GLAST Large Area Telescope:

Overview of GLAST Offline Software

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http://www-glast.slac.stanford.edu/software

Outline

- The GLAST mission and instrument
- Introduction to GLAST simulation and reconstruction
- Beg Borrow and Steal (® Bob Jacobsen)
- Use of Gaudi
  - Tools
  - G4 interface
  - Root I/O
  - Calibration Infrastructure
- Track Reconstruction in a (massive) pair conversion telescope
- Links to other GLAST talks at CHEP03
- Summary

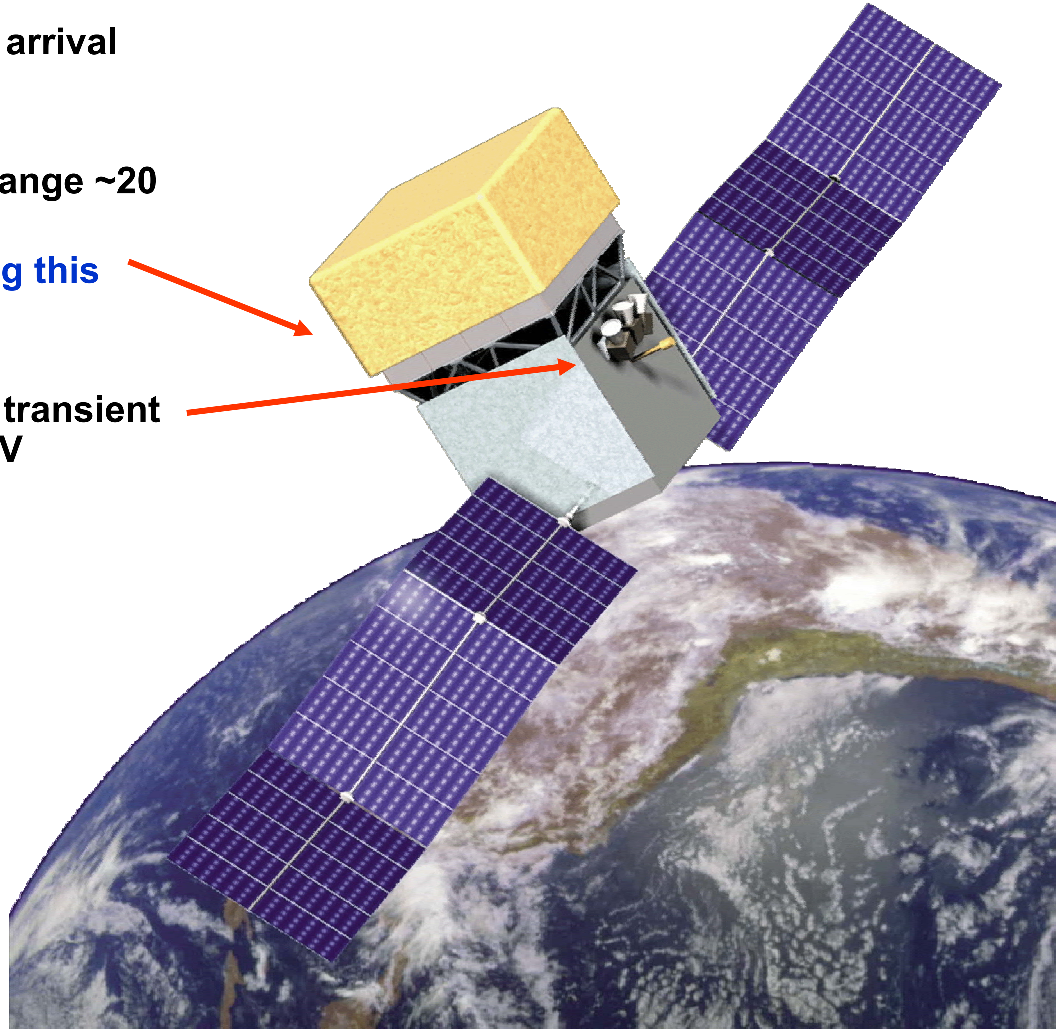
GLAST Mission

GLAST measures the direction, energy and arrival time of celestial gamma rays

-LAT measures gamma-rays in the energy range ~20 MeV - >300 GeV

- There is no telescope now covering this range!!

- GBM provides correlative observations of transient events in the energy range ~20 keV – 20 MeV

