Particle Flow and Detector Optimisation Studies

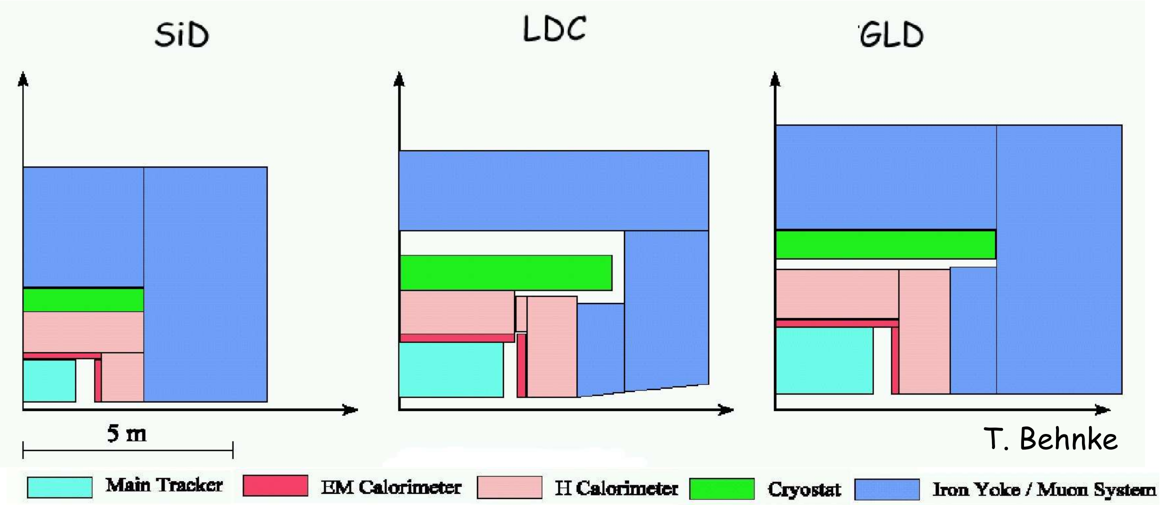
Outline:

- MarlinReco on the GRID
- Reconstruction of Z^0
- First look into ttbar events
- PFlow Studies
- Summary

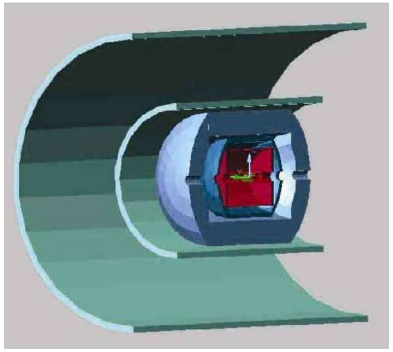
PFlow and Detector Optimisation Studies

Goal:

- perform detector optimisation study for the **LDC** (performance vs. cost)
  - choose **different detector sizes** varying around the standard LDC design
  - length and radius of TPC, number of layers in ECAL, several B fields
- take 'realistic' physics events for the full energy range of the ILC
- use **PFlow** algorithm to **optimise detector**



4th Concept



J. Hauptman

different scale

MarlinReco on the GRID

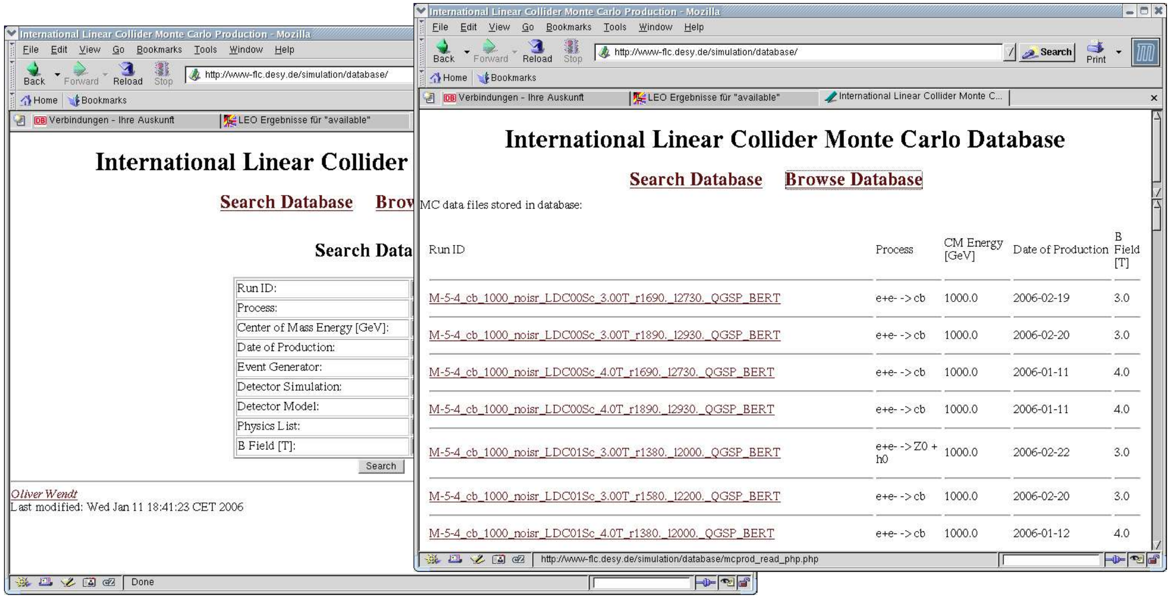
- '**mass production**' of events on the **GRID** (latest Mokka v05.04)
  - 2 different detectors: **LDC00Sc** and **LDC01Sc**
    - LDC00Sc: 30 + 10 ECAL Layers, LDC01Sc: 20 + 10 ECAL Layers
    - same overall thickness of ECAL, HCAL unchanged
  - 2 different sizes of TPC: (**R**)adius and (**L**)enght
  - 2 magnetic fields
  - ➔ overall **8 'different' detectors**

B field (T)	LDC01Sc (mm)		LDC00Sc (mm)	
3	R = 1380	R = 1580	R = 1690	R = 1890
	L = 2000	L = 2200	L = 2730	L = 2930
4	R = 1380	R = 1580	R = 1690	R = 1890
	L = 2000	L = 2200	L = 2730	L = 2930

MarlinReco on the GRID

- Physics processes
  - WW, Zh, uds, cb, tt @ 360, 500 and 1000 GeV
  - Z @ 91.2 GeV
- ≈ **450000** events (**500 GByte**) of simulated data
- all data available on the **GRID** for ILC VO members
- meta data, logical file names etc. stored in **MC Database**

http://ilcsoft.desy.de



MarlinReco on the GRID

- after simulation:
- ➔ run the reconstruction (**MarlinReco**) on the **GRID**
  - ≈ 90% finished
  - yet not all data analysed
- ➔ **GRID** is a comprehensive, powerful and 'easy to use' tool
  - ➔ see talk of D. Martsch

Reconstructed M_{inv} of Z^0

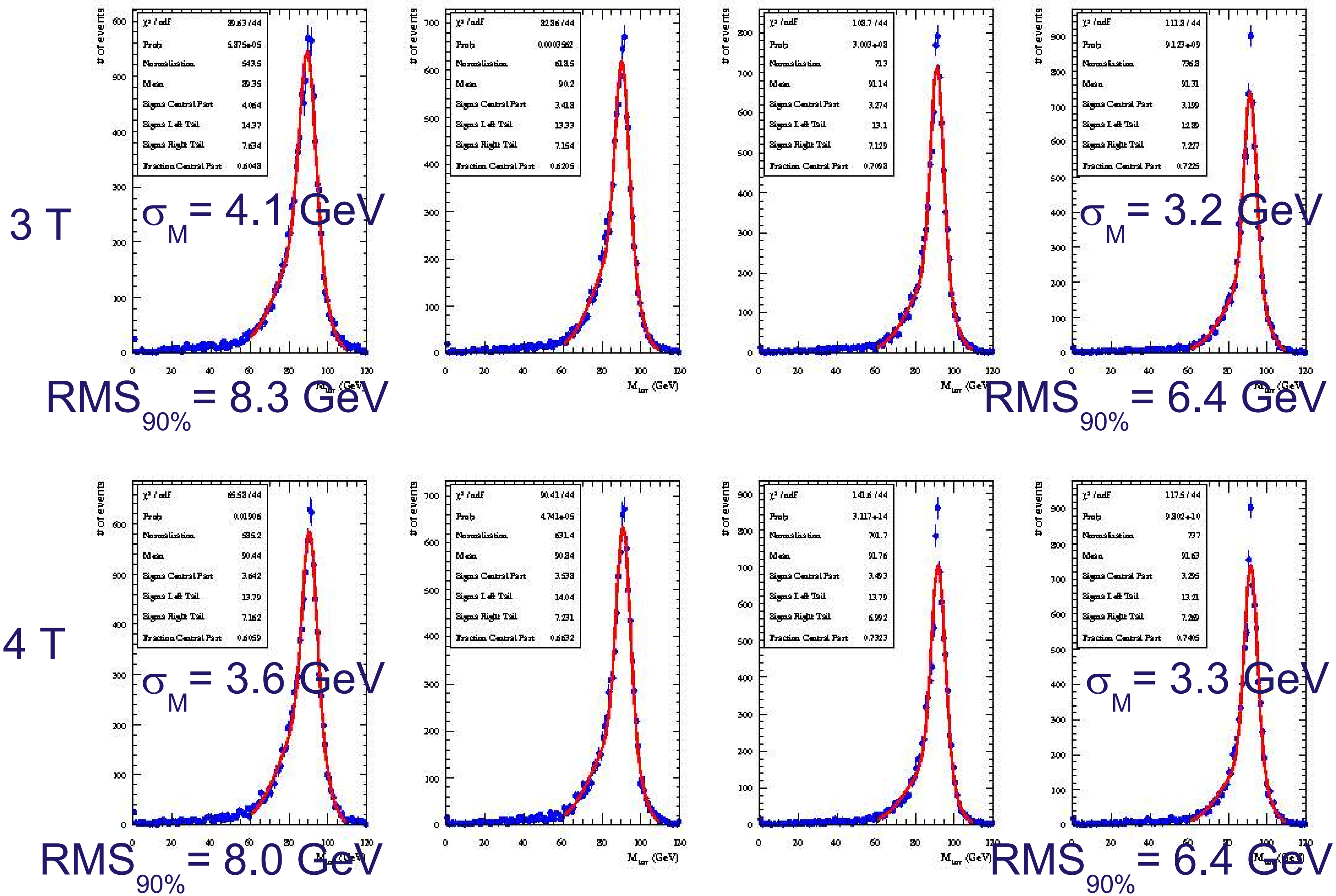
- reconstruct M_{inv} of Z^0
  - first study, one of our standard benchmark processes
  - TrackCheater used in reconstruction
- plot M_{inv} for the 4 different detectors and 2 different magnetic fields
  - fit M_{inv} and extract σ_M
  - calculate $RMS_{90\%}$

➔ dependencies on Geometries / magnetic field ?

