Vibration studies for the QD0-support system

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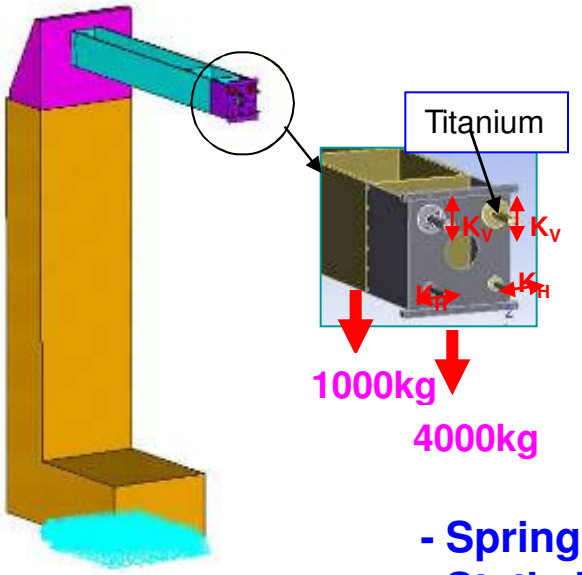
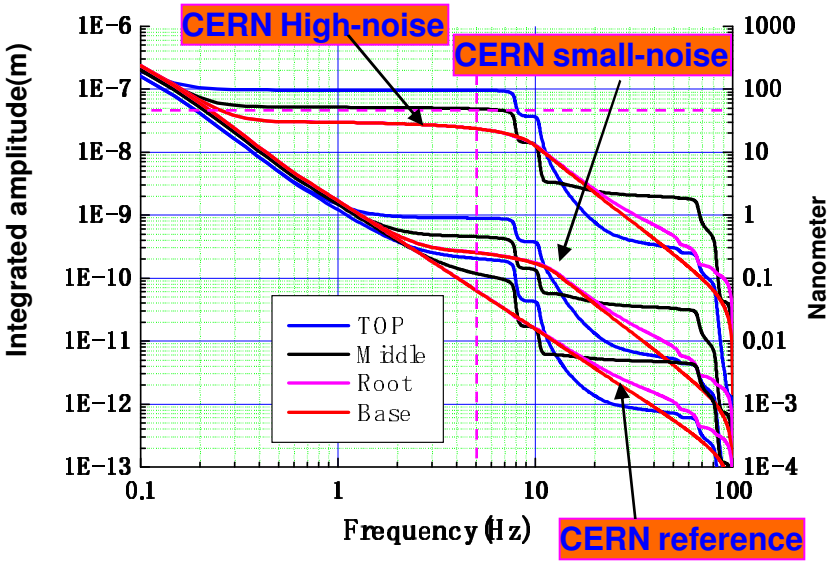
KEK

At LCWS09



- Spring constant
- Static loads
are defined.



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

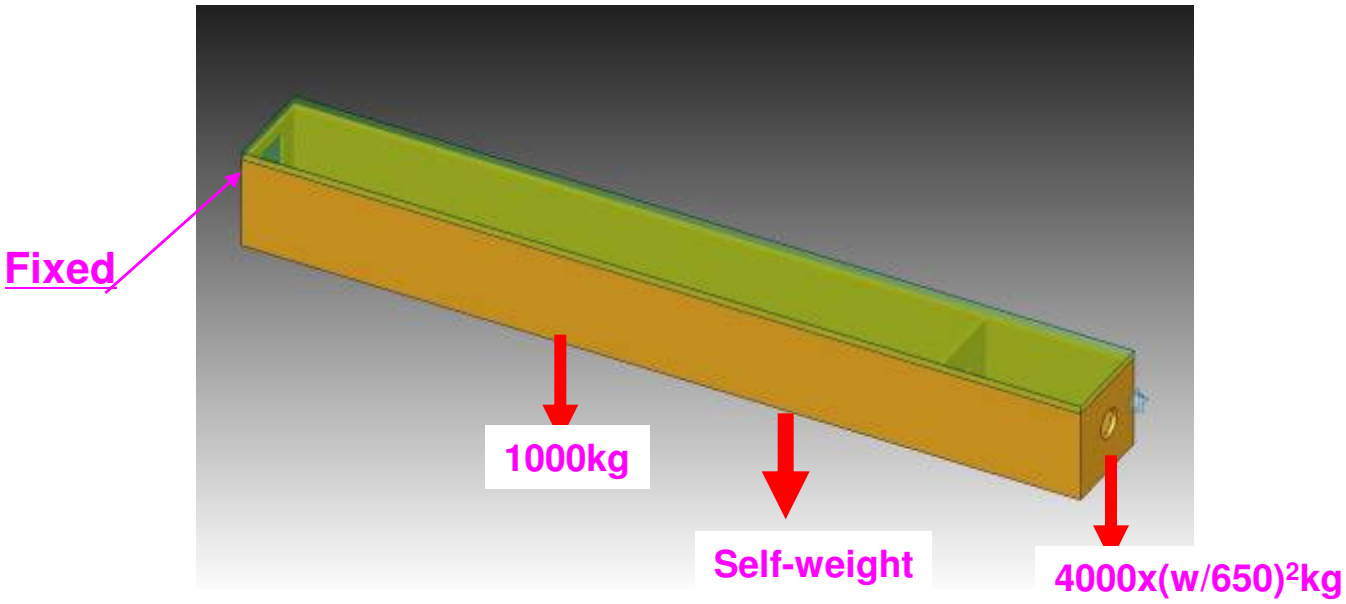
Conclusions at LCWS09

- Vibration behavior for the ILD QD0 support system was studied.
  Measurement data of ATF/CERN were input.
  Integrated amplitude of the support system was calculated.

→ Integ. amplitude in case of ATF and CERN high-noise are larger than 50nm at 5Hz.

➔ Stiffness of (support tube + support position) should be increased.

