CMS Phase I upgrades

LHCC September 2009 Meeting

Agreed at the May 2008 Upgrades Workshop
http://indico.cern.ch/conferenceDisplay.py?confId=28746

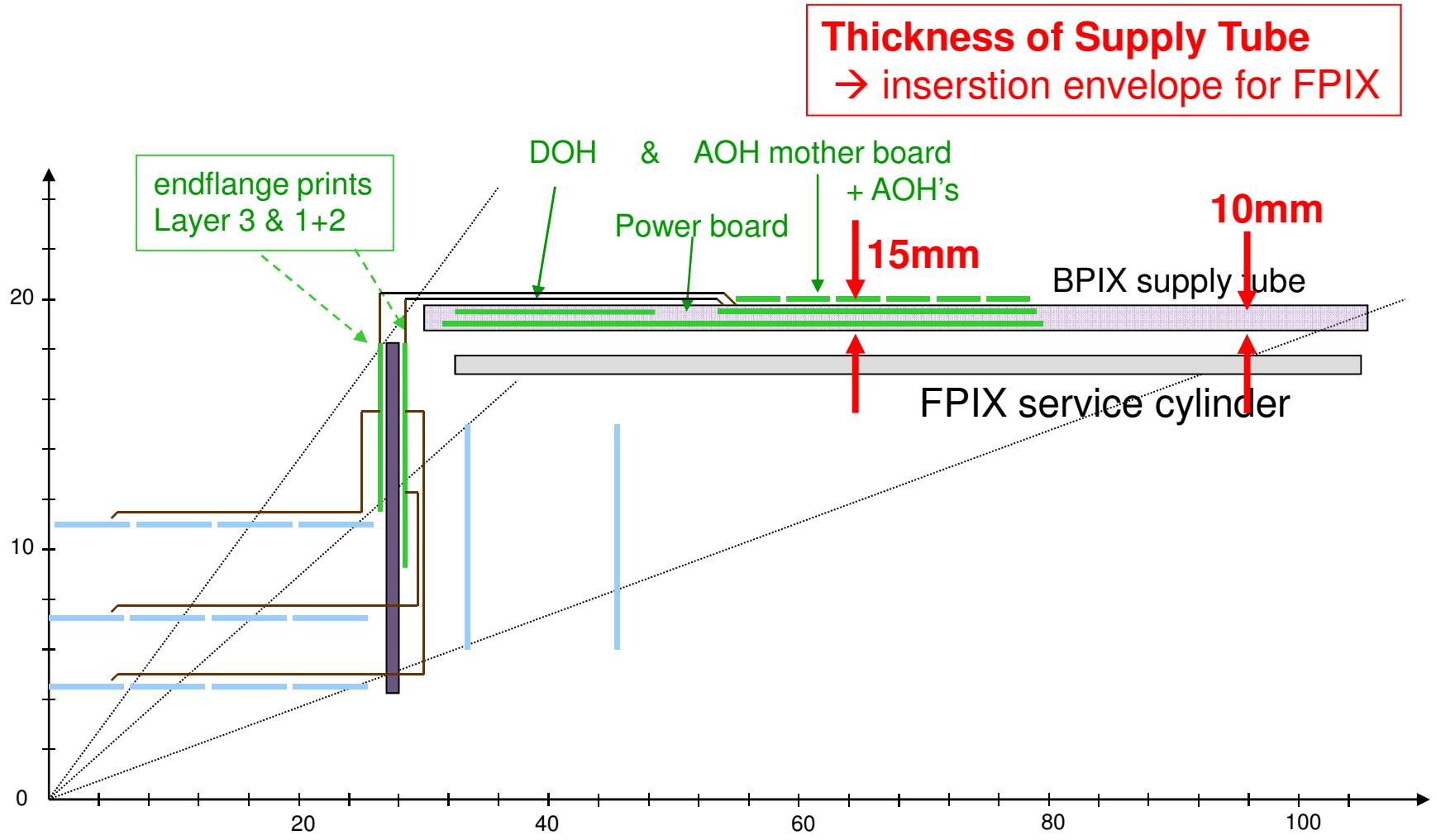
Upgrade Scope

System	Phase 1	Phase 2
Pixel	New Pixel Detector (1 or 2 iterations?)	
Tracker	FEDs?	New Tracking System (incl Pixel)
HCAL	Electronics + PD replacement	HF/HE?
ECAL	TP (Off Detector Electronics) ?	EE?
Muons	ME4/2, ME1/1 ,RPC endcap, Minicrate spares, some CSC Electronics	Electronics replacement
Trigger	HCAL/RCT/GCT to μTCA	Complete replacement

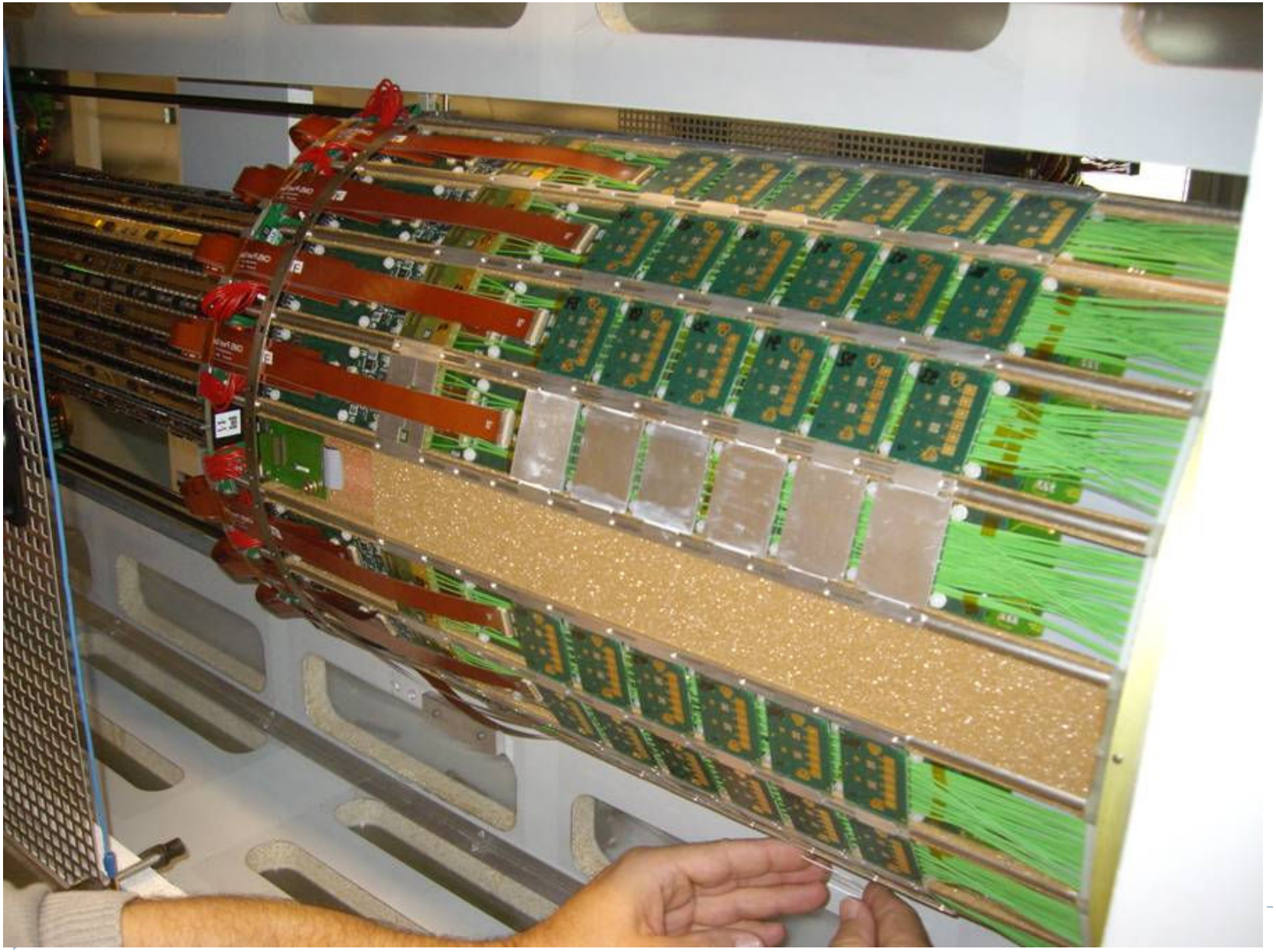
Phase I Upgrades issues

- Meeting at FNAL next month to discuss status of phase I and Phase 2 Upgrades
- For Phase I
  - Quantify physics improvements as a function of luminosity
  - Verify robustness for both peak and integrated luminosity
- For Phase 2
  - Major efforts in two areas which span multiple sub-systems
    - Incorporating the tracking in the Level 1 Trigger
    - Forward Calorimetry at high luminosity
  - Two cross-detector working groups set up
    - Regular meetings ongoing
    - Examine progress and plan work at the FNAL meeting
- For today:
  - Brief look at status of Phase I work, emphasis on areas near the beampipe