Reconstructed M_{inv} of Z^0

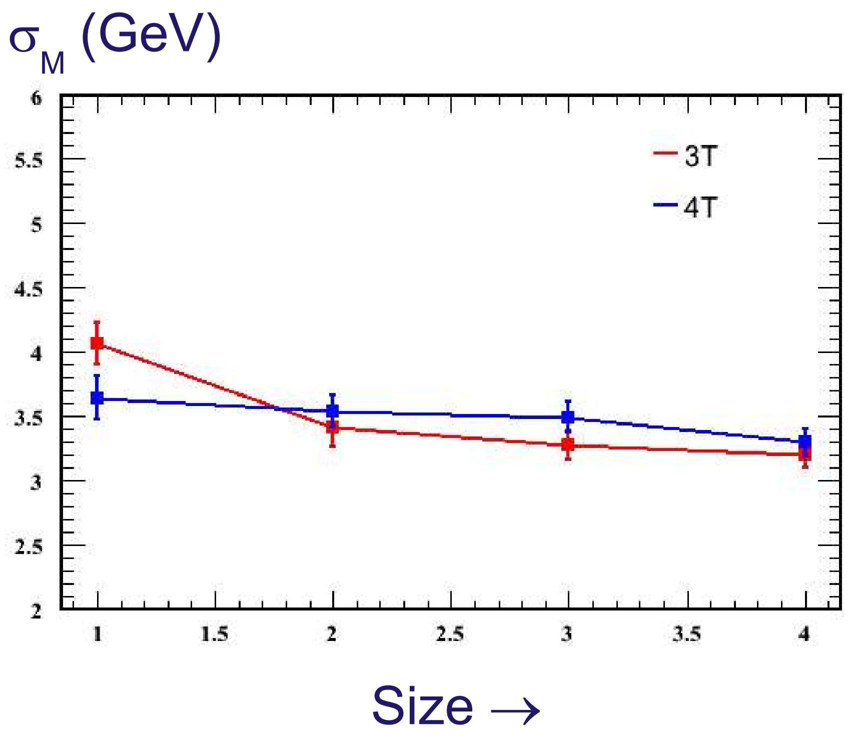
$Z^0 \rightarrow$ all

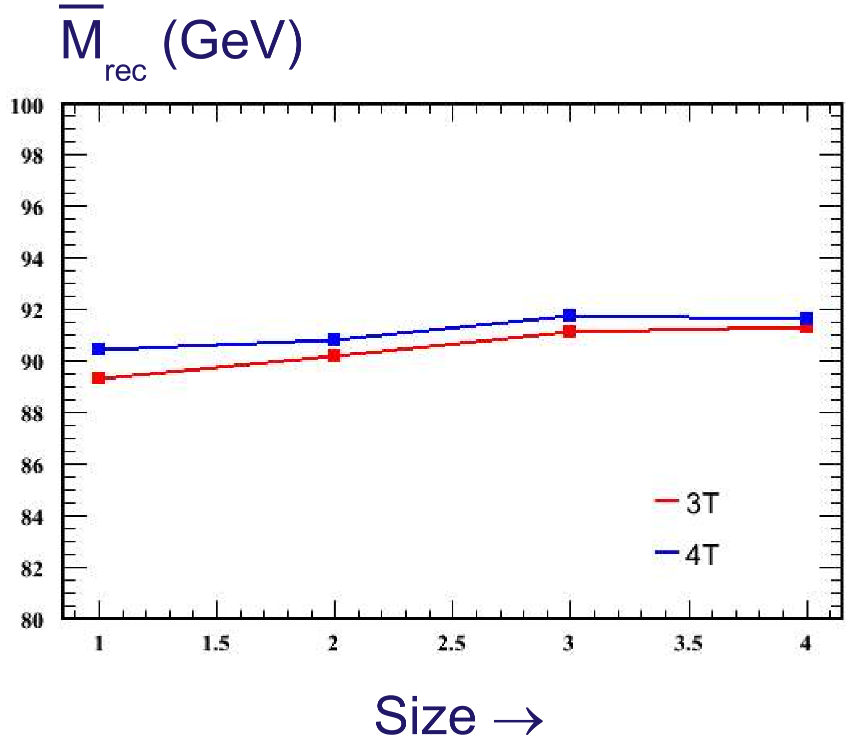
Size $\rightarrow$



Reconstructed M_{inv} of Z^0

$Z^0 \rightarrow$ all

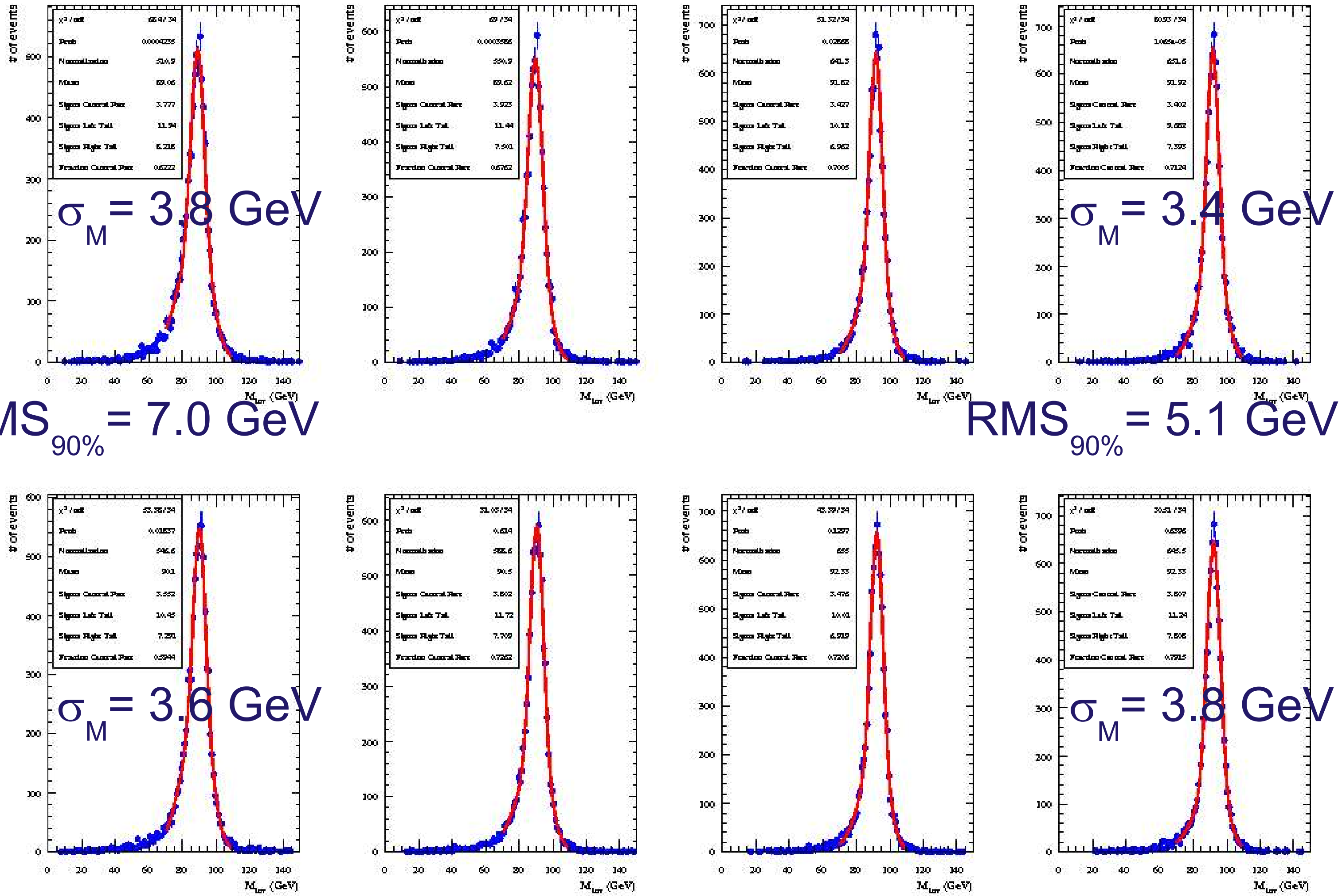




Reconstructed M_{inv} of Z^0

$Z^0 \rightarrow$ **uds**

Size $\rightarrow$



3 T

σ_M = 3.8 GeV

$RMS_{90\%}$ = 7.0 GeV

σ_M = 3.4 GeV

$RMS_{90\%}$ = 5.1 GeV

4 T

σ_M = 3.6 GeV

$RMS_{90\%}$ = 6.3 GeV

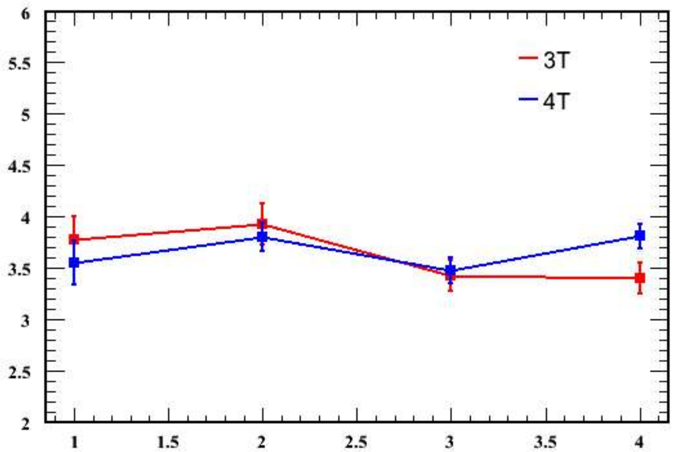
σ_M = 3.8 GeV

$RMS_{90\%}$ = 5.0 GeV

Reconstructed M_{inv} of Z^0

$Z^0 \rightarrow$ uds

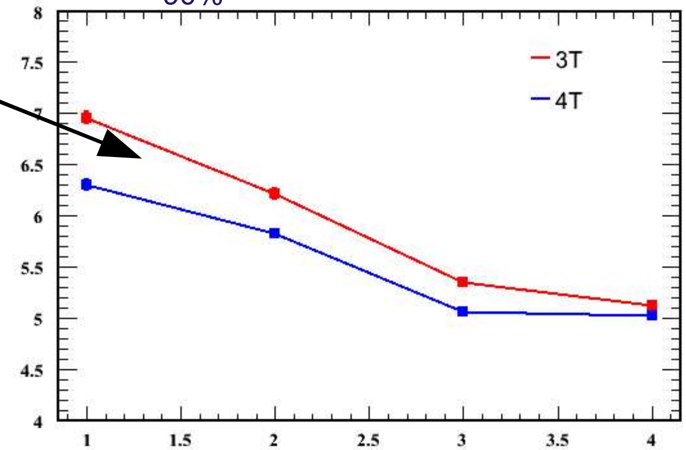
σ_M (GeV)



Size →

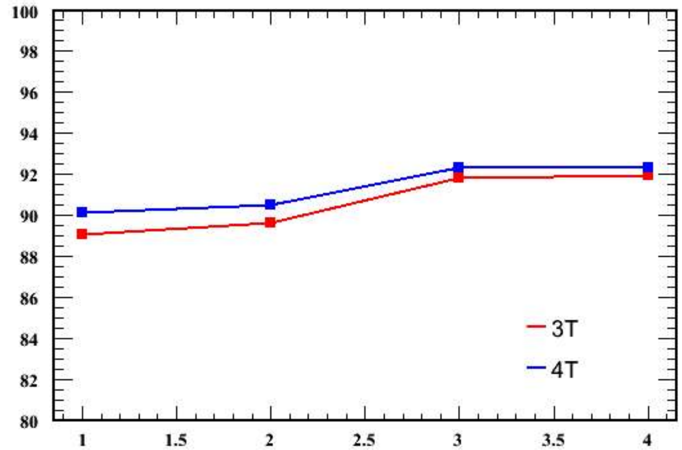
geometry effect?

$RMS_{90\%}$ (GeV)



Size →

$\overline{M}_{rec}$ (GeV)



Size →

Reconstructed M_{inv} of Z^0

- Z^0 reconstruction looks **reasonable** (compared with prior studies)
  - ➔ good to compare different algorithms in a certain parameter range
  - ➔ nice 'benchmark' plot
