

# **Cryogenics Group Report**

Oct. 8. 2015

KAGRA Domestic Collaborator Meeting

Takayuki TOMARU, KEK

# Cryogenic Payload

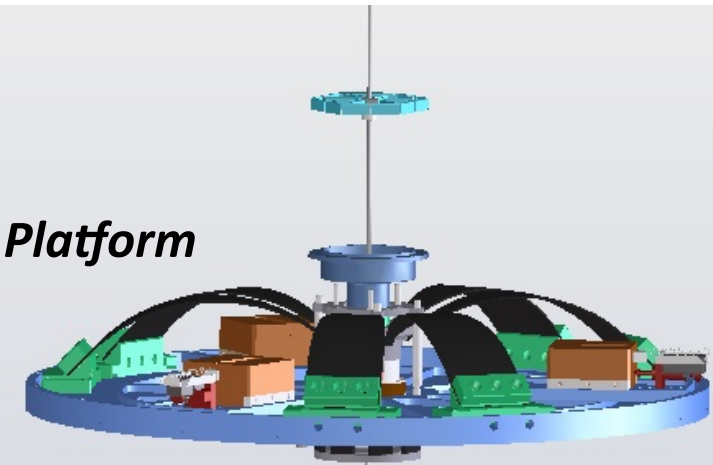
Fundamental mechanical design of cryogenic payload was done.

Fabrication and cost estimation of this cryogenic payload, except for platform are under discussion with a company.

We got many advices to design this payload from VIS group. We introduced some improvement point from their experience. Thanks, VIS group.

