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GLAST LAT tracker signal simulation and trigger timing study

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(presented by F. Loparco)

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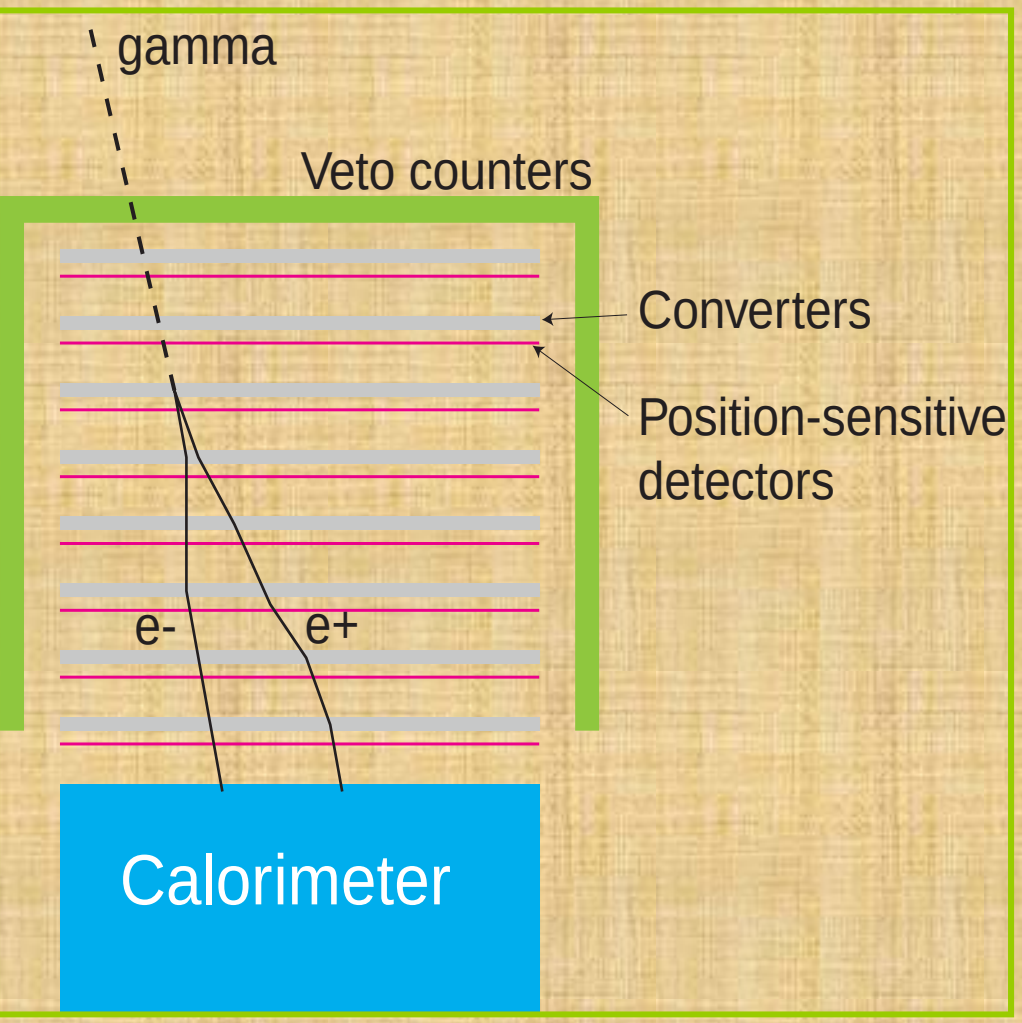
OUTLINE

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

LAT Tracker system

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

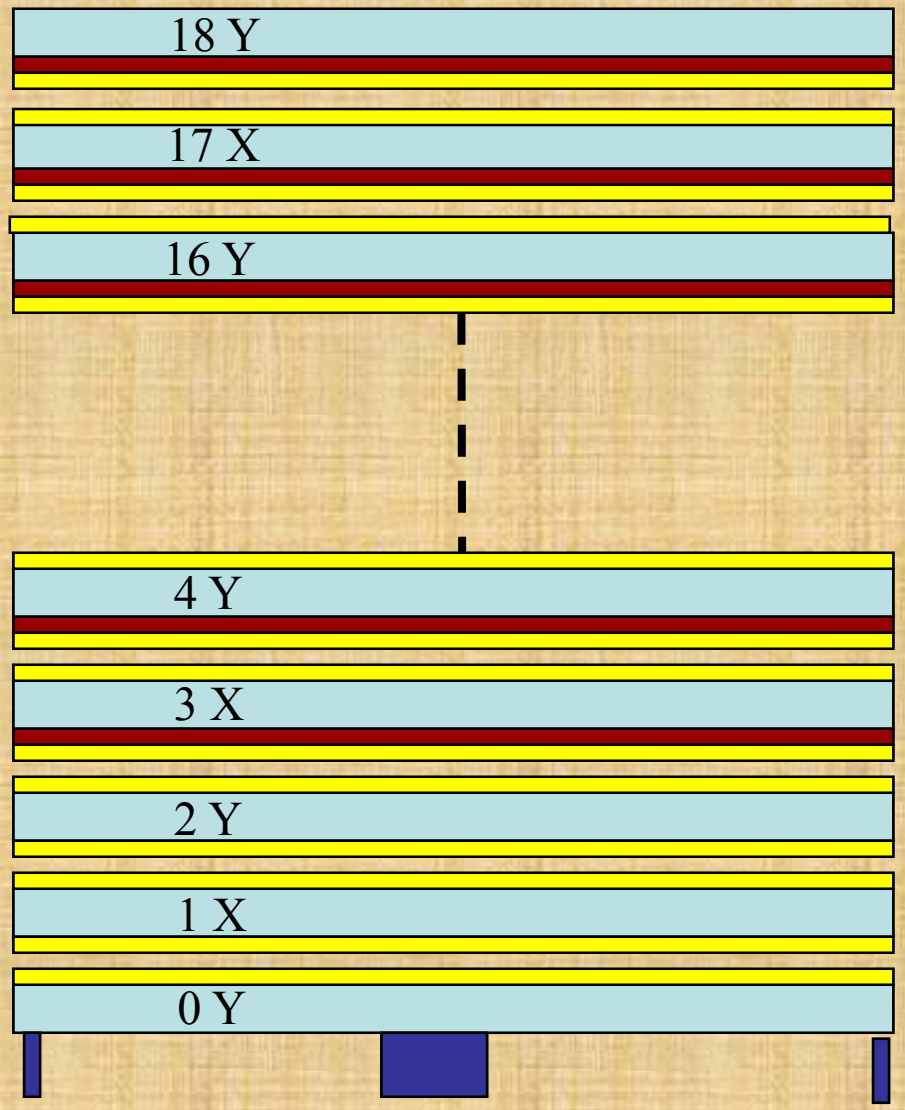


- **Si-strip Tracker (TKR)**
  19 tracking planes. Single-sided silicon strip detectors + W. Measure the photon direction; gamma ID.

