ILD Vibration studies

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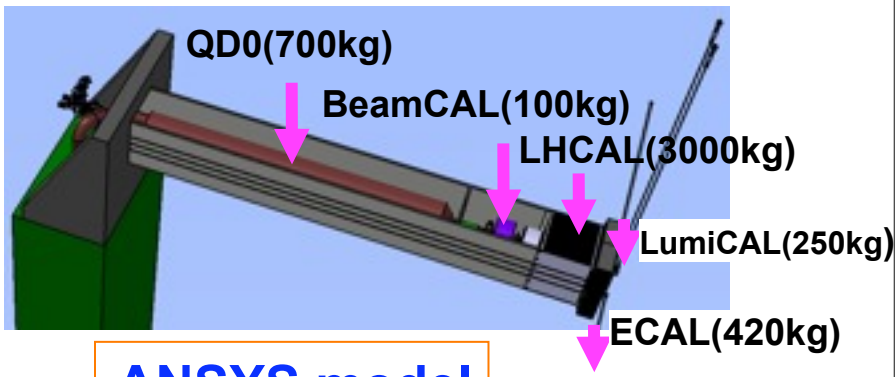
LCWS2010, Beijing, China, 26-30 March, 2010

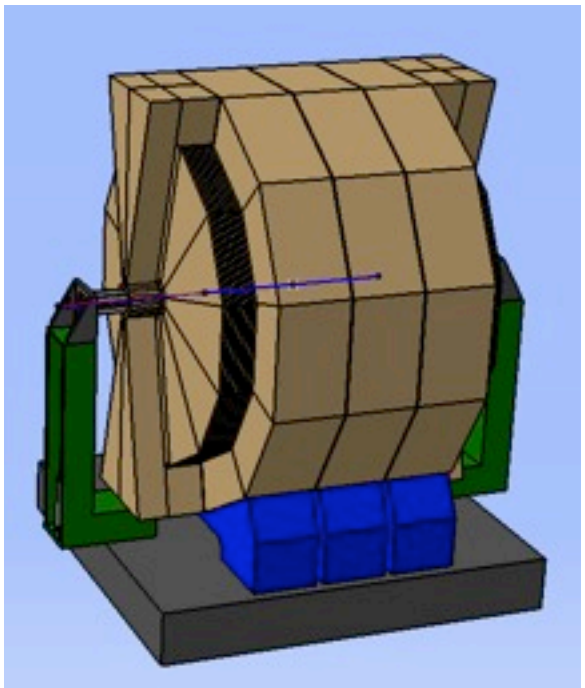
Introduction

Vibration properties of the ILD QD0 support system has been studied.

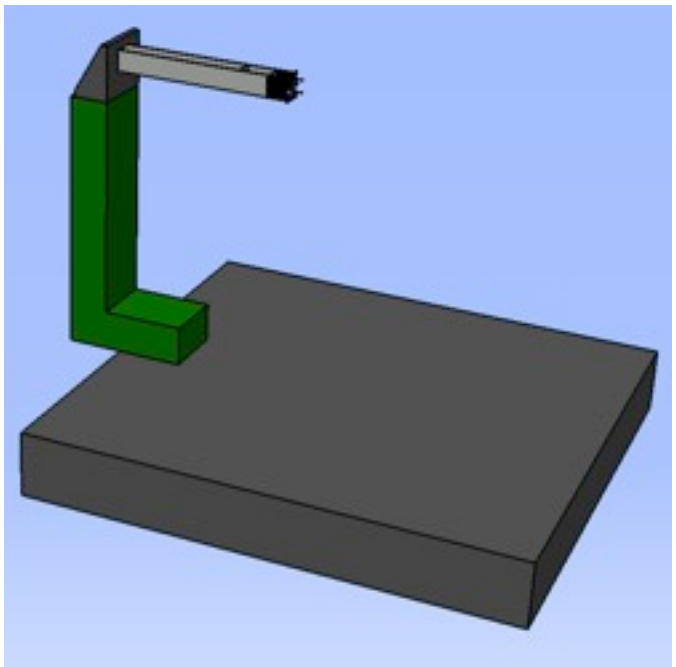


ANSYS model

ILD00 model



ILD QD0 support system



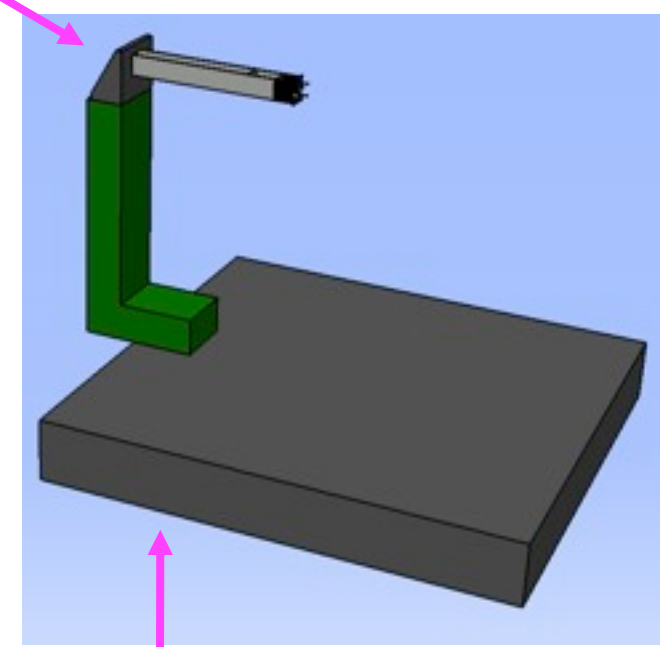
To improve vibration behavior;

➔ We need to solve these issues.

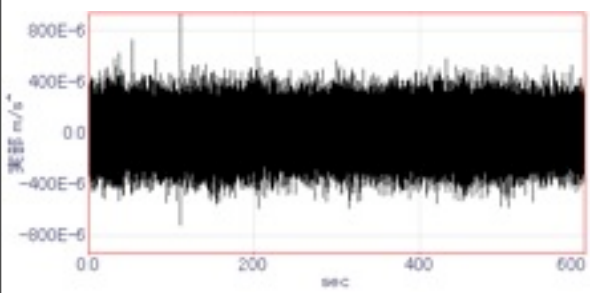
1. Design of stiff support structure

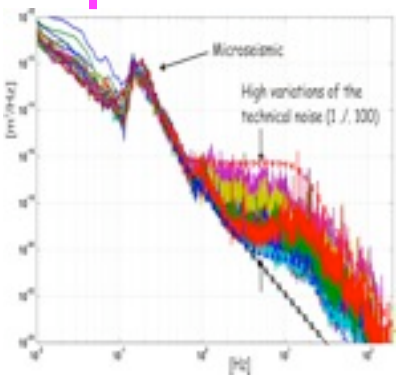
2. Calculations
   Static
   Modal
   P.S.D.

3. Correct?
   Check consistency



4. Vibration data
   CERN
   KEK
   Coherency?



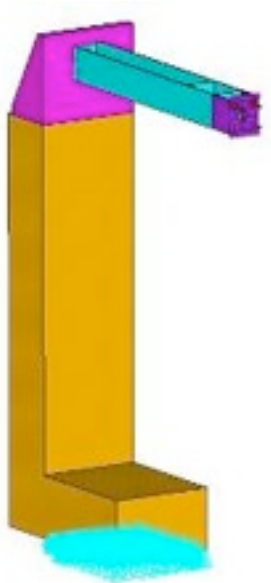


5. Realistic data

Allowable Amplitude: < 50nm(V)
(Above 5Hz) < 300nm(H)

1. Design stiff support structure

@LCWS09



Titanium

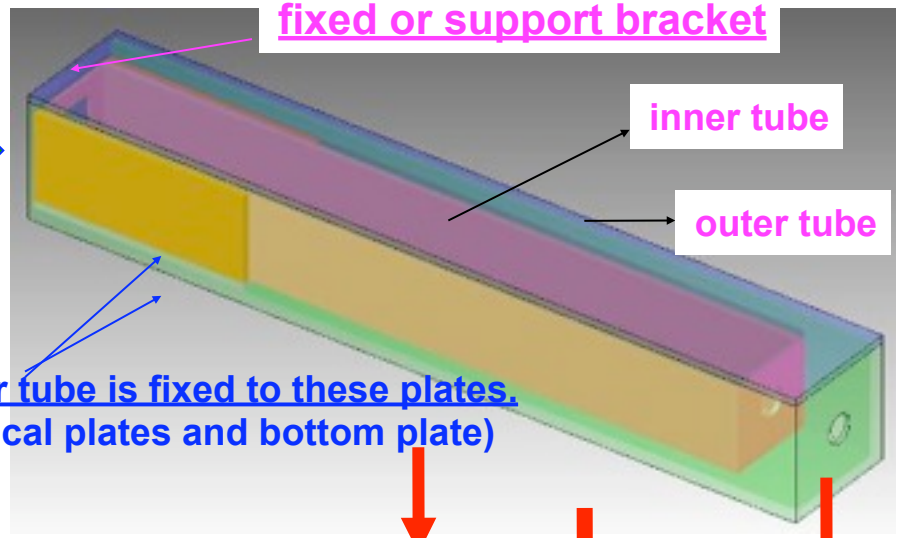
1000kg

4000kg

- Spring constant
- Static loads

are defined.

New proposal: Double tube

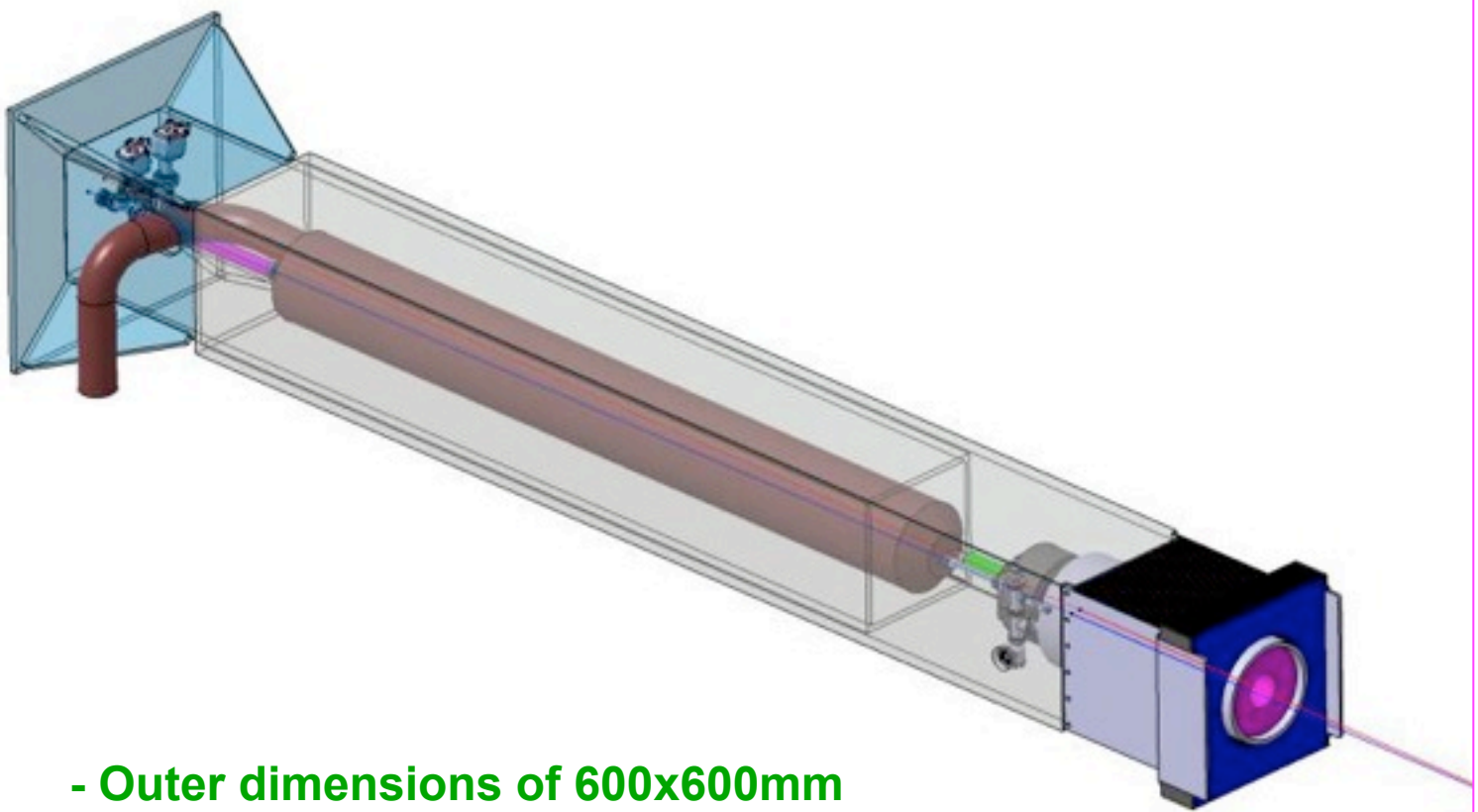


Allowable Amplitude: < 50nm(V)
(Above 5Hz) < 300nm(H)