New models and assumptions

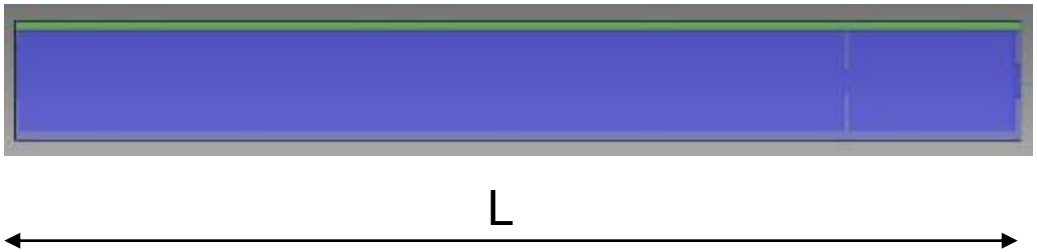


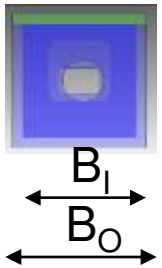
1. Size of the tube is larger.
   650x650 t50
   650x650 t100
   1000x1000 t50
   1000x1000 t100

2. The tube is not supported by tension rods
   → Cantilever
   → Spring constant is NOT defined.

3. The tube is covered with a plate fixed by pins.

Investigations by hand-calculations





Deformation

$\delta_C = \frac{PL^3}{3EI}$ due to weight of the calorimeter

$\delta_s = \frac{PL^3}{8EI}$ due to Self - weight and QD0

Spring constant

$k = \frac{EI}{\alpha \cdot L^3}$ In case of self - weight, $\alpha = \frac{1}{8}$