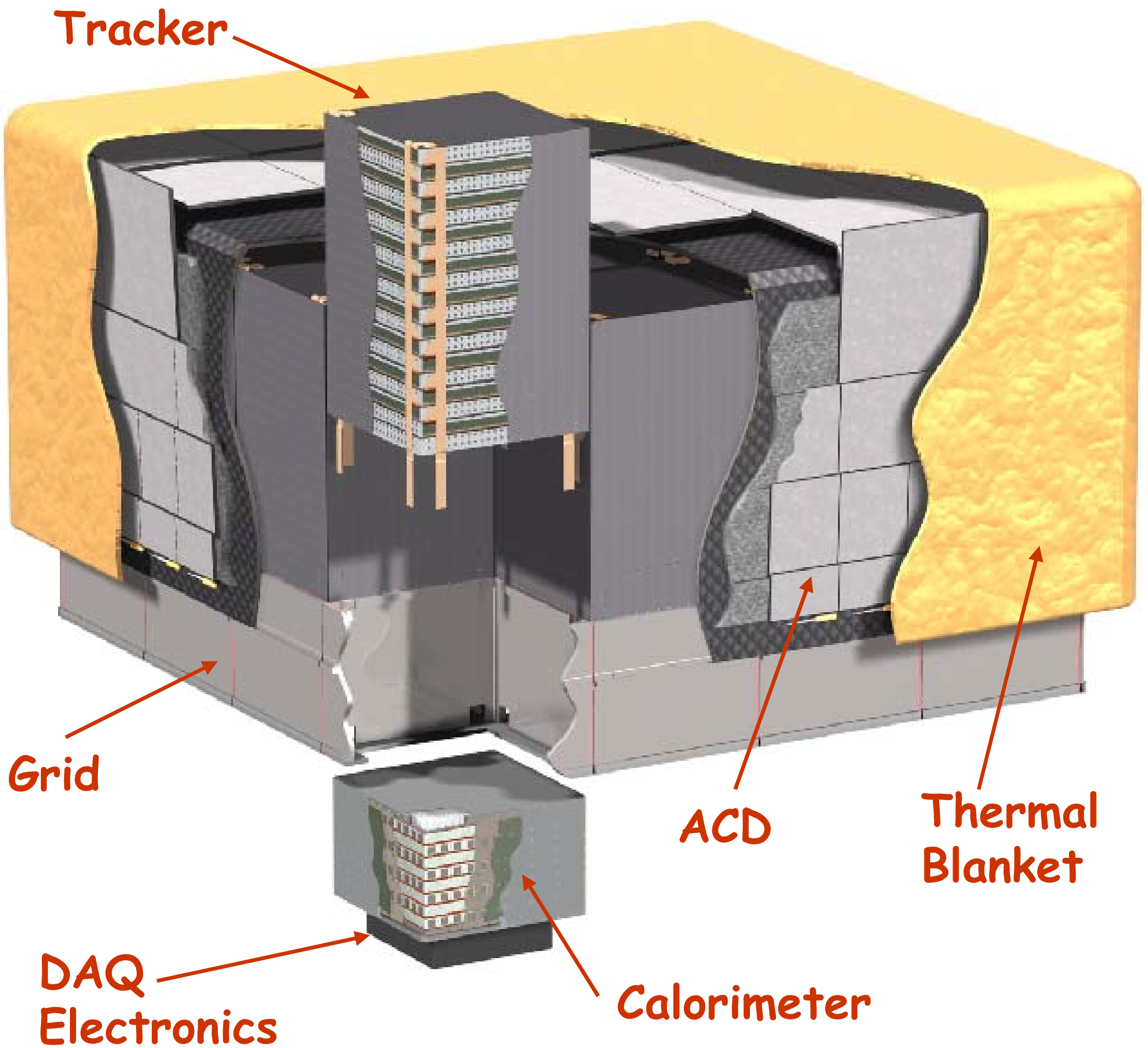


Launch: September 2006 Florida

Orbit: 550 km, 28.5° inclination

Lifetime: 5 years (minimum)

GLAST Instrument: Large Area Telescope (LAT)



- Array of 16 identical "Tower" Modules, each with a tracker (Si strips) and a calorimeter (CsI with PIN diode readout) and DAQ module.
- Surrounded by finely segmented ACD (plastic scintillator with PMT readout).

Sim/Recon Toolset – Beg, Borrow and Steal

applications

- unique to GLAST

Root, IDL – analysis

TkrRecon, CalRecon, AcdRecon, Astro sources

GEANT4 – simulation package

xml – geometry, parameters

Root – object I/O

Gaudi – code framework

doxygen – doc

VC++ – Windows IDE
gnu tools - Linux

vcmt – Windows, Linux gui

CMT – package version management

ssh – secure cvs access

cvsweb – www view of repo

cvs – file version management

utilities

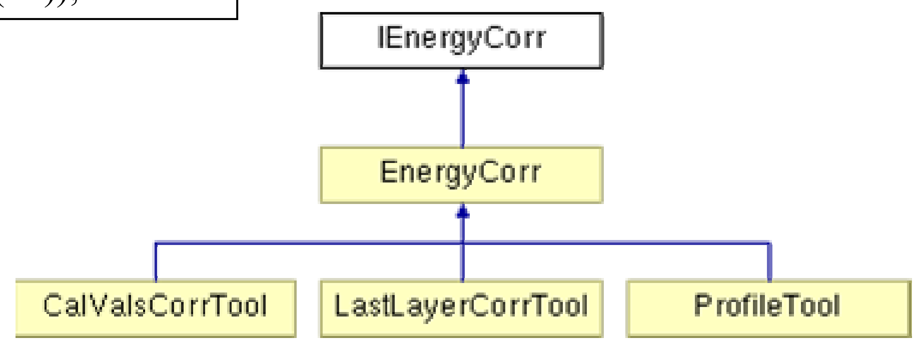
Example of Using Gaudi Tools

```
IEnergyCorr* m_lastLayerTool;
sc = toolSvc()->retrieveTool(m_lastLayerToolName, m_lastLayerTool);

m_lastLayerTool->setTrackSlope(slope);
m_lastLayerTool->doEnergyCorr((*it)->getEnergySum(),(*it));
```

Retrieve tool by name via base class

Refer to base class functions. Does not know which concrete tool it is.



