



Simulation checks

Ph. Bruel

on behalf of many working groups :
Beam tests, Instrument analysis,
Calibration & analysis

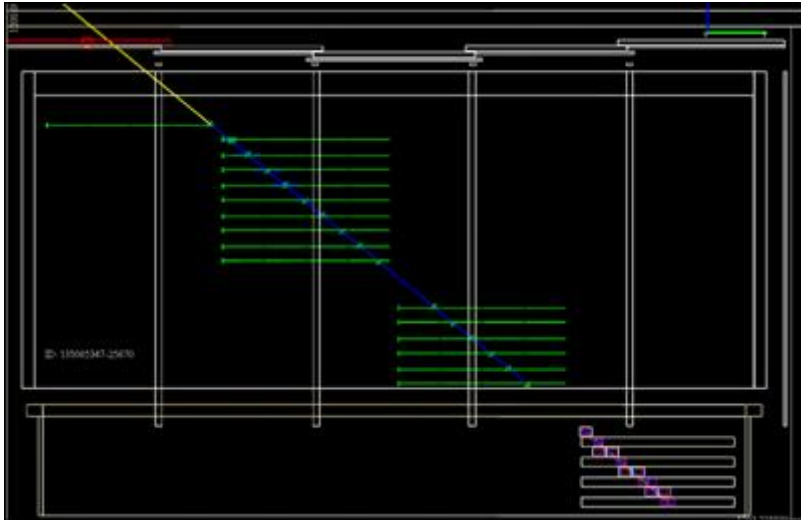
Simulation checks

- Data/simulation agreement
- LAT ground muons results
- Beam tests at CERN
 - Tracker
 - Calorimeter
 - ACD
 - Background studies
- Beam test at GSI
- Conclusions

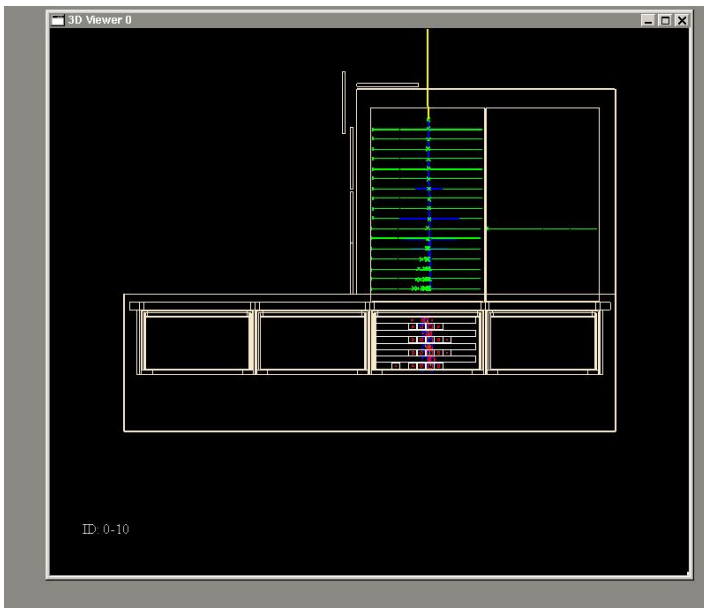
Data/MC agreement : agreements

- Event processing steps :
 - Trigger and On Board Filter
 - Reconstruction algorithms
 - Classification trees
 - (-> Instrument Response Functions and Background rejection)
- Different kinds of agreements :
 - For raw signals
 - Local and usually not too complex
 - For reconstruction variables
 - Local or global, can be complex but still a concrete quantity
 - For classification variables
 - Global, very high correlation level
- For the whole phase space and all types of particles...

LAT ground muons and CERN beam tests

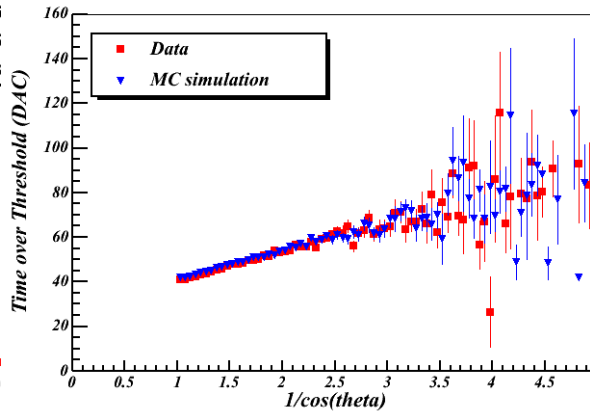
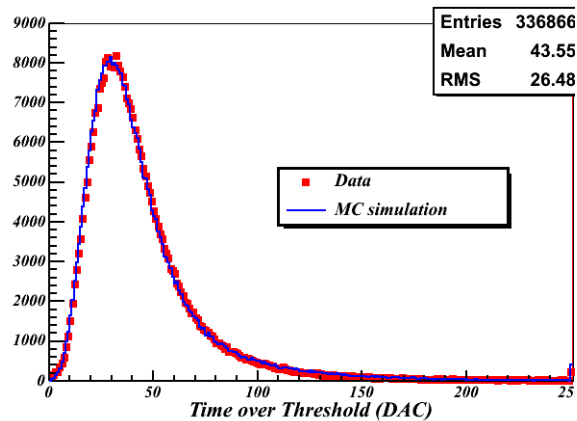
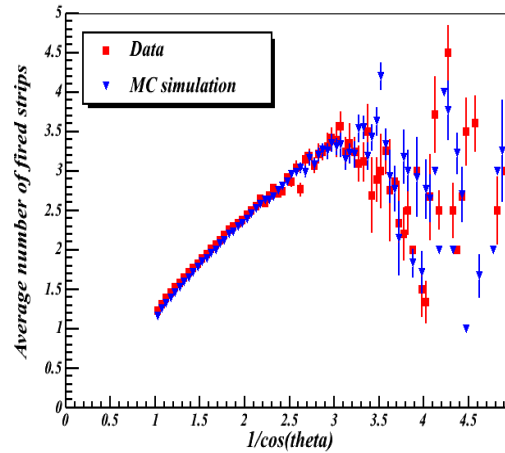
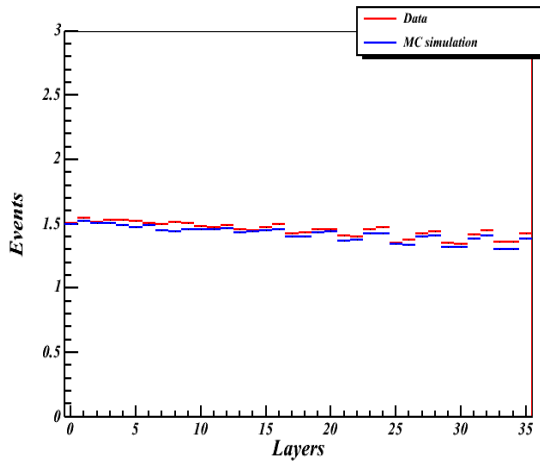


