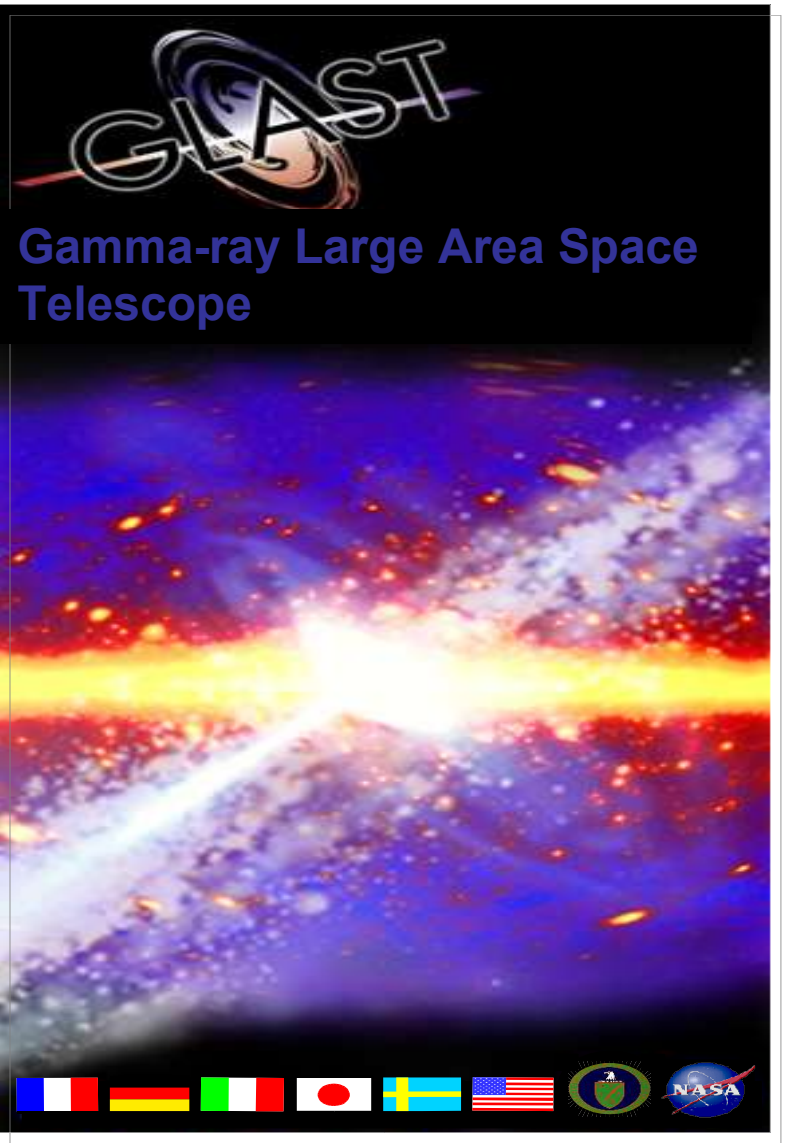

Study of the Time over Threshold in the 4 towers data samples

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Francesco Loparco

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Overview

- *Event selection and definitions*
- *Data samples*
- *Study of the ToT in track layers:*
  - *Analysis of the ToT distributions*
  - *Dependence of the ToT on the track parameters (θ,φ)*
  - *ToT in X-view and Y-view SSD planes*
  - *Study of the ToT overflows*
- *Study of the ToT in triggering layers*
  - *Evaluation of the hit capture efficiency*
- *Conclusions*

Event selection and definitions

Event Selection:

Trigger from 3 consecutive layers: GemConditionWord = 2

Single tower events: GemTkrVector[tower] ≠ 0 for only one tower

Single muon tracks in the TKR: TkrNumTracks = 1

Track Layers = Layers from Tkr1FirstLayer (First layer in the track) to Tkr1LastLayer (Last layer in the track)

Triggering Layers = The set of 3 layers in a row issuing the trigger request

Actually, we assume that Triggering Layers correspond to the ones from GltLayer to GltLayer+2

Data samples

A sample of 14 runs in the 4 towers configuration have been analyzed (runs from 135002498 to 135002511)

