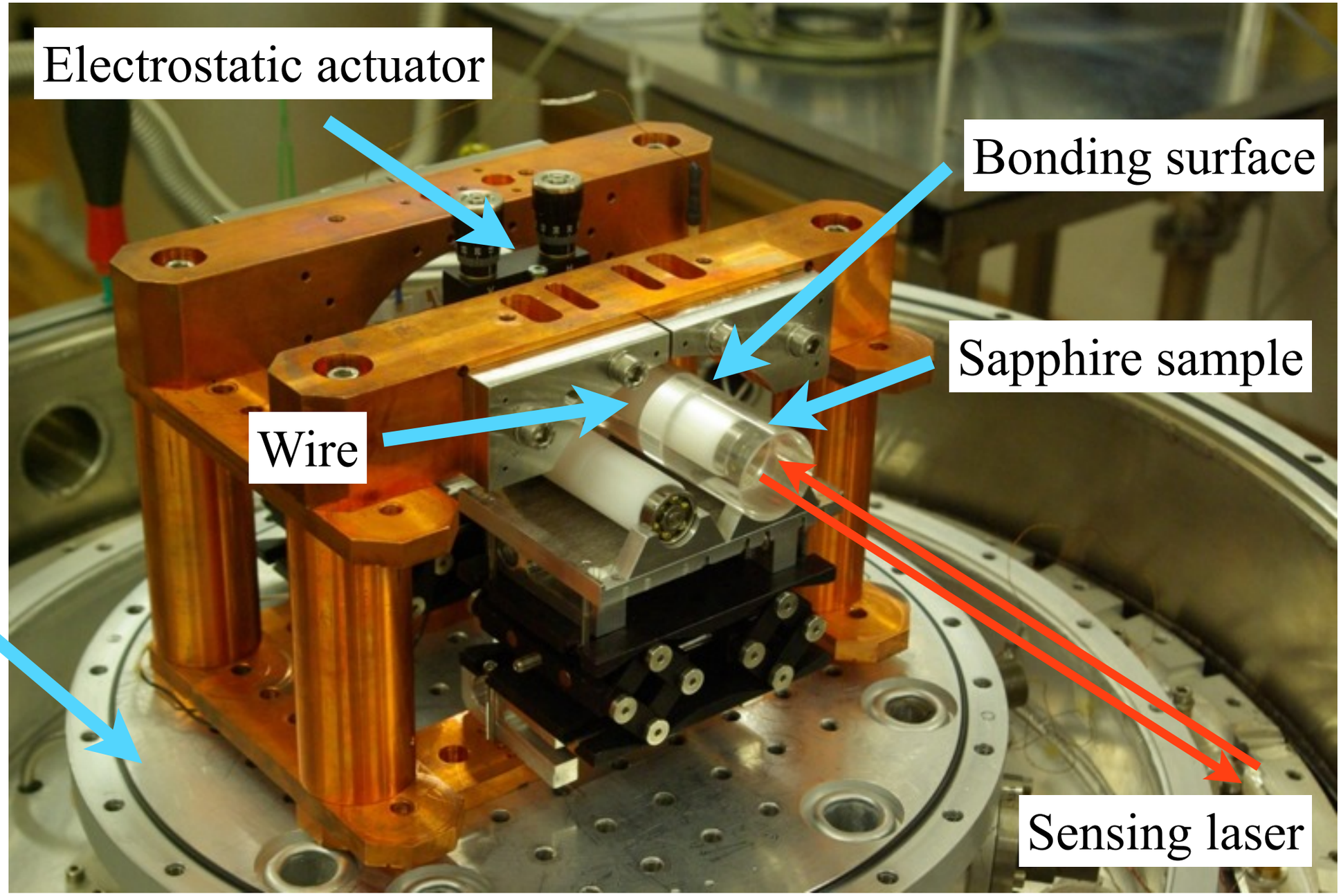
Q measurement of HCB

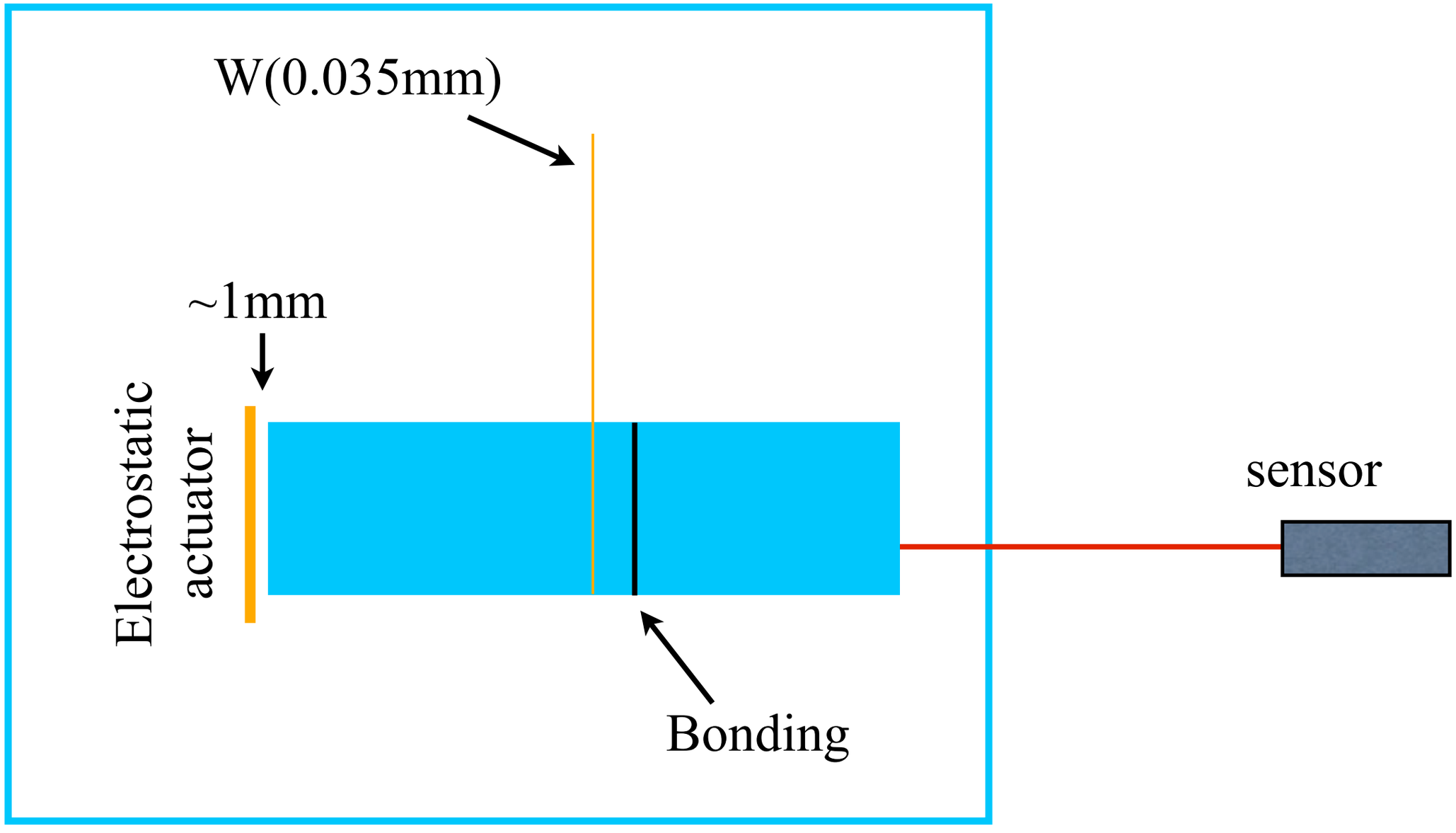
2014/11/18

Report by Dan Chen