- LAT ground muons
 - Testing the real LAT
 - With a lot of muons but no gammas, no protons



- CERN beam tests
 - Muons, gammas, electrons, positrons, protons, pions
 - From few MeV to 280 GeV
 - Testing the Calibration Unit
 - Most of the events are within two towersbut the CU is not the real LAT

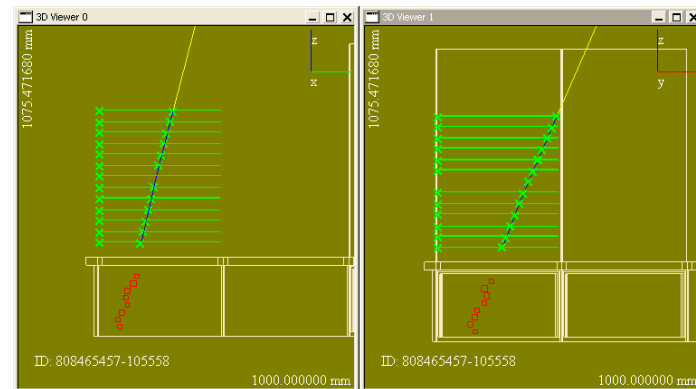
The tracker and muons



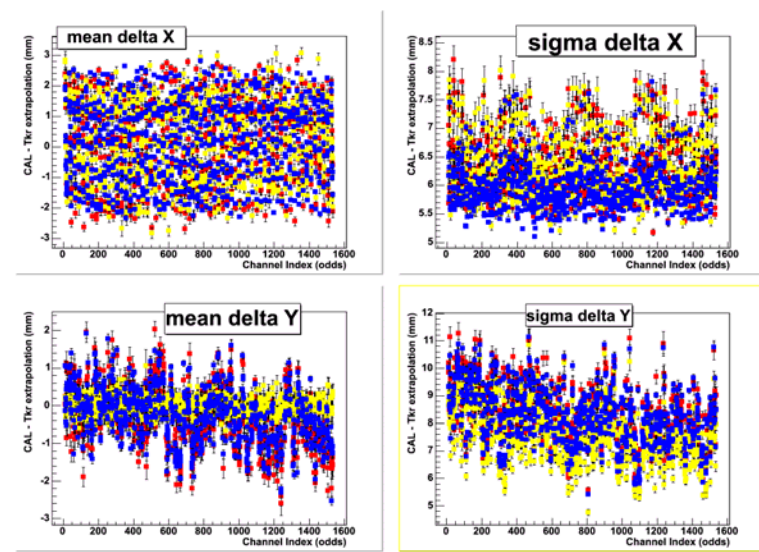
- Within muon selection, the agreement between data and MC is very good, both for
 - hit multiplicity
 - ToT
- Ground muons were used to perform the tower alignment

The calorimeter and muons

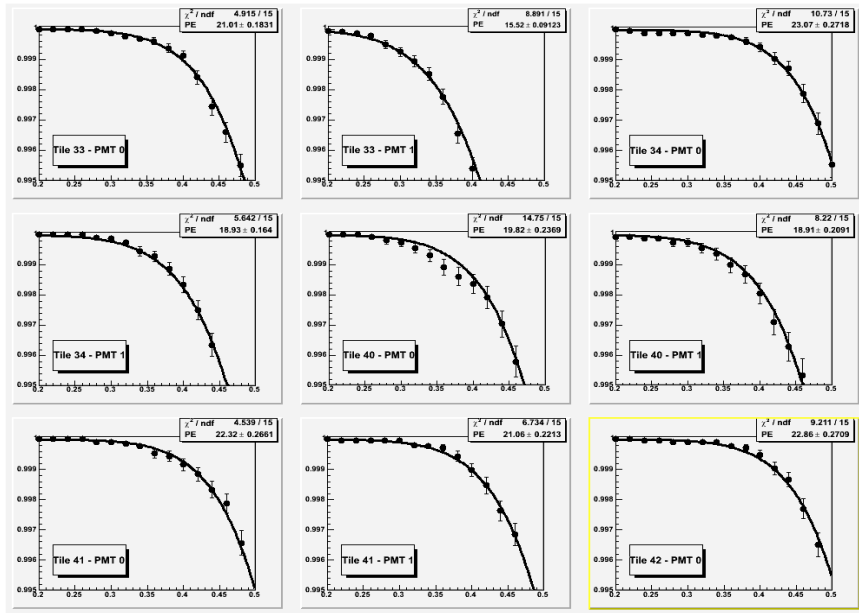
- Muon calibration
 - The energy distribution is a little broader in the data than in MC
 - Likely explained by intrinsic light emission in CsI
 - Only at very low energy
- Position measurement
 - Comparing calorimeter measurement along the crystal to the tracker extrapolated position
 - Very sensitive to intercalibration (~1% calibration error can lead to a 5mm position error)



Data (red,blue) MC (yellow)

