CALICE AHCAL main meeting
DESY, 12.-13.12.2011

Spartial resolution of AHCAL for EM showers

– First results –

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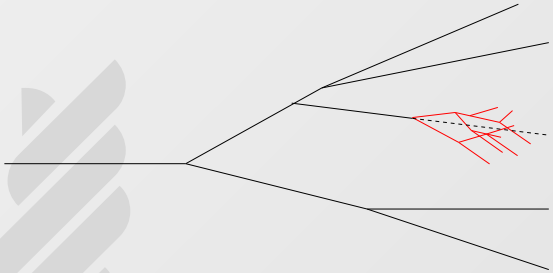
Introduction

- EM showers in had. Calorimeters
  - Dense, compact energy deposition
  - EM-hits – once identified – allow for precise track reconstruction (→ PFA)

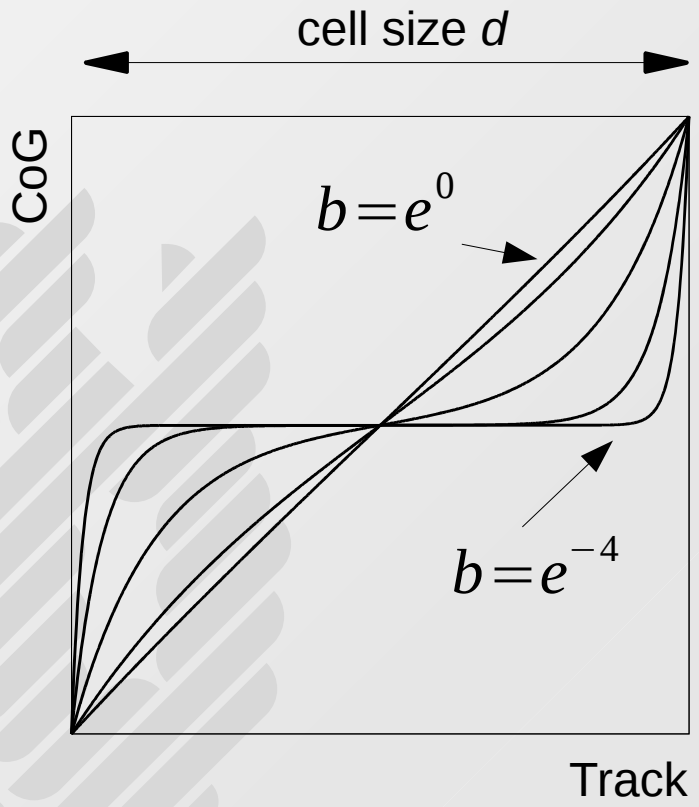


- **Today**: first analysis of HCAL track resolution
  - TB CERN '07 (positrons, without ECAL)
    - *Rotated HCAL*
  - TB CERN '11 (electrons, Tungsten)

Theory in short

- Assume exp. shower profile
- Detector response (CoG) to track position is stepfunction:

$$x_{HCAL} = \frac{\sinh\left(\frac{x_{TRACK}}{b}\right)}{\sinh\left(\frac{d}{2 \cdot b}\right)} \cdot \frac{d}{2}$$

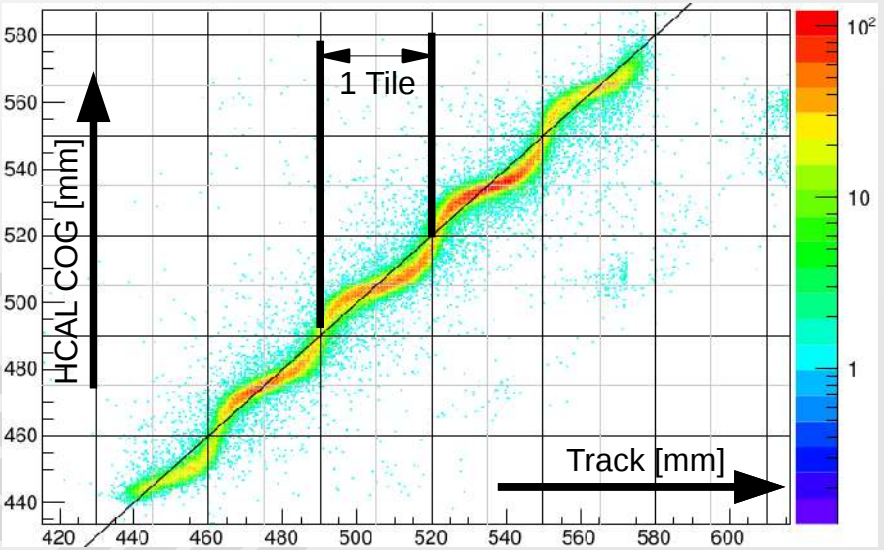


- Shape parameter b depends on energy & layer
  - First layer: distinct step, last layers: smooth
- **Correct CoG by inverse function**

