GLAST Science Analysis Software

Simulation and Reconstruction Status for DC1

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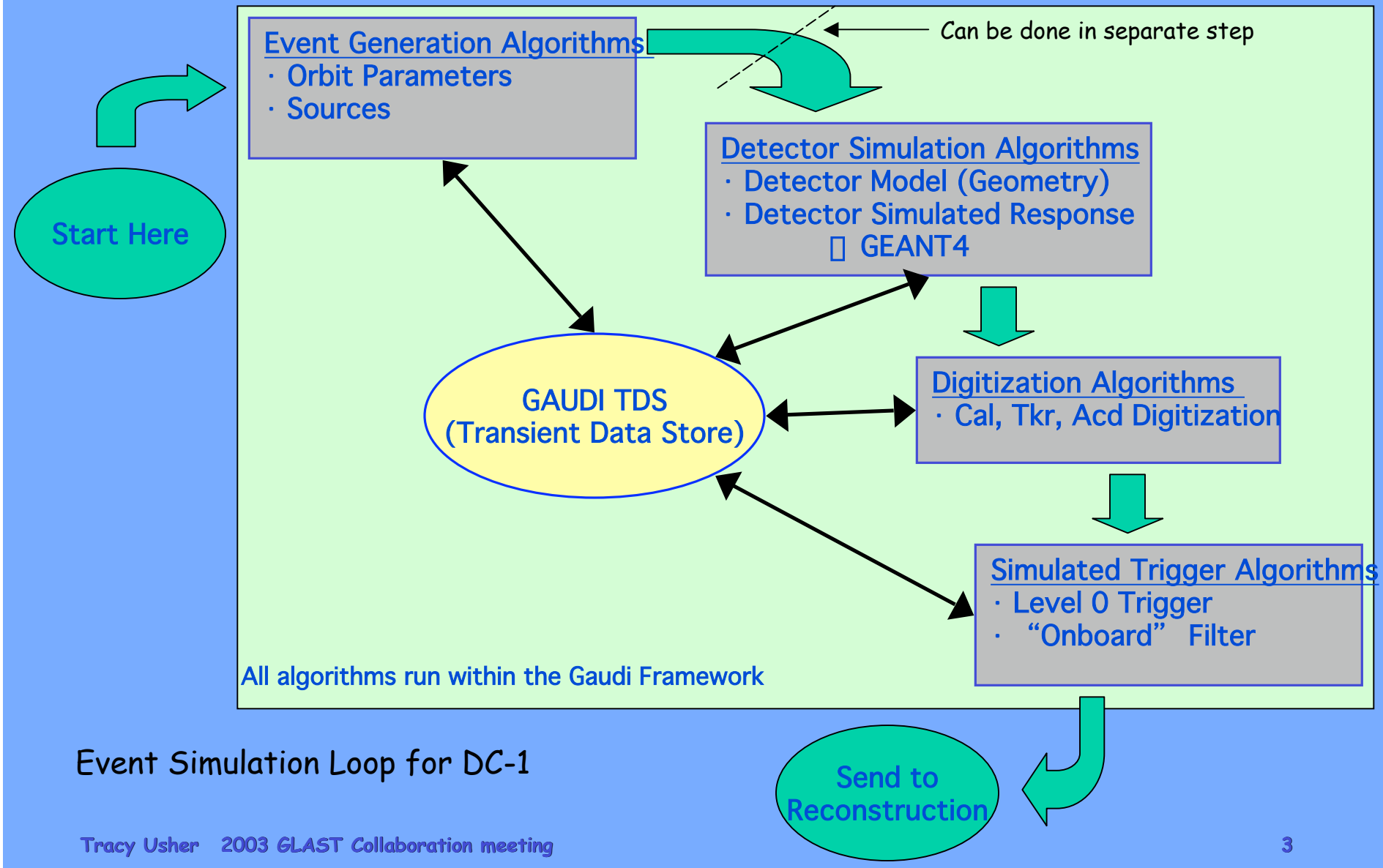
Outline

Goal: Overview of Sim/Recon to be used for DC-1

- Simulation
  - Event Generation / Sources
  - Simulation Framework
    - Detector Geometry
    - Geant4
  - Trigger / Onboard Filter
- Reconstruction
  - Cal Reconstruction
  - Tkr Reconstruction
  - Acd Reconstruction
  - Event Classification / AnalysisNTuple
- Processing
  - Strategy
  - Implementation
- Schedule

