

ILD Machine-Detector Interface and Integration

Experimental Area, Detector Assembly, Timelines

Karsten Buesser

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LCWS Arlington

Overview

- TDR/DBD are almost done....
- Still many topics are only defined on conceptual level
- Engineering design or at least a better technical understanding is required for many things
- Most importantly detector-accelerator integration questions w.r.t.
 - Civil facilities
 - Services
- Need to concentrate more on the specific requirements of the Japanese mountain sites

Site Differences (Detector Point of View)

Flat Sites

Access via vertical shaft:

~18 m diameter, ~100 m long

Assembly in CMS style:

pre-assemble and test large detector parts

max. part dim.: < ~3.5 kt, < ~17.5 m

minimise underground work (~1a)

Installation schemes of detectors and machine de-coupled to large extent

Mountain Sites

Access via horizontal tunnel:

~11 m diameter, ~1 km long,
~10 % slope

Modified assembly scheme:

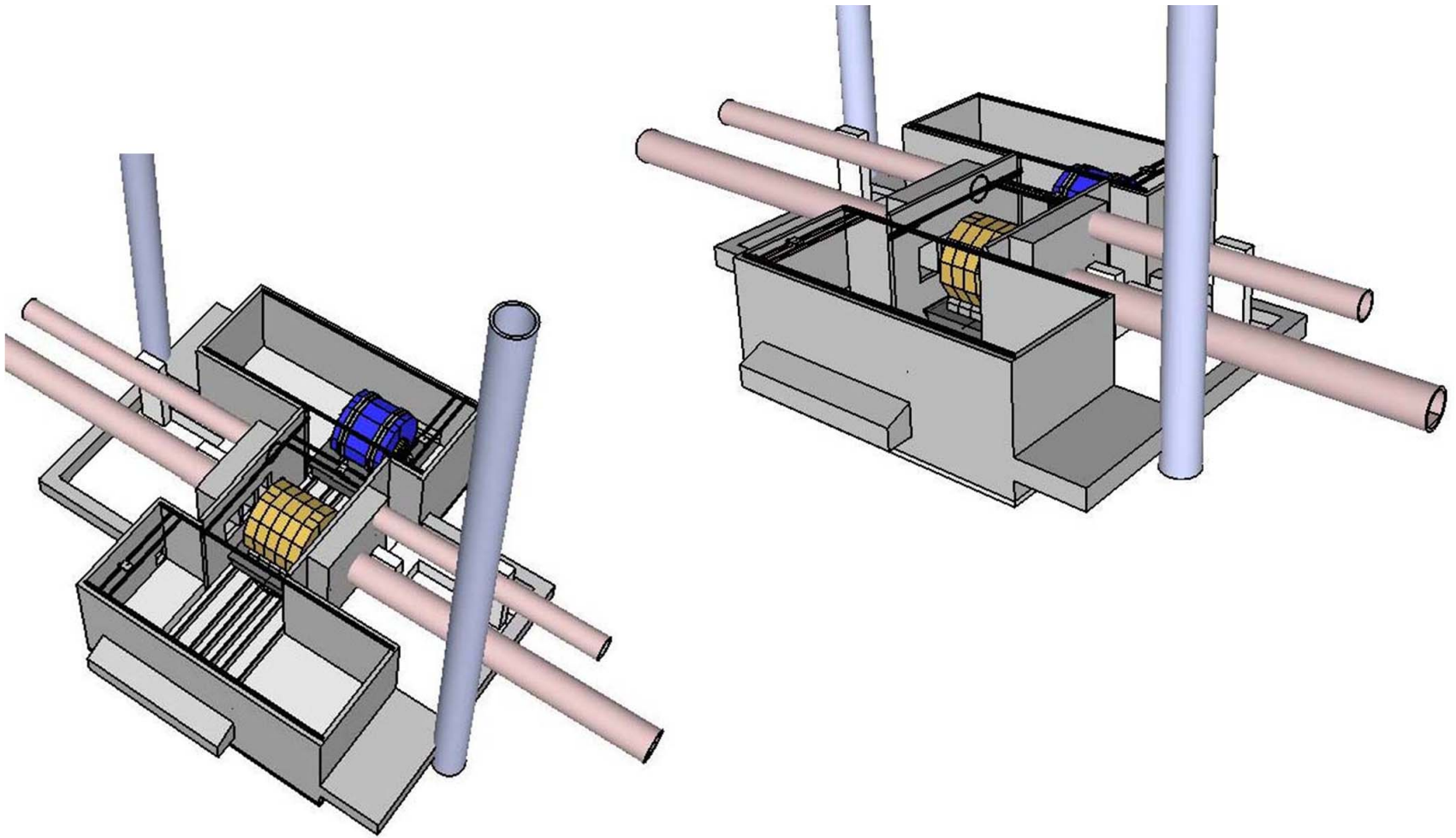
assemble sub-detectors as far as possible

max. part dim.: < ~400 t, < ~9m

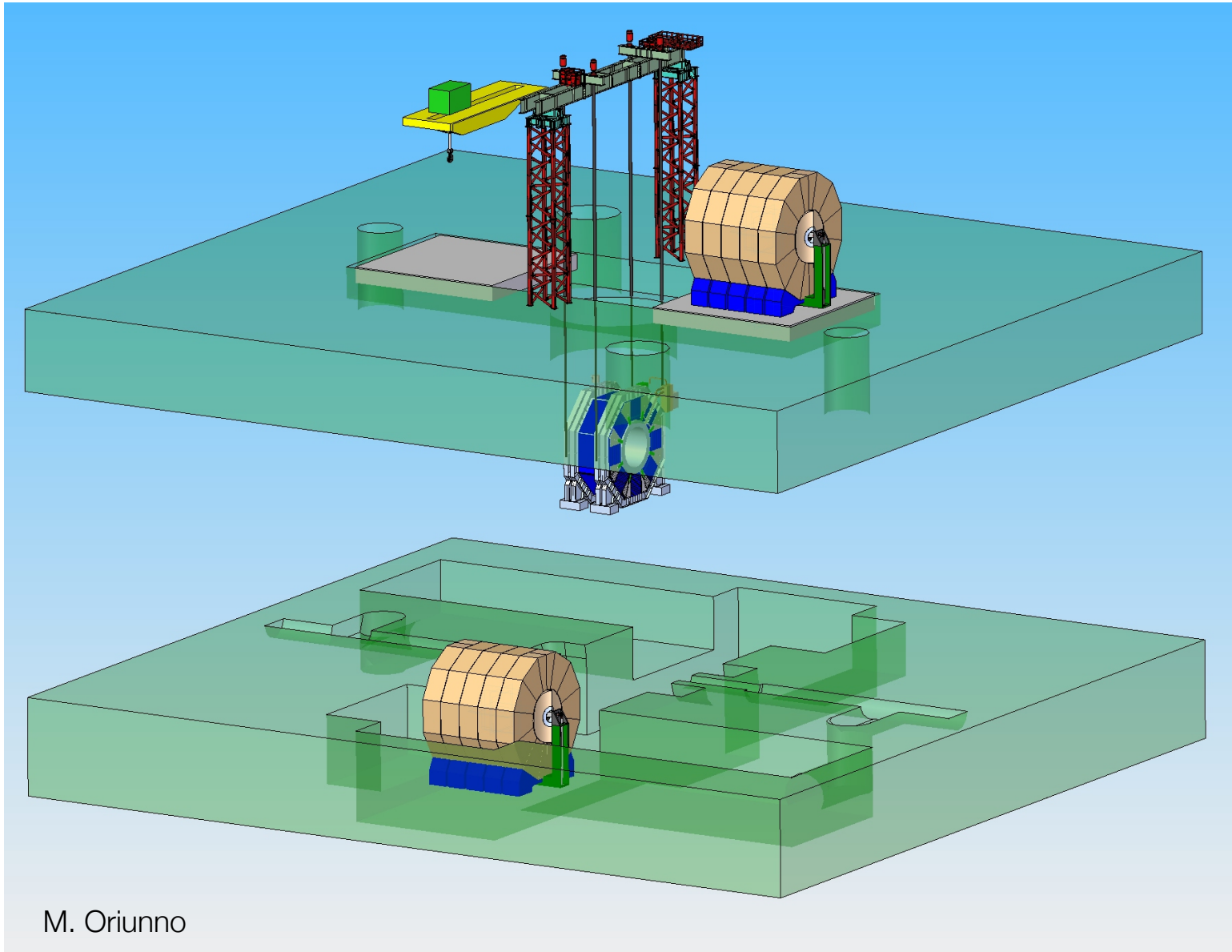
long underground work (~3a)

