JADE Computer Note No. 92

REDUC1 and REDUC2 for 1986 Data

E. Elsen, J. Olsson

February 24, 1987

Introduction The production of REDUC1 and REDUC2 tapes had to follow slightly different paths in 1986 compared to the standard way, where REDUC1 tapes were produced at Rutherford Lab and REDUC2 was run at DESY. The reasons for redoing the reduction, or for recalibrating tapes, are laid out in JADE Computer Note 89. This note summarizes the status for the different runs and where the tape information can be found. All REDUCONE and REDUCTWO tapes are now available at DESY.

REDUC1 The REDUC1 output tapes for 1986 are broken up into several groups, which have to be distinguished according to the calibration used. In this respect the **preliminary** JETC calibration refers to a JETC calibration with estimated parameters (gain and pedestals), whereas **final** JETC calibration denotes the constants that are currently installed on the calibration file. The **preliminary** calibration has been used for some REFORM tapes to perform the selection of events. In these cases PATREC has been called again afterwards to use the final calibration for the selected events. The selection of events would have been slightly different though, if it had been performed with the final calibration from the beginning. Similarly, new lead glass gain constants were installed at DESY while REDUC1 was progressing. Here the different calibrations are denoted as **extrapolated** (from 1985) and **final**. Different to the JETC calibration most REDUCONE tapes have the results of the extrapolated calibration stored. The concerned user should, therefore, do the lead glass calibration again, himself.

0̃ 2 1 5 9 2 n

The V° finding package KOMAKS: JADE Computer note 93

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March 1987

Introduction.

This note describes how to use the V° finding program package KOMAKS. As far as the authors of the note are aware, it has up to now only been used for K° searches however it could in principle be used for other V°s, e.g. Λs. In this respect it should be noted that all tracks are treated as pions. KOMAKS is based on the routine KST1 written by S. Komamiya (hence the name) somewhere back in the grey dawn of time and gently massaged into its present form by the other authors.

KOMAKS essentially consists of three steps.

(a) With the aid of several of the Dittmann vertex routines[1] (VTXPRE, VTXEE) each pair of tracks is examined as regards its feasibility of being a V°. For example pairs of tracks each with the same sign, or γ conversions are rejected. Also pairs containing tracks which do not pass the quality cuts in VTXPRE (see code for details) or which have less than the required minimum number of hits are rejected.

(b) Secondary vertices are then searched for by first looking for tracks which intersect in the $r\phi$ plane. It is possible to select only those pairs whose tracks do not come from the event vertex (see below), taken in this case as the run vertex from the common `/CALIBR/` .

(c) The z coordinate of the V° vertex is determined by performing a common fit in z.

How to use KOMAKS.

The KOMAKS package is for historical reasons written in FORTRAN IV (*ugh!*) and resides on

F11LHO.JADEGS/L

It is also necessary that

(a) the JADE block data (JADEBD) must be properly filled,

(b) one call is made to VTXINI at the start of the program,

(c) member WERTEX is INCLUDEd from JADEGL in order to pick up the appropriate version of the Dittmann vertex routines.

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[1] See JADE computer note 32 and Appendix 1.

Run	REDUCTWO Tape
24214 - 26356	F11OLS.REDUC22.G0420V00 - F11OLS.REDUC22.G0470V00
26357 - 26371	F11OLS.REDUC22.G0470W00
26372 - 26387	F11OLS.REDUC22.G0470W00
26388 - 29187	F11OLS.REDUC22.G0471V00 - F11OLS.REDUC22.G0539V00
29188 - 29339	F11OLS.REDUC22.G0539V00 - F11OLS.REDUC22.G0544V00
29340 - 29899	F11OLS.REDUC22.G0554V00 - F11OLS.REDUC22.G0569V00
30900 - 30397	F11OLS.REDUC22.G0570V00 - F11OLS.REDUC22.G0582V00

The summary information on REDUC2 output tapes is kept in member REDUCTWO on 'JADEPR.TEXT'.

PCOMB1/2(4,n) : The four-vector of the $1^{st}/2^{nd}$ track making up the n^{th} vertex (GeV).

HTR1/2(n) : The number in the PATR bank of the $1^{st}/2^{nd}$ track making up the n^{th} vertex (note that these arrays are INTEGER * 2).

VMAS(n) : The $\pi\pi$ mass of the n^{th} vertex (GeV).

DMAS(n) : The error on the $\pi\pi$ mass of the n^{th} vertex (GeV).

DVLKO(n) : The $r\phi$ decay length of the n^{th} vertex.

DKO(n) : The minimum distance between the event vertex and the $r\phi$ flight path the n^{th} vertex.

XYZKO(3,n) : The coordinates of the n^{th} vertex. If IZRFIT=0 then the third dimension of this array is meaningless.

The arguments in the call to KOMAKS have the following meaning.

IPRINT : is an input flag to switch on the WRITE statements.(0= no print and the amount of print increases with the non-zero value).

IKOMA : is an error return flag.
0 = normal return
1 = no PATR bank
2 = < 3 PATR tracks (then the whole exercise is a little pointless!).

ITRY : is the number of two particle combinations tried.

IERRK(50) : contains a code for the first 50 combinations tried.
0= V° candidate passes all selection criteria.
1= array IEEFG(50,2) has a non-zero element. For the first 50 combinations each track is flagged in this array. The meaning of the non-zero values are
1= track is part of γ conversion (given by VTXEE),
2= not used,
3= track comes from event vertex (only causes rejection if IEEFG3 = 1and hence the name of this flag),
4= r_{min} > ARLIM,
5= Z_{min} > 350.0, mm
6= track judged bad by VTXPRE.
2= one of the tracks has < MNHIT hits.
3= tracks do not originate from the same side of the event vertex.
4= error return from subroutine XYVRTX.
5= error return from subroutine XYVOPT.
6= error return from subroutine ZRVOPT.
7= track momentum > PCUTT.
8= error return from subroutine ELOSS.
9= γ conversion.
10= DVL > DVLMIN.
11= DKO > DKOMAX.
12= two tracks have the same charge.