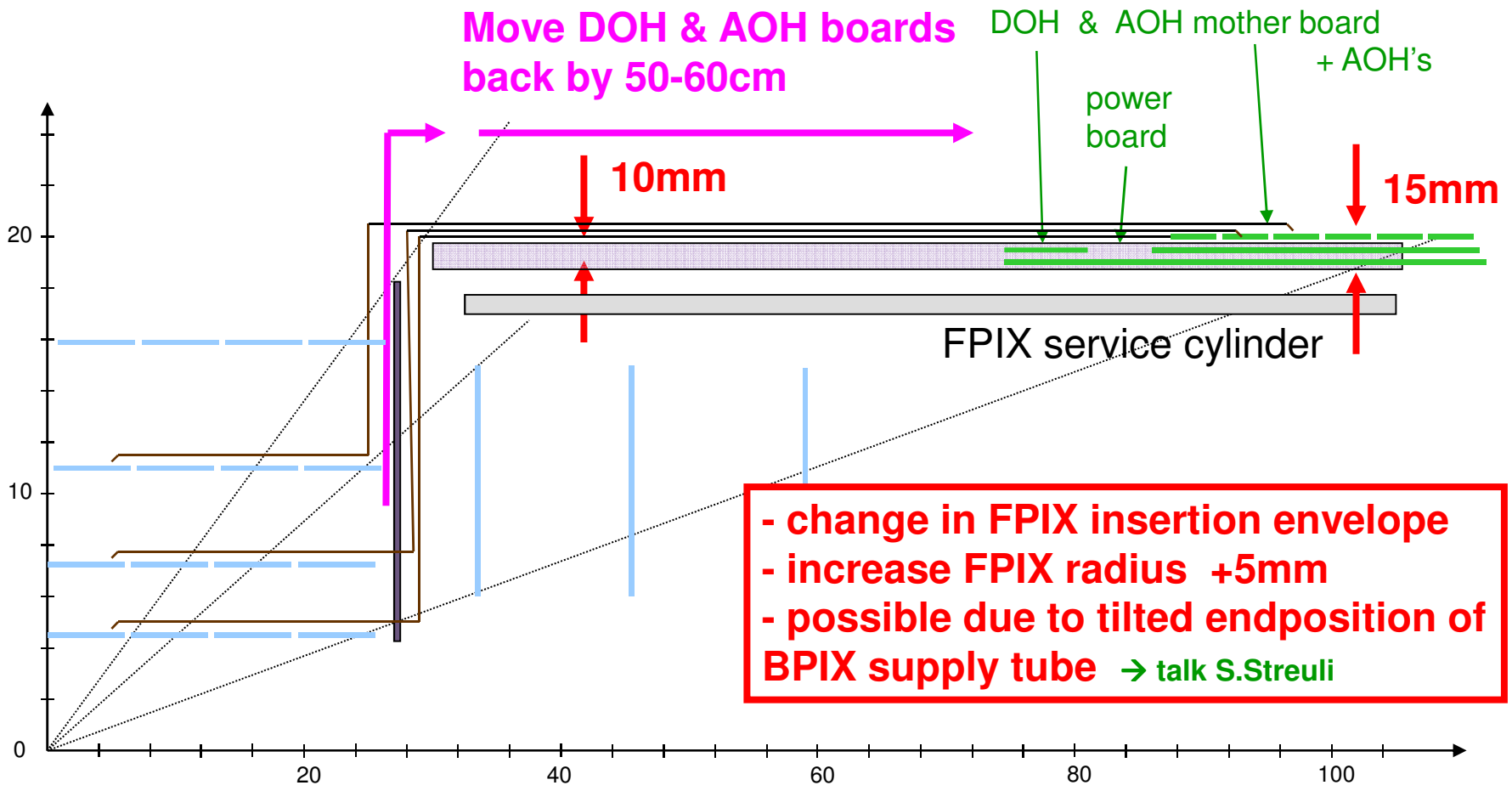
Current Pixel System with Supply Tubes / Cylinders



BPIX & Supply Tube with AOH, DOH, PCBs & Fibres

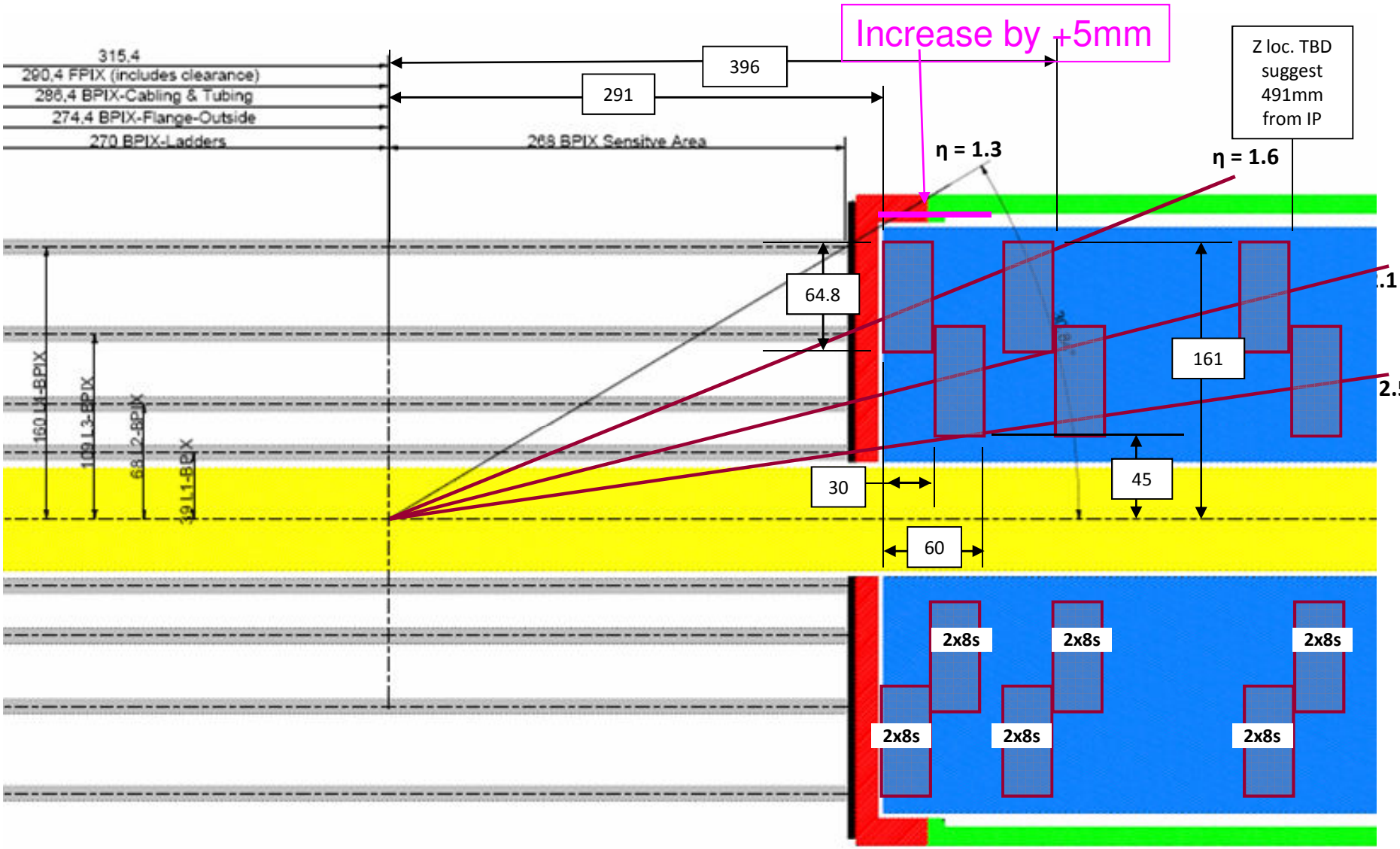


Shift Material out of tracking Volume



→ new BPIX modules with long pigtails (~0.95m) (→ micro-twisted pair

BPIX / FPIX Envelope Definition for 4 Hit Pixel System

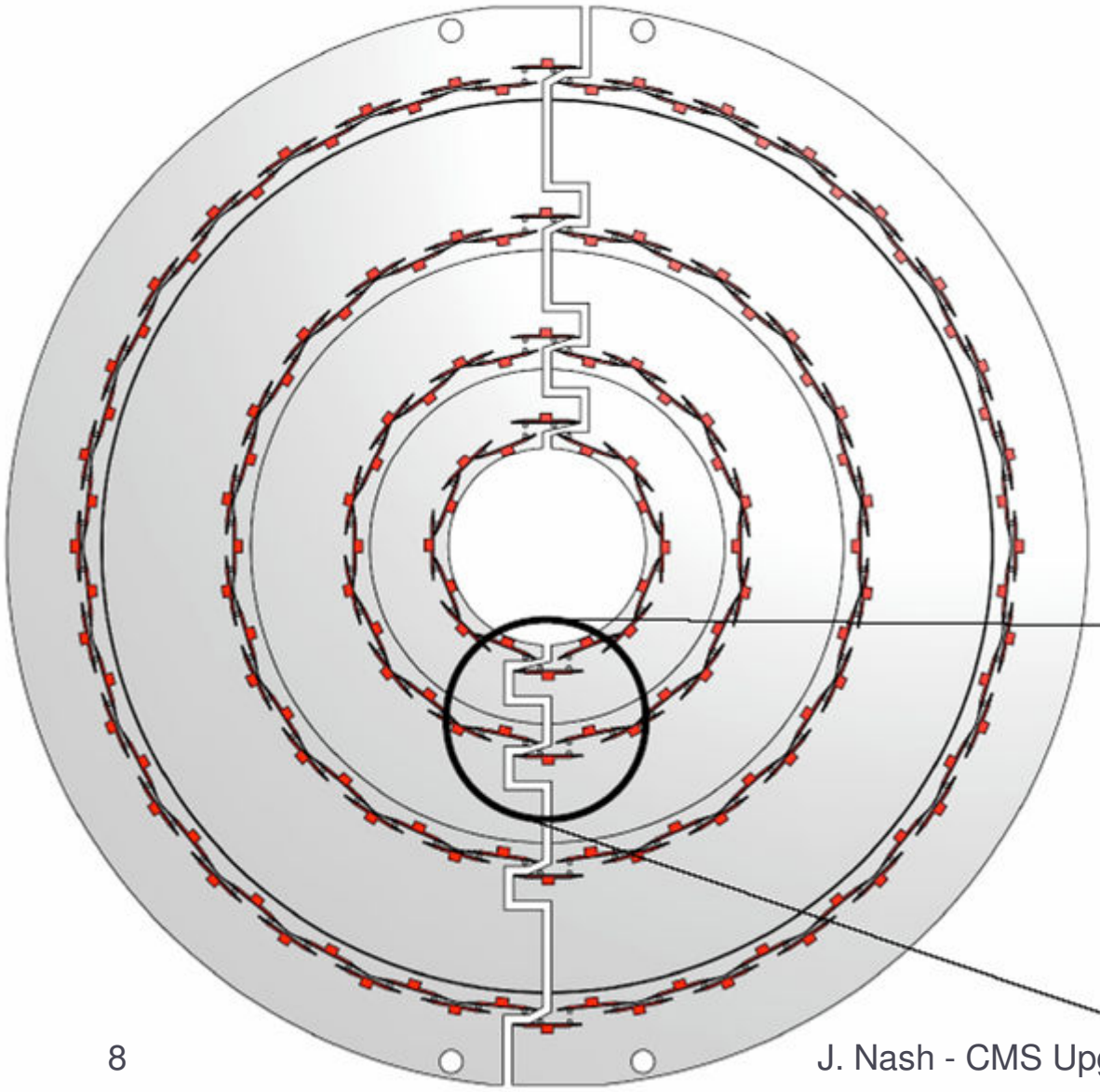


All Identical disks (1st and 2nd disks in locations to maximize 4-hit eta coverage)

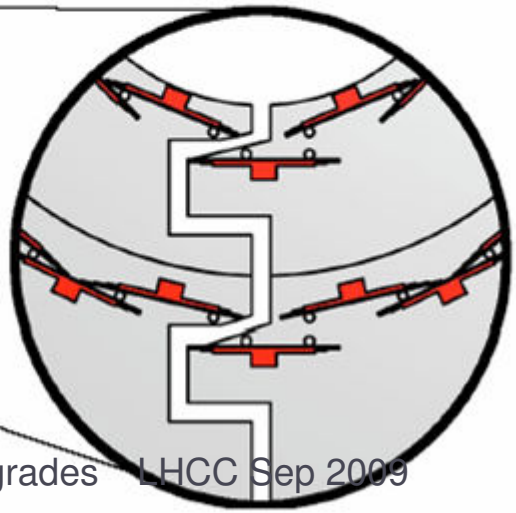
6 disks = (6x68) outer + (6x44) inner = 672 2x8 modules (10752 ROCs)

