GLAST tracking reconstruction

Status Report

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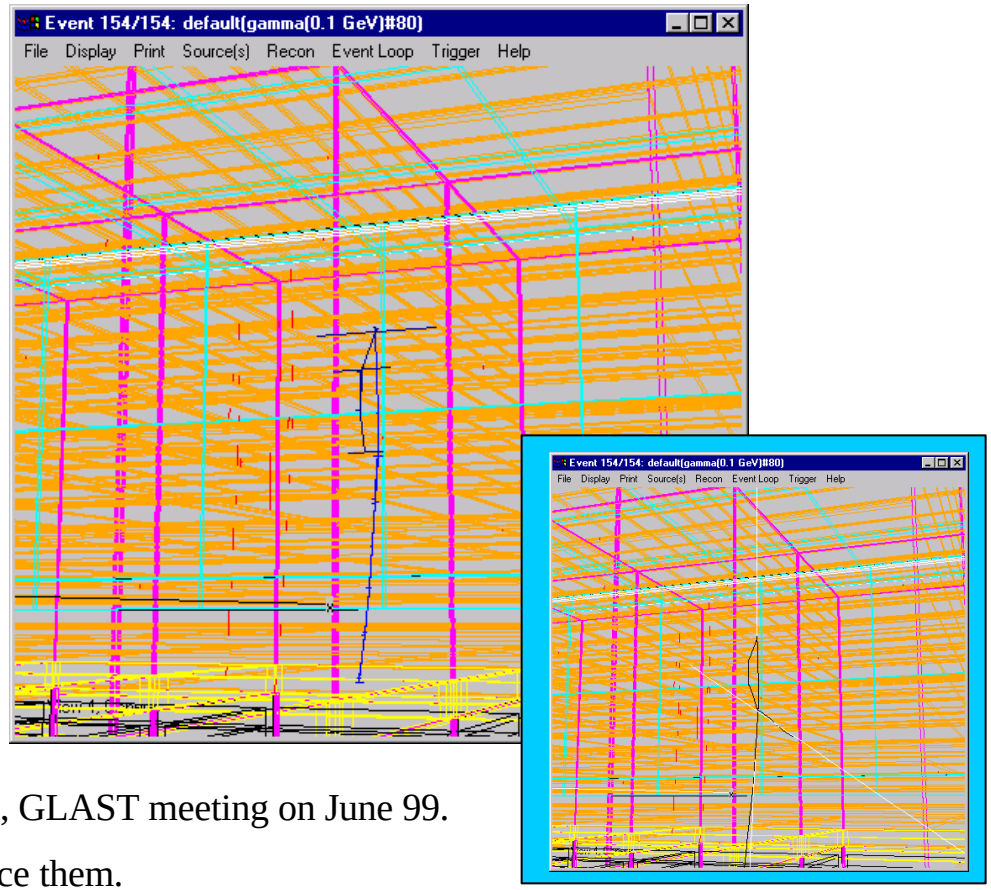
Tracking simulations

Versions and Status

A gamma event reconstructed in
3D using the Pair Fit



Reconstruction Versions:

Kalman Filter - Nov 98

Kalman Filter

2D Pair Fit - The 711 Pre-Release

Kalman Filter

Pair Fit - Pattern Recognition

3D Pair Fit - The current Release

Individual tracks (for cosmic events)

Match between x-y projections

Status:

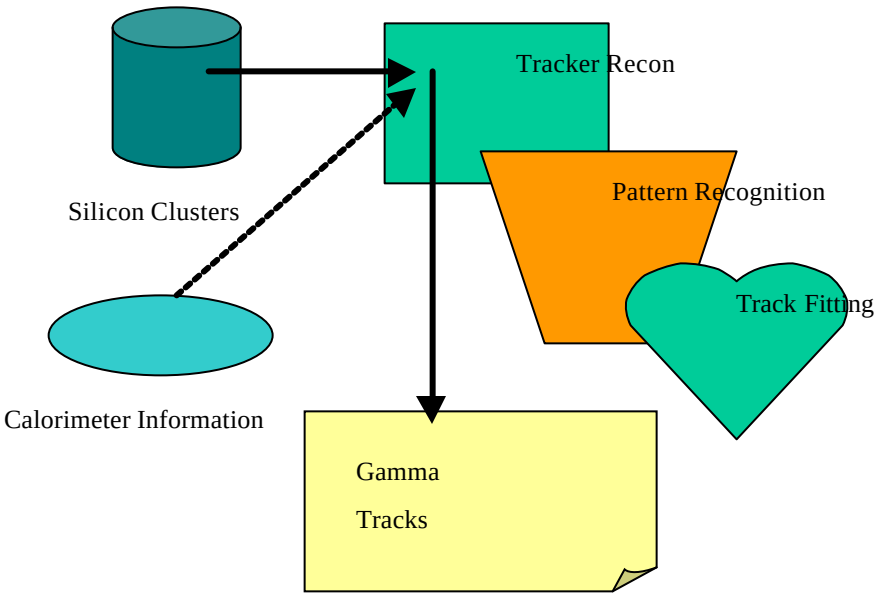
The 3D Pair Fit status was presented at UCSC, GLAST meeting on June 99.

No relevant changes have been introduced since them.

Tracking simulations

Tracking Reconstruction Scheme

Tracker Reconstruction main organization:



Implementations:

TrackerRecon :

Reconstruction Driver

Pattern Recognition:

Search of Pair/track objects

"V" signature

Tracks simultaneously reconstructed

Quality of tracks, no veto hits.

