Current Status of the FCalClustering Software

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FCal Reconstruction Software Status

- Clustering for LumiCal and BeamCal
  `https://github.com/FCalSW/FCalClusterer`
- Depends on iLCSoft: `Root, Marlin, LCIO, dd4hep, lcgeo`
- Installations of iLCSoft including FCalClustering available in CVMFS, e.g.,
  `/cvmfs/clicdp.cern.ch/iLCSoft/builds/2017-08-23`

LumiCal Reconstruction

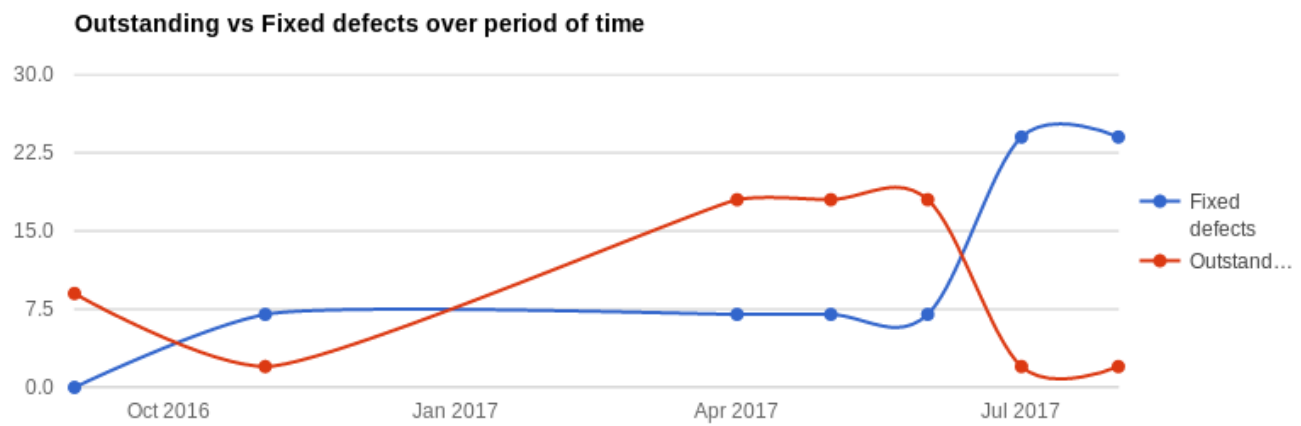
- LumiCalClusterer mainly focused on optimal reconstruction of Bhabha electrons for luminosity measurements
  - Requires excellent polar angle resolution
- Nearest neighbour clustering and identification of separate close by showers from initial or final state radiation
- Documented in `https://arxiv.org/abs/1010.5992` I. Sadeh Master's Thesis

BeamCal Reconstruction

- BeamCal reconstruction contains
  - Utilities to extract background distributions from full simulation files
  - Different levels of background creation based on full simulation possible
    - ⋆ resulting background distributions are similar and lead to similar performances
  - Two clustering algorithms implemented: nearest-neighbour and shower fitting
- Documented in CLICdp-Note-2016-005 http://cds.cern.ch/record/2227265 (A. Sapronov, AS)

