# FCal Validation

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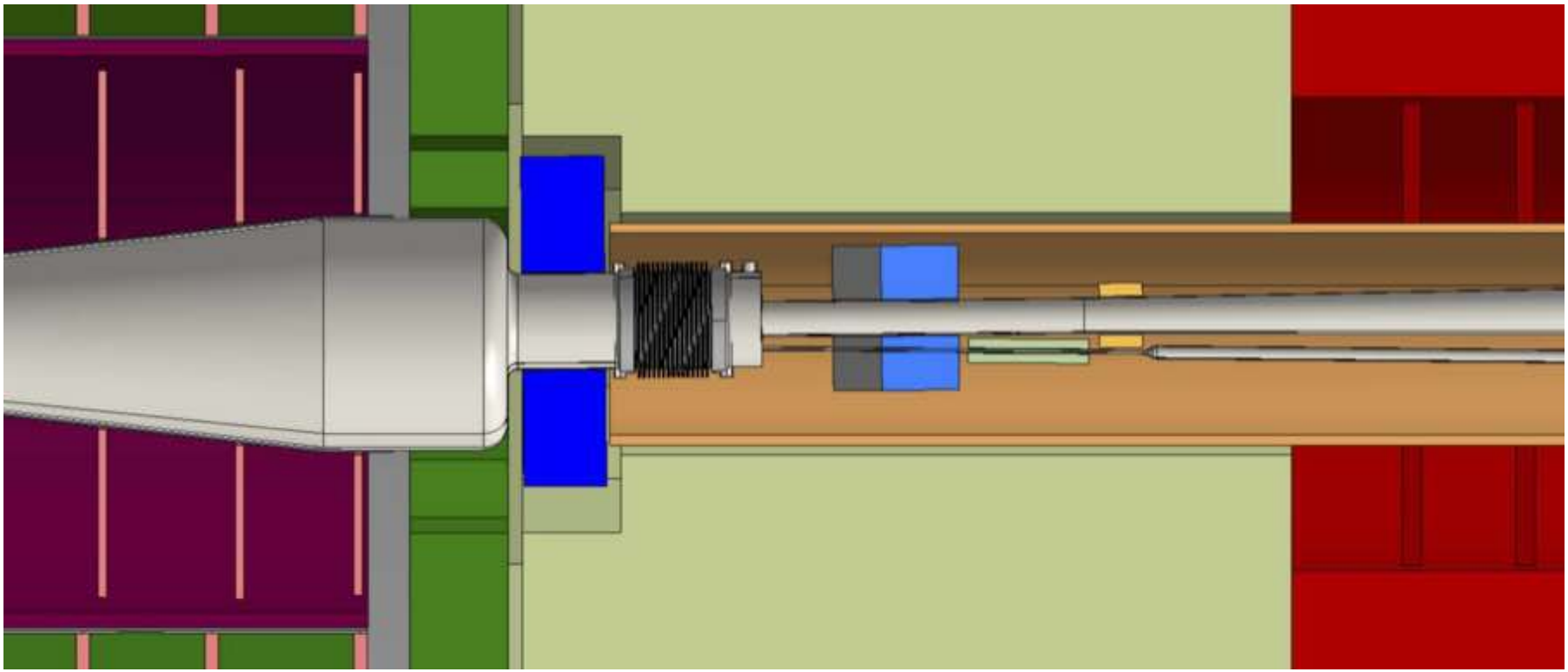
# Content

# LumiCal Reconstruction Performance

Preliminary look at LumiCal performance to test reconstruction algorithm

- Simulated 2k–20k events per polar angle and energy in CLIC LumiCal
- CLIC detector model
  - LumiCal 40 layers, 39 mrad to 134 mrad geometric acceptance, 48 azimuthal, 64 radial segments, no Anti-DID
  - Parts of LumiCal covered by ECal endcap ($\approx$ 100 mrad), depending on azimuthal angle
- Lorentz boost for crossing angle, theta in the LumiCal system
- Step of 0.1 mrad in $\theta^{\star}$, flat in $\phi$, from 42.0 mrad to 129.9 mrad
- Energies[GeV]: 10 20 30 50 100 150 200 250 300 400 500 750 1000 1250 1500