SO

Appendix 1.

To help those brave souls who do venture to look at the code of KOMAKS the details of the common /CWORK1/ are given here. This has been taken from F22KLE.VERTEX.S(VTXDEF). For further information regarding this common and the updated Dittmann WERTEX package contact Claus Kleinwort.

```
C X-Y-Z VERTEX FIT
C
COMMON /CWORK1/ NT,T(2000),NV,V(200)
C INPUT PARAMETERS IN /CWORK1/ (MM, MEV, RADIANS)
C ================
C NT = TOTAL NR OF TRACKS OF EVENT
C IT(1) = FLAG (0 = TRACK INCOMPLETE OR BAD, NOT USED
C              1 = GOOD, BUT DO NOT USE IN VERTEXFIT
C              2 = GOOD)
C T( 2) = +-R RADIUS(+ MEANS ANTICLOCKWISE LOOKING TO -Z)
C T( 3) = PHI AZIMUTH AT POINT XT,YT,ZT
C T( 4) = THETA POLAR ANGLE TO XY-PLANE(0=VERTICAL TO BEAM)
C T( 5) = XT .
C T( 6) = YT . FIRST MEASURED POINT ON TRACK
C T( 7) = ZT .
C T( 8) = DPHI ERROR OF PHI
C T( 9) = DTHETA ERROR OF THETA
C T(10) = DXT .
C T(11) = DYT . ERROR OF XT,YT,ZT
C T(12) = DZT .
C IT(13) = NPT NUMBER OF POINTS ON TRACK (INTEGER)
C T(14) = 0 NOT USED ON INPUT
C T(15) = SO INITIAL ARCLENGTH ( = 0.  OR CLOSEST
C APPROACH TO RUNVERTEX )
C 16-40 FOR INTERNAL USE (SEE BELOW)
C (41-80) 2.  TRACK
C .....  ........
C OUTPUT PARAMETERS IN /CWORK1/ (MM, MEV, RADIANS)
C =================
C FOR TRACKS WITH IT(1) GT 0
C IT(1) = FLAG (3 = TRACK WAS USED IN VERTEXFIT)
C T( 3) = PHI AZIMUTH AT POINT XT,YT,ZT
C T( 5) = XT .
C T( 6) = YT . POINT ON TRACK NEAREST TO VERTEX
C T( 7) = ZT .
C T(10) = DXT .
C T(11) = DYT . ERROR OF XT,YT,ZT
C T(12) = DZT .
C IT(14) = NV NUMBER OF VERTEX TO WHICH TRACK BELONGS (I)
C t(15) = S EXTRAPOLATED ARC LENGTH (USUALLY NEGATIVE)
C ALL OTHER T'S ARE UNCHANGED
C
```

```
C IT(31)= 1 FOR 'COMFIT'TED TRACKS, 0 ELSE
C ( COVAR. DEFAULTS : )
C T(32)=RPHI COVARIANCE :X**4(180SIG**2/N/L**4)
C T(33) = RPHI COVARIANCE : X**3 ( 0.0 )
C T(34) =RPHI COVARIANCE :X**2(-18SIG**2/N/L**2)
C T(35) = RPHI COVARIANCE : X**1 ( 0.0 )
C T(36) = RPHI COVARIANCE : X**0 ( 9/4 SIG**2/N )
C T(37) = SIG**2/NPT IN ZS
C T(38) = PROJ. TRACKLENGTH IN ZS
C T(39) = SO(ZS) - SO(RPHI)
C T(40) = COVARIANCE TERM FOR ANGULAR ERROR
C
```

How to use the new ID calibration

JADE Computer note 94

J. Spitzer

March 26, 1987

ABSTRACT. Implementation of the new $r - \varphi$ calibration for the inner detector and the programs that can use it are described.

Implementation of the new ID calibration.

The new $r - \varphi$ calibration covers the entire JADE data taking period and provides a substantially better resolution than the standard calibration. The calibration data together with new run vertices are stored on the standard calibration files (F11LHO.AUPDAT1 e.t.c). KLREAD reads them into the common /CALIBR/ starting at the location associated with the name 'IDJS'. Subroutine KALIBR, which is standardly called now for each event, immediately after the call to KLREAD calls the new routine CNEWID(INDEX) which transforms the calibration data into the form used later. The input parameter INDEX is zero for these "normal" calls.

The selection of new or standard calibration can be changed with a single call to CNEWID in the following way: INDEX=-1 selects standard calibration, -2 new calibration with old run vertex overwritten with the new one (on each event) in the standard locations of /CALIBR/. (This latter feature can be supressed with -3 instead of -2 but since the vertex chamber software takes the vertex from a different place, -3 should not be used.) The new run vertex is in agreement in general with the old one but more detailed, each one corresponds to (typically) 200 single Bhabha tracks. The new selection will be in effect starting at the next event until an other call with these negative arguments. Normally, you will have to make the choice *before the first event is read in.* Probably, by the time of reading, the new calibration will be default and you have to make a call only if you need the standard calibration instead. not possible.

The new calibration has currently effect only for those programs which use JFETCH for reconstructing the hit coordinates. (It is not available in the graphics, in particular.) JFETCH has been modified to call the new reconstruction routine JFTNEW, having the same output conventions, in case a flag in a common set by CNEWID indicates that the new calibration was requested, otherwise the code in JFETCH will be executed.

