ILD Machine-Detector Interface

Overview and Future Plans

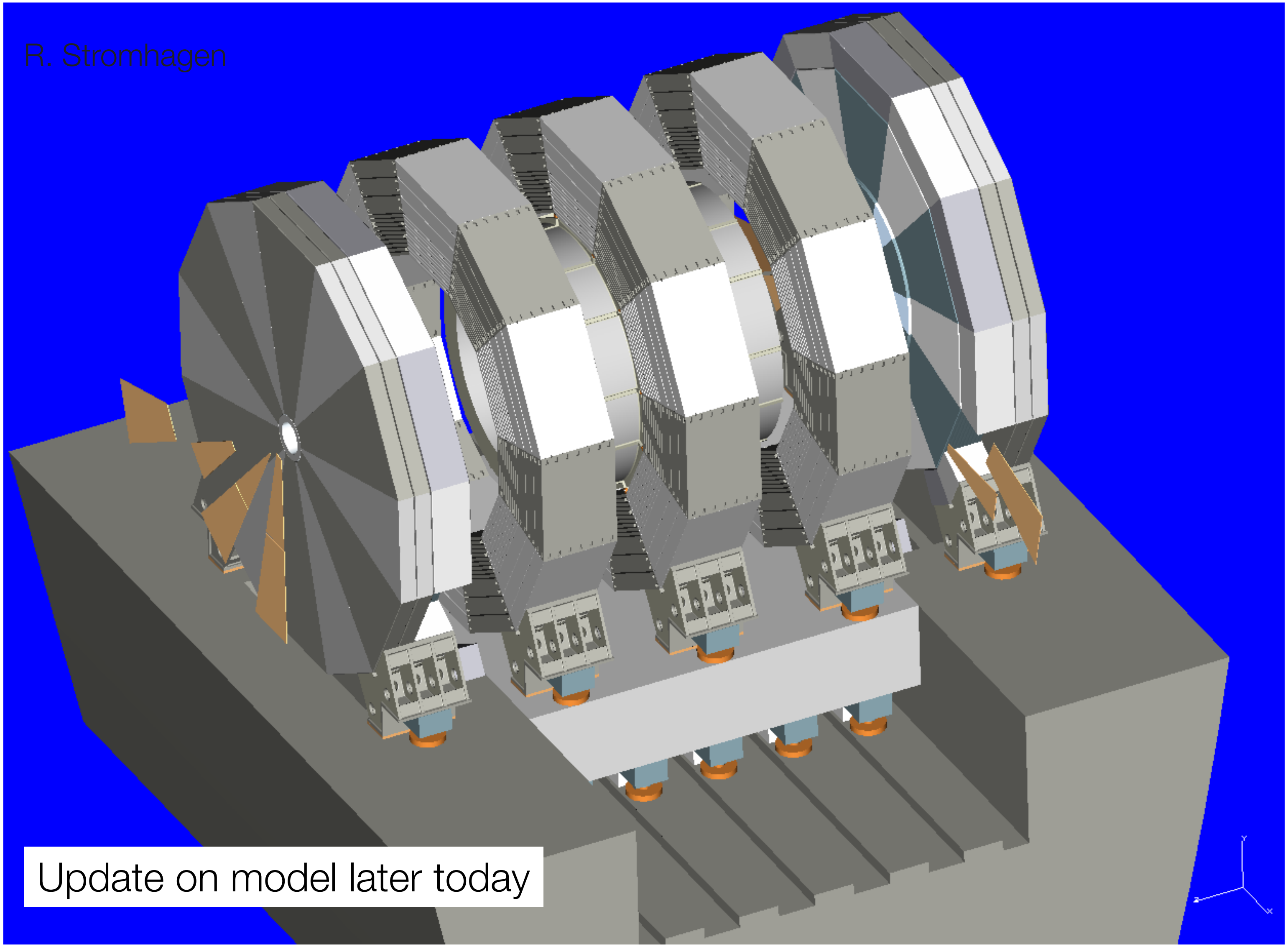
Karsten Buesser

28.05.2013
ECFA LC2013 Workshop

Introduction

- ILD has been concentrating on the finalisation of the TDR/DBD
- Very little new work has been done since LCWS12 (Arlington)
  - So many things I will present represent the status of the DBD
  - Plus some ideas on future work...
- We still need to develop an ILD MDI/Integration plan for the next 3-4 years
  - transition period
  - goal: „construction readiness“, „real TDR“?
  - maybe have some time to even look into design optimisation or changes in the next couple of years...
- MDI/engineering resources within ILD are rather unclear so far
- All of what I say here are my personal thoughts!

ILD Mechanical Design



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 a possible site decision later this year?

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)

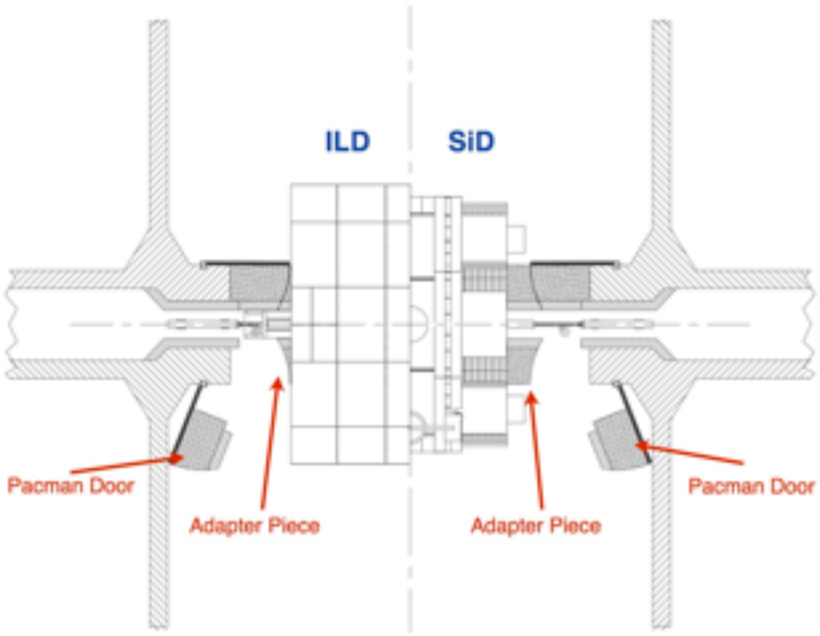
Abstract
The Interaction Region of the International Linear Collider [1] is based on two experimental detectors working in a push-pull mode. A time efficient implementation of this model sets specific requirements and challenges for many detector and machine systems, in particular the IR magnets, the 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.

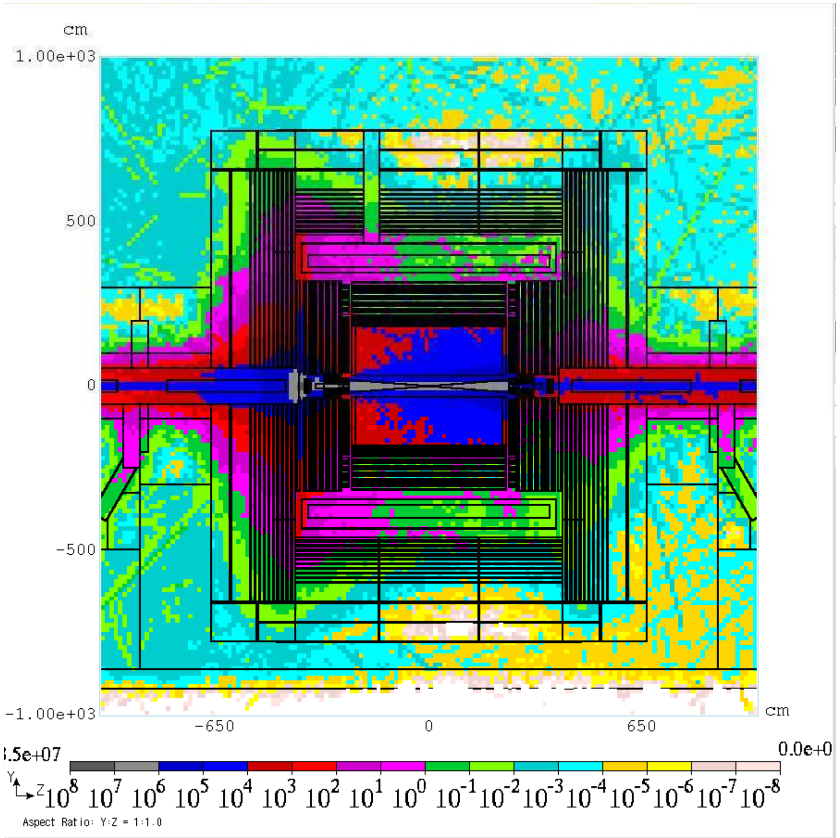
Re-visit functional requirements

- Japanese safety regulations and site realities might change some of the pre-requisites we assumed in the 2009 document?
- Possible relaxations on requirements might make life in a mountain site hall eaiser for ILD.
- Example: „<50 G at 15 m from the beamline“ magnetic field limit
    - this drives the amount of iron in the ILD yoke
    - If we could relax that requirement:
        - ILD would become smaller
        - Less material to bring into the hall
        - Possible shorter construction time
- NB: I do NOT suggest to change this requirement now
- But we should have a closer look at the old requirements in view of the given conditions at a possible Japanese site
- Maybe we find even other requirements that make our life harder...

