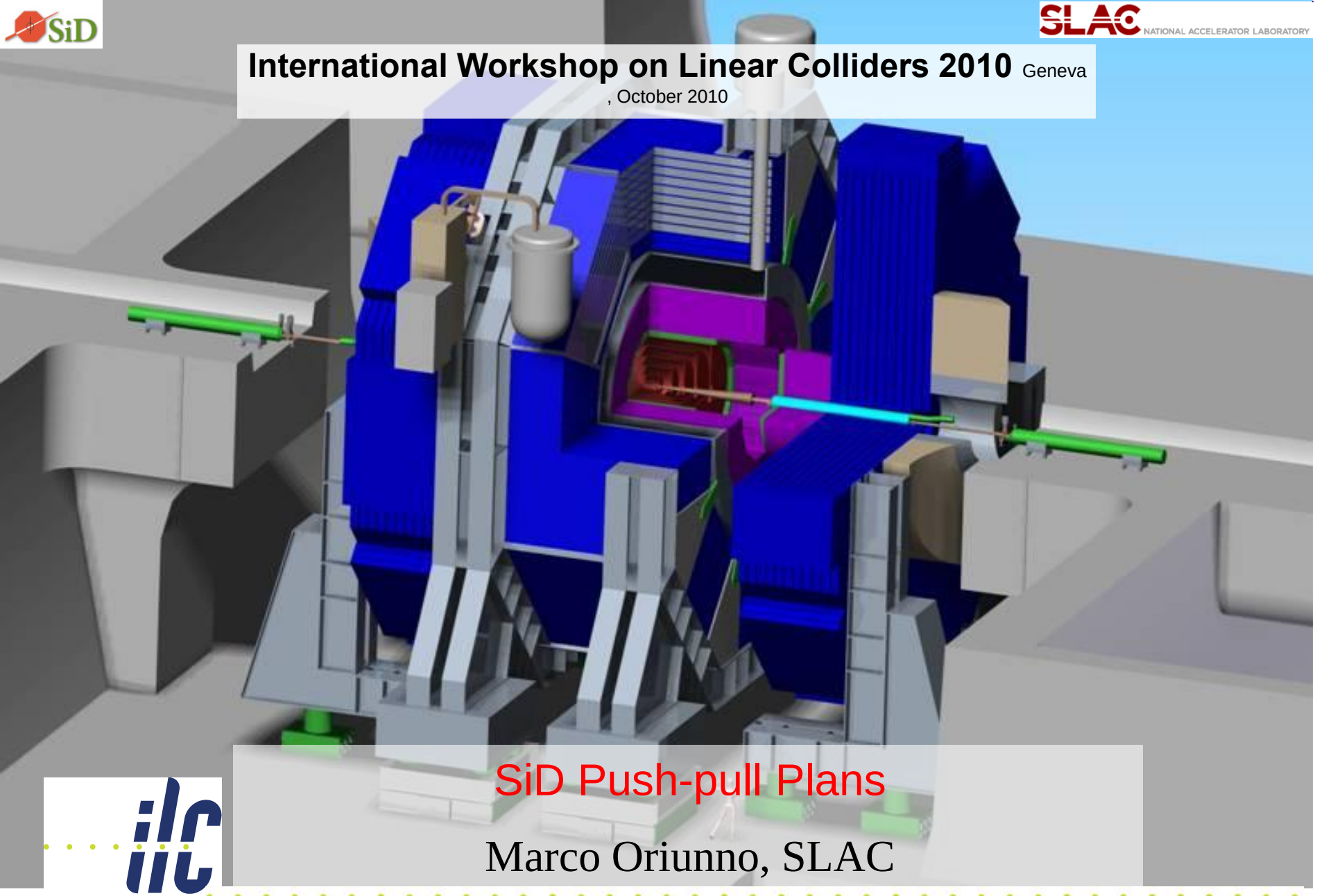
International Workshop on Linear Colliders 2010 Geneva, October 2010



SiD Push-pull Plans

Marco Oriunno, SLAC

Push pull Issues

Support of the detector and QD0

- SiD favors a minimal L*. This means that the QD0's are supported by the doors, and the beam-line breaks between QD0 and QF1 for push-pull.

- There is ~1.5 m radial difference between SiD and ILD (different technology choices in the tracking region)

- Beam height is 9 m from the floor, which increases to ~13 m with the adoption of a platform (platform thickness + motion system) by one or both detectors.

- Studies are needed to understand the vibration performance and the cost implications of the push-pull approaches.

