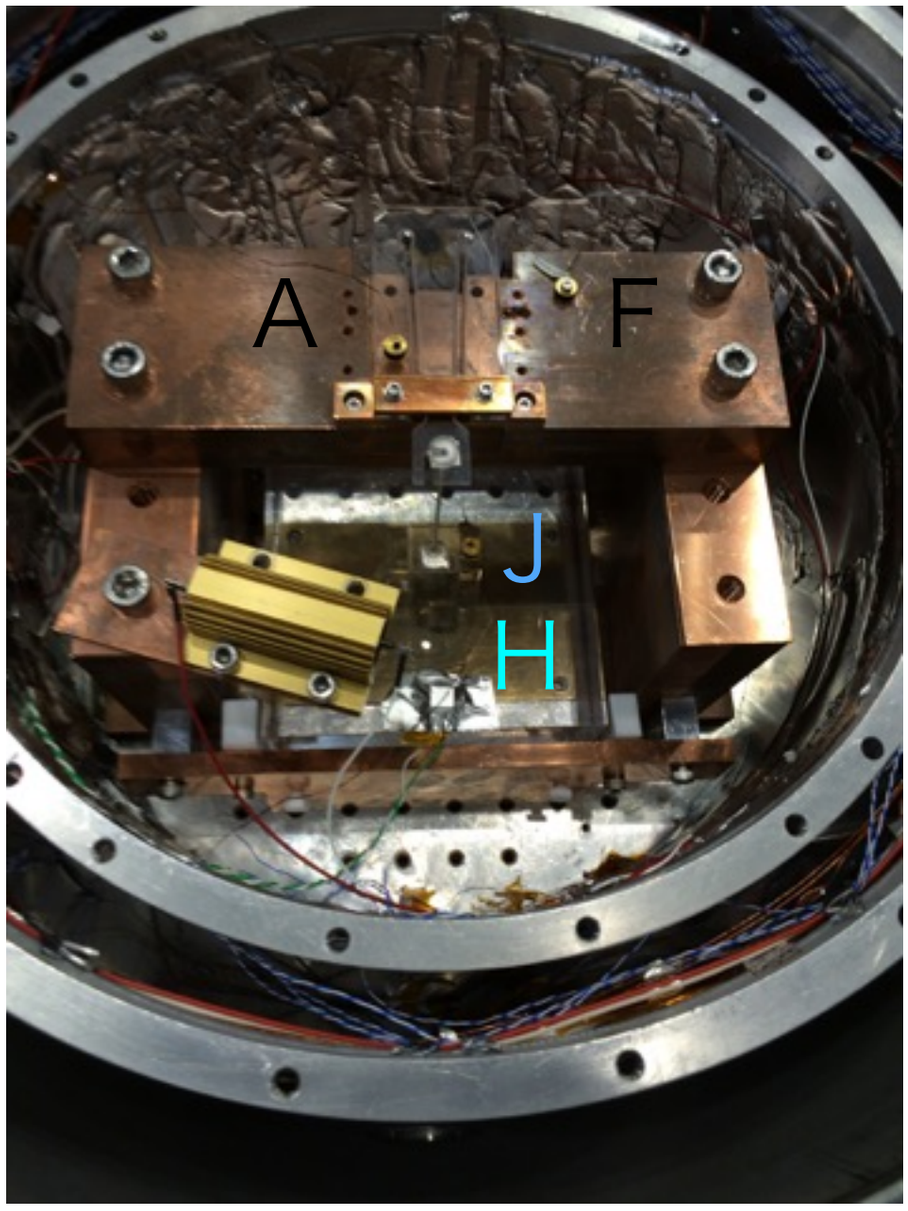
My work in 2016

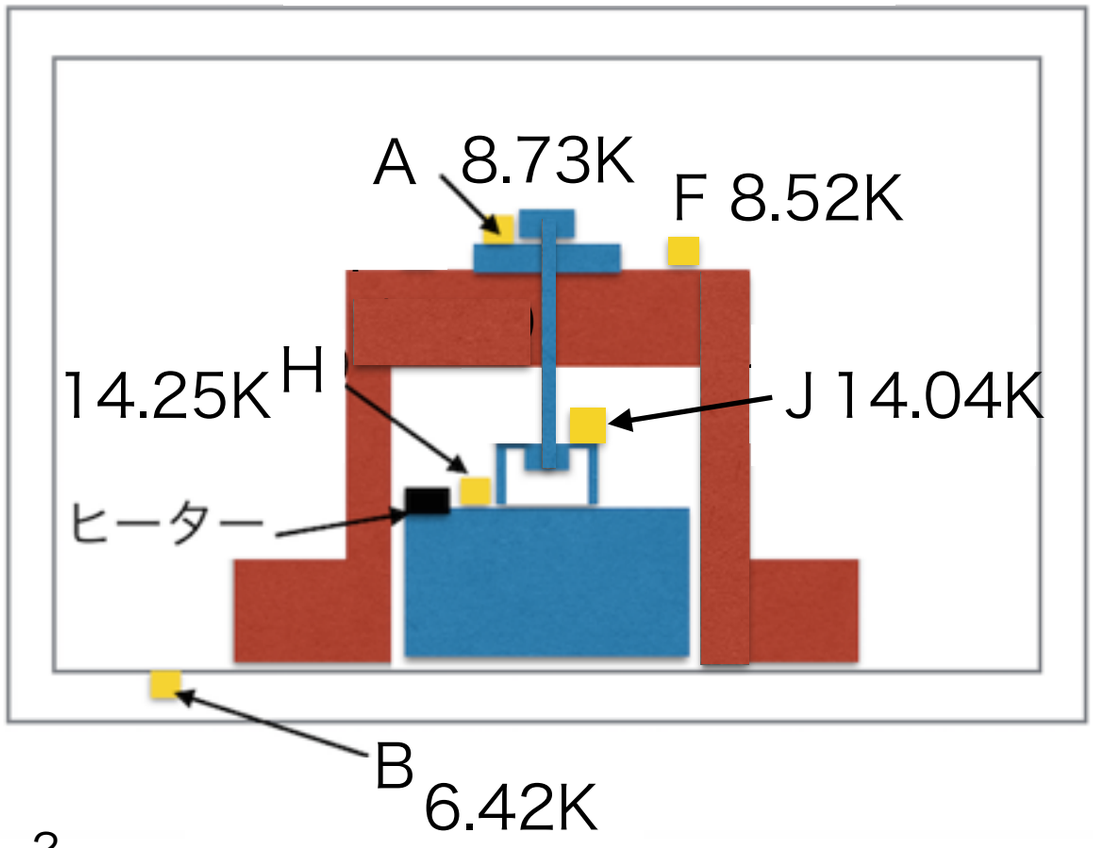
8-2

Hiroki Tanaka

heat load test



When the power of the heater was 0.2475W（5.50V、0.045A）…



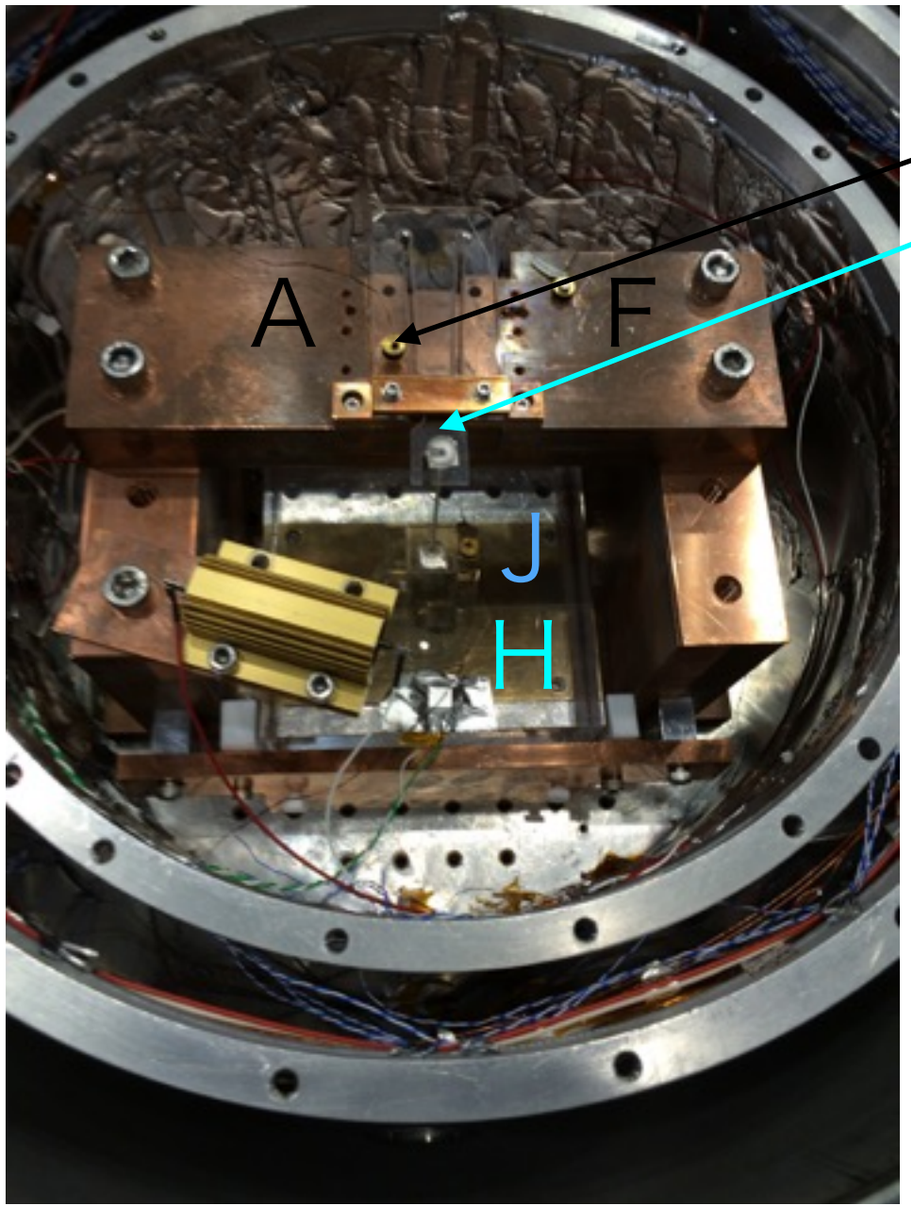
heat load test

- Our purpose is to calculate the temperature of the KAGRA mirror during the bKAGRA-phase III observation.

- In order to calculate that, I must know the thermal conductivity of the blade.

- I calculated the thermal conductivity of the blade by the result of this heat load test.

heat load test



point A (sensor A)
point B (No sensor)

- In order to measure the thermal conductivity of the blade, I calculated the temperature of the point B (see the left picture).

heat load test

- When I calculated the temperature of point B, I used the equation below.

- $0.2475[W] = \int_{T_{bladepoint\,B}}^{T_{hanger}} \kappa \frac{S}{l} dT$

heat load test

- The power（0.2475W）is calculated by the equation below.

- $P=IV=0.045(A)\times5.50(V)=0.2475(W)$.

- I found that both I *and* V have errors.

