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Circle Fit and Estimation of recoverable leakage from tracks in DHCAL

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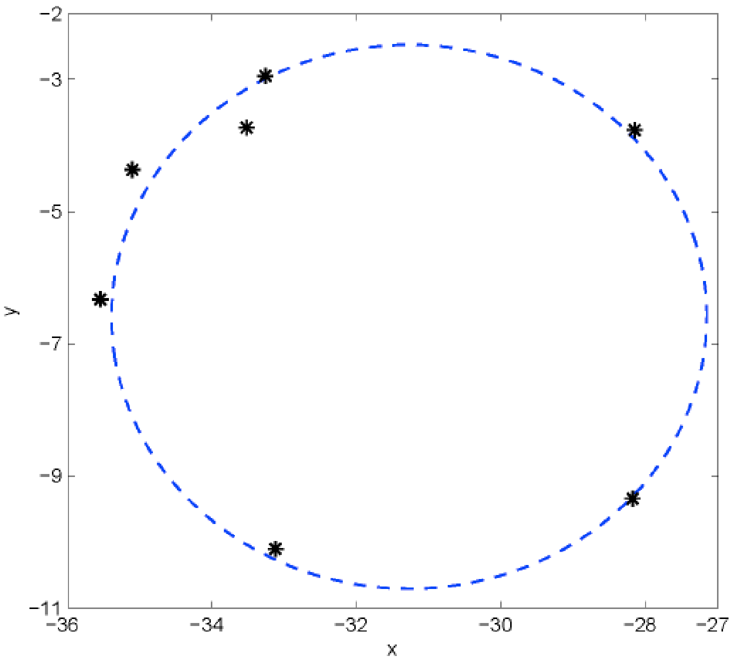
Introduction

- Use of Pratt's circle fit method for tracks in DHCAL
- Calculation of transverse momentum from circle tracks fit.
- Estimation of individual and total recoverable leakage.

All this work is preliminary

Pratt[1] fit method

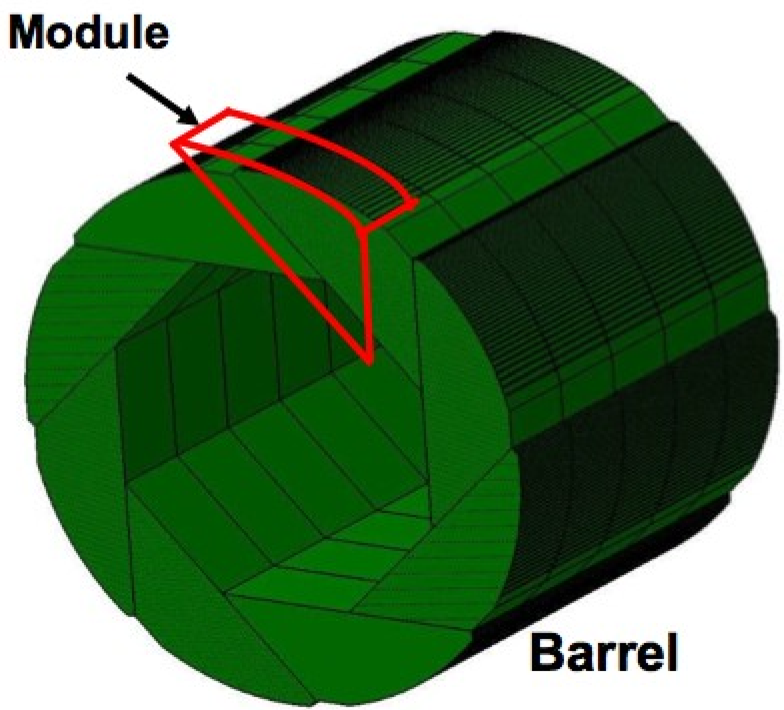
- Specialized & robust fit for circle & ellipses
  - Newton convergence method

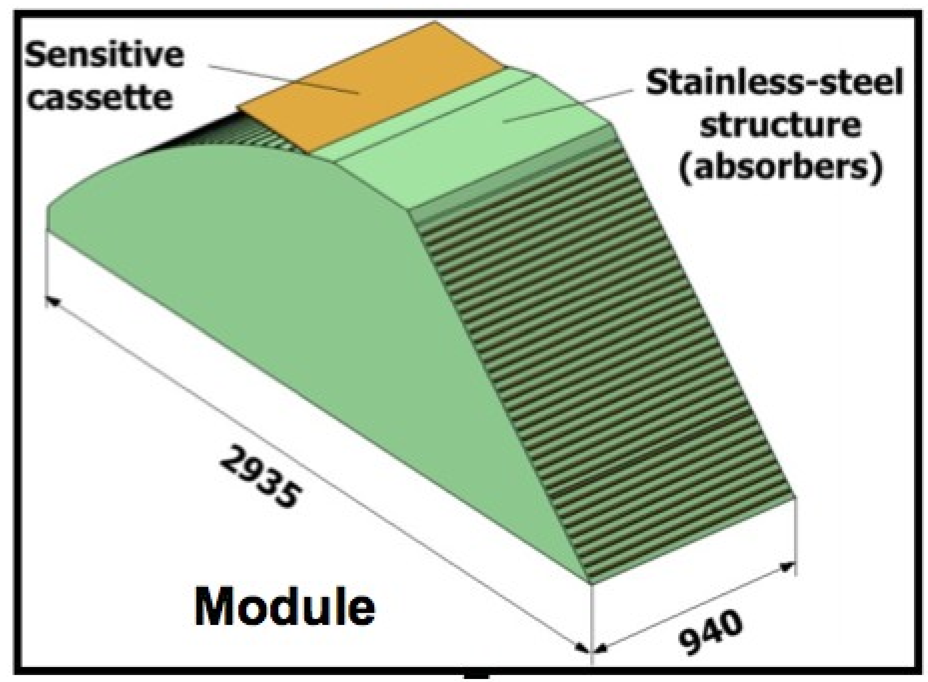


Example of a circle fit to 7 data points (stars)

