ILD Integration - Internal and External

A Review

Karsten Buesser

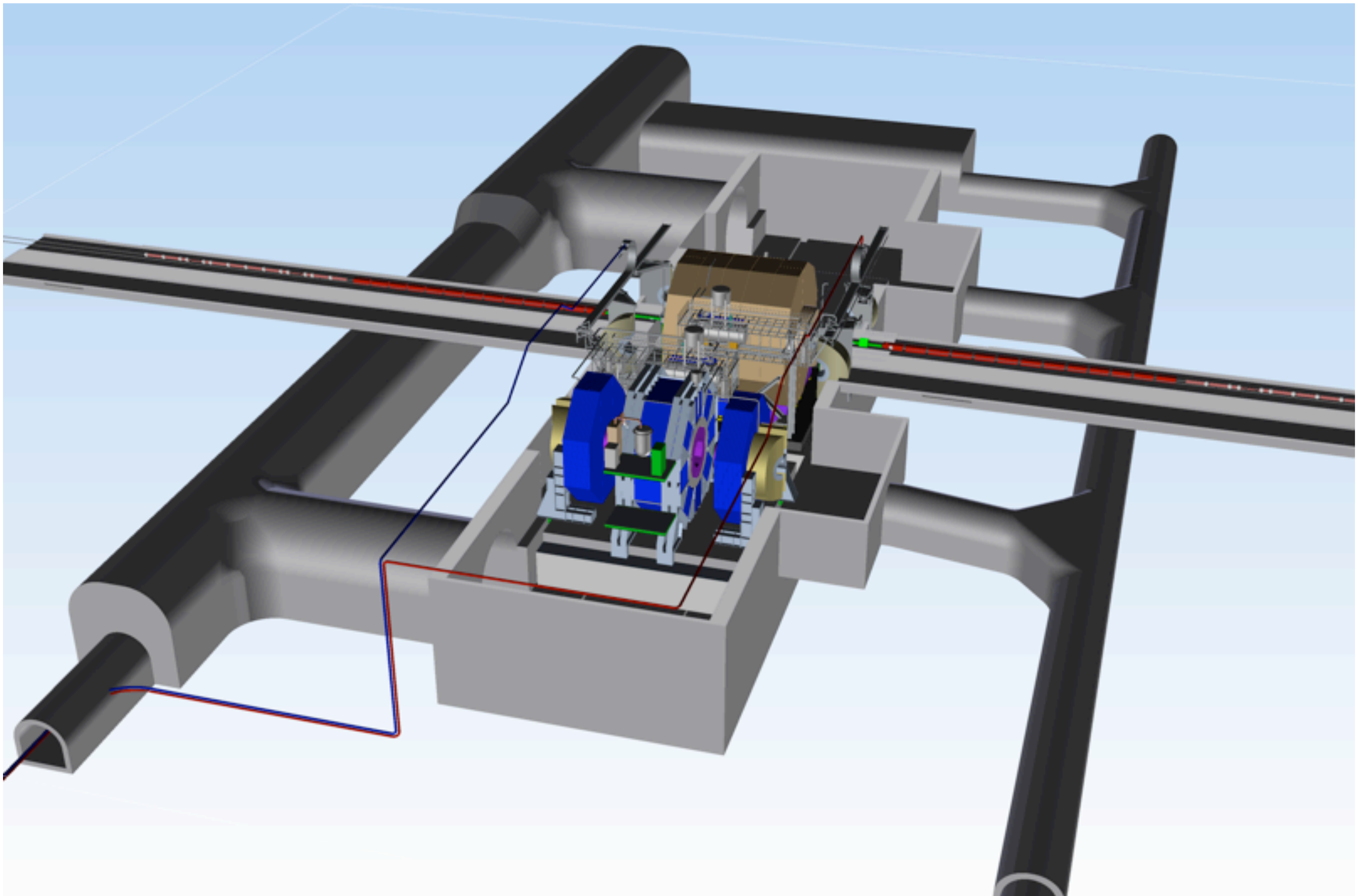
24.09.2013

ILD Workshop Cracow

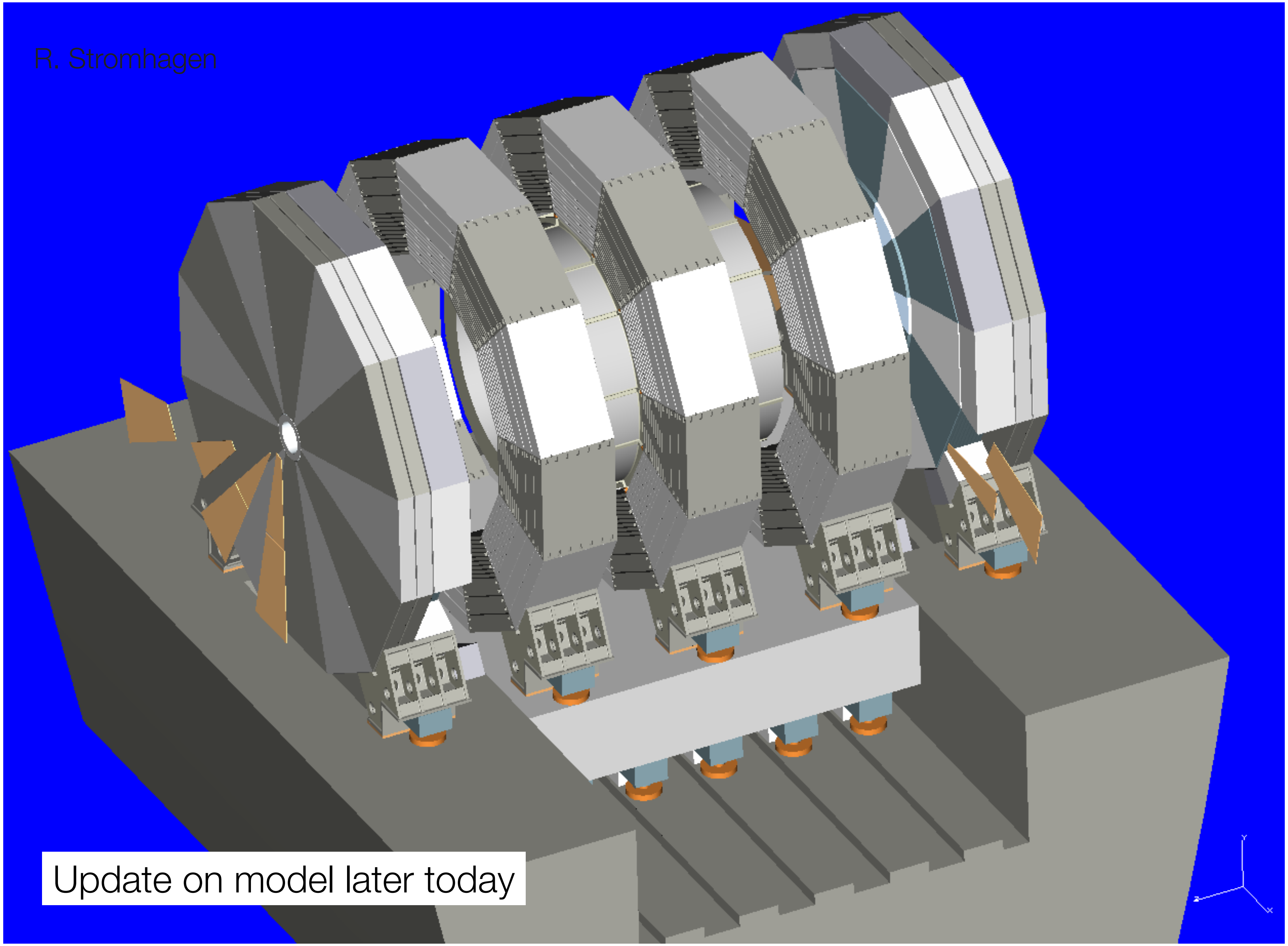
Introduction

- An integrated detector model for ILD has been developed for the DBD/TDR
  - No site-specific issues have been taken into account
  - Now we have a site in northern Japan
- At the same time ILD is undergoing the next round of optimisation
  - improvements, cost efficiency, sharpening of physics case
- Subdetector collaborations get more experience with realistic full-system and full-scale prototypes
  - More realistic designs of mechanics, cabling, cooling
- Time to review the current design w.r.t. realistic boundary conditions
  - Internal integration: the ILD engineering model
  - External integration: integration with the machine and SiD

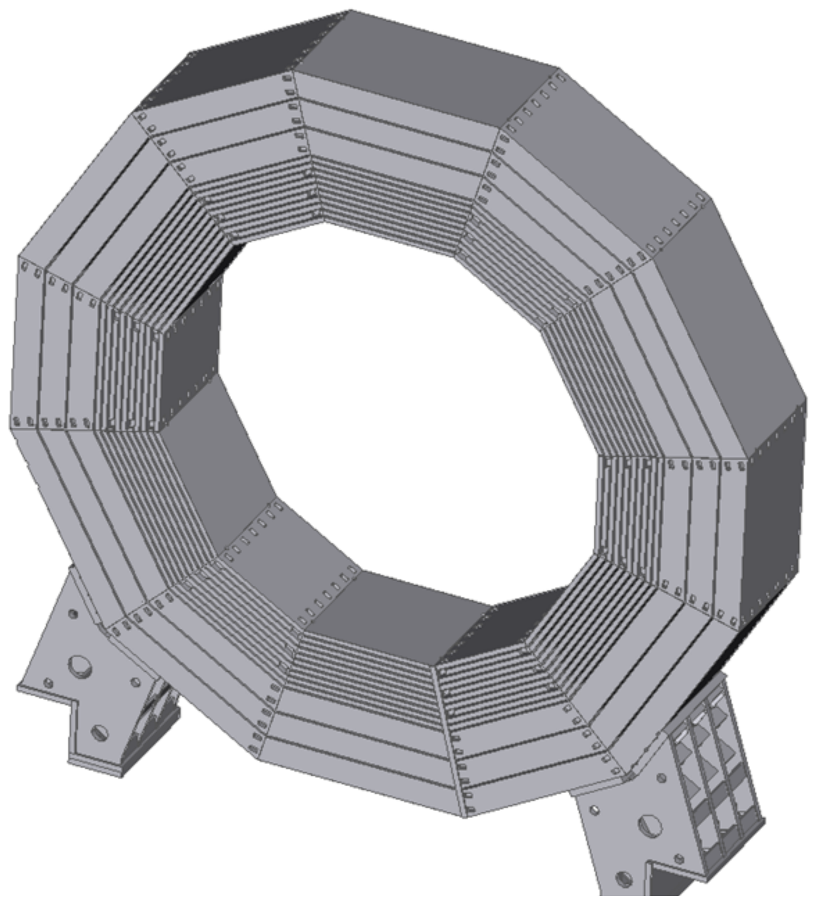
ILD in its Natural Environment...

