# Improoving the calorimetry ?

Of course it can be done. But be careful about trying to be "optimal". Any detector needs trade-offs, and money.

Graham Wilson

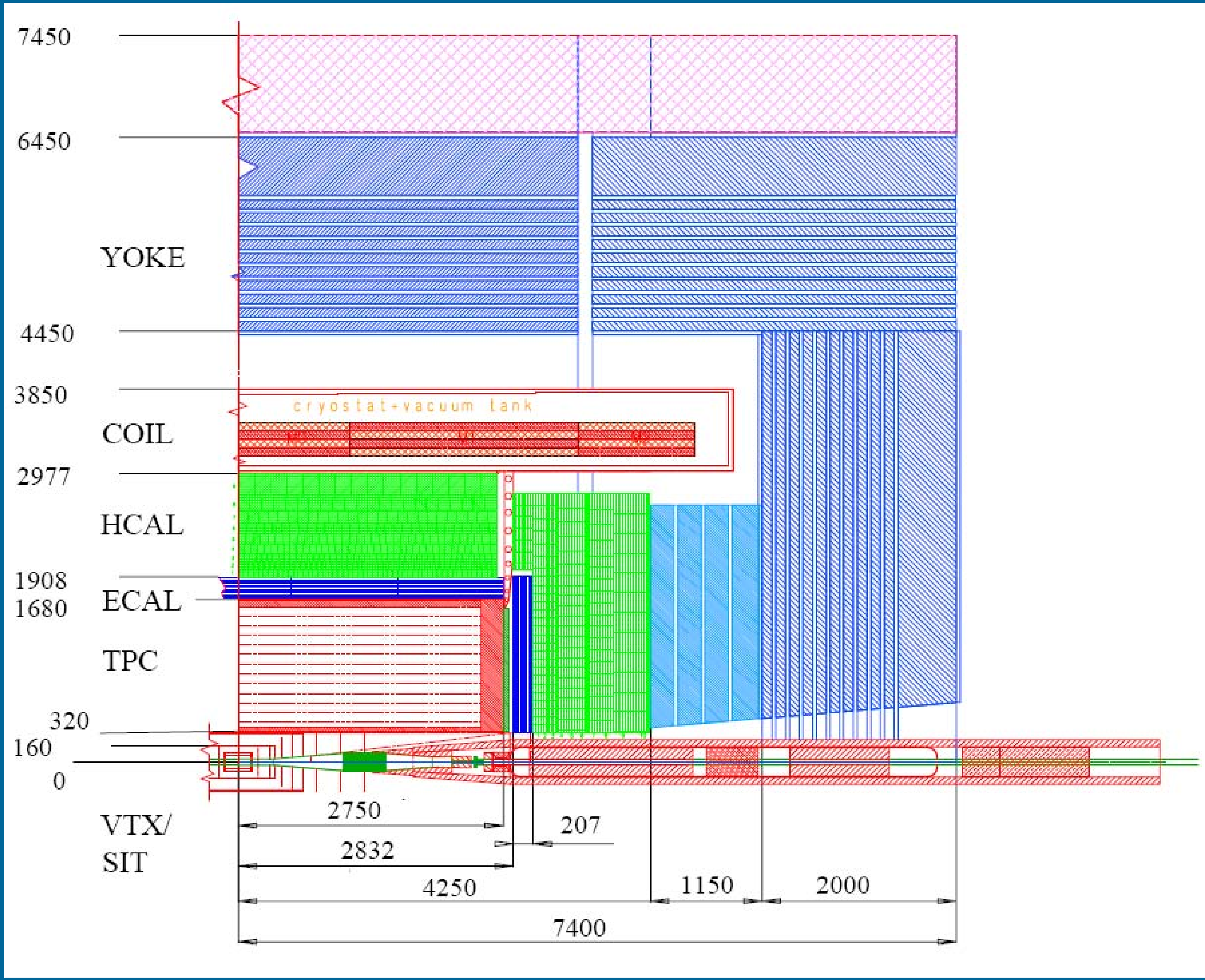
# LDC plans for Snowmass

| | |
|---|---|
| Graham Wilson | What is optimal thickness of the ECAL/ HCAL? What is the optimal sampling structure? Is the approach used in the LDC detector optimal, can it be improved? |
| Marcello Piccolo | What is importance of muon system: muon id, tail catcher, cosmic veto? How many layers are needed? |
| Week 2: | |
| Dan Peterson | What quality of the B field do we need? How can we measure and monitor the field distortions at the required level of accuracy? Can the large distortions in the large crossing angle be accounted for? Can control samples be used to improve the knowledge of the field map? Does it make sense to eliminate the plug, at the cost of a shorter magnet and thus a less homogeneous field? |
| Henri Videau, Felix Sefkow, Steve Magill | Calorimetry optimization questions |

