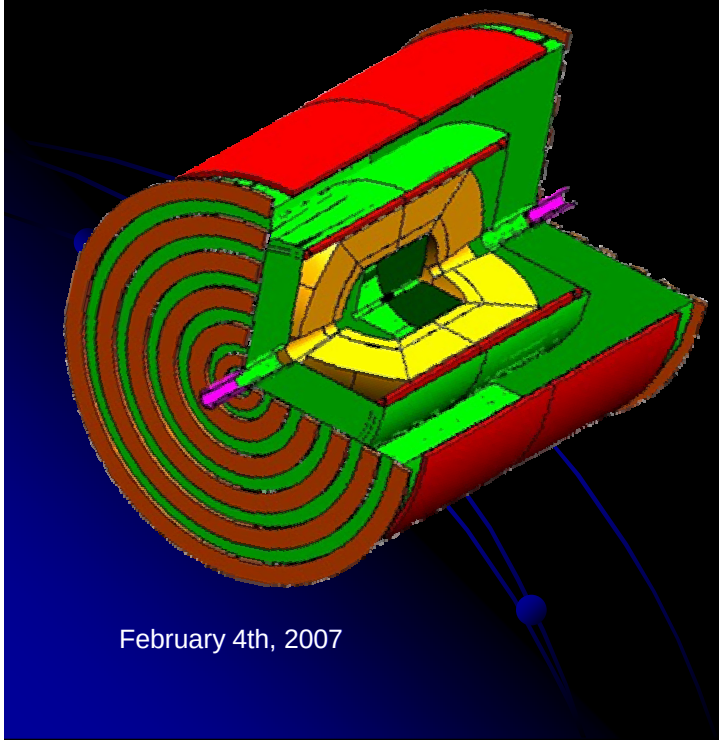
Performance of the 4th Concept Muon Spectrometer



On behalf of 4th Concept Software Group

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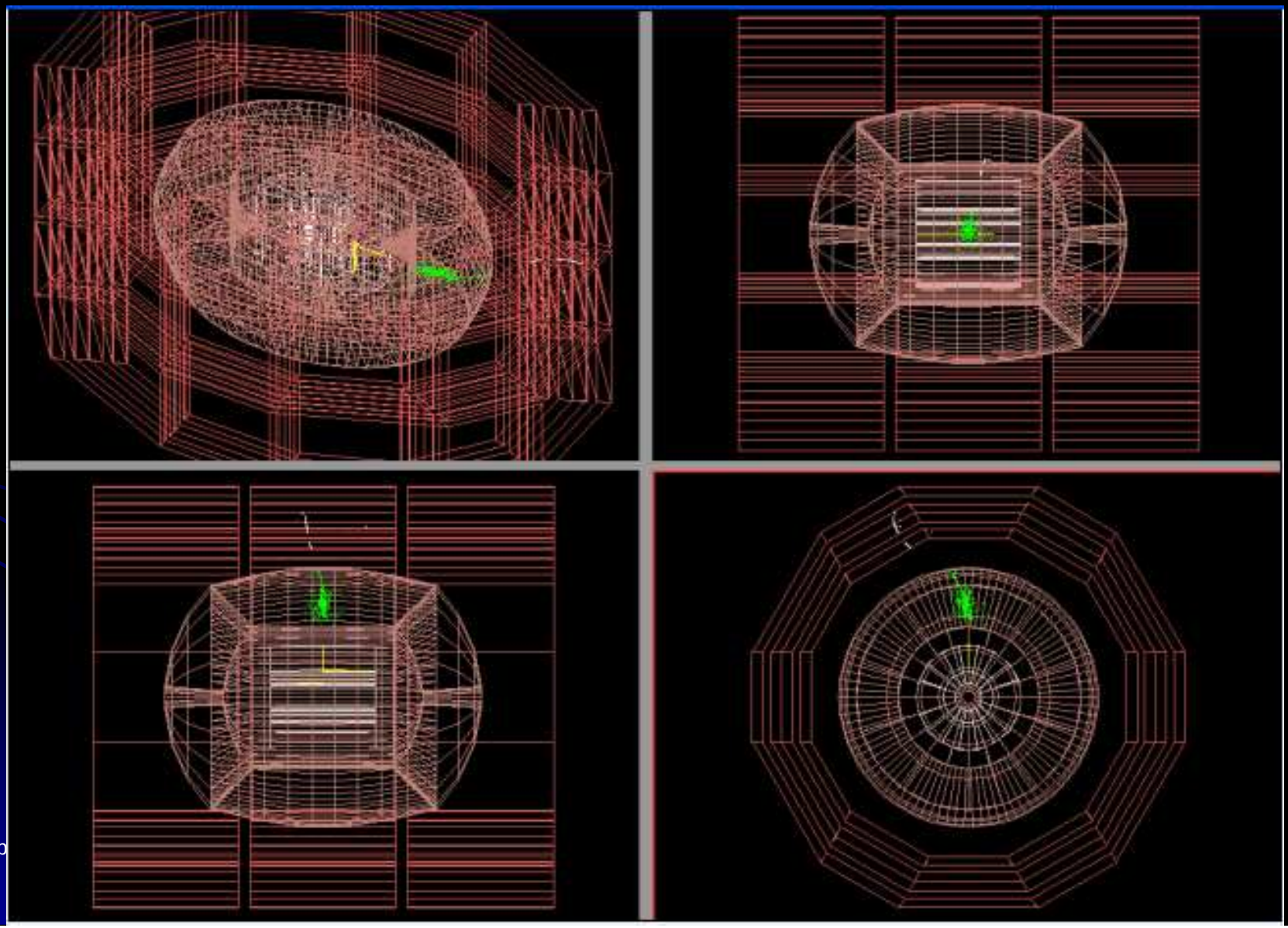
G. Terracciano

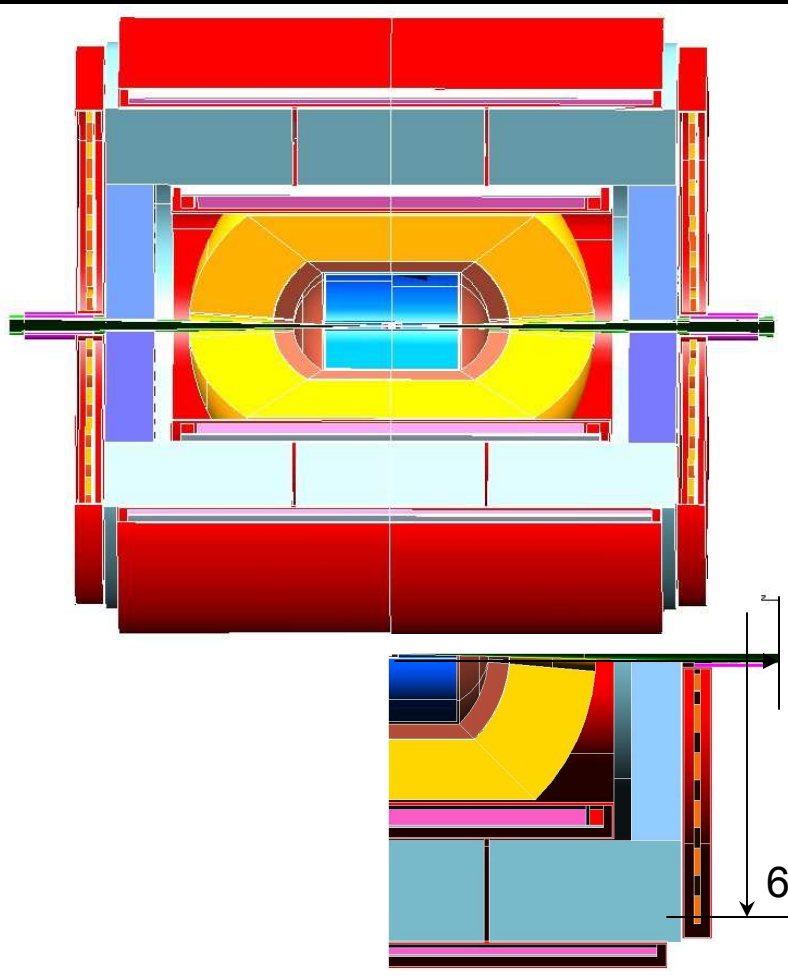
4th Concept Software and Simulations

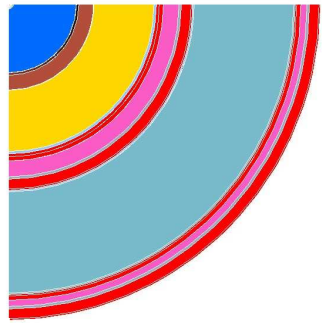
- The 4th Concept has completed the **full simulation** study to test the performance of the baseline configuration
- A 56 pages document is available on : http://4thconcept.org
- The studies have been carried within ILCroot framework
- The event generators (for tracking studies) used:
  - Pandora-Pythia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