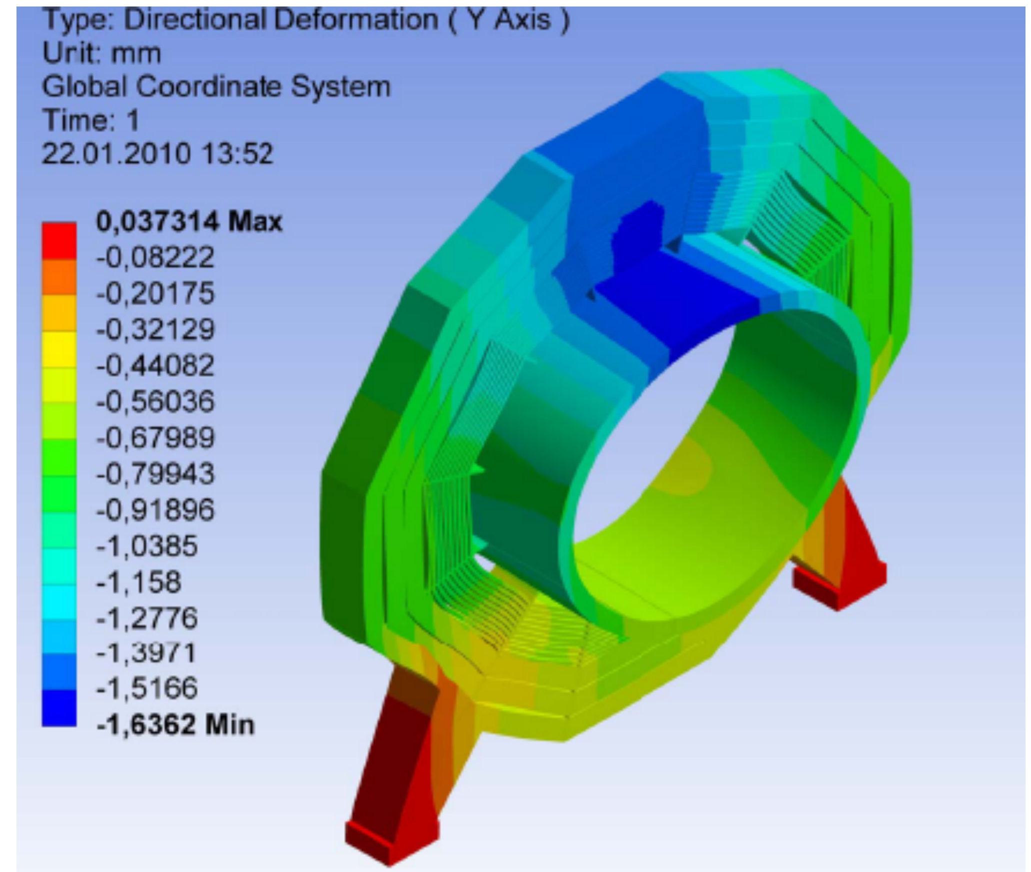


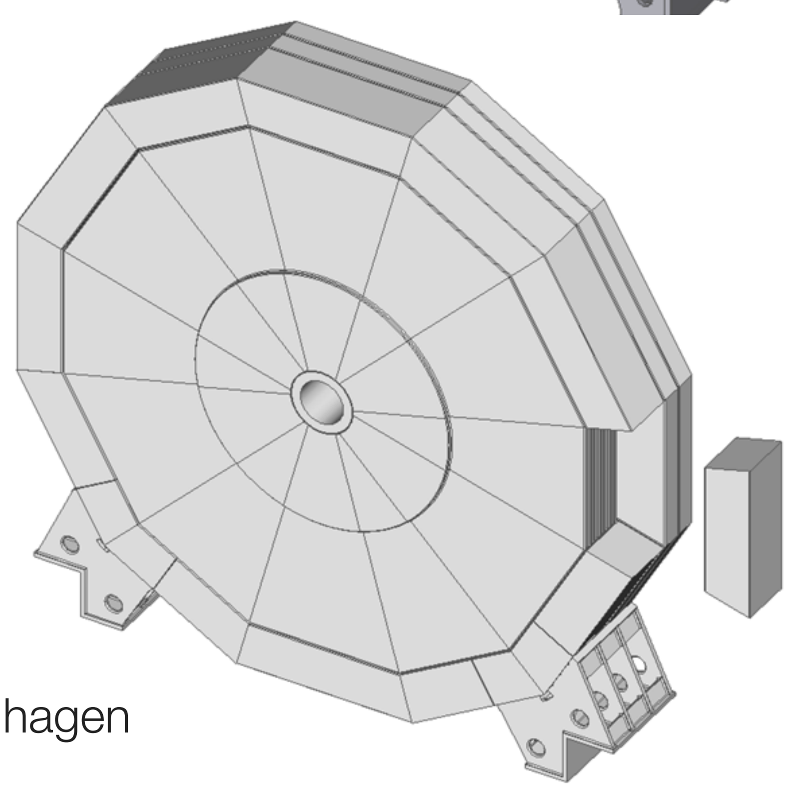
ILD Mechanical Design



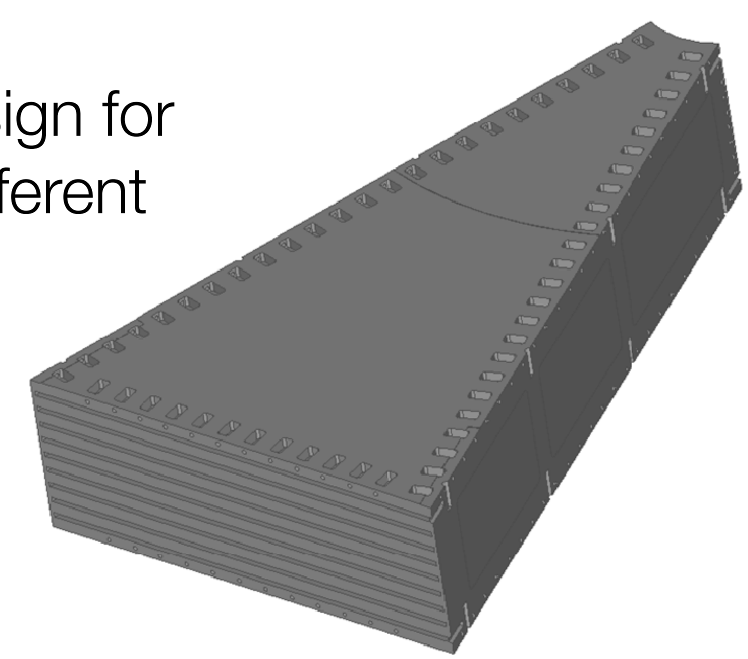
Yoke





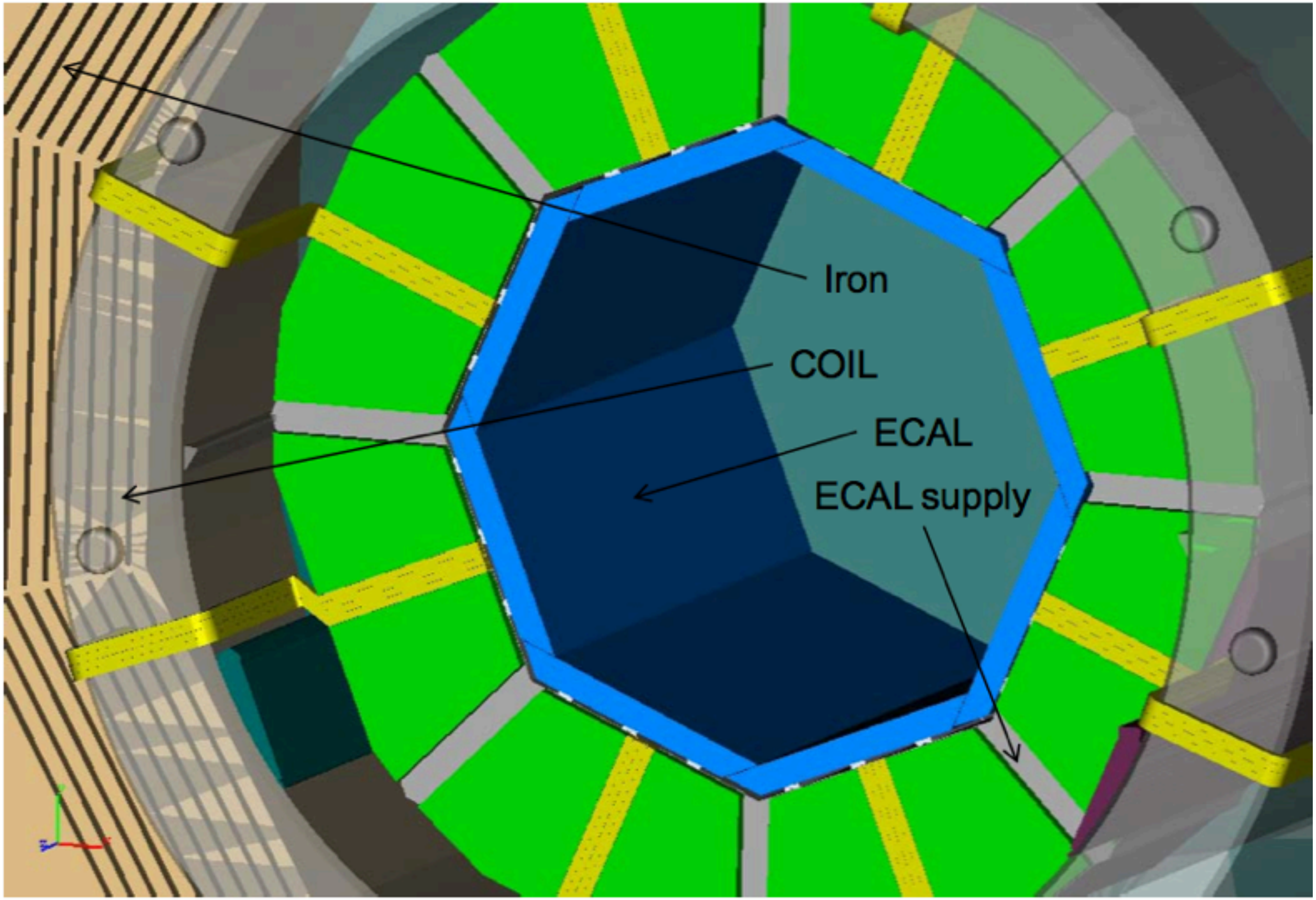


NB: Endcap Design for ILD@CLIC is different

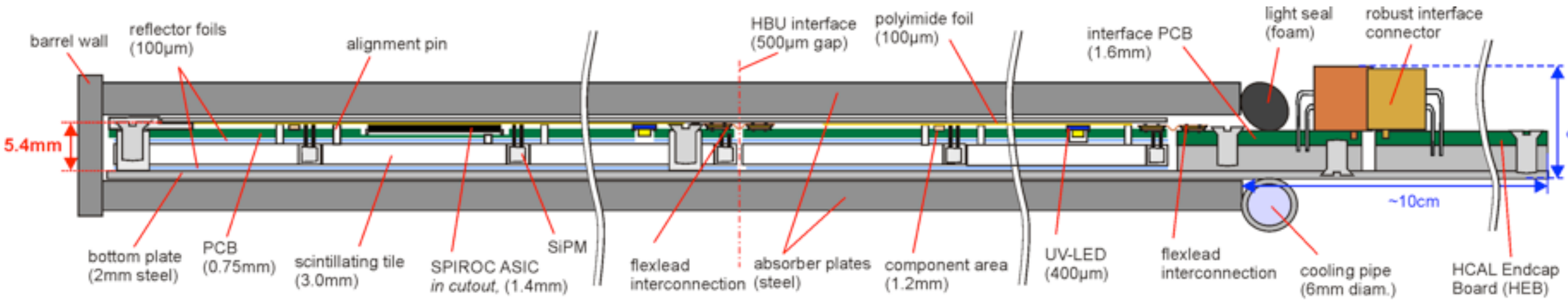


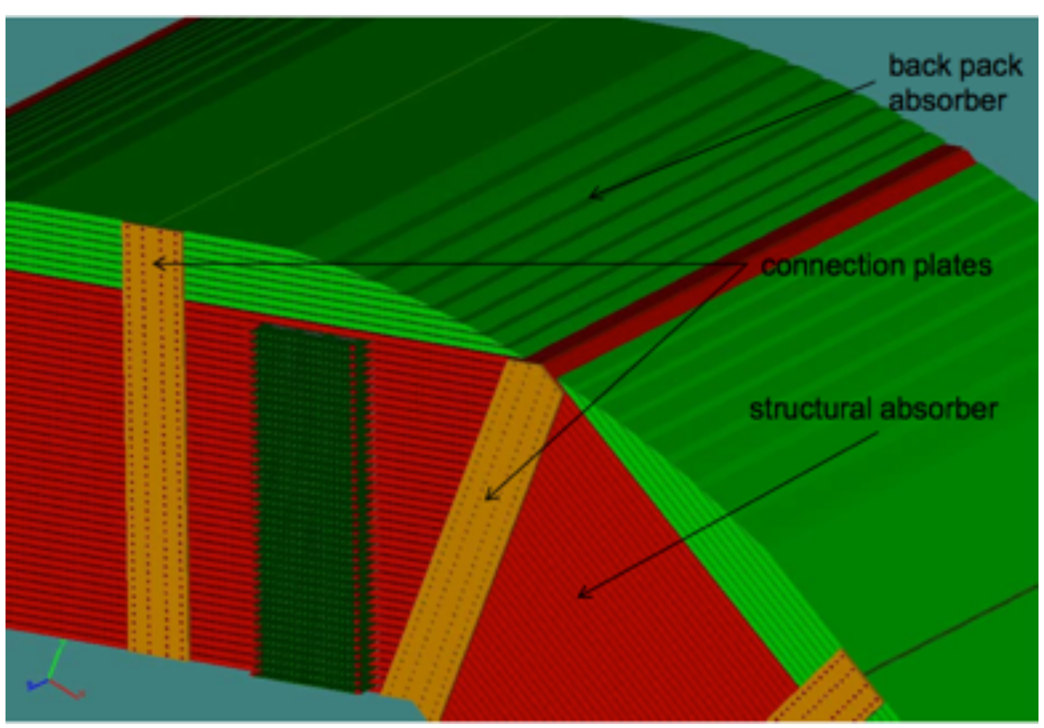
R. Stromhagen

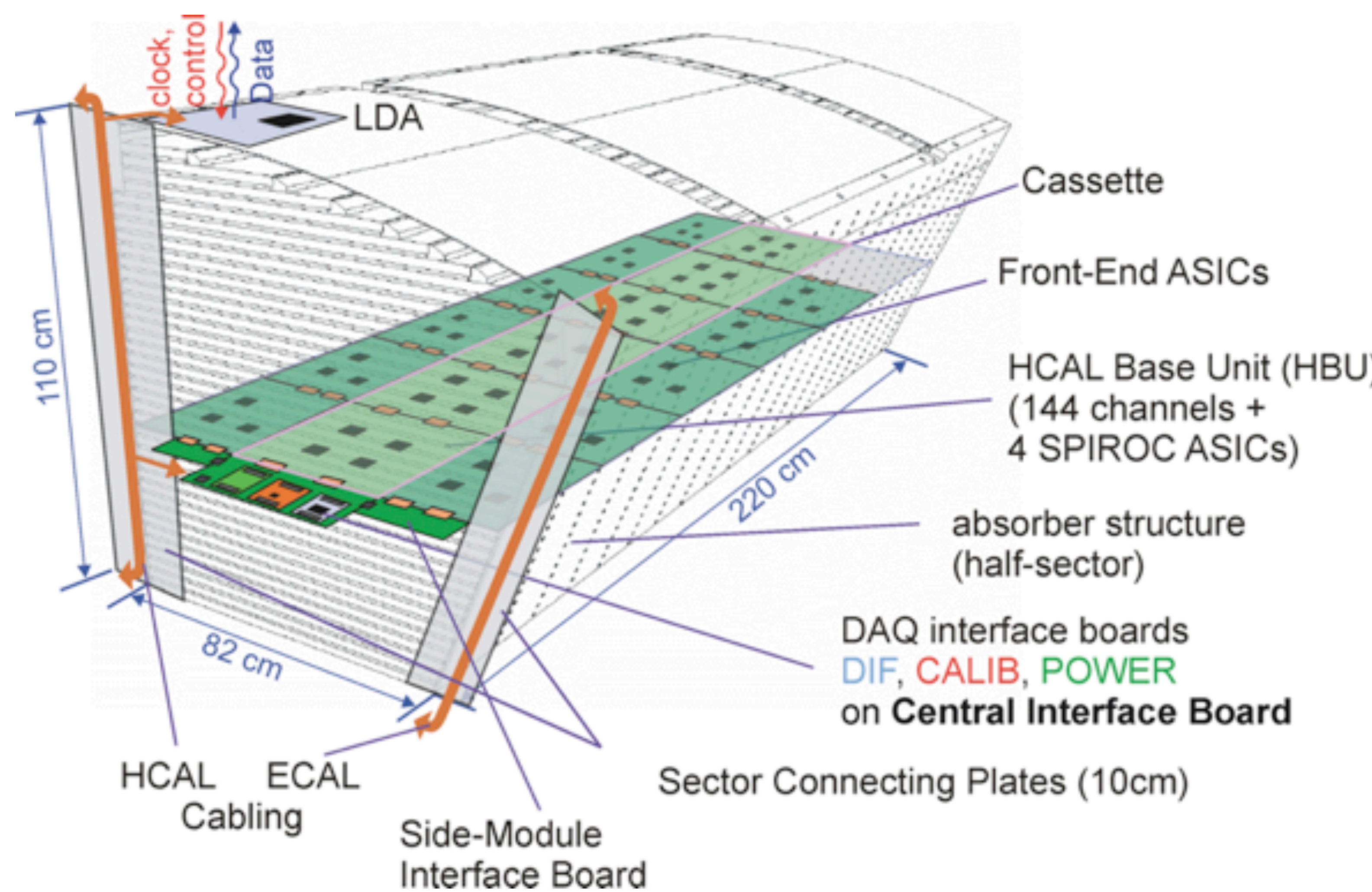
Calorimeter Integration



Analogue HCAL



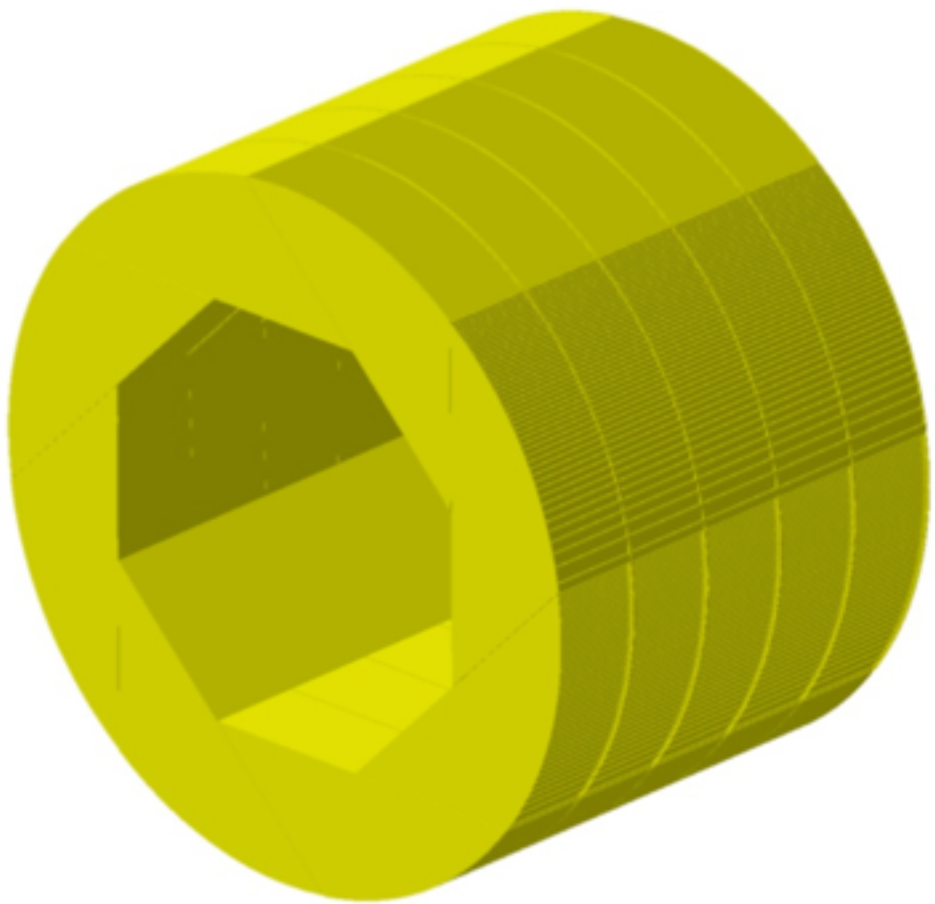


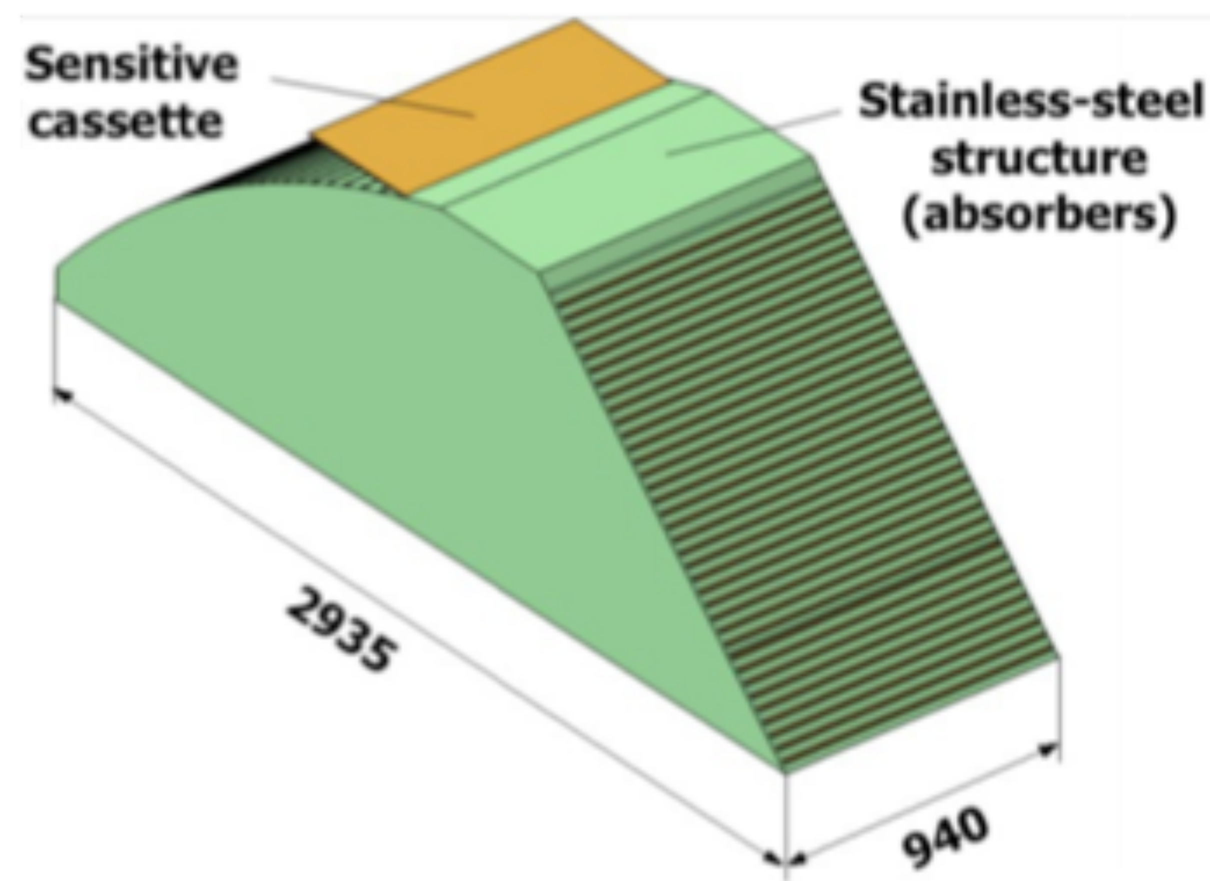


K. Gadow

Semi-Digital HCAL

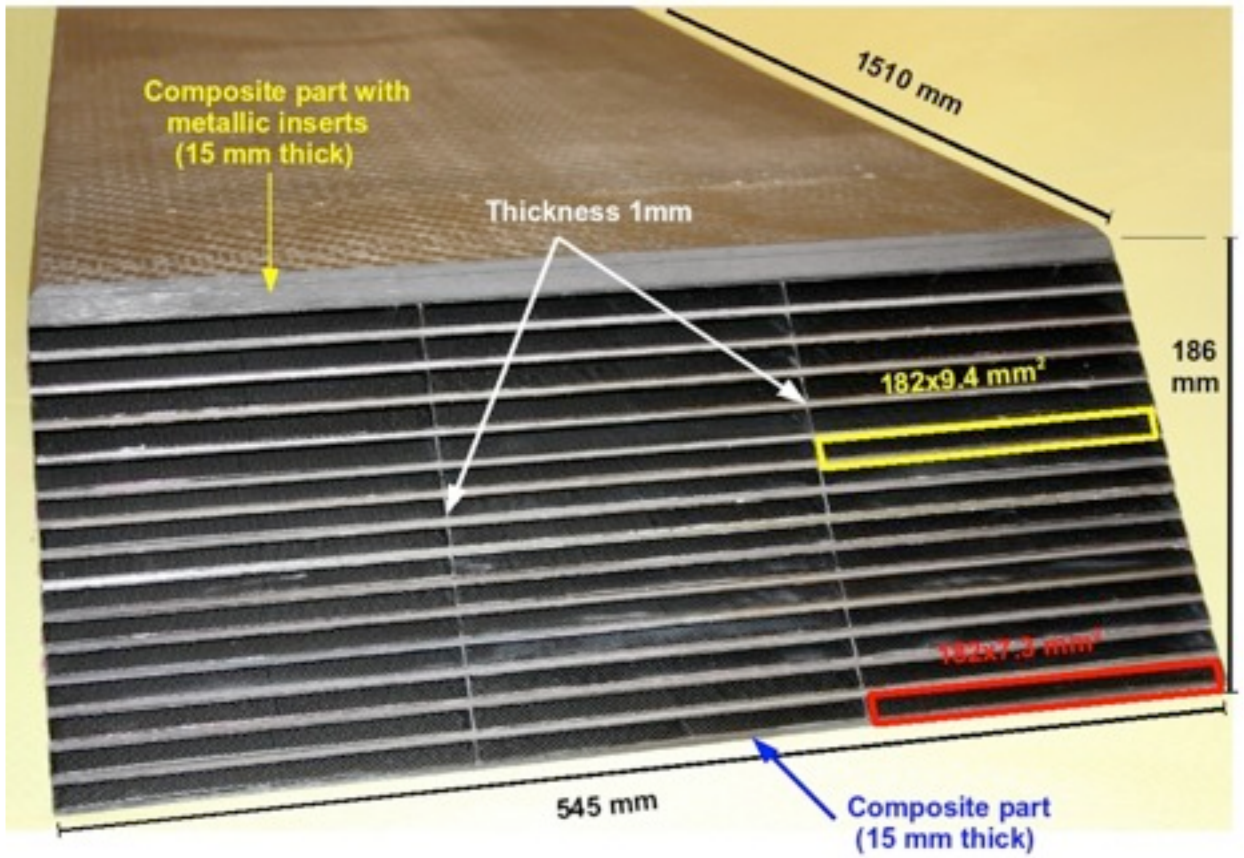
J.C. Ianigro

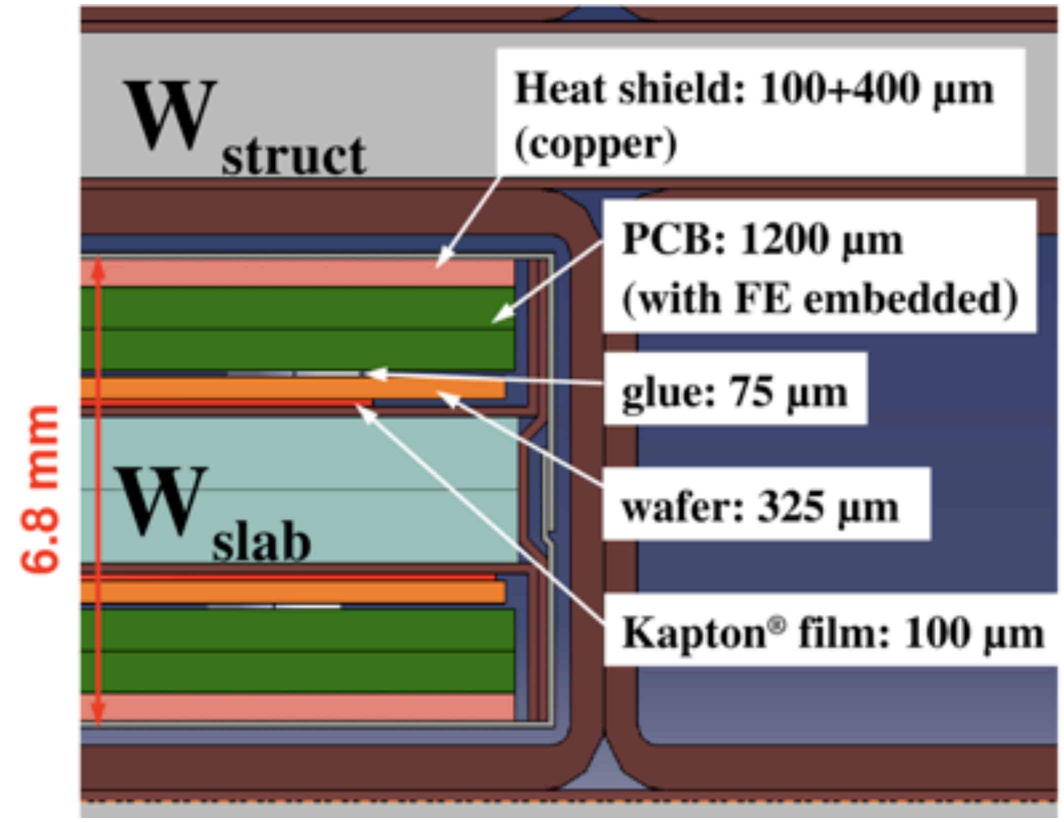


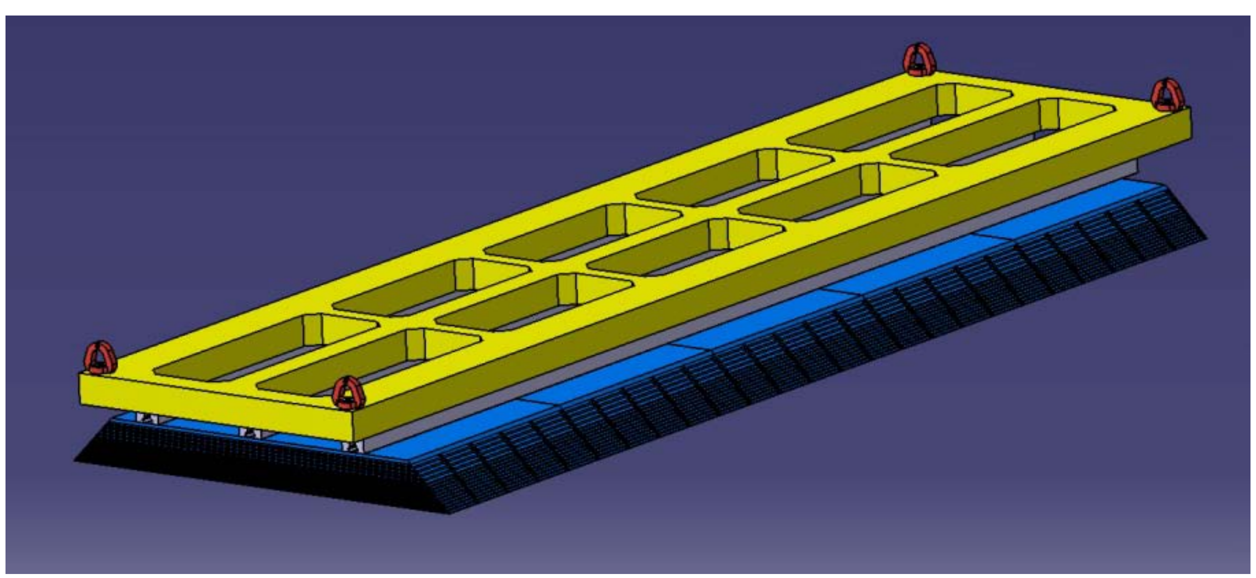


- 5 Rings:
  - Structure mass: 440 t
  - Detector mass: 184 t
  - Total mass 624 t

