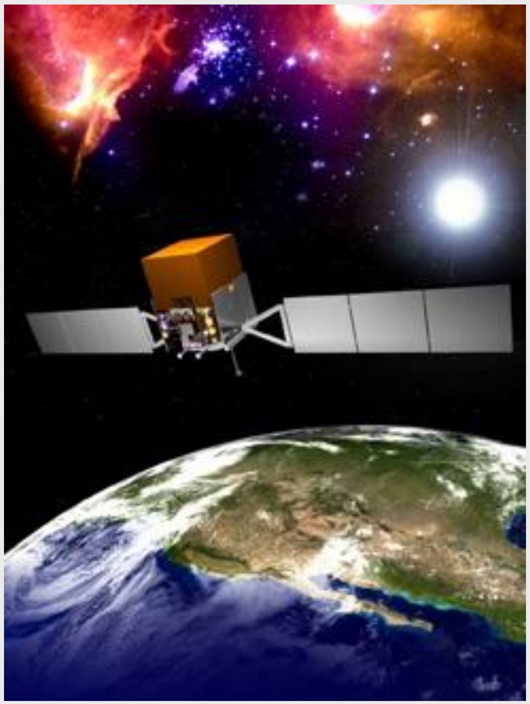

Energy reconstruction

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Introduction

- 5 GeV, 0 deg electron run 1460 (data: v1r030603p7, MC: v6r0919p1) from PS
  10 GeV, 0 deg electron run 2338 (data: v1r030604p6, MC: v6r0919p1) from SPS
  20 GeV, 0 deg electron run 2083 (data: v1r030604p6, MC: v6r0919p1) from SPS
  50 GeV, 0 deg electron run 2039 (data: v1r030604p6, MC: v6r0919p1) from SPS
  99 GeV, 0 deg electron run 1980 (data: v1r030604p6, MC: v6r0919p1) from SPS
  196 GeV, 0 deg electron run 1911 (data: v1r030604p6, MC: v6r0925p2) from SPS
  282 GeV, 0 deg electron run 1922 (data: v1r030604p6, MC: v6r0925p2) from SPS

- Idea:
  Comparison of the different energy reconstruction methods in single tower for a center of tower head-on beam

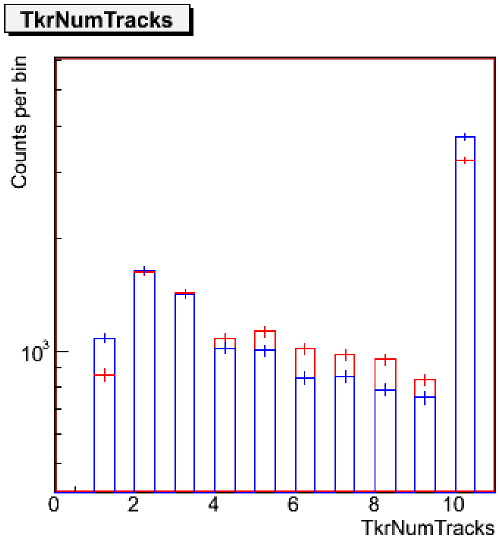
- Normalization by number of counts in histograms

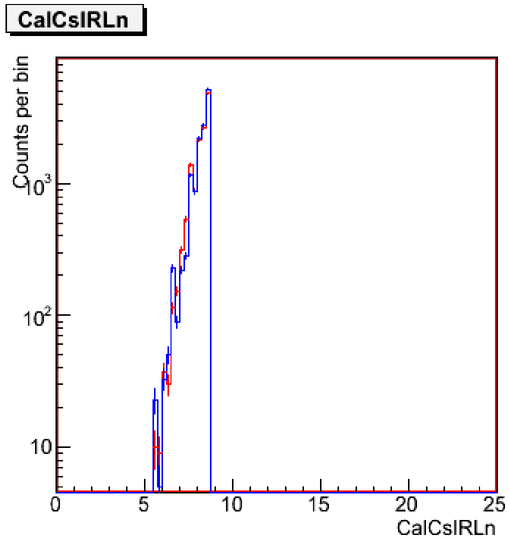
Cuts

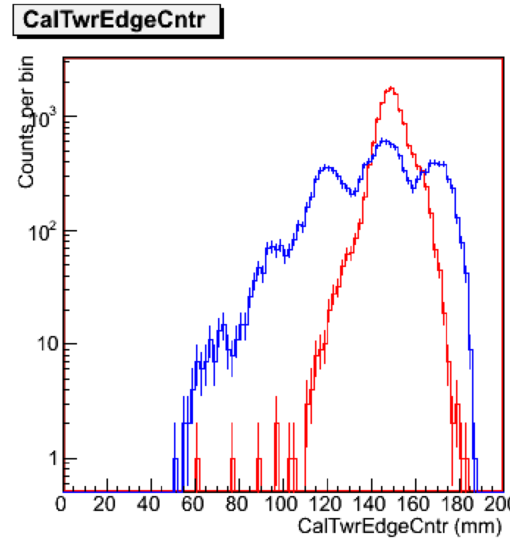
- Using the following cuts:

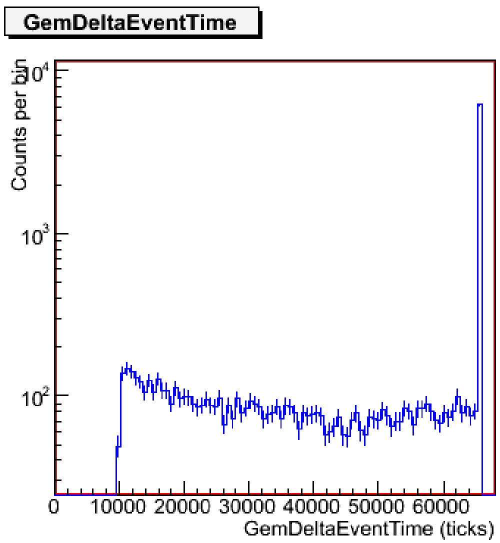
GemDeltaEventTime > 10000 (50 ns)	(for correct read out and no pile-up)
CalEnergyRaw > 1000 MeV	(for cosmic muon rejection)
CalEnergyRaw < beam energy	(to avoid simultaneous cosmic rays)
CalCsIRLn > 1 X_0	(so that suffient energy is deposited)
CalTwrEdgeCntr > 50 mm	(to avoid crack effects)
TkrNumTracks > 0	(to be able to do a space angle cut)
Space angle(TkrDir vs. CalDir) < 0.5 rad	(correctly reconstructed directions)
Tkr1X0 > 50 && Tkr1X0 < 350 && Tkr1Y0 > -150 && Tkr1Y0 < 150	(to make it is in the right tower)
CalXEcntr > 50 && CalXEcntr < 350 && CalYEcntr > -150 && CalYEcntr < 150	(same as above)

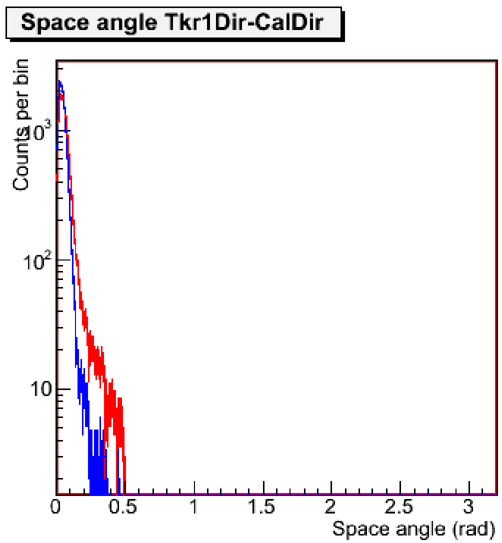
Cut variables after cuts (1)







