ILD Machine-Detector Interface
Overview and Future Plans

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21.12.2012
ILC Tokosui Workshop

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

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

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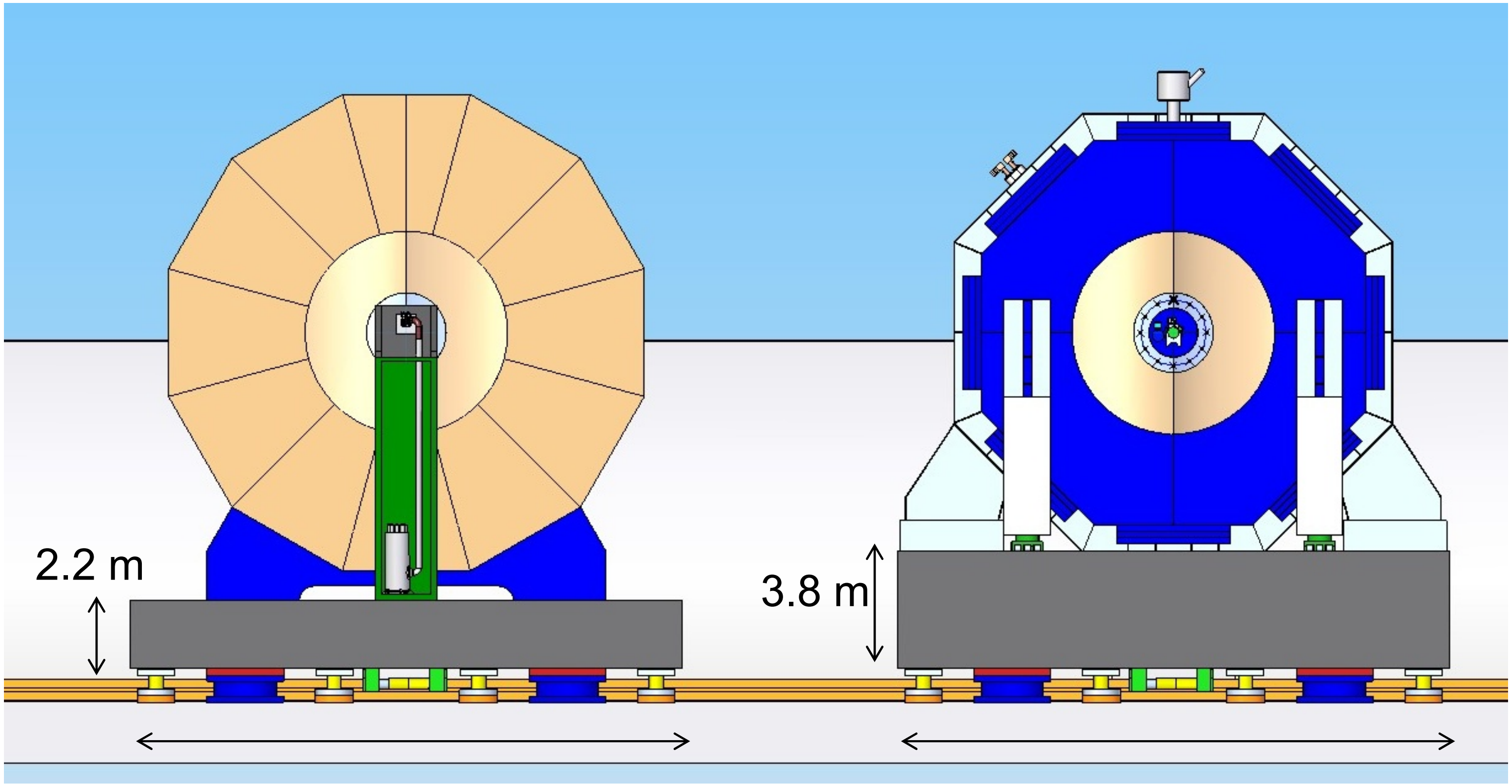
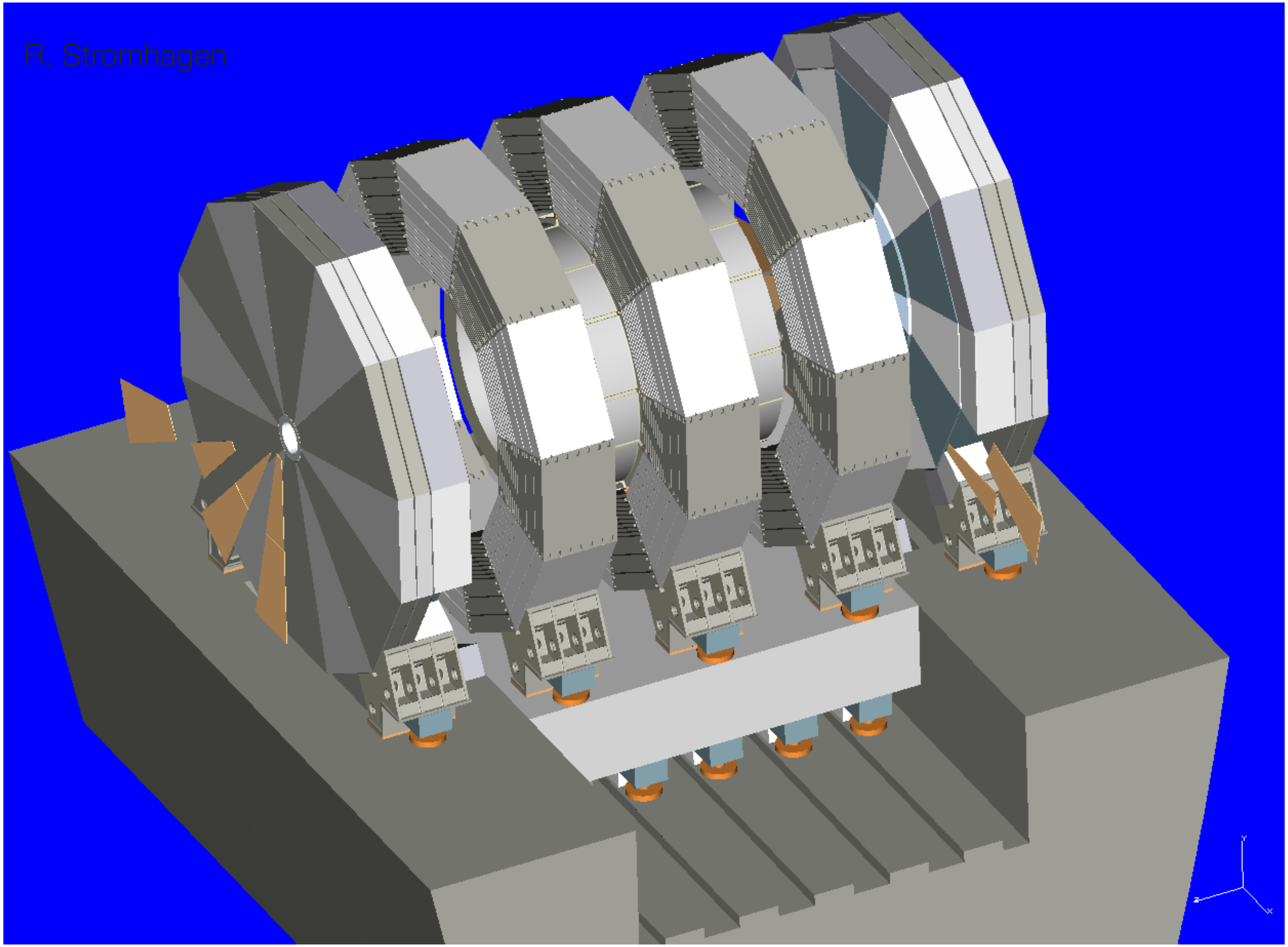
Abstract
The Interaction Region of the International Linear Collider [1] is based on two experimental detectors working in a push-pull mode. A time efficient implementation of this model sets specific requirements and challenges for many detector and machine systems, in particular the IR magnets, the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

Push-pull System

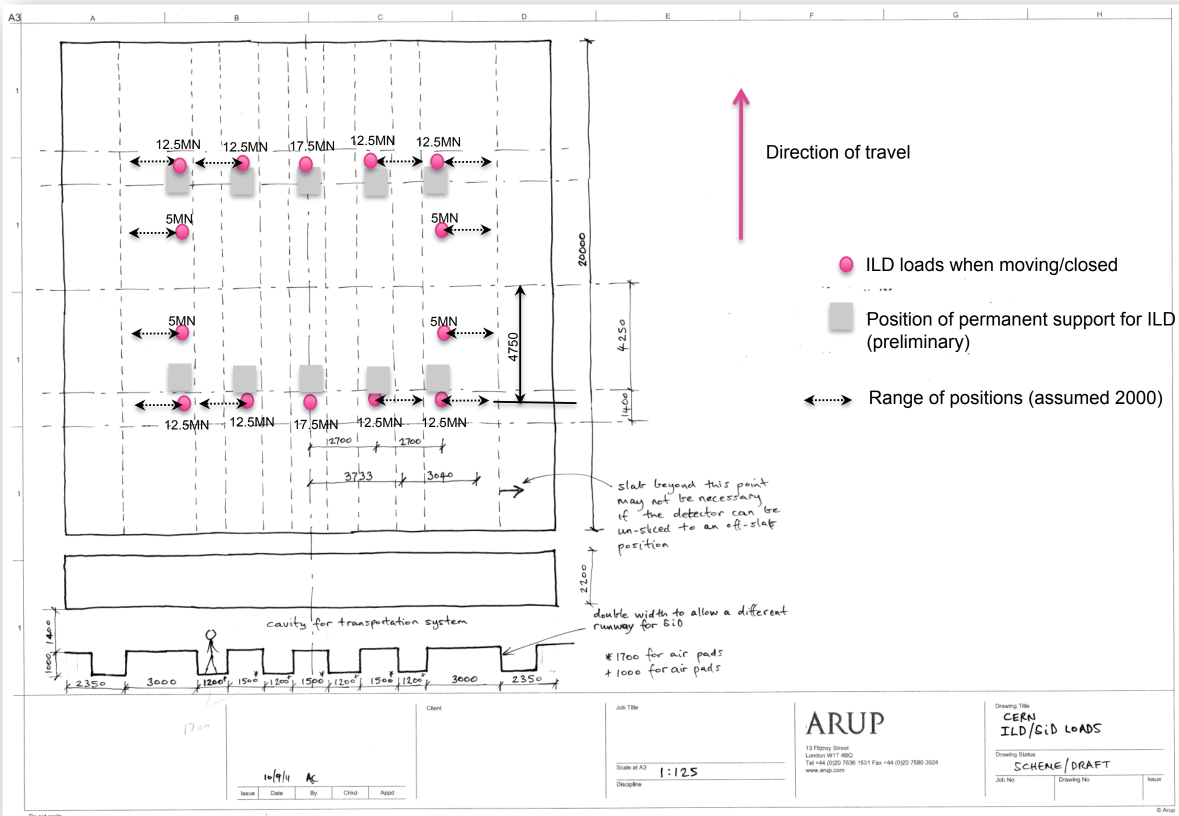


- Platform based detector motion system
- Allow turn-arounds (lumi-lumi transition) in a few days

