IR Engineering Specifications

Toshiaki Tauchi (KEK)

LCWS 2011
Granada, Spain
26-30 September 2011

For DBD/TDR : Design Study for the Interaction Region; Push-Pull System for the ILC

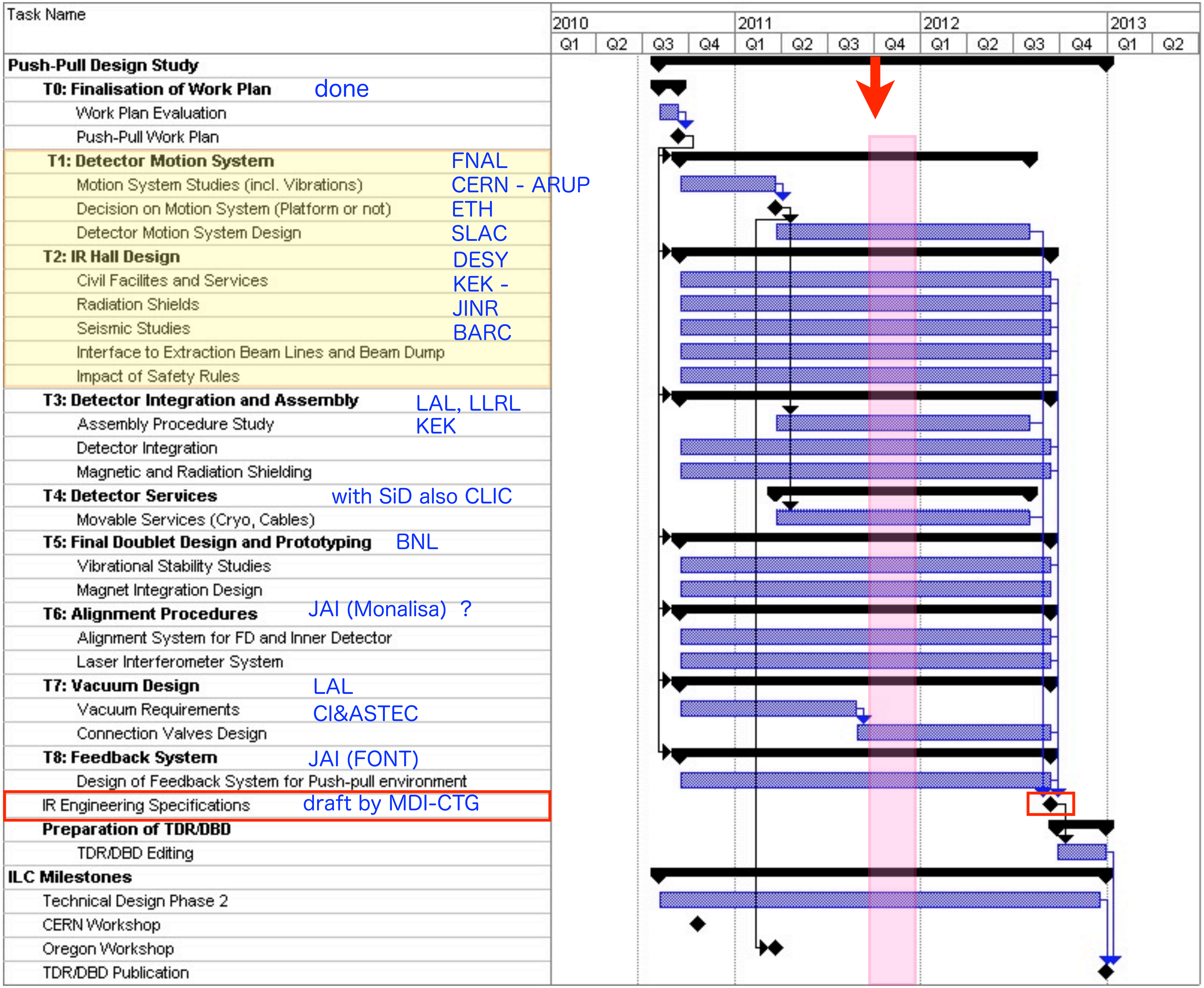
by the MDI-CTG + A.Seryi (BDS) , July 2010

Tasks (Work Plan)

The following list summarises the major tasks of the working plan.

1. Design of the detector motion system; study of its vibration properties in simulation and experiment.
2. Design of the IR underground hall for push-pull, including facilities and services for the operation of the detectors, radiation shields, seismic issues, impact of safety rules.
3. Optimisation of the detector integration and its impact on assembly procedures, magnetic and radiation shielding, vibration sources.
4. Design of detector services supplies for push-pull (data and HV cables, cryogenics).
5. Design and prototype of the final doublet quadrupoles and verification of their stability.
6. Design of alignment system for the final doublet magnets and the inner detector components, including the design of a laser interferometer system.
7. Study on IR vacuum design, including vacuum requirements and design of quick connection valves.
8. Study of intra-train feedback systems in a push-pull system.

Work Plan Diagram



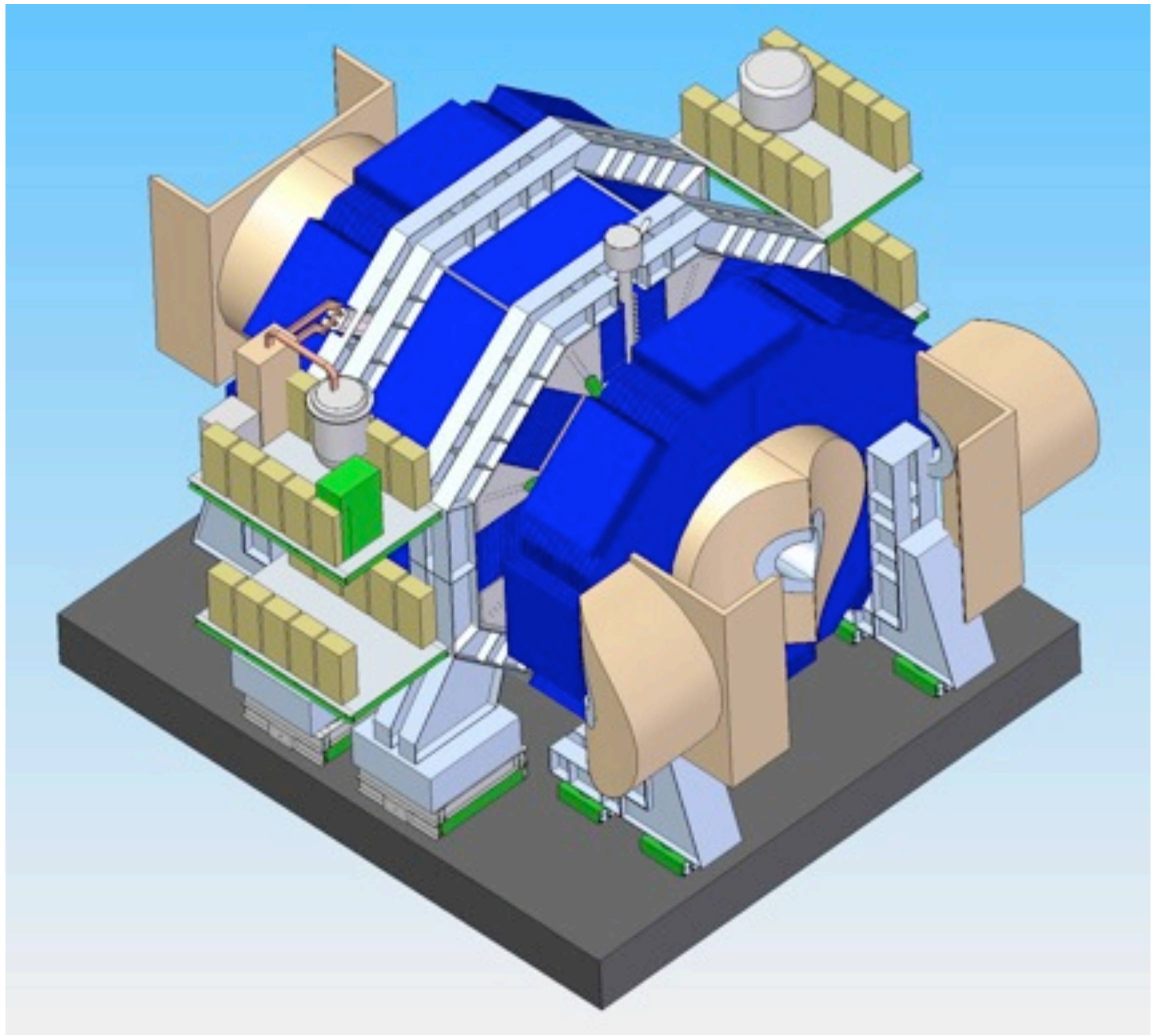
Plenary summery talk on “Planning the Push-Pull”

Conclusions by Marco Oriunno at ALCPG11

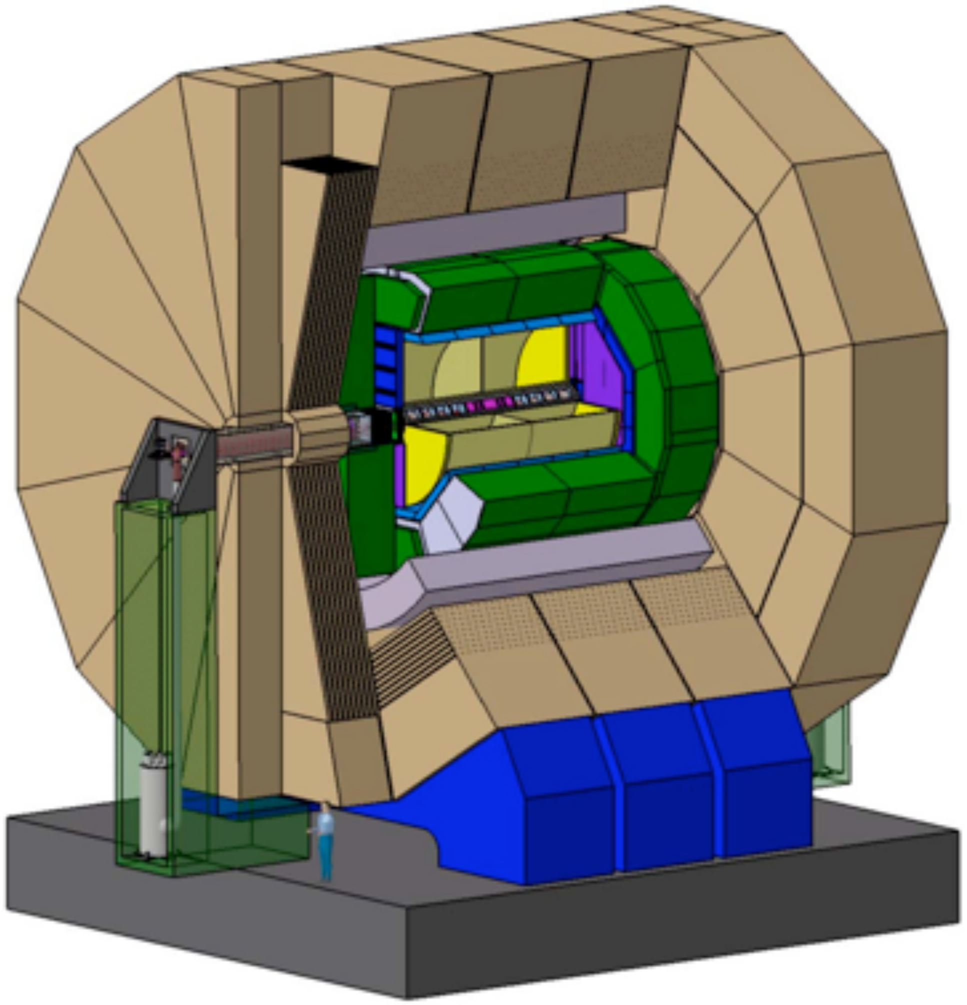
- Platforms are a technically acceptable solutions for the push pull, which preserves the respective design of the detectors and does not amplify the ground vibrations.
- The platforms must be designed according to a set of Functional Requirements, specifying the static and dynamic performances. These requirements will be defined by the detectors.
- The design and construction of the platforms becomes a task of the CFS group, which will develop the project along the requirements list and together with the detectors.

Trade off study - Conclusion

by Marco Oriunno at ALCPG11



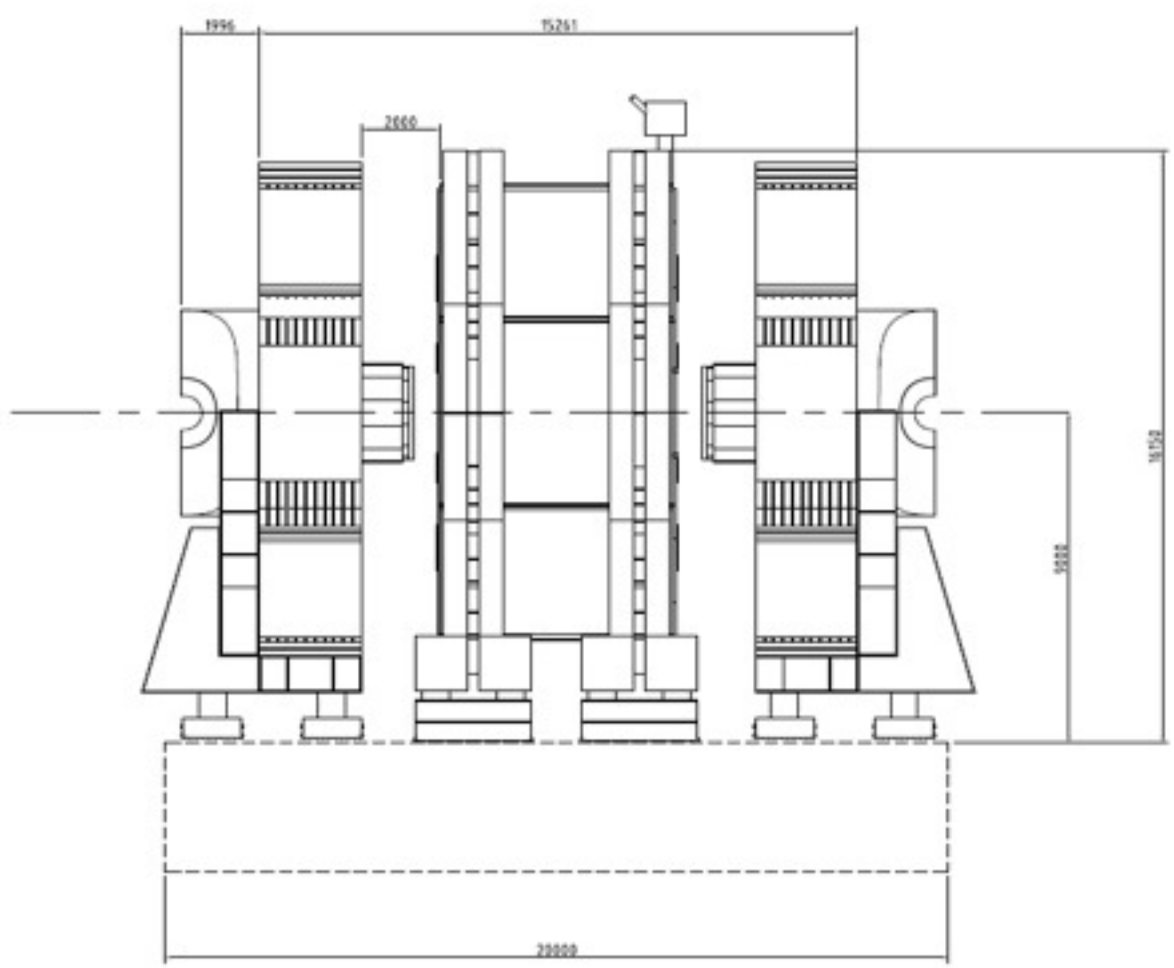
SiD with Platform

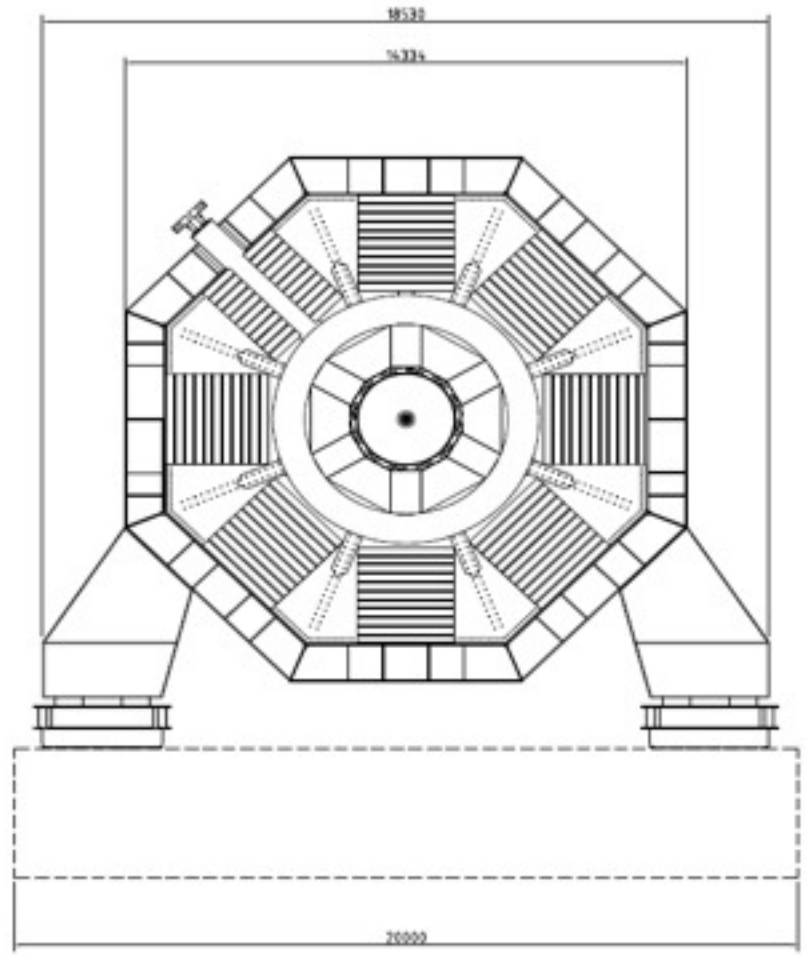


ILD with Platform

Mandatory requirements	SiD	ILD
Design Change Impact	None	None
Vibrations Amplification	Low	Low

