

9th Topical Seminar on Innovative Particle and Radiation
Detectors- 23-26 May 2004 Siena, Italy

GLAST LAT tracker signal simulation and trigger timing study

Monica Brigida
for the Italian Glast LAT Collaboration
(presented by F. Loparco)

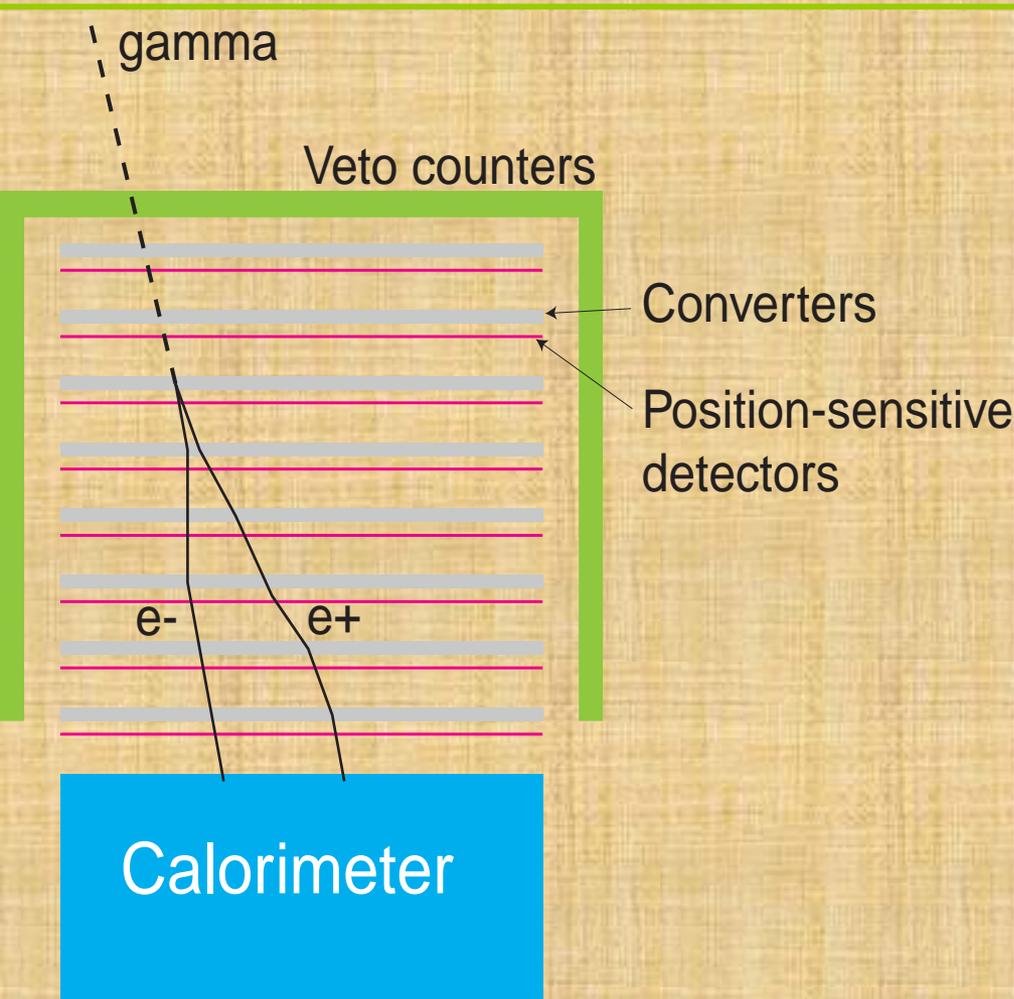
monica.brigida@ba.infn.it
Phys. Dep. of Bari University & INFN
Via Orabona, 4
70126 Bari - Italy

OUTLINE

- The *Glast* LAT tracker system
- The digital signal read-out simulation
- Timing study: hit capture efficiency
- Conclusions