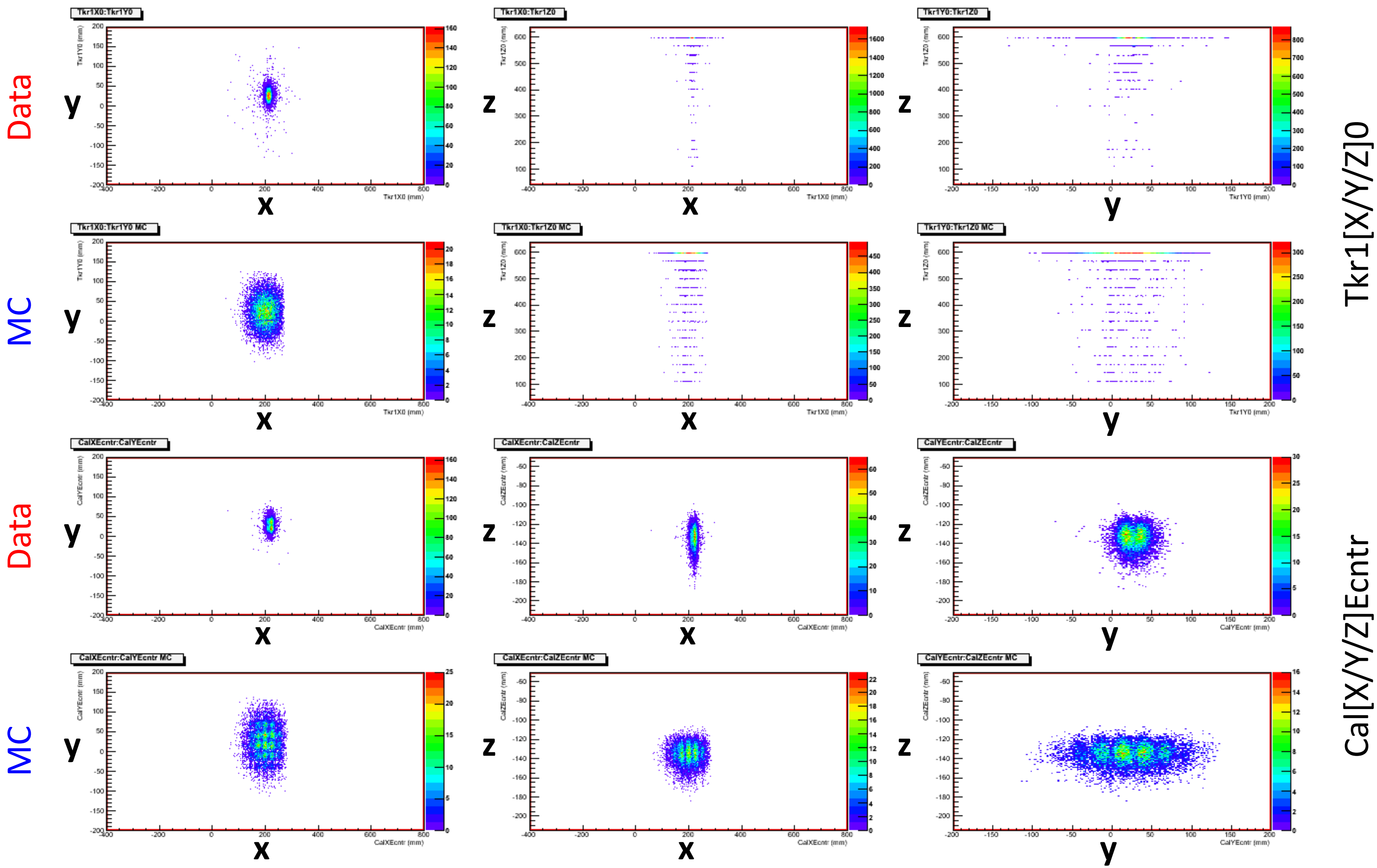




DATA

MC

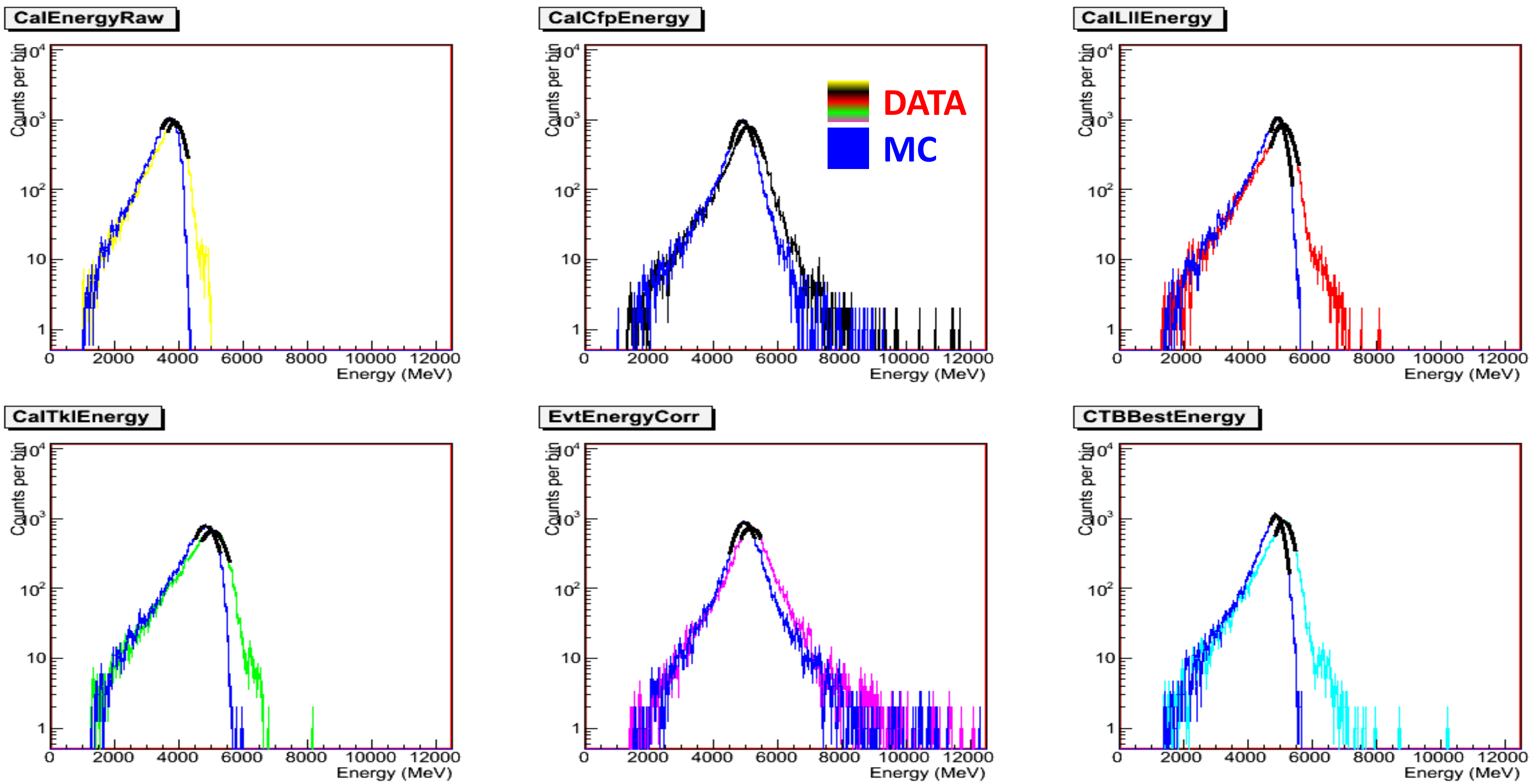
Cut variables after cuts (2)