ILD Design



ARUP Task 1: Platform Design

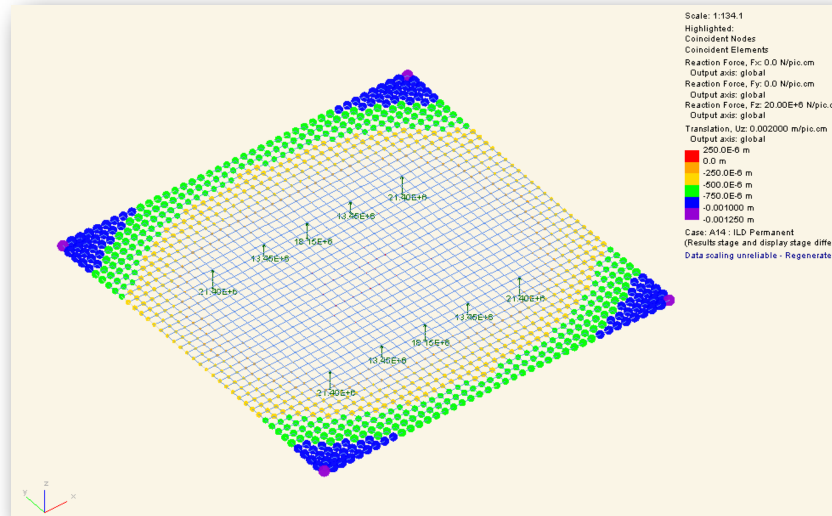


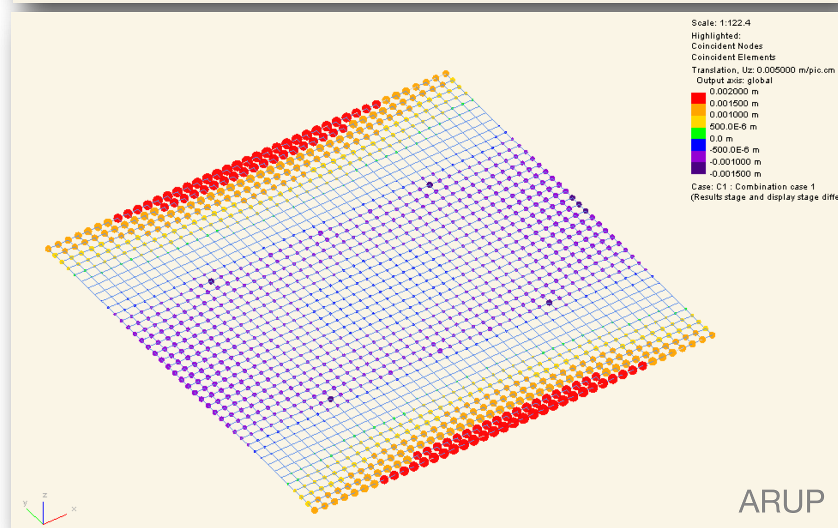
ARUP

- ILD is the bigger challenge: heavier and larger than SID:
  - Thinner platform at same beam height
  - Larger loads on platform

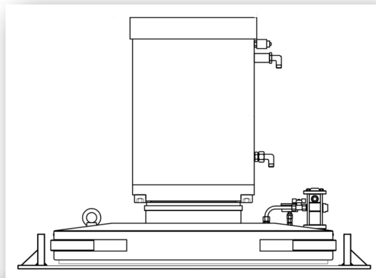
ARUP Task 1: Platform flexures

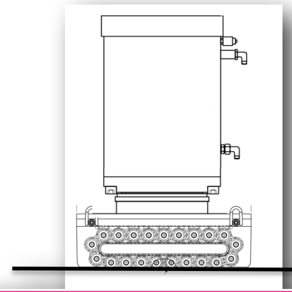
- Unloaded platform:
  - Flexure: +0.25mm; -1.25mm
- Loaded platform jacking onto transport system:
  - Flexure: +1.9mm; -1.0mm





ARUP Task 1:
Detector Movement System





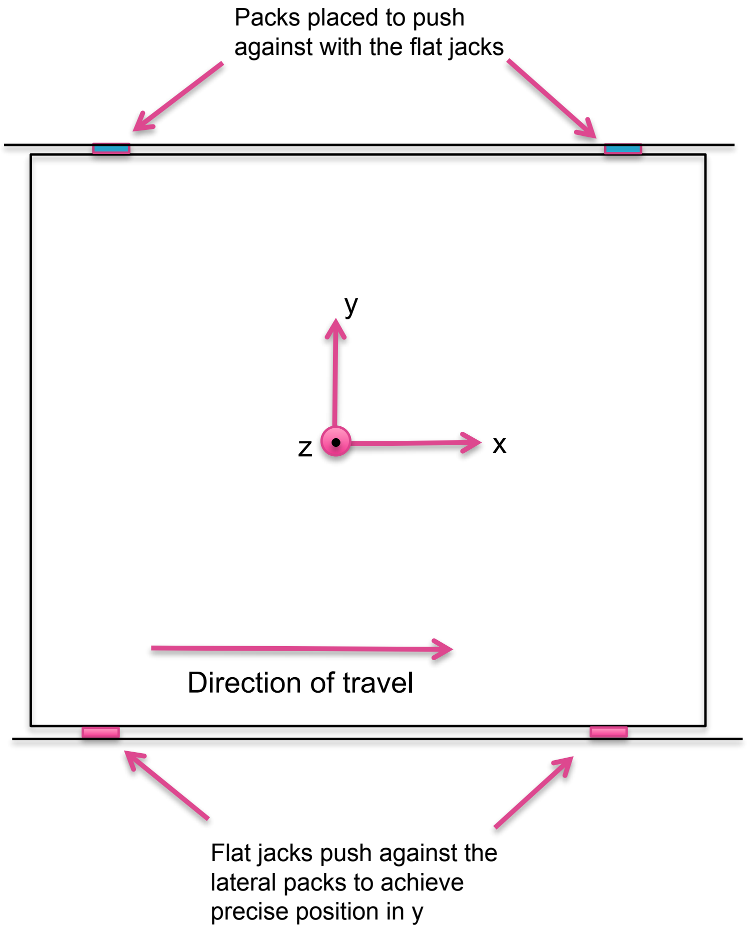
Pads	Rollers
Min 60 required (for ILD, no redundancy)	Min 18 required (for ILD)
No hardened track->can accommodate minor steps	Specialist hardened and flattened track
Design for 1% friction	Design for 3% friction
Pressure infrastructure	Larger propulsion infrastructure
Run-away	Higher friction ->less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

ARUP

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

ARUP Task 1: Positioning System

The final positioning system



Degree of freedom	Methodology
x, Rzz	Push pull system
z, Rxx, Ryy	Pack adjustment under slab
y (air-pads) *illustrated*	Lateral push with flat jacks whilst air pads are active
y (rollers) *illustrated*	Lateral push with flat jacks whilst the lateral slider (on the roller) is un-locked

Note, Rxx is rotation about the x-axis, etc

ARUP

Conclusion on ILD movement

Moving the Detector

- **Can achieve disp limits of +/-2mm when moving**
  - ILD on 2.2m slab with pads or rollers
  - SiD on 3.8m slab with pads or rollers
  - Design works with pads and rollers, choice outside scope of assessment
- **Recommended Contingency/Studies**
  - Jacking and packing if the invert does flex (to keep the slab permanent supports plane)
  - Provide 50mm packing from the start to allow the height to be reduced
  - Evaluate slab final positioning systems (eg PTFE sliding surface)
  - Movement system not examined in detail (stick-slip accelerations require evaluation, $0.05m/s^2$)

Un-slicing

- **Limits exceeded when un-slicing…….but not applicable**
- **But props/shims will be needed under tracks when un-slicing to avoid a step**

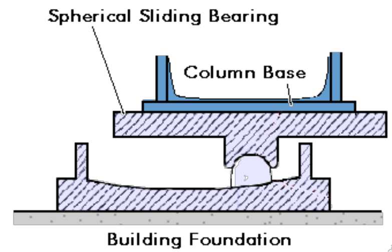
BUT

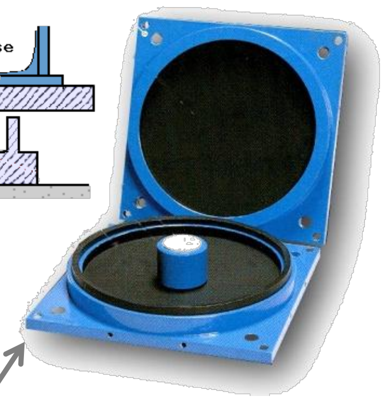
- **Conclusions above dependent on invert flex ----- Displacement limit of ~0.5mm**

