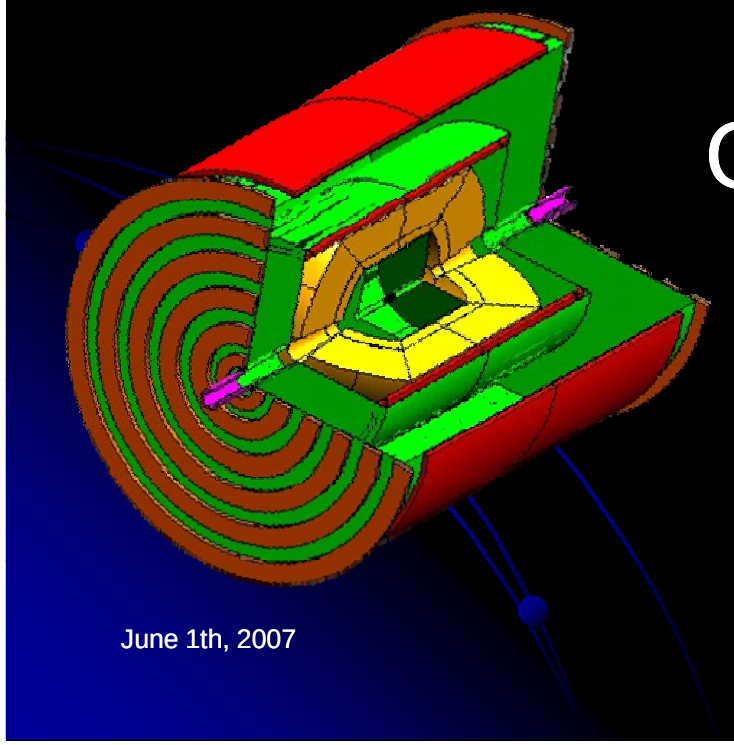
Calorimeter Calibration with the Muon Spectrometer

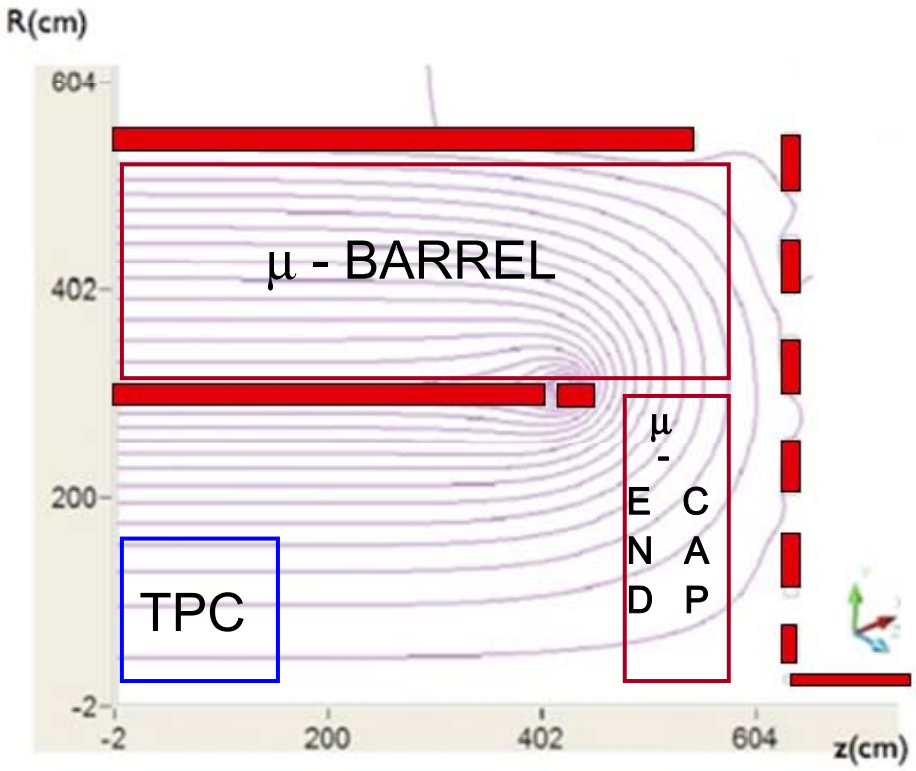


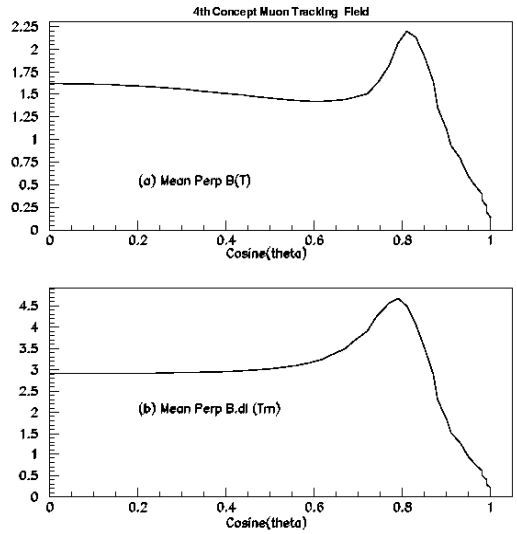
On behalf of 4th Concept

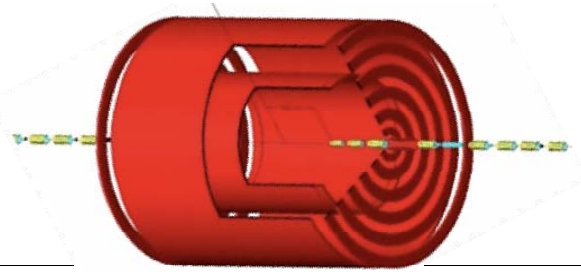
A. Mikailicenko talk, ILC Workshop Valencia 2006

Dual Solenoid B-field

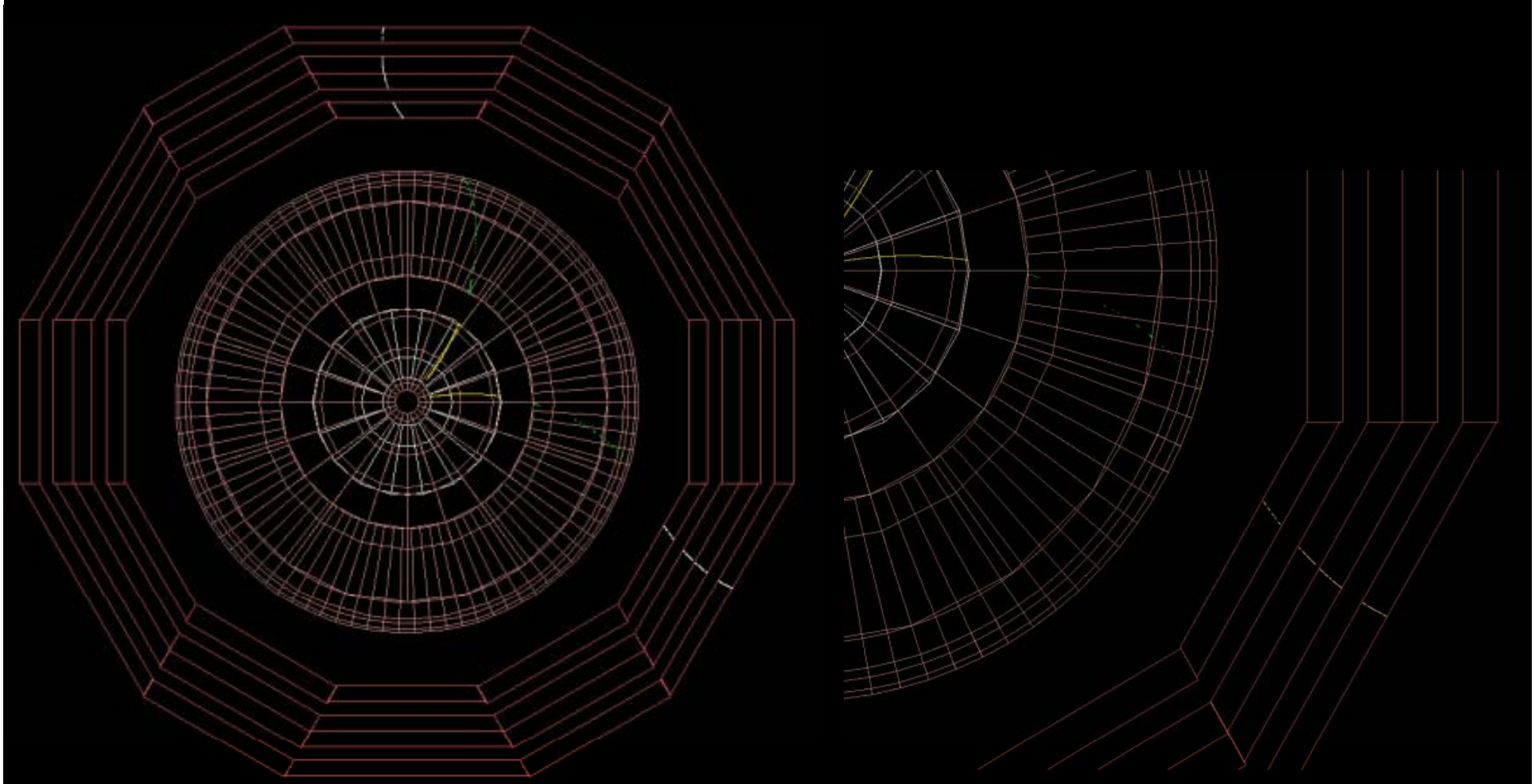
Magnetic field of dual solenoid and wall of coils