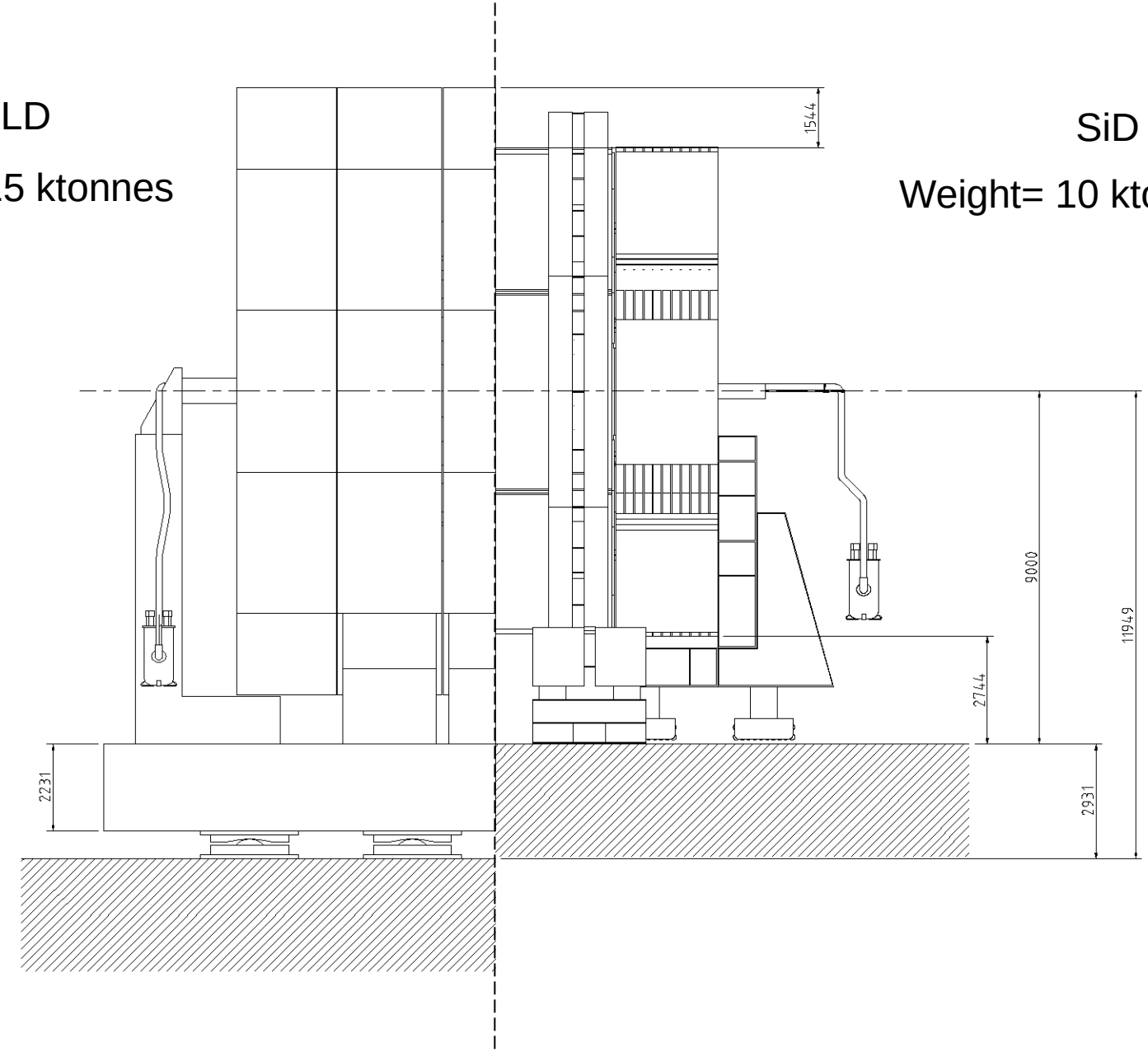
ILD and SiD differences

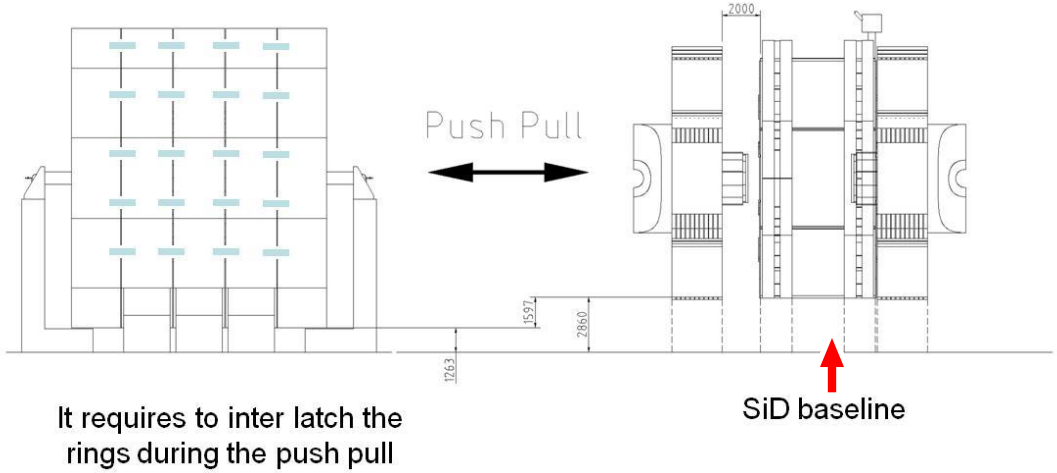
ILD

Weight= 15 ktonnes

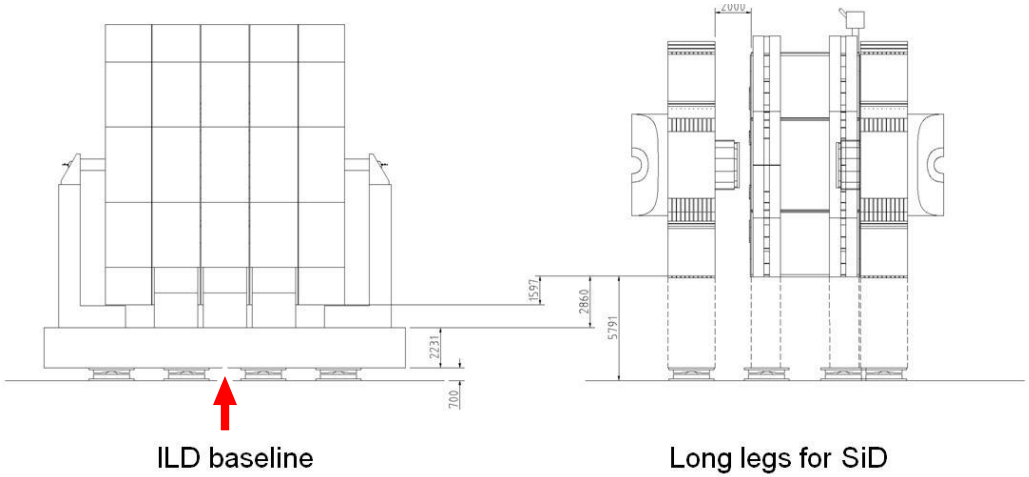
SiD

Weight= 10 ktonnes

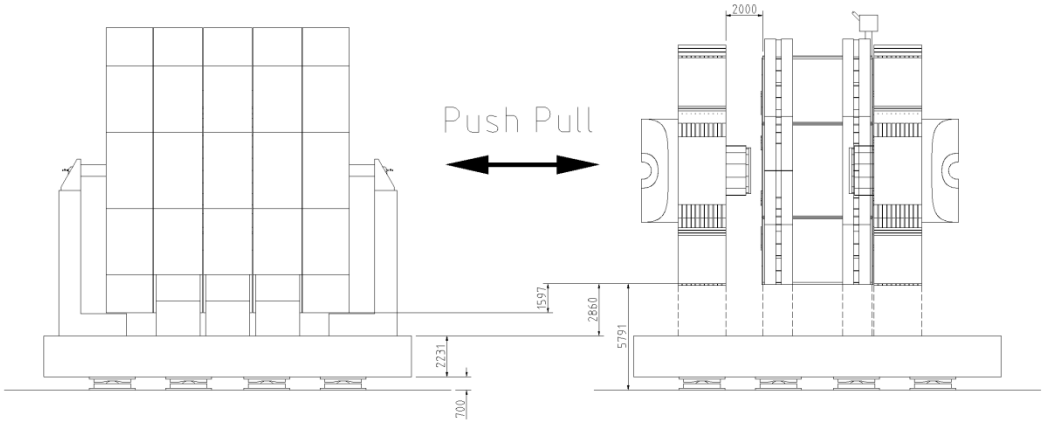




Option 1, ILD and SiD moving on the floor



Option 2, ILD on a platform, SiD moving on the floor



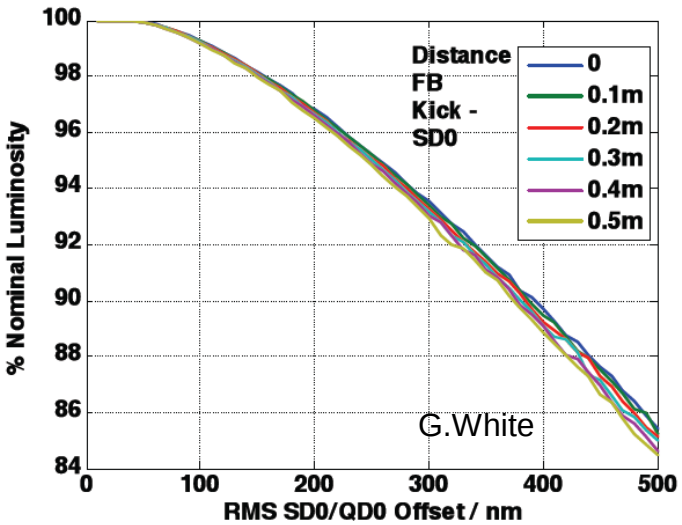
Option 3, ILD and SiD on platforms

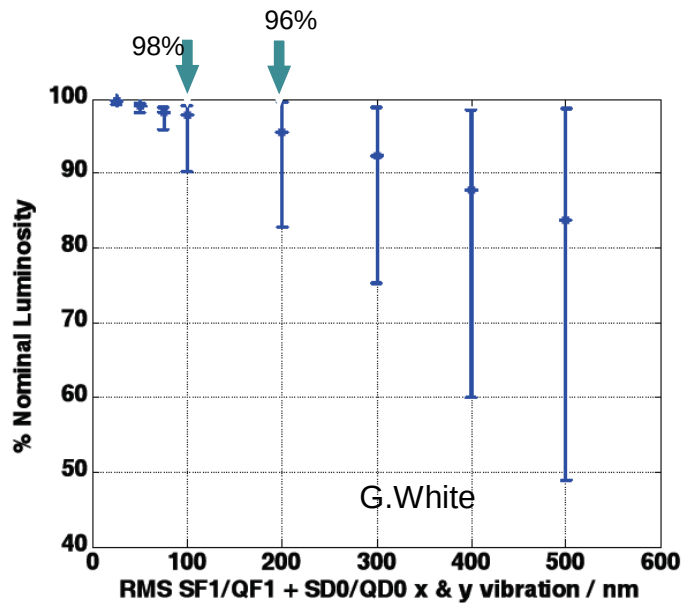
QD0 stability Requirements

Most acute luminosity loss mechanism due to relative jitter of final focusing magnet elements : Ground Motion and Mechanical vibration sources

ILC has Active Fast Feedback based on beam trajectory after collision

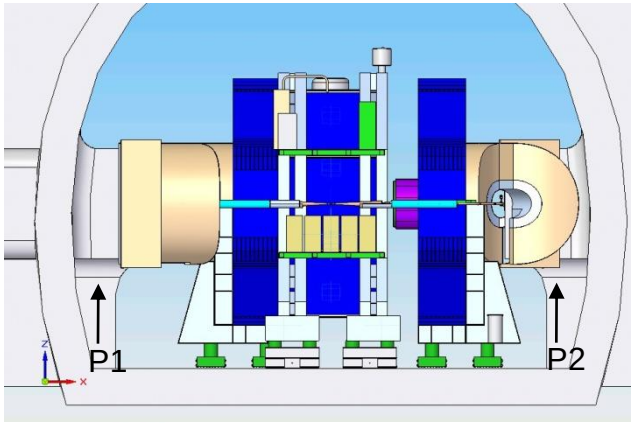
Max. Integrated displacement: 100÷200 nm > 5 Hz

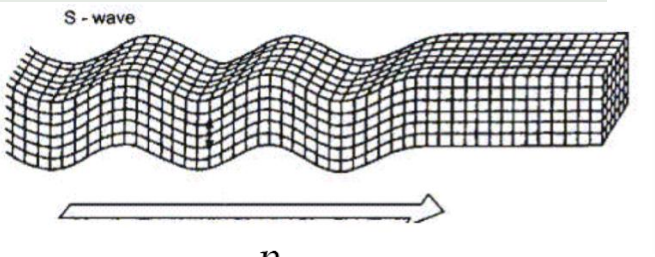




Lumi loss due to beam offset in SD0 (beamsize growth) and IP misalignment of beams

Vibrations : Absolute, Relative and Coherent and motion





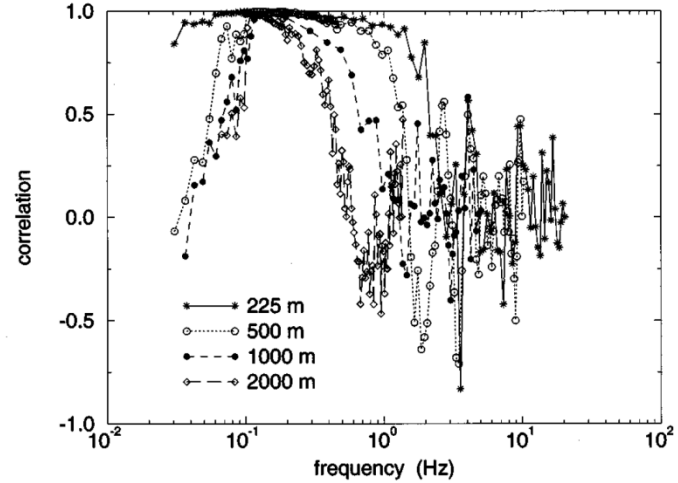


FIG. 3. Correlation spectra of ground motion measured at CERN in the LEP tunnel [7]. The distances between sensors were 225, 500, 1000, and 2000 m.