BPIX Upgrade Phase 1 (2013)

→ **1216 modules**
(1.6 x present BPIX)

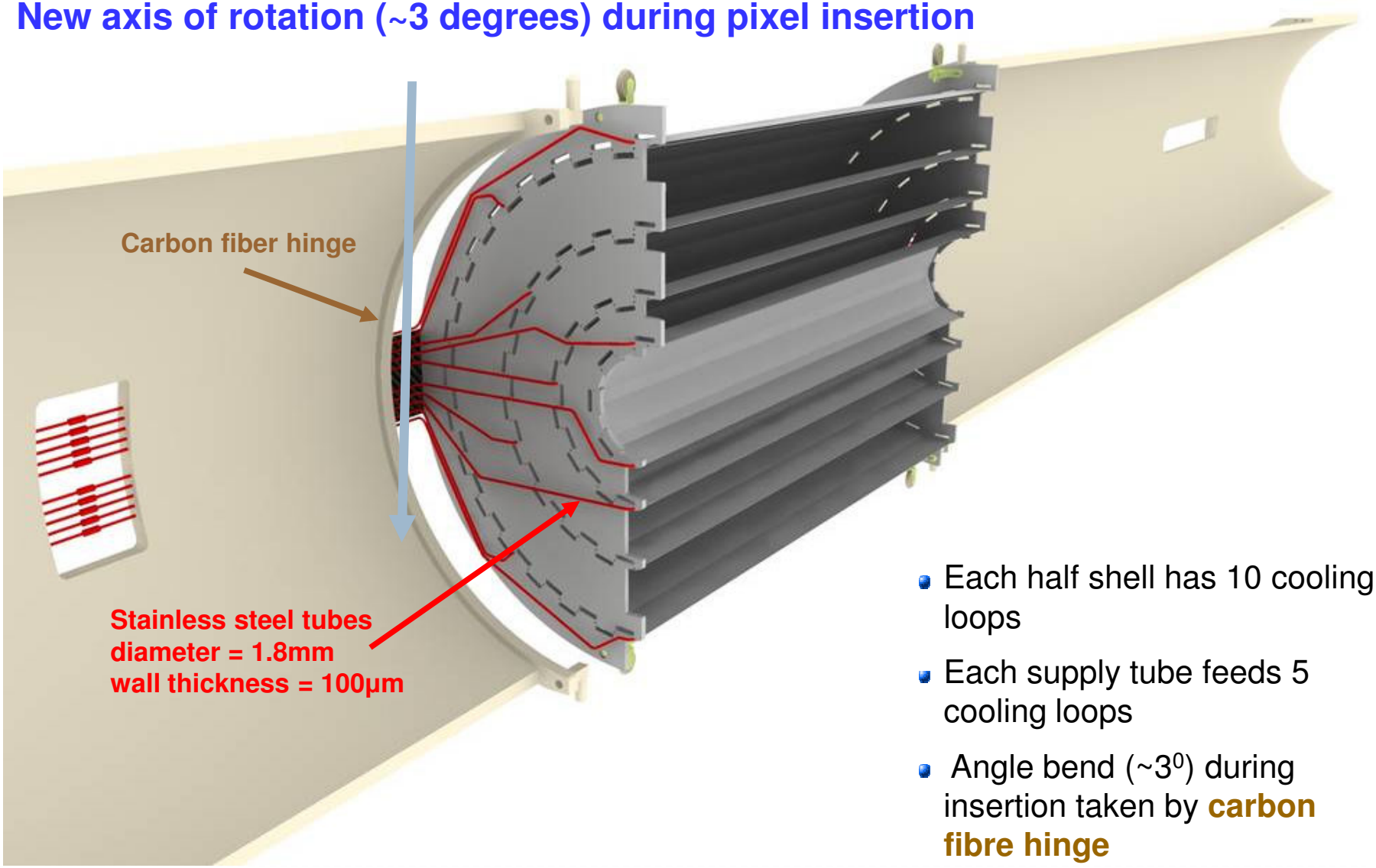


- Two identical half shells
- 1 type of fullmodule only
- Layer 1: R 39mm; 16 faces
- Layer 2: R 68mm; 28 faces
- Layer 3: R 109mm: 44 faces
- Layer 4: R 160mm: 64 faces
- Clearance to beampipe 4mm



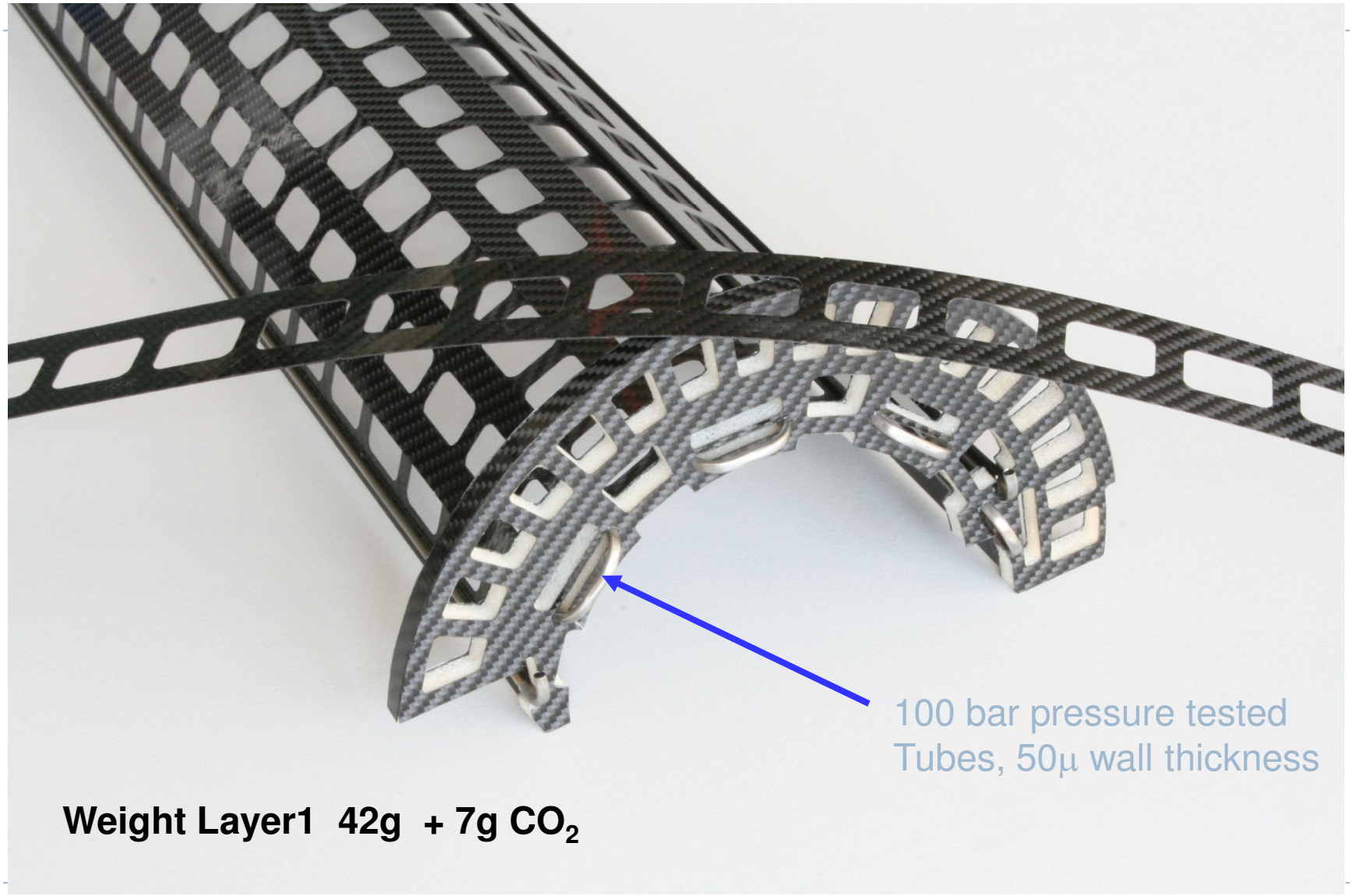
Inertion of BPIX – Supplytube System with new CO2 Cooling

New axis of rotation (~3 degrees) during pixel insertion



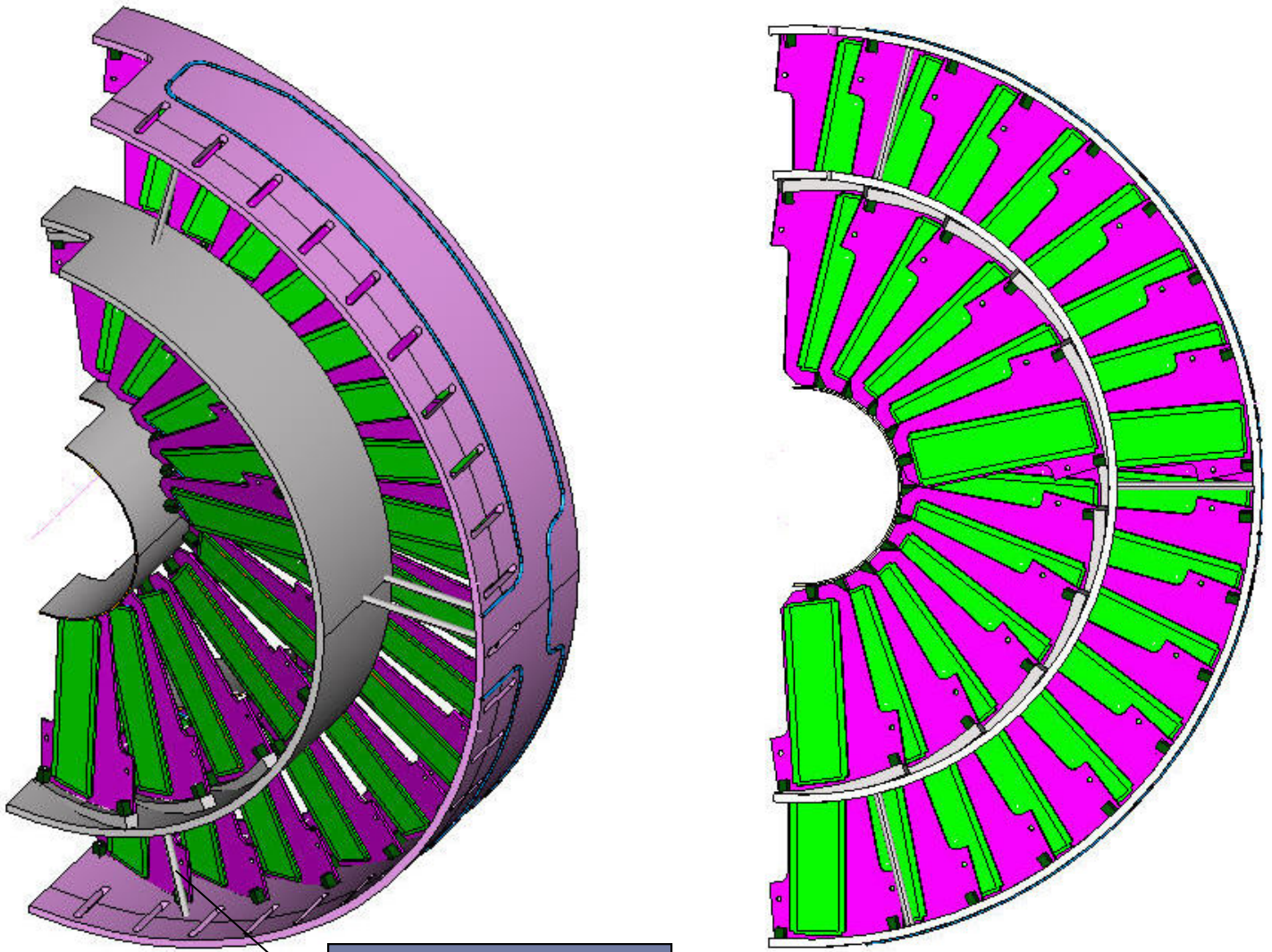
- Each half shell has 10 cooling loops
- Each supply tube feeds 5 cooling loops
- Angle bend (~3^0) during insertion taken by **carbon fibre hinge**

