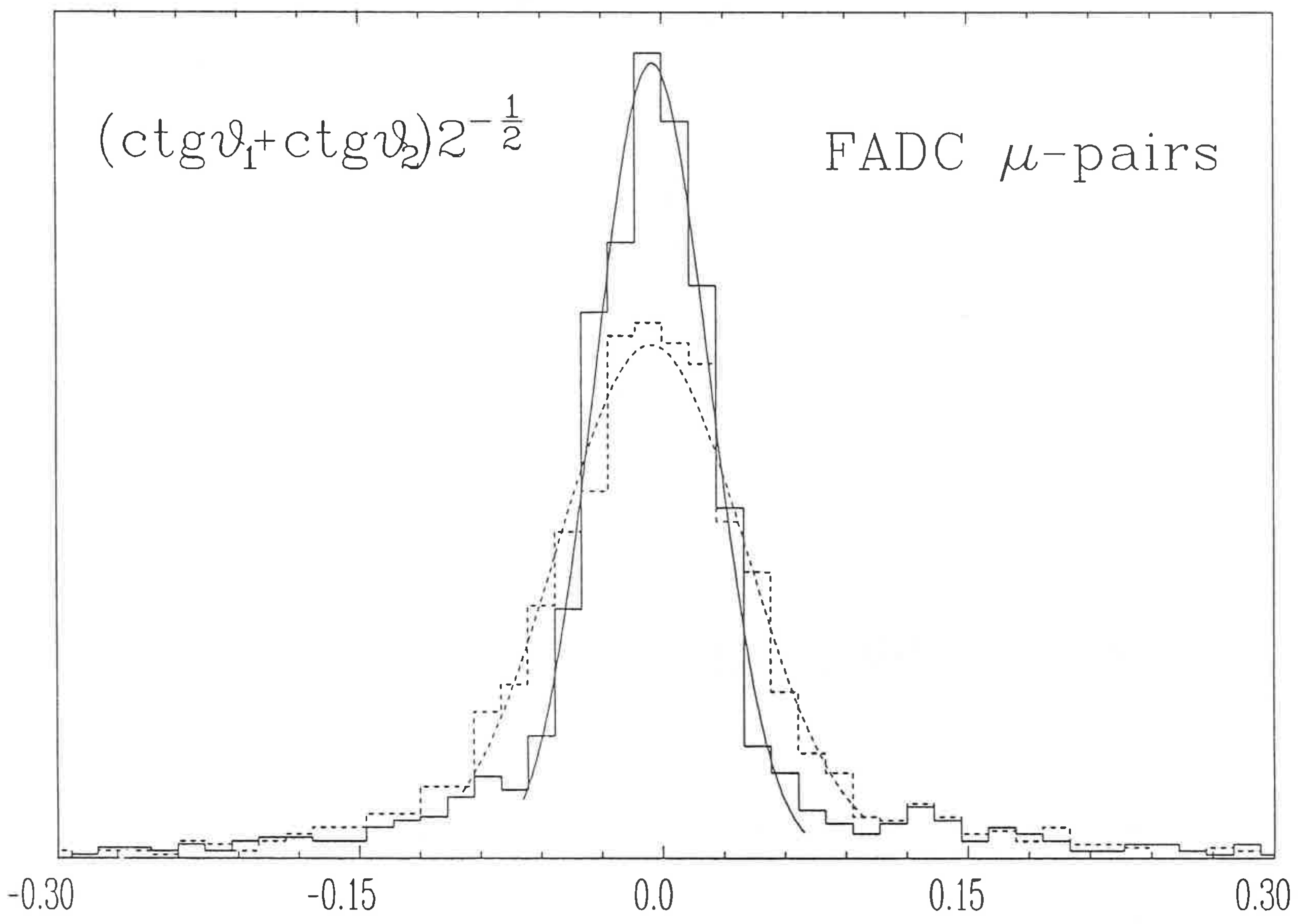


Fig.10. Common z fits w/ and w/o constraint to z≈0 (ZSRFTV)

Improved resolution with z-chamber hits

JADE Computer note 95
Supplement 1

J. SPITZER
July 28, 1987

ABSTRACT. The very precise information from the z-chamber improves considerabely the resolution in the $s-z$ fit parameters, especially in ϑ, both for the DL8- (starting with run ≈18250 in 1984) and for the FADC data.

Following Beate's suggestion, I've investigated what improvement if any results if one includes the z-chamber hits into the $s-z$ fits. The following results have been obtained:

There is a relatively large z-dependent mismatch between the z-chamber hits and the tracks extrapolated from the jet-chamber. I have fitted (or rather roughly described) the mismatch as function of z separately for the years 84, 85 and 86, for the inner and outer wires and for $x < 0$ and $x > 0$ corresponding to the two separate halves of the z-chamber (see JN 138). The results are indicated in Fig.1. The difference in the mismatch for the inner and outer wires is negligible relative to their common (averaged) mismatch. Errors in the z-chamber wire T_0's have effects within 300 μm. These are small compared to the mismatch and to the track extrapolation error (12-18 mm) and are in the range of the statistical and systematic uncertainties in the determination of the mismatch. Since no further improvement in the resolution is expected, I did not try to correct the T_0's.

It is not clear whether the jet-chamber- or the z-chamber calibration is (rather) in error. An overall shift might be understandable but the mismatch is significantly z-dependent. The jet-chamber was calibrated to the lead glass whereas the z-chamber by using cosmics which, besides having an angular distribution different from that for tracks from interactions, are partially "out of time" and fly from outside to inside. On the other hand, the mismatch can not be accounted for by errors in the T_0's and drift velocities in the z-chamber, one would need errors in the relative wire positions in the order of several mm's within the z-chamber (and varying in time). In any case, the correction for the mismatch is, of course, applied to the z-chamber hits rather than moving all the other components of the detector.

When two z-chamber hits are assigned to the track, from the difference of their residuals one can extract the single hit resolution of the z-chamber: 600 μm, in agreement with Susan's findings. Since this is much better than the resolution of the jet chamber (20-40 mm) and the extraploation error, the z-chamber hits must help!

The corrected z-chamber hits were then supplied to the fitting program ZSRFTV. It was found by trial that the optimum weight for the z-chamber hits relative to that for the jet-chamber is in the order of 50 for FADC- and 30 for the DL8-data. (One would expect it to be much bigger.) The resolutions in the fit parameters for μ-pairs with and without the z-chamber hits are summarized in Table 1. Note that the sample on which the DL8 numbers were based in Table 1. of JCN 95, was dominated by μ-pairs in '81 with the best z-resolution only one hit association) which is a little too high but, according to my experience, this setup still shoud work reasonably well. (The two hits are very close to each other anyway. When I use a single hit for fitting with coordinates averaged for those of the two, the result is only slightly worse, even for large weights, than the fit with two hits.) Susan did correct for an overall shift between the chambers. The remaining z-dependent mismatch may have only a small effect on the resolution. I have found two errors in the χ^2-minimization code in ZRVOPT, which apparently do not cause any disaster. In fact, one of them had already been noticed by Susan but when correcting it the peak was not as nice as before, she reinstalled the wrong statement!

Without having done any serious investigation, I can only make the following guess. The comparison was made on top of a common-z constraint. As mentioned in JCN 95, due to correlations, the statistical error of the difference in the angles may be small compared to the single track angular measurement error so that the mass resolution is then dominated by other errors. This may or may not be provable on the real data by releasing the constraint in ZRVOPT (or simply not calling it) but should be testable on Monte Carlo where the other sources of errors can be set to zero.

The request for including the z-chamber hits in the fits by ZSRFTV can be made by setting appropriately the weight for them in ZCHWW of /CCMZCT/ which has been extended again:

COMMON/CCMZCT/ DIMPCT, ZCUTV, ZCUTVV, IZVCST(5), ZCHWW.

If the value of ZCHWW is between 0.1 and 2000.0, JFETCH or JFTNEW, when called with INDEX=4, will fetch the z-chamber hits as well, otherwise not. (Only ZSRFTV makes such a call.) The new routine ZCFTNW supplies the hit coordinates corrected for the mismatch. At the first hit request for an event, it calls Susan's ZCDATA which calculates the coordinates for each z-chamber hit and performs the track-hit association. I have made only a few minor corrections to some of Susan's routines but one of them is a removal of a divide check so please don't use the original versions in F22CAR.ZS. The recommended value for the weight is 50 which will apply to FADC and scaled automatically down by a factor of 3/5 for the DL8. The current default is ZCHWW=0.0 (no z-chamber hits).

To summarize, Susan did a pretty good job on the z-chamber calibration. The hits are almost immediately usable for the z-fits (correcting the mismatch in a z-dependent way has only a minor importance concerning the resolution). The association algorithm she established can hardly be improved. The z-chamber can be considered as a success rather than a failure providing us for '85 with the best angular resolution ever and even for the FADC data almost as good as the best DL8 resolution.

JADE Computer Note No. 96

Changes to dE/dx-Routines and
Description of Bank JHTQ

K. Ambrus, E. Elsen

July 22, 1987

Introduction The dE/dx-programs require some information on the quality of hits to be used. This quality information, in most cases can be taken from the z-fit information, stored in bank JHTL. Whereas, in the past, the user was required to care for the z-calibration himself, the dE/dx routines have now been changed to call the z-calibration routine ZSFIT automatically.

However, as for the case of overflow hits, some hits have bad quality for z-fits and are still usable for dE/dx. Since all bits in bank JHTL are already in use (not always properly documented) an extra bank, called JHTQ had to be generated to provide the hit quality information for the dE/dx-programs.

The new version of the program ZSFIT(MODE) will generate bank JHTQ if the 8-Bit (Bit 28 in IBM notation) is set in the argument MODE. DEDXBN, the standard dE/dx-routine, calls ZSFIT with argument $9, (= 1 + 8)$, such that both the JETC-amplitudes are recalibrated - as in the past - and - as a new feature - the bank JHTQ is created. A new version of the dE/dx- program (available as member DEDXCN) calls ZSFIT with mode $11, (= 3 + 8)$ to perform the so called hit cleaning and provide consistent results in banks JHTQ and JHTL. This routine will become the standard after the summer conferences.

Note that with this scheme it is still left to the responsibility of the user to provide tracks with adequate z-fits. The results of the fit obtained by ZSFIT are not stored in bank PATR and only used internally to provide the hit quality information. The user should be reminded that a bad z-information neccessarily influences the result of the dE/dx-calculation. There are several programs available to perform z-fits (JCN 95).

Format of Bank JHTQ

```
COMMON / BCS / IW(10000)
DIMENSION HW(20000)
EQUIVALENCE (HW(1),IW(1))
```

IW(...+1)	=	JHTQBT = Number of Bits per Hit (=2 presently)
		NHPW = (32/JHTQBT) hits per 32 Bit word
IW(...+1+1)	=	packed dE/dx flags for hits 1 to NHPW
IW(...+1+2)	=	packed dE/dx flags for hits NHPW+1 to 2*NHPW
IW(...+1+(NHits-1)/NHPW+1)	=	...

Position of dE/dx-flags for the different hits packed in a 32-bit word for JHTQBT=2

Hit 16																												Hit 2		Hit 1	
0	1																											28	29	30	31

JADE Computer Note No. 97

dE/dx Monte Carlo

E. Elsen

November 25, 1987

Introduction Several private versions of dE/dx Monte Carlo generators are already in existence. However, at least to my knowledge, none of them have been incorporated into the standard analysis chain, so that cuts in the selection of hits etc. were only approximately treated like in the data. This note describes the Monte Carlo generator, that was implemented in the standard dE/dx-package on November 17, 1987 and is since then available for all users.

Principle of Simulation The simulation is sufficiently detailed to generate a spectrum of dE/dx amplitudes for the hits associated with a given track, such that a full truncated mean analysis can be performed as for the real data; in fact, identical analysis routines are used. The individual dE/dx amplitudes are determined using the spectra measured by K.Ambrus for the real data. The simulation of a given amplitude is dependent on the properties (i.e. mass and momentum) of the particle that produced the hit and not on the properties of a particle found to reconstruct most hits (the track).

An additional systematic error σ_{sys} seen in the data is accounted for by smearing the generated amplitudes ϵ_i in the Monte Carlo by a common factor according to the prescription laid out in K.Ambrus' thesis: For fixed number of hits the logarithm of the energy loss measurement follows nicely a gaussian distribution.

$$f(\ln\epsilon) \propto e^{-\frac{\ln\frac{\epsilon}{\epsilon_T}}{2\sigma_0^2}}$$

where ϵ_T is the theoretical mean energy loss. This implies a constant relative error ($\sigma_0 = \sigma(\epsilon)/\epsilon = const.$). The experimentally observed error (σ_{exp}) is larger than the value σ_{stat} derived from the statistical analysis of the experimental Landau distribution using the truncated mean technique. The defect observed in Monte Carlo is parameterized in the quantity σ_{sys}:

$$\sigma_{exp}^2 = \sigma_{stat}^2 + \sigma_{sys}^2.$$

It is used to generate random numbers z taken from a gaussian distribution with $\sigma = \sigma_{sys}/\sigma_{exp}$ and mean 1 applied to rescale the amplitudes:

$$\epsilon_i \Rightarrow z \cdot \epsilon_i$$

The values of $\sigma_{sys}/\sigma_{exp}$ are run range dependent and typically around 35%. A total of 39 different periods have been identified for the real data and are used in DEDXBN. The Monte Carlo simulates the effect of the different periods by selecting the matched value of σ_{sys} according to the time specified in COMMON /TODAY/ and translating this time into a run range.

The result of a Monte Carlo simulation for multihadronic events using standard analysis routines is shown in Fig. 1.

The dE/dx generator has not been implemented at the level of the Jet chamber hits stored in bank JETC, which would have been the proper place. The reason for this is simply that the many 'smeared' Monte Carlo events already produced would be unusable for dE/dx analyses.

