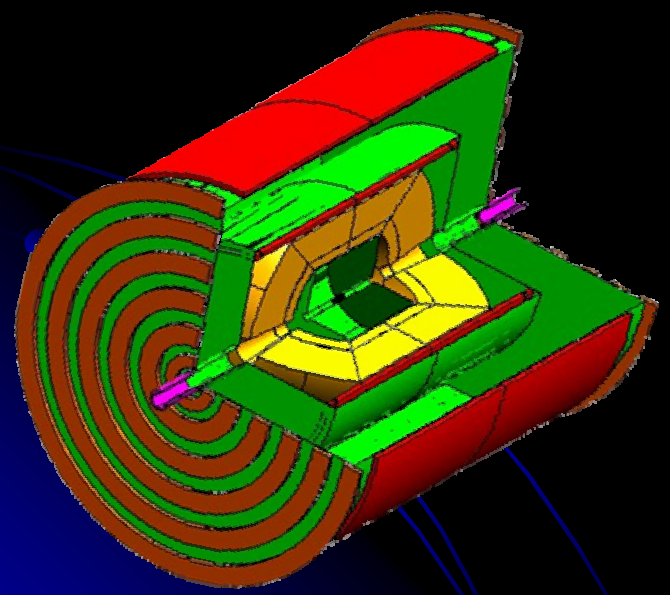
Physics Studies in the 4th Concept



On behalf of 4th Concept Software Group

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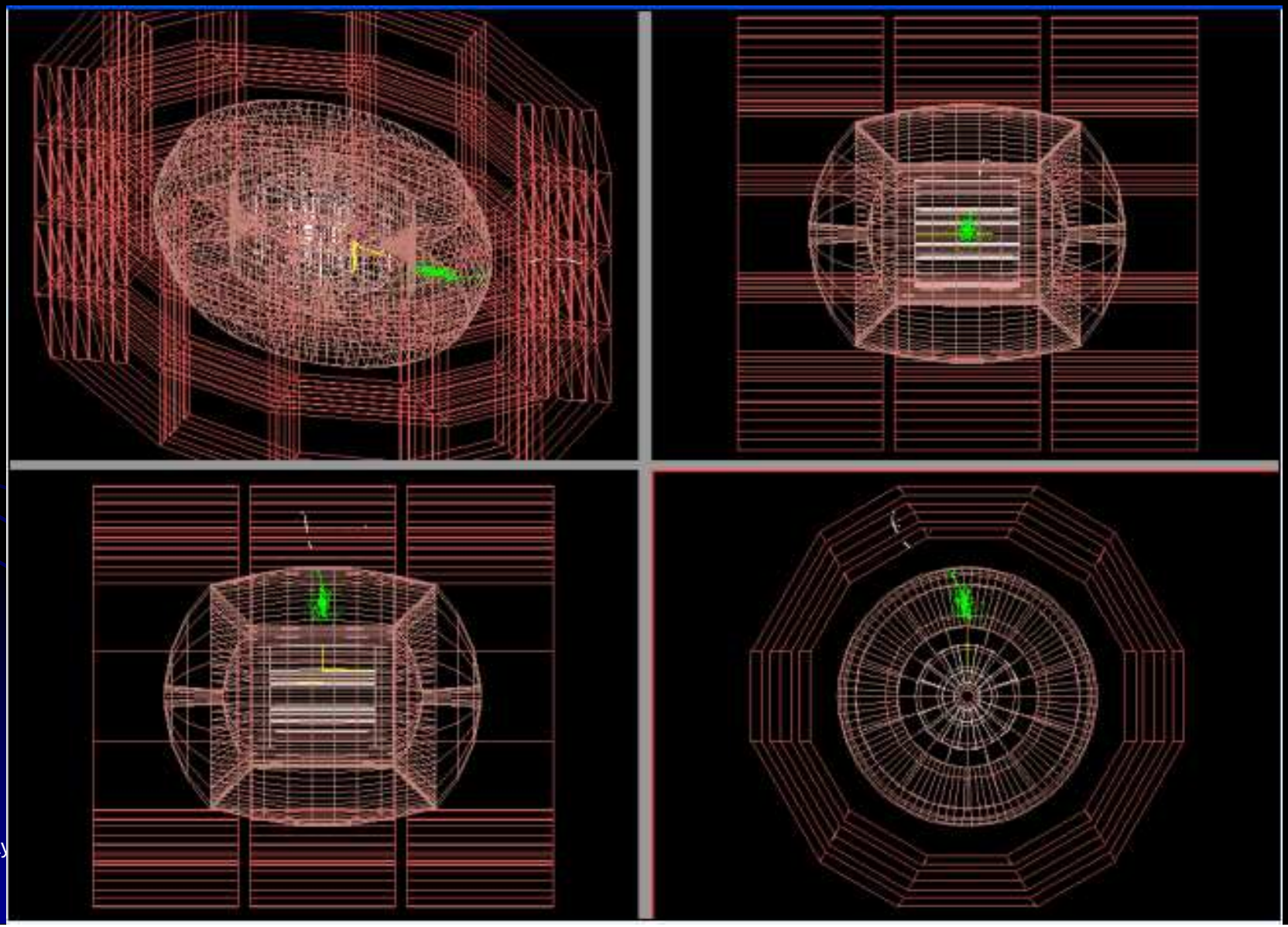
V. Di Benedetto
E. Cavallo
F. Ignatov
A. Mazzacane
G. Terracciano

4th Concept Software and Simulations

- The 4th Concept has completed a **full simulation** study to test the performance of the baseline configuration
- A 56 pages document is available on : http://4thconcept.org
- The studies have been carried over within ILCroot framework
- The event generators (for tracking studies) used:
  - Pandora-Pythia for Physics
  - Guinea-Pig for Beam Background
  - A variety of phase space generators and cocktails of them

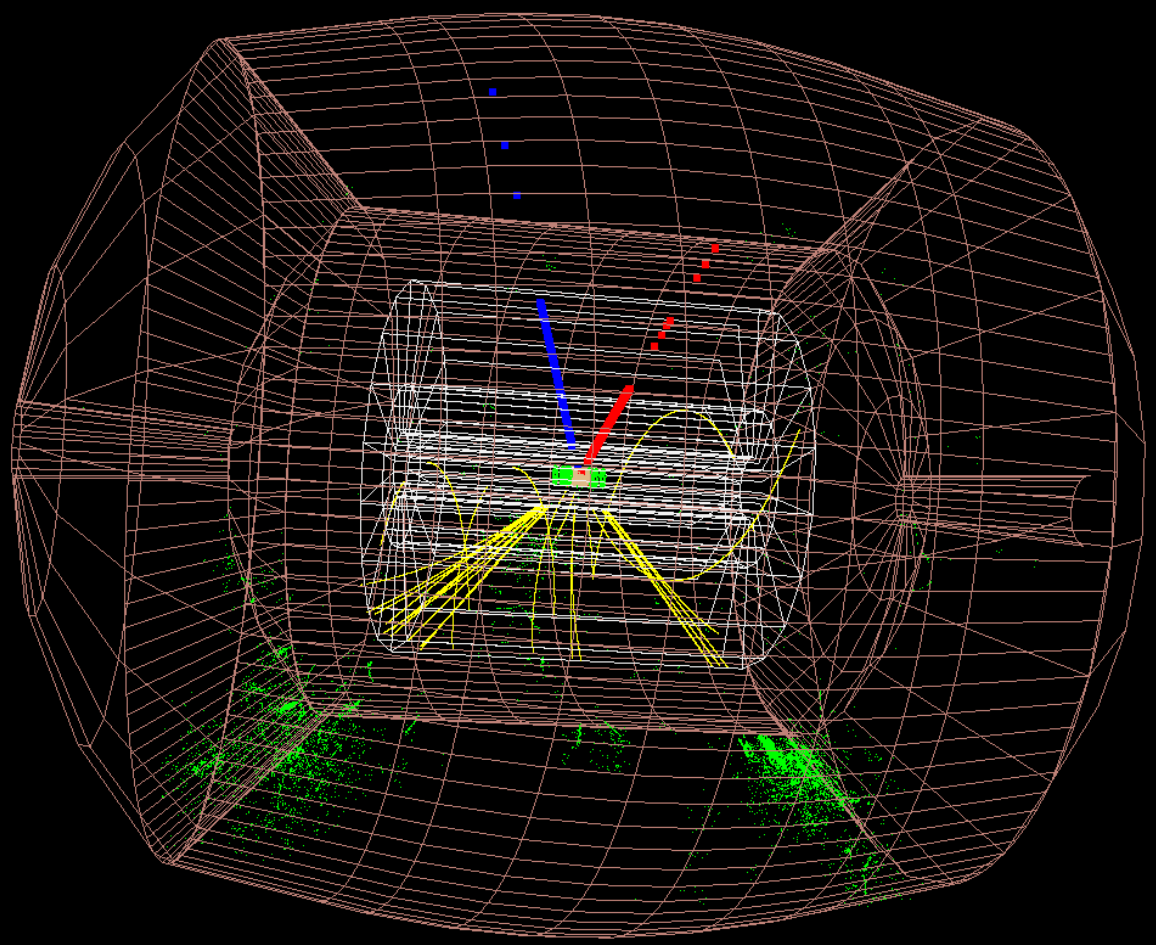
The Baseline Detector



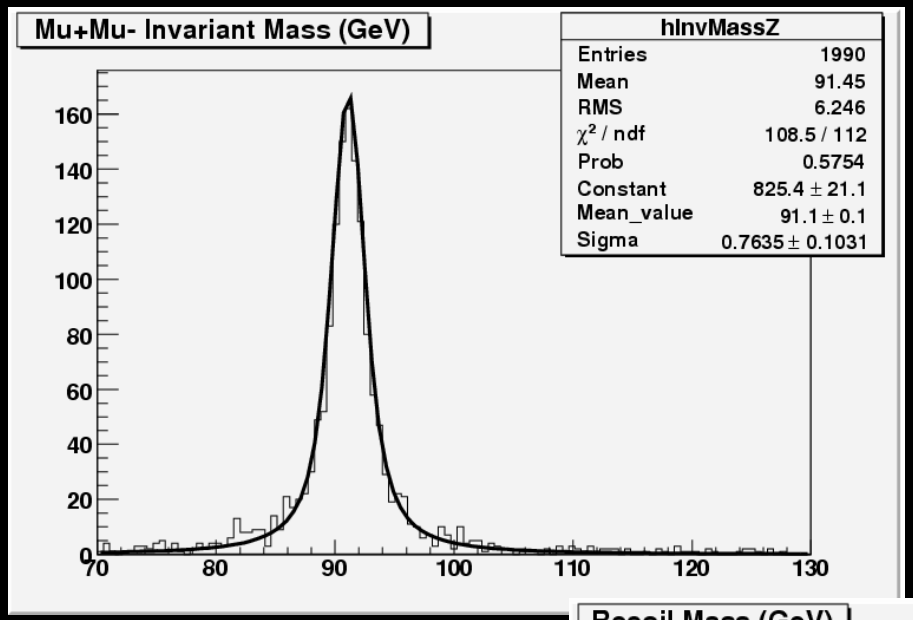
$e^+e^- \to Z^oH^o \to \mu^+\mu^-X$

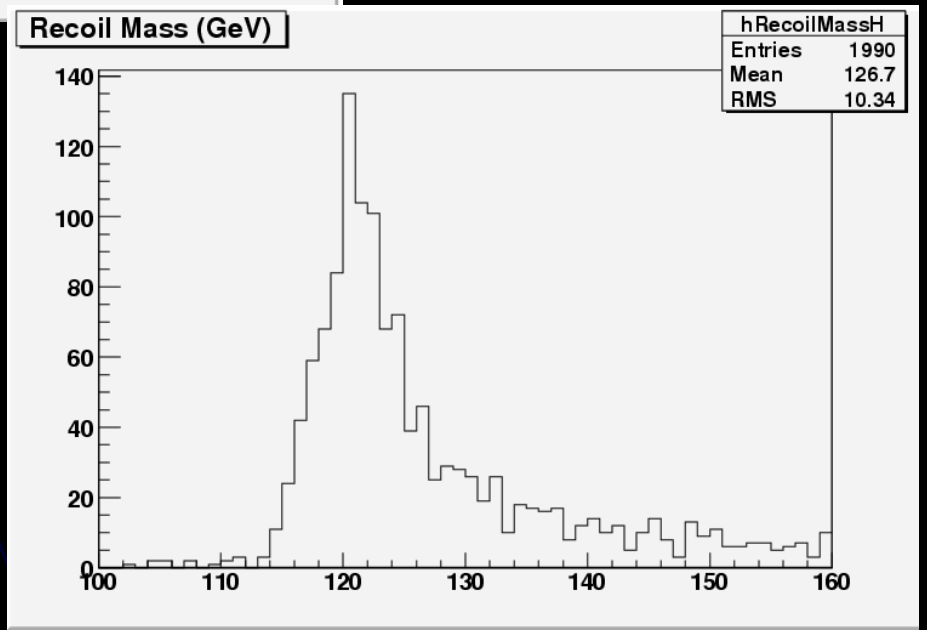
- VXD+TPC+HCAL+MUD
- Very simple analysis
- Parallel Kalman Filter Only (no VXD SA Tracker)
- Cut $|P| > 20$ GeV
- Loose DCA cuts:
  - $\eta < 50\ \mu m$
  - $\xi < 40\ \mu m$
- Requires no kinks in track reconstruction
- Multiple entries per event

