A clustering algorithm for e-m showers

04/05/07 - ILC Software Workshop, LAL Orsay
Marcel Reinhard – LLR, Ecole polytechnique

Outline

- Principal idea of the algorithm
- Step-by-step description
- MC studies
- The CALICE Si/W ECAL prototype and data taking in test beam
- Application on test beam data
- Further plans

The principle idea of the algorithm

- First step in a PFA analysis will be recognition and clustering of γ's
- High granularity of ECAL gives a precise image of em shower
- Simple neighbouring criterion is sufficient for clustering!
- Implemented as MARLIN processor

The algorithm: step-by-step

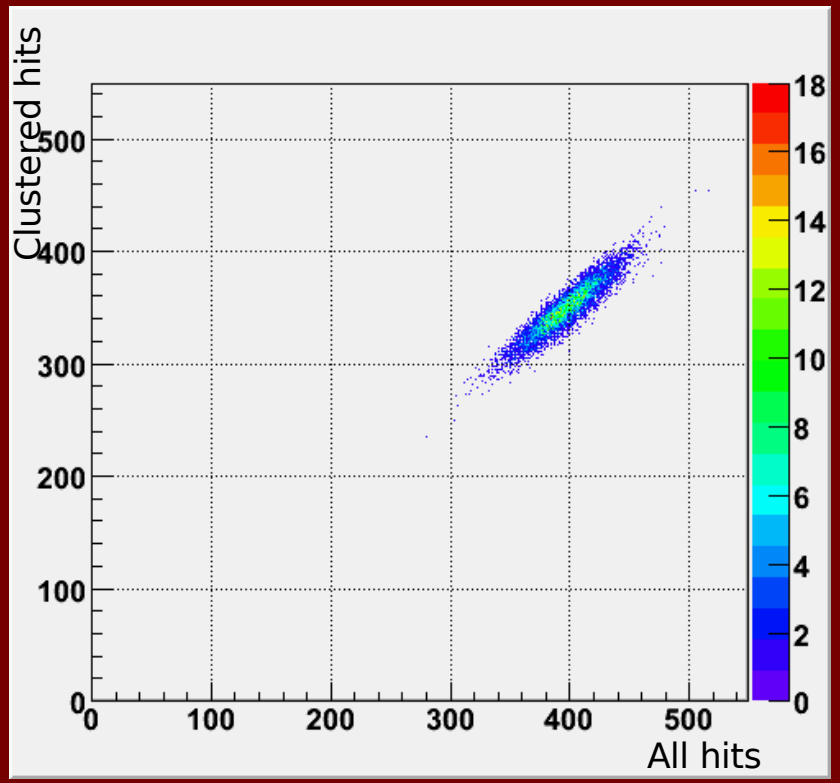
- Based on REPLIC
- At $5X_0$ more than 99% of γ's will have started to shower
- 2-dim projection of hits in first $5X_0$ on the plane perp. to the impact direction (for now: fixed parameter according to exp setup, later: event-by-event determination)
- Define seed of cluster as nearest hit to the highest energy projection
- Build cluster core by adding projective hits in deeper layers
- Cluster hits using a simple neighbouring criterion while doing several iterations from front to back
- Check cluster criteria (min Hits, ”holes”, shower shape) and free hits of rejected clusters

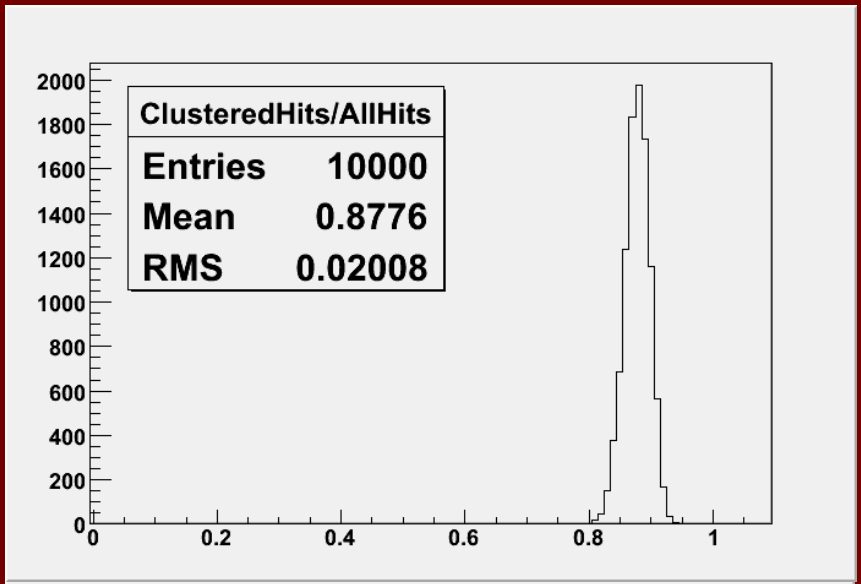
MC studies

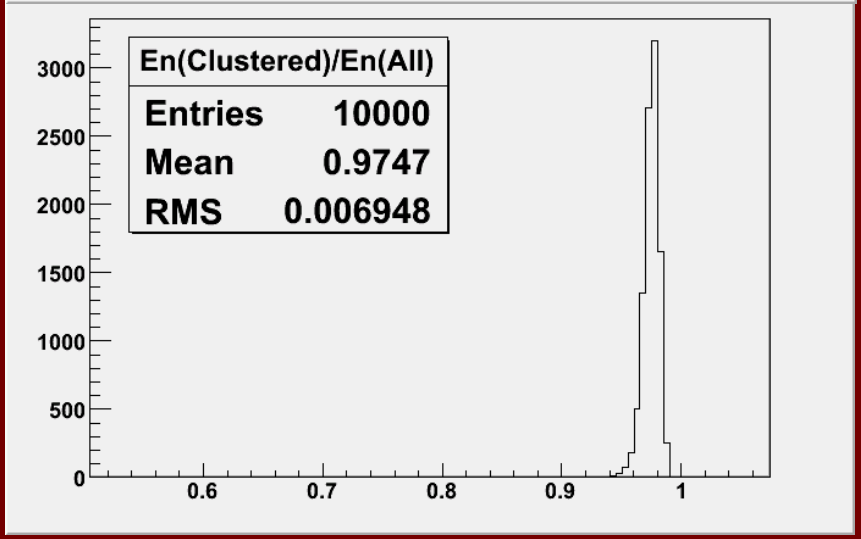
- Based on files generated by N.Watson with MOKKA and the GEAR file for the Prototype model
- Mimic runs used for TB analysis at different energies (45,30,10 GeV) and different impact angle (0,20,30,45 degrees)

MOKKA: e^- at 45 GeV and 0°

- Sample size: 10000 events
- efficiency = 100%, 2nd small cluster in 3 events (merged with main cluster)

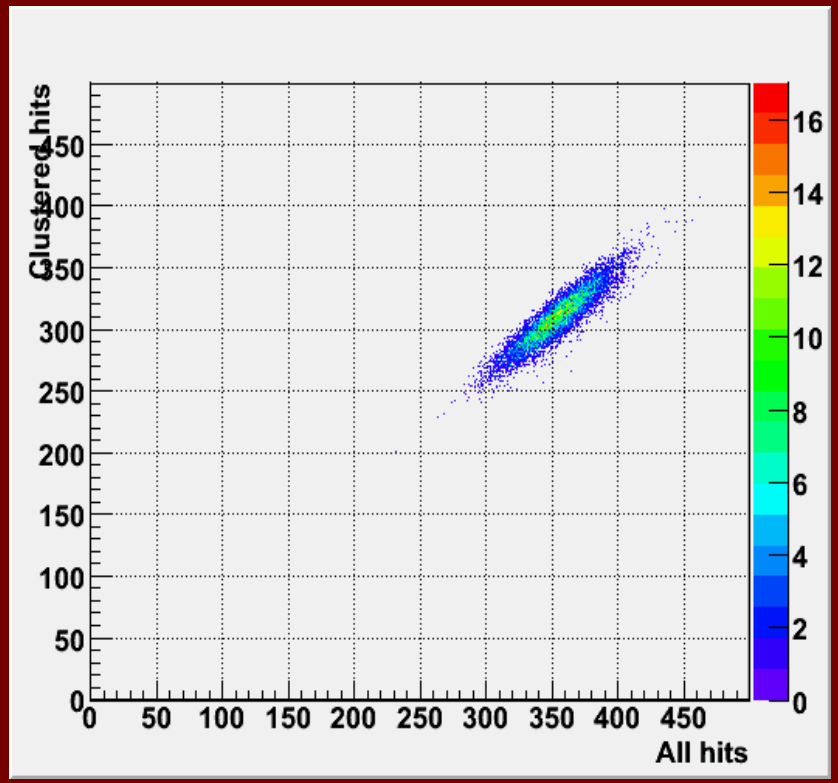


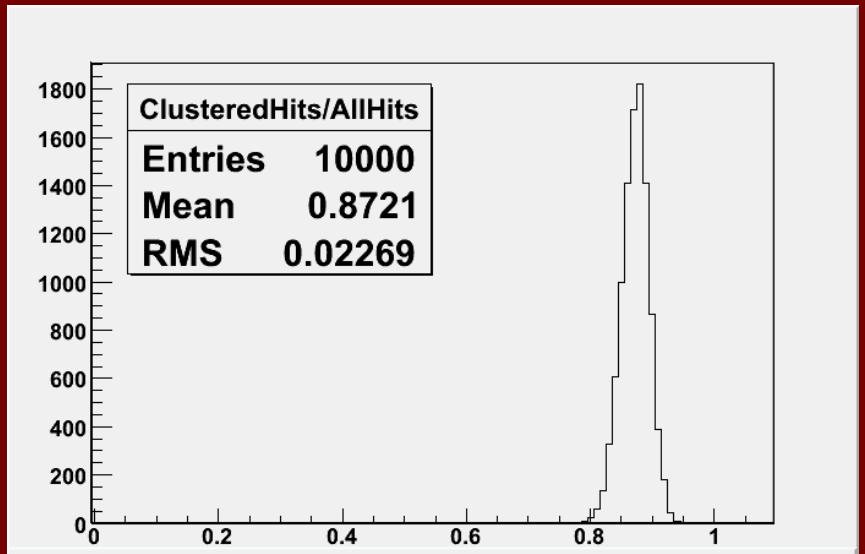


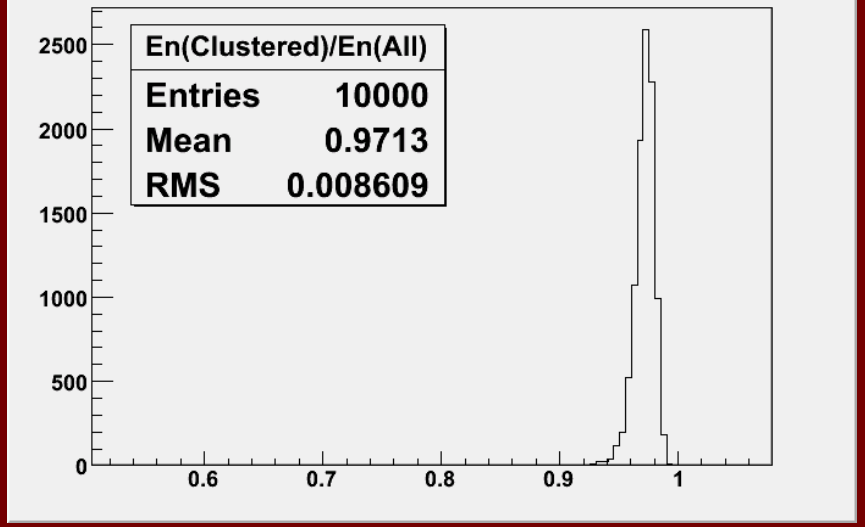


MOKKA: e^- at 30 GeV and 0°

- Sample size: 10000 events
- efficiency = 100%, 2nd small cluster in 4 events (merged with main cluster)

