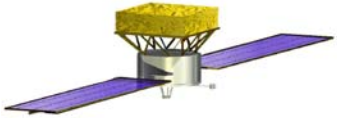
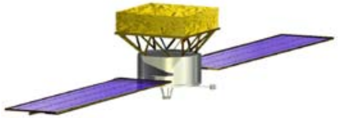


Introduction and Status of CalRecon

A.Chekhtman

What Cal Recon should do



Read raw calorimeter data, produced by

- real GLAST detector
- testbeam module
- simulation

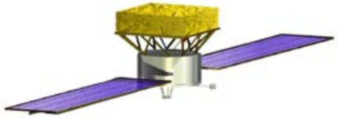
Reconstruct the parameters of incident photon

- Energy
- Direction
- Position

Calculate the shower shape parameters used for background rejection

- Transversal shower size

CalRecon structure



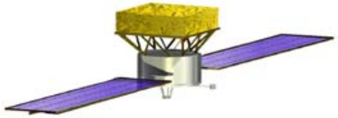
Crystal reconstruction

- Conversion from adc scale to energy, measured at each crystal end
  - Non-linearity correction based on charge injection calibration data
  - Gains defined from muon (cosmic rays) calibration
- Calculation of the position along the crystal from signal asymmetry
  - Position vs asymmetry calibration

Cluster reconstruction

- Calculation of energy per layer
- Calculation of energy sum
- Profile fitting
- Leakage correction by last layer correlation
- Calculation of average position per layer
- Calculation of average position for a cluster
- Direction fit in XZ and YZ planes

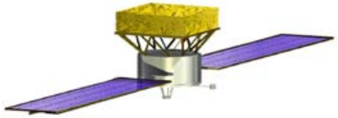
CalRecon Evolution



Environment and infrastructure

- 1st implemetation by Jose Hernando in “Centella” framework for SLAC beam test data processing (tb_recon, Feb,2000)
- Moved to Gaudi without significant modifications (Feb,2001)
- Used with Gismo simulation in pdrApp (2001)
- Modified to be used with Geant4 (March,2002)
- Data classes were rewritten to comply with GLAST requirements (Apr, 2002)
- TDS Data classes separated from algorithms and moved to Event package (May,2002)

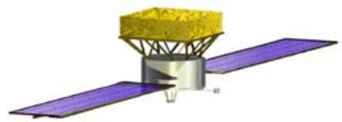
CalRecon evolution (continued)



Reconstruction algorithms

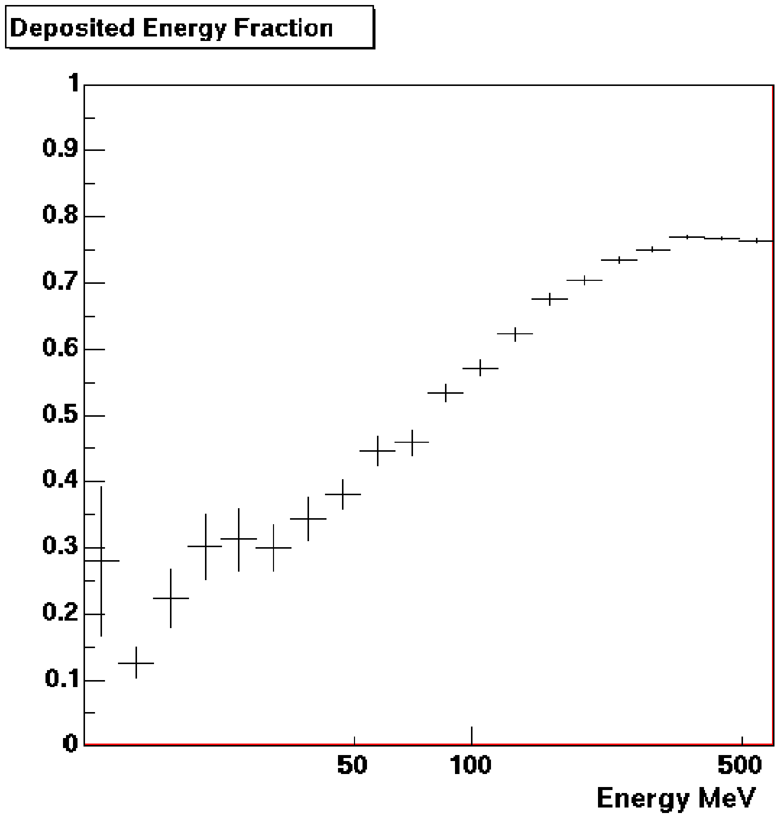
- Existing algorithms mainly developed at tb_recon stage
  - Non-linearity correction based on charge injection calibration data (E.Grove, A.Chekhtman)
  - High energy corrections: profile fitting and last layer correlation (R.Terrier)
- Non-linearity correction modified: from quadratic fit to linear interpolation between charge calibration peaks
- After last package modification: calibration data not yet implemented, package temporary used only with simulated data
- Energy correction algorithms use coefficients based on simulation with old GLAST geometry – need to be updated
- Some algorithms are not implemented in the code yet
  - Cluster search
  - Low energy corrections
  - Corrections to position and direction calculations