SiD Platform Functional Requirements





SiD nominal mass: Barrel 5000 T; (each) Door 2500 T

Dimensions:
- Z = 20.0 m
- X = 20.0 m
- Delta Y = 9 m (Top of Platform to beamline)

Positioning Tolerance on beamline
- Consider points Z=+-max, X=0. Position to + 1mm wrt references in X,Y,Z
- Consider points Z=+-max, X=+-max: Position to +- 1 wrt references in Y.

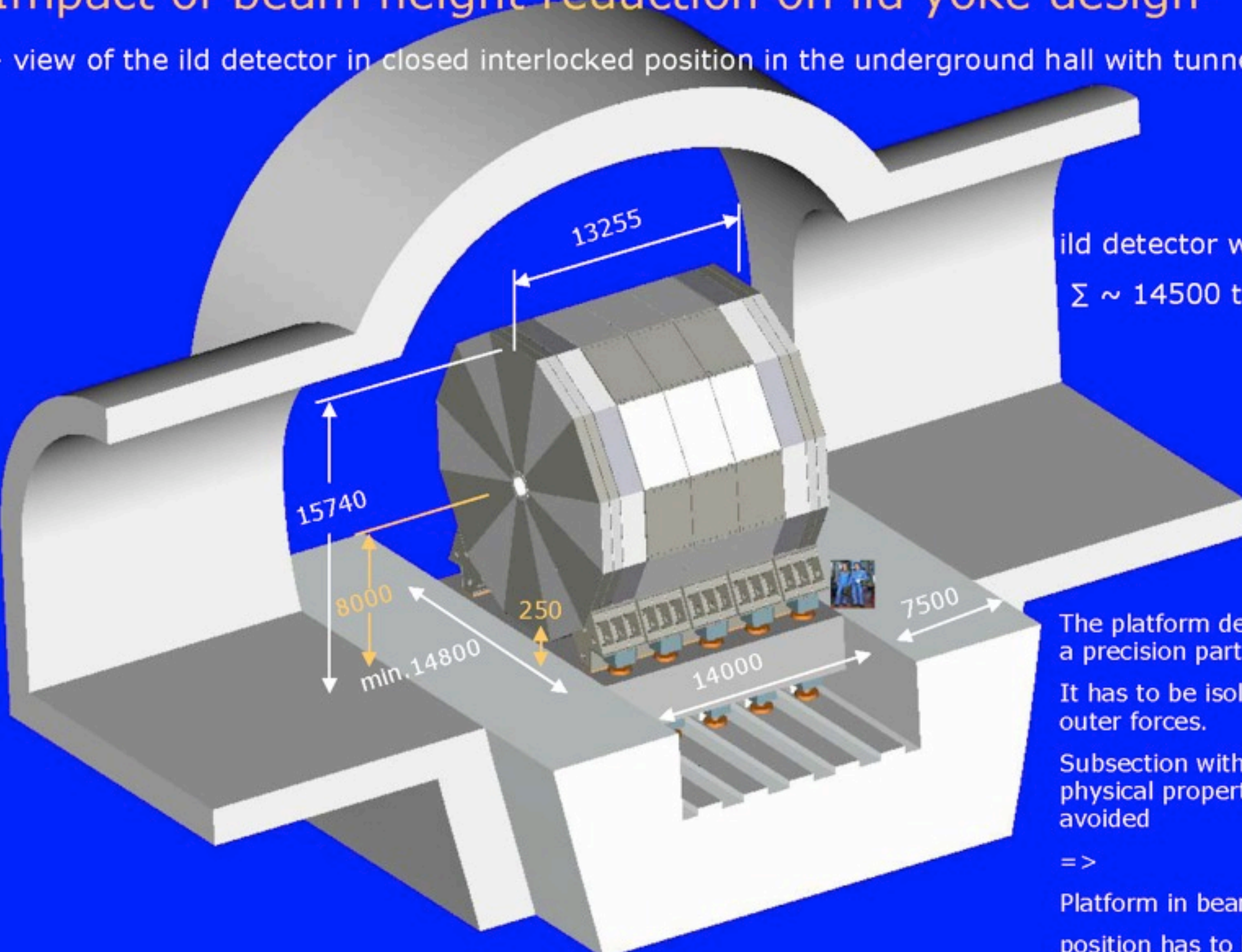
Static Deformations: <+-2 mm

Vibration Transfer Function from ground : Amplification < 1.5 between 1 and 100 Hz.

Seismic stability: Appropriate for selected site. (Beamline must be designed with sufficient compliance that VXD will survive)

Impact of beam height reduction on ild yoke design

- view of the ild detector in closed interlocked position in the underground hall with tunnel



ild detector weight

Σ ~ 14500 tons

The platform detector unit is a precision part.

It has to be isolated from outer forces.

Subsection with different physical properties are to be avoided

=>

Platform in beam position has to be locked.

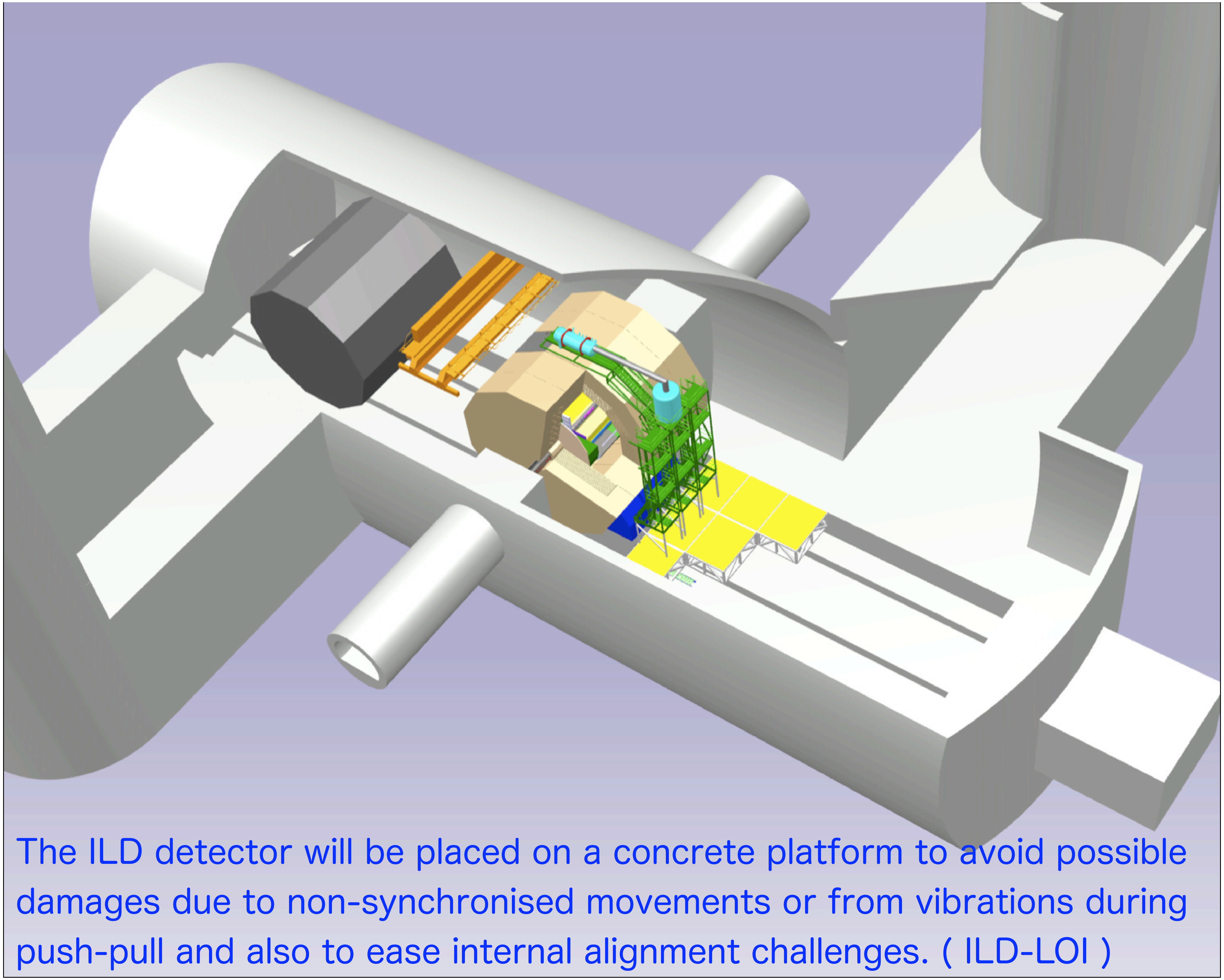


FIGURE 6.3-4. Design study of the underground experiment hall with ILD (left) and the second detector in push-pull configuration.

CERN

to be completed by LCWS2011

Linear Collider Study Task 1 and 2

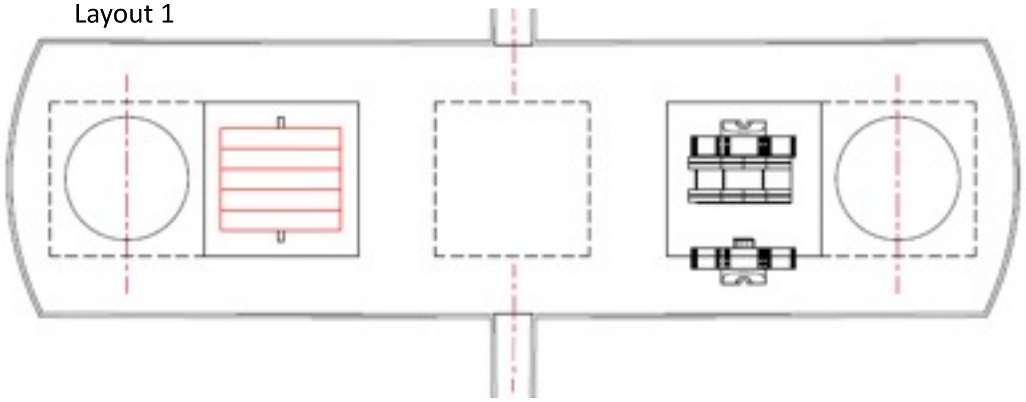
Technical Basis for Study

REP/Basis/216967/MJS/260511

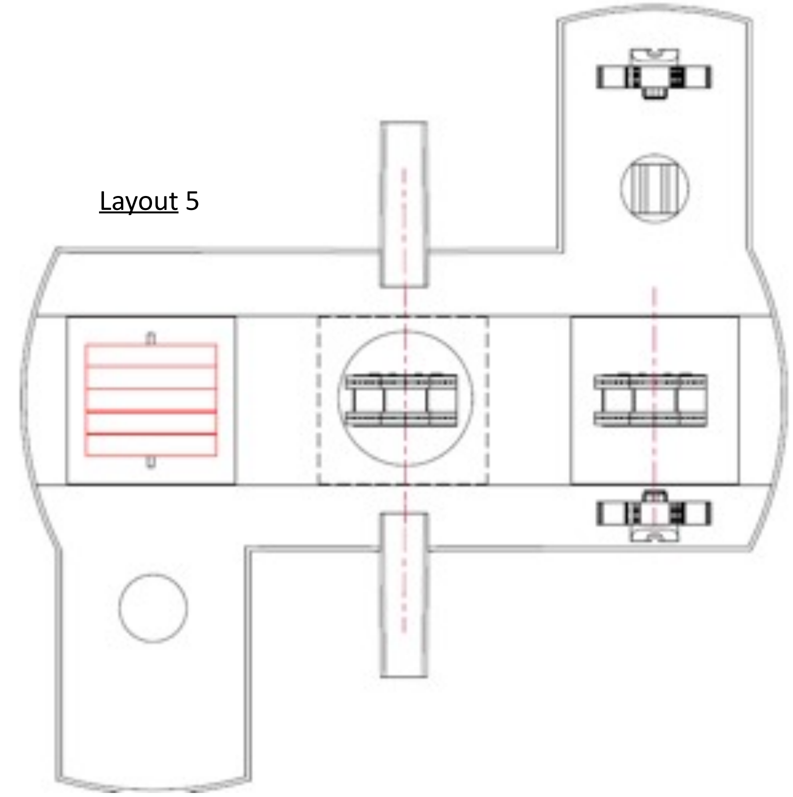
Rev 1 | June 2011

CFS technical workshop was held for 25/26 July in London, to check on the design progress. Participants are J.Osborne, A.Gaddi , M.Gastal , A.Herve (ILD) , V.Kuchler , T.Lackowski, M.Oriunno (SiD), K.Sinram (ILD) ...