The Baseline Detector



4th Concept Detector Layout

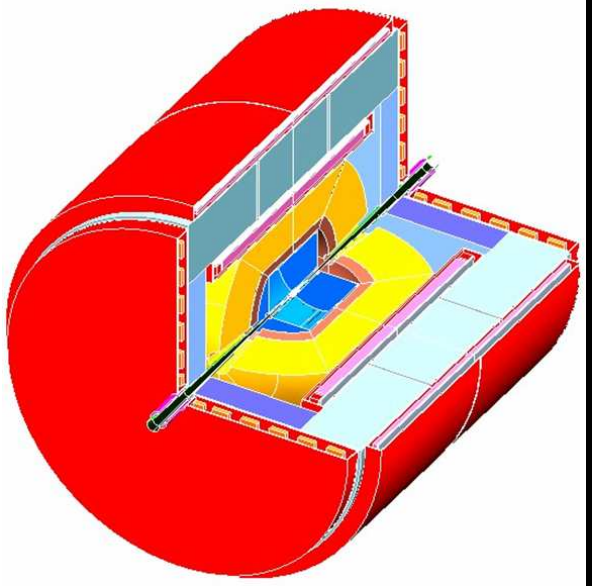




NOVEL FEATURES:

Triple-readout fiber calorimeter: scintillation/Cerenkov/neutron

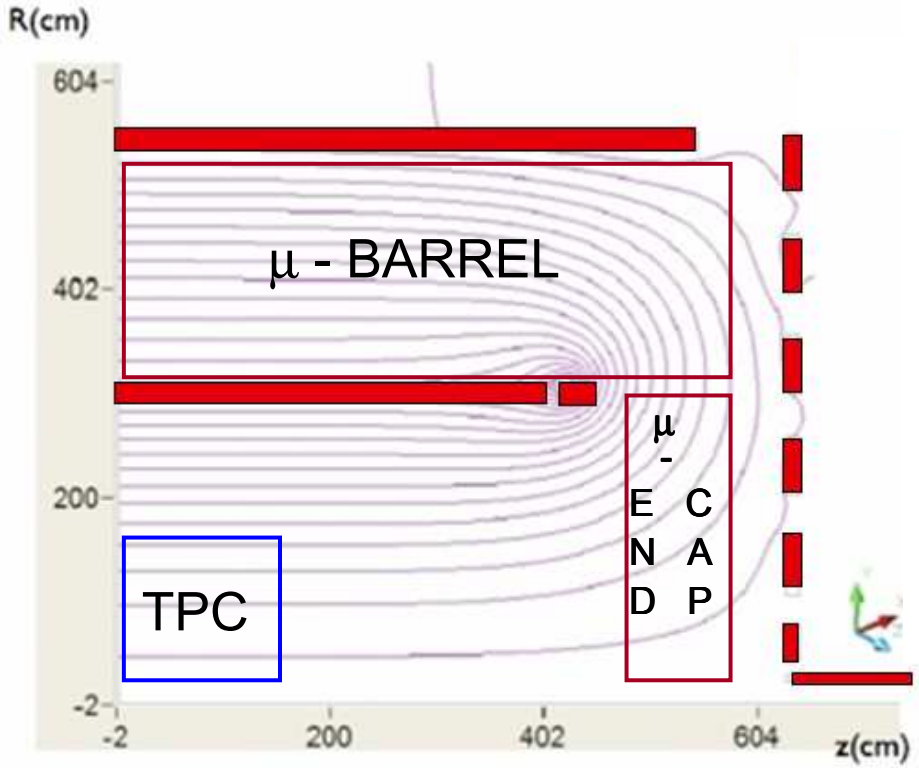
Muon dual-solenoid iron-free geometry

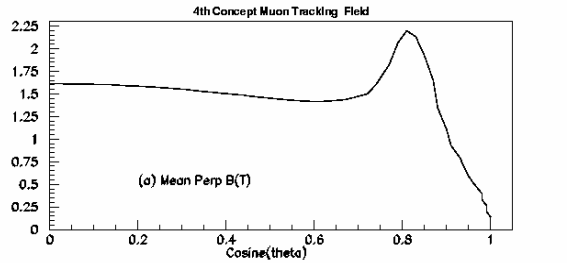


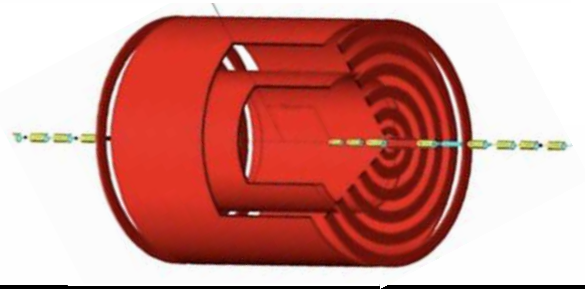
A. Mikailicenko talk, ILC Workshop Valencia 2006

Dual Solenoid B-field

Magnetic field of dual solenoid and wall of coils







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:

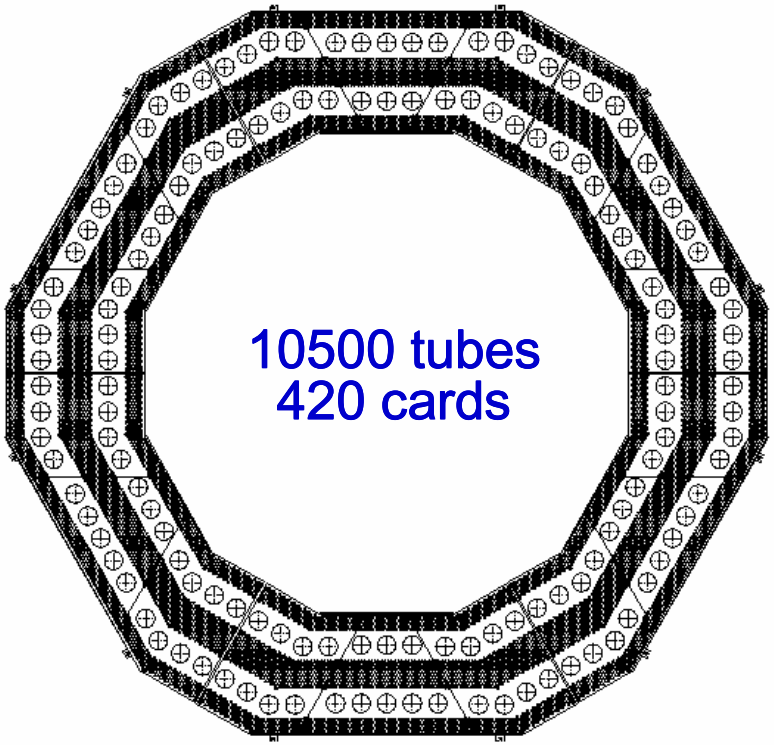
- > 1.5 GHz bandwith
- 8 bit fADC
- > 2 Gsa/s sampling rate
- free running memory

