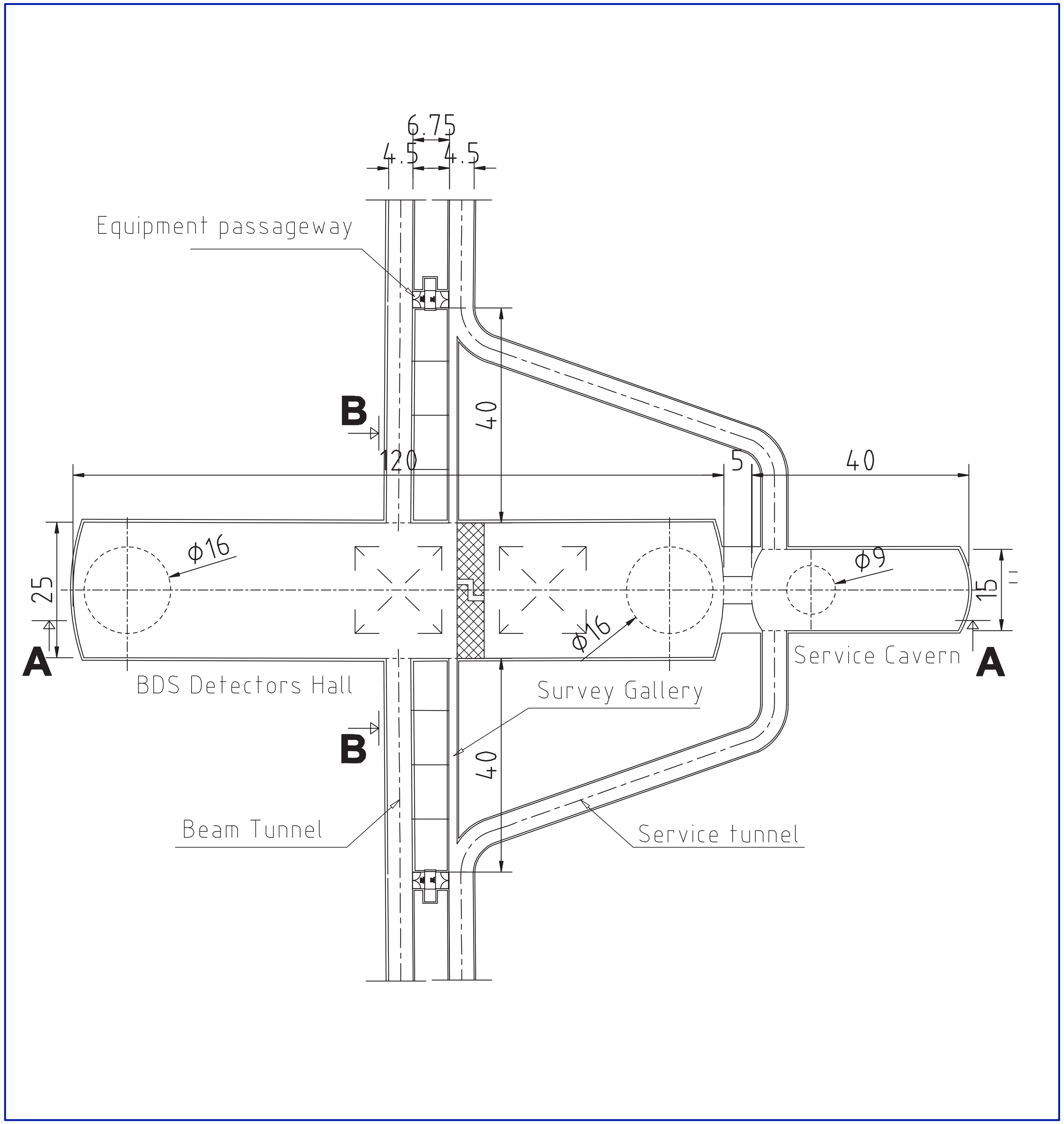
ILD MDI and Experimental Hall Issues

Karsten Buesser
DESY

ALCPG 2011 Workshop
20. March 2011

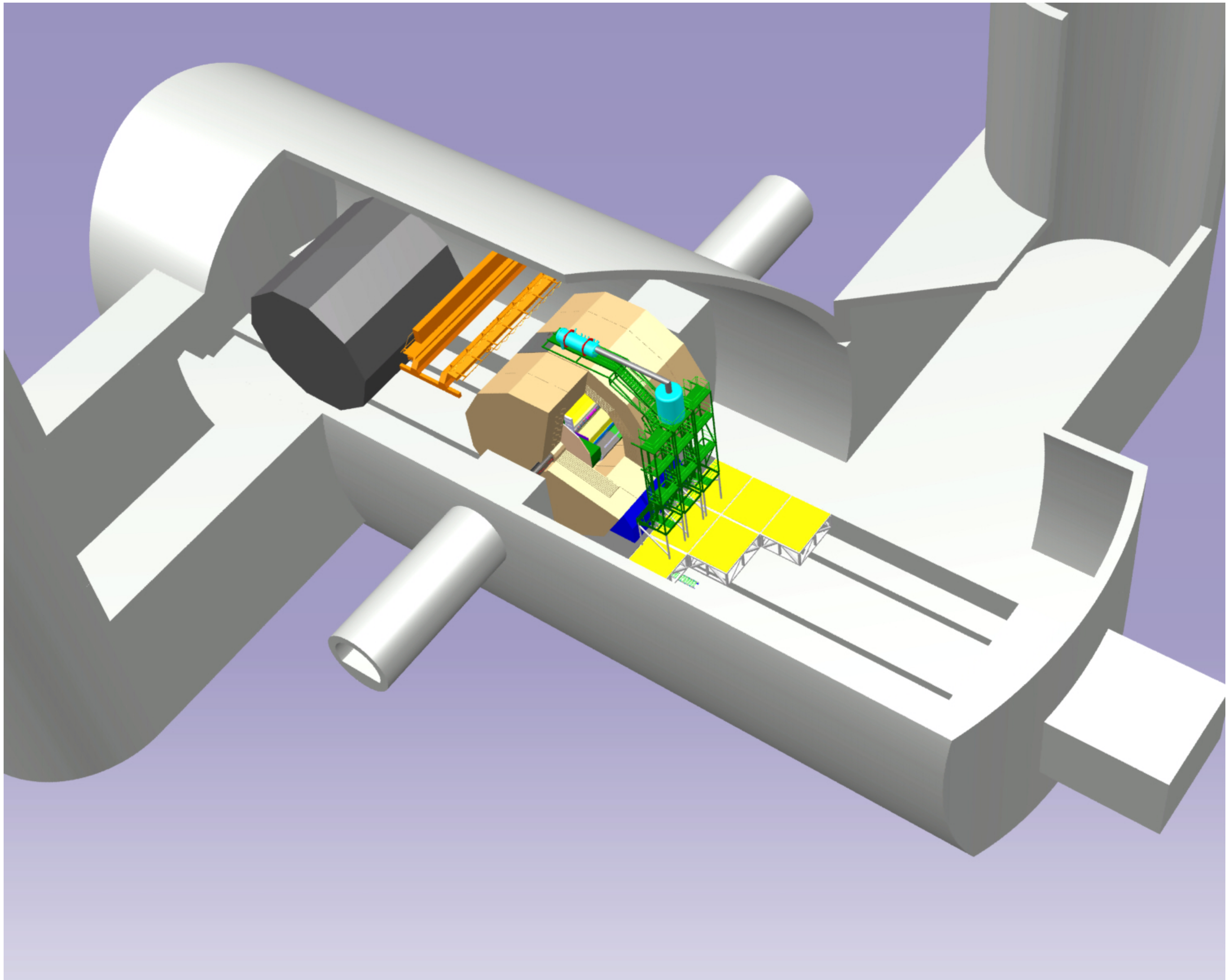
Experimental Hall (RDR Design)

- Rather large (120m)
- Shafts above experiments
- Not enough space for detector maintenance in parking position
- Unnecessary shielding wall
- No service caverns for detectors



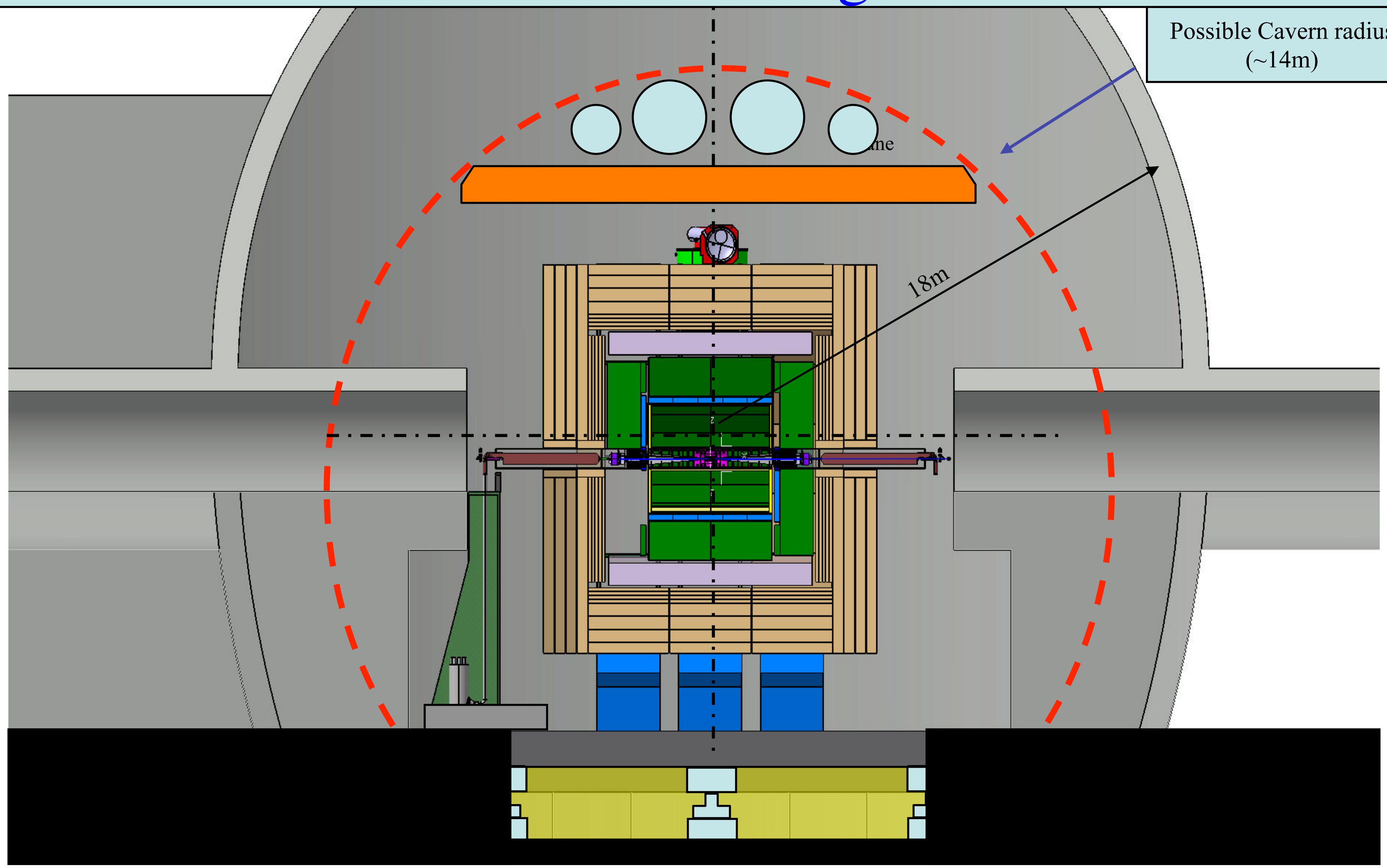
ILD Experimental Hall Design Study

- Shafts not above experiments
- Alcoves provide access to shafts and space for detector maintenance in parking position
- Additional alcoves for detector services
- Potentially less expensive than RDR hall design (smaller volume)



Cavern Size

An effort has been made to reduce the radius of the Underground Hall

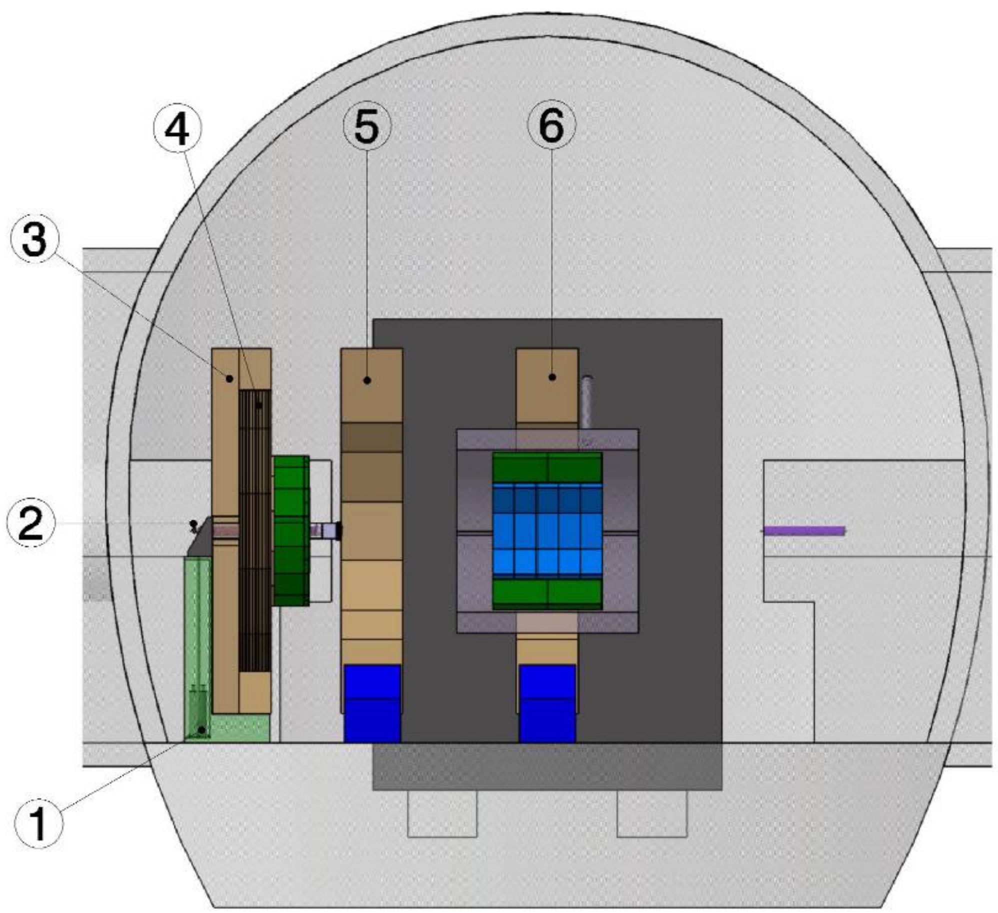


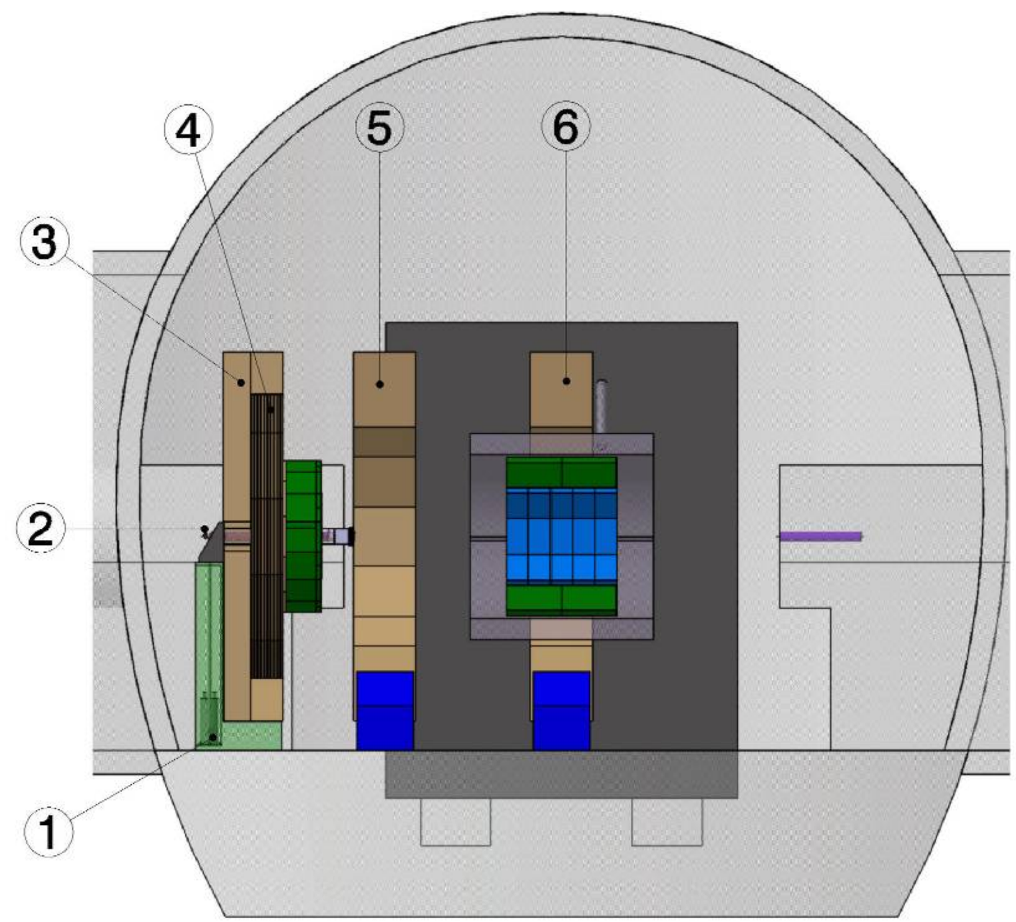
4366-ILD-T-Platform-and-environment.ppt A. Hervé

Design N.S. ETH-Z, January 2009.

