ATLAS Muon Detector Upgrade

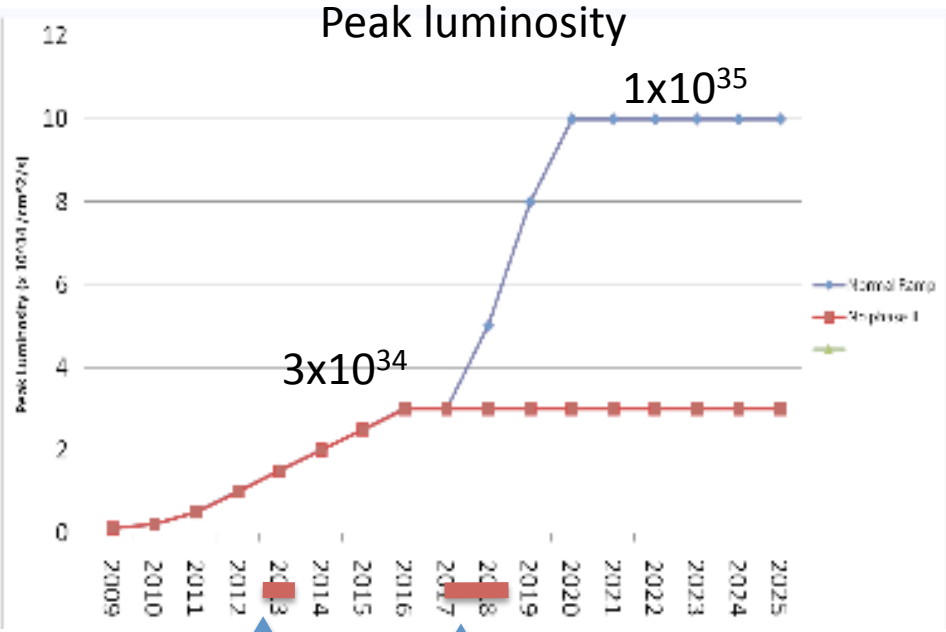
T. Kawamoto

3rd LHC Detector Alignment Workshop

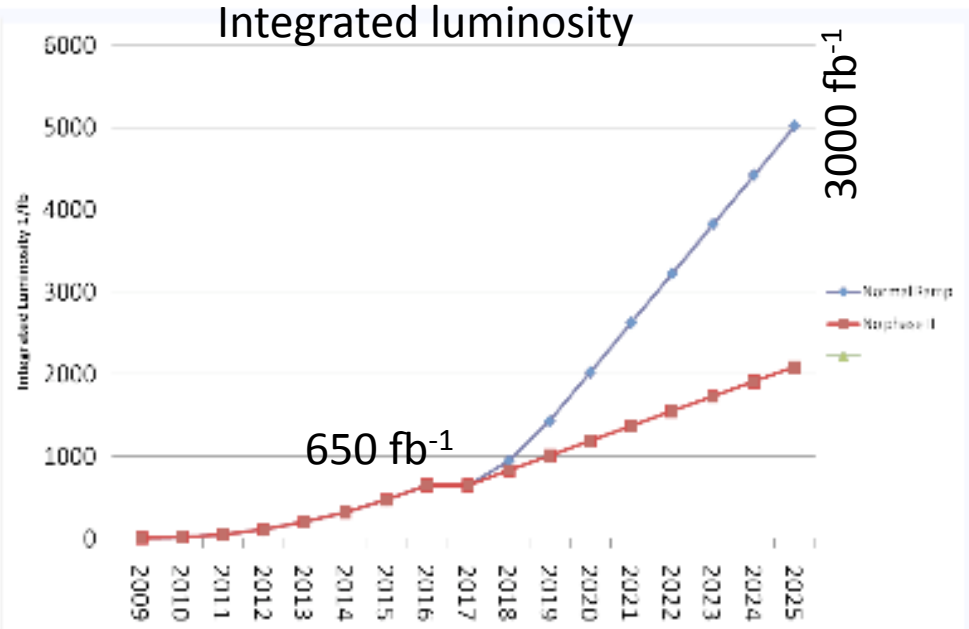
16.06.2009

Machine upgrade scenario

Peak luminosity



Integrated luminosity



Phase-2 : New IP (multiple scenarios)

