JADE Computer Note No. 100

Vertex Chamber Software

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Introduction The vertex chamber software was been modified in accordance with the suggestions made at the last JADE software meeting. [1] All the necessary vertex chamber calibration data and run vertices are now on the standard JADE calibration files AUPDAT1 and BUPDAT1. The vertex chamber software can be found on **'F22KLE.JVTXC.GS/GL'**, which is on the JADE volume STOR05. The user has to call two subroutines (**VTXCSV**, **VTXCRV**).

VTXCSV(MODE,NBPFLT,NBPCFT,IRET)

This subroutine steers the whole vertex chamber pattern recognition and the combined fit. A short description of this routines can be found in JCN 98. VTXCSV has to be called in the event loop of the users main program *after* the calls to KALIBR and INPATC.

Description of input arguments:

MODE	-1	To get final statistics printout VTXCSV has to be called at the end of the program with MODE = -1
	0	Dummy call
	1	Perform vertex chamber pattern recognition
	2	Perform combined fit in the $R\varphi$-plane
	3	Perform pattern recognition *and* combined fit
NBPFLT		Number of PATR bank to be used for the vertex chamber pattern recognition. To get the lowest bank NBPFLT has to be set negative.
NBPCFT		Number of PATR bank to be used for the combined fit. To get the lowest bank NBPCFT has to be set negative.

[1] See JCN 98

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.

VTXCRV(RVX,RVY,RVDX2,RVDY2)

VTXCRV has to be called after KLREAD or KALIBR and delivers the position (RVX,RVY) of the fill-wise run vertex determined with the vertex chamber. RVDX2 and RVDY2 contain the squares of the beamsize in the X and Y direction. If this fill-wise run vertex is not available (e.g. run number < 20000), the run vertex determined with the ID and default beamsizes will be returned. For Monte Carlo events all four return parameters are zero.

Remark The standard JADE graphics module supports neither the vertex chamber calibration, pattern recognition nor the combined fit!

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 **VPAT** Bank

Header	1	header length (6)
$I*2$	2	number of selected PATR bank
	3	generation date *((year-1986)*1000 + day-of-year)*
	4	track data length (12)
	5	total number of tracks with ID-link from VTXC-PATREC step 1 and from PASS I + PASS II of step 2
	6	number of tracks with ID-link only from PASS I of VTXC-PATREC step 2
Track 1	1	ID-track number of first linked track
$I*2$	2	distance of first VTXC-hit from ID-track in units of μm
	3	distance of last VTXC-hit from ID-track in units of μm
	4	link code : (1) PASS I (2) PASS II (10) VTXC-PATREC step 1
	5	number of associated VTXC-hits
	6	hit number in VTXC bank for 1^{st} hit
	7	hit number in VTXC bank for 2^{nd} hit
	8	hit number in VTXC bank for 3^{rd} hit
	9	hit number in VTXC bank for 4^{th} hit
	10	hit number in VTXC bank for 5^{th} hit
	11	hit number in VTXC bank for 6^{th} hit
	12	hit number in VTXC bank for 7^{th} hit
Track 2	13	ID-track number of second linked track
$I*2$	⋮	...

Remark The hit numbers are *positive* or *negative*. The *sign* of the hit number corresponds to the selection of *hit* or *mirror hit*.

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)		

$R*4$	32	σ_z	
$I*4$	32	# of used hits in z-fit	
	33	cells with	
	⋮	ID-hits	
	39	of track	
	40	copied from see JADE-	
	⋮	selected computer	
	48	PATR bank note 12	
	49	$d_0 - R$ X_0 ID-	
	50	φ Y_0 parametrisation	
	51	weight for covariance matrix	
	52	cov_4: error from cov. matrix x^4	
	53	cov_3: error from cov. matrix x^3	
	54	cov_2: error from cov. matrix x^2	
	55	cov_1: error from cov. matrix x^1	
	56	cov_0: error from cov. matrix x^0	
	57	error from cov. matrix angular	
	58	σ of VTXC-line 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	
	65	same as words 53–56,	
	⋮	but for the	
	68	ID parametrisation	
TRACK 2	69	...	
	⋮	...	

COMFIT return codes:

0	successful fit with vertex chamber
-1	successful fit without vertex chamber (forced)
-2	successful fit without vertex chamber (no linked hits)
-3	ID refit failed
-4	error in number of ID hits
-5	χ^2 too bad for combined fit
-6	ID refit failed
-7	ID refit failed
-8	track has no intersection with vessel wall
-9	radial momentum too low

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.