Measuring the PSF and the energy resolution with the GLAST-LAT Calibration Unit

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on behalf of the beam test working group

Measuring the PSF and the energy resolution

- Data/Simulation agreement and the LAT analysis
- Beam tests at CERN (PS and SPS)
  - Tracker and PSF
  - Calorimeter and energy resolution
- Conclusions

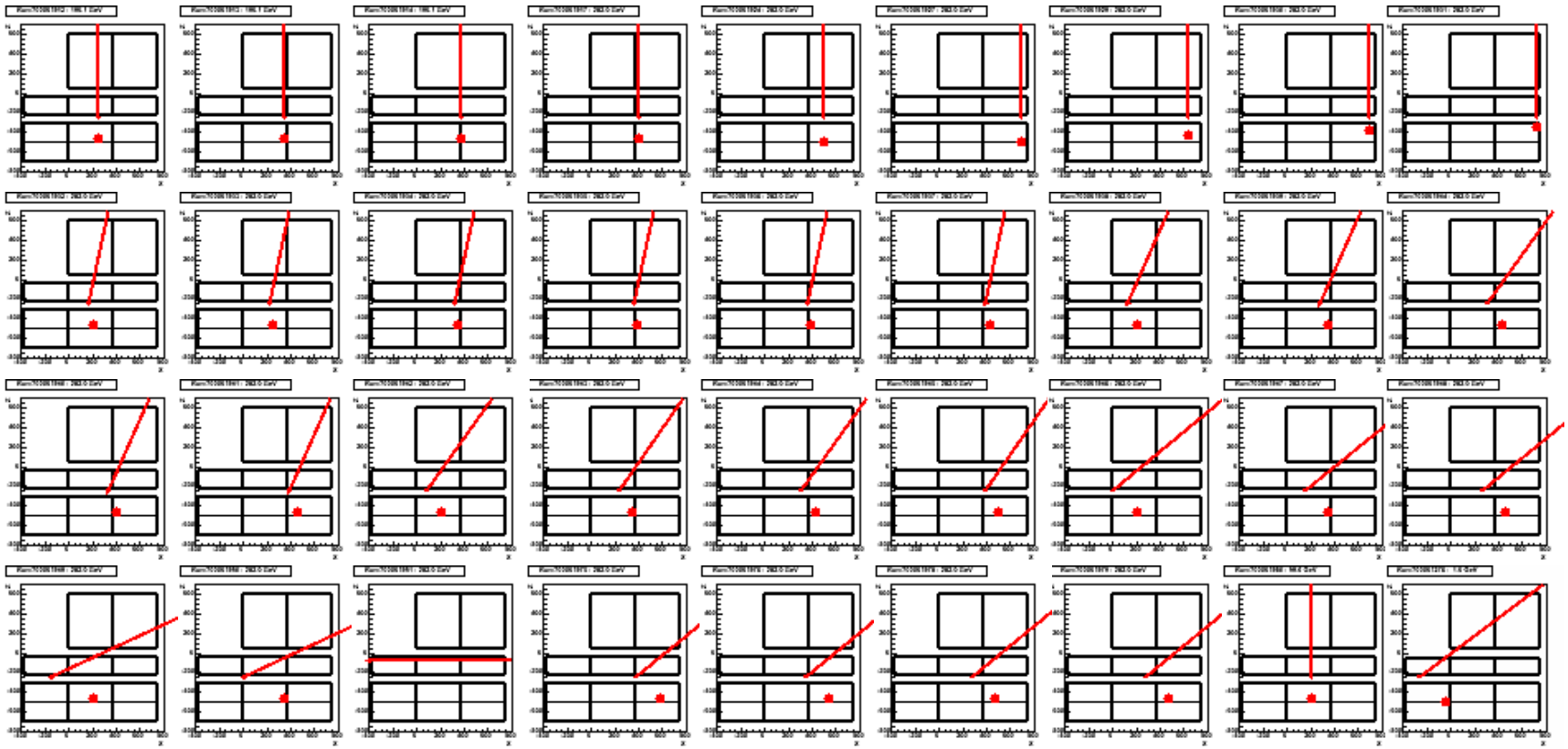
Data/simulation agreement and analysis

- Event processing steps :
  - Trigger and On Board Filter
  - Reconstruction algorithms
  - Classification trees (-> IRFs and Background rejection)
- Example 1 : PSF
  - Tracks, vertices are reconstructed
  - Using not only tkr variables, the classification tree gives :
    - The best estimate of the incoming direction of the gamma
    - A quality variable used to select the best measured gammas
- Example 2 : Energy resolution
  - 3 energy reconstruction algorithms -> 3 estimates
  - Using not only cal variables, the classification tree gives :
    - The best estimate of the energy of the gamma
    - A quality variable used to select the best measured gammas
- The calibration unit is different from the LAT
  - We can not apply directly and simply the classification tree analysis
  - But we can compare between data and MC
    - the PSF of each direction estimate
    - The energy resolution of each energy estimate

