

LCGT

June 14, 2007

PAC 22 @ Caltech

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National Astronomical Observatory of Japan



Program Overview



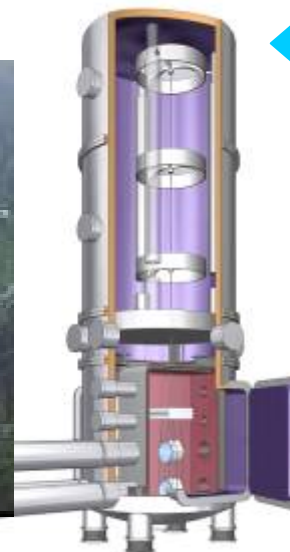
Aso's Experiment

- SPI



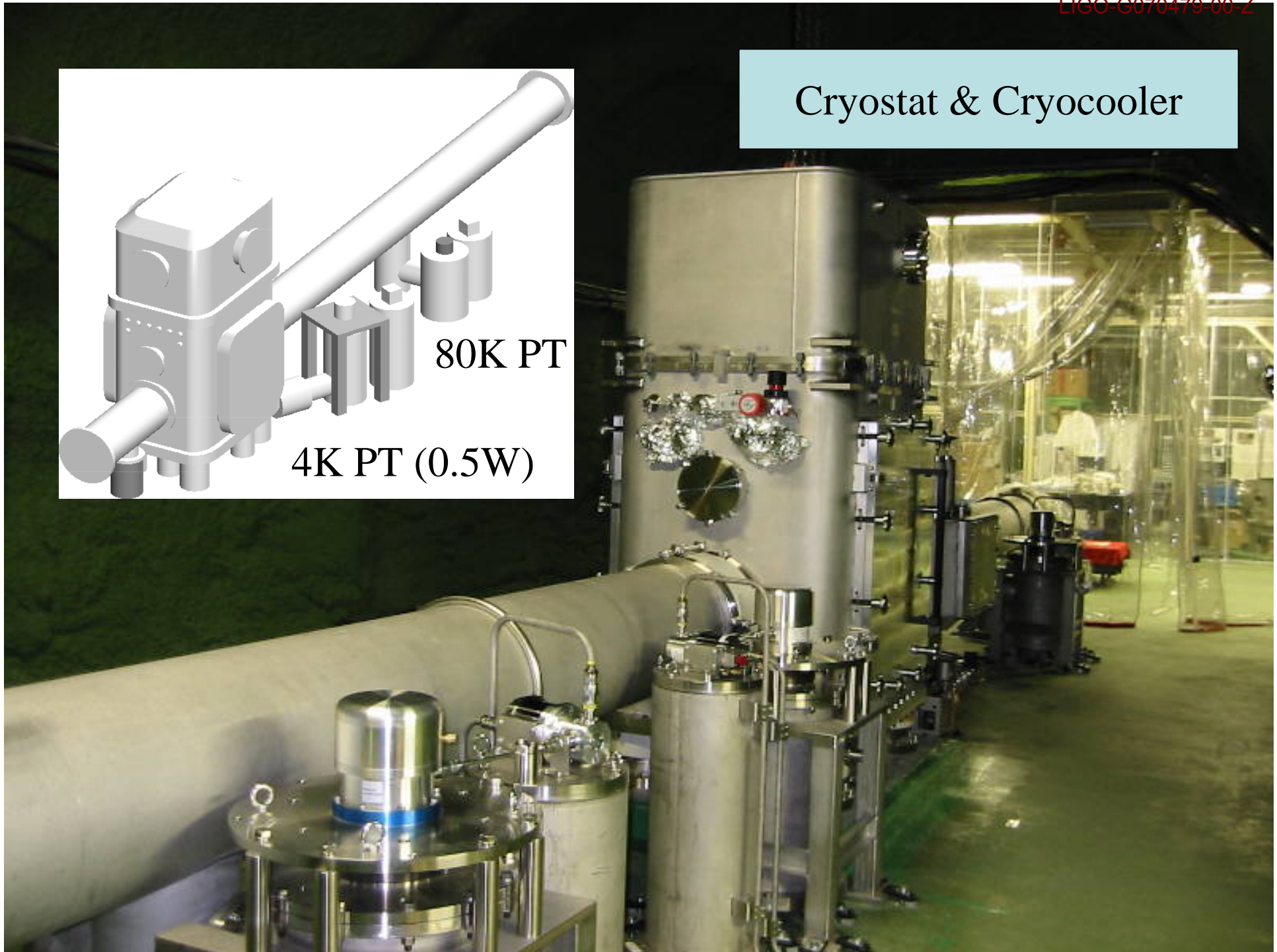
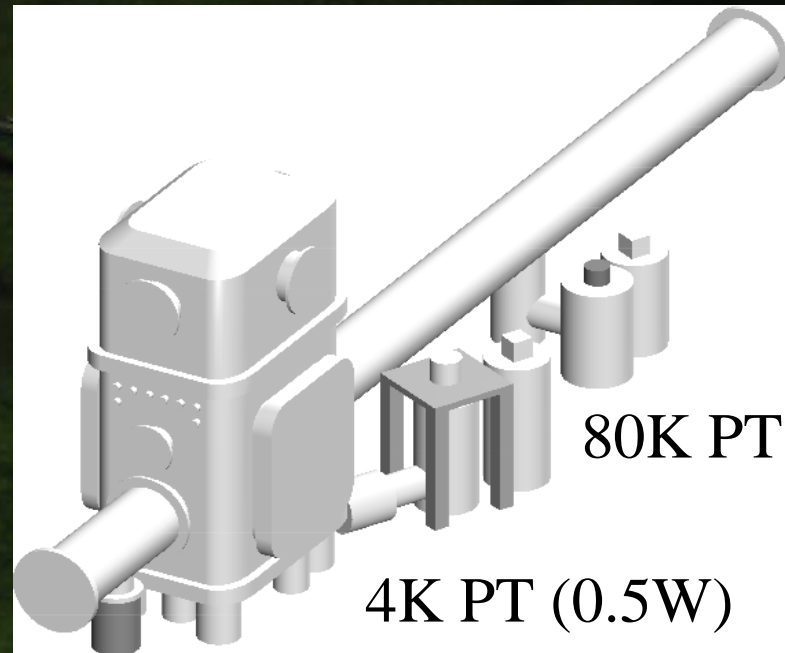
- SAS

- Cryogenic
- Kamioka Mine

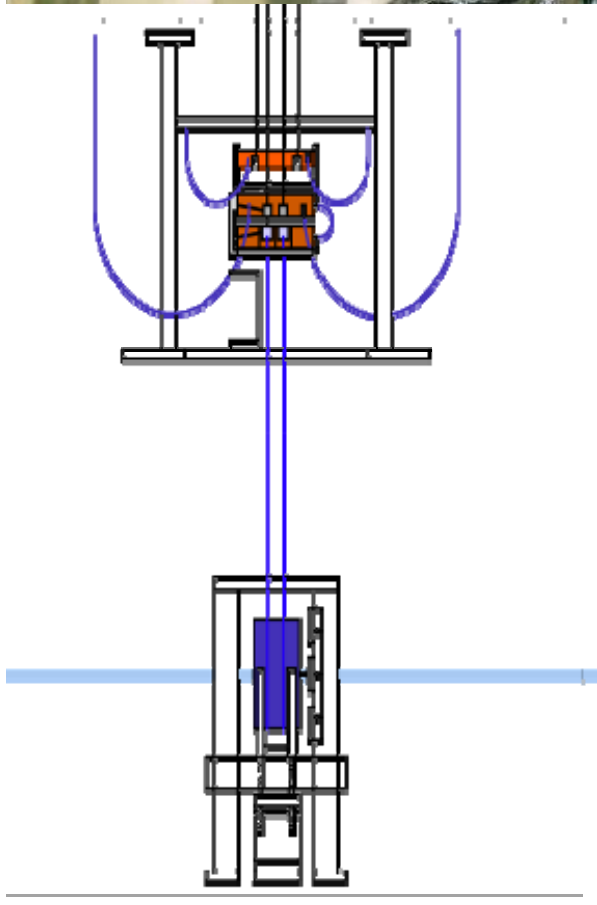


CLIO (Cryogenic, Mine)

