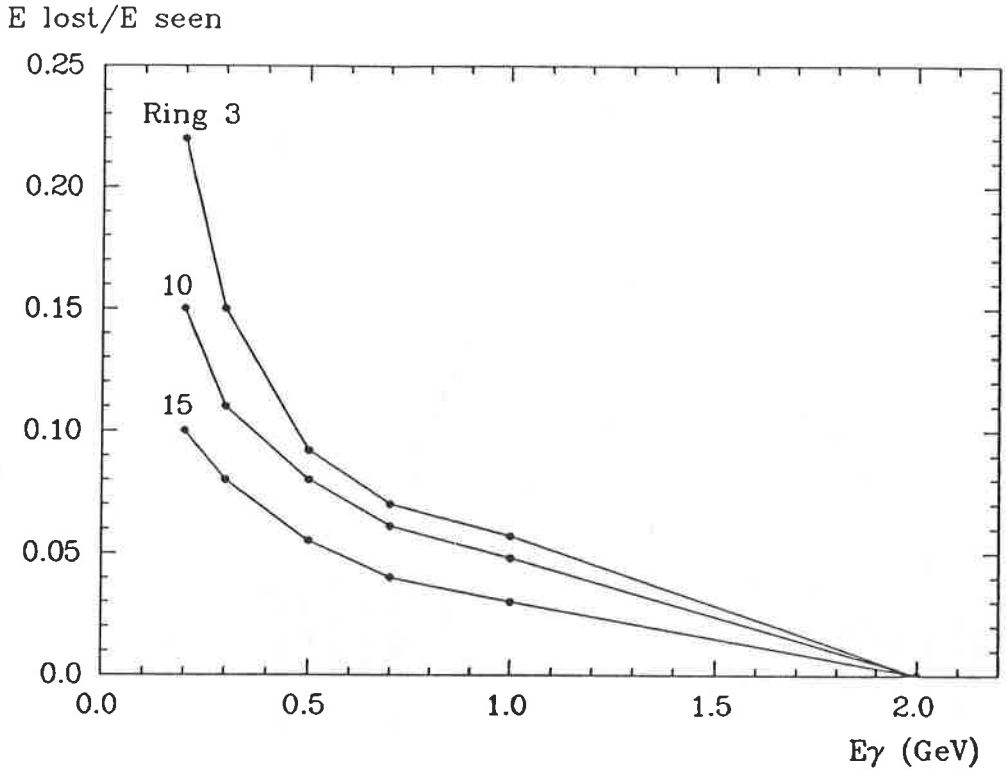

Figure 5: *Energy loss due to a readout threshold of 36 MeV*

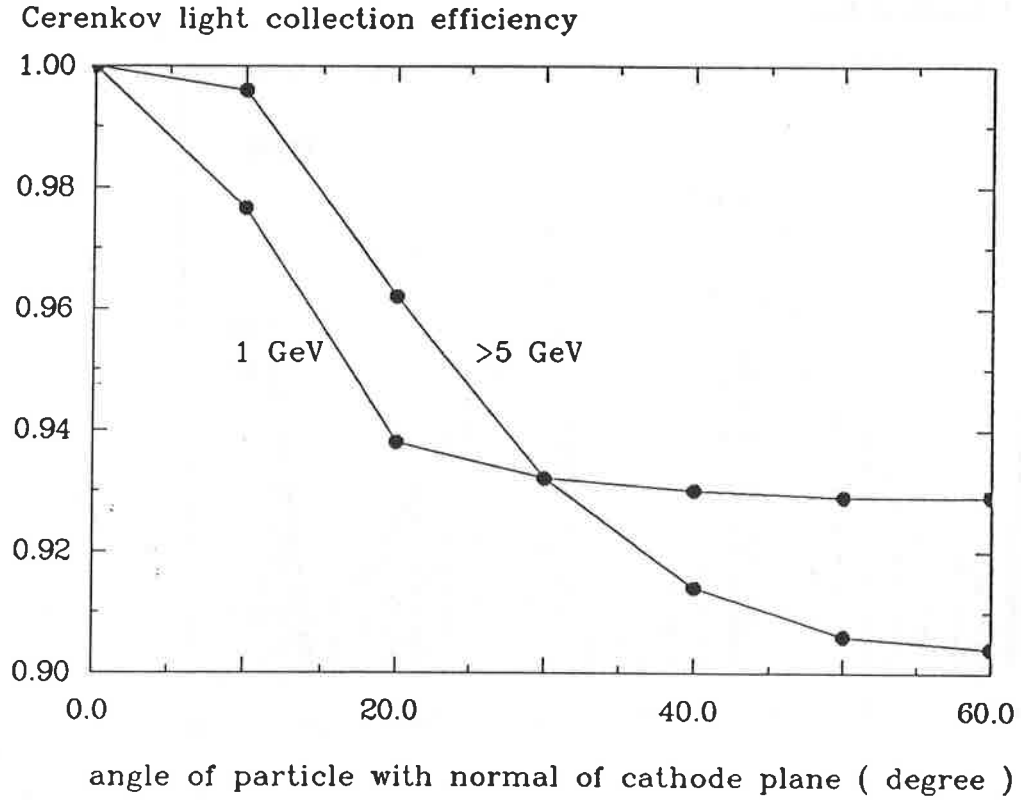

Figure 6: *Efficiency of Čerenkov light collection*

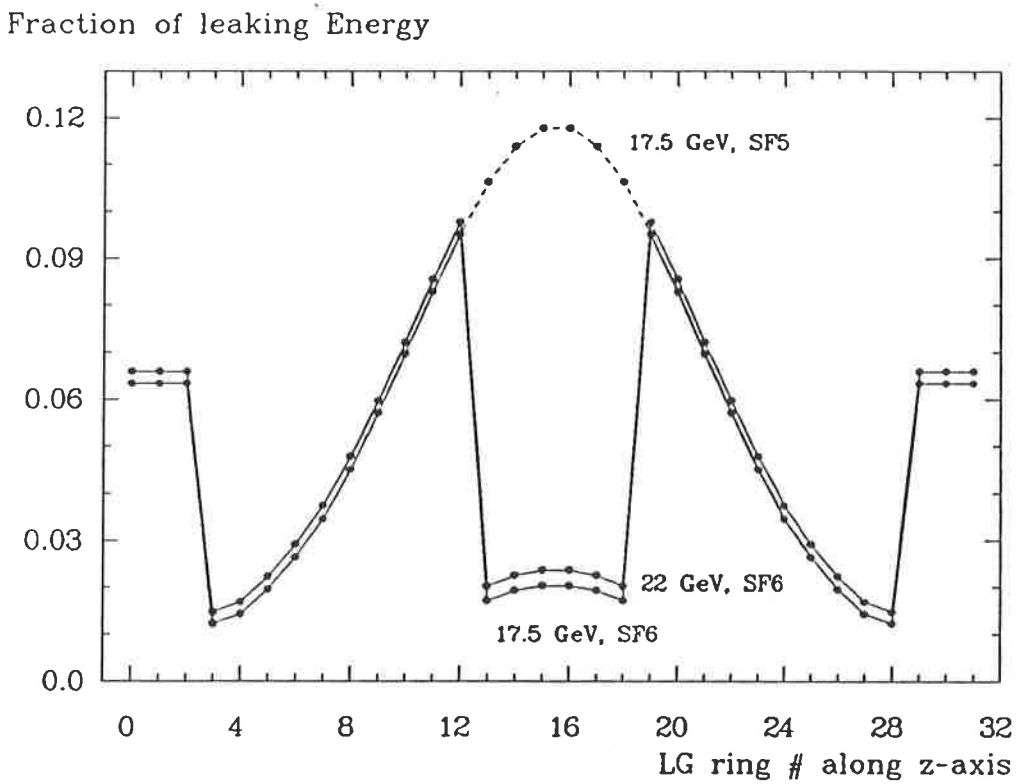

Figure 1: *Leakage of bhabha showers*

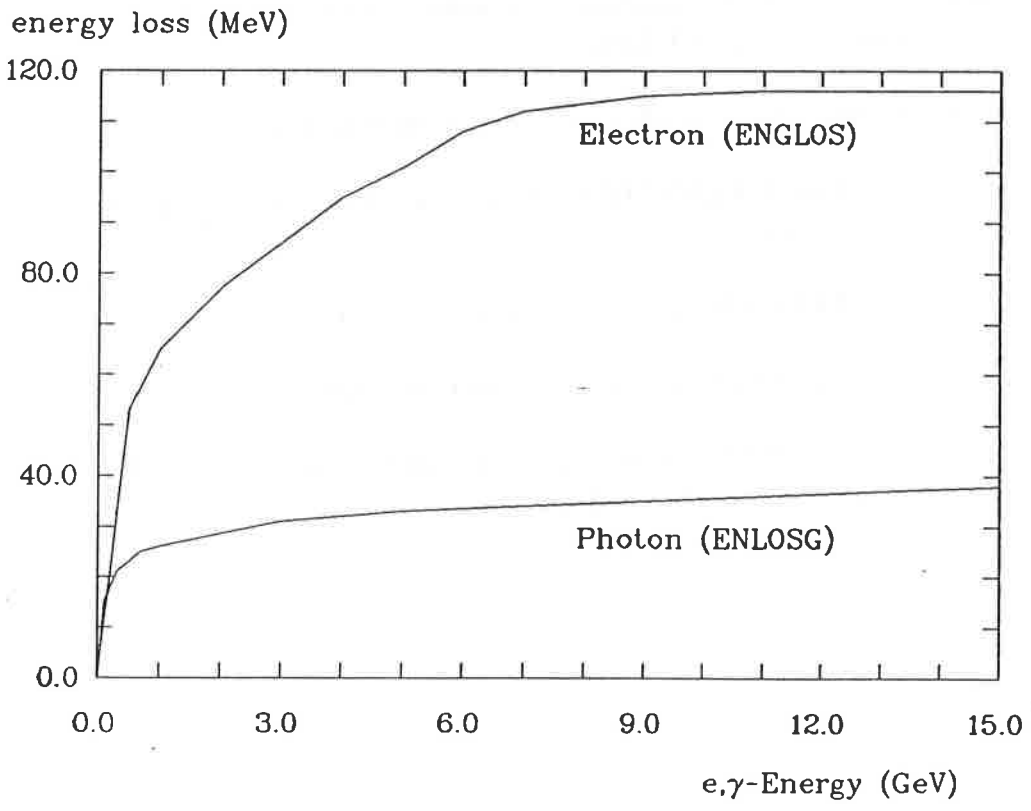

Figure 2: *Energy loss of electrons and photons in 1 X_0 Aluminium*

THCORR : energy loss due to the readout threshold, data from EGS4 (see fig 5). The lead glass readout threshold was set to 5 ADC counts á 5 MeV in 1979-82 and to 6 counts á 6 MeV in 1983-86 to reduce the electronic noise. An example for the effect of the threshold is given in JCN 70.

ANGBAR : efficiency of Čerenkov light collection on the photokathode, values from the Tokyo people (see JCN 20, see fig 6).

Usage of LGECOR:

- The routines LKCORR and THCORR are valid for photon showers.
- Monte Carlo : the shower leakage is not simulated in the Meier Magnussen lead glass tracking or the 1 dimensional tracking. (selected by LFLAG(4) = .T. or .F. when calling MCJADE in the tracking step). Therefore LKCORR is not called for these Monte Carlos. The Tokyo shower program includes shower leakage (selected by LFLAG(6) = .T. , see JCN 98) and for this Monte Carlo LKCORR is used (identified by MCTYP in LGECOR).
- For electrons below 5 to 10 GeV LKCORR should be used while for electrons with higher energy a treatment as Bhabhas gives the smaller error.
- Bhabhas: do not call LKCORR, the leakage is compensated by the calibration constants if BBLEAK was not called. The same holds for Bhabha Monte Carlo with 1 dimensional or 3 dimensional Meier Magnussen tracking where leakage is not simulated. But the Tokyo shower program includes leakage which must then be corrected by a call to LKCORR.