Simulation: Overview

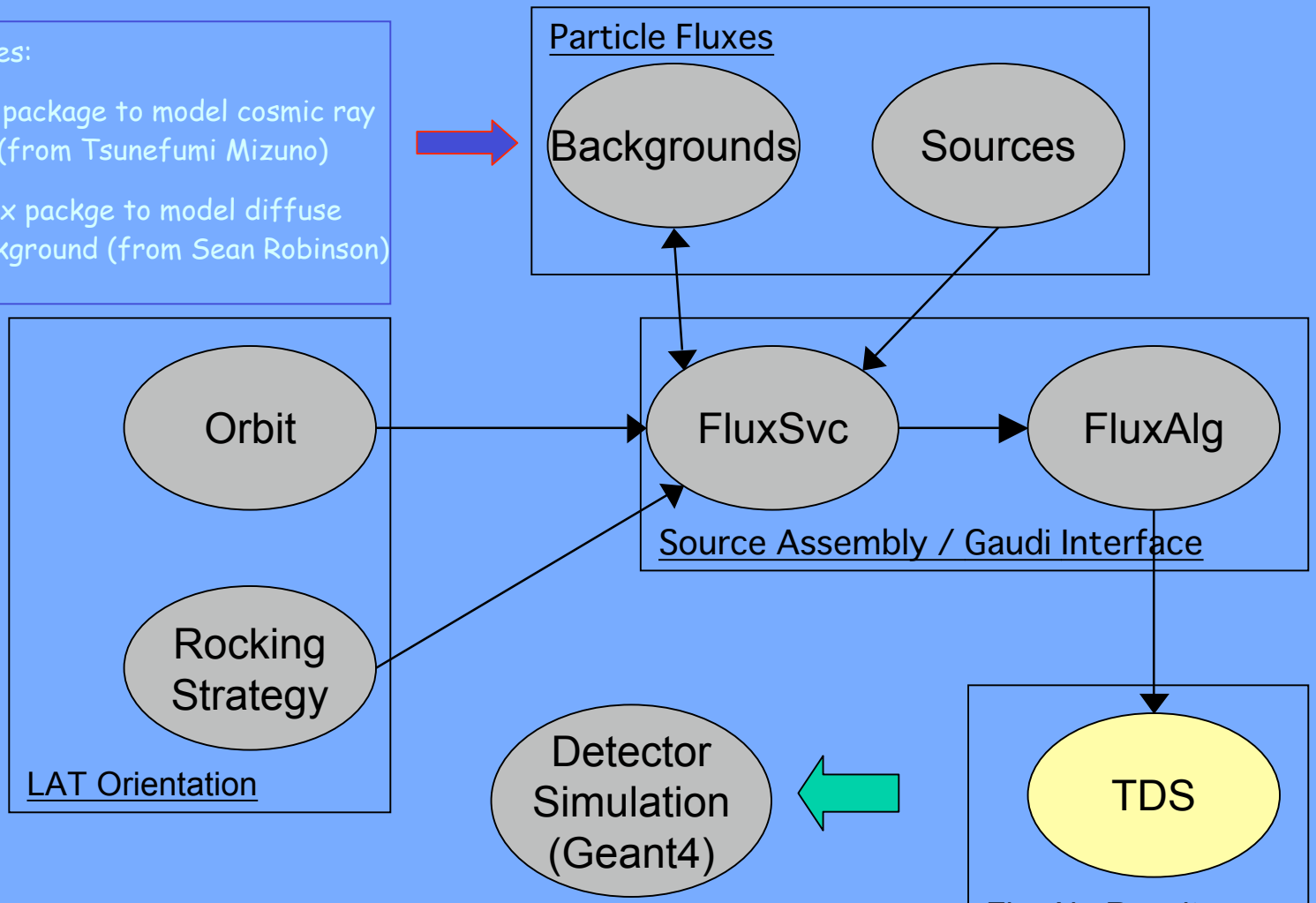


Event Simulation Loop for DC-1

Simulation: Event Generation

Sources Notes:

- New CRflux package to model cosmic ray background (from Tsunefumi Mizuno)
- New MapFlux packge to model diffuse galactic background (from Sean Robinson)
- ...



Strategy to Simulate Single Orbit Day for DC-1

Simulation: Detector Geometry

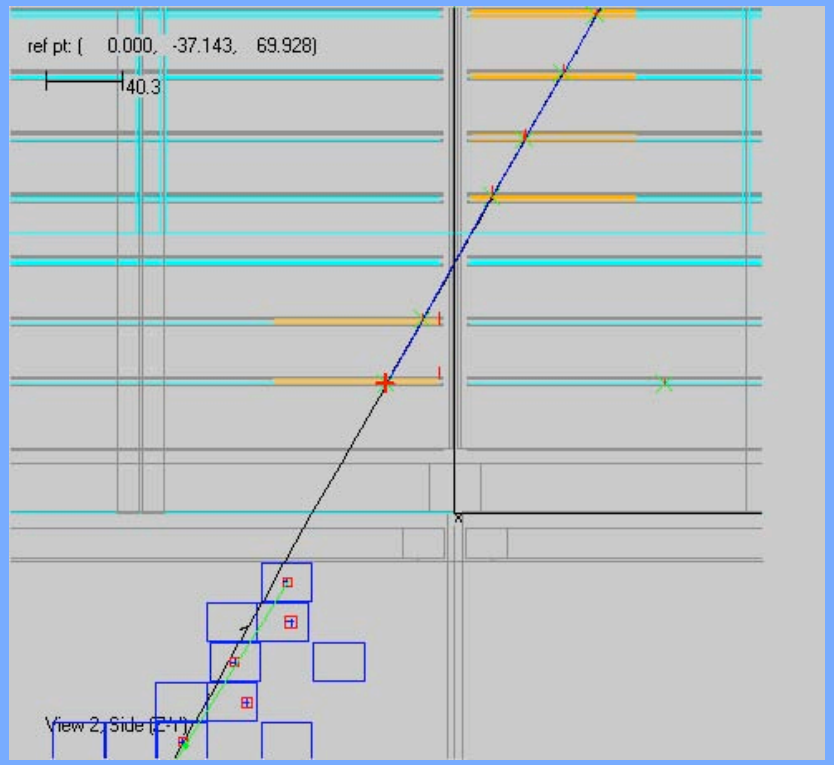
- Gleam uses the same geometry database for simulation and reconstruction.
  - Encoded in xml
  - Simulation builds its GEANT4 geometry using detModel
  - Reconstruction derives necessary positions, dimensions and materials directly from the xml database.
- The Data Challenge prompted reviews of the entire geometry
  - TKR, CAL, ACD
  - NAD (Not A Detector)
- Two "Passes"
  - Get the positions (and dimensions) right
  - Get the material right
- Several problems found / fixed
  - Basically, two categories:
    - Changes since geometry first "captured"
    - Mistakes in encoding into xml
  - While not completely negligible, these changes and corrections are expected to have only a minor effect on the results of our simulations.
- At this point, most of the modifications have been made.
  - The remainder will be made before the "real" DC-1 runs.

