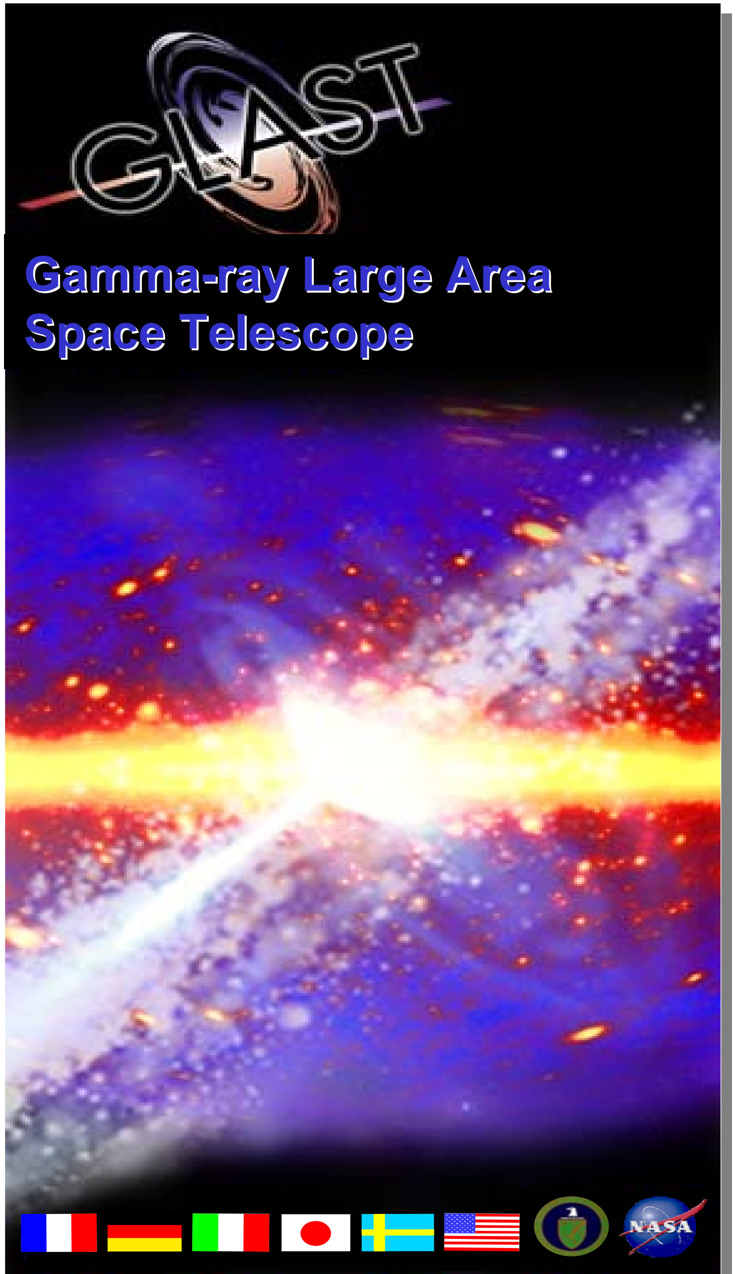

First results from mini-tracker OFF-Line data analysis

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Luca Baldini
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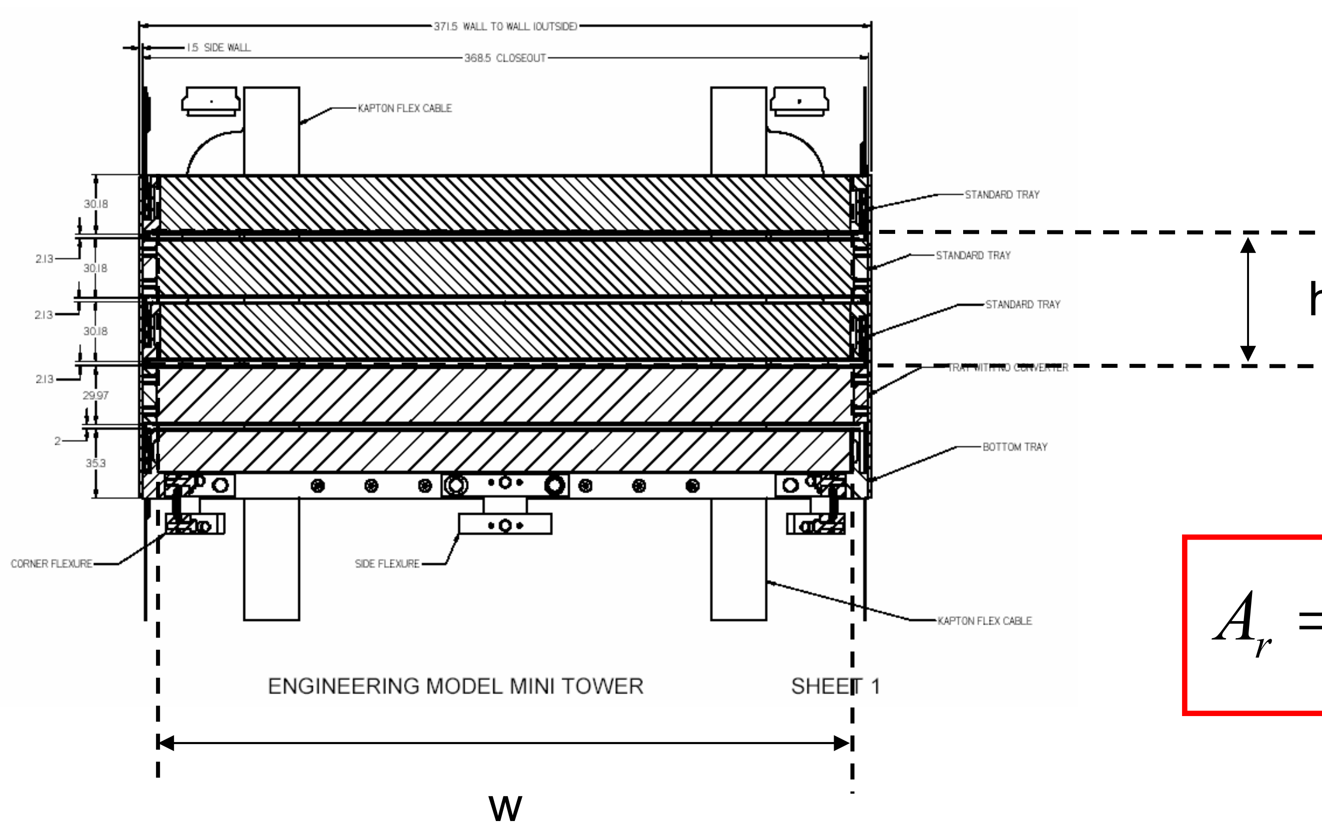
November 12, 2003

The GLAST mini-tracker



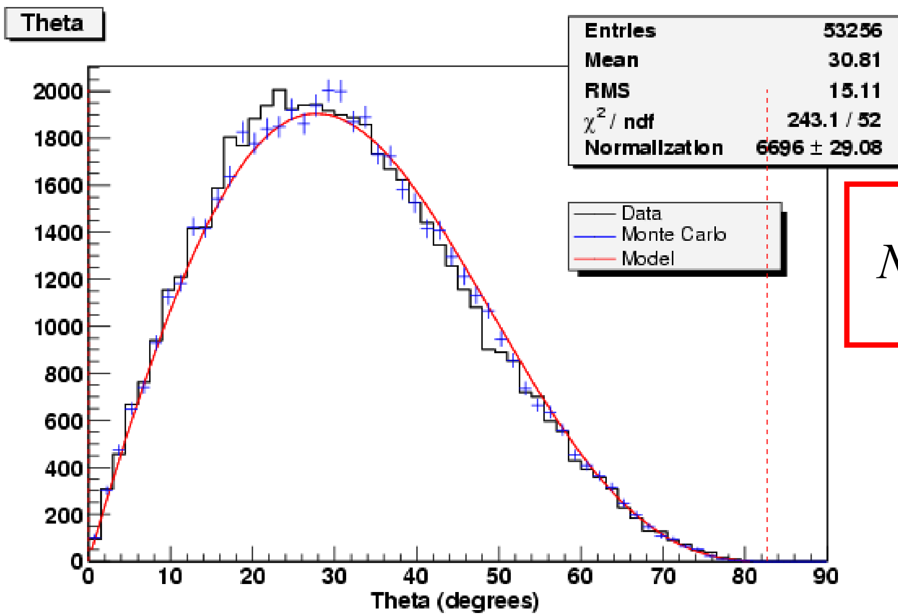
$$A_r = \frac{w}{h} \approx 5.14$$

Given this aspect ratio, the angular acceptance in terms of θ and its projections onto XZ and YZ planes is:

$$0 \le \theta \le 82^\circ$$
$$-79^\circ \le \theta_{XZ,YZ} \le 79^\circ$$

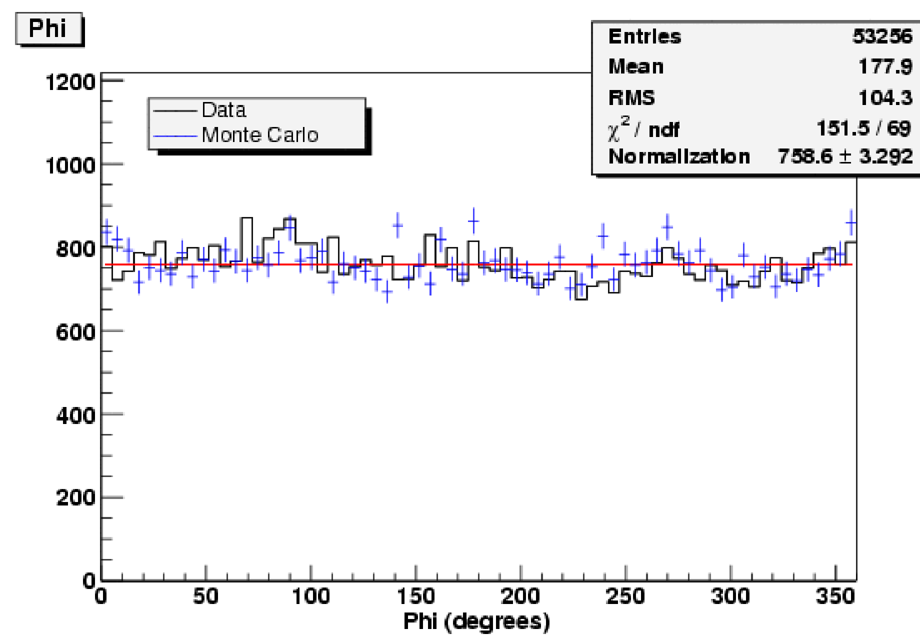
Angular distributions (θ, φ)

Reconstructed angular distributions of cosmic rays have been compared both with full MC simulation (blue crosses) and with a simple analytical model (red line) taking into account the angular acceptance of the detector. The agreement is very good.

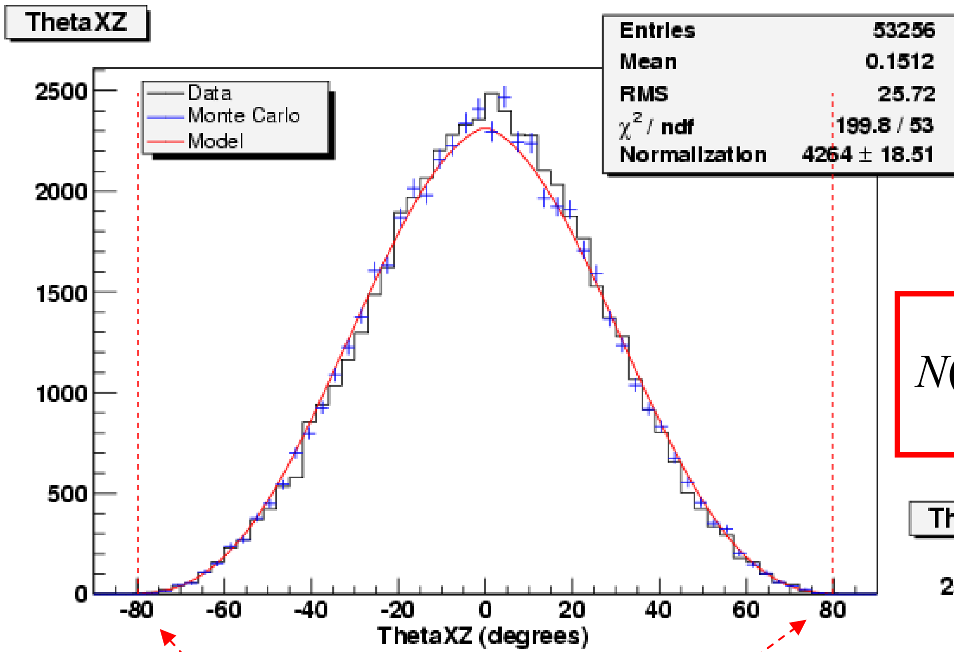


$$N(\theta) = N_0 \cos^3\theta \sin\theta \left(1 + \frac{1}{\pi A_r^2} \tan^2\theta - \frac{4}{\pi A_r} \tan\theta \right)$$

At the zero order the φ distribution is expected to be flat (but a π/2 modulation, due to not-cylindrical shape of the mini tracker is clearly visible.)

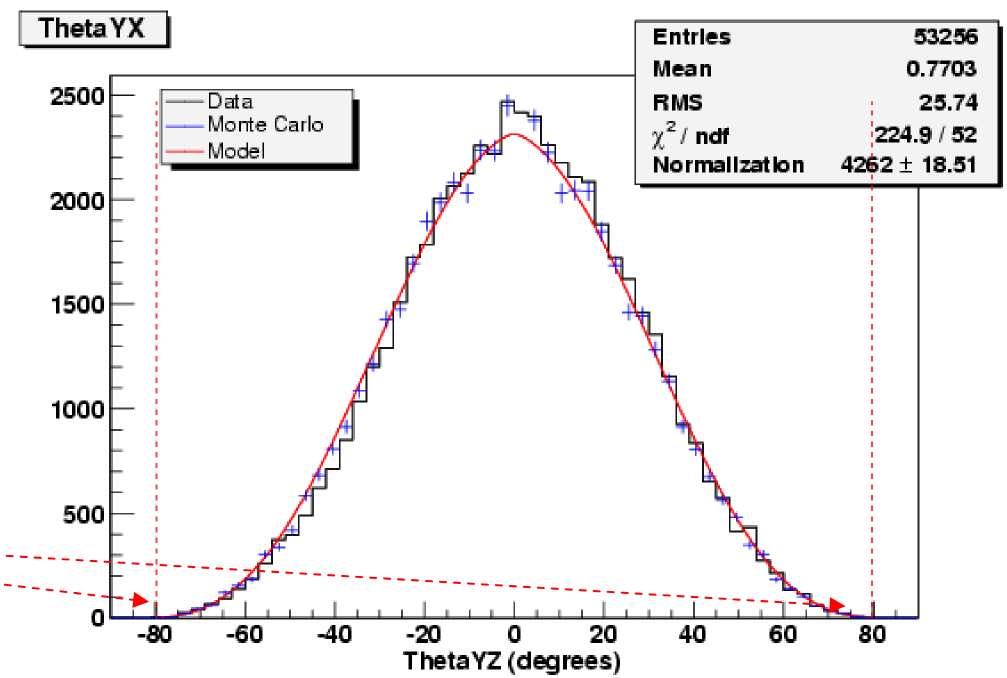


Projections onto XZ-YZ planes



The distributions of the θ angle, as projected onto the XZ and YZ planes, are also reasonably well described by the model.