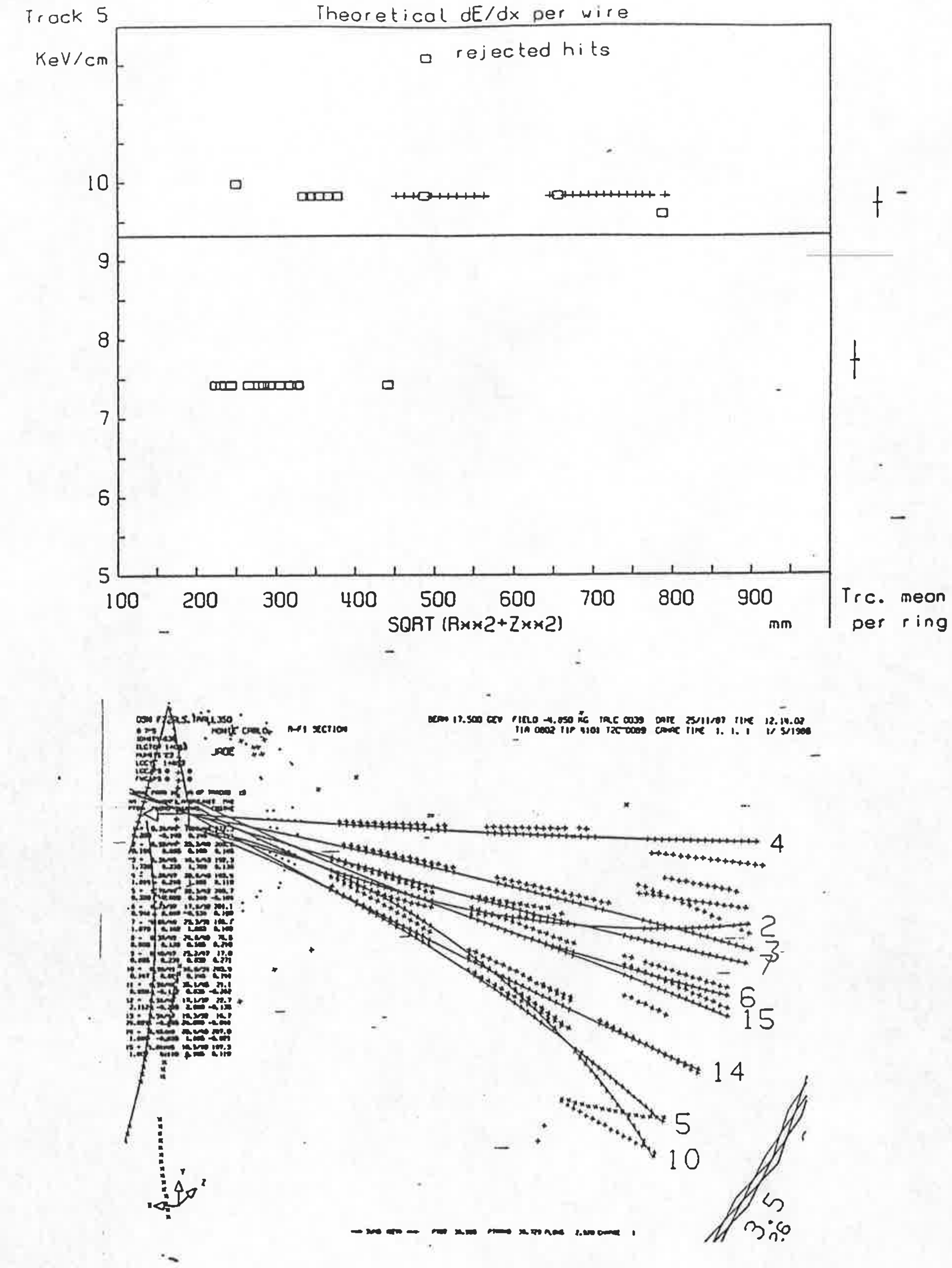


Figure 2: Theoretical mean dE/dx values for the hits associated with a single track (5). The boxes indicate the hits that have been rejected by the 'hit cleaning' procedure. The hit cleaning is based mainly on the proximity of adjacent tracks. The hits of the track have been created by different particles explaining the scattering of the theoretical values. The solid line indicates the value of the truncated mean after full simulation including the extra contribution σ_{sys}.

Fels

January 5, 1988

JADE Computer Note No. 98

W. Bartel

Minutes of the JADE Software Meeting of Dec. 14, 1987 at DESY

This note is a collection of transparencies which have been shown during the software meeting at Dec. 14, 1987.

- **D. Pitzl** : New Routines for the Reconstruction of Photon Energies
- **J. E. Olsson** : Tokyo Shower Program for γ's
- **E. Elsen** : Chamber Resolutions in Monte Carlo
- **E. Elsen** : dE/dx Monte Carlo
- **R. Ramcke** : Inclusion of VTXC-Software
- **G. Eckerlin** : TP-ed MH-Events at DESY
- **C. Bowdery** : Which FORTRAN Compiler?

The following decisions were taken at the meeting:

1. The Pitzl leadglass programs should be implemented on the JADE library.
2. A separate library for vertex chamber routines should be created.
3. The vertex chamber calibration constants should be cast into a form which is compatible with the JADE calibration system.
4. Information on tapes containing data and tracked Monte Carlo events should be transferred to the library **JADEPR.TEXT.**
5. Before a decision can be taken on the FORTRAN 77 compiler to be used in JADE further investigations are necessary.

New Routines for the reconstruction of Photon Energies

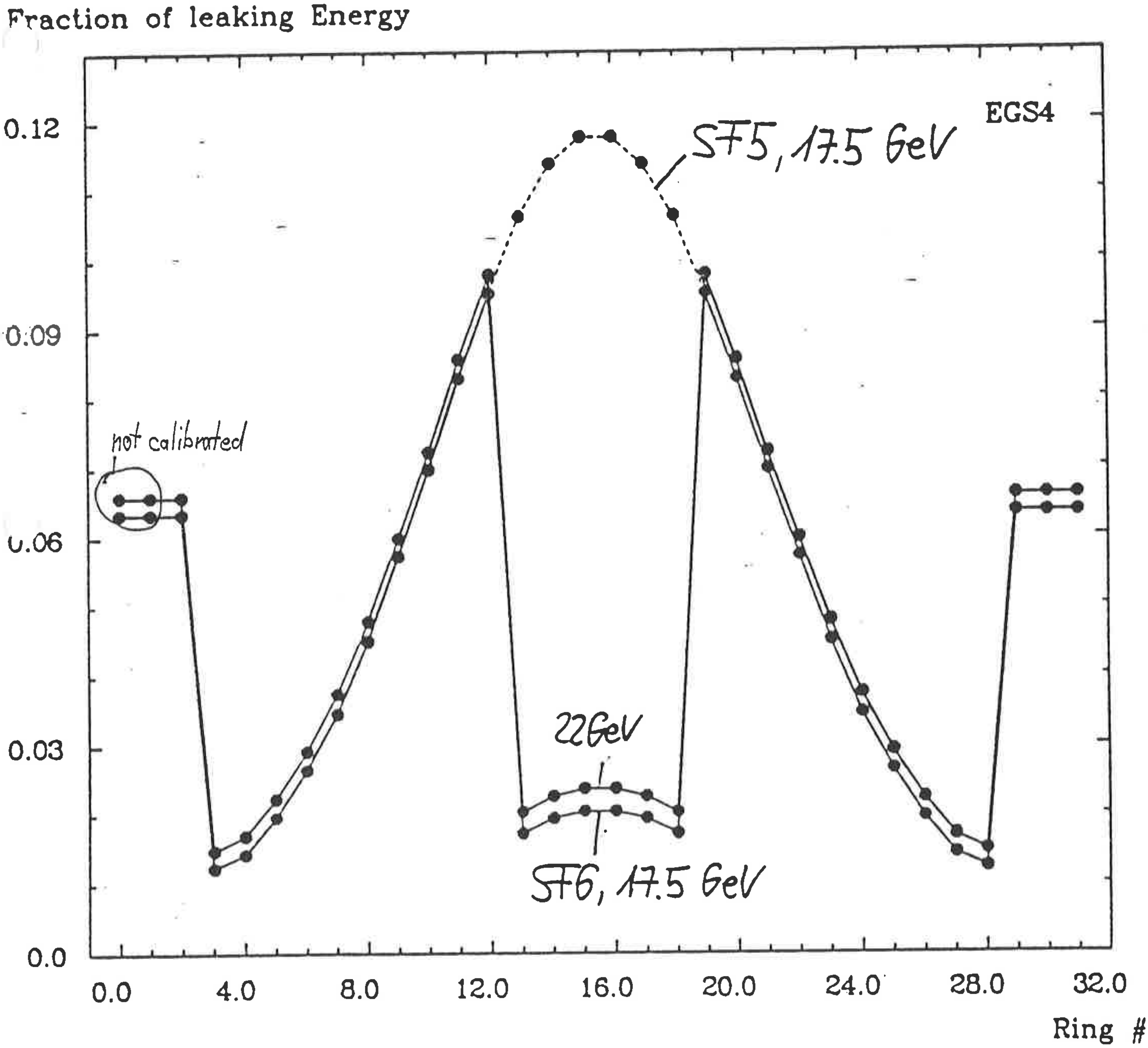
- Corrections calculated by EGS4
  (Electron-Gamma Shower Monte Carlo, Version of 1985)
- valid for the Barrel-LG for 1979-86
- Effects considered are:
  1.) Leakage of Bhabha-Electron-Showers in the LG-Calibration: BBLEAK
  2.) Energy deposited by Photons in the material in front of the LG: ENLOSG
  3.) Leakage of Photon-Showers: LKCORR
  4.) Correction for the LG-readout-threshold: THCORR

Leakage of Bhabha - Showers

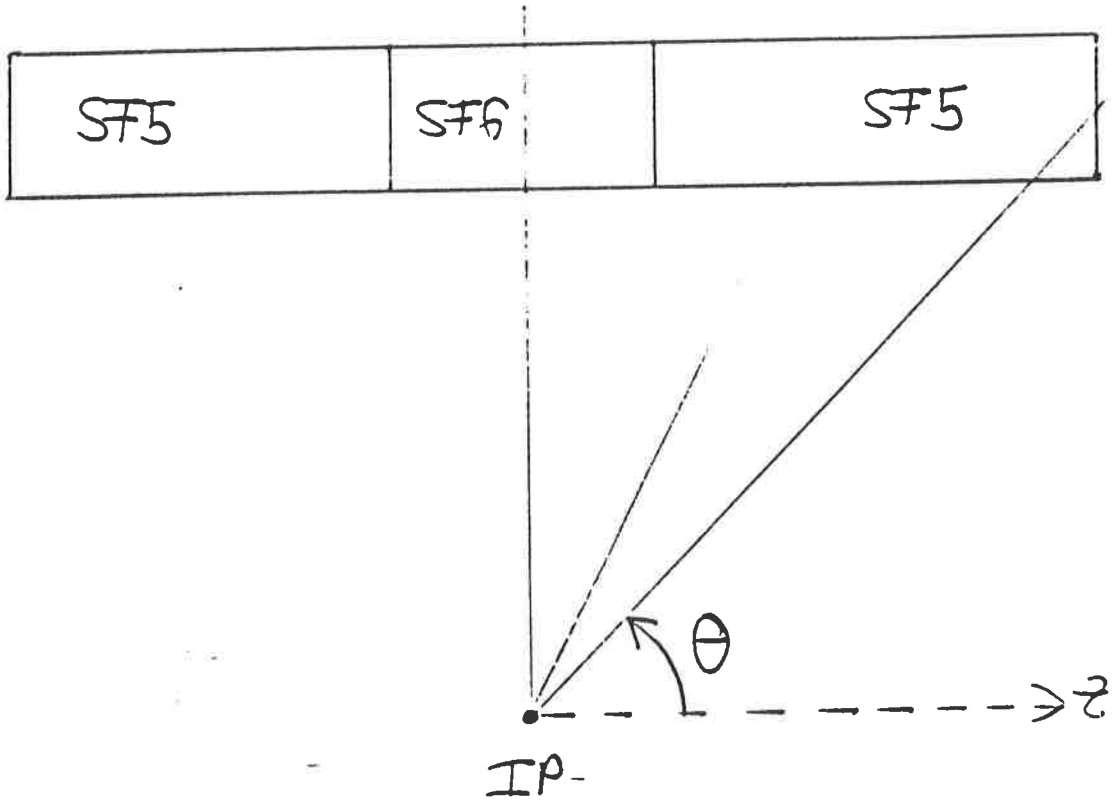
17.5 GeV with and without SF6 in the 6 central rings

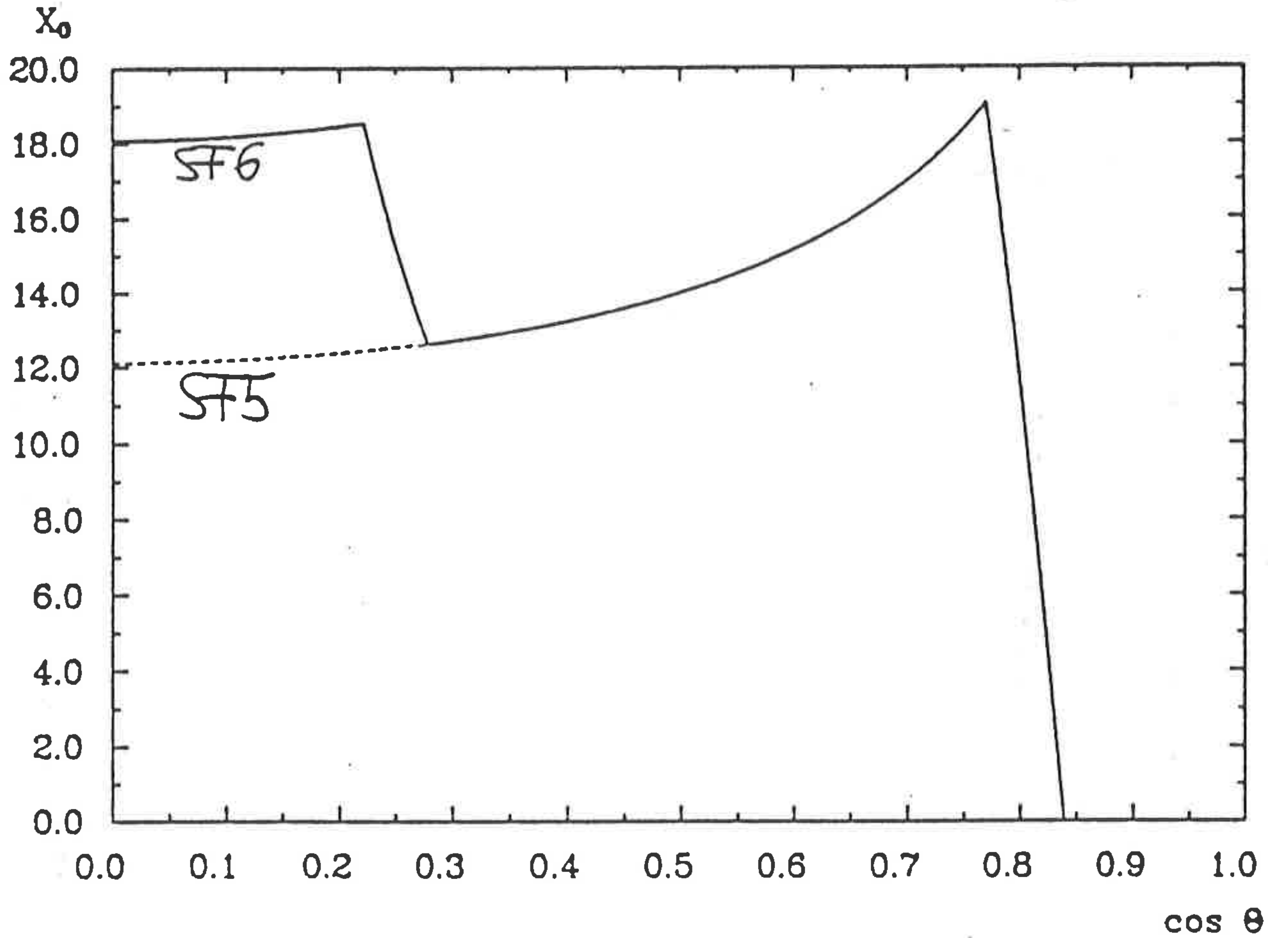
22.0 GeV with SF6.

