ToT analysis on the full LAT data sample

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Overview

- *Study of the ToT in the full LAT cosmic ray data samples*
  - *ToT distributions in triggering and track layers*
  - *evaluation of the hit capture efficiency*
  - *Study of the ToT as a function of the track parameters (θ,φ)*
  - *Study of the ToT uniformity in TKR towers*
  - *Comparison with previous data*
- *Comparison of experimental data with MC simulation*
  - *Hit strip multiplicity*
  - *ToT distributions*
- *Study of ToT overflows*

List of the runs analyzed

A data samples of 20 runs has been analyzed:

135005345, 135005347, 135005349, 135005351, 135005355, 135005357, 135005359, 135005363, 135005365, 135005367, 135005371, 135005373, 135005375, 135005377, 135005379, 135005381, 135005383, 135005385, 135005387, 135005389

These runs have been performed on Jan 14-15, 2006 in the B2 configuration

Event selection & definitions

Event Selection:

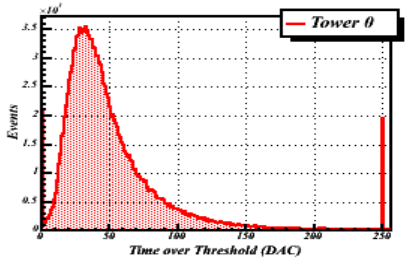
- ***Trigger from 3 consecutive layers: GemConditionWord = 2***
- ***Single tower events: GemTkrVector[tower] ≠ 0 for only one tower***
- ***Single muon tracks in the TKR: TkrNumTracks=1***

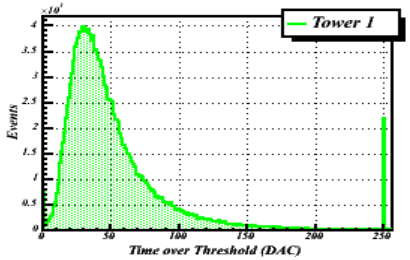
***Triggering Layers** = Layers in both views from **GltLayer** (First Triggering Layer) to **GltLayer+2** (Last Triggering Layer)*

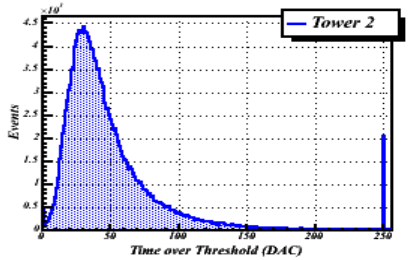
***Track Layers** = Layers in both views from **Tkr1FirstLayer** (First layer in the track) to **Tkr1LastLayer** (Last layer in the track)*

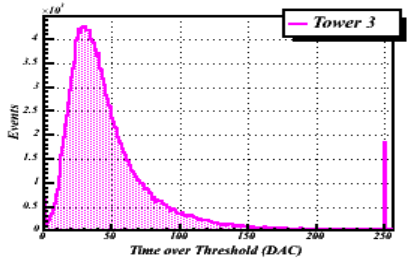
$$ToT = \begin{cases} 0 & \text{if both left and right ToT} = 0 \text{ or NA} \\ \text{left ToT} & \text{if right ToT} = 0 \text{ or NA} \\ \text{right ToT} & \text{if left ToT} = 0 \text{ or NA} \\ \text{left and right ToTs} & \text{if both left and right ToTs} > 0 \end{cases}$$