1st mode of Resonant frequency

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

Moment of Inertia

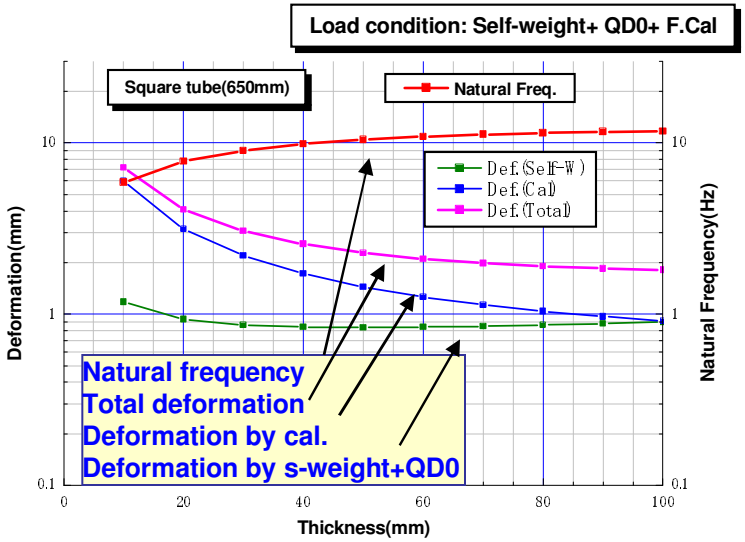
$I = \frac{B_O^4 - B_I^4}{12}$

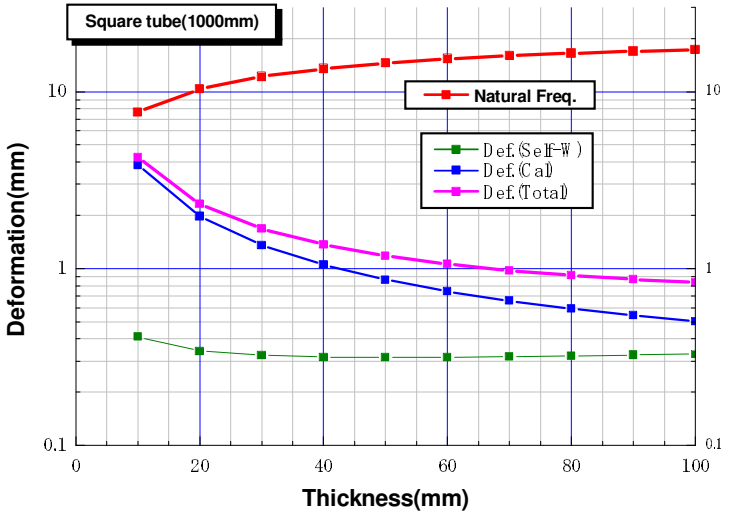
E : Young's modulus

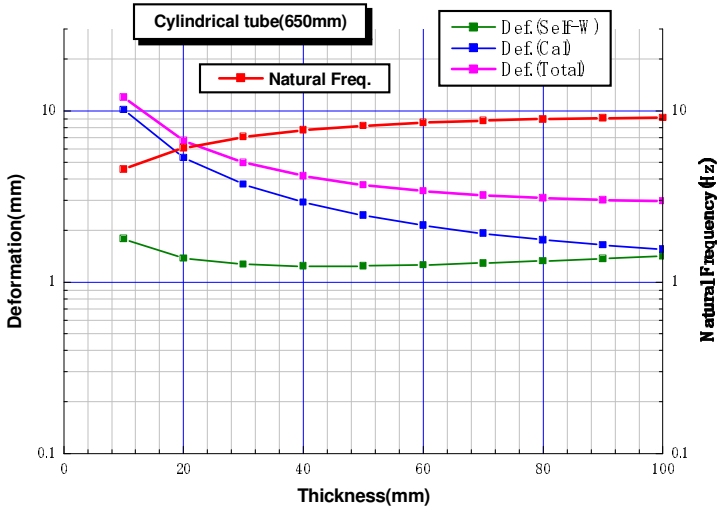
M : Mass

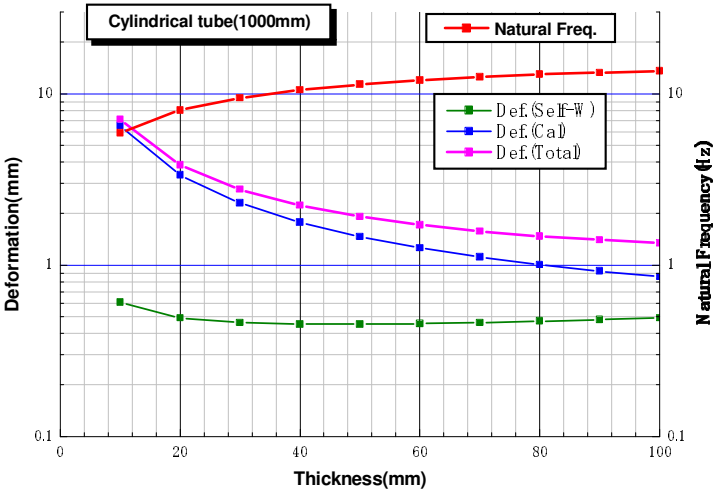
Results

Loads: Self-weight + QD0 + Cal





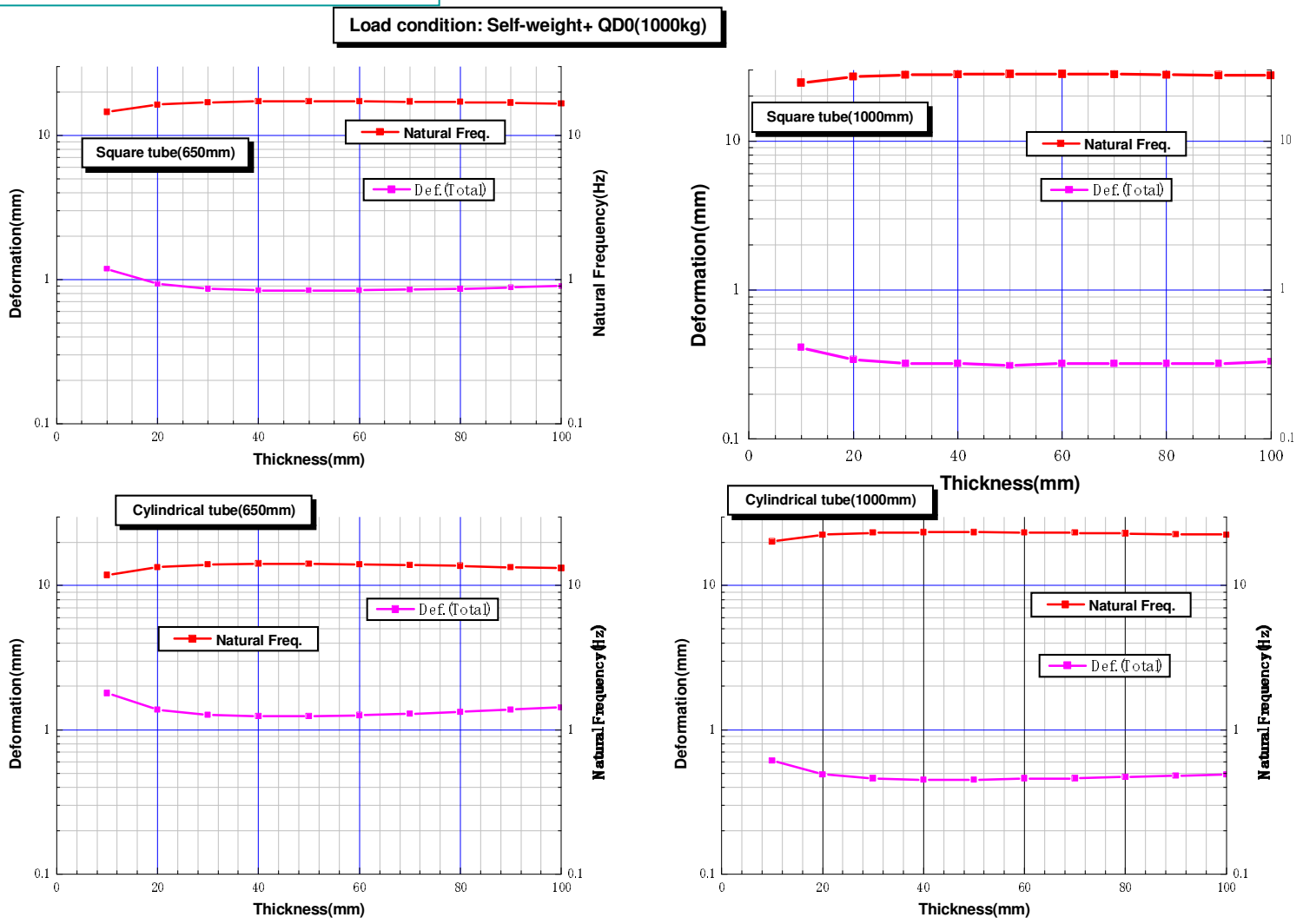




→ **Deformation/Frequency is saturated even if *thickness and the size* is increased. This is due to the weight of calorimeter.**

If the weight of the calorimeter could be removed on the tube,...