- Radius of experimental hall could go down from ~18 to ~14m

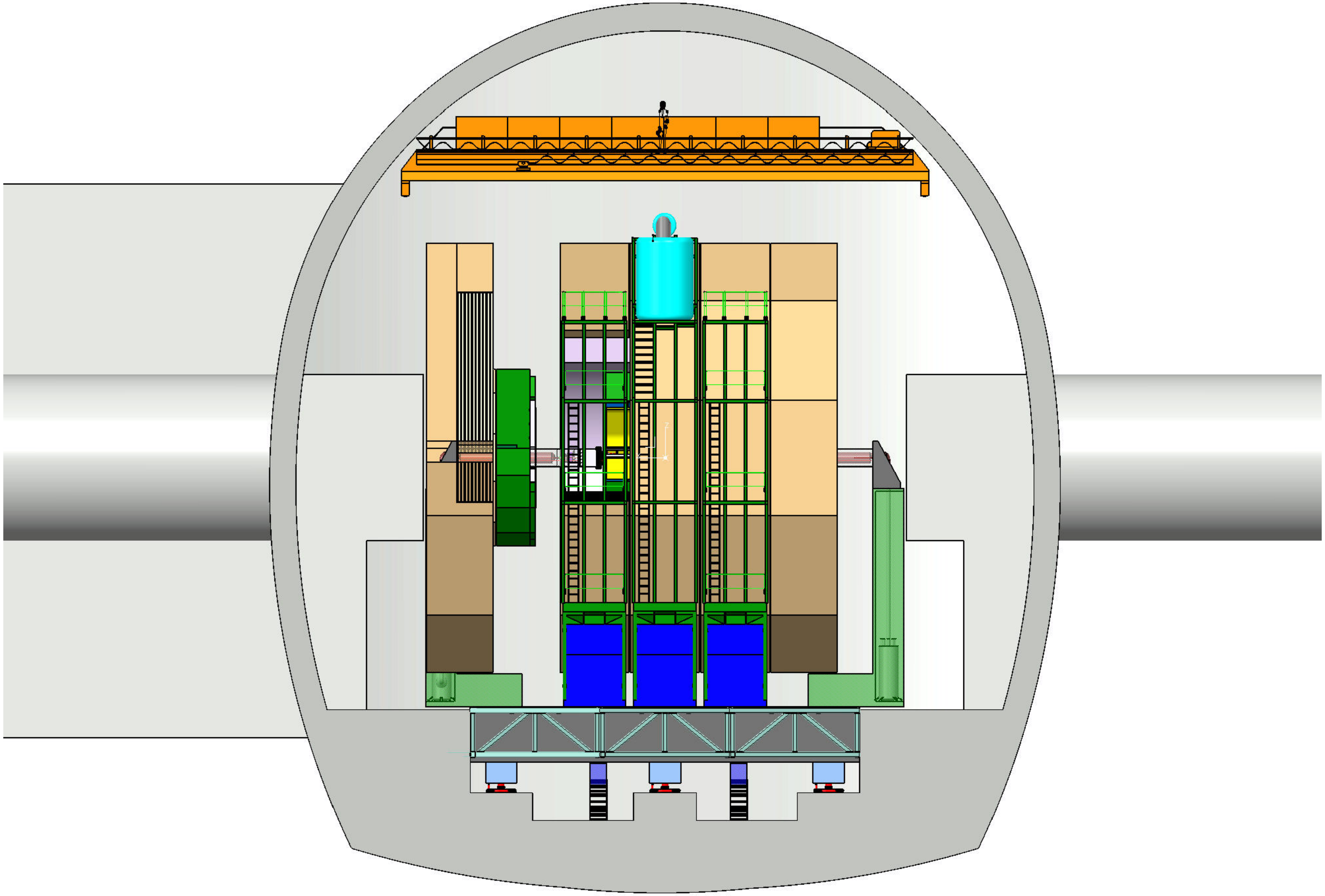
Detector Assembly CMS-Style





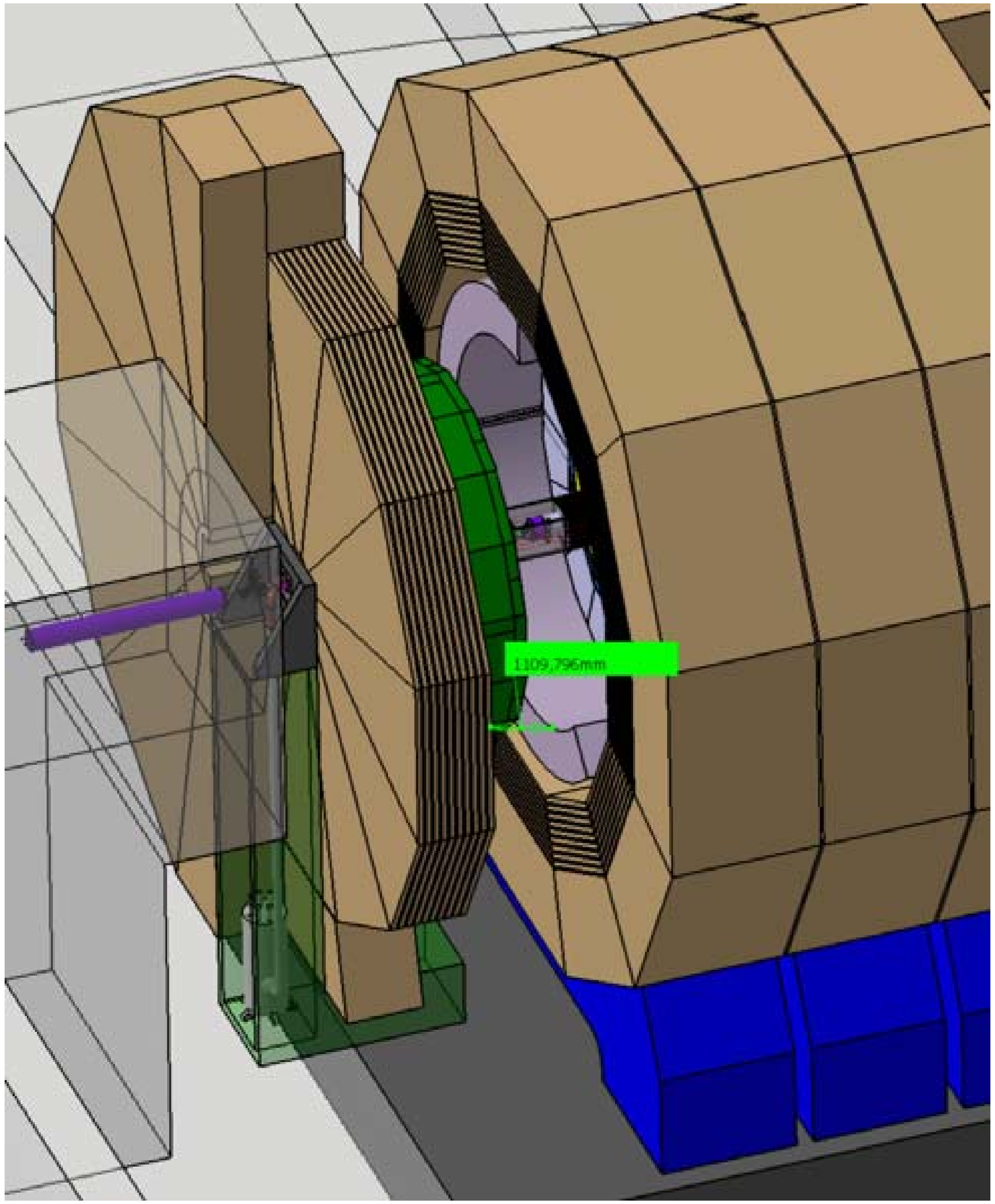
- Pre-assembly of large structures on surface
- Sub-assemblies lowered into the experimental hall
- Main parts:
  - three barrel yoke rings; central carries magnet and barrel detectors
  - two yoke endcaps
  - central tracking system (TPC)

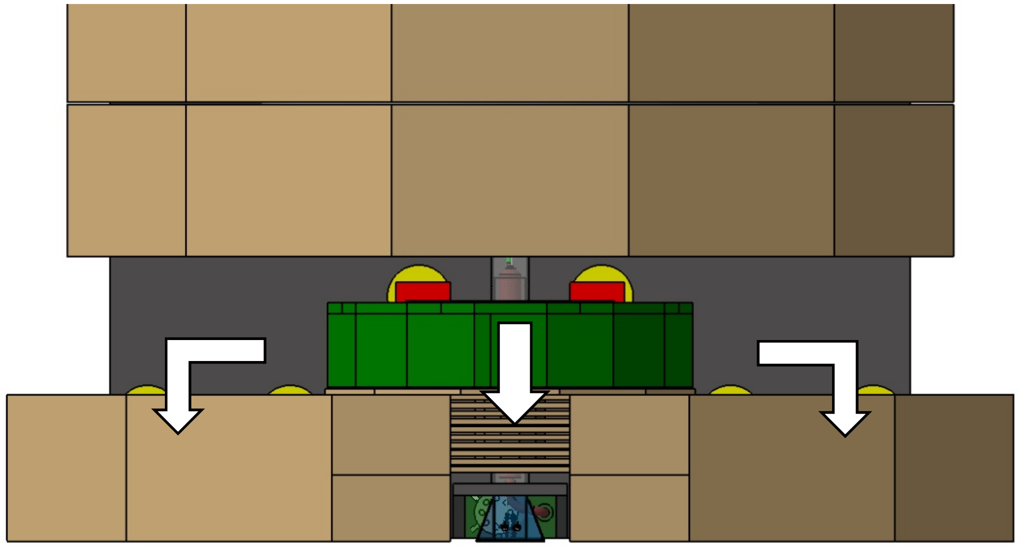
Detector in Beam Position



- NB: Optimised hall size

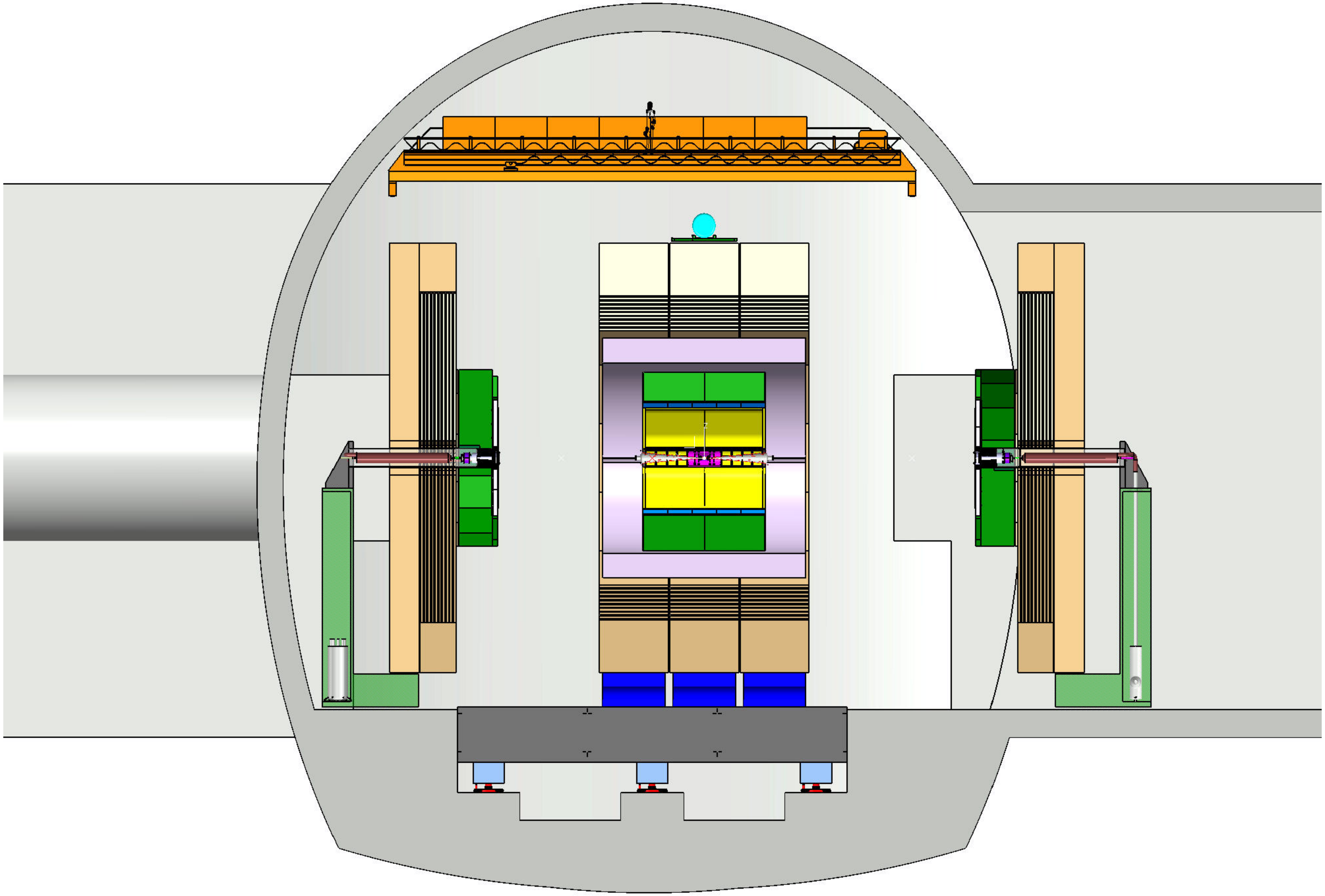
Detector Opening - Beam Position





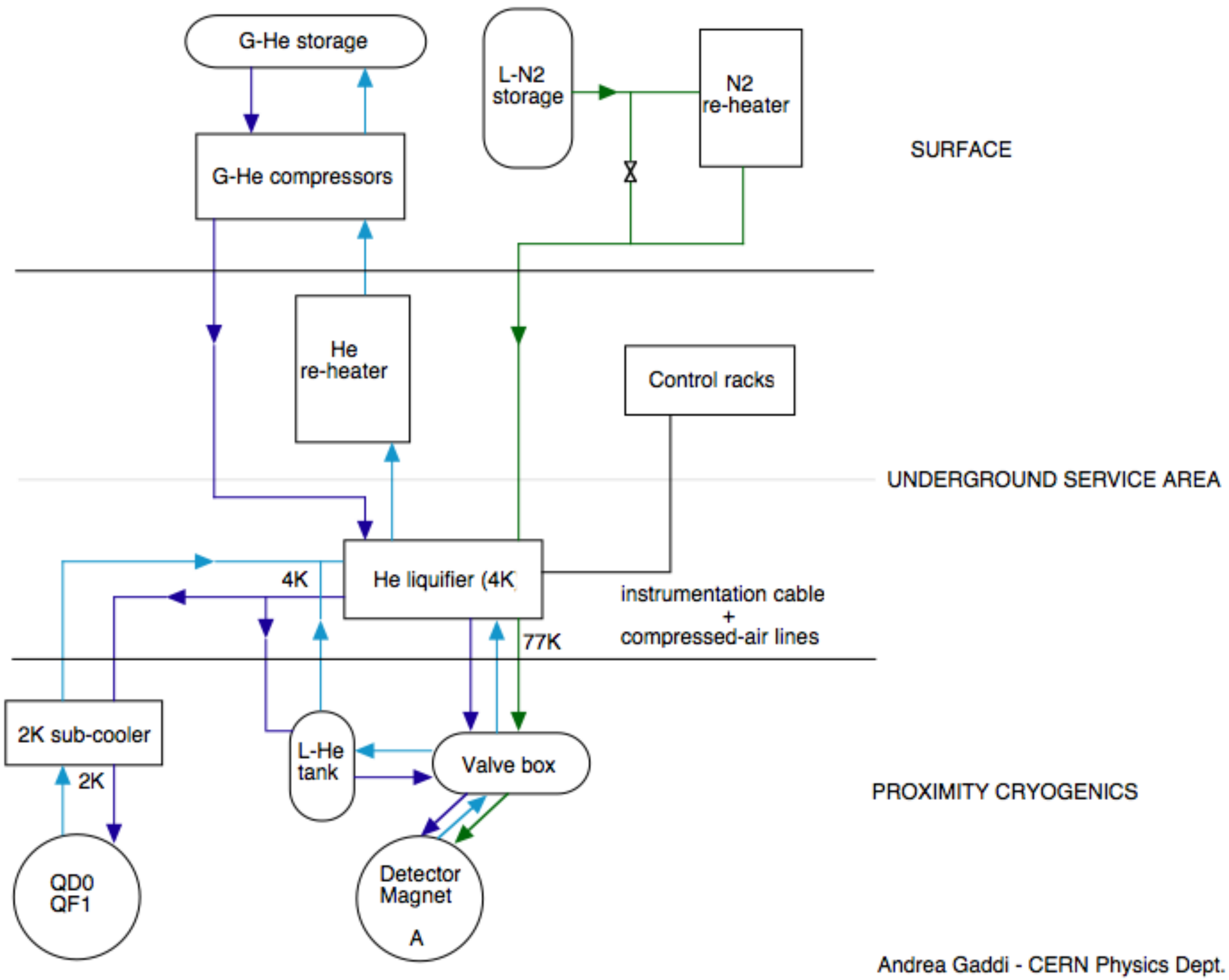
- Option to open the endcap in the beam position for limited access
  - Still under discussion; might not be needed if push-pull concept is taken seriously

Detector Opening - Garage Position



- Alcove needed for allowing access to subdetectors
  - TPC removal needs ~6m opening

Detector Services



- Cryogenics for the magnets

Detector Services

- Primary services (on surface)
  - Water chillers
  - HV transformers
  - Diesel and UPS facilities
  - He storage and compressors
  - Gas storage

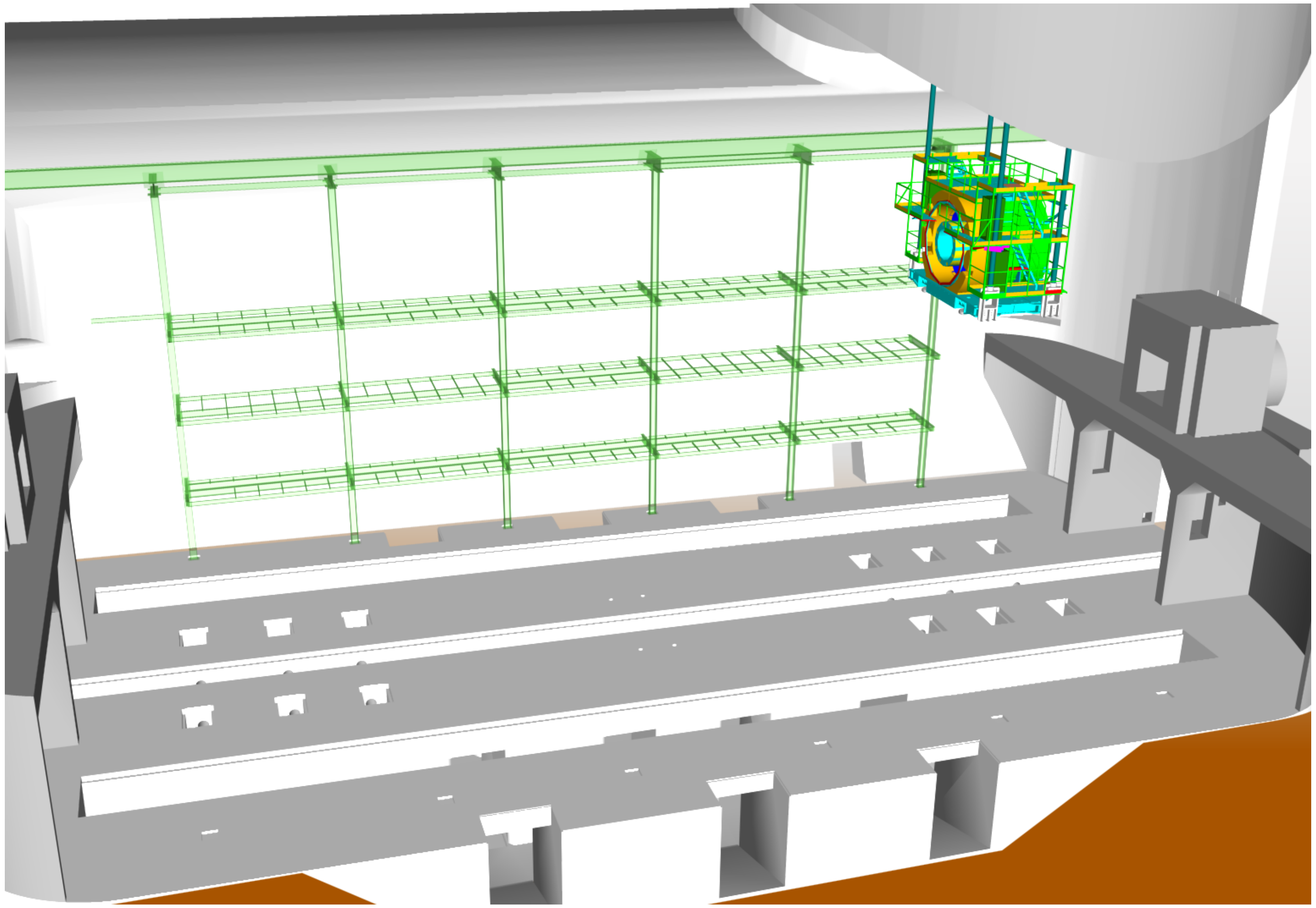
- Secondary services (underground in alcoves)
  - Cooling water
  - Power supplies
  - Gas mixtures
  - Power converters
  - Cryogenics