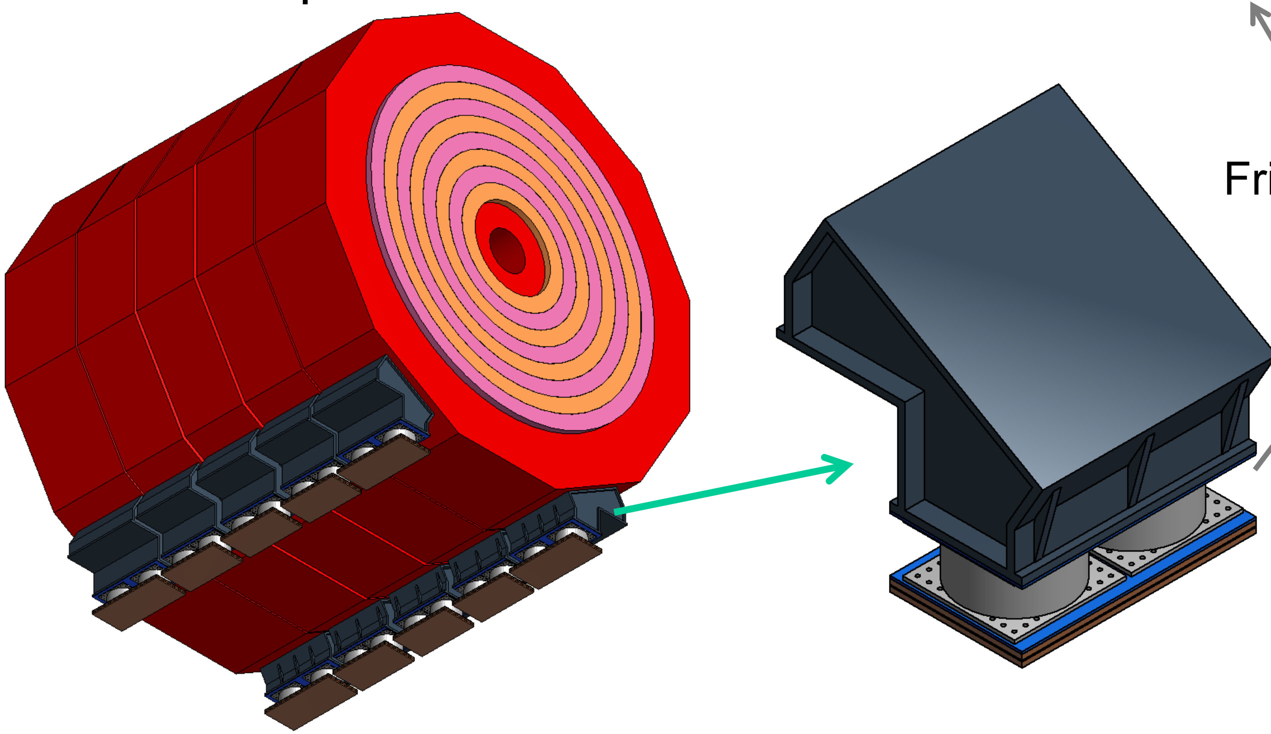
ARUP

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



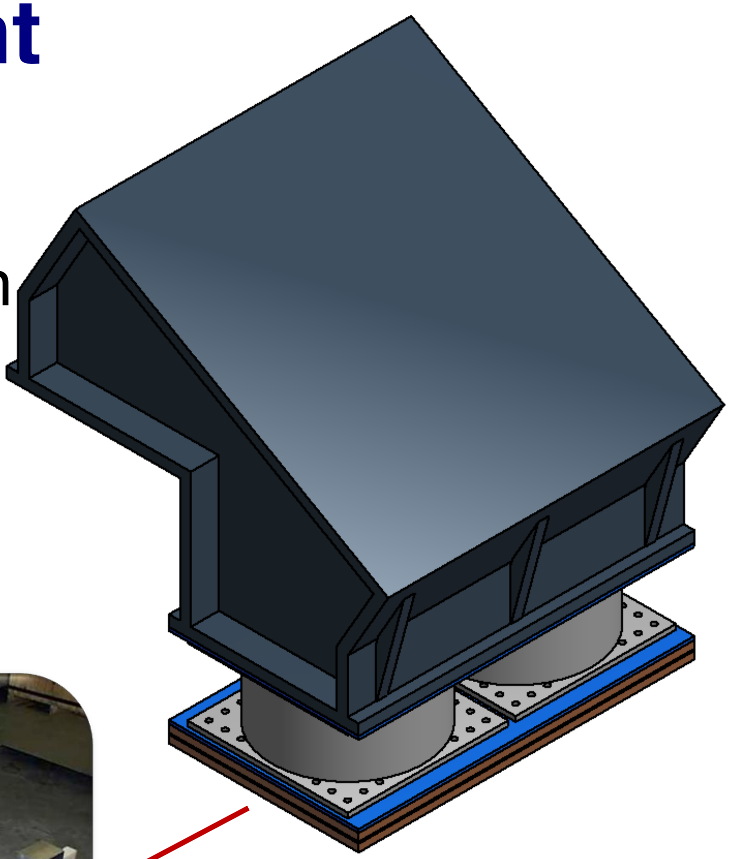


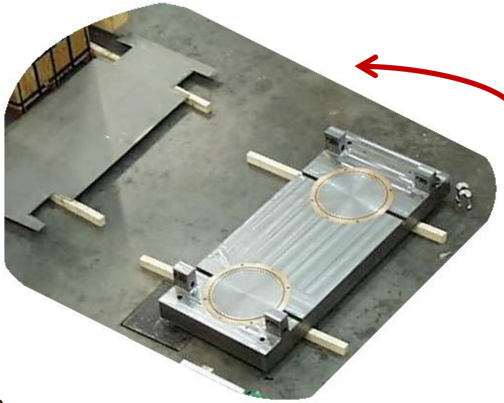


Friction pendulum bearings

Final precise adjustment

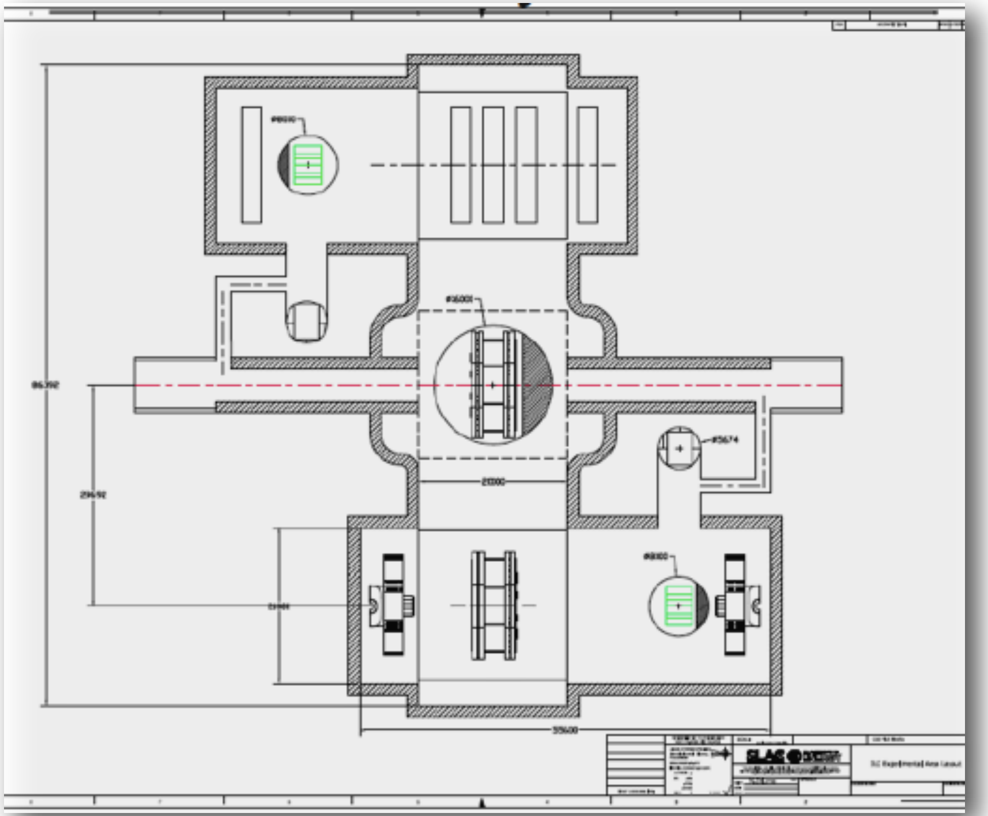
- The grease pads are needed to allow a final precise adjustment of the main components of each detector. The grease will lower the friction between the sliding components and therefore less force is needed.





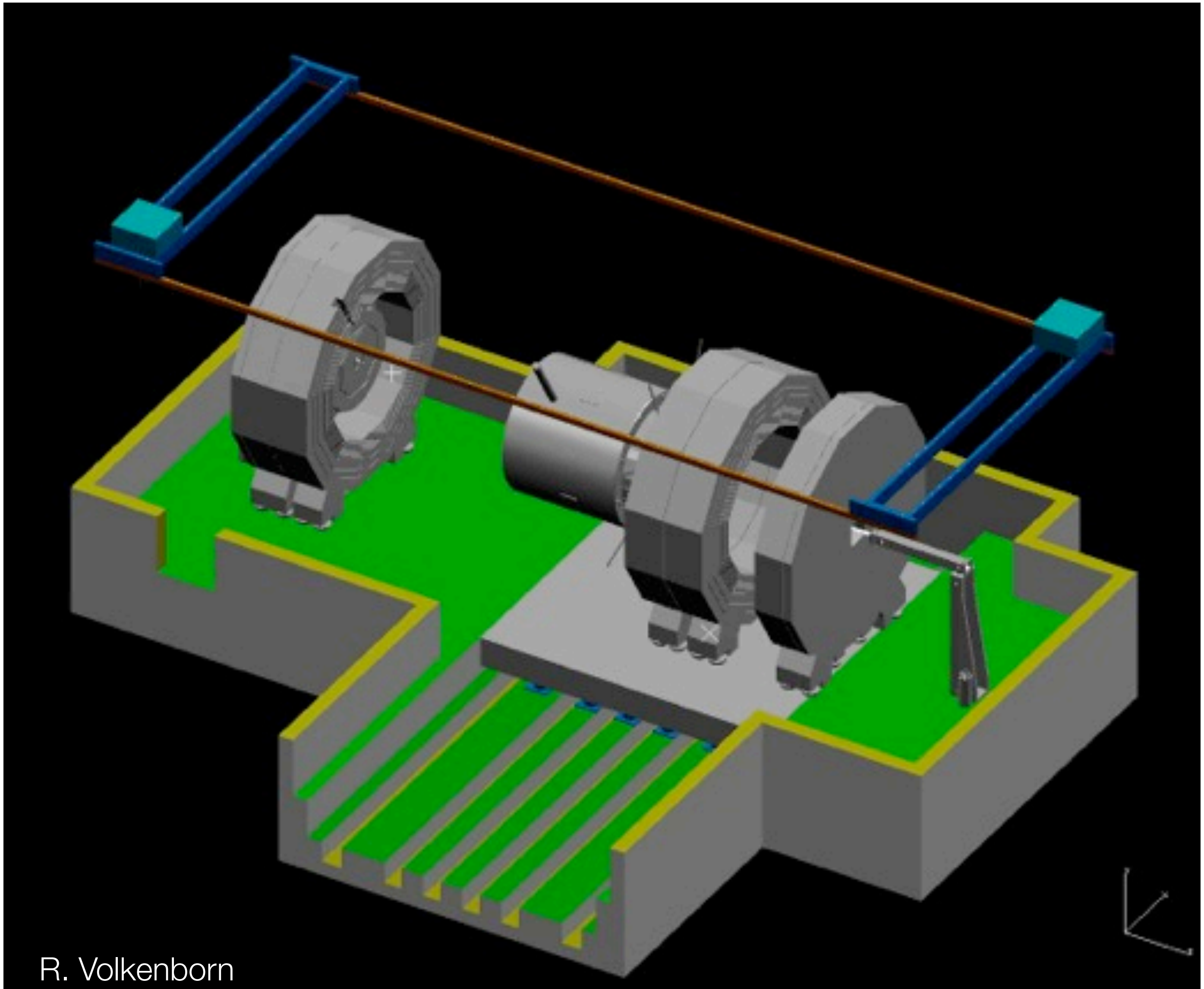
IR Hall Layout for Flat Topography Sites