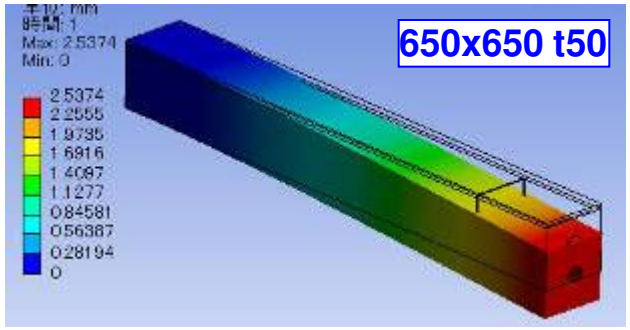
Loads: Self-weight + QD0

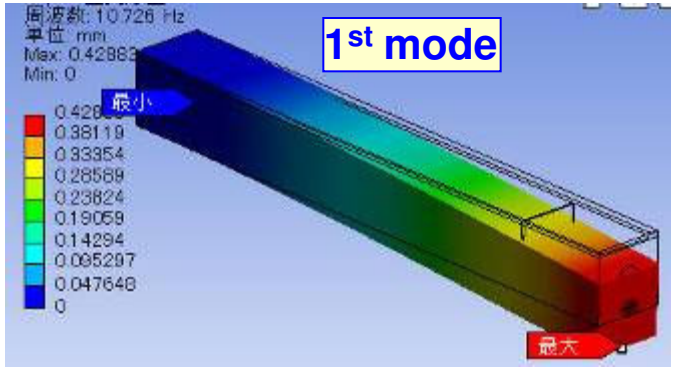


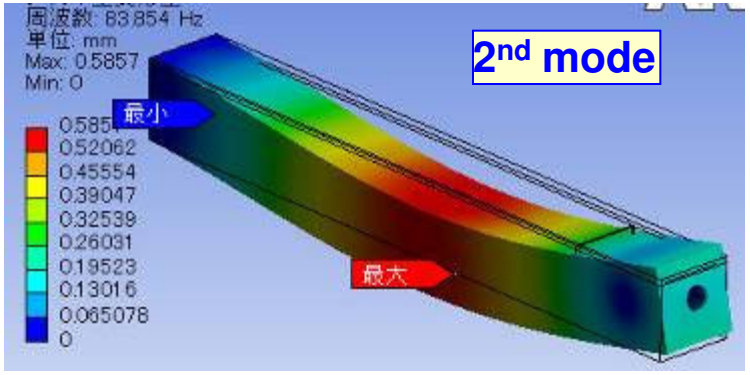
- Deformation/Frequency is saturated even if thickness is increased.
- Deformation/Frequency can be improved by increasing the size.

ANSYS calculations

Deformation



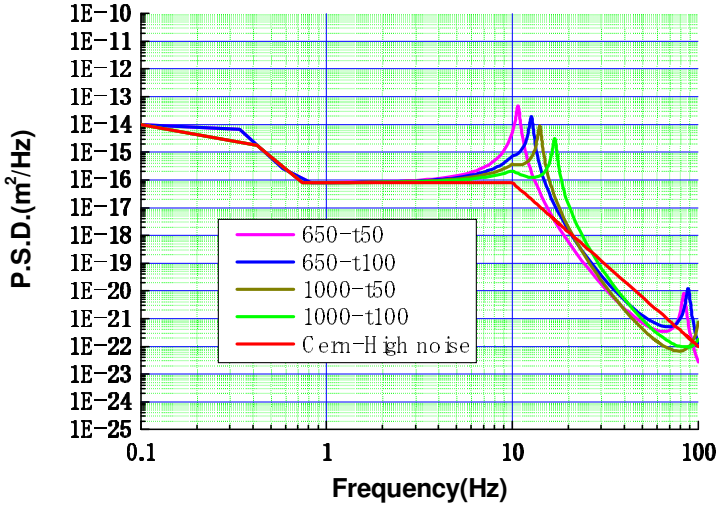


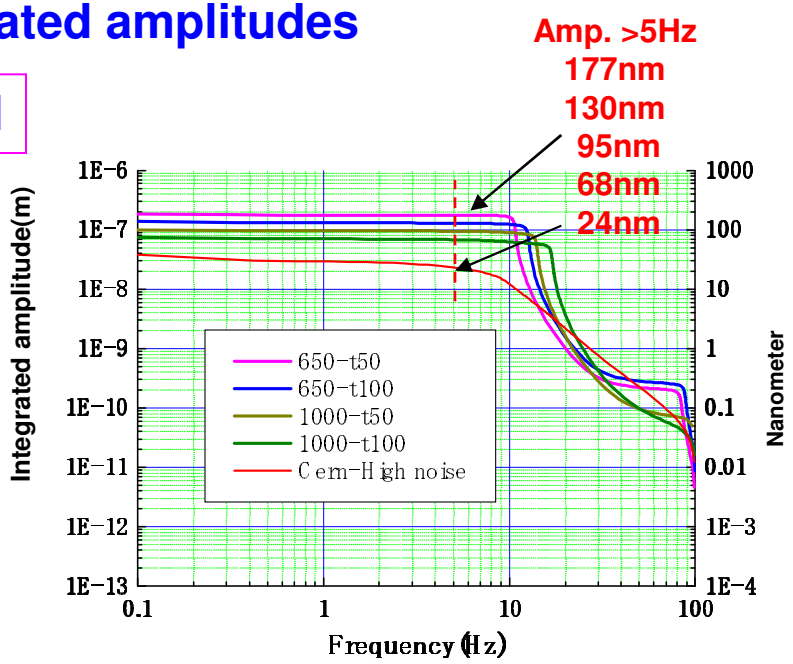


Size(mm)	650x650		650x650		1000x1000		1000x1000	
Thick.(mm)	50		100		50		100	
Self.W(kg)	5313		9563		8609		15834	
QD0(kg)	1000		1000		1000		1000	
F-Cal.(kg)	4000		4000		9468		9468	
Loads	Self.W+QD0	Self.W+QD0+Cal	Self.W+QD0	Self.W+QD0+Cal	Self.W+QD0	Self.W+QD0+Cal	Self.W+QD0	Self.W+QD0+Cal
Deform.(mm)	0.95	2.5	0.95	1.9	0.4	1.4	0.42	1
Freq: 1st.	20.4	10.7	20.2	12.7	30.6	14	30	16.9
Freq: 2nd.	109.9	83.9	111.8	88.3	119.8	103.8	123.9	112.1

