Nov. , '08
KEK H. Yamaoka

Support system of final quadrupole magnet in a Detector

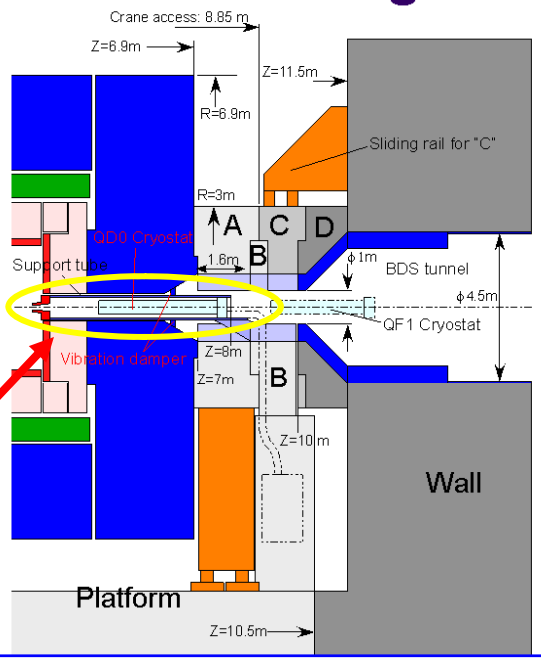
Contents

Introduction

'MDI at GLD' by Y. Sugimoto
ILD Workshop at DESY, Zeuthen

Components of IR-region are planed to support with the Support tube.

Pacman design and FD support



- A: slide sideway using air pad
- B: supported from the floor of platform
- **QD0 cryostat is supported by the support tube and the support tube is supported from B**
- We can put additional support for the support tube at the entrance of endcap yoke to damp the vibration, if necessary
- Upper part of B (~10 ton) must be removable by crane for installation and removal of the support tube
- C: slide along the wall (D) (common to both experiments) ~50 tonx2
- D: part of the wall
- Wall distance can be as small as 11.5 m from IP, if the crane can access to 2.65m from the wall
- Construction of C is done by a mobile crane (CMS style)
- Inner radius of pacman should be determined after design of gate valve etc. between QD0 and QF1 is fixed

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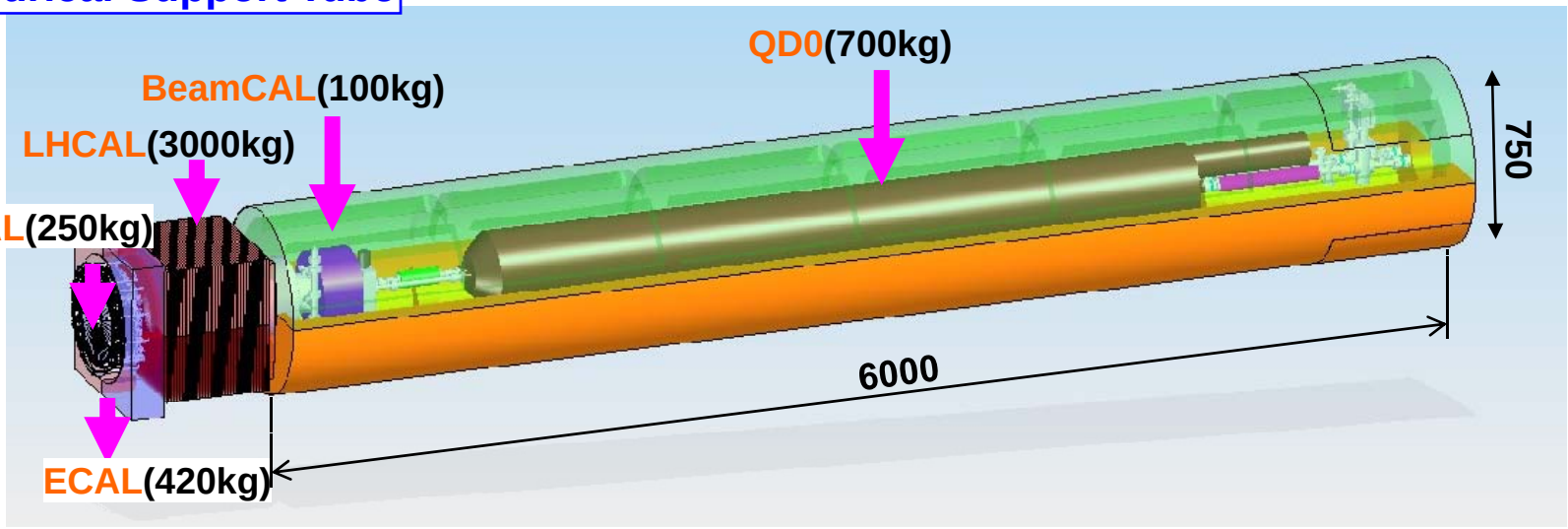
Cylindrical Support Tube



Strength, Installation scheme will be presented.

Boundary conditions;

-Models

- Half-Cylinder
- Full-Cylinder
- Half-cylinder with reinforcement ribs
- Thread Bolts connection