A total of 1254616 events survived to the cuts

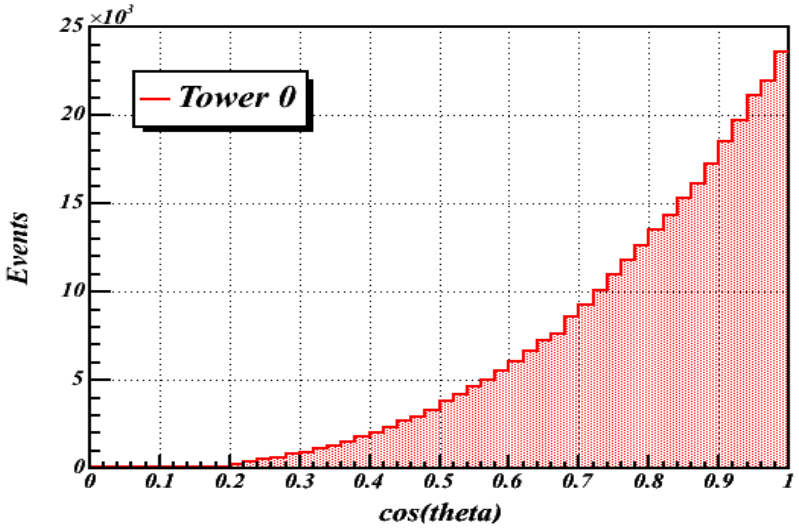
Tower 0: 318435 events

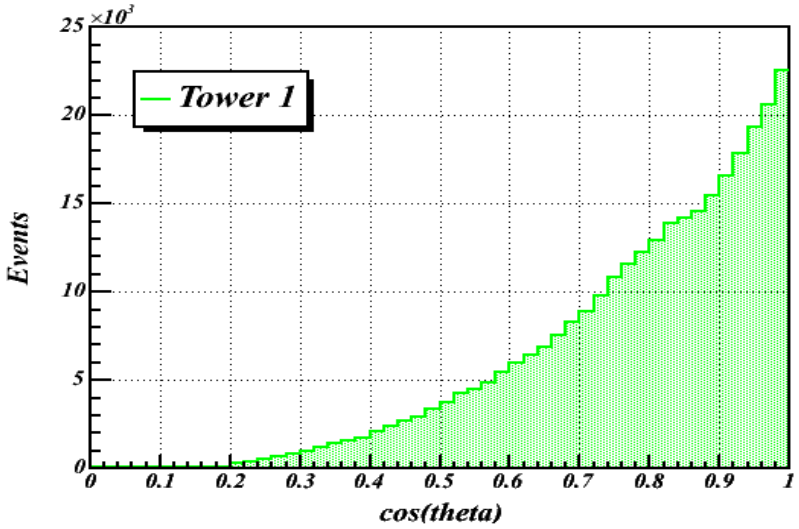
Tower 1: 302857 events

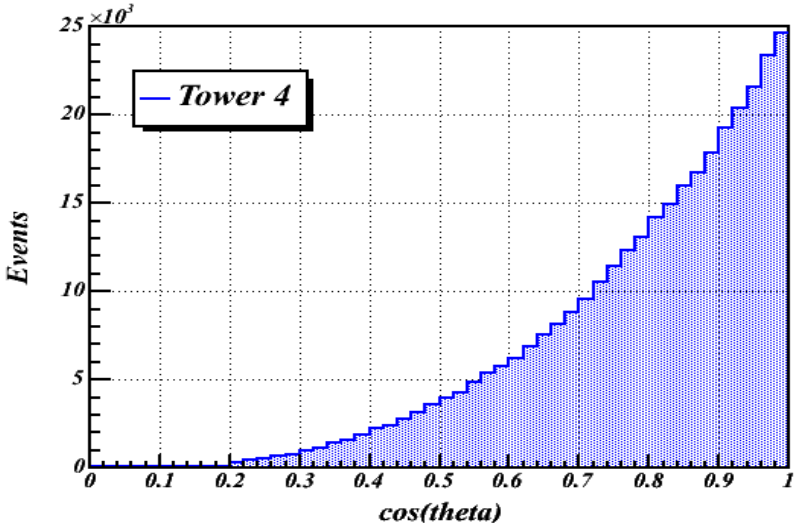
Tower 4: 332002 events

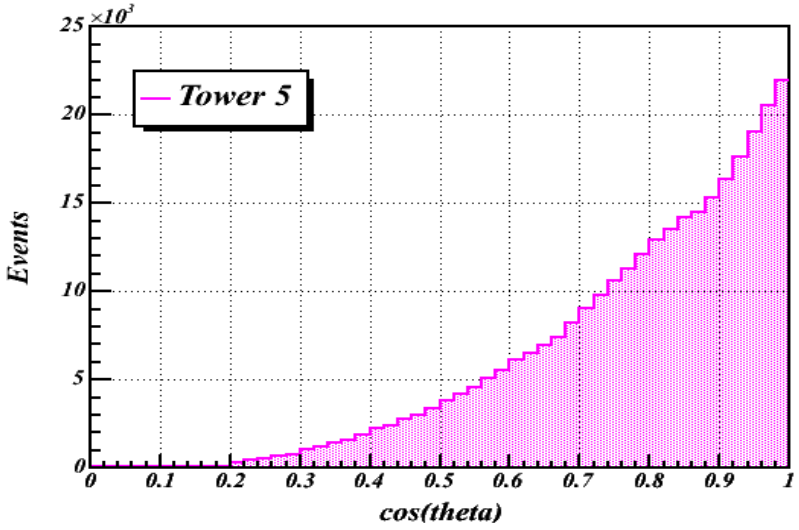
Tower 5: 301322 events

Muon cosθ distribution

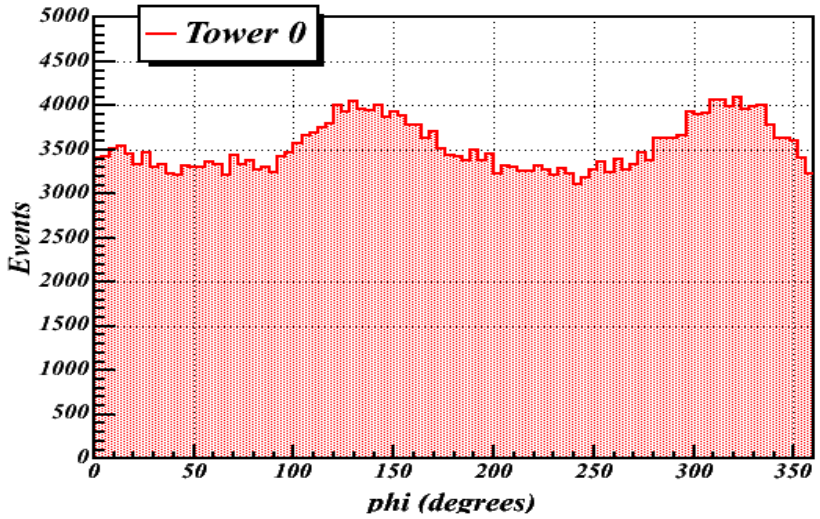


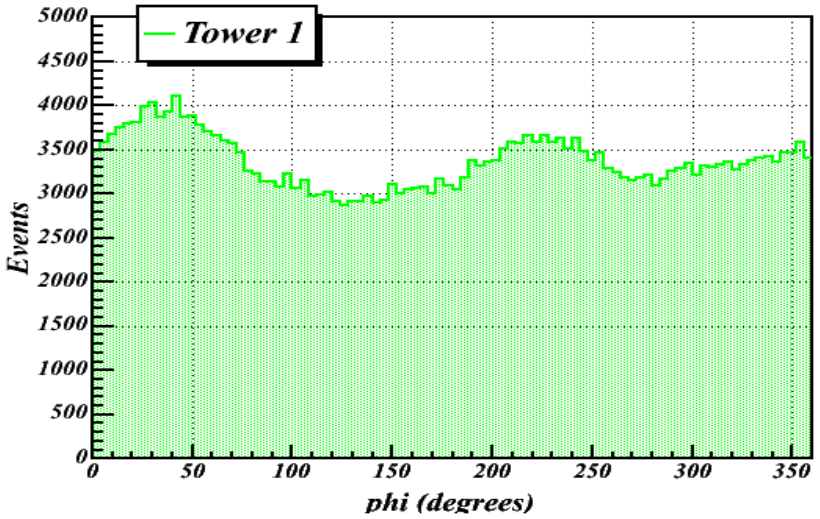


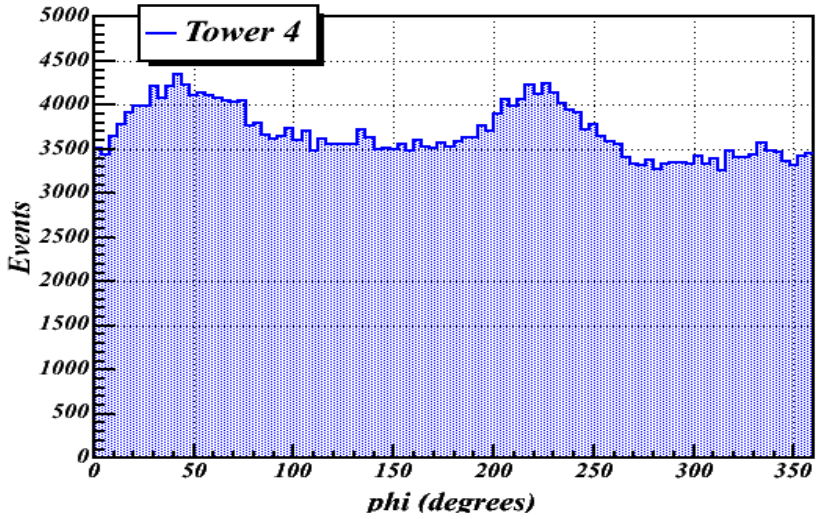


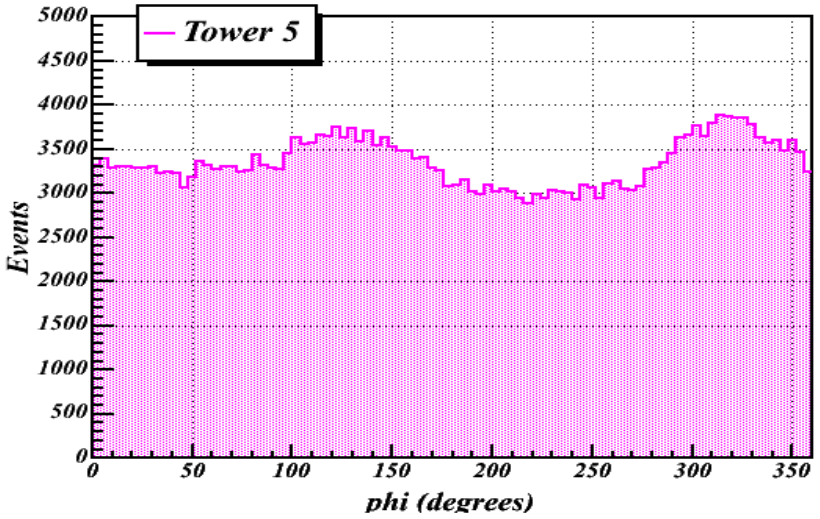


Muon φ distribution