Energy reconstruction algorithms

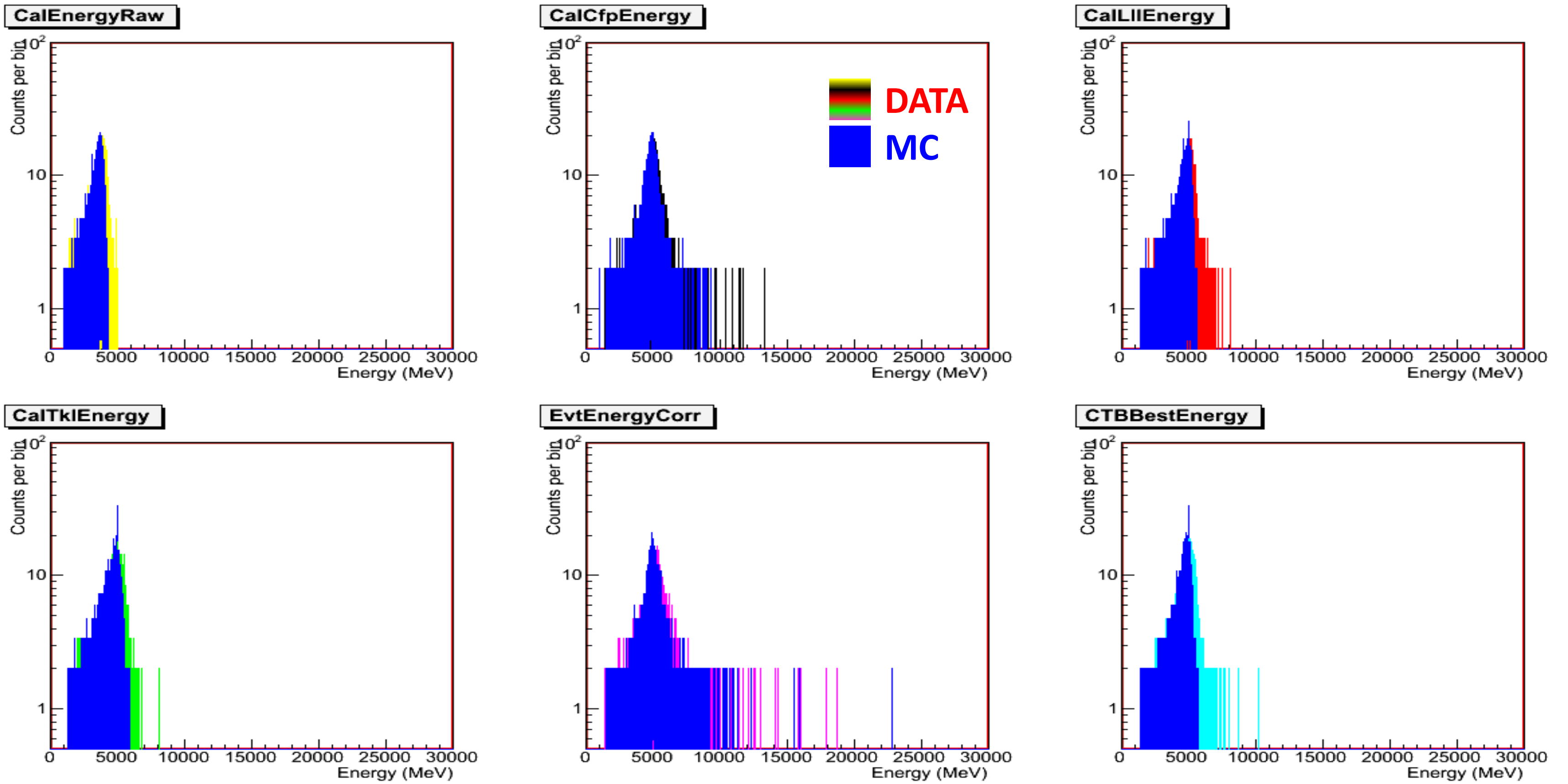
- CalCfpEnergy
  Estimation of energy using shower profile fitting in the calorimeter
- CalLllEnergy
  Estimation of energy using CAL last layer parametrization.
- CalTklEnergy
  Estimation of energy using TKR hits parametrization.
- EvtEnergyCorr
  Event energy formed by adding the corrected TKR energy (TkrEnergyCorr) to the layer-by-layer corrected CAL energy (CalEnergyCorr)
- CTBBestEnergy
  The best of the above?