Simulation: Detector Geometry

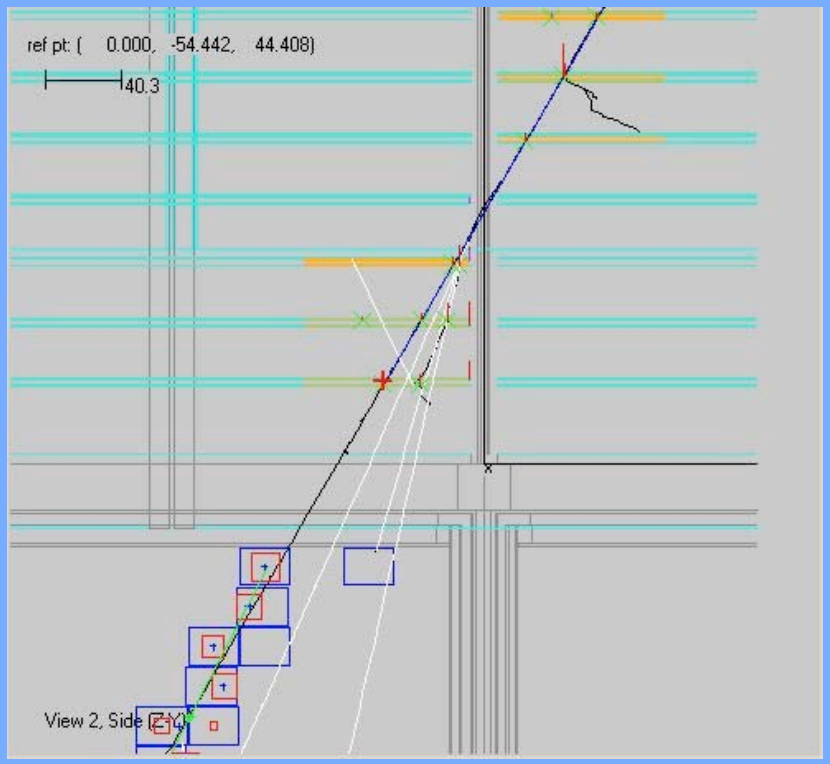
Cross Checking the Tracker Positions

Example of position problem: Tracker was found to be ~15 mm too high above the grid.