-FEM analyses

- Static analysis
- Modal analysis
- Dynamic load such as ground motion

- Materials

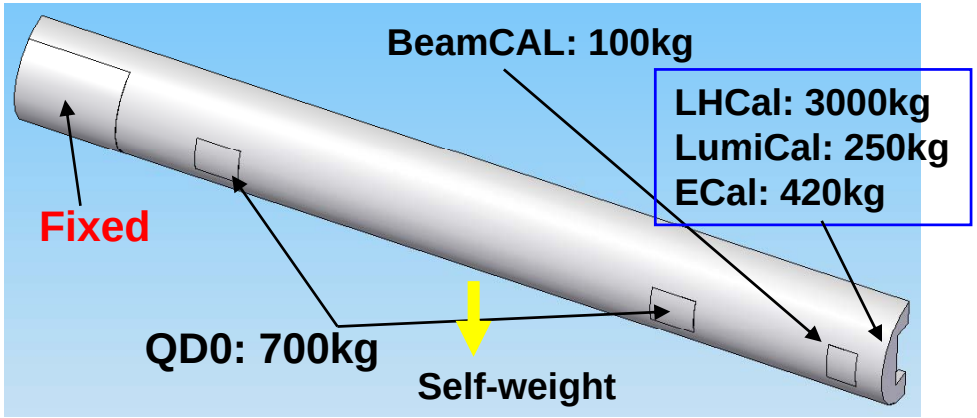
- Stainless steel
- Aluminum

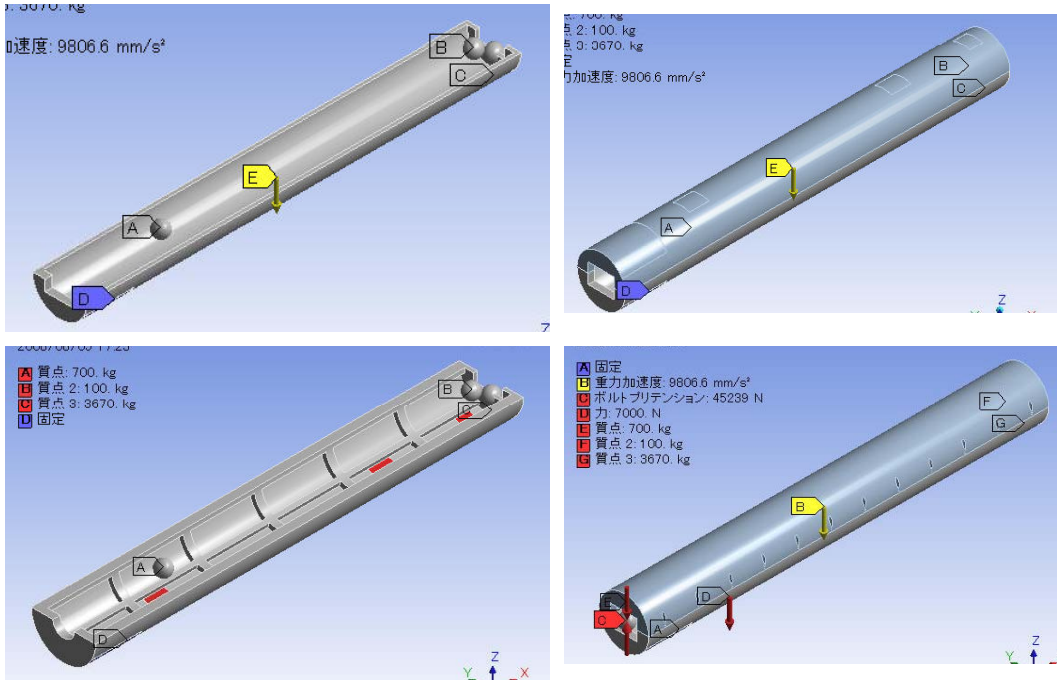
-Load condition

See: right-upper

-Constraints

- Only cylinder's end. (Cantilever)



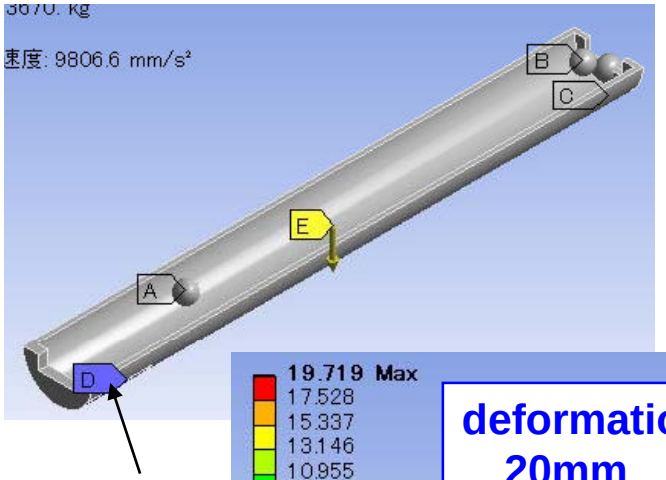


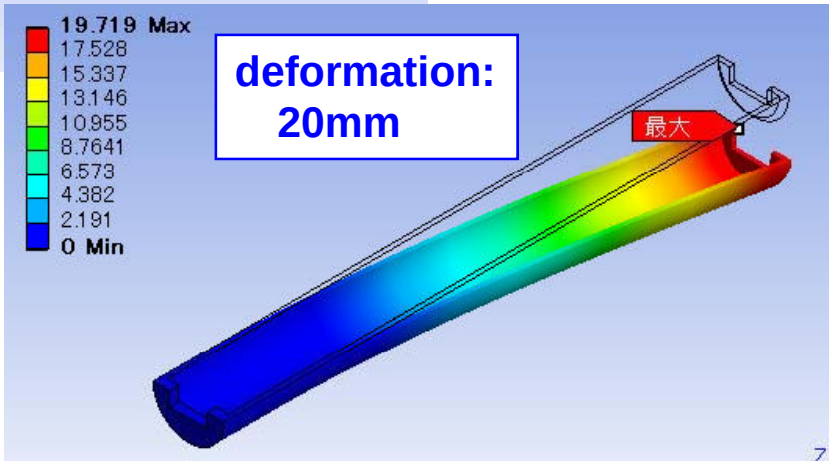
Results

Static analysis

Half-cylinder

- Stainless-steel
- 50mm-thick

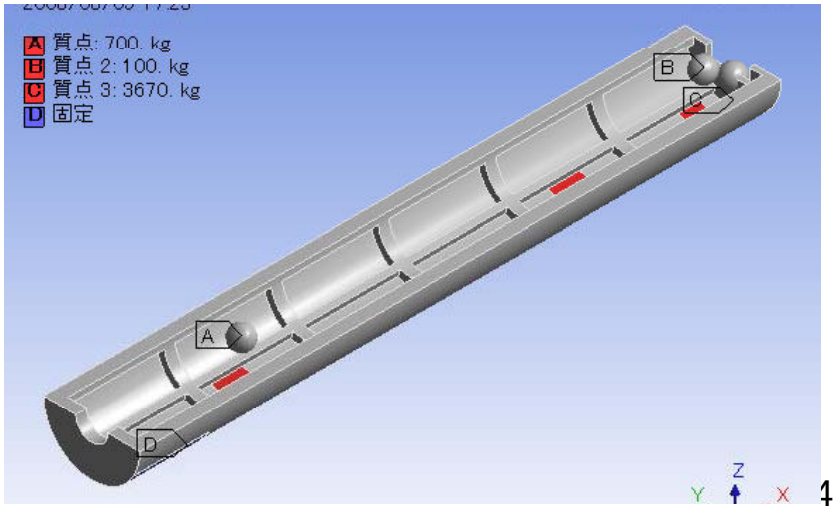




→Deformation(Static)=20mm
→The deformation is too large.

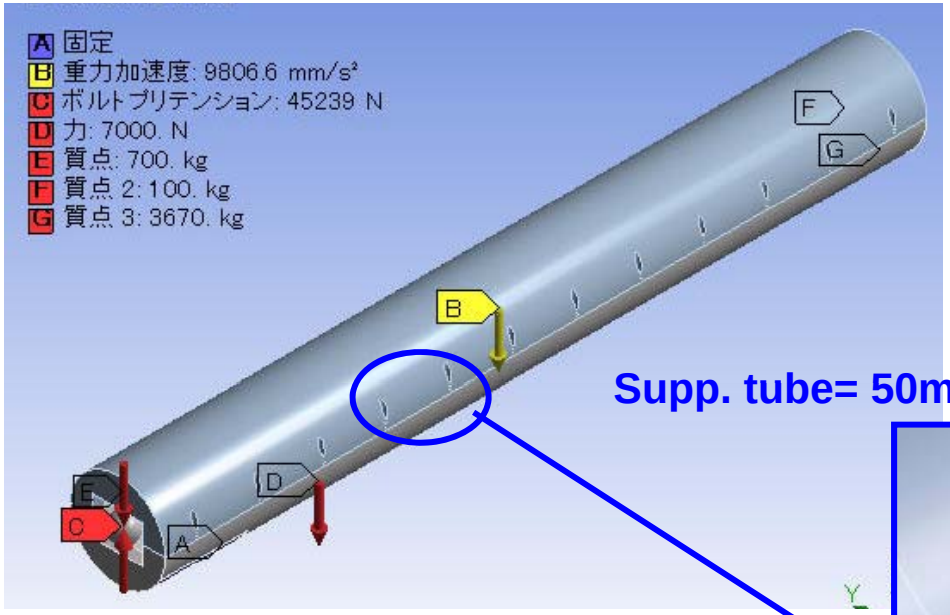
Half-cylinder with reinforcement ribs.