Layout 1



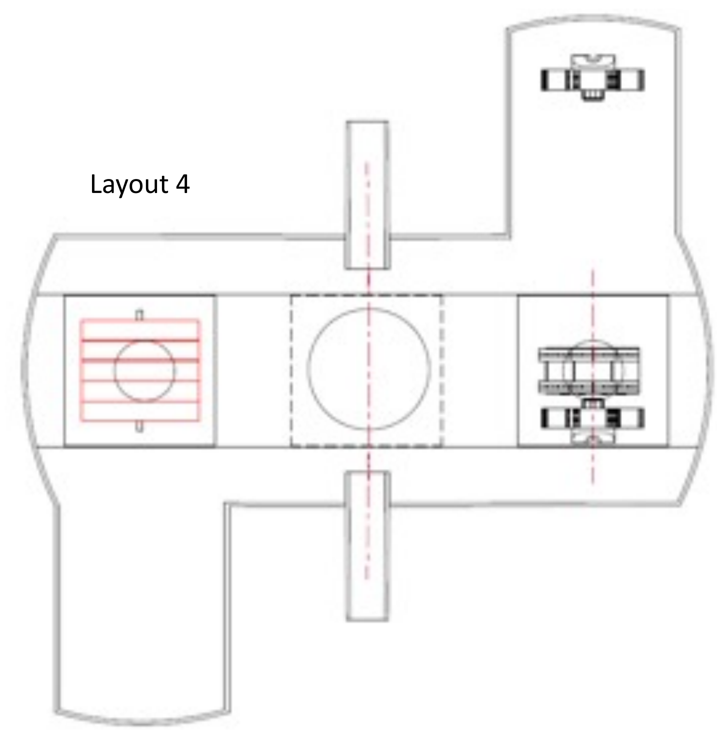
Layout 5



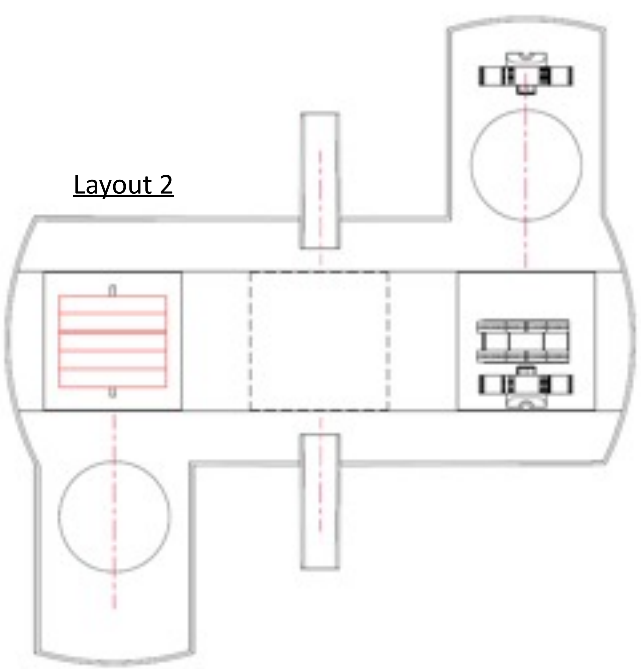
Rating Scale 1÷5 : 1=Low, 5=High

#	Requirement	Layout 1	Layout 2	Layout 3	Layout 4	Layout 5
1	Surface assembly of Magnet	1	4	3	3	4
2	Underground installation of Tracker, Calorimeters and Forwards	1	4	2	2	4
3	Number and Size of Cranes	3	3	3	2	4
4	Costs: Shafts and Halls size	4	2	2	2	3
5	Infrastructures	NA	NA	NA	NA	NA
6	Easy Maintenance, Smooth Operation	2	4	3	2	4
7	Beam Commissioning	1	1	1	4	4
8	Safety	2	4	2	2	4
	Final Score	14	22	16	17	27