Dealing with a huge phase space…

1700 runs, 94M events, 330 configurations (particle, energy, angle, impact position)

For PSF and energy resolution analysis : gammas (->2.5 GeV), electrons (5->280 GeV)



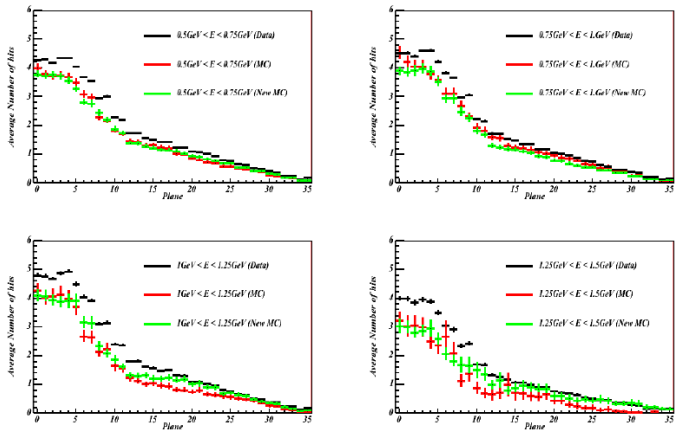
Mass simulation

Site	Particle	Energy	Angle
PS	Full-brem	2.5	0,30,50,-215
PS	Tagged g	0.5,1,1.5 ,2.5	0,10,20,30,50
PS	e+, e-	1	
PS	e- scan	5	
PS	p	6,10	0,30,60,90
SPS	e-	10,20,50 ,100,200 ,280	10,20,30,45,60 degree
SPS	p	20,100	0

- Simulation of the beam upstream the CU (Geant4)
  - Trigger/veto scintillators & cerenkov
  - Electron tagger at PS
- LAT simulation (GLEAM-Geant4)
- Automatic generation of the run configuration
  - Allowing the best comparison
- Efficient processing through the pipeline at SLAC
- Geant4 optimization
  - Simulation parameters
  - Physics lists

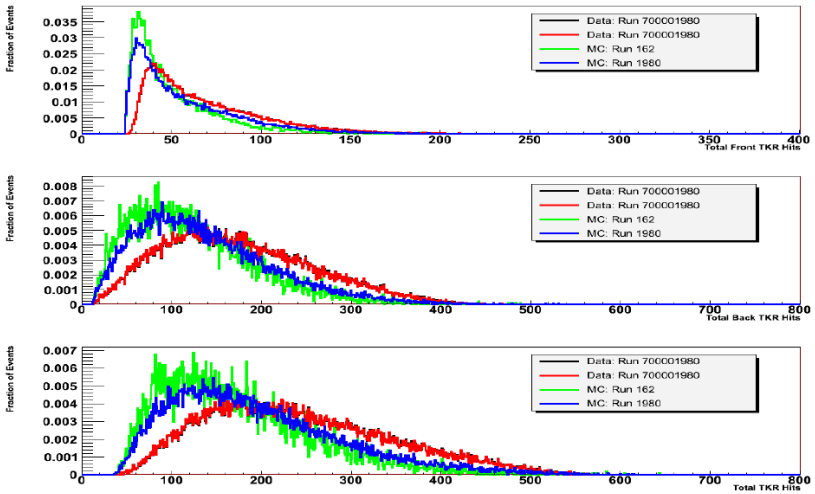
Tracker (work in progress…)

Hit multiplicity for gammas (0.5 to 2.5 GeV)