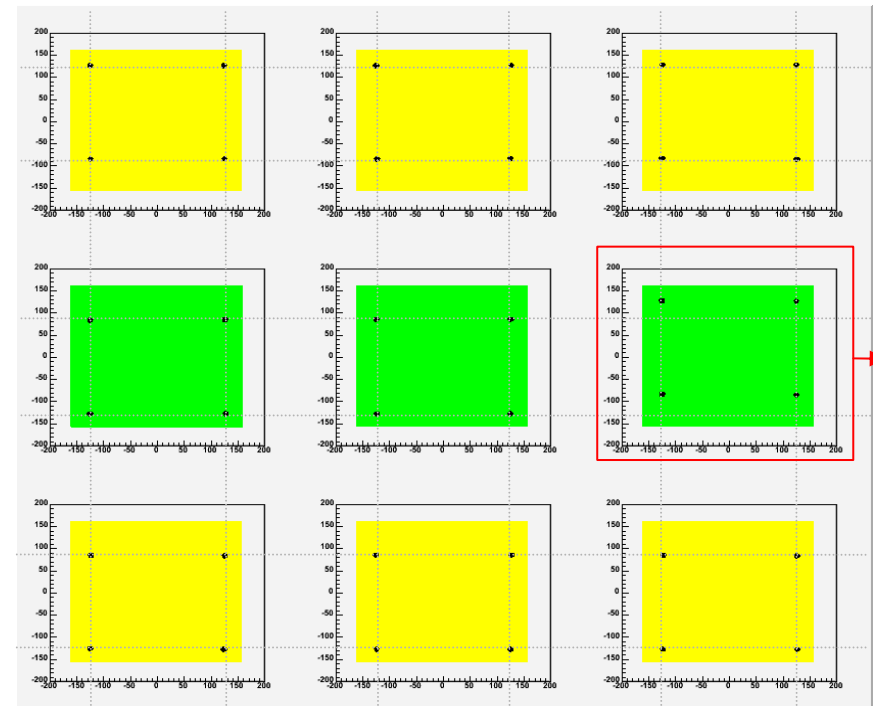


The ACD and muons

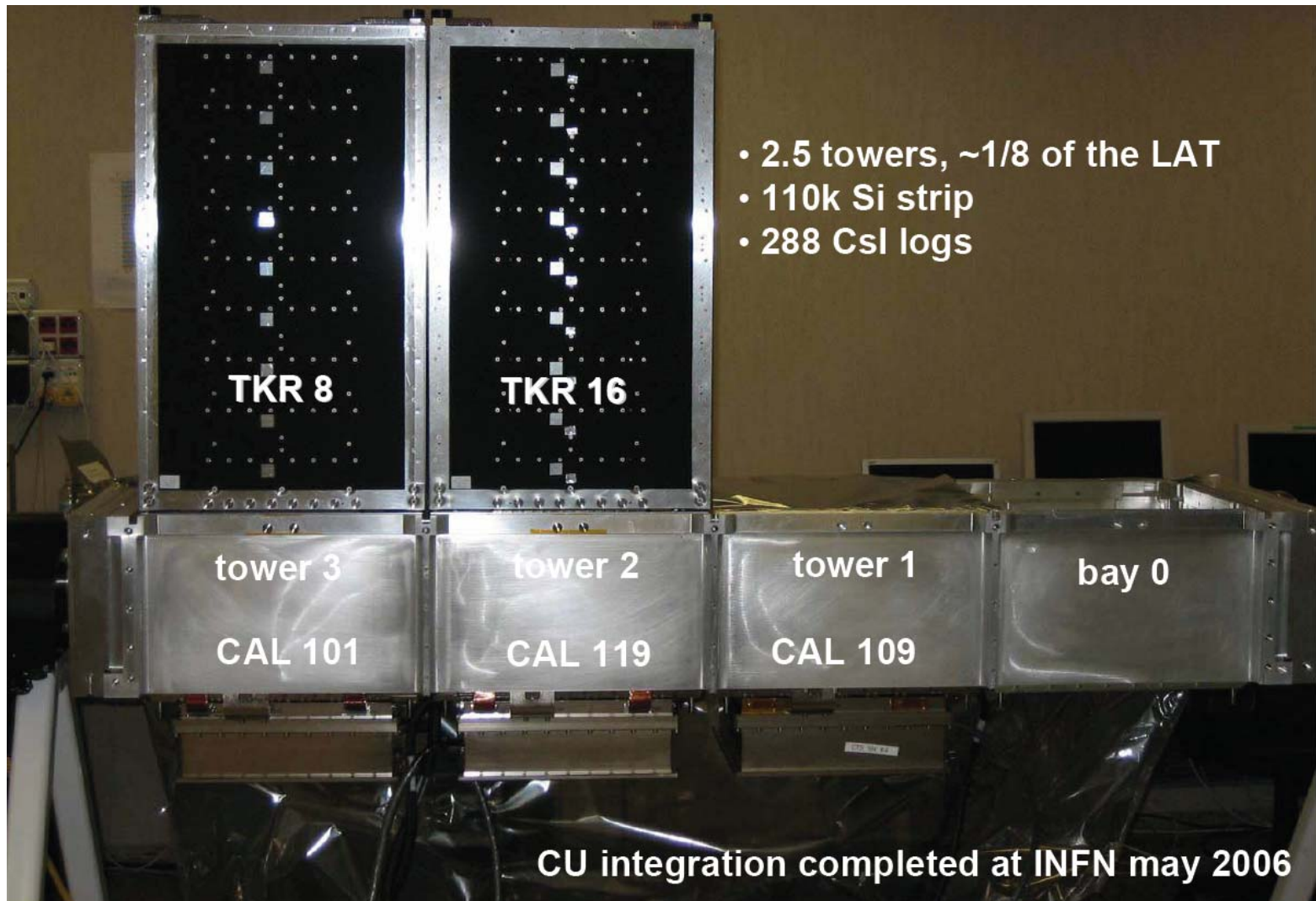


ACD efficiency as function of threshold $\rightarrow$ implemented in the simulation

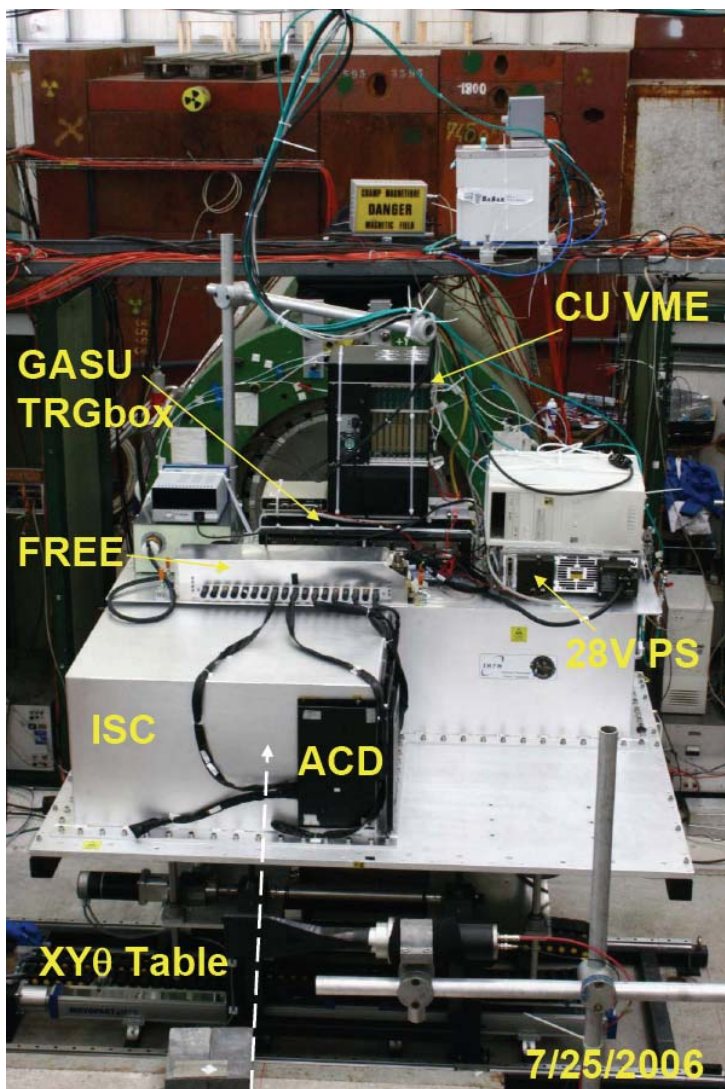
Ground muons allow an accurate implementation of the ACD geometry of the ACD in the simulation (holes, ribbons,...)