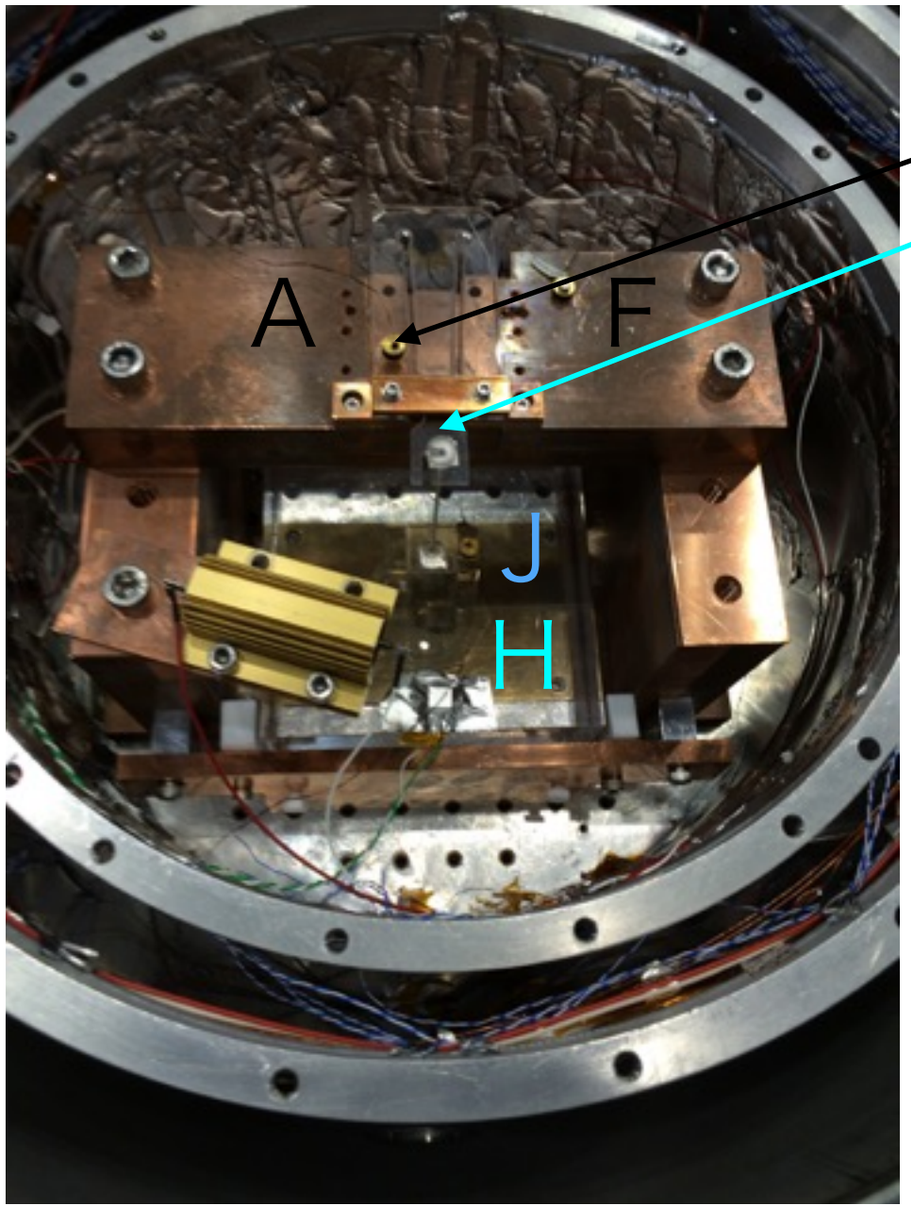
heat load test

- The error…

- $I=0.045\pm0.005(A),\ V=5.50\pm0.005(V)$

- $W=0.2475\pm0.0275(W)$ $(propagation\ of\ errors)$

heat load test



point A (8.73K)
point B (under 9.23K)

In my calculation, the temperature of point B is under 9.23K.

heat load

The thermal conductivity of the blade（κ_{blade}）
is more than 1794(W/(m・K)) at 9K.
(The thermal conductivity of the fiber（κ_{fiber}）
is 1085(W/(m・K)) at 9K)

$\kappa_{\mathrm{bulk}} \geqq \kappa_{\mathrm{blade}} \geqq \kappa_{\mathrm{fiber}} \times 1.65$

heat load

- Now I can calculate the temperature of the KAGRA mirror during bKAGRA phase III.