  - ➔ geometry effect visible on $RMS_{90\%}$ values?
- alone **NOT** appropriate for detector optimisation
  - ➔ CM energy too small (physics processes at 500 GeV)
  - ➔ 'need' large number of tracks and clusters
  - ➔ 'need' many overlapping clusters

  $\Rightarrow$ stress PFlow and detector performance

➔ need WW, Zh or ttbar @ 500 GeV and 1000 GeV

ttbar @ 500 GeV

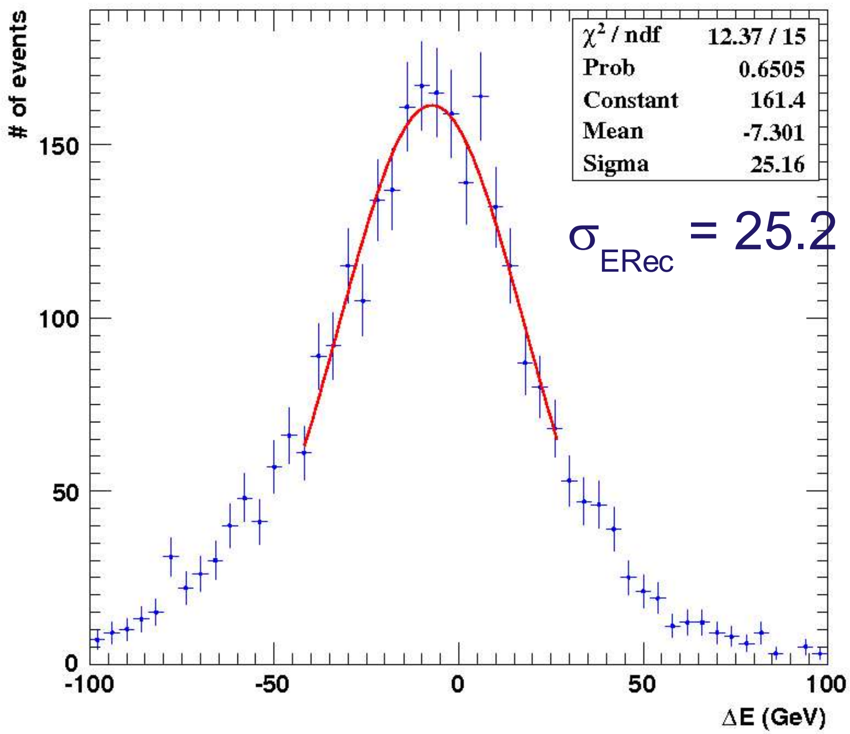
- calculate $\sigma_{ECal} = \Sigma E_{Cal} - \Sigma E_{avail}$ and $\sigma_{ERec} = \Sigma E_{rec} - \Sigma E_{avail}$
- simple sum over all calorimeter cells
  - for 500 GeV ttbar: σ_{ECal} = **12.6 GeV** (LDC00Sc, 4T)
- energy resolutions of reconstruction with MarlinReco
  - for 500 GeV ttbar: σ_{ERec} = **25.2 GeV** (LDC00Sc, 4T)

PROBLEM

- PFlow reconstruction with BRAHMS (SNARK)
  - for 500 GeV ttbar: σ_{ERec} = **9 GeV**

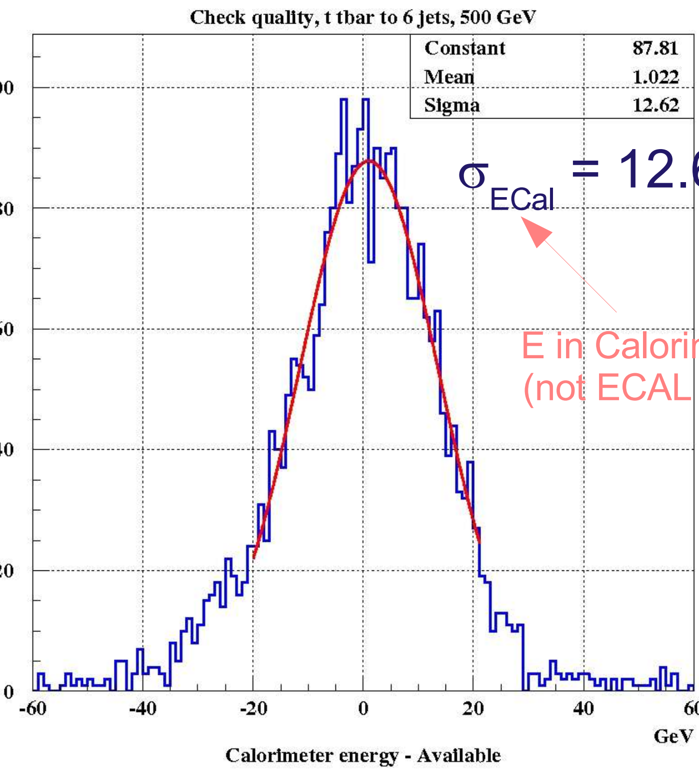
ttbar @ 500 GeV

compare reconstructed energy with available MC energy (per event):



