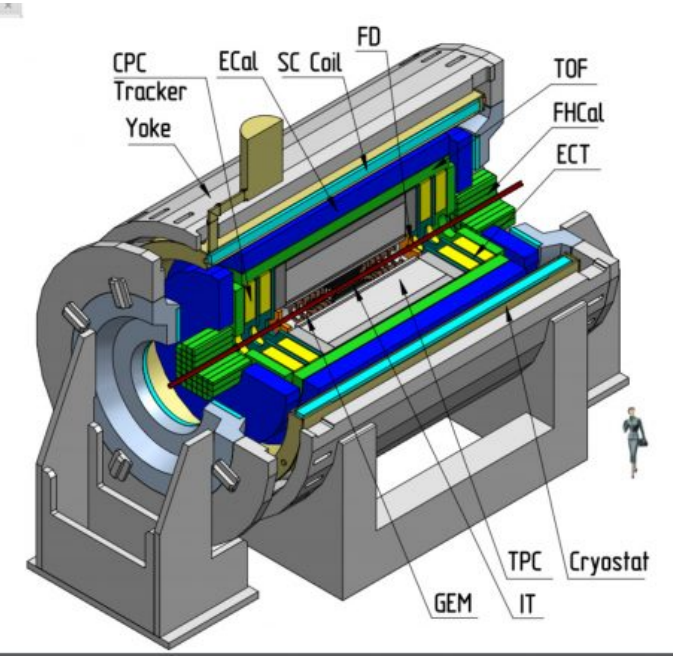
Analysis of beam-test results

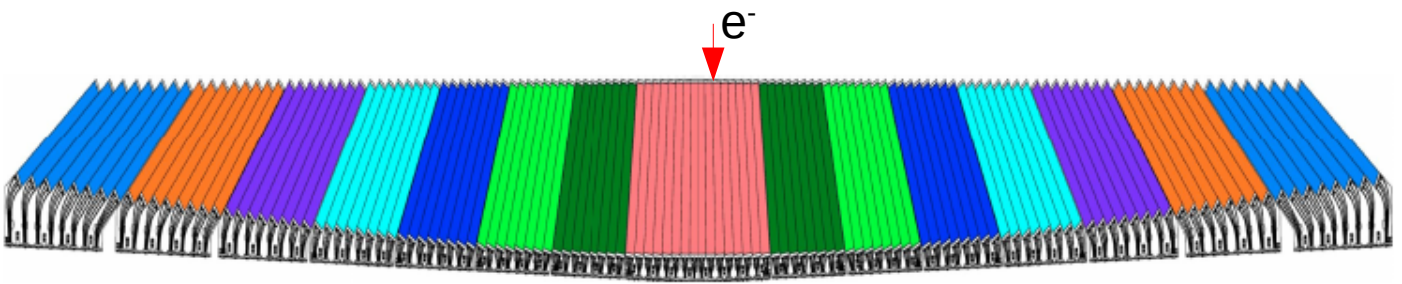
D.Peresunko
NRC “Kurchatov institute”