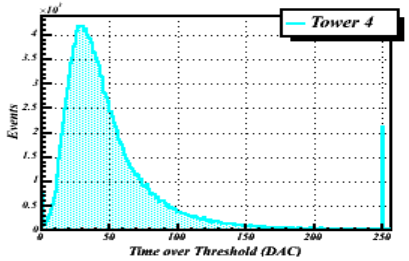
ToT distributions for triggering layers

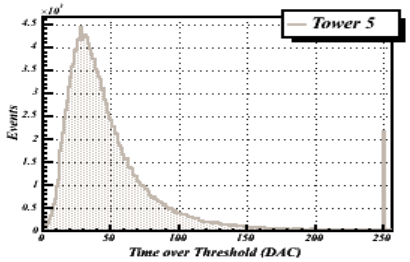


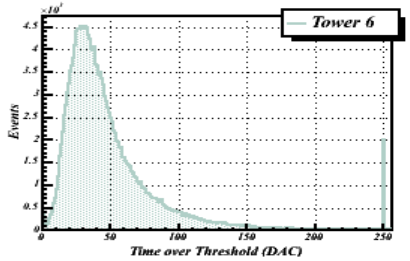


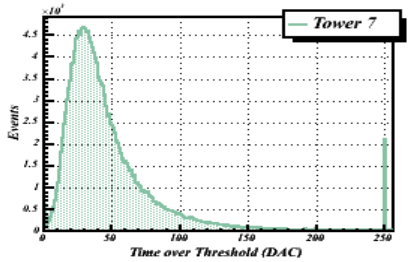


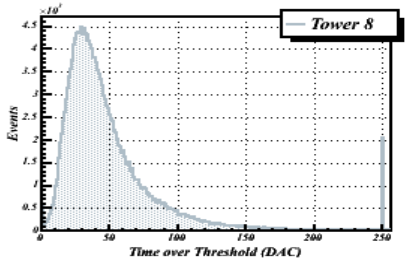


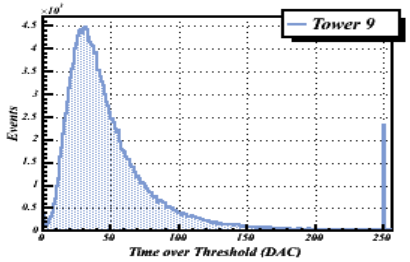


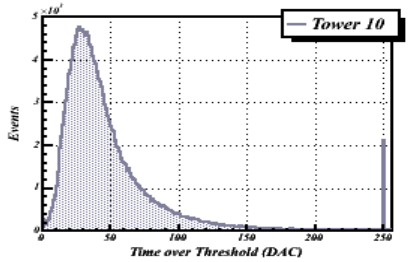


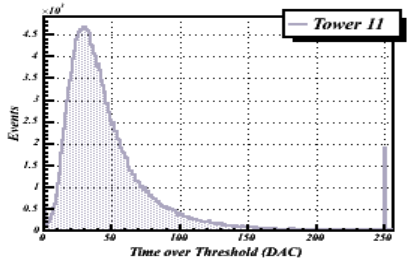


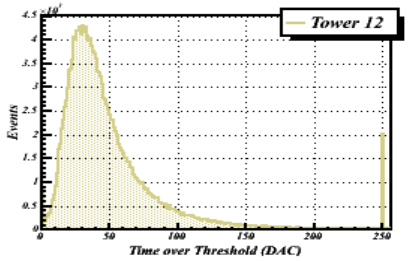


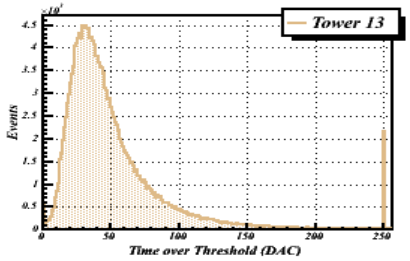


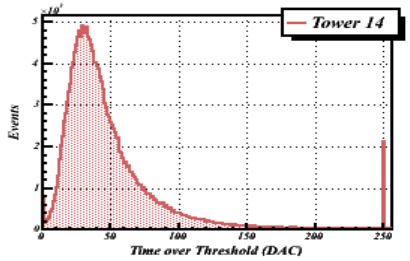


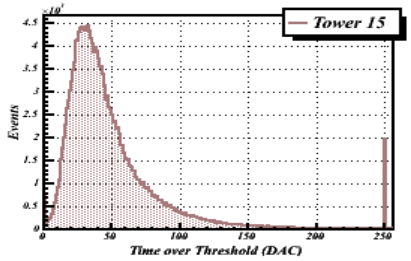










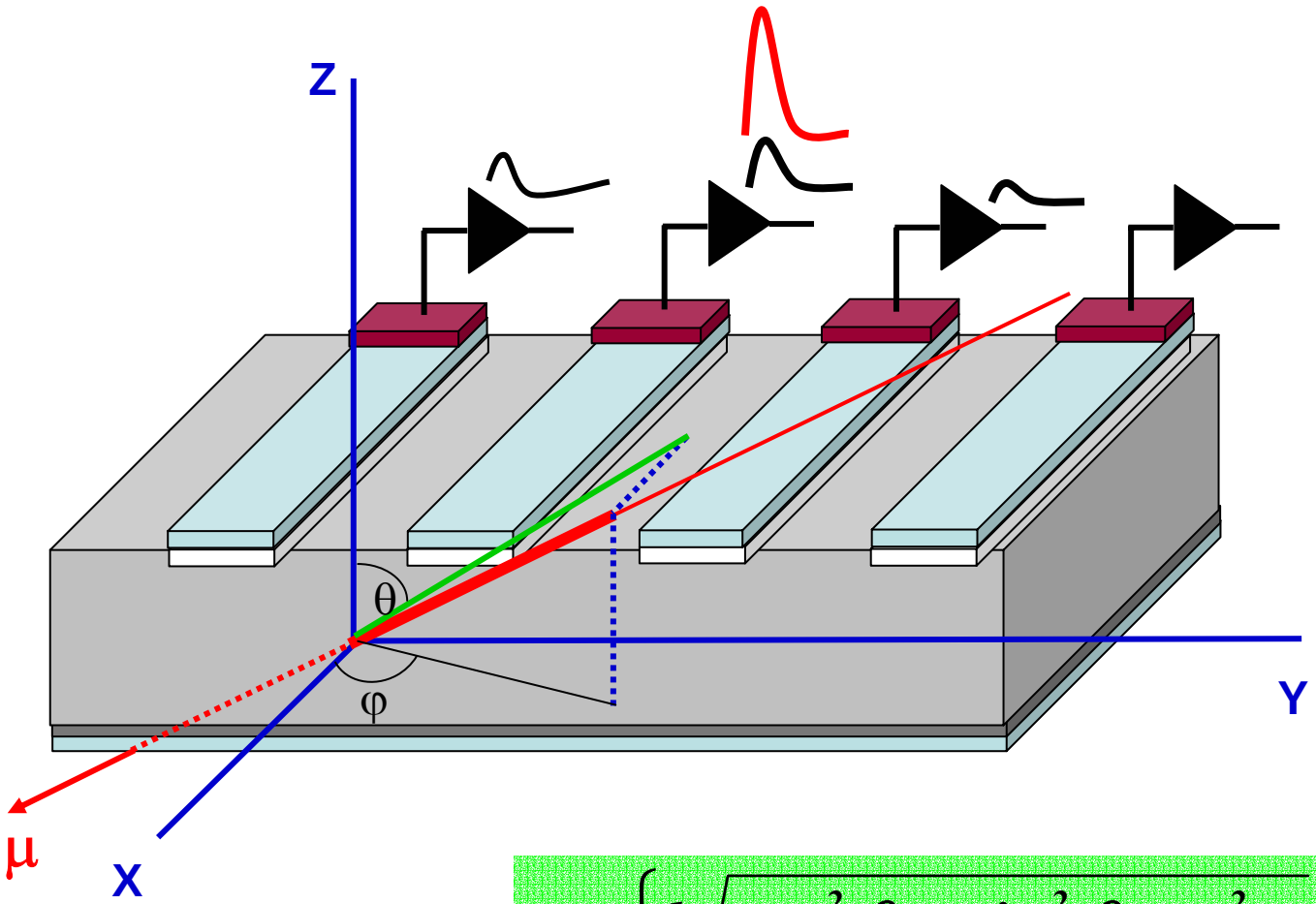


Evaluation of the hit capture efficiency

$$1-\varepsilon = f(ToT = 0)$$

Bay ID	$1-\varepsilon$ ($\times 10^2$)	Bay ID	$1-\varepsilon$ ($\times 10^2$)	Bay ID	$1-\varepsilon$ ($\times 10^2$)	Bay ID	$1-\varepsilon$ ($\times 10^2$)
0	1.2	4	0.4	8	0.3	12	0.4
1	0.4	5	0.2	9	0.2	13	0.3
2	0.4	6	0.2	10	0.1	14	0.4
3	0.4	7	0.3	11	0.3	15	0.4

