GARLIC
An algorithm for GAmma Reconstruction at the LInear Collider

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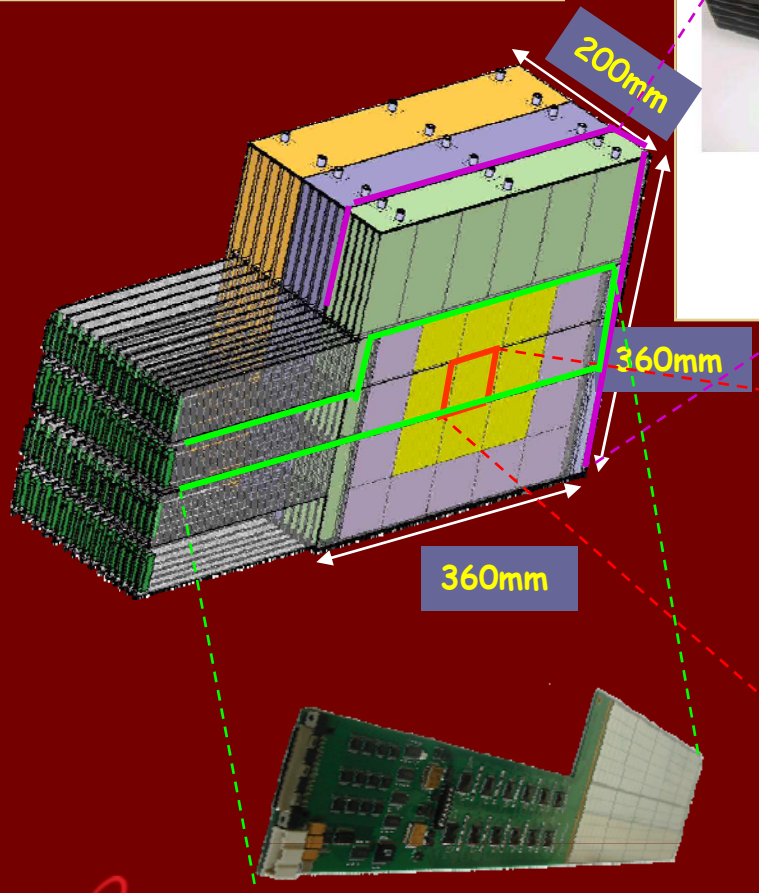
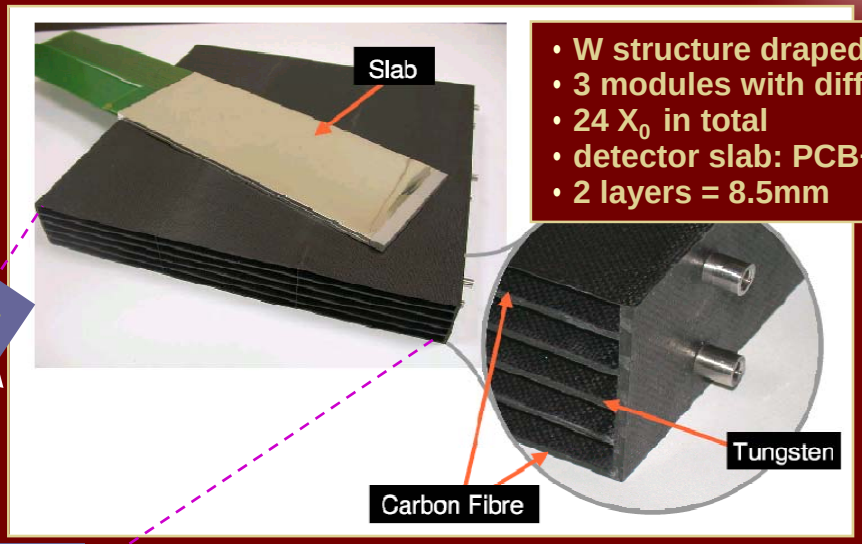
The GARLIC algorithm

- Try to improve clustering of photon contribution in jets
- Based on REPLIC
- Implemented in the MARLIN software framework
- For SiW ECAL: Prototype + ILD version
- Seed search via 2-dim energy projection in first $7X_0$
- Clustering based on neighbour criterion
- Several iterations from front to back
- Designed for pointing photons, works for all angles
- Rejection via simple criteria (#hits, minimum energy, seed criteria,...)
- + Computation of cluster variables (eccentricity, width, direction, energy deposit in different regions,...) - ANN
- Correction for wafer guard ring and module gaps

The SiW ECAL prototype

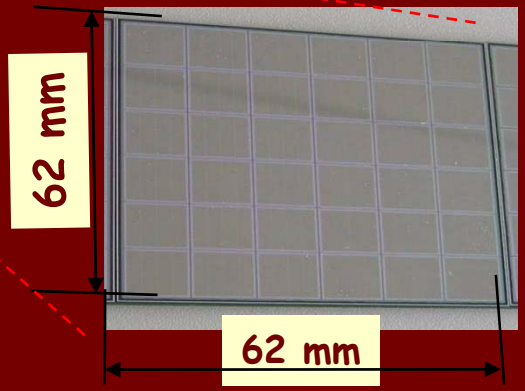
- 60 PCBs (30 layers)
- 216 channels/PCB (centre)
- 108 channels/PCB (bottom)
- 9720 total channels