- **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



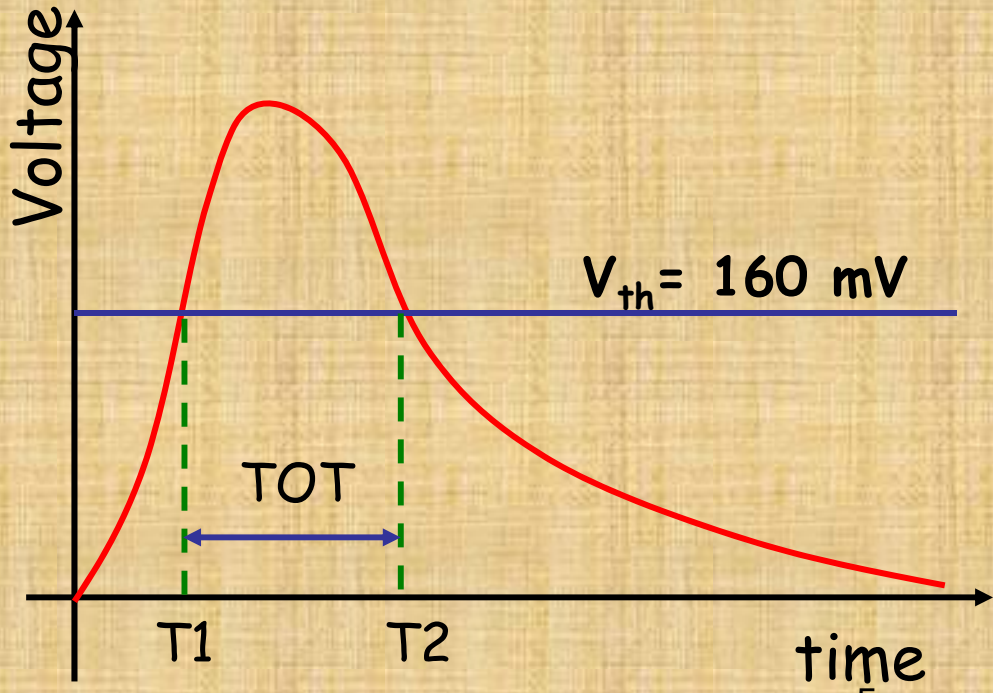
- 16 "towers" (36cm × 36cm)
- 83m² of Si
- 11500 SSDs, 1M channels
- 18 *x,y* layers per tower
  - 19 "trays"
    - 12 with 3% X_0 *("Front")*
    - 4 with 18% X_0 *("Back")*
    - 3 no converter
- Total length: 1.5 X_0
- SSDs (Silicon Strip Detectors)
  - Wafer thickness 400 μm
  - Wafer Area 8.96 x 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)

ToT ≈ 1.6 μs/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

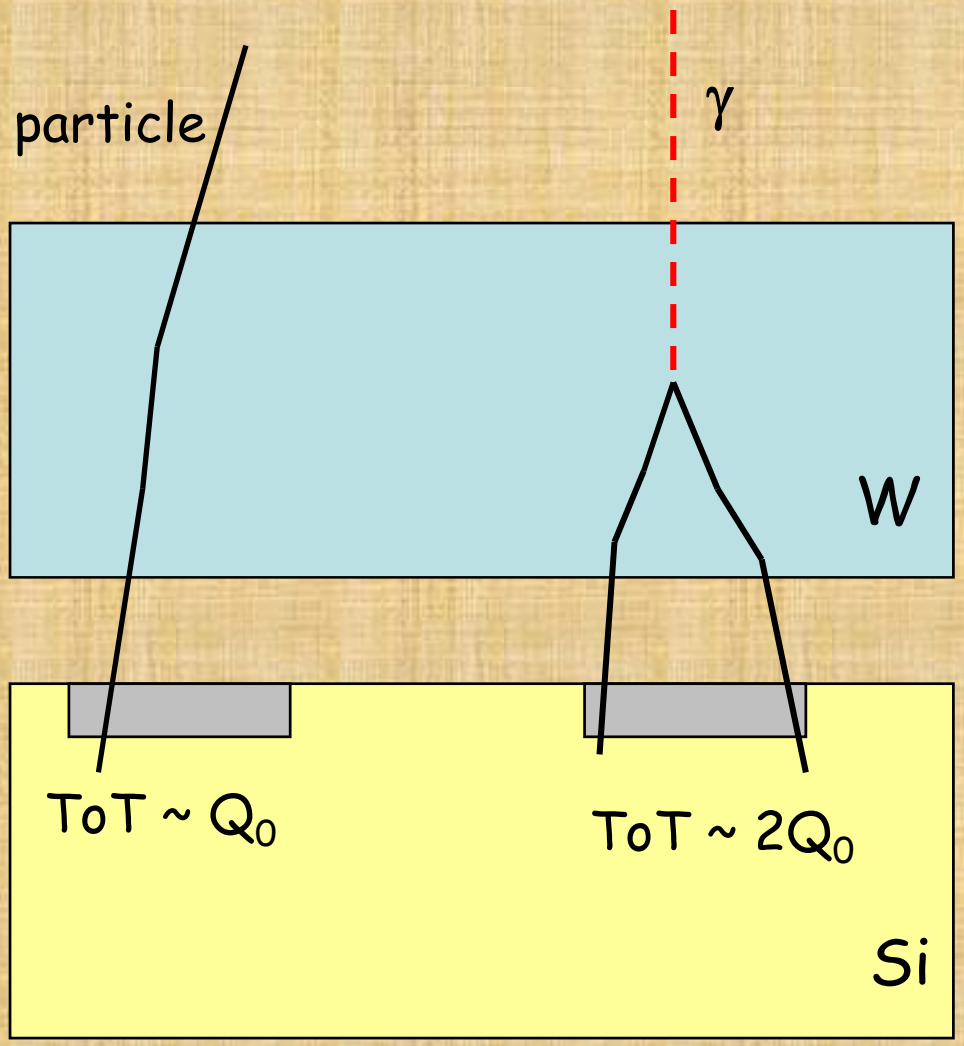
OUTPUT:
· Fired strips list, per layer
· TOT per layer