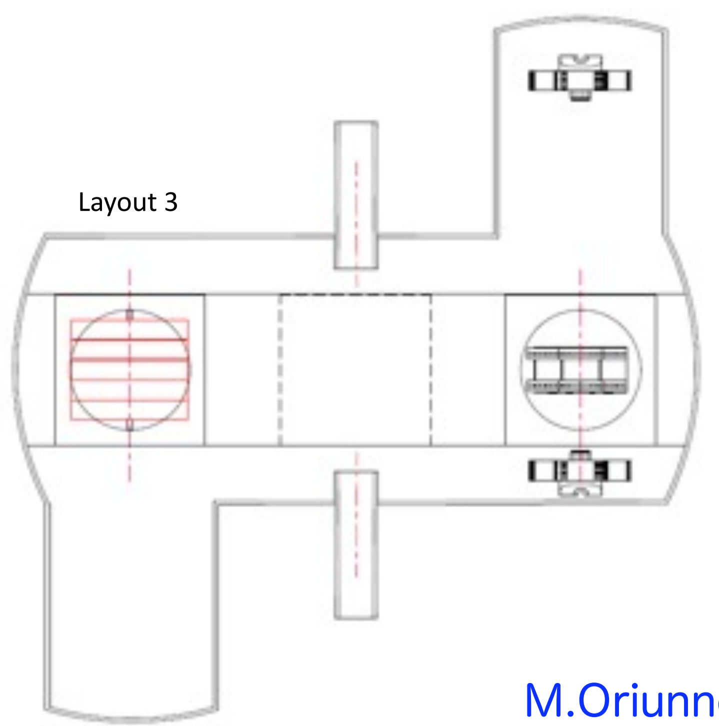
Layout 4

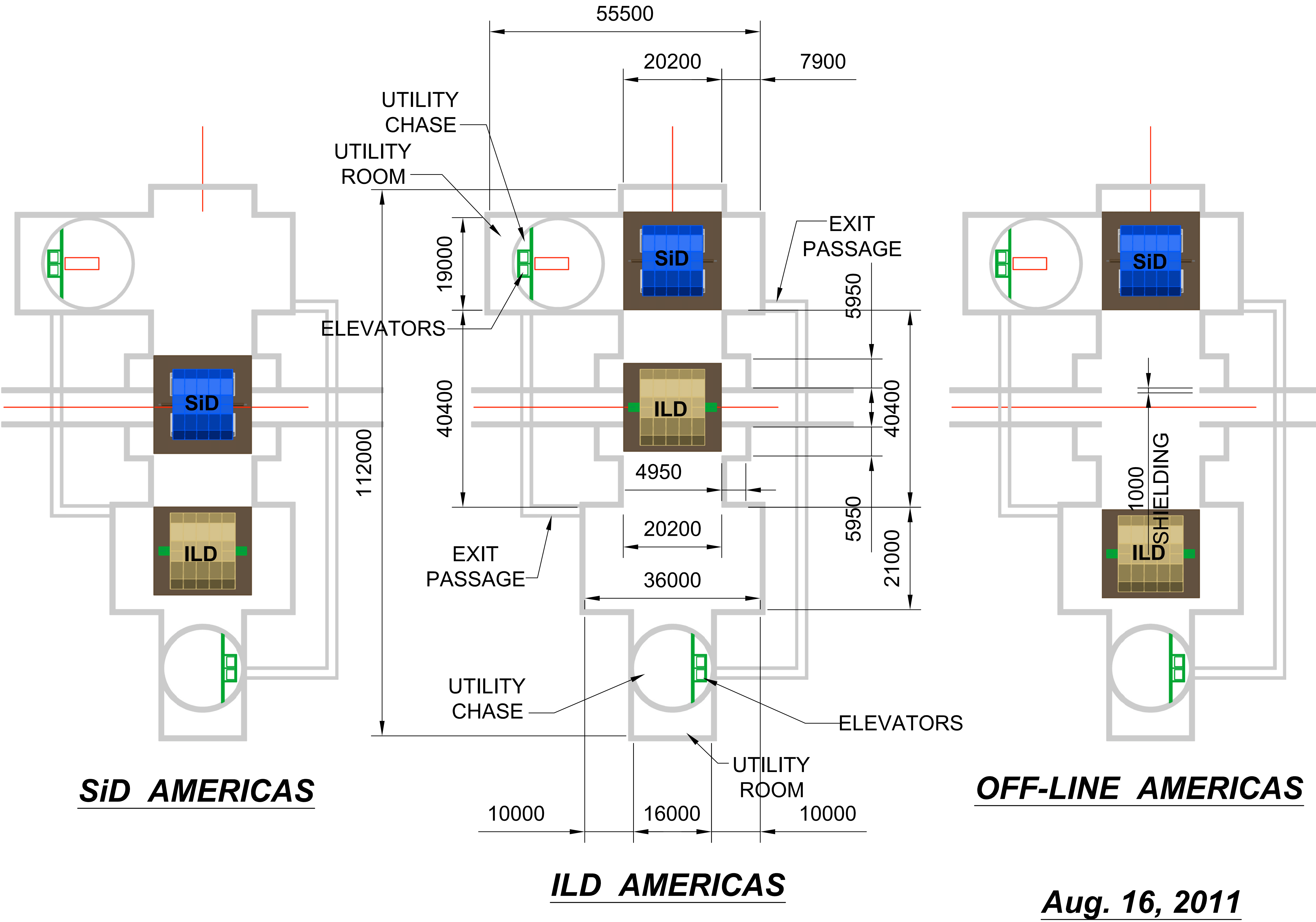


Layout 2



Layout 3



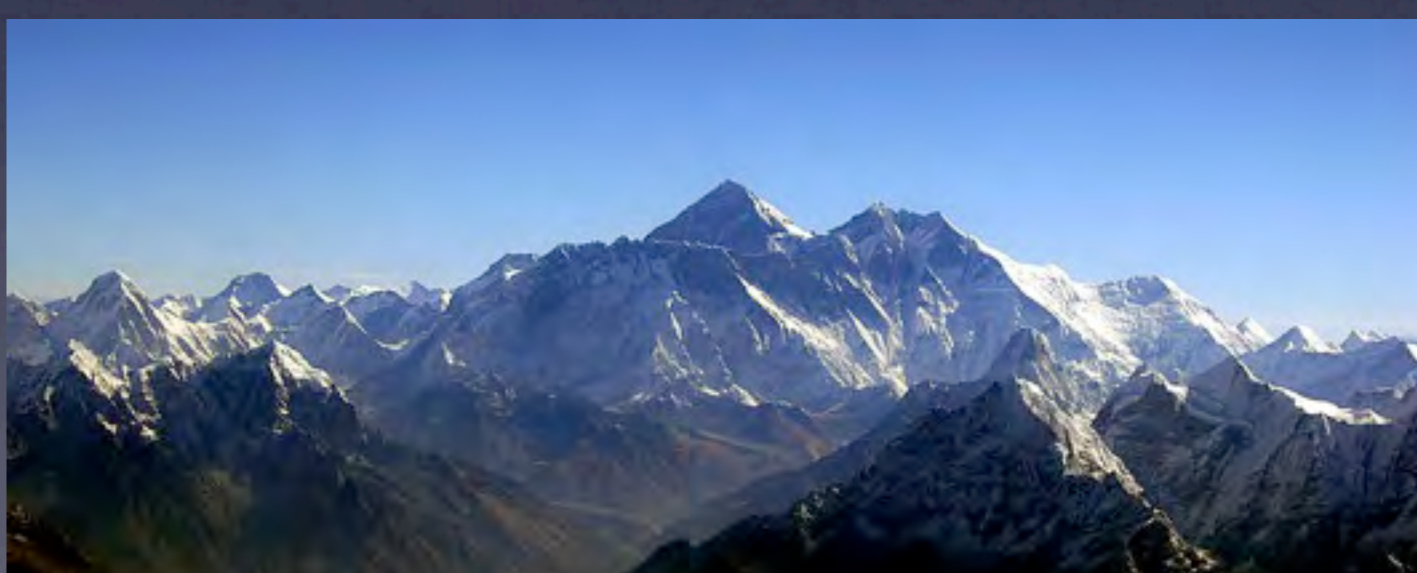


Tom Lackowski (FNAL), MDI-CFS webex meeting

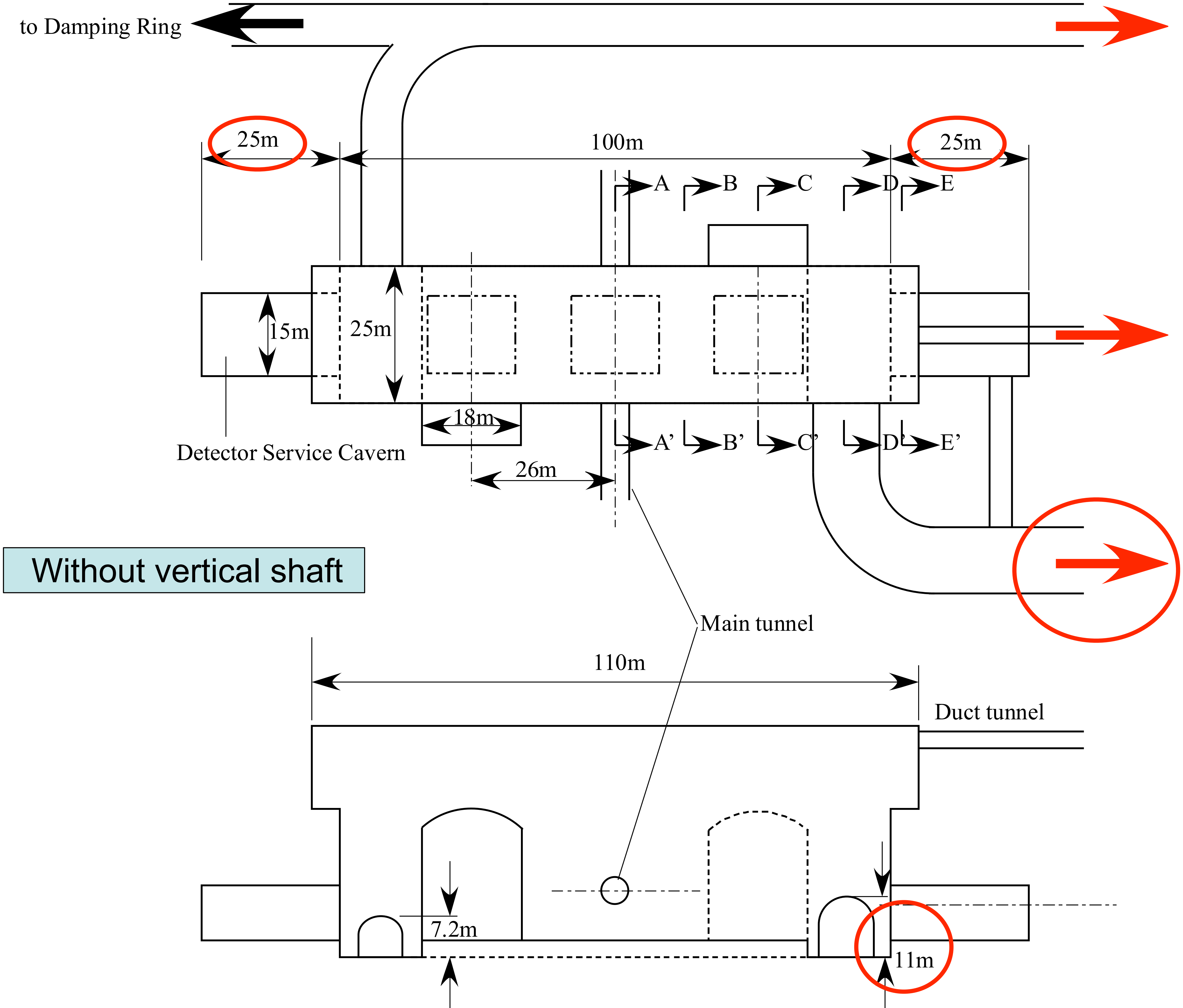
~~Mountain~~ Site

Kitakami

Hilly Site

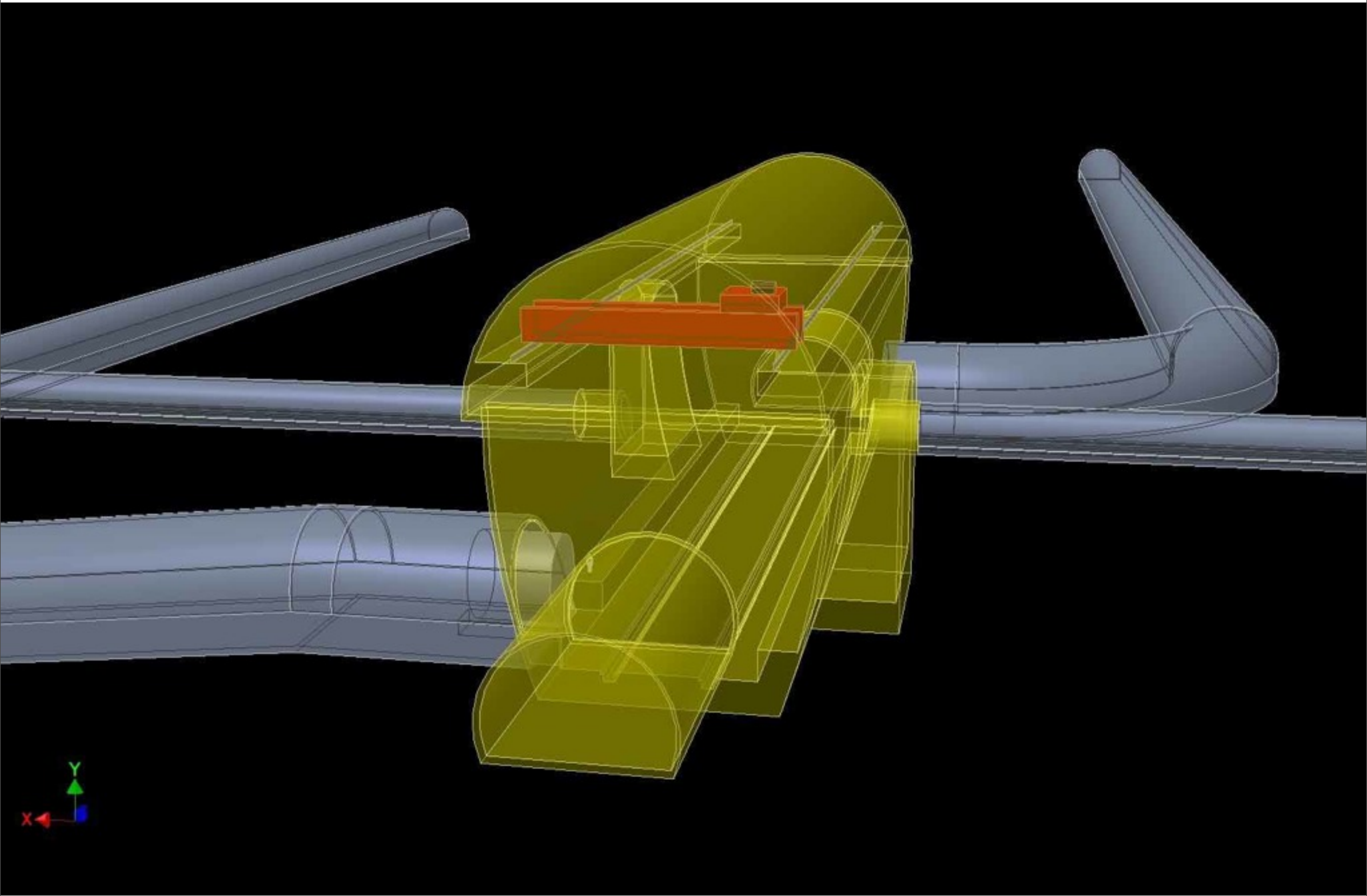


Mountain Site



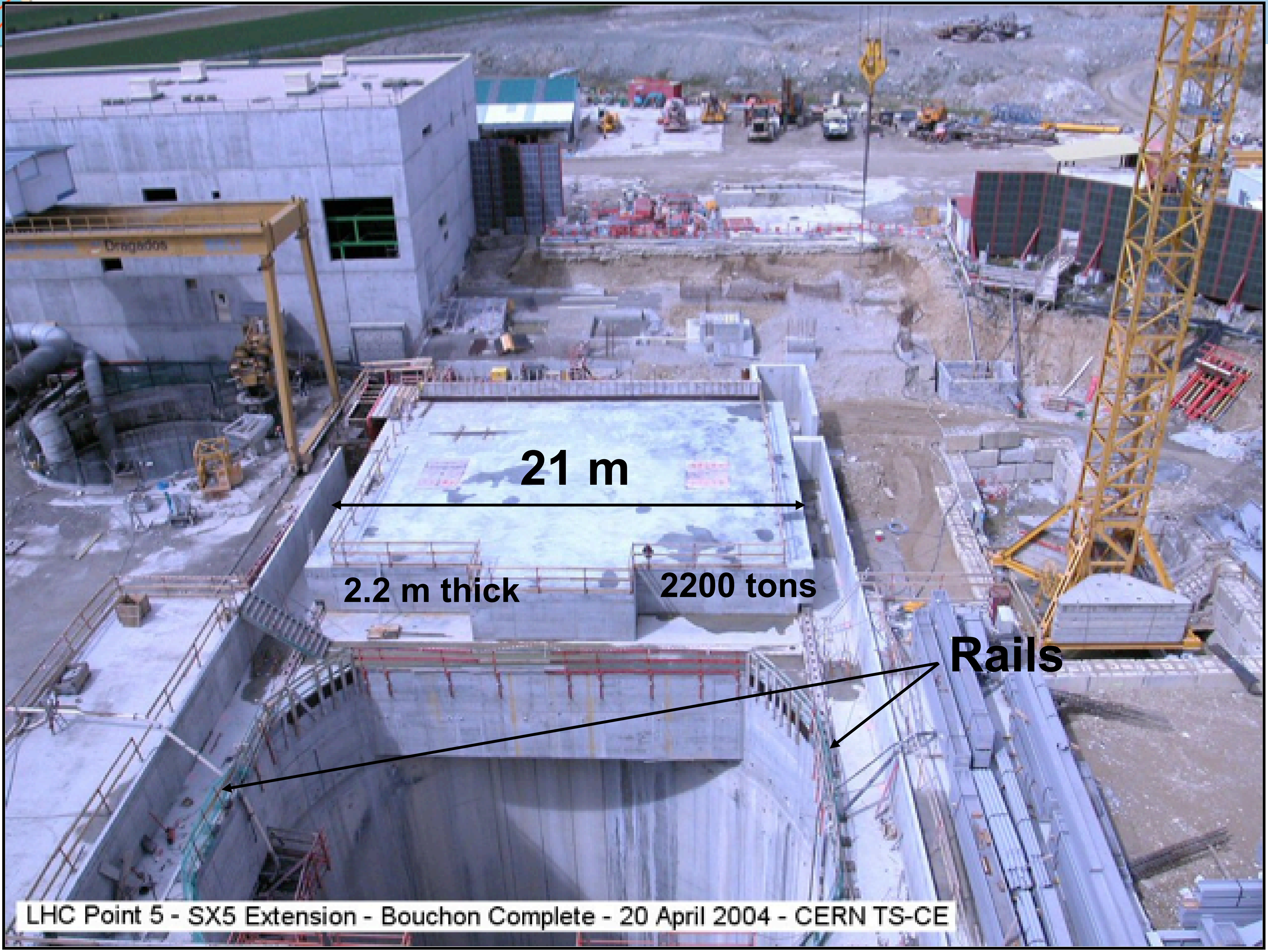
Without vertical shaft

Y. Sugimoto, ALCPG11, 20 March, 2011



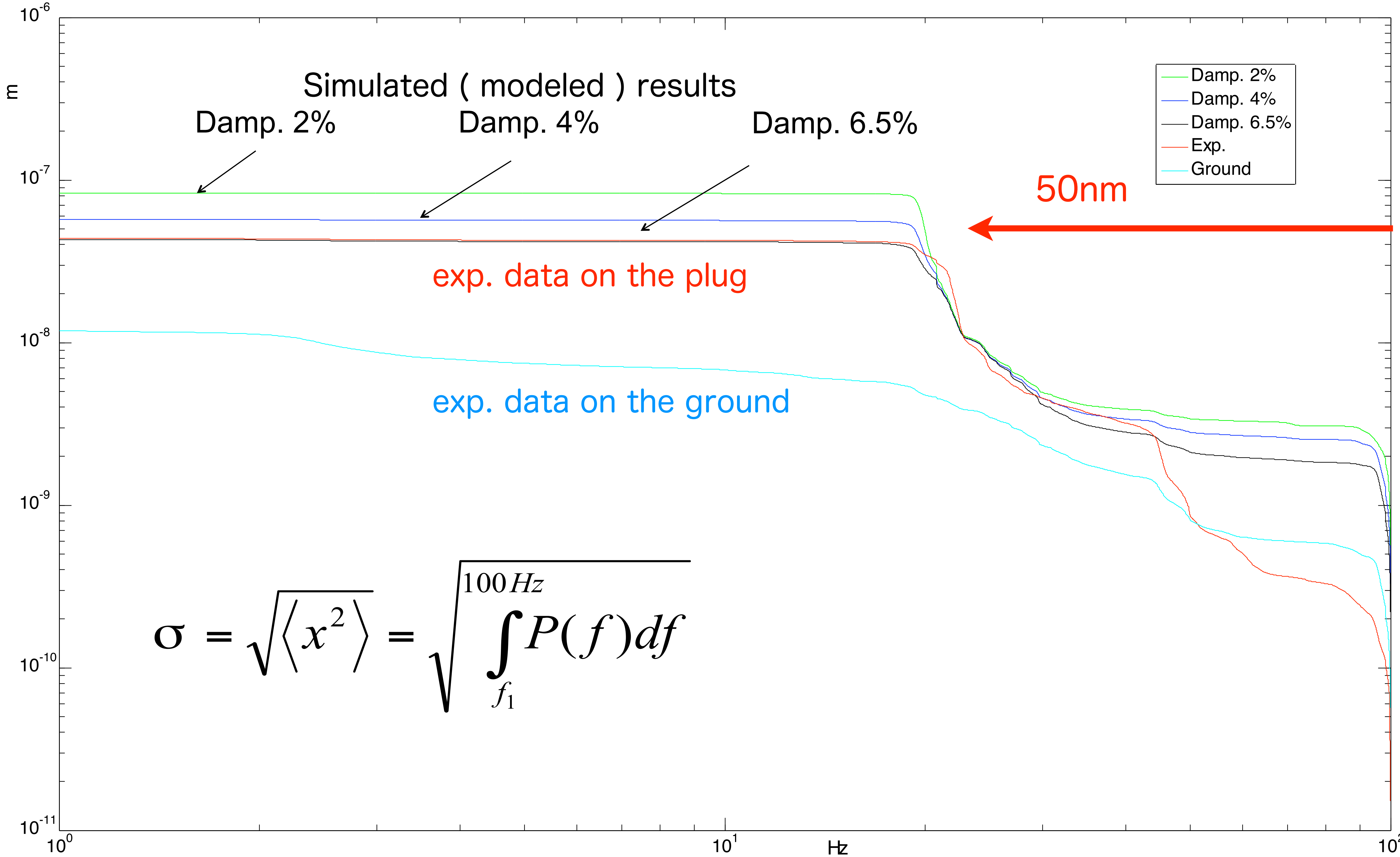
Y. Sugimoto, IWLC10, CERN/CICG, 8 Oct.2010

The CMS plug is good example of a platform



Integrated Displacement σ (r.m.s.)

on the CMS plug



$$\sigma = \sqrt{\langle x^2 \rangle} = \sqrt{\int_{f_1}^{100\,Hz} P(f)df}$$

by Marco Oriunno at ALCPG11

CMS PLUG load Test

The plug with 2500 tons - SX5 – 15/05/2006

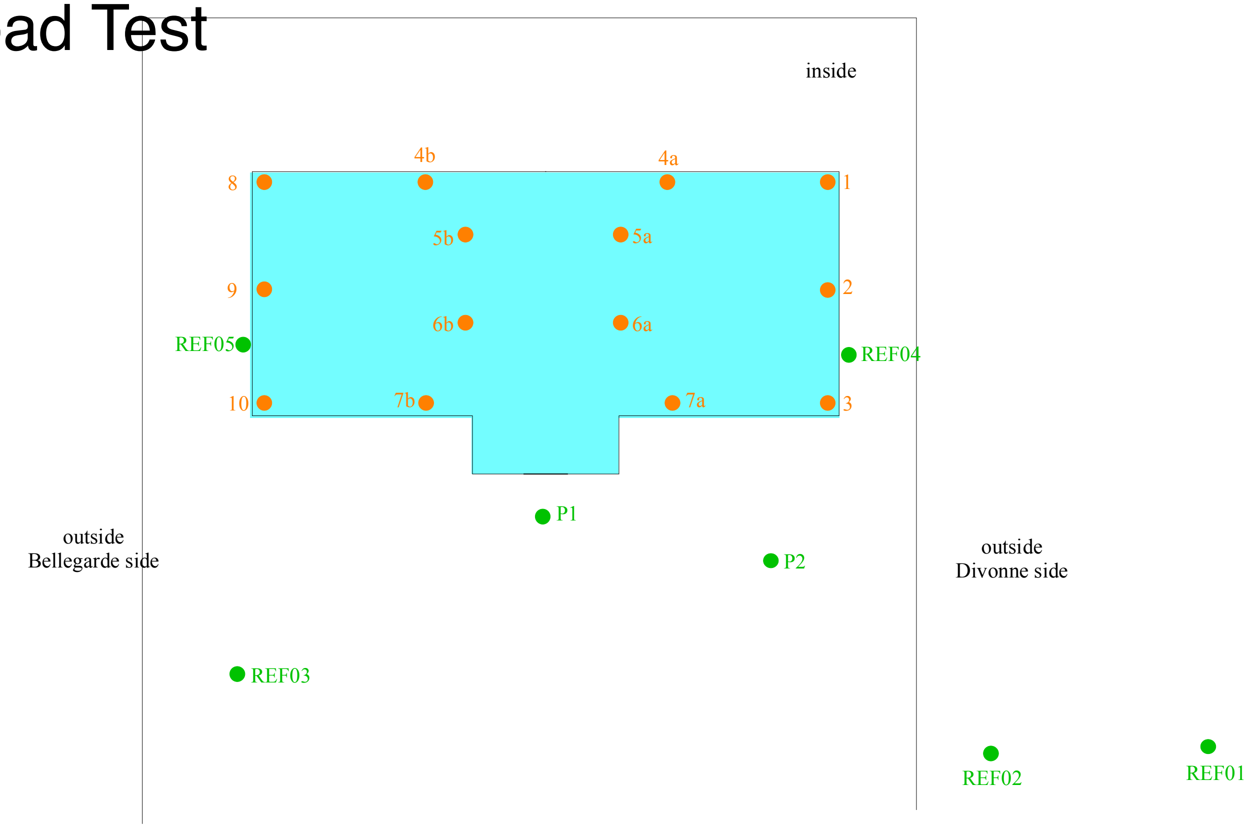
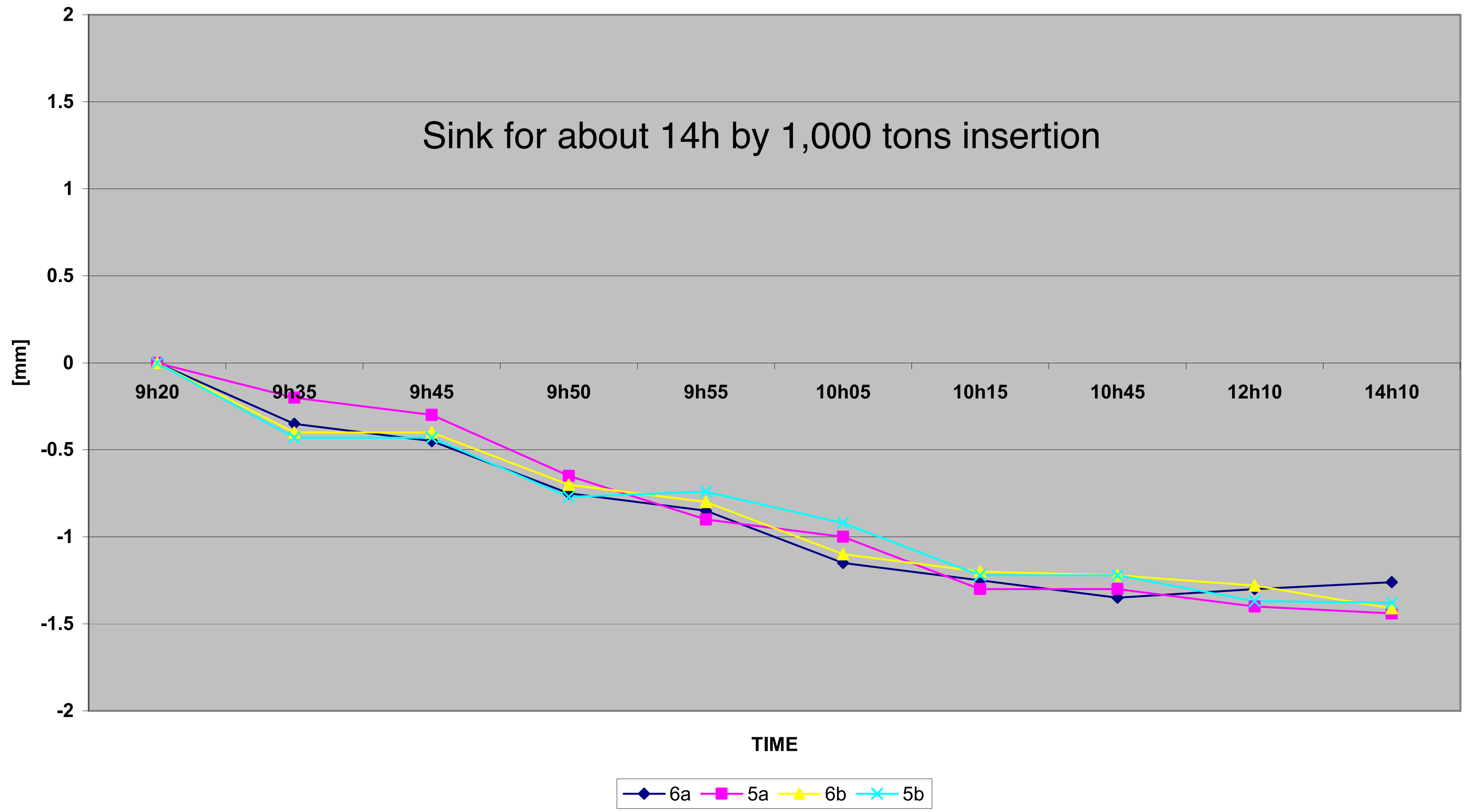