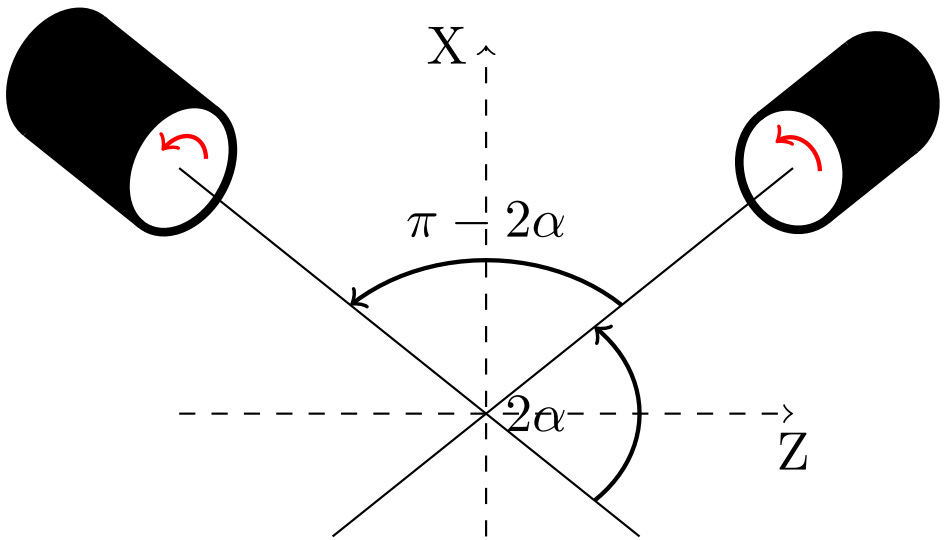
Recent Changes

- LumiCalReco
  - Fiducial volume cuts no longer applied by default – cluster was not written out if too close to the edge of the detector
- BeamCalReco
  - Fix reconstructed cluster position of the BeamCal at $-Z$
  - Allow running without background to estimate raw resolutions
- Fixed some memory issues; adapted to changes in dependencies; fixed some compiler warnings and *coverity* issues



Cluster Position Issue

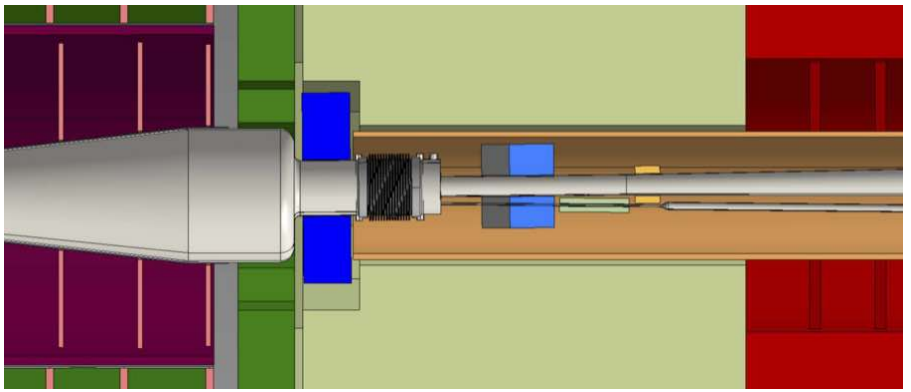
- Fixed position of reconstructed cluster on the backward side
  - *Local coordinates* azimuthal angle rotation differently than global coordinate system
  - Cluster position wrongly calculated based on pad IDs
- Added test to check reconstructed cluster position automatically for forward and backward direction




```
Start 1: t_BeamCalReco
1/1 Test #1: t_BeamCalReco .......   Passed   27.79 sec
100% tests passed, 0 tests failed out of 1
```

