

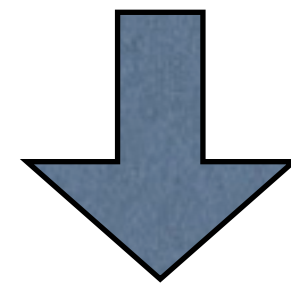
Cryopayload meeting

5th Aug. 2014

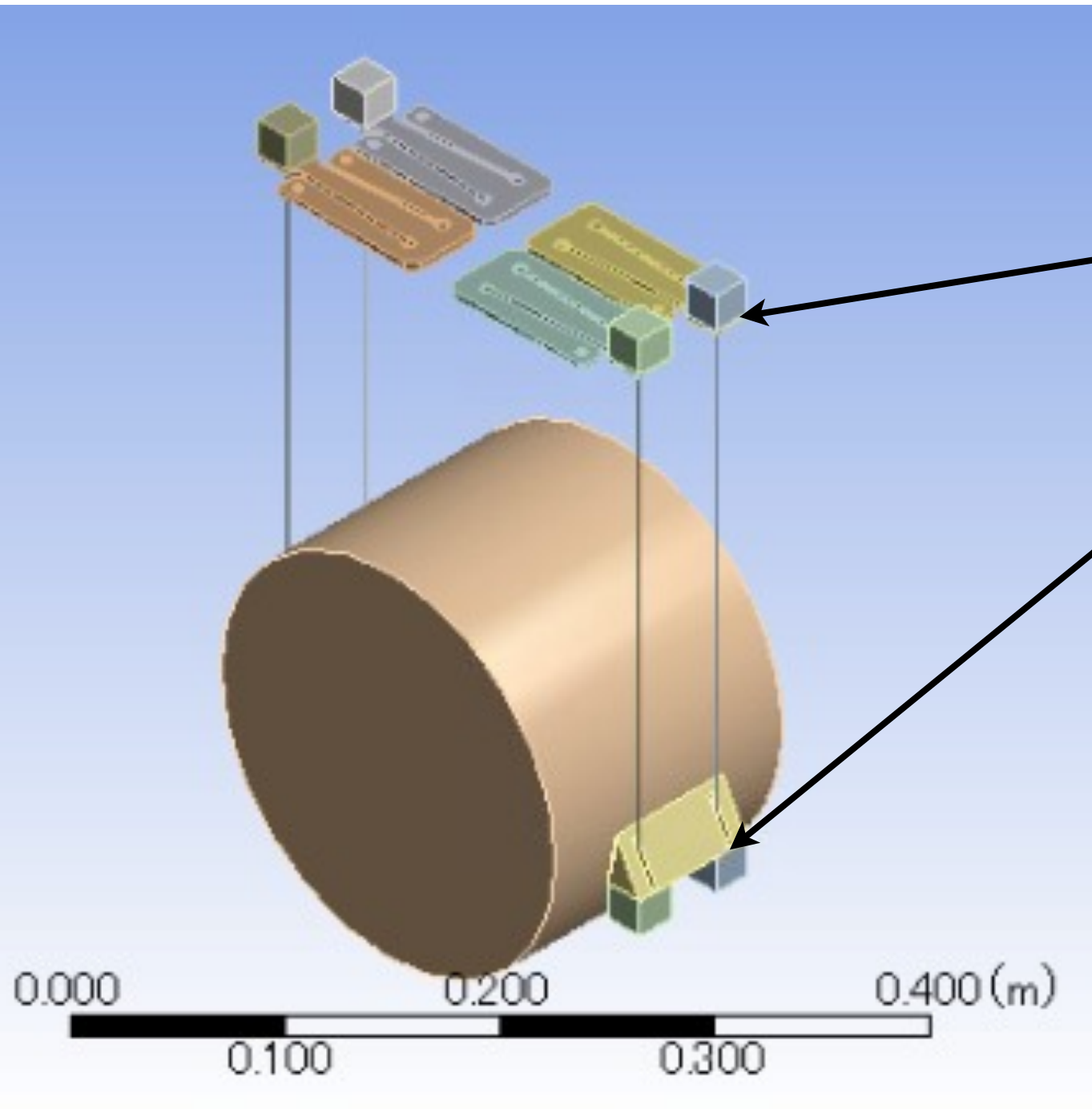
Dan Chen

Mechanical loss measurement of indium bonding

Our current plan is applying indium bondings here

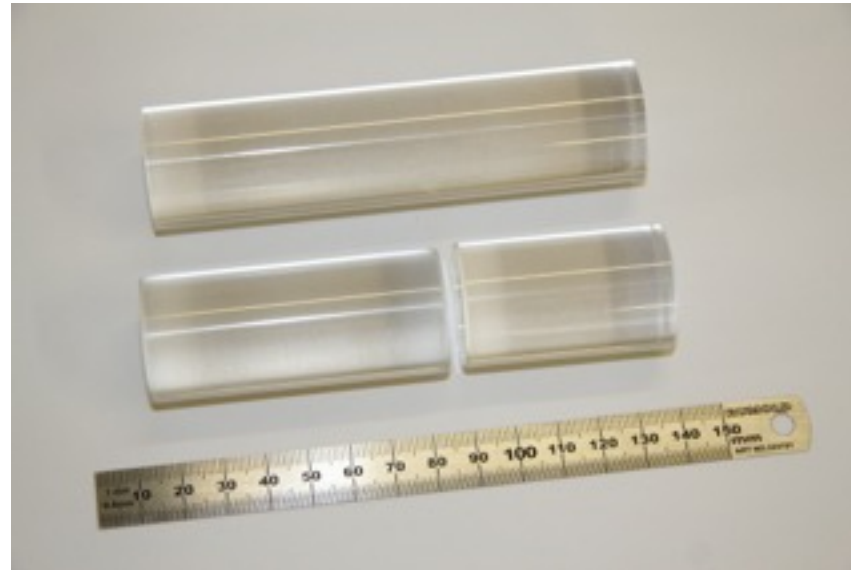


Loss of indium bonding should be measured to estimate the influence on the KAGRA sensitivity.



