Cryopayload meeting

26th Aug. 2014
Dan Chen

Thermal noise calculation

Thermal noise:

Yu. Levin PRD 1998

$$S_x(f) = \frac{2k_B T}{\pi^2 f^2} \frac{W_{\text{diss}}}{F_0^2},$$

$$W_{\text{diss}} = 2\pi f U_{\text{max}} \phi(f),$$

We can calculate thermal noise from stroed energy "U_max" when we apply a "Levin force" on the mirror.

Levin force:

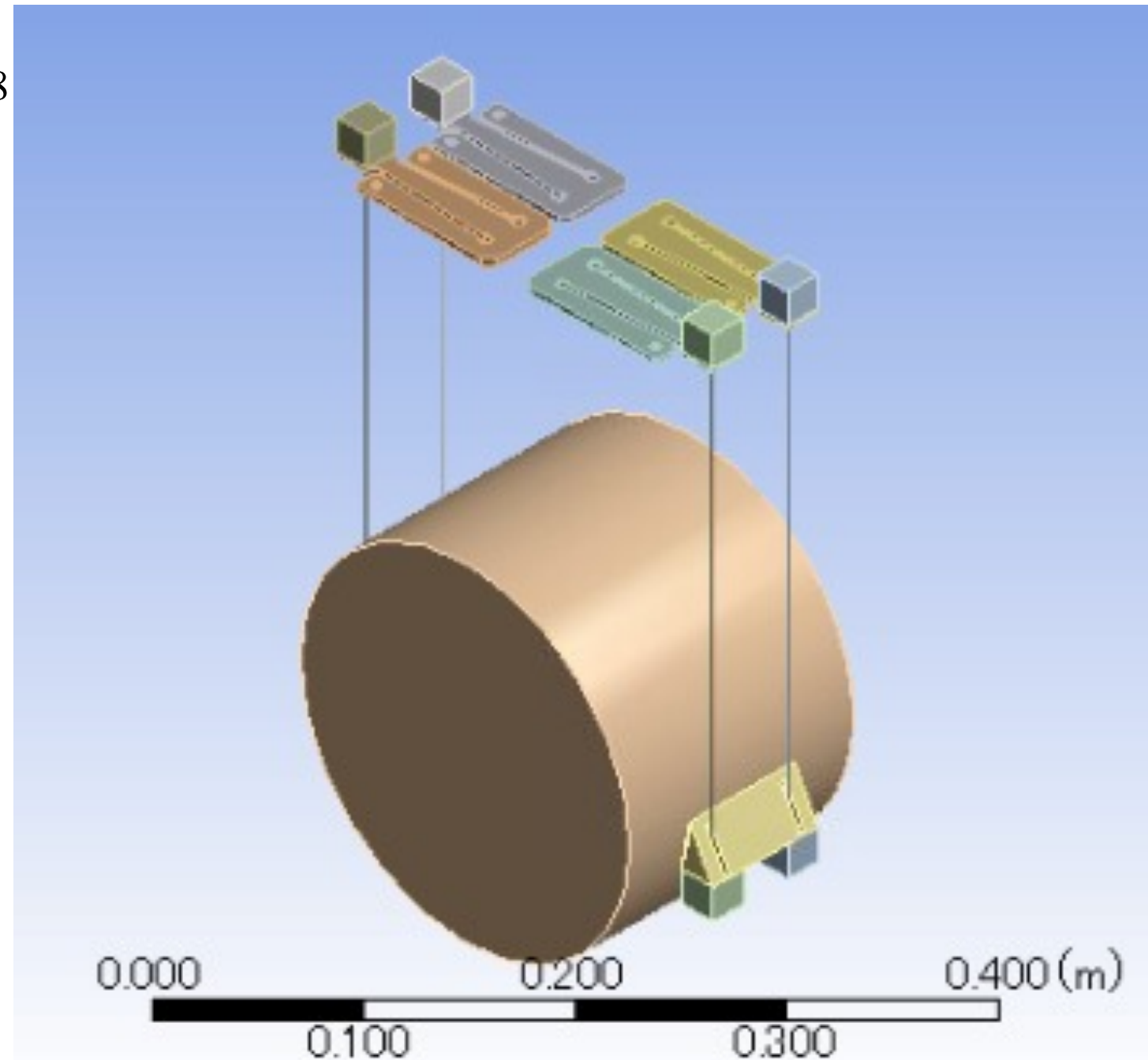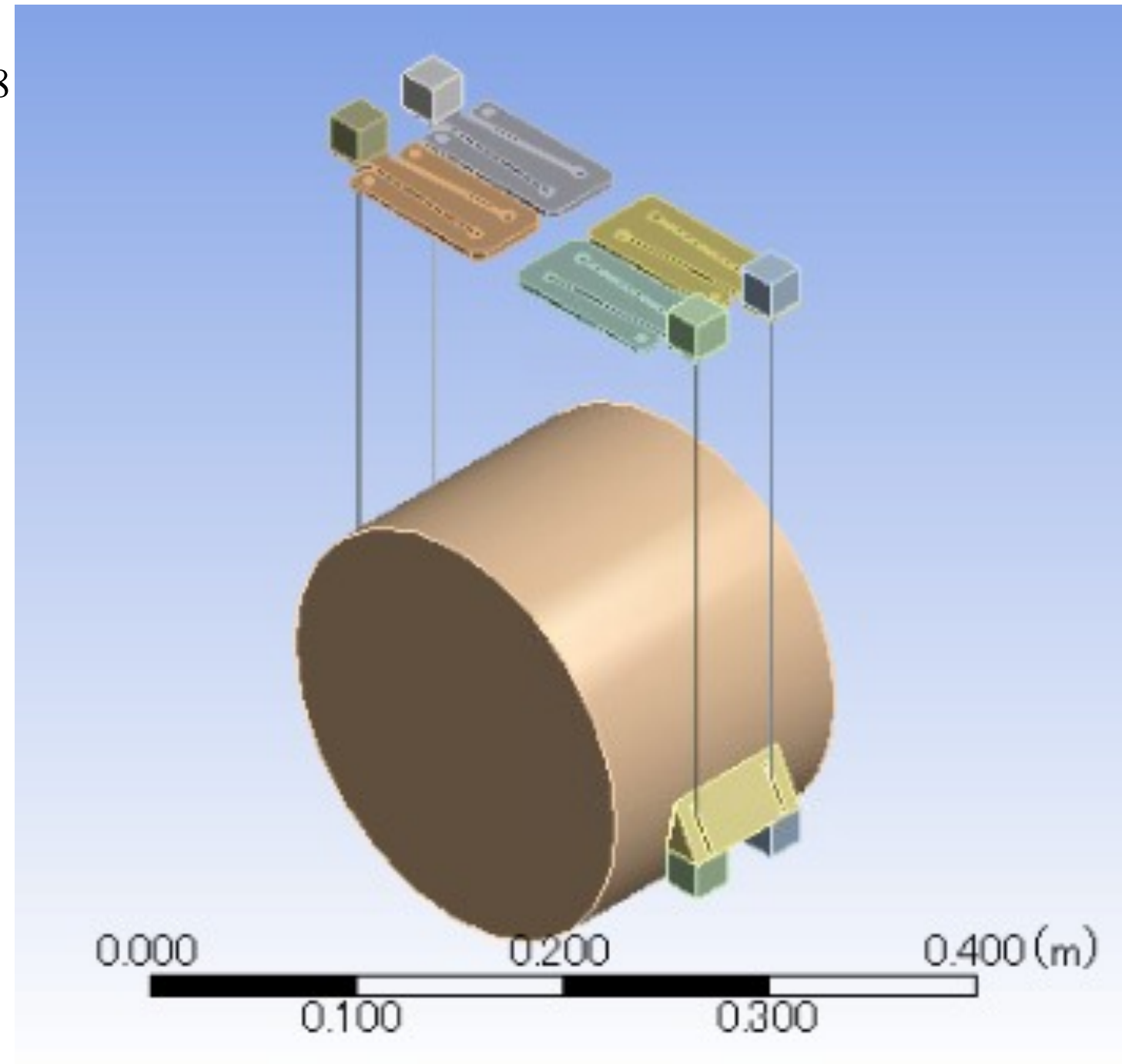$$F_L = \frac{2a}{\pi w_0^2} \exp\left(-\frac{2r^2}{w_0^2}\right)$$