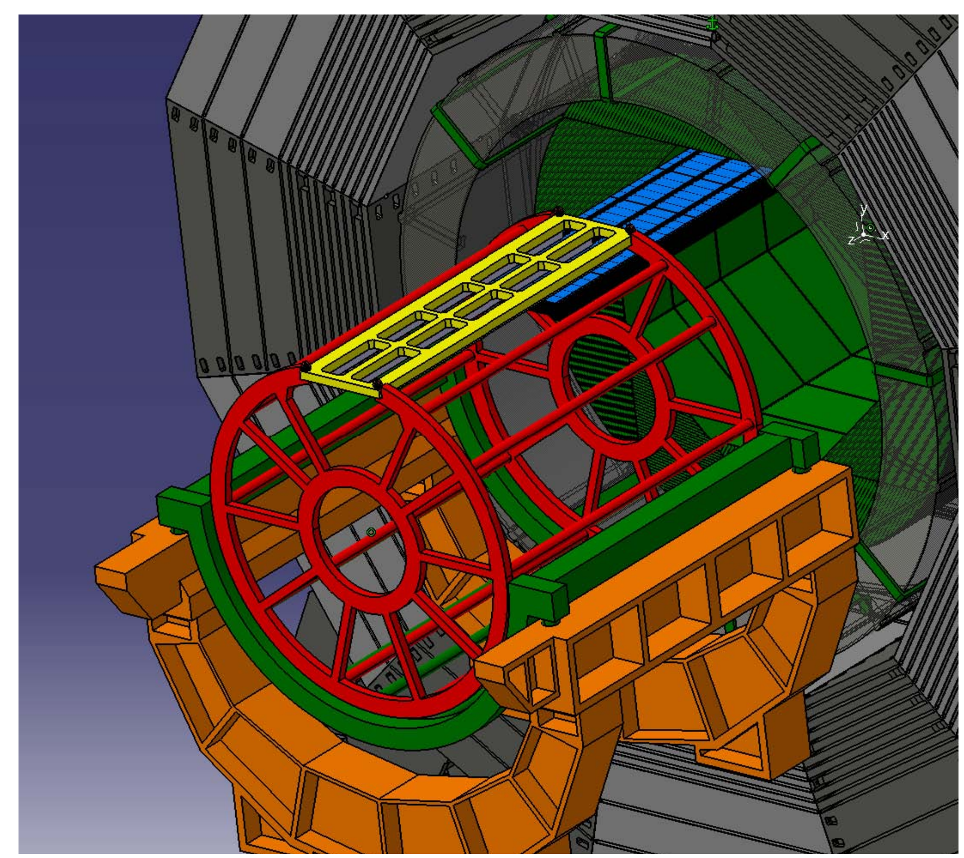
Si/W ECAL





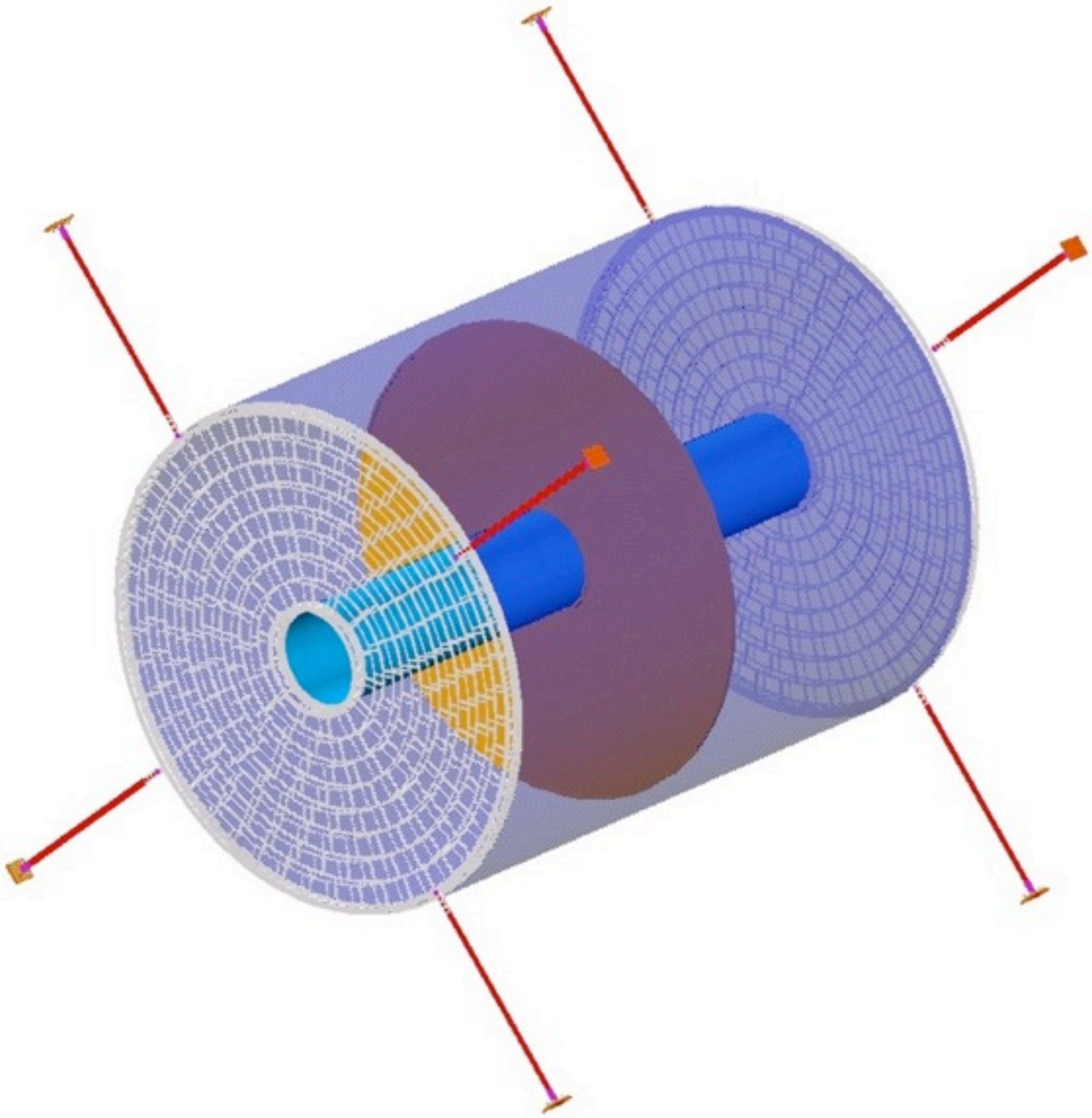


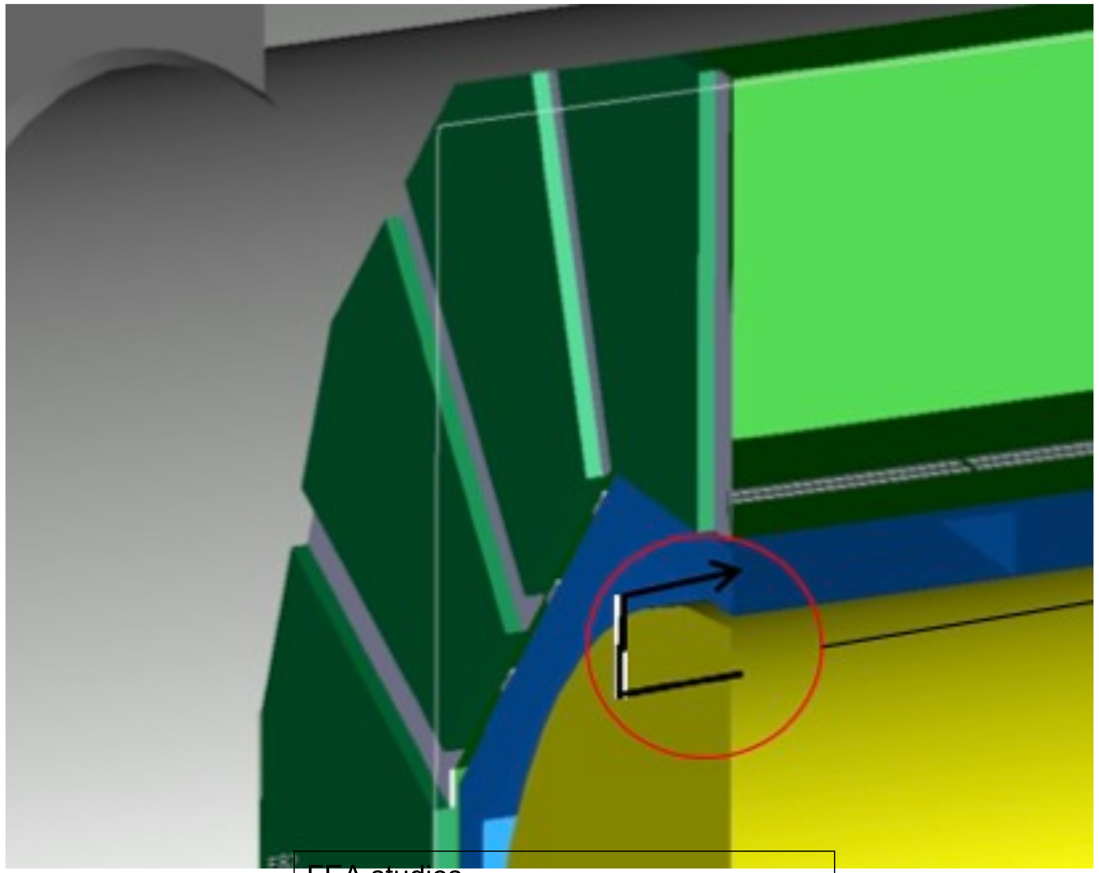
C. Clerc



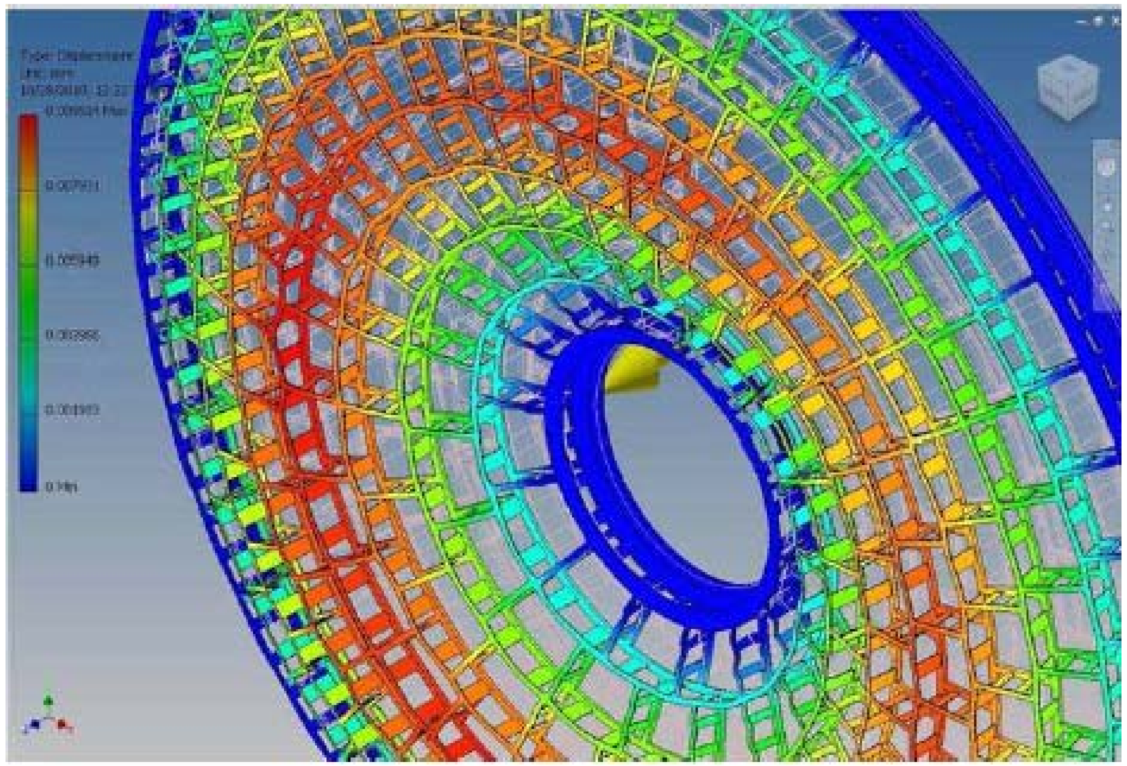
TPC Integration

V. Prahl



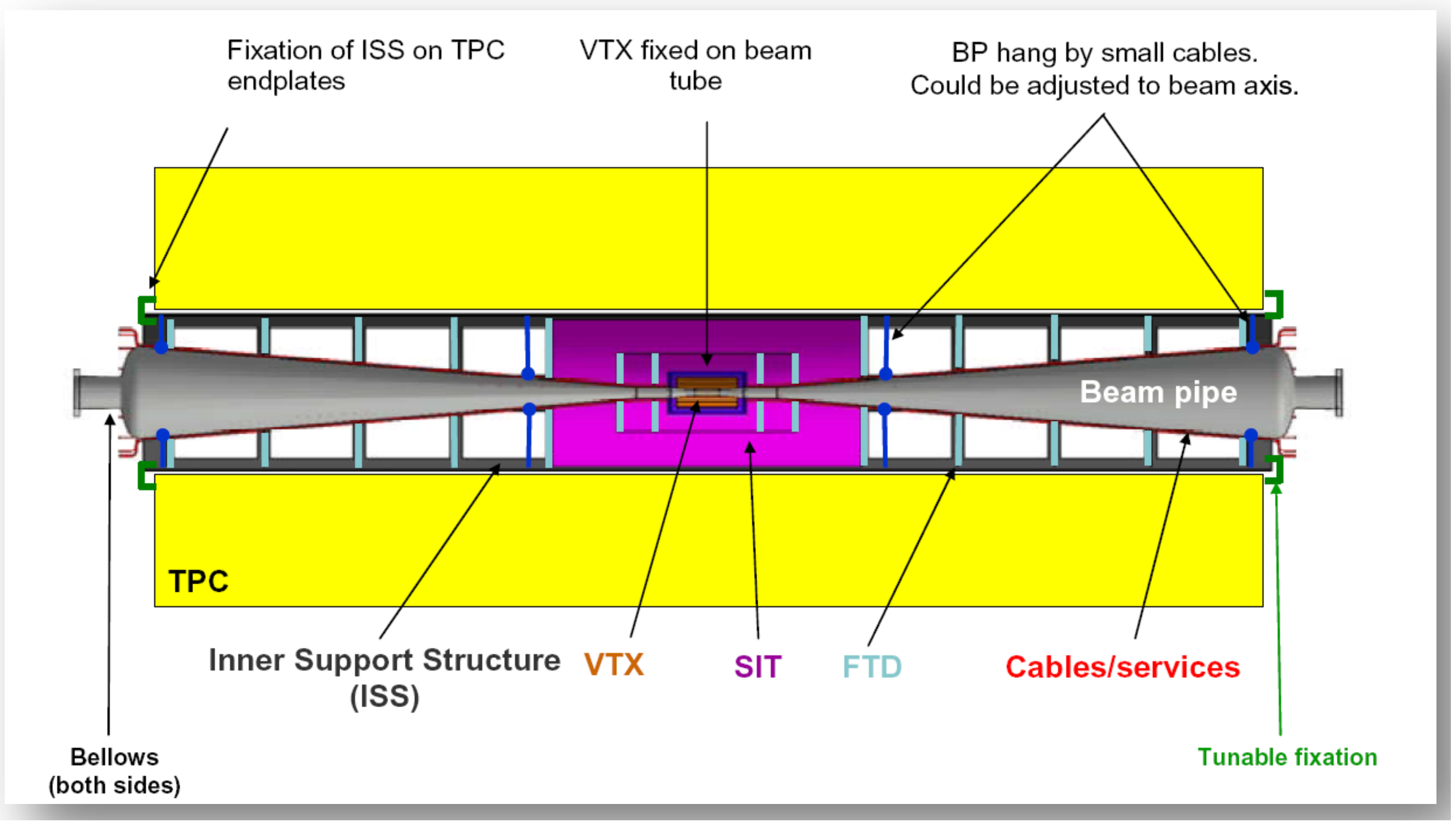


FEA studies

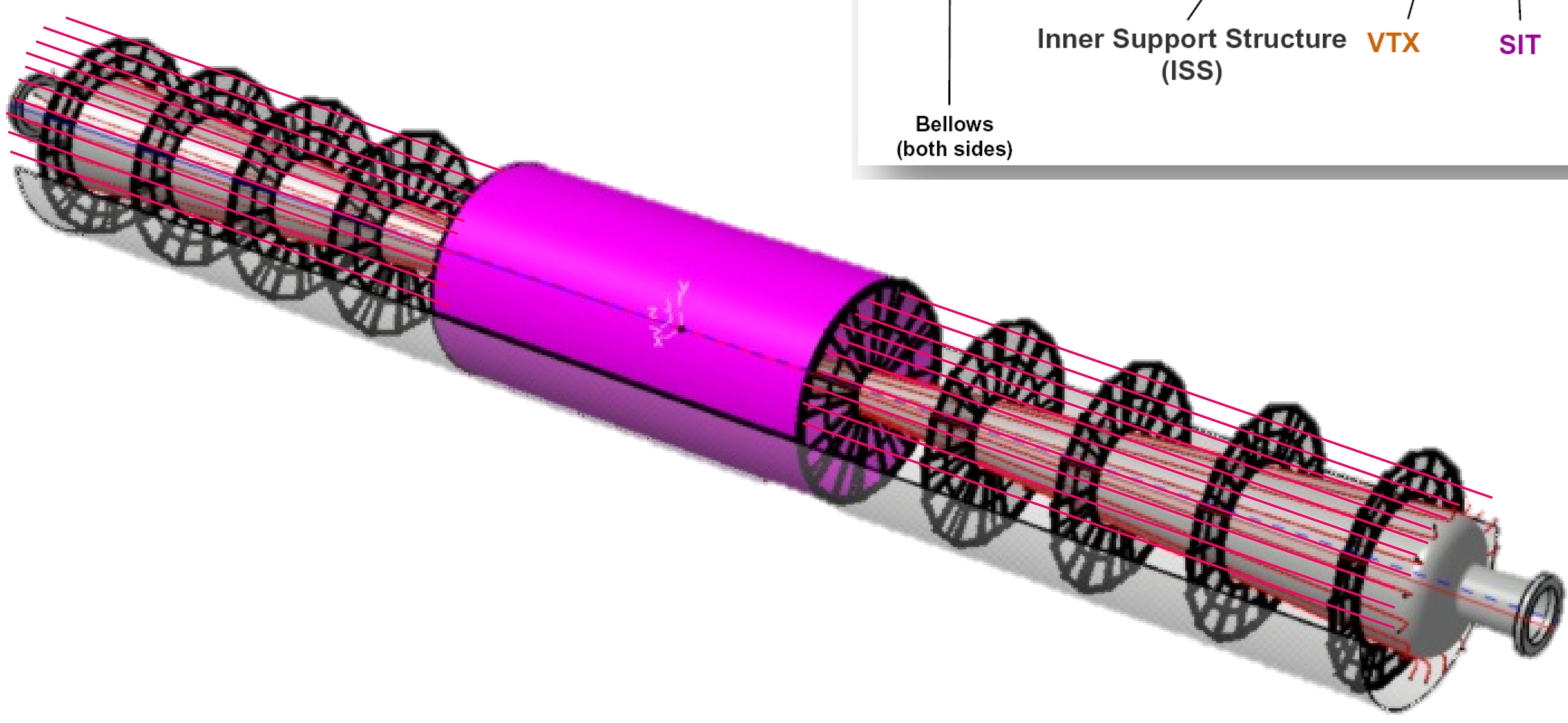


Inner Detector

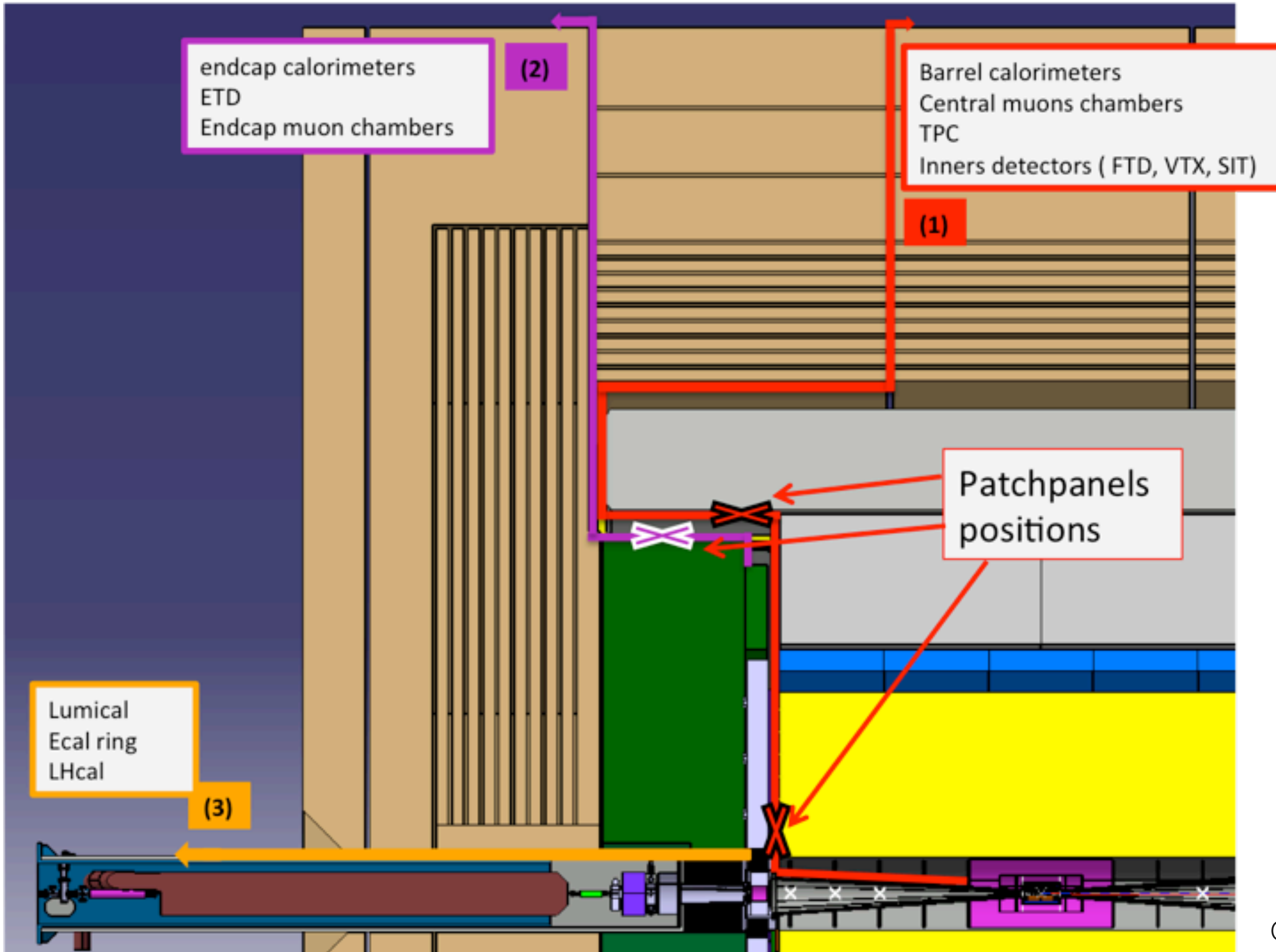
- Need adjustable fixation to the TPC endplate
  - push-pull precision is only 1 mm
  - stay-clear from pairs is of same order....



C. Bourgeois

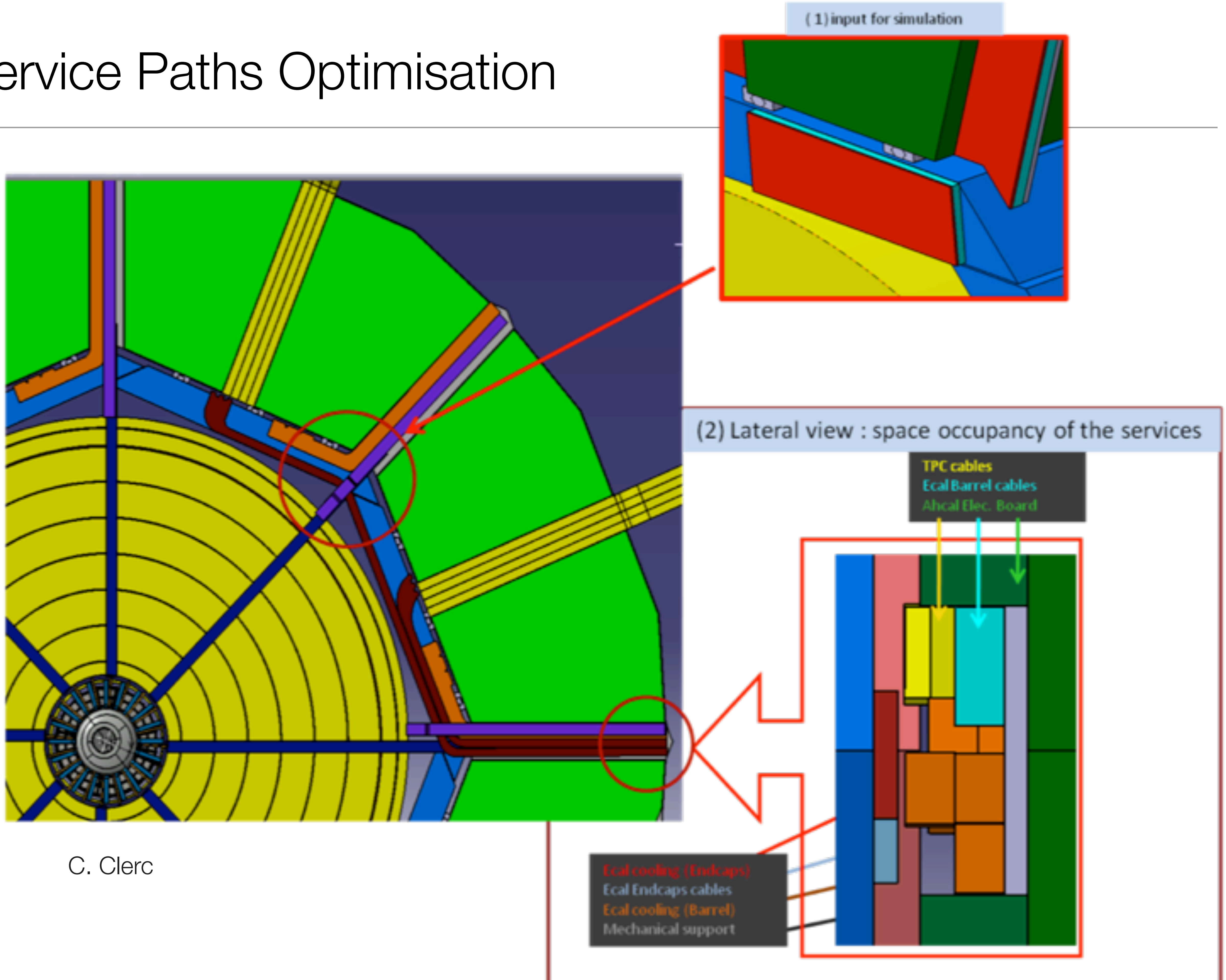


Service Paths



C. Clerc

Service Paths Optimisation



C. Clerc

Questions

- Is our engineering model still valid?
- Are major ILD design changes to come?
    - smaller yoke, other geometries?
- How do we proceed with the different subdetector options?
    - fully integrated ILD models for all possible permutations?
- Do we understand the service needs for all sub-detectors?
    - Cooling, cabling, fire protection, (...)?
- Do we understand the heat budget?
- Do we understand possible vibration sources and limits?
- How do we keep close links between subdetector collaborations and central integration team?