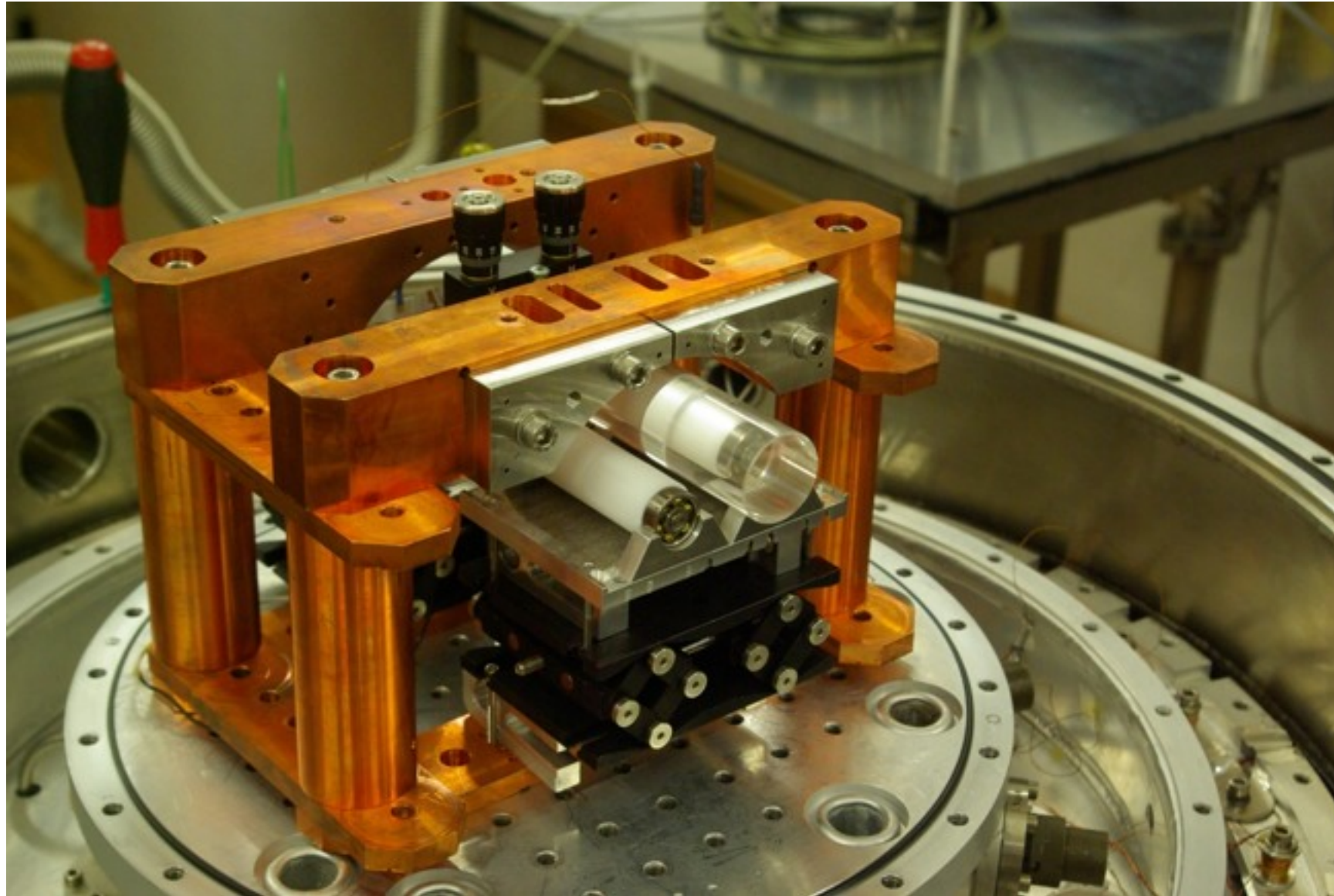
Bonding setting

Weight on the bond:
 $582+964+197=$
1743g

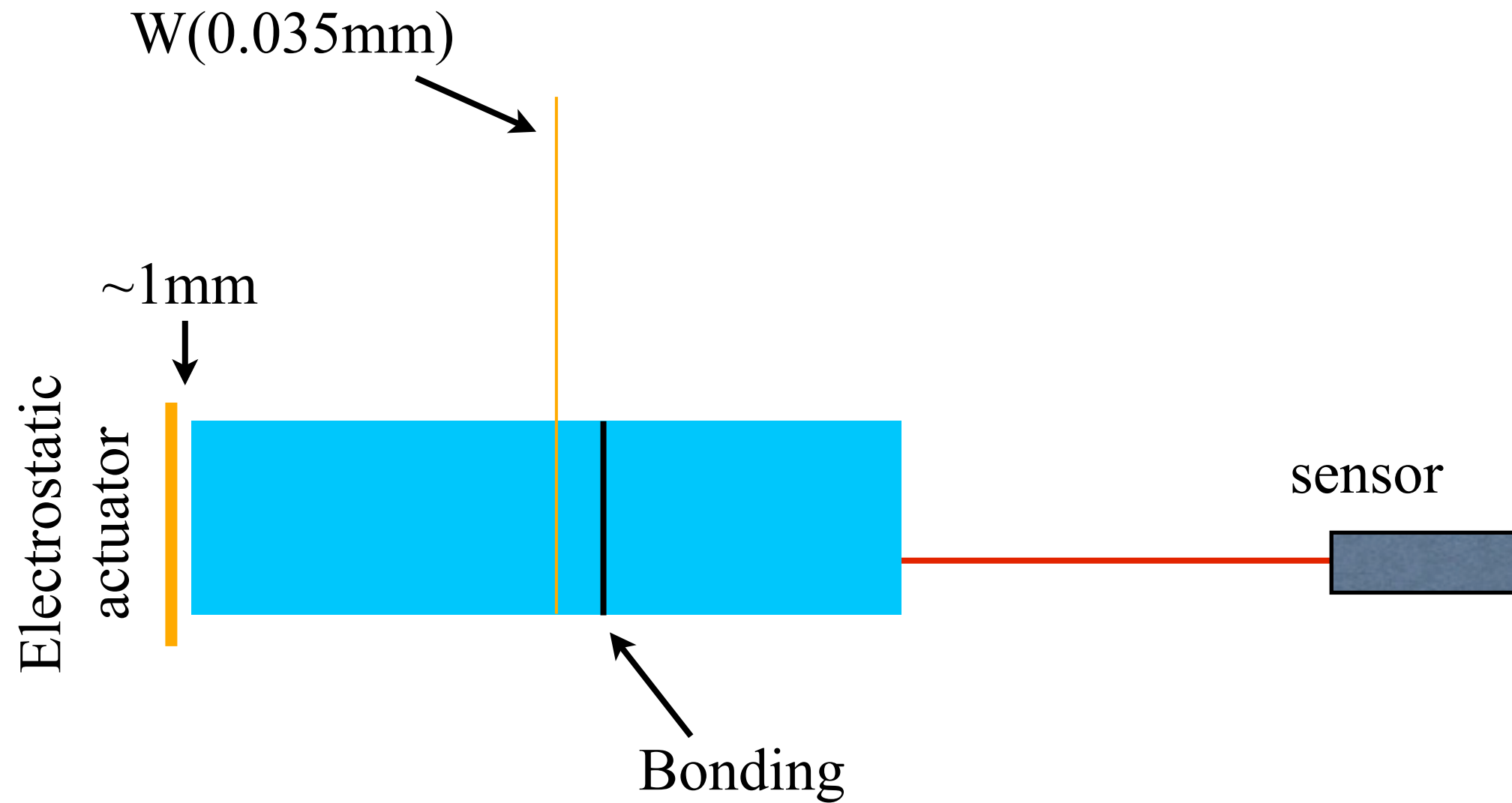


$T_{\text{set}}=200^{\circ}\text{C}$
 $T_{\text{bon}}\sim 170^{\circ}\text{C}$
(Time=3hours)

