GLAST Large Area Telescope:

Beam Test Status Report

GLAST-IFC Meeting
Frascati 3 September 2007

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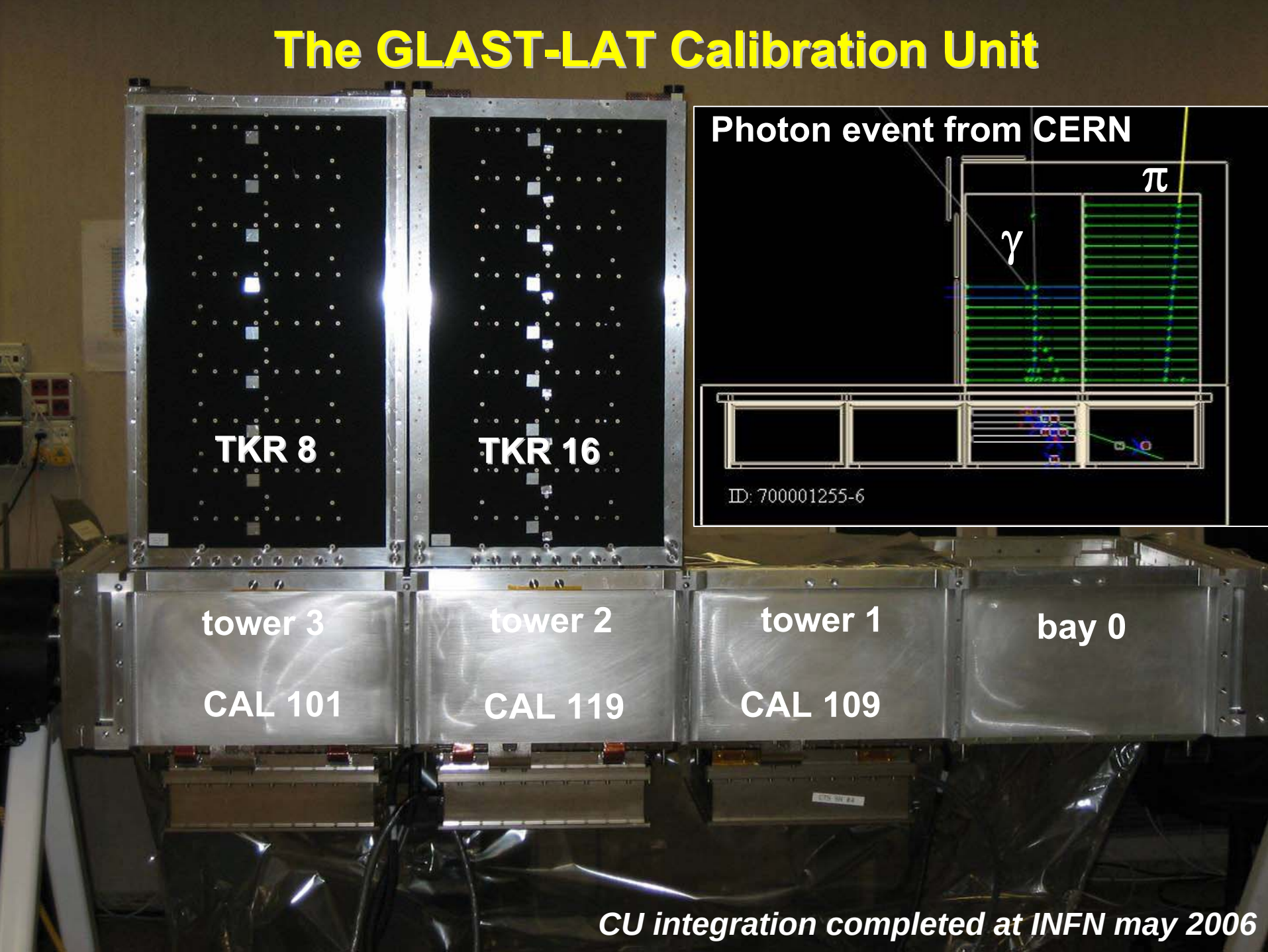
On behalf of the Beam Test Working Group

The GLAST-LAT Calibration Unit



CU integration completed at INFN may 2006

Data Set Summary

Particle	Energy
γ	0-2.5 GeV
e-	1, 5,10,20,50,100,200,280 GeV
e+	1GeV (through MMS target)
p	6, 10GeV (also through MMS), 20,100 GeV
π	20GeV
C, Xe	1, 1.5GeV/n, + Xe on target

