

Status of KAGRA Vibration Isolation System

Y.Fujii*, T.Sekiguchi^A, R.Takahashi, M.Barton, F.E.P.Arellano, H.Ishizuka, A.Shoda, K.Okutomi, T.Miyamoto^A, K.Hayama^B, Y.Aso, T.Akutsu, H.Ishizaki, D.Tatsumi, N.Hirata, R.Flaminio
*yoshinori.fujii@nao.ac.jp NAOJ, ICRR^A, OsakaCU^B

1. Introduction

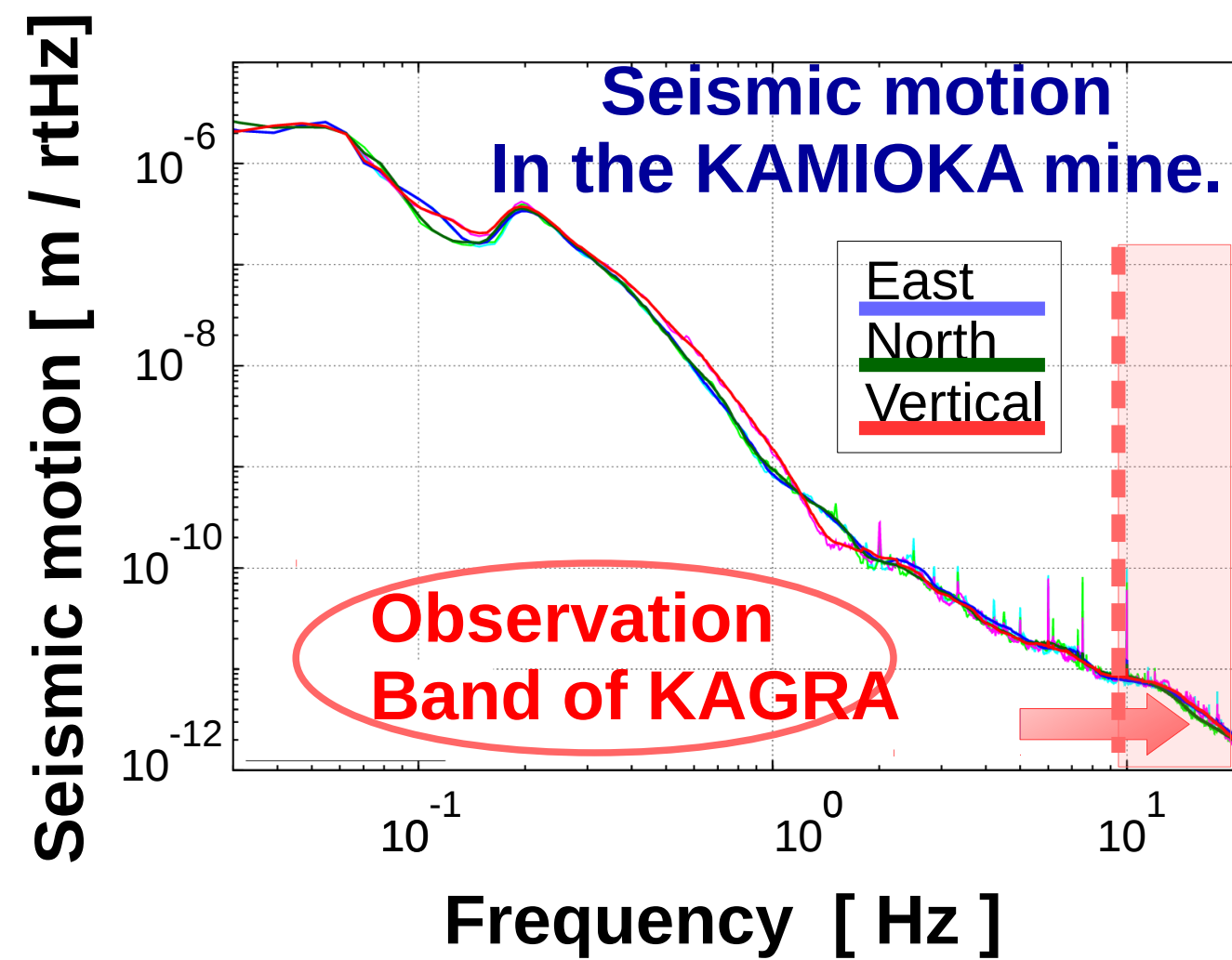
We present the status of **vibration isolation system (VIS)** of the Large-scale Cryogenic Gravitational-wave Telescope (**KAGRA**). KAGRA will be operated at the cryogenic temperature of 20 K under the ground. A test run with the interferometer operated at room temperature is planned this year (iKAGRA). We **assembled one prototype Seismic Attenuation System** for the beam splitter of KAGRA, which we call type B. The vibration isolation performances of the prototype are being tested in vacuum at NAOJ (Toyko, Mitaka). In this poster, we present the concepts and current performance of the KAGRA type B suspension system.

2. KAGRA Seismic Attenuation System (Type A/B/C)

Seismic motion

The **ground always vibrates** at low frequencies with the amplitude of a few μm .