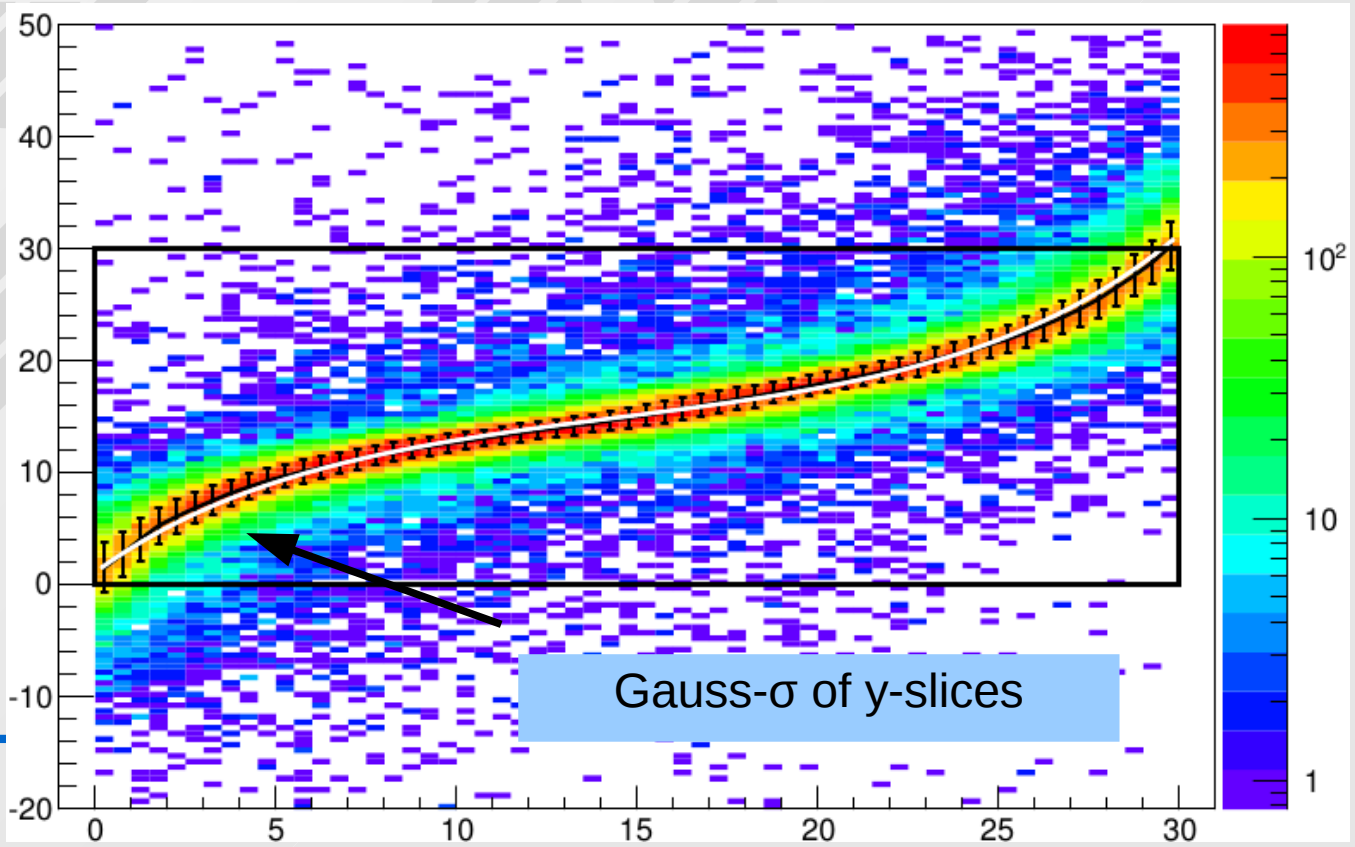
$$x_{HCAL}^{Corr} = b \cdot \operatorname{arsinh}\left(\frac{2}{d} \sinh\left(\frac{d}{2 \cdot b}\right) \cdot x_{HCAL}\right)$$