1) V. Pratt in article "Direct least-squares fitting of algebraic surfaces", Computer Graphics, Vol. 21, pages 145-152 (1987)

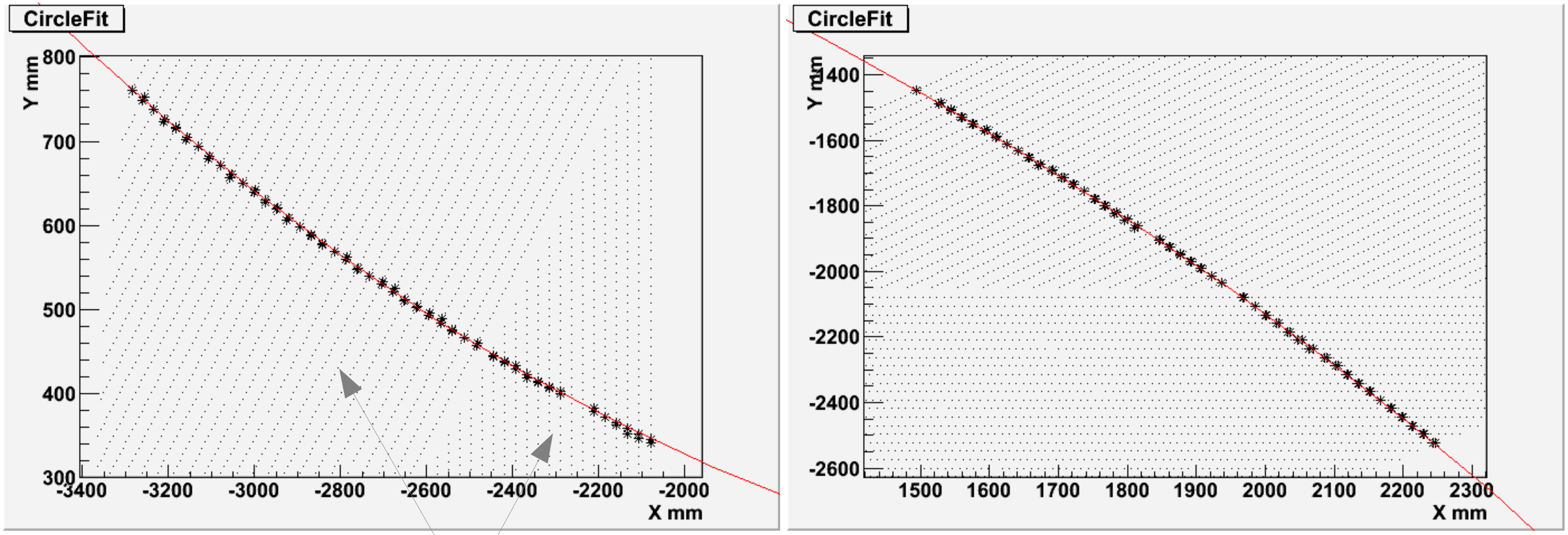
DHCAL Geometry





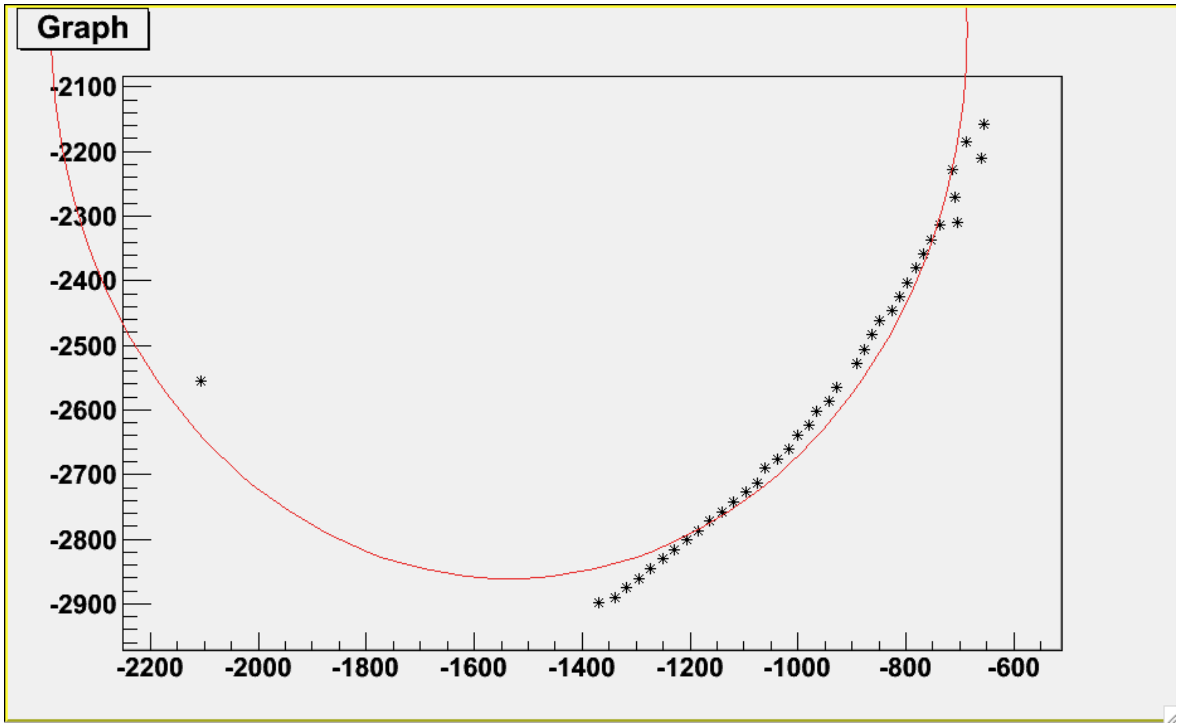
Fit Results

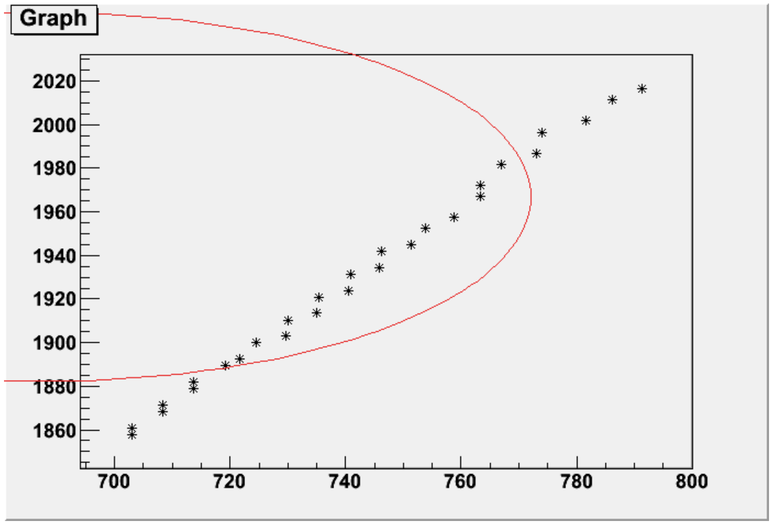