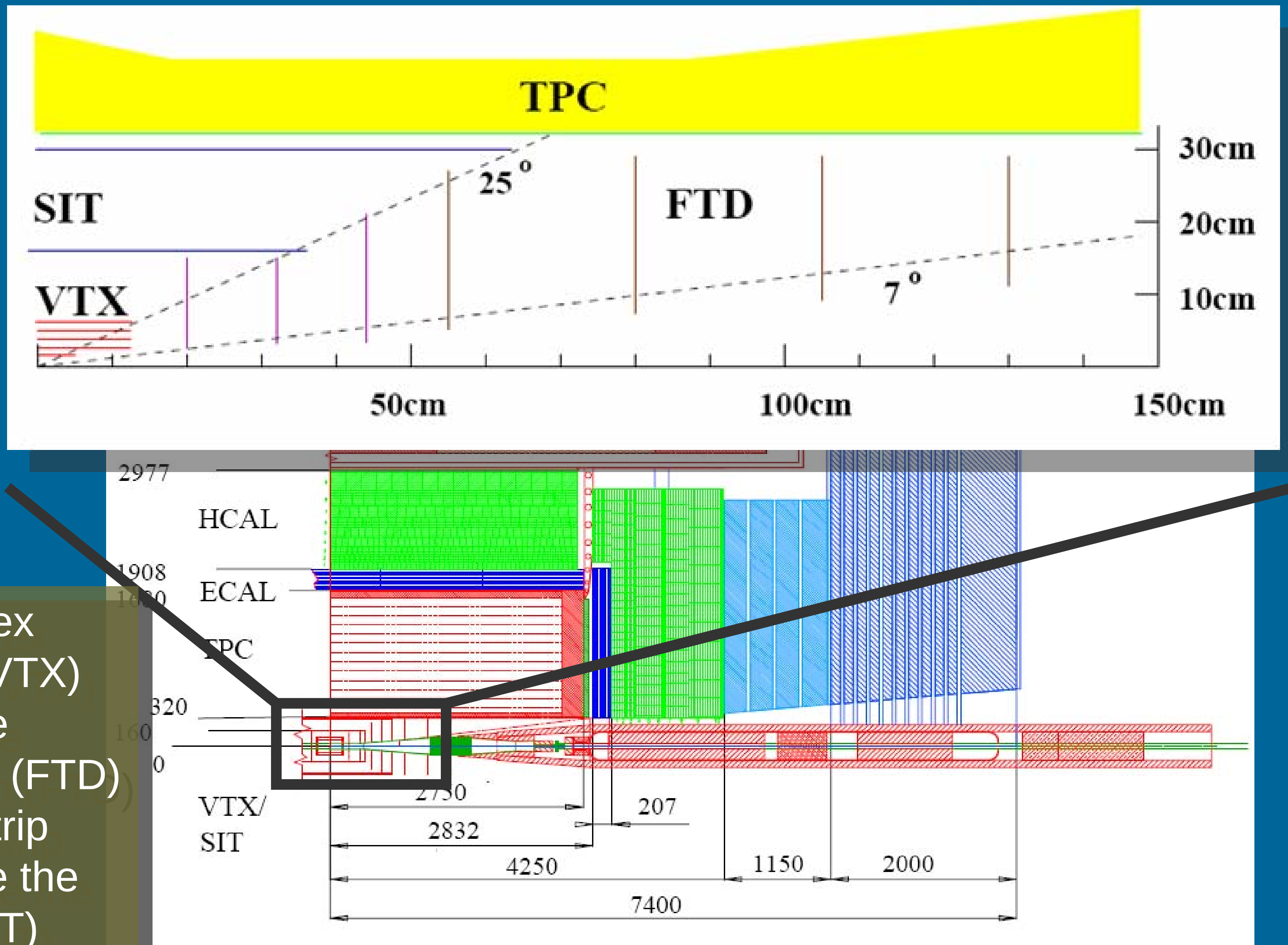
# Overall Design Issue List

- Hermeticity
- Aspect Ratio (Barrel/Endcap transition)
  - Cost is optimized for short-barrel – and R can be increased
  - But what about the endcap jets
- Shape: octagons great for hermeticity, but lose in lever arm for given cylindrical coil.
- EM Energy Resolution / # of layers / Si cost.
- Maybe we really need fine transverse granularity at start of ECAL ?
- What radius do we want? In the TESLA optimization the calorimeter depth was basically a function of the B=4T choice motivated by VTX, the imposed momentum resolution, and the technical risk of a coil as aggressive as CMS.
  - No studies were really done investigating different design concepts
  - Eg. no one has ever proved that a thin lower B-coil after ECAL wouldn't be acceptable.
- ECAL design – benefits of W somewhat negated by large gap size, need to minimize these.
- HCAL design was basically: "I need 10 mm for my detectors" which is something we need to reduce, and it was a given that the absorber is SS. W, Pb, and maybe U are potential alternatives, especially if the HCAL becomes more and more like an ECAL.
- Not clear to me that muon performance is a significant constraint. (in e+e-, there are lots of muons). We need to do a very good job, but not a superlative hadron collider type job.