Prototype Fabrication Layer 1

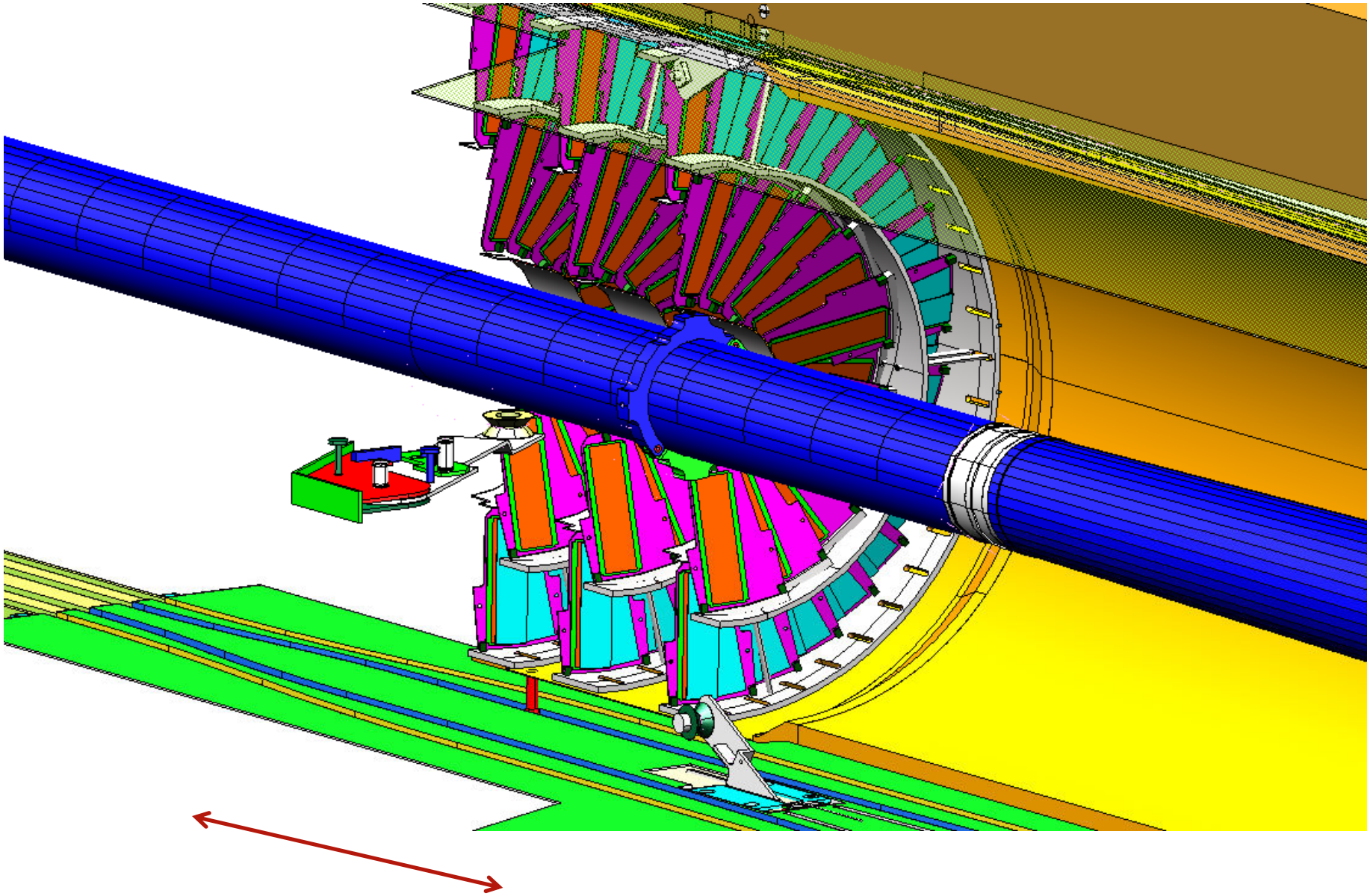


Weight Layer1 42g + 7g CO_2

The Half Disk (to be completed)