Interaction Region Radiation Shielding

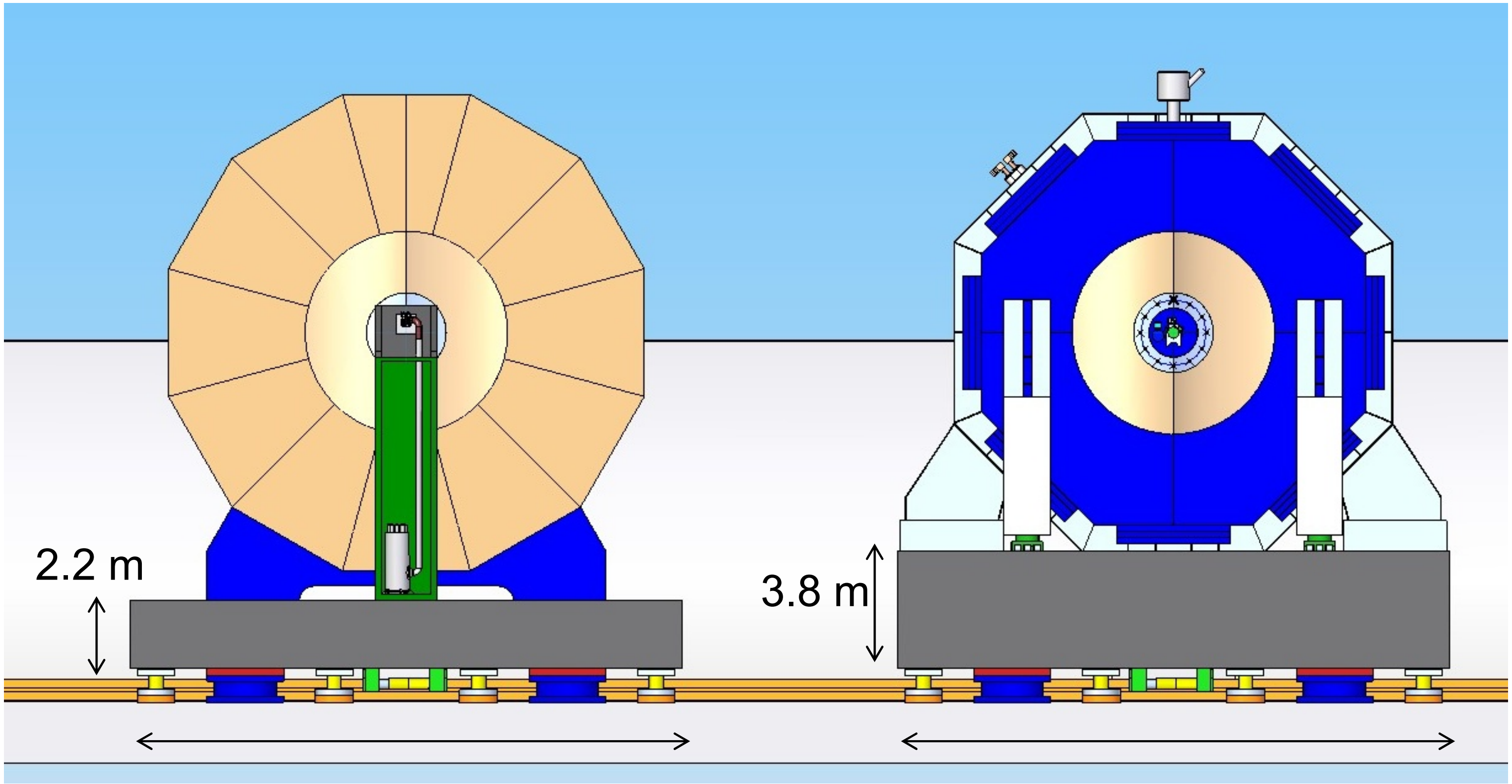
- Detectors are self-shielding w.r.t. maximum credible beam loss scenarios
- Adaptable shields between hall and detector („pacman“) required
- If we really should change the ILD design, we need to re-check that!





Sanami et al., SLAC-RP-09-08

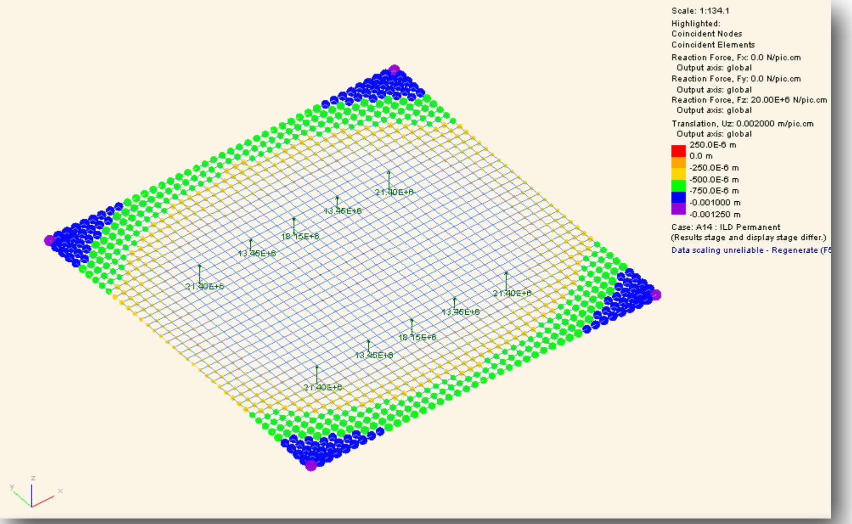
Push-pull System

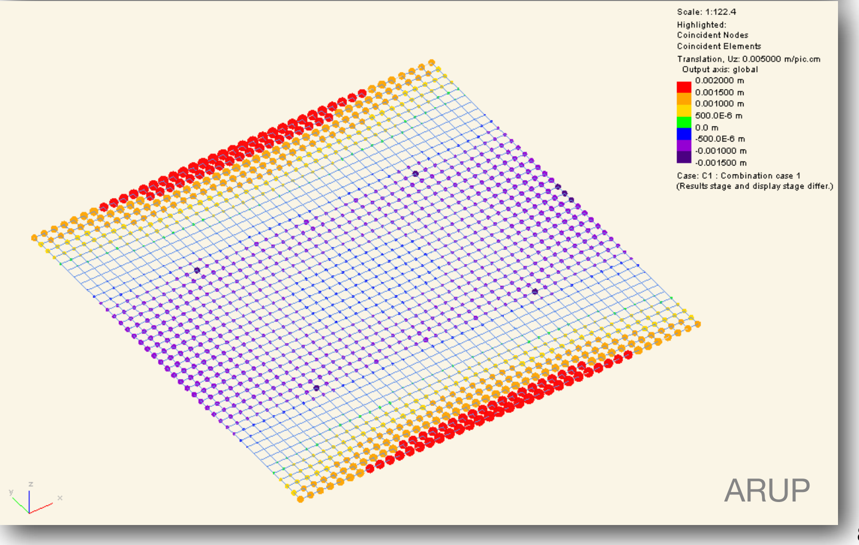


- Platform based detector motion system
- Large difference in platform thickness between ILD and SiD
- Did some work on reducing the feet height of ILD some time ago
  - interfered with the ARUP studies
  - need to re-visit this in context of earthquake protection

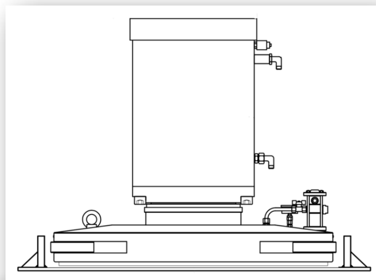
ARUP Task 1: Platform flexures

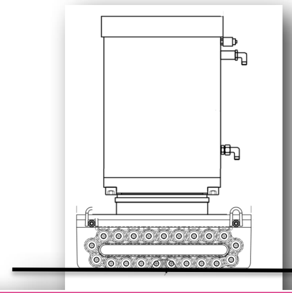
- Unloaded platform:
  - Flexure: +0.25mm; -1.25mm
- Loaded platform jacking onto transport system:
  - Flexure: +1.9mm; -1.0mm





ARUP Task 1:
Detector Movement System





Pads	Rollers
Min 60 required (for ILD, no redundancy)	Min 18 required (for ILD)
No hardened track->can accommodate minor steps	Specialist hardened and flattened track
Design for 1% friction	Design for 3% friction
Pressure infrastructure	Larger propulsion infrastructure
Run-away	Higher friction ->less run-away

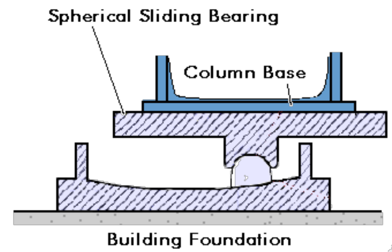
ARUP

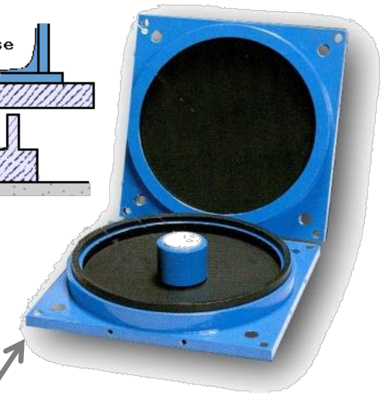
- Two solutions under study:
  - Air pads
  - Hilman rollers

Need to pick up that ball again sometime...

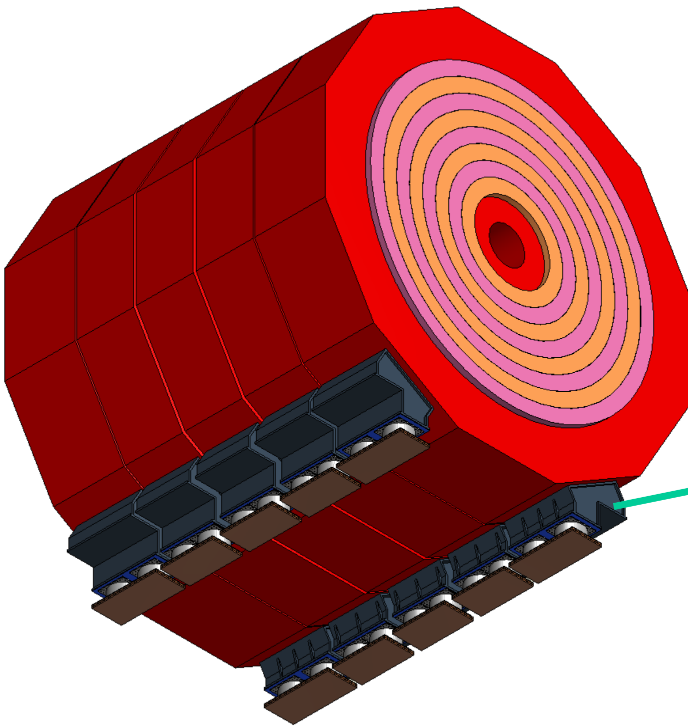
Detector with seismic isolated feet

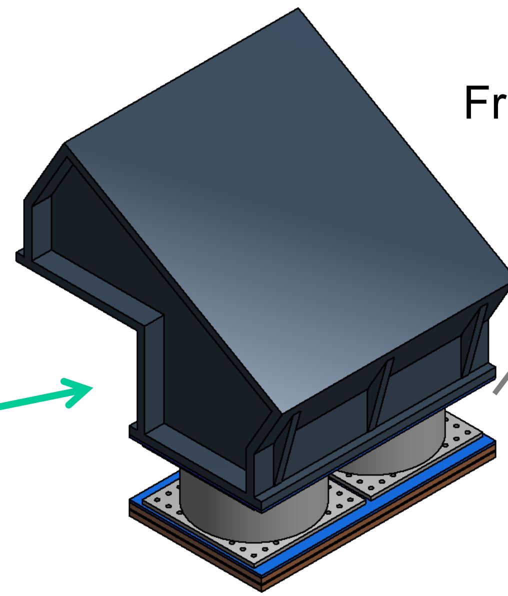
Each barrel stands on feet that are isolated
In this solution separated parts are still protected during maintenance when detector is opened





