1 Benefits of STT for $t\bar{t}$ Events

To study the benefits of the STT for the selection of $t\bar{t}$ events, two samples of events generated by ISAJET and processed with the FEB97 version of UPG_GEANT were used:

- a sample of 2126 events in which both W's decay into hadrons, denoted as $t\bar{t} \rightarrow$ *all jets*;
- a sample of 1175 events in which one of the W's is forced to decay into a muon+neutrino final state, and denoted as $t\bar{t} \rightarrow \mu + jets$.

The procedure used to analyze the $t\bar{t}$ events was similar to other studies. First, the STT tracks with reduced $\chi^2 > 4$ were refitted after having dropped the SVX hit giving the largest contribution to the χ^2. Next, quality cuts were applied to remove badly reconstructed tracks: the track fit reduced χ^2 must be lower than 4 and the track be associated with hits in at least 3 layers of the SMT. Finally, the error on the impact parameter of each track, σ_b, was estimated using equation () and the impact parameter significance, $S_b = b/\sigma_b$, was computed. For tracks coming from the primary vertex, the distribution of impact parameter significance is satisfactorily described by a Gaussian with a width of 1.2. Non–Gaussian tails are present due to the high multiplicity of tracks in $t\bar{t}$ events.

To demonstrate the usefulness of the STT, we start by selecting events with a pure calorimeter trigger, asking for at least 2 jets with $E_T > 7$ GeV at L1 and $E_T > 20$ GeV at L2 (JET2MED). This trigger gives combined L1 and L2 efficiencies of 98.3% and 88.3% for $t\bar{t} \rightarrow$ *all jets* and $t\bar{t} \rightarrow \mu + jets$ events, respectively. The background rate for this trigger is 186 Hz at L1 and 85.2 Hz at L2. We then demand the presence of a given number of STT tracks with an absolute impact parameter significance greater than a given threshold S_{min}.

The evolution of the STT efficiency relative to the JET2MED efficiency is shown in Fig. 1 for the $t\bar{t} \rightarrow$ *all jets* sample. Very similar results were obtained for the $t\bar{t} \rightarrow \mu + jets$ events. About 8% of the events are lost when requiring at least 1 STT track due to the limited acceptance of the SMT along the z axis. Efficiency well above 80% is obtained when requiring only one track with a large impact parameter significance.

The reduction of the background rate relative to JET2MED due to the STT is illustrated in Fig. 2. It shows that the trigger rate can be reduced by a factor of ~ 2 when requiring at least 1 track with a significance greater than 3. A reduction factor of 4 is reached when at least 2 tracks with $\mid S_B \mid > 3$ are requested. The $t\bar{t} \rightarrow$ *all jets* trigger efficiencies corresponding to these two criteria are 86.9% and 77.7%, respectively.

A 30 μm uncertainty on the primary vertex position leads to a 5% reduction of the signal efficiency for a fixed JET2MED background rate of 20 Hz. A systematic shift of the primary vertex position in the transversal plane limited to 100 μm does not introduce a signal efficiency loss as long as the STT criterium is adapted to maintain the background rate at a constant level.

The background rates and signal efficiencies obtained for various trigger configurations with and without STT are compiled in Table 1. The STT criterium consists in requiring at least two tracks with $\mid S_B \mid > 2.5$. The definition of the various triggers used in that table is given in Appendix A. In the top part of this table, the rate and efficiency for each of the 6 base triggers is listed separately. In the middle part of the table, these individual triggers are logically ORed together and the STT criterium is applied to each event. Finally, the bottom part corresponds to special combinations where the STT criterium is applied to the events only selected by at least one of the triggers numbered 4 to 6. The combination $\Sigma\,(1 \rightarrow 3)$ based on calorimeter-only triggers gives efficiencies of 86% and 96.2% for the signal samples with a background rate of 7.2 Hz at L2. To reach efficiencies close to 100% for both the $t\bar{t} \rightarrow \mu + jets$ and $t\bar{t} \rightarrow$ *all jets* events, it is necessary to use a combination of 5 or 6 of the base triggers but the corresponding background rates increase to about 110 Hz. The trigger combination $\Sigma\,(1 \rightarrow 3) + \Sigma(4 \rightarrow 6) \times STT$ allows then a reduction by a factor 3 of this background rate without significantly affecting the signal efficiencies. This combination allows to reach better signal efficiencies than the combination $\Sigma\,(1 \rightarrow 3)$ while keeping background rates well below 100 Hz.