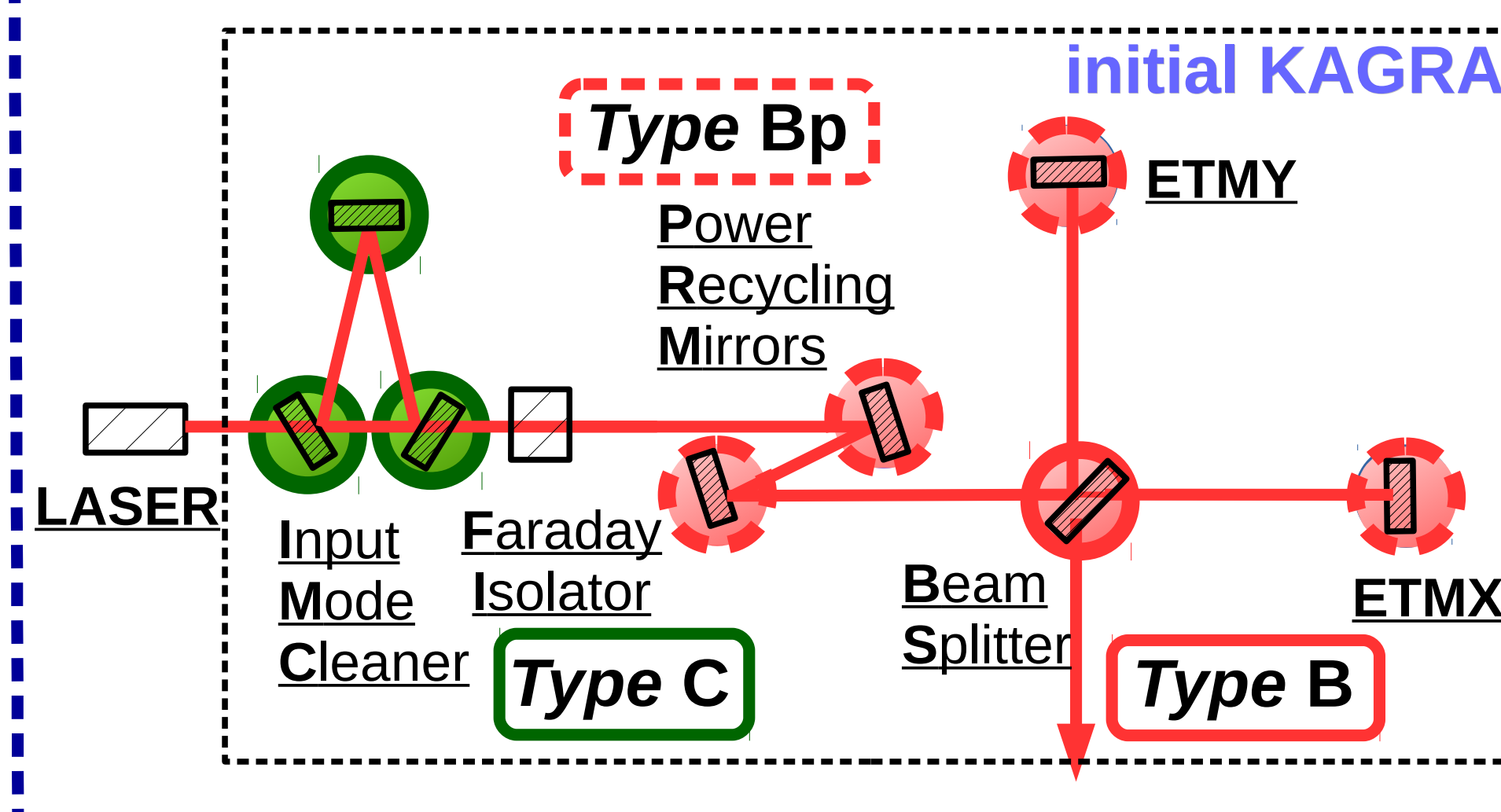
This **seismic motion** has to be Attenuated, **not to transfer** the seismic vibration **to the mirrors**.



KAGRA SAS

Mirrors for ground based gravitational wave detector are suspended to attenuate the seismic motion.

- Purpose of KAGRA Seismic Attenuation System (SAS); attenuate the seismic motion **over 10 Hz**



Type A

- For **bKAGRA TM**
- 7 stage pendulum
- With **Cryogenics**
- Height is 13 m.