Performance Studies

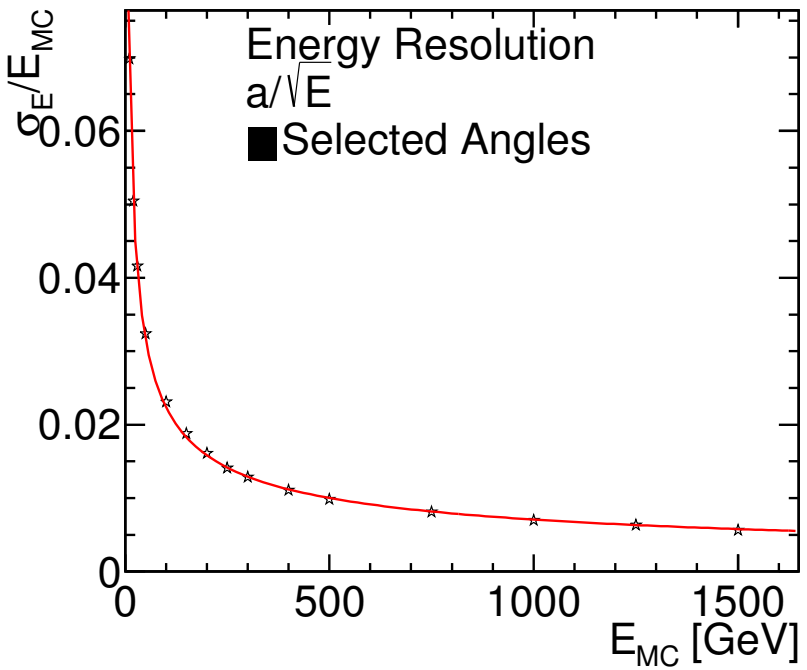
- Performance studies of the LumiCal and BeamCal detector and reconstruction software
- Simulation with the CLIC detector model
- Nothing completely new since last workshop, but on-going studies by Alon Joffe and Jean-Jacques Blaising
- Lead to discovery of the issued mentioned above



	Z_{start}[mm]	Z_{end}[mm]	R_{in}[mm]	R_{out}[mm]	θ_{min}[mrad]	θ_{max}[mrad]
LumiCal	2539	2710	100	340	39	134
BeamCal	3181	3441	32	150	10	46

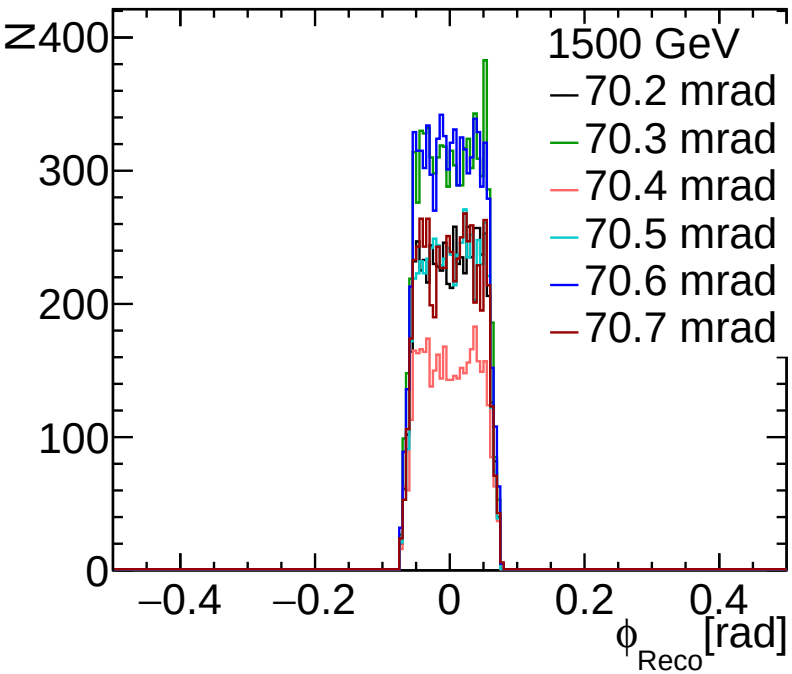
LumiCal Energy Resolution

- Based on the standard deviations of the selected angular range (fiducial volume) for the different energies
- $\sigma E/E = a/\sqrt{E[\mathrm{GeV}]}$
- $a = 0.22$, constant term negligible, no gaps or noise
- As expected from the design from 2009