# Quadrant view

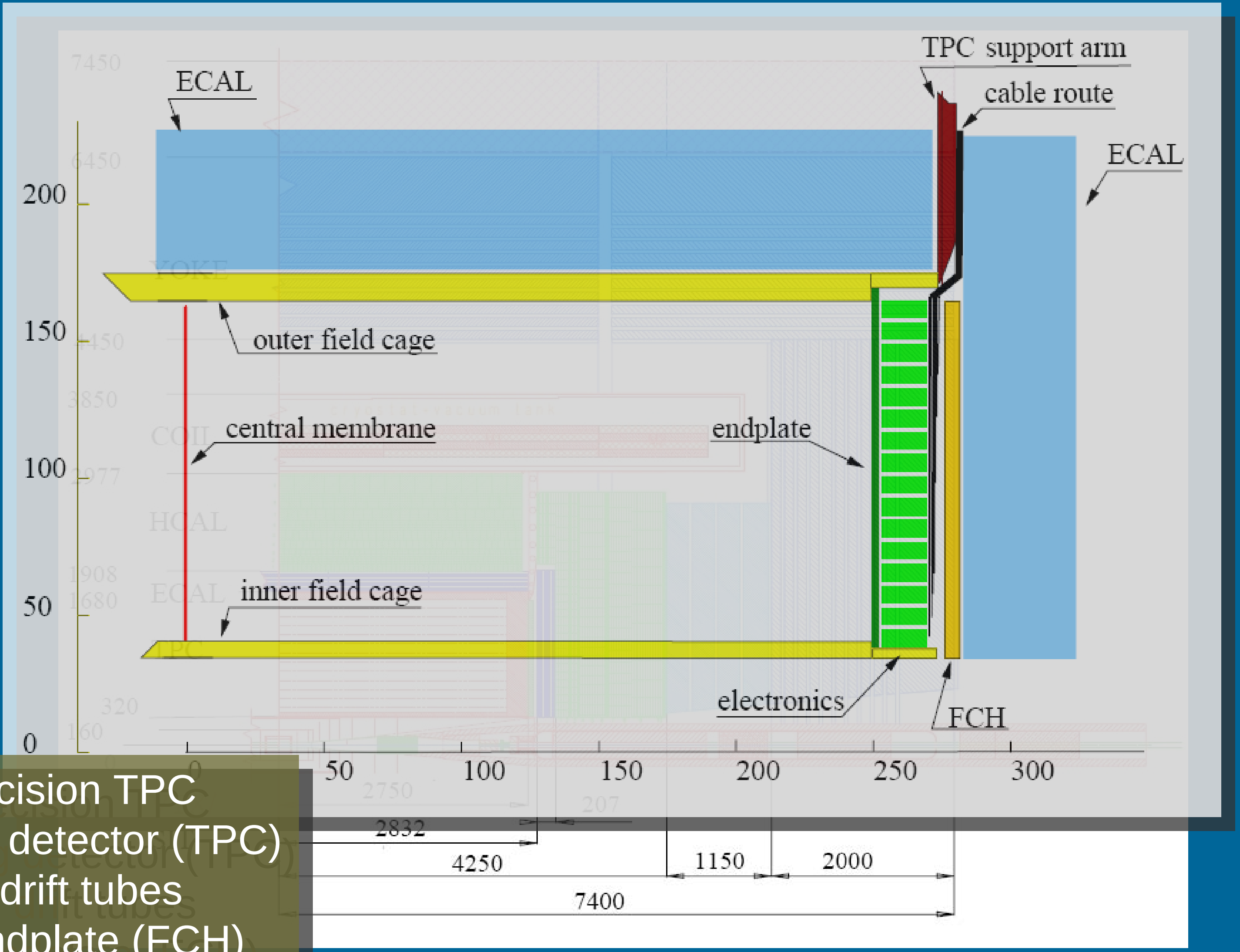


# Quadrant view – vertex and forward tracking



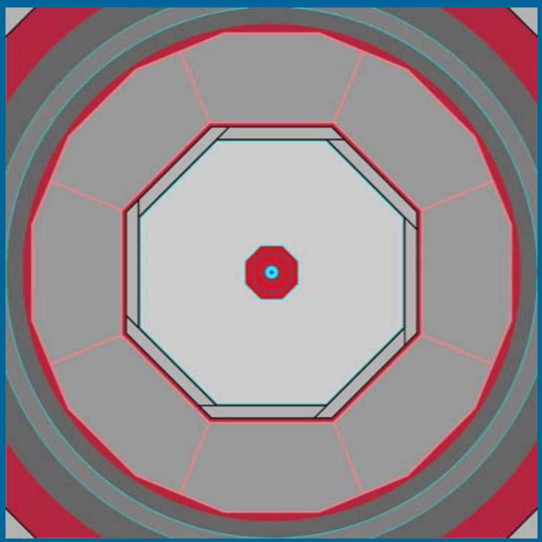

- 5 layers of vertex pixel detectors (VTX)
- 7 Si disks in the forward direction (FTD)
- 2 layers of Si strip detectors outside the VTX detector (SIT)

# Quadrant view – central tracking

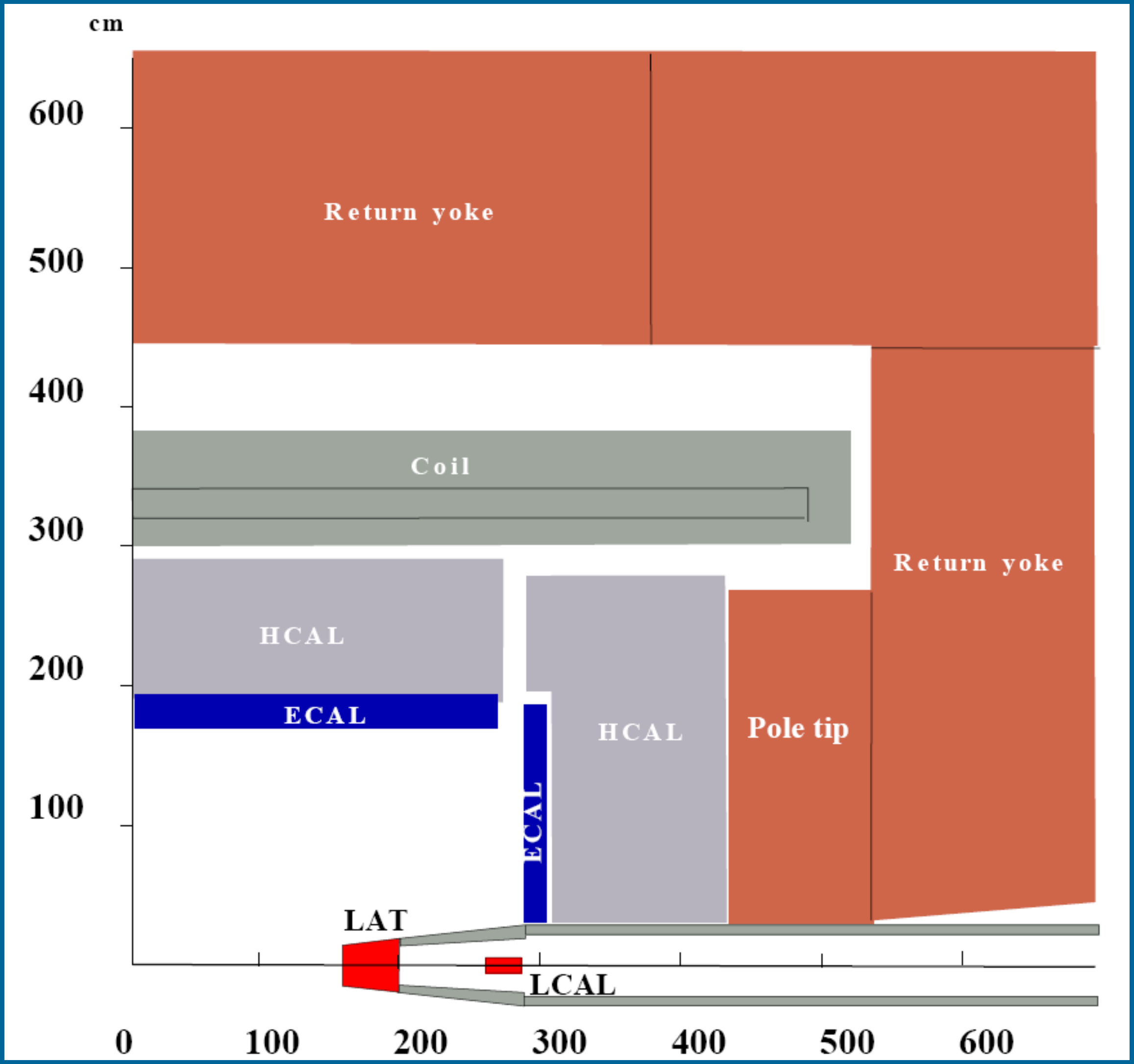



- large volume precision TPC as central tracking detector (TPC)
- several layers of drift tubes behind the TPC endplate (FCH)