*by Tomaru & Hagiwara*

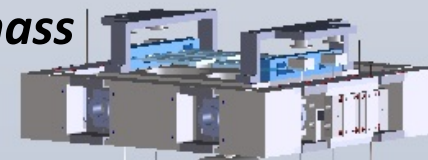
***Platform***



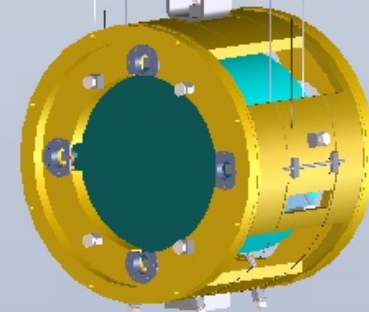
***Marionette & Recoil mass***



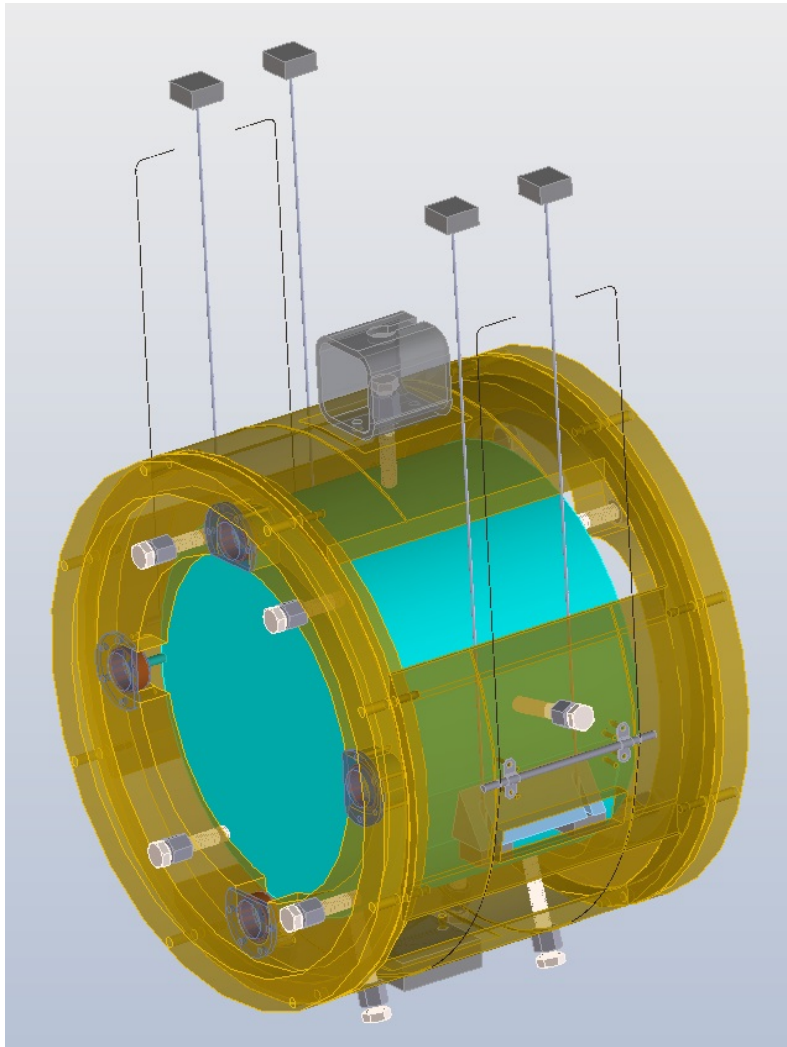
***Intermediate mass & recoil mass***



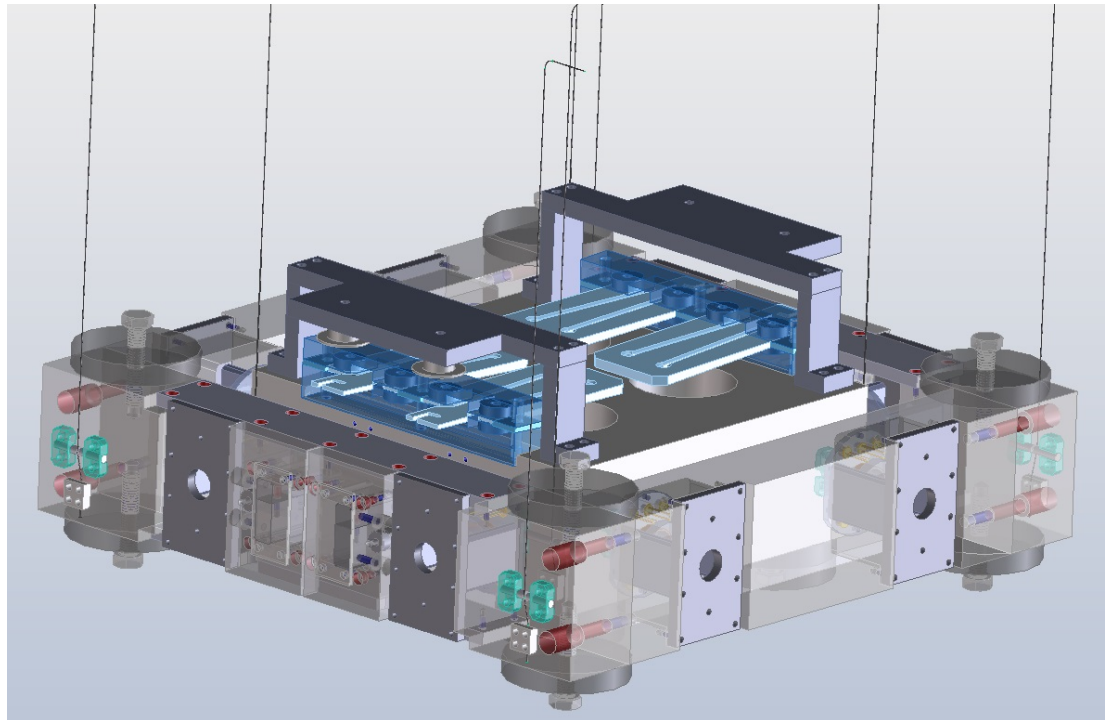