→ Integ. amplitude in cases of ATF and CERN high-noise are larger than 50nm at f > 5Hz. (ATF/KEKB and CERN have GM integrated amplitude of ~ 20nm at f > 5Hz.)

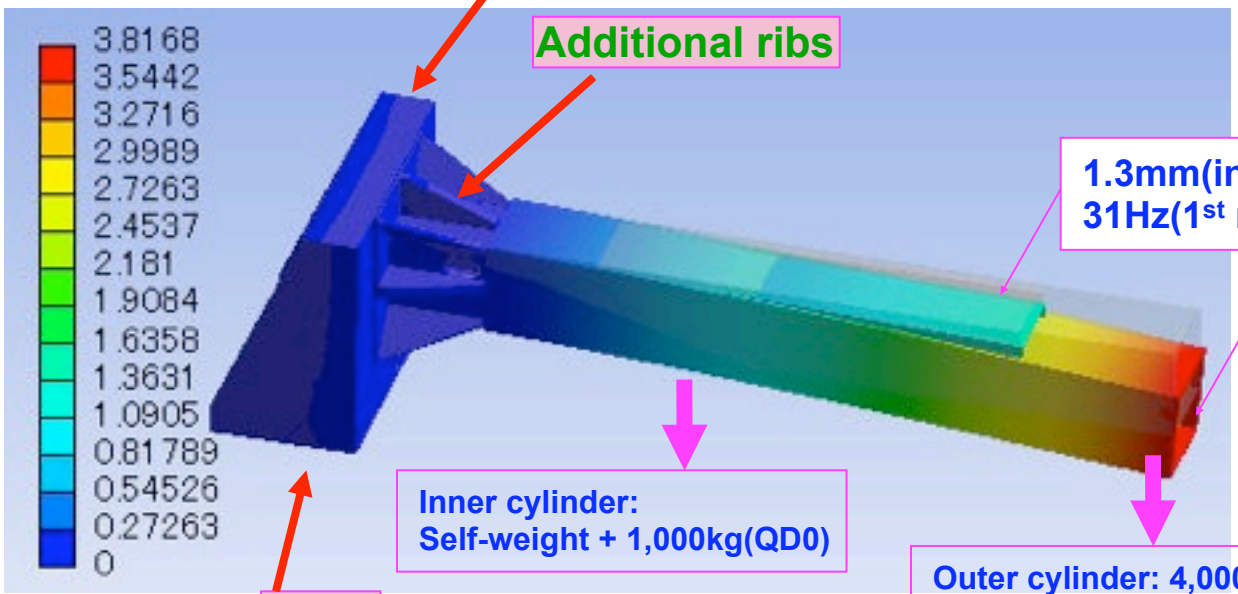
➔ Double tube is proposed.

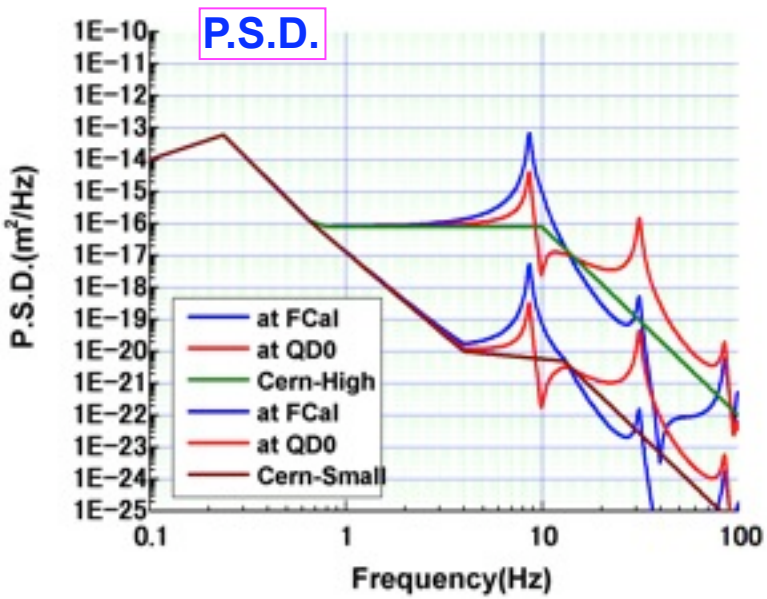
- Support tube consists of double square tube.
- Outer tube supports FCAL.
- Inner tube supports QD0.

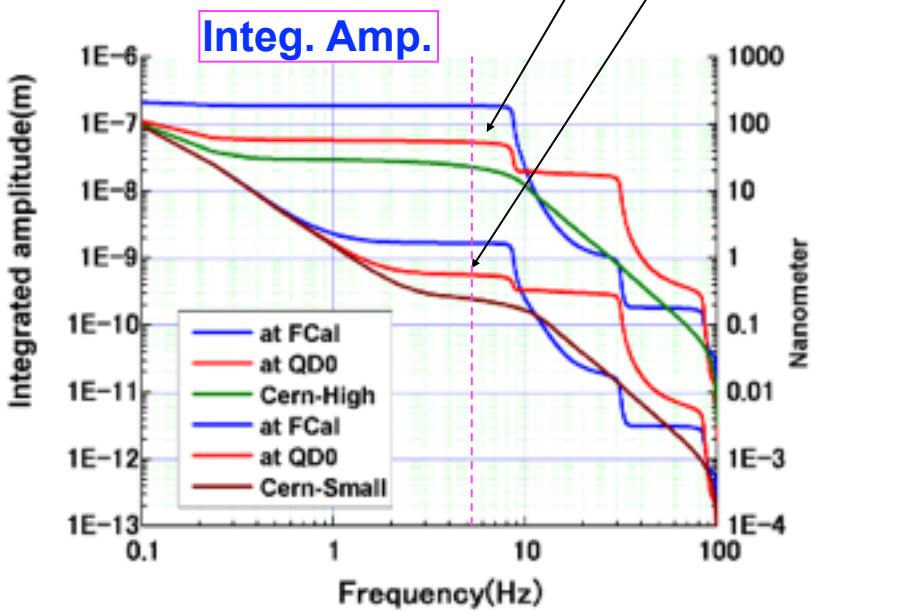


- Outer dimensions of 600x600mm
- 25mm thick

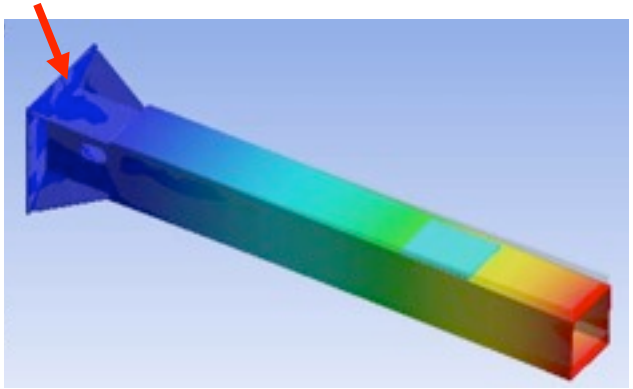
Calculation-3



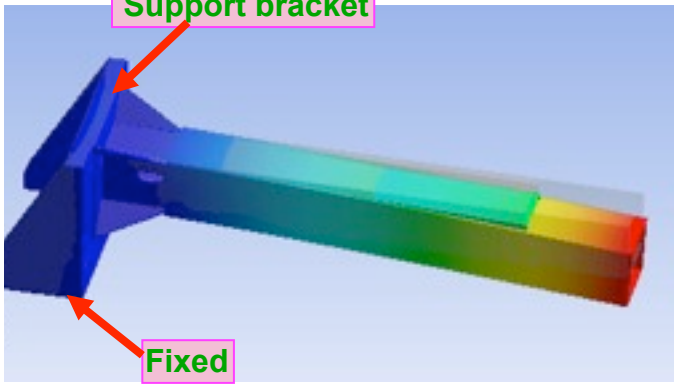




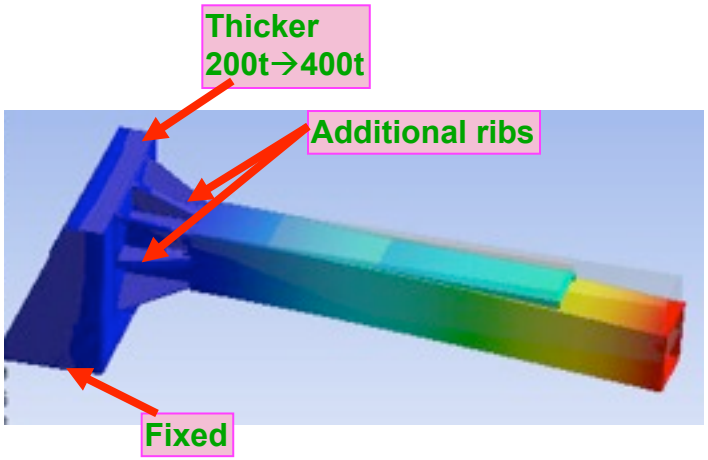
Calculation-1



Calculation-2



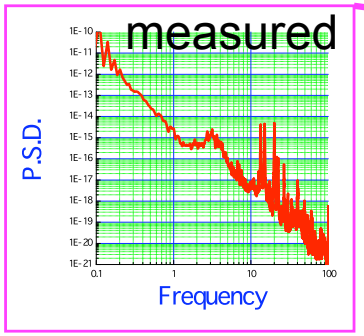
Calculation-3



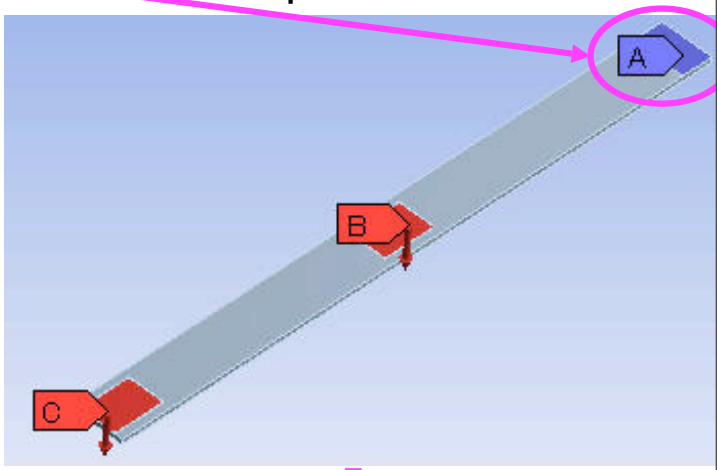
	QD0				FCal	
	Deform.	1st mode	Amp.>5Hz (nm)		Deform (mm)	1st mode
	(mm)	(Hz)	Cern-H	Cern-S	(mm)	(Hz)
Cal-1	0.8	31	49	0.5	3	8
Cal-2	2.1	29	69	0.7	4.9	7.7
Cal-3	1.3	31	54	0.6	3.8	8.6