Testbeam data

- Combine data of several runs
  i.e. several stage positions
- Real world coordinates
  useless – need something
  tile-based: CellIndex



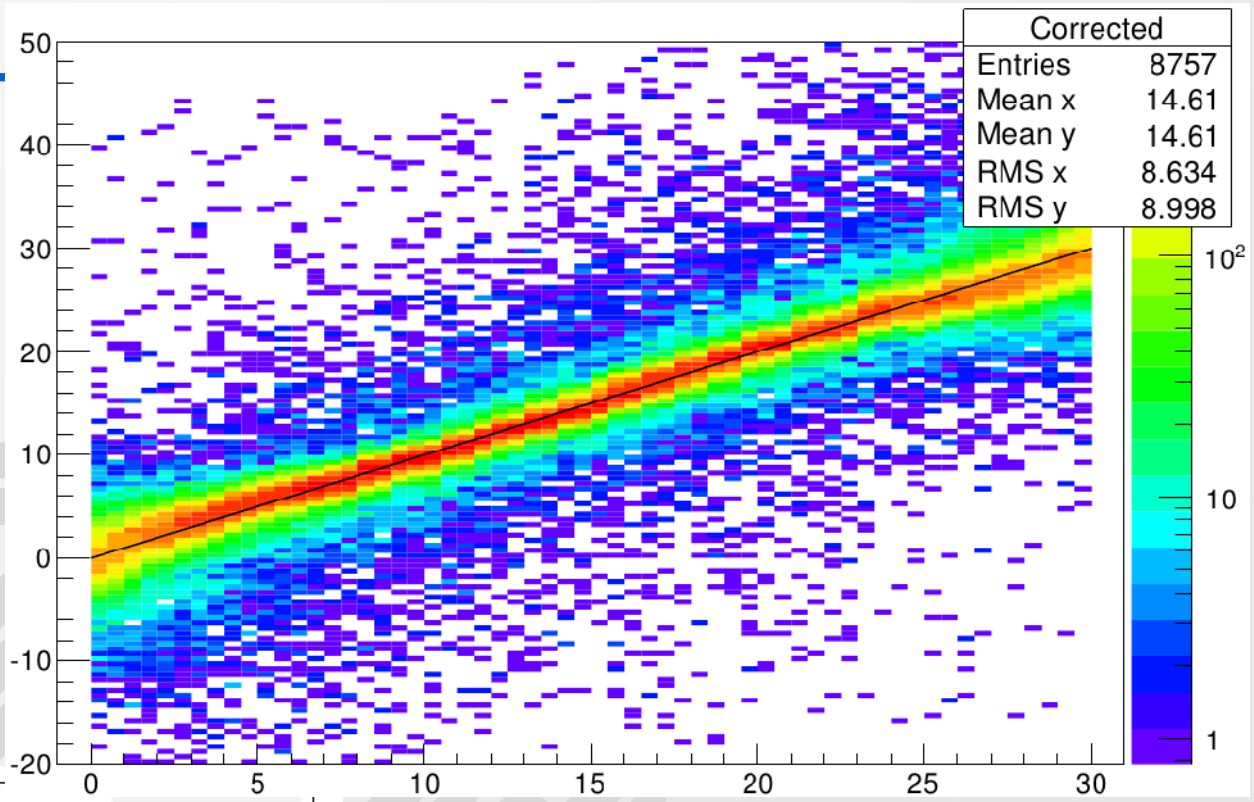
- Merge to single tile
- Fit profile
- Correct hits