Type B

- For **BS, bKAGRA SRMs**
- 5 stage pendulum

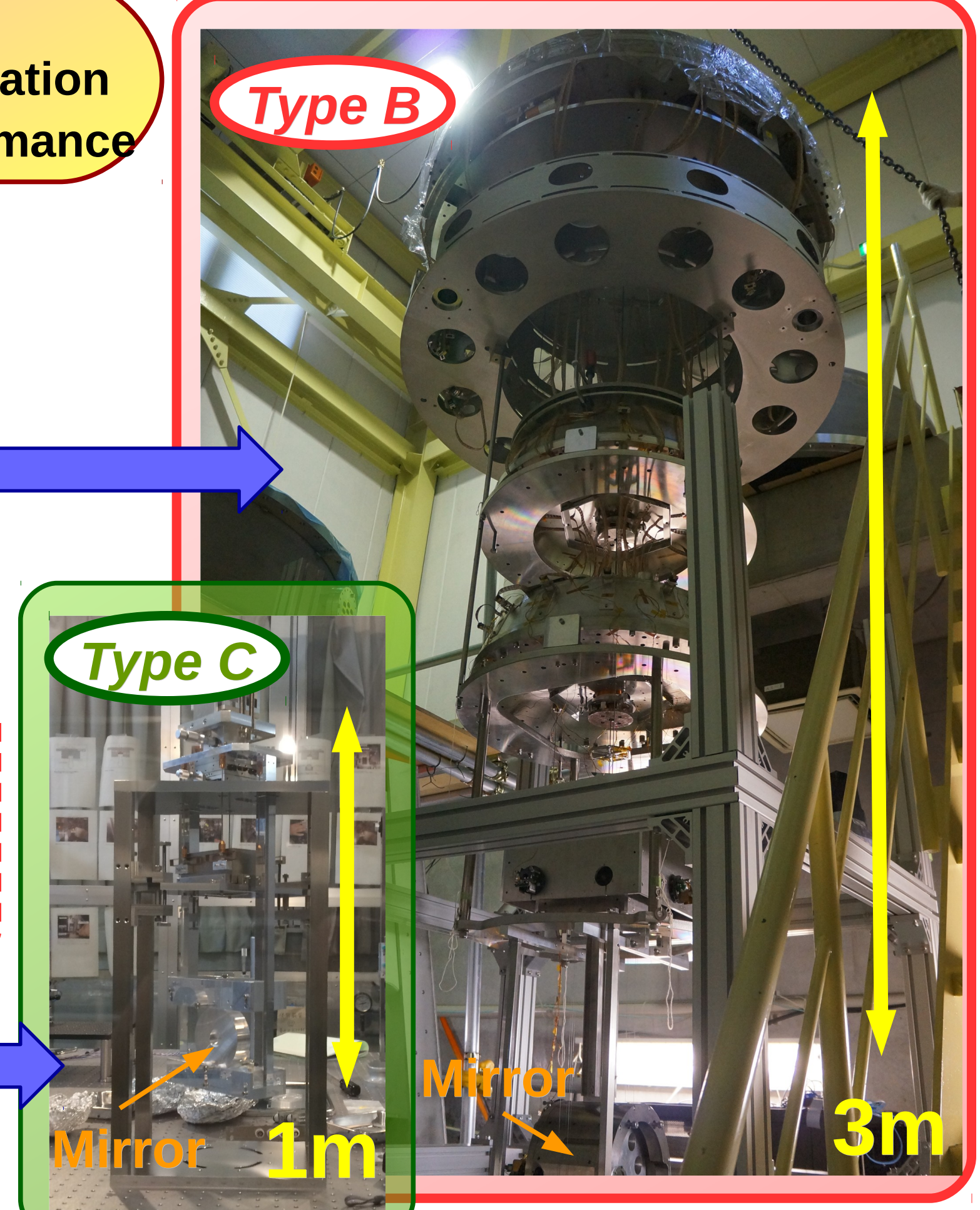
Type Bp

- For **PRMs, iKAGRA TM**
- 2 or 3 stage pendulum

Type C

- For **Mode Cleaner**
- Double pendulum

Type B

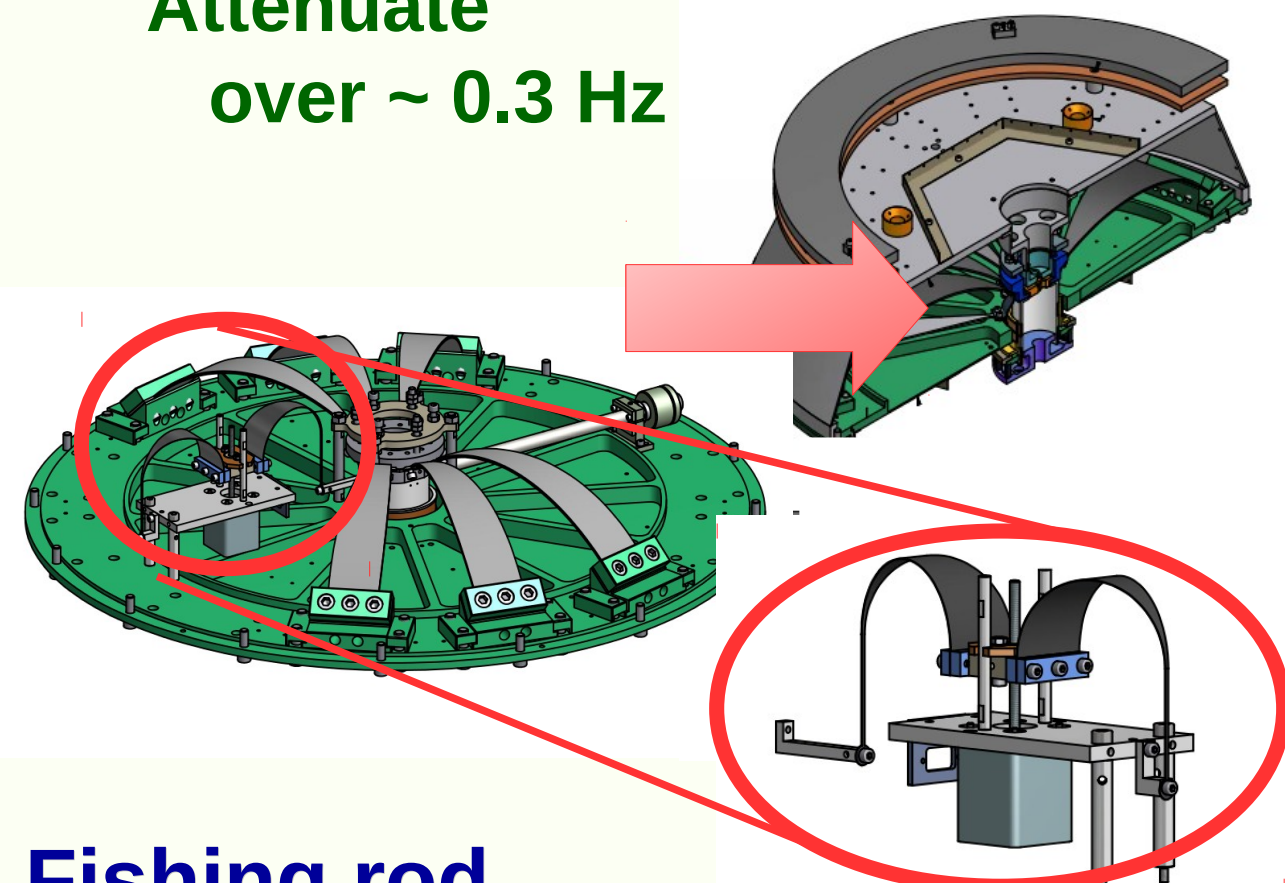


3. TypeB SAS details