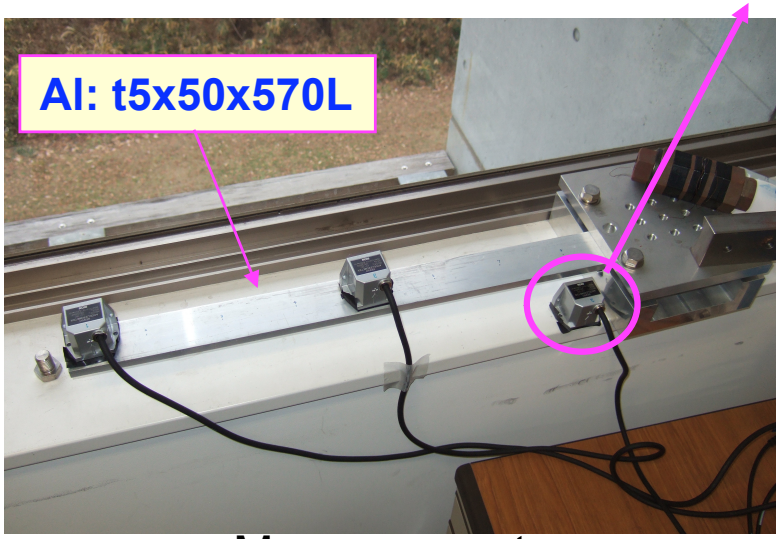
3. Investigation of consistency between the calculations and measurements

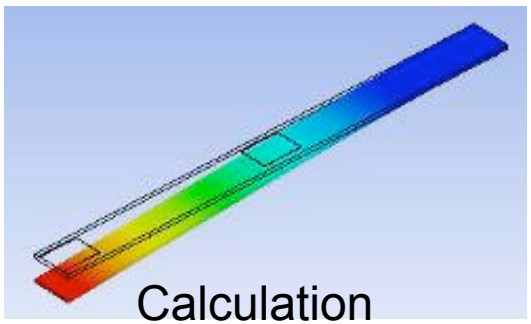
LION LS10C
Servo accelerometer
0.3V=1m/s^2
DC~40Hz
<10^{-5}m/s^2



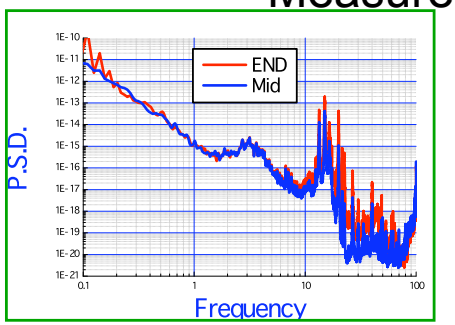
input

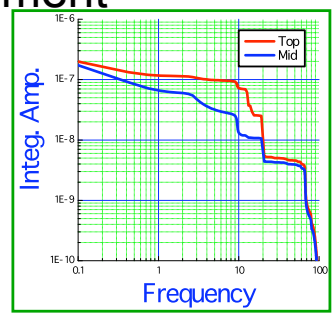




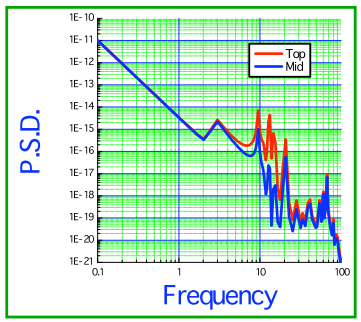


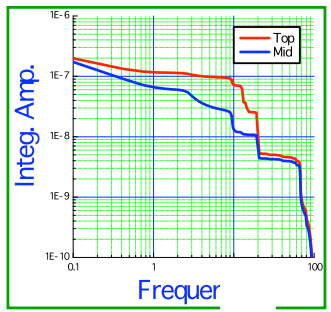
Measurement



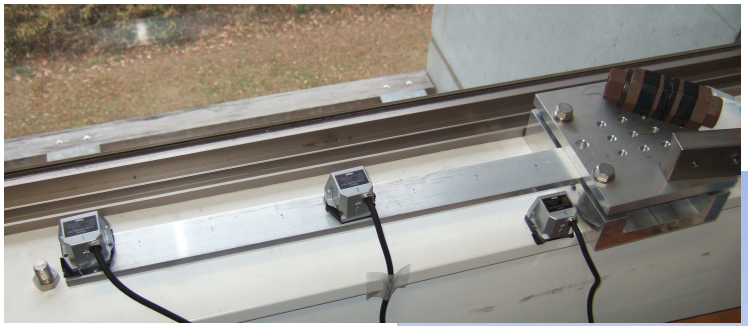


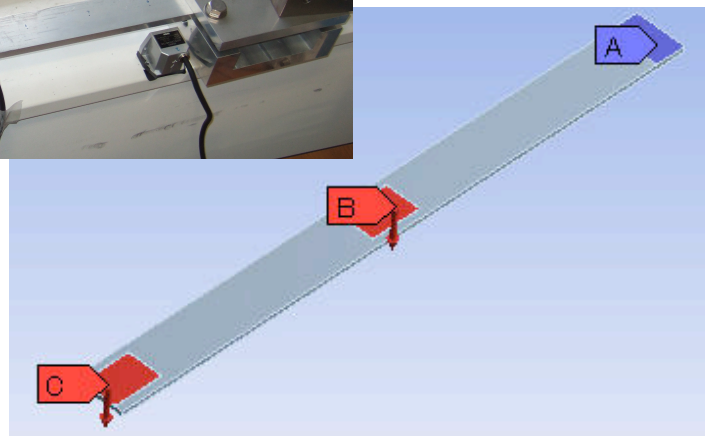
Calculation

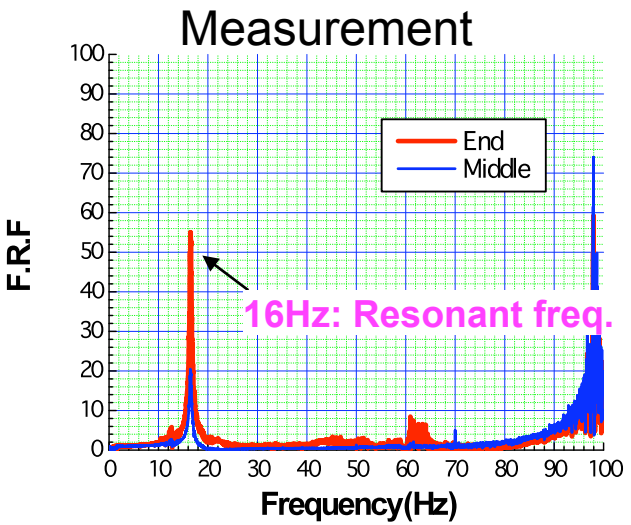


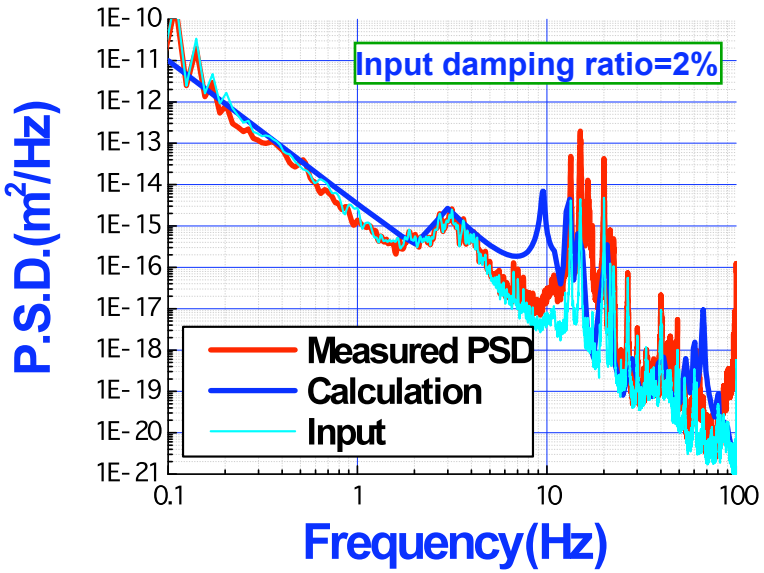


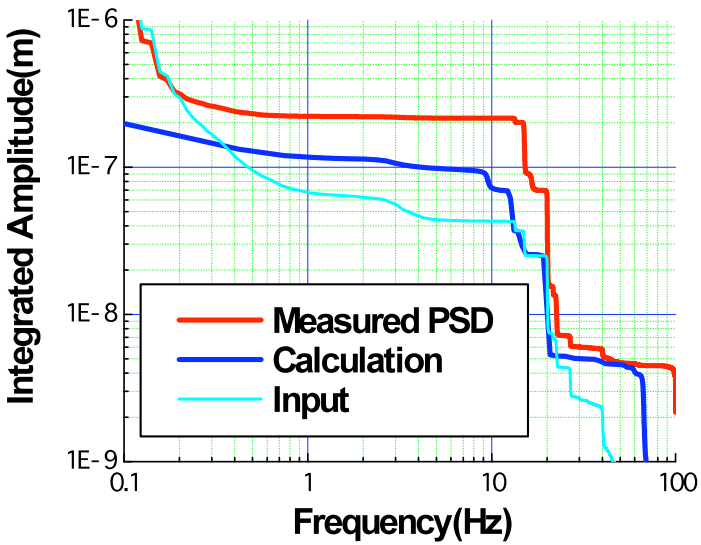
Results: Comparison PSD/Amplitude.











➔ - 1st mode of resonant frequency is ~6Hz different.
- Amplitude is ~100nm different.