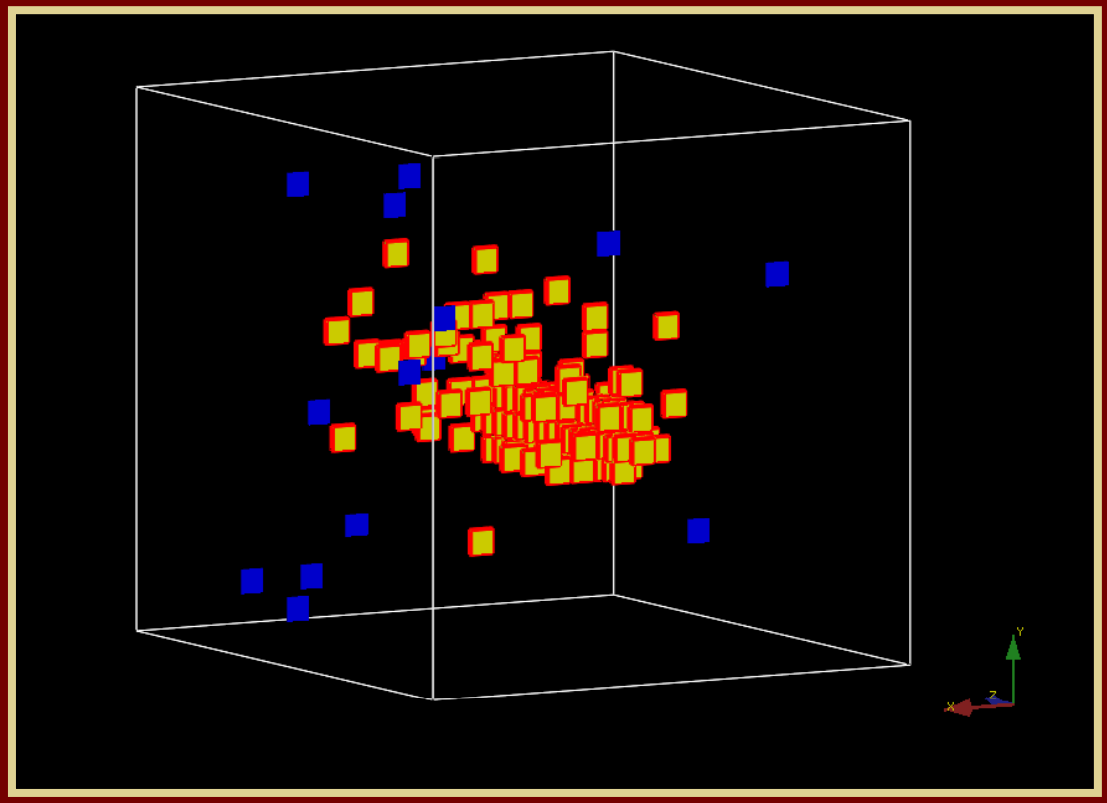


- W structure draped in carbon fibre
- 3 modules with different W thickness
- 24 X_0 in total
- detector slab: PCB+Si+W+Si+PCB
- 2 layers = 8.5mm

6x6 1x1cm² Si pads glued conductively to PCB



GARLIC for the SiW ECAL prototype



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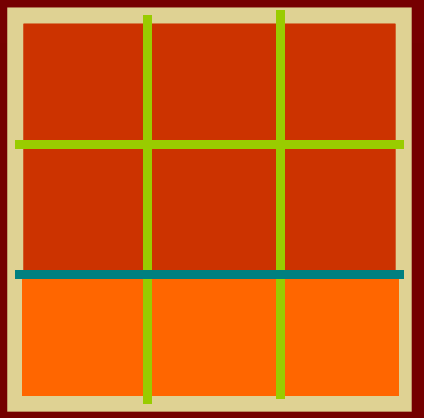
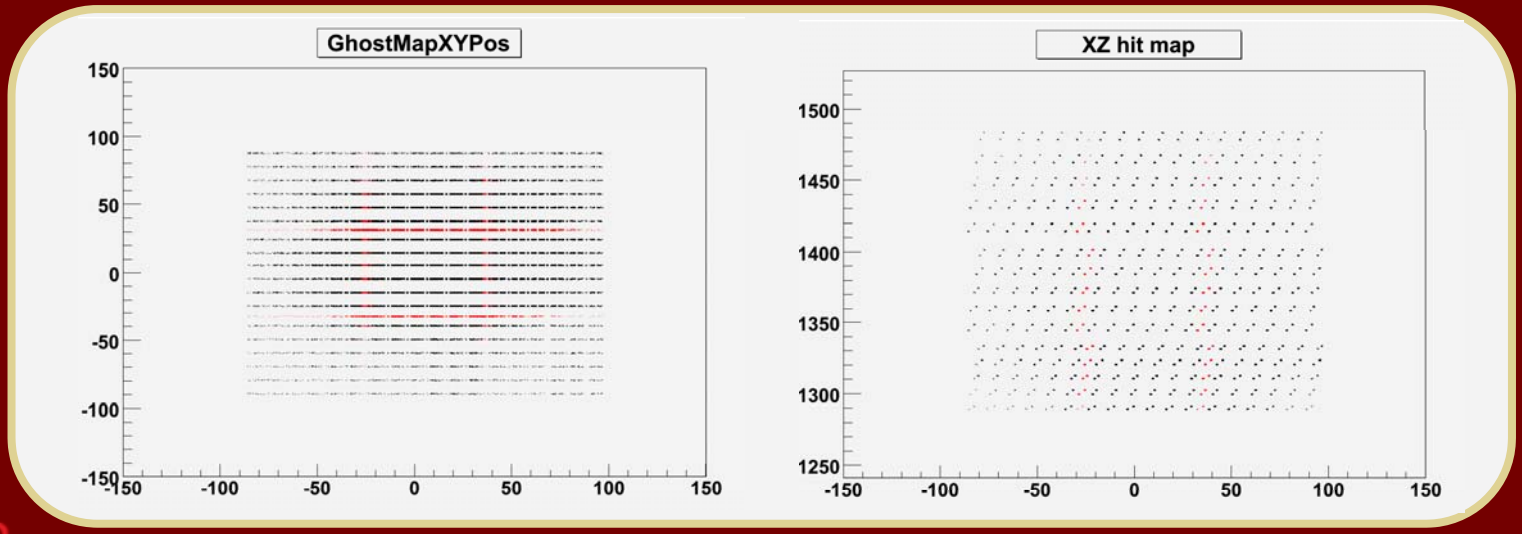
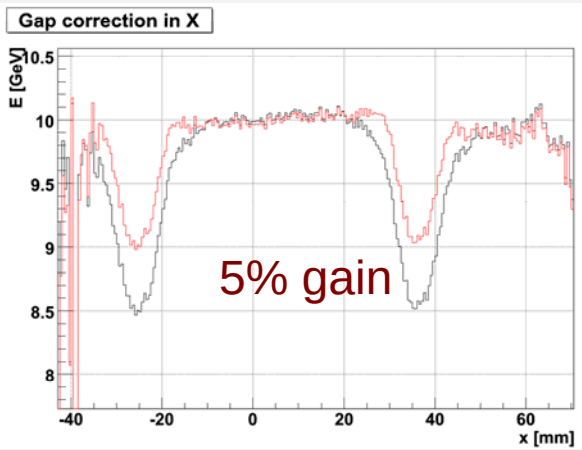
Gap correction

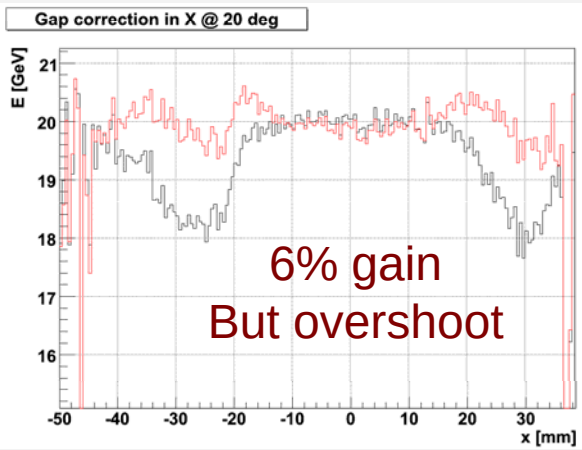
- Introducing „Ghost hits“ in a gap between two adjacent hits
- Linear energy interpolation
- angle independent
- Sensible to position in the shower
- Expecting reasonable improvement