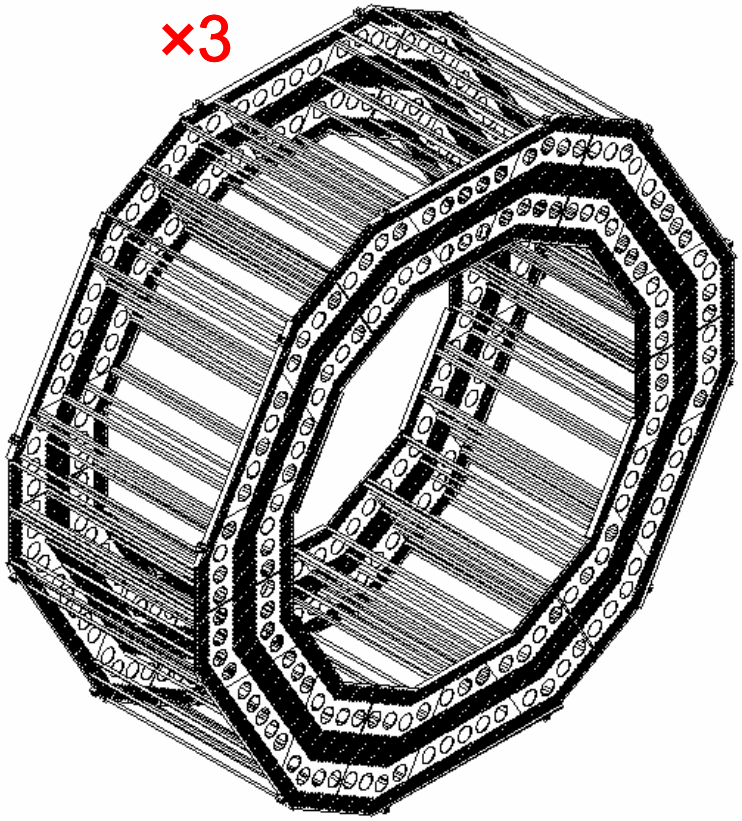
ASIC chip under development at INFN-LE

for a

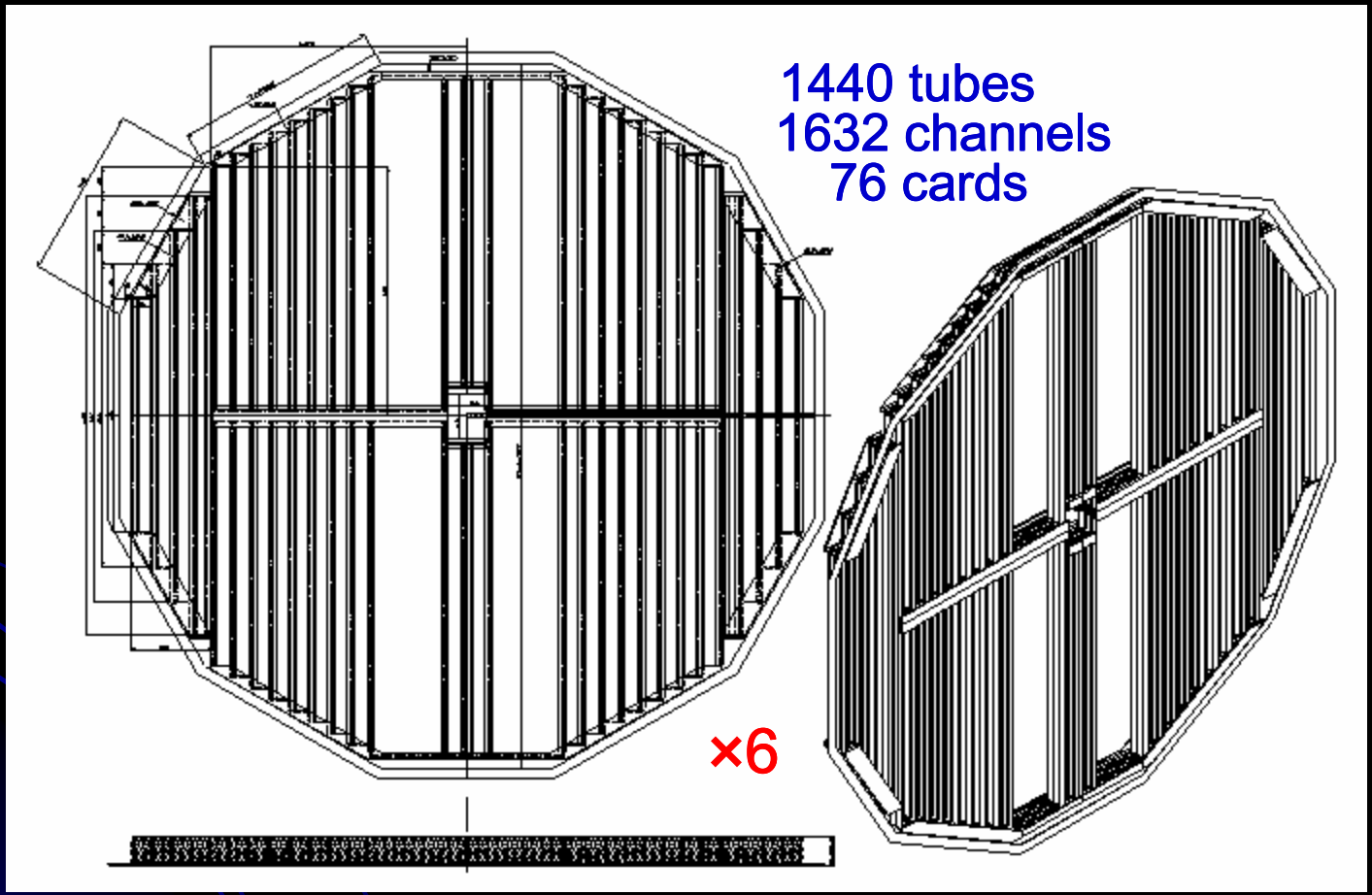
- fully efficient timing of primary ionization: **cluster counting**
- accurate measurement of longitudinal position with **charge division**
- particle identification with **dN_{cl}/dx**

MUD Barrel (1/3)