Tests on 10 GeV Muon fitted tracks 80 degrees in ILD



Two different modules

Cleaning

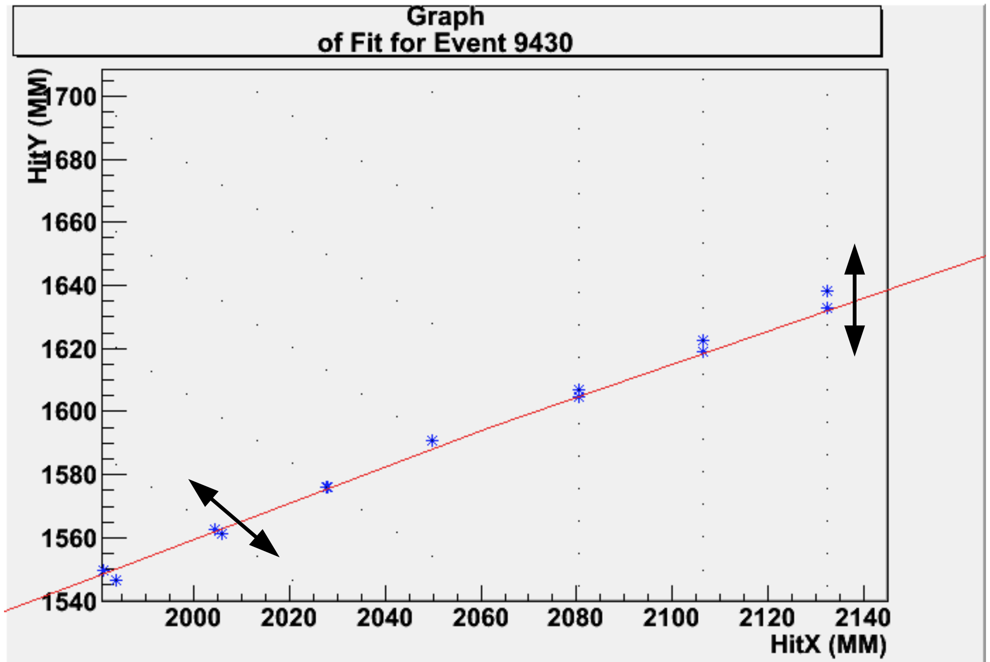




Rare case of «gone wild»

- Even μ's event are never 100% predictable
- Cleaning of cells far from the «bulk»