Cryostat & Cryocooler



Cryo-suspension



10K

Intermediate mass

20K

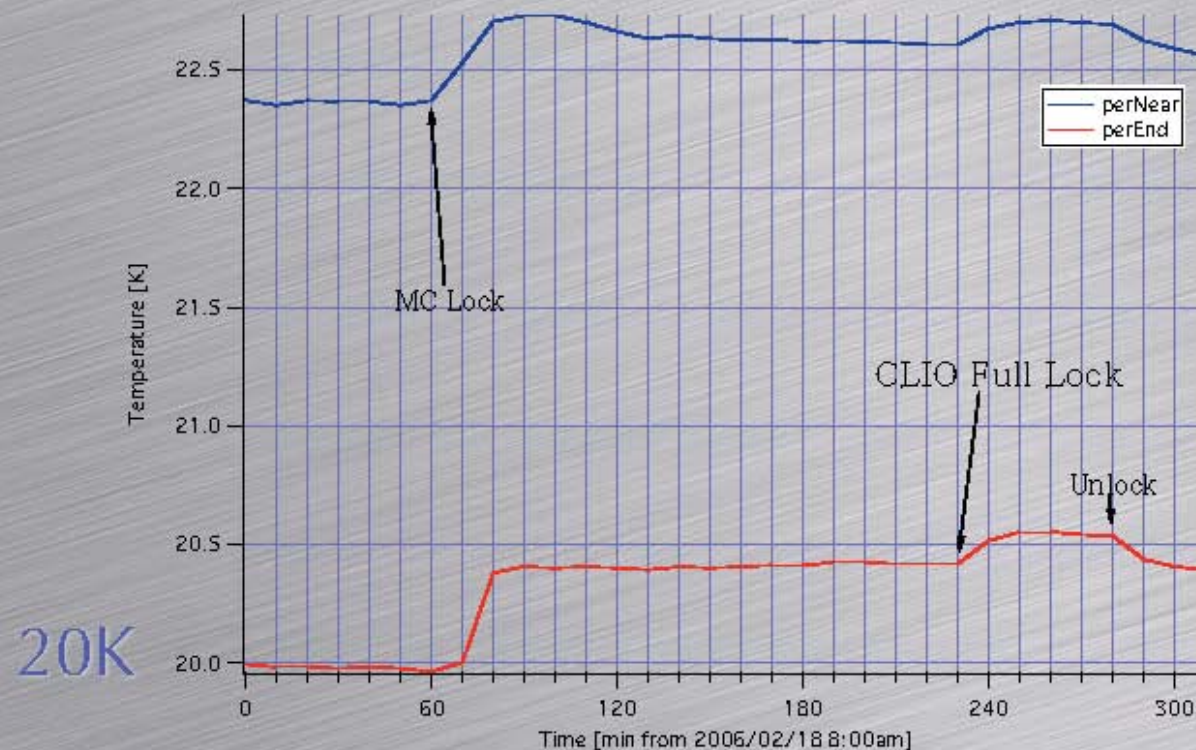
Sapphire mirror



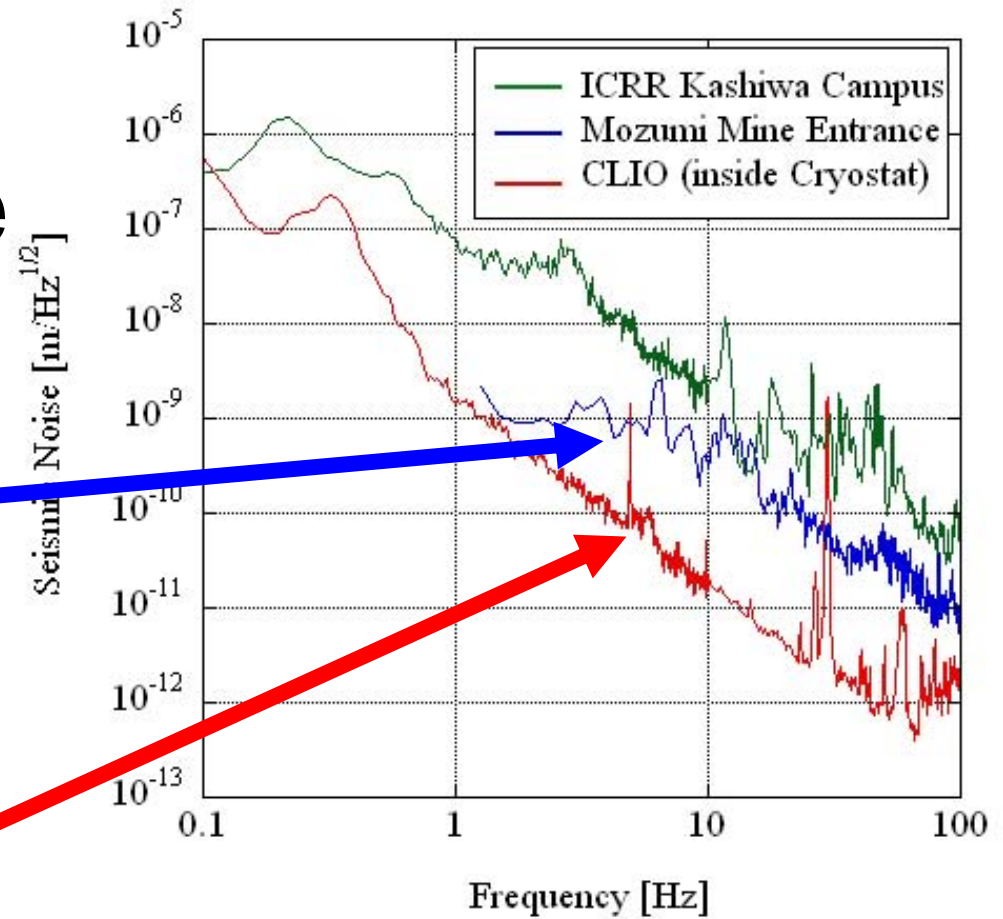
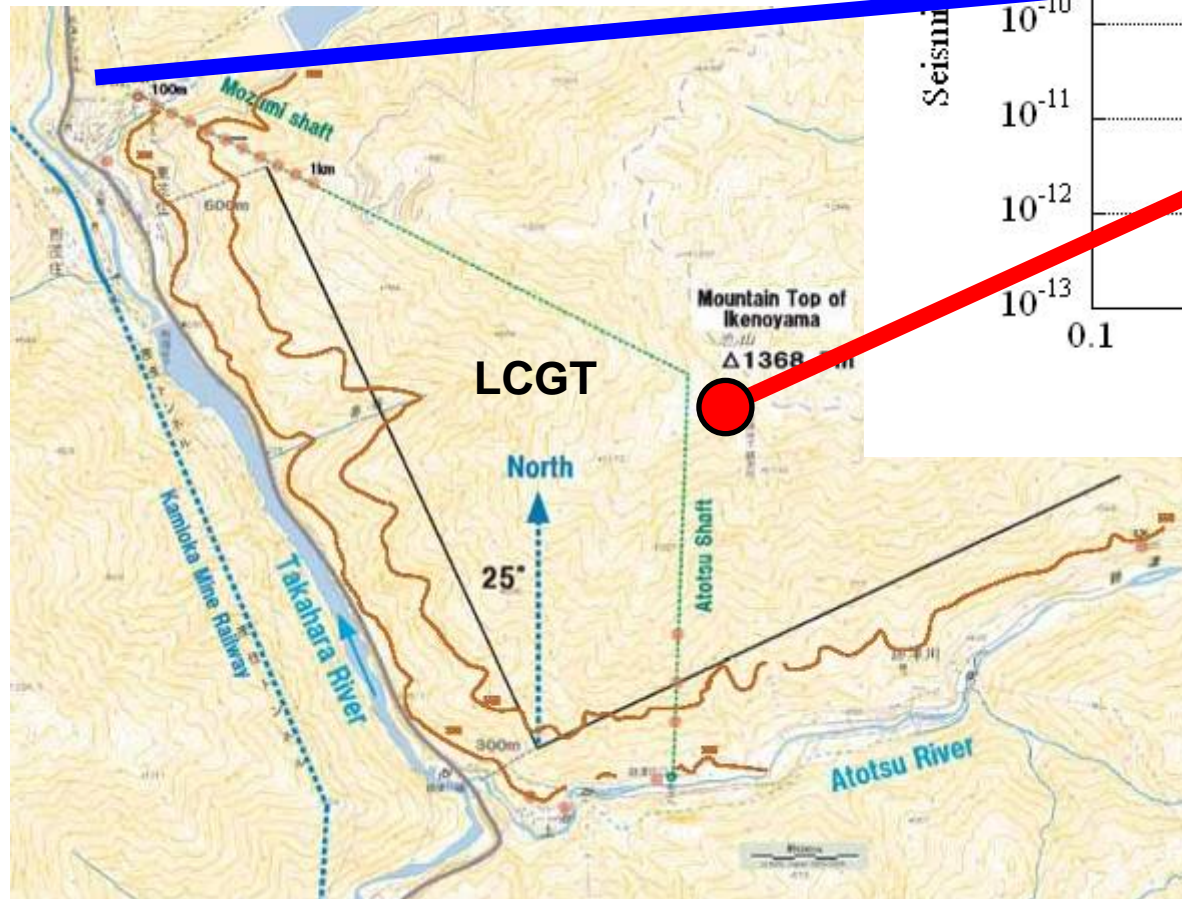
2006 Feb. 18

The first full lock operation has been done!