heat load test

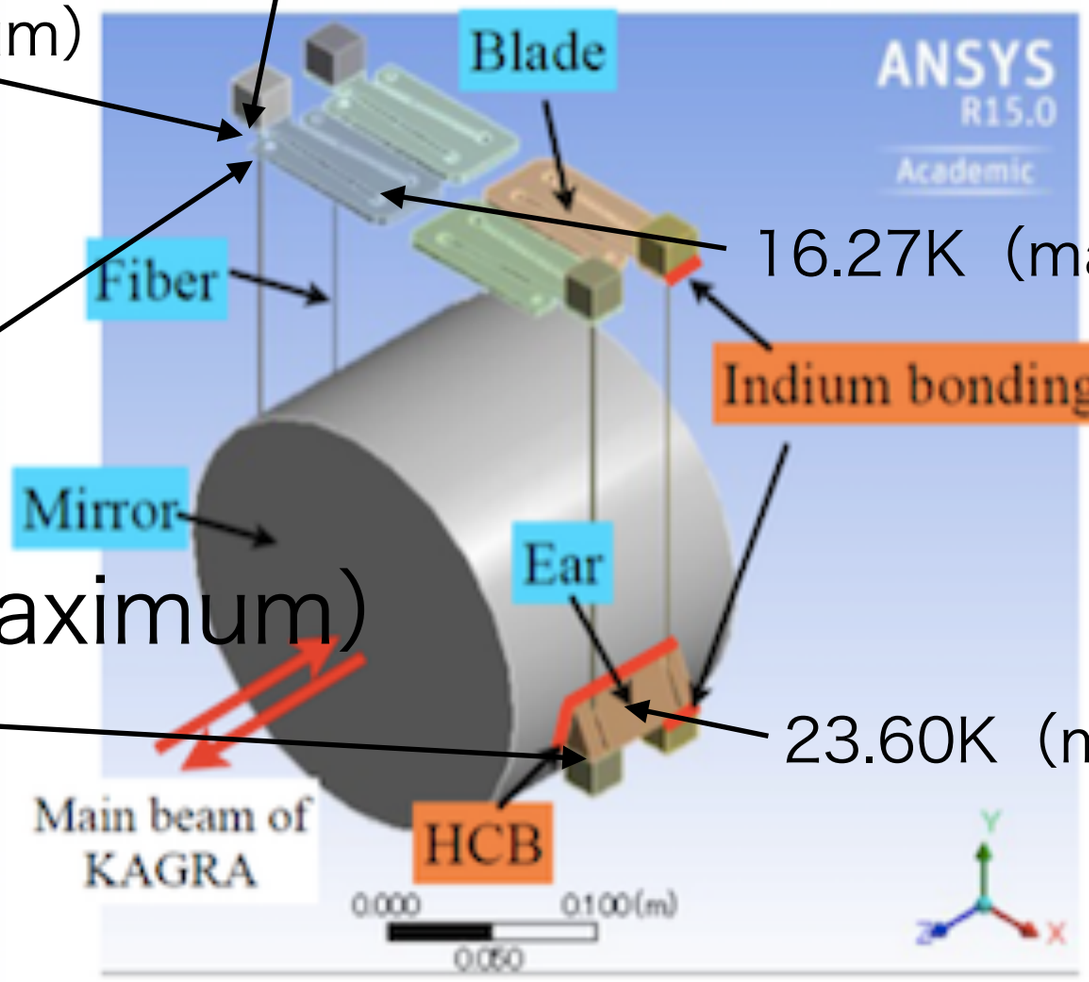
When 1W is absorbed into the mirror…

16.38K（fiber head、maximum）

16.39K（back of Indium、maximum）

Intermediate mass…16K

16.21K



16.27K（maximum）

mirror…23.60K（maximum）

23.59K（fiber head、maximum）