$e^+e^- \to Z^oH^o \to \mu^+\mu^-X$

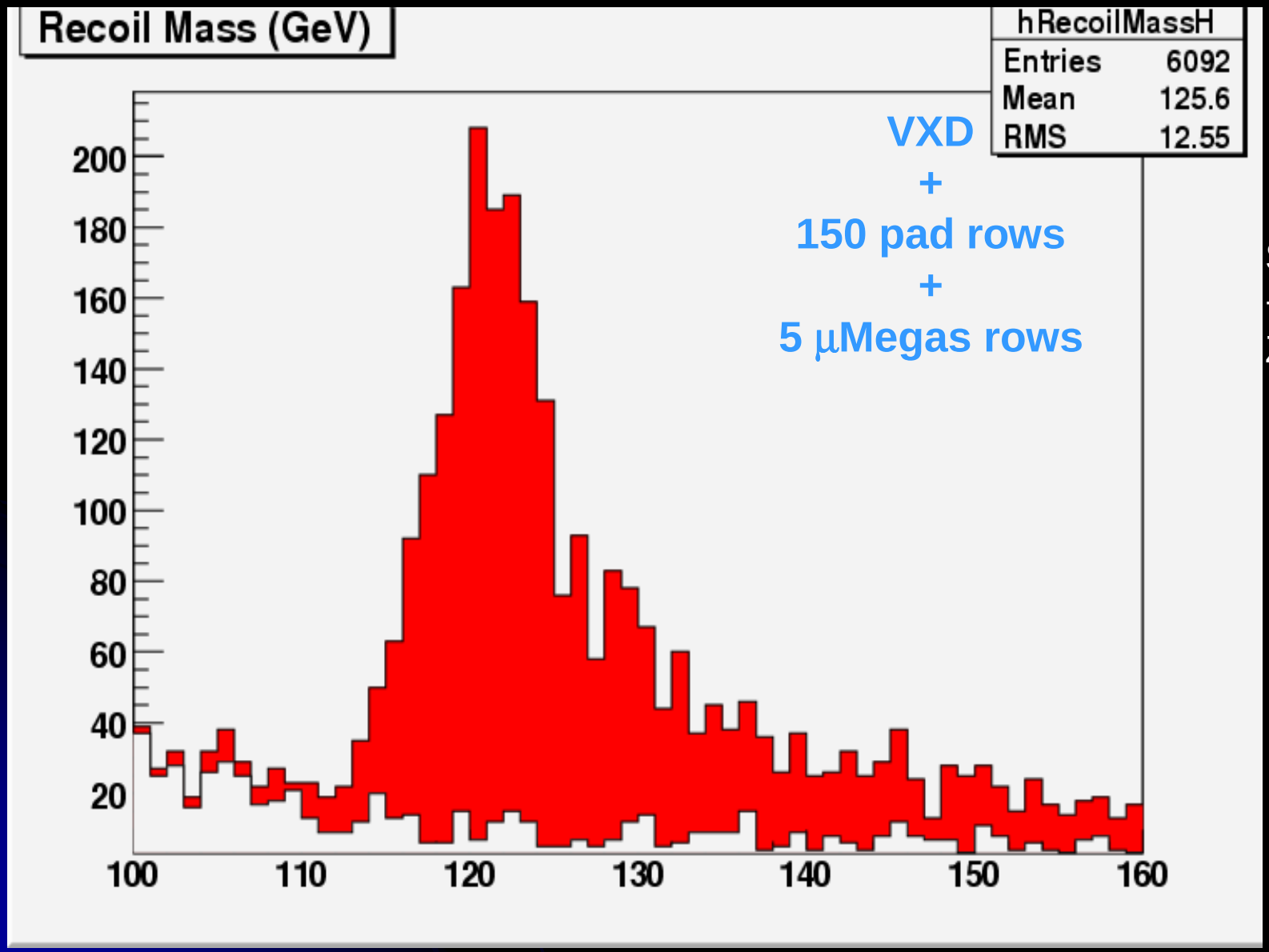


Mass Plots


Mu+Mu- Invariant Mass (GeV)
hInvMassZ
Entries 1990
Mean 91.45
RMS 6.246
χ² / ndf 108.5 / 112
Prob 0.5754
Constant 825.4 ± 21.1
Mean_value 91.1 ± 0.1
Sigma 0.7635 ± 0.1031
0 20 40 60 80 100 120 140 160
70 80 90 100 110 120 130


Recoil Mass (GeV)
hRecoilMassH
Entries 1990
Mean 126.7
RMS 10.34
0 20 40 60 80 100 120 140
100 110 120 130 140 150 160

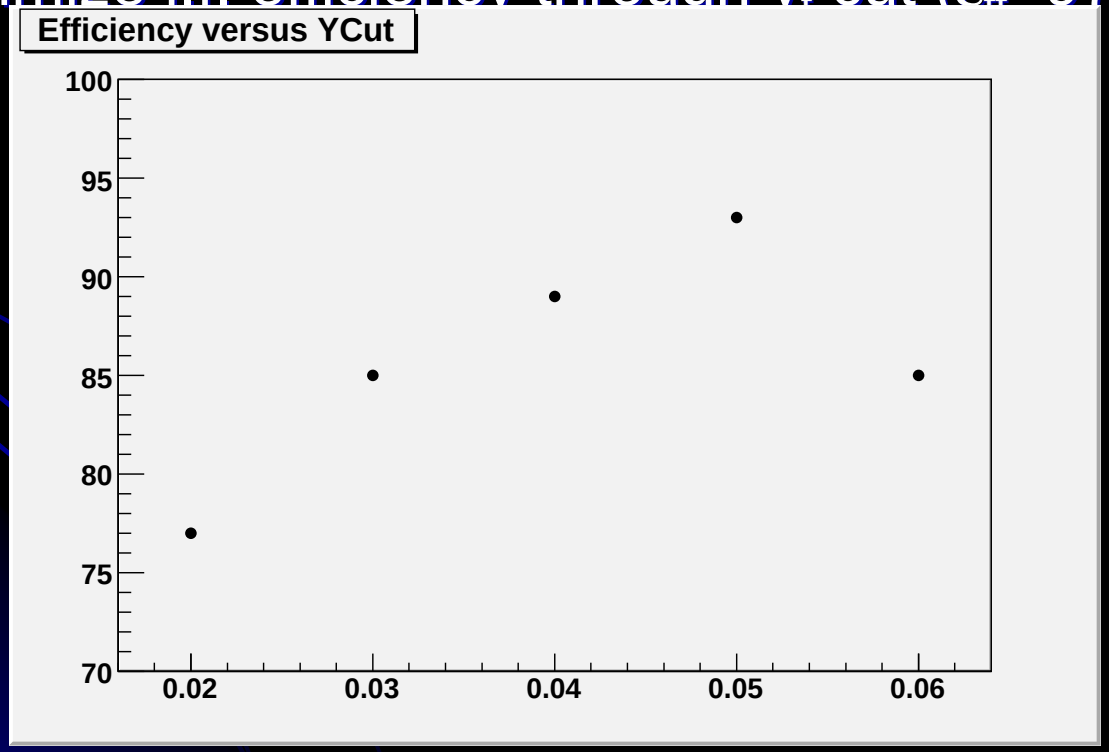
Recoil Mass (500 fb)



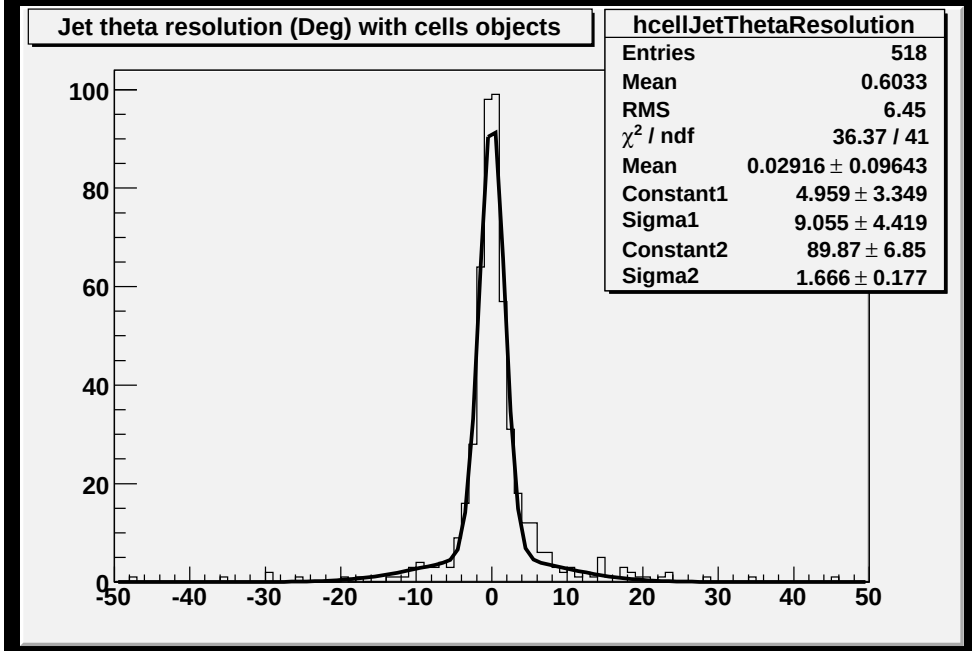
Signal
+
ZZ->$\mu^+\mu^-$X
background

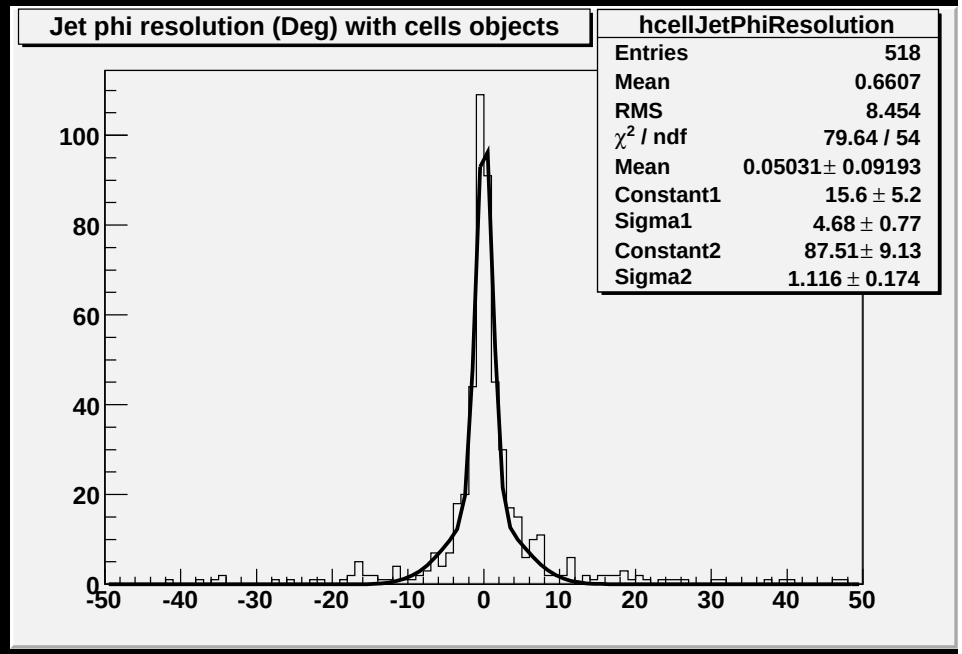
$e^+e^- \to Z^oH^o \to \nu\bar{\nu}\, c\bar{c}$