- 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)



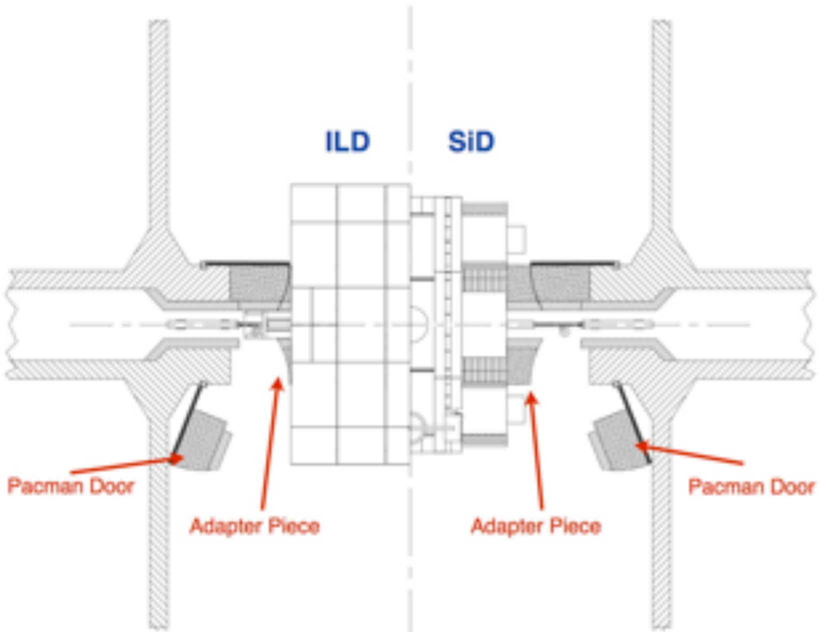
M. Oriunno

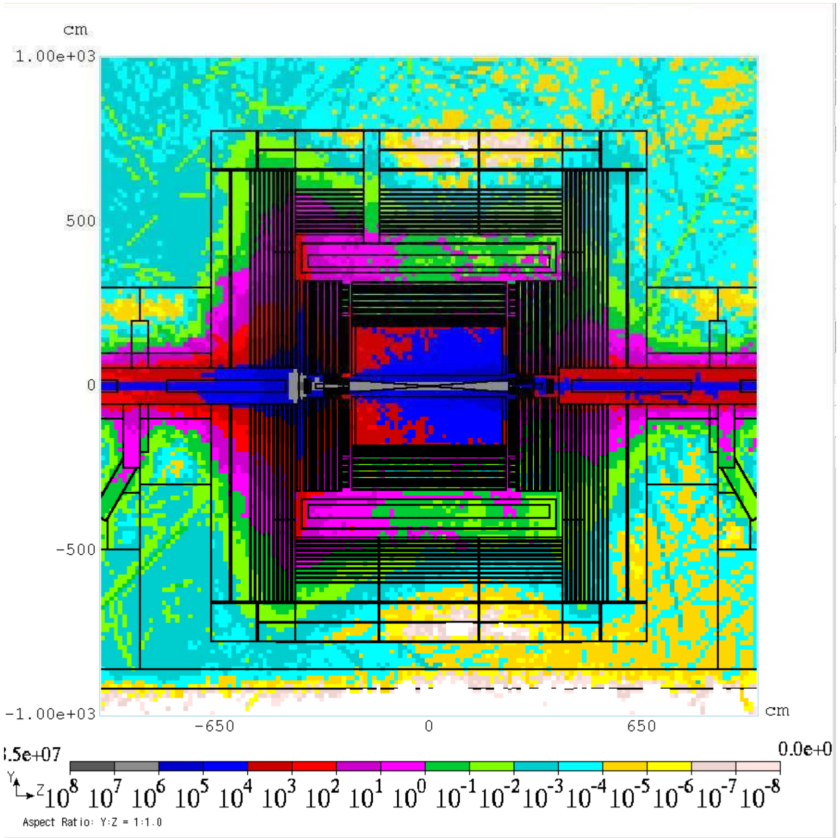
ILD in Maintenance Region (non-mountain site)



Interaction Region Radiation Shielding

- Detectors are self-shielding w.r.t. maximum credible beam loss scenarios
- Adaptable shields between hall and detector („pacman") required