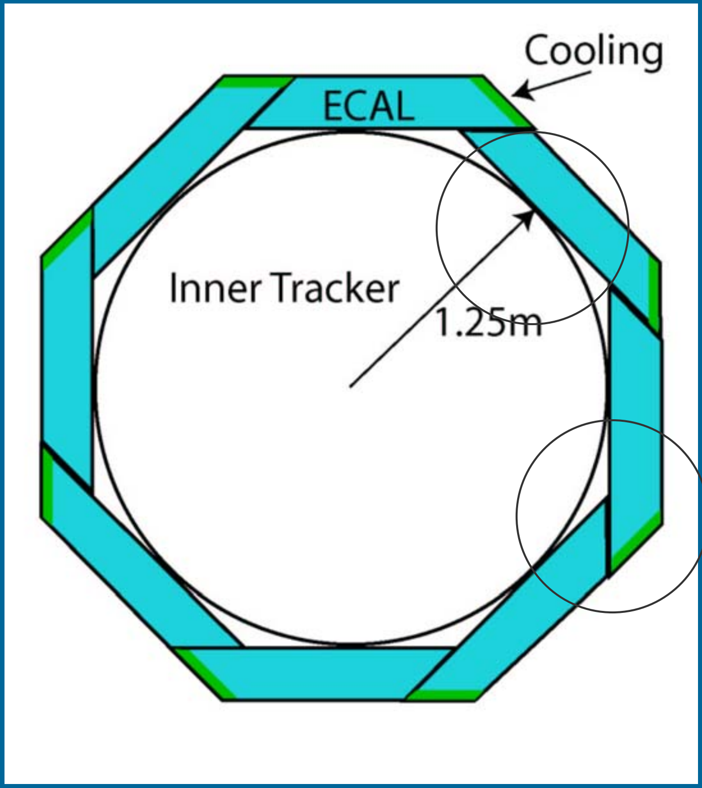
# Quadrant view – calorimetry, muon

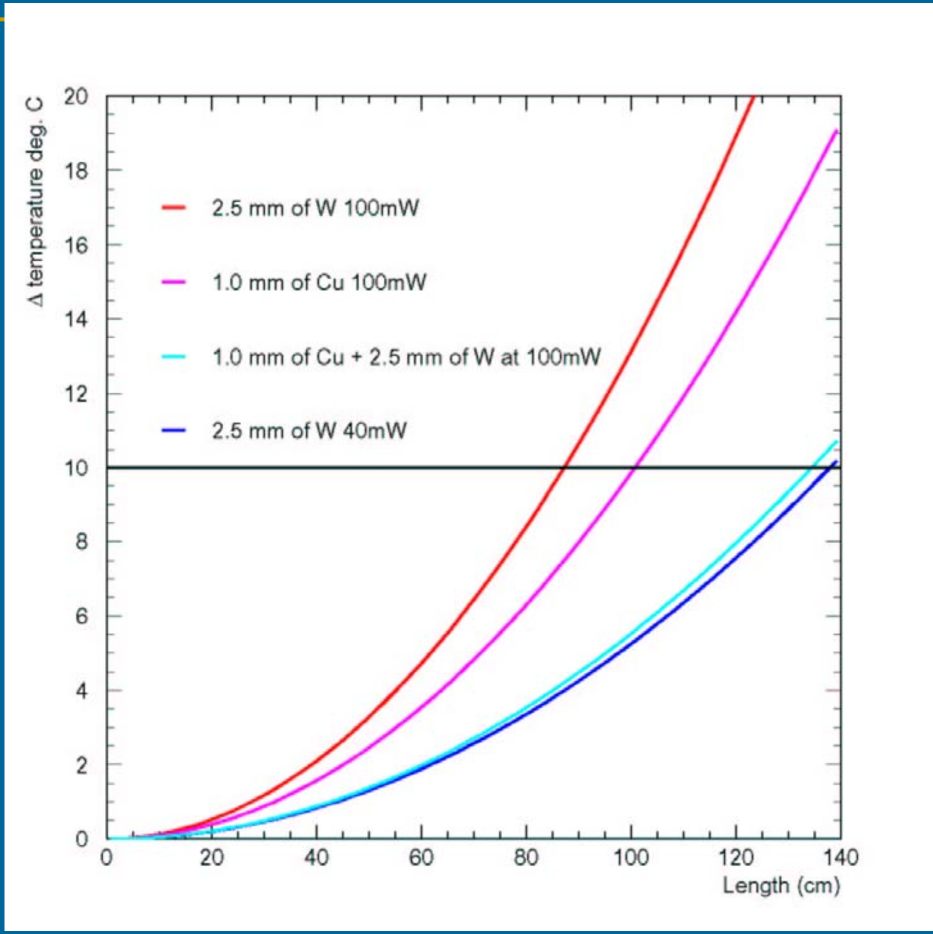


- Si-W ECAL in barrel and end cap (ECAL)
- Steel-Scint. or steel-RPC barrel and end cap (HCAL)
- 4T superconducting coil
- Instrumented iron return yoke with RPC (MUON)