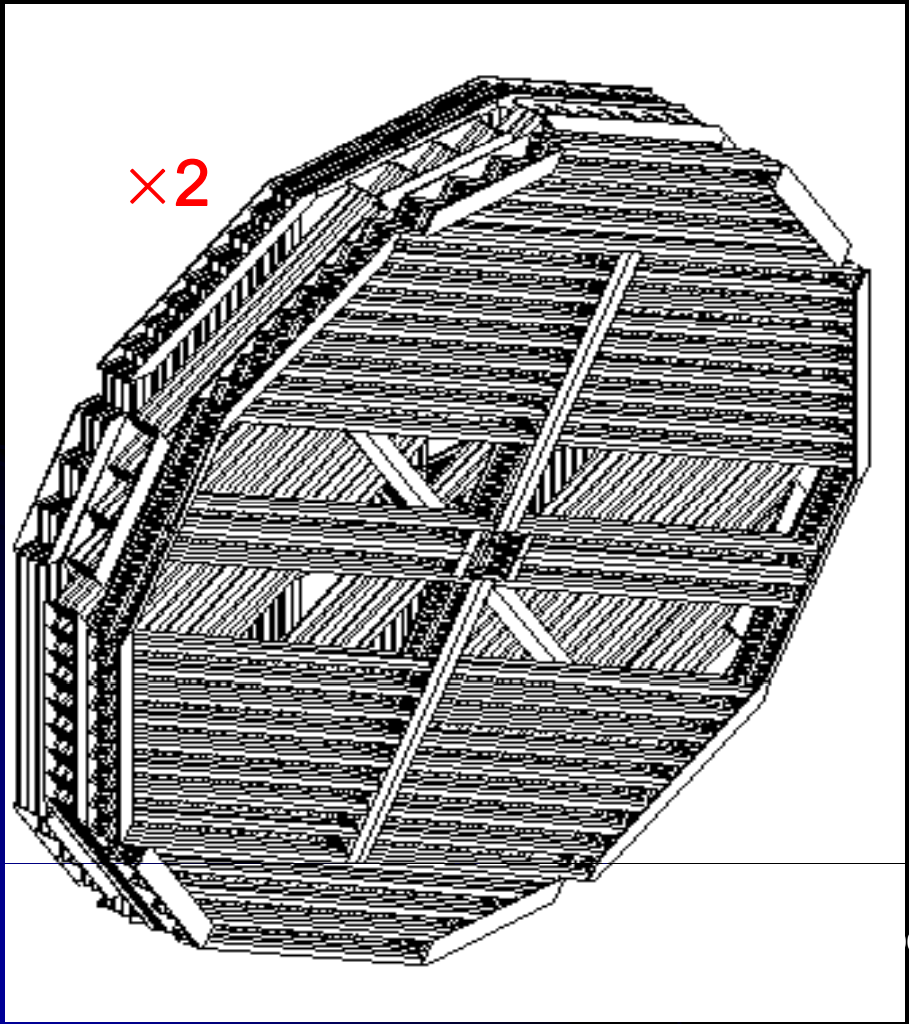


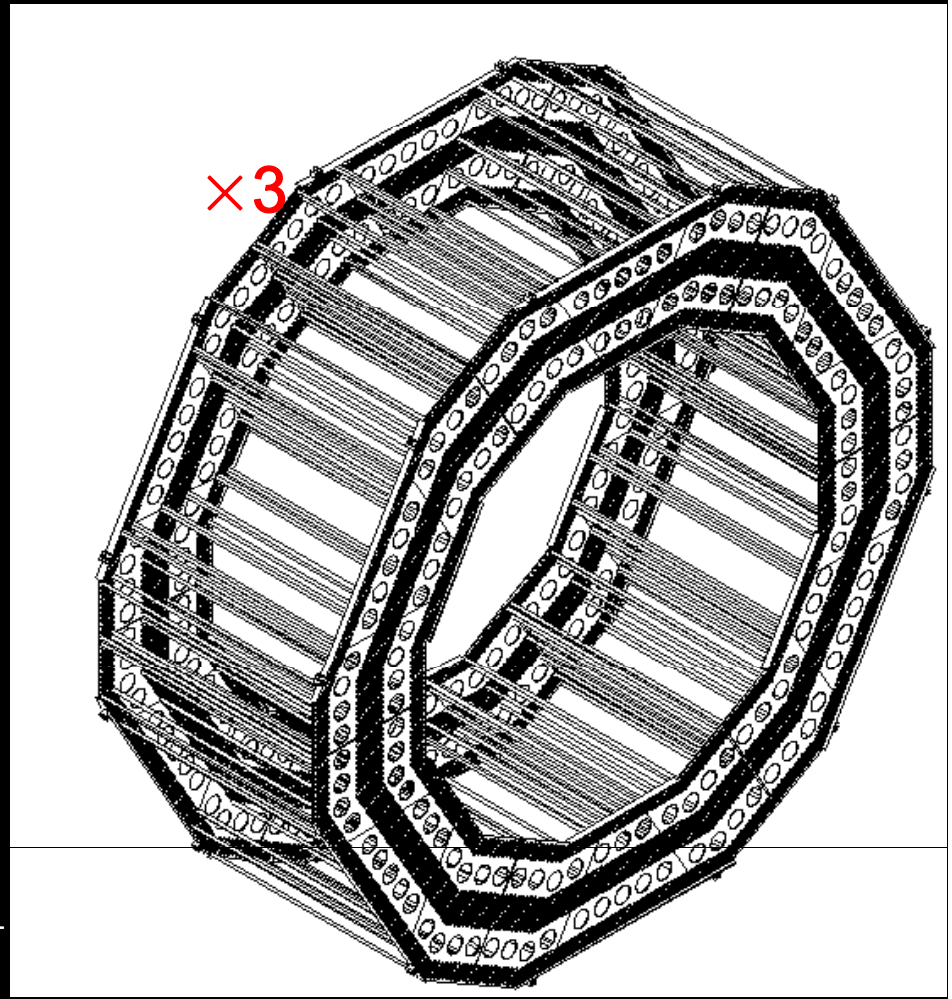


$\mu^+ \mu^-$ at 3.5 GeV/c

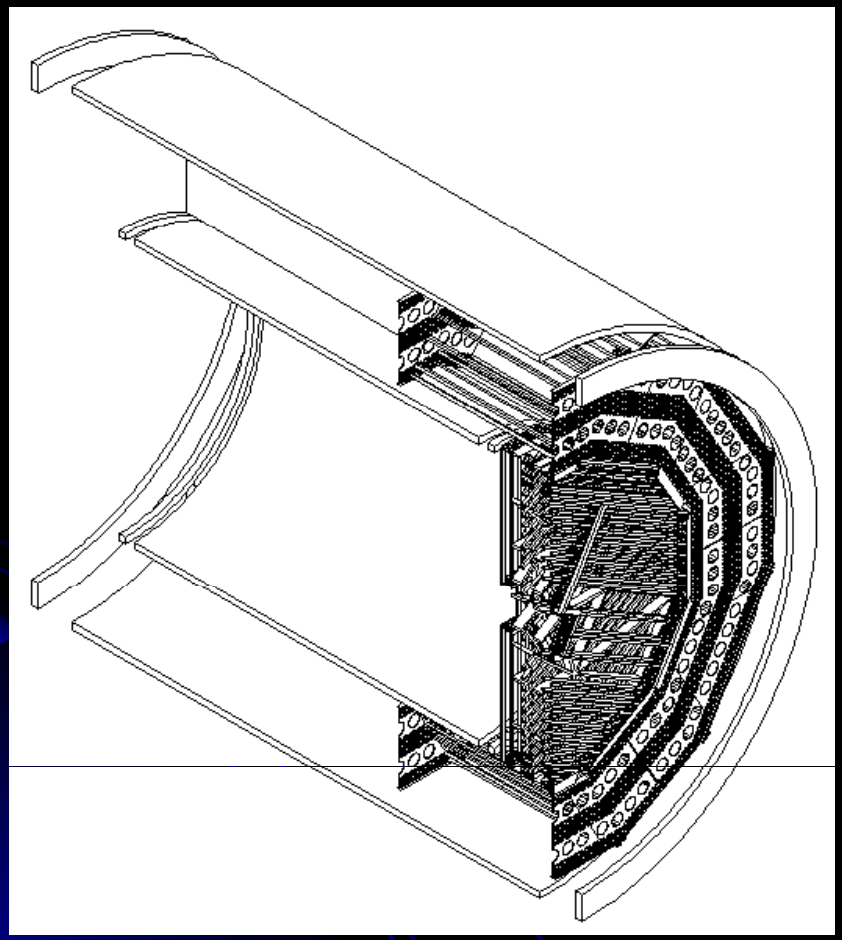


Muon Spectrometer





Channel Count



Barrel:

31500 tubes
21000 channels
840 cards

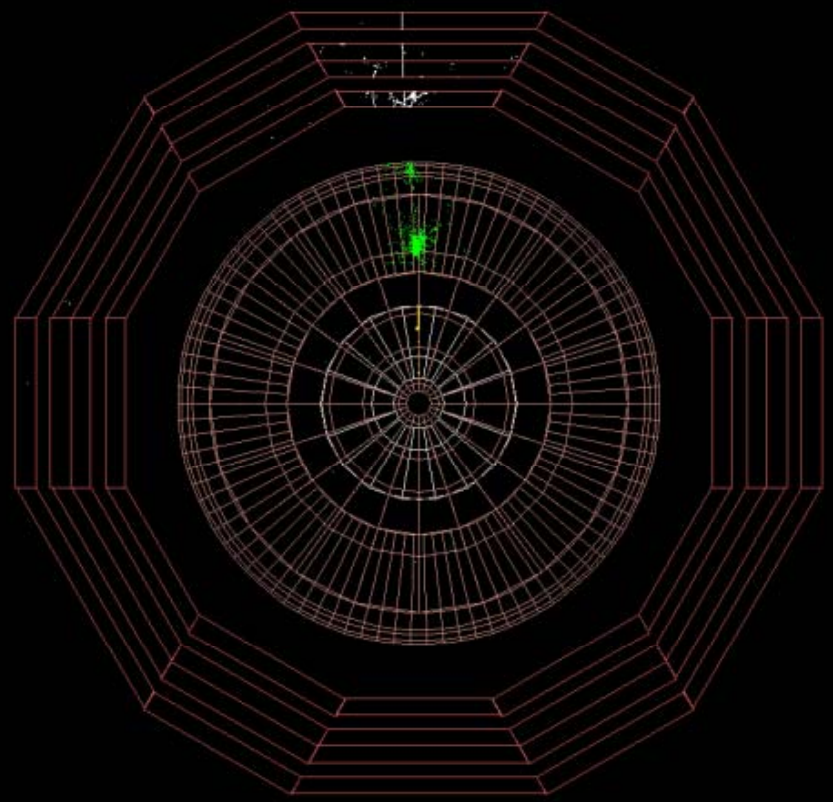
End caps:

8640 tubes
9792 channels
456 cards

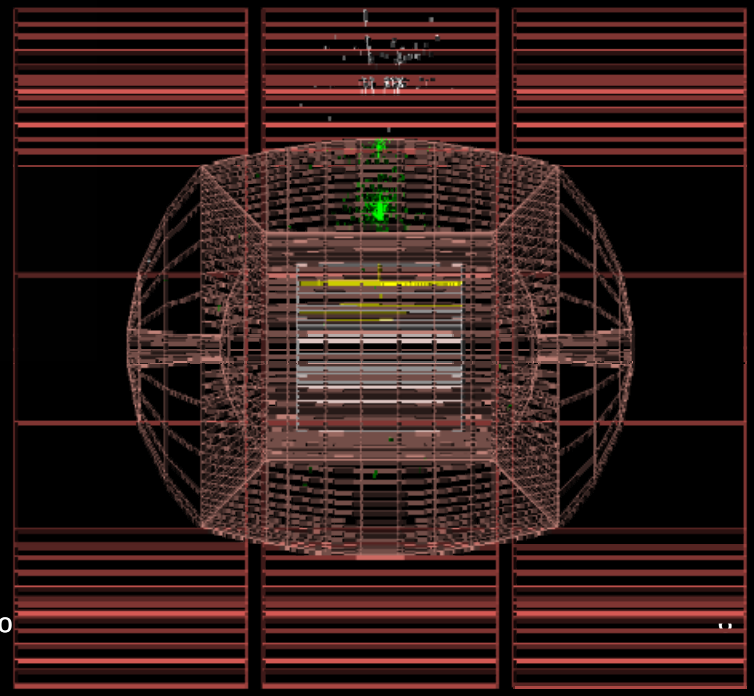
Total:

40140 tubes
30792 channels
1296 cards

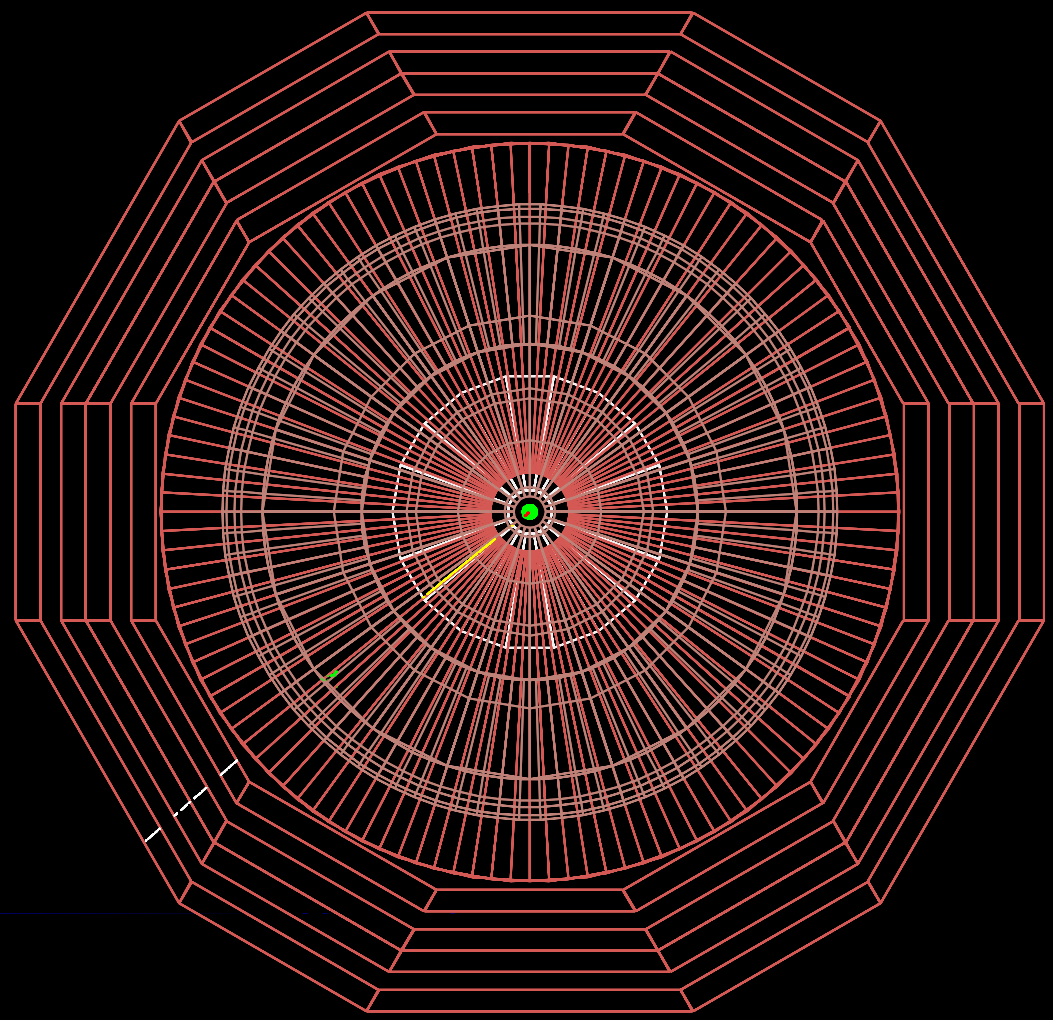
MUD for jet finding and tail catching



80 GeV jet with escaping particles



MUD in Calorimeter Calibration



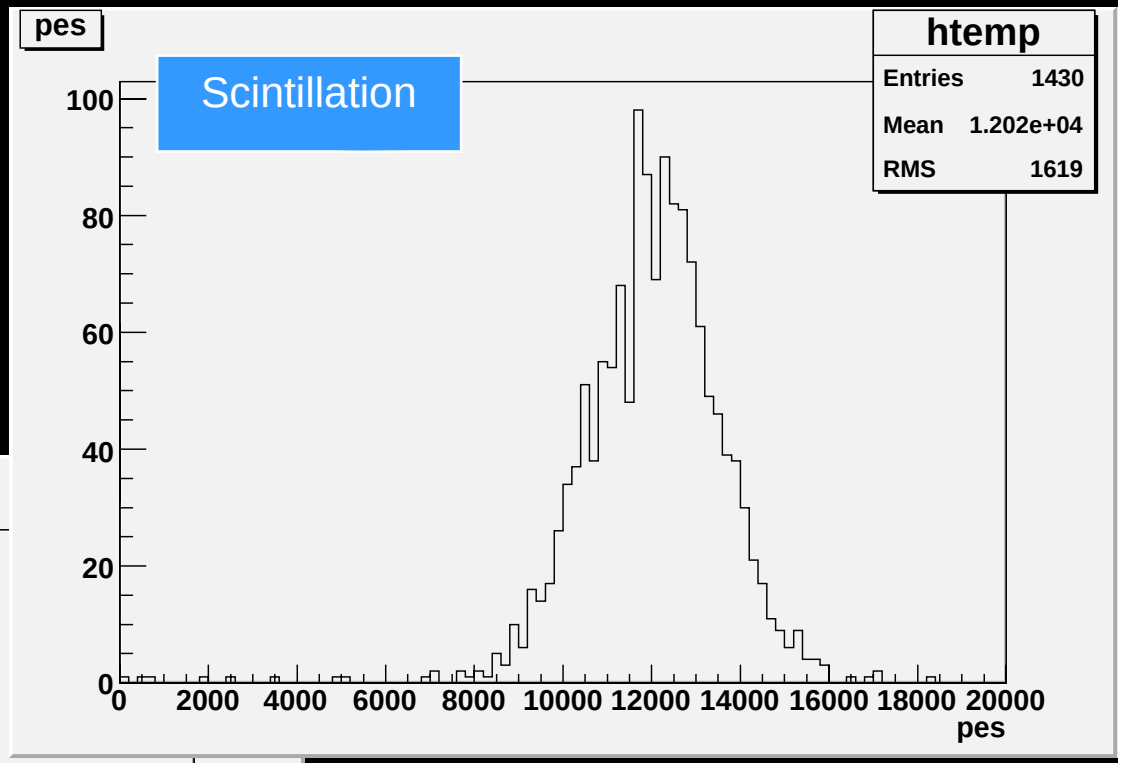
- P_{CT}=44.5 GeV
- P_{MUD}=38.0 GeV
- E_{γ}(truth)=8.0 GeV