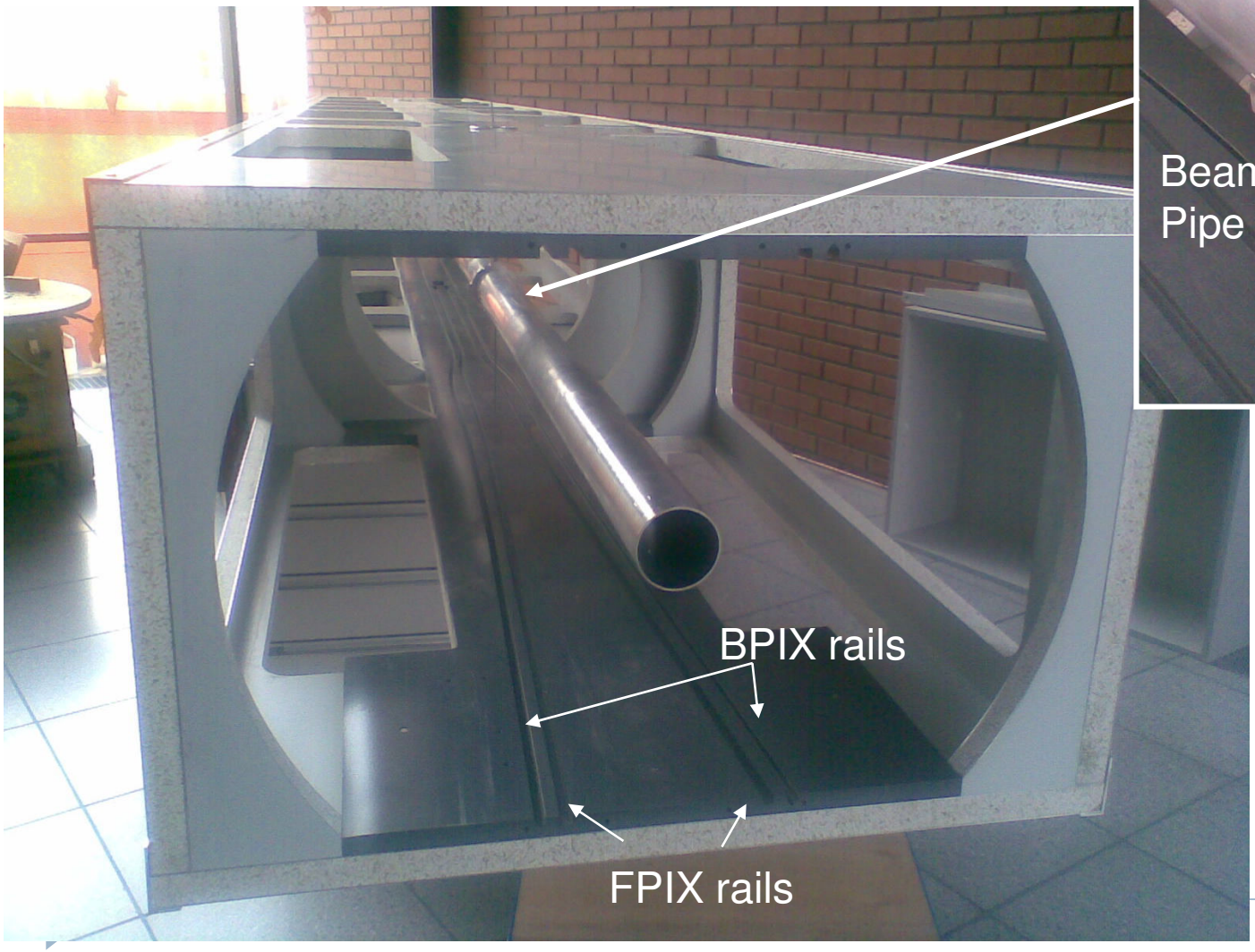


Carbon fiber supporting spokes

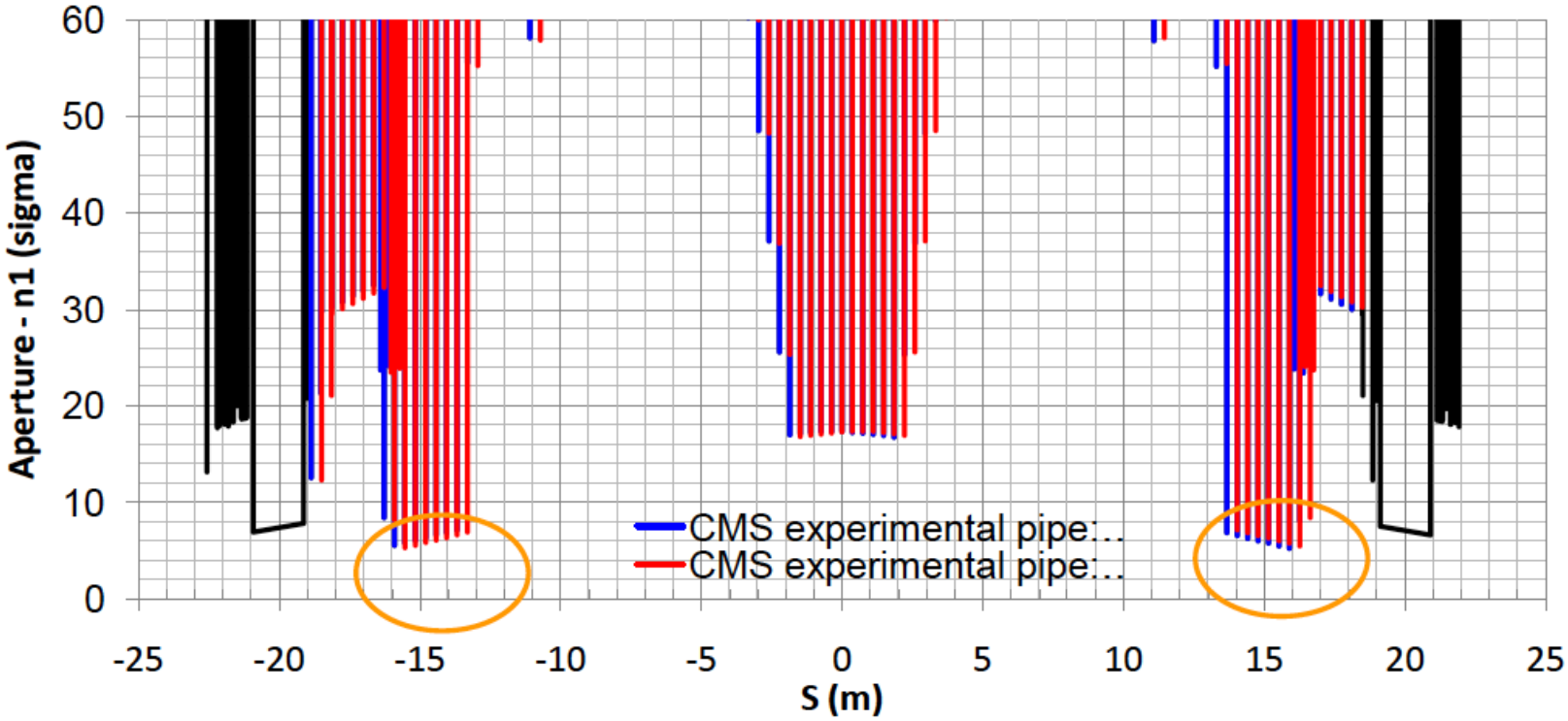


Checking for clearance as the FPix half-cylinder slides along insertion rails

Mock-up of CMS interaction region for insertion tolerance tests



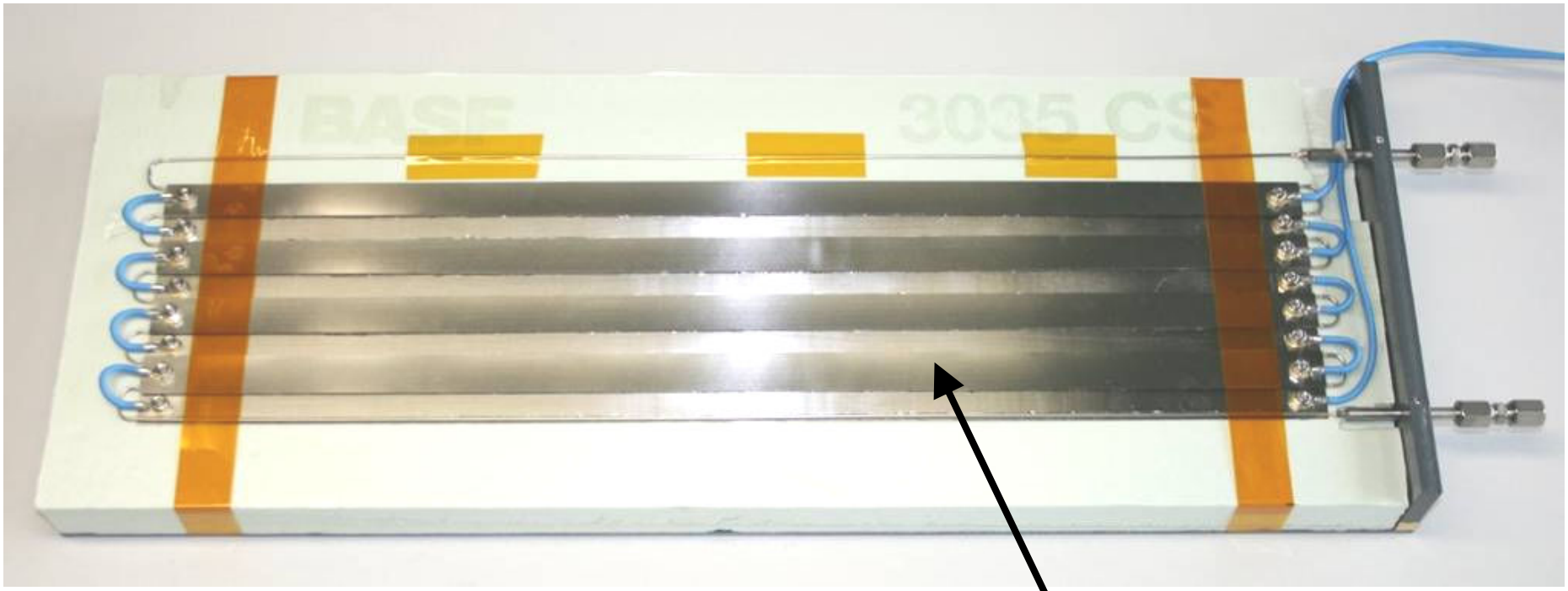
Aperture at CMS: injection, 450 GeV



M. Giovannozzi

Reducing tolerance from 15 mm to 11 mm increases n1 by 4.5 σ (far from the IP) and up to 8.9 σ (next to the IP). This puts the spotlight on the CT2 section of the pipe

Test of long CO2 cooling loop (as in Layer 1)

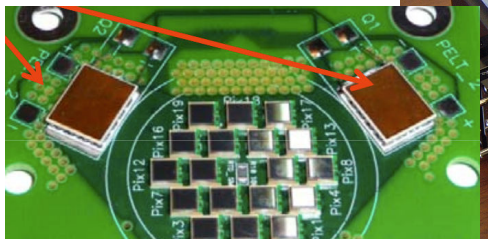


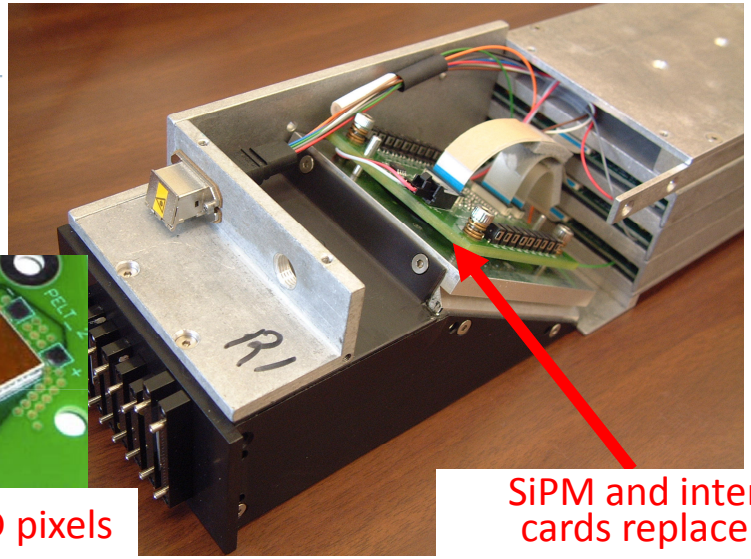
- **Cooling loop of layer 1 for CO2 tests at CERN**
- **CO2 Teststand (H.Postema & A. Onnella, CERN)**
- **Tests for individual Temp. distribution at Lyon**

Stainless steel facets used as heater resistors to simulate the power consumption of the sensor modules.

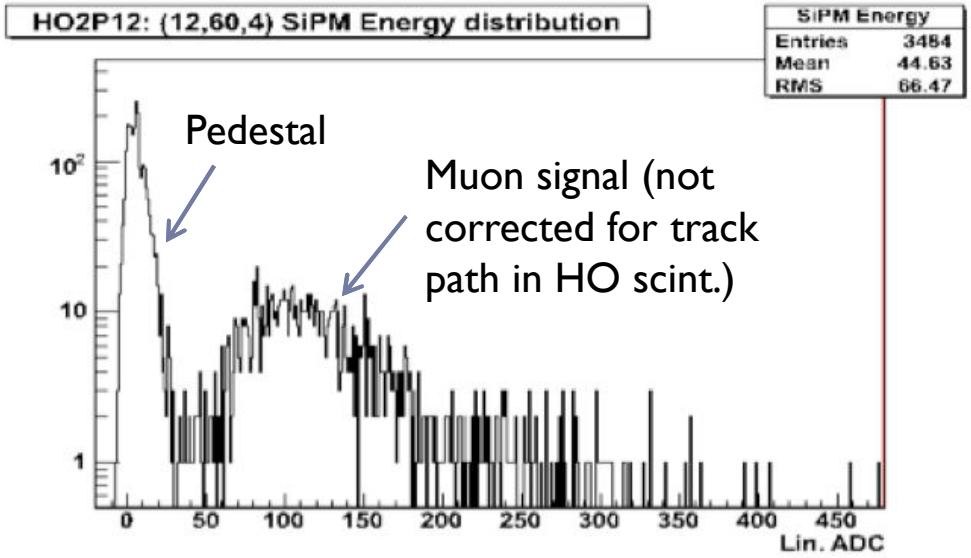
SiPMs in HO

- 2RBXs (144 channels) are instrumented with SiPMs to confirm suitability for HO
- Packaged to replace HPD in existing RM
- Two suppliers:
- Hamamatsu (400 pix/mm^2)
- Zecotek (15K pix/mm^2)





- Compared in 2009 Test Beam
- S/B much higher than HPD
- Insensitive to B-field
- But gain is temperature-dependent
- Consider replacement for HPDs in R1/2 in during 2011 shutdown



SiPM in B-field

Variation is consistent with temperature change:

Hamamatsu
gain changes 8-10% per deg

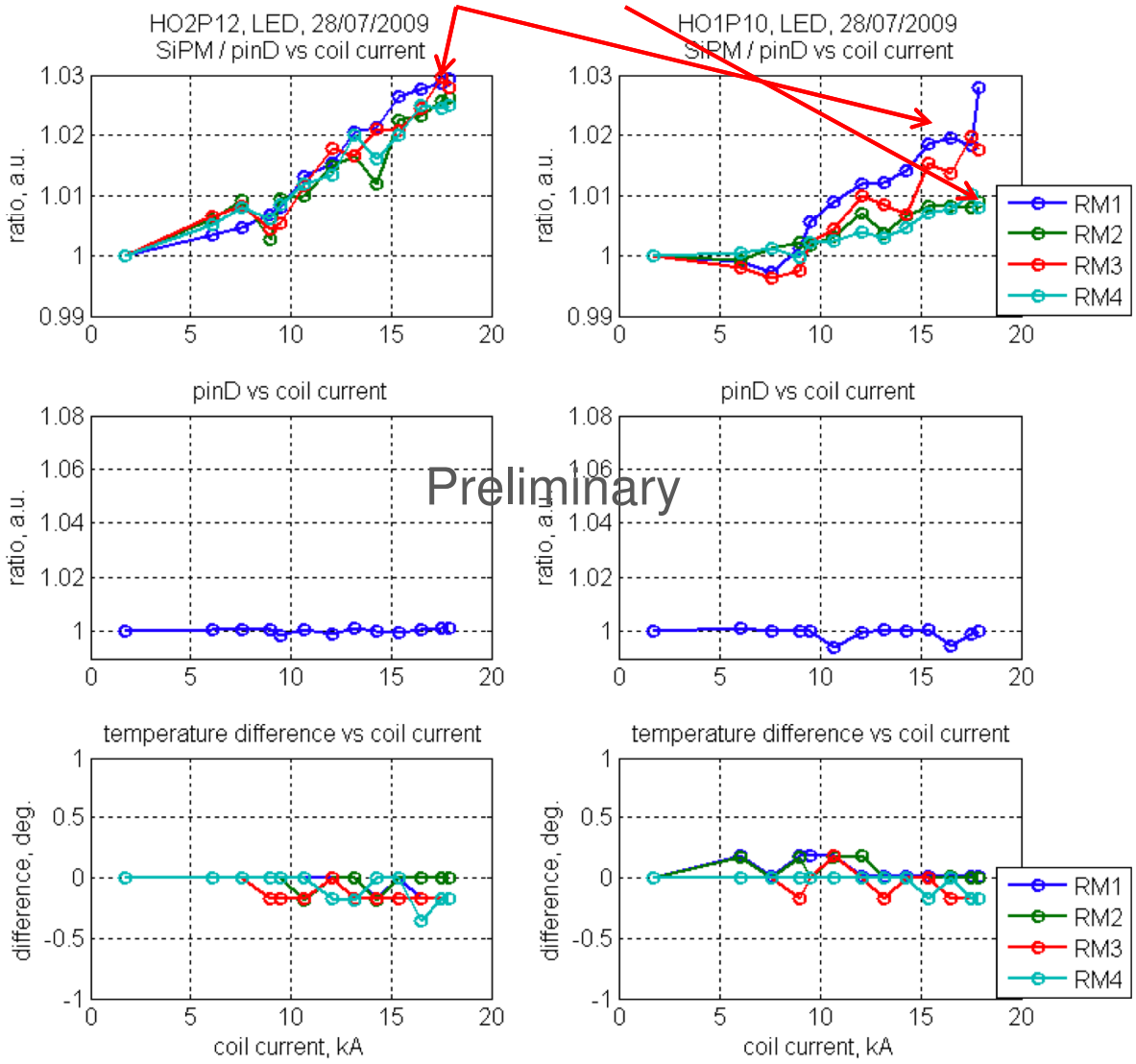
Zecotek
4-5% per deg

Two changes needed:

Will want better temp precision (currently 1bit=0.2deg)

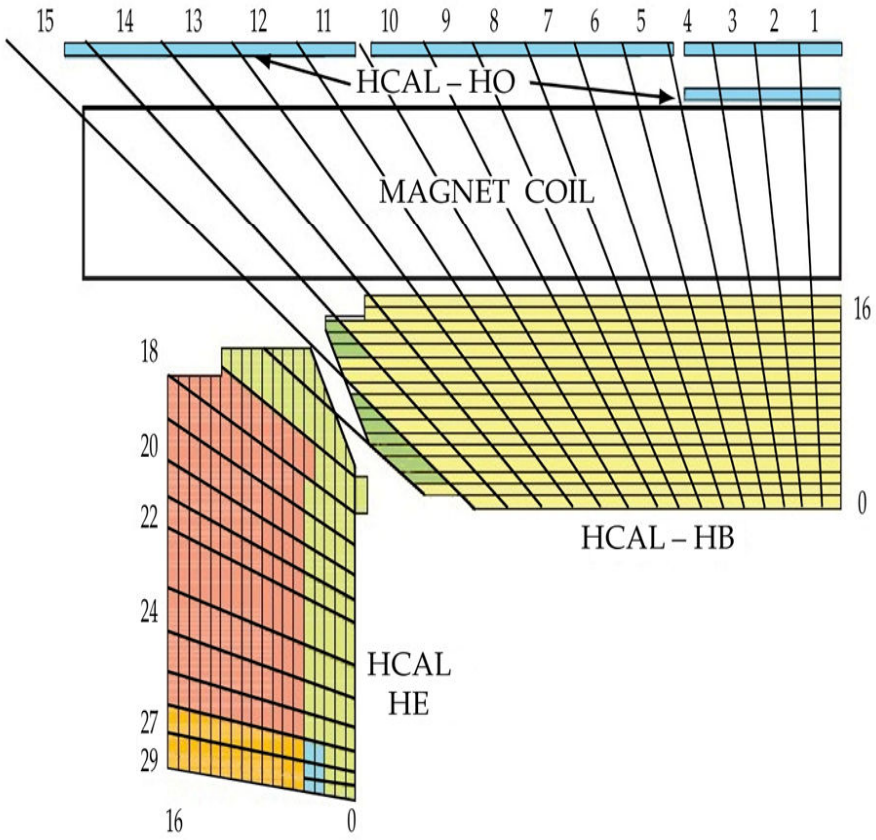
Also, cross-talk to a specific few channels from control lines - likely an easy board modification

LED data: SiPM/pinDiode

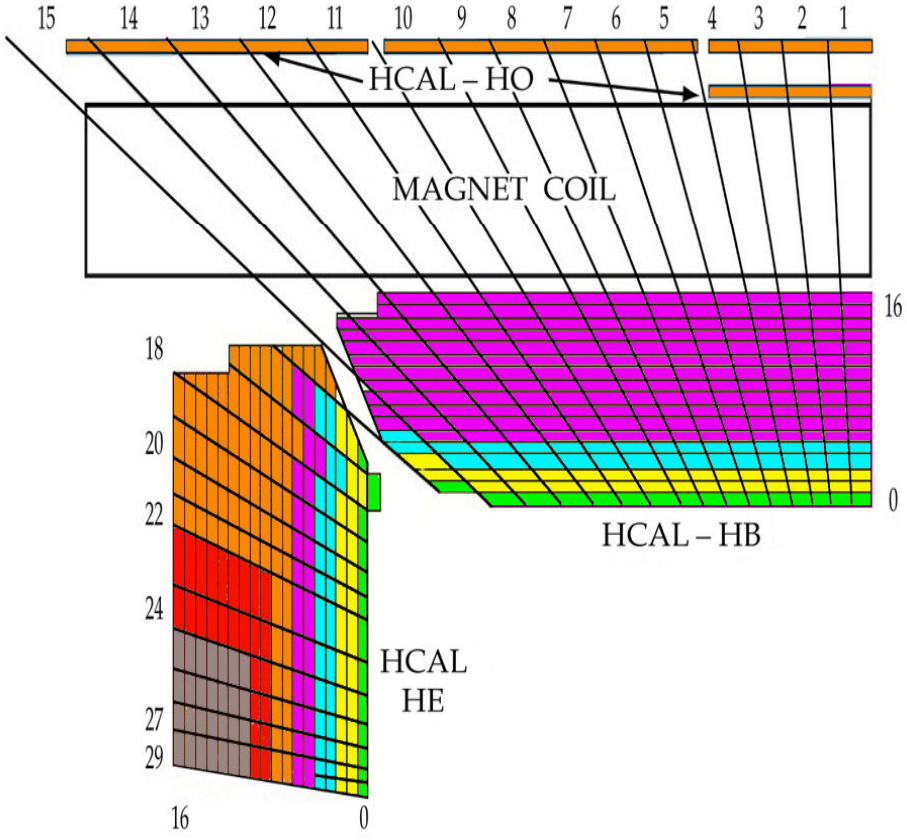


More Depth Segmentation in HCAL

Current
18-Channel RMs

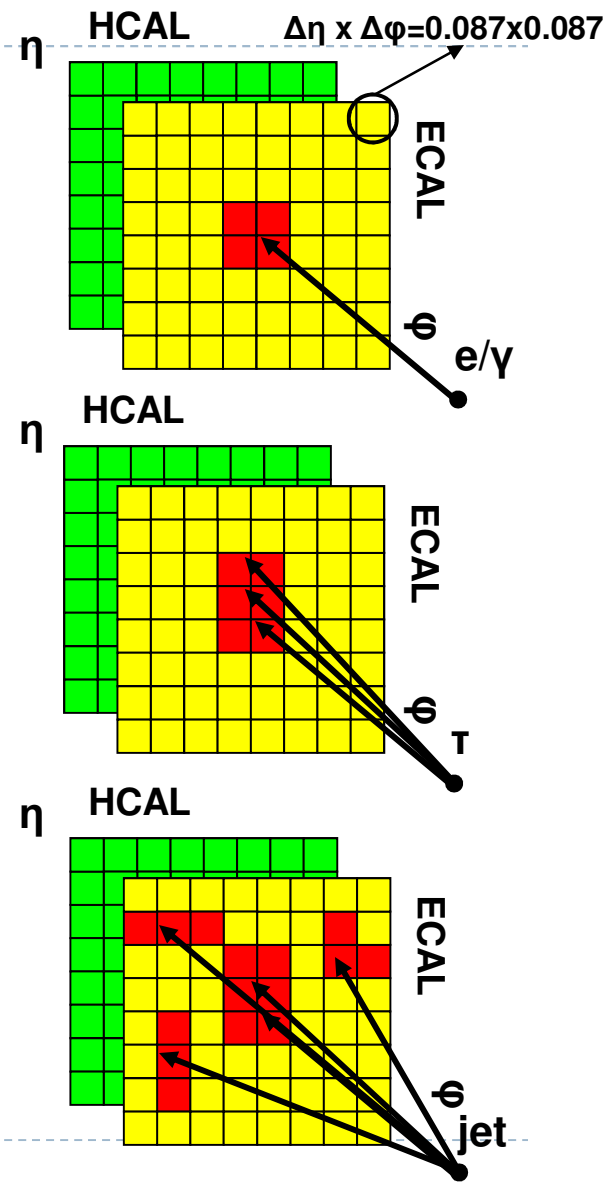


Upgrade
64-Channel HB RMs
48-Channel HE RMs



Calorimeter signatures

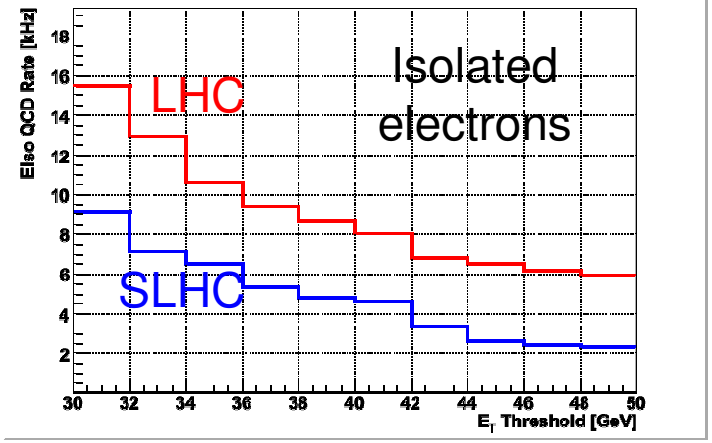
- Electrons/Photons
  - Spatially confined in a cluster of 2x2 trigger towers
  - Significantly higher ECAL contribution
  - Isolated e/γ should have low energy deposits in the surrounding area
- **Taus**
  - **Confined in 2x3 Clusters**
    - **3 prongs/1 prong + π^0s have wider φ profile**
  - **Small energy leak in surrounding towers**
- **Jets**
  - **Most of the energy confined in a central core**
  - **For jets over 20 Gev the energy is included in a 8x8 region**

