Measuring Profiles in a Rotated Detector and Finding the Shower Start

Benjamin Lutz

30th July 2009

Motivation

Achieved so far

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- Find layer of shower start

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- Measure shower start point distribution

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- Compare to Simulation

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  - How does it influence the measurement of λ_{I}?
  - What is its smearing of the reduced profi le?

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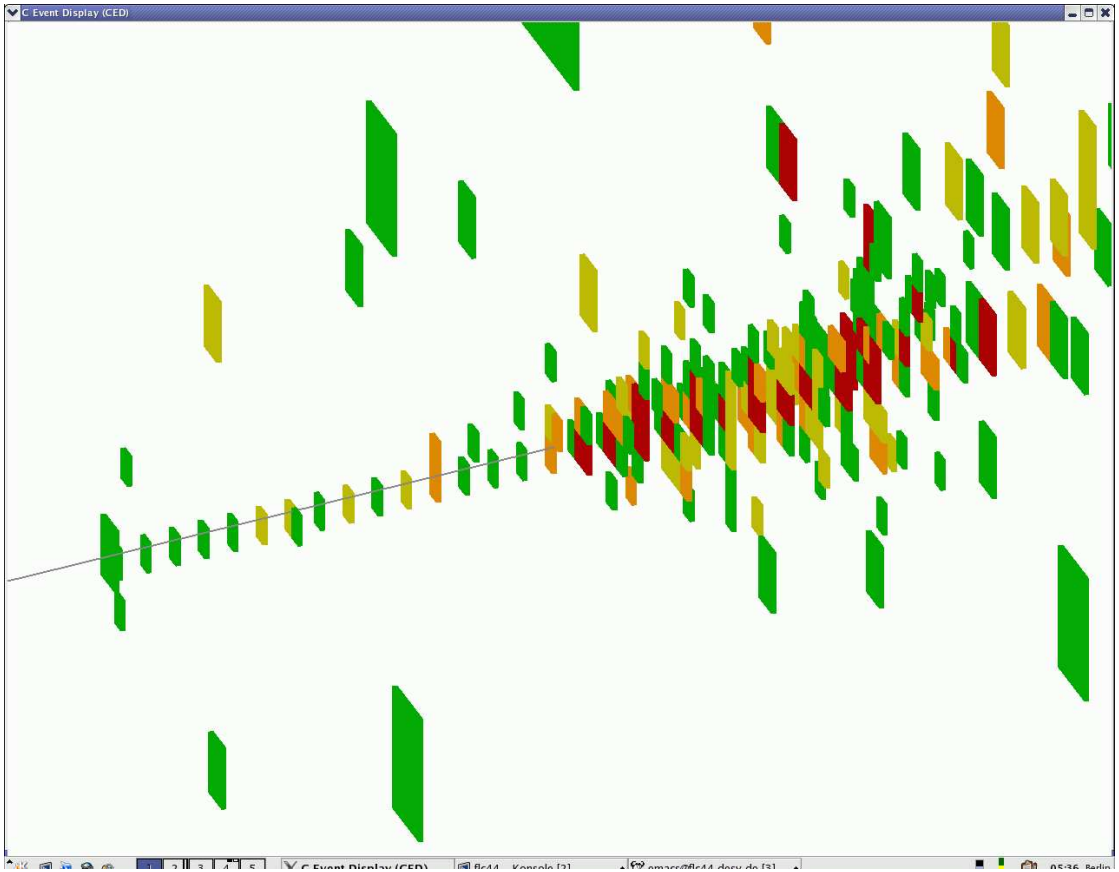
  - What is its smearing of the reduced profi le?
- Where in x-y-plane does the shower start?

New Shower Start Finder



π^+ 30GeV showering in AHCAL

color code: MIP 2 MIP 3 to 4 MIP $\geq$ 5 MIP

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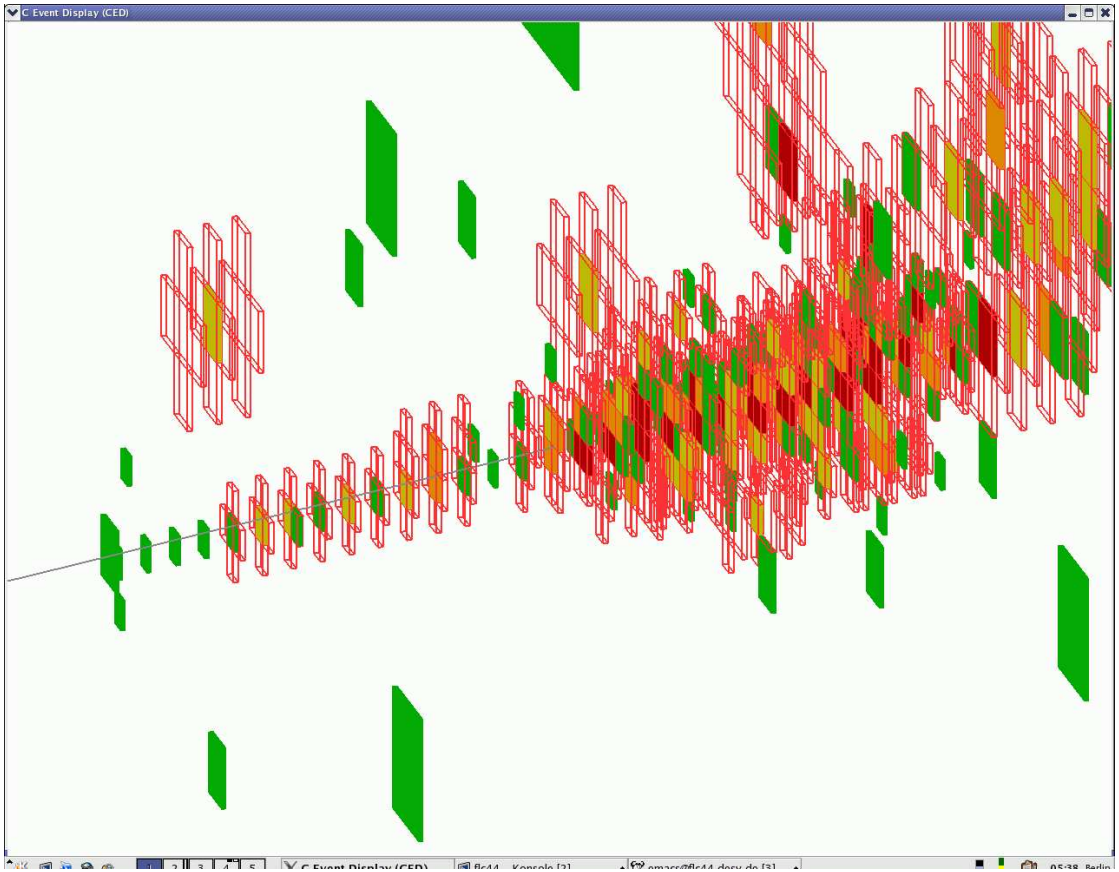

- cells with 2 or more MIP are used as seeds
- neighbours are added
- neighbours with 2 or more MIP are new seeds

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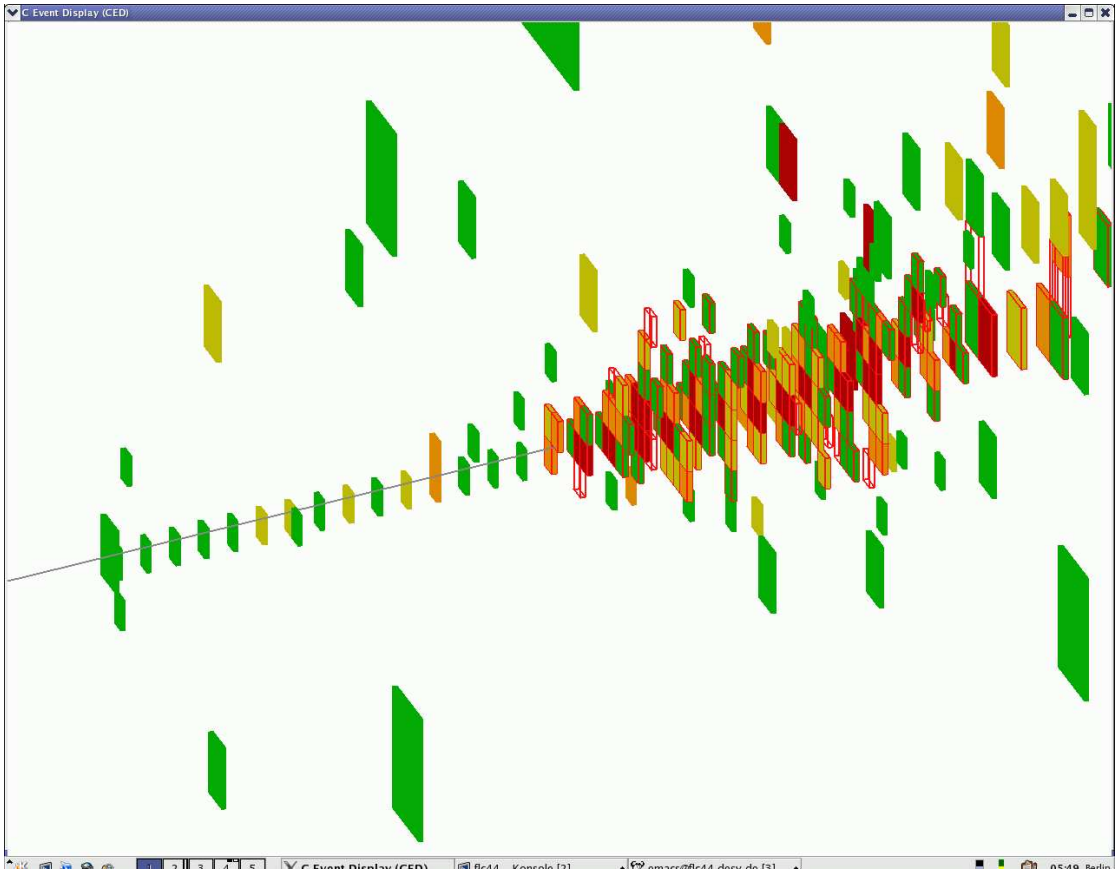

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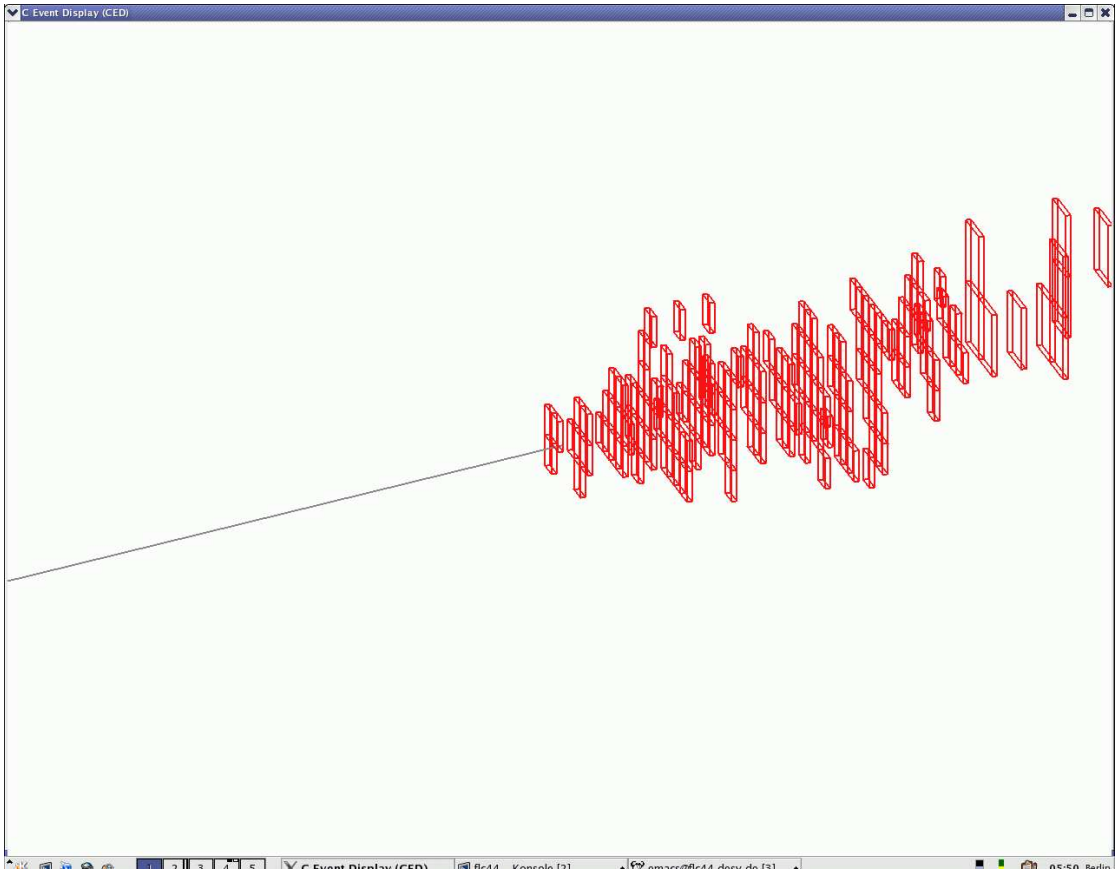