Coherence : $N_{12}(f) = \dfrac{p_{12}}{\sqrt{p_1 p_2}} = J_0(\omega L / v)$

If P1=P2, then :

Jo = 0th Bessel function

L= distance between points

v = speed of sound in rock, ~3 km/s

$$\rho(\omega, L) = p(\omega) 2\{1 - \mathrm{Re}[N_{12}(\omega, L)]\}.$$

Relative displacement spectrum

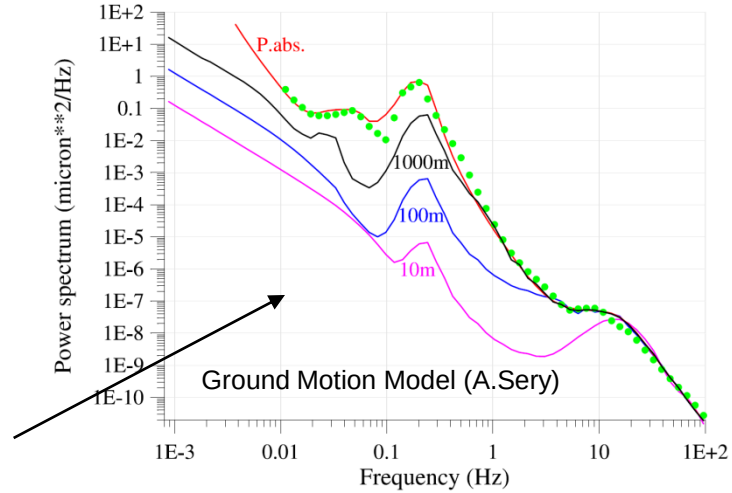
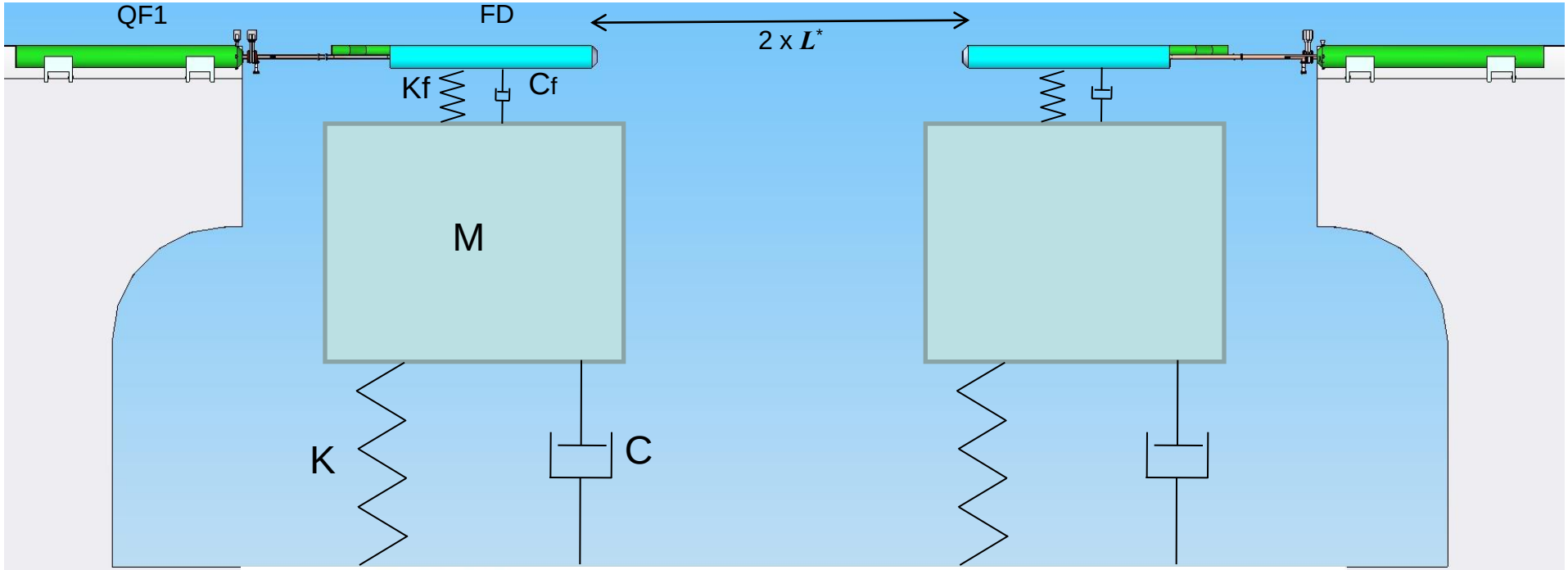
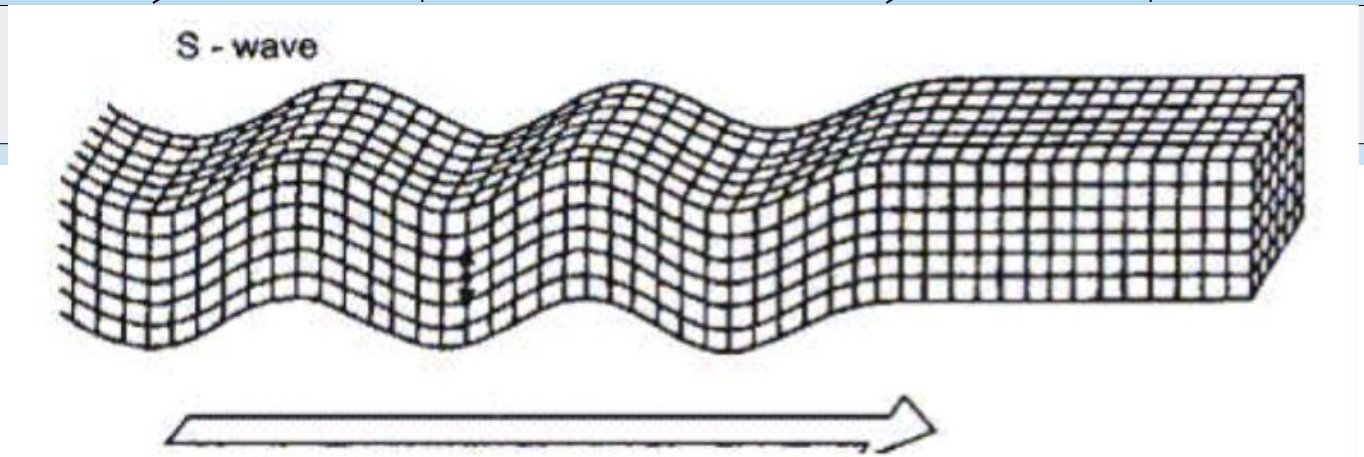


Figure 3: Measured (symbols) and modeling spectra $p(\omega)$ of absolute motion and $p(\omega, L)/2$ of relative motion for the 2 a.m. SLAC site ground motion model.