***Mirror & Recoil mass***

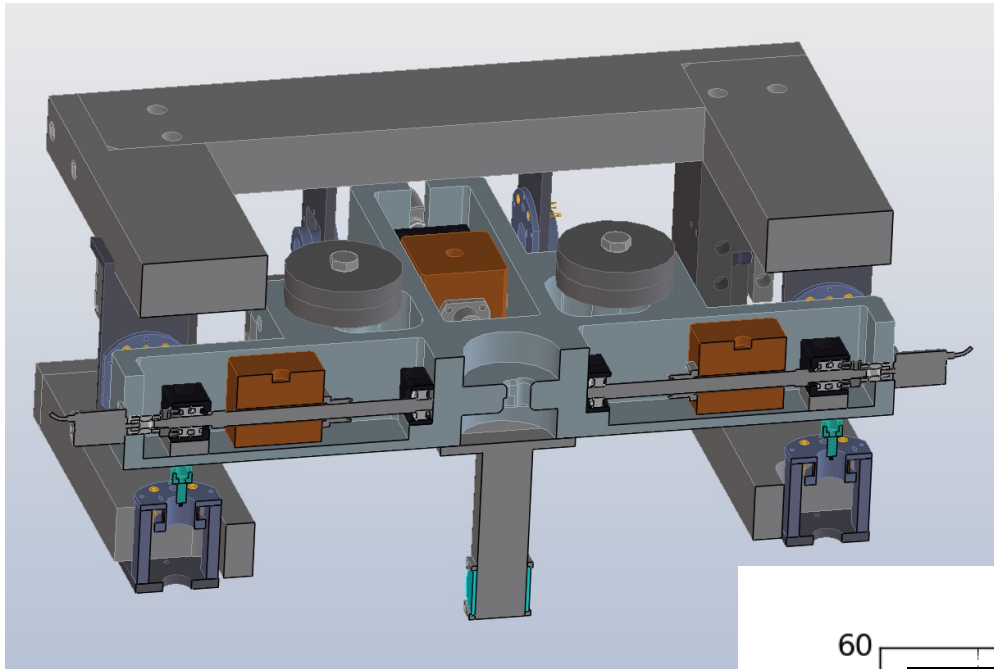


Mirror & Recoil mass



Intermediate mass &  
intermediate recoil mass



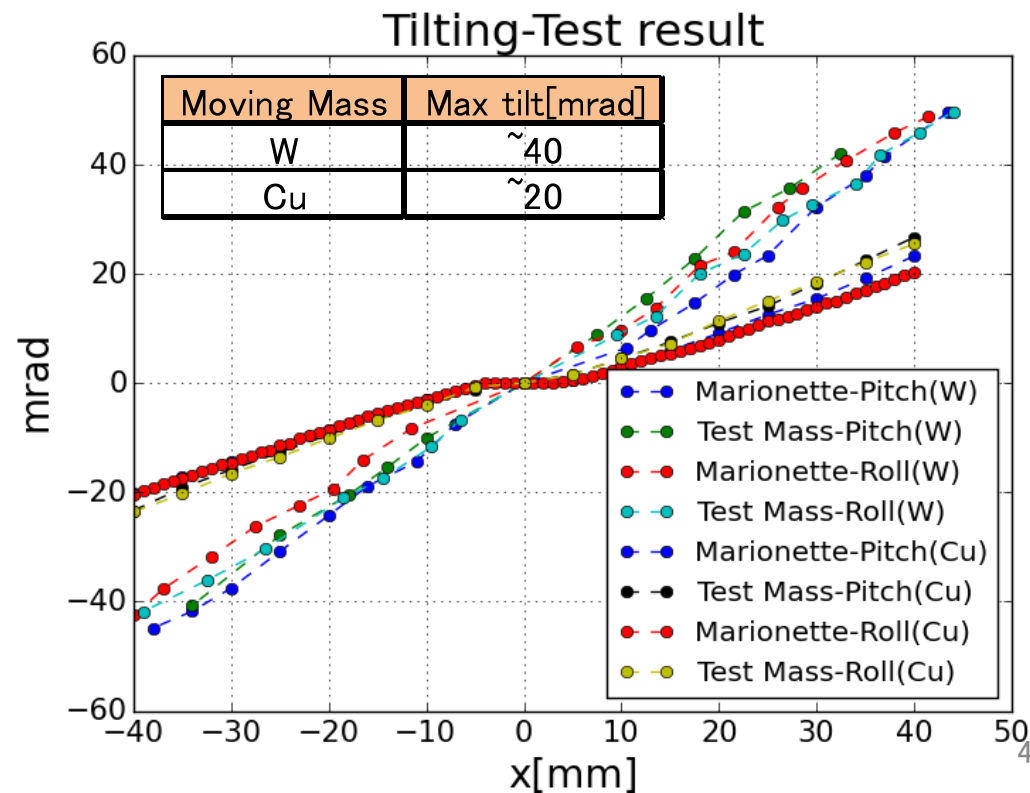


## Marionette and Marionette recoil mass

Mechanism to move masses