Table 1: Background rates and $t\bar{t}$ trigger efficiencies

	Background (Hz)		$t\bar{t} \rightarrow \mu + jets$ (%)		$t\bar{t} \rightarrow$ *all jets* (%)	
Trigger	L2	L2+STT	L2	L2+STT	L2	L2+STT
1–JMULT	2.1	0.8	27.4	22.3	69.8	58.5
2–MJTMET	3.3	1.0	68.5	55.1	48.7	38.6
3–JMAX	13.0	6.3	68.3	55.7	84.2	69.7
4–MUJET	41.6	8.1	74.3	58.5	53.2	42.4
5–JET2MED	85.2	24.2	88.3	70.9	98.3	80.2
6–MUMAX	6.5	3.4	51.6	42.0	14.3	10.9
7–$\Sigma\,(1 \rightarrow 3)$	17.2	7.2	86.0	69.1	96.2	78.3
8–$\Sigma\,(1 \rightarrow 5)$	113	28.5	96.1	76.0	99.8	81.1
9–$\Sigma\,(1 \rightarrow 6)$	118	31.3	97.2	76.8	99.8	81.1
10–$\Sigma\,(1 \rightarrow 3)+$ $\Sigma(4 \rightarrow 5) \times STT$	113	38.5	96.1	92.9	99.8	98.6
11–$\Sigma\,(1 \rightarrow 3)+$ $\Sigma(4 \rightarrow 6) \times STT$	118	41.3	97.2	93.7	99.8	98.6

Appendix A: Trigger Definition

The definition of the various triggers used in this analysis is the following:

- **JET2MED**
  - L1: at least 2 jets with $E_T \geq 7$ GeV
  - L2: at least 2 jets with $E_T \geq 20$ GeV
- **JMULT**
  - L1: at least 4 jets with $E_T > 5$ GeV
  - L2: at least 4 jets with $E_T > 15$ GeV
- **MJTMET**
  - L1: at least 3 jets with $E_T > 5$ GeV and $\not{E}_T \geq 10$ GeV
  - L2: at least 3 jets with $E_T > 10$ GeV and $\not{E}_T \geq 20$ GeV
- **JMAX**
  - L1: at least 4 jets with $E_T > 5$ GeV
  - L2: at least 1 jet with $E_T > 45$ GeV
- **MUJET**
  - L1: at least 1 μ with $p_T^\mu \geq 1.5$ GeV/c and 2 jets with $E_T > 5$ GeV
  - L2: 1 jet with $E_T > 20$ GeV and 1 jet with $E_T > 10$ GeV
- **MUMAX**
  - L1: at least 1 μ with $p_T^\mu \geq 6$ GeV/c
  - L2: at least 2 CFT tracks with $p_T \geq 6$ GeV/c