Installation schemes of detector and machine coupled at high level

Flat Sites: Experimental Cavern

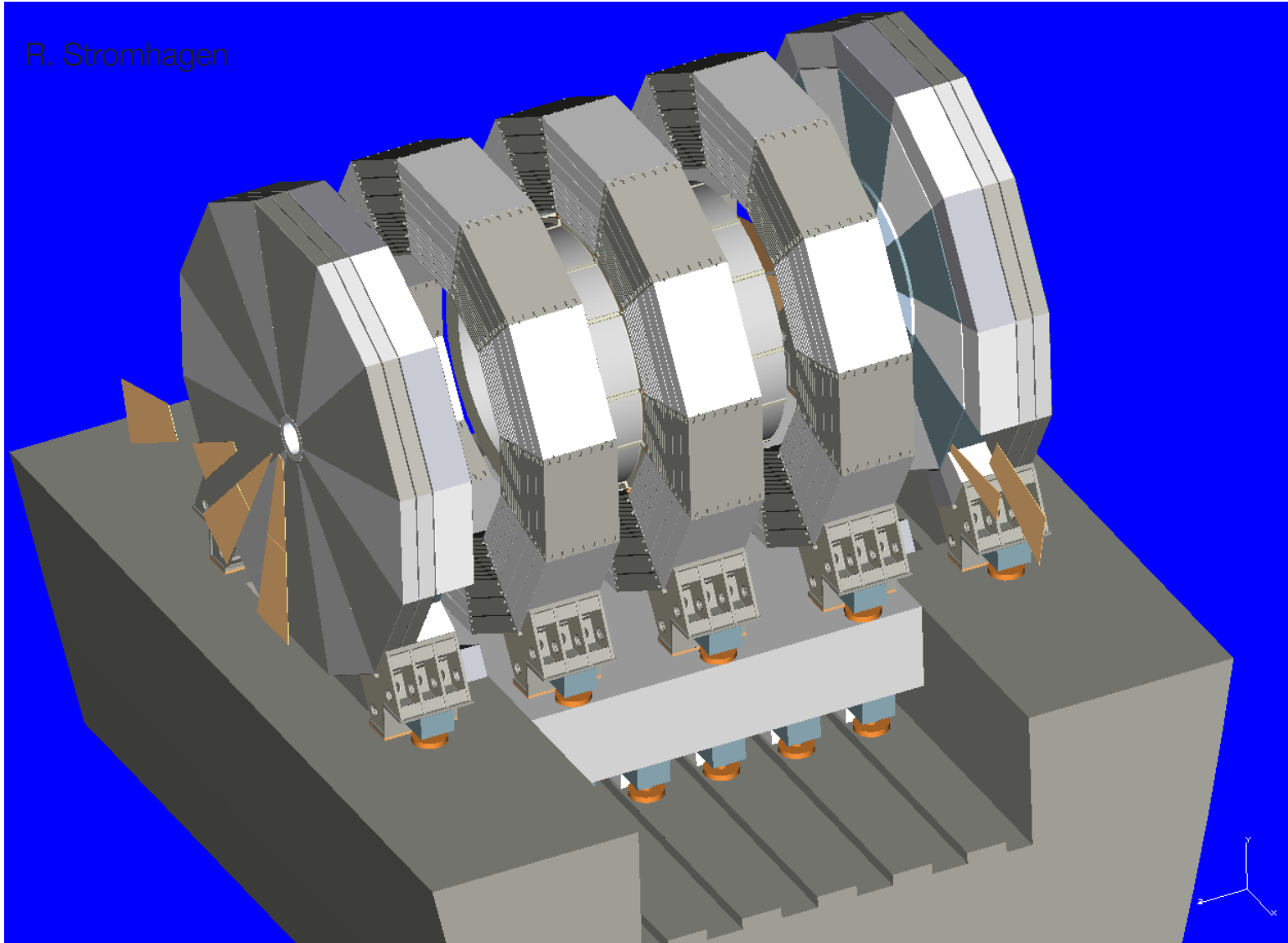


Vertical Shaft Assembly

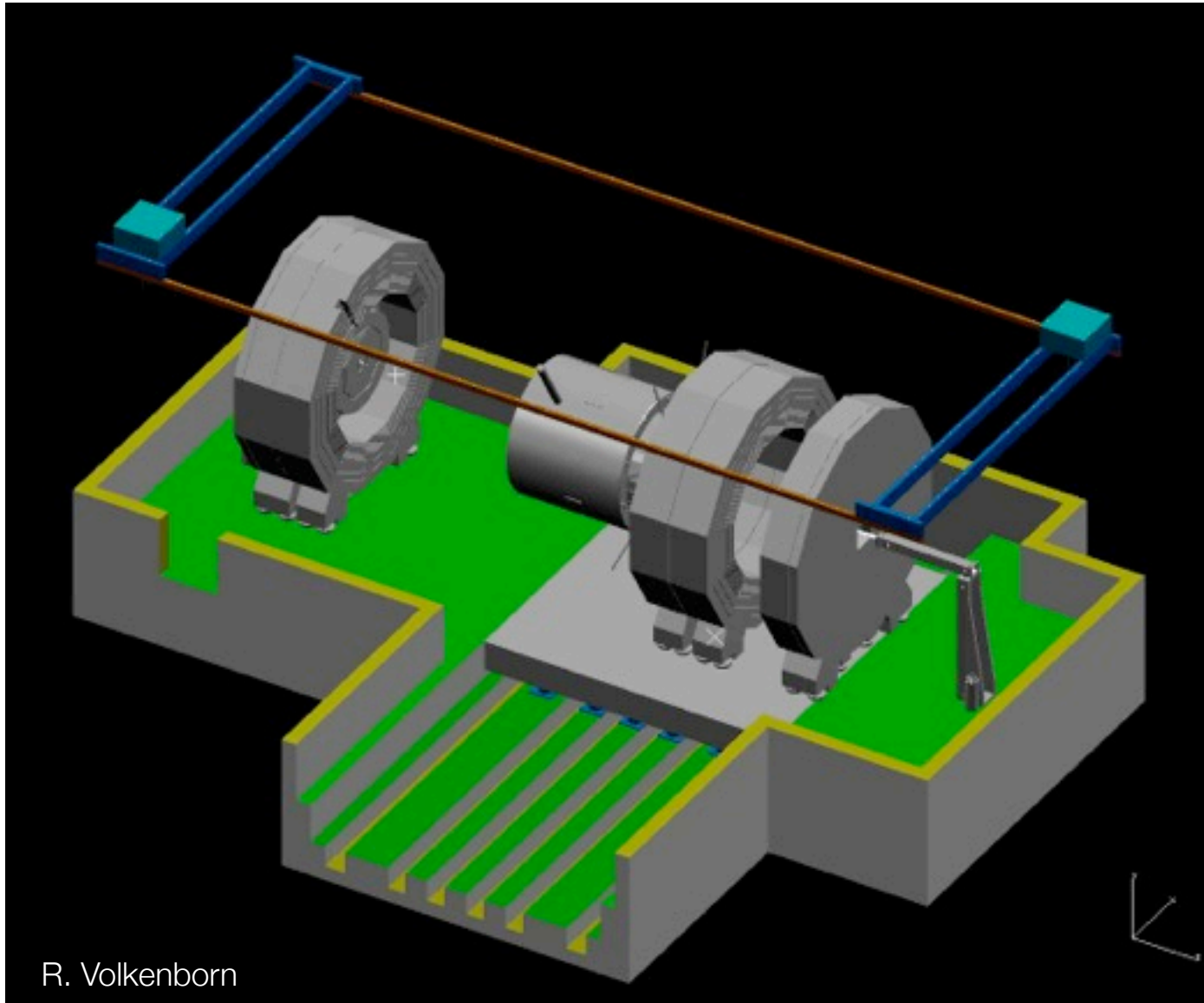


ILD Design

R. Stromhagen

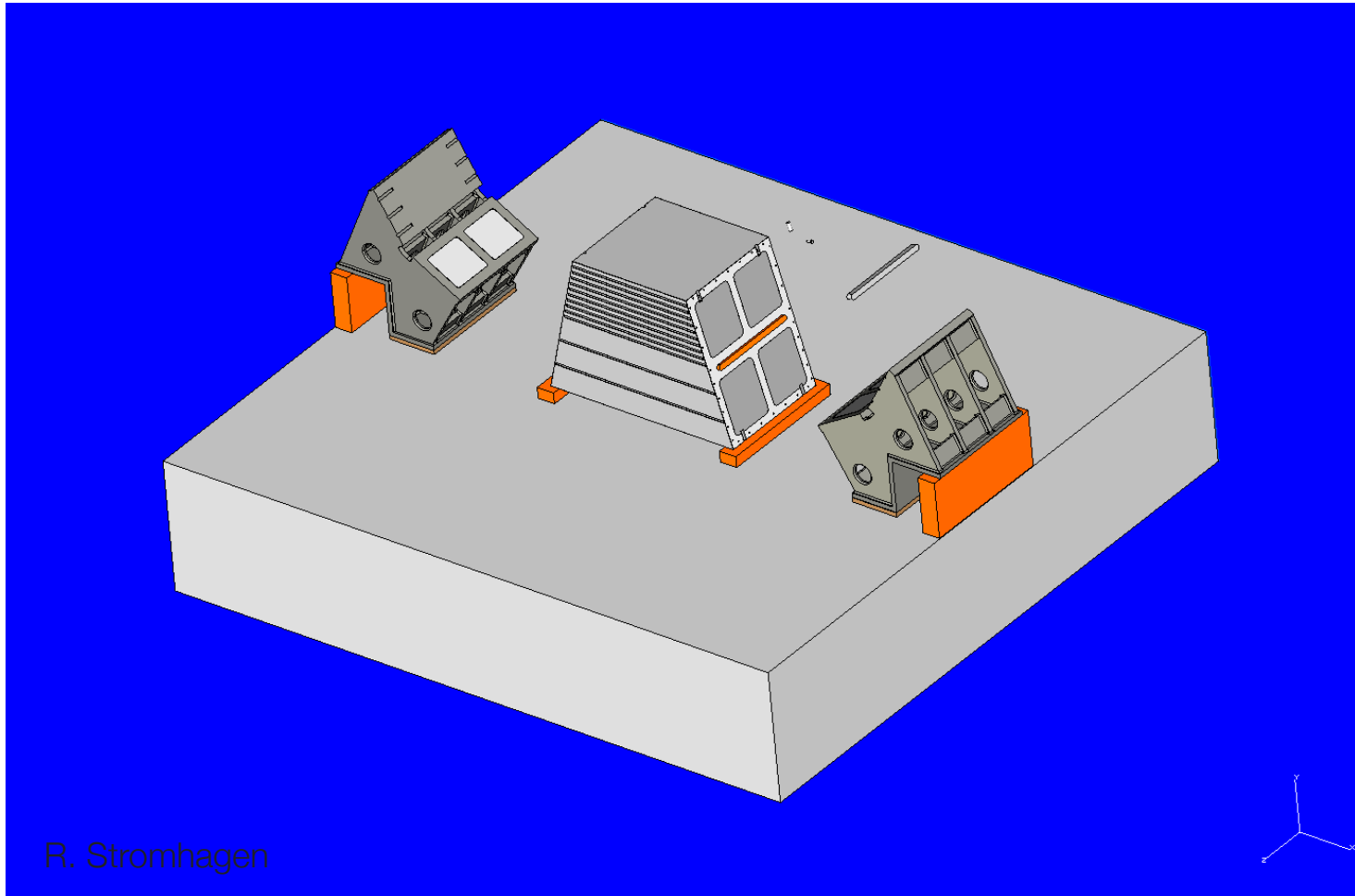


ILD in Maintenance Region (non-mountain site)

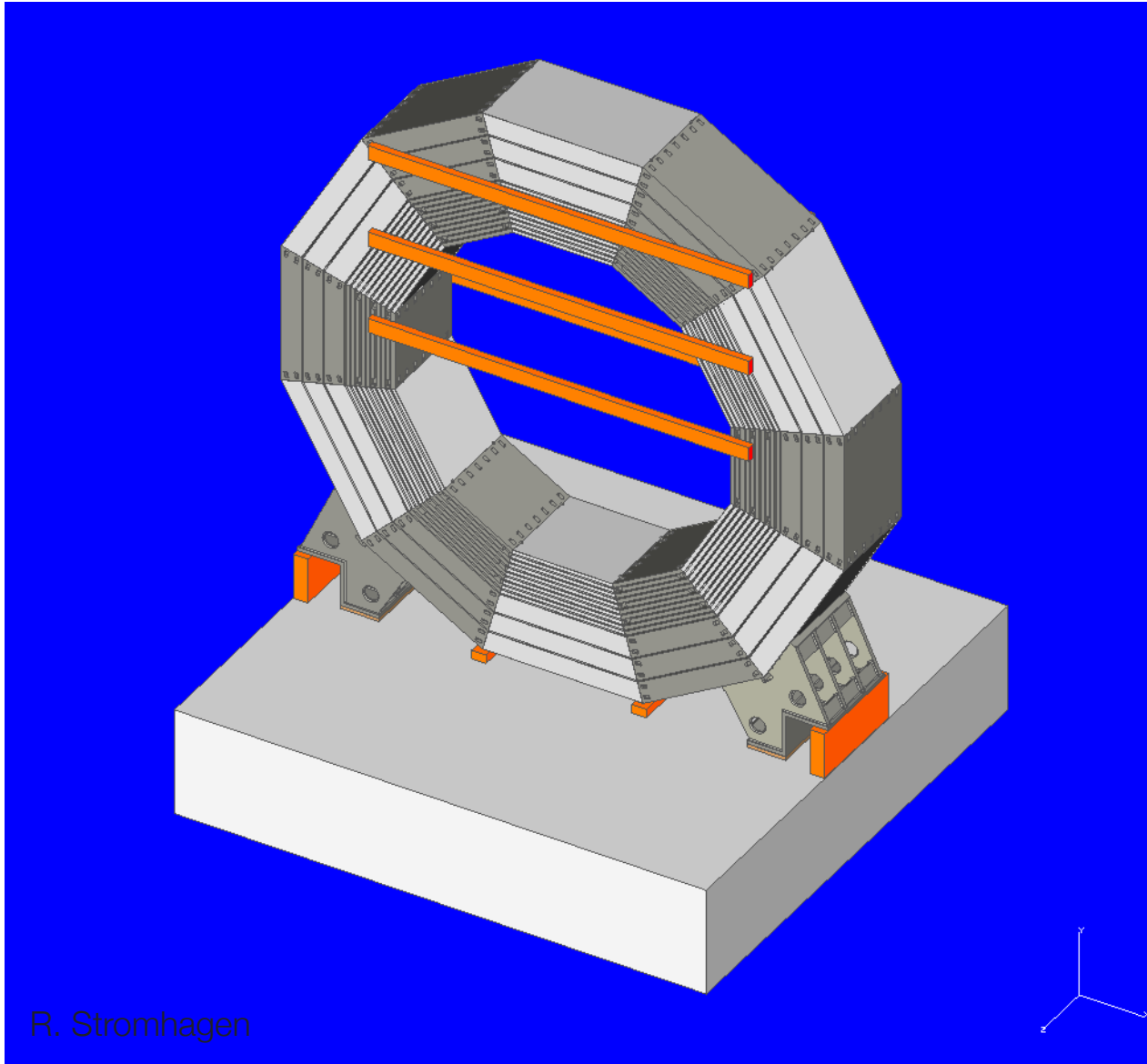


Yoke Assembly - Barrel

- Start with central ring on platform
- Space needed for: tools, scaffolding, surveying equipment



Yoke Assembly - Barrel

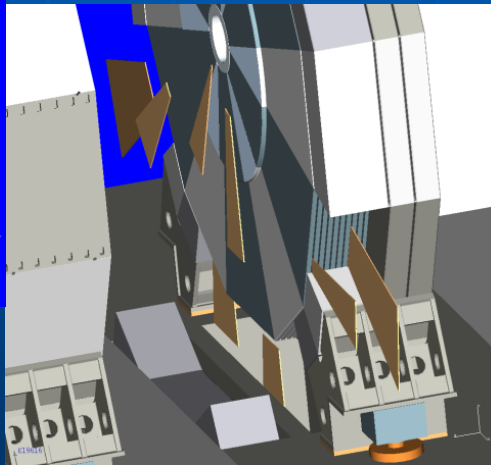
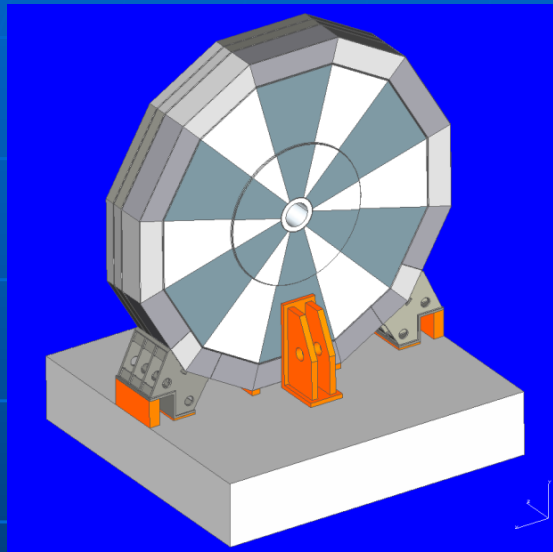