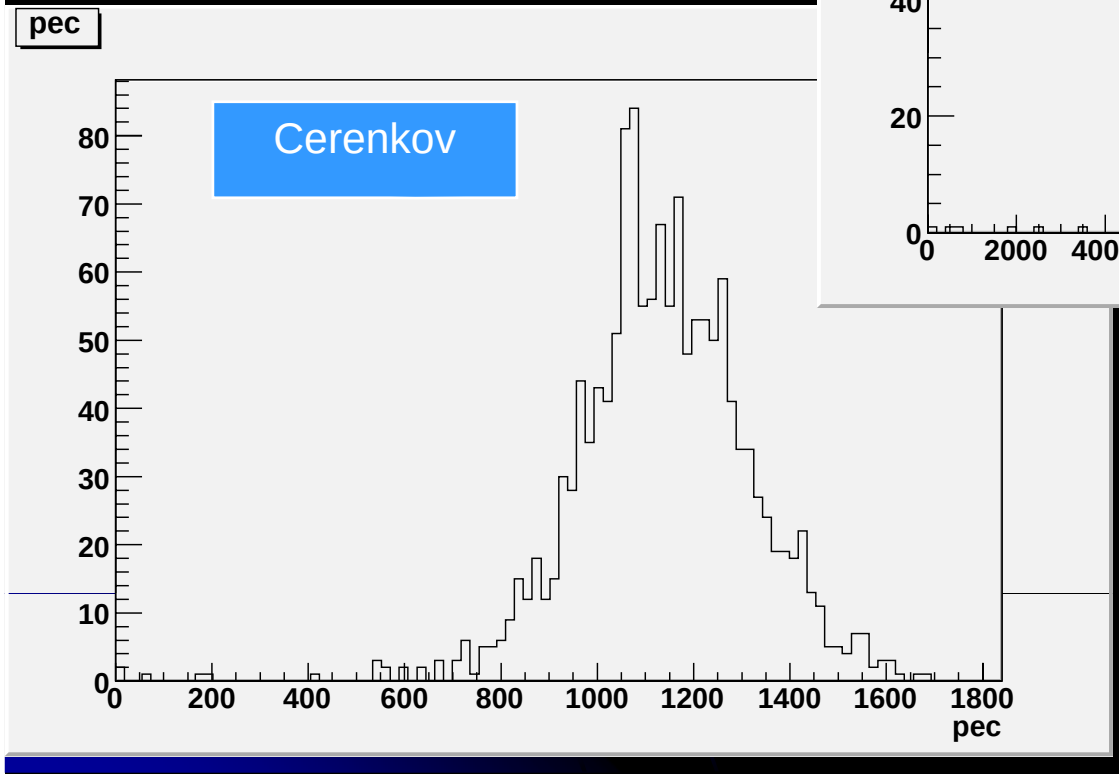
$\mu \rightarrow \mu\gamma$

Backup slides

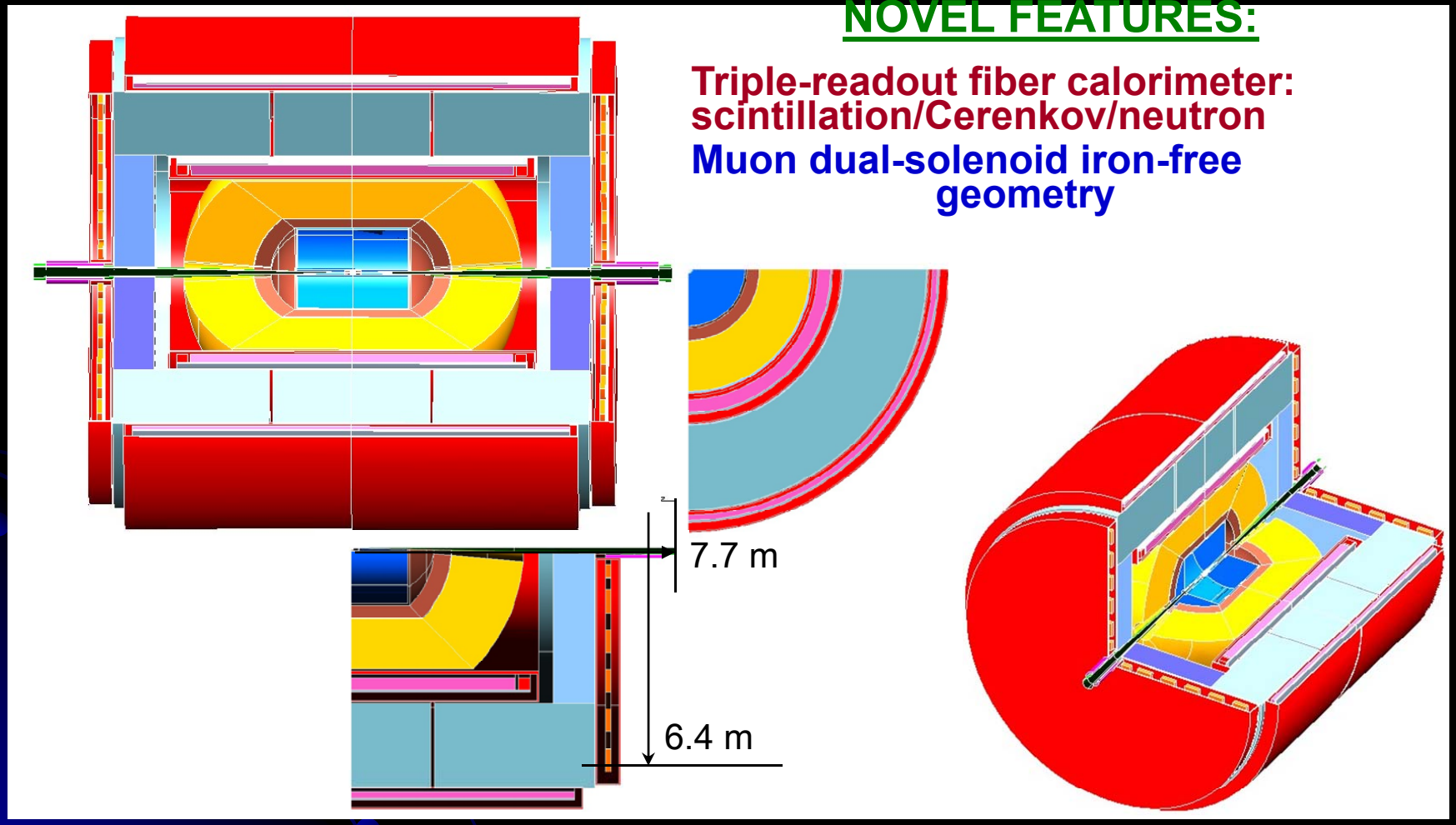
PE Distribution

- 40 GeV π^-

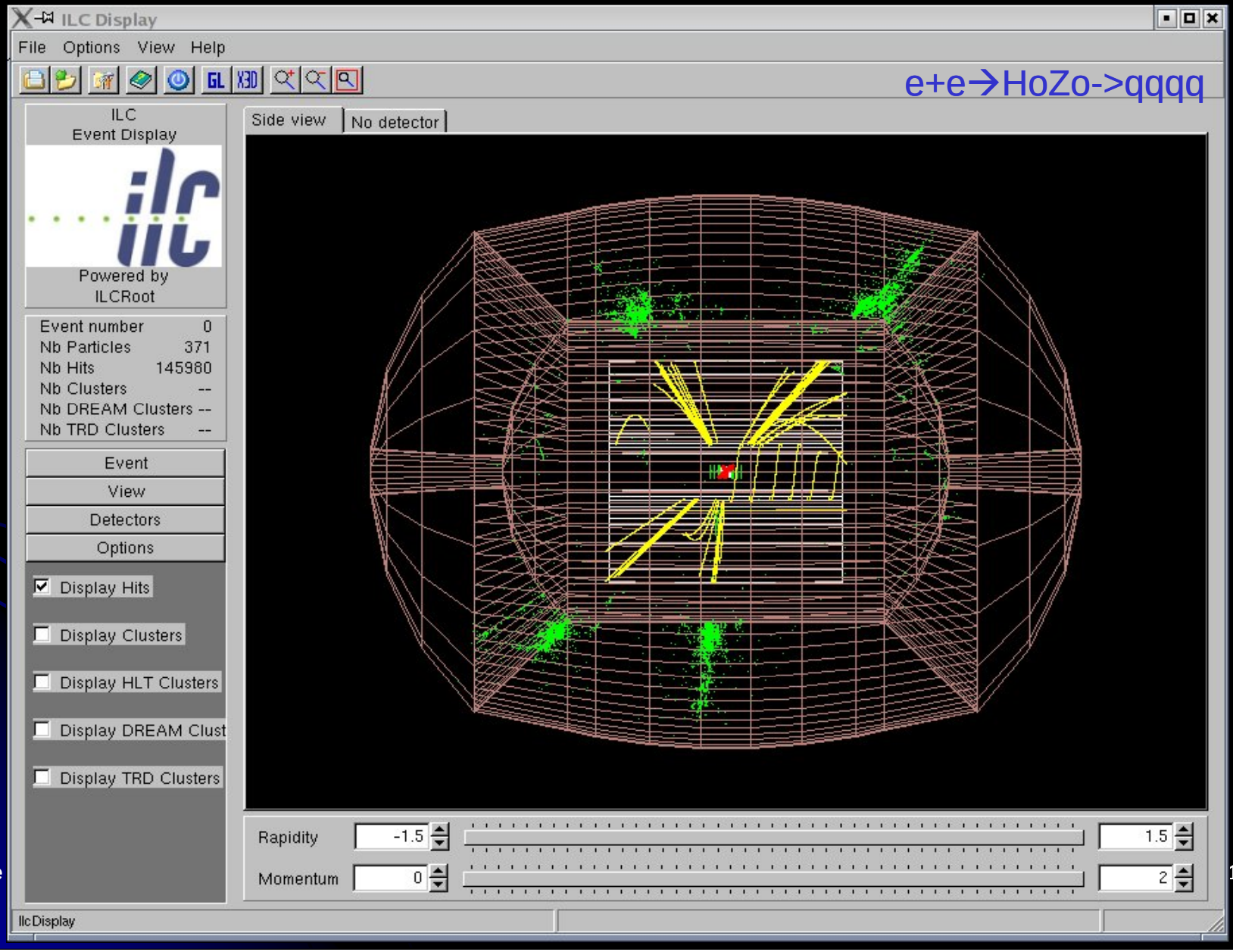




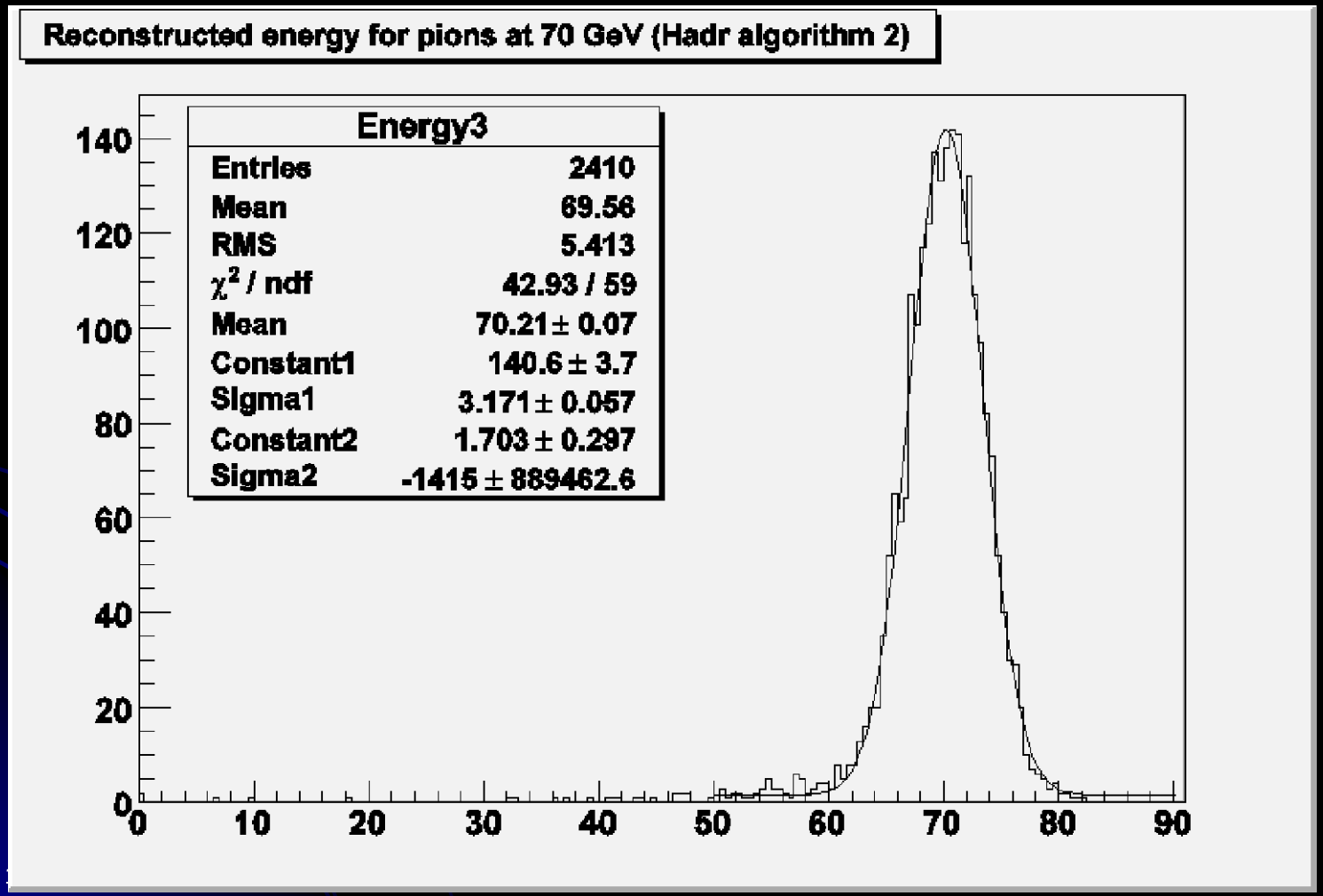
4th Concept Detector Layout



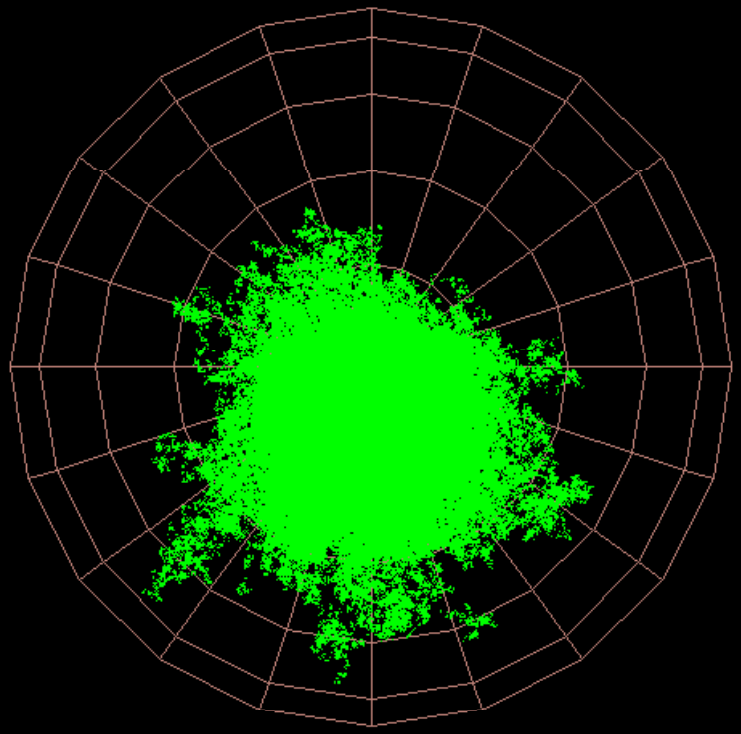
Present Status: VXD+TPC+DREAM



Dream Performance (pions)

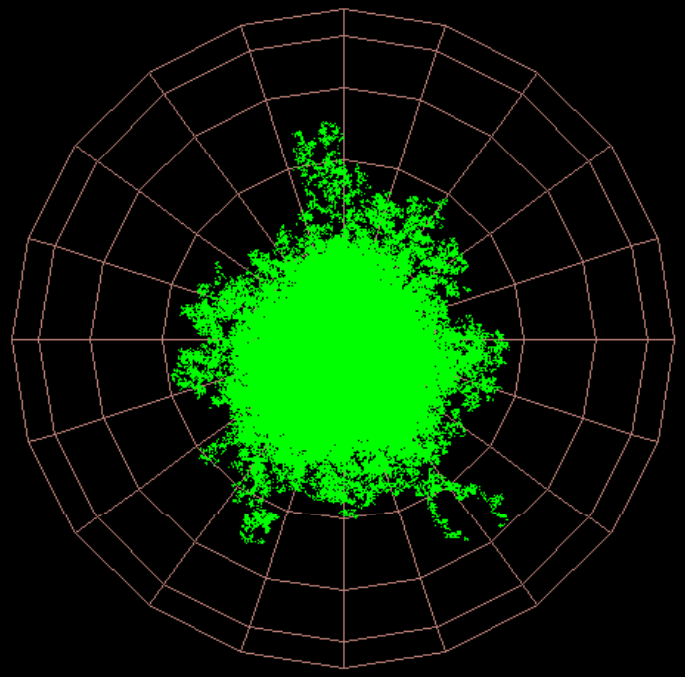


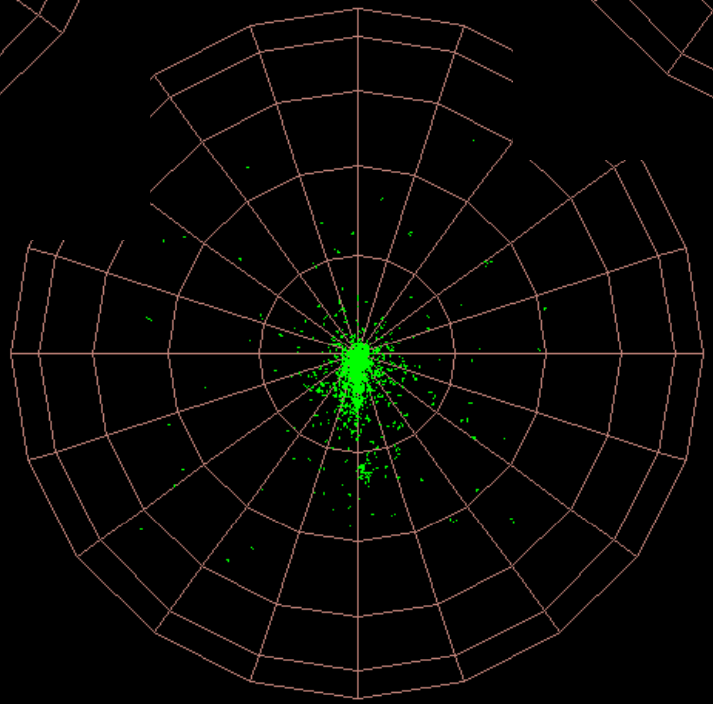
Fluka vs G3/G4



Fluka

Geant3





Geant4

π^- at 50 GeV in Pb Sphere of 500 cm Radius

m-System basic element: drift tube

radius 2.3 cm
filled with 90% He – 10% iC_4H_{10} @ NTP
gas gain few × 10^5
total drift time 2 μs
primary ionization 13 cluster/cm ⇒ ≈ 20 electrons/cm total
both ends instrumented with:

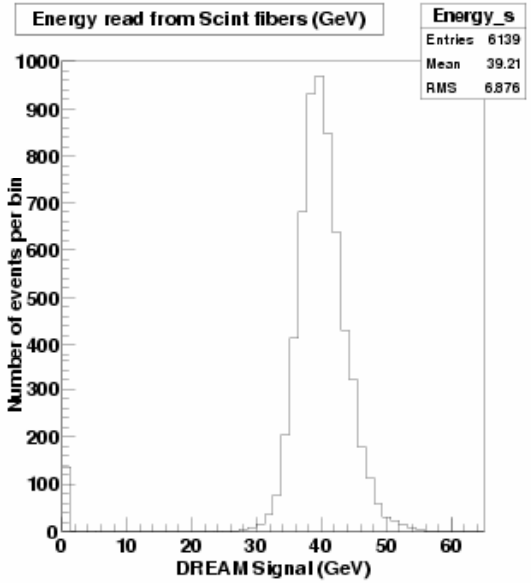
- > 1.5 GHz bandwith
- 8 bit fADC
- > 2 Gsa/s sampling rate
- free running memory