Based on $?^2$ of the hit

Fitting - Kalman Filter

Treatment of MS by plane

Natural link with Pattern Recognition

Tracking simulations

Driver of the Tracking Reconstruction

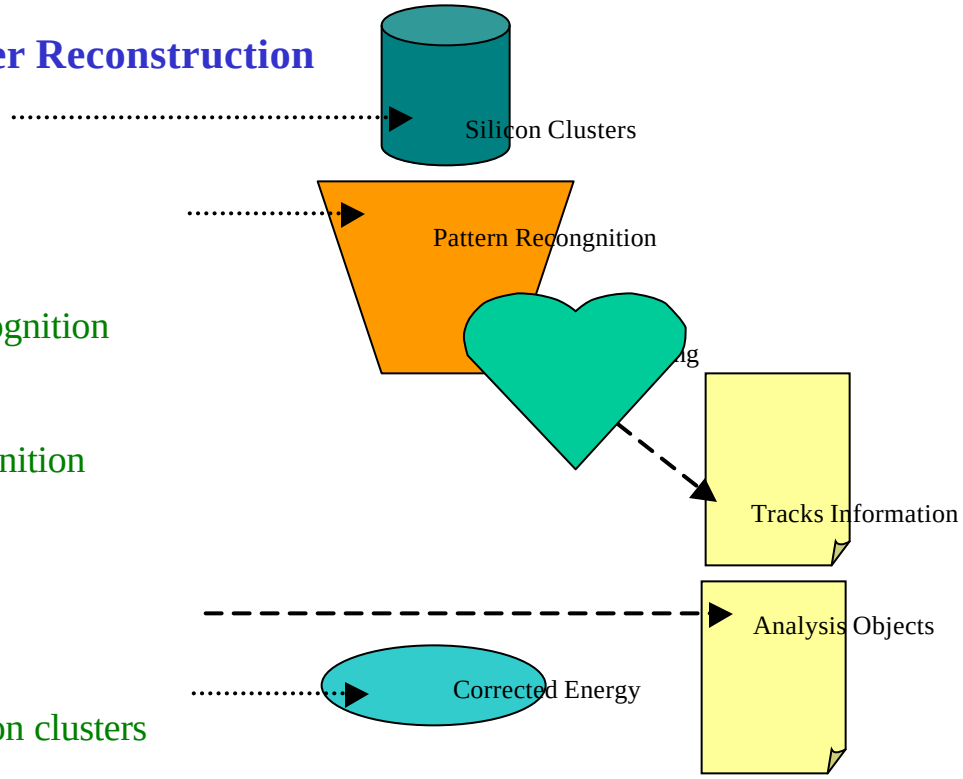
Class TrackerRecon - steers the tracker Reconstruction

- new SiliconClusters();
- SearchGamma();

  Uses the 3D pair as Pattern Recognition
- SearchTracks();

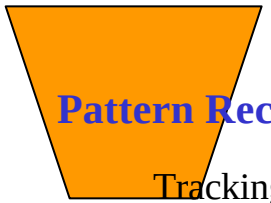
  Uses the 3D track Pattern Recognition
- new AnalysisObject();
  - new CorrectedEnergy();

  Calorimeter clusters + # of Silicon clusters



Tracking simulations

Pattern Recognition



Pattern Recognition - Toolkit of Tracking Classes and Search procedures:

Tracking classes:

A Track	**A Pair Event**
A 3D track	**A 3D Pair Event**

Search algorithm:

Select a list of tracking classes candidates

The idea:

The Pattern Recognition should recognize the gamma signature:

two tracks split from a common vertex or an initial segment.

Tracking simulations

Pattern Recognition

Pattern Recognition - Search Candidates:

- **Loop in all Si Clusters** as vertex
- Create objects using a **Ray**:
  - *Vertex - Si Clusters*
  - *Direction - Vertex and Calorimeter centroid*
- Select candidates according:
  - **Veto:**

    *no Si hits around **sigmaCut** of the extrapolated track in precious planes*
  - largest **Quality** track

    The Quality of the track is (naive) a linear combination of of the track and number of hits.

Pattern Recognition - Construction of objects

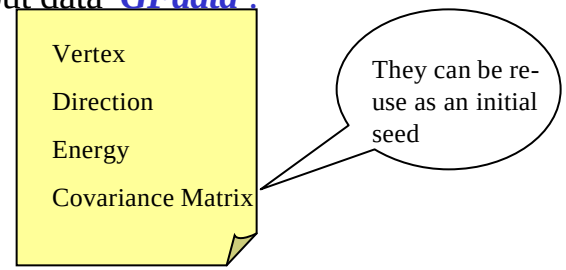
- Uses a **Ray** (Vector + Direction) as an input seed

  The ray is corrected by the centroid of the neighbor hits in the initial planes.
- The search is based in plane by plane

  step();
- The search is controlled by an unique parameter

  s***igmaCut*** :

  maximum distance in standard deviations at which a hit is located away from a prediction point
- A common output data ***GFdata*** :



Tracking simulations
The Pair Fit

Pattern Recognition - Pair Fit

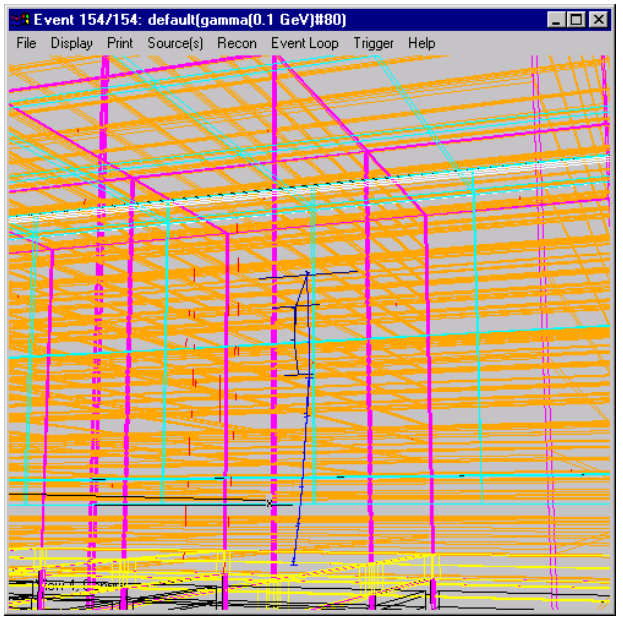
- A “pair” tracks is created when:

  A second segment can be constructed in the vicinity of N-first hits of the “best” track.

- ***Step()*** function propagates both tracks into the same plane
- The tracks do a competition for hits:
  - selfish or generous criteria?: (selfish of course!)