Concrete classes that customize behaviour

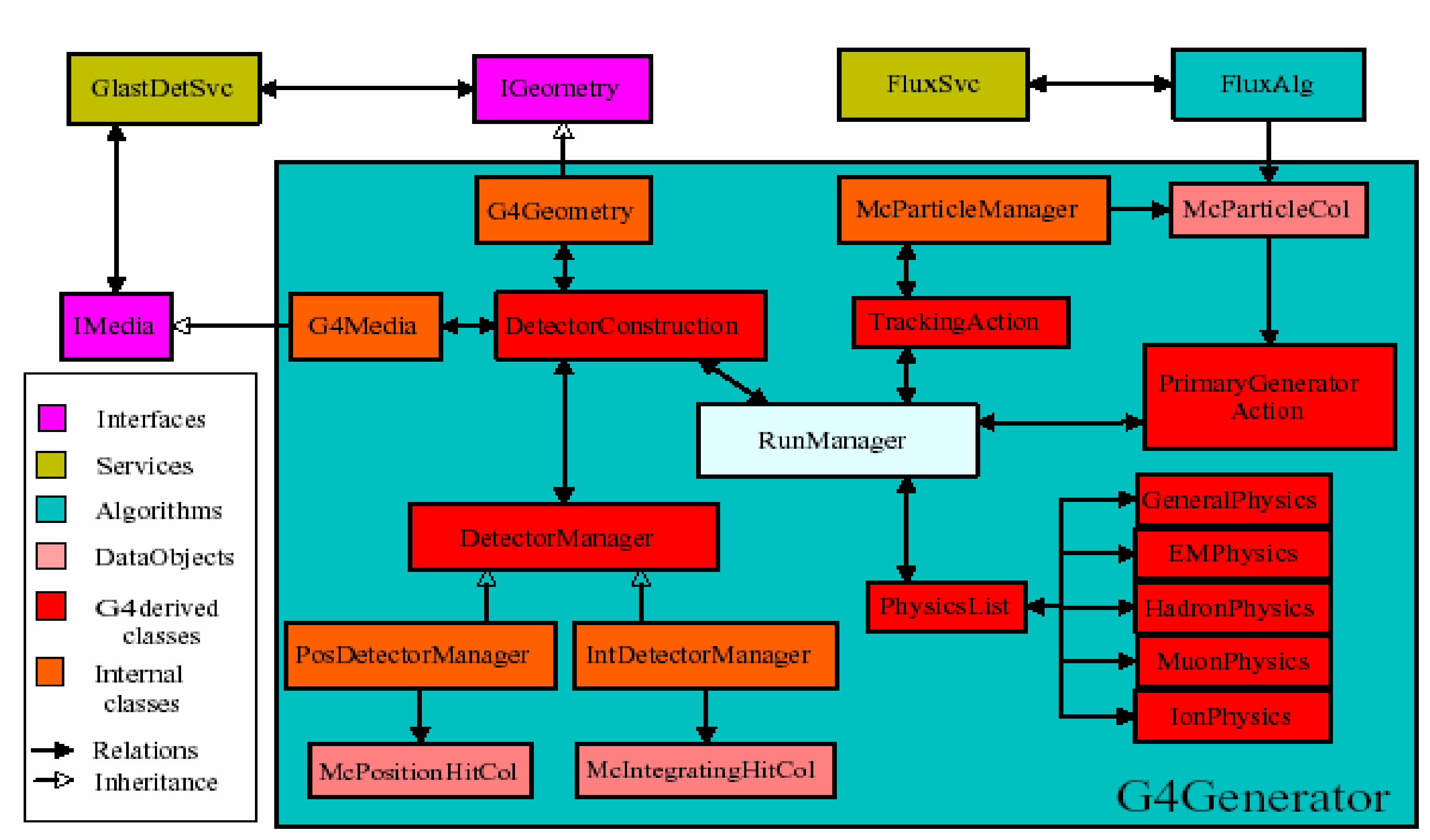
jobOptions

Parameters:

CalClustersAlg.callNumber	this parameter is used to distinguish multiple calls to **CalClustersAlg** (for example, before and after TkrRecon). The default value is 0 .
CalClustersAlg.clusterToolName	name of tool performing clustering. Default is **SingleClusterTool**
CalClustersAlg.lastLayerToolName	name of tool performing last layer energy correction
CalClustersAlg.profileToolName	name of tool performing profile fitting energy correction

Tools id'ed by name in ascii config file ("jobOptions")

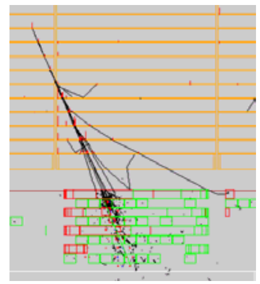
Gaudi Interface to Geant4



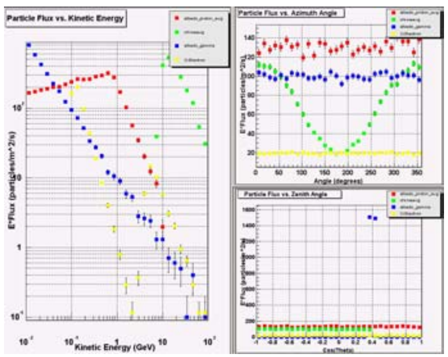
http://www-glast.slac.stanford.edu/software/core/documentation/reviews/G4Generator/g4greview.pdf