330 configurations

- Incoming angle
- impact point
- Rate
- CU register configurations

1800 runs

100M evts

4 weeks at CERN-PS/T9, 26/7-23/8

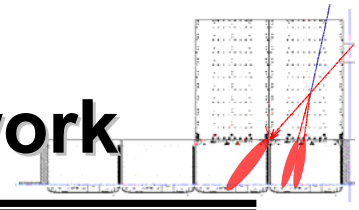
11 days at CERN-SPS/H4, 4-15/9

1 week at GSI

60 people active in data taking

survivors packing the CU after final data taking campaign at GSI

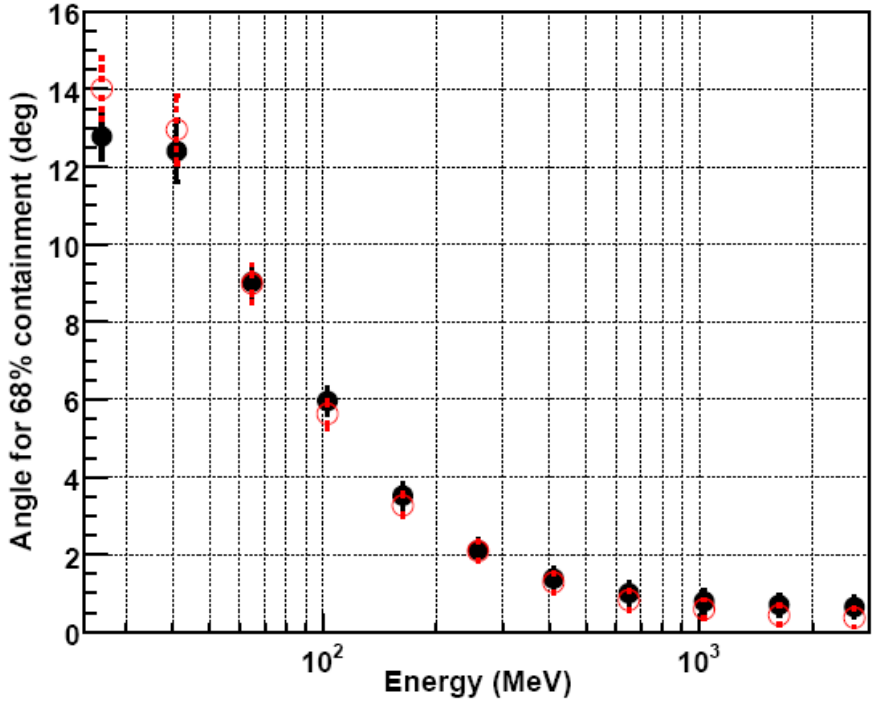
Mass processing, simulation and work

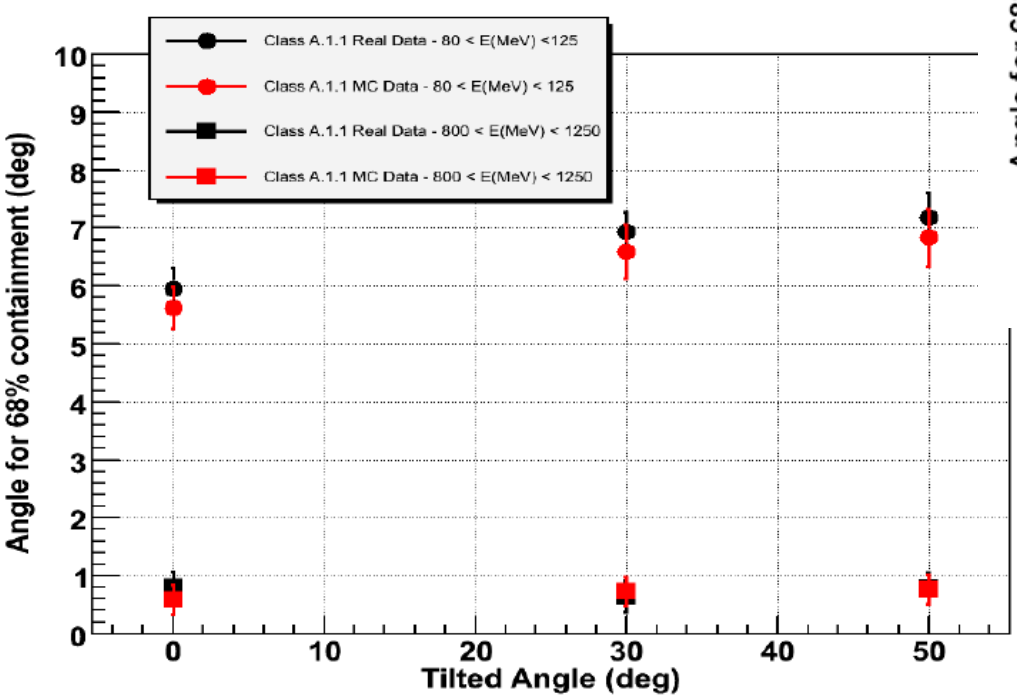


- SLAC pipeline for mass simulation and data processing and storage
  - Data processing in almost realtime (2hrs turn-around from CERN)
  - 1 MC run per data run configuration
  - Experience with run logbook and database
- Custom sim/recon package BTRelease
  - Special geometry (CU, ISC, MMS target)
  - Specific changes to sim/recon/calibration
- Very active weekly analysis meetings
  - >50 meetings often longer than 2hours
  - Usual SWG tools
- Great worldwide team
  - Several conference contributions and proceedings
  - Final paper planned

TKR Performance – Angular Resolution

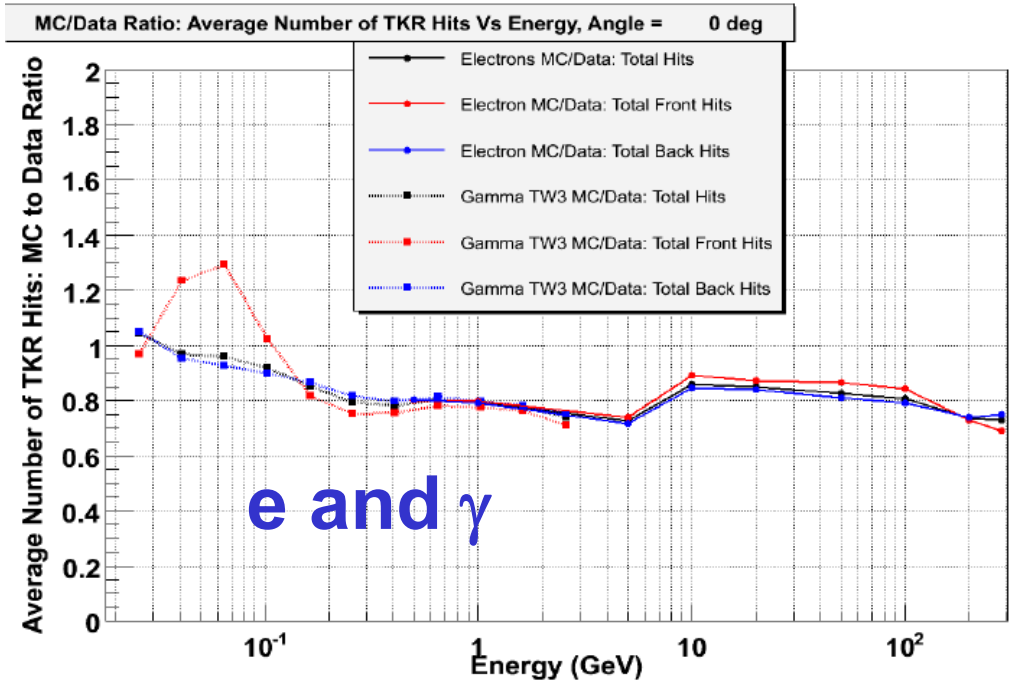
- 68% angular dispersion for vertex events
- Good Data/MC agreement

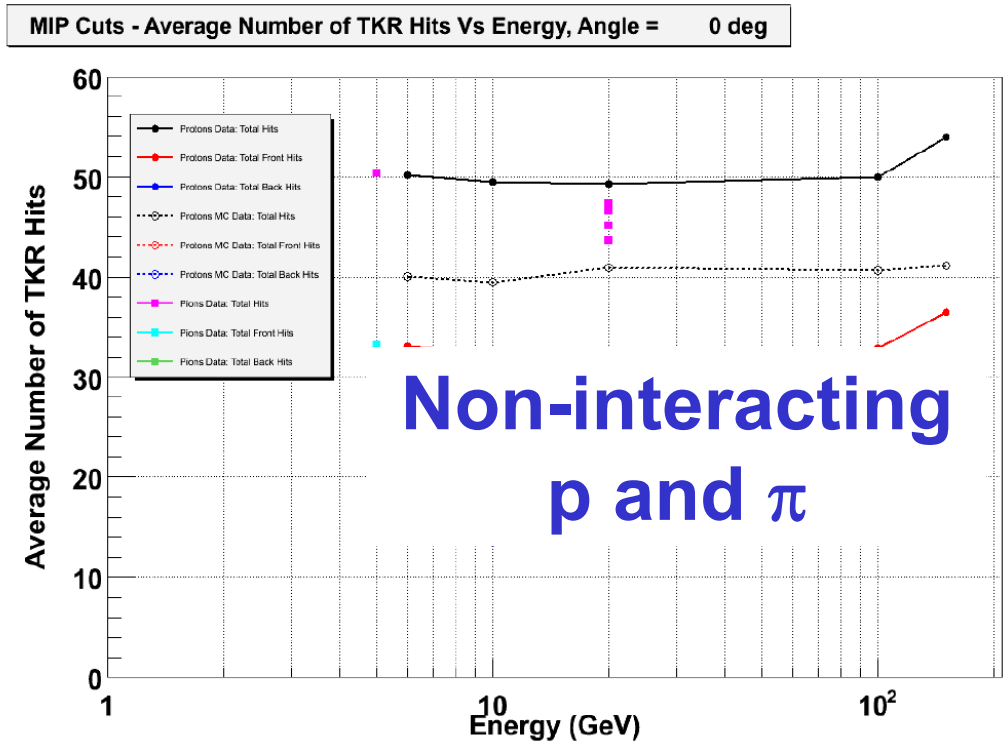




TKR Signal - Hits

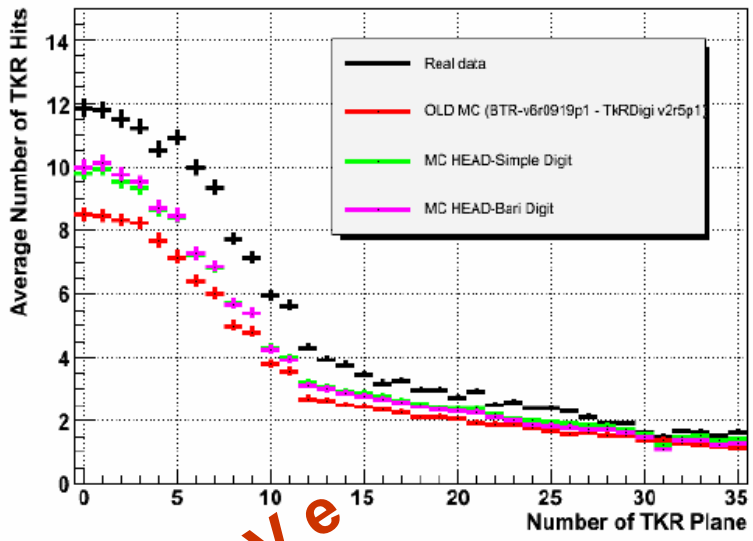
- MC simulations show fewer hits than data
  - ≈20% less hits
  - ≈10% less clusters
- Independent of beam line, trigger type, incoming angle, energy, particle (γ, e, hadrons)
  - not a data excess (e.g. noise or beam halo)
  - ≈10% less hits for CR muons on LAT and CU
- Does not affect PSF
  - negligible difference on best 2 tracks
  - Significant artificial noise increase does not impact tracking and direction reconstruction

