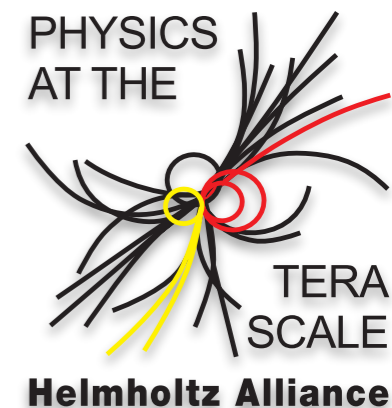
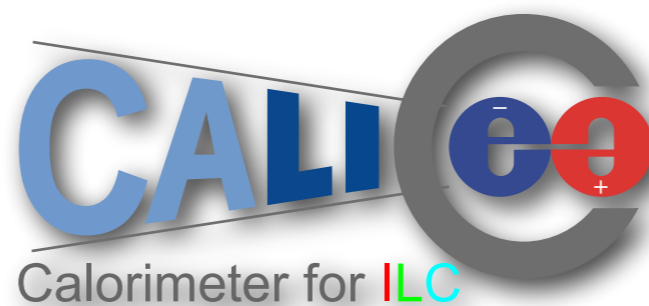


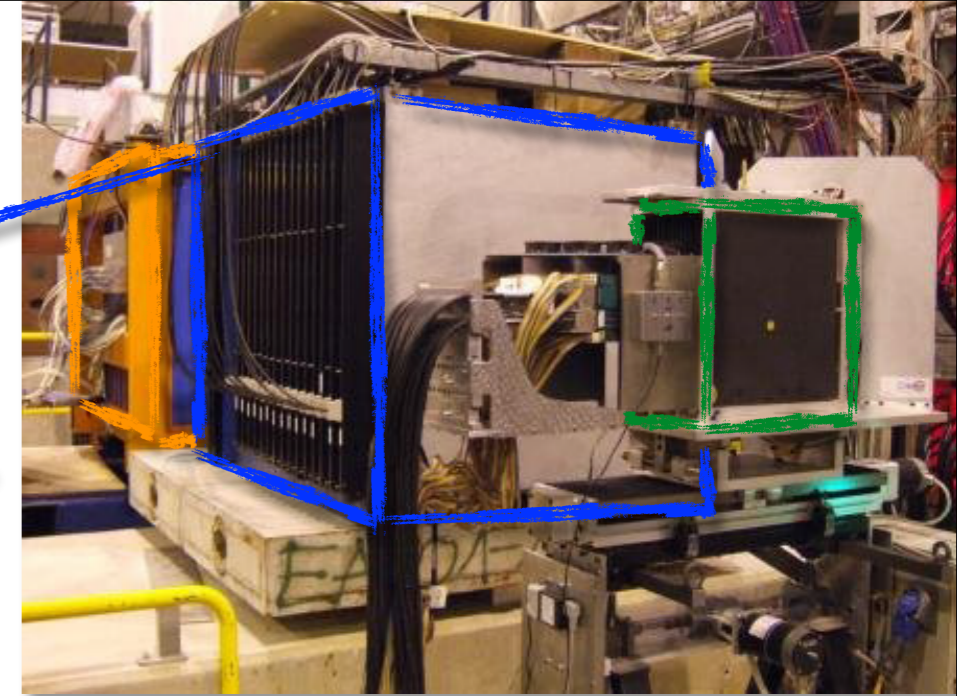
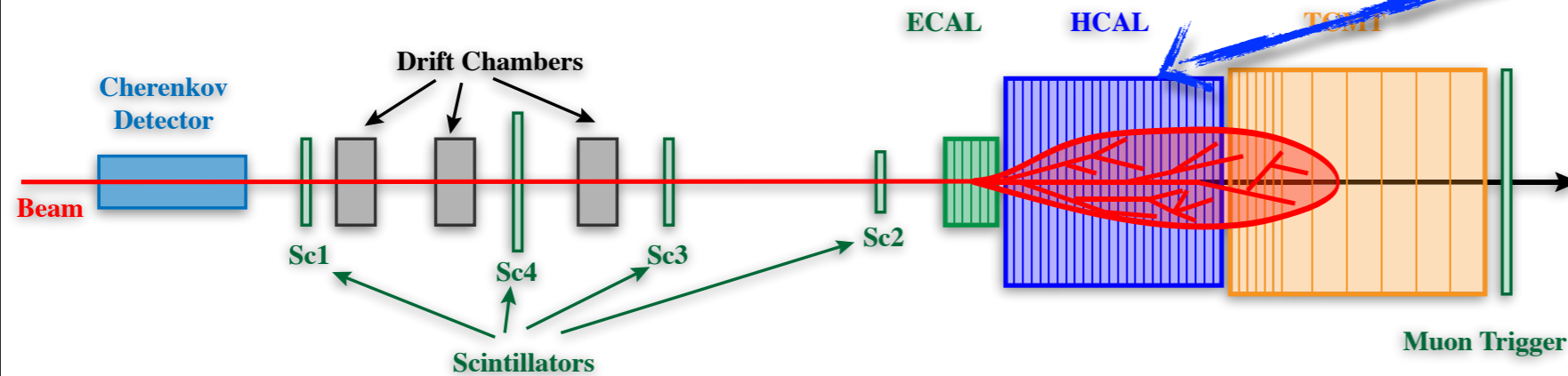
# Spatial resolution of the AHCAL



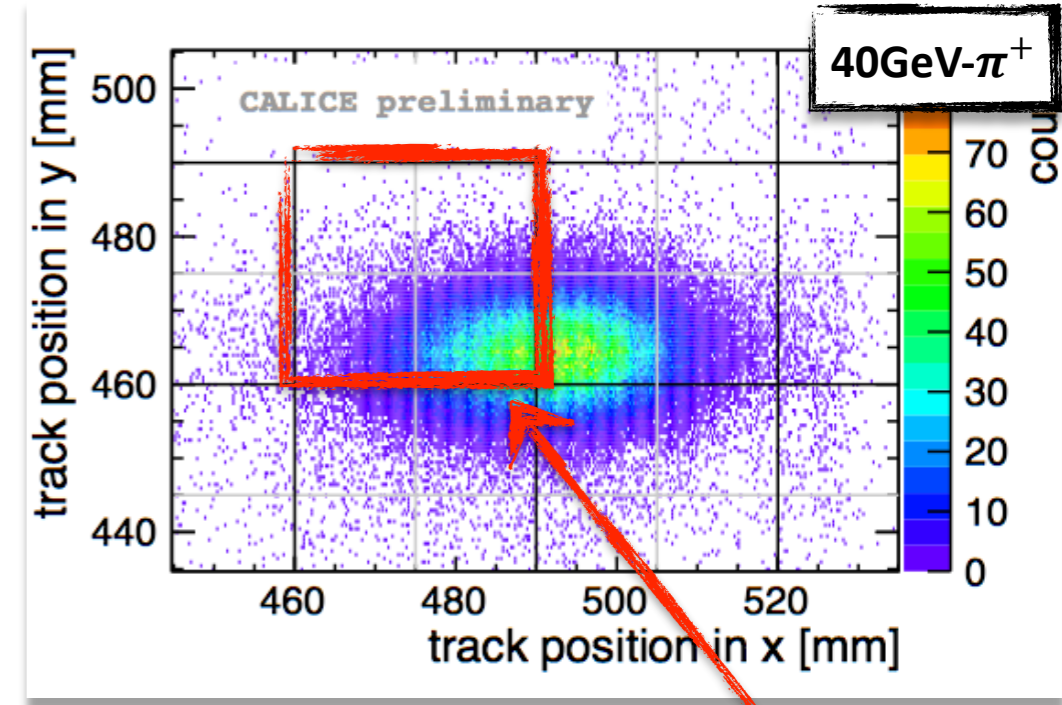
# Outline:

- Test beam reminder
- Spatial resolution
  - ▶ Theory
  - ▶ Electrons
  - ▶ Pions
- Summary / current Issues

# Test beam setup



- Test beam period CERN 2007 & 2011 (electrons)
- 3 Drift Chambers -> First one broken wire!
- Theoretical Resolution on the front face of HCAL of 200-400 $\mu\text{m}$  (and determined by ECAL analysis)
- Runs without ECAL
- Energy Range
  - Electron 10-50 GeV
  - Pion 30-80 GeV



- Used only projection in x direction, due to more coverage of the tiles

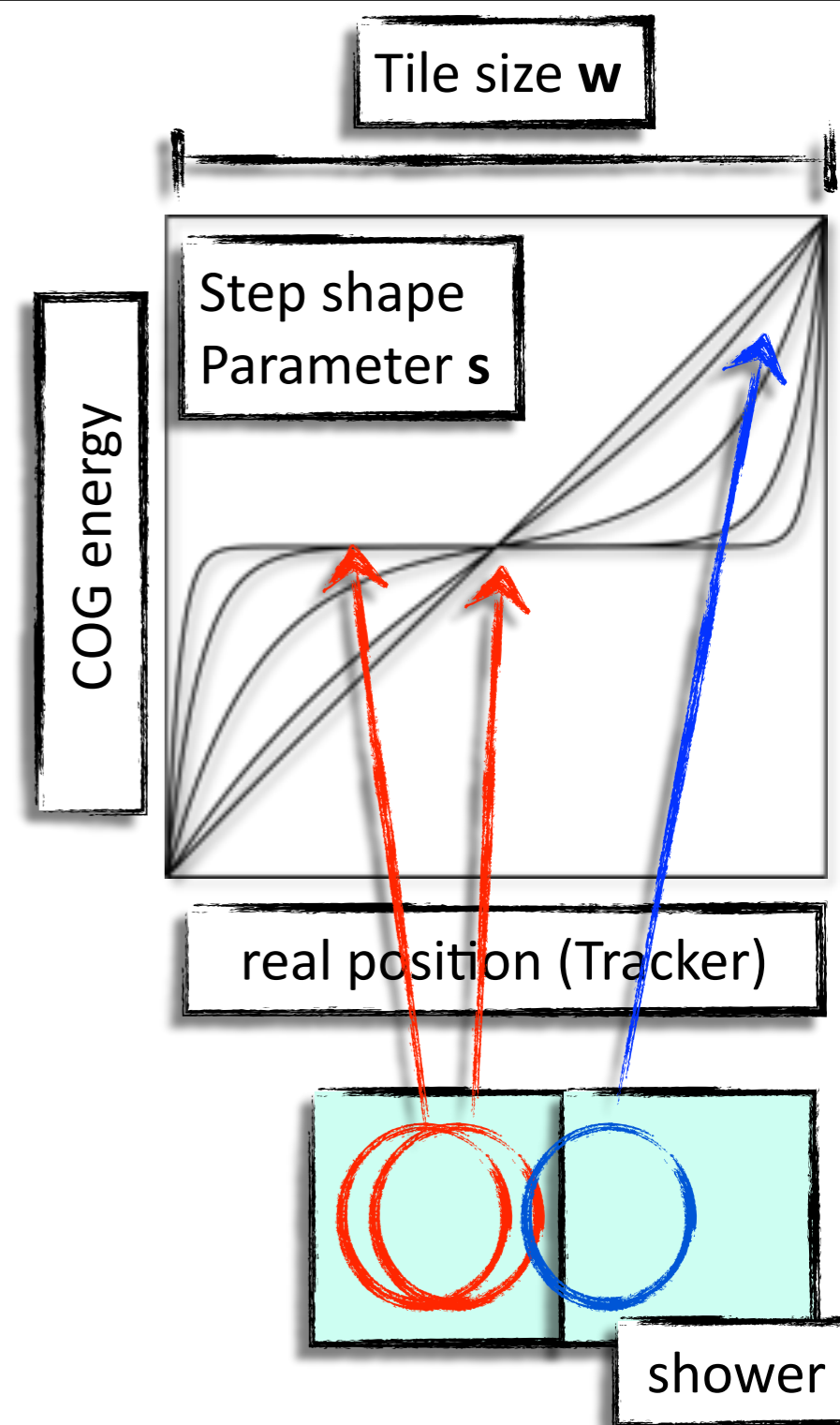
# Theory in short

- Assume exp. shower profile in transversal direction
- Size of a electron shower is limited due the Molière Radius (approx. size of one tile)
- Detector response as centre-of-gravity energy of all tiles (layer) vs. the „real“ track position from tracker
- Correction necessary, cause of the step shape

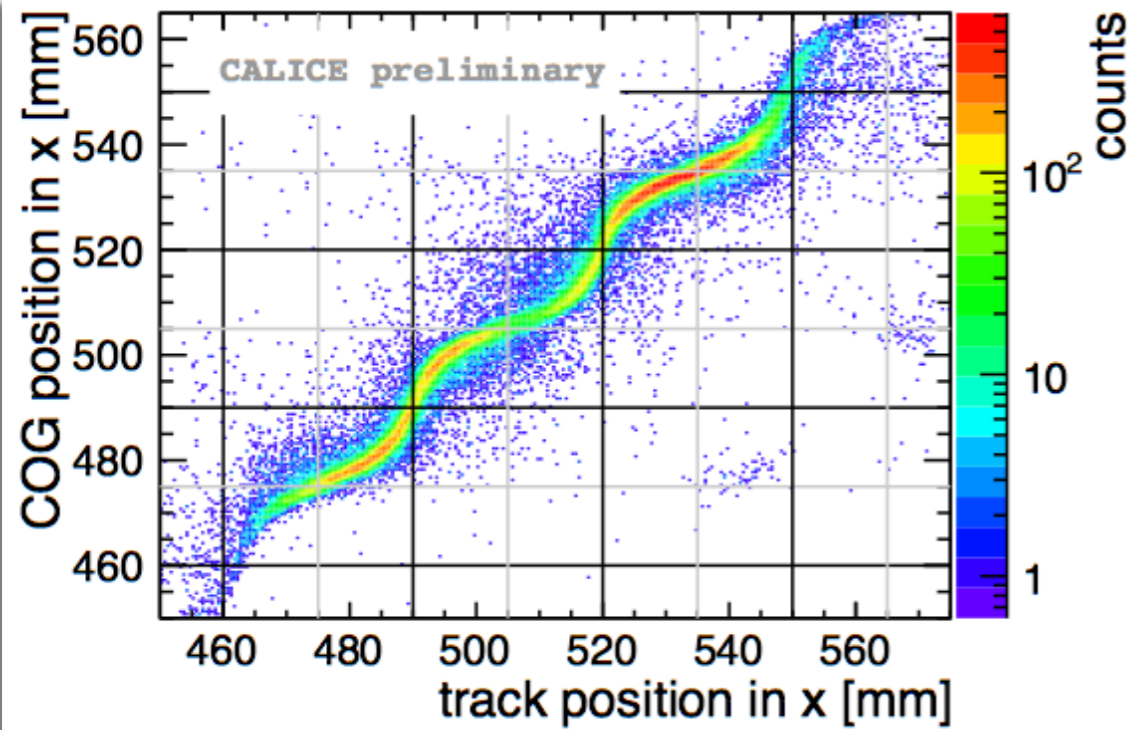
$$x_{Det} = x_0 + \frac{\sinh((x_{Ref} - x_0)/s) \cdot w}{\sinh(w/(2s))} \cdot \frac{w}{2}$$

- Shape parameter  $s$  &  $w$  depends on energy & layer
  - ➔ 1. layer: sharp step → last: smoother step
- Corrected COG by inverse function

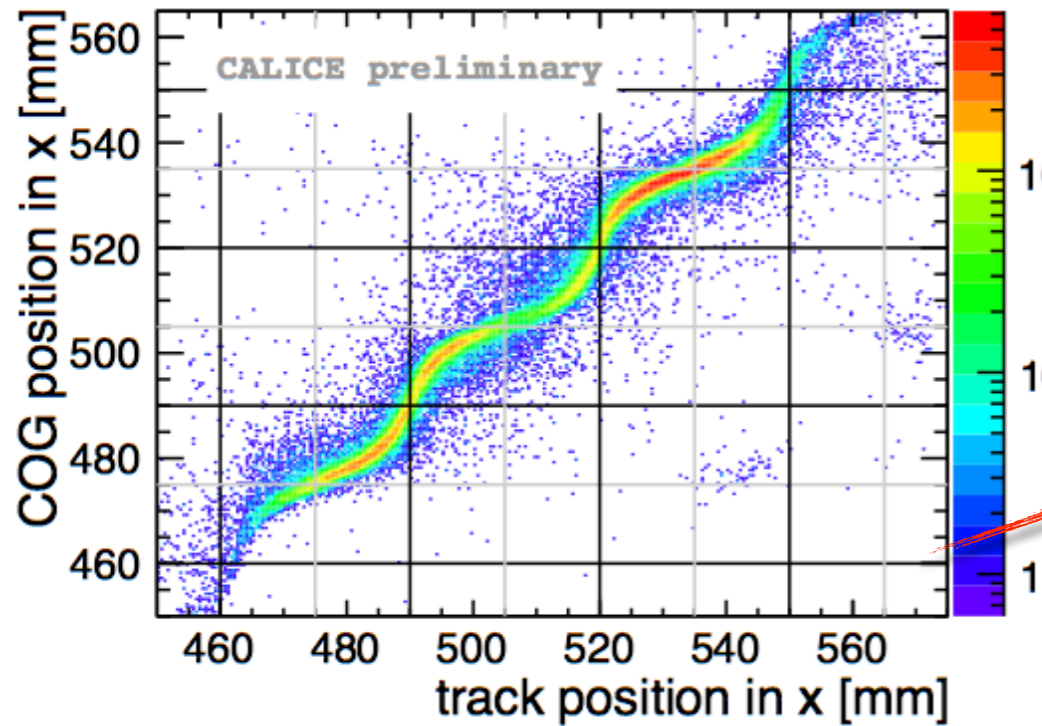
$$x_{Det}^{Corr} = s \cdot \operatorname{arcsinh} \left( \frac{2(x_{Det} - x_0)}{w} \cdot \sinh \frac{w}{2s} \right) + x_0$$



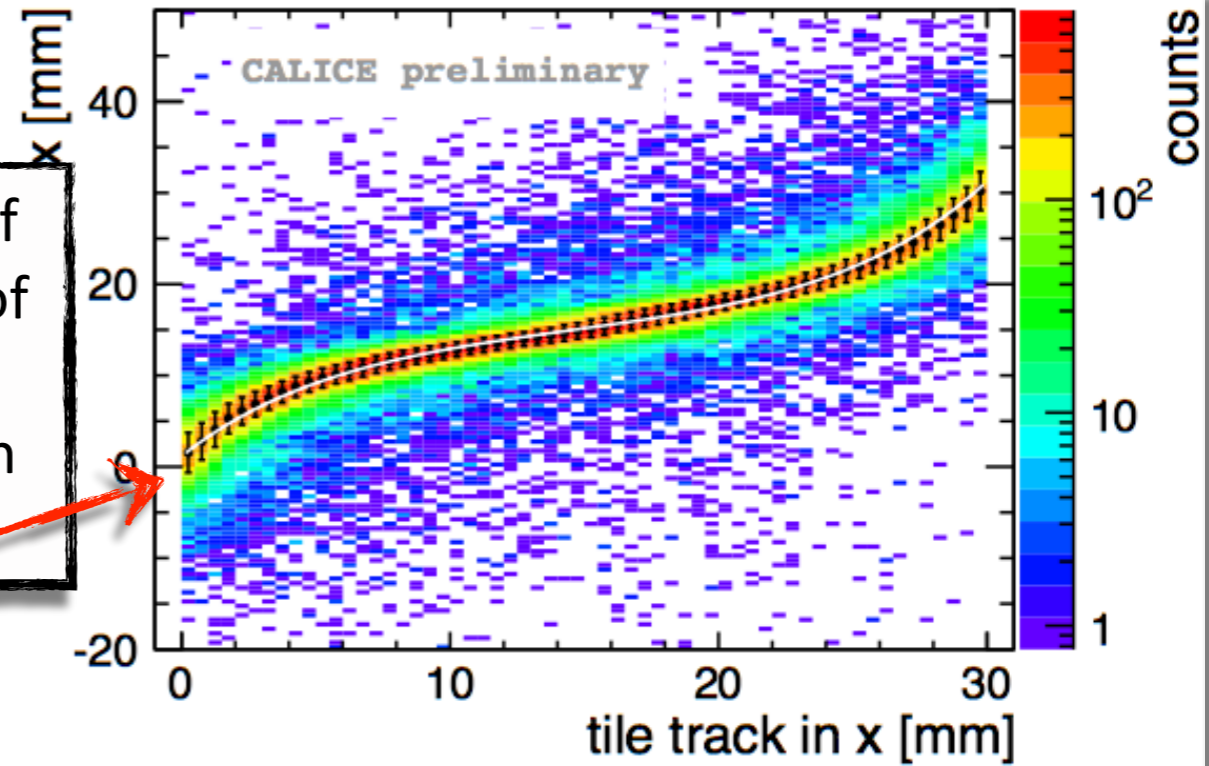
# Spatial Resolution



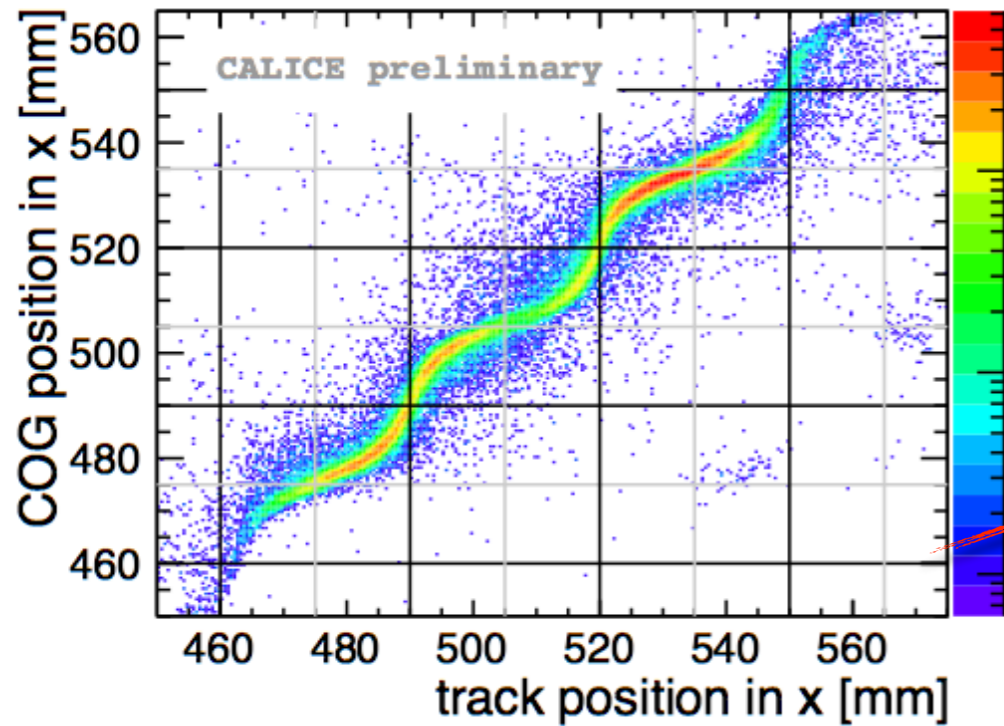
# Spatial Resolution



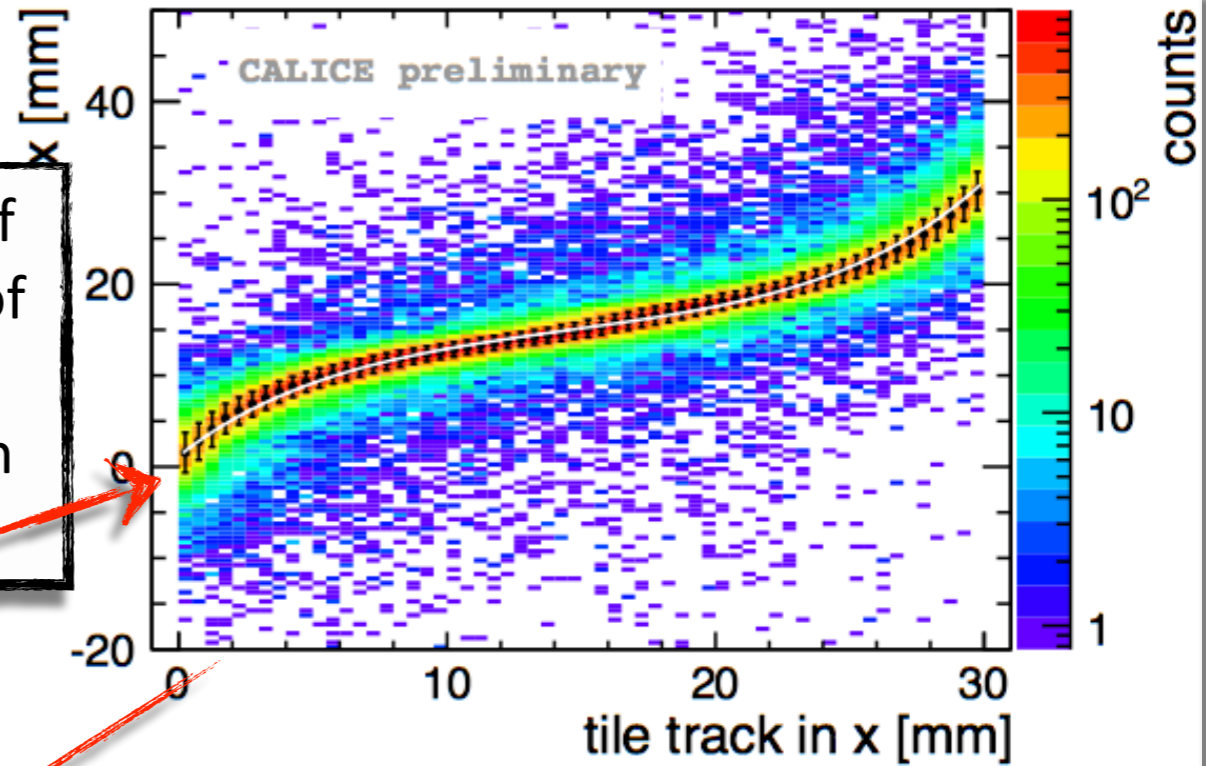
Combination of multiple runs of same energy  
→ Projection on tile



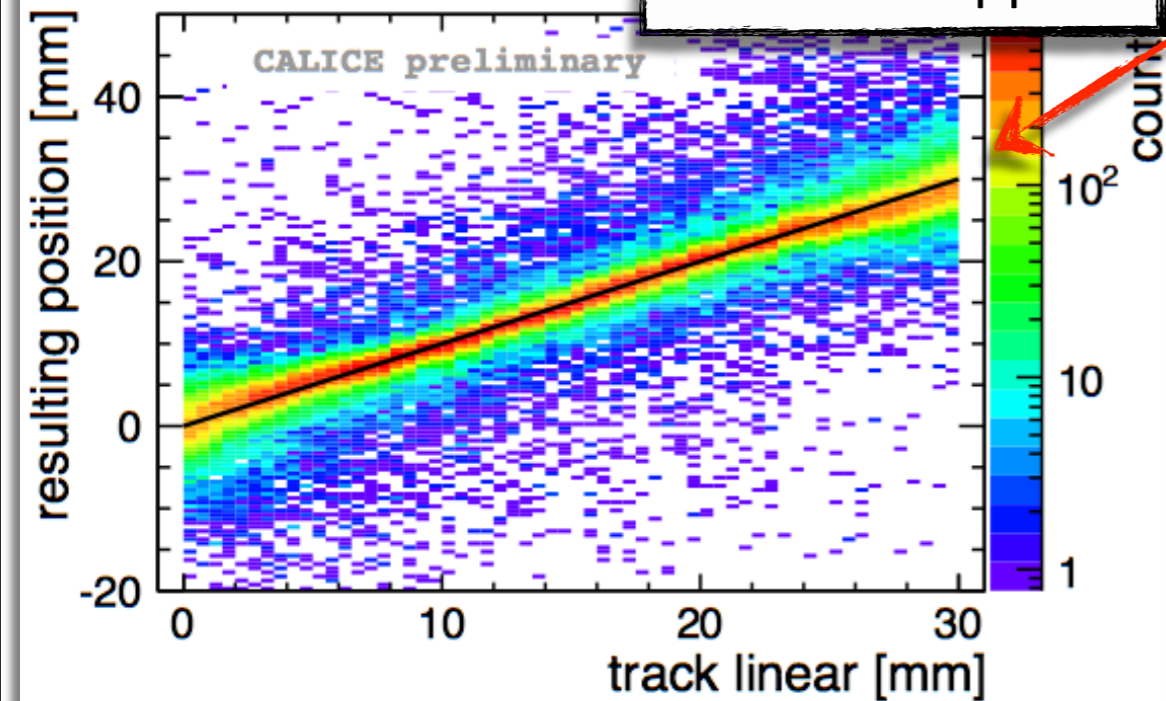
# Spatial Resolution



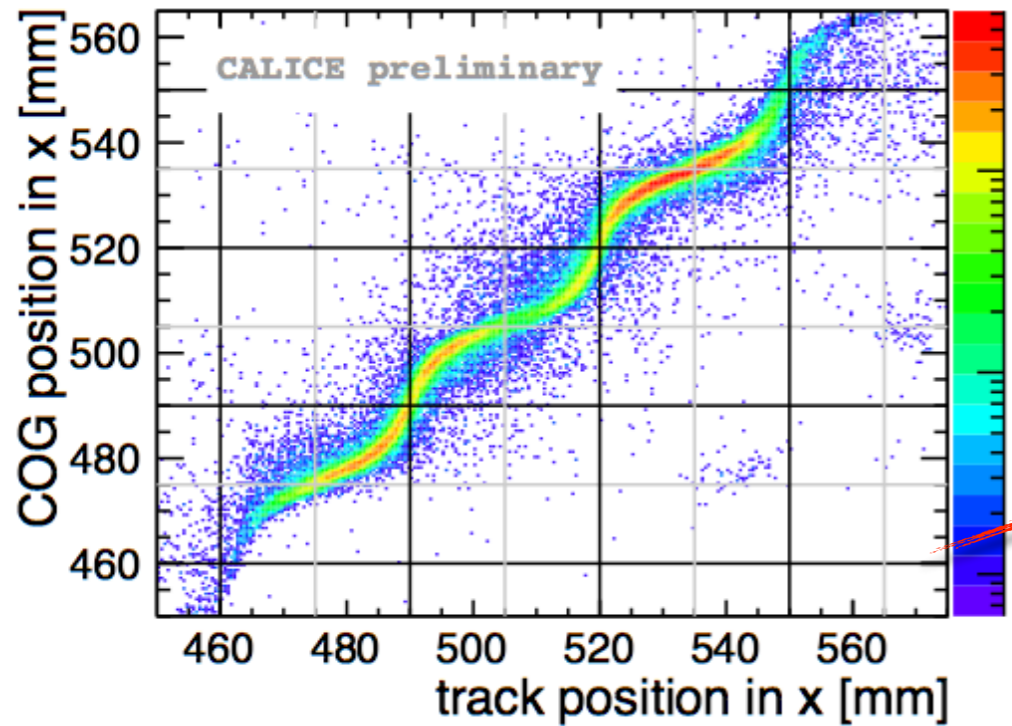
Combination of multiple runs of same energy  
→ Projection on tile



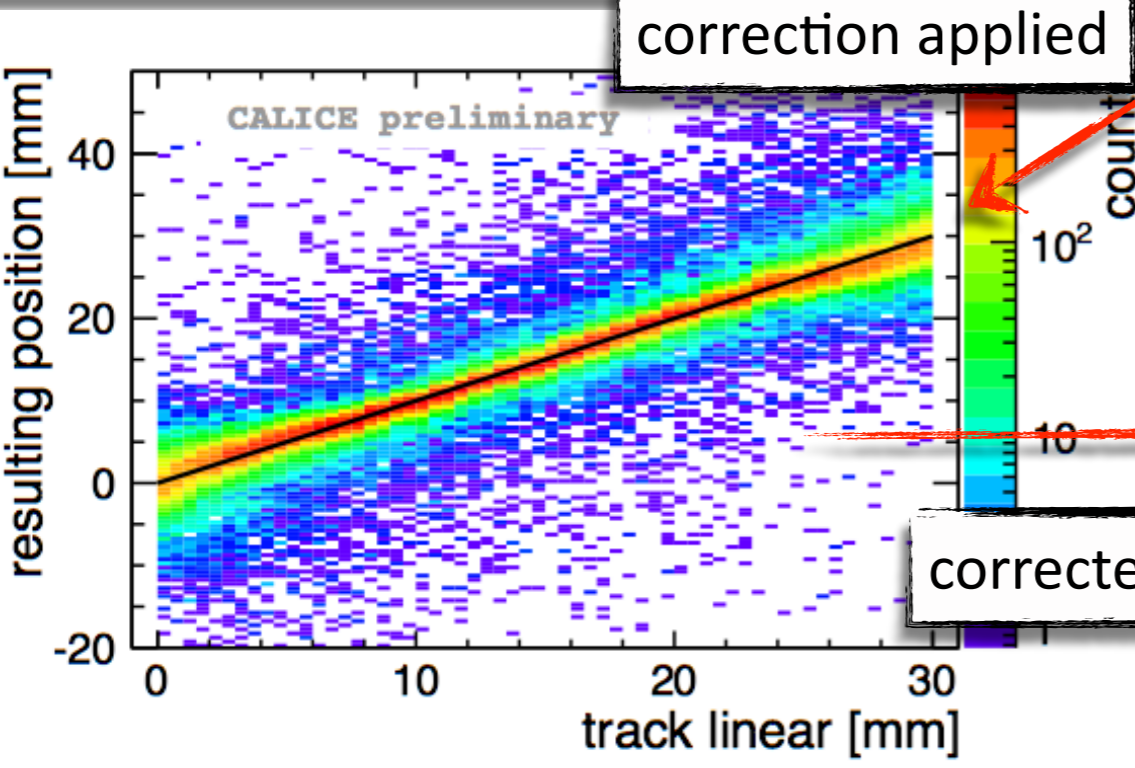
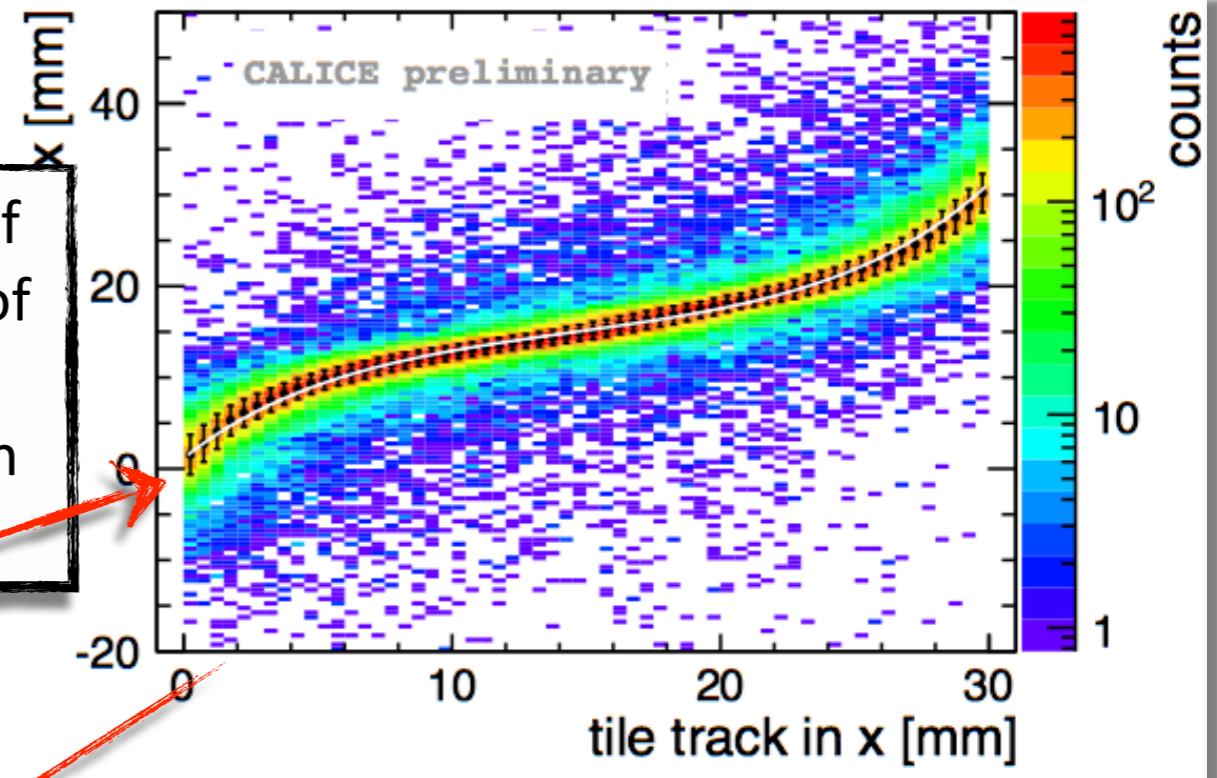
correction applied



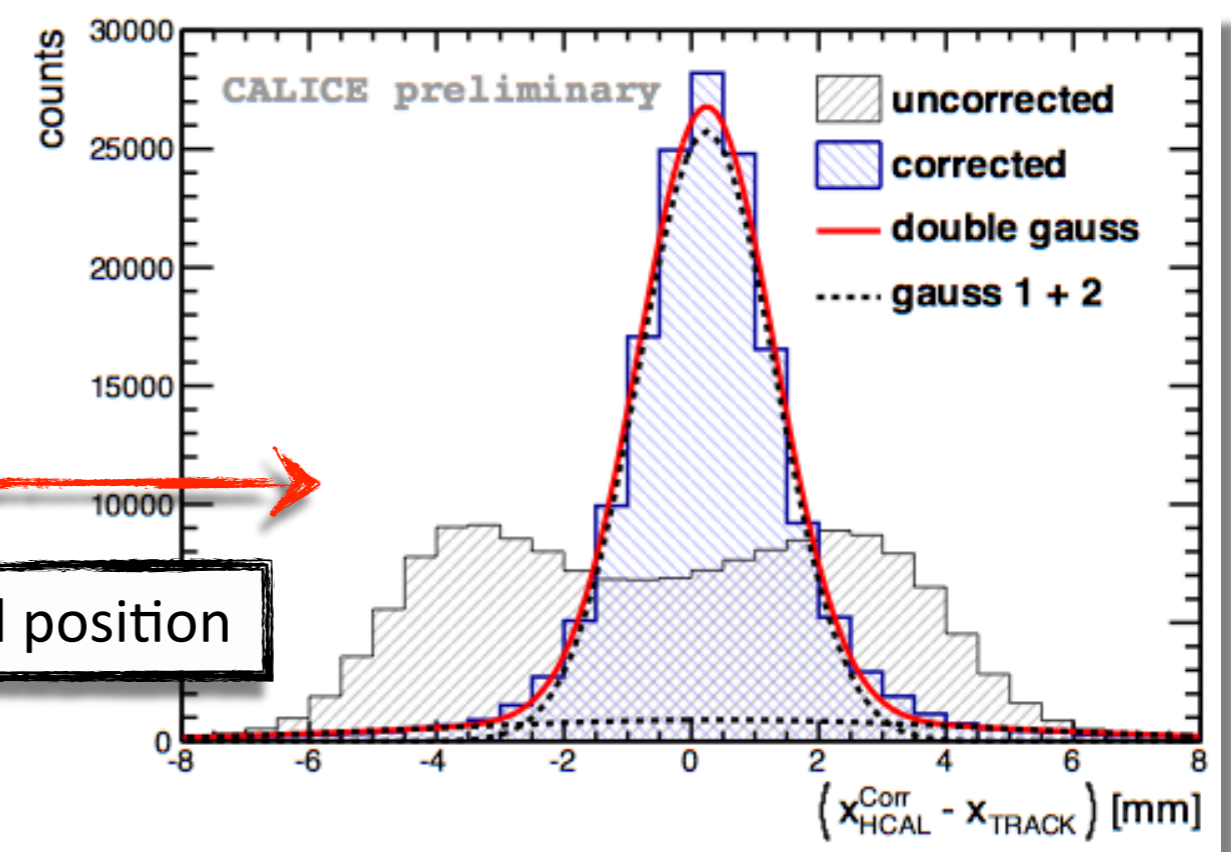
# Spatial Resolution



Combination of multiple runs of same energy  
 → Projection on tile



corrected COG - real position





# Results for electrons

- Energy dependent spatial resolution parameterized as:

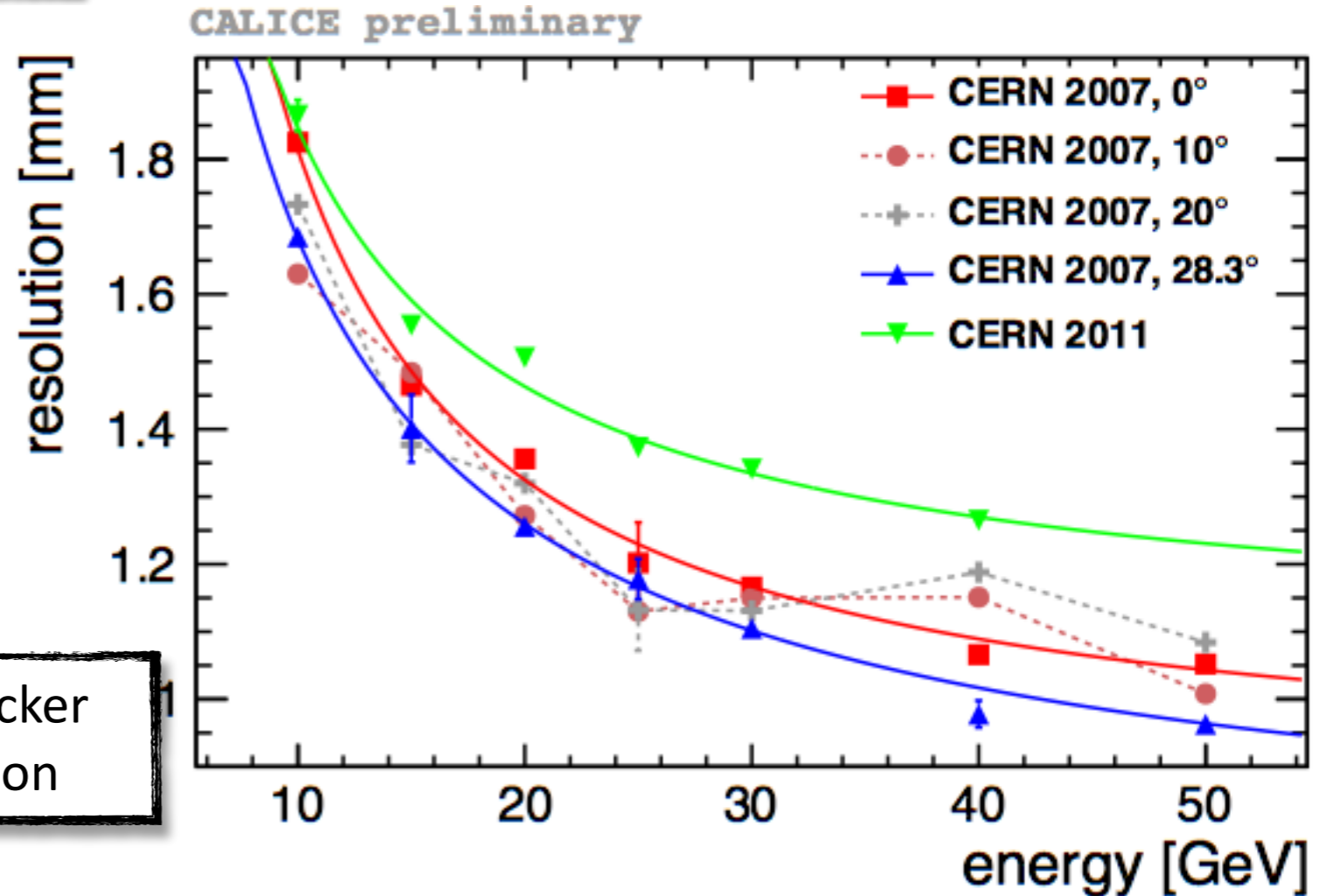
$$\sigma(E) = \frac{a}{E} \oplus \frac{b}{\sqrt{E}} \oplus c$$

Noise effects  
(Pedestal etc.)

Resolution

Limit Tracker  
resolution

- Cause of the searing the segmentation of the AHCAL is smaller than  $3 \times 3 \text{ cm}^2$
- $10^\circ/20^\circ$  statistics too low for full coverage of the tiles (beam was too small)

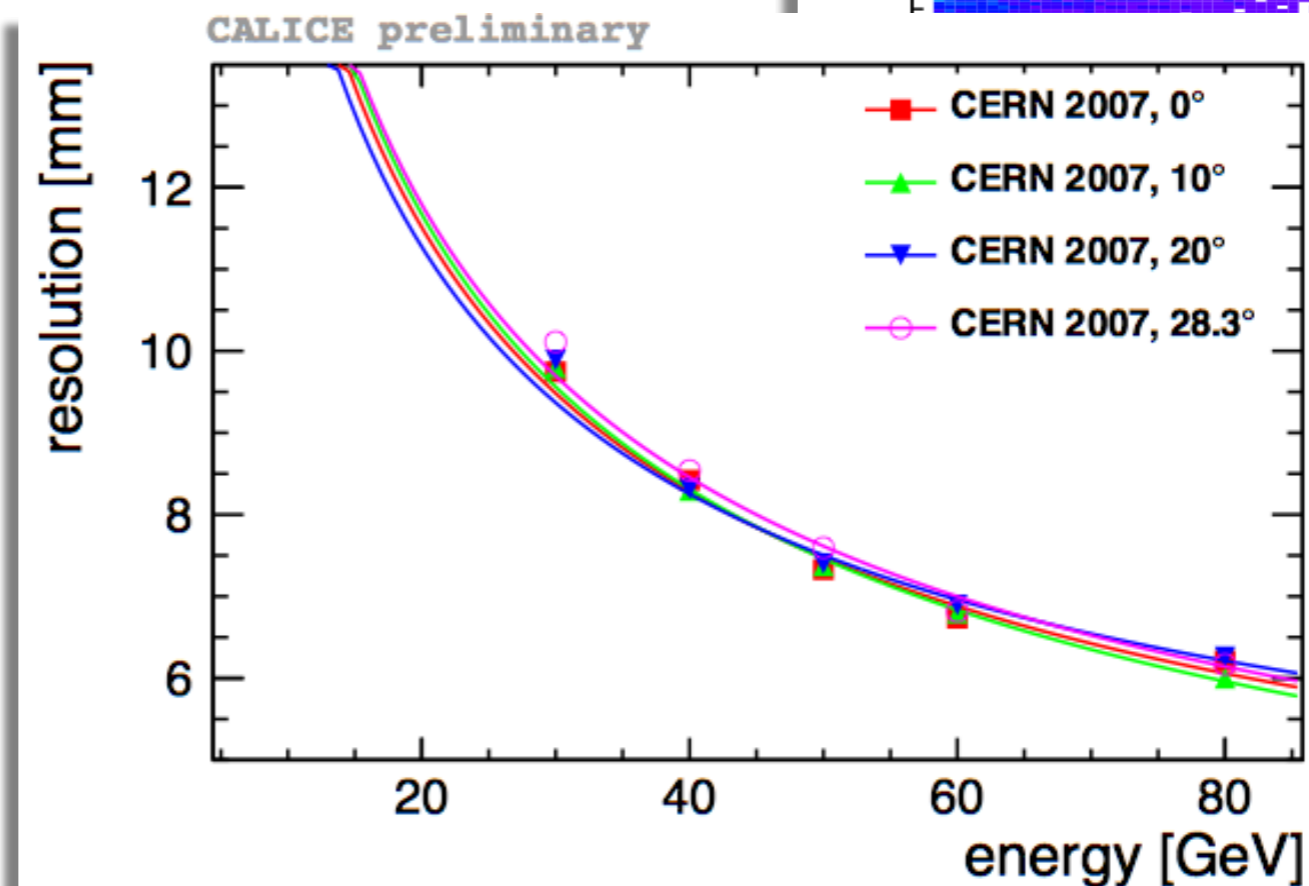
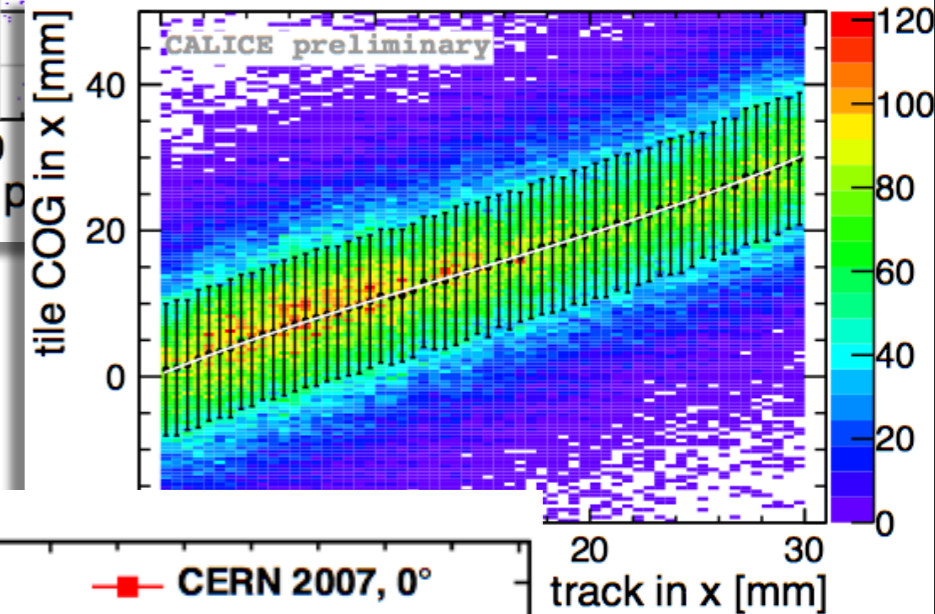
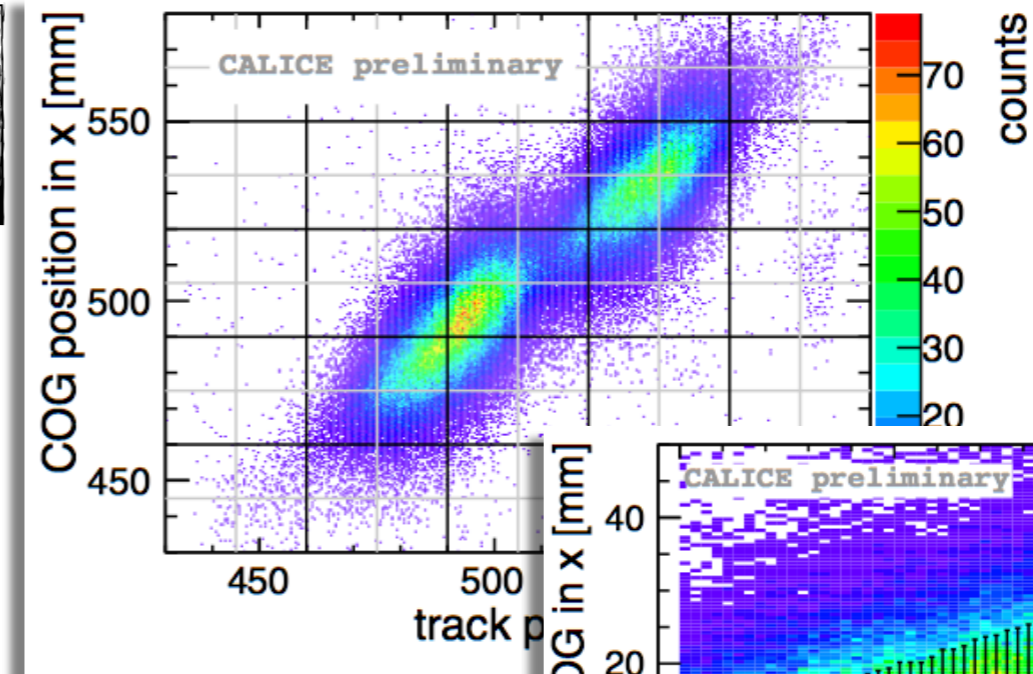


# Resolution for pions

- Pion shower huge in comparison to a single tile
- Spatial resolution parameterized as:

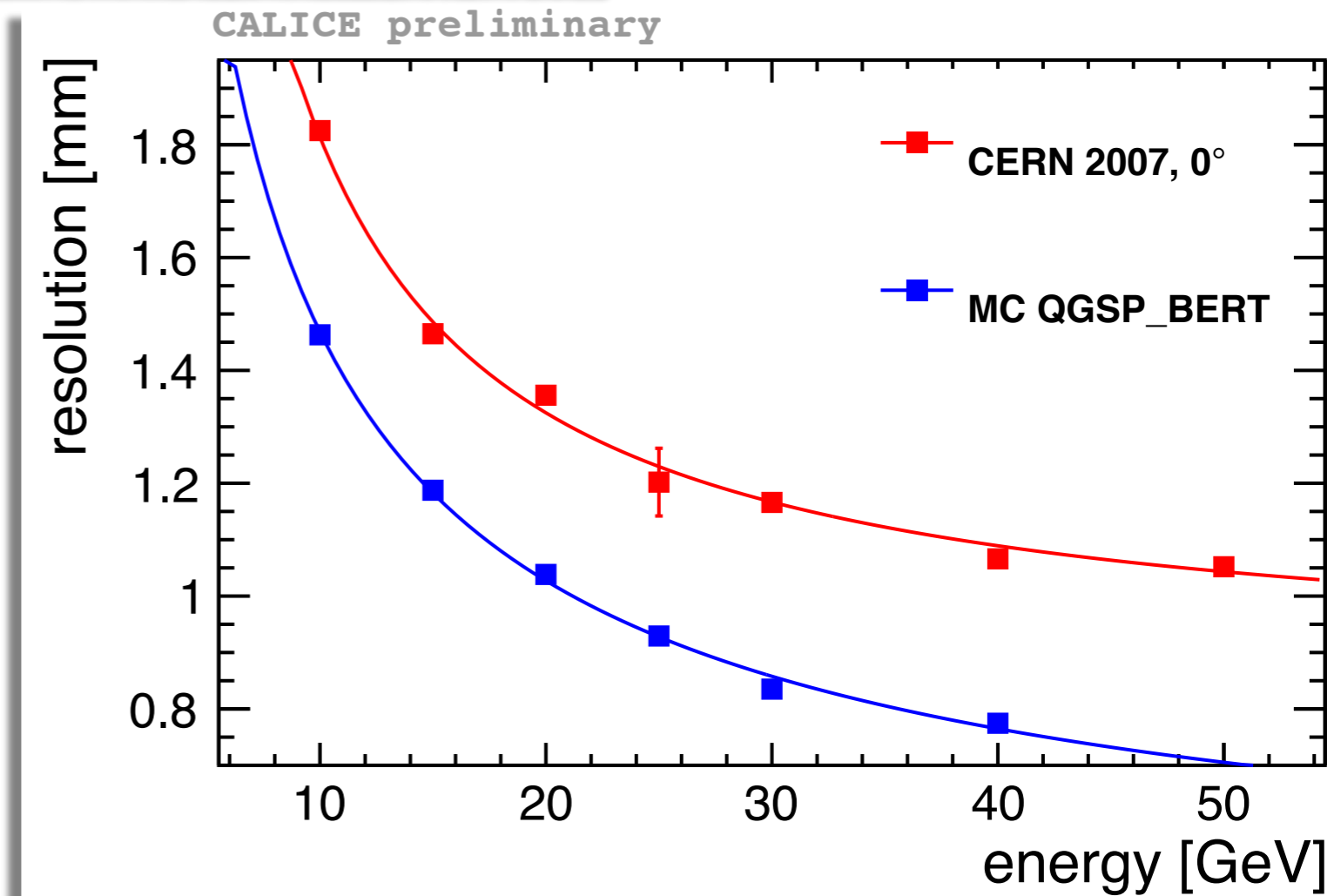
$$\sigma(E) = \frac{b}{\sqrt{E}} \oplus c$$

- Influence of Parameter a is too small
- Behavior as expected (Tile size change is too small)



# Data-Monte Carlo comparison

- Trackposition out of the MC was used
- no smearing of the Trackers!
- but smearing of the Beam itself!
- Comparison for electrons  
constant offset of 1mm
- Alignment Issues ?
  - tried COG of single layers (1-5)
- Tracker Resolution not Correct ?
  - Currently have a look into Tracker-code with the help of Paul D. (author of the code)



- Same Problem for Pions
  - 30GeV: Data (~10mm) vs MC (~5mm)
- Not understand yet!

# Conclusion & Outlook

- Spatial Resolution done for electrons and Pions
- Work in Progress on a Analysis Note (Data only, very soon)
- Problems with Monte Carlo simulation
  - Big difference between Data/MC
  - Not understand yet!
  - Possible addendum to Note (if understand!)