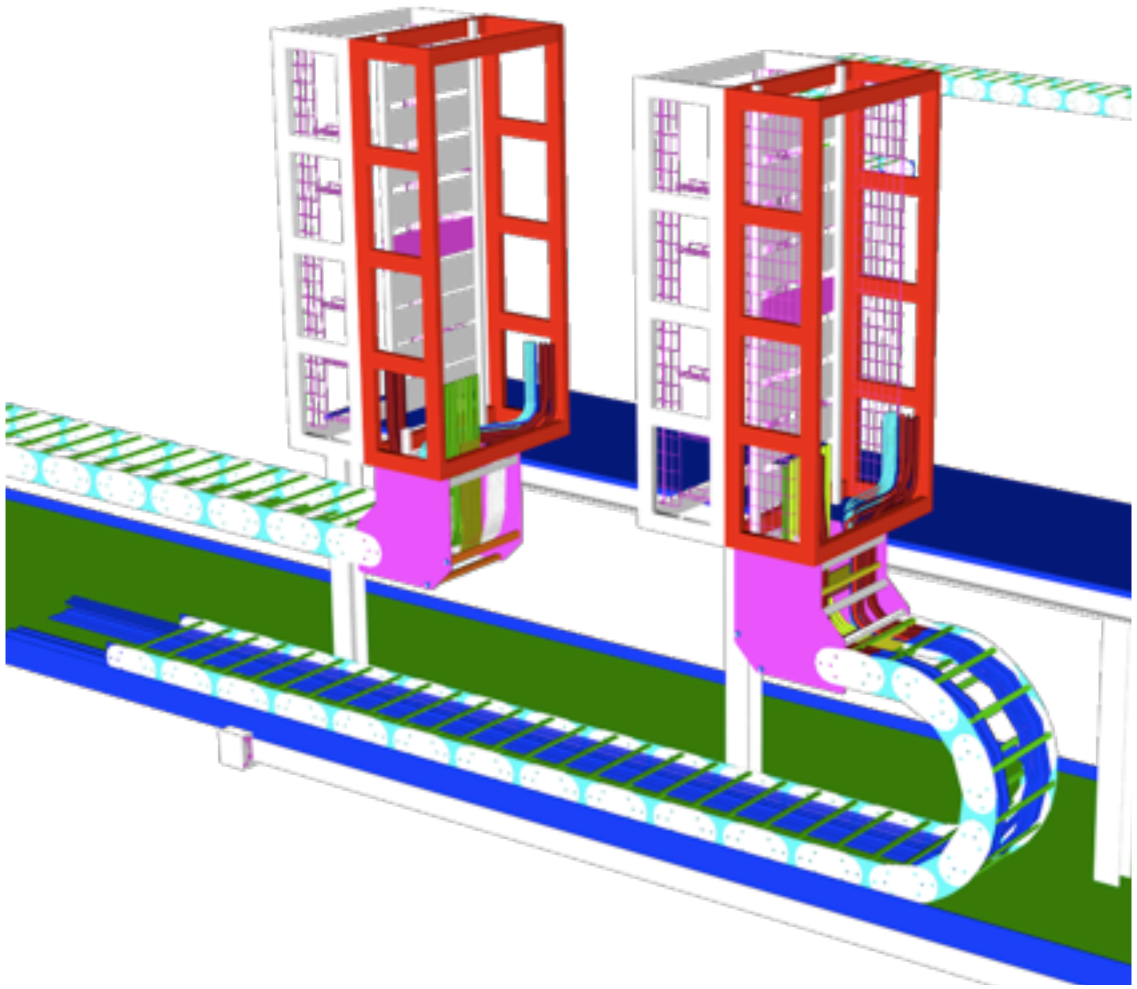
Cable chains

- On-board services (move with detector)
  - Electronic containers

- Need an integrated approach to the service needs of ILD and SiD!

Cable Ways and Supplies

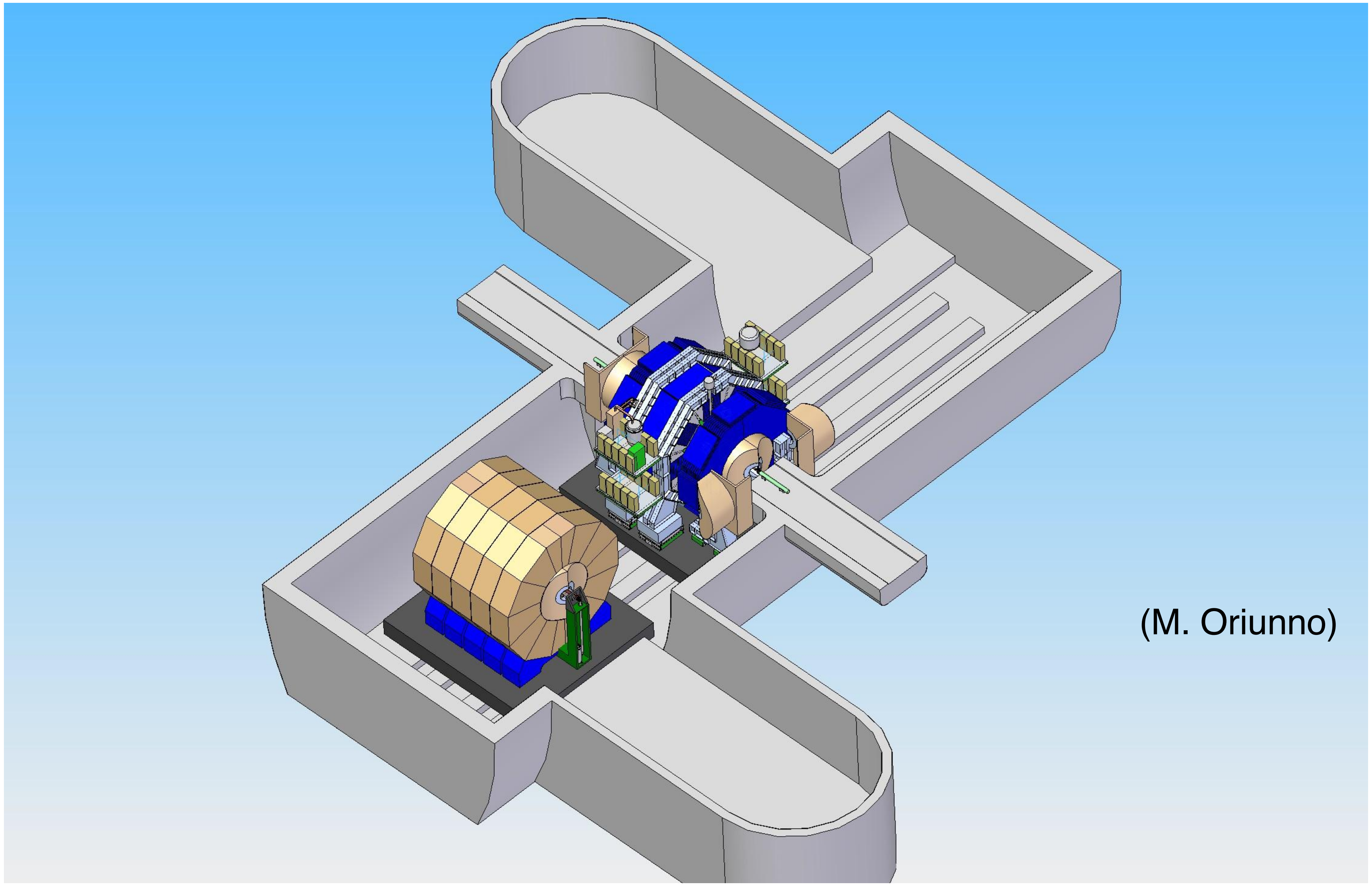




- CMS Example
- Trenches are needed under a platform: cables, safety, motion system access

Platform Based Detector Motion System

Both detectors on a platform



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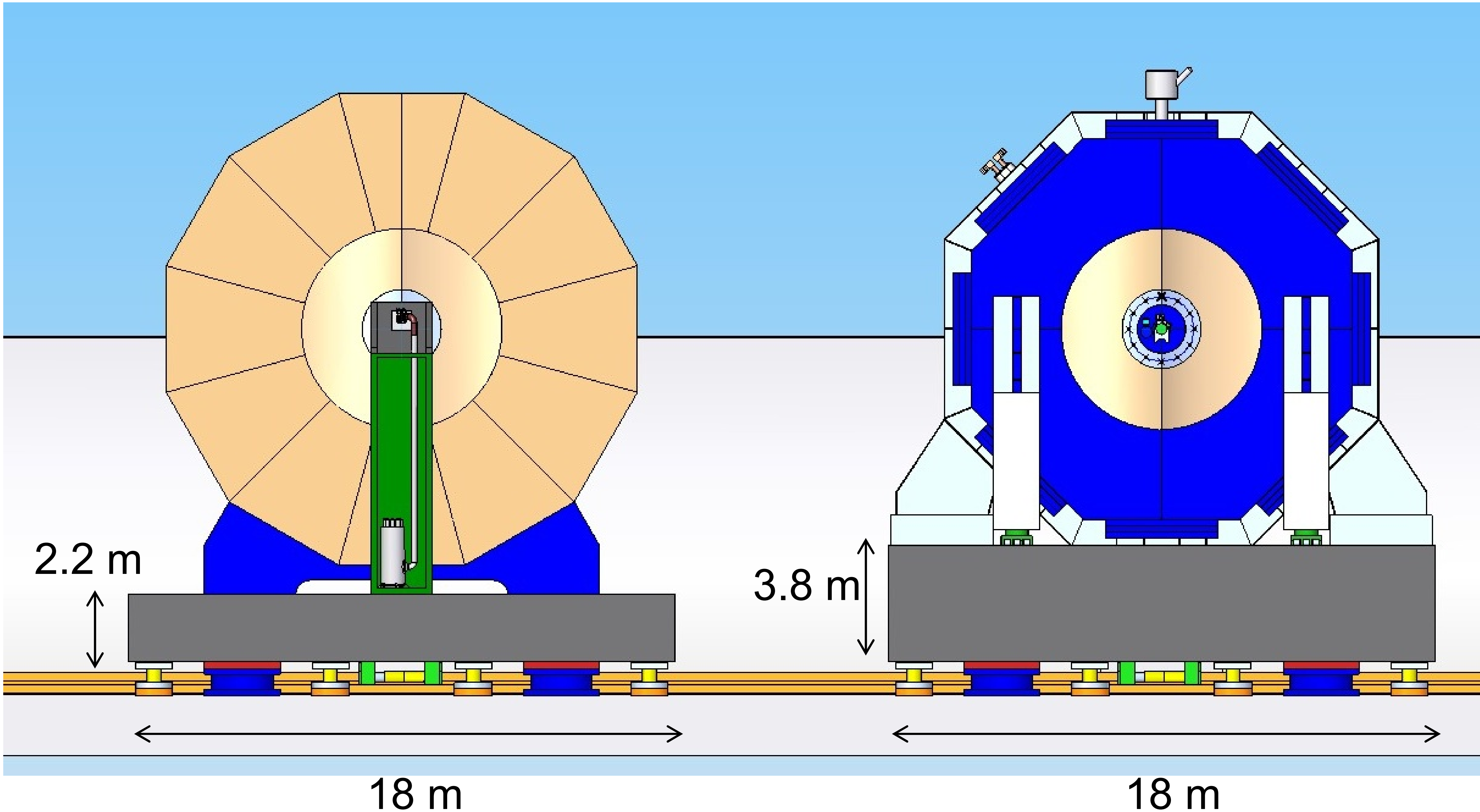
- ILD prefered solution

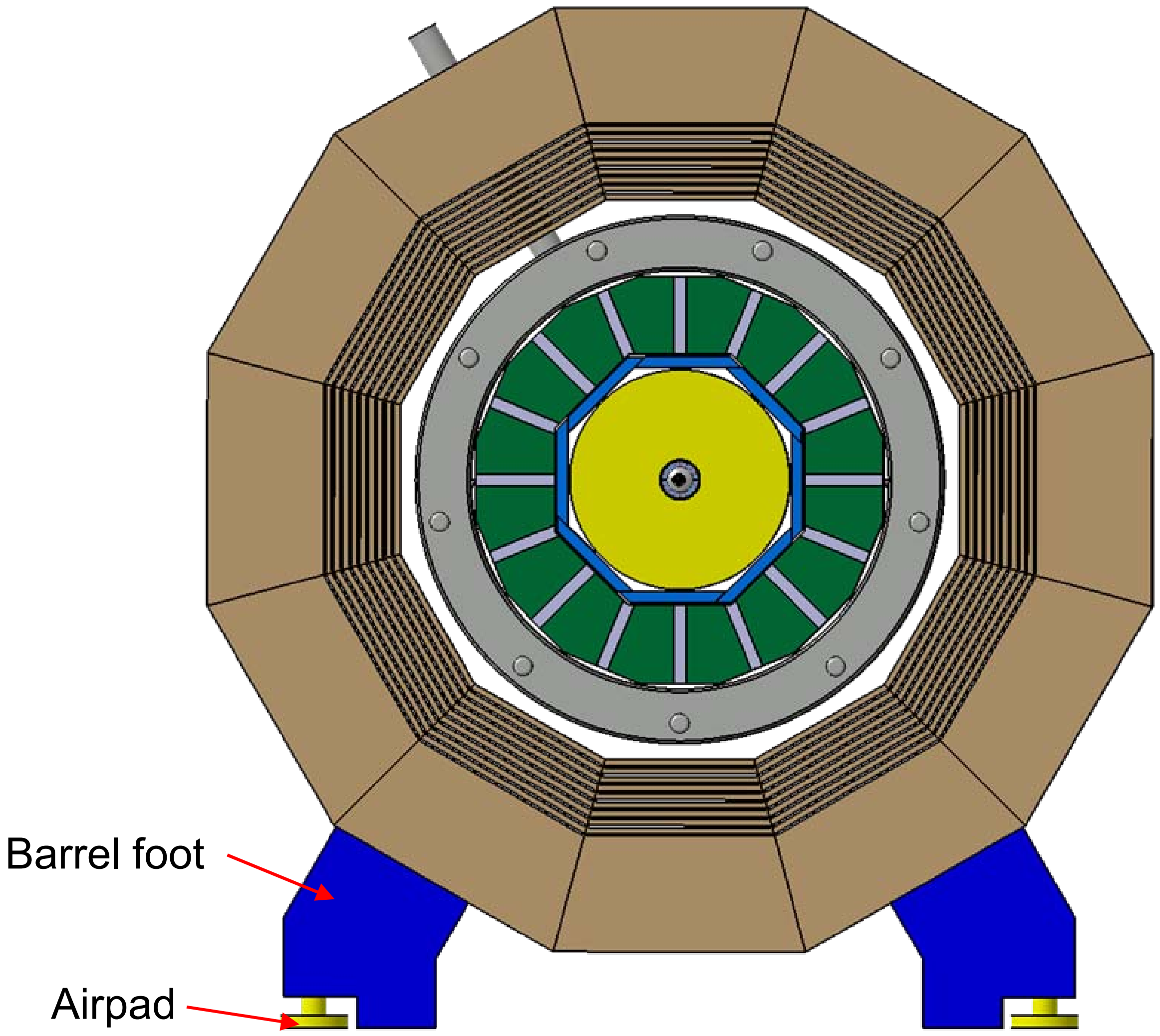
Reducing ILD Beam Height

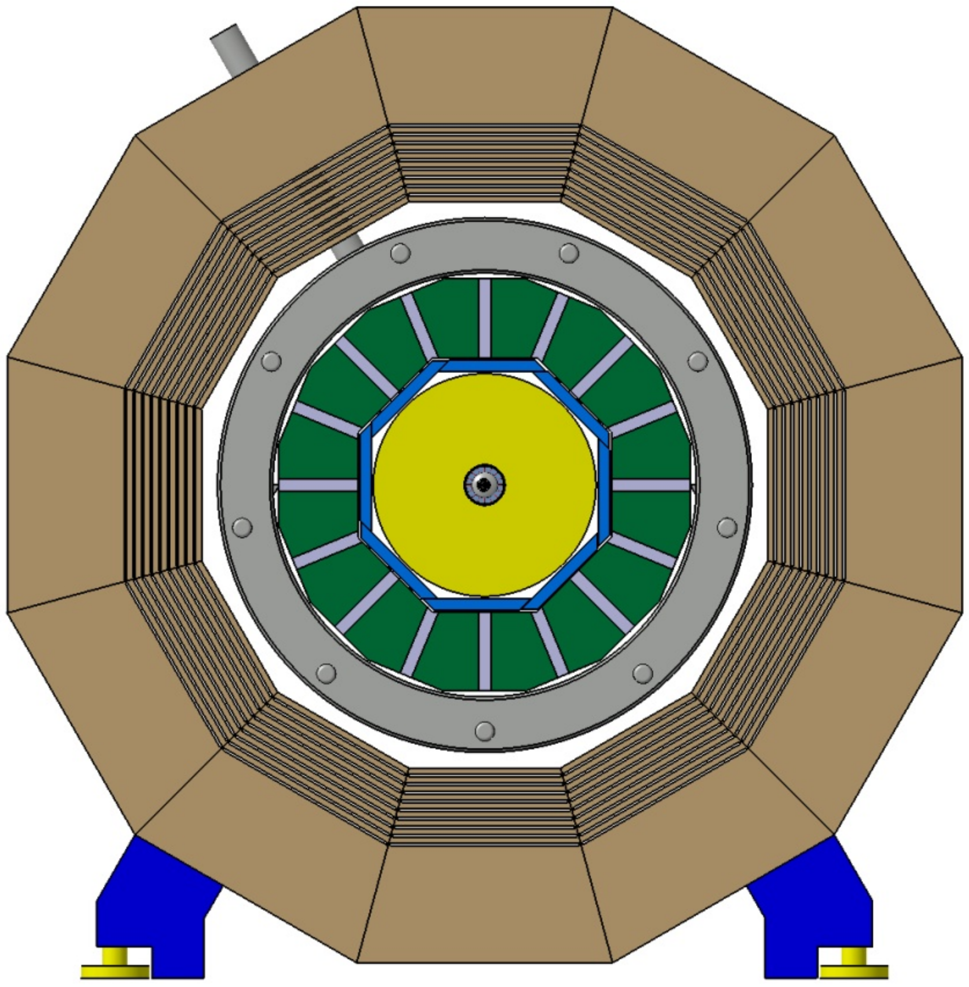


From M. Oriunno @ SiD workshop 2010 after CERN workshop

- Beam height difference between SiD and ILD: 1.6m
  - This results in different floor levels in the underground hall