Refitting tracks in $r - \varphi$.

JFETCH was written by P. Steffen for a final reconstruction of all hits assigned to a given track and used by his refitting package initiated by the subroutine FITEVR. For tracks originating from the run vertex (within 25 mm in $r - \varphi$), FITEVR calls for an $r - \varphi$ refit and subsequently for a common z vertex fit. The subroutine FRFITV which actually performs the $r - \varphi$ fit is basically the same as the routine REFITV but the latter can be used alone, independently from FITEVR.

tine calling JFETCH, it can be used with the standard as well as with the new calibration. The routine will update all parameters and only those which are determined in it (see the code for details), in particular it supplies a curvature error in the way it is done in FRFITV (the (more) standard routines set it to zero).

Bits set in the program identifier word of the 'PATR' bank.

The routine JFTNEW sets on the bit corresponding to 256 in the word IDATA(ITPO+2) to indicate that the new ID calibration was used. XYRFT1 sets on the bit 512 or 1024 in case the vertex constraint was actually used.

Some details concerning the $r - \varphi$ fit in XYRFT1.

The hits assigned to the given track are reconstructed by JFETCH (or JFTNEW) in the coordinate system with x-axis going through the first and last points of the track as given by the earlier fit, the origin being halfway in between. If the curvature from the earlier fit multiplied by the half distance between the first and last points does not exceed .04, parabola fit, otherwise circle fit is planned to be performed. The parabola fit needs a smaller amount of cpu time and hence is useful in case the data sample has mostly large momentum tracks. The algorithm for the circle fit is safe againt division by zero curvature and machine precision problems like subtraction of large numbers and could be used for small curvatures as well. The fit range is extended beyond the first and last points to recover hits frequently lost (mostly if the curvature is large) by the earlier fit.

Shift and rotation with curvature kept fixed to the original value is fitted first. Except for a very small fraction of tracks, the changes in the fit parameters are within certain specified limits and one may start the iterative fitting procedure and "hit cleaning". For those tracks which did not survive these cuts and for those for which an adjustment of the original curvature had previously been necessary in order to become compatible with the specified (by the original fit itself) first and last points (this occours for large curvature tracks fitted with parabola), a search for appropriate starting values is necessary or else the circle fit based on the linearized equations would later not converge. In this search, a parabola with three parameters is fitted to the residuals to the circle and the circle parameters are updated using three far points. The procedure is repeated 10 times altogether without checking any stop condition but reducing in each step the original very large 400 mm residual cut by a factor of 2 (not going below 10 mm). It is necessary to start with this very lose cut otherwise tracks will be lost. Very rarely, the circle fit will not converge even after this procedure, but the result obtained here will still be accepted.

In the iterative fit and hit cleaning part only a lose residual cut of 8 mm is used. At each iteration, the largest residual hits are exluded in such a way that they may be included later if their residual happens to decrease. The number of hits allowed to be thrown away, N/8 is proportional to the number of hits N available for the fit. The iteration continues until a stopping condition based on two parameters, the χ^2/d.o.f. and its rate of decrease for the next fit. (At larger χ^2/d.o.f. the iteration stops below a smaller decrease then at a smaller χ^2/d.o.f.) According to my experience, cutting on a single variable like residual, χ^2/d.o.f., its rate of decrease or χ^2-probability give very similar results but not as good as the one based on the two variables. Note that for the circle fit the linearized equations are used (two iterations each time) and instead of the distance between the points and the circle in radial

A general $s-z$ fit routine: ZSRFTV

JADE Computer Note 95

E. ELSEN AND J. SPITZER
June 10, 1987

ABSTRACT. The new routine ZSRFTV can be used for refitting individual tracks as well as for performing common z fits for subsets of tracks going through specified common points in $r-\varphi$. The fits are helix fits in the sense that linear $s-z$ rather than $r-z$ relation is used where s is the track length along the circle in $r-\varphi$. For FADC multihadron data, the resolution in the fit parameters has been improved by modifying ZSFIT and the hit classification. A further improvment is provided by a new single track fitting routine ZSRFT1 used by ZSRFTV. FADC and DL8 data are compared.

The subroutine ZSRFTV (MODE, IOPT)

may be called to perform the following tasks:

MODE =

- 0 Overwrite old 'PATR' bank with new results.
- 1 Create new 'PATR' bank with new results.

IOPT =

- 1 $s-z$ fits separately for all tracks.
- 2 $s-z$ fits separately for all tracks and subsequently a common z fit for those ones which extrapolate to within 15 mm to the run vertex in $r-\varphi$ and have $|z(r\approx 0)| < 800$ mm.
- 4 Common z fits for user specified (up to 5) sets of tracks going through user specified common (x,y) points or $s-z$ fit for a single track. The single track fits are performed for tracks occuring in the sets only. If a requested track is not within 15 mm to the specified common (x,y) point or $|z(x,y)| > 1600$ mm, it will be excluded from the common fit.

In case of using IOPT=4, you must specify your request in the COMMON /CZSSTE/ NSETZS, NTSTZS(5), KTSTZS(100,2,5), XYSTZS(2,5), SQCHZS(3,5). The following variables must be properly set prior to the call: Number of track sets NSETZS for which a common fit is to be done; number of tracks in each set NTSTZS($\cdot$); sequence number (in 'PATR') of tracks requested for the I-th set KTSTZS($\cdot$,1,I); x and y of common point for the I-th set XYSTZS($\cdot$,I).

Refitting of a single track may be requested by setting only

$$\text{NSETZS} = 1; \quad \text{NTSTZS}(1) = 1; \quad \text{KTSTZS}(1,1,1) = \text{track seq. nr.}$$

nothing else, besides IOPT=4, is needed.