was changed to another idea, linear ball screw.

We found that it is sufficient to control payload tilting by copper mass.

*By Miyamoto*

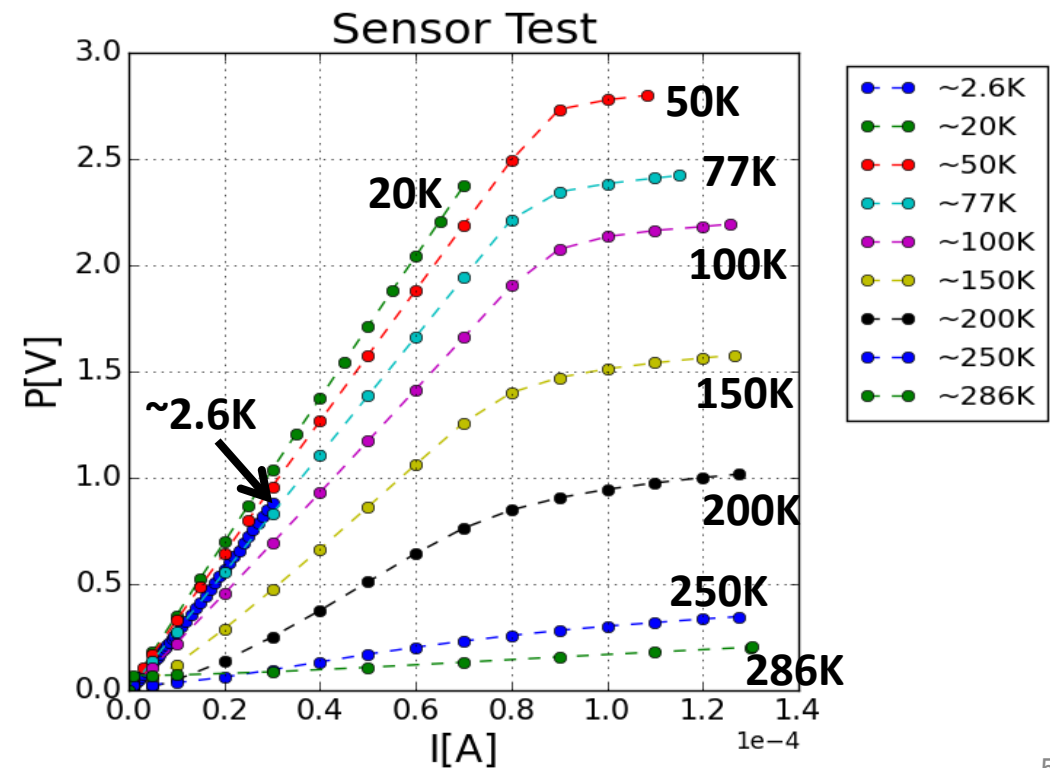
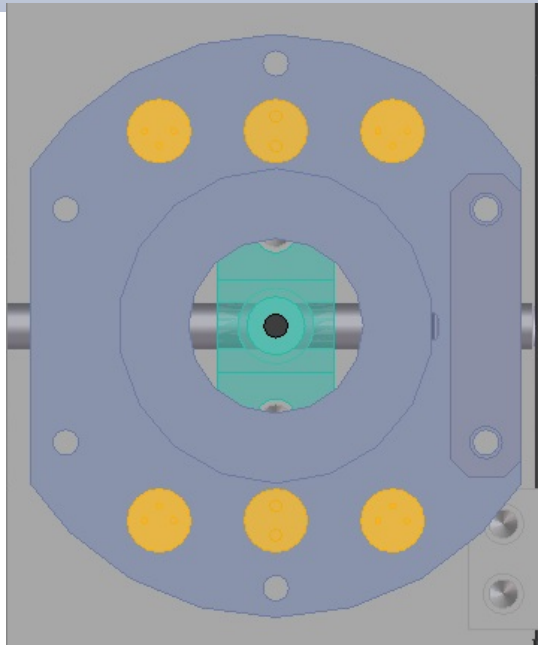
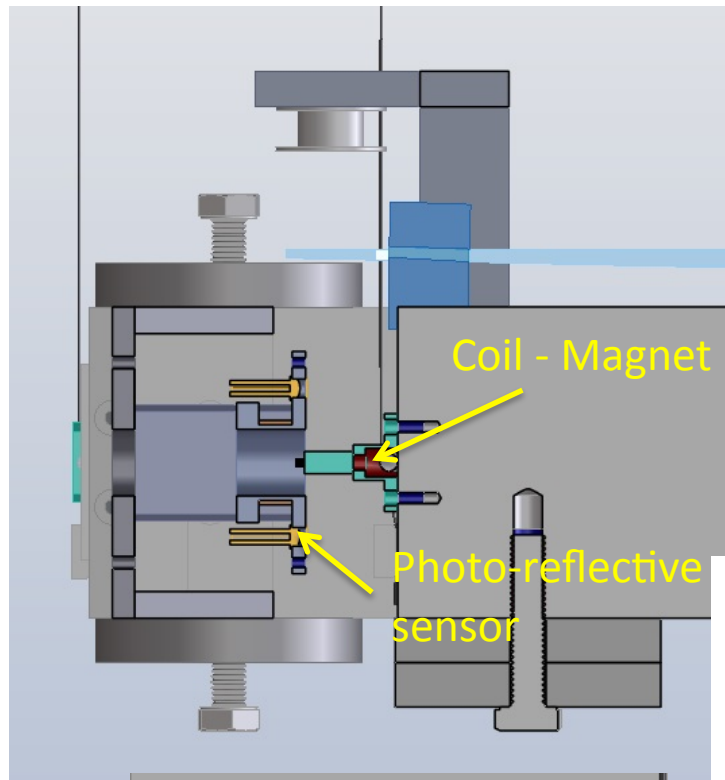