TKR DIGIT simulation chain:

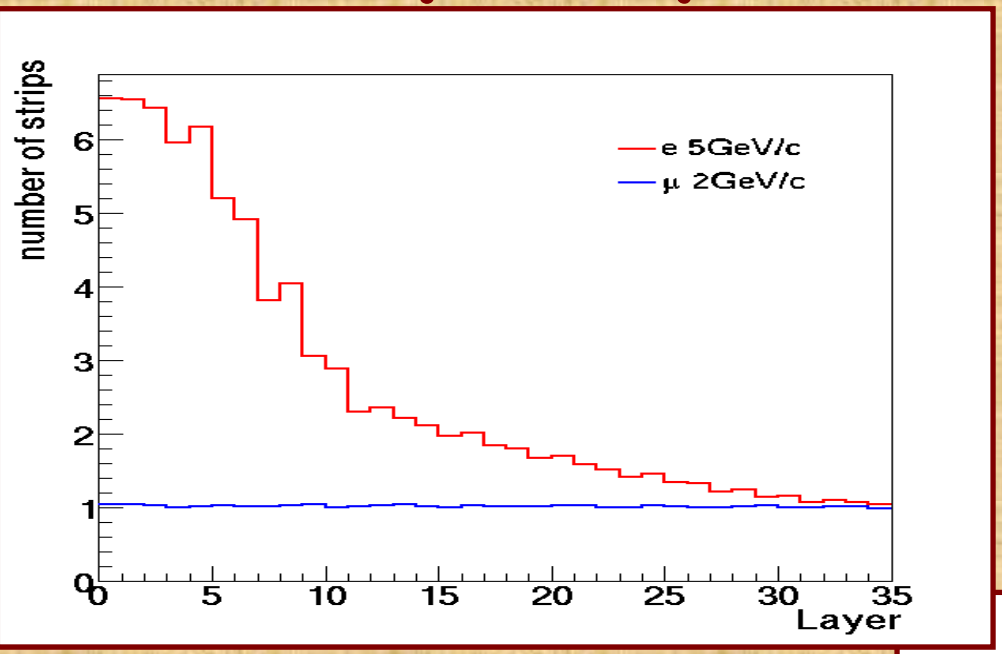
we use a simplified version of a full SSD signal simulation (see F.Loparco talk)