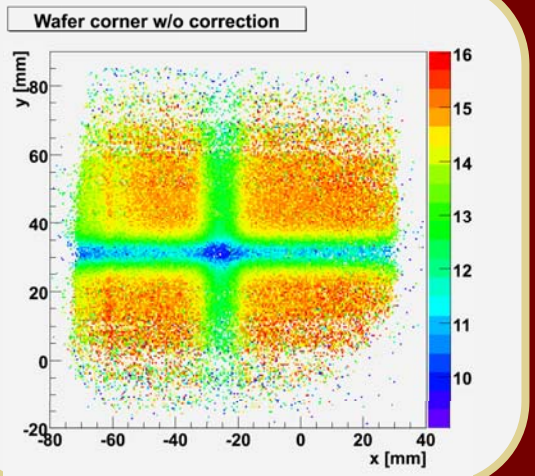




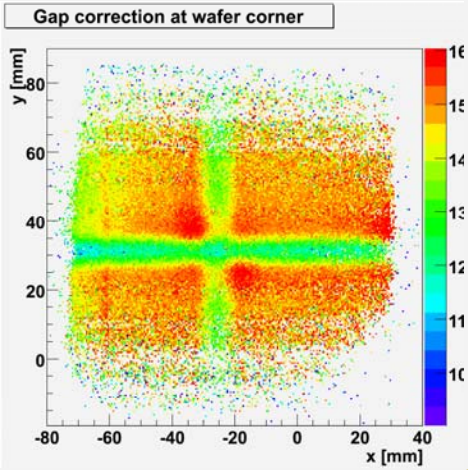
Gap correction: performance







~8% gain



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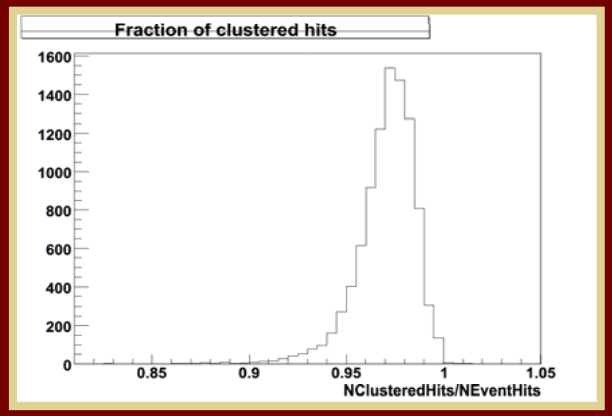
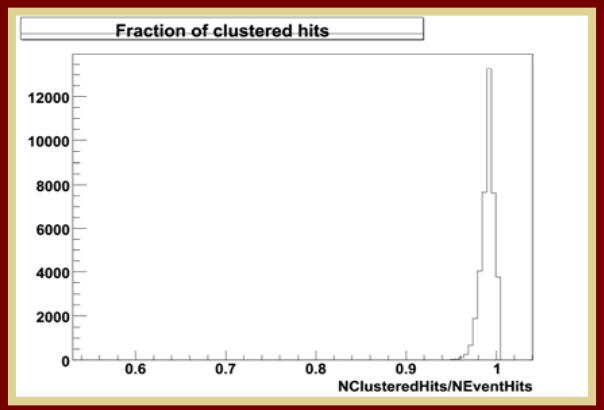
Clustered fractions

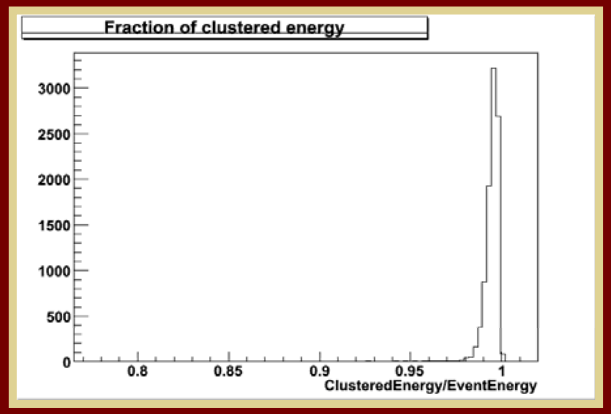
- „Ghost hits“ in fiber gap are counted
- Supression of noise hits and flactuations
- Works well at angles != 0
- Further optimisation possible