Appendix

leakage is neglected the expected cluster energy is too high and all calibration constants are too high.
Consequences:

- Bhabhas: For electrons with beam energy there is perfect cancellation, since the calibration corrects their leakage. Electrons with lower energy in hard bremsstrahlung events have a smaller leakage and therefore their reconstructed energy is sytematically too high. This applies also to electrons in τ-decays and multi hadrons.

- Photons from π^0 and η decays: Photon showers below 1 GeV have small leakage (see fig 3 and 4), so their energies are overestimated by the calibration. Nevertheless the π^0 peak was approximately at its nominal value in the past due to an accidental cancellation with another effect, namely the energy loss in the lead glass readout threshold (see below). But there remained a dependence of the position of the π^0 peak on the π^0 energy and on the polar angle of the photons (see JN 136).

- Monte Carlo: Monte Carlo data are not calibrated. Therefore the cancellation of energy mismeasurements for photons from π^0 decay does not occur in the Monte Carlo, resulting in a π^0 peak around 115 MeV for multi hadrons. In the Meier Magnussen lead glass tracking this was compensated by a fudge factor which raised every photon or electron cluster energy by 11%. This fudge factor was taken out of the Meier Magnussen Monte Carlo on the library F22ELS.JMC.S in April 1987.

The lead glass calibration is now corrected for the leakage of Bhabha showers in the routine LGCLPB which is called by LGANAL and processes the clusters in the barrel part. LGCLPB calls for each block in each cluster the routine BBLEAK which returns a correction factor depending on the block position along the beam axis (the lead glass rings are numbered from 0 to 31 along the z axis) and the period (1979 - 82: only SF5 with beam energy of 17.5 GeV, 1983-86: SF6 in the rings 13 to 18 with beam energy of 17.5 Gev or 22.0 GeV). The block energy in the ALGN bank is then reduced.
Usage of BBLEAK:

- Monte Carlo: LGCLPB does not call BBLEAK for Monte Carlo events (identified by run number < 100).

- A flag in the ALGN bank indicates that the calibration correction was applied: halfword #2 (HNORML in the work common) is increased from 10000 to 22000.

- Bhabha events: The calibration constants compensate the leakage of electron showers with beam energy and therefore BBLEAK needs not to be called in LGCLPB. Then the routine LKCORR wich corrects the leakage of photon showers (see below) must not be called from LGECOR either.

- For a study of π^0 or η mesons, call BBLEAK.

- For a hard photon study, BBLEAK should be called. The leakage of photon showers is corrected by the routine LKCORR in the next step.

From internal fitting procedure VF4SC

-11 # of hits on track ≤ 6

-12 # of hits used in fit ≤ 5

-13 error in internal hit array

-14 matrix could not be inverted

-15 tracklength > circle diameter

-16 # of iterations for circle fit > 20

From line fit through vertex chamber hits

In these cases the fit would be redone without vertex chamber

-21 # of hits on track ≤ 2

-22 matrix could not be inverted

-23 error in internal hit array

Remarks In the case of a successful fit (return codes 0, -1, -2, $\leq$-20) the bit 15 in the program identifier word is set, and the results of the fit (including the covariance matrix) are stored in the HWDS bank. In all other cases the results of the $R\varphi$-fit in the selected PATR bank are copied into the HWDS bank. All the z-information is copied from the PATR bank anyway.