The 3D Pair Fit

- 3D “loose” connection :
  - A check is perform to guaranty that X-Y Si clusters of a connected track are in the same tower
- The 3D pair are ambiguous (4 X-Y combinations) unless:
  - Topological identification (hard)
    - One track crosses to a neighbor tower
    - One track stops
  - Energy criteria (soft)
    - Connection of the “best” tracks in both projection
- Versatility: (The 3D identification (combinatory or topology) is a free parameter)

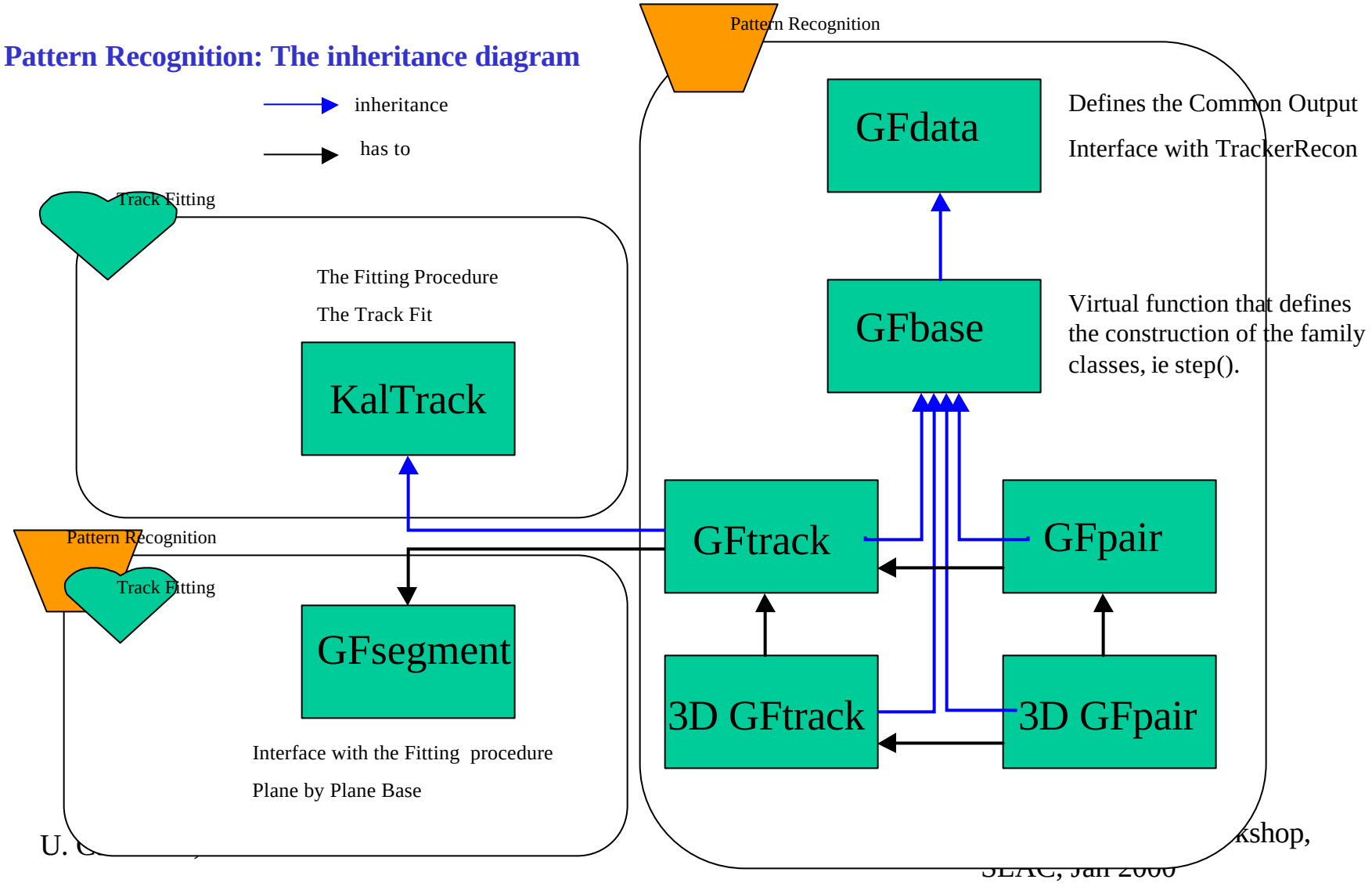


The 3D pair Fit reconstruction of a gamma event

Tracking simulations

Tracking Reconstruction Classes Organization

Pattern Recognition: The inheritance diagram



Tracking Fitting procedure: The Kalman Filter

Track Fitting: Kalman Filter

- Is a track follower algorithm.