Measurement setup

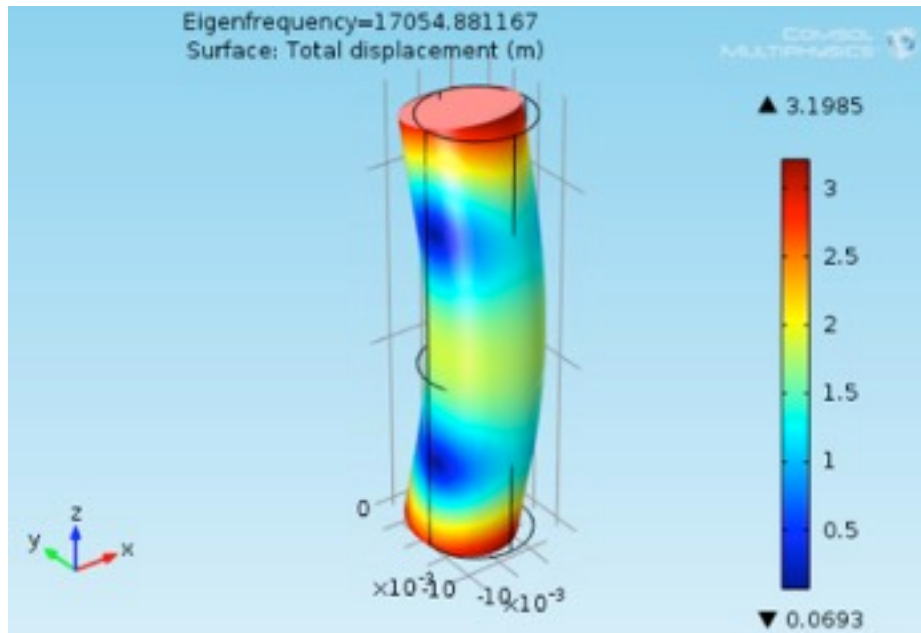


Measurement setup

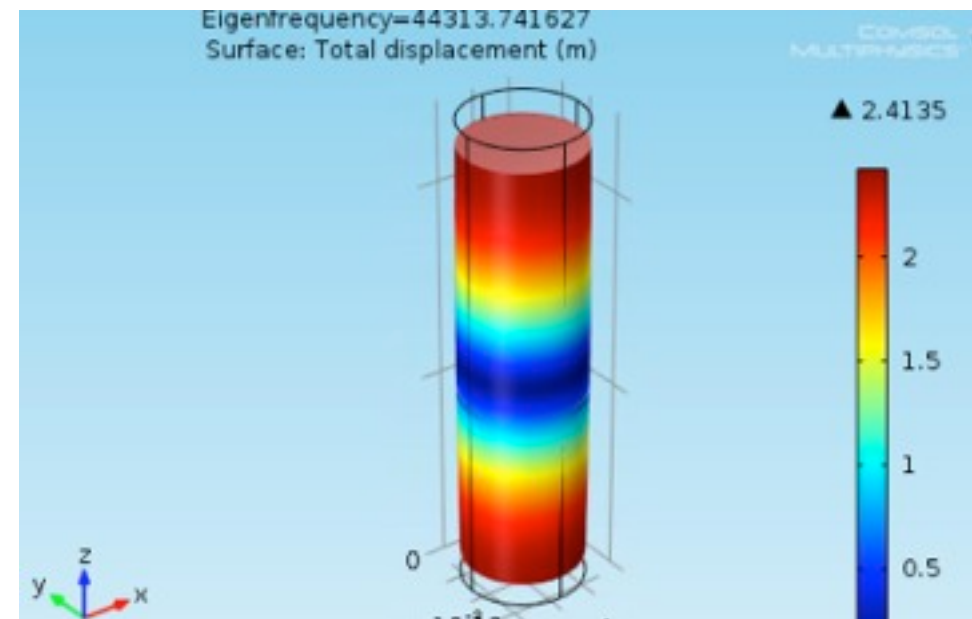


$$L = 70 + 50 = 120\text{mm} \quad \phi = 30\text{mm}$$

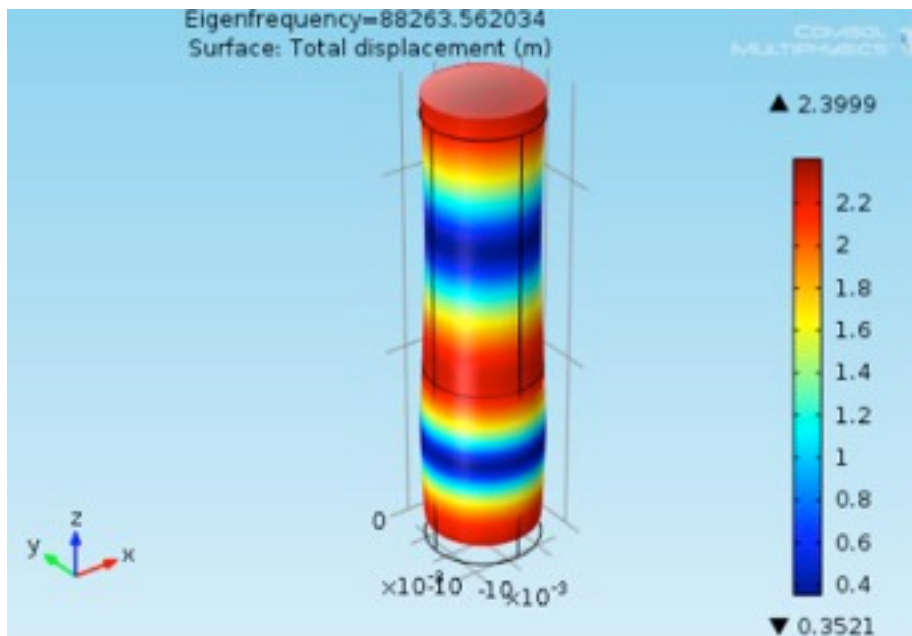
Resonant frequency



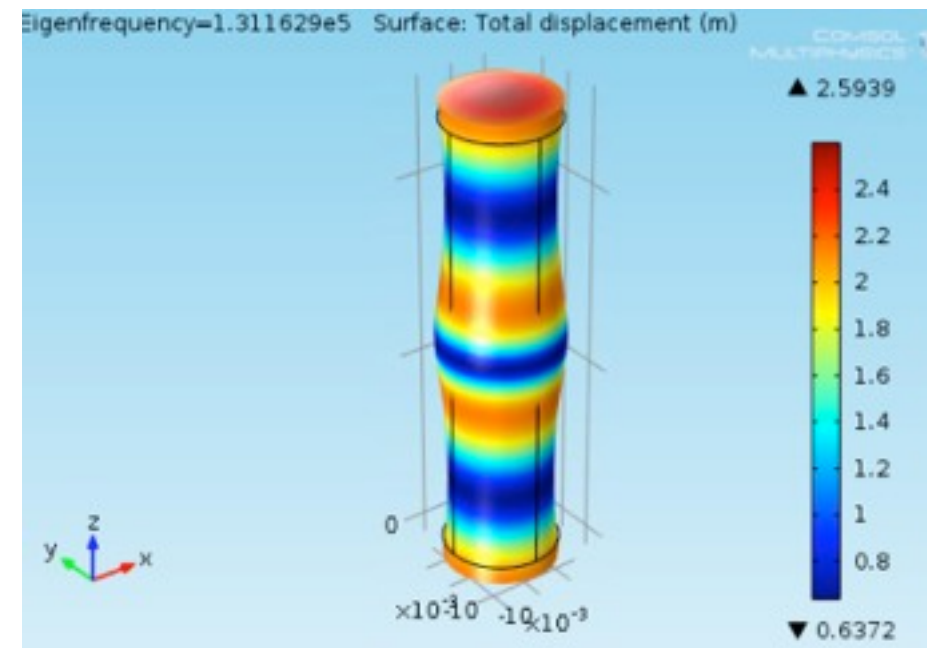
Mode1 = 17kHz



Mode3 = 44kHz

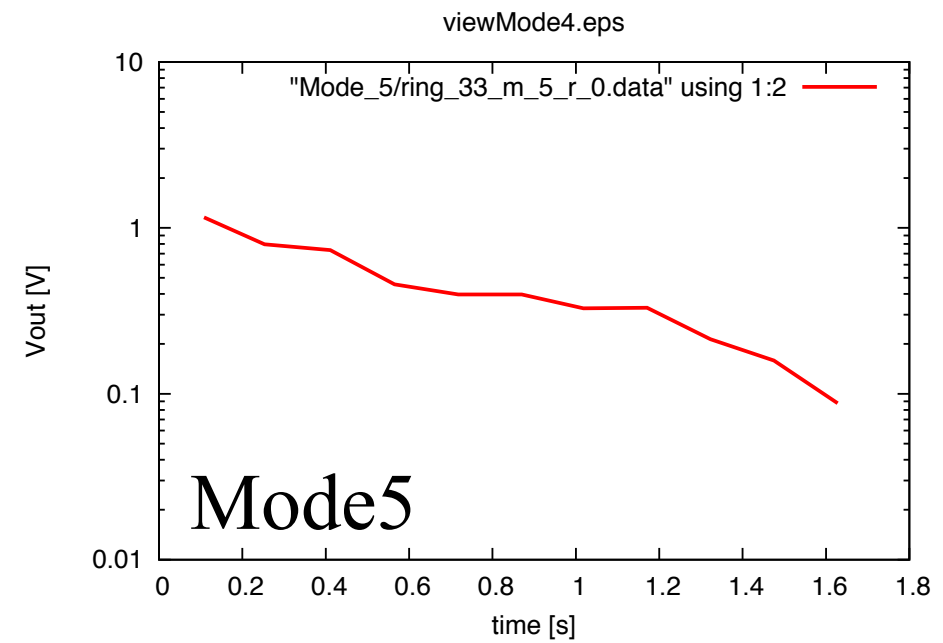