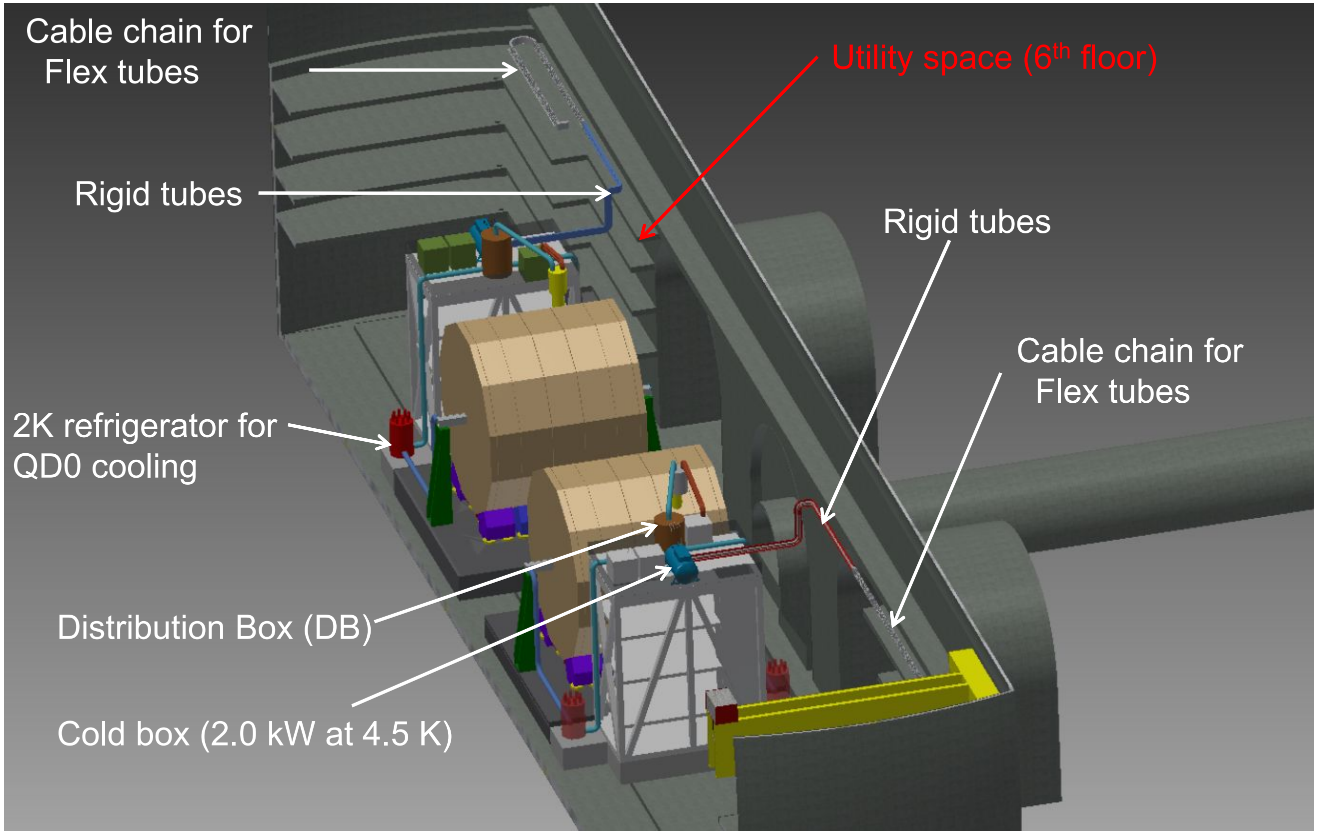




Sanami et al., SLAC-RP-09-08

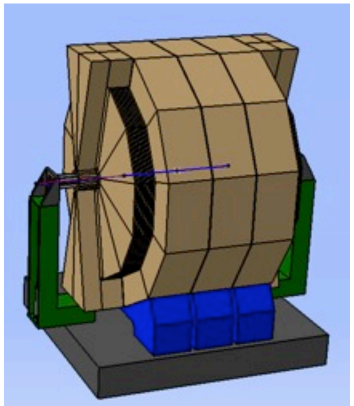
Common Services

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

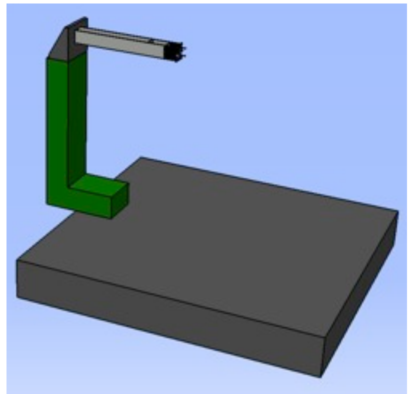


QD0 Supports in Detectors

ILD00 model



ILD QD0 support system



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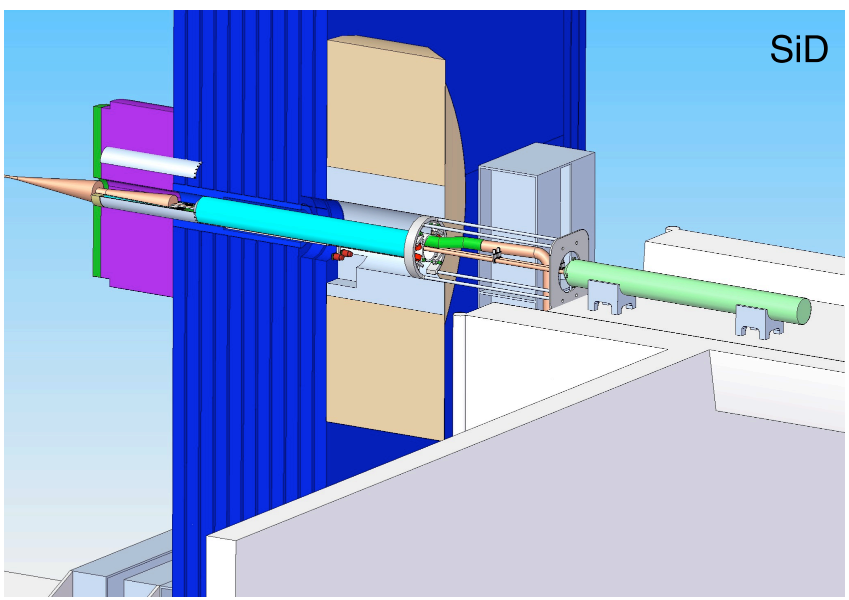
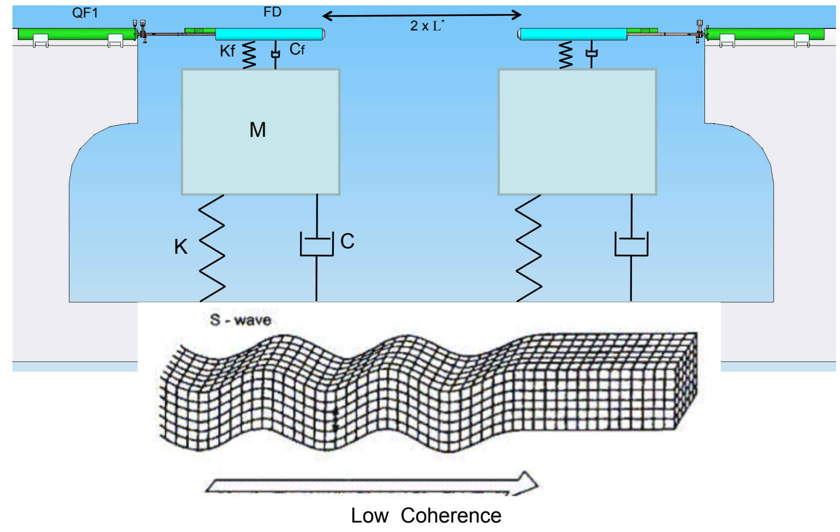
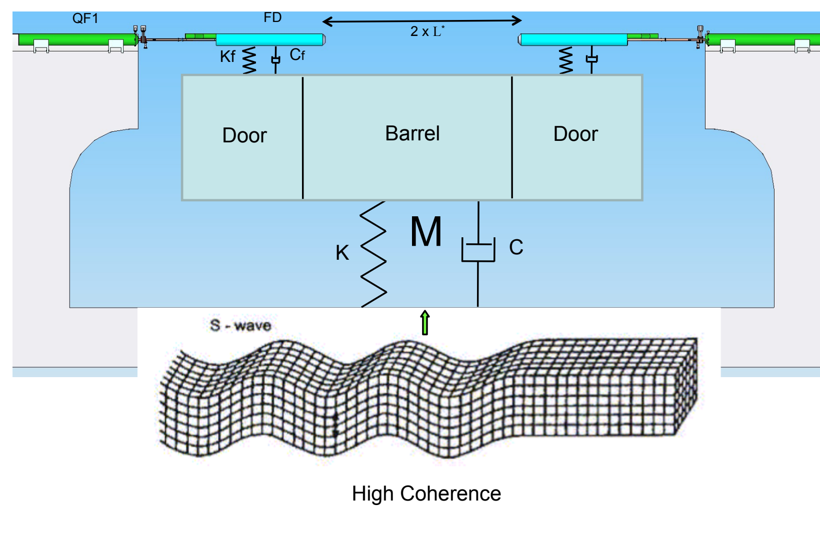


Independent Supports (Cavern,Pillars Platform)

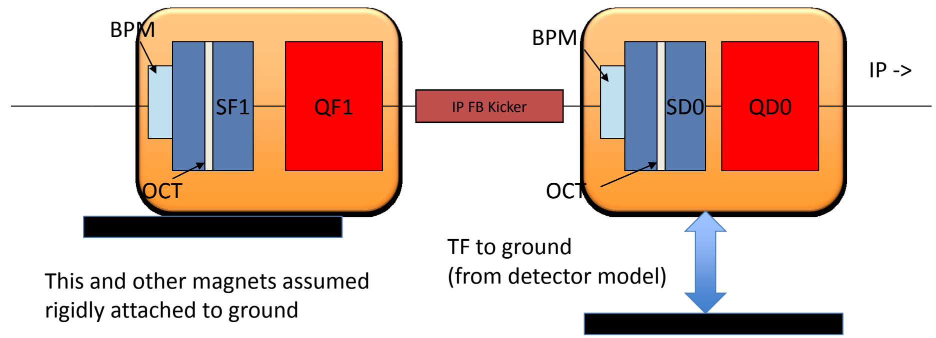


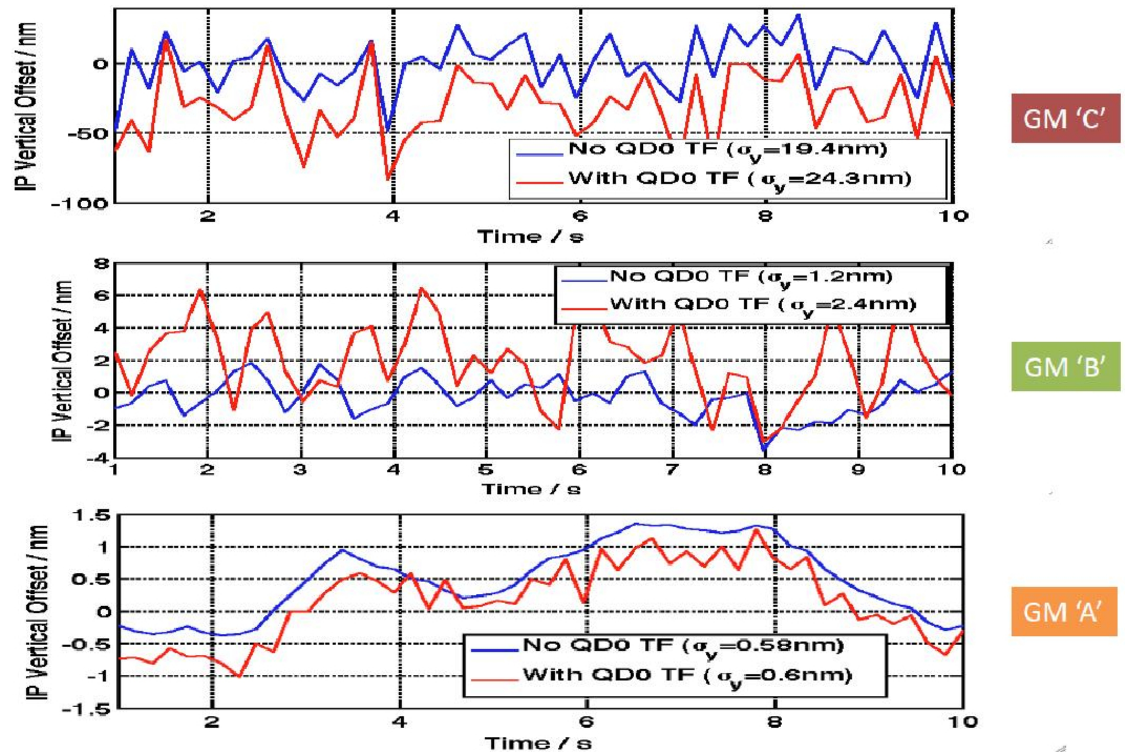
Common Supports (Detector under mag.field)