Energy Measurement below 500 MeV



GLAST Tracker is $1.1X_o$ thick

large fraction of energy never reaches CAL



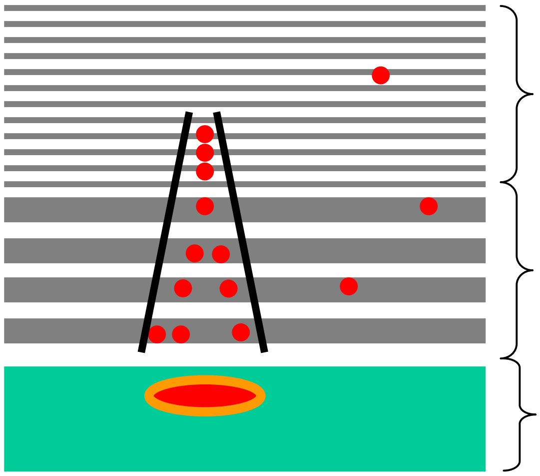
Use the tracker as a sampling calorimeter

Find hits in a cone around fitted track

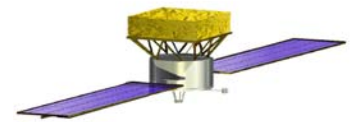
cone opening angle 5 θ_{MS}

Around 90% of the hits in this cone are due to the track (as opposed to electronic noise)

$$E_{corr} = \frac{\alpha n_1 + \beta n_2}{\cos\theta} + E_{CAL}$$



Shower leakage - Last layer correction



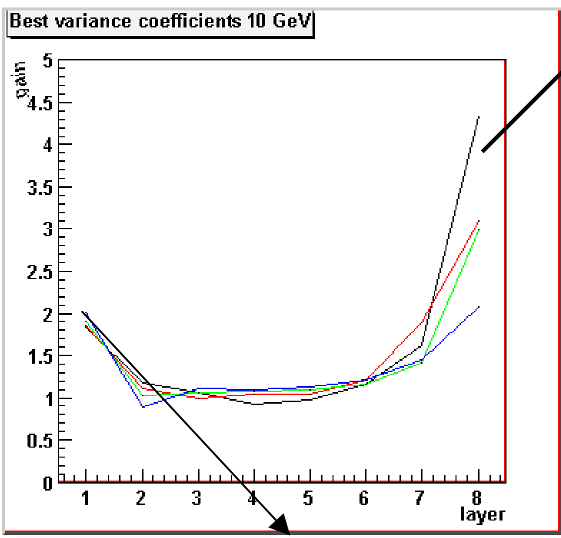
Minimizing global width on MC data

on a layer by layer basis

$$\min(\mathrm{var}(E_0 - \sum_{i<n} g_i E_i))$$

Contribution from last layer only

Energy deposited in the last layer is proprtionnal to the number of escaping particles