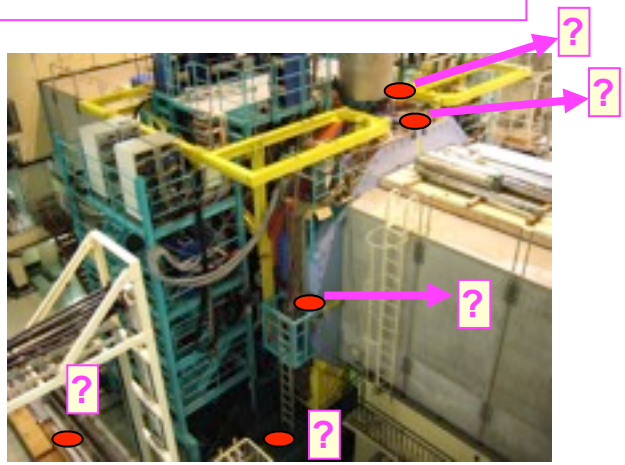
i.e. not perfect fixing

Vibration measurements at the Belle/KEKB

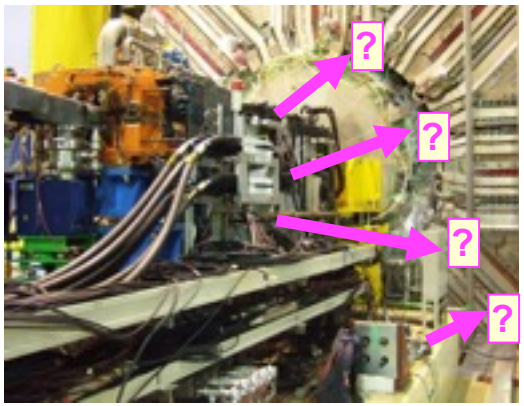
Study items

- Vibrations on each place
- Coherency between both sides

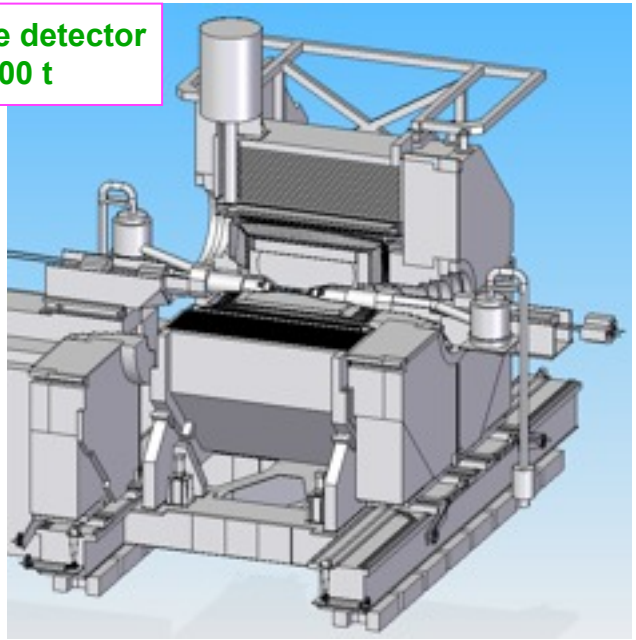
Measure vibrations on the Belle



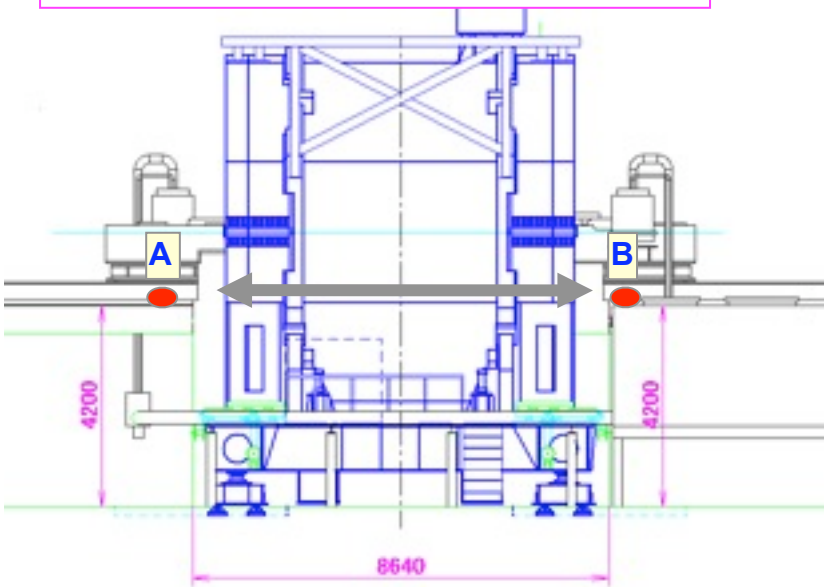
Measure vibrations on KEKB



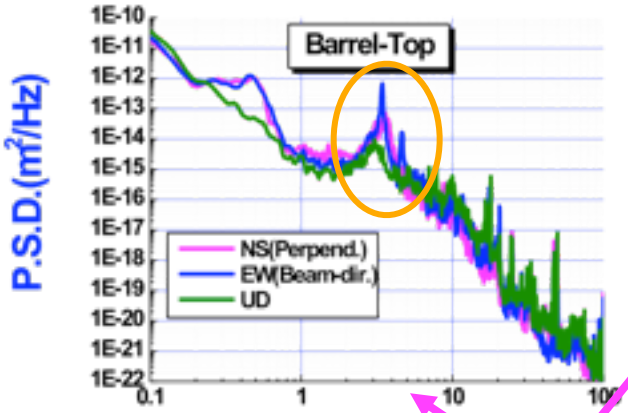
Belle detector
~1,300 t

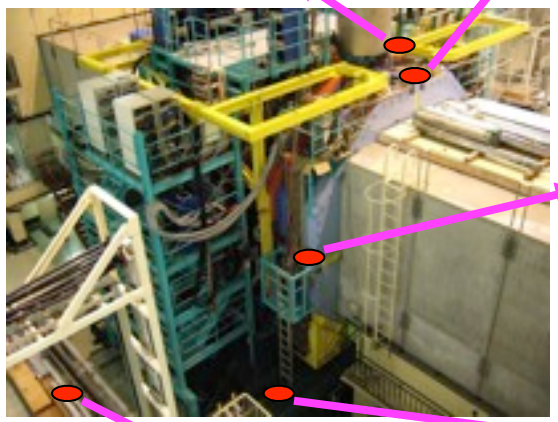


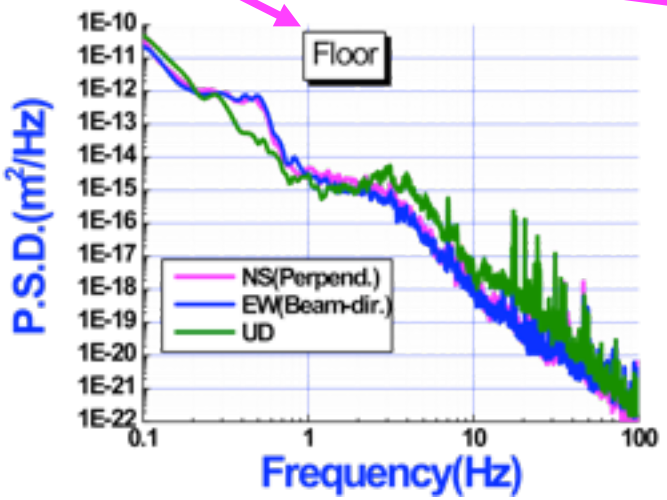
Coherency between A - B

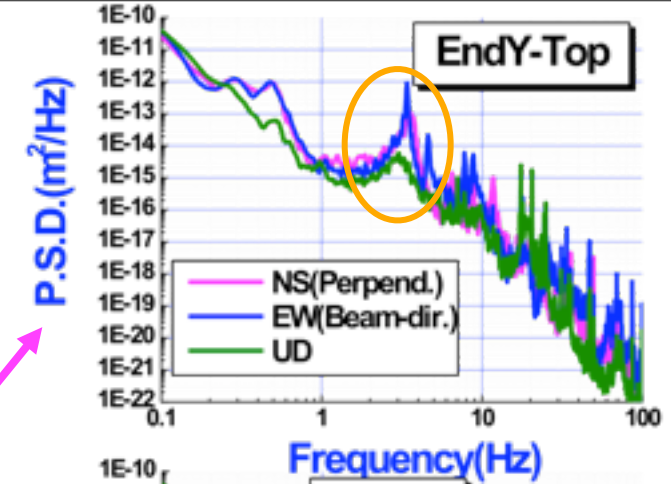


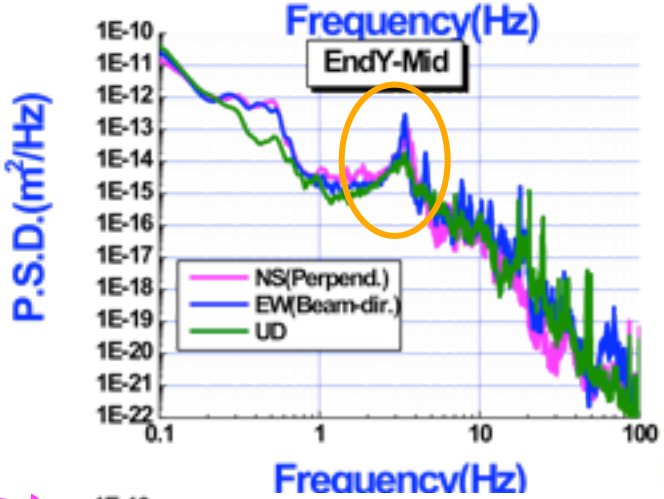
4. Vibration data@KEK

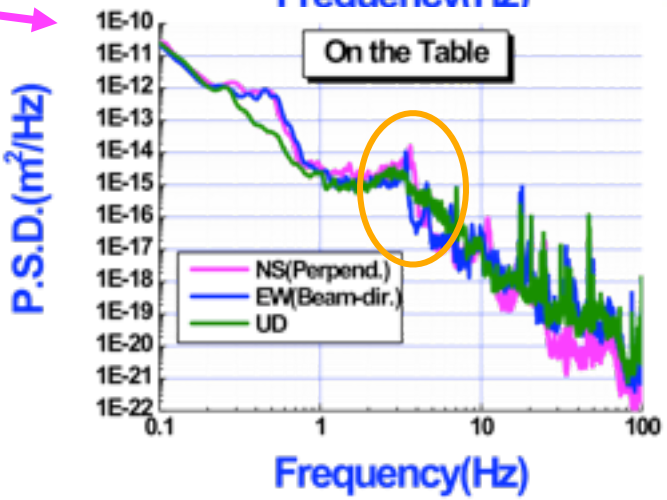






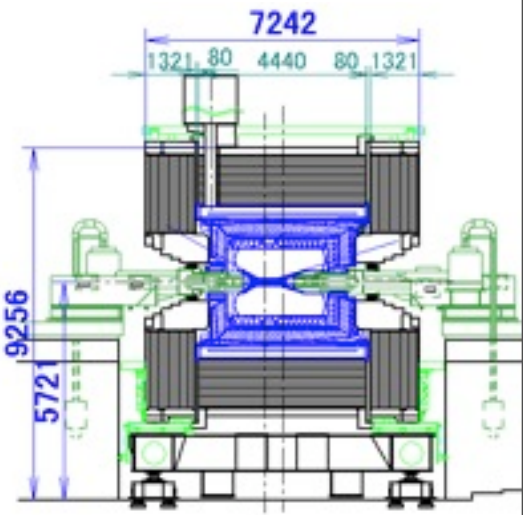


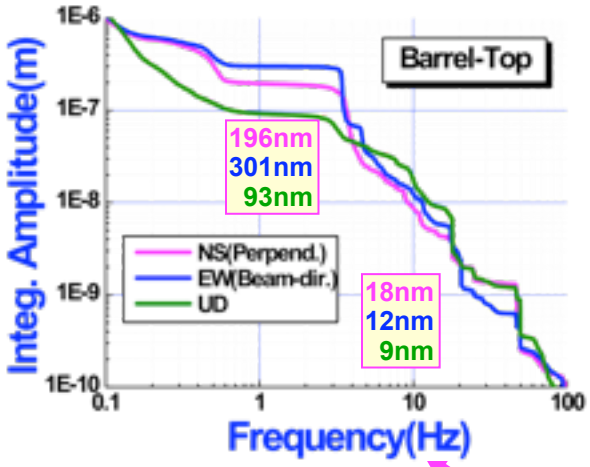


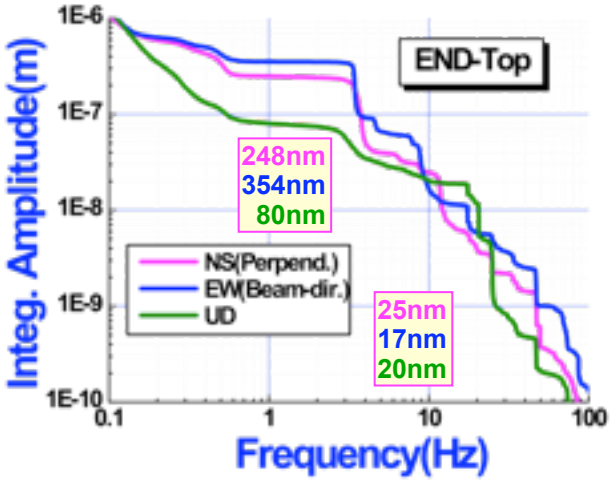


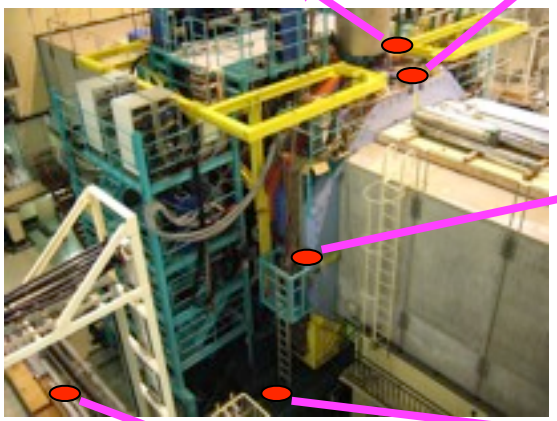
Servo Accelerometer
MG－102

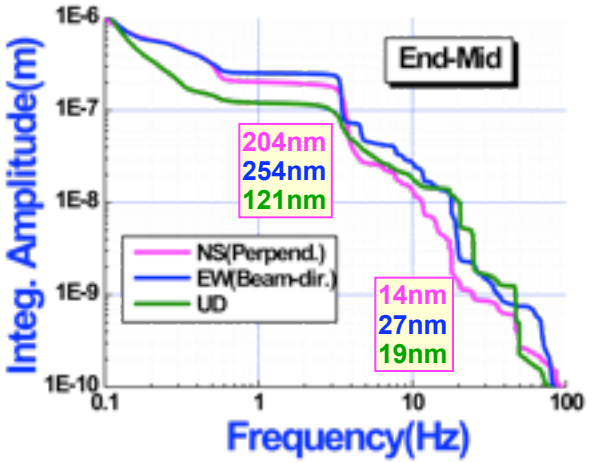
Acc. 0.1～400Hz Acc. 60dB = 1gal/V

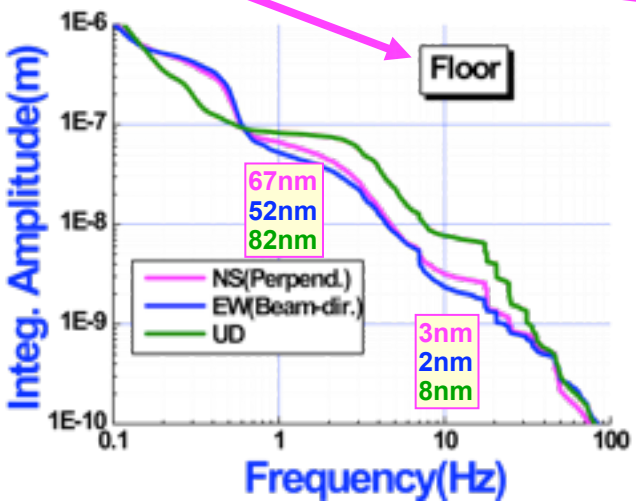


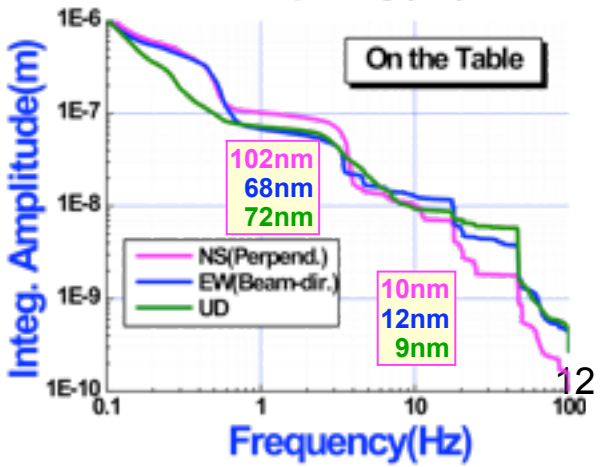

Barrel-Top
196nm
301nm
93nm
18nm
12nm
