ILD Machine-Detector Interface

Experimental Area, Detector Assembly, Timelines

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24.05.2012
ILD Workshop

Overview

- Machine group is finalising the design of the civil facilities for the TDR/DBD
- This is in the focus of the ILC management: cost drivers!
- Discussions between detector concepts (SiD/ILD) and ILC CFS group have been intensified since Granada
- Started with the „non-mountain“ sites - hall design finalised
- Japanese site requirements are different
- CFS Baseline Technical Review Workshop at CERN on March 22-23
  - Discussions with GDE on cost issues continued during KILC12
  - Discussions will go on until TDR/DBD are finished...
    - ... and probably beyond

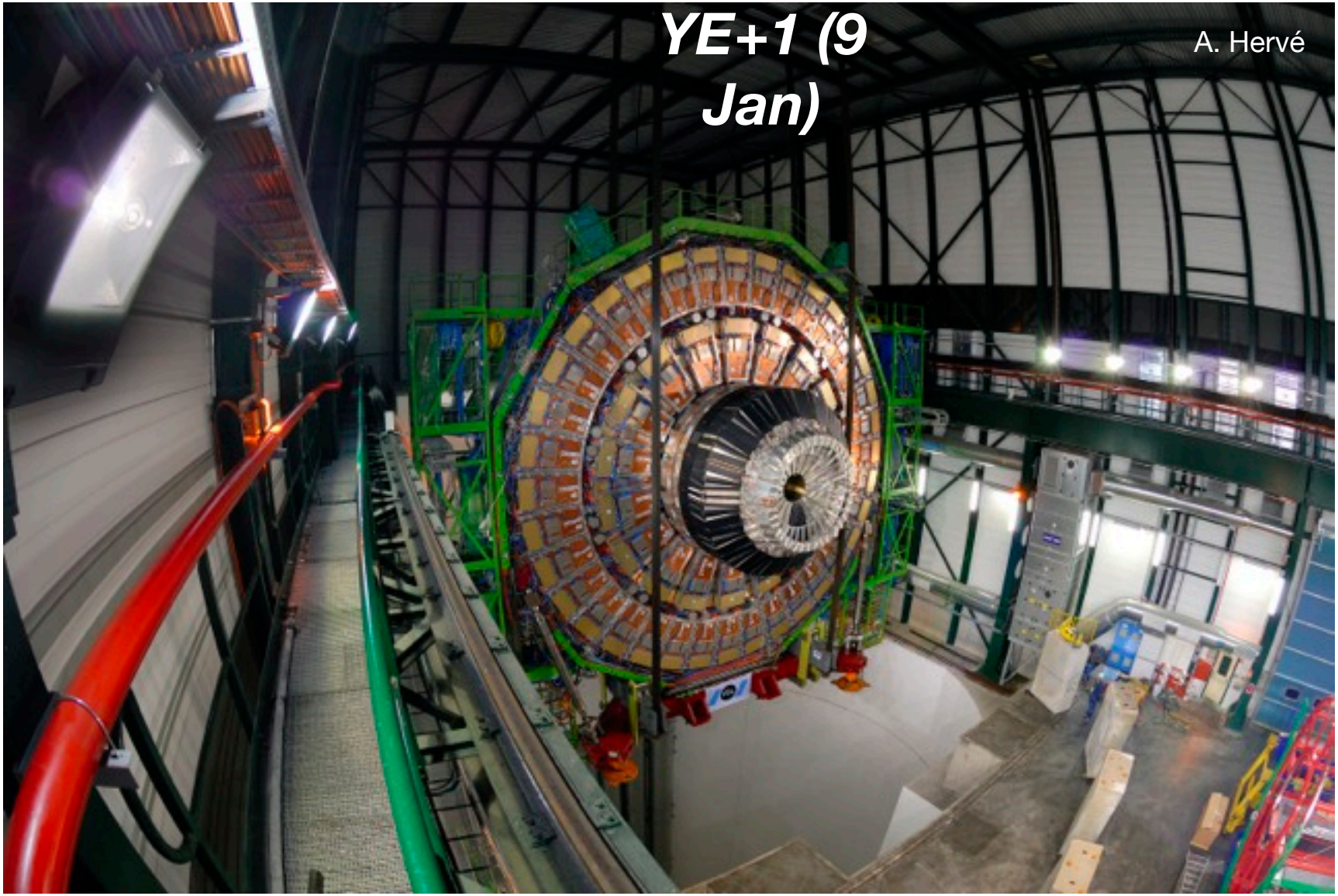
ILC Flat Site ;-)

ILC Mountain Site

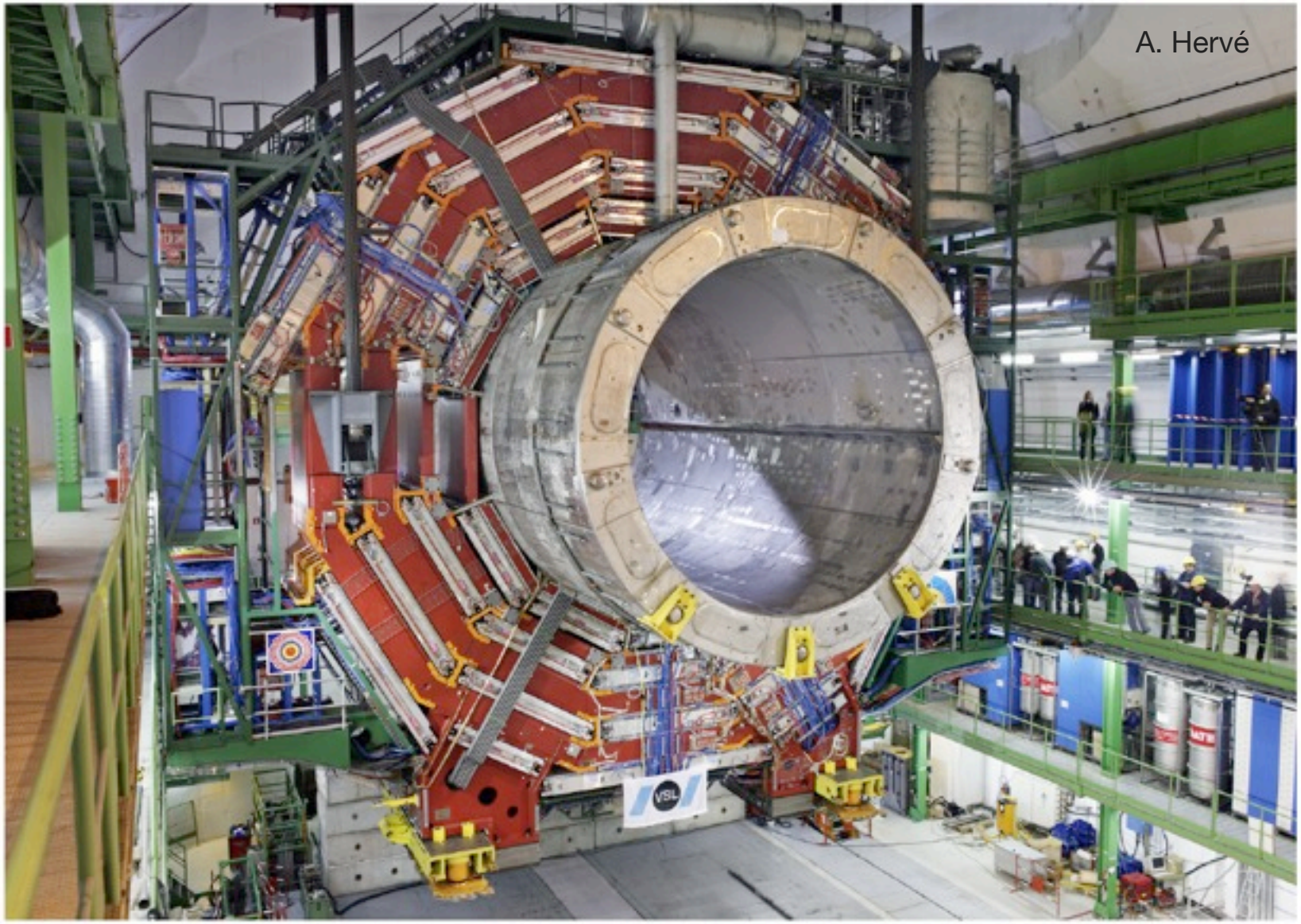
Differences (Detector Point of View)

Flat Sites	**Mountain Sites**
Access via vertical shaft:	*Access via horizontal tunnel:*
~18 m diameter, ~100 m long	~11 m diameter, ~1 km long, ~10 % slope
Assembly in CMS style:	*Modified assembly scheme:*
pre-assemble and test large detector parts	assemble sub-detectors as far as possible
max. part dim.: < ~3.5 kt, < ~17.5 m	max. part dim.: < ~400 t, < ~9m
minimise underground work (~1a)	long underground work (~3a)
Installation schemes of detectors and machine de-coupled to large extent	*Installation schemes of detector and machine coupled at high level*