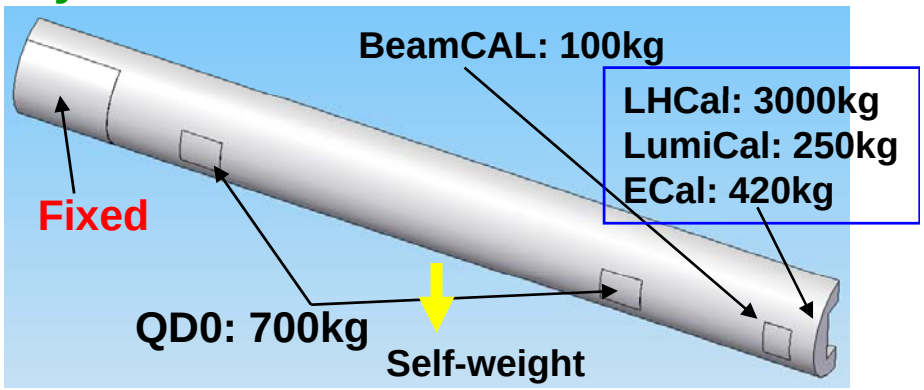
- Stainless-steel
- 50mm-thick
- Each weight + Self-weight
  →Deformation(Static)=8.5mm
  →The deformation is also large.
  →Complicate fabrication.



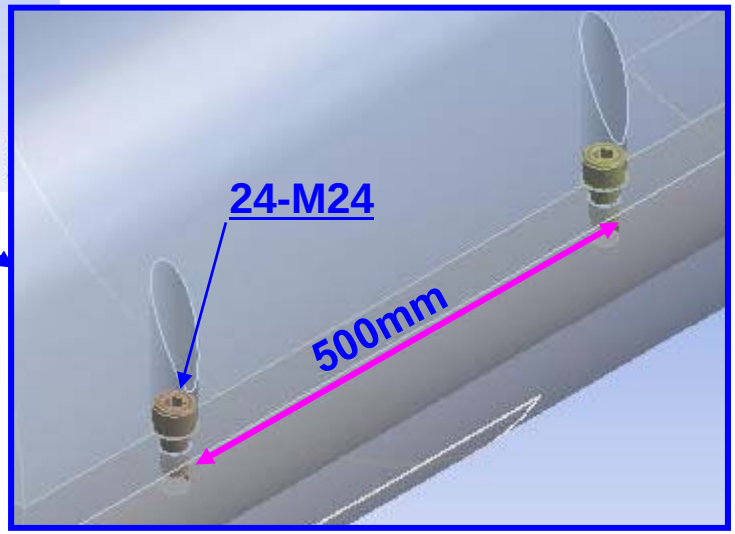
➔ **Support tube should be full-cylinder.**

・ **Full-Cylinder is assembled from two half-cylinders**





Supp. tube= 50mm-thick.



- Materials

-Stainless steel or Aluminum

-Load condition

See: right-upper

-Assumptions

- Fixed only cylinder's end (Canti-lever).

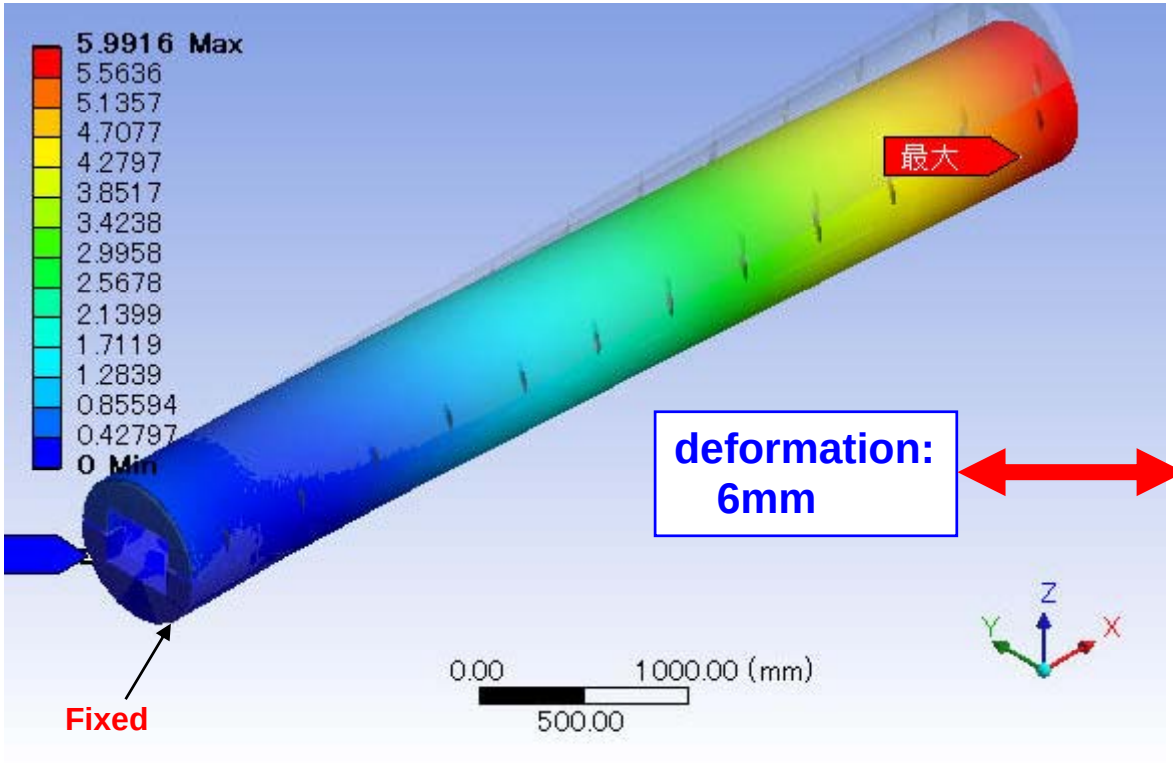
- Bolt pre-tension was defined.

- Defined slide on the boundary of half-cylinders.

