Tracking with the Hough transform

Update

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Tracking with Hough transformation

Why:

- fast, robust, and simple

- well understood – many applications and papers

- provides starting point / benchmark

Application for CALICE:

- apply algorithm to busy events (e.g. 30 GeV showers)

- do not rely on isolated hits only

- systematic studies: analyse π contamination in e runs

- try to improve energy resolution

The improved algorithm

The extended 2D Hough transformation (in XZ, YZ):

- coarse hit selection (energy and layer dependent)

- weighted Hough transformation

- filtering

- Gerig-Klein backmapping algorithm

- filtering

Post-processing:

- combine results for XZ and YZ into 4D space

- apply quality threshold (QT) clustering algorithm

Red items are new since previous talk.

Preparatory work

Some preparatory work for analysis:

- modified existing (local) data class CaloHit to include MC truth information (parent PDG codes)

- ported existing QT clustering algorithm from JAVA to C++

- simple plotting tool (Python) for ECAL events

- scripts to scan for optimal parameter values
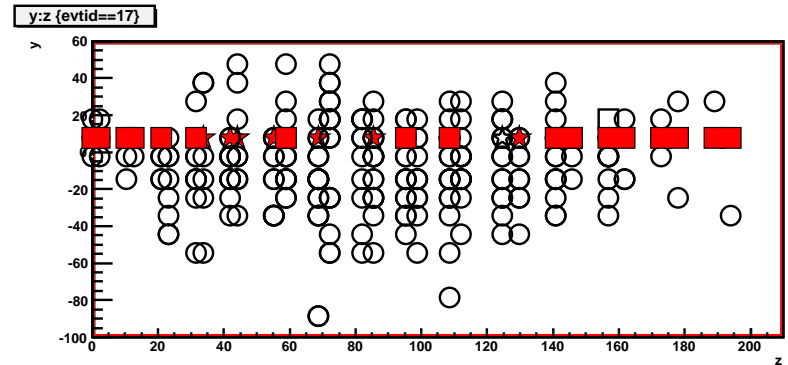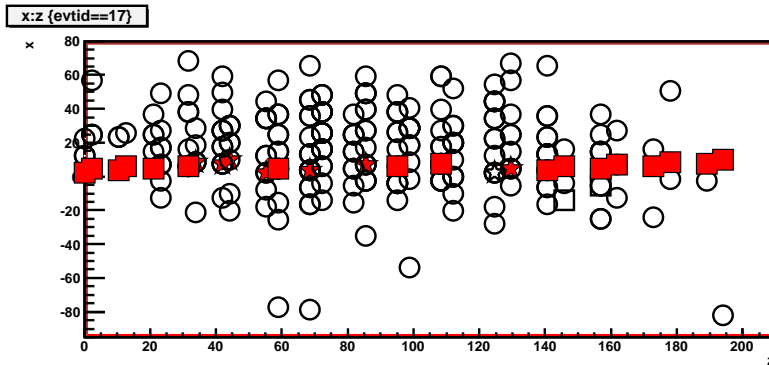
- scripts for evaluating performance

# Simulation

Generate overlay events:

- merge electron showers and MIPs

- based on 30 GeV electrons and 30 GeV muons

- from 2006 MC production

- use LCIO command line tools to merge events:
  ```
  lcio merge -f <file> -f <file> -o <merged
  file>
  ```

MC files not from final 2006 mass production / information from MC expert needed.
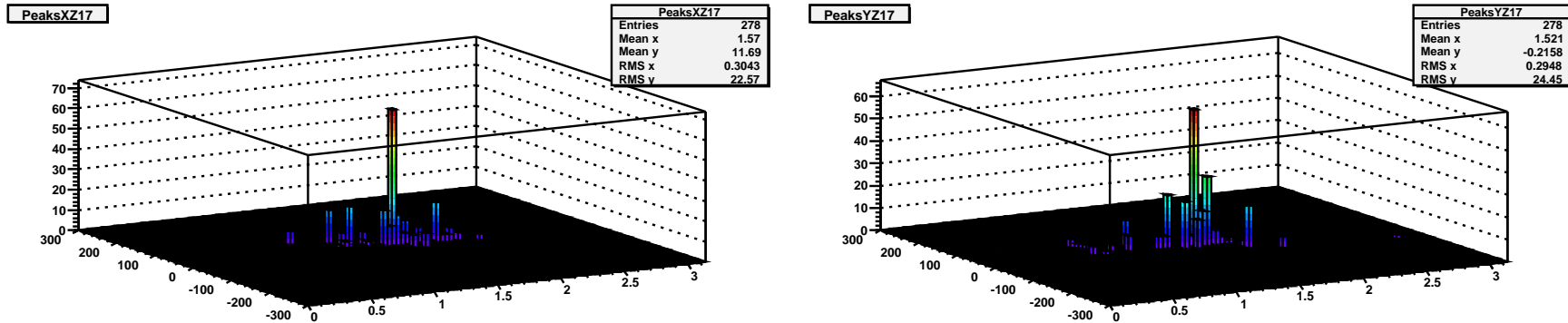
Example event (I)