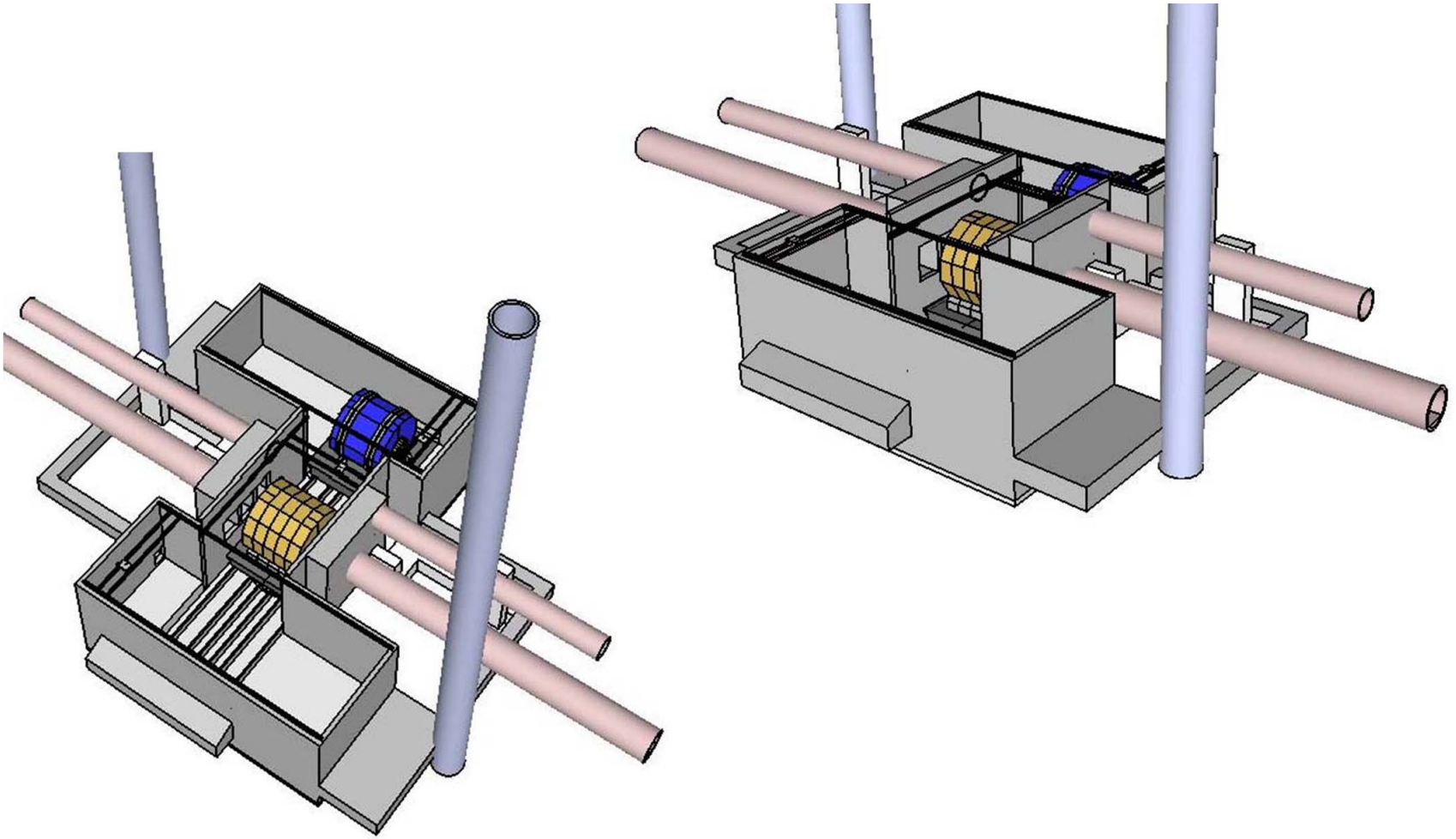
CMS Assembly



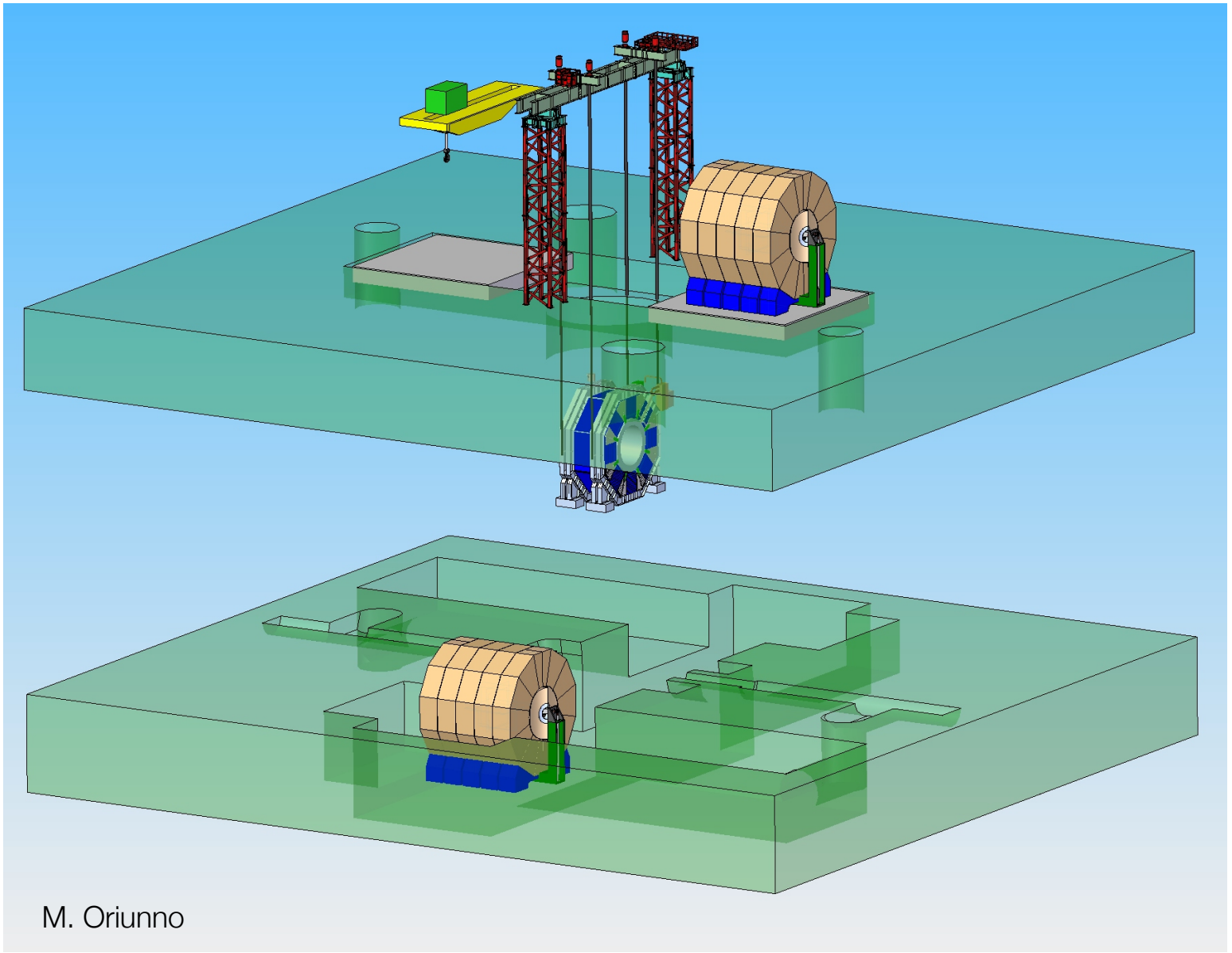
CMS Assembly



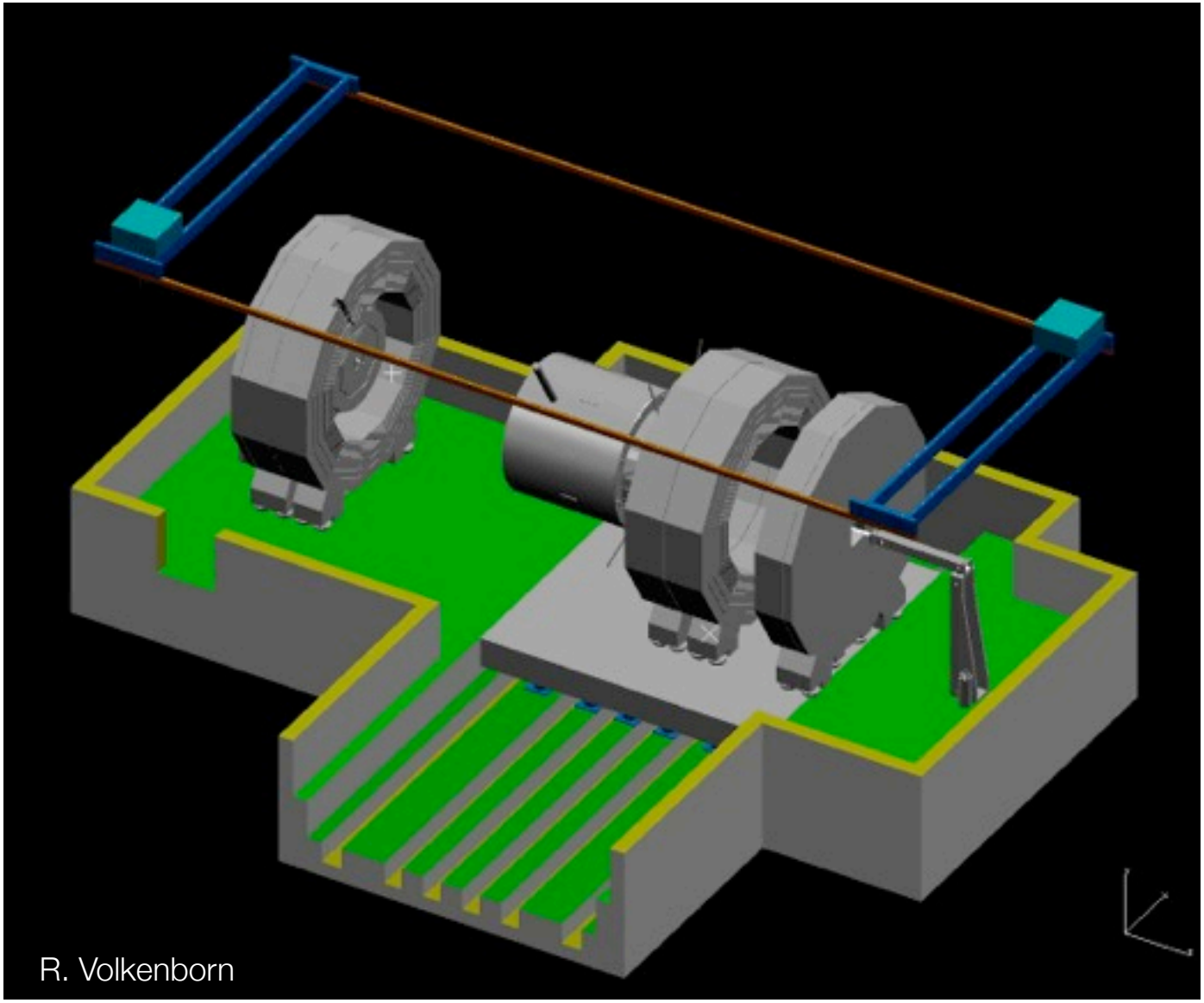
Flat Sites: Experimental Cavern



Vertical Shaft Assembly

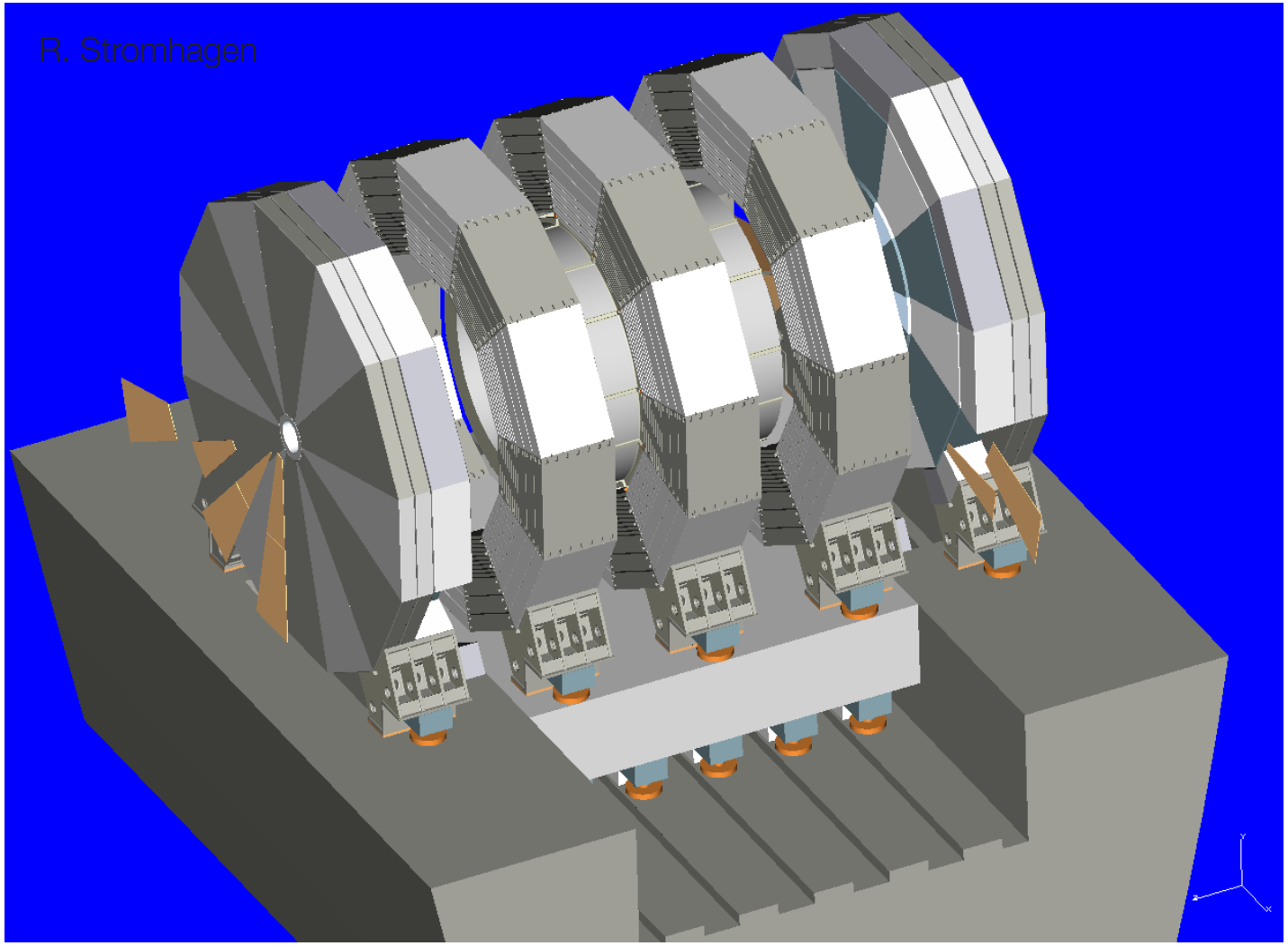


ILD in Maintenance Region (non-mountain site)