R. Stromhagen

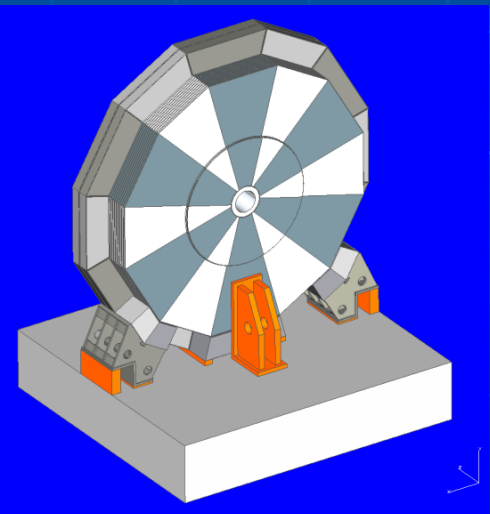
Yoke Assembly - Endcap

End cap Assembly / Step 36 to 50

R. Stromhagen

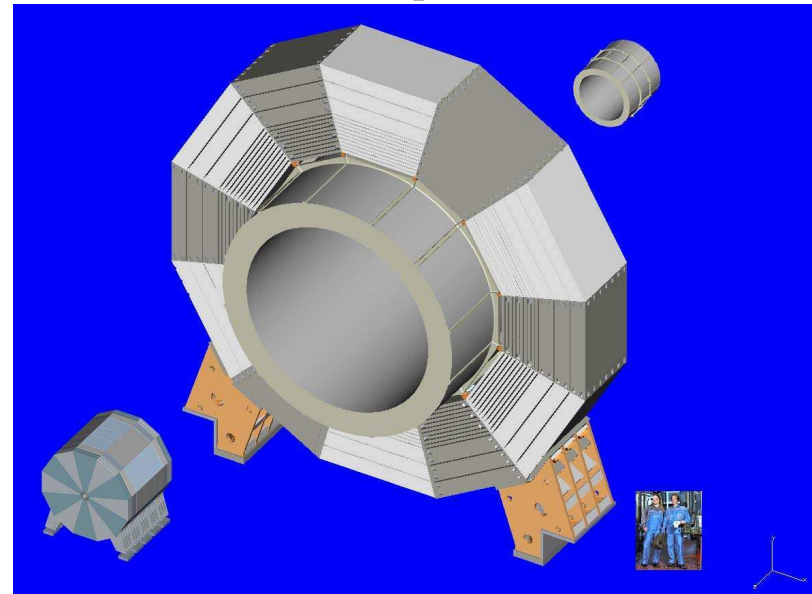


Chamber omitted for clarity



Coil Installation

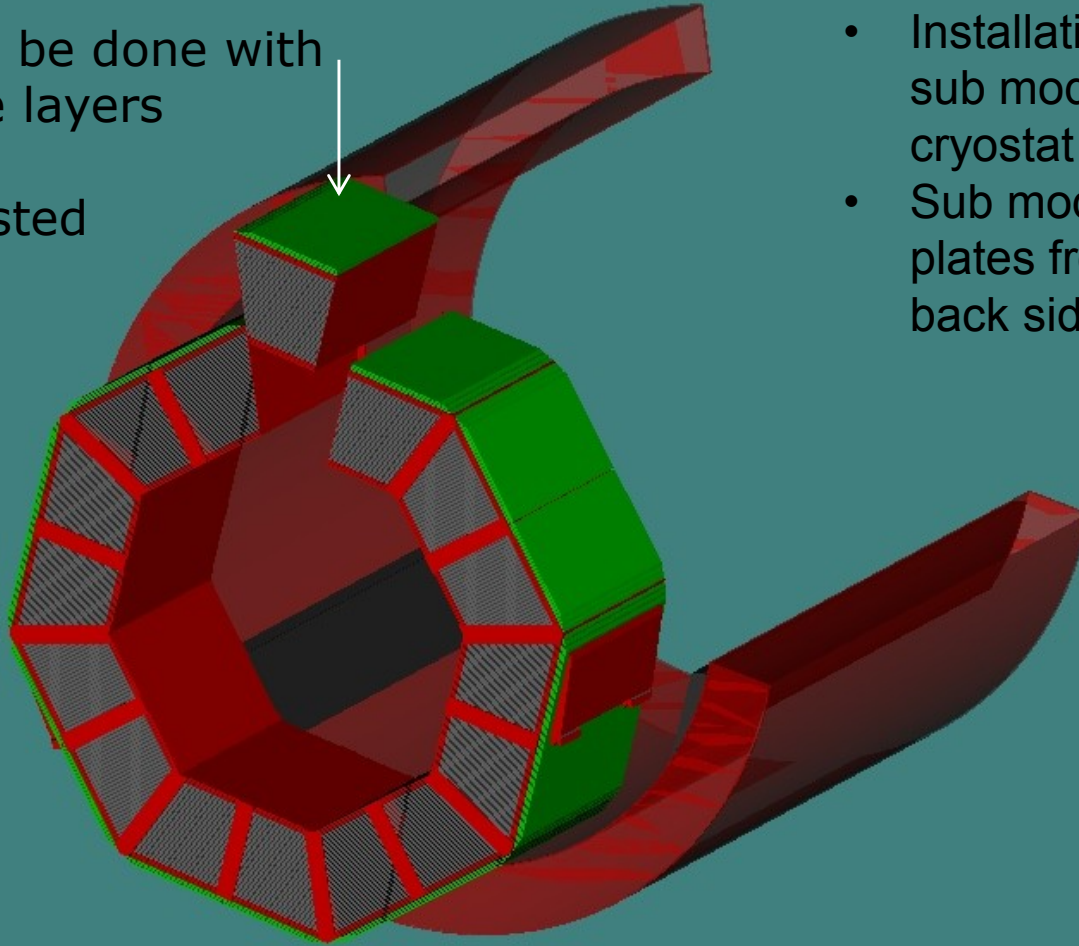
- In case of mountain sites:
 - Coil can only be transported without its ancillaries (cold box, chimney)
 - Functional test needs to be done underground after installation into central barrel yoke ring
 - very low fields, yoke will not be ready by then
 - Takes >3 months (incl. cool-down and warm-up)
- Test of field mapping equipment is needed at the same time
 - ALEPH experience



R. Stromhagen

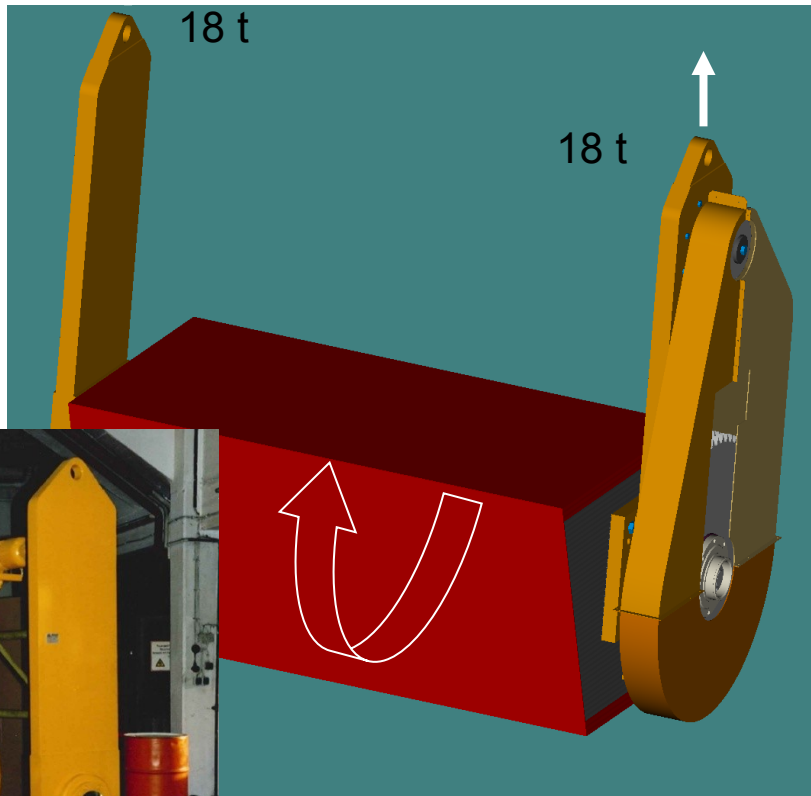
AHCAL Installation

Can also be done with
sensitive layers
in place
- and tested
before



- Installation of last AHCAL sub module in front of the cryostat
- Sub module connection by plates from the front and back side

AHCAL Installation



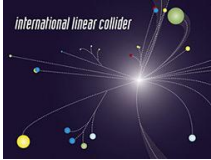
K. Gadow

- > lifting and turning tool for AHCAL barrel absorber sub-modules available
 - 2 x 18 t capacity
 - operation with 2 hooks (z angle adjustment)
 - precise motor controlled turning
 - design for adaptation for sub-modules with and without sensitive layers started

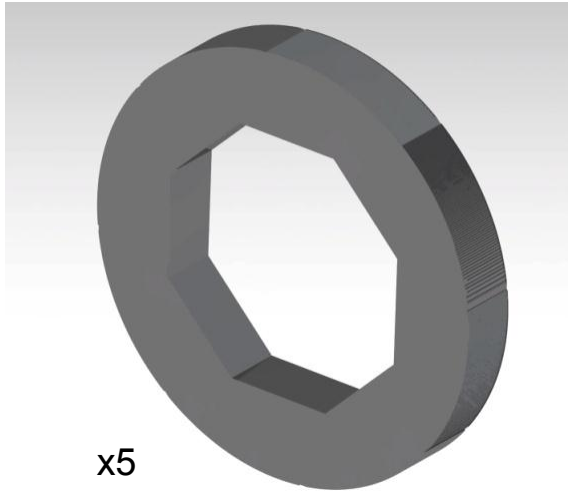
- > mounting, support and insertion frame
 - one frame for everything
 - design depends on installation procedure

- > push and pull tool available
 - must be modified to the rail distance and rail shape/size

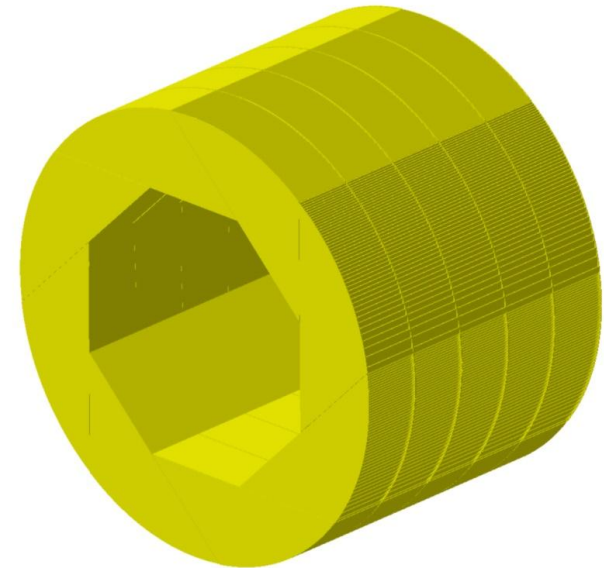
SDHCAL Installation



Barrel design : 5 wheels



Ext. Diameter : 6770 mm
Int. Diameter : 4116 mm
Length : 4700 mm



Stainless steel

Structure Weight (t):

Detectors Weight (t):

Total Weight (t) :

1 wheel

88 t

36.8 t

124.8 t

5 wheels

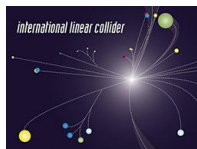
440 t

184 t

624 t

J.C. Ianigro

SDHCAL Installation

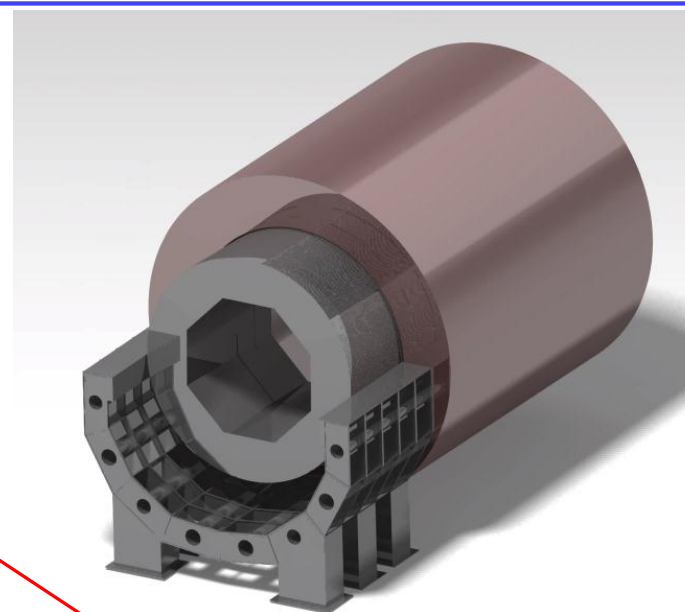


Barrel tooling : phase 3 – Barrel insertion

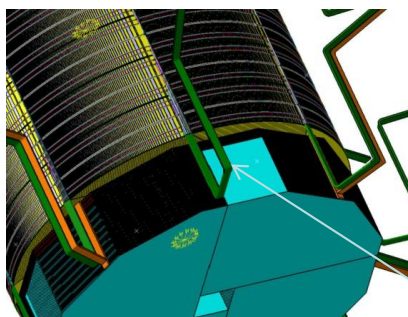
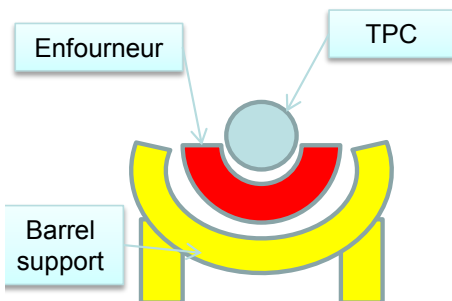
J.C. Ianigro

■ Barrel on structure inside the yoke

- Barrel with 5 linked wheels inserted
- slipping on rails inside the yoke
- barrel fixed inside the yoke on both sides
- services installation along the yoke to patch panels