9nm
NS(Perpend.)
EW(Beam-dir.)
UD
Integ. Amplitude(m)
Frequency(Hz)


END-Top
248nm
354nm
80nm
25nm
17nm
20nm
NS(Perpend.)
EW(Beam-dir.)
UD
Integ. Amplitude(m)
Frequency(Hz)



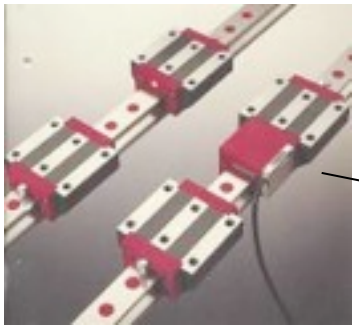

End-Mid
204nm
254nm
121nm
14nm
27nm
19nm
NS(Perpend.)
EW(Beam-dir.)
UD
Integ. Amplitude(m)
Frequency(Hz)

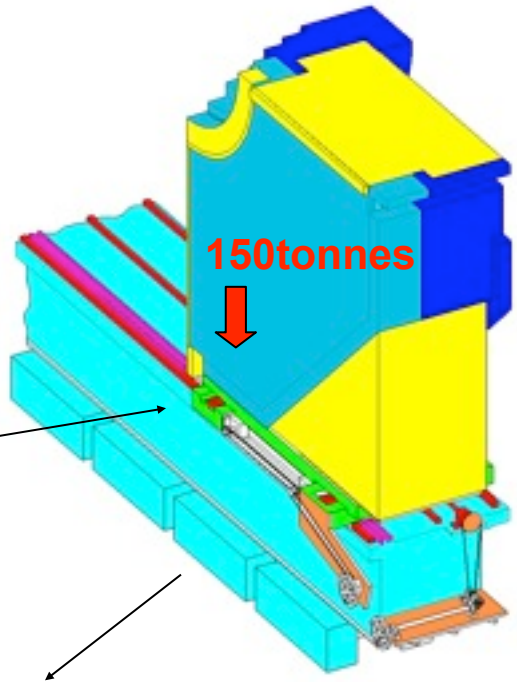

Floor
67nm
52nm
82nm
3nm
2nm
8nm
NS(Perpend.)
EW(Beam-dir.)
UD
Integ. Amplitude(m)
Frequency(Hz)


On the Table
102nm
68nm
72nm
10nm
12nm
9nm
NS(Perpend.)
EW(Beam-dir.)
UD
Integ. Amplitude(m)
Frequency(Hz)

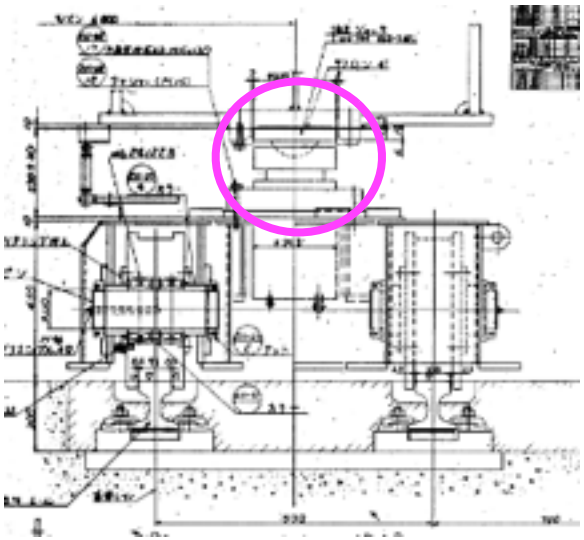
Considerations on the measurement results

- First resonance is around ~3-4Hz.
- Amplitude on the barrel is bigger than the table.
- Amplitudes on the End-Y becomes larger as the position of EY rises





Spherical support

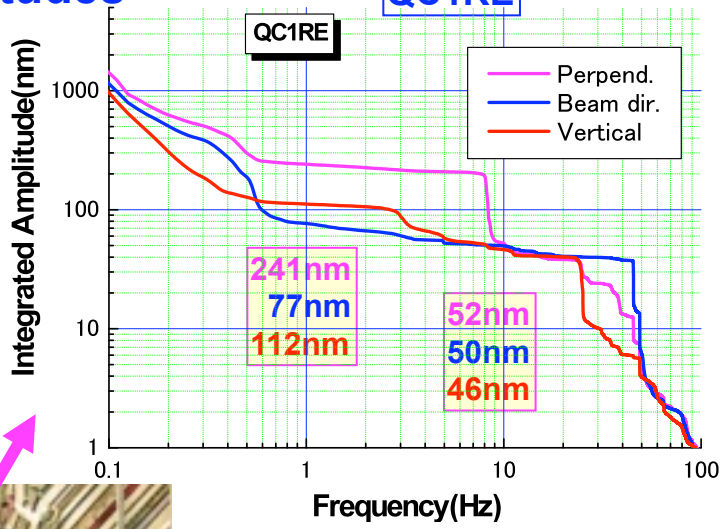


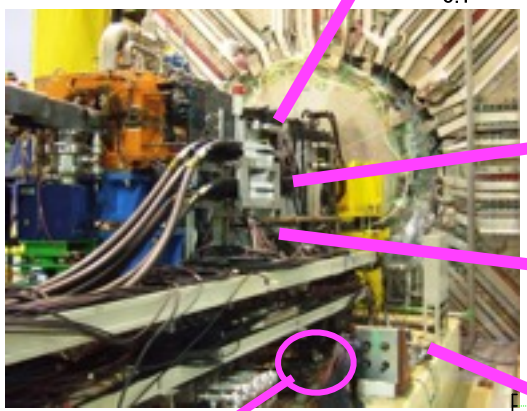
Large amplitudes on the Belle;

- The belle detector is not fixed on the floor.
- The barrel yoke is not fixed on the table rigidly.
- Top of the end-yoke is not fixed.