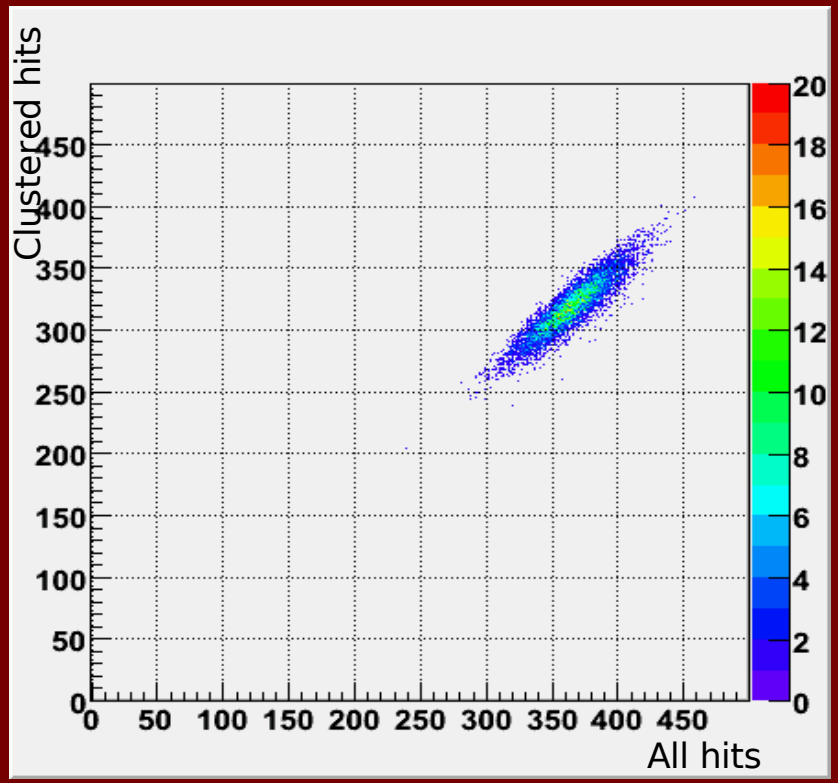


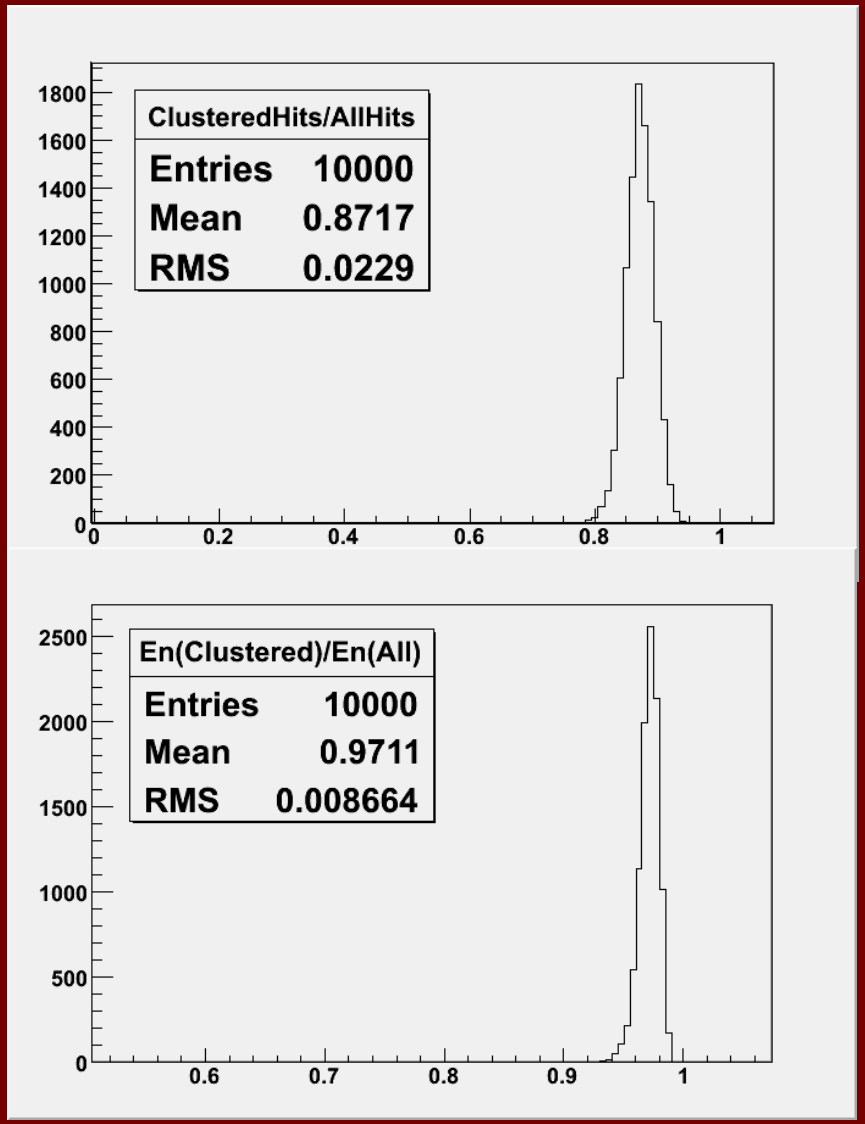




MOKKA: e^- at 30 GeV and 20°

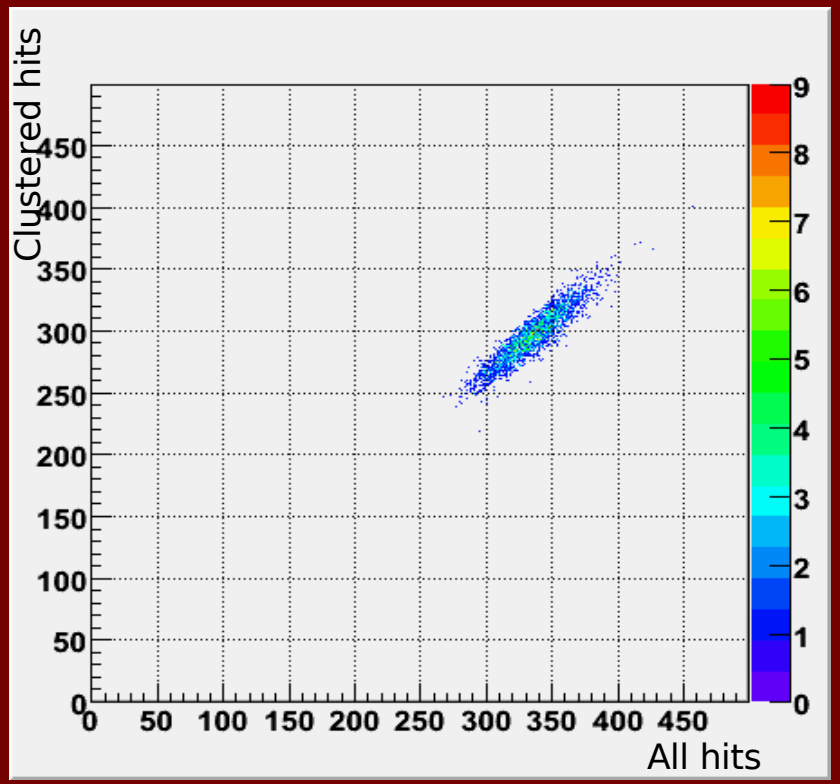
- Sample size: 10000 events
- efficiency = 100%, no 2nd cluster