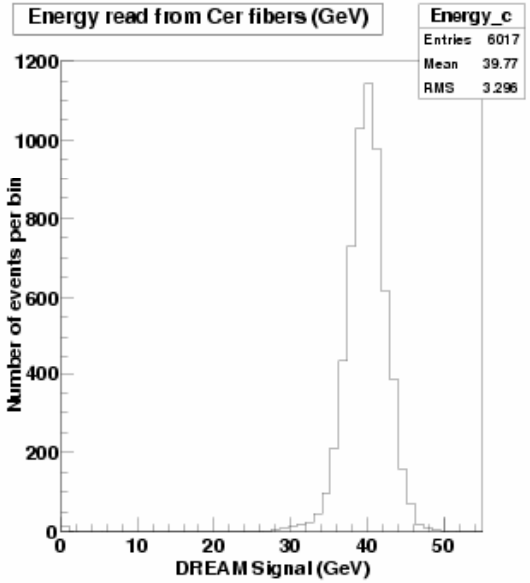
ASIC chip under development at INFN-LE

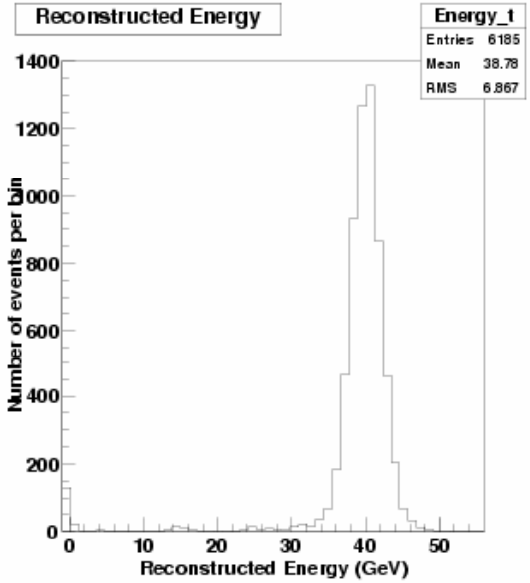
for a

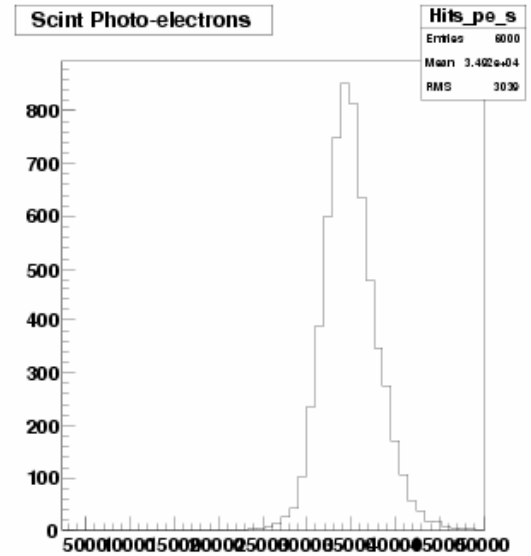
- fully efficient timing of primary ionization: **cluster counting**
- accurate measurement of longitudinal position with **charge division**
- particle identification with **dN_{cl}/dx**