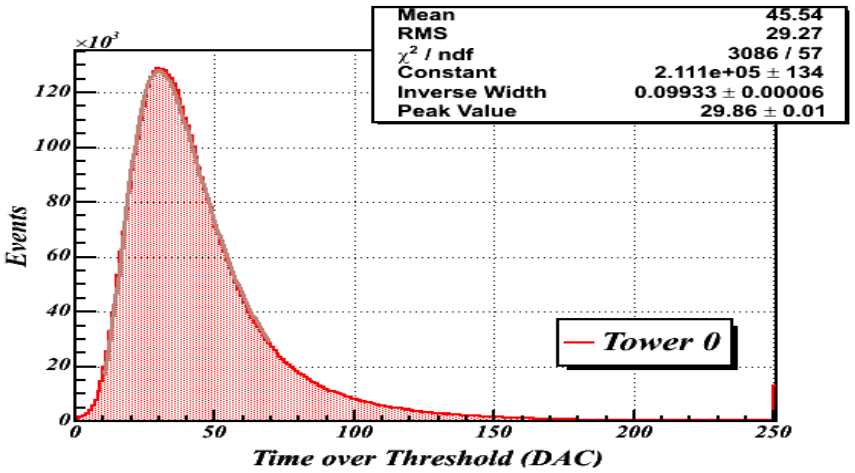


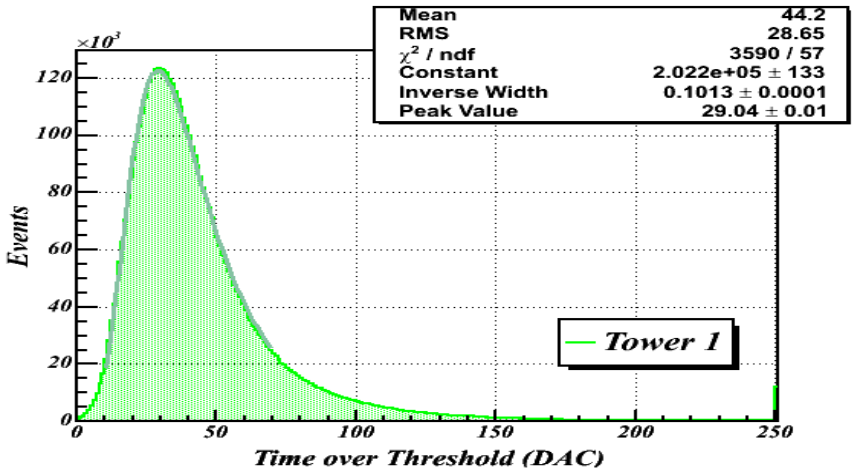


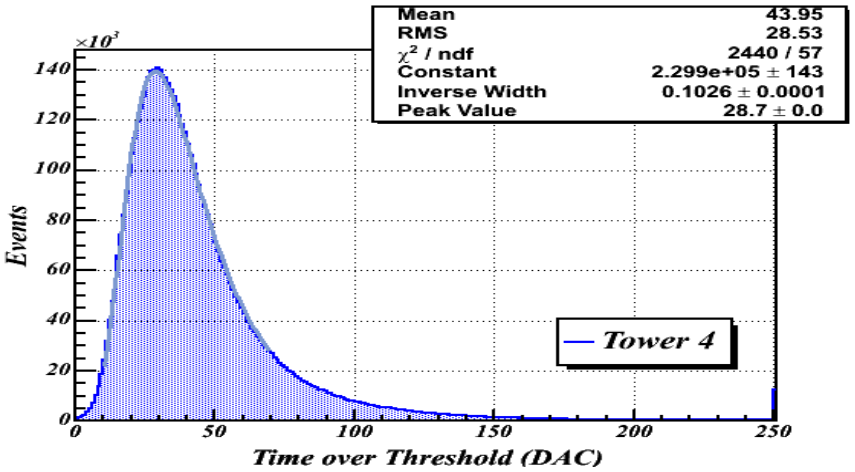


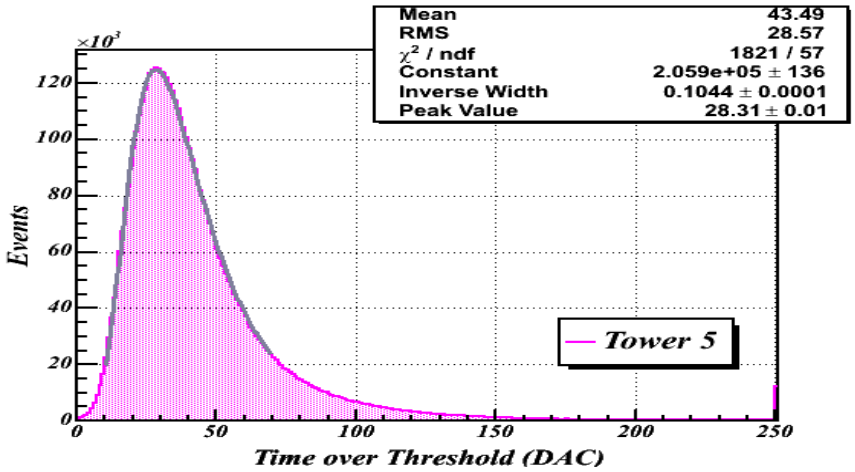


ToT distributions in track layers







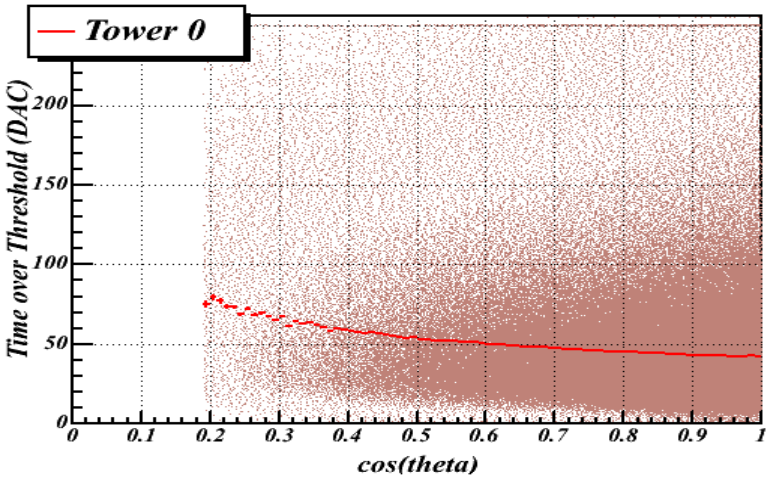


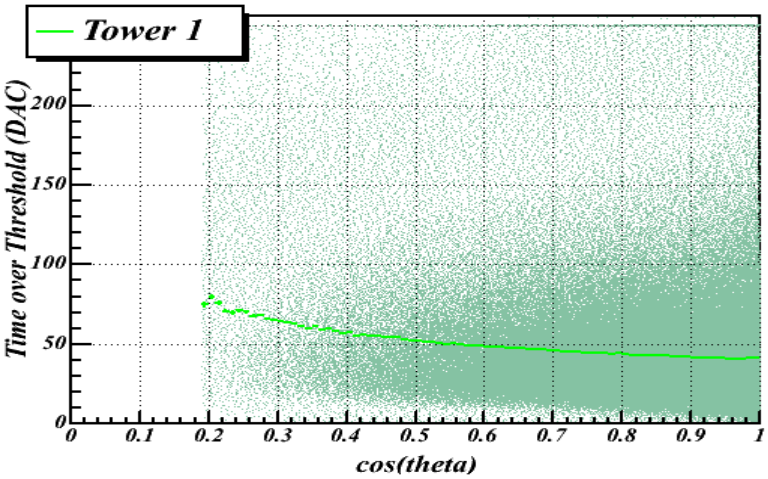
Events with ToT=0 have been ruled out

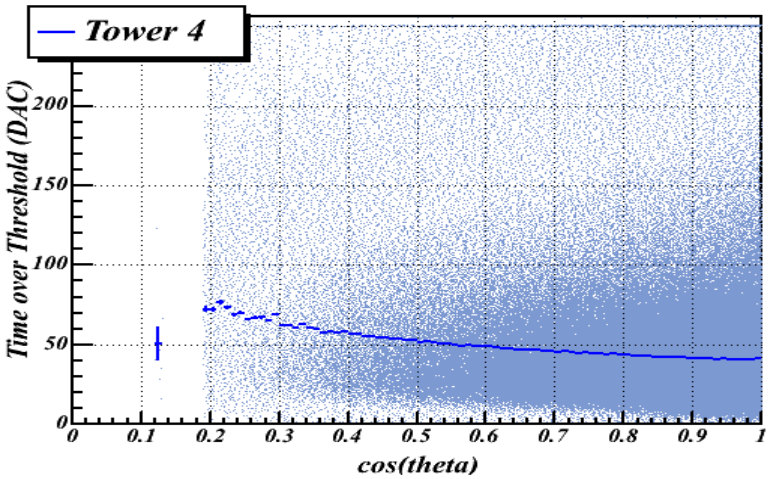
The ToT distributions can be fitted by Landau functions:

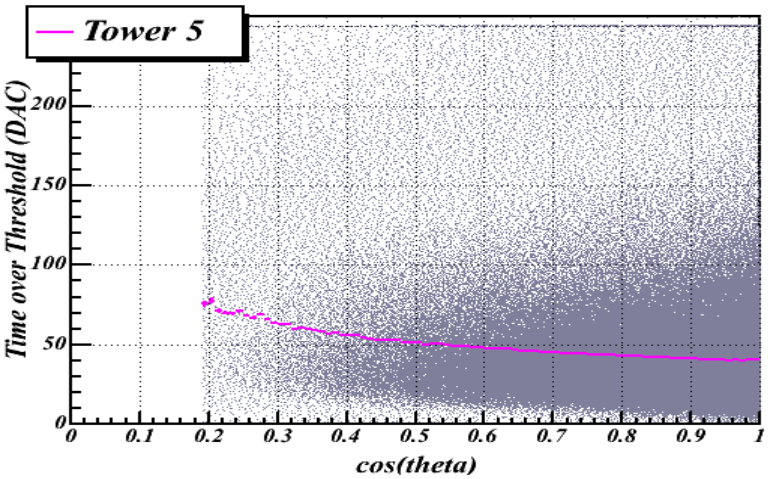
ToT peak value ≈ 5.8μs → q_{mp} ≈ 4 fC ?