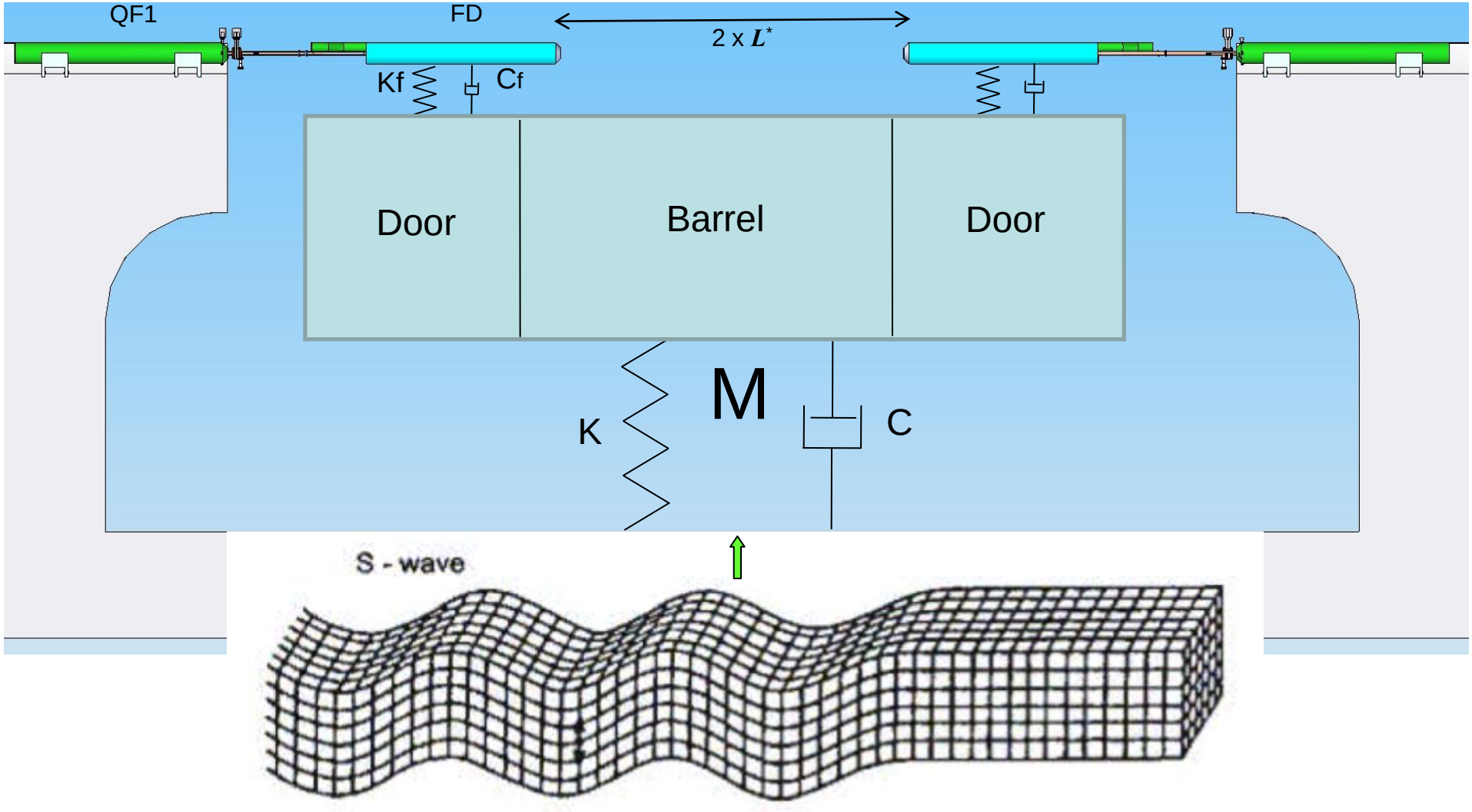
Independent Supports (Cavern,Pillars Platform)





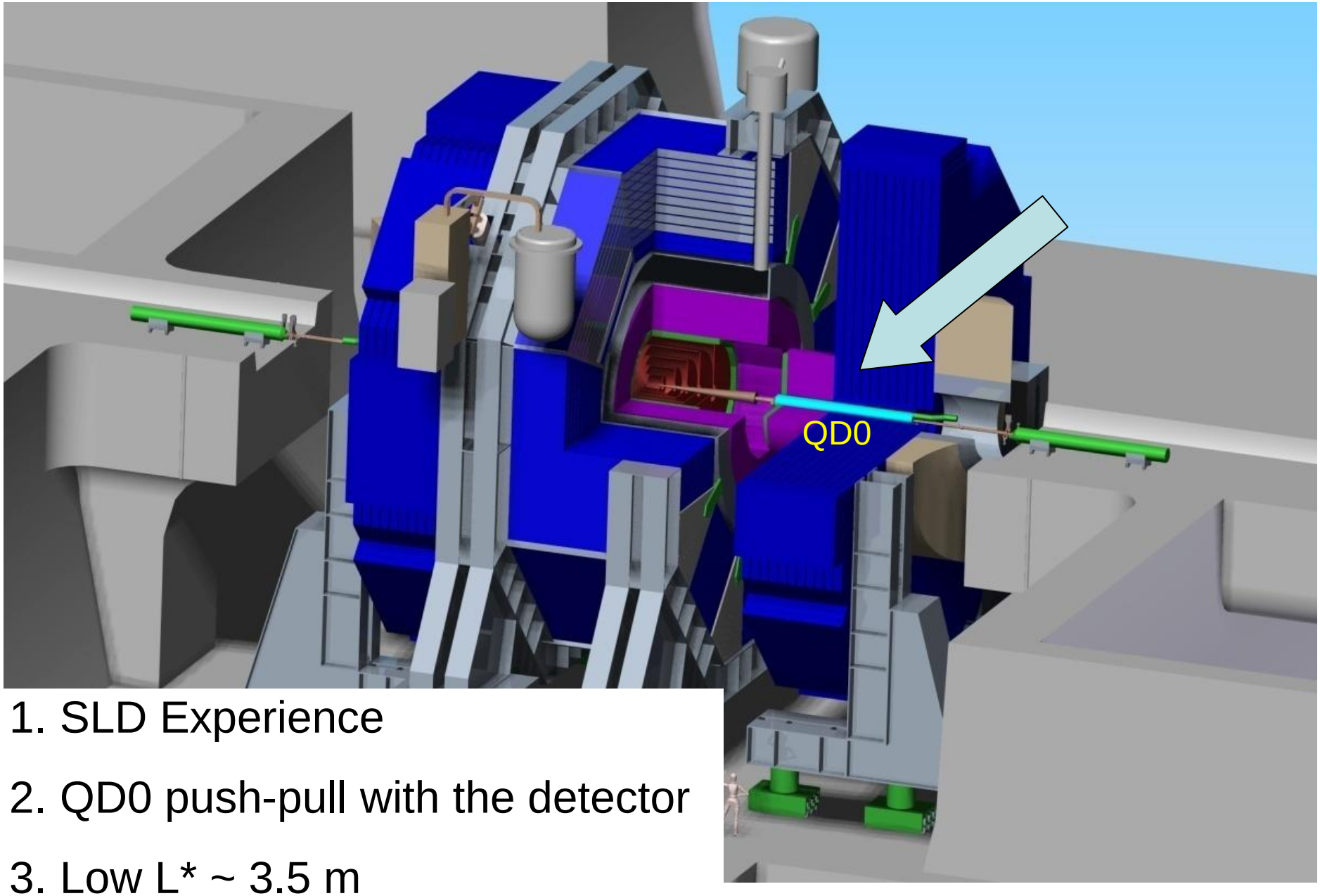
Low Coherence

Common Supports (Detector under mag.field)



High Coherence

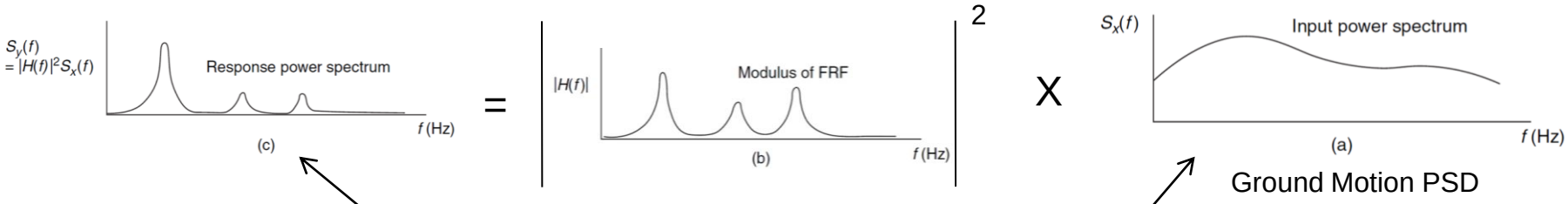
QD0 supported from the doors



1. SLD Experience
2. QD0 push-pull with the detector
3. Low L* ~ 3.5 m

Random vibrations study

The Model requires the Ground Motion Spectrum P(f) and the Frequency Response Function H(f) of the structure



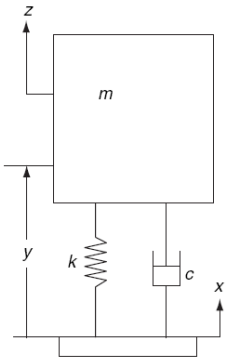
Frequency Response Function

Ground Motion PSD

$$Sy(f) = |H(f)|^2 P(f)$$

Analytically

FEA



$$Fr(f) = \sqrt{\frac{1+\left(2c\frac{f}{fn}\right)^2}{\left(1-\left(\frac{f}{fn}\right)^2\right)^2+\left(1+2c\frac{f}{fn}\right)^2}}$$

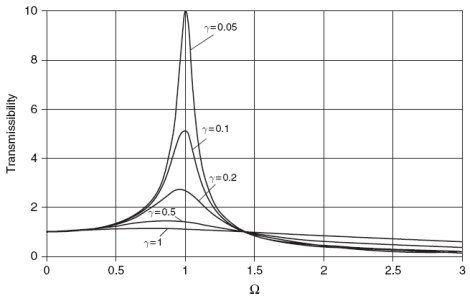
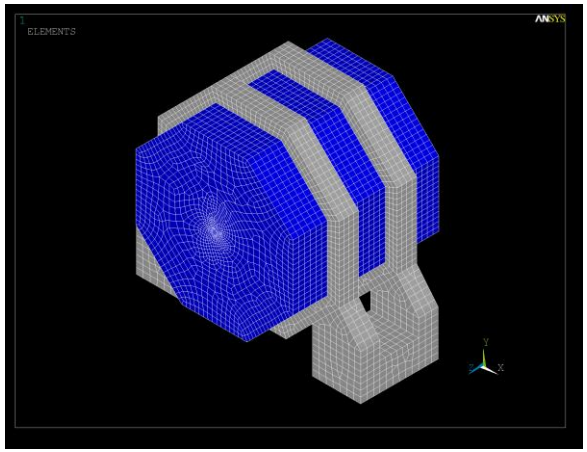