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

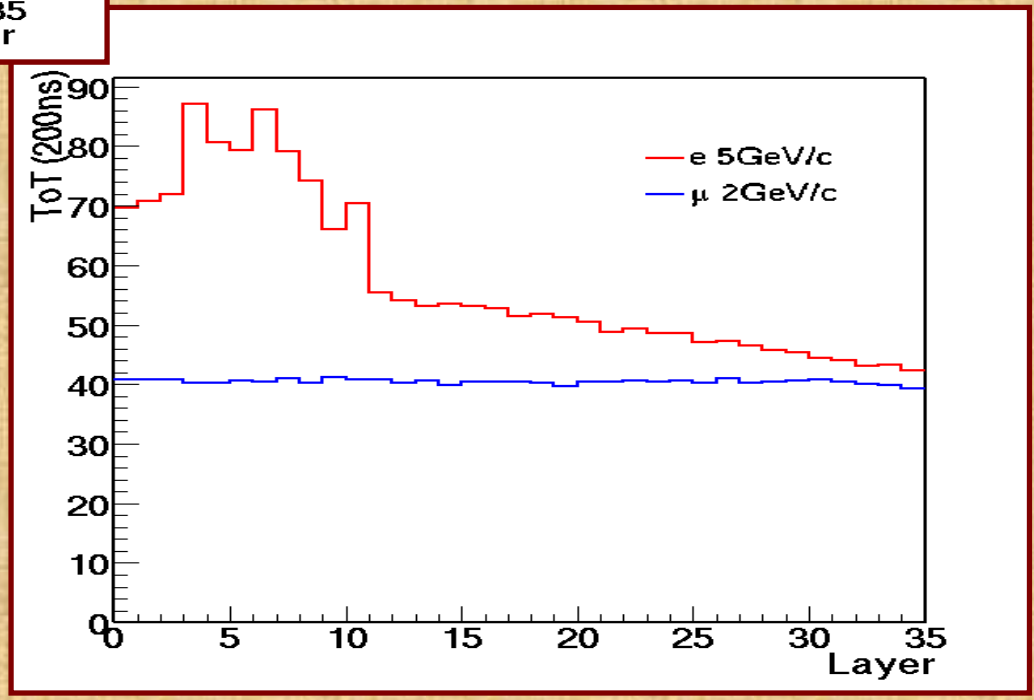


Multiplicity and ToT for layers

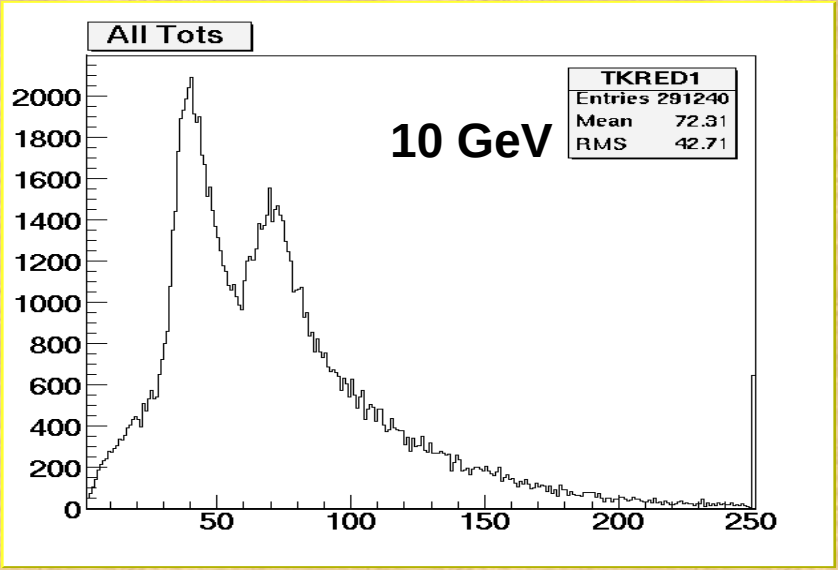


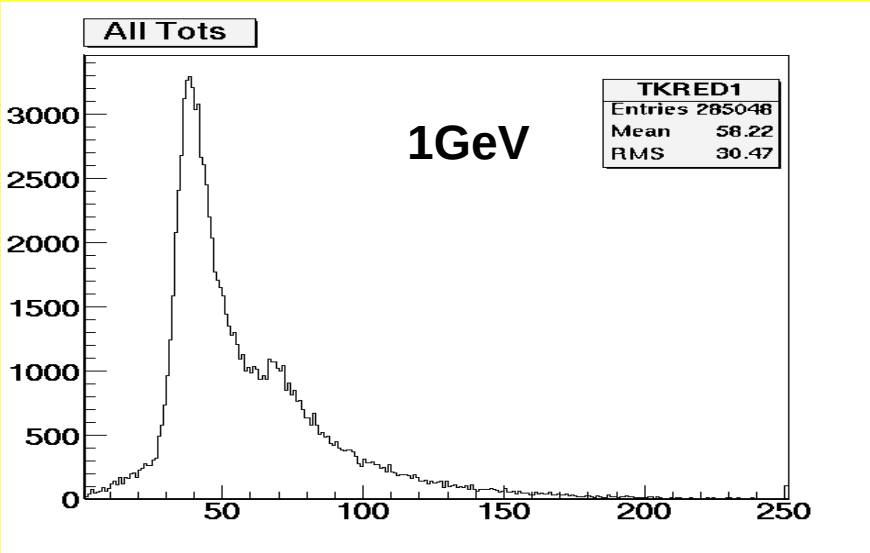
Average strip multiplicity per layer

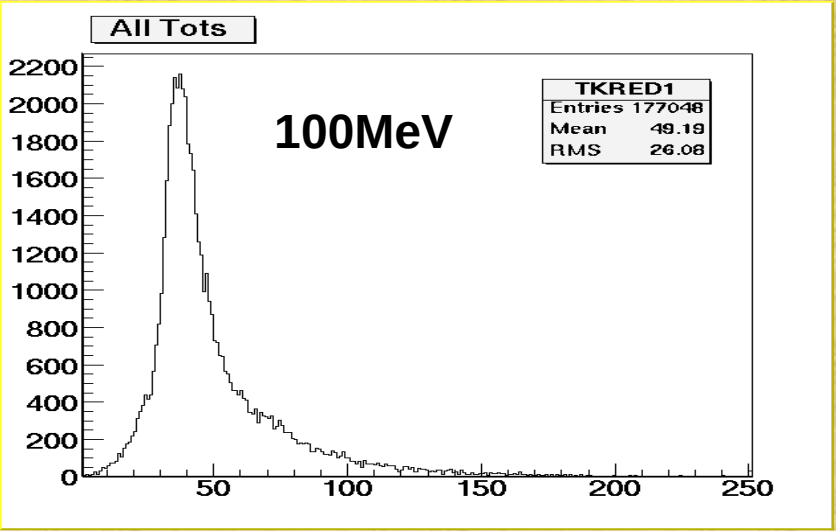