- Noticeable effect when projecting tracks into the Cal



Previous Gleam

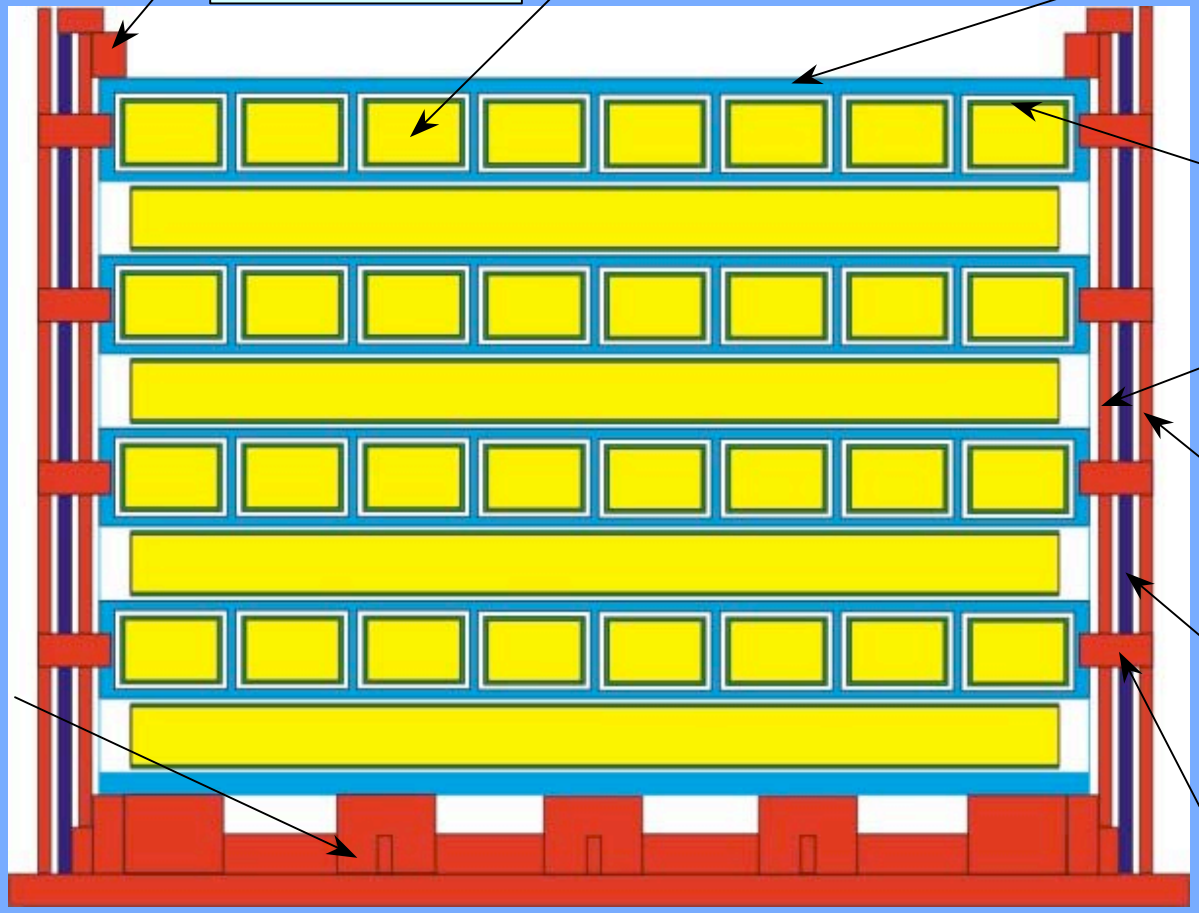


Latest Gleam

Simulation: Detector Geometry

CAL geometry overview

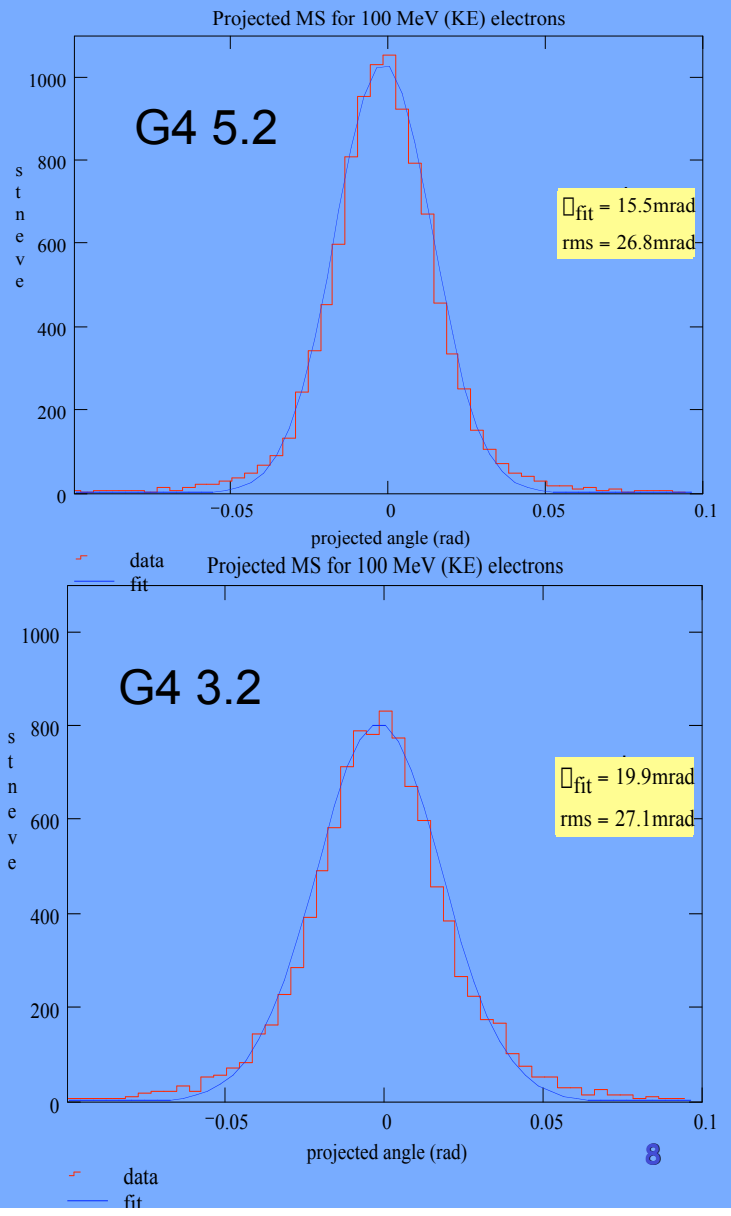
(not to scale – only 8 crystals per layer shown)



Simulation: Geant4 Status

Multiple Scattering Problem and DC-1 Solution

- Upgraded to Geant4 5.0 (from 3.2) in Feb 2003
  - Then to Geant4 5.1 in May 2003
- Motivation:
  - Newest version with many updates
  - In particular really wanted ability to set energy range cutoff values by "region"
- But…
  - Not backward compatible, many changes to the "RunManager" interface, etc.
- Problem (!!)
  - Discovered that a significant change, ~20% had happened from 3.2 to 5.1 in the multiple scattering widths (by getting too "good" answers!)
  - Example: 100 MeV e- incident on 105 μm of W
- Solution for DC-1
  - Upgrade G4 v3.2 MS code interface to v5.2
    - Get "region" range cut off and expected MS
  - Include ability to switch between versions



Simulation: Geant4 Status

Preventing the Problem for Future GLAST G4 Upgrades

- GEANT4 Side
  - Developing a validation framework
  - Providing GLAST support for interfacing to this validation framework
    - Tatsumi Koi (at SLAC)
- GLAST Side
  - "Trust but verify"
    - Assume GLAST must check G4
  - Develop test suite to allow validation of all physics processes
    - Processes to test
    - Recreate validation done by Tune, et al
    - Automated comparison of new G4 releases to previous to look for changes
    - Run validation test suite before switching to any new version of Geant4
  - Compare to data whenever possible
  - Work well under way
    - See comparisons next page
- Both Sides
  - Liaisons on both sides
  - GLAST will have access to prerelease code updates for testing
    - e.g. will have access to newest MS code for testing by end of October