Geometric Anti Spring(GAS) filter

- Vertical Seismic Filter

Attenuate over ~ 0.3 Hz

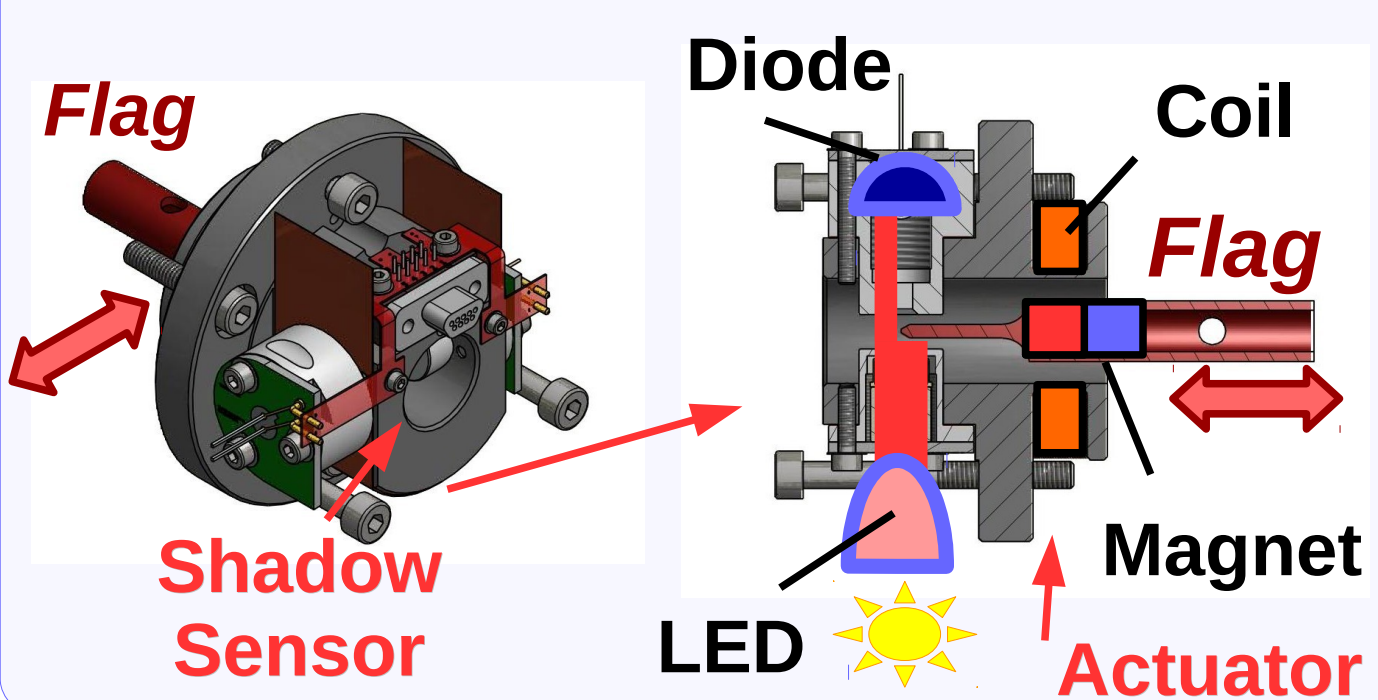


Fishing rod

- GAS filter height adjustment

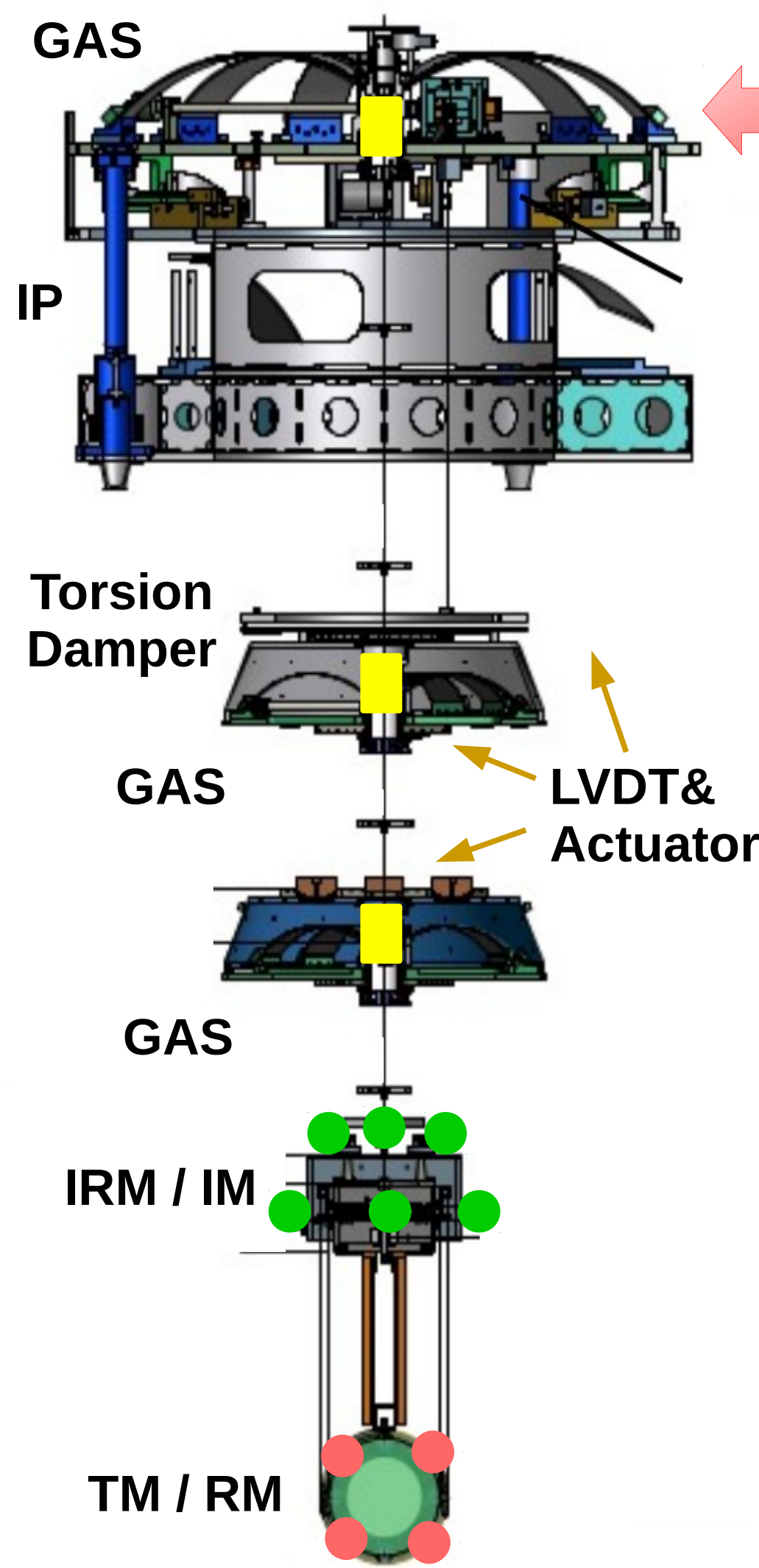
Optical Sensor and Electro-Magnetic actuator (OSEM)