23.60K（maximum）

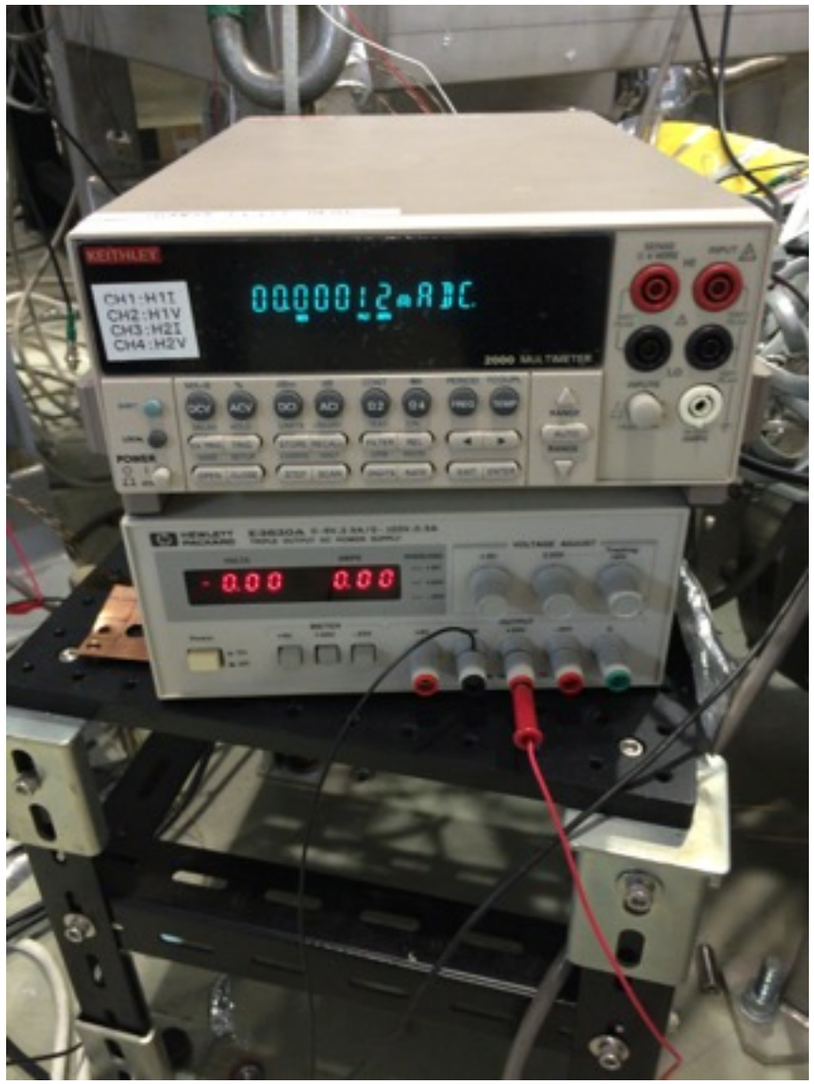
Future work

- In the previous test, the error was large.
- I am preparing for the next heat load test （I will start to cool down this week）.
- Next time I will make the error smaller.