ToT vs track parameters



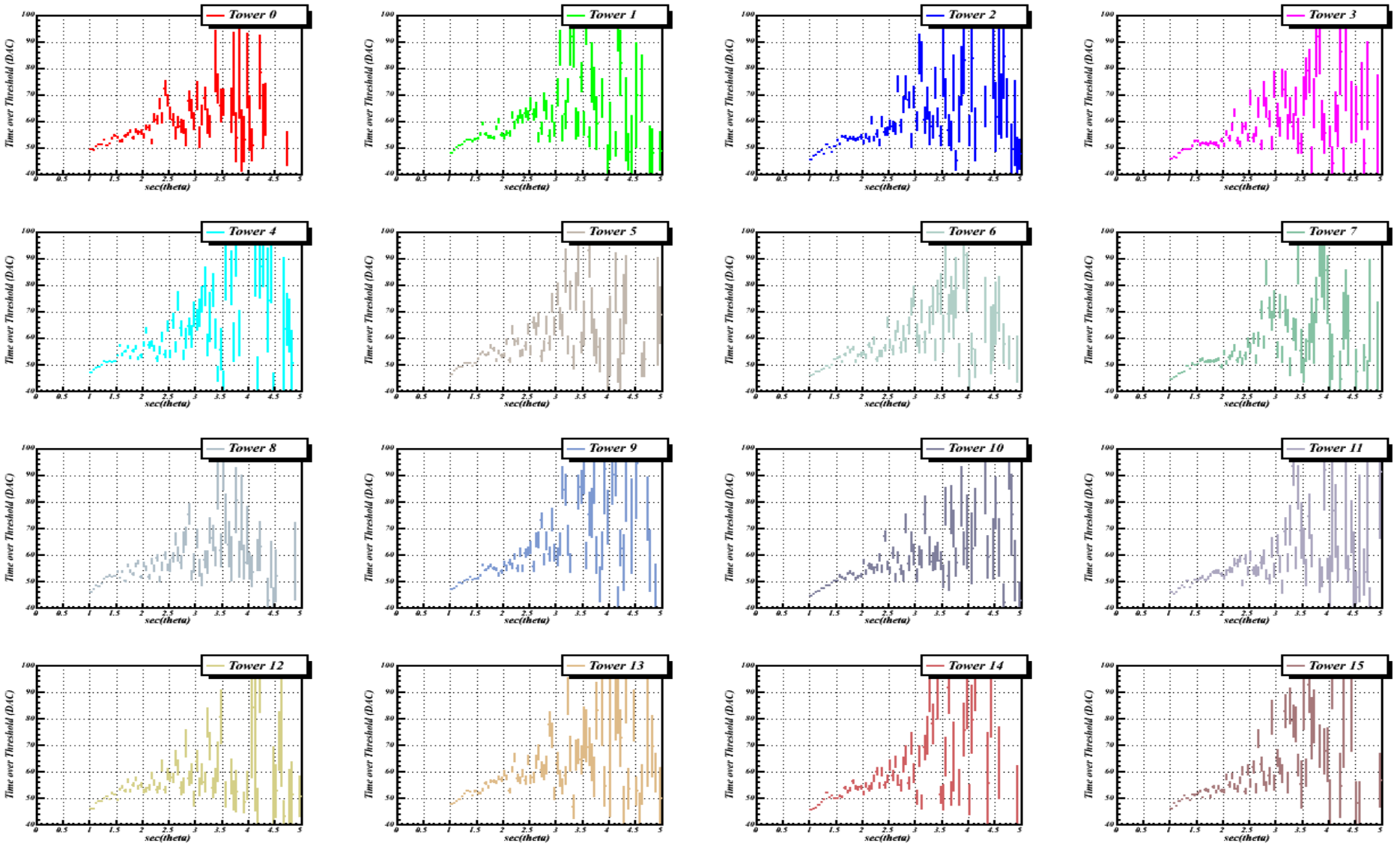
Track length

$$l \propto 1/\cos\vartheta$$

Projected track length

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

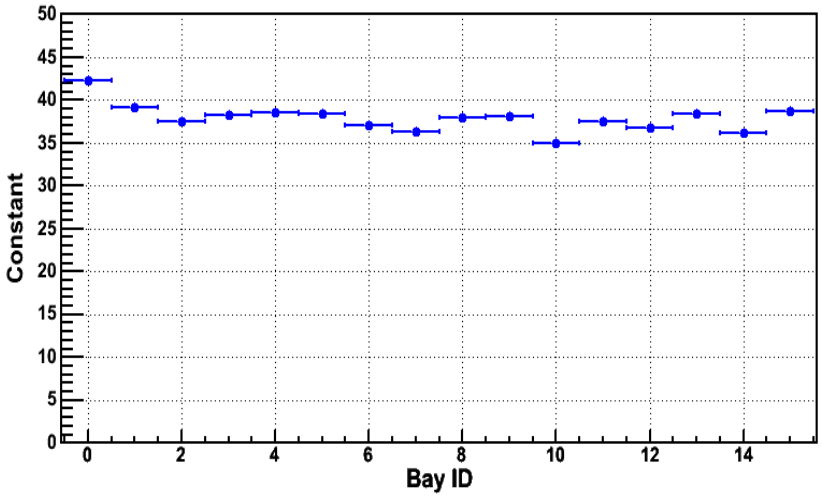
ToT vs zenith angle

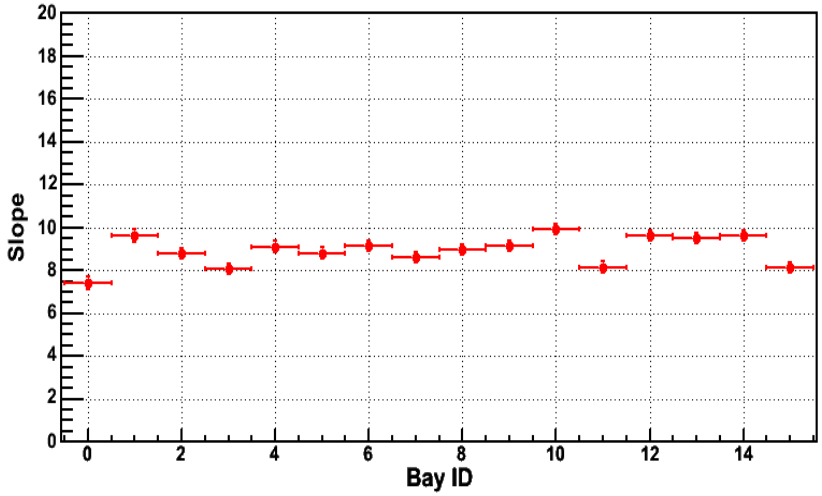


ToT vs zenith angle: linear fit results

The previous histograms have been fitted with a linear function:

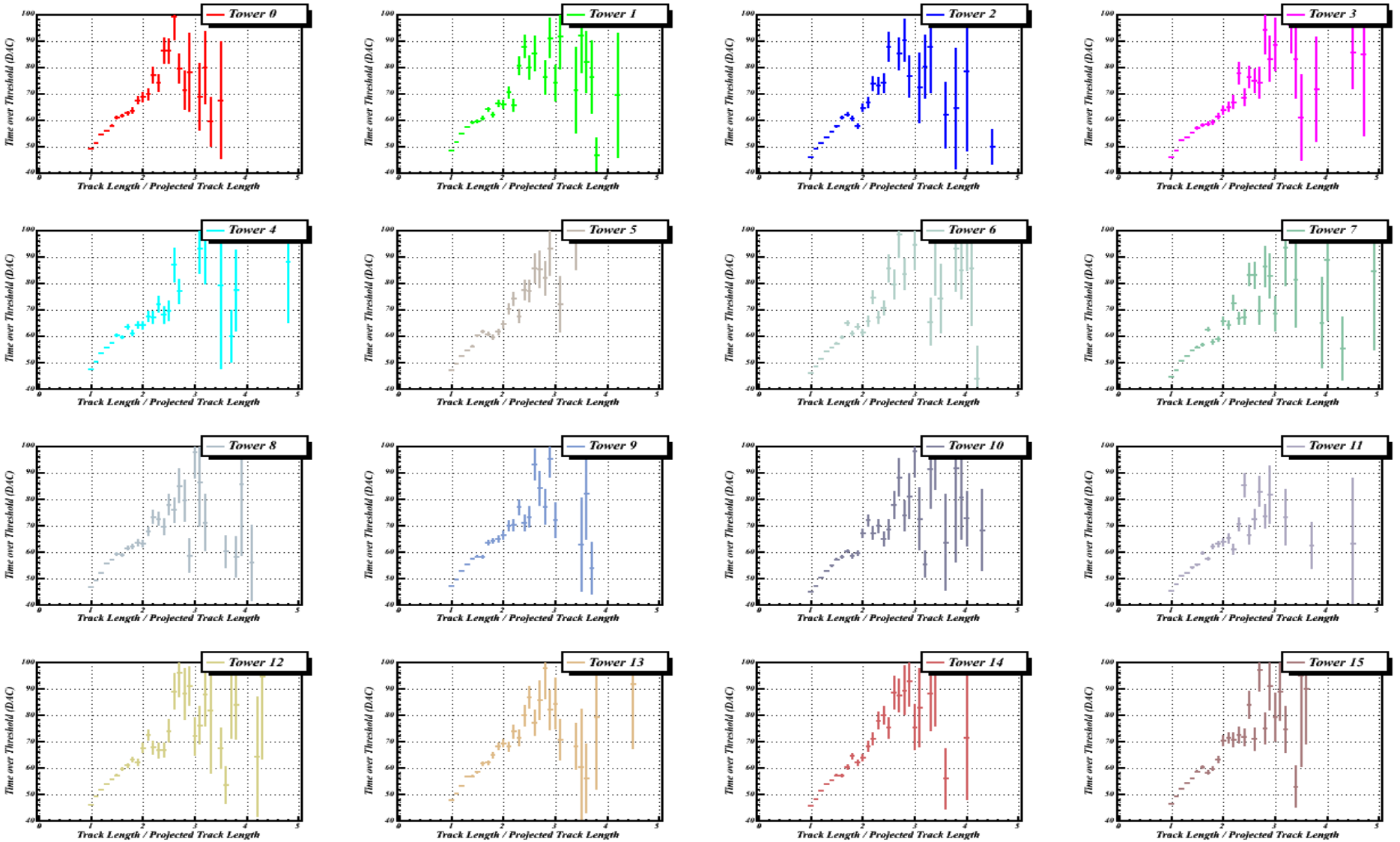
$$ToT = a + b/\cos\vartheta$$





As expected, the fit results are similar for all integrated towers.

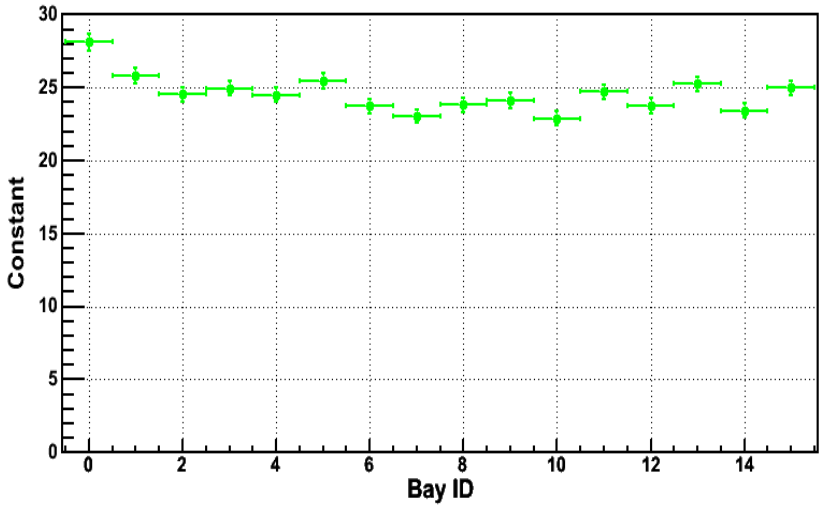
ToT vs l/l'


Tower 0
Tower 1
Tower 2
Tower 3
Tower 4
Tower 5
Tower 6
Tower 7
Tower 8
Tower 9
Tower 10
Tower 11
Tower 12
Tower 13
Tower 14
Tower 15
Time over Threshold (DAC)
Track Length / Projected Track Length

ToT vs l/l': linear fit results

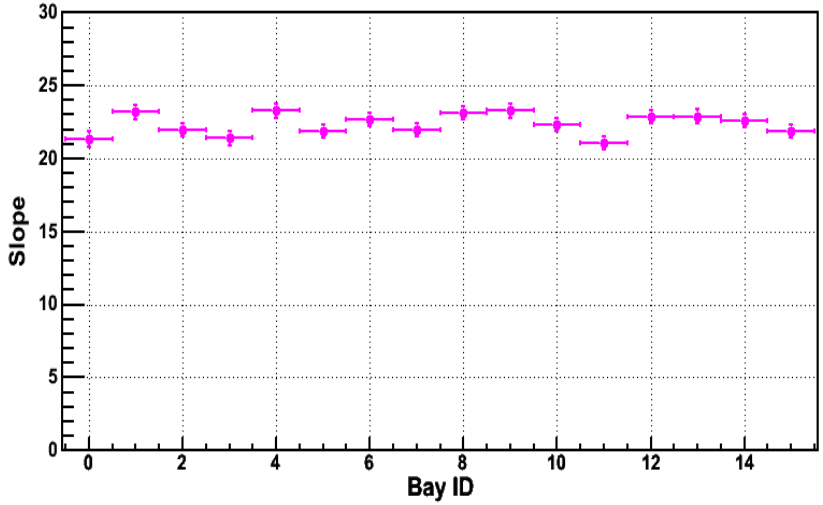
The previous histograms have been fitted with a linear function:

$$ToT = a + b(l/l')$$

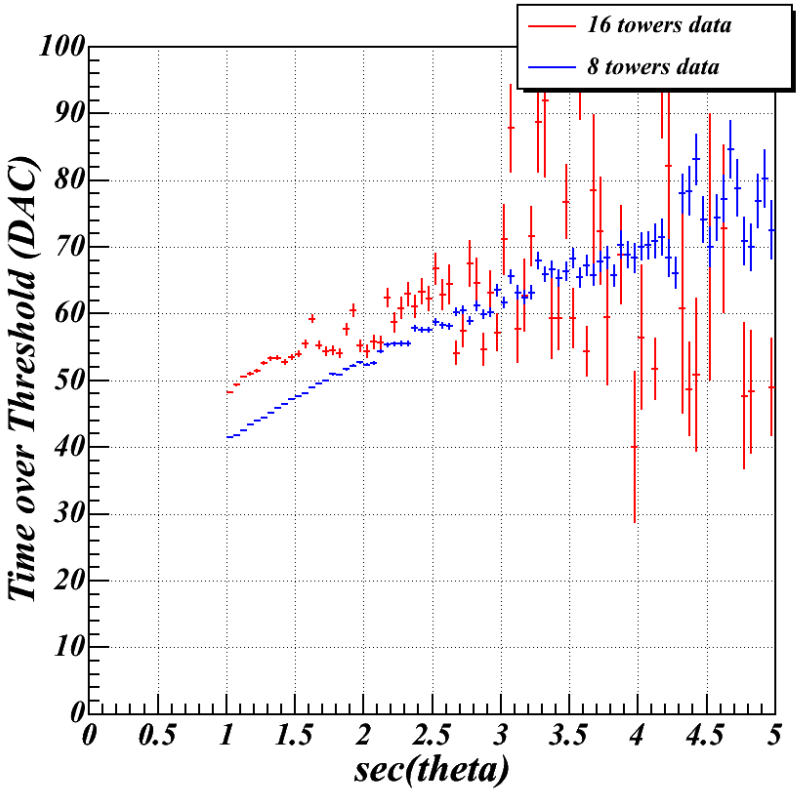


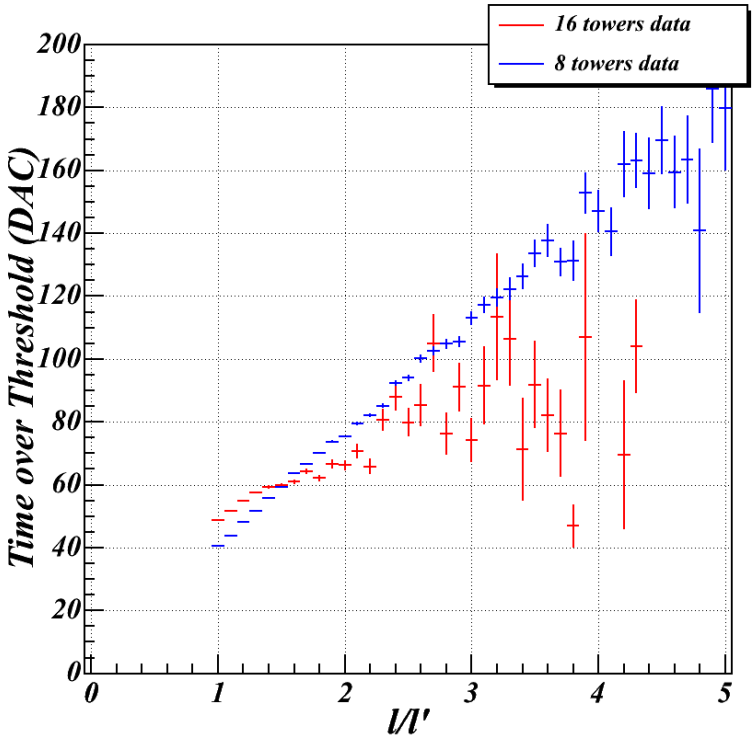
The slope and the constant have almost the same value: the ToT increases with l/l'

Again, the fit results are almost similar for all integrated towers.



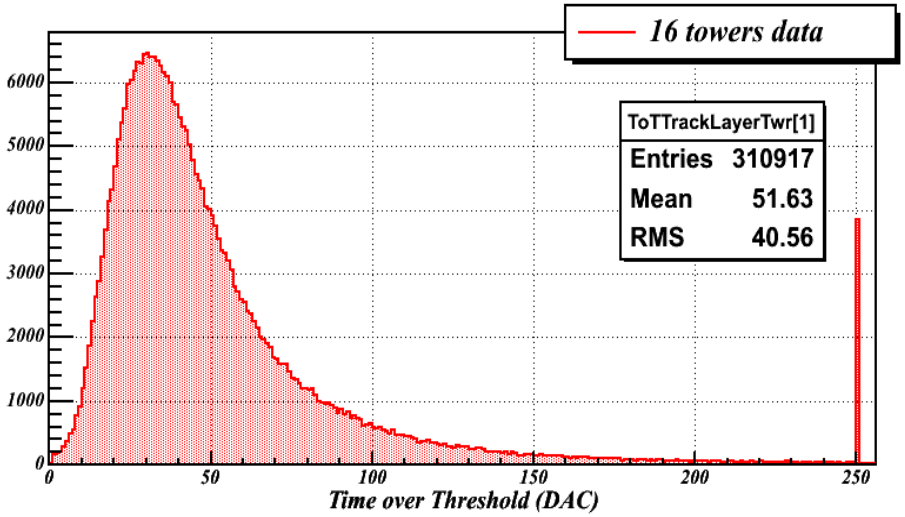
Everything ok? Let's take a look at previous data ...

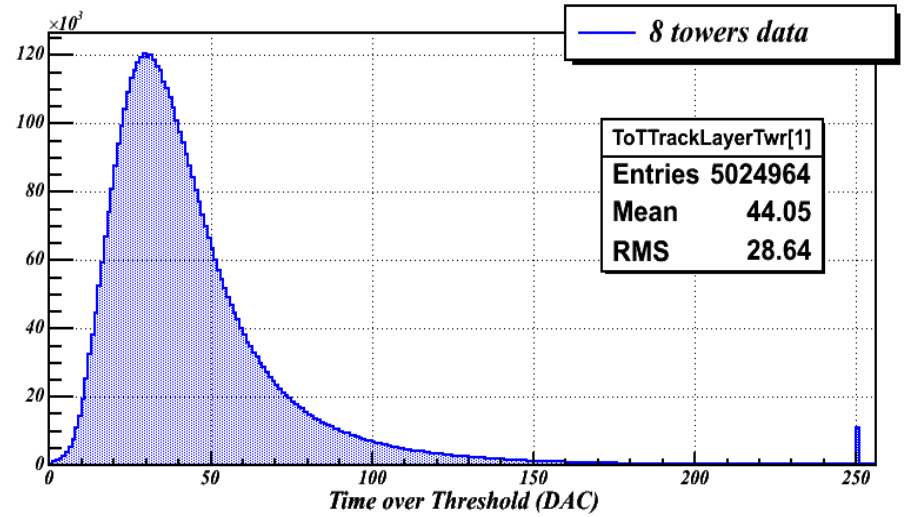




There are large discrepancies with previous data! Where do they come from?