Material infront of LG : 1.22 X_0 Al



Leakage of Bhabha-Showers at 17.5 and 22. GeV





effective Depth of Barrel-LG

Radiation Length

$$\frac{dE^e_{rad}}{dx} = -\frac{E^e}{X_0}$$

1.) Messel, Crawford

$$\frac{1}{X_0^{MC}} = 4\alpha r_e^2 N_A \frac{\rho}{A} Z(Z+1) \ln\left(183/Z^{1/3}\right)$$

2.) Rossi : Coulomb-correction for high Z

$$\frac{1}{X_0^R} = 4\alpha r_e^2 N_A \frac{\rho}{A} Z(Z+1) \frac{1}{1+0.12\left(Z/82\right)^2} \ln\left(183/Z^{1/3}\right)$$

3.) EGS :

$$\frac{1}{X_0^{EGS}} = 4\alpha r_e^2 N_A \frac{\rho}{A} Z(Z+a(Z)) \cdot \left[\ln\left(183/Z^{1/3}\right) - b(Z)\right]$$

$$a(Z) = \ln\left(1440/Z^{2/3}\right) \Big/ \left[\ln\left(183/Z^{1/3}\right) - b(Z)\right]$$

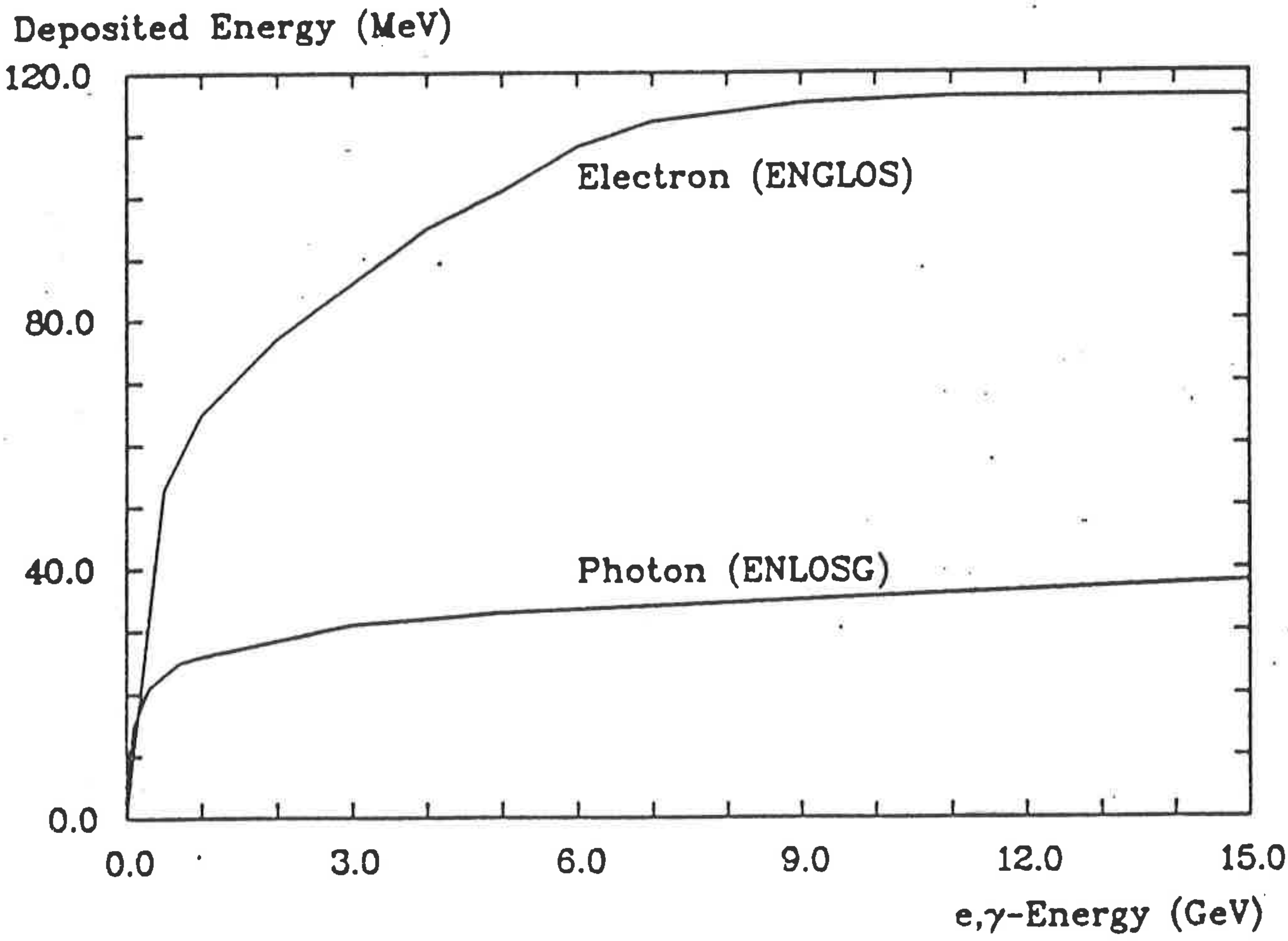
$$b(Z) = (\alpha Z)^2 \left[\frac{1}{1+(\alpha Z)^2} + 0.202 - 0.037(\alpha Z)^2 + 0.008(\alpha Z)^4 - 0.002(\alpha Z)^6\right]$$

cm	X_0^{MC}	X_0^R	X_0^{EGS}
SF5	2.23	2.54	2.475
SF6	1.53	1.70	1.66

mixture:

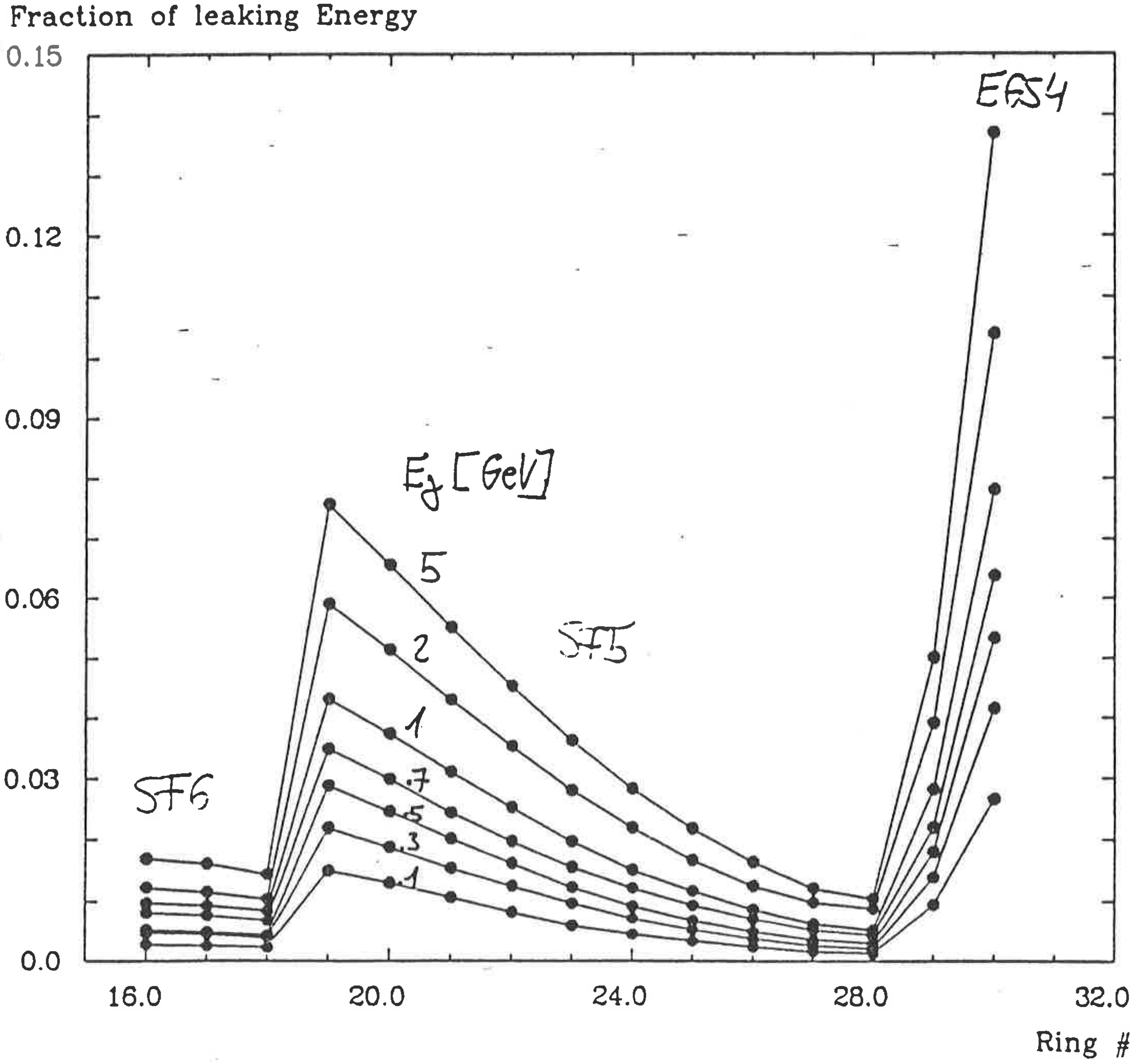
$$\frac{1}{\rho X_0} = \sum_i \frac{w_i}{\rho_i X_{0i}}$$

w_i = mass fraction



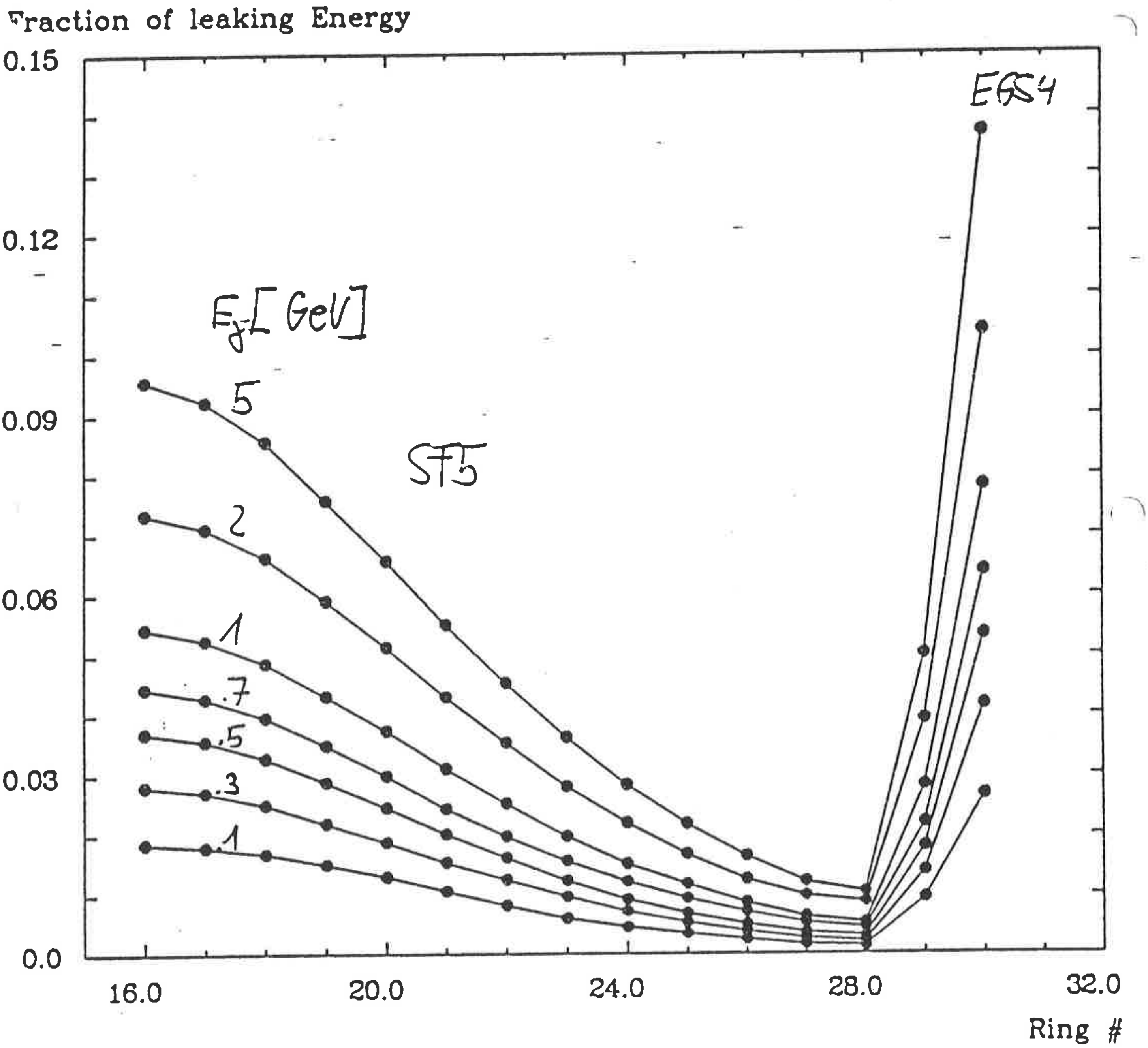
Energy deposited in 1 X_0 Alu by Electrons and Photons