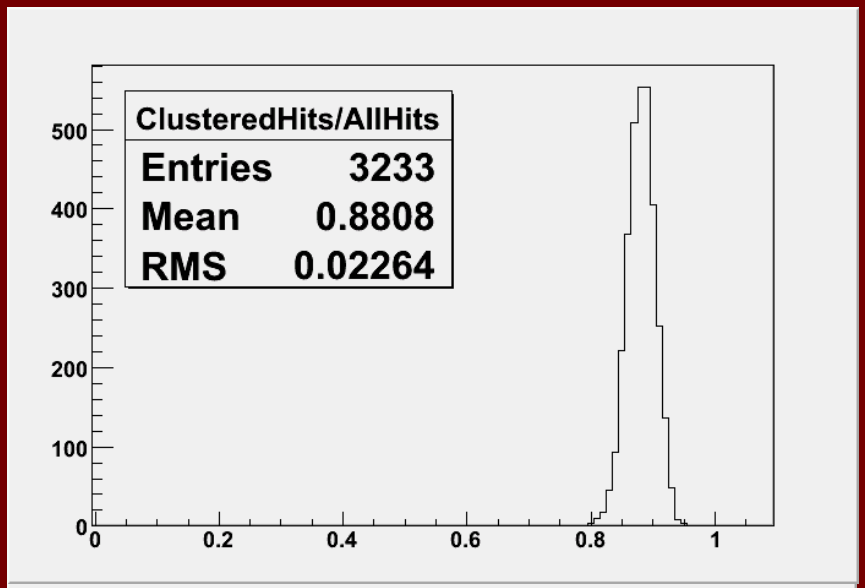


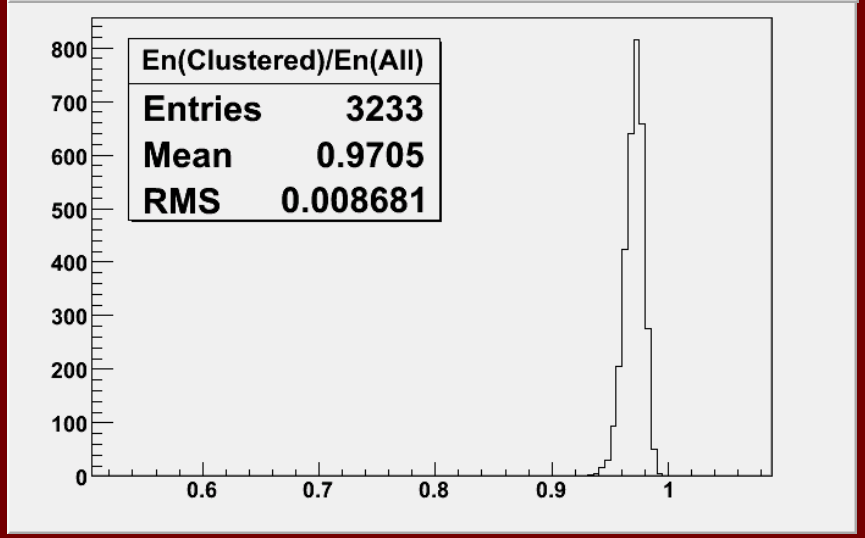


MOKKA: e^- at 30 GeV and 30°

- Sample size: 3233 events
- efficiency = 100%, 2nd small cluster in 2 events (merged with main cluster)

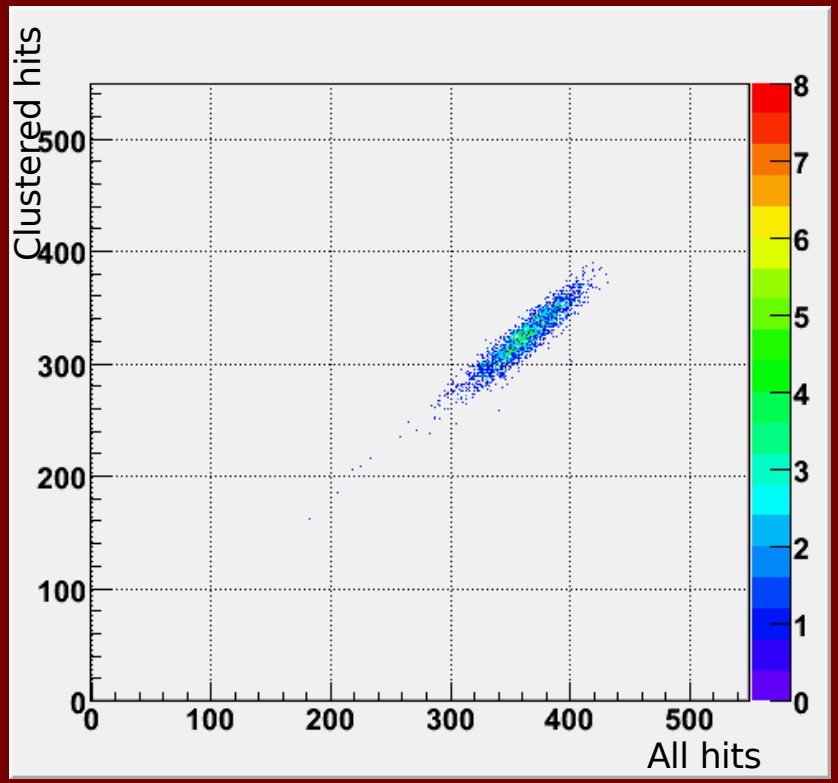


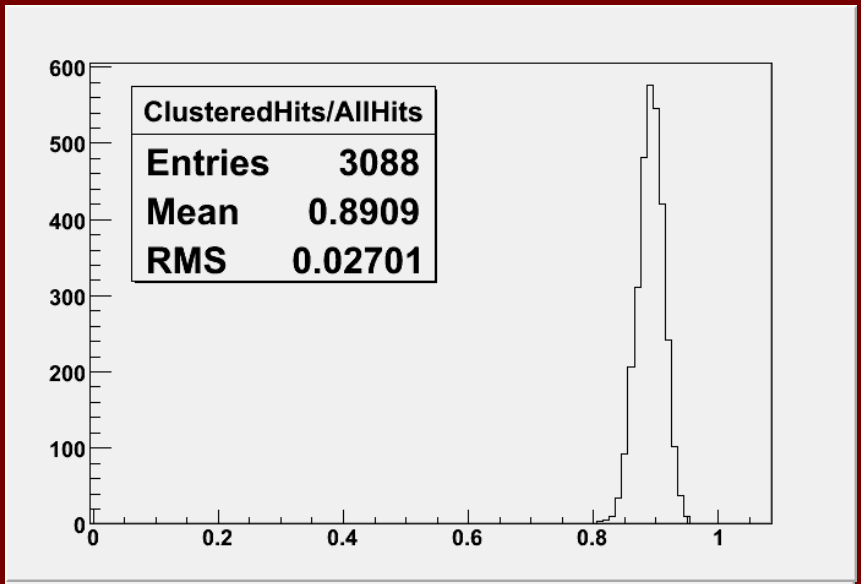


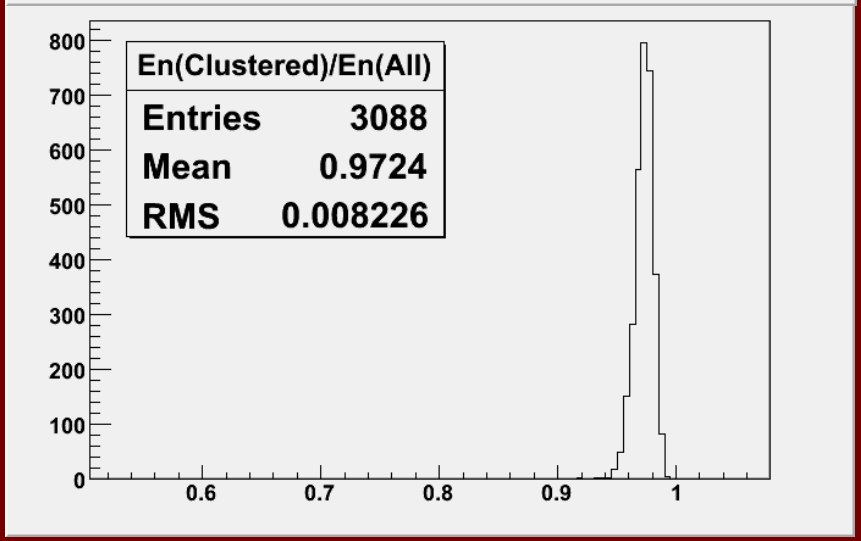


MOKKA: e^- at 30 GeV and 45°

- Sample size: 3088 events
- 1 single event without a cluster (particle hits corner of det)