ToT vs cosθ in track layers



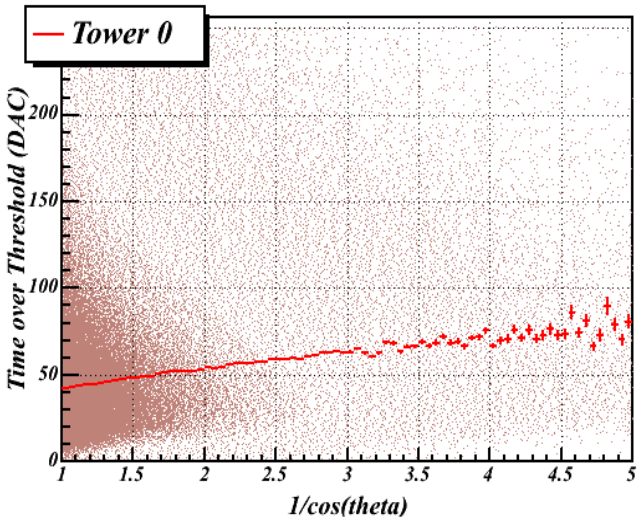


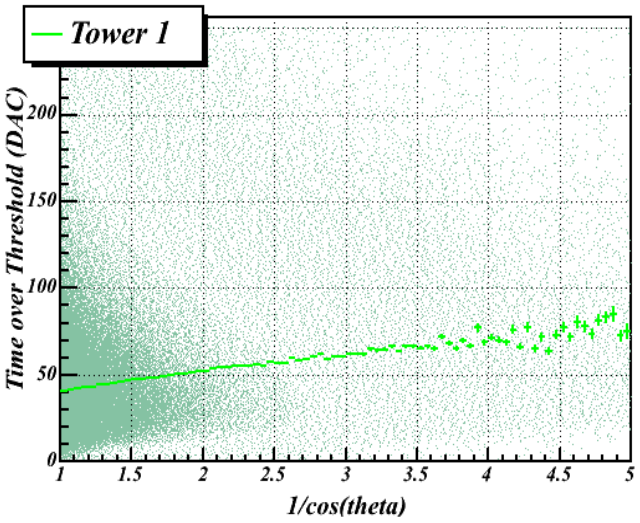


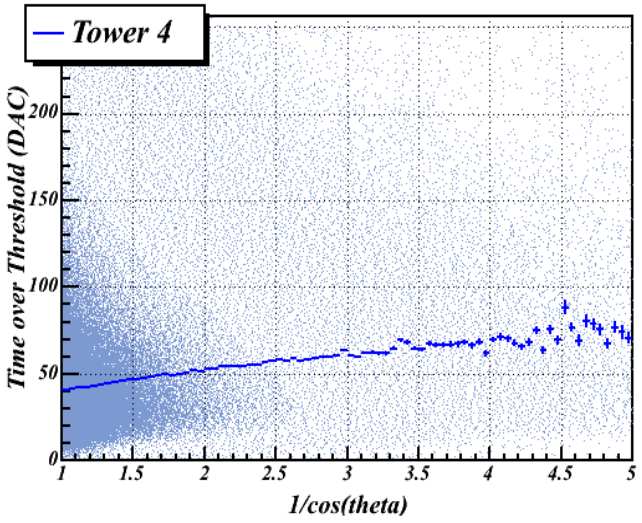


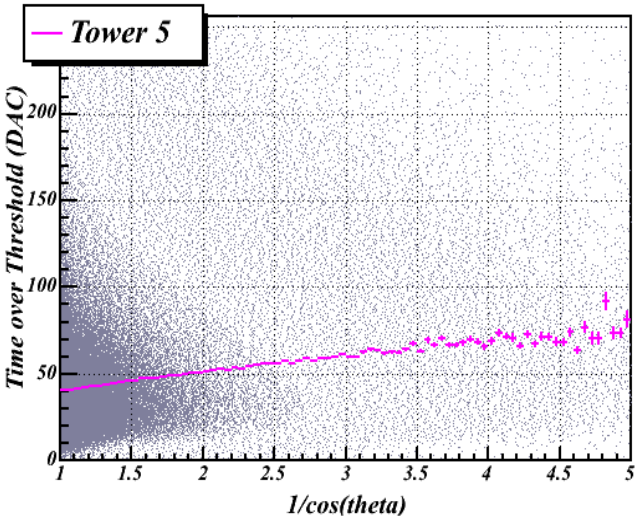
The ToT is minimum for vertical tracks and increases with θ

ToT vs 1/cosθ for track layers





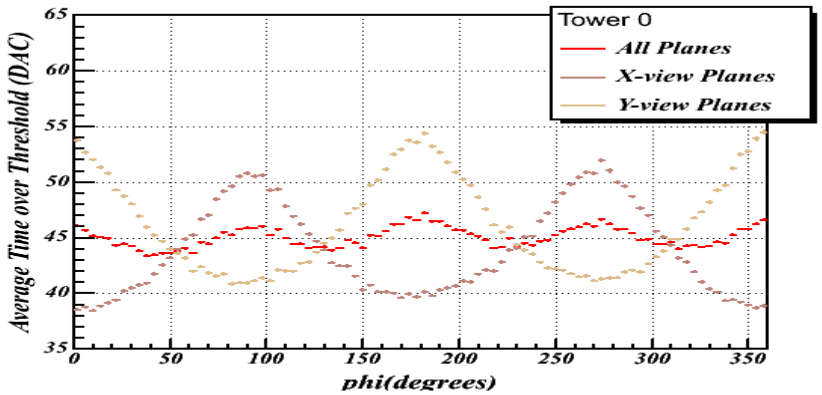


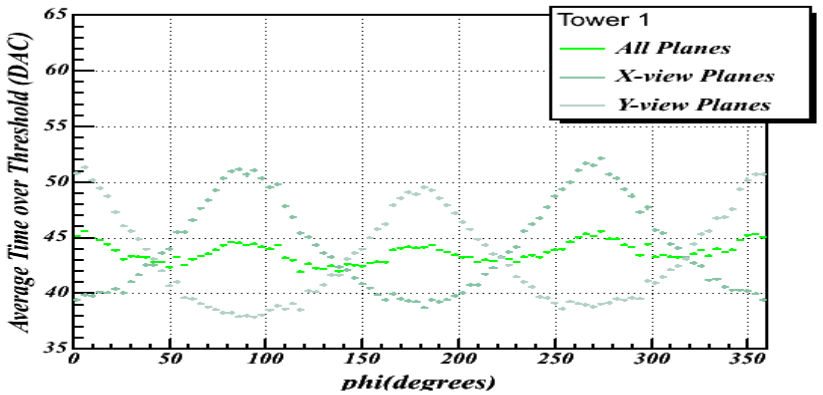


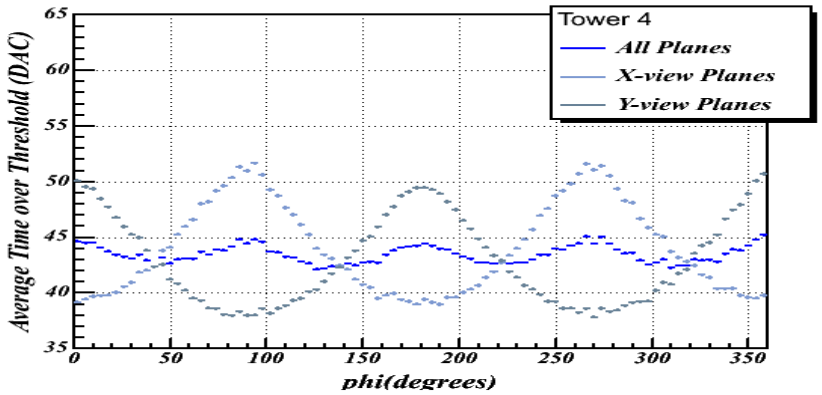
ToT ***increases*** ***linearly*** ***with 1/cosθ***

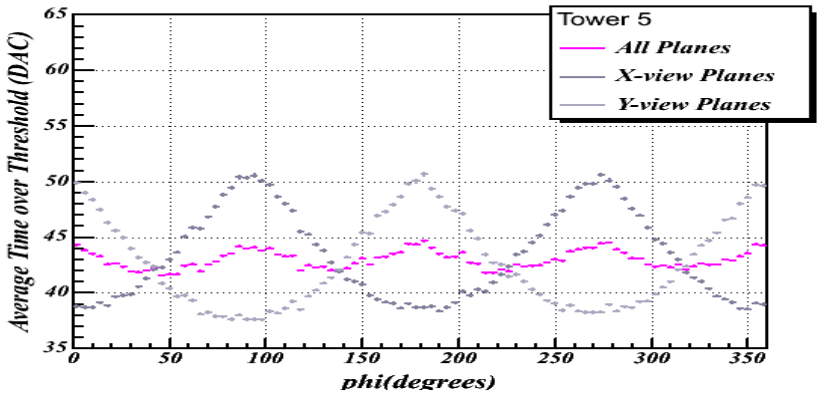
ToT ***increases*** ***linearly*** ***with track*** ***length***

