Workshop on the development of innovative tools for new collaborations within gravitational wave detection experiments

JGW-G2214025

KAGRA Commissioning Activities

2022/4/15

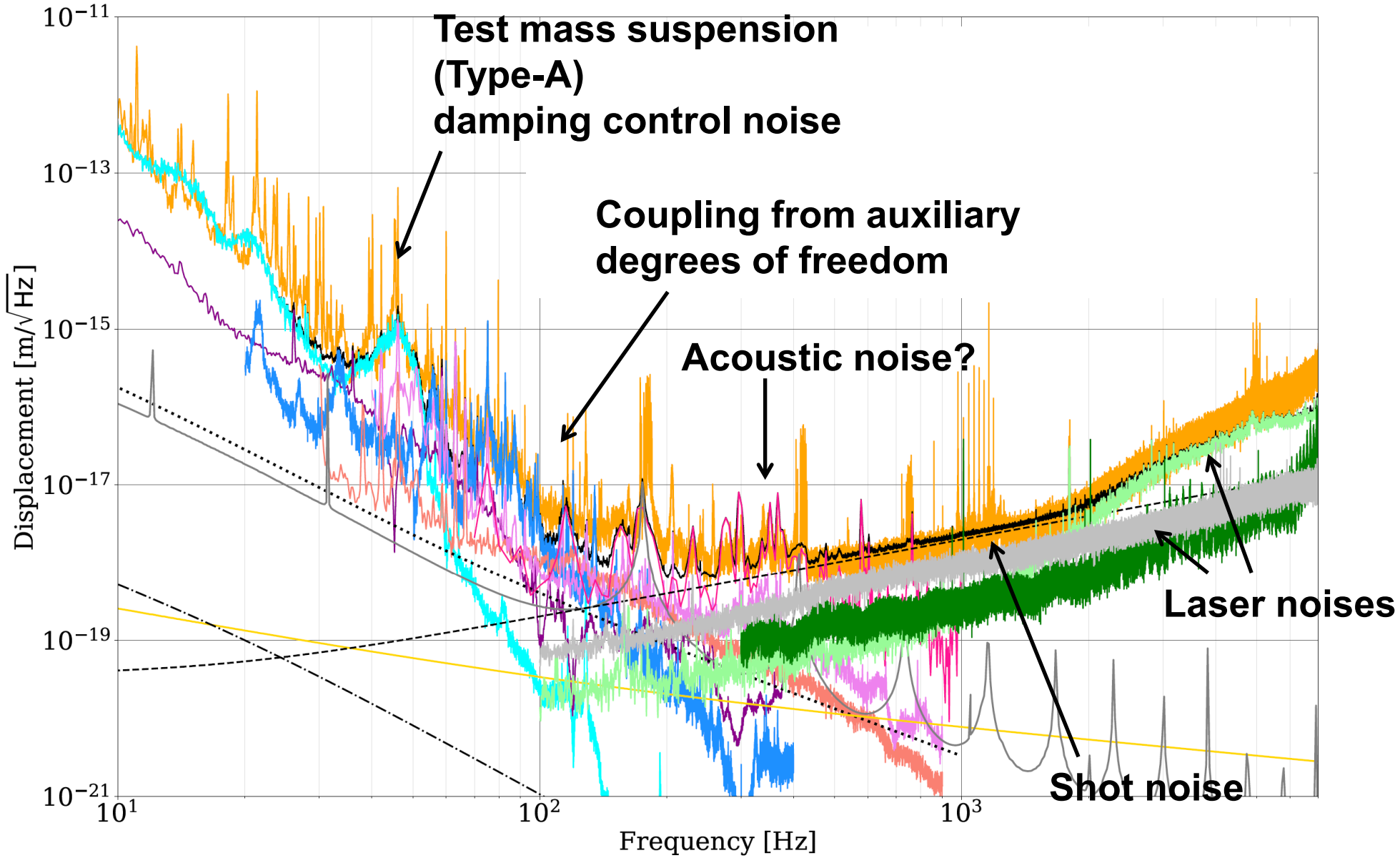
Yoichi Aso on behalf of the KAGRA collaboration
National Astronomical Observatory of Japan

What has been going on in KAGRA lately?