Fig. 4.8



Ground motions

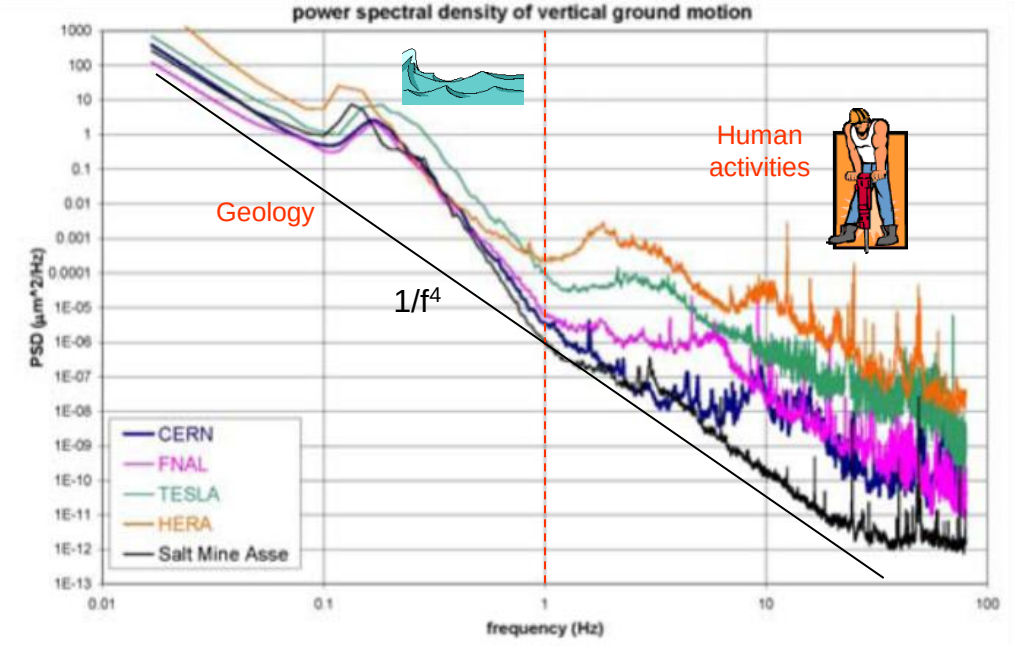
Ground vibrations measurements are available for all the major accelerators sites

Main features :

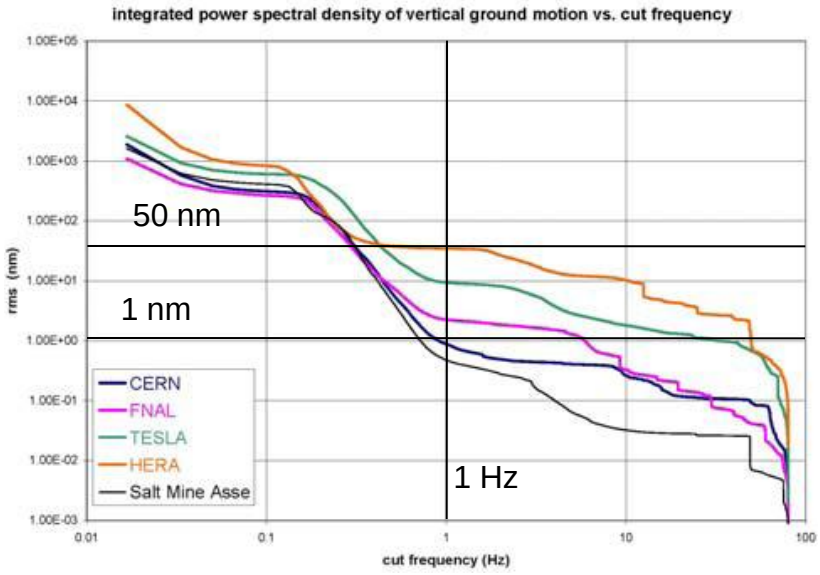
Separation at ~few Hz between geology and human induced noise (pretty much the separation between the slow and fast luminosity feedback)

Some site are more noisier than other because of Human activity

Motion falls as $1/f^4$

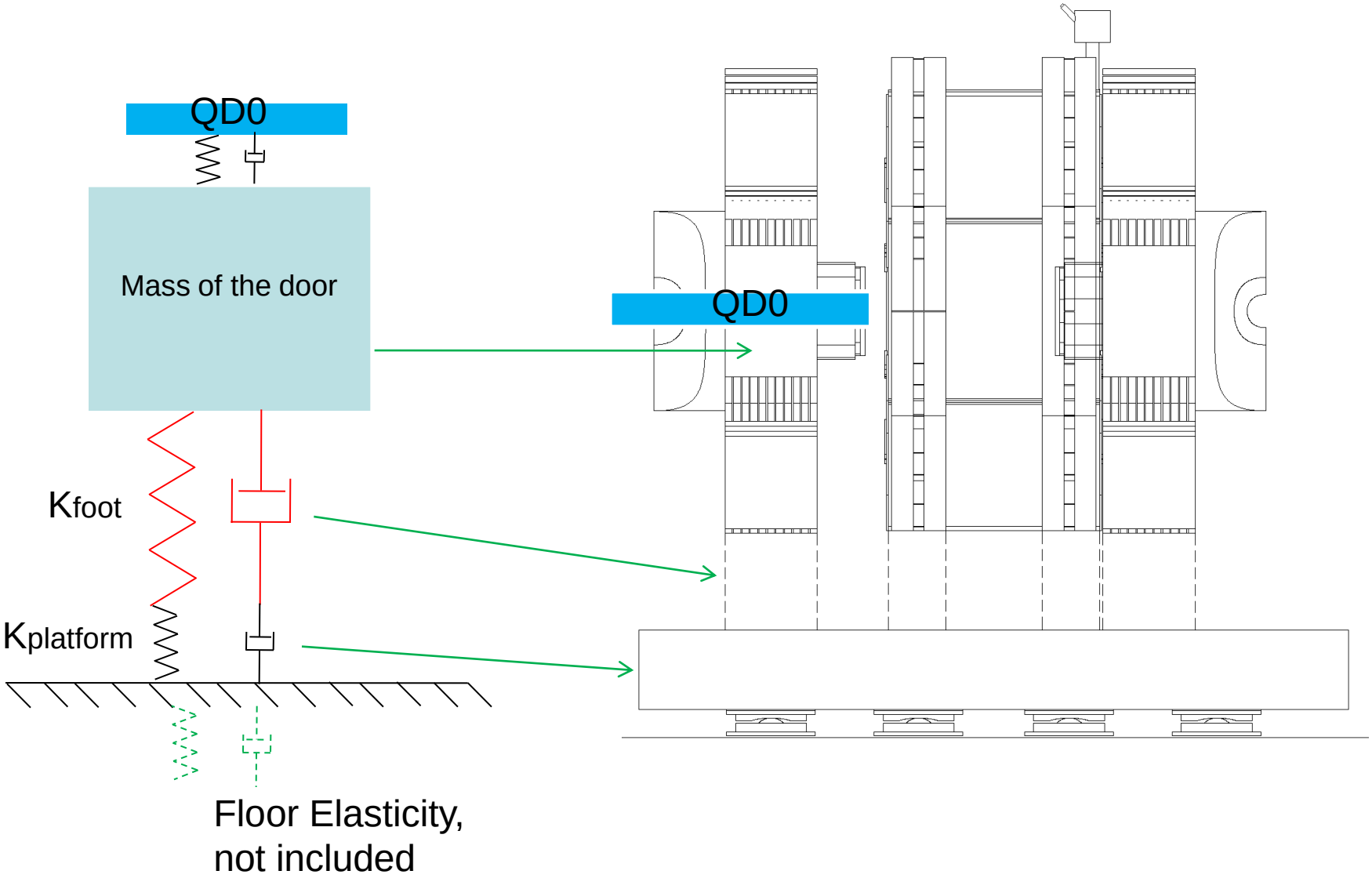


Power Spectrum Density

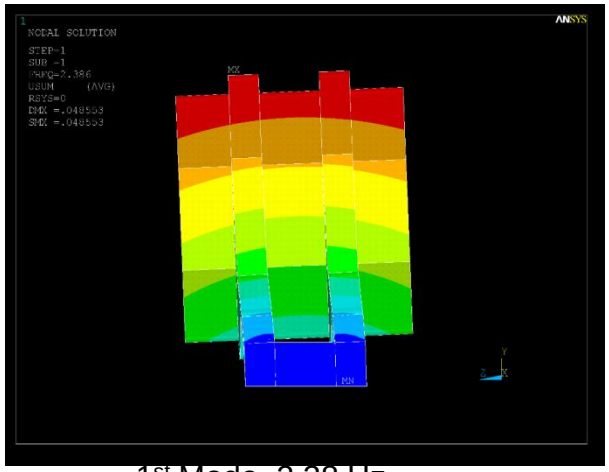


Integrated r.m.s. displacement

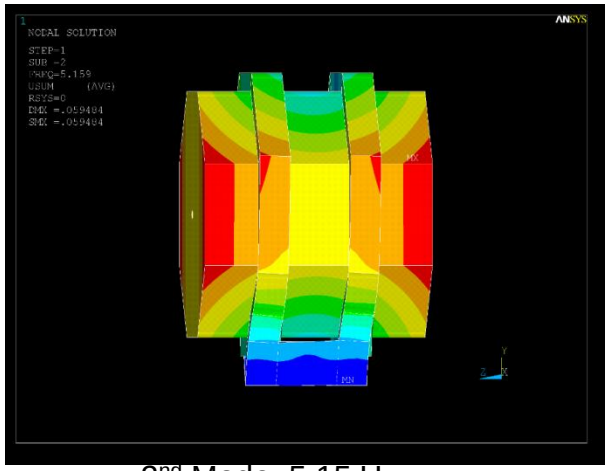
SiD Vibration Model : 1 degree of freedom M,K,C oscillator