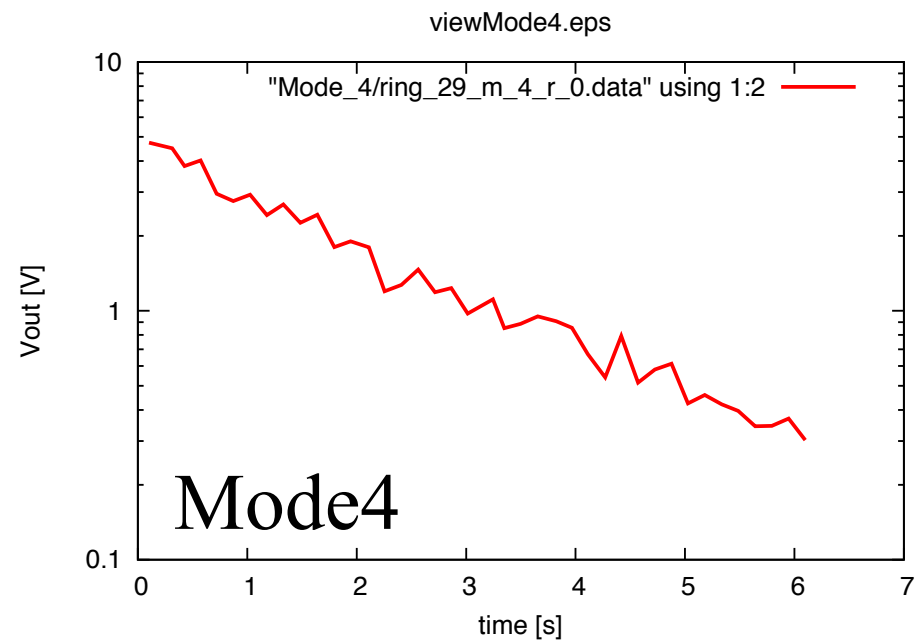
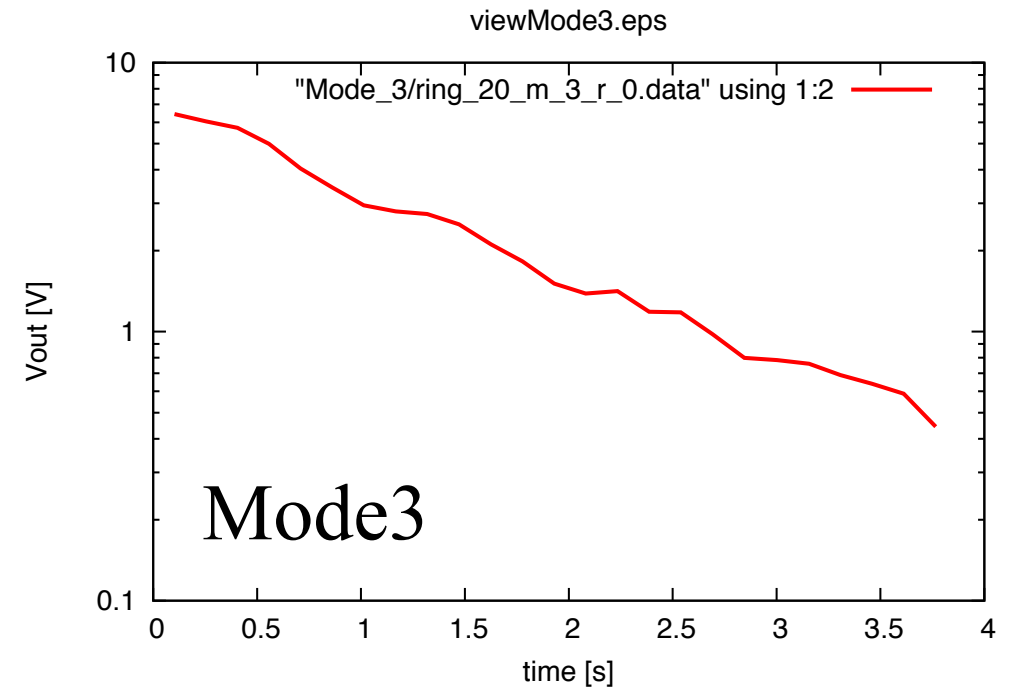
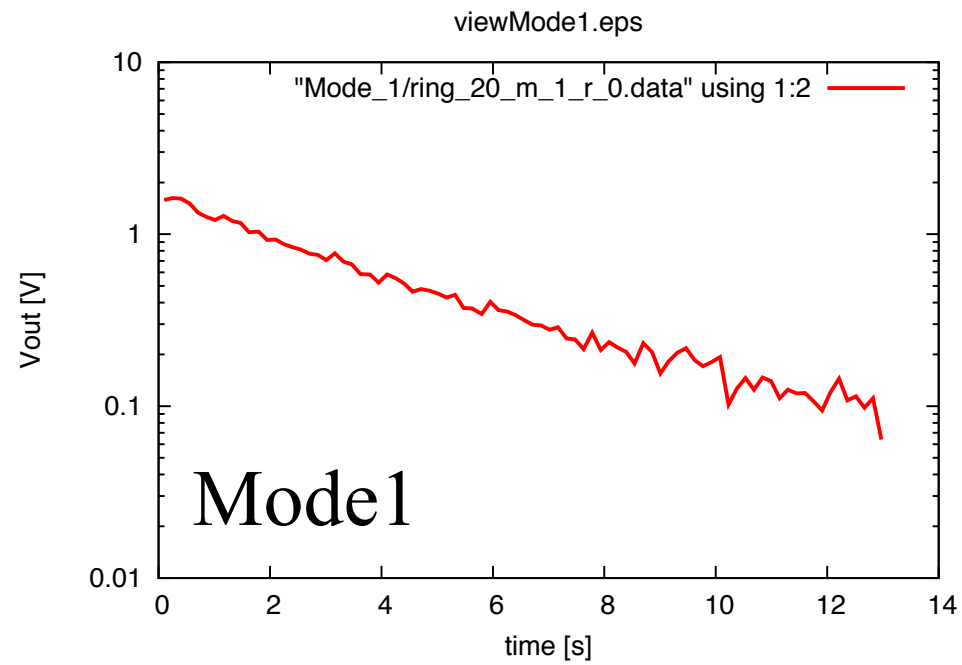


Mode4 = 89kHz



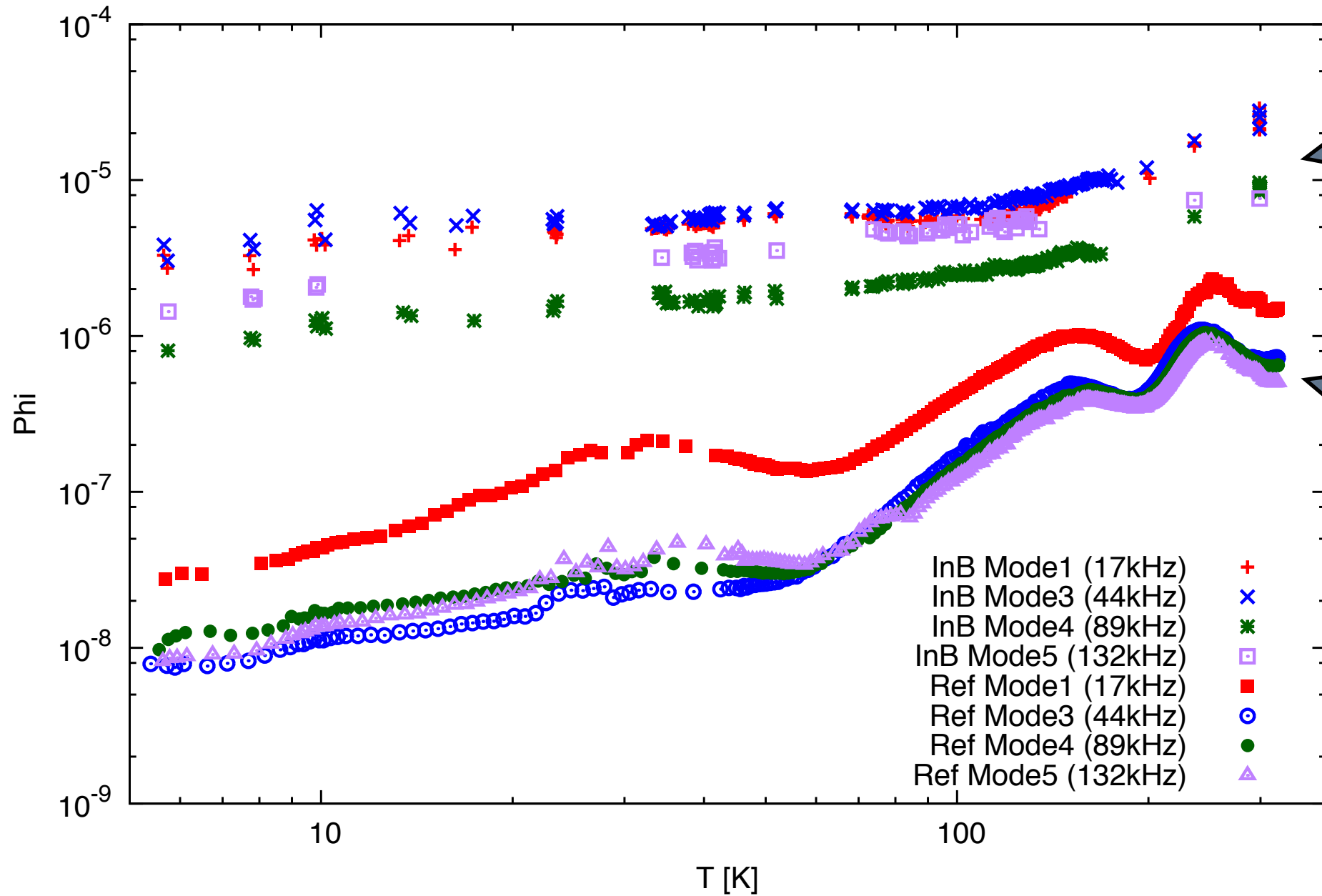
Mode5 = 132kHz

Typical decay curve



Measurement result

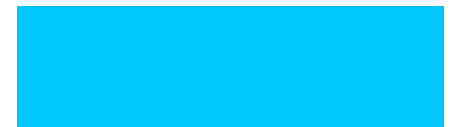
InBLoss005.eps (t=6um, bonded ample using an In sheet)