Average ToT per layer

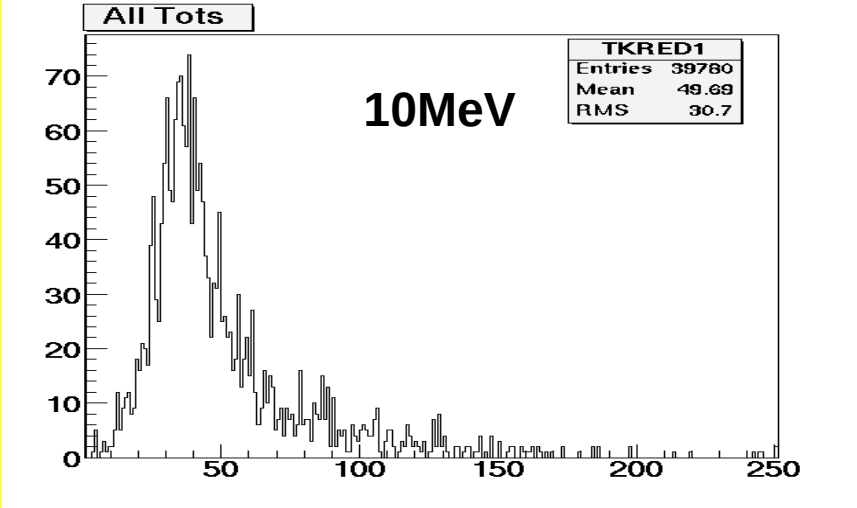


ToT distribution for γ-rays



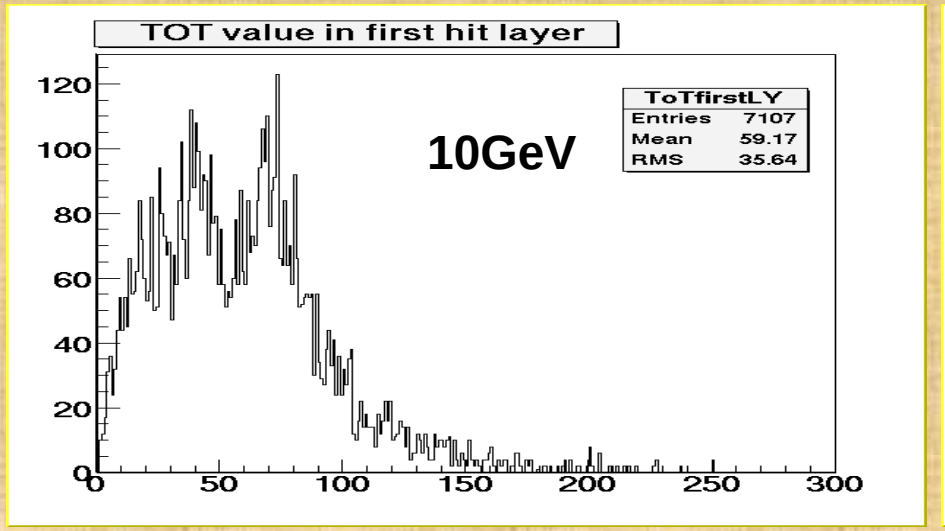


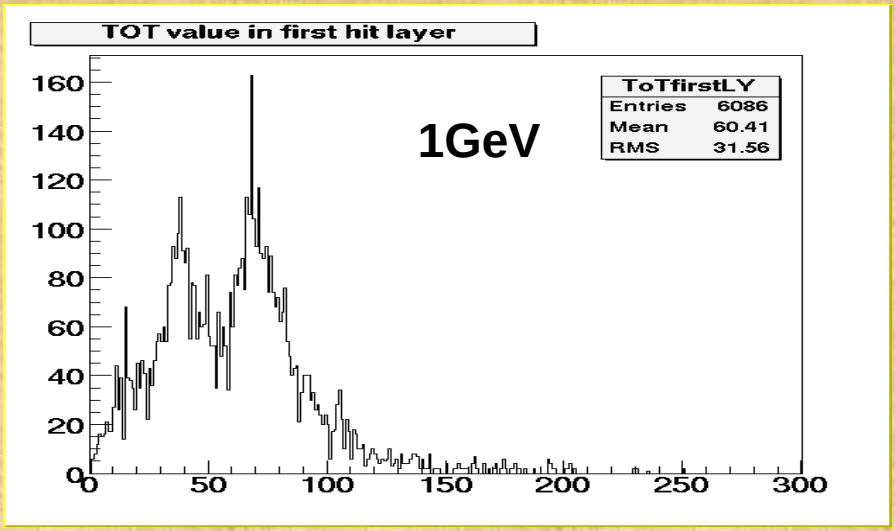


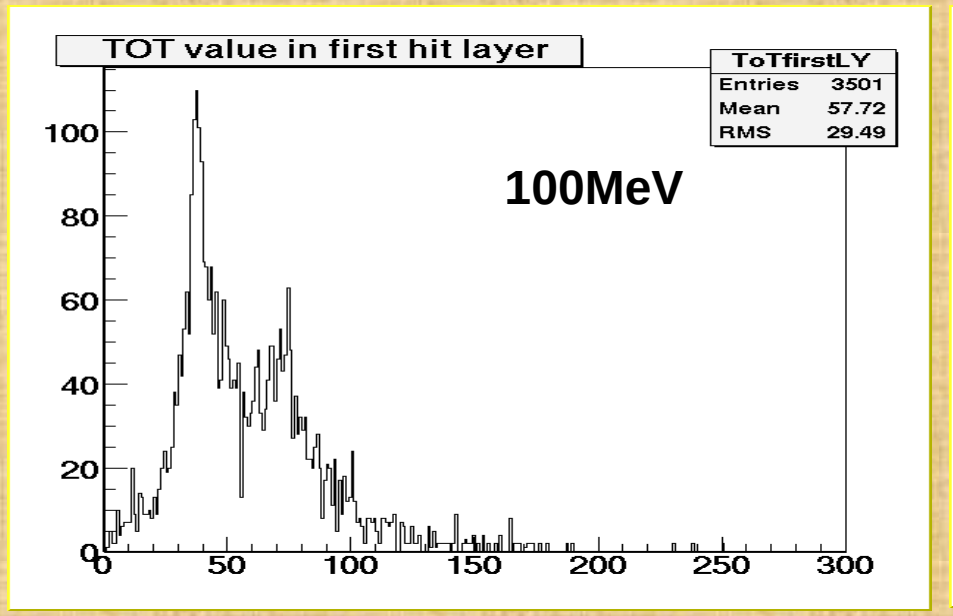


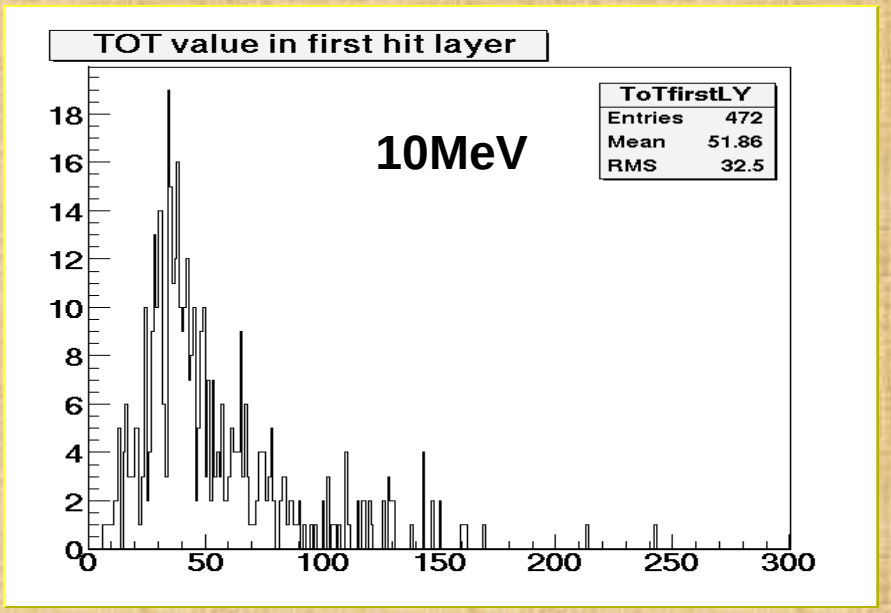
ToT (200ns step)