Leakage of Photon-Showers
with SF6 in the 6 central rings
material between ID and L6: 1.04 X_0



Leakage of Photon Showers with SF5 and SF6

Leakage of Photon showers
only SF5

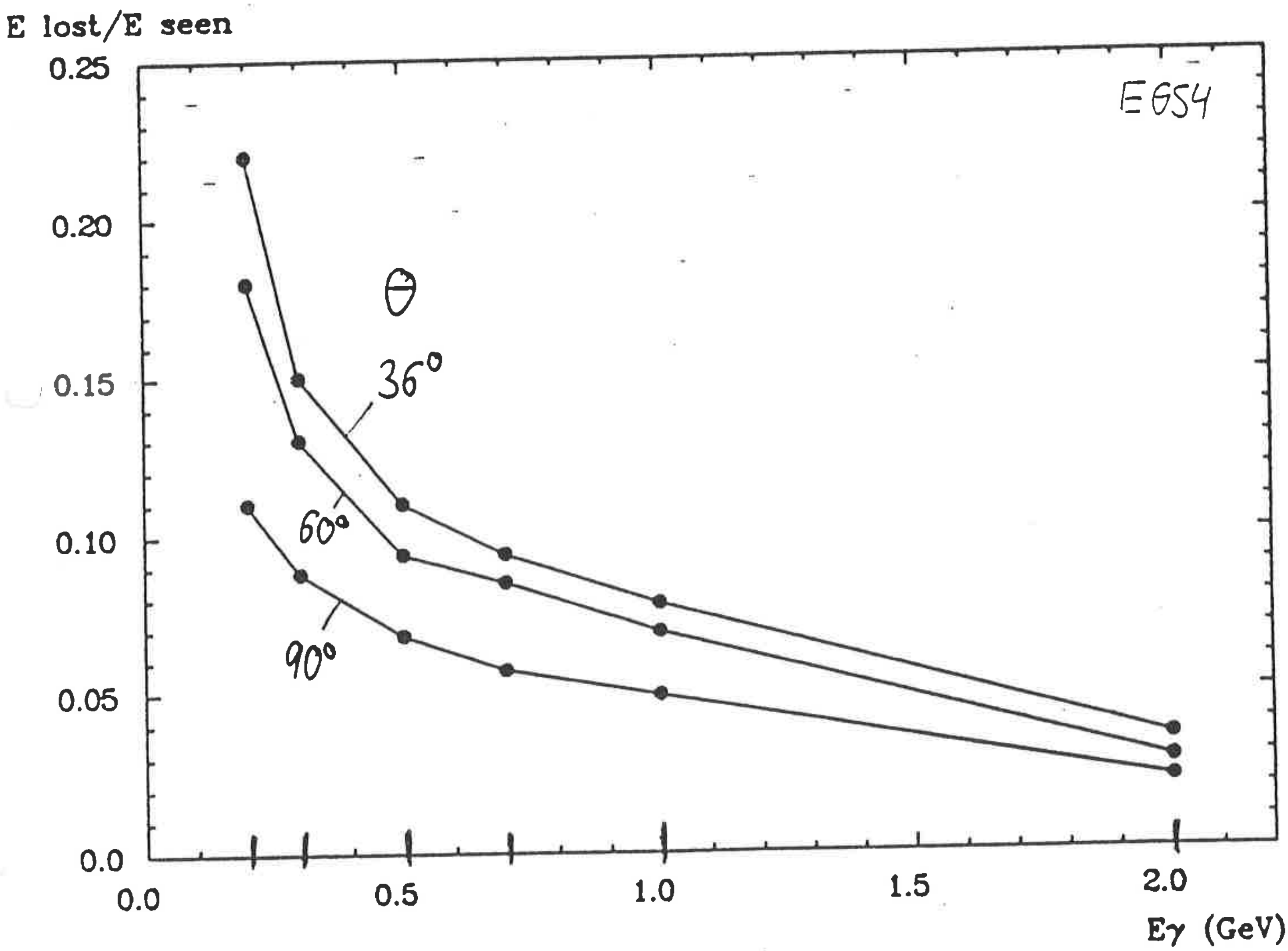


Leakage of Photon Showers with SF5 only

LG-Signal lost due to readout-threshold

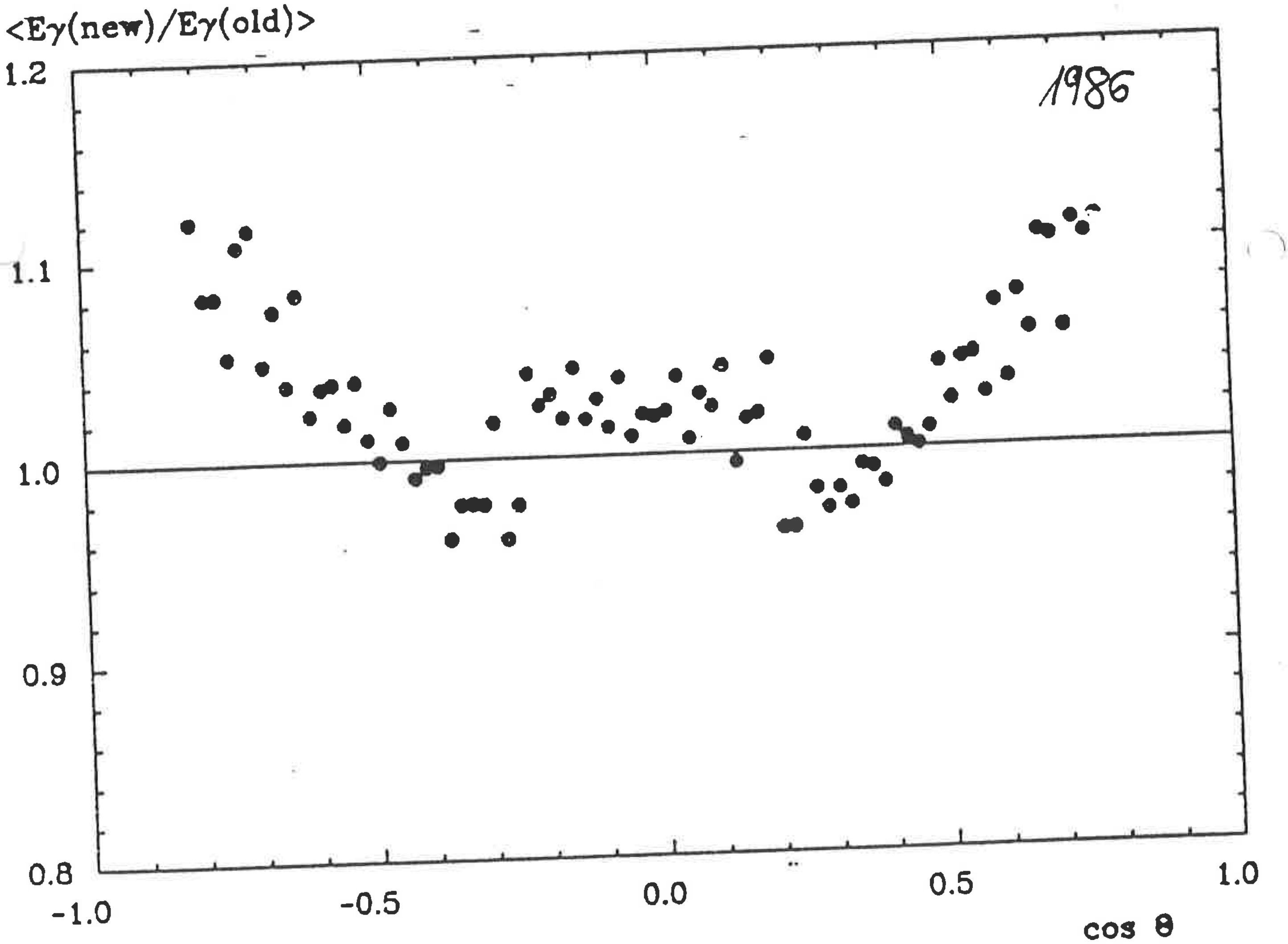
1979-82 : threshold of 5 ADC-counts ≙ 25 MeV

1983-86 " " 6 ADC-counts ≙ 36 MeV

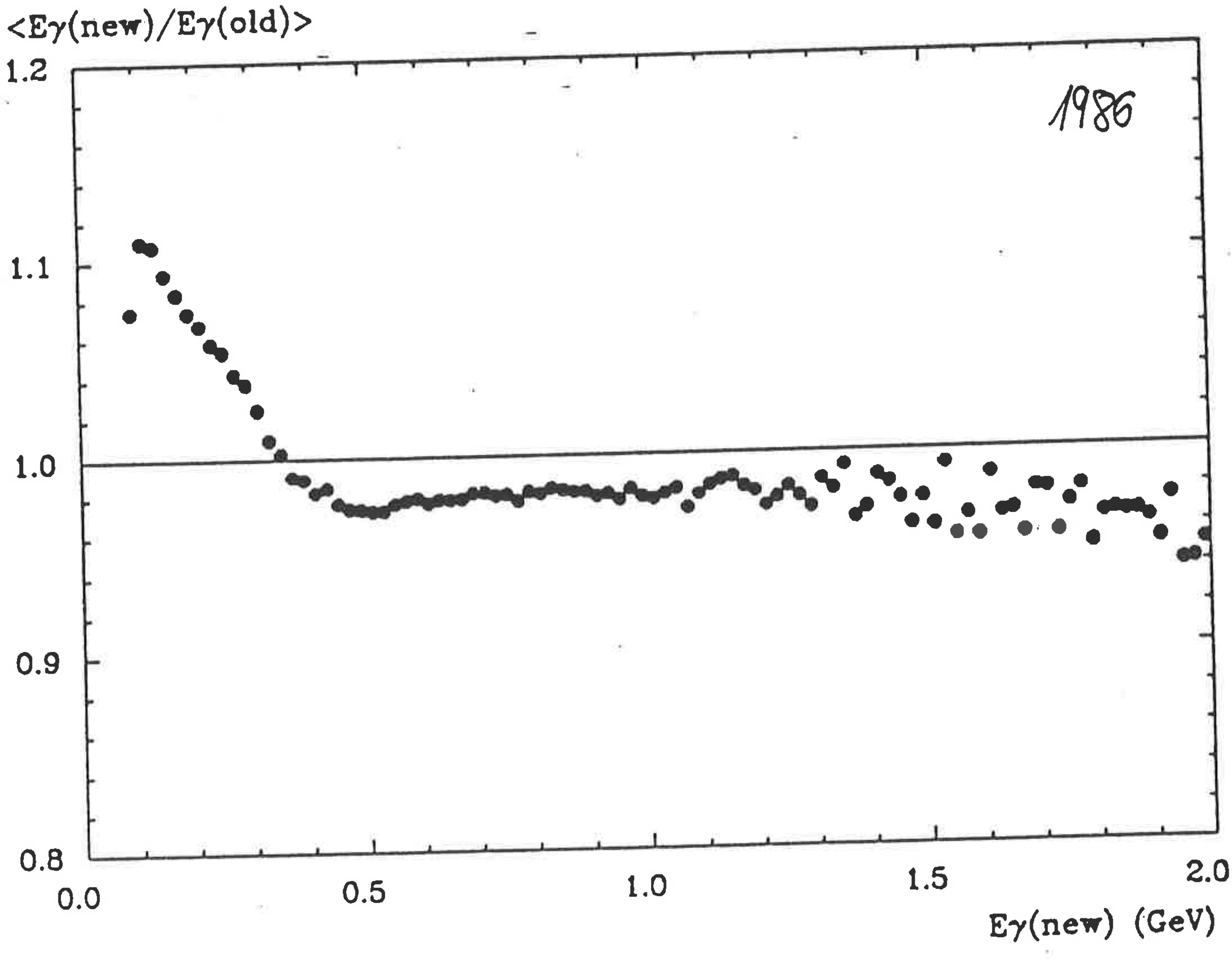


Threshold loss for θ = 36°, 60°, 90°

Comparison of 'new' and 'old' Photon Energies
cos θ-distribution, integrated over Energies



Integrated over Barrel-Part



Implementation

Two routines from the official JADE Lead Glass library 'JADELG.SOURCE/LOAD' have been changed:

- LGCLPB (called by LGANAL) calls BBLEAK and reduces the energy of every block in a cluster to correct the calibration. The result is stored in the ALGN-Bank. BBLEAK is not called for Monte Carlo Data (run number < 100).

- LGECOR (called by LGCOIR) calls ENLOSG, LKCORR and THCORR in an iteration loop which reconstructs the photon energy. All three routines increase the measured cluster energy.
  LKCORR is not called for MC-data which used Meier-Magnussen LG-Shower routines (Word 17 in HEAD-Bank =1) since here the leakage of photon showers is not simulated.

The new routines were installed on 'JADELG.SOURCE/LOAD' on 22.12.1987

J. Olsson 14/12-87

TOKYO Shower program for Simulation of photons/electrons in the JADE Lead Glass Detector

(1) Originally developed by A. Sato
(Master Thesis, Tokyo 1979)

General el. magn. shower program, based on
Messel & Crawford "Electron-Photon Shower Distribution Function"

(2) JADE specific details included by S. Yamada
Subr. NPECER, J.N. 20
"Nr of Photoelectrons from Čerenkov radiation"

Takes account of:

- Transparency of Leadglass to Č-radiation
- " – " Lightguide material
- Directional Dependence (total reflection)
- Photo Cathode Sensitivity of PM (Hamamatsu R594)

(3) Inclusion in private version of JADE standard tracking.
Used in $\gamma\gamma$ physics analysis for simulation of low energy γ.