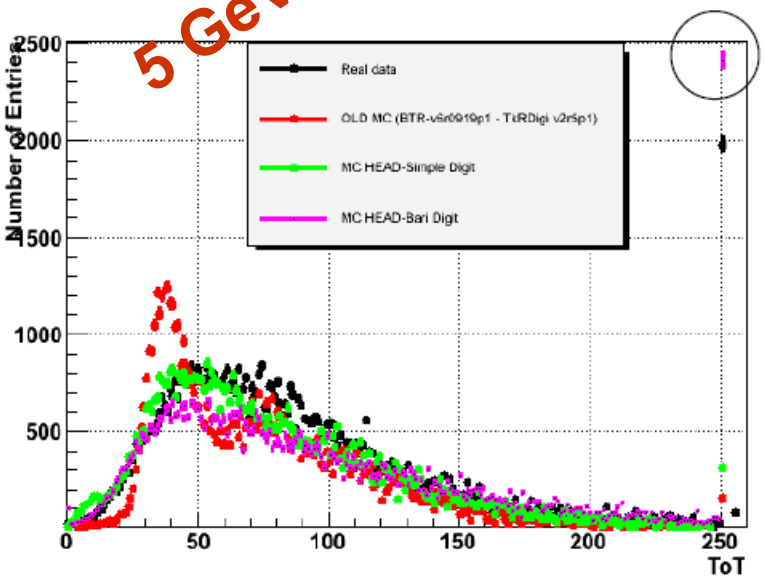




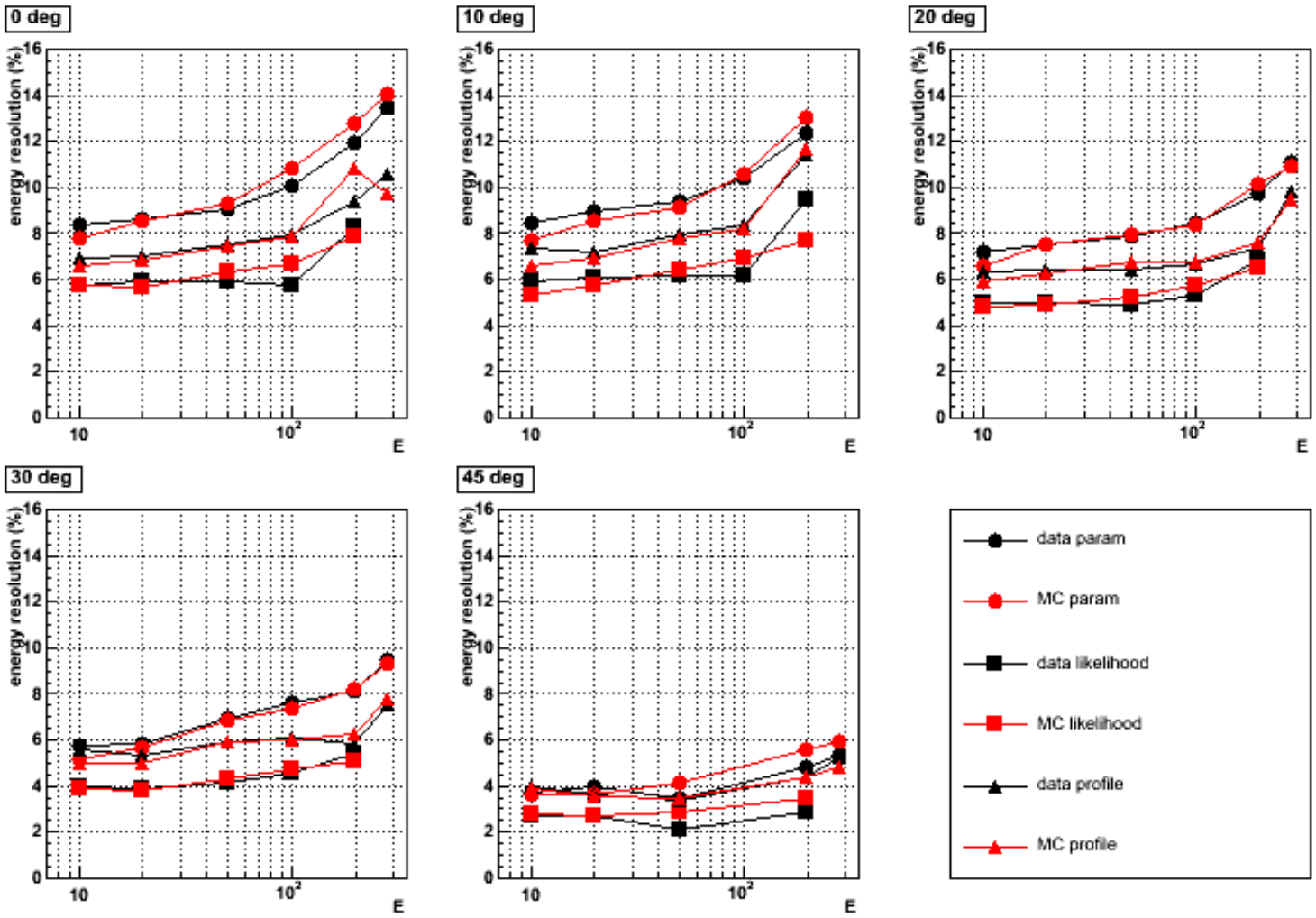
TKR simulation products

- 2 updated TKR digi algorithms
  - SimpleAlg:
    - strip xtalk for ion signals
  - BariAlg:
    - charge sharing through charge clusters propagation
    - realistic signal time development
- Both available in GlastRelease
- Correct link to TKR calibration DB
  - ToT shape correct in MC
  - slight improvement on hits/clusters discrepancy