Phase-1 : New large aperture triplet, new LINAC4

New Pixel B-layer

Horizontal axes are indicative only

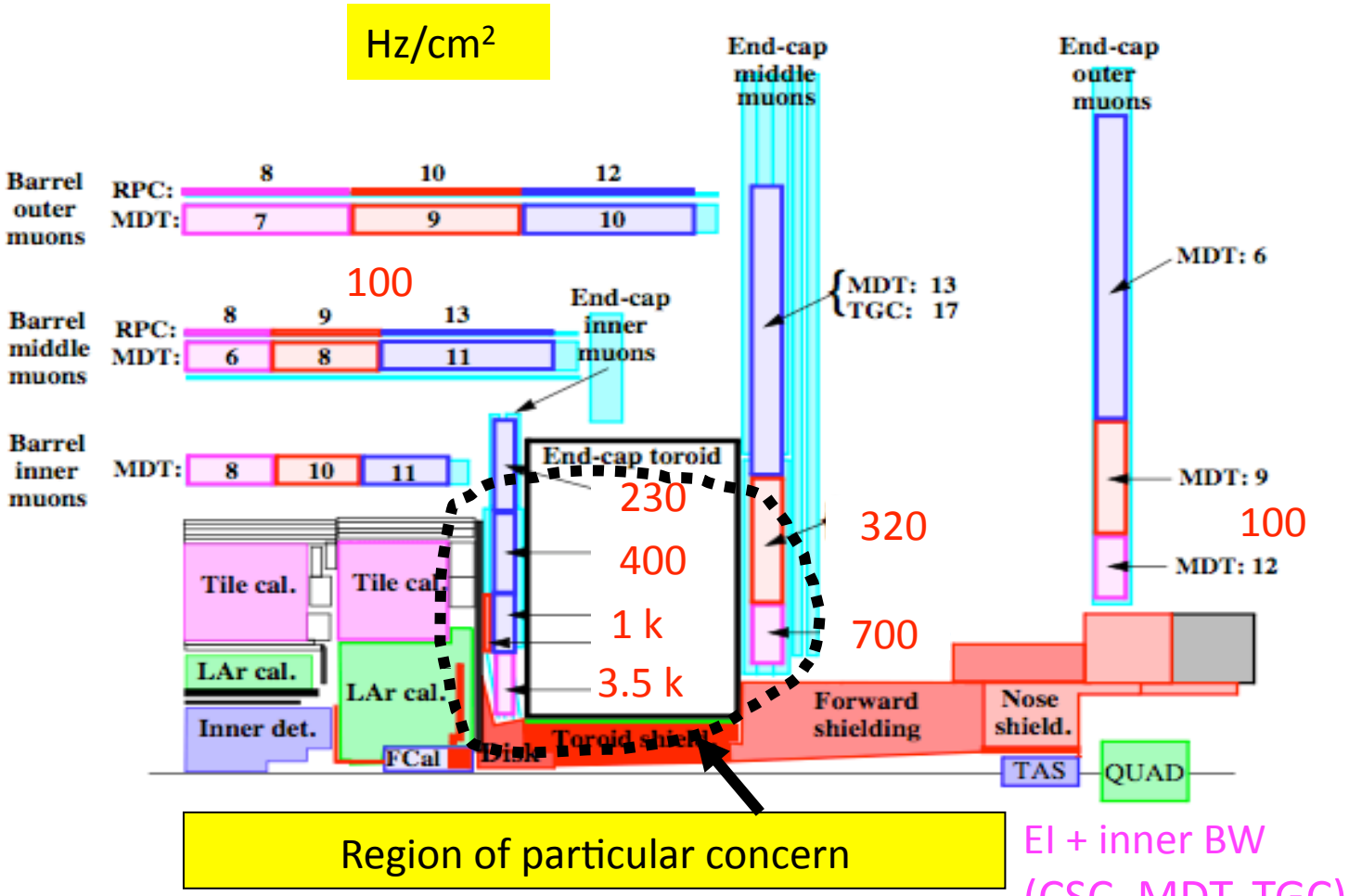
2 long shutdowns,
occasion to do anything major to be prepared to the condition of the following period.

Implications for the muon detector

- x10 cavern background
  - Deterioration of tracking performance (in some corners)
- x10 physics rate
  - L1 trigger rate exceeds the limit
- and many other problems
  - radiation damages, data band-width, etc