- Contact free displacement sensor and coil-magnet actuator

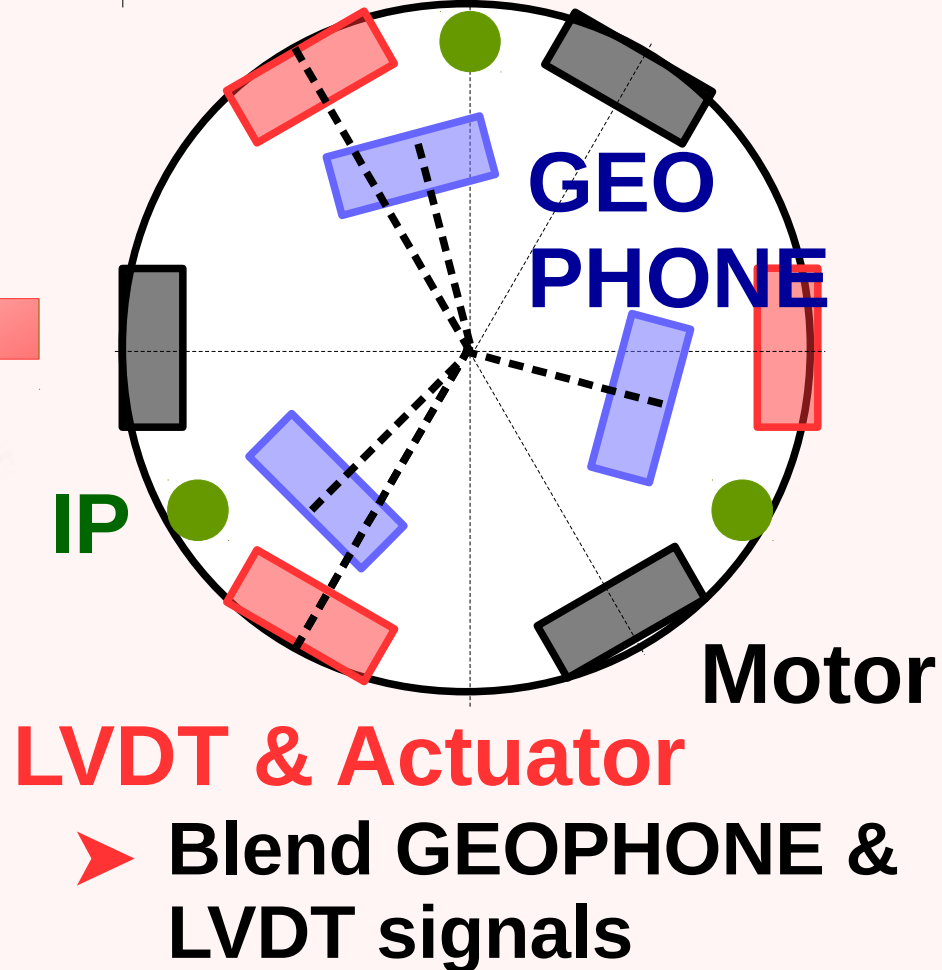


Inverted Pendulum (IP)

- Horizontal Seismic Filter
- Attenuate over ~ 0.1 Hz



Pre-Isolation Stage



- Torsion Damper**
- Eddy current damper
- Attenuate low frequency wire torsion mode

OSEMs in TypeB

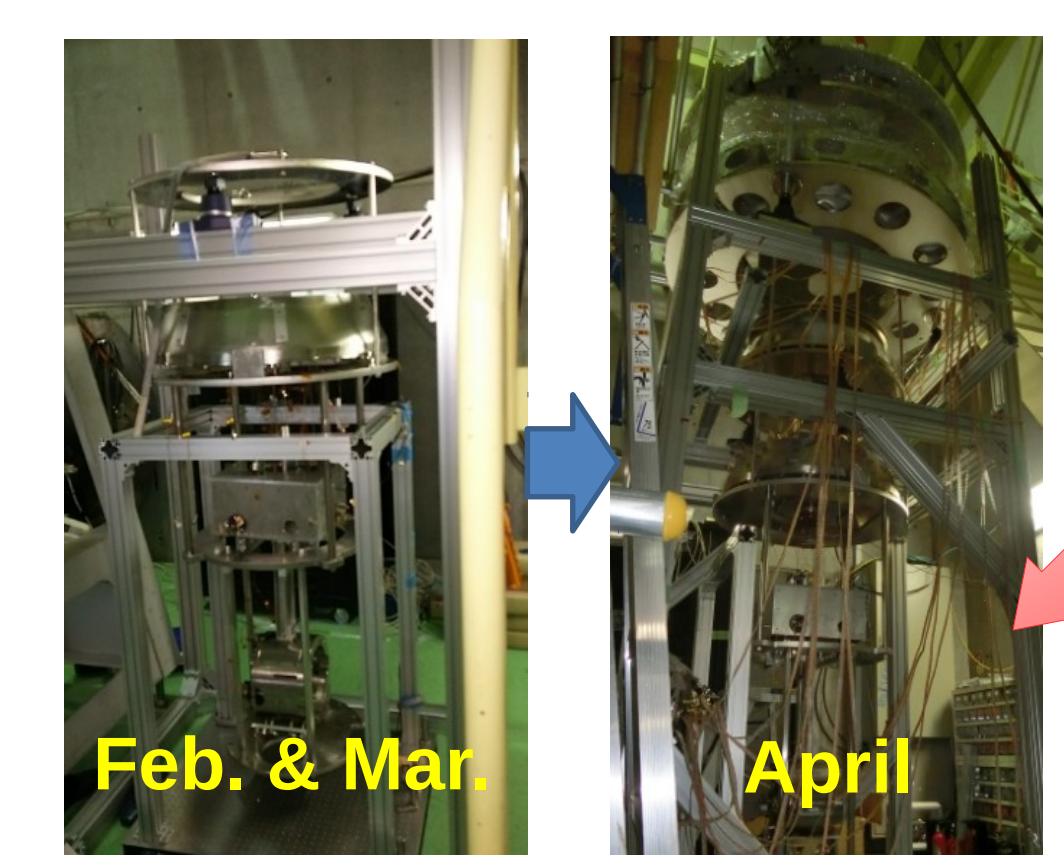
- Local control for damping provided by 6 or 4 OSEMs
- Intermediate Recoil Mass & Intermediate Mass (6)
- Recoil Mass & Test Mass (4)