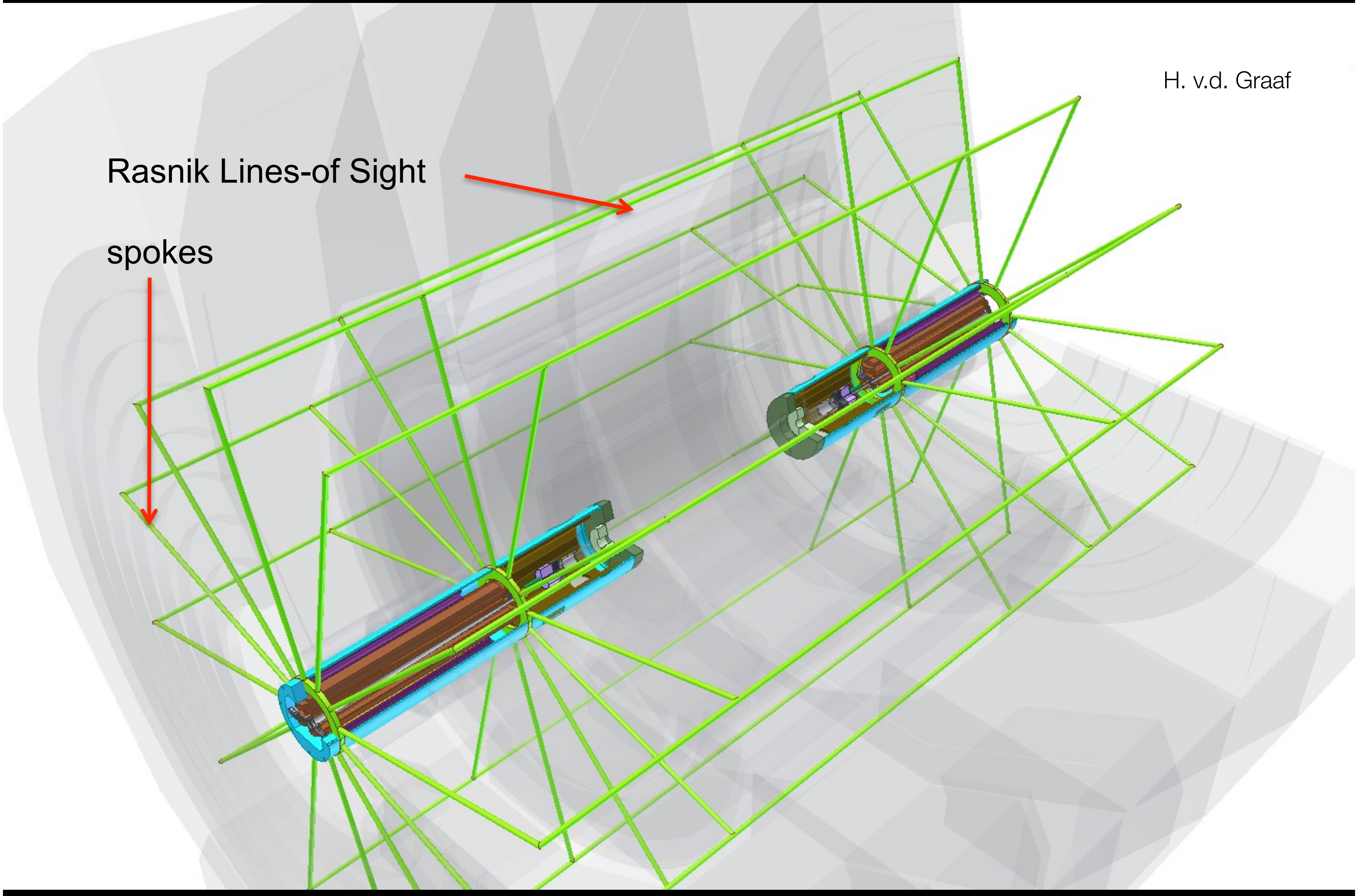


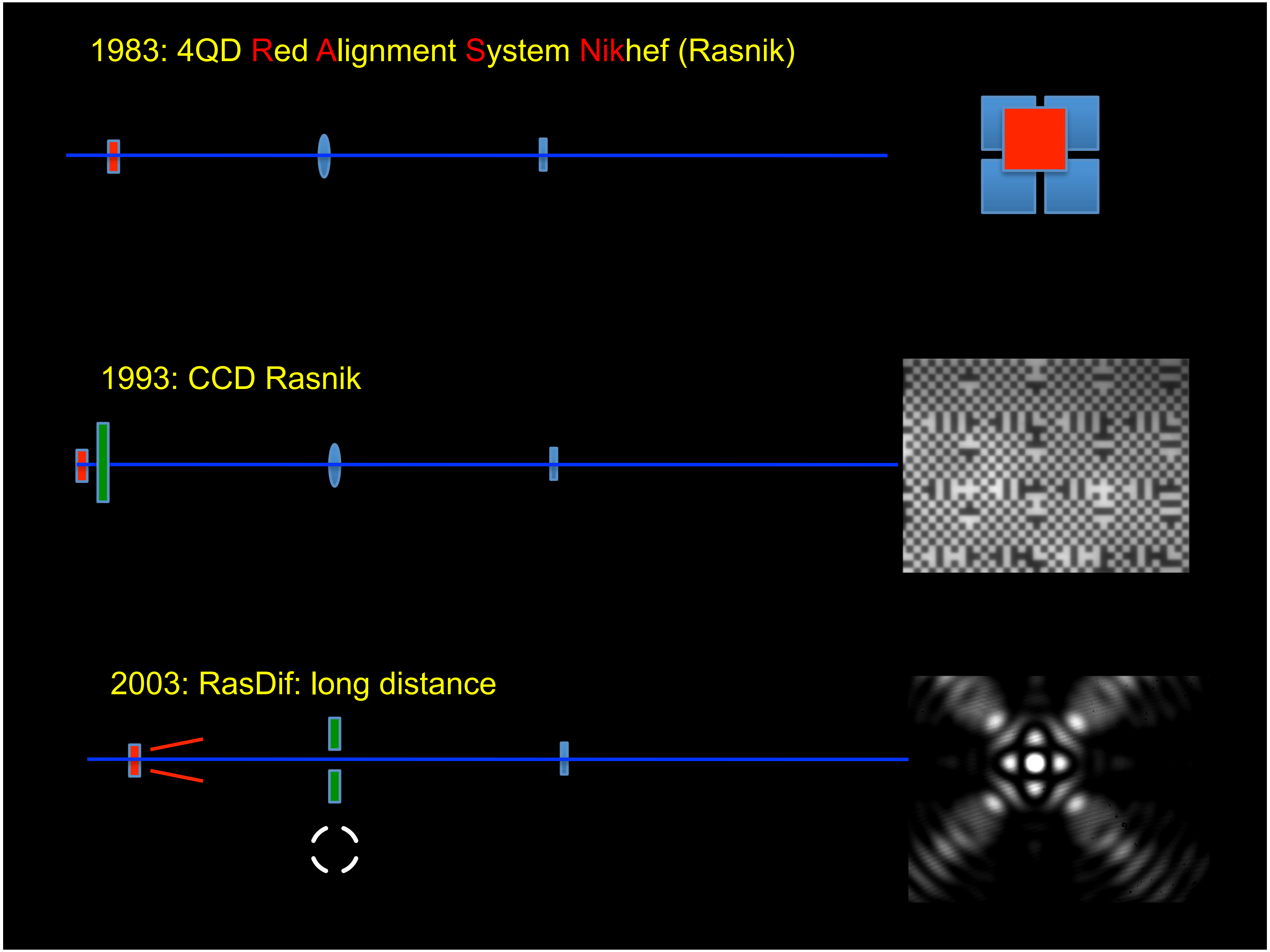
Vibration Analysis

- Vibration limits for QD0 magnets:
  - Δ(QD0(e+)-QD0(e-) < 50 nm during 1 ms pulse
- Beam transport simulations with different ground motion models take into account transfer functions of detector platform and QD0 support
- 50 nm goal can be achieved






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

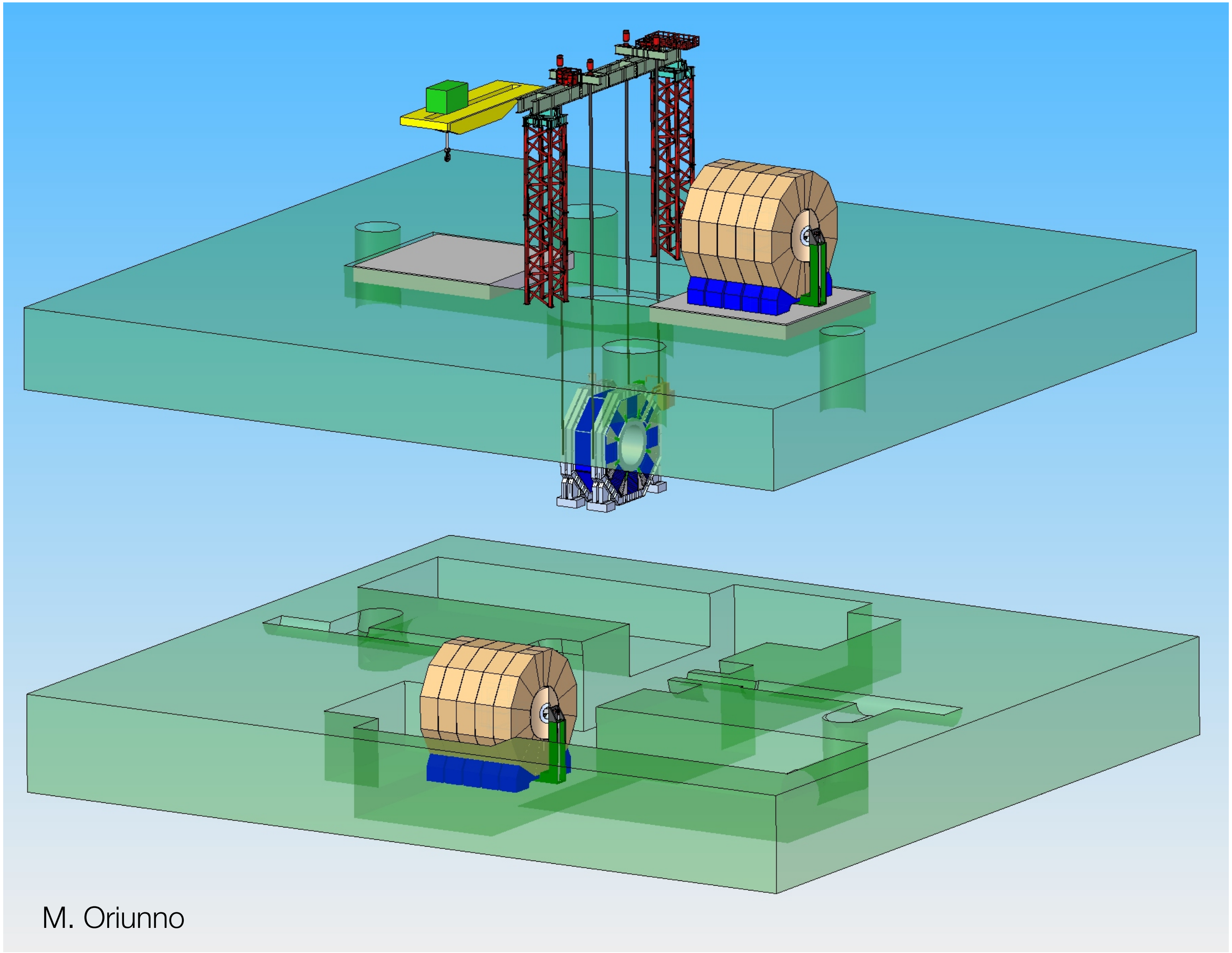

1983: 4QD Red Alignment System Nikhef (Rasnik)
1993: CCD Rasnik
2003: RasDif: long distance