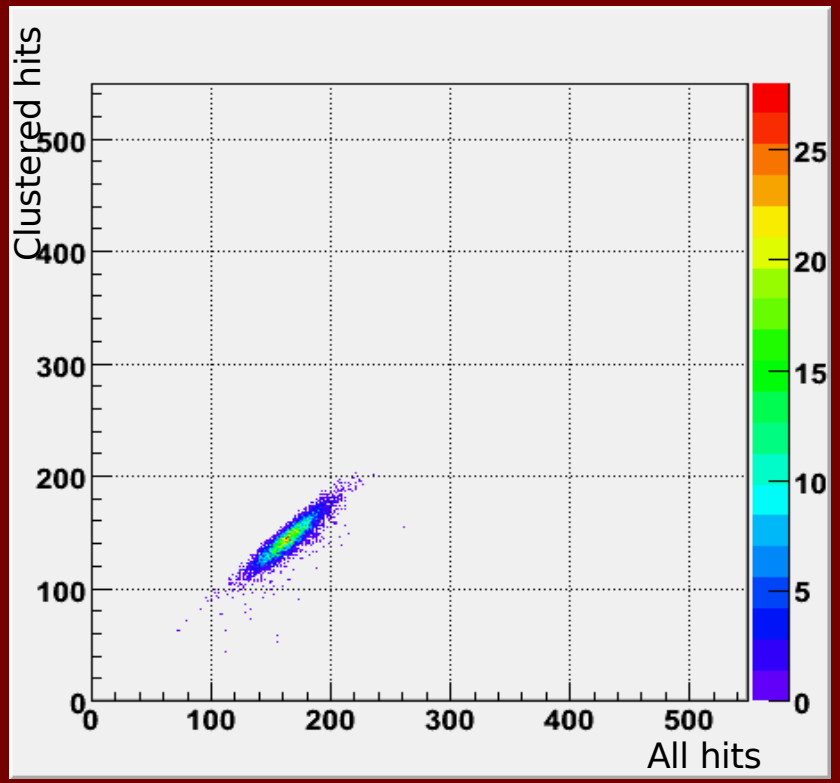


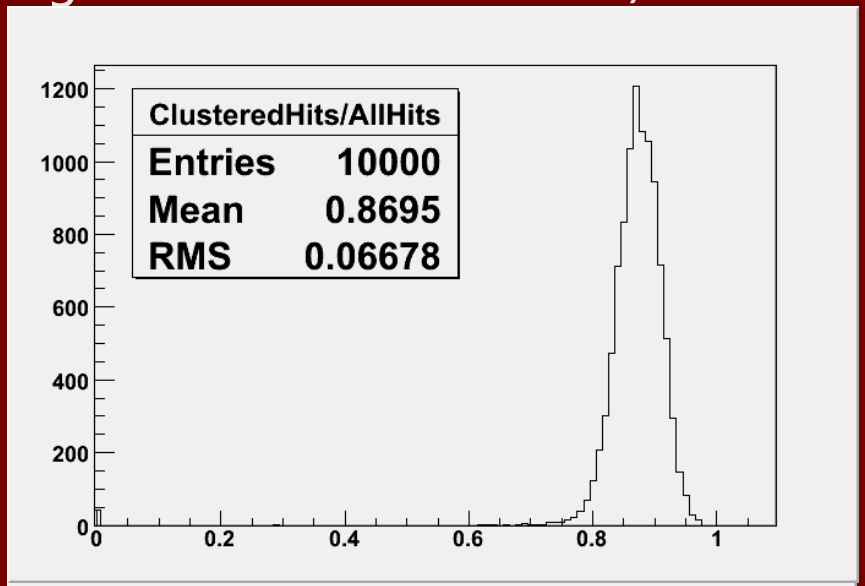


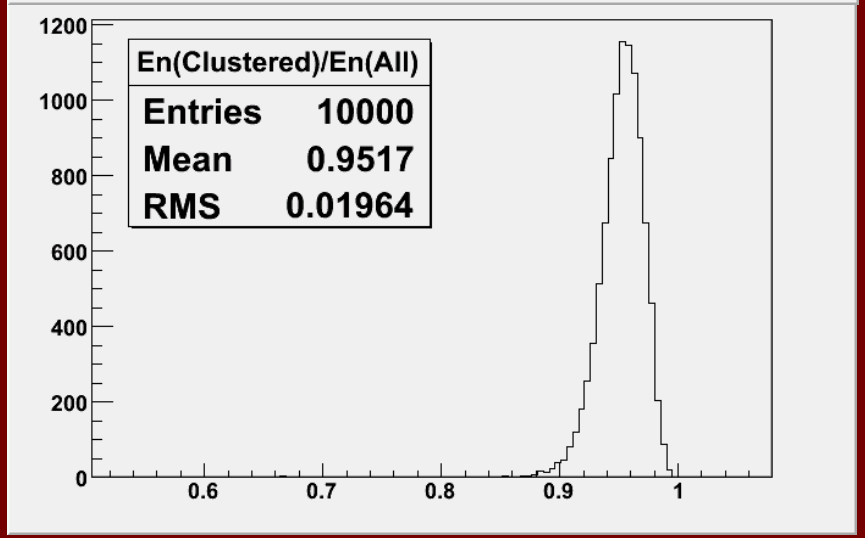


MOKKA: e^- at 10 GeV and 0°

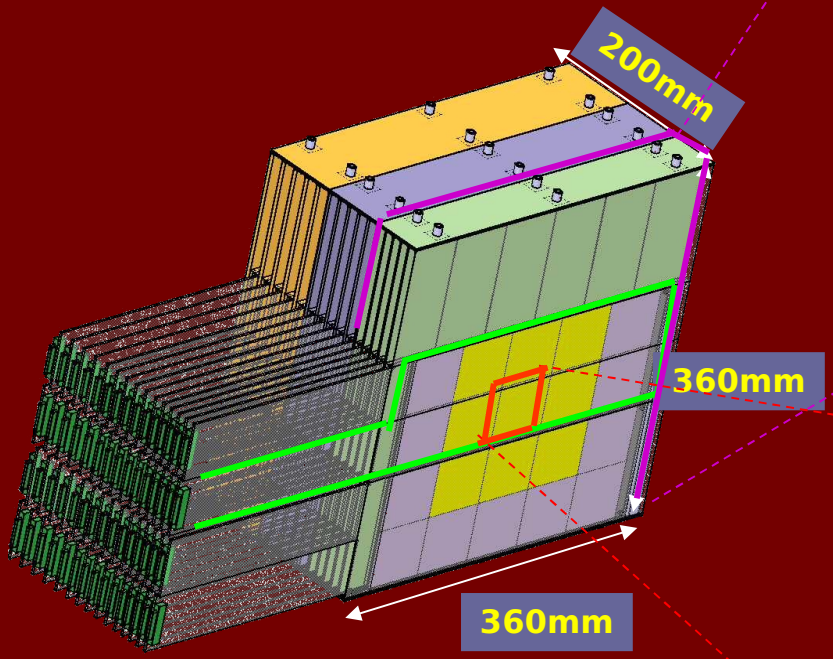
- Sample size: 10000 events
- 42 events without cluster, but those are close to the border
- 2nd small cluster in 24 events (merged with main cluster)

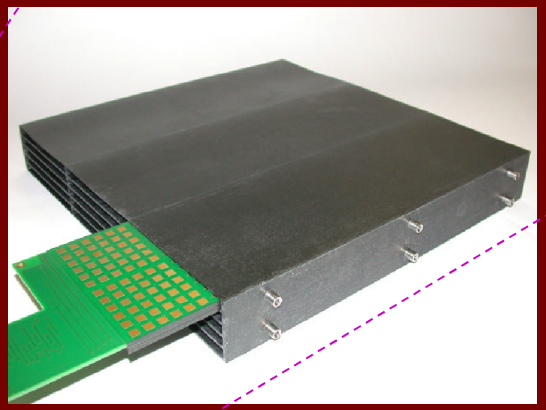






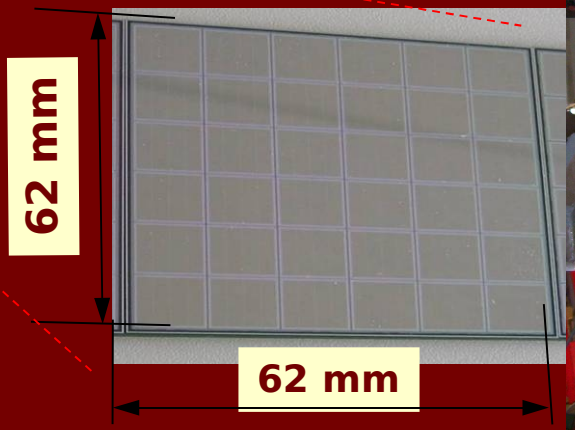
The CALICE Si/W ECAL prototype

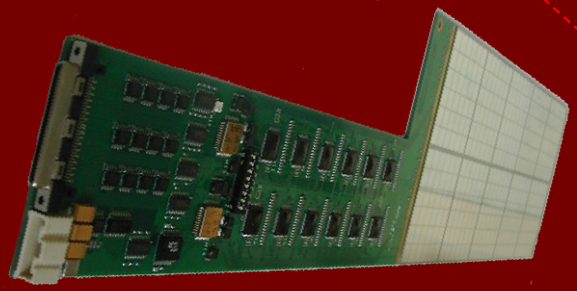




- structure of W wrapped in carbon fiber
- 3 modules with different absorber thicknesses
- in total: 24 X_0

- 6x6 1x1cm² Si pads
- glued on PCB

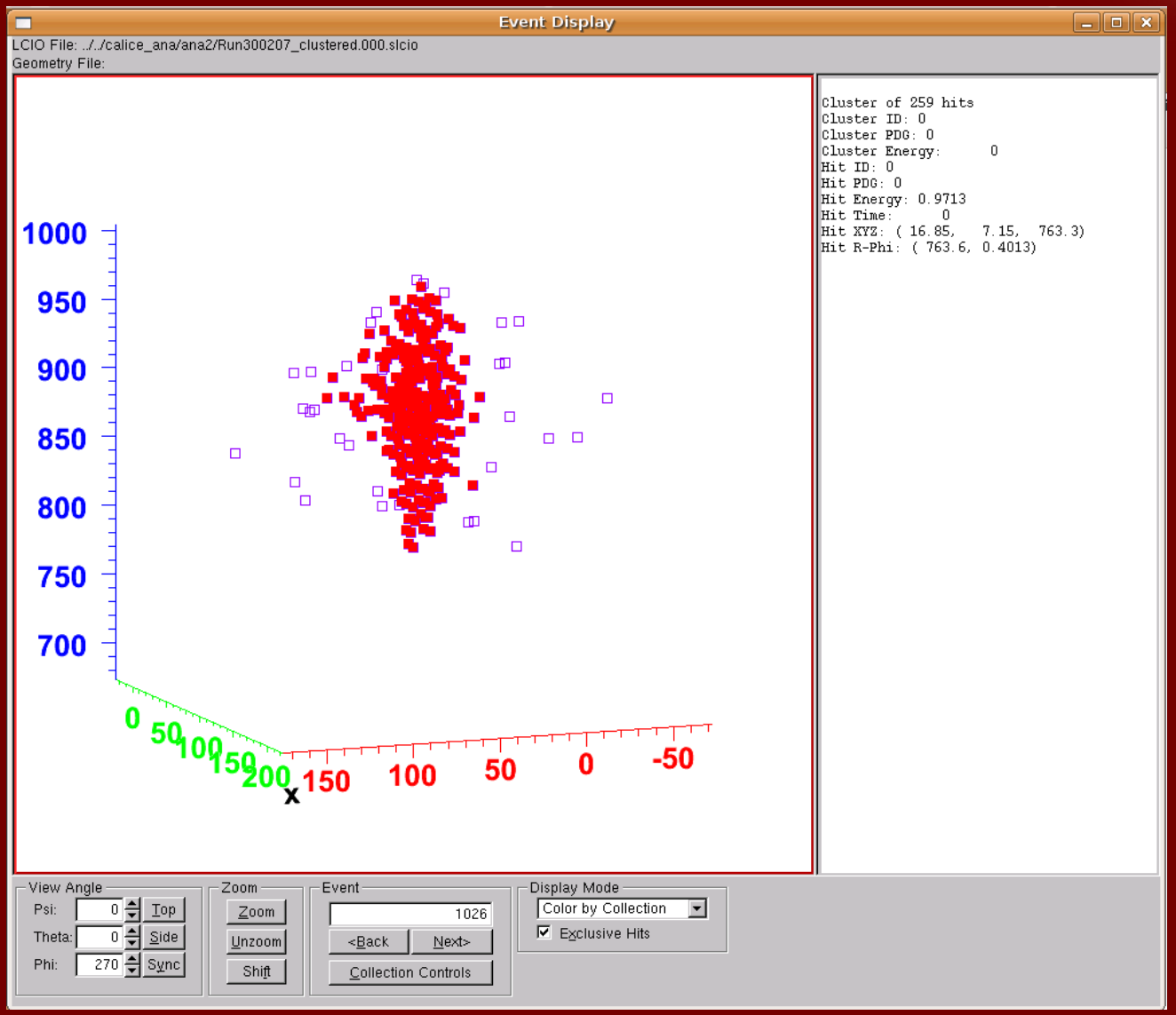




The CALICE test beam

- Samples taken during CALICE test beam at CERN during August and October 2006
- incident e^- at different energies and angles