(Cern-High noise) P.S.D. values and Integrated amplitudes

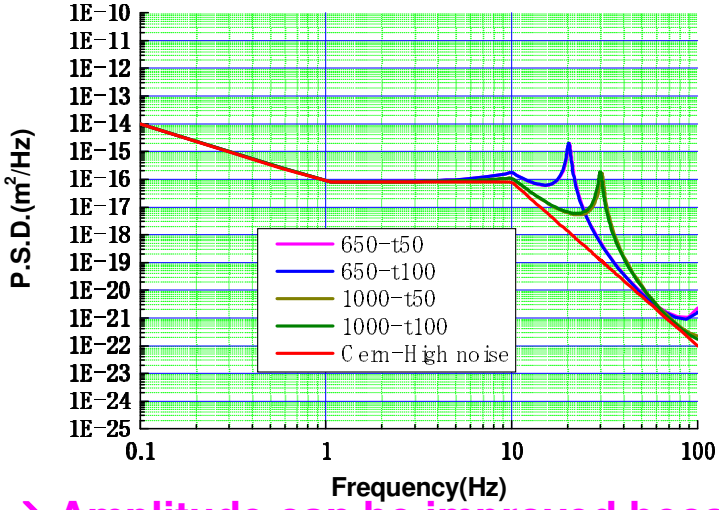
Loads: Self-weight + QD0 + Cal

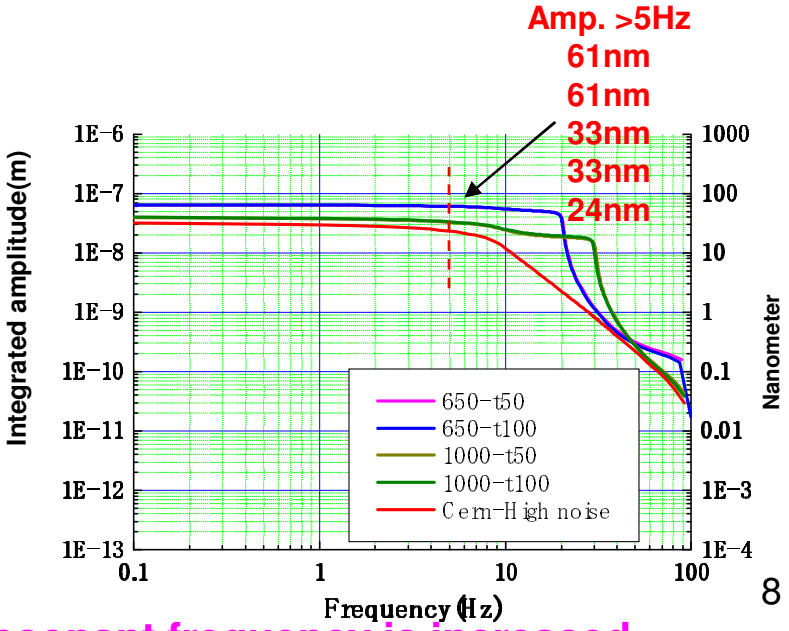




→ Amplitude can not be improved because resonant frequency is not increased.

Loads: Self-weight + QD0

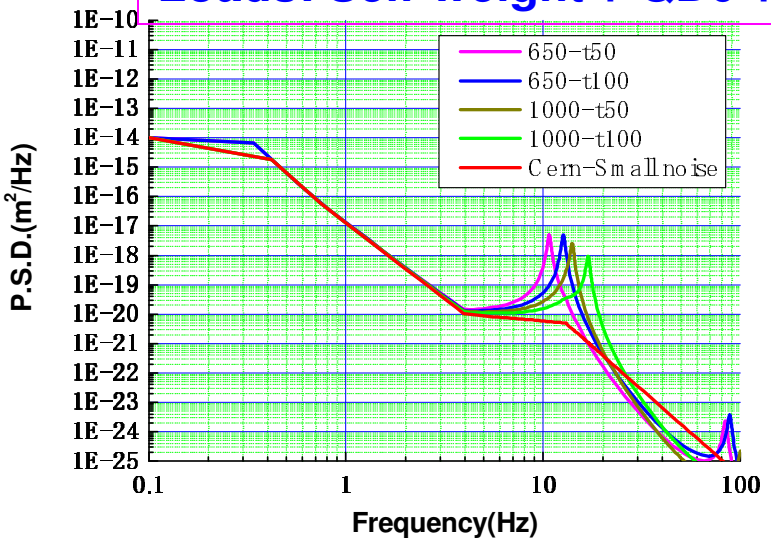


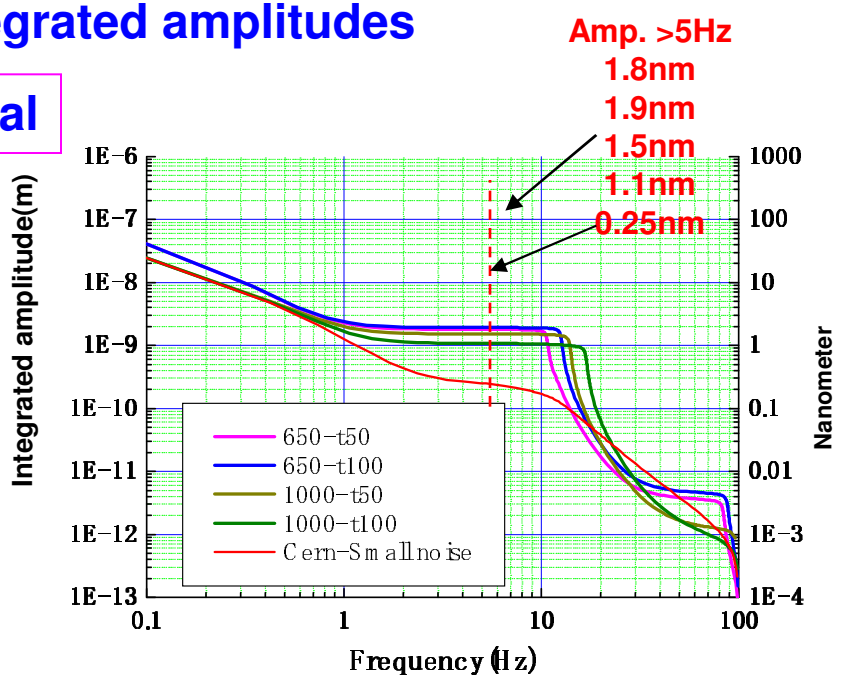


→ Amplitude can be improved because resonant frequency is increased.