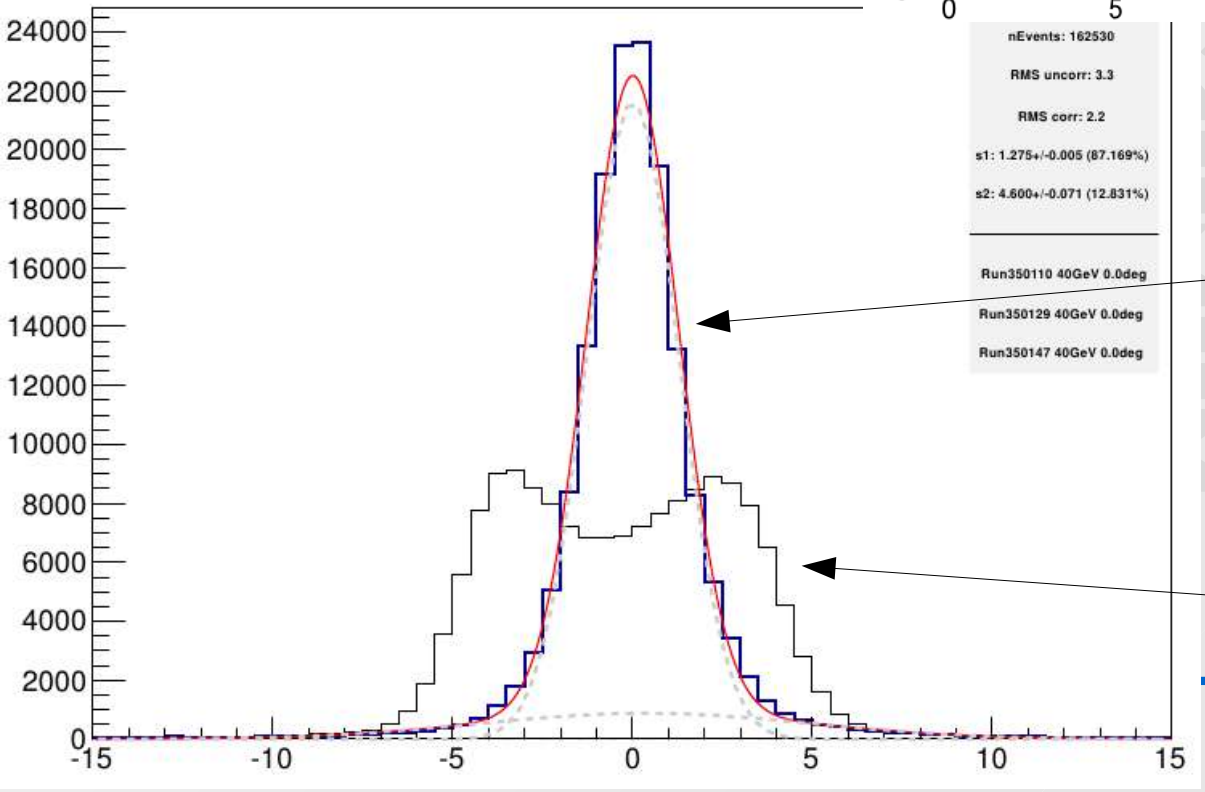


Resolution

- After correction: CoG ↔ track linear
- Resolution

$$\left(x_{HCAL}^{(Corr)} - x_{TRACK}\right)$$





- 40GeV positrons:
- Corrected (RMS: 2.2mm)
- First aproach:
  Double gauss
  σ1: 1.3mm (~90%)
  σ2: 4.6mm (~10%)

- Uncorrected (RMS: 3.3mm)