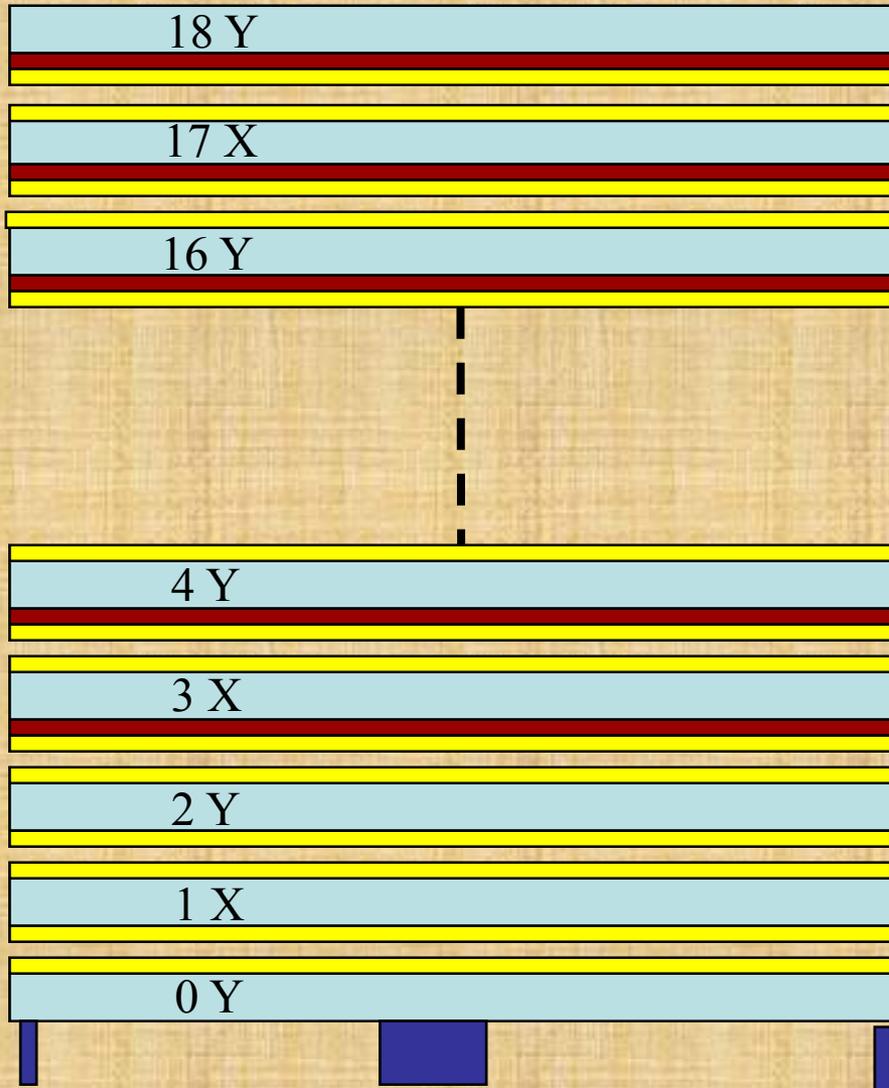
LAT Tracker system

$$\gamma \rightarrow e^+ e^-$$



- **Si-strip Tracker (TKR)**
19 tracking planes. Single-sided silicon strip detectors + W.
Measure the photon direction; gamma ID.
- **CsI Calorimeter (CAL)**
Array of CsI(Tl) crystals
Measure the photon energy; image the shower.
- **Anticoincidence Detector (ACD)**
Plastic scintillator tiles.
Reject background of charged cosmic rays; segmentation removes self-veto effects at high energy.

Tracker Tray Configuration



➤ 16 "towers" (36cm × 36cm)

➤ 83m² of Si

➤ 11500 SSDs, 1M channels

➤ 18 *x,y* layers per tower

➤ 19 "trays"

➤ 12 with 3% X_0 ("Front")

➤ 4 with 18% X_0 ("Back")

➤ 3 no converter

➤ Total length: 1.5 X_0

➤ SSDs (Silicon Strip Detectors)

➤ Wafer thickness 400 μm

➤ Wafer Area 8.96 × 8.96 cm²

➤ Strip pitch 228 μm

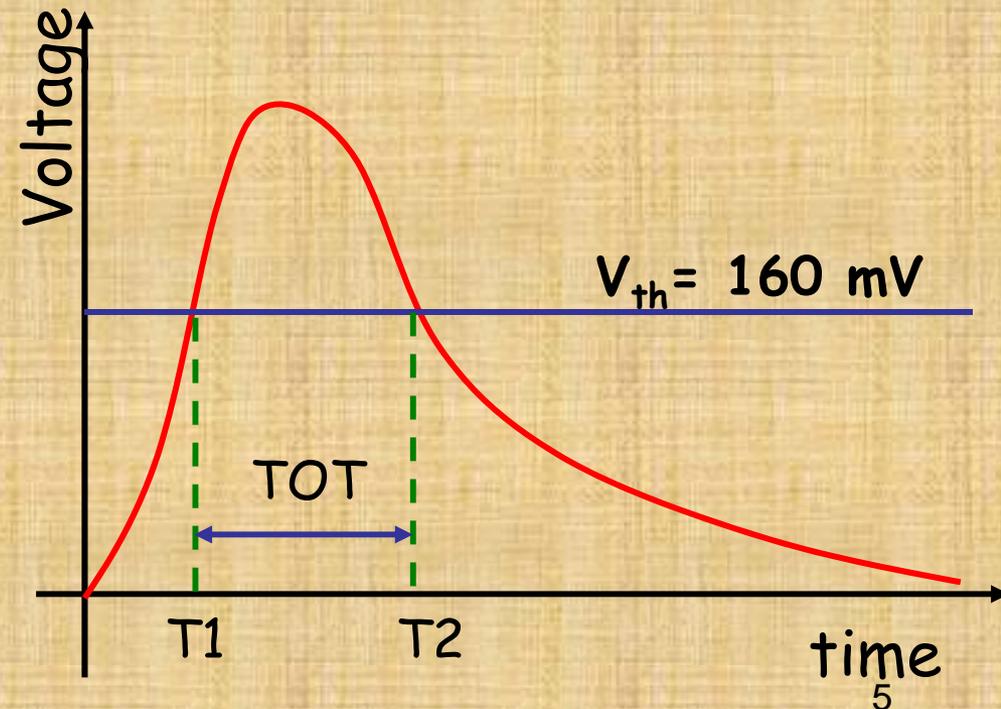
➤ Strip width 64 μm

LAT Tracker digital signal read-out

- The electronics chain consists of charge preamplifier, shaper and comparator
- The front-end electronics has been designed to evaluate the charge collected by the strips from the Time-over-Threshold (ToT).

- **Digital Output:**
 - IDs of fired strips
 - ToT per layer (i.e. ORing per layer)

$$\text{ToT} \approx 1.6 \mu\text{s}/\text{fC}$$



G4 LAT simulation
(see previous talk)