*by Miyamoto*

## Local Sensor & Actuator

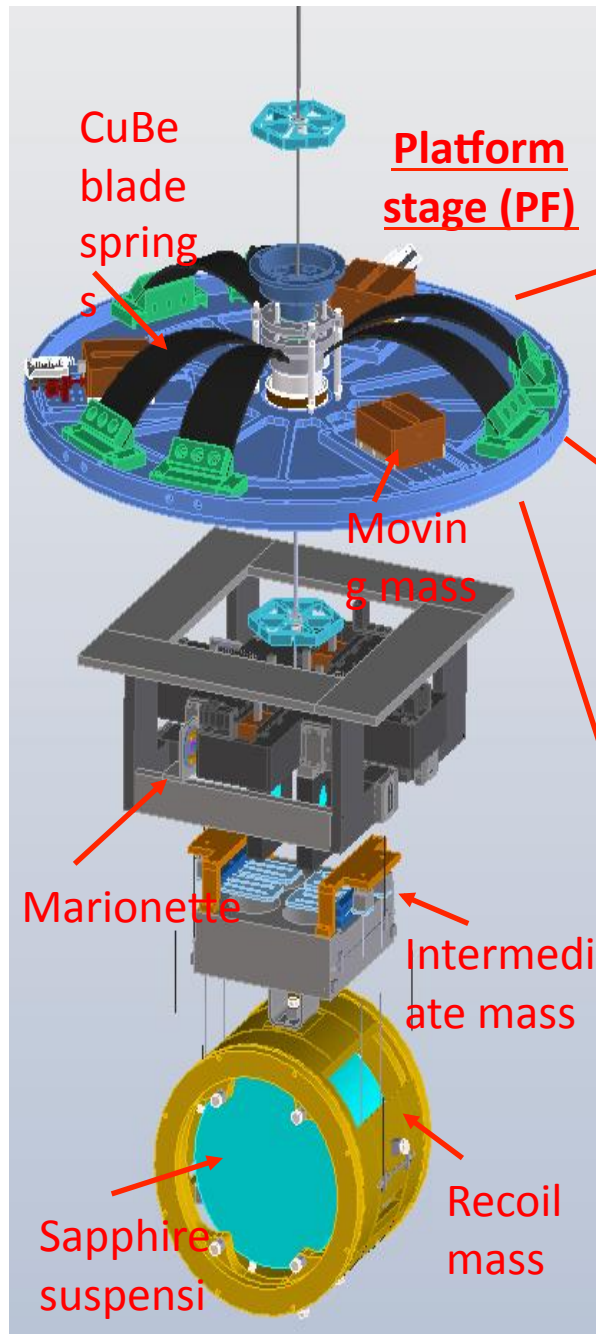
Coil – Magnet actuator + Optical Lever

Cryogenic test of photo-reflective sensor



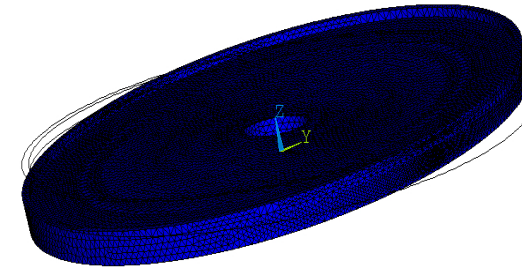
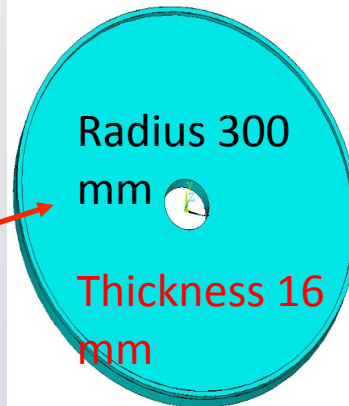


# Platform stage redesign



ons

by Rahul



1<sup>st</sup> mode (ANSYS)