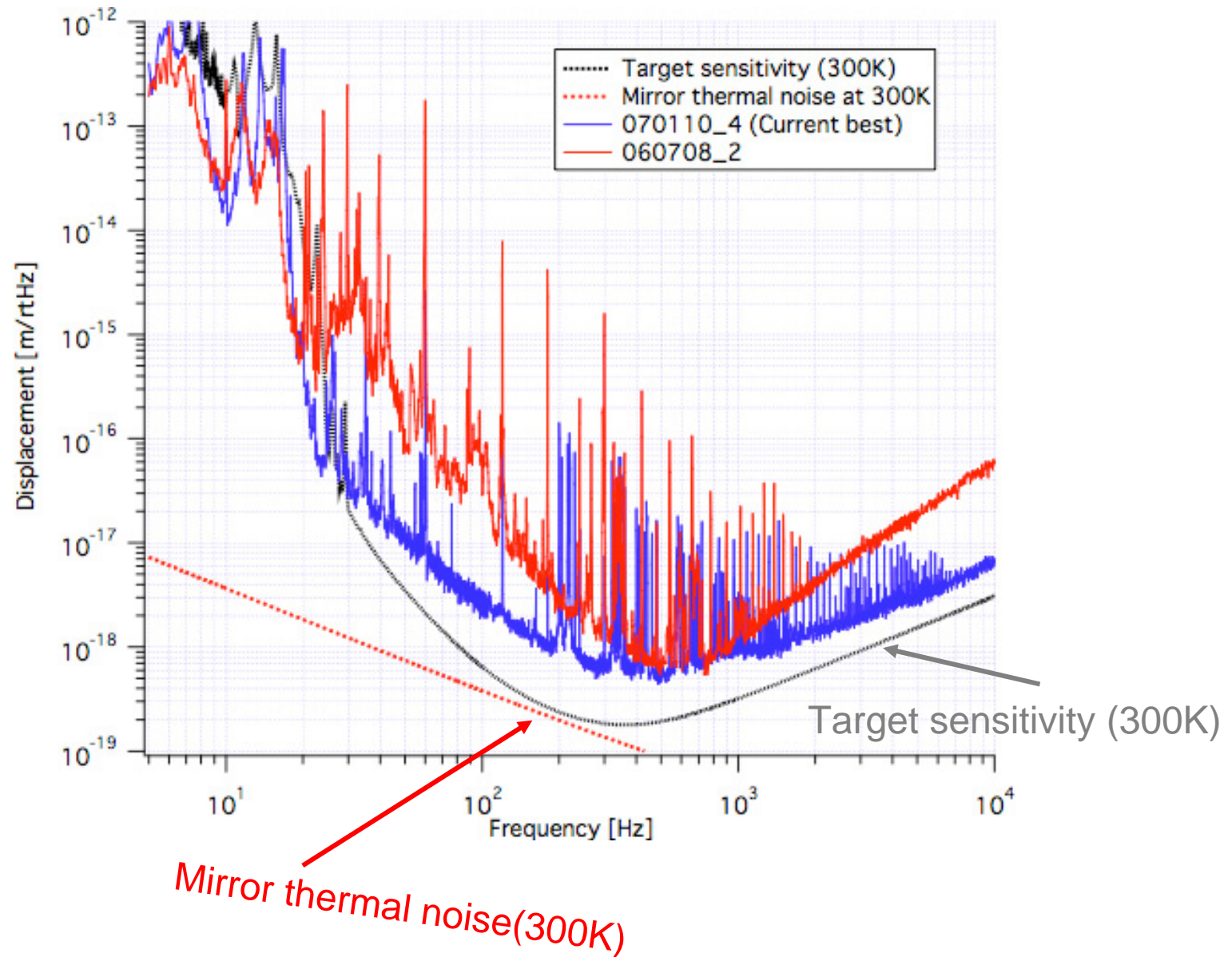
Near mirror of the perpendicular arm is 20K.
End mirror of the perpendicular arm is 23K.



Underground site



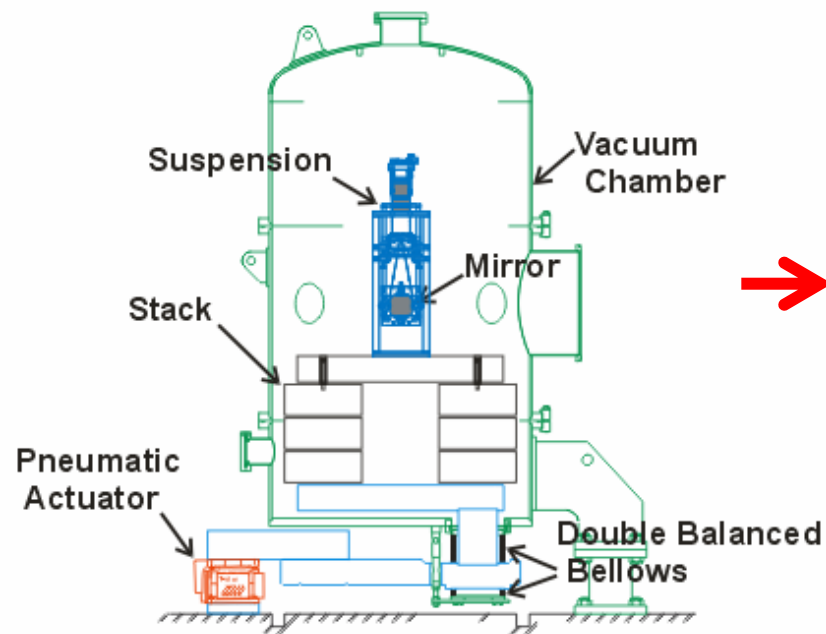
Graphical summary of CLIO activity



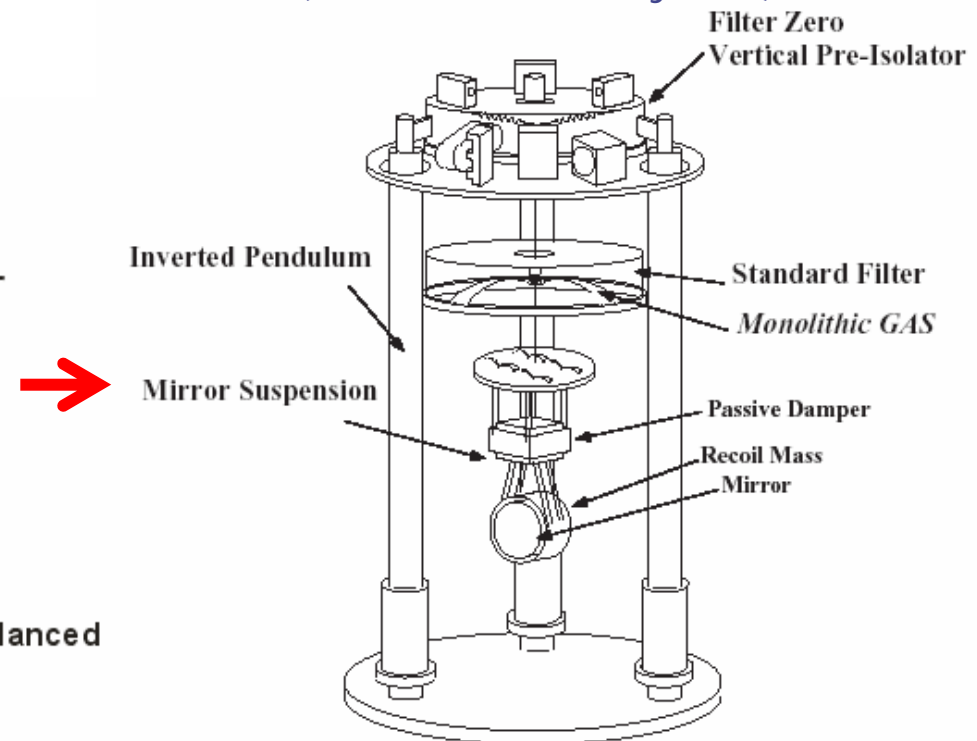
TAMA (SAS)

Improvement of Vibration Isolation System

Old Suspension
($\alpha 2$ + Stack + SUS)



