JADE COMPUTER NOTE 79

THE JADE TP PROGRAM

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ABSTRACT. This note describes the JADE TP Program, what it does, how it can be steered and what restrictions are imposed.

1. What is the TP Program?

The job of the JADE TP Program is to provide a simple means to analyse a JADE event and produce a set of banks summarising the results obtained. It is not so flexible for data reduction as the JADE SUPERVISOR Program[1] but it includes more analysis steps and is easier to control. The program reads a set of 'data cards' which the user must supply. These influence which analysis packages are called. A full set at present consists of 1 header 'card' and 19 TP flag 'cards'.

2. What do these Summary Banks contain?

The TP program produces 3 types of summary bank — TPEV, TPTR and TPVX. The TPEV bank contains a summary of the whole event such as the number of charged and neutral particles found, the number of vertices, the number of identified particles, etc. Thus there is only 1 TPEV bank per event. In contrast to this, there is a TPTR bank for every found particle in an event. Where present, charged particles occupy the TPTR banks with the lowest numbers with the photons and reconstructed V^0 particles following. The TP program does not take all charged tracks from the latest PATR bank because it attempts to eliminate those which are continuations of other ones, especially curling tracks. Also there is no attempt to match LG clusters to charged tracks other than by position. This implies that not all photons are found.

The TPVX banks give information about each vertex found by the Dittmann search program. A separate TPVX bank is created for each vertex with TPVX/1 being the bank for the primary vertex. All photons are assumed to originate from this vertex.

Full details of the TP banks can be found in JADE Computer Note 80.

[1] See JADE Computer Note 73.

3. What does the TP program do?

The program consists of a number of a steps which are executed in strict order. Each step performs a particular task. A short list of the tasks is given below. A more complete description is given on the following pages. As changes are made, the appropriate page will be issued as an update to this note.

a) Jet chamber processing (incl. pattern recognition and refitting).

b) Vertex finding and fine momentum determination.

c) TOF analysis.

d) dE/dx analysis.

e) LG analysis.

f) Muon chamber analysis.

g) Tagging system analysis.

h) Searches for V^0 particles and charged decays.

i) Sphericity and thrust calculations.

j) Production of the summary banks (TPEV, TPTR, TPVX).

4. What about the 'data cards'?

There are, as stated above, 20 'data cards' which can be used to steer the program. They are read by the program from FORTRAN unit 5 (SYSIN). The first one is special in that it has a different format from the others. Its function is to specify the maximum number of events to be processed, the run number range and the time-out safety margin. The format is (10X, I10, 10X, 2I10, 10X, I10) but it is easier to modify a copy of a model job than to create your own JCL. The layout is shown below with an actual example beneath it.

```
MAX EVNTS=nnnnnnnnnn, RUNS   =ssssssssssssssssssss, /!.NTOUT=tttttttttt
MAX EVNTS=    999999, RUNS   =          0  99999999,   NTOUT=       500
```

Note that the run range is given as a START run number and an END run number with both START and END being part of the range. The format is a little strange in order to include the experiment number, being 100,000 * Experiment No. + Run Number. Also the time-out units are 1/100 *s*.

The next 19 'data cards' control the various options. Their format is (27X,I3). The model jobs contain sample 'data cards' with comments on them to assist in choosing the right value for your application. However because of lack of space, not all options can be mentioned. The list of the TP flags on the next page, in association with the descriptions of the various TP steps, should be definitive.

The TP flags are:

1 Existing TP banks: 1 = scratch , 0 = keep

2 Pattern recognition: 1 = do if not already done, 2 = always do it, 0 = do nothing, < 0 = delete all PATR, JHTL and ZVTX banks[1] and then do pattern recognition

3 Vertex finding: 0 = omit, 1 = coplanar analysis only, 2 = 3-d Dittmann analysis

4 TOF analysis: 0 = omit, all other values = do analysis

5 TOF TP: 0 = omit, all other values = store results

6 dE/dx: 0 = omit, not 0 = do analysis and TP results

7 LG Cluster analysis: 0 = omit, 1 = do if not done, −1 = delete and re-analyse

8 LG matching to Tracks: 0 = omit, 1 = do it

9 LG Cluster TP: 0 = omit, 1 = store results

10 Muon analysis: 0 = omit, 1 = do if not done, −1 = delete old results and re-analyse

11 Unused

12 TP Muon results: 0 = omit, 1 = do it, −1 = as for 1 but MUR2 banks 4, 5 and 6 deleted at end of step,−2 = as for −1 but MUR2 banks 2 and 3 are also deleted. (Space saving option.)