Energy reconstructions (1)



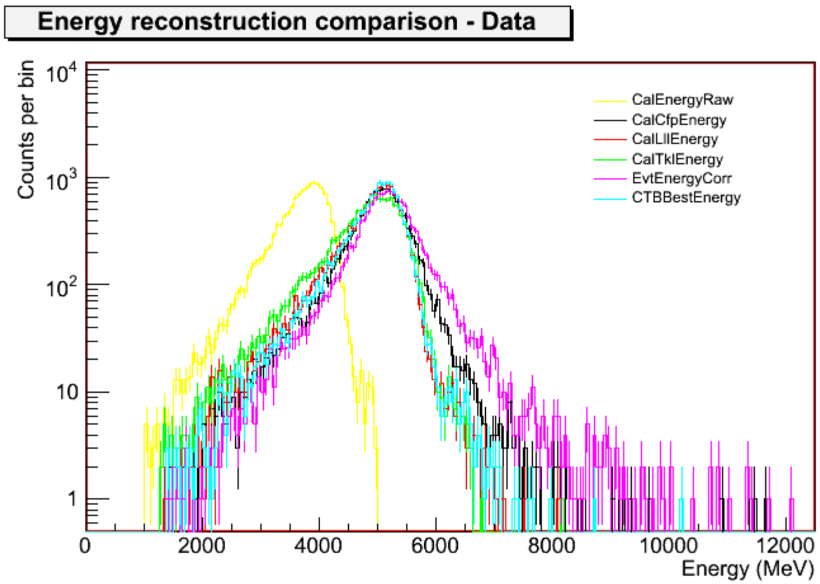
- <u>Step 1</u>
  Find peaks by fitting Gaussian
  These particular plots from 5 GeV, 0 degree electrons

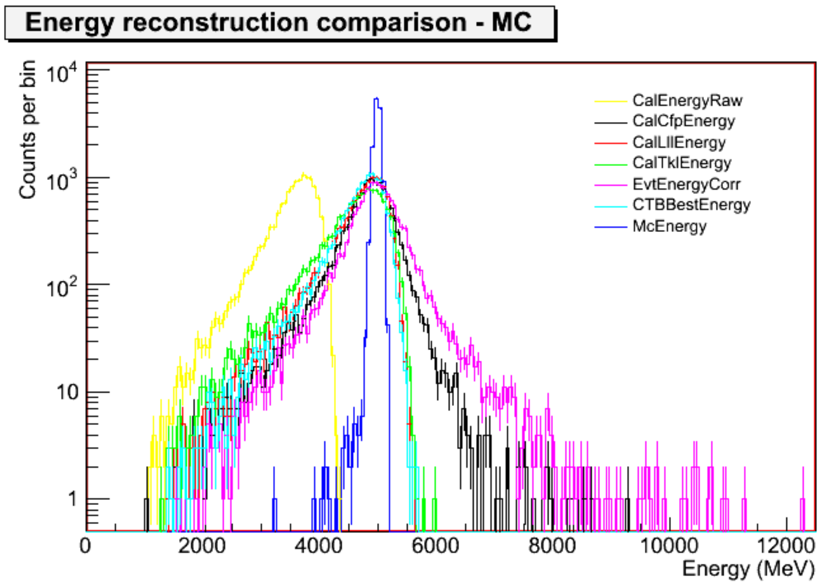
Energy reconstructions (2)