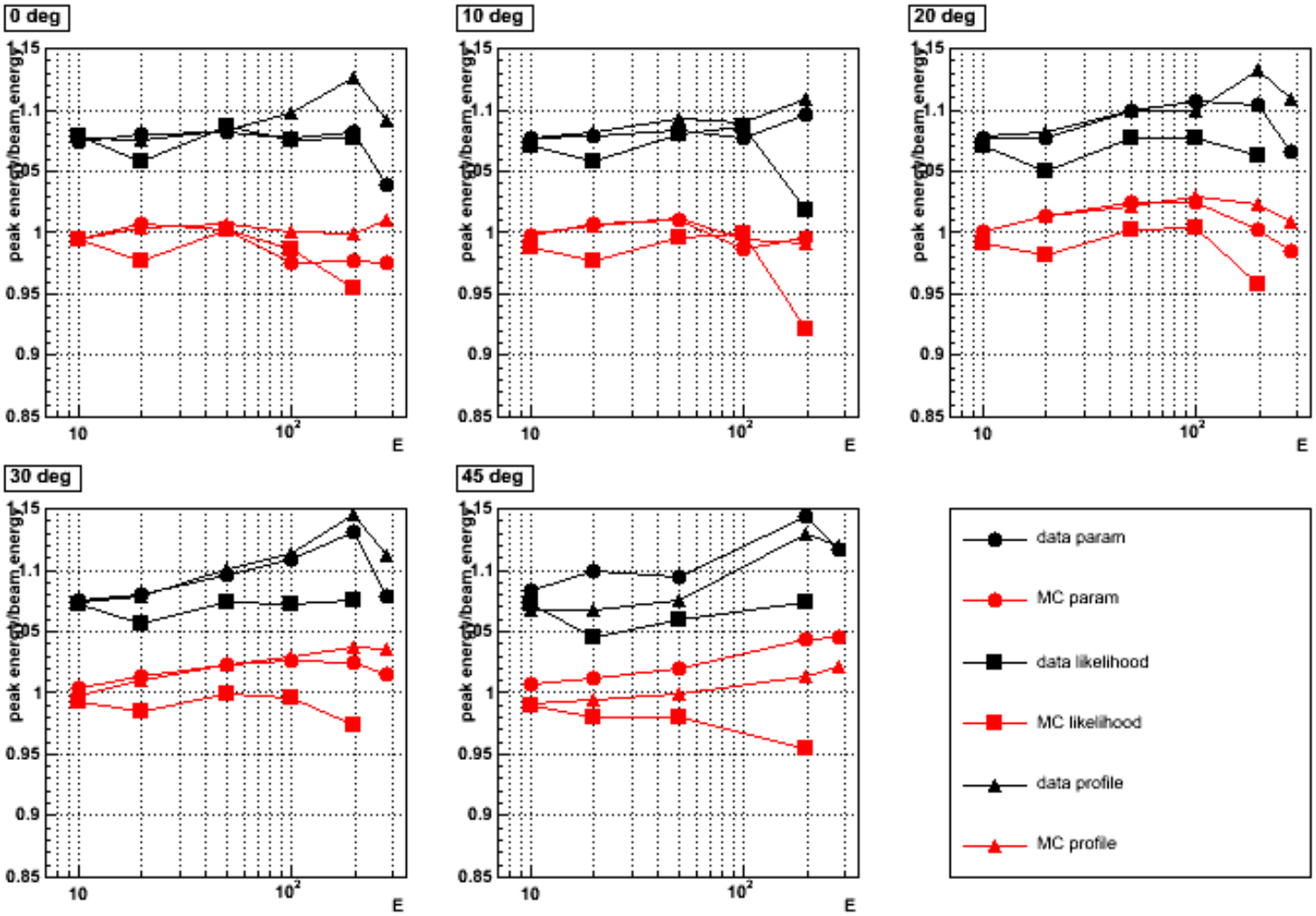




CAL Performance - energy resolution

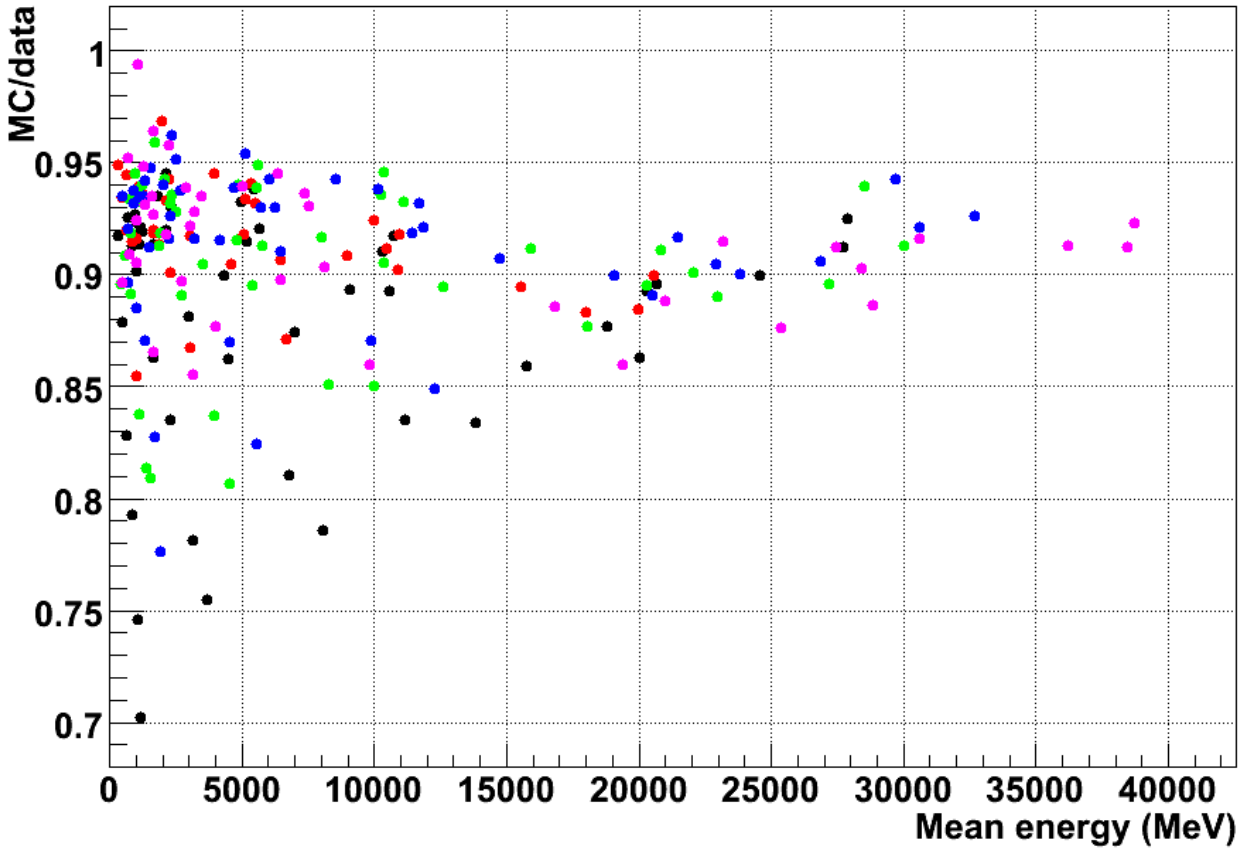


CAL Performance - energy bias



CAL Signal – raw energy deposit

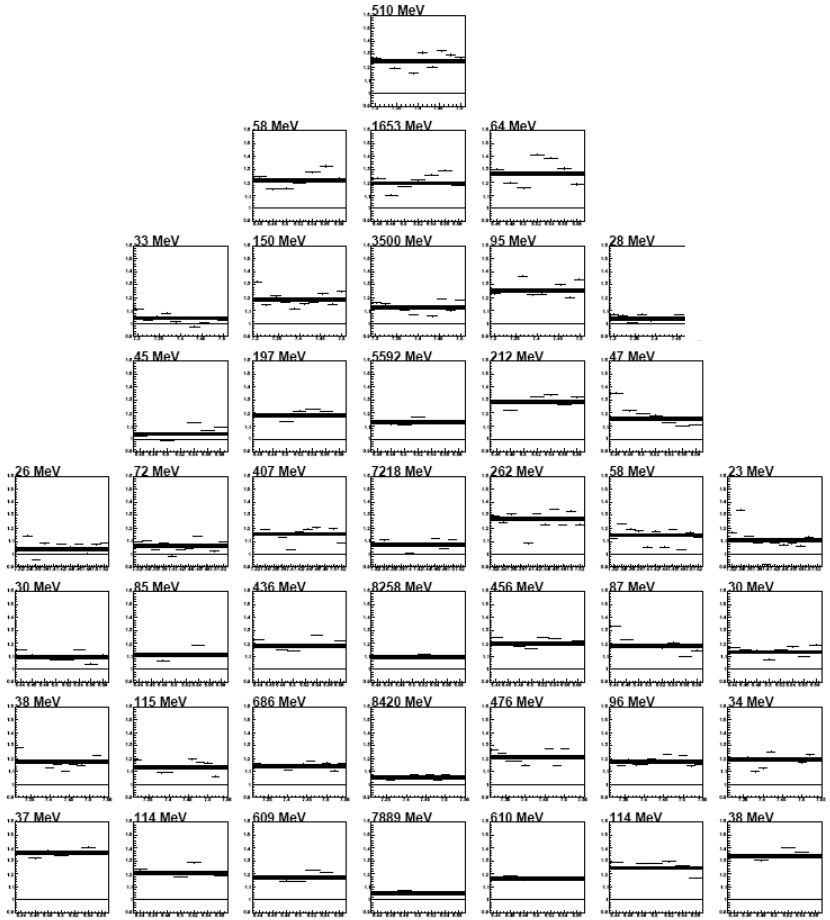
- We still have a discrepancy : 5 to 20% less energy in the MC
- All energies (10,20,50,100,196,282 GeV) and all angles (0, 10, 20, 30, 45deg) and all layers :