Circle: hit due to e^-, Square: hit due to μ, Star: overlay e^-, μ hit. Red: selected hits
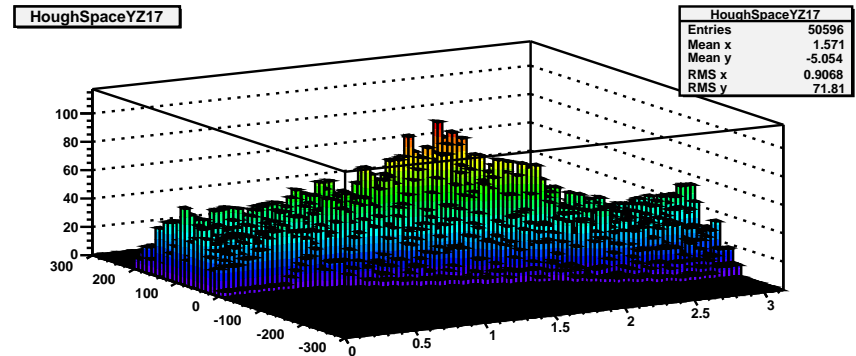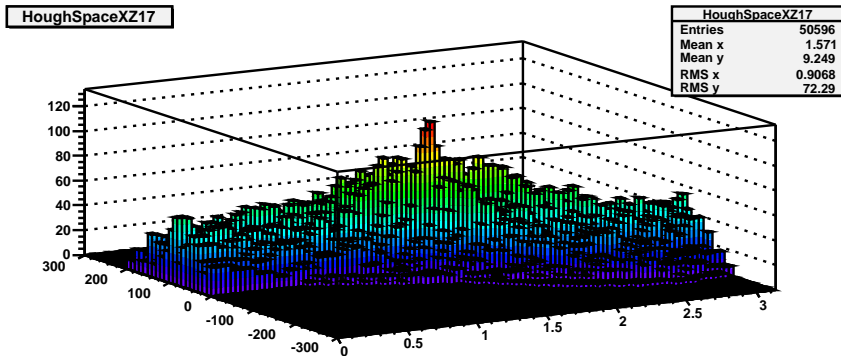