Measurement setup



Measurement setup

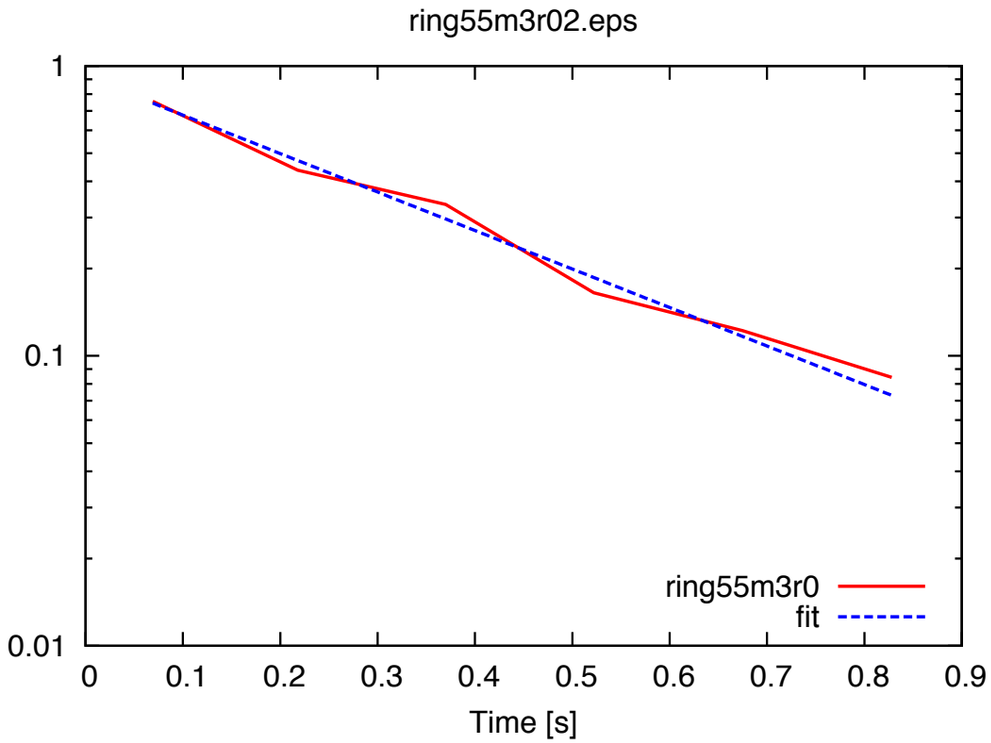


L=70+50=120mm　　ϕ=30mm

Typical decay curve (HCB)