Clustering & Error calculation

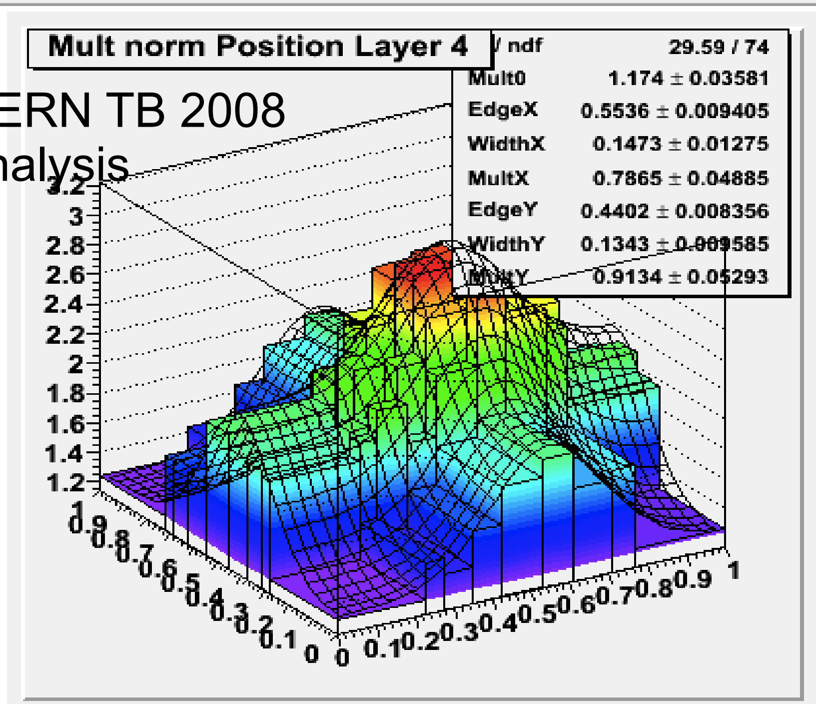


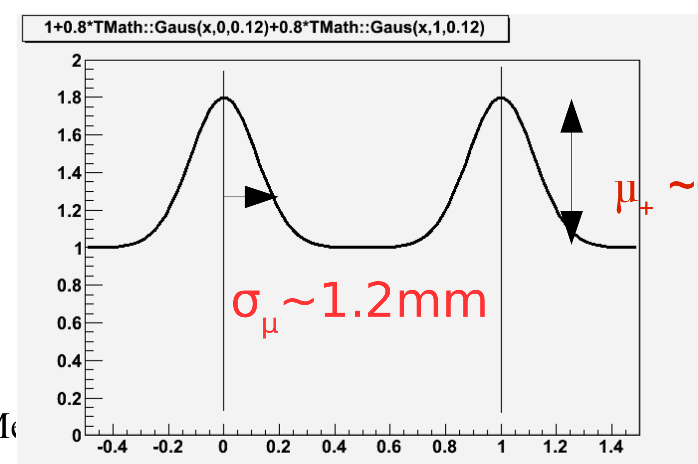
- Filling in TProfile indep[ly] in (i,j) according to S,K,M

- Error vs μ (multiplicity)
  - $\mu = 1 \rightarrow$ var = 0
  - $\mu = 2 \rightarrow$ var = $10mm/\sqrt{2}$

- Corrected error
  - var = 0 $\rightarrow \sigma = (10-2\times\sigma_\mu)/\sqrt{12}$
  - var = $10mm/\sqrt{2} \rightarrow \sigma = \sigma_\mu$

CERN TB 2008 analysis

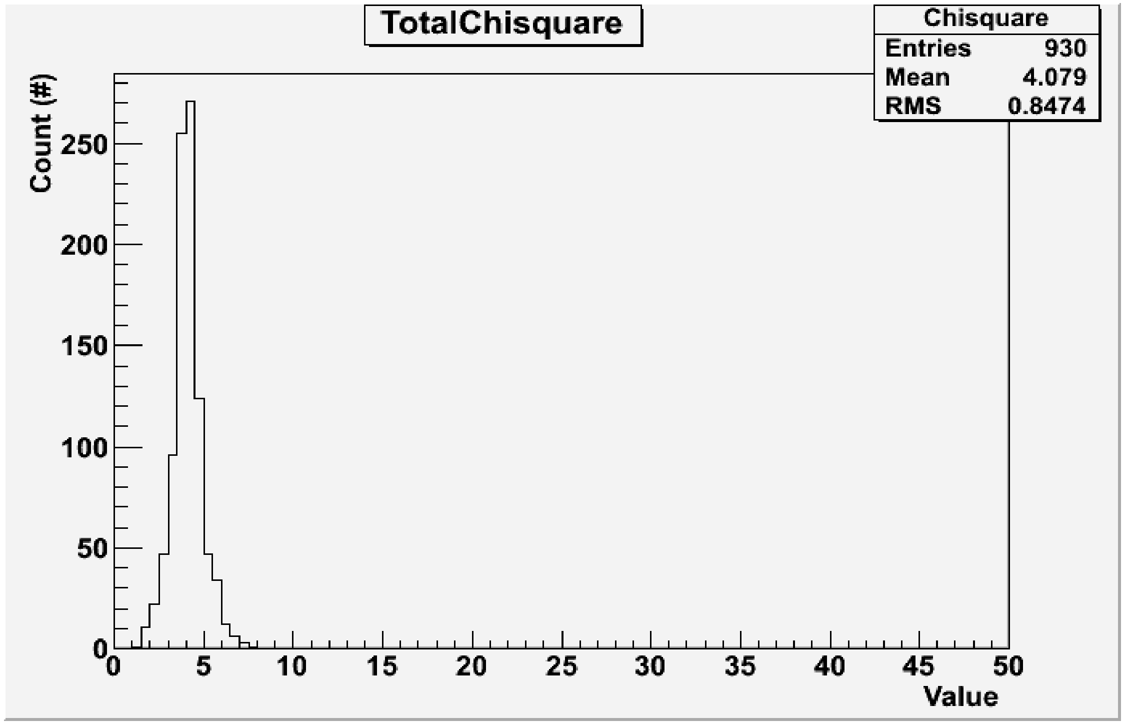




χ^2 distribution

$$\chi^2 = \frac{\frac{D}{\epsilon}}{N}$$

D~ non-perpendicular distance of a hit to the circular track
ϵ ~ efficiency
N ~ number of hits belonging to the track



$\langle\chi^2\rangle \sim 4$
Distribution ~OK + tails.

$\Rightarrow$ Still some improvements to do on error calculations.