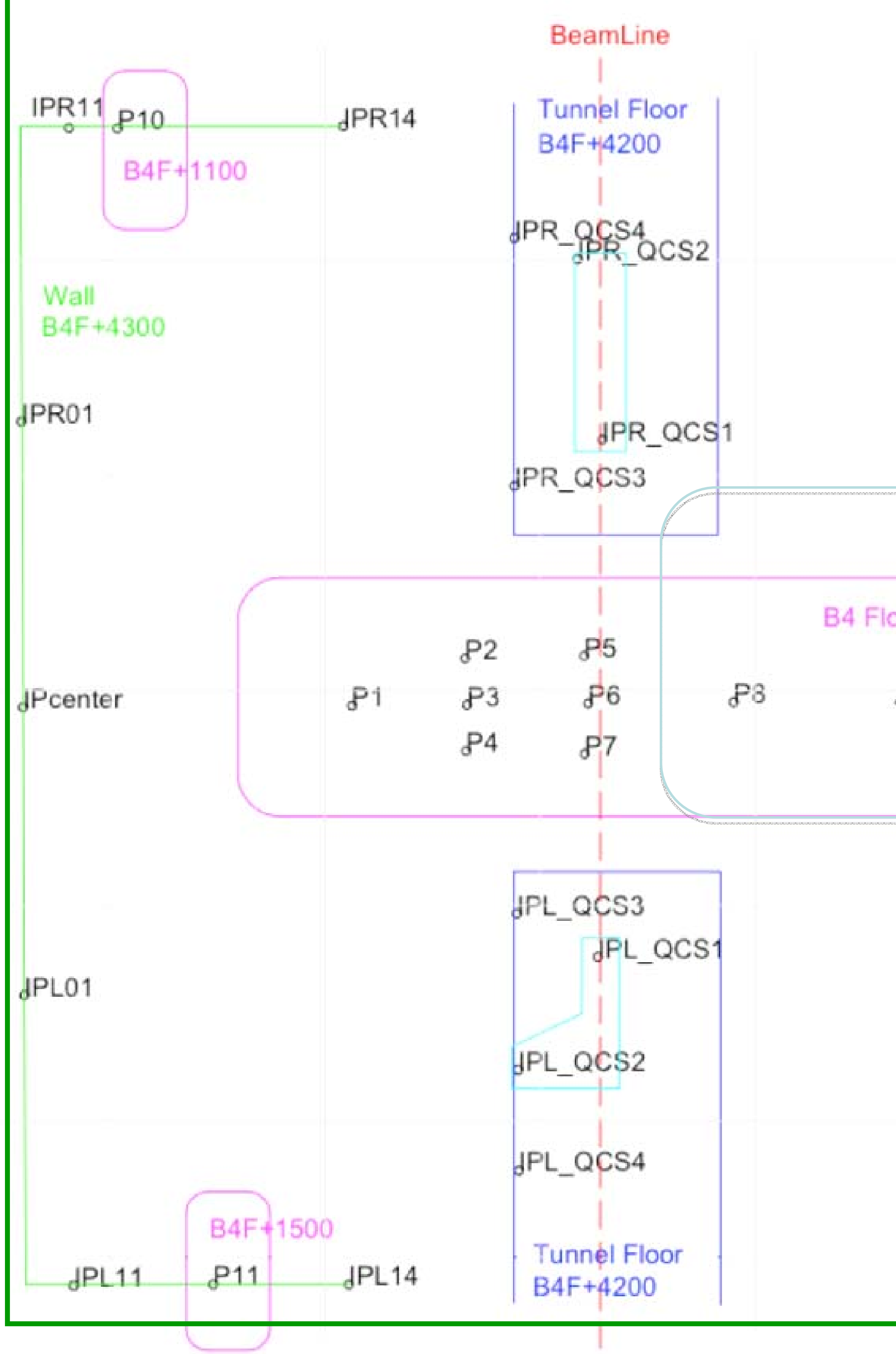
Figure 3. Top view of the pug

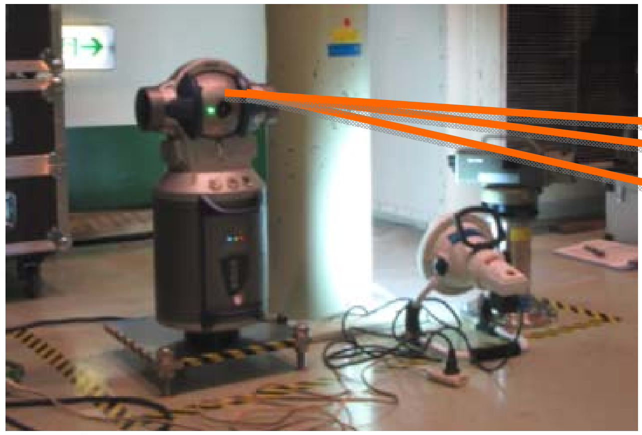


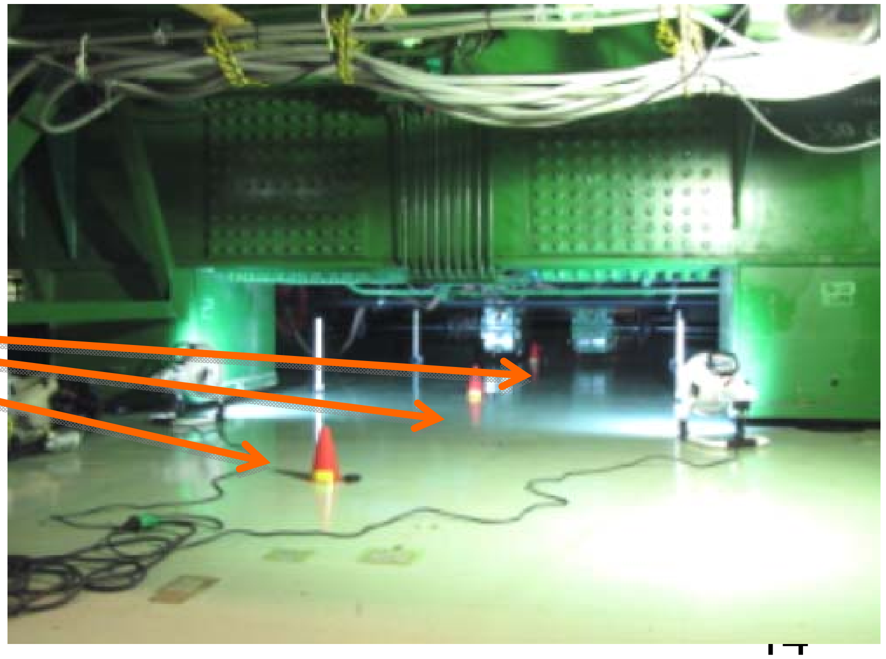
Made by Masuzawa-san@KEKB Revire

Beam line & floor motion during Belle roll-out analyzed.

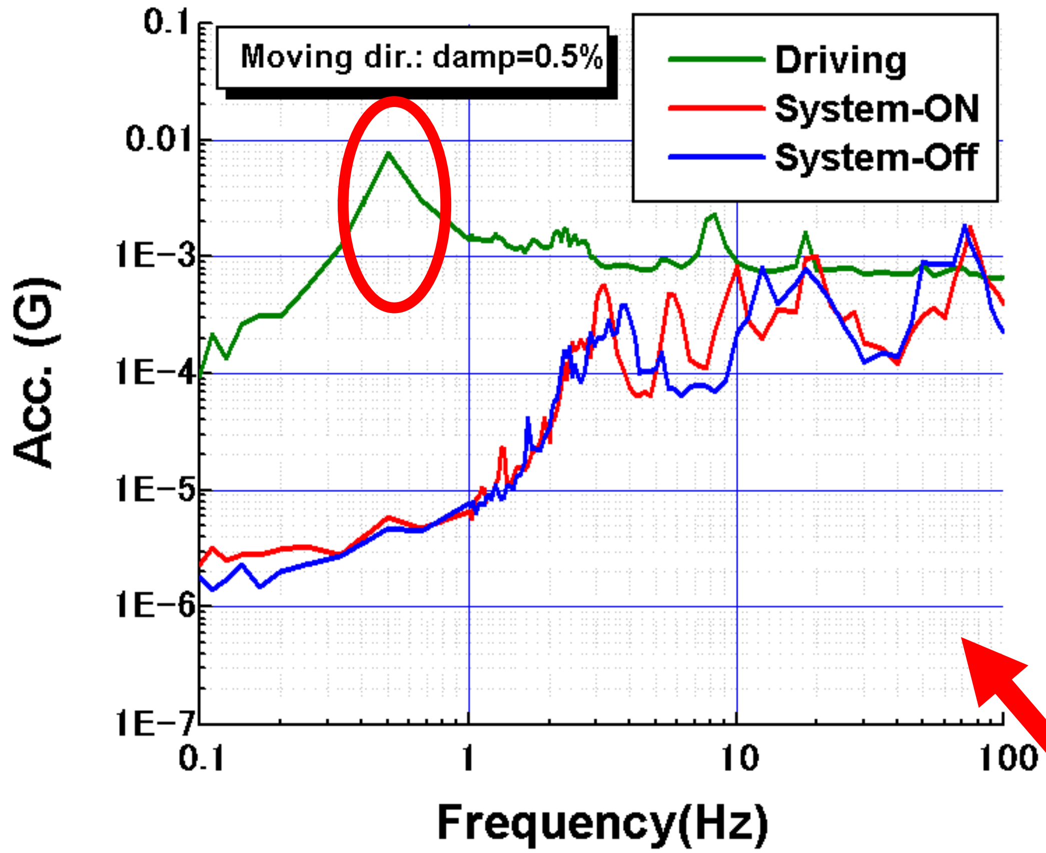
Beam line floor & Cryostat (retracted) motion

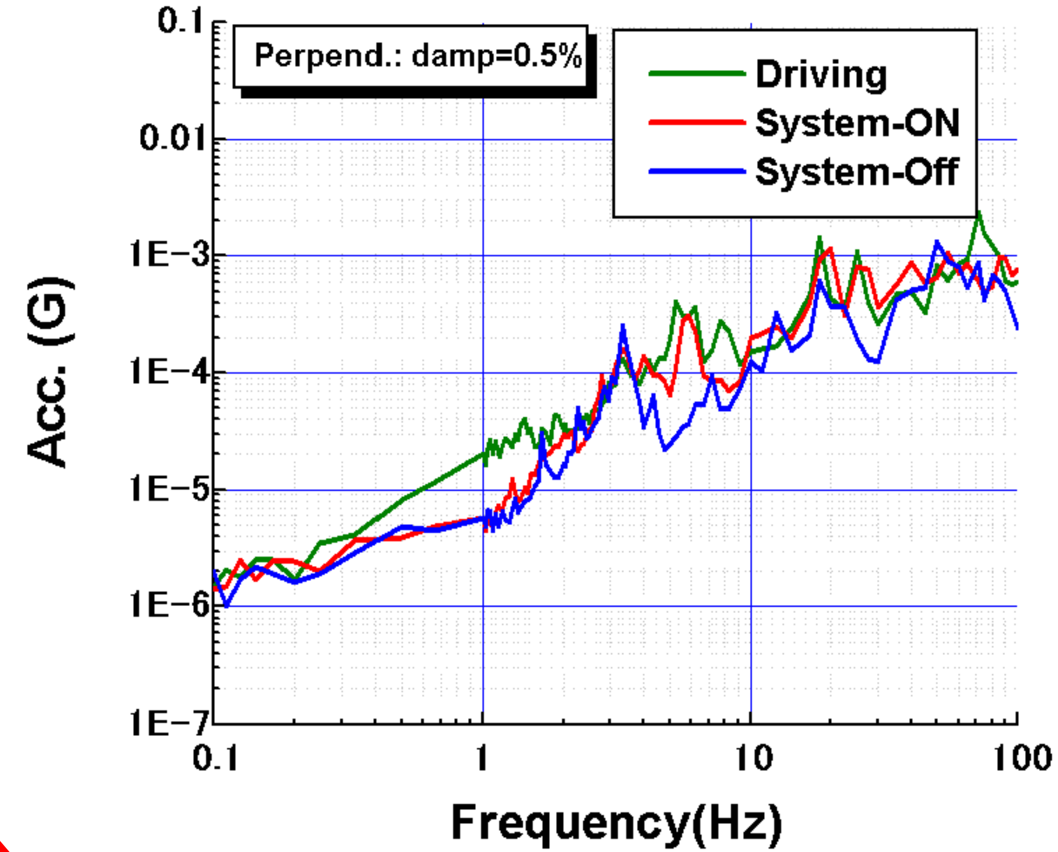


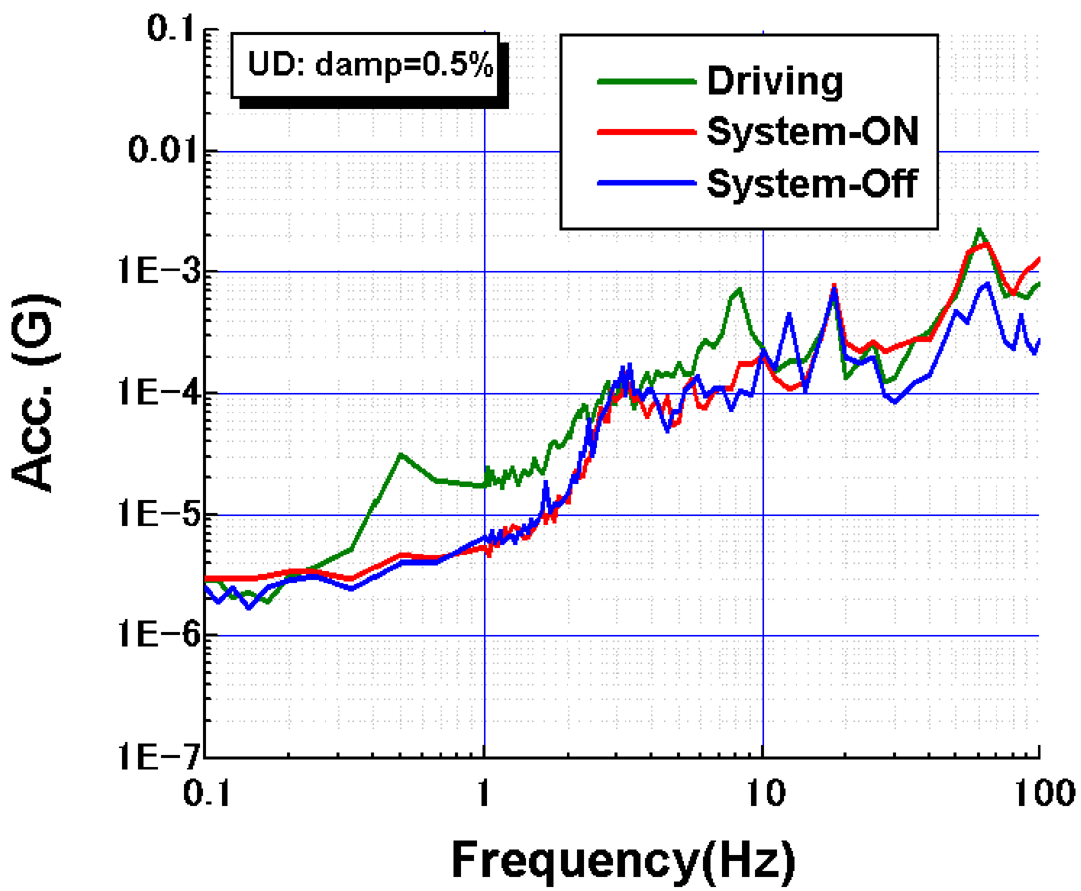




Response acceleration @platform (Belle detector 1,300t, 90cm/min)