# CLICdet Forward Region



# Tuning Knobs

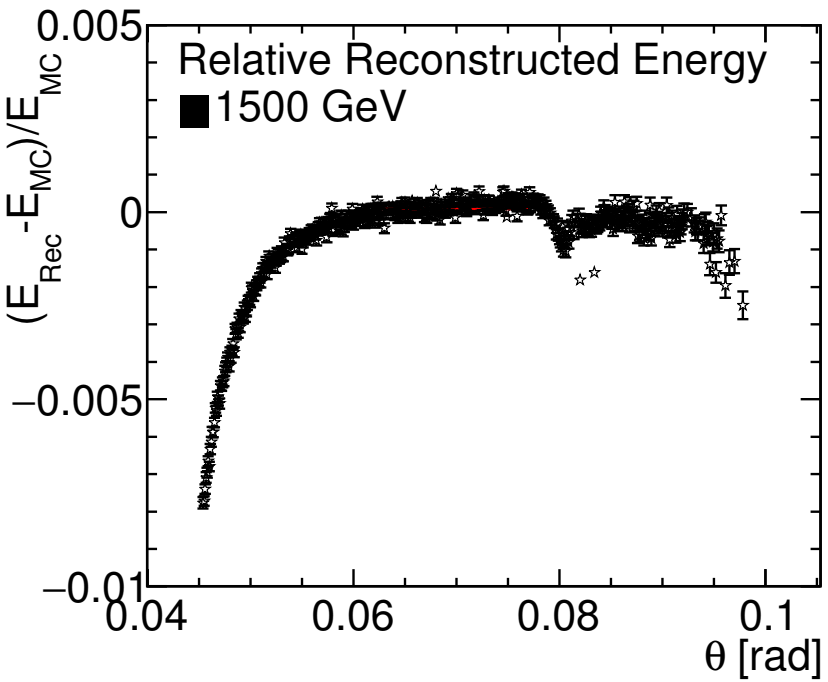
There are a few tuning knobs in the LumiCal reconstruction software

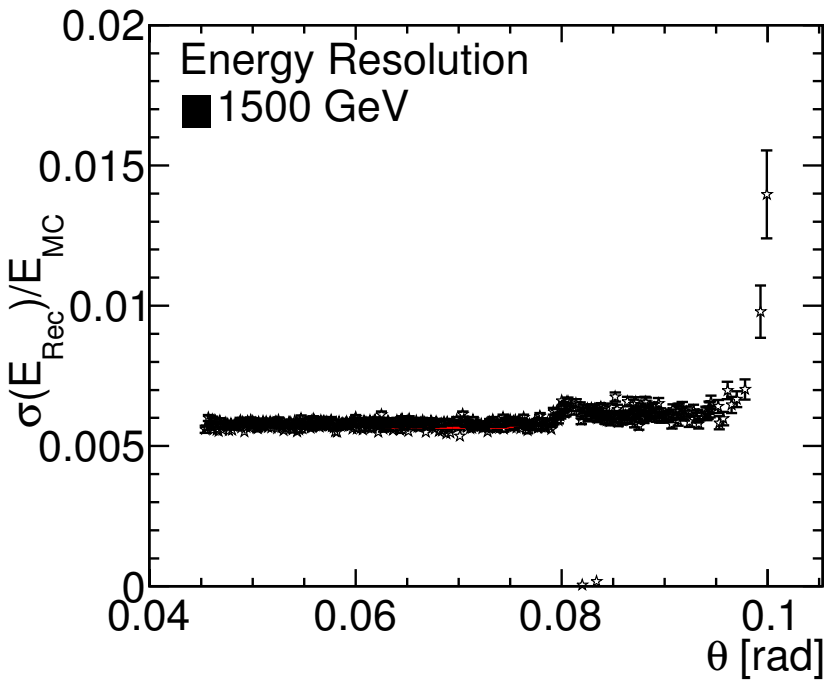
- Energy calibration factor
- Logarithmic weighting constant for energy weighting: $w = C + log(E/E_{\text{total}})$
  Goal is to have best resolution in polar angle reconstruction
- Expected shower size, controlling two particle separation, cluster merging

Not a lot of tuning has been done for the results presented in the next two slides besides energy calibration.

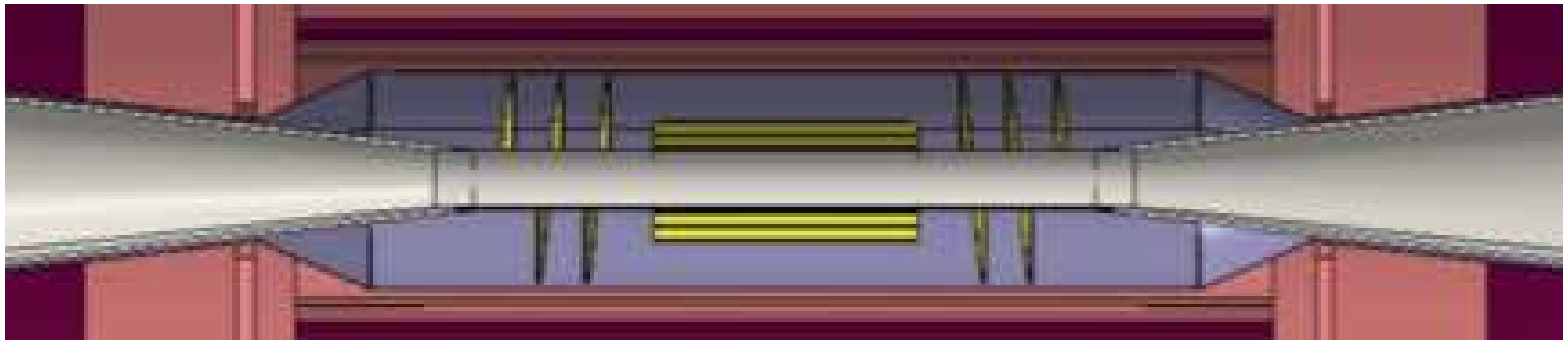
# Energy Calibration

- Obtain fiducial volume based on constant reconstructed energy
- Change calibration factor until correct energy is reconstructed
- Bias in energy reconstruction, while resolution is constant in larger range
- Used 62 mrad $< \theta <$ 77 mrad to estimate energy resolution