Shortcomings:

* Original program 1-material program only (i.e. SF5 only)

Sato's code is perfectly general, but the surrounding framework did not switch between different materials.

In the JADE tracking program inclusion, it was necessary to introduce equivalent thicknesses of radiation as inactive (black) leadglass in front of the barrel and end cap detectors.

* From 1983, with both SF5 and SF6 leadglass in the barrel, it did not give a useful simulation, since NPECER is only valid for SF5, and SF6 is much different.

* No possibilities for TOKYO to improve these shortcomings (time, manpower.)

Improvements: Autumn 85 – Summer 87.

Update Yamada's programs to derive NPECR6
(J.N. 2.0, supplem. 1)
⇒ describe Čerenkov radiation in SF6 blocks

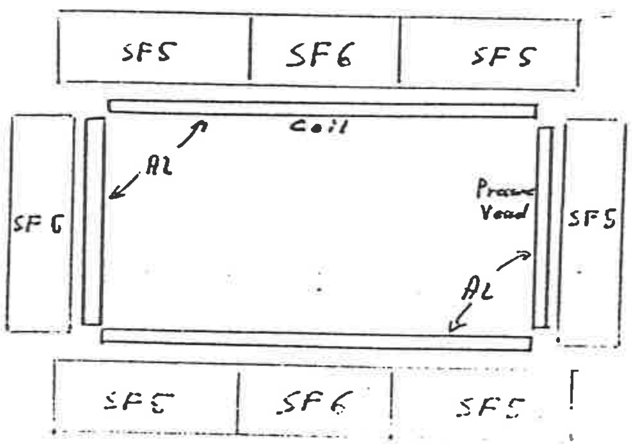
Use the structure of Yamada's simulation program for OPAL Lead glass system, to make the JADE program multi material.

Integrate with JADE standard Tracking program.

⇓

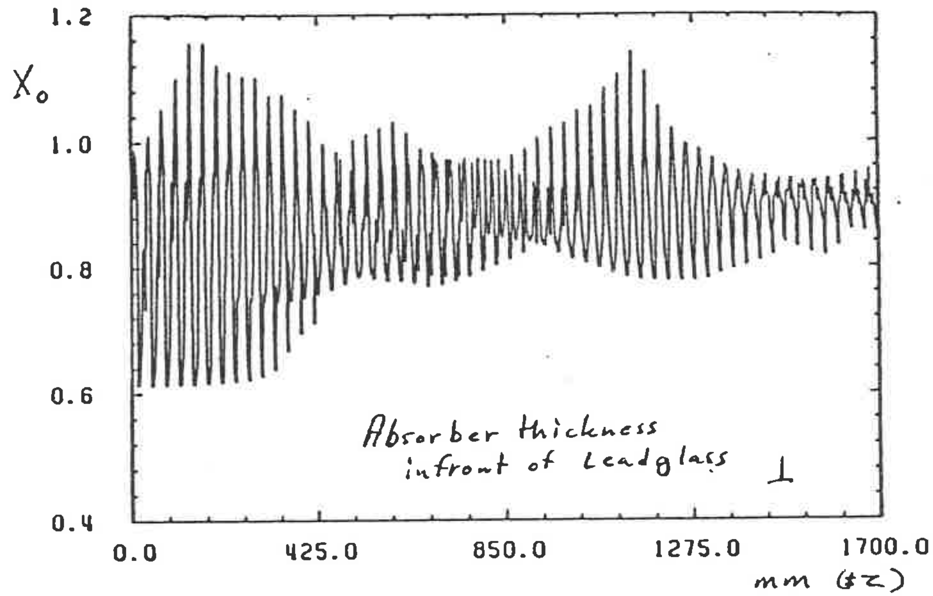
F11OLS. JADE66. S/L

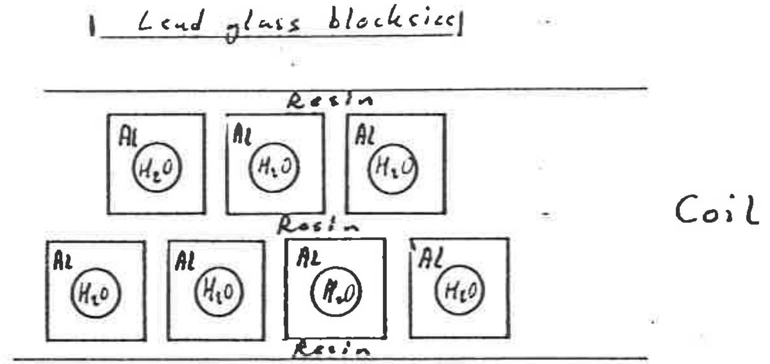
Now 3 materials: Al, SF5, SF6



(3)

subr. TJOCK





Average radiation slightly less than assumed in Block Data. (0.97 X_0)

(4)

IMPLEMENTATION

Several Subroutines changed (on JADE56.S):

MCJADE, STHEAD, WRTMCB, TRKGAM
TRKGMV

MCJADE:

a) New logical flag, LFLAG(6)

```
      COMMON/CFLAG/LFLAG(10)
      LOGICAL * 1 LFLAG
C
C          LFLAG(1) = SMEAR GAMMA AND ELECTRON ENERGIES
C          LFLAG(2) = GAMMA CONVERSION IN OUTER TANK AND COIL (TRKGAM)
C          LFLAG(3) = ABSORPTION LOSSES
C          LFLAG(4) = 3 DIM SHOWER PROFILE FIT TO EGS CODE
C          LFLAG(5) = .TRUE.   -->  WITH VERTEX CHAMBER TRACKING
C                   = .FALSE.  -->  WITHOUT VERTEX CHAMBER TRACKING
C                                   BUT OLD BEAM PIPE GEOMETRY AND
C                                 BEAM PIPE COUNTERS (BEFORE MAI 84)
C          LFLAG(6) = 3 DIM TOKYO SHOWER PROGRAM
```

b) Electrons (e.g. from γ conversion in beampipe) do not get standard lead glass tracking (i.e. in subr. TRLGL), but are passed into the TOKYO Shower program, by MCJADE calling the interface routine LGMC56

STHEAD:

Word 17 in 'HEAD' is set = 2, for LFLAG(6)=.TRUE.
(set to = 1 for M-M Lg tracking)

Word 14 in 'HEAD' set to Version nr. of LGMC56

WRTMCB:

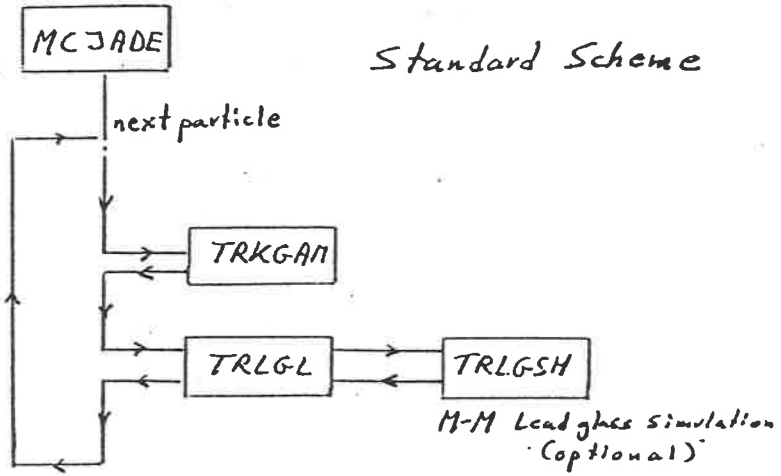
Writes a short bank 'SF56' containing some information on conversion of photons in material before leadglass. Useful in resolution studies.

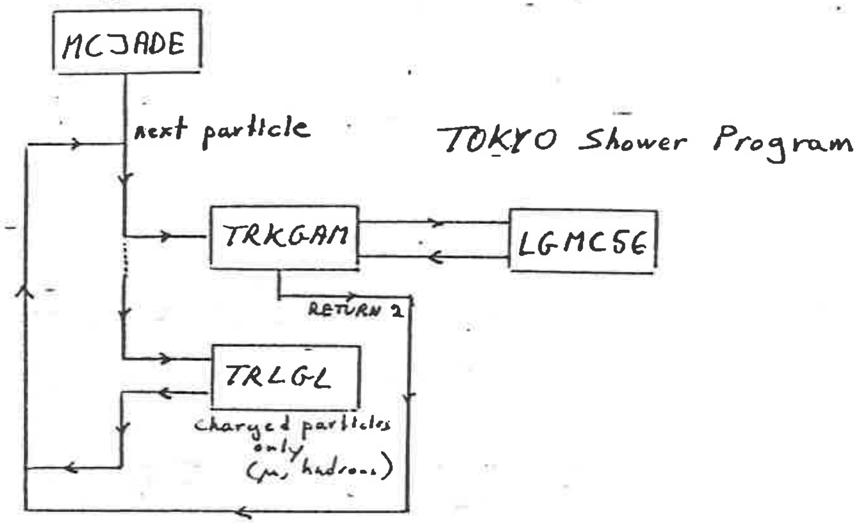
TRKGAM, TRKGMV:

Tracking of photon from interaction point to outer pressure vessel wall of Inner Detector, identical to standard TRKGAM/TRKGMV

Difference: The normal RETURN to MCJADE and subsequent call to TRLGL is replaced by call in TRKGAM to LGMC56 and a RETURN 2 (finish this particle).

γ tracking, simplified





Bedienungsanleitung

* Link with F11OLS.JADE56.L

  in front of

  F22RJB.RLMC.L (optional)

  F22ELS.JMC.L

* Main program should contain

  LFLAG(6) =.TRUE.

  other LFLAG's are set correctly by program, if not correct already

  (LFLAG(1)=LFLAG(2)=LFLAG(3)=.TRUE.)

* JADE Computer Note in preparation.

If you want to use the program before this note appears, please speak to J. Olsson concerning possible temporary INCLUDE's.

Performance

Speed: For low E_γ (≤ 500 MeV) somewhat faster than standard M-M Lg simulation.

For high E_γ much slower, rising $\sim$ linearly with $\gamma/e^\pm$ energy.

Simulation: So far almost exclusive usage in $\gamma\gamma$ physics.

Direct comparison with data and other MC simulations somewhat unclear, due to ongoing development of γ reconstruction routines, systematic effects in calibration and lack of pure, high statistics sources of low E_γ.

But: $\eta' \to \eta\pi^+\pi^-$, $\eta \to \gamma\gamma$

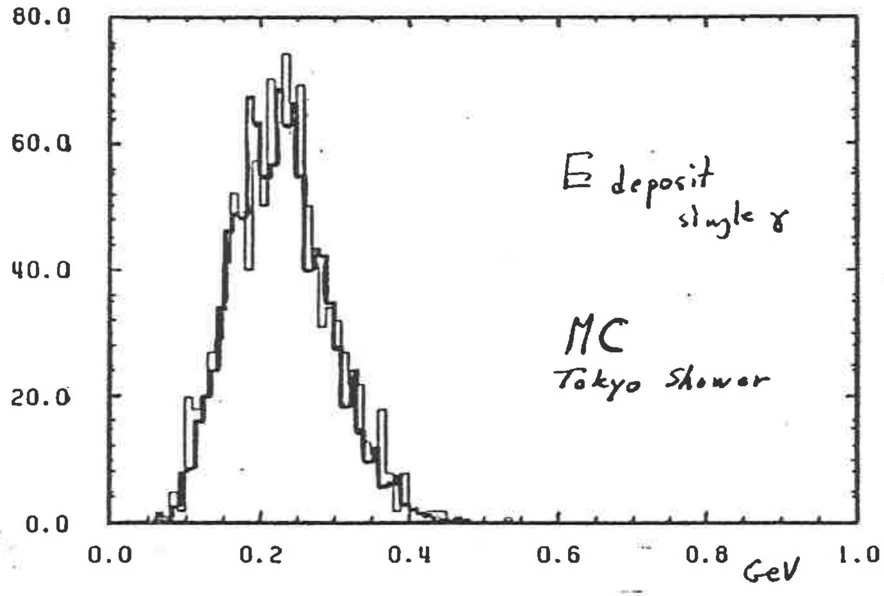
$f \to 2\pi^0$, $\pi^0 \to \gamma\gamma$

Kuhlen: Υ-pair simulation

Low energy γ ~ OK, e.g. block multiplicities.

High energy γ: Too low block multiplicity, i.e. too narrow showers

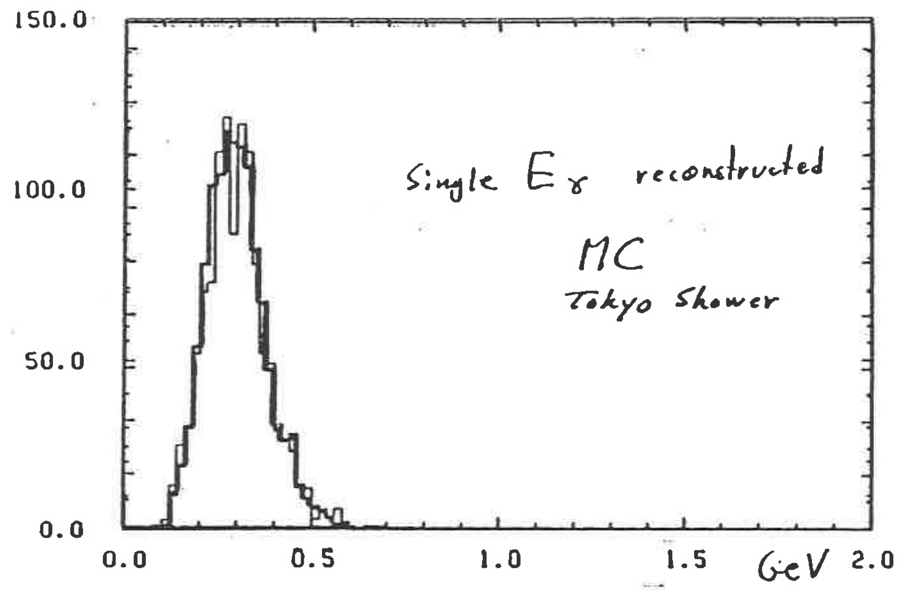
Yamada: At higher energies, photo- and electroproduction may be important, giving hadronic contributions to shower. This is not simulated.