Resolution

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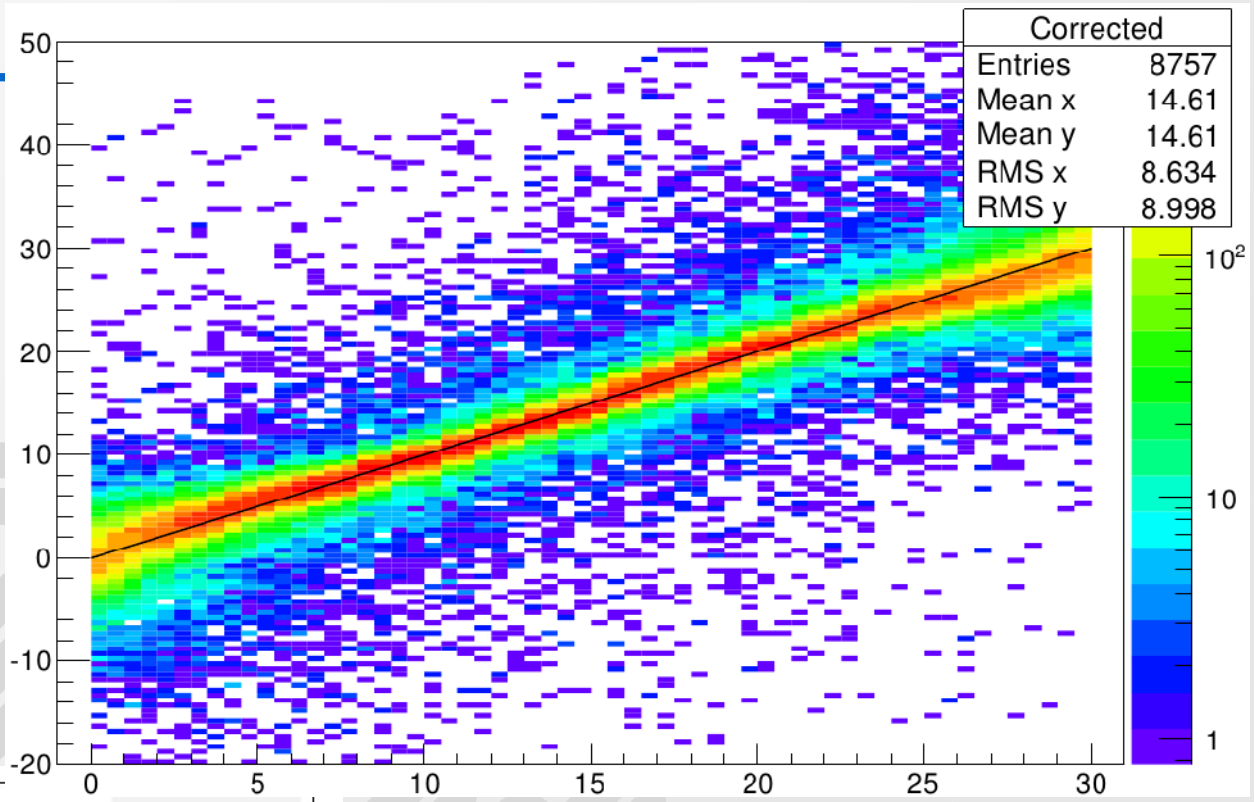
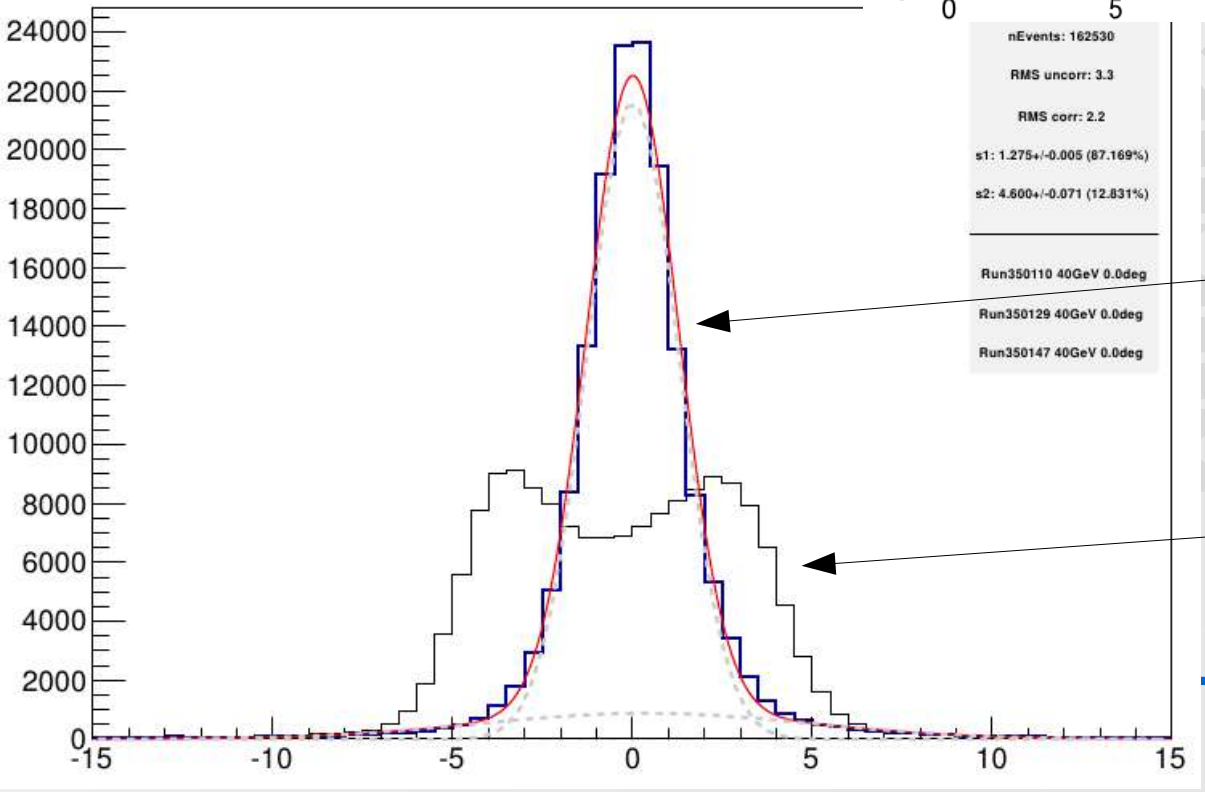
- Resolution