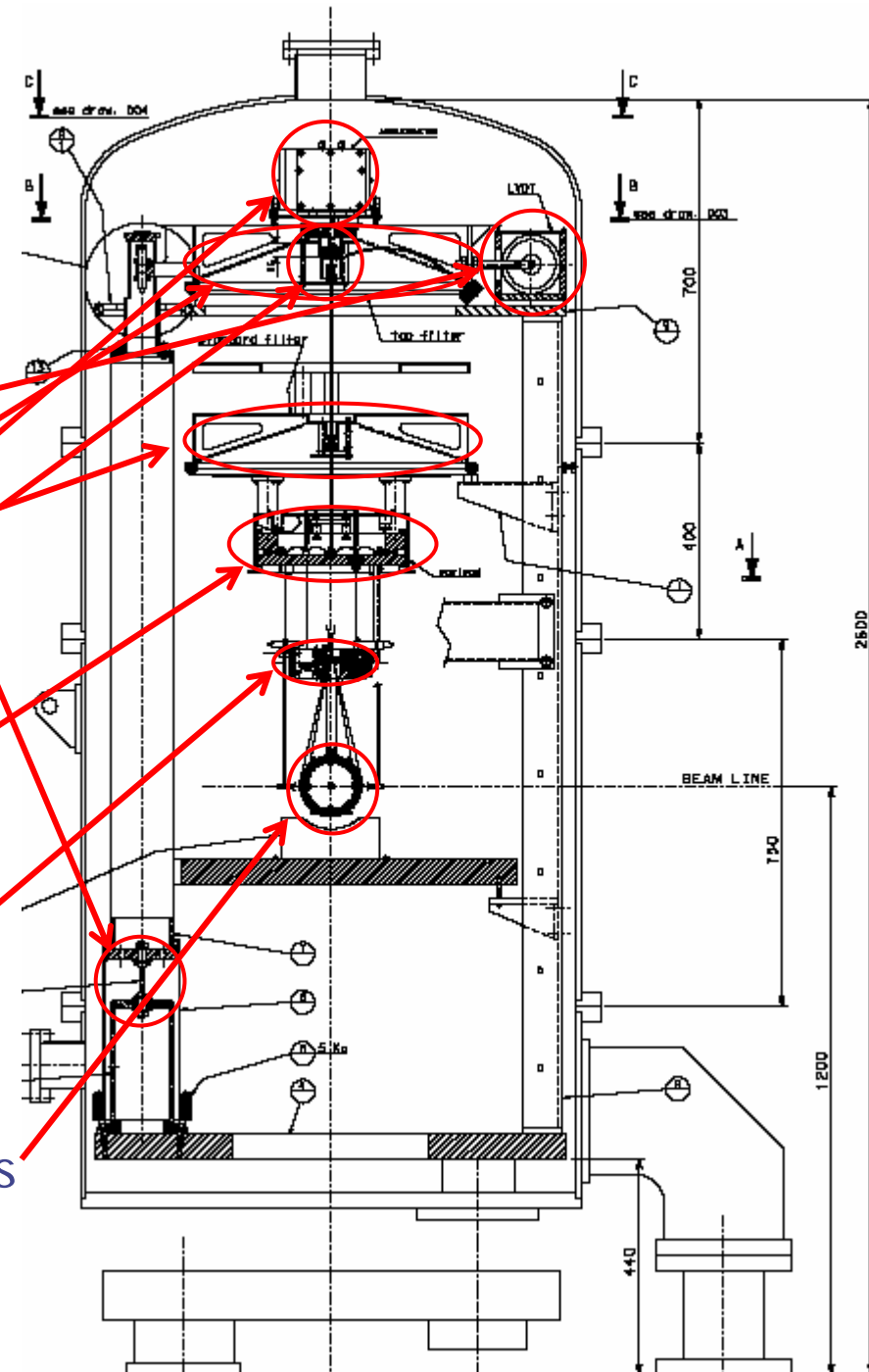
TAMA-SAS
(IP + GASF + Payload)



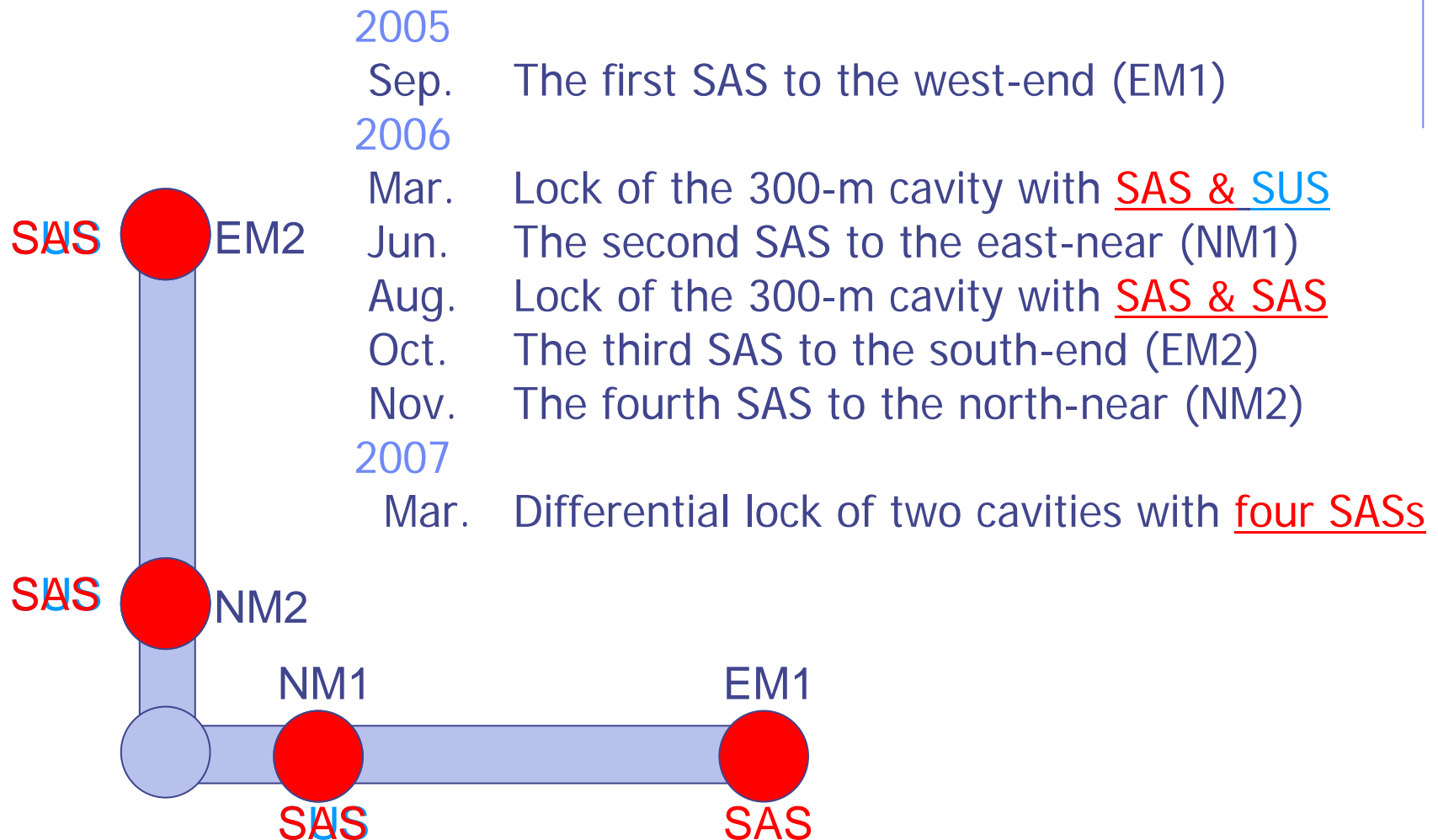
Exchange of four sets of test masses

Structure of TAMA-SAS

1. Inverted Pendulum (IP)
 - Horizontal, 30mHz
 - LVDT x3, ACC x3,
 - coil-magnet x3
2. MGAS Filter0、1
 - Vertical(2-stage), 0.5Hz
 - LVDT x1、coil-magnet x1
3. Payload
 - Platform (PF)
 - coil-magnet x8
 - Intermediate mass
 - Test mass (TM) - Recoil mass
 - coil-magnet x4