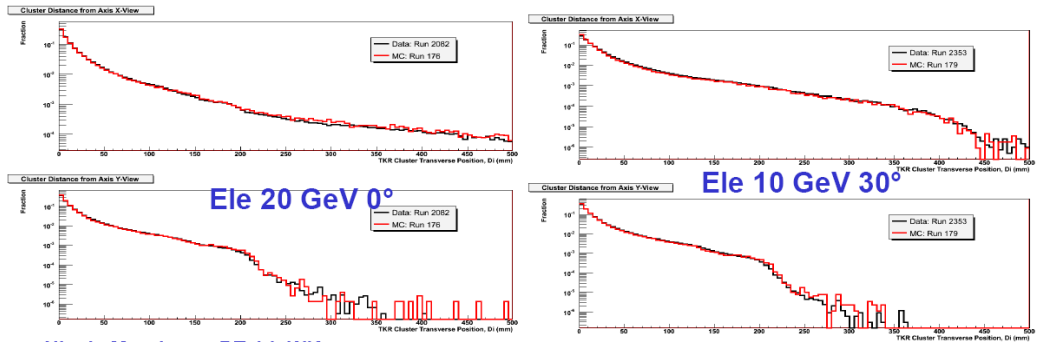


- 10-20% more hits in data than in MC
- Effect almost independent of particle, E
- Clusters are well reproduced by MC
- More secondary particles / preshower ?
  - Lower range cuts in Geant4 : no effect
  - Testing low energy processes
  - The calorimeter should say if there is extra material upstream the CU

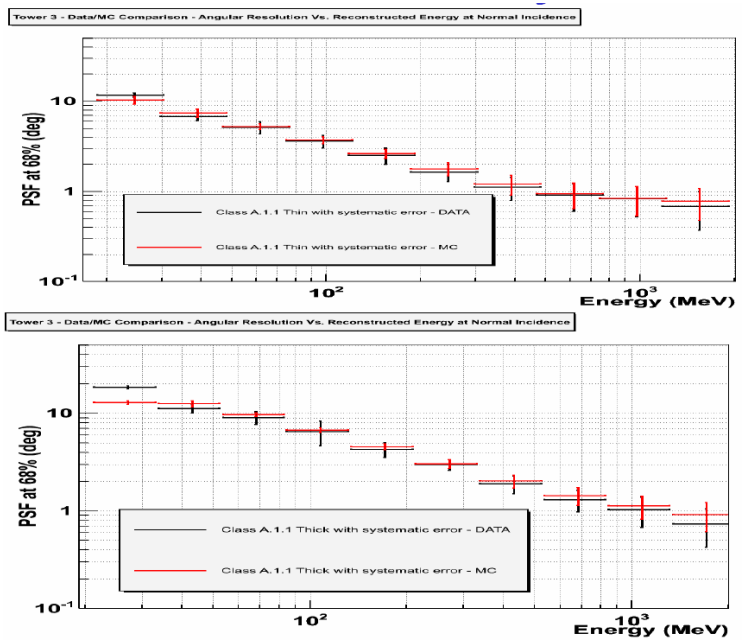
Hit multiplicity for 100 GeV electrons



Cluster-axis distance for 20 GeV electrons



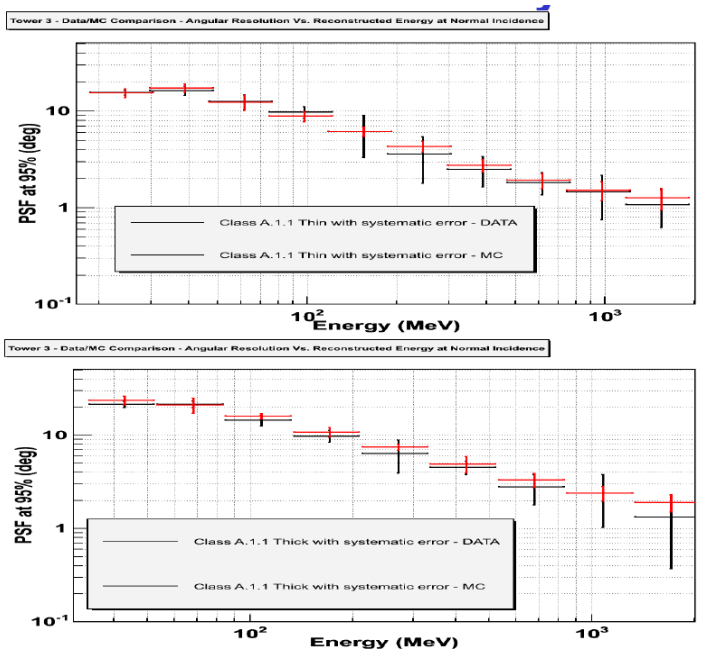
Tracker (work in progress…)