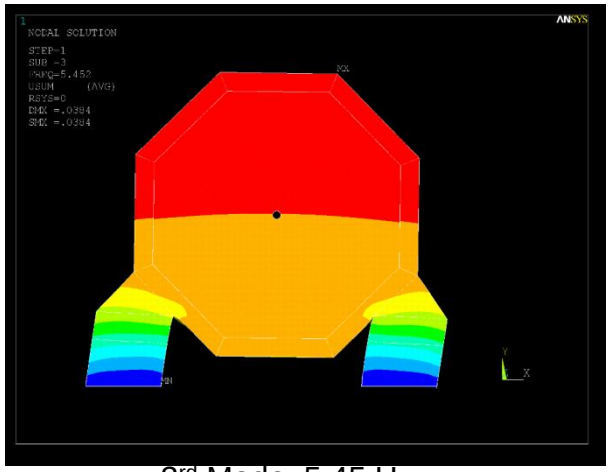
SiD Free Vibration Mode



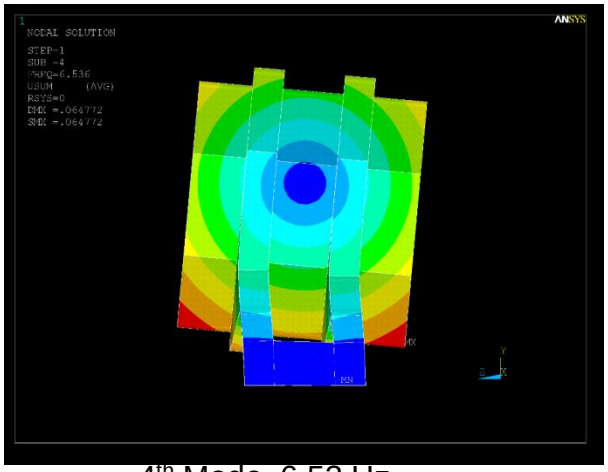
1st Mode, 2.38 Hz



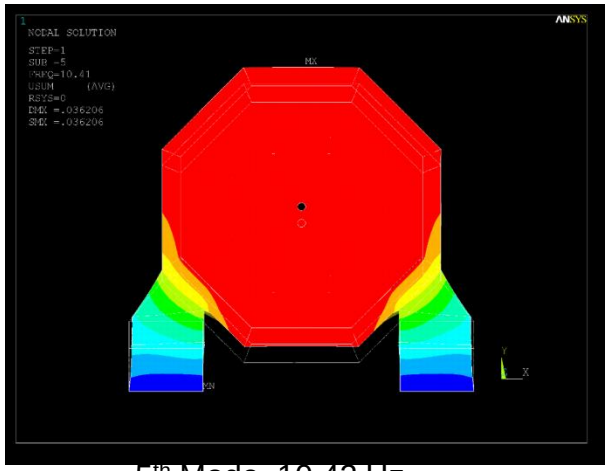
2nd Mode, 5.15 Hz



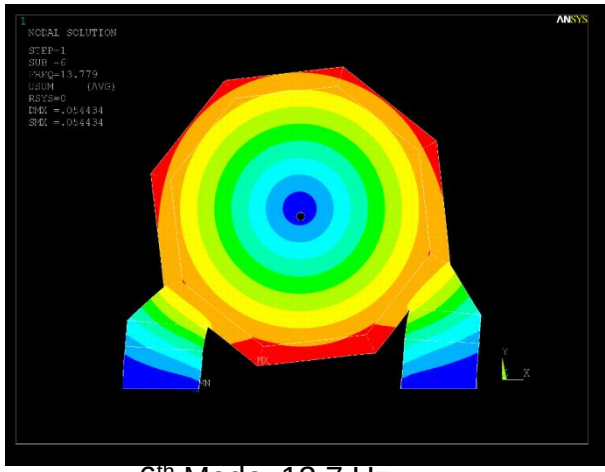
3rd Mode, 5.45 Hz



4th Mode, 6.53 Hz



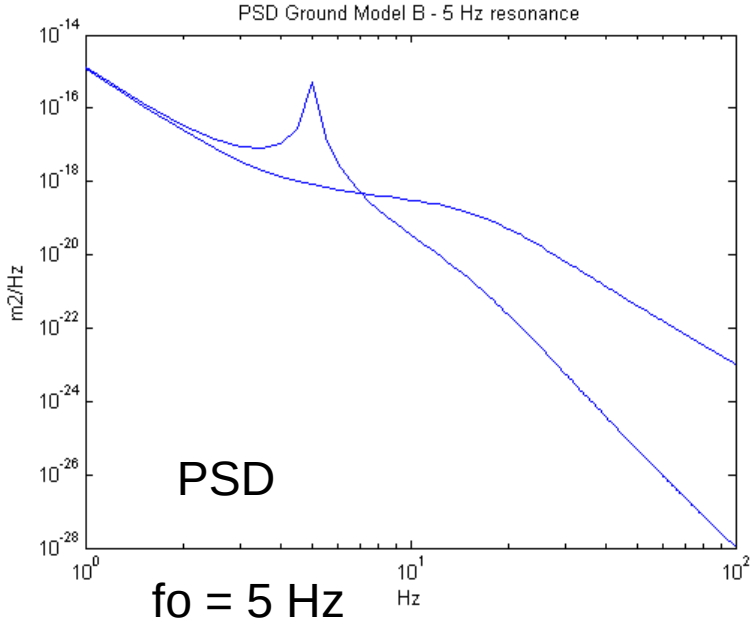
5th Mode, 10.42 Hz

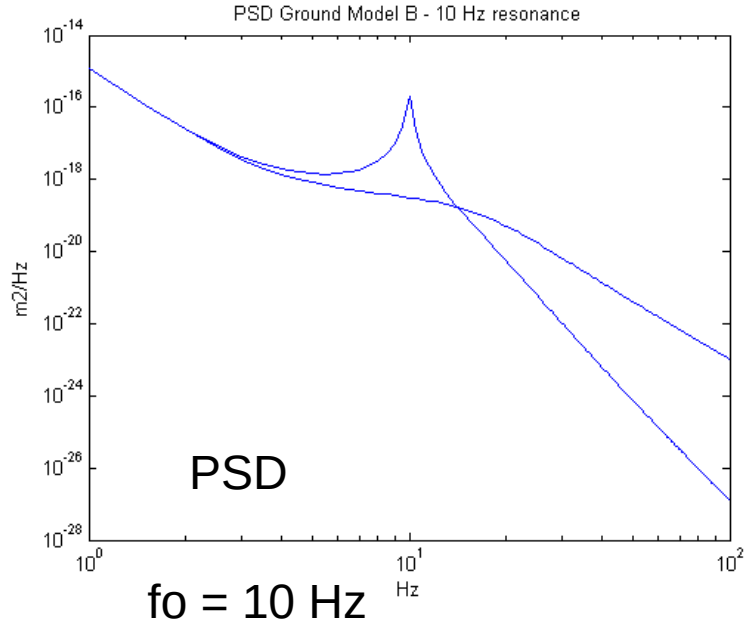


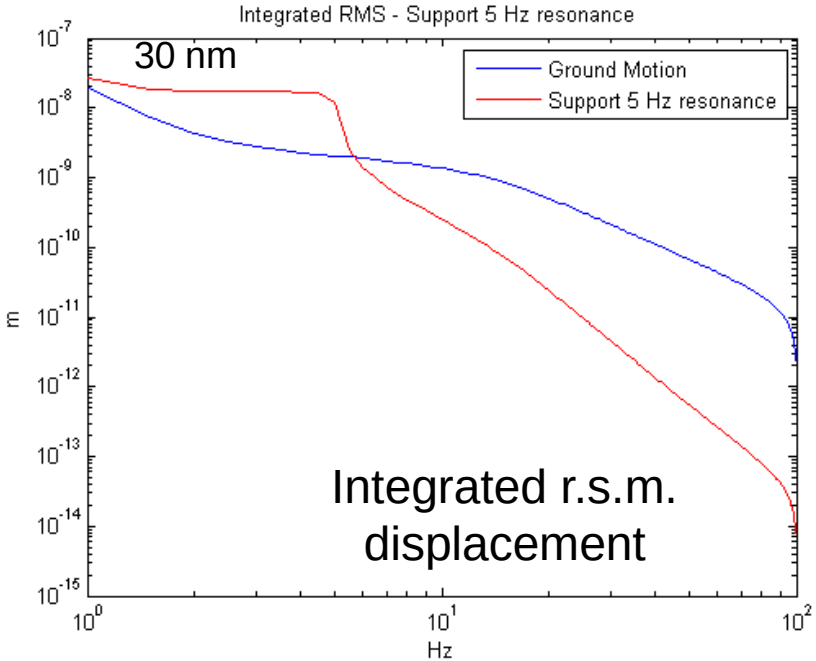
6th Mode, 13.7 Hz

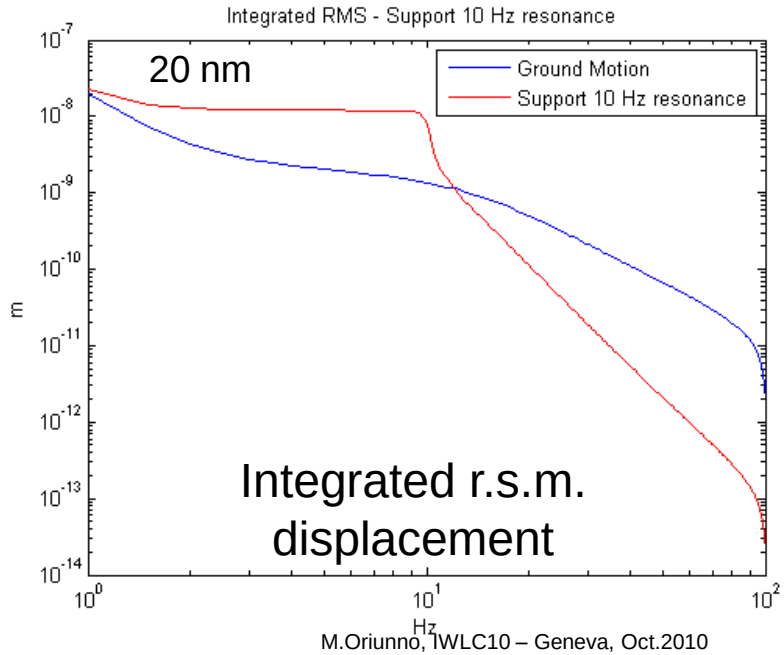
Vertical motion

Random vibration Studies : SiD O.K. on the floor, no platform