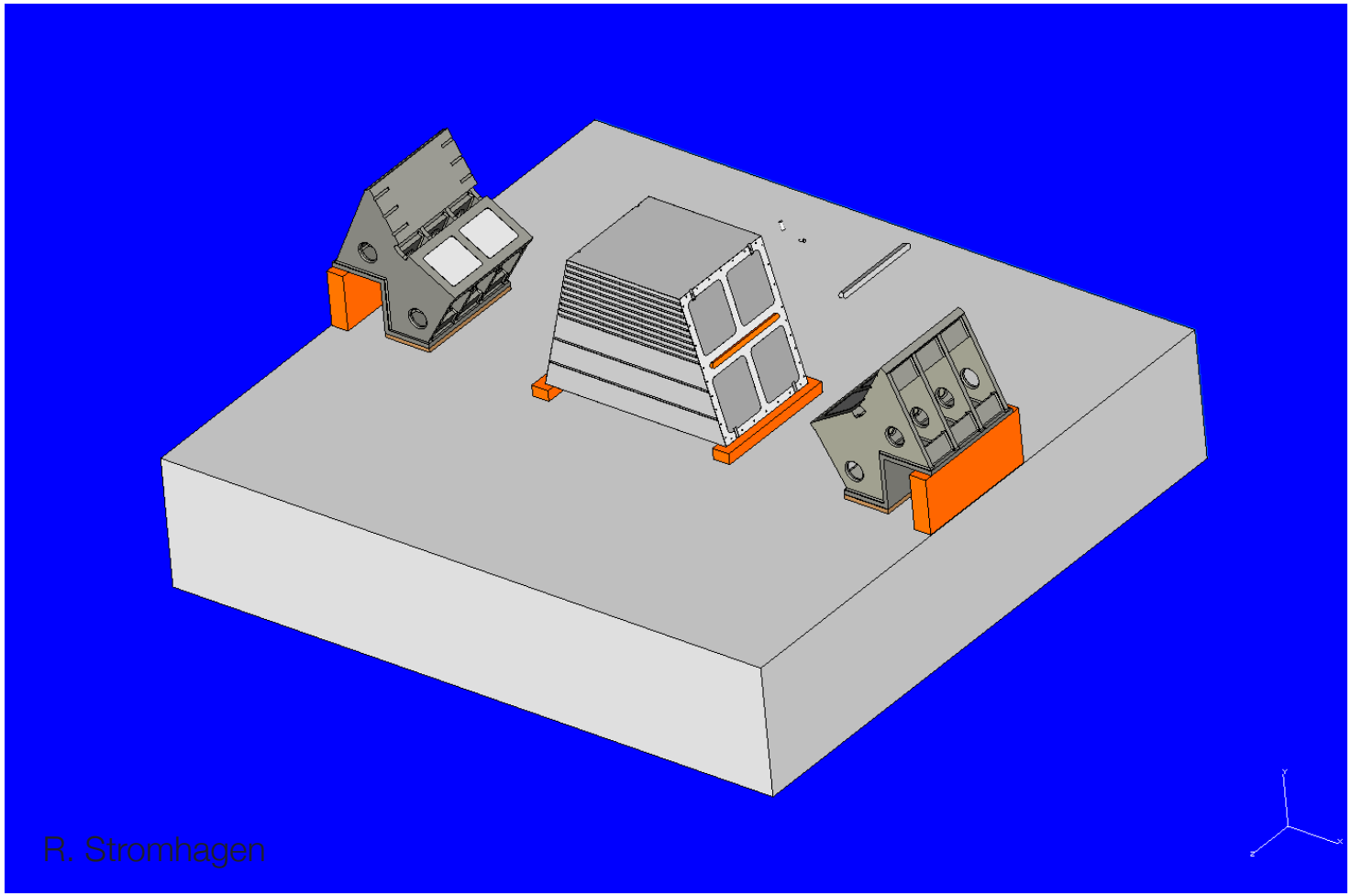
ILD Design

- Assumption: basic detector model will not change for mountain sites



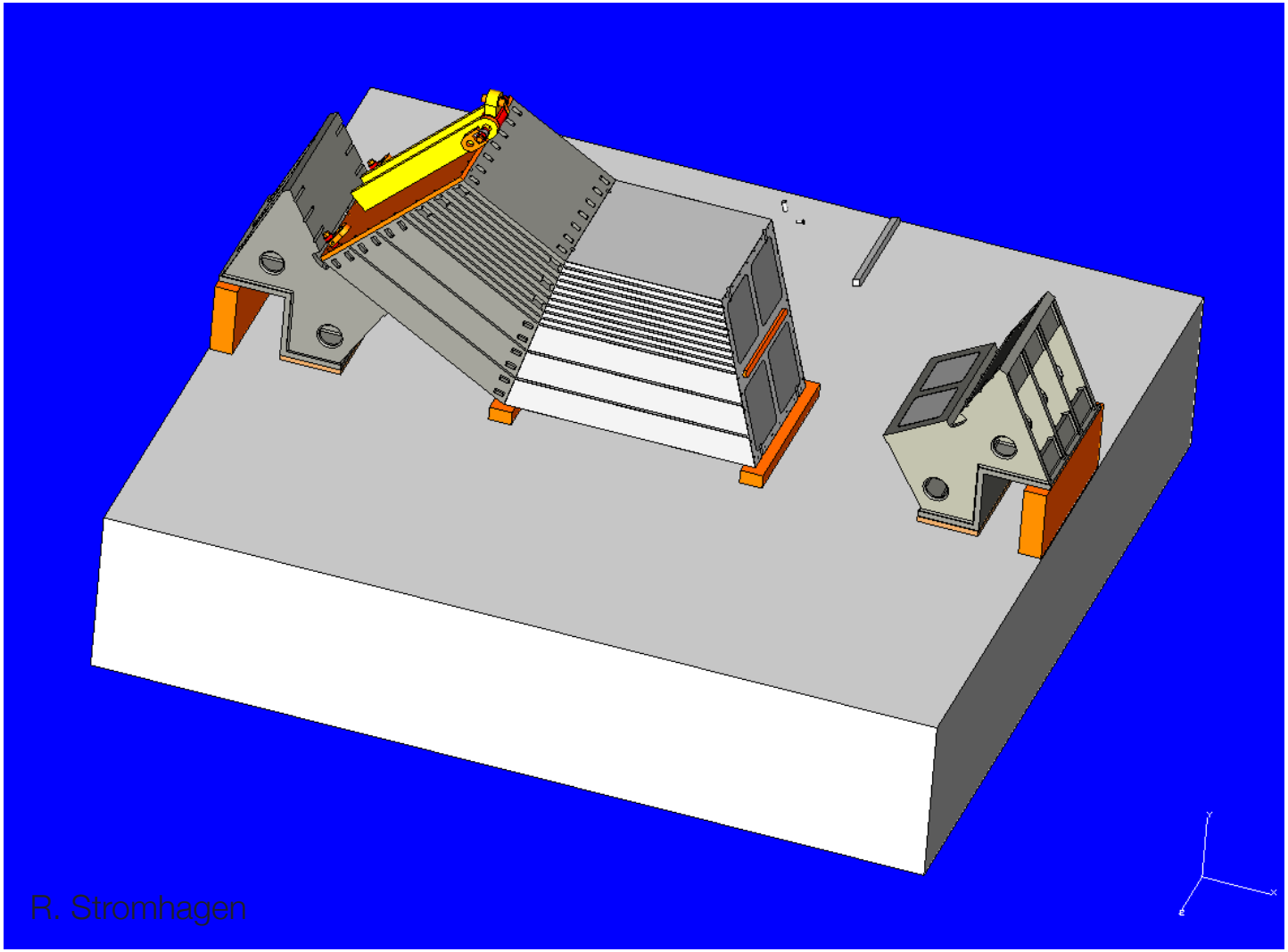
Yoke Assembly - Barrel

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

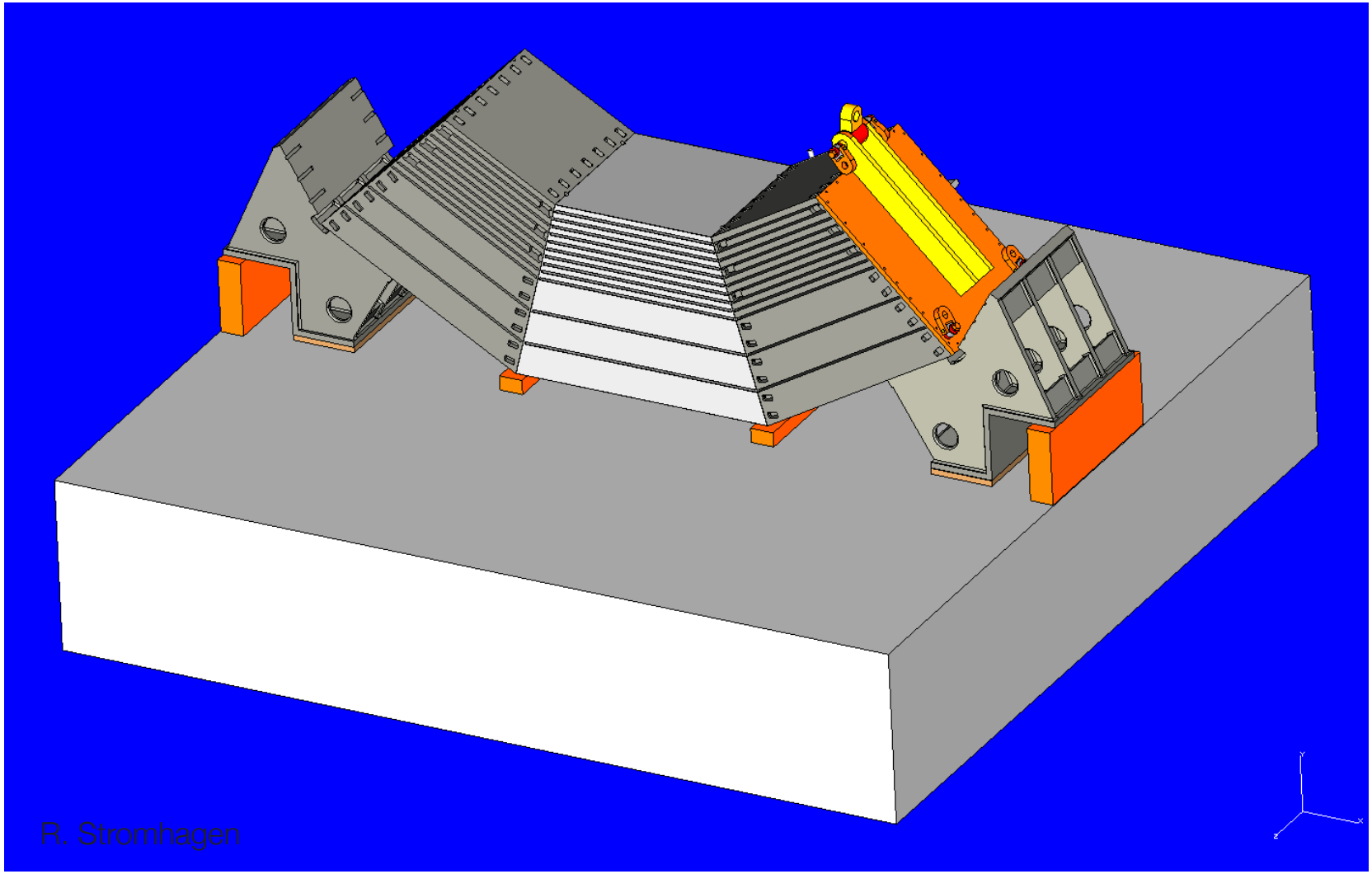


Yoke Assembly - Barrel

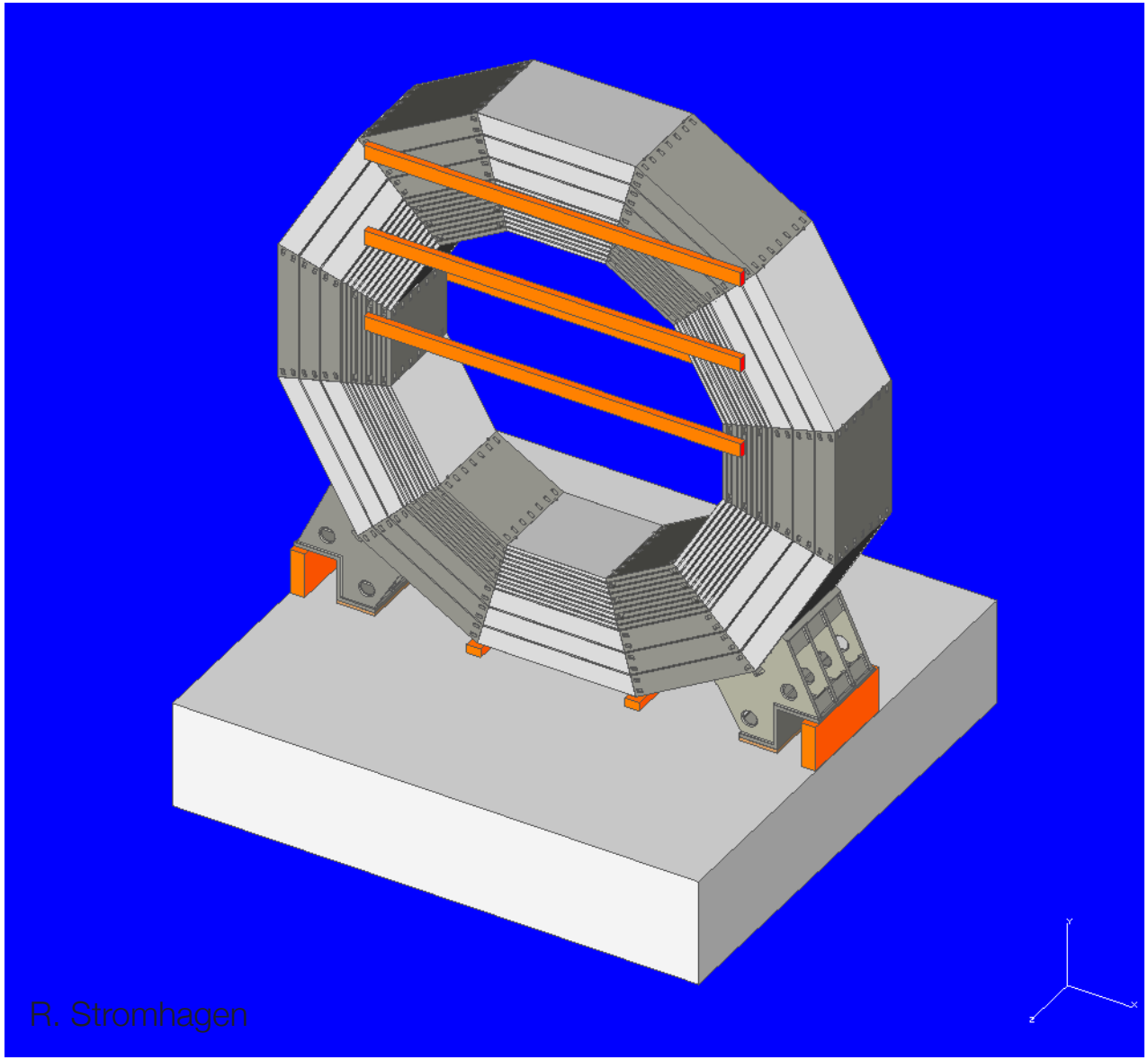
- 200t crane coverage needed



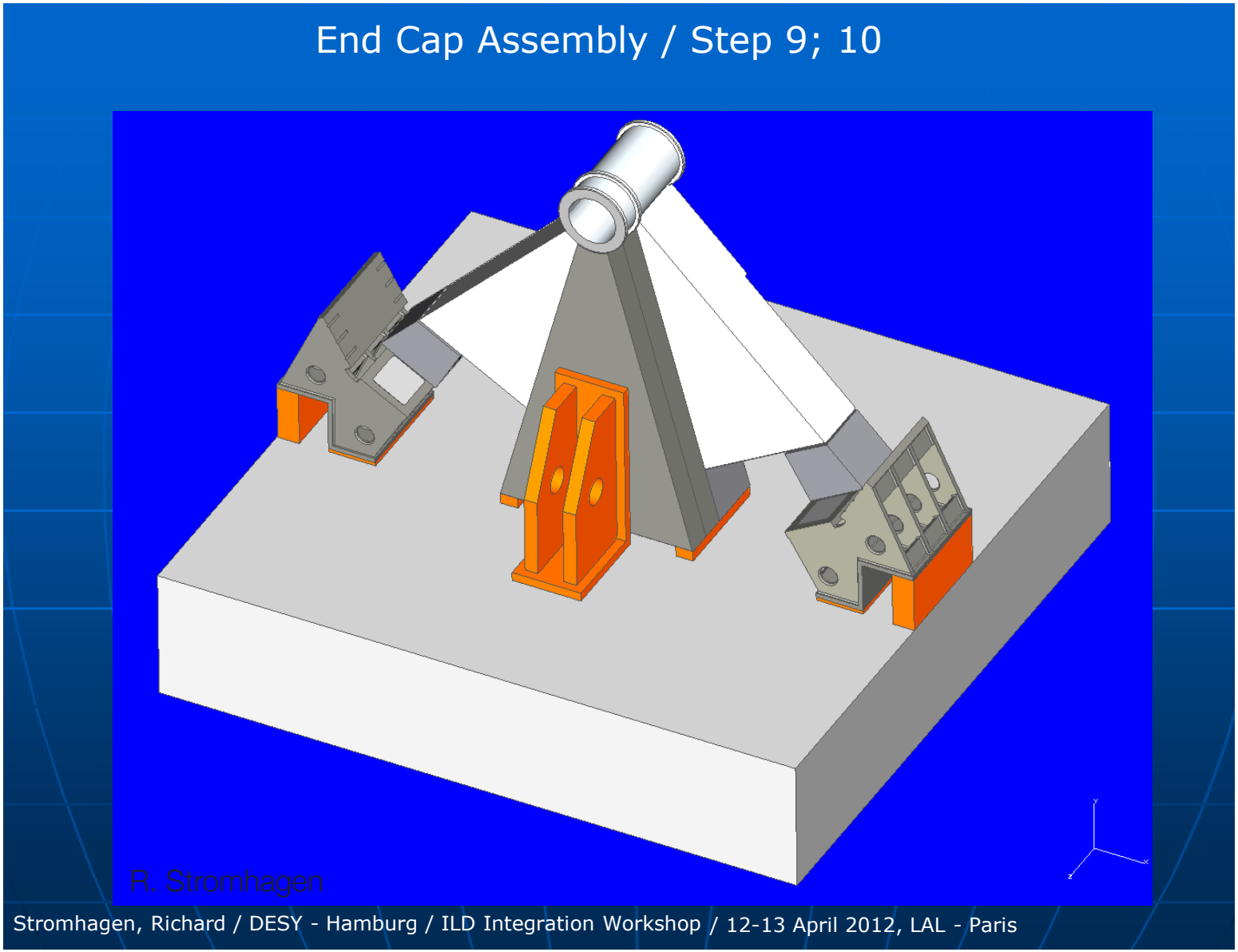
Yoke Assembly - Barrel



Yoke Assembly - Barrel



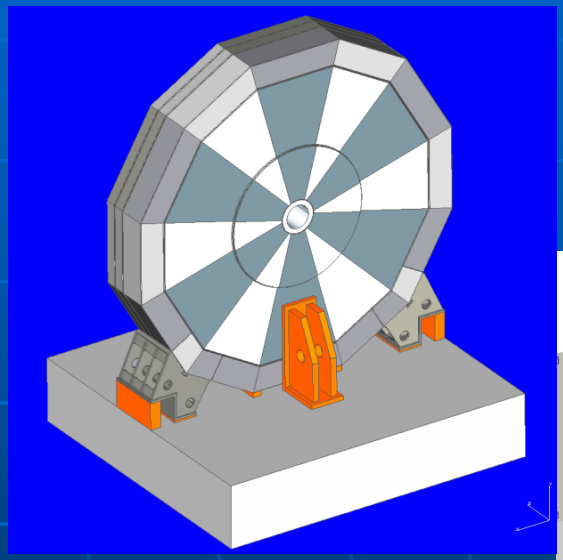
Yoke Assembly - Endcap

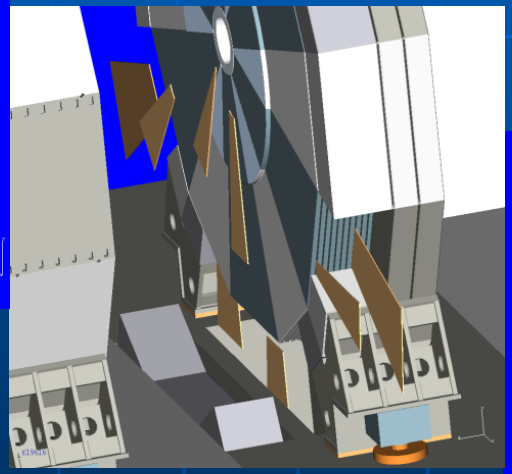


Yoke Assembly - Endcap

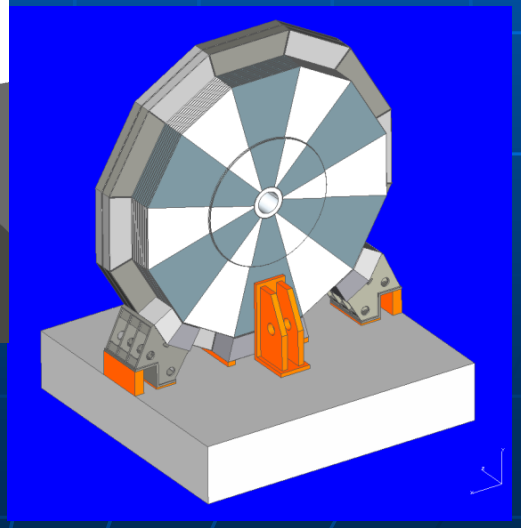
End cap Assembly / Step 36 to 50

R. Stromhagen



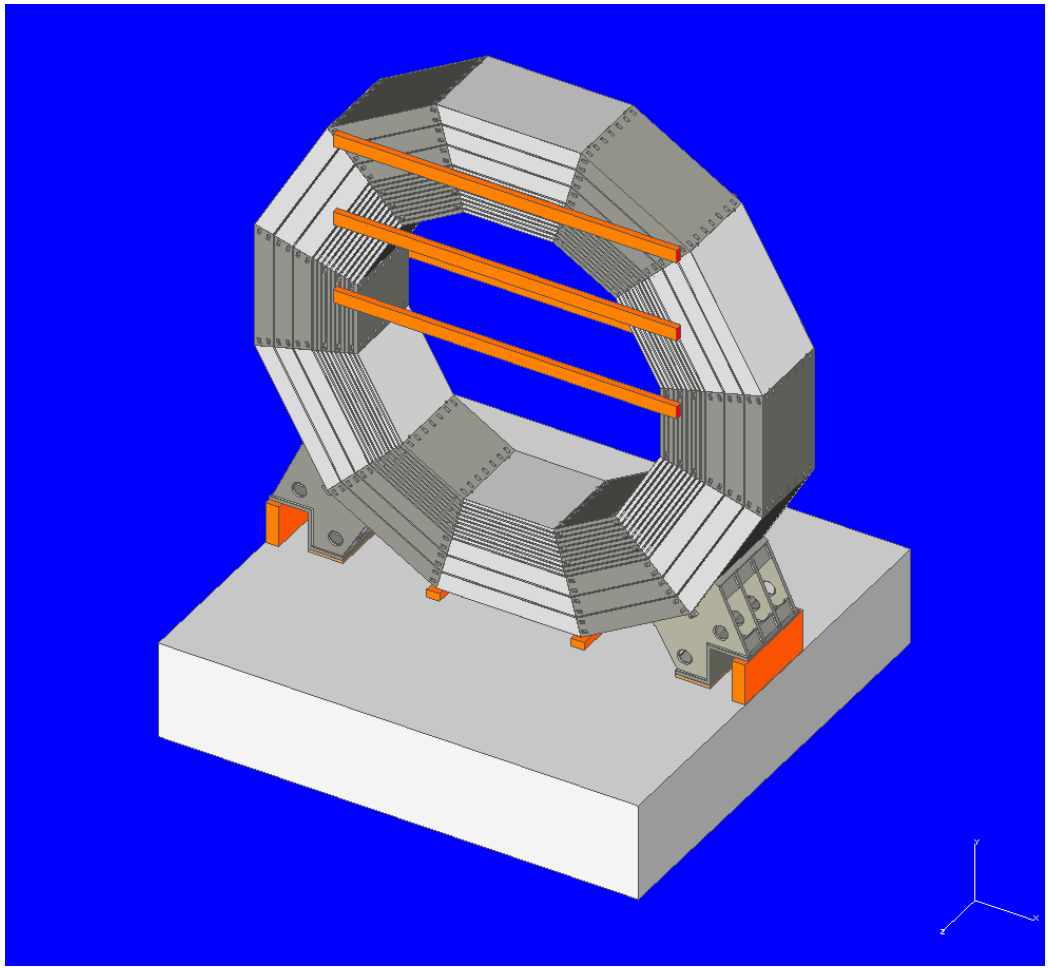


Chamber ommited for clarity



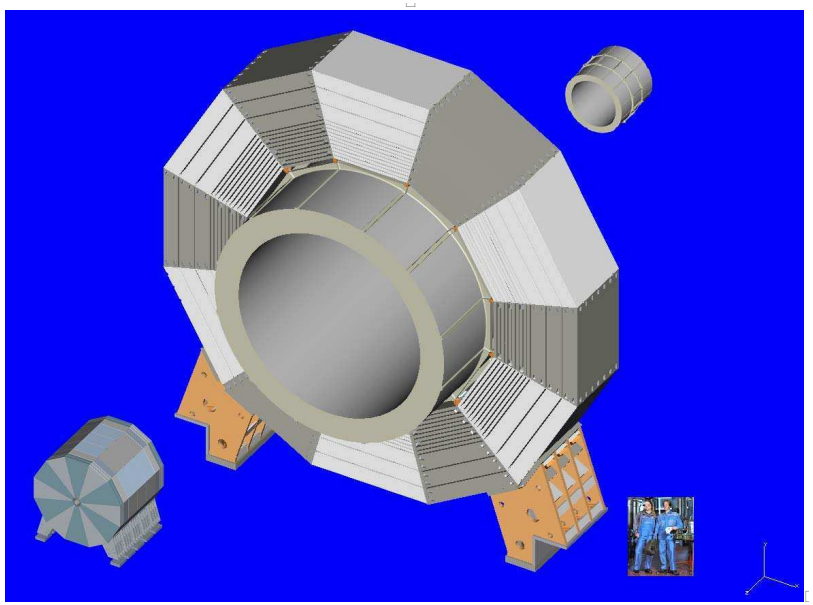
Yoke Assembly

- Tolerances of the ring segments need to be better than 1 mm
- Laser surveying needed during full assembly
- Tools needed
  - 200t crane
  - chain hoists
  - taylored tools: beams etc.
  - hydraulics
  - surveyors
- Time estimate: 60 working days per ring



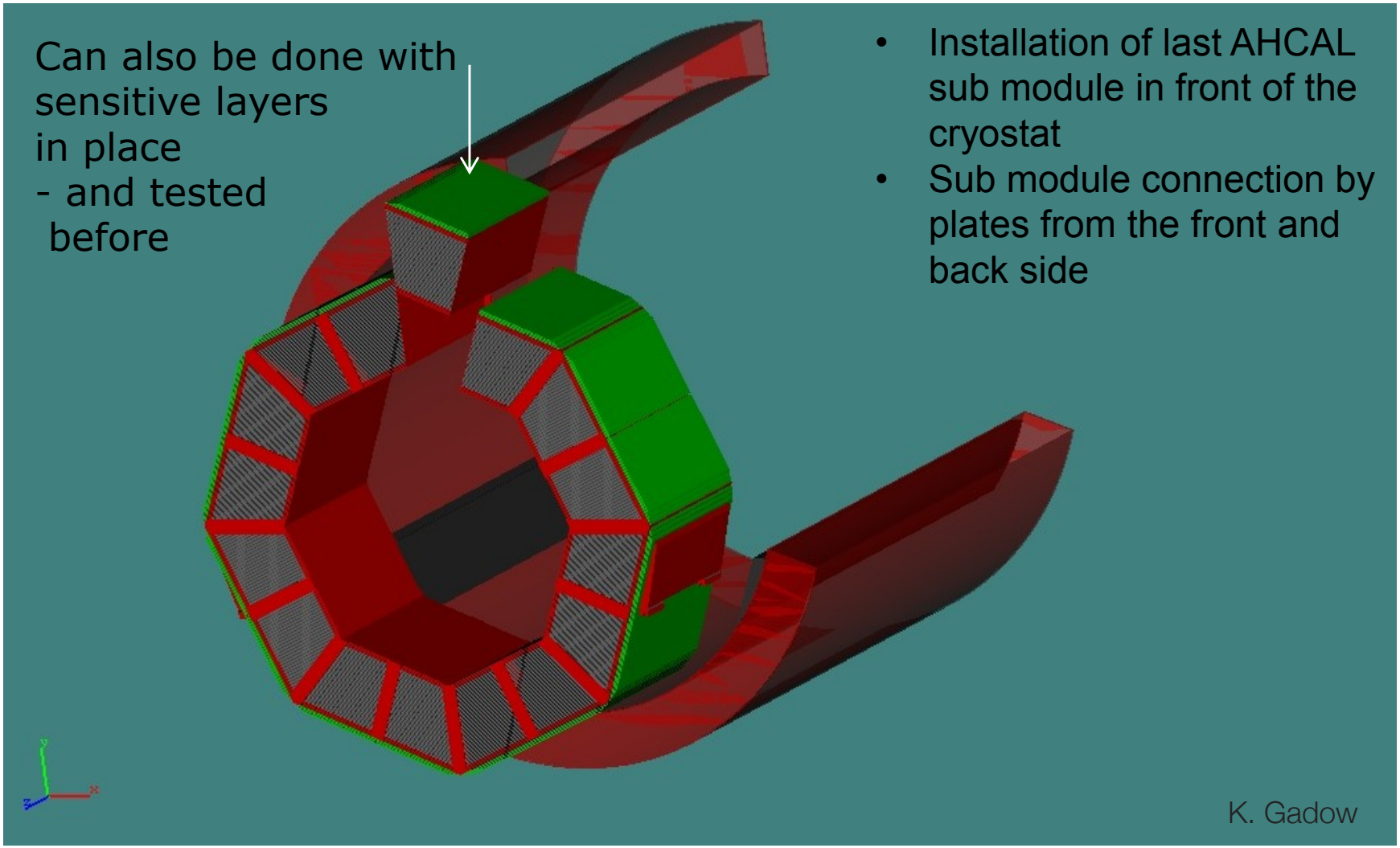
Coil Installation

- 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

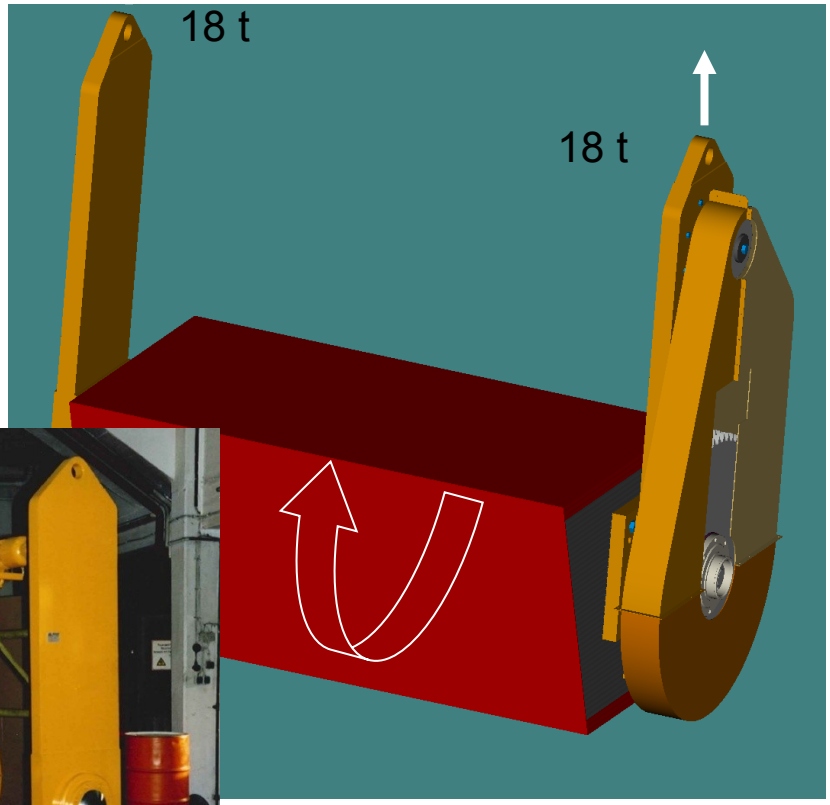


R. Stromhagen

AHCAL Installation



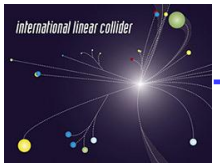
AHCAL Installation



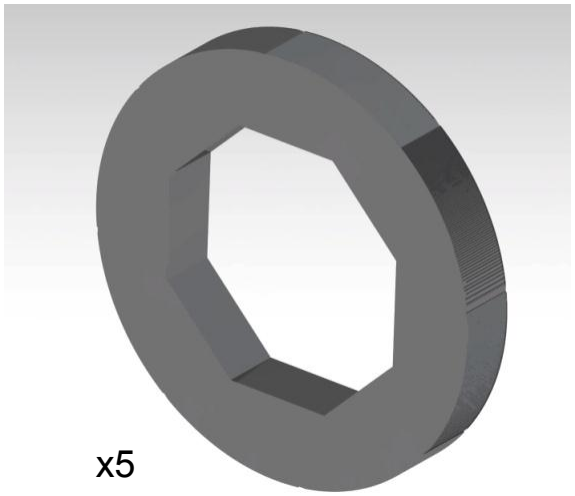
K. Gadow

- 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

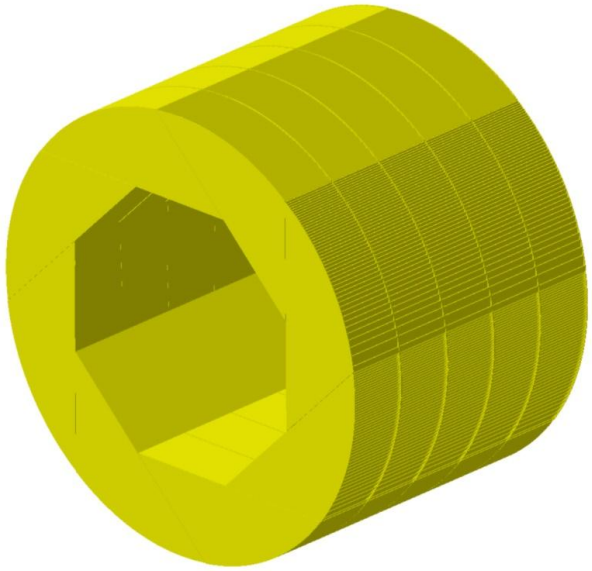


x5

Ext. Diameter : 6770 mm

Int. Diameter :4116 mm

Lenght : 4700 mm



Stainless steel	**1 wheel**	**5 wheels**
Structure Weight (t):	88 t	440 t
Detectors Weight (t):	36.8 t	184 t
Total Weight (t) :	124.8 t	**624 t**

J.C. Ianigro

SDHCAL Installation

Barrel tooling : phase 3 – Barrel insertion

J.C. Ianigro

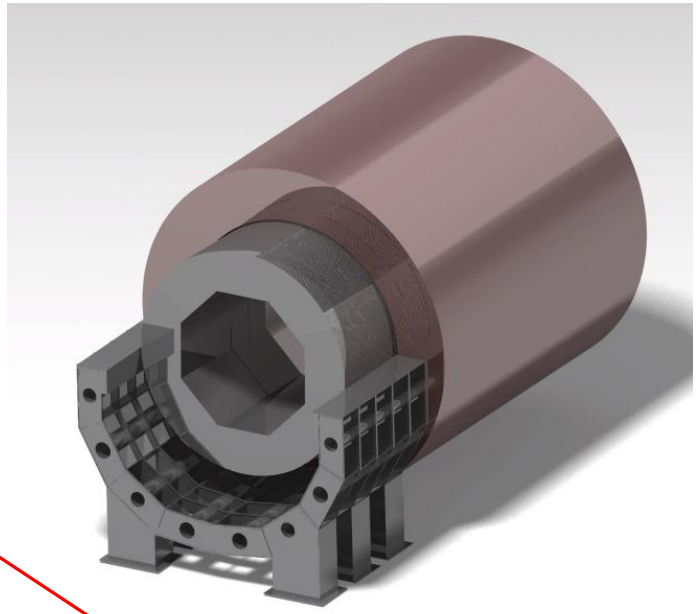
- Barrel on structure inside the yoke

• Barrel with 5 linked wheels inserted

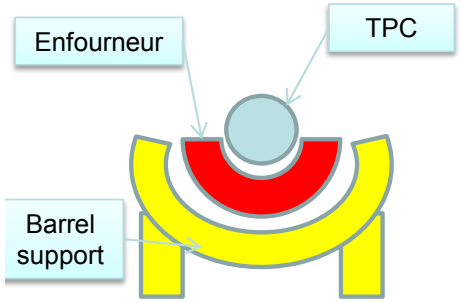
• slipping on rails inside the yoke

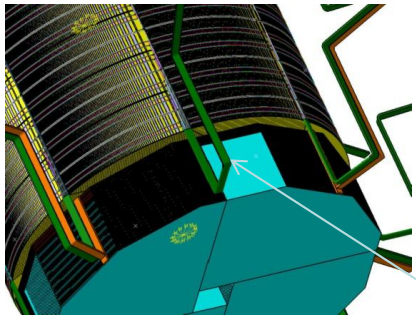
• barrel fixed inside the yoke on both sides