Barrel insertion



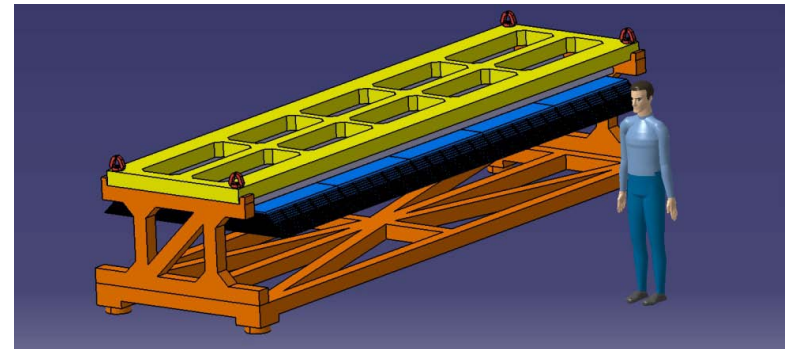
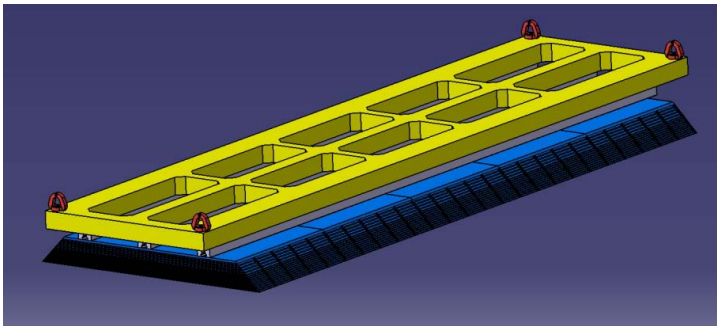
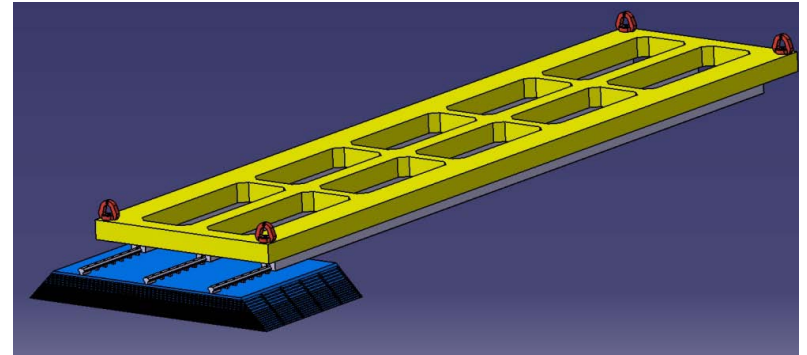
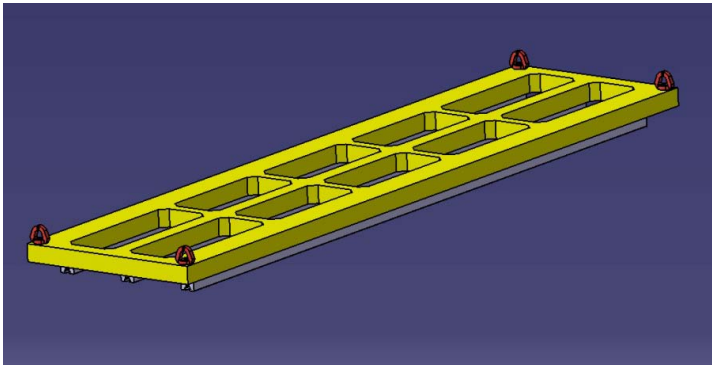
Structure could be used for TPC with another specific structure as CMS « enfourneur » (red)

Services issues

ECAL Installation

Ecal integration steps (Assembly hall) :

A full (mechanical) stave structure is mounted on a frame (yellow) making a beam
The beam is then placed on its transport and storage cradle(orange)

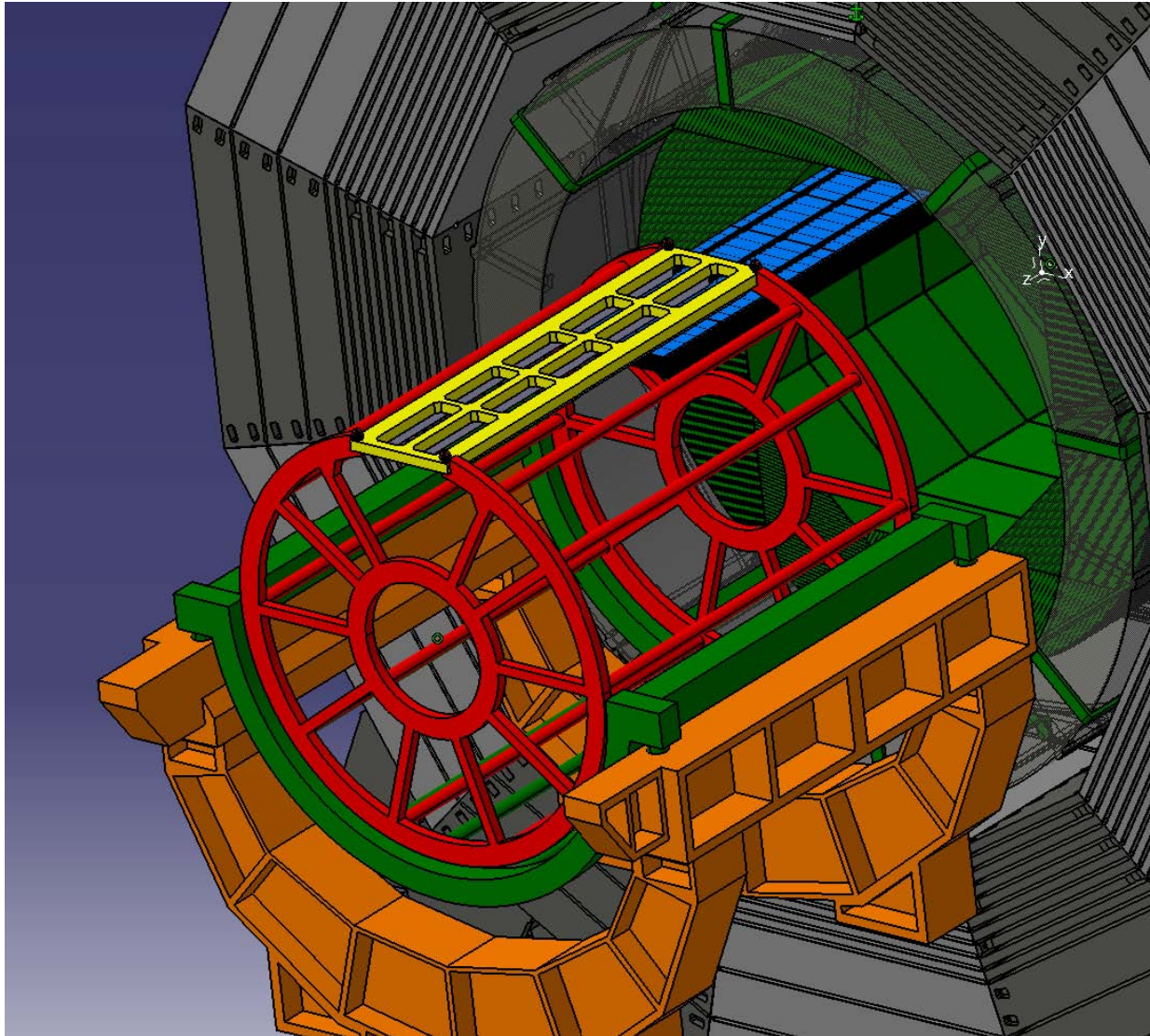


The stave is then ready to be equipped with slabs , cabled and tested

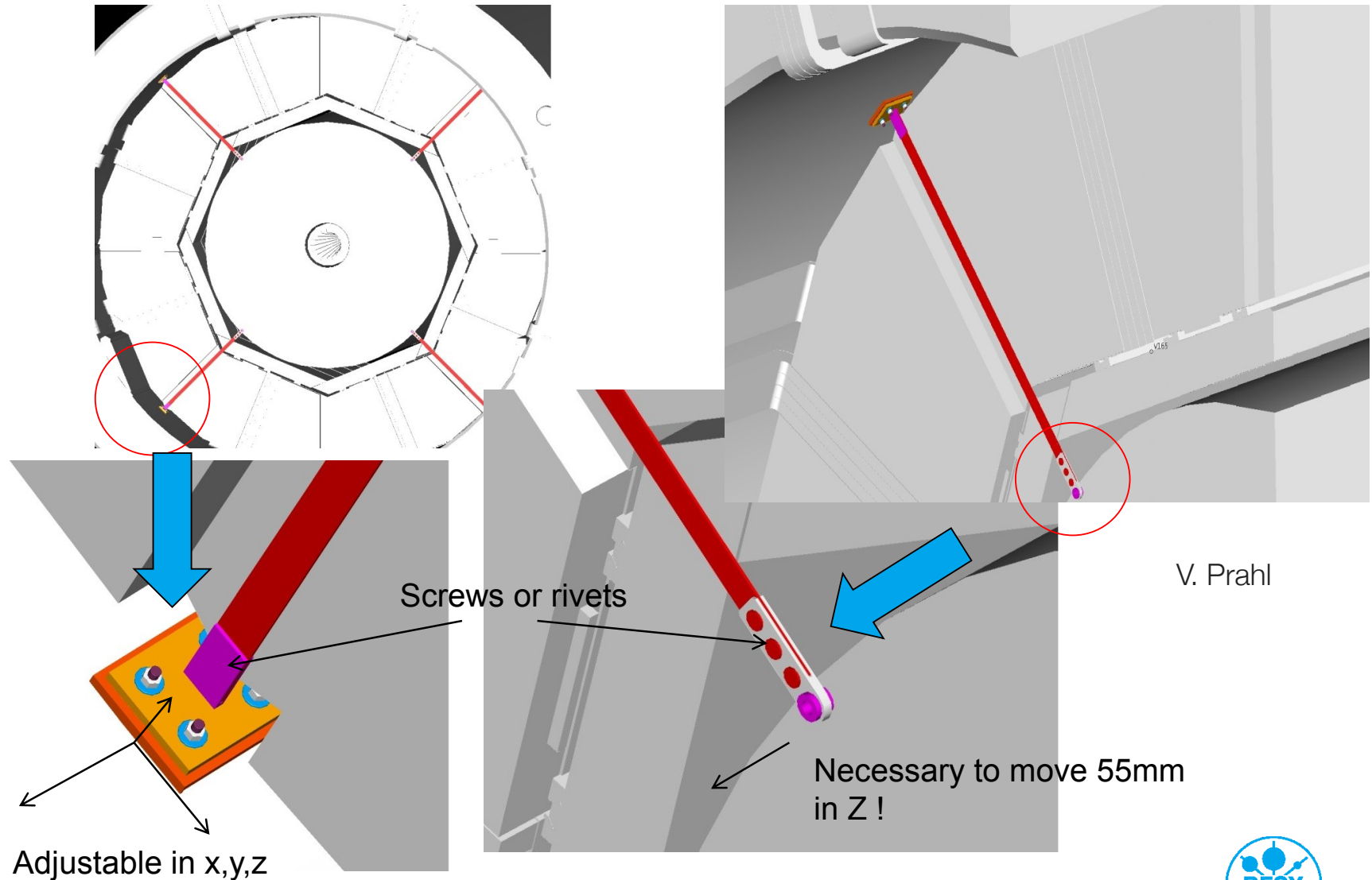
C. Clerc

To be done 8 times

Adaptation of this tooling to the ILD considerations and to the mountain site constraints

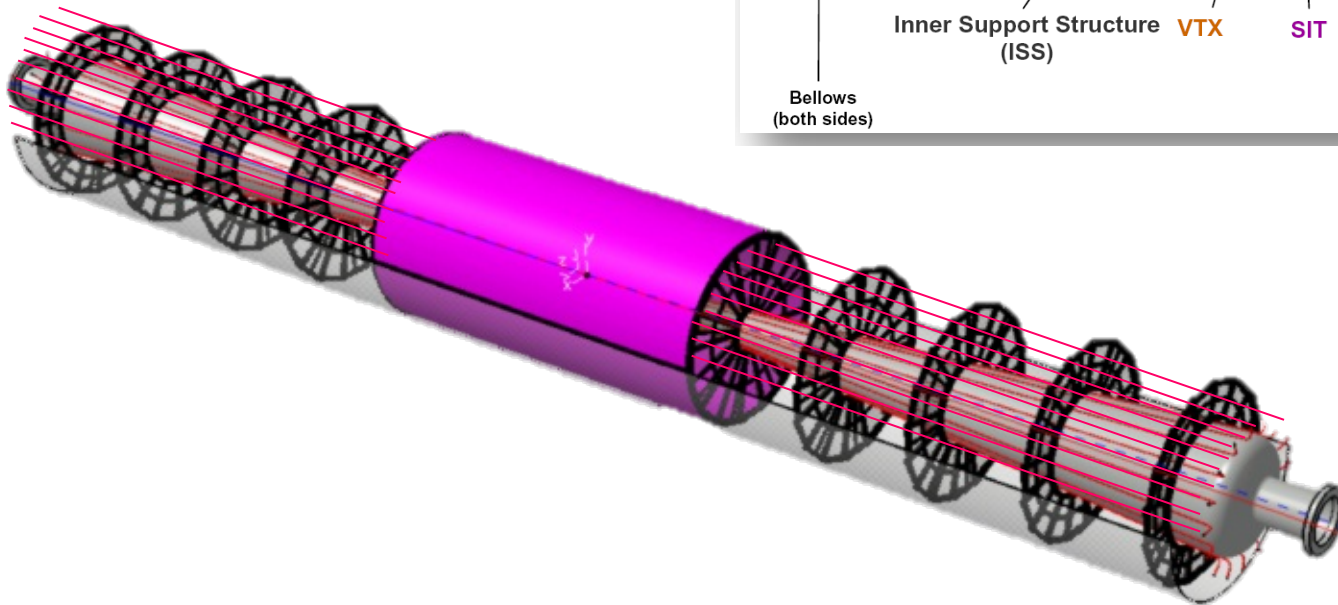
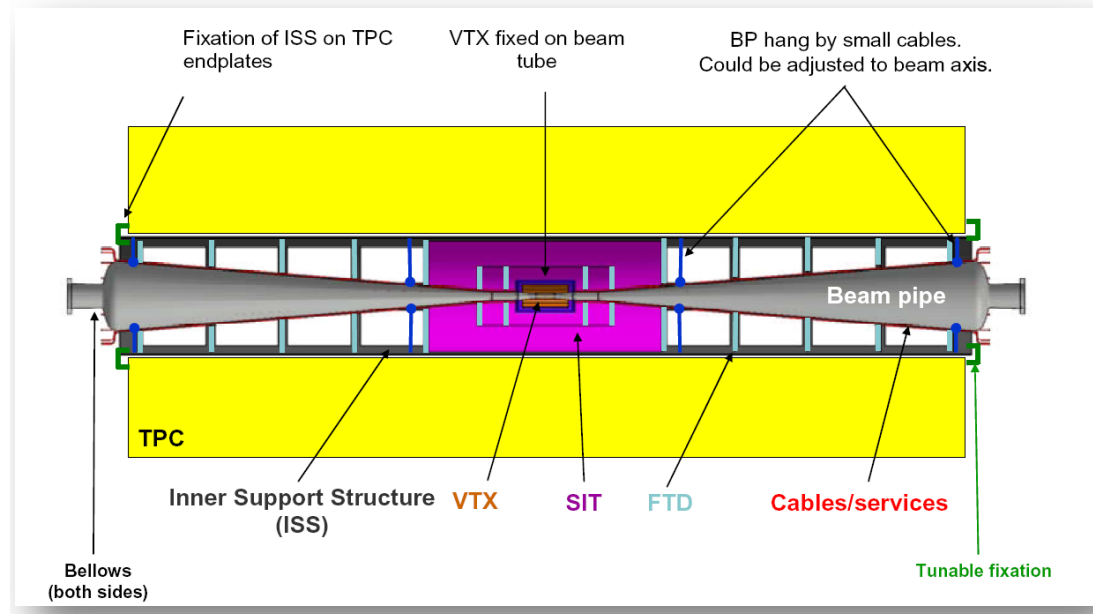