(Cern-Small noise) P.S.D. values and Integrated amplitudes

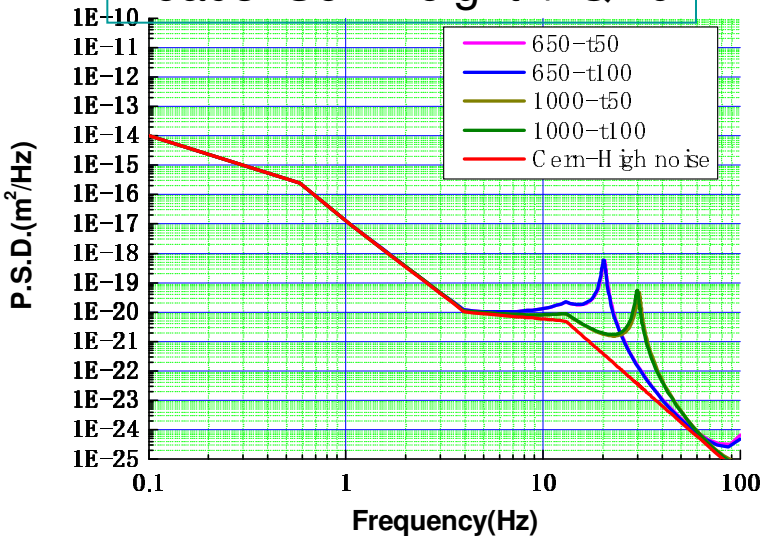
Loads: Self-weight + QD0 + Cal

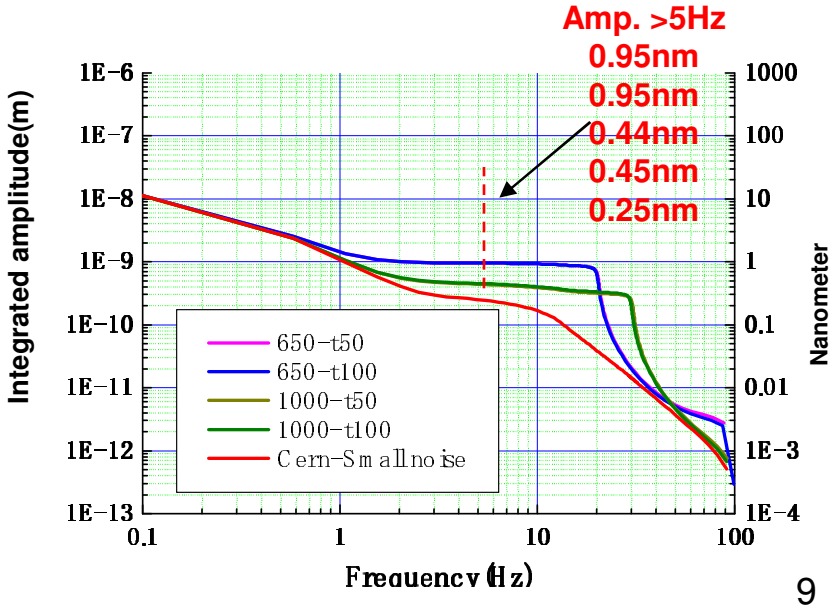




→ Amplitude can not be improved because resonant frequency is not increased.