- threshold
  - no. hits
  - energy
- limit
  - angle of cluster axis

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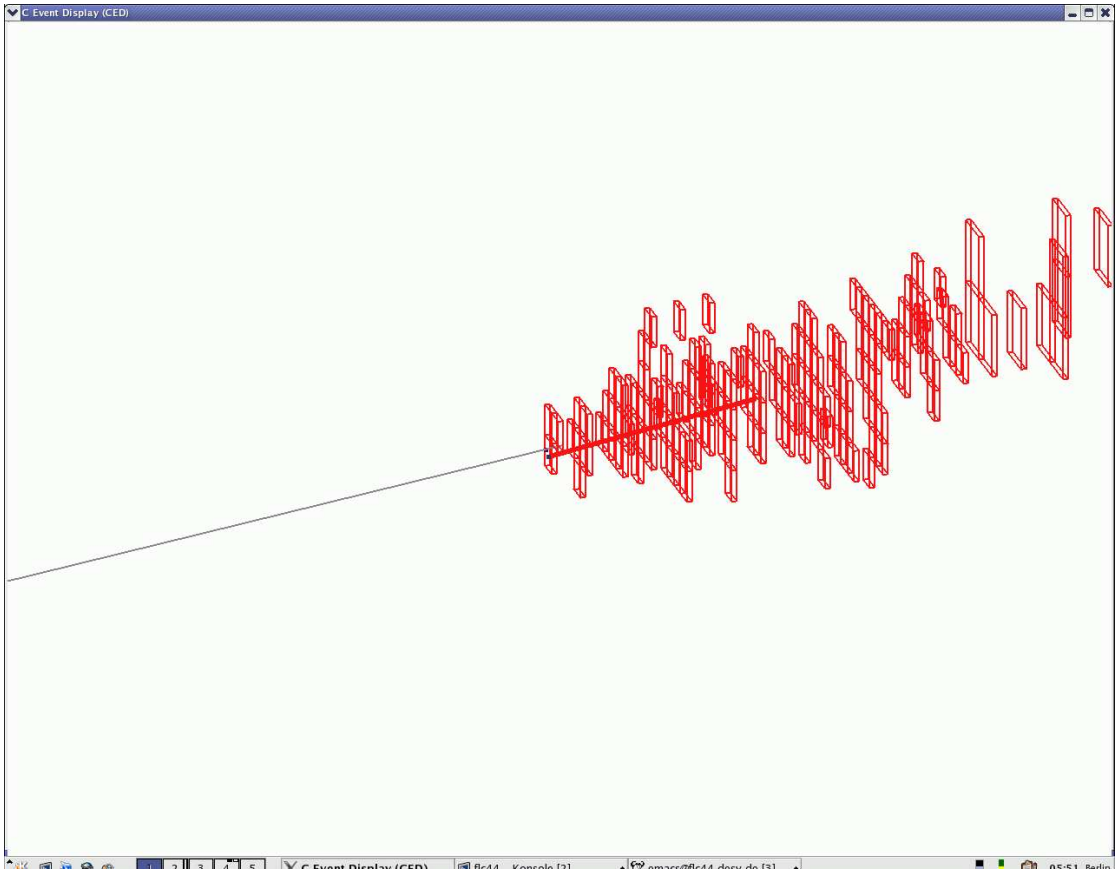

shower start

end of main axis is shower start

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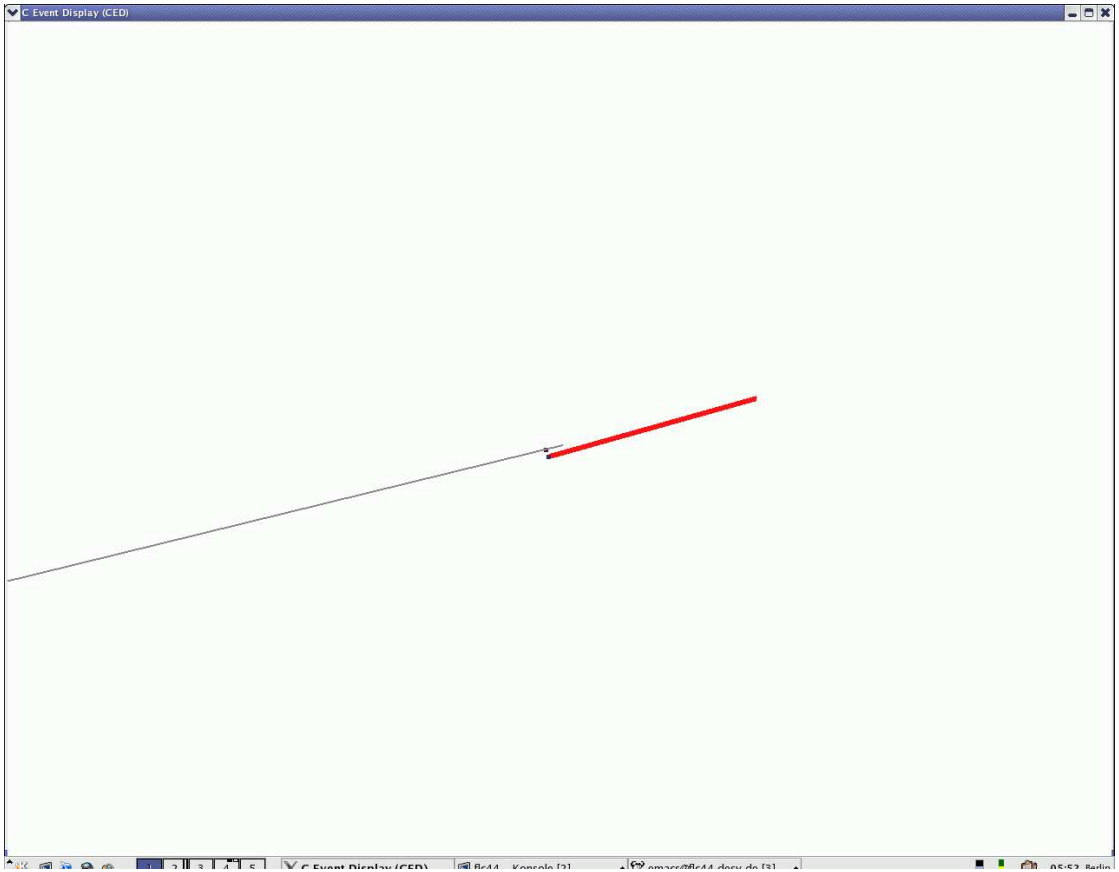

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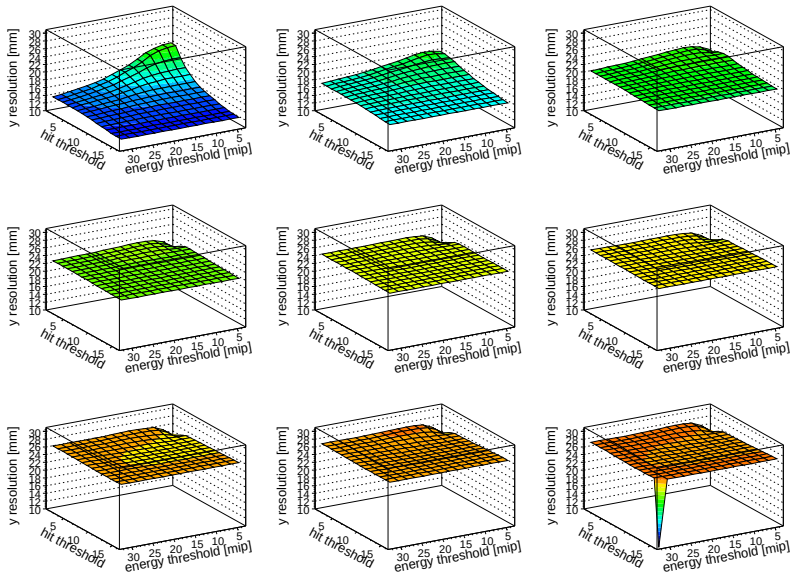
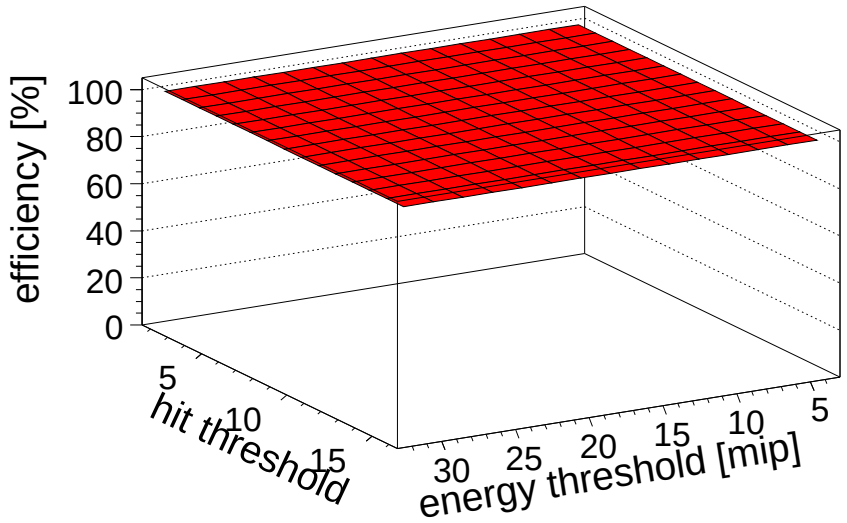
Optimization of the Shower Start Finding



Optimization

- Three parameters to optimize
  - hits in cluster
  - energy in cluster
  - angle of cluster

Optimization of the Shower Start Finding



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  - effi ciency to fi nd a cluster at all

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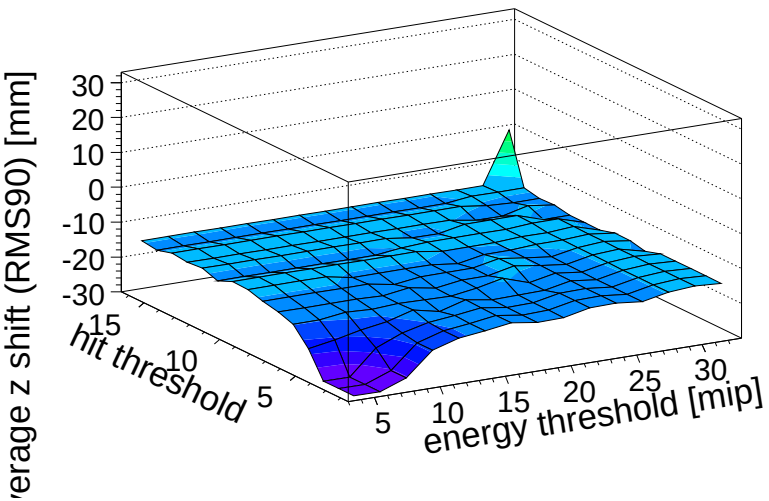

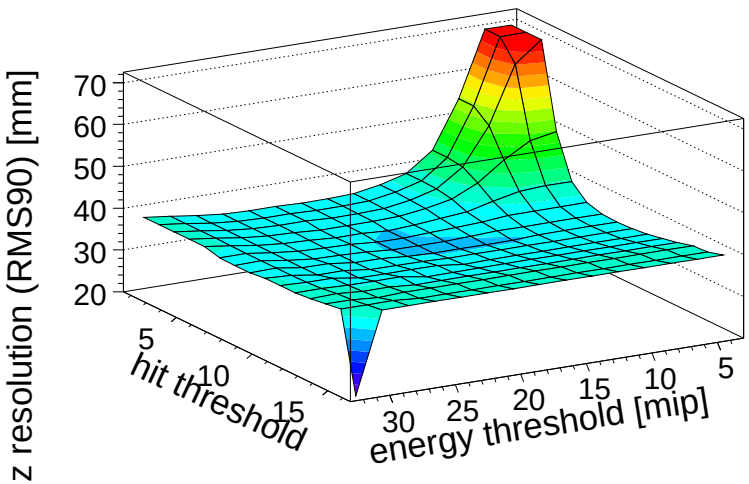

Optimization

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  - hits in cluster
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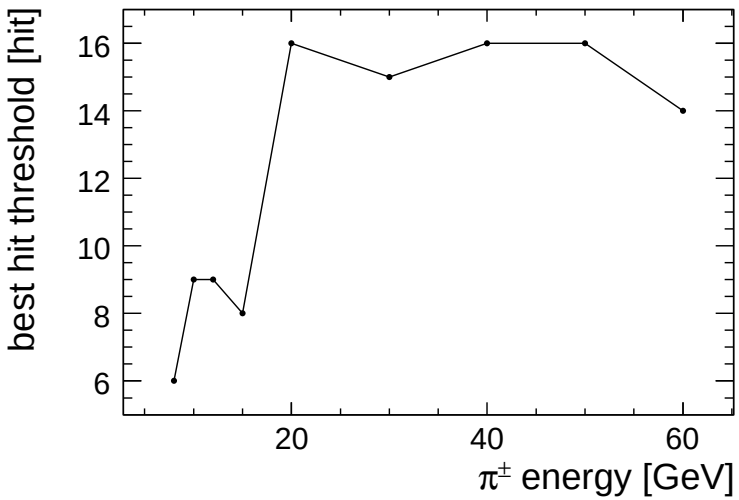
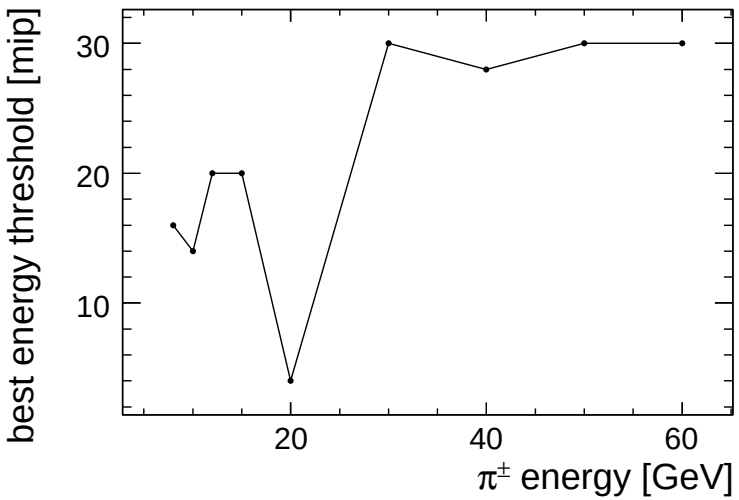
- Observables
  - effi ciency to fi nd a cluster at all
  - mean position and resolution (RMS90)