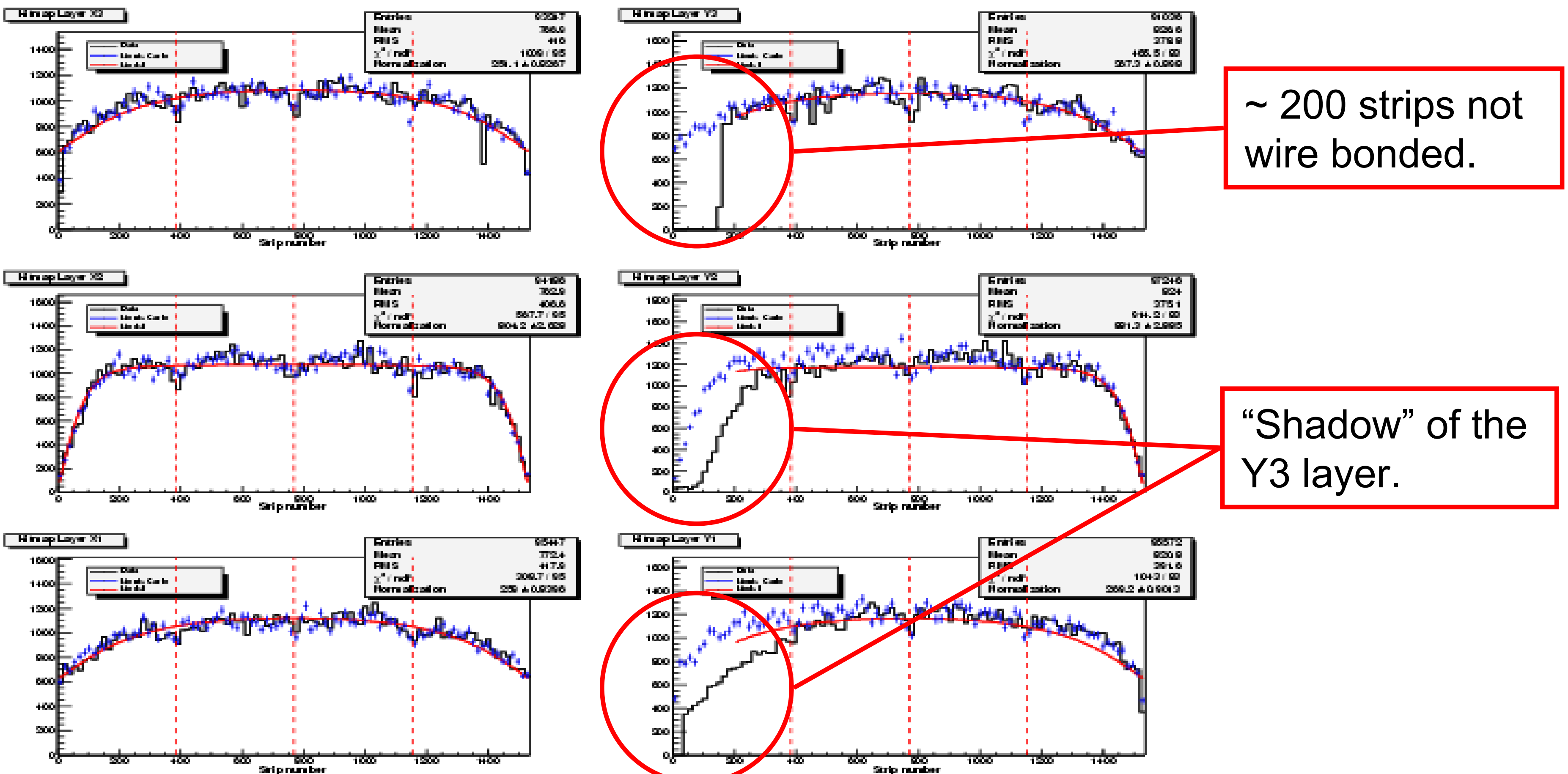
$$N(\theta_{\mathrm{Proj}}) = N_0\left(1 - \frac{1}{A_r}\tan\theta_{\mathrm{Proj}}\right)\left(\cos^3\theta_{\mathrm{Proj}} - \frac{4}{3\pi}\frac{1}{A_r}\cos^2\theta_{\mathrm{Proj}}\right)$$



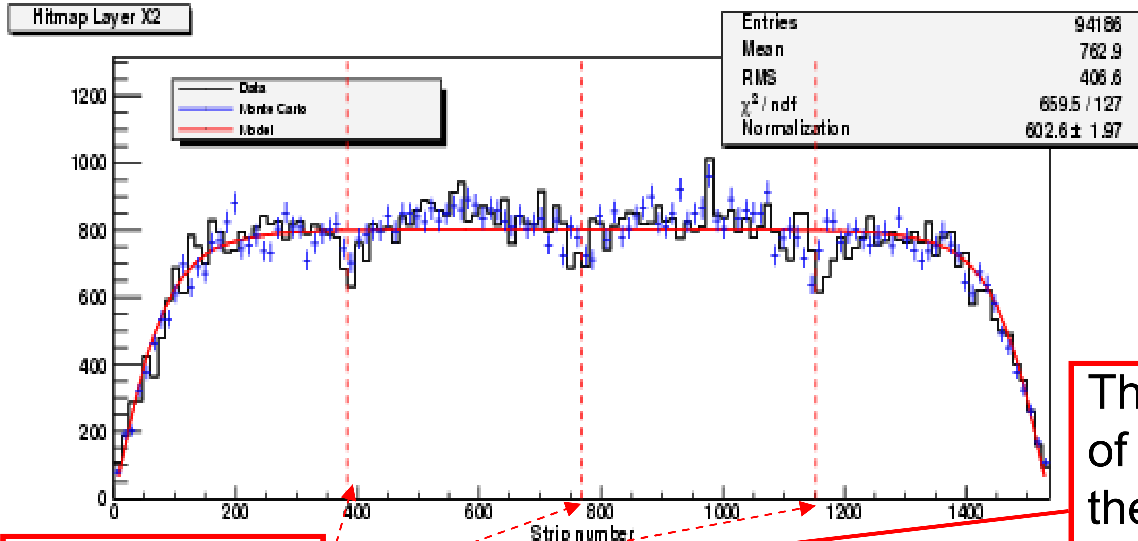
Geometrical limits due to the angular acceptance of the detector.

Hit maps

Here again the data are in black and the MC simulation in blue. The red line represents a simple model for a perfect detector (i. e. not including inactive regions), given the cosmic rays angular distribution (note that the hit map for the two inner layers is different from the outer ones).



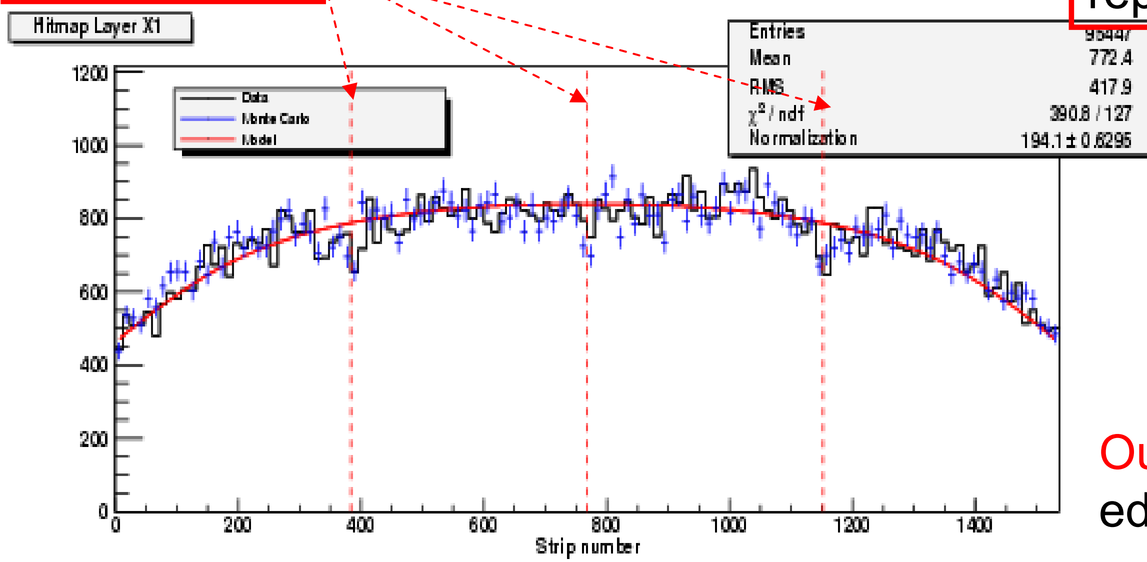
Hit maps



Inner layer: ~ no hits on the edges (vertical particles only).