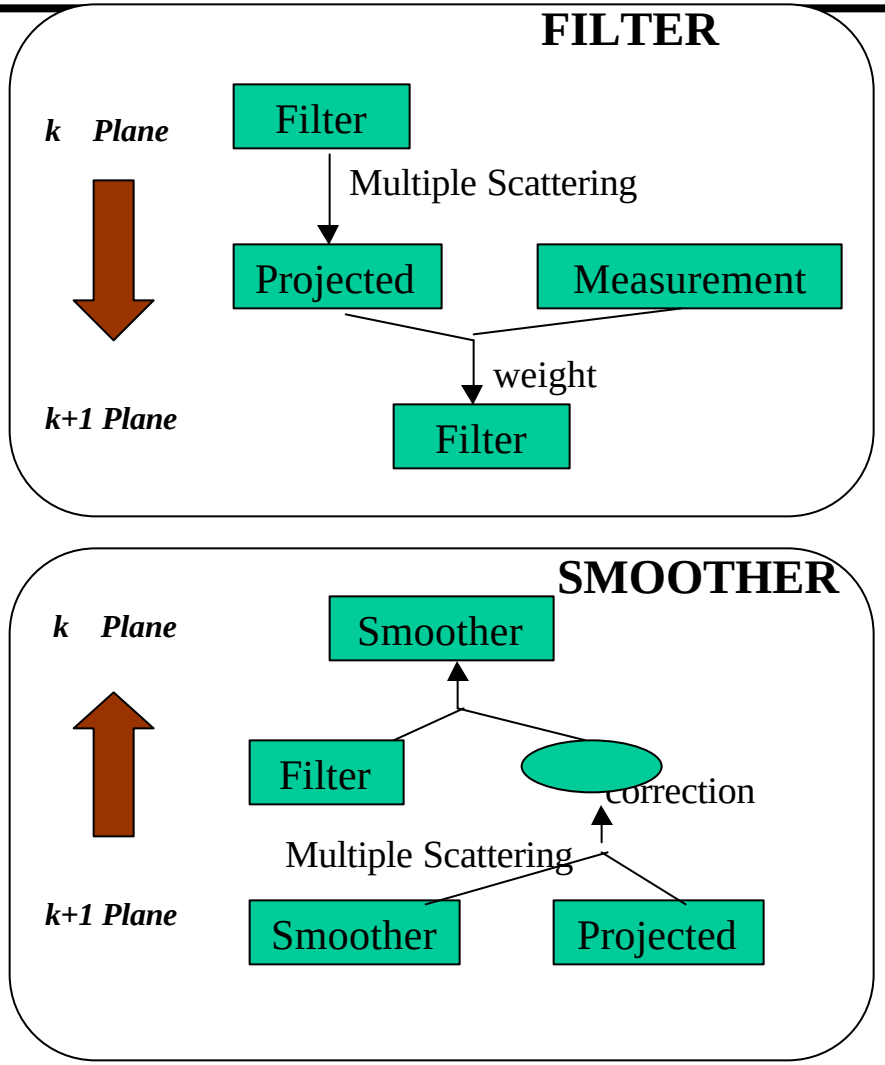
  It is a Filter

  Each measurement is incorporated each time

- It solves the problem of incorporate “random” noise between two measurements (ie Multiple scattering)
- It is based on minimum residual estimators

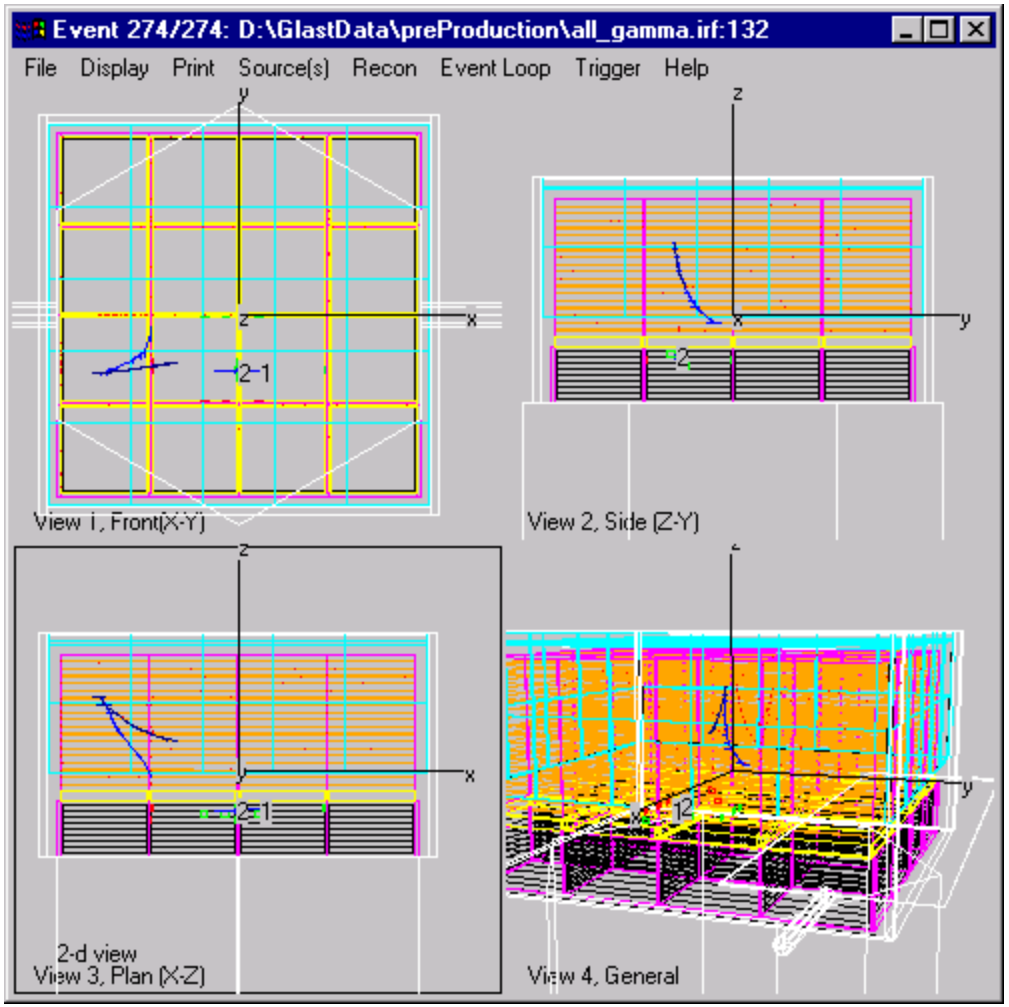
  It is an optimal method with gaussian errors