Data analyzed

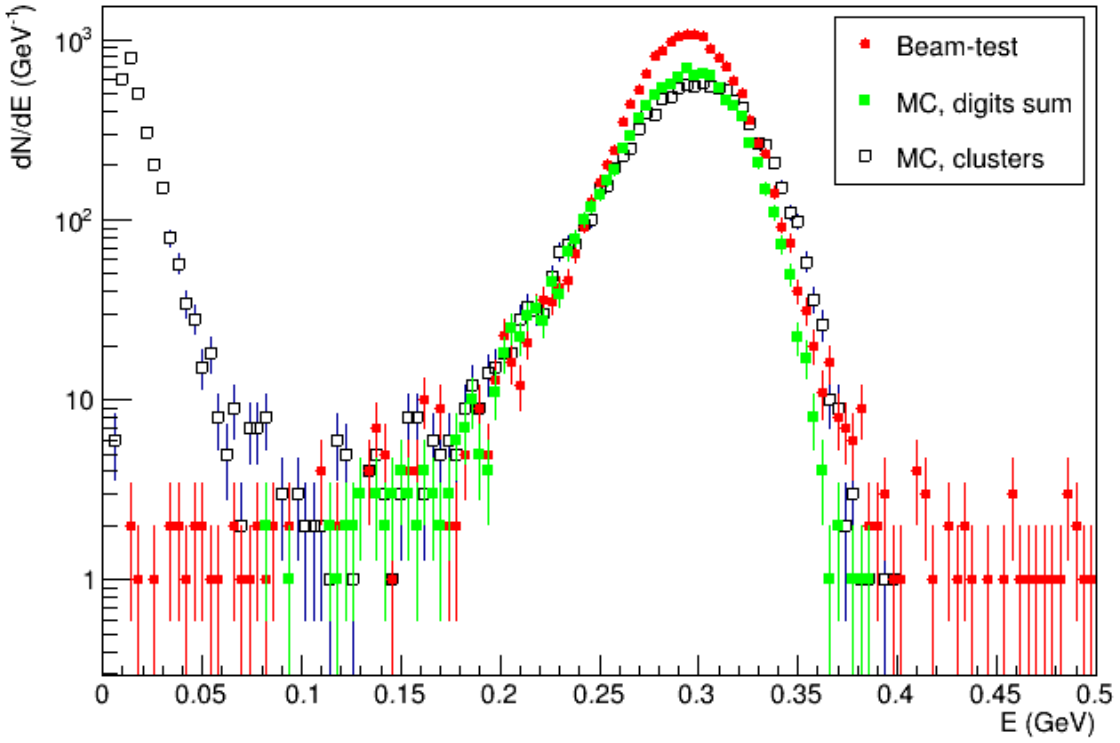
- **Data**
  - Kindly provided by Viacheslav Kulikov
  - Electron beam 293 MeV
  - Prototype 6*8 towers
  - 14000 events



- **MC**
  - Single electron simulation
  - pt 290 MeV,
  - direction η=0, ϕ=270°
  - vertex just in front of EMCal (7.5, -168., 7.5)cm
  - Magnetic field off
  - 10000 events



Comparison of energy resolution



Beam-test: sum of energies of all towers in event with E_i>100 ADC(1.43 MeV)

σ=22.2 MeV*

MC, digits sum: sum of all energy depositions in event above threshold (1.4 MeV)

σ=24.1 MeV**

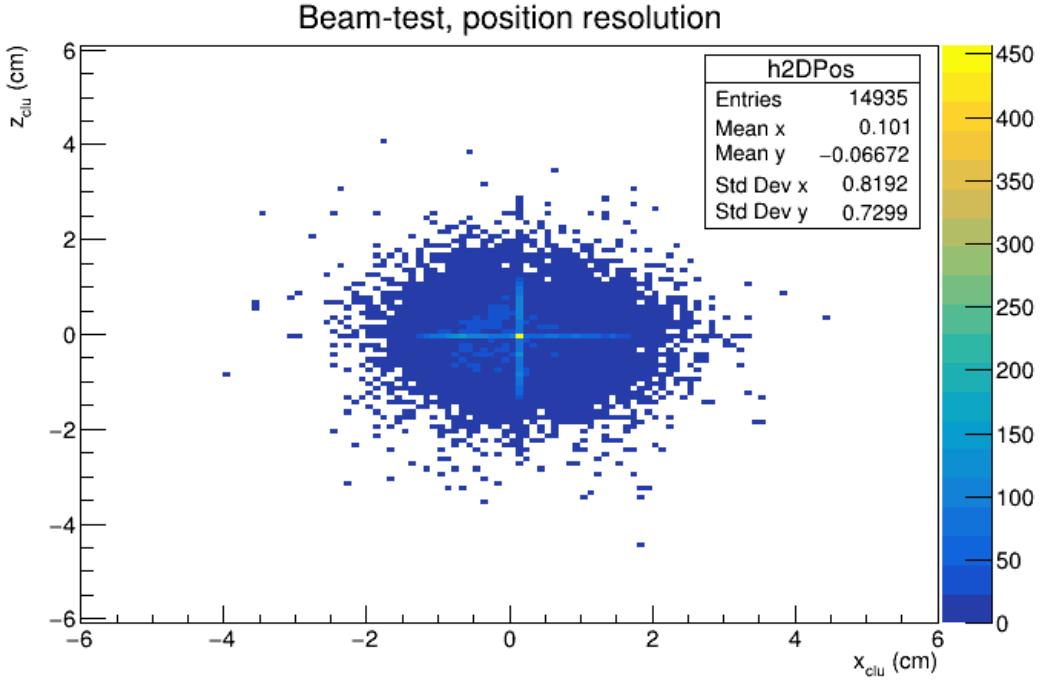
MC, clusters: standard clusterization applied. E_{min}=1.5 MeV, E_{seed}=10 MeV, Digits with common edges added to cluster, common vertex not sufficient.