Fit parameters in the 'PATR' bank.

The new $s-z$ fits are associated with fit type 2. The two parameters stored are: $dz/ds = \cot\vartheta$ and z at the closest point on the circle to the origin in $r-\varphi$ (ϑ is the polar angle measured from the $+z$ axis). The meaning of these parameters is identical to that approximated by the $r-z$ (type 1) fit parameters dz/dr and $z(r=0)$, when the curvature is small and the particle motion is radial in $r-\varphi$. ($dz/ds = dz/dr \cdot dr/ds$; while the product is invariant, both factors vary along the track if it does not lie in the radial direction even when the curvature is small.) The corresponding helix is displayed by Jan Olsson's old routine HELDIS. The locations of the parameters are given in JCN 12. The quantities connected with the last and first fitted points are, of course, updated too.

Please check the routine you use for calculating the momentum as to whether it checks on the fit type ! The same code as for type 1 should be used. Subroutine MOMENT has already been changed.

The covariance matrix (see JCN 12 and also JCN 94 Suppl. 1) is provided if the number of hits used in the fit is at least 4 and the length of the track area in the 'PATR' bank is at least 59. The length can be extended (prior to calling ZSRFTV) by using the routine EXPATR as described in JCN 94 Suppl. 1.

The results from the single track fit routine ZSRFT1 are overwritten in ZSRFTV if the track is used in a subsequent common fit, except for the covariance matrix.

Hit selection, fit procedure.

The "P. Dittmann's" z coordinates are used with *amplitude dependent weights* normalized, for the different periods, such that the average weight is close to 1. The z dependence of the weight has been modified for the FADC. If one of the amplitudes is zero or the reconstructed $|z| > 1250$ mm or, in case of FADC, the wire has another hit within ≈ 3.6 mm, the hit is marked not to be used for z fit.

The routines JFETCH and its version for the new ID calibration JFTNEW have been modified in the following two aspects:

1 The z coordinates, hit classification and weight are determined in a new routine AMPS2Z (IP, NPJETC, Z, W, IFLAG), where NPJETC=IDATA(IBLN('JETC')) is the pointer to the calibrated 'JETC' bank and IP points to the (I*4) hit data in it. The Dittmann's z coordinates and weights are set if the corresponding z calibration has previously been requested by calling ZSFIT, otherwise one gets the "standard" z and weight 1. AMPS2Z is called now also in Dittmann's package.

2 The meaning of the input flag INDEX for selecting the coordinate system has been slightly modified. The same role inside the routine is now played by the variable INDX which gets the value of INDEX when it is 1, 2 or 3 (the only valid values until now) and is set to 1 (coordinates in real space) when INDEX has the new value 4. In this latter case the hit data passed in /CWORK/ are different from those set if INDEX < 4 and no track data is stored.

		DL8	FADC
$\sigma(z_0) = \sqrt{\sigma^2_{int}(z_0) + \sigma^2_{beam}(z_0)}$		17.8 mm	27.6 mm
$\sigma(z_0)\|_{\text{common } z} = \sqrt{\frac{1}{2}\sigma^2_{int}(z_0) + \sigma^2_{beam}(z_0)}$	$\left\{\begin{array}{l}\text{ZSRFTV}\\ \text{FITEVR}\end{array}\right.$	14.9 mm 15.5 mm	20.3 mm 23.5 mm
$\sigma\left(\frac{z_{01} - z_{02}}{\sqrt{2}}\right) = \sigma_{int}(z_0)$		**12.8 mm**	**25.4 mm**
$\sigma_{beam}(z_0)$ from $\sigma(z_0)$ and $\sigma\left(\frac{z_{01} - z_{02}}{\sqrt{2}}\right)$		12.4 mm	10.8 mm
$\sigma_{beam}(z_0)$ from $\sigma(z_0)$ and $\sigma(z_0)\|_{\text{common } z}$		11.3 mm	7.9 mm
$\sigma\left(\frac{\cot\vartheta_1 + \cot\vartheta_2}{\sqrt{2}}\right) = \sqrt{\sigma^2_{int}(\cot\vartheta) + \sigma^2_{beam}(\cot\vartheta)} =$		0.028	0.048
$= \sigma\left(\frac{\cot\vartheta_1 + \cot\vartheta_2}{\sqrt{2}}\right)\Big\|_{\text{common } z}$	$\left\{\begin{array}{l}\text{ZSRFTV}\\ \text{FITEVR}\end{array}\right.$	0.028 0.030	0.048 0.056
$\sigma_{int}(\cot\vartheta)$		**0.023**	**0.045**
σ^{eff}_{hit}		19.1 mm	37.9 mm

Table 1. Measured and derived resolutions for μ-pairs

state radiation to the intrinsic resolution in that plot can not be removed that easily as the spread of the interaction point for, on one hand, the $\cot\vartheta$ distribution of single tracks gives no information and, on the other hand, the improvement by an approximate factor of $\sqrt{2}$ in $\cot\vartheta$ in a common z fit has no effect on $(\cot\vartheta_1 + \cot\vartheta_2)/\sqrt{2}$: the sum does not improve due to the correlation introduced by the common z constraint itself. The same correlation makes that the difference of $\cot\vartheta$'s has almost no statistical error and this is what roughly enters into an invariant mass! The effects can, nevertheless, be separated by using the fact that the relative change in $\sigma_{int}(\cot\vartheta)$ has to be the same as that in $\sigma_{int}(z_0)$ when going from DL8 to FADC. One obtains $\sigma_{beam}(\cot\vartheta) = 0.016$ that can be translated into $\sigma_p/p|_{beam} = 0.016$, where σ_p denotes the fluctuation of the total longitudinal momentum in the initial state. (The average transverse momentum of the muons in the sample was taken to be $p_{beam}/\sqrt{2}$.)