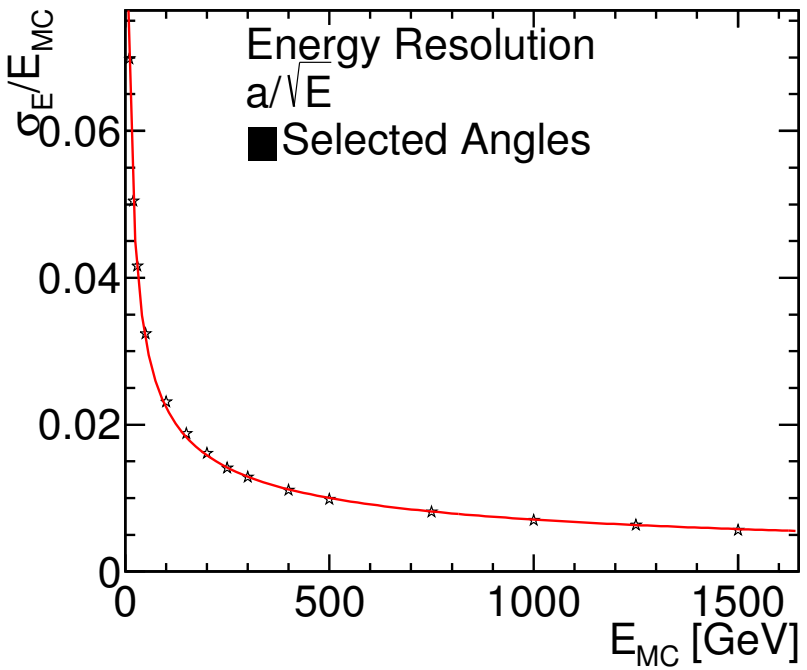
# CLICdet Vertex Region



- Last part of cylindrical beampipe cuts into LumiCal acceptance at R=29.4 mm, Z=337 mm, corresponds to 79 mrad including Lorentz Boost

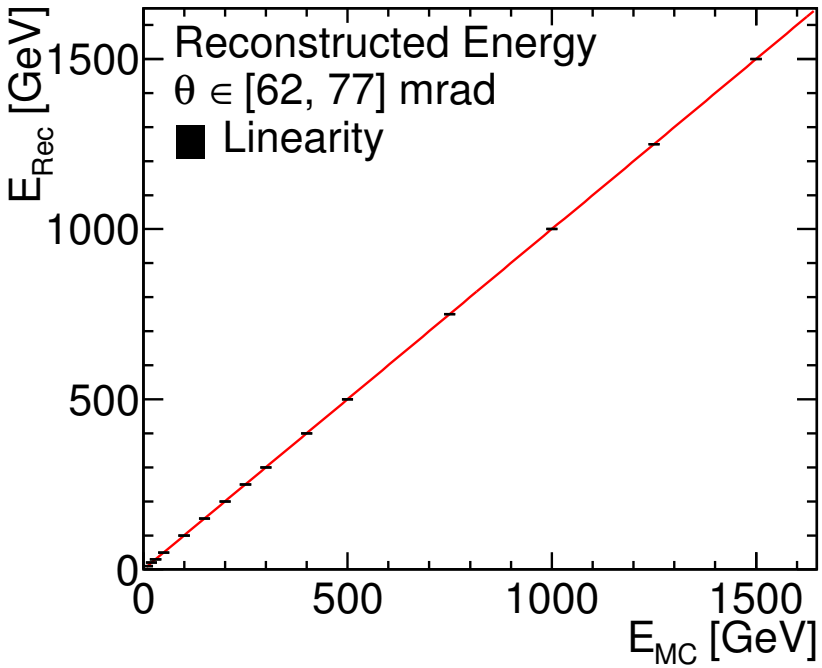
# Energy Resolution

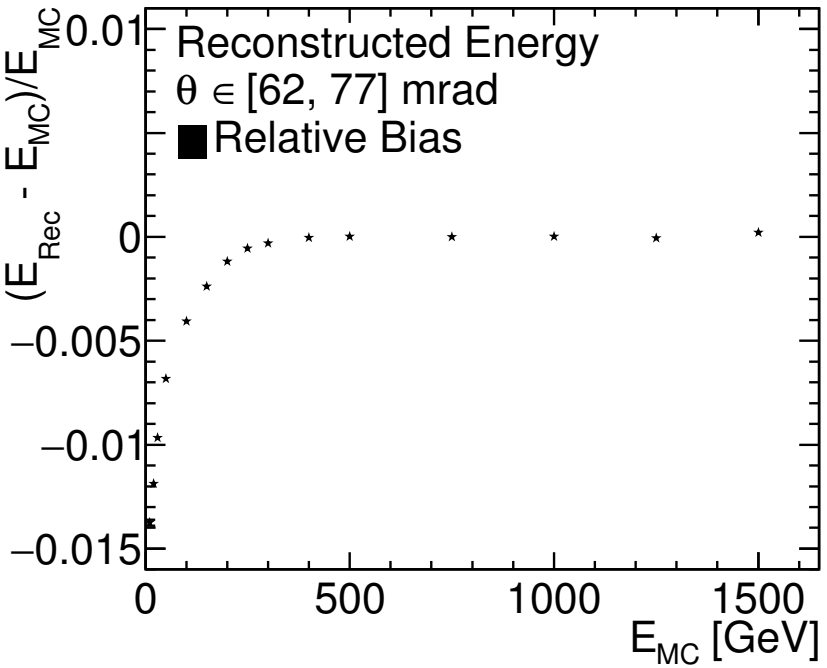
- Based on the standard deviations of the selected angular range for the different energies
- $\sigma E/E = a/\sqrt{E[\text{GeV}]}$
- $a = 0.22$, constant term negligible
- As expected from the design from 2009