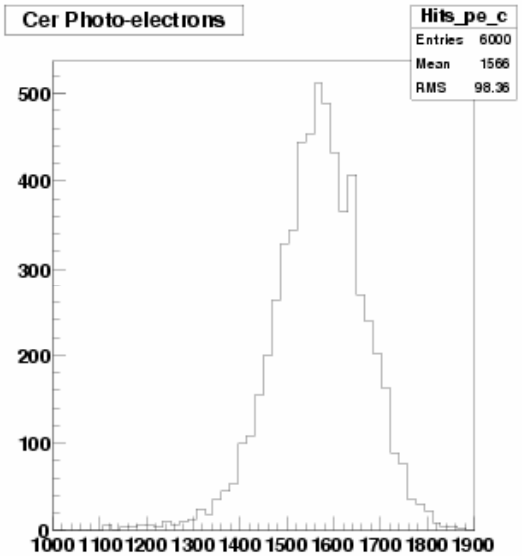
Histos electrons at 40 GeV in Cu

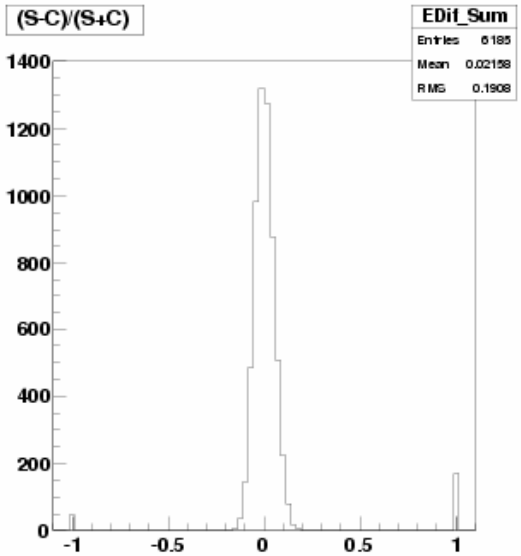




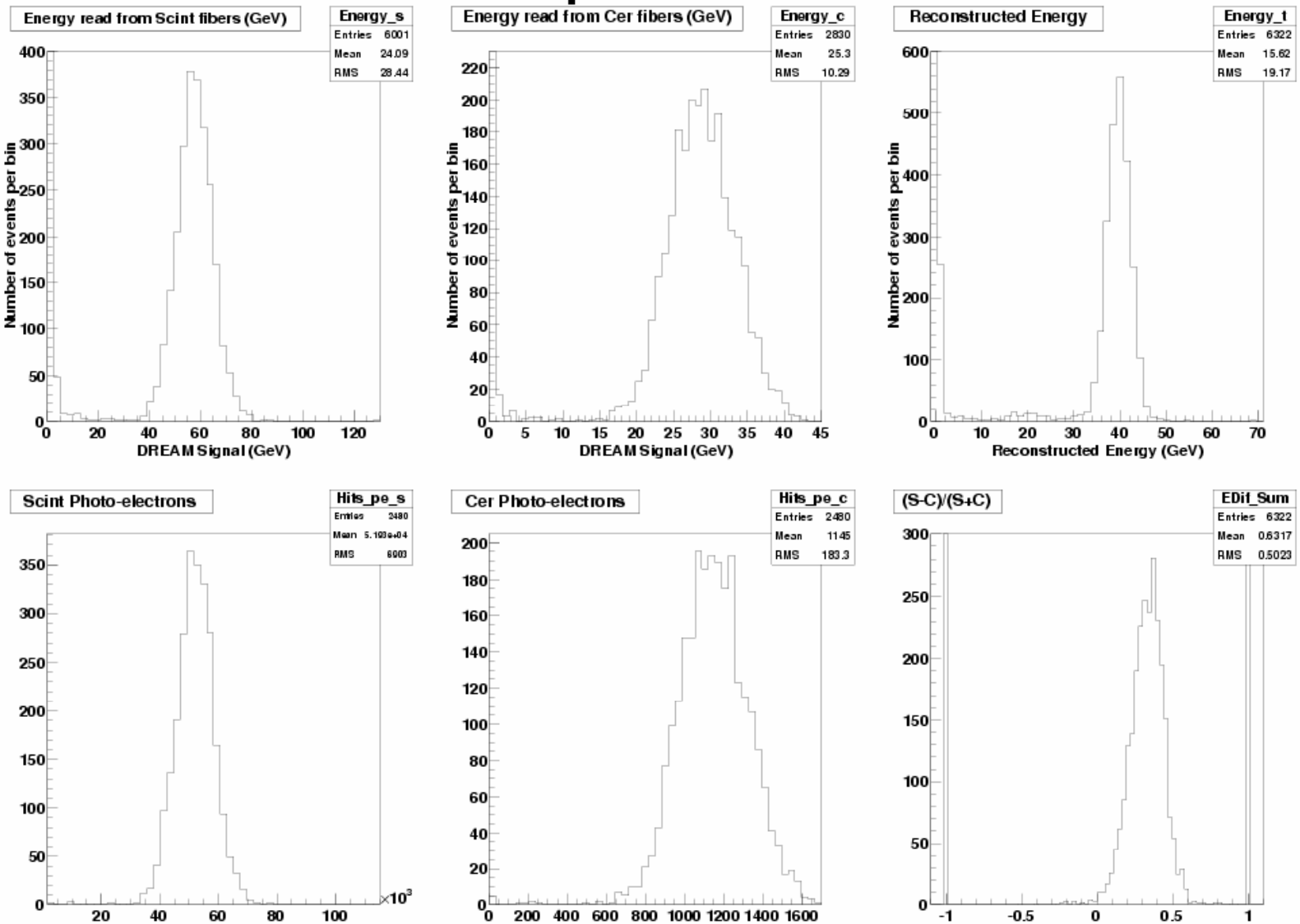




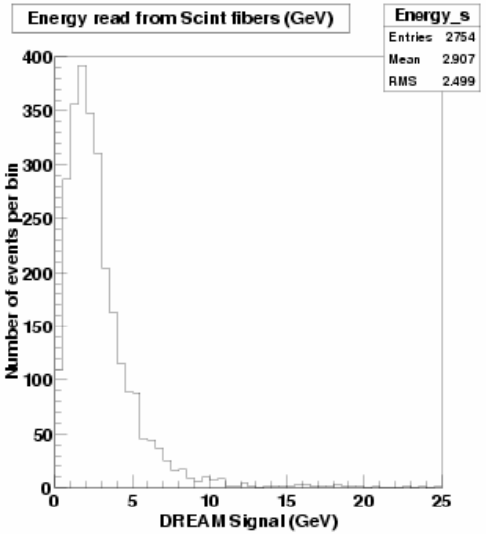


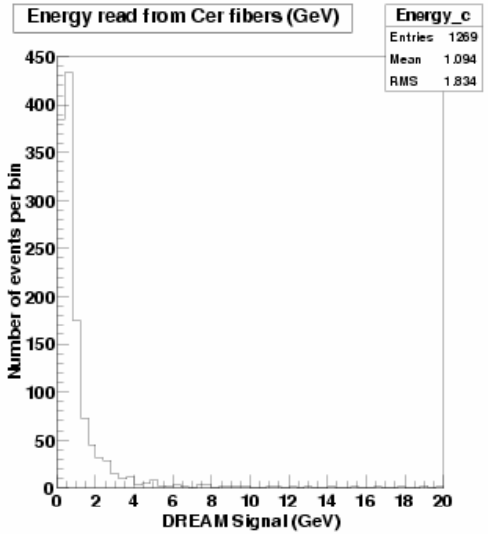


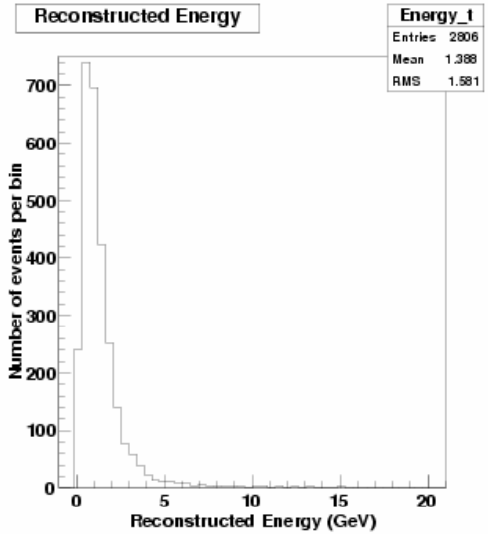
Histos pions at 40 GeV in Cu

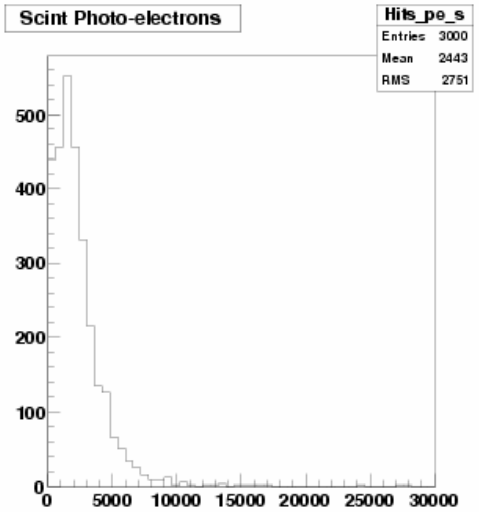


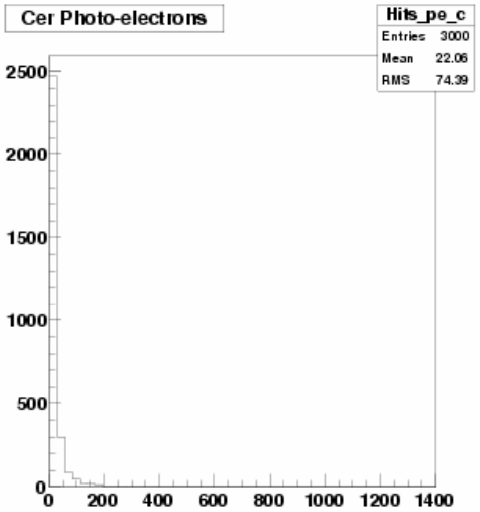
Histos muons at 100 GeV in Cu

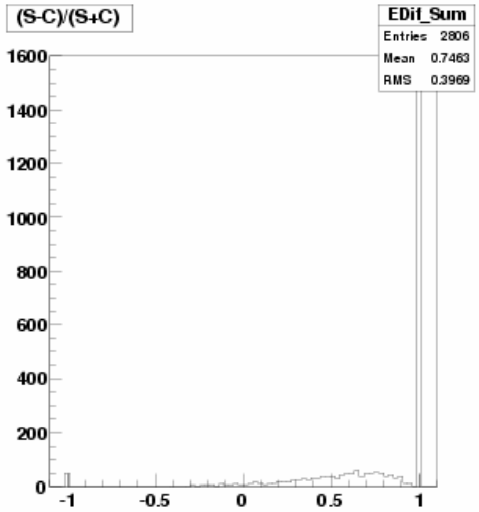


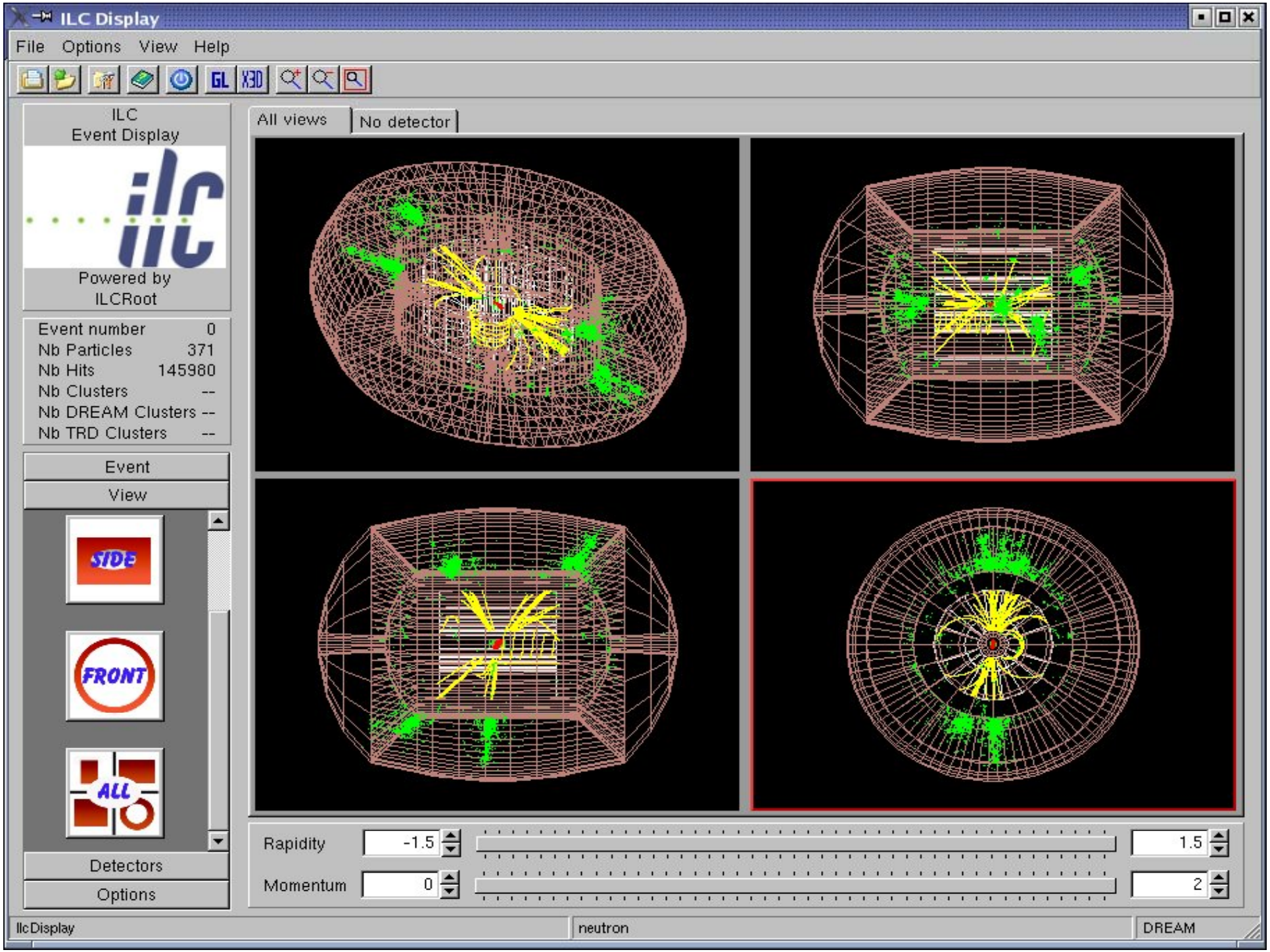




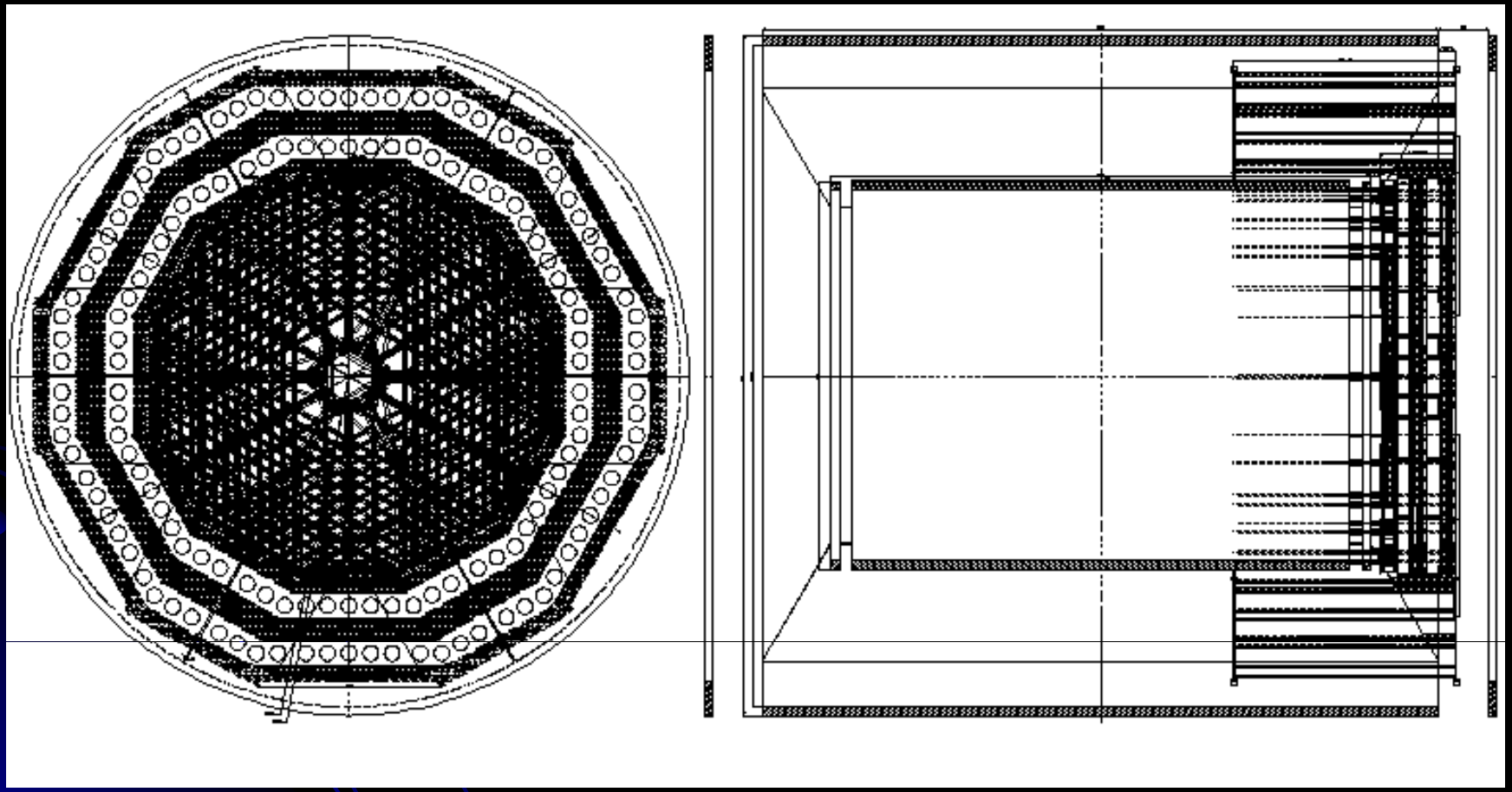




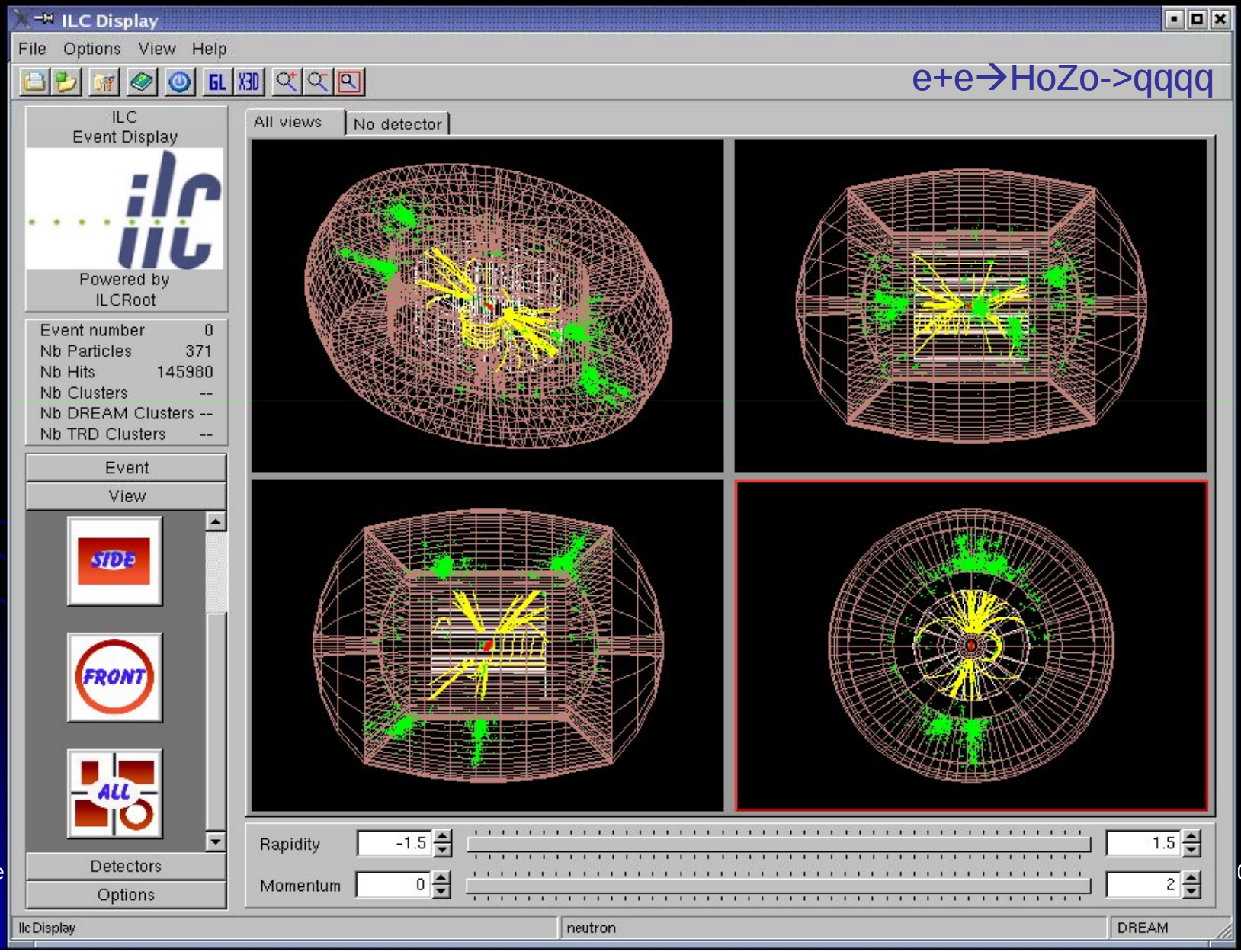



ILC Display
File Options View Help
ILC
Event Display
Powered by
ILCRoot
Event number 0
Nb Particles 371
Nb Hits 145980
Nb Clusters --
Nb DREAM Clusters --
Nb TRD Clusters --
Event
View
SIDE
FRONT
ALL
Detectors
Options
All views
No detector
Rapidity -1.5 1.5
Momentum 0 2
IlcDisplay
neutron
DREAM