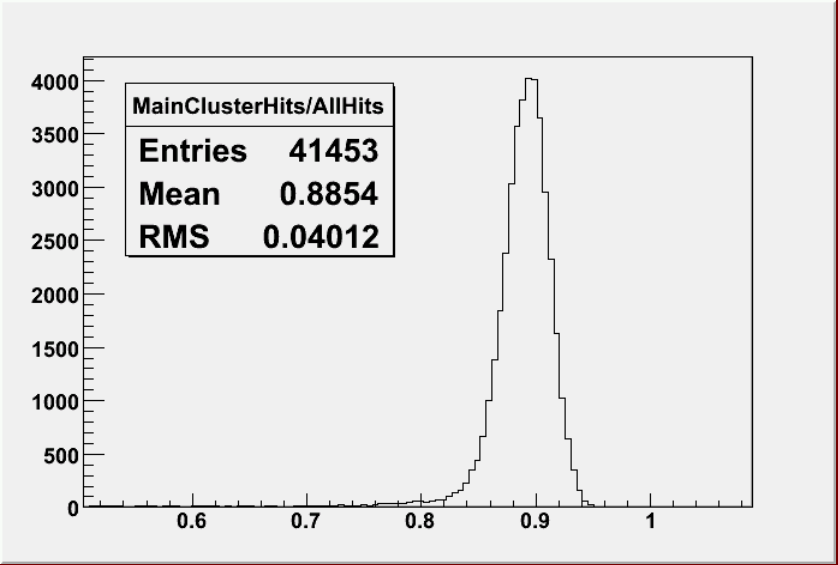
A typical e^- event

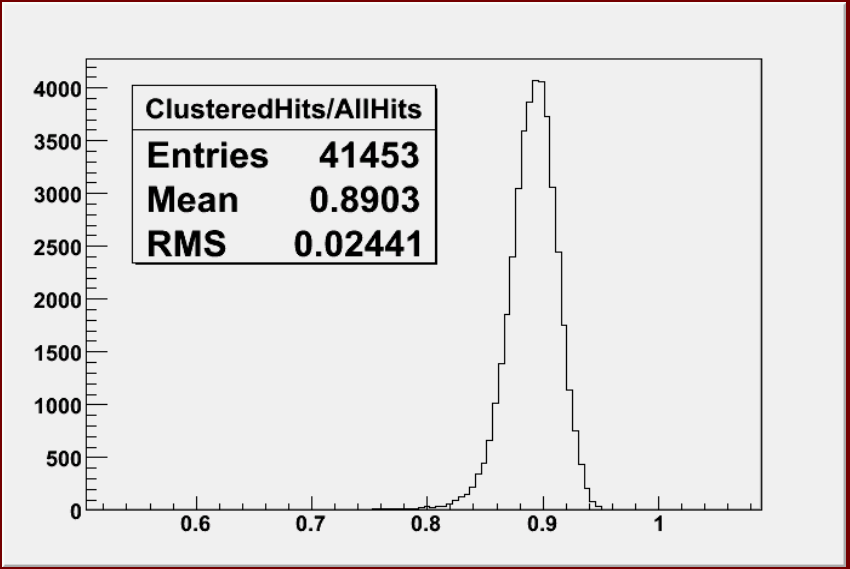


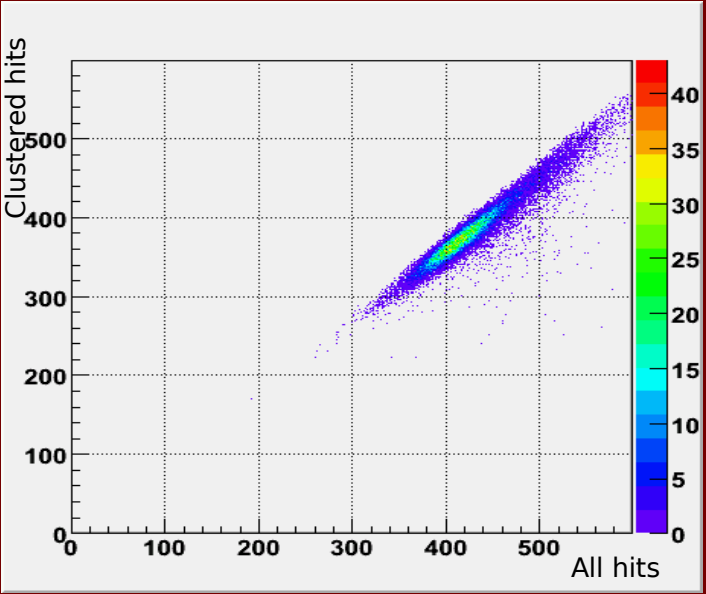
- visualization with XED by A.Sanchez

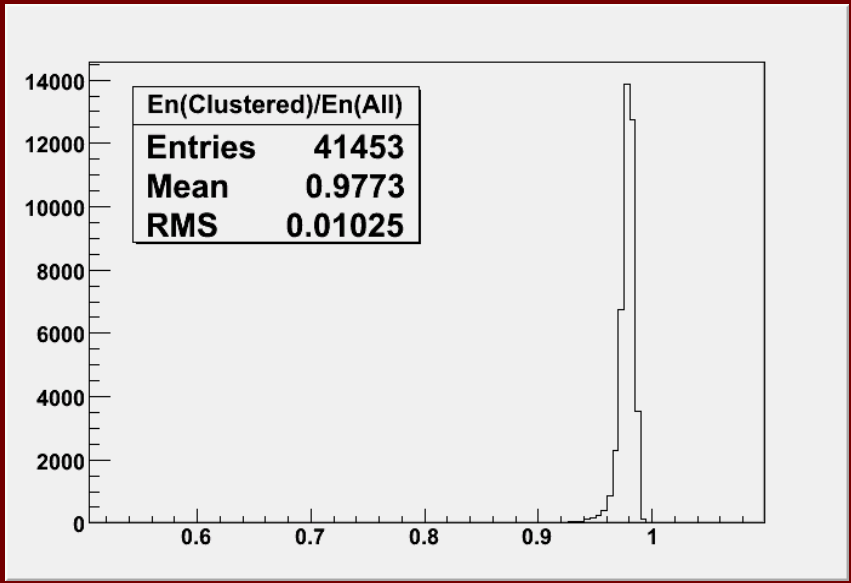
Data: e^- at 45 GeV and 0°

- Sample size: 41453 events
- efficieincy = 100%, 2nd cluster in 1111 events

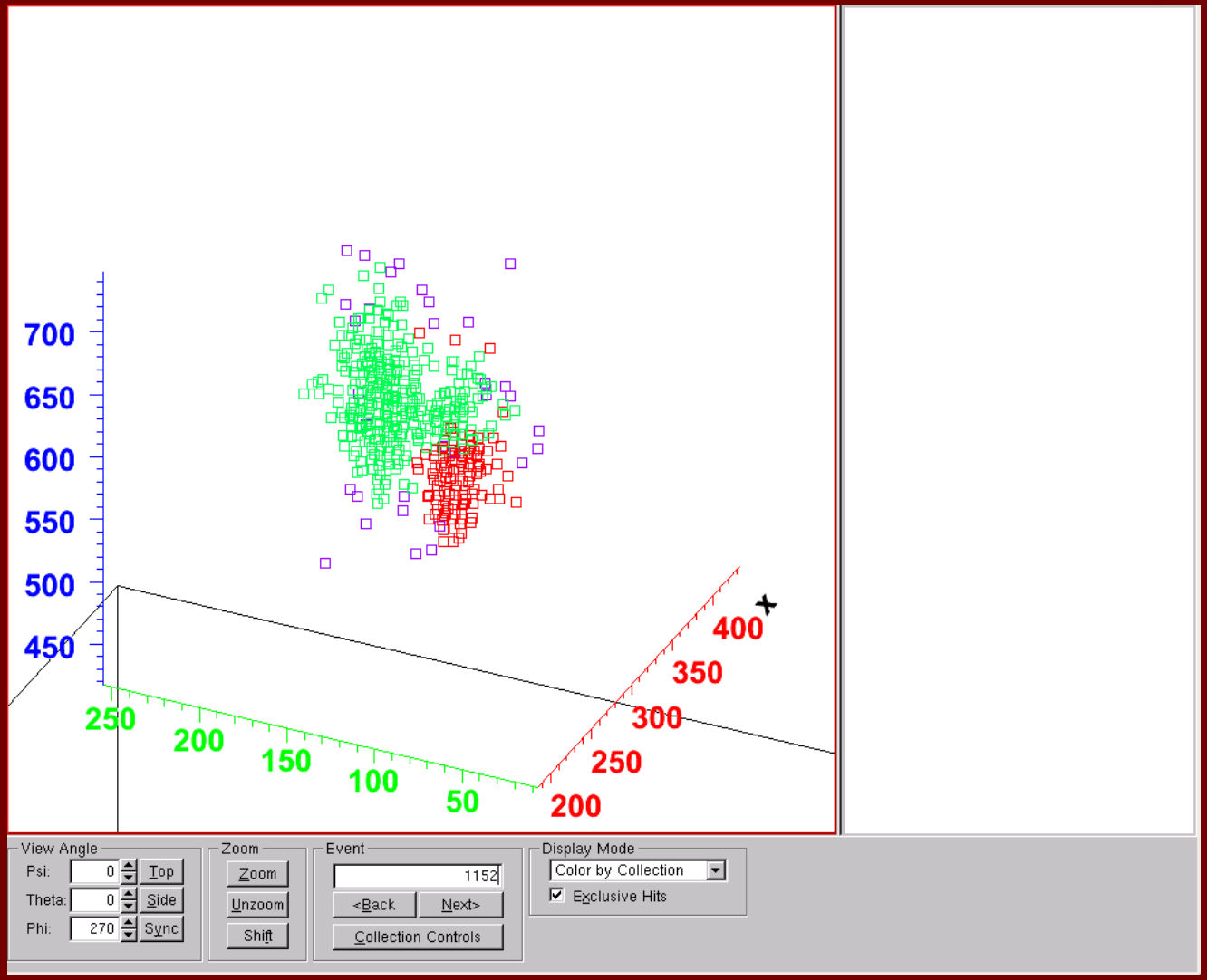








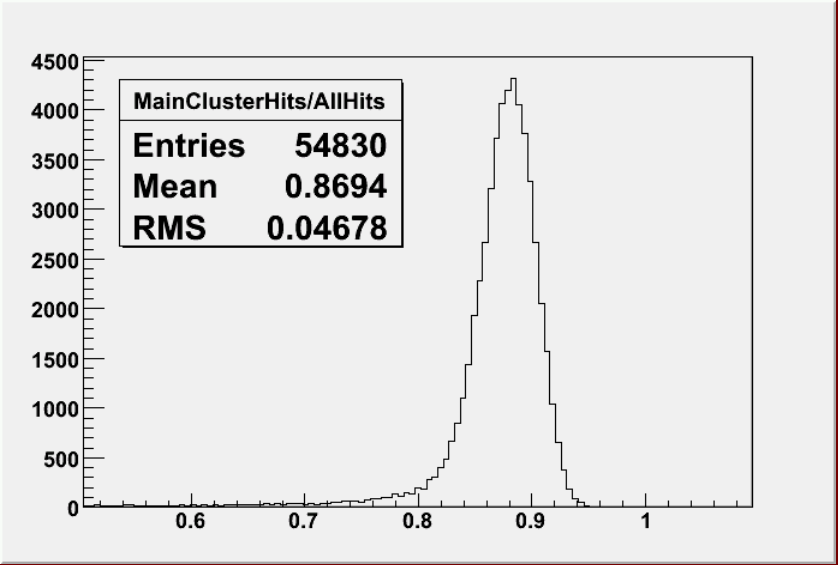
Still some ”dirty” events

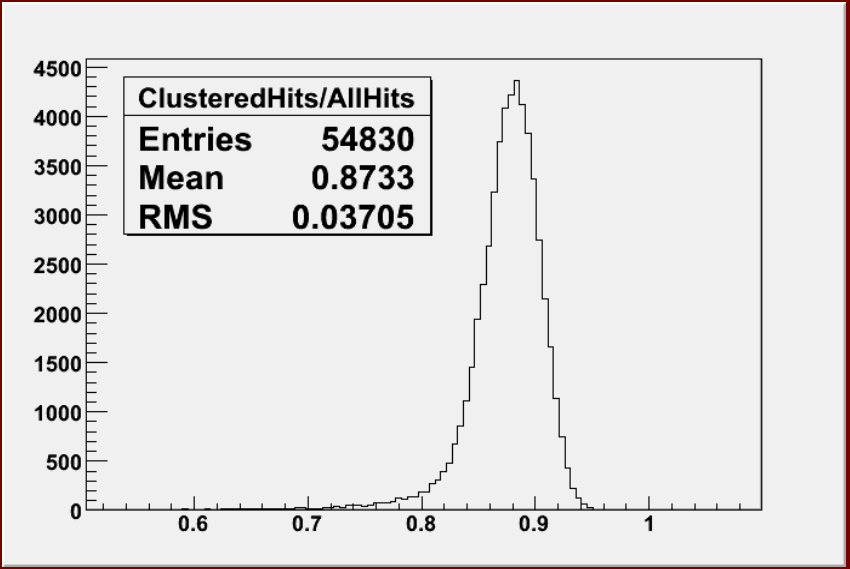


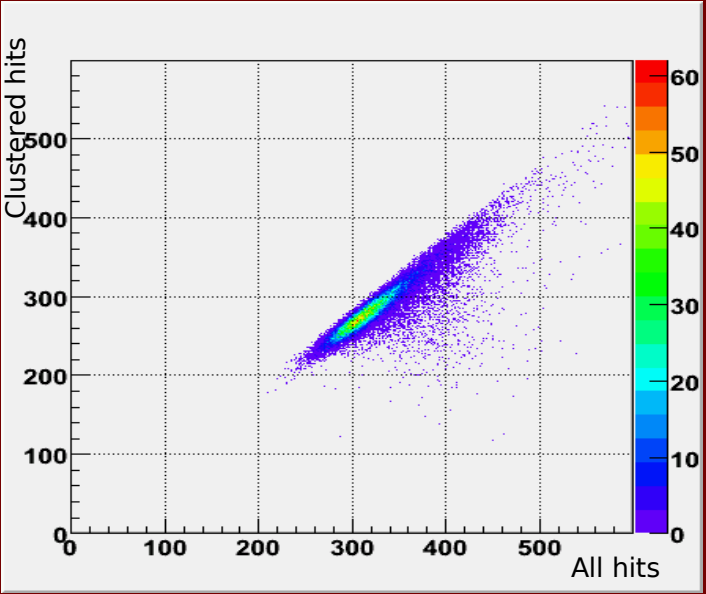
- visualization with XED by A.Sanchez