H. v.d. Graaf

Site Differences (Detector Point of View)

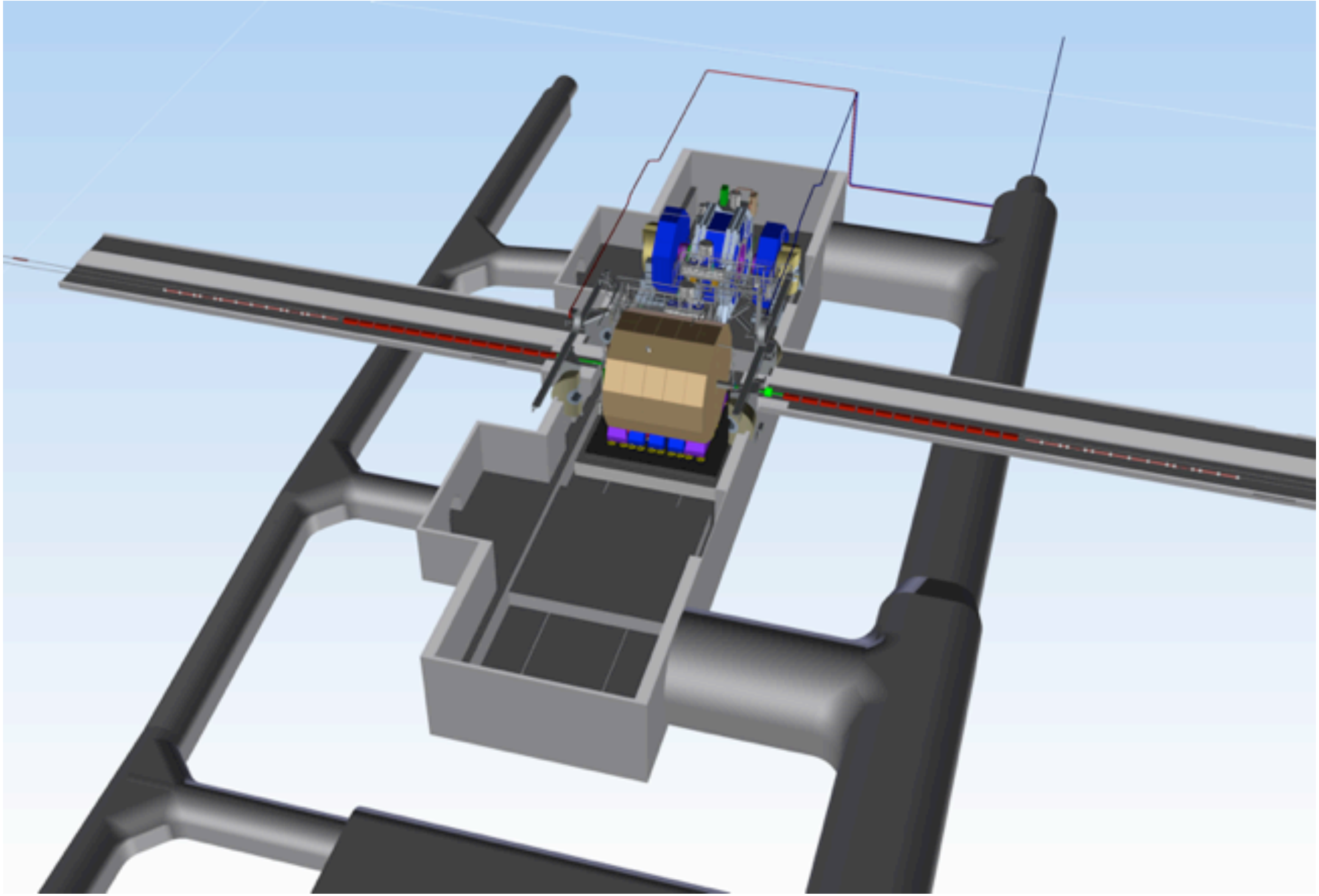
Flat Sites	**Mountain Sites**
Access via vertical shaft:	*Access via horizontal tunnel:*
~18 m diameter, ~100 m long	~11 m diameter, ~1 km long, ~10 % slope
Assembly in CMS style:	*Modified assembly scheme:*
pre-assemble and test large detector parts	assemble sub-detectors as far as possible
max. part 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*