# Energy Linearity

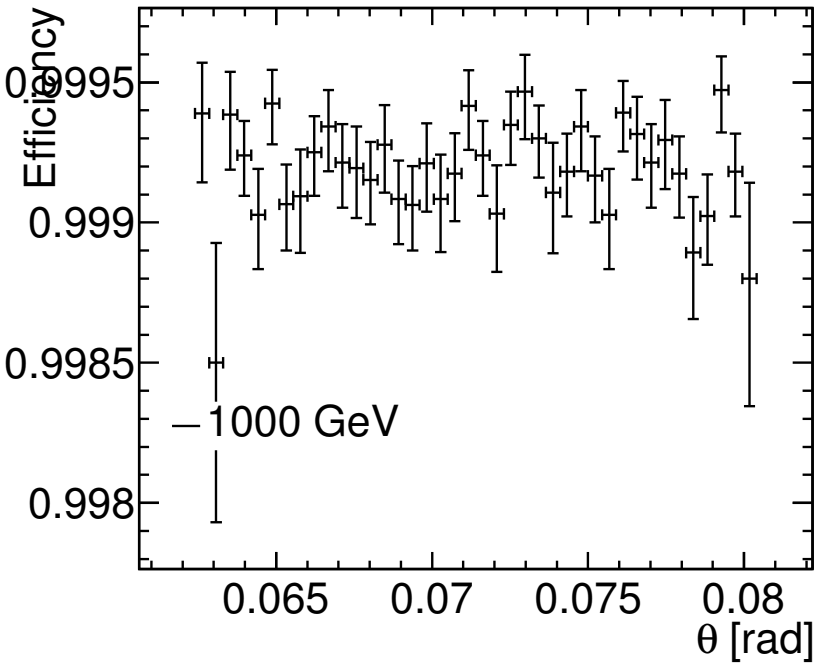
- Reconstructed energy is linear
- Very small bias at higher energies, larger at lower energies