- How earthquake-proof are the subdetector designs?
- (...)

Seismic Conditions

- Talk by Tauchi-san on Thursday
- Need to follow ISO3010:

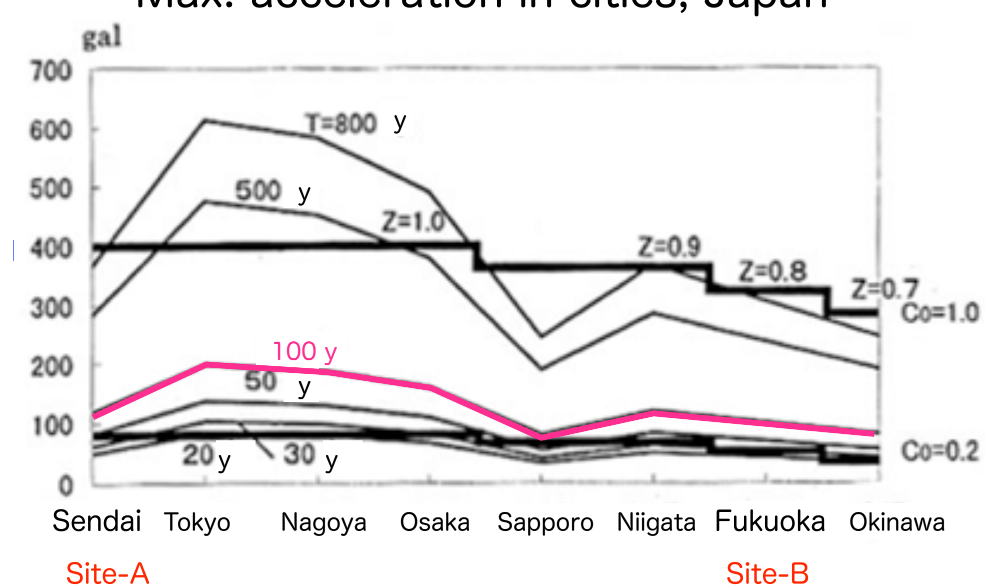
a) (ultimate limit state: ULS) The structure should not collapse nor experience other similar forms of structural failure due to severe earthquake ground motions that could occur at the site .

b) (serviceability limit state: SLS) The structure should withstand moderate earthquake ground motions which may be expected to occur at the site during the service life of the structure with damage within accepted limits.

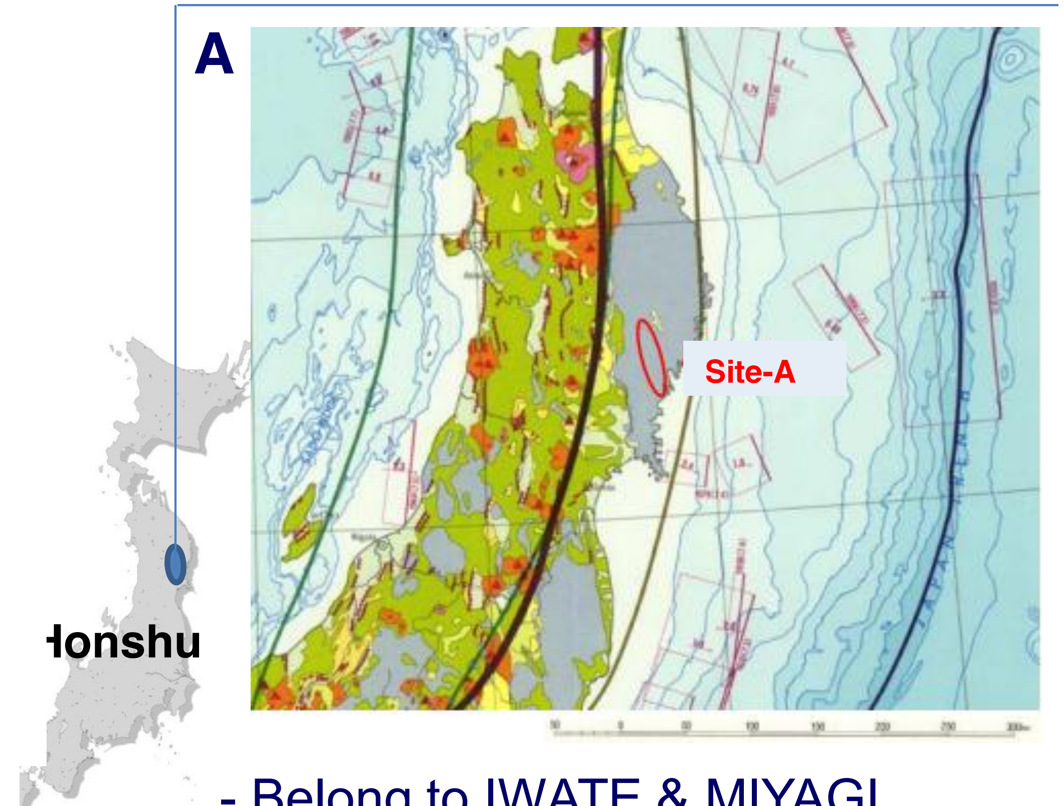
In both cases, the seismic force can be the maximum acceleration of earthquakes in the recurrence intervals of 100 years.

- 1 gal ~ 0.001g

Max. acceleration in cities, Japan



KITAKAMI-Site



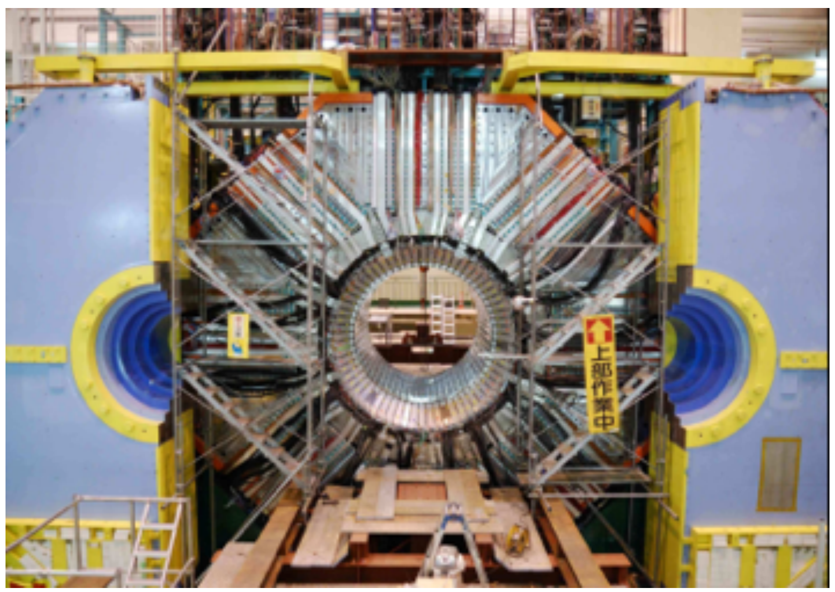
- Belong to IWATE & MIYAGI Prefecture in TOHOKU District
- Located in stable Granite zone
- Have not Active Fault zone
- Separate from Volcano Front line
- Annual average Temperature:10℃
- Annual total Precipitation : 1,300mm

T. Tauchi

When an Earthquake Hits...