TPC Installation



Inner Detector

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



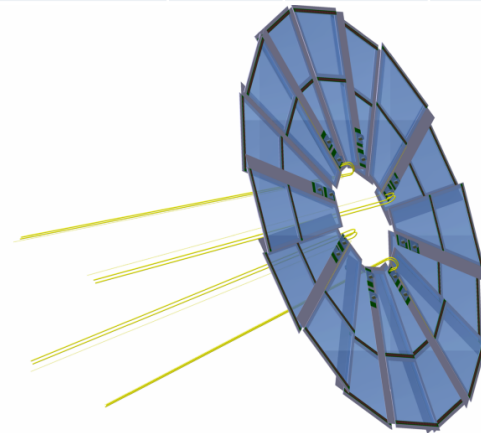
C. Bourgeois

μStrip FTD power cables

Cables per disk: cross section and power dissipation

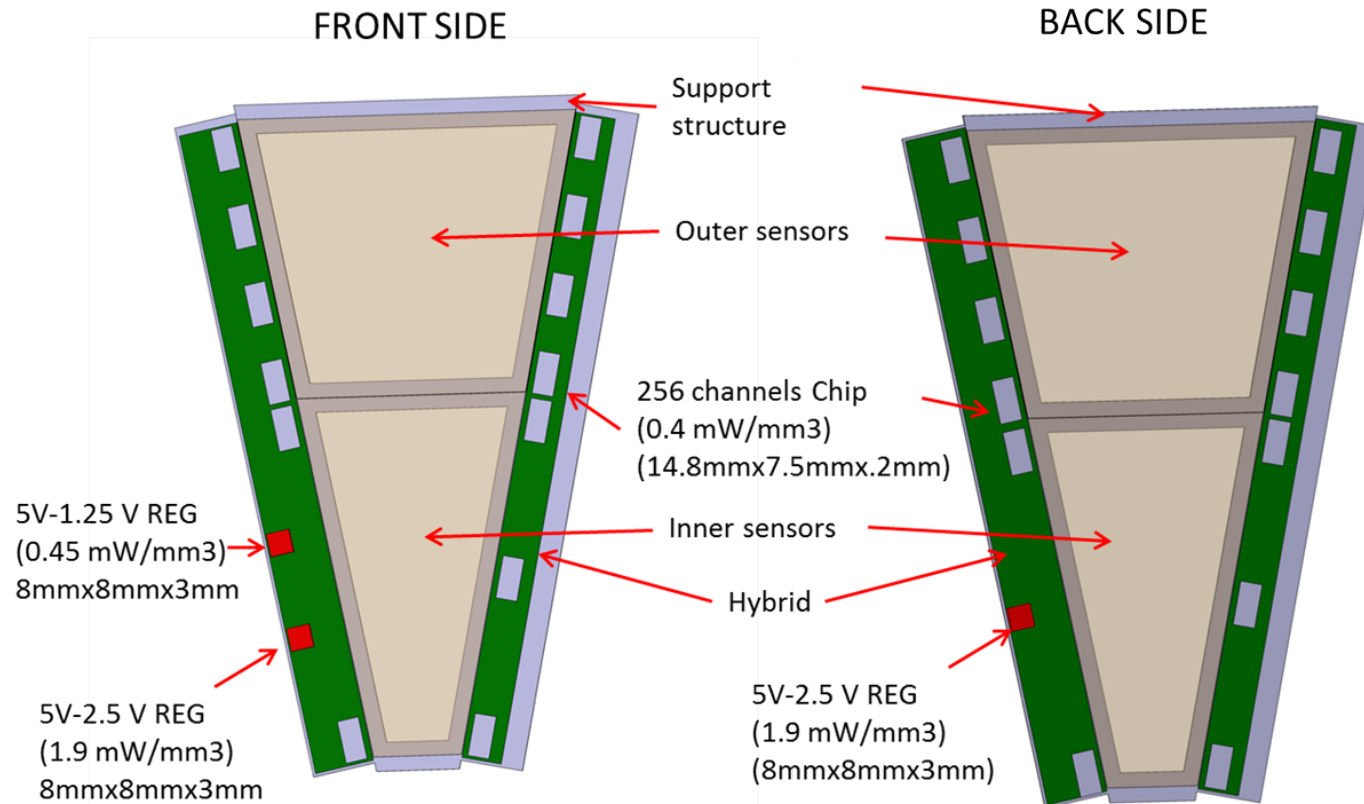
- 4 single sided sensors per petal, 16 petals per disk, for disk 3 to 6 and 2 single sided sensors and 16 petals for disk 7, this per side (+z, -z)
- Two different approaches:
 - DC-DC converters
 - Super-capacitors
- Both designs:
 - with a modularity of ¼ Disk
 - Each Disk overall cable Cu section <15 mm²
 - FTD 3-7 cables total Power dissipation per meter below 2 W/m

		Component	Nº Cables	CABLE NEEDED	Power dissipated (W/m)	Total Cu section
DC-DC solution	1/4 DISK	4 X 12v-1.25 V DC-DC	2	AWG 15	0.093	3.3 mm ²
		2 X 12V-2.5V DC-CD				
		High voltage cable	2	AWG 24	0.000	0.4 mm ²
		TOTAL	4		0.093	3.7 mm ²
	All DISK	DC-DC-s	8	AWG15	0.373	13.2 mm ²
		High voltage cable	8	AWG24	0.000	1.6 mm ²
		TOTAL	16		0.373	14.8 mm ²
Super Capacitor solution	1/4 DISK	2 supercapacitors	2	AWG 16	0.040	2.6 mm ²
		High voltage cable	2	AWG 24	0.000	0.4 mm ²
		TOTAL	4		0.040	3 mm ²
	All DISK	Supercapacitors	8	AWG 16	0.16	10.4 mm ²
		High voltage cable	8	AWG24	0.000	1.6 mm ²
		TOTAL	16		0.16	12mm ²



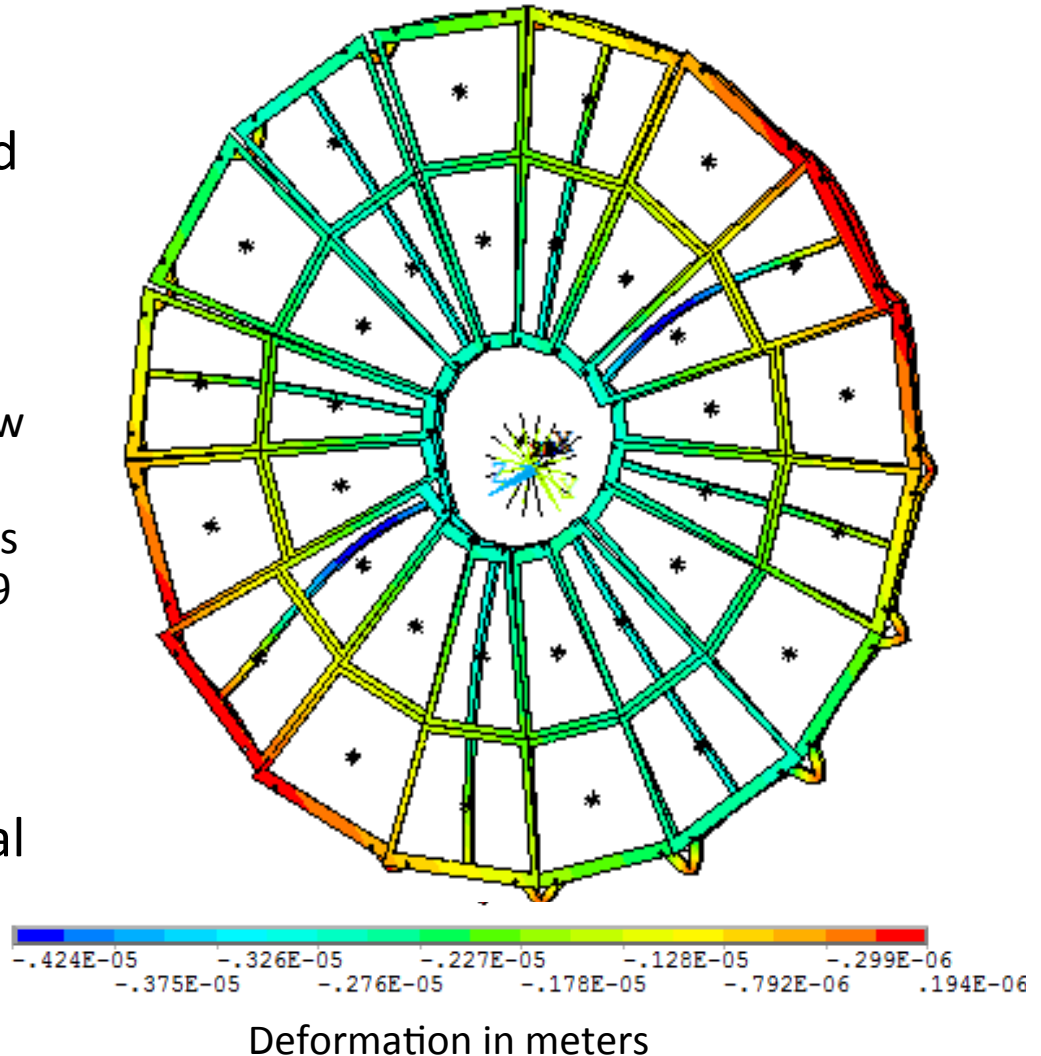
THERMAL MANAGEMENT OF FTD PETALS

- Thermal simulations in collaboration with CERN (F.Duarte, H.Gerwig). The aim:
 - Assess the option of passive cooling for μ strip FTD sensors
- Compare the super-capacitors and DC/DC options.
 - Main sources of power dissipation in the petal:
 - Readout chips and LV Regulators (or DC-DC converters)

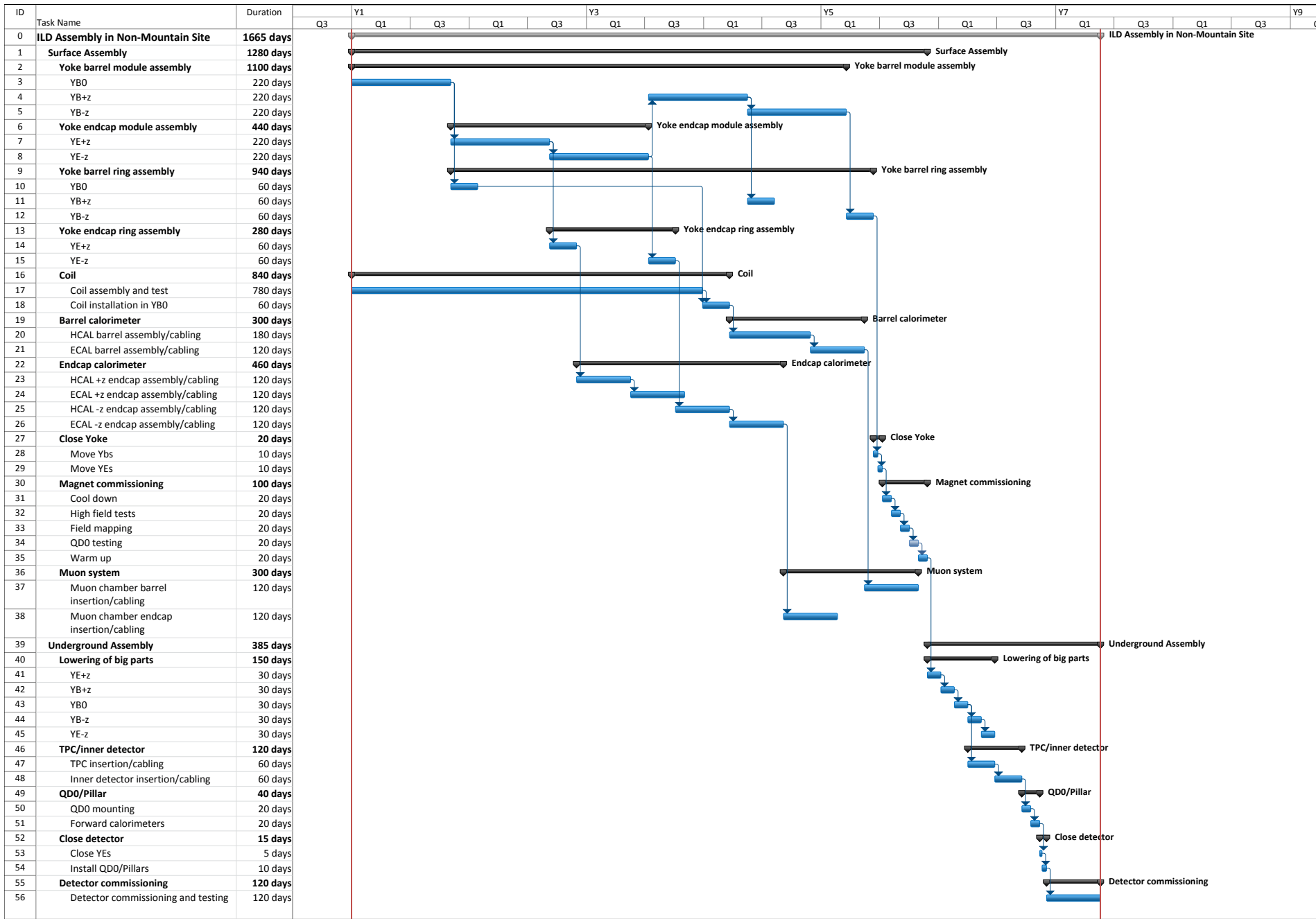


REALISTIC MECHANICAL SIMULATION

- First mechanical simulation of FTD3 (Gravitational load, and vertex, SIT, beam pipe and FTD1-2 loads)
- Very rigid structure:
 - Max deformation bellow 5 μm
 - First natural frequencies (44 HZ for FTD3 and 49 Hz for FTD4)
- Design must be optimized for reducing the amount of material without affecting the natural frequency