The covariances are measured in the fit system. The words 52–56 are not the elements of the 4×4-covariance matrix, but linear combinations cov_i of these elements which have the same dimensions. To calculate the extrapolation error δ_{xy} in the $R\varphi$-plane (without multiple scattering) at any point on the track, the user has to calculate two things in $R\varphi$. First the extrapolation length from the first measured point S has to be calculated for the point of interest. Going from the first measured point to the vertex means that S is *negative*. Secondly the track length L must be known. It is simply the distance in $R\varphi$ between the first and last measured points. With this one gets:

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

The user should remember, that each track is described now by *two* parabolae or circles. The first accounts for the multiple scattering in the vessel wall and describes the track from the vertex to the vessel wall. The parameters for this parametrisation are stored in the 'default' positions 19–22 and their covariances in 52–56. The second parametrisation describes the track from the vessel wall to the outer parts of the detector. To use this, the words 20–21 and 53–56 must be replaced by the words 49–50 and 65–68.

Description of **HWDS** Bank from Combined Fit

Header	1	header length		8
$I*4$	2	# of tracks		
	3	track data length		68
	4	PATREC history word		
	5	# of hits in ID		
	6	# of uncorrelated hits		
	7	# of uncorrelated line elements		
	8	marker for combined fit (COMFIT)		2
		no VTXC bank		1
TRACK 1	1	track number		
$R*4$	2	program identifier (bit map)		bit
$I*4$		combined fit done		15
		vertex constraint		14
	3	date at fit run		
	4	type		first
	5	x-coordinate		point
	6	y-coordinate		
	7	z-coordinate		of
	8	unit vector	x	
	9	of flight	y	fit
	10	direction	z	
	11	type		last
	12	x-coordinate		point
	13	y-coordinate		
	14	z-coordinate		of
	15	unit vector	x	
	16	of flight	y	fit
	17	direction	z	
	18	r-φ-fit type :	1	2
	19		$\lvert R\rvert^{-1}$	α
	20	VTXC-	$d_0 - R$	X_0
	21	parametrisation	φ	Y_0
	22		unused	c
	23	$\sigma_{r\varphi}$		
	24	# of used hits (ID + VTXC)		
	25	curvature		
	26	curvature error		
	27	curvature at first point		
	28	curvature at last point		
	29	z-fit type		
	30	P_1 (slope)		
	31	P_2 (offset)		

Description of **VTXC** Bank

Header	1	header length	5
*I**4	2	microprocessor program version	(MC = 0)
	3	VTXCBK program version	(MC = 0)
		(since 08/86 = 4)	
	4	generation date	(MC = 0)
		*(year-1986)*1000 + day-of-year*	
	5	unused	
Hit 1	1	wire number	1 - 168
*I**2	2	VTXC 9	*Pedestal + 256* Channel1*
		VTXC 10	amplitude (odd wireside number)
	3	VTXC 9	*Channel2 + 256*Channel3*
		VTXC 10	amplitude (even wireside number)
	4	drift time	(Data 0.1 ns, MC 0.001 mm)
Hit 2	5	...	
	⋮	...	

Description of **VTHT** Bank

Header	1	header length *(6)*
*I**2	2	program version
	3	generation date *((year-1986)*1000 + day-of-year)*
	4	track data length *(8)*
	5	total number of tracks from PASS I + PASS II
	6	number of tracks only from PASS I
Track 1	1	number of VTXC-hits, track 1
*I**2	2	hit number in VTXC bank for 1^{st} hit
	3	hit number in VTXC bank for 2^{nd} hit
	4	hit number in VTXC bank for 3^{rd} hit
	5	hit number in VTXC bank for 4^{th} hit
	6	hit number in VTXC bank for 5^{th} hit
	7	hit number in VTXC bank for 6^{th} hit
	8	hit number in VTXC bank for 7^{th} hit
Track 2	9	number of VTXC-hits, track 2
*I**2	⋮	...

Remark For PASS-II-tracks the hit numbers can be *negative*. The *sign* of the hit number corresponds to the selection of *hit* or *mirror hit*. For PASS-I-tracks the hit numbers are always positive. For tracks with less than 7 hits, the hit numbers for unused hits are set to *zero*.