- From KEK 03/11 earthquake damage report

Belle detector



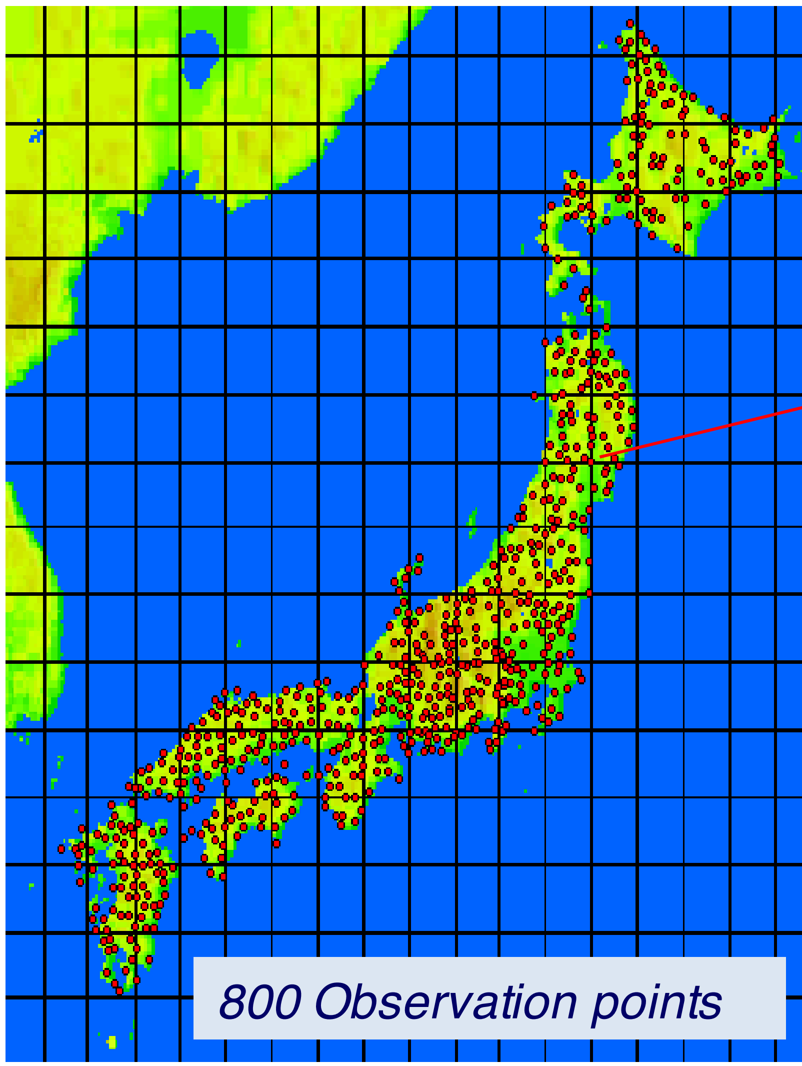
Belle detector was positioned in the assembly hall next to the collision hall, for the major upgrade (8 meters each, weight: 1400 ton)

The detector was fixed with 32 anchor bolts thru brackets. All anchor bolts were broken by the earthquake and the entire detector slid by about 6 cm.

No serious damages were observed by visual inspections. Further inspections are necessary, especially for inner part such as CsI crystals and glass plate detectors.

Seismic Conditions

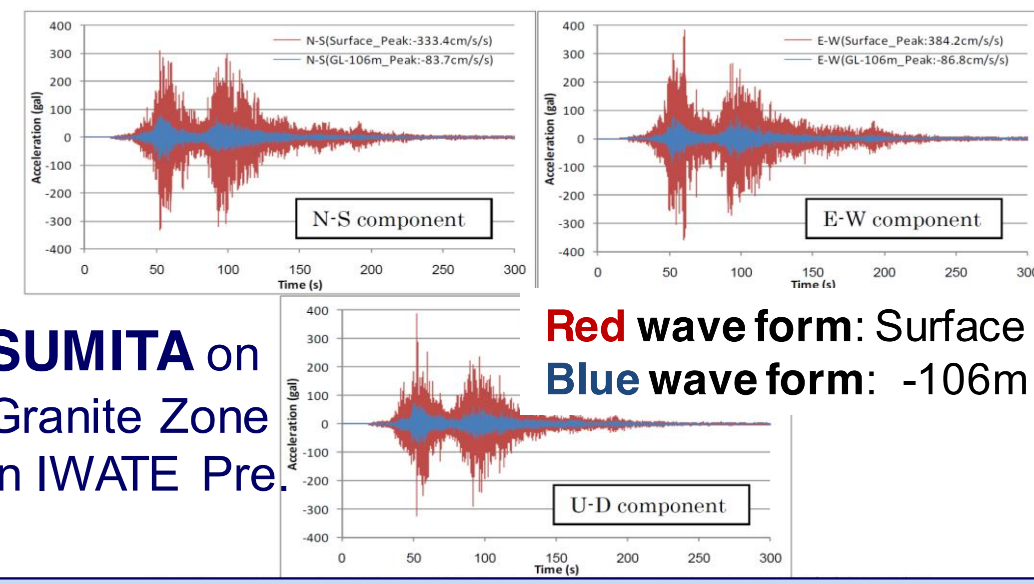
3.11 Seismic Observation



KiK-net Observation Network

(Kiban:Bedrock, Kyoshin:Strong-Motion)

Data by "National Research Institute for Earth Science and Disaster Prevention"



SUMITA on Granite Zone in IWATE Pre.

Red wave form: Surface
Blue wave form: -106m

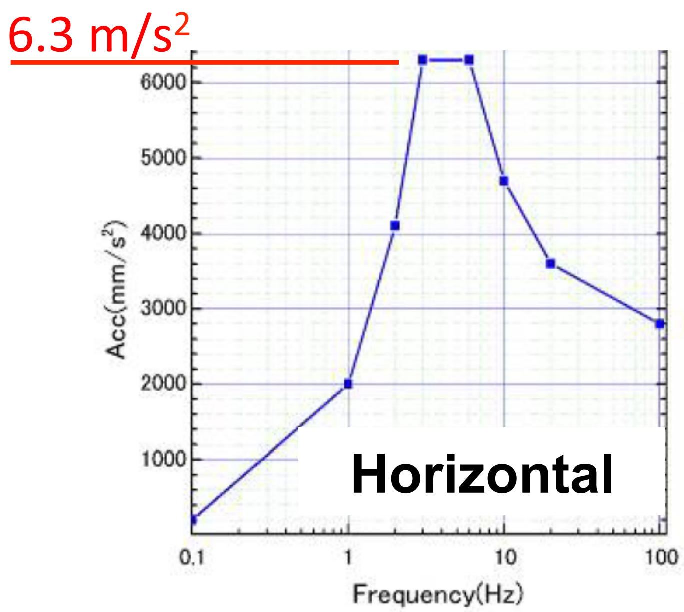
Acceleration comparison of the Surface & underground at SUMITA in IWATE

Observation Data

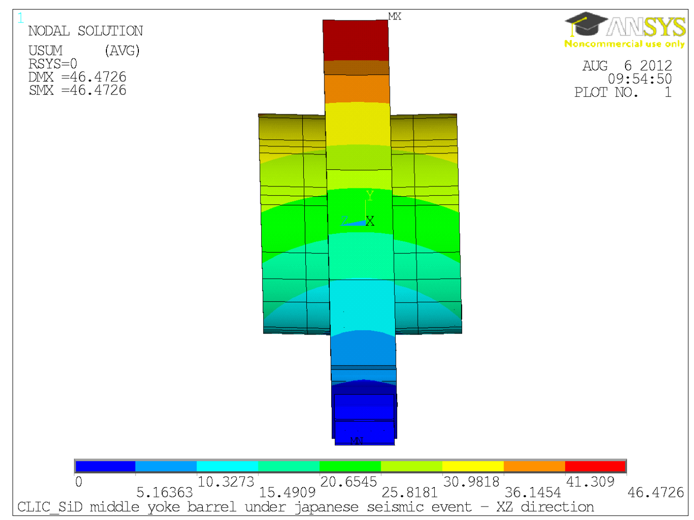
Direction	Acceleration (gal)		Rate
	Surface	Underground	Undergrund /Surface
N-S	333.4	83.7	0.25
E-W	384.2	86.8	0.23
U-D	388.9	73.5	0.19

M. Miyahara

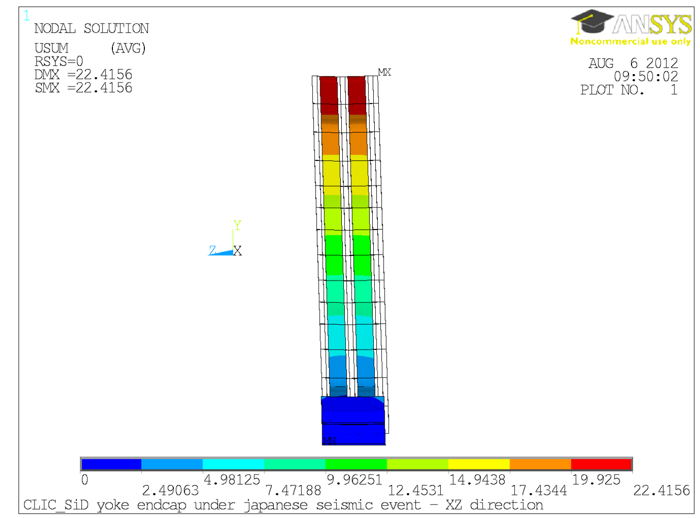
CLIC_SiD yoke – J-PARC spectrum



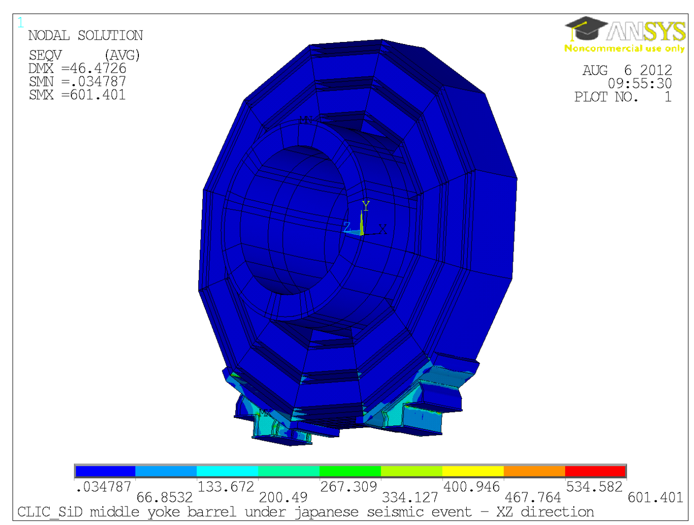
J-PARC - ND280 magnet system spectrum
Courtesy: T. Tauchi (KEK)



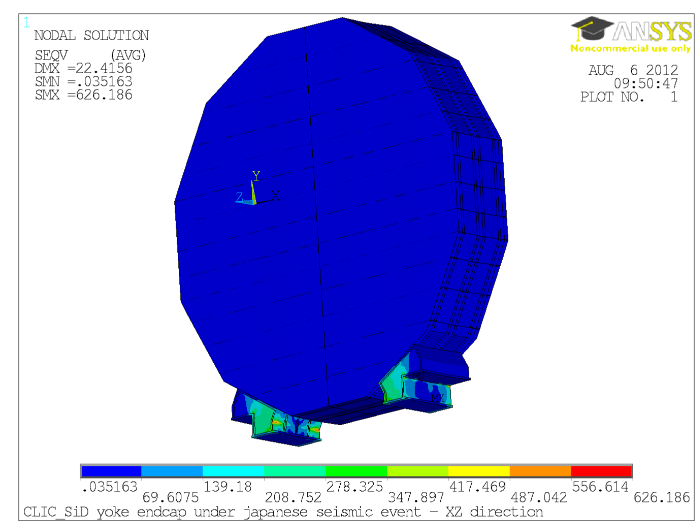
Maximum deformation: **46.4 mm**



Maximum deformation: **22.4 mm**



Maximum v. Mises stress: **601 MPa**

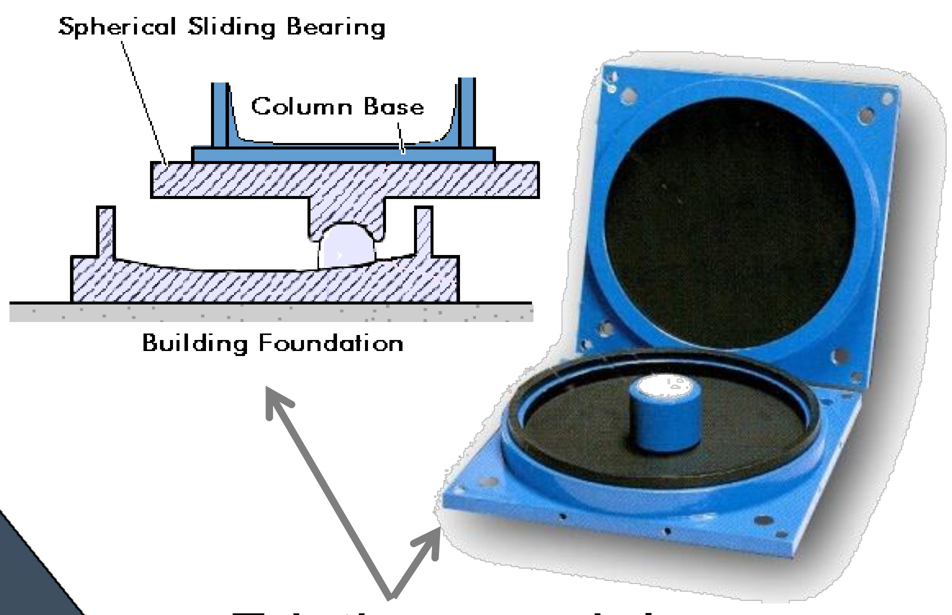


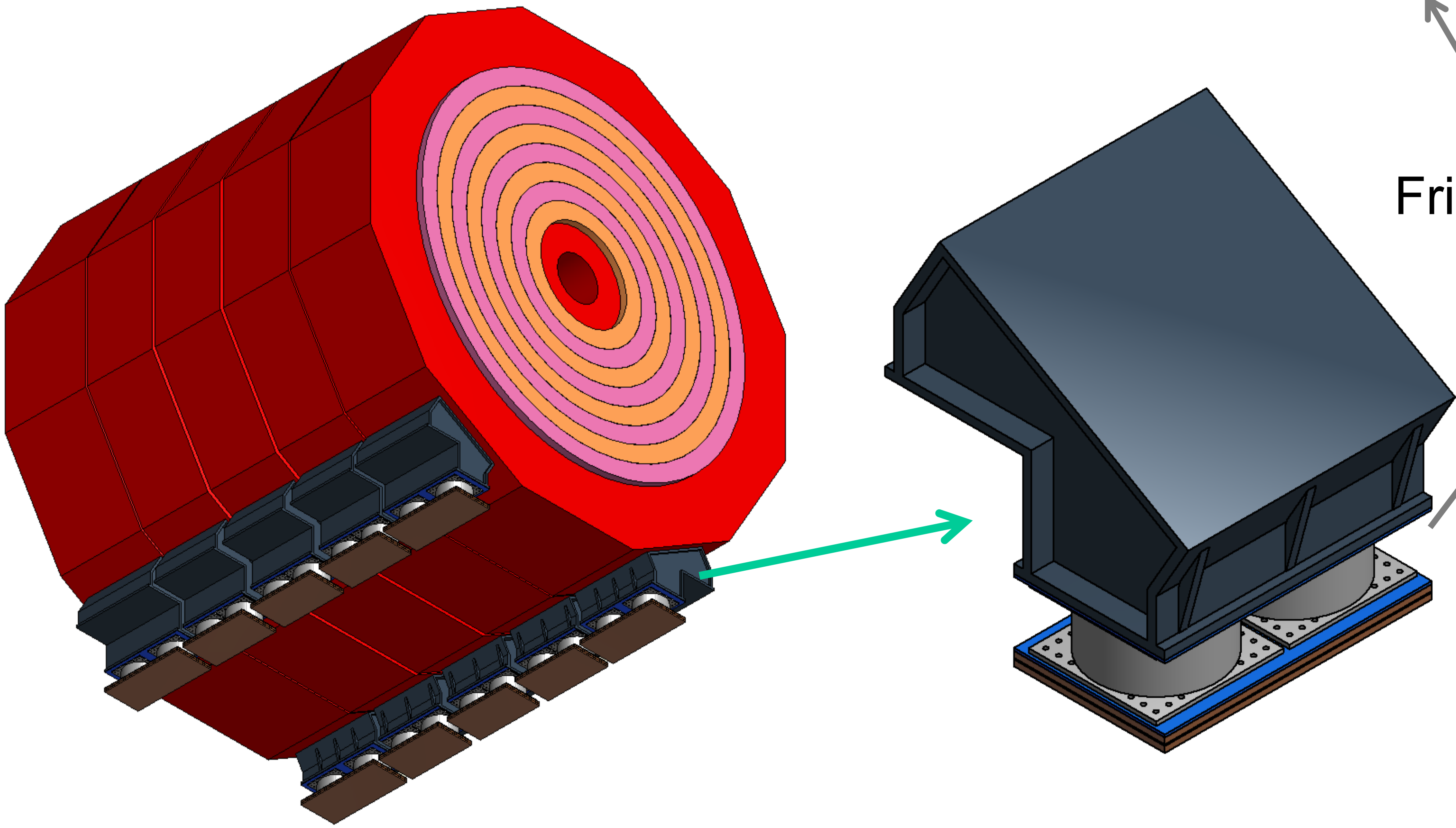
Maximum v. Mises stress: **626 MPa**

Rigid strategy **not feasible** in high seismicity locations

Detector with seismic isolated feet

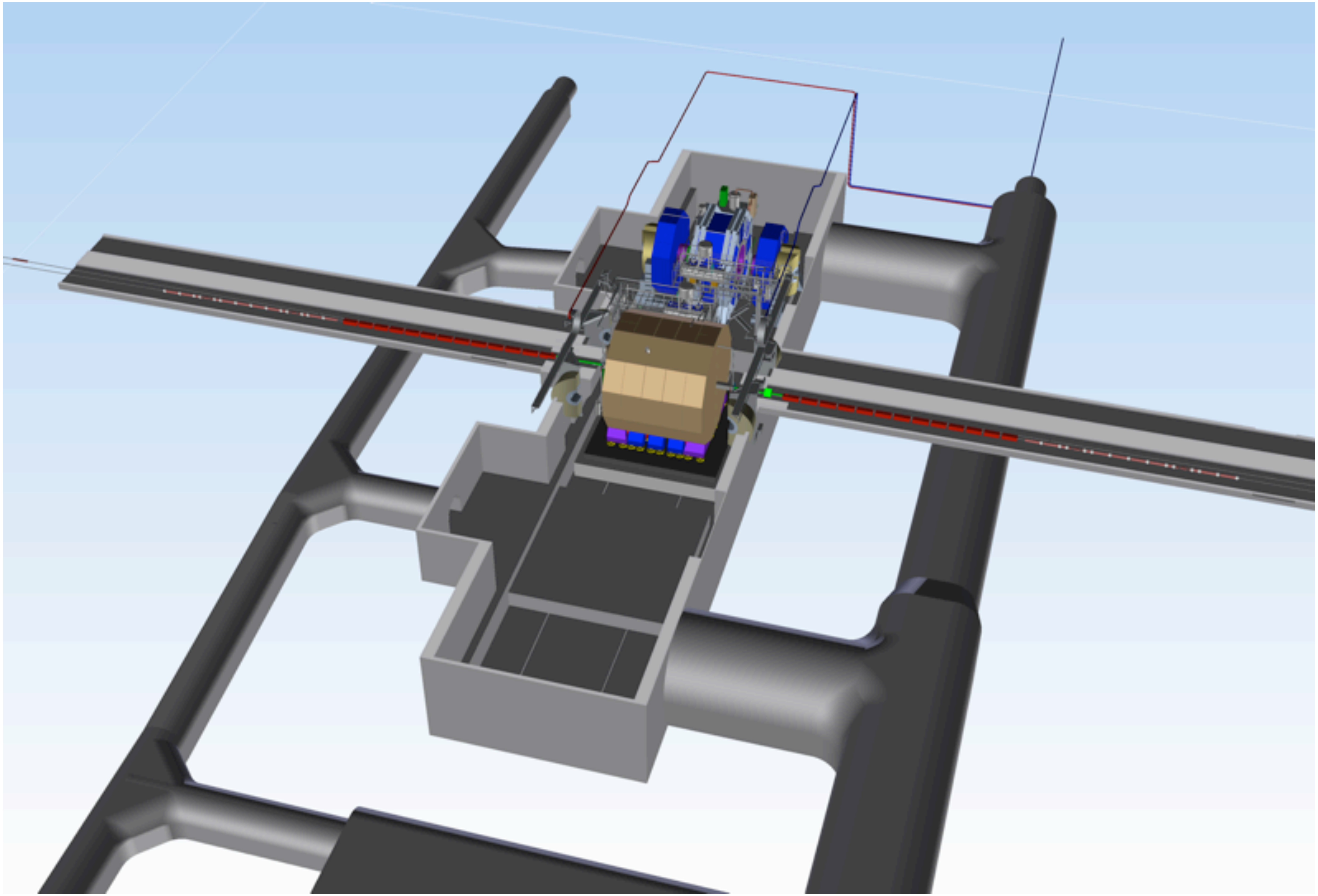
Each barrel stands on feet that are isolated
In this solution separated parts are still protected during maintenance when detector is opened





Friction pendulum bearings

External Integration: ILD, SiD, and ILC...