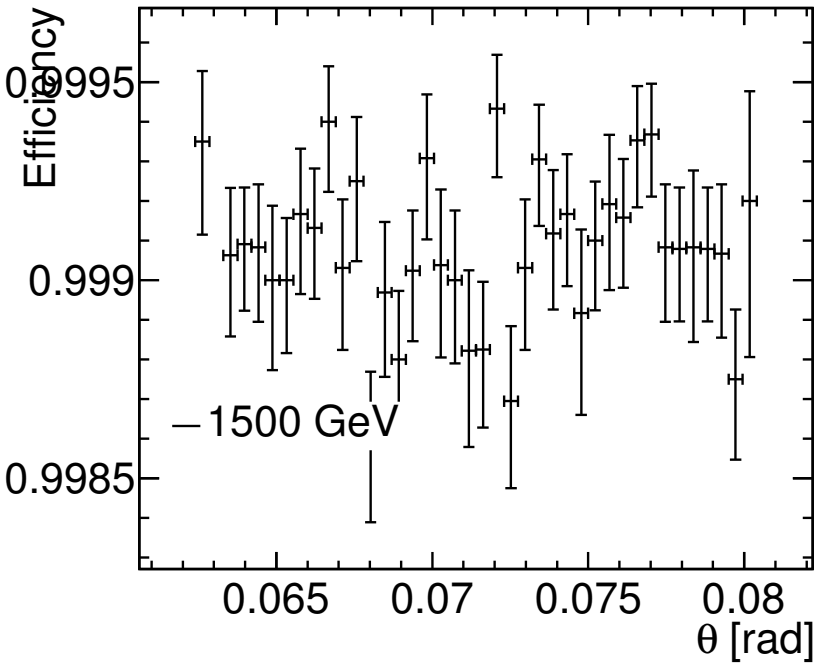


# Efficiencies

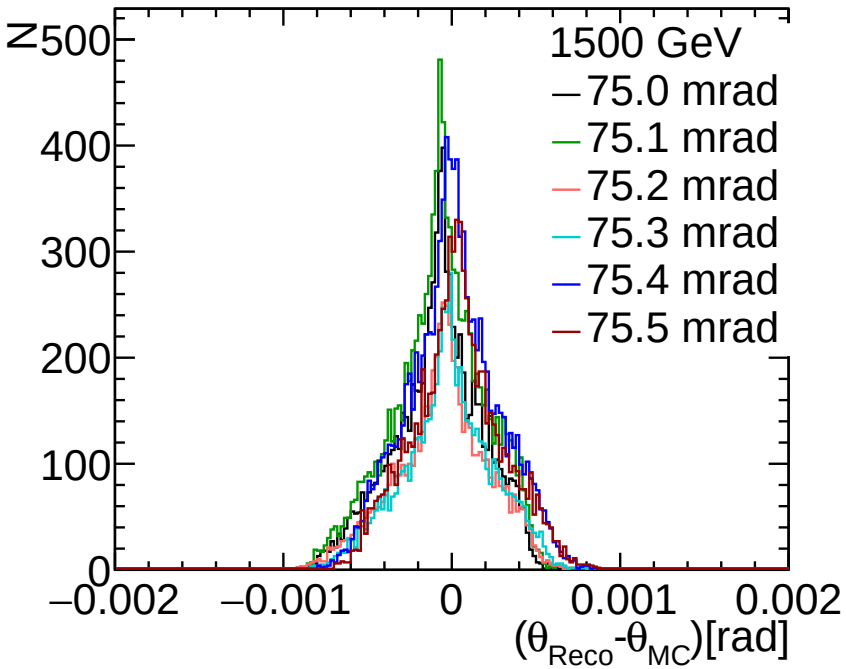
- Efficiency to find cluster within 10% of expected energy in LumiCal
- Efficiency above 99.8% in fiducial volume



# Theta Resolution

- No tuning of logarithmic weighting (4) to minimise angular resolution
- For 1.5 TeV electrons find bias dependent on polar and resolution of 20 mrad. Resolution 10 times worse than previously estimated.
  - Using RMS of distribution
  - Bad weighting constant, bug, too much material before LumiCal?



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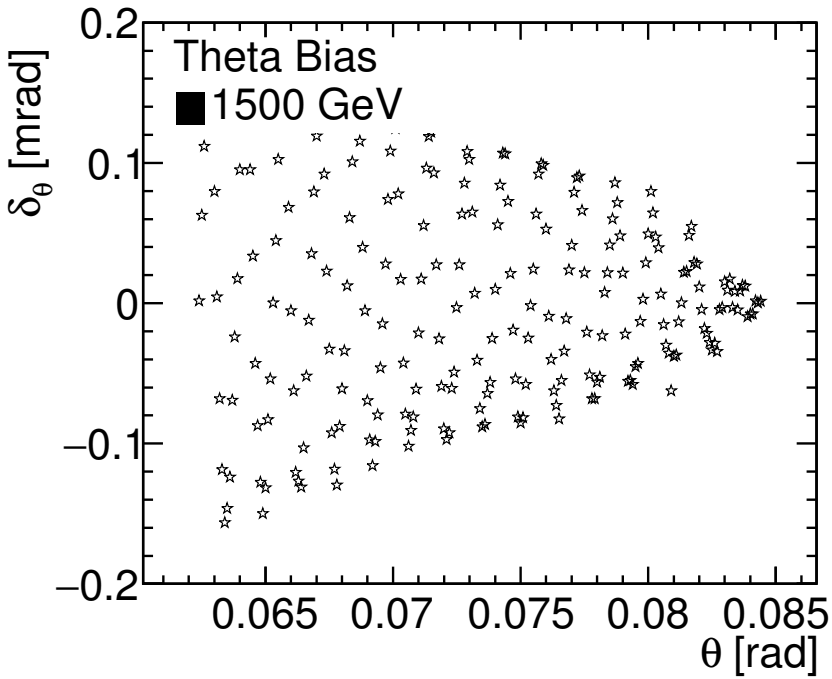
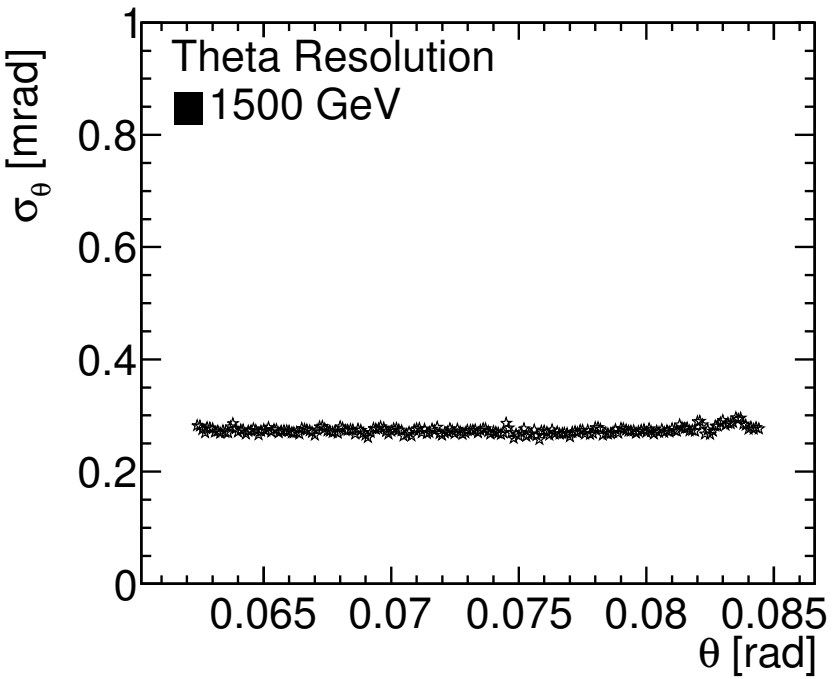
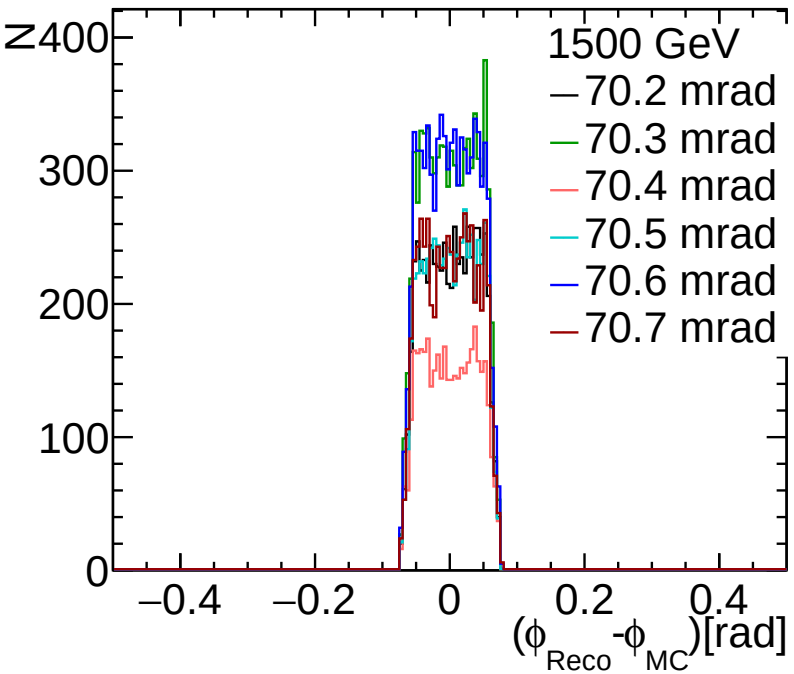