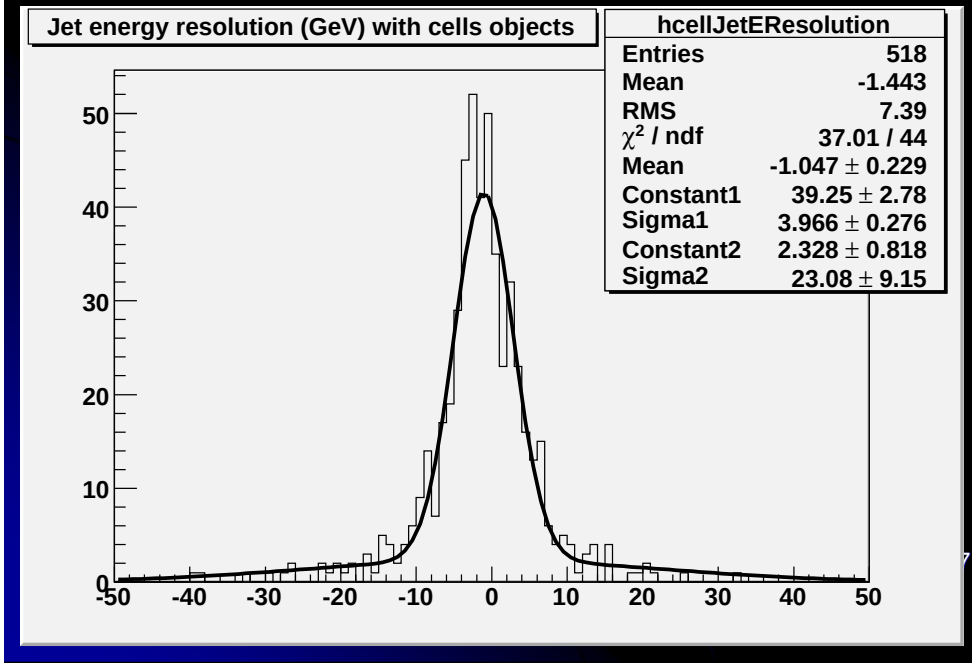
- Parallel Kalman Filter + VXD Standalon Tracker
- Pandora-Pythia + Fluka
- No MUD (use MC truth for muons)
- Cut recoil mass 20 GeV around Z^o mass
- Maximize i.f. efficiency through y_t cut (ε_{ff}=97.5%)