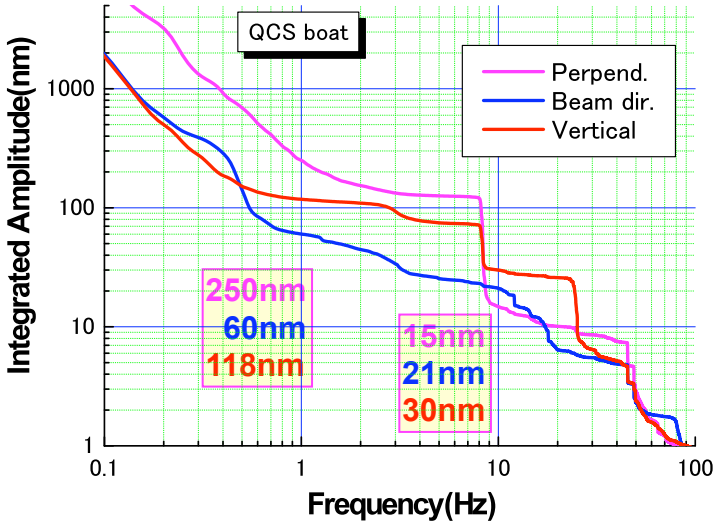
Integrated amplitudes

QC1RE

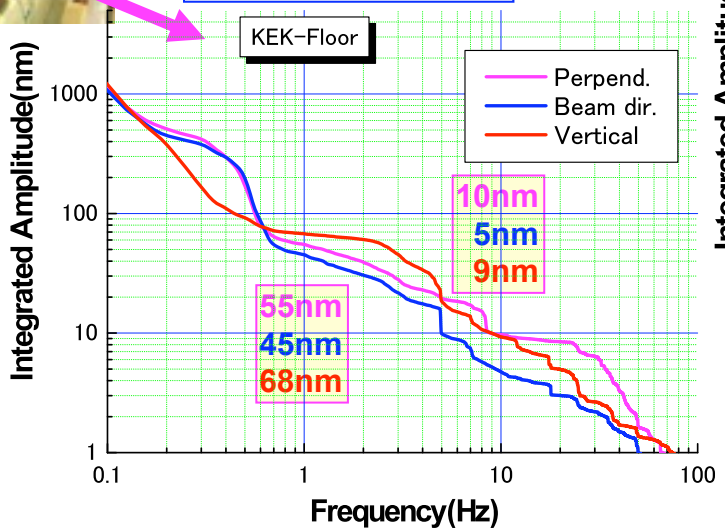




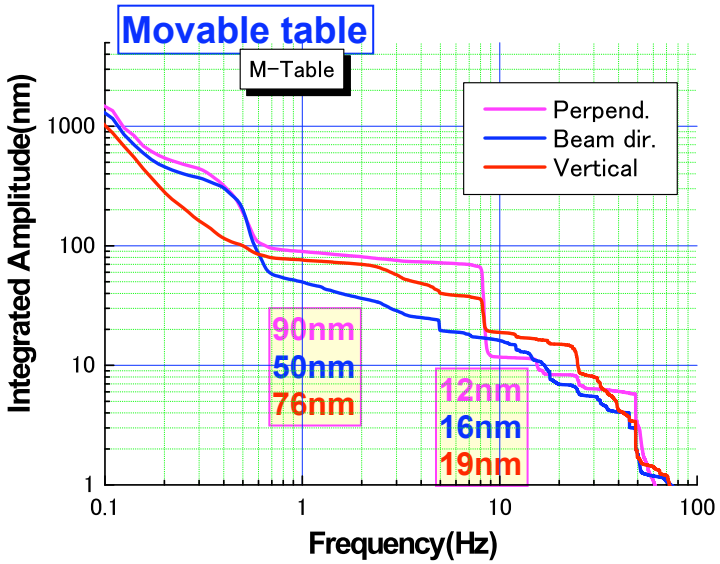
QCS boat



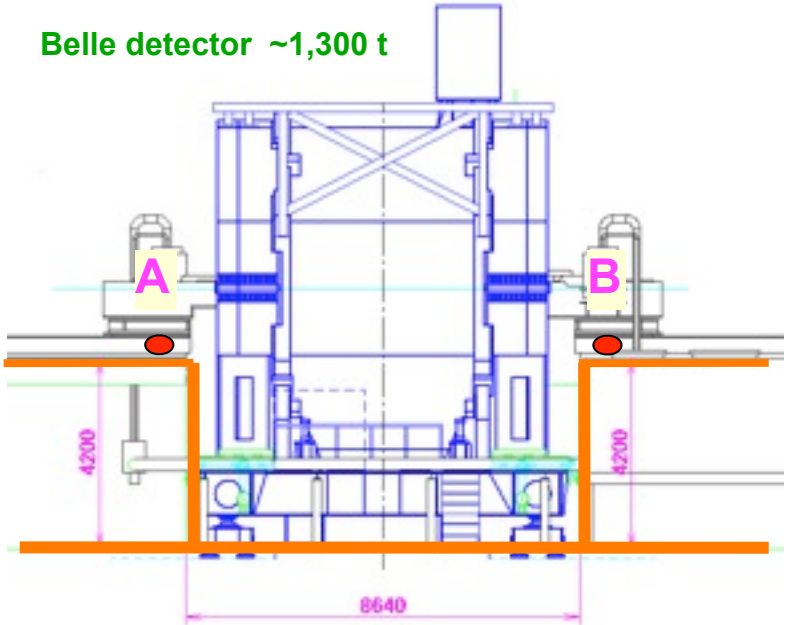
KEKB tunnel floor



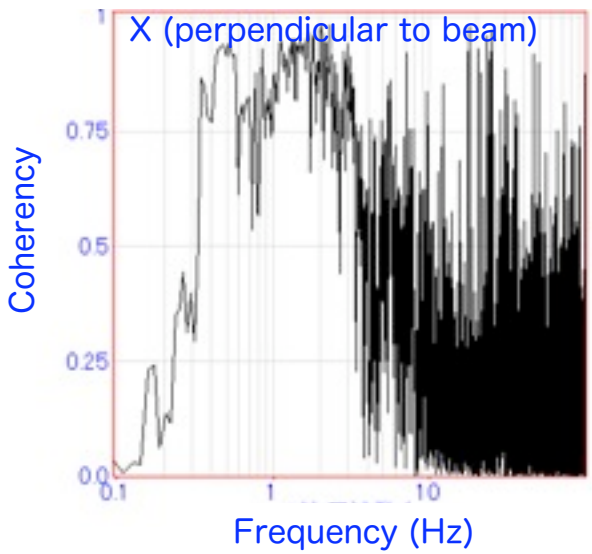
Movable table

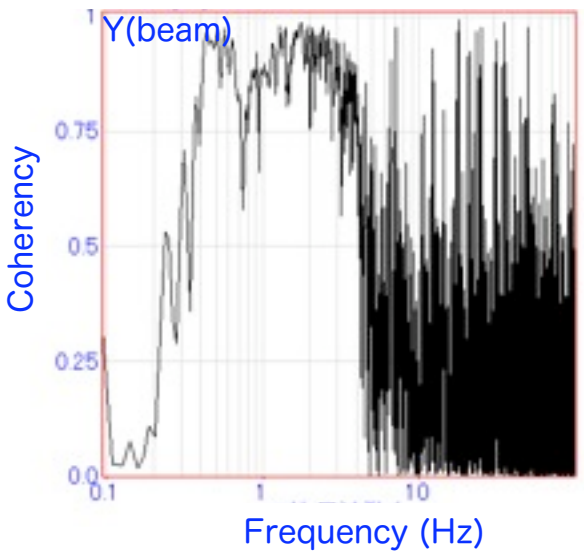


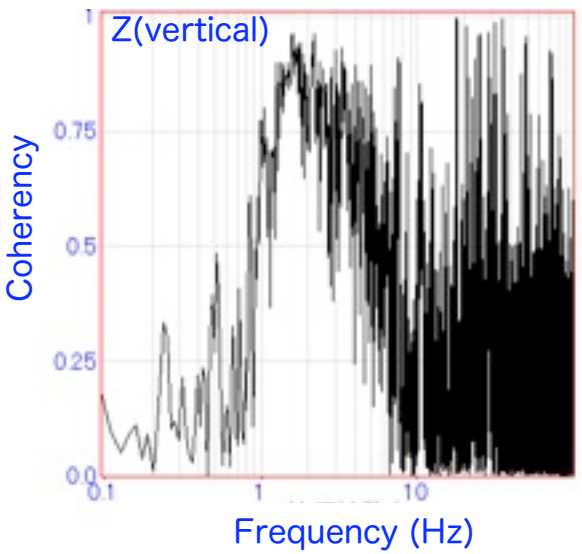
Coherency measurement at KEKB-tunnel



Coherency between positions A and B



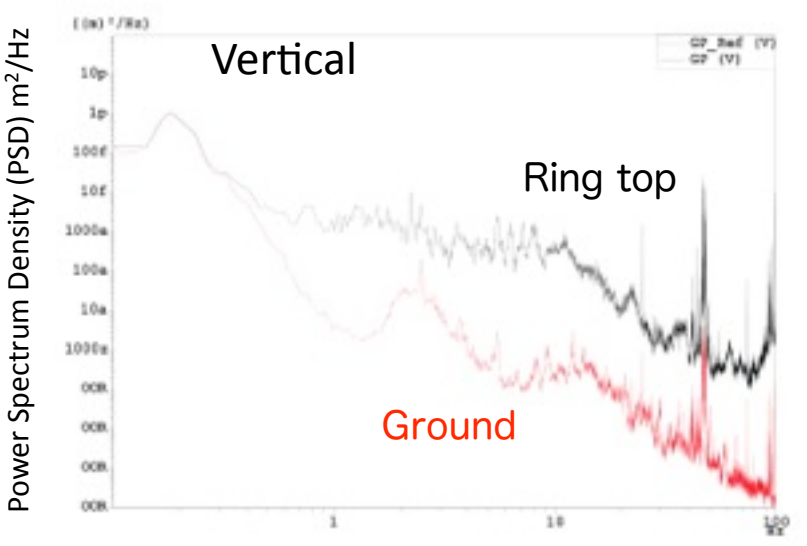


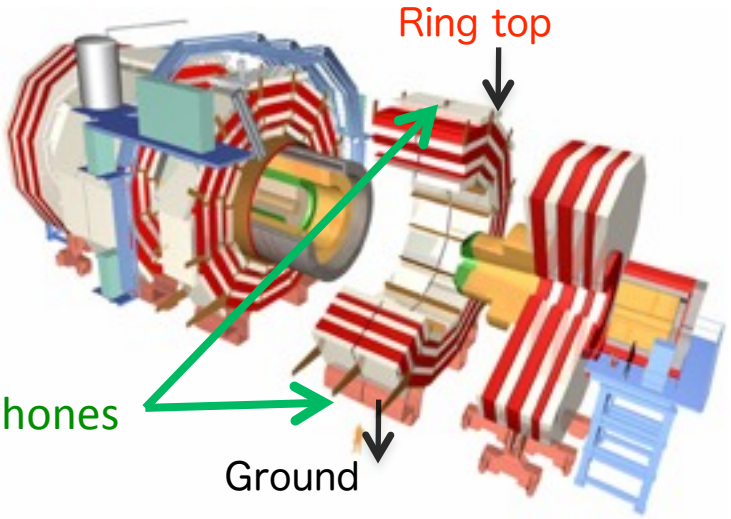


➔ It seems that there is no coherency between two positions.