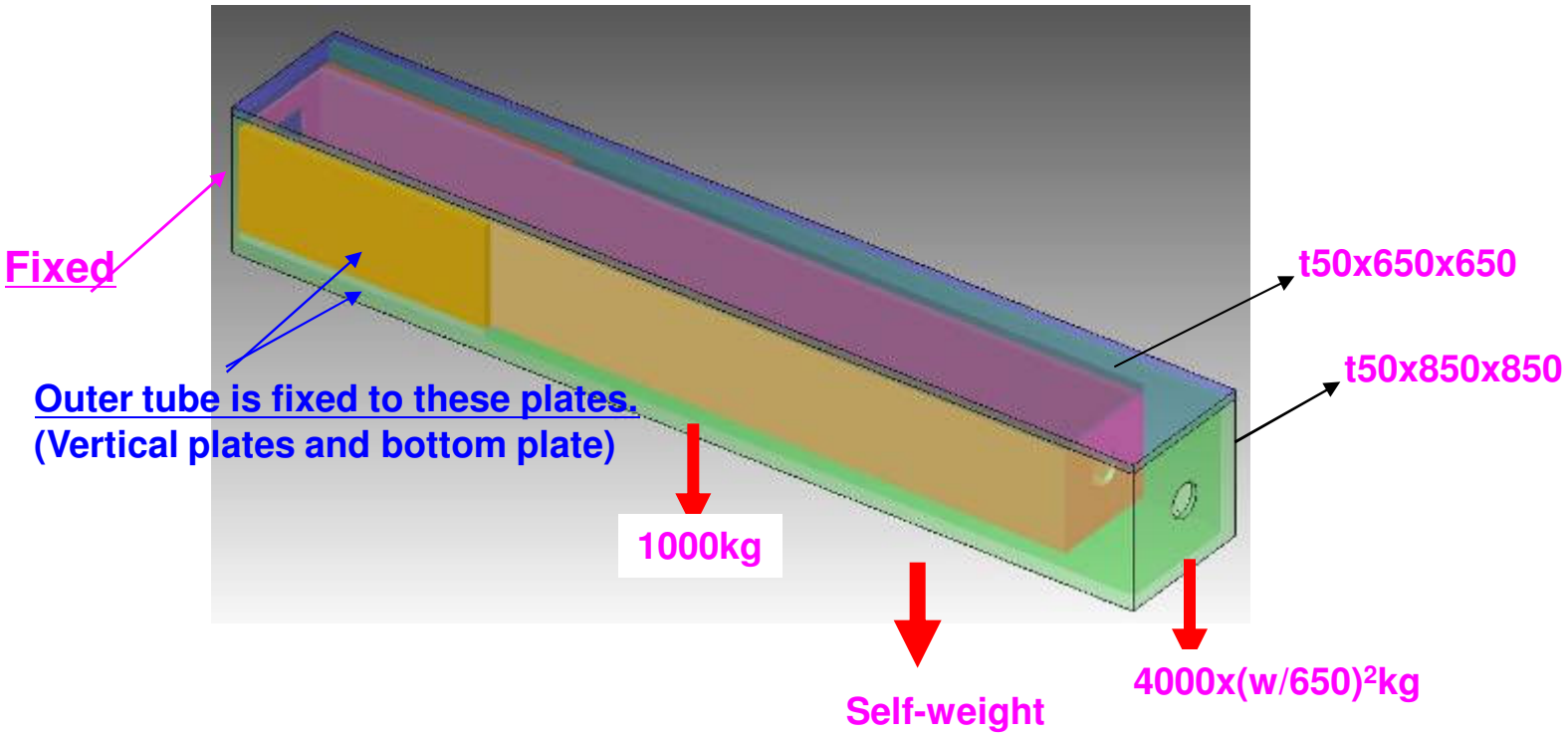
Loads: Self-weight + QD0





→ Amplitude can be improved because resonant frequency is increased.

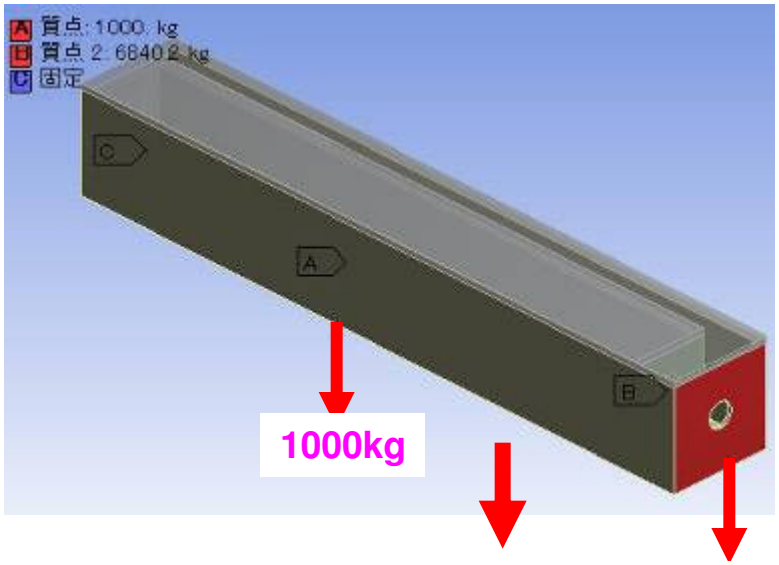
How do you think this configuration?

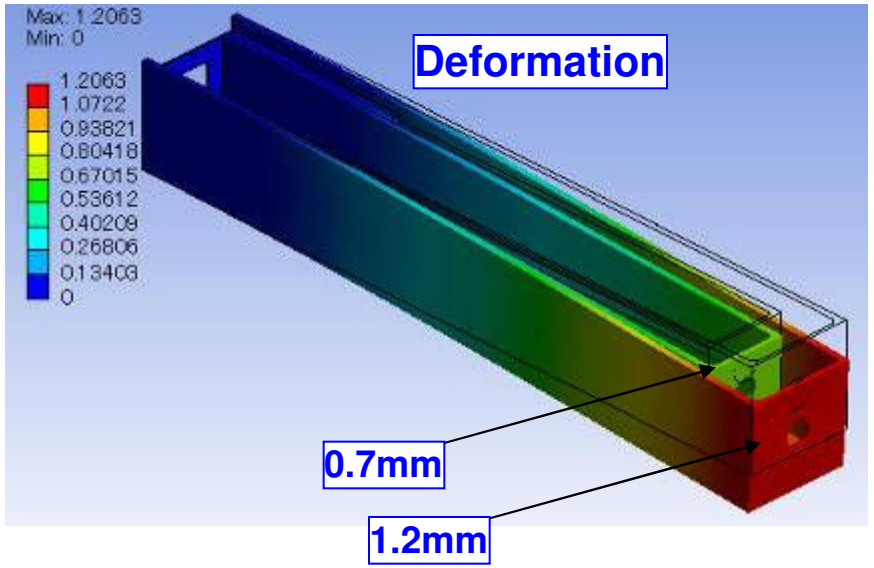


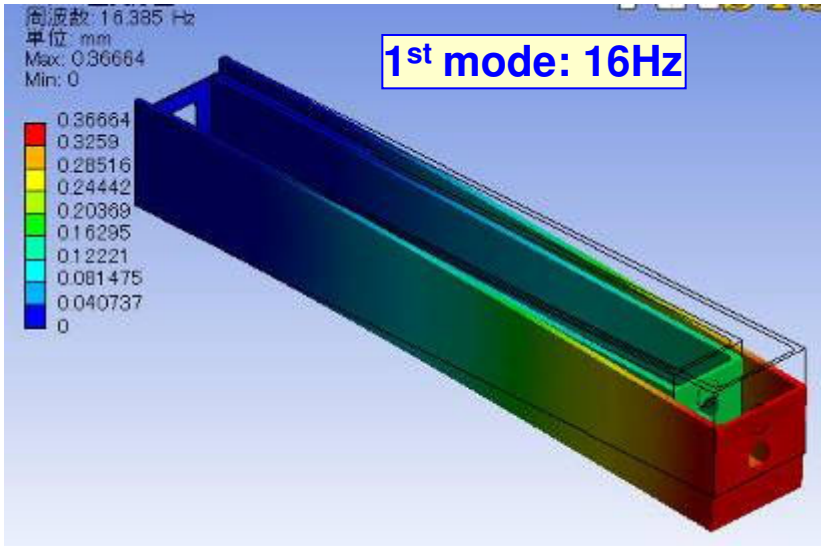
If the FCAL weight is supported at close to the constraint position of the tube, the deformation of the QD0 position must be small even though deformation of FACL support position is big.