a=1.0, w_0=0.035

Loss
Sapphire fiber: 1.0919e-7 measured at Roma
Sapphire bulk: 4.0e-9 measured by Uchiyama-san

Thermal noise calculation
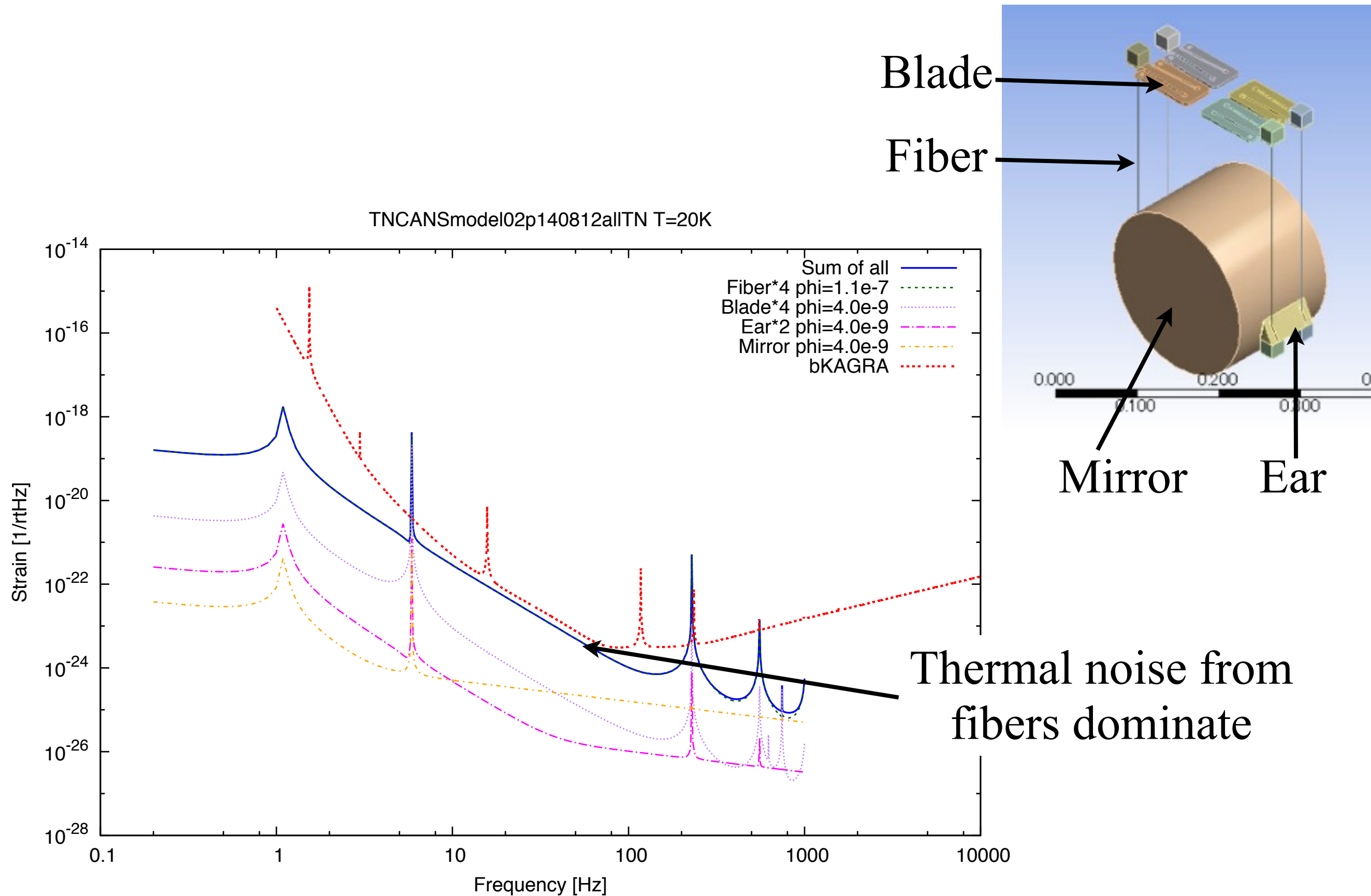
Thermal noise:

Yu. Levin PRD 1998

$$S_x(f) = \frac{2k_B T}{\pi^2 f^2} \frac{W_{diss}}{F_0^2},$$
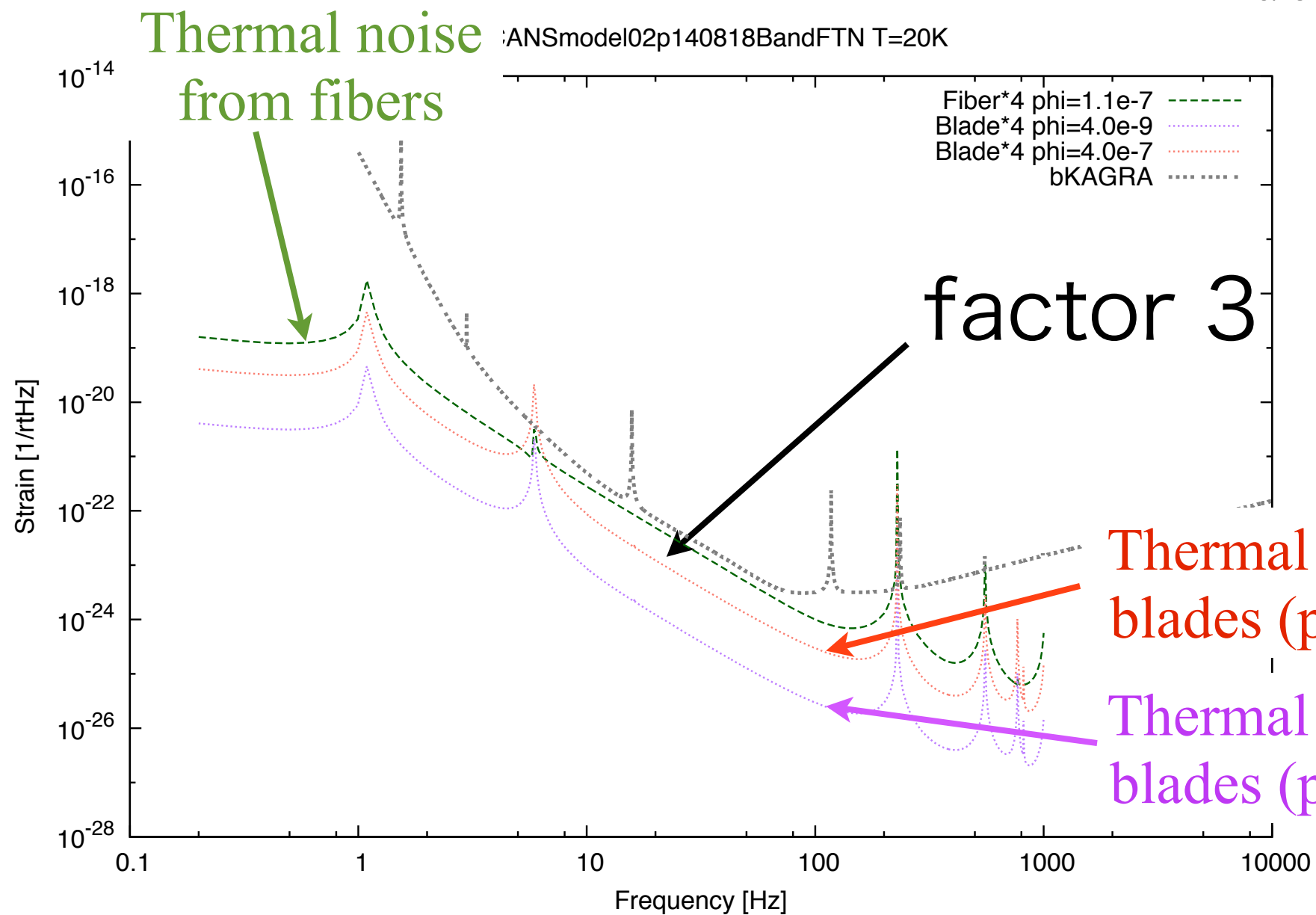
$$W_{diss} = 2\pi f U_{max} \phi(f),$$

If we can calculated U_max for each part, we can extimate the contribution from each part.

Thermal noise calculation

TNCANSmodel02p140812allTN T=20K

Legend:
- Sum of all
- Fiber*4 phi=1.1e-7
- Blade*4 phi=4.0e-9
- Ear*2 phi=4.0e-9
- Mirror phi=4.0e-9
- bKAGRA

Blade
Fiber
Mirror
Ear

Thermal noise from fibers dominate

Thermal noise calculation
Requirement for blades

Blade

Thermal noise from fibers

factor 3

Thermal noise from blades (phi=4.0e-7)

Thermal noise from blades (phi=4.0e-9)

Requirement for loss of blades: phi=4.0e-7 (?)