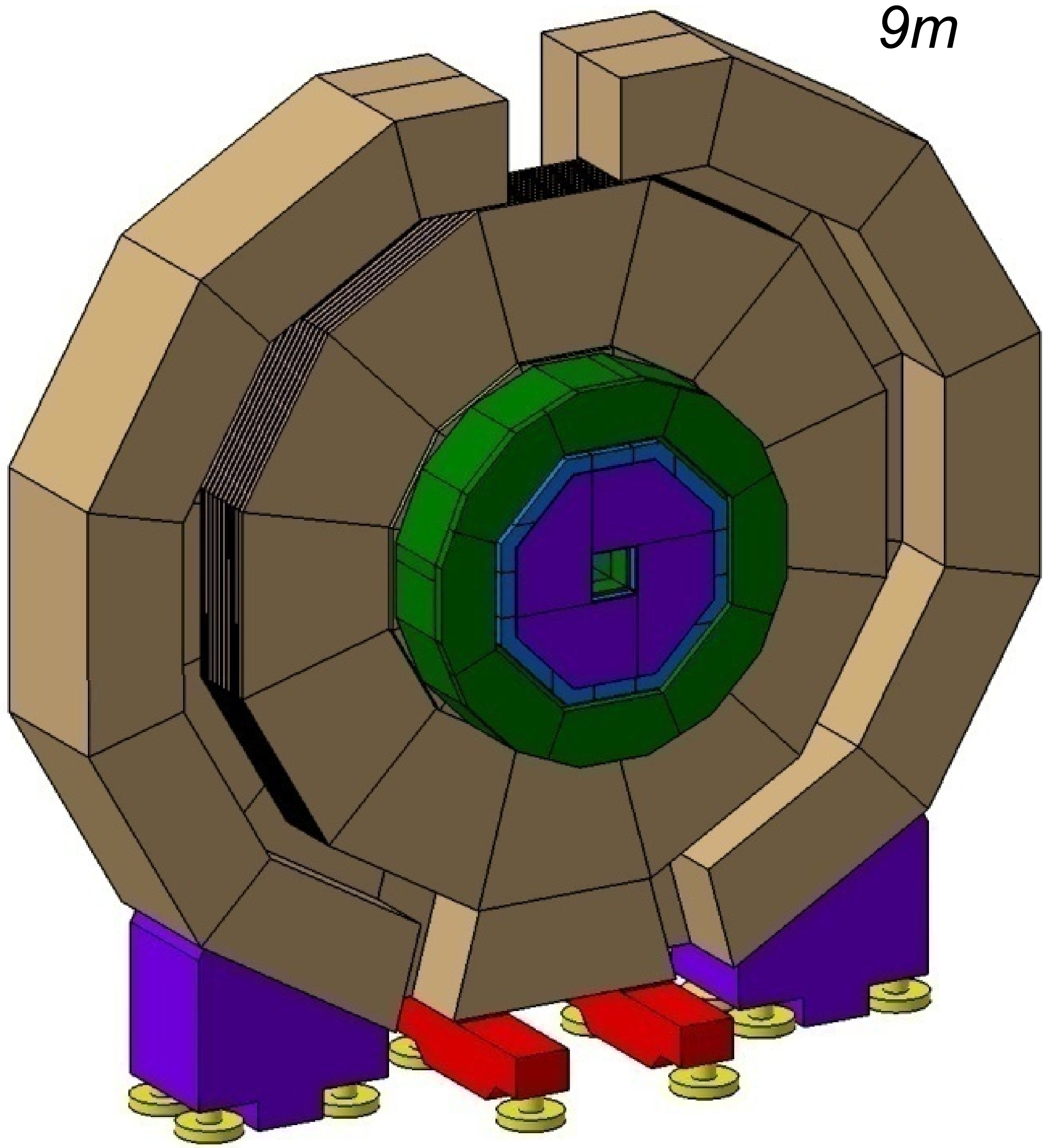
Reducing ILD Beam Height

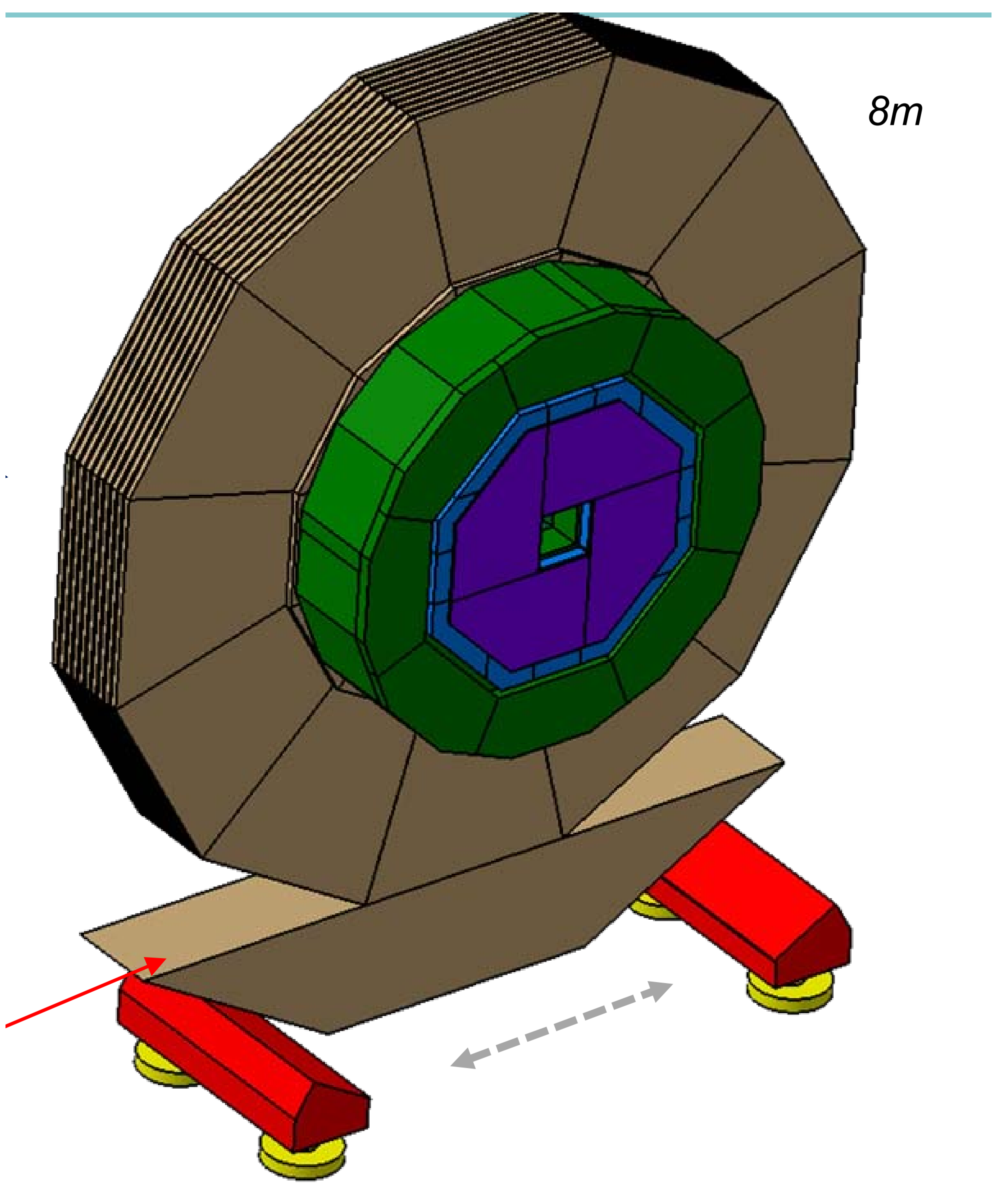




- Barrel yoke modification

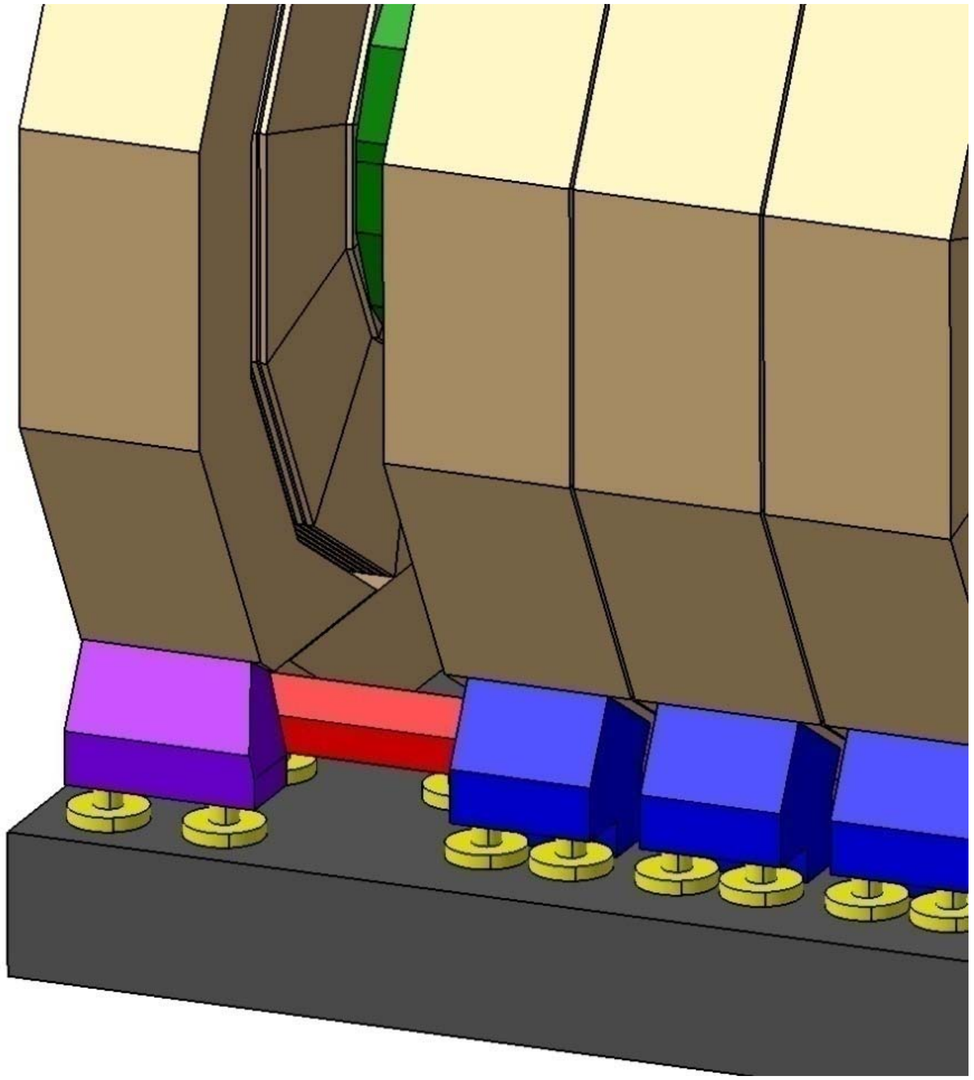
Reducing ILD Beam Height

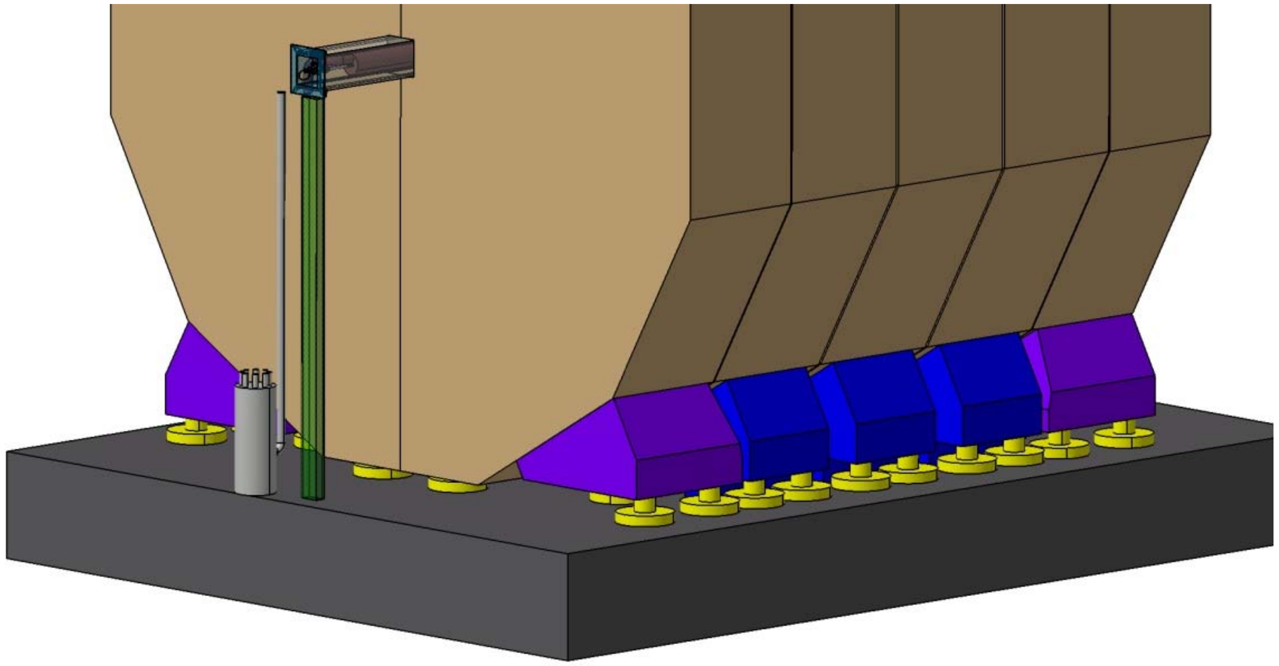


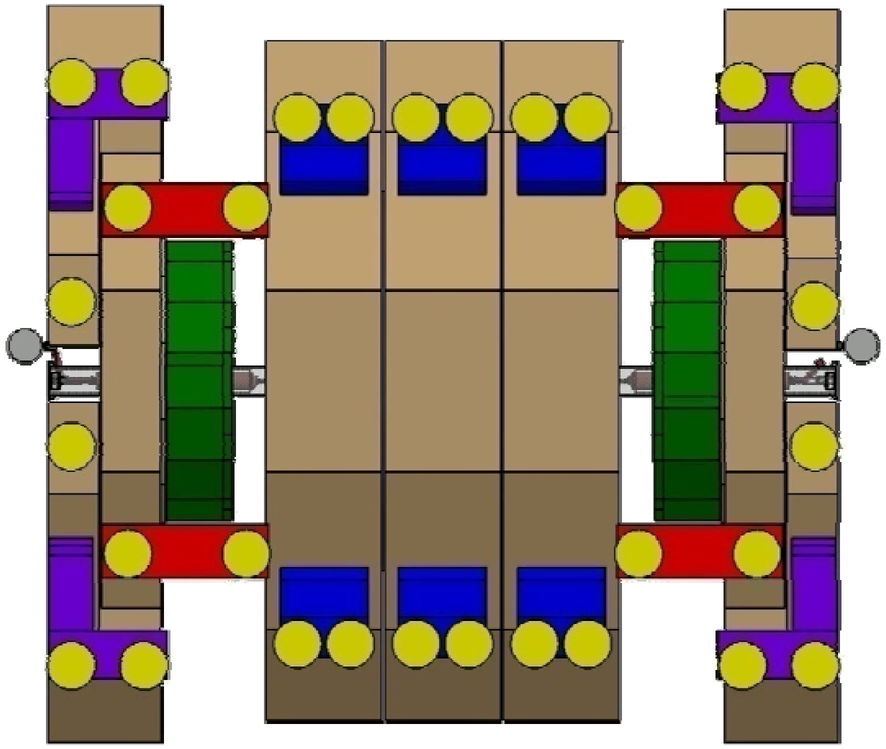


- Endcap yoke is more problematic