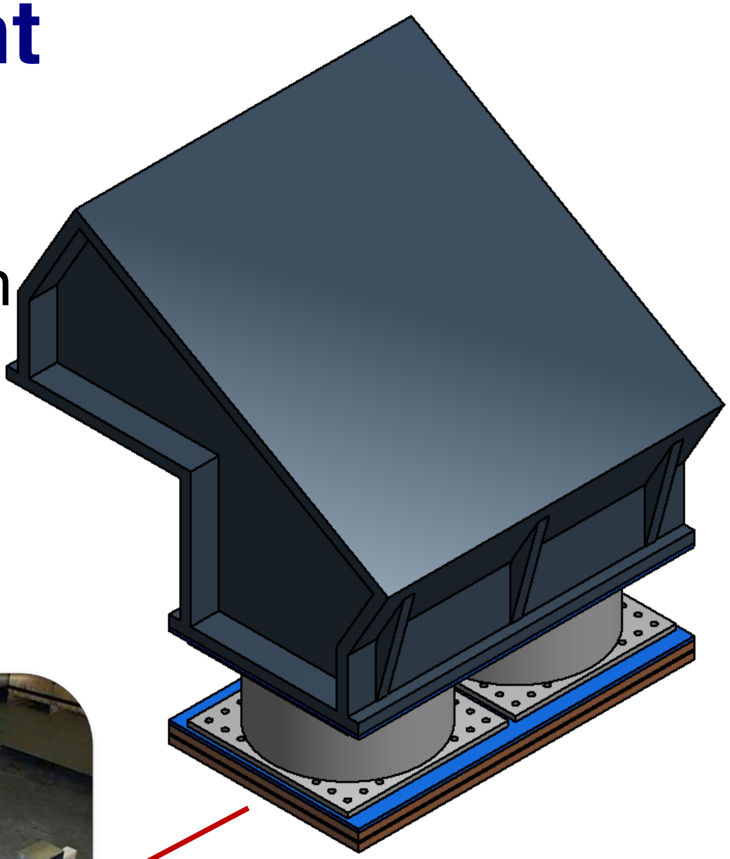
Friction pendulum bearings

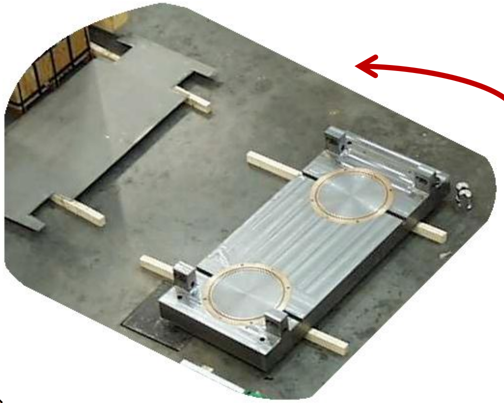




Final precise adjustment

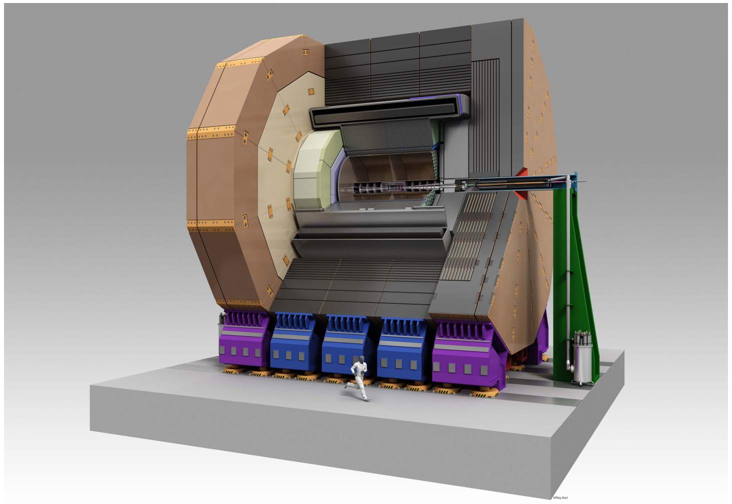
- The grease pads are needed to allow a final precise adjustment of the main components of each detector. The grease will lower the friction between the sliding components and therefore less force is needed.

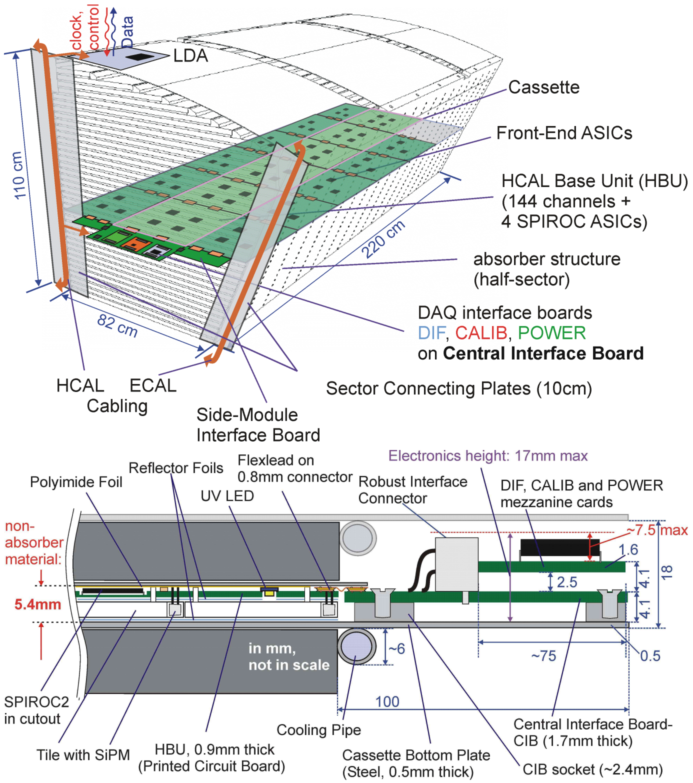




How earthquake proof is ILD?

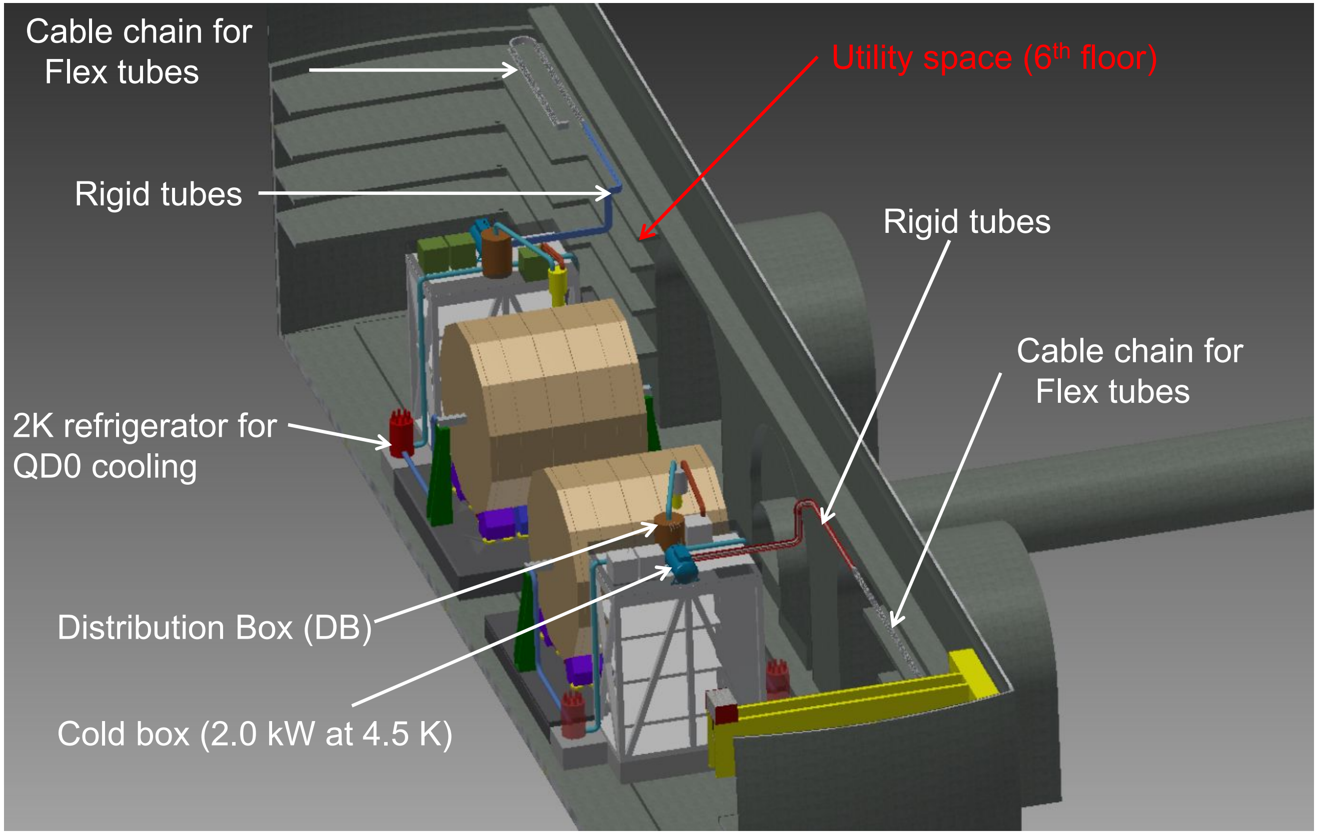
- ILD is so far not designed following clear guidelines on earthquake safety
- Acceleration tolerances?
- Interplay between possible attenuators in the support and integrated detector design?
- Design of sub-detectors?





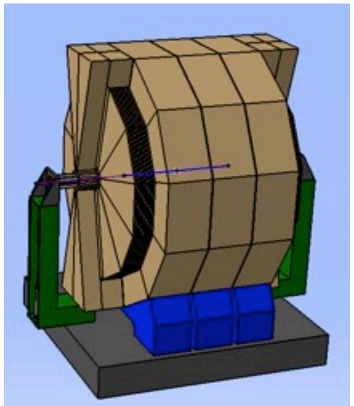
Common Services

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

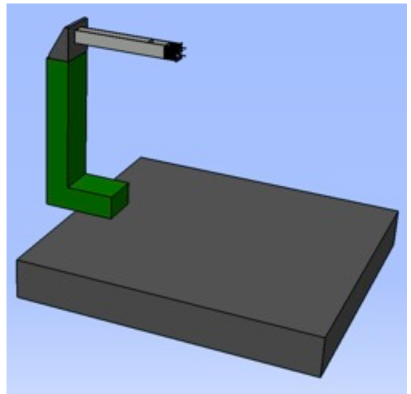


QD0 Support in Detectors

ILD00 model

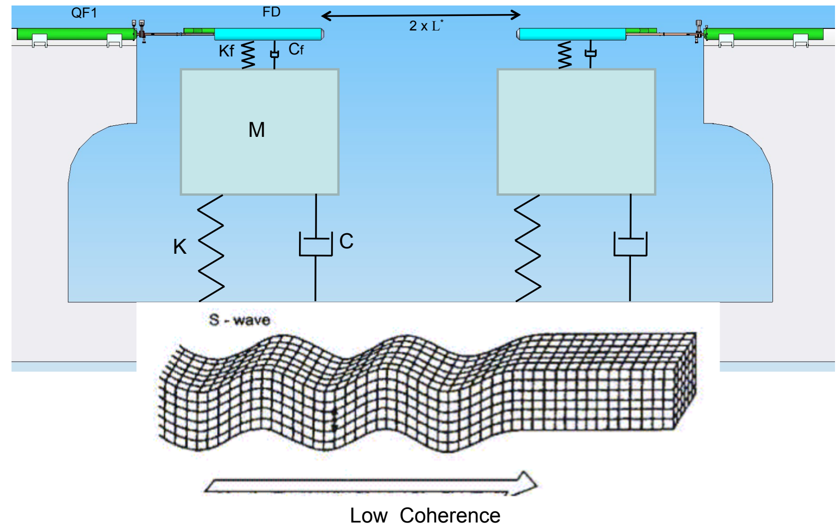


ILD QD0 support system



M . Joré

Independent Supports (Cavern,Pillars Platform)



