deposit in the HAC section is required to be less than 1GeV, as determined by studies on Monte Carlo and real data.

In summary, the trigger signature of elastic $J/\psi \to e^+e^-$ was two tracks in the CTD, at least 2GeV energy deposit in the EMC section and less than 1GeV energy deposit in the HAC section. In the actual implementation, modifications were made to accommodate energy resolution, errors in track counting, and the peculiar scheme of the EMC and HAC segmentation in the CAL-FLT readout electronics.

Since track-cluster matching as well as track and cluster data were available at the TLT, albeit not well-tested, a more sophisticated TLT subtrigger based on lepton identification was also developed for J/ψ acceptance.

4.2 Global first level trigger

For $J/\psi \to e^+e^-$, the relevant component FLT data were from the CAL-FLT, CTD-FLT, the Veto Wall and C5. The Veto Wall and C5 FLT data were used to reject the proton beam halo and beam-gas background. The CTD-FLT provided the number of tracks in the first superlayer and a track quality indicator. The CAL-FLT provided regional energy sums. In the CAL-FLT, the CAL was divided into 16 regions, each containing 56 trigger towers. The CTD-FLT was designed to be segmented into 32 stereo angle regions. The matching between the CAL and the CTD subregions was implemented in design but was not available in 1993.

The EMC and HAC segmentation was partially implemented in the CAL-FLT readout electronics. Available energy sums(relevant to the J/ψ subtrigger) from the CAL-FLT were:[55,56]

- CAL_EEMC: energy in the EMC section of the CAL excluding the towers adjacent to the rear beampipe and the towers in the first three square rings around the forward beampipe. Digitization step $\Delta E =$ 0.196GeV.

Table 7: GFLT $J/\psi \to e^+e^-$ subtrigger logic

GFLT $J/\psi \to e^+e^-$ subtrigger
C5 .AND. VW_inner
TRK_mult $= 1, 2, 3$ .AND. TRK_qual $= 2, 3$
FCAL_bp$<$ 3.75GeV .AND. CAL_EMC $\geq$ 0.66GeV
CAL_E $\geq$ 2.0GeV .OR. FCAL_out$\geq$ 2.5GeV

- CAL_E: energy in the CAL excluding the towers adjacent to the rear beampipe and the towers in the first three square rings around the forward beampipe. $\Delta E = 0.196$GeV.
- FCAL_Ebp: energy in the towers adjacent to the forward beampipe. $\Delta E = 1.25$GeV.
- FCAL_Outer: energy in the second and third square rings around the forward beampipe.$\Delta E = 1.25$GeV.

The energy digitization was calculated within a trigger tower. An EMC or a HAC energy of a trigger tower was required to be over 0.464 GeV to be included in energy sums. Monte Carlo studies and online tests lead to the finalization of the logic of the GFLT $J/\psi \to e^+e^-$ subtrigger as listed in Table 7.[57]

In the table, VW_inner is the Veto Wall hits on the inner side of the iron wall. TRK_qual is a four-value(0-3) track quality indicator, with 2 and 3 corresponding to "good" and "very good" quality. Summation of CAL_E and FCAL_Outer would provide energy deposit in the CAL excluding the towers adjacent to the forward and rear beampipes. However, these two quantities were digitized with different energy scales so summing was not possible at the GFLT. Therefore, summation was implemented as a logical OR of two conditions.

In order to evaluate the subtrigger's acceptance to the signal events and reduction of background events, signal and background data were passed through the GFLT simulation. For the signal data, Monte Carlo elastic $J/\psi \to e^+e^-$ events were used(the detector simulation was done by MOZART). For background data,