ToT distribution for γ-rays









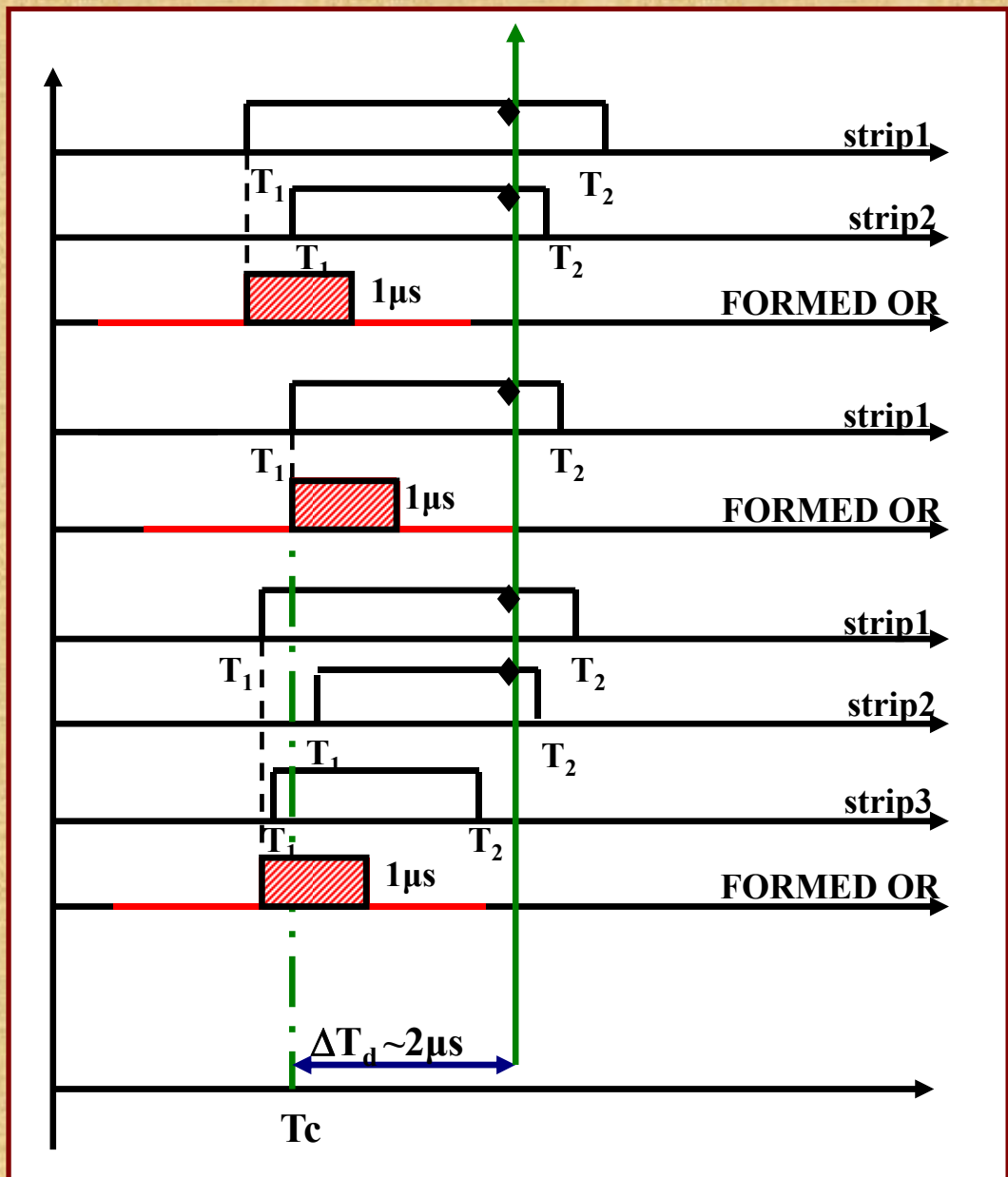
ToT (200ns step)

TKR L1 trigger simulation

L1 trigger

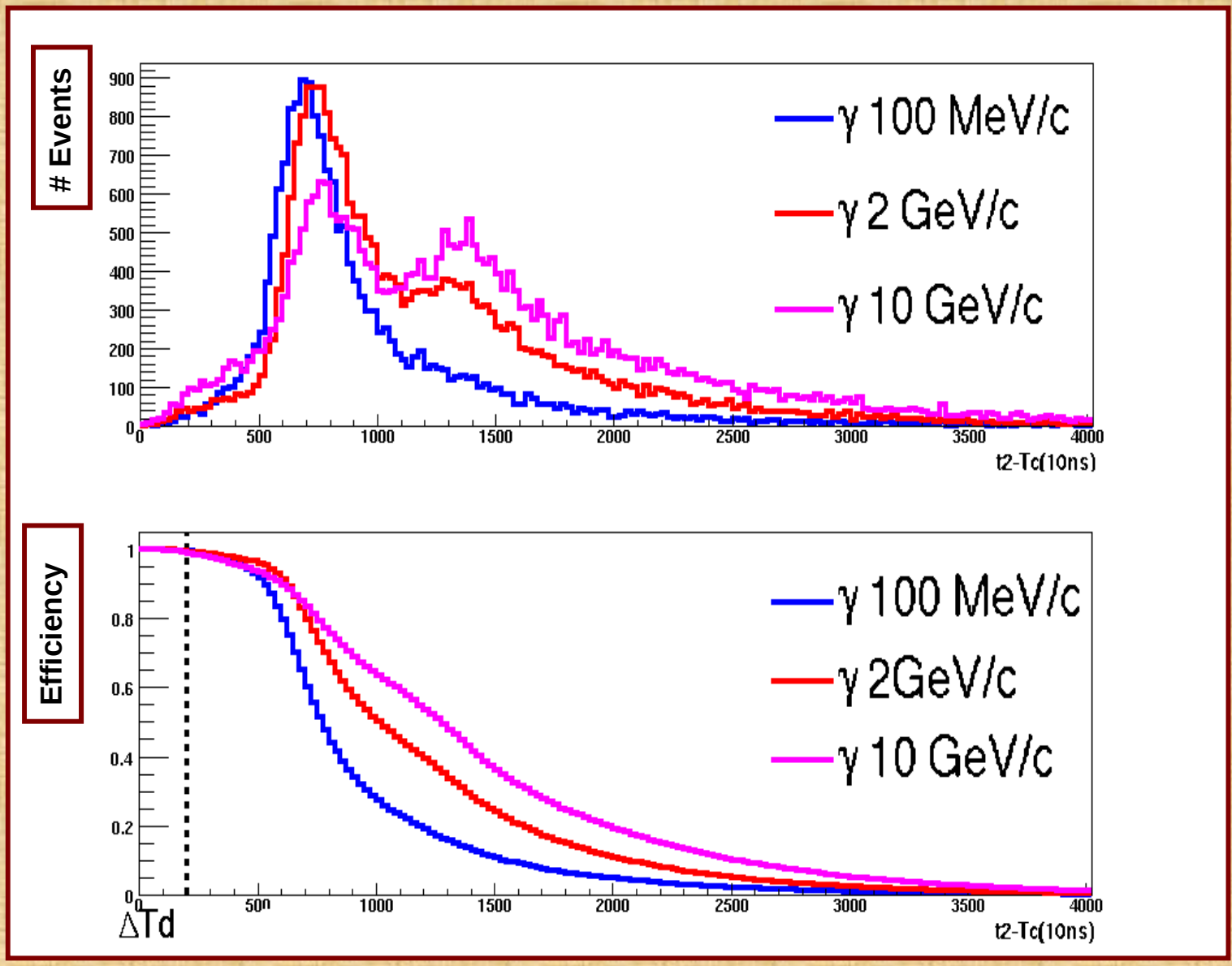
- 6-fold coincidence
  (first 3-x and 3-y hit layers)
- Tc is the time coincidence