We need to decide saftly factor
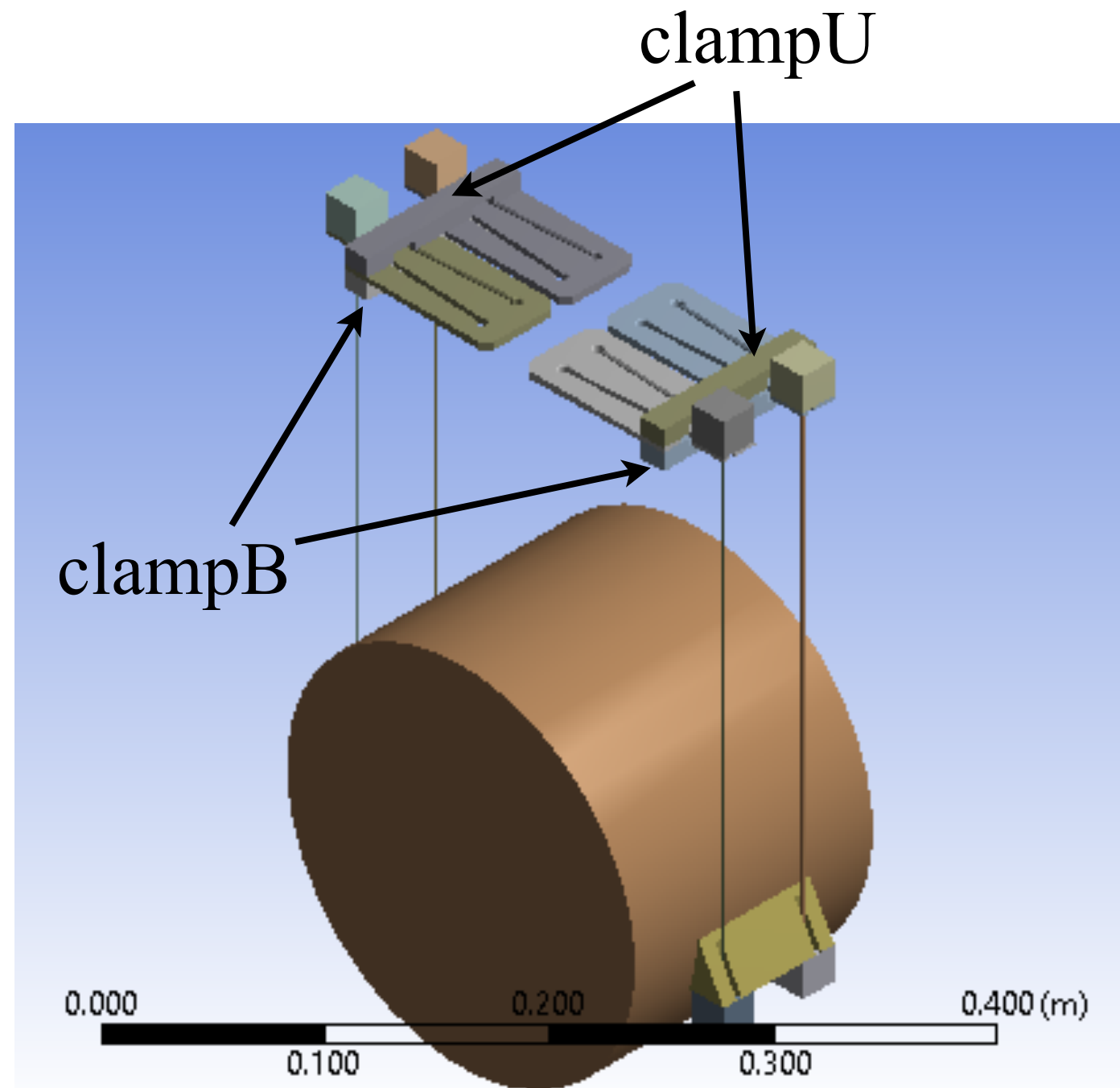
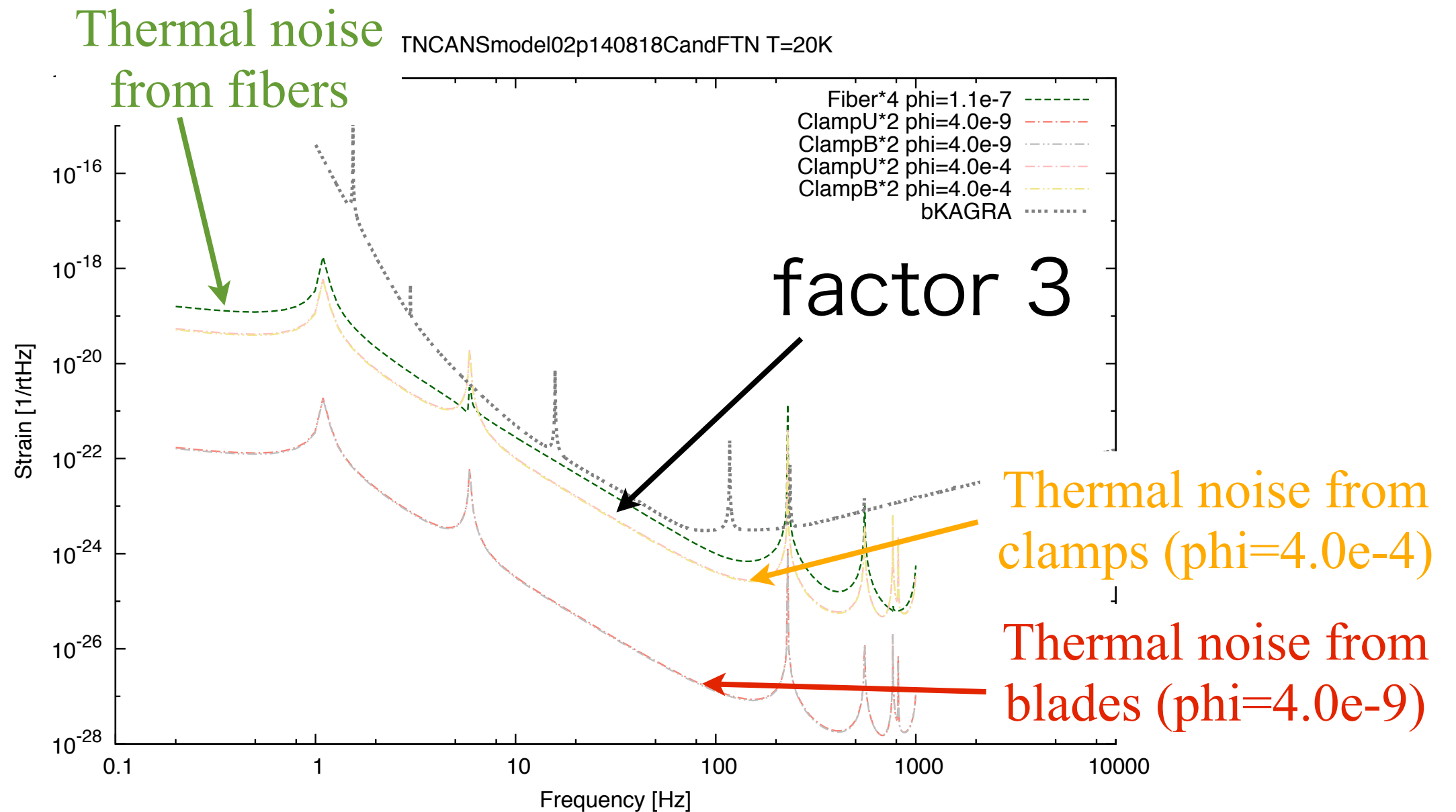# Thermal noise calculation with clamp