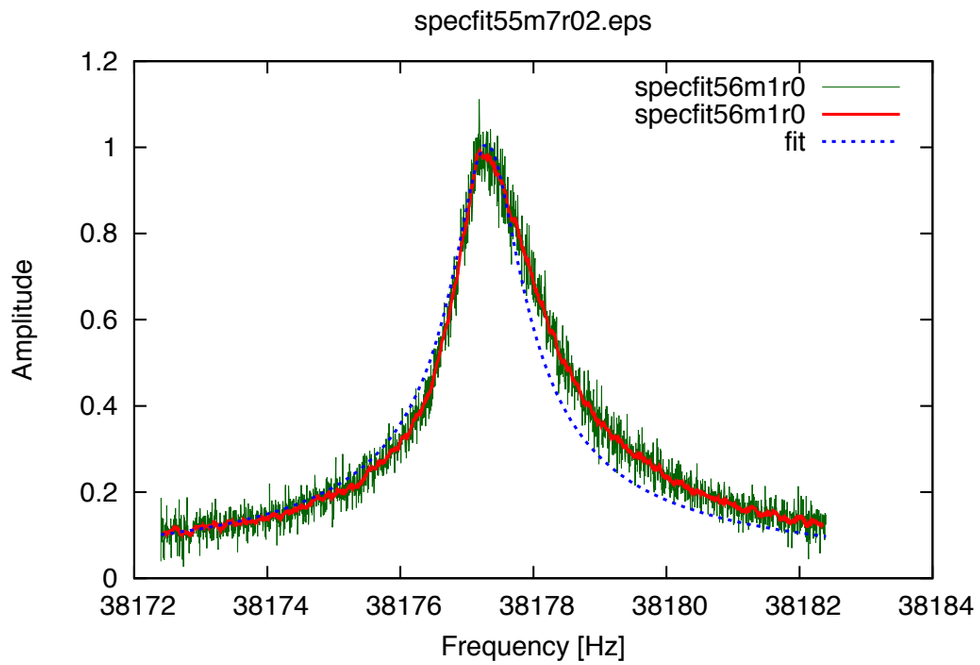
This is not the loss of HCB but the loss of sapphire sample with HCB

38kHz



T=20.1K

$$\phi = 2.56 \times 10^{-5} \pm 0.2 \times 10^{-5}$$



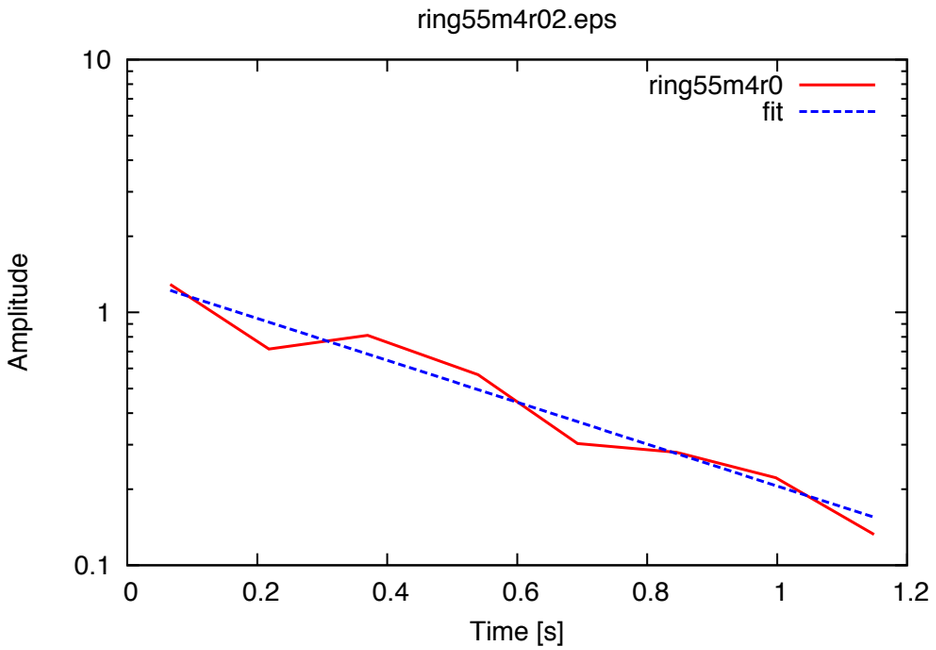
T=20.2K

$$\phi = 2.58 \times 10^{-5} \pm 0.03 \times 10^{-5}$$

Typical decay curve (HCB)