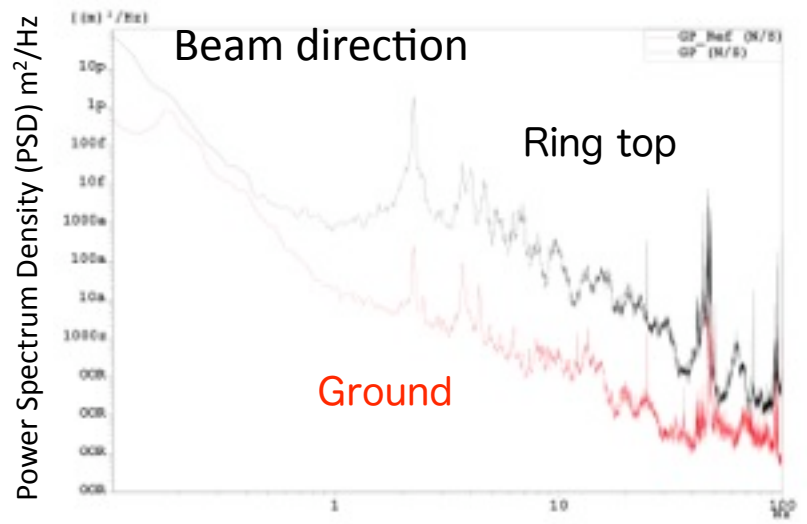
Except for the frequency of microseismic(~0.5Hz) and resonance of soil(~3Hz).

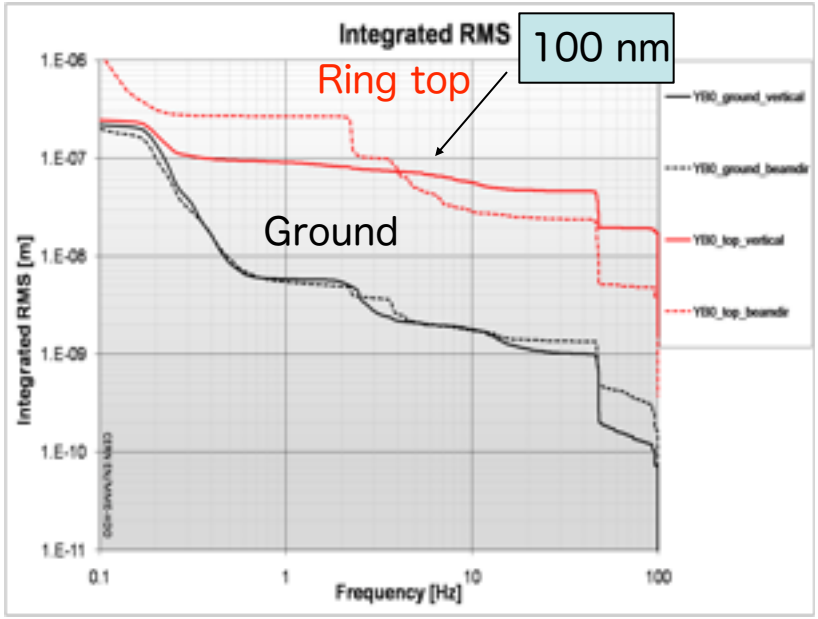
Measurements on ground and top of CMS-ring : by A. Herve





Cooling system OFF





Summary of vibration measurements at Belle, KEKB tunnel and CMS

Belle	Integrated amplitude(nm)					
	>1Hz			>10Hz		
	Perpend	Beam	Vertical	Perpend	Beam	Vertical
Barrel-Top	196	301	93	18	12	9
EY-Top	248	354	80	25	17	20
EY-Mid.	204	254	121	14	27	19
Belle stand	105	69	71	13	11	13
B4 floor	50	46	67	4	3	9
KEKB floor	55	45	68	10	5	9
Mag.-table	90	50	76	12	16	19
QCS-boat	250	60	118	15	21	30
QC1RE	241	77	112	52	50	46

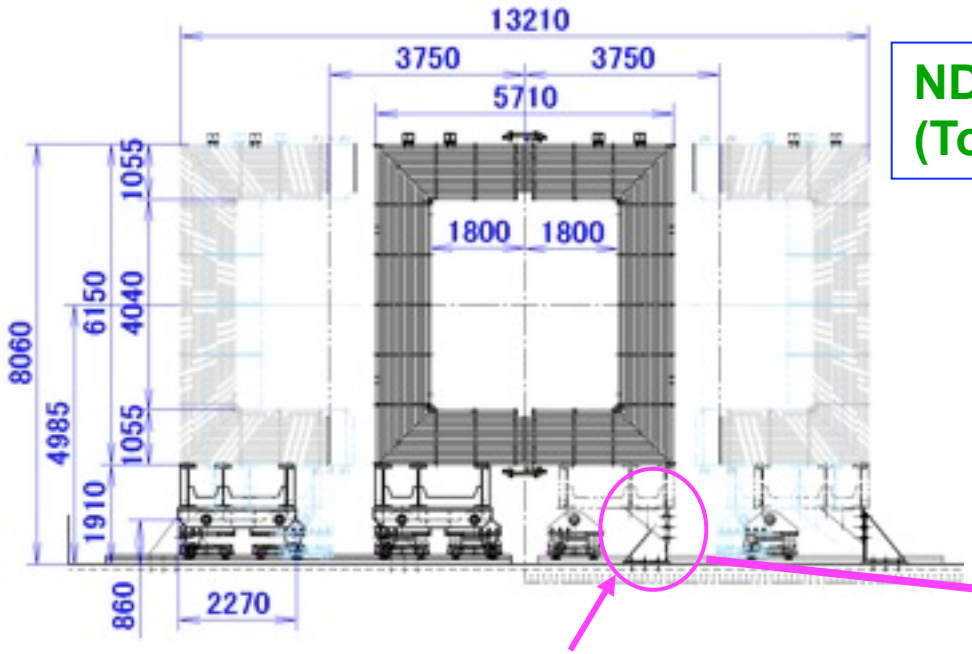
CMS	Integrated amplitude (nm)			
	> 1 Hz		>10Hz	
	Beam	Vertical	Beam	Vertical
Ground	5	5	1.8	1.8
Ring top	180	90	30	56

Acceleration during movement - Push-Pull

Investigations of efficiency of detector support structure

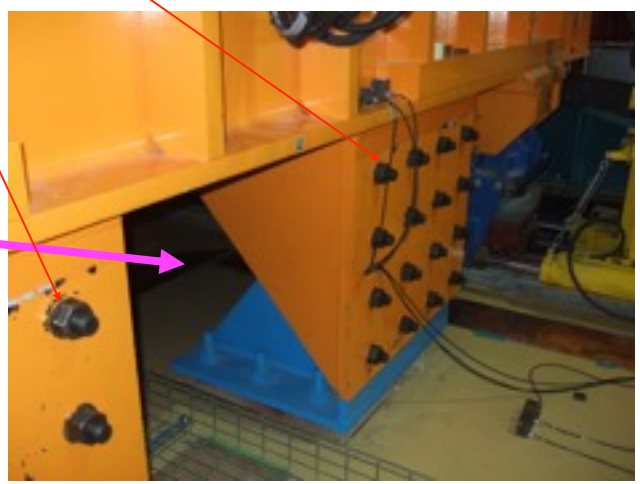
- Detector should be fixed to the floor ? or,
  Is it enough to just placed it on the floor ?

➔ Difference of vibration properties between fixed and un-fixed the yoke to the support bracket were measured.



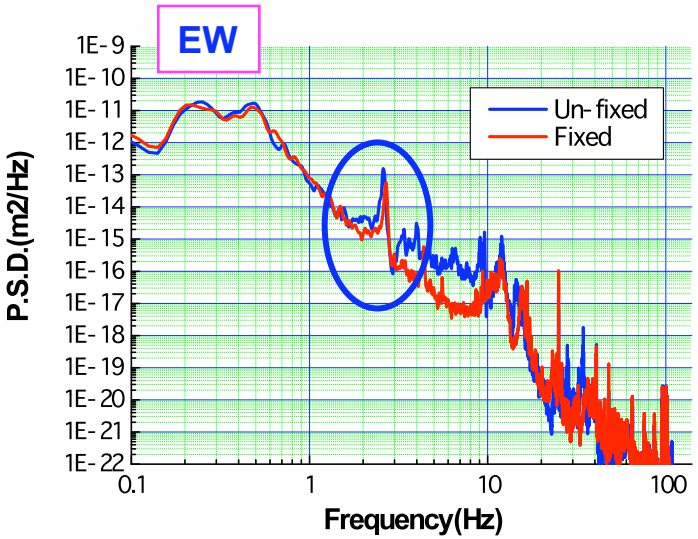
ND280 detector (Total: 1,100 t)

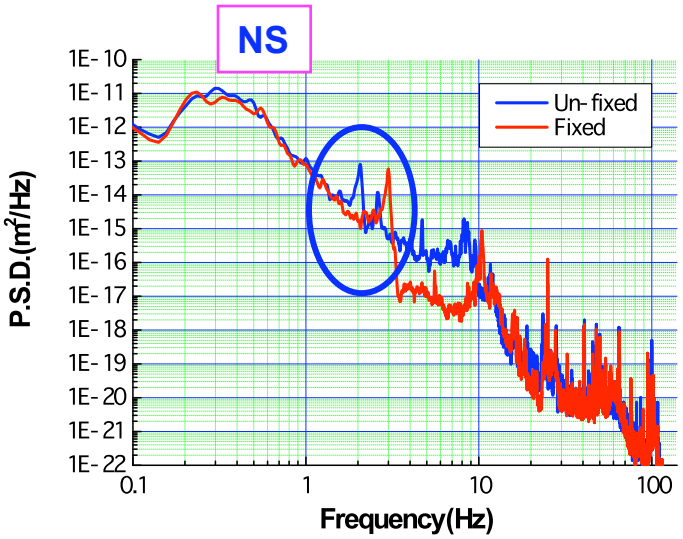
2-16xM36

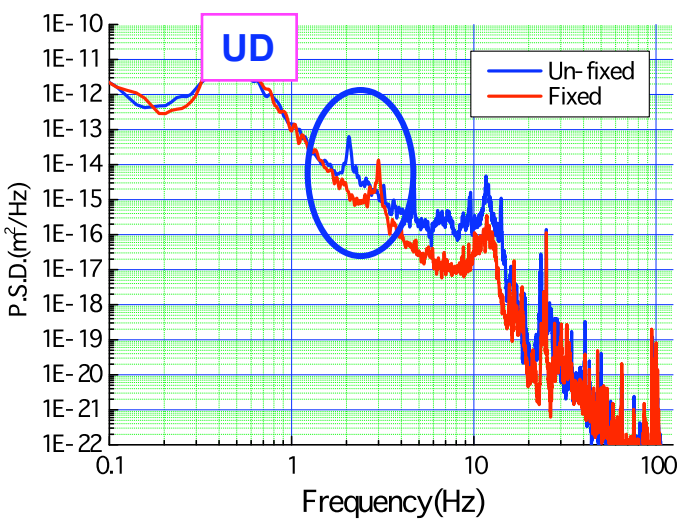


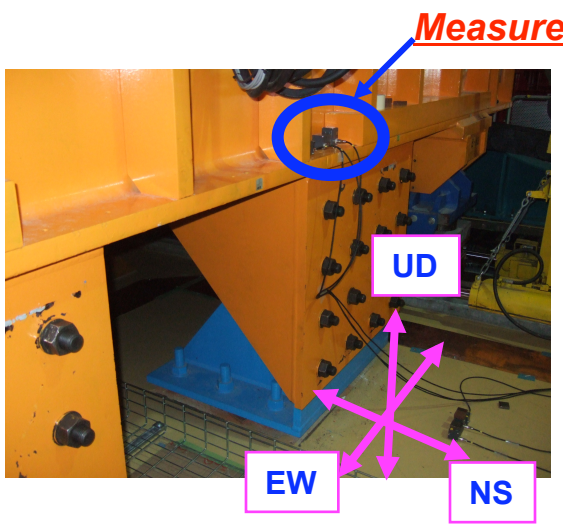
- The ND280 detector is fixed to the support-brackets with ***2-16xM36 thread bolts***.
- The support bracket is designed to withstand against ***0.5G seismic force***.