σ_{ERec} = 25.2 GeV

$\sigma_{ERec} = \Sigma E_{rec} - \Sigma E_{avail}$



σ_{ECal} = 12.6 GeV

E in Calorimeter (not ECAL only)

preliminary

$\sigma_{ECal} = \Sigma E_{Cal} - \Sigma E_{avail}$

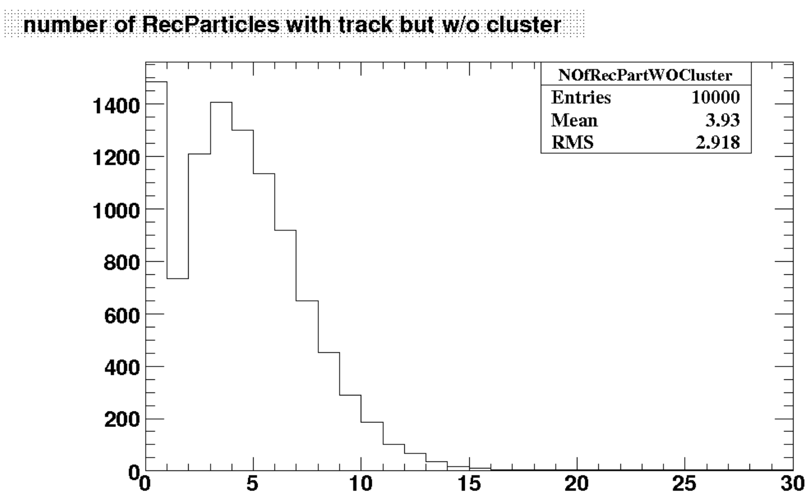
PFlow Studies

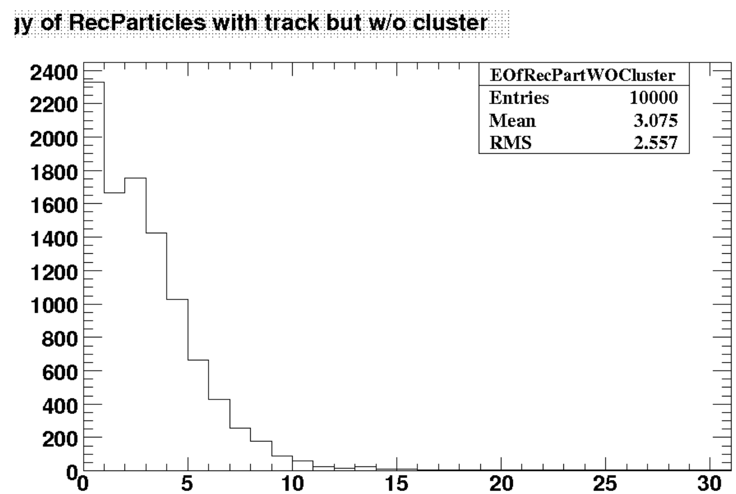
- choose LDC00Sc, 4T, R = 1690mm, L = 2730 mm
- compare Z pole with ttbar @ 500GeV
- ➔ see also talk of Predrag Krstonosic

1. study reconstructed particles with track but w/o cluster:
   - neighbouring tracks with clusters taking over the energy ?
   - neighbouring neutrals taking over the energy ?
   - ...