INPUT:
• Input and exit point
• Energy loss



Clusters generation



CLUSTER PROPAGATION:
• e-h motion
• Induced current signal



ELECTRONICS:
• NOISE
• Voltage signal evaluation



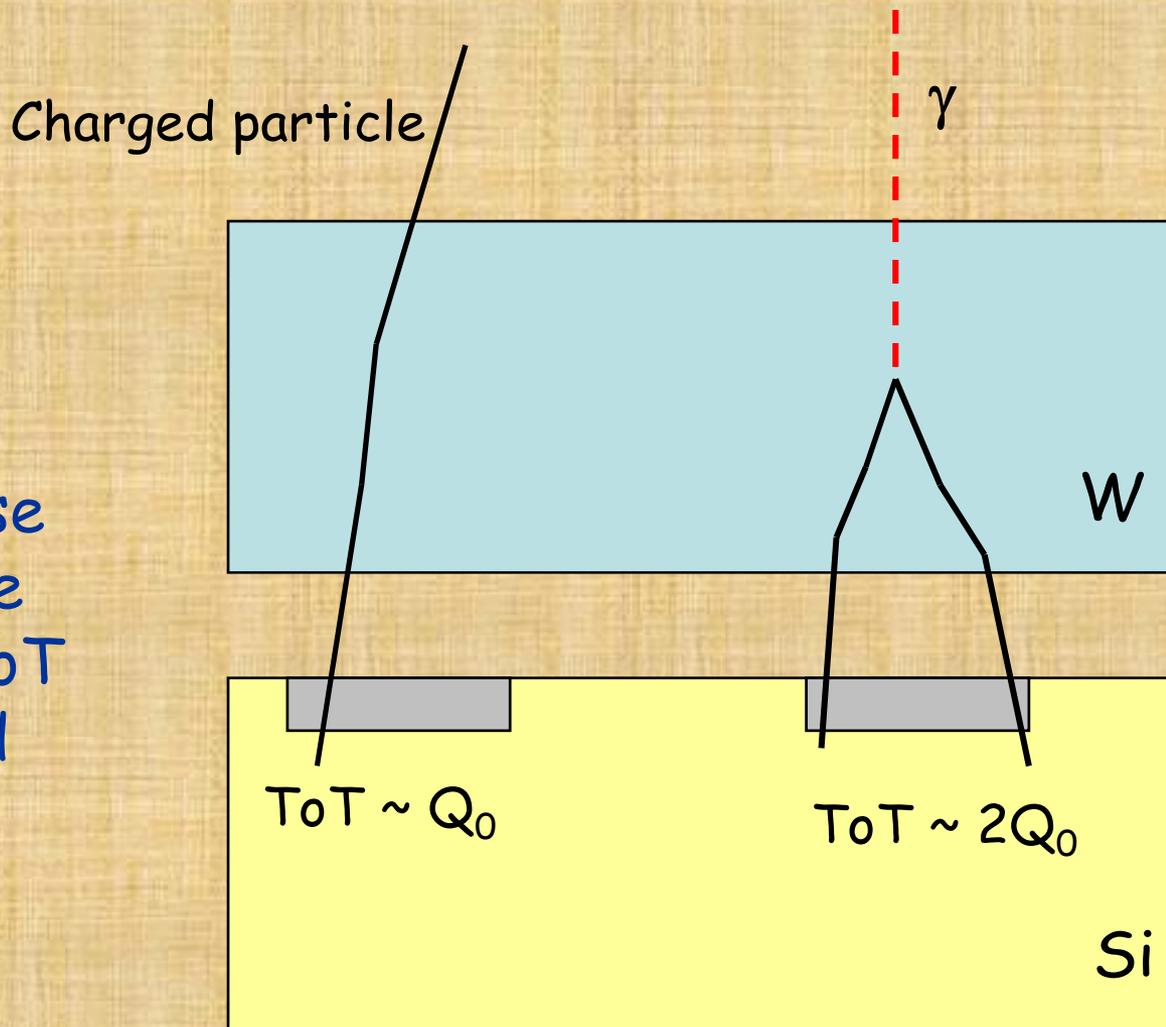
OUTPUT:
• Fired strips list, per layer
• TOT per layer

TKR DIGIT

simulation chain:

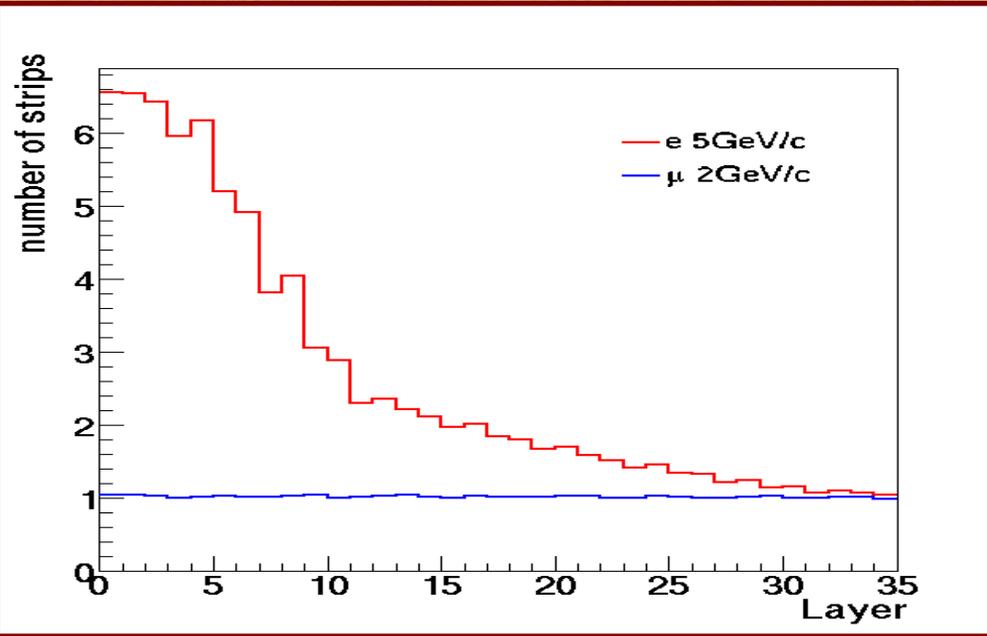
we use a simplified version of
a full SSD signal simulation
(see F.Loparco talk)

ToT for γ and charged particles



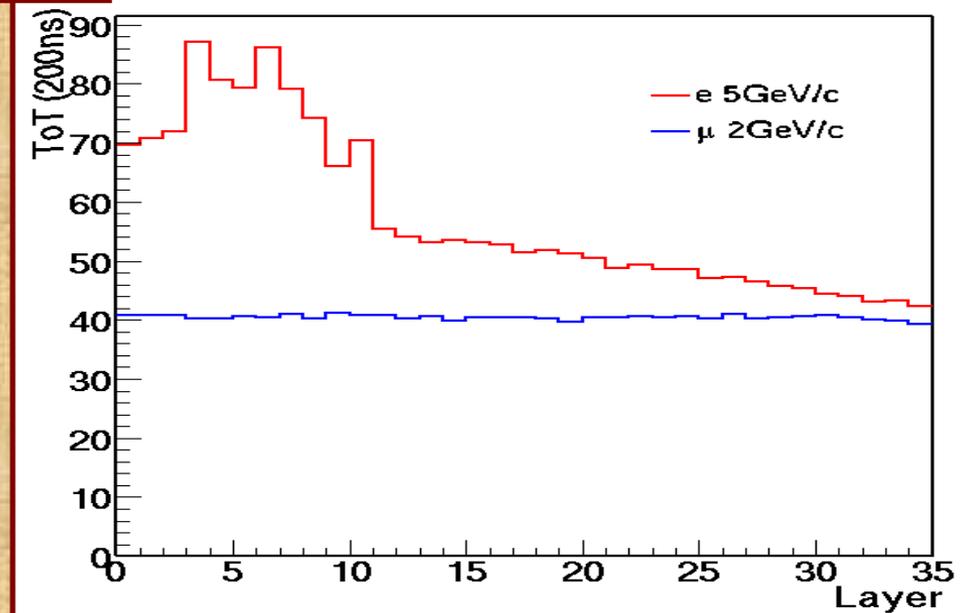
If electron and positron from γ conversion release charge on a single strip, a double ToT value is expected