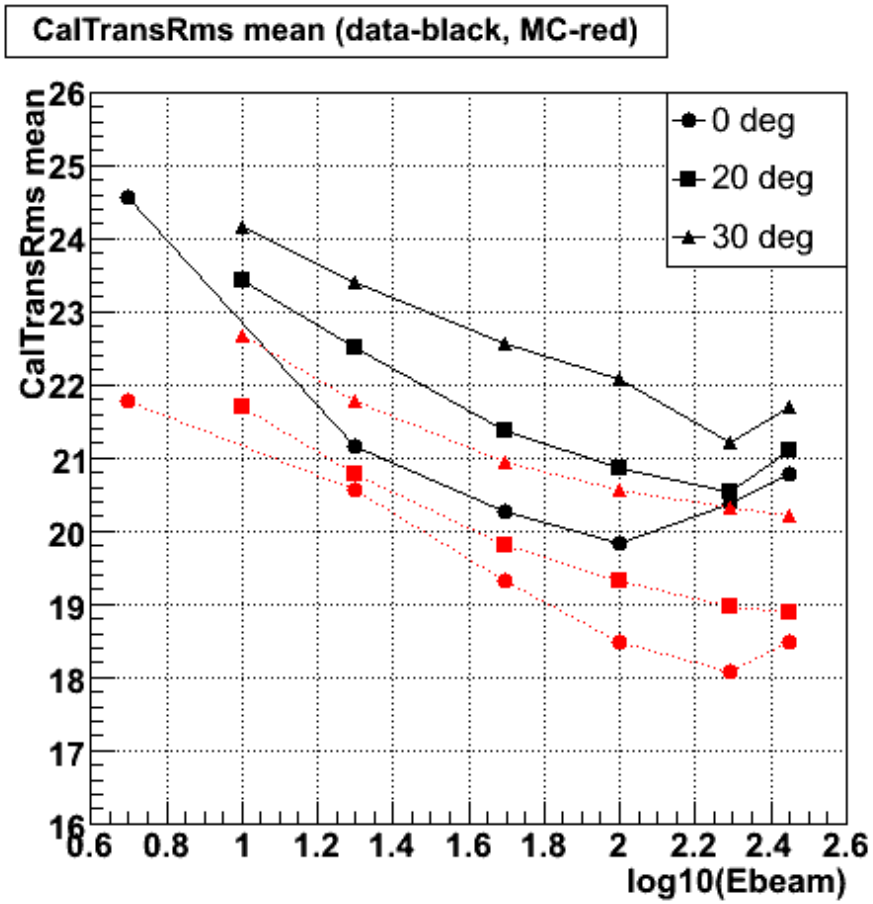


- Incompatible with more material along beam line

Shower transverse size

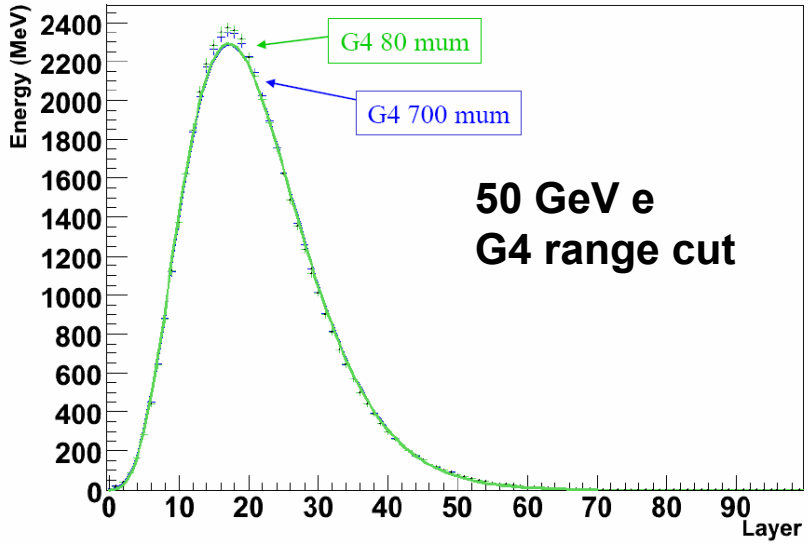
- The transverse size of the showers is larger in data than in MC
- It will not be solved by a global calibration factor

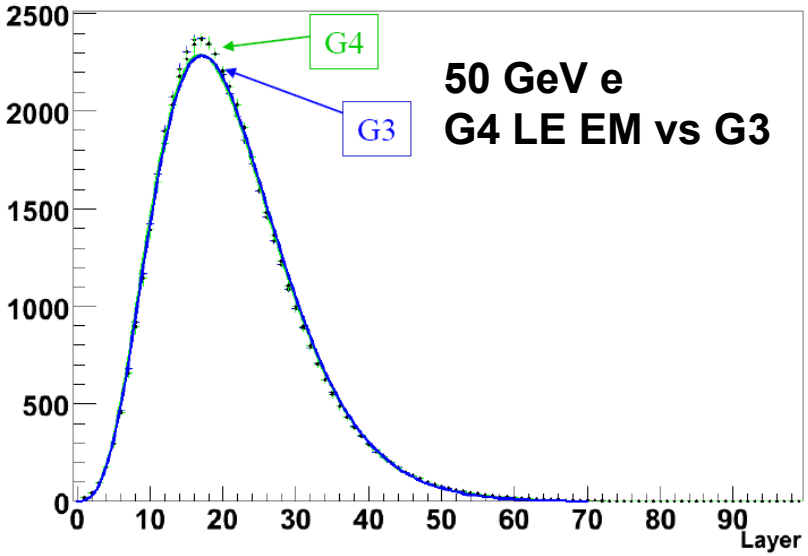


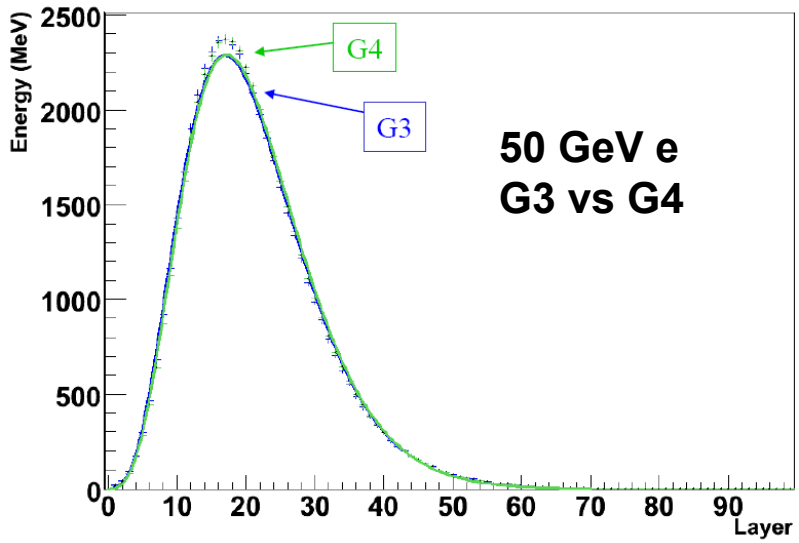


Geant4 consistency checks

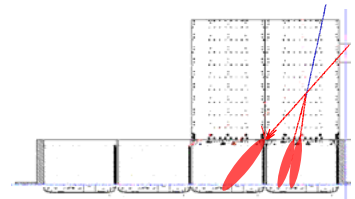
- No effects from general Geant4 configuration parameters
- Similar results obtained when checking effect of changes on TKR Hits