Bonded sample

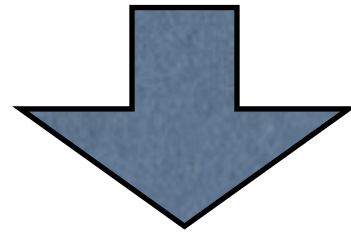


Reference sample



How to estimate loss of bond?

$$\frac{E_B}{E_{tot}} \ll 1 \quad \frac{\phi_{sub}}{\phi_{meas}} \ll 1$$



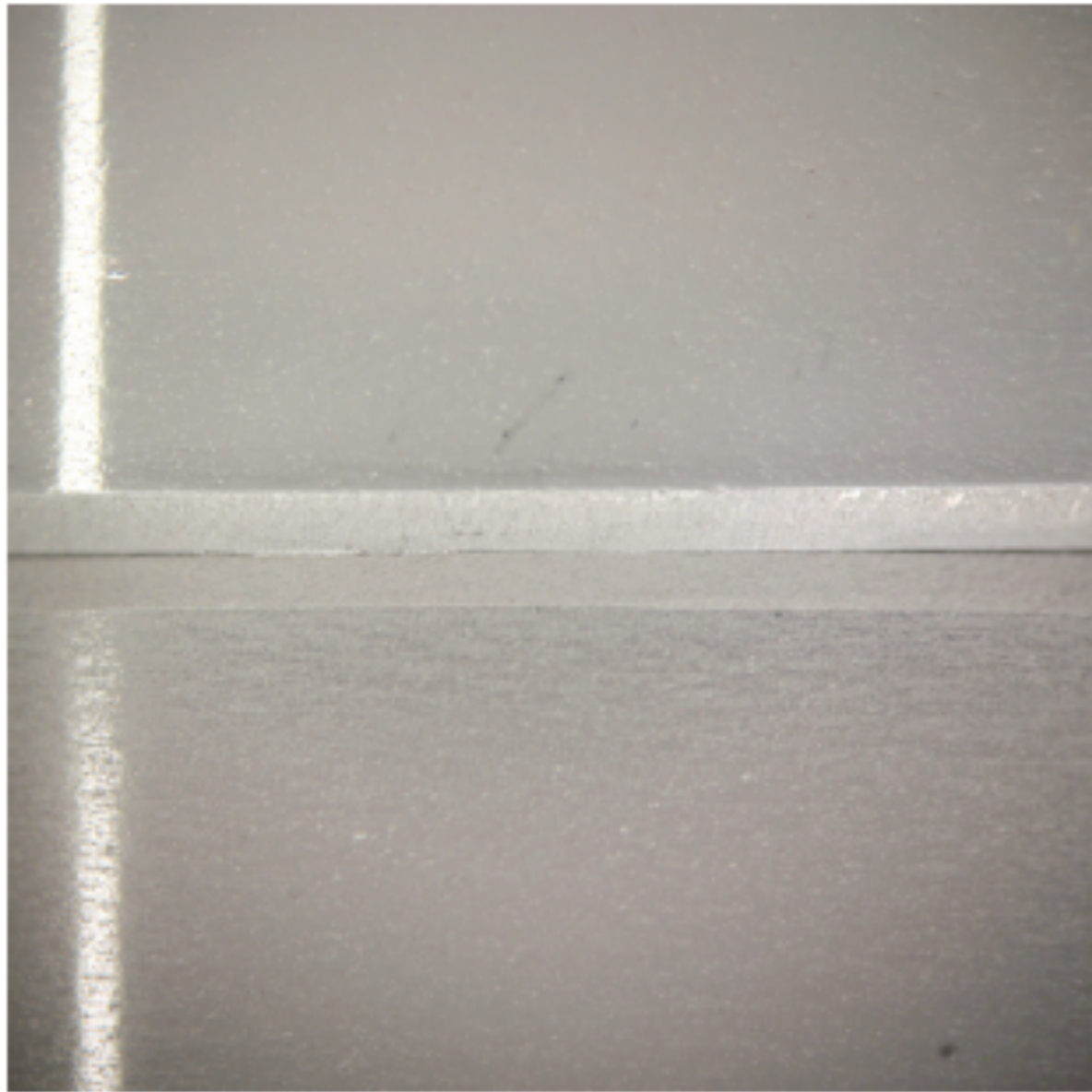
$$\phi_B \simeq \frac{E_{tot}}{E_B} \phi_{meas}$$



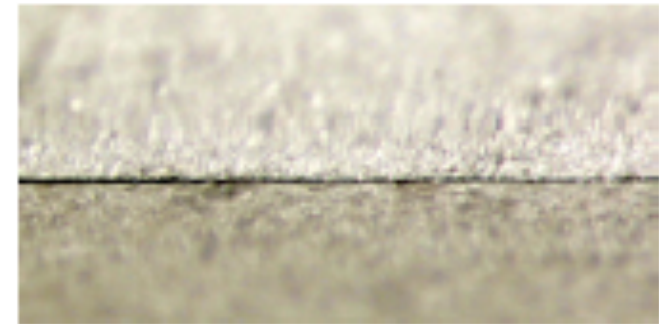
We used COMSOL to calculate this ratio

Thickness of the indium bond

We saw the bonding by a microscope



(a)



(b)



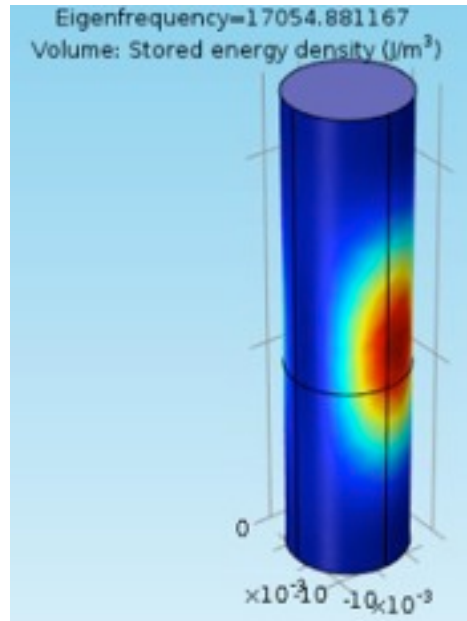
(c)

$t \sim 6 \mu\text{m}$

Energy ratio between sapphire bulk and indium bonding(t=6um)

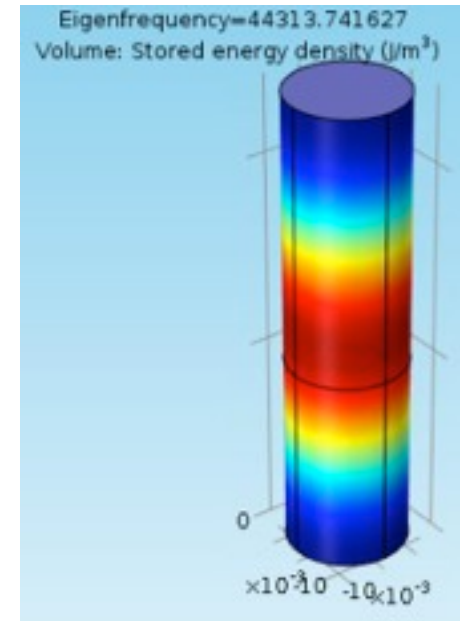
We assumed the bonding surface is covered by indium fully.