PFlow Studies

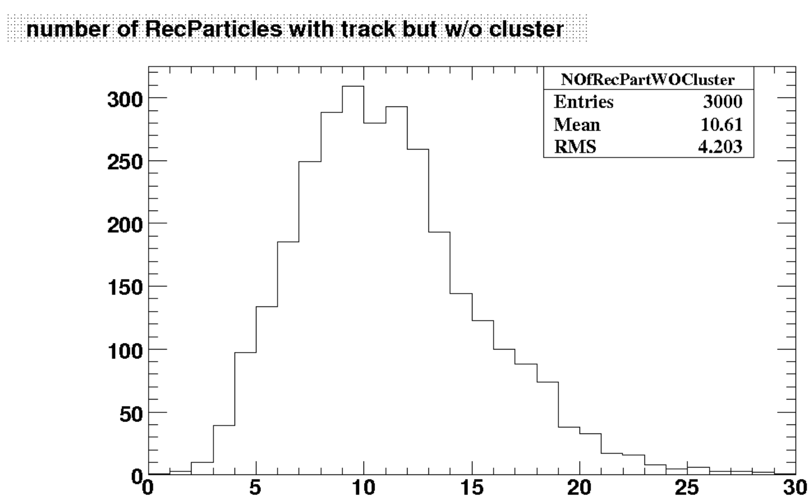
Z pole

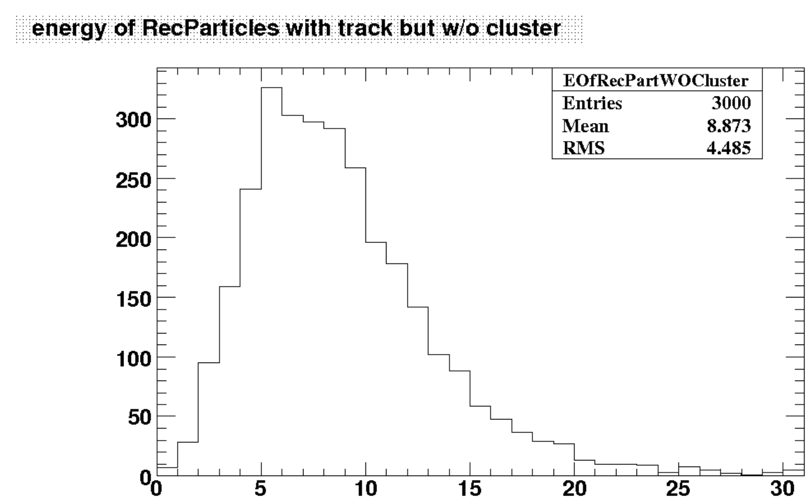




GeV

ttbar @
500 GeV

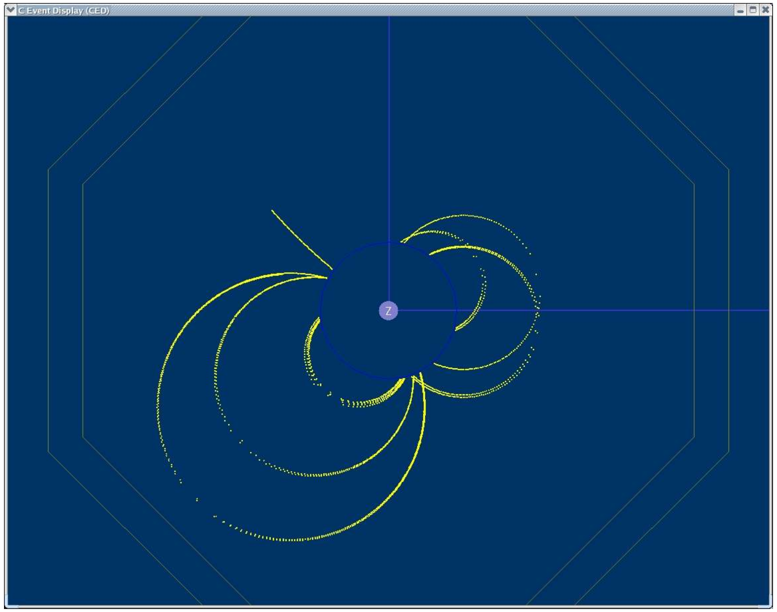


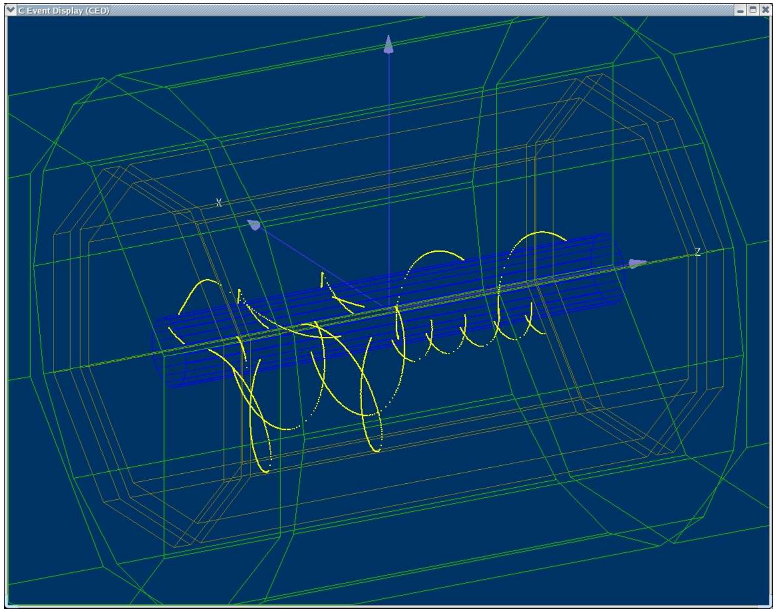


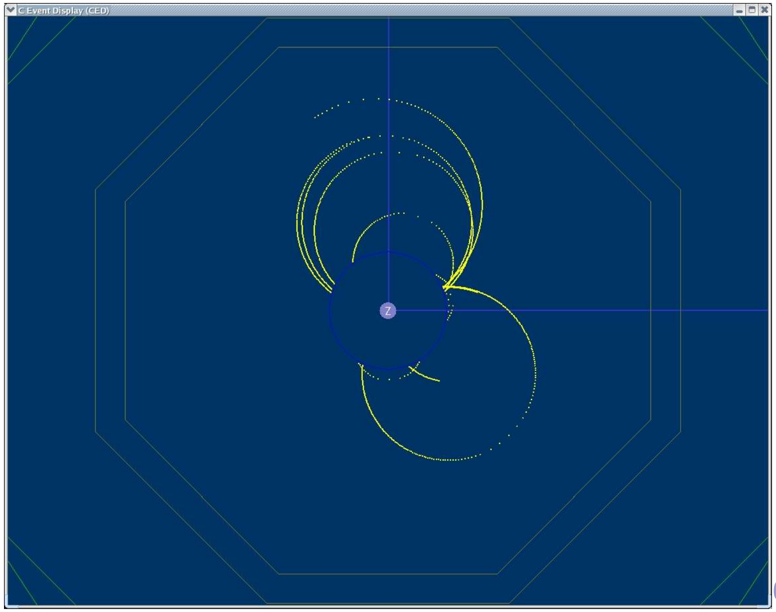
GeV

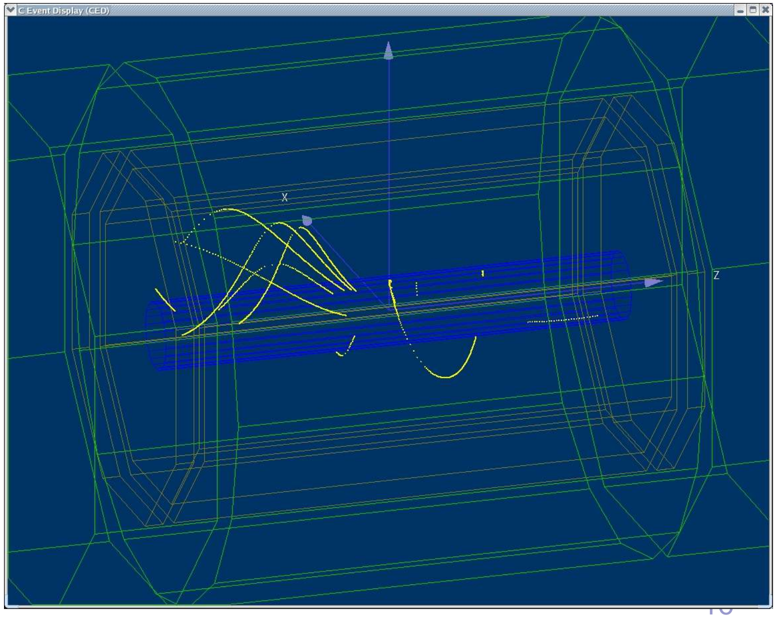
PFlow Studies

ttbar @
500 GeV





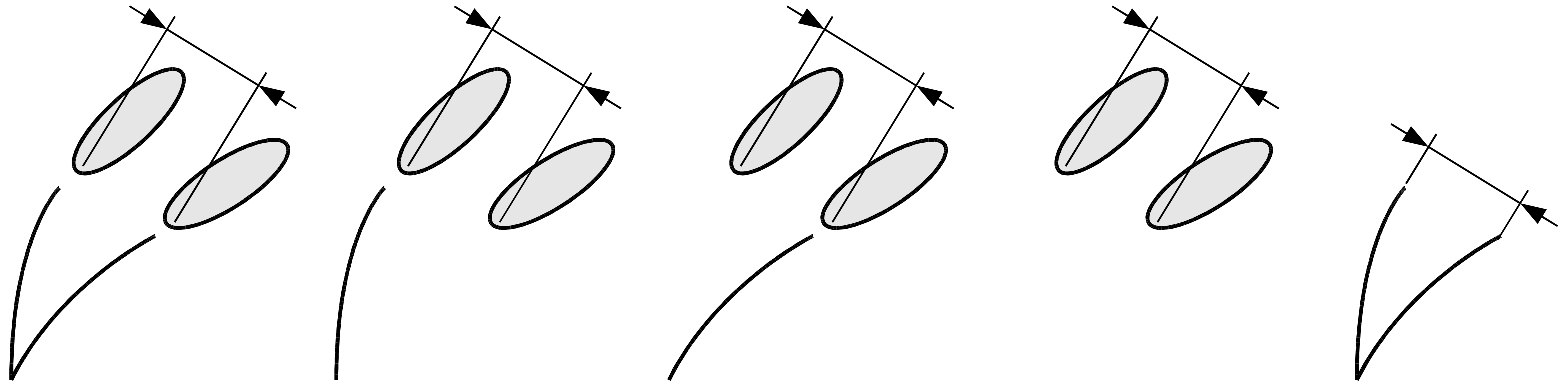




PFlow Studies

- scanned approx. 100 events by eye
- 90% show this behaviour
- not so large energy contribution
- cannot explain our problem

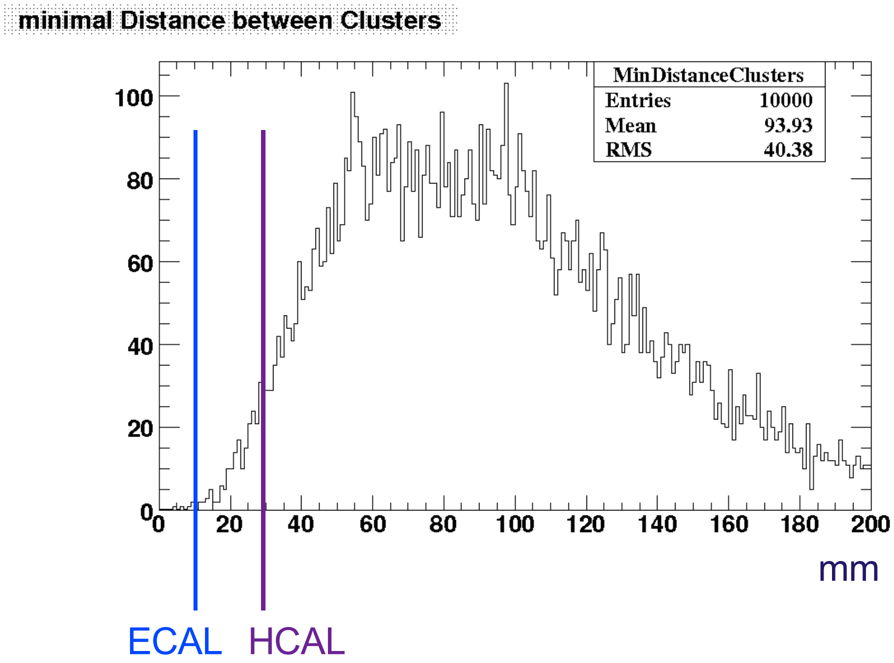
2. study neighbouring, reconstructed particles in general
   - mismatch of clusters ?
   - calculate distance by clusters or tracks



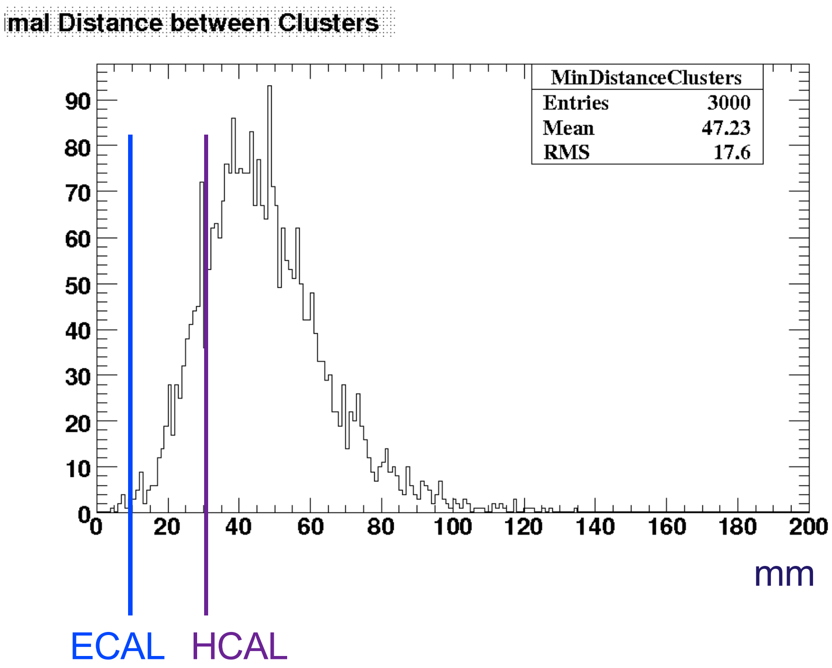
PFlow Studies

minimal distance between clusters per event:

Z pole

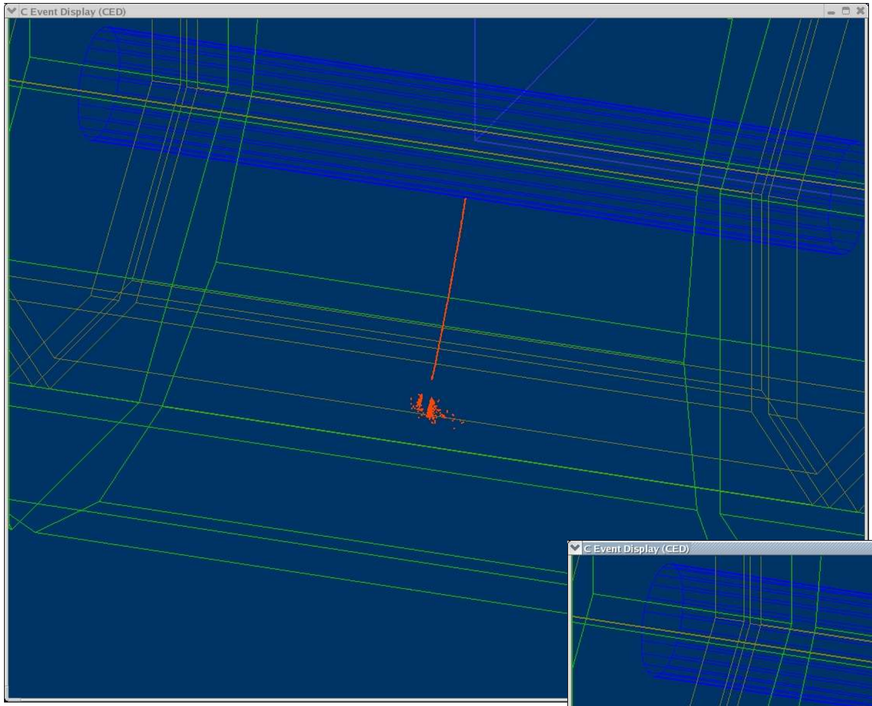


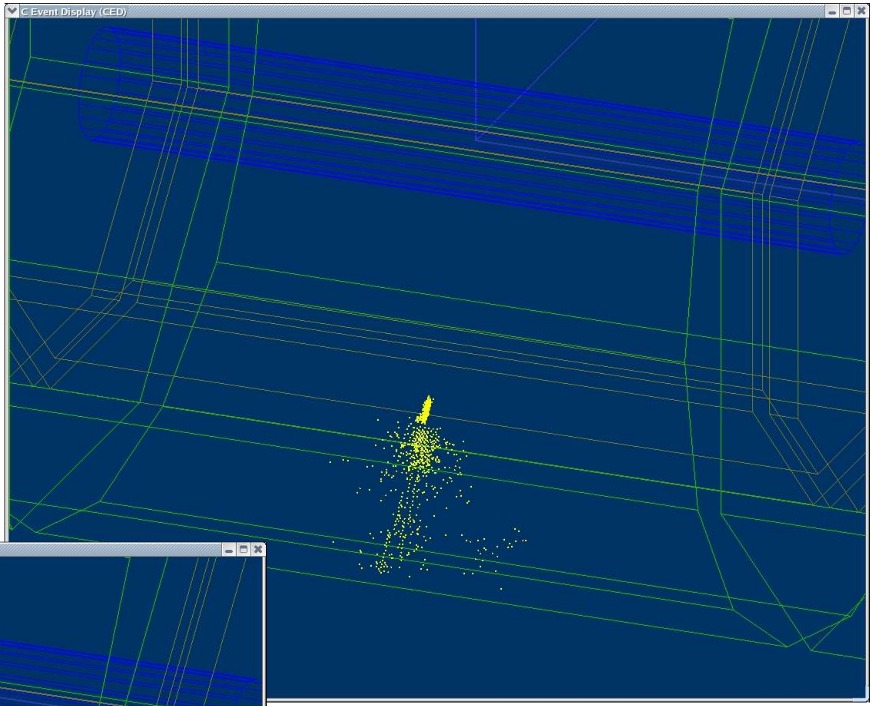
ttbar @ 500 GeV

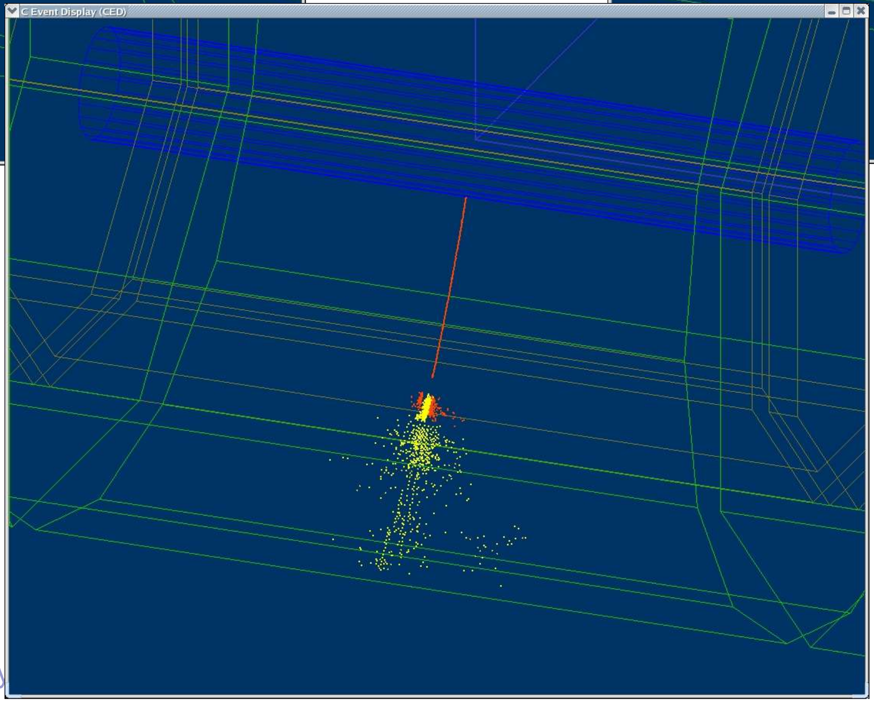


segmentation

PFlow Studies



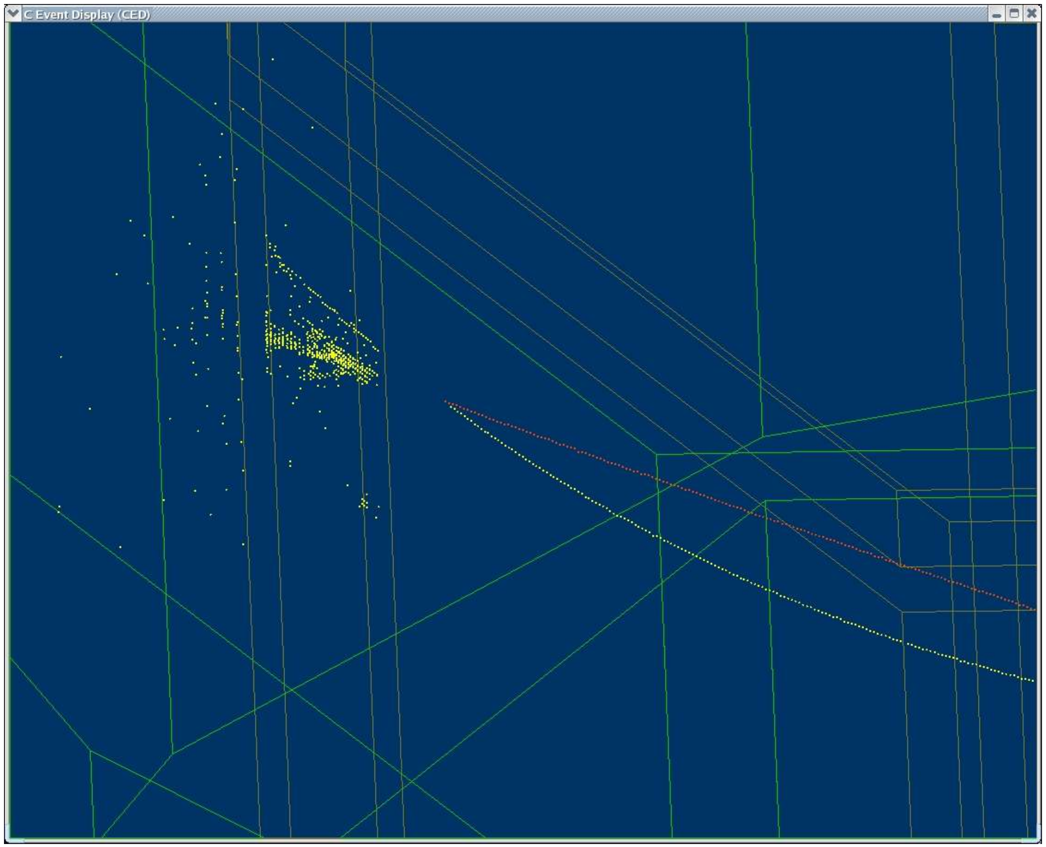


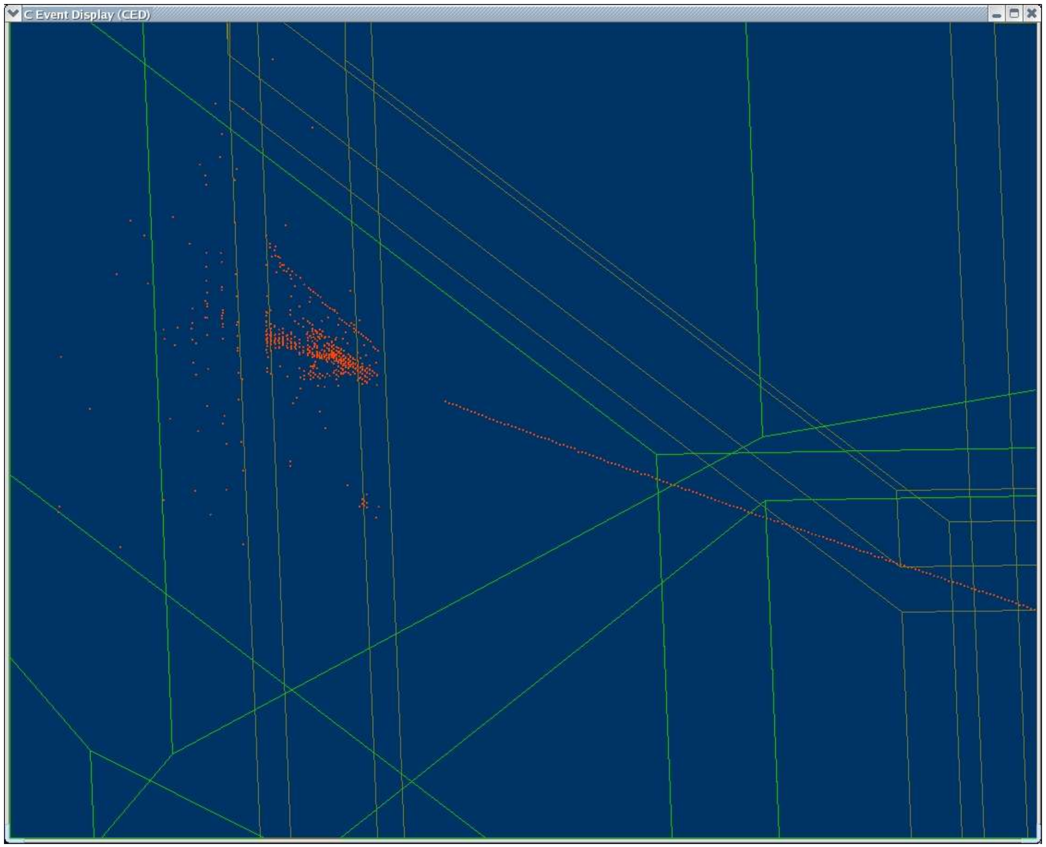


ttbar @ 500 GeV

PFlow Studies

ttbar @ 500 GeV





- not analysed quantitatively yet
- studies are ongoing

Conclusions

1. <u>many tools / processors are not ready yet</u>
   - analyse tools for PFlow ⇒ *which tools do we need ?*
   - neutral / charged vertex, kink finding and particle ID
   - track digitisation, vertex and forward tracking
2. <u>performance of PFlow Algorithm</u> ⇒ *what are the figures of merit ?*
   - Track-Cluster-Matching
   - Clustering
   - compare with perfect PFlow or MC-Tree ?
3. <u>detector optimisation</u> ⇒ *what are the figures of merit ?*
   - Z^0 pole
   - di-jet mass resolution $ZZ\nu\nu$, $WW\nu\nu$
   - top mass reconstruction
   - other geometries / magnetic fields