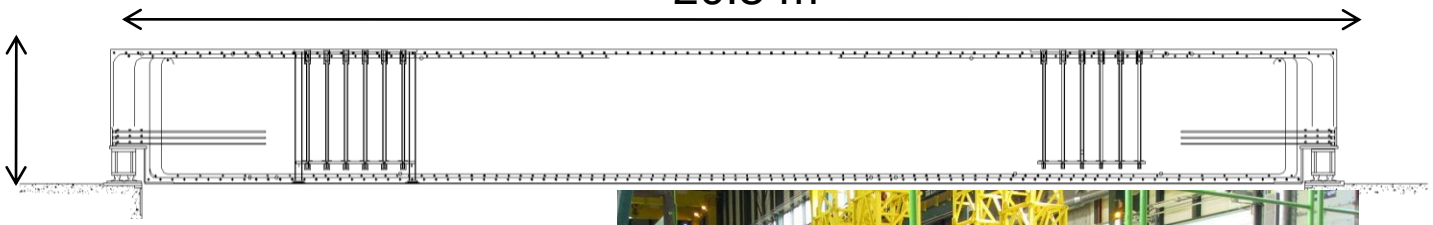




Platform Studies

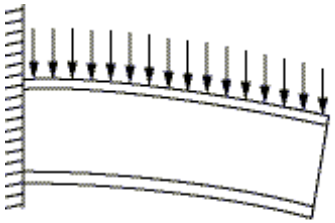
20.5 m

2250



CMS Platform during costruction

Simplified ANSYS Model : SHELL91Layered Plate element



Deformed shape without sandwich option

Iron re-bars (equivalent th. 35 mm)

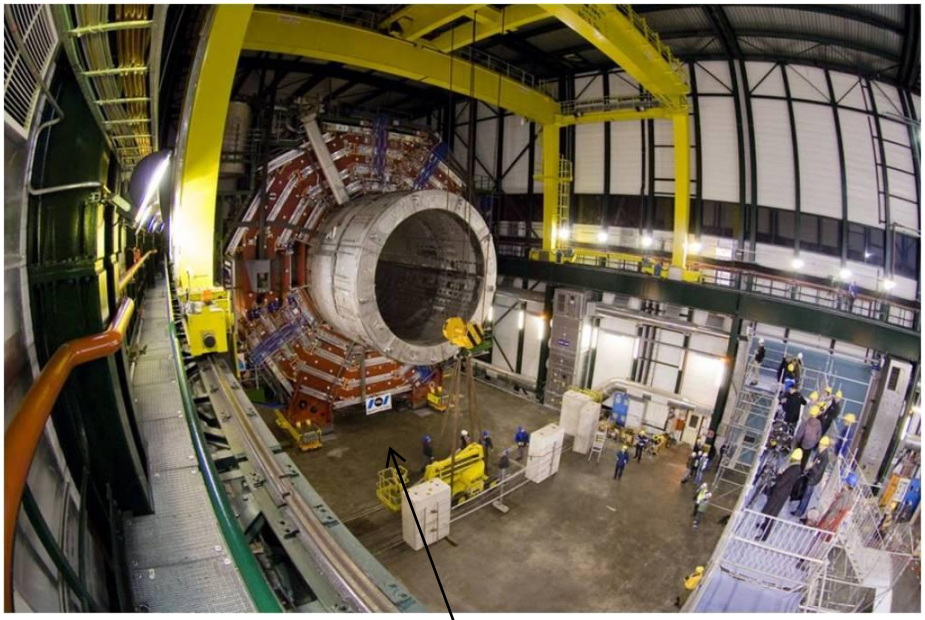
Concrete, 2130 mm

Iron re-bars (equivalent th. 35 mm)

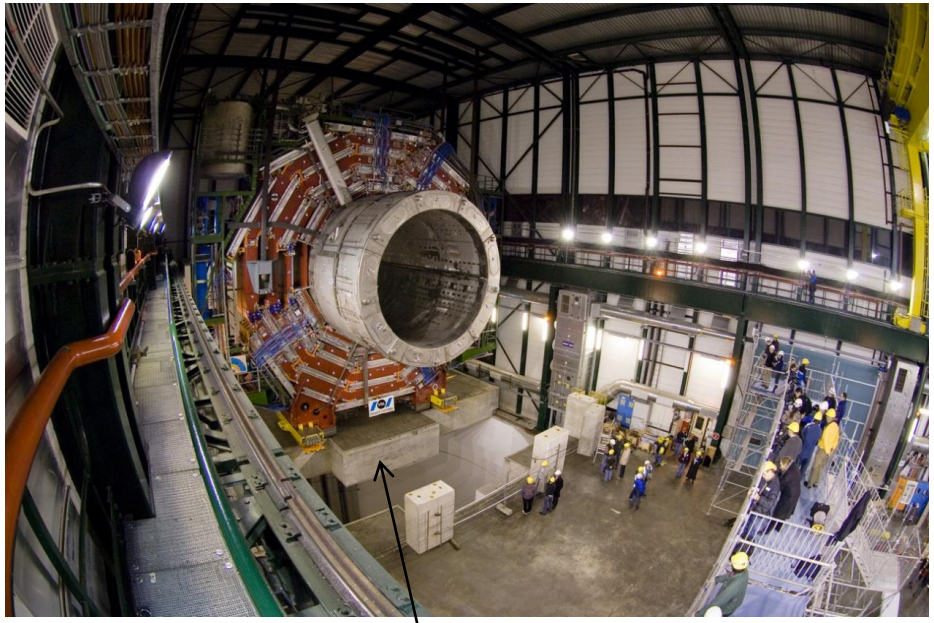
Benchmark the FEA code: The CMS platform

1. The radiation cover shield of the PX56 shaft at the LHC Point 5 is has very close dimensions to the push-pull platform.