And the ToT distributions?





ToT distributions look different:

- ***slightly higher peak value***
- ***more overflows***

What has changed?

The ACD!!!

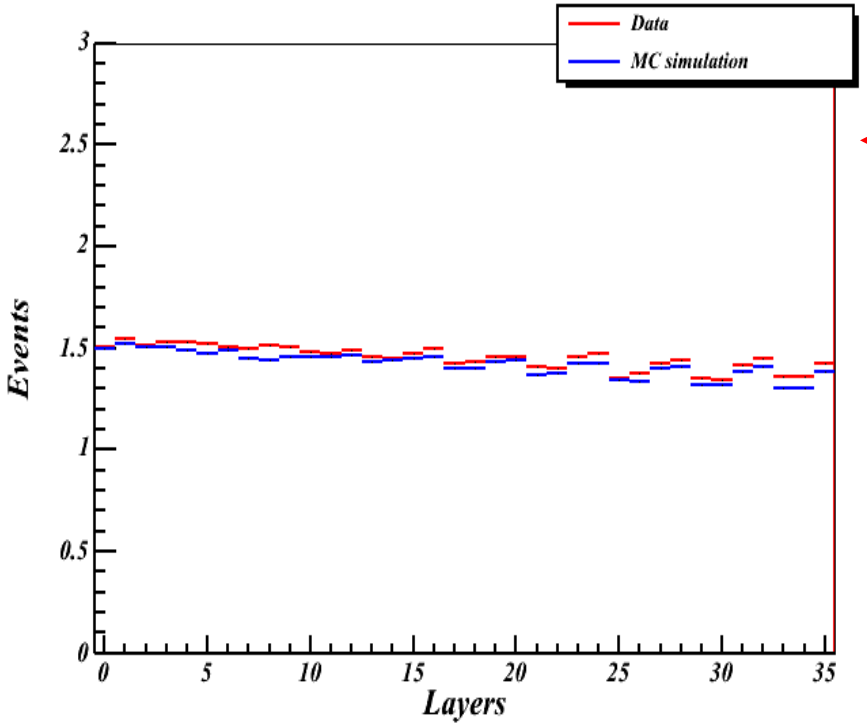
With GemConditionWord==2 we are selecting muon events which did not hit the ACD!!!

The analysis will be repeated asking GemConditionWord==3

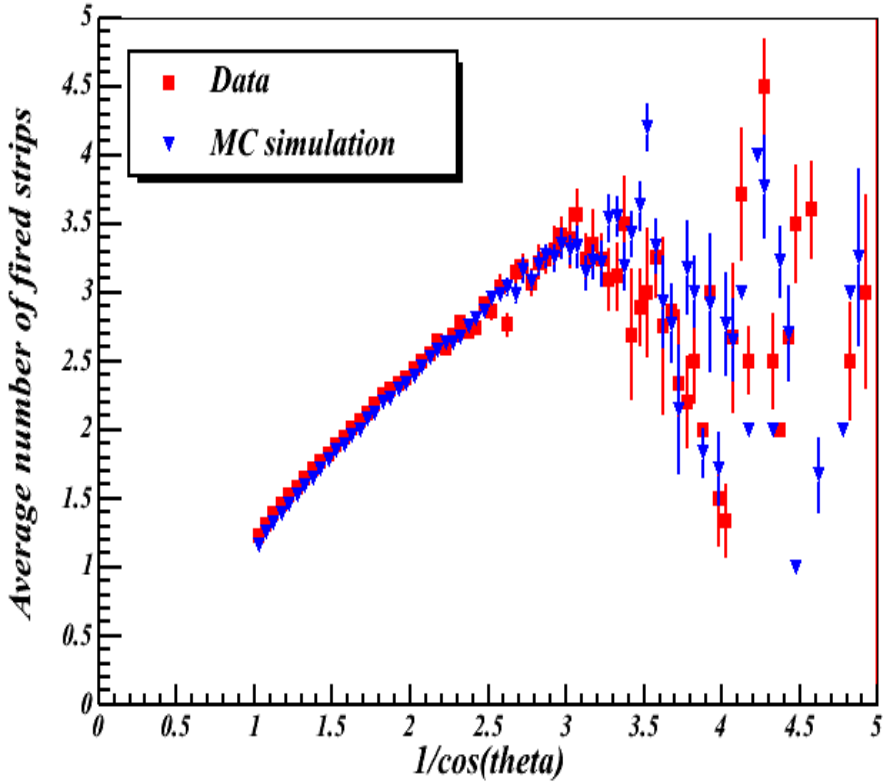
Data-MC comparison

- ***We used the cosmic ray data sample in the 8 Towers LAT configuration (Merit and SVAC N-tuples). The event selection criteria were the "usual" ones:***
  - ✓ ***events triggered only by the TKR;***
  - ✓ ***only single muon tracks;***
  - ✓ ***minimum ionizing particles***
- ***We studied the dependence of the hit strip multiplicity and of the ToT distributions on the zenith angle.***
- ***We used the MC surface muon simulated data samples (surface_muons_1M_merit.root and surface_muons_1M_svac.root)***