Thermal noise:

Yu. Levin PRD 1998

$$S_x(f) = \frac{2k_B T}{\pi^2 f^2} \frac{W_{\text{diss}}}{F_0^2},$$

$$W_{\text{diss}} = 2\pi f U_{\text{max}} \phi(f),$$

I added clamps made of sapphire for blades to calculate the thermal noise contribution.
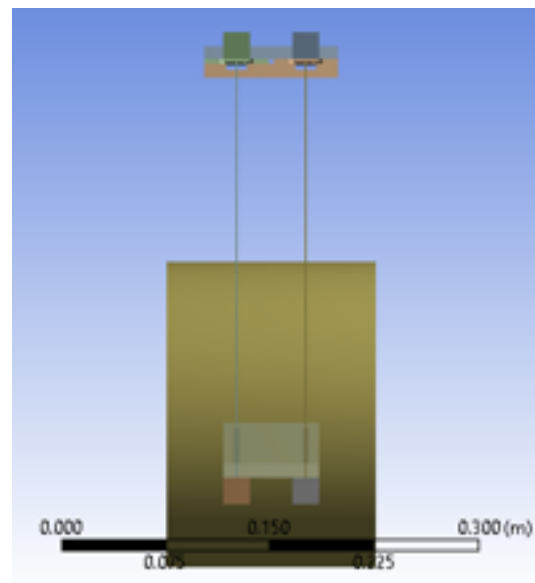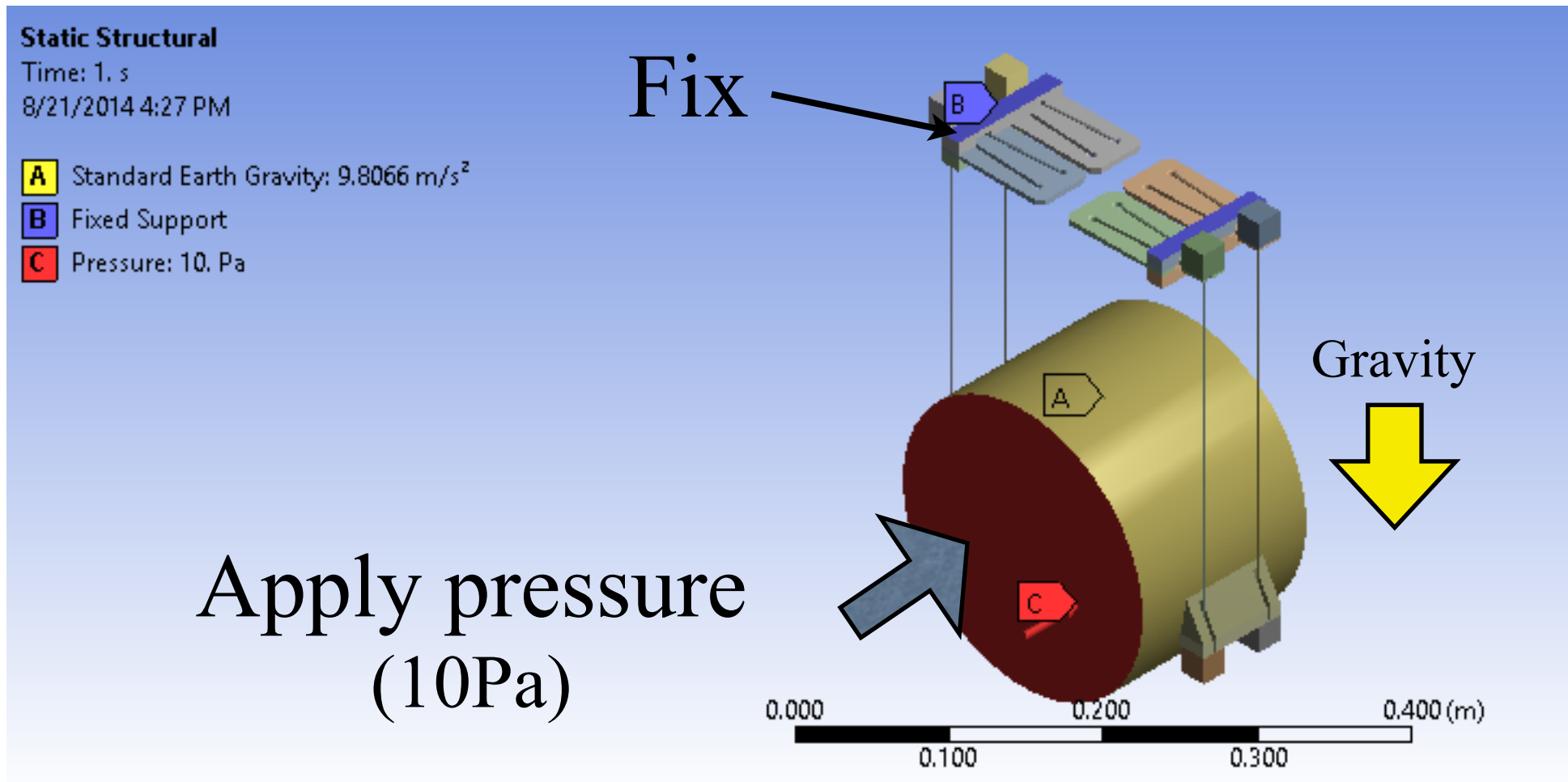
clampU

clampB

Thermal noise calculation with clamp

I used Y of sapphire for the clamps.
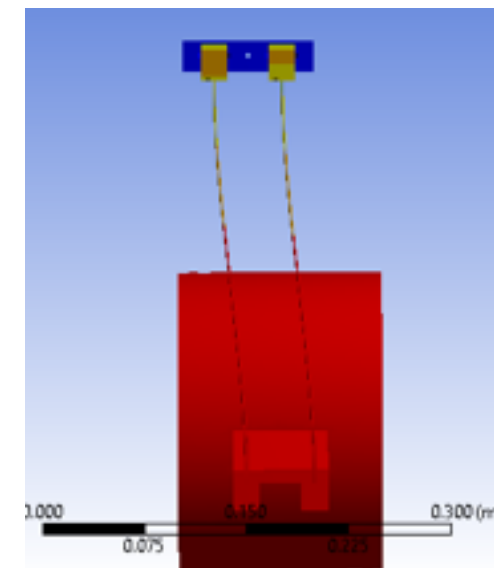
Requirement for loss of clamps: phi=4.0e-4 (?)