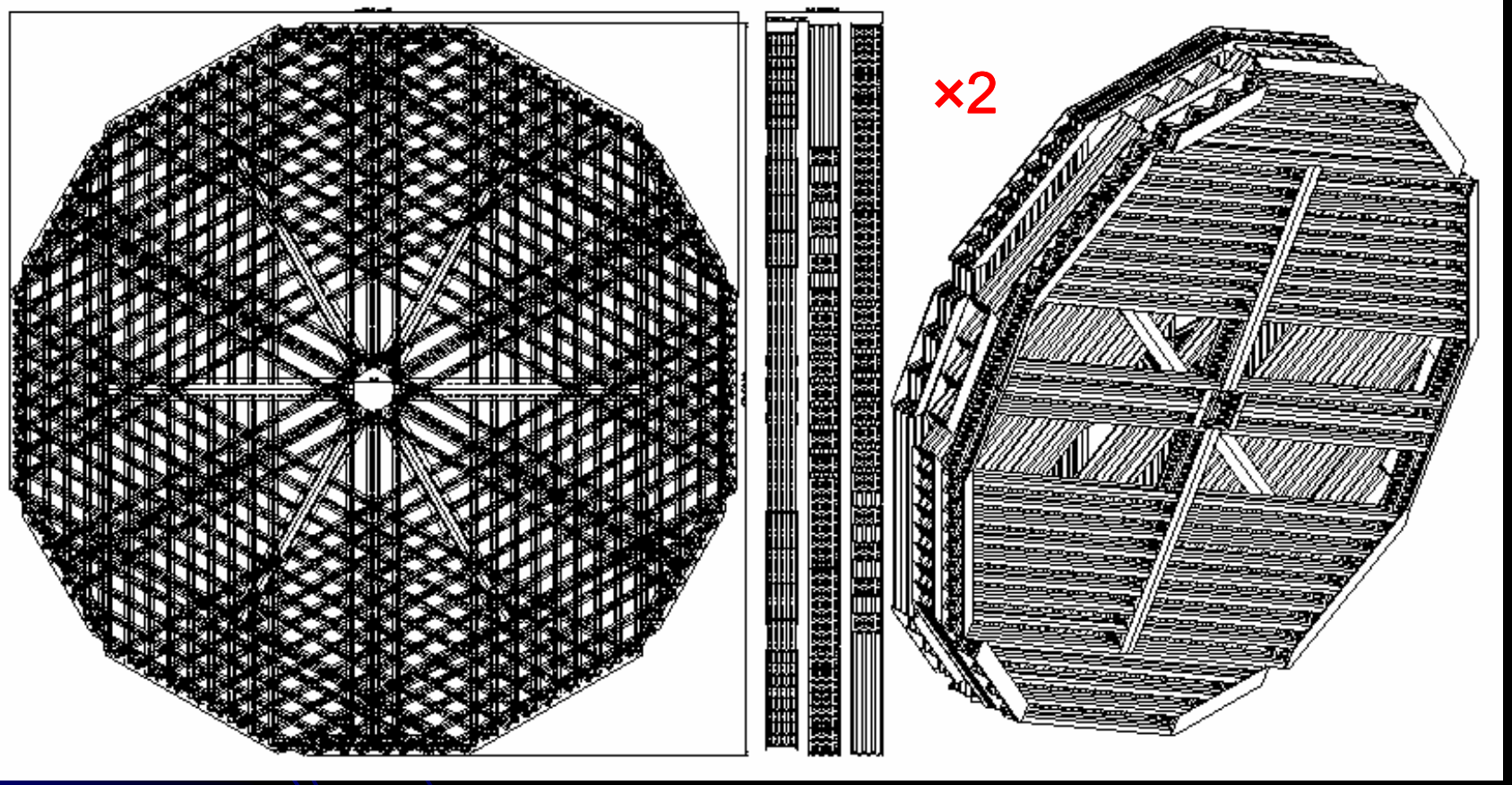




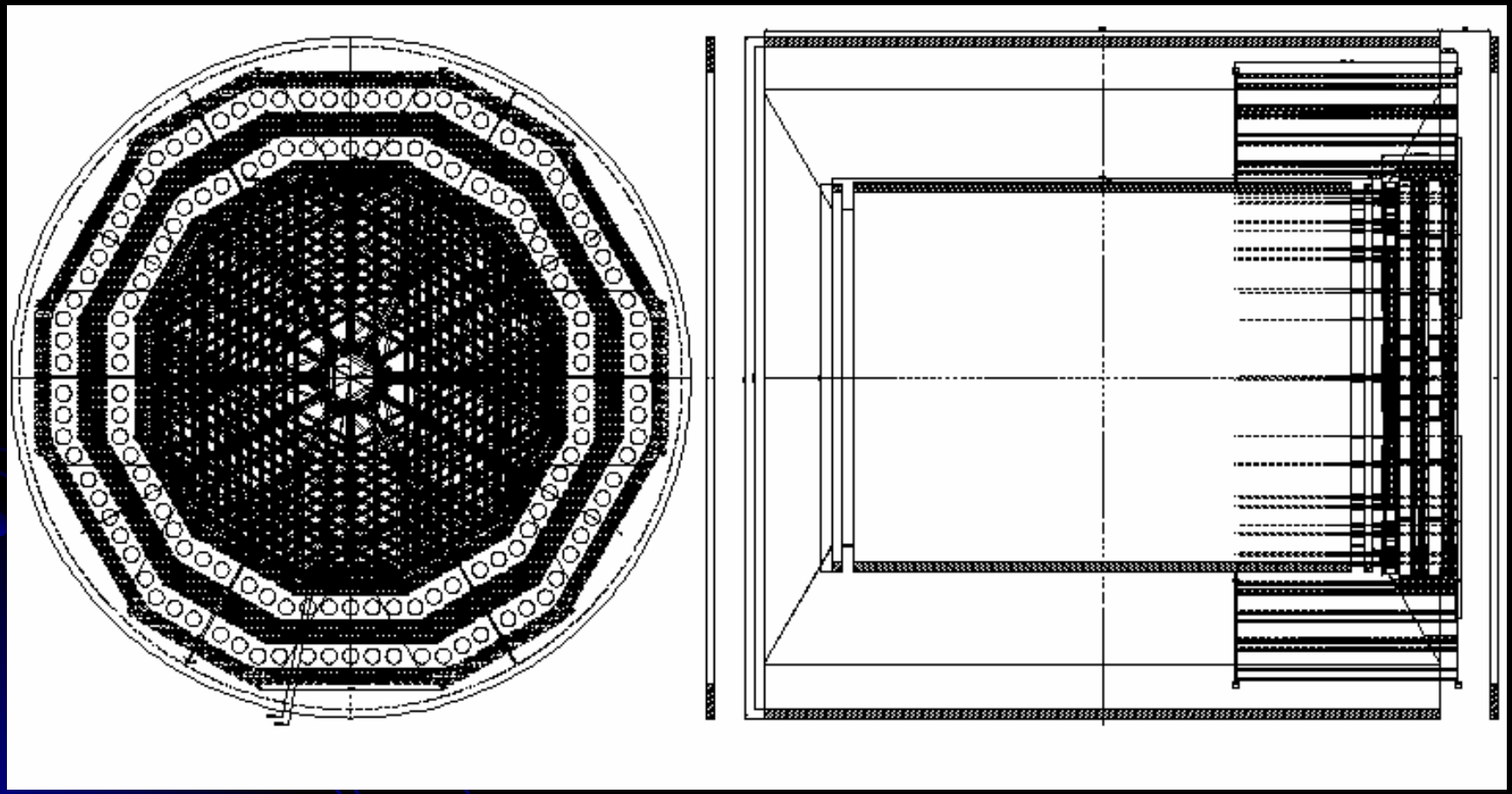
MUD Endcap (1/3)



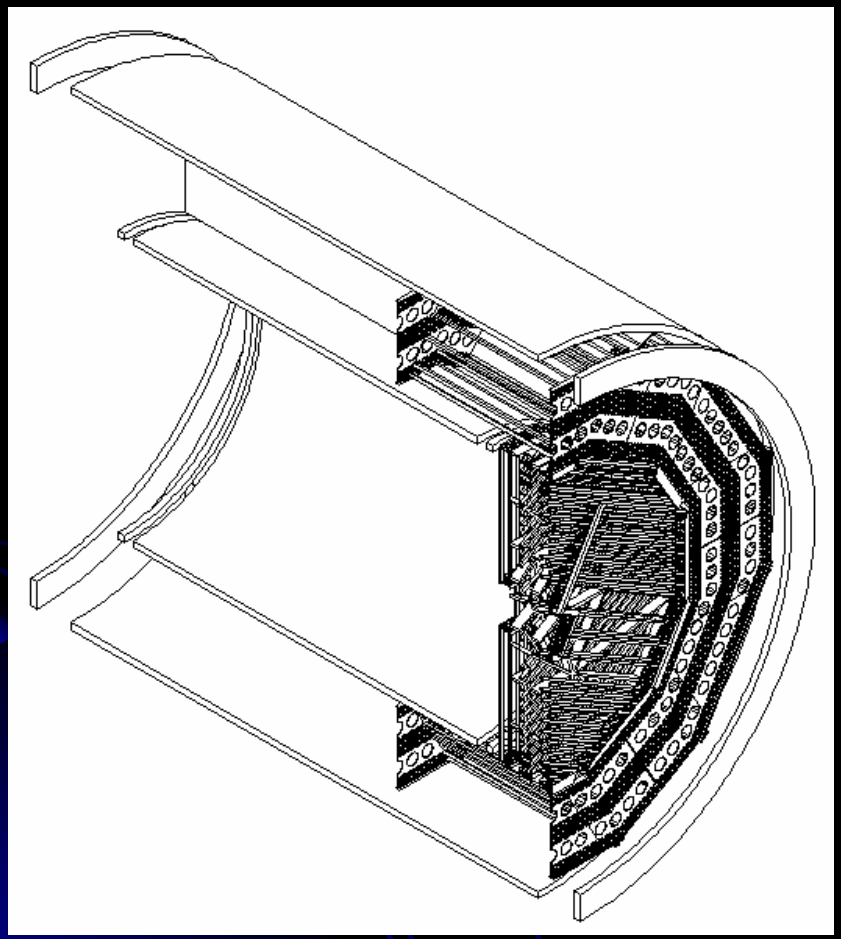
MUD Endcap



Full Spectrometer



Channel Count



Barrel:

31500 tubes
21000 channels
840 cards

End caps:

8640 tubes
9792 channels
456 cards

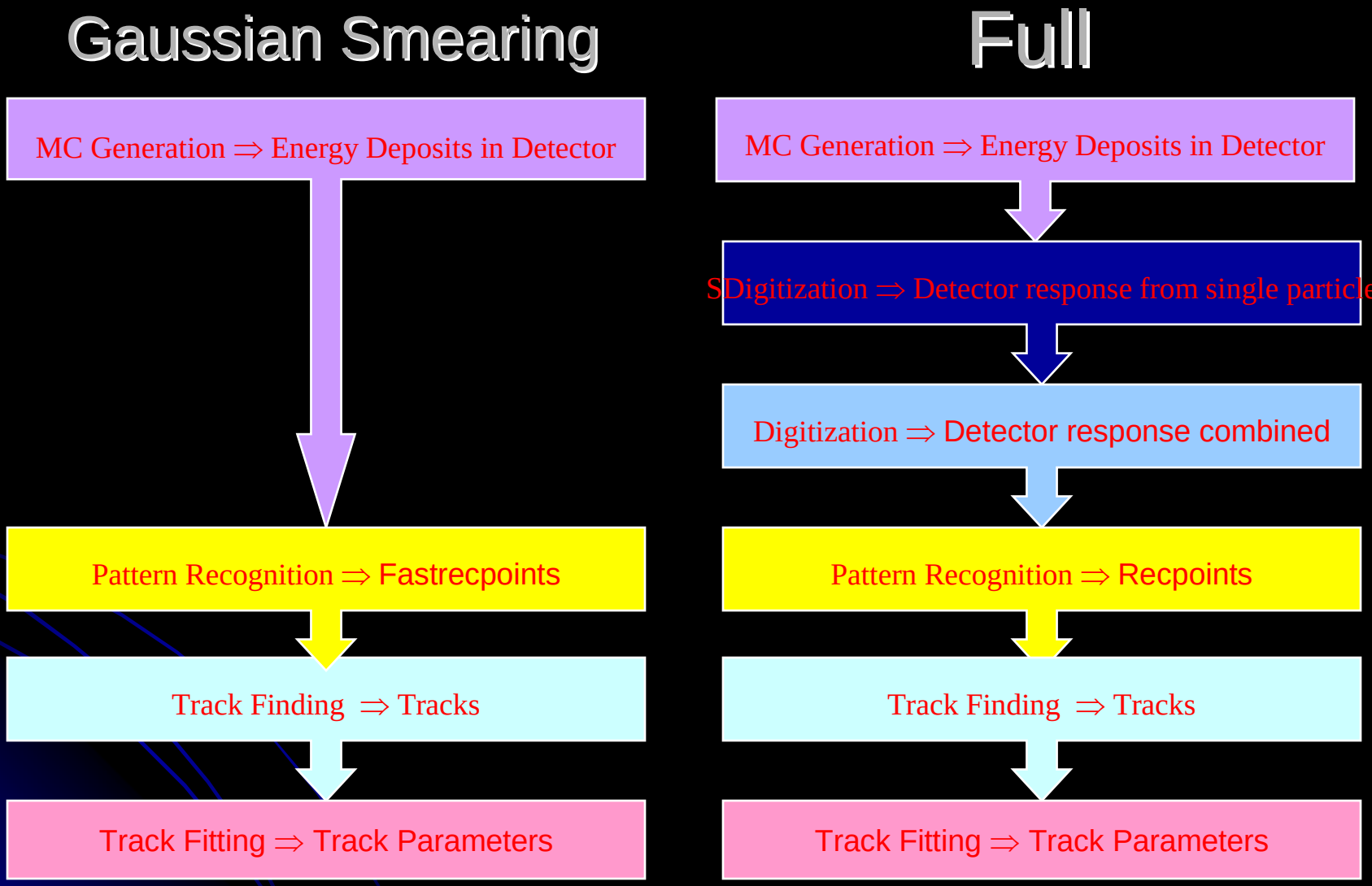
Total:

40140 tubes
30792 channels
1296 cards

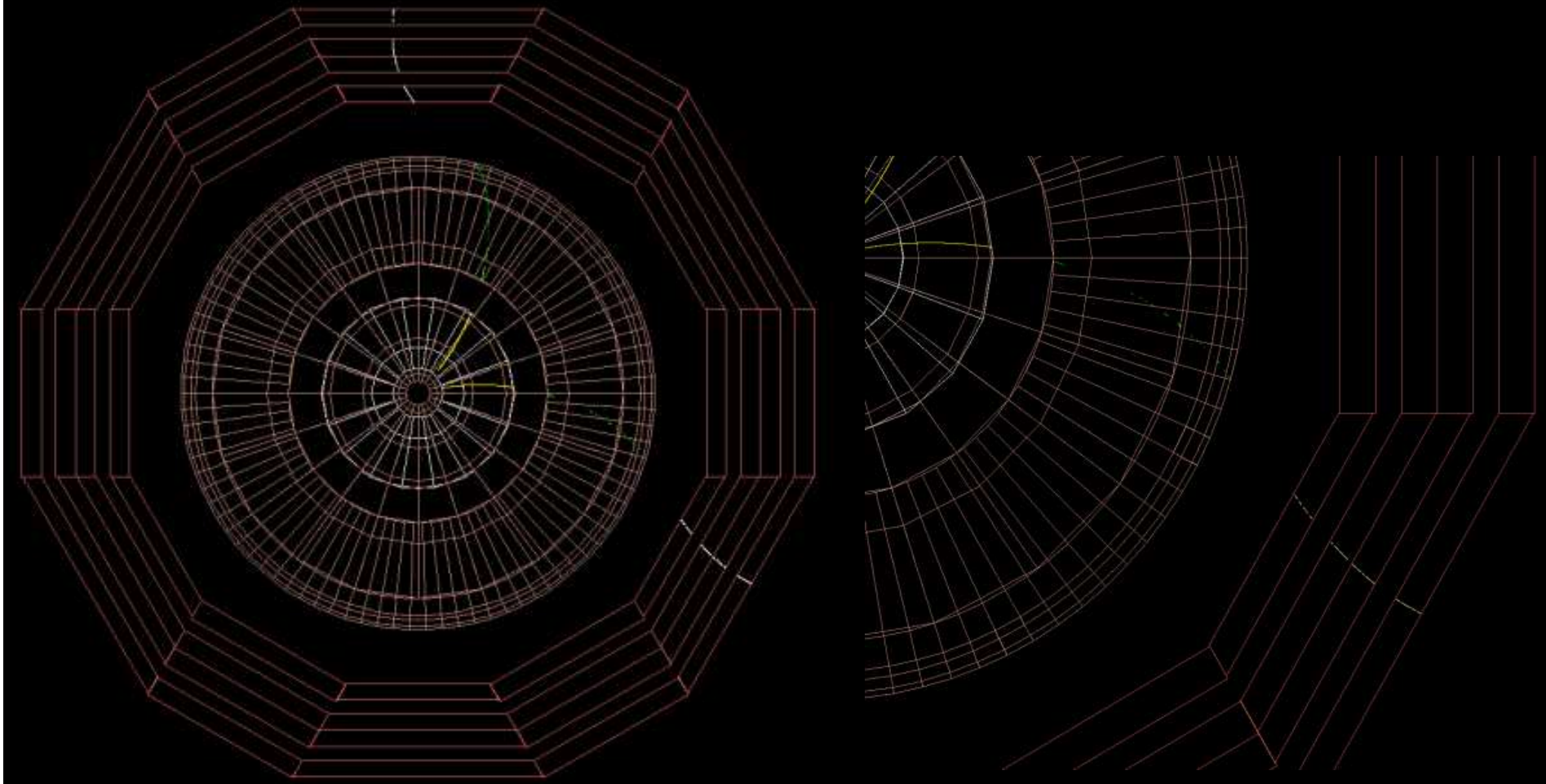
Simulation Details

- Full simulation is in place for VXD, TPC, DREAM and MUD Barrel
- Hits using Geant3 (for tracking studies)
- Older studies have gaussian smearing of hits in VXD and TPC
- Newer studies have full SDigits + Digits + Pattern Recognition chain for VXD
- Full Parallel Kalman Filter for track reconstruction in VXD + TPC + MUD (includes kinks and V0's)
- Standalone VXD tracker
- No PID