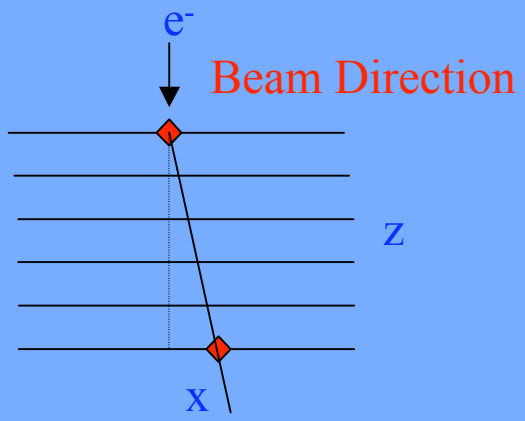
Processes Validation List

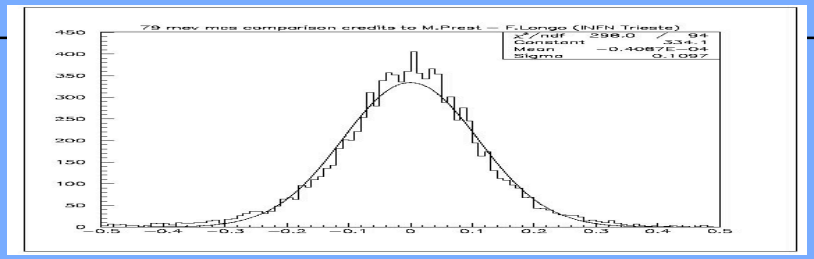
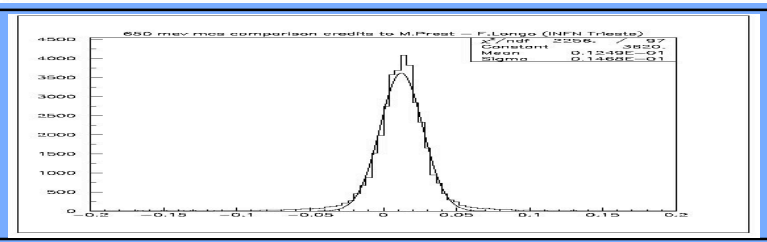
- Multiple Scattering
  - Angular distribution, Energy Dependence
- Photon processes: Photoelectric, Compton Scattering and Pair Production
- Cross Section, Angular and Energy Distribution
- Charged particles processes
- Ionization
  - Landau and Bethe Bloch
  - Range, Straggling, Stopping Power
- Bremsstrahlung
  - Cross Section, Angular and Energy Distribution
- Delta Ray production
  - Energy distribution, Multiplicity
- Positron Annihilation
- EM shower development
  Muon-nucleus interactions
- Neutron interactions
- HE hadron-nucleus interactions
- Nucleus-nucleus elastic scattering
- Hadronic showers in CsI
- Radioactive decay

Simulation: Geant4 Status

Multiple Scattering Validation with data

- Electron test beam at Frascati for AGILE, (2003) [F. Longo]
- Geometry:
  - 6 planes with 300 μm of W
  - Inter-plane distance 1.6 cm
- Analysis:
  - Require single cluster on the 1st and 6th plane
  - plot x/z



Energy (MeV)	Data: x/z distribuition	Fit sigma deflection (mrad)			
		Expt	G3	**G4 5.2**	G4 3.2
79		109	104	**81**	101
650		14.6	13.3	**8.4**	14.2