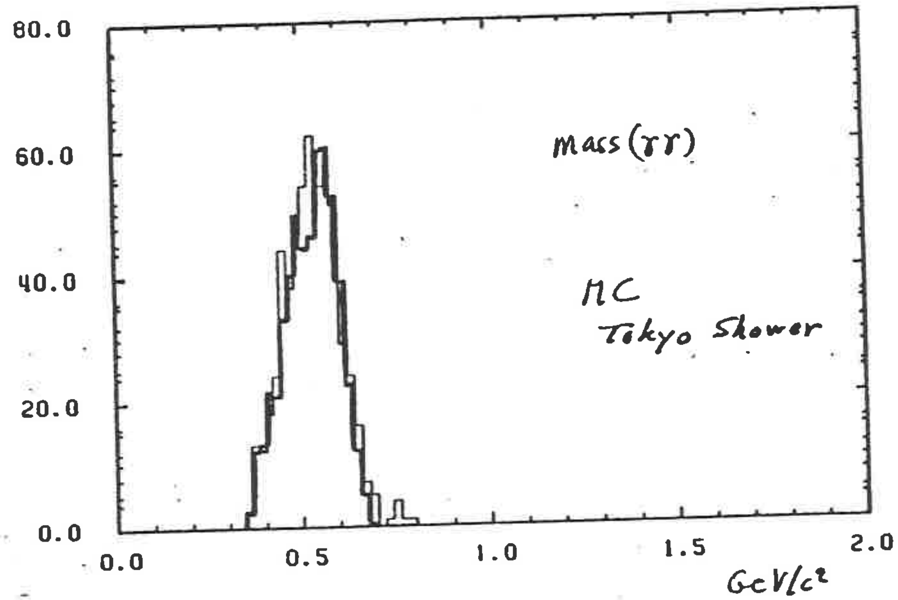


$e^+e^- \to e^+e^- \eta'$
$\hookrightarrow \eta\pi^+\pi^-$
$\hookrightarrow \gamma\gamma$

$E_{deposit}$: Calibrated pulse heights in Leadglass but no corrections for γ reconstruction

Here: Calibration systematics corrected.





E_γ : Cluster energy, corrected for energy loss, readout threshold, directional dependence etc.

(Pitzl, status 7/87)

Chamber Resolutions in Monte Carlo

With the improved understanding of both Jet- and vertex chamber an update of the Monte Carlo smearing procedure is neccessary.

The tail of $r\varphi$ resolution (asymmetric for DL8 data) may now be simulated both chambers using double gaussians.

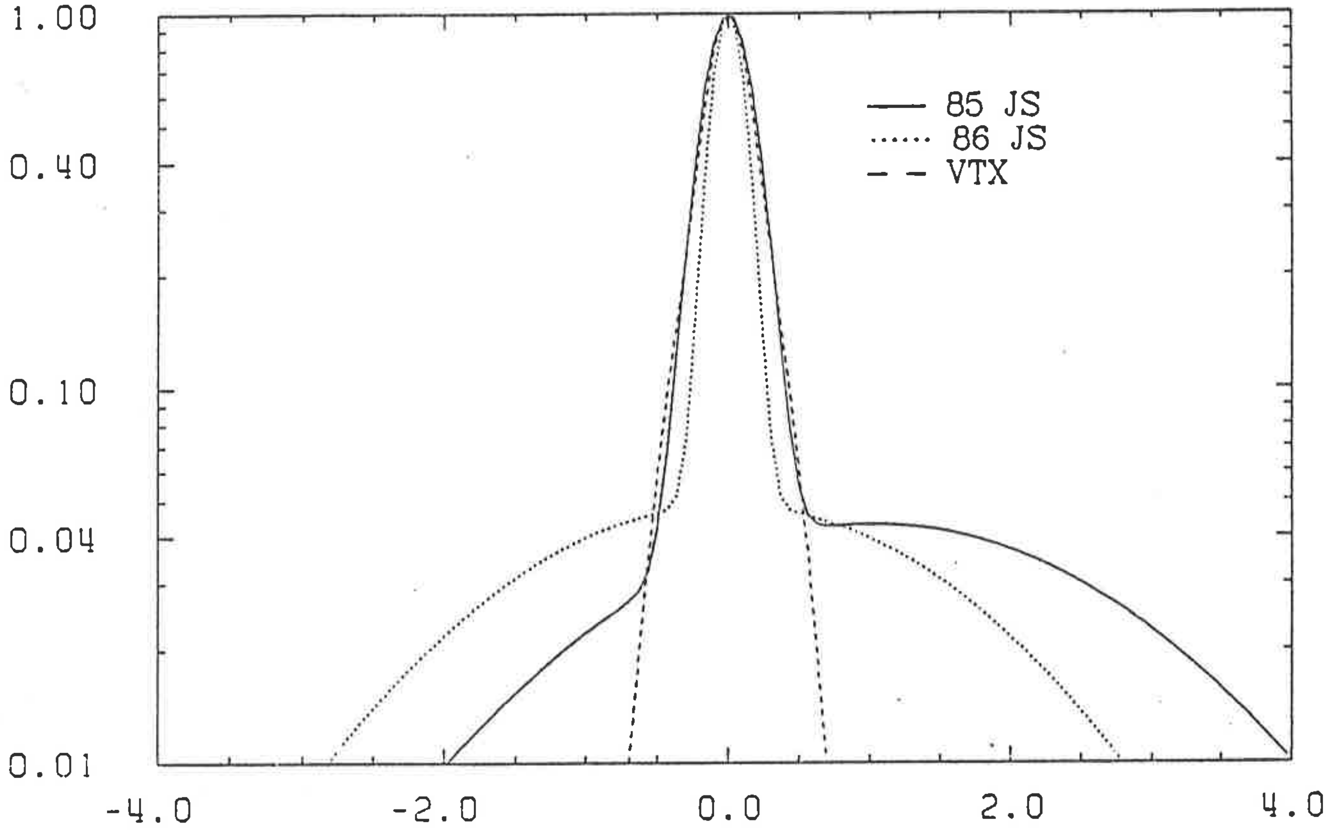
Other properties differ for DL8 and DL300 data:

	DL8	DL300
$r\varphi$ resolution	170 μm	112 μm
$r\varphi$ 2 track	7.5 mm	2 mm
z resolution	20 mm	40 mm

Routines are now available to simulate these properties correctly.

9/12/87   17.28.39   DSN=F22ELS.GP.RES

ST:	85	0	0	1
	86	0	100	2
	87	0	100	3



The new parameters are stored at the end of bank 'MTCO' which has been extended to 156 words.

Suggest to install in standard libraries after this meeting.

There will be drastic effects in some analyses!

dE/dx Monte Carlo

New dE/dx Monte Carlo generator (see JADE Computer Note 97). K.Ambrus' hit research and full simulation of the hit composition of a track:

- Simulated energy loss spectrum matched to JADE data.
- Additional systematic error for agreement with exptl. resolution.(39 periods are distinguished)
- Expected mean truncated energy loss derived from JADE data.

Thesis K. Ambrus

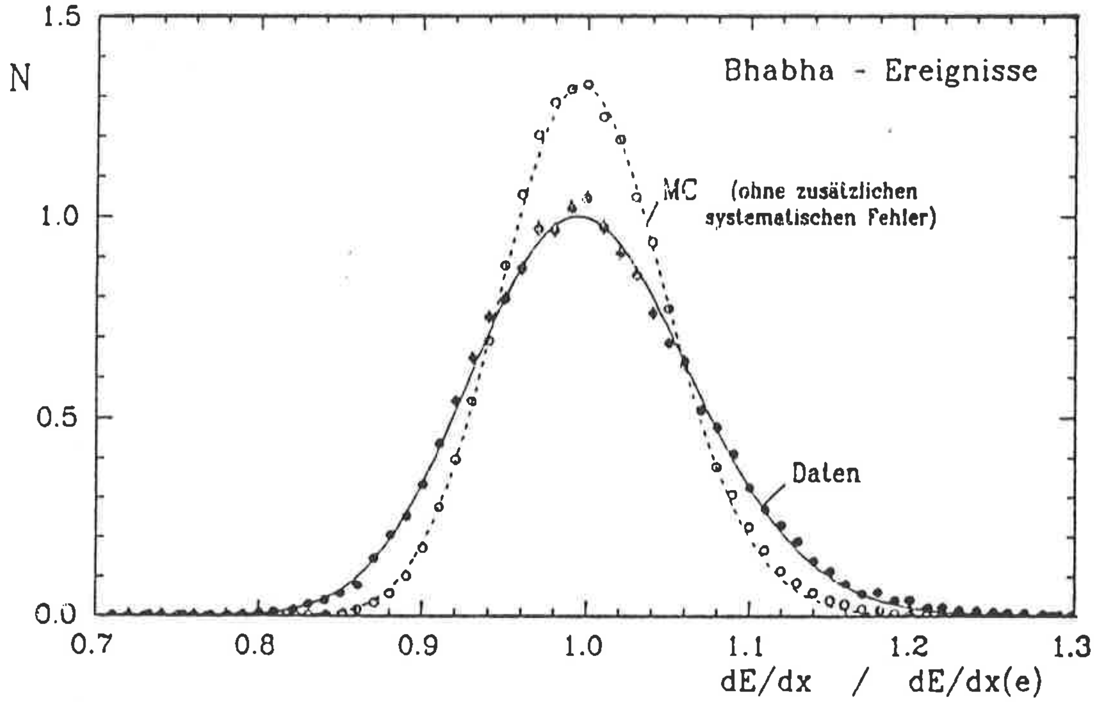


Abb. 3.10:
Die gemessenen truncated mean - Verteilung ist breiter als das mit derselben Landau-Verteilung rein statistisch erzeugten dE/dx-Spektrum. Dies deutet auf zusätzliche systematische Effekte bei der Energieverlustbestimmung hin.

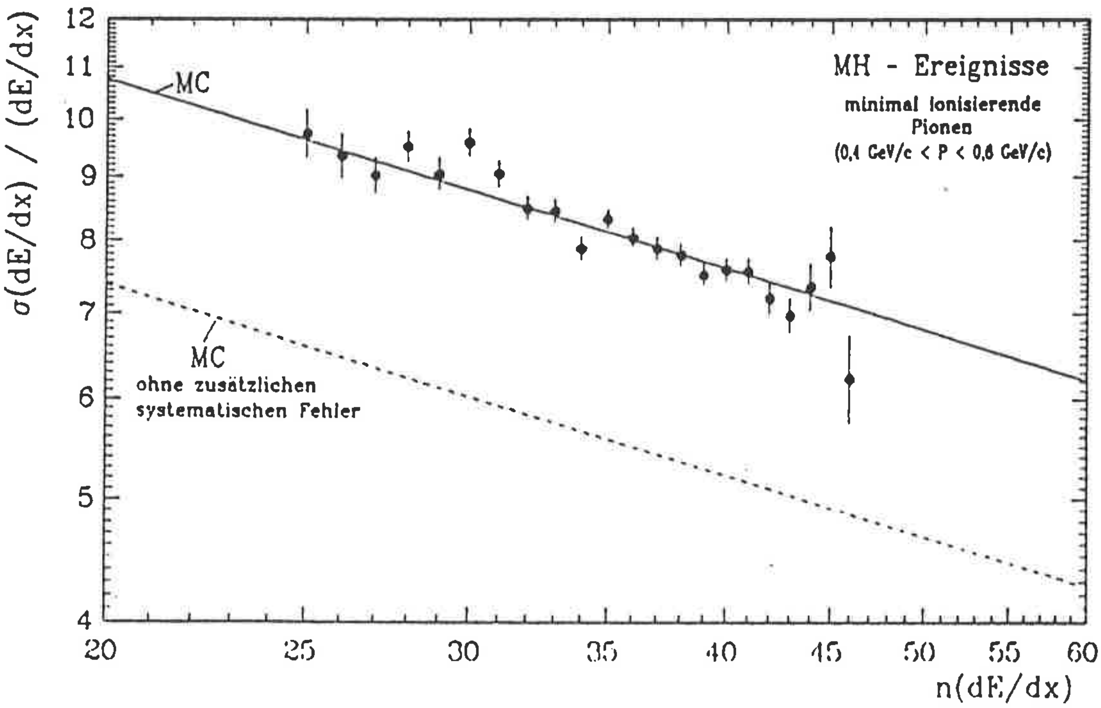


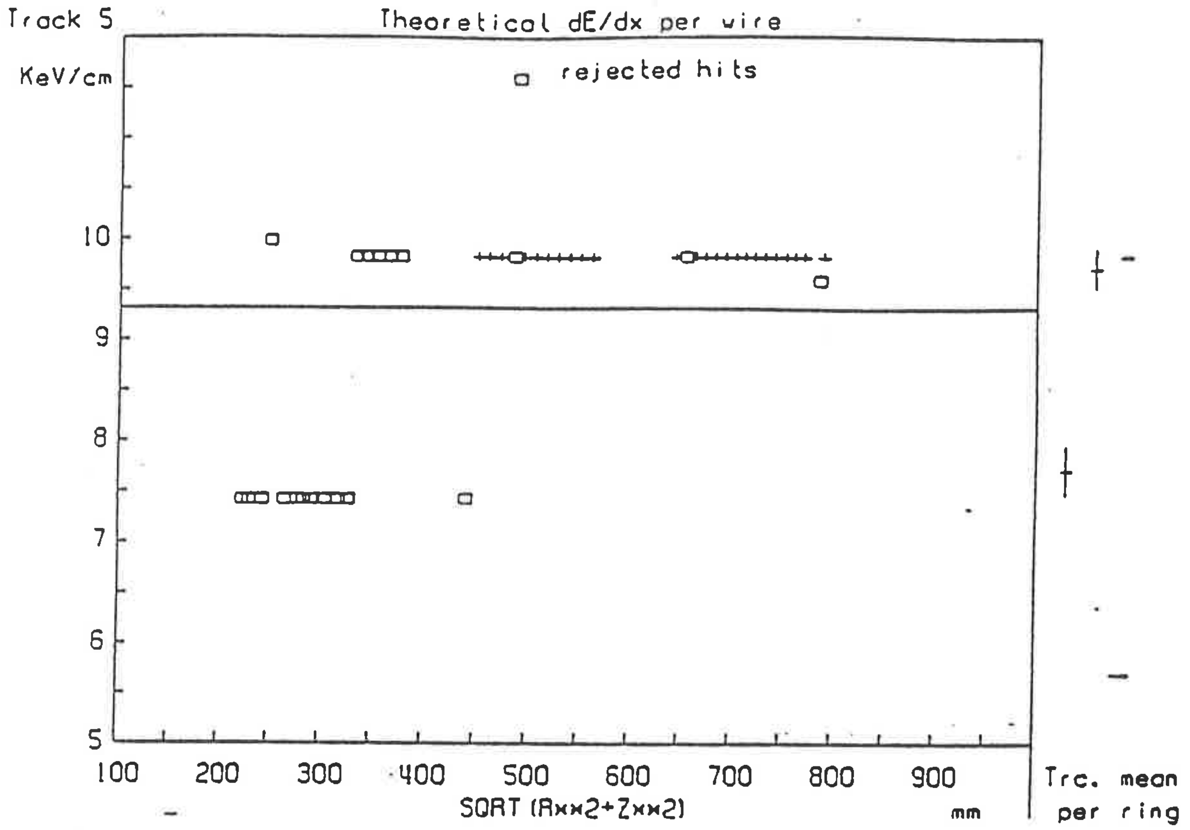
Abb. 3.11:
Sowohl der dE/dx-Fehler der Daten, als auch der Fehler der statistisch erzeugten Monte Carlo-Mittelwerte ist umgekehrt proportional zur Wurzel aus der Anzahl der Meßpunkte.