Results

Static analysis

- Full-cylinder assembled from two half-cylinder.
- Stainless-steel
- 50mm-thick
- Each component weight +Self-weight

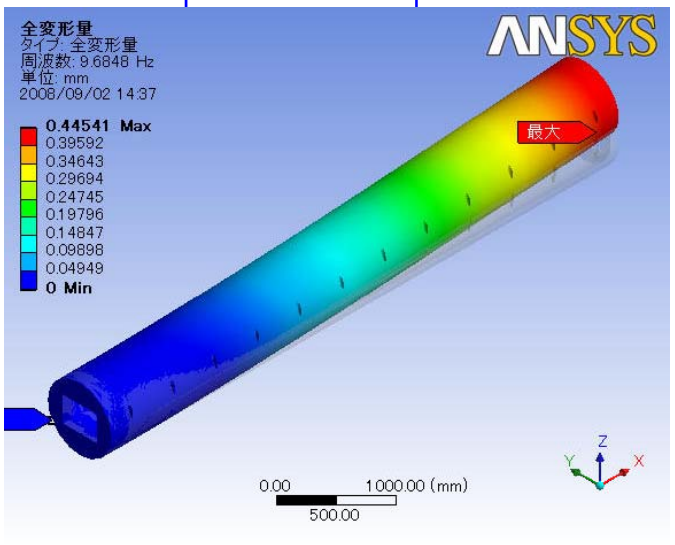


deformation: 6mm

- 3.2mm(Full cylinder)
- 20mm(Half-cylinder)

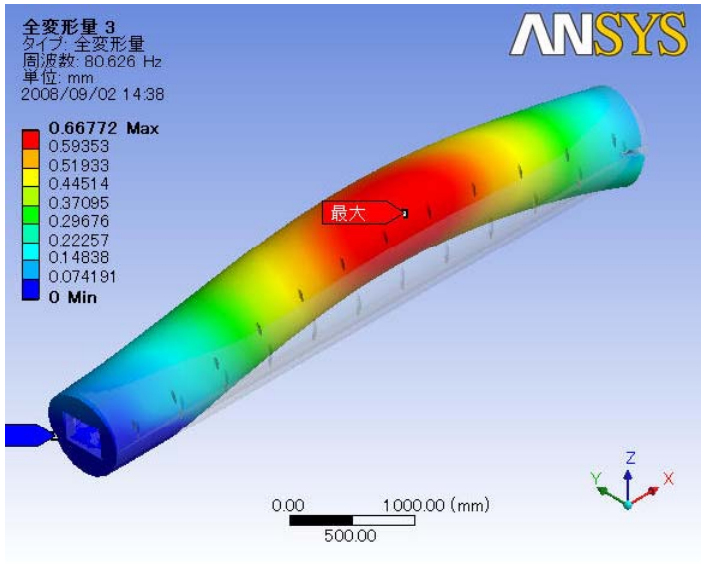
Natural frequencies

1st mode: 9.6Hz

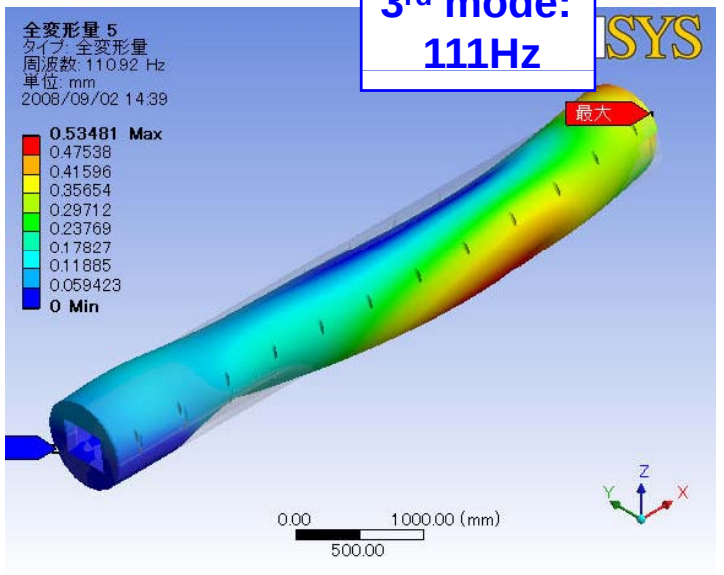


10Hz(Full cylinder)
4Hz(Half-cylinder)

2nd mode: 81Hz

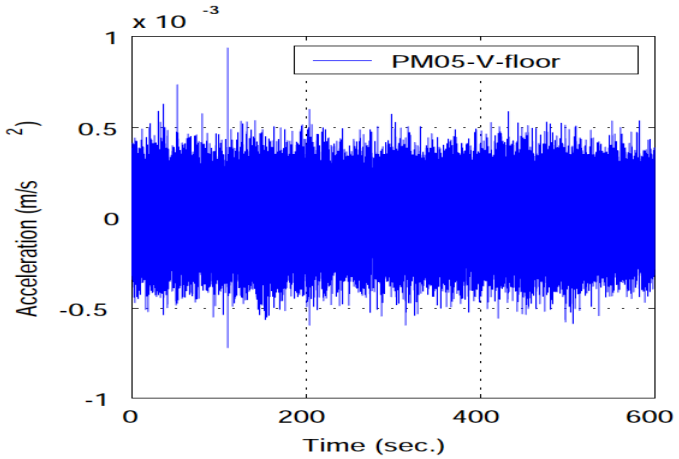


3rd mode: 111Hz

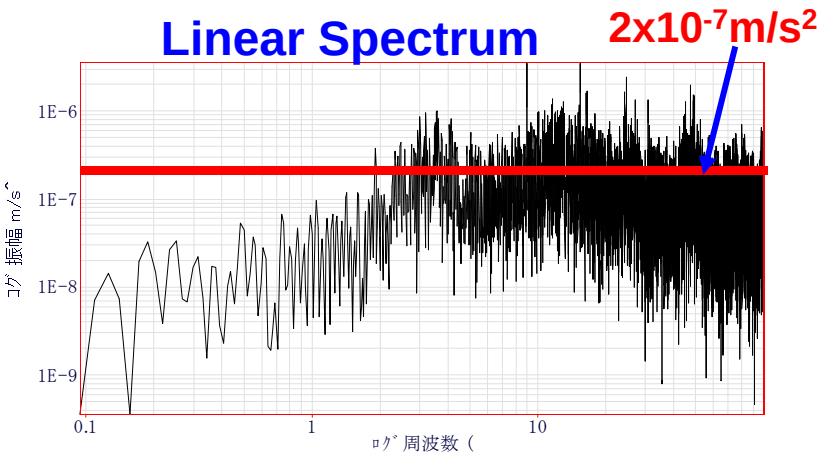


Amplitude due to ground motion

Vertical-dir. @KEK: ATF(17:00 Feb. 10, 2004)



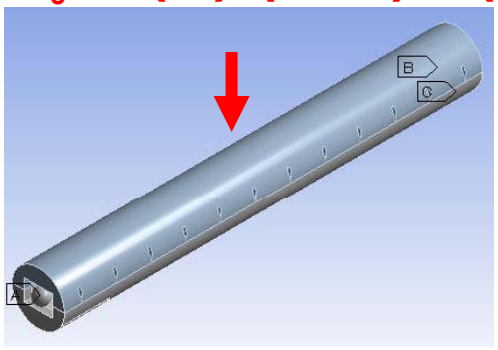
FFT



- Input Acc. : a= 2×10^{-7}m/s^2
- Mass: m=(5411.5+700+100+3000+250+420)/9.8[m/s^2]
- Damping ratio=2%