Multiplicity and ToT for layers

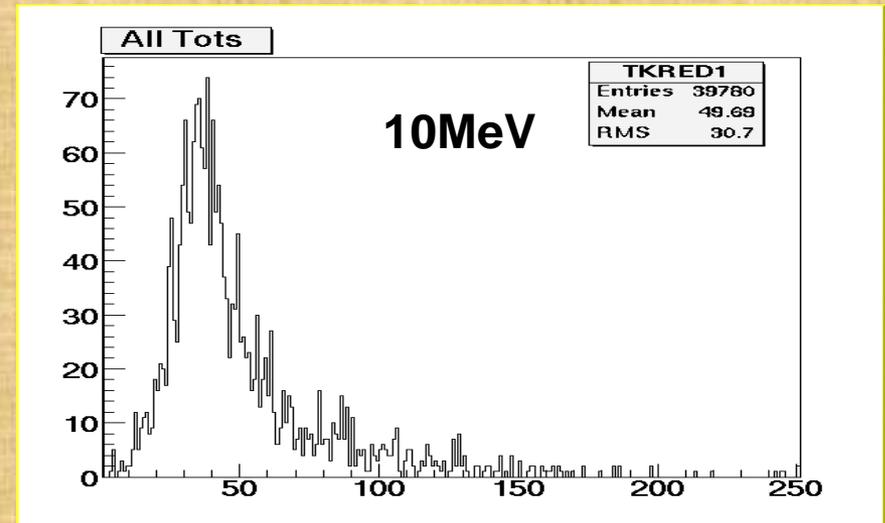
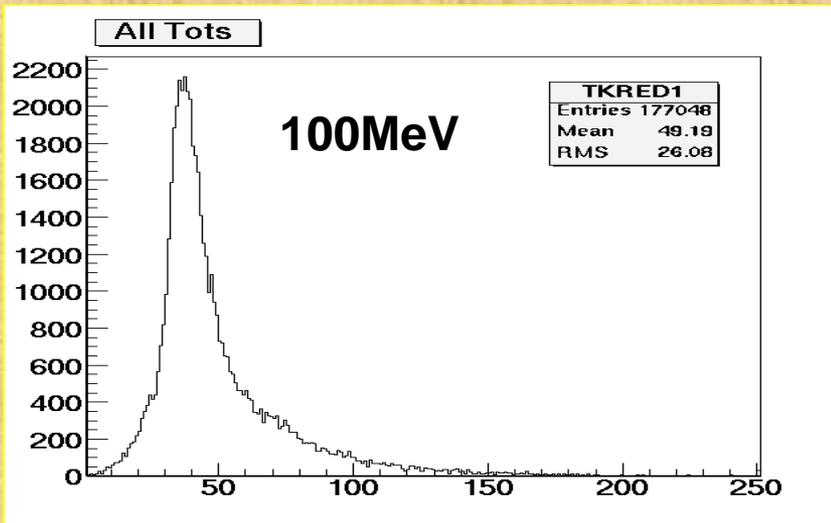
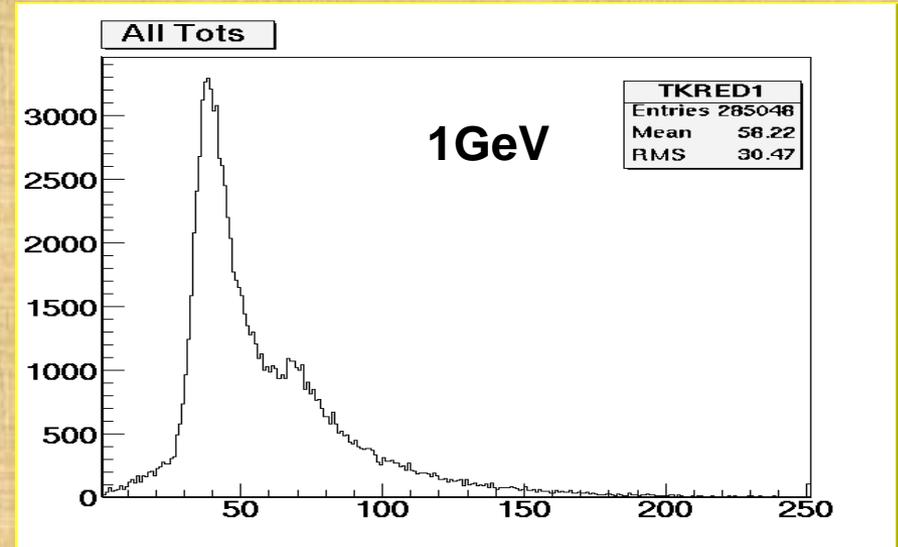
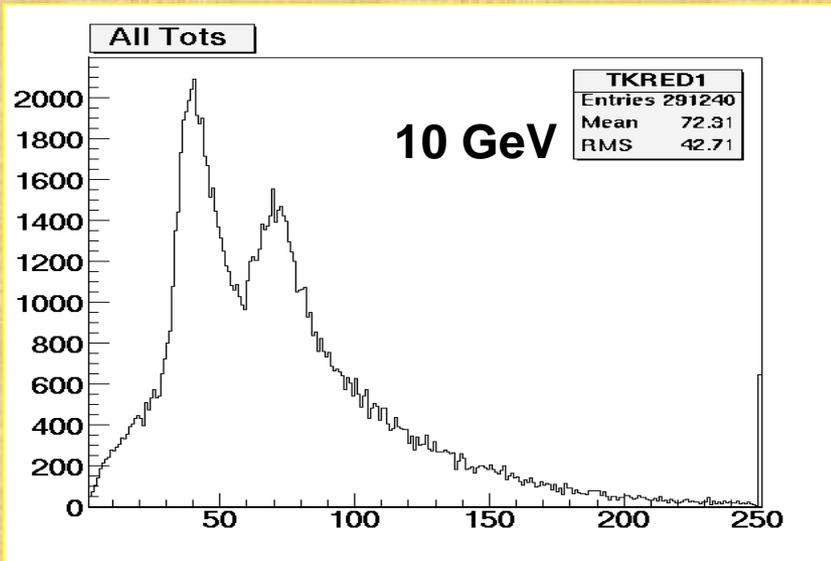