Cavern background

Estimated cavern bkg rate : $L=10^{34} \times 10$



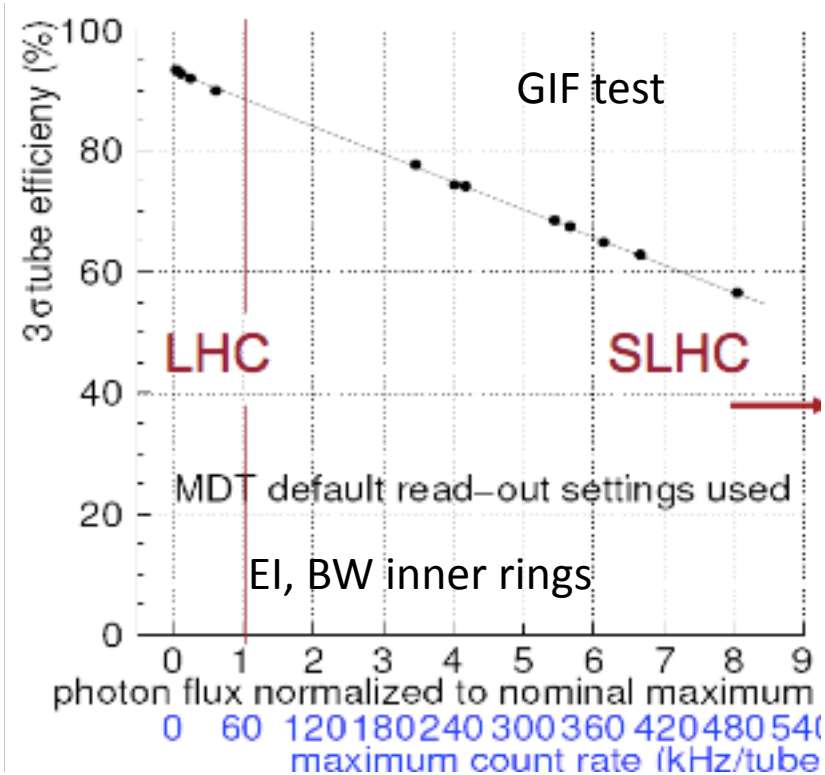
Region of particular concern

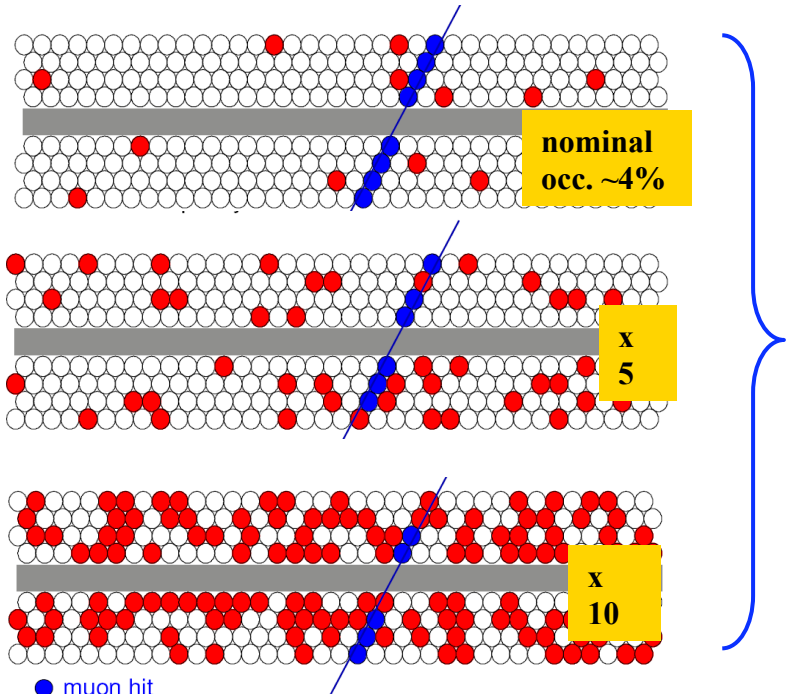
EI + inner BW
(CSC, MDT, TGC)

MDTs in the high rate region

Present MDT : 30mm diameter

max drift time = 700 ns





Large reduction of single hit eff.