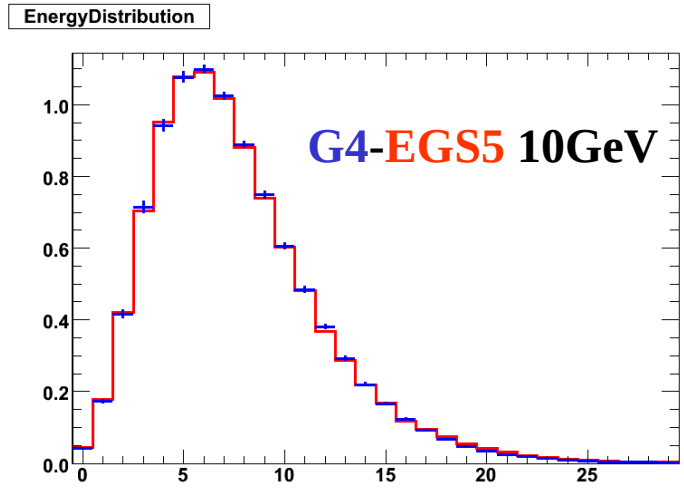


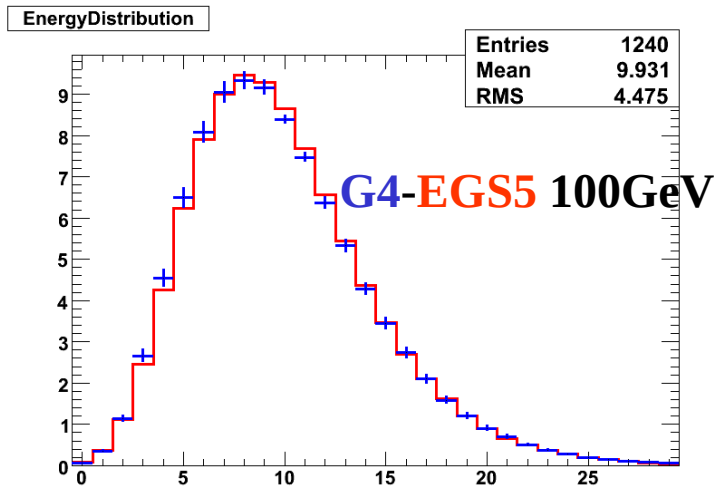


Geant4 and other simulators



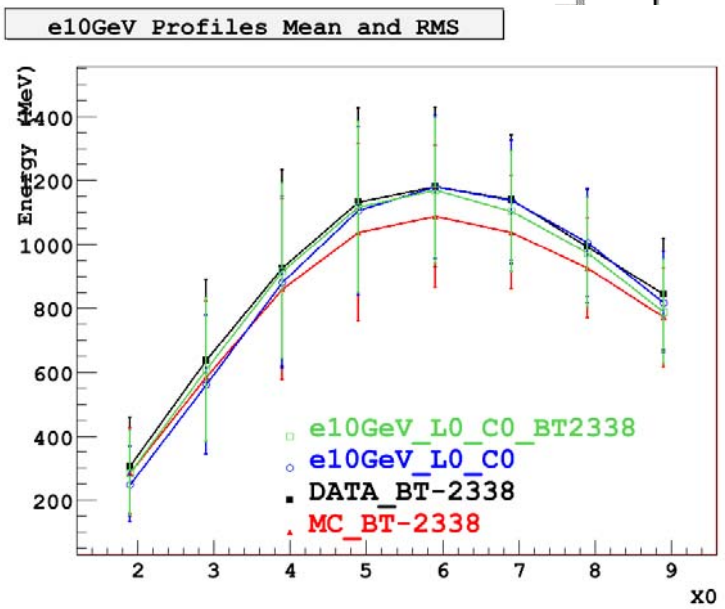
- Longitudinal EM shower profile in simple geometries (solid CAL)
  - earlier in Penelope
  - Later in mars15 and incosistent with general EM shower theory
  - Good matching withGeant4 and EGS5
  - well fitted by Γ functions in G4
- Lateral shower development
  - G4 is narrower wrt G3
- Stating the obvious
  - Geant4 has a correct description of EM showers
  - CAL gaps and TKR material are making the difference and we must keep them under control

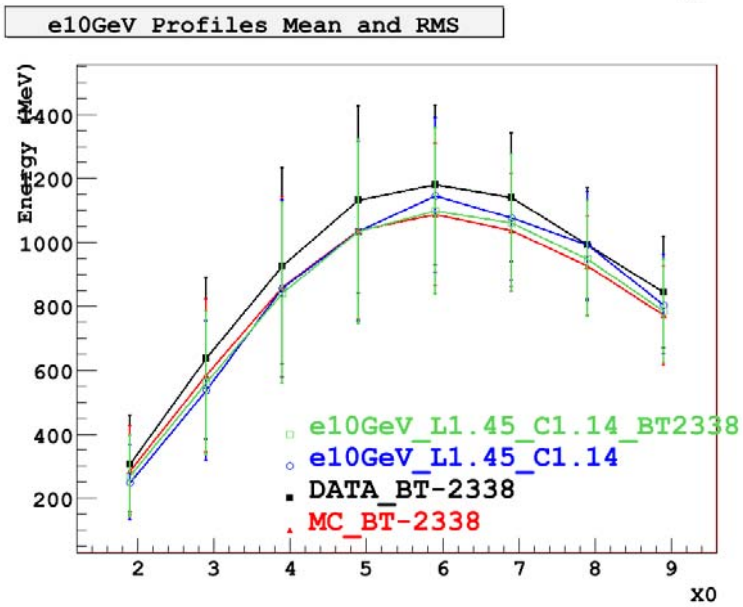


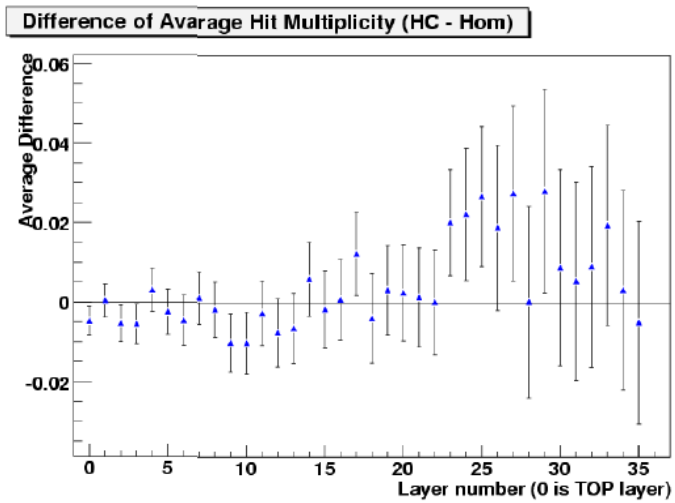


CU Tower G4-standalone simulation

- Decoupled detector geometry, particle propagation and generation MC code (G4), beam line simulation
  - The effect of gaps between crystals is important
- TKR Hits with realistic honeycomb vs averaged-density material
  - No effect on EM shower or TKR hits