M.Oriunno, IWLC10 – Geneva, Oct.2010

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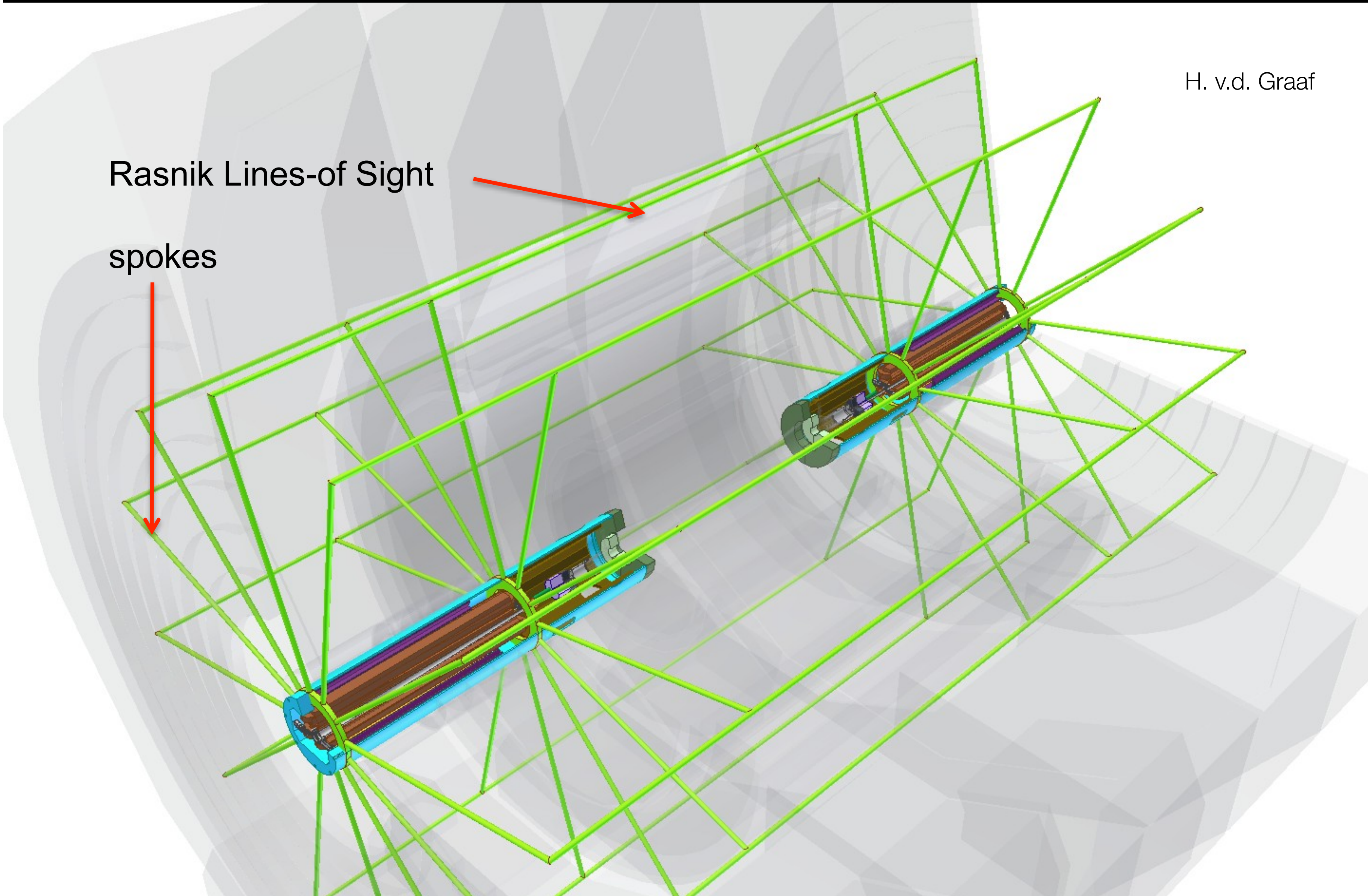
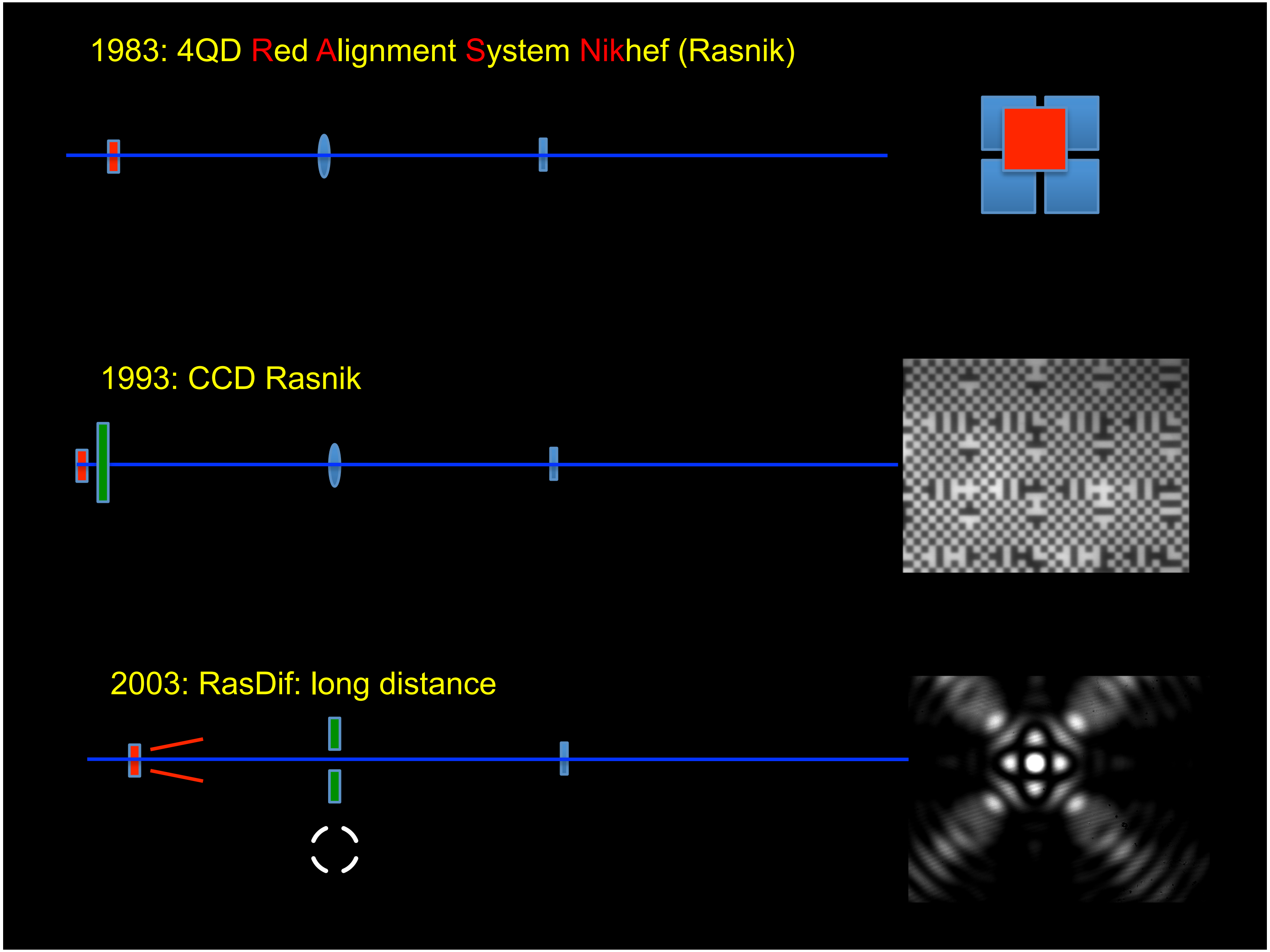
- Pillar de-couples QD0 to some extent from detector
    - direct support from the platform
- Need to do more work on the alignment of QD0s and detector


Rasnik Lines-of Sight
spokes
H. v.d. Graaf


1983: 4QD Red Alignment System Nikhef (Rasnik)
1993: CCD Rasnik
2003: RasDif: long distance