Instrument Simulation and Reconstruction

3 GeV gamma interaction



Source Fluxes

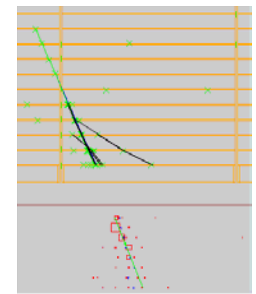


Particle Transport

"Raw" Data

Instrument data

Recon

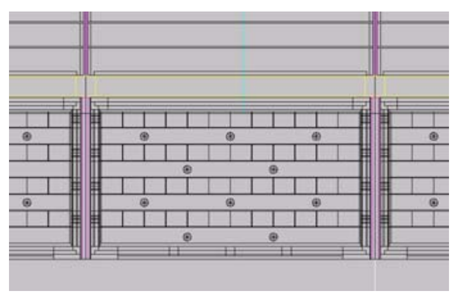


3 GeV gamma recon

Geometry

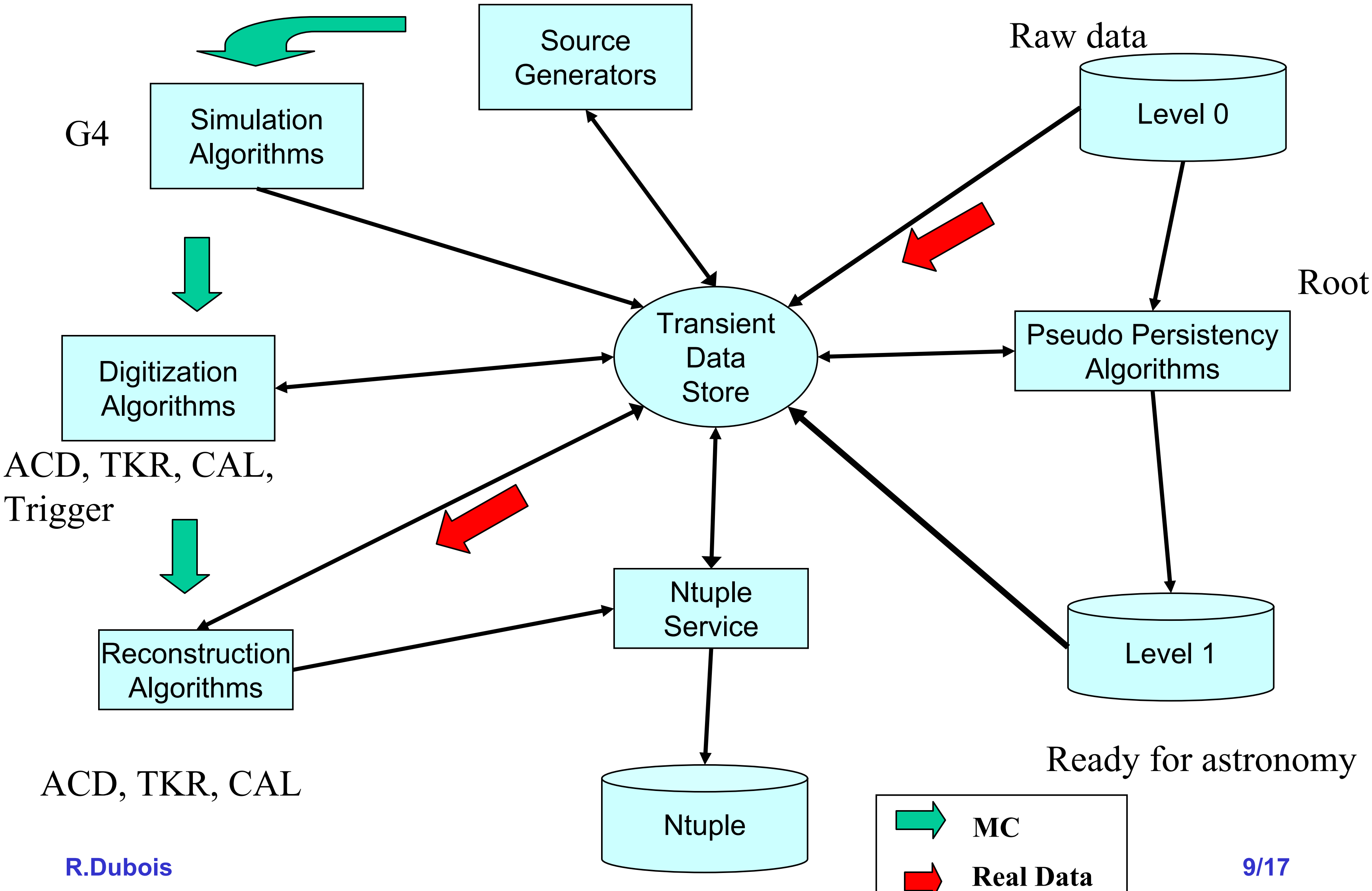
Background Rejection - Particle ID

Full geometry in xml with C++ interface
G4 discovers instrument from the xml

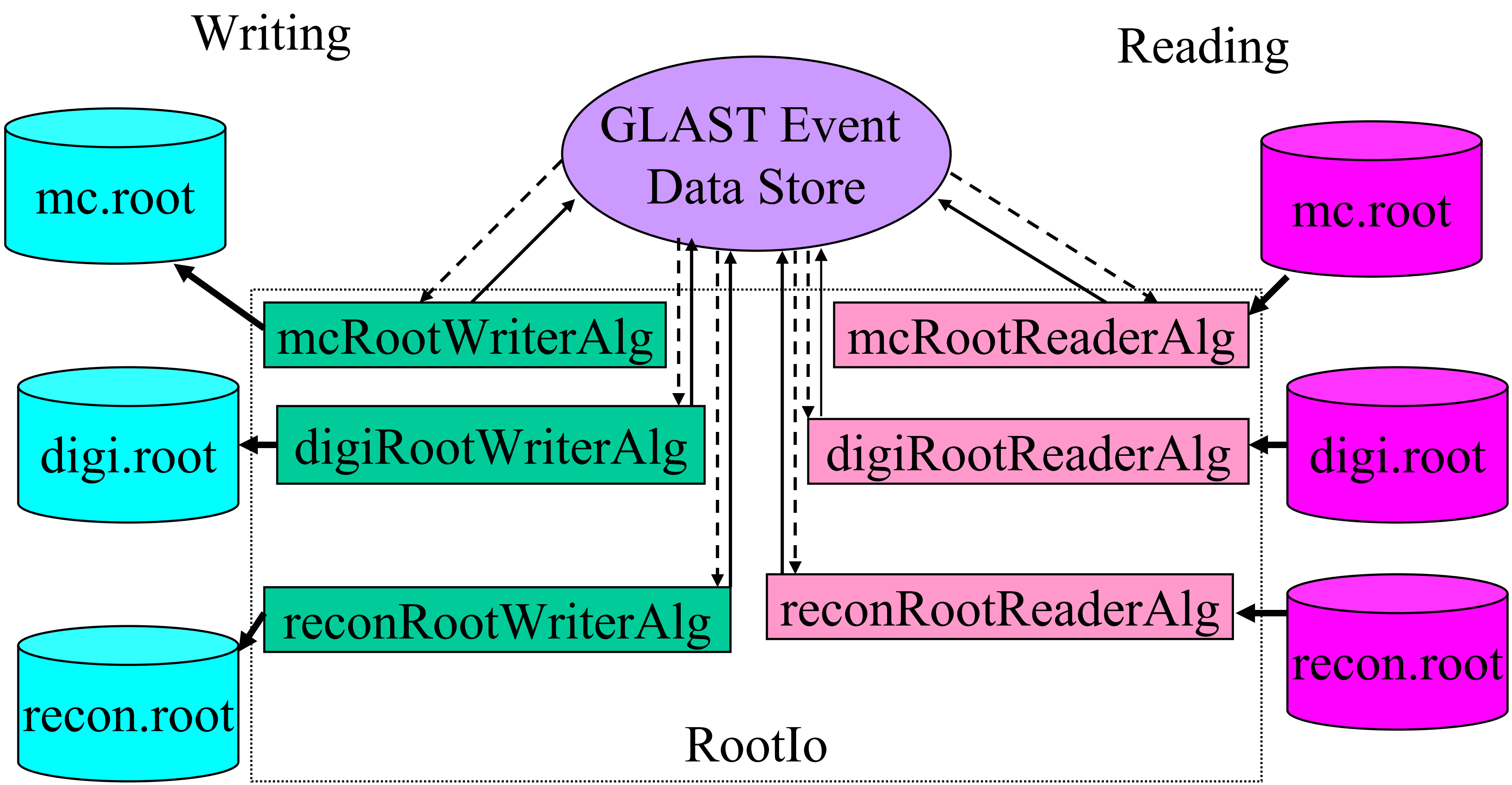


CAL Detail

Data flow in the Gaudi framework