Description of output argument:

IRET	-1	No HEAD bank
	-2	No PATR bank
	-3	PATR 12 selected for Monte Carlo

Following banks will be created by the pattern recognition:

Data	Monte Carlo	Contents
VTXC 9		Vertex chamber hits (from BPCH)
	VTXC 10	Vertex chamber hits (created by MC tracking)
VPAT 9	VPAT 10	All linked vertex chamber tracks
VPAT 19	VPAT 20	Linked vertex chamber tracks from 1^{st} step
VTHT 9	VTHT 10	All vertex chamber tracks from 2^{nd} step (linked to ID or not)

Following banks will be created by the common fit:

Data, Monte Carlo	Contents
HWDS NBPCFT	Results of combined fit in $R\varphi$
HHTL NBPCFT	Corresponding updated ID hit label bank (description see JADE computer note 21)

The input to the combined fit is the work array in the common /CWORK/ filled by J. Spitzers refit XYRFT1 without any constraint.

For special applications there are three additional steering parameters (MODECF, VCWGHT, CFSFAC) for the combined fit located in the common /CCOMF/. The description of this common can be found in 'F22KLE.JVTXC.GS(MCCOMF)'. Changes to these parameters should only be done once before the event loop in the main program.

MODECF (default 0):

Bit 31 on or '+1'	Fit without vertex chamber hits forced
Bit 30 on or '+2'	Estimation of resolution of vertex chamber and ID from residuals of first fit and refit with these resolutions as weight
Bit 29 on or '+4'	Constraint with fill-wise run vertex

VCWGHT (default 1.0):
For combined fits with vertex constraint the error at the run vertex is calculated from the beamsize and could be scaled with the additional factor VCWGHT. A factor of 1.6 is recommended for the data of 85 and 86.

CFSFAC (default 1.0):
To simulate systematic effects in the Monte Carlo a *"track smearing"* is incorporated in the fit. The track parameters are smeared according to $\sqrt{\texttt{CFSFAC}^2 - 1}$ and the covariance matrix of the fit.

APPENDIX : Detailed Description of the ZE4V-Bank

Header Section

NPZE4V = IW(IBLN('ZE4V'))

HW	(2NPZE4V+ 1)	Length of header (LH)
HW	(2NPZE4V+ 2)	Words per vertex (Lv)
HW	(2NPZE4V+ 3)	Number of vertices (Nv)
HW	(2NPZE4V+ 4)	Length of MC-Information part (=0 for data) (LMC)
HW	(2NPZE4V+ 5)	Length of general track section (LT)
HW	(2NPZE4V+ 6)	Total number of particles (charged + photons)
HW	(2NPZE4V+ 7)	Length of specific track section for charged (Lch)
HW	(2NPZE4V+ 8)	Number of charged particles (Nch)
HW	(2NPZE4V+ 9)	Length of specific track section for photons (Lph)
HW	(2NPZE4V+10)	Number of photons (Nph)
HW	(2NPZE4V+11)	Length of 'private' track section (Lpr)
HW	(2NPZE4V+12)	Number of 'private' particles (Npr)
HW	(2NPZE4V+13)	Run number
HW	(2NPZE4V+14)	Event number
RW	(NPZE4V+ 8)	Beam energy (GeV)
RW	(NPZE4V+ 9..12)	Sphericity axis (3 values) + Sphericity (TP convention)
RW	(NPZE4V+13..16)	2nd axis and value
RW	(NPZE4V+17..20)	3rd axis and value
RW	(NPZE4V+21..24)	Thrust axis and Thrust
RW	(NPZE4V+25..28)	Acoplanarity axis and value
RW	(NPZE4V+29)	not used
RW	(NPZE4V+30)	not used
IW	(NPZE4V+31)	MCREDU-Flag (1=accepted -1=not accepted 0=not tested)
RW	(NPZE4V+31+1)	x_1
RW	(NPZE4V+31+2)	y_1 coordinates of vertex 1
RW	(NPZE4V+31+3)	z_1
...		...
RW	(NPZE4V+31+Nv*Lv-2)	x_{Nv}
RW	(NPZE4V+31+Nv*Lv-1)	y_{Nv} coordinates of vertex Nv
RW	(NPZE4V+31+Nv*Lv)	z_{Nv}
	Following words are filled only for Monte Carlo	
HW	(2NPZE4V+62+2Nv*Lv +1)	Number of created jets (partons) (N_j)
HW	(2NPZE4V+62+2Nv*Lv +2)	Original quark flavour (1=u, 2=d, 3=s, 4=c, 5=b)
RW	(NPZE4V+32+Nv*Lv+1)	p_x
RW	(NPZE4V+32+Nv*Lv+2)	p_y of parton 1 (GeV)
RW	(NPZE4V+32+Nv*Lv+3)	p_z
RW	(NPZE4V+32+Nv*Lv+4)	E
...		...
RW	(NPZE4V+32+Nv*Lv+4N_j-3)	p_x
RW	(NPZE4V+32+Nv*Lv+4N_j-2)	p_y of parton N_j (GeV)
RW	(NPZE4V+32+Nv*Lv+4N_j-1)	p_z
RW	(NPZE4V+32+Nv*Lv+4N_j)	E