Summary

- **MarlinReco** used for the reconstruction of 'mass data' on the **GRID**
  - ➔ goal: detector optimisation
- Reconstruction works **fine for Z Pole**
- **problems** with the reconstruction for **ttbar @ 500 GeV**
  - ➔ **needs improvement** to perform detector optimisation
  - ➔ PFlow concept is **not** the reason (see SNARK)
  - ➔ **might** be a fundamental drawback of the cluster-based approach
  - ➔ studies are ongoing

⇒ *what's your experience in reconstructing events at 500 or 1000 GeV ?*

visit our portal:
http://ilcsoft.desy.de

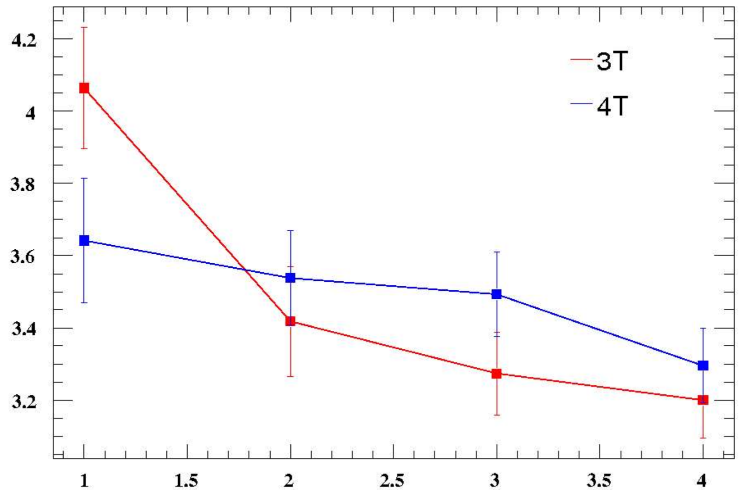
Thanks to all collaborators:
S. Aplin, F. Gaede, T. Kraemer, P. Krstonosic
A. Raspereza (MPI Munich), J. Samson,
H. Albrecht, D. Martsch, A. Vogel
and V. Morgunov

Backup Slides ...

Reconstructed M_{inv} of Z^0

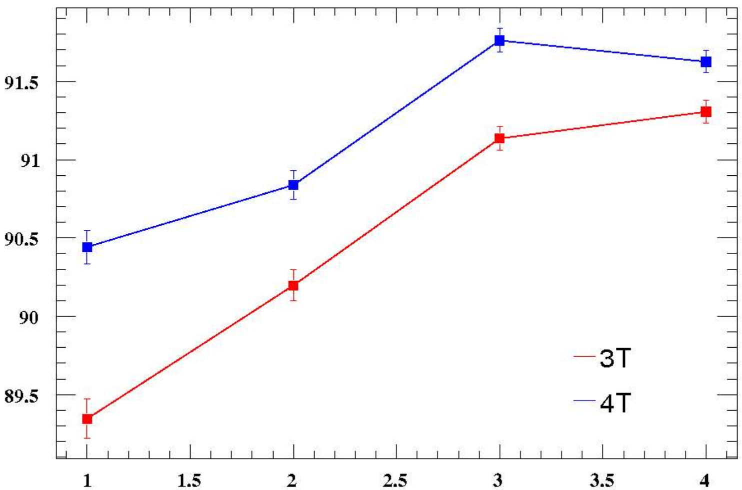
Z0 → all

σ_M (GeV)



Size →

$\overline{M}_{rec}$ (GeV)

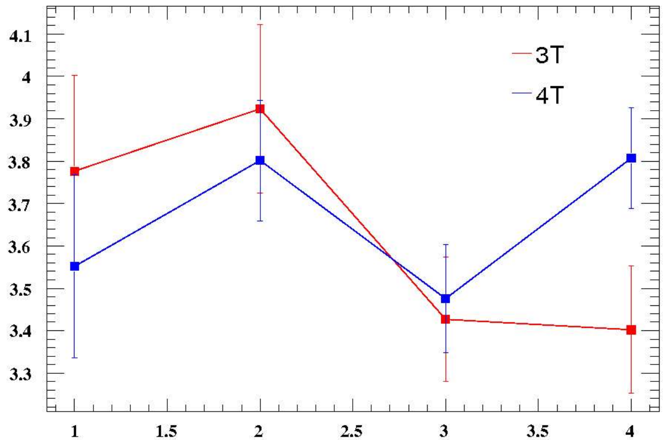


Size →

Reconstructed M_{inv} of Z^0

$Z0 \rightarrow uds$

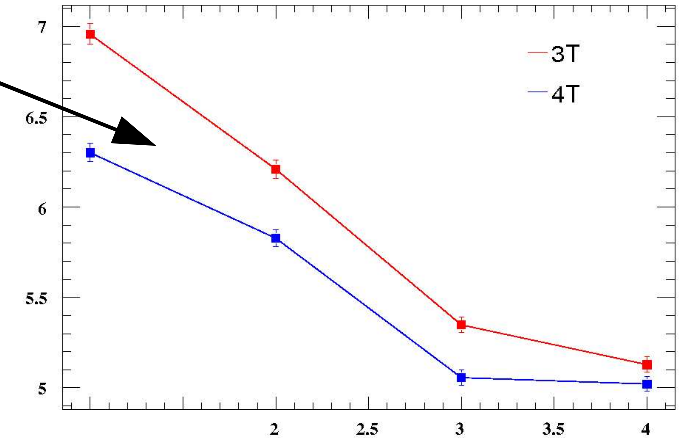
σ_M (GeV)



Size →

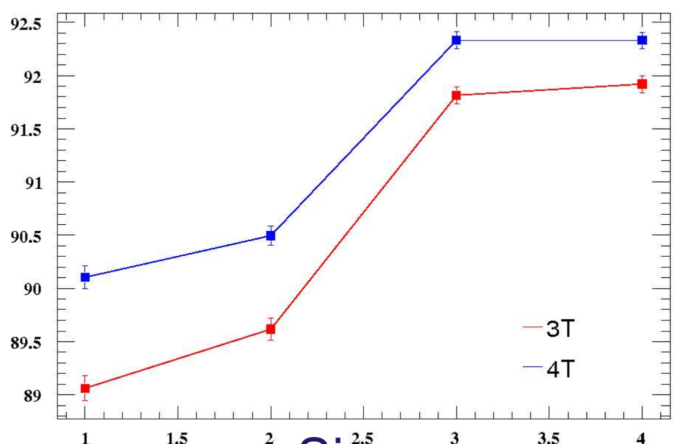
geometry effect?

RMS$_{90\%}$ (GeV)



Size →

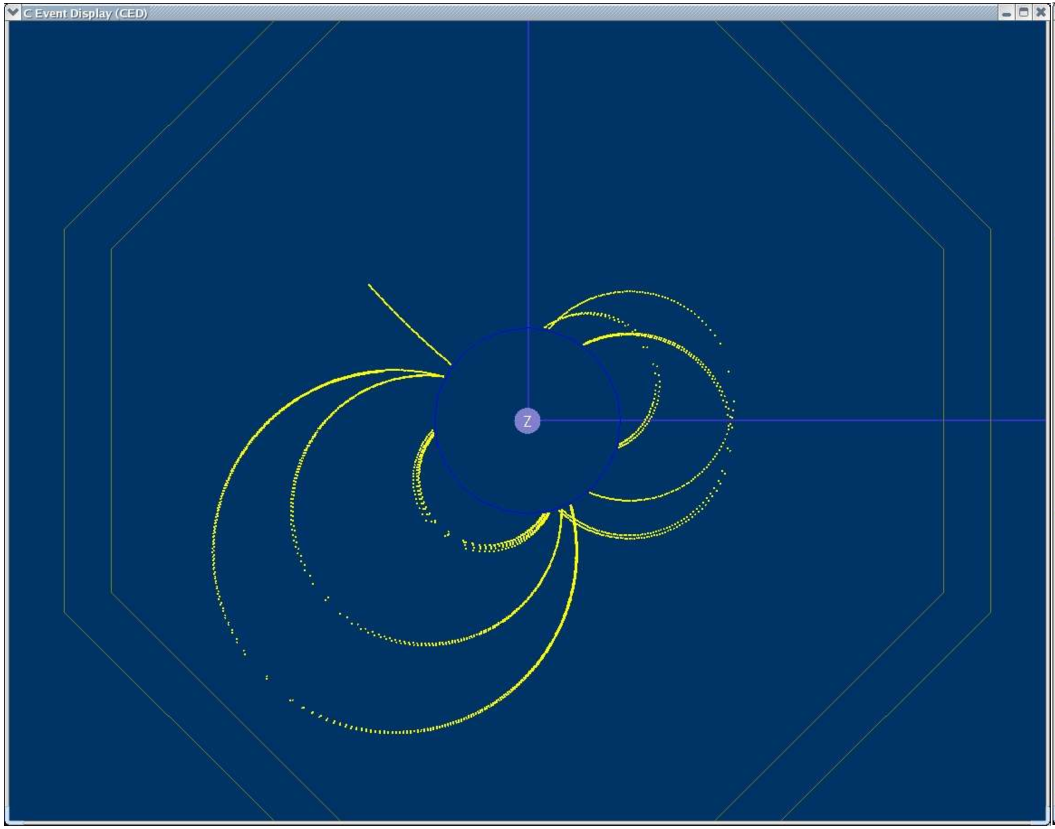
$\overline{M}_{rec}$ (GeV)