  It is equivalent to the LSQ method in absence of “random” noise



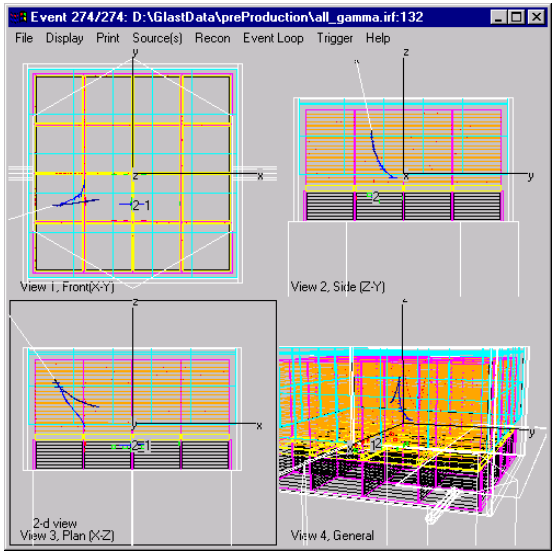
Tracking simulations

Example of a reconstructed gamma



The projection and 3D view of a reconstructed gamma event

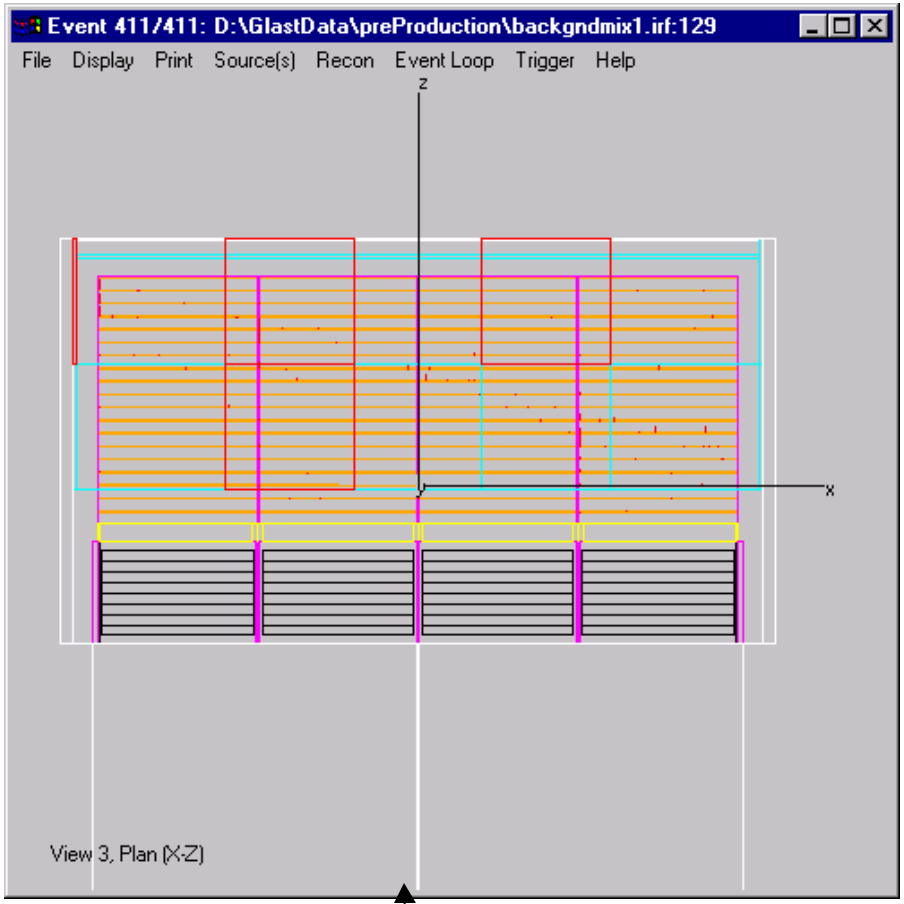
Example of a 3D Pair Fit



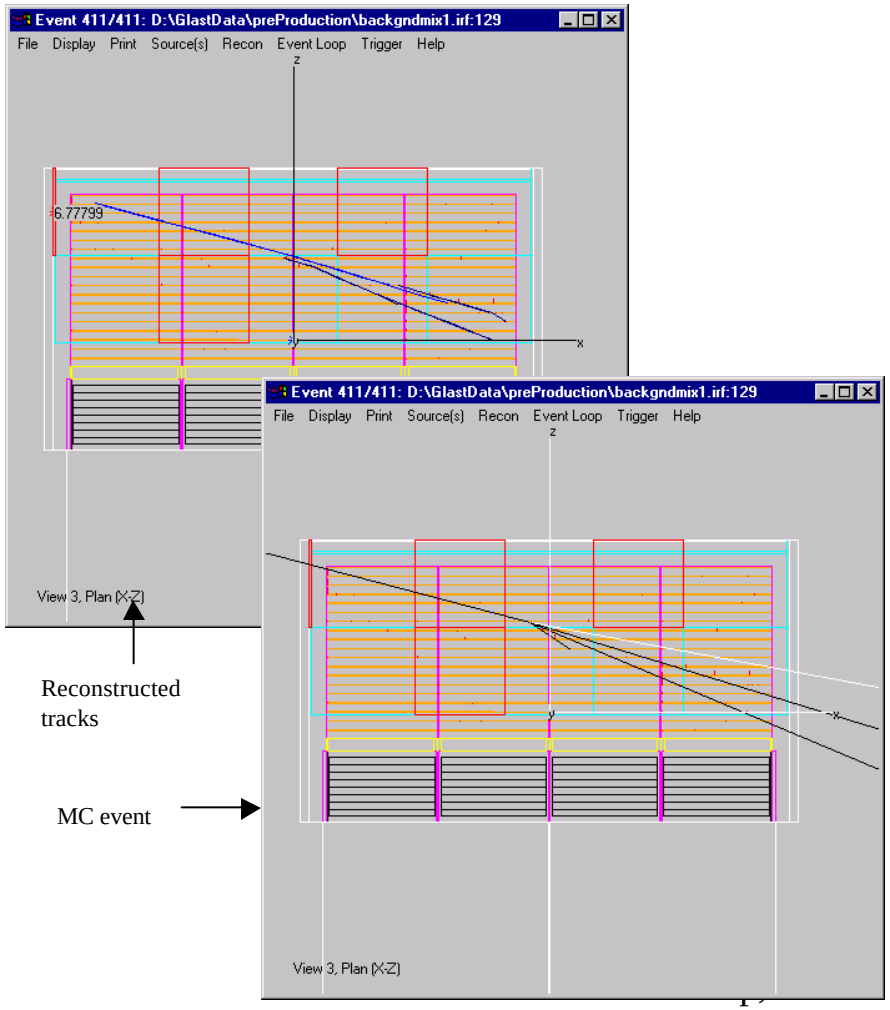
Tracking simulations

An example of a reconstructed cosmic event

Reconstruction of cosmic Background - protons



Recorded hits on the Silicon detector.