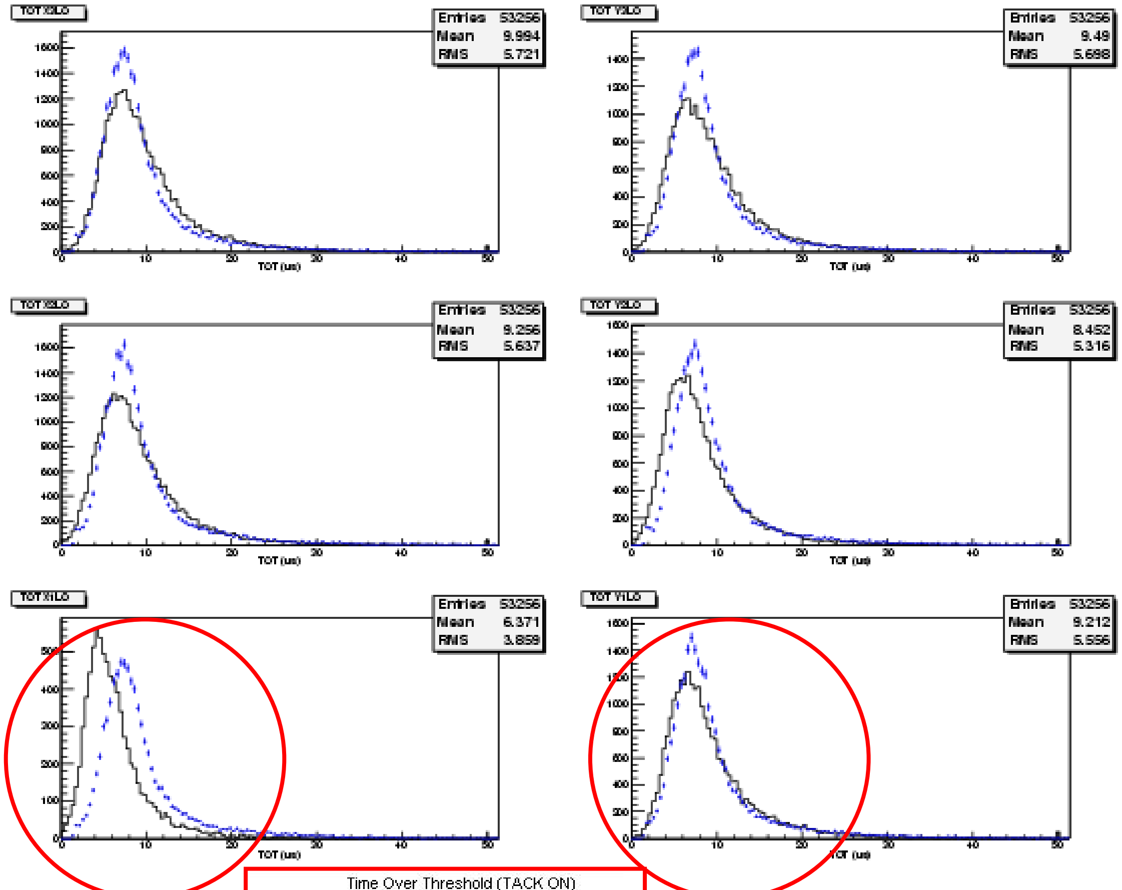
The shadow of the inactive regions of the other layers (corresponding to the edges of the ladders) is clearly visible in the hit maps and very well reproduced by MC.

Ladder edges



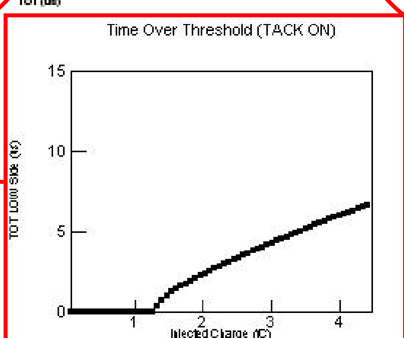
Outer layer: ~ hit density on the edge lower but different from zero.

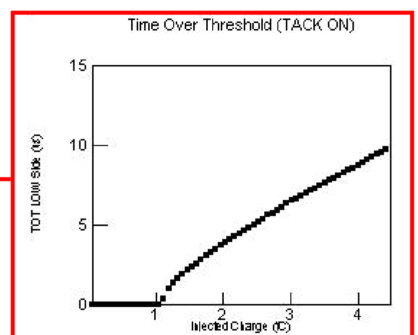
TOT distributions



The distributions of the Time Over Threshold (here only the Left GTRC reported) has been compared with the result of MC (blue line).

- TkrSimpleDigiAlg (linear TOT-E relation) used.
- Average values slightly different.
- Poor agreement in the shape of the TOT distribution.

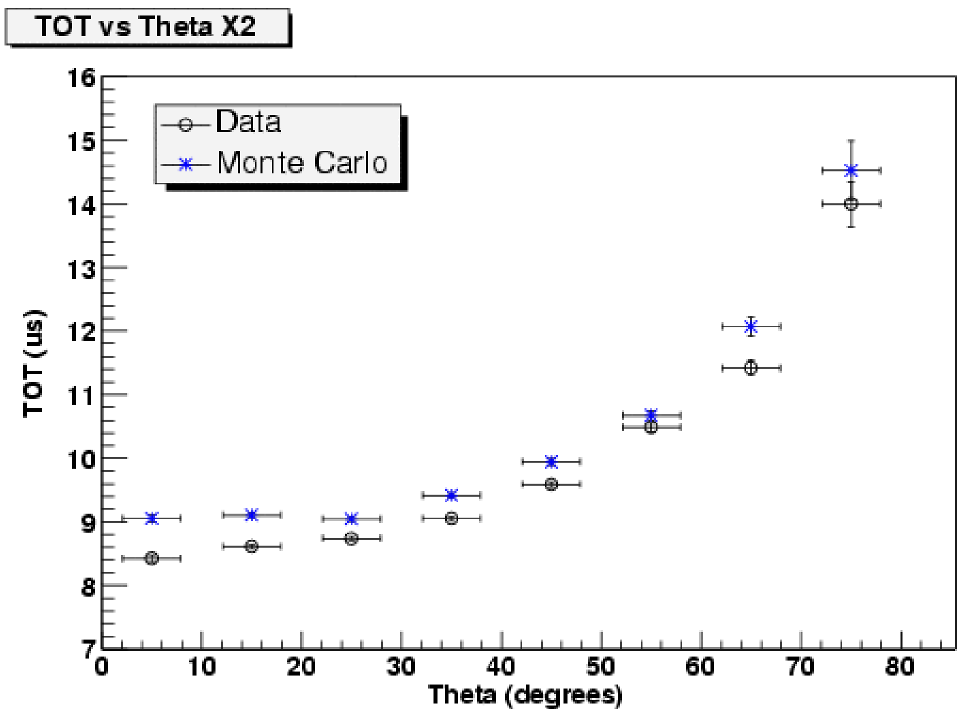




Left GTRC of layer X1 shows a peculiar behavior (basically systematically lower TOT). Feature already seen in the online analysis.

TOT vs. θ

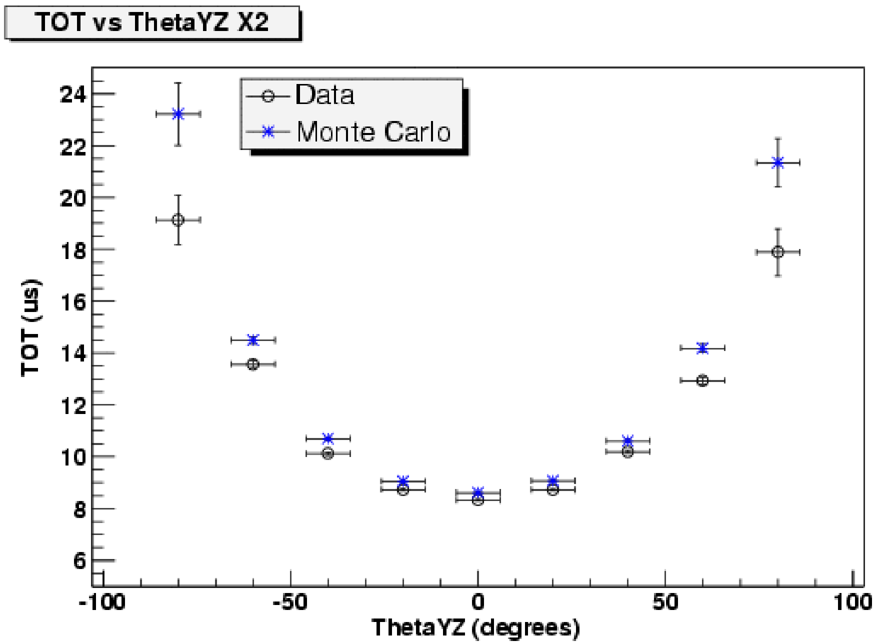
This plot shows TOT as function of θ (mean TOT values, corresponding to different cuts on the angle, are reported). TOT increases as θ increases (longer path inside the Silicon detector).