4. Production / Setting

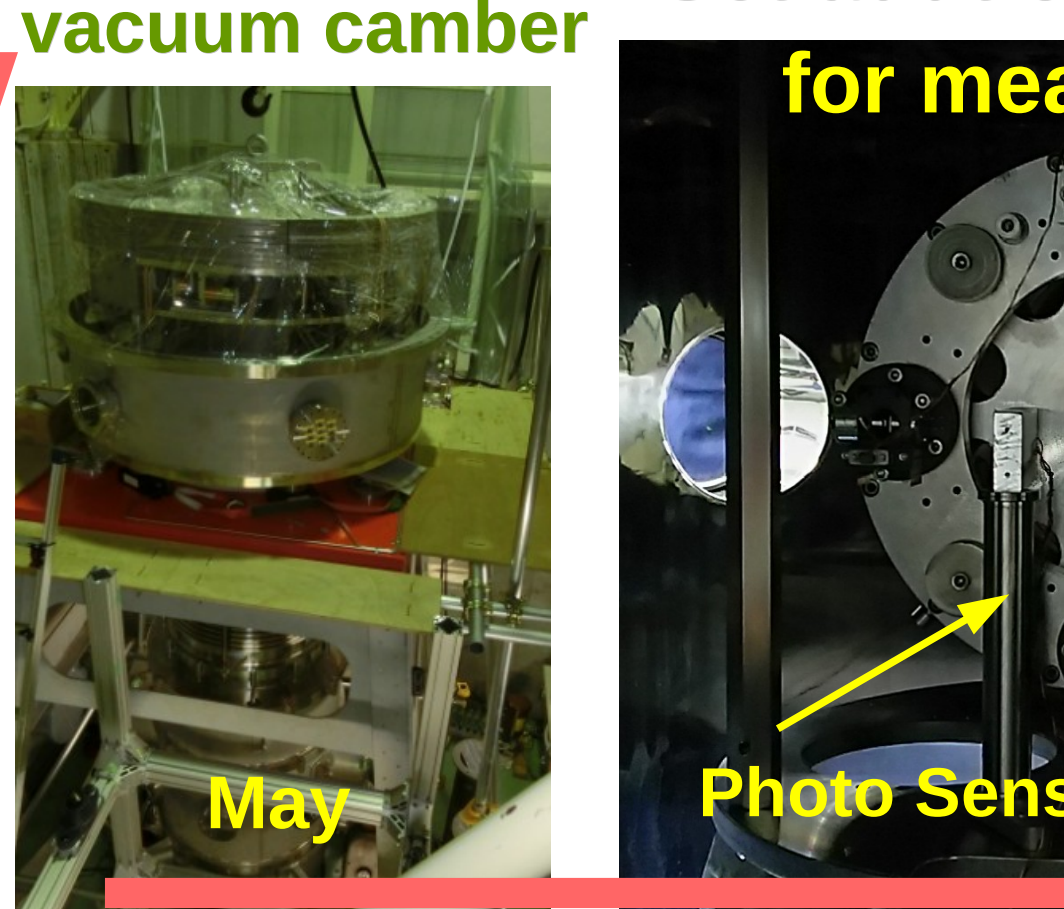
Assemble



Make GAS filter Chain



Install inside vacuum chamber



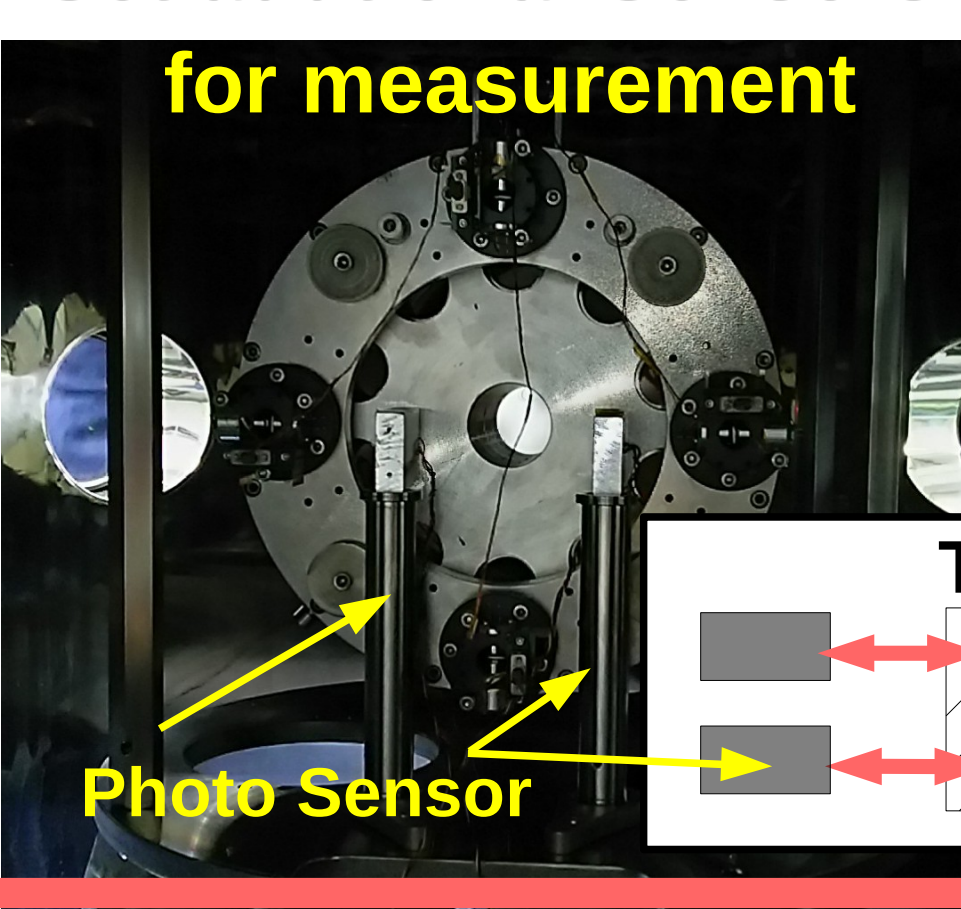
Response Check

- Output Signals
- Transfer Functions
- Power Spectrum

Compare with Simulation

- Any strange response?
- Yes: Debug the system