Data-MC comparison: hit strip multiplicity

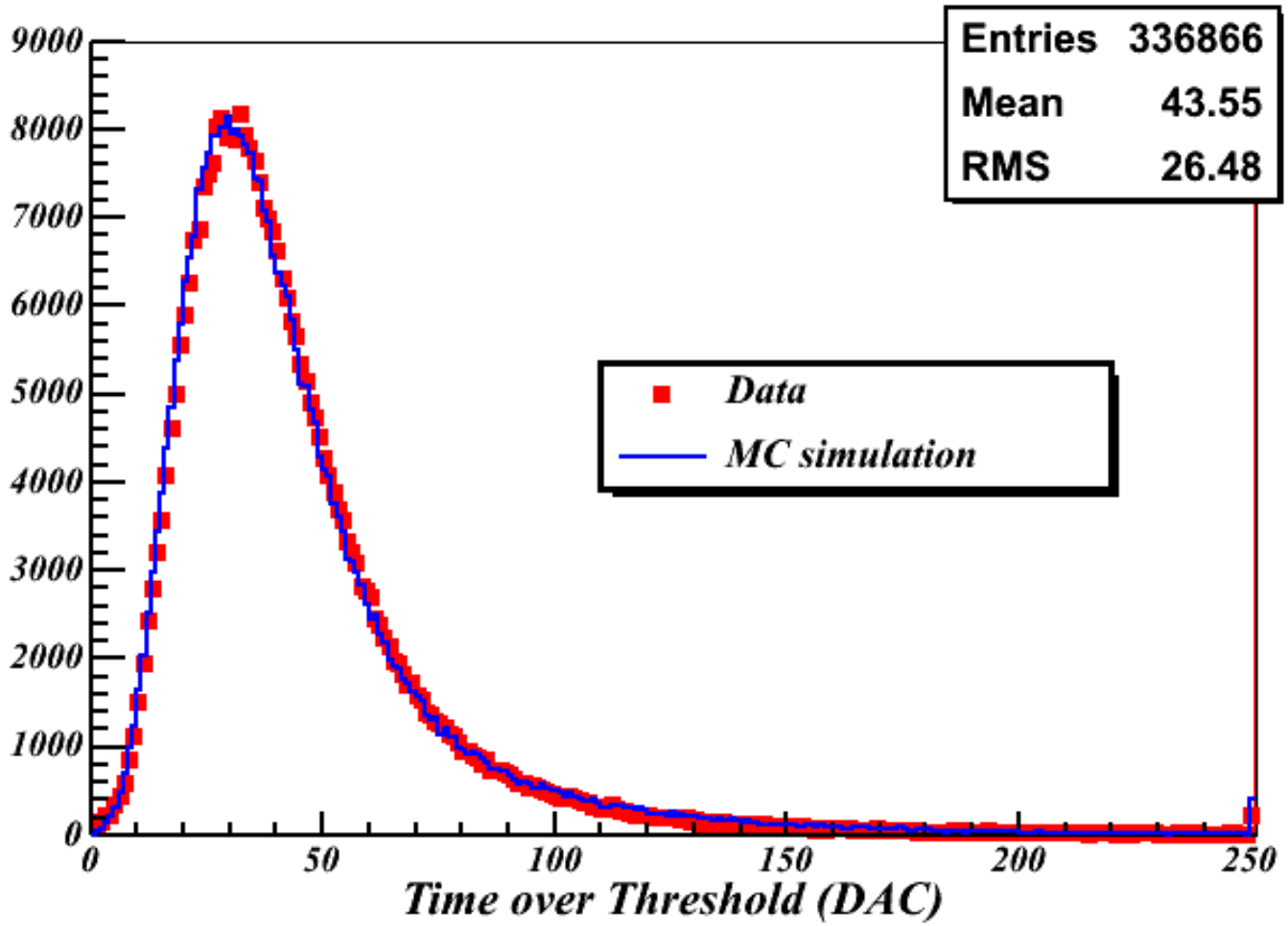


Muon flux



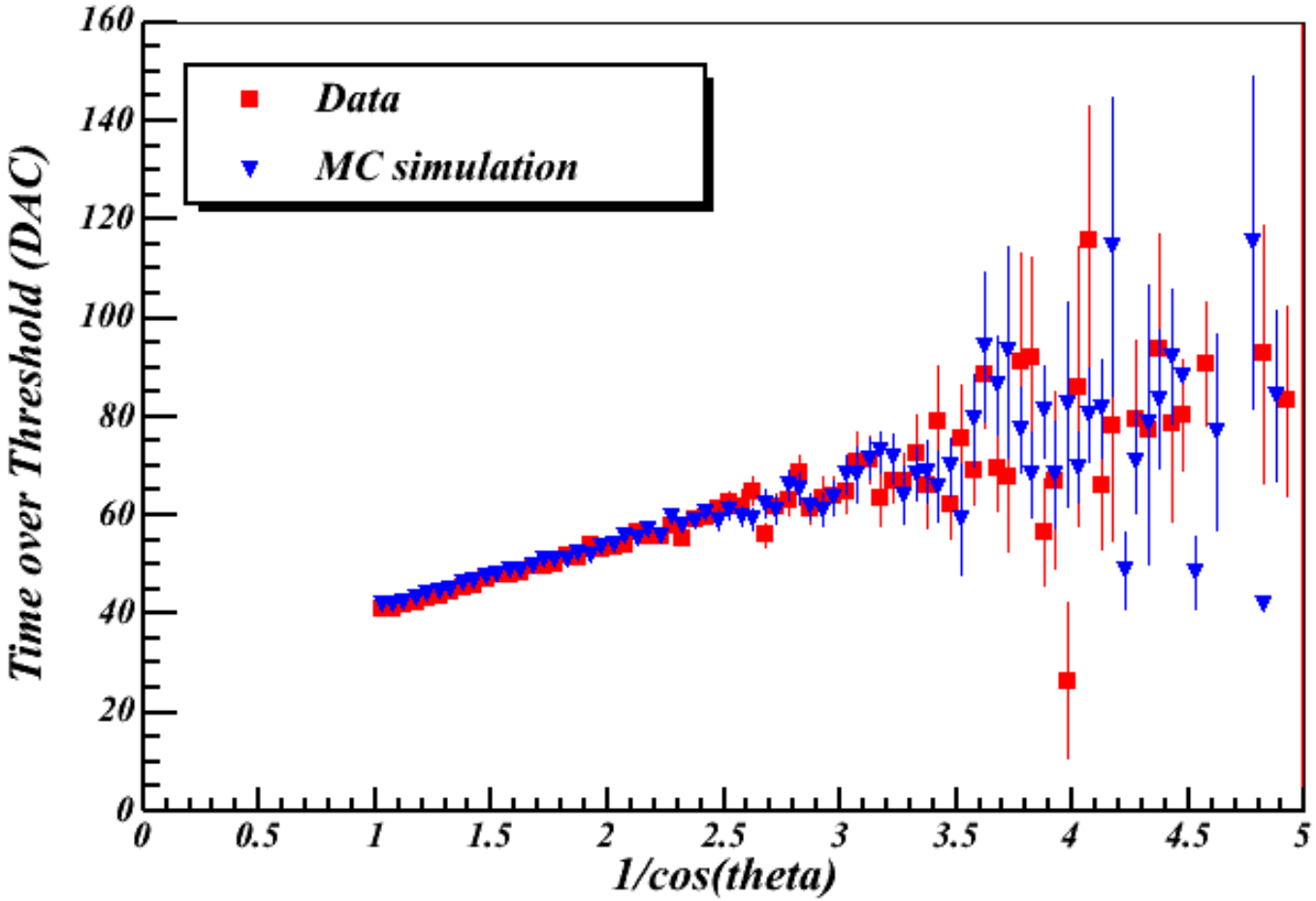
- *Experimental hit strip multiplicities are well reproduced by the simulation*
- *MC also reproduces the dependence of hit strip multiplicity on zenith angle*

Comparison of the ToT distributions



The MC simulation reproduces the measured ToT distribution ...