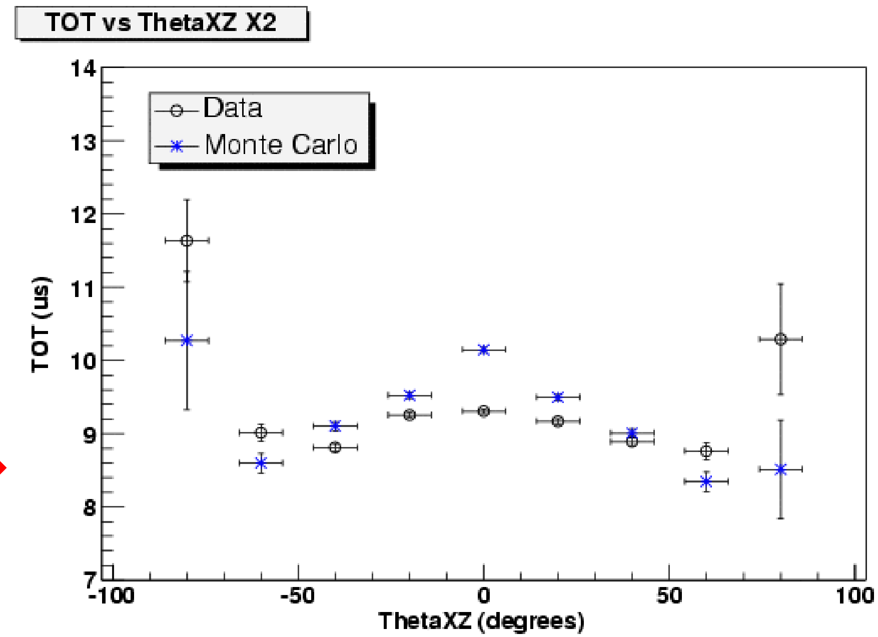
- General trend very well reproduced by the MC simulation.
- MC data slightly higher.

TOT vs. θ projections

Dependence of the average TOT on the projections of θ onto XZ and YZ planes is more complicated (results are shown for a X layer – i.e. strips along Y direction).



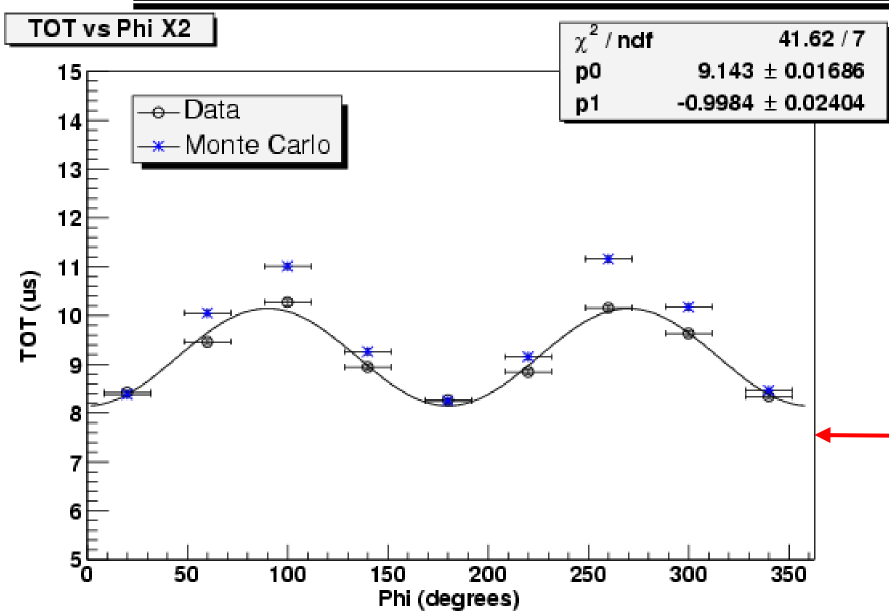
← Projection on the plane parallel to the strips: the higher θ, the longer the path in the silicon, the higher the TOT.

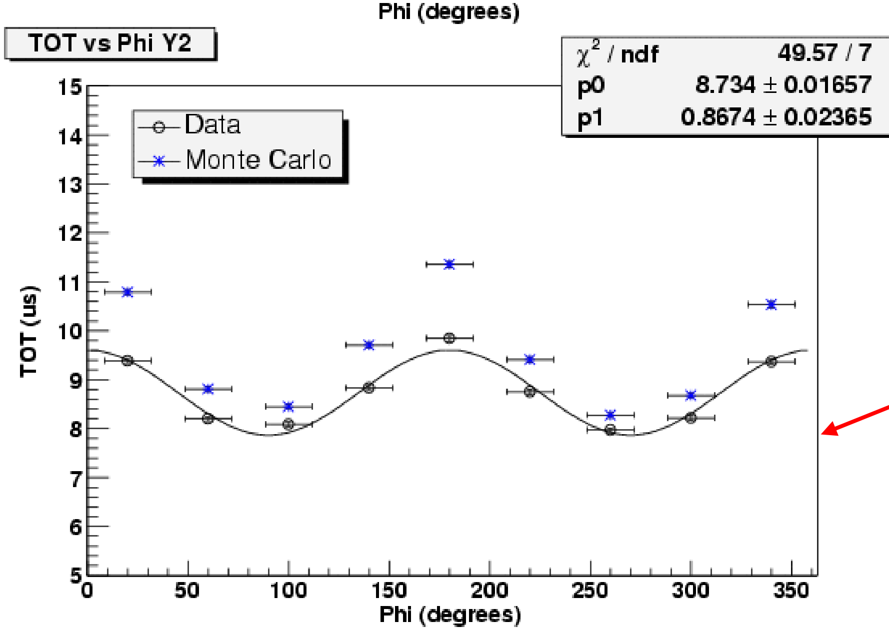


Projection on the plane orthogonal to the strips: charge sharing effects. →

The effect is much more prominent in the first plot (plane parallel to the strips) – dominant contribution in the TOT vs. θ distribution (previous slide).

TOT vs. ϕ





When TOT is plotted as function of ϕ a modulation with 180º period is expected. 90º phase shift of the X layers (i.e. strips along Y axis) with respect to the Y layers (strips along X).

Strips along the $\phi = \pi/2$ direction:
Max at $\phi = (n+1/2)*\pi$
Min at $\phi = n*\pi$

Solid line is a fit to real data with the "semi empirical" function:

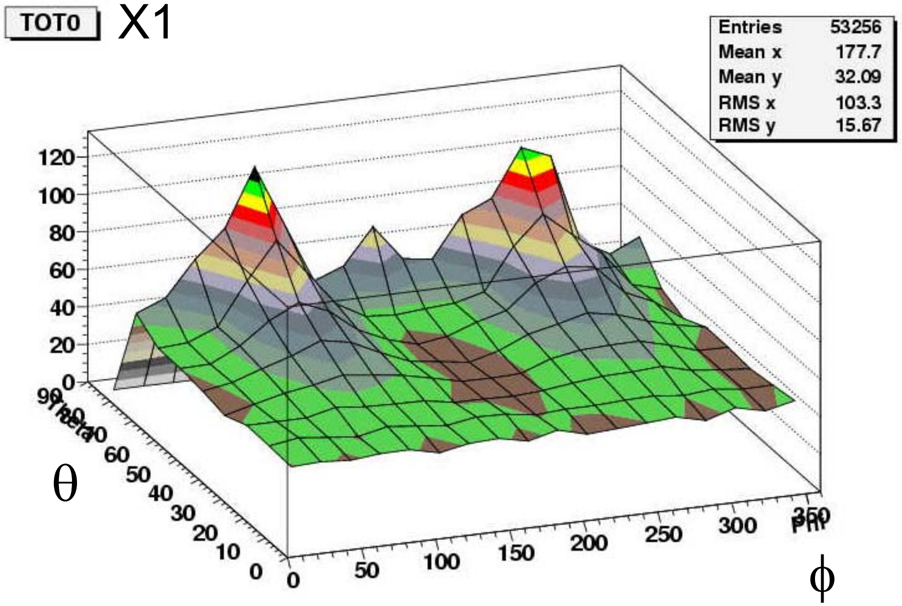
$$f = P_0 + P_1 \cos(2x)$$

Strips along the $\phi = 0$ direction:
Max at $\phi = n*\pi$
Min at $\phi = (n+1/2)*\pi$

MC TOT values systematically higher.