Optimisation Result





optimal thresholds/limits

angle is best not restricted

hits depends on beam energy, can give bias for coarse modules

energy not much help if hits are already restricted

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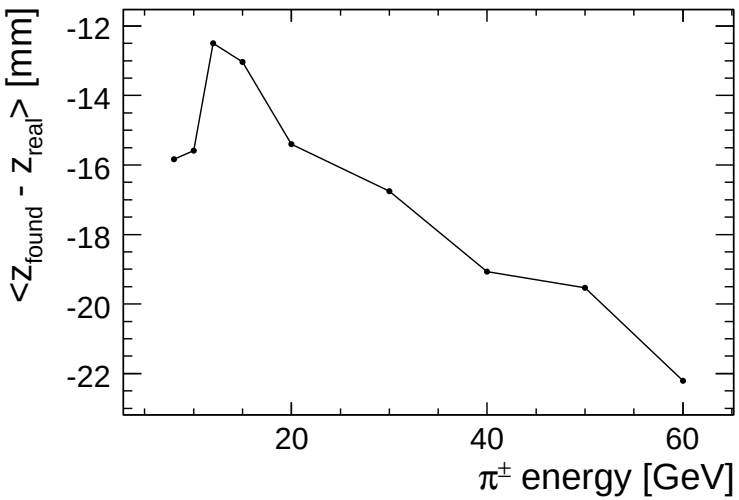

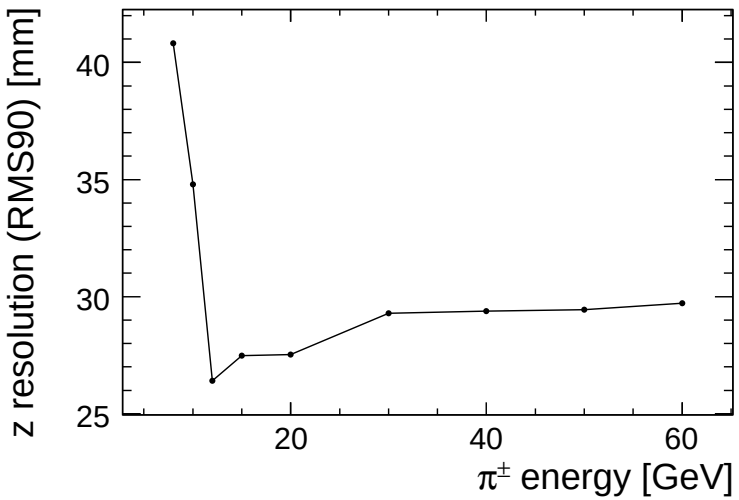

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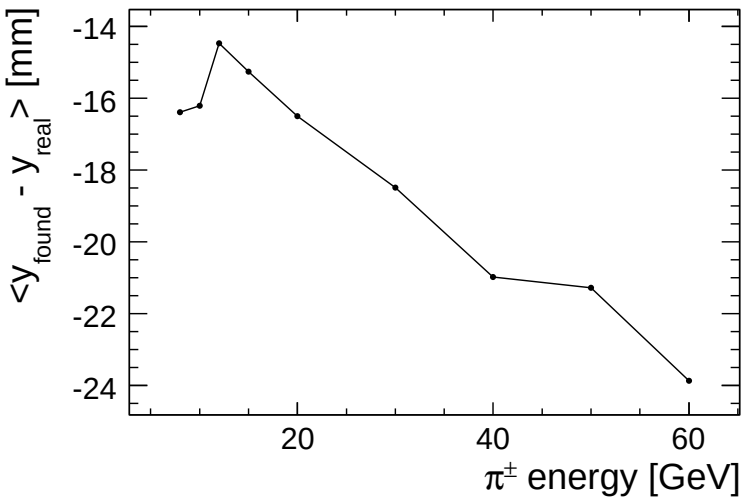
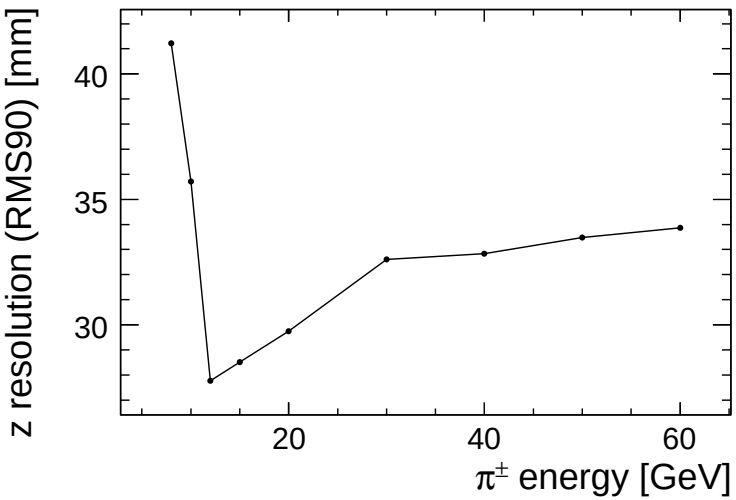


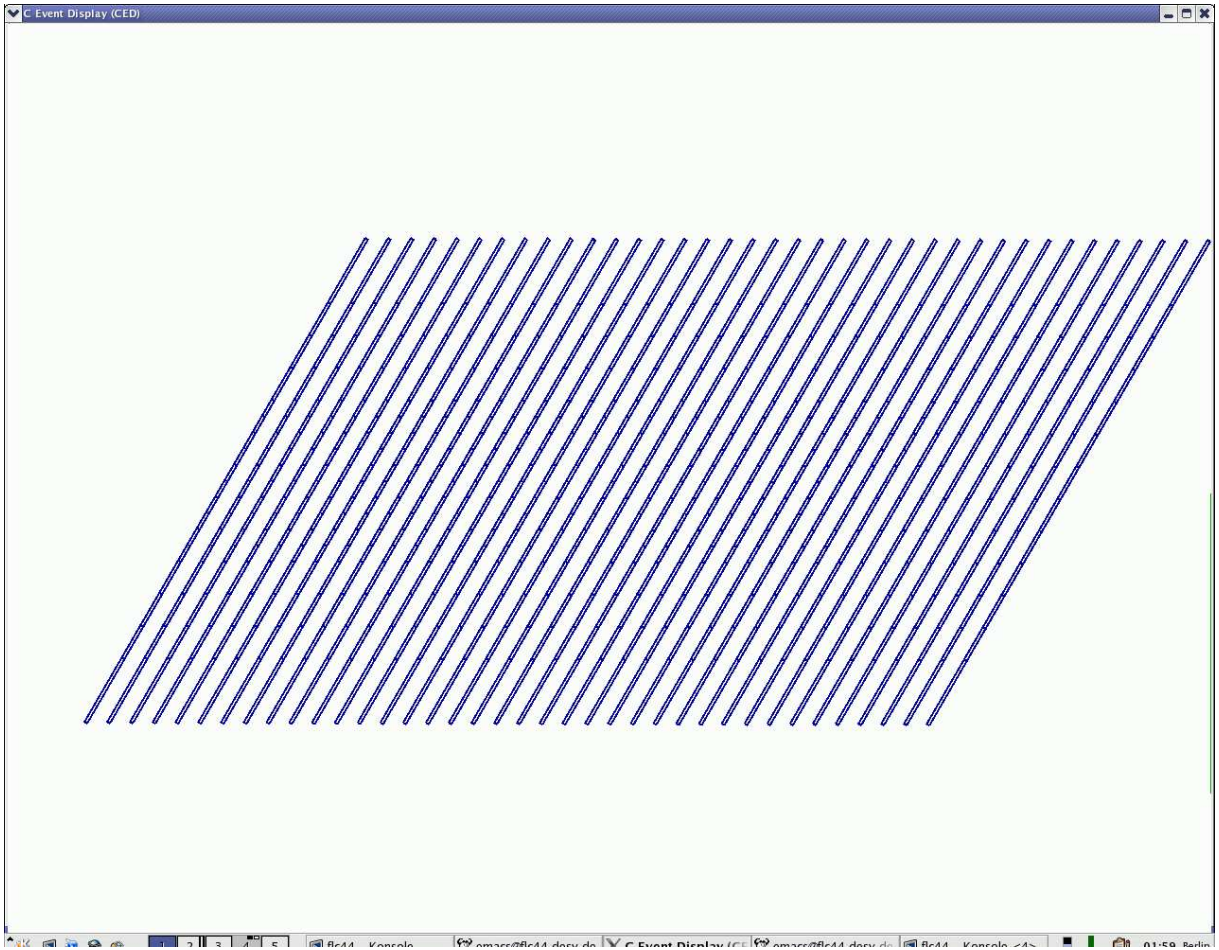


fi xed set of limits with minimal bias in coarse region

- at least 16 mip energy
- low hit restriction (4)
- used for current measurements
- should be improved in future