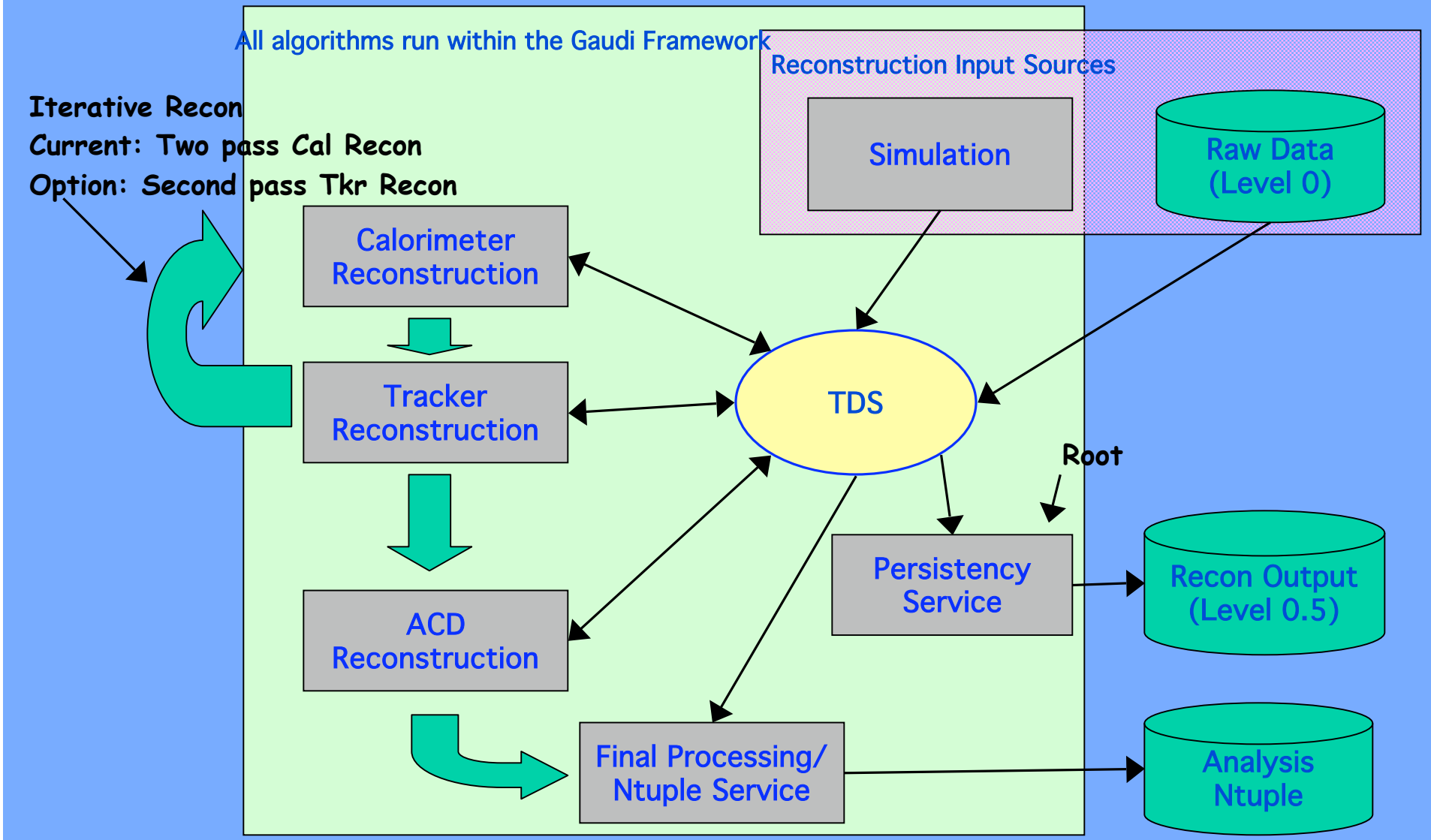
Default MS in simulation for DC-1

Simulation: Trigger and Onboard Filter

- Trigger
  - Did something interesting happen in the LAT?
- Basic Elements (in simulation)
  - Tracker 3-in-a-row
  - Cal Hi, Cal Lo
  - Etc.
- Keep Everything that passes?
  - 5 kHz rate
  - Too much data (?)
    - 10's of TB!
- Filter Triggered Events
  - Do we want to keep this event?
- Onboard Filter
  - Use JJ's Flight Software Filter Code in simulation
  - See Steve's talk from yesterday
    - Code ported to the simulation
    - Some diagnostics available
- Keep only events passing filter?
  - <30 Hz rate
  - 10's of GB

DC-1 Simulation will use the Onboard Filter "as is" to reject possible background events.

Reconstruction: Overview



Event Reconstruction Loop for DC-1

Reconstruction: CalRecon

- Pass 1 of CalRecon
  - Cal Digi's input
  - Apply corrections
    - Gains
    - Pedestals
  - Reconstruction
    - Sums over all layers
    - Initial position/direction
- Pass 1 output:
  - Total energy estimate
  - Cluster centroid position
  - Cluster direction

DC-1 Cal Recon will use two pass CalRecon with the "Shower Profile Method."

- Pass 2 of CalRecon
  - Input
    - Cal Digis (again)
    - Gamma direction from TkrRecon
  - Improved energy determination
    - Primarily Leakage correction
      - "Shower Profile Model" developed by Bill Atwood
      - "Last Layer correlations" developed by Berrie Giebels
        - » Lots of work currently underway on this algorithm but may not be quite ready for DC-1
- Pass 2 Output
  - Corrected energy
  - Cluster centroid position
  - Cluster direction