$$\left(x_{HCAL}^{(Corr)} - x_{TRACK}\right)$$





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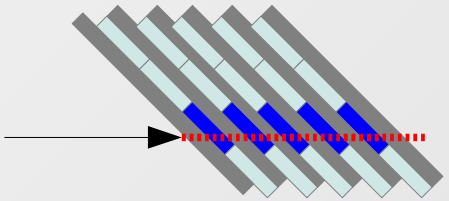
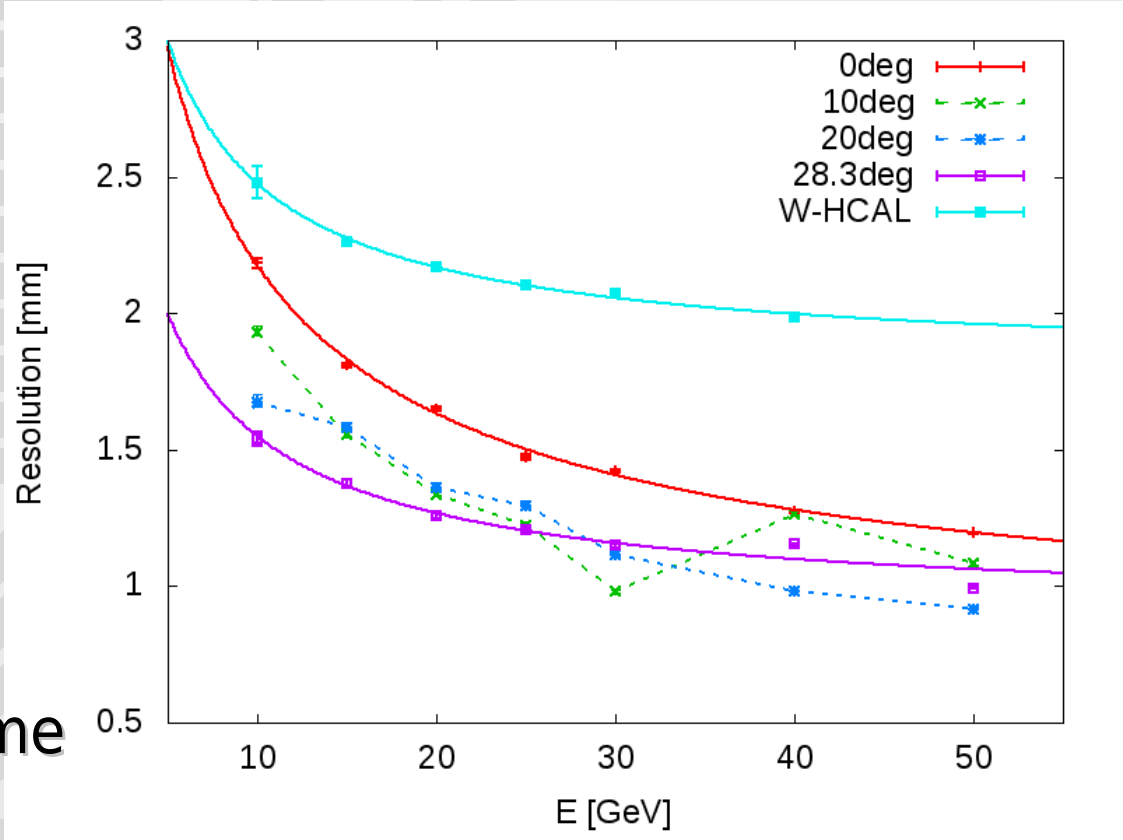
Preliminary results