From these measurements, one may estimate an effective (hits are used with weights, far hits are discarded) single hit resolution in the following way. From the consistency of the equations in (1), one obtains the relation

$$r_{mid} = \sqrt{\left(\frac{\sigma_{int}(z_0)}{\sigma_{int}(\cot\vartheta)}\right)^2 - d^2\frac{n^2 - 1}{12}}. \tag{2}$$

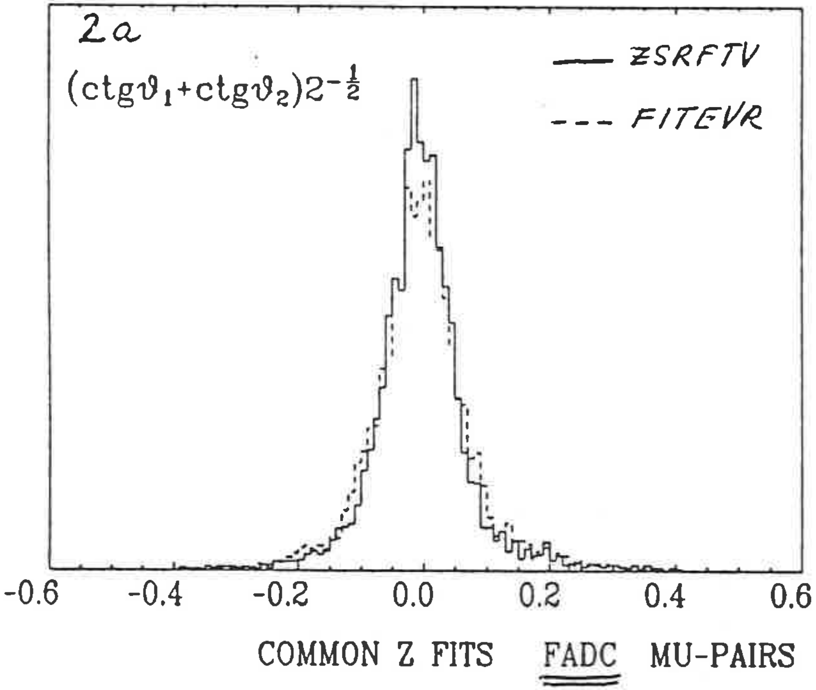
Addendum.

When a common z fit is requested (IOPT= 2 or 4), you may ask for having a constraint on the common z to $z = 0$ with a width of 10 mm. In the case of FADC μ-pairs this additional constraint improves the width of the $(\cot\vartheta_1 + \cot\vartheta_2)/\sqrt{2}$ plot by 40%. Plots with and without this "vertex constraint" (common z constraint in both cases) are shown in Fig.10. In case of DL8 μ-pairs, where the resolution is better, the corresponding improvement is 9% only. The distributions of the track intersections with the beam line in FADC multihadronic events when common z fits with and without the vertex constraint are performed, are shown in Fig.11 that can be compared with the corresponding distribution in uncostrained fits in Fig.4a.

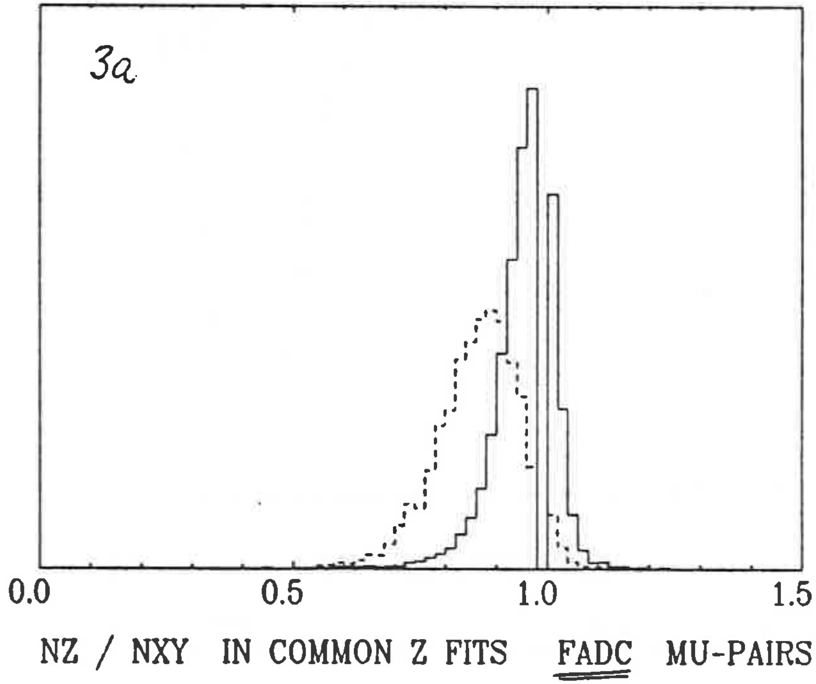
The common in ZSRFTV, /CCMZCT/, described in this note, has been extended by the flags IZVCST(5) which are initialized in BLOCK DATA to /5*0/. For IOPT=2, IZVCST(1)=1 has to be set to get the new constraint and for IOPT=4, the new constraint will be applied to the K-th track set if IZVCST(K)=1 is set. (No combined fit and no new constraint is applied if IOPT=4 is used for refitting a single track.)