- No: Assemble other parts

Set additional Sensors for measurement



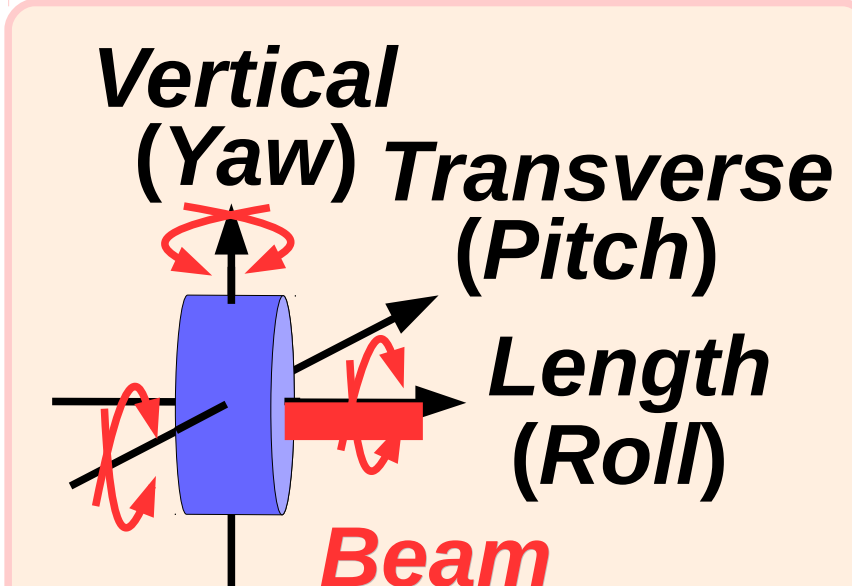
Pump down

- Test under the vacuum is ready

5. Frequency Response in the Air

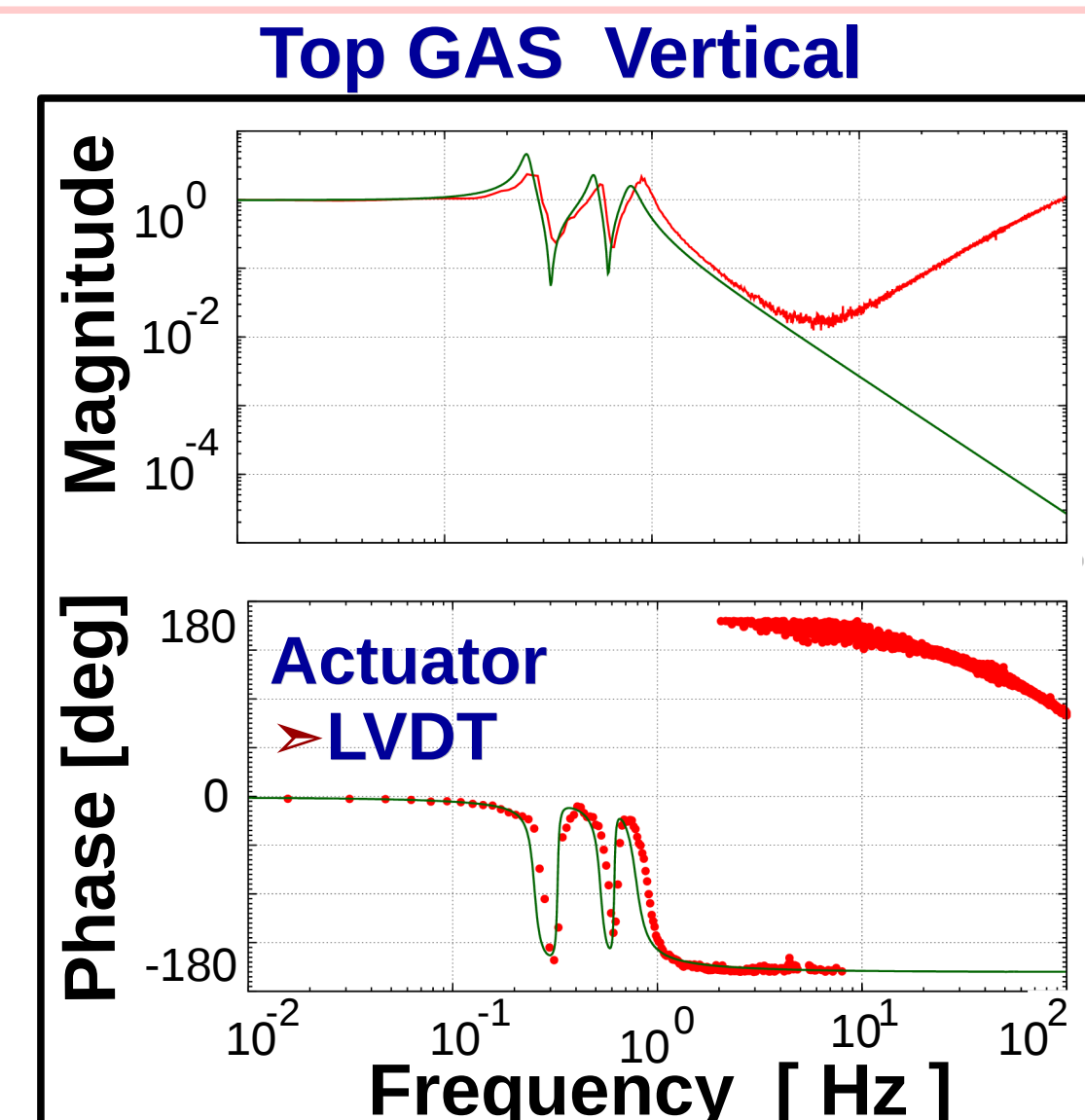
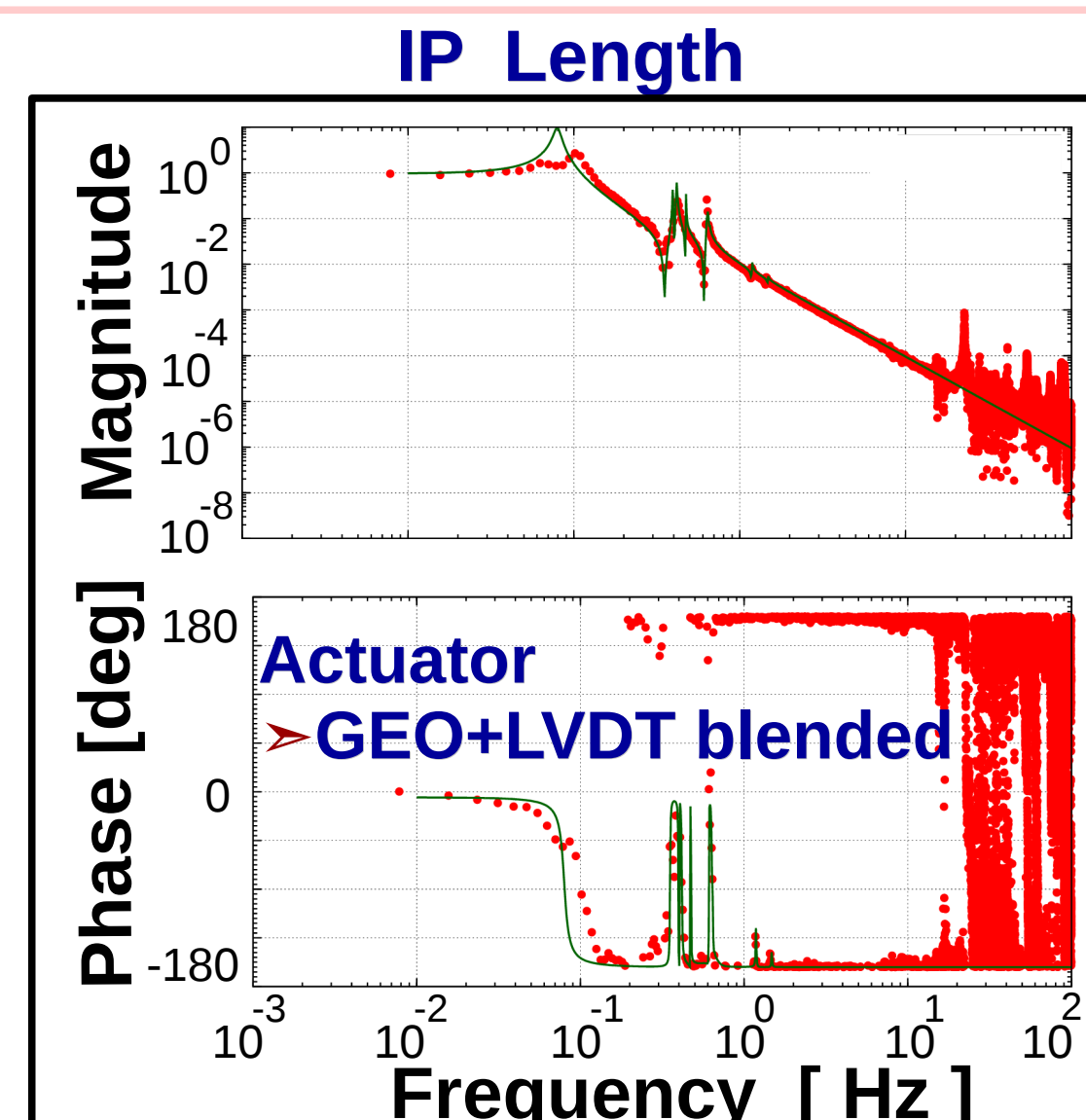
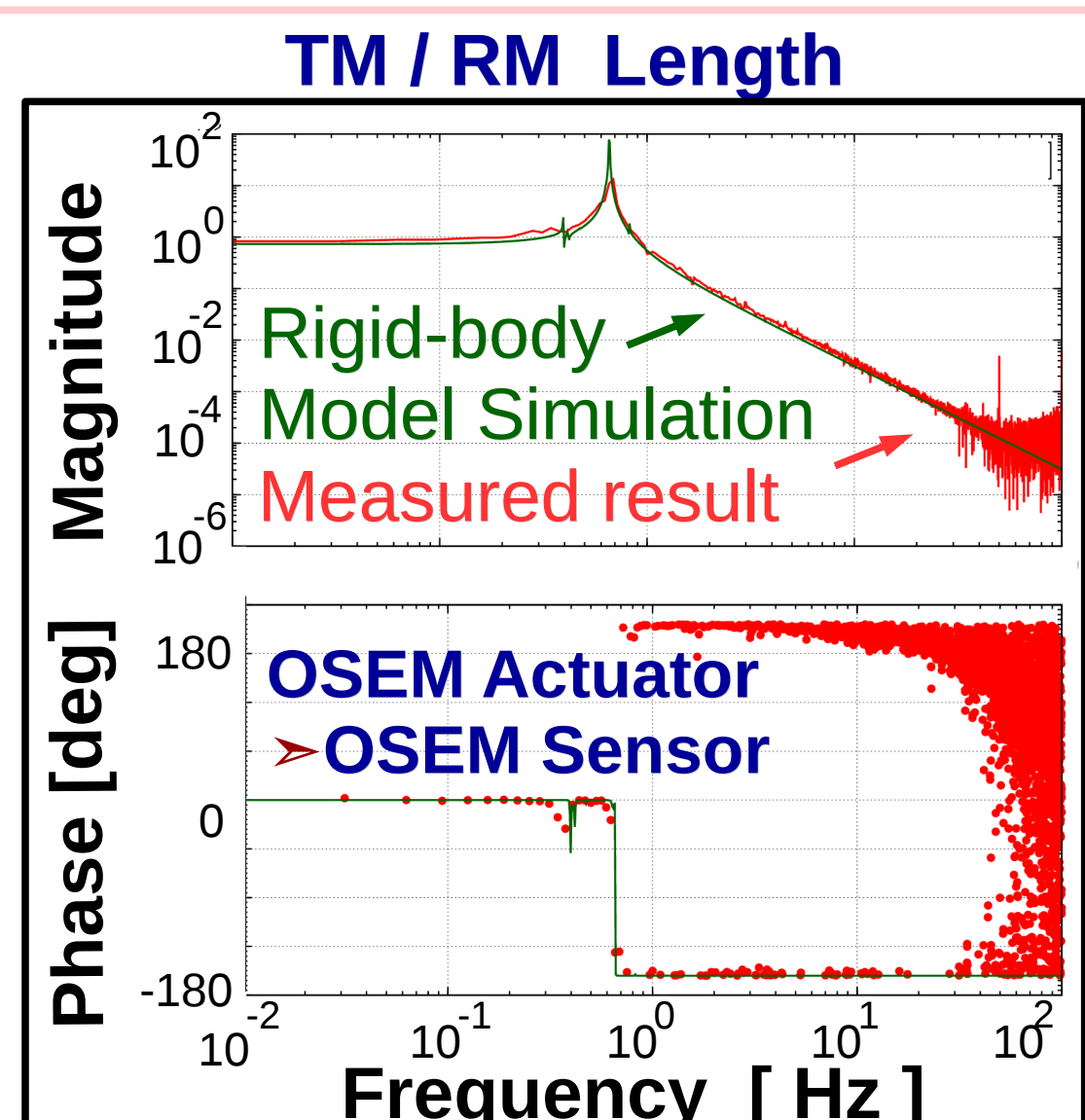
Transfer Functions