LumiCal 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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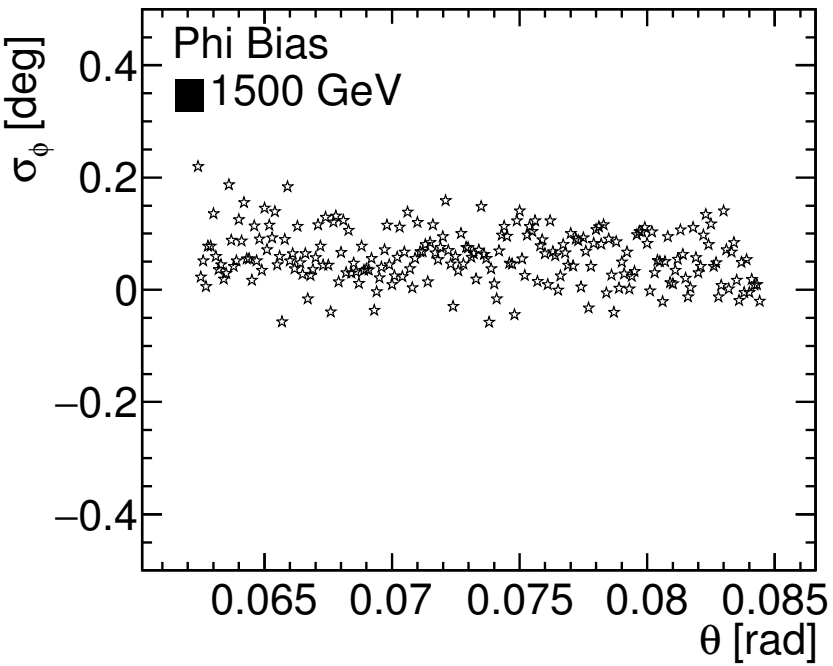
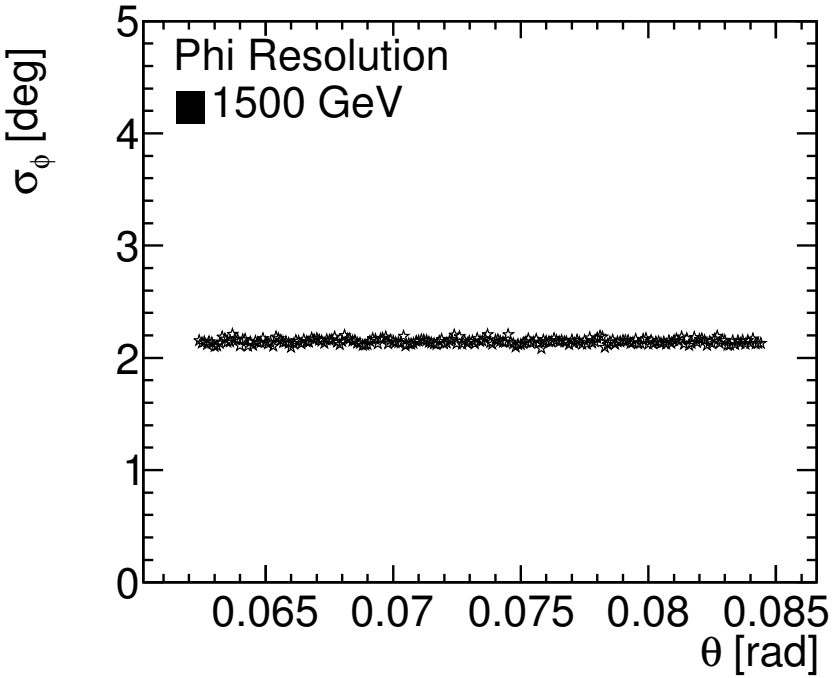
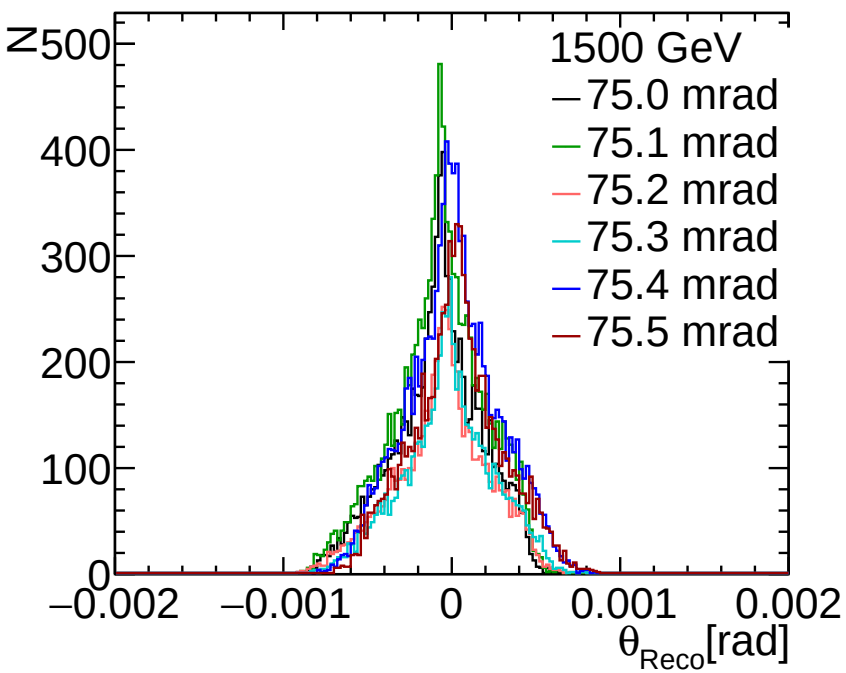