- Analysis done for
  - CERN'07 data: 0°, 10°, 20°, 28.3°
  - CERN'11 (Tungsten)
- Energy dependant spartial Resolution:

$$\sigma_{Spart} = \frac{a}{\sqrt{E}} \oplus b$$

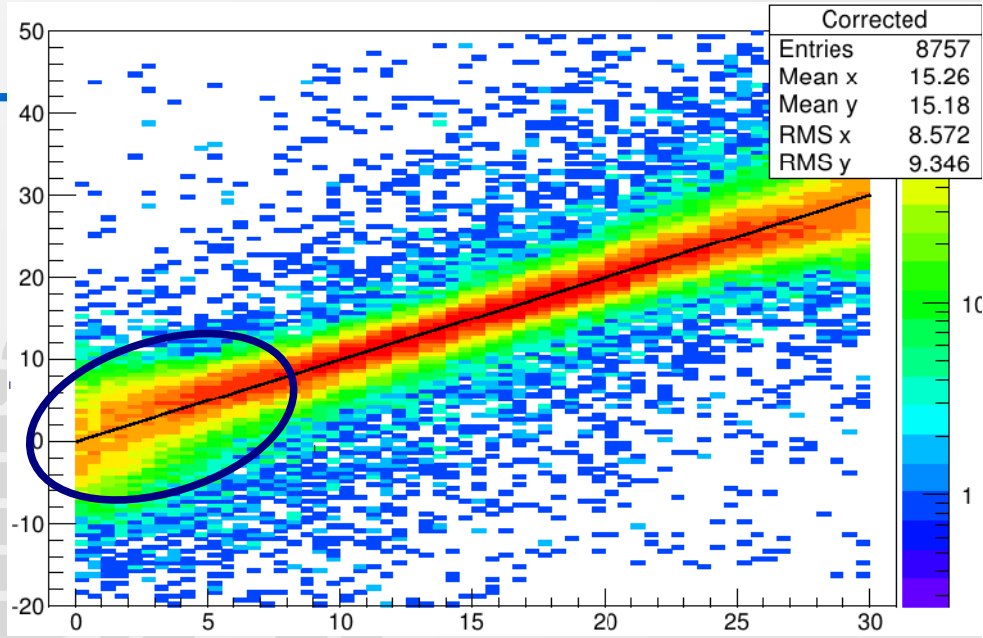
- 10° and 20° still need some work...



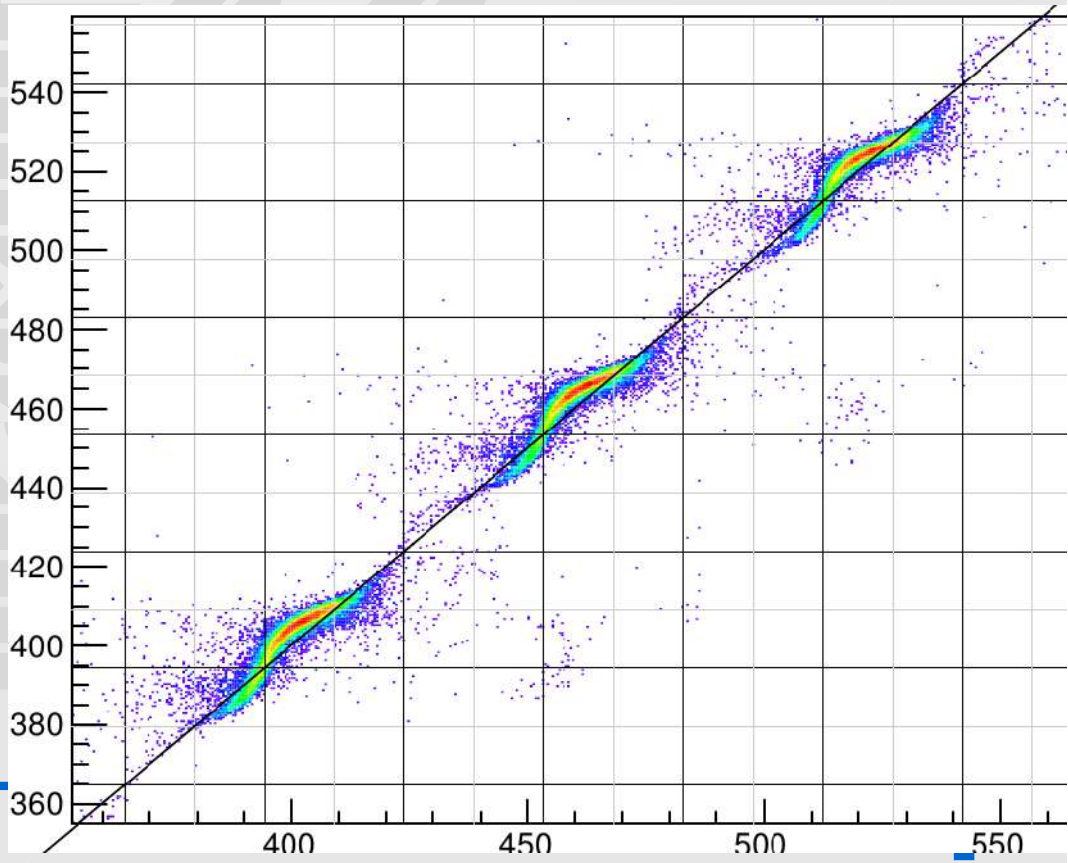
data	*a*	*b*
0°	6.41±0.10	0.79±0.02
28.3°	3.99±0.11	0.90±0.02
W-AHCAL	5.34±0.17	1.81±0.02