History of Installation

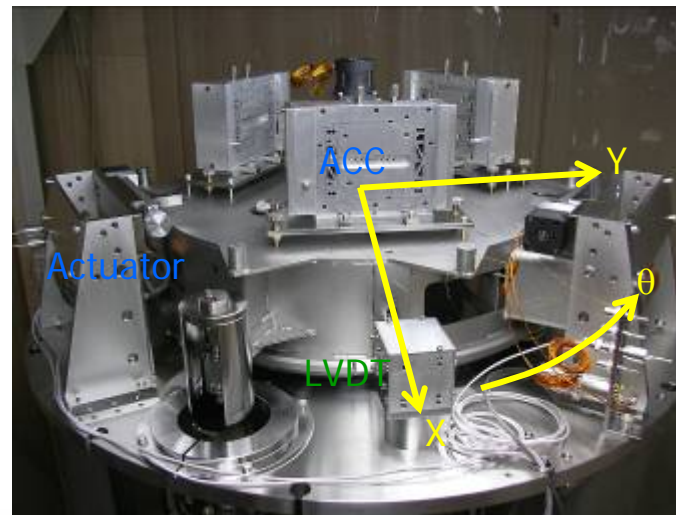


Installation works

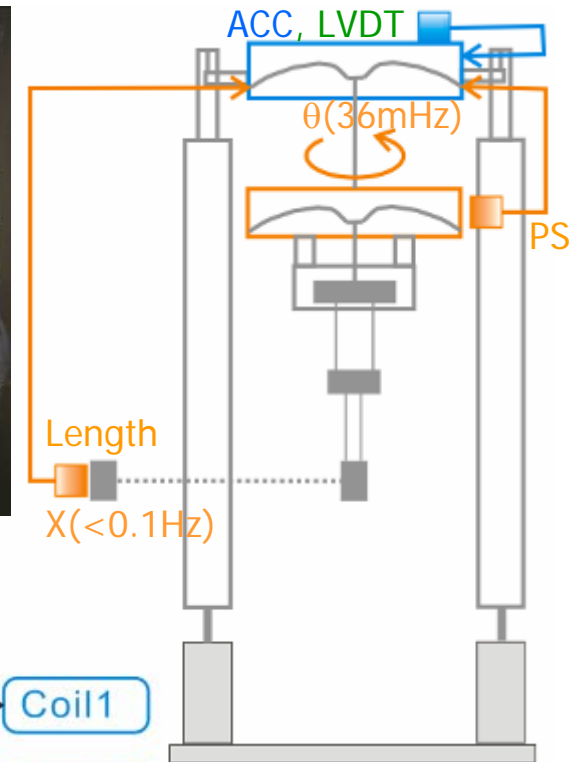
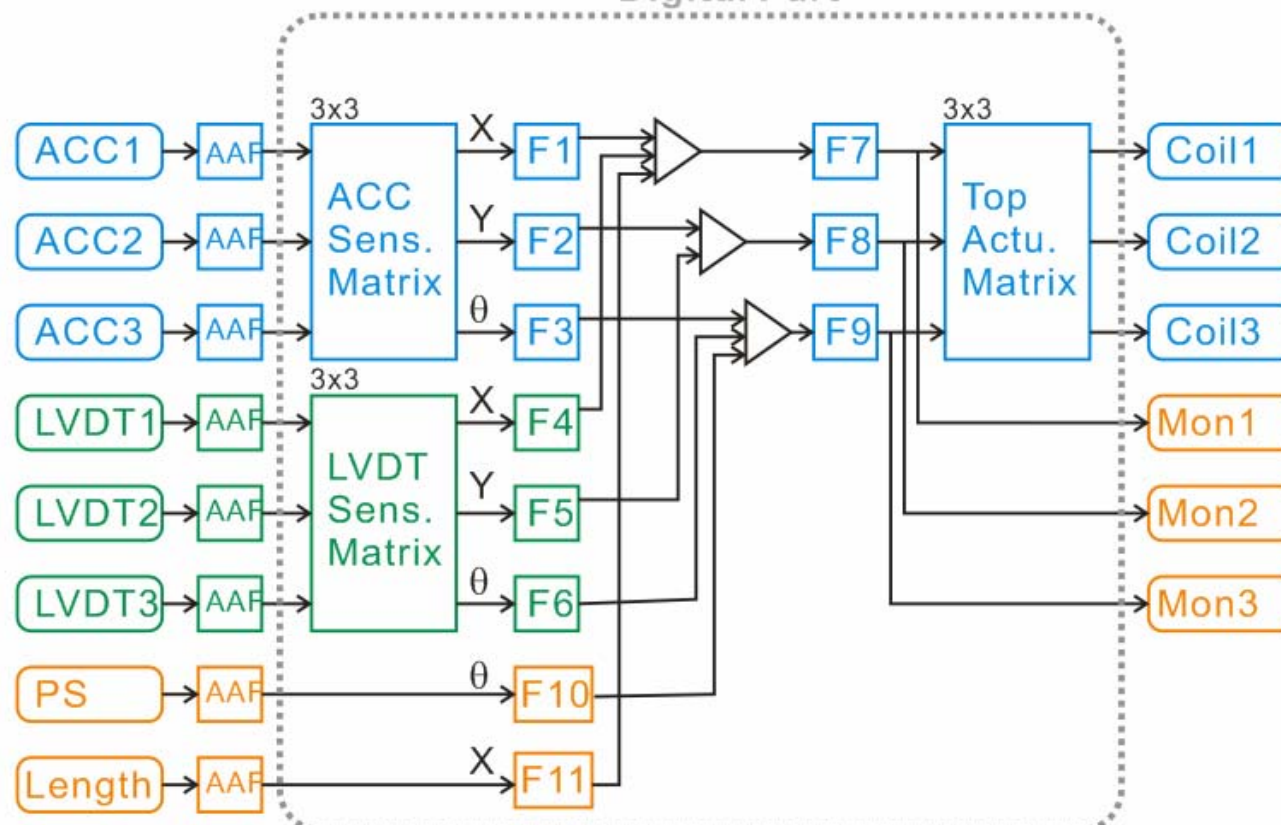


IP control

Sampling: 250Hz
Bandwidth: 2Hz



Digital Part

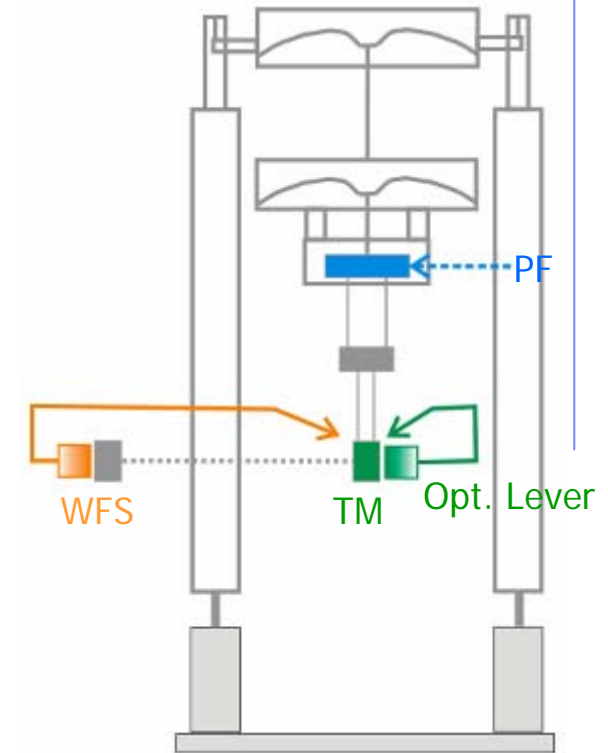
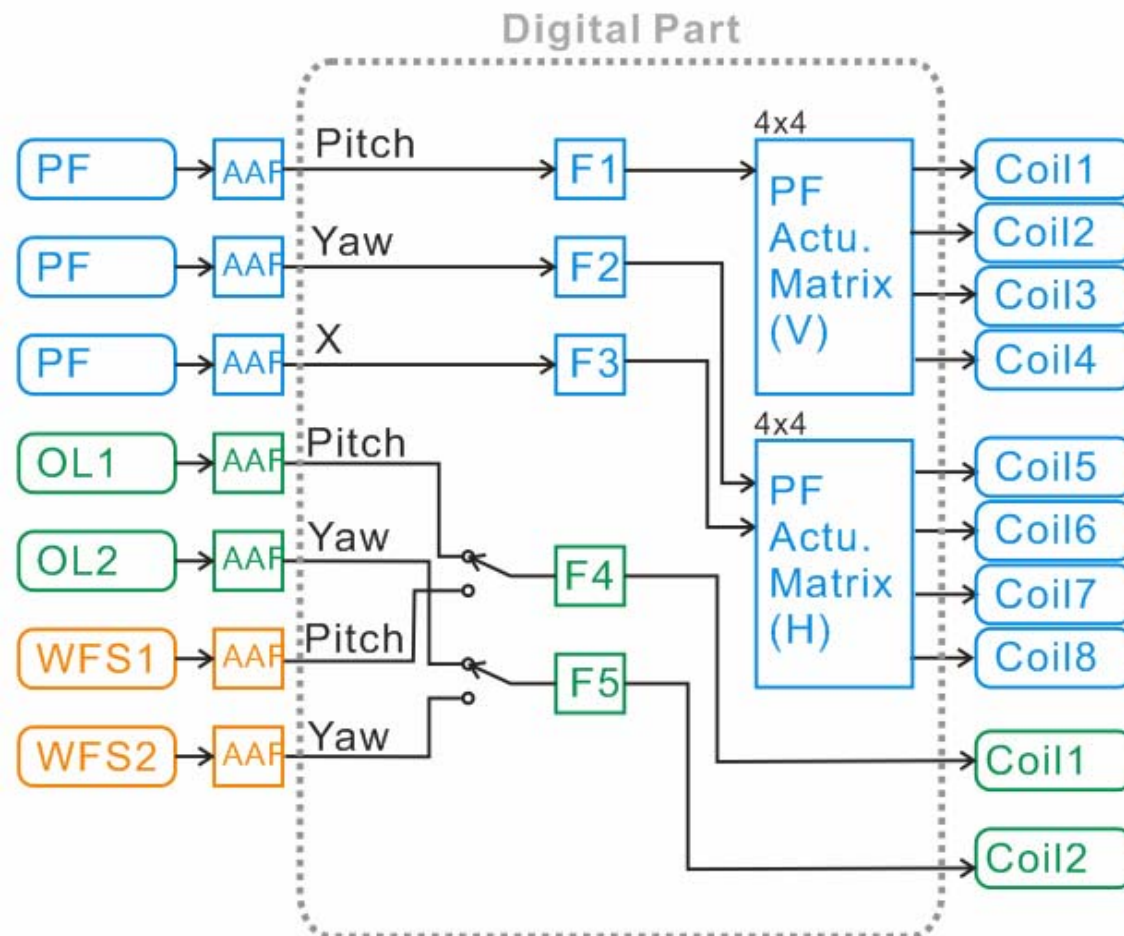