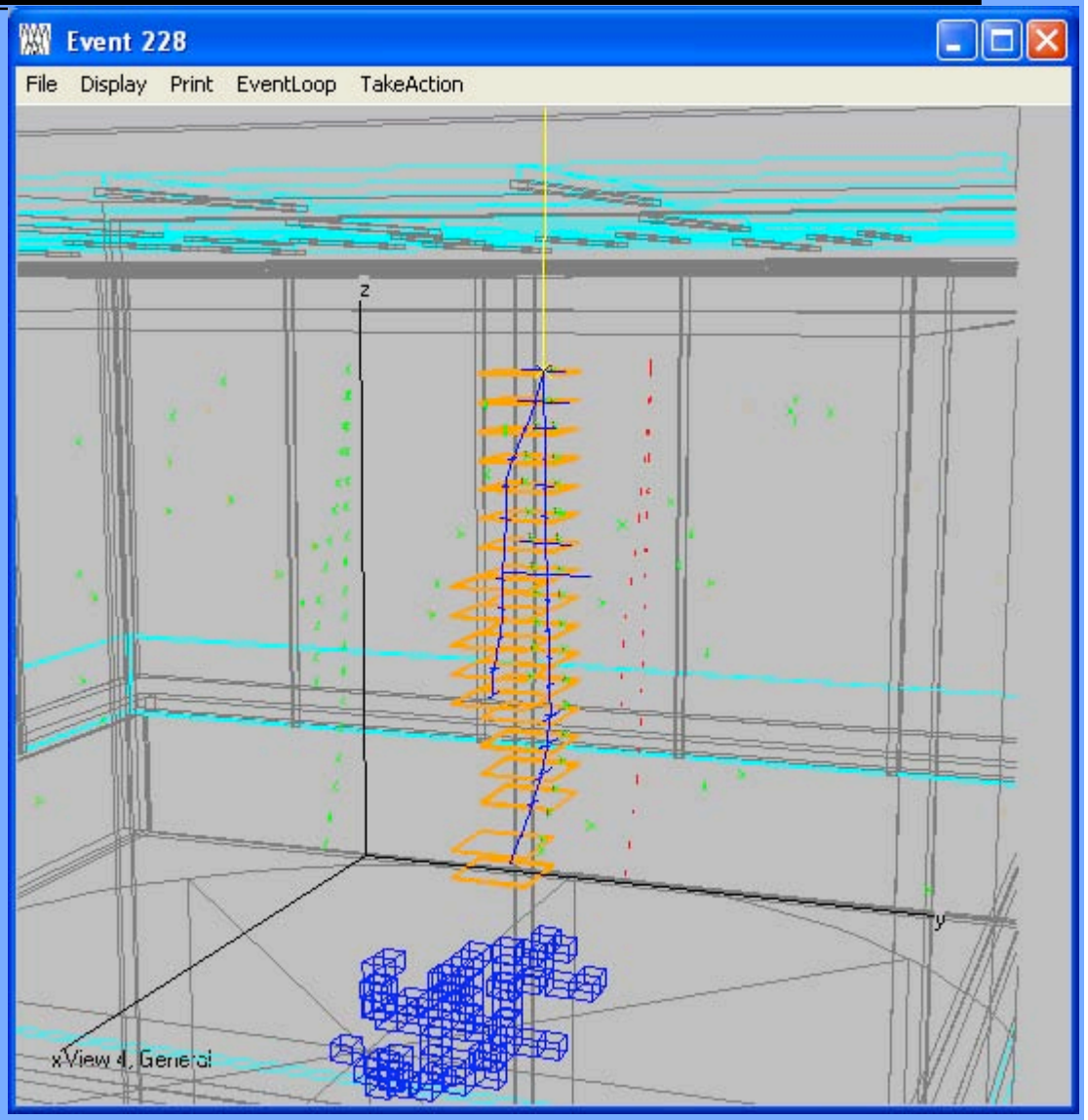
Reconstruction: TkrRecon

Tracking proceeds in four steps:

- Clustering
- Pattern Recognition
  - Use "Combo" Pattern Rec
    - Brute Force approach
    - By far best understood approach
  - Most important step!
- Track Fitting
  - Kalman Filter Track Fit
    - Need good Energy from Cal/Tkr
- Vertex Finding/Fitting
  - Straightforward
    - Combine two approaches in one
- **Reconstruction for DC-1**

Iterative TkrRecon

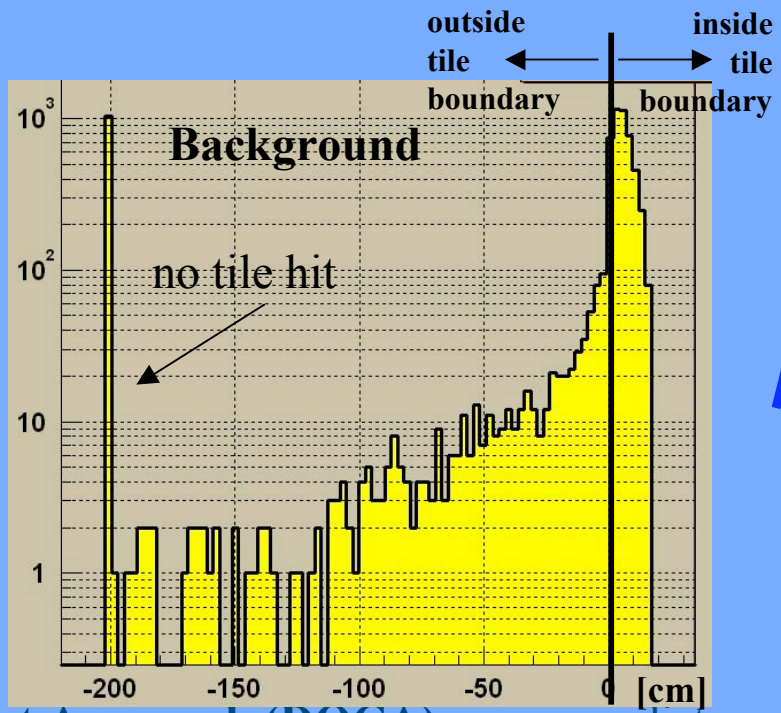
- Re-runs Track Fit and Vertexing
- Need improved energy from Cal
  - **Not used for DC-1 (?)**

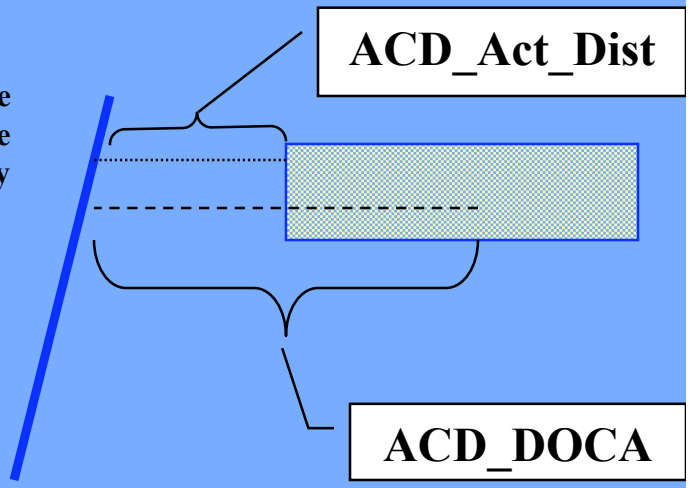


Reconstruction: ACDRecon

Primary outputs (both originally designed by Bill Atwood):

1) Active Distance: measures distance from edge (done once for entire ACD, and by region)





2) **Distance of Closest Approach (DOCA):** measure distance from the center of a tile. Done also for different regions of the ACD, since tile size varies.