RootIo – No TBlobs for Us



Problems and a Possible Solution

- **Use of algorithms is inconsistent with the spirit of Gaudi's Persistency Service.**
- **Does not provide fine control over what is read/written – it's all or nothing as currently implemented.**
- **Monolithic algorithms are more difficult to maintain versus light weight converters.**

- **There is a "real" ROOT service under development**

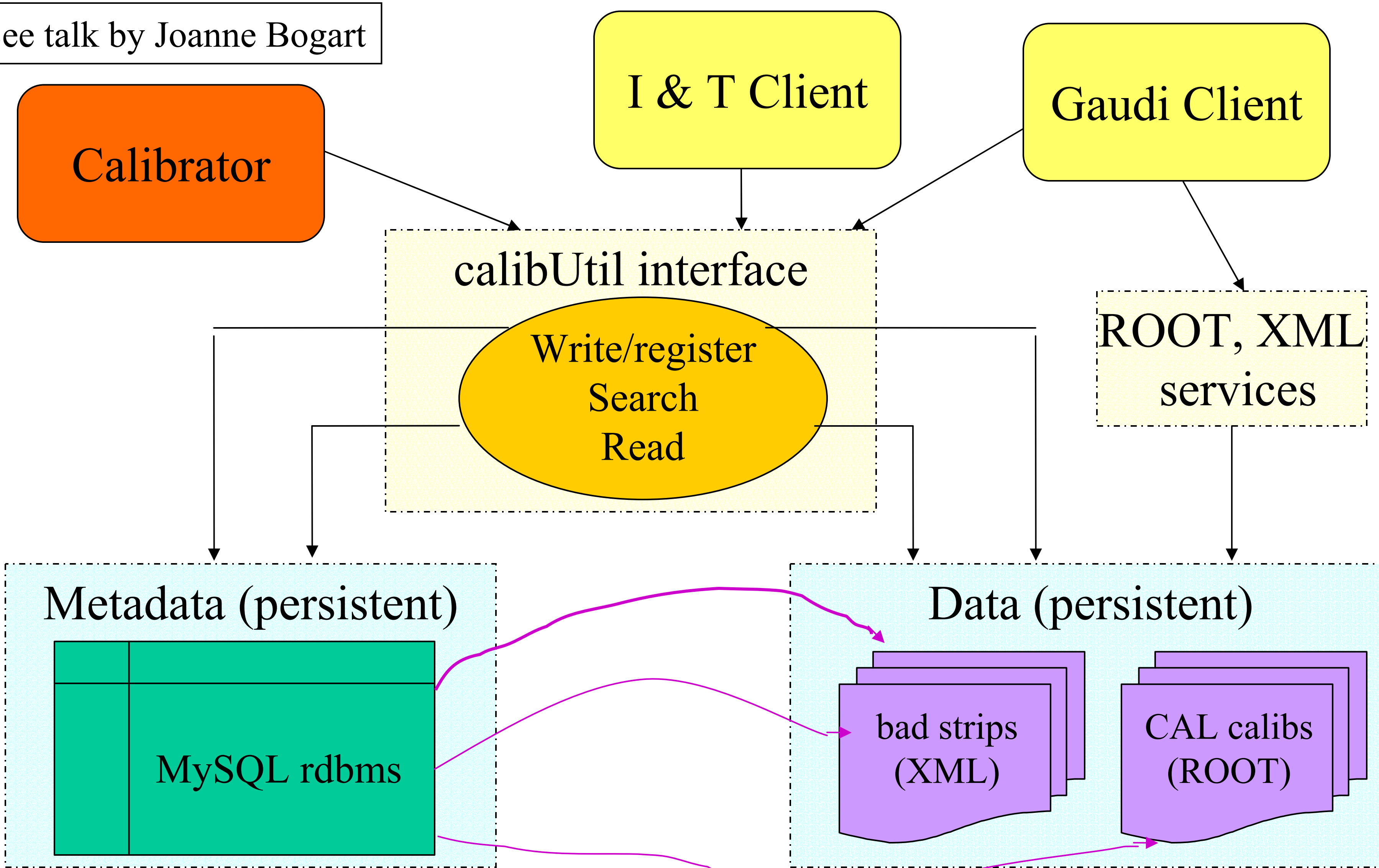
http://www.usatlas.bnl.gov/computing/software/db/rootio.html