Boundary Conditions

- IR Interface Document
  - Functional requirements for the co-existence of two experiments and the machine in a push-pull scenario
  - ILC-Note-2009-050
  - Major milestone and deliverable for TDR
- Need to re-visit this in view of the site decision
- Started discussions with SiD

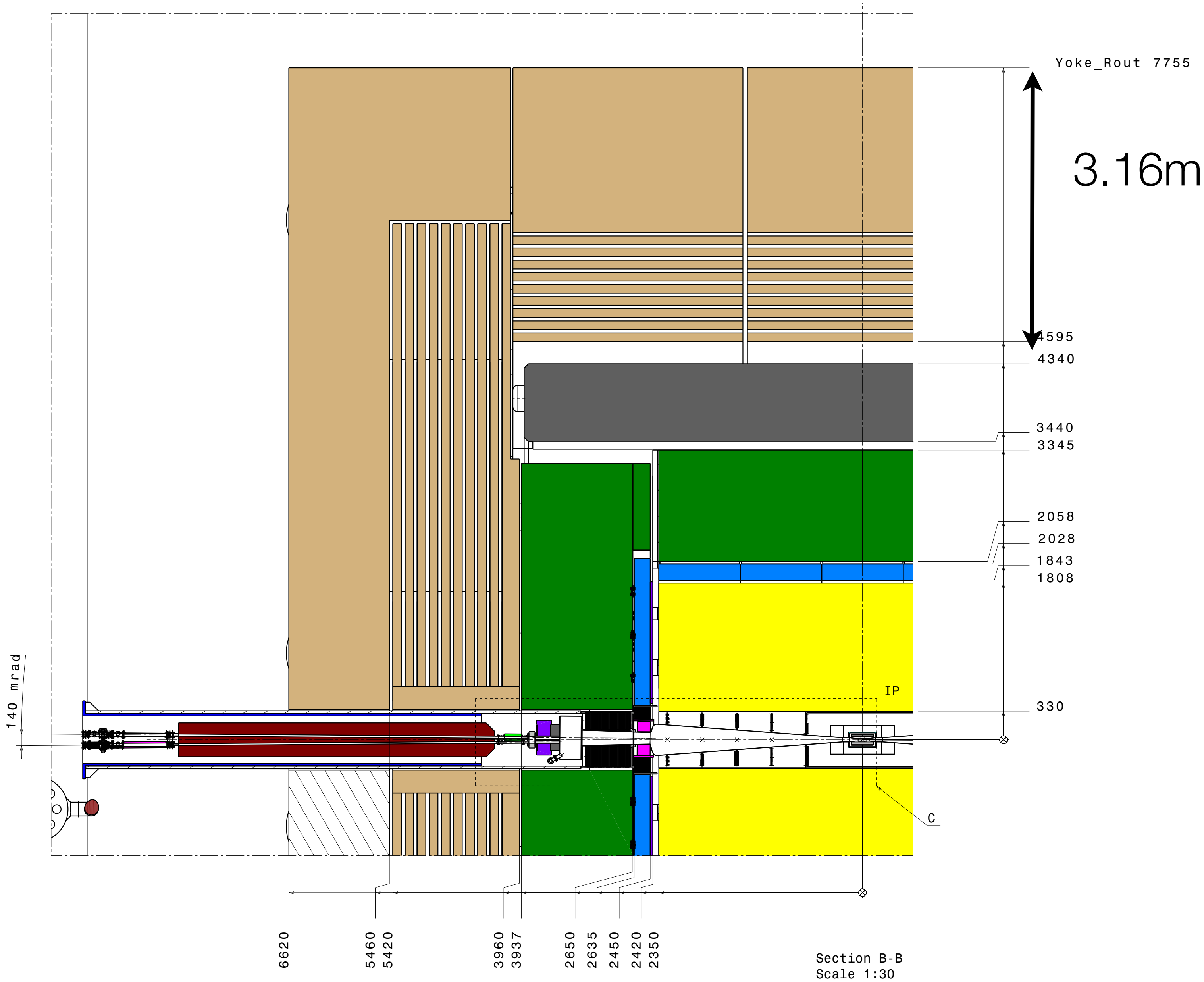
ILC-Note-2009-050
March 2009
Version 4, 2009-03-19

Functional Requirements on the Design of the Detectors and the Interaction Region of an e^+e^- Linear Collider with a Push-Pull Arrangement of Detectors

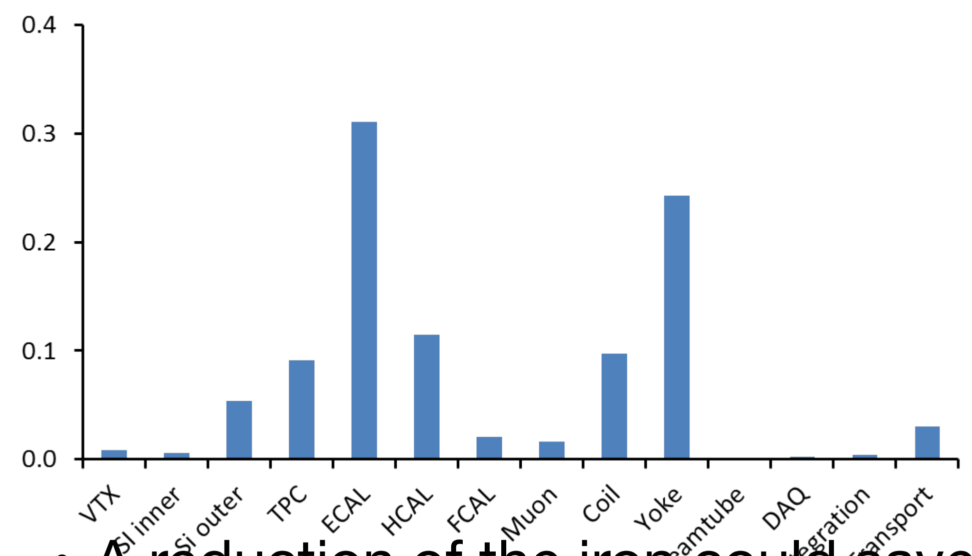
B.Parker (BNL), A.Mikhailichenko (Cornell Univ.), K.Buesser (DESY), J.Hauptman (Iowa State Univ.), T.Tauchi (KEK), P.Burrows (Oxford Univ.), T.Markiewicz, M.Oriunno, A.Seryi (SLAC)

Abstract
The Interaction Region of the International Linear Collider [1] is based on two experimental detectors working in a push-pull mode. A time efficient implementation of this model sets specific requirements and challenges for many detector and machine systems, in particular the IR magnets, the cryogenics and the alignment system, the beamline shielding, the detector design and the overall integration. This paper attempts to separate the functional requirements of a push pull interaction region and machine detector interface from any particular conceptual or technical solution that might have been proposed to date by either the ILC Beam Delivery Group or any of the three detector concepts [2]. As such, we hope that it provides a set of ground rules for interpreting and evaluating the MDI parts of the proposed detector concept's Letters of Intent, due March 2009. The authors of the present paper are the leaders of the IR Integration Working Group within Global Design Effort Beam Delivery System and the representatives from each detector concept submitting the Letters Of Intent.

ILD Iron Yoke



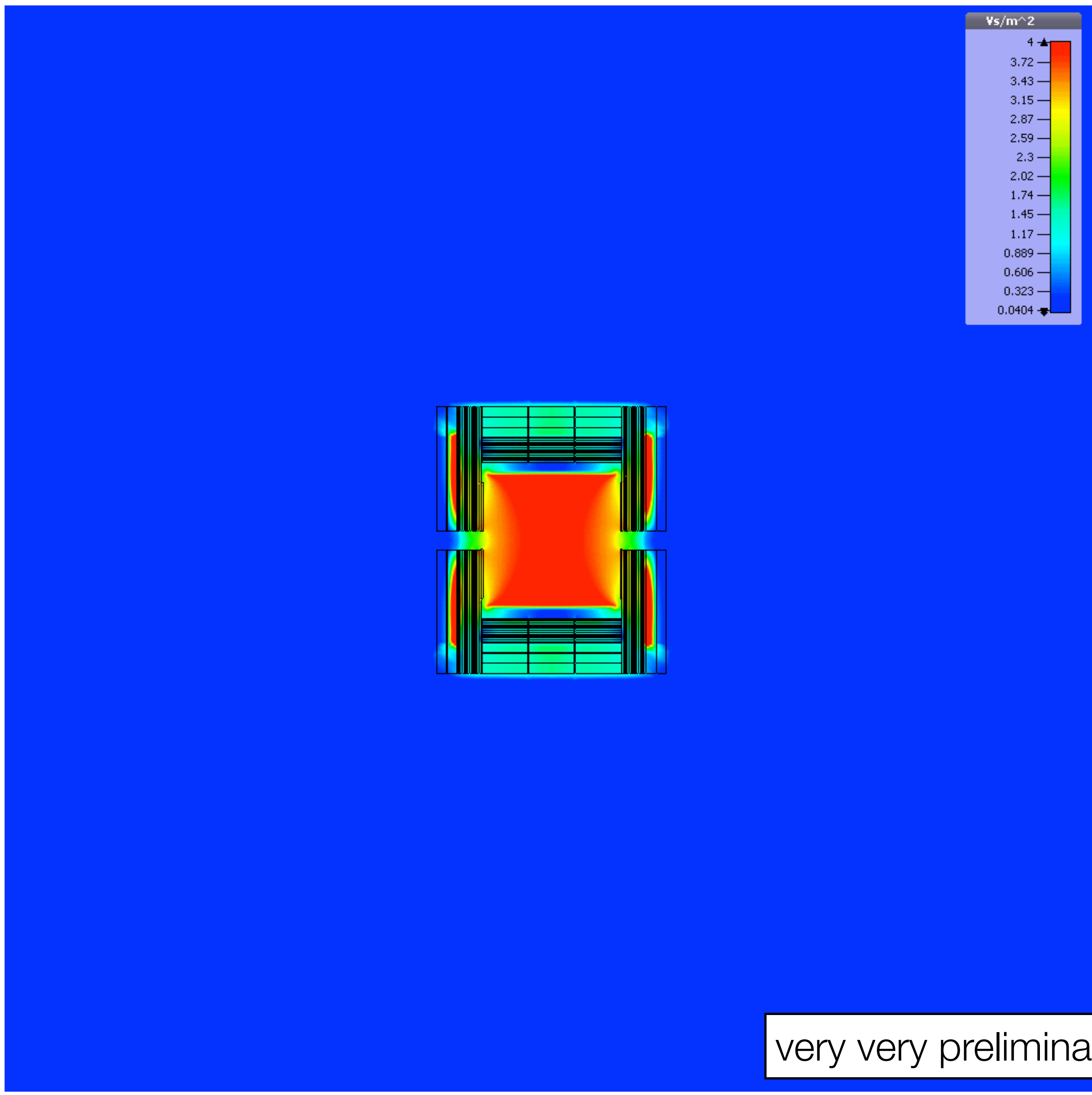
- Total cost of yoke:
  - 95 MILCU
  - 80 MILCU for steel and machining