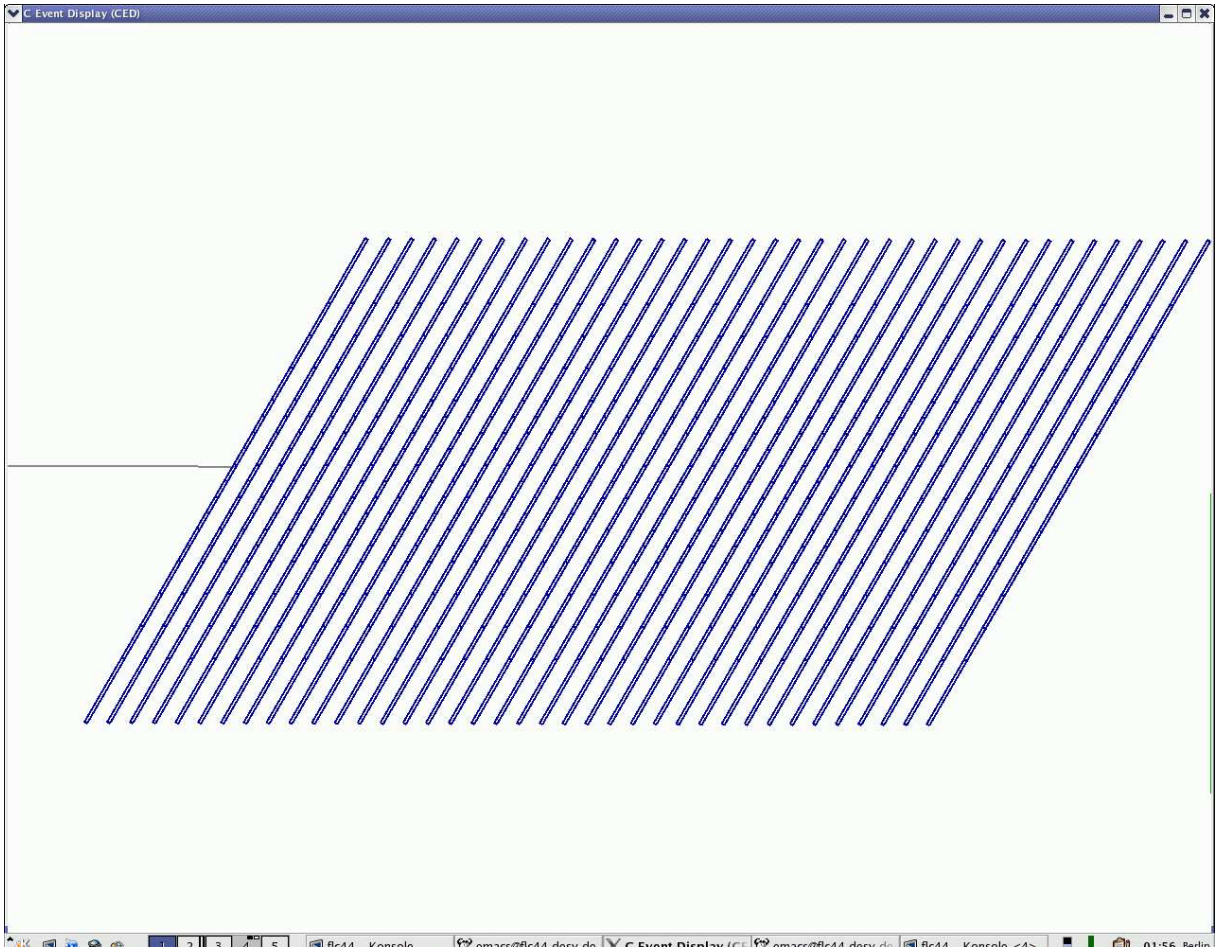
Rotated Detector

Rotated Detector



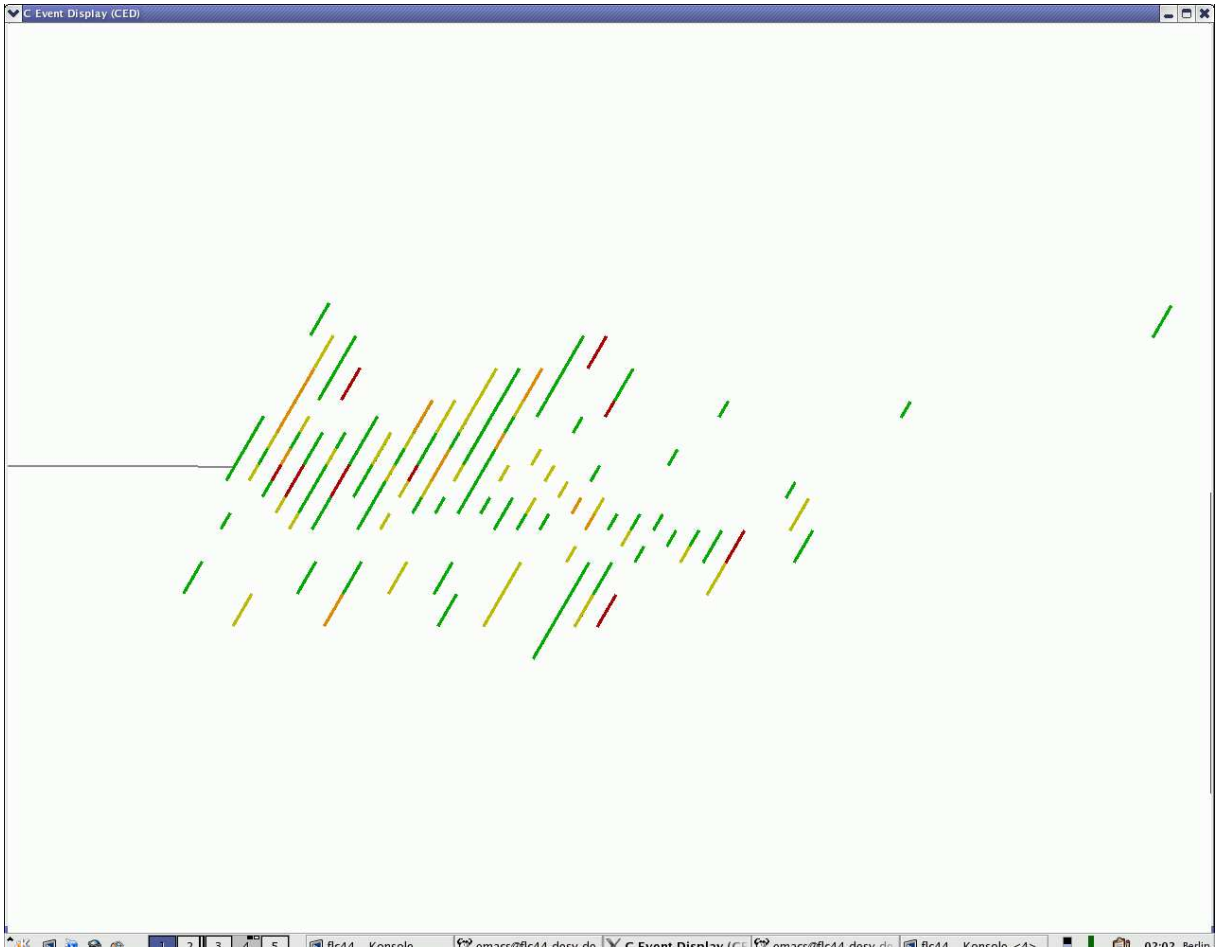
detector rotated for 30 deg.

Rotated Detector



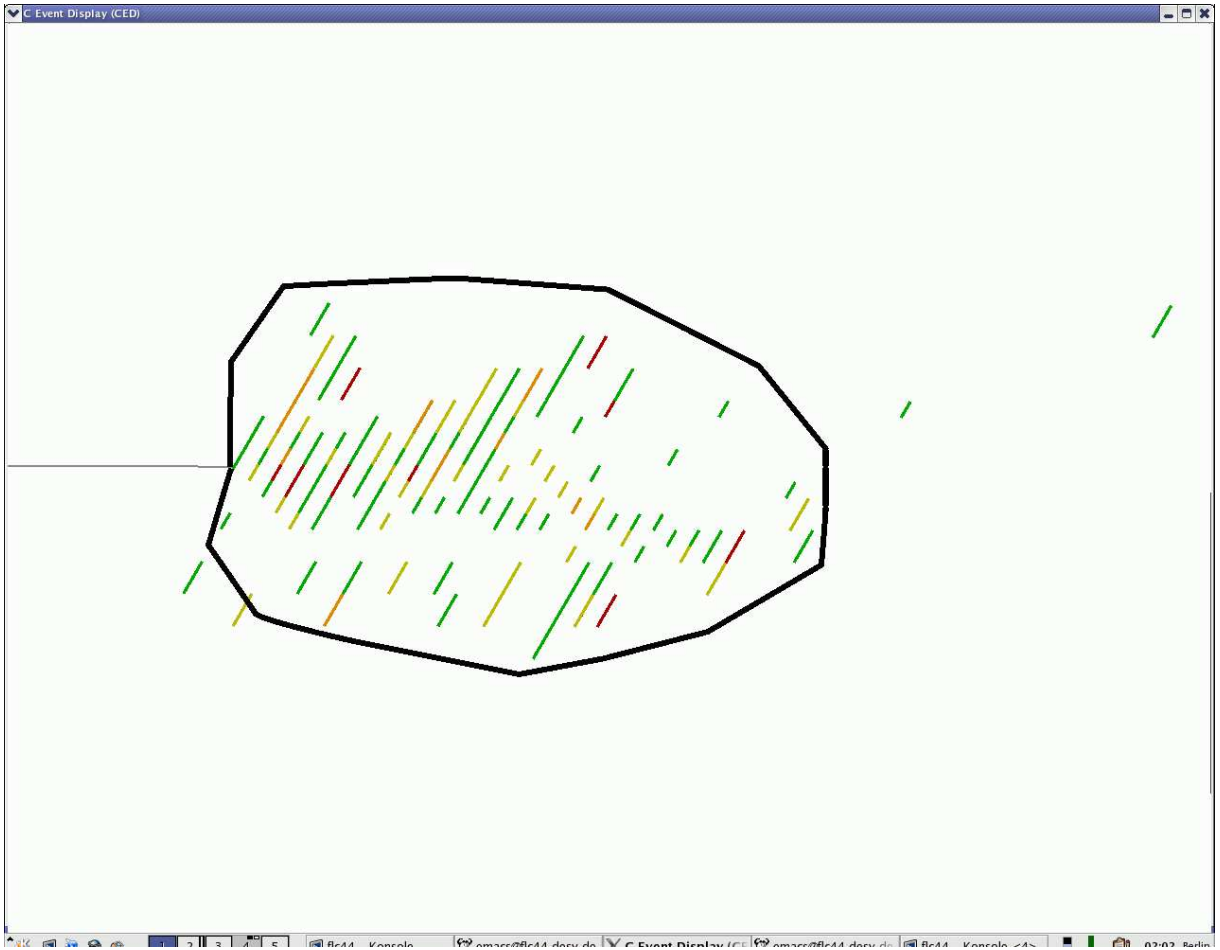
incoming 30GeV π^+.

Rotated Detector



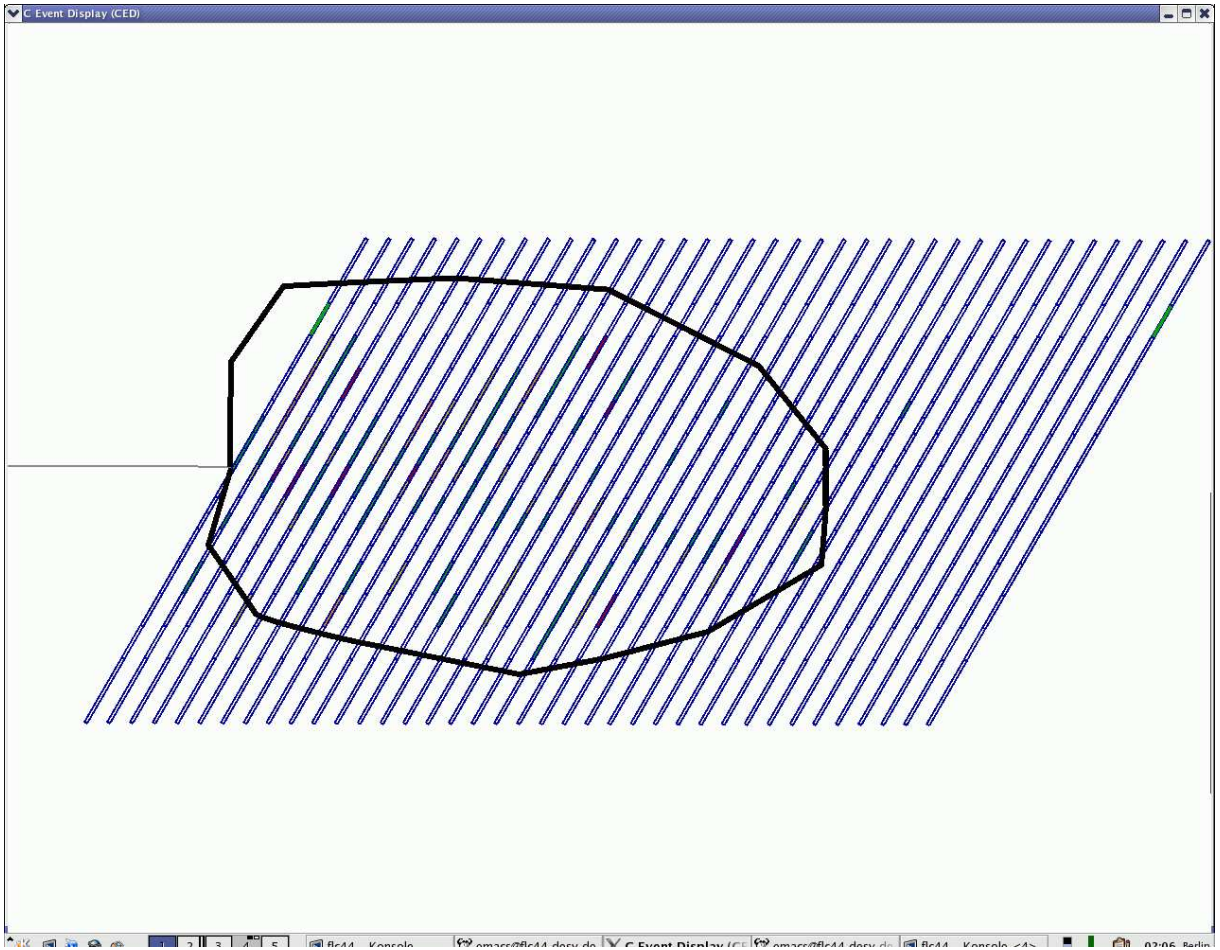
shower activity in rotated detector

Rotated Detector



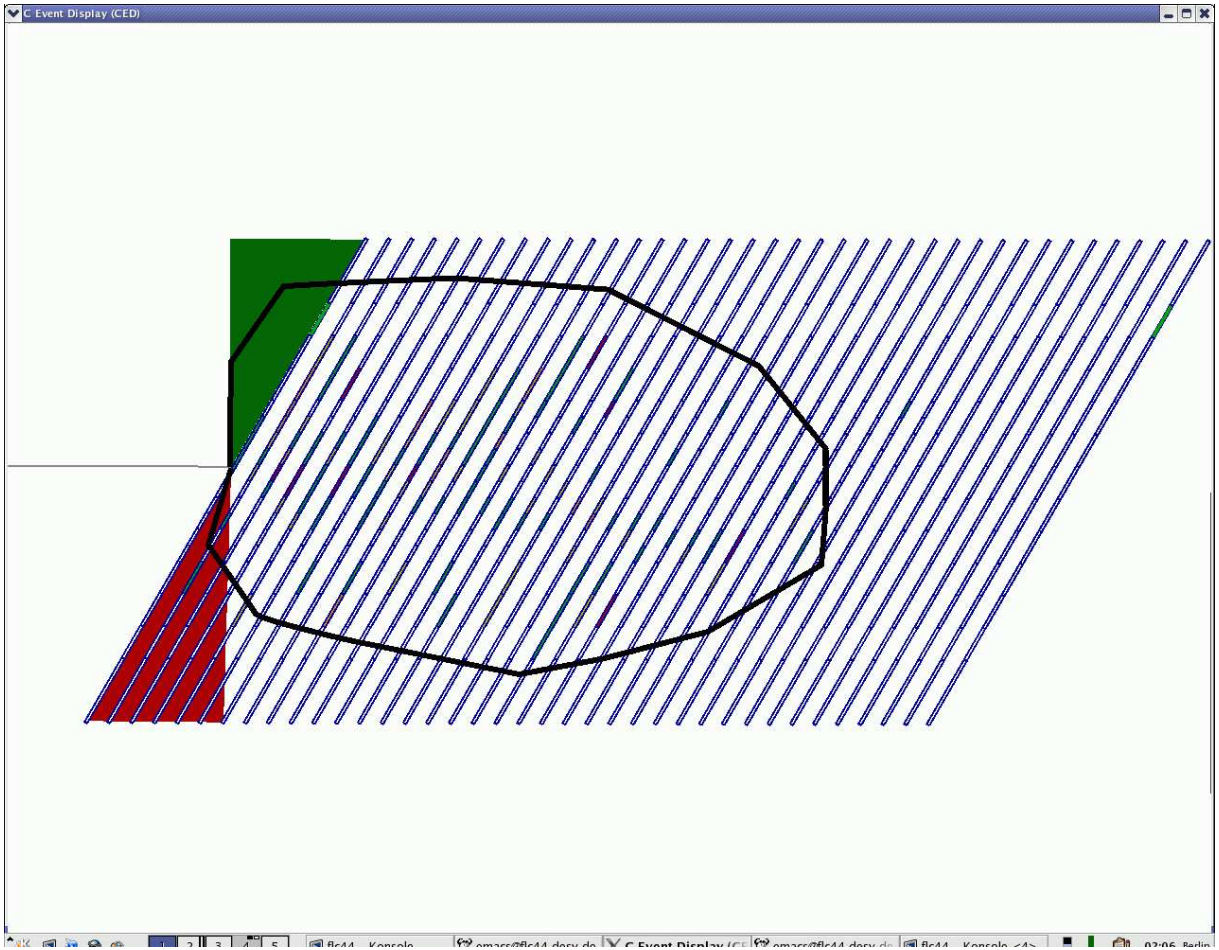
envelope of shower

Rotated Detector



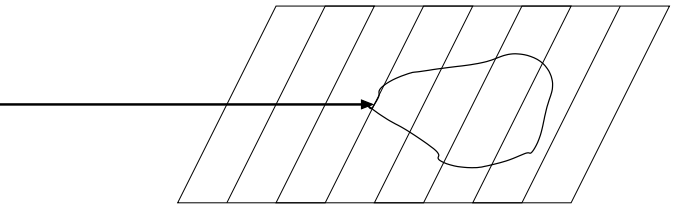
envelope of shower compared to detector

Rotated Detector



in green area the detector response is reduced
in red area the detector covers not all radial positions