Jet Finder Performance

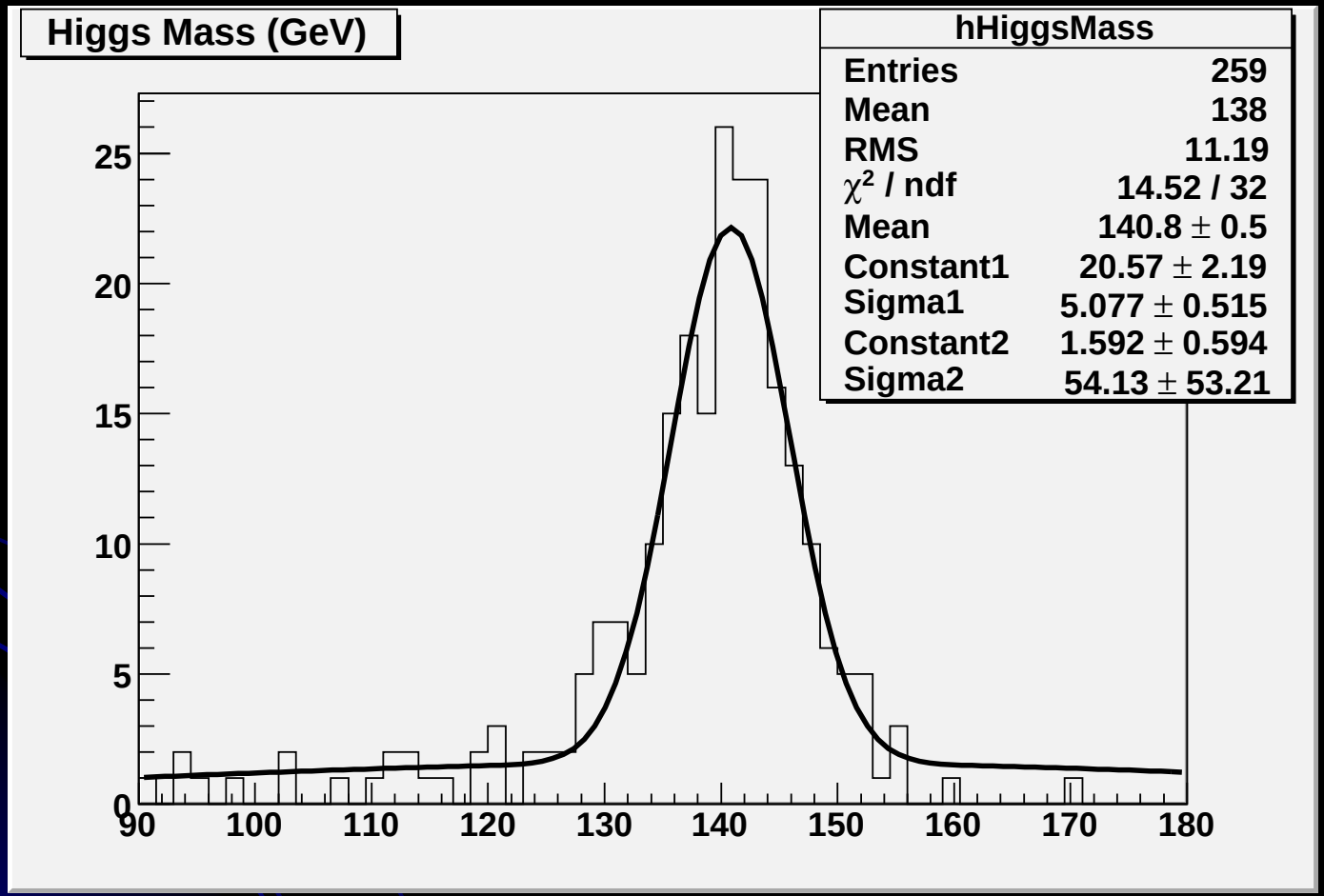






- Angular resolution < 2°
- Energy resolution = 4 GeV

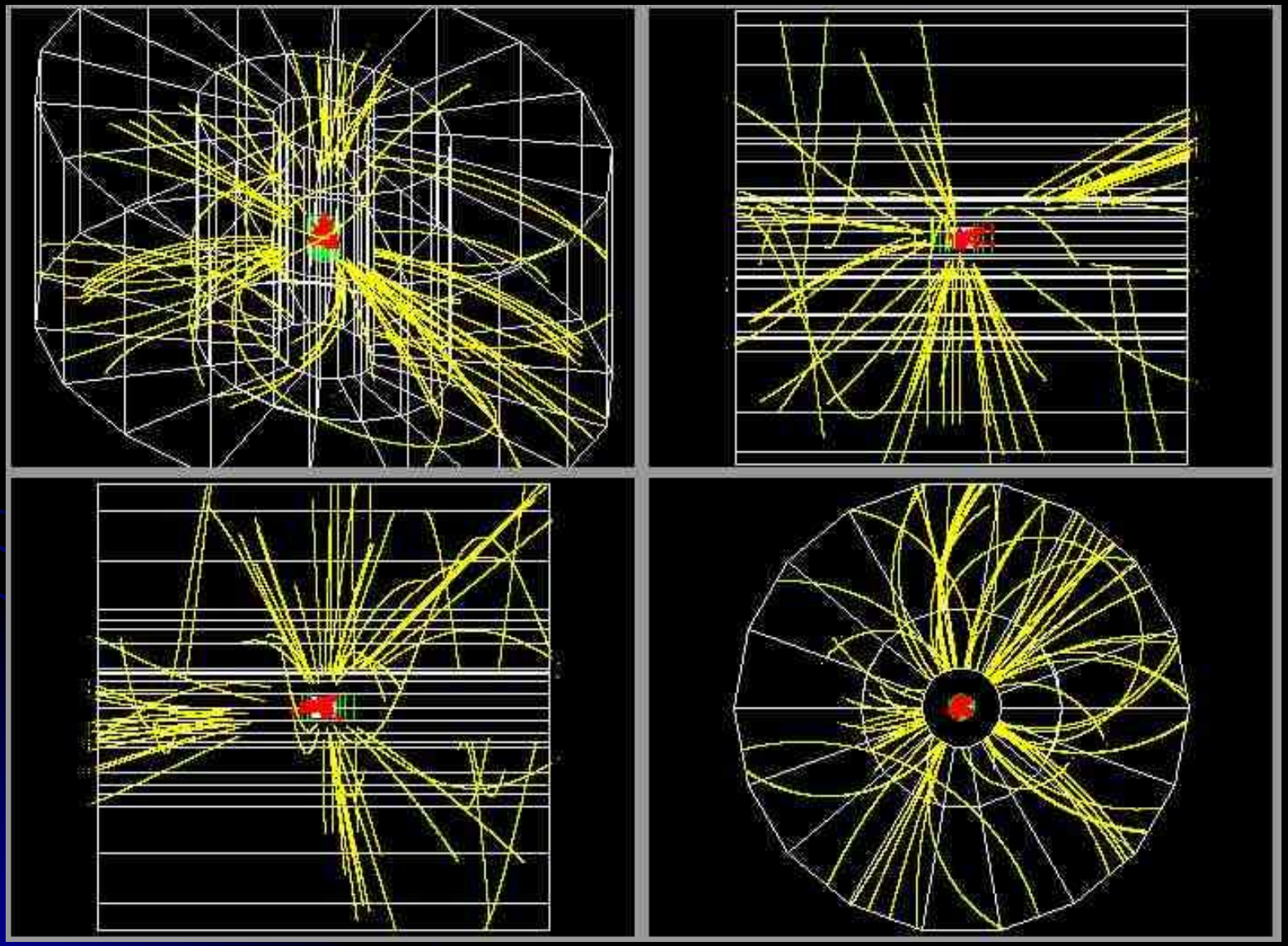
Jet-Jet Mass Plot



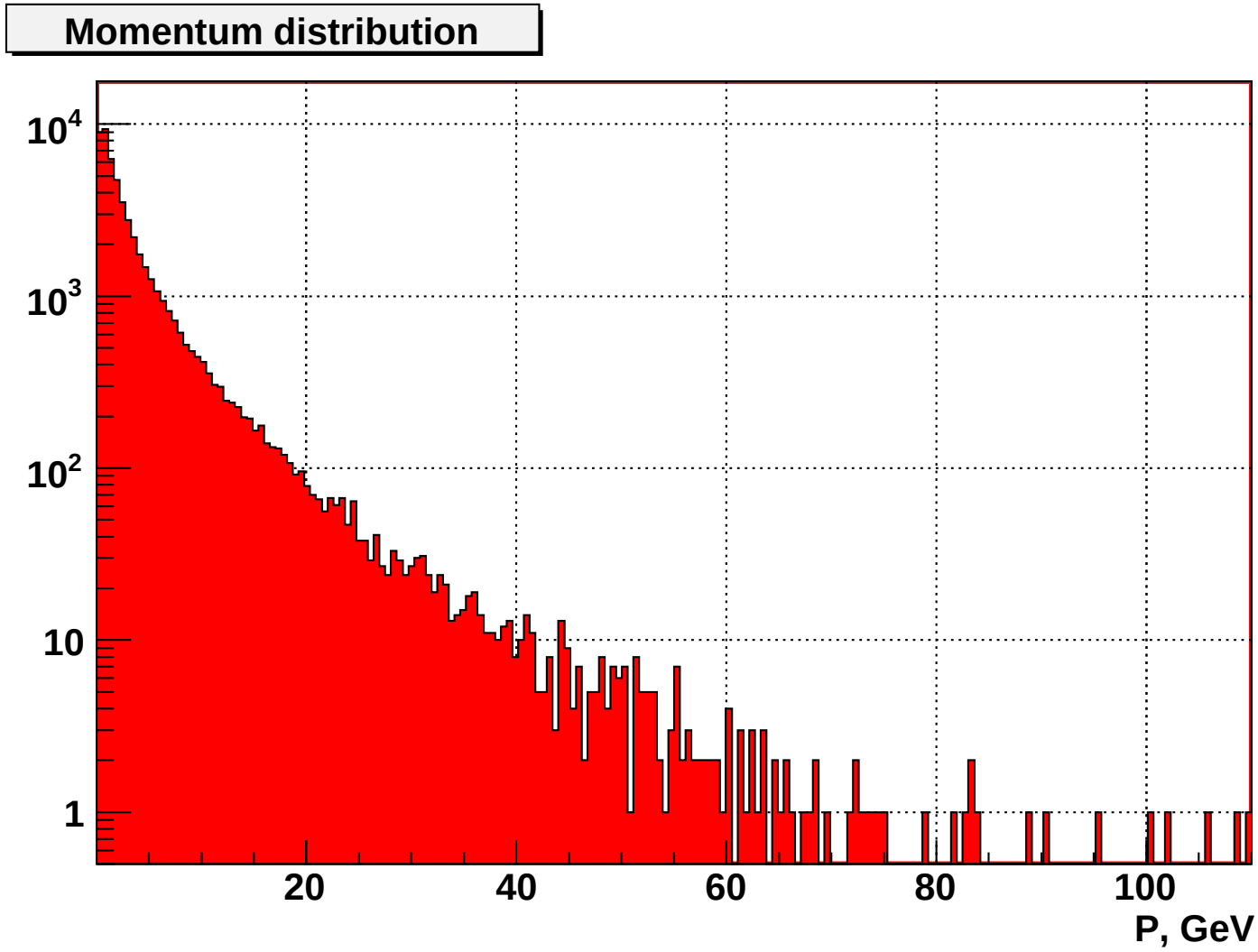
New Studies since Beijing

- e^+e^- -> $t\bar{t}$ -> 6 jets
  - Full digitization and clusterization in VXD
  - Improved track reconstruction
  - First studies with ClouCou Drift Chamber
- e^+e^- -> H^oZ^o -> $b\bar{b}q\bar{q}$ (Preliminary see Anna's talk)
  - Full digitization and clusterization in VXD
  - Reconstruction in Barrel MUD