Self-weight

$F_0\cos(\omega t)=(m\cdot a)\sin(\omega t)$

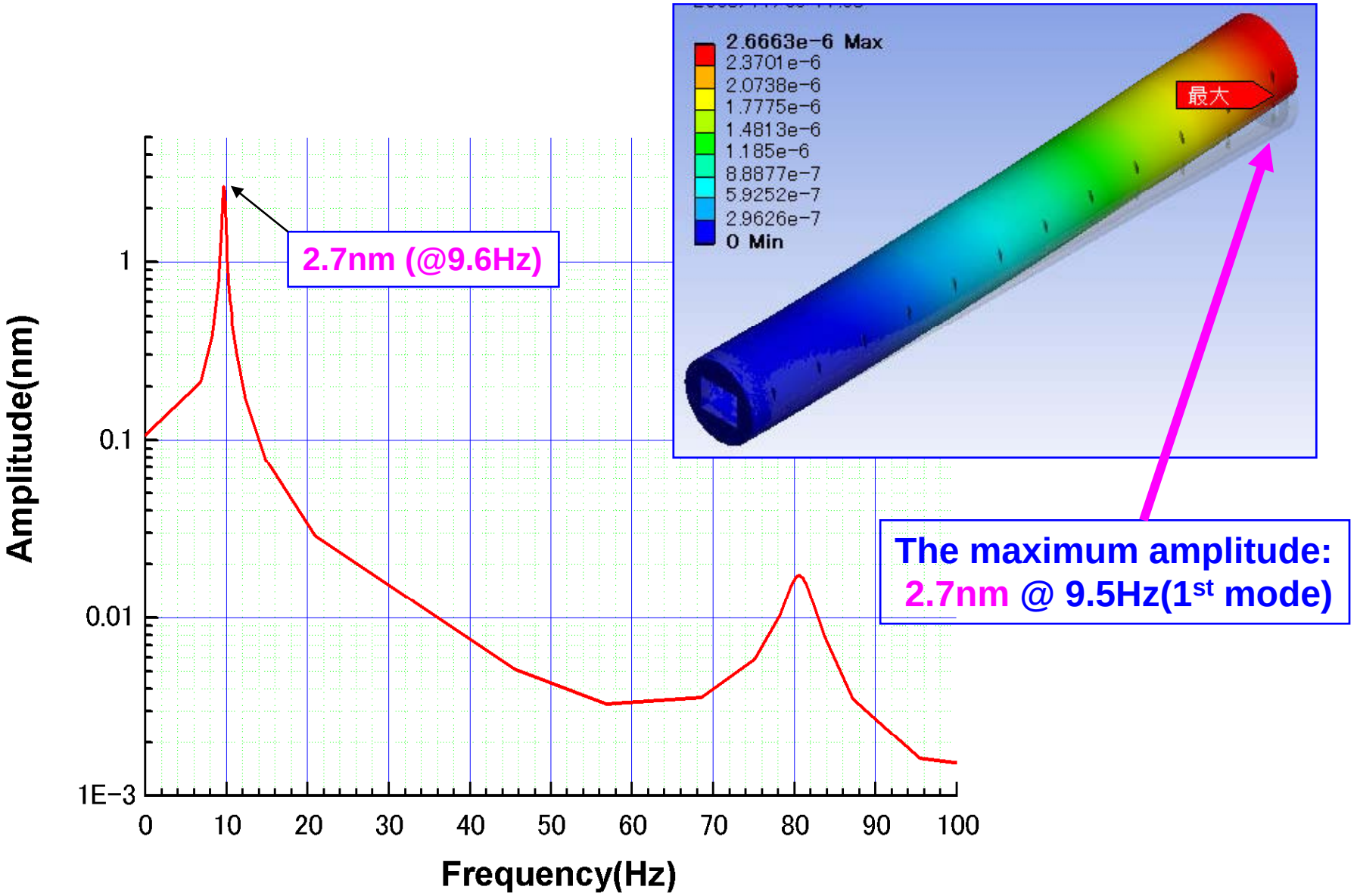


$F_0=2\times10^{-3}$N

ω= 0 – 1000Hz

- Input Acc. is the measurement data at ATF in KEK.
- Input data is assumed to be harmonic vibration.

Calculation result



Installation scheme

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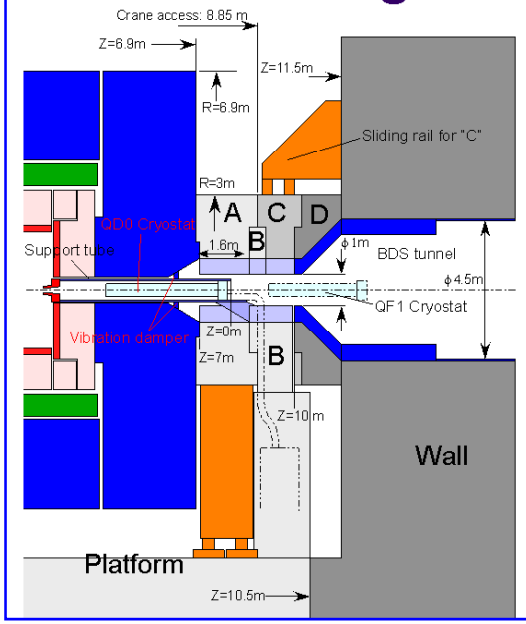
Pacman design and FD support



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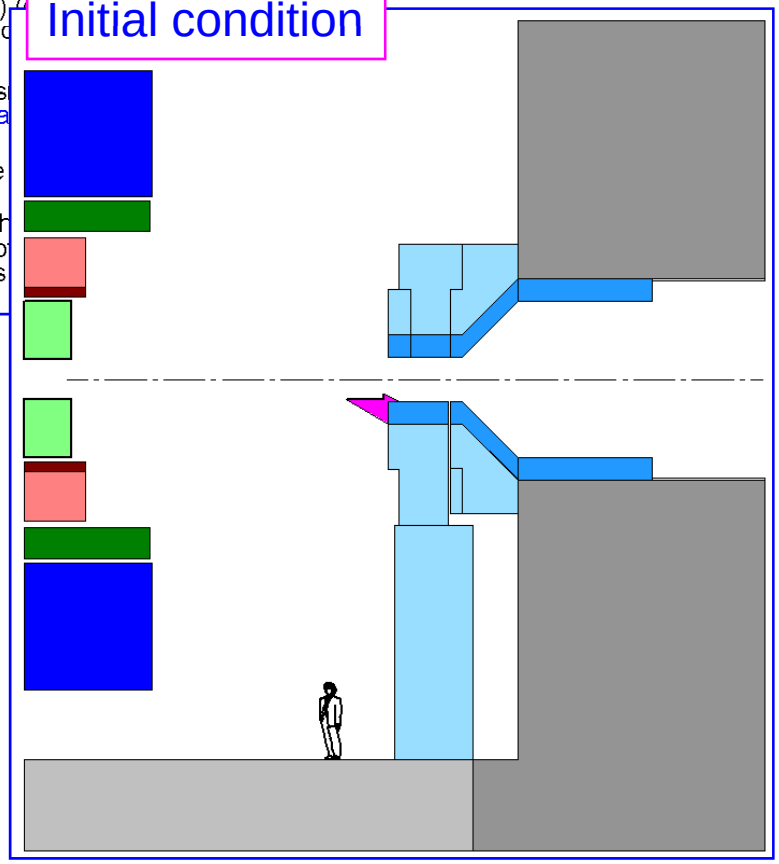
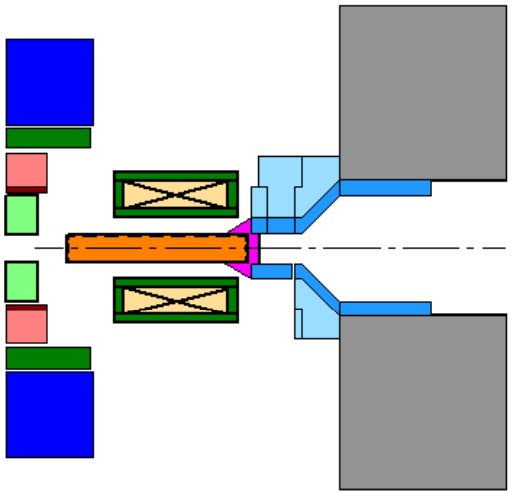
- B: supported from the floor of platform
- **QD0 cryostat is supported by the support tube and the support tube is supported from B**
- We can put additional support for the support tube at the entrance of endcap yoke to damp the vibration, if necessary
- Upper part of B (~10 ton) must be removable by crane for installation and removal of the support tube
- C: slide along the wall (D) (
  both experiments) ~50 to
- D: part of the wall
- Wall distance can be as s
  from IP, if the crane can a
  from the wall
- Construction of C is done
  crane (CMS style)
- Inner radius of pacman sh
  determined after design o
  between QD0 and QF1 is