# Phi Resolution

- Distribution of reconstructed azimuthal angle uniform
- Resolution $2.1^\circ = 30$ mrad as expected for 48 segments. $360/(48 * \sqrt{12})$
  - Only one azimuthal segment per shower?



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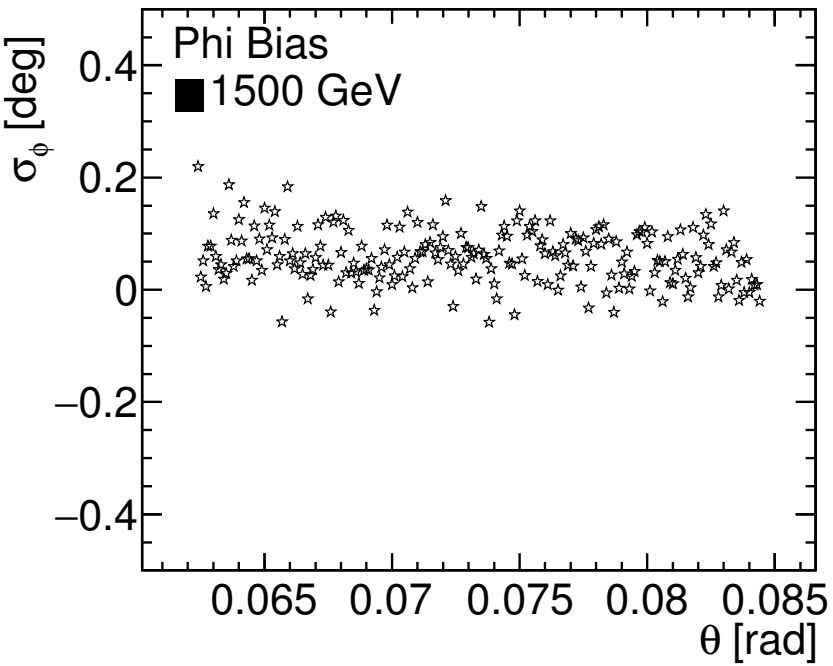
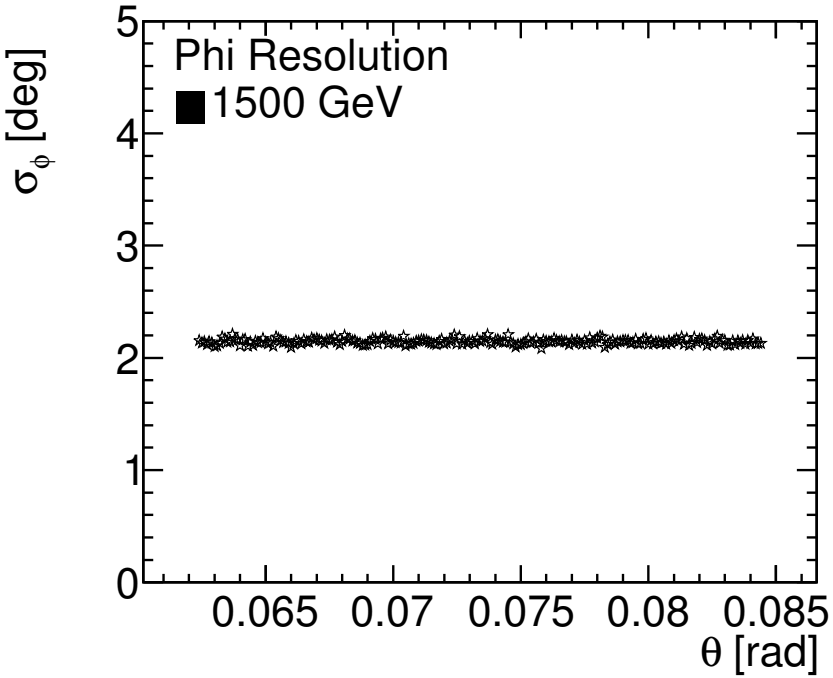