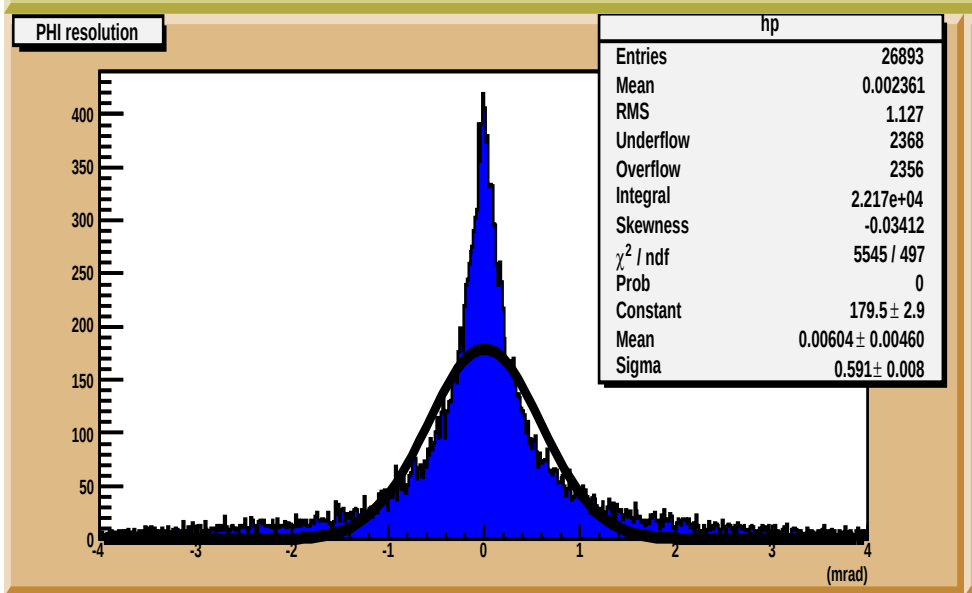
$e^+e^- \to t\bar{t} \to 6$ jets

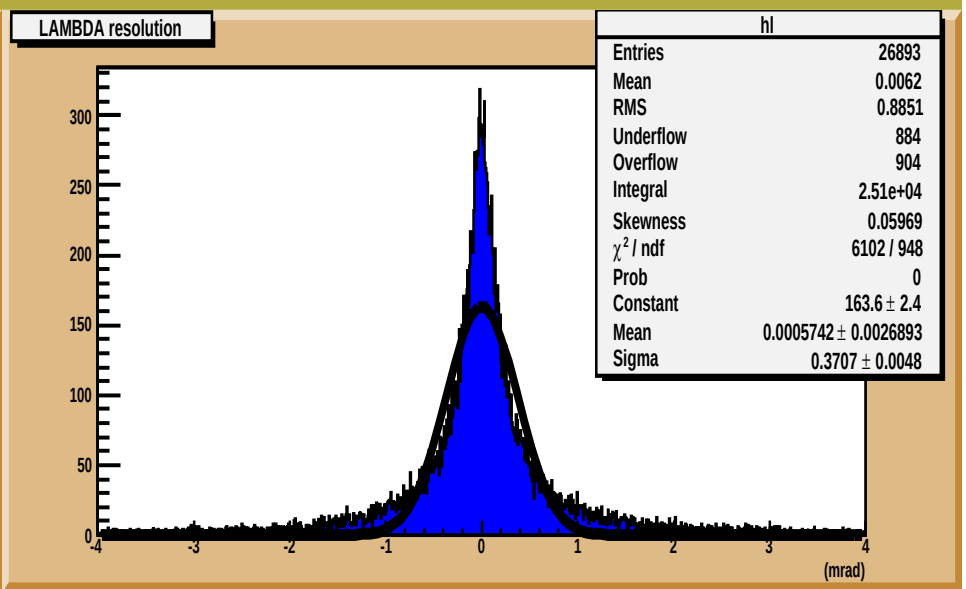


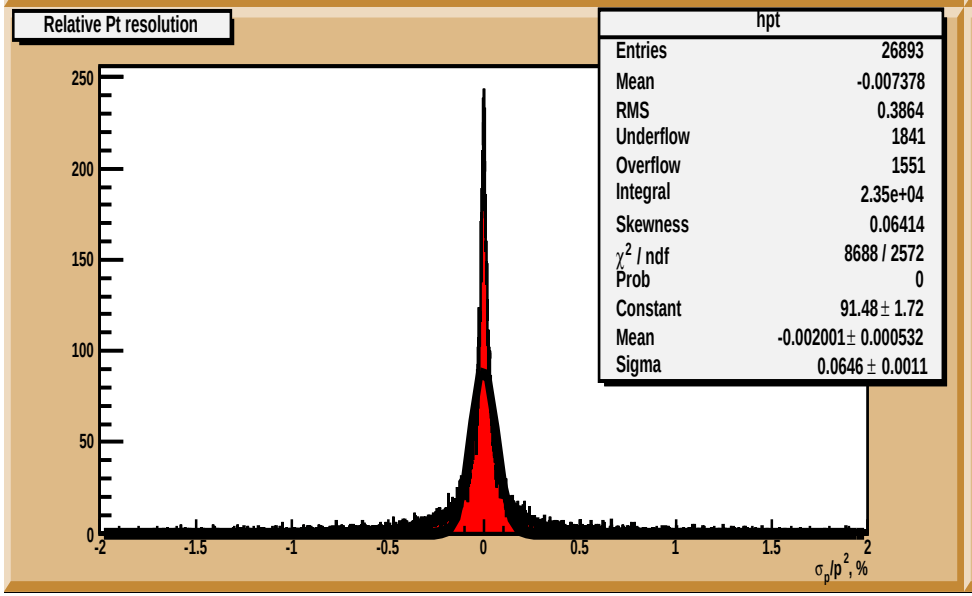
$e^+e^- \to t\bar{t} \to 6$ jets

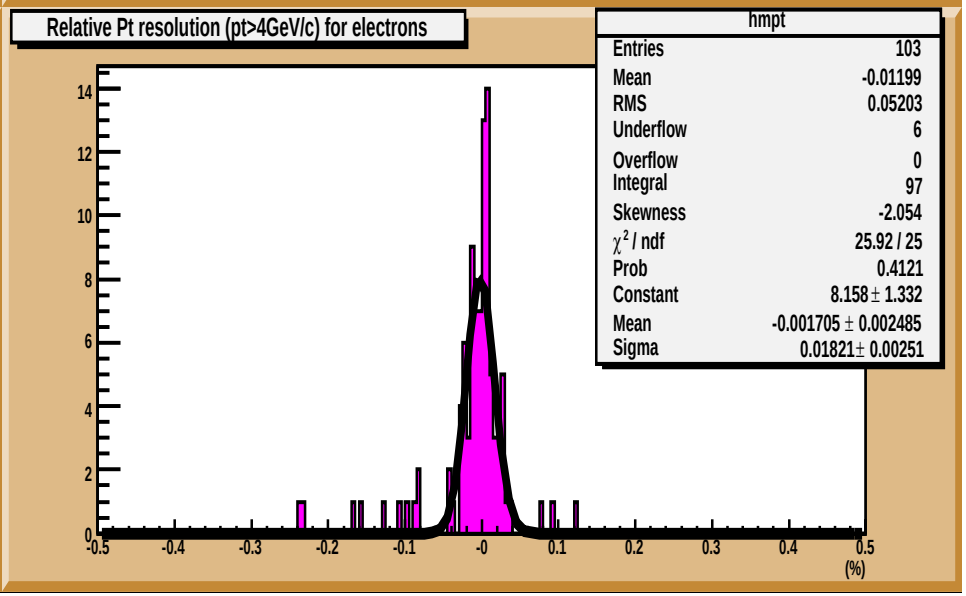


Track Resolutions

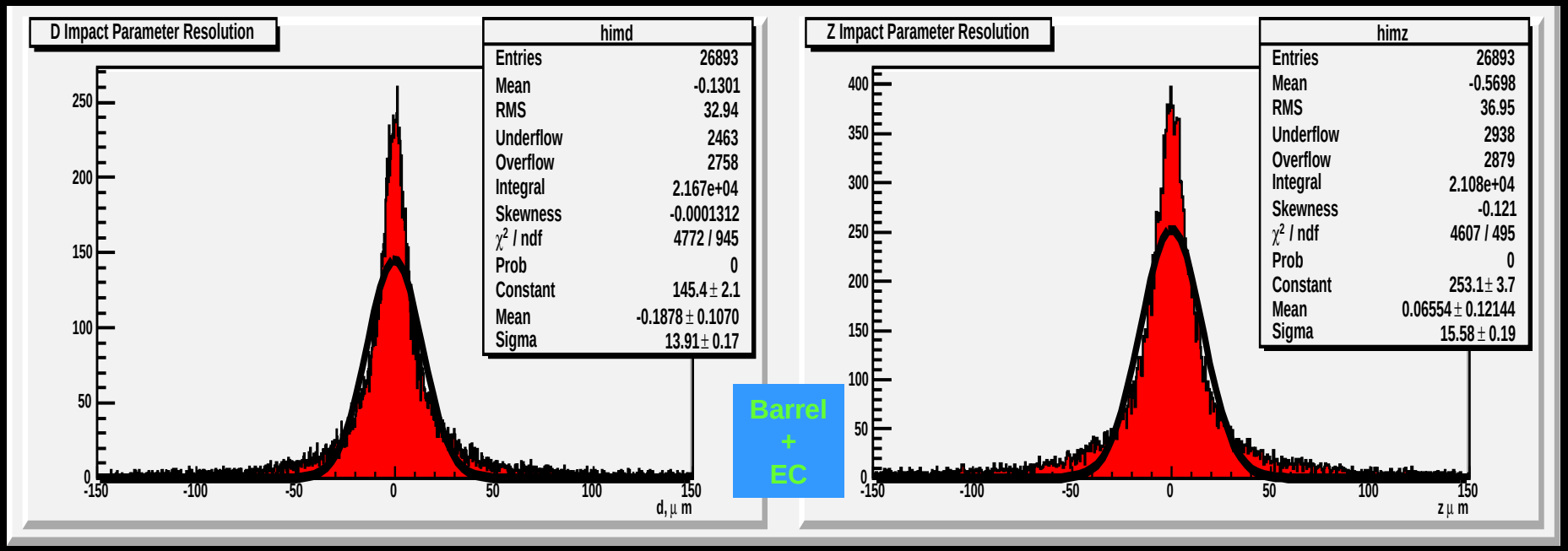


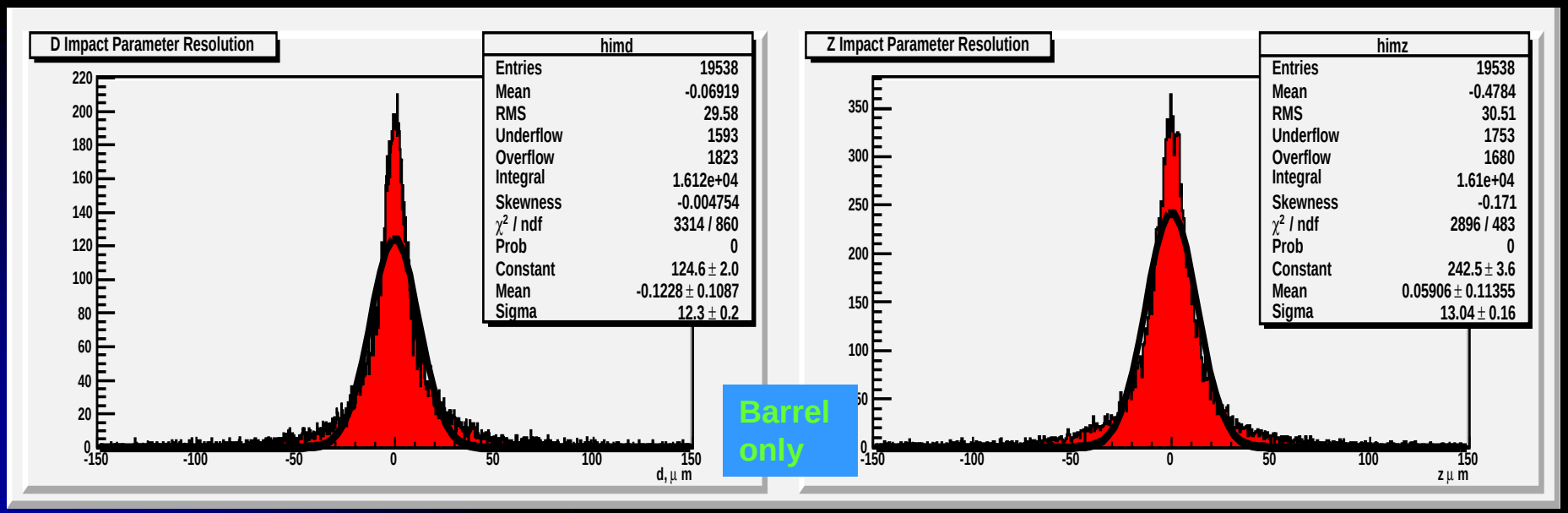




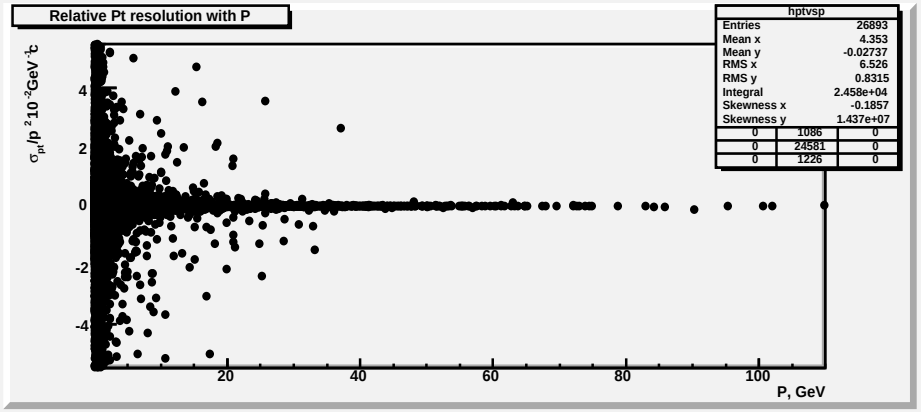


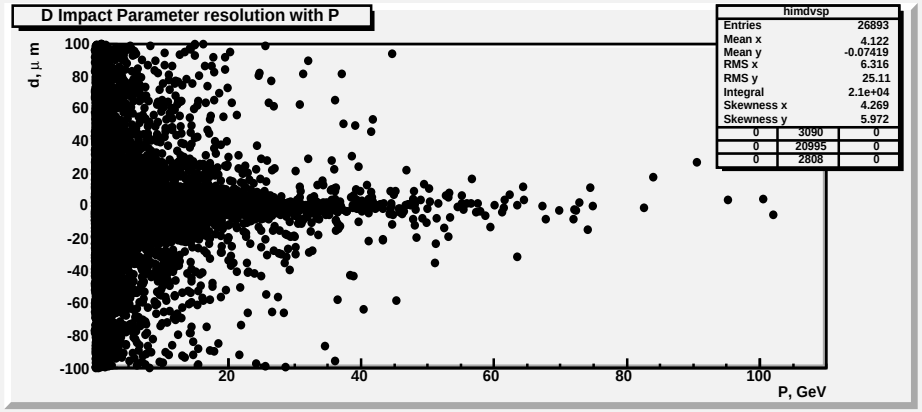
$e^+e^- \to t\bar{t} \to 6$ jets

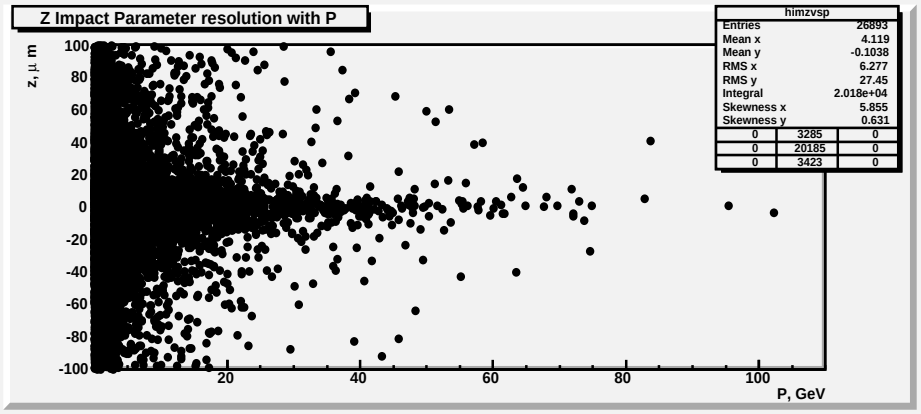