Increase of bkg occupancy

→ Need faster tracker

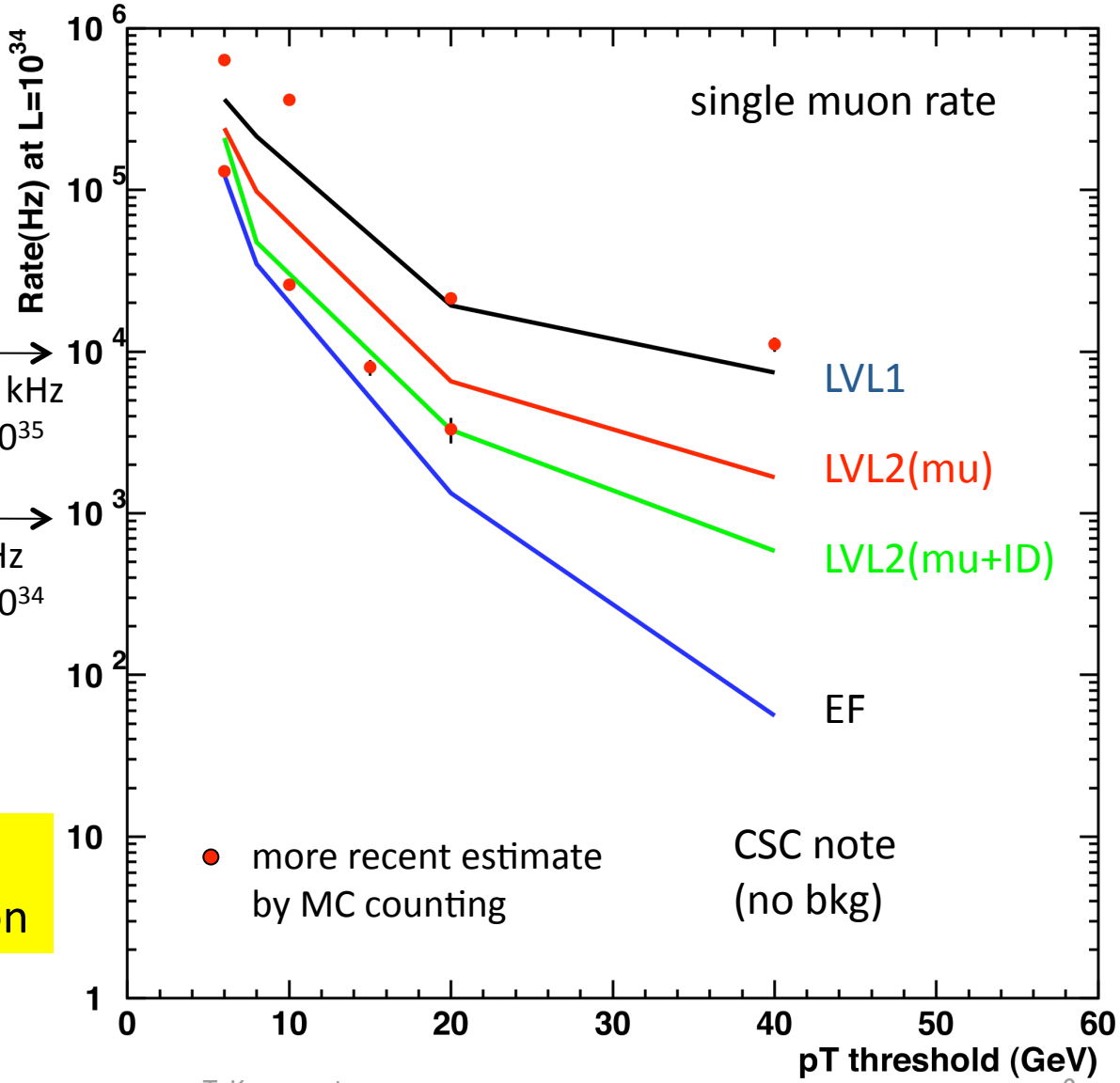
Muon trigger

Single μ L1 rate is too high

No control of rate above ~20 GeV

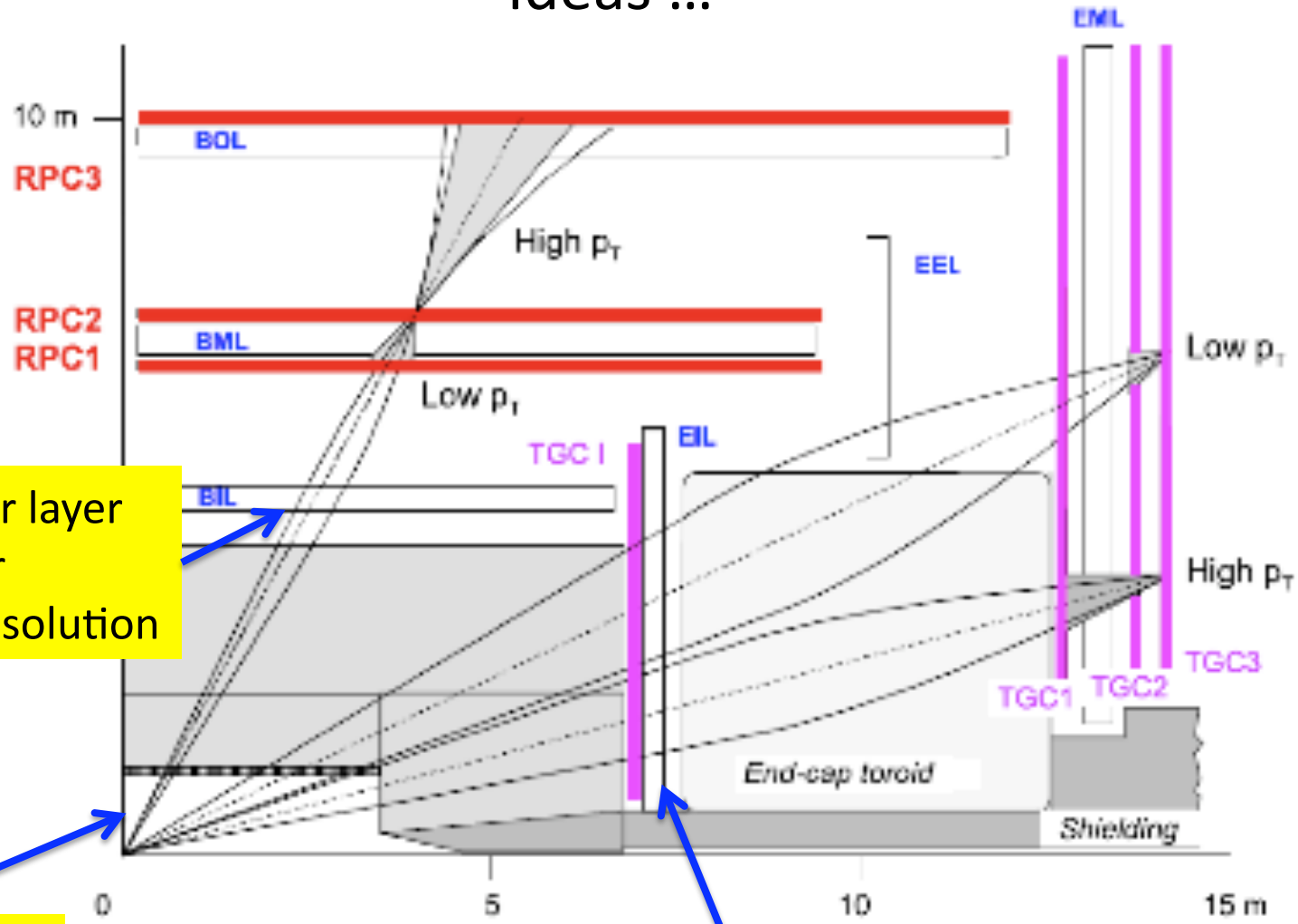
→ 100 kHz at 10^{35}

→ 1 kHz at 10^{34}



→ Improve the L1 Pt resolution

Ideas …



Use the inner layer
for L1 trigger
to help pT resolution

ID track trigger

Need to upgrade anyway.
Use it to improve pT resolution.

Detector R&D

Improved MDT : precision tracking

Familiar technology, similar electronics

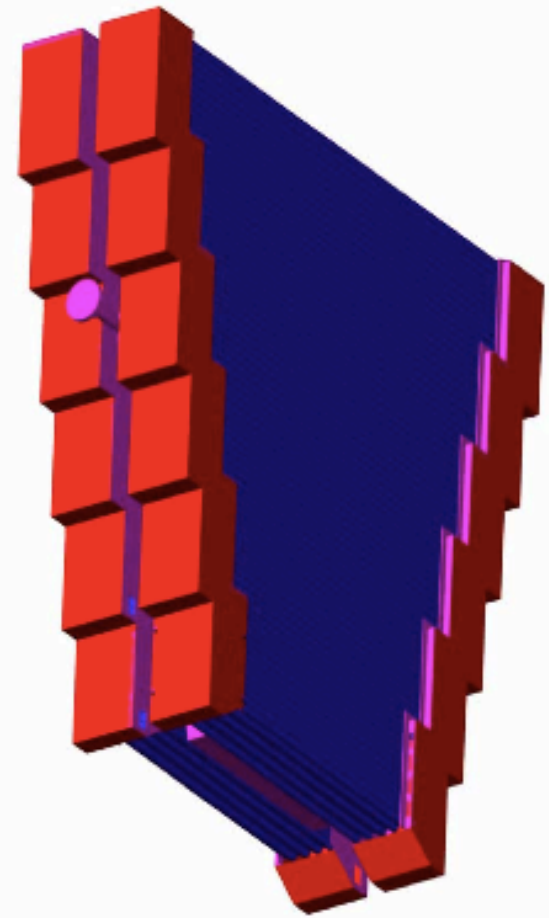
need in addition a detector for ϕ coordinates and trigger.