# Geometry ..



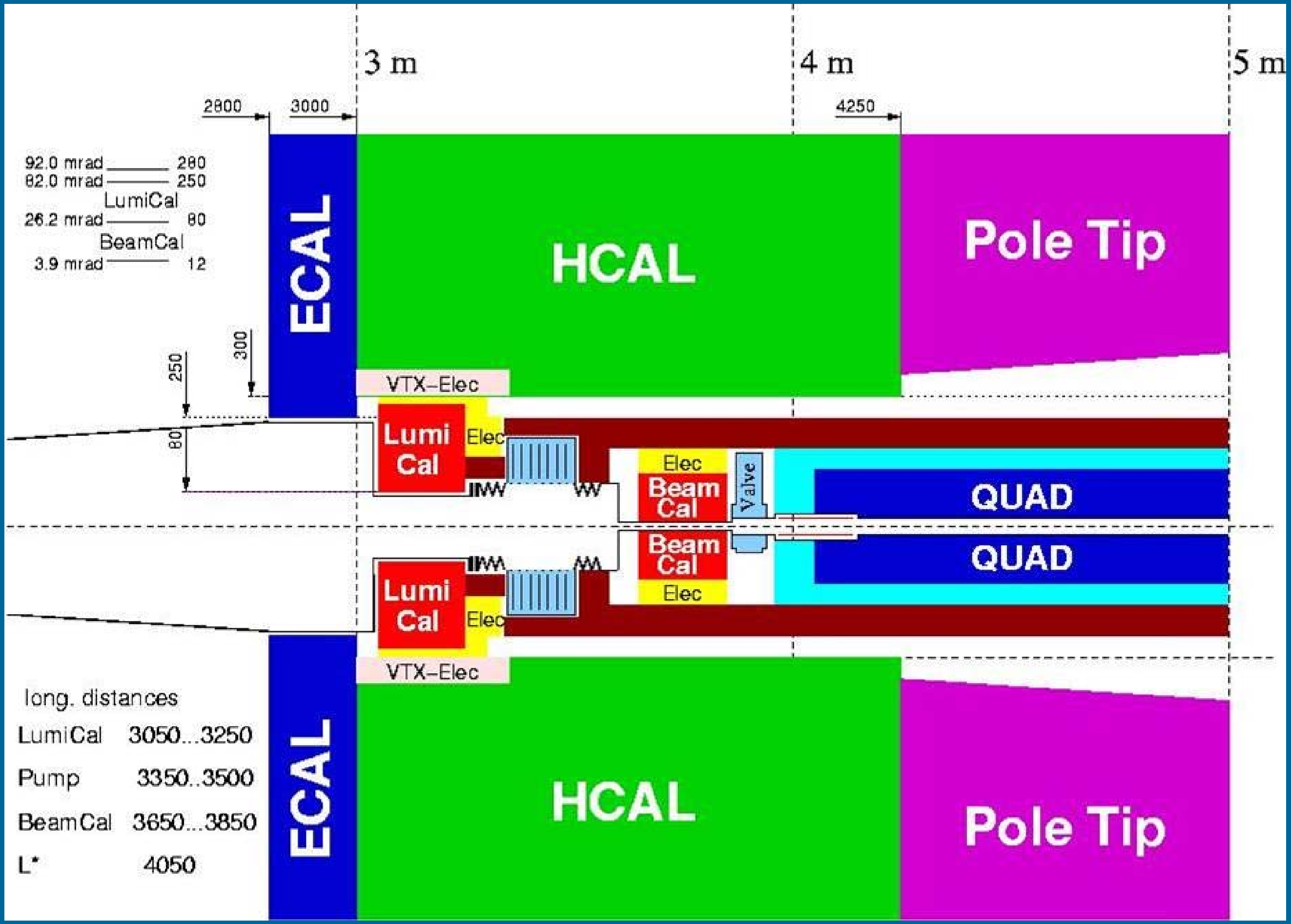

Physical model tests in progress – prefer to avoid adding Cu

Longest path = 1.4 m

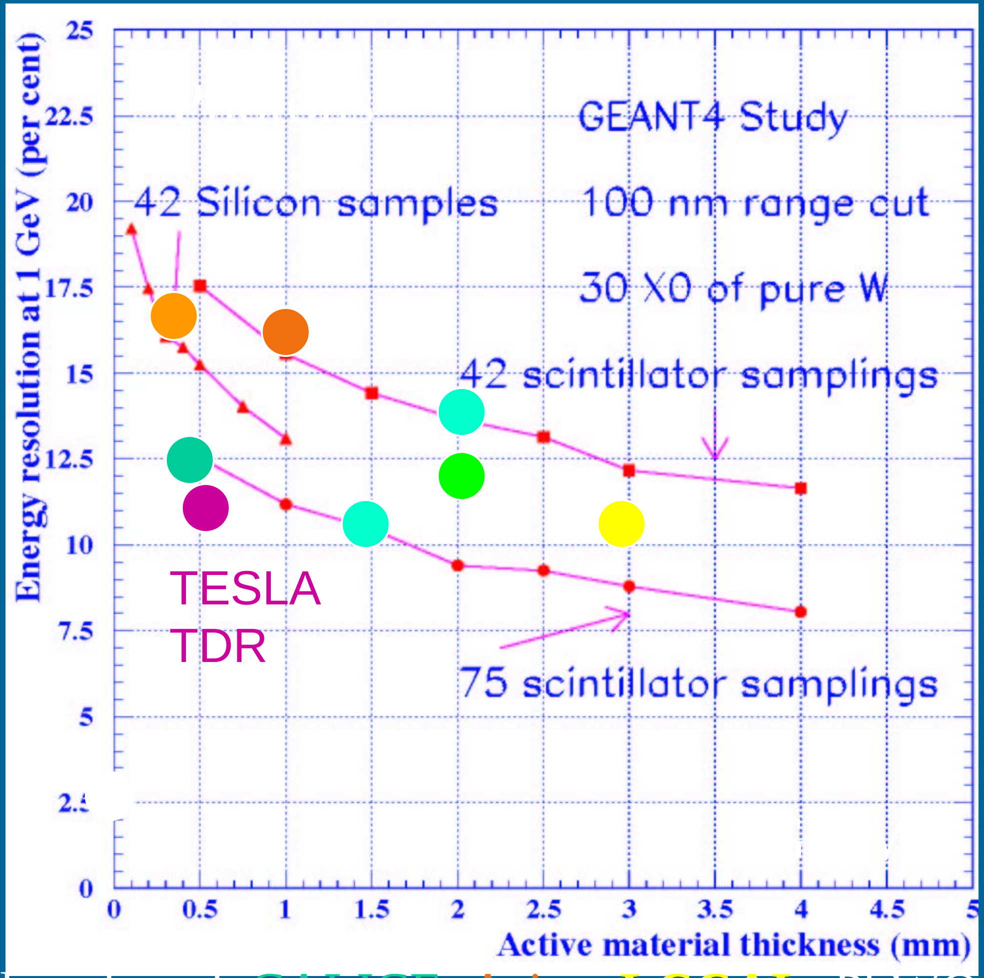
*Isn't this suggesting a more circular geometry (or even smaller radius !) ? (GWW)*