- Global control of cavity **Length** after cavity lock
- Damping of excited torsion mode using **Photo Sensor**

PF-TM control

Sampling: 500Hz

Bandwidth: 5Hz

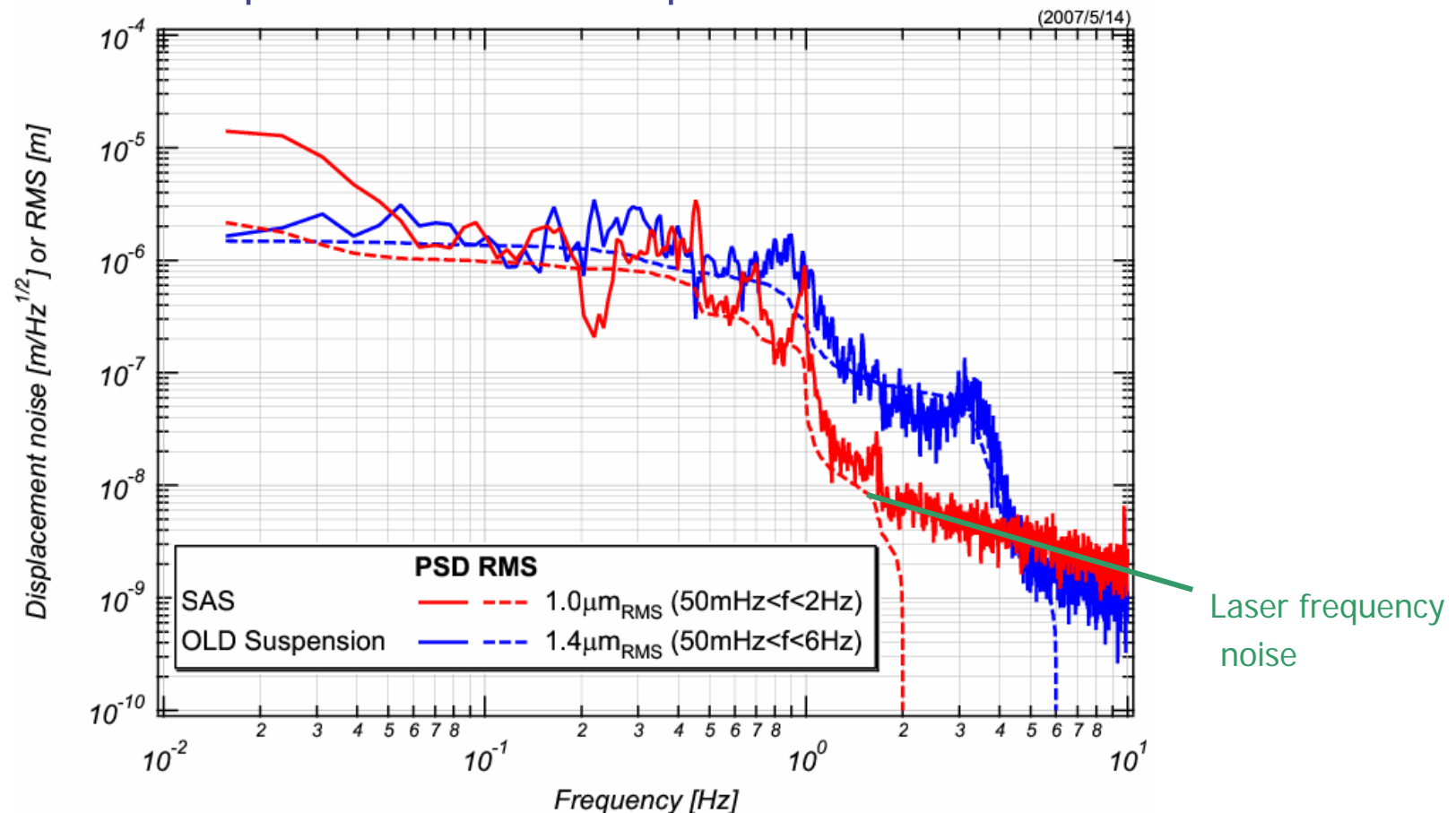


- Exchange sensor from local **Optical Lever** to global **WFS** after cavity lock
- DC actuation to **PF**