ToT vs φ for track layers





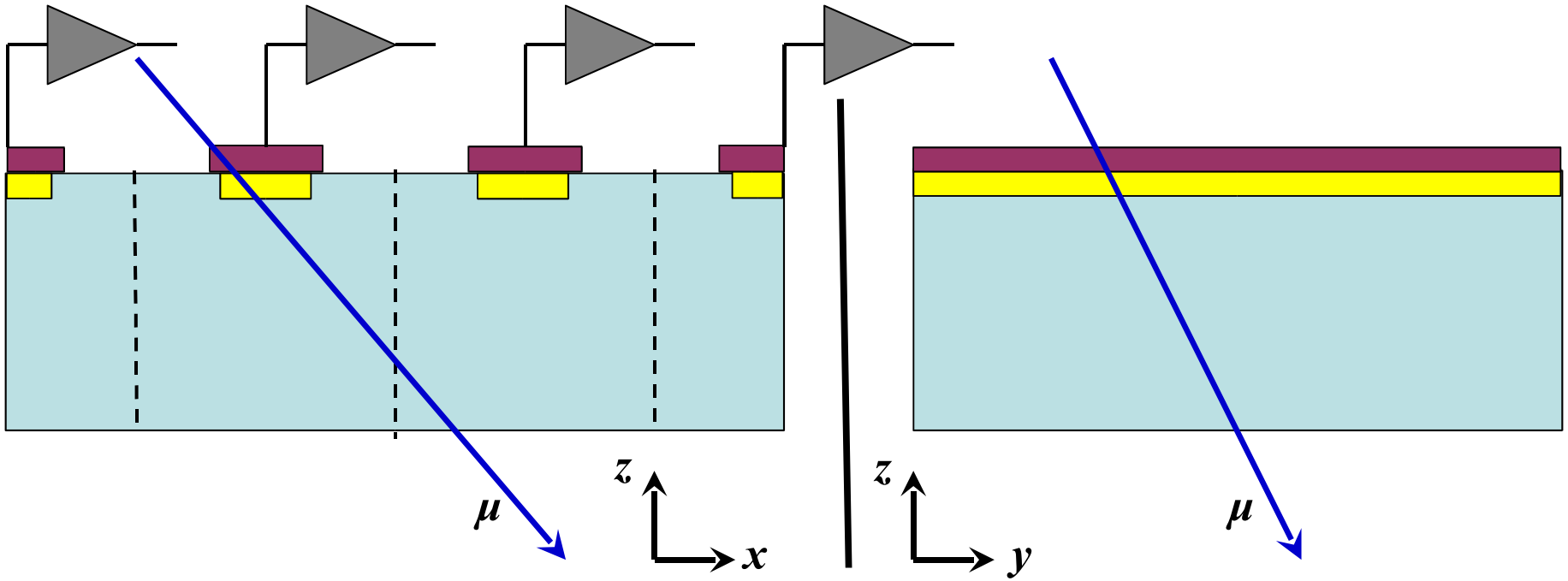




Average ToT exhibits a periodic dependence on φ (180° period)

- *X-view layers: maxima at 90° and 270°*
- *Y-view layers: maxima at 0° and 180°*

Track length and projected track length



- *ToT* is proportional to *maximum strip pulse amplitude*
- Pulse amplitudes on strips are proportional to the *fraction of track length* belonging to their sensitive volume

ToT depends on the *track length projected* along the strip view

ToT, track length and projected track length

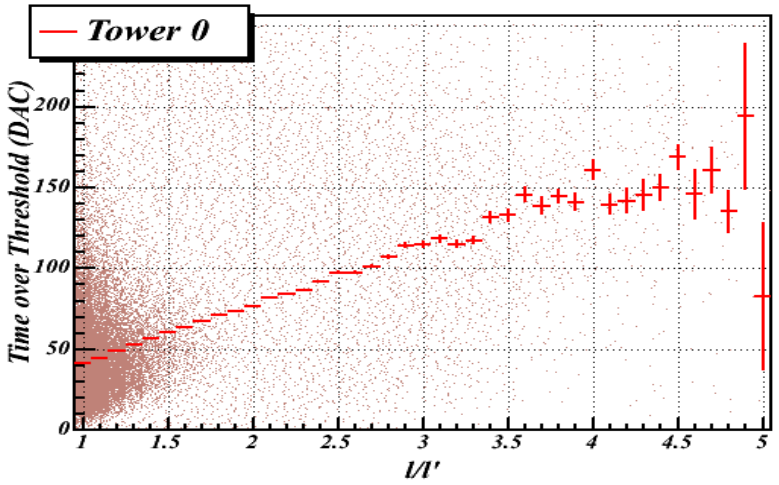
Study of the dependence of the ToT on cosθ → *The ToT is a function of the track length*

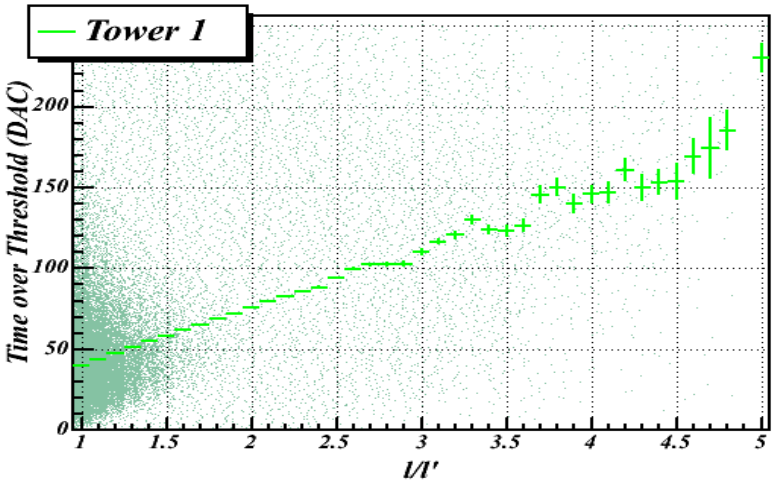
Study of the dependence of the ToT on φ → *The ToT is a function of the projection of the track length in the SSD plane*

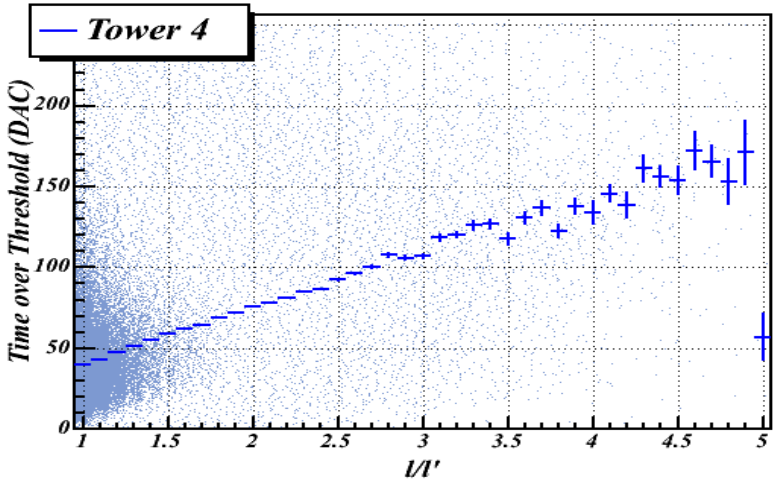
$$l' = \begin{cases} l\sqrt{\cos^2\vartheta + \sin^2\vartheta\cos^2\varphi}\ , & \text{for X layers} \\ l\sqrt{\cos^2\vartheta + \sin^2\vartheta\sin^2\varphi}\ , & \text{for Y layers} \end{cases}$$

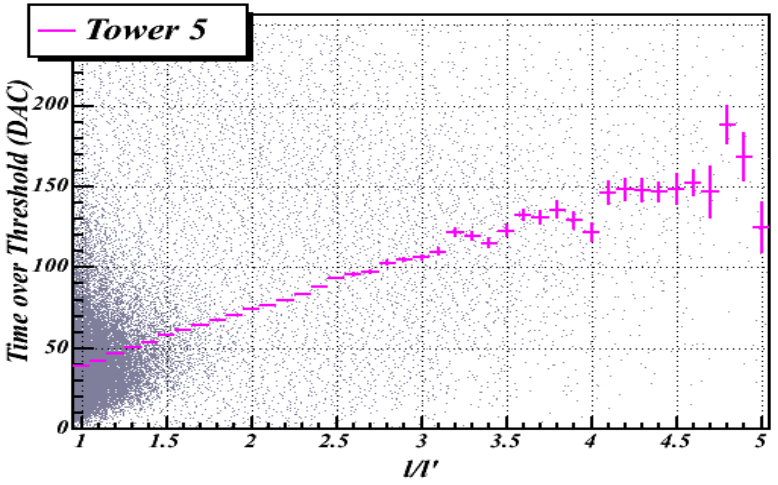
We have introduced a new variable: the ratio l/l'