- Thin tube
  - 15mm tube instead of current 30mm ~x8 gain in rate tolerance
  - Works perhaps even at the CSC region
  - Prototype tests, radiation tests (GIF) already made

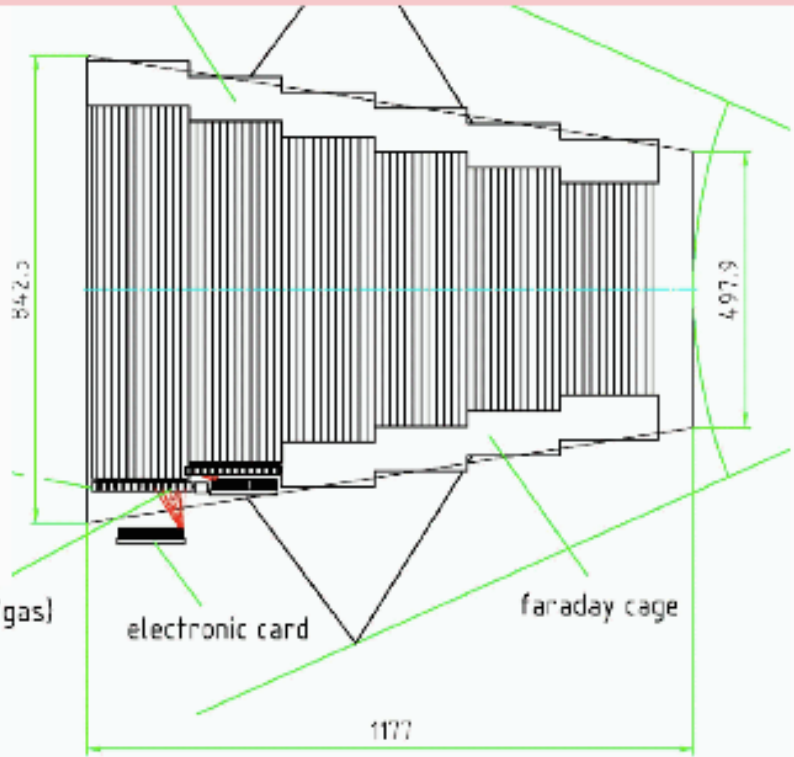
- Field shaped tube
  - New idea (originate from a SDC design)
  - Same 30 mm tube should be OK. Same geometry, similar electronics.

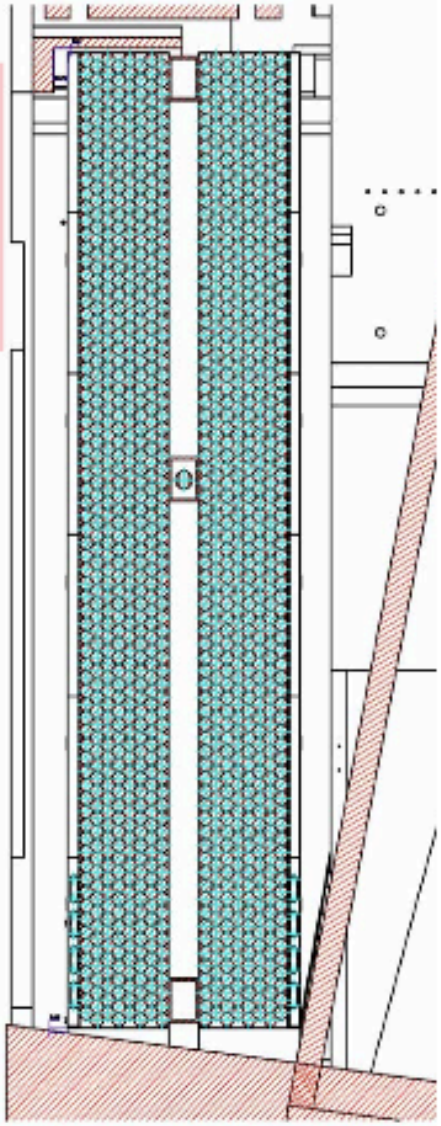
Thin tube mdt

Chamber design

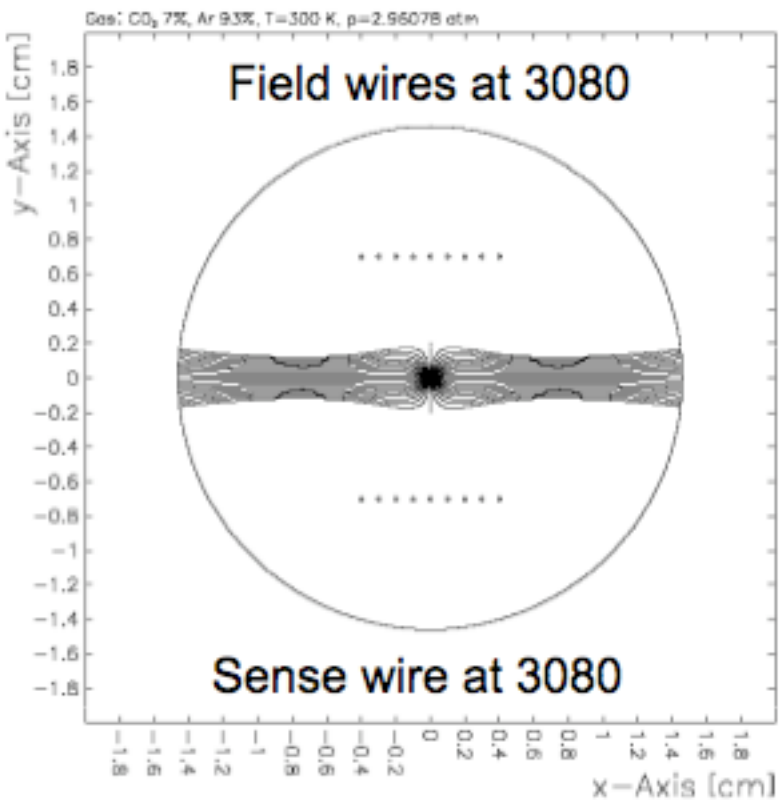


2 x 8 tube layers consisting of 8 x 12 tube modules with sep. gas distribution system, electronics cards, Faraday cage