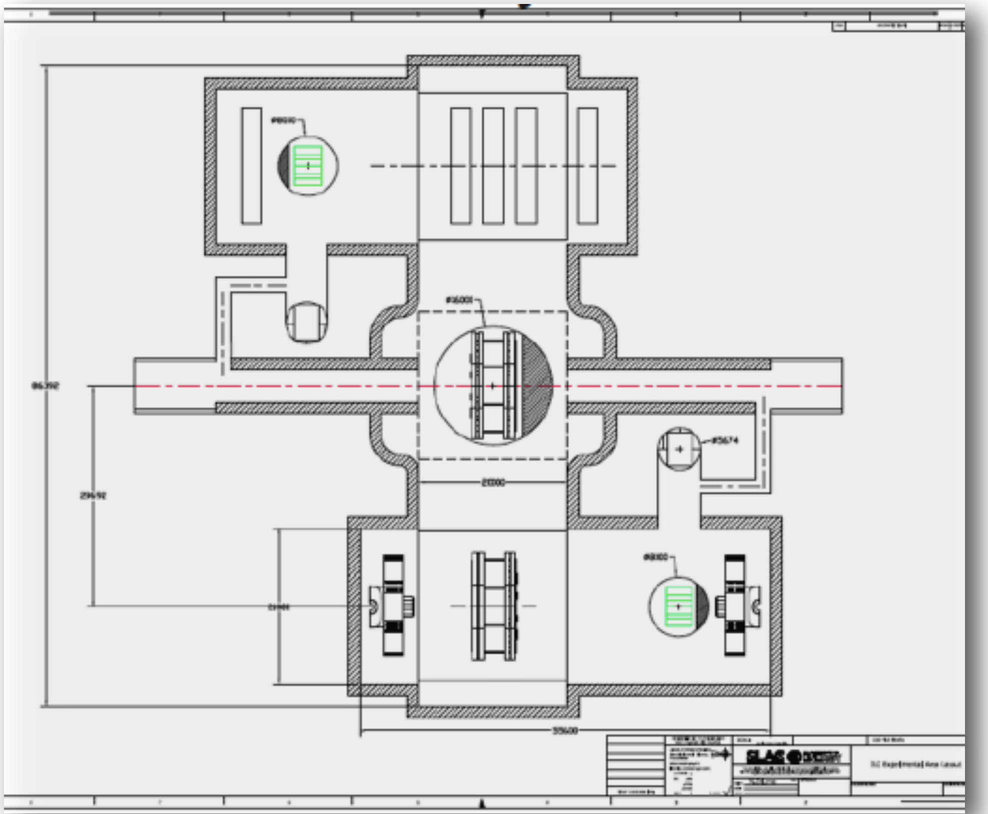
H. v.d. Graaf

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*

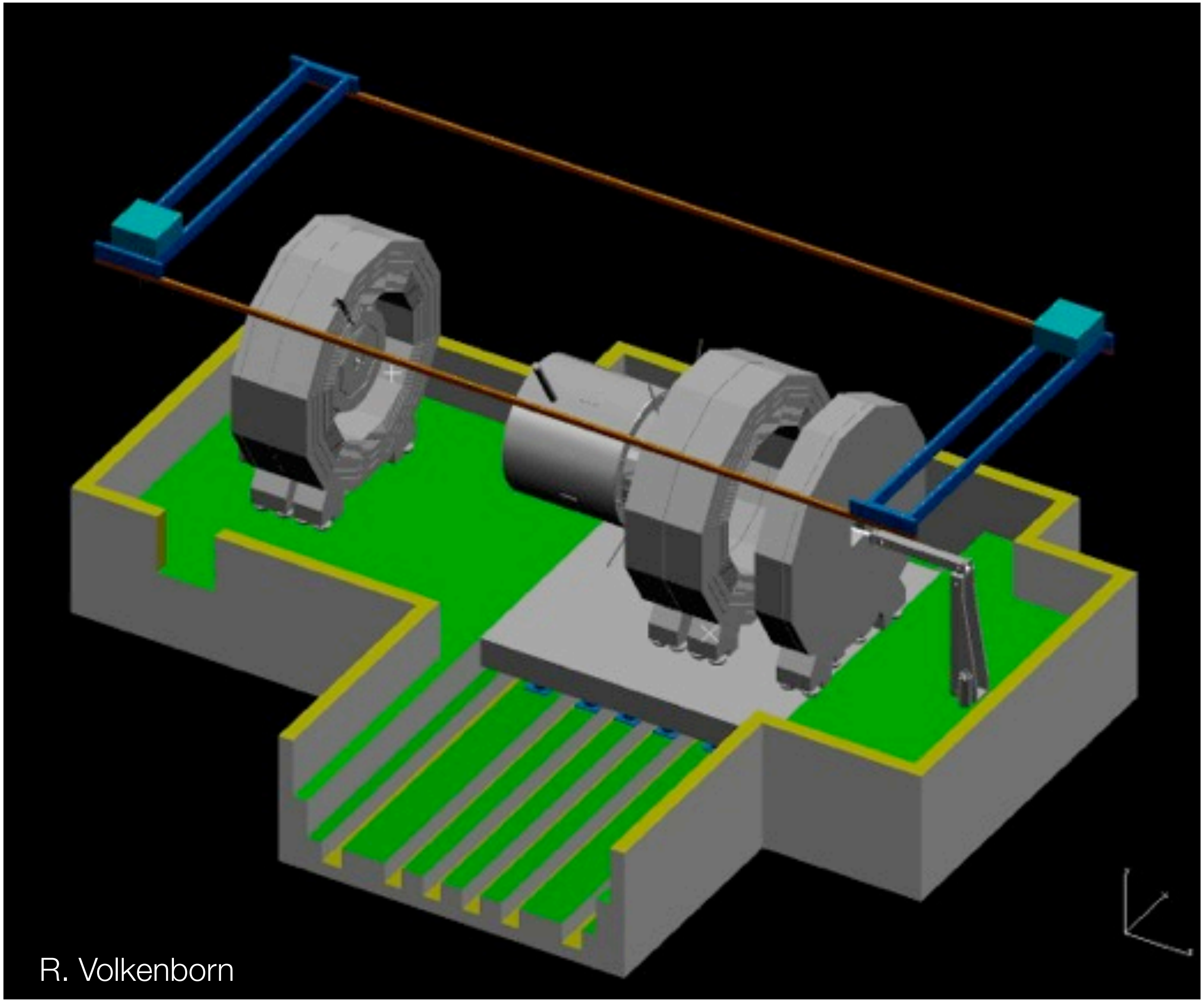
IR Hall Layout for Flat Topography Sites

- Z-Shape
- Garage positions allow detector maintenance
- Only one large (~18m) shaft
    - used only in installation phase
- Maintenance shafts (~9m) in garage positions
- Small shafts for elevators (safety issues)

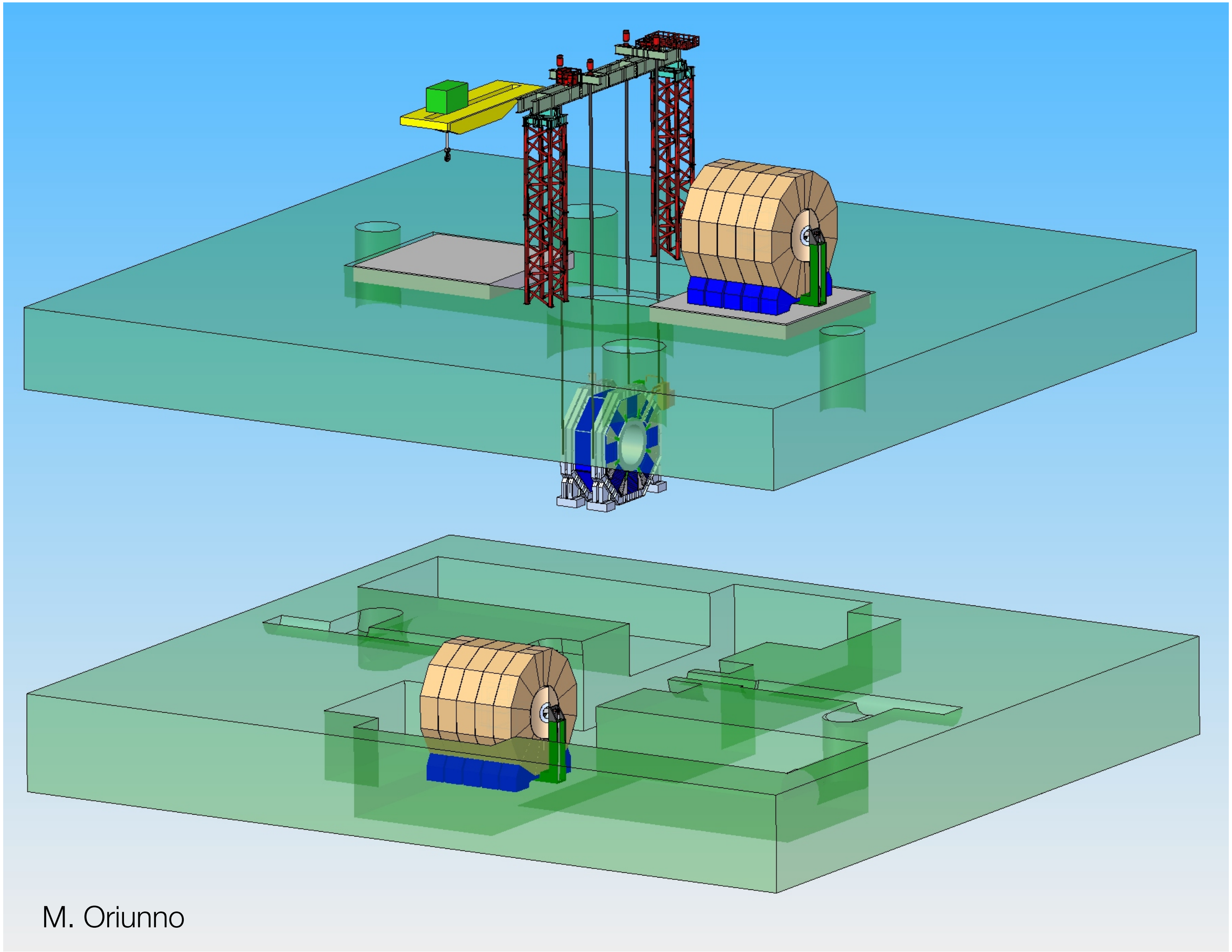


M. Oriunno

ILD in Maintenance Region (non-mountain site)