Average strip
multiplicity per layer

Average ToT per layer

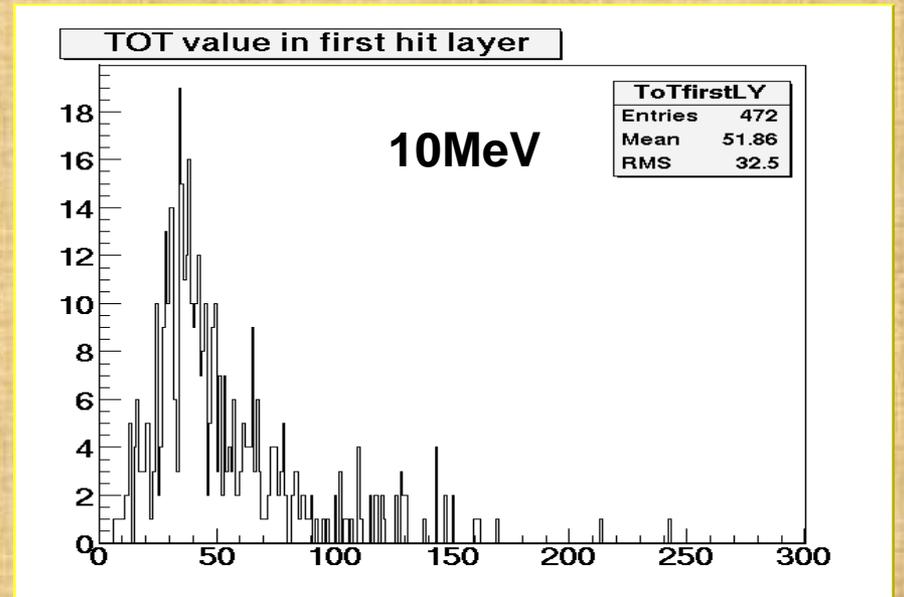
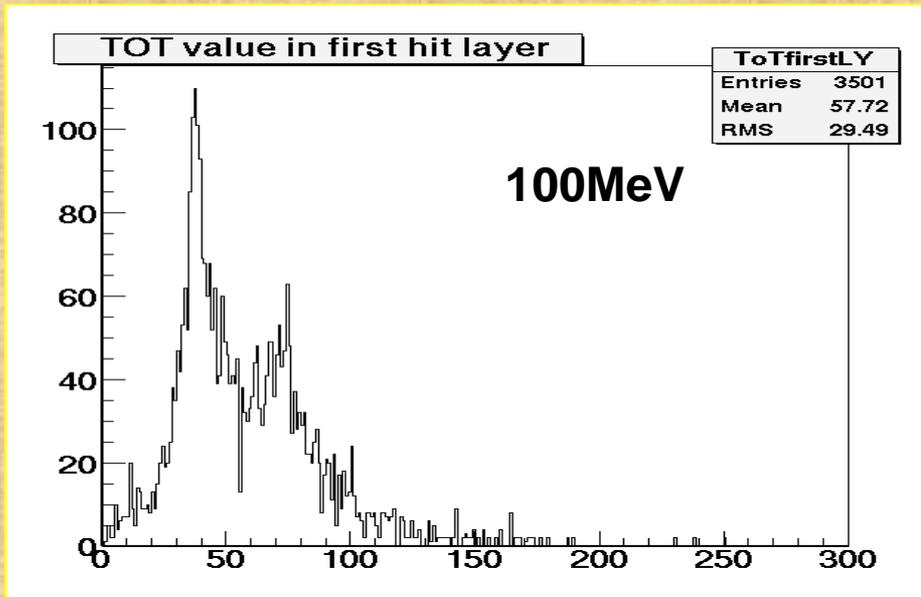
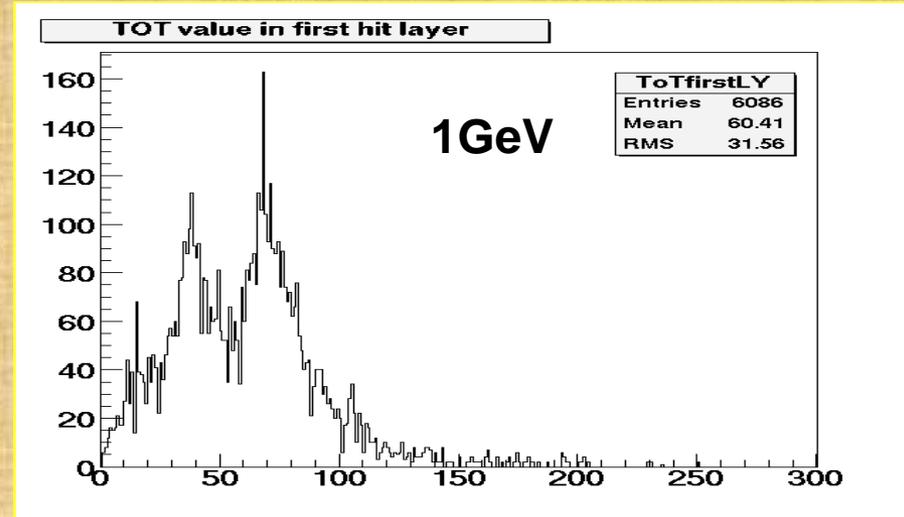
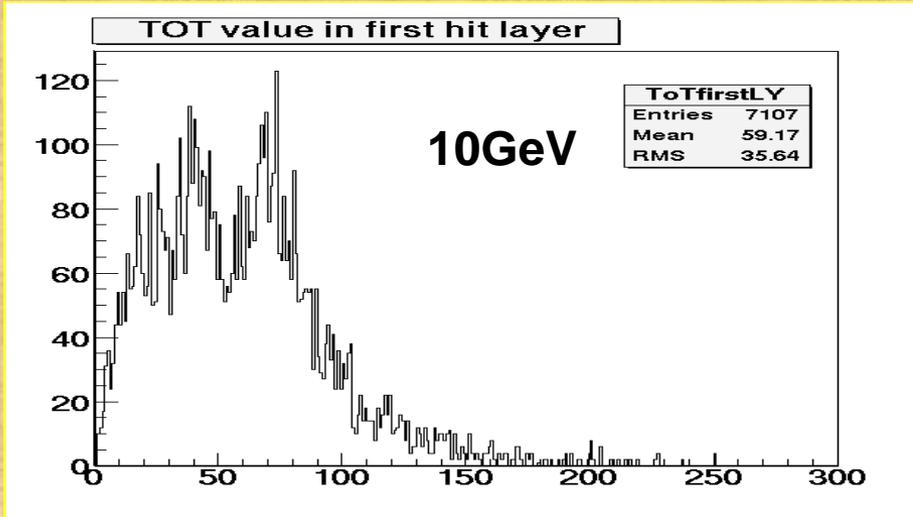


ToT distribution for γ -rays



ToT (200ns step)