heat load

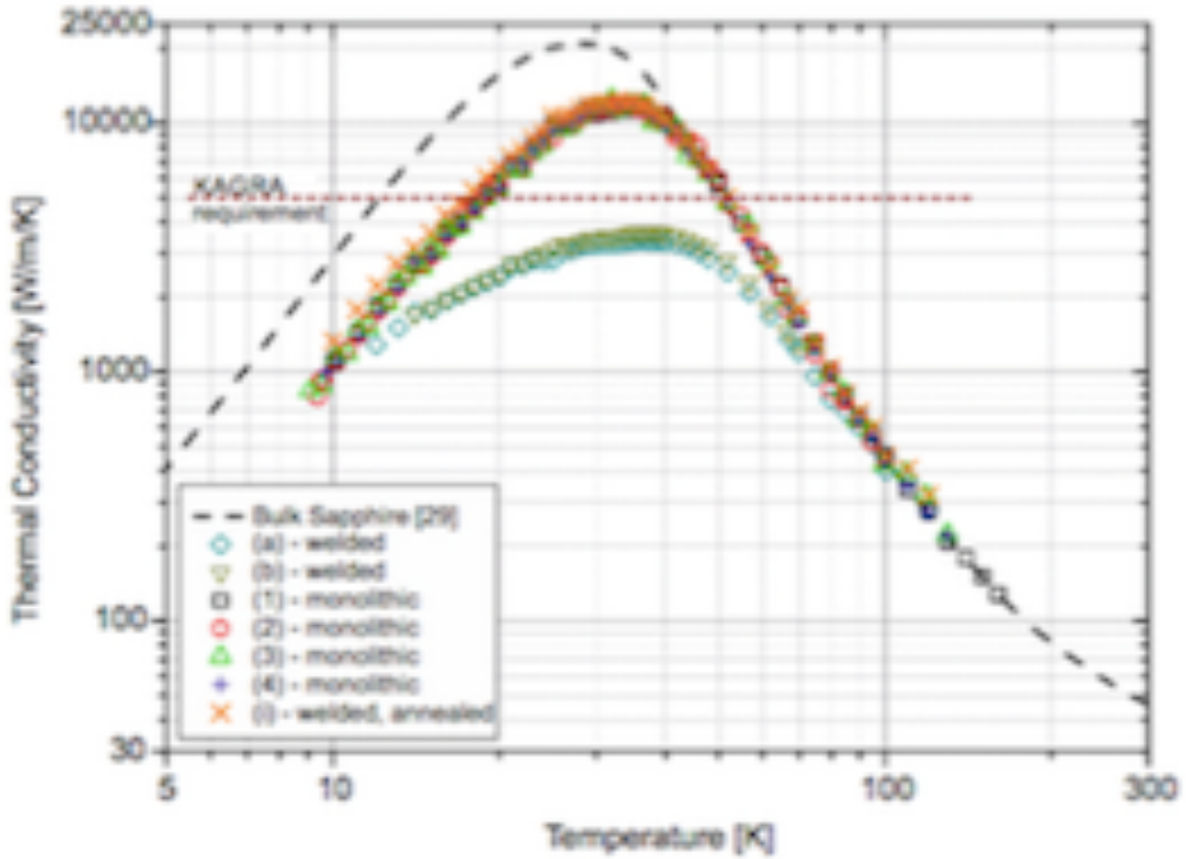
next time

previous



Analysis

- We know the thermal conductivity of the sapphire fiber whose diameter is 1.6mm (Sascha's data).



heat load

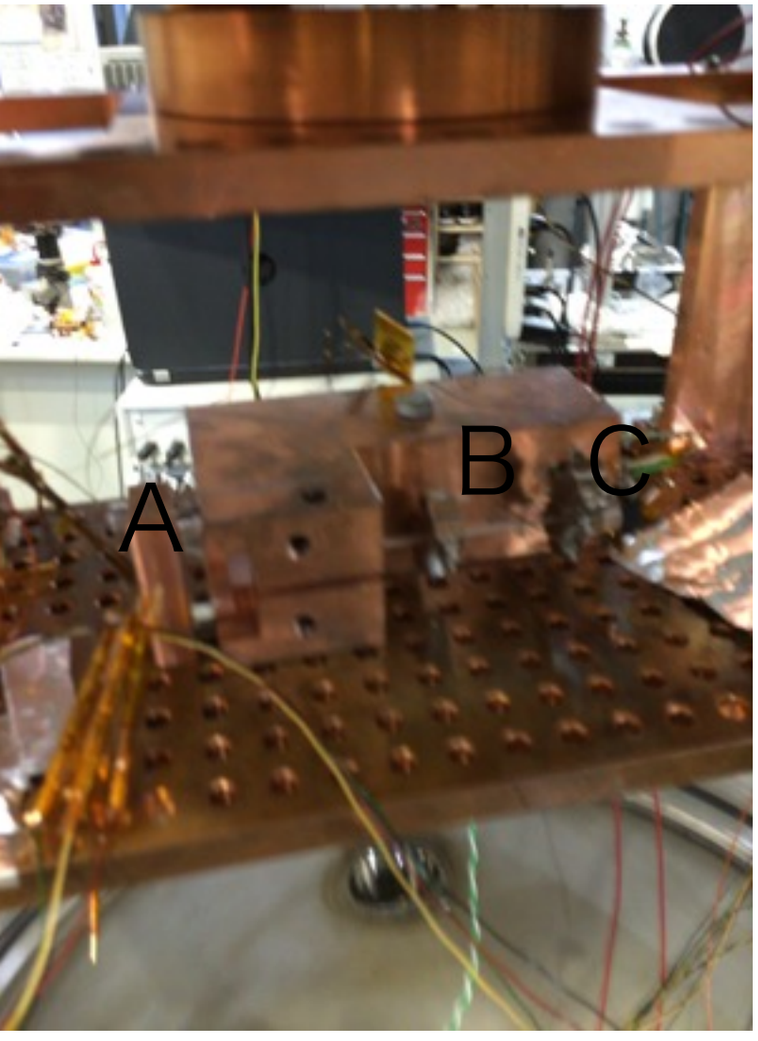
- By minimum square method, the thermal conductivity of the fiber can be approximated to $\kappa = 2.80T^{2.6}$