The GLAST-LAT Calibration Unit



The CERN campaign



Feb. 2, 2007

- 4 weeks at PS/T9 area (26/7-23/8)
 - Gammas @ 0-2.5 GeV
 - Electrons @ 1,5 GeV
 - Positrons @ 1 GeV (through MMS)
 - Protons @ 6,10 GeV (w/ & w/o MMS)
- 11 days at SPS/H4 area (4/9-15/9)
 - Electrons @ 10,20,50,100,200,280 GeV
 - Protons @ 20,100 GeV
 - Pions @ 20 GeV
- Data, data, data...
 - 1700 runs, 94M processed events
 - 330 configurations (particle, energy, angle, impact position)
 - Mass simulation
- A very dedicated team
 - 60 people worked at CERN
 - Whole collaboration represented

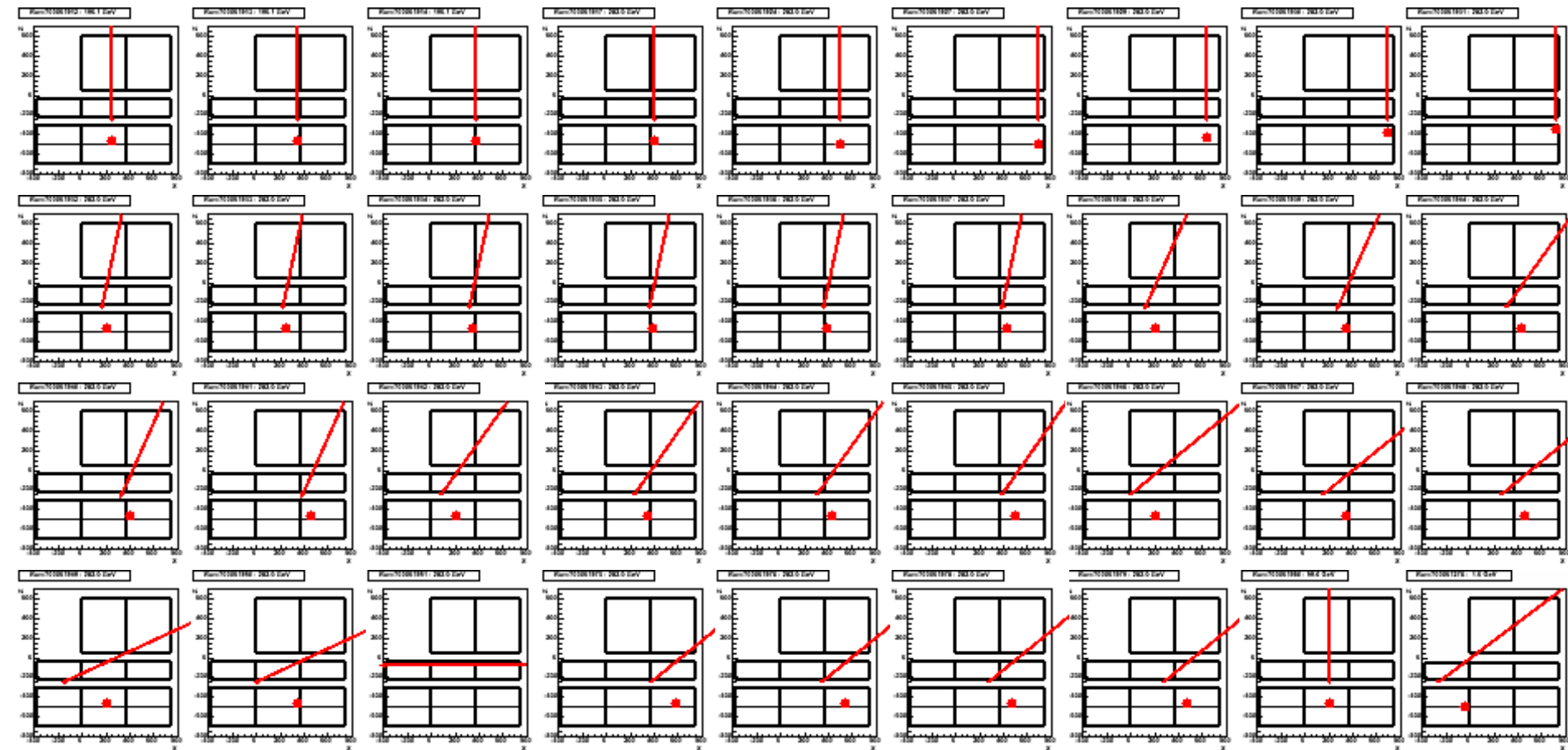
SWG review

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

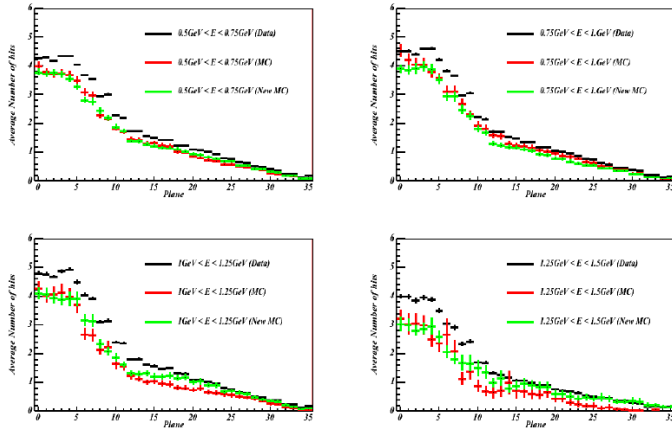
- Simulation of the beam upstream the CU (Geant4)
 - Trigger/veto scintillators & cerenkov
 - Electron tagger at PS
- LAT simulation (GLEAM-Geant4)
- Automatic generation of the run configuration
 - Allowing the best comparison
- Efficient processing through the pipeline at SLAC
- Geant4 optimization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

Dealing with a huge phase space...



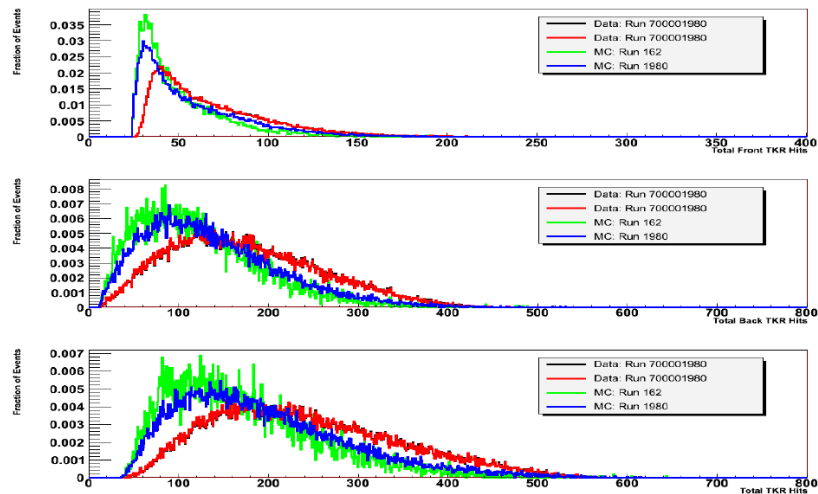
Tracker (work in progress...)