• services installation along the yoke to patch pannels



Barrel insertion





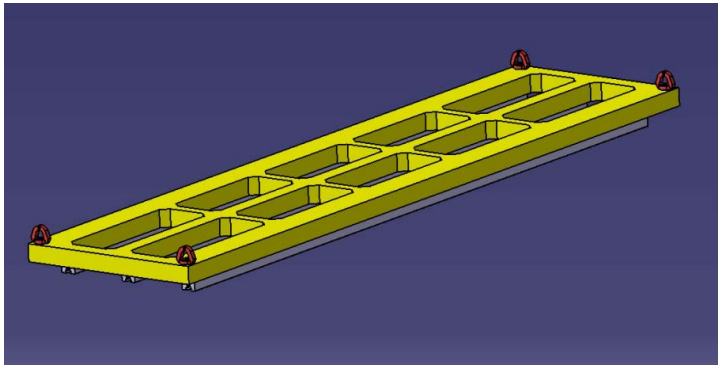
Structure could be used for TPC with another specific structure as CMS « enfourneur » (red)

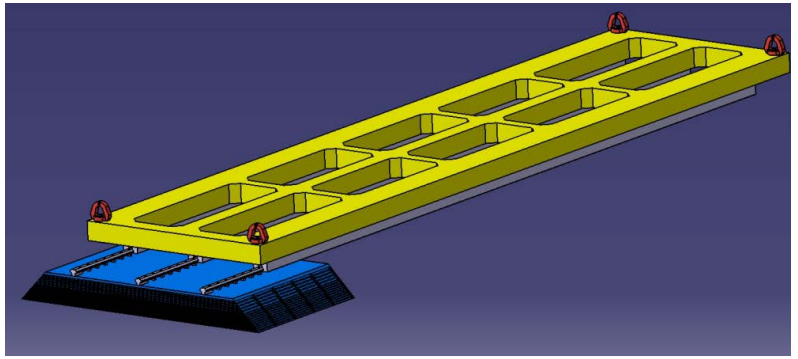
Services issues

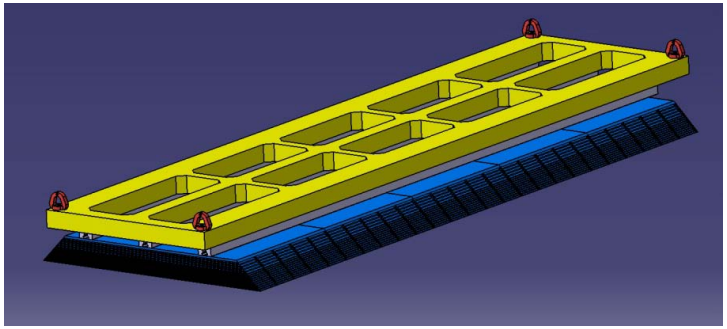
ECAL Installation

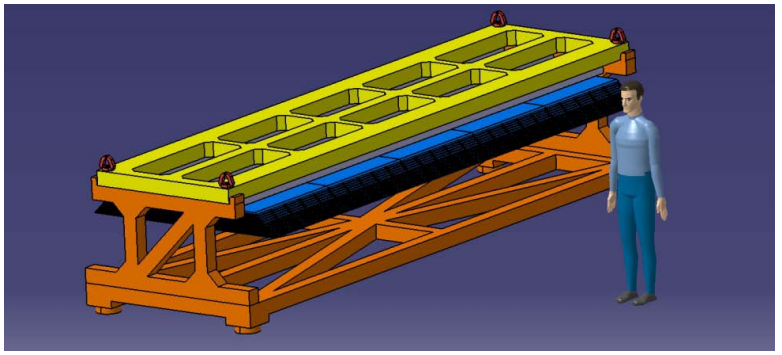
Ecal integration steps (Assembly hall) :

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)







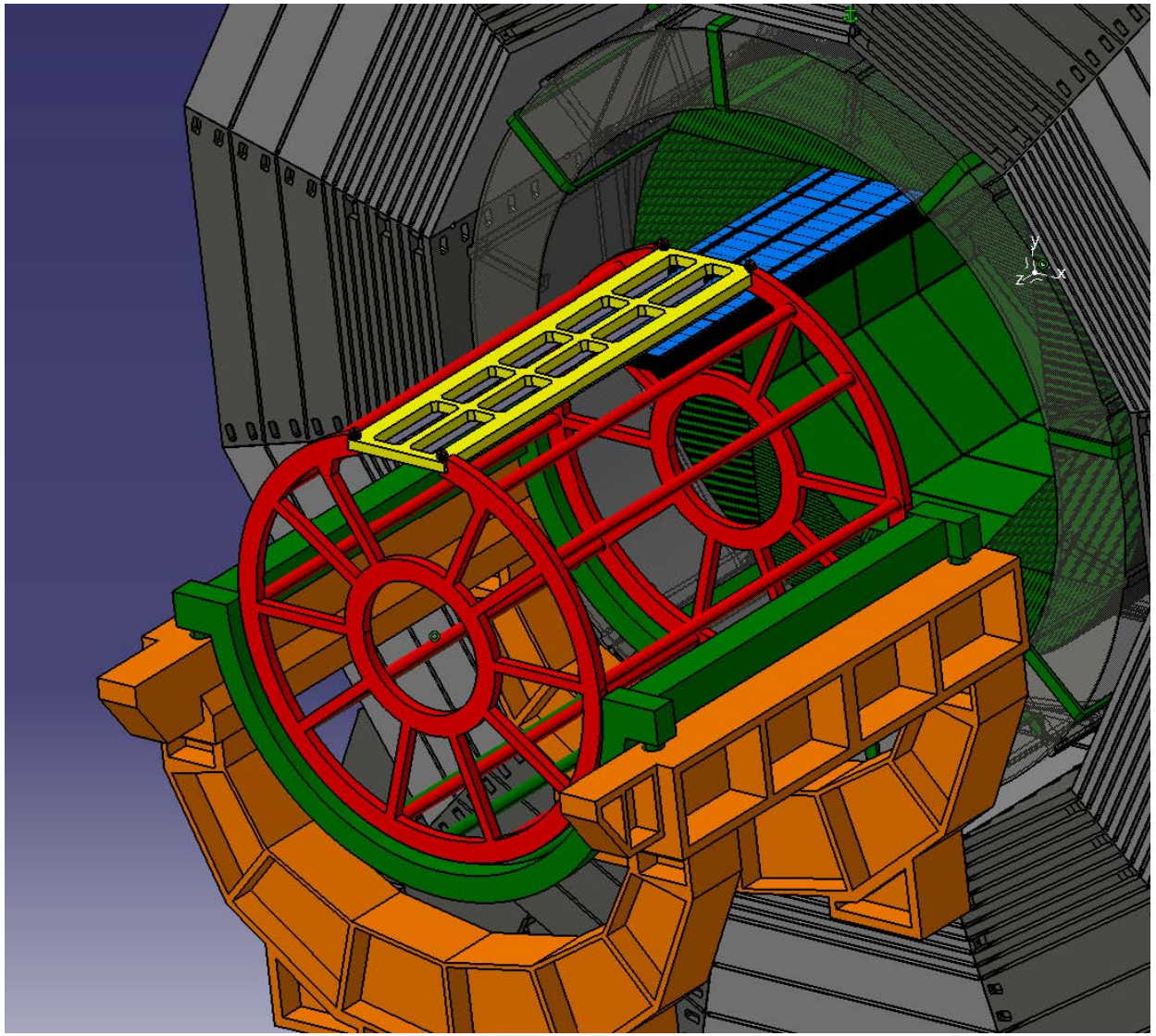


The stave is then ready to be equipped with slabs , cabled and tested

C. Clerc

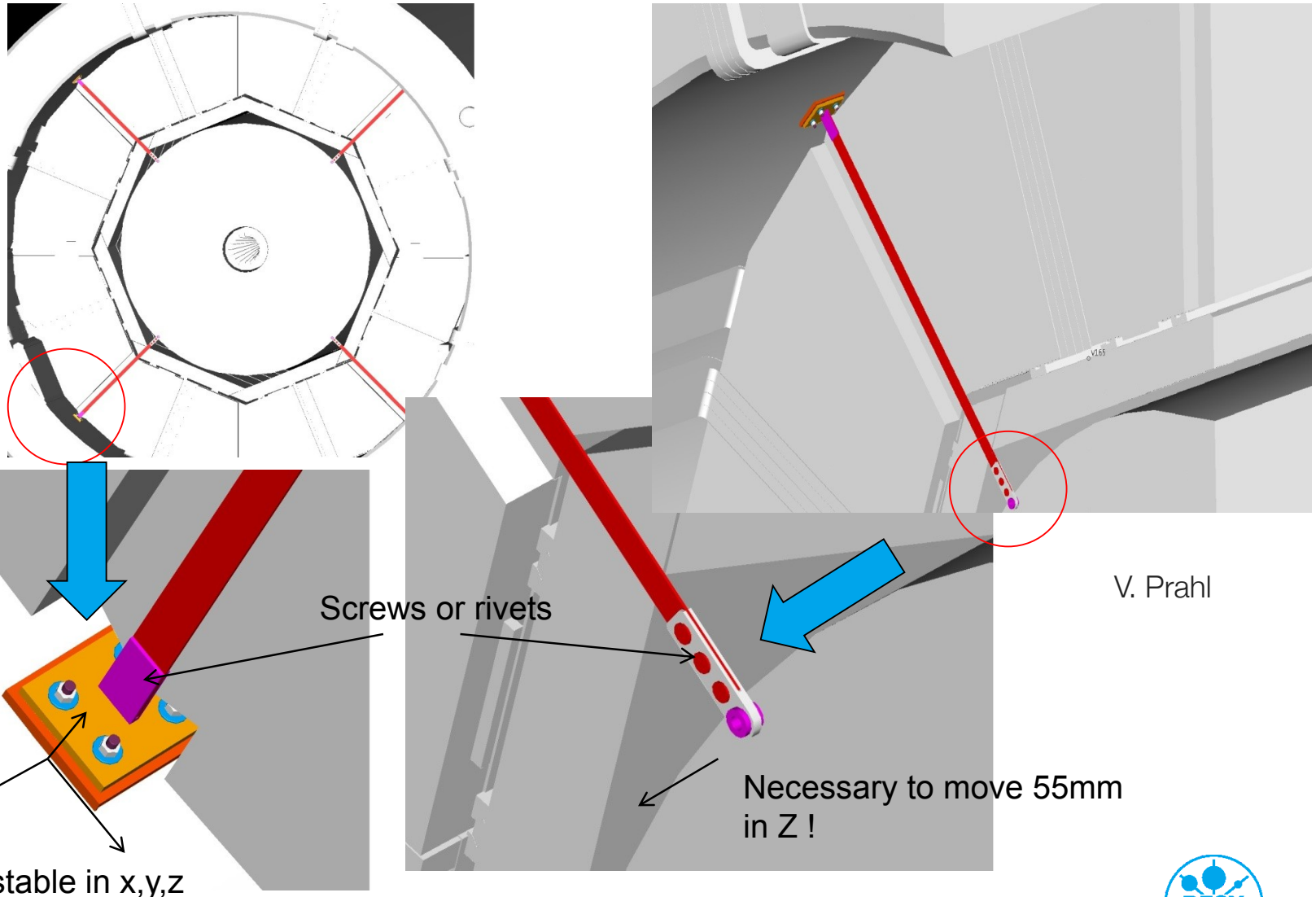
To be done 8 times

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



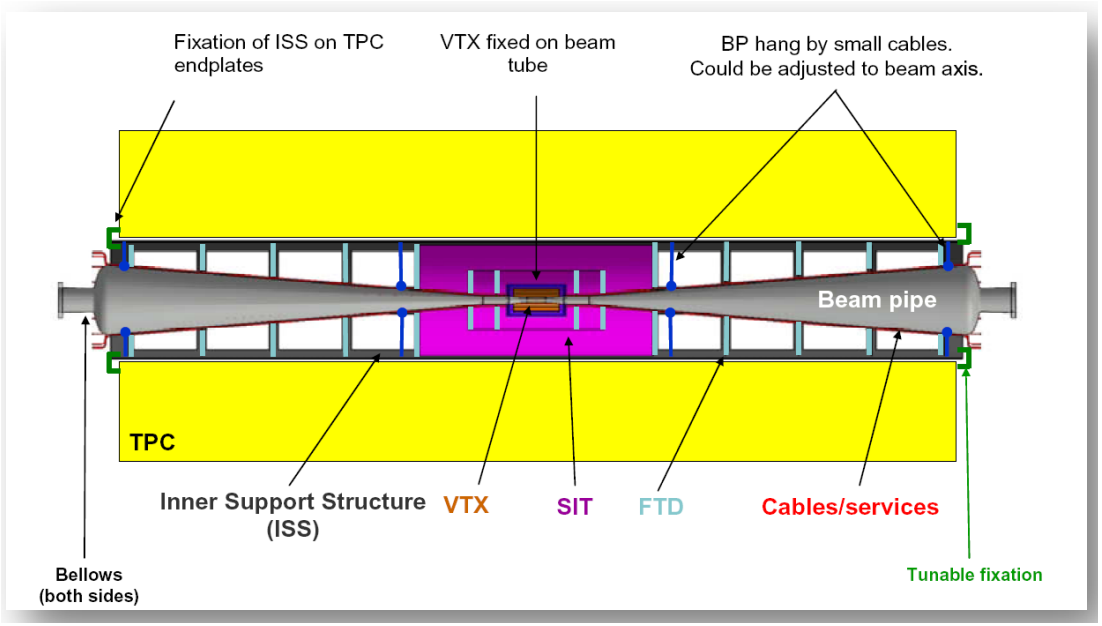
C. Clerc

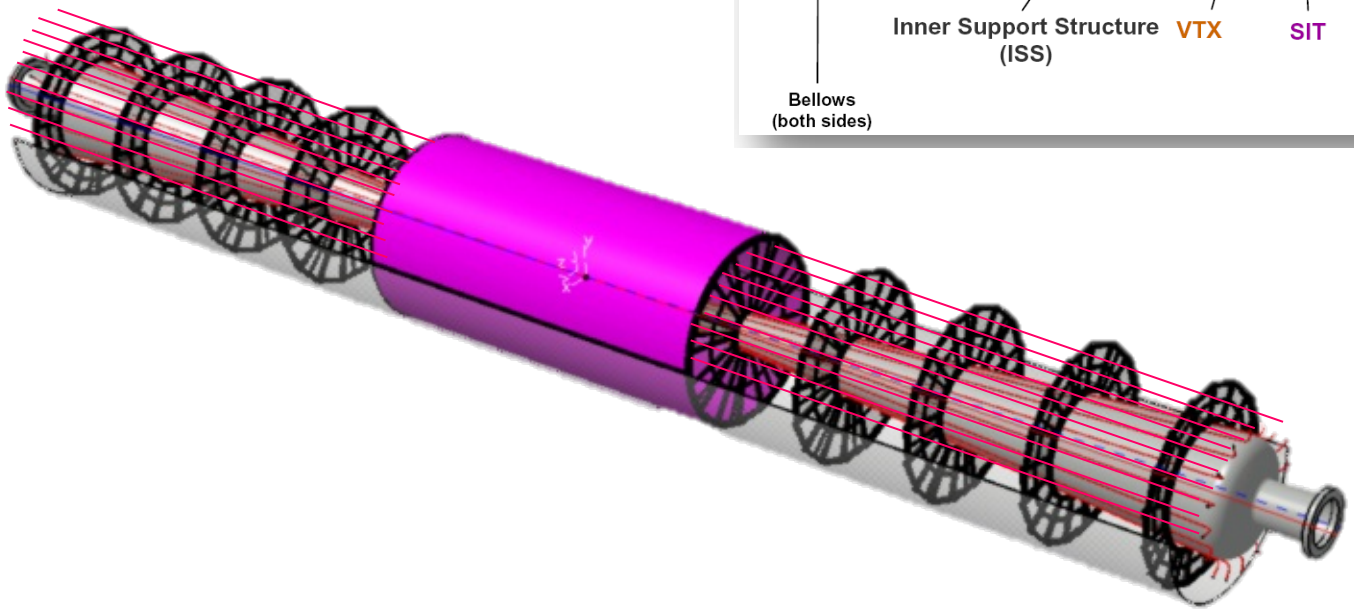
TPC Installation



Inner Detector

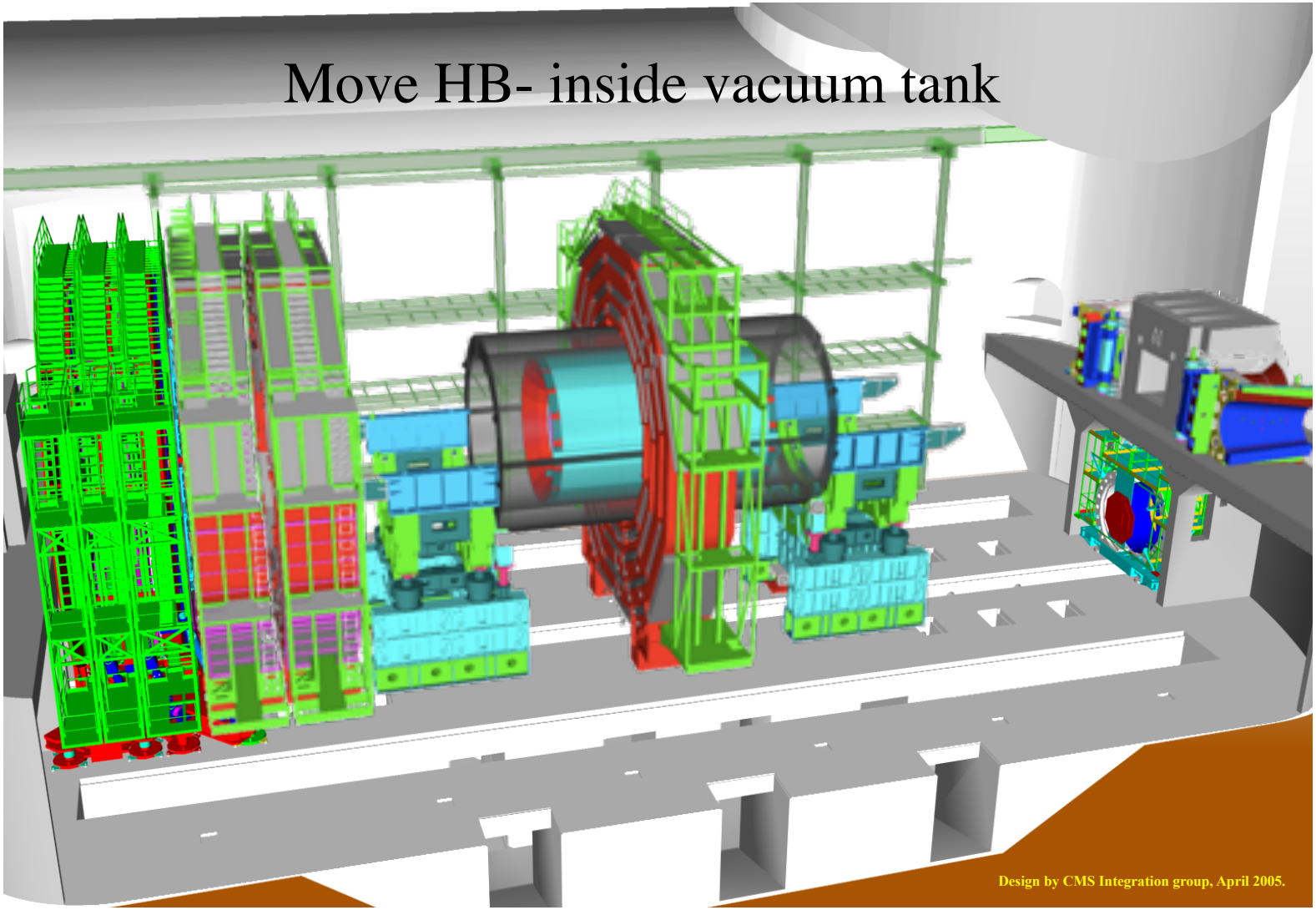
- Need adjustable fixation to the TPC endplate
  - push-pull precision is only 1 mm
  - stay-clear from pairs is of same order....