- <u>Step 2</u>
  Increase bin number dramatically and calculate 68% containment symmetrically around calculated peak position. Higher bin number → Higher precision in quantile calculation

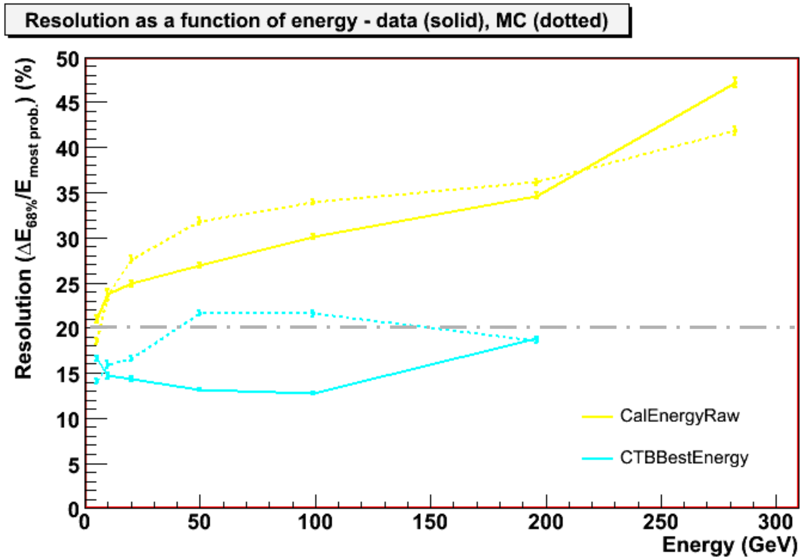
Energy reconstructions (3)

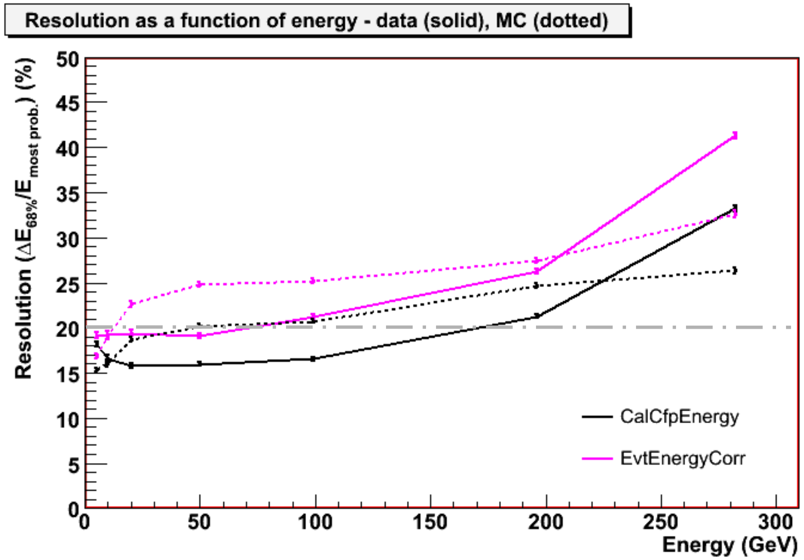


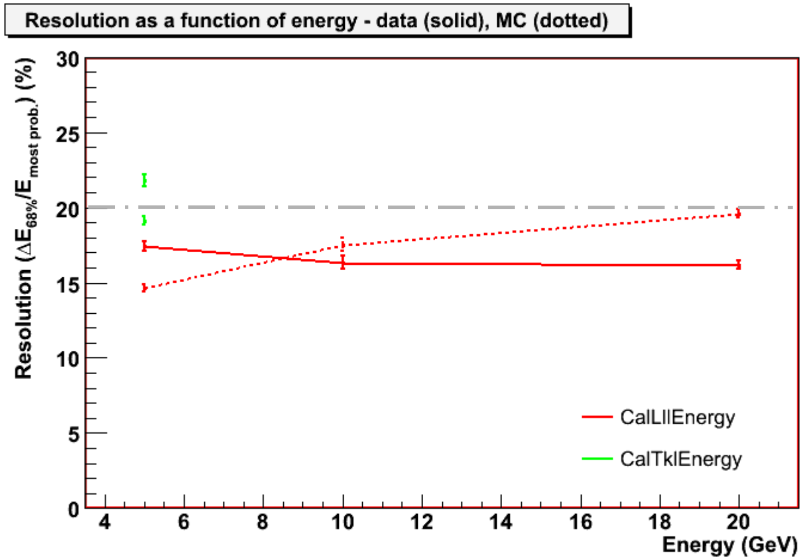


- Merged into the same plot (again for 5 GeV, 0deg electrons)