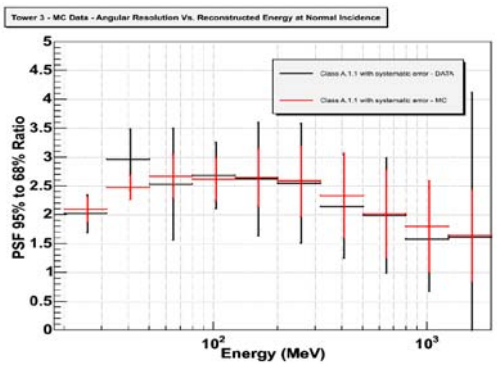


<- 68%

PSF

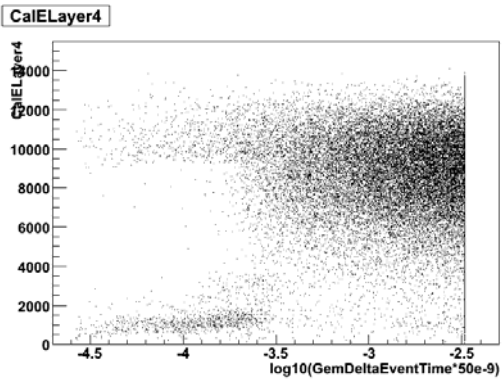
95% ->

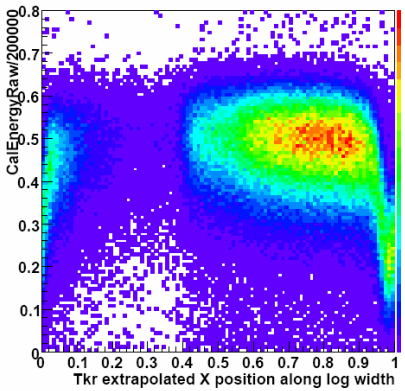


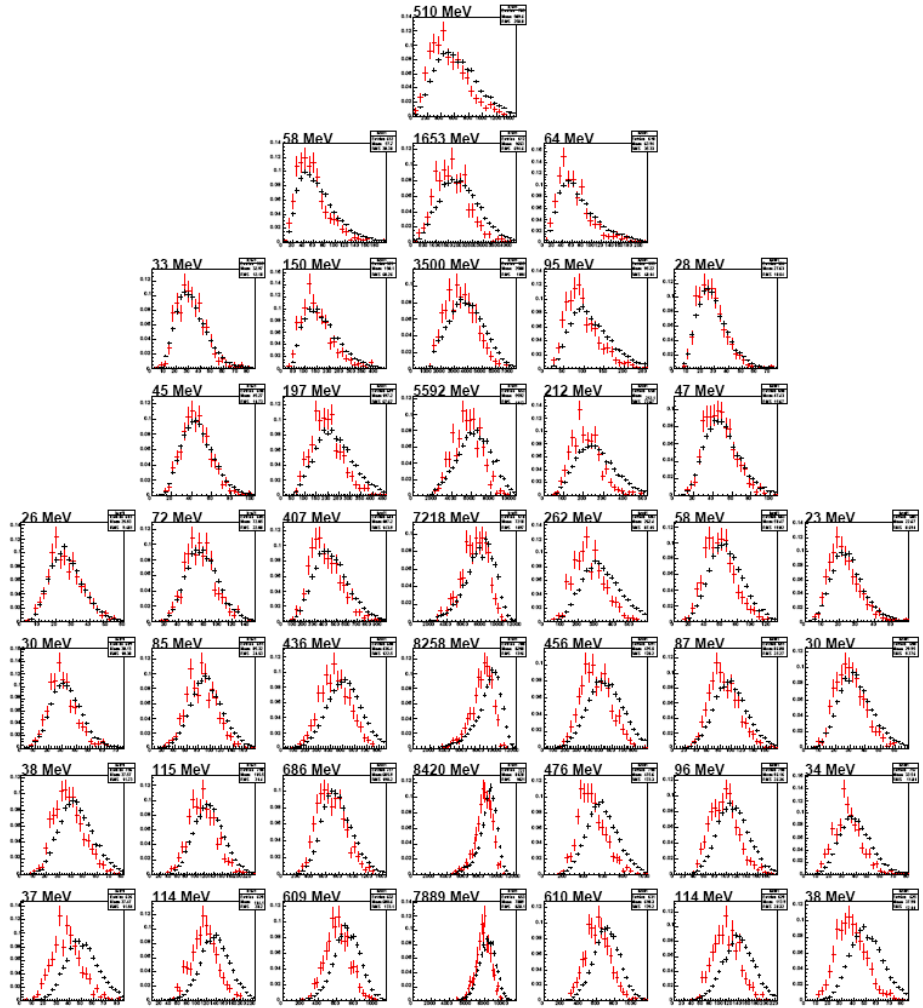


- Preliminary PSF results for events with 1 vertex and 2 tracks shows a good agreement between data and the simulation
- This not yet the PSF from the IRFs (i.e after signal selection and background rejection)