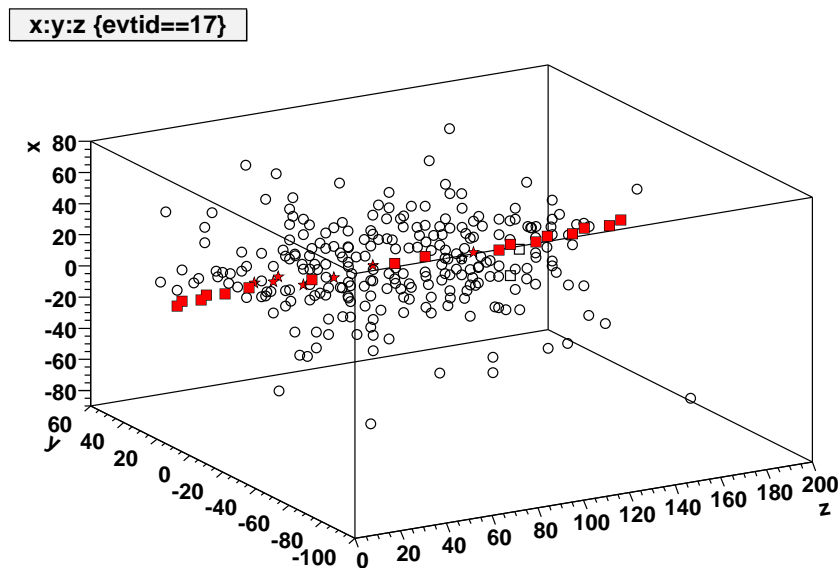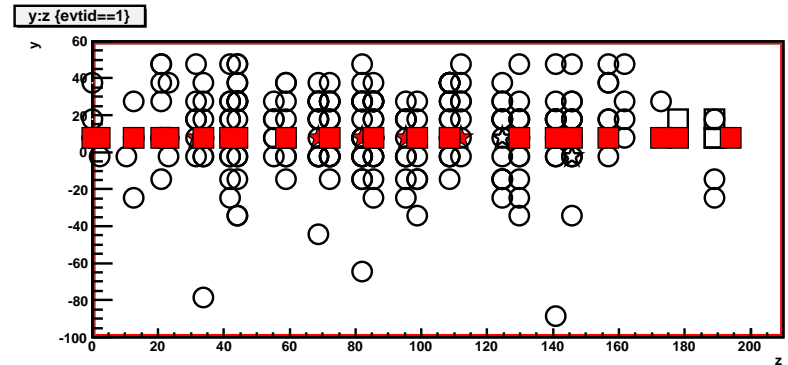
No clear peak visible.
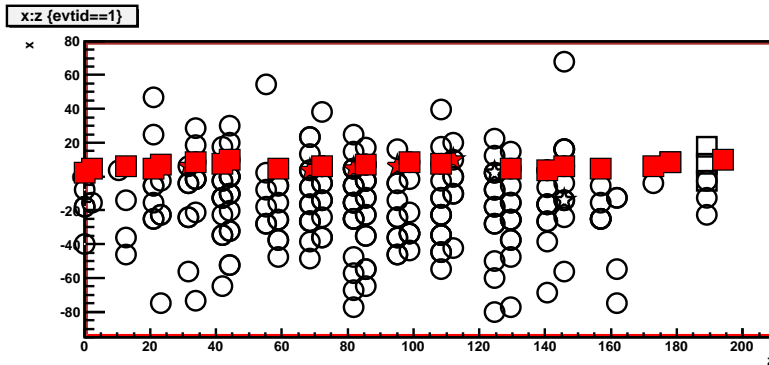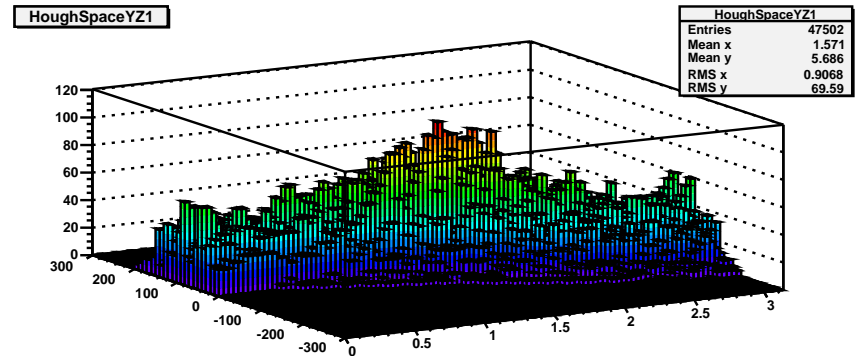
Reconstruction (I)