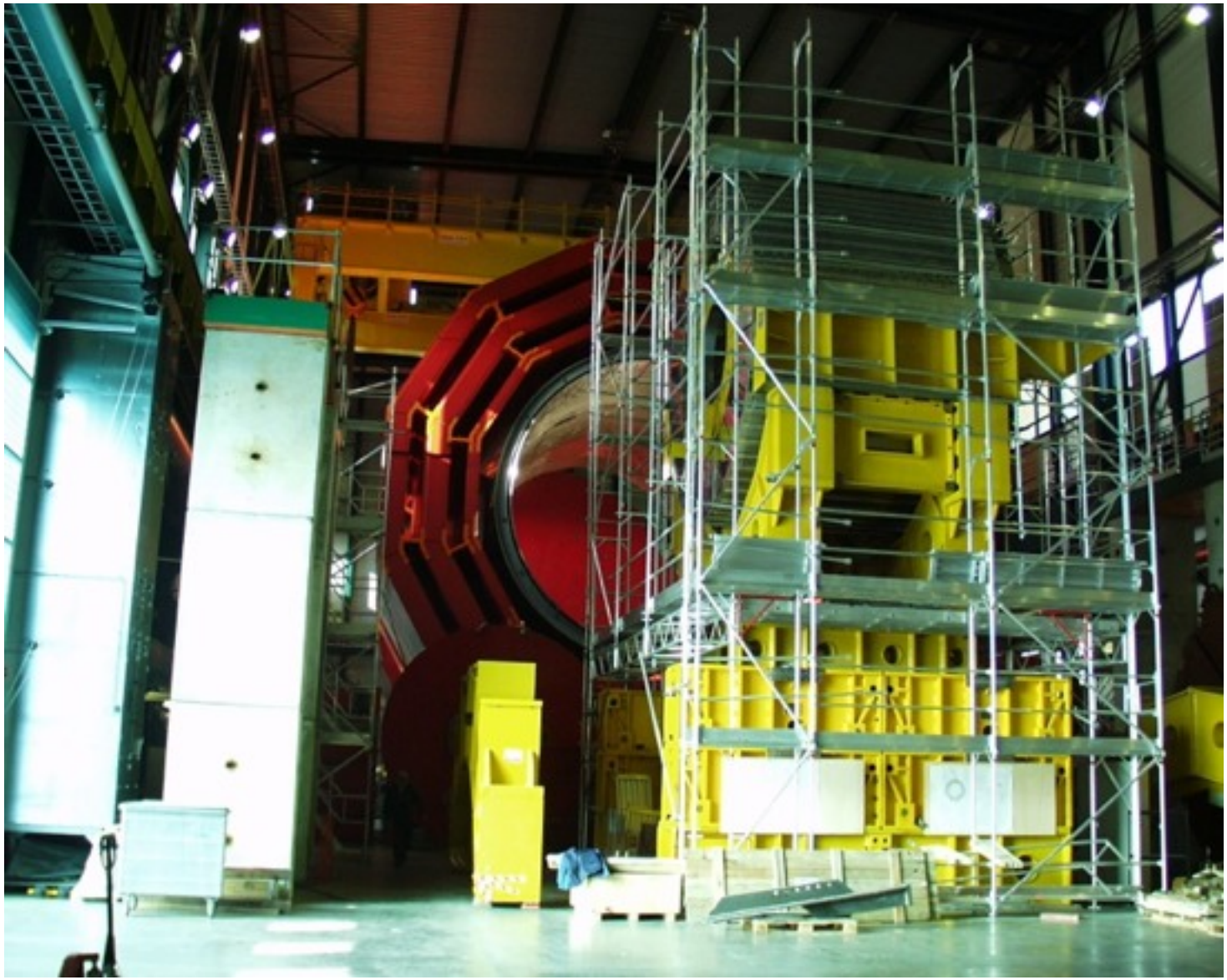


C. Bourgeois

CMS Assembly - Tooling

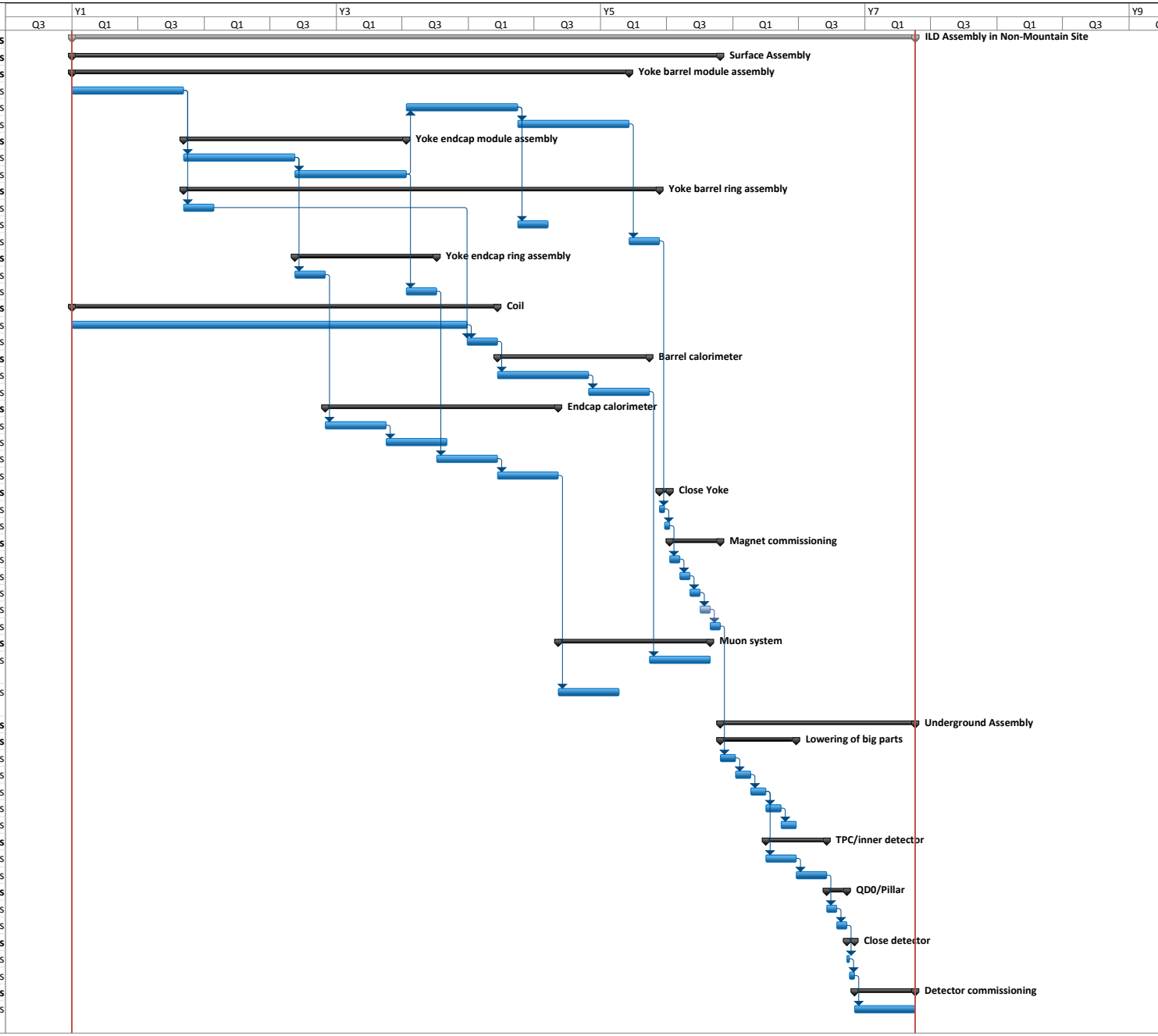


CMS Surface Assembly Hall



ILD Assembly Time Line (Non-Mountain Sites)

ID	Task Name	Duration
0	**ILD Assembly in Non-Mountain Site**	**1665 days**
1	**Surface Assembly**	**1280 days**
2	**Yoke barrel module assembly**	**1100 days**
3	YB0	220 days
4	YB+z	220 days
5	YB-z	220 days
6	**Yoke endcap module assembly**	**440 days**
7	YE+z	220 days
8	YE-z	220 days
9	**Yoke barrel ring assembly**	**940 days**
10	YB0	60 days
11	YB+z	60 days
12	YB-z	60 days
13	**Yoke endcap ring assembly**	**280 days**
14	YE+z	60 days
15	YE-z	60 days
16	**Coil**	**840 days**
17	Coil assembly and test	780 days
18	Coil installation in YB0	60 days
19	**Barrel calorimeter**	**300 days**
20	HCAL barrel assembly/cabling	180 days
21	ECAL barrel assembly/cabling	120 days
22	**Endcap calorimeter**	**460 days**
23	HCAL +z endcap assembly/cabling	120 days
24	ECAL +z endcap assembly/cabling	120 days
25	HCAL -z endcap assembly/cabling	120 days
26	ECAL -z endcap assembly/cabling	120 days
27	**Close Yoke**	**20 days**
28	Move Ybs	10 days
29	Move YEs	10 days
30	**Magnet commissioning**	**100 days**
31	Cool down	20 days
32	High field tests	20 days
33	Field mapping	20 days
34	QD0 testing	20 days
35	Warm up	20 days
36	**Muon system**	**300 days**
37	Muon chamber barrel insertion/cabling	120 days
38	Muon chamber endcap insertion/cabling	120 days
39	**Underground Assembly**	**385 days**
40	**Lowering of big parts**	**150 days**
41	YE+z	30 days
42	YB+z	30 days
43	YB0	30 days
44	YB-z	30 days
45	YE-z	30 days
46	**TPC/inner detector**	**120 days**
47	TPC insertion/cabling	60 days
48	Inner detector insertion/cabling	60 days
49	**QD0/Pillar**	**40 days**
50	QD0 mounting	20 days
51	Forward calorimeters	20 days
52	**Close detector**	**15 days**
53	Close YEs	5 days
54	Install QD0/Pillars	10 days
55	**Detector commissioning**	**120 days**
56	Detector commissioning and testing	120 days

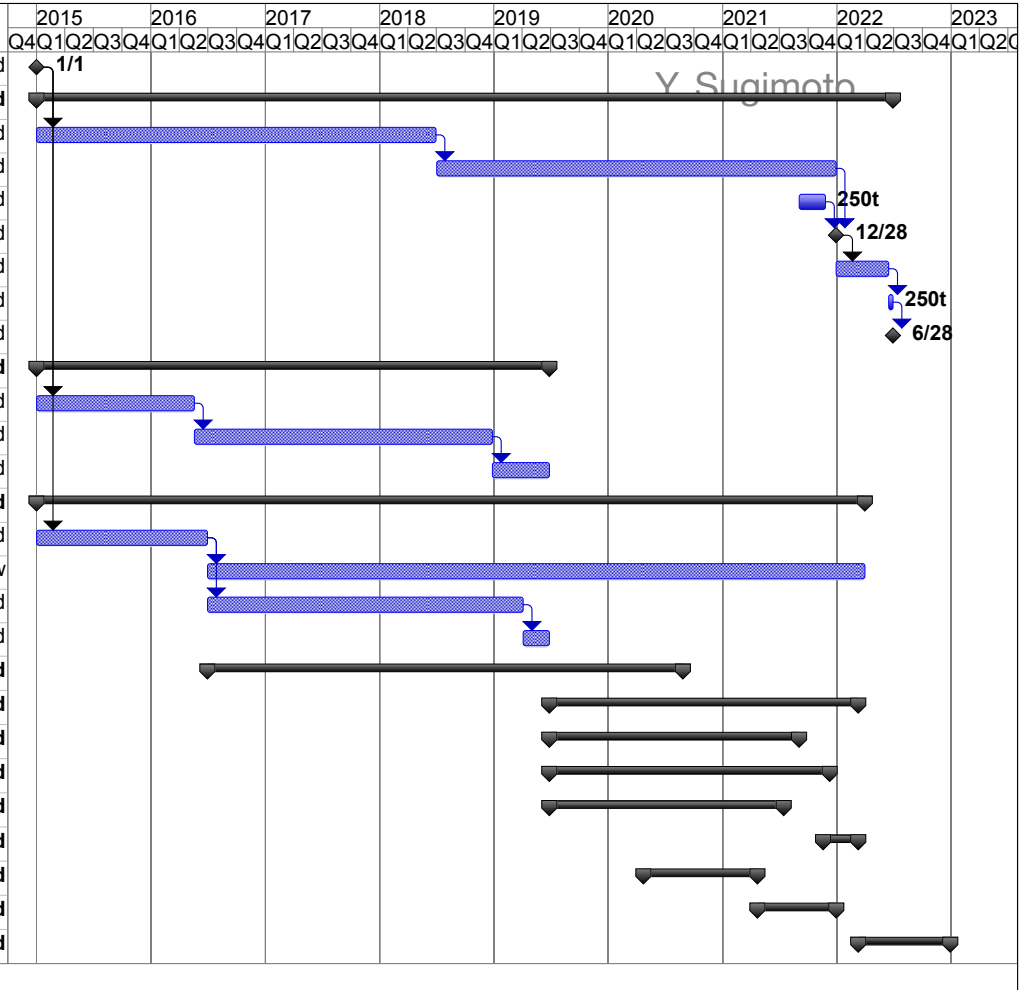


Assembly Timeline (Flat Sites)

- 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)

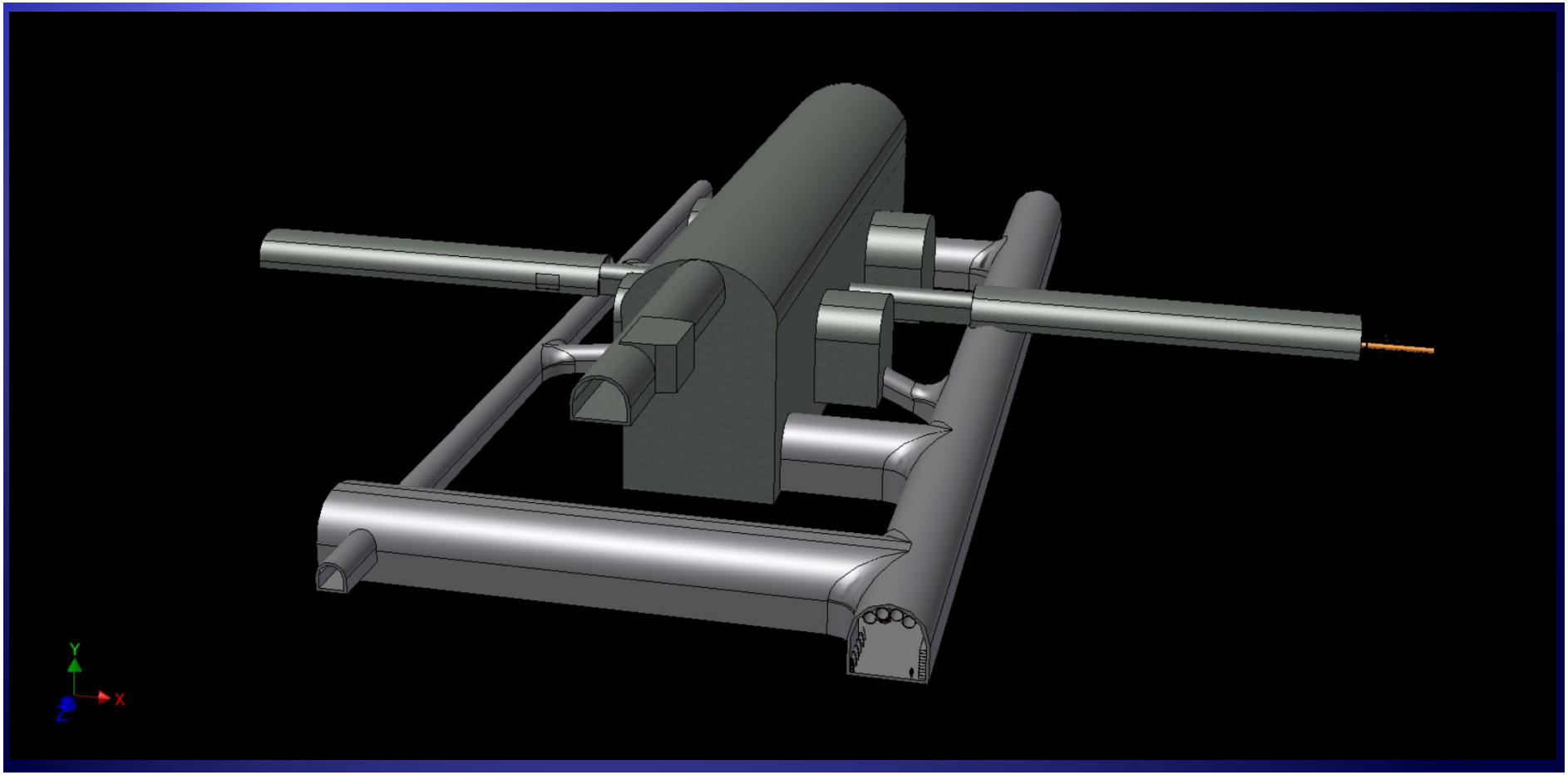
ID	Name	Duration
1	Ground breaking	0d
2	**Beam lines construction**	**1954d**
3	Tunnel	912d
4	Beamline harware install	912d
5	Beam line shield	60d
6	Start of beam commissioning	0d
7	BDS pre-commissioning	120d
8	Shield removal	10d
9	BDS ready for detectors	0d
10	**Experimental Hall**	**1170d**
11	Access tunnel	360d
12	Cavern	680d
13	Services	130d
14	**Detector construction on surface**	**1890d**
15	Surface assembly hall	390d
16	Detector assembly on surface	300w
17	Solenoid construction	720d
18	Solenoid surface test	60d
19	**Yoke pre-assembly**	**1085d**
25	**Detector assembly in cavern**	**705d**
26	**Yoke assembly**	**570d**
38	**Solenoid**	**640d**
49	**Barreal detectors**	**535d**
64	**Barrel inner detectors**	**80d**
67	**Endcap detectors**	**260d**
76	**QD0/FCALs install/cabling/test**	**180d**
82	**Commissioning**	**210d**



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

Y. Sugimoto

Japanese Hall Design (Status: 22.03.2012)