- I measured the diameter of the fiber and found that it is $\phi 1.7(\mathrm{mm}) \rightarrow \kappa = 2.975T^{2.6}$ (Size effect)

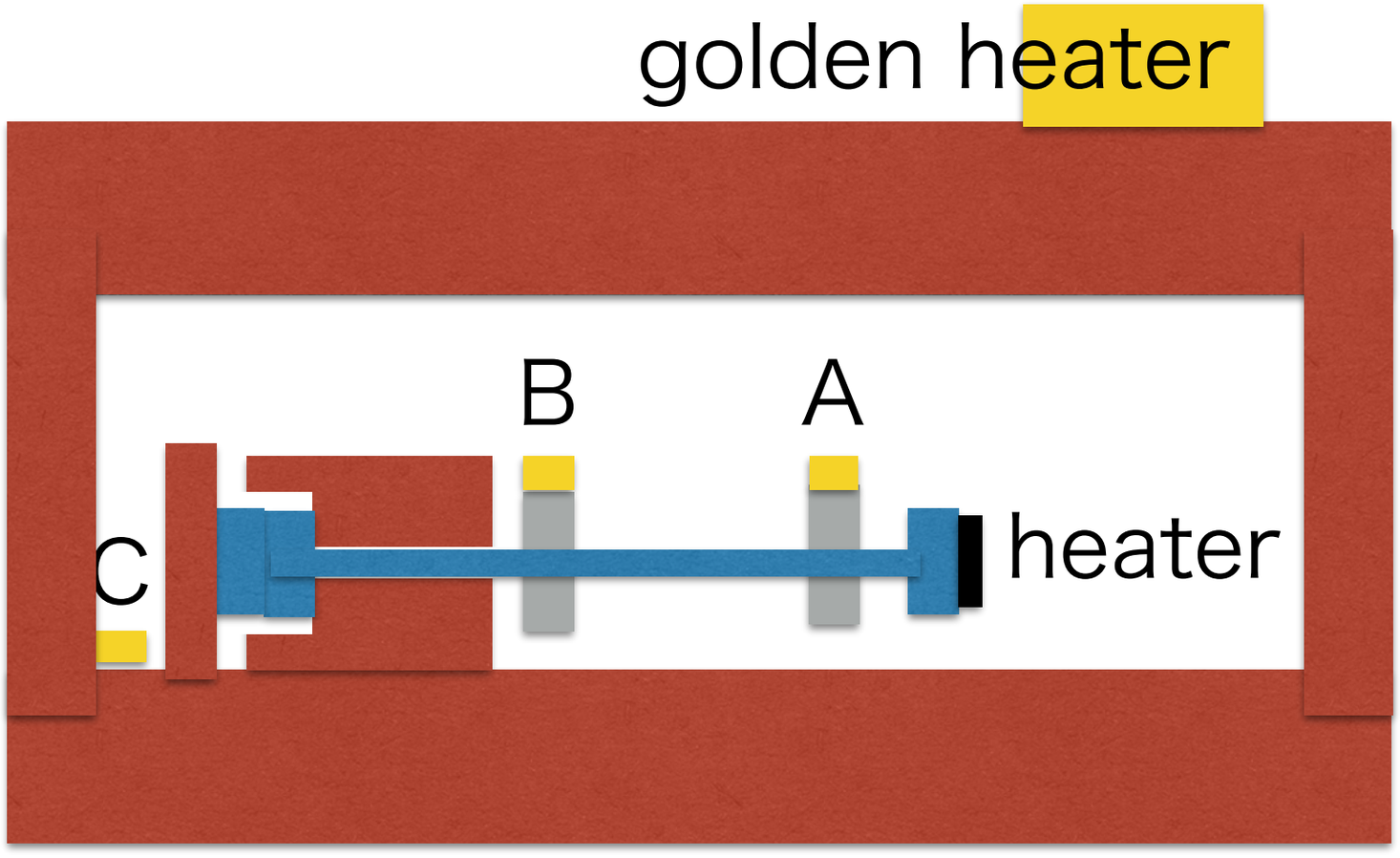
mirrorが吸収する熱量

- ITM 1W、ETM 1W未満（∵ミラー内部で500W×50(ppm/cm)×30(cm)=0.75(W)、コーティング部分で400（kW）×0.1(ppm)=0.04(W)、計0.79W）