After filtering and cleaning:

Full reconstructed event after filtering and clustering:

Example event (II)

x:z {evtid==1}

y:z {evtid==1}

Circle: hit due to e^-, Square: hit due to μ, Star: overlay e^-, μ hit. Red: selected hits

HoughSpaceXZ1

HoughSpaceXZ1	
Entries	47502
Mean x	1.571
Mean y	-9.508
RMS x	0.9068
RMS y	70.37

HoughSpaceYZ1

HoughSpaceYZ1	
Entries	47502
Mean x	1.571
Mean y	5.686
RMS x	0.9068
RMS y	69.59

No clear peak visible.

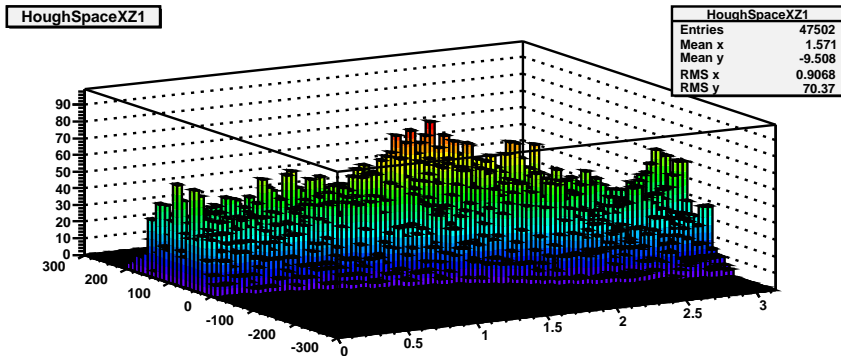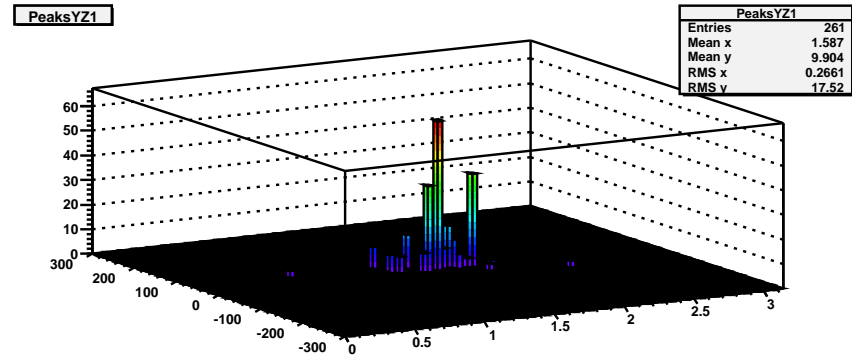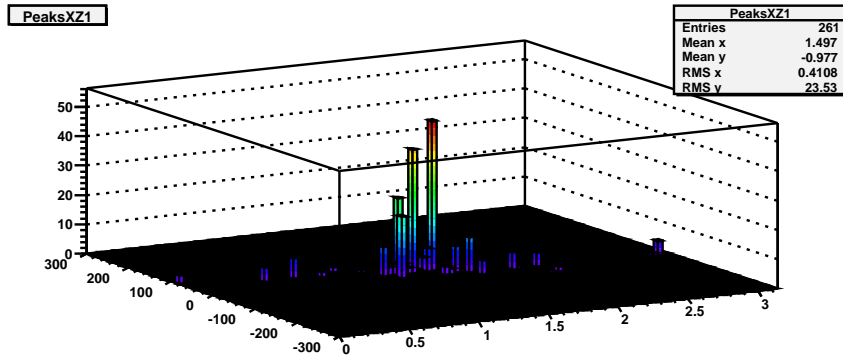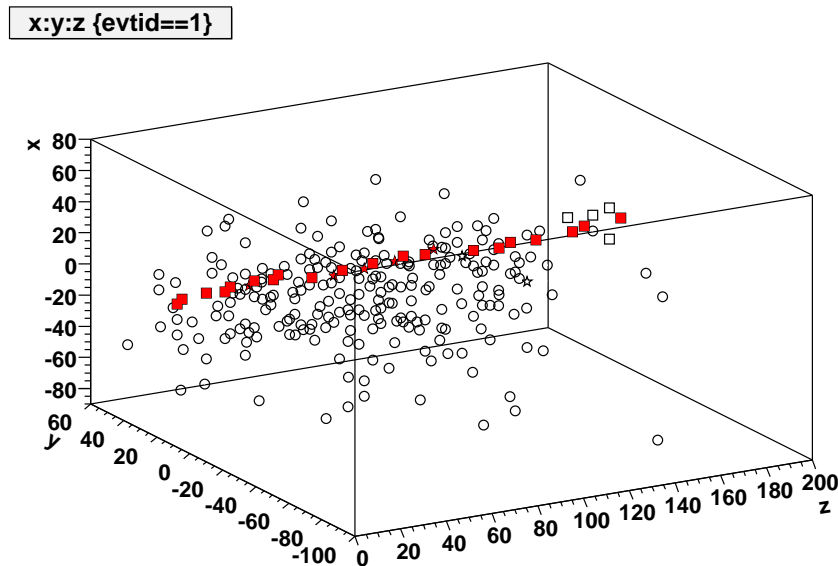# Reconstruction (II)

After filtering and cleaning:

Full reconstructed event after filtering and clustering:

Conclusions / Outlook

Conclusions:

- Hough transformation can be used to identify MIPs

- fast algorithm

- can be used to analyse even 'busy' events

Next steps:

- optimise: repeat scanning for optimal quantisation, revisit hit selection / weighting

- design quality cuts for event selection (MIP/no MIP)

- perform a full characterisation:
    - purity, efficiency, acceptance of final hit selection
    - performance for event classification

- apply algorithm to data.