Simulation Steps



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



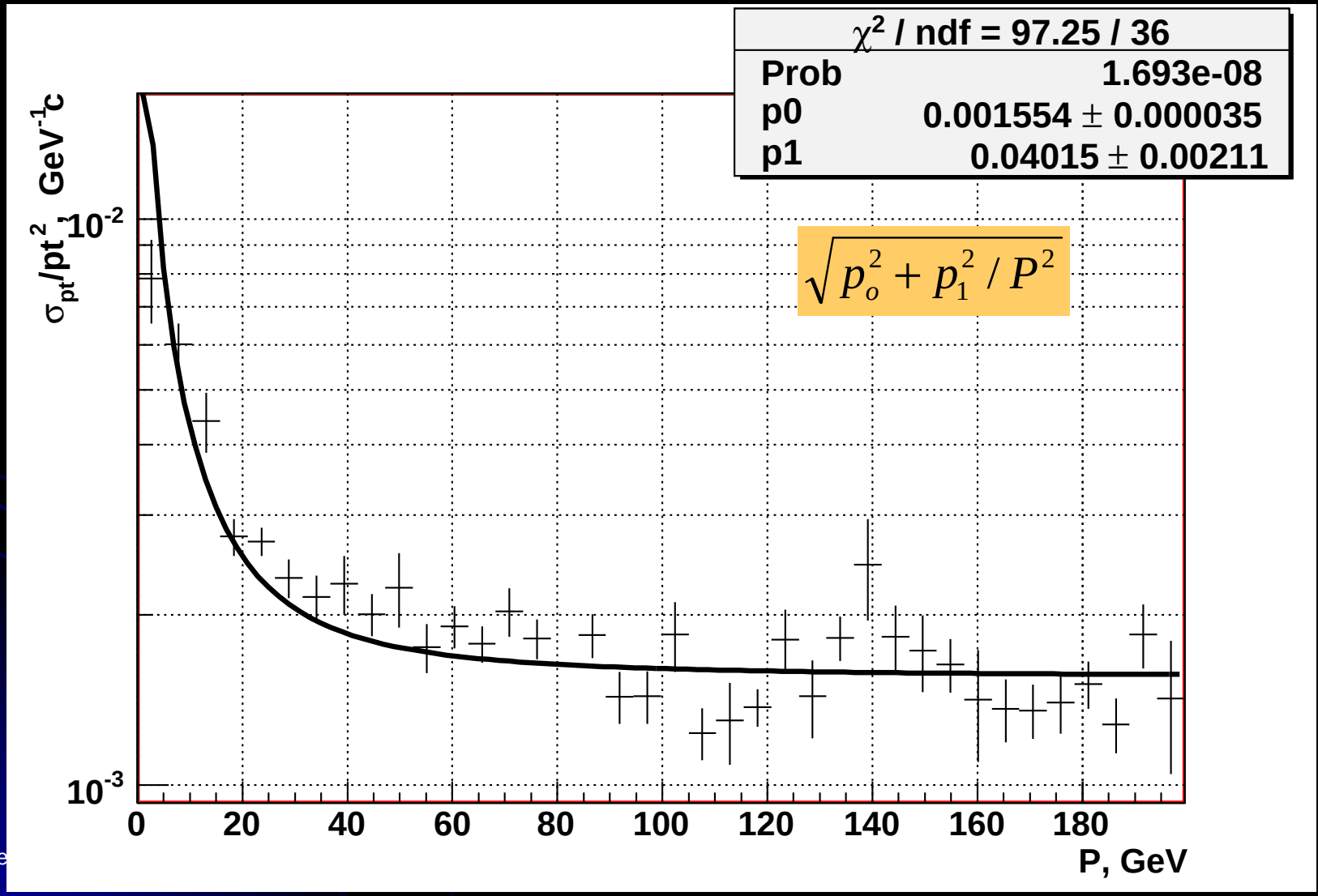
MUD Simulation

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

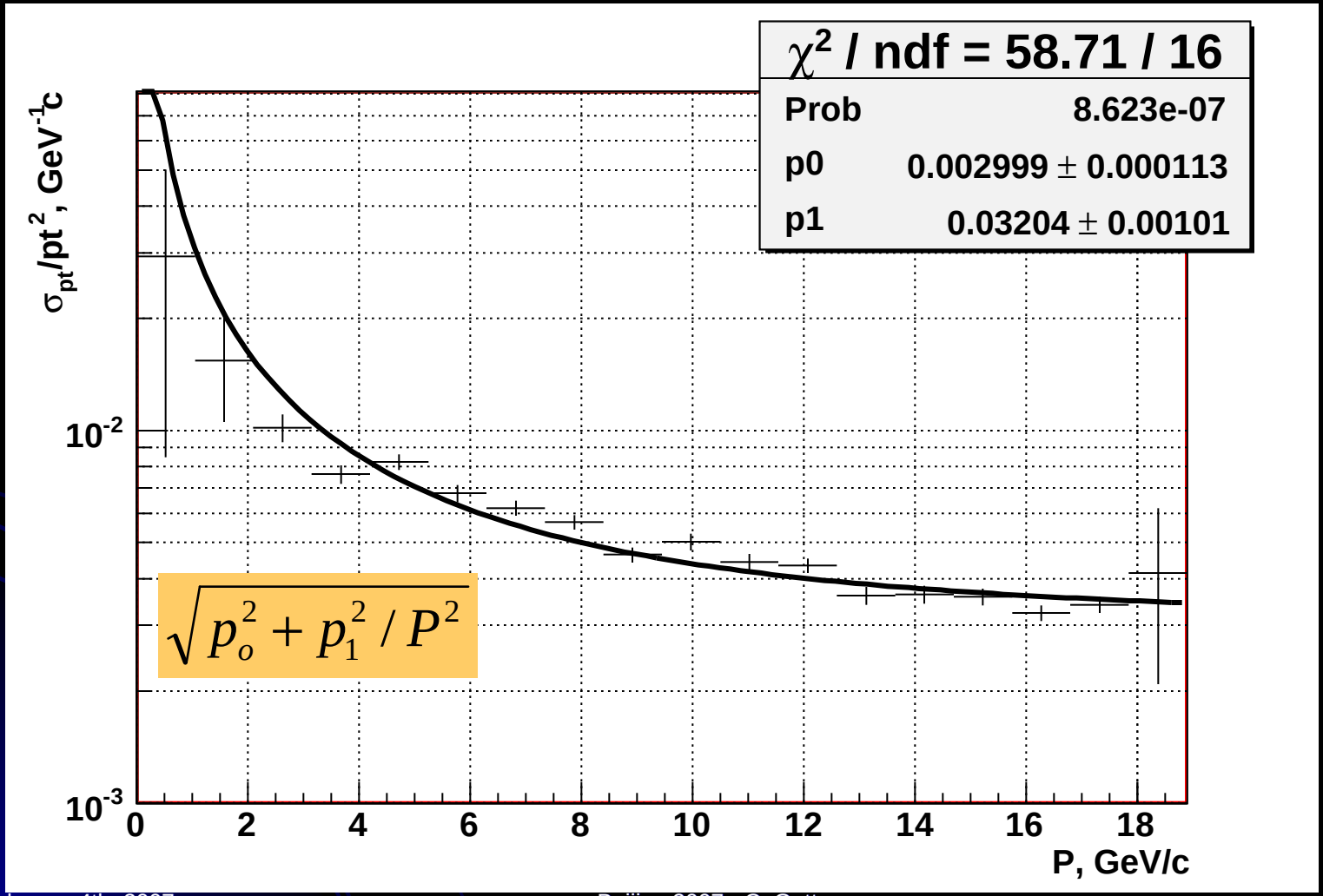