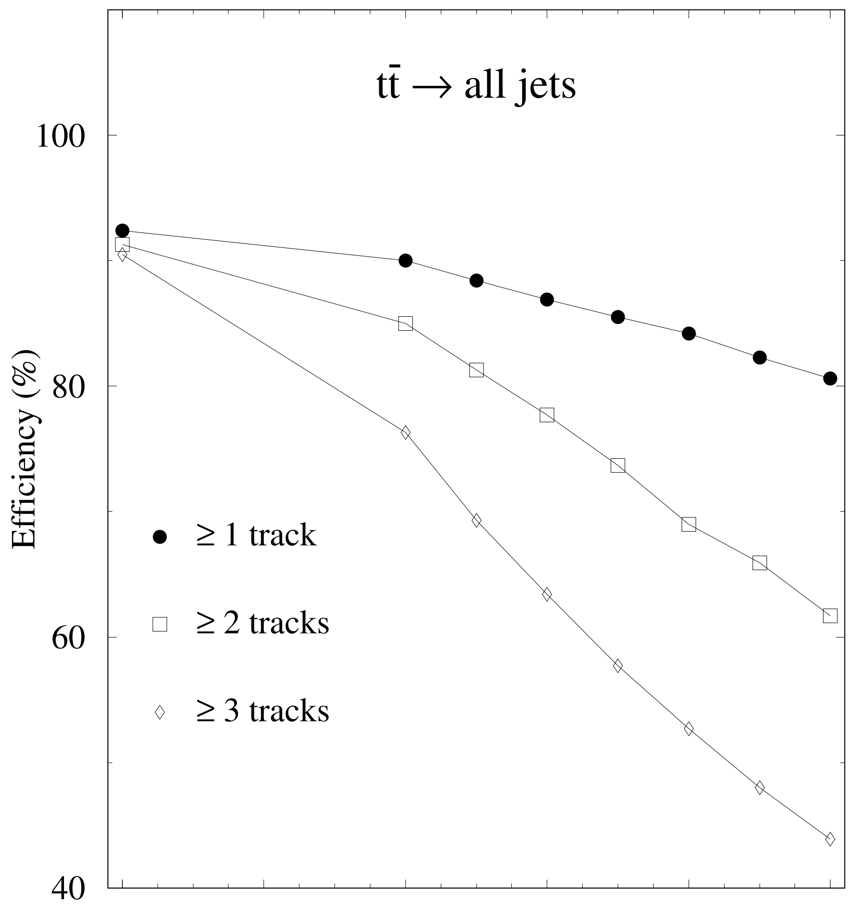

Figure 1: STT efficiency for $t\bar{t} \to$ *all jets* events.

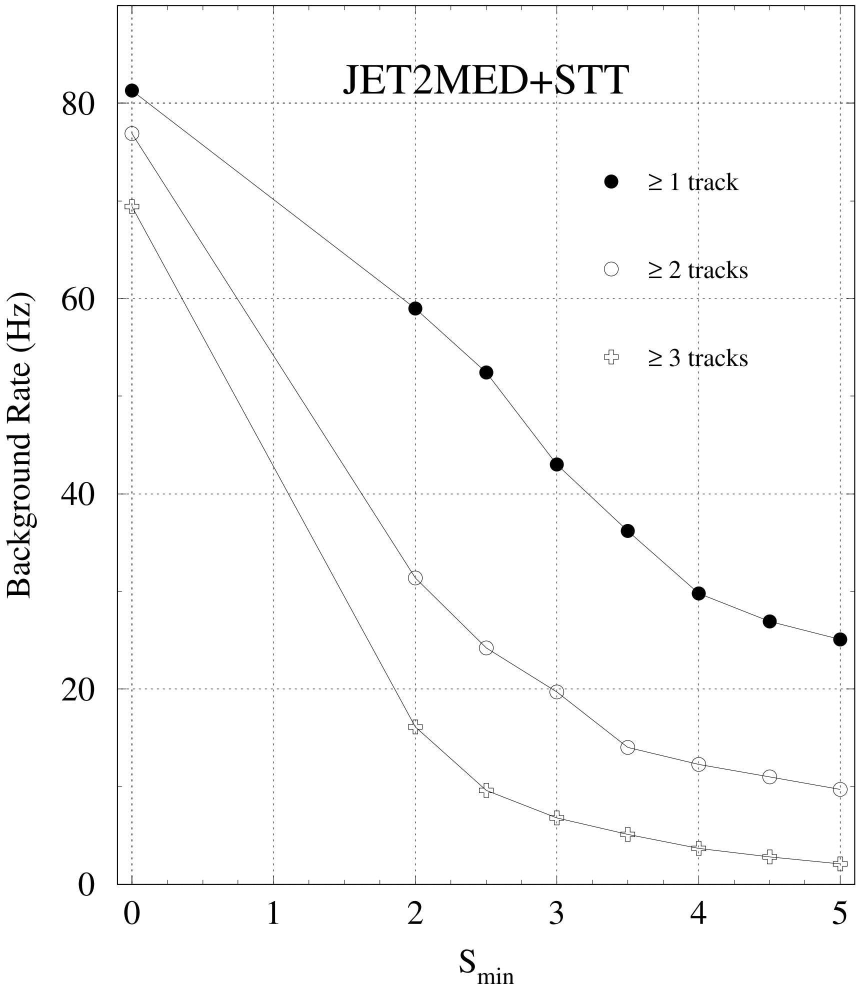

Figure 2: QCD background rate for the events satisfying the L2 JET2MED trigger together with a STT trigger.