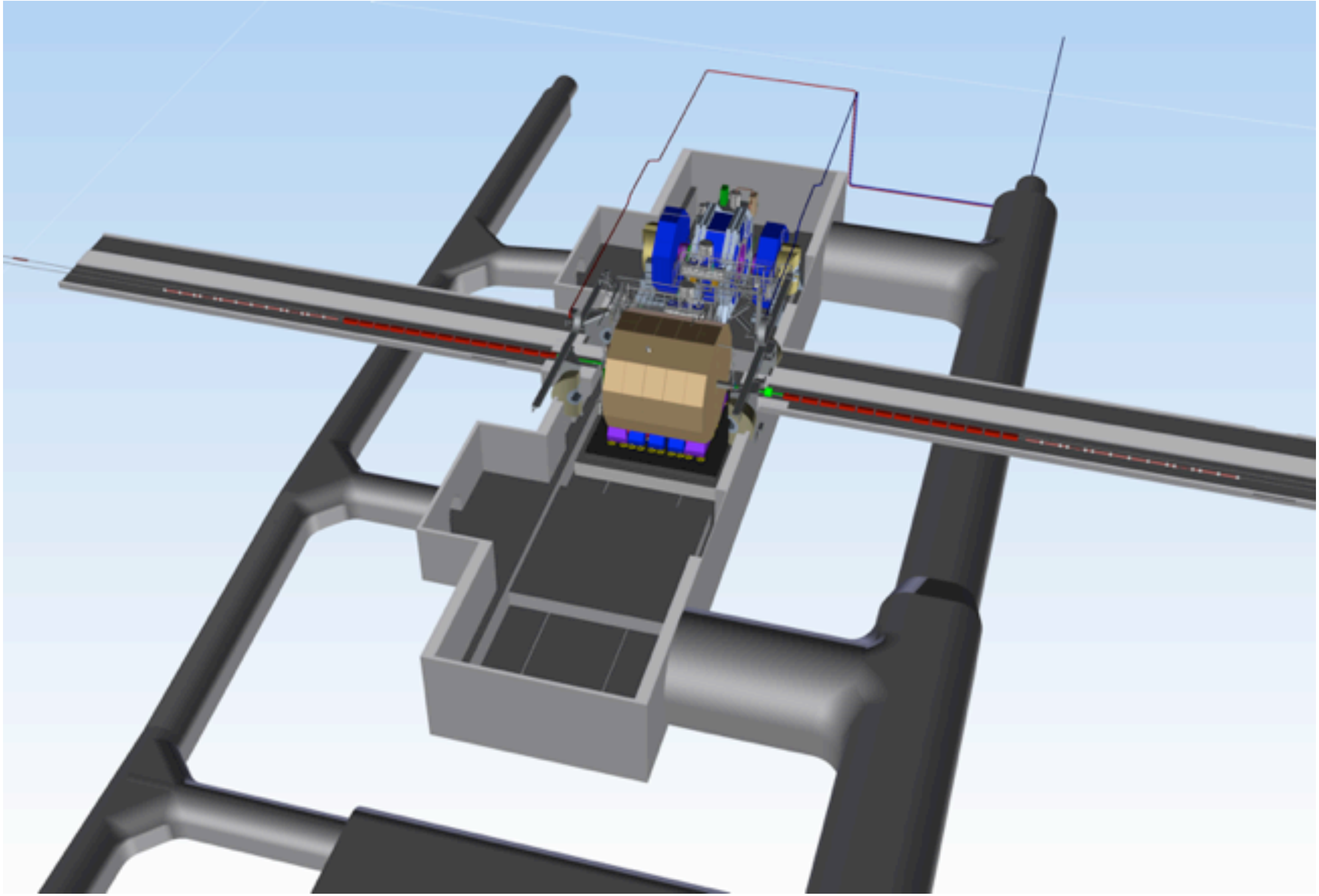


Vertical Shaft Assembly



ILC Mountain Site

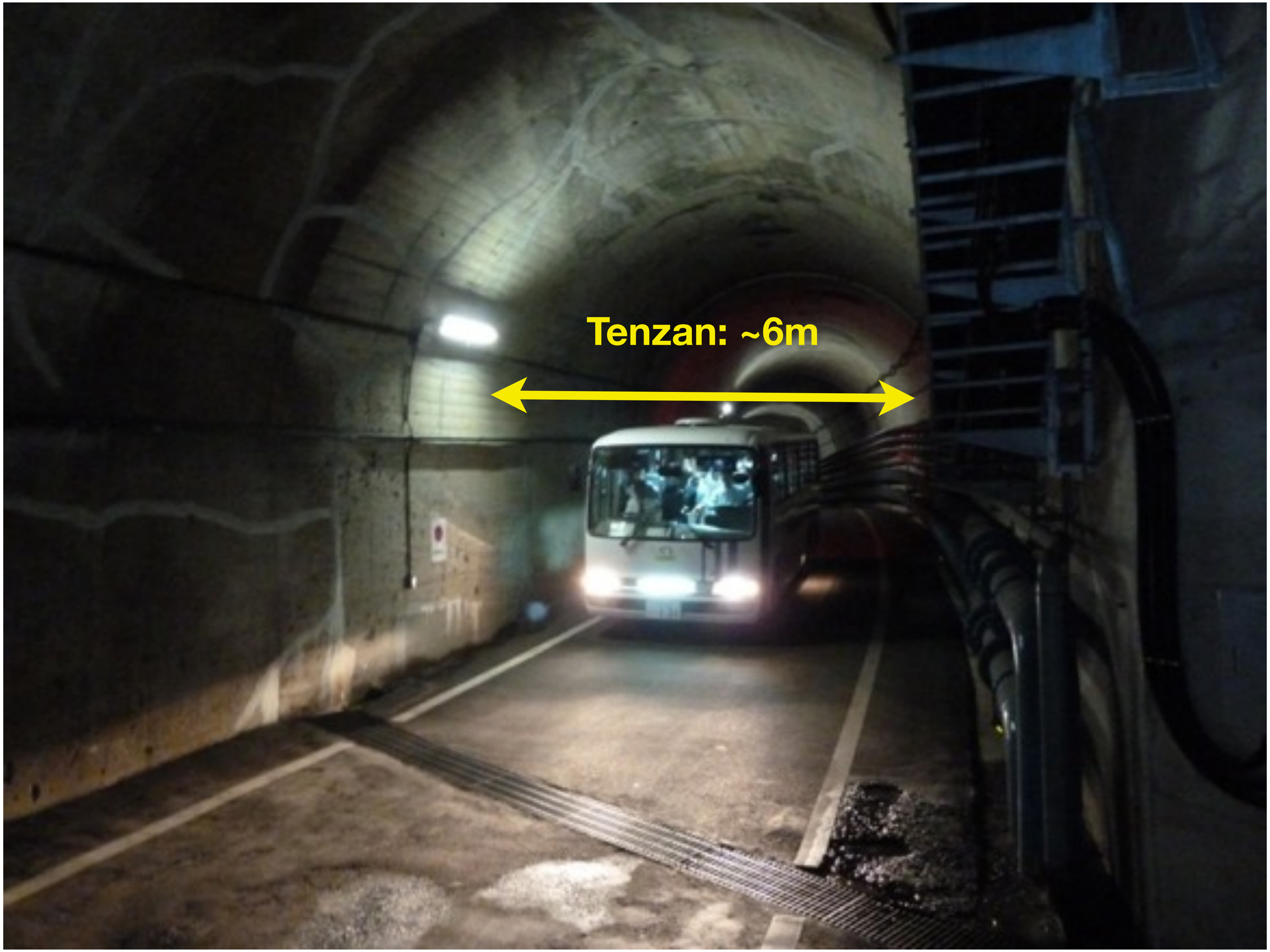
Underground Sites in ILC-EDMS



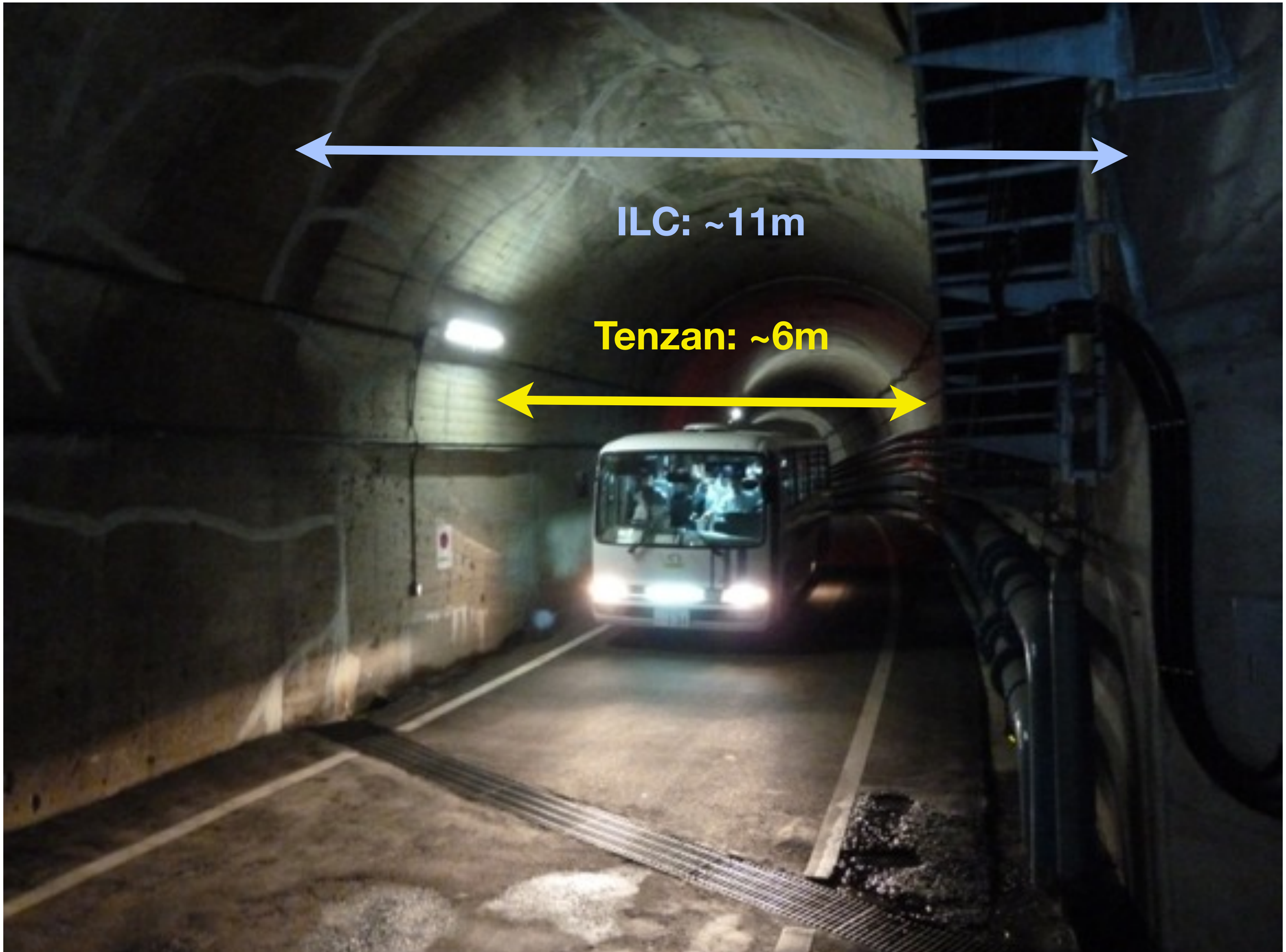
Tenzan Power Plant Underground Hall

Access Tunnel

Access Tunnel



Access Tunnel

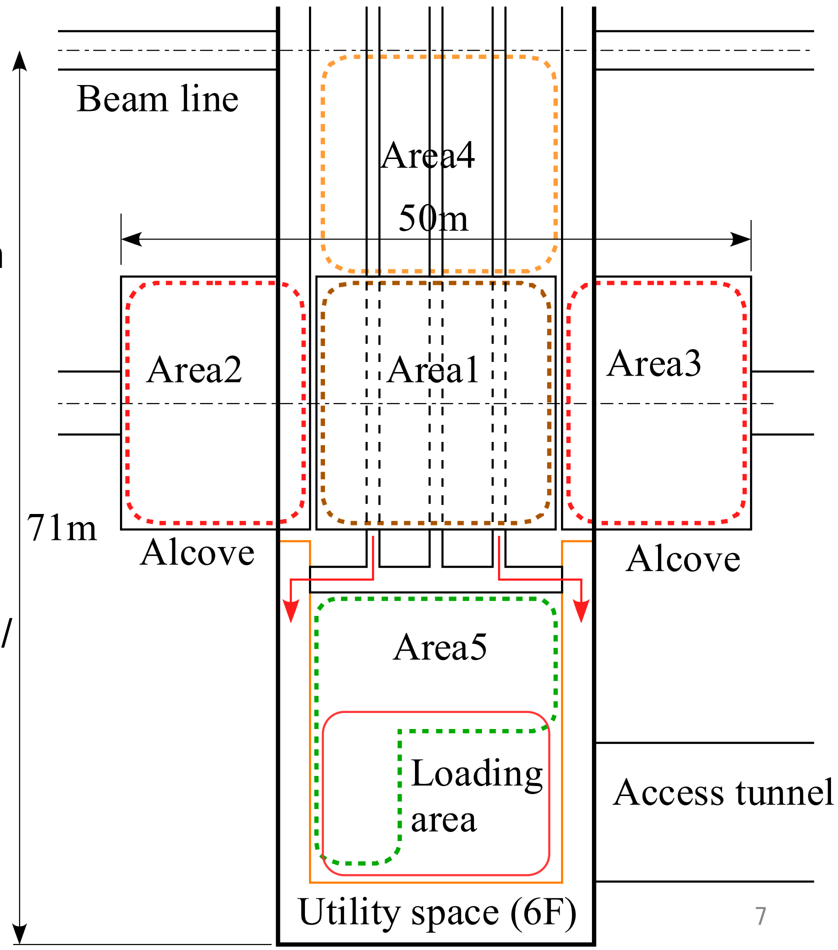


ILD Installation Study (Preliminary)

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



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Need to move big yoke rings in more than one direction!