Tracking simulations

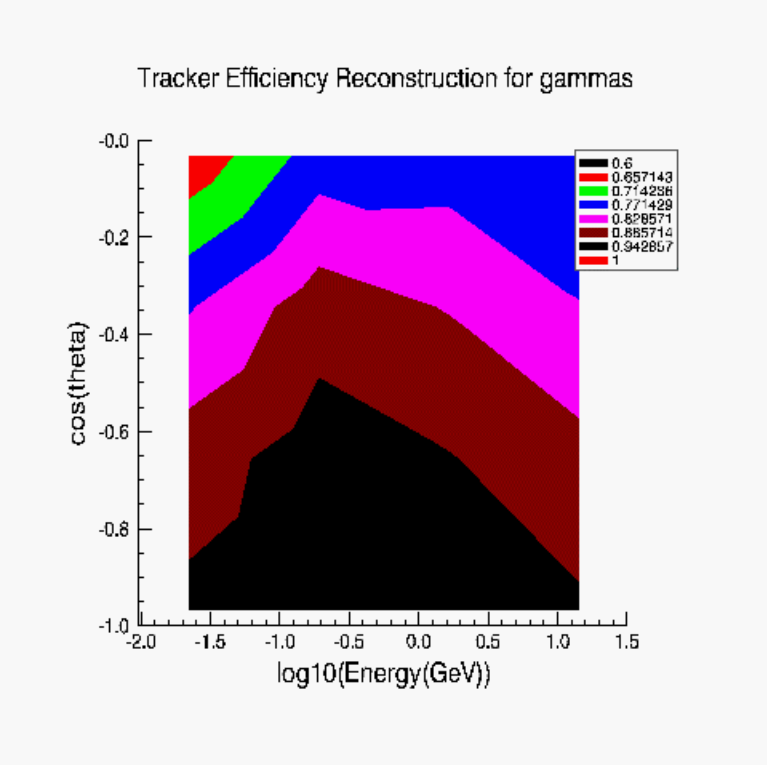
Tracking efficiencies

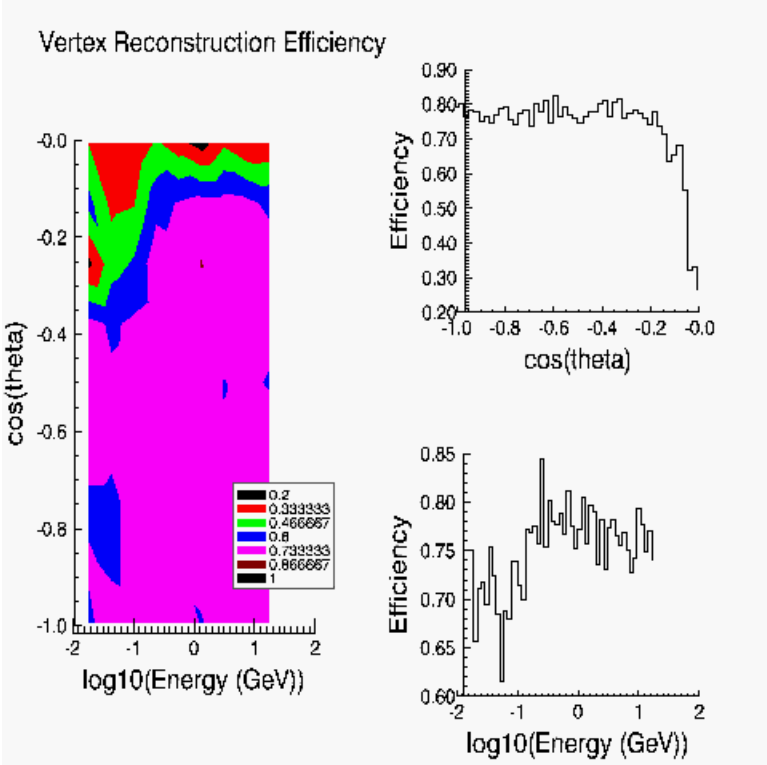
Tracking Efficiency:

- 95% for angles ? < 45 deg
- 80% for angles ? < 80 deg
- almost flat with energy

Vertex Efficiency:

- ~80% for angles ? < 80 deg
- Almost invariant with energy and incident angle.