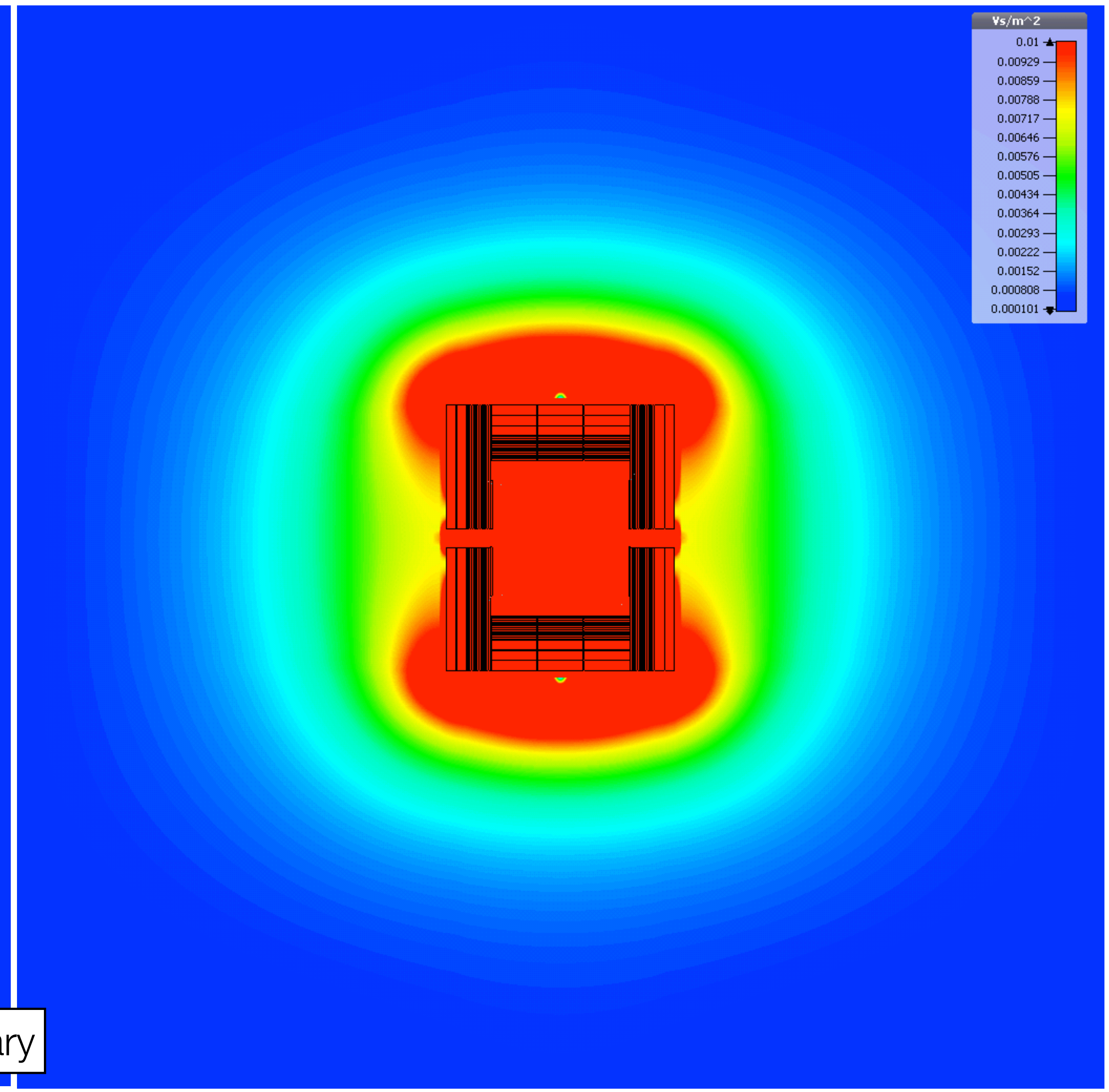


- A reduction of the iron could save a lot

ILD Magnetic Field Simulations

- CST EM Studio
  - ILD DBD design yoke with 4T field

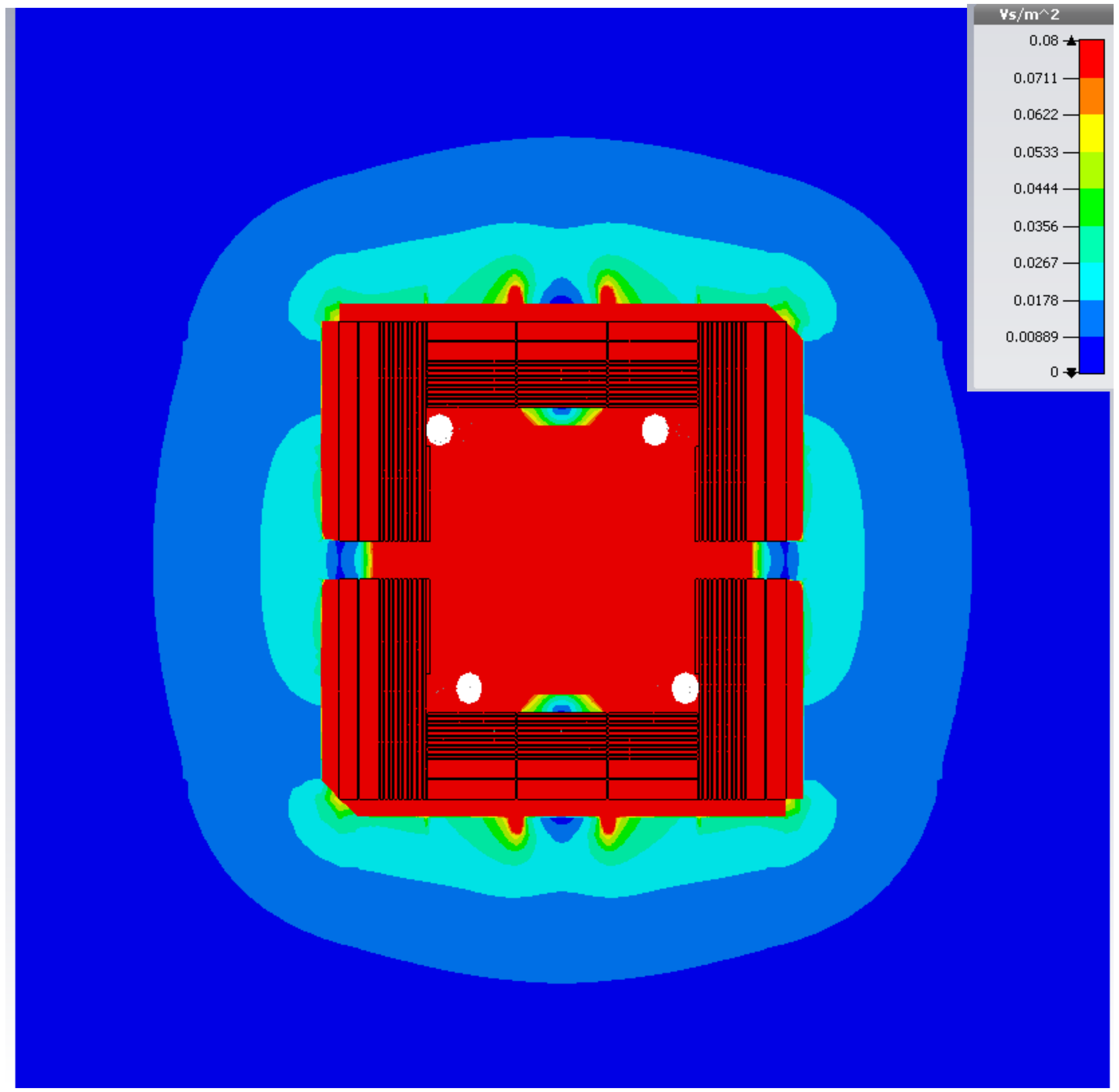


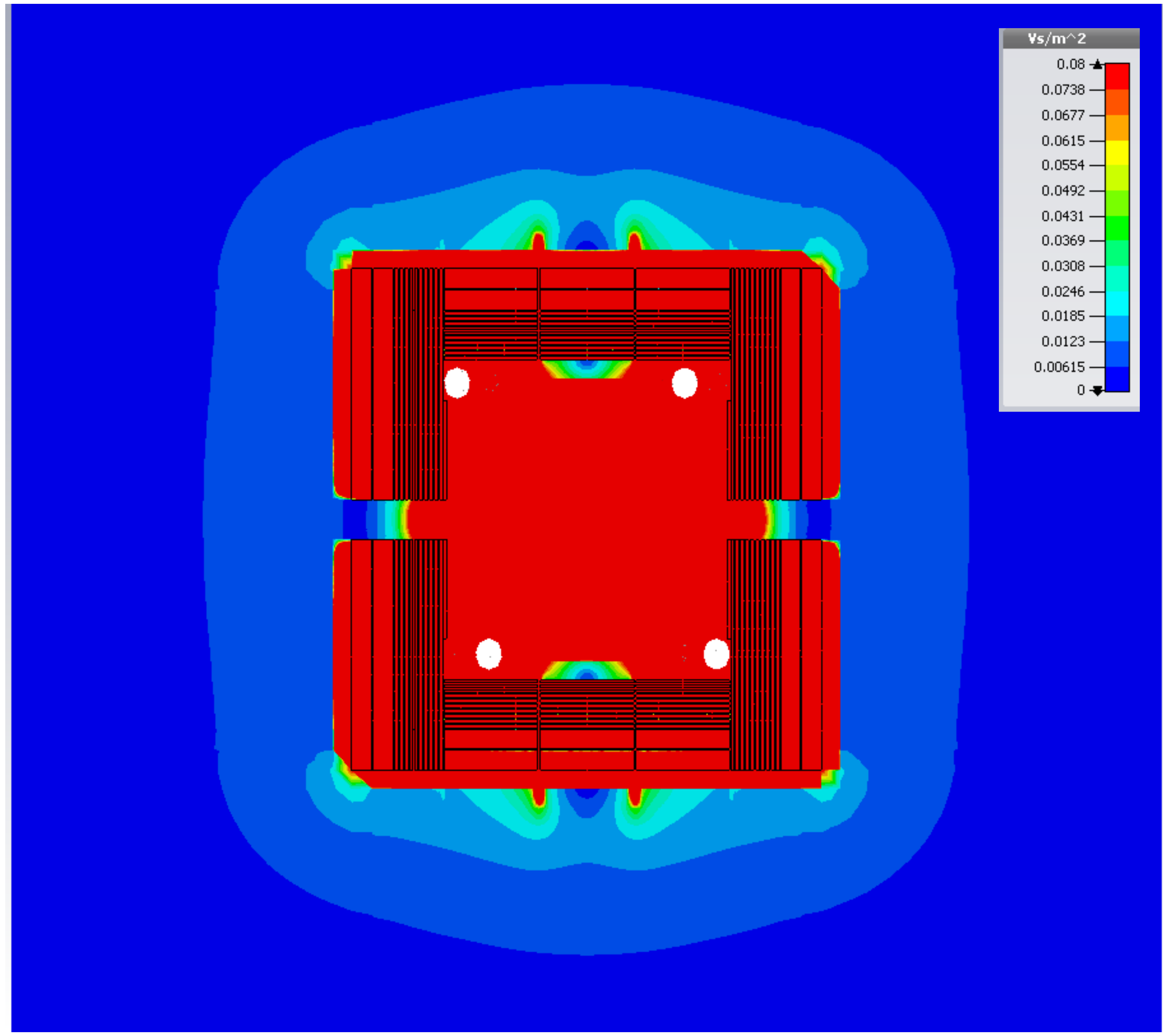


very very preliminary

ILD Magnetic Field Simulations

- Other options:
  - smaller yoke with 4T field (left) and 3.5T field (right)

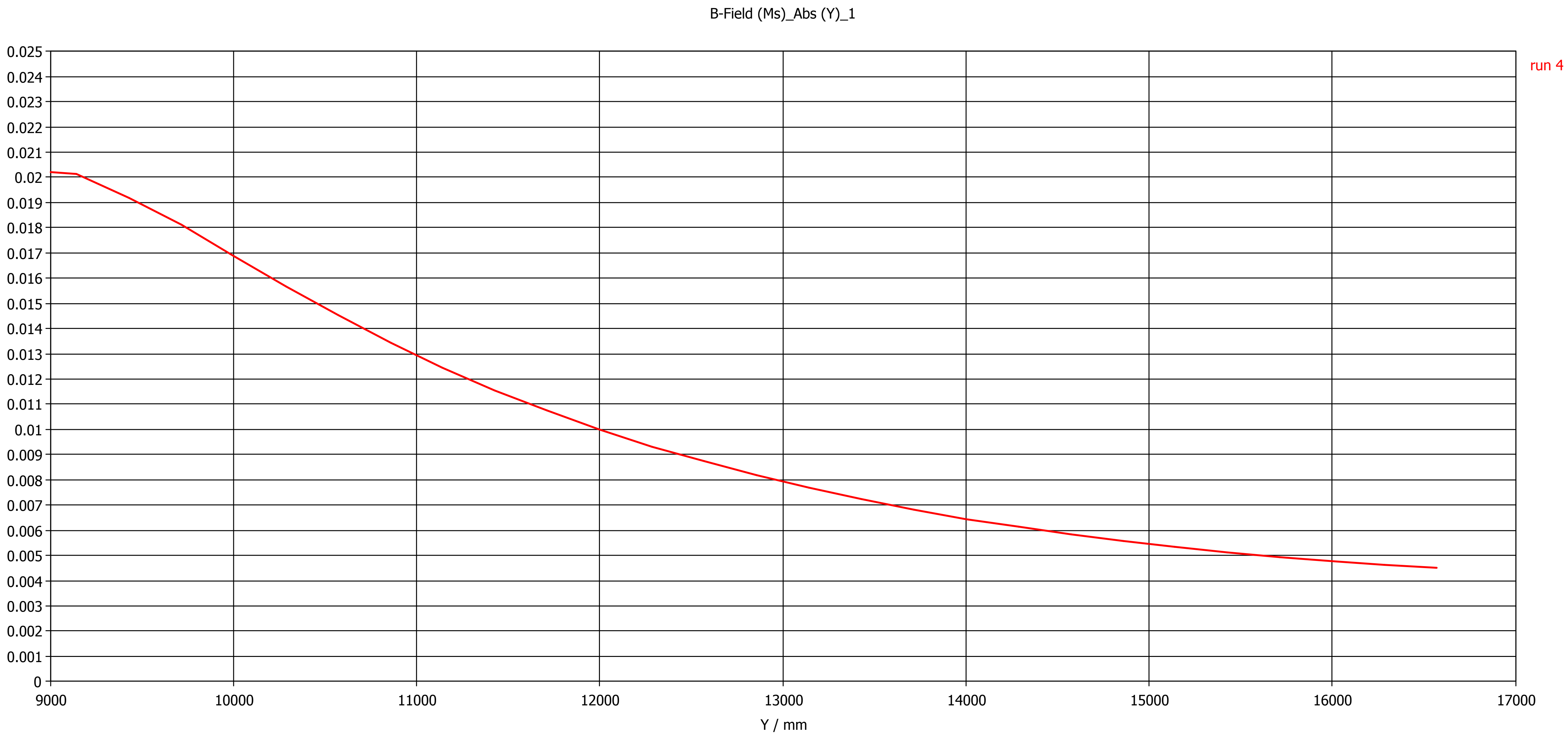




A. Petrov

ILD Magnetic Field Simulations

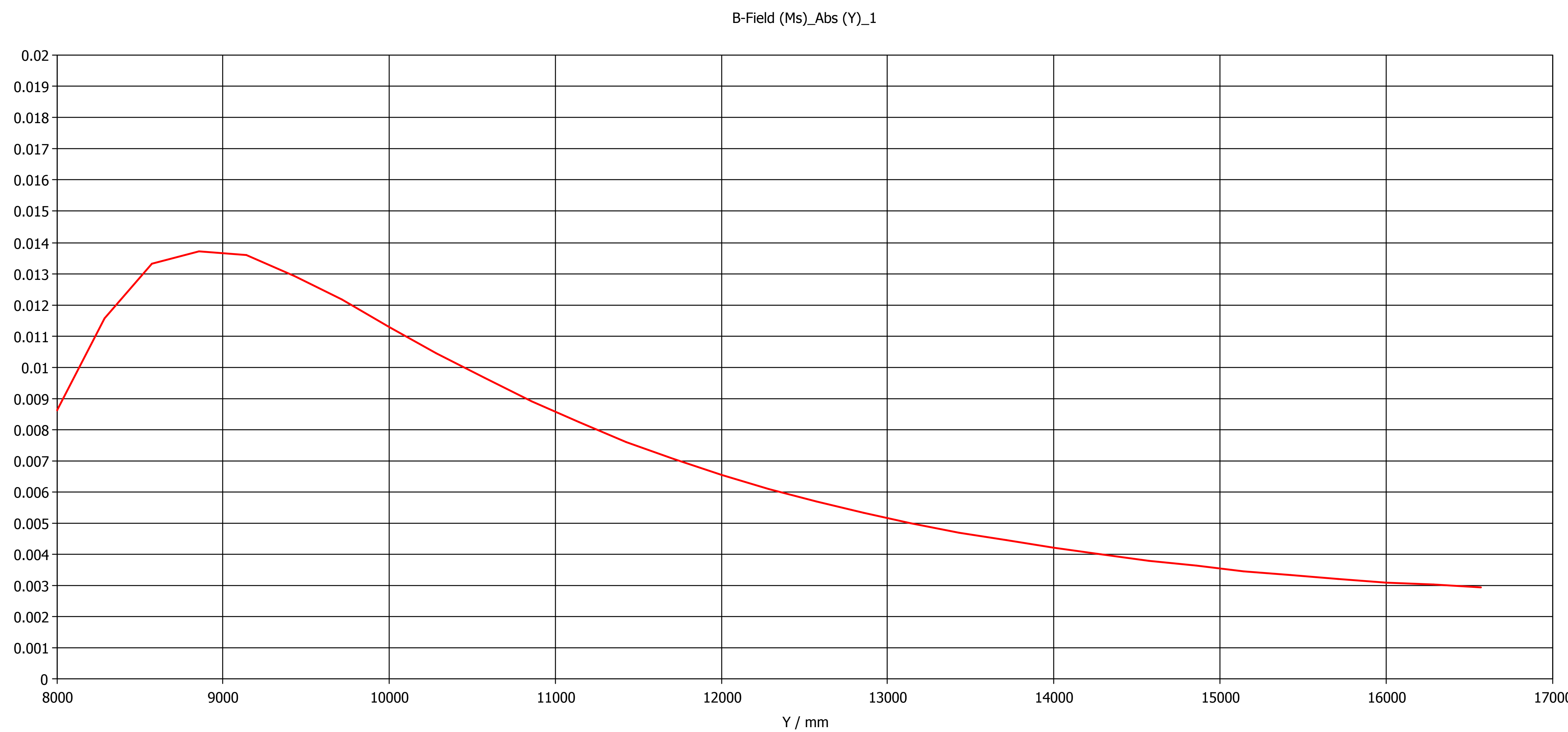
- Smaller Yoke, 4T:
  - ~55G at 15m



A. Petrov

ILD Magnetic Field Simulations

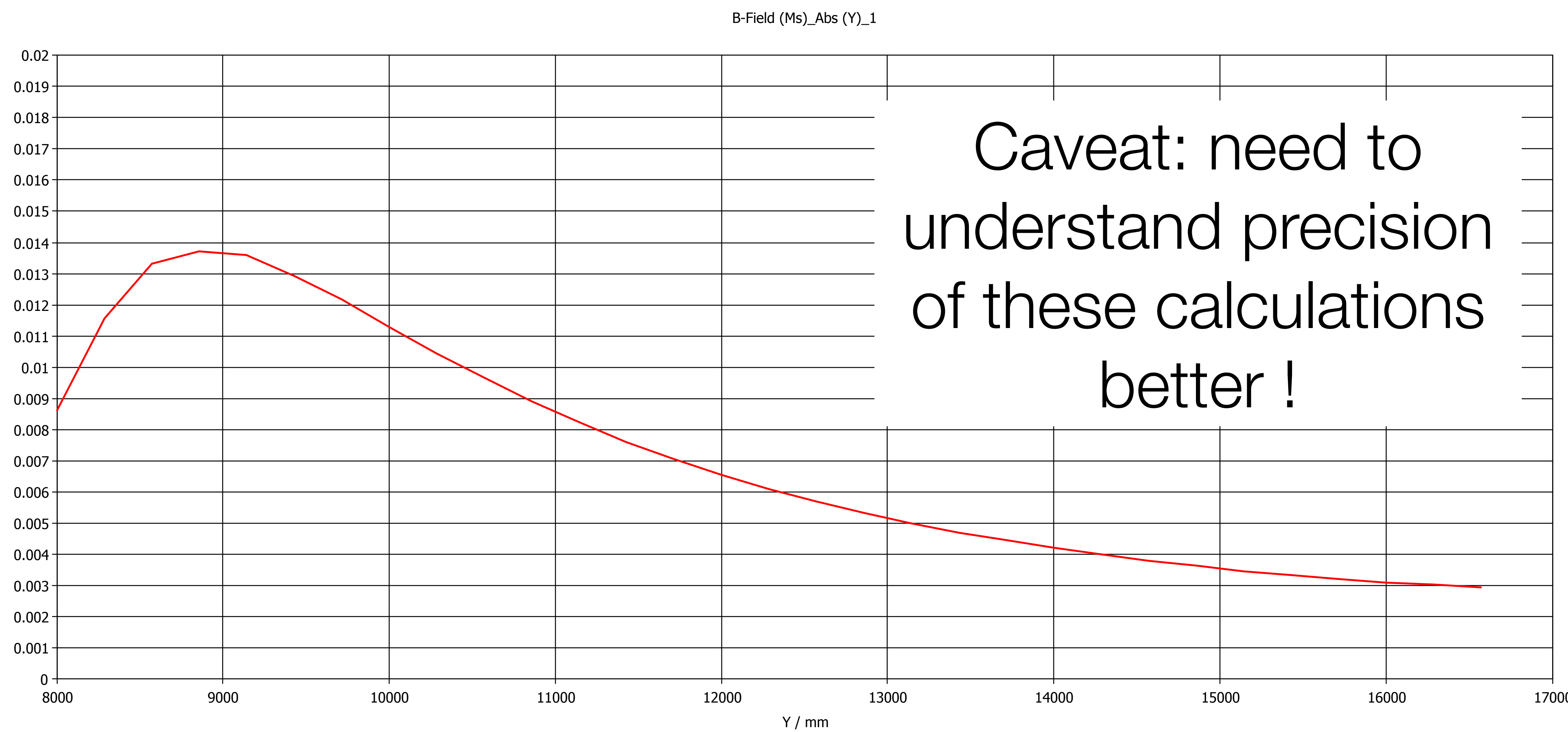
- Smaller Yoke, 3.5T:
  - >40G at 15m



A. Petrov

ILD Magnetic Field Simulations

- Smaller Yoke, 3.5T:
  - >40G at 15m

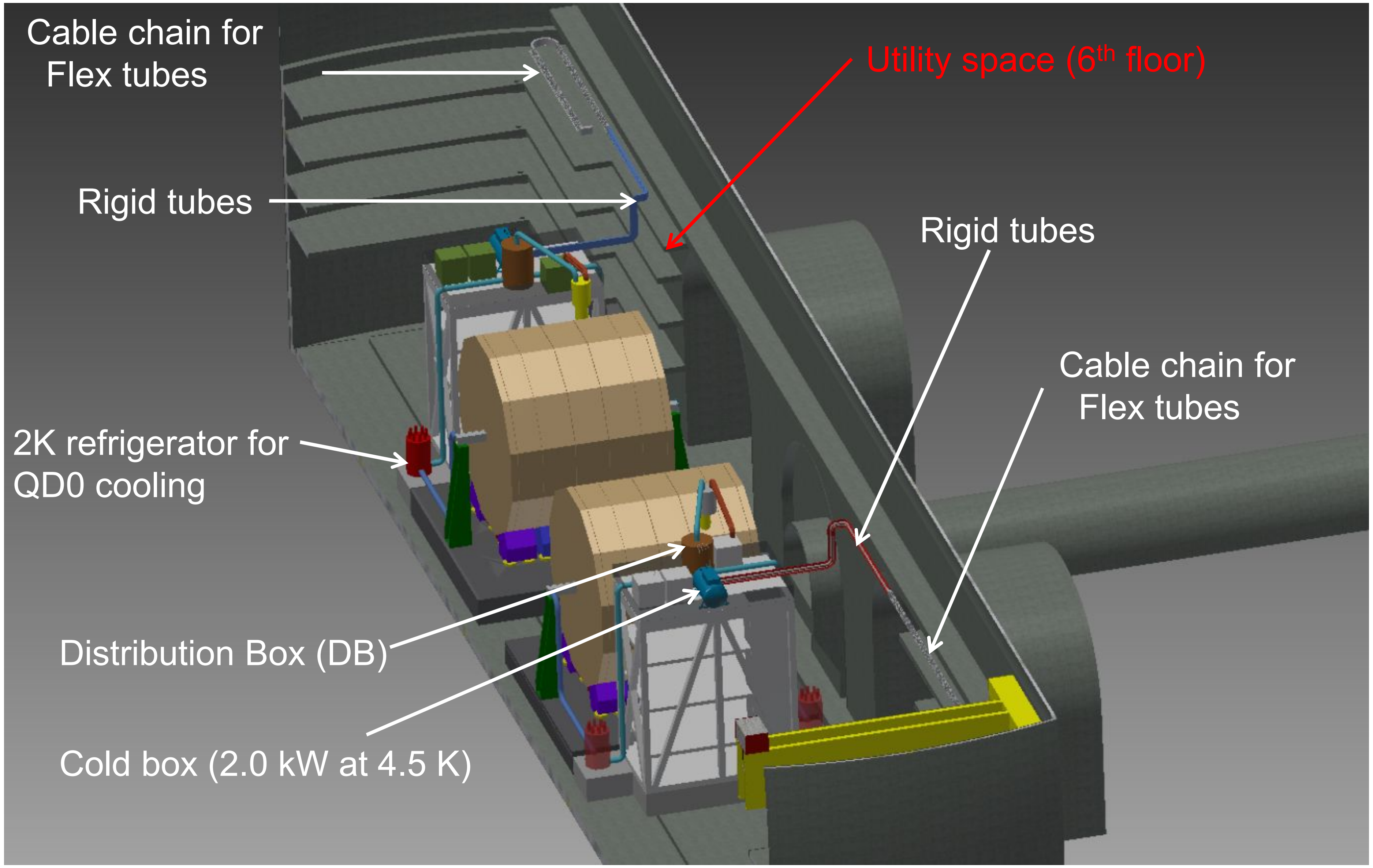


Caveat: need to understand precision of these calculations better !