ToT distribution for γ -rays



ToT (200ns step)

TKR L1 trigger simulation

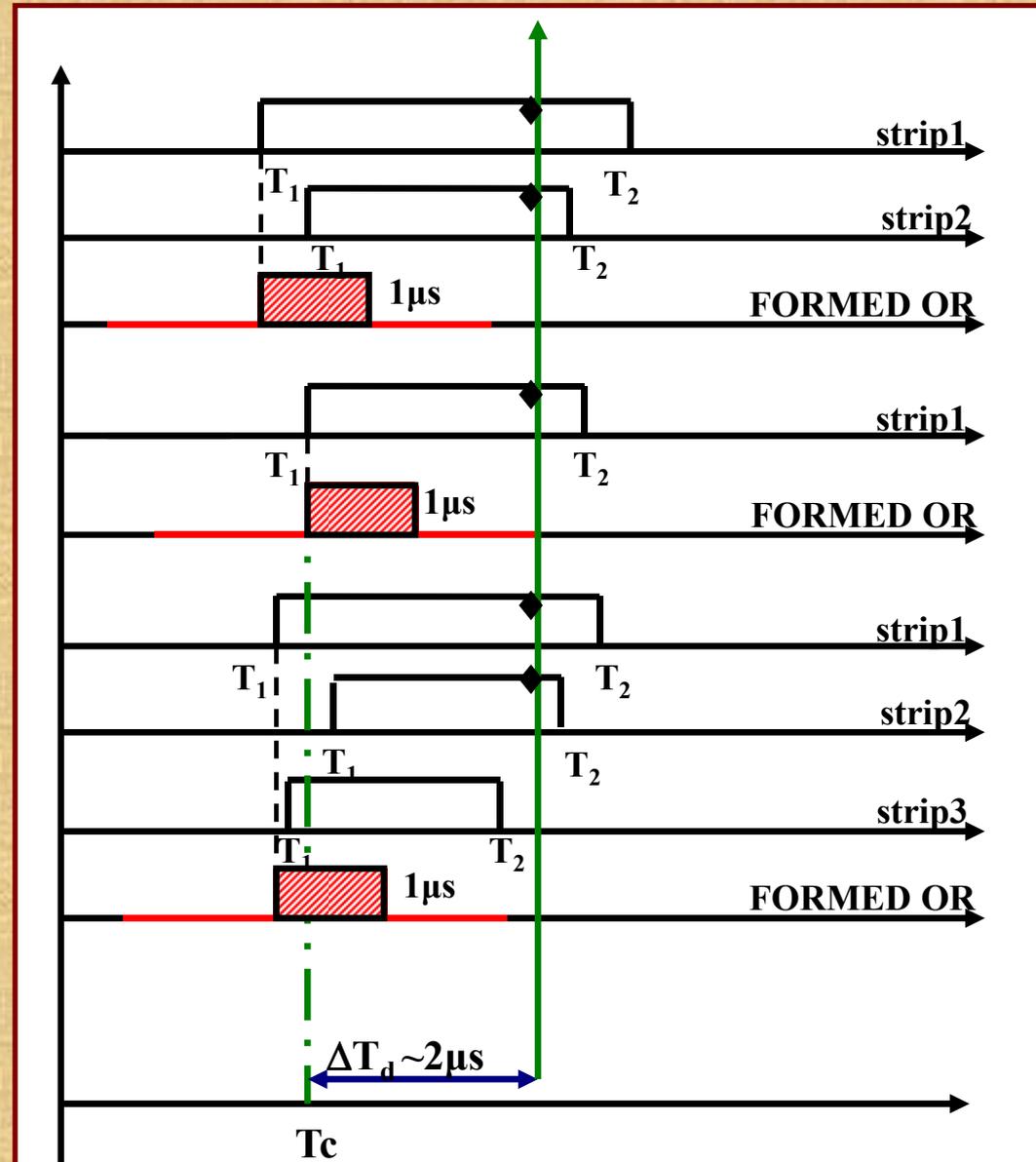
L1 trigger



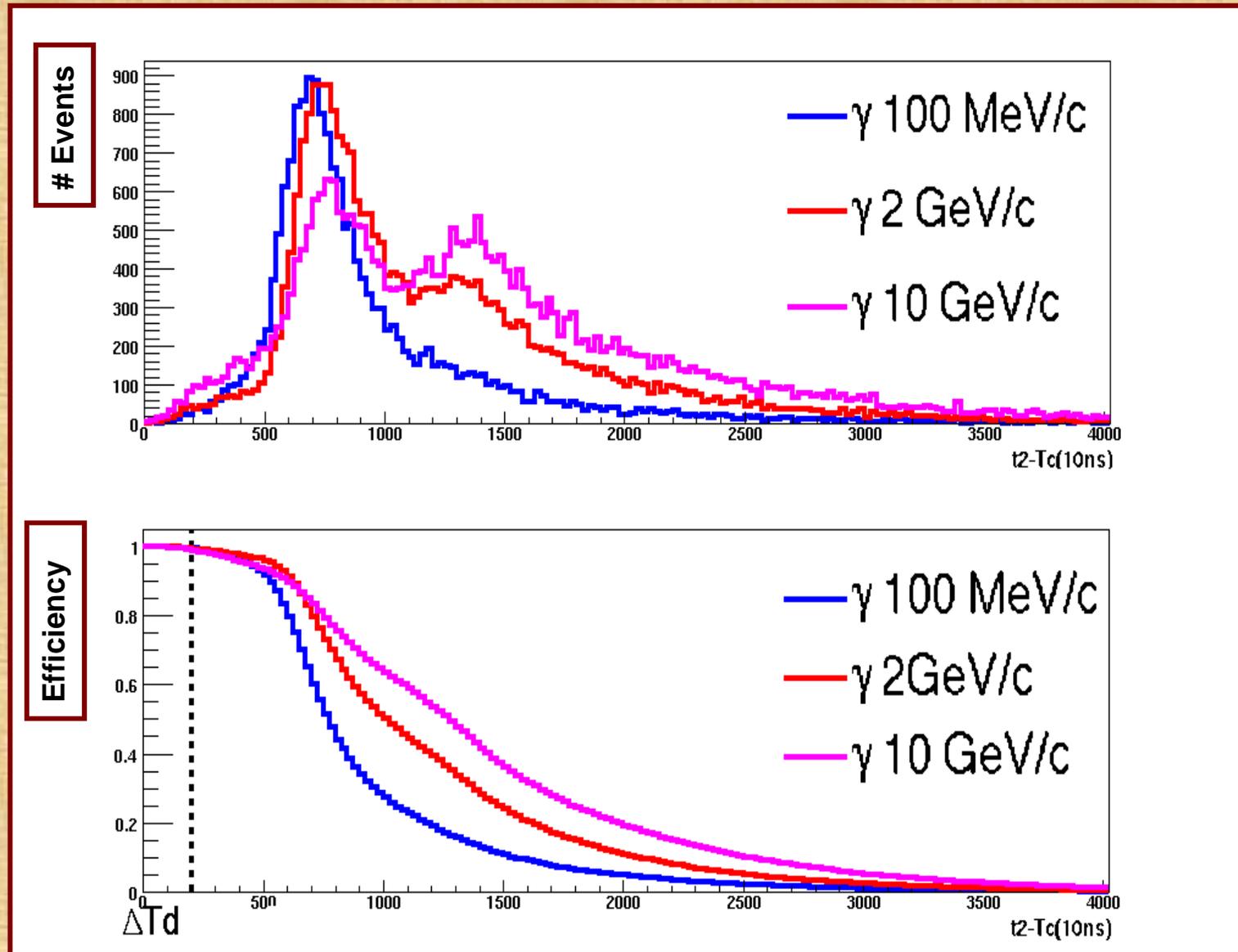
- 6-fold coincidence
(first 3-x and 3-y hit layers)
- T_c is the time coincidence