Resolution - Problems

- Lots of „Noise“ hits
- Overall CoG of several layers used:
  - Large distribution width at edges
  - Different shape parameter *b* per layer
  - Misalignment
  - → **have to look at each layer**

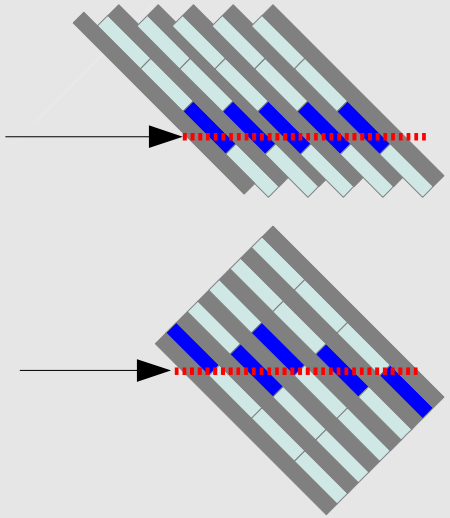


- Testbeam data
  - Sometimes disadvantageous runs
  - Runs with 3 different stage positions
  - Narrow beam at high energies
    - ✓ CERN'07 only
    - ✓ CERN'11: 60mm@40GeV
    - ✓ Only left half of tiles hit



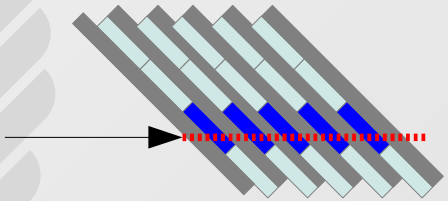
Summary and Outlook

- First aproach to calculate resolution for EM showers
  - ~ 1-2mm for >10GeV
  - CoG calculated from several layers
- Analysis layer by layer
  - Alignment
  - Different shape parameters per layer
  - Only few hits to calculate CoG per layer
- Write code to apply results on each event
  → Directly get corrected CoG
- Compare to Geant4

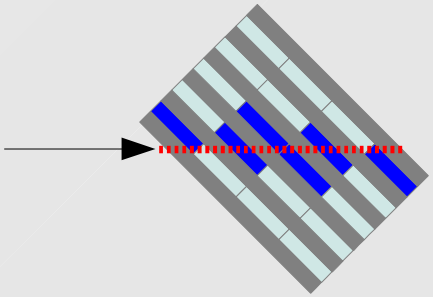


Summary and Outlook

- Rotation of HCAL at test beam: Layer by layer
  - Same tile hit in each layer



- More realistic: HCAL rotated in total
  - Design of ILD
  - Benefit from different impact position on tiles



  - So far no TB data...
  - Geant4 only