Tracking Algorithm

- 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

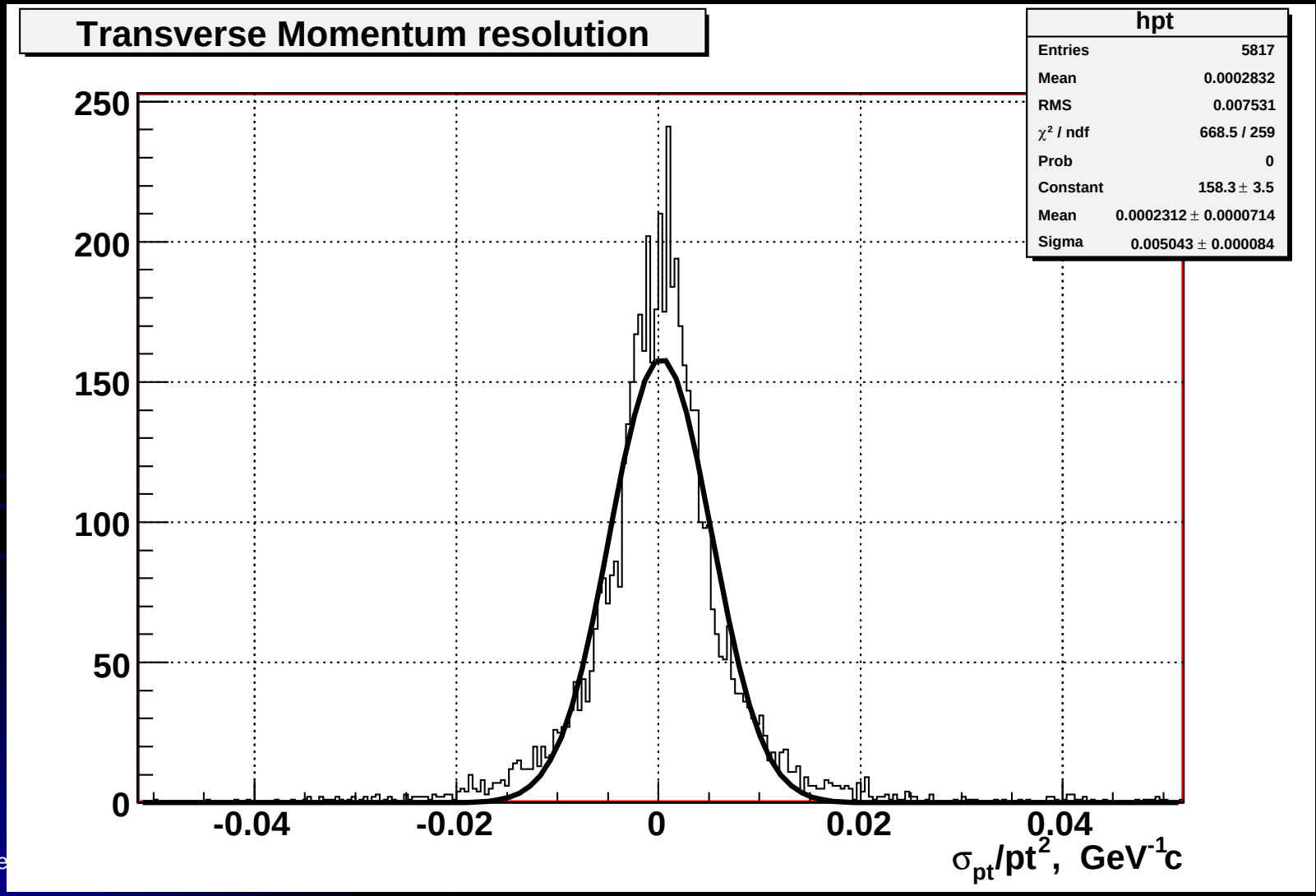
P_t Resolotion



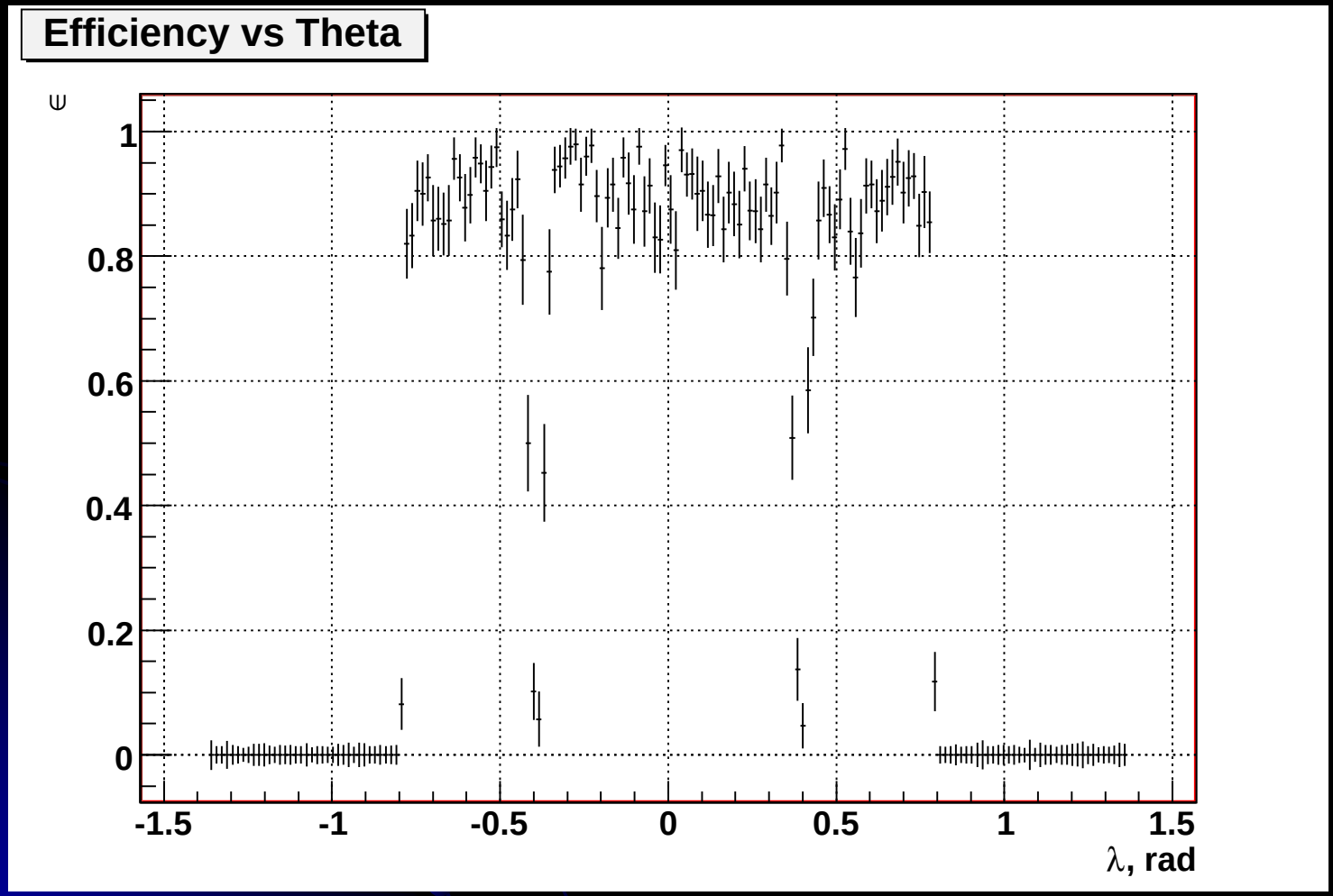
P_t Resolution (low momentum)



P_t Resolution (0.3-20 GeV)