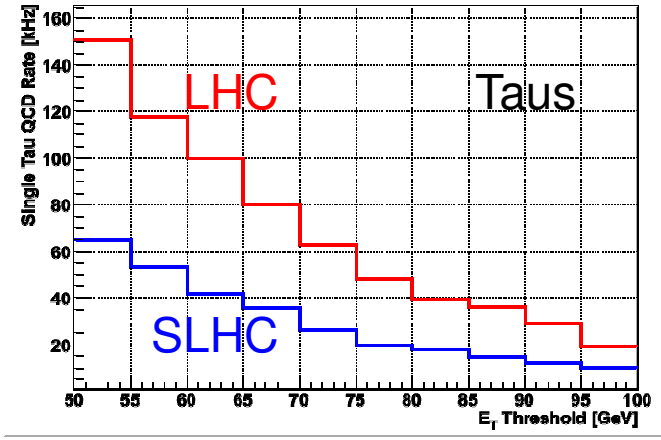


Phase I Calorimeter Trigger Simulation Results: Factor of 2

Michalis Bachtis & Kevin Flood

QCD Rate (kHz)

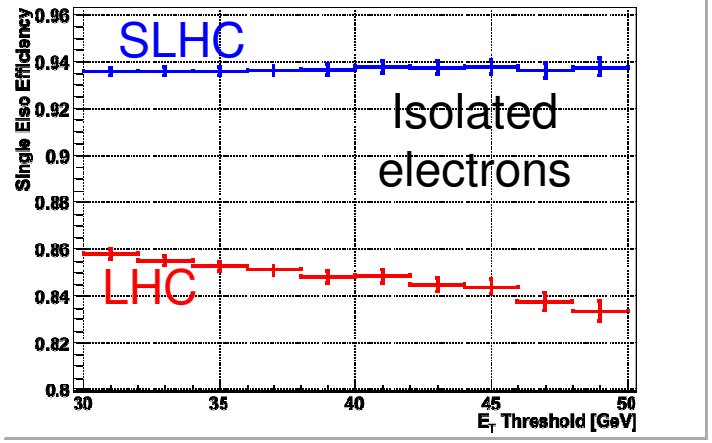


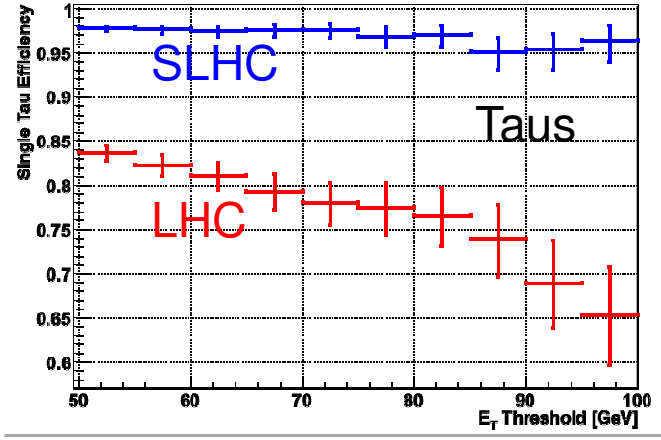


QCD Rate (kHz)