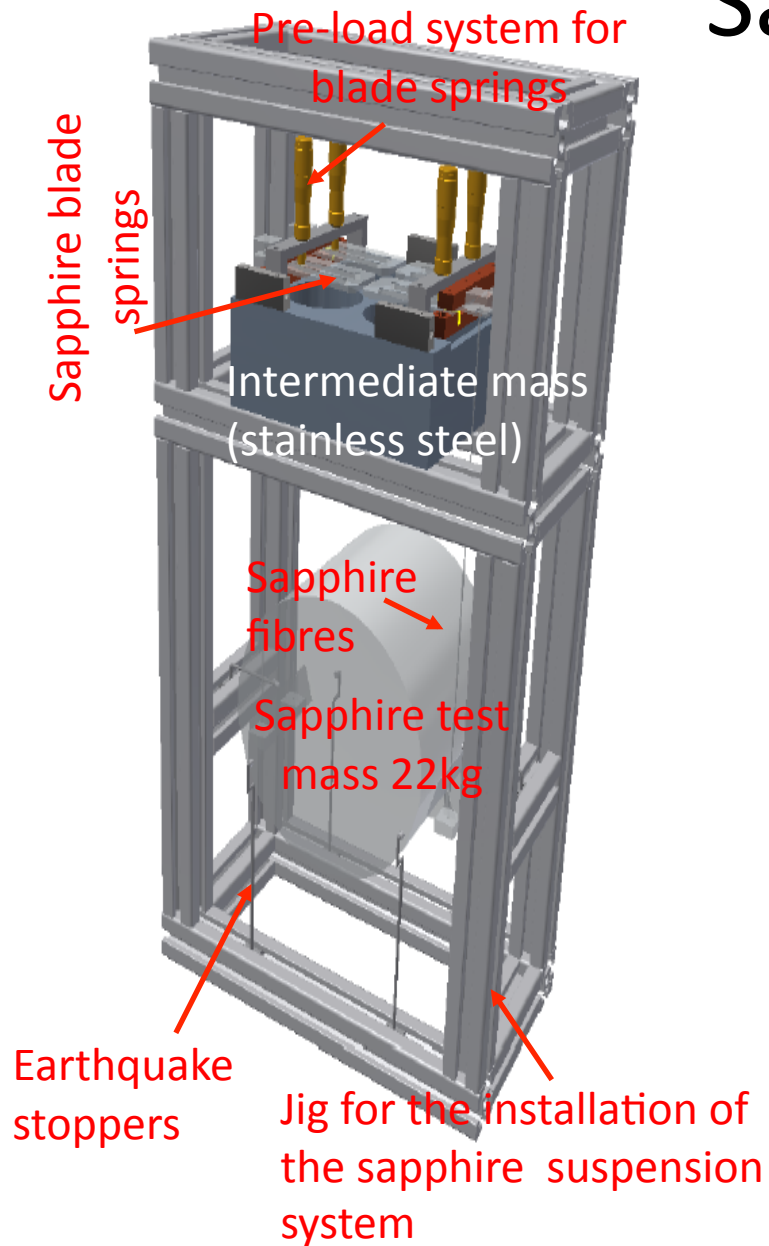
Thickness, mm	Mode 1, Hz	Mode 2, Hz	Mode 3, Hz
16	161	191	250
25	238	285	370
50	441	553	604

Result: Platform base plate of radius 300 mm and **thickness 25 mm** suits our requirement. The mass of the baseplate is around 36 kg. The 6 CuBe blades and their clamps will add another 10-15 kg, taking the total weight of PF stage between 50-55 kg. 6

# Sapphire test suspensions:

## - fabrication & characterization

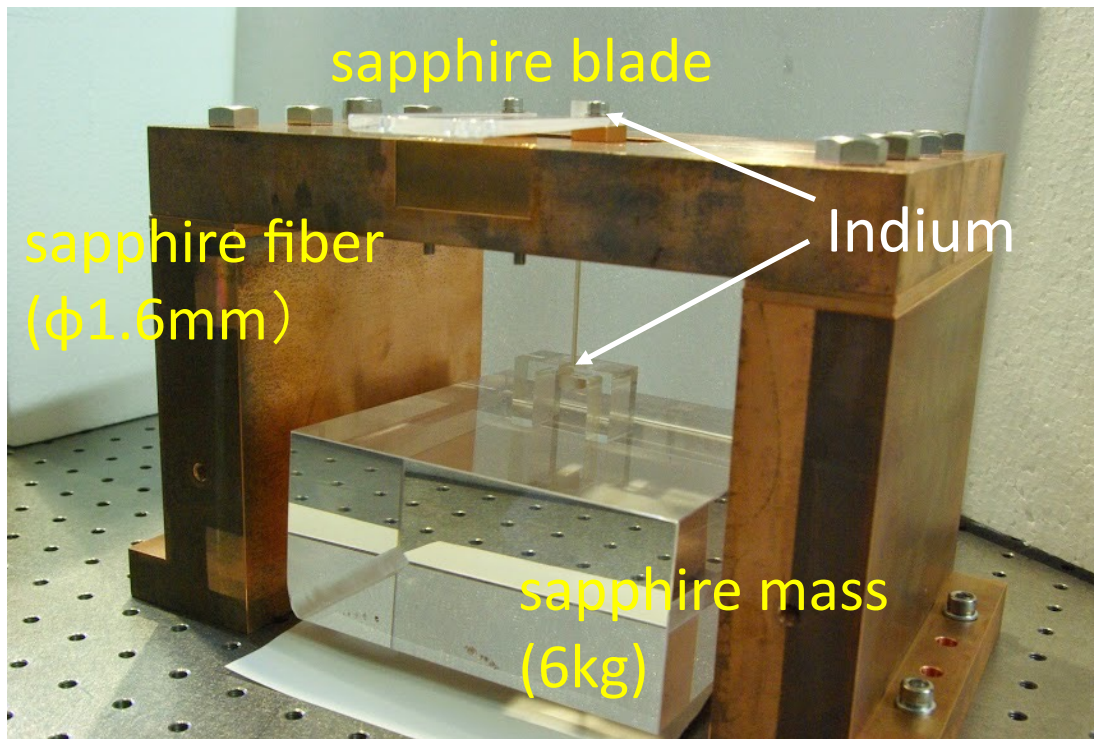
- A prototype sapphire test suspensions has been planned to be fabricated and characterized at KEK & ICRR
- The test suspensions will have sapphire test mass (22 kg), 4 sapphire fibres (1.6 mm diameter, 350 mm length), 4 sapphire blade springs (with pre-load tension)
- The sapphire components will be suspended from 23 kg stainless steel intermediate mass (IM)
- For jointing sapphire components, hydroxide catalysis bonding technique and Indium bonds (few microns thick) will be used.
- A jack (cryo-compatible) will be used for lifting and lowering the test mass after bonding is complete
- The test suspensions will be cooled in a cryostat at 20 K (mirror) and thermal conductivity and Q measurements will be undertaken
- The measured Q experimentally will be compared with the predicted simulations results from FEA, ANSYS