Energy resolutions

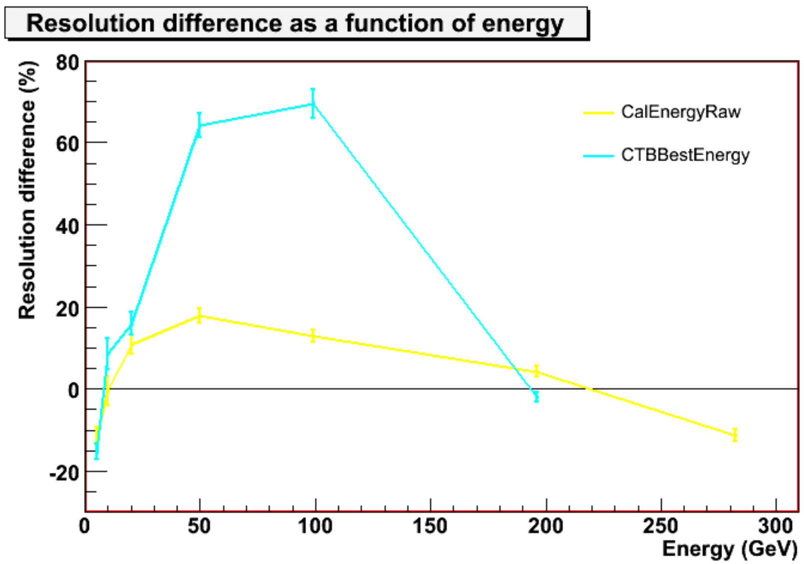


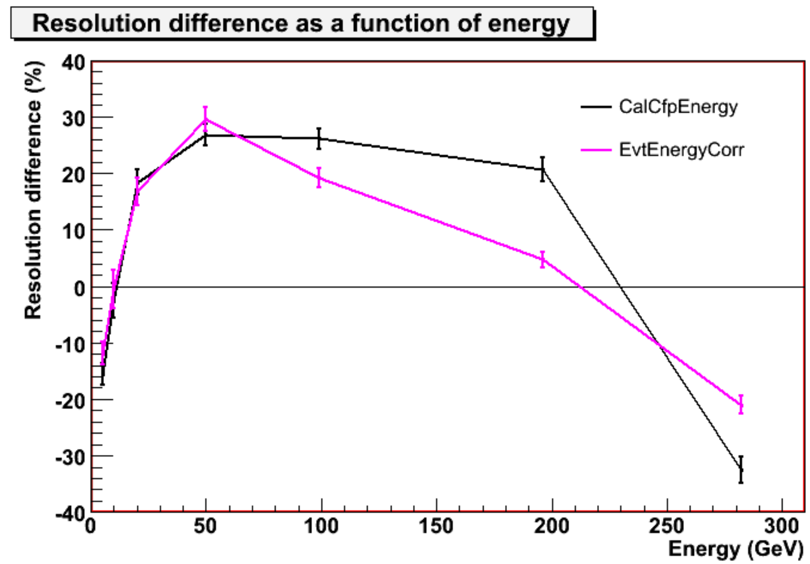


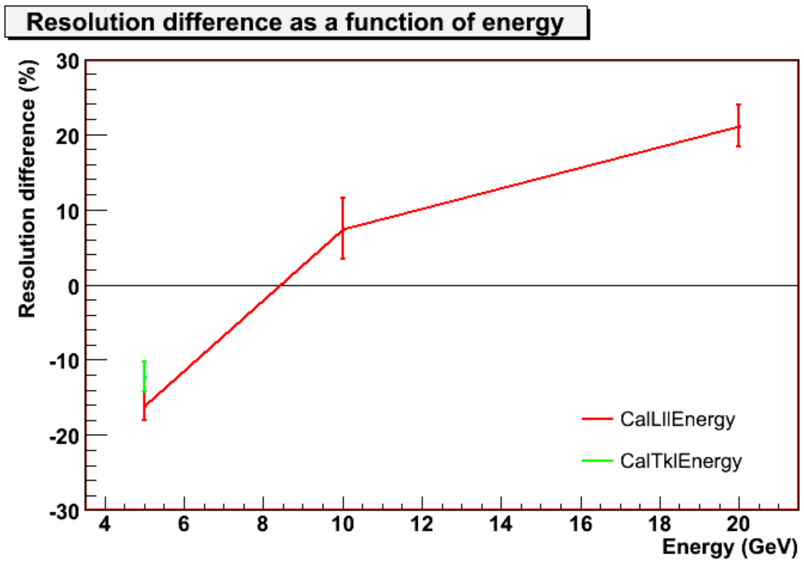


- Resolution = 68% energy interval symmetrically around most probable energy / most probable energy
- LAT science requirement according to beam test plan:
  On axis, 1-10 GeV: ≤ 10%
  On axis, 10-300 GeV: ≤ 20%