We need to decide saftly factor

Bending length calculation
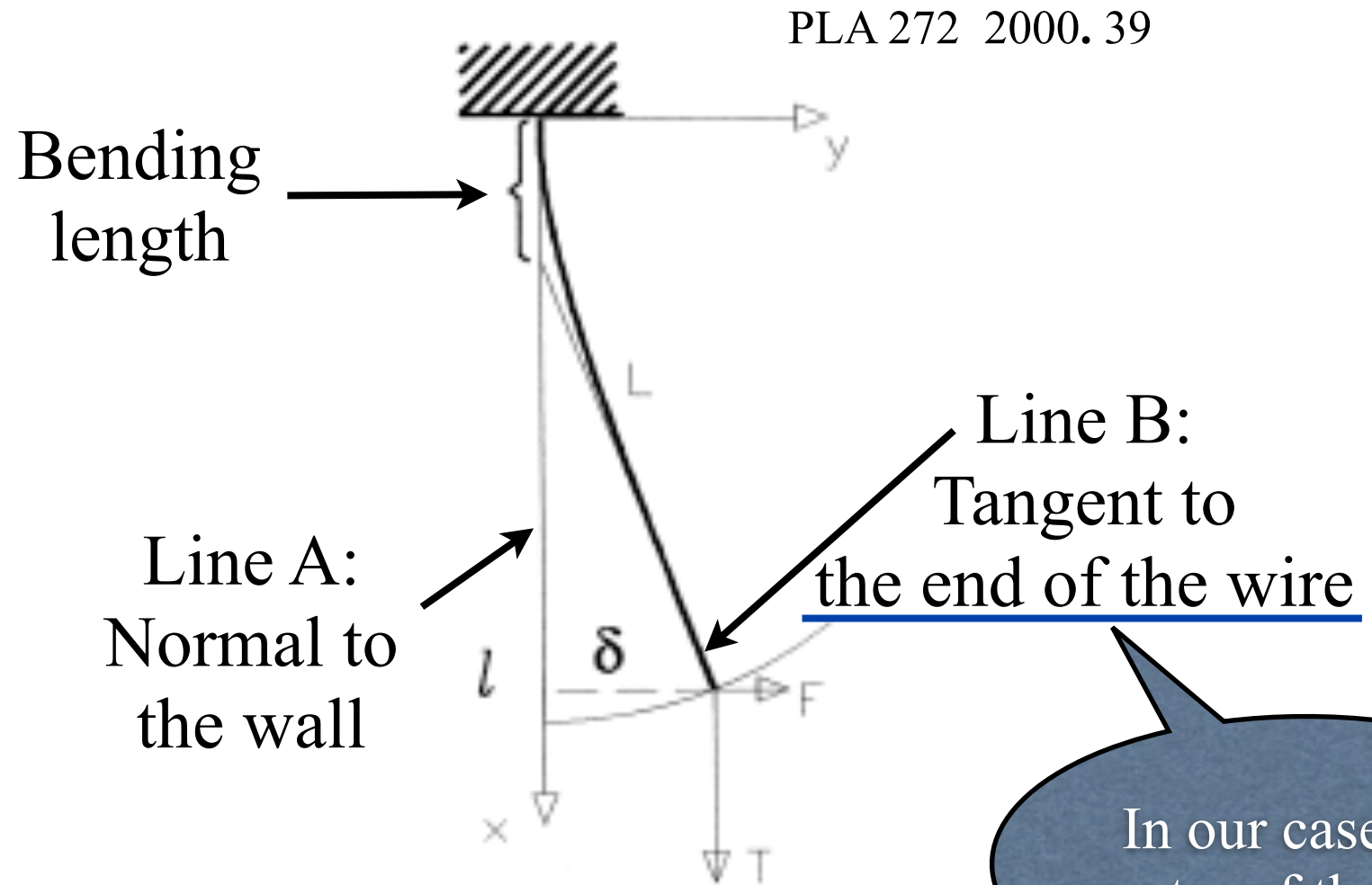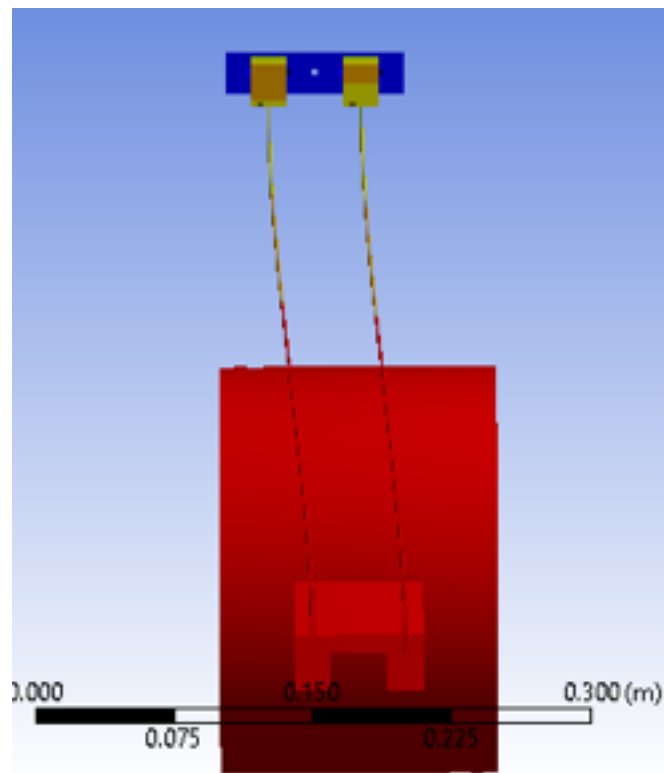
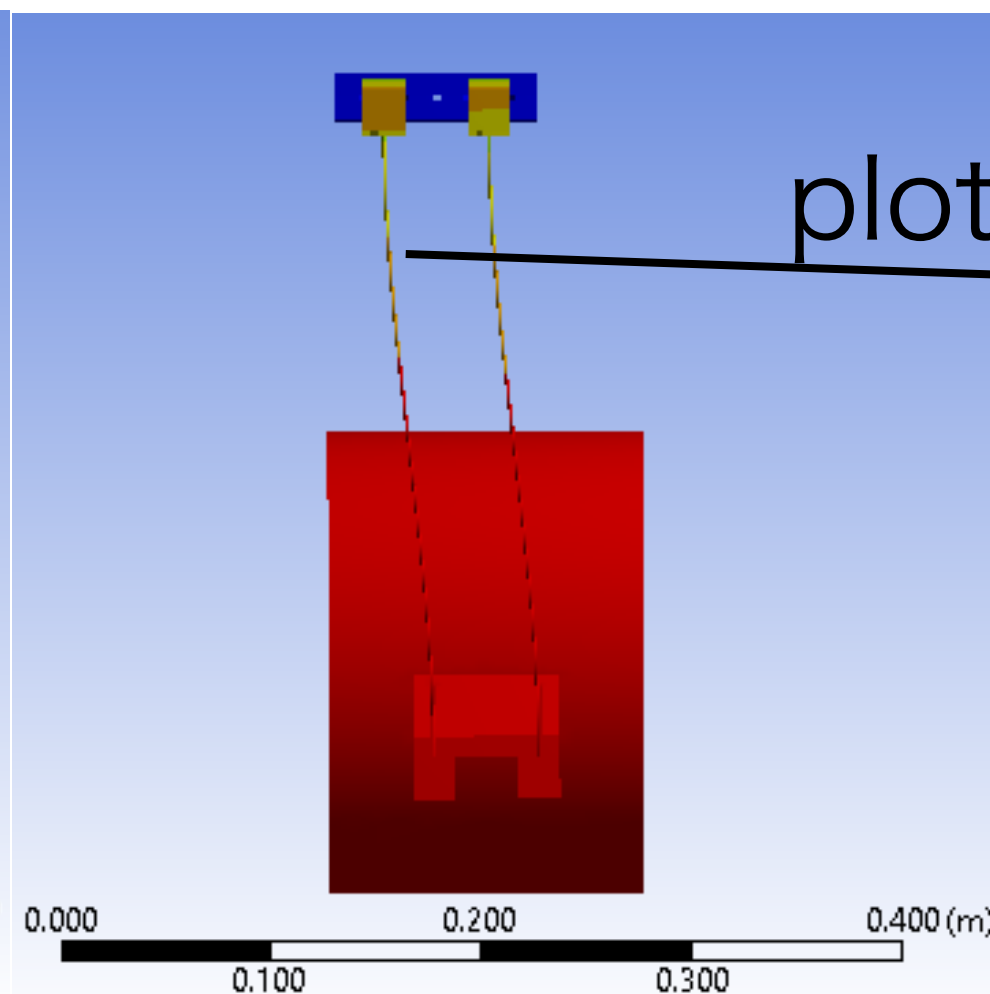# Bending length calc by ANSYS