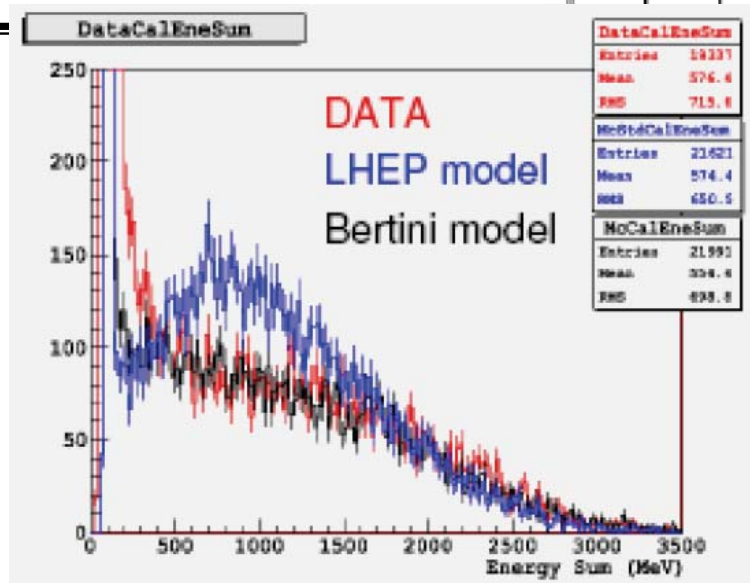


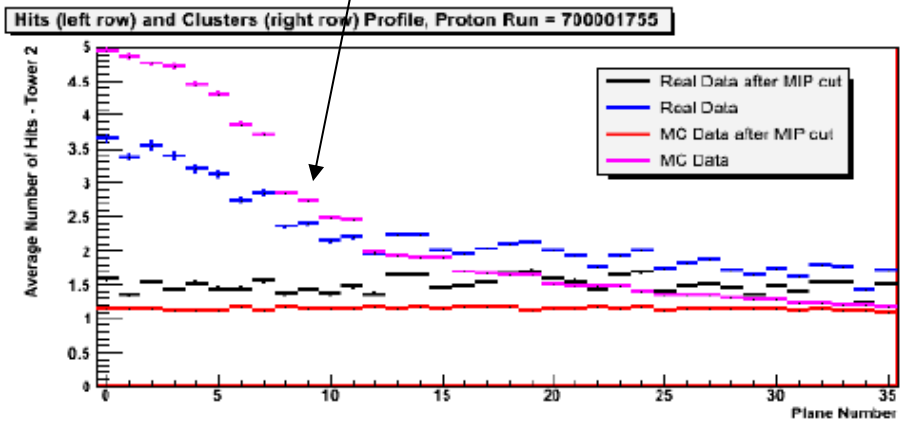


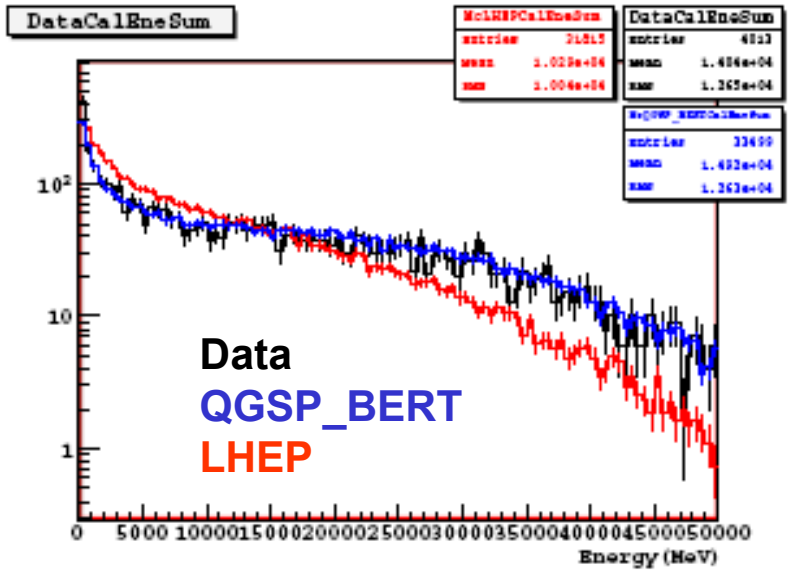


CAL Signal – Hadronic interactions

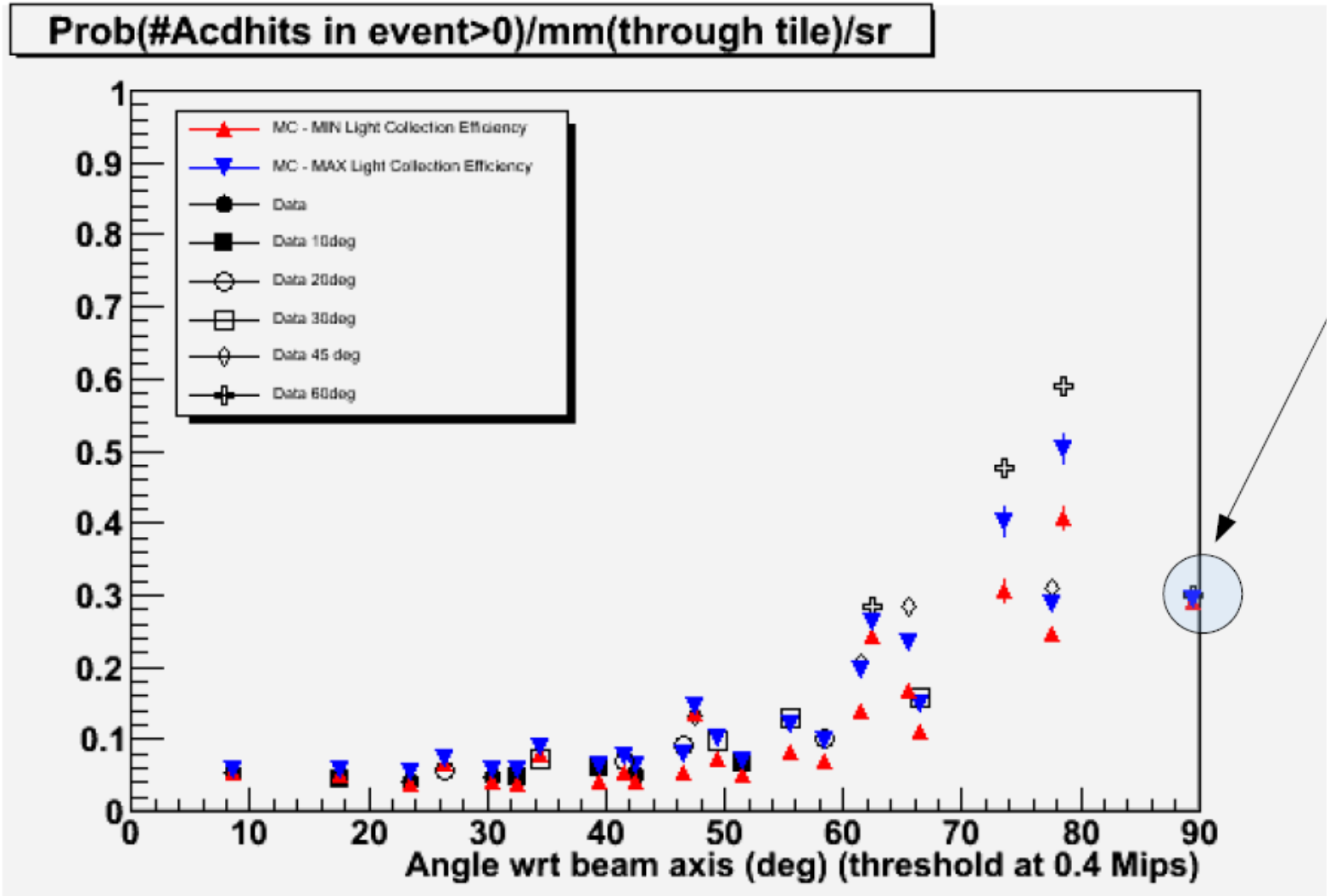
- crucial for bkgnd rejection
- Current best hadronic physics list
  - Bertini <10GeV
  - QGSP_BERT >20GeV
- But agreement is not perfect on whole phase space, e.g weird things to check in TKR hits