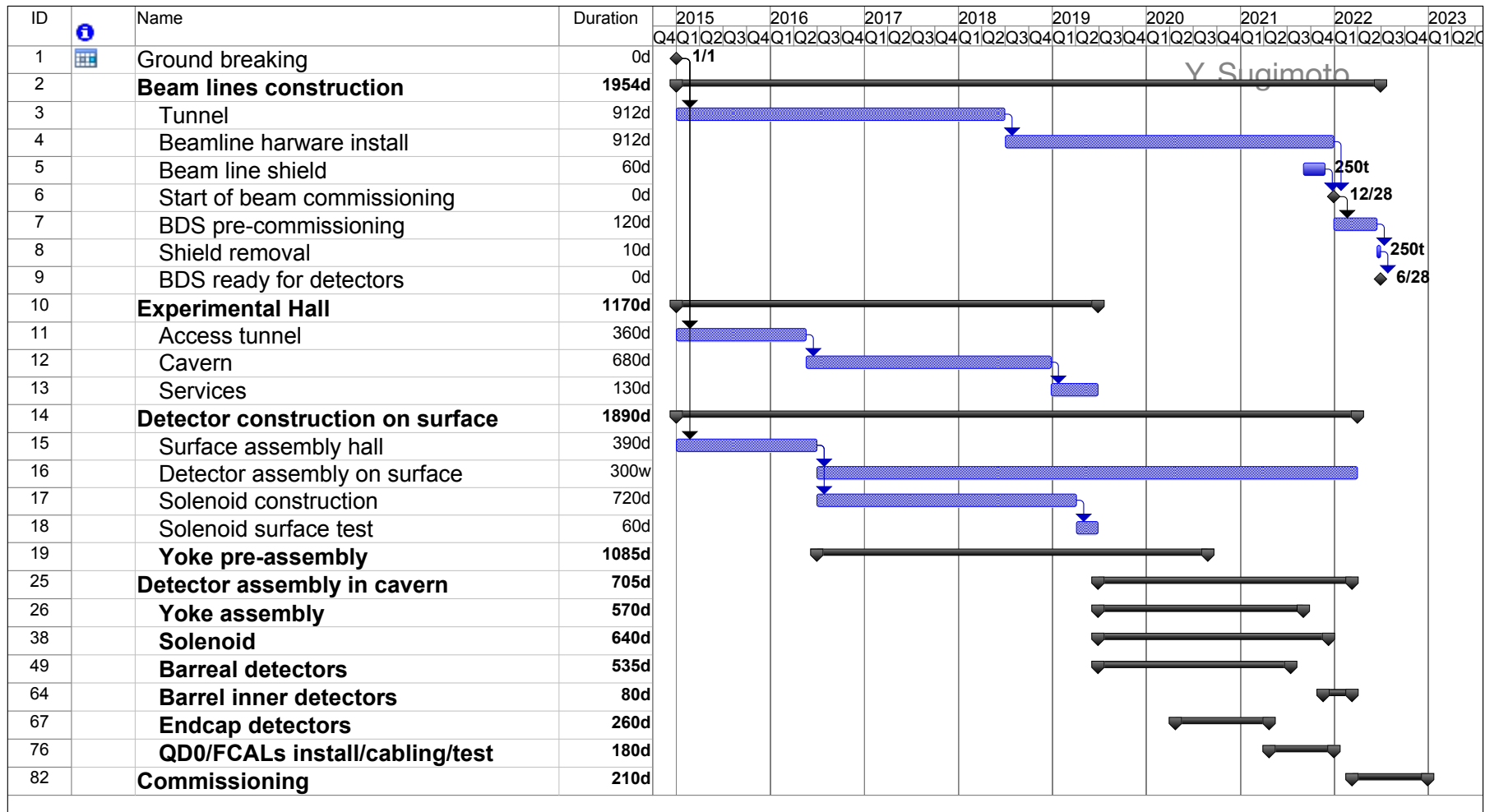
ILD Assembly Time Line (Non-Mountain Sites)



Assembly Timeline (Flat Sites)

- Critical path is defined by central detector construction:
 - central yoke ring, coil, barrel calorimeter, TPC, inner detector
- Assume to build coil and yoke segments on site
 - yoke segments could also be built at vendour, but rings need to be assembled on site
- Assume ~5.25 y of surface assembly time
 - could only start after surface buildings are ready
- Assume ~1.5 y of underground assembly and commissioning time
- Total: ~7 y plus preparation of surface buildings
- So total schedule of ~8 y seems doable

ILD Time Line Study (Mountain Sites)



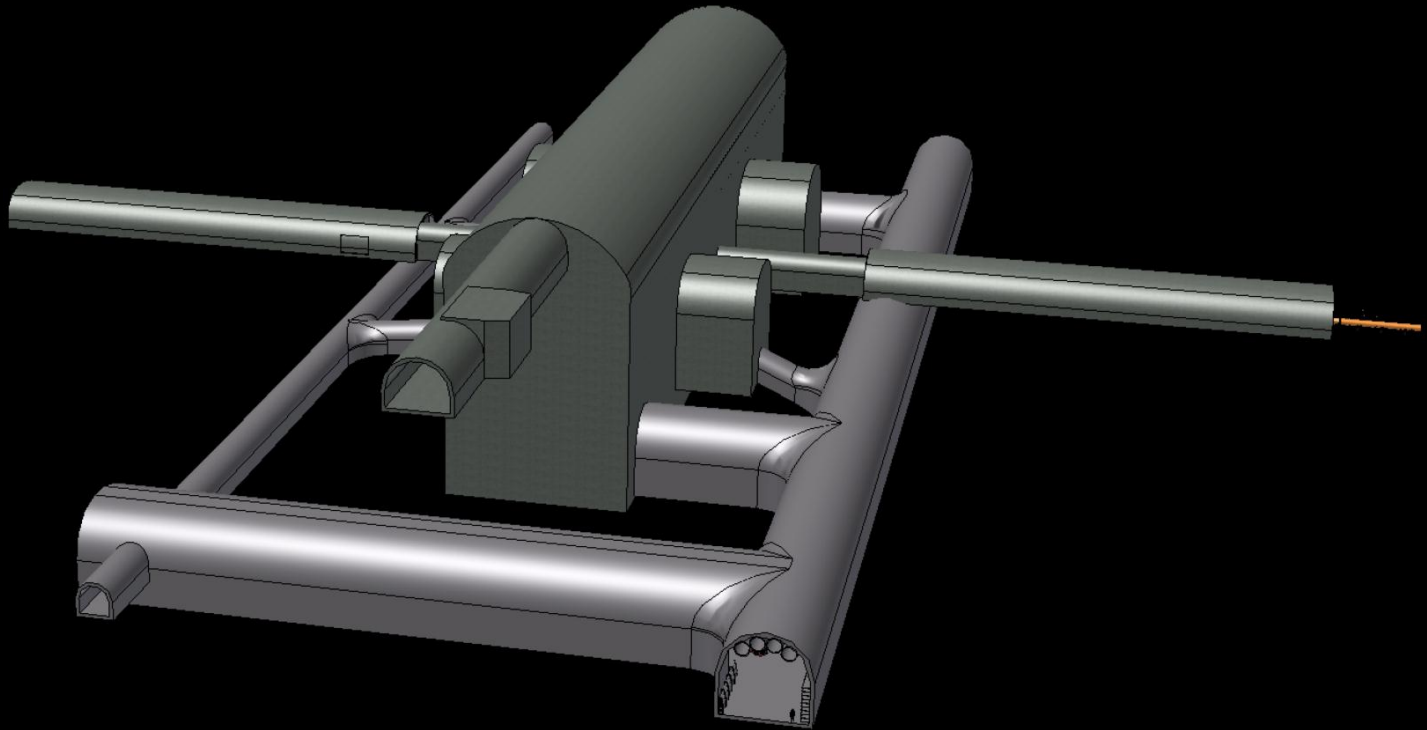
- Total construction time: ~8 years
- Detector underground construction: ~3 years

Y. Sugimoto

ILC Mountain Site



Japanese Hall Design (Status: 22.03.2012)