13 Forward detector: 0 = omit, 1 = do if not done, −1 = as for 1 but old results deleted first

14 JETC calibration : 0 = omit, 1 = calibrate

15 Calculations: 0 = sphericity, > 0 = thrust[2] + sphericity

16 z recalibration: 0 = omit, 1 = yes, 2 = as 1 plus refit with no hit cleaning

17 Circle $r\phi$ refit: 0 = omit, 1 = yes, −1 = yes plus newest unrefitted PATR and JHTL banks deleted at end

18 Parabola $r\phi$ refit: 0 = omit, 1 = with no vertex constraint, 2 = with weak vertex constraint, 3 = with strong vertex constraint; add 10 for a common r-z refit; −ve option = +ve option but newest unrefitted PATR and JHTL banks deleted at end

19 TP Tracks: 0 = omit, 1 = choose circle fit PATR bank if present, 2 = choose parabola fit PATR bank if present, −ve options = +ve options but all JHTL banks deleted at end except for latest.(Space saving option)

[1]Except MC PATR/12

[2]Flag value = max. no. of tracks used in calculation

5. What JCL is needed to use the TP program?

There are 2 standard jobs available on F22YAM.TPSOURCE, which is also the dataset with the TP source routines. The jobs execute the TP program in the form of a load module thus avoiding linking the routines every time. The simplest job is in member #RUNTP. If tapes are to be used for input and output, #RUNTPC is to better as it includes a step to copy the input data to temporary disk before the TP program is executed. If the load module has to be relinked, #LINKTP exists to do it.

It is recommended to check that your copies of the above JCL jobs are still up-to-date before you use them. This is because it is possible that library changes may necessitate alterations in the JCL statements from time to time.

6. The TP Program Structure.

The main program, in member @TPMAIN, calls s/r TPINIT to initialise the analysis packages and read the 'data cards'. Then an event is read using s/r EVREAD and processed by s/r TPSPRV and written out by s/r EVWRIT. (This is a simplified description as other routines are also called by the main program.) Some TP error messages may be printed but these should be self-explanatory. The actions of s/r TPSPRV are described in the following pages.

Title: Keep/Scratch Existing TP Banks

TP Flag 1: 1 ⇒ scratch, 0 ⇒ keep (see note)

Action: s/r TPSCRC called if TP flag 1 is non-zero. This deletes the TPEV bank and all the TPTR and TPVX banks.

Notes: Since partial TP updates cannot yet be done, it is essential that existing TP banks are deleted. To avoid mistakes, TP flag 1 is forced to be 1 and a warning message printed if the flag is set to another value. However it is the user's responsibility to set the correct flags to recreate the TP banks.

TP Error Messages: None.

Title: Jet Chamber Processing

TP Flag 2: Pattern recognition: 0 ⇒ no, 1 ⇒ yes if not done, −1 ⇒ yes, after deleting all PATR,[1] JHTL and ZVTX banks, 2 ⇒ add new PATR and JHTL banks.

TP Flag 14: JETC calibration: 0 ⇒ no, ≠ 0 ⇒ yes

TP Flag 16: z recalibration[2]: 0 ⇒ no, 1 ⇒ yes, 2 ⇒ yes plus PATR z refit.

TP Flag 17: Circle $r\phi$ refit: 0 ⇒ no, 1 ⇒ yes, −1 ⇒ yes[3]

TP Flag 18: Parabola $r\phi$ refit with vertex constraint: 0 ⇒ omit, 1 ⇒ without vertex, 2 ⇒ weak, 3 ⇒ strong; +10 ⇒ plus common rz fit; −ve options ⇒ +ve[3].

TP Flag 19: TP Tracks: 0 ⇒ omit, 1 ⇒ from circle fit PATR , 2 ⇒ from parabola fit PATR, −ve options ⇒ as for +ve plus only latest JHTL bank kept.

Action: s/r TPJETC is called. This calls s/r TPJTCA, if TP flag 14 is non-zero, to calibrate the Jet Chamber. S/r TPJTCA calls s/r JETCAL if no calibrated JETC bank exists, s/r JRECAL if it does. If TP flag 16 is positive, s/r ZSFIT is called to do z recalibration and optionally a PATR rz refit. Then s/r PATRCO is called according to TP flag 2 with prior deletion of banks if requested. Next there is an optional call to s/r RFEVFT[4] to perform a circle $r\phi$ refit, creating new PATR and JHTL banks. Then there is the optional call to s/r FITEVR[5] to perform a parabola $r\phi$ refit, creating new PATR and JHTL banks. If the current event is Monte Carlo, s/r MCTR4V is called to trace the origin of PATR tracks. If no ZVTX bank exists, s/r ZVERTF is called to find the 'fast' z vertex. The PATR banks are then re-arranged so that the bank with the chosen fit is the one with the lowest number. Finally the s/r TPPATR is called to create and fill TPTR banks for every charged track in the PATR bank with the lowest number except for those tracks determined to be continuations of other tracks.

TP Error Messages: None.