Max. response acceleration ➔ ~0.01G

Seismic criteria for the Belle detector

➔ 0.3G

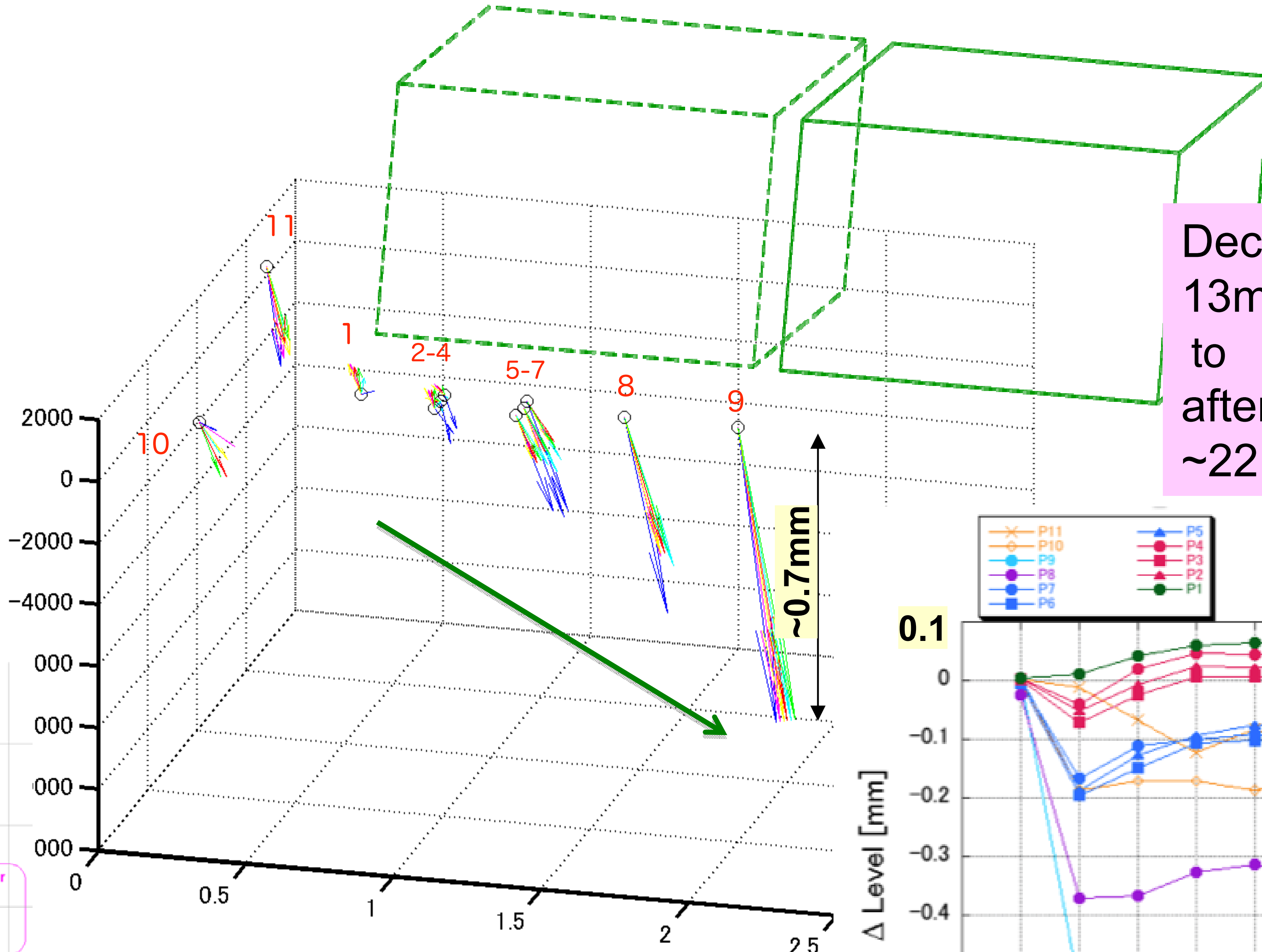
→ 0.01G of respond acc .is very small.

➔ This seismic level is safe enough.

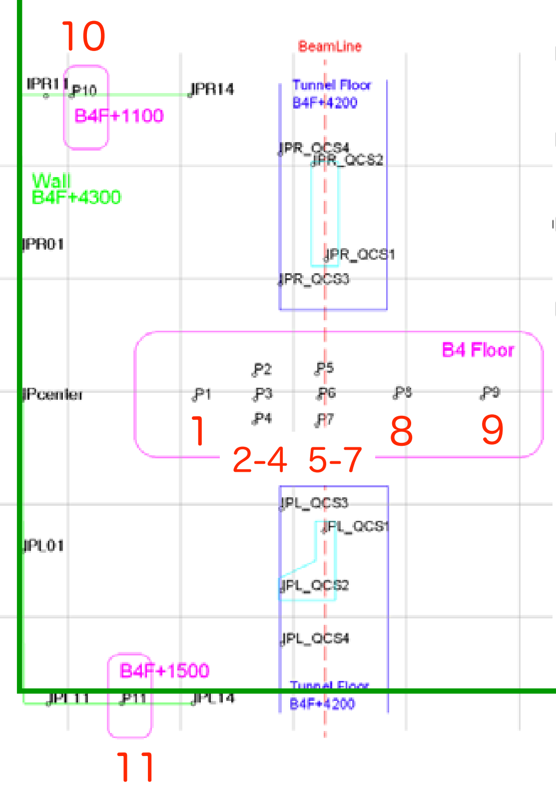
Made by Masuzawa-san@KEKB Review

(Belle detector 1,300t, 90cm/min, in Fuji experimental hall, KEK)

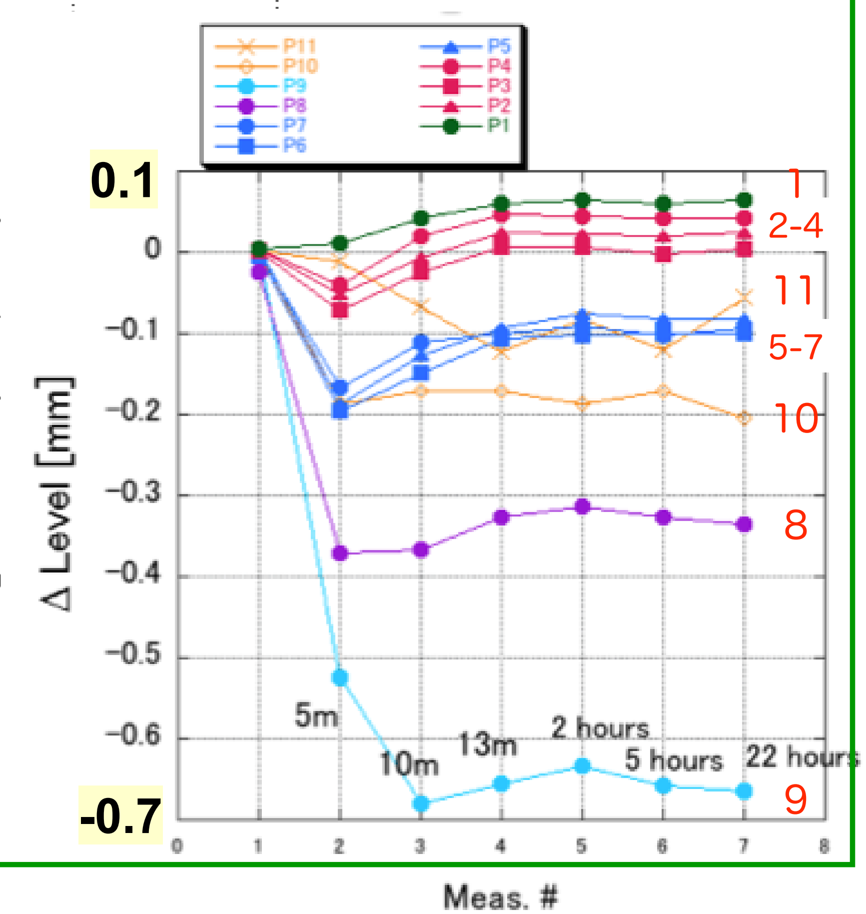
Vertical motion of the B4 floor



Dec.10 9:00
13min
to
after
~22 hours



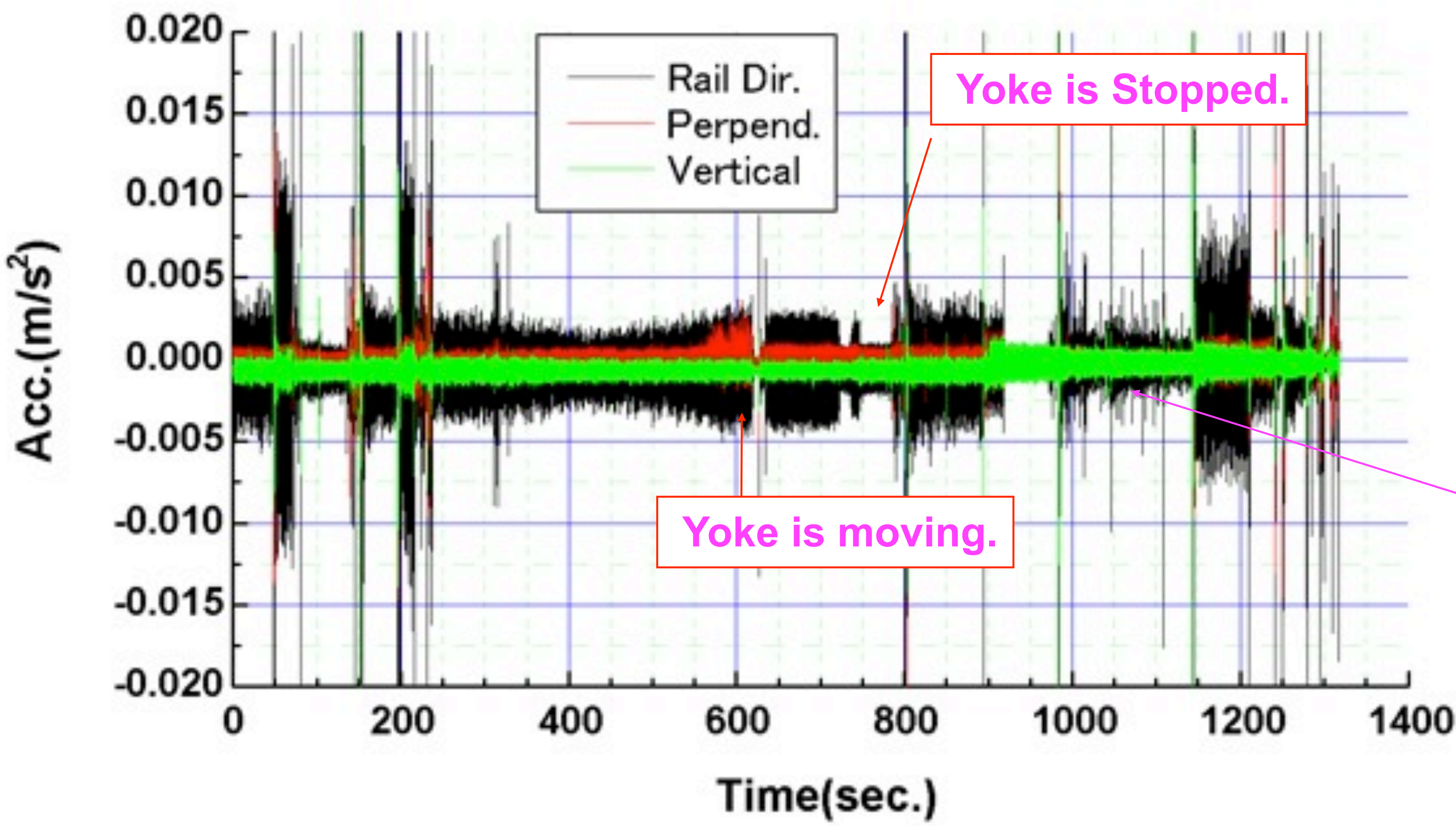
Experimental building floor (B4 floor) tilts towards Belle



2011年 9月 27日 火曜日

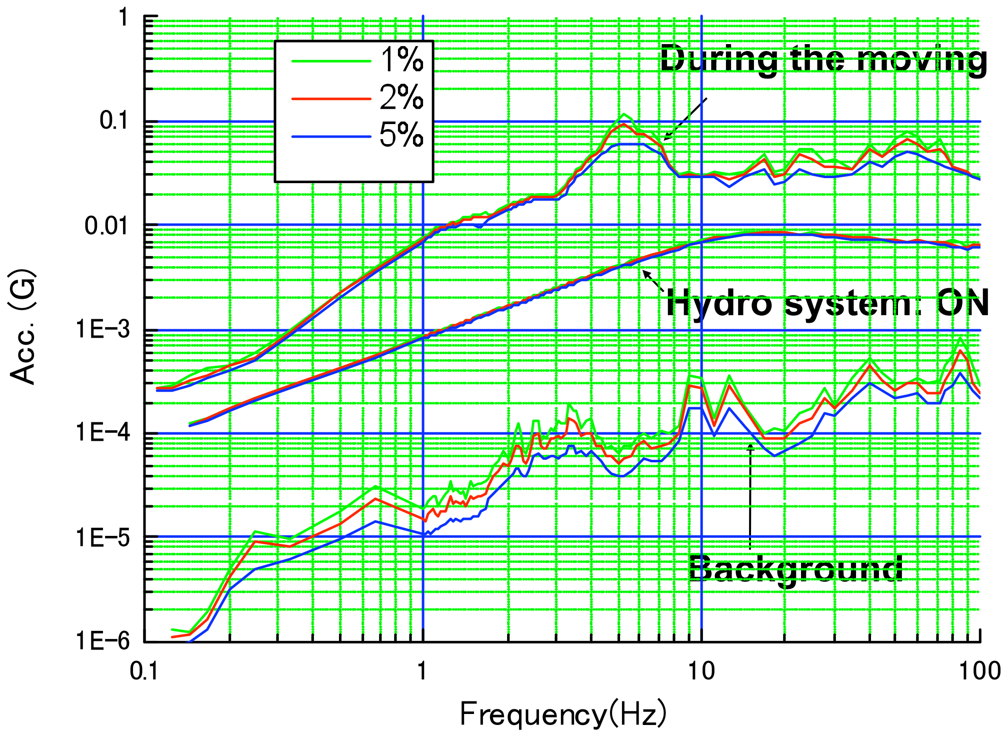
Compare response acc. to the other moving system

ND280@J-Parc

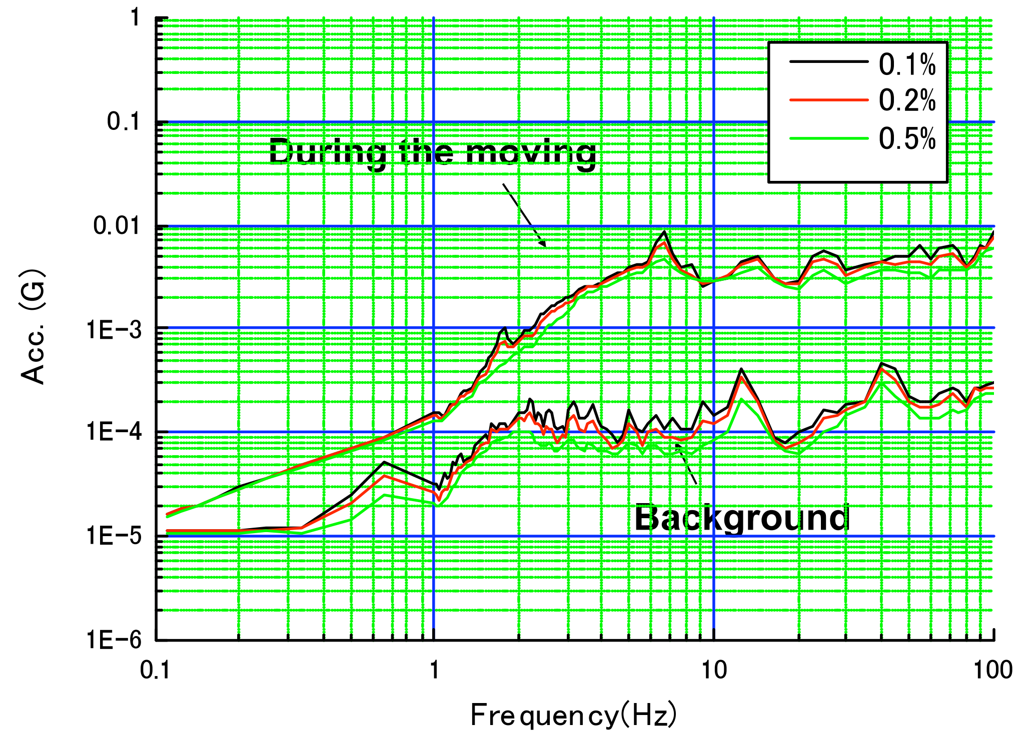


Response acceleration@ND280

On the roller: Rail dir.