# Open Issues

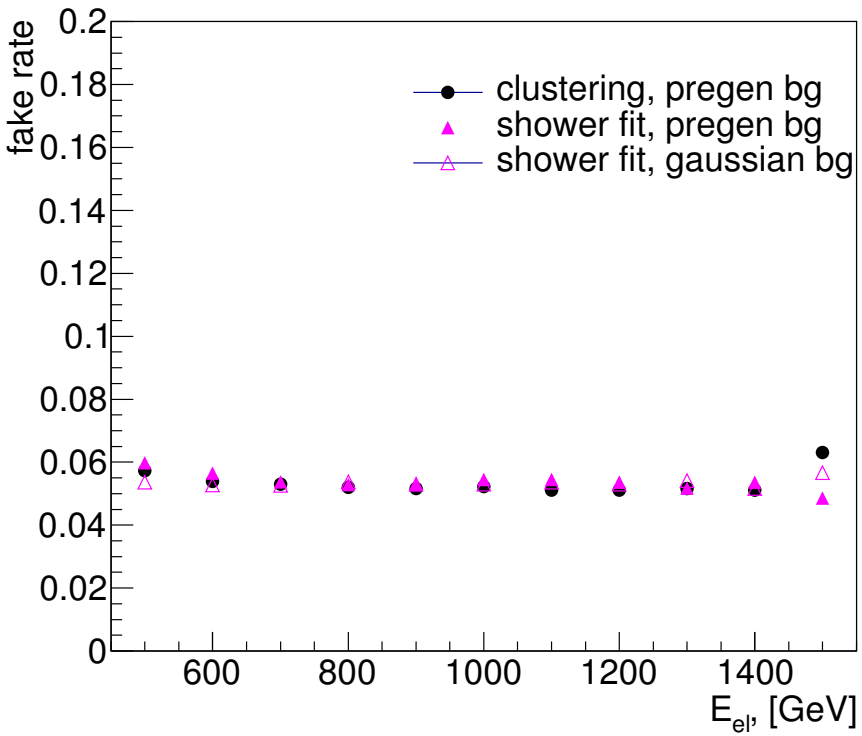
- Theta resolution, phi resolution
- Tune logarithmic weighting constant, expected shower size
- Two particle separation, actual Bhabha events
- ...

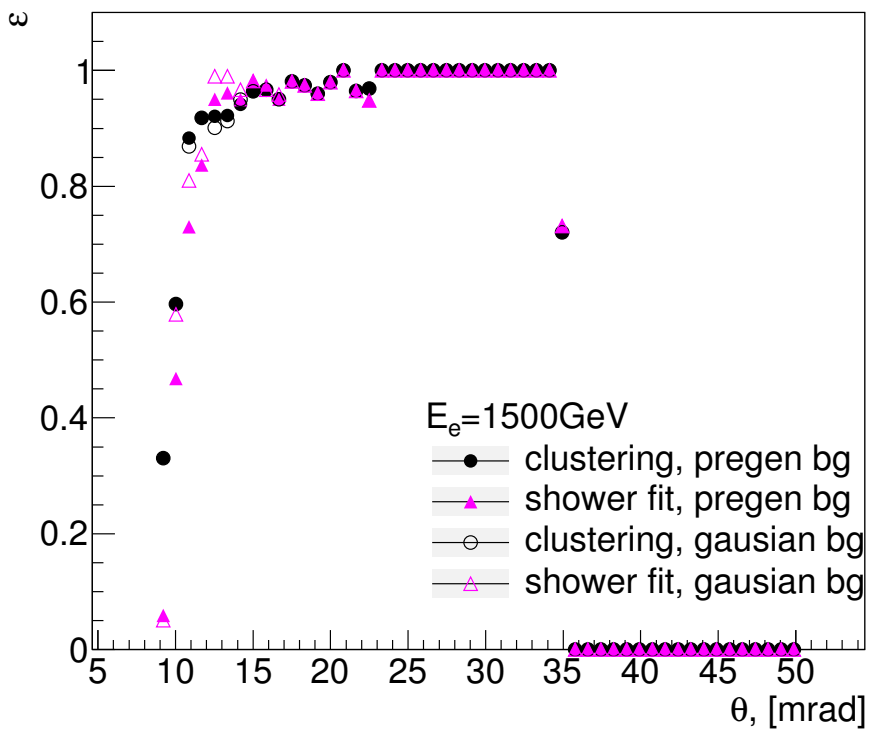
# BeamCal Reconstruction

- Results from CLICdp-Note-2016-005 on BeamCal Reconstruction
- Different options of Background simulation
  - Fully simulated background files: large file size for backgrounds
  - Gaussian/parametrised distributions: small file size for backgrounds
- Different reconstruction algorithms
  - Shower fit
  - Nearest neighbour clustering