$$\frac{E_b}{E_{tot}} = 1.15e-3$$



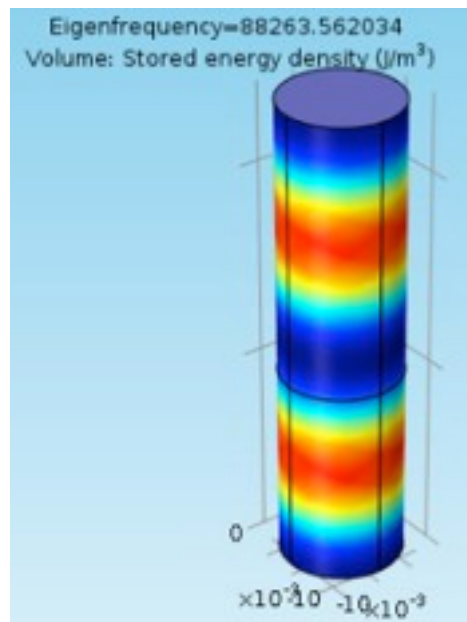
Mode1 = 17kHz

$$\frac{E_b}{E_{tot}} = 1.01e-3$$



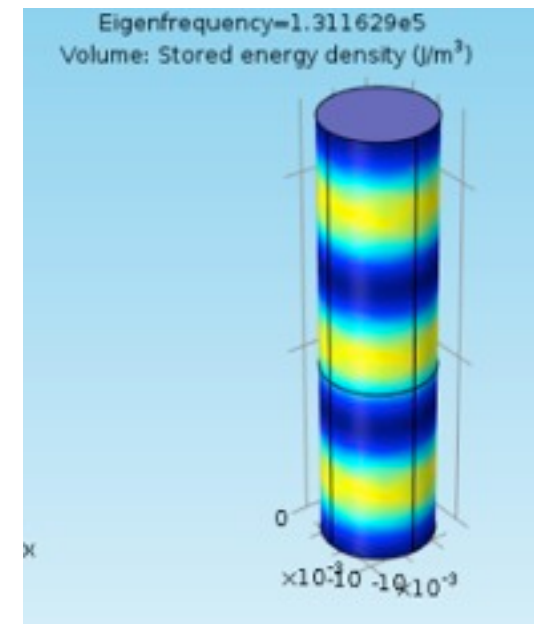
Mode3 = 44kHz

$$\frac{E_b}{E_{tot}} = 2.69e-4$$



Mode4 = 89kHz

$$\frac{E_b}{E_{tot}} = 5.22e-4$$

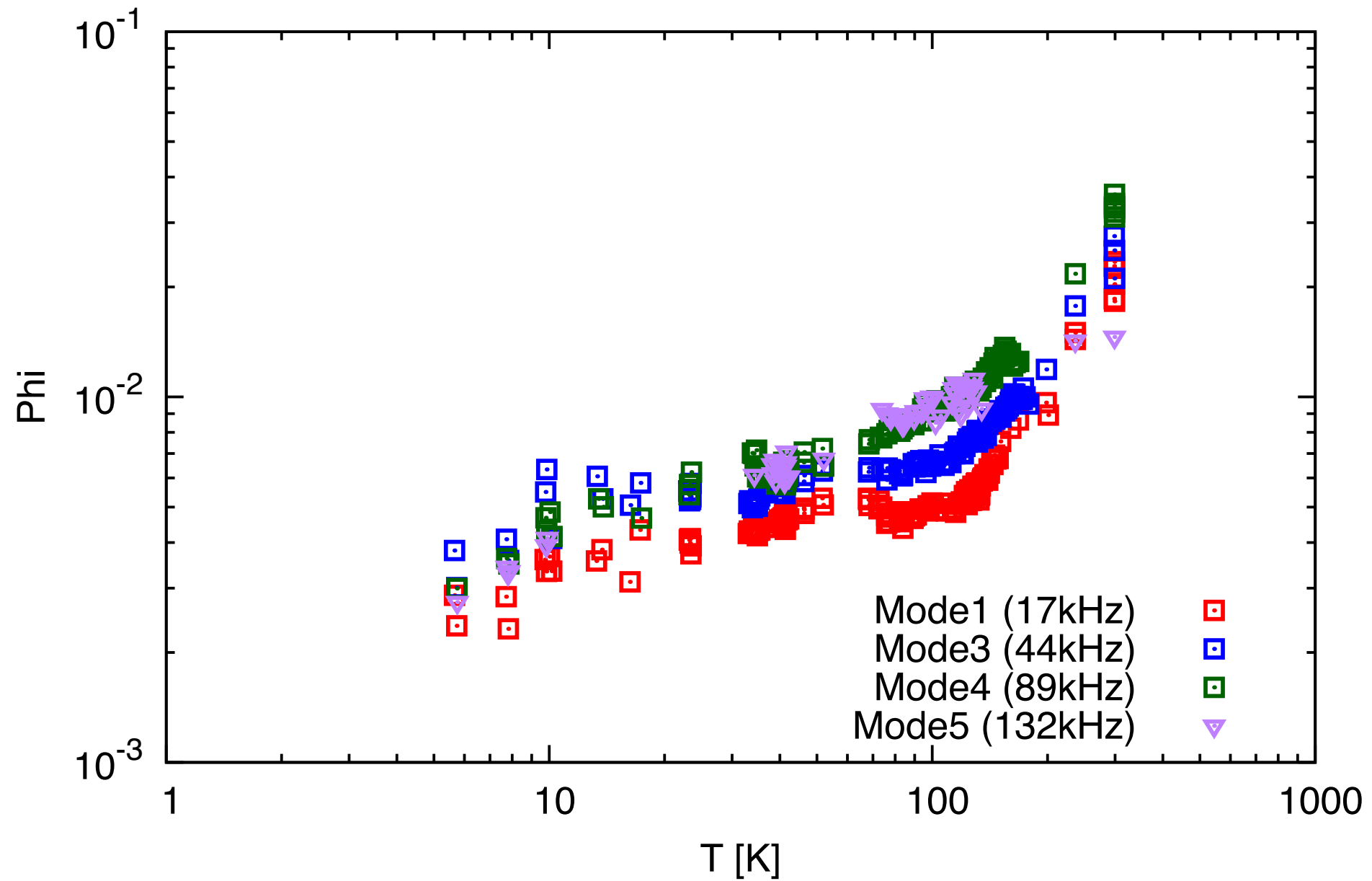


Mode5 = 132kHz

Loss of bonding

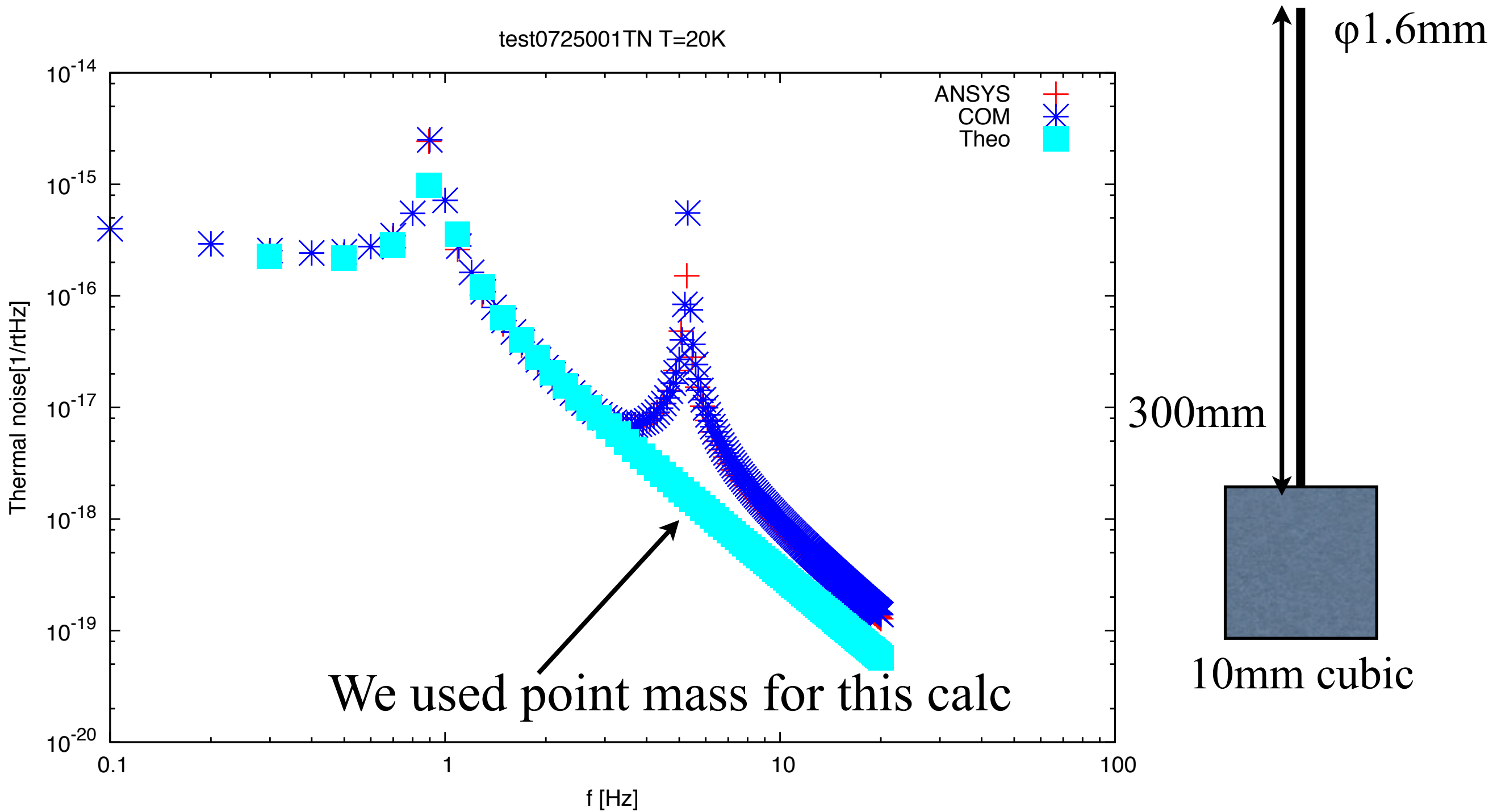
Bonding thickness = 6 μ m

InBLoss006.eps (t=6 μ m, loss of indium bonding)