# Forward calorimetry

- Modified from TESLA to conform to larger L*



# Energy resolution for sampling W calorimeters (with uniform sampling)




Also plotted, CALICE, Asian, **LCCAL**, $PbWO_4$

42 layers = 2.5 mm W

56 layers = 1.75 mm W

75 layers = 1.4 mm W

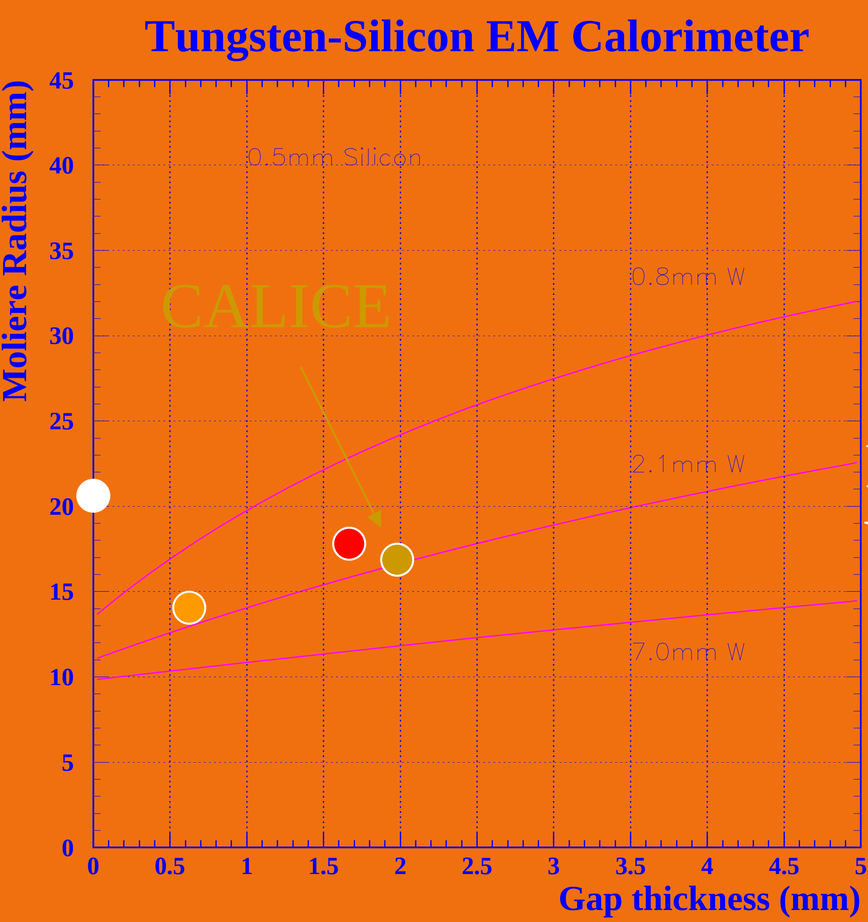
135 layers = 0.78 mm W

Cost issues:

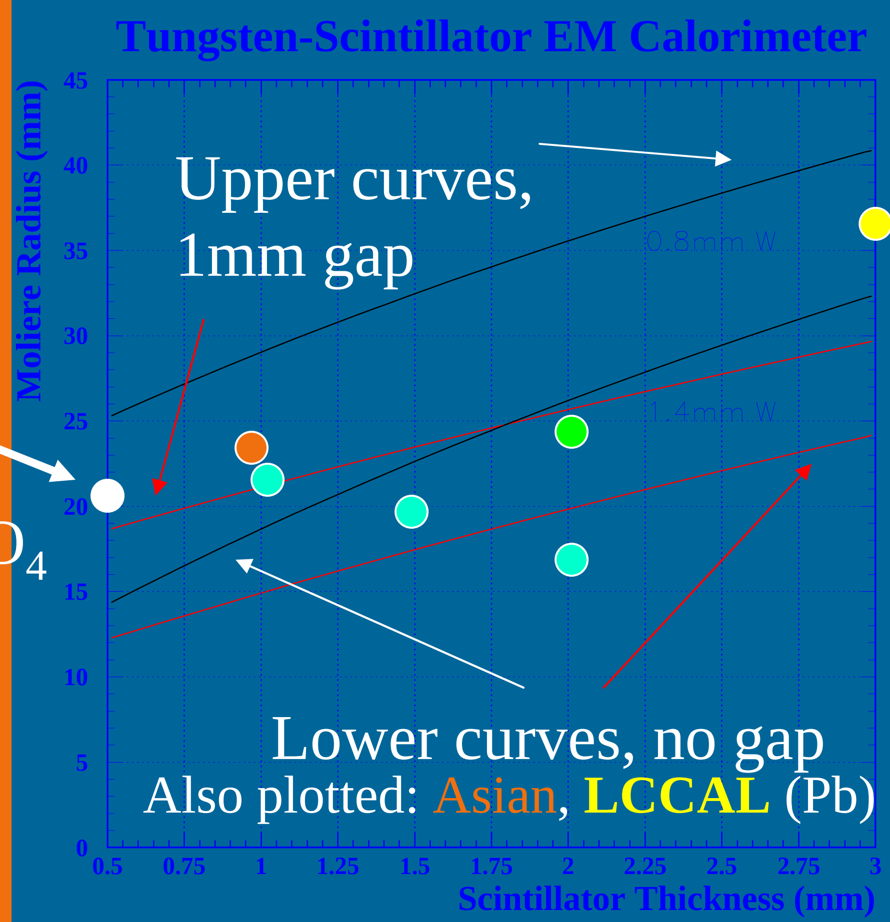
W cost ≈ independent of thickness if rolled ?