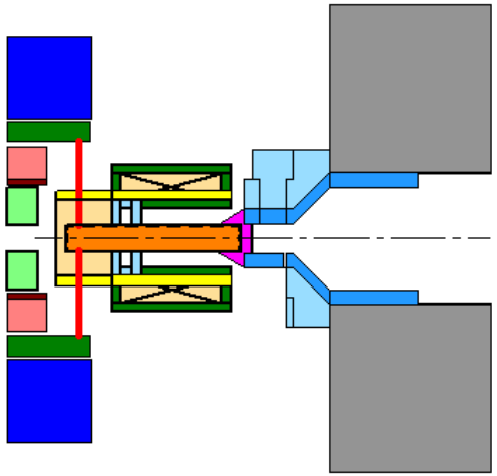
Initial condition

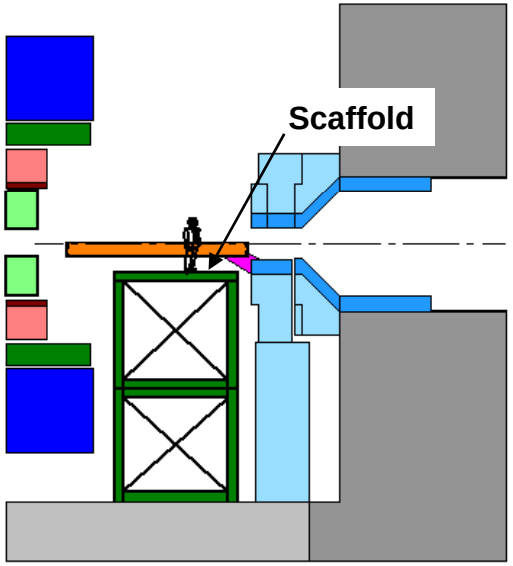


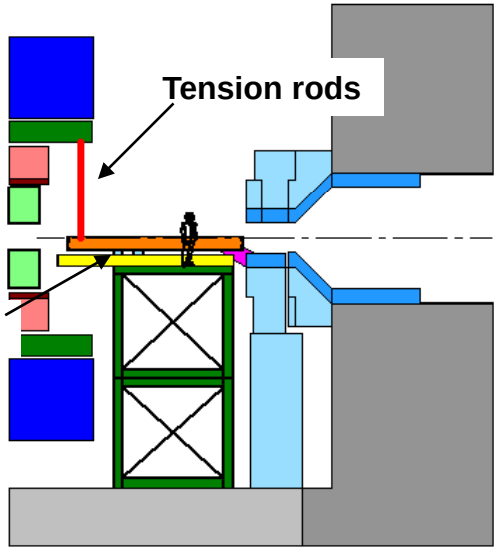
1.



2.