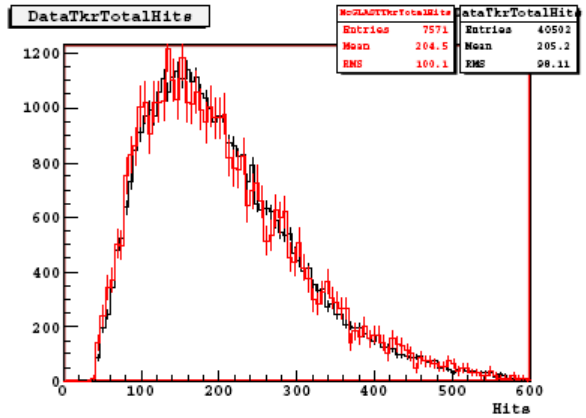


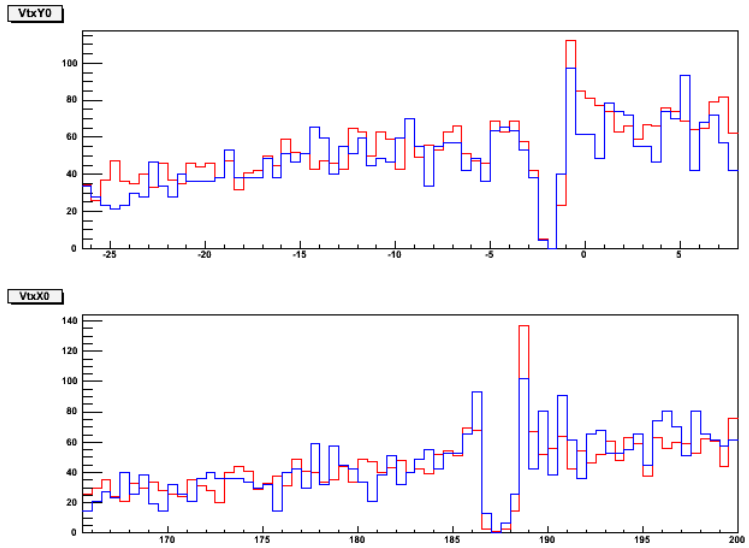
ACD Backsplash angle probability



Recent developments

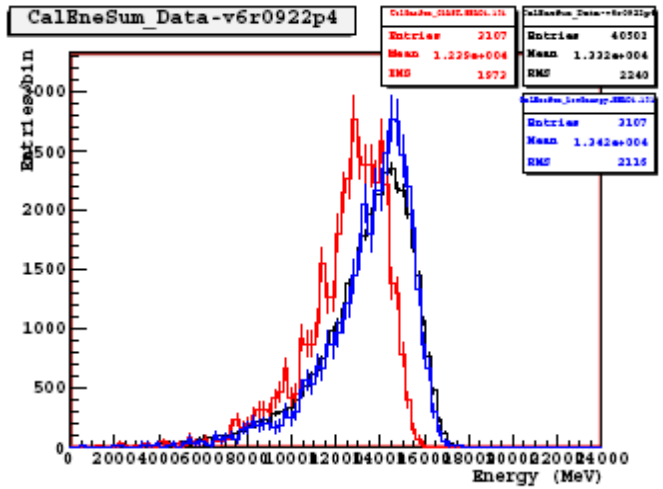
- **TKR alignment**
  - Greatly improved TKR hits turning on alignment in MC (i.e mis-aligned and then aligned)
  - Eventually tracked to a bug displacing delta-rays away from main track
  - Bug was quick-fixed
  - Back to old discrepancy
  - Alignment works well
  - Quick solution for a data-like TKR simulation

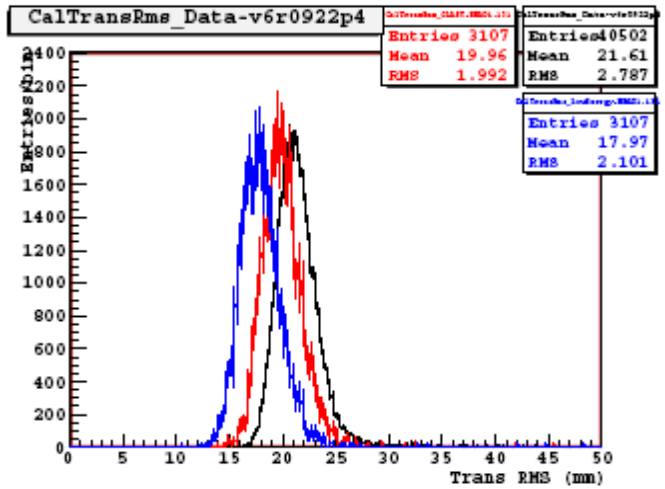




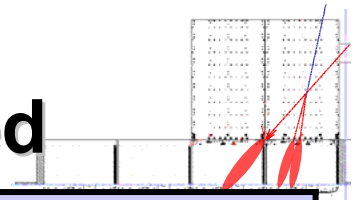
Recent developments

- New LE simulations after synchronizing updates in GLAST simulation management of G4 hadronic physics
  - More energy, narrower shower
  - Suspicious double energy release in TKR and ACD
  - Immediate check with automatic BT system test with standard plots collected so far
  - Maybe a starting point for a data-like CAL simulation



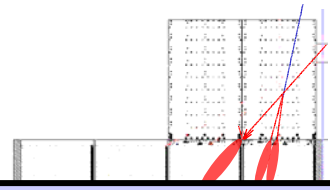


Beam Test Deliverables - delivered



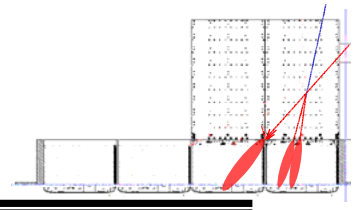
Topic	Software update	Description	notes
Tkr digitization	✓ TkrDigi v2r6	Charge sharing and ion signal	No significant changes to TKR hit counts
Cal calibration procedure	✓ column-wise charge injection in CAL CPT	Correct non-linearities in charge injection	Improved CAL calibration but did not solve energy shift Default calibration for the LAT Not relevant for simulation
CalRecon	✓ GRv11	Correct xtal and inter-range xtalk	Require mapping of xtalk for the LAT Not relevant for simulation
AcdDigi	✓ GRv11	better single ph-e signal simulation	
Hadronic physics list	✓ GRv12		1 background run with LE model (Bertini) already produced in current SC
TKR Material audit	✓ GRv12	Real TKR W thickness (-8%)	Must complete review of other subsystems

Beam Test Deliverables



Topic	Expected delivery	Description	notes
TKR Material audit	End september	Passive material real mass	Missing mass in current model mostly around active area – probably small effect
CAL Material audit	End september	Real CAL mass	Preliminary surveys indicate current model is good
TKR alignment in MC	Quick fix available	Fix bug in MC alignment	Checking out alternative alignment philisophy
Background simulations with higher TKR hits	End september	Increase nb of simulated TKR hits to mimick BT data	Check effect of TKR hit discrepancy on bkg rejection
Background simulations with shifted CAL energies	End september	Scale simulated CAL energies to mimick BT data	Will start with average value. Require full mapping of meaningful variables (CalTransRms, single-layer energy …)
Final best physics list	November	Final MC tuning	Possibly dig deeper into single processes parameterization

Conclusions



- Fundamental detector performance validated
  - Angular and energy resolution, backsplash probability and angular resolution
- Beam Test successes
  - Complete material audit
  - Improved TKR and ACD signal simulation
  - CAL calibration extensively reviewed and corrected for non-linearities and cross-talk
  - Improved hadronic physics list for background rejection
  - Geant4 package and LAT simulation scrutinized and in good shape
- Residual issues
  - total number of TKR hits and energy scale
  - No obvious simulation fine-tuning
  - Preparing data-like simulation to test background rejection and event reconstruction