Factor of 2 rate reduction

Efficiency

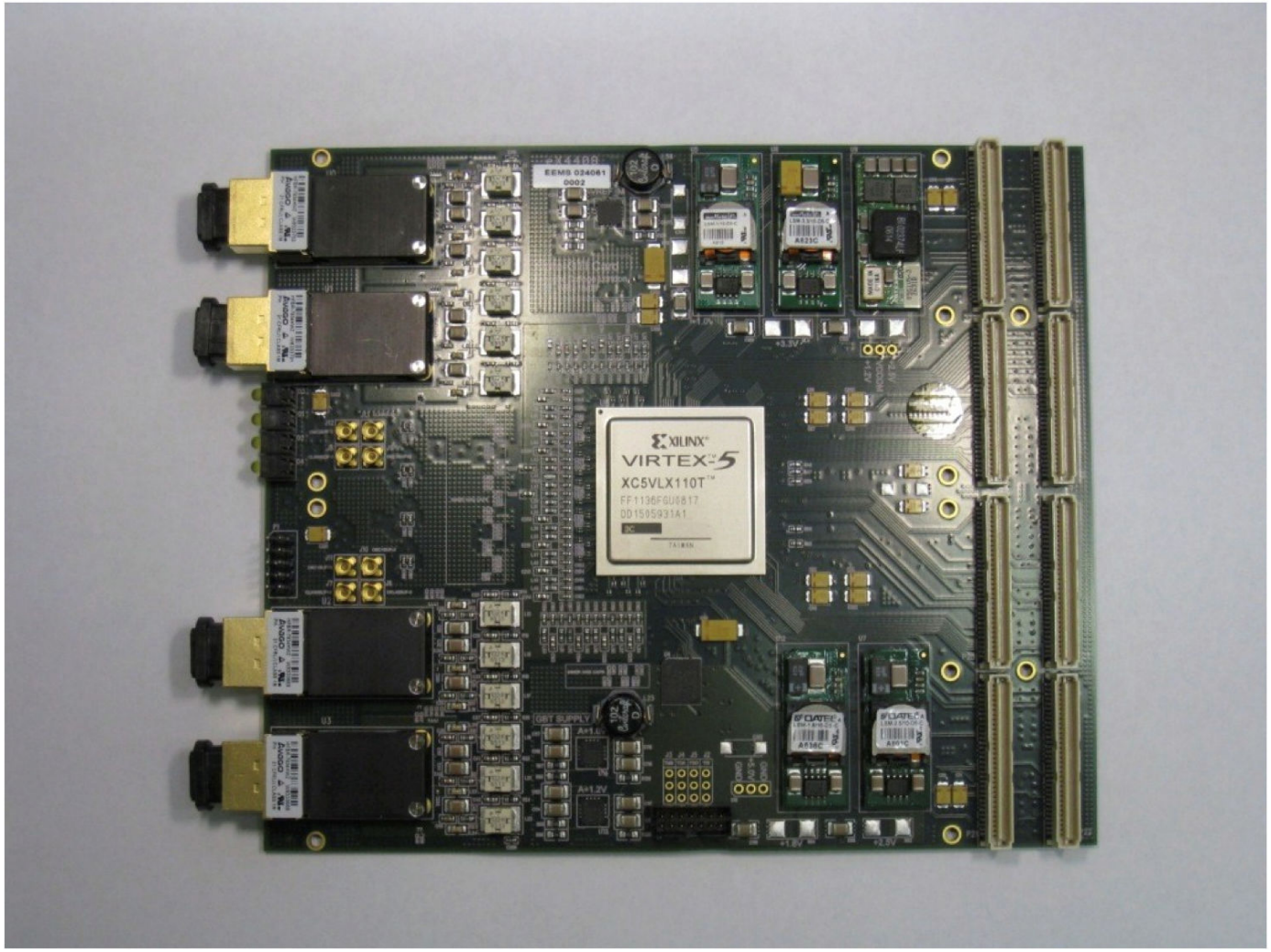




Efficiency

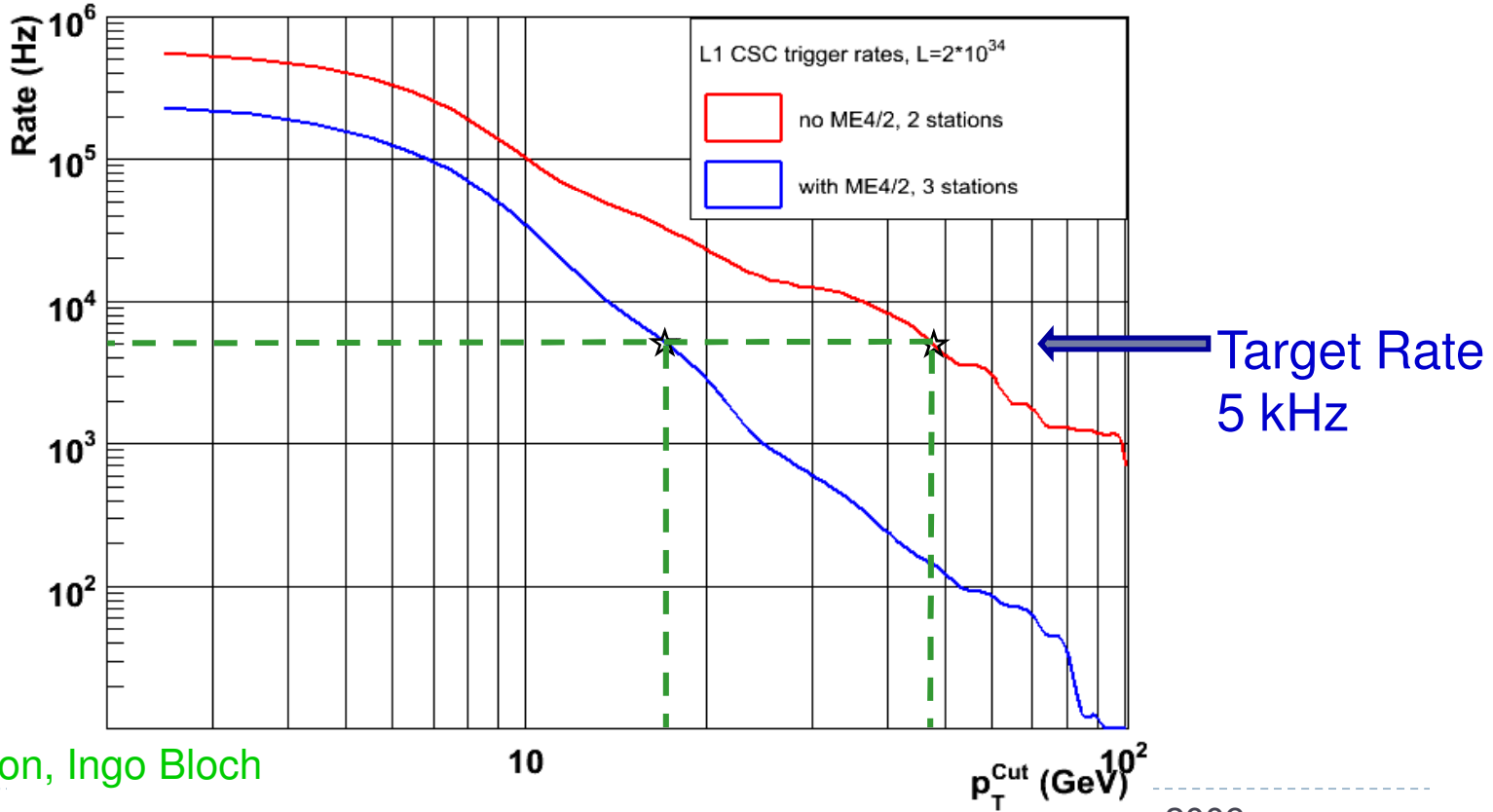
Higher Efficiency

Hardware prototype for new trigger architecture



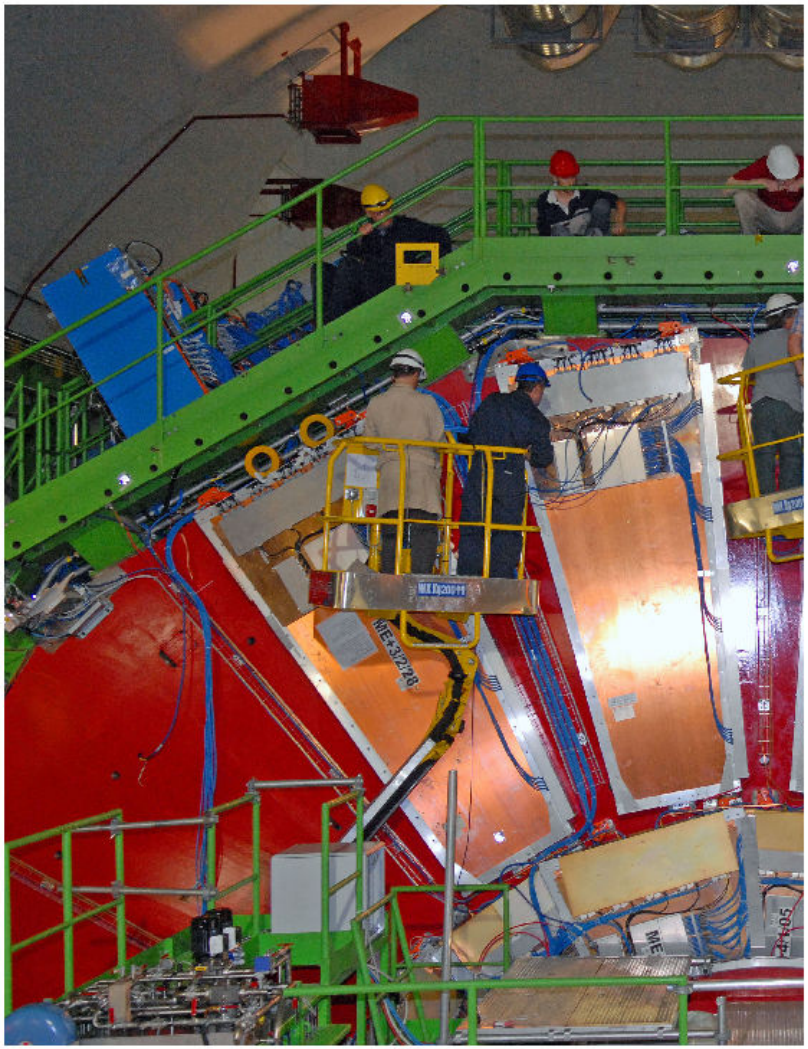
Phase 1 : Muons ME4/2 upgrade motivation

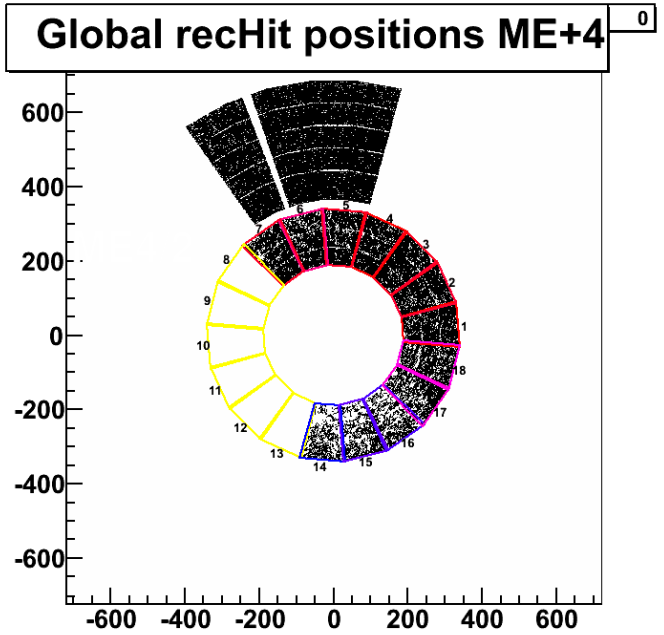
- Compare 3/4 vs. 2/3 stations:
  - (Triggering on *n* out of *n* stations is inefficient and uncertain)
- Recent simulation with & without the ME4/2 upgrade:
  - The high-luminosity Level 1 trigger threshold is reduced from 48 → 18 GeV/c

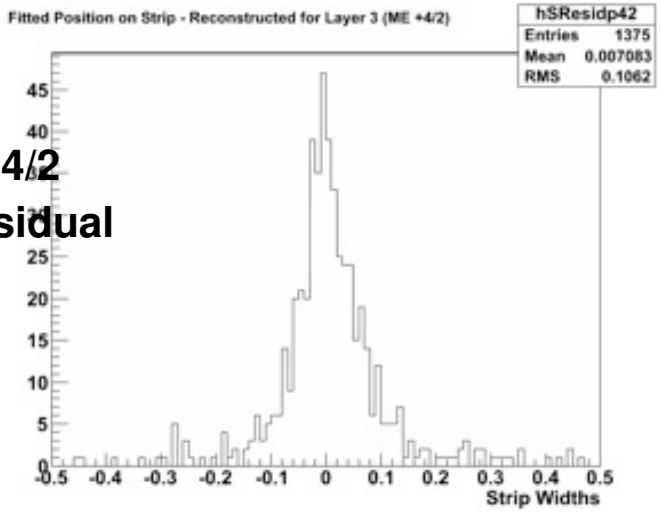


Rick Wilkinson, Ingo Bloch

Five ME+4/2 chambers installed



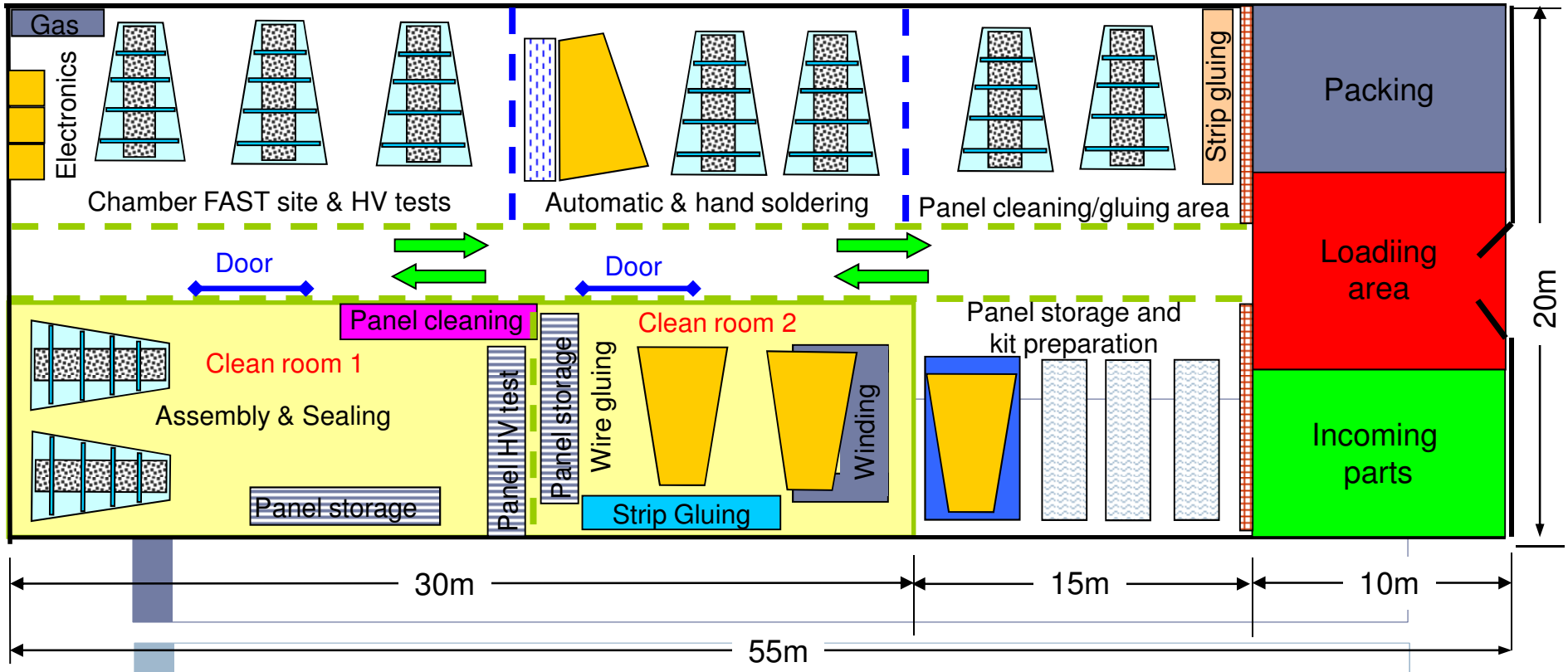




ME4/2 Residual

CSC Factory Production Site at CERN

Floor plan layout at Bldg 904 (Draft)



Based on experience of ME4/2 prototype production the proposed area at 904 of ~ 1000 m2 should be enough to place a factory production and FAST test site. For the completed chambers we need additional storage area of ~ 250m^2.

Conclusions

- Phase I work progressing well
- Understanding of the issues surrounding the beampipe is well advanced
- Major meeting in October to look at how we go forward