Example: Longitudinal in a Rotated Detector



Profile

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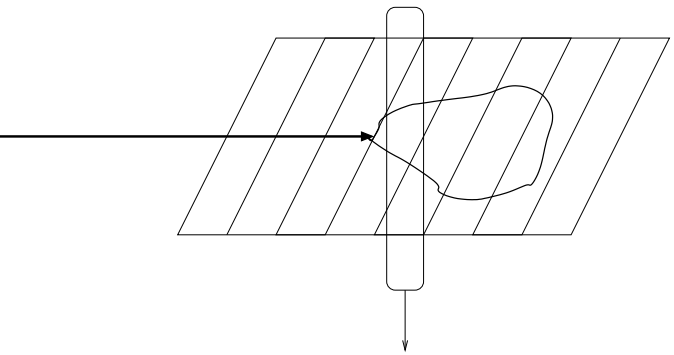

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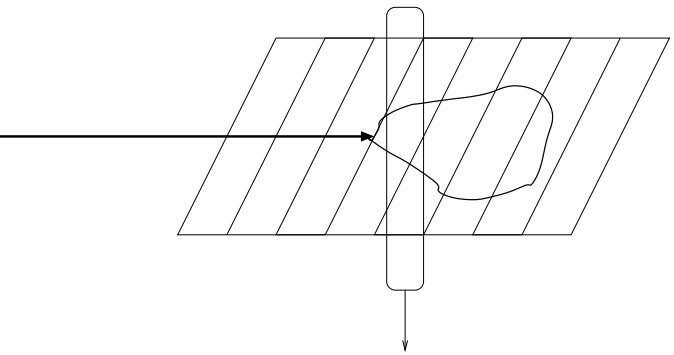

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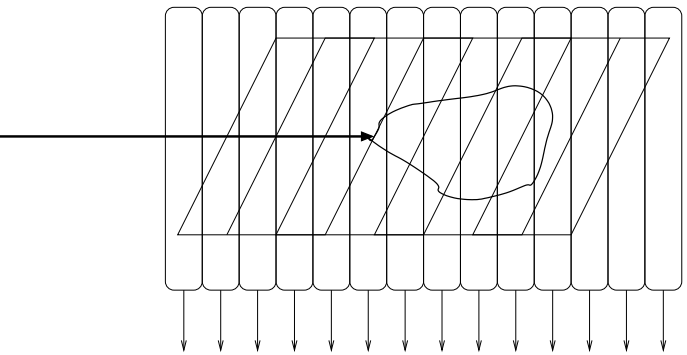

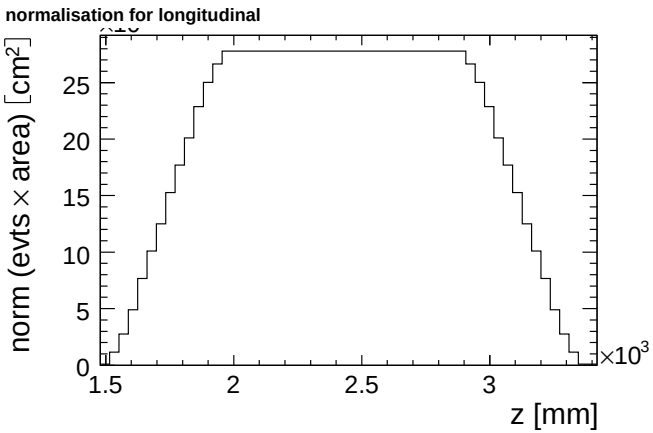

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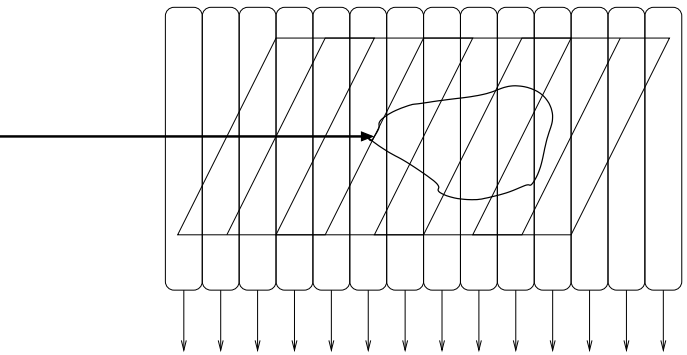

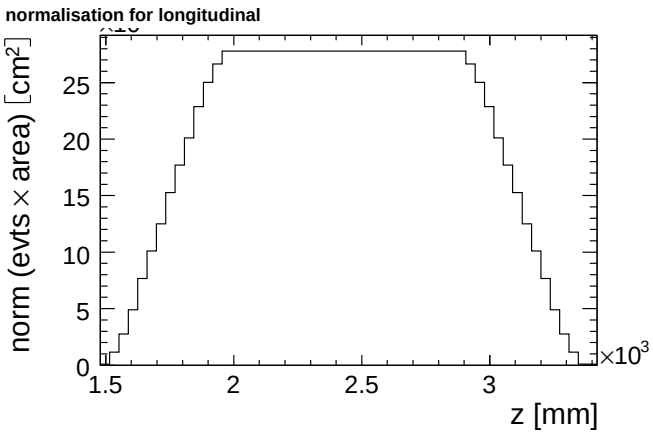

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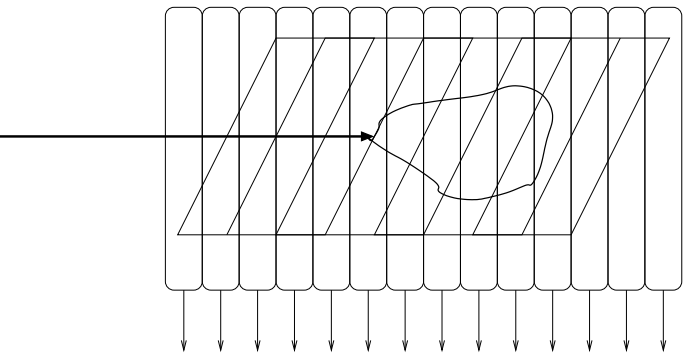

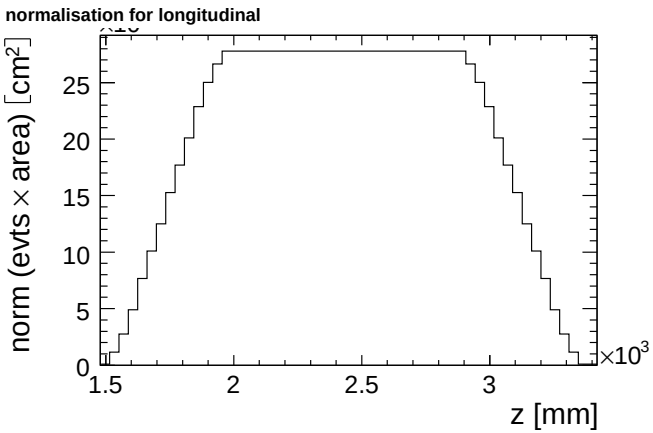

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  - needs some splitting of energy from cells larger than binning
- calculate the detector sensitivity for each bin
  - needs information about detector geometry
- avoid regions where detector has not full radial coverage

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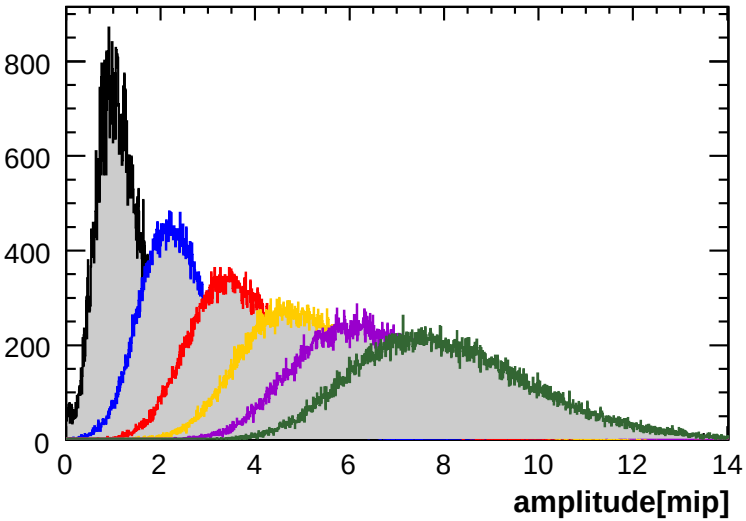

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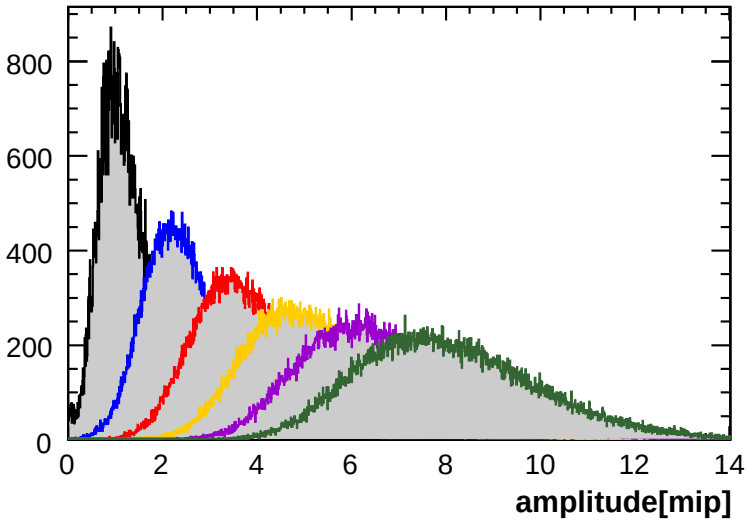

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- find thresholds where N MIP becomes more probable than $N - 1$ MIP

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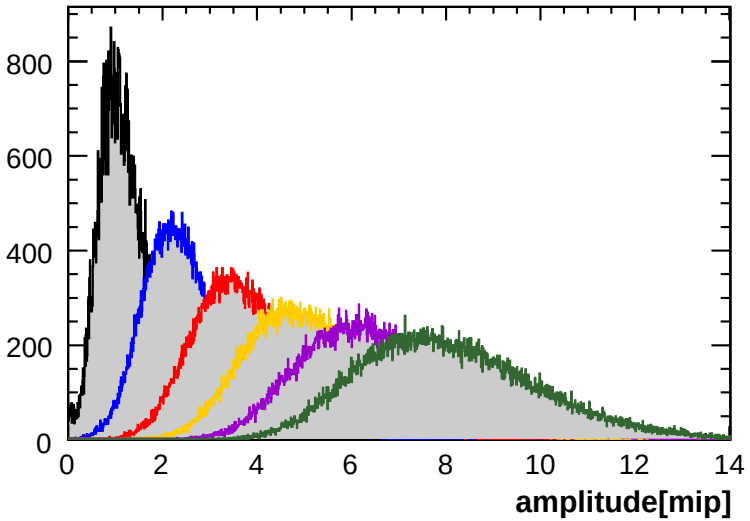

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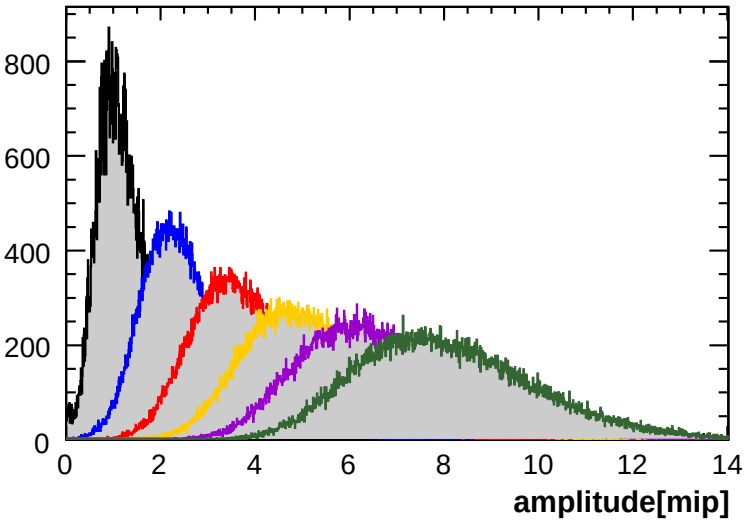