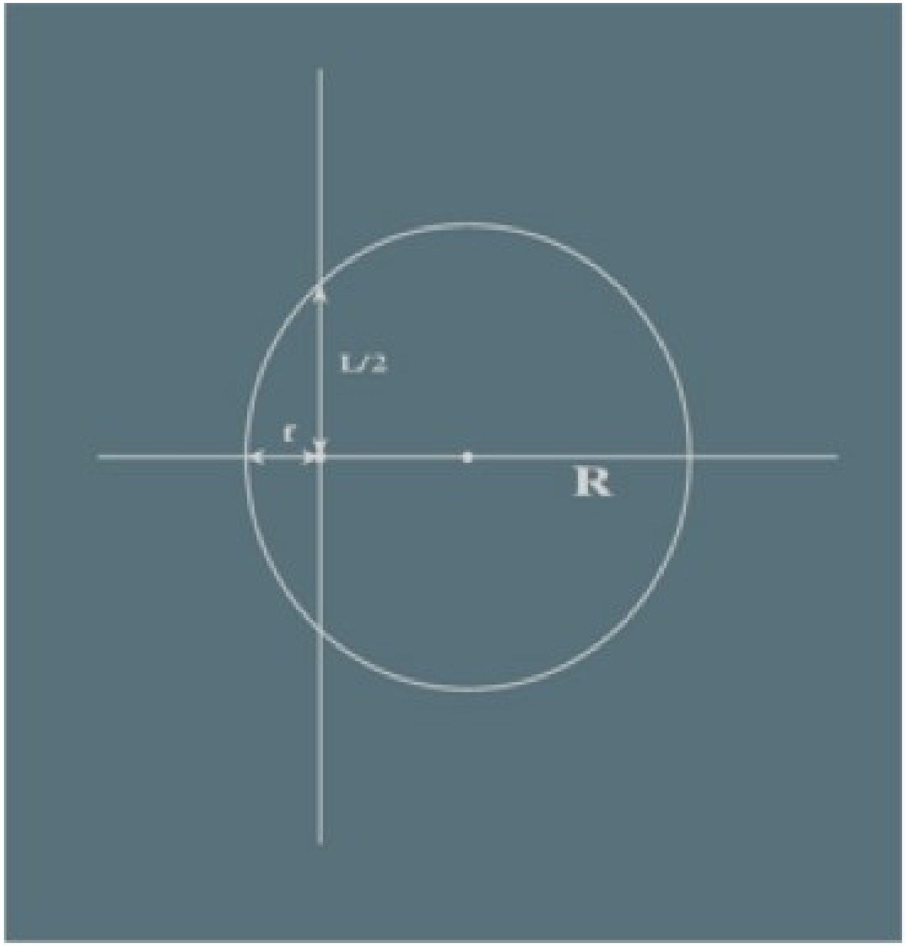
Circle Fit Method

Geometric relationship :

$$f*(2R-f)=\frac{L^2}{4}$$

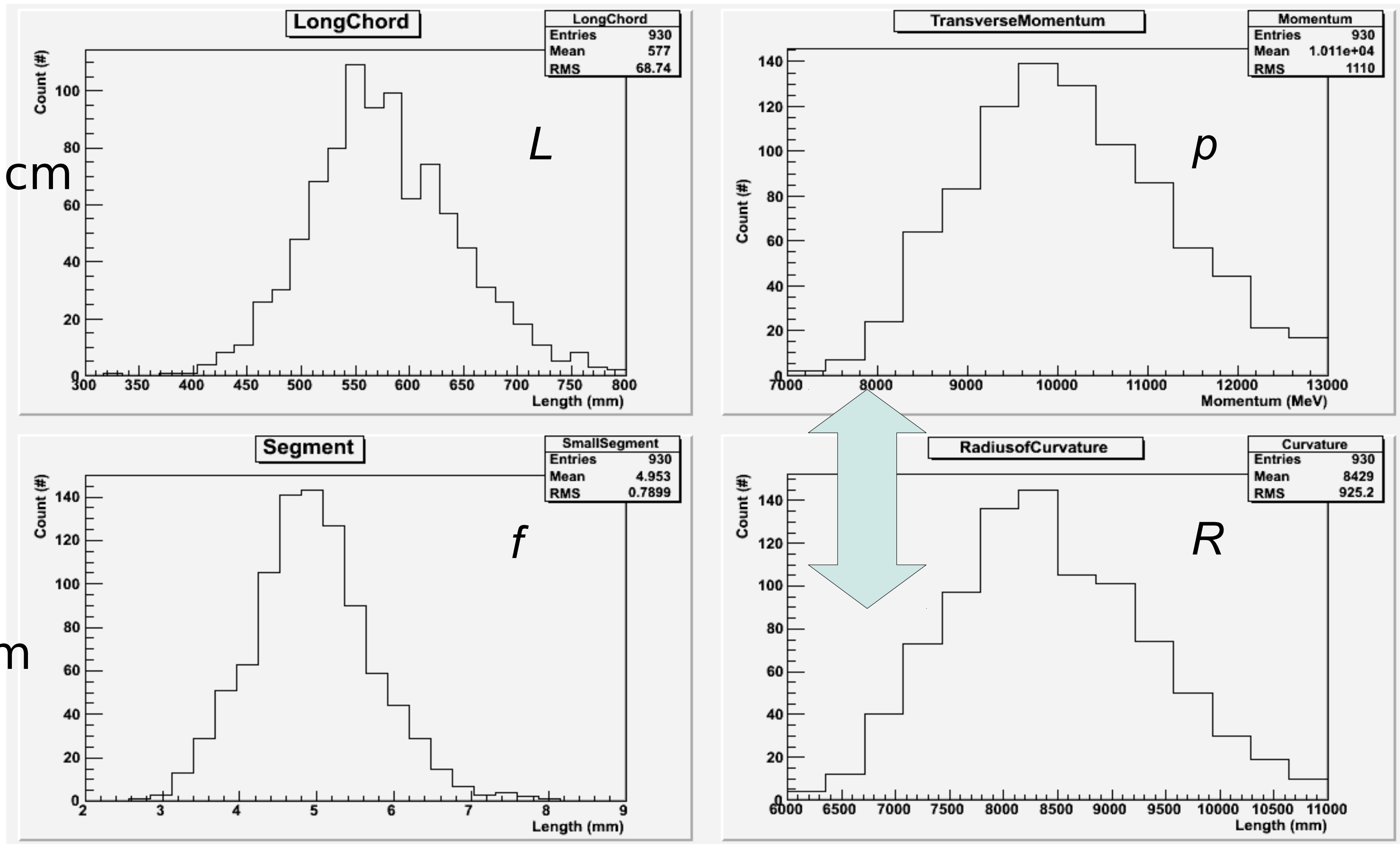
Keeping the linear part we obtain :

$$f=\frac{L^2}{8R}$$



Fit parameters results (bulk)