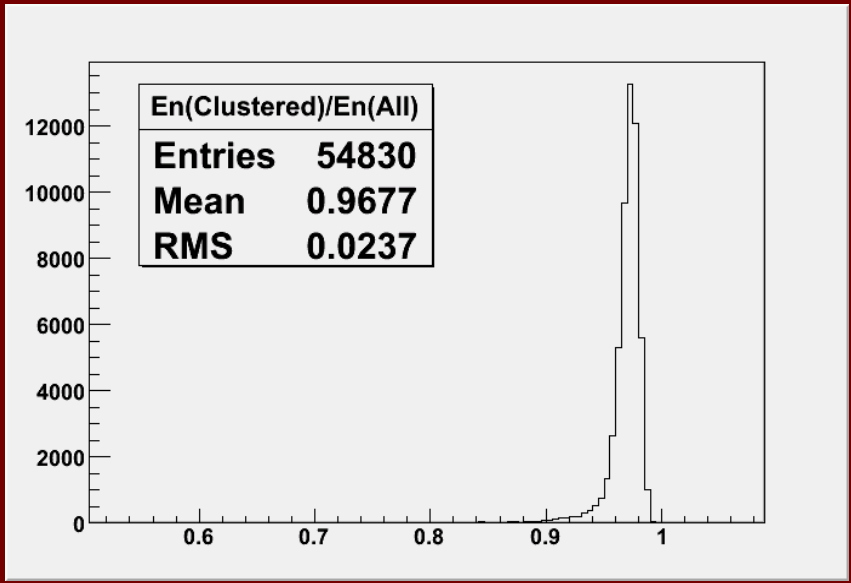
Data: e^- at 30 GeV and 0°

- Sample size: 54830 events
- efficieincy = 100%, 2nd cluster in 1044 events



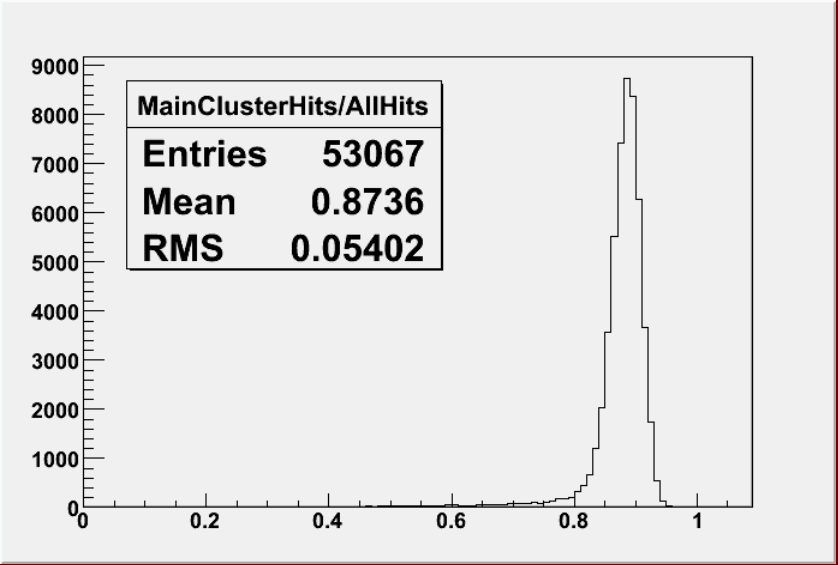


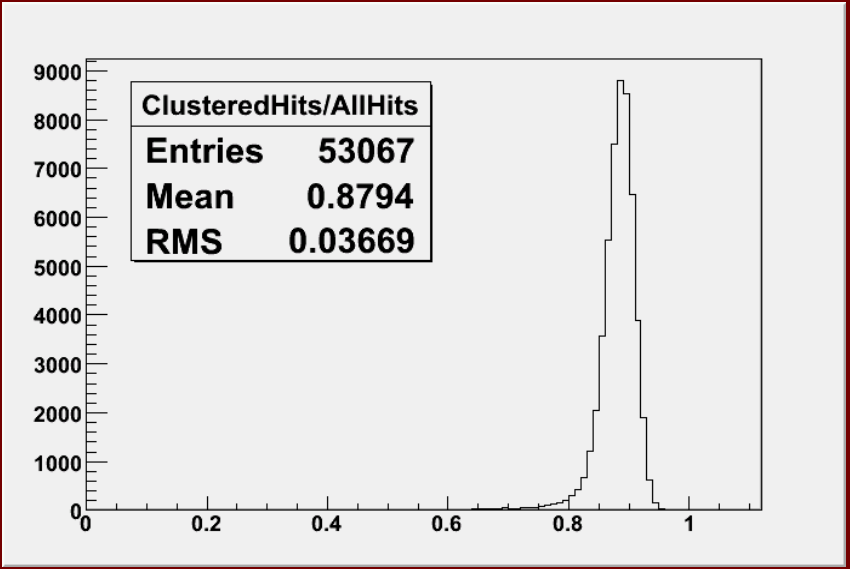


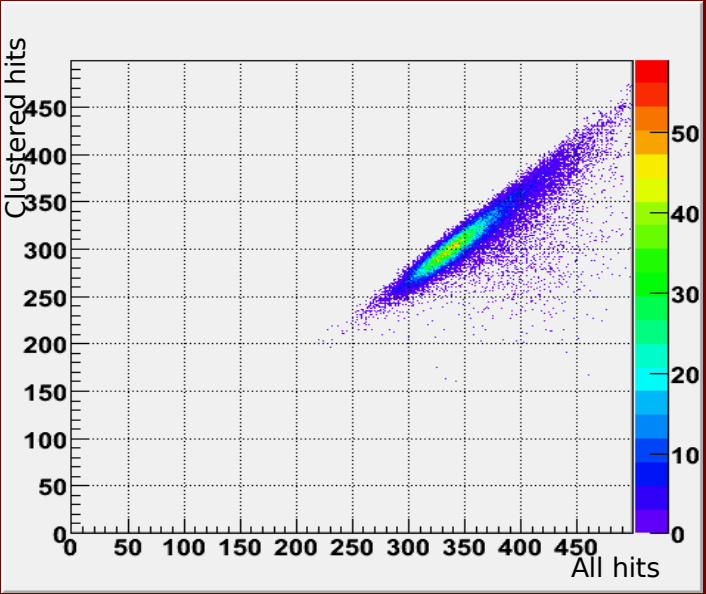


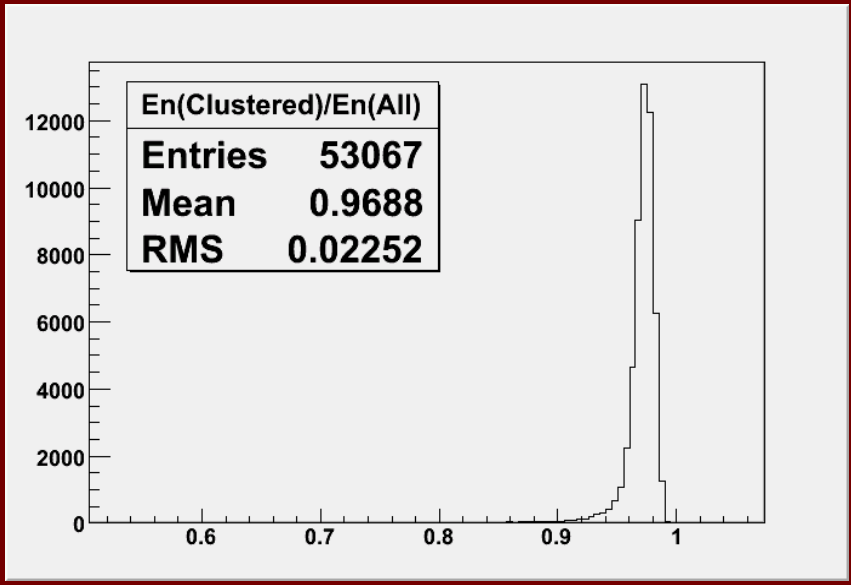
Data: e^- at 30 GeV and 20°

- Sample size: 53067 events
- efficieincy = 100%, 2nd cluster in 1074 events



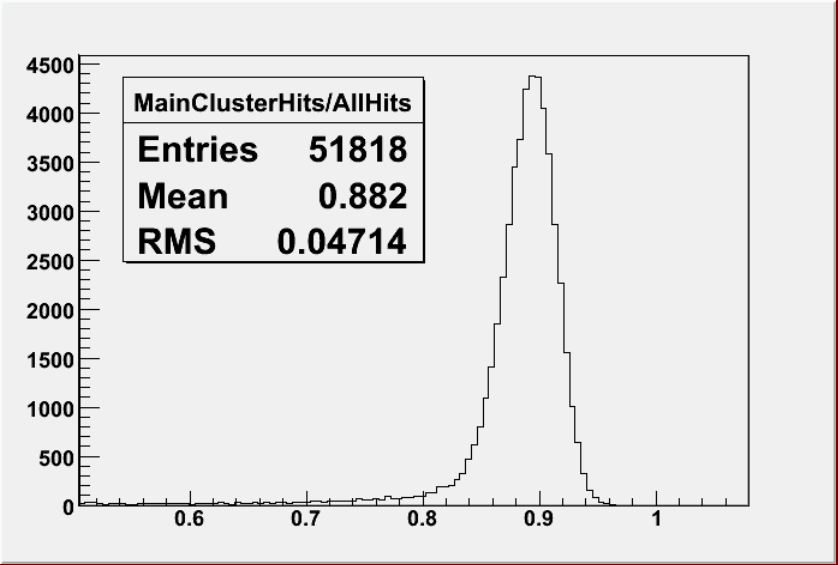


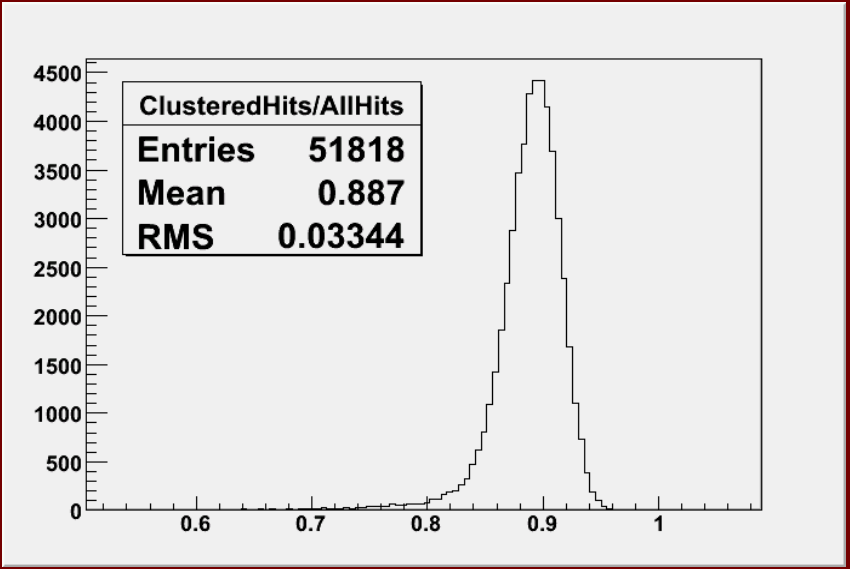


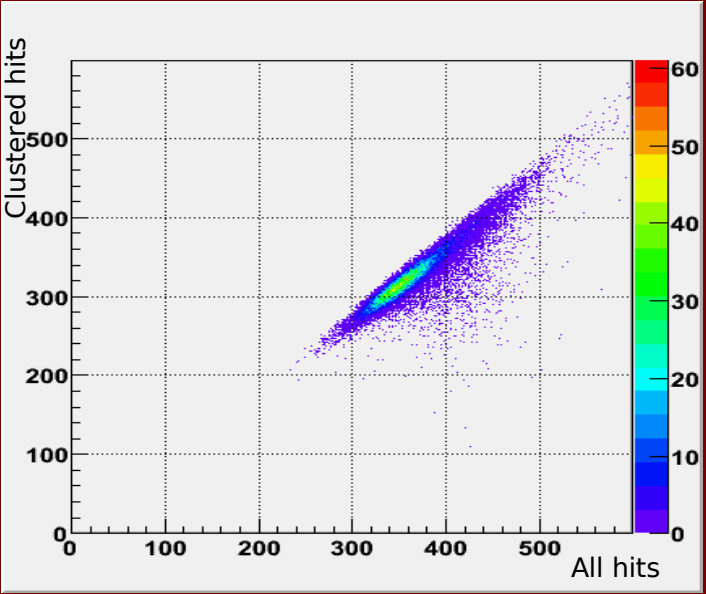


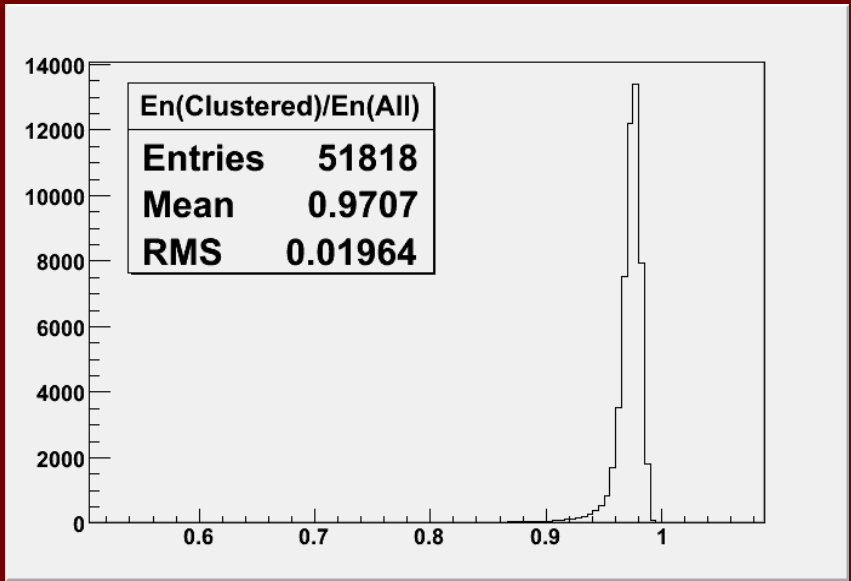