Length performance by SAS

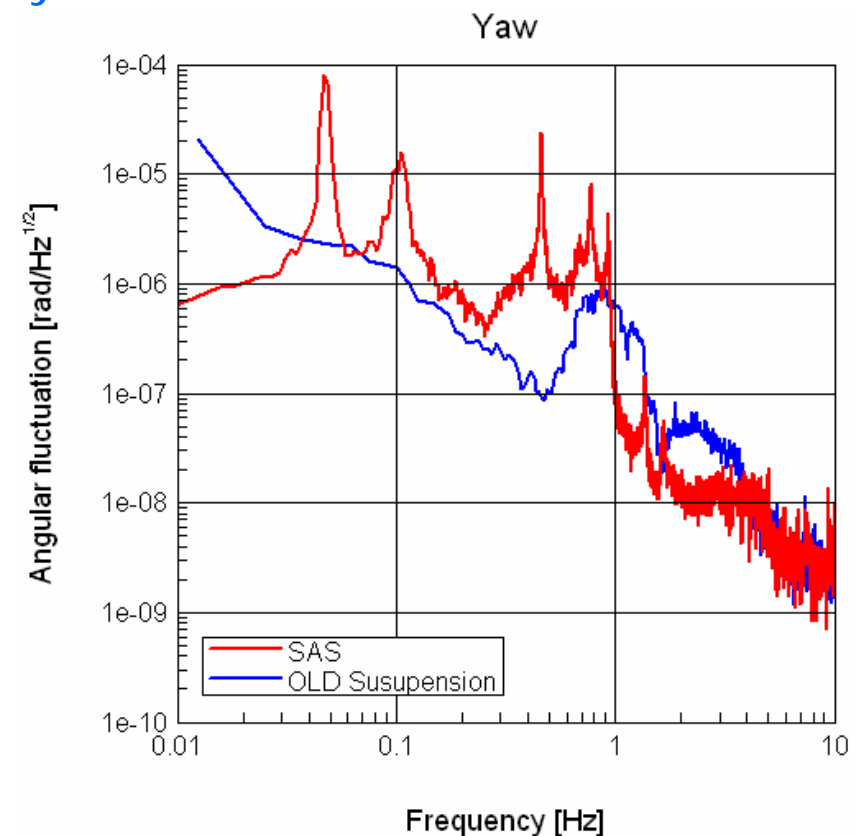
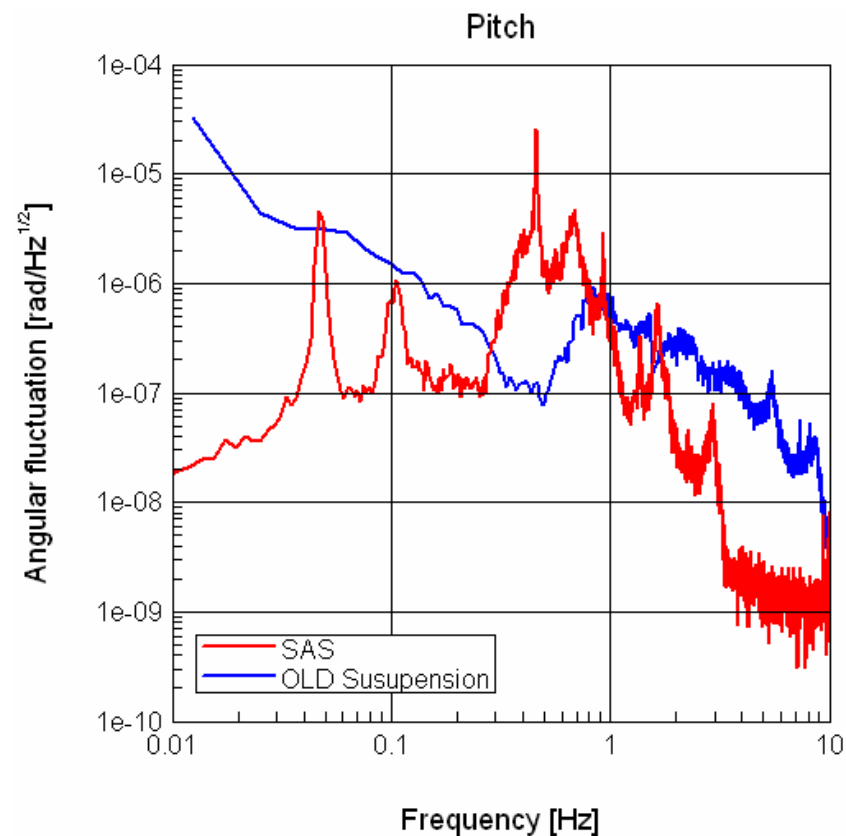
Stable lock of the 300-m cavity with SAS pair.

- Length fluctuation of the 300-m cavity was improved at $>1\text{Hz}$.
- RMS is comparable with old suspension.



Angular performance by SAS

- Angular fluctuation of the test mass was improved at $>1\text{Hz}$.
- It is possible to set the bandwidth of the alignment control to be lower than 2Hz . → Expected reduction of the alignment noise which limited the former sensitivity of TAMA300.



SPI

Suspension Point Interferometer (SPI)

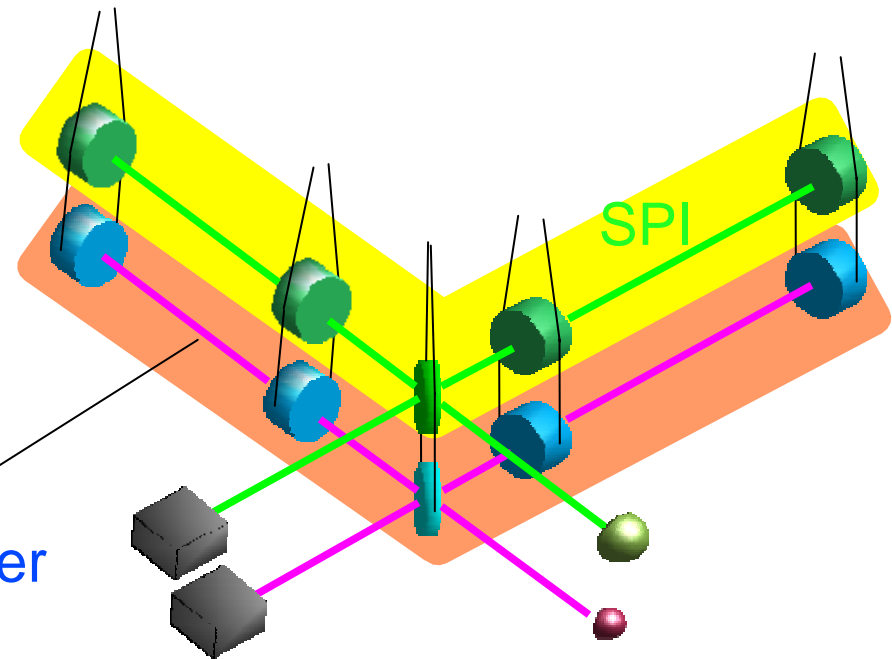
Active vibration isolation system

Sensor = auxiliary interferometer

Global-sensor, DC sensitivity

Low-noise, Low-frequency

Main
Interferometer



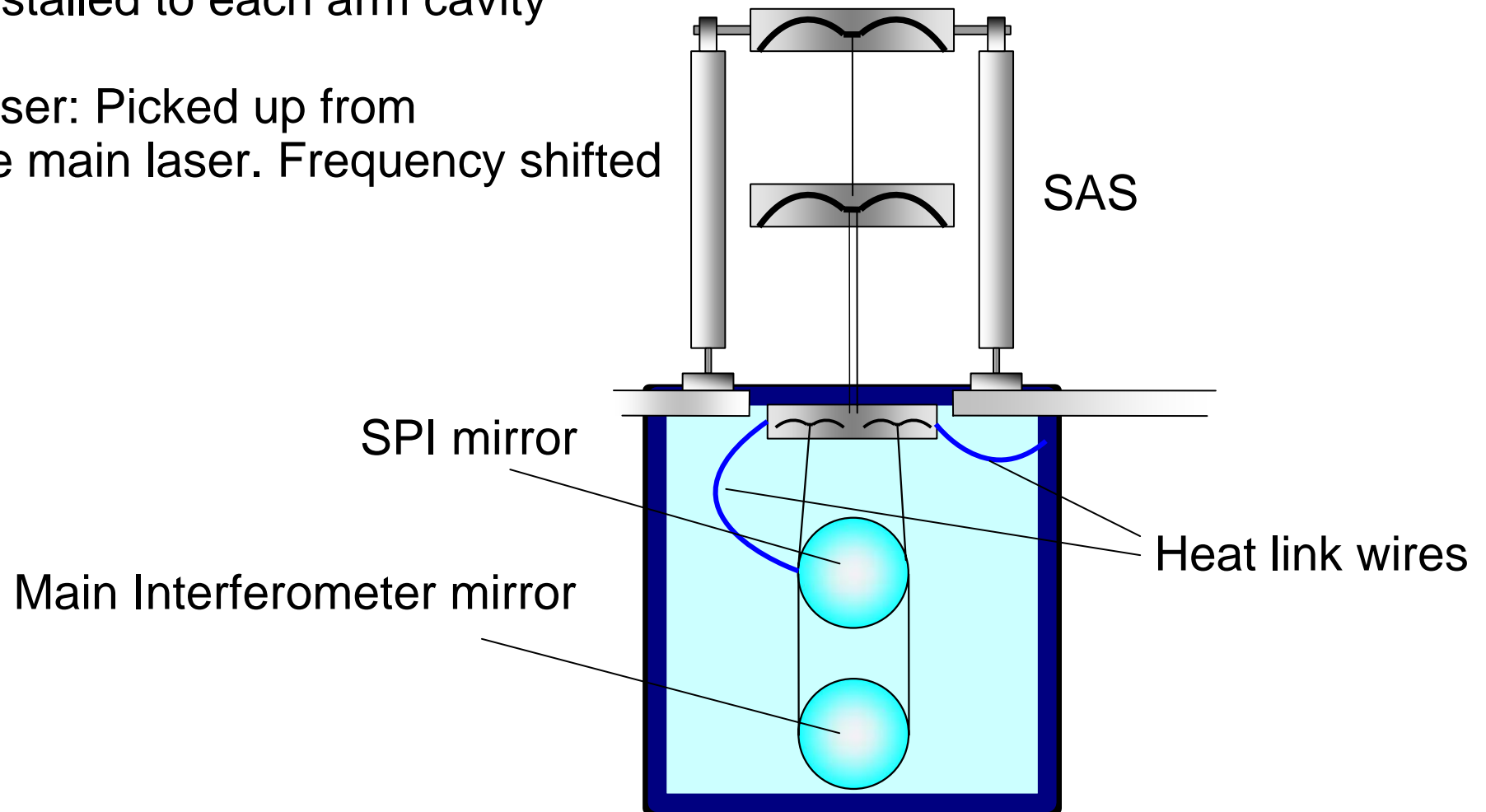
Benefits

- **Suppress the seismic vibration introduced from heat link wires**
- Reduction of the RMS motion of the mirrors
 - Robust Lock Acquisition
 - Stable Operation
 - Relaxed requirement for actuators → actuator noise reduction
 - Improved Contrast → Laser noise reduction