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[1] Except MC PATR/12

[2] No hit cleaning

[3] Newest unrefitted PATR bank and JHTL bank are deleted at the end of the step.

[4] See JADE Note 48

[5] JCN 61 needs updating

Title: Vertex Finding and Fine Momentum Determination

TP Flag 3: 0 ⇒ omit, 1 ⇒ coplanar analysis only, 2 ⇒ analysis for all event types

Action: Existing GVTX banks are first deleted. If TP flag 3 is set to 2, s/r TPVTXD is called to find the primary and secondary vertices and compute the momentum of the associated particles at those vertices. The Dittmann 3 dimensional vertex search is used. If the event is coplanar, s/r TPVTXD abandons the vertex search and s/r TPVTX1 and s/r TPVTX2 are called to handle these cases. They perform a 2 dimensional vertex search in the x-y plane. If TP flag 3 is set to 1, these two subroutines are called immediately without calling s/r TPVTXD. In both cases, TPVX banks are created and filled for each vertex found.

TP Error Messages: Three error messages are possible from TP routines in this step. In addition there may be printout from the Dittmann routines if errors are found. Recovery action is taken.

- `**** Error in TPVTX1 ****` Vertex calculation does not converge
- `**** Error in TPVTX1 ****` No. of charged tracks (NTRK) exceeded 128
- `**** Error in TPVTX2 ****` No. of charged tracks (NTRK) exceeded 128

Title: TOF Analysis

TP Flag 4: $0 \Rightarrow$ omit, $\neq 0 \Rightarrow$ do analysis

Action: s/r TOFINT called if TP flag 4 is non-zero. This creates a TOFR bank if an ATOF bank exists.

TP Error Messages: No TP error messages are produced in this step but error messages may be printed by s/r TOFINT including a short bank dump. Recovery action is taken.

Title: Put TOF results into TP banks

TP Flag 5: 0 ⇒ omit, 1 ⇒ store results, −1 ⇒ as for 1 & delete TOFR bank

Action: s/r TPTOF called if TP flag 5 is non-zero. The most important TOF results are copied from the TOFR bank (if present) to the appropriate TPTR track summary banks. If TP flag 5 is set to −1 then the TOFR bank is deleted at the end of the step.

TP Error Messages: Two error messages are possible from the TP routine in this step. Recovery action is taken.

- **** Error in TPTOF **** Invalid inner detector track index found
- **** Error in TPTOF **** 'TOFR' bank is missing

Title: dE/dx Analysis and TP Summary

TP Flag 6: 0 ⇒ omit, ≠ 0 ⇒ do analysis & TP

Action: s/r DEDXAN called if TP flag 6 is non-zero. This first calls for inner detector z recalibration and hit cleaning without altering the PATR bank (ZSFIT(3)). Then DEDXBN is called to do the dE/dx analysis (see JCN 71). Finally the results are placed in the appropriate TPTR track summary banks.

TP Error Messages: No TP error messages are produced in this step but error messages may be printed from s/r ERRMON called by s/r DEDXBN. These indicate a rare error in the PATR bank which has not been tracked down and corrected yet. They can usually be ignored.

Title: LG Energy Cluster Finding

TP Flag 7: 0 ⇒ omit, 1 ⇒ do analysis if not done, −1 ⇒ delete old results and re-analyse

Action: s/r LGCALB (if needed) and s/r LGANAL are called if TP flag 7 is non-zero. LGCALB calibrates the ALGL bank to produce an ALGN bank if this is not already existing. LGANAL searches for clusters of electromagnetic energy deposited in the lead glass blocks (see JCN 14c). The results are stored in the LG cluster bank, LGCL.

TP Error Messages: None.

Title: LG Clusters Matched to I.D. Tracks

TP Flag 8: $0 \Rightarrow$ omit, $\neq 0 \Rightarrow$ carry out step

Action: s/r LGCDIR is called if TP flag 8 is non-zero. This performs energy corrections to the clusters, determines the cluster directions and associates clusters to inner detector tracks by impact position. Unassociated clusters are assumed to be photons.

TP Error Messages: No TP error messages are printed in this step but an error message from s/r ILCTRC about tracks being out of the Jet Chamber is not uncommon. This is due to a 'harmless' but annoying bug in PATREC for some tracks which leave the Jet Chamber through the end walls.[1]

[1]If a track has a hit associated, by chance, at a radius greater than the exit point of the track, it is often kept. When the r-z fit is done, the z position of this hit is ignored but the stored end point of the track is taken from the radial position of this hit and its predicted z by extrapolation, which puts it outside the chamber.

Title: LG Cluster Data Stored in TP Banks

TP Flag 9: 0 ⇒ omit. ≠ 0 ⇒ carry out step

Action: s/r TPLGCL is called if TP flag 9 is non-zero. Information from the LGCL bank (if present) is used to modify the TPTR banks for charged tracks and a new TPTR bank is created and filled for each photon cluster. The photons are assumed to originate from the primary vertex so the photon TPTR bank numbers are added to the TPVX/1 bank.