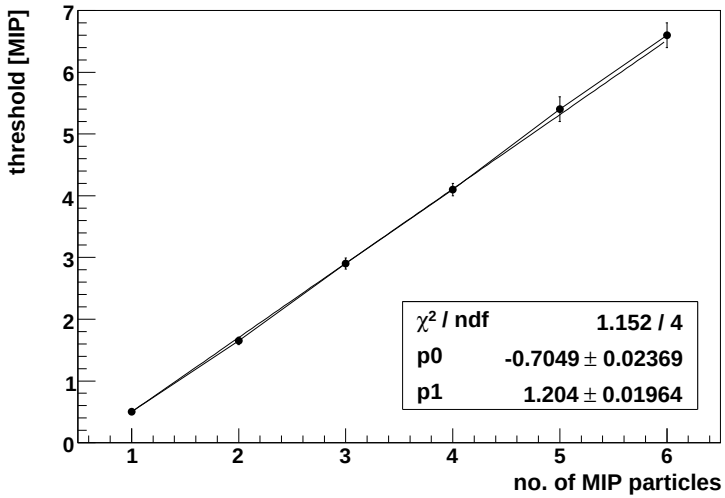

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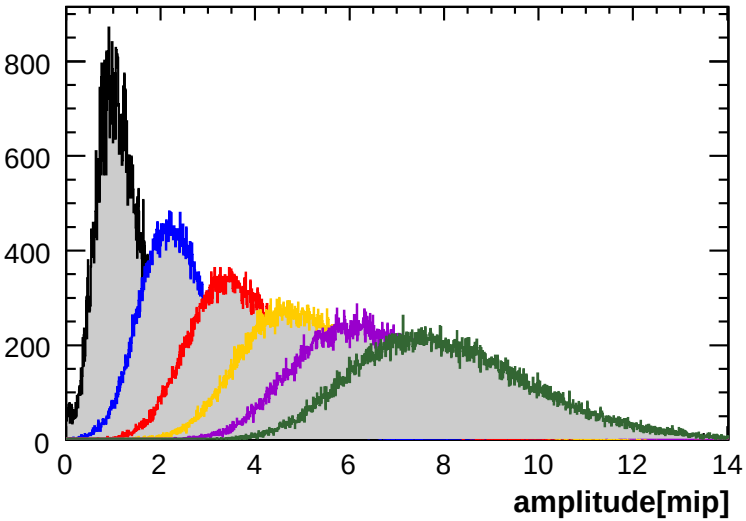

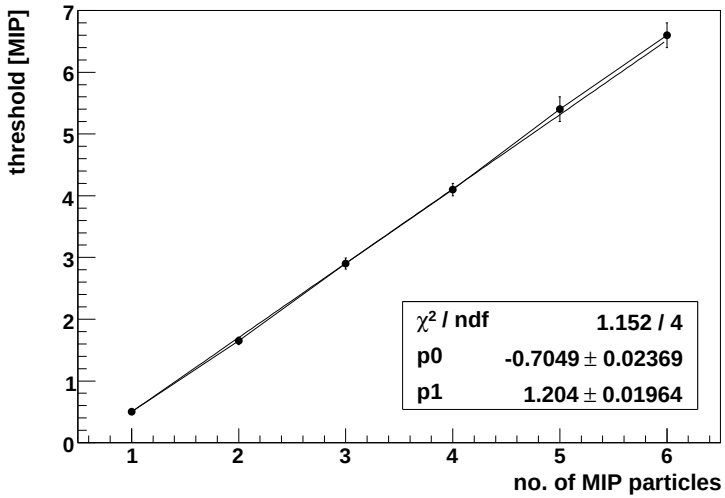

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- these thresholds follow linear behaviour
- inverse can be used to estimate probable number of particles in cell

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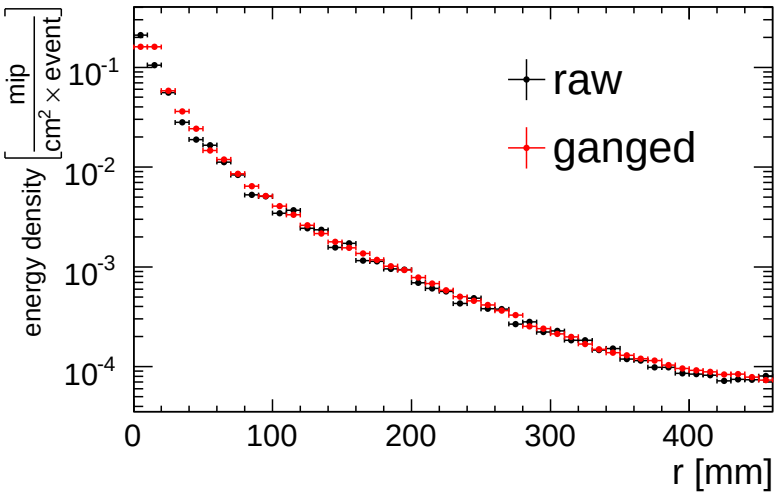

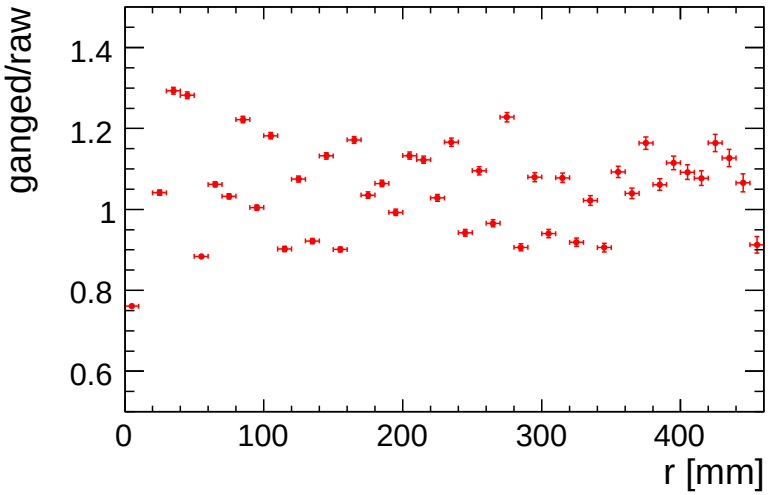

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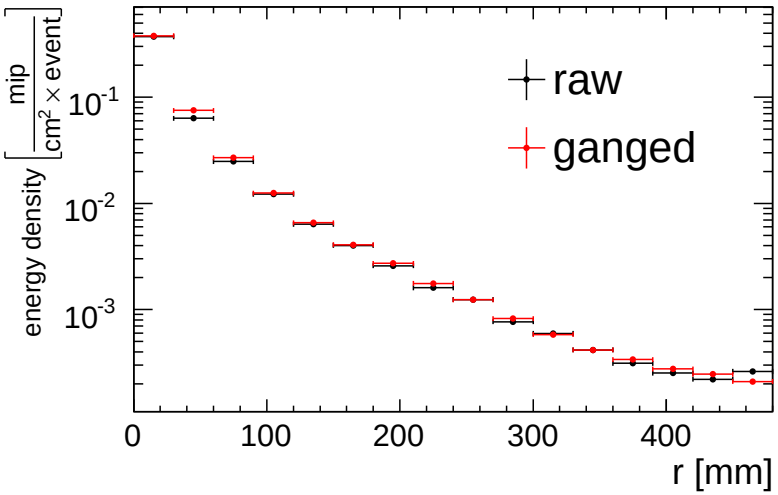

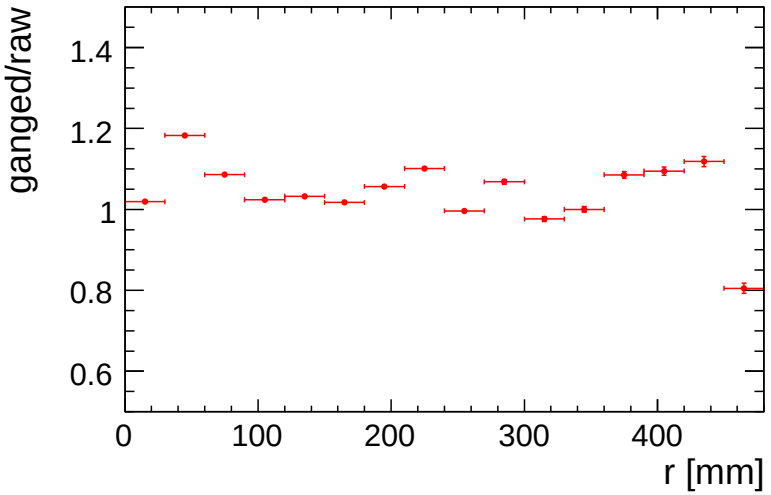

Reason for Bad Match

Two Bugs

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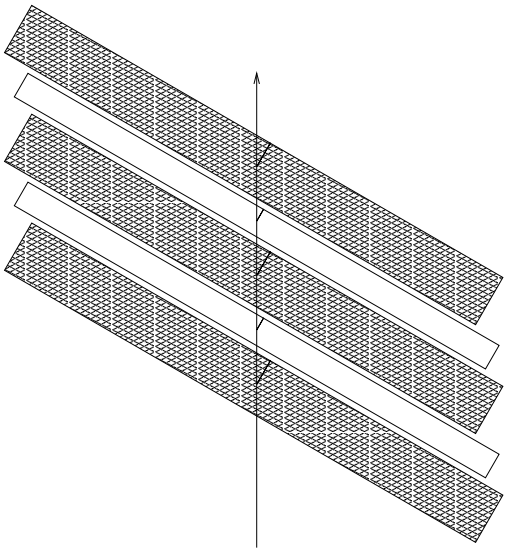
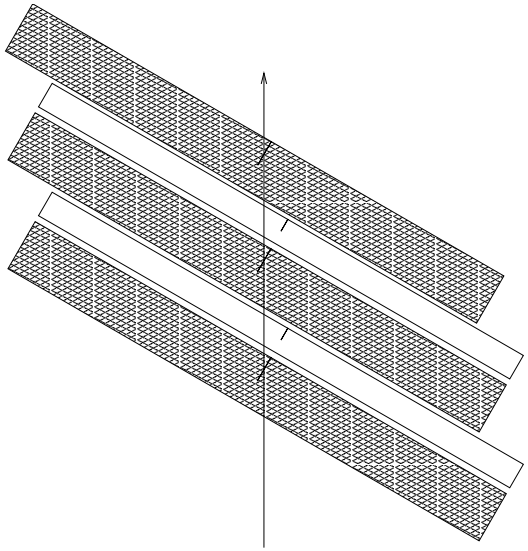
- Mokka geometry is wrong

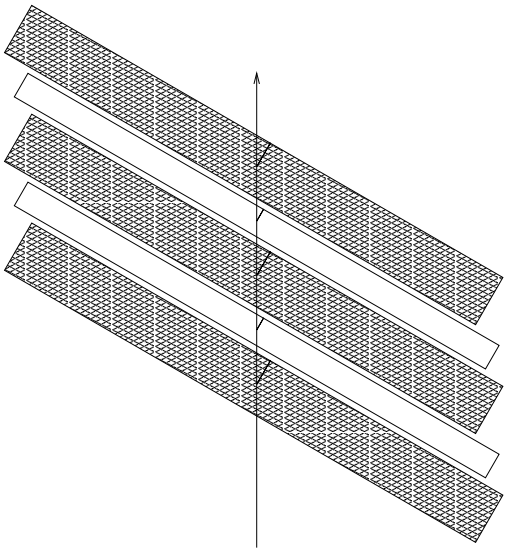


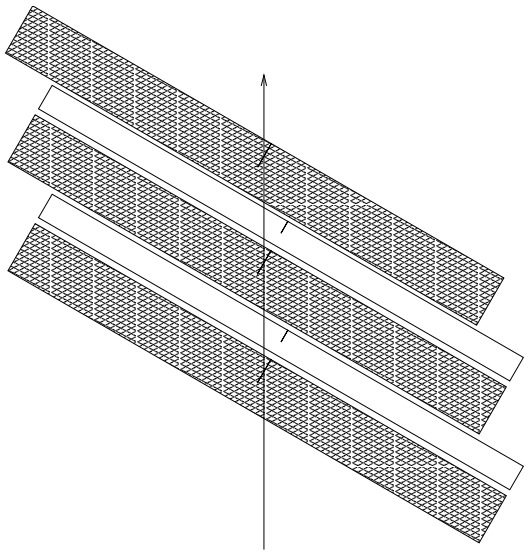


Reason for Bad Match

Two Bugs

- Mokka geometry is wrong
- MIP cut works on different cell sizes





Reason for Bad Match

Fast Fix

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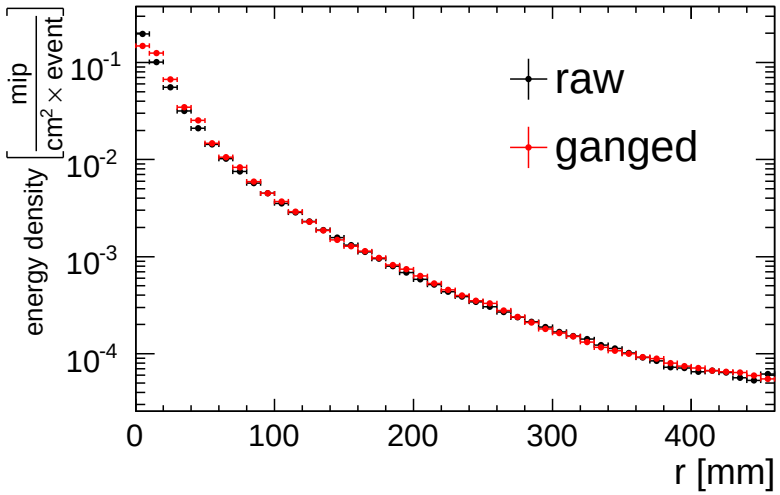
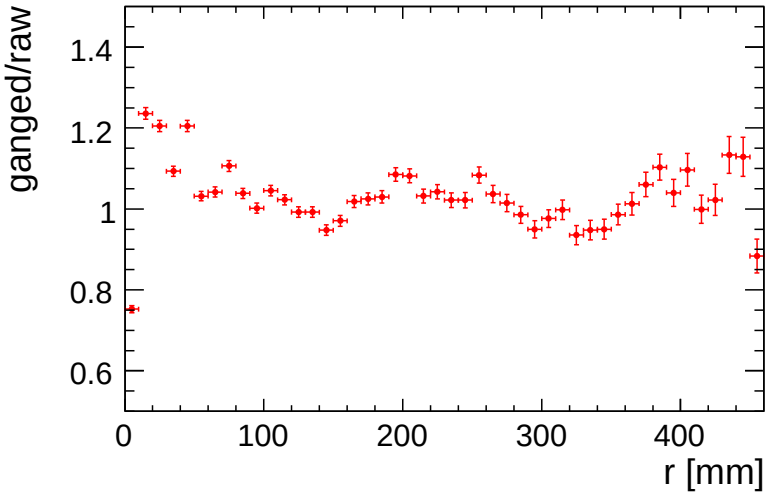
- Gangin with the same offsets like mokka