  - **-ROOT I/O**
  - **-ROOT interactive session by demand**
  - **-ROOT share library dynamic loading by demand**
  - **-ROOT control over the Gaudi algorithms**

- **We hope to use this code directly, or modify it for our needs.**

Calibration Infrastructure Diagram

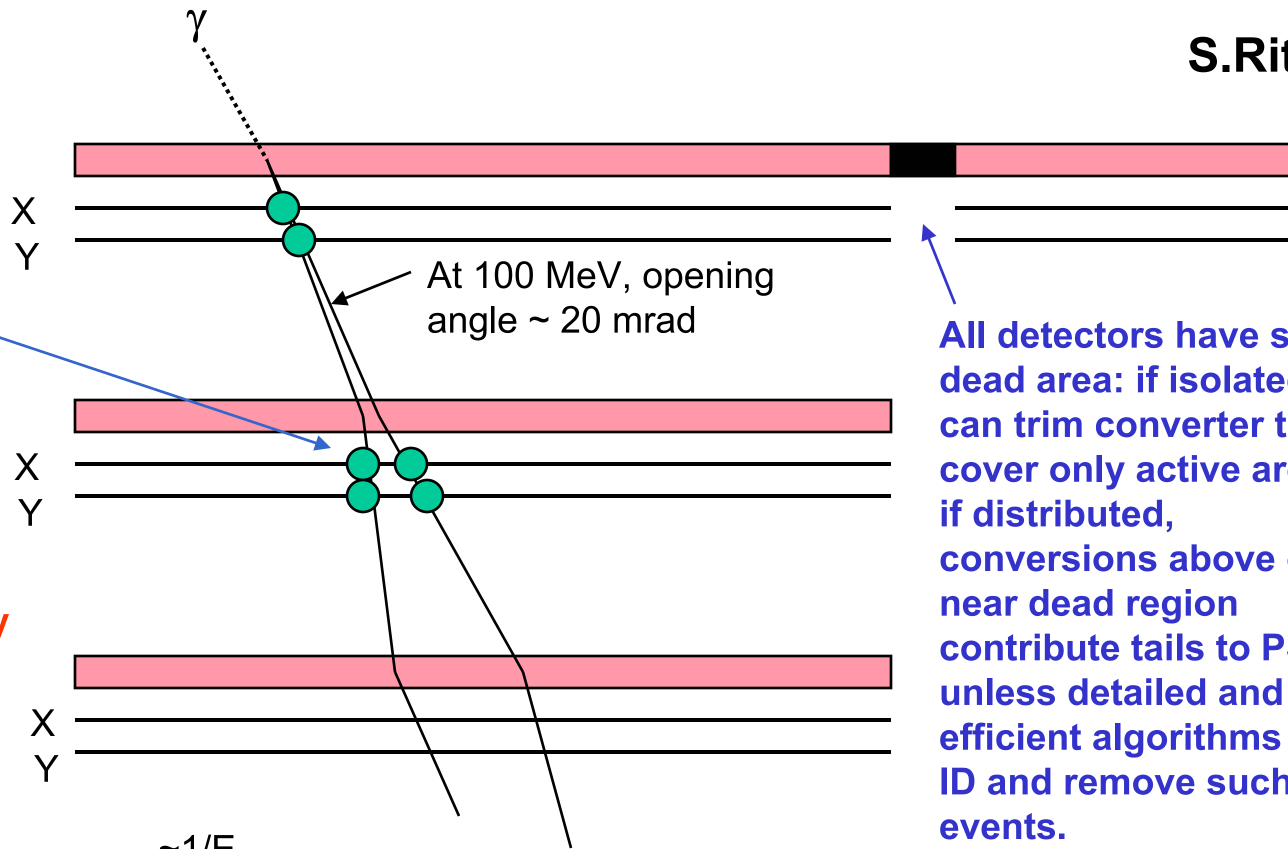
See talk by Joanne Bogart



Tracker/Converter Issues

Expanded view of converter-tracker:

S.Ritz

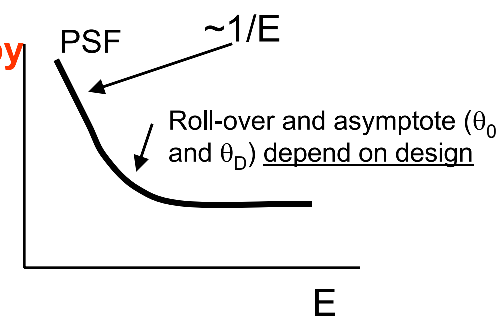


At low energy, measurements at first two layers completely dominate due to multiple scattering--

All detectors have some dead area: if isolated, can trim converter to cover only active area; if distributed, conversions above or near dead region contribute tails to PSF unless detailed and efficient algorithms can ID and remove such events.