2. It is an ideal benchmark



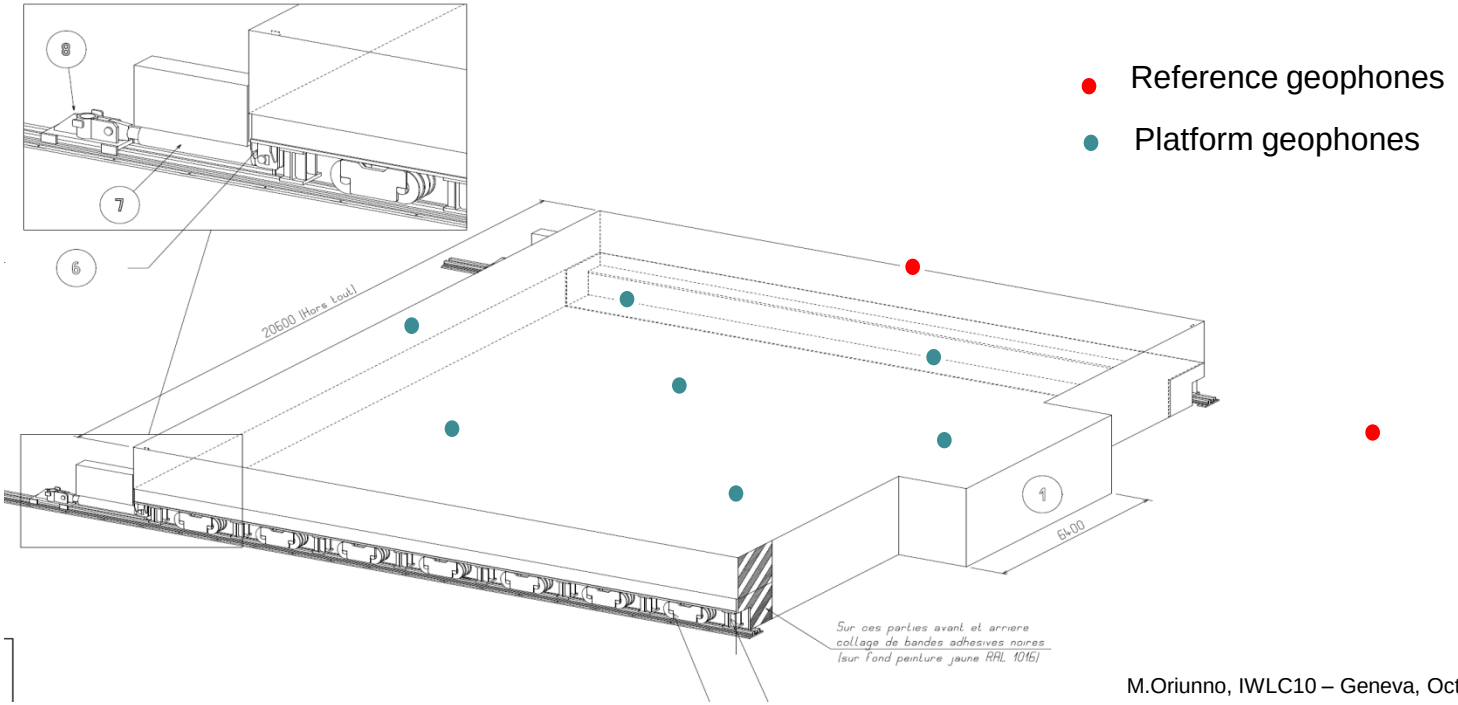
Platform
Closed



Platform
half open

New Vibrations Measurements done at CERN last week, Analysis of the data in progress (CERN-EN Department)

- Absolute PSD spectra on various locations on the top of the platform, P1…P7, with the reference points PREF1, PREF2
- Relative PSD spectra, P12, …. P17 (Coherence) (can be calculated from the previous measurements)
- Transfer functions on various locations on the top of the platform P1-2-3-4-5 with respect to the reference points
- Transfer Functions P1…P7 with reference to the ground vibration



Alternative benchmarks available at SLAC
EX-6 Shielding Block

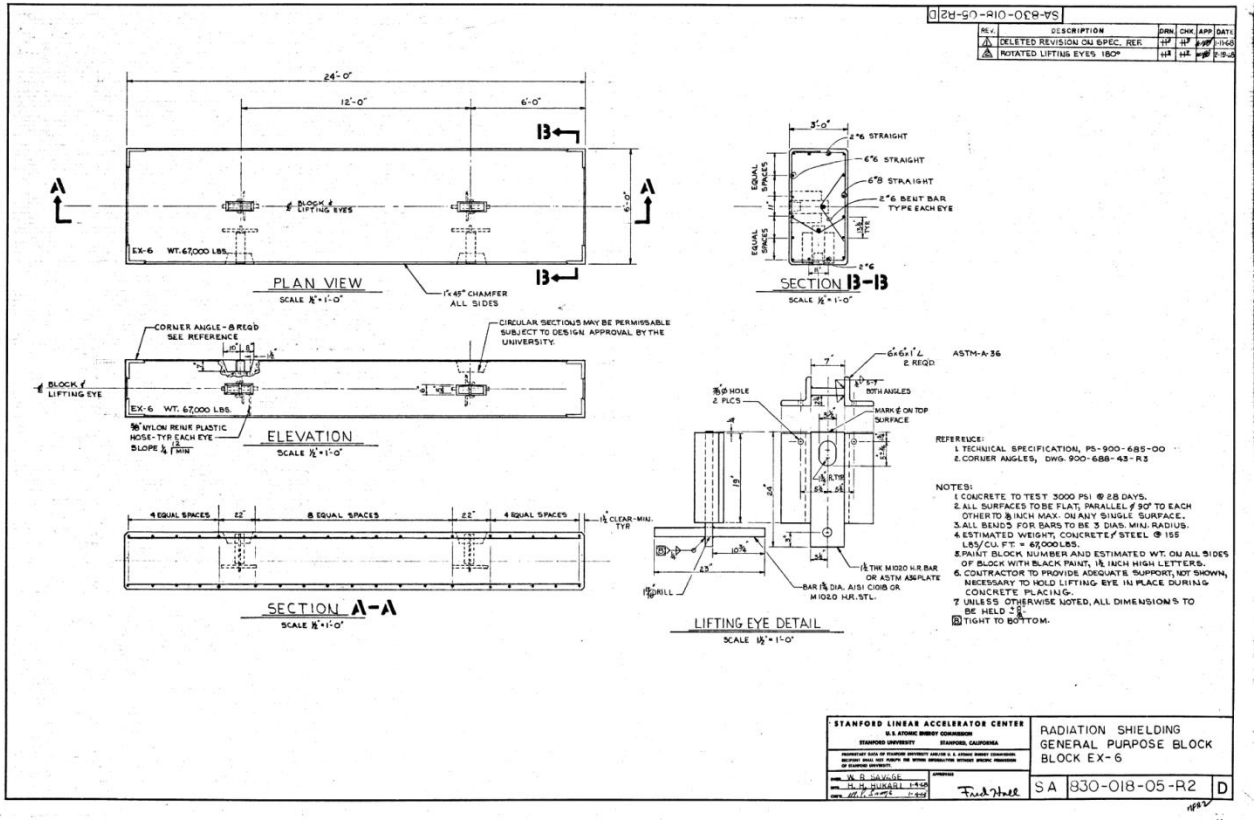
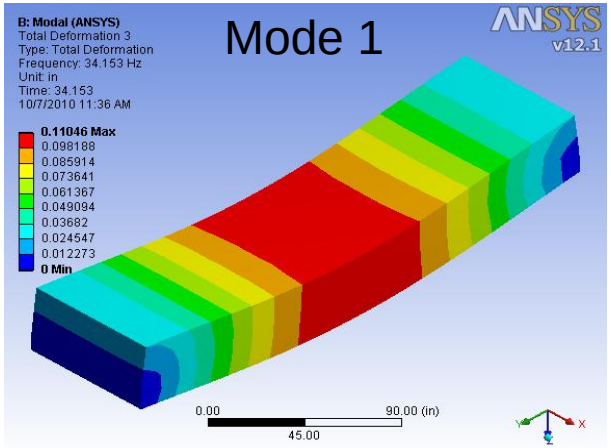
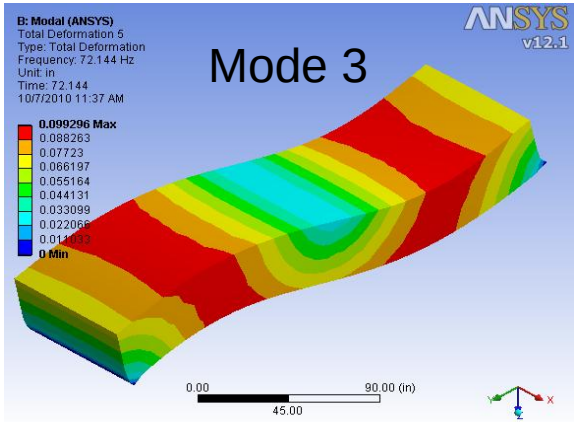


TABLE 20
Model (A4, B4, C4) > Modal (B5) > Solution (B6)

Mode	Frequency [Hz]
1.	34.153
2.	53.163
3.	72.144
4.	79.687
5.	122.84
6.	134.61





Summary

1. Different dimensions between ILD and SiD have to be accommodated for a common push-pull solution

2. A platform with sub-trenches in the floor will increase these differences

2. Because of 1 & 2, there is concern about the ground vibration effects on SiD

3. Preliminary studies of the QD0s supported from the door, with SiD moving directly on the floor, shows results compatible with the vibration budget given in the requirements

4. The design of a platform which may mitigate the ground motions effects is under study

5. A FEA model of the platform is in progress and a benchmark is required to validate the model

3. Experimental vibration analysis are in progress at CERN on the CMS platform