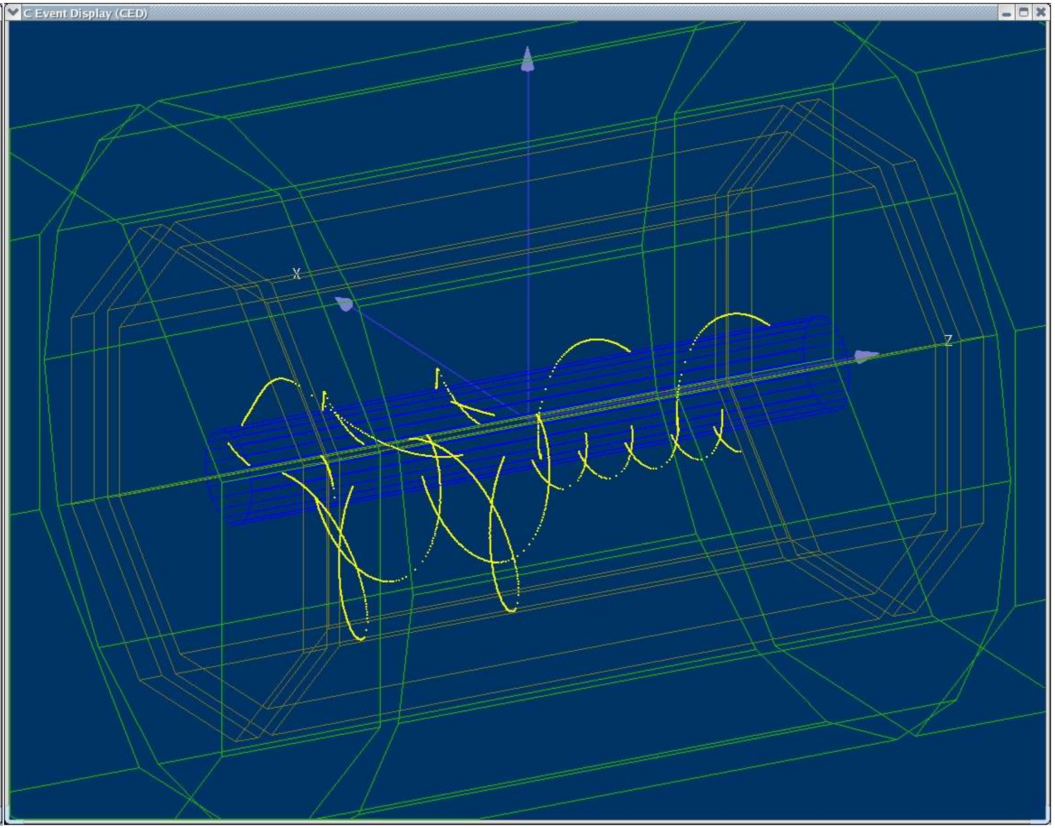


Size →

PFlow Studies

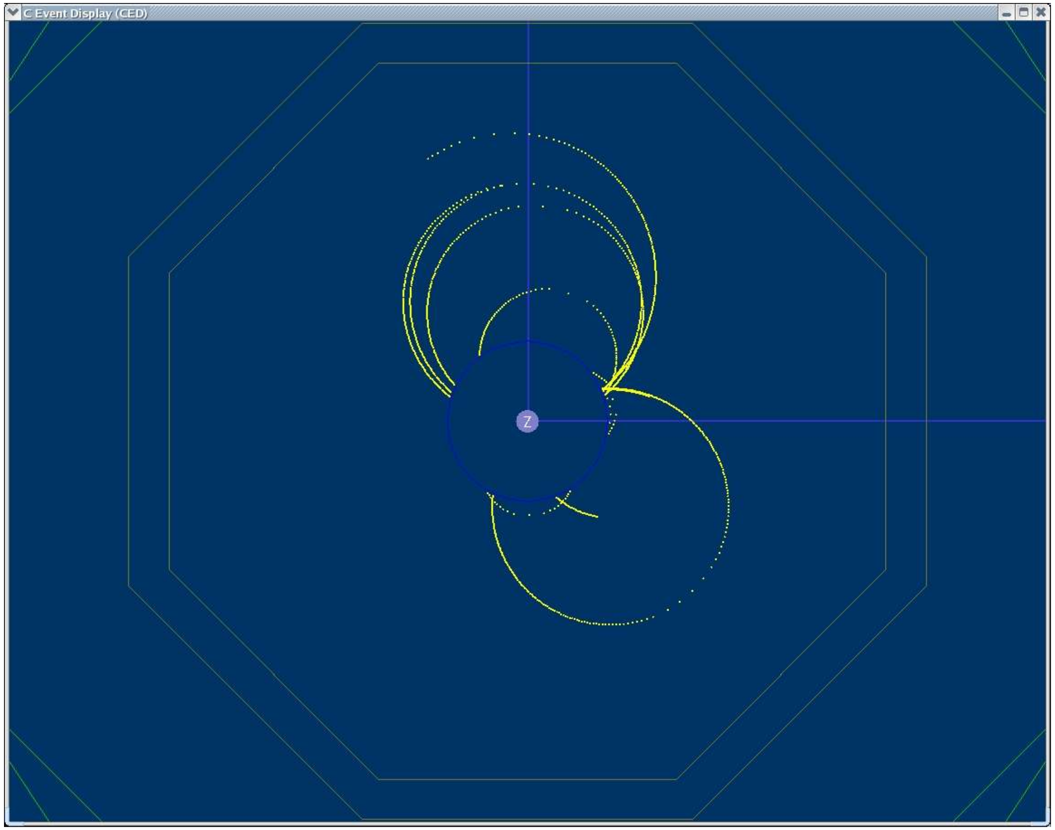
ttbar @ 500 GeV

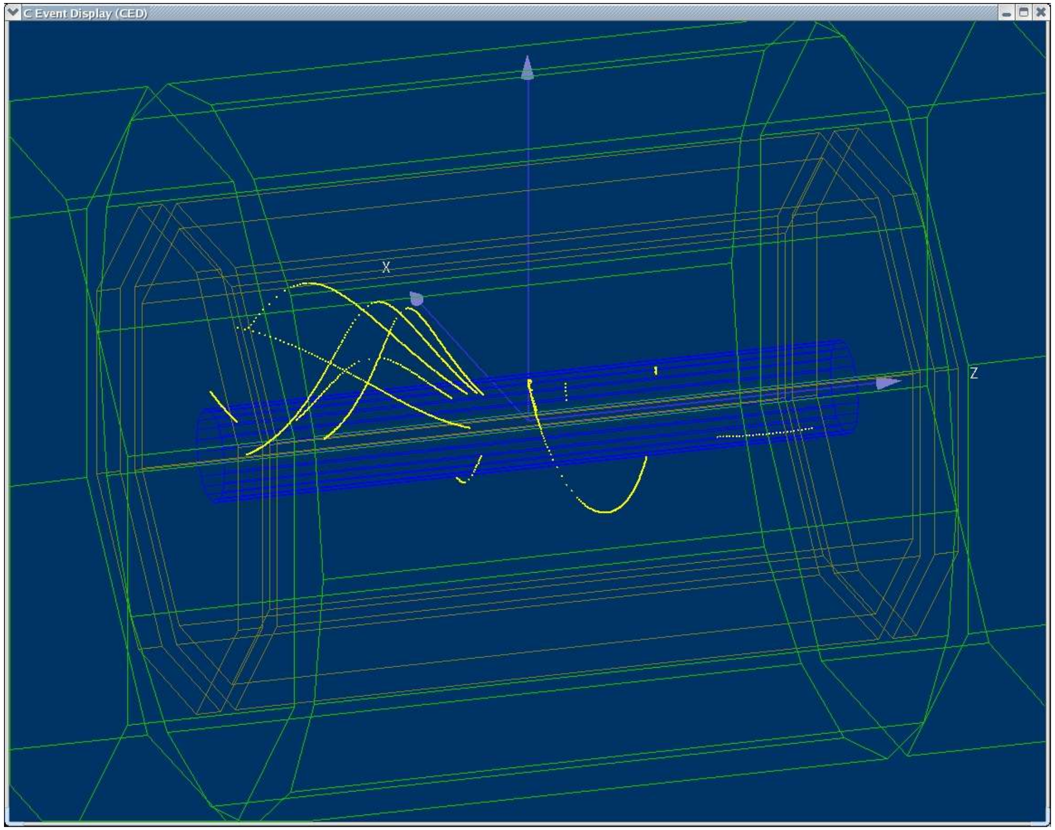




PFlow Studies

ttbar @ 500 GeV





PFlow Studies

ttbar @ 500 GeV