Low energy PSF completely dominated by multiple scattering effects:
$\theta_0 \sim 2.9$ mrad / E[GeV]
(scales as $(x_0)^{1/2}$)

High energy PSF set by hit resolution/plane spacing:
$\theta_D \sim 1.8$ mrad.

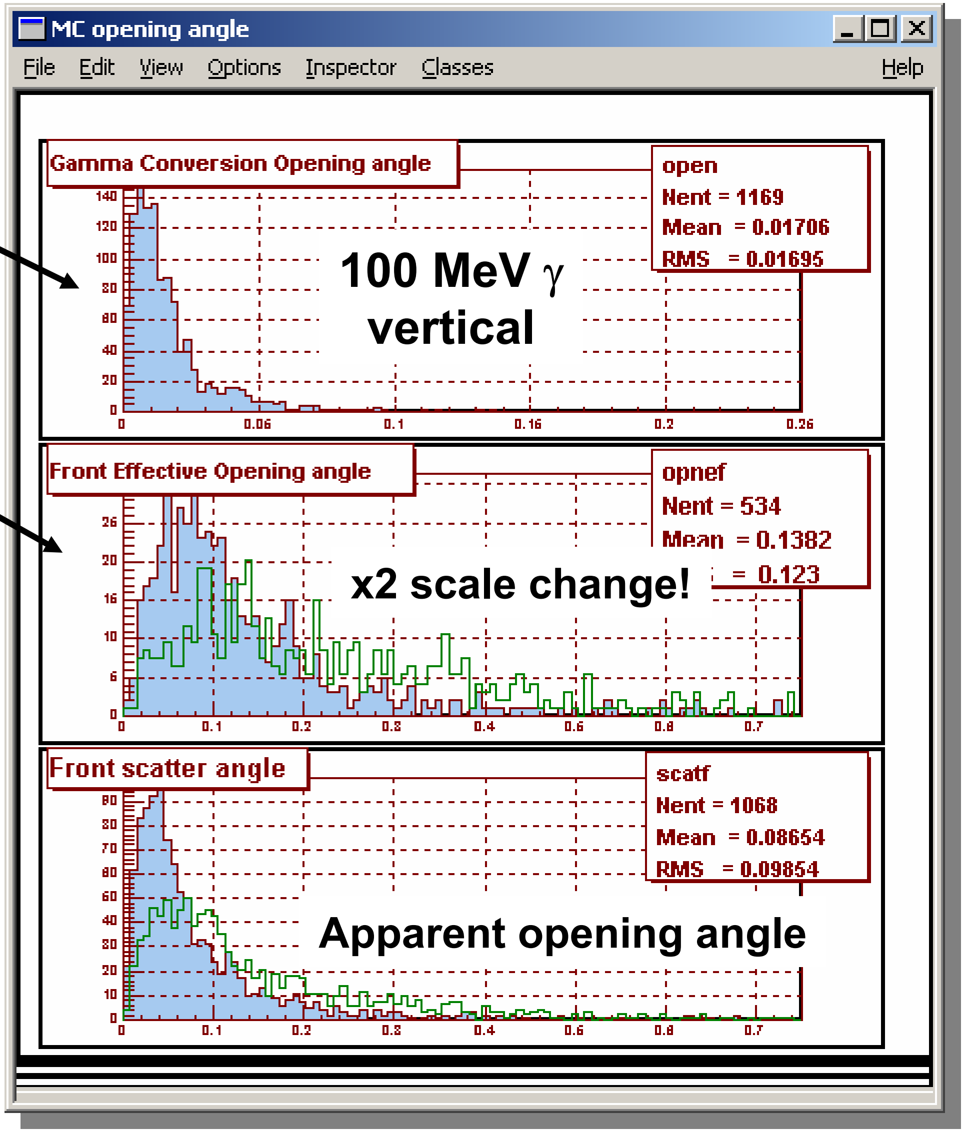


At higher energies, more planes contribute information:

Energy	# significant planes
100 MeV	2
1 GeV	~5
10 GeV	>10

Multiple Scattering in Converter Layers

- 100 MeV gammas
  - Mean angle: ~17 mr
  - Separation at next layer: ~550 μm
  - Strip pitch 228 μm
  - Barely resolvable into separate strip hits @100 MeV!
- MS blows up the opening angle significantly!
  - Mean angle: ~ 140 mr
  - Separation at next layer: ~4.5 mm
  - Easily resolvable
- Note design:
  - Blue is "front" 12 3% X0 layers
  - Green is "back" 4 25% X0 layers
    - Last 2 have no radiator
  - To optimize interaction rate vs resolution