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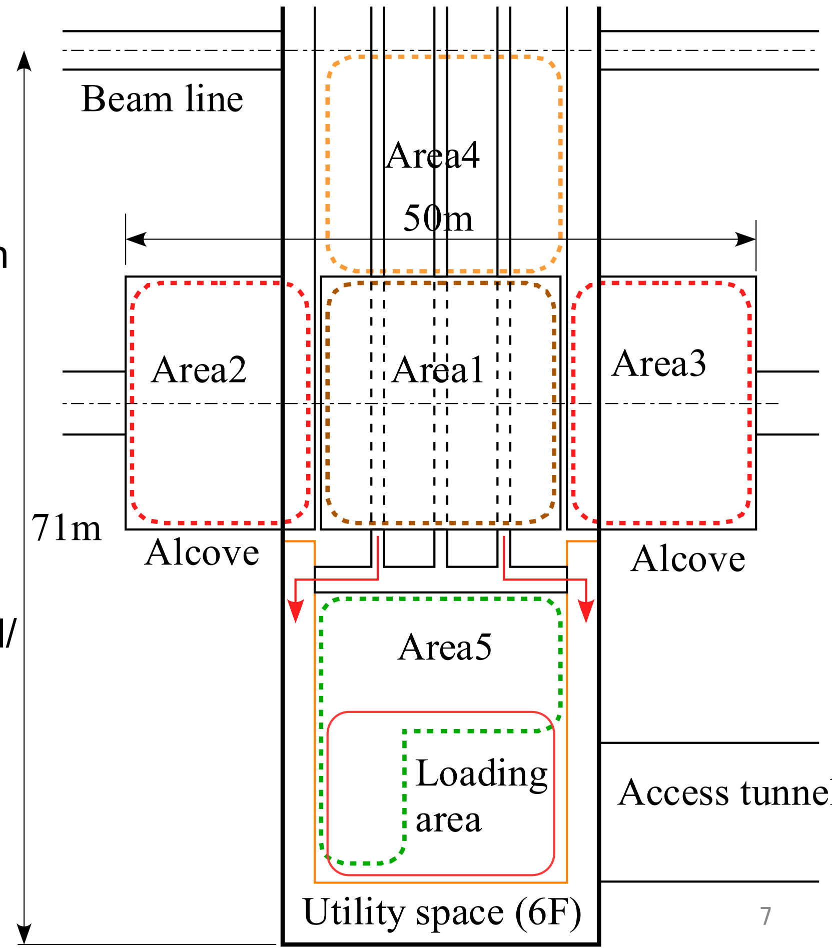

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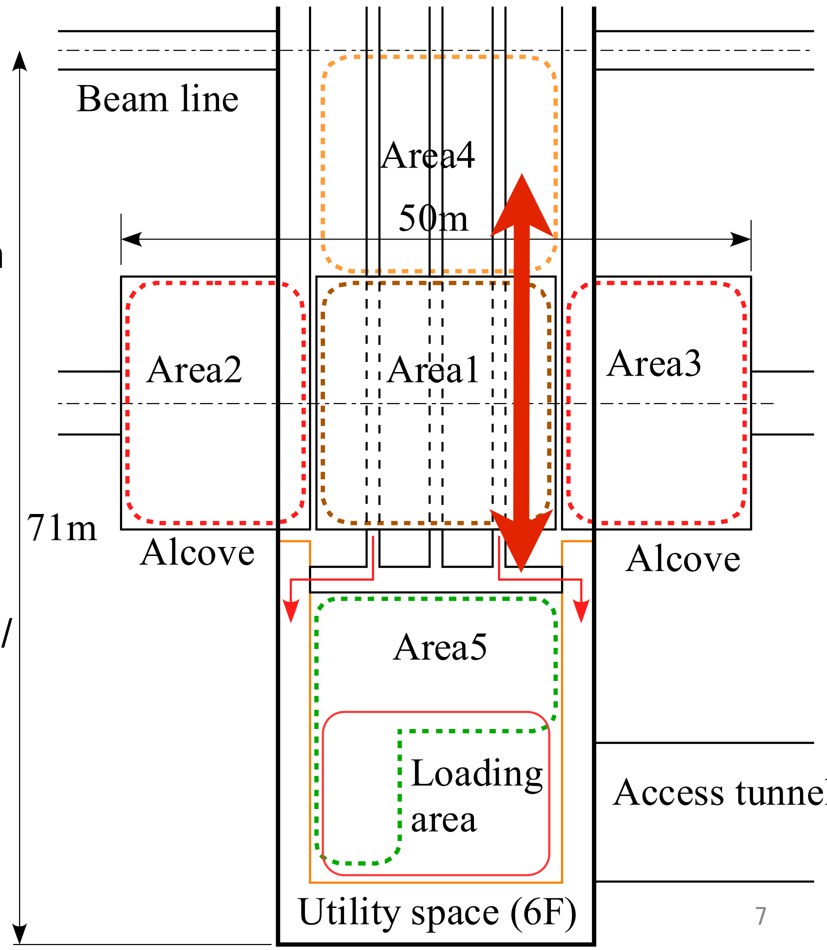

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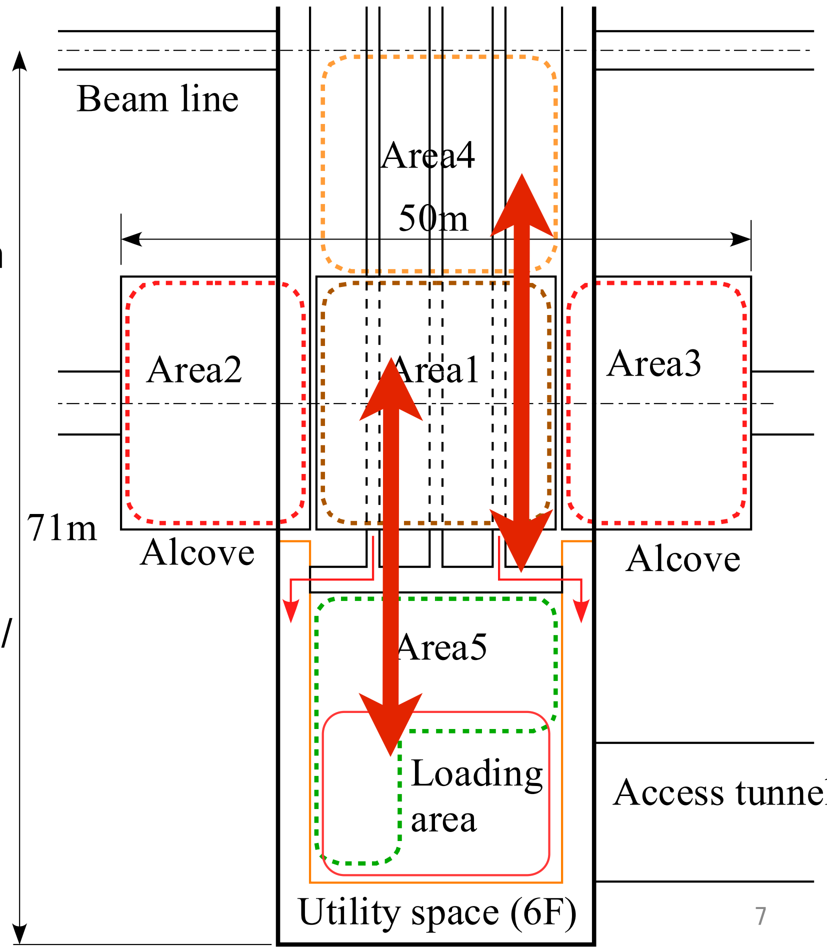

ILD Installation Study (Preliminary)

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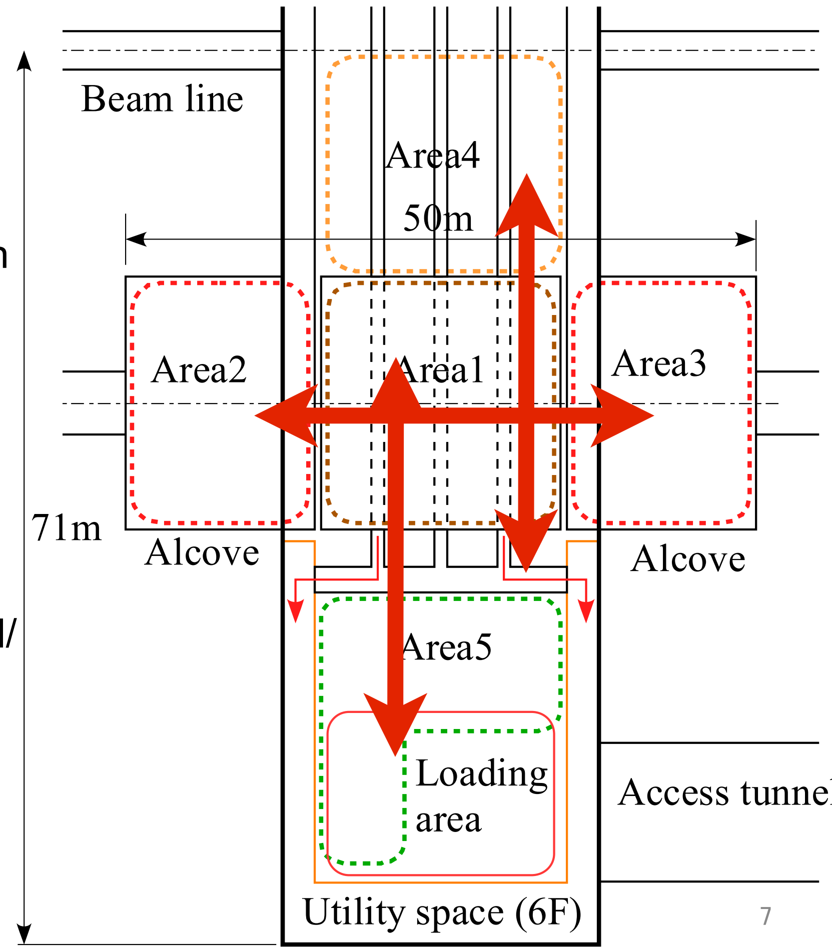
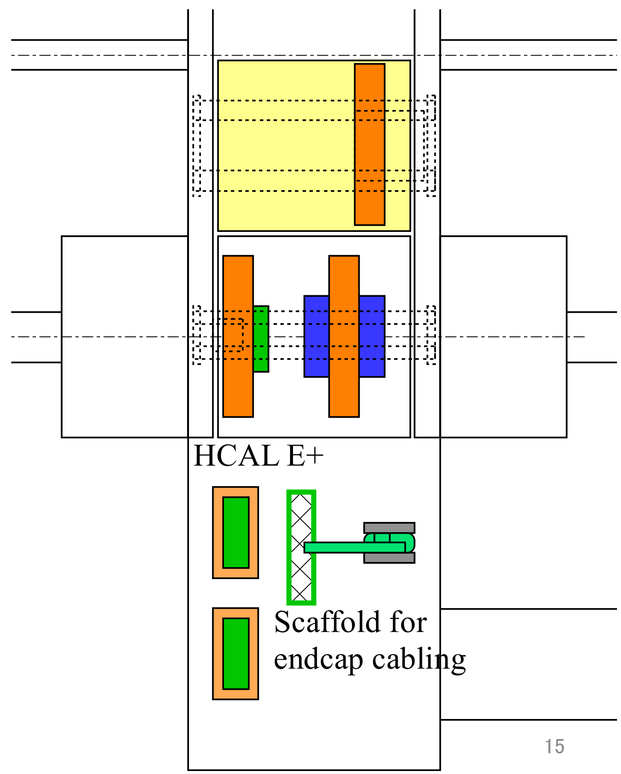