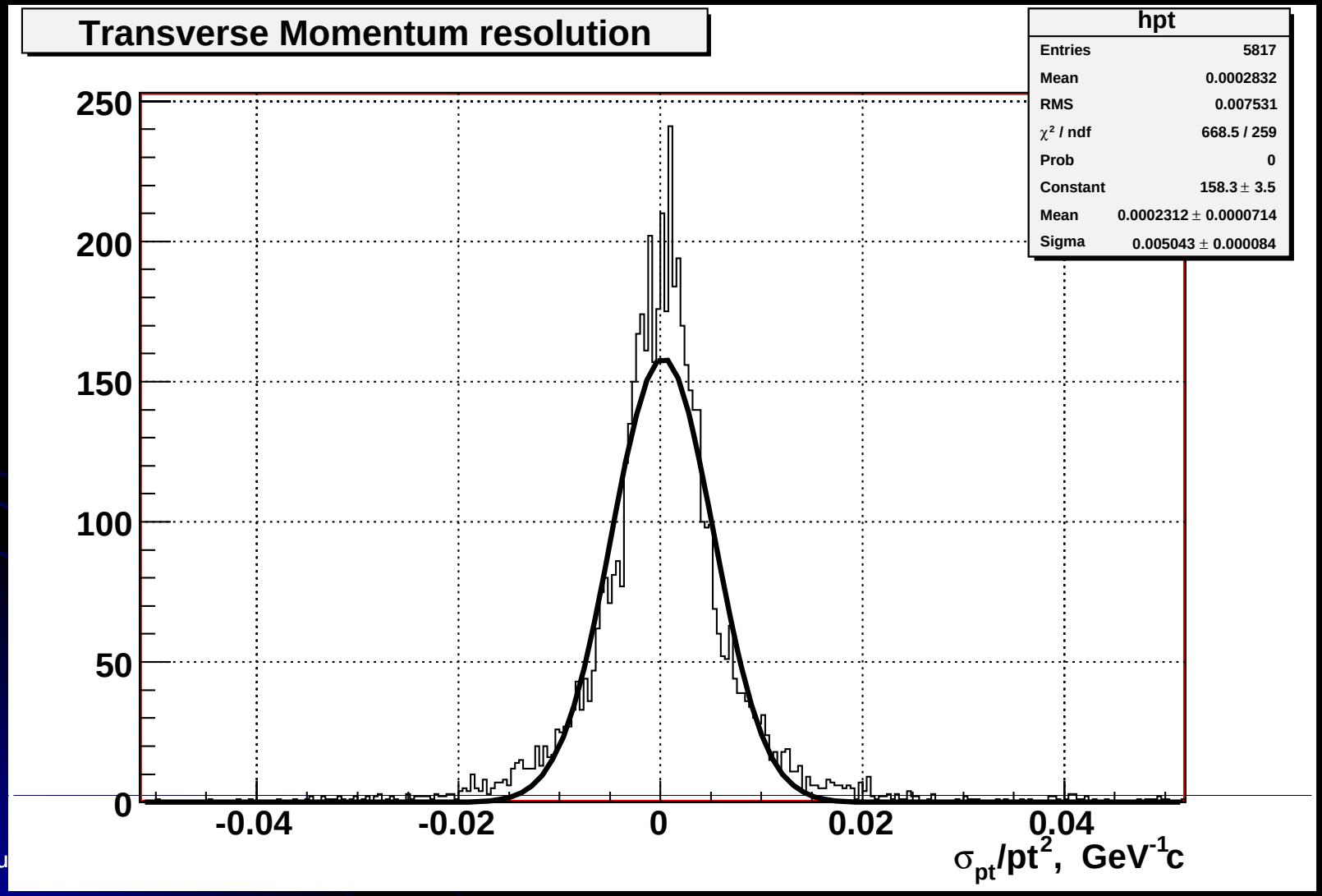
Full Spectrometer



Present Status: VXD+TPC+DREAM



P_t Resolution (0.3-20 GeV)



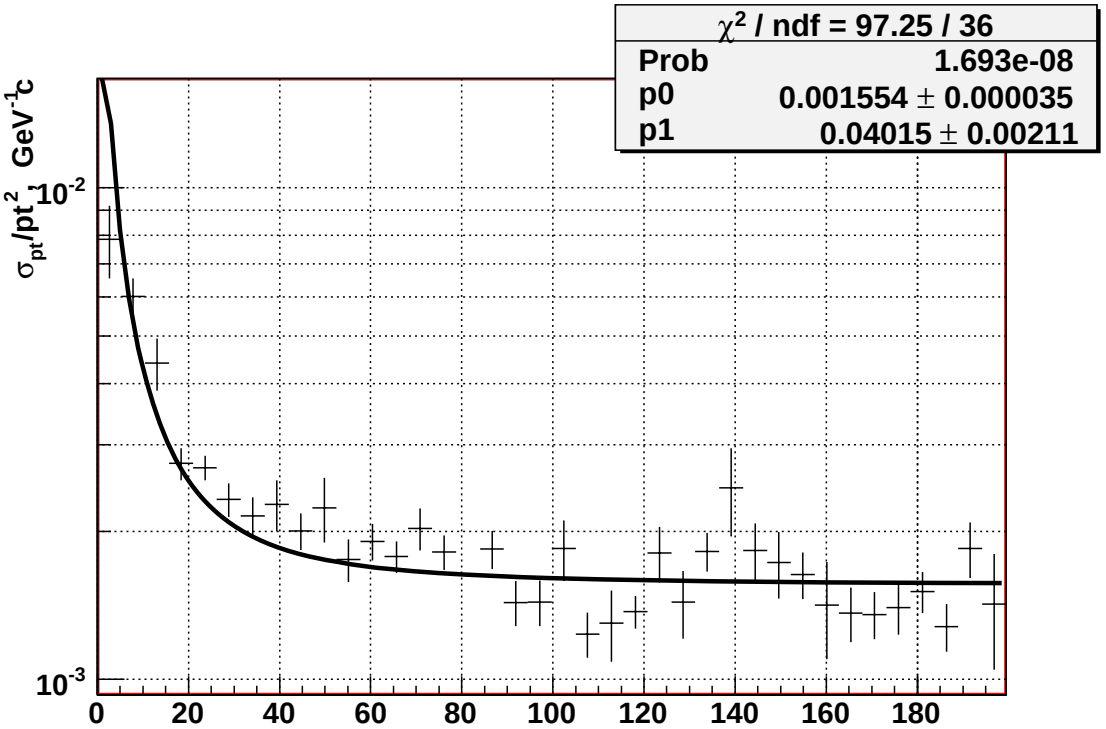
Tracking Algorithm

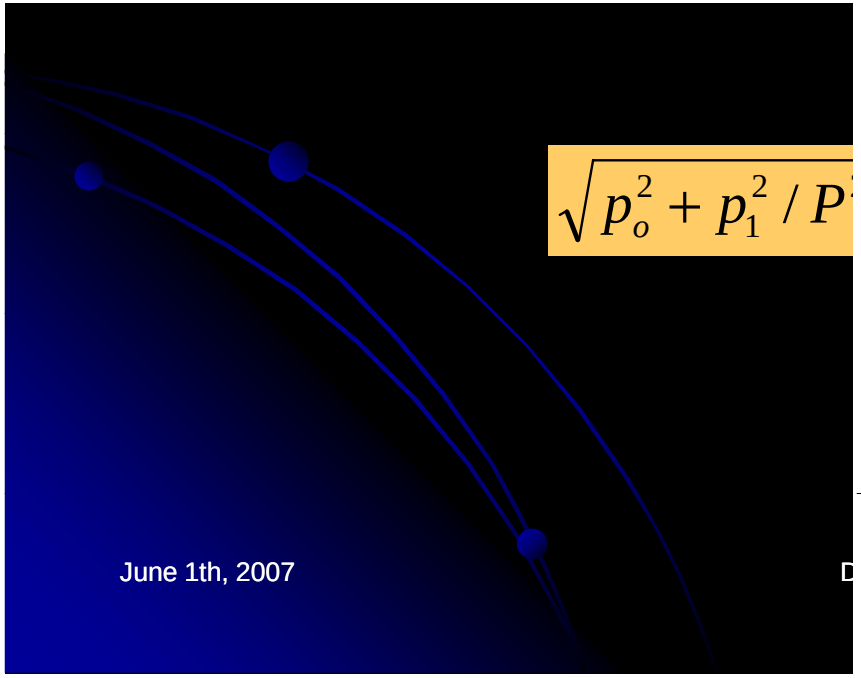
- Primary TPC seeding: looks for tracks with 20 hits (pads and/or μmegas) apart + beam constraint
- Secondary TPC seeding: looks for tracks with hits in layer 1, 4 and 7 (no beam constraint)
- **Parallel Kalman Filter** then initiated:
  - 1st step: start from TPC fit + prolongation to VXD (add clusters there)
  - 2st step: start from VXD, refit trough TPC + prolongation to MUD
  - 3st step: start from MUD and refit inword with TPC + VXD
- Final step: isolated tracks in VXD and in MUD
- Kinks and V0 fitted during the Kalman filtering
- All passive materials taken into account for MS and dEdx corrections

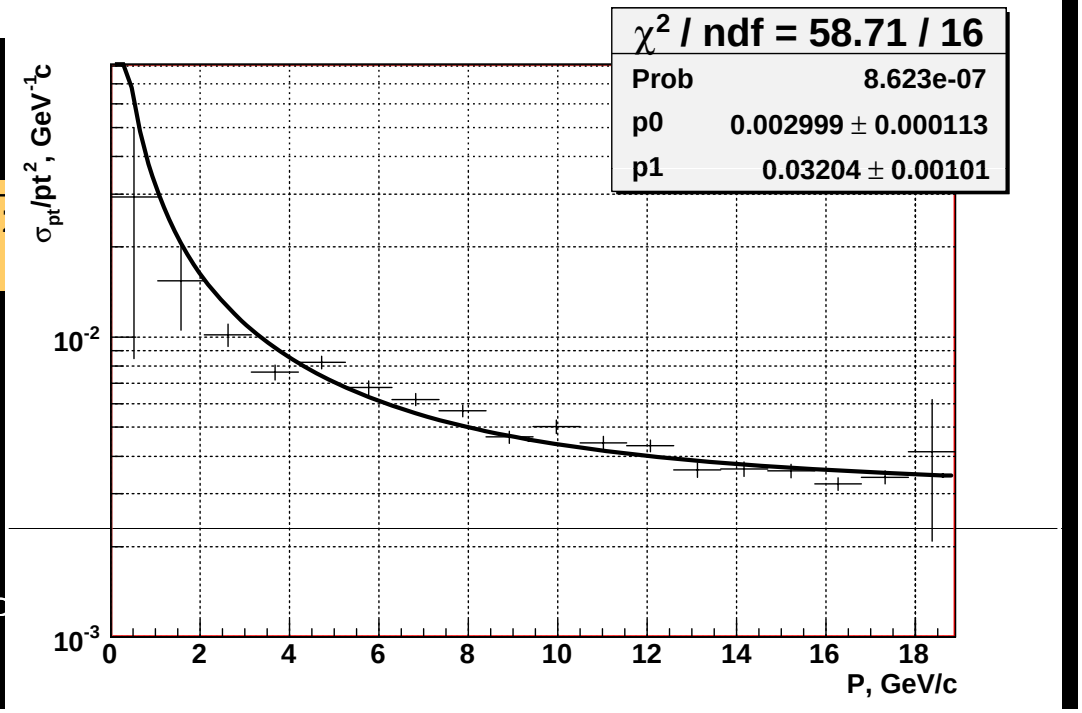
MUD Simulation

- Individual Drift Tubes, no support, electronics, services
- Gaussian smearing of hits (200μm x 4mm) to make Fastrecpoints (no Cluster Counting yet)
- Pattern recognition through Parallel Kalman Filter
- Standalone Tracker not yet implemented