ToT vs l/l' in track layers



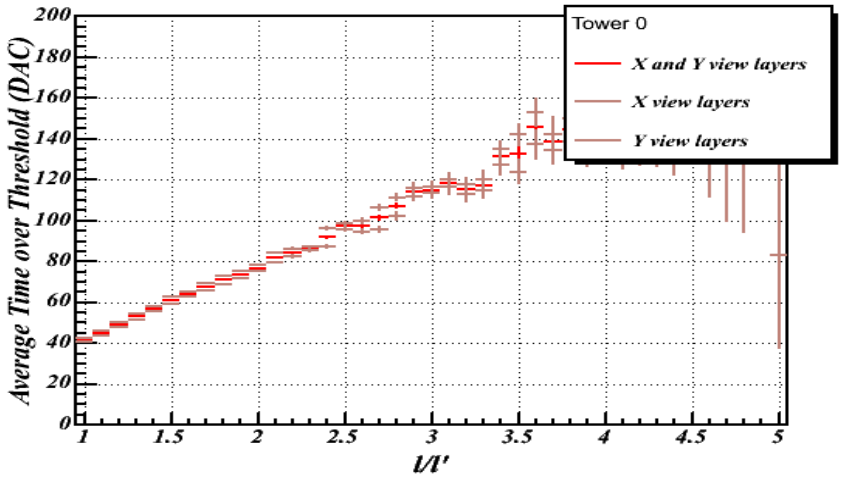


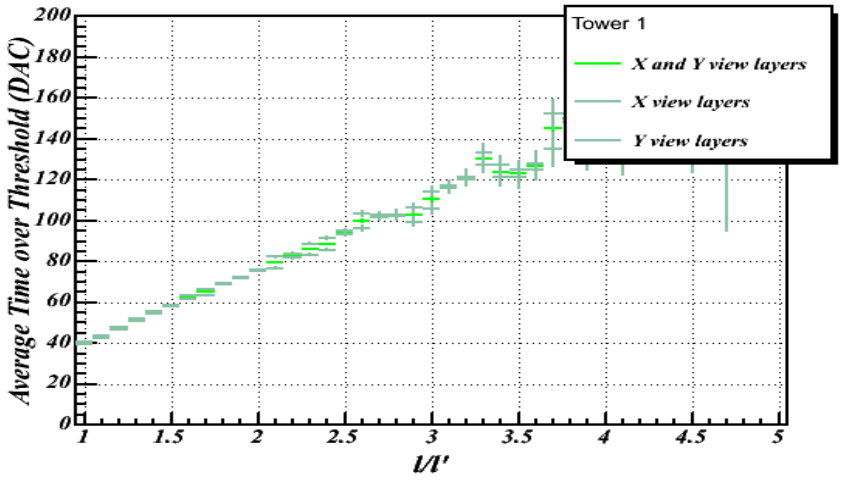


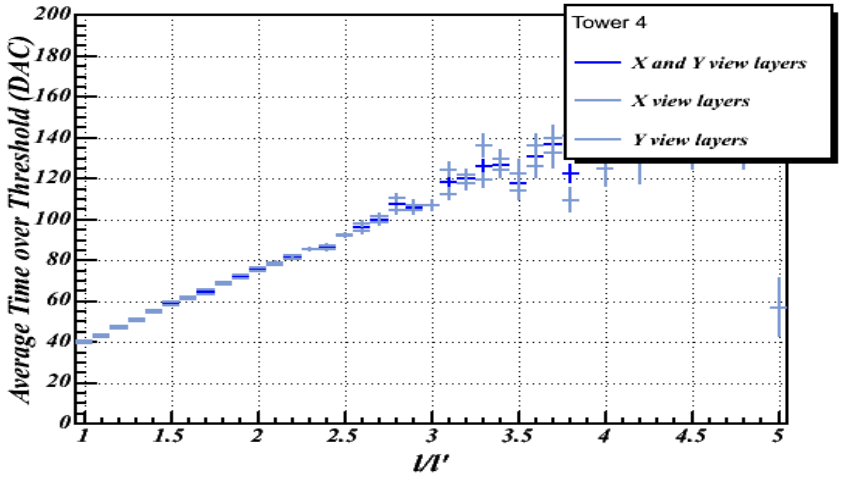


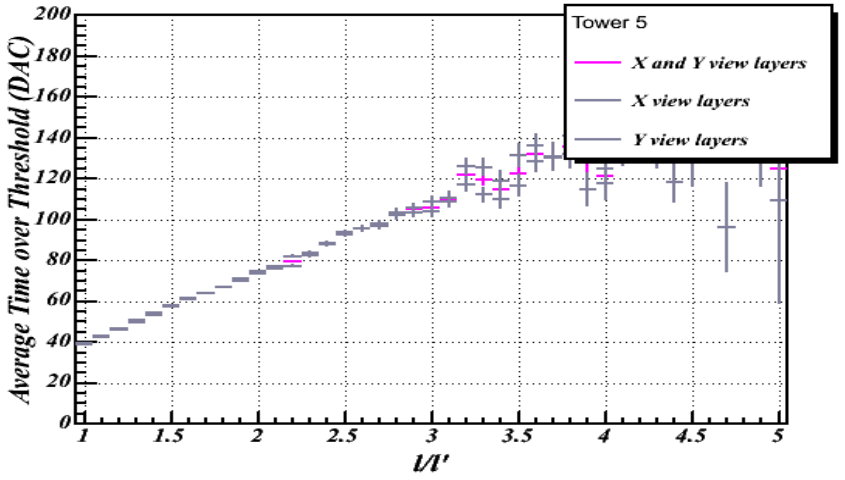
The ToT depends linearly on l/l' and increases with the same rate

ToT vs projected track length: X and Y views









No significant differences in ToT vs l/l' between X and Y view layers

Study of ToT overflows in track layers

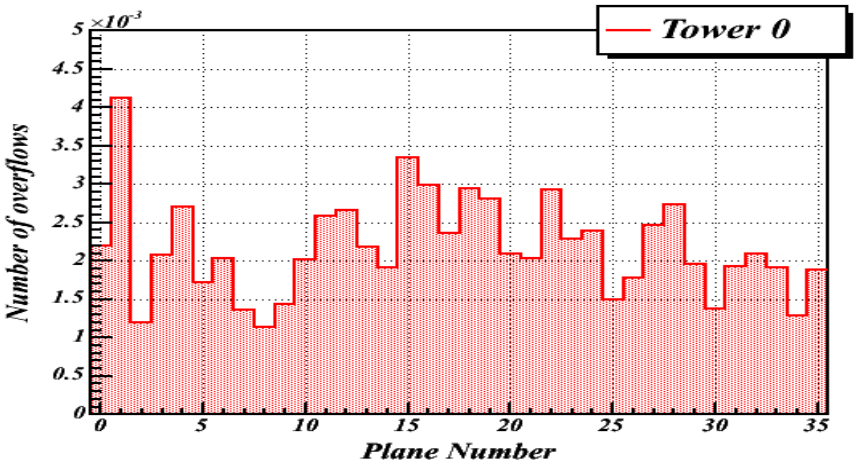
We have studied the ToT overflows as a function of:

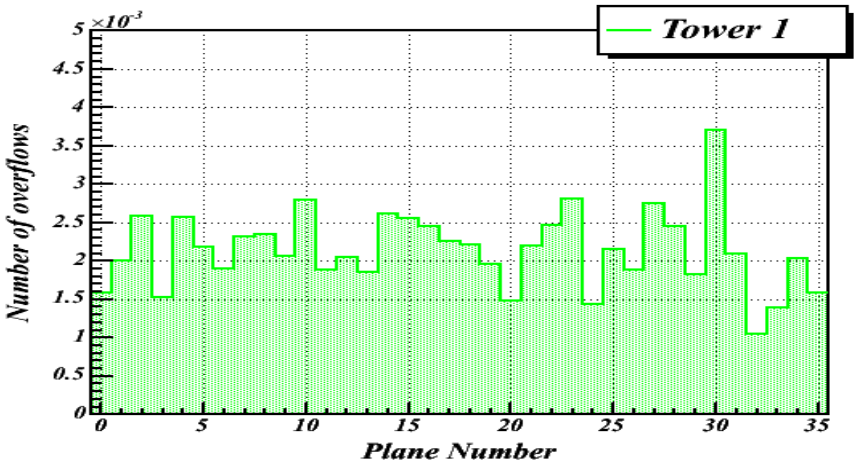
- *tower planes* ➡ *to look for eventual noisy planes*
- *track parameters (θ, φ)* ➡ *to search for eventual anomalies*

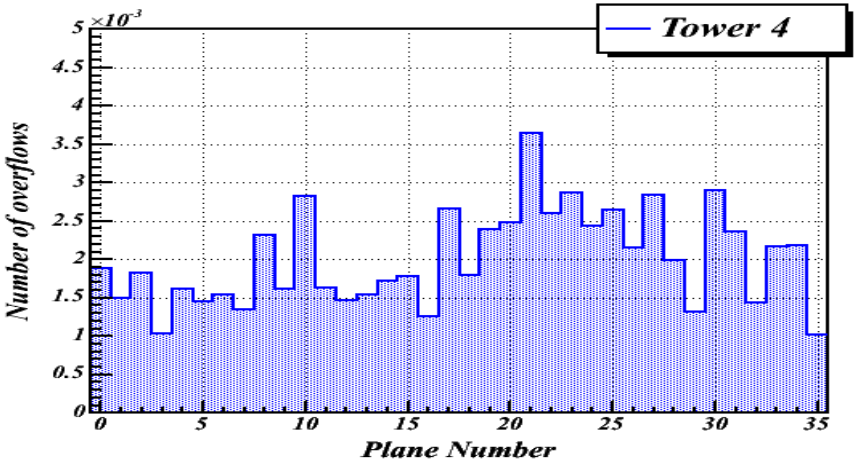
Experimental data show that:

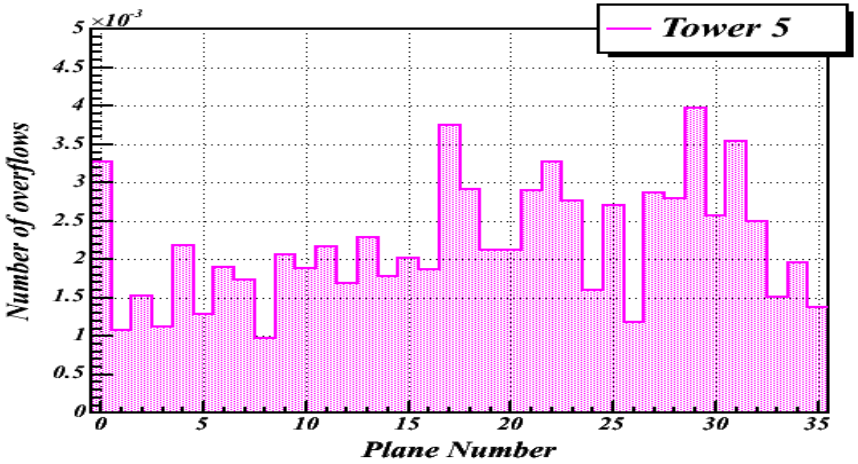
- *The fraction of overflows fluctuates among the planes*
- *As expected, the fraction of overflows increases with increasing track length*
- *The fraction of overflow shows a small dependence on the φ angle for the Tower 0 data sample* ➡ *small difference between the average response of X-view and Y-view layers*

ToT overflows in SSD layers



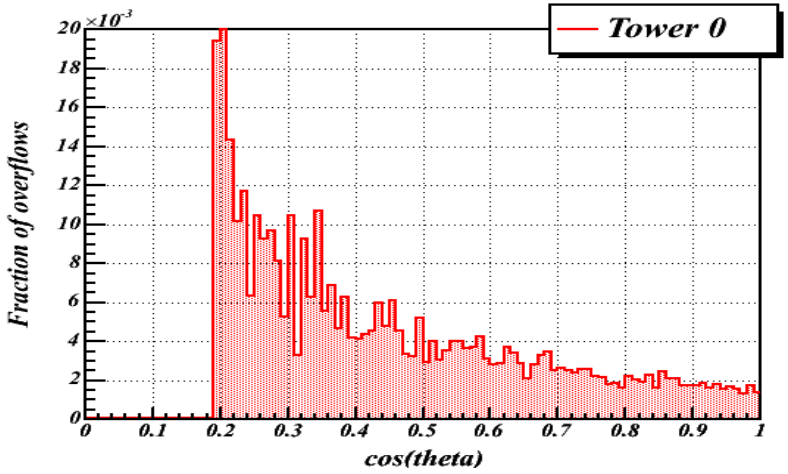


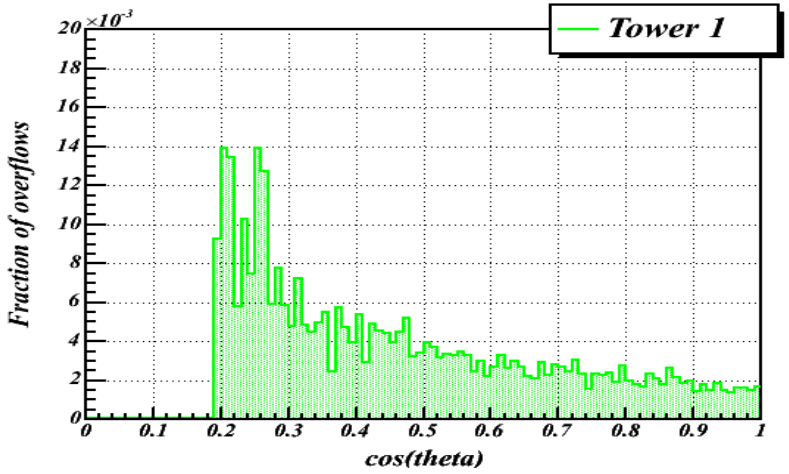


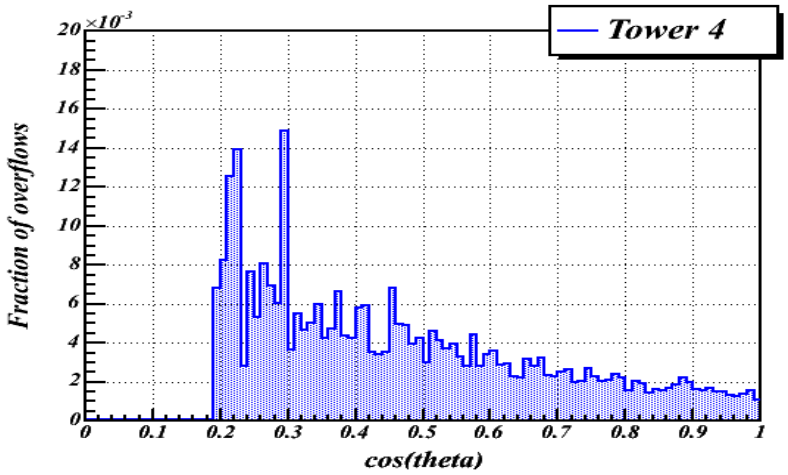


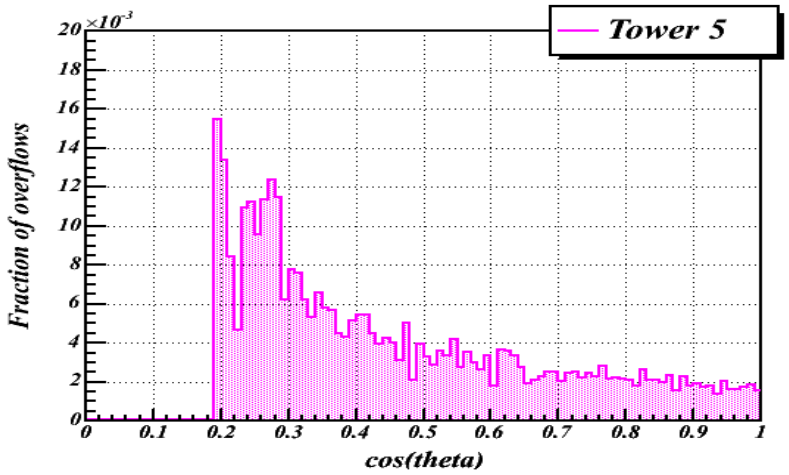
The average behavior of the 4 towers is the same. The number of overflows fluctuates among the planes