Last layer

0° 30° 45° 60° losses in the tracker

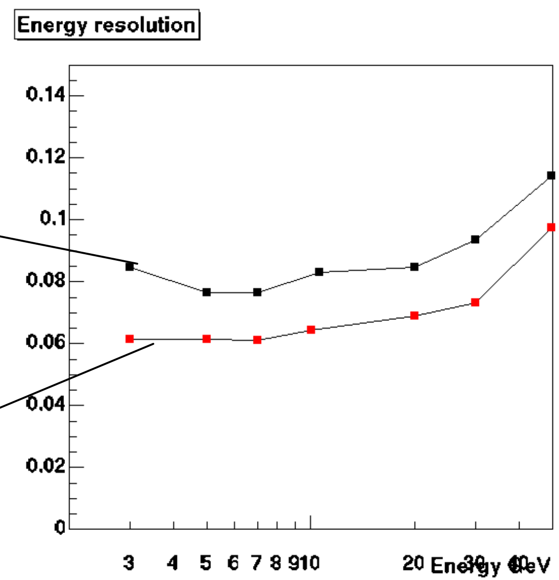
Energy estimate given by:

$$E_{corr} = f(E_{sum},\theta)\, E_{last} + E_{sum}$$

f depends on deposited energy and angle

Restore linearity and provides good energy resolution

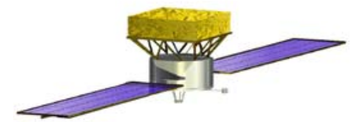
Works as long as shower maximum is contained



68% containment

gaussian

Shower leakage - Mean shower profile fitting



Minimize:

$$\chi^2 = \sum_{i<8} \frac{(E_i - \overline{E}_i)^2}{\sigma_i^2}$$

Longitudinal energy density profile model:

$$f_L(z) = \frac{1}{\lambda}(z/\lambda)^{\alpha-1} e^{-z/\lambda}$$

Parameters:

E_0 incident energy → free parameters

z_0 shower starting point

α → fixed to their

λ mean value at E_0

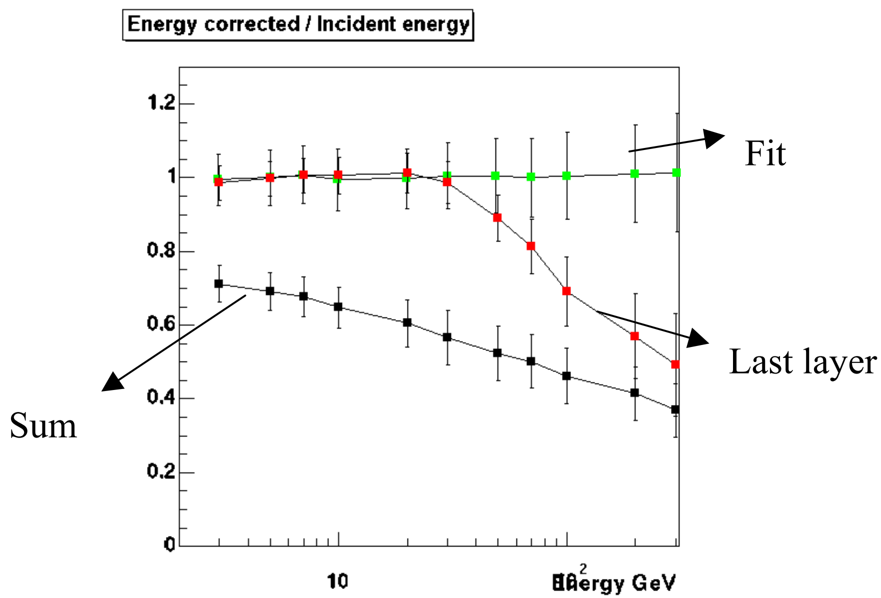
↓

Mean profile fitting

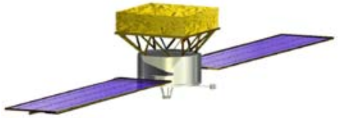
Restores linearity over the whole energy range