Hit multiplicity for gammas (0.5 to 2.5 GeV)

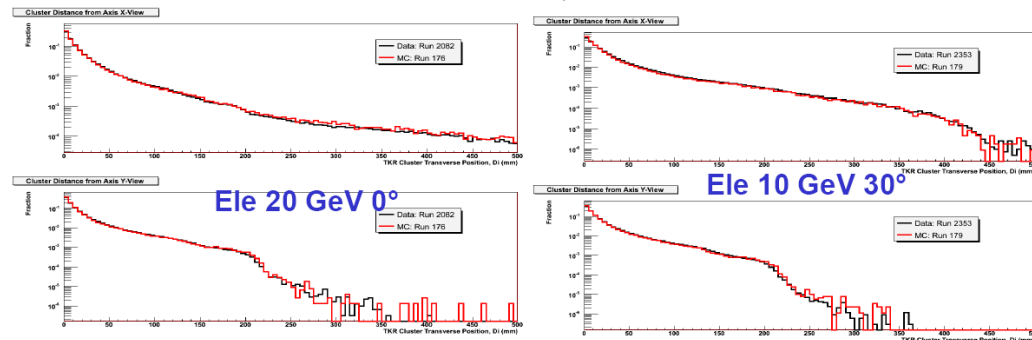


- 10-20% more hits in data than in MC
- Effect almost independent of particle, E
- Clusters are well reproduced by MC
- More secondary particles / preshower ?
 - Lower range cuts in Geant4 : no effect
 - Testing low energy processes
 - The calorimeter should say if there is extra material upstream the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

Hit multiplicity for 100 GeV electrons



Cluster-axis distance for 20 GeV electrons

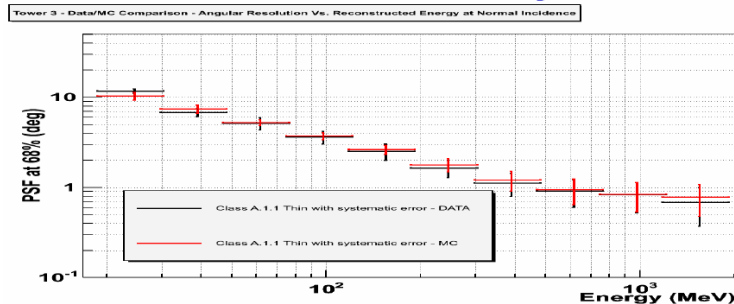


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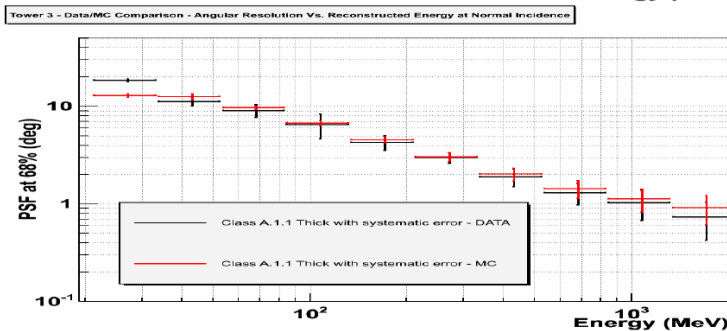
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Tracker (work in progress...)

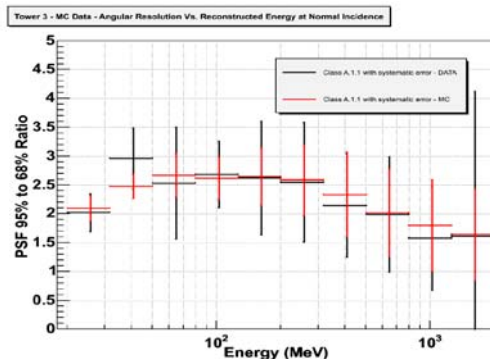
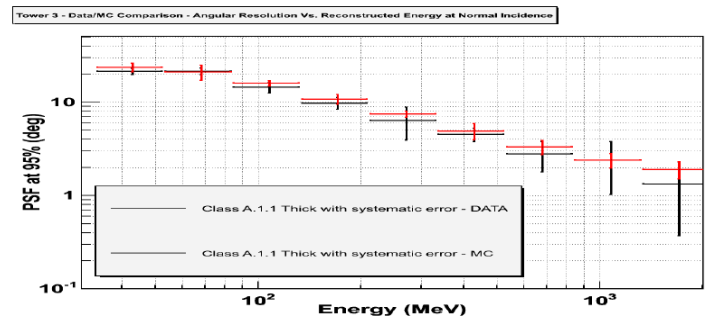
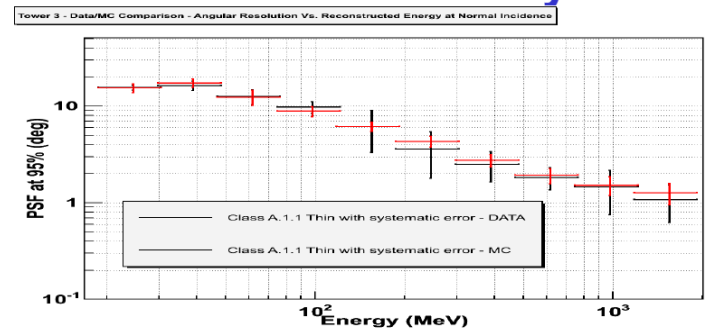