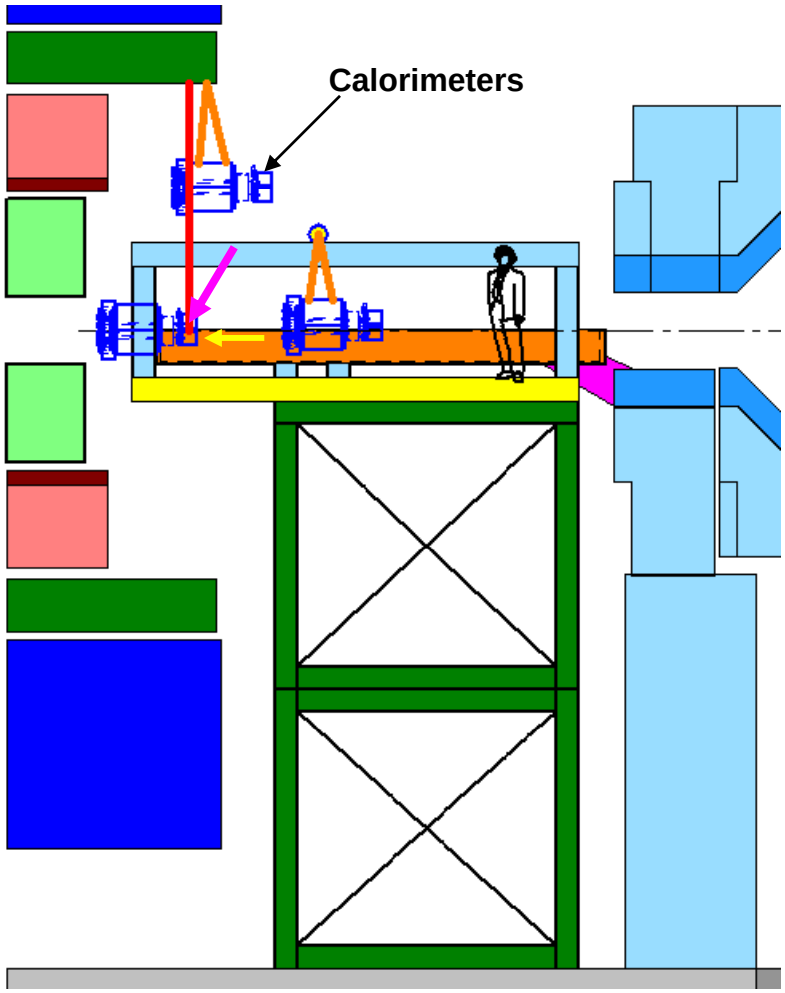




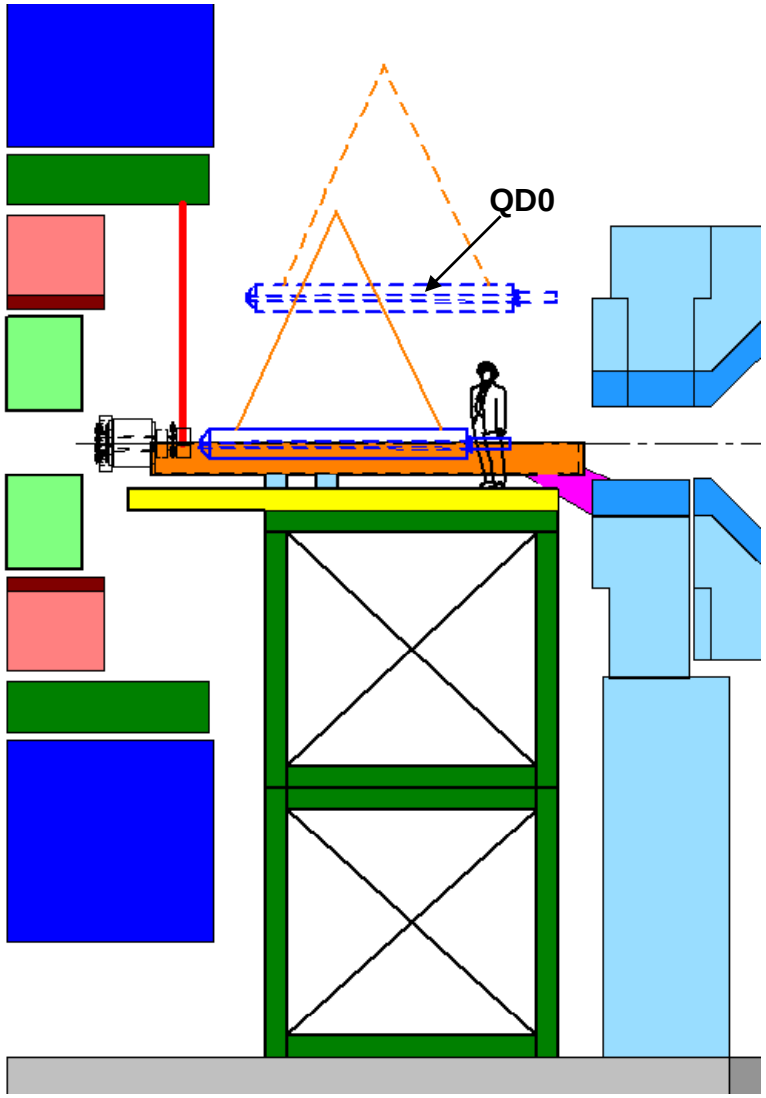
- Temporal rigid scaffold is set on the floor.
- The bottom half-cylinder is connected.

-Top of the support tube is supported by tension-rods.
- or, It is supported by timbers at the bottom.
→ 20mm sagged in case of the half-cylinder.

3.



4.



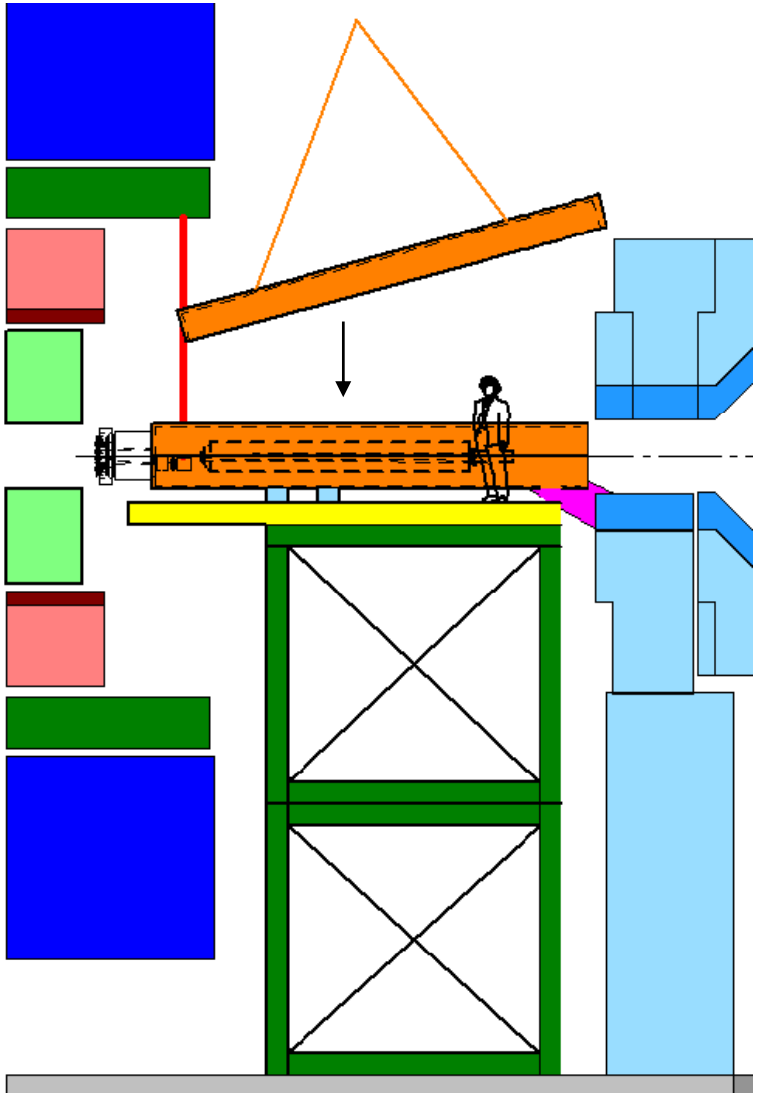
- Set Calorimeters.
  (a) Set chain hoist on the inner cryostat.

or

  (b) Assemble support frame on the temporal scaffold.

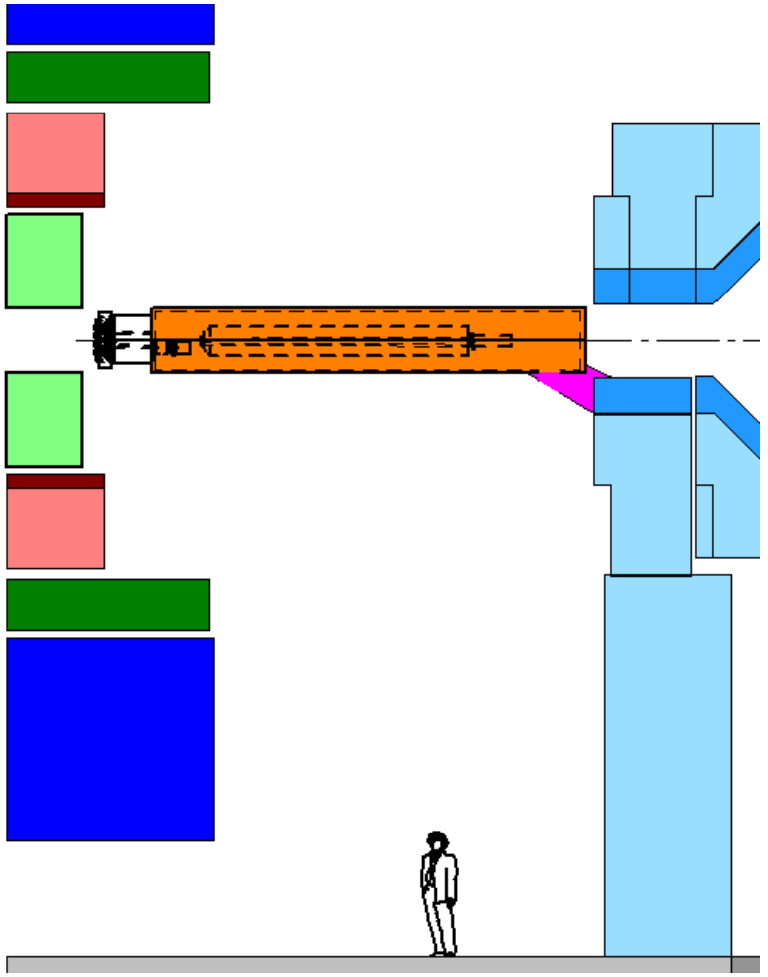
- QD0 is lifted by crane.
- Set it to the correct position.

