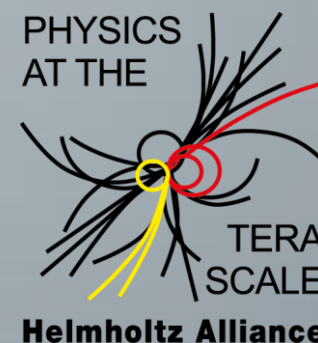


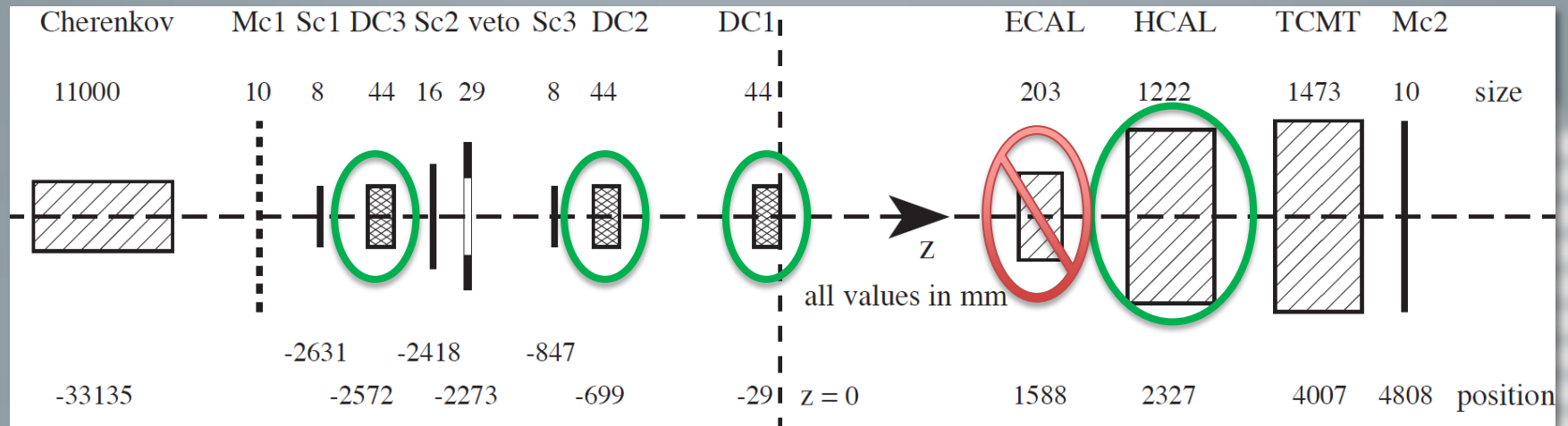
Spatial resolution for electrons & uniformity of the response of the AHCAL to Pions



- **Spatial resolution for electrons**
 - Introduction
 - Results
- **Uniformity of response of the AHCAL to Pions**
 - Introduction
 - Analysis
 - Results



Testbeam setup



- Track: delay wire chambers (DC)
0.2 mm in x-direction & 0.4 mm in y-direction
- Runs with **no** ECAL
 - No electrons in HCAL
 - Pion shower already started

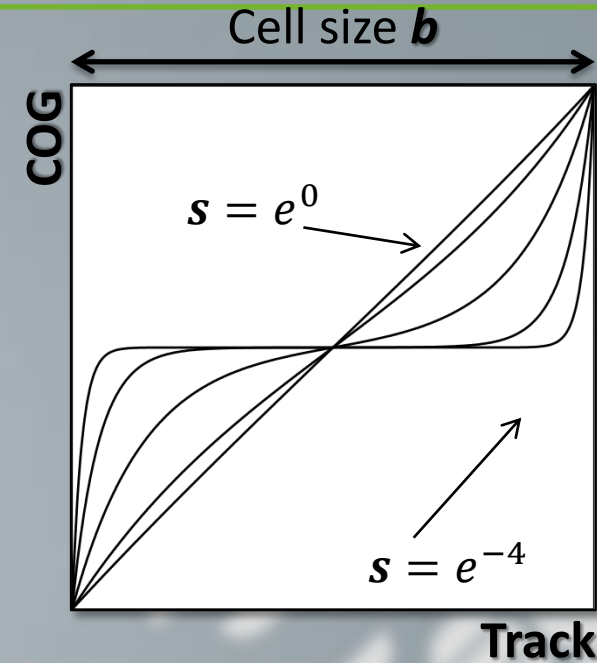
Theory in short

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

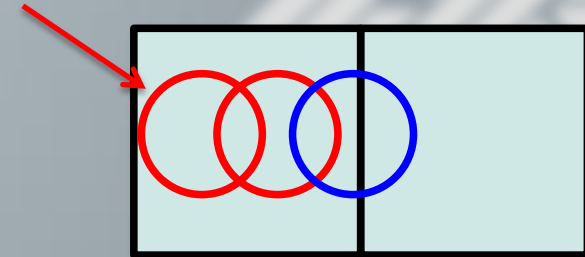
$$x_{CoG} = x_0 + \frac{\sinh\left(\frac{(x_{track} - x_0)}{s}\right)}{\sinh\left(\frac{b}{2 \cdot s}\right)} \cdot \frac{b}{2}$$

- Shape parameter s & b depends on energy & layer
- **Correct CoG by inverse function**

$$x_{CoG}^{corr} = s \cdot \operatorname{arsinh}\left(\frac{2(x_{CoG} - x_0)}{b} \cdot \sinh\left(\frac{b}{2 \cdot s}\right)\right) + x_0$$

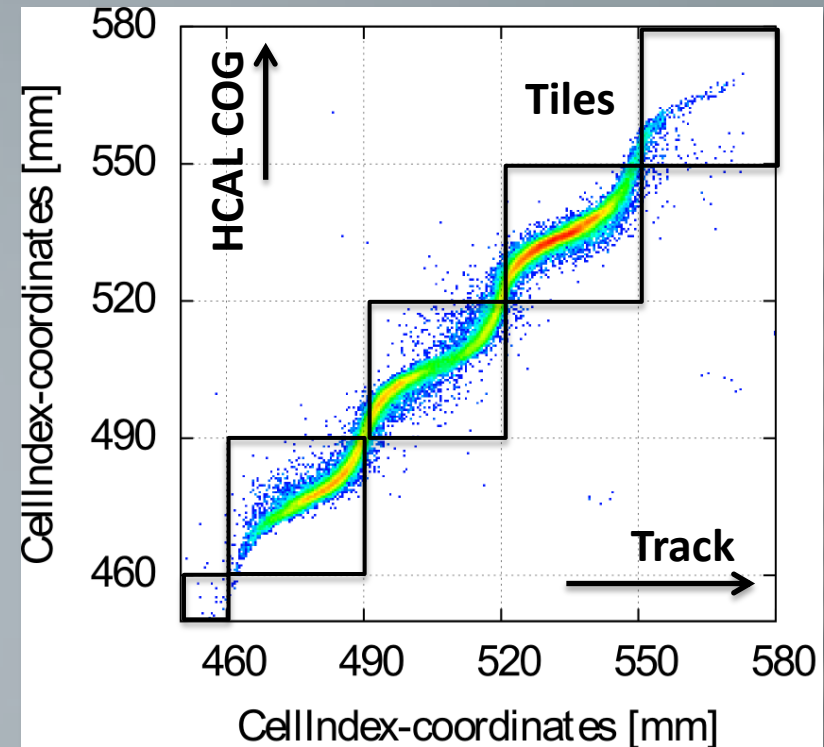
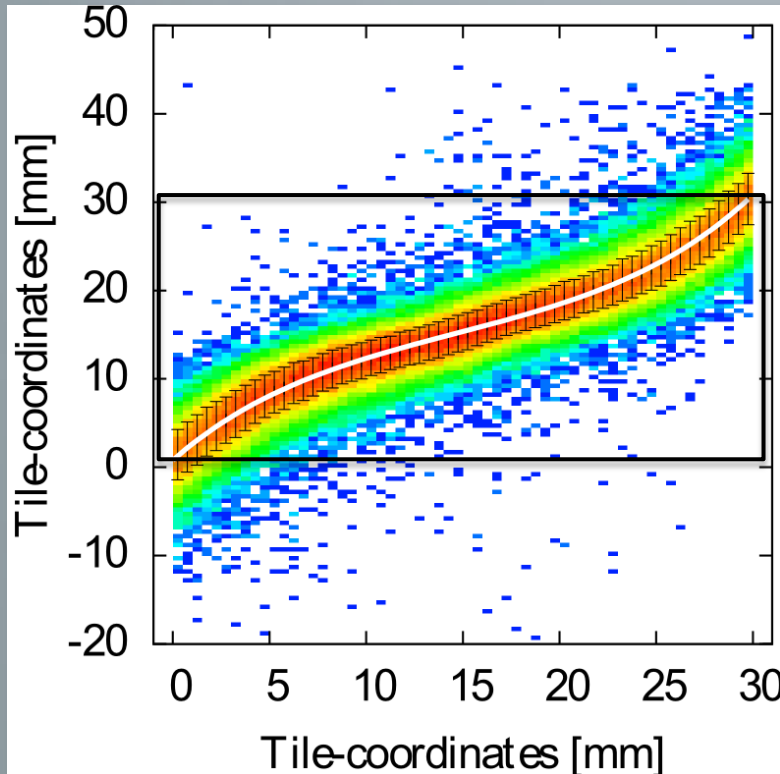