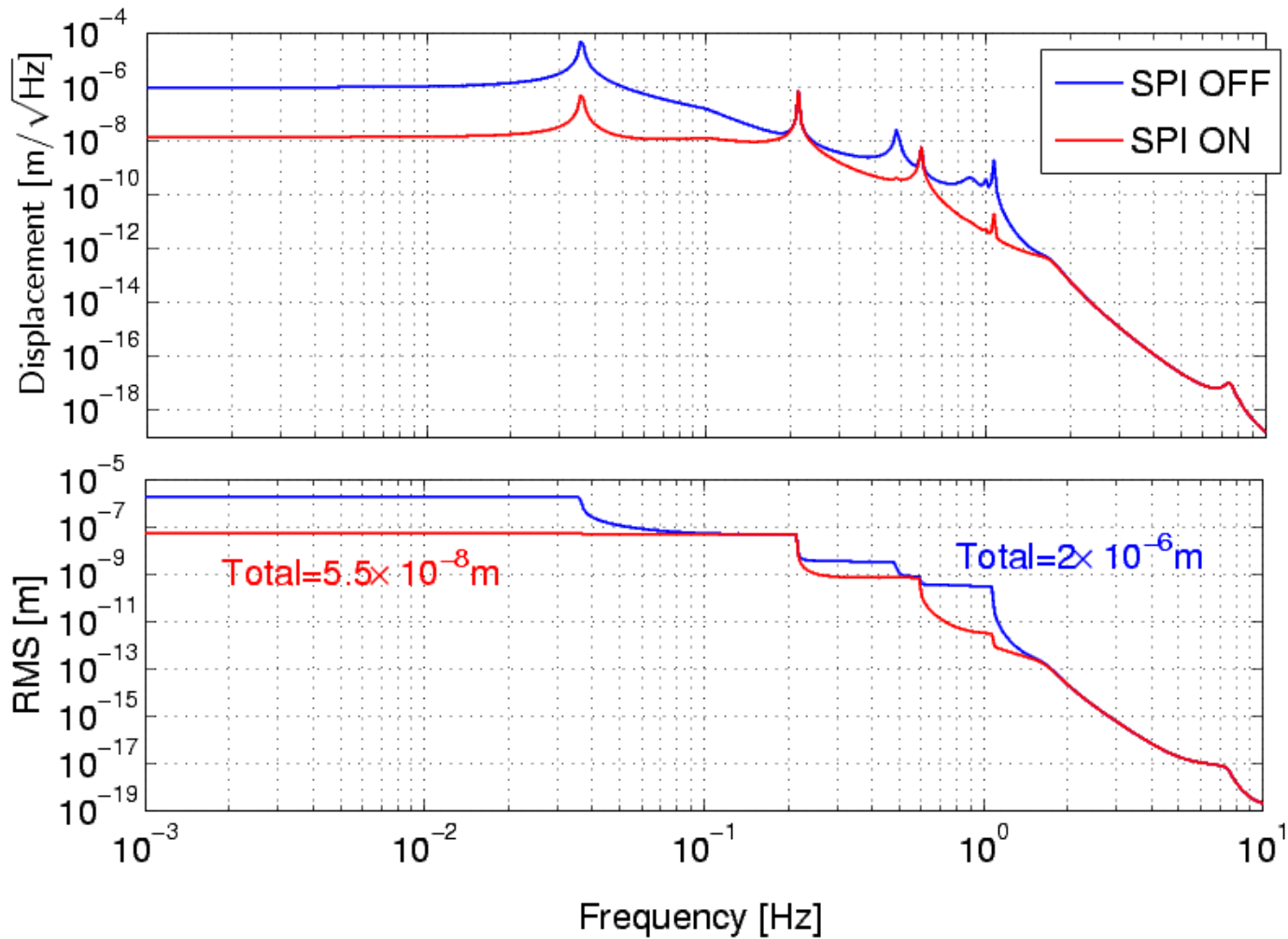
Conceptual design of LCGT-SPI

Fabry-Perot interferometers installed to each arm cavity

Laser: Picked up from the main laser. Frequency shifted



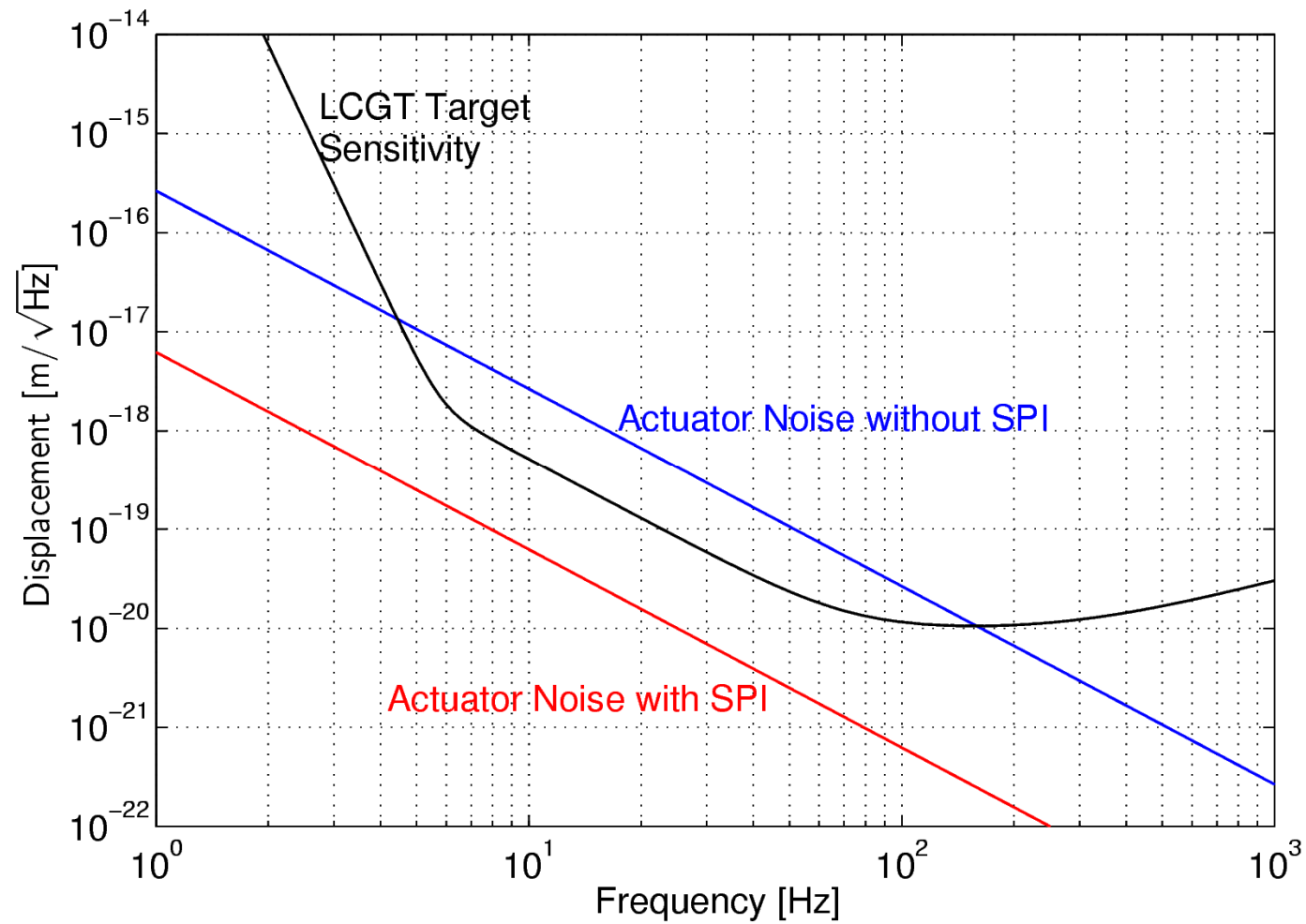
Simulated performance



RMS displacement 1/40

RMS speed 1/6

Estimated reduction of the actuator noise by the relaxed requirement for the actuators



Prototype Experiment

- 1.5m long Fabry-Perot interferometers.
- Triple pendulum suspension with two MGAS filters
- Max **40dB** of attenuation
- RMS displacement & speed reduced by **a factor of 10**