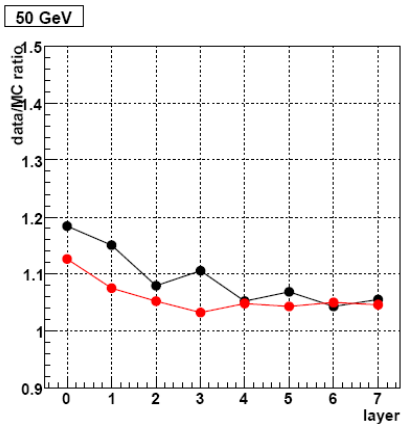
Calorimeter (work in progress…)

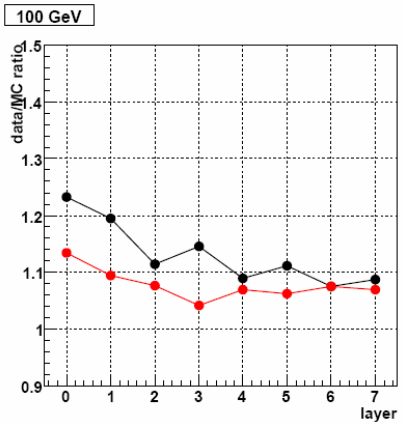




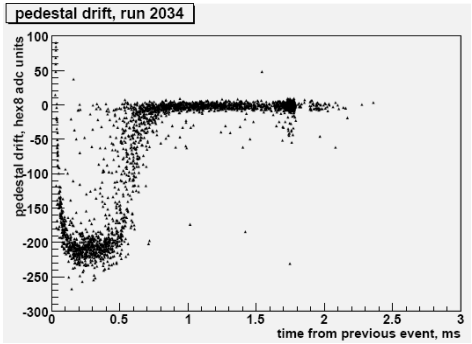


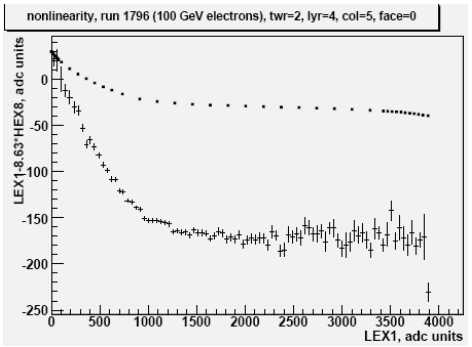
- Importance of quality/fiducial cuts
- Raw energy : 10% more energy in data for electrons at SPS

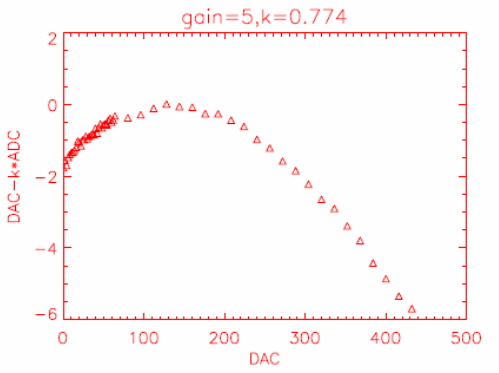




Calorimeter (work in progress…)