On the roller: Vertical



Response acceleration ➔ ~0.1G

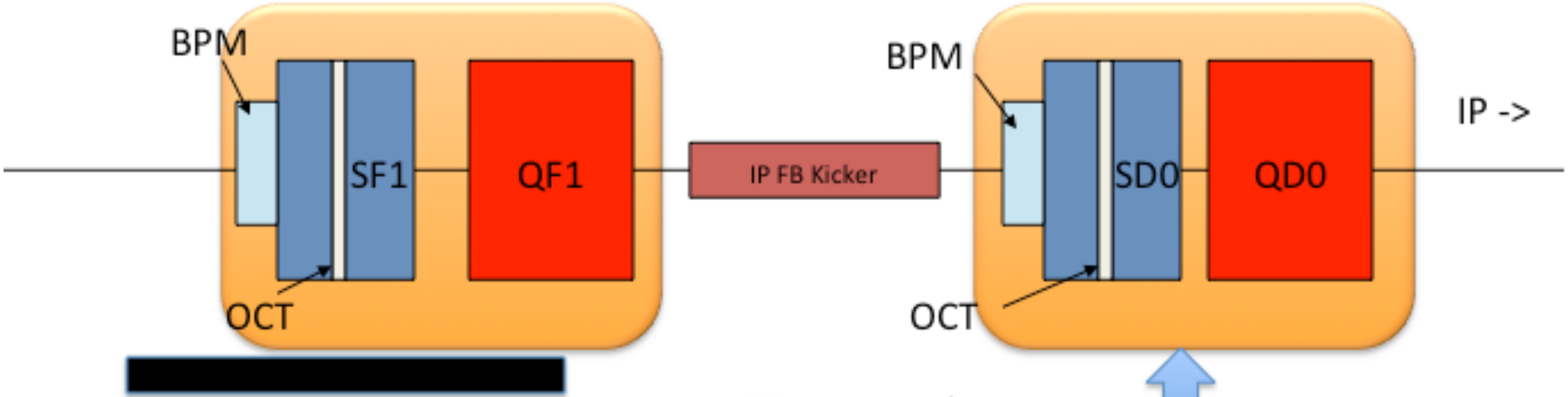
Seismic criteria for the ND280

➔ 0.5G

→ 0.1G of Acc is less than the criteria.

➔ But 10 time bigger than the Belle moving system.

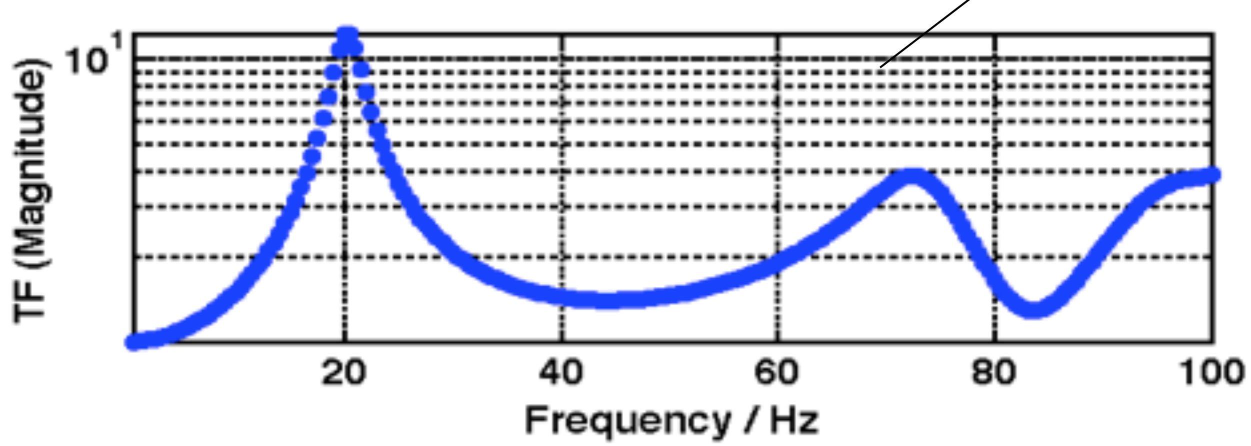
IP Region Final Doublet

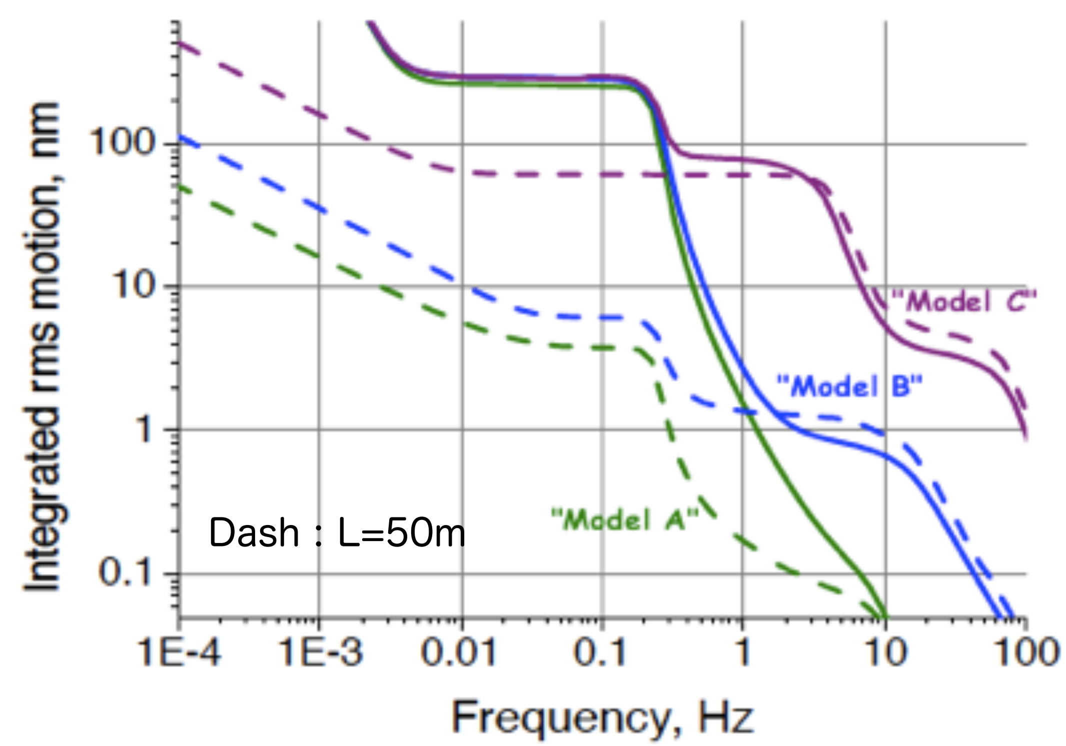


TF to ground
(from detector model)

This and other magnets assumed
rigidly attached to ground

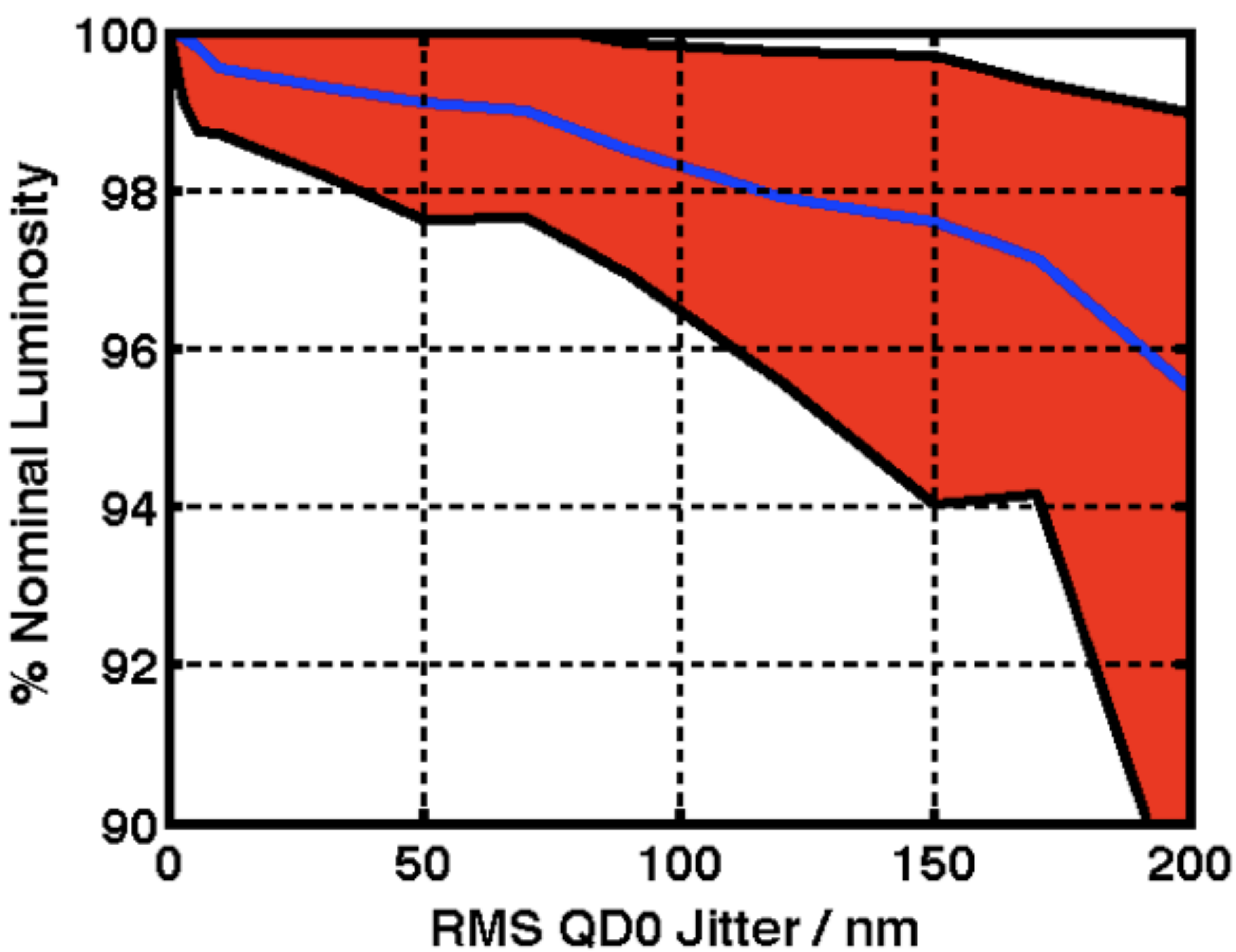
Rigid support model from SiD
(M.Oriunno)