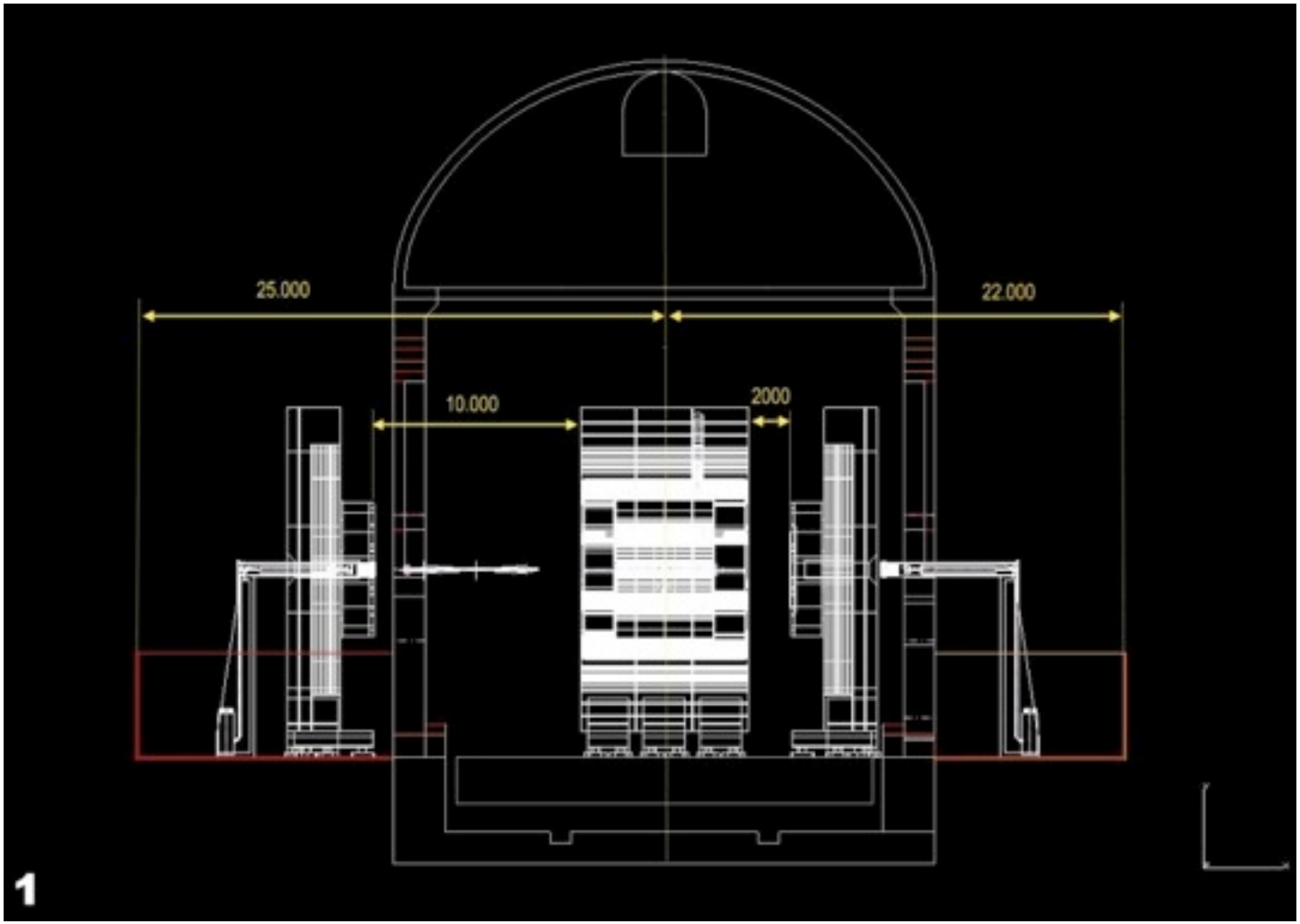


- Enlarged Alcoves
- 142 m long

G. Orukawa

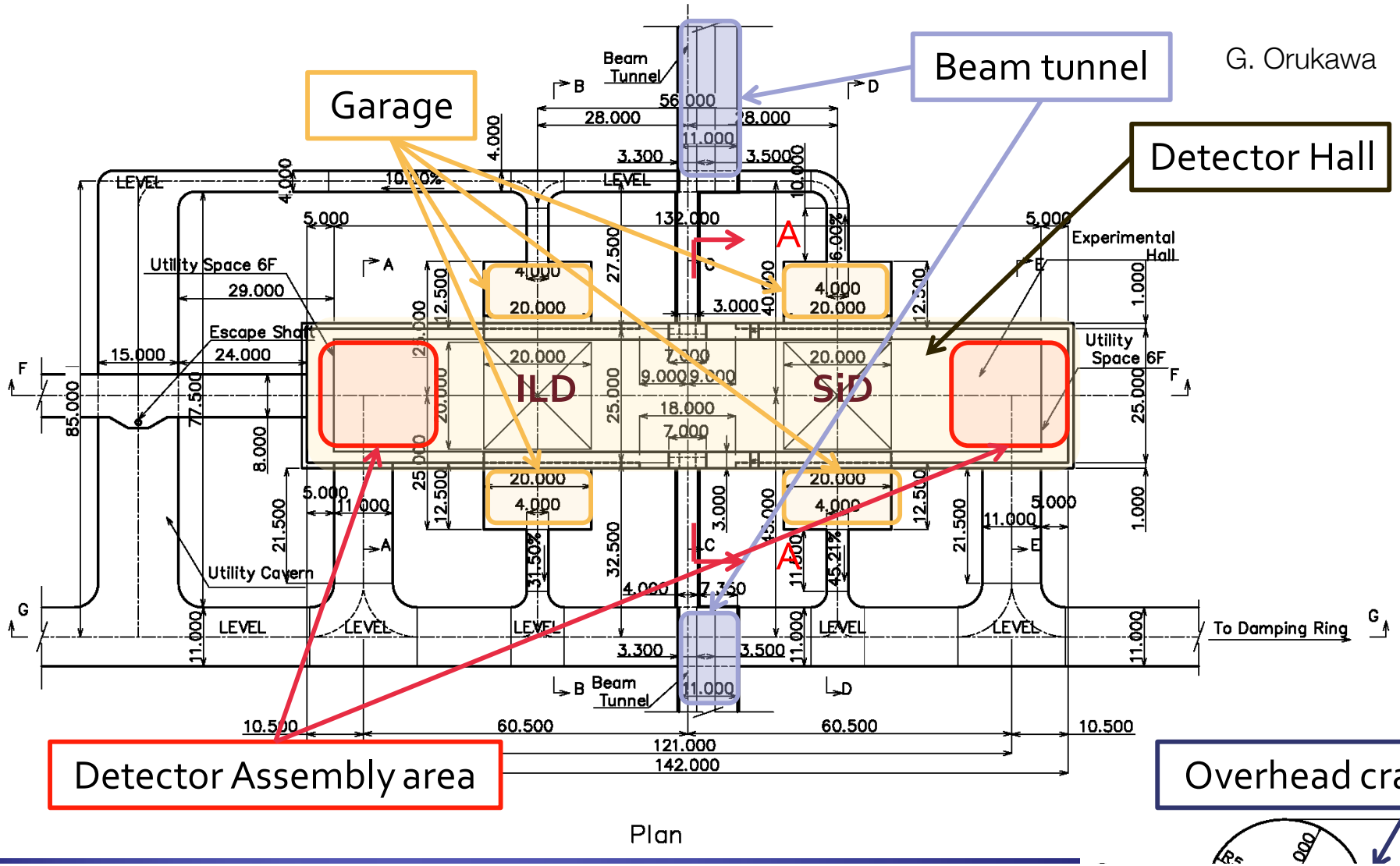
Maintenance Position (ILD Study)

- Alcoves needed to open the detector for maintenance



R. Volkenborn

Japanese Hall Design (Status: 22.03.2012)

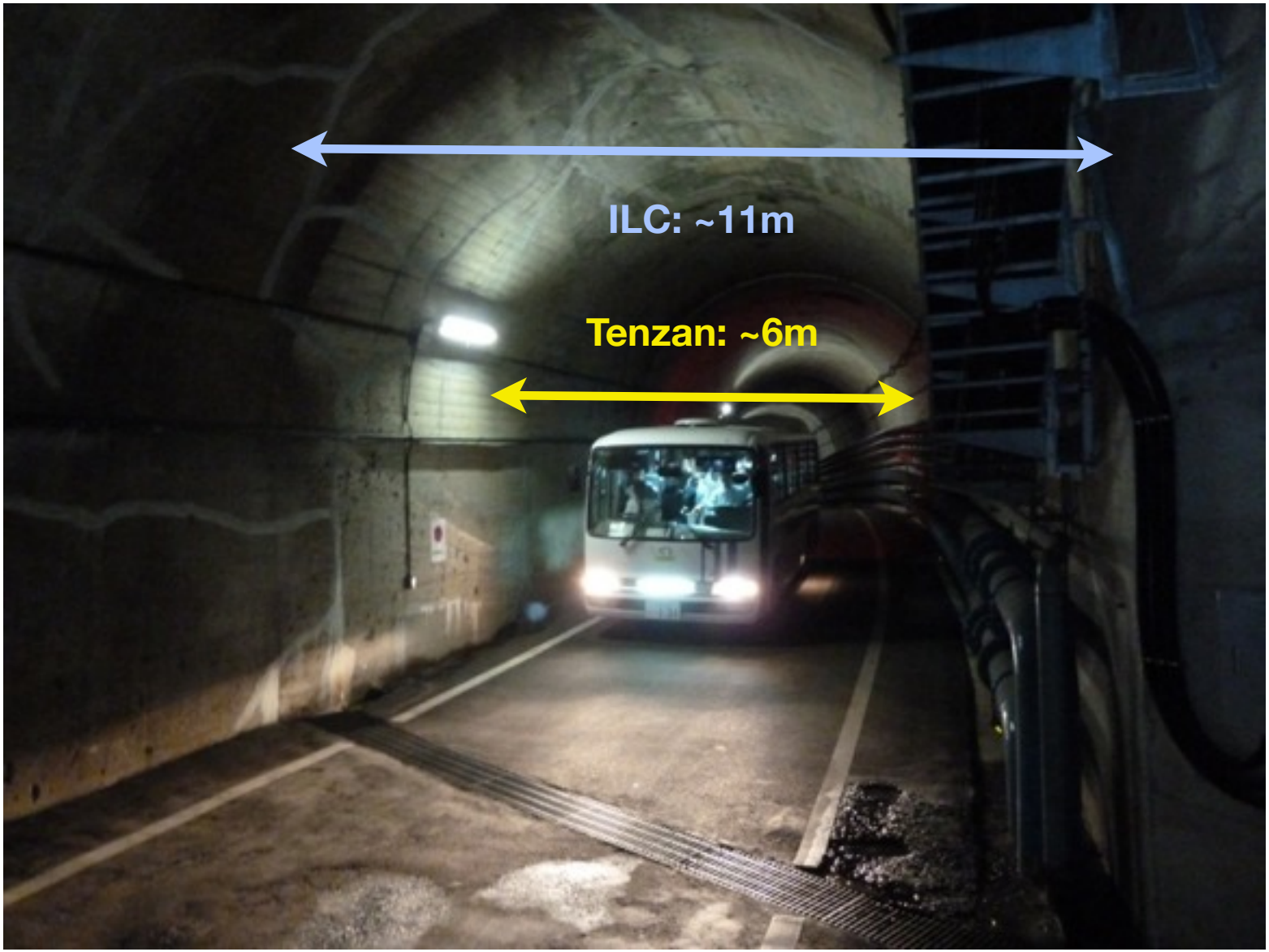


Tenzan Power Plant Underground Hall

Access Tunnel

Access Tunnel

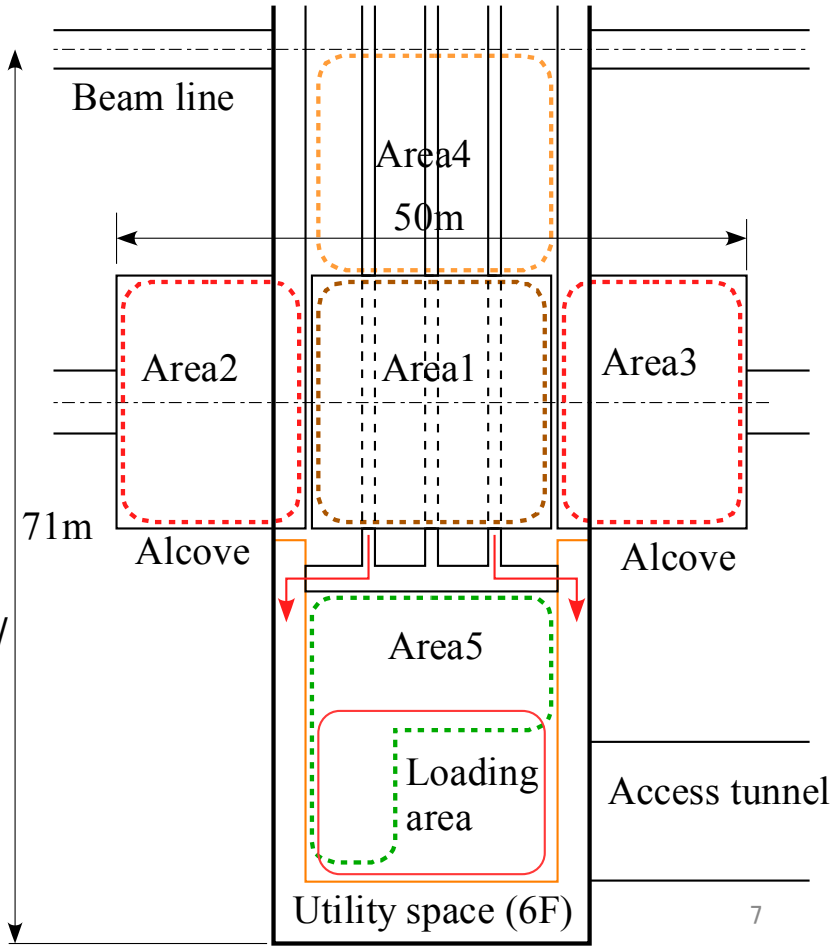
Access Tunnel



Detector assembly area

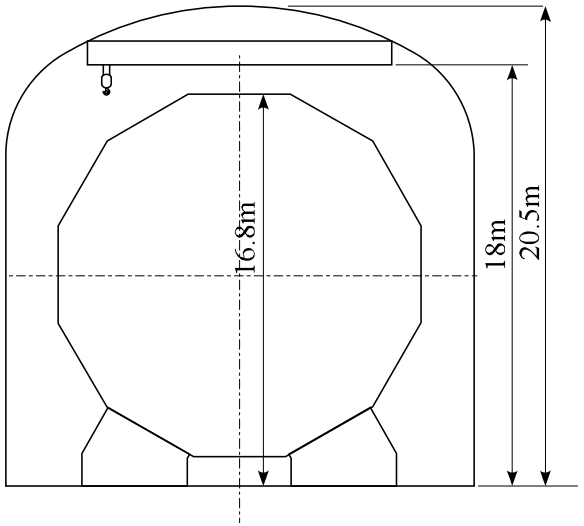
Y. Sugimoto

- 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

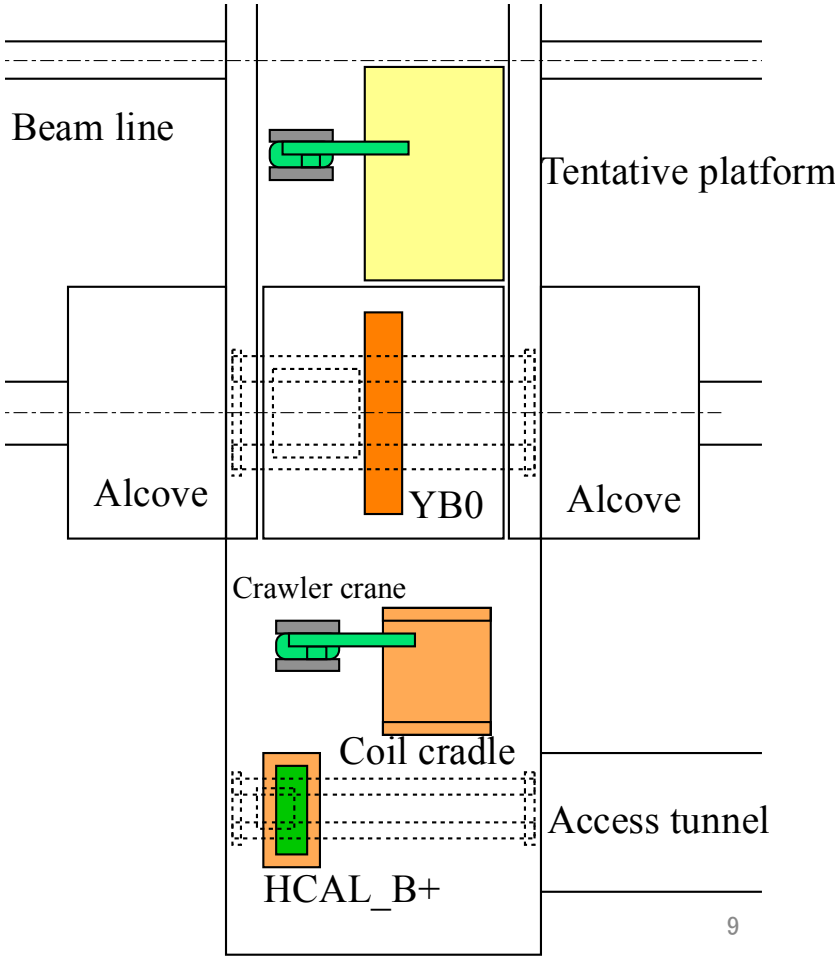


Y. Sugimoto

ILD Installation Study (Preliminary)

Step 1

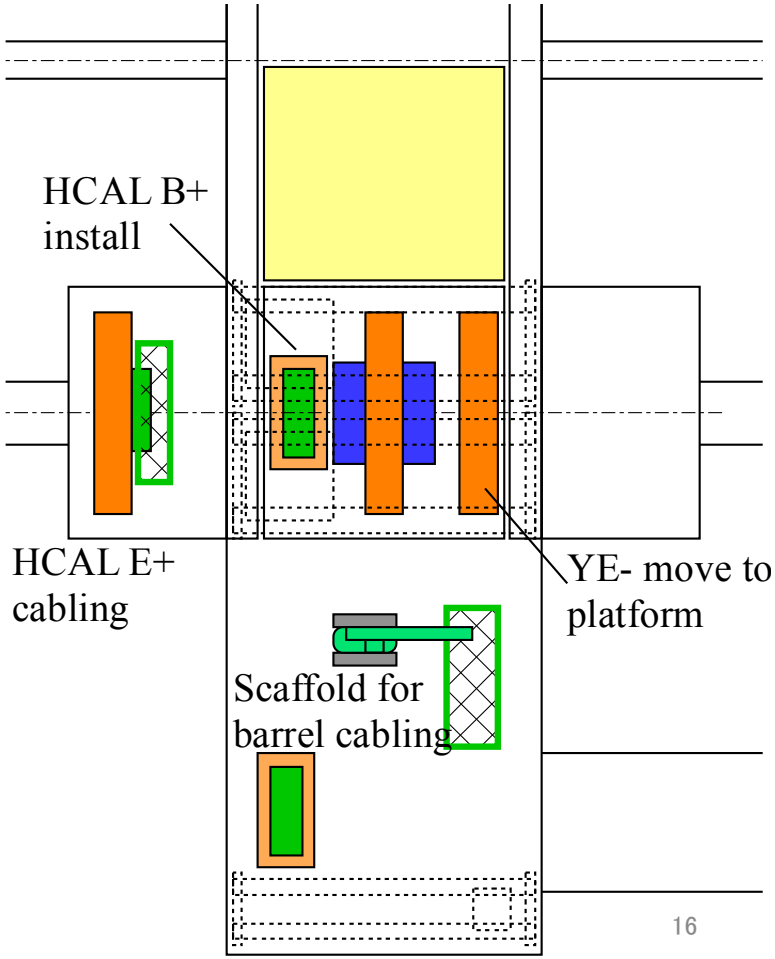
- Tentative platform is assembled in Area4 using a crawler crane
- Central barrel yoke YB0 is assembled on the platform using 250 ton crane
- HCAL modules are assembled to a ½-z ring in Area5 using 30 ton crane
- Cradle for coil installation is assembled in Area5 using a crawler crane



ILD Installation Study (Preliminary)

Step 8

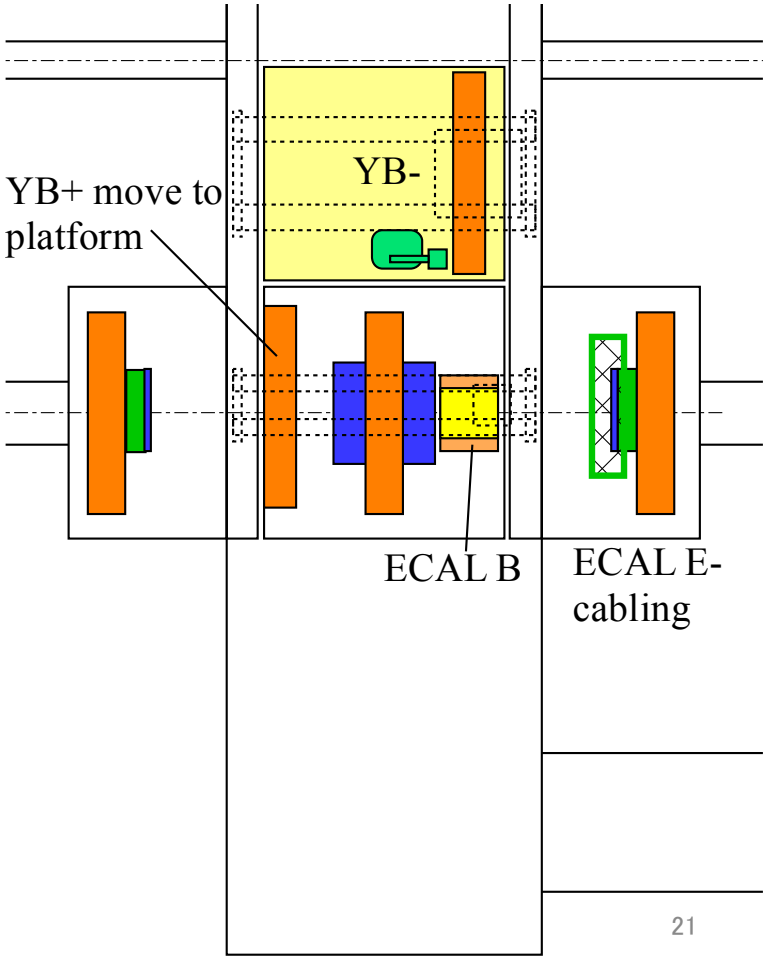
- YE- is moved to platform
- ½ of barrel HCAL is moved to platform using two 250 ton cranes, and installed
- Endcap yoke (+) is pushed into Area 2
- Endcap HCAL cabling in Area 2
- Scaffold for barrel cabling is assembled in Area 5



ILD Installation Study (Preliminary)