ToT overflows vs cosθ



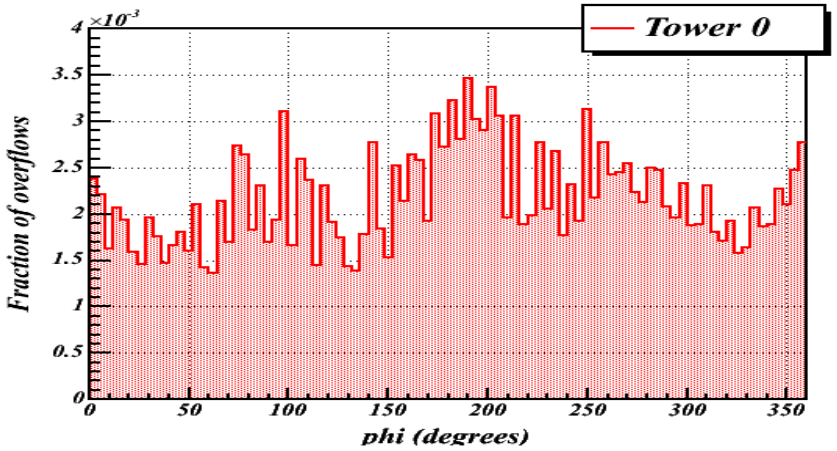


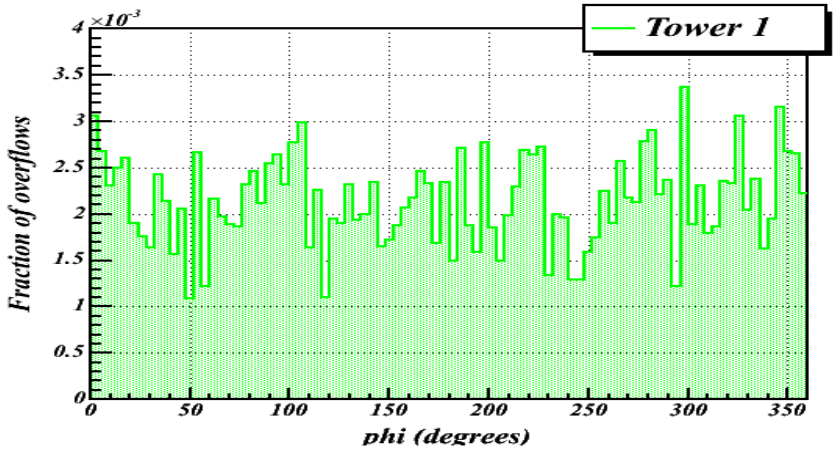


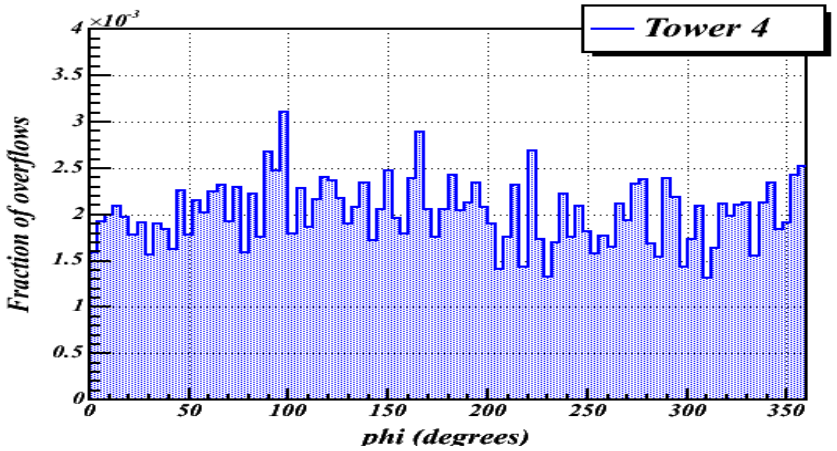


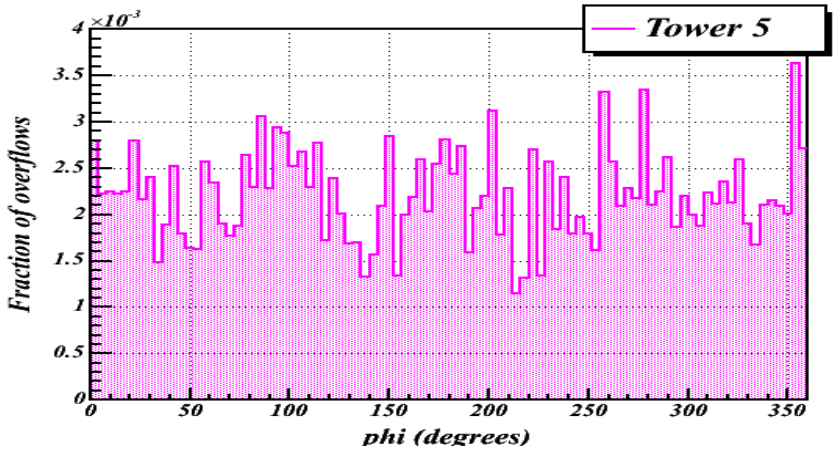
- *All towers exhibit the same behavior*
- *The fraction of ToT overflows increases with increasing track length*

ToT overflows vs φ









Fraction of overflows in Tower 0 seems to depend on φ with a period of 90° . This effect could be caused by small differences between the average behavior of SSDs in X-view and Y-view layers

ToT in triggering layers

Why studying ToT in triggering layers?

To generate a trigger, a coincidence among 3 layers (6 planes) in a row is requested ⟹ *the probability of a noisy plane being involved in the trigger is negligible*

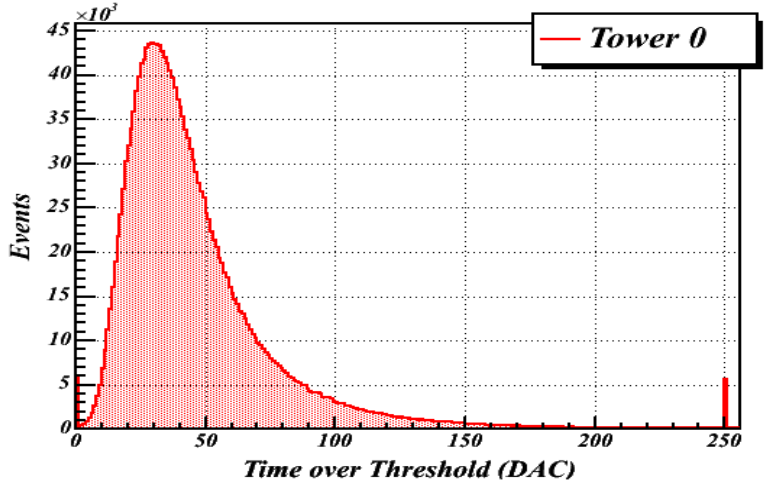
The study of hit distributions in triggering layers allows to get an estimate of the SSD hit capture efficiency

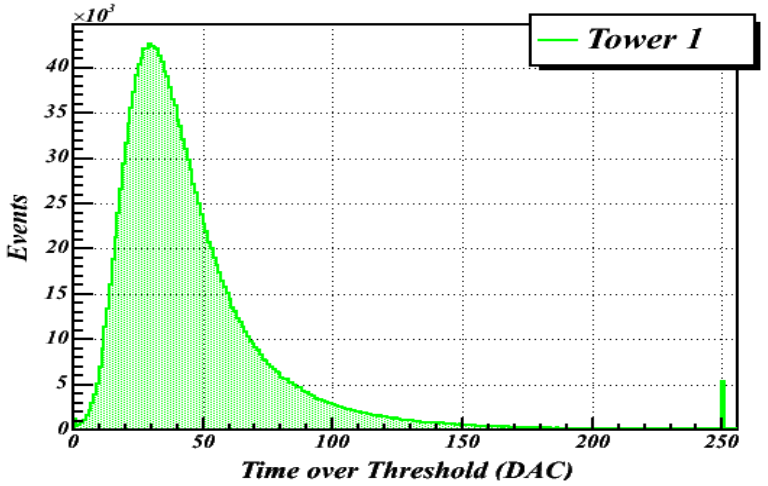
Which are the triggering layers?

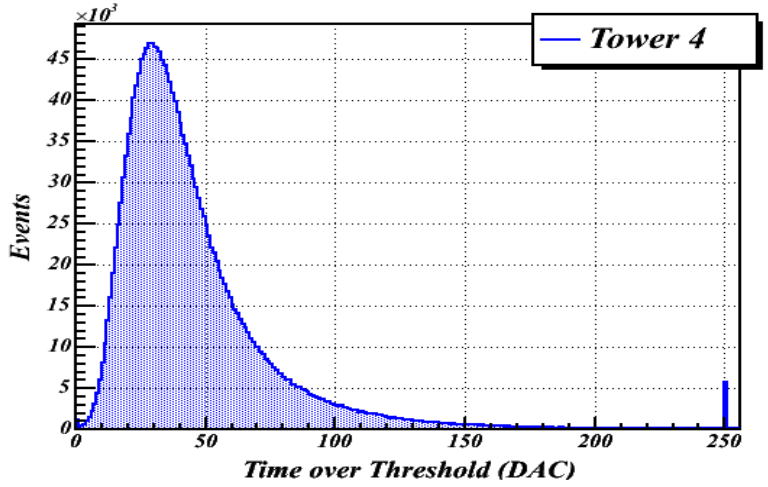
Actually, we assume that triggering layers are the ones from GltLayer to GltLayer+2

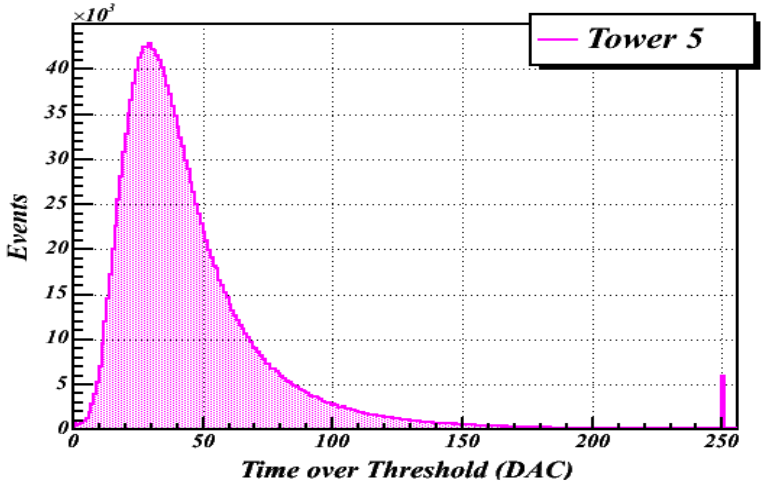
we know that GltLayer corresponds to the first layer of the lowest "3 in a row" possible combination

ToT distributions in triggering layers









In this case events with ToT = 0 have been included!

Estimate of hit capture efficiency

Hit capture efficiency:

$$\varepsilon = 1 - \frac{events\ with\ ToT = 0}{total\ events}$$

Tower 0: $1-\varepsilon = 3.0\times10^{-3}$

Tower 1: $1-\varepsilon = 0.7\times10^{-3}$

Tower 2: $1-\varepsilon = 0.6\times10^{-3}$

Tower 3: $1-\varepsilon = 0.5\times10^{-3}$

Conclusions

The ToT distributions can be fitted with Landau functions

The dependence of ToT on the track parameters θ and φ has been investigated

- *The ToT increases linearly with 1/cosθ*
- *The ToT increases linearly with l/l'*

An analysis of the ToT overflows has been performed

The ToT in triggering layers has been studied

- *Hit capture efficiencies of all LAT Towers are > 99%*

Requests & future plans

ToT conversion in charge units (fC)

to provide an absolute measurement of energy deposited in SSDs for all strips

as a feedback for the simulations

Information, in the digi files, about the hit positions (a pair of xz or yz coordinates related to each hit)

to study single strip efficiencies

to perform further studies:

- *analysis of spurious hits*
- *search for stopping muons*
- *…*