Thermal noise calculation

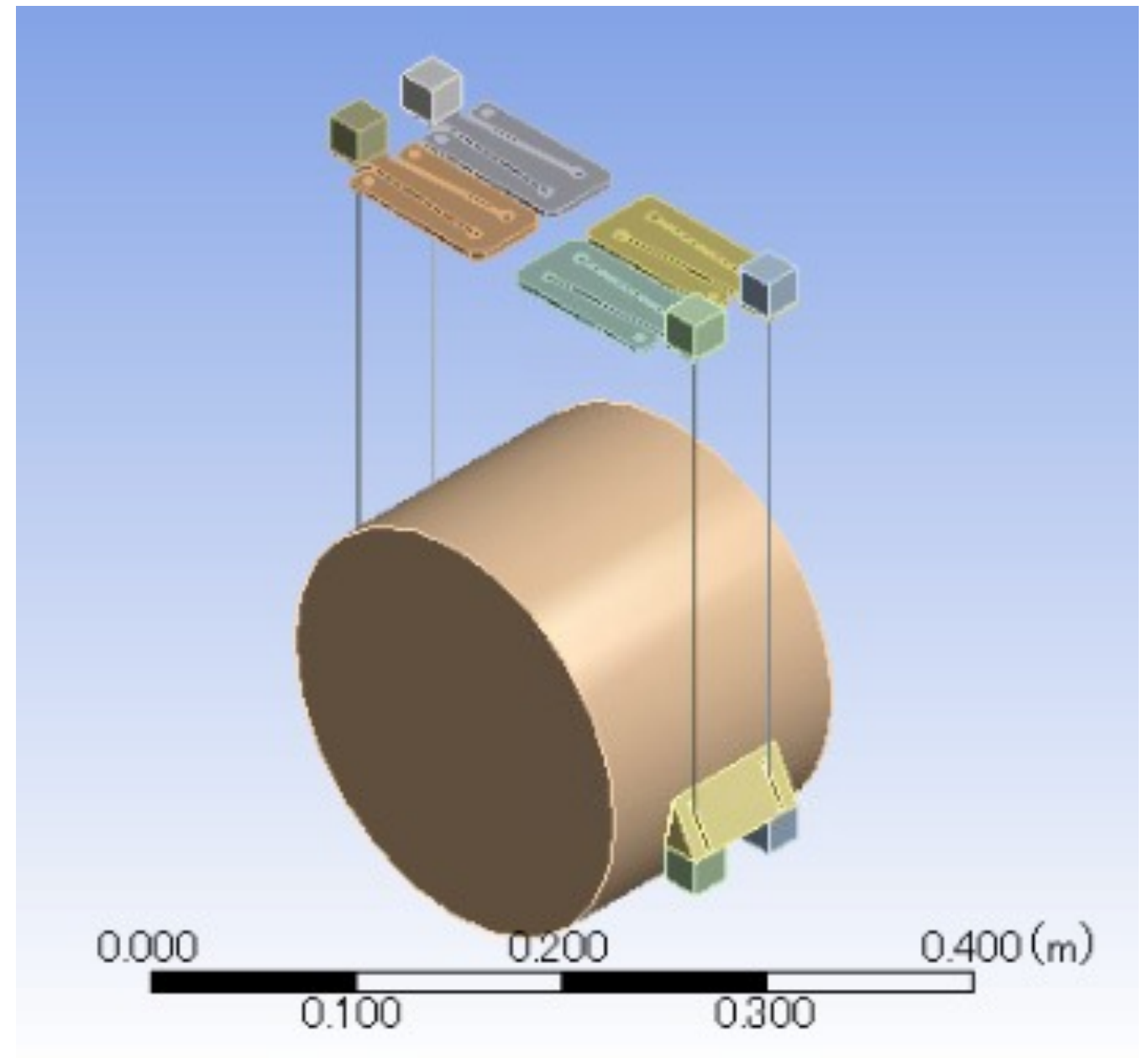
Compare (ANSYS, COMSOL, Analytical)



Thermal noise calculation

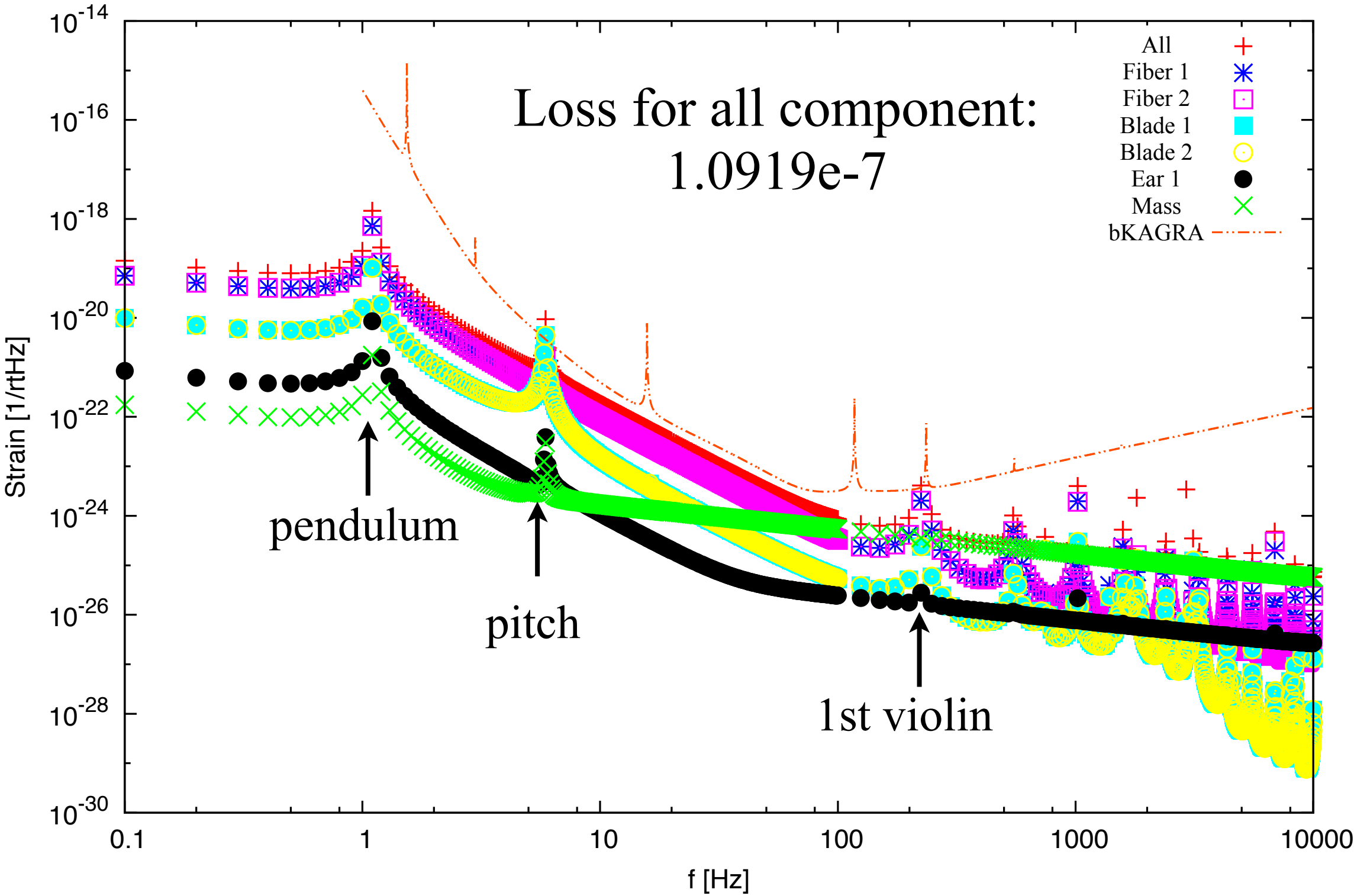
Model: monolithic (no bonding)