The strip is "captured" if
T2-Tc > ΔTd (2μs)
where ΔTd is the trigger acknowledgement



Hit capture efficiency (Vth = 160mV)

~ 100% captured "hit"



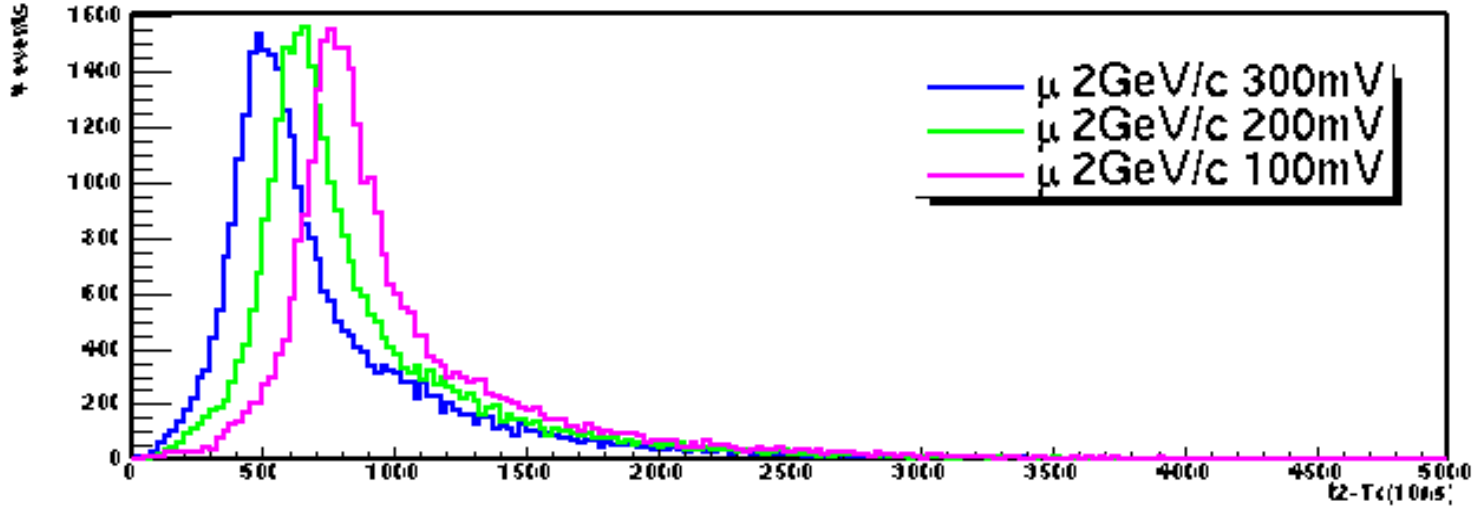
Hit capture efficiency: threshold study

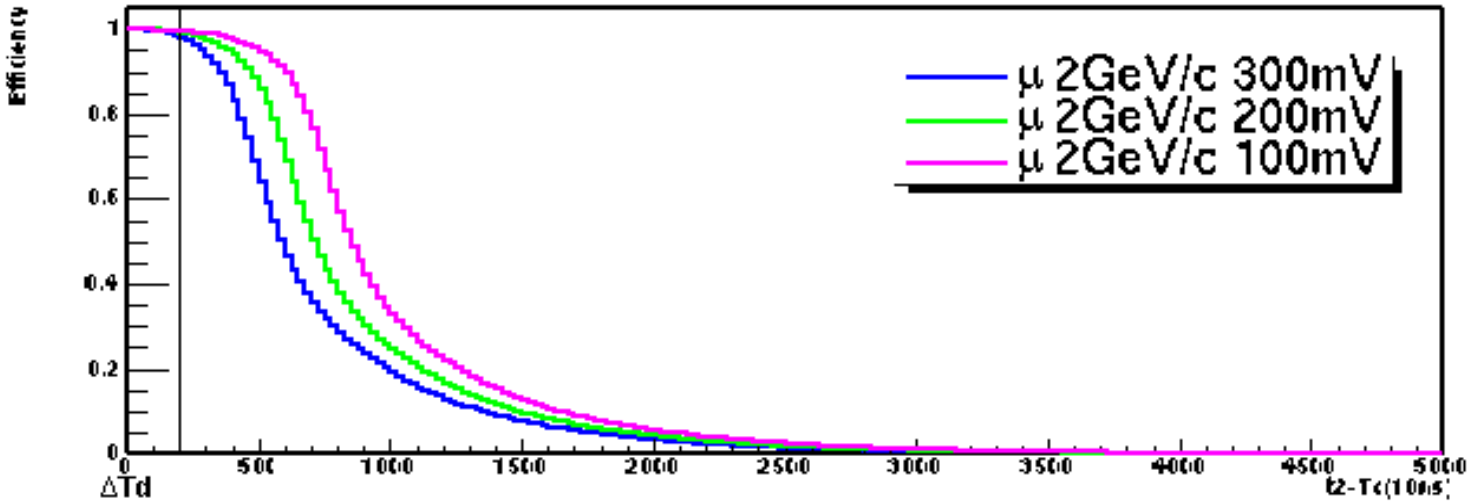
- The hit capture efficiency has been studied as a function of Vth (100mV, 200mV and 300mV);
- A sample of 2GeV/c muons and 2GeV/c gamma, crossing the tower orthogonally has been simulated;