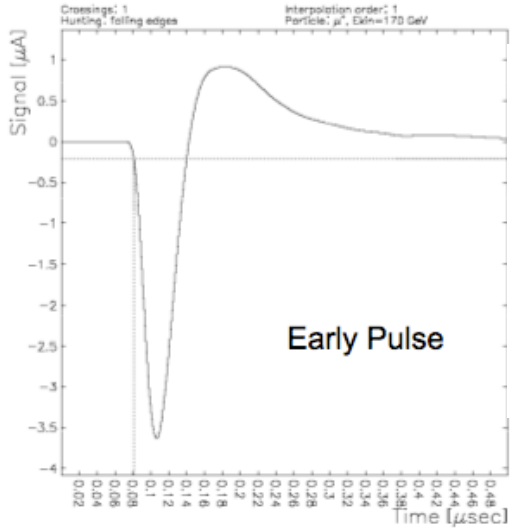


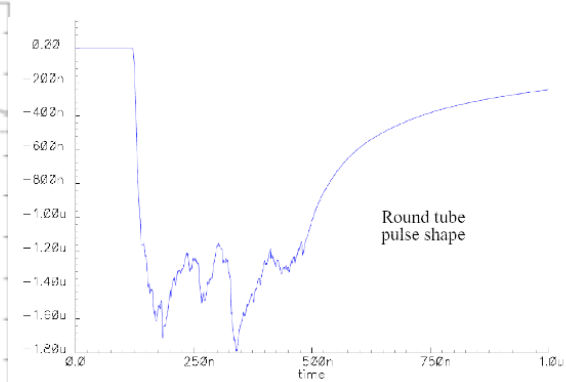


Field shaped tube



8mm plate, 50µm wire at 7mm





Detector R&D

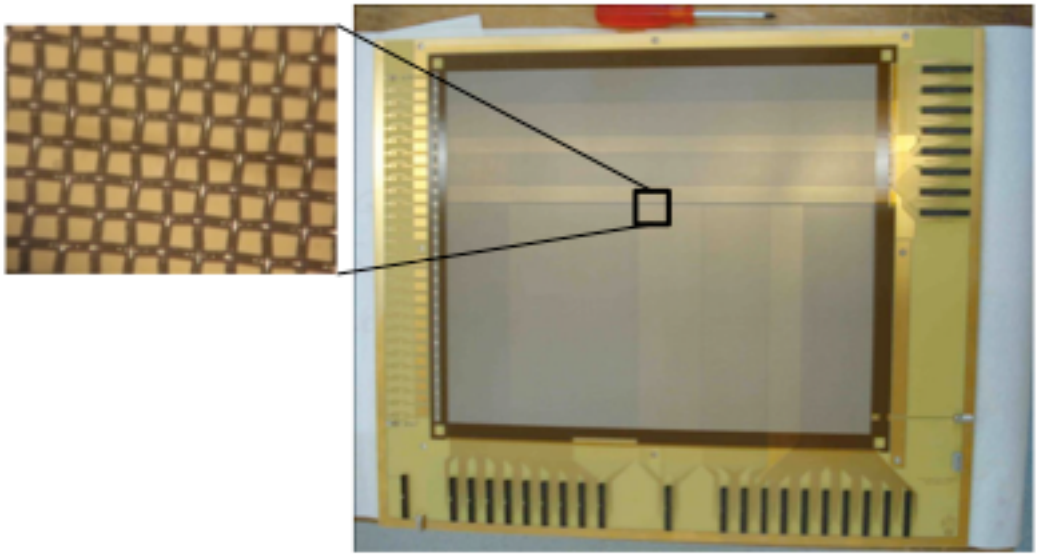
Tracking and Trigger combined

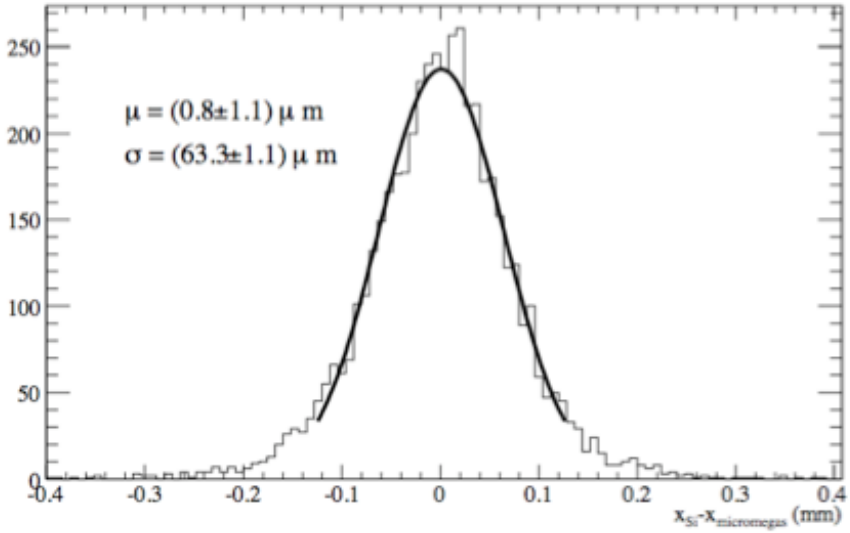
- Micromegas
  - High rate tolerance
  - Good spatial and time resolution
  - Big detector never made/used, but seems promising

- TGC
  - Familiar technology
  - Already used as a trigger detector.
  - precision tracking by thin strips (similar to CSC)