- May 2020: O3GK finished (~1Mpc BNS range)
- July – Oct. 2020: RSE trial
- Oct. 2020 -
  - Opened Vacuum Chambers
  - Upgrade of vibration isolation systems
  - IMC commissioning
  - IFO re-alignment
  - X-arm single arm commissioning
  - ALS commissioning
  - Pcal upgrade
  - PEM upgrade

O3GK Noise Budget

arXiv:2203.07011



O3GK Noise Budget

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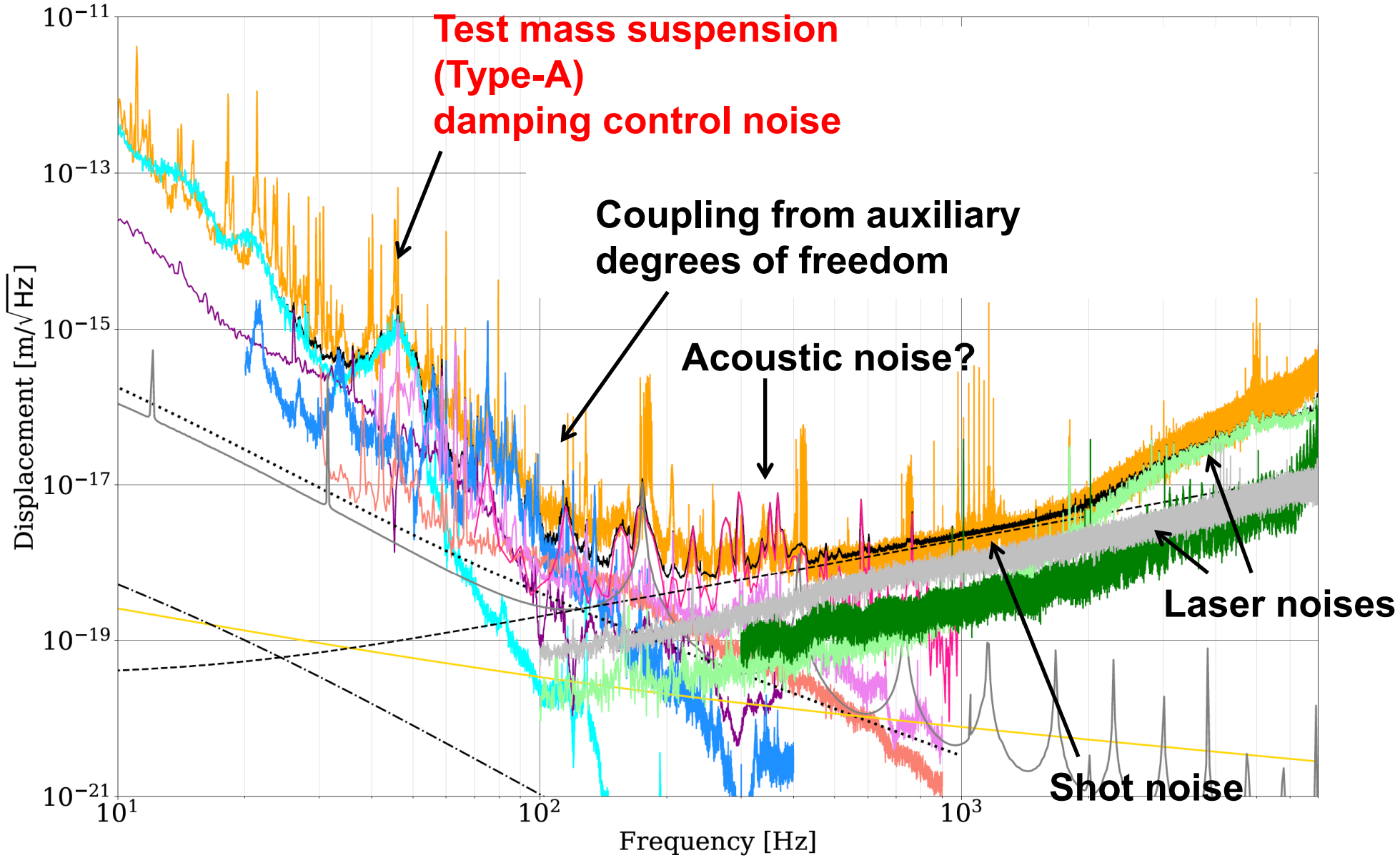