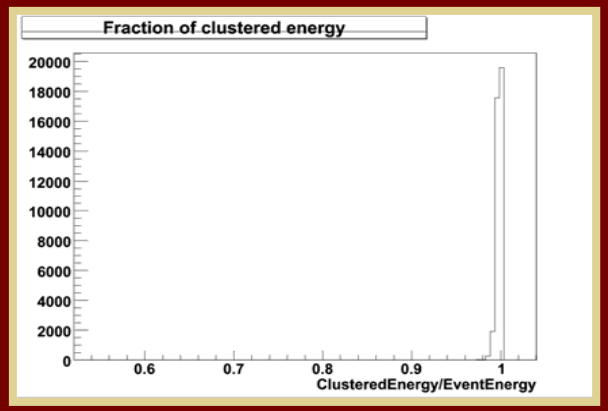
0 deg



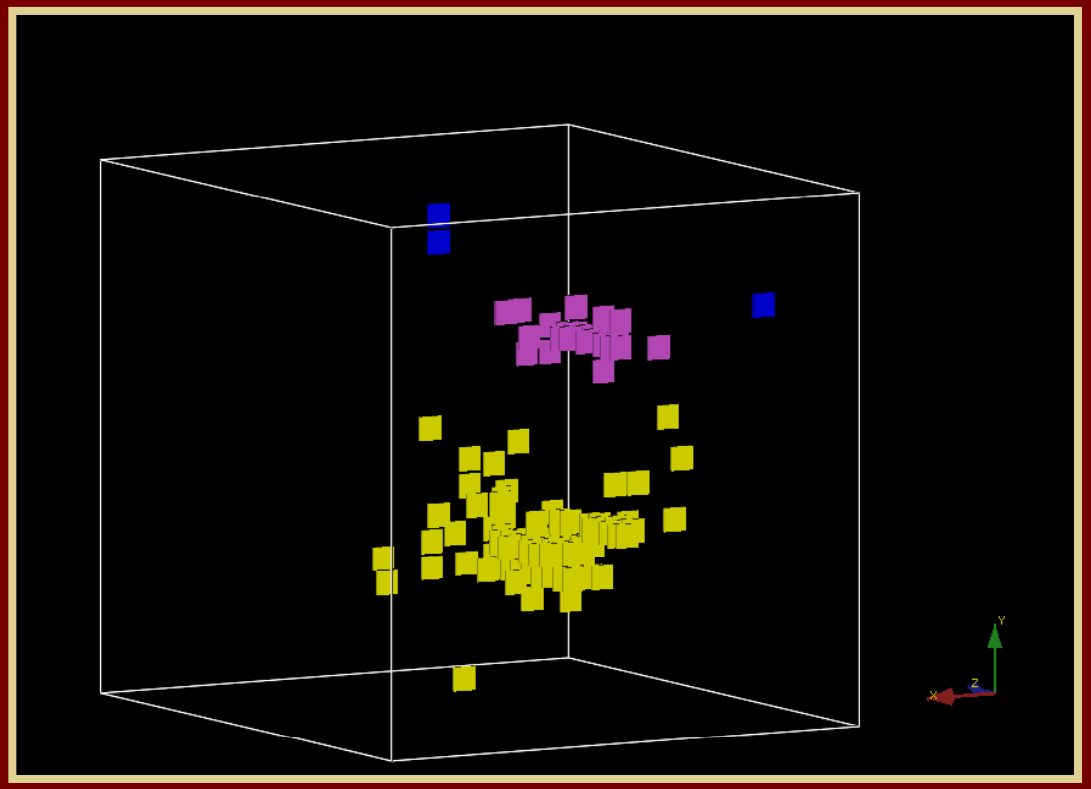
20 deg





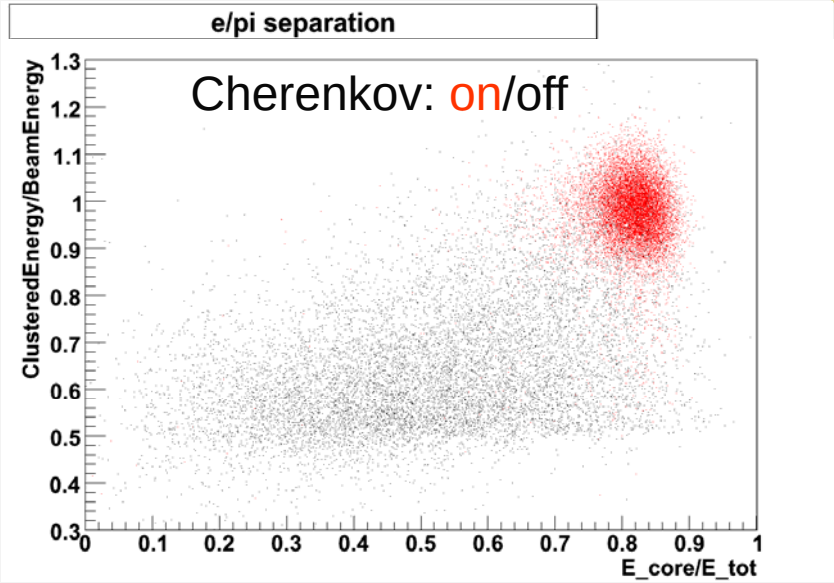


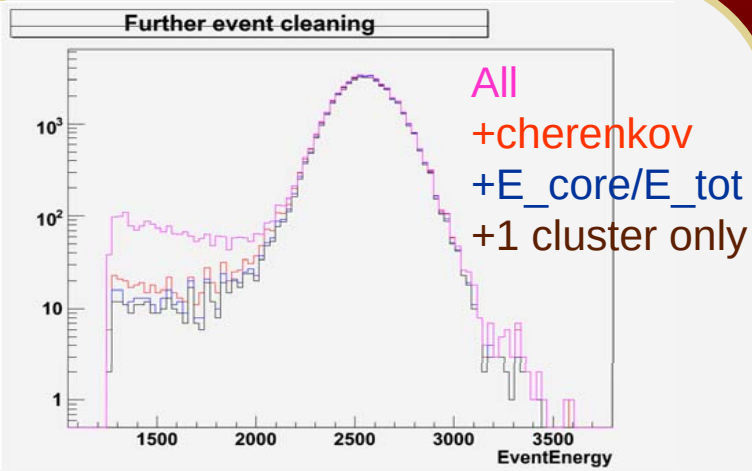
Removing dirty events

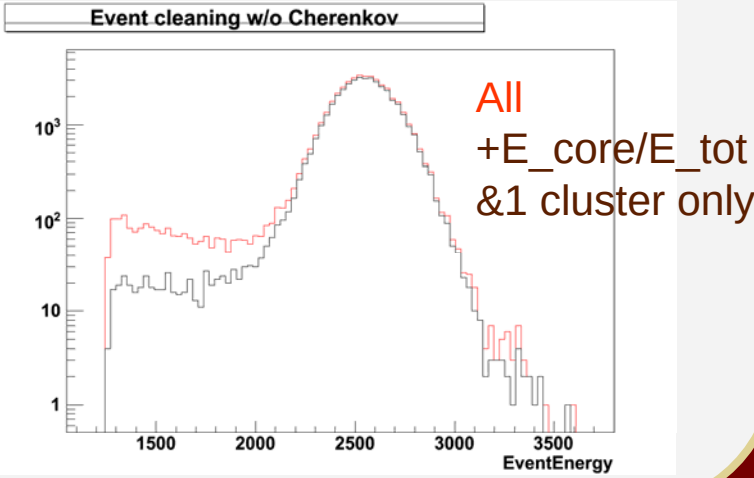


Additional Event cleaning

- Use energy deposit in shower core to reject pions
- Core = 2x2 pixel