Results









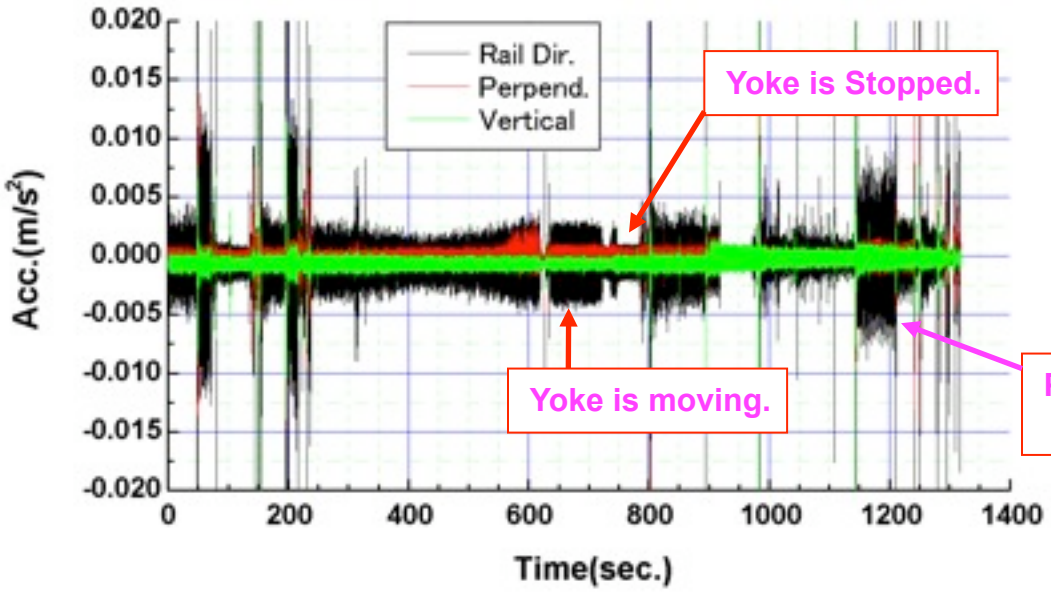
→ - Natural frequency after fixed to the bracket is increased to ~1Hz(NS, UD).
- P.S.D. is reduced because natural frequency is increased.

→It is not so big different but it's efficient to use the support-brackets.

→!Support stiffness is increased.

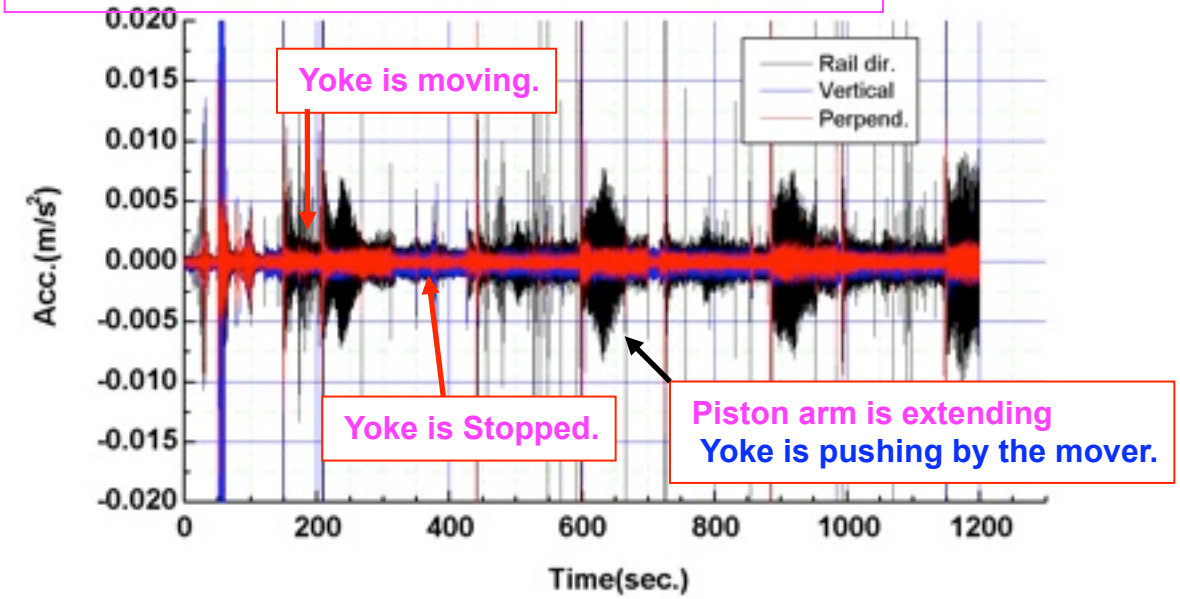
Vibration measurements during the detector moving

Time data- On the roller (@South yoke)



~1m/stroke, ~50cm/min

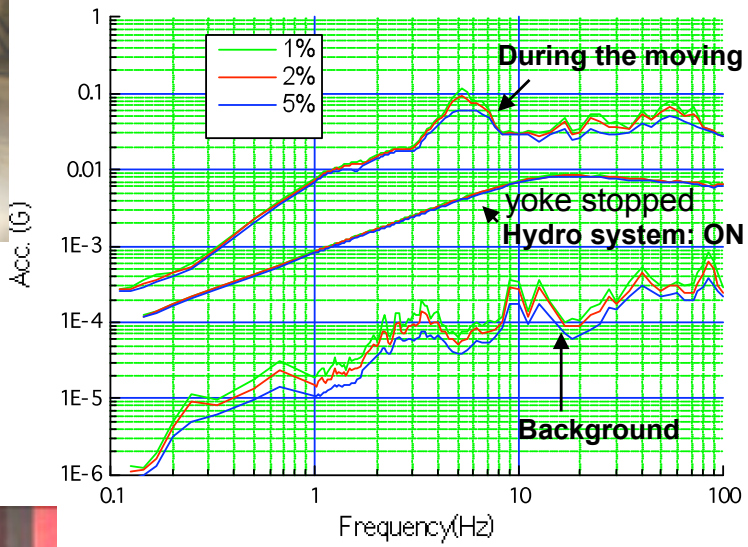
Time data- On the support stand (@North yoke)



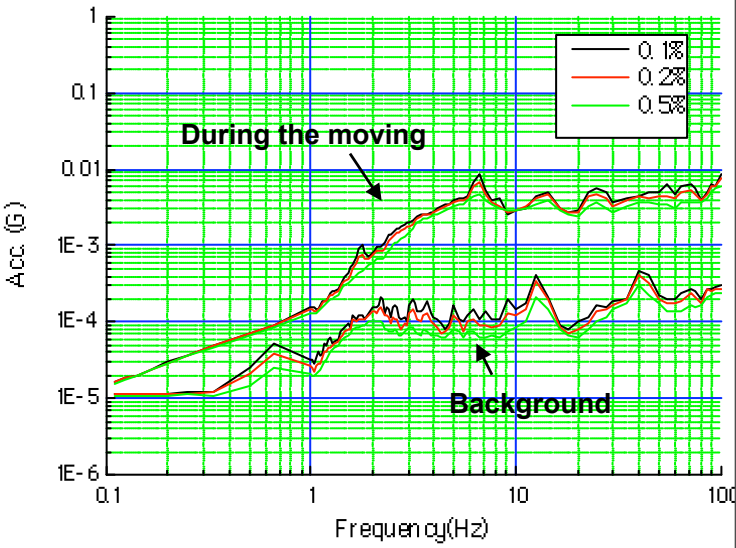
- Piezo-sensor couldn't detect these vibrations.

Measurement results (Response spectrum) with damping factors (oil damper)

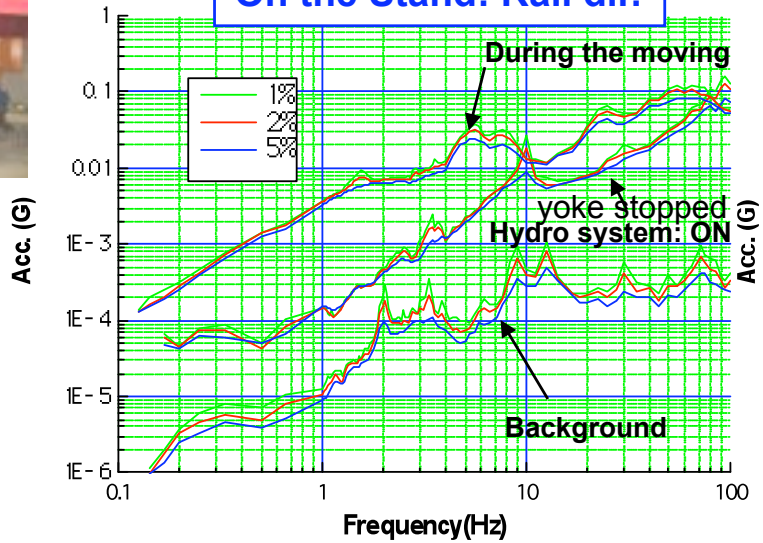
On the roller: Rail dir.



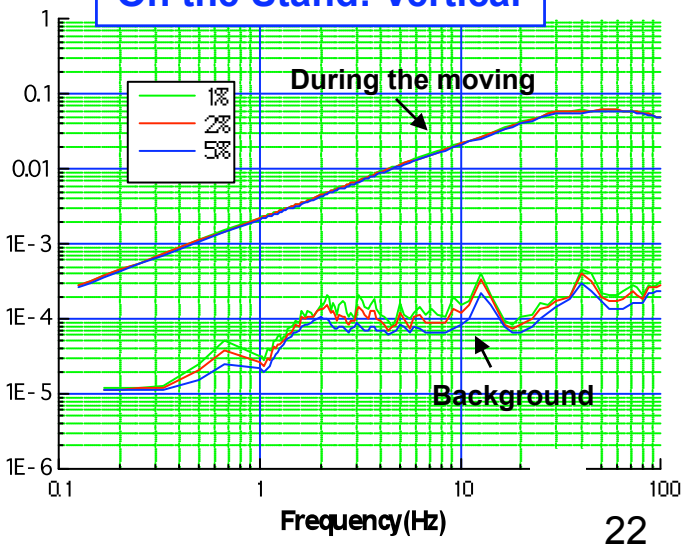
On the roller: Vertical



On the Stand: Rail dir.



On the Stand: Vertical



Summary

1. Design stiff support structure

- Double shaped tube/Realistic tube have been proposed.
- Integrated amplitude is less than 50nm.

2. Calculations

- Static, modal and PSD have been carried out.

3. Check consistency

- Simple vibration tests have been done.
  → Resonant frequency was measured lower than ANSYS calculation.
  Measured integrated amplitude was larger than ANSYS calculation.

4. Vibration measurements

Vibrations at the Belle detector/KEKB and CMS were measured.

- Amplitude on the barrel yoke is bigger than the support table.
- The integrated amplitude becomes larger when going from the bottom of the end yoke toward the top.

5. Realistic vibration data for calculations

CMS data?

6. Other measurements

(1) Efficiency of support structure was investigated with the ND280 detector.
Support stiffness of the detector is increased.

(2) Vibration measurement during the moving on the rail was carried out.
Response acceleration was measured to 0.1G in rail direction, 0.01G in vertical.