Loss for all component:
 $1.0919e-7$

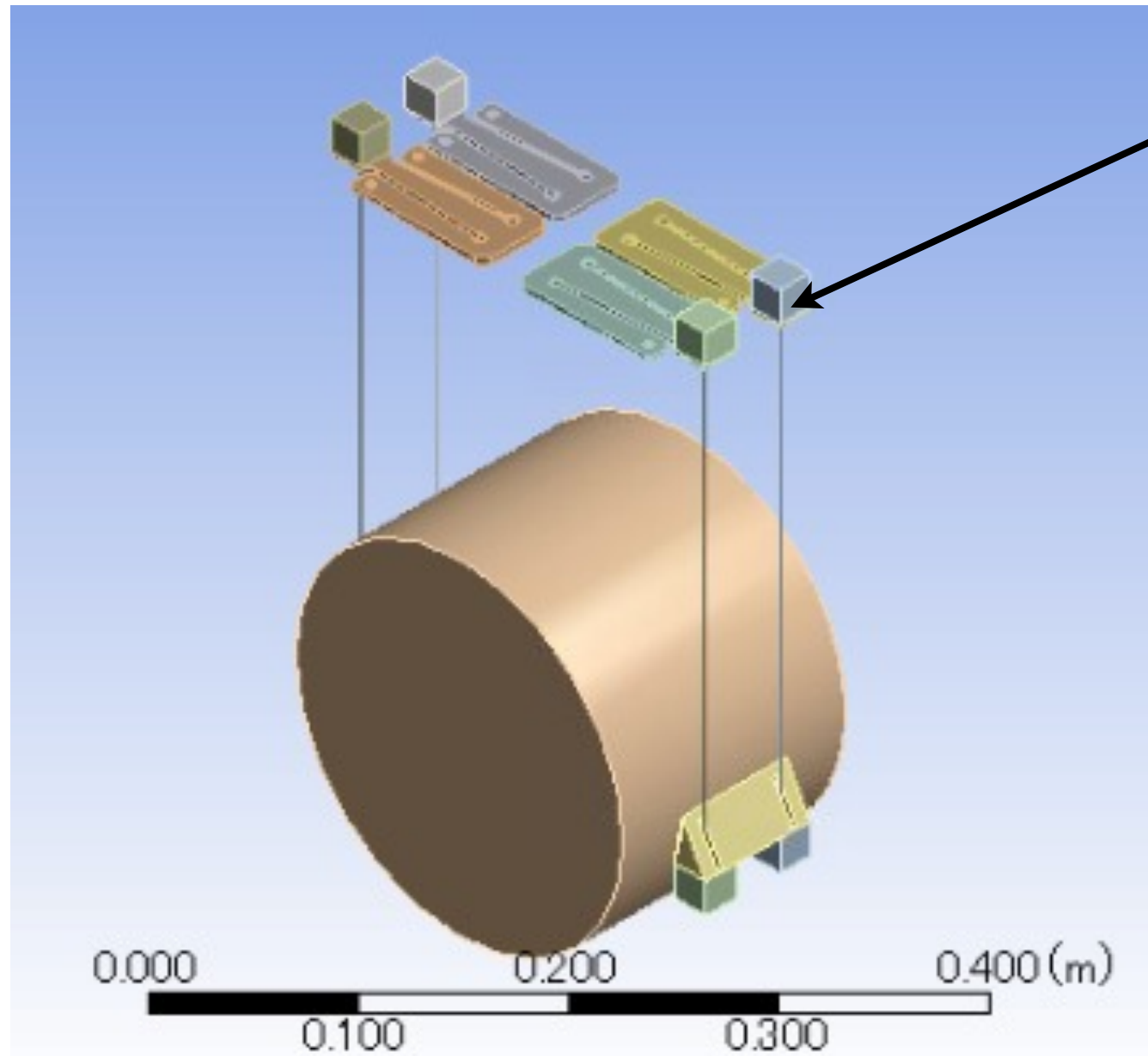


Thermal noise calculation

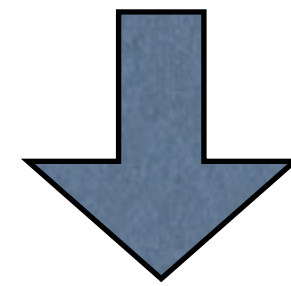
ANSYS calculation



Thermal noise of indium bonding



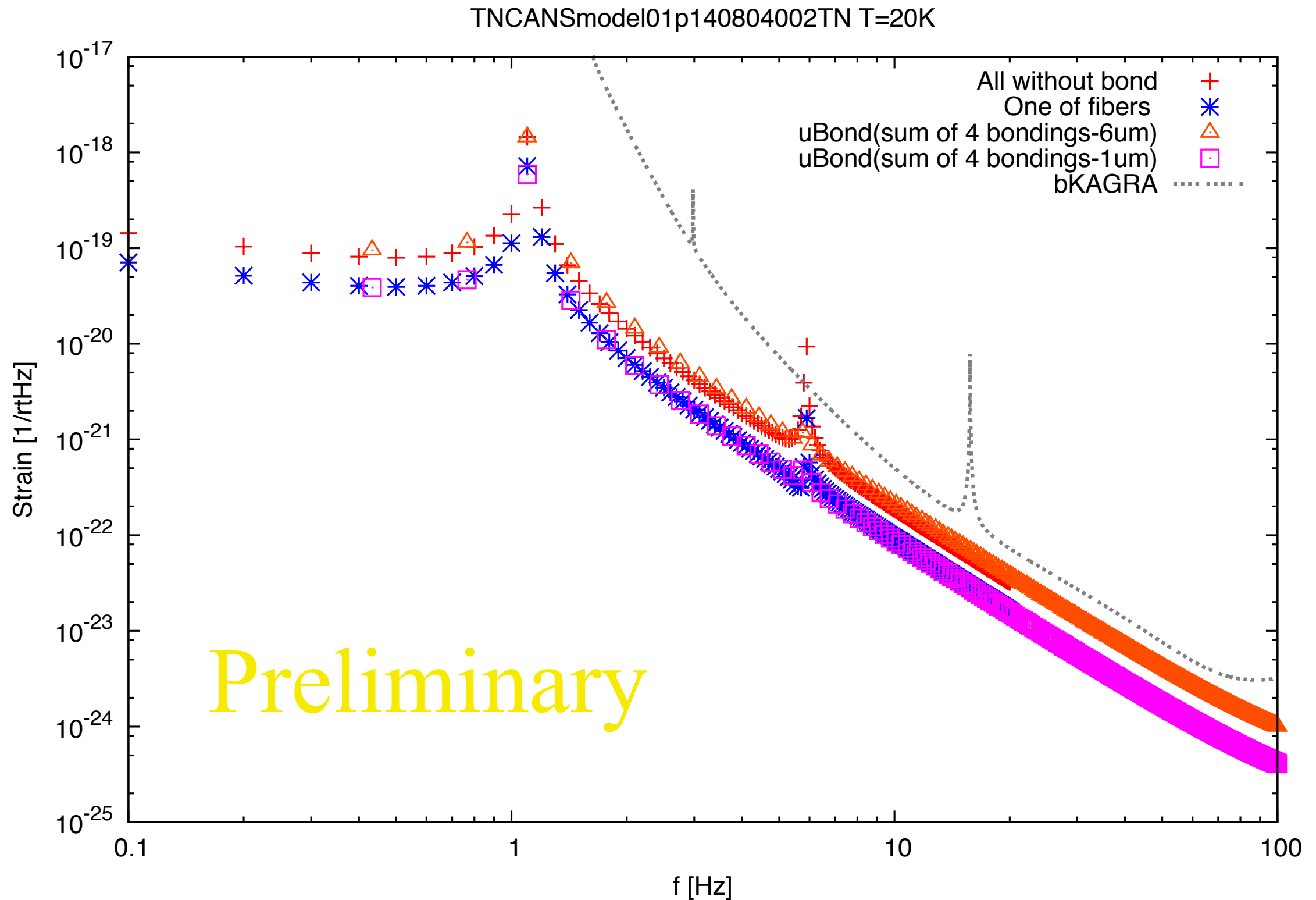
We put a layer between blade and fiber-head.
(4 bondings)



We calculated the thermal noise from the sum of these 4 bondings.

Loss of bonding we used for calc:
 $5.0e-3$

Thermal noise of indium bonding



Next plans

1. Thermal noise calculation
2. Q measurement of sapphire fibers for cross check
3. One fiber prototype
 1. Q measurement of violin mode
 2. Cooling test
4. Thermal cycling test of HCB