- Detailed hit simulation even for 'mixed tracks', i.e. tracks composed of hits from more than one particle.

- Hit Cleaning as in real data.

- Analyis of energy loss with routines used for real data.

Main difference to other existing generators is the simulation of the hit selection using the same analysis programs as for the real data (Modification of ZSFIT, which did not work for Monte Carlo at all.)



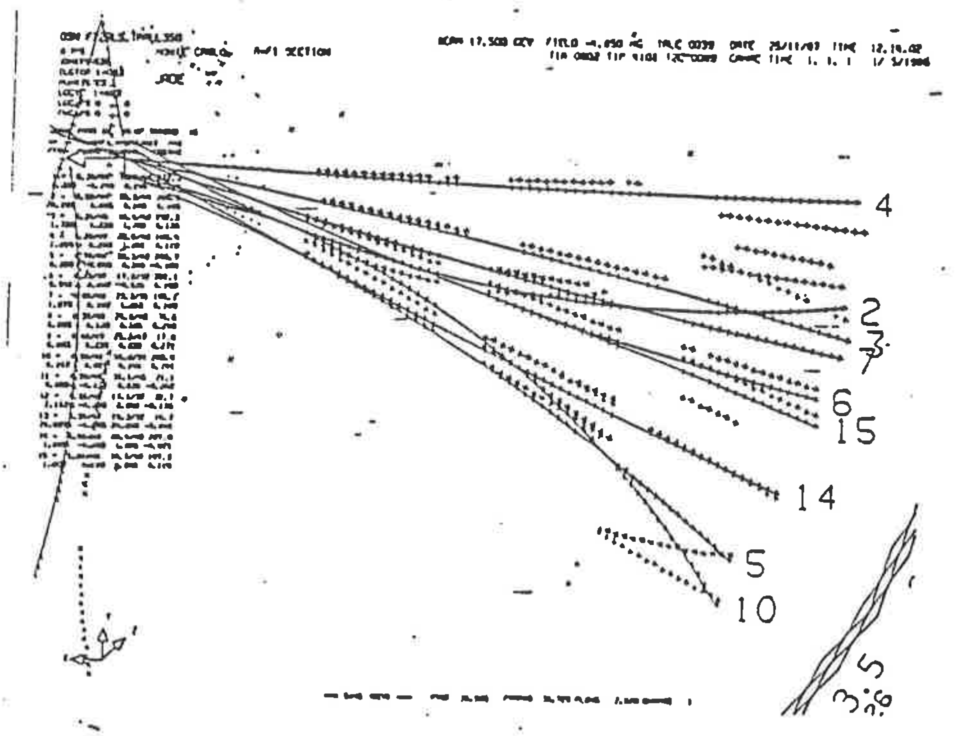


Figure 2: Theoretical mean dE/dx values for the hits associated with a single track (5). The boxes indicate the hits that have been rejected by the 'hit cleaning' procedure. The hit cleaning is based mainly on the proximity of adjacent tracks. The hits of the track have been created by different particles explaining the scattering of the theoretical values. The solid line indicates the value of the truncated mean after full simulation including the extra contribution σ_{sys}.

Usage

DEDXBN simulates the energy loss and performs the analysis as for real data. May be called in SUPERVISOR environment. Systematic error chosen according to selected simulation date in bank HEAD.

DEDXAN calls DEDXBN and fills dE/dx into TP banks.

R. Ramcke

Inclusion of VTXC- Software

Overview of Main Parts of VTXC- Software

1. Online Pulsefinding

The results of the online pulsefinding algorithm are stored in the "raw data bank" **'BPCH'**. All FADC values belonging to a pulse are kept. Therefore it is possible to calculate the timing offline

2. Reform Job

Only data checking is performed.

3. Creating VTXC-Bank

This JETC-like bank contains the timing information which is used in the combined fit. There are two methods whereby the VTXC-banks are created:

1. Using the online pulsefinding algorithm. A one dimensional timing correction (SK1) depending on the ratio ofthe heights of the first two bins in the pulse $< A_2 > / < A_1 >$ is performed. The results are stored in **'VTXC'** 10.
2. In order to get a better double pulse resolution an offline pulsefinding algorithm is used (ADN-SK2). That means: **A**dd signals from left and right side of wires. Calculate the **D**ifferences of all pairs of adjacent bins in the sum signal and look for **N**ew pulses. A two dimensional timing correction (SK2) depending on the contents of the two first bins is then performed. The results are stored in **'VTXC'** 9. The VTXC 9 bank is *not* JETC compatible anymore. The amplitude of the pulse is replaced by the contents of the first two added bins. This information is needed

by the timing correction routines.
'VTXC' 9 format:
HDATA(i+1) = # of wire
HDATA(i+2) = added left and right 1st bins minus pedestal
HDATA(i+2) = added left and right 2nd bins minus pedestal
HDATA(i+4) = "raw" timing from added bins

4. VTXC-Pattern recognition

There exists a two-step pattern recognition for VTXC data:

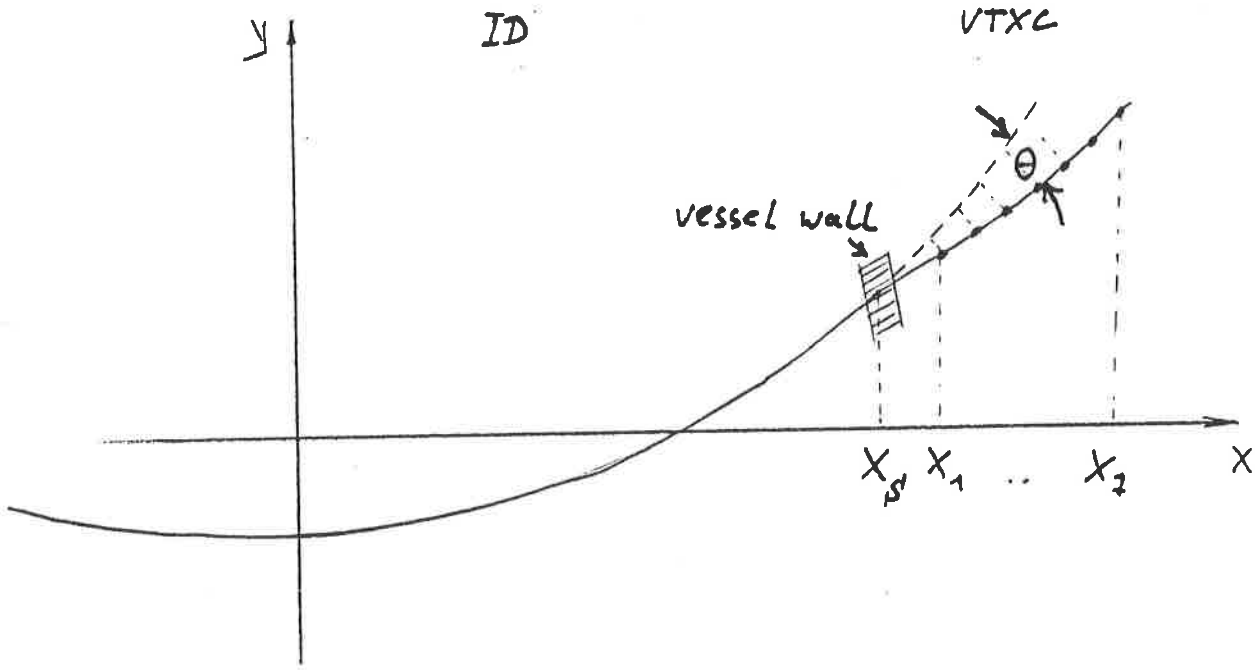
1. ID tracks are extrapolated into the VTXC in order to find clear tracks in the VTXC. This procedure allocates about 75 % of possible links. The results are stored in a special VTXC pattern bank: **'VPAT' 19 or 20** (the number depends on the used VTXC generation 9 or 10)
2. The remaining VTXC hits are transformed into a parameter-space (ρ, θ) according to the following formula:

   $$\rho = x \cdot \cos\theta + y \cdot \sin\theta$$

   In that space, tracks ($\approx$ straight lines) are represented by clusters. Found clusters (tracks) are stored in a hit label bank: **'VTHT' 9 or 10**. These tracks are linked with ID tracks. All succesfully linked tracks - including those from 'VPAT' 19 or 20 - are collected in **'VPAT' 9 or 10**

5. Combined VTXC- and ID Fit: "COMFIT"

This fit includes multiple scattering in the inner vessel wall. The input of the combined fit is the work common filled by *P.Steffen's REFIT without vertex contraint.* In a system, in which the X-axis is determined by the first and last measured hit, the situation is shown in the following picture:



The deviation due to the multiple scattering can be approximated by the following equation:

$$\delta_i = (x_i - x_s) \cdot \tan \Theta \qquad i = 1..7$$

As θ is small: $\tan \Theta \approx \Theta$. A track is represented by two parabolae:

$$F_{ID} = cx^2 + bx + a$$

$$F_{VT} = cx^2 + bx + a + (x - x_s)\Theta$$

That leads to the following χ^2 ansatz:

$$\chi^2 = \sum_{i=1}^{N1} \frac{(Y(x_i) - F_{ID}(x_i))^2}{\sigma_{ID}^2} + \sum_{i=1}^{N2} \frac{(Y(x_i) - F_{VT}(x_i))^2}{\sigma_{VT}^2} + \frac{\Theta^2}{\sigma_\Theta^2}$$

with:

$$\sigma_\Theta = \frac{0.014}{p}\sqrt{\frac{X}{X_0}} \cdot \left(1 + \frac{1}{9}\log(\frac{X}{X_0})\right) \qquad (p \ in \ GeV/c)$$

The scatterpoint x_s is fixed by the position of the vessel wall. There are four parameters (c, b, a, θ) which must be determined. This leads to system of linear equations whose matrix is four dimensional and symmetric. The inverse matrix (covariance matrix) is used for error propagation.

The approximation of parabolae is not valid for low momentum tracks. For such tracks an iterative circle fit is made. The curvature error due to using parabolae is:

$$\Delta crv = crv^3 \cdot (\frac{L_{Trk}}{2})^2$$

If Δcrv is bigger then a certain fraction of the reconstruction error $\epsilon \cdot err(crv)$ of the curvature then a circle fit is used. In the iteration loop the deviations of the hits from the reconstructed "circle" $(r = 0.5/c)$ are used to correct the parabola $(c, b, a, \Theta) \rightarrow (\bar{c}, \bar{b}, \bar{a}, \bar{\Theta})$. This leads to a new "circle" $(\bar{r} = 0.5/\bar{c})$. The iteration stops if the relative change in the curvature is small compared with the reconstruction error (taken from the covariance matrix). It also stops in the case of no convergence after a fixed number of iterations.

Discription of 'PATR' Bank from combined Fit

Head	1	header lenght	8
I*4	2	# of tracks	
	3	track data length	64
	4	PATERC history word	
	5	# of hits in ID	
	6	# of uncorr. hits	
	7	# of uncorr. linel.	
	8	COMFIT marker	0,1,2
TRACK 1	9		
R*4	..	see JADE-comp. note 12	
	48		
	49	X0 or (d0-r)	
	50	Y0 or phi	
	51	weight from covarianz matrix	
	52	error from cov. matrix x^4	
	53	error from cov. matrix x^3	
	54	error from cov. matrix x^2	
	55	error from cov. matrix x^1	
	56	error from cov. matrix x^0	
	57	error from cov. matrix angular	
	58	σ of VTXC-pre fit	
	59	# of VTXC hits used in COMFIT	
	60	extended VTXC-hitmask	
	61	extended VTXC-hitmask	
	62	COMFIT return code	
	63	bank generation number	9,10
	64	track number in VPAT-bank	
TRACK 2	..	...	

Remarks:

Position	
8:	0: no COMFIT-bank.
	1: COMFIT without VTXC, 2:COMFIT with VTXC
49,50:	save ID coord. systems. Used for extrapolation
:	into lead glass and muon filter
51:	weight: $w = N\sigma^2_{COMFIT}/(N1/\sigma^2_{ID} + N2/\sigma^2_{VT})$
63,64	used for backtracing into VPAT-bank

Status of Inclusion of VTXC- Software

At the moment (Dec. 87) there exsits a fine working "stand alone solution". First efforts have been made, to incorporate the VTXC-software into the JADE standard package. In this new version all internal commons have been overlayed on the standard CWORK common. So no additional common space is requried. The inclusion of all VTXC-calibration files into BUPDATE is under discussion. At the moment one can use our stand alone solution to run all VTXC software. In the near future, there will be a version which performs the whole VTXC analysis by a simple subroutine call.