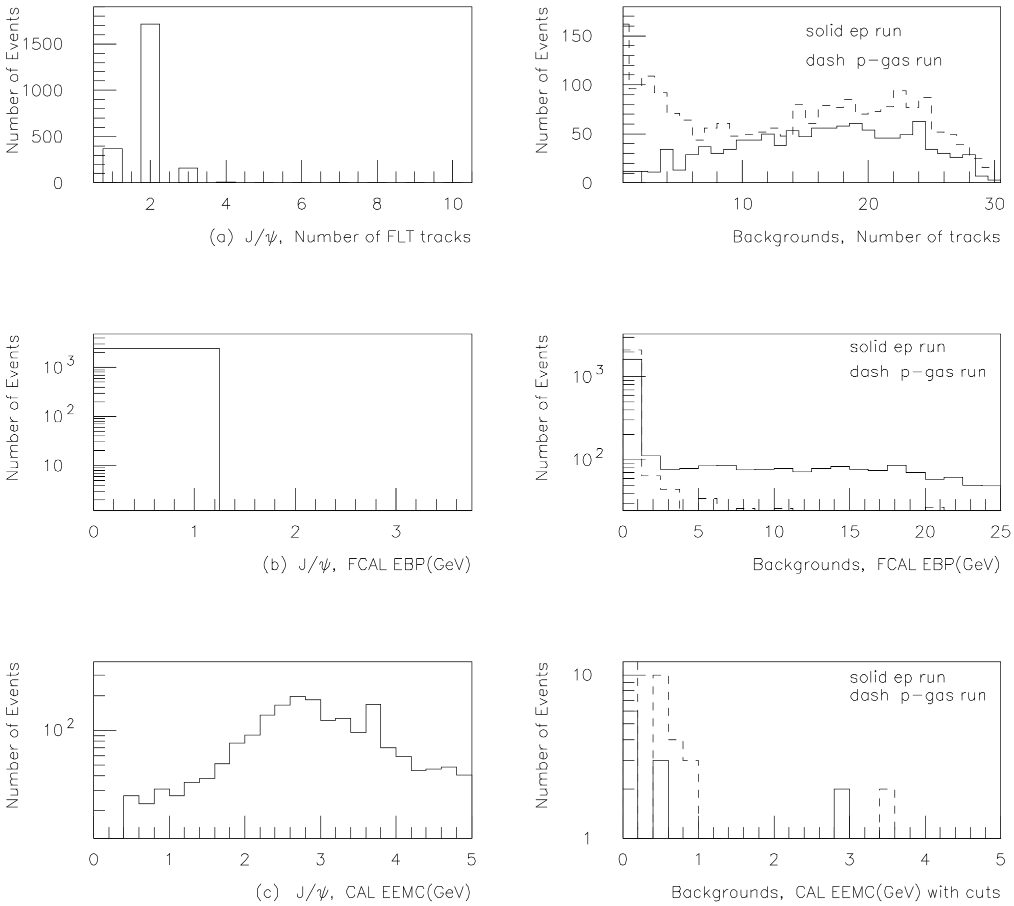

Figure 23: Comparison of the J/ψ signal and background at the GFLT.
Leftside: the visible MC J/ψ signals (generated within the CTD coverage $10^\circ < \theta < 170^\circ$).
Rightside: the real data taken from an *ep* run and a p-gas run before implementation of the J/ψ triggers.
(a) Number of good tracks found by the CTD-FLT.
Trigger cut: number of good tracks = 1,2,3.
(b) Energy deposition in the towers adjacent to the FCAL beampipe.
Trigger cut: FCAL_Ebp < 3.75GeV(3 ADC counts).
(c) CAL_EMC histogram for events which have survived above cuts. Trigger cut: CAL_EEMC > 0.660GeV(3 ADC counts).

real events taken from an ep physics run and a proton beam-gas run before implementation of the J/ψ triggers were used. Effects of the GFLT $J/\psi \to e^+e^-$ trigger cuts on the J/ψ signal and background are shown in Figure 23 and Figure 24. Since the trigger can only accept events within the geometrical coverage of the CTD, a cut on the polar angles of the tracks was applied to the MC J/ψ events.

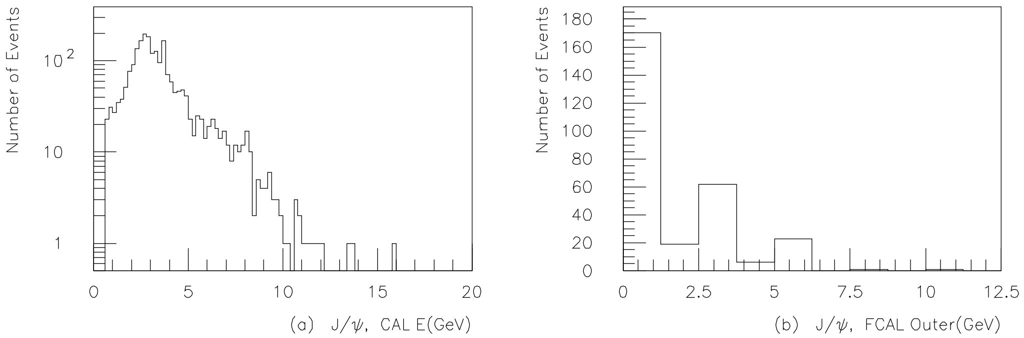

Figure 24: $J/\psi \to e^+e^-$ energy as measured by the CAL-FLT.
(a) CAL_E for events which have passed all cuts in Figure 23.
Trigger cut: CAL_E $\geq$ 2.0GeV *OR* FCAL_Out $\geq$2.5 GeV.
(b) FCAL_Out for events which have passed all cuts in Figure 23 and have CAL_E $<$ 2.0GeV. FCAL_Out $\geq$2.5 GeV logic helps to pick up some events missed by CAL_E $\geq$ 2.0GeV logic.