shower



Testbeam data

- Combine data of several runs i.e. several xy-stage positions
- Tile-based coordinates

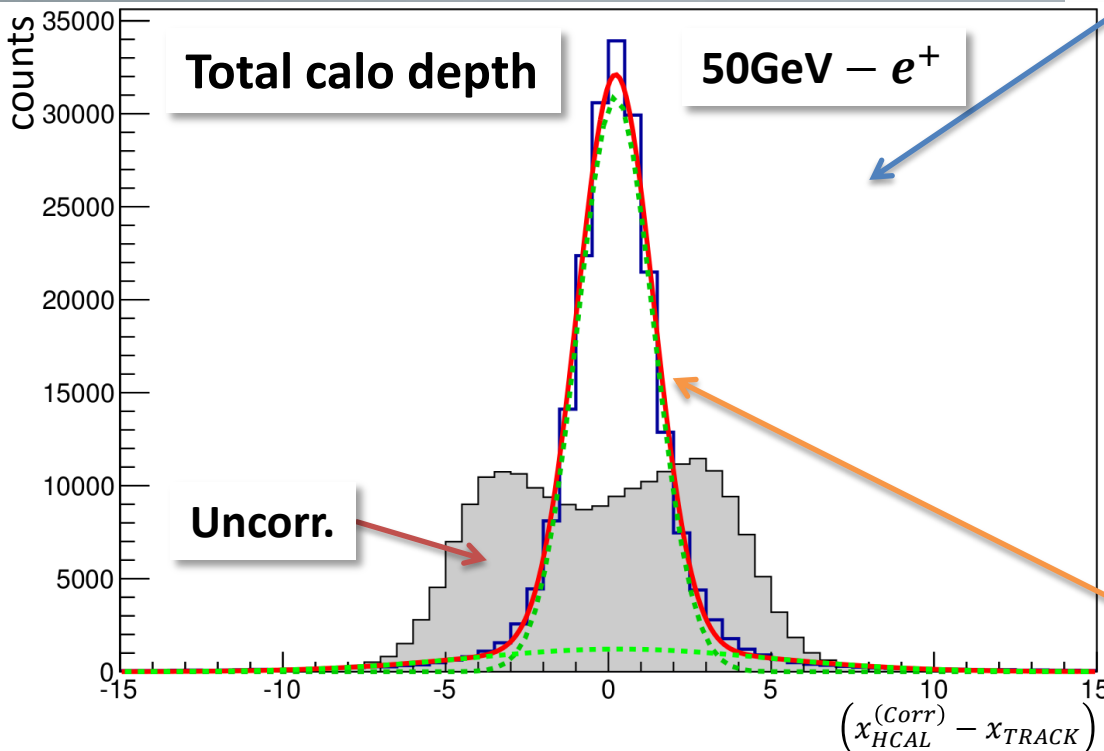
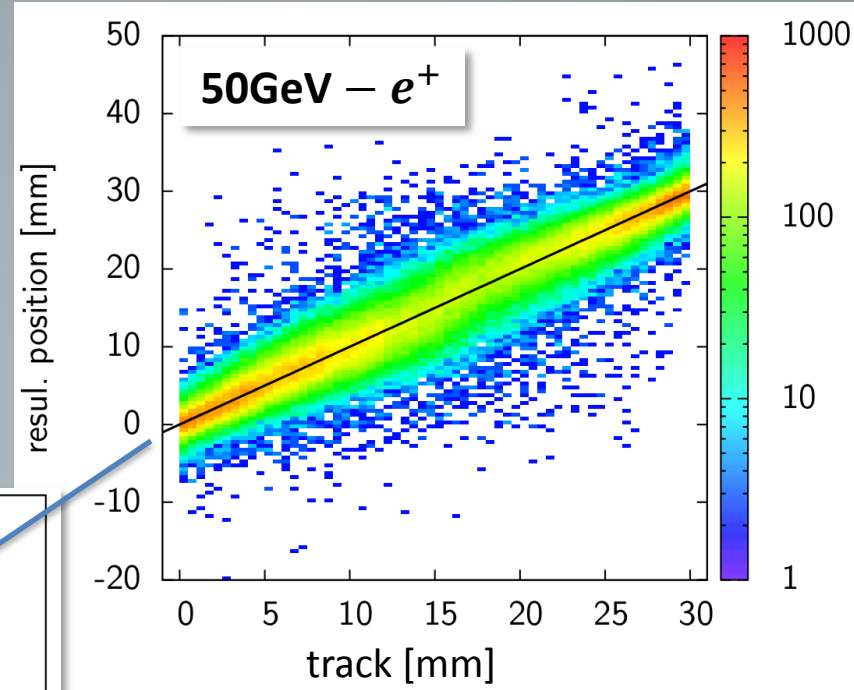