The strip is "captured" if
 $T_2 - T_c > \Delta T_d (2\mu s)$
where ΔT_d is the trigger
acknowledgement



Hit capture efficiency ($V_{th} = 160\text{mV}$)



Events

Efficiency

~ 100%
captured
"hit"

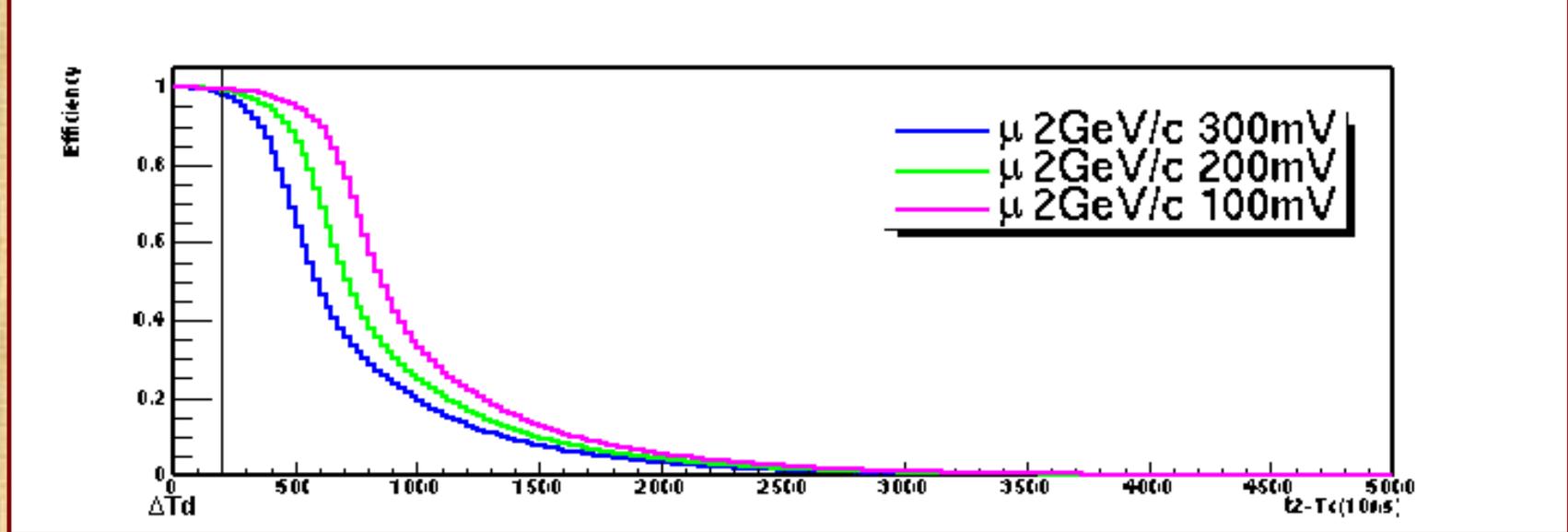
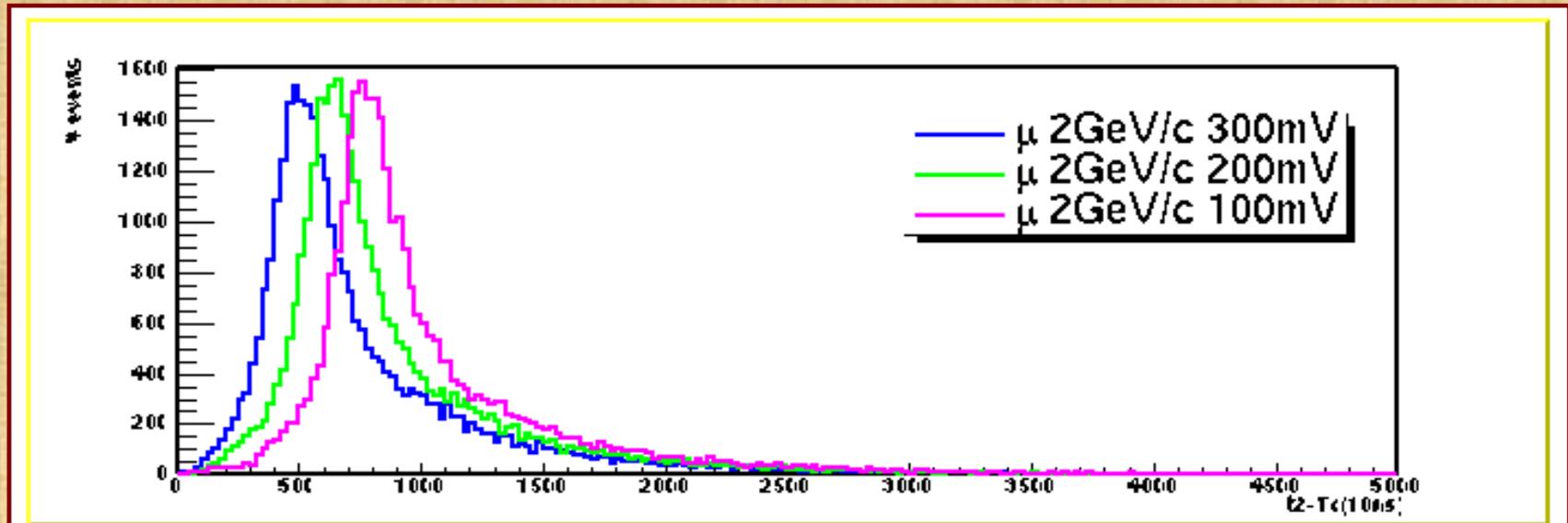
Hit capture efficiency: threshold study