5.



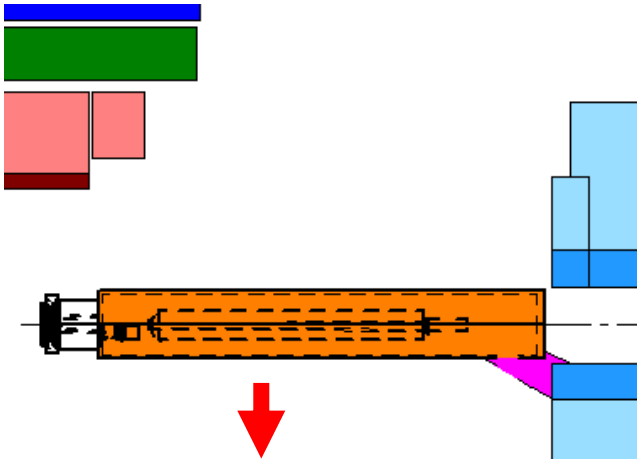
- Upper support tube is lifted by crane.
- Set it to the correct position.

6.

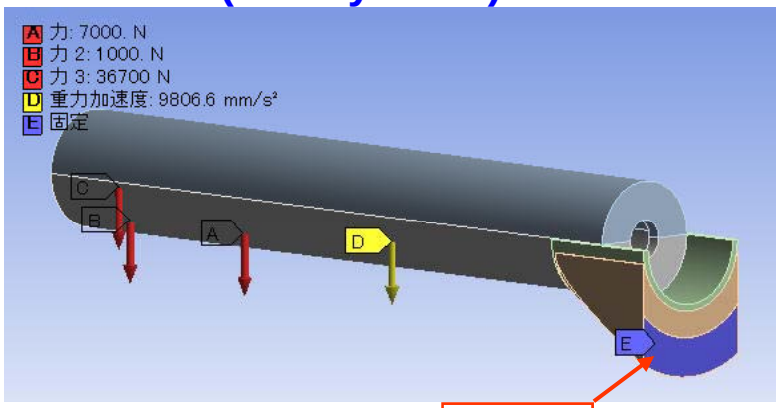


-Remove the temporal scaffold.
-Finished.

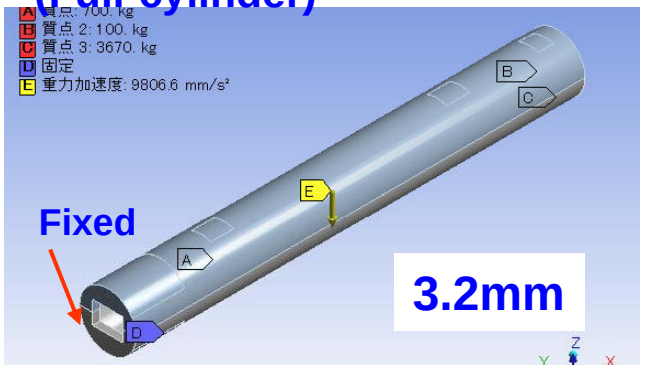
Stiffness at the support position

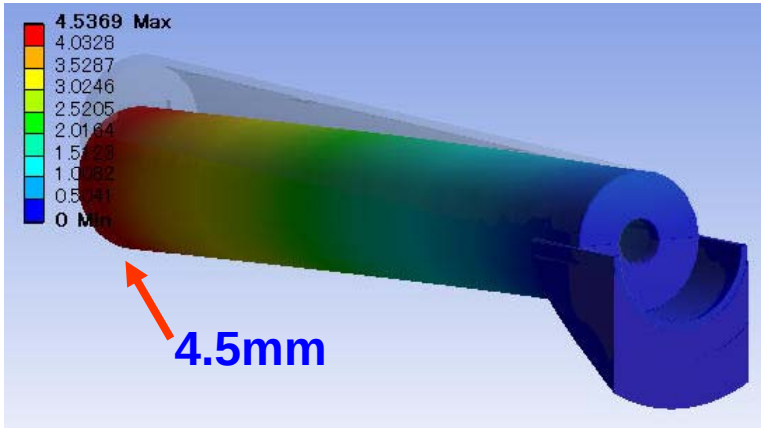


(Full-cylinder)



(Full-cylinder)





➔Deformation is 40% increased.

3.2mm → 4.5mm(Full cylinder)

6.0mm → 8.4mm(Estimation: Bolts connection)

➔There must be some ideas to increase the stiffness at the support position.

Conclusions

	Configuration	Half Cyl.	Full Cyl.	Full + Supp. str	Full with Bolts	Half Cyl.	Full Cyl.	With Ribs	With Ribs
	Material	SUS	SUS	SUS	SUS	Al	Al	SUS	Al
Size	Thickness(mm)	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
	Length(mm)	6000	6000	6000	6000	6000	6000	6000	6000
	Rib size(mm)							75(H)x60(W)	75(H)x60(W)
Load conditions	QD0(kg)	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0
	BeamCAL(kg)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	LHCAL(kg)	3000.0	3000.0	3000.0	3000.0	3000.0	3000.0	3000.0	3000.0
	LumiCAL(kg)	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
	ECAL(kg)	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0
	Self-Weight(kg)	2685.5	5371.0	5371.0	5371.0	960.0	1920.0	4528.3	1597.9
Static analysis	Stress(MPa)	83.4	38.4	--	--	71.2	28.0	53.5	41.2
	Deformation(mm)	19.7	3.2	4.5	6.0	46.9	6.7	8.5	19.5
Natural Frequency	1st mode(Hz)	3.7	9.5	8.0	--	2.3	6.3	5.7	3.7
	2nd	5.7	78.9	62.1	--	3.7	64.9	7.6	4.9
	3rd	20.2	122.5	80.7	--	16.5	91.1	27.5	23.4
Harmonic analysis	Inp. force (N)	2.0E-03	2.0E-03	--	--	2.0E-03	2.0E-03	2.0E-03	2.0E-03
	Amp.(nm)	7.8	2.7	--	--	15.3	3.0	3.1	8.6

- Half-cylinder is too large deformation.
  Support tube should be assembled to full-cylinder.
- Adequate material for the support tube is supposed to be stainless steel.
  Smaller deformation/stress rather than aluminum case.
  CFRP/Tungsten for the support tube is not realistic.
- Amplitude due to the ground motion is a few nm.
  It is necessary to check whether it's acceptable or not.
- Preliminary installation scheme was thought.
  This scheme should be made more realistic.

End