Motivation:

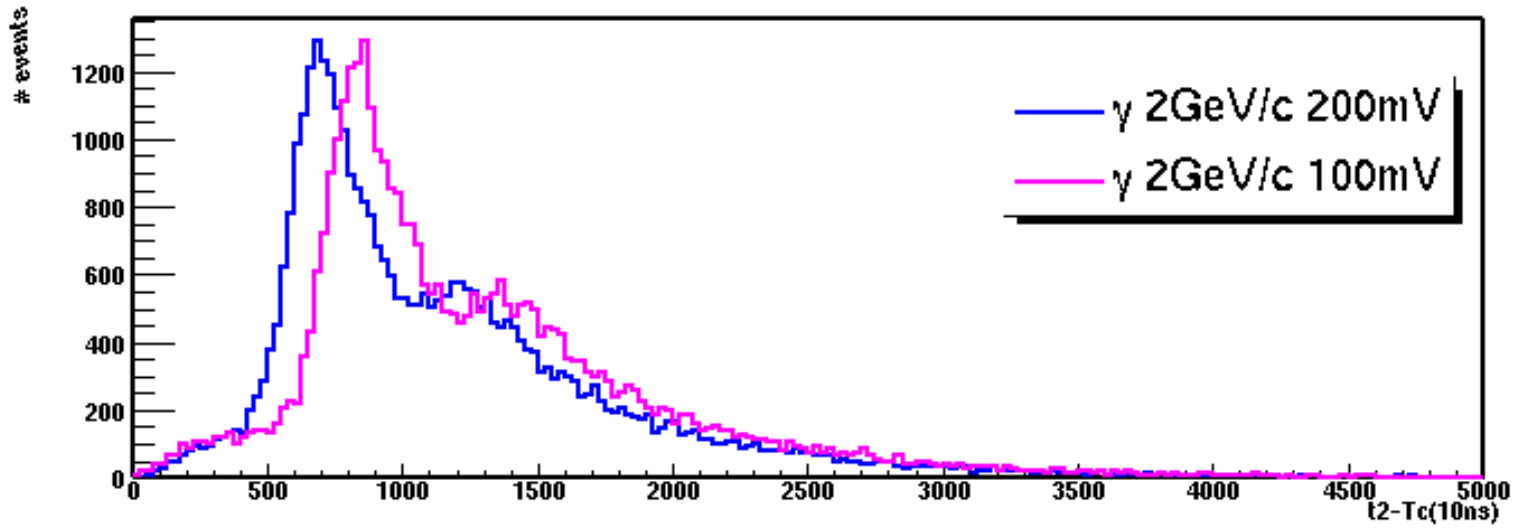
- the SSD noise increases with the temperature
- the threshold could be consequently tuned (see S.Rainò talk)

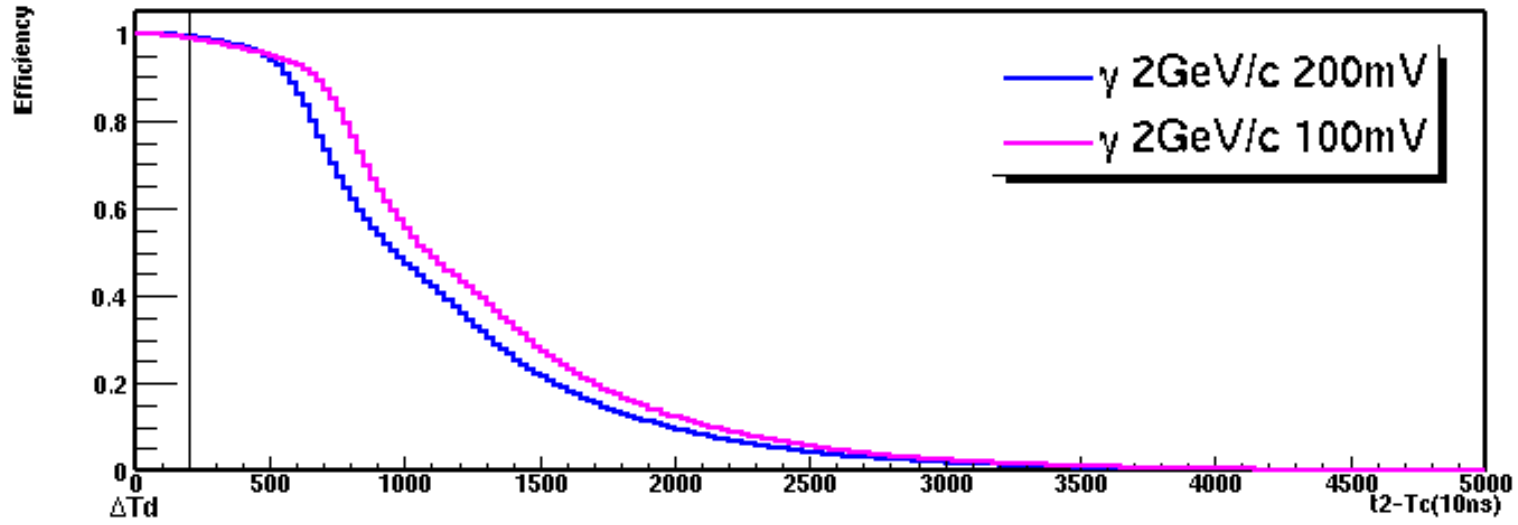
Efficiency vs V_{th} (muons)





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.