*by Rahul and Kieran*

# One-fiber prototype

*by Tanaka & Yamamoto*

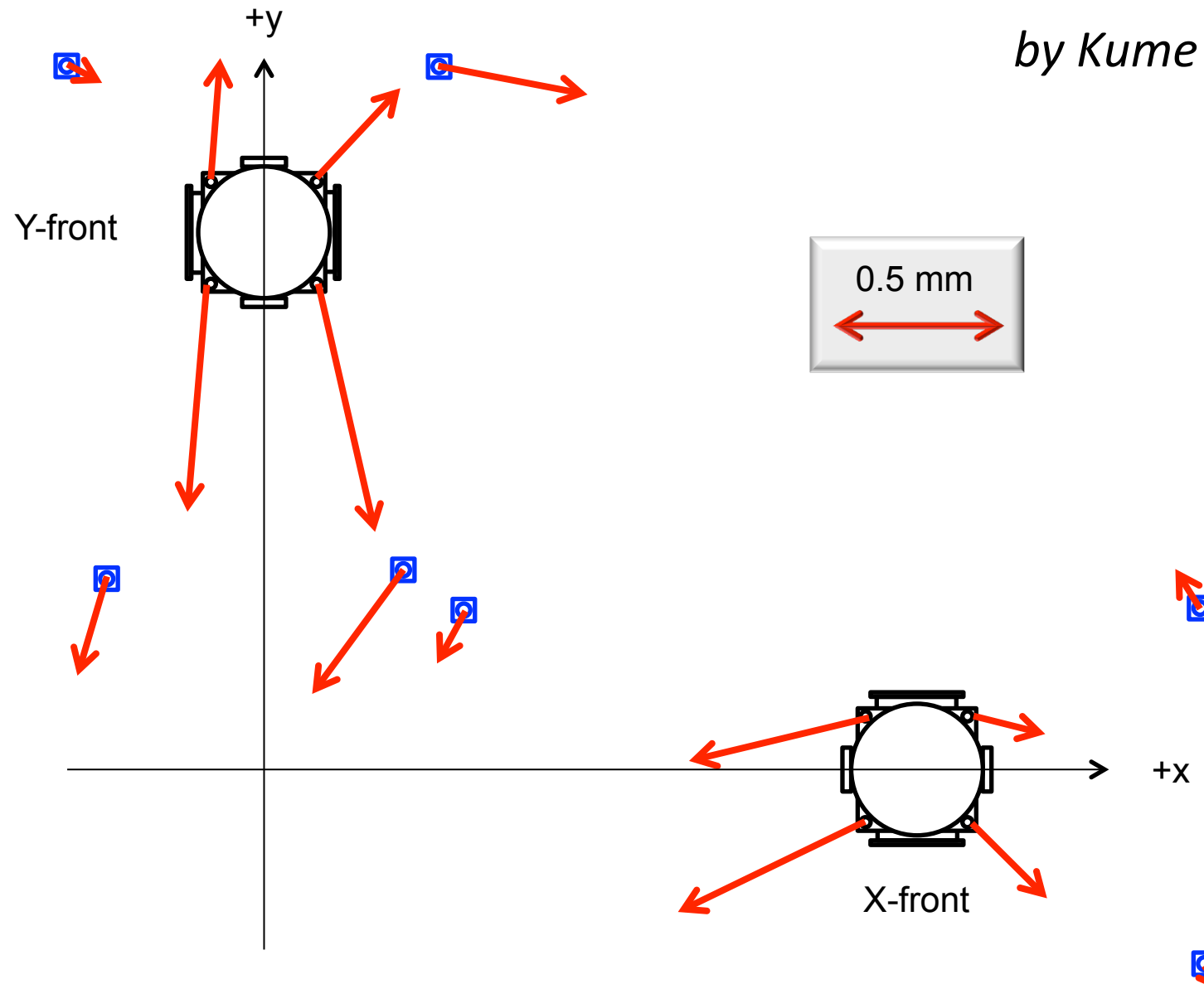


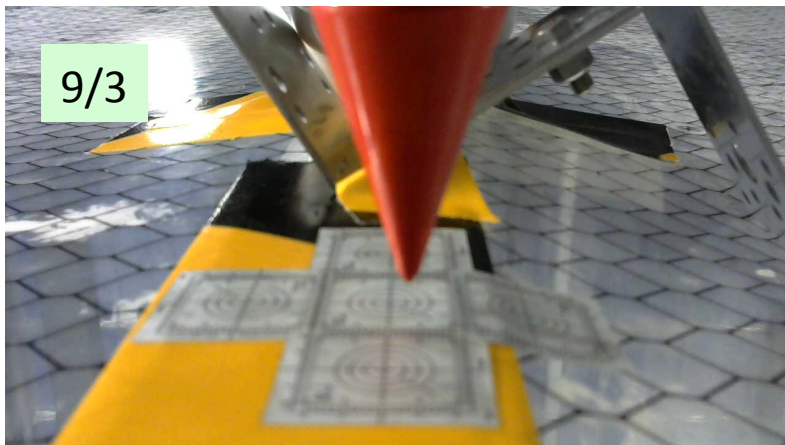
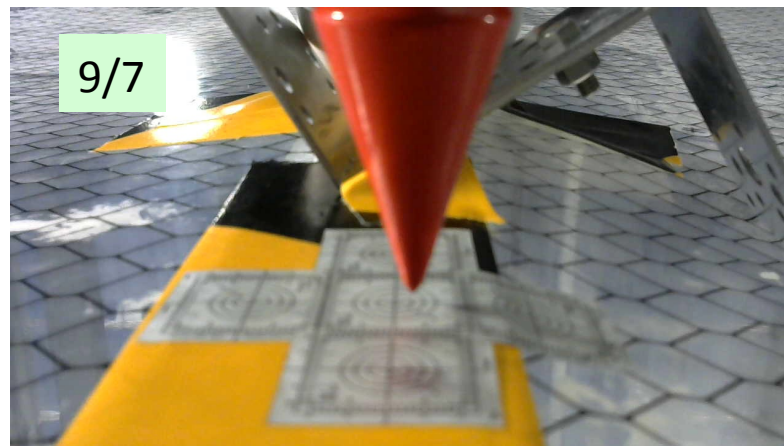
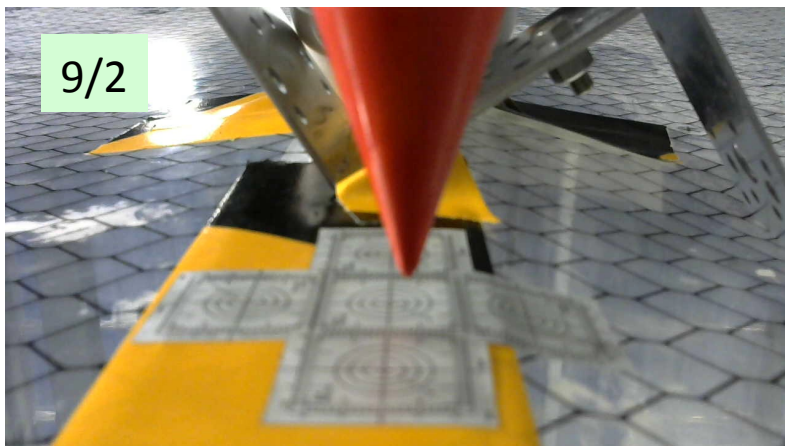
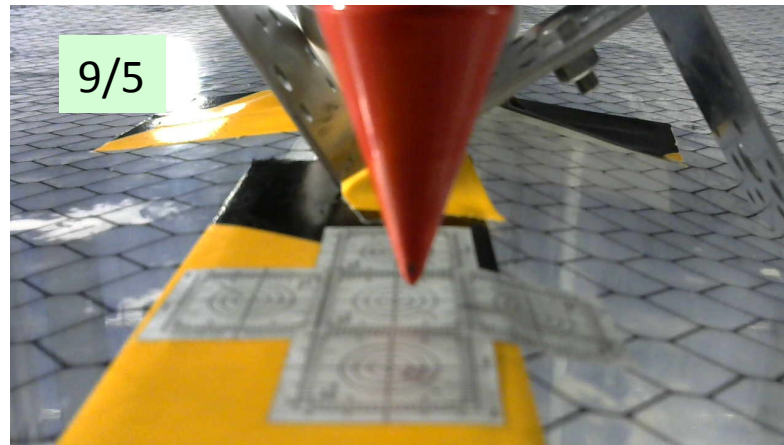
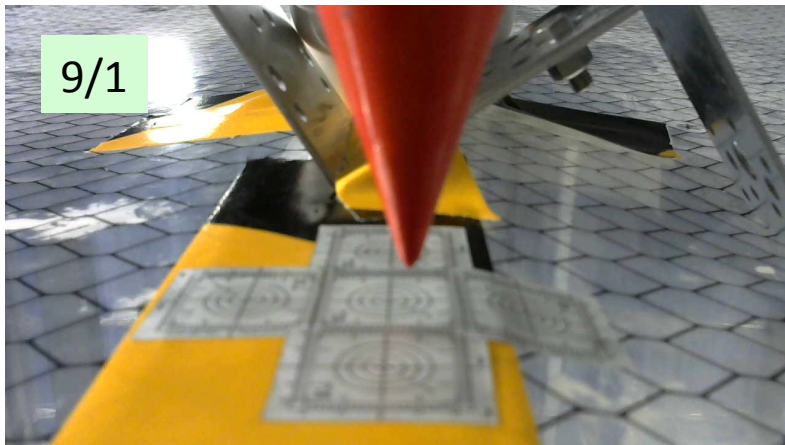
We will insert the indium between the blade and the fiber head, and between the hanger and the fiber. Then we will make the indium melted. This method (Indium welding) will be used in KAGRA.