<L> ~ 60 cm
δL ~ 7 cm
(∫ over φ)



δp/p ~ 11%
@ 10 GeV

f ~ 5 mm
δf ~ 0.8mm

preliminary

Distribution of fit parameters with a cut of 2σ

Recoverable leakage study

- Tracks selection (tracks in calo).
- Monte Carlo 40, 100 Gev Pions tracks in ILD SDHCAL.
  without ECAL in front
- Leaking tracks :
  - Lenght > 20 cm in the DHCAL and ending outside of it.

- $R = 0.3 * (P_T/B)$

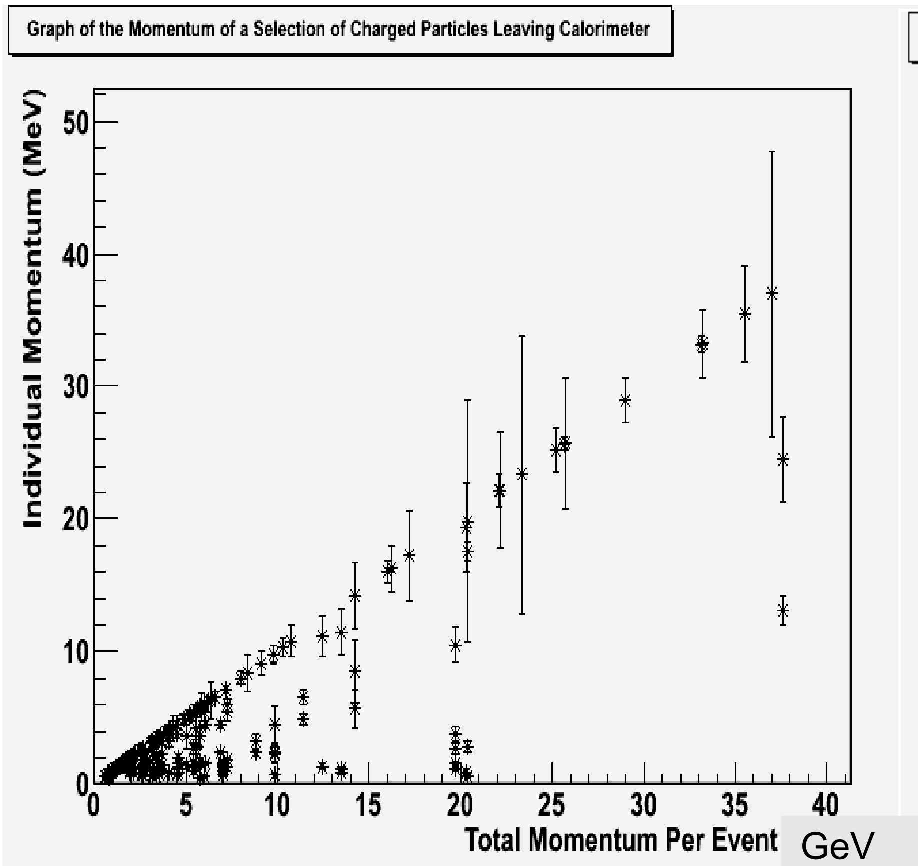
Errors formulas

$$\frac{\delta p}{p} = \frac{\delta R}{R} \quad \Rightarrow \quad \frac{\partial p}{p} = \frac{\frac{\partial L^2}{\partial L} * \delta L}{L^2} + \frac{\frac{\partial 8f}{\partial f} * \delta f}{8f} \quad \Rightarrow \quad \frac{\delta p}{p} = \frac{2\delta L}{L} + \frac{\delta f}{f}$$