  - Split endcap design gets complicated

Reducing ILD Beam Height

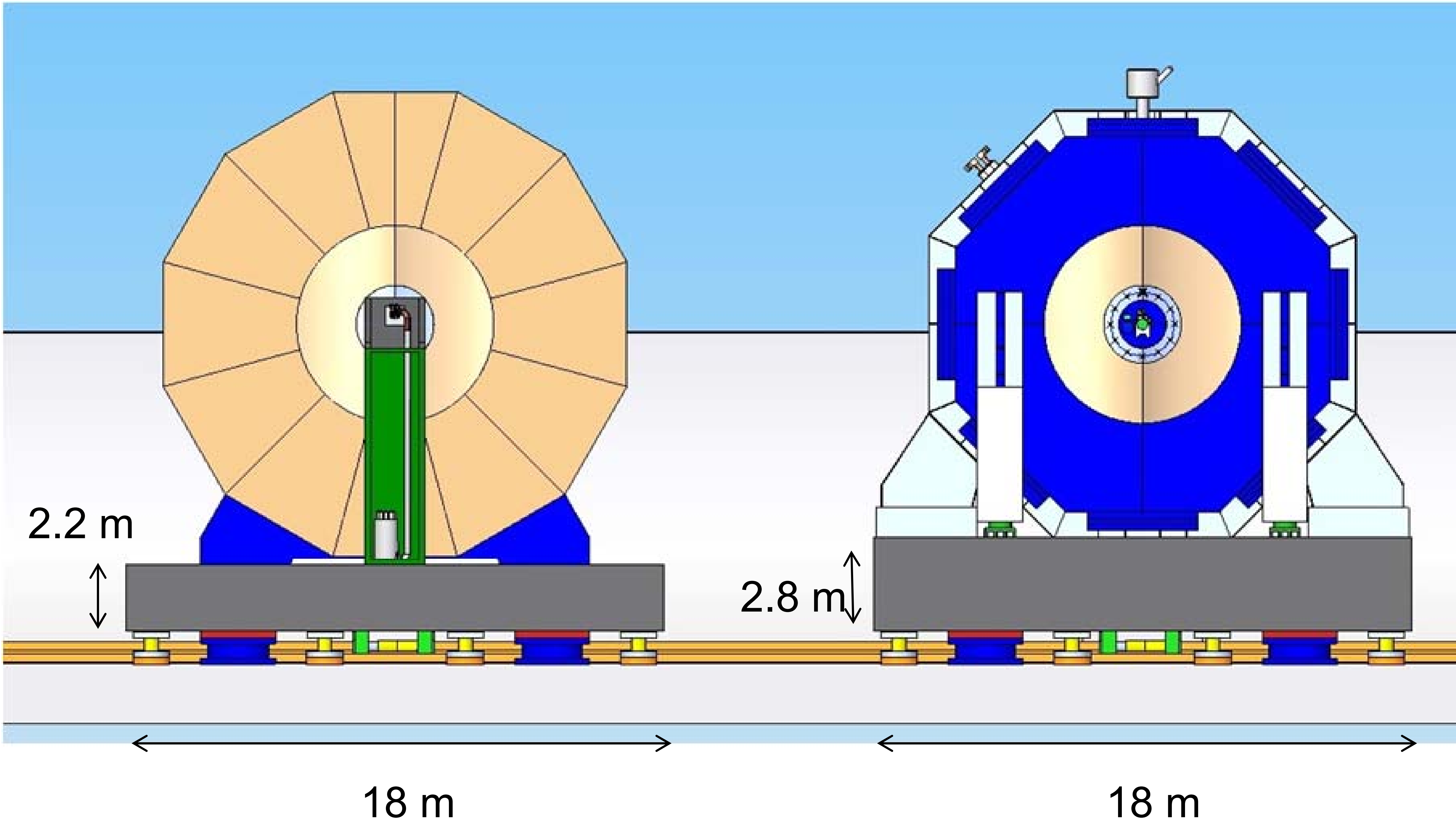






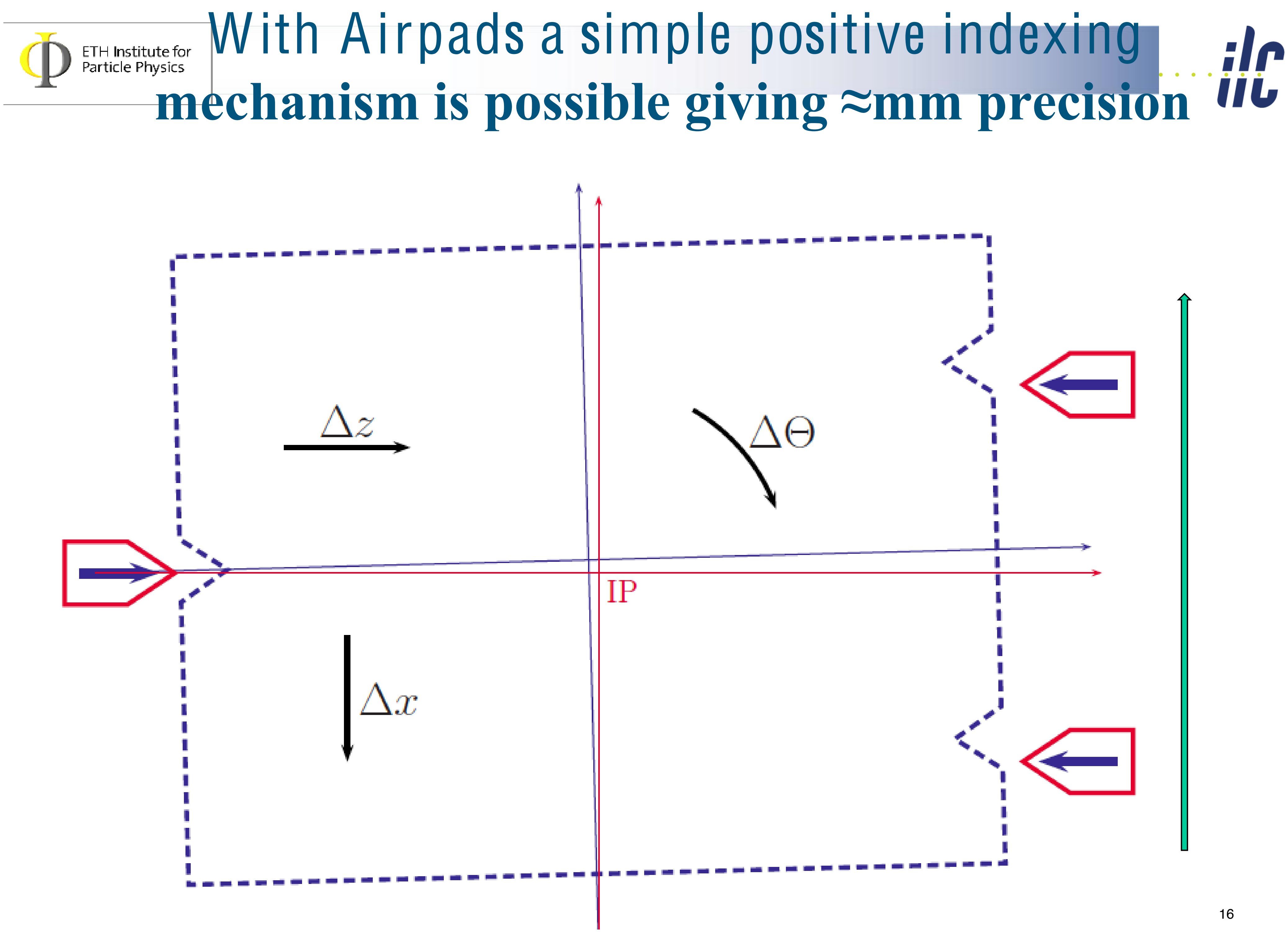
- Possible configuration of feet and airpads

Reducing ILD Beam Height



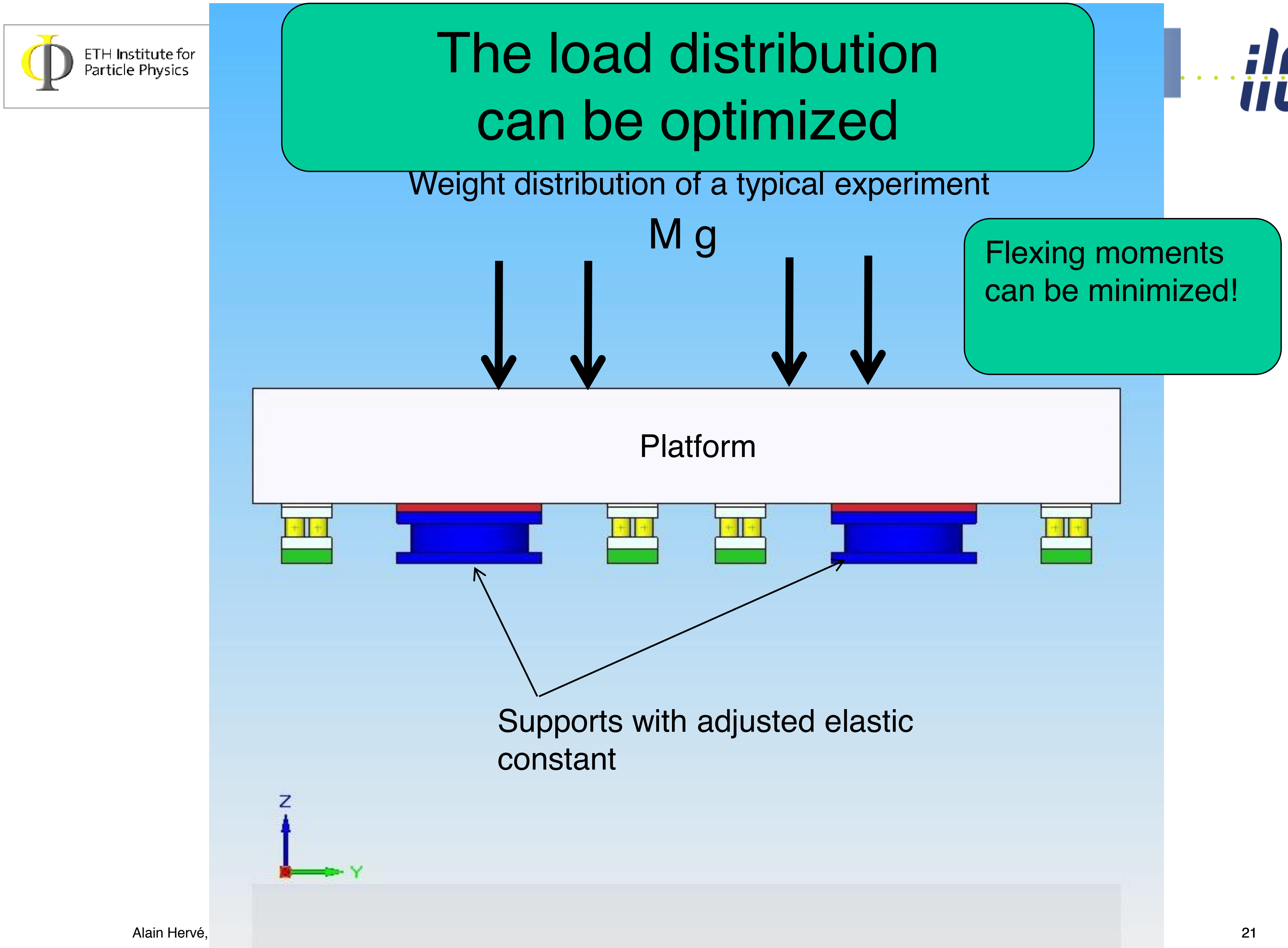
- Reducing difference to 0.6m
  - Maybe even less if yoke instrumentation design will be changed