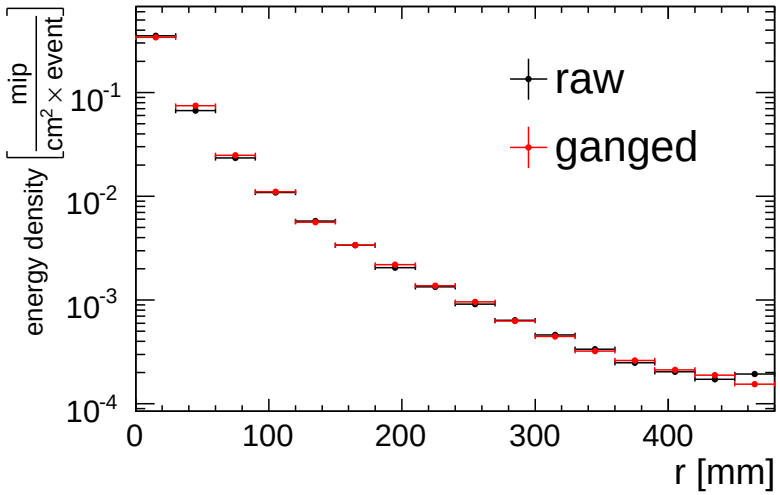


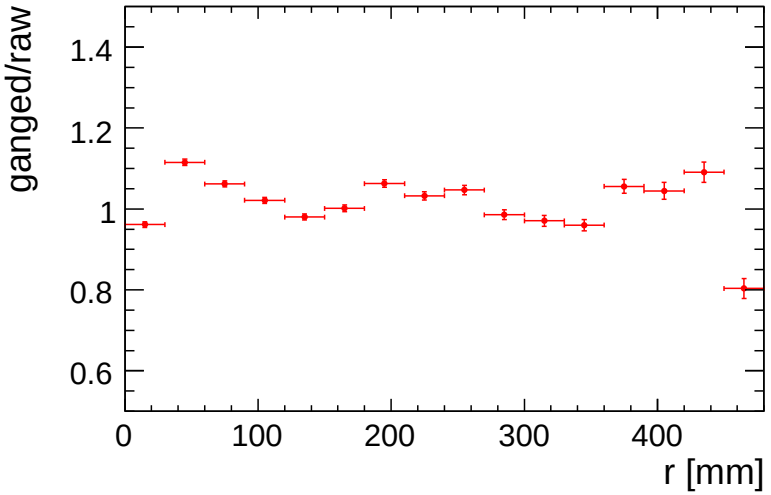


Reason for Bad Match

Fast Fix

- Gangin with the same offsets like mokka
- cut already before ganging
  $\Rightarrow$ increased effective threshold





Profiles from Shower Start

pitfalls

- superimposing measurements of different depth

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  - shorter HCAL for shower
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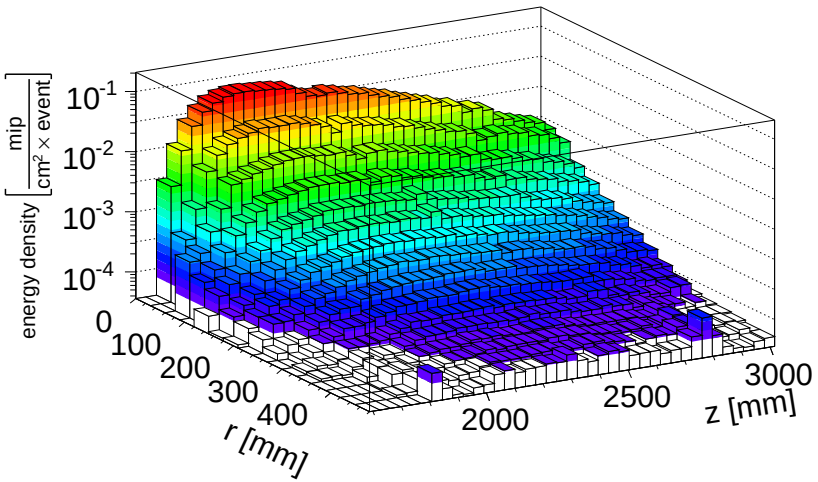
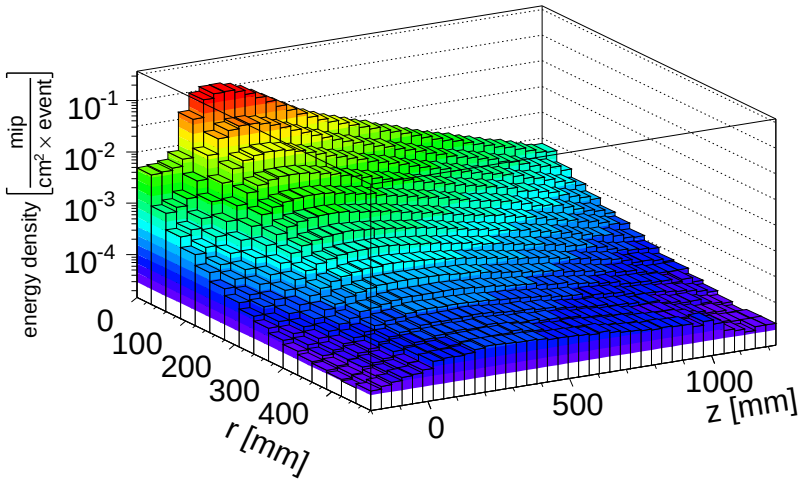
- restrict to shower start away from the border

Results of the Measurements

π^- 12 GeV



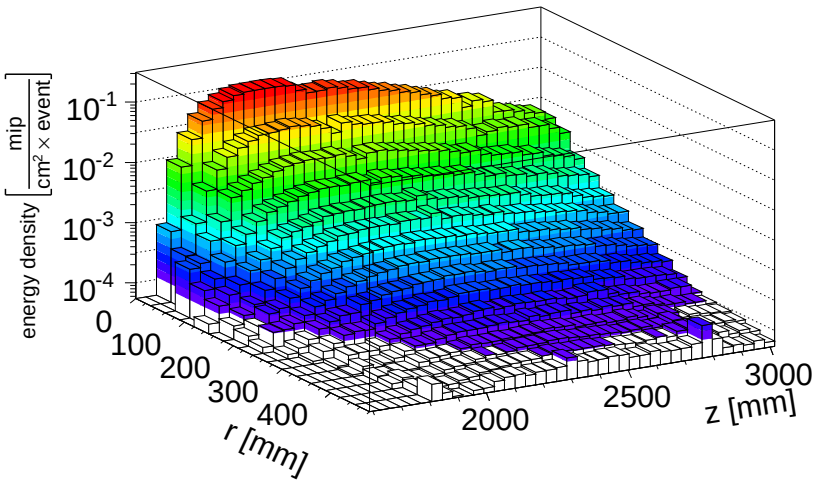
2D profile



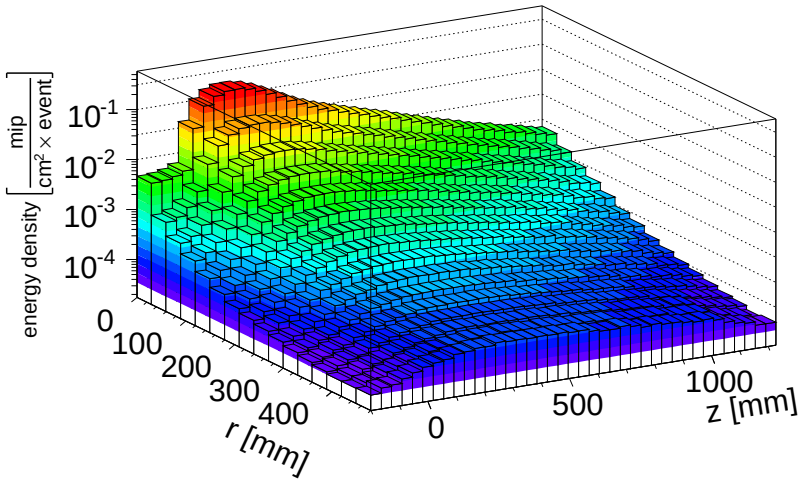
2D profile measured from shower start

Results of the Measurements

π^- 20 GeV



2D profile



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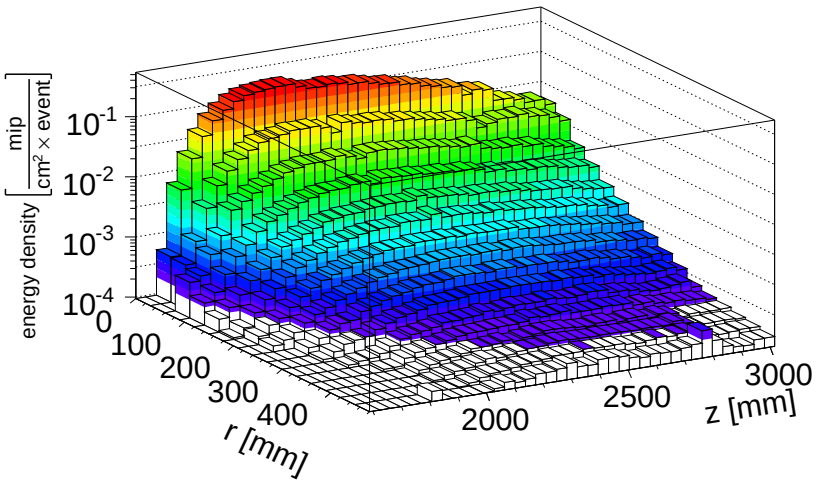
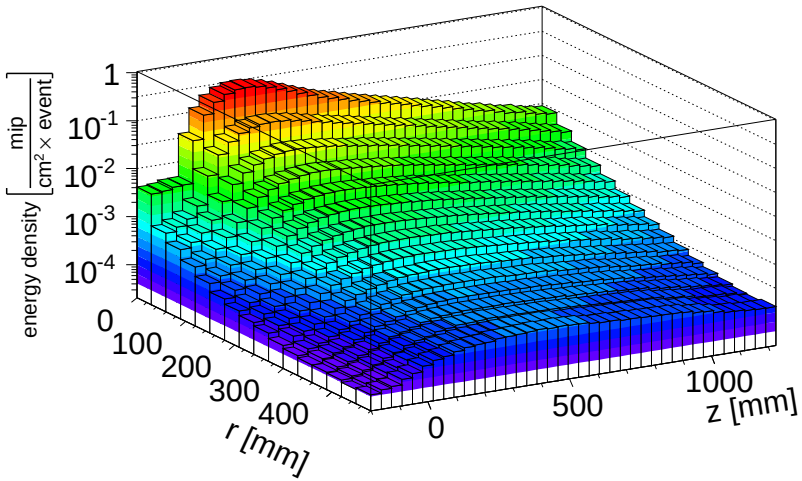