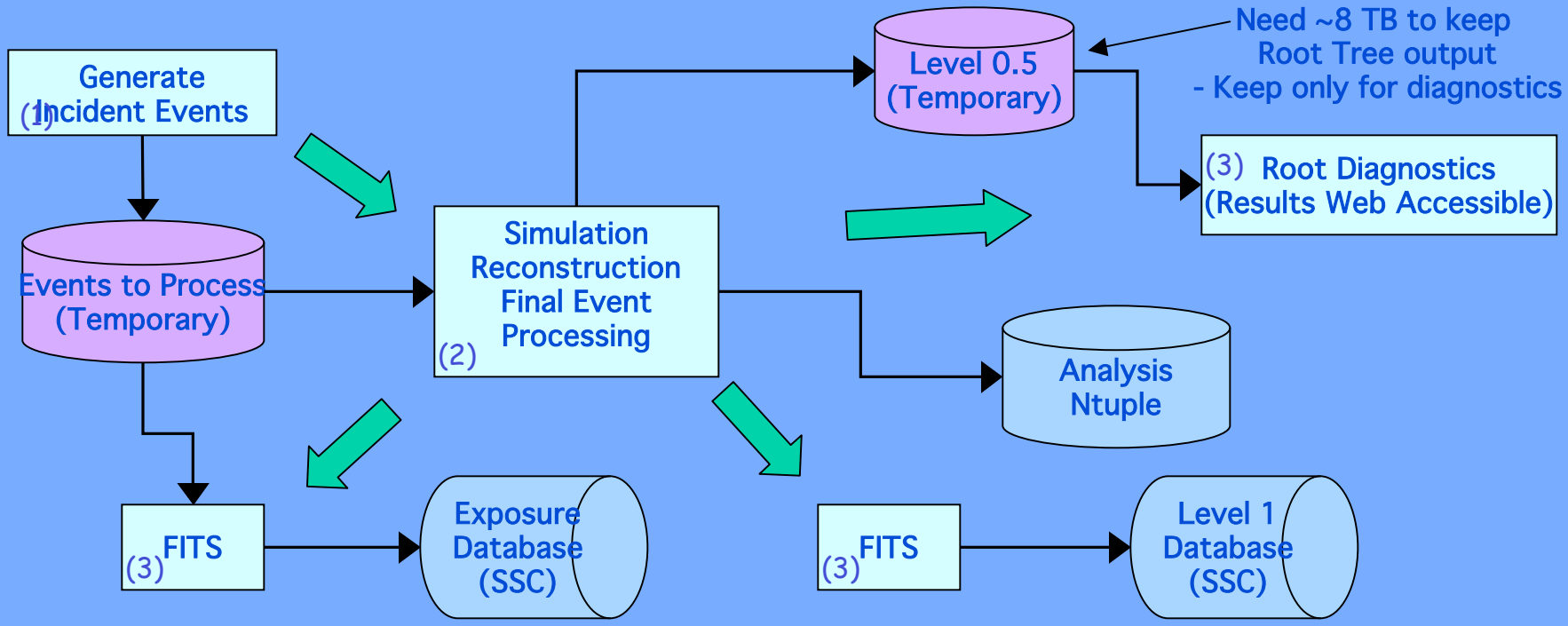
Recon also provides: energy deposition estimate and counts of tiles above threshold by region. (slide courtesy of Heather Kelly)

Reconstruction: Post-Recon Processing

- Final Event Processing - meritAlg
  - Construct output ntuple
    - Best Gamma Energy, pointing, etc.
    - Calculate useful quantities for downstream analyses
      - e.g. TkrTwrEdge: The average distance of the track from the "edge" of each tray, weighted by radiation lengths traversed.
    - Over 200 quantities output, explanation of all of them found at: http://www-glast.slac.stanford.edu/software/DataChallenges/DC1/AnalysisNtuple_doc.htm
  - Event Classification
    - Event type and quality
    - Separate signal from background
    - Via classification trees
      - Classification trees for gammas, background
      - Details of all of this in Bill's talk

- FITS file output 
  - Level 1 database input
  - Everything needed is available at the completion of meritAlg
  - Work on conversion in progress

Processing: Strategy for DC-1



DC1 Goal: One day's input to the onboard filter

- <5 kHz Trigger rate
- ~1.75 CPU sec/event processing time

Will need:

- 1250 CPU-weeks for ~400 M events
- ~ 50 GB output disk space
  - No Level 0.5 output kept

Strategy:

- Break into 86,400 1 orbit-second jobs
- Break each job into 3 major pieces
  1) Incident event generation
  2) Event simulation and reconstruction
  3) FITS Output / diagnostics
- Processing controlled by OPUS

DC1 Prep Schedule

ID	Task Name
1	**Embed Onboard Filter**
2	wrap JJ's code
3	test filter in Gleam
4	add full filter info to TDS
5	prepare for code review
6	code review
7	Insert"tracks" on TDS
8	**Get sources ready to run**
9	update CRFlux source
10	modify GlastRandomSvc for timestamps
11	set up scheme to run jobs by time interval
12	get exposure output available
13	produce FITS output of exposure
14	Do Initial PSF Analysis
15	**Do Background Rejection**
16	reprocess 50M with run nums & onboard filter
17	fix missing columns problem
18	run diffuse gammas
19	Define bkg classification tree
20	Do background rej analysis
21	Parameterize response
22	**Set up Classification Trees in Gleam**
23	implement latest PSF scheme
24	implement bkg trees
25	**Create Utilities**
26	List run/event to extract events from Root files
27	**L1 output**
28	make L1 quantities available
29	Create app for L1 output from tuples
30	**Documentation**
31	document analysis ntuple
32	**Collaboration Meeting presentations**
33	Sim/Recon talk
34	SciTools talk
35	Tutorials
36	Collaboration Meeting
37	**OPUS**
38	Get source code
39	Write interface to dataset database
40	Write interface to LSF
41	Write web interface to dataset catalogue
42	First events out of OPUS into database
43	Run 1M task
44	Run 50M task
45	Transfer data to SSC via DTS