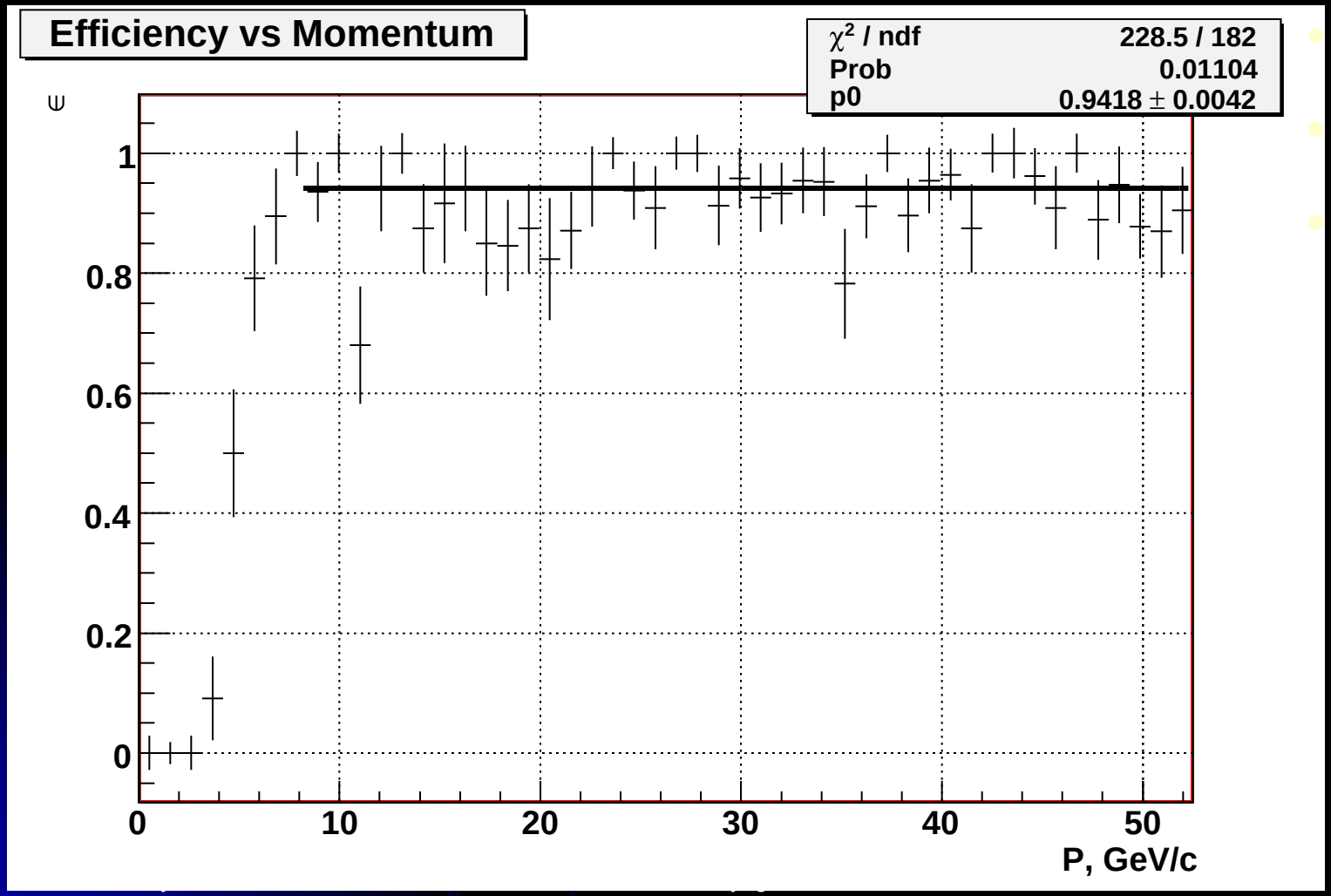
Efficiency (Barrel Only)



P>20 GeV

Tracks already reconstructed in TPC

Efficiency vs Momentum



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

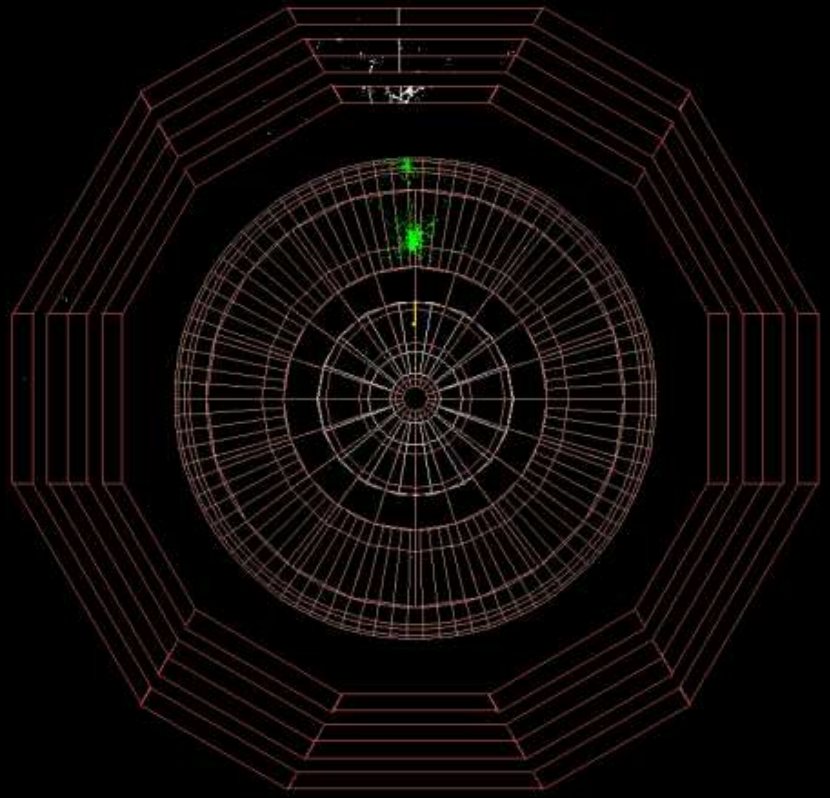
Tracking Performance

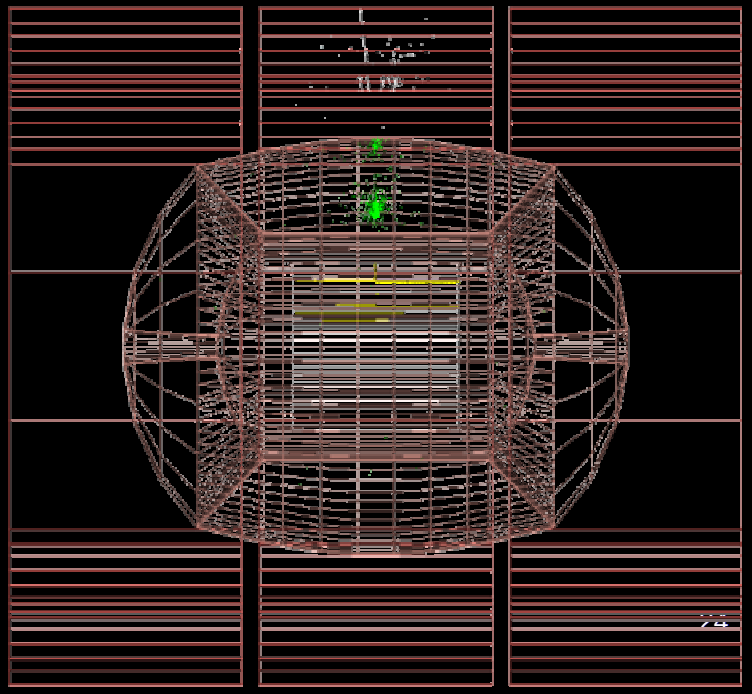
- Tracking is working for:
  - P_t > 400 MeV
  - $|\theta|$ > 45˚ (barrel only)
- High momentum tracks resolution:
  - $\sigma(1/p_t) = 1.6 \times 10^{-3}$
- Efficiency (P_t>6 GeV) = 94.2%

What's Next

- Add MUD Endcaps in ILCroot (in progress)
- Implement Standalone Tracker
- Optimization of the layout
- Muon detection in the midst of jets
- Punch-through recovery from HCAL (tail catching)
- Physics studies
  - $e^+e^- \rightarrow Z^oH^o$, $H^o \rightarrow \mu^+\mu^-$, $Z^o \rightarrow \nu\nu$
  - Flavor tagging of jets

80 GeV jet with escaping particles





Conclusions

- MUD Barrel detector implemented in ILCroot
- Tracking performance is good:

$\varepsilon = 94.5\%$

$\sigma(1/p_t) = 16 \times 10^{-4}$

- Parametric implementation of the code: easy to modify layout
- Detector optimization and Physics studies will start soon

Backup slides