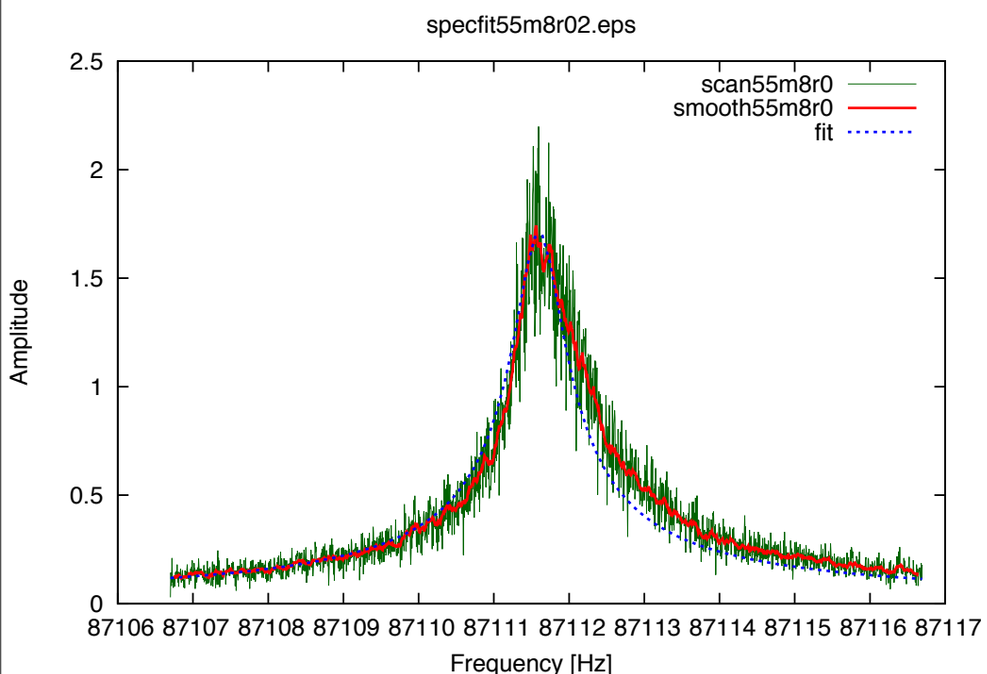
This is not the loss of HCB but the loss of sapphire sample with HCB

87kHz



T=20.2K

$$\phi = 7.0 \times 10^{-6} \pm 0.9 \times 10^{-6}$$



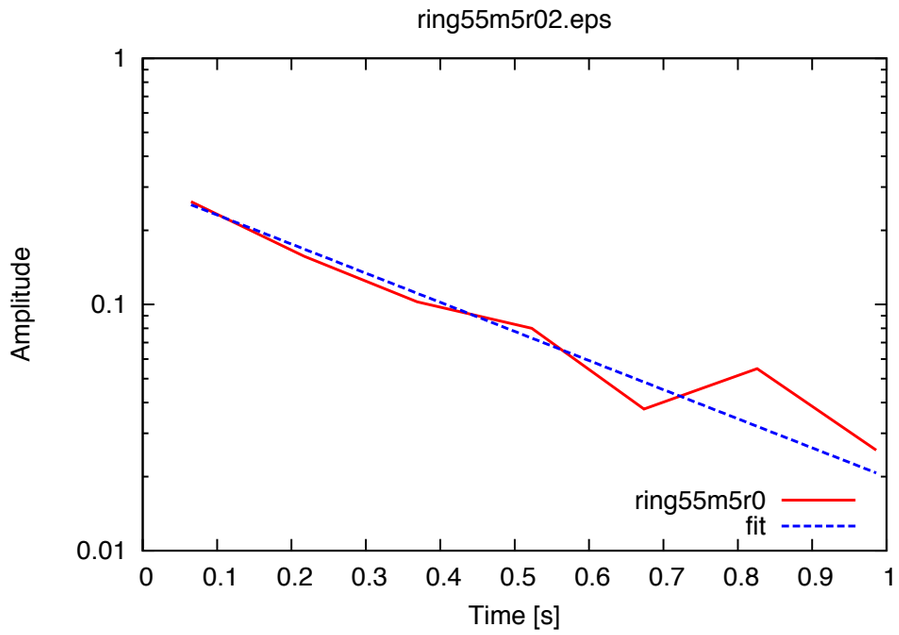
T=20.2K

$$\phi = 7.8 \times 10^{-6} \pm 0.1 \times 10^{-6}$$

Typical decay curve (HCB)