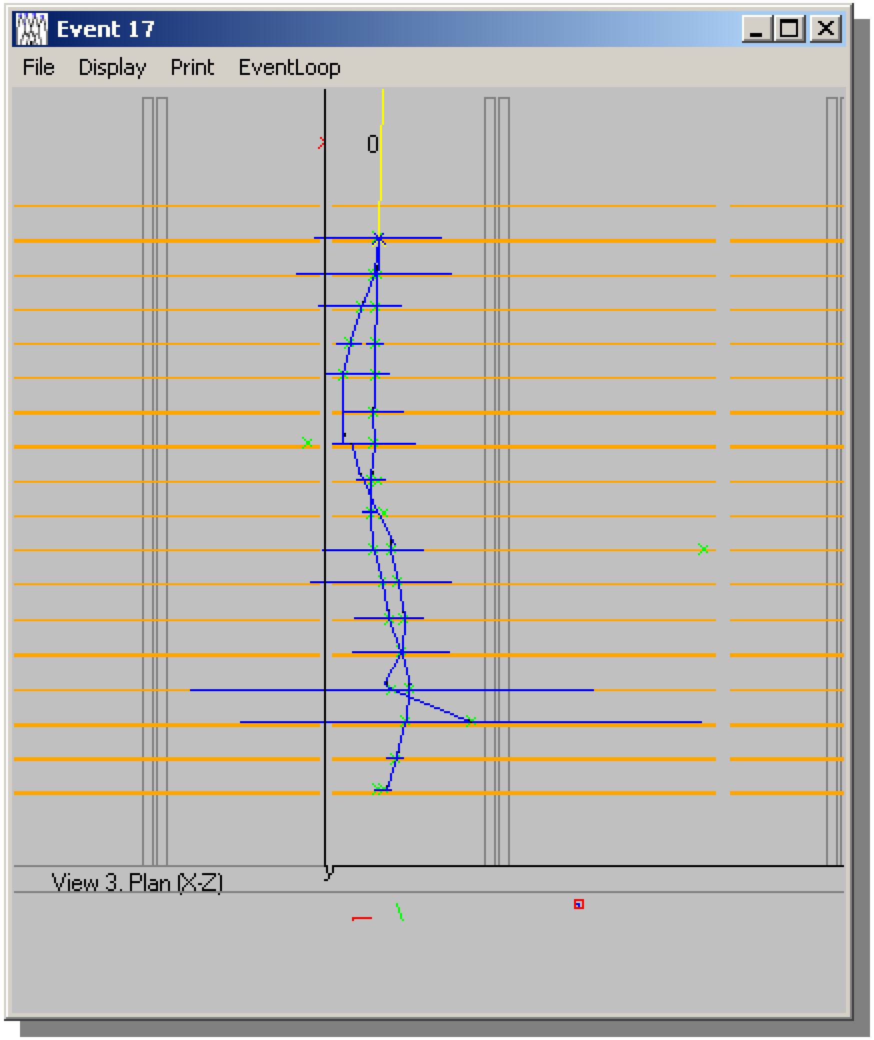


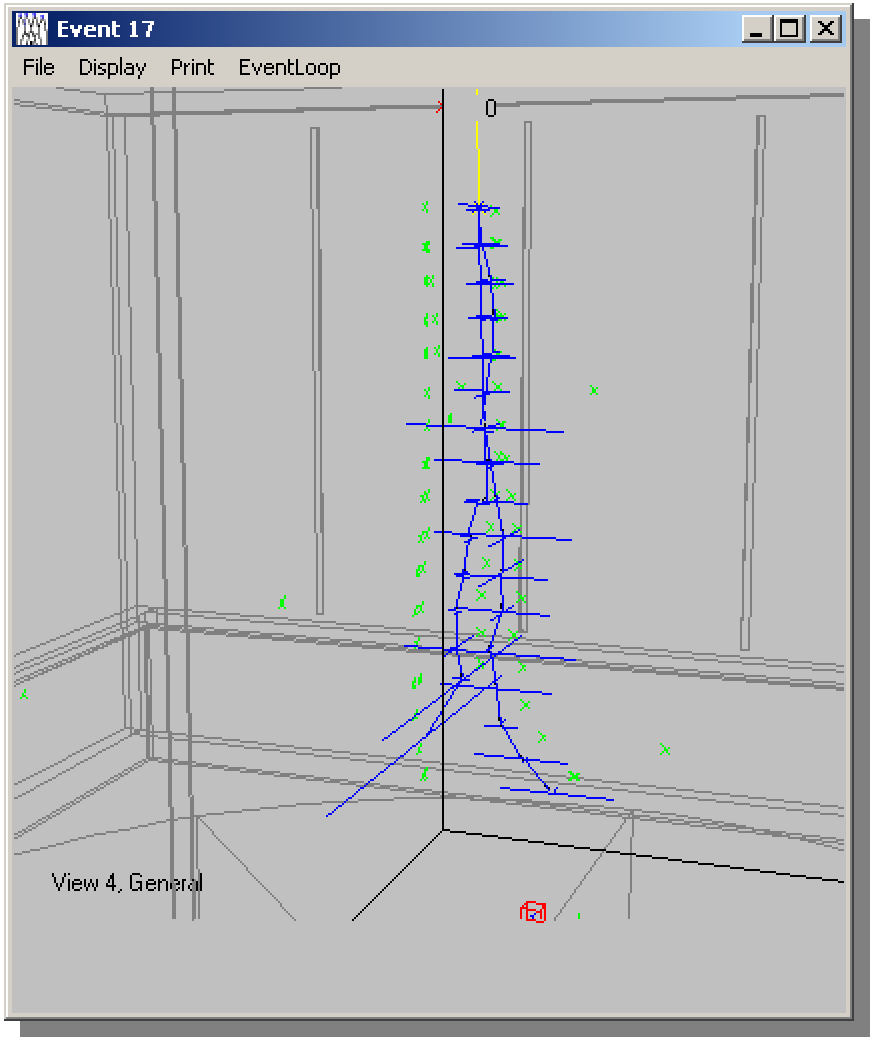
Multiple scattering critical to tracking at low E!

Use Kalman filter to account for large MS contributions

Tracking Reconstruction Example

100 MeV Gamma





GLAST Talks at CHEP03

- Simulation/Reconstruction Overview – R.Dubois
- System Tests and Build Environment – K.Young
- Calibration Infrastructure – J.Bogart
- GUIs on CMT – T.Burnett
- HepRep for GLAST – J.Perl
- FRED Event Display – R.Giannitrapani

Summary

- GLAST sim/recon has same problems as “the big boys”
- Adopted HEP standards
  - GEANT4, Gaudi, Root, CLHEP, CMT
  - Flexible geometry in xml to describe beam tests & flight unit without code changes
- Added user interfaces on top of CMT
- Pair converter recon is unique to GLAST