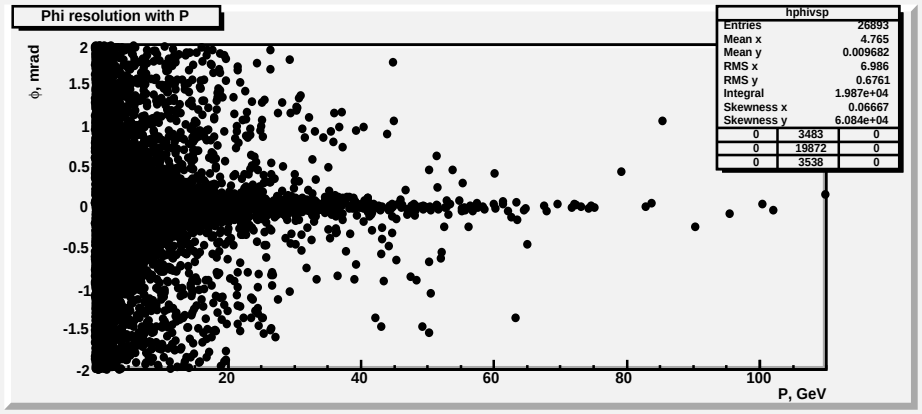


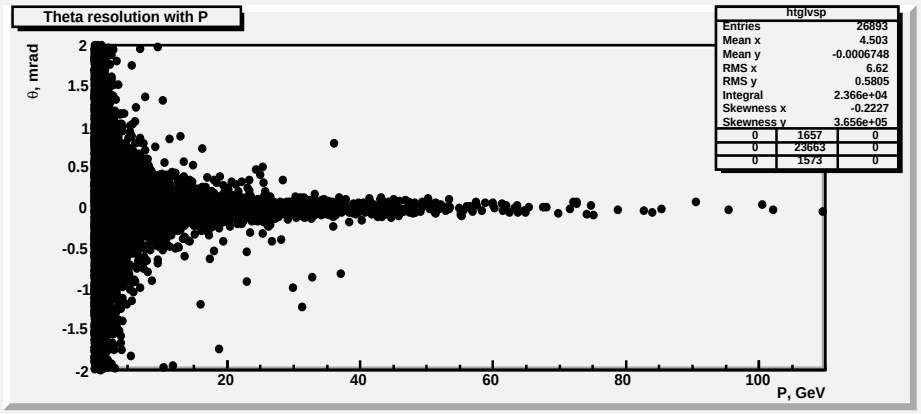
$e^+e^- \to t\bar{t} \to 6$ jets

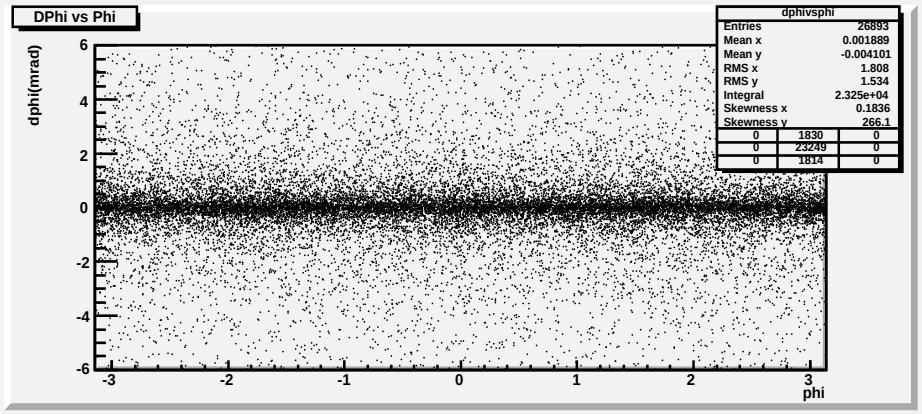




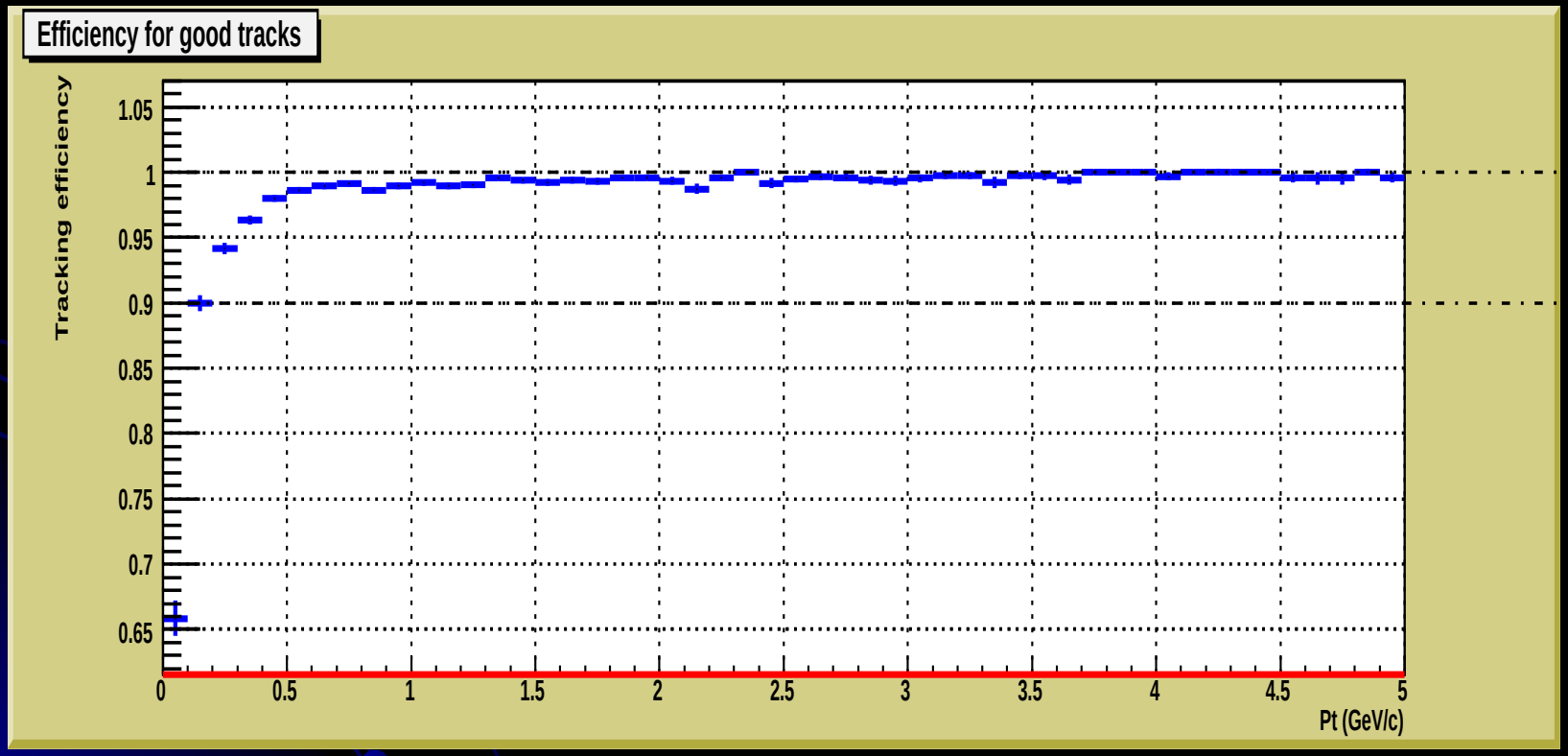




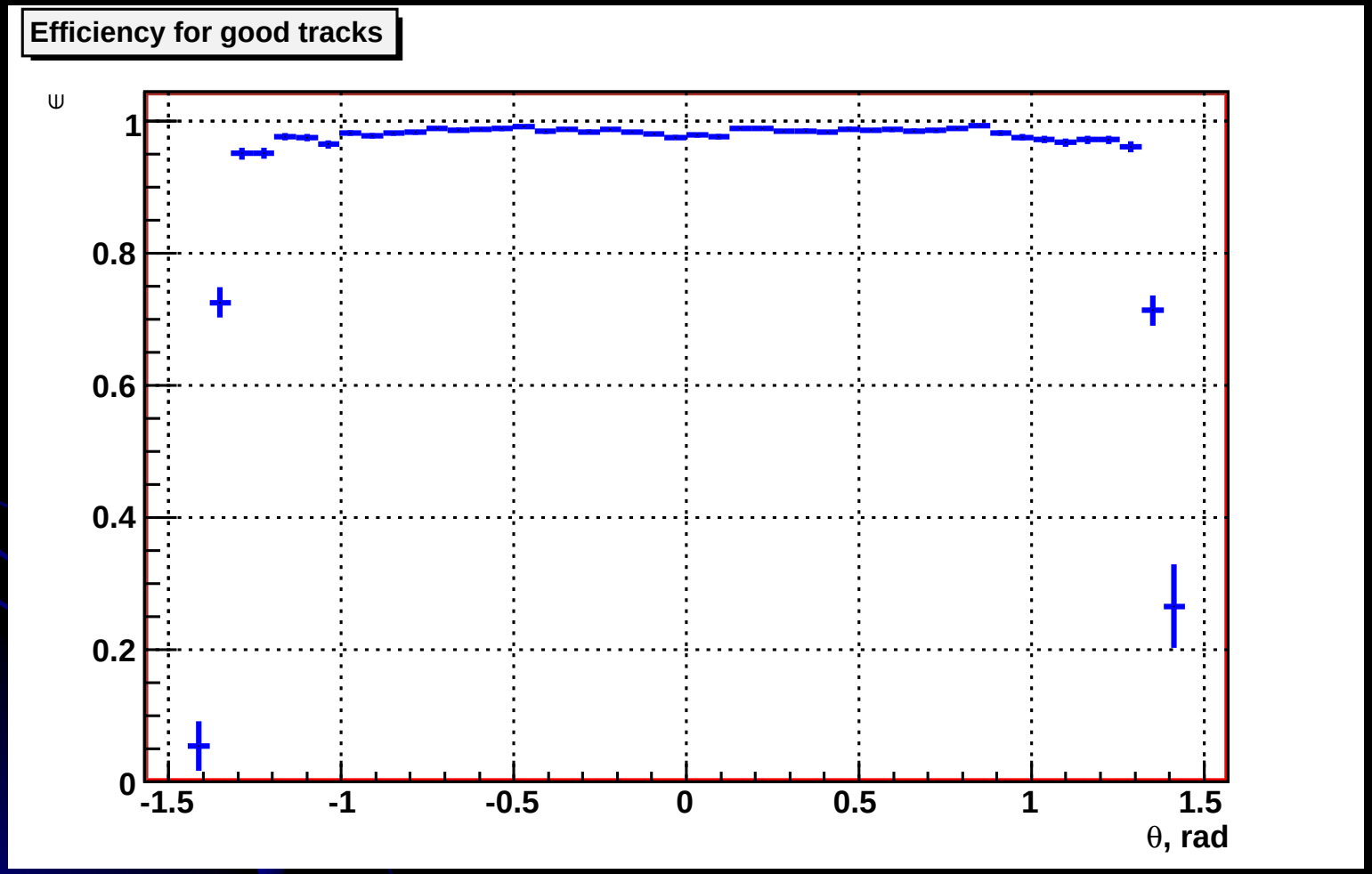




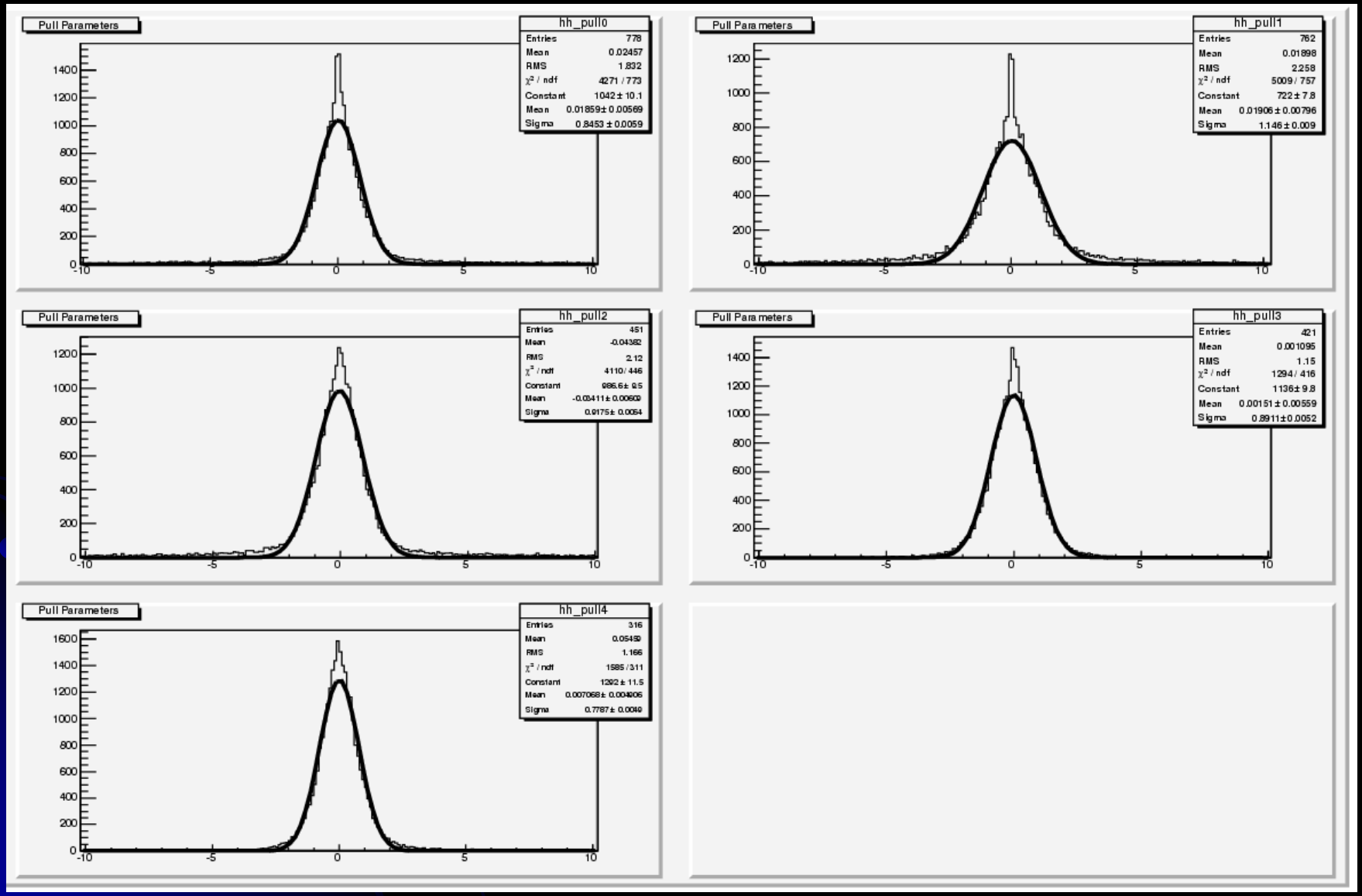
$e^+e^- \to t\bar{t} \to 6$ jets



$e^+e^- \to t\bar{t} \to 6$ jets



Pulls (full digitization)



e^+e^- -> $t\bar{t}$ -> 6 jets
Summary of Performance

- Tracking efficiency:

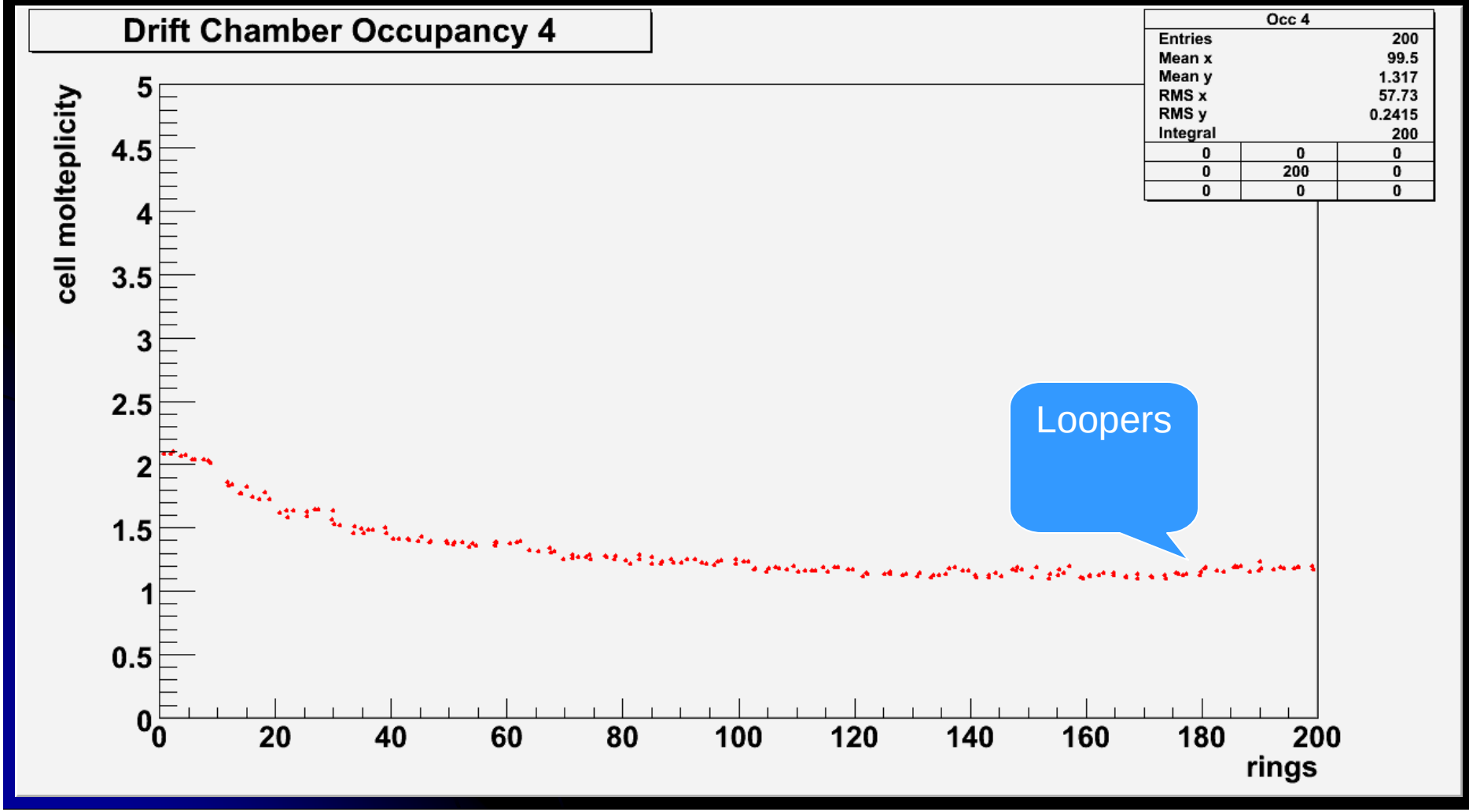
  ε_{reco} > 90 % above 100 MeV

  ε_{reco} = 99.7 % above 1.5 Gev

- TPC + VXD resolution (gaussian smearing):
  - $\sigma(1/p_t) = 6.5\ 10^{-4}$ ($5.0\ 10^{-4}$ in barrel)
  - $\sigma(d) = 14\ \mu m$ (12 μm in barrel)
  - $\sigma(z) = 16\ \mu m$ (13 μm in barrel)
  - Totally dominated by MS

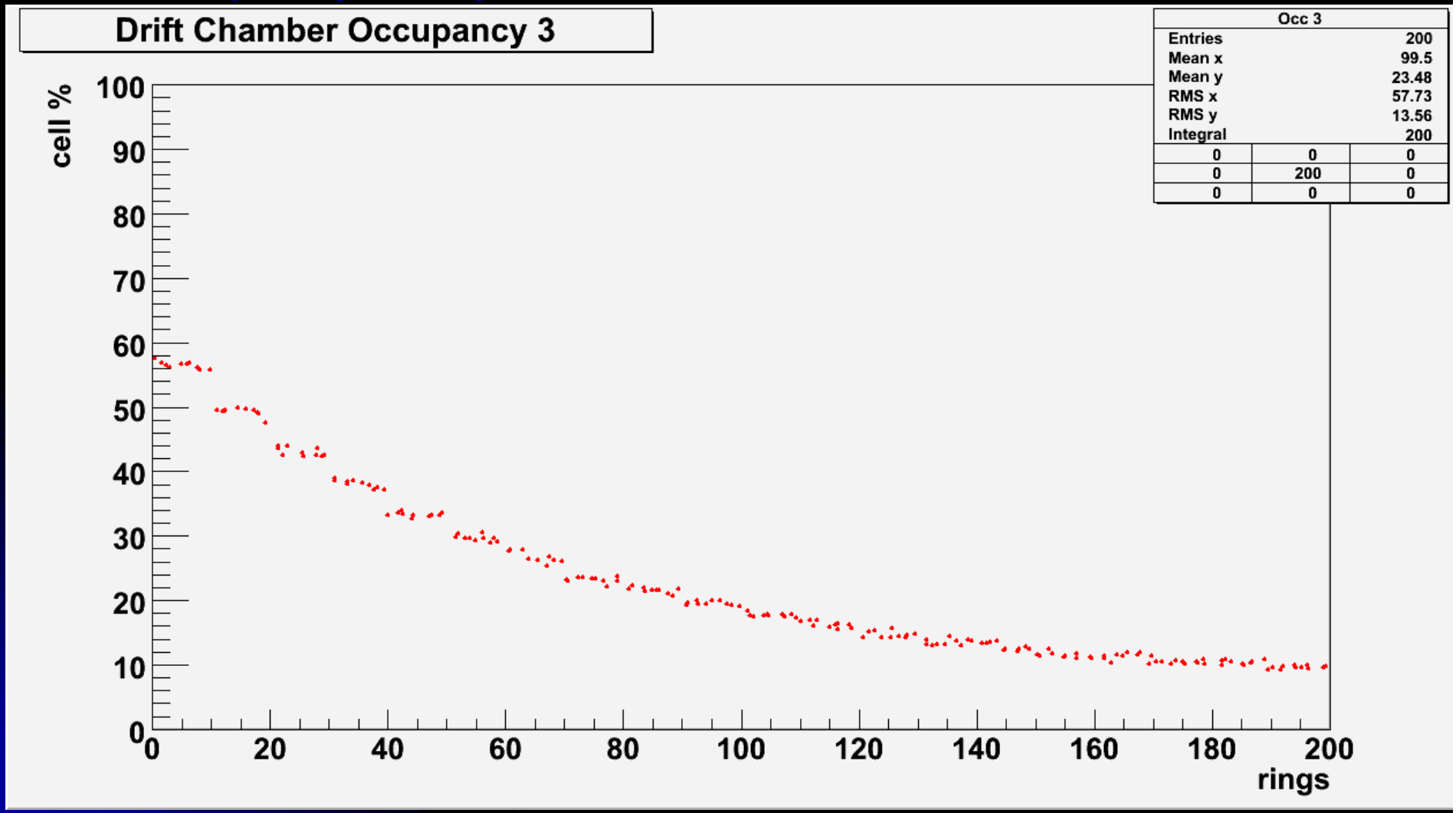
$e^+e^- \to t\bar{t} \to$ 6 jets with DCH

- Hits per cell vs layer



$e^+e^- \to t\bar{t} \to$ 6 jets with DCH

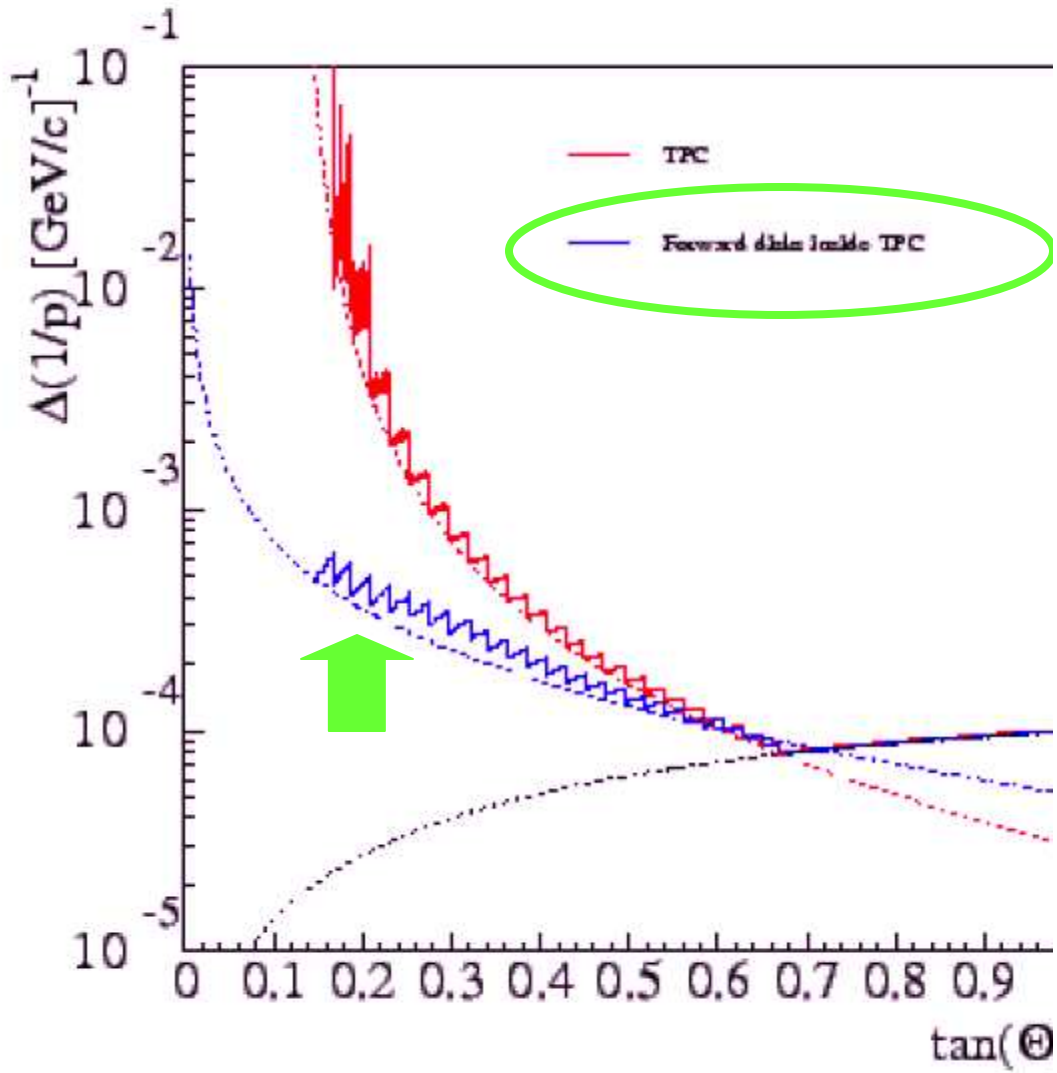
- Occupancy vs layer



SiLC assets: fast simulation

SGV simulation (M. Berggren) of the LDC
racker central region

mpact of silicon (FTD) disks on momentum
esolution on forward tracking.
To maintain an adequate performance in
he forward region, the TPC must be
complemented by silicon.