Si and scintillator scale as area, and can be more expensive if thinner.

# Compactness




Pb
$WO_4$




Need to minimise gaps, reduce space needed for fiber routing, by sharing fiber routing gaps among layers

Assume 25% of scintillator thickness used for readout

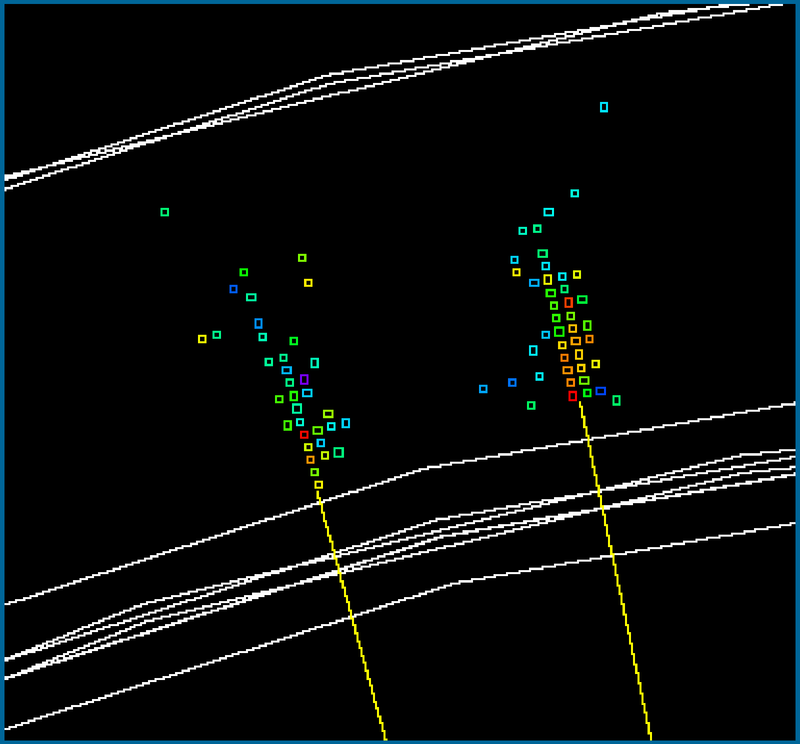
# Using $\pi^0$ mass constraint to improve particle flow ?

Study prompted by looking at event displays like this one of a 5 GeV $\pi^0$ in sidmay05 detector.

Here photon energies are (3.1, 1.9 GeV), and clearly the photons are very well resolved.

Prompt $\pi^0$'s make up most of the EM component of the jet energy.