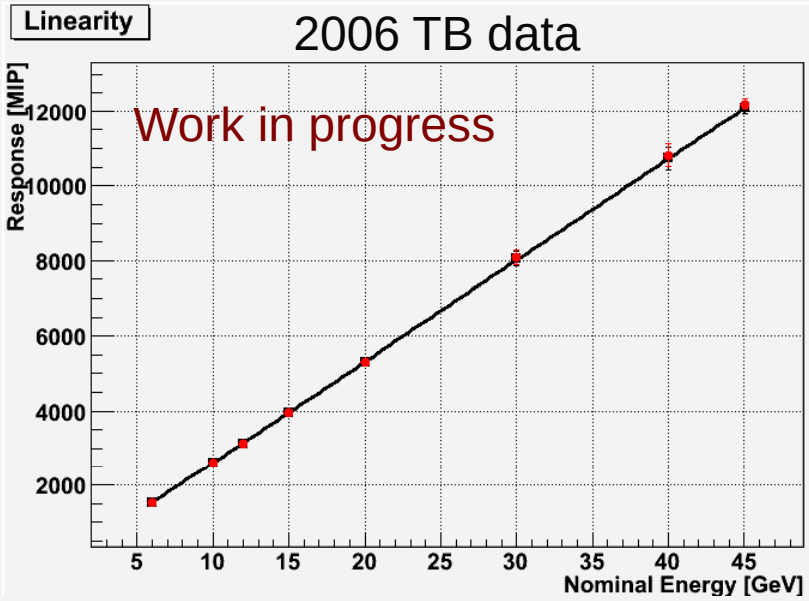


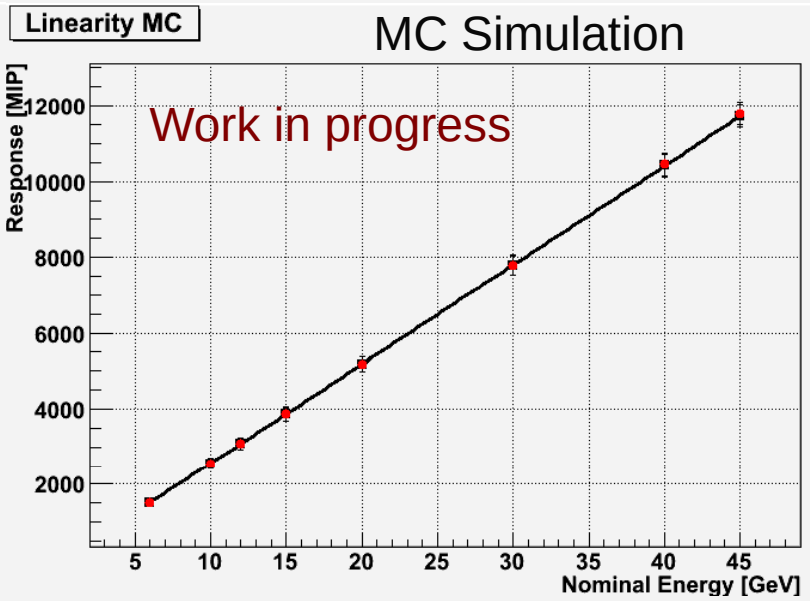




Linearity

unclustered
clustered

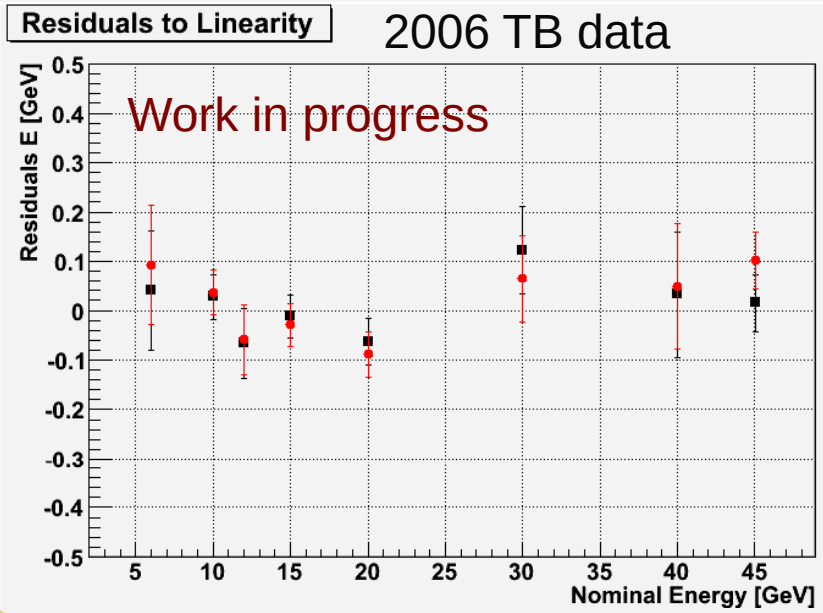


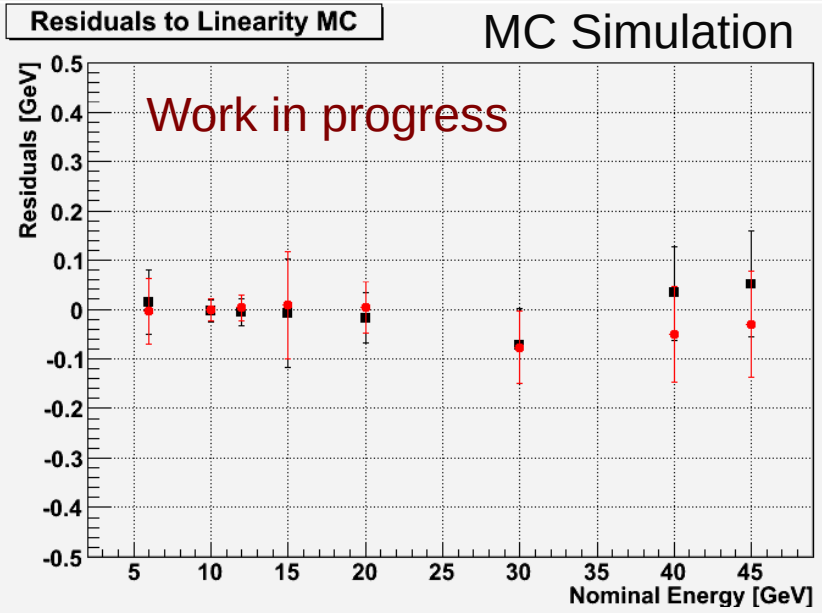


Cluster values are fitted with a parabolic function to correct for non-linearity effects
The quadratic turns out to be small