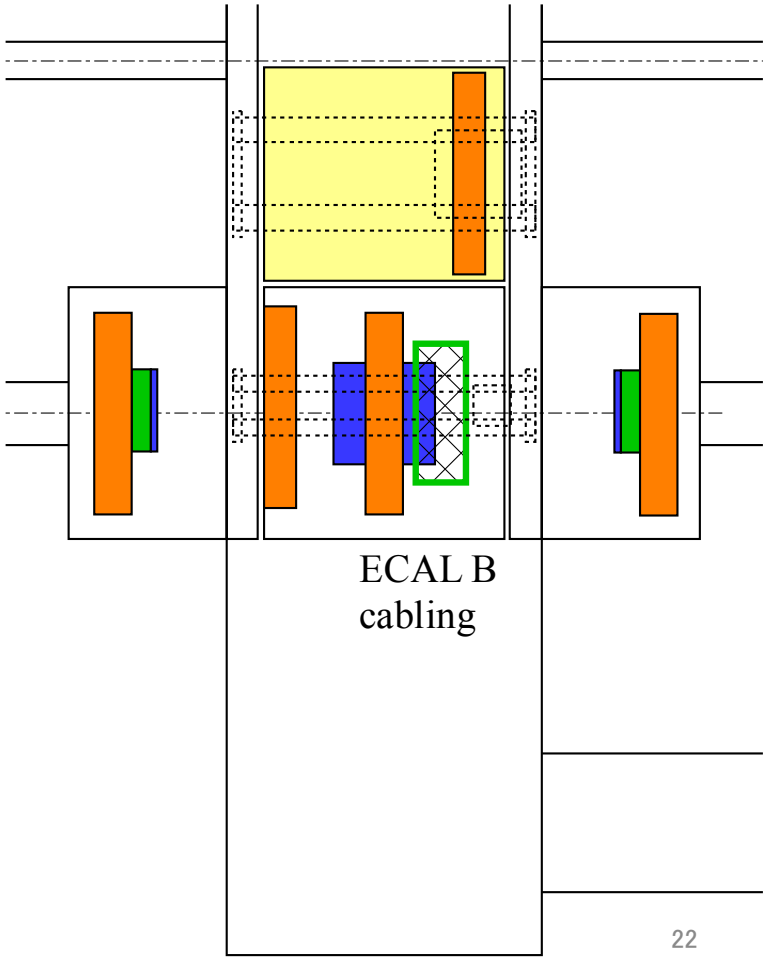
Step 13

- YB+ is moved to Area 1
- Another barrel yoke ring YB- is assembled and muon detectors installed in Area 4
- Endcap ECAL (-) cabling in Area 3
- Barrel ECAL is installed in Area 1



Step 14

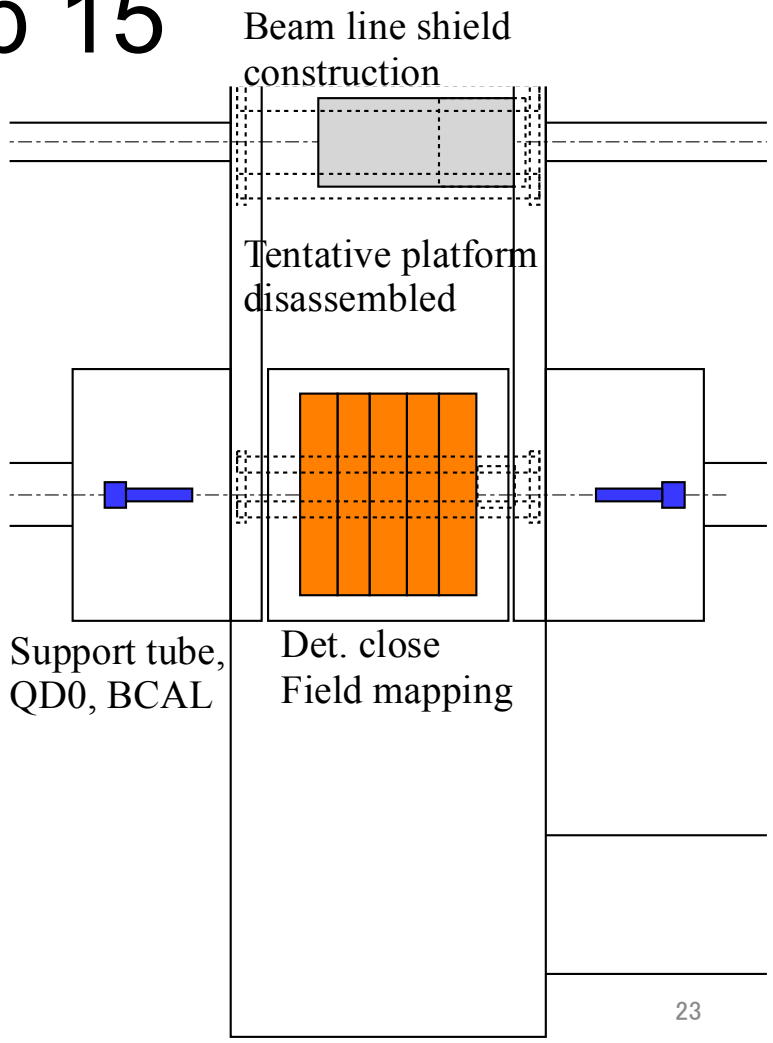
- Barrel ECAL cabling in Area 1



ILD Installation Study (Preliminary)

Step 15

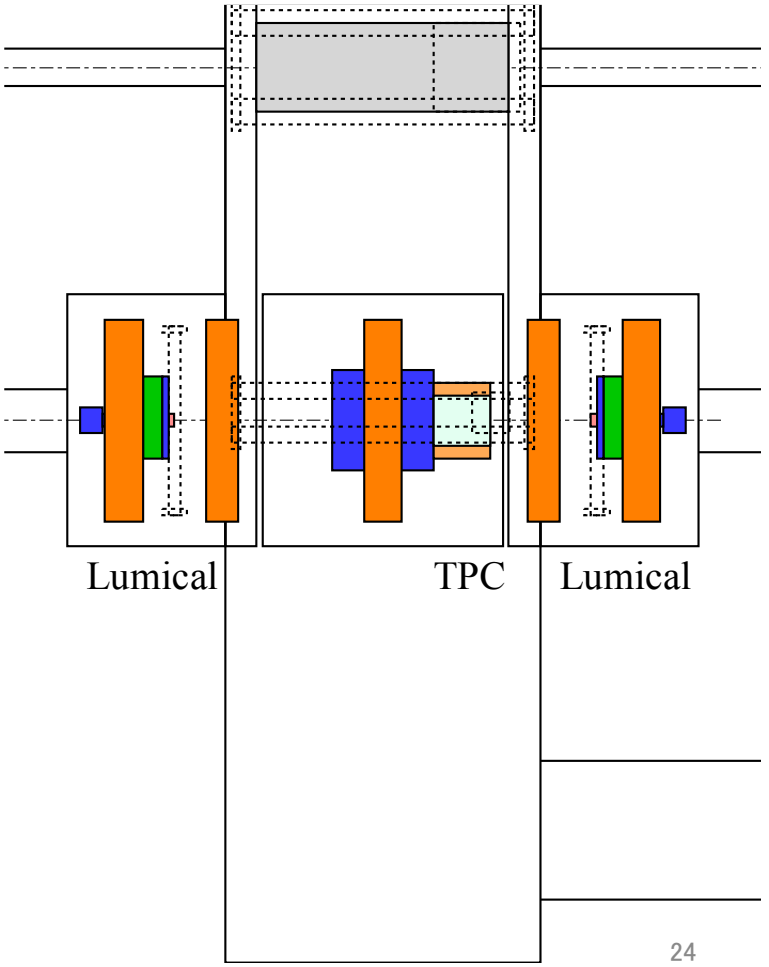
- Detector is closed and field mapping is performed
- QD0 support tubes assembly in Area 2/3
- QD0 and BCAL installation/cabling in Area 2/3
- After removing the tentative platform in Area 4, beam line shield is constructed



ILD Installation Study (Preliminary)

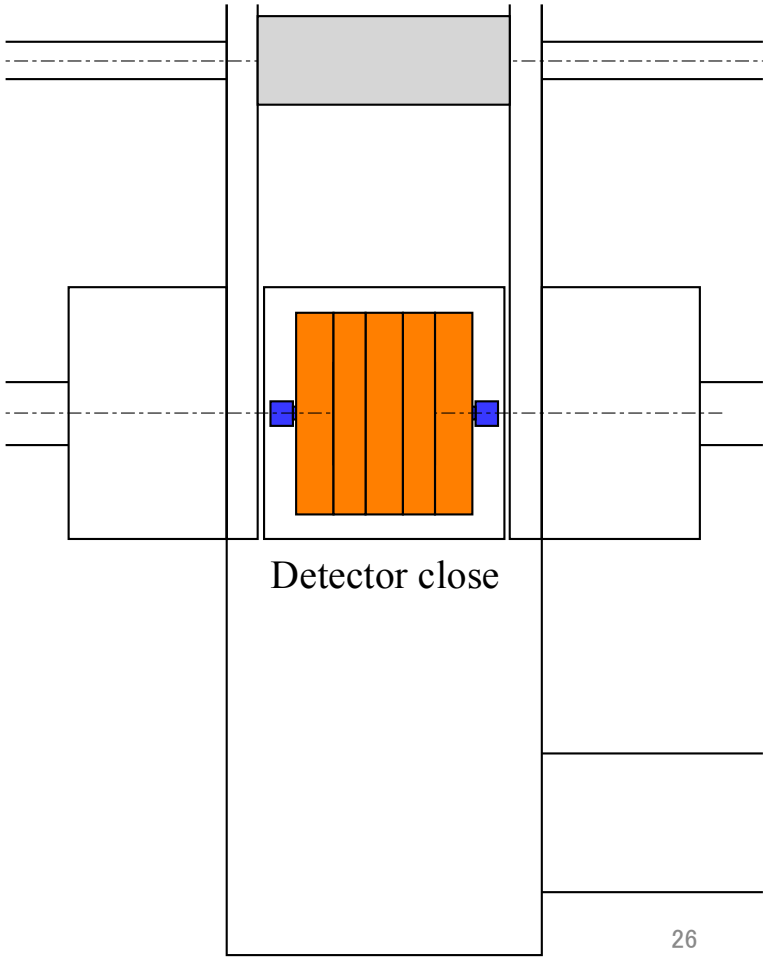
Step 16

- Detector is opened again
- TPC installation in Area 1
- Lumical installation using 2.8 ton cranes in Area 2/3



Step 18

- Detector is closed again and ready for detector pre-commissioning



ILD Installation Study (Preliminary)

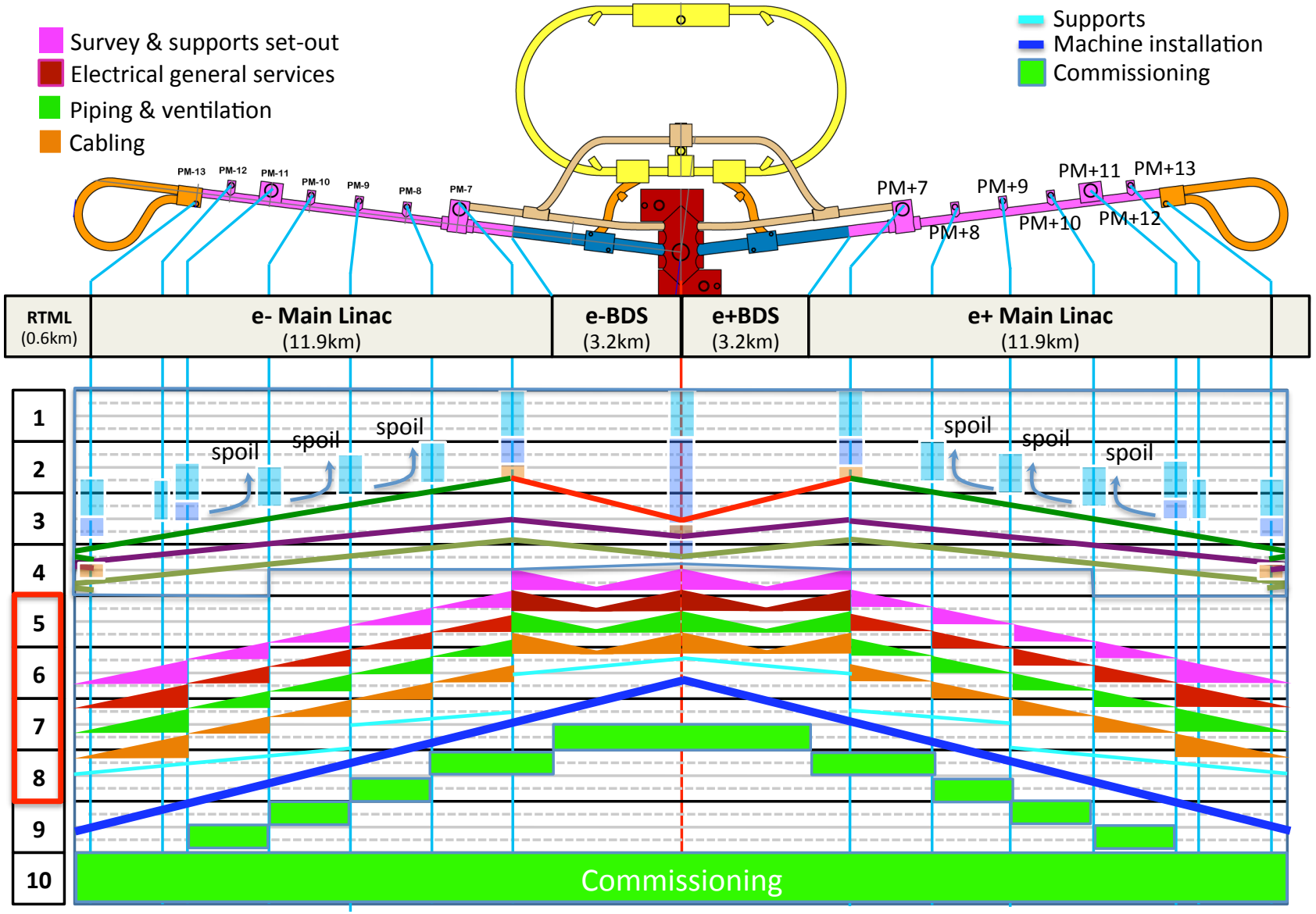
- Installation studies are still work in process
- Cross-checks with 3D models are yet to be done
- Implications of common infrastructure use (access tunnel, cranes) not studied yet
  - Might need buffer space

- Clearly: installation of ILD in the mountain site hall is a challenge!

ILC Construction Schedule Discussion

- GDE is looking into global construction schedules now in more detail
- Working group: PMs, E. Paterson, M. Gastal, KB (detector contact)
- Started discussions at KILC
- Webex meeting on May 8th 2012
- Will follow this up during the coming weeks

M. Gastal (8 May 2012)



From Martin Gastal…. possible example TDR schedule (CERN site)

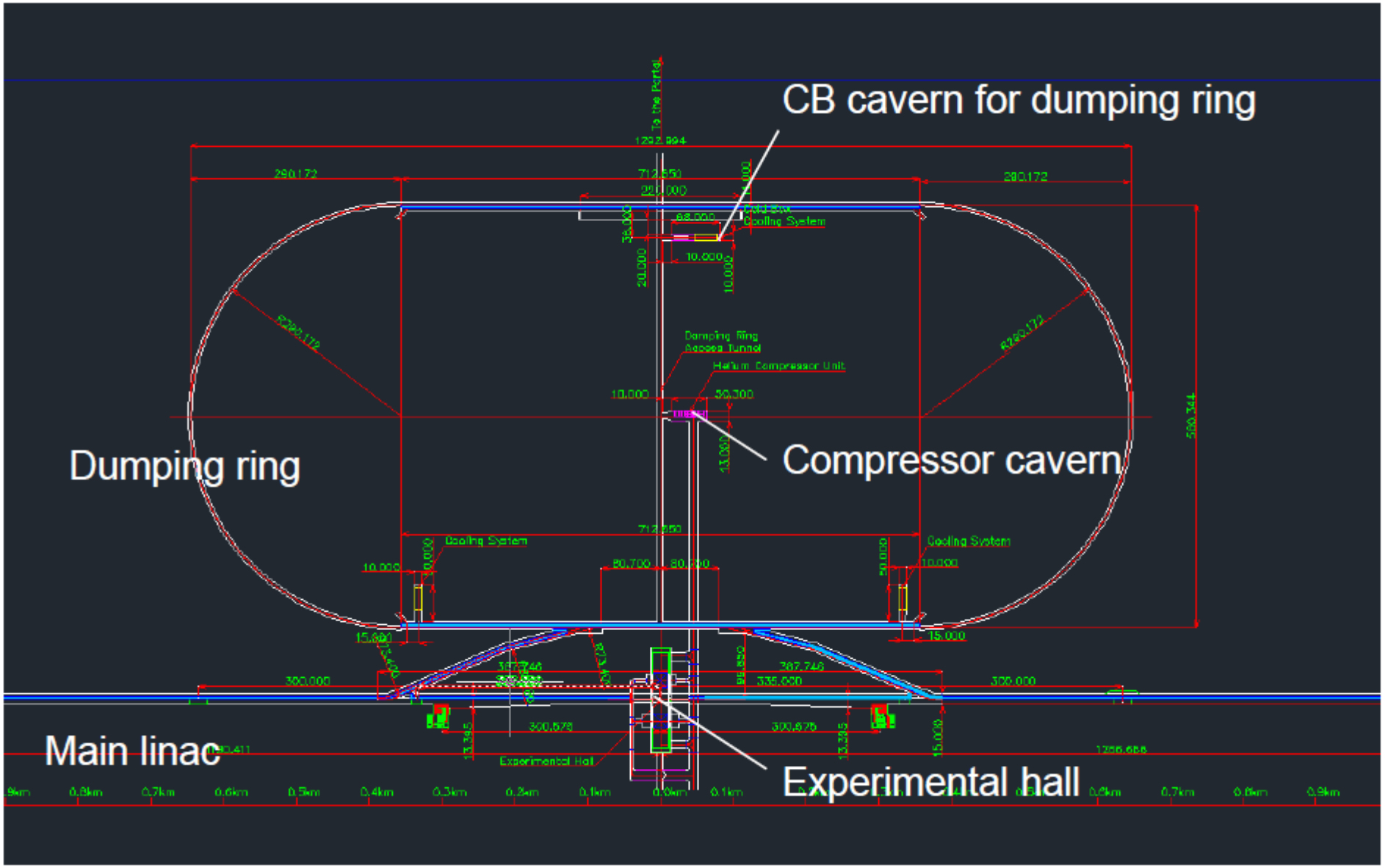
SUMMARY DESCRIPTION of POSSIBLE ILC CONSTRUCTION SCHEDULES

ACTIVITIES DURING YEARS X -> Y

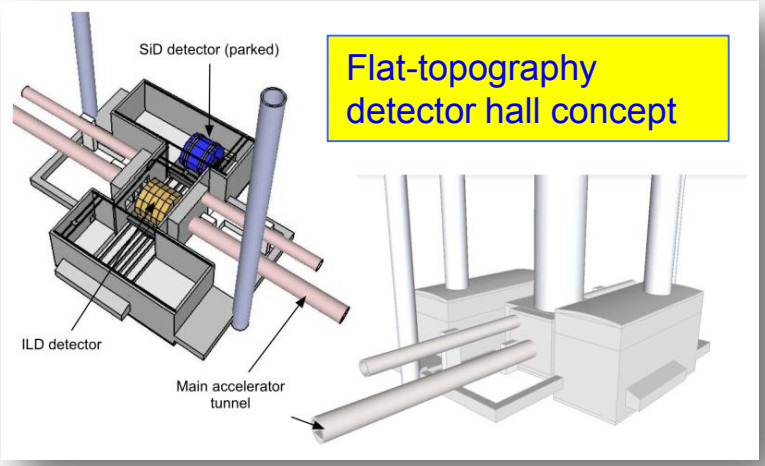
- Final Site Design and Site Preparation ? -> 1
- Civil Construction 1 -> 5
- Completion of Conventional Facilities 4 -> 8
- Production and Testing of Components 1 -> 9
- Installation of Technical Systems 6 -> 9
- In-situ Testing/Processing 7 -> 9
- Beam Commissioning of Central Region 8 -> 9
- Assembly and Installation of Detectors 2 -> 10
- ILC Beam Commissioning. Move of first Detector Online. Begin Physics Run 10

Questions

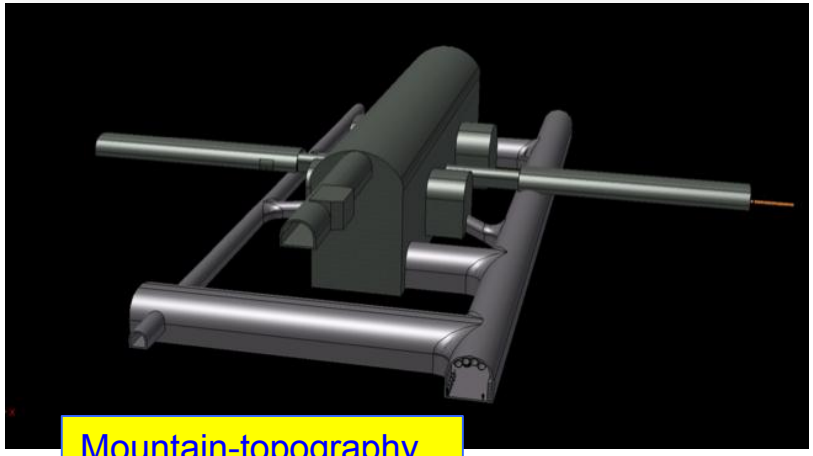
- Can we consider for today's discussion that the schedule as shown (in slides 2,3 and some explanatory text) to be TDR ready for "flat" sites?
- Can we make a corresponding schedule for a mountainous site with similar end dates and stages?
- Does this require a second detailed diagram schedule or can the differences be covered with text only? (This is to avoid detailed site dependencies)
- The same questions apply for the detector assembly and test schedules.