- μ-PIC
  - another mpgd type detector

Micromegas



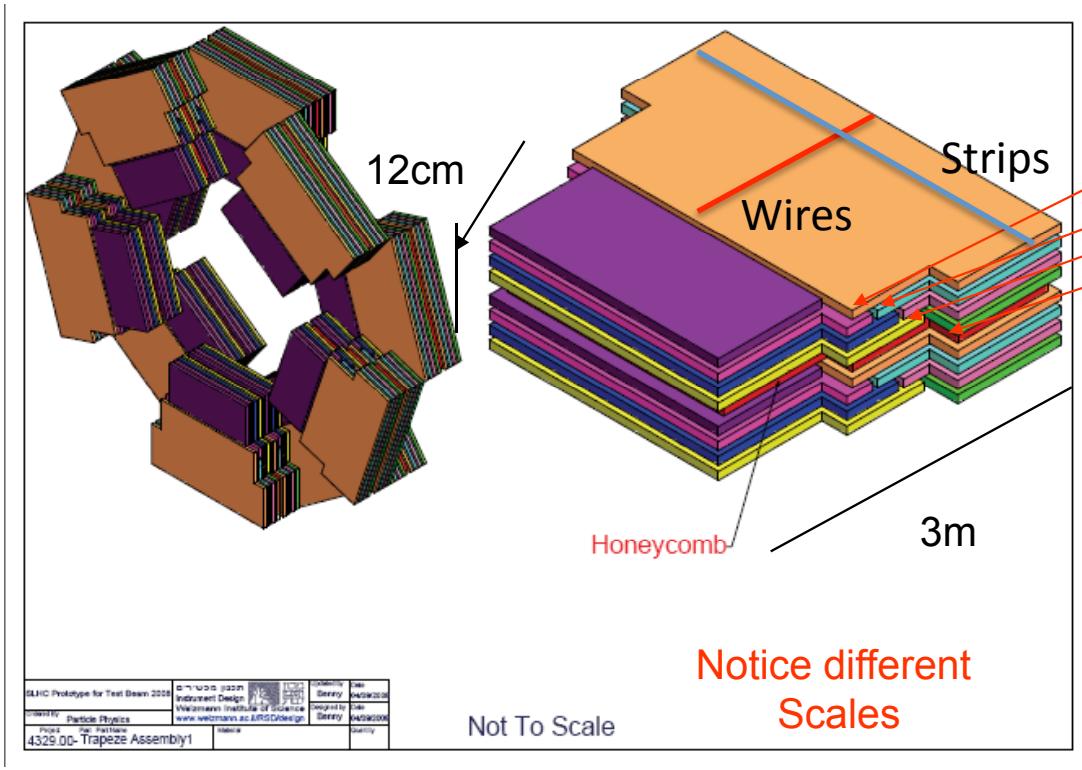

μ = (0.8±1.1) μ m
σ = (63.3±1.1) μ m
250
200
150
100
50
0
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
x_{Si}-$x_{micromegas}$ (mm)

The stretched micromegas
mesh on its frame

TGC tracker + trigger

Strip readout for precision tracking

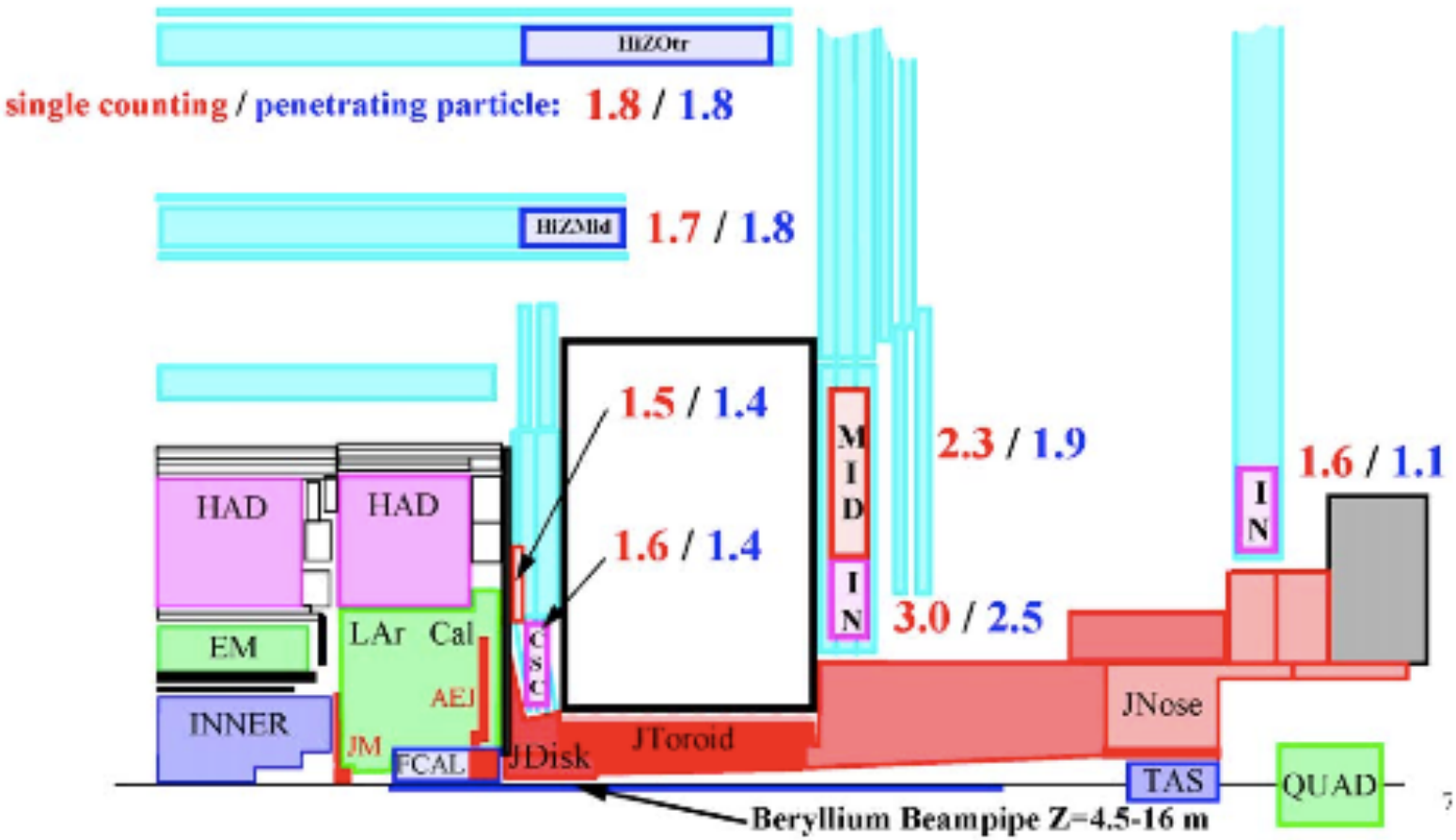
Proposed arrangement for SW



Transition between two
Gas volumes occurs at 4
Places in each multilayer
To allow relative alignment
With tracks
Each multilayer is precise
To ~microns by construction