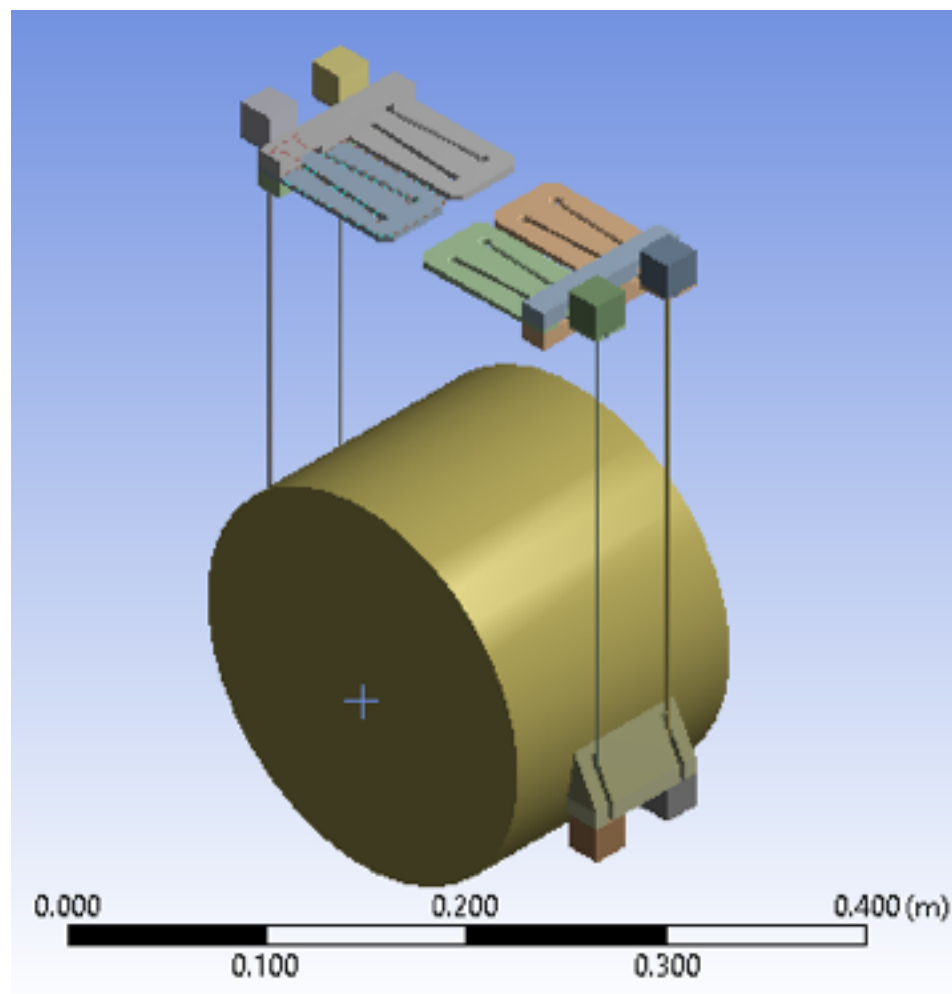## Let's define the bending length.
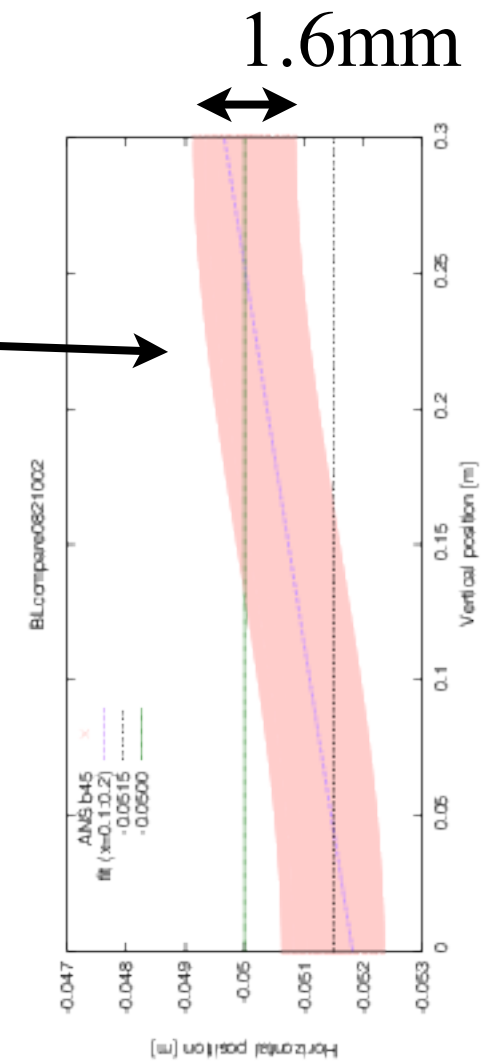