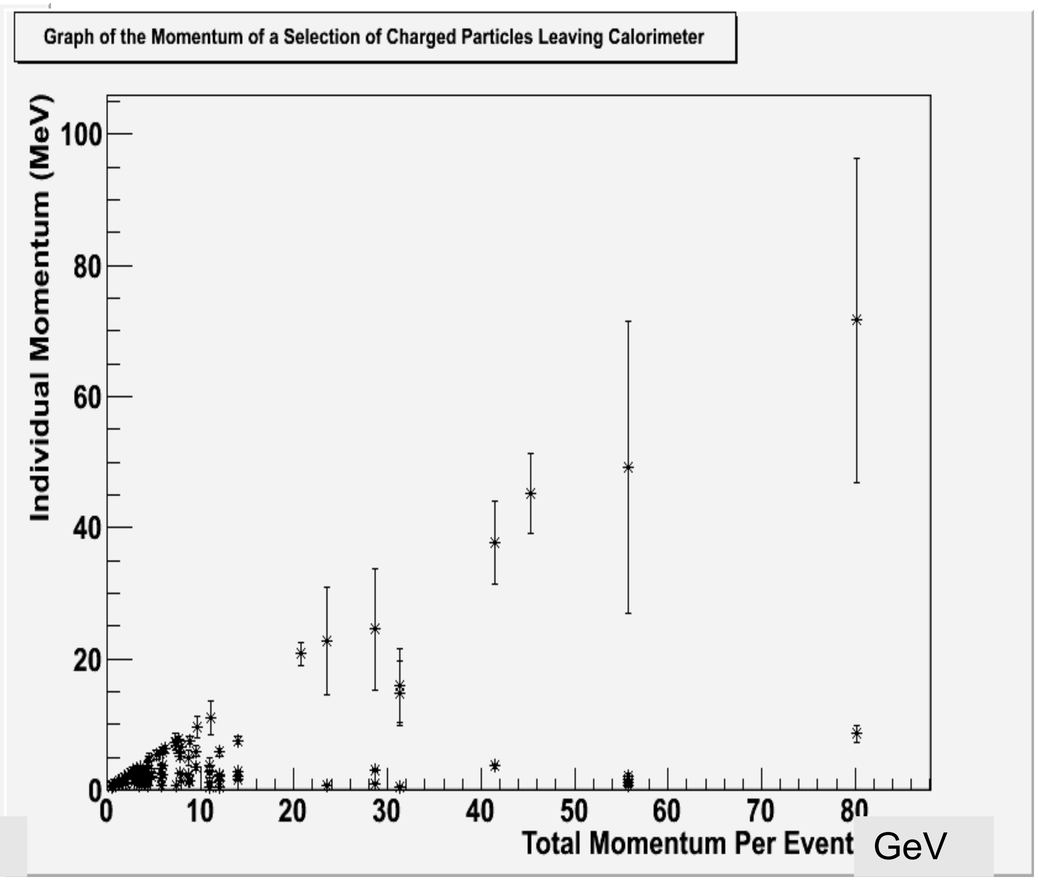
δf = cell size ~ $\delta f = 1\,cm$

δL = gap between two sensitive layers ~ $\delta L = 2.5\,cm$

Individual Recoverable Momentum



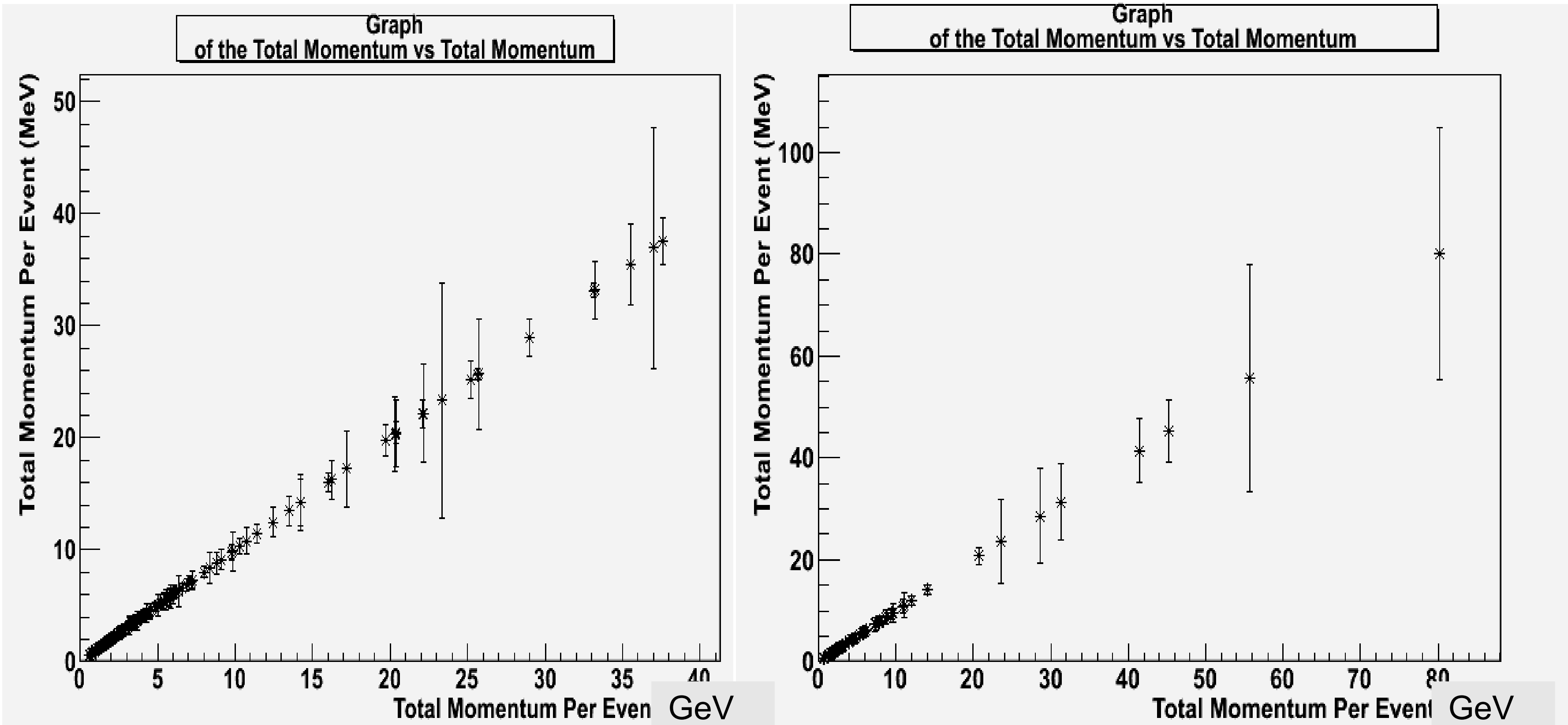
40 GeV Pions



100 GeV Pions

preliminary

Total Recoverable Momentum

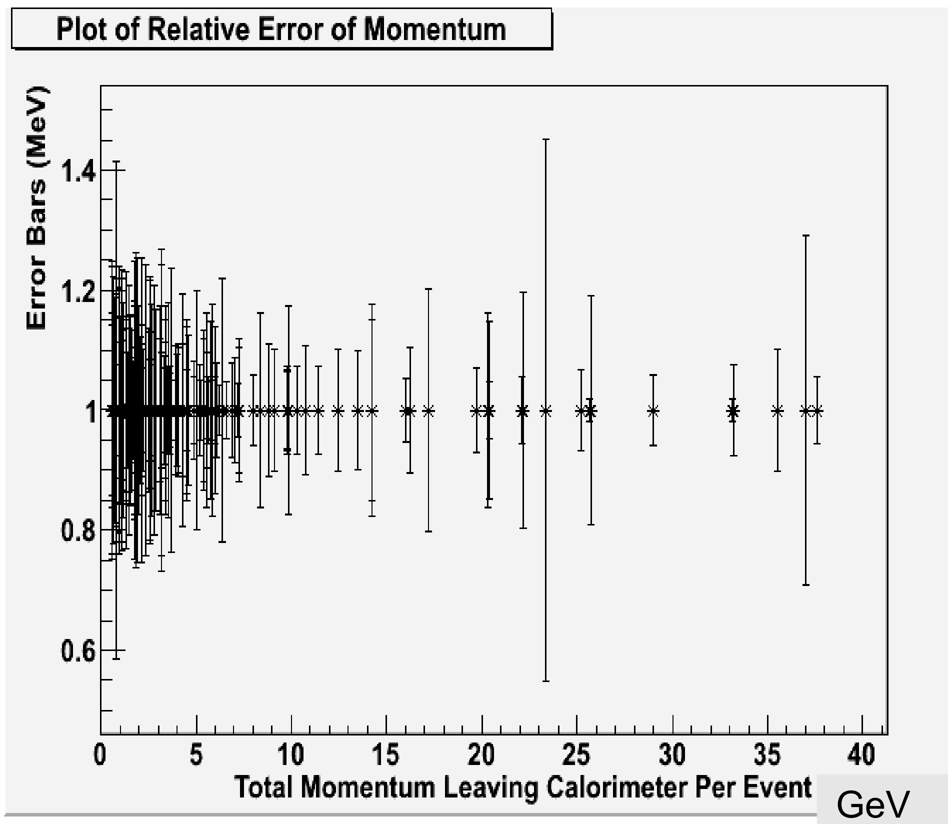


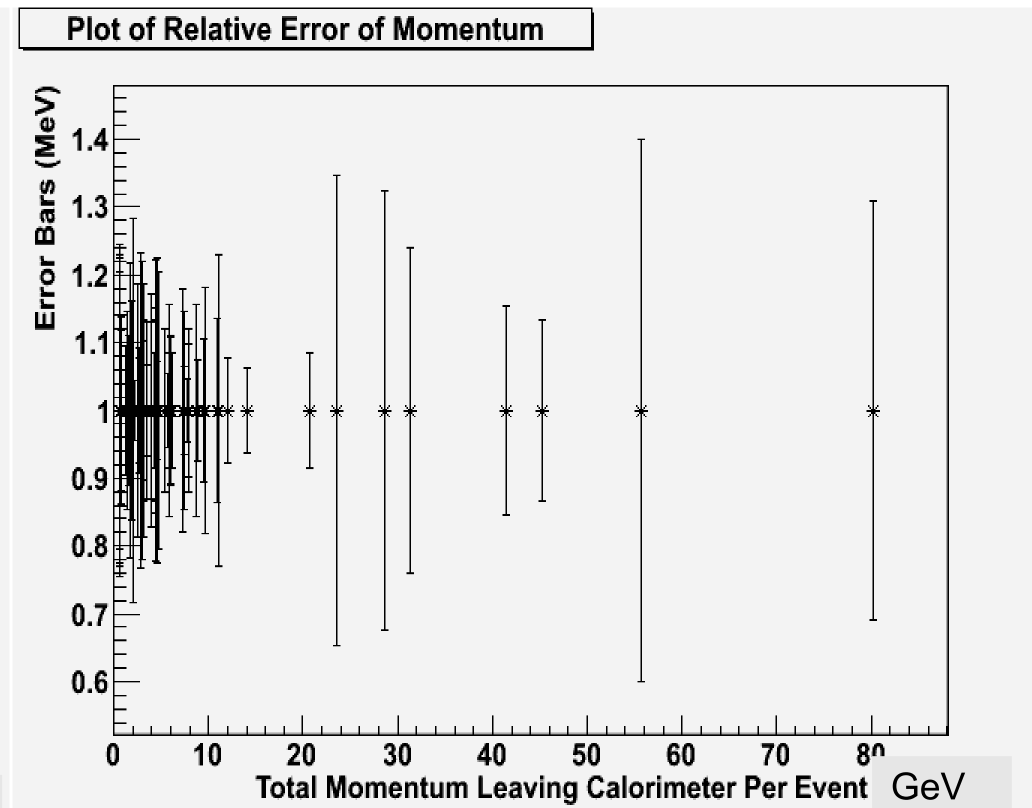
40 GeV Pions

100 GeV Pions

preliminary

Relative Error vs Total momentum





40 GeV Pions

100 GeV Pions

preliminary

Prelim : Tracks can be recovered with a σ(p)/P ~ 10%

Conclusion

- simple & robust Pratt track fit method was tested on μ's
  - requires clean samples (μ ~ OK)
  - still require some clean-up and X-checks
  - ~10% precision for 10 GeV μ's with 1cm² cells in SDHCAL
  - Marlin Processor implemented
  - will be used in ARBOR (see M. Ruan's talk) to improve track momentum

- Estimation of leaking charged tracks ➔ ~10% accuracy
- Global estimators to validate the method
  - # of events with leakage > 10%
  - <E> of events with leakge > 10%
  - RMS_{90}...