- Merge to one single tile
- Fit profile
- Correct hits

Resolution

- After correction:
CoG \leftrightarrow track linear
- Resolution

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



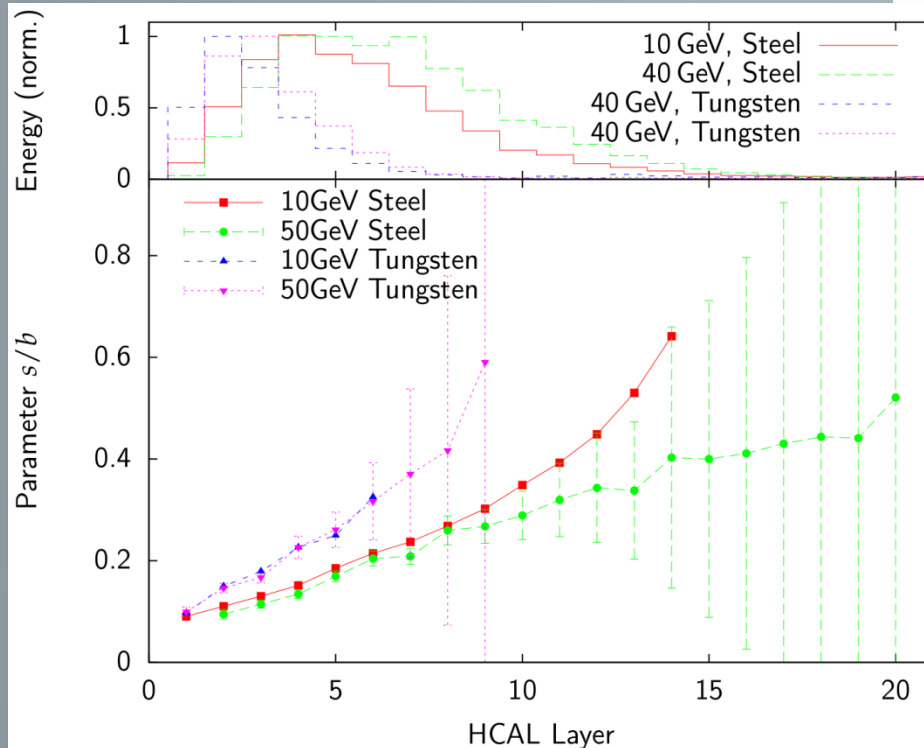
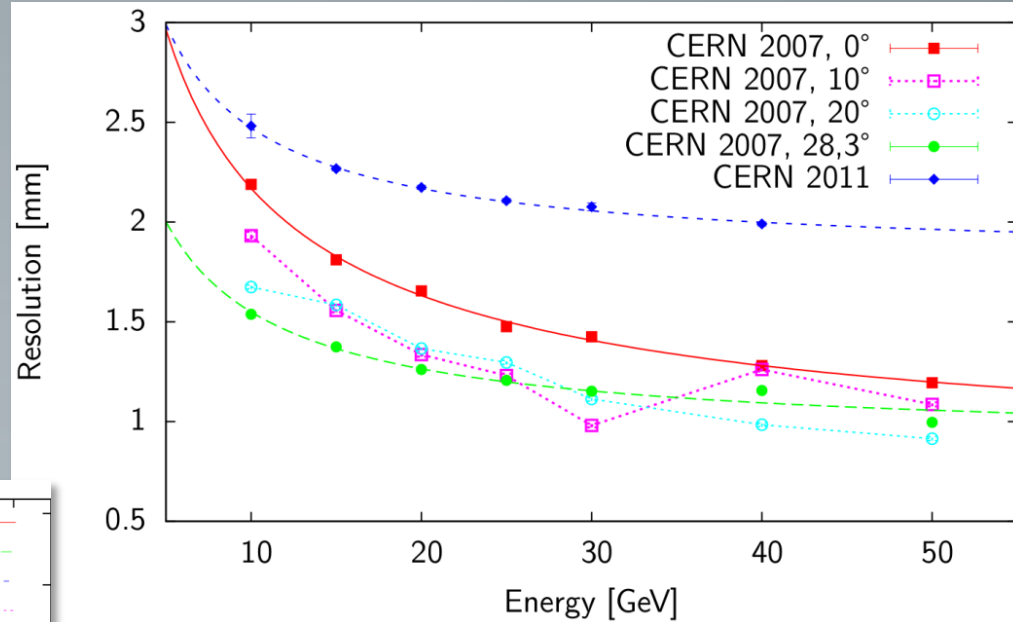
40GeV positrons:

- Uncorrected (RMS: 3.3mm)
- Corrected (RMS: 2.2mm)
- First approche: double gaus
- σ_1 : 1.3mm (~90%)
- σ_2 : 4.6mm (~10%)

Results I

- Energy dependent spatial resolution:

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

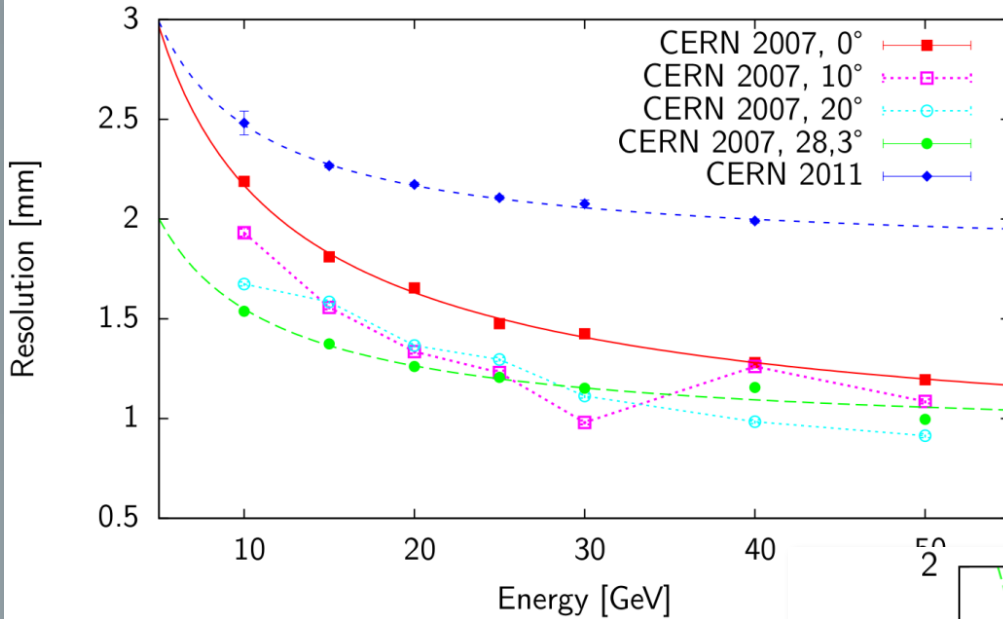


- CoG calculated from several layers → every layer values for s & b are different!
- Layer-wise correction needed → next slide

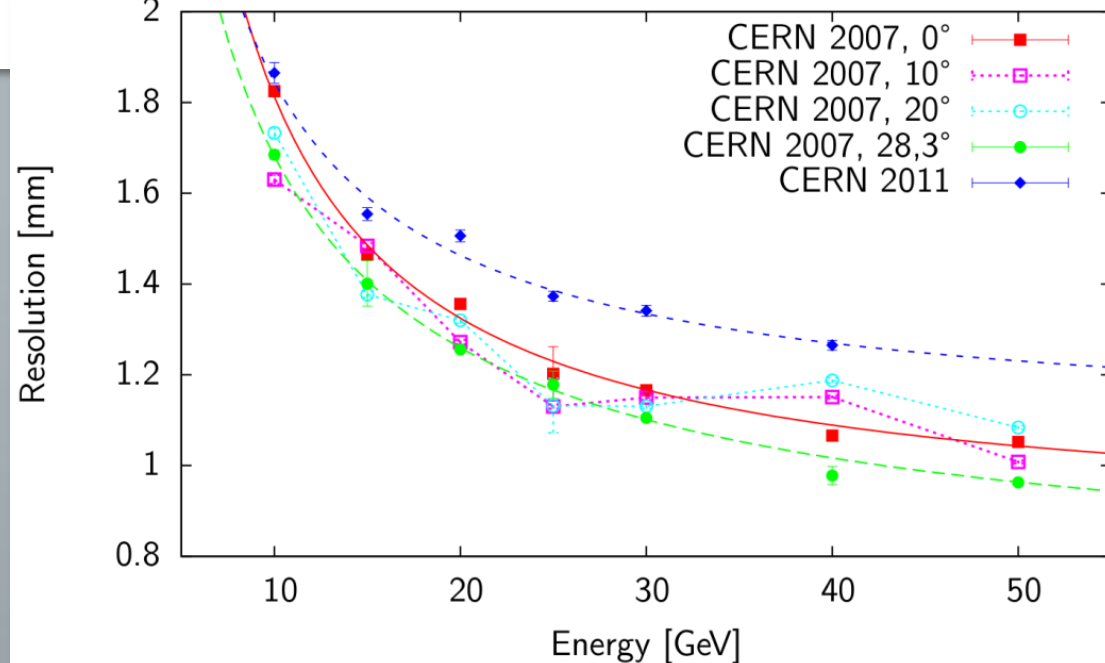
Results II

- Layer-wise correction
→ improves resolution
- parameterization for resolution

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



- Resolution:
 - >20 GeV, Steel, better than 1.4 mm
 - >20 GeV, tungsten, better than 1.6mm