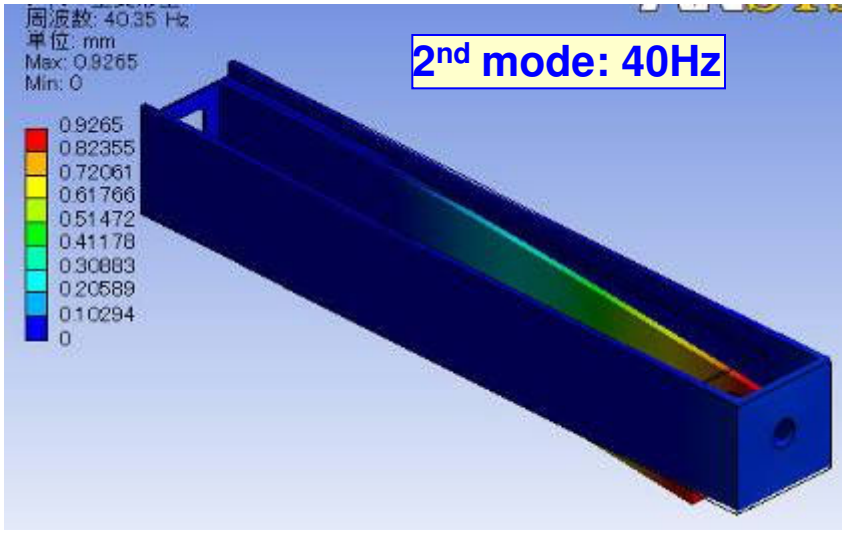
- Support tube consists of double square tube.
- Outer tube supports FCAL.
- Inner tube supports QD0.

ANSYS calculations

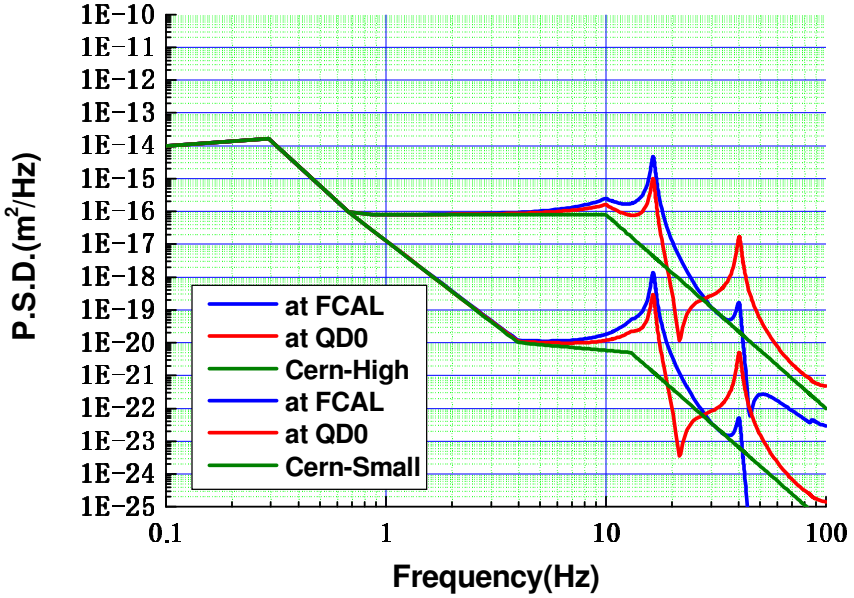








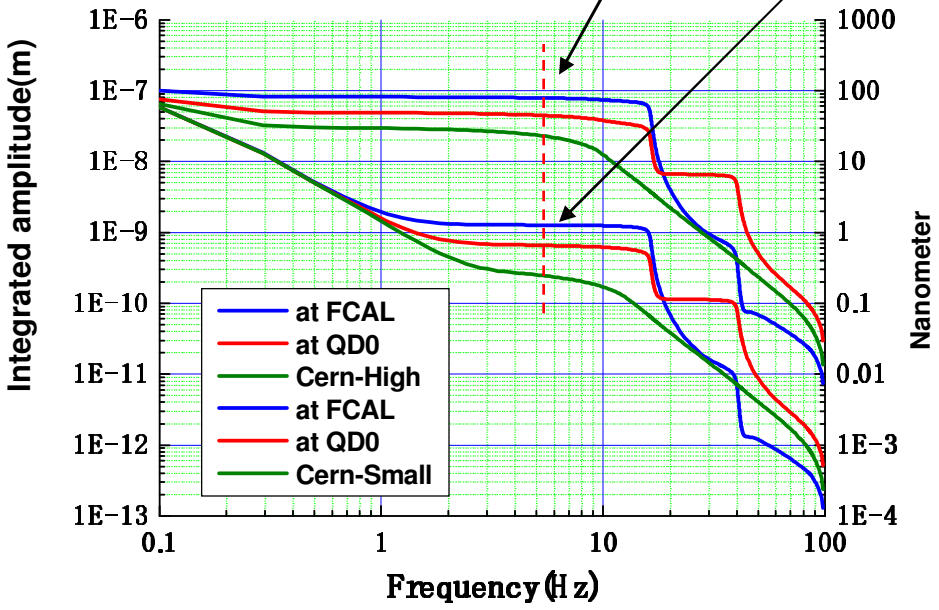
P.S.D. values and Integrated amplitudes



Loads: Self-weight + QD0(Inner cyl.)
Self-weight + F-Cal(Outer cyl.)

Amp. >5Hz
79nm(@Fcal)
45nm(@QD0)
24nm(@C-high)

Amp. >5Hz
1.3nm
0.65nm
0.25nm



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

→ **Amplitude can be improved.**

Summary

It is very difficult to improve integrated amplitudes due to the effect of the weight of calorimeter.

To improve vibration properties;

- Try to optimize the size of tube.
- My proposal?
- Matthieu-san's proposal?

Next step

- Carry out further calculations.
- Investigations of consistency of calculations.