Platform Motion System

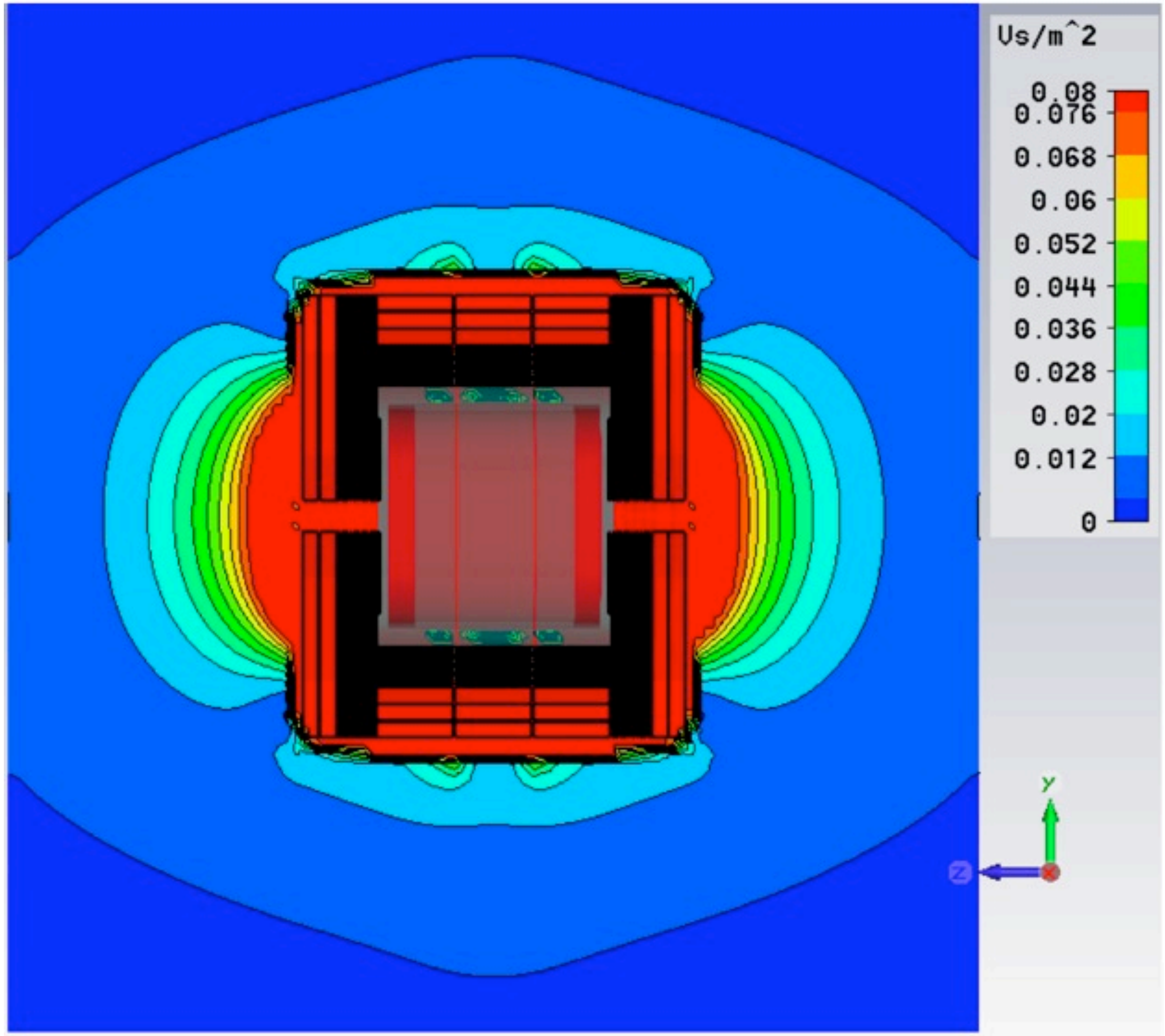


- Final precision: +-1 mm and +- 0.1 mrad

Platform Motion System

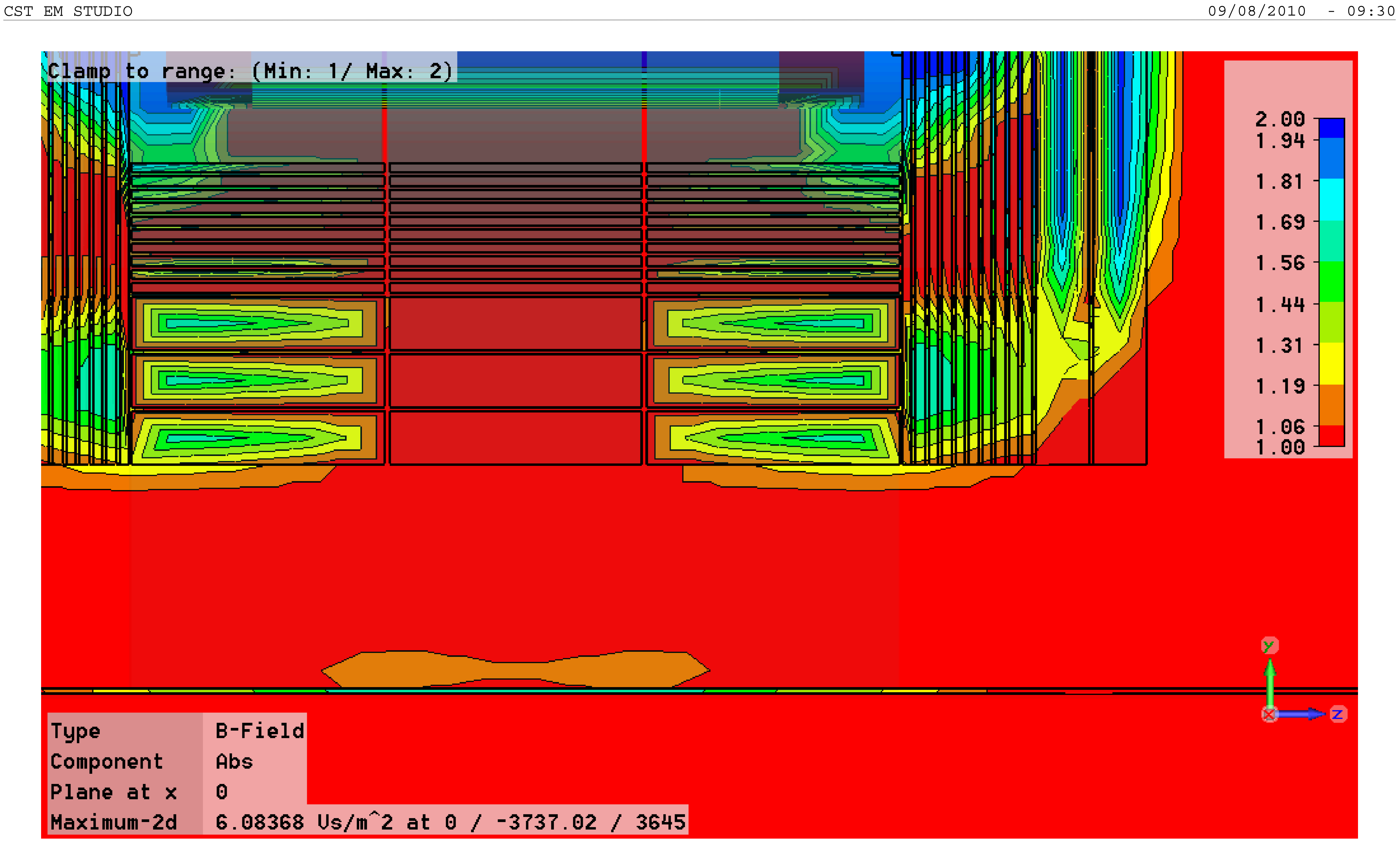


ILD Magnetic Stray Fields



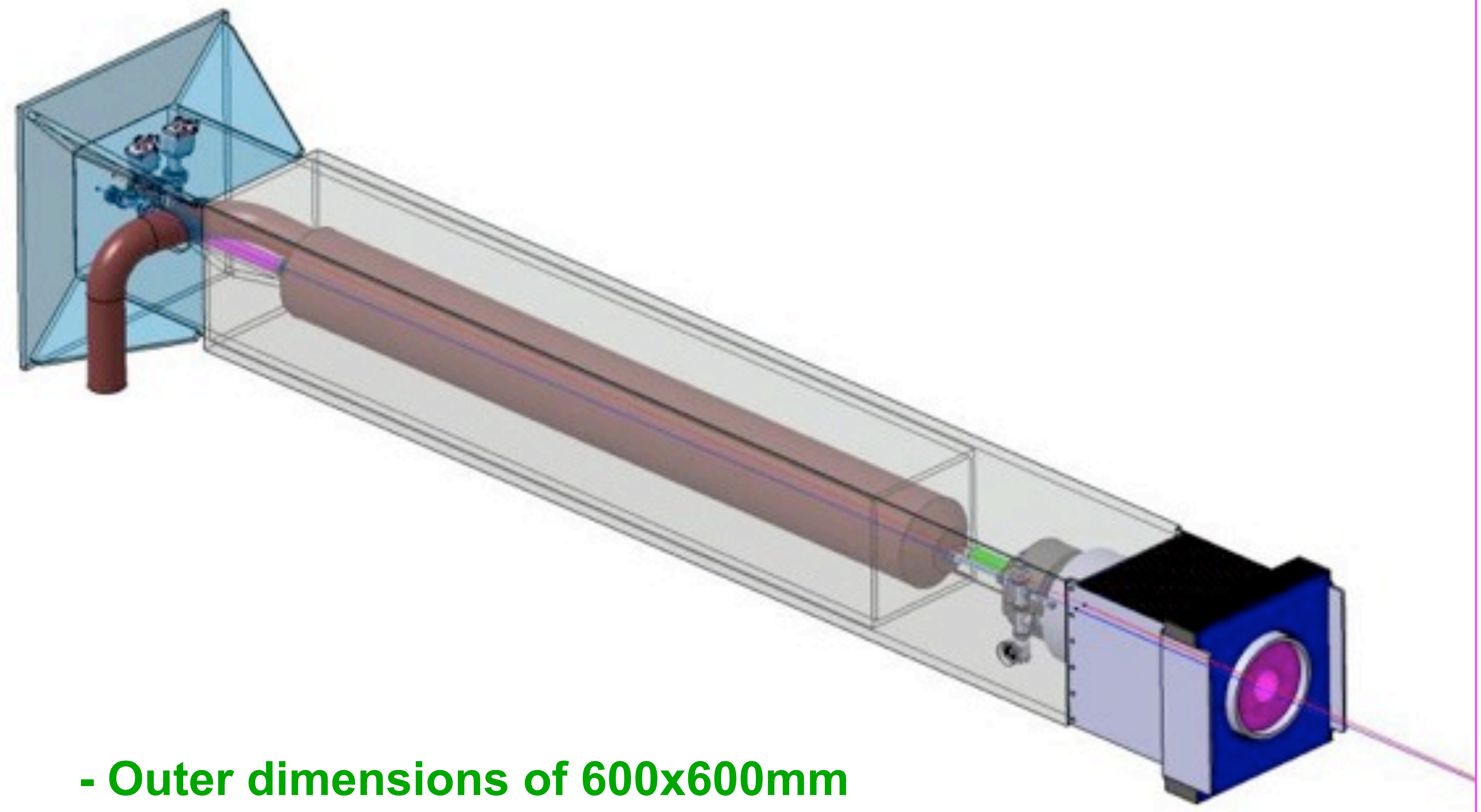
- ILD barrel yoke: ~3m of iron to ensure 5mT at 15m from beam pipe
  - main cause of ILD mass: ~15000 tons

Magnetic Field on Steel Floor



- Simulation with steel layer on platform
- Large induced magnetic fields! Might have consequence on reinforcements in concrete?

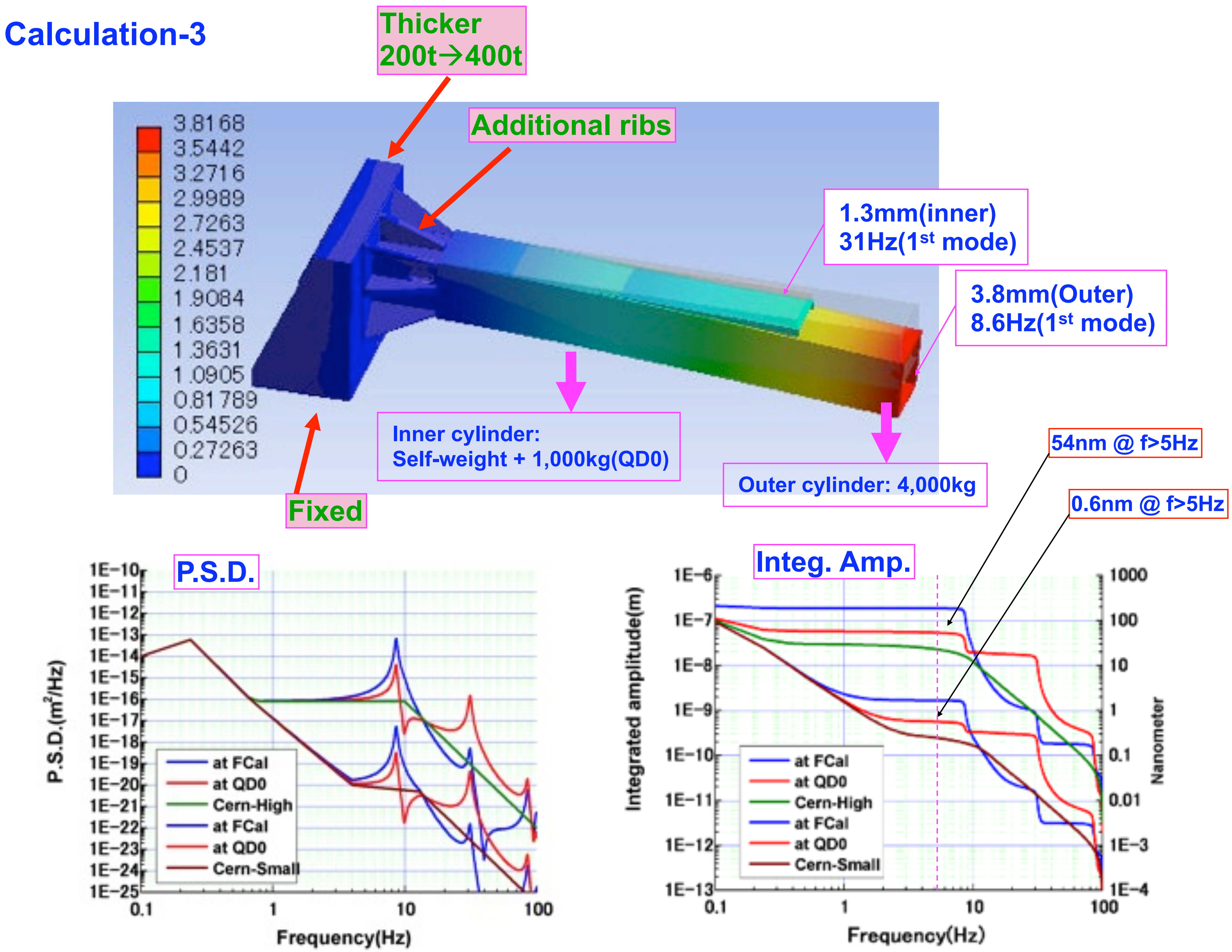
QD0 Support



- Outer dimensions of 600x600mm
- 25mm thick

- M. Joré, H. Yamaoka

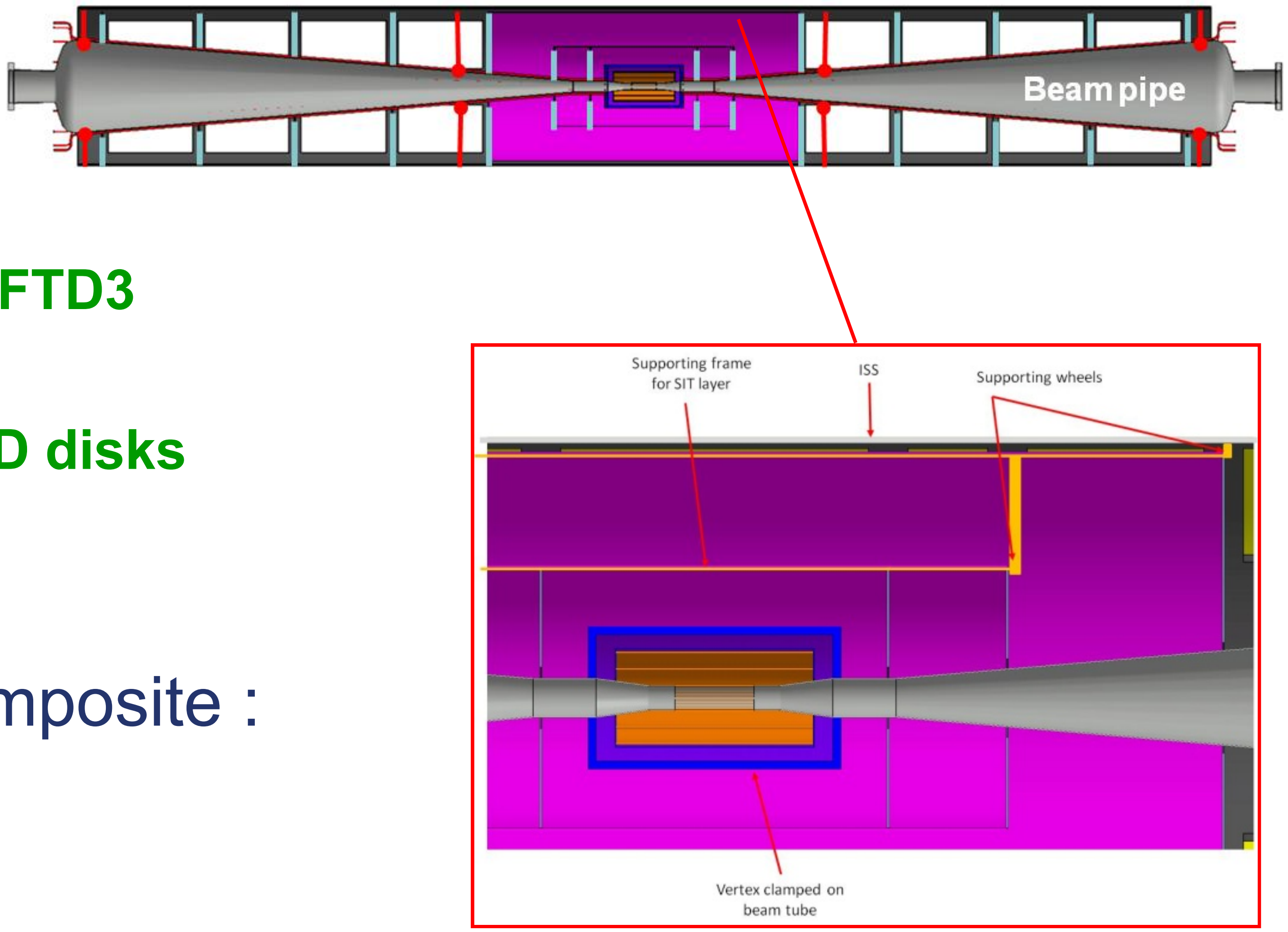
QD0 Support Vibration Analysis



- H. Yamaoka
- Ok for quite site

Inner Region Integration Studies

- Components to be supported :
  - **Vertex : 300g supported on FTD3**
  - **FTD : 500g / disks**
  - **SIT : estimated at 5Kg supported on FTD3**
  - **Beam pipe : ab. 15Kg with wires**
  - **Cables : ab. 15Kg supported with FTD disks (ab. 1Kg/disks)**

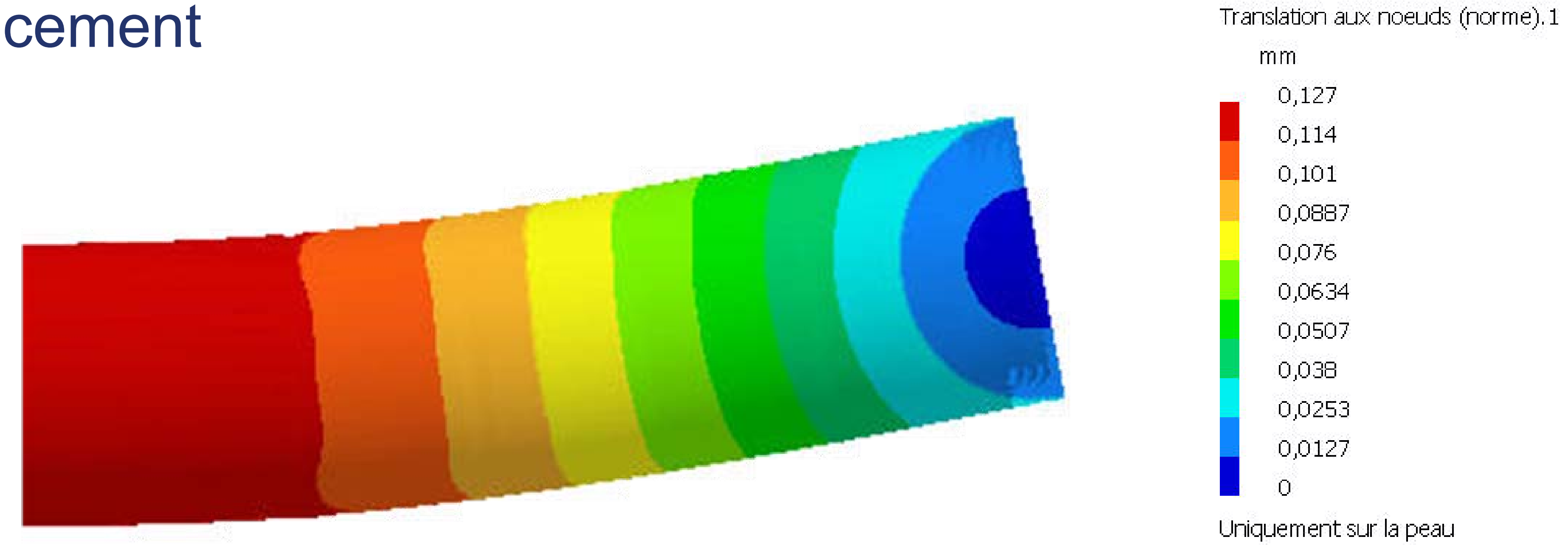


- Material : Carbone fiber / epoxy composite :
  - **Young modulus : 50GPa**
  - **Density : 1750Kg/m3**
  - **First assumed to be isotropic**
    - Realistic with the pure traction/compression loading (flexure of the tube)