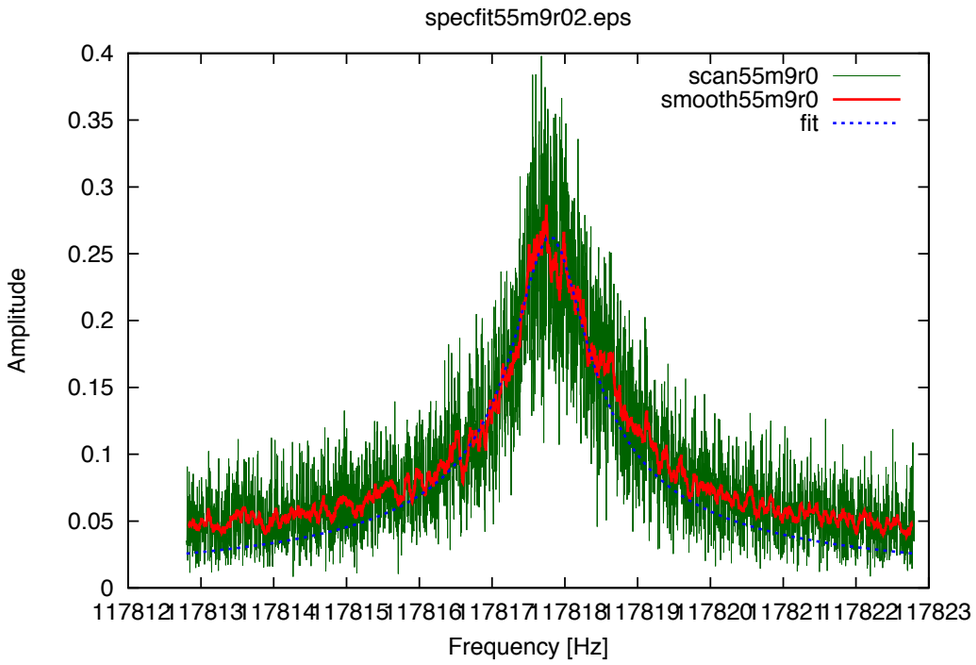
This is not the loss of HCB but the loss of sapphire sample with HCB

118kHz



T=20.2K

$$\phi = 7.4 \times 10^{-6} \pm 0.6 \times 10^{-6}$$



T=20.2K

$$\phi = 8.3 \times 10^{-6} \pm 0.2 \times 10^{-6}$$

How to estimate loss of bond?

measured loss — substrate loss — bonding loss

$$\phi_{meas} E_{tot} = \phi_{sub} E_{sub} + \phi_B E_B$$

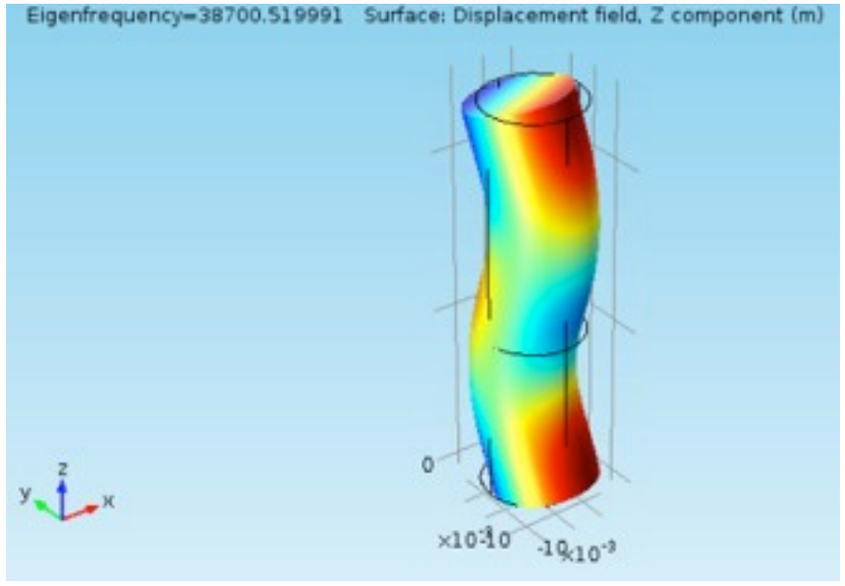
total energy — energy in sub — energy in bond

$$\frac{E_B}{E_{tot}} << 1 \qquad \frac{\phi_{sub}}{\phi_{meas}} << 1$$

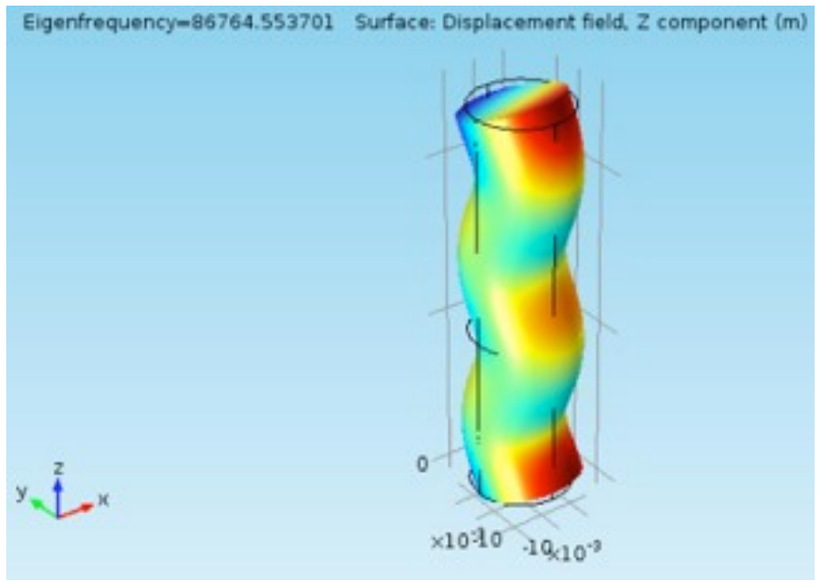
$$\phi_B \simeq \frac{E_{tot}}{E_B} \phi_{meas}$$

We need to know the thickness of the bond.

