 – 29392
TAPE86GE	23166	29393 – 29443
TAPE86GF	23533	29444 – 29490
TAPE86GG	23632	29491 – 29545
TAPE86GH	23340	29546 – 29597
TAPE86GI	23639	29598 – 29648
TAPE86GJ	23807	29649 – 29702
TAPE86GK	24002	29703 – 29746
TAPE86GL	24390	29747 – 29789
TAPE86GM	23873	29790 – 29835
TAPE86GN	23917	29836 – 29880
TAPE86GO	23652	29881 – 29927
TAPE86GP	23333	29928 – 29973
TAPE86GQ	23399	29974 – 30026
TAPE86GR	23340	30027 – 30073
TAPE86GS	23405	30074 – 30121
TAPE86GT	23252	30122 – 30165
TAPE86GU	23072	30166 – 30210
TAPE86GV	23734	30211 – 30233
TAPE86GW	23762	30234 – 30302
TAPE86GX	22615	30303 – 30353
TAPE86GY	13493	30354 – 30397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TIA 200 'P 0000 T2C 8000 CAMAC TIME 1.39. 5 13/ 6/1986
26676 1432 914
IDHITS 94
ELGTOT 366
MUHITS 0
LGCYL 366
LGCAPS 0 0
FWCAPS 0 0
JADE
BANK PATR 10 NR OF TRACKS 3
NR +- RMSRFI RMSRZ/HIT PHI
PTOT PLONG PTRANS COSTHE
1 + 0.94/20 57.9/17 181.4
0.074 0.044 0.060 0.597
2 + 0.66/28 60.8/22 181.9
0.120 0.057 0.106 0.475
3 - 0.81/25 51.1/15 173.0
0.136 -0.128 0.046 -0.941
BANK LGCL 1 NR OF CLUSTERS 2
NR 1 BARREL PHOTON 1
E 0.167 FI 272.1 COST 0.048
NR 2 BARREL PHOTON 2
E 0.257 FI 62.1 COST 0.645
216
148
+Z
-Z
*** SUMS (GEV) *** PTOT 0.331 PTRANS 0.212 PLONG 0.230 CHARGE 1
TOTAL CLUSTER ENERGY 0.424 PHOTON ENERGY 0.424 NR OF PHOTONS 2

FIG 7