Residuals to linearity

unclustered
clustered

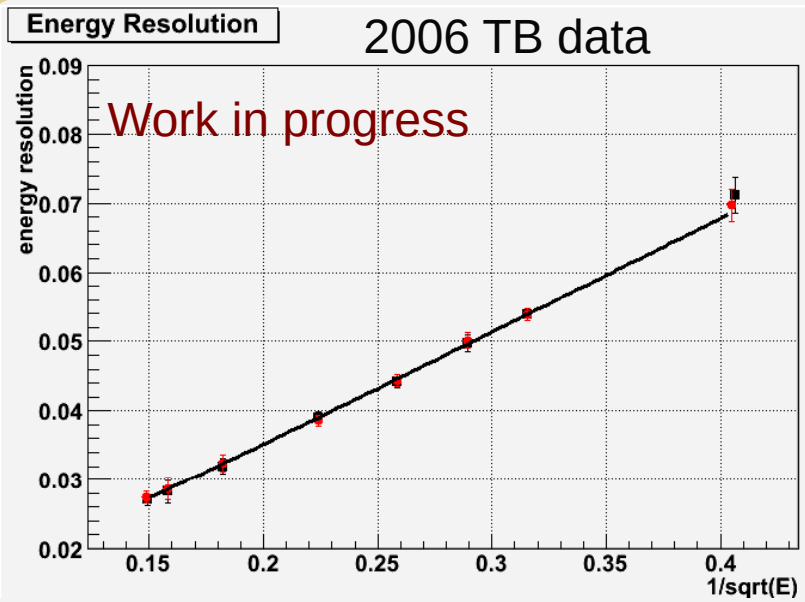


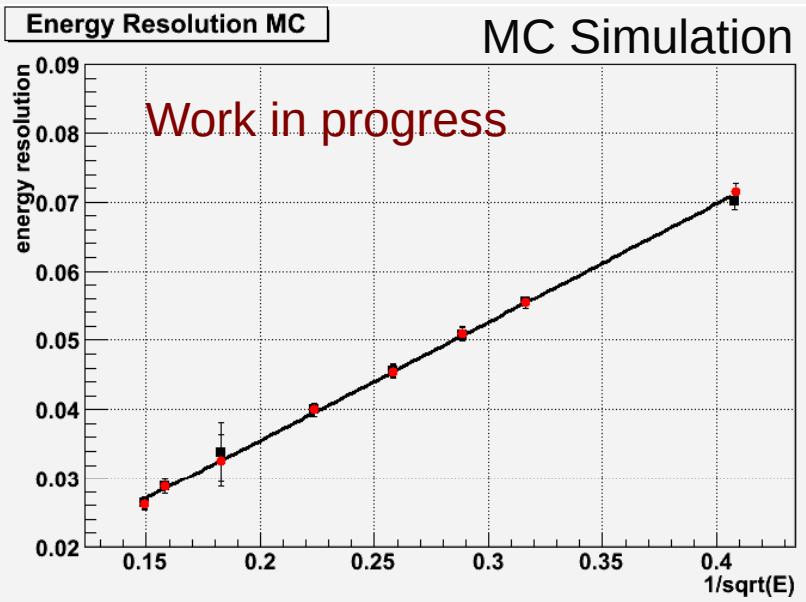


Residuals agree within ~1%

Resolution

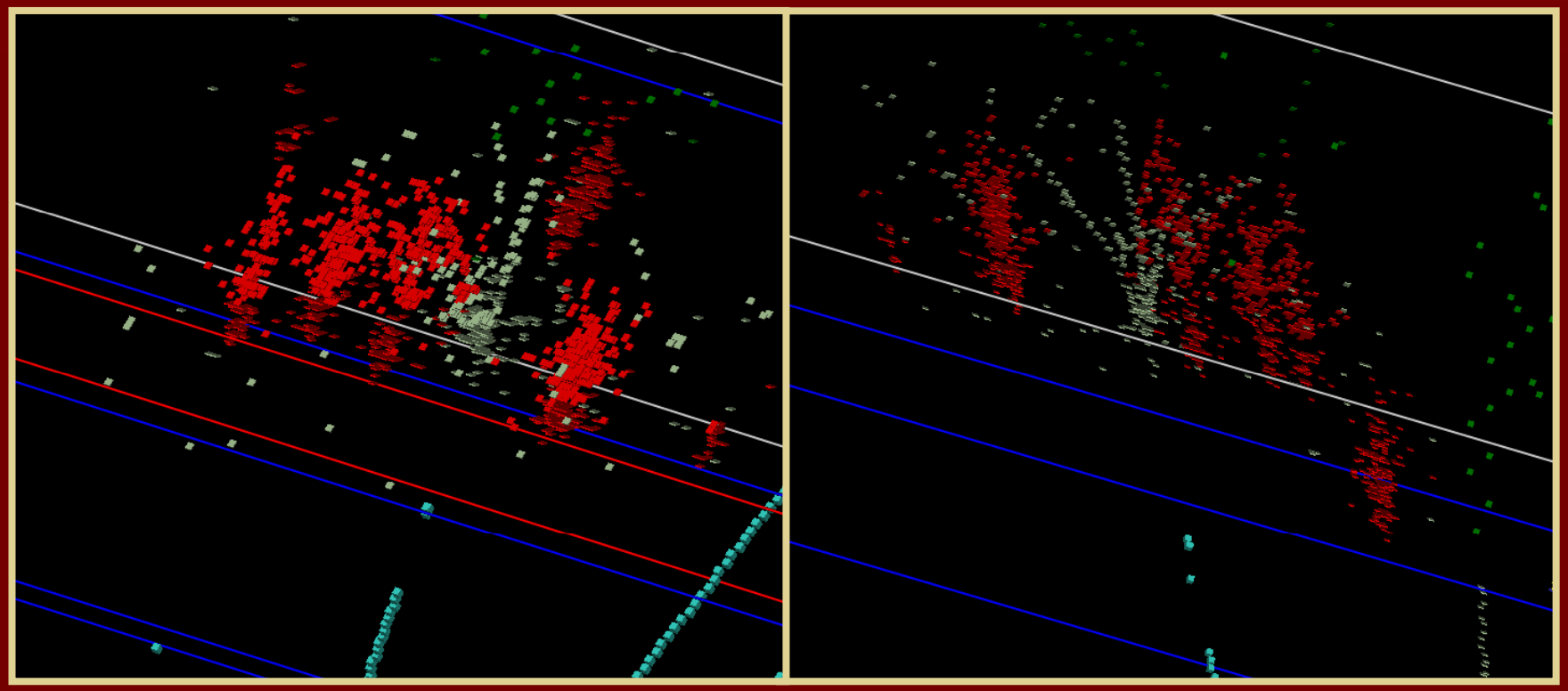
unclustered
clustered



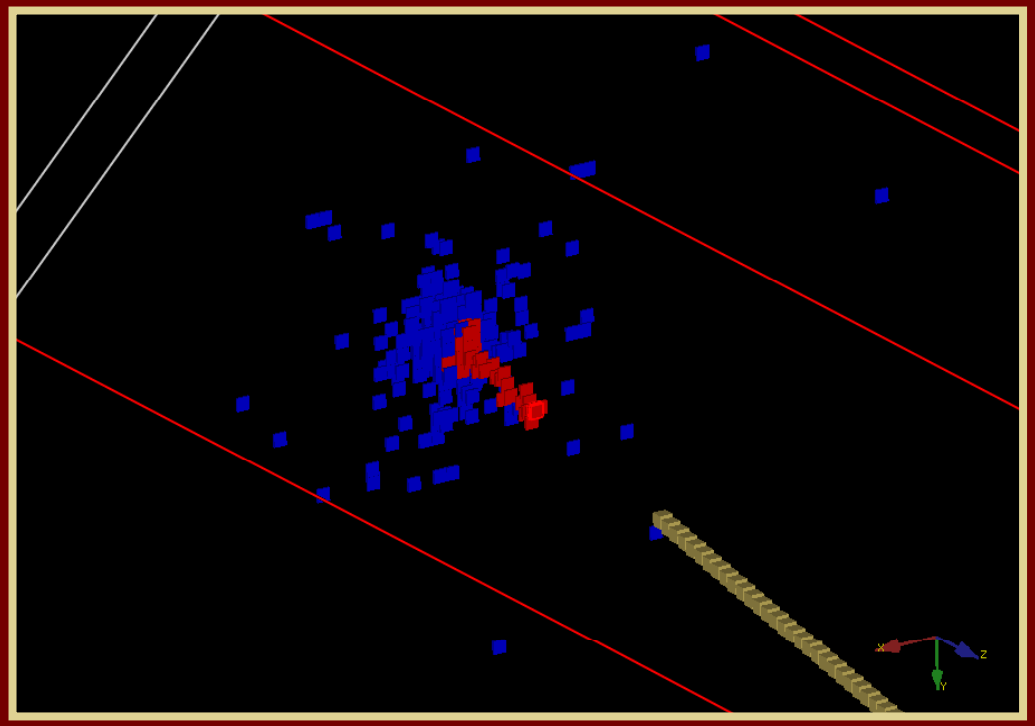


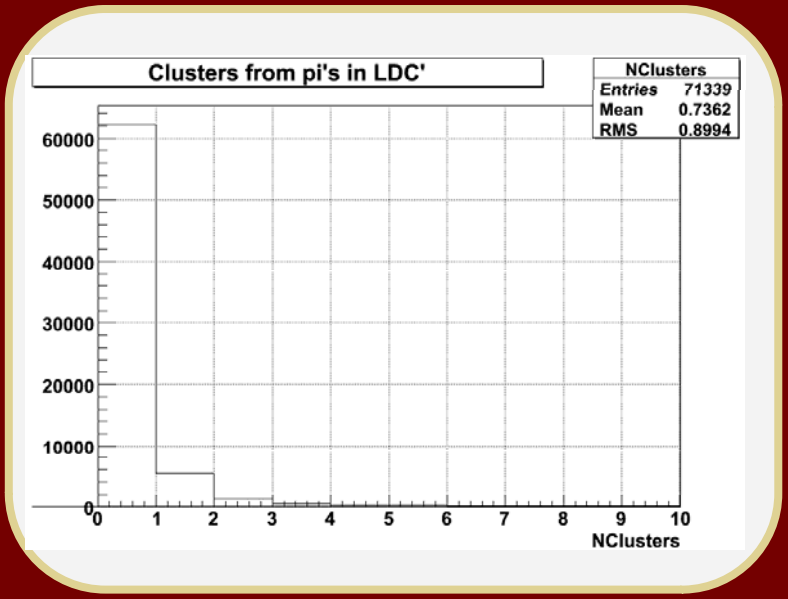
Difference in stochastic term of resolution ~0.1%,
Values agree perfectly within the error