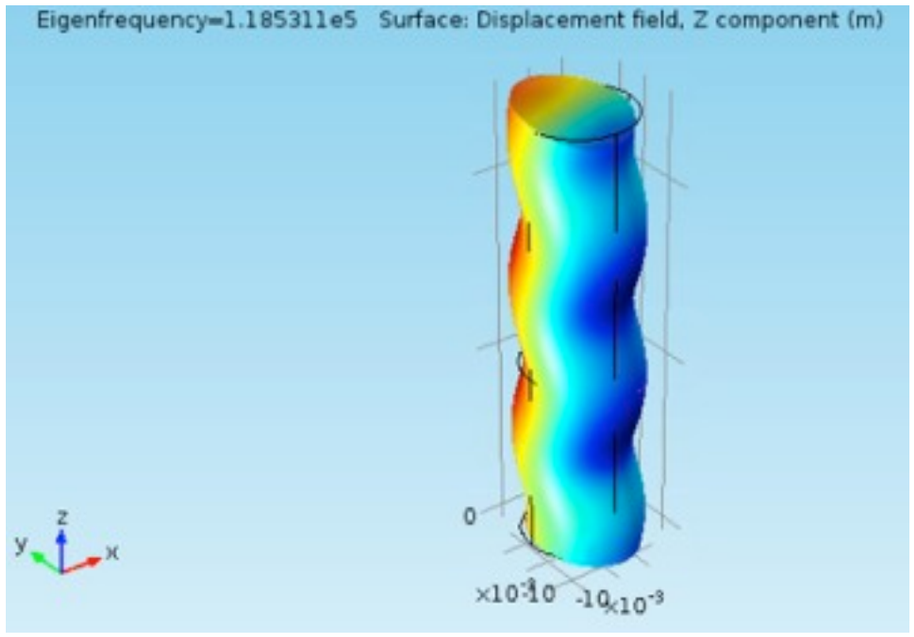
Resonant frequency HCB



38kHz Eb/Et=2.8e-5

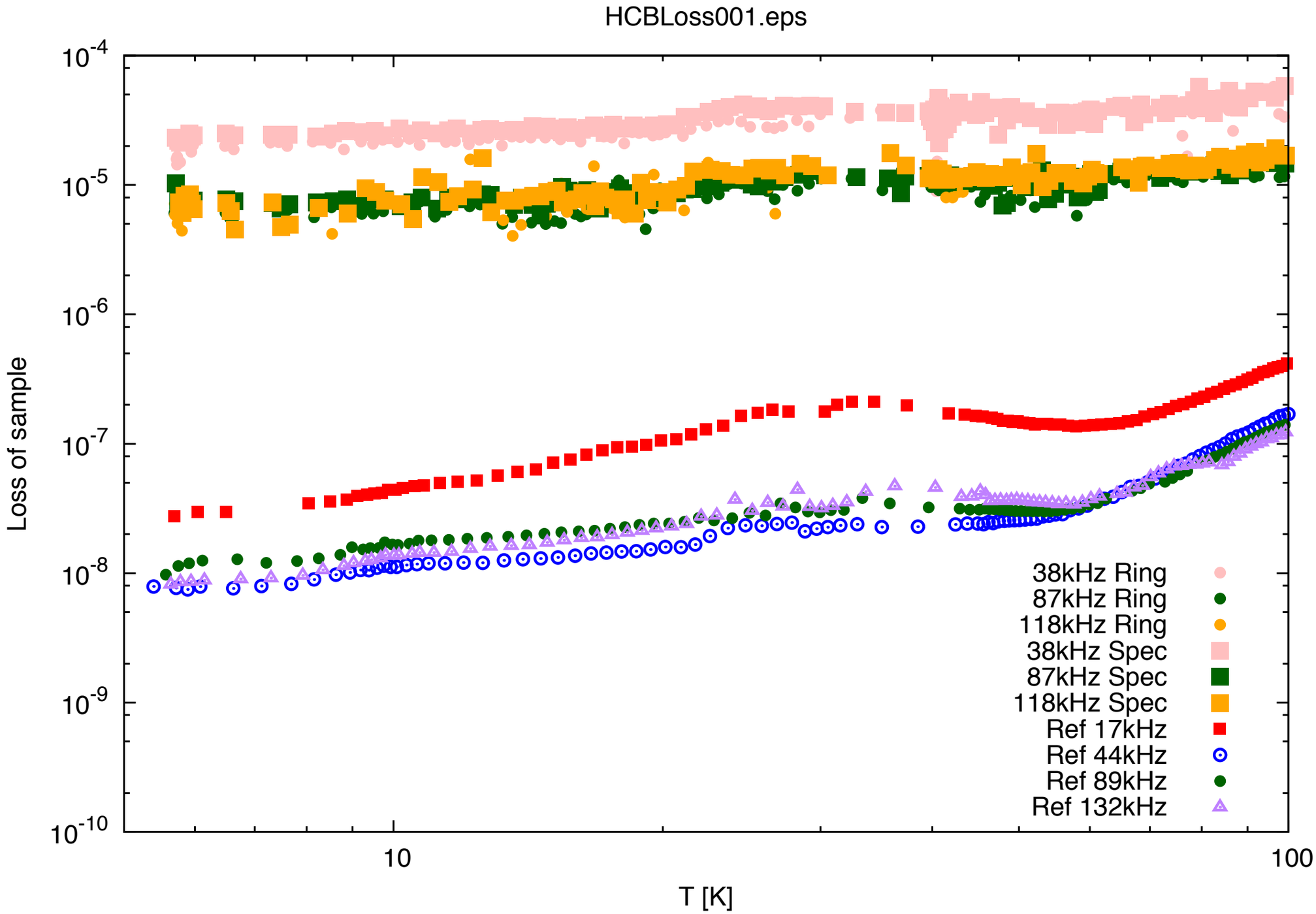


87kHz Eb/Et=1.3e-5

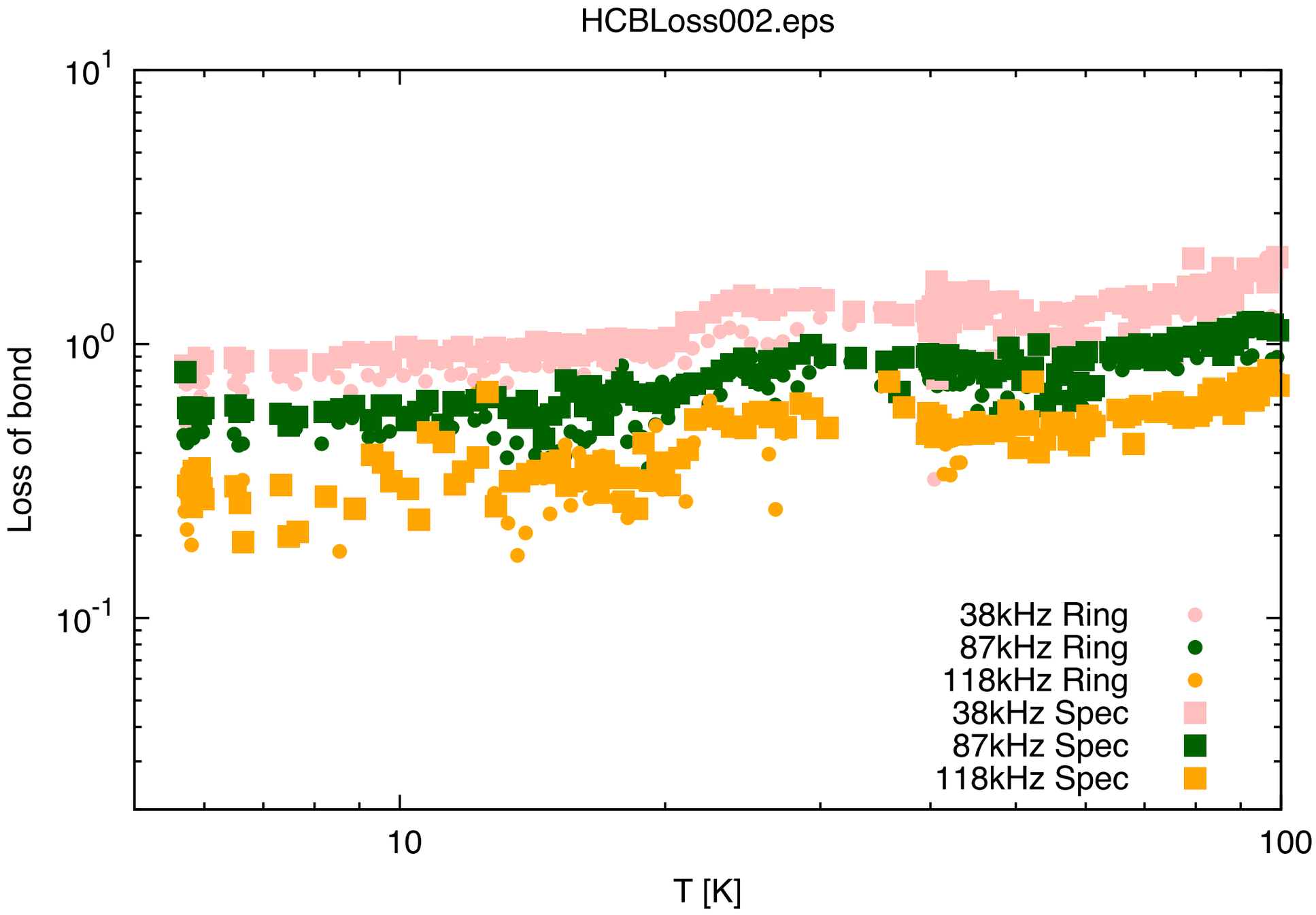


118kHz Eb/Et=2.4e-5

Result


HCBLoss001.eps
Loss of sample
T [K]
10
100
38kHz Ring
87kHz Ring
118kHz Ring
38kHz Spec
87kHz Spec
118kHz Spec
Ref 17kHz
Ref 44kHz
Ref 89kHz
Ref 132kHz