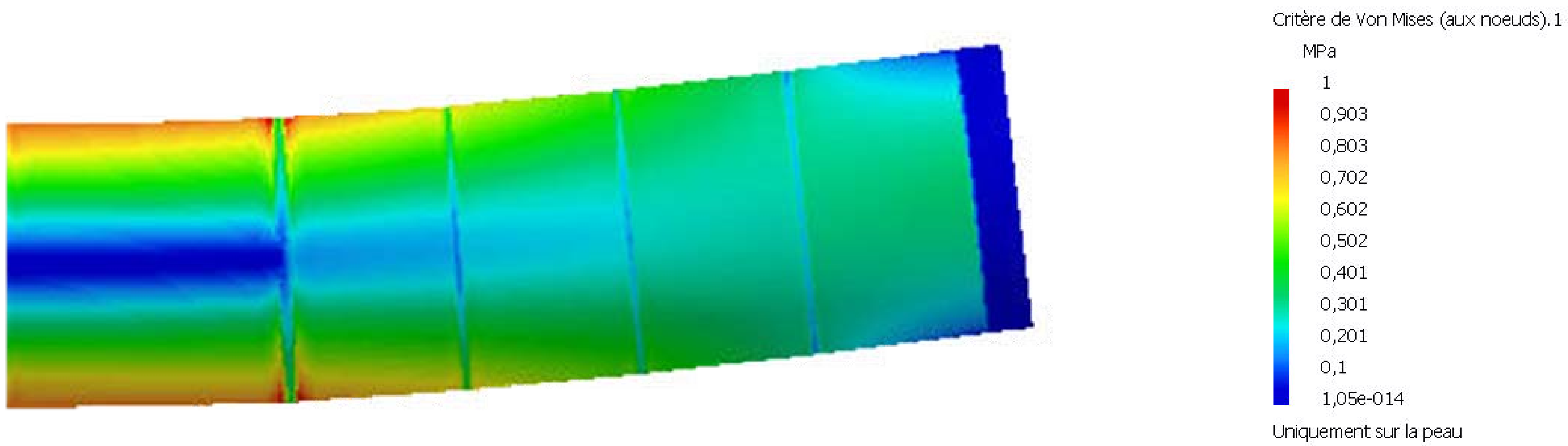
- M Joré

Inner Region Integration Studies

- Displacement



- Stress



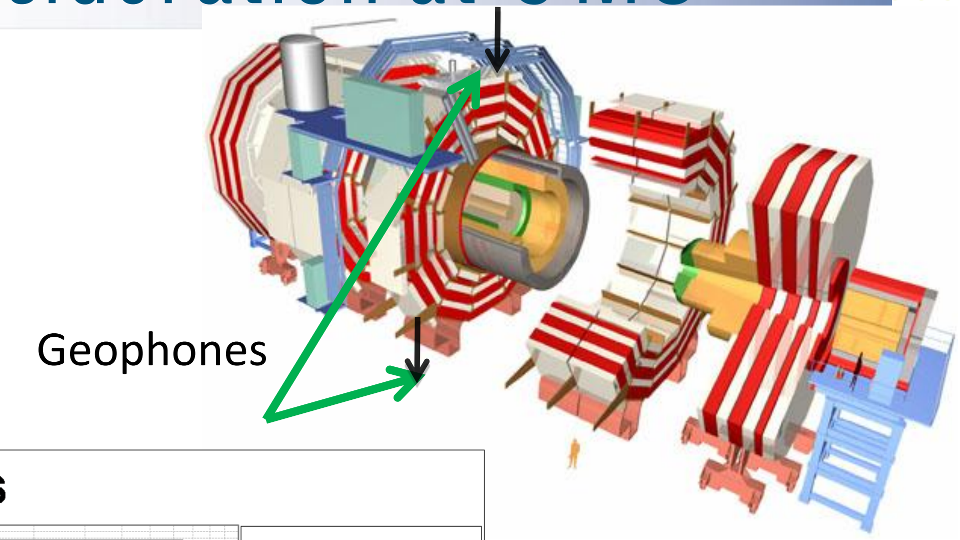
- M. Joré

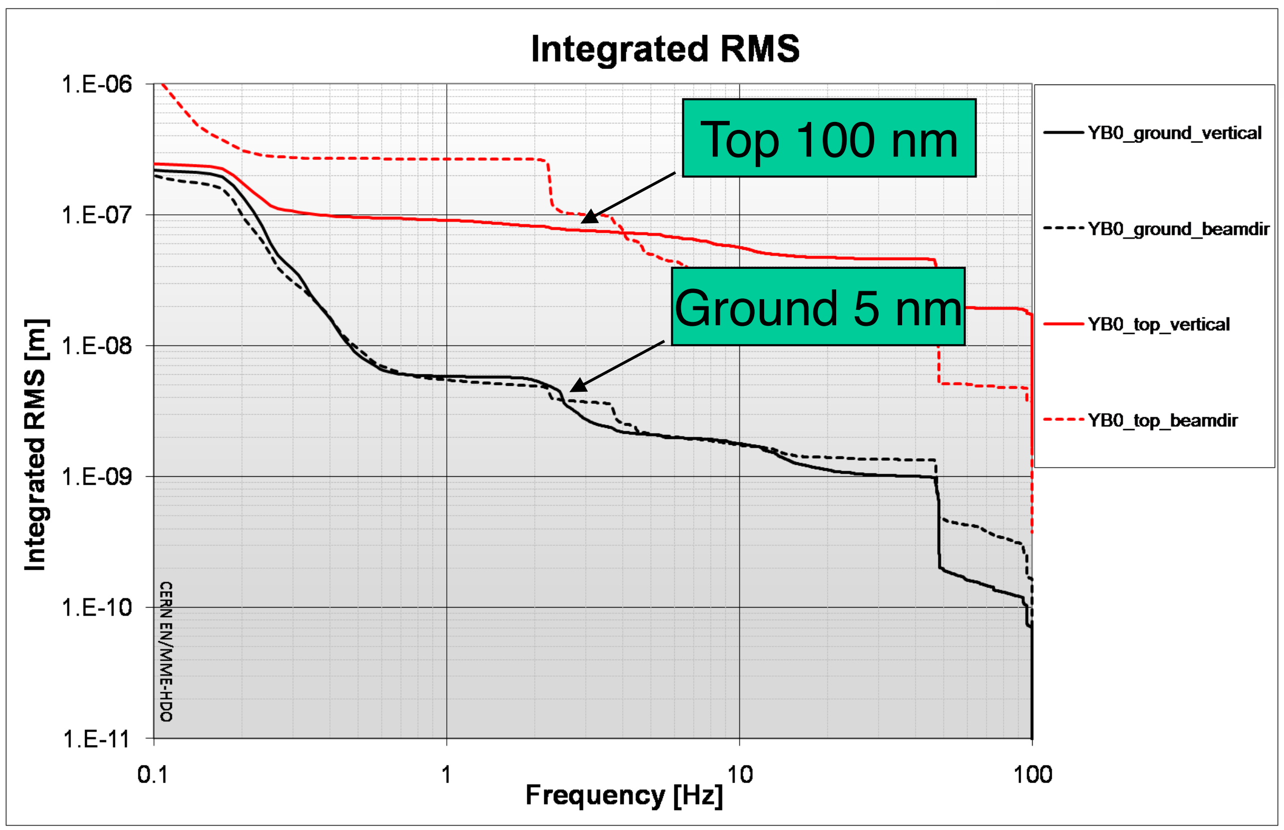
Vibration Issues

ETH Institute for Particle Physics

Vibration consideration at CMS

Vibrations on top of CMS central barrel YB0 with 'Quiet experimental area'





Measurements at KEK on BELLE (Hiroshi Yamaoka) have also shown a degradation of performances when moving up along the yoke.

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- Vibration limit: 50nm at beam line
- What would a platform change?

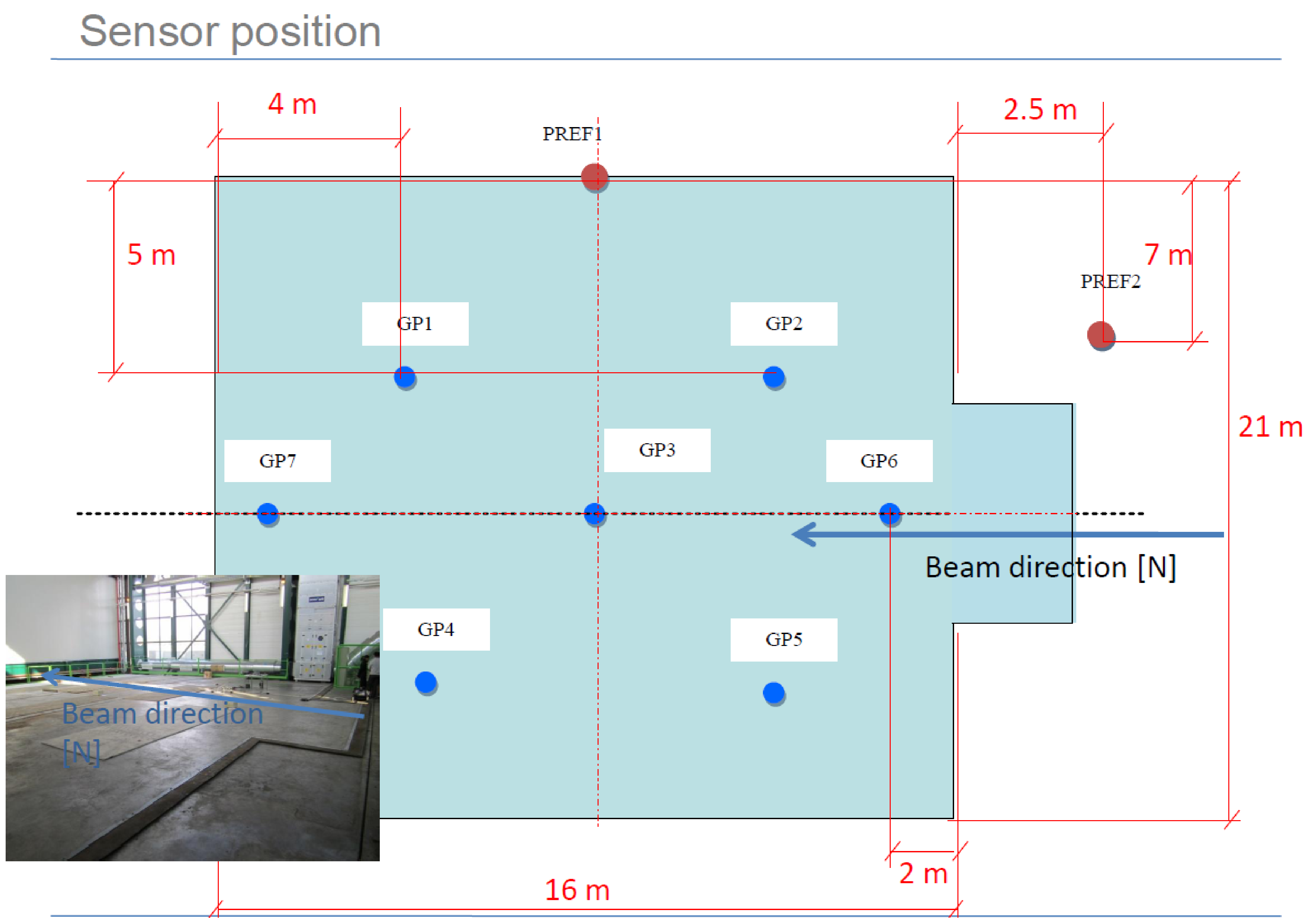
Vibration Issues

ETH Institute for Particle Physics

CMS Plug finished

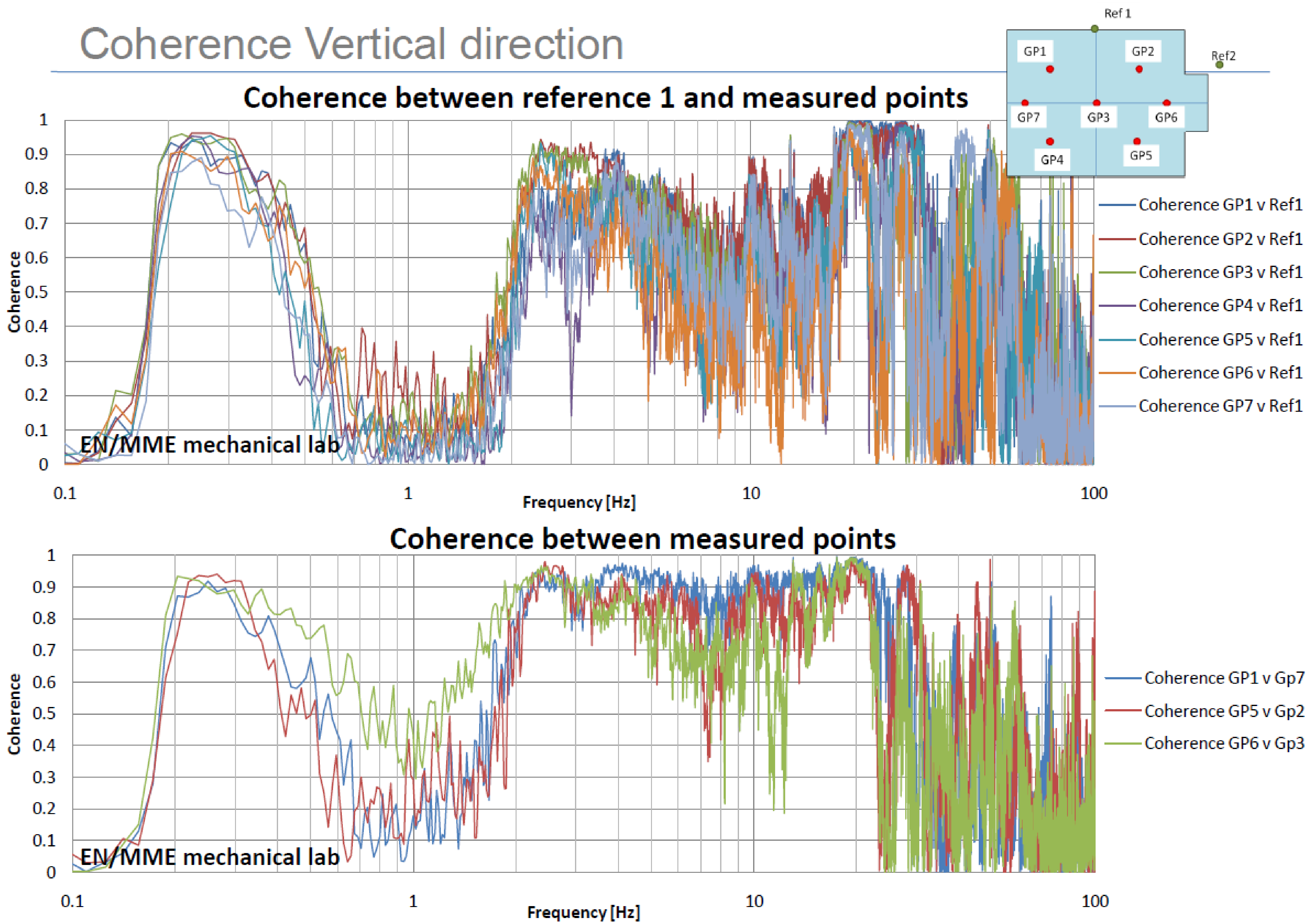
ilc

Platform Vibration Measurements and Modelling



- M. Oriunno

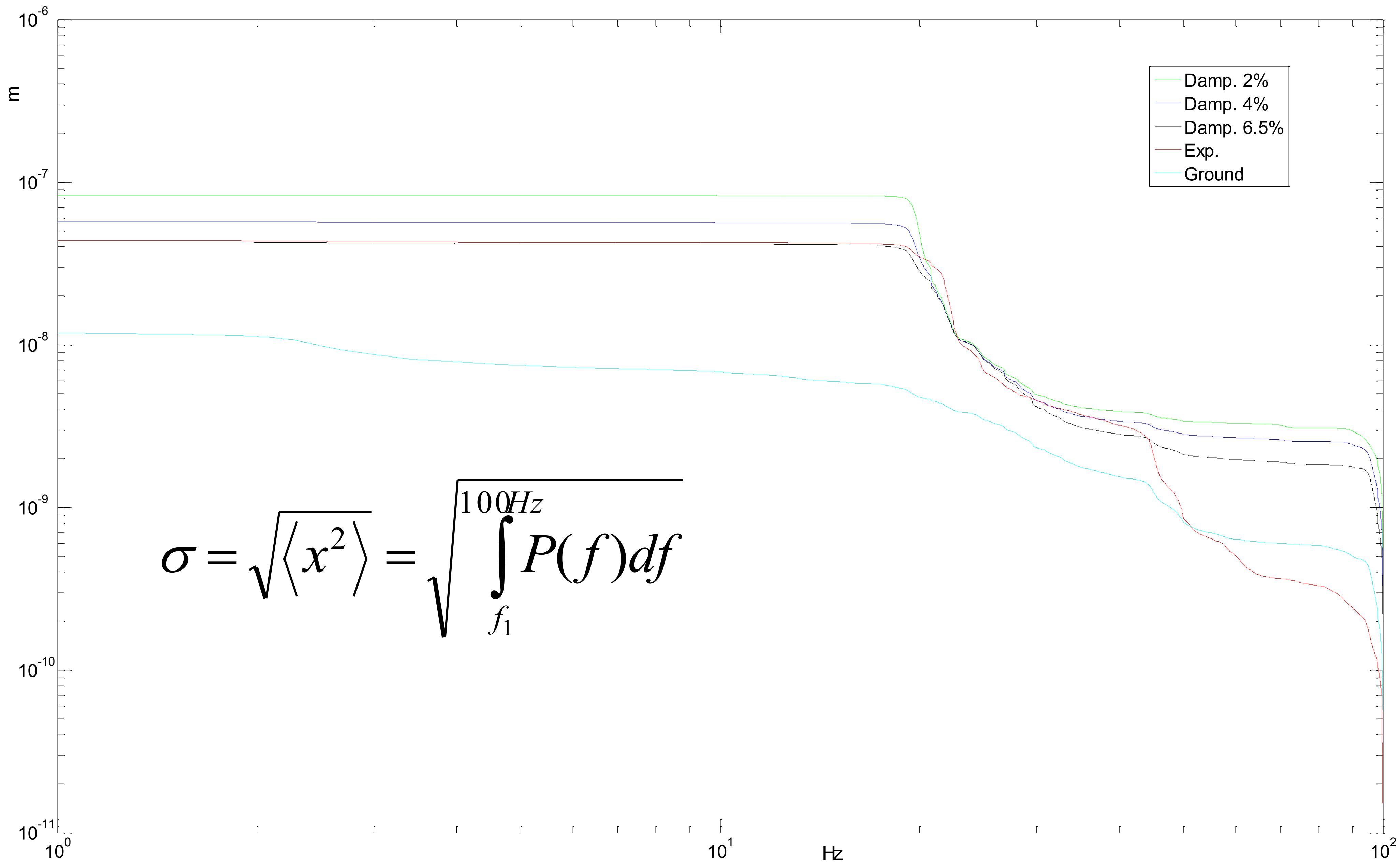
Platform Vibration Measurements and Modelling



- M. Oriunno

Platform Vibration Measurements and Modelling

Integrated Displacement (r.m.s.)

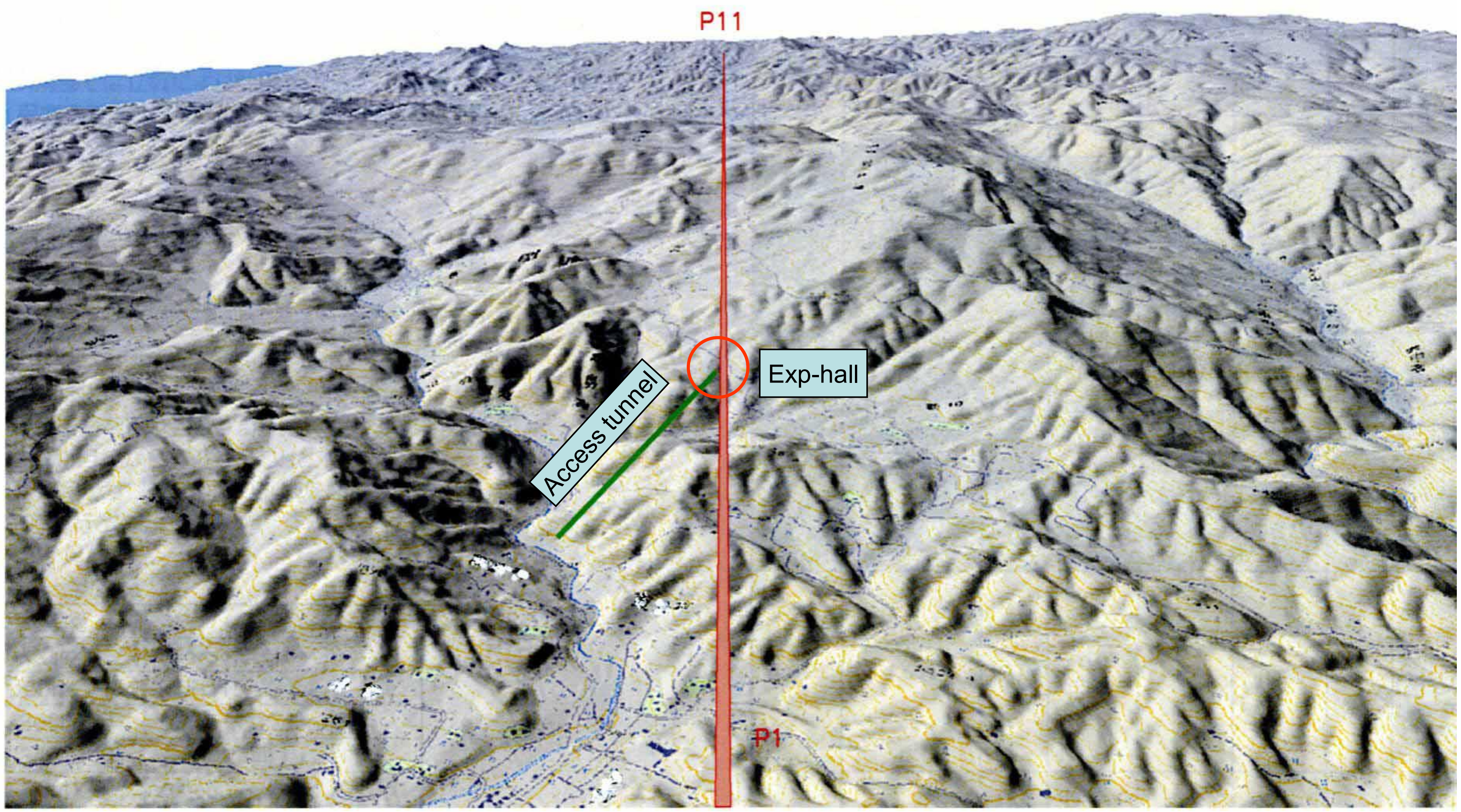


$$\sigma = \sqrt{\langle x^2 \rangle} = \sqrt{\int_{f_1}^{100Hz} P(f)df}$$

- Ground motion amplification of factor ~3

Alternative Detector Assembly Studies (Y. Sugimoto)