Data: e^- at 30 GeV and 30°

- Sample size: 51818 events
- efficieincy = 100%, 2nd cluster in 1211 events



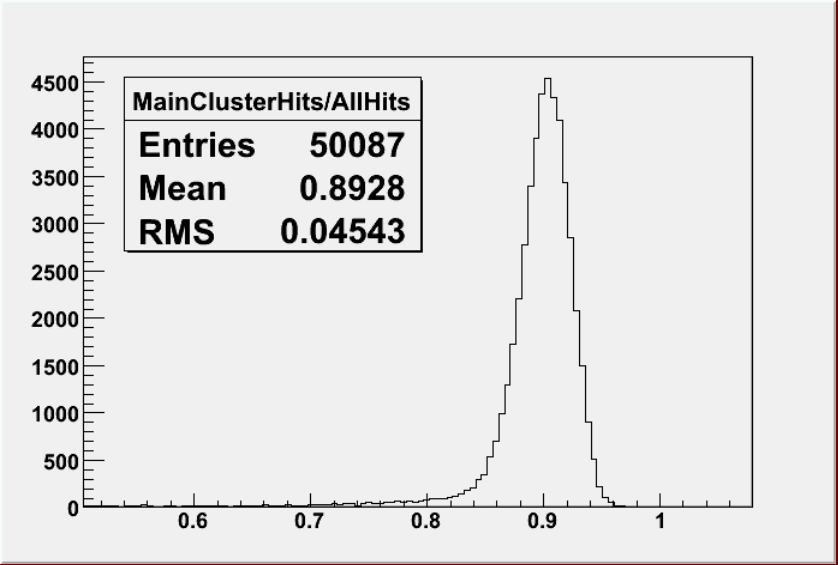


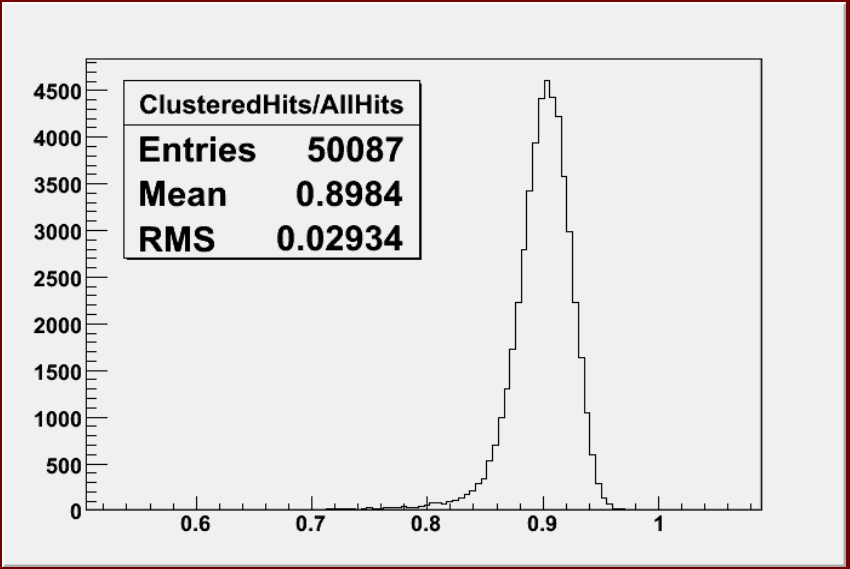


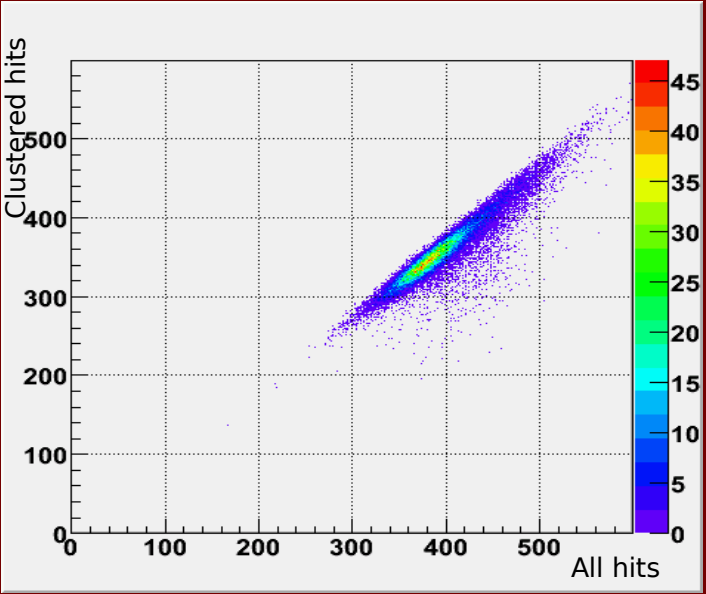


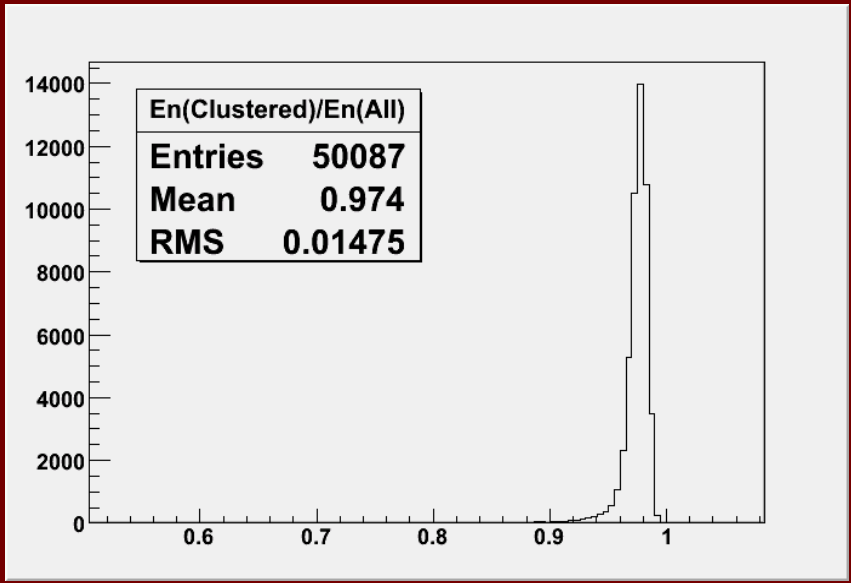
Data: e^- at 30 GeV and 45°

- Sample size: 50087 events
- efficieincy = 100%, 2nd cluster in 1363 events



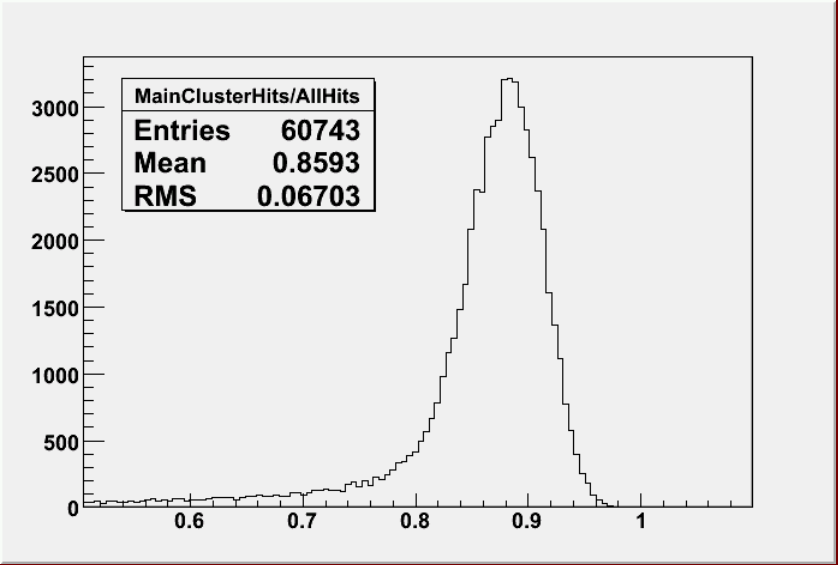


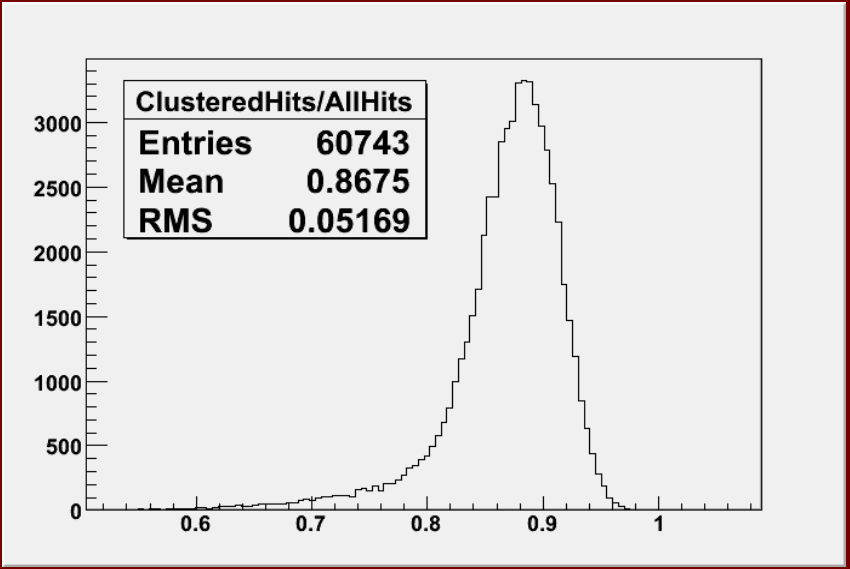


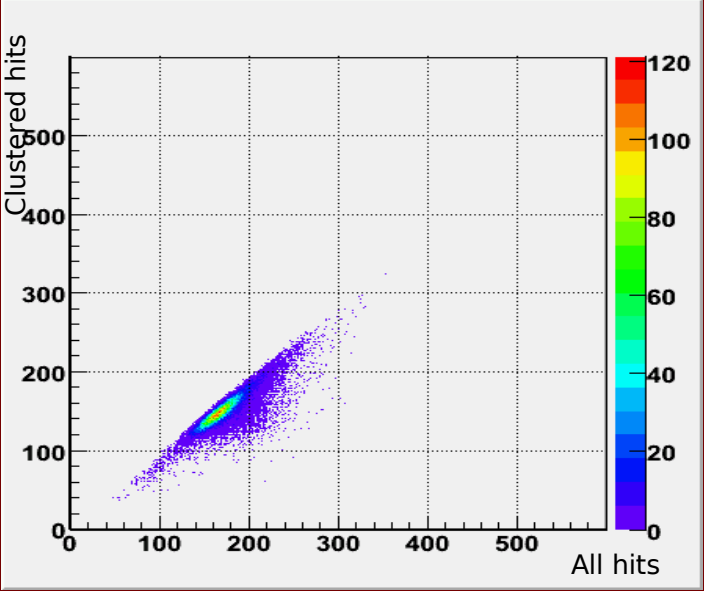


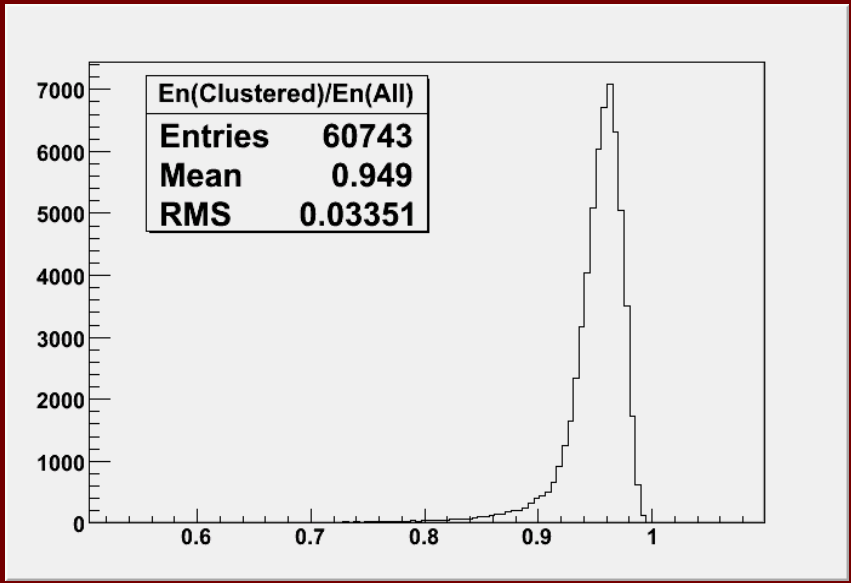
Data: e^- at 10 GeV and 0°

- Sample size: 60743 events
- efficieincy = 100%, 2nd cluster in 2440 events









Further plans

- Improve the clustering efficiency on the testbeam data with better event quality selection
- Improve cuts on shower shape for rejection
- Develop criteria for the merging of clusters
- Implement possibility of 2-particle events
- Determine fake rate
- Translate the algorithm from CALICE prototype to complete detector model
- Apply and optimise on full events
- Integrate algorithm in a PFA framework and use it as first step to remove photon clusters