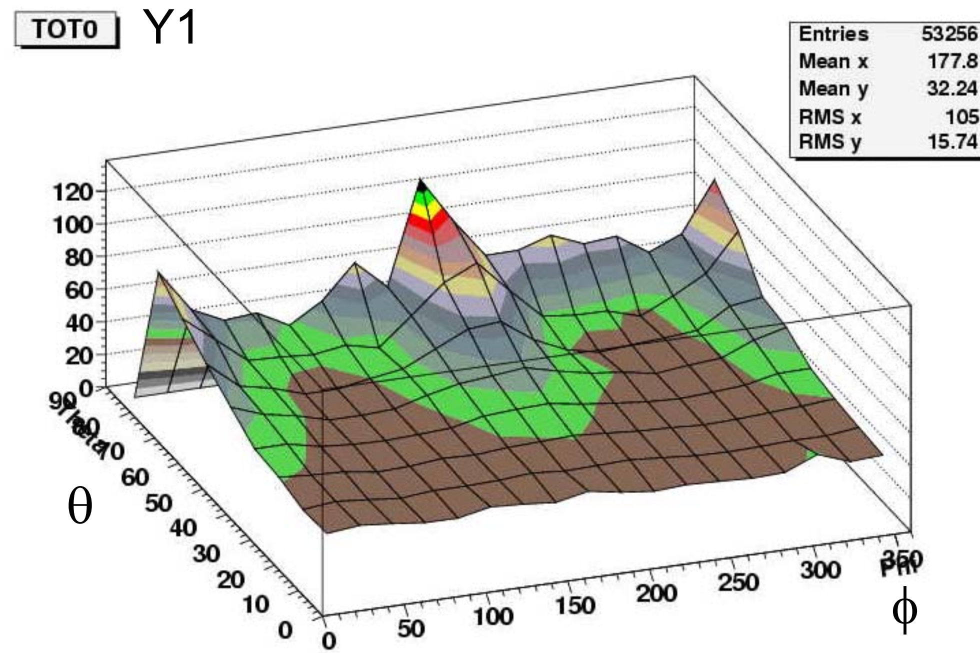
TOT summary

X1



TOT is plotted as function of θ and ϕ for a X layer and a Y layer.

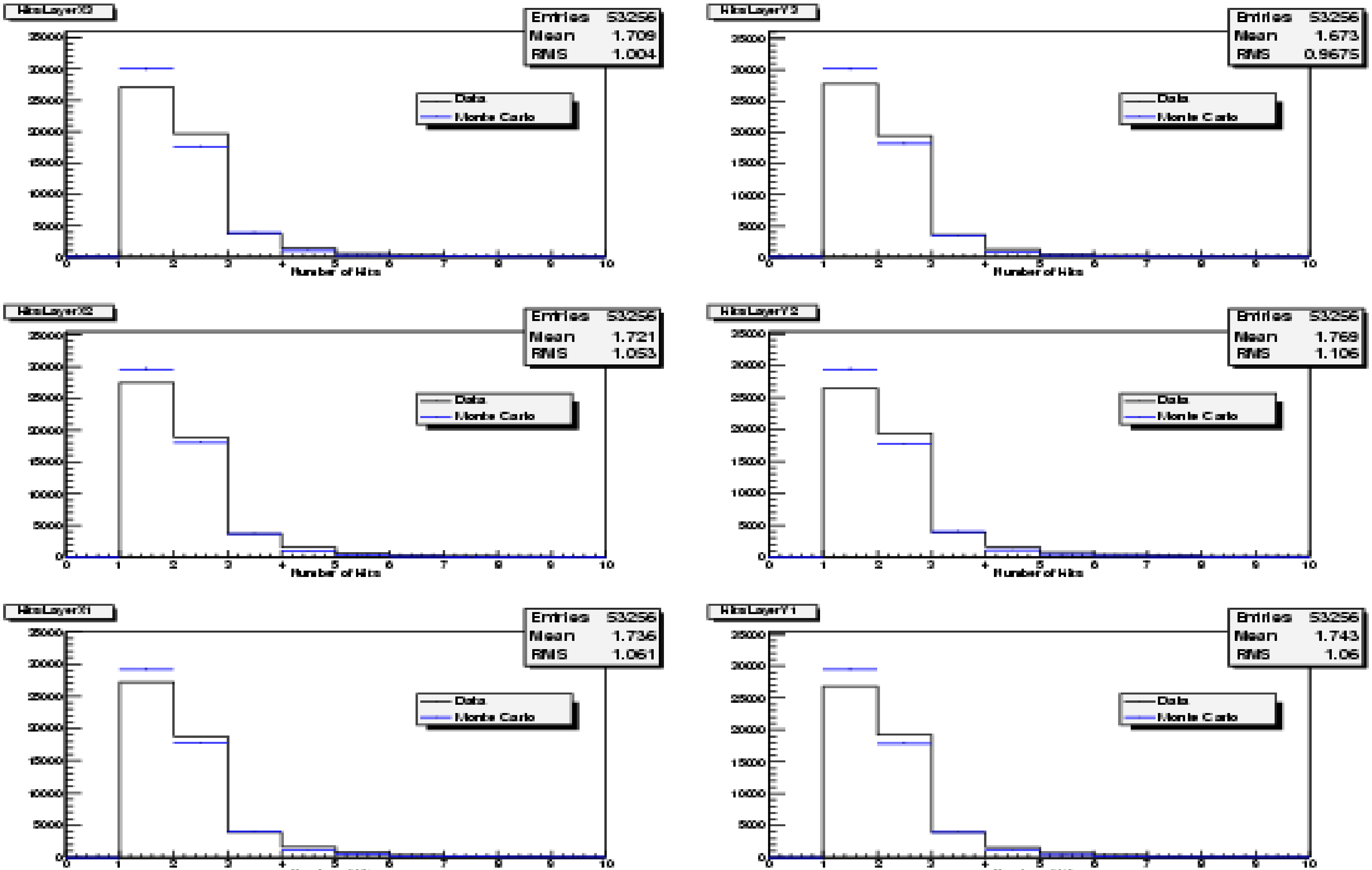
Y1



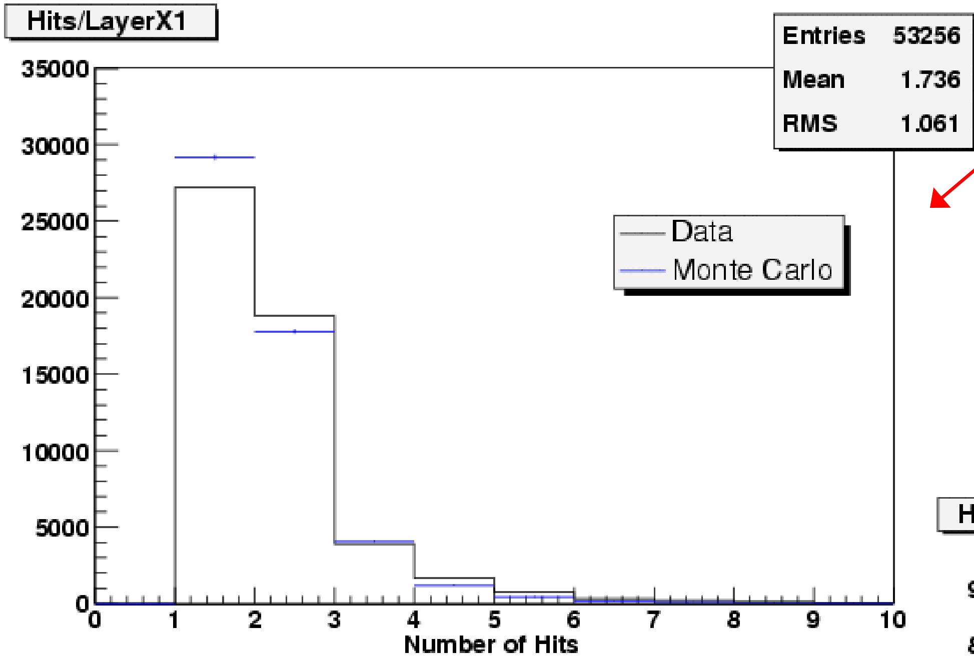
Max values for:

- ϕ along the strip direction
- θ close to his maximum ≈ 82°

Hit multiplicity per layer

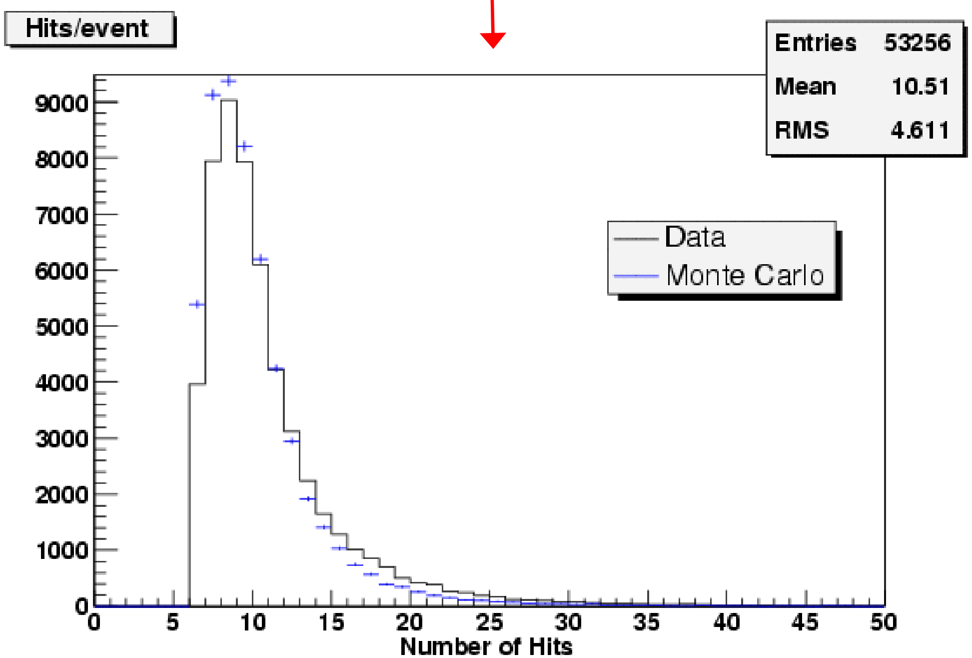


Hit multiplicity



Hit multiplicity (number of hits per event) distribution for a single layer (X1).

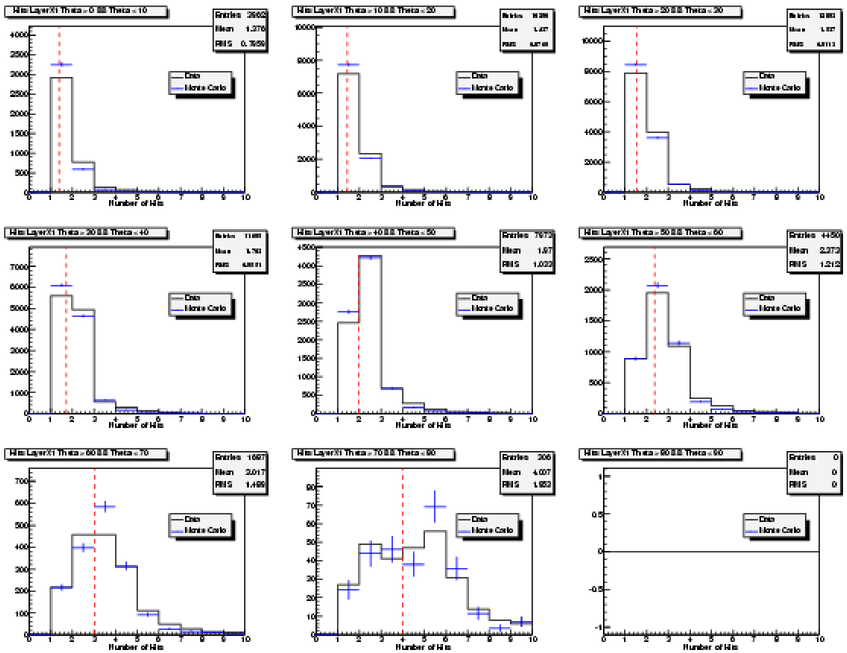
Hit multiplicity distribution for the mini-tracker.



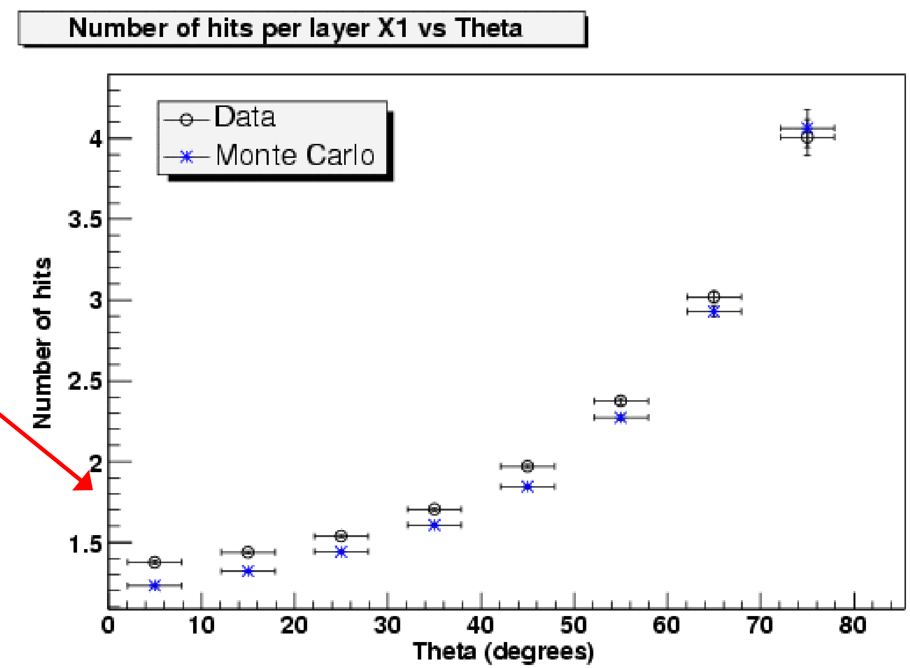
Discrepancy between real data and simulation: MC somehow produces a lower hit multiplicity.

- Check threshold settings (1/4 MIP in the MC).
- Investigate the effect of cross talk in the silicon detector.

Hit multiplicity vs. θ



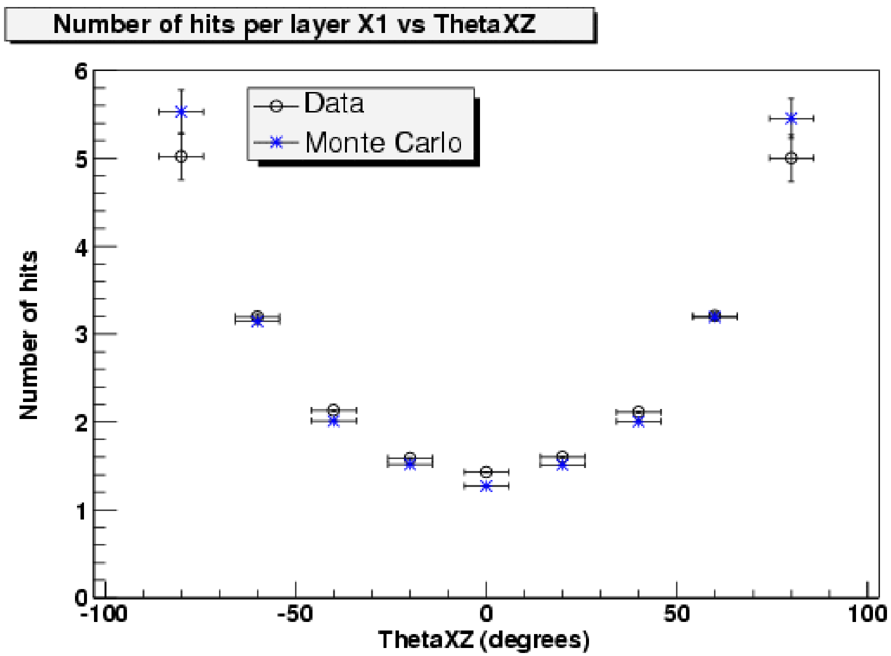
Cosmic rays with different direction are selected and mean hit multiplicity is plotted as function of θ.