LumiCal Theta Resolution

- No tuning of logarithmic weighting $w = \max(0, C + \log(E/E_{\text{total}}))$ to minimise angular resolution, yet
- For 1.5 TeV electrons find bias dependent on polar angle and resolution of 0.3 mrad. Resolution 10 times worse than previously estimated.
- Caused by:
  - Bad weighting constant?
    - ★ Selecting too few pads for good position calculation based on shower shape?
  - Bug?
  - Using RMS of distribution?



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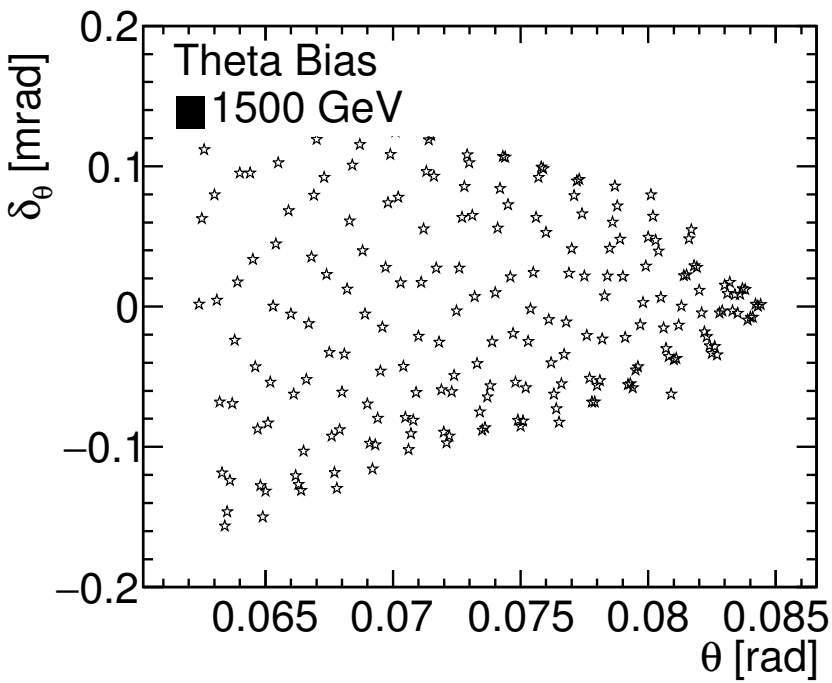
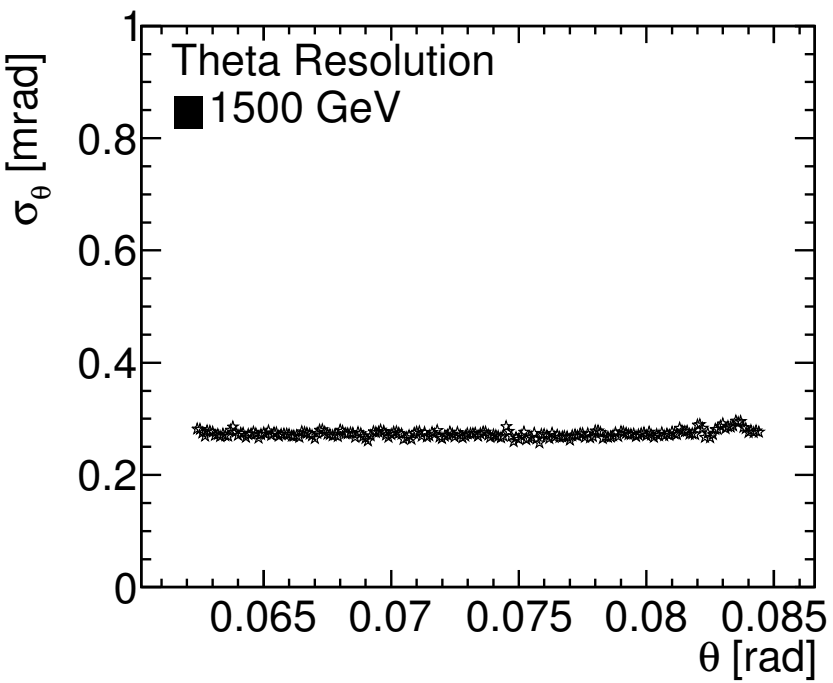
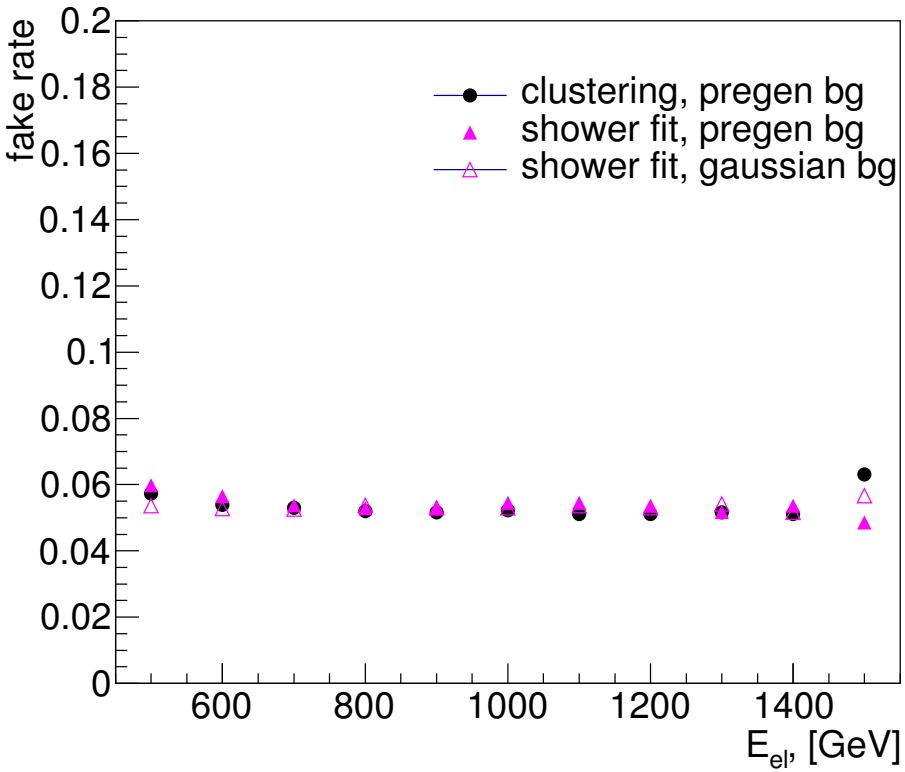
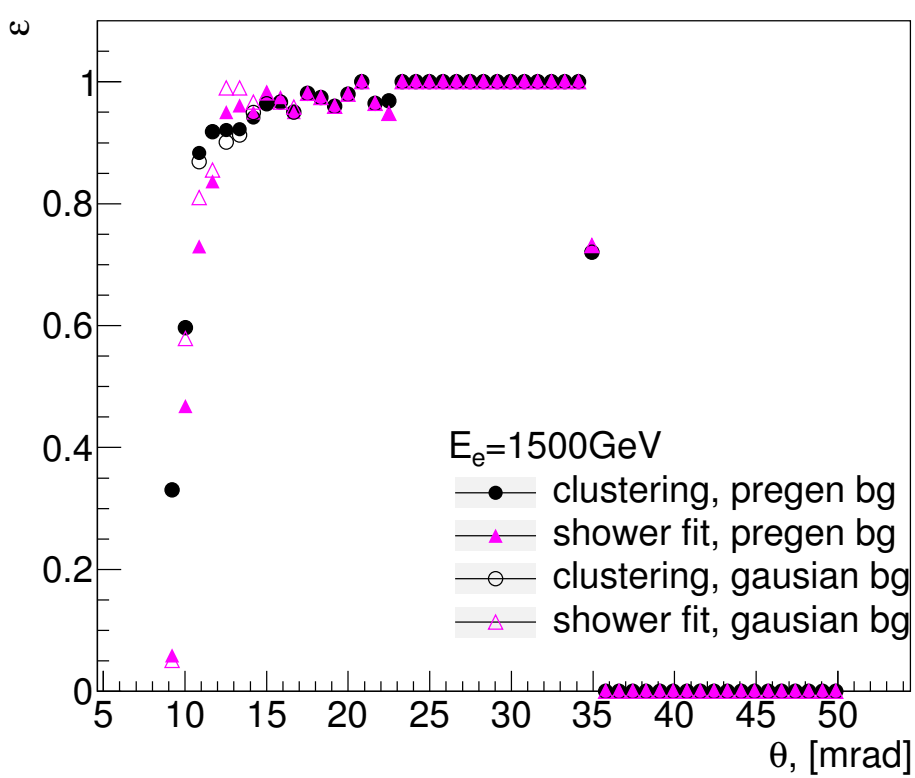