Energy resolutions







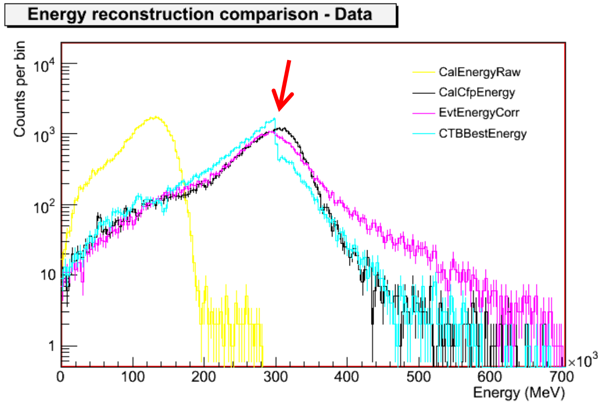
- Difference in percent between data and MC

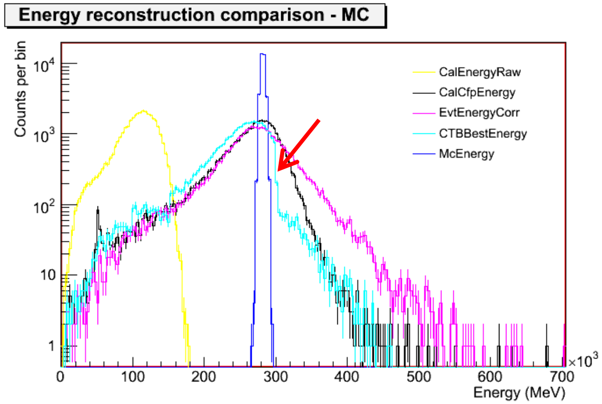
$$\Delta E_{res} = \frac{\Delta E_{68\%,MC} - \Delta E_{68\%,data}}{\Delta E_{68\%,data}}$$

- Positive percentage → MC is larger
  Negative percentage → Data is larger

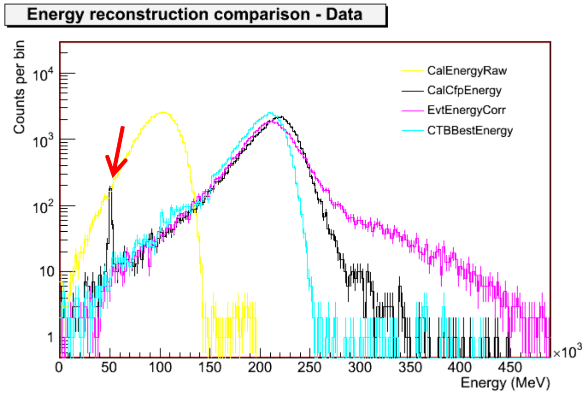
Issues

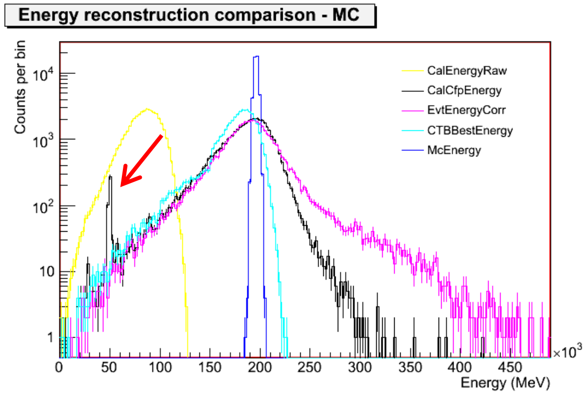
- CTBBestEnergy has strange shape at 282 GeV





- A small peak, centered at 50 GeV, of unknown origin in CalCfpEnergy at 196 GeV





Summary/Conclusions

- If energy resolution of e.g. **CTBBestEnergy** is compared to the LAT science requirement, it is below the required 20% for energies 10-196 GeV for data but somewhat above for MC. For 5 GeV, the resolution is above the 10% requirement. 282 GeV was omitted due to the shape of the peak

- MC consistently has worse resolution for energies 20-196 GeV than data. For e.g. **CTBBestEnergy** the difference is as high as ≈70%. For CalEnergyRaw the difference is ≈10%

- **CTBBestEnergy** not meant for CU (?) → Distribution peak shape distorsions → Large resolution differences between data and MC

- Electrons are not equivalent to photons in terms of conversion point (≈0.1% of the electrons and ≈21.4% of fullbrems photons are CAL-only in BT-data) → Resolutions probably different for photons