ILD Installation Study (Preliminary)

Step 7

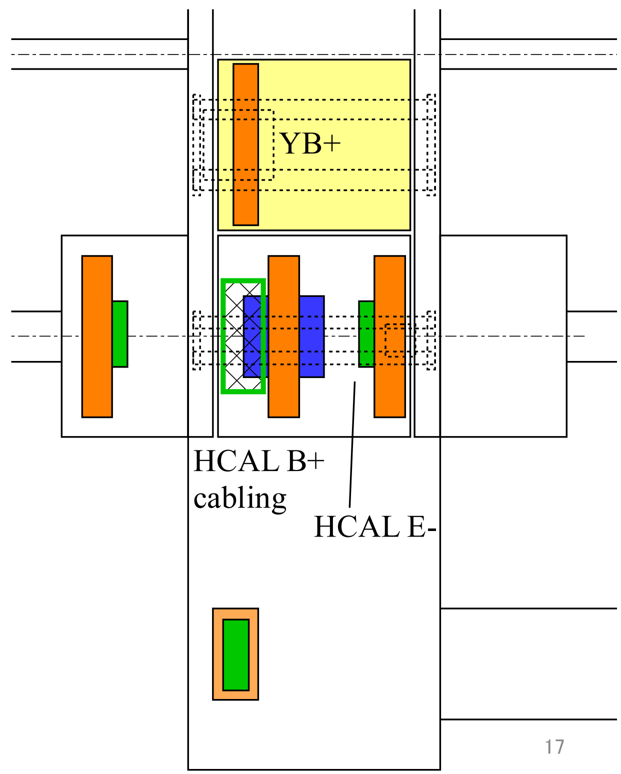
- YB0 shifted in z direction
- Endcap HCAL installation in Area 1
- Scaffold for endcap cabling is assembled in Area 5



ILD Installation Study (Preliminary)

Step 9

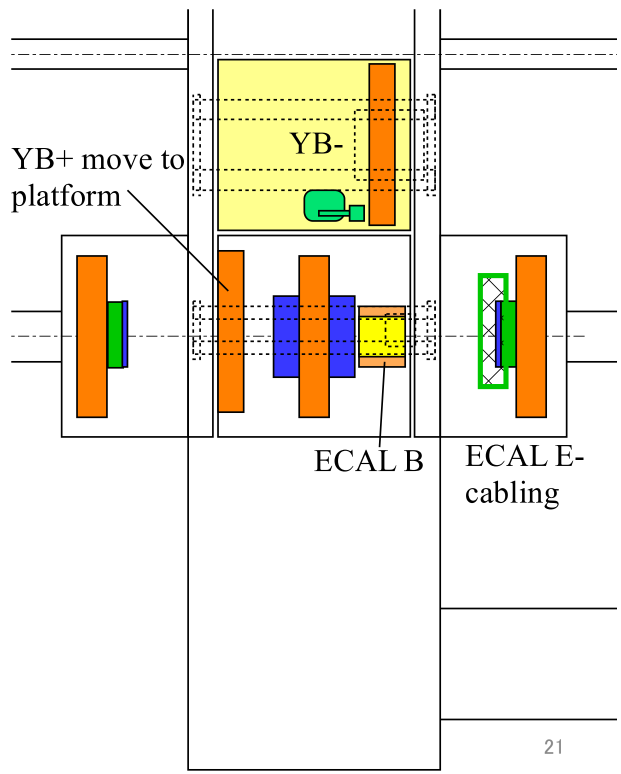
- Another barrel yoke ring YB+ is assembled in Area 4
- Central barrel YB0 is shifted in z direction
- Barrel HCAL (+) cabling in Area 1
- Endcap HCAL (-) installation in Area 1



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



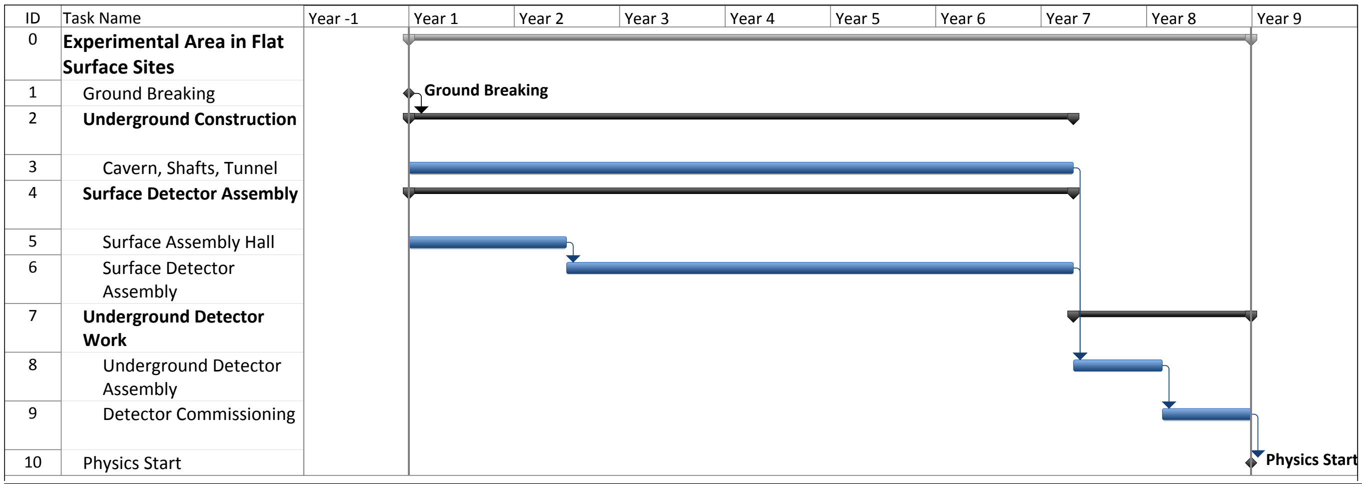
CMS Example (Video by Klaus Sinram)

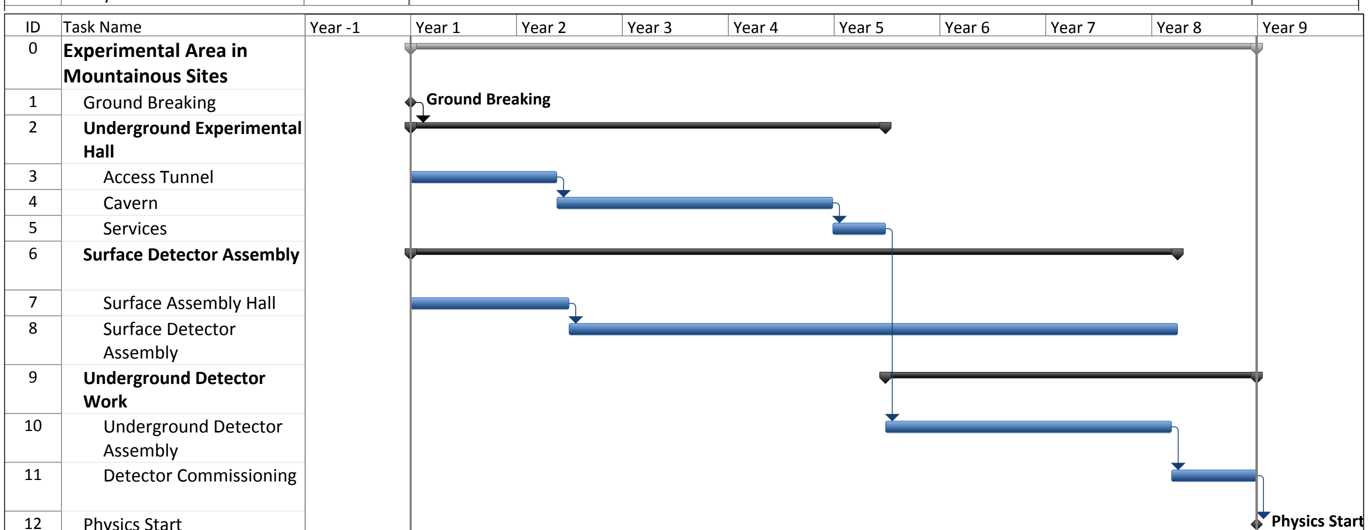
Study needed

- How do we really plan to move big detector parts around in the Japanese hall design?
- Air pads are fine to get things off the ground
- But we need to find a solution to safely guide and push or pull the heavy objects...
- CMS uses fixed steel cables and gripper jacks
    - fine for one-dimensional movements
        - as for ILD when it is installed
    - but what can be done if we need more flexibility in the installation phase?

Time Constraints

- Detector assembly possible in both site versions within 8 years
- Timelines for detector and machine assembly are less coupled in flat-top sites





Future Tasks for a common MDI group

- The MDI Common Task Group comes to a formal end now
- But the work needs to continue
  - Technical and engineering details to be studied
  - Want to keep momentum

- MDI experts want to continue on certain level
- Engineering resources will be very difficult in the coming years

- Started discussions within the MDI-CTG on possible work plan for the next 1-2 years
  - This plan needs to be possible to be executed resource-driven
  - Needs re-adjustment when the details of the future collaboration become clearer

- Maybe we should really start with a second look at the requirements...

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
- Meeting during this workshop is the first „all hands“ ILD meeting to discuss future structures and plans
- Will try to re-start the ILD engineering work as soon as possible
  - this work is resource-driven, not task-driven....

- I don‘t know (at the time when I write this talk) whether a formal common MDI group will exist in the new LCC structures
- But we should anyhow keep the close contacts in this business!