CB cavern for dumping ring
Dumping ring
Compressor cavern
Main linac
Experimental hall
To the Portal
1232.894
280.172
712.350
280.172
220.000
68.000
Cooling System
10.000
20.000
10.000
35.000
5292.172
6292.172
Damping Ring
Access Tunnel
Helium Compressor Unit
10.000
30.300
13.000
586.744
712.350
Cooling System
Cooling System
10.000
80.700
80.700
10.000
50.000
15.000
15.000
300.000
387.746
335.000
387.746
300.000
300.578
300.578
13.335
13.335
15.000
Experimental Hall
1266.666
0.9km
0.8km
0.7km
0.6km
0.5km
0.4km
0.3km
0.2km
0.1km
0.0km
0.1km
0.6km
0.7km
0.8km
0.9km

Detector Installation



Flat-topography detector hall concept

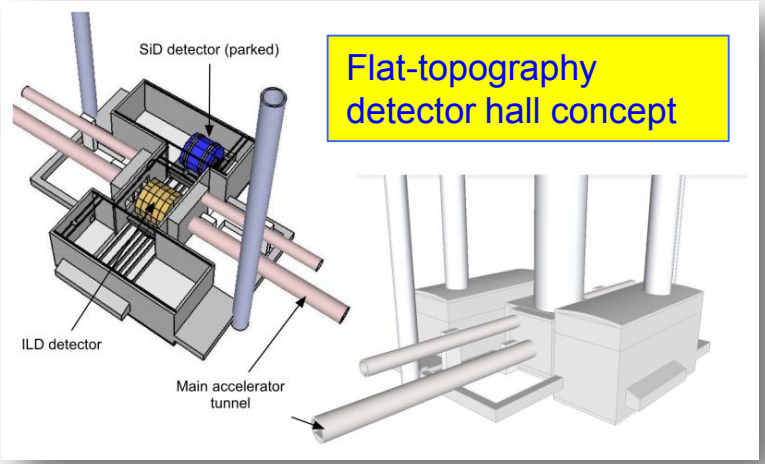


Mountain-topography detector hall concept

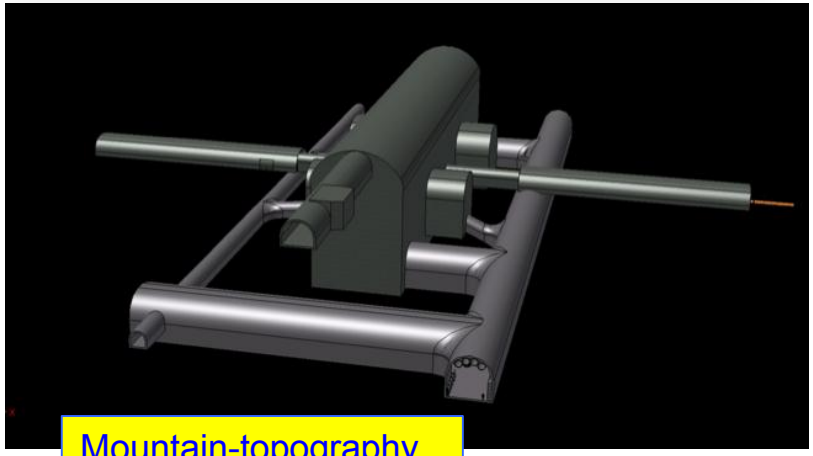
Comments by M. Ross:

- In mountain region,
  - an 11-m diameter access tunnel may need to be shared with SiD and ILD, under very careful coordination.
- Please consider an example:
  - the installation and assembly of ILD with the use of the access tunnel restricted to only one 8 hour shift per day (1/3 occupancy).
  - The other two shifts will be used by SiD and machine installation.

Detector Installation



Flat-topography detector hall concept



Mountain-topography detector hall concept

Coordination is crucial

Comments by

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- Please consider an example:
  - the installation and assembly of ILD with the use of the access tunnel restricted to only one 8 hour shift per day (1/3 occupancy).
  - The other two shifts will be used by SiD and machine installation.

- The common use of infrastructures and resources (e.g. space and time) needs to be planned carfully

- Self-organisation works only on small scales...

  ... sometimes

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- Self-organisation works only on small scales...

  ... sometimes


The detector as seen by the machine people?

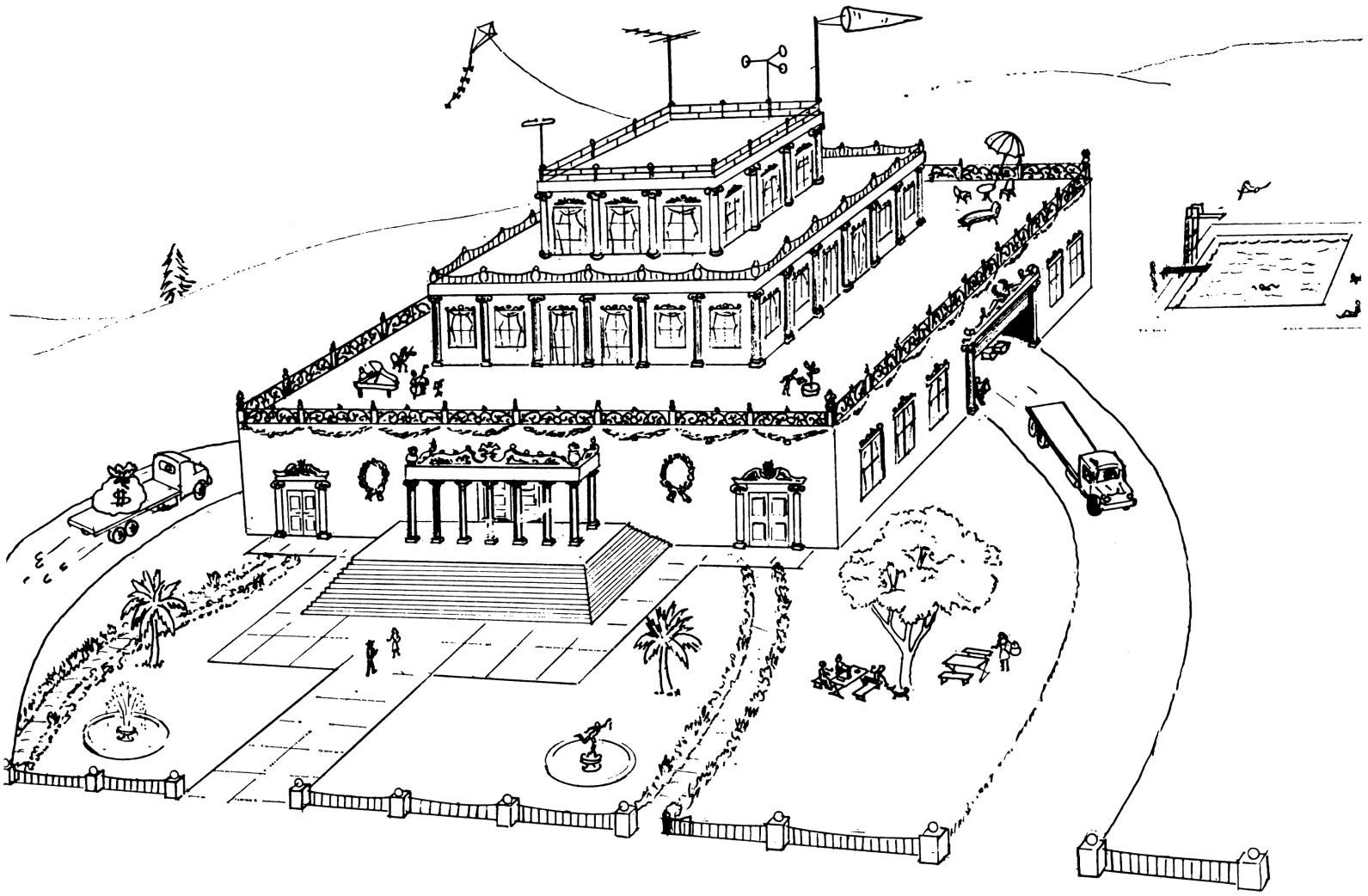

The detector as seen by the machine people?
Expensive and of not easy understandable use....


12
700


The machine as seen by the detector people?
12
12
JR700


The machine as seen by the detector people?
Expensive, but at least the benefits are clear....

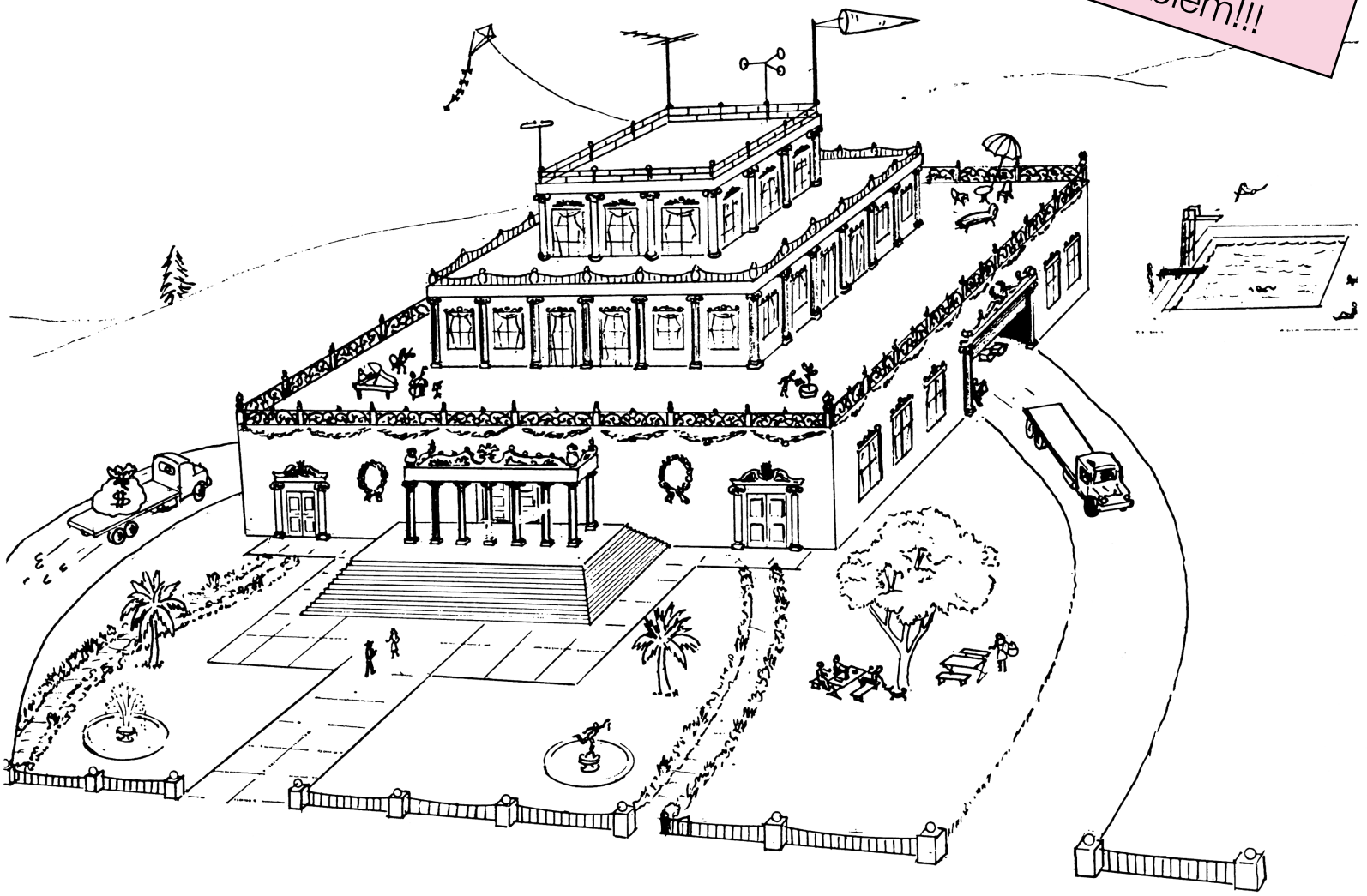
The ILC as seen by...



. . . the governmental funding agency

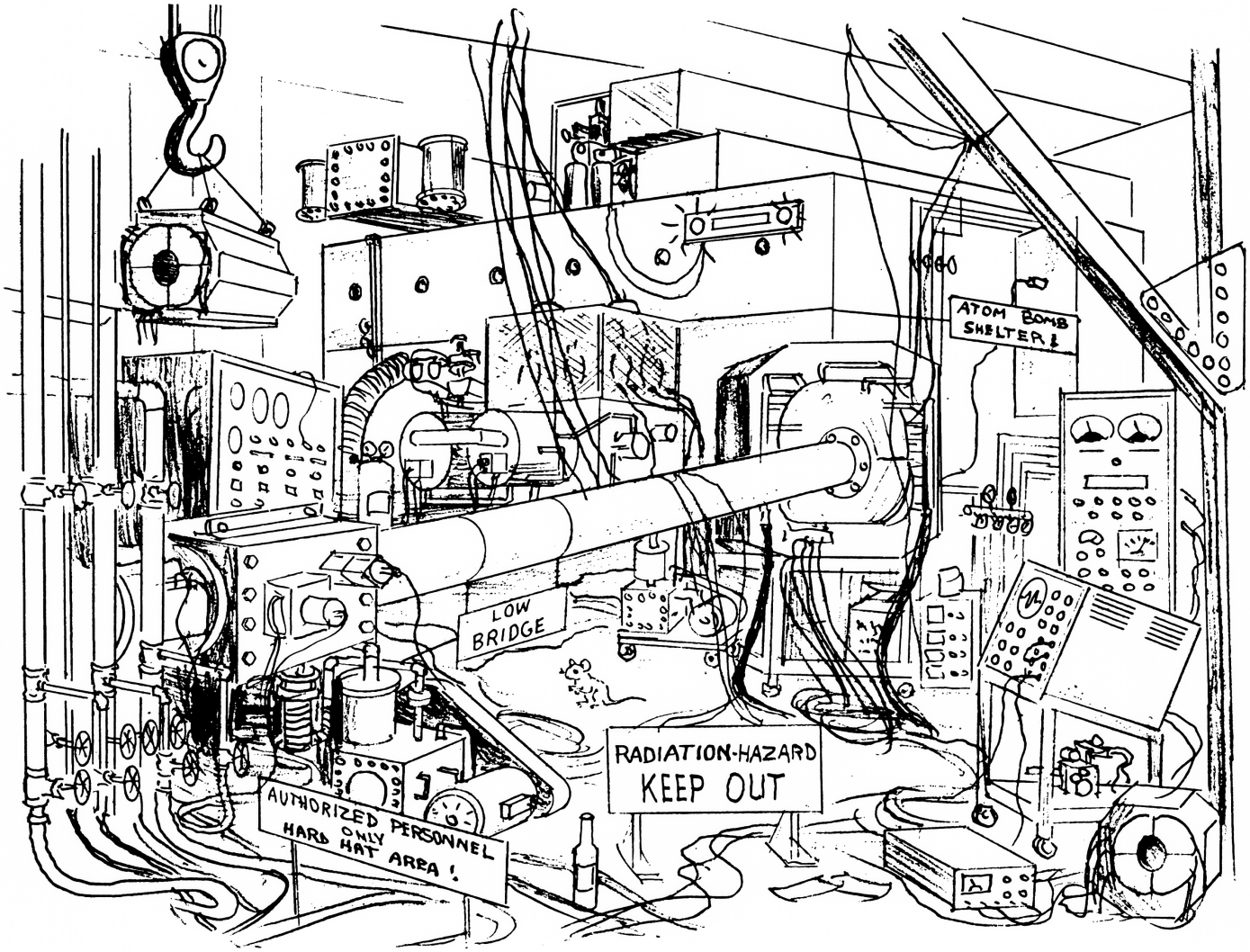
The ILC as seen by...

Our common problem!!!



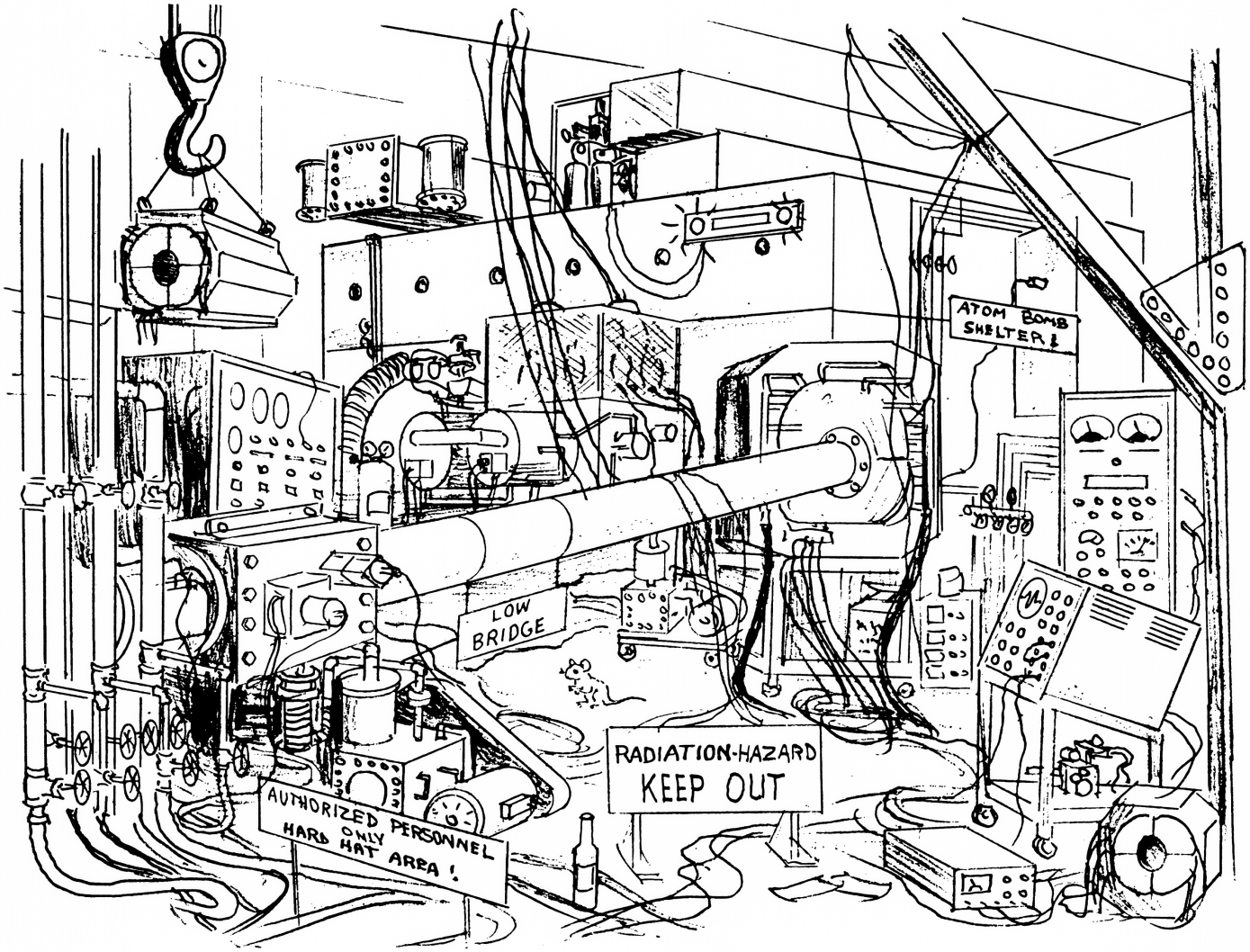
. . . the governmental funding agency

The ILC as seen by...



. . . the visitor

The ILC as seen by...



...myself in sleepless nights

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
- Started to write the DBD....