Result



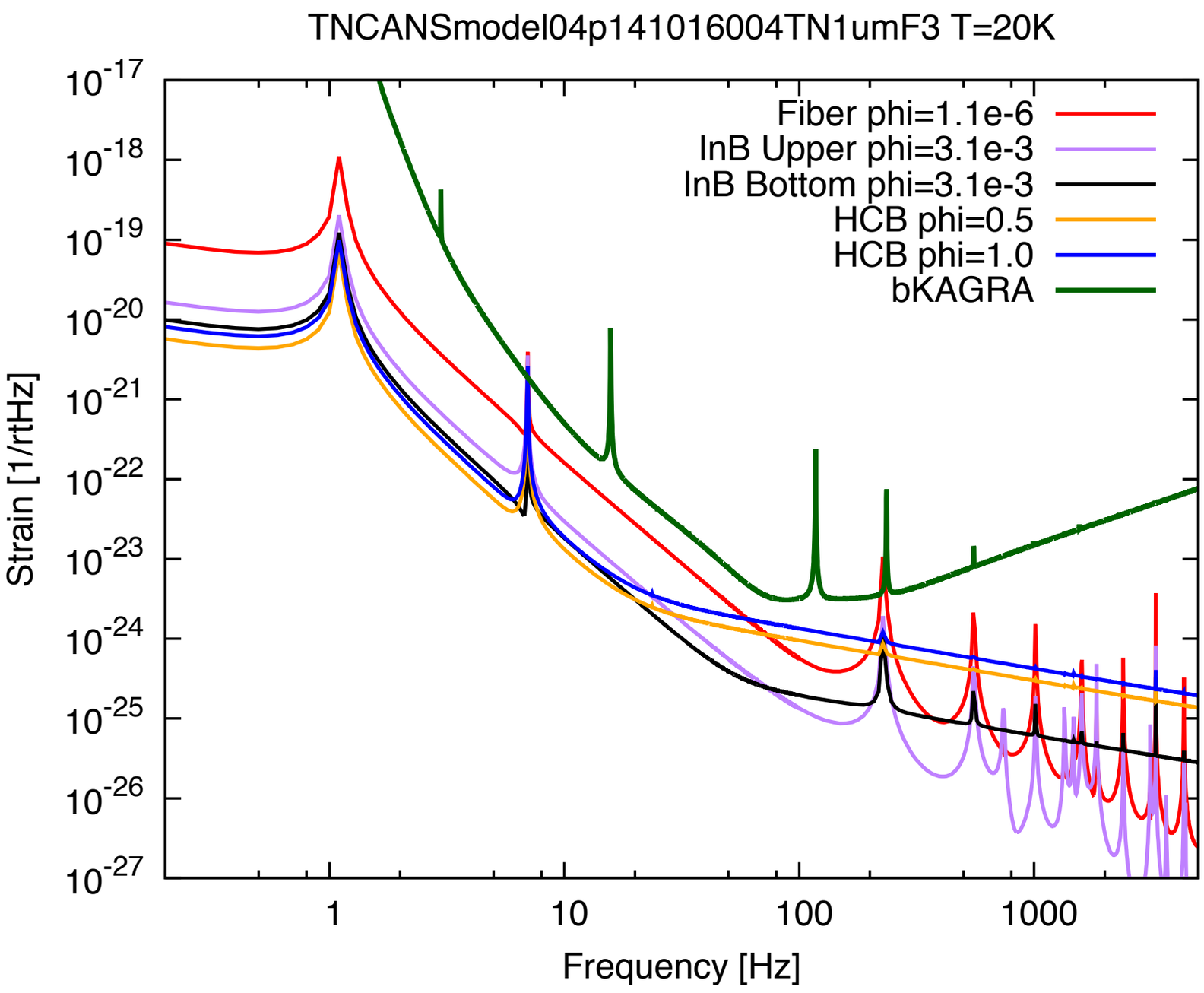
Let's say the loss of HCB is 1 at 20K.

ANSYS calculation with bonds

Model: KAGRAcryopayload8b45mmWithClammpFD60WB.iam

KAGRAcryopayload14.wbpj (Rahul's PC)

Bonding



InB thickness = 1um

InB area = 352mm^2*8

HCB thickness = 60nm

HCB area = 2400mm^2*2

The noise of HCB is still below the bKAGRA design.

We can reduce it more by changed the size of the fiber heads