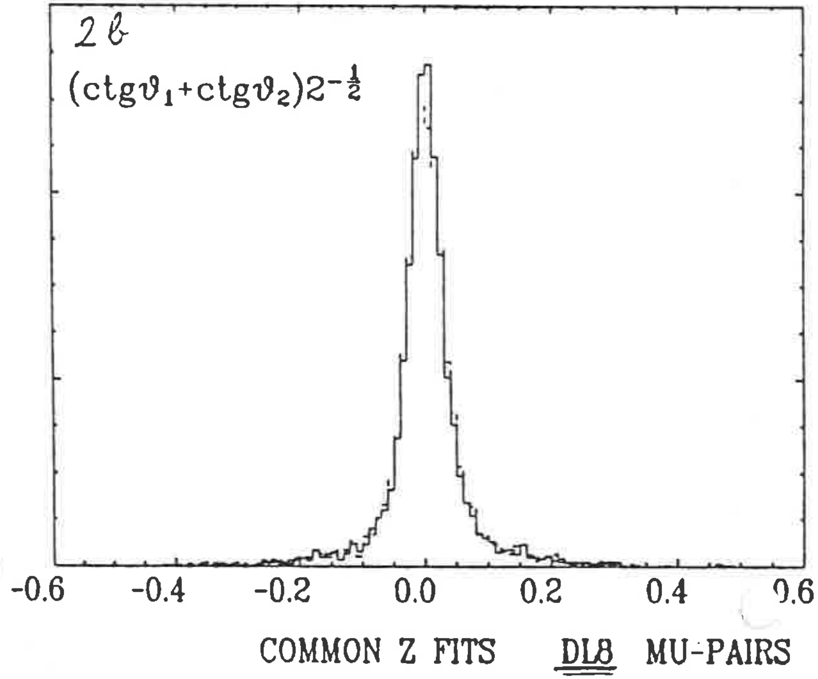
Warning:

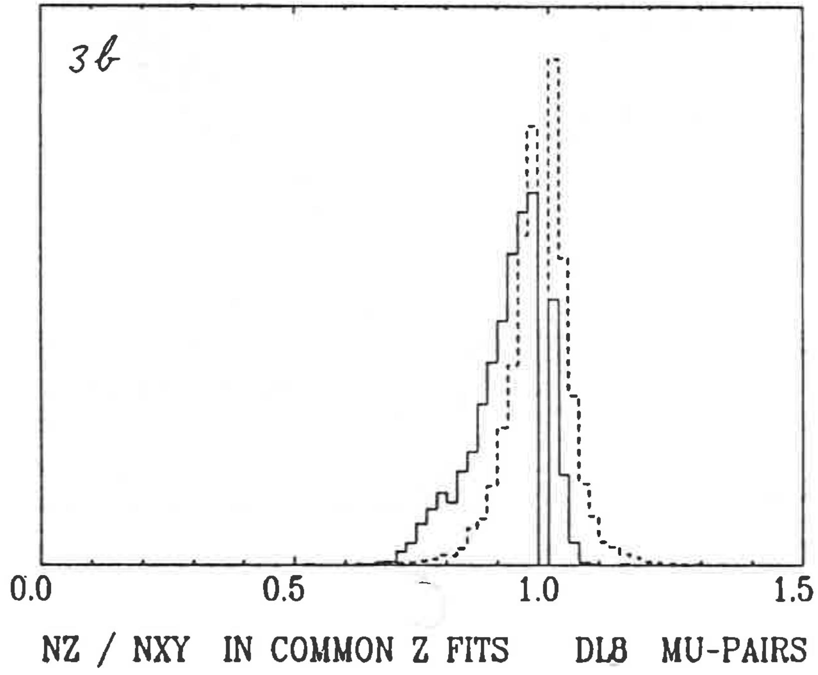
The current test version of the dE/dx program in member (DEDXCN) on the standard library calls ZSFIT with MODE=0. Besides updating the JETC and JHTL banks, the z fit results are overwritten in the PATR bank and hence earlier fit results are lost. This side effect will be avoided in a new version of the program which will be released soon.