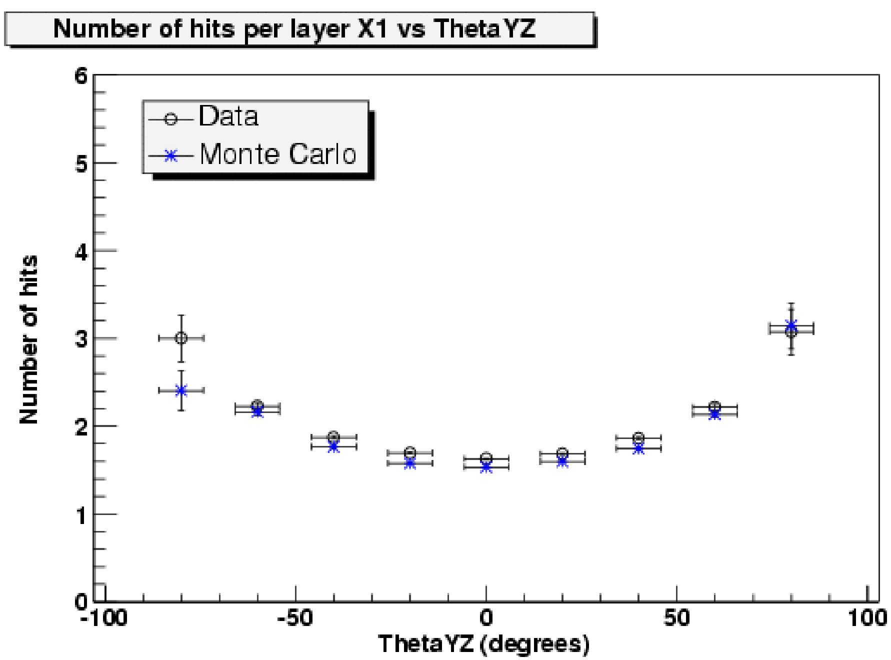
- Hit multiplicity increases with θ (the greater the angle, the longer the path in the silicon).
- MC hit multiplicity lower than real data.

Hit multiplicity vs. θ proj.

Dependence of the average hit multiplicity on the projections of θ onto XZ and YZ planes (for a X layer – i.e. strips along Y direction).



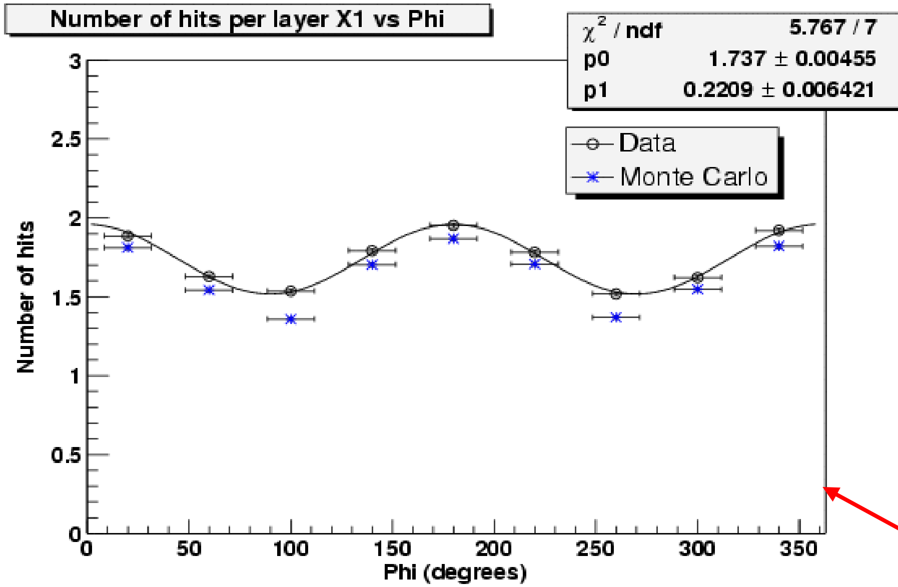
Projection on the plane orthogonal to the strips: the higher θ, the higher the hit multiplicity (charge sharing).



Projection on the plane parallel to the strips: slighter effect.

Compare with the TOT plots: here the situation is reversed!

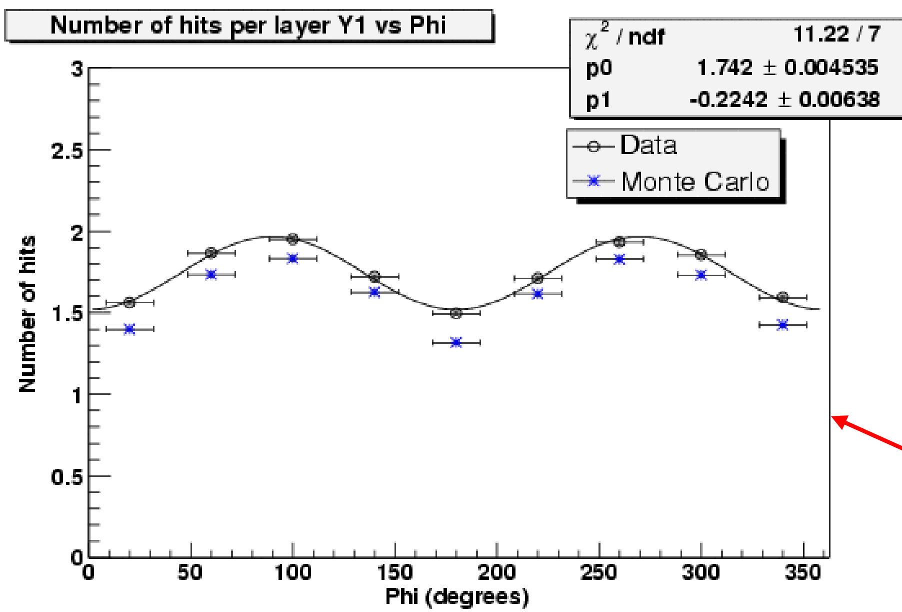
Hit multiplicity vs. ϕ



Hit multiplicity plotted as function of ϕ:

- modulation with 180º period
- 90º phase shift of the X layers (i.e. strips along Y axis) with respect to the Y layers (strips along X)
- 90º phase shift with respect to the TOT plots (see previous slide).

Strips along the $\phi = \pi/2$ direction:
Max at $\phi = n*\pi$
Min at $\phi = (n + 1/2)*\pi$



Solid line is a fit to real data with the "semi empirical" function:

$$f = P_0 + P_1 \cos(2x)$$

Strips along the $\phi = 0$ direction:
Max at $\phi = (n + 1/2)*\pi$
Min at $\phi = n*\pi$

Conclusions

• A set of data collected with the GLAST mini tracker have been analyzed and compared with the results of the full MC simulation.
• Simple analytical models for the relevant distributions, where possible, have also been compared with the data.
• Very consistent overall picture of the situation (good general agreement with MC and models, nice correlations between different variables).
• TOT measurement contains rich information and it's a powerful diagnostic tool.

• Unsatisfactory agreement between the MC and the data for what regards the TOT distribution (tune the TkrSimpleDigiAlg parameters, use more sophisticated algorithms…)
• Investigate the difference between data and MC in the hit multiplicity (threshold effect, cross talk between adjacent strips…)