We will check whether the mass is cooled down to 20K and the Q value of the one-fiber prototype.



# Horizontal Motion@X,Y-front(May 26-29->Sep. 10-11, 2015)





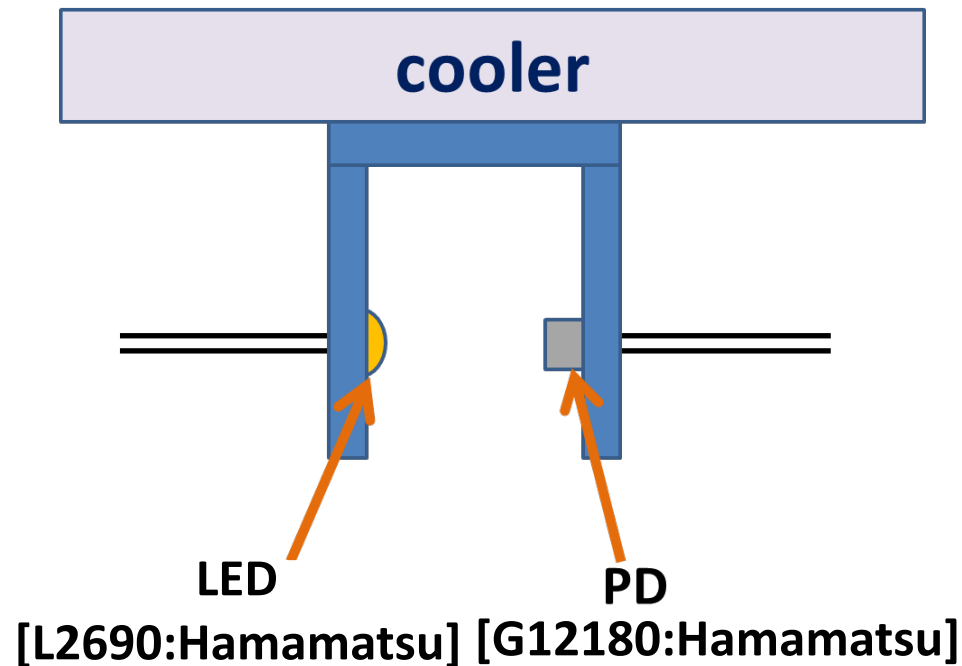
Creeping of string?

I will exchange the string today.  
And we will purchase 2-axis  
tilting meter.

*by Tomaru*

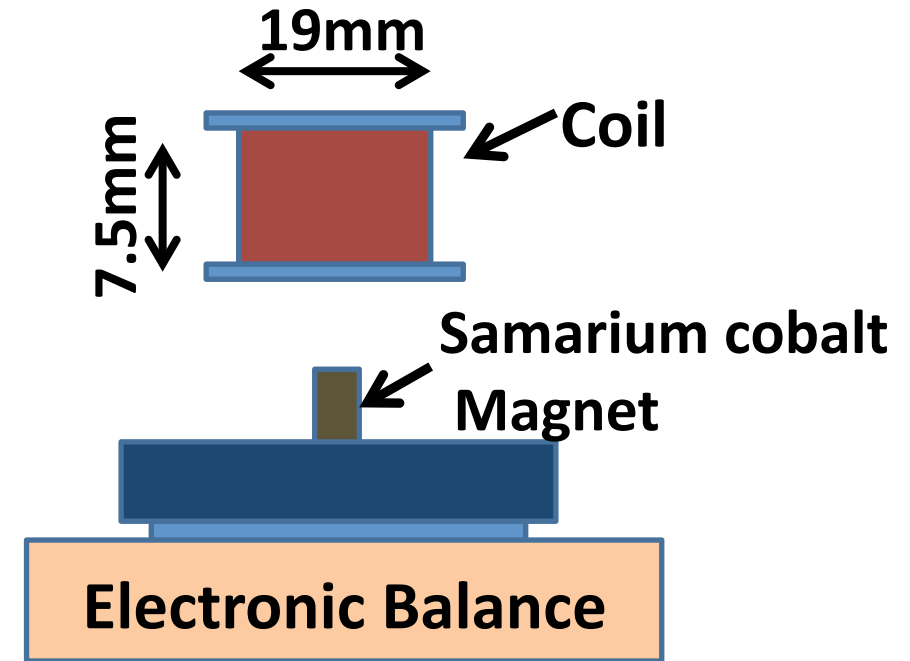
# Backup

## Sensor and actuator Test



We confirmed that this sensor operated in low temperature ( $\sim 4\text{K}$ ).

We will test it as displacement sensor.



Coil : 500 winding ( $\Phi 0.1$ , Cu-wire)  
Magnet :  $\Phi 2\text{mm} \times 2\text{mm}$

We measured the biggest power to act between a coil and magnet (at 100mA).

Power of maximum 1.6mN acted by this combination.

## status of procurement and budget

Table 1: Cryogenics Subgroup 2015 Budget

Items	Allocation (¥)	Spent (¥)	Residue (¥)
Duct Shield	$1.3 \times 10^8$	$1.092 \times 10^8$	$2.08 \times 10^7$
Cryo-payload	$1.64 \times 10^8$	$4.571 \times 10^6$	$1.59 \times 10^8$
Cryocooler Unit	0	0	0

Two sets of Duct Shield are in manufacturing.  
Residue will spend for a facility or common works.

One set of cryopayload will be fabricate in this financial year.  
Remaining will be carry forward to the next year.

Production of cryocooler unit has been finished.  
Incidental facilities such as cooling water supply and gas piping will construct.