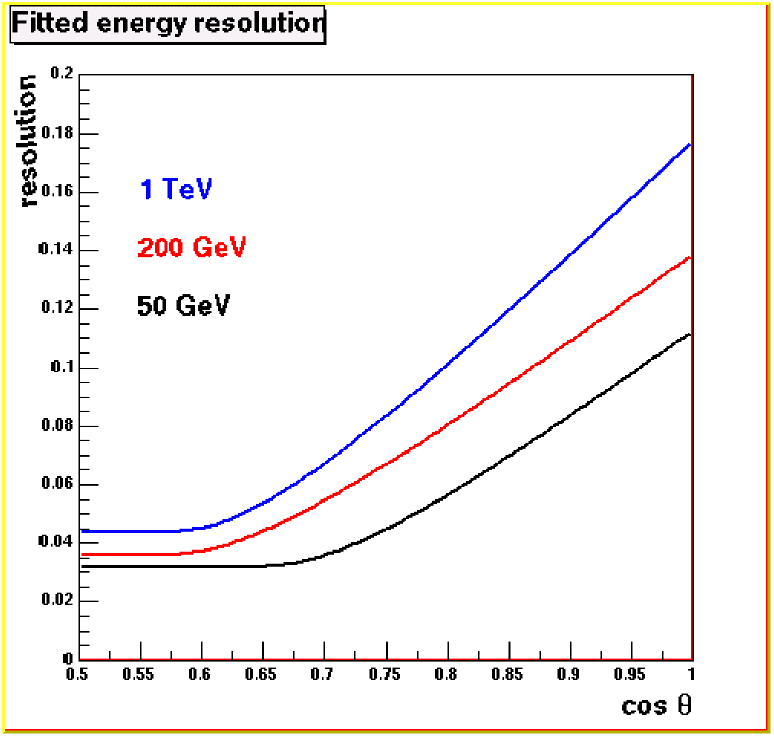
Gives energy measurement even when shower maximum is not contained

Good energy resolution up to very high energies (~20% at 1 TeV normal incidence)