See slides at
http://heplx3.phsx.ku.edu/~graham/gww_sid_july27.pdf

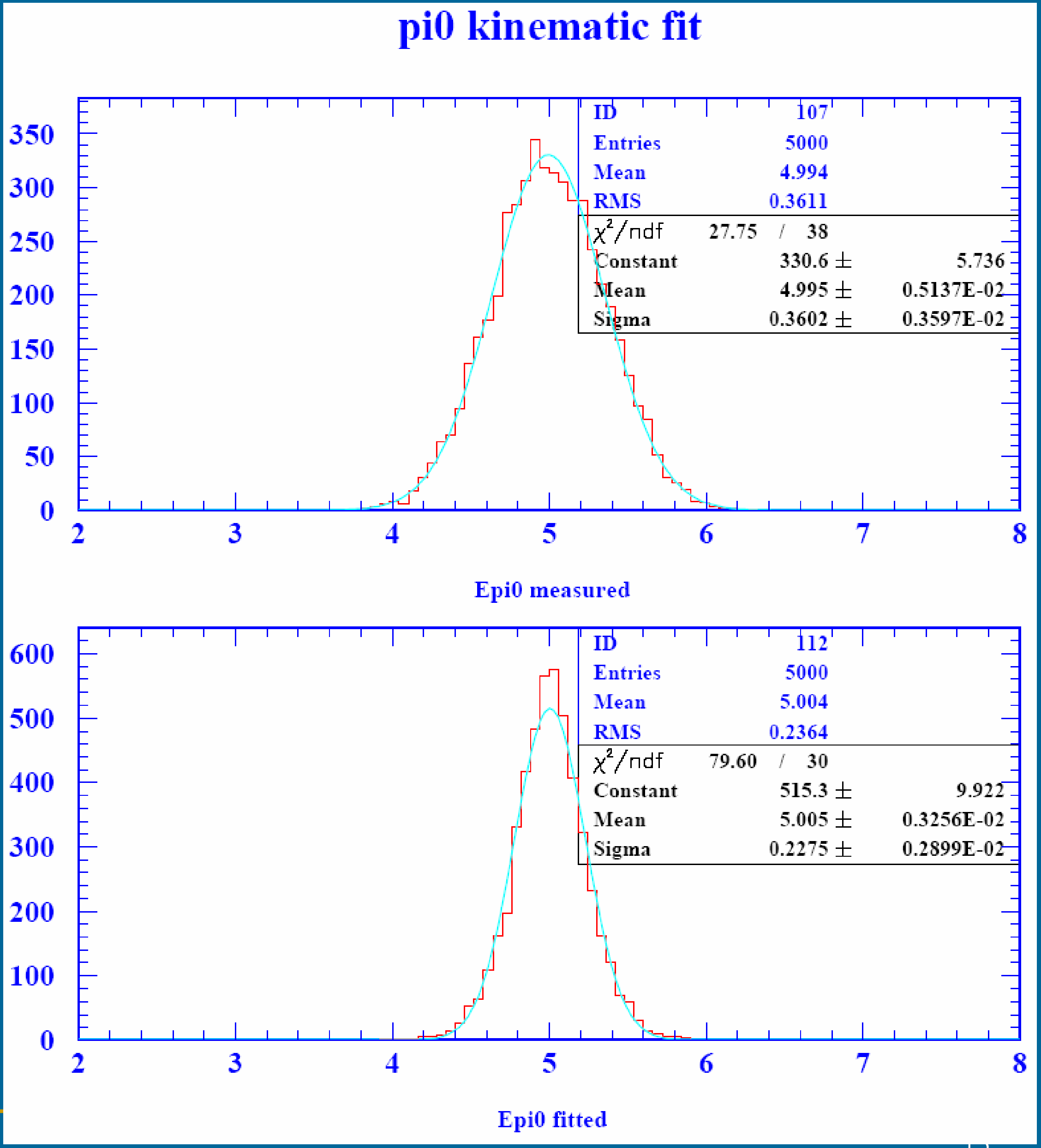


# $\pi^0$ energy

Measured

Fitted (improves from 0.36 GeV to 0.23 GeV)

(factor of 0.64 !!)



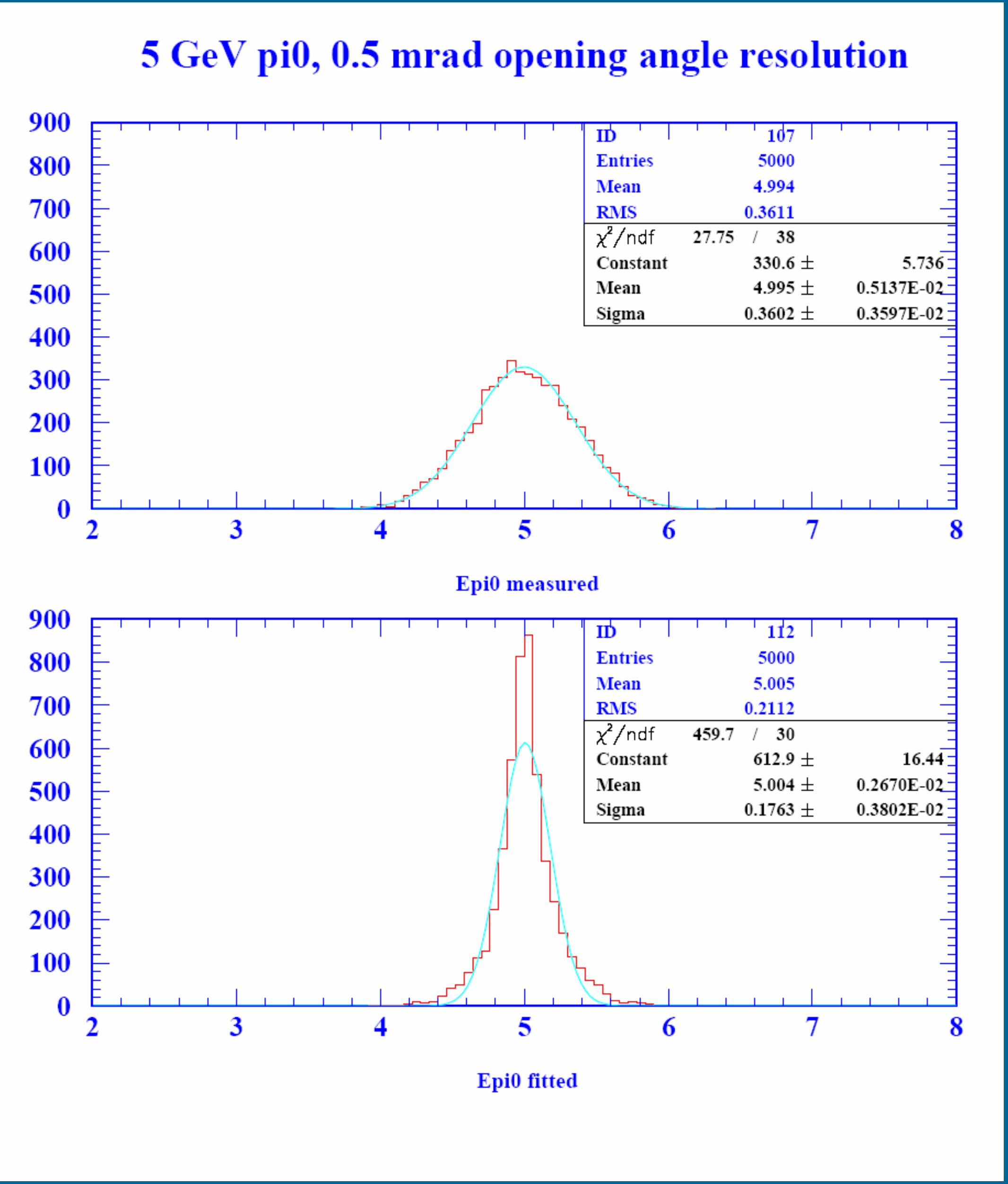
# $\pi^0$ energy resolution improvement

0.5 mrad $\theta_{12}$ resolution

Dramatic !

Factor of 2 for ALL asymmetries.

Large R helps too !



# LDC plans for Snowmass

| | |
|---|---|
| Aurora Savoy-Navarro | The SIT was introduced for track merging and for V0 efficiency reasons. These studies should be redone. Is the current SIT and SET layout optimal? Which role does the material play in the overall track reconstruction? |
| Lee Sawyer | How important is the FCH behind the TPC? Do we need stand-alone tracking capability in there, or is a simple device which adds one or two hits sufficient? Which technology is optimal for the FCH? |
| Alexei Raspereza | What is the possible particle flow performance? What have we achieved? |
| Mike Ronan | How important are gaps between the calorimeter components? How important are gaps between the calorimeters and other components such as the TPC? What is the penalty for a round TPC inside an octagonal ECAL? How efficient is the TPC for detecting backscattered particles? etc… |