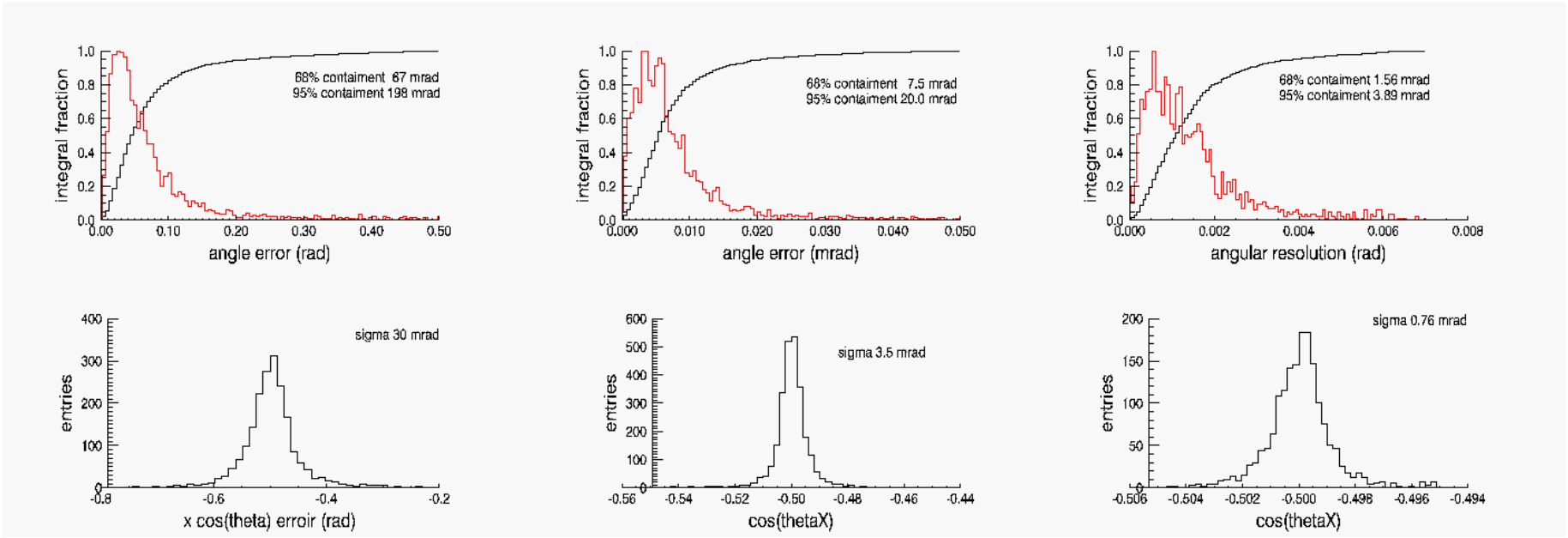




Tracking simulations

Angular distributions

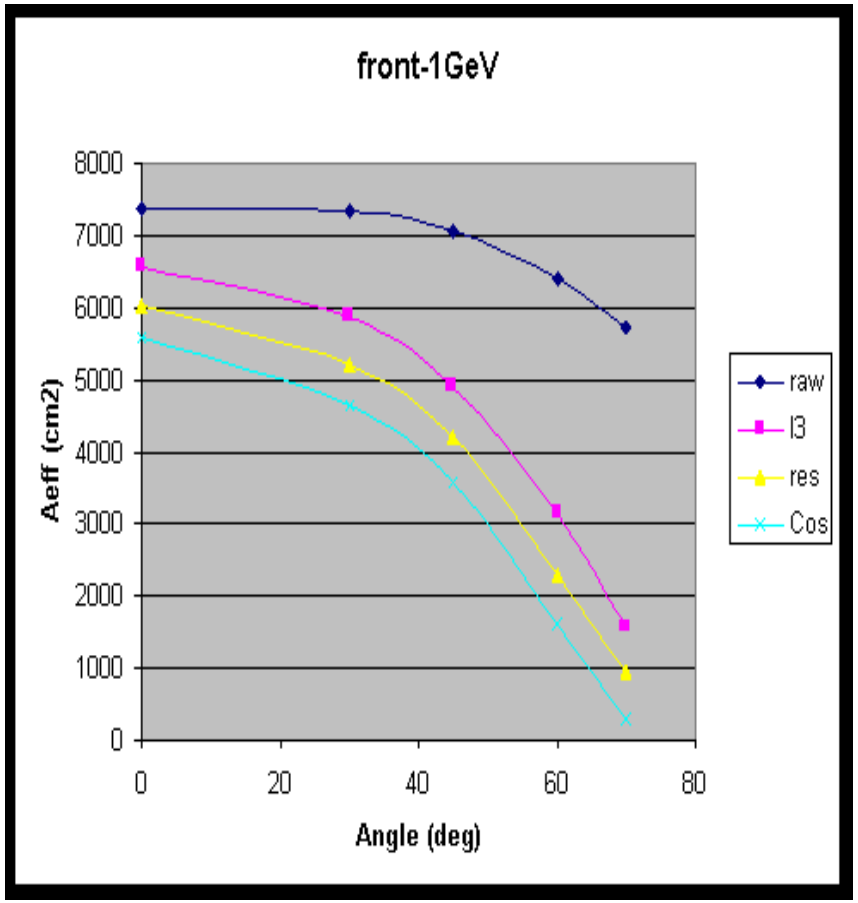
Angular distributions for gamma 30 degrees incident angle in X direction

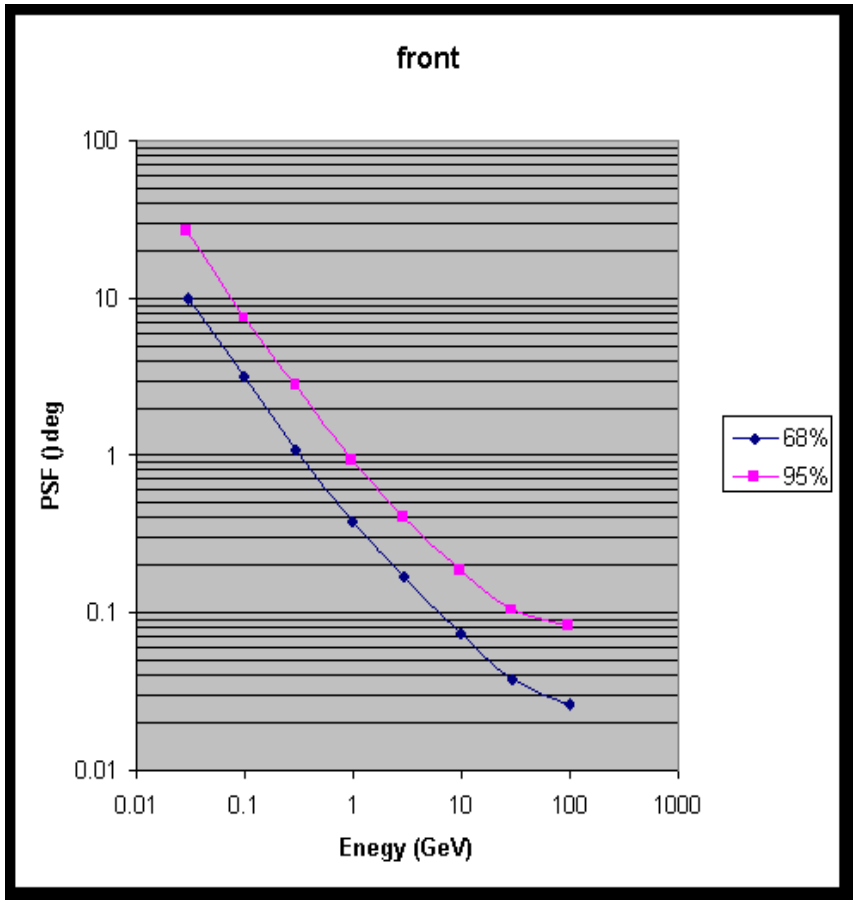


Tracking simulations

PSF and Effective area

AO





Tracking simulations

Future Planes

Short term

- **Energy Determination using the tracker and the Kalman Filter 90%**

  Preliminary 45-50% below 2 GeV

  Revisiting algorithms: 60%

  - **Seed track segment criteria**
    - **from PSF tail studies - bias on the track kink.**
  - **Best track selection criteria**
    - **Quality - $?^2$ and # of hits**
    - **Energy determination?**
  - **gamma direction for pair events**
    - **residuals or $?^2$ criteria**
    - **Energy determination?**