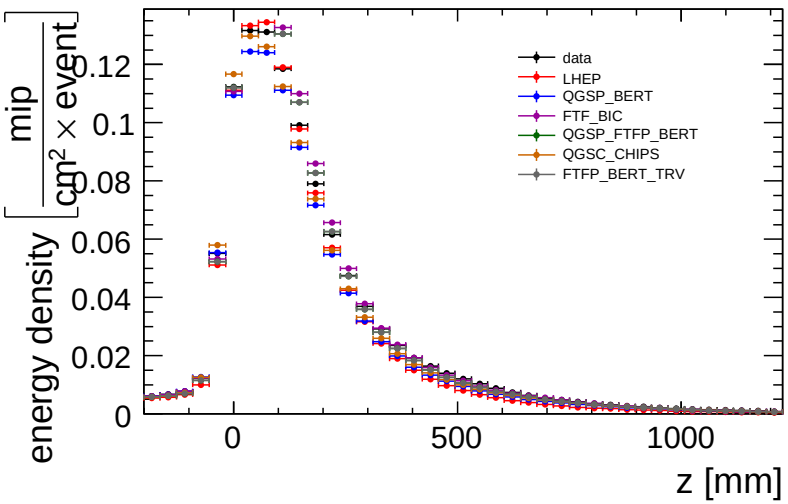
2D profile

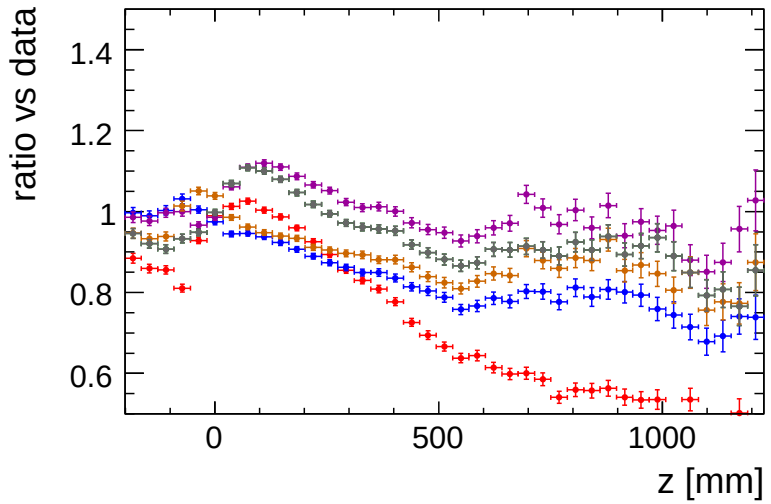


2D profile measured from shower start

Comparison of Data and Simulation

π^- 10 GeV
longitudinal profile for radius $<$ 6cm





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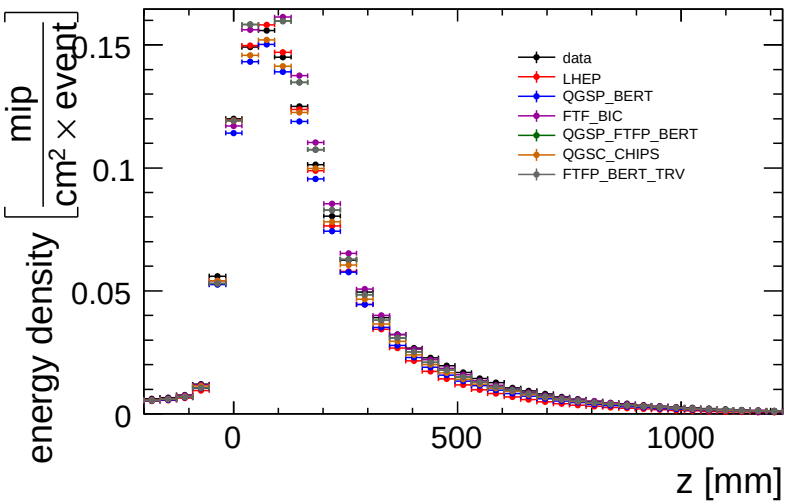

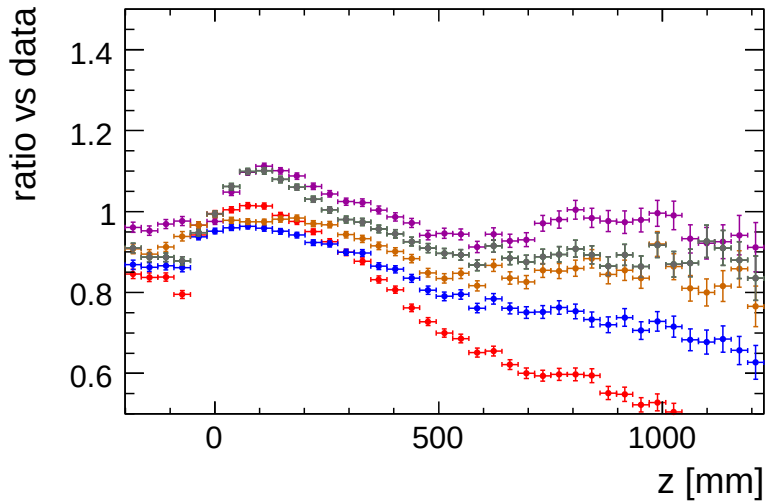

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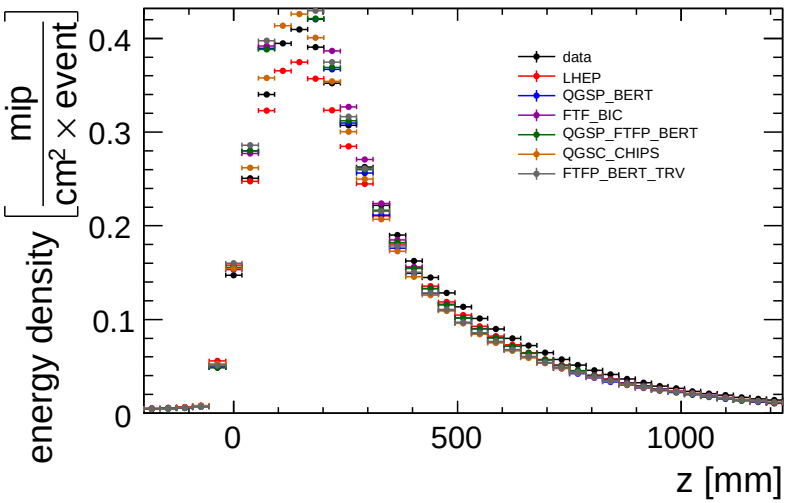

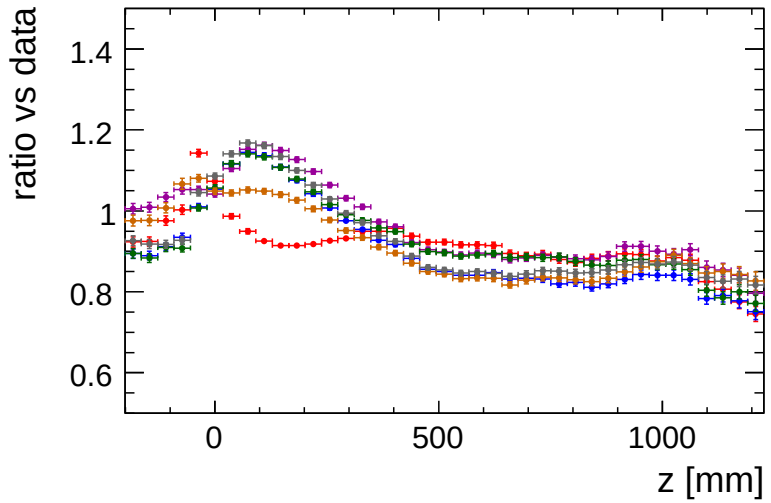

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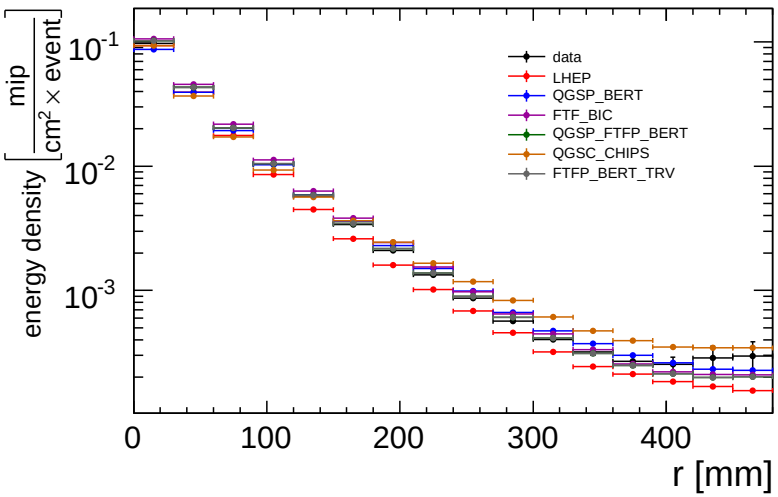

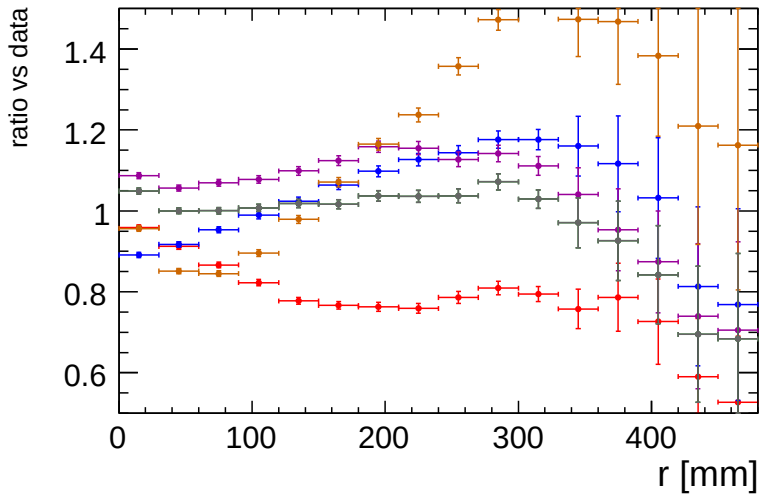

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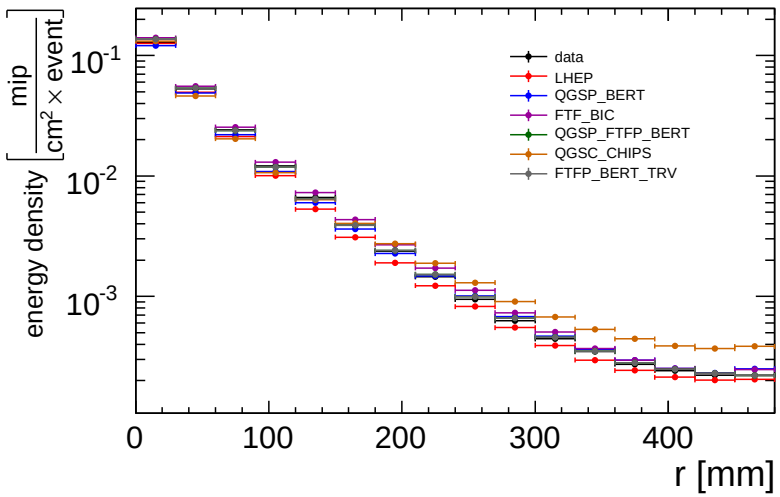

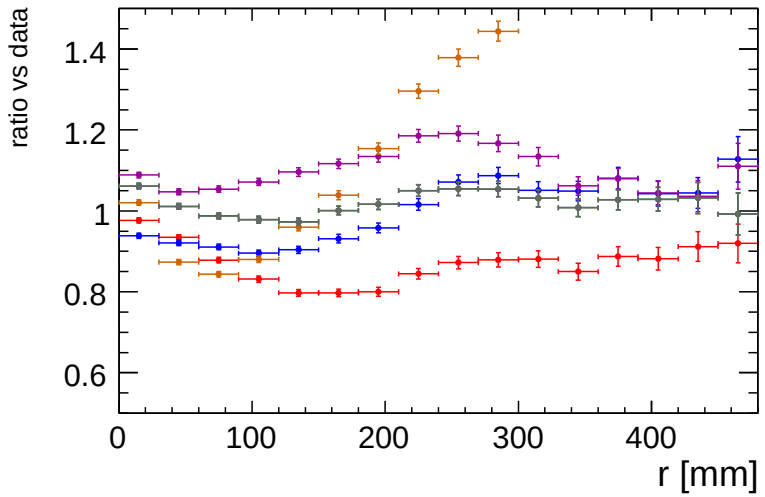

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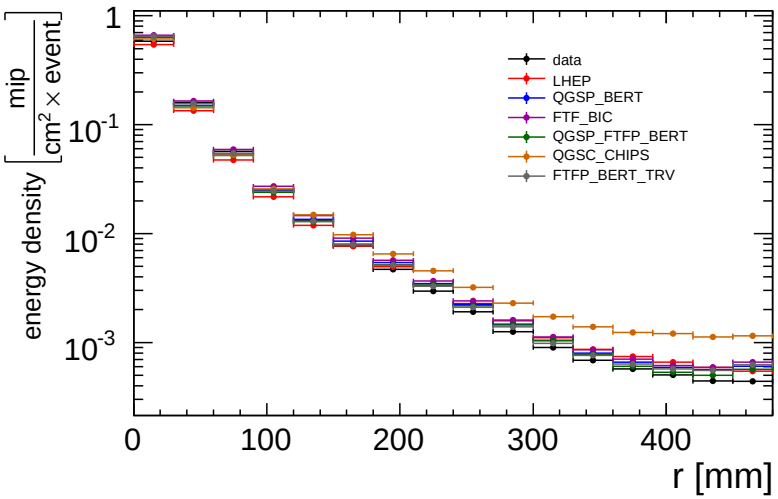

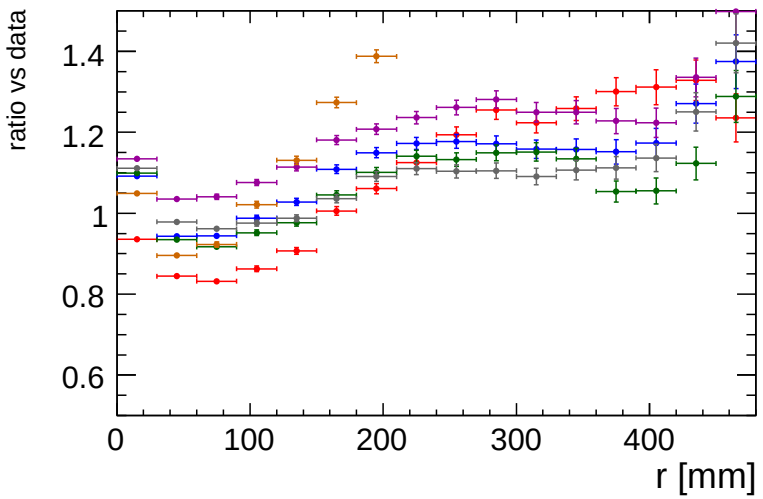

Conclusions & Outlook

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  - 3D space point
  - extensive optimization
  - accuracy quantifi ed
- corrected profiles for rotated detector
- code development for
  - cell properties during reconstruction
  - cell positions correction
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Outlook

- fix Mokka for proper profile comparison
- repeat analysis with optimized thresholds
- measure interaction lenght (including resolution)
- analyze leakage exploiting
  - new shower start
  - code capabilities