: Intended arrangement for the replacement for the detectors in the Smal Wheel. Notice the different scales in the radial dimensions (3m in radius) and in the thickness (120mm total thickness). Each module consists of 2 multilayers, each layer (50mm thickness) containing 4 gas gaps (each gas gap made of 2 chambers in the radial direction, but staggered with respect to its neighbor, for relative alignment). Each gap provide 3 coordinates (radial strips, radial pads and azimuthal wires).

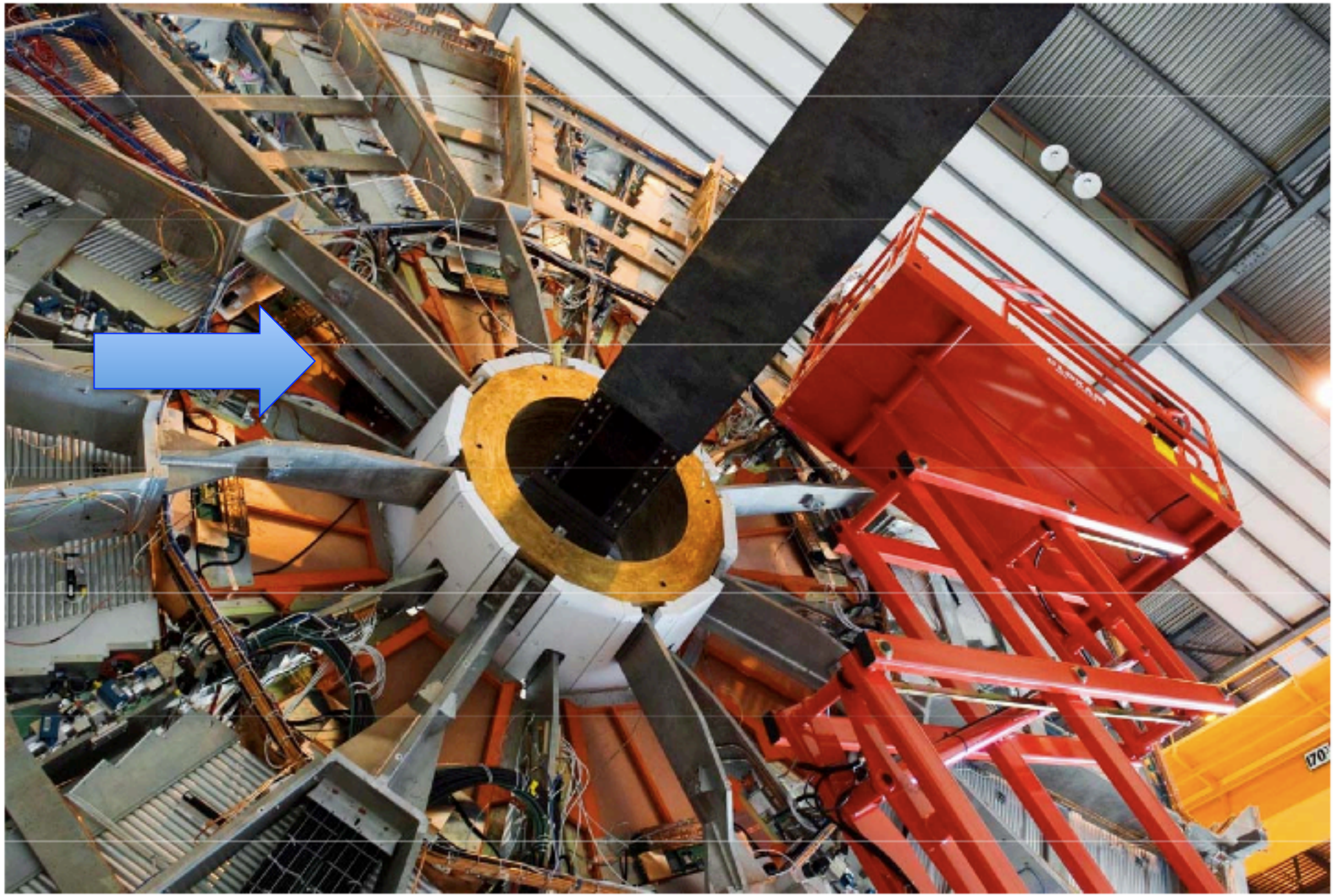
and, Be beam pipe helps to reduce cavern bkg



Reduction of x 1.5 ~ 3 !

Phase-1 upgrade

- L → 2~3x10^{34} : it is within the design safety factor of x5, but.
- CSC (tracker at the smallest R in the endcap) may suffer.
- Limited upgrade, to prepare in relatively short time.
- The idea is to add layers of fast trackers to help the CSC.
  - TGC with fine strip readout
  - Micromegas
  - Thin tube MDT



Conclusion

- Muon system needs upgrades to maintain its performance at the high luminosity LHC.
- Detector R&D are on-going. There are several viable options eventually to chose.

- The alignment system works very well. Its performance should be maintained also at the sLHC.
  - Radiation damage (e.g. optical sensors) ??
  - New detectors should be integrated in the optical alignment system.
  - New alignment concept may be needed for sLHC, depending on how the detector layout will be.