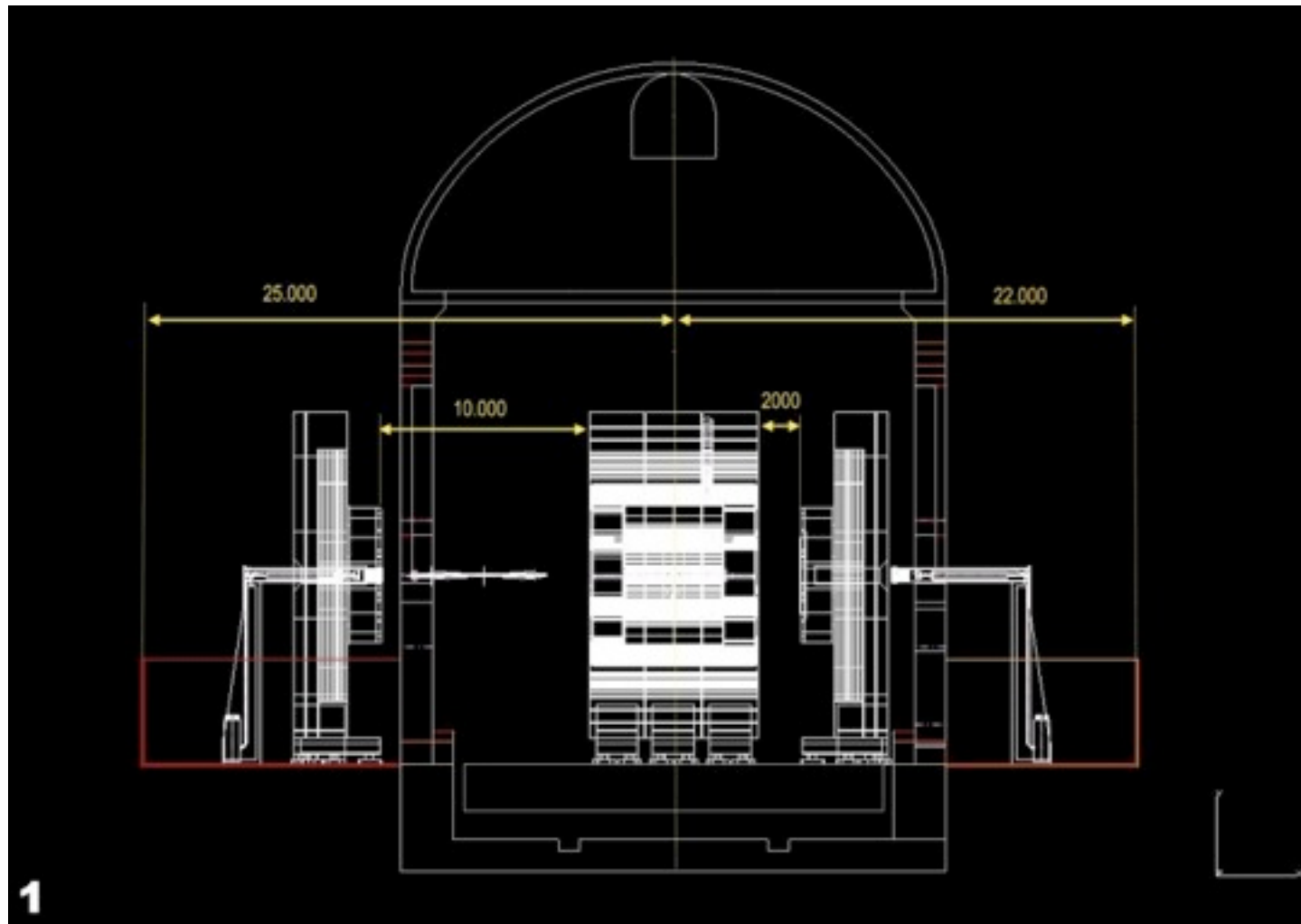


- Enlarged Alcoves
- 142 m long

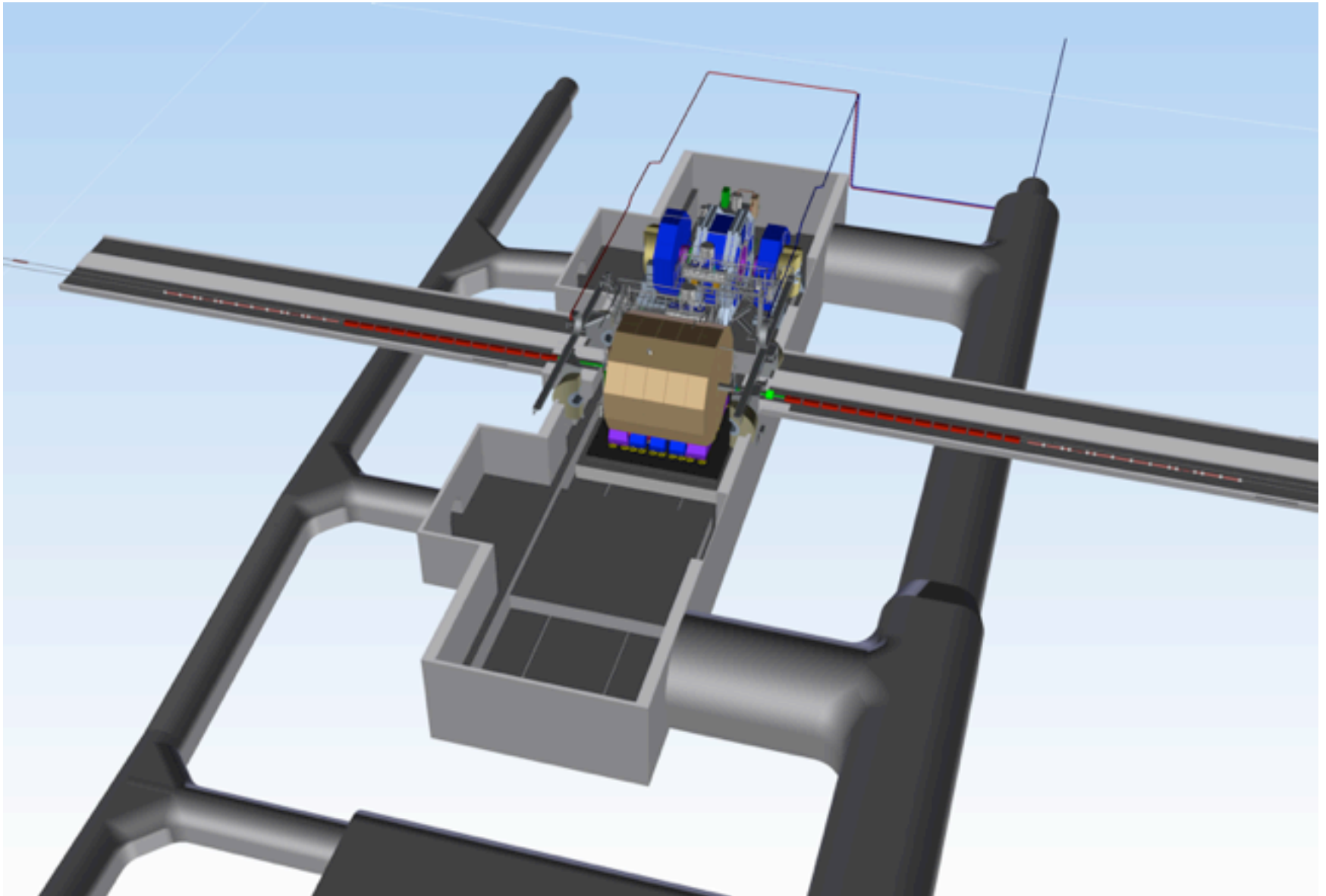
G. Orukawa

Maintenance Position (ILD Study)

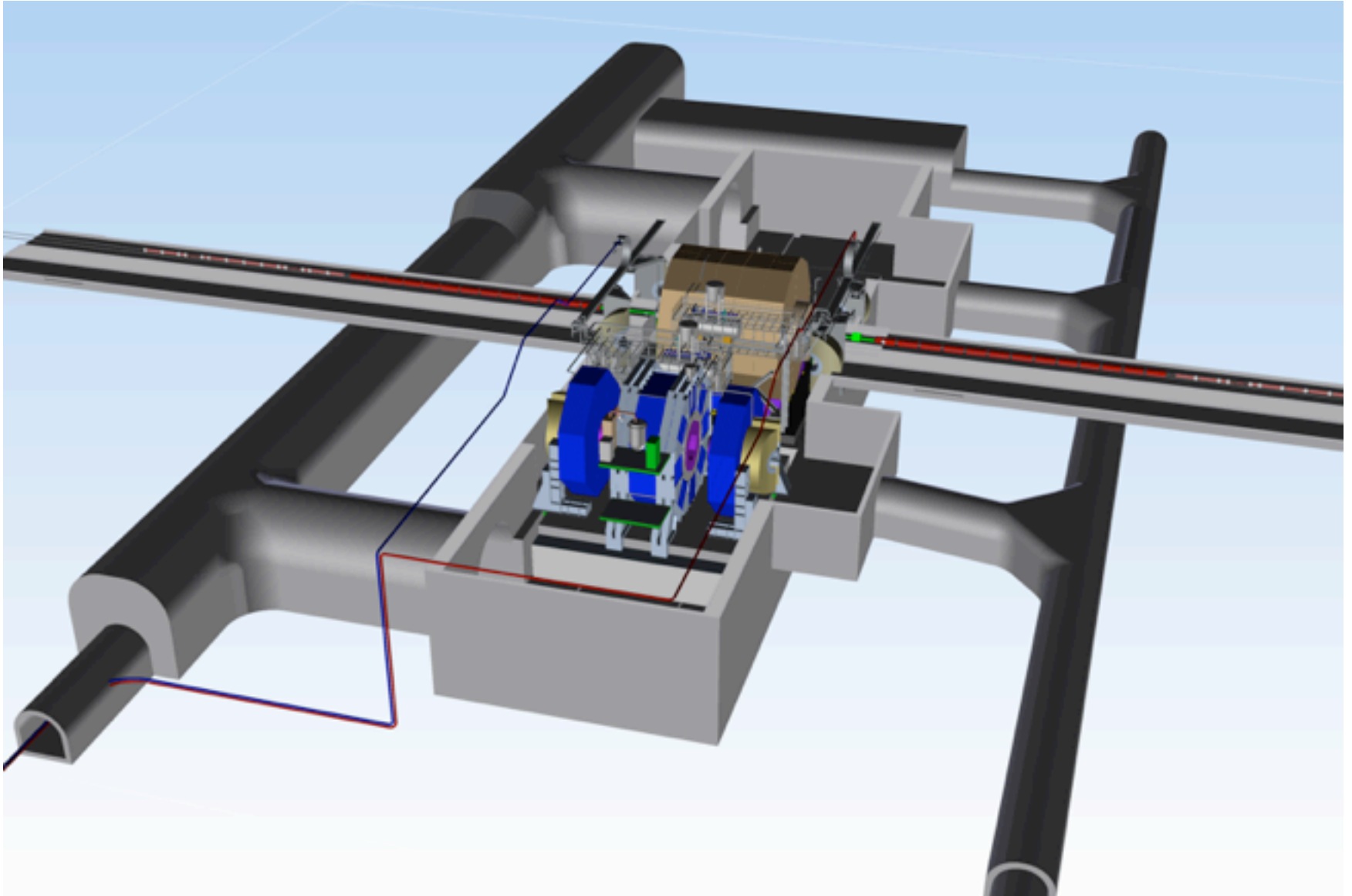
- Alcoves needed to open the detector for maintenance