Thermal conductivity of the fiber

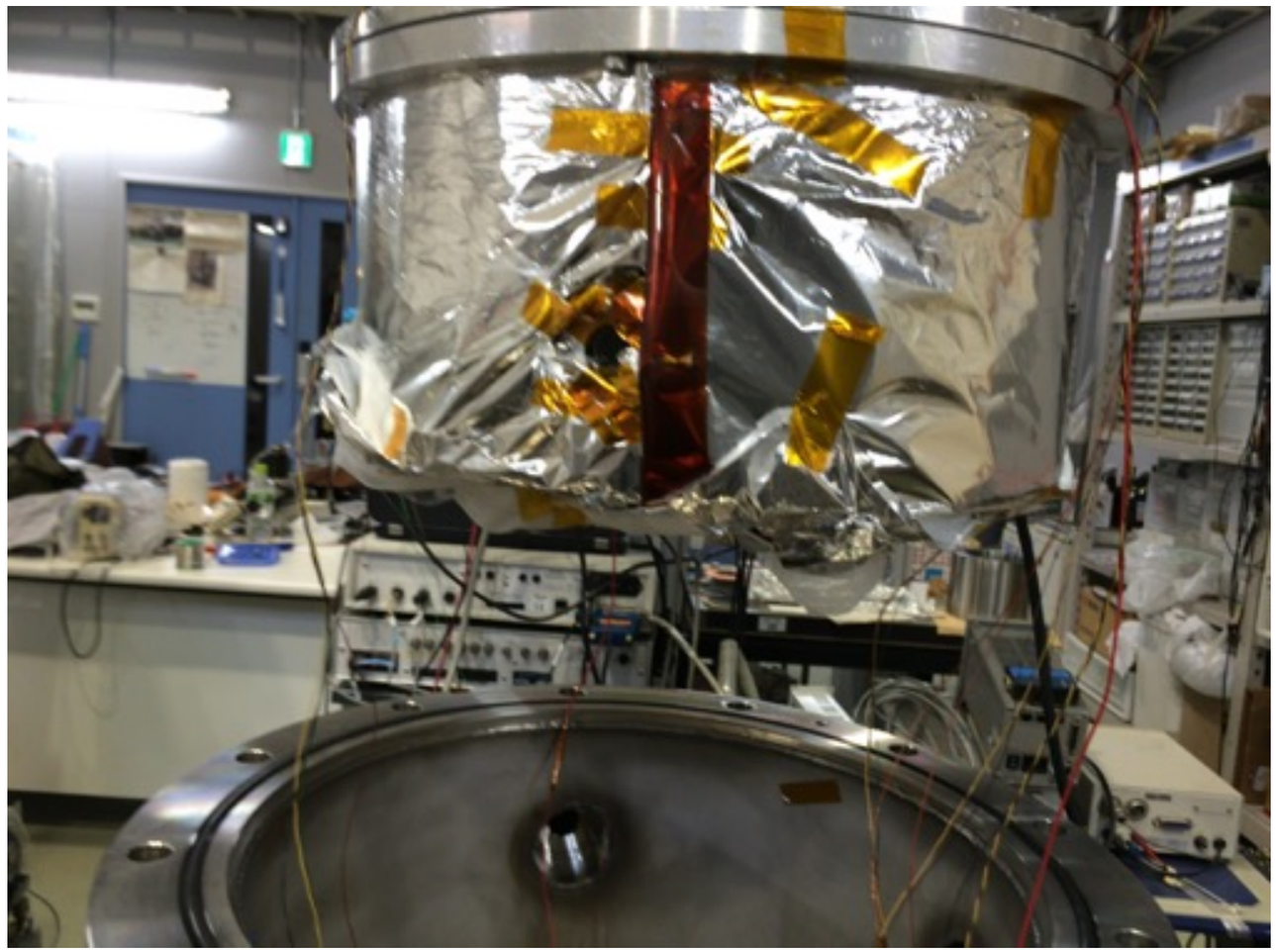


クランプを変更し、
fiberとヒートシンクの接触面積を増加。



Thermal conductivity

SIが破れていたので、カプトンで貼った。



Thermal conductivity

熱浴が10.5Kまでしか冷えなかった。