<- 68%

PSF

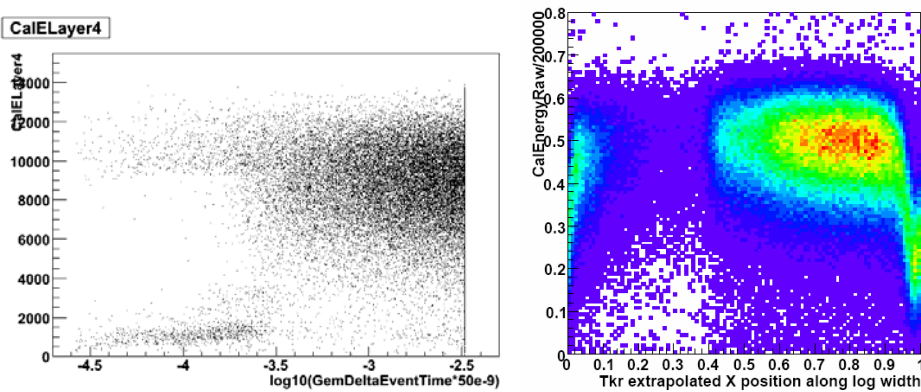


95% ->

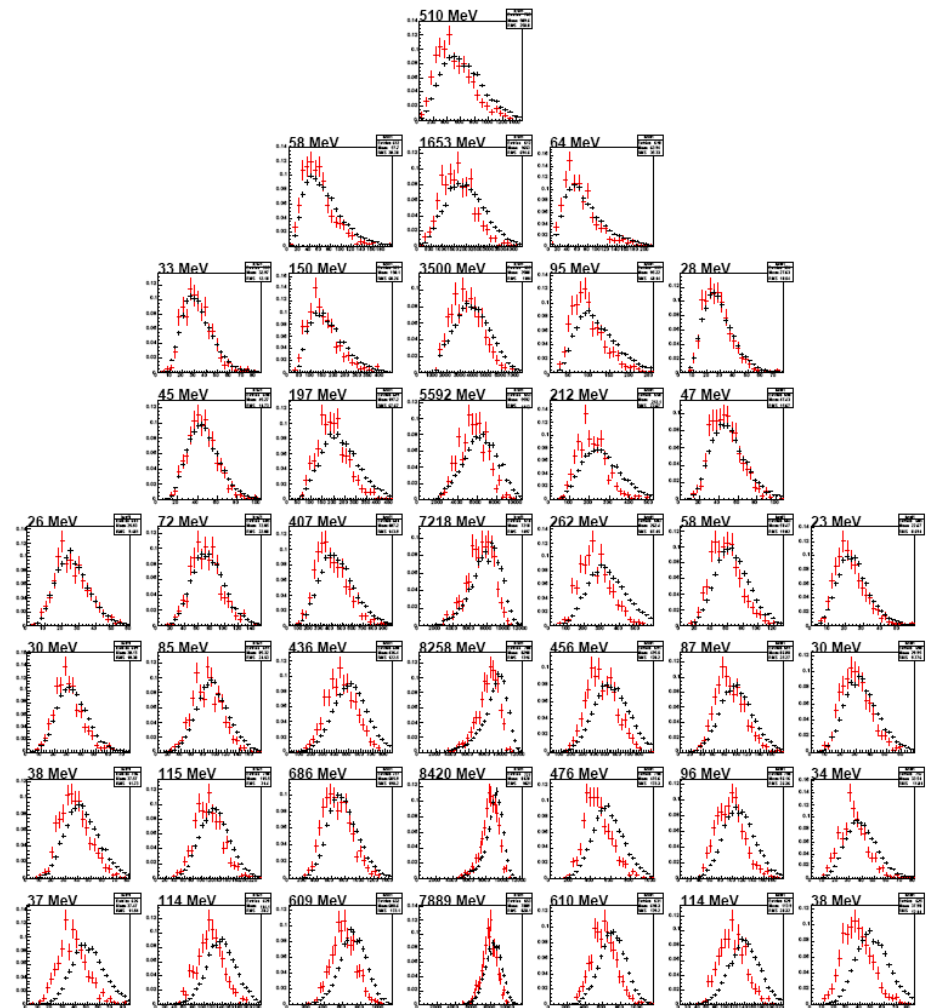
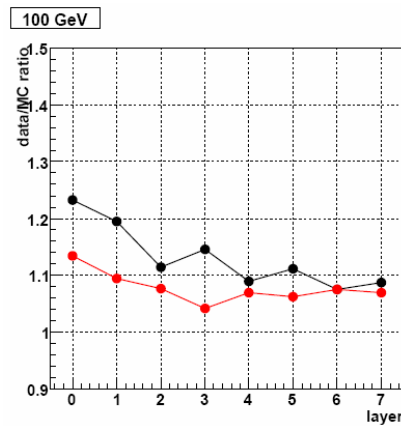
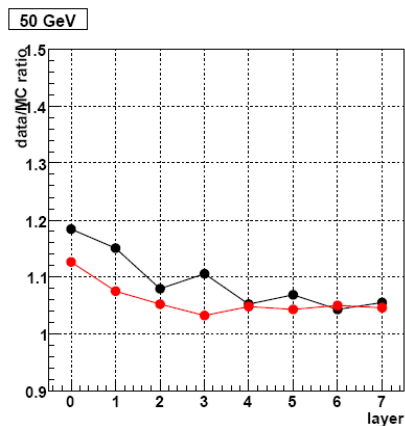


- Preliminary PSF results for events with 1 vertex and 2 tracks shows a good agreement between data and the simulation
- This not yet the PSF from the IRFs (i.e after signal selection and background rejection)

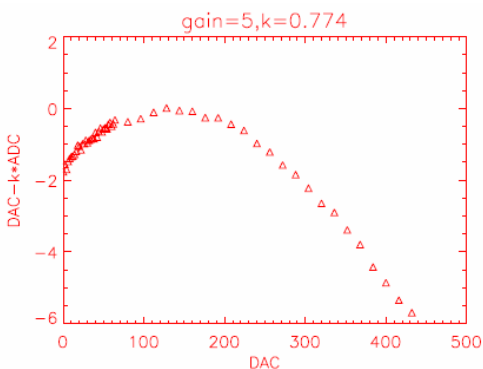
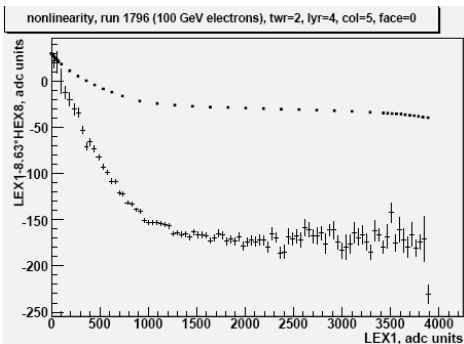
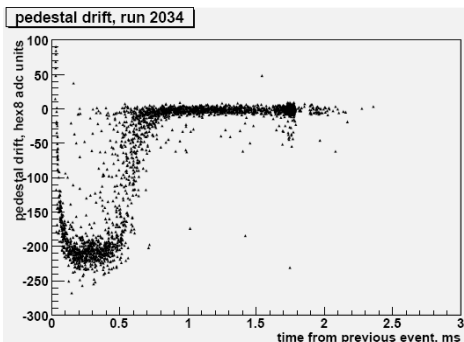
Calorimeter (work in progress...)



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



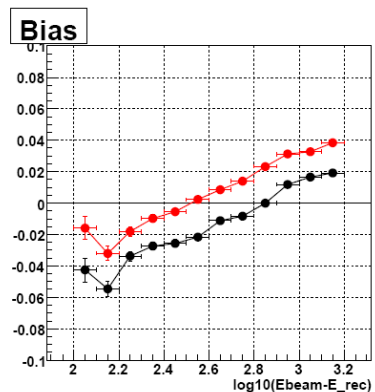
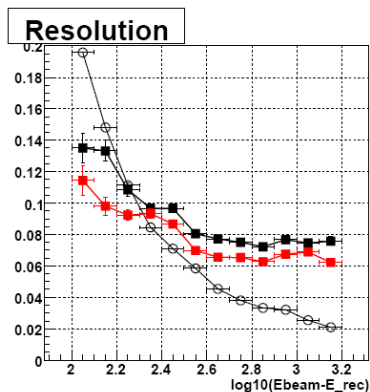
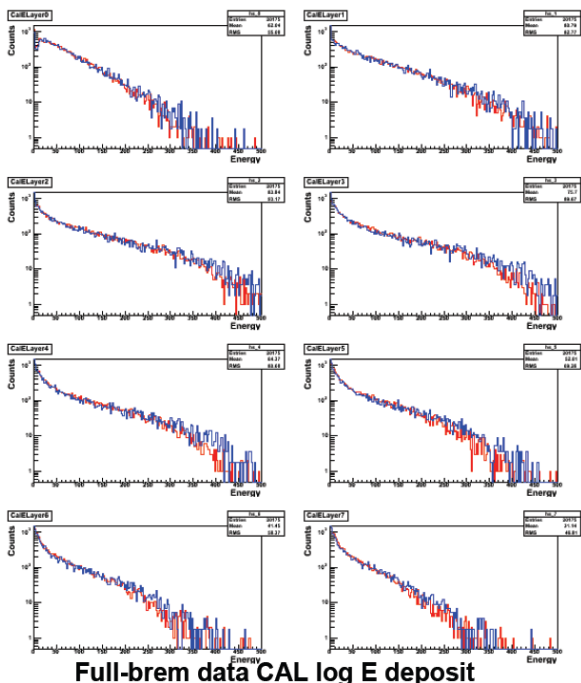
Calorimeter (work in progress...)