  Preliminary small changes respect present algorithms

Medium term

- **Cleaning and optimization of class relationships 60%**
  - **Standard-lone reconstruction**
  - **User Control Parameters.**
  - **Reorganization of** trackerRecon**.**
- **Extrapolator**
  - **KalParticle class**
- **Documentation**

Long term

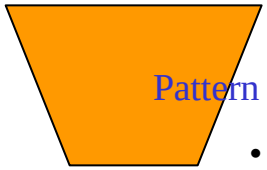
- **Better Implementation of electron energy lost**
- **Complicated patter recognition events - gaps in tower walls**

Tracking simulations

GLASTsim tracker RC future structure

New TrackerRecon

- It constructs SiClusters
- It will provide a gamma a tracks objects.
- It should provide access to internal track information and extrapolations
- No Analysis Objects should be computed in this class!
- How we implement the correction of the energy?
  - trkcalRecon? Or a iterative process trk-cal Recon? Or inside trackerRecon?



Pattern Recognition

- It should provide trackerObjects (Pair or tracks) according with a search criteria.
- Control parameters visible (modifiable by?) the user -xml-

Kalman Filter

- It should fit a list of hits
- better C++ stile.

Tracking simulations

Conclusions

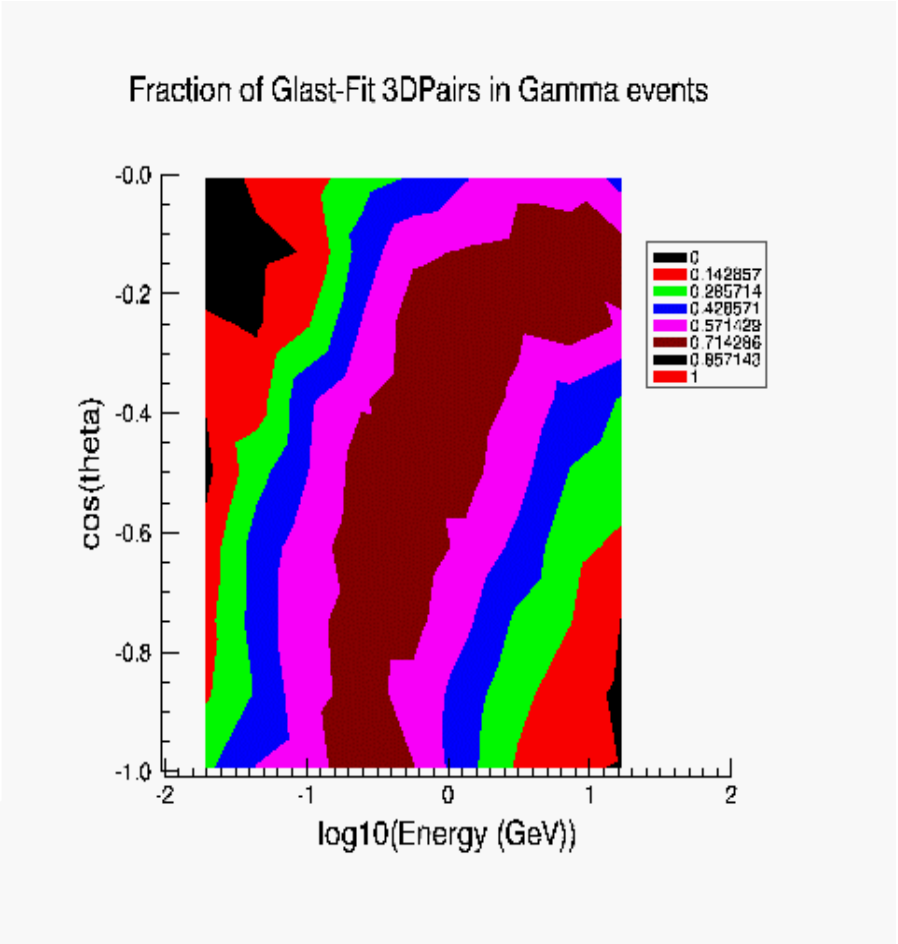
Conclusions:

- The tracker reconstruction (3D Pair Fit) works (~~acceptable for AO)~~ quite well
- The major work is already implemented.
- Delicate algorithms which have important implications are being revisited

  ☞ **Tune up and understanding**
- Cleaning a reorganization of the code:

  trackerRecon.
- Documentation.
- The Pair Fit topology and the Kalman Filter should be used in physics analysis.

  ☞ **Potential Explored**



Tracking simulations

Tracking for the Test-Beam

- **TestBeam Studies**
  - We need to **validate the AO GLAST performance results**.
    - PSF distributions for angle and energies.
  - We need to check that **our MC describes the data**.
    - Hits distributions, track reconstructed, behavior of SuperGLAST layers
  - We need to understand the performance and efficiency of our subdetectors (I.e Tracker)
- We need **Test Beam Tower Simulation, Read-Data, Reconstruction/Analysis programs**.
  - A Simulation program and a Read-Data program generates simulated/real data in the same format.
  - A standard-lone reconstruction program reads, reconstructs, (analyses?) the formatted data.
- **UCSC part:**
  - The GLASTsimTracker Reconstruction should work.
  - Anyhow **UCSC has the tracking reconstruction working** standard-lone.
    - This program includes the tracker geometry details and graphics.
    - A ROOT ntuple is currently been implemented.
    - It is valid for Tracker specific studies as efficiencies, triggering, but not for PSF!.