Underground Sites in ILC-EDMS



Underground Sites in ILC-EDMS



Tenzan Power Plant Underground Hall



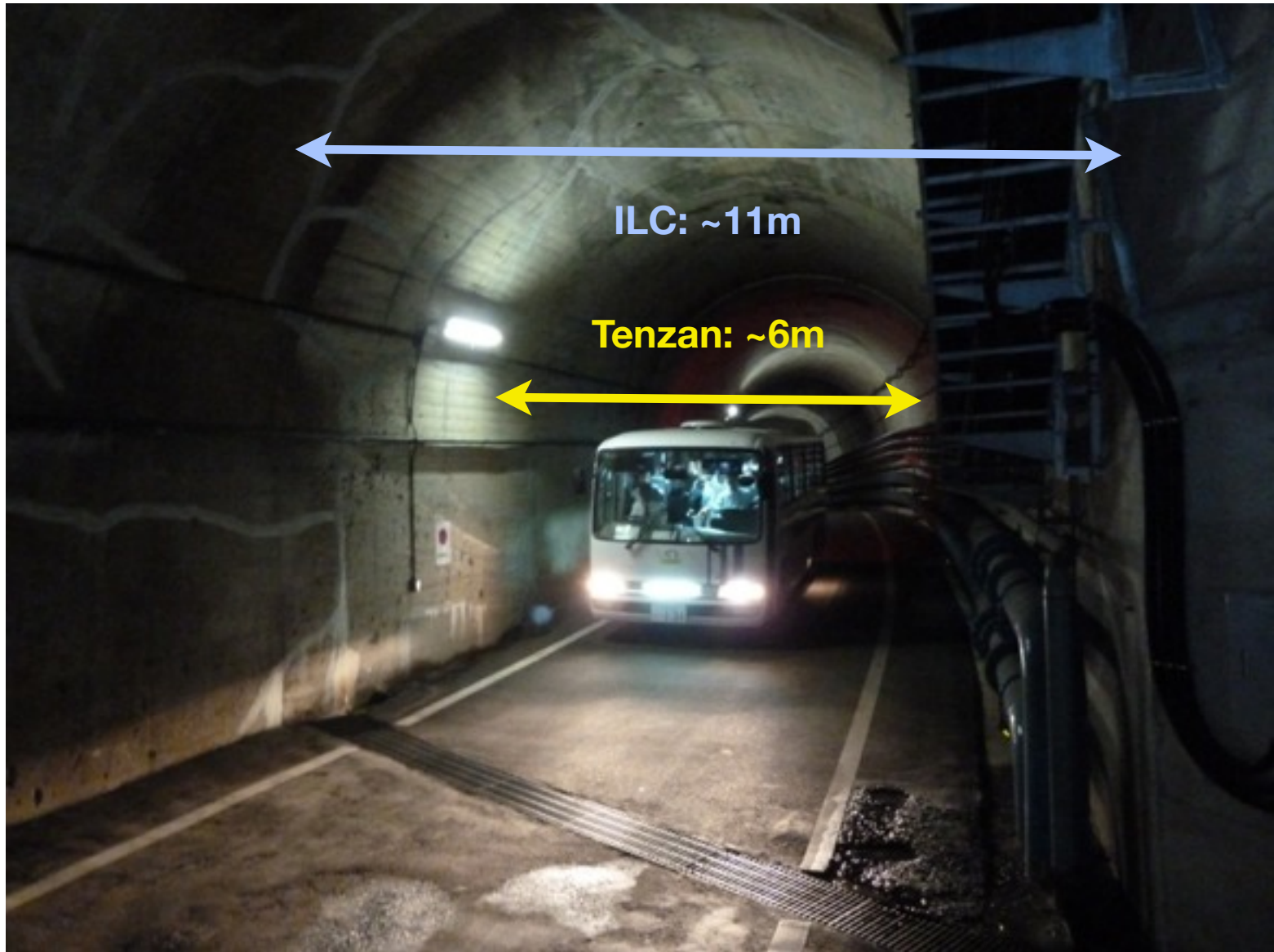
Access Tunnel



Access Tunnel



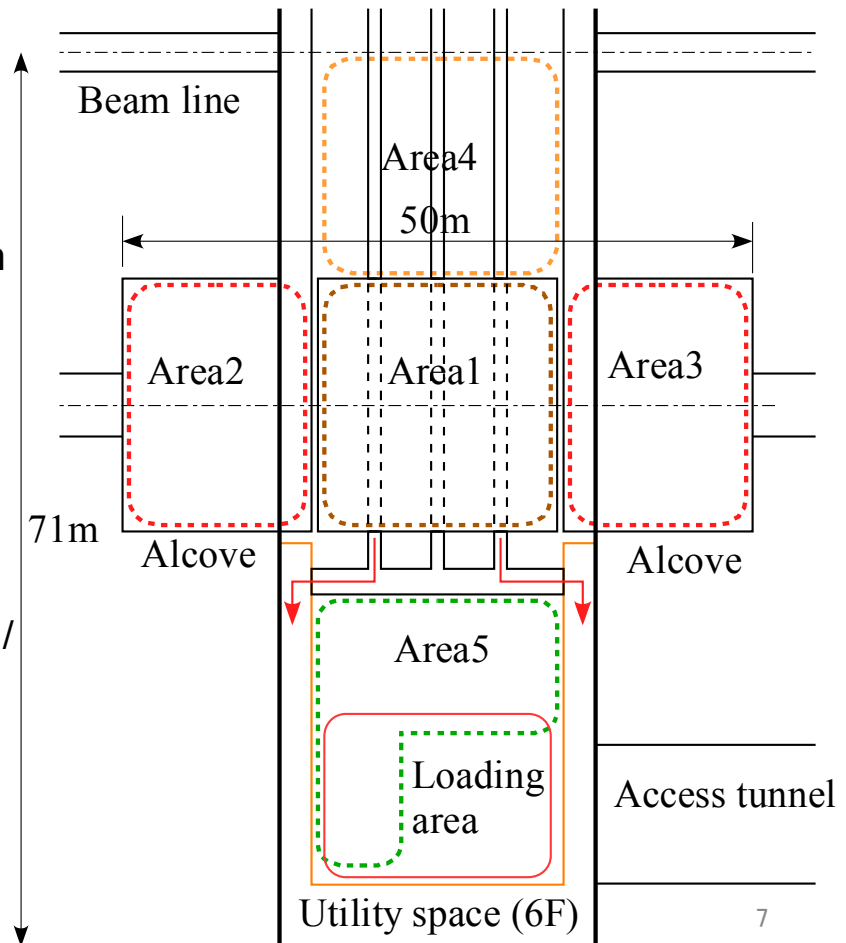
Access Tunnel



Detector assembly area

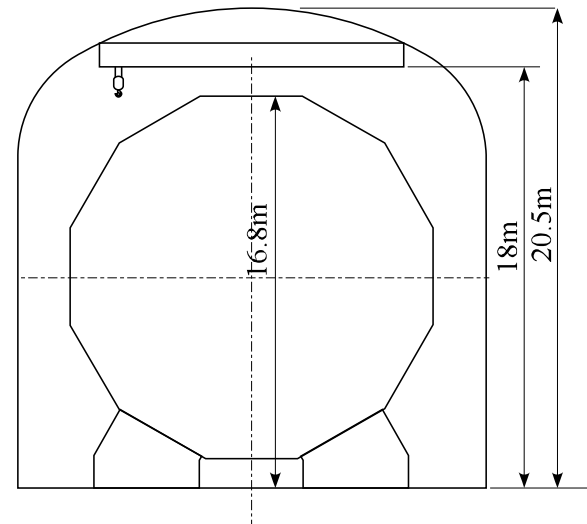
Y. Sugimoto

- 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



Boundary conditions

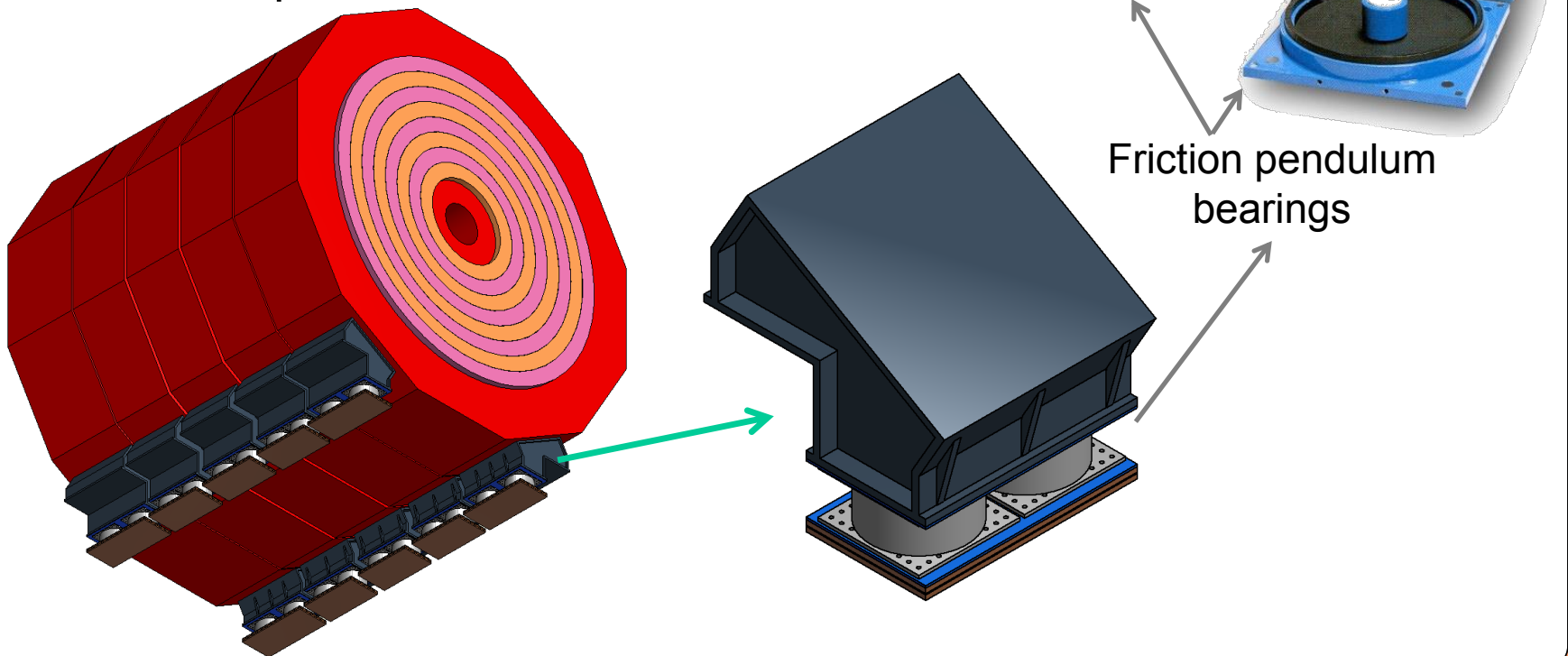
- Cranes
 - 250 ton crane for each detector on beam line side
 - 30 ton crane for each detector on loading area side
 - 2.8 ton crane in each alcove
 - In order to minimize the size of alcoves, the crane rails should be supported from the arch part → Only small cranes can be used
 - The height of alcoves have to be increased from 19.6m to 20.5m (for ILD) to let the crane girder pass over the detector
- Work conflicts
 - In order to avoid conflicts of parallel works, first few hours of each working day should be dedicated to transportation to each assembly area



Y. Sugimoto

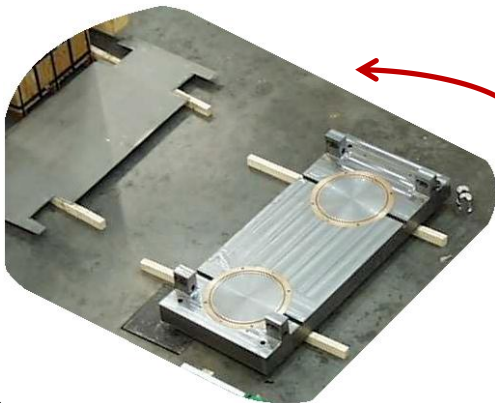
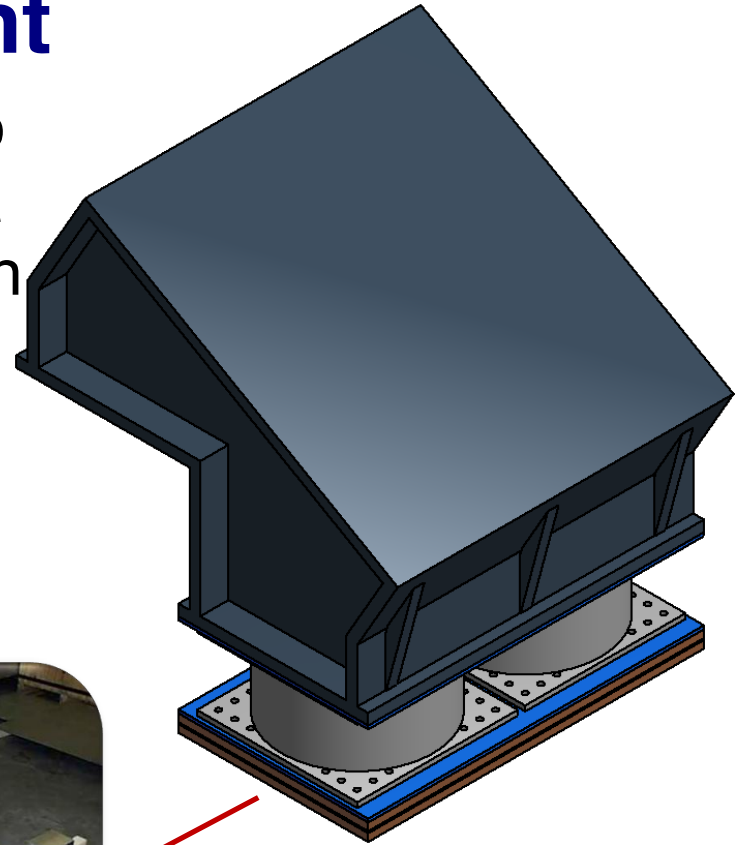
Detector with seismic isolated feet

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



Final precise adjustment

- The grease pads are needed to allow a final precise adjustment of the main components of each detector. The grease will lower the friction between the sliding components and therefore less force is needed.

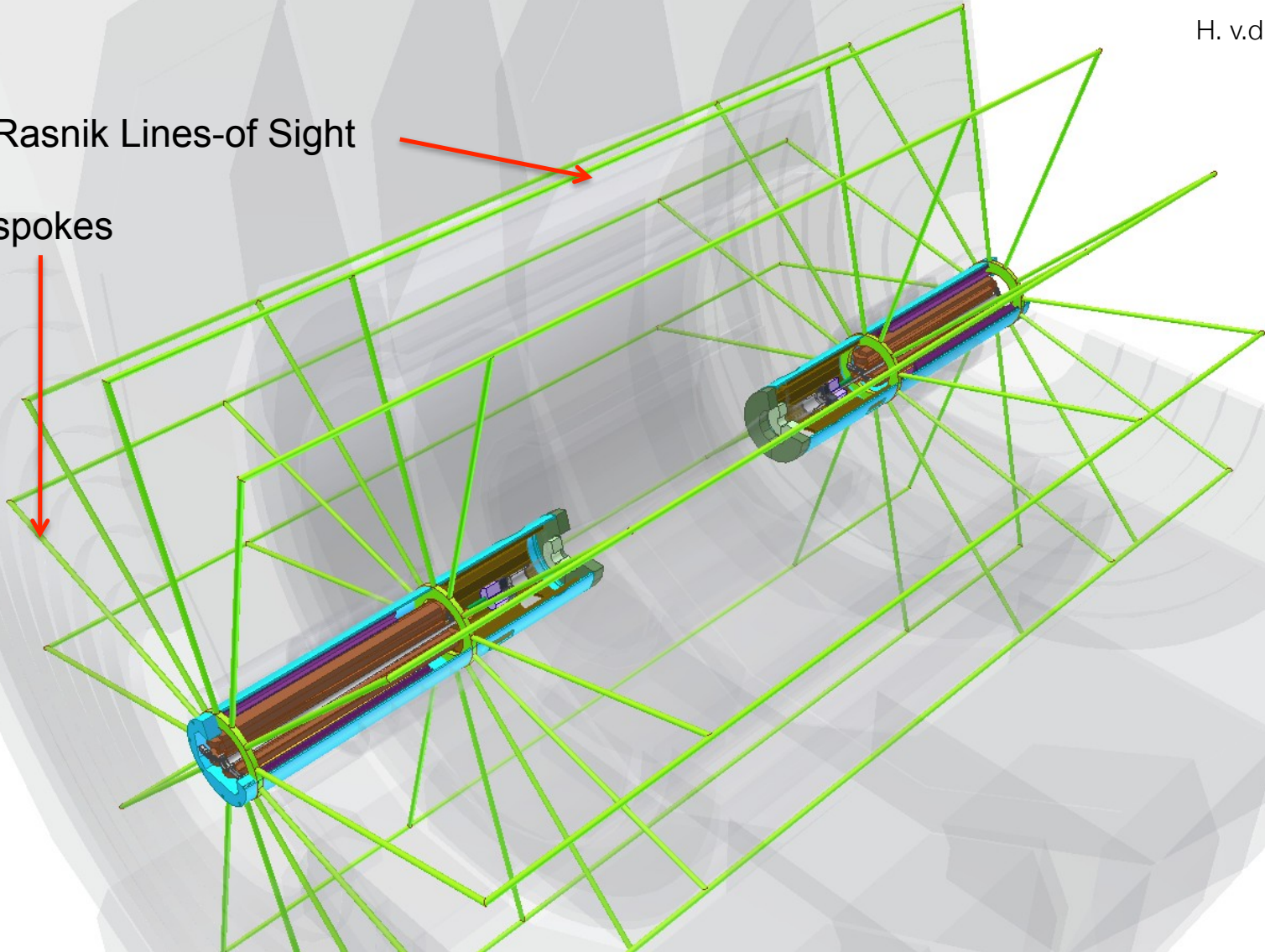


Alignment Requirements

- ILD detector axis:
 - ± 1 mm, ± 100 μ rad
 - laser reference system on platform or hall, positive indexing system on platform
- QD0 magnets:
 - before low current beam is allowed in:
 - ± 50 μ m, ± 20 mrad (roll) ± 1 mrad (pitch, yaw)
 - after beam-based alignment:
 - Stability over 200 ms: ± 200 nm, 0.1 μ rad
 - Vibration stability: less than 50 nm within 1ms bunch train
 - Alignment and positioning system on ILD
 - Cam movers on QD0s
- Reference line: defined by QF1 magnets in the beam line

Rasnik Lines-of Sight

spokes



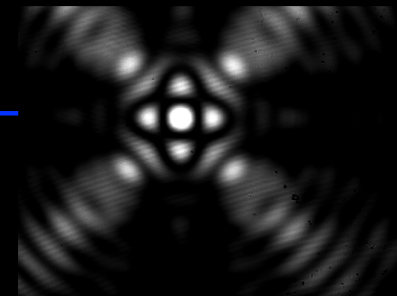
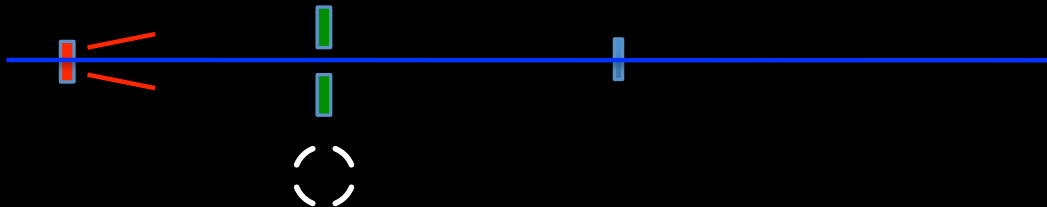
1983: 4QD Red Alignment System Nikhef (Rasnik)



1993: CCD Rasnik



2003: RasDif: long distance



Summary and Outlook

- ILD MDI work is concentrating on integration issues and time line issues in flat and mountain sites
 - Underground facilities are cost drivers!
- We are studying the ILD assembly in the Japanese hall
 - First studies done on 2D models
- We need to understand better the implications of the common use of the infrastructures (e.g. the access tunnel) during the assembly of
 - ILD
 - SiD
 - Machine
- Finalising the DBD/TDR....