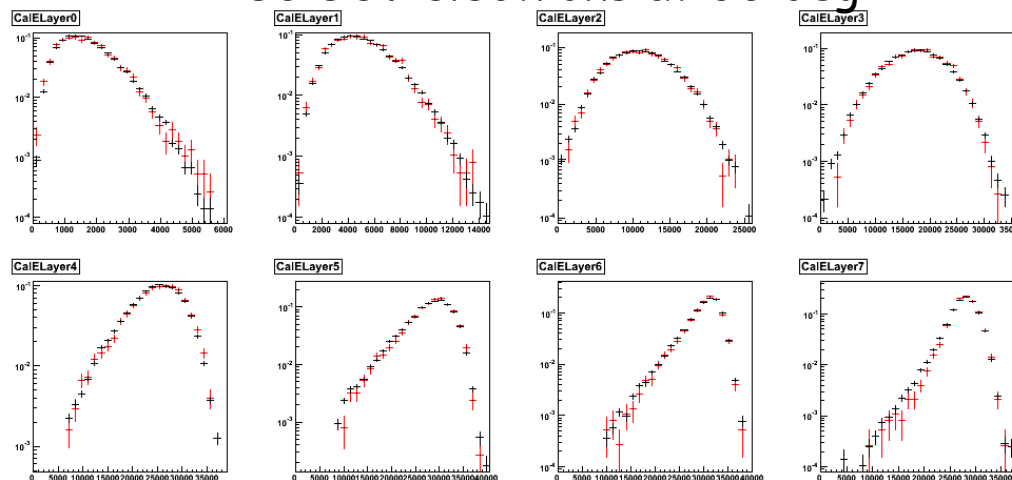
- The beam tests allow us to fully understand the electronics of the calorimeter
 - High rates
 - Cross-talk
 - Non linearity
- The 10% energy excess at high energy is mainly due to calibration issues
 - 2diodes x 2gains : 4 ranges from 1 MeV -> 70 GeV
 - Ground calibration : muon peak at 11 MeV
 - CERN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

Calorimeter (work in progress...)

- 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

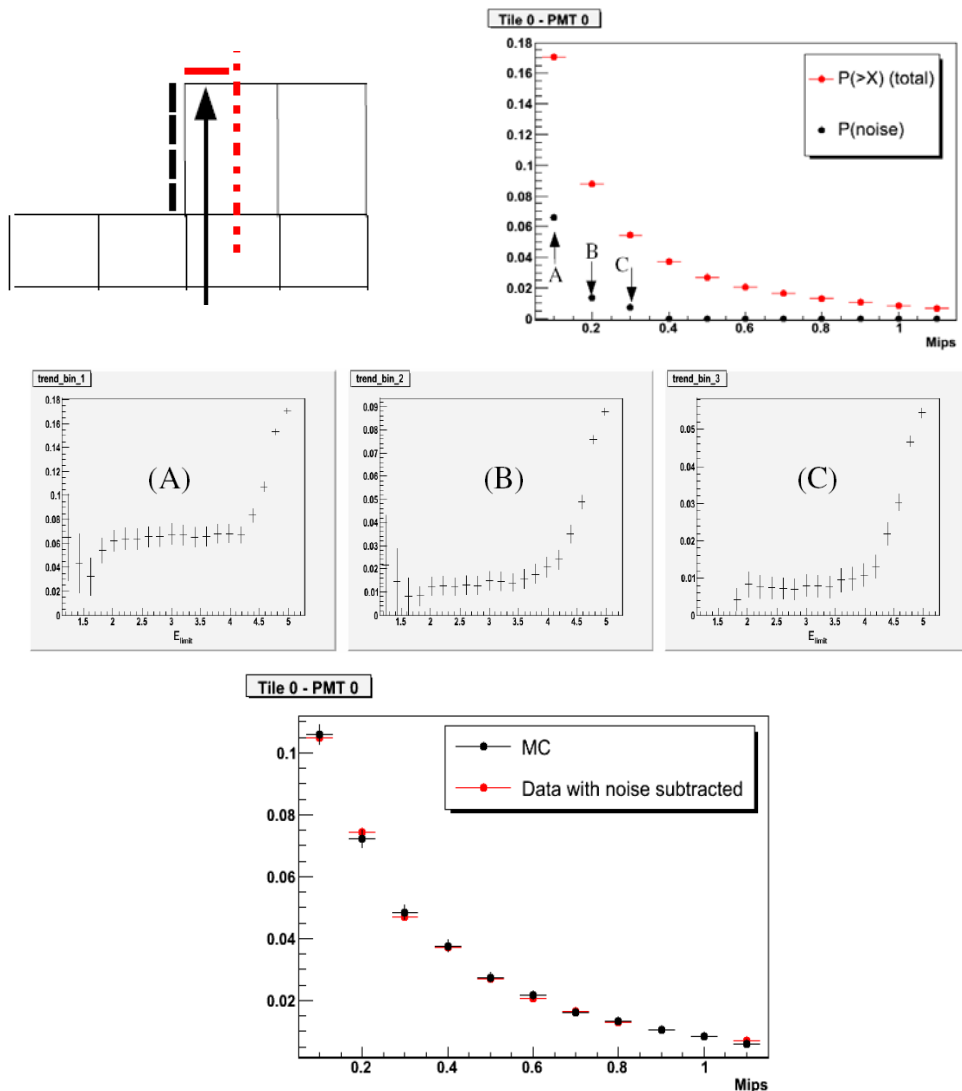


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SWG review

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Preliminary backsplash study with ACD

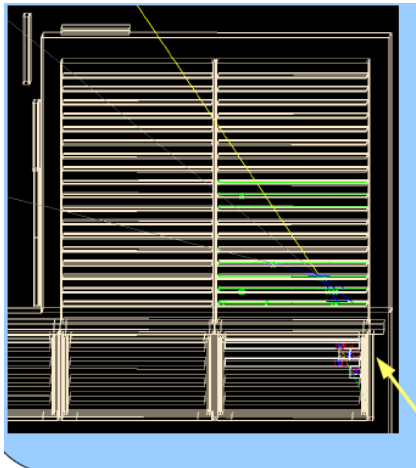


- Many configurations in order to test the backsplash simulation as function of energy, angle, distance to tile
- Use the dependance with the energy in cal to determine the beam noise contribution
- After noise subtraction, data is well reproduced by MC