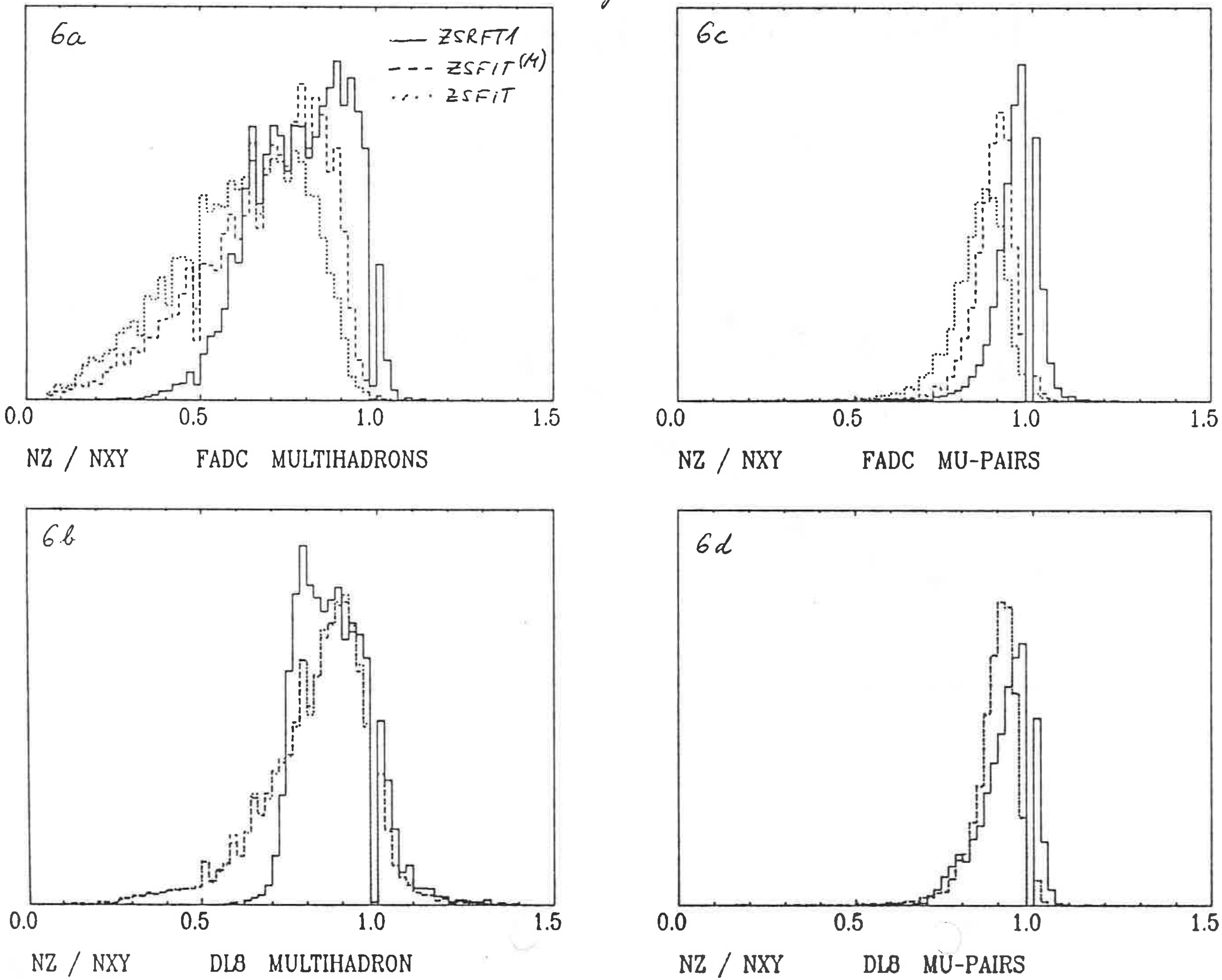
Hit rejection







Hit rejection



DSN F11SPI.BHABH826
27600 2632 1
IDHITS 1042
ELGTOT 11875
MUHITS 15
LGCYL 9081
LGCAPS 525   2269
FWCAPS 0   313

JADE

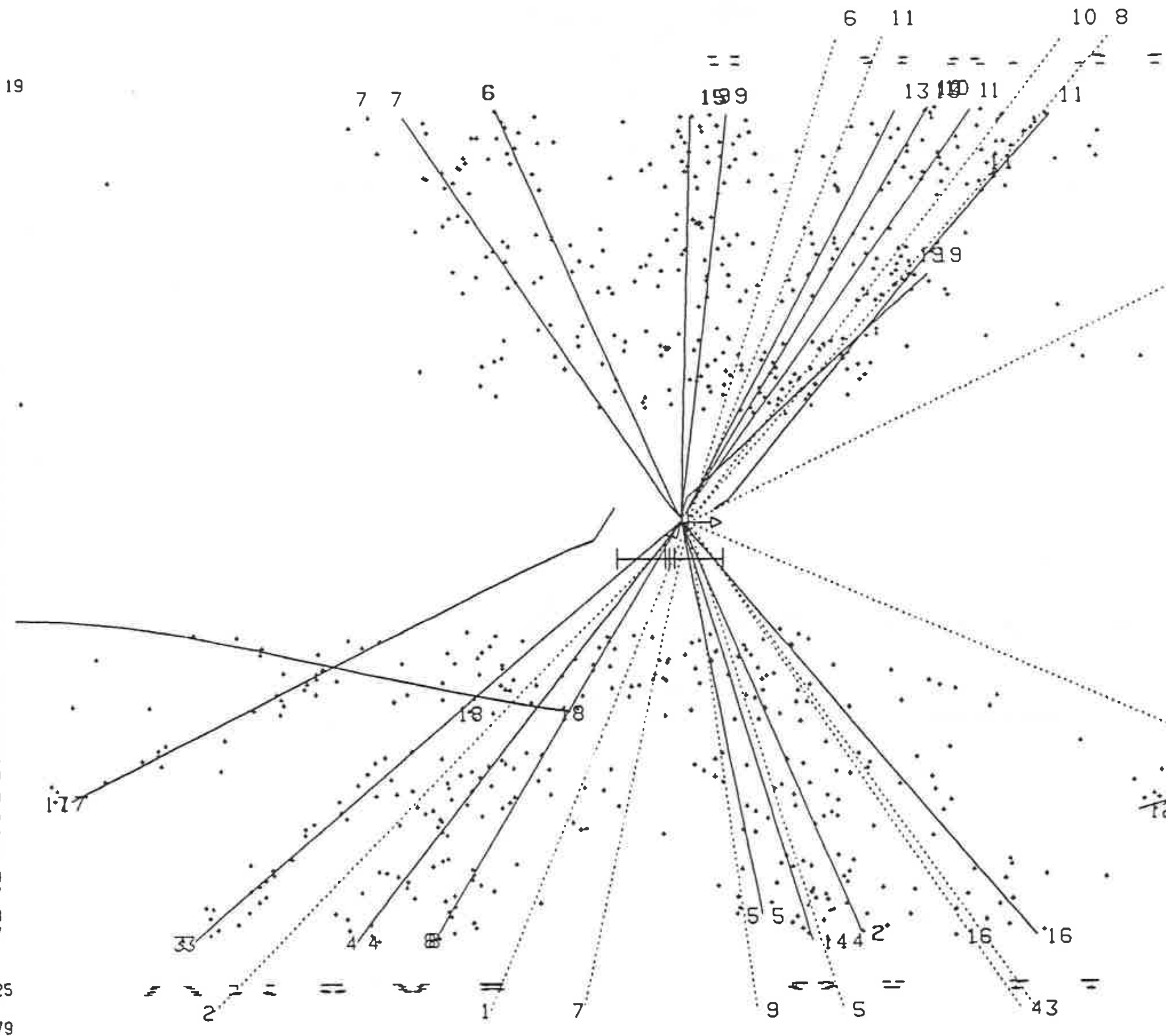
Z-X SECTI(
ROTATE MODE

BEAM 17.501 GEV FIELD -4.844 KG TALC C879 DATE 04/06/87 TIME 09.30.21
T1A 1AC T1P .01 T2C 8089 CAMAC TIME 27.26.19 22/ 7/1986

```
BANK PATR  9  NR OF TRACKS  19
NR +-  RMSRFI RMSRZ/HIT  PHI
PTOT  PLONG  PTRANS   COSTHE
MUQUAL  CHIP  MUPR    PIPR

1 +  0.45/48  44.1/32  333.2
3.797   2.167   3.119  0.571
2 +  0.41/46  41.6/40  178.7
0.458   0.180   0.421  0.393
3 +  0.17/48  44.5/46  161.9
6.344  -4.812   4.134 -0.759
   2     0.0    1.00   0.017
4 -  0.37/46  40.6/33  133.8
1.646  -1.011   1.299 -0.614
5 +  0.32/38  47.2/28  117.9
0.612   0.119   0.601  0.194
6 -  0.56/47  43.7/37   89.2
0.719  -0.287   0.660 -0.399
7 -  0.70/49  43.1/40   74.6
0.337  -0.187   0.280 -0.556
8 -  0.38/46  42.5/40  177.7
2.093  -1.067   1.801 -0.510
9 -  0.35/46  40.2/44  310.7
1.121   0.131   1.113  0.117
10 + 0.52/48  44.2/36  334.1
2.742   1.397   2.360  0.509
11 - 0.58/52  34.8/50   57.4
0.128   0.079   0.100  0.616
12 - 0.79/14  53.2/11  122.4
0.044  -0.040   0.017 -0.921
13 + 1.00/48  52.6/19  340.5
2.374   1.091   2.108  0.460
14 + 0.66/44  41.6/27  136.4
0.410   0.119   0.392  0.291
15 - 0.32/48  44.8/47  358.8
0.307   0.009   0.307  0.030
16 - 0.74/47  60.2/30  121.0
0.423   0.273   0.324  0.645
17 - 0.72/29  30.7/18  141.7
0.320  -0.285   0.145 -0.891
18 - 0.83/14  85.3/10  283.9
0.071   0.069   0.015  0.977
19 + 0.97/20  30.0/15   64.8
0.110   0.079   0.076  0.717