GARLIC for ILD



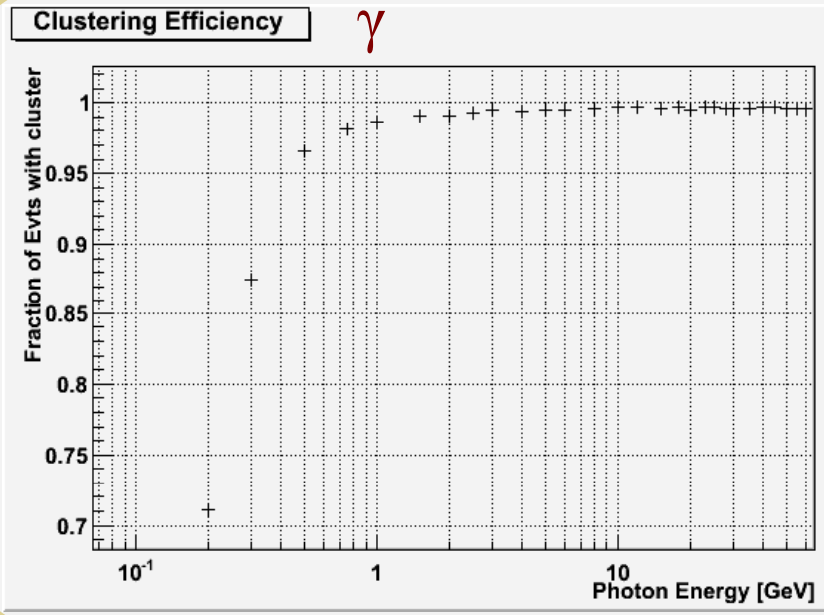
Pion rejection

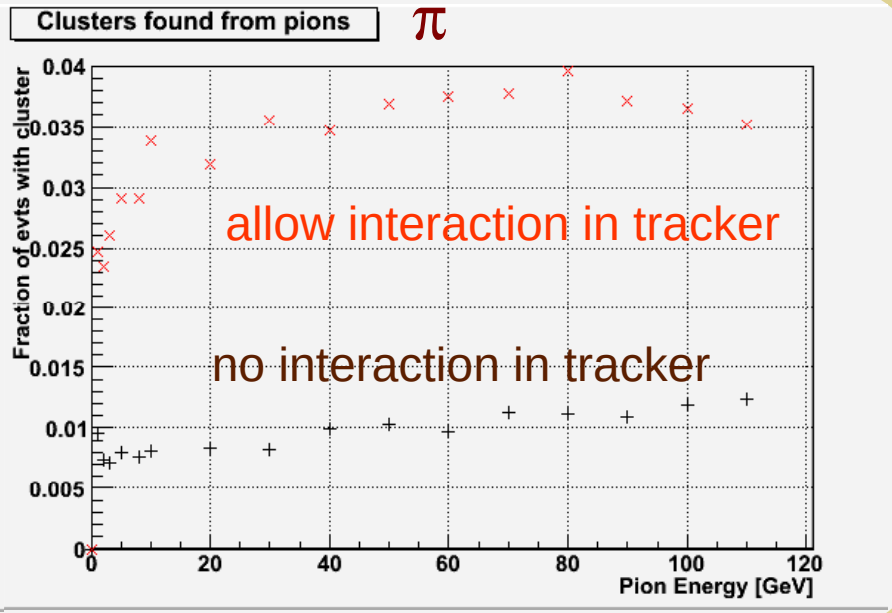




87% pi rejection “out of the box”
Apply ANN cuts afterwards

Single particle efficiencies with cuts

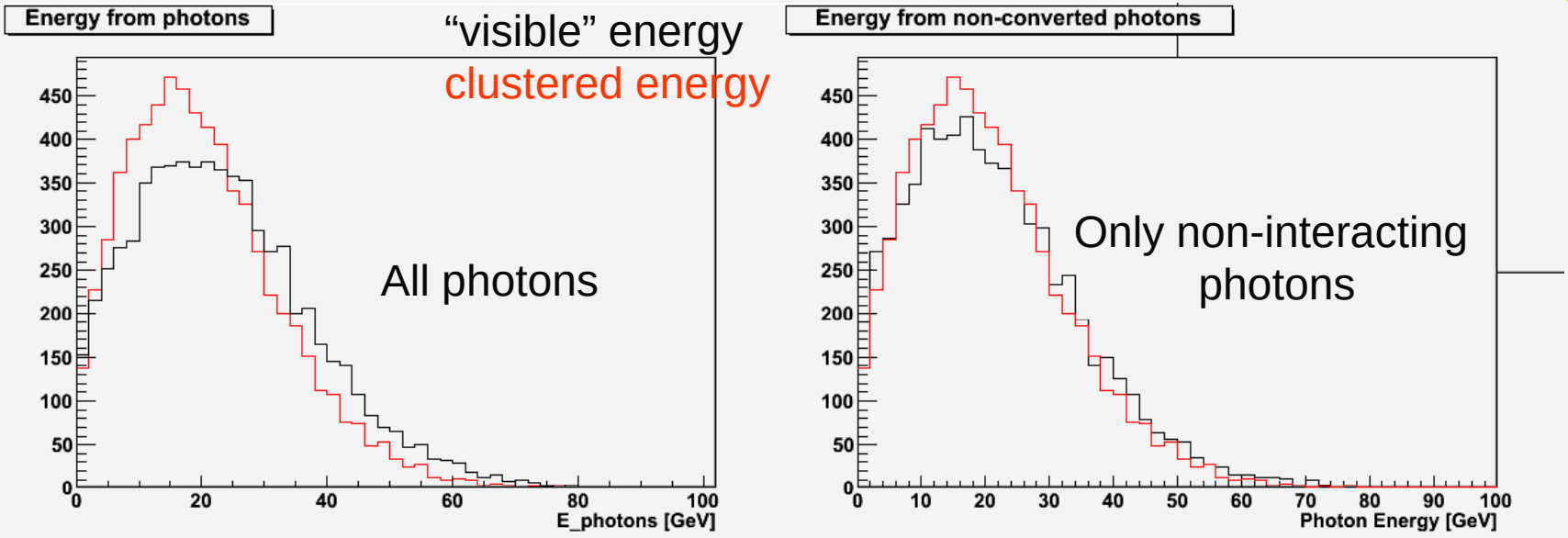




Works down to 150MeV
Efficiency:
>96% @ 500 MeV
98.6% @ 1GeV
>99% for E>1GeV

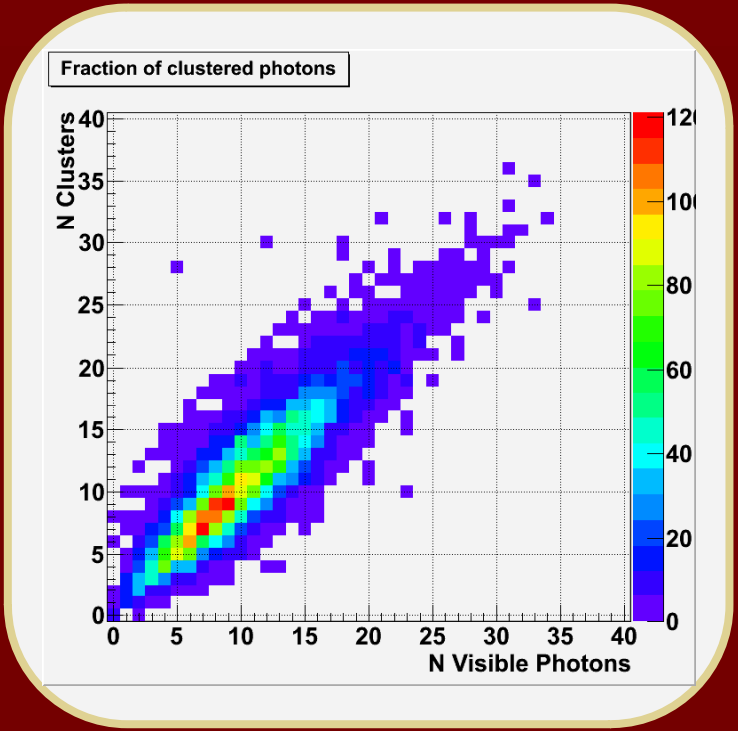
Pion interactions in tracker create fake clusters that are impossible to reject

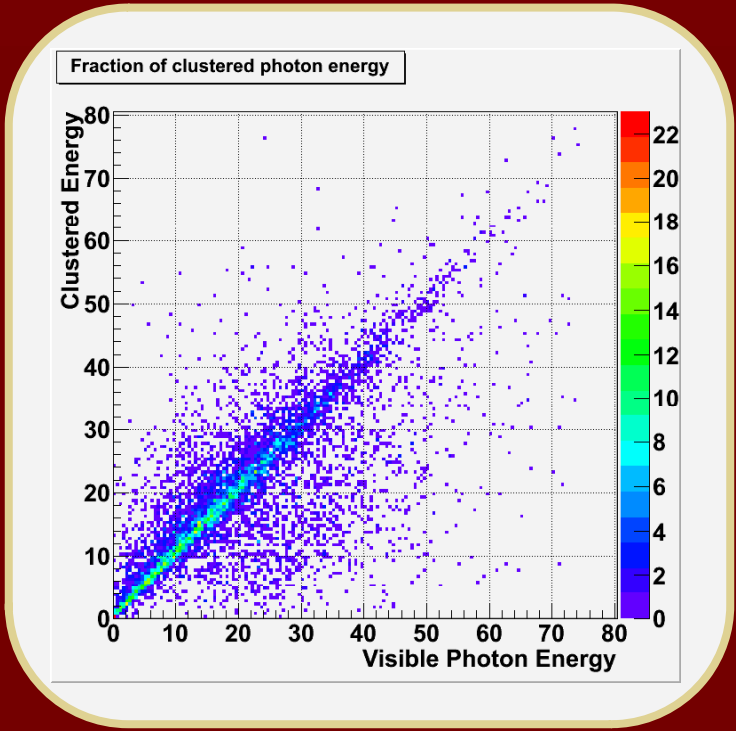
First try on jets: $q\bar{q}$ at 100GeV



Photon conversion results in strong underestimation of energy
Slight underestimation remains visible

First try on jets: $q\bar{q}$ at 100GeV





Pion interactions not suppressed
Reasonable performance

Outlook

- TB:
  - Clustering seems not to degrade resolution, possible improvement should be clearer visible with 2007 tb data (detector equipped with more channels)
  - Need to improve gap correction to reduce overshoot (non-linear interpolation)
- ILD:
  - Single particle efficiency looks good
  - First look on jets is promising, but…
  - Need further investigation to understand losses
  - Try on jets with higher energies
  - GARLIC can help with the detector optimization!

GARLIC and MOKKA
go quite well together!