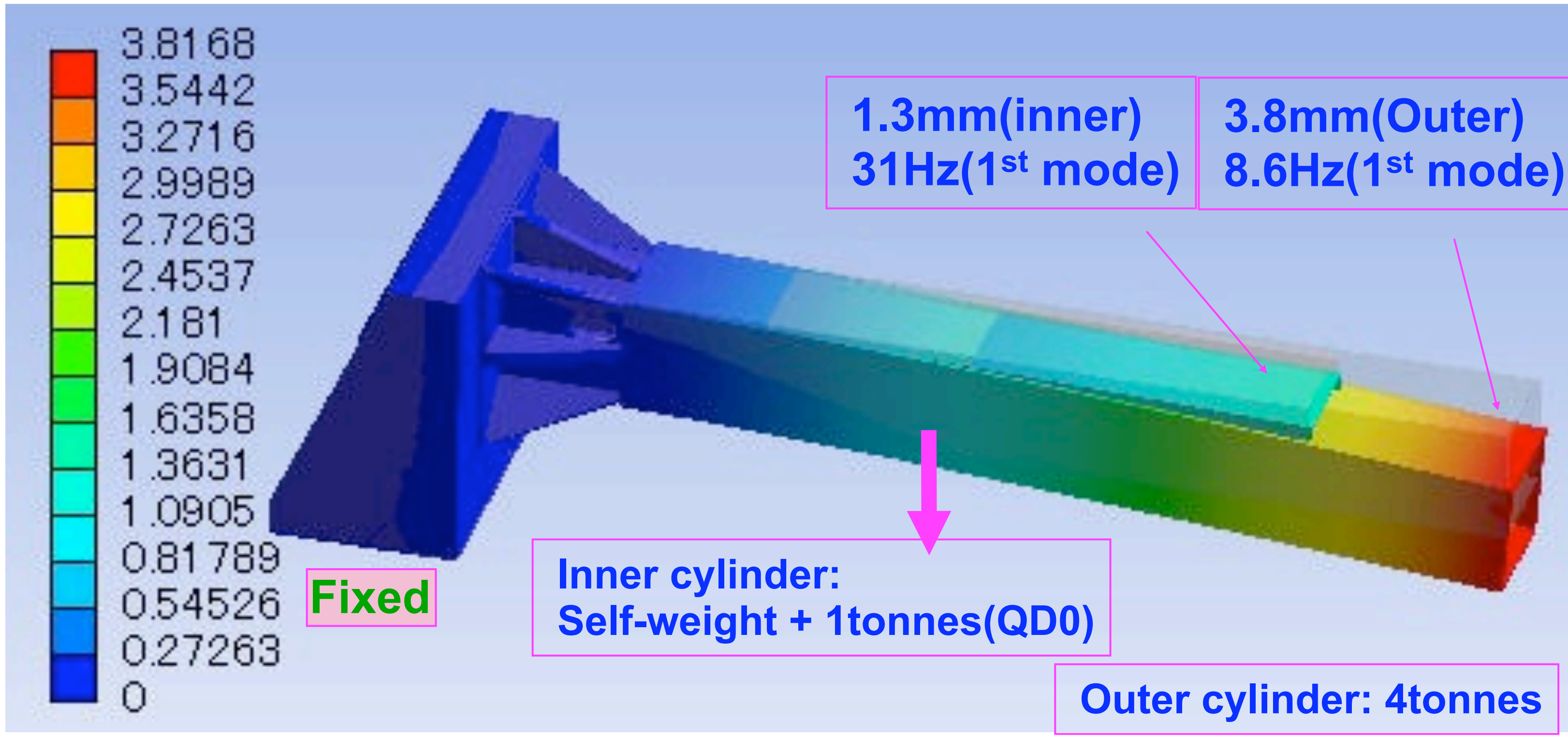
Glen White/ SLAC , ALCPG11

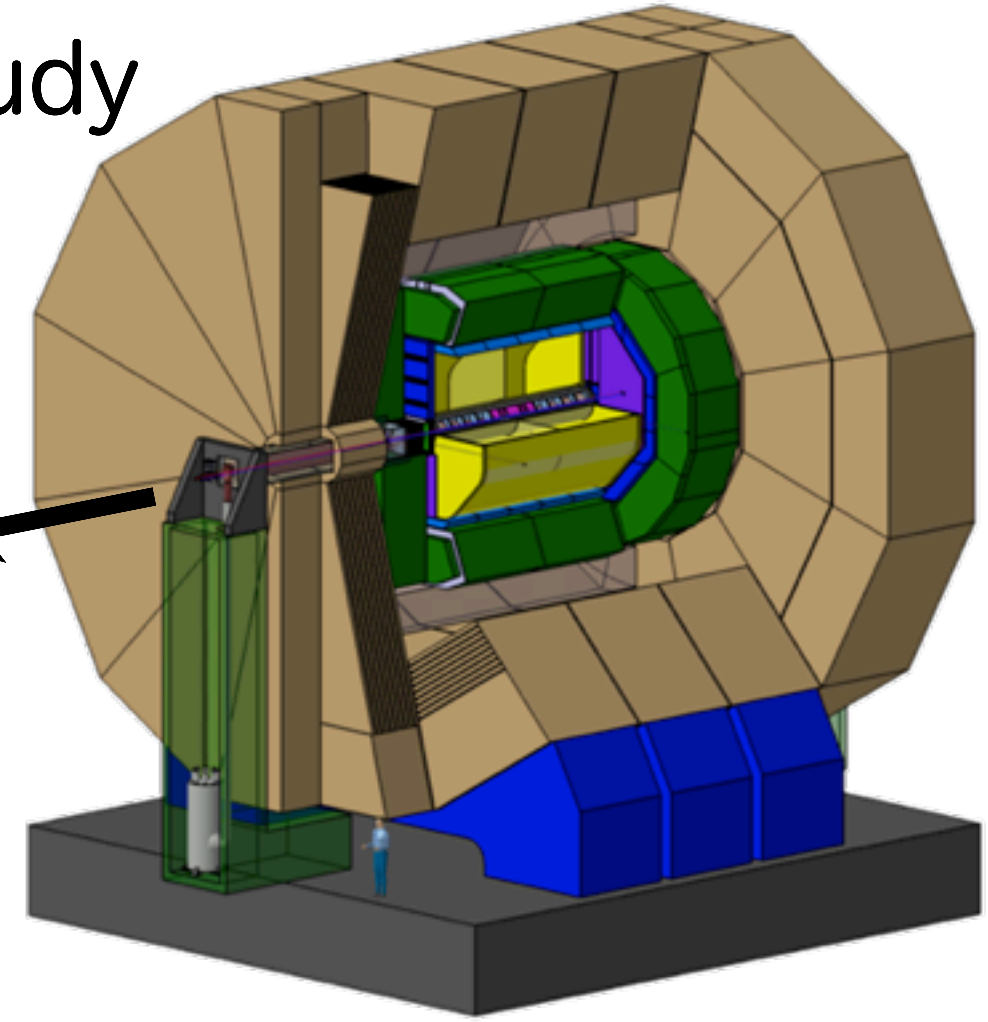
Luminosity Loss vs. QD0 Jitter

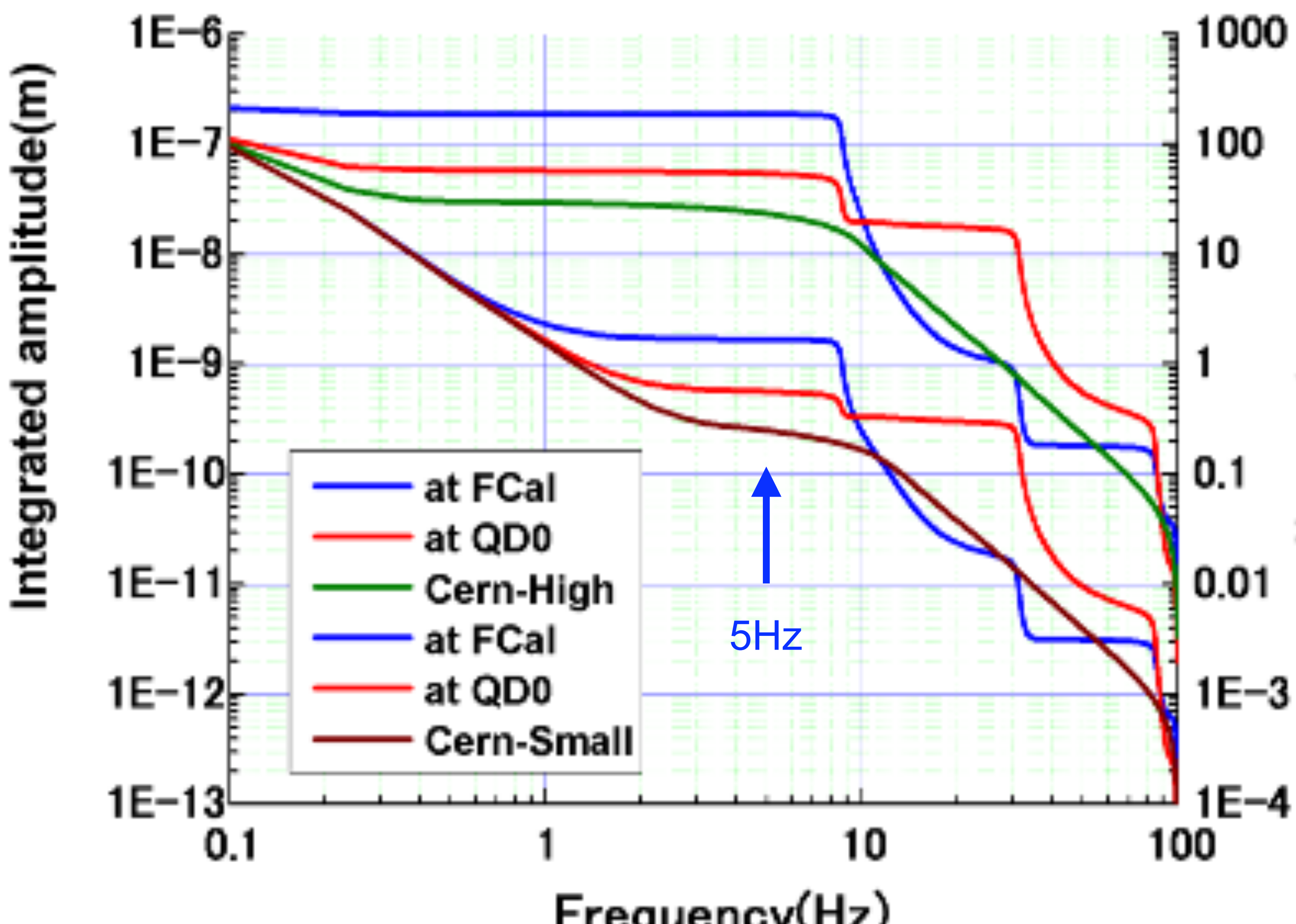


- Data shown gives % nominal luminosity for different levels of uncorrelated QD0 jitter.
  - 100 pulses simulated per jitter cases with FFB
  - Mean, 10% & 90% CL results shown for each jitter point from 100 pulse simulations
- **Tolerance to keep luminosity loss <1% is <50nm RMS QD0 jitter.**

ILD : QD0 Vibration Study







54nm @ f>5Hz at CERN-High (between Model C and B)

0.6nm @ f>5Hz at CERN-Small (~model B)

(with 2% damping factor)

H. Yamaoka, LCWS2010, Beijing, March 2010

Draft of “engineering specifications”, 12 September 2011

Engineering Specifications (1) : Push Pull Issues	unit	value	SiD	ILD
Time for Exchange experiments with rough alignment (mm)	day	1		
Time for Fine alignement, vacuum evacuation	day	1		
Time for Restart the machine and experiment	day	1		
Time for Beam calibration and alignment for the nominal luminosity	day	1		
Number of Pushpull operation	/year	10		10
Number of Pushpull operation for 15 years	times	150	100	150
Detector total weight	tons	15,000	10,000	15,500
Detector beam level	m	9	9	9
Maximum acceleration on the detectors during the movement	G	0.5	0.0001	
Total moving distance from IP to the garage position	m	15		25
Residual magnetic field at IP from detector in the garage	Gauss	50		50
Pulling forces with two lines (multiple anchoring points?)	tons/line	300		
Number of anchoring points		4		
Movement speed	cm/min	10	6 to 30	
Displacement due to the movement : radius	mm	20		
Displacement due to the movement : angle	mrad	2.5		
Adjustment of the movement : x,y	(±)mm	1		
Adjustment of the movement : angle	mrad	0.1		
Slow downward movement of the floor within ±50m around IP (for several weeks?) with feedback system	mm	5		
Platform : width	m		20	14
Platform : length	m		20	14.8
Platform : thickness	m			2.2
Platform : wall clearance	mm		10	
Platform : max. vibration transfer function for microseisms	1<f<100Hz		1.5	
Platform : pulling force in locomotion system with rollers	tons	750	500	750
Platform : pulling force in locomotion system with airpads	tons	300		300
Roller : a roller system must be supplemented by another system that allows a 3-axis movement on IP. A good candidate would be a grease-pad system on top of the roller supporting platform.				
Airpad : Standard airpad systems have the disadvantage of requiring a slight lift of the load of around 5 mm. However as the landing is obtained by leaking air through orifices this landing is very smooth as it had been verified by installing accelerometers on CMS elements.				
hydraulic jacks :				

I.) A scenario suggested by R.Settles and modified by T.Tauchi,

--Notation: BPL=best possible luminosity.

--Assumption: two detectors acquire BPL in 1.25×10^{7} sec each year. That is, 0.62×10^{7} sec per detector.

--Assumption: 1.25×10^{7} sec = 145 days = 20 weeks running at BPL. That is, 10 weeks per detector per year.

--Assumption: Yearly long shutdown for yearend holidays and machine work/detector work = 12 weeks (week 51 to week 10).

--Scenario: -start week 11, det-1 on beam.

-det-1 BPL running	2 weeks + 1 week contingency for machine study and inefficiency
-push-pull+calib	1 week
-det-2 BPL running	2 weeks + 1 week contingency for machine study and inefficiency
-push-pull+calib	1 week

--Therefore 1 cycle = 8 weeks.

--Need 5 cycles so that each detector gets 10 weeks of BPL running.

--Total running time = 40 weeks, meaning from week 11 to week 50.

II.) Evolution of BPL from “Parameters for the Linear Collider”, November 2006:

For 1.25 x10^7 sec of running in a year and L_{goal}=2x10^{34}cm^{-2}sec^{-1},

--Yr 0: commissioning of machine and detectors, i.e. no BPL running.

--Yr 1: BPL = 10% of L_{goal} = 25 fb^{-1} : 2.5 fb^{-1}/push-pull

--Yr 2: BPL = 30% of L_{goal} = 75 fb^{-1} : 7.5 fb^{-1}/push-pull

--Yr 3: BPL = 60% of L_{goal} = 150 fb^{-1} : 15 fb^{-1}/push-pull

--Yr 4: BPL =100% of L_{goal} = 250 fb^{-1} : 25 fb^{-1}/push-pull

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total = 500 fb^{-1} (250 fb^{-1} each for two detectors)

This model involves 10 push-pulls per year while for precision-physics measurements, we may need fewer push-pulls.

Do we need Gentleman's agreement between the two detectors for common publication of experimental results ?

“Discovery papers” with all members of two collaborations plus accelerator physicists as authors

Draft of “engineering specifications”, 12 September 2011

Engineering Specifications (2) : Experimetnal Hall	RDR	SiD	ILD	ILD in Mtn. site
Parameters that define the underground hall volume				
IR Hall Area(m) ; (W x L)	25x120			25x100
Beam height above IR hall floor (m)	8.6	9(7.5)	8(9)	9
IR Hall Crane Maximum Hook Height Needed(m)	20.5	5m above top of detector	20.5	20.5
Largest Item to Lift in IR Hall (weight and dimensions)	400t	380t(HCAL)	55t, 3x3x1.5m	400t
IR Hall Crane	400t+2*20t	400t(200tx2)/10t	80t(40tx2)	(200t+20t)x2
IR Hall Crane Clearance Above Hook to the roof (m)	14.5(includes arch)		6	12.5
Survice caverns(m) ; (W x L xH)	none		15x25x11	15x25x11
Resulted total size of the collider hall (W x L x H)	25x120x39	20.2x90x30	29x100x30	25x100x33
Area at garage position		19x 55.5	w/ side access tunnel	with side cavern
Parameters that define dimensions of the IR hall shaft and the shaft crane				
Largest Item; Heaviest item to Lower Through IR Shaft (weight and dimensions)	9x16m, 2000t	2500t	3500t, 15.7x7.81m	-
IR Shaft Size : diameter(m)	16	18	18	-
IR shaft fixed surface gantry crane. If rented, duration	1.5 years	1.5 years	1.5 years	-
Surface hall crane should serve IR shaft	Yes	Yes	Yes	-
Other shafts near IR hall for access	No	Yes	No	-
Elevator and stares in collider hall shaft	Yes	?	Yes	
Size of access tunnel at Mtn. site (W x H, m)	-	-	-	11x11, 10.2x8.0
Parameters that define dimensions of the surface assembly building and its crane				
Surface Assembly Building Area ((W x L , m)	25 x 100 / detector		30x60	27x100 / detector
Largest Item to Lift in SurfAsm. Bldg. (weight and dimensions)	400t	380t(HCAL)	180t	400t, 8.6ϕx8
Surface Assembly Crane	400t+2*20t	400t(200tx2)/10t	2x80t	(200t+20t)x2
SurfAsm. Crane Maximum Hook Height Needed(m)	18	20	19	20.5
SurfAsm. Crane Clearance Above Hook to the roof (m)	7		5m to ceiling	6.5
Resulted volume of surface assembly building (W x L x H, m)	25 x 100 x 25		30x60x24	27x200x27
Parameters that define crane access area and clearance around detector				
SurfAsm. crane accessible area (needed) / available (W x L, m)	20 x 102		28x56	
IR hall crane accessible area (needed) / available (W x L, m)	22 x 98		28x41	18x98
Maximum Detector Height(m)		16.15	15.74	15.74
Detector Width (m)		18.53(14.334)	15.665	15.665
Minimum Detector Clearance (W x L x H, m)			15.67x13.26x15.74	15.67x13.26x15.74
FILL IN OTHER IMPORTANT PARAMETERS WHICH ARE MISSING				
Maximum AC power (MW)	-			
Temerature control (°C)	-			
Humidity control (%)	-			
Sump Pump Control System (ground water)	-			
Cryogenics system : 4K He liquefier and large dewar	-	same level as the coil	service cavern	service cavern
Dump registor	-	on the detector		service cavern

Draft of “engineering specifications”, 20 May 2011

Engineering Specifications (3) : QD0 Issues	unit	value	
Mover : number of degrees of freedom		5	horizontal x, vertical y, pitch φ, yaw ψ, roll α
Mover : Range per x,y degree of freedom	mm	± 2	
Mover : Range per φ, ψ degree of freedom	mrad	± 1	
Mover : Range per α degree of freedom	mrad	± 30	
Mover : Step size per degree of freedom of motion	μm	± 0.05	
Before BBA : Accuracy per x,y degree of freedom	μm	± 50	
Before BBA : Accuracy per φ, ψ degree of freedom	μrad	± 20	
Before BBA : Accuracy per α degree of freedom	mrad	± 20	
BBA : alignment accuracy per x,y	nm	± 200	from a line determined by QF1s for 200ms
BBA : Accuracy per α degree of freedom	μrad	± 0.1	from a line determined by QF1s for 200ms
Vibration stability : $\Delta(QD0(e^+)-QD0(e^-))$	nm	50	within 1ms long bunch train

Engineering Specifications (4) : Radiation shield	unit	value	
Self shielding		must	
Normal operation : anywhere beyond the 15m zone housing the off-beamline detector	μSv/hour	0.5	
Accidental beam loss : dose for occupational workers	mSv/hour	250	The acident is defined as the simultaneous loss of both e^+ and e^- beams at 250 GeV/beam anywhere, at maximum beam power.
Accidental beam loss : integrated doze for occupational workers	mSv/accident	1	
Accidental beam loss : beam shut-off time after the accident	beam-train	1	

Engineering Specifications (5) : Vacuum	unit	value	
in the 200m upstream of the IP	nTorr	1	$=1.3 \times 10^{-7}$ Pa
in the remainder of the BDS system	nTorr	10	$=1.3 \times 10^{-6}$ Pa
in the 18m zone of the detector			not specified in the IR document

Conclusions

- Platform system was chosen for the push pull operation at ALCPG11.
- MDI continues to study based on the work plan with milestones for the DBD/TDR and additional resources by the ILCSC.
- Draft of the engineering specifications was made for designs of the push-pull system and experimental hall with collaboration of the CFS group.
- We will enlarge the synergy with CLIC.