Notes: The first photon TPTR bank has the number following sequentially after the last TPTR charged track bank. If the TPTR bank for a photon already exists, then Step 9 terminates prematurely. This can lead to later error messages about missing TPVX banks.

TP Error Messages: There is only one TP error message, which could indicate that Step 3 was not done.

```
 **** Error in TPLGCL **** , 'TPVX/1' bank is missing
```

Warning: Step 9 requires that Step 8 is called in the same job since /CWORK/ is used to pass certain data values between the steps. If Step 9 is requested then Step 8 will be forced to be done.

Title: Muon Analysis

TP Flag 10: 0 ⇒ omit, 1 ⇒ do analysis if not done, −1 ⇒ delete old results and re-analyse

Action: If TP flag 10 is set to −1 or either of the 2 banks MUR1/0 or MUR2/0 is missing, all MUR1 and MUR2 banks are deleted. Then s/r MUANA is called to carry out muon finding using as input the PATR and MUEV banks (see JCN 22). The output banks are MUR1 and MUR2 (two of the former, 7 of the latter).

TP Error Messages: None but there may error messages from the muon routines, particularly s/r MUCOOR. These are explained in a short table printed out during processing of the first event. A summary of errors and statistics is printed at the end of the job before the TP histogram printout.

Title: +++ Unused +++

TP Flag 11: reserved for future use

Action: None.

TP Error Messages: None.

Title: Store the Muon Results Summary

TP Flag 12: 0 ⇒ omit, 1 ⇒ store results, −1 ⇒ +1 but MUR2/4,5,6 deleted at end, −2 ⇒ −1 but MUR2/2,3 deleted as well.

Action: s/r TPMUR is called if TP flag 12 is non-zero. This copies muon analysis information from the MUR2/1 bank to the TPTR summary banks. At the end of the step, some MUR2 banks are deleted if requested by TP flag 12 in order to save space. These are essential for graphical display purposes though so it is not advisable to delete them if muon results scanning is to occur later.

TP Error Messages: None.

Title: Tagging System Analysis and TP Summary

TP Flag 13: 0 ⇒ omit, > 0 ⇒ do if not done, < 0 ⇒ delete and re-analyse

Action: If ACLS/0 and TAGG banks 0 to 2 are present and TP flag 13 is positive, s/r TPFOWD is called to add new TPTR banks for each found tagging cluster. If any of the above banks are missing or TP flag 13 is negative, all the above banks are deleted and s/r TAGAN is called to analyse the Tagging Detector and then s/r TPFOWD is called.

TP Error Messages: None but error messages may be printed by the tagging analysis routines, possibly accompanied by a short dump.

Title: TP Mass Assignment, Decays and V^0 Finding

Action: s/r TPMASS is called to identify as best as possible the particles in the event. A mass code is written into every TPTR bank even if it is 0 (= unknown type). In addition a mass value is also stored, which is that of a pion for unidentified particles for the purposes of calculating total energies, etc. Decaying tracks in the Jet Chamber are searched for by s/r TPCH2V and converted photons and V^0 particles are searched for by s/r TPVEE. If any are found, additional TPTR banks and TPVX banks are created. Finally s/r TPTCNT is called to count the number of tracks found and update the event summary bank TPEV.

TP Error Messages: There are two TP error message, the first of which could indicate that Step 3 was not done and the second, that Step 9 ended prematurely.

- `**** Error in TPCH2V ****  'TPVX/1' bank is missing`
- `**** Error in TPTCNT ****  'TPVX/I' bank is missing`

Title: Event Shape Calculations

TP Flag 15: 0 ⇒ sphericity only. > 0 ⇒ thrust as well (see below).

Action: s/r TPGNRL is called to compute the event momentum tensor eigenvectors and eigenvalues Q_i (related to sphericity). Note that the sum of the eigenvalues is normalised to 3. If TP flag 15 is positive, then thrust is also calculated using the value of TP flag 15 as the maximum number of particles to be used in the calculation.

- tracks / photons ?

TP Error Messages: Three TP error messages are possible from this step.

- `**** Error in TPGNRL ****` 'TPVX'/I bank is missing
- `**** Error in TPGNRL ****` 'TPTR'/I bank is missing although ...
- `**** Error in TPGNRL ****` Momentum buffer overflow

Title: Finalise the TPVX/1 Bank

Action: s/r TPBNKS is called to cut the tail of the TPVX/1 bank. For the first event only, a list of banks that will be output is printed using s/r EVBKPR.

TP Error Messages: There is one TP error message possible from this step, originating from a BOS error return.

- **** Error in TPBNKS **** Error return from BOS routine BCHM