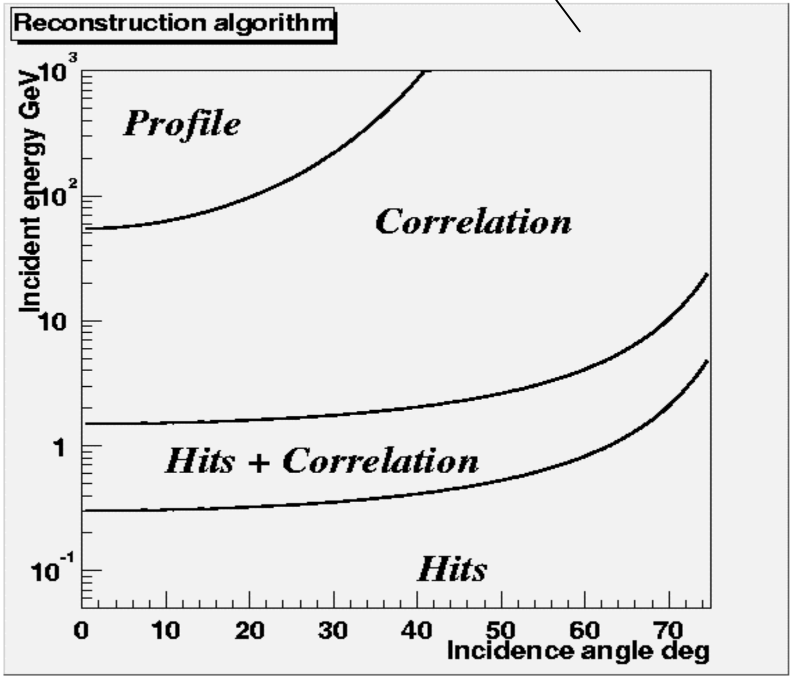


Energy reconstruction performances





Depending on energy and angle, different corrections have to be applied



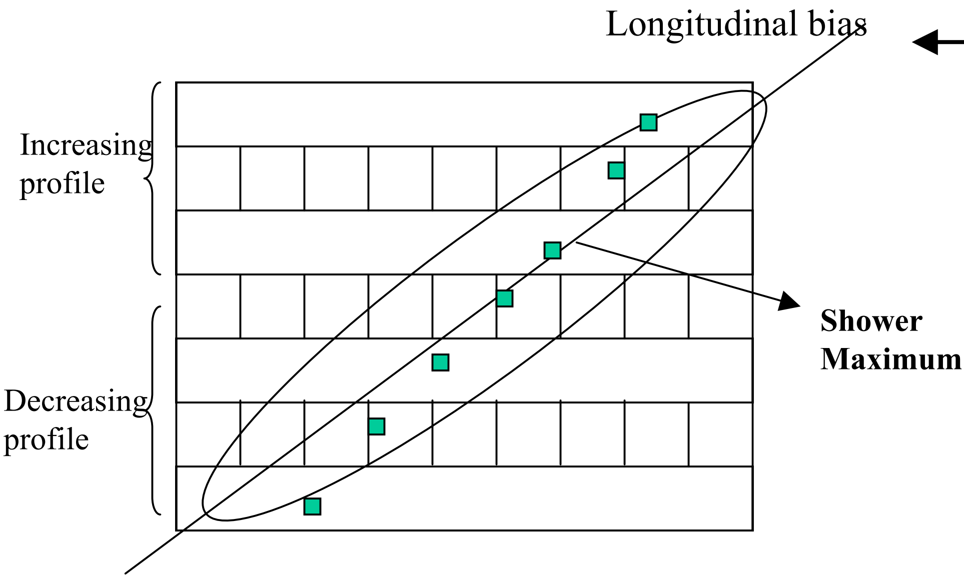
Fitted energy resolution for very high energies

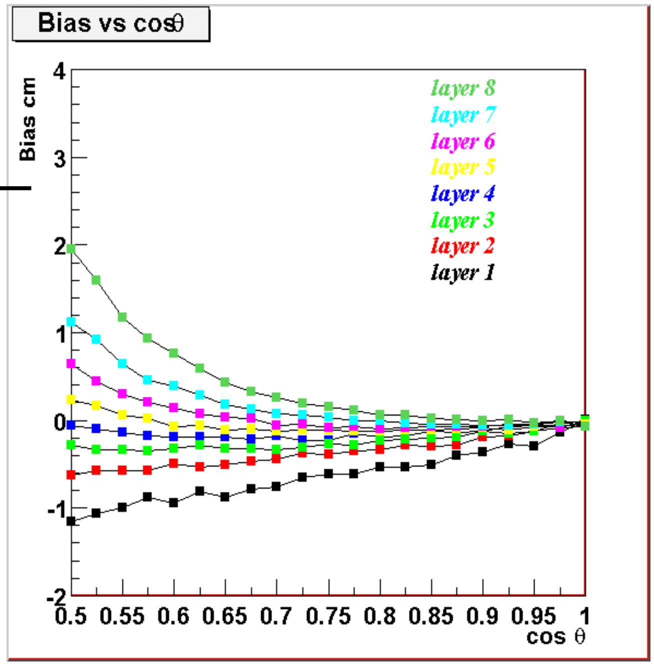
At angles larger than 50°, less than 6% resolution at 1 TeV

Position –Longitudinal bias

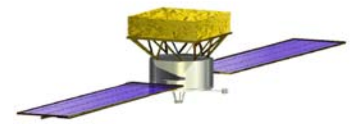
For large incidence angles, the barycentre position in a crystal is different from the shower axis

effect due to the mixing of longitudinal and transverse shower profiles



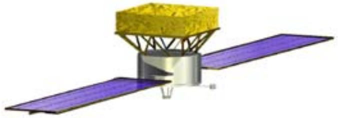


Direction Fit and shower size calculation



- Direction is calculated independently in XZ and YZ planes by fitting linear function to transversal coordinates of crystals, weighted by deposited energies
- Longitudinal coordinate measurements are not included in the fit, because the errors of these measurements strongly depend on energy and this dependence should be found before these measurements could be used
- Longitudional measurements used for calculation average position of the cluster together with transversal measurements with equal weights (proportional to the deposited energy). It is not correct, but effect is not so dramatic as for direction
- Moments, which were calculated in early versions of calorimeter reconstructions, are not calculated now due to the problem of the error of longitudinal position measurement. They could be replaced by shower size calculation – to be implemented.

CAL Recon Status and Plans



- Modification of TDS classes used by CalRecon has been finished
- CalRecon is able to process simulated data with ideal digitization
- Energy correction algorithms for high energies should be updated for new detector geometry
  - the choice of the best energy correction should be implemented
- New calibration classes, extraction from calibration database
- algorithms to be implemented:
  - Low energy corrections
  - Corrections to position and direction measurements at non-zero incident angle due to transversal shower profile
  - error calculation for longitudinal position measurement
  - Cluster search