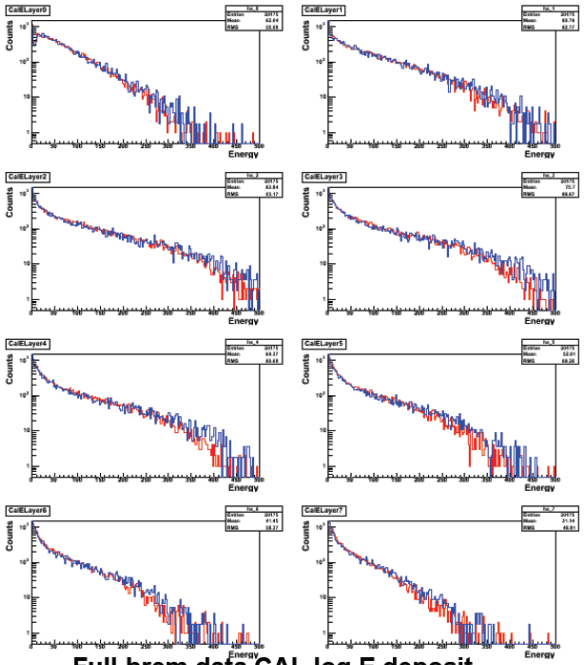






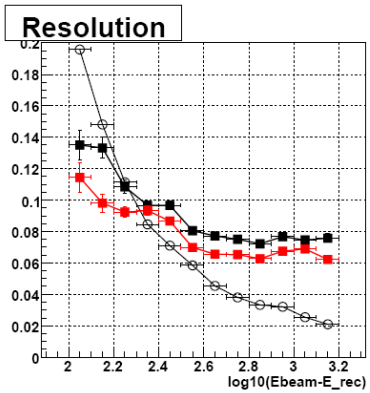
- The beam tests allow us to fully understand the electronics of the calorimeter
  - High rates
  - Cross-talk
  - Non linearity
- The 10% energy excess at high energy is mainly due to calibration issues
  - 2diodes x 2gains : 4 ranges from 1 MeV -> 70 GeV
  - Ground calibration : muon peak at 11 MeV
  - CERN data allow a complete check of our procedure to extrapolate the energy scale from 11 MeV up to 70 GeV

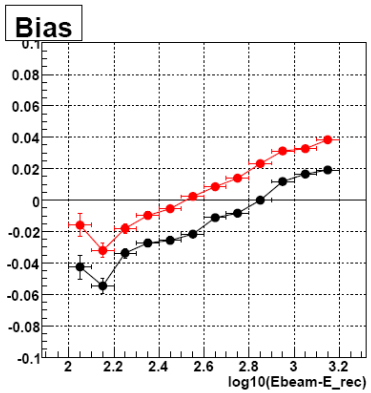
Calorimeter (work in progress…)



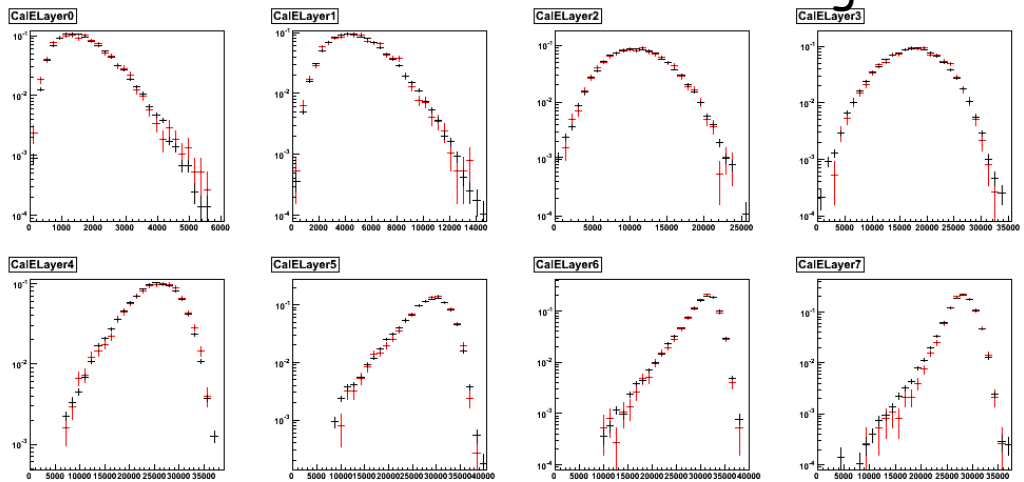
Full-brem data CAL log E deposit

- Very good agreement at PS energies
- Thanks to the electron tagger, we can measure the energy resolution from 50 MeV up to 2.5 GeV
- After naive calibration correction, very good agreement at SPS energies





280 GeV electrons at 30 deg



Conclusions

- A huge amount of good quality data to ensure that our simulation well reproduces the data through the LAT very large phase space
- Data reprocessing and mass simulation are fast and easy
- Ongoing tests to understand the current low-level disagreements
- The preliminary results show that PSF and energy resolution are well reproduced by the simulation