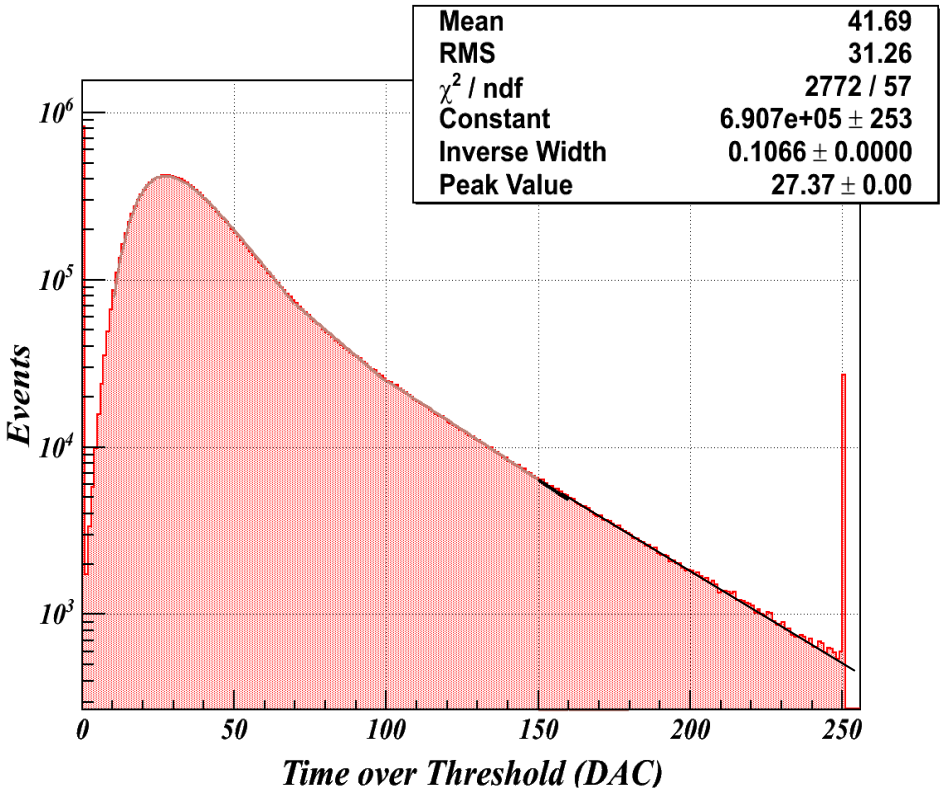
Data-MC comparison: ToT vs zenith angle



... and also the ToT angular dependence !

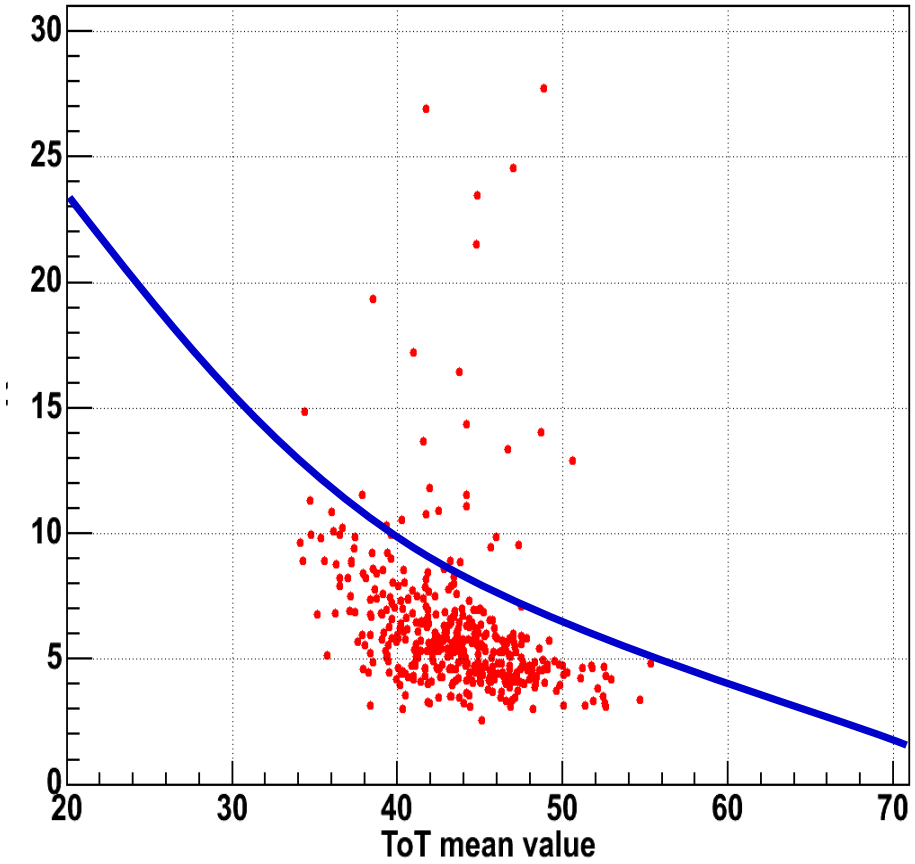
Study of Saturated ToT events

- We fitted the ToT distributions with different Landau functions in different ranges
- We calculated:
  - N = # of events with ToT above 250 DAC
  - F = # of events with ToT above 250 DAC, as expected from the fit function extrapolated to the tail of the distribution
  - R = N/F



Study of Saturated ToT events (2)

- We plotted R vs the mean (and also vs the peak value) of the ToT distributions
- Layers with R values above the blue curve can be considered "suspect"!
- The R variable can be used as a diagnostic tool



Conclusions

- *Analysis of the ToT distributions on the full LAT data sample*
  - ✓ *estimate of the hit capture efficiency*
  - ✓ *investigation of the ToT dependence on track parameters*
  - ✓ *uniformity of the TKR response*
  - ✓ *discrepancies with previous data... investigation in progress!!!*
- *Comparison of data with MC predictions*
  - ✓ *simulations reproduce both hit strip multiplicity and ToT data in the 8-tower configuration*
  - ✓ *investigation in progress on the full LAT configuration*
- *Study of the ToT overflows*
  - ✓ *the R variable as a diagnostic tool*