BANK LGCL 1 NR OF CLUSTERS 25
NR  1   BARREL   PHOTON  1
E   1.403 FI 135.0 COST-0.379
NR  2   BARREL   CHARGE 110
E   2.612 FI 329.9 COST 0.404
NR  3   BARREL   PHOTON  2
E   1.919 FI 200.7 COST-0.698
NR  4   BARREL   CHARGE 104
E   0.545 FI 128.7 COST-0.581
NR  5   BARREL   CHARGE 109
E   0.547 FI 307.6 COST 0.201
NR  6   BARREL   CHARGE 101
E   0.698 FI 338.2 COST 0.504
```



```
NR  7   BARREL   PHOTON  3
E   0.265 FI 143.6 COST 0.572
NR  8   BARREL   CHARGE 102
E   0.282 FI 186.4 COST 0.405
NR  9   BARREL   CHARGE 103
E   0.317 FI 160.7 COST-0.776
NR 10   BARREL   CHARGE 106
E   0.370 FI  83.6 COST-0.414
NR 11   BARREL   CHARGE 114
E   0.200 FI 143.6 COST 0.265
NR 12   BARREL   CHARGE 115
E   0.143 FI 349.3 COST-0.049
NR 13   BARREL   PHOTON  4
E   0.138 FI 126.4 COST 0.555
NR 14   BARREL   PHOTON  5
E   0.127 FI 199.3 COST 0.295
NR 15   BARREL   PHOTON  6
E   0.127 FI 323.6 COST 0.295
NR 16   BARREL   CHARGE 108
E   0.285 FI 176.7 COST-0.499
NR 17   BARREL   PHOTON  7
E   0.124 FI 130.7 COST-0.215
NR 18   BARREL   CHARGE 116
E   0.087 FI 109.3 COST 0.613
NR 19   BARREL   PHOTON  8
E   0.072 FI  79.3 COST 0.650
NR 20   BARREL   PHOTON  9
E   0.053 FI 117.9 COST 0.132
NR 21   BARREL   PHOTON 10
E   0.053 FI 345.0 COST 0.608
NR 22   BARREL   PHOTON 11
E   0.055 FI 345.0 COST 0.372
NR 23   ENDCAP   CHARGE 117
E   0.596 FI 132.4 COST-0.912
NR 24   ENDCAP   PHOTON 12
E   2.399 FI 174.4 COST 0.918
NR 25   ENDCAP   PHOTON 13
E   0.068 FI 344.7 COST 0.894
```

Fig. 8 Example for common z fit

```
 * SUMS (GEV) ***   PTOT  24.055   PTRANS  19.271 PL    13.402 CHARGE  -3
TOTAL CLUSTER ENERGY  13.481  PHOTON ENERGY   6.801 NR     PHOTONS  13
```