Vertical Shaft Assembly



ILC Mountain Site

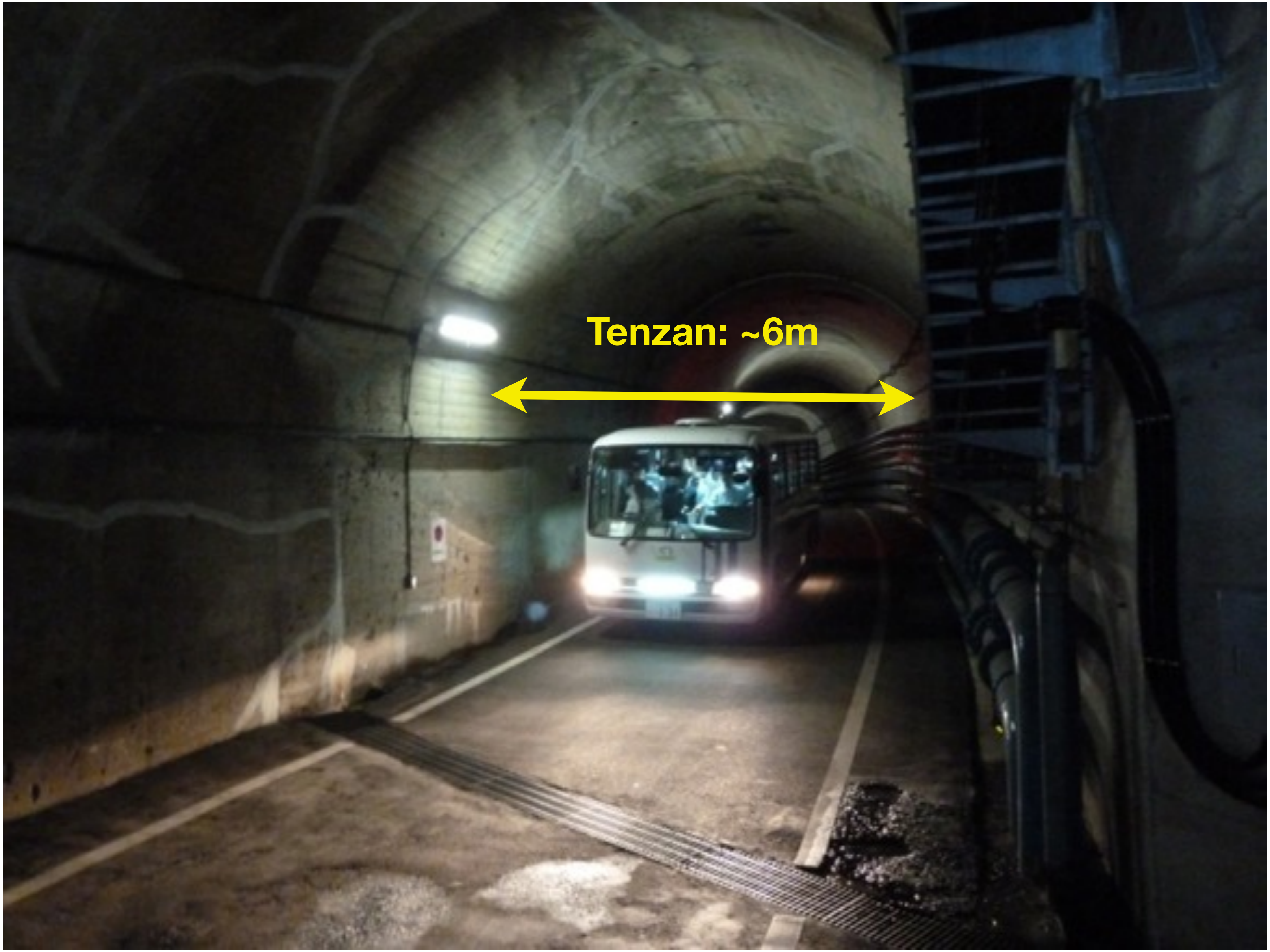
Underground Sites in ILC-EDMS



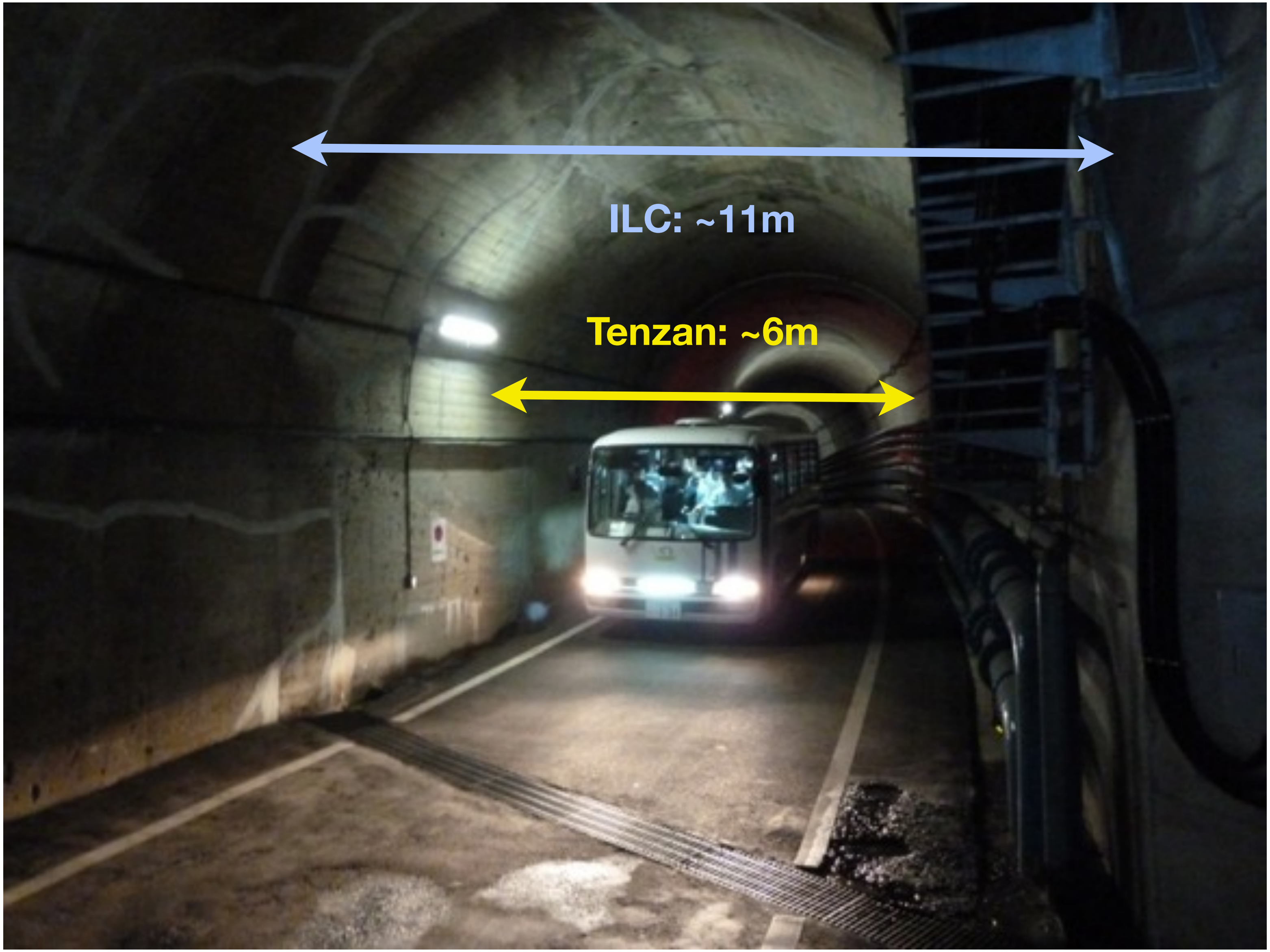
Tenzan Power Plant Underground Hall

Access Tunnel

Access Tunnel



Access Tunnel

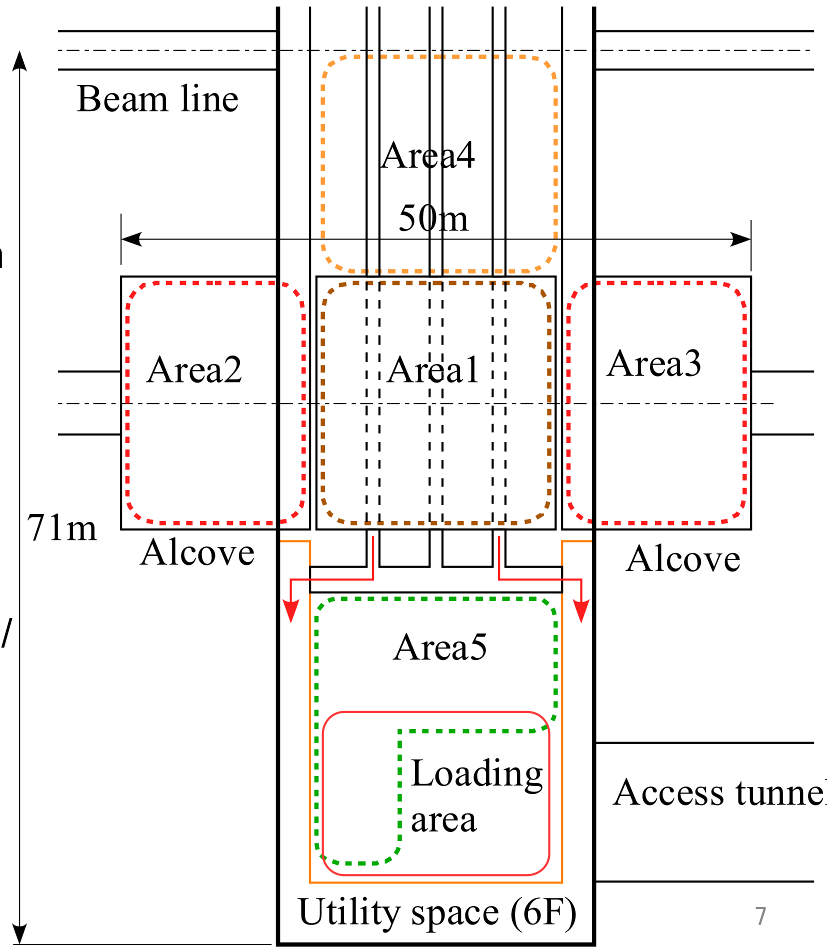


ILD Installation Study (Preliminary)

Detector assembly area

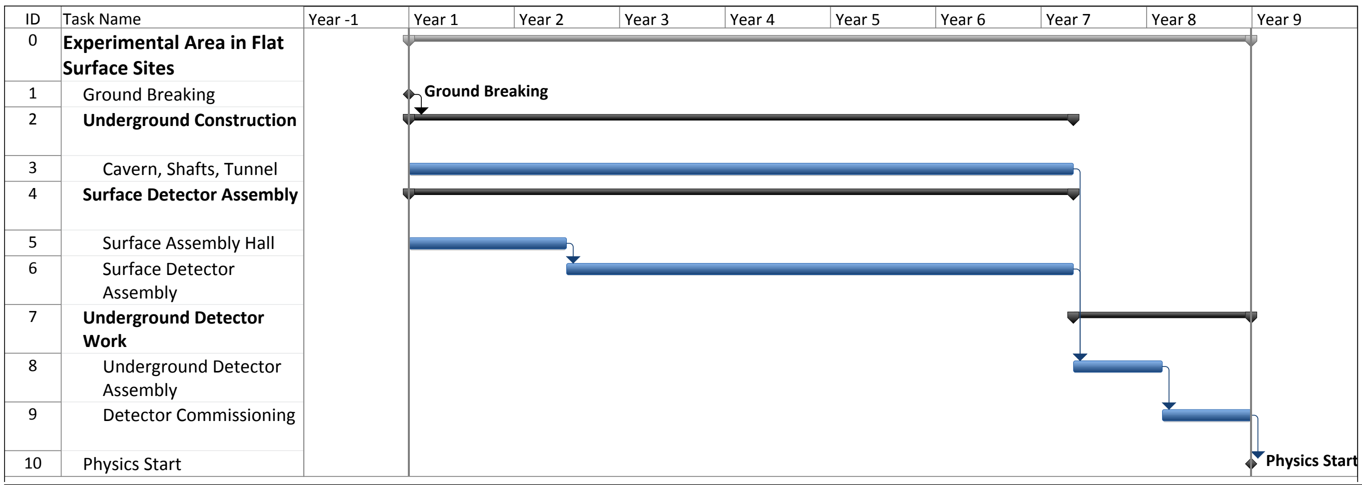
Y. Sugimoto

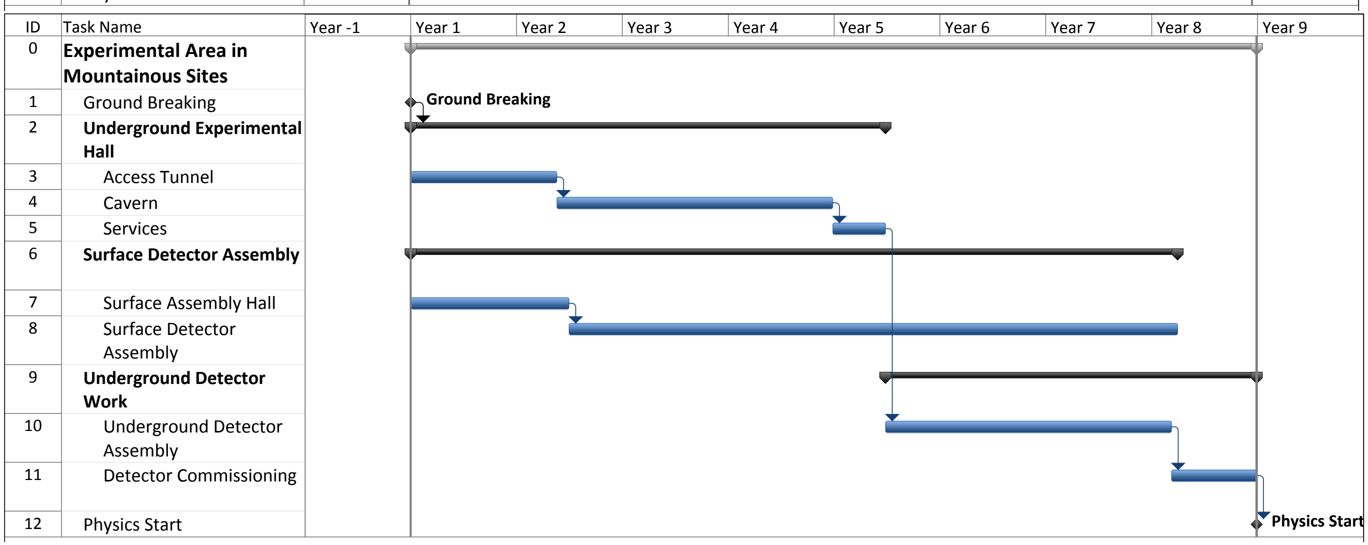
- Area 1: Platform
  - YB0 assembly
  - Barrel detectors installation/ cabling
  - Endcap calorimeters installation
- Area 2/3: Alcoves
  - Endcap calorimeters cabling
  - QD0 support tube assembly
  - FCAL install/cabling
- Area 4: Tentative platform on beam line side
  - YE, YB+, YB- (iron yoke and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



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

- 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

Tentative List of Future Tasks

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 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
- Discussed list of future tasks in global MDI project