Short discription of VTXC stand alone solution

All programs can be found on: **F22KLE.JVTXC.S**. The main program is **VTXMAIN**. Following steps are done:

- Load externals BDVTXC,JADEBD,T9CORR
- Set up constants for VTXC-analysis
- Load runvertices: CALL VTXCRJ
- Start event iteration loop
  - Fill event info common: CKOPP
  - Select calibration for current period: CALL VTXCAL
  - Build VTXC bank: CALL VTXCBK
  - Set up Spitzer's ID calibration
  - Run first part of VTXC pattern recognation: CALL YPREFT
  - Run second part of VTXC pattern recognation: CALL XFILT
  - Link VTXC and ID tracks together: CALL XTRLNK
  - Perform combined fit: CALL EVFITV. In EVFITV P.Steffen's REFIT will be called in order fill common CWORK.
- Print final statistics

The JCL-member is @VTXMAIN:

```
//FLTCFT JOB CLASS=A,NOTIFY=F22XXX,MSGLEVEL=(0,0),TIME=(1,00)
//*MAIN RELPRI=MED
%MACRO 'F22KLE.JVTXC.S(MORTGEP)'
// EXEC MORTGEP,MPGM=MORT3,CPGM=HXE,
//      GOREGN=2500K,DN=NULLFILE
%MACRO VTXMAIN
//LKED.SYSLIB DD
//            DD
//            DD
//            DD
//            DD
//            DD DISP=SHR,DSN=F22KLE.JVTXC.L
//            DD DISP=SHR,DSN=F11LHO.JADEGL
//            DD DISP=SHR,DSN=F11GOD.PATRECLD
//            DD DISP=SHR,DSN=JADELG.LOAD
//            DD DSN=R02SCH.TSOIPS.LOAD,DISP=SHR
//            DD DISP=SHR,DSN=F22ALL.JADEMUL
//            DD DISP=SHR,DSN=R01UTL.HBOOK321.L
//            DD DISP=SHR,DSN=R01UTL.CERN.KERNLIB4
//            DD DISP=SHR,DSN=F1EBLO.BOSLIB.L
//            DD DISP=SHR,DSN=SYS1.FT77LIB
//*-------------------------------------------------------------------
//*                   I N P U T
//*-------------------------------------------------------------------
//*                                                        FROM
MSS, DISK
//GO.FT02F001  DD DISP=SHR,DSN=F22XXX.INPUT.DISK
//*                                                        FROM
TAPE
//*O.FT02F001 DD UNIT=TAPE,DISP=SHR,
//*   DSN=F22XXX.INPUT.TAPE1
```

```
//*DD UNIT=AFF=FT02F001,DISP=SHR,
//*   DSN=F22XXX.INPUT.TAPE2
//*
//*
//*----------------------------------------------------------------
//*                    O U T P U T
//*----------------------------------------------------------------
//*O.FT03F001 DD DUMMY,DCB=R01DCB.VBS
//*
//*O.FT03F001 DD DSN=F22XXX.OUTPUT.MSS,
//*             DISP=SHR,DCB=R01DCB.VBS
//*
//*O.FT03F001 DD UNIT=FAST,DISP=(NEW,CATLG,CATLG),
//*        DCB=R01DCB.VBS,SPACE=(TRK,(240,60),RLSE),
//*        DSN=F22XXX.OUTPUT.DISK
//*
//*
//GO.FT03F001 DD UNIT=TAPE,DISP=(NEW,CATLG,CATLG),VOL=(,RETAIN),
//    DCB=(RECFM=VBS,LRECL=6236,BLKSIZE=24948),
//    DSN=F22XXX.OUTPUT.TAPE
//*----------------------------------------------------------------
//*             C  A  L  I  B  R  A  T  I  O  N
//*----------------------------------------------------------------
//GO.FT21F001 DD DISP=SHR,DSN=F11LHO.BUPDAT0
//GO.FT22F001 DD DISP=SHR,DSN=F11LHO.BUPDAT1
//*                                      FADC-Calibration
//GO.FT11F001 DD DSN=F22KLE.VCALB.S(CALB03),DISP=SHR,UNIT=FAST
//*                                      VTXC-Calibration
//GO.FT12F001 DD DSN=F22KLE.JVTXC.DATA(CALIBALL),DISP=SHR,UNIT=FAST
//*                                      RUNVERTEX
//GO.FT13F001 DD DSN=F22KLE.JVTXC.DATA(RUNVERTV),DISP=SHR,UNIT=FAST
```

ZEUS Meeting Dec 14 - 16, 1987 at DESY

Monday Dec 14 Plenary Session Seminarroom 4

9:00 - 9:30	Satus of HERA	D. Trines
9:30 - 9:45	Aim of the meeting G. Wolf	
9:45 - 10:30	Report from the Technical Coordinator	B. Loehr
10:30- 10:40	On safety	G. Poelz
11:00- 13:00	Test results	
	FCAL prototype	E. Ros
	VXD - IDC	A. Walenta
	VXD - TEC	C. Del Papa
14:00- 15:00	Report from electronics/DAQ meeting	K. Gather / L. Wiggers
15:00- 15:20	Report from the meeting of the Reconstruction Group	H. Kowalski
15:20- 15:35	Report from HEDA	E. Lohrmann
16:00-18:30	Parallel Sessions : CAL tracking DAQ SOS MUON	
18:40-19:15	Executive Meeting 1. Financing of FCAL, BCAL, RCAL 2. Finances of experiment 3. Financing of DAQ and of SASD tools 4. Deputy coordinator for DAQ 5. ZEUS members for HEDA 6. schedule 7. custom formalities 8. next ZEUS meetings	
19:30	Dinner in DESY Cafeteria	

Tuesday, Dec 15

9:00 - 11:00	Parallel Sessions	
9:30 - 10:30	Magnetic field measurements chaired by D. Saxon	
11:00- 15:00	Plenary Meeting Seminarroom 4 Status reports on	
11:00- 11:10	Solenoid, compensator	
11:10- 11:20	Iron yoke	
11:20- 11:30	yoke coils	
11:30- 11.50	FCAL prototype, design, construction	D. Hasell
11:50- 12:10	BCAL prototype, design, construction	D.Reeder
12:10- 12:30	Hadron-Electron separator	
12:30- 12:50	BAC	
12:50- 13:05	CTD	
	- - - - B R E A K - - - -	
14:00- 14:15	FDT,RTD,TRD	
14:15- 14:25	FMUON	
14:25- 14:35	BMUON	
14:35- 14:45	LPS	
14:45- 14:55	LUMI	
15:00- infinitum	Parallel Sessions	
17:00	W. Smith Dimuons DESY - seminar	

Wednesday Dec 16

9:00 - 12:00	Parallel Sessions	
9:00 - 10:00	Installation of tracking detectors chaired by D. Saxon	
10:30- 12:00	Spokeswheels chaired by B. Loehr	
12:00- 13:00	Executive meeting with P. Soeding and V. Soergel	
14:00-	Plenary Session Seminarroom 4	
14:00- 16:00	Data acquisition , software, Monte Carlo Trigger and DAQ for LUMI	A. Dwurazny
16:00- 16:30	Summary of the meeting	G. Wolf
17:00	A. Wroblewski Fits and Misfits DESY - seminar	

The modified vertex package

on F22KLE.VERTEX.S/L

Main modifications:

1. **Implementation of the Vertex chamber hardware**

   The multiple scattering is calculated in the (new or old) beampipe and the inner vessel wall.

   (VTXEE,VTXPRE,VTXPNT)

2. **Implementation of the common fit with Vertex- and Jetchamber ('COMFIT')**

   For proper calculation of the extrapolation errors in $R\varphi$ the full covariance matrix is used. The covariances are taken from COMFIT or from Gluckstern's formula. To store these covariances the T-array contains now 40 instead of 30 words for each track.

   Problems:
   COMFIT performs no ZS-fit, but copies the results of the ZS-fit from the input 'PATR'-bank. If this bank has more than 48 words per track, these words will be overwritten and any covariances lost. There is no guarantee that the (Gluckstern-) covariances used for ZS are correct. In addition one now has different multiple scattering, first measured points and track lengths for the $R\varphi$- and ZS-fits.

   All the Gluckstern covariances are calculated *without* any vertex constraint taken into account.

   (VTXPRE,VTXPNT)

3. **New vertex fitting procedure based on the Davidon variance algorithm**

   In contrast to the old procedure VERTEX this new procedure VTXDAV gives correct covariance matrices for the vertices, but wasn't designed to *find* vertices. To store these covariances in the V-array each vertex occupies now 13 instead of 10 words.

   Vertex-fits are now possible with up to 20 instead of 7 tracks. Several special- and debug-features are steered by the bits in the word MODE. It's possible to fit the vertex only in $R\varphi$ or in three dimensions.

   (VTXDAV,VERTEX)

Minor modifications:

1. All calculations of errors and of points on tracks are done in VTXPNT. For all circle calculations double precision is used.

2. To allow further changes the number of words for each track in the T-array (ITDLEN) and for each vertex in the V-array (IVDLEN) are kept in variables. They are initiated by VTXINI.

3. All common definitions are available in three macros:

Macro	Common	Contents
MVERTEX0	CVTXC	parameters set by VTXINI
MVERTEX1	CWORK1	T- and V-array
MVERTEX2	CVTX2	MODE and debug-information

4. A short description of the T- and V-arrays is available in VTXDEF.

5. For type 2 tracks in the PATR-bank a correction of the curvature and a recalculation of the first measured point is done by VTXPRE during the construction of the circles describing the tracks in the T-array.

   Two fudge-factors (SIGFAC,SFMUSC) are now used to adjust the extrapolation error in $R\varphi$. The new one scales the momentum dependence of the extraploation error.

   (defaults: 1.0)

6. To save the vertex fit results with all the covariances a new routine VTXBNC produces a bank named 'CVTX'.

7. In the calculation of the multiple scattering it is possible to set $\beta < 1$ by using one mass (DFMASS) for all charged particles.

   (default: 0.0)

8. The procedure VTXPNT has an extra parameter (DPHIT) returning the error of φ (without multiple scattering, used by VTXEE). A new entry (VTXIMP) allows the calculation of impact parameters.

Description of T-array (JT = track number · 40 − 40)

IT(JT+1)	=	flag	0 = track is incomplete or bad. not used 1 = track is good, but do not use in vertex fit 2 = tracl is good, use in vertex fit 3 = track was used in vertex fit (set by fit procedure)
T(JT+2)	=	$\pm R$	radius (+ means anticlockwise looking to -Z)
3	=	φ	azimuth at point (x_t, y_t, z_t), φ_0 at first measured point
4	=	θ	polar angle to xy-plane (0 = vertical to beam)
5	=	x_t	
6	=	y_t	point on track
7	=	z_t	
8	=	$\Delta\varphi$	error of φ
9	=	$\Delta\theta$	error of θ
10	=	Δx	error of x_t
11	=	Δy	error of y_t
12	=	Δz	error of z_t
IT(JT+13)	=	N_{point}	number of points on track
IT(JT+14)	=	N_V	number of vertex to which track belongs
15	=	S	extrapolated arc length (= 0 at first measured point)
16	=	$\Delta\phi_{MS}$	multiple scattering angular error (inner vessel wall)
17	=	$\Delta\phi_{MS}$	multiple scattering angular error (beampipe)
18	=	S	extrapolated arc length to inner vessel wall (near)
19	=	S	extrapolated arc length to beampipe (near)
20	=	L	projected track length in $R\varphi$
21	=	$\sin\varphi_0$	
22	=	$\cos\varphi_0$	
23	=	$\sin\theta$	
24	=	$\cos\theta$	
25	=	S	extrapolated arc length to origin (VTXDAV only)
26	=	S	extrapolated arc length to inner vessel wall (far)
27	=	S	extrapolated arc length to inner vessel wall (near)
28	=	SDX	number of standard deviations in x
29	=	SDY	number of standard deviations in y (used by VTXSRC)
30	=	SDZ	number of standard deviations in z
IT(JT+31)	=	flag	1 for COMFITted tracks, 0 else
32	=	cov_4	$R\varphi$ covariance (180 σ^2/N_{point} / L^4 (from Gluckstern))
33	=	cov_3	$R\varphi$ covariance (0.0)
34	=	cov_2	$R\varphi$ covariance ($-18\,\sigma^2/N_{point}$ / L^2)
35	=	cov_1	$R\varphi$ covariance (0.0)
36	=	cov_0	$R\varphi$ covariance ($9/4\,\sigma^2/N_{point}$)
37	=		σ^2/N_{point} in ZS
38	=	L_{ZS}	projected track length in ZS
39	=	ΔS	difference in arc length between $R\varphi$ and ZS
40	=		$R\varphi$ covariance for angular error (0.0)

Square of extrapolation error in $R\varphi$ without multiple scattering:

$$\delta^2_{xy} = \sum_{i=1}^{4} \mathrm{cov}_i \cdot X^i, \; X = S - {}^1\!/_2\, L$$

The words 1–15 are stored by `VTXBNK` or `VTXBNC` in the `GVTX` or `CVTX`-bank. To get the values for the point nearest to the vertex. `VTXAFT` has to be called first.

Description of V-array (JV = vertex number · 13 − 13)

`IV(JV+1)`	=	flag	0 = no vertex fit 1 = bad vertex fit 2 = vertex of one- or collinear two-prong 3 = good vertex 4 = e^+e^--pair vertex 5 = isolated single track vertex
`V(JV+2)`	=	x_V	
`3`	=	y_V	vertex coordinates
`4`	=	z_V	
`5`	=	Δx	error of x_V
`6`	=	Δy	error of y_V
`7`	=	Δz	error of z_V
`IV(JV+8)`	=	N_{fit}	number of tracks used in vertex fit
`9`	=	χ^2	χ^2 of vertex fit
`IV(JV+10)`	=	N_{all}	number of tracks belonging to vertex
`11`	=	cov_{XY}	XY-covariance
`10`	=	cov_{XZ}	XZ-covariance
`13`	=	cov_{YZ}	YZ-covariance

Special features steered by `MODE`

- `Bit 31 on :` startpoint for vertex fit is the origin (`VERTEX` only)
- `Bit 30 on :` vertex fit with runvertex constraint (`VERTEX` only)
- `Bit 29 on :` vertex fit with constraint to a given axis (`VERTEX` only)
- `Bit 28 on :` vertex fit only in $R\varphi$ (`VERTEX,VTXDAV`)
- `Bit 27 on :` print some local statistics (`VERTEX` only)
- `Bit 26 on :` overwrite `PATR`-bank with circle-parameters for type 2 tracks (`VTXPRE`)
- `Bit 25 on :` message from `VTXEE` if failed (reason for failure)
- `Bit 24 on :` use penalty function to constrain the vertex (`VTXDAV` only)