- The hit capture efficiency has been studied as a function of V_{th} (100mV, 200mV and 300mV);
- A sample of 2GeV/c muons and 2GeV/c gamma, crossing the tower orthogonally has been simulated;

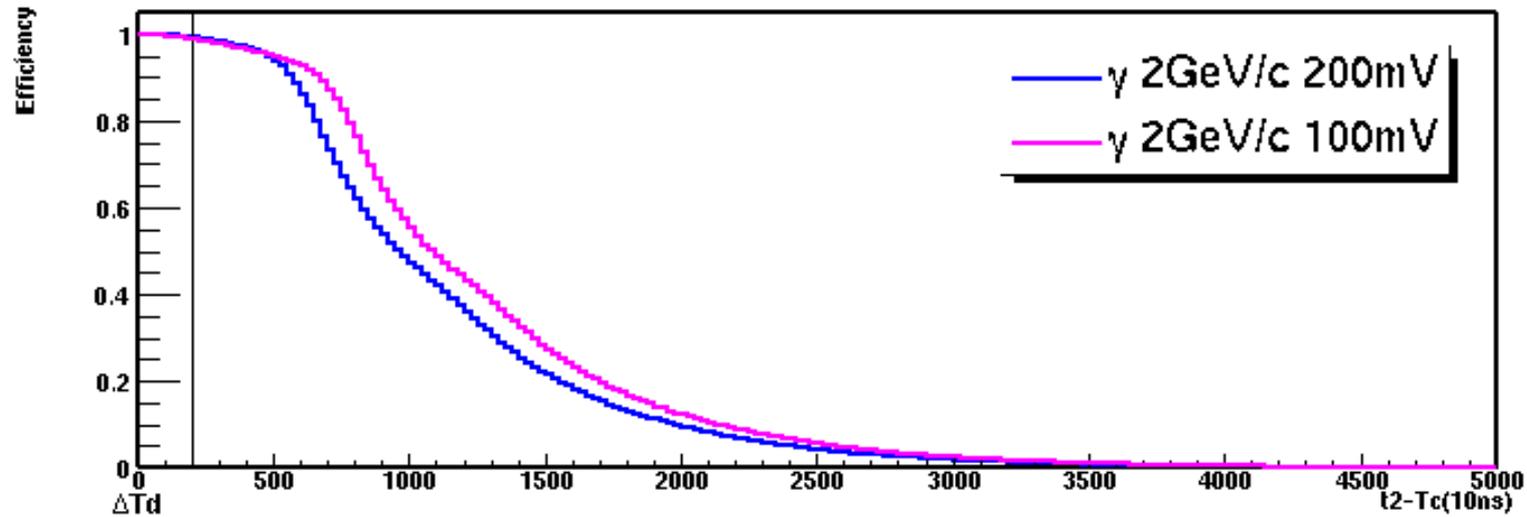
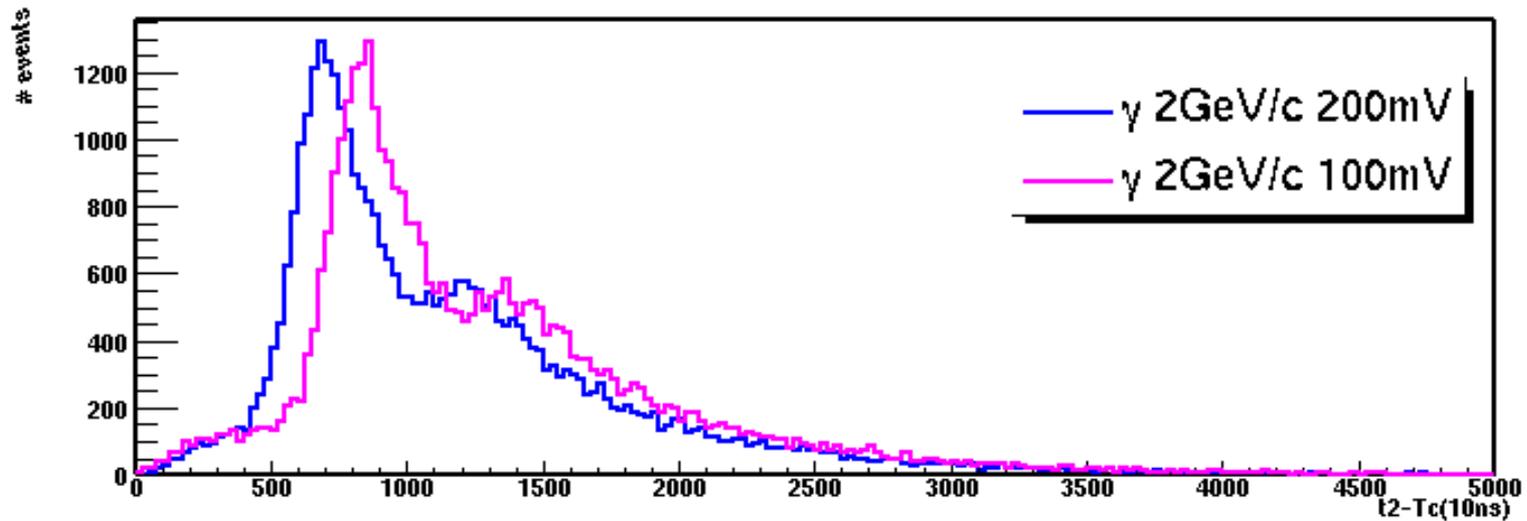
Motivation:

- the SSD noise increases with the temperature
- the threshold could be consequently tuned
(see S.Rainò talk)

Efficiency vs V_{th} (muons)



Efficiency vs V_{th} (gamma)



Conclusions

- The TKR digit simulation has been used to study the tracker behavior
- A simulation of L1 trigger has been developed and a complete hit capture efficiency study performed
- The efficiency is not very dependent from the gamma energy, but
.... the efficiency slightly decreases as the threshold increases.