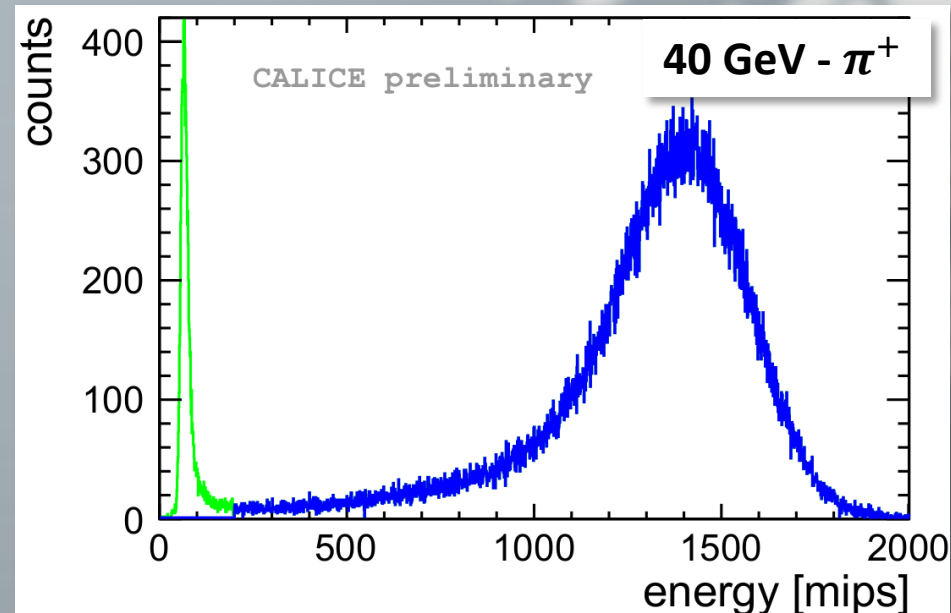
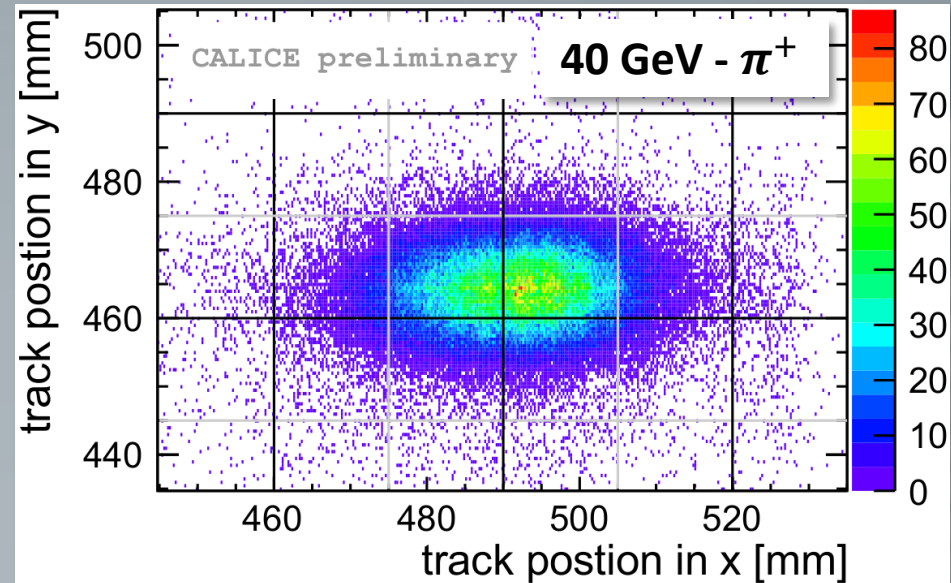


Uniformity of response of the AHCAL to Pions

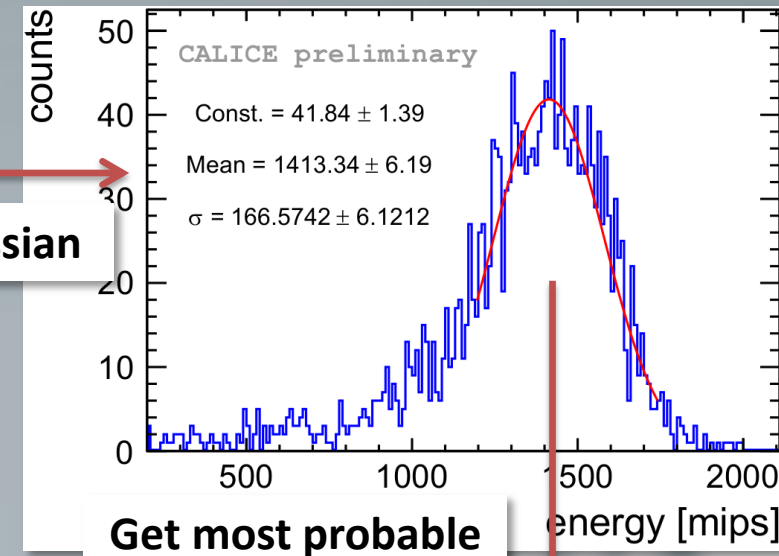
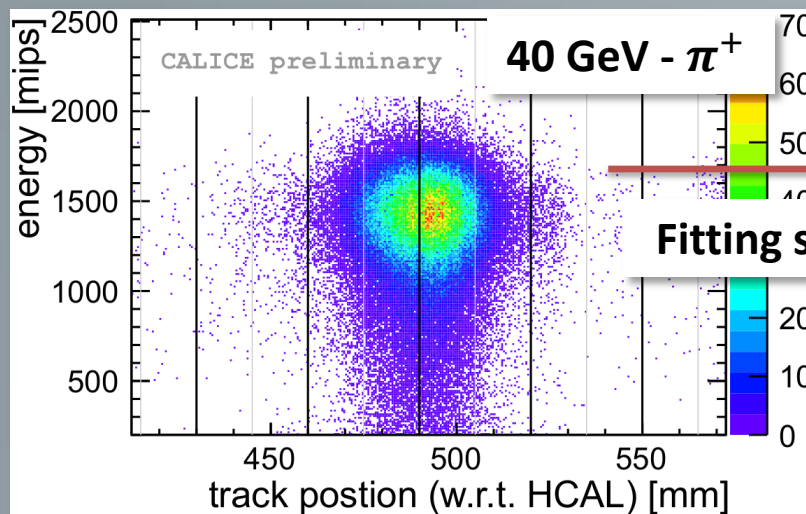


Beam characteristics

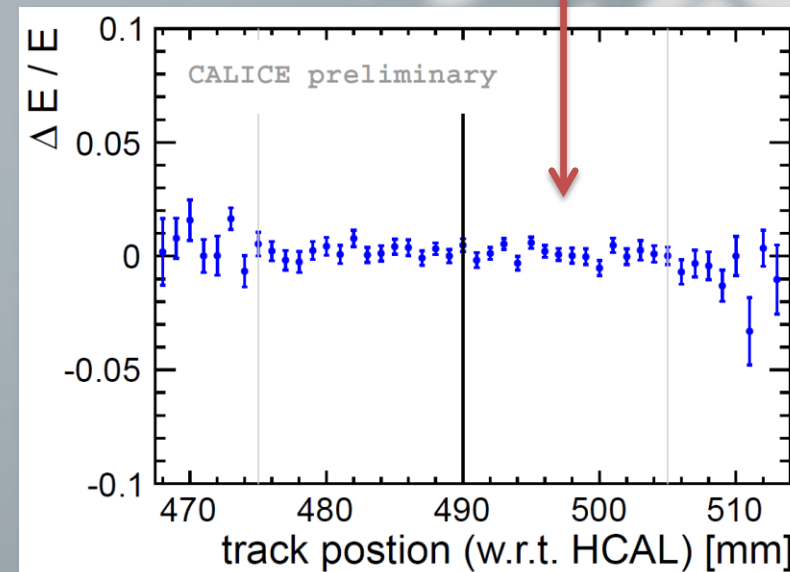
- Beamprofile in y-direction smaller
- Integration over full y-direction (higher statistic)
- Energy range 30-80 GeV (π^+)
- Runs without ECAL
- **Energy Cut**
 - 0.5 mip for each tile (reduce noise)
 - 200 mips muons on total energy



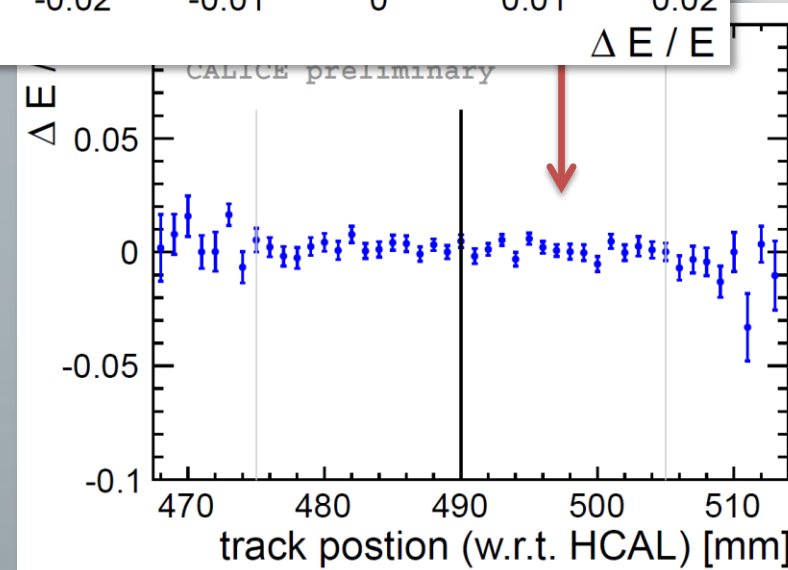
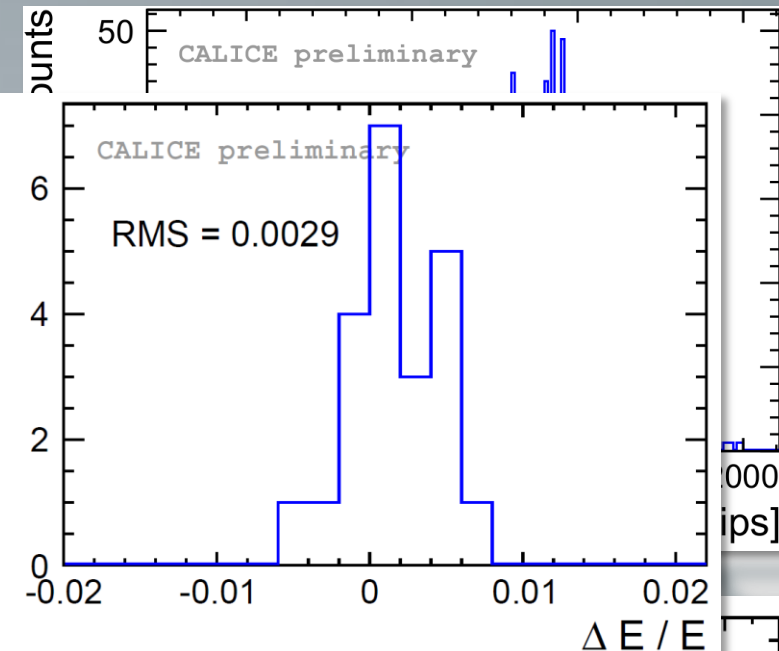
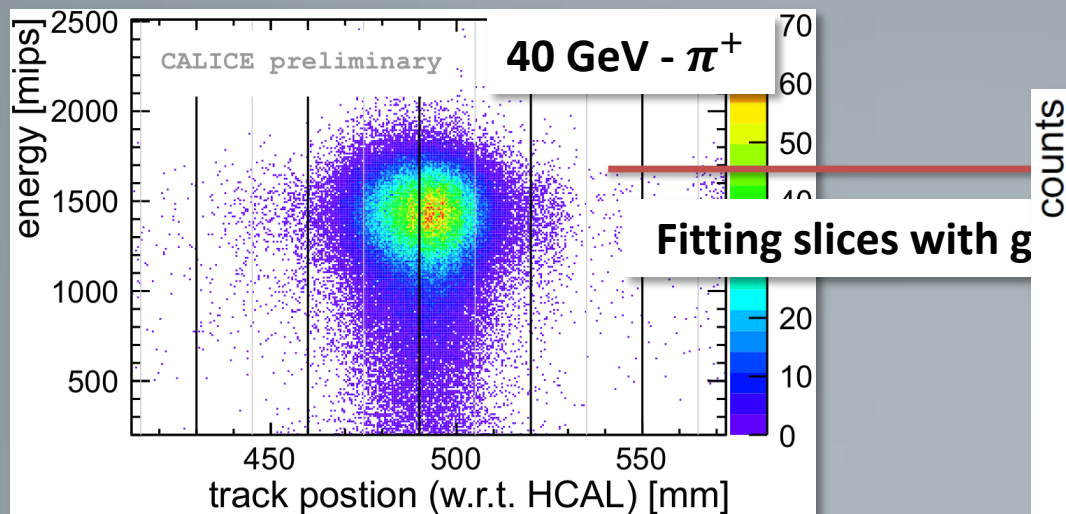
Trackposition ↔ Energy



- Calculating mean energy in 1mm slices of track position
- Plot deviation ΔE from mean energy E over all slices
- RMS of residuals $\Delta E/E = 0.0029$
- Combination of runs with same energy, but different xy-stage position not directly possible
→ shift in total energy of 1-3%

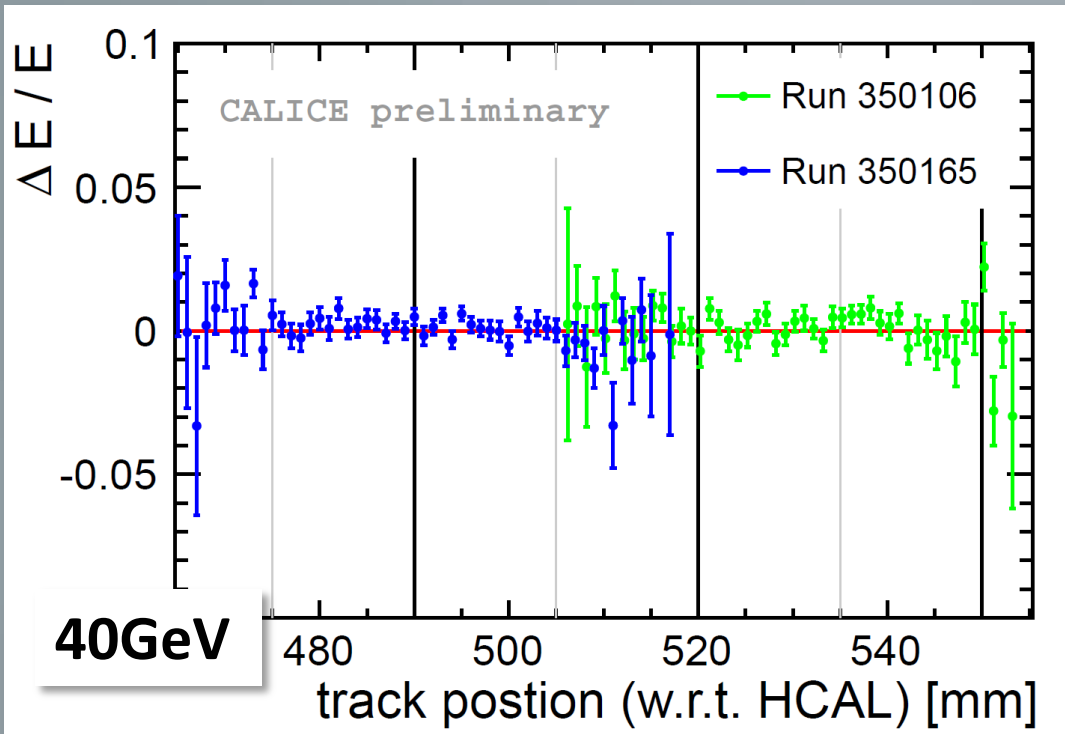


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Combining Results

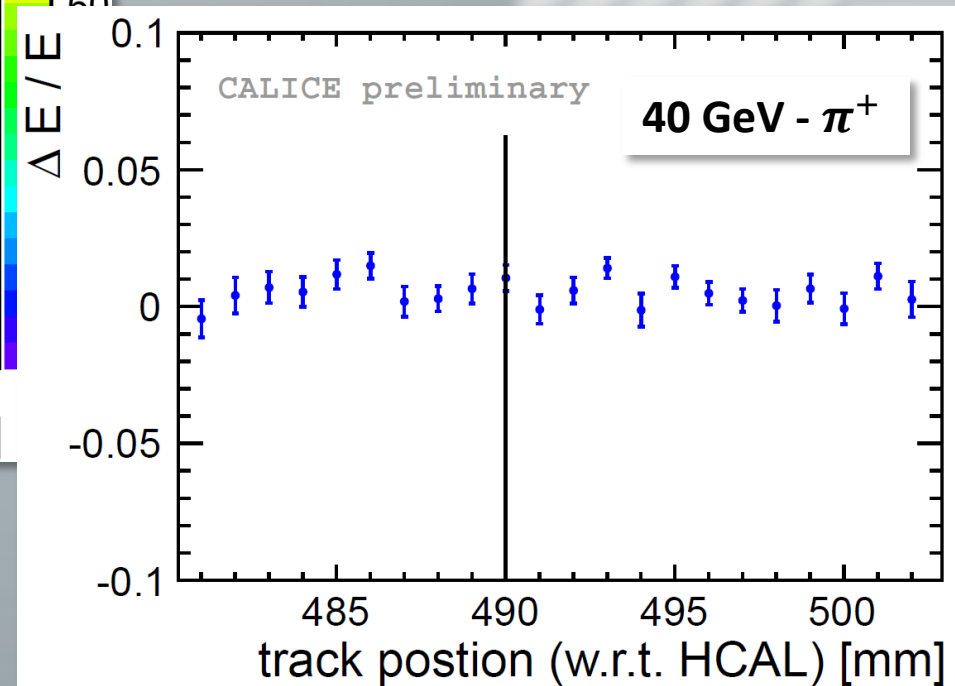
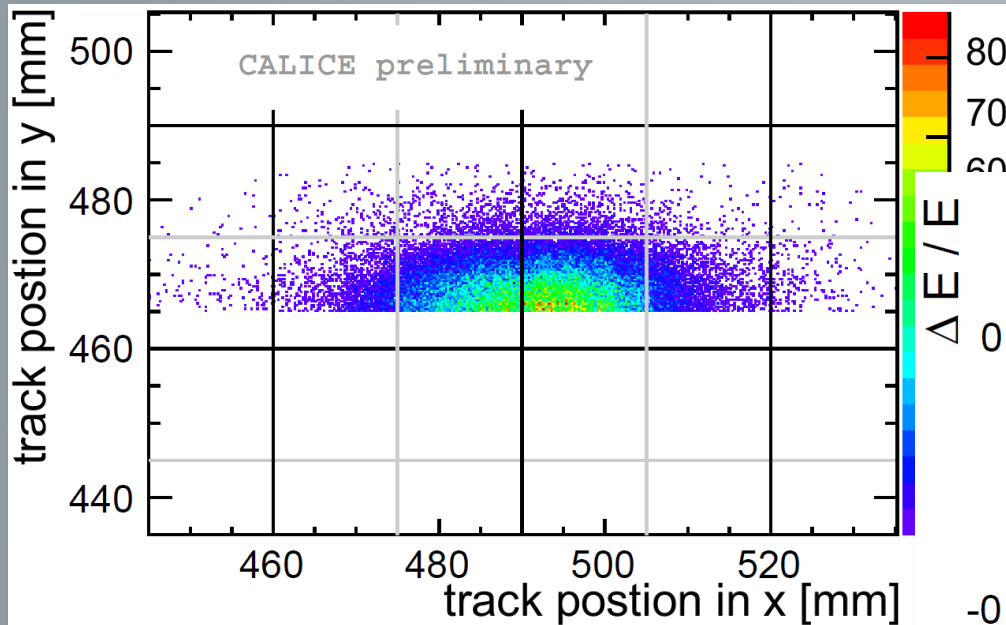


energy [GeV]	RMS of residual
30	0.0056
40	0.0038
50	0.0052
60	0.0040
80	0.0040

- RMS of residuals $\Delta E/E = 0.0038$
- Within errors no anomaly was registered

Check Beamprofile

- No integration in y -direction, just two neighbouring tiles !
- Problem reduced statistic
- Use central 2 cm of 3 cm tiles



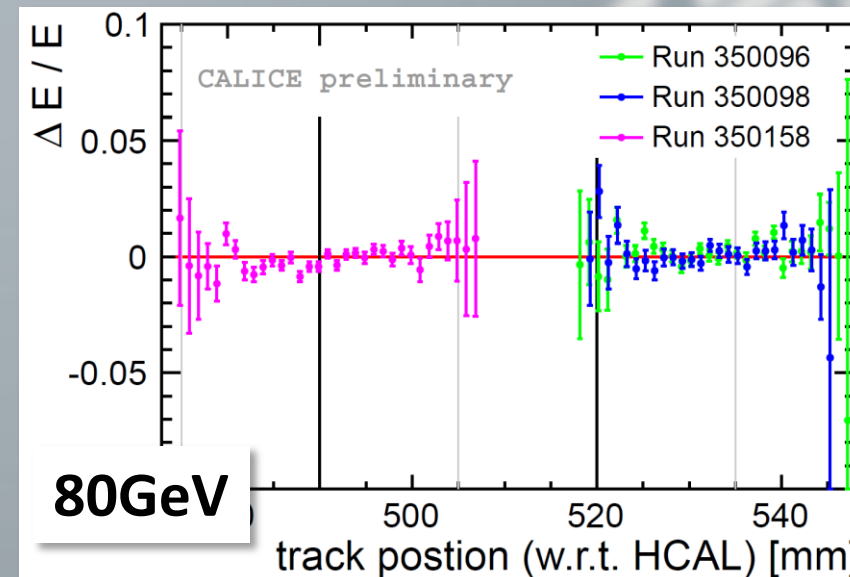
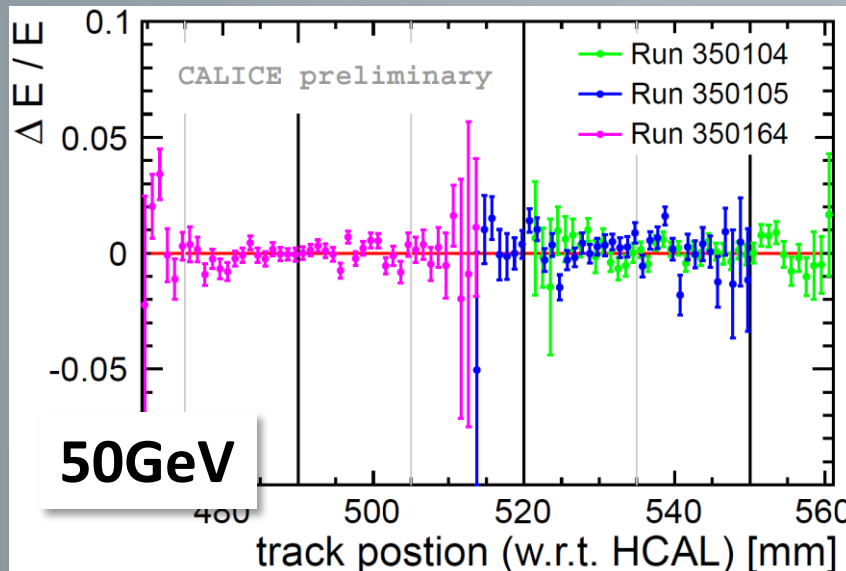
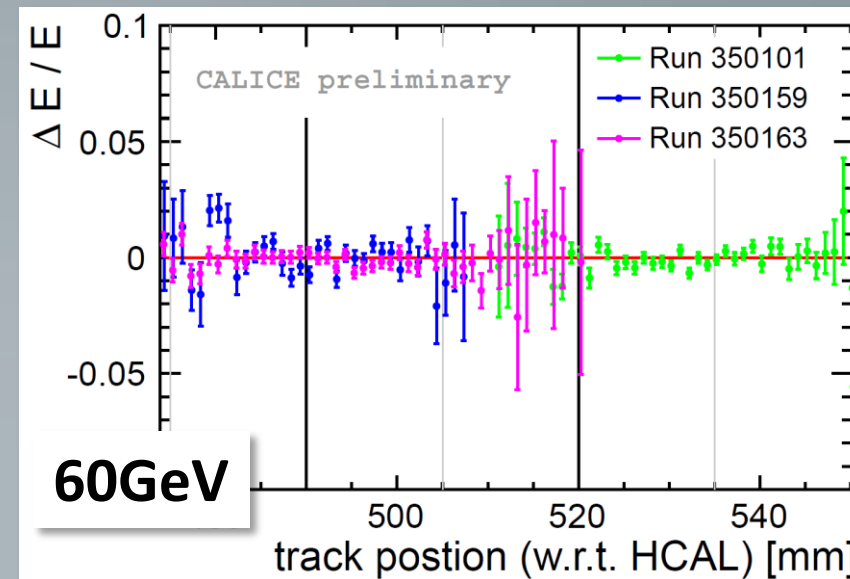
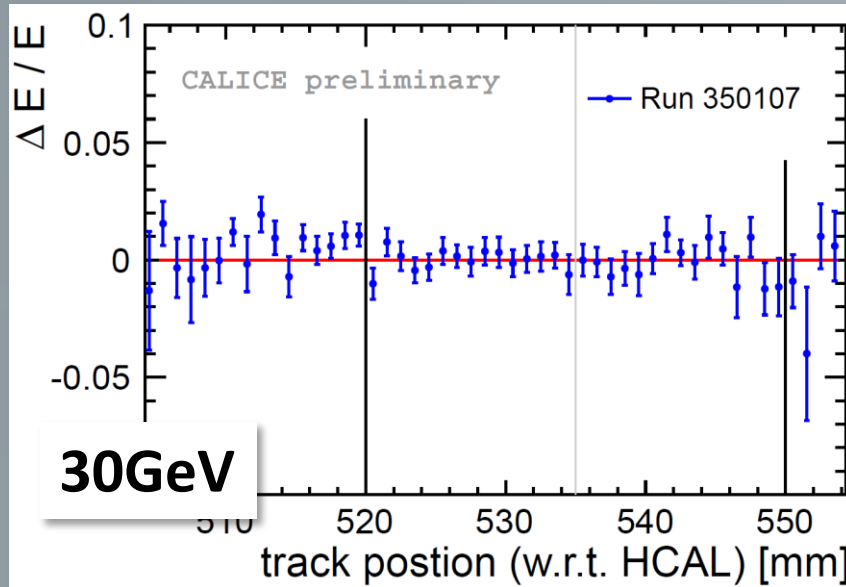
- **Spatial resolution for electrons**
 - Achieve good resolution
 - better than 1.4mm, >20 GeV, steel
 - better than 1.6mm, >20 GeV, thungsten
- **uniformity of the response to Pions**
 - <0.6 % in RMS of residual $\Delta E/E$ over the whole tile (x-direction)
 - No anomaly on “Integrated” y-direction
 - Have to be checked with “software-collimator”
- **note (each) coming soon**



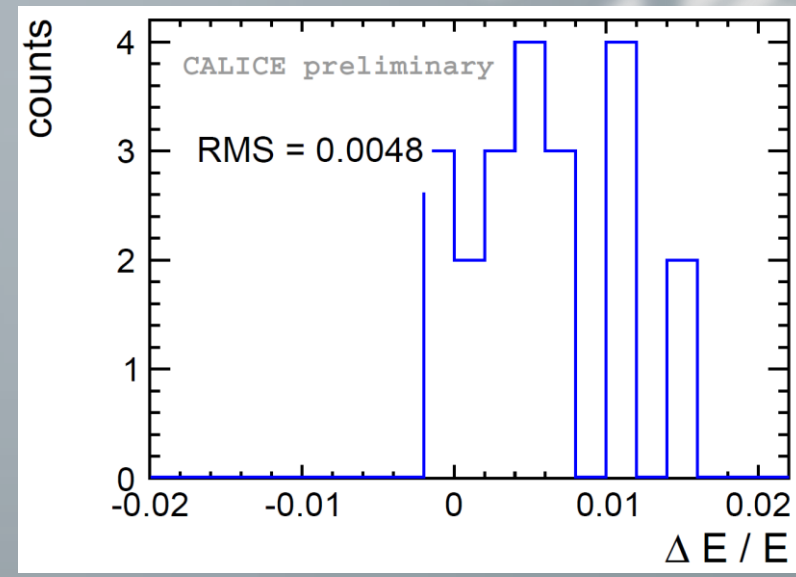
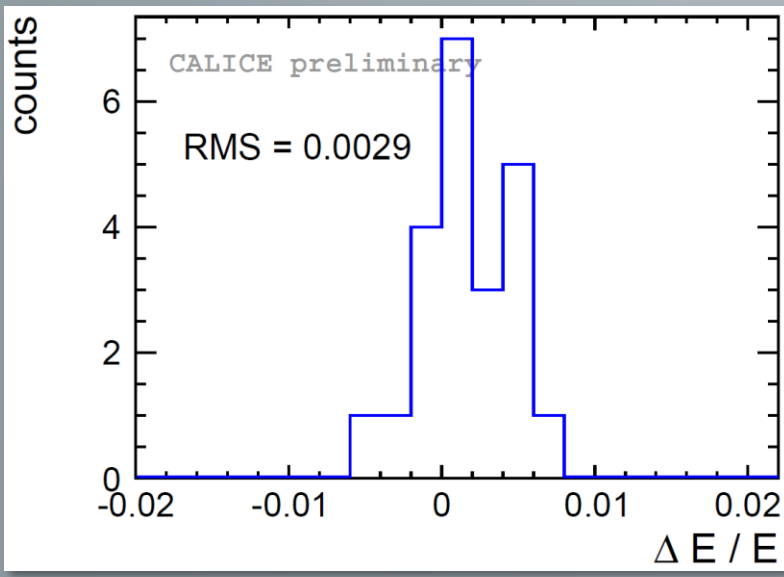
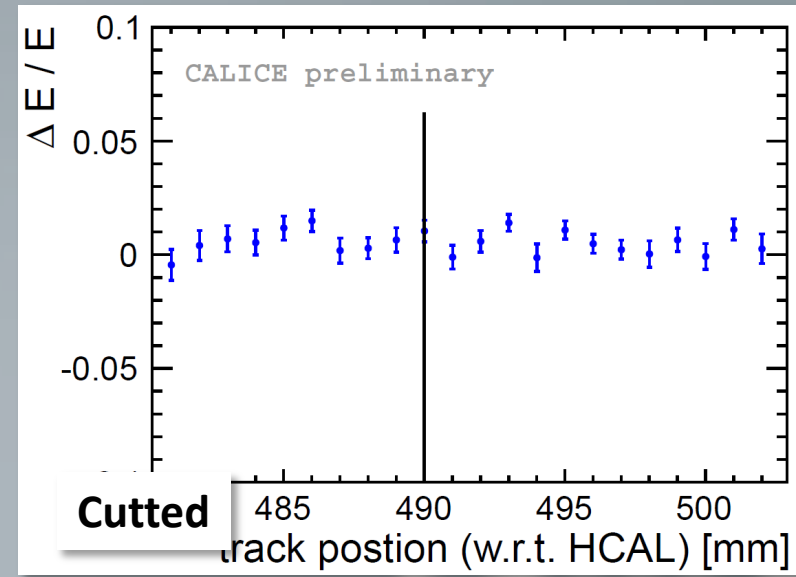
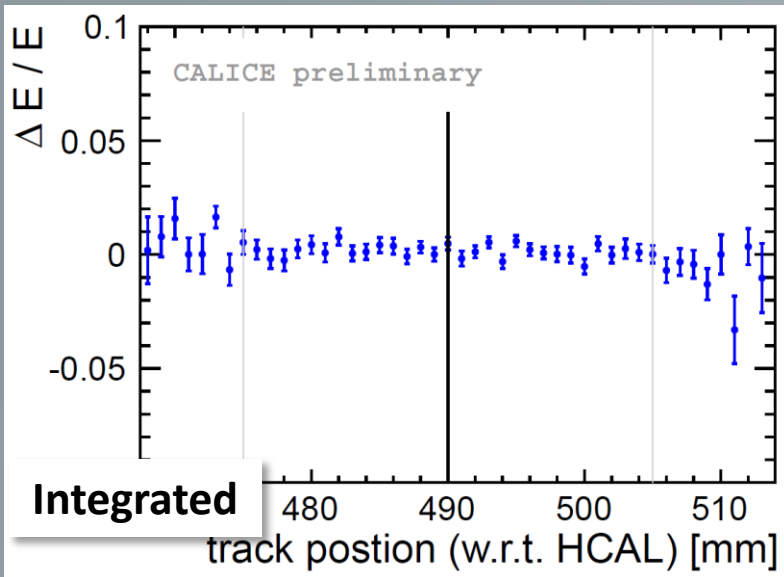
Backup



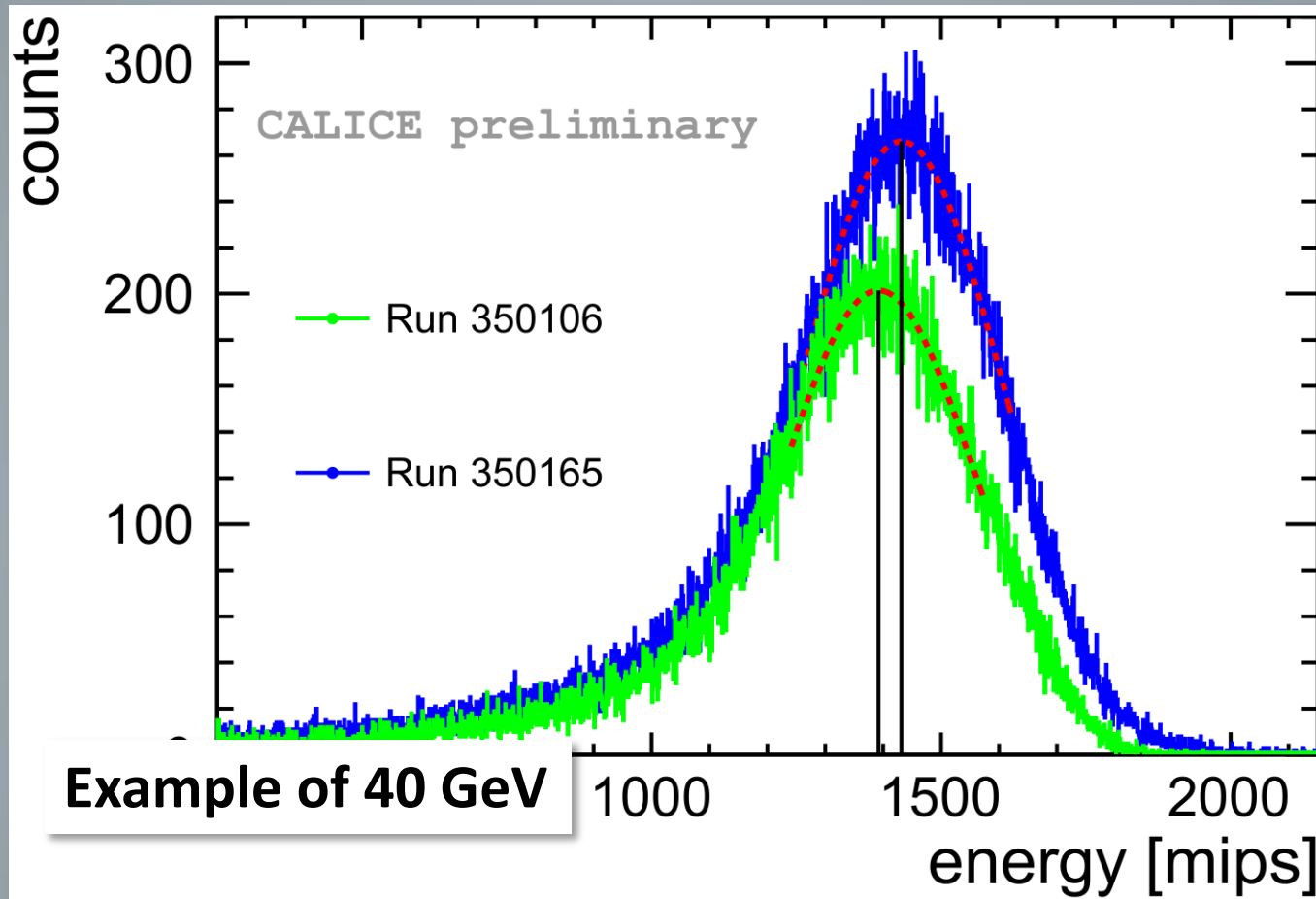
Merged



Example 40GeV



Energy shift



Energy shift of **1-3%** of the total energy in runs with the same beam energy but different stage positions!

Energy shift II

run number	energy [GeV]	mean energy [mips]	RMS of residual
350107	30	1028.38 ± 1.71	0.0056
350106	40	1392.12 ± 1.44	0.0045
350165	40	1432.55 ± 1.18	0.0029
350104	50	1748.78 ± 1.81	0.0035
350105	50	1746.02 ± 2.30	0.0075
350164	50	1795.33 ± 1.51	0.0033
350101	60	2097.69 ± 1.62	0.0030
350159	60	2146.33 ± 2.41	0.0054
350163	60	2144.12 ± 1.57	0.0026
350096	80	2760.03 ± 2.57	0.0041
350098	80	2804.05 ± 2.98	0.0030
350158	80	2811.76 ± 2.13	0.0031