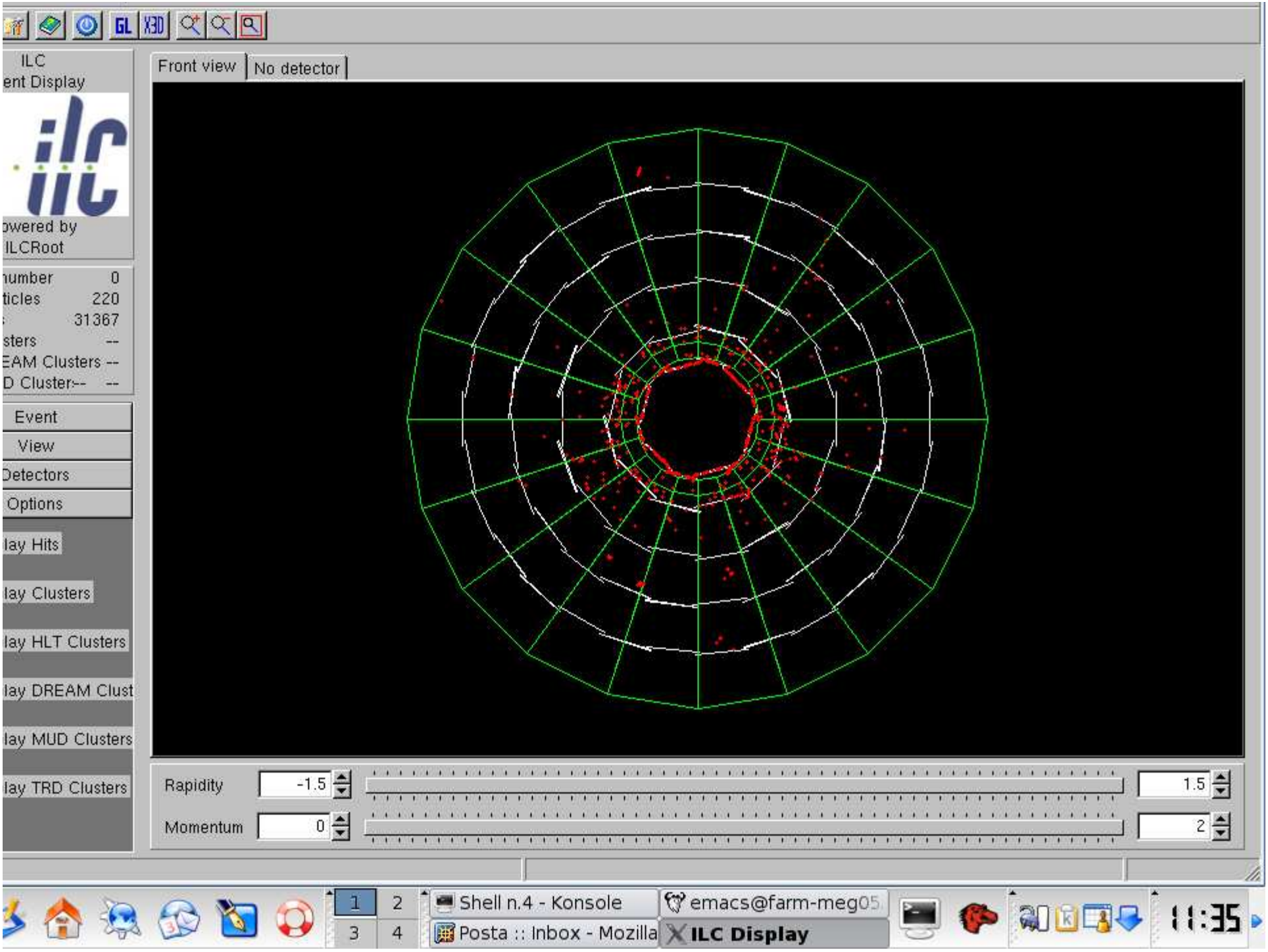
Marcel Vos's Talk Orsay2007

Beam Pair Background Study

- Interface to Guinea-Pig output added to ILCroot
- Tested with current SA VXD tracker and generic accelerator parameters
- Full VXD Digitization

Acc.dat

```
$ACCELERATOR:: NLC-B-500
{ energy    = 245.  ;
  particles = 0.95 ;
  emitt_x  = 4.5 ;
  emitt_y  = 0.1 ;
  beta_x = 12. ;
  beta_y = 0.12 ;
  sigma_z = 120. ;
  dist_z    = 0  ;
  espread = 0.003 ;
  which_espread = 0;
  offset_x  = 0   ;
  offset_y  = 0.   ;
  waist_x = 0 ;
  waist_y = 0 ;
  angle_x = 0 ;
  angle_y = 0 ;
  angle_phi = 0 ;
  trav_focus = 0 ;
  charge_sign = -1;
}
```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D Cluster-- --
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View
Detectors
Options
lay Hits
lay Clusters
lay HLT Clusters
lay DREAM Clust
lay MUD Clusters
lay TRD Clusters
Front view
No detector
Rapidity
-1.5
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Shell n.4 - Konsole
emacs@farm-meg05
Posta :: Inbox - Mozilla
ILC Display
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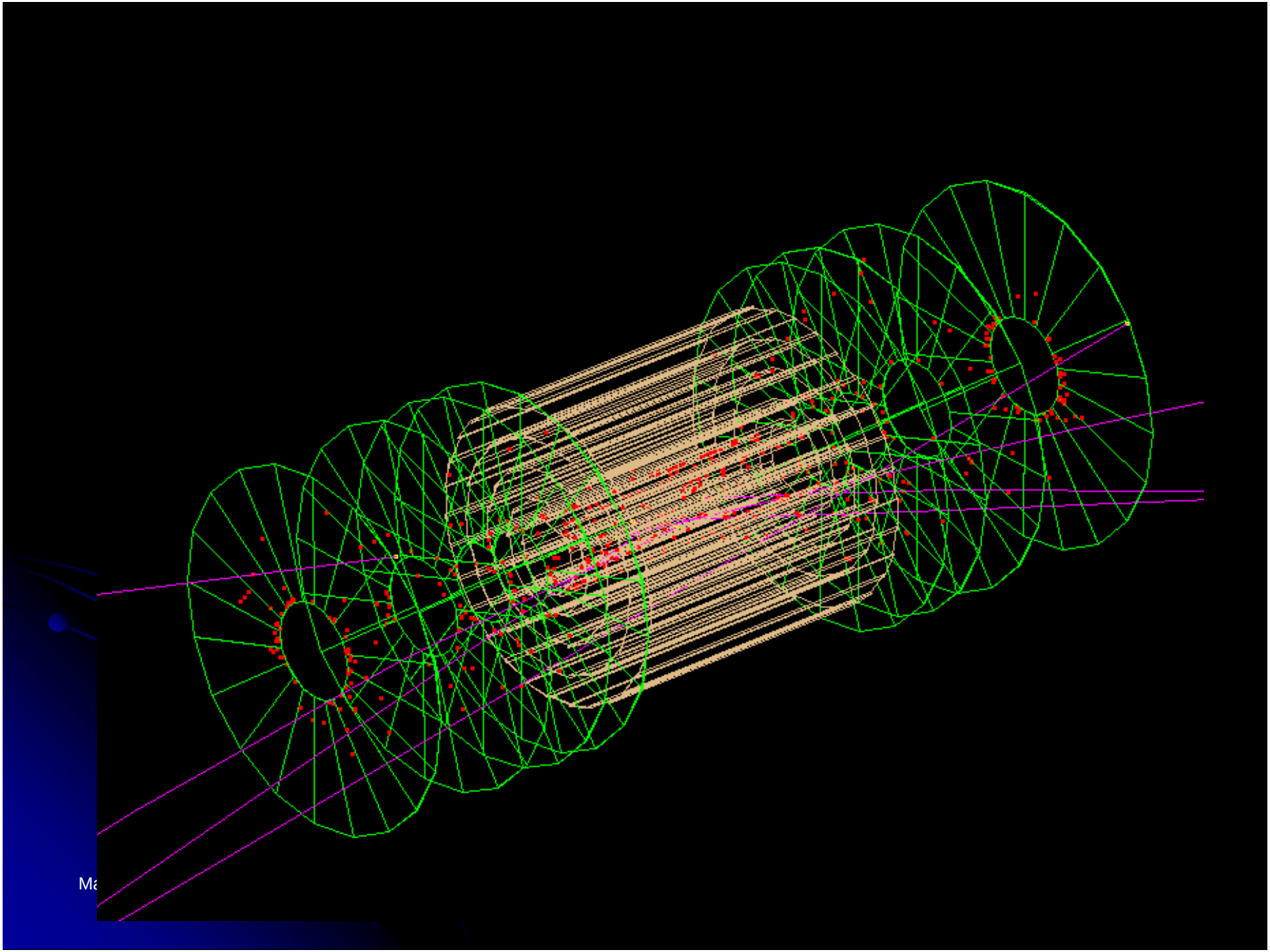

Ma

Results

- More than 30000 hits/evt
- Average of 18 reconstructed particles (8 in TPC)
- Will merge SDigit from Signal and Background to evaluate the overall effect

What's Next

- Some of the studies are being repeated with updated simulations of the detector
- Events are in production on several farms on the GRID
- Fluka takes up to 6 hours to generate one event
- Studies are targeted for LCWS07

Events in Production

- e+e- -> $q\bar{q}$ at several angles and energies
- e^+e^- -> H^oZ^o -> $b\bar{b}q\bar{q}$
- e^+e^- -> $H^oH^oZ^o$ -> 6 jets
  - Goal is to estimate the performance of the calorimeter and for tuning the jet reconstruction algorithm
  - Fluka for hit generation
- e^+e^- -> $H^oH^oZ^o$ -> 4 jets $\mu^+\mu^-$
  - Goal is to estimate the muon reconstruction efficiency in the midst of a jet
  - G3/G4 for hit generation

τ polarization studies

- $e^+e^- \rightarrow H^oZ^o \rightarrow \tau^+\tau^- X$
- Encouraged by F. Richard
- Intend to study the τ polarization
- Goal is to test the performance of the calorimeter + tracking
- Will start event production after the ECAL is ready

The Event Generator Saga

- Pandora-Pythia has been used for most of the analyses
- It appears to have scarce support
- Pythia8 is optimized for hadronic collisions
- Pythia6 is OK, but need to be adapted to a particular beam configuration
- Whizard OK but:
  - Not straightforward to use
  - Need to purchase a fortan compiler
- Sherpa is promising
  - Very easy to use
  - Good support by Darham group
  - Beamstrhalung will be inserted soon
- Guinea-Pig OK

Conclusions

- Most of the 4th Concept software group (still) busy on detector simulation:
  - DCH and Si Central Tracker
  - FTD
  - ECAL
- Limited effort on Physics analyses and other (i.e. LCIO compatibility)
- New results are expected for LWCS07