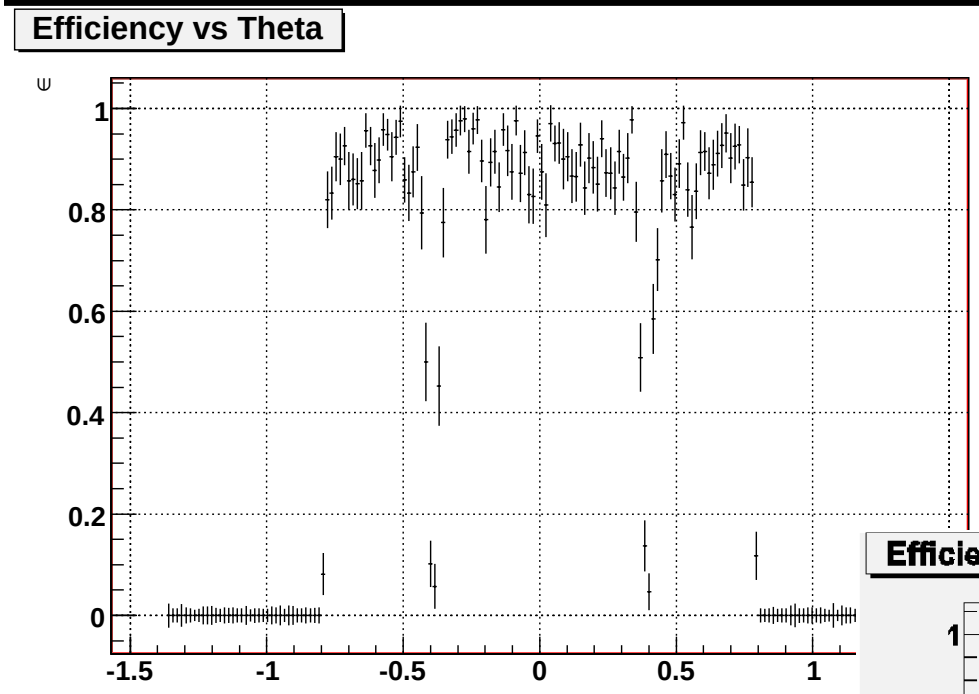
P_t Resolution



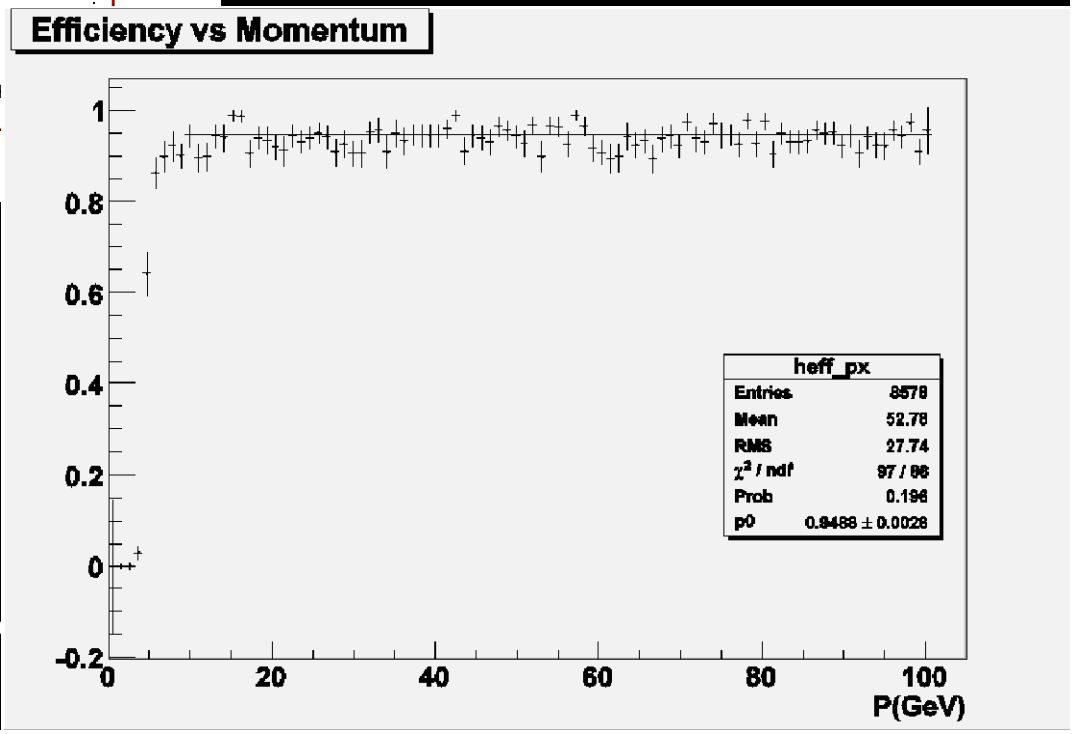




Efficiency (Barrel Only)



- P>20 GeV
- Tracks already reconstructed in TPC



June 1th, 2007

- P>4 GeV
- Cracks excluded
- Tracks already reconstructed in TPC

D

MUD Performance

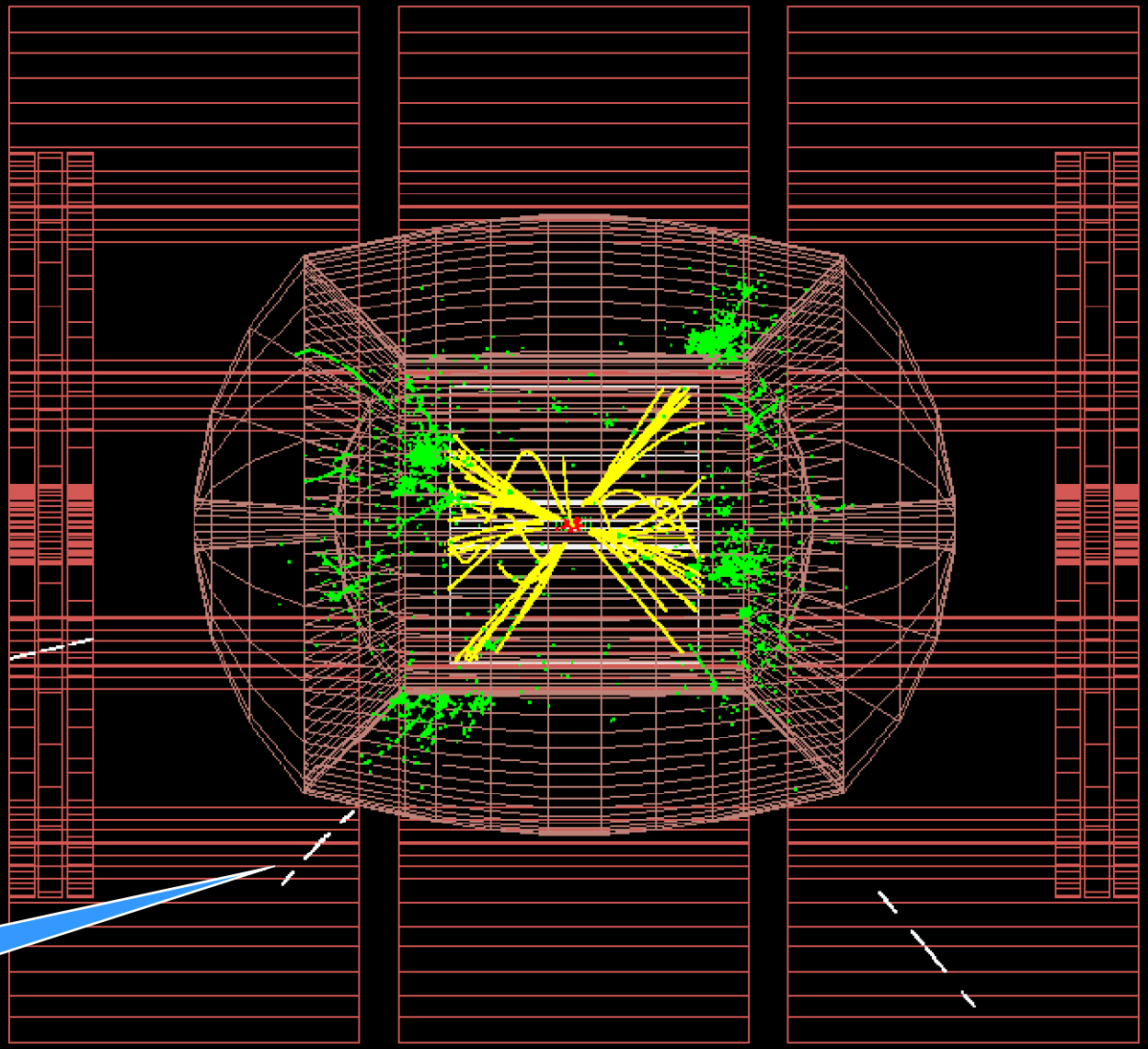
- Tracking is working for:
  - $P_t > 400$ MeV
  - $|\theta| > 45^\circ$ (barrel only)
- High momentum tracks resolution:
  - $\sigma(1/p_t) = 1.6 \times 10^{-3}$

Very conservative single point resolution used

- Efficiency (P_t>6 GeV) = 95%

Finding muons in the midst of jets

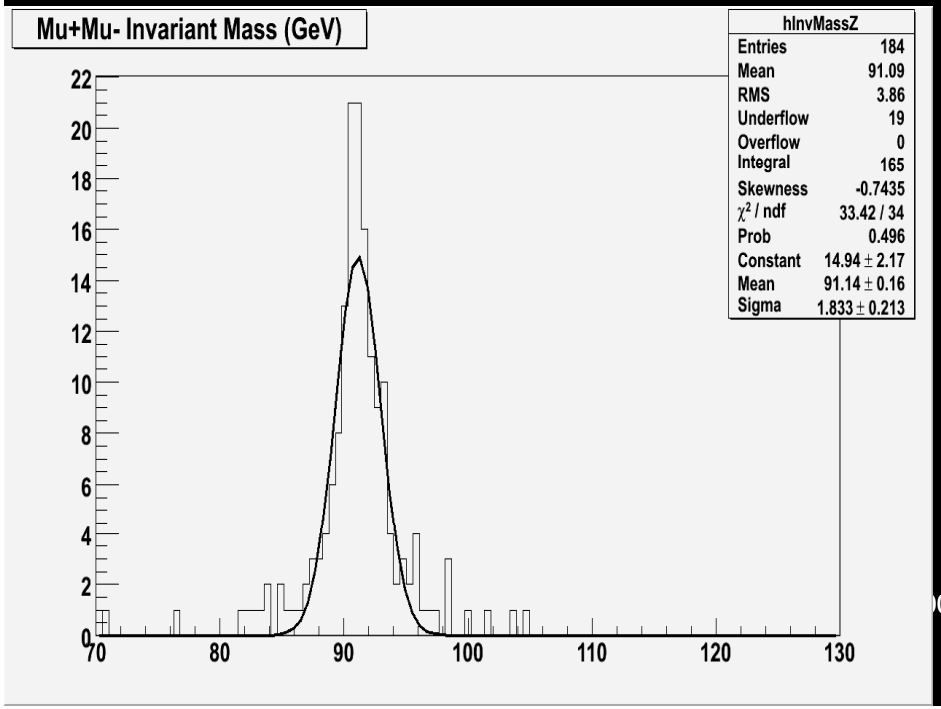
$e^+e^- \rightarrow H^oH^oZ^o$ –> 4 jets 2 muons

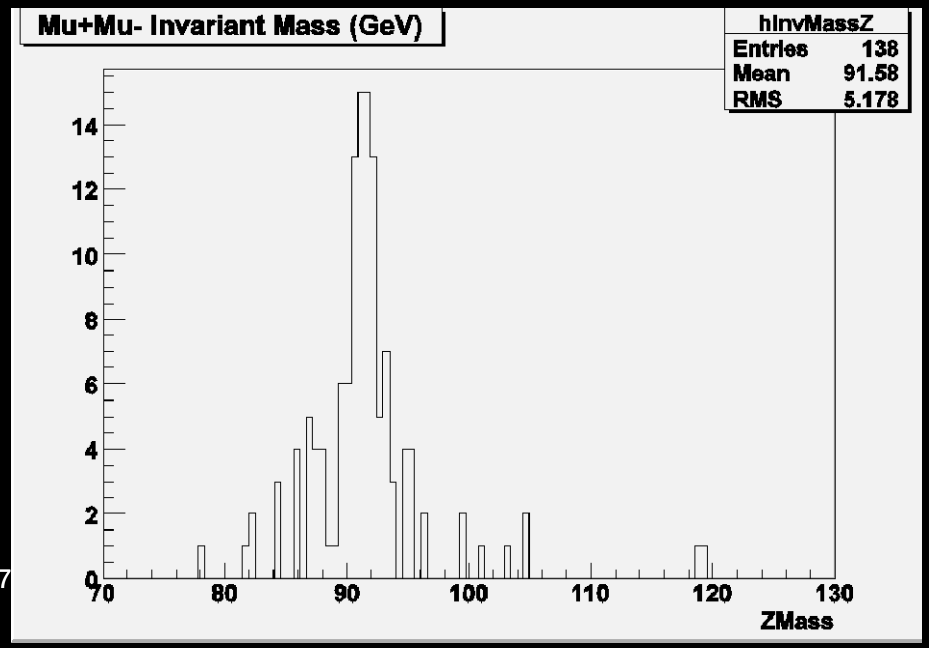


Low pt secondary muon

$e^+e^- \to H^oH^oZ^o \to$ 4 jets 2 muons

- E_{cm} = 500 GeV
- Efficiency (total) = 92%





Conclusions

- Performance of Hadron Calorimeter is good (including pattern recognition) and **INDEPENDENT OF ENERGY**:

  $\sigma_E/E = 34\%/\sqrt{E}$ (single hadrons)

  $\sigma_E/E = 40\%/\sqrt{E}$ (jets – total energy)

- Expected to improve with jet finding (recovery of soft tracks and lost muons)
- Detector optimization not yet started (Cu vs Pb, fibers fraction)
- New Dual Readout EMCAL implemented

  $\sigma_E/E = 5\%/\sqrt{E}$ (very preliminary)

- $\gamma\gamma$ separation from τ decay is very good
- Performance studies under way
- Very high efficiency of muon finding in the midst of 4 jets (Muon Spectrometer)