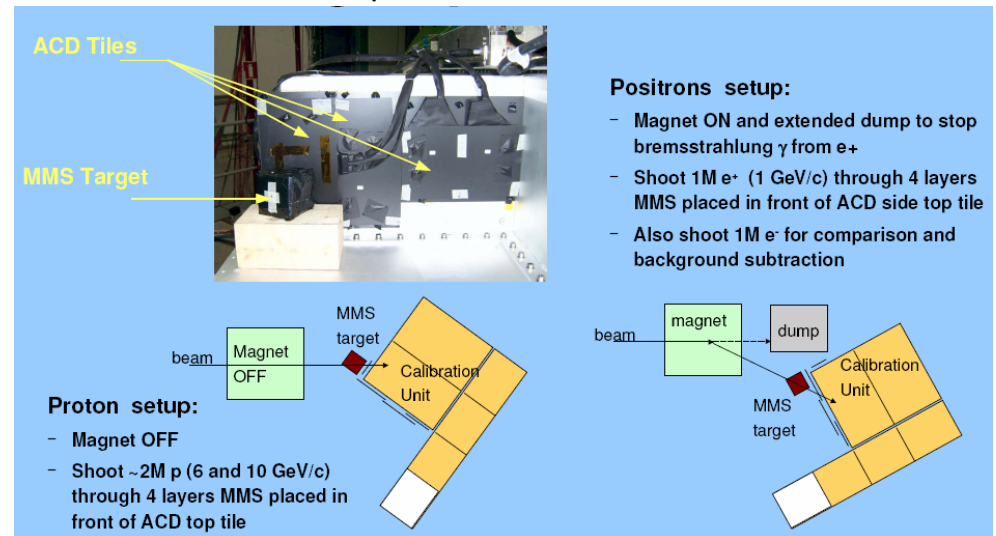
Preliminary background studies

- Simulation of hadronic processes with *Geant4*
- Albedo gammas
- Charged particle interaction in *MicroMeteoroid Shield*
 - Measure the probability that the particle creates a gamma like signal in the CU (no ACD signal, good signal in tracker and calorimeter)
 - Protons : preliminary results show a reasonable agreement
 - Positrons : preliminary analysis shows a clear signal due to positron annihilation with the expected probability

Albedo gammas (from 2.5 GeV e^-)

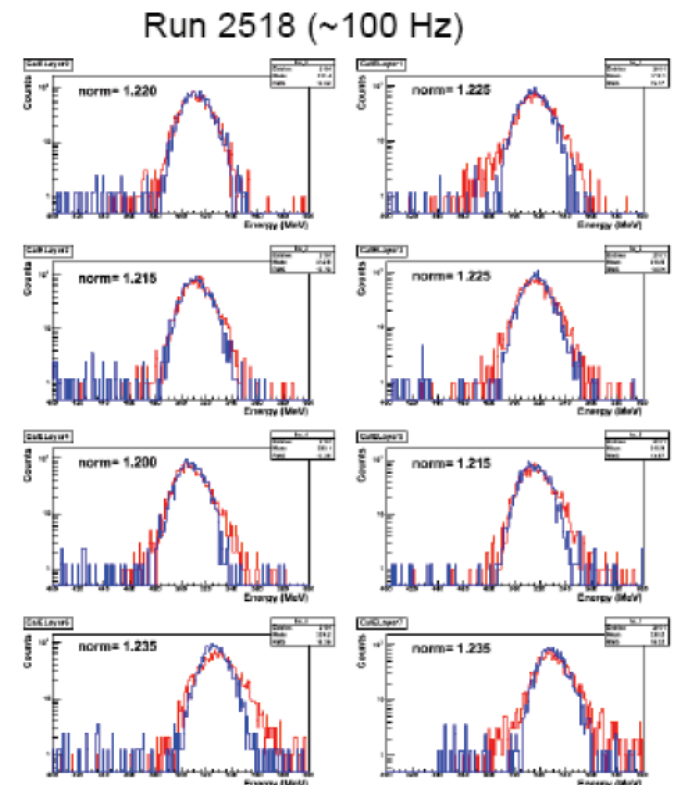
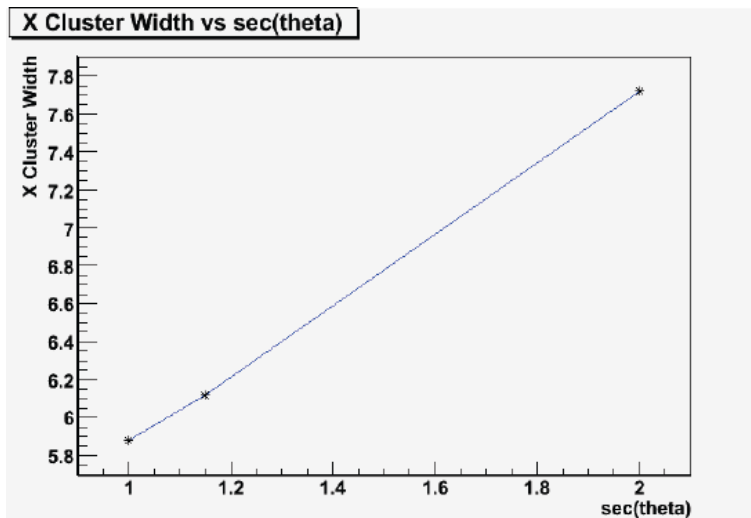


Protons and positrons interaction in MMS



Preliminary GSI results

- 17-19 November
- Beam : C @ 1.5 GeV, Xe @ 1 GeV
- Tracker clusters are x2 wider in data
- Same calorimeter quenching factors as measured in 2003



Analysis status

- Beamtest working group
 - Beamtest preparation workshops
 - Beamtest data taking at CERN, GSI
 - Data analysis coordinated by :
 - Luca Latronico (INFN-Pisa)
 - Philippe Bruel (IN2P3-LLR)
 - Weekly VRVS since September + analysis workshops
- Tracker : hit excess
 - Secondary particle excess
 - Ongoing tests with low energy processes ON in Geant4
 - Tray standalone simulation
- Calorimeter : energy excess
 - Understanding and improving the calibration
- Higher level studies (PSF, energy resolution, background,...)
 - Hampered by tracker hit and cal energy discrepancies
 - But the analysis tools are ready

Conclusions

- Ongoing tests to understand the current disagreements
- Data reprocessing and mass simulation are fast and easy
 - Testing new ideas or implementing a new calibration can be done within 1-2 weeks
- A huge amount of good quality data to ensure that our simulation well reproduces the data through the LAT very large phase space
- This effort must continue
 - Our results have to be implemented in the LAT simulation
 - The whole LAT analysis will then have to be checked before launch