Bending length:
The distance between the wall and the cross point of line A and B

Bending length calc by ANSYS

Result (b=45mm)

1.6mm
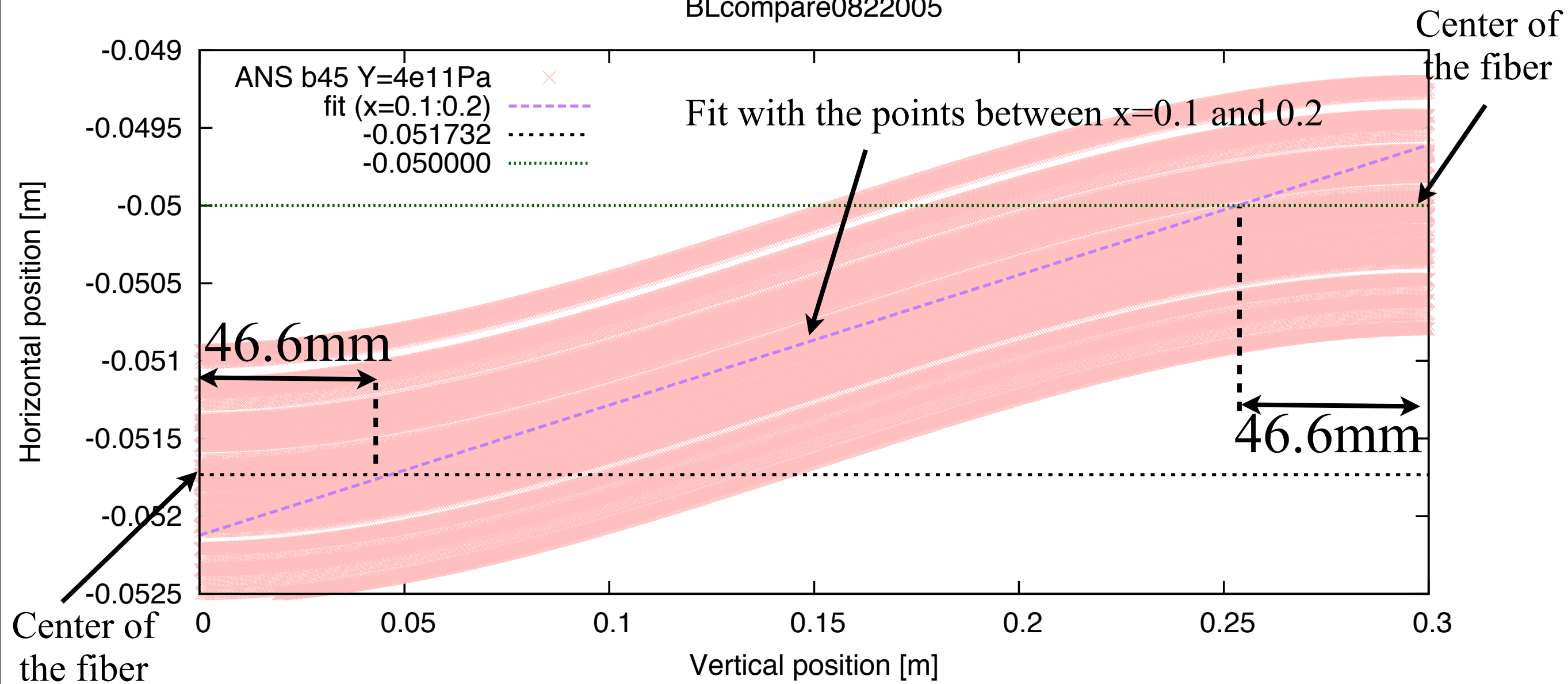
plot

Bending length calc by ANSYS

Result (b=45mm, **Y=400GPa**)

BLcompare0822005

Center of the fiber

Fit with the points between x=0.1 and 0.2

46.6mm

46.6mm

Center of the fiber

Bending length: 47mm