# BeamCal Reconstruction

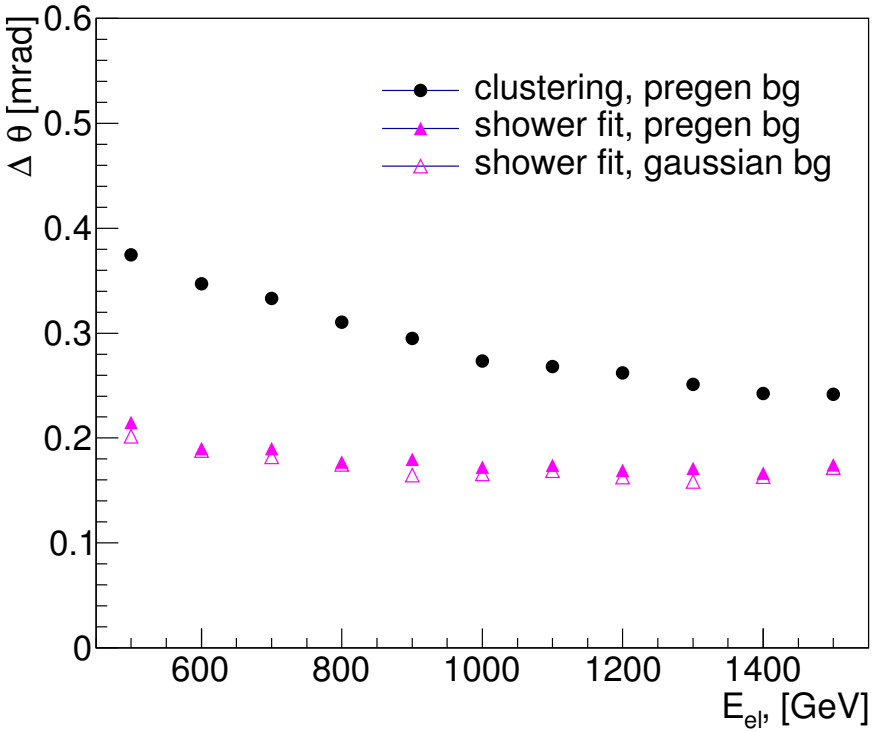
- Reconstruction efficiency similar for different algorithms and background simulation methods
- Tuned to have same fake rate for different algorithms
- Similar reconstruction efficiency for different background and reconstruction methods
  - Except at very small angles, where clustering is better than the shower fit
- Can use simple way to simulate background for mass production

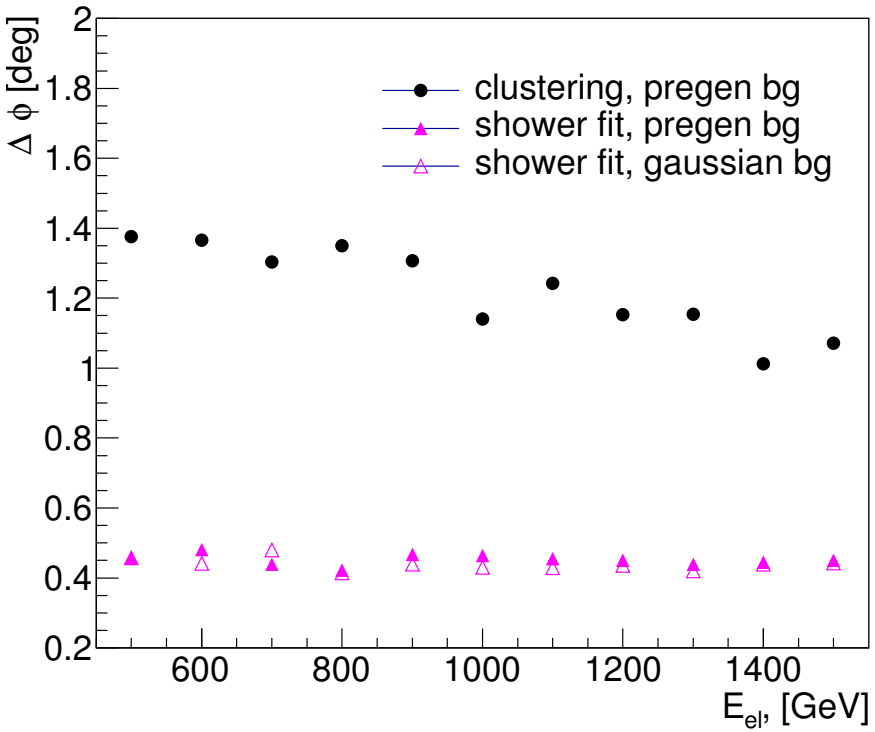


# Angular Resolutions

- Better angular resolution for shower fit algorithm



# Summary

- LumiCal and BeamCal reconstruction working with DD4hep geometry
- First close look at LumiCal reconstruction performance since moving code shows decent results.
- Tuning of reconstruction and further performance checks necessary