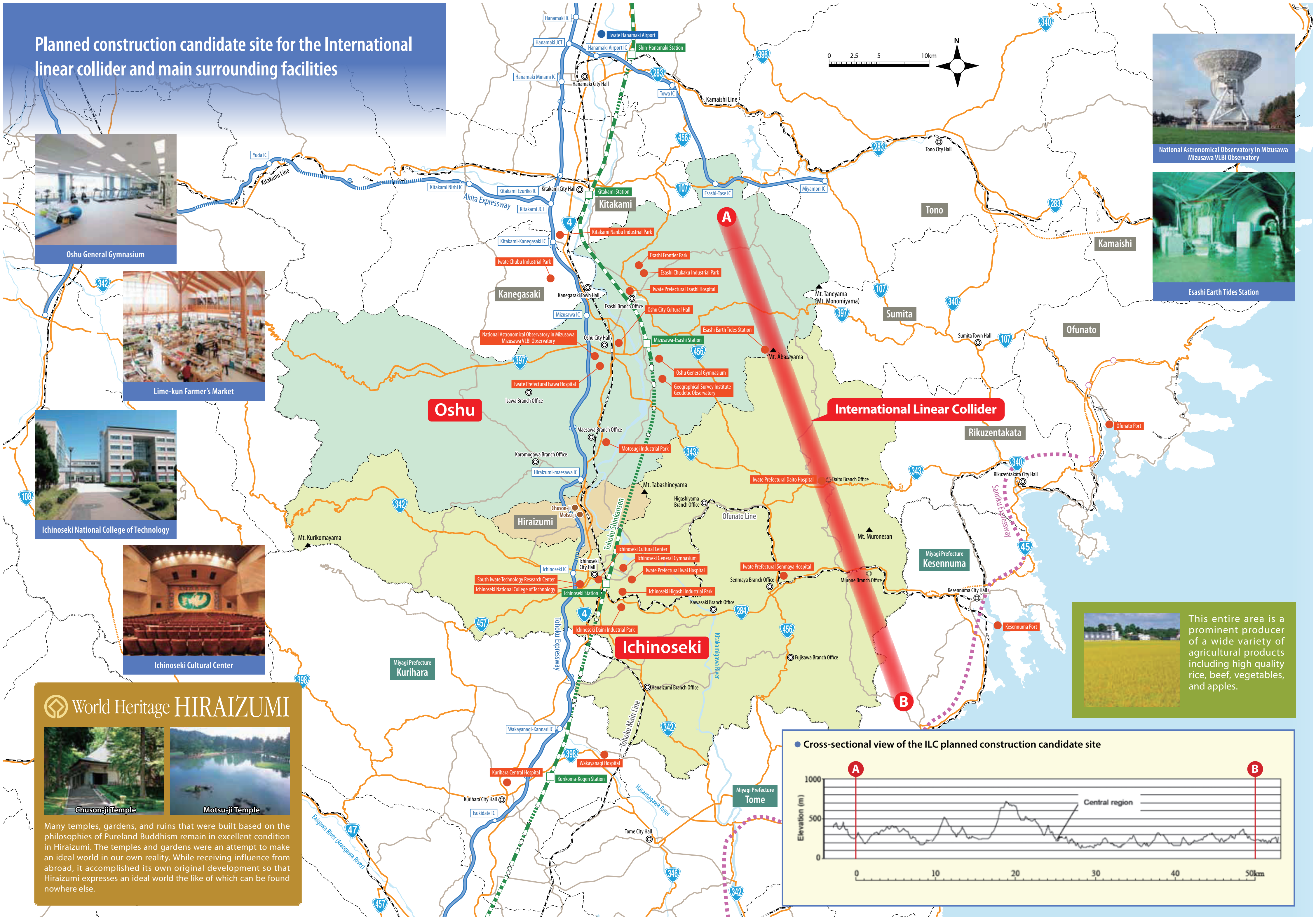
A. Petrov

Common Services

- Many detector service systems are common for SiD and ILD
- One example: common cryogenic system (c.f. talk by Okamura-san):



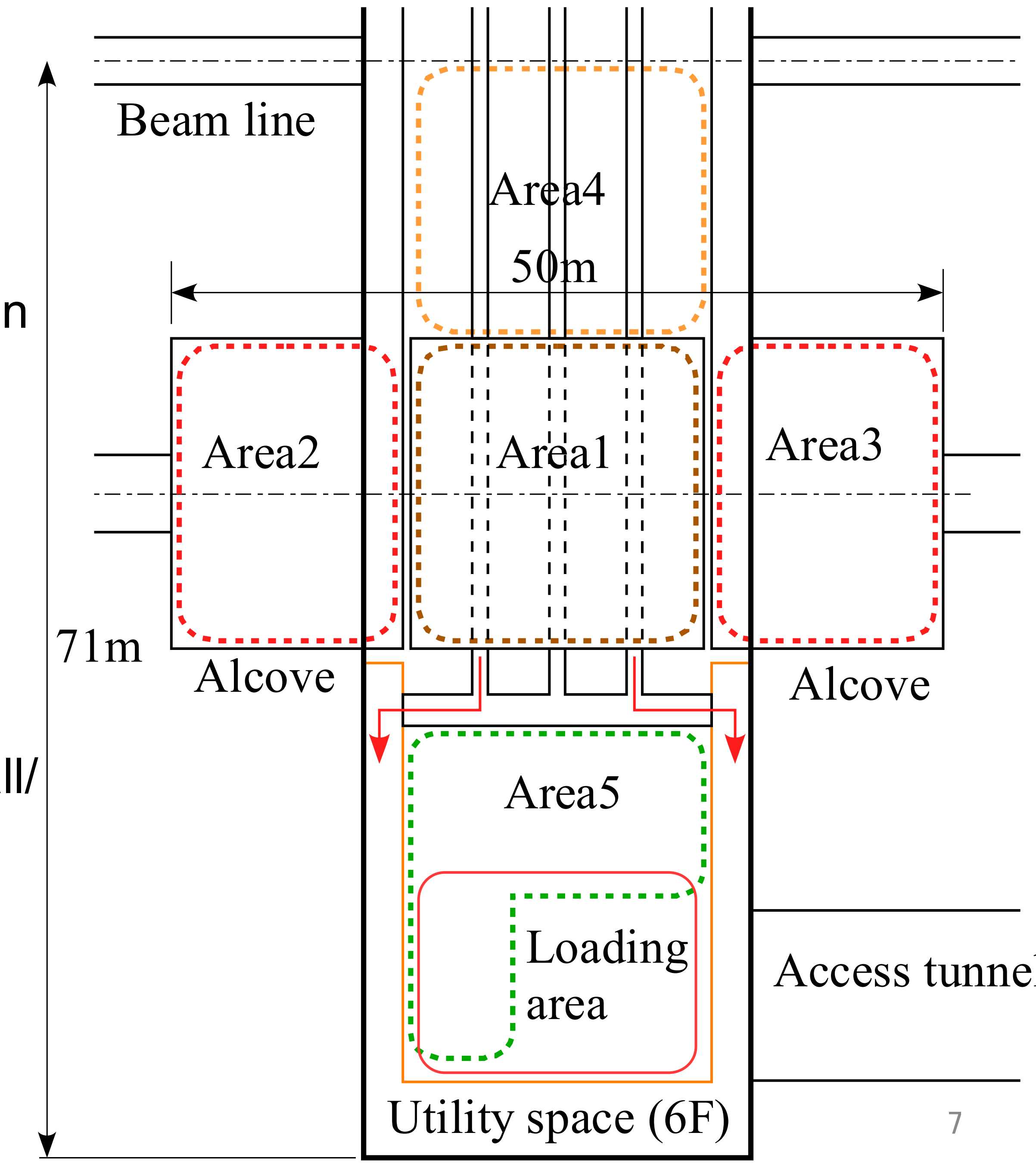
Kitakami Site (Japan)



Detector assembly area

Y. Sugimoto

- Area 1: Platform
  - YB0 assembly
  - Barrel detectors installation/ cabling
  - Endcap calorimeters installation
- Area 2/3: Alcoves
  - Endcap calorimeters cabling
  - QD0 support tube assembly
  - FCAL install/cabling
- Area 4: Tentative platform on beam line side
  - YE, YB+, YB- (iron yoke and muon detector) assembly/install/ cabling
- Area 5: Loading area side
  - HCAL rings assembly
  - Tooling assembly
  - Storage area



ILD Installation Study (Preliminary)

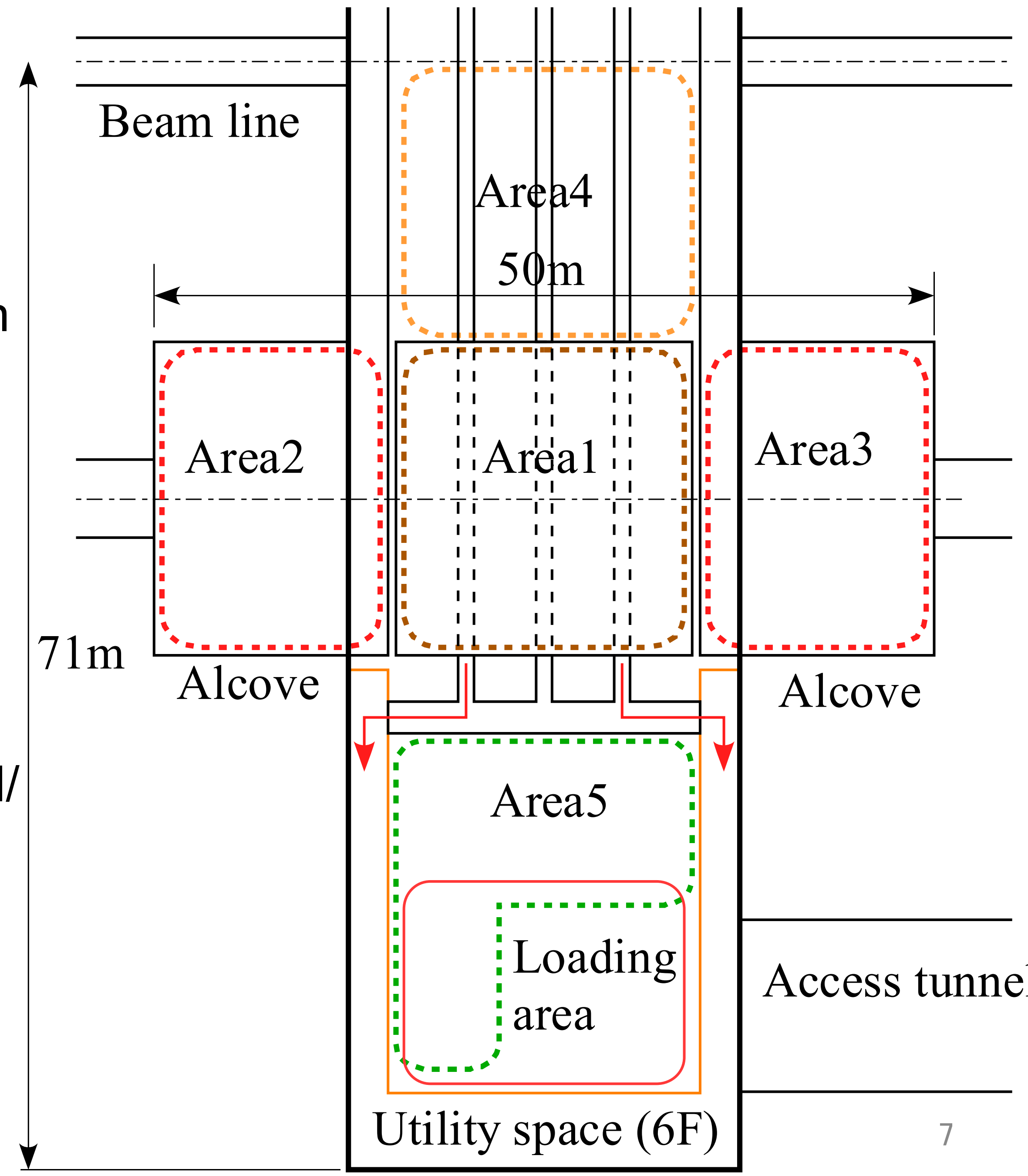
Detector assembly area

Y. Sugimoto

- Area 1: Platform
  - YB0 assembly
  - Barrel detectors installation/

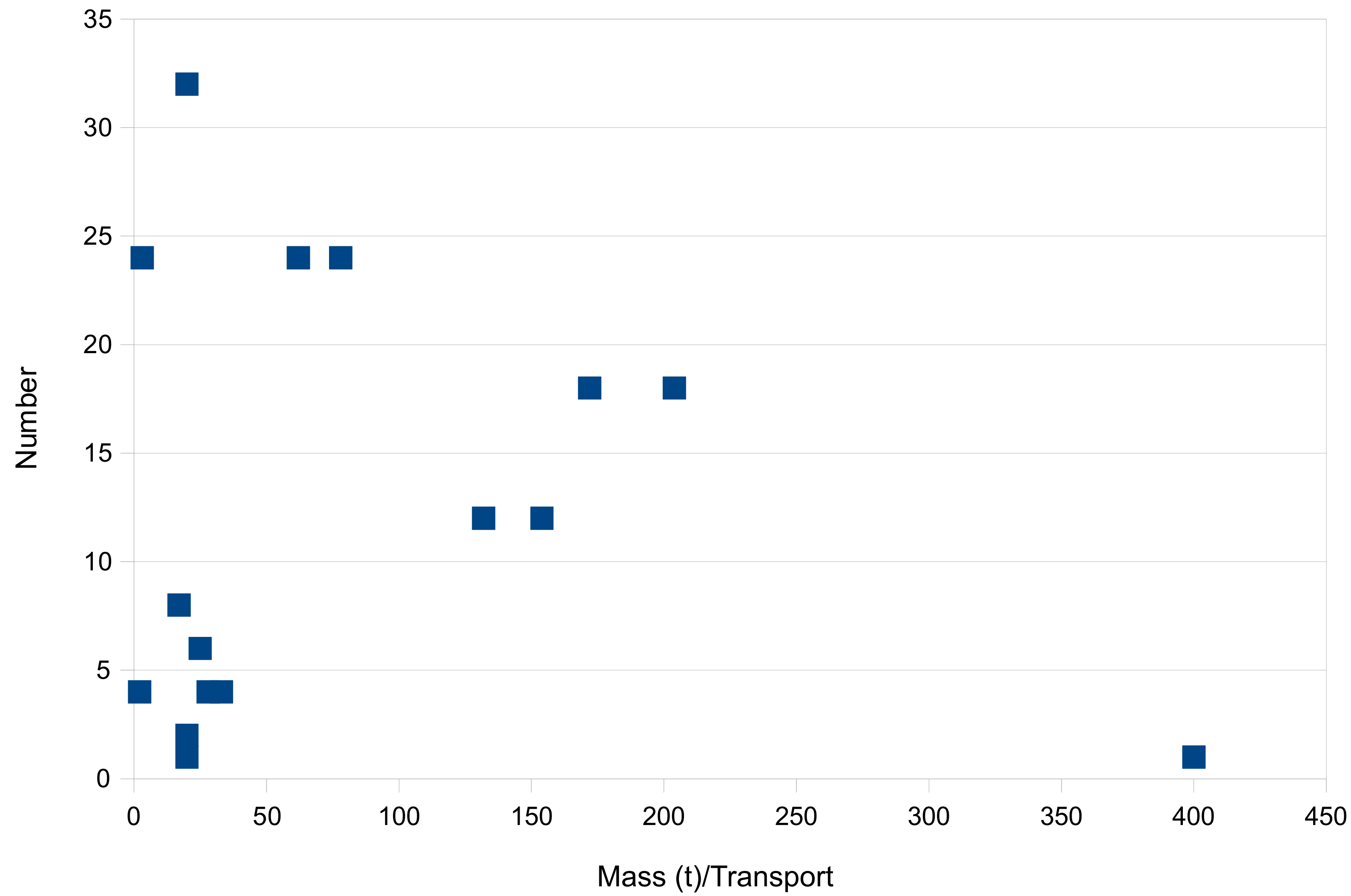
Need now a detailed study on ILD assembly and timelines

  - YE, YB+, YB- (iron yoke and muon detector) assembly/install/ cabling
- Area 5: Loading area side
  - HCAL rings assembly
  - Tooling assembly
  - Storage area



Transportation Issues

- Only for detector elements:
  - ~200 heavy weight transports
  - 61 transports with more than 100t
- Plus:
  - toolings, etc.
  - services
  - ...



- Important:
  - What can be built on-site (on surface)?
  - What needs to be built in factories far away?

Access to the site

- A possible route for Kitakami site (street view available for >50%)

- Talk by T. Sanuki on Thursday

Tentative List of Future Tasks (ILC-MDI)

Priority	Task #	Description	Goal	Parties involved
10	1	Push-pull motion system	Platform design progress. There is substantial interest in the choice between rollers and airpads. Preliminary work is needed for door motion rail design; seismic restraints; and any tolerances for detector placement on the platform.	One egnineer from the participant Labs/Institute/Universities. In alternative an external contractor as ARUP or a direct contact to a supplier of roller- or airpad systems like Hillman or Konecranes
11	2	Cryogenic Distribution system	Define the basic layout of the cryogenic distrubution scheme for the Solenoids, the FFS and the Crab Cavities	ILD, SID, Cryogroup at KEK
12	3	Surface Assembly Facilities. Only a crude estimate of the space require for detector subsystem assembly was made.	The surface assembly for the flat site is better understood, being similar to the one devloped for CMS. The surface assembly area for the mountain site has specific contraints because of the site topology. (The requirements for a mountain site are different from the flat site since the final installation from smaller pieces takes place in the underground hall.)	One engineer from Japan, having close ties with the CE group designing the Mountain site
13	4	Alignment of detector to beamline after transport on platform. This presumably needs a coarse system covering the full range of motion, and an additional system with a conservative 1 mm tolerance measuring xyz and roll at both ends of the detector.	The external alignement system must be the same for the two detectors to aligne the detector with the integrated QD0´s with respect to the QF1`s and the beam axis	An alignement expert, possibly with deep knowledge of FSI or Rasnik. Alternativley a general alignement expert
20	5	Detector Services = umbilicals, interface, to CFS, routing in the Detector Hall	Revise the list of umbilcals for each detector. Define the routing in the detector hall and the interface with a CFS system	SID, ILD plus Japanese CFS contact
22	6	QD0 Prototyping	Design and Testing of QD0. RF testing. Vibration testing	BNL
25	7	Sesimic requirements and solution		ILD.SDI, CE exspert
28	8	QD0 Integration	Movers, FRWD, Beam Instrumentation	ILD, SID, BNL
30	9	Magnetic field leakage	Compare the current field map with the the existing rules in Japan	ILD, SID with magnet expert from japan
31	10	Vibrations analysys	Crrelation measuremts, cold box	ILD, SID, Expert
32	11	Radiation shielding properties of SID and ILD	Revise the worst conditions of radiation exposure like a beam loss. Compare it with the existing rules in Japan. Eventually reconsider the PACmen design	ILD, SID with a radiation expert from Japan
35	12	Beam Commissioning	Define Physics Requirements for beam commissioning without detectors	ILD, SID, Machine expert
35	13	Detector internal alignement procedure	Ideally the internal alignement system will be the same technology used for the external one. The two systems should be designed as an integrated systems. FSI pursued by SID shows good potentiality. Or a Rasnik system pursued by ILD.	ILD, SID plus alignement expert (FSI or Rasnik)
40	14	Local Control Rooms. What is scope of permanent facilities associated with the experiment? Utilities. Machine shop.	Detectors will enumerate the list of the techncial rooms needed for the operation and maintenace of the detectors. CFS?)	To be implemented by the Civil engineering group in charge opf the site layout (J-Power or ILC-CFS)
50	15	Vacuum around the IP	Agree on the preesure distribution around IP	ILD, SID, Vacuum expert

Summary and Outlook

- ILD was busy with the writing of the DBD/TDR
- We need to re-start the ILD engineering work as soon as possible
  - this work is resource-driven, not task-driven....
  - this workshop should be a starting point
- We have now a site! We need to adapt our focus to that!
- More realistic subdetector designs need to be integrated into a more detailed ILD model
- Need to make better use of documentation systems (EDMS)

- The global MDI work - together with SiD and the machine groups - is important
- We have a specific site now, we need to adapt our plans for that