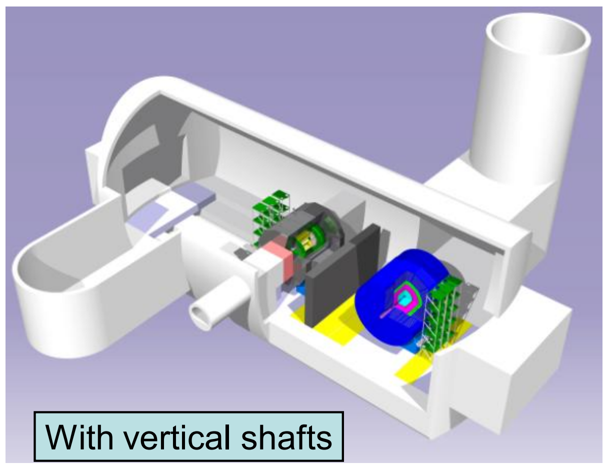
An example of Asian mountain site

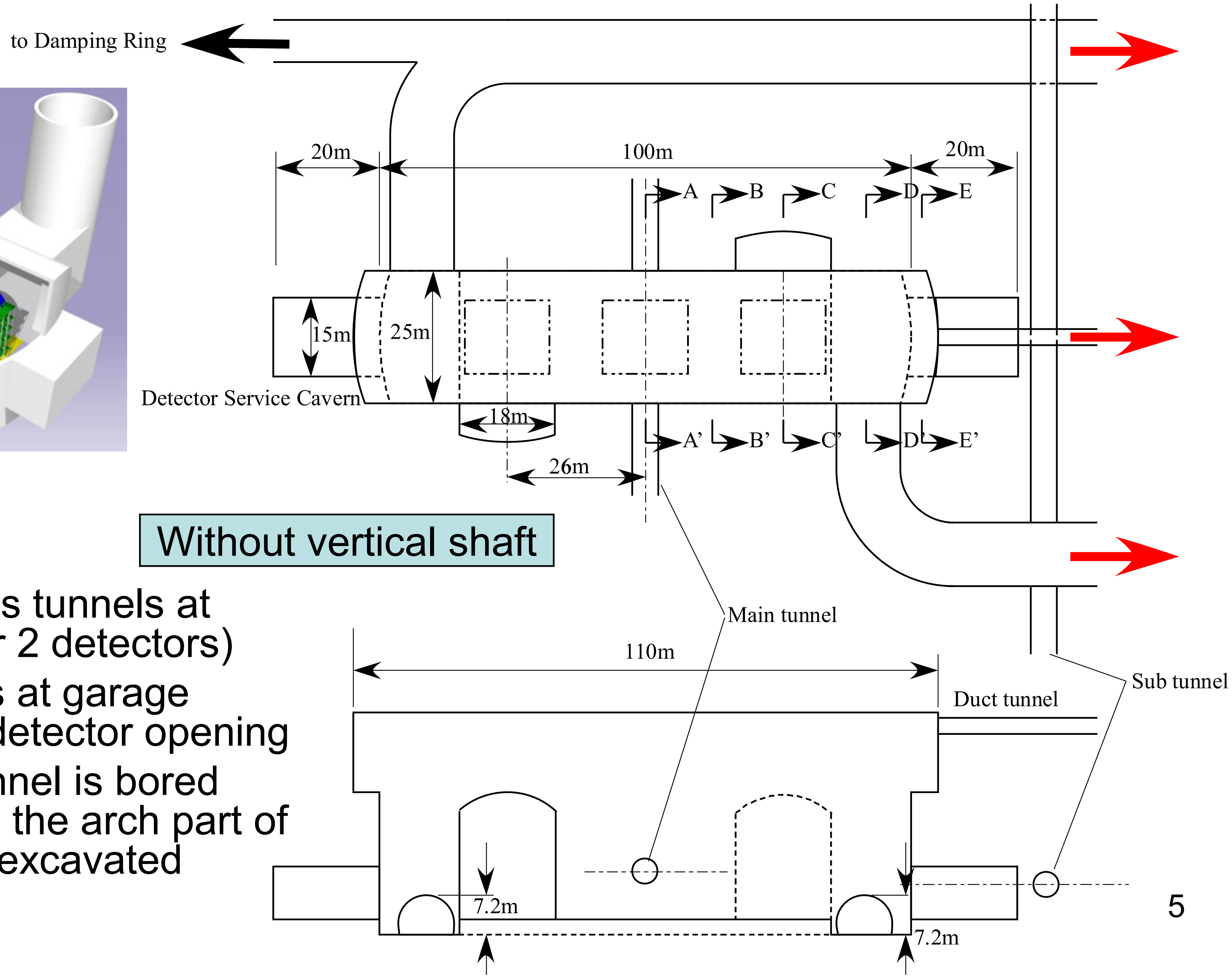


3

- ILC site could be quite different from „plain field“ assumptions
- No vertical access shafts (~100m) but horizontal access tunnels (~1km)
- CMS-type assembly of detector needs to be reviewed

A possible design of exp-hall

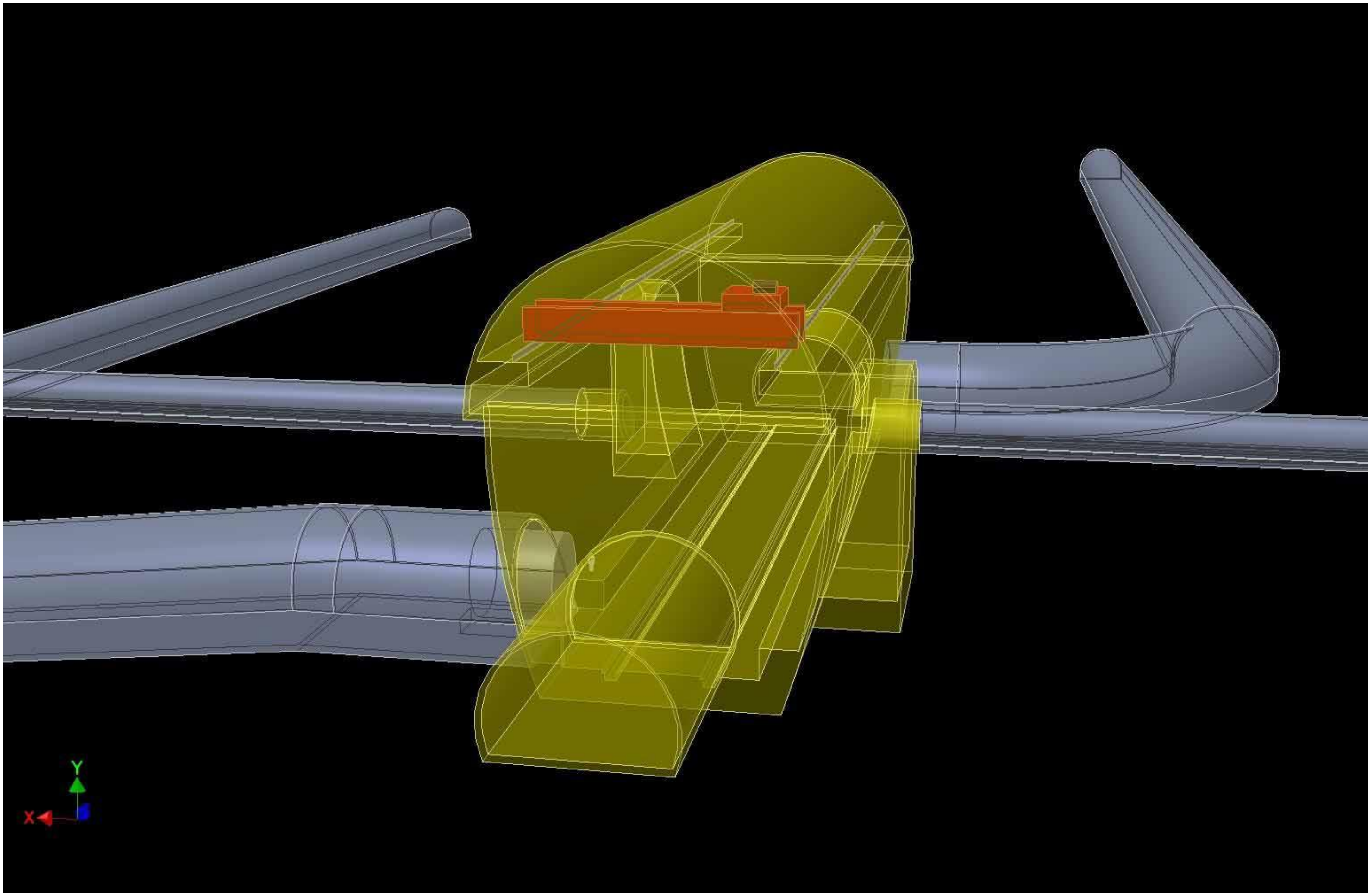




Without vertical shaft

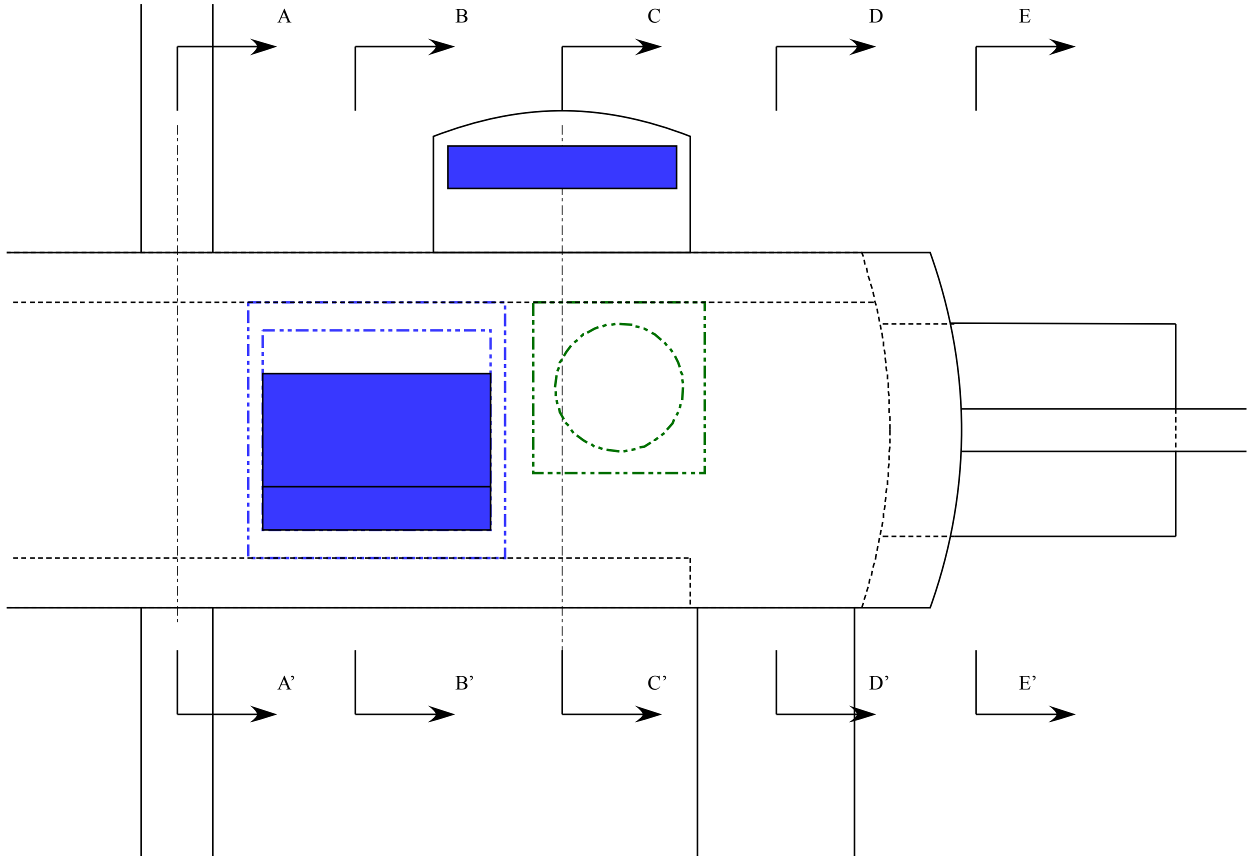
- Bottom access tunnels at both ends (for 2 detectors)
- Small alcoves at garage positions for detector opening
- Top (duct) tunnel is bored first, and then the arch part of the cavern is excavated

Alternative Detector Assembly Studies (Y. Sugimoto)



Space for assembly

- We need enough space to assemble the iron yoke and the solenoid in parallel
- Solenoid assembly procedure and installation method have to be studied
- Exp-hall should be equipped with two 200-ton cranes: usually one for each detector, and occasionally two cranes are used together to carry heavy (>200 ton) components



12

- Needs to be studied carefully

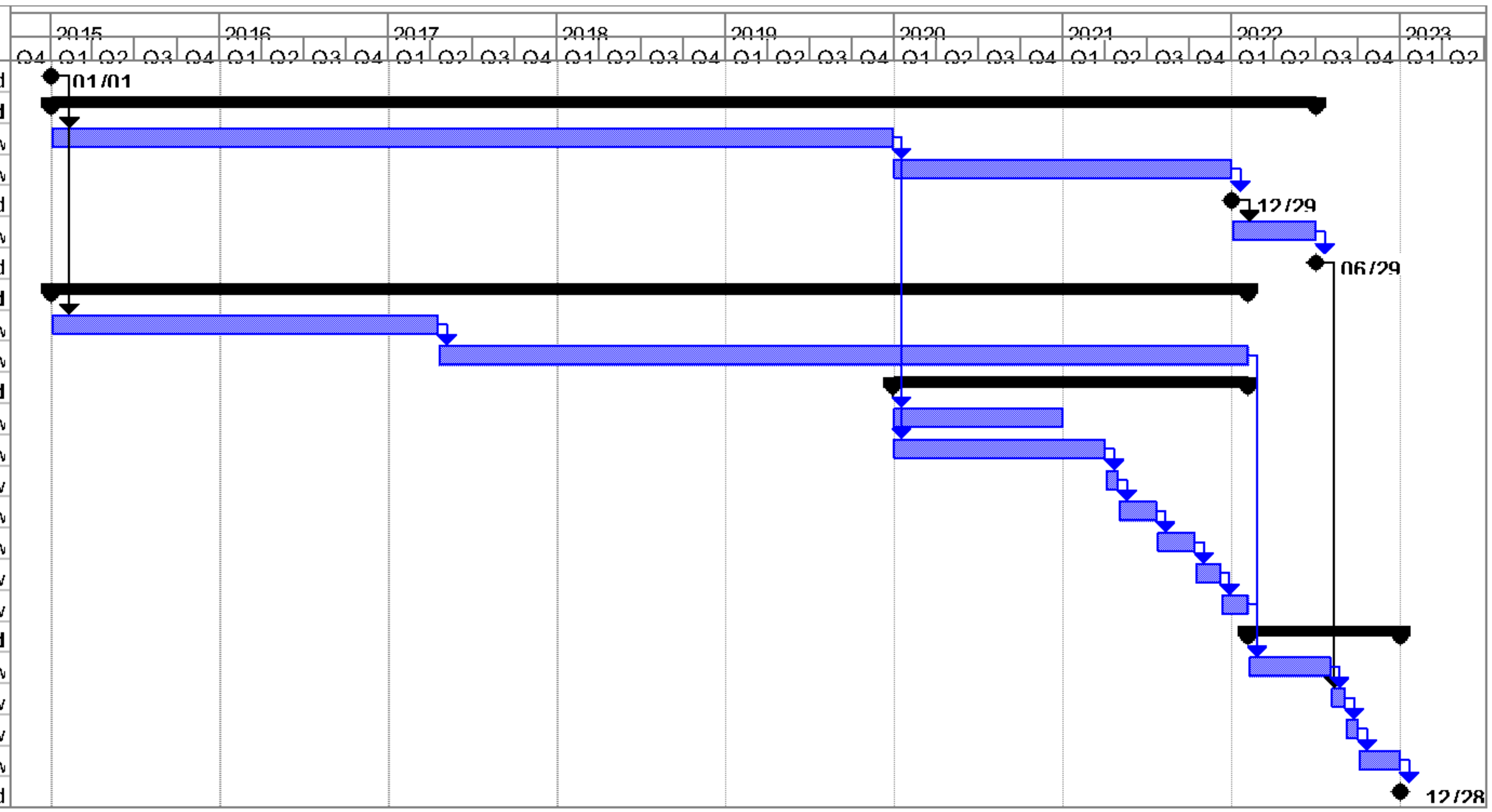
Detector assembly

- Assembly hall locates at the entrance of access tunnel where wide flat surface and wide roads exist
- Detector would be assembled to relatively small pieces (<100~200 ton) at the assembly hall, carried to the cavern through the access tunnel, and integrated to the large detector inside the cavern (Similar to “modified CMS style assembly” which was proposed by GLD group in 2006)
- Barrel iron structure would be divided in ϕ (and R) direction, rather than Z direction
- Solenoid coil would be wound on surface for 5 modules, and these modules are connected into one solenoid in the cavern
- Detailed study on the assembly method is necessary

6

New modified CMS style

ID	Name	Duration
1	Project approval	0d
2	**Beam lines construction**	**1955d**
3	Cavern/Tunnel	260w
4	Beamline harware install	105w
5	Start of beam commissioning	0d
6	BDS pre-commissioning	26w
7	BDS ready for detectors	0d
8	**Detector construction on surface**	**1850d**
9	Surface assembly hall	120w
10	Detector assembly on surface	250w
11	**Detector assembly in cavern**	**550d**
12	Yoke assembly	53w
13	Solenoid assembly/install/test	66w
14	Field mapping	4w
15	HCAL install/cabling/test	12w
16	ECAL install/cabling/test	12w
17	TPC install/cabling/test	8w
18	SIT/FTD/VTX install/cabling/test	8w
19	**Commissioning**	**235d**
20	Detector pre-commissioning	26w
21	Detector roll-in	4w
22	Detector check-out	4w
23	Final beam commissioning	13w
24	Ready for physics run	0d



- Timing issues need to be studied in more detail
  - Coupling of machine underground cfs work and detector construction
- In the end the site might not be our choice, so we should be prepared

Summary

- The underground hall design presented in the RDR is not optimal for ILD
  - Common design needed that fits ILC, SiD, ILD and is aligned with the push-pull paradigm
  - Common collaboration between ILD, SiD, ILC-BDS and ILC-CFS needed
- A platform based push-pull motion system seems feasible but needs detailed engineering work
  - Common collaboration between ILD, SiD, ILC-BDS and ILC-CFS needed
- Site-specific modifications need to be taken into account
  - e.g. mountainous site has different requirements than flat site
- Less than two years to go for the TDR/DBD!