- From Force to Sensors
- Without control loop



- DoF in Measurement

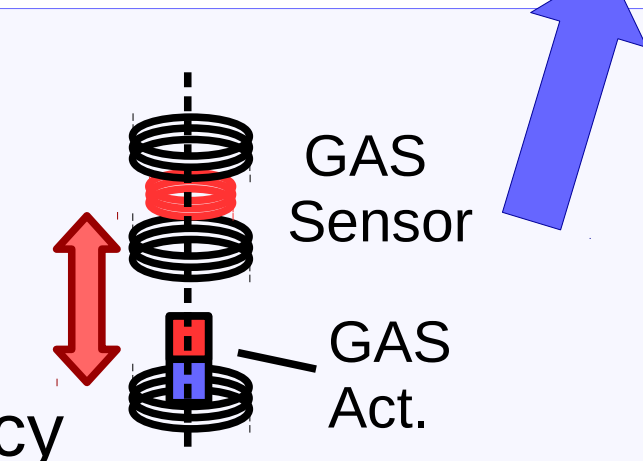
IP 3 (L, T, Y)
GAS 1 (V)
IM / IRM 6 (ALL)
TM / RM 3 (L, P, Y)



differences remain > causes mostly identified

- Idealized simulation;**
- Asymmetry of IPs
- Difference of CM position
- IP(80 mHz)

- Not mechanical response**
- Direct electromagnetic coupling of GAS actuator and sensor
- Difference in High Frequency



The transfer functions of the SAS is confirmed as designed

6. Summary

✓ We assembled one whole Type B SAS prototype and confirmed that the transfer functions of the SAS worked as we designed. Now TypeB prototype test under vacuum is ready.

Future Work : start test

- Confirm local control loop
- Test performance with control loop in vacuum
- Evaluate long term stability

After the test -----

Assemble 5 more iKAGRA SASs similar to this type and Install into the Kamioka mine.