BeamCal Reconstruction Efficiency

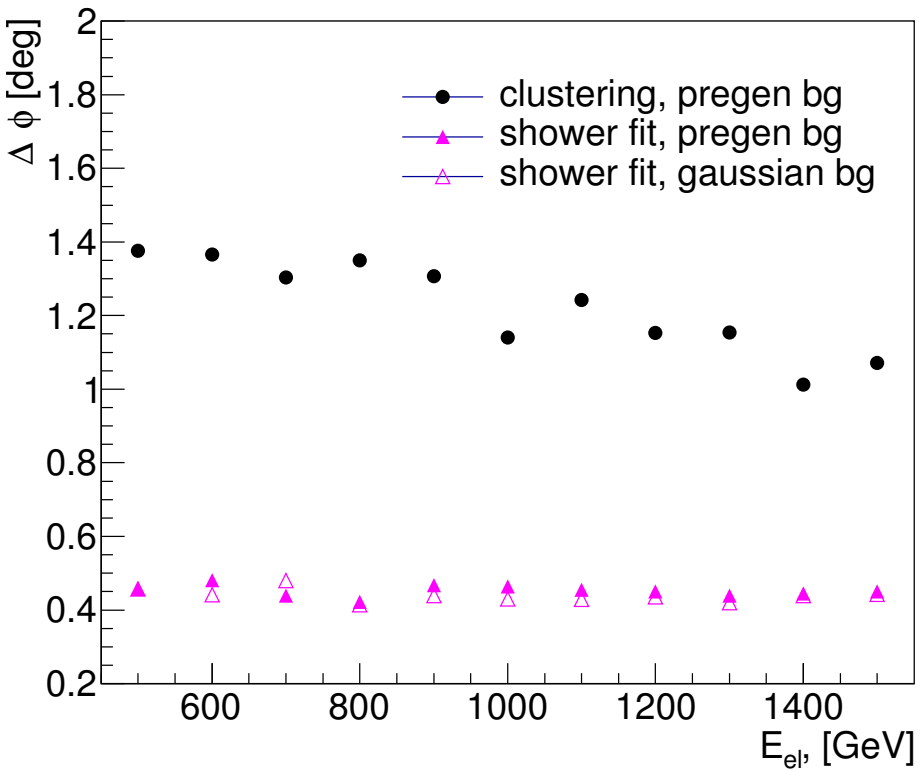
- Fake rate and reconstruction efficiency of 1.5 TeV electrons with 40 BX of CLIC 3 TeV incoherent pair background
- Reconstruction can be tuned to reduce fake rate or increase efficiency

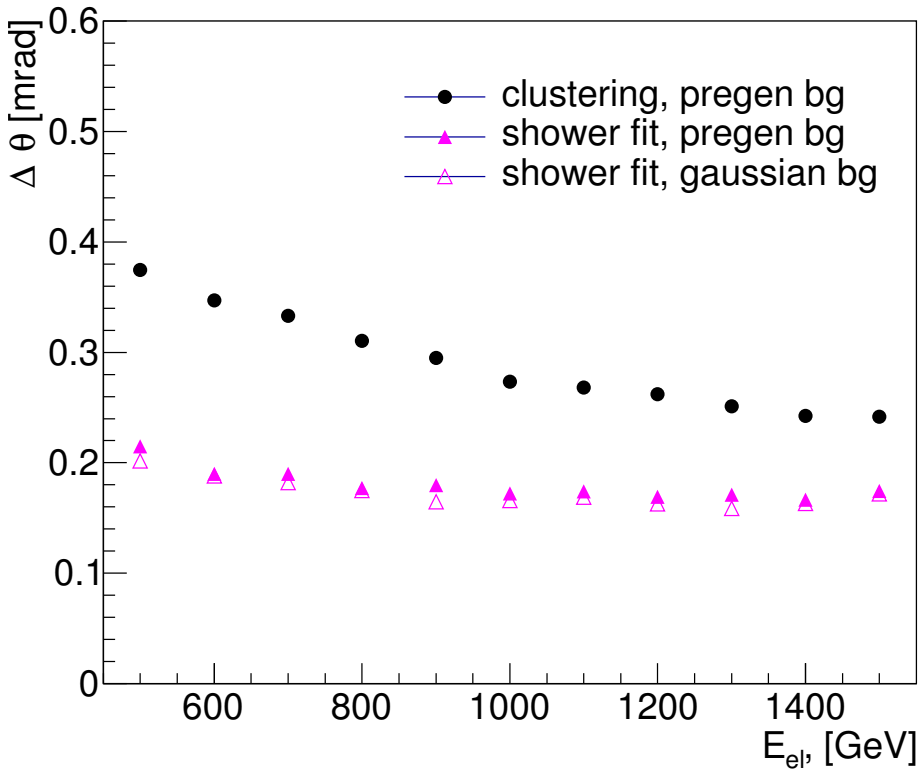




BeamCal Angular Resolutions

- Angular resolutions generally better with shower fitting reconstruction





Summary

- On-going studies of the LumiCal and BeamCal in the CLIC Detector have discovered some issues
- Awaiting further results and expecting improvements