particles most of the information is taken from the PATR-bank with lowest number, dE/dx and leadglass information stems from corresponding TPTR and LGCL banks. Each track is required to fulfill the following quality criterions :

≥ 20 hits in $r - \phi$

≥ 12 hits in $r - z$

$R_{min} \leq 50$ mm

$|Z_{max}| \leq 350$ mm

$P_{min} \geq 50$ MeV

A leadglass-cluster is accepted as a photon, if after subtracting the minimum-ionizing-energy for each connected track(corrected for tracklength), the remaining cluster energy is more than 150 MeV. For all particles the corresponding track numbers in PATR , LGCL and TPTR banks are provided. For MC - Events a traceback to the PALL bank is performed (for details see JCN 69). A detailed description of the bank is given in the appendix.
The routines and jobs, which create and unpack the ZE4V bank are all contained in the libraries :

F11ZIM.ZLIB.S (source)

F11ZIM.ZLIB.L (load)

To create the ZE4V bank from TP'ed events the job #ZE4VPK can be used. The subroutine ZE4VDP produces a printout of the ZE4V-bank in a readable format. For use together with the VECSUB routine package (DESYLIB), the subroutine ZE4VUN unpacks the fourvectors and some additional information for all particles into the VECSUB COMMON.
This library also contains subroutines (like THRUST or SPHRCY) which are copied from other JADE libraries, so it is useful to check for interferences.

Example of a Simple Unpack Routine (FORTRAN 77)

```
      IMPLICIT INTEGER*2 (H)
      COMMON / BCS / IW(10000)
      DIMENSION HW(20000) RW(10000)
      EQUIVALENCE ( HW(1),RW(1),IW(1) )
      INTEGER LENGTH ( -1:2 )
      NPZE4V = IW(IBLN('ZE4V'))
      LH = HW( 2*NPZE4V + 1 )
      LENGTH (-1) = HW( 2*NPZE4V + 5 )
      LENGTH (1) = HW( 2*NPZE4V + 7 ) + LENGTH( -1 )
      LENGTH (0) = HW( 2*NPZE4V + 9 ) + LENGTH( -1 )
      LENGTH (2) = HW( 2*NPZE4V +11 ) + LENGTH( -1 )
      NPART = HW( 2*NPZE4V + 6 )
      ...
      NPTR = NPZE4V + LH
      DO 10 I = 1,NPART
         ...
         IFLAG = HW ( 2*NPTR + 18 )
         IF (IFLAG .EQ. 1) DEDX = RW( NPTR + LENGTH(-1) + 9 )
         NPTR = NPTR + LENGTH ( IFLAG )
10    CONTINUE
      END
```