σ=28.5 MeV

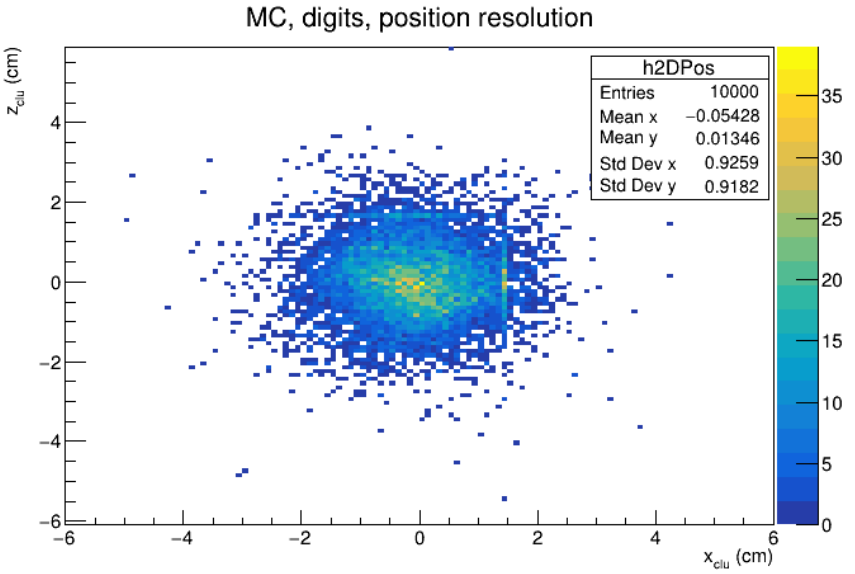
*Fit with Gaus in range 0.22-0.35
**MC calibration fixed to reproduce mean

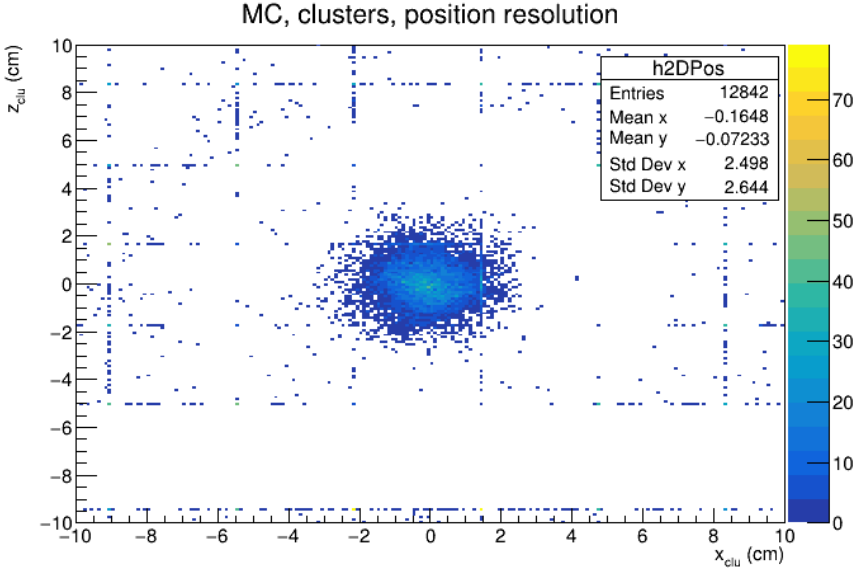
Beam-test provides better resolution than MC:
- check MC simulation chain?
- check description of tower in geometry, e.g. width/number of scintillators?

Position resolution



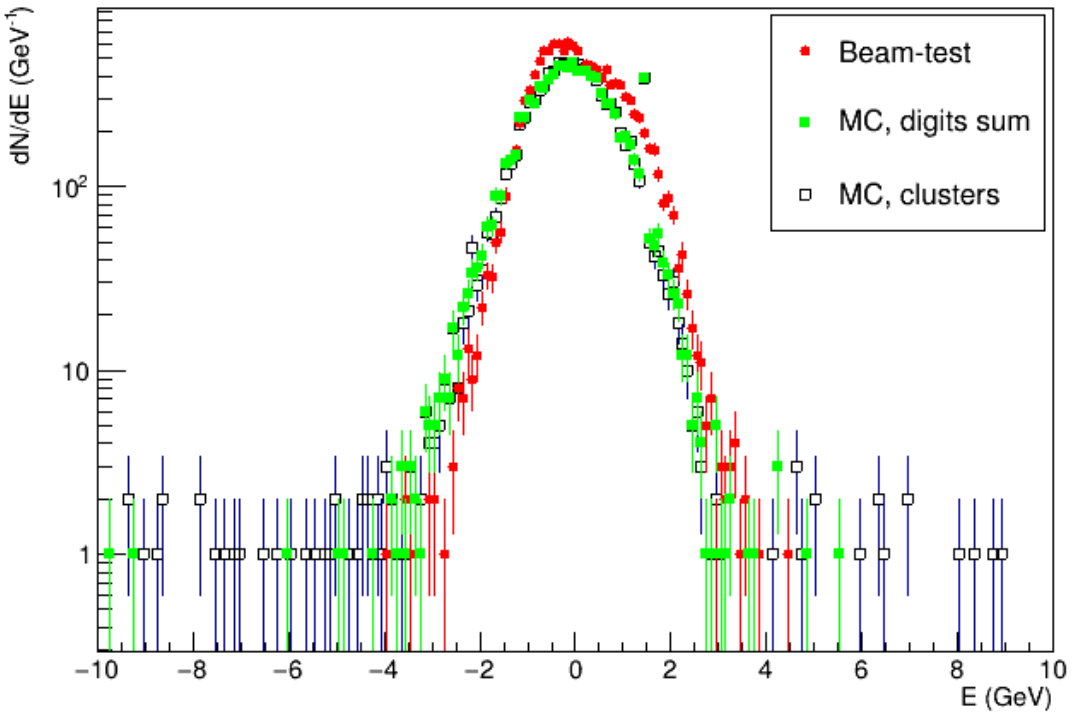
Assume, beam size << 1 cm
=> spread of centers of gravity = position resolution





Position resolution 2

$$x = \frac{\sum x_i w_i}{\sum w_i} \qquad w_i = Max(0, 3 + \log(E_i / E_{tot}))$$



Beam-test: use all towers in event with E_i>100 ADC(1.43 MeV)

σ=0.84 cm

MC, digits sum: use all energy depositions in event above threshold (1.4 MeV)

σ=0.88 cm

MC, clusters: standard clusterization applied. E_{min}=1.5 MeV, E_{seed}=10 MeV, Digits with common edges added to cluster, common vertex not sufficient.

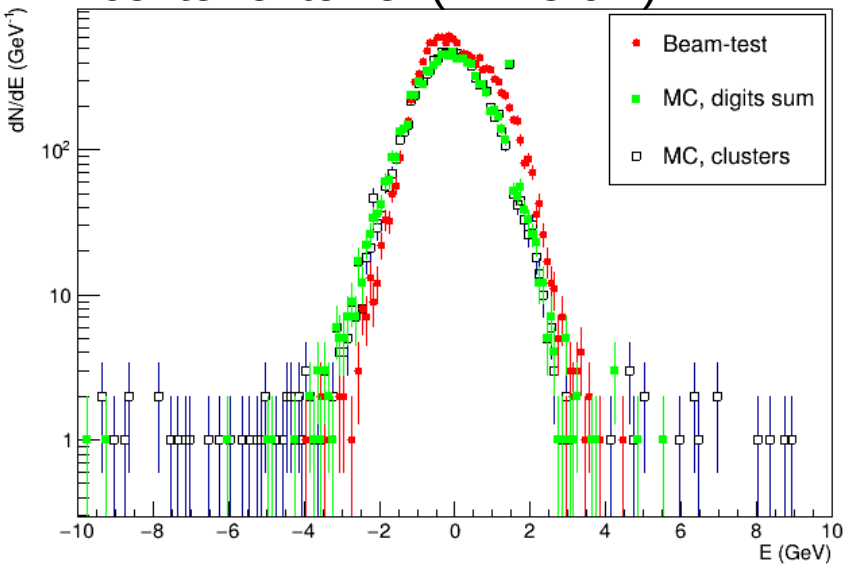
σ=0.85 cm

All distributions shifted to have mean at zero.

Position resolution is close, but shape in beam-test is different
- beam hit not exactly center of tower?
- potentially BT predict narrower distribution.

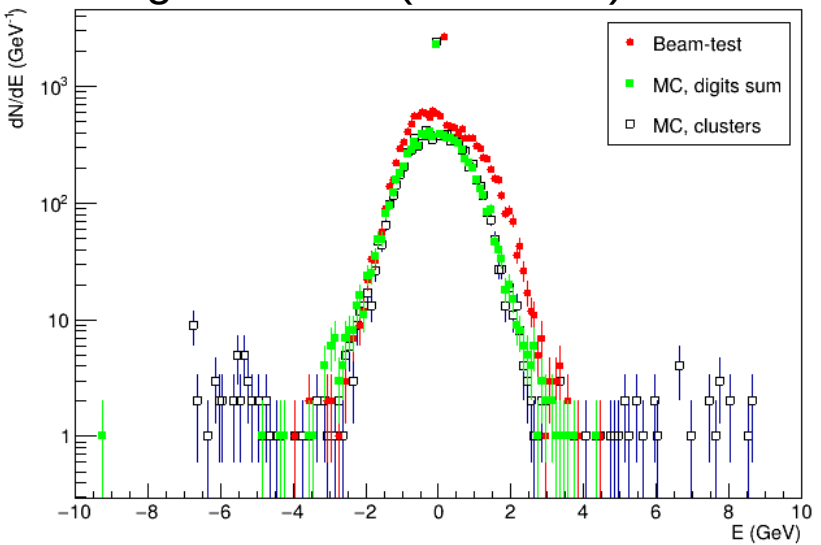
Position resolution 3: dependence on hit position

MC simulations: electrons in the center of tower (z=7.5 cm)



σ=0.88 cm

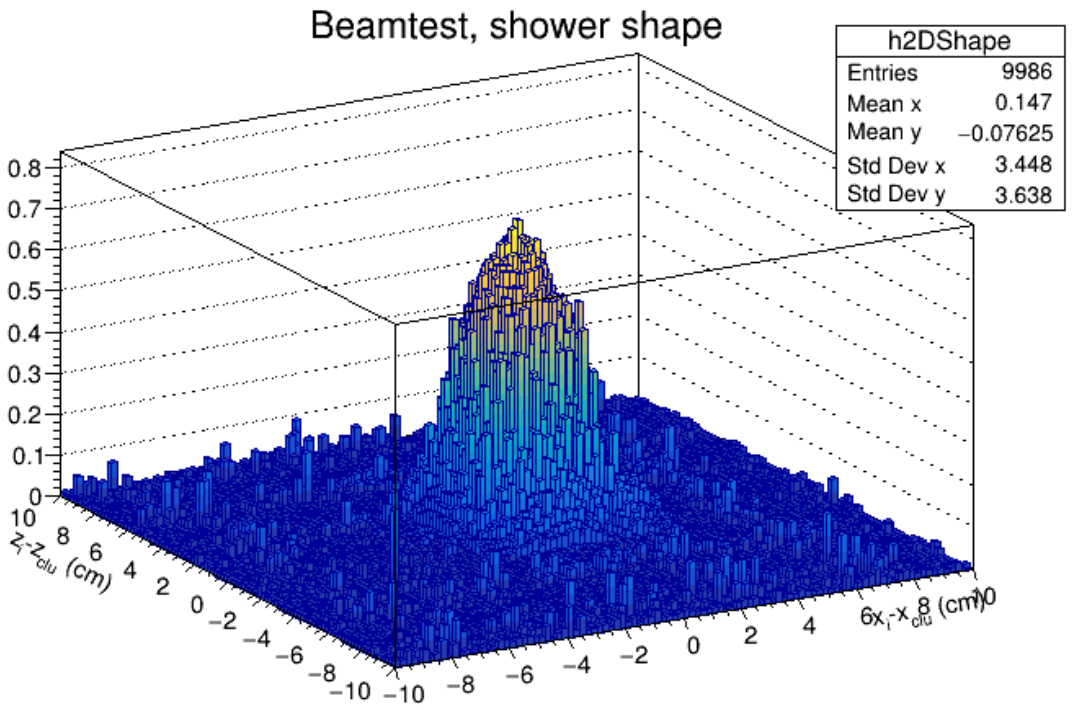
MC simulations: electrons in the edge of tower (z=9.5 cm)

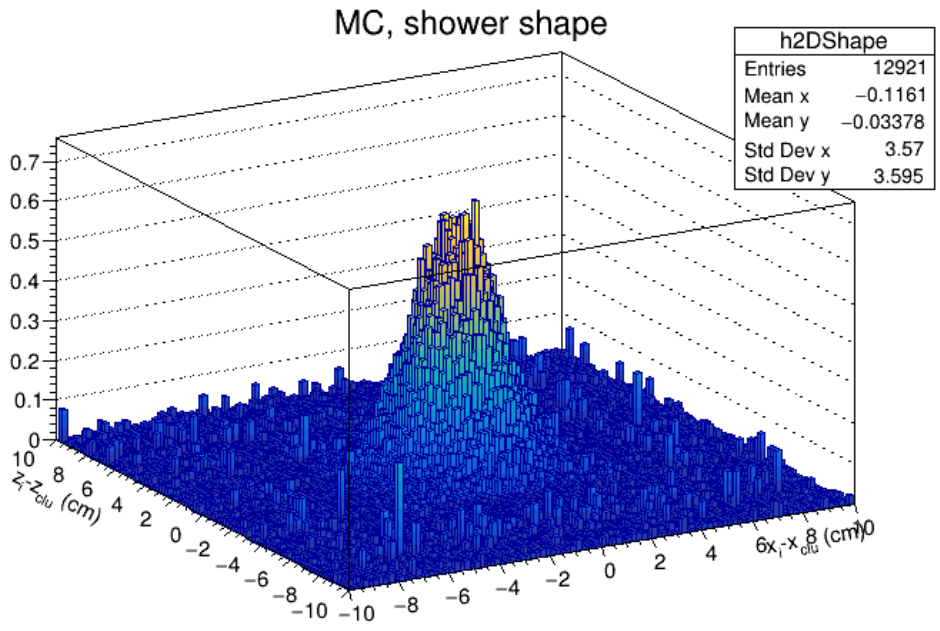


σ=0.77 cm

If electron hits edge of tower, its position is reconstructed with better precision.
For quantitative comparison BT<-> MC need to know exact position of beam in beam-test

Shower shape

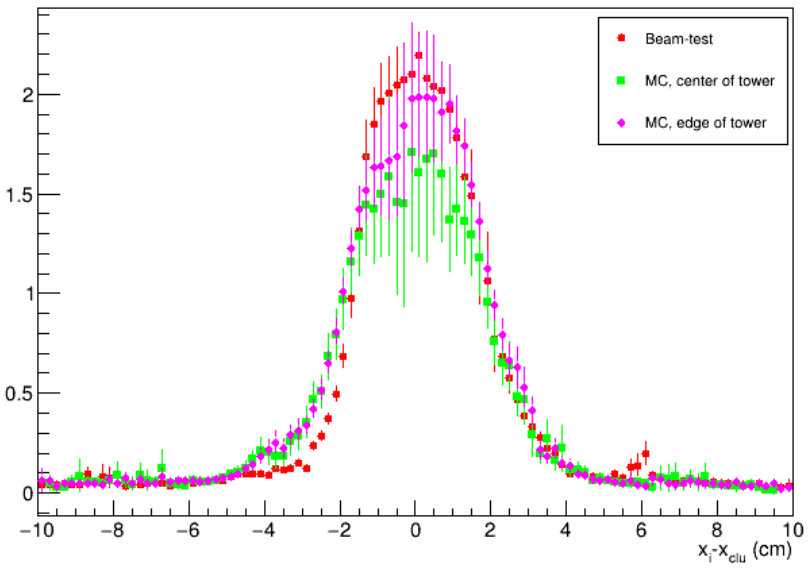




Estimate of shower shape: energy deposited/total cluster energy vs distance to center of gravity of cluster.

MC shower is more compact.

Shower shape 2



MC simulations: electrons in the center of tower (z=7.5 cm)

MC simulations: electrons in the edge of tower (z=9.5 cm)

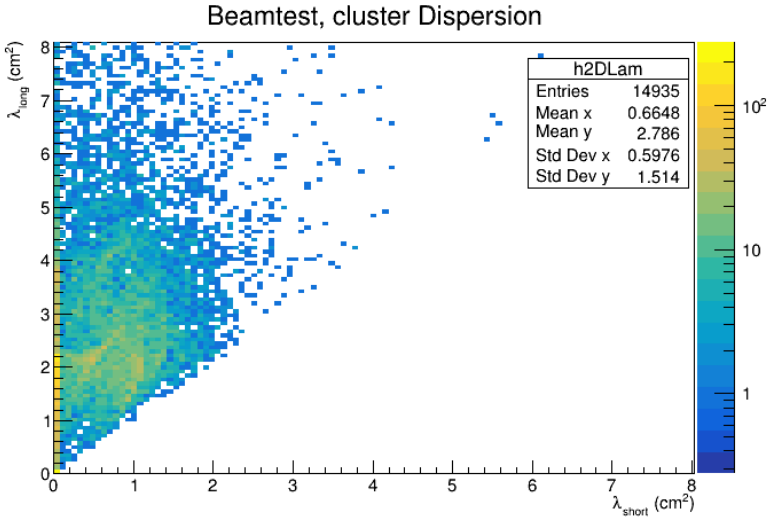
MC predicts wider showers
MC simulations with electrons hiting close to edge reproduce shape better.

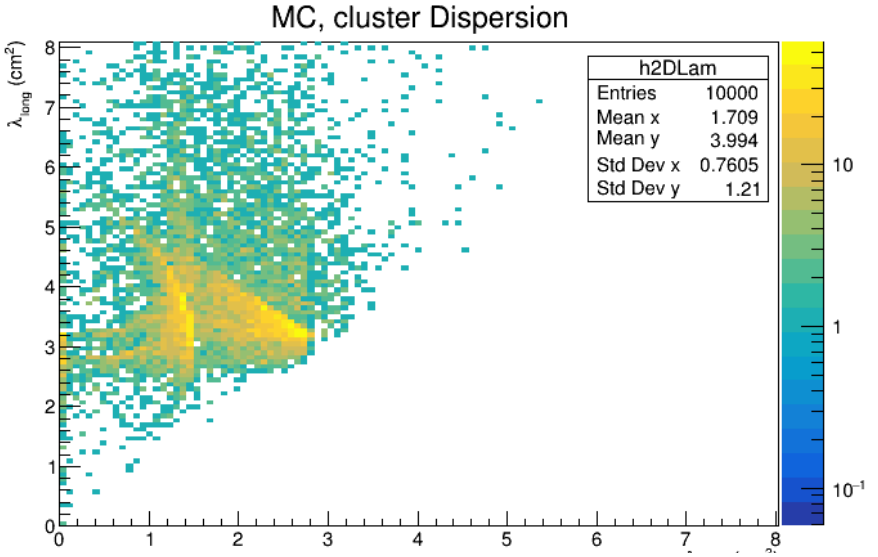
Dispersion

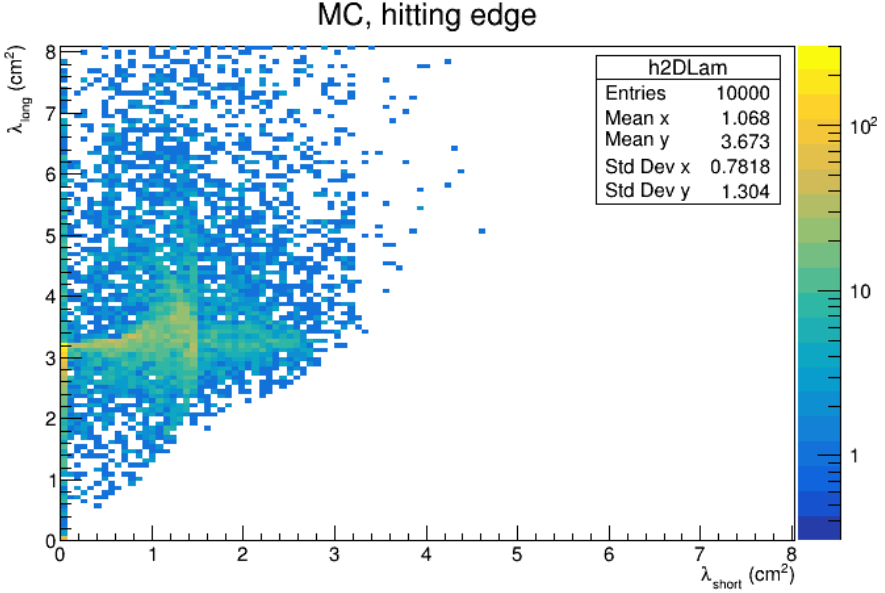
$$D^{ij} = \frac{\sum_k w_k (x_k^i - \bar{x^i})(x_k^j - \bar{x^j})}{\sum_k w_k}$$

$$\lambda_{1,2} = \frac{1}{2}(D_{xx} + D_{zz}) \pm \sqrt{(D_{xx} - D_{zz})^2/4 + D_{xz}^2}$$

$$w_i = Max(0, 3 + \log(E_i / E_{tot}))$$

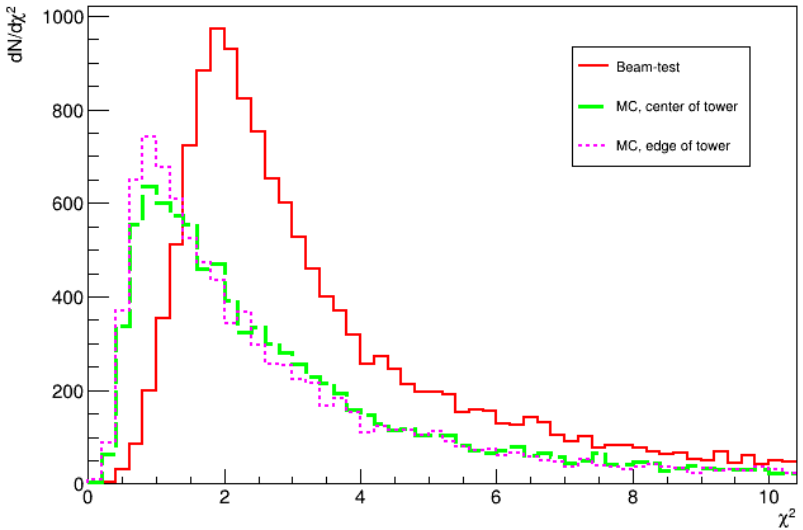






Clusters in BT more compact compared to MC

χ^2 distribusions



Fit shower shape with parameterized EM shower and calculate χ^2 of the fit

Shower shape is significantly different in BT and MC, similar to dispersion

Conclusions

- Some discrepancies exist in all components:
  - Energy resolution
  - Position resolution
  - Shower shape
- Difference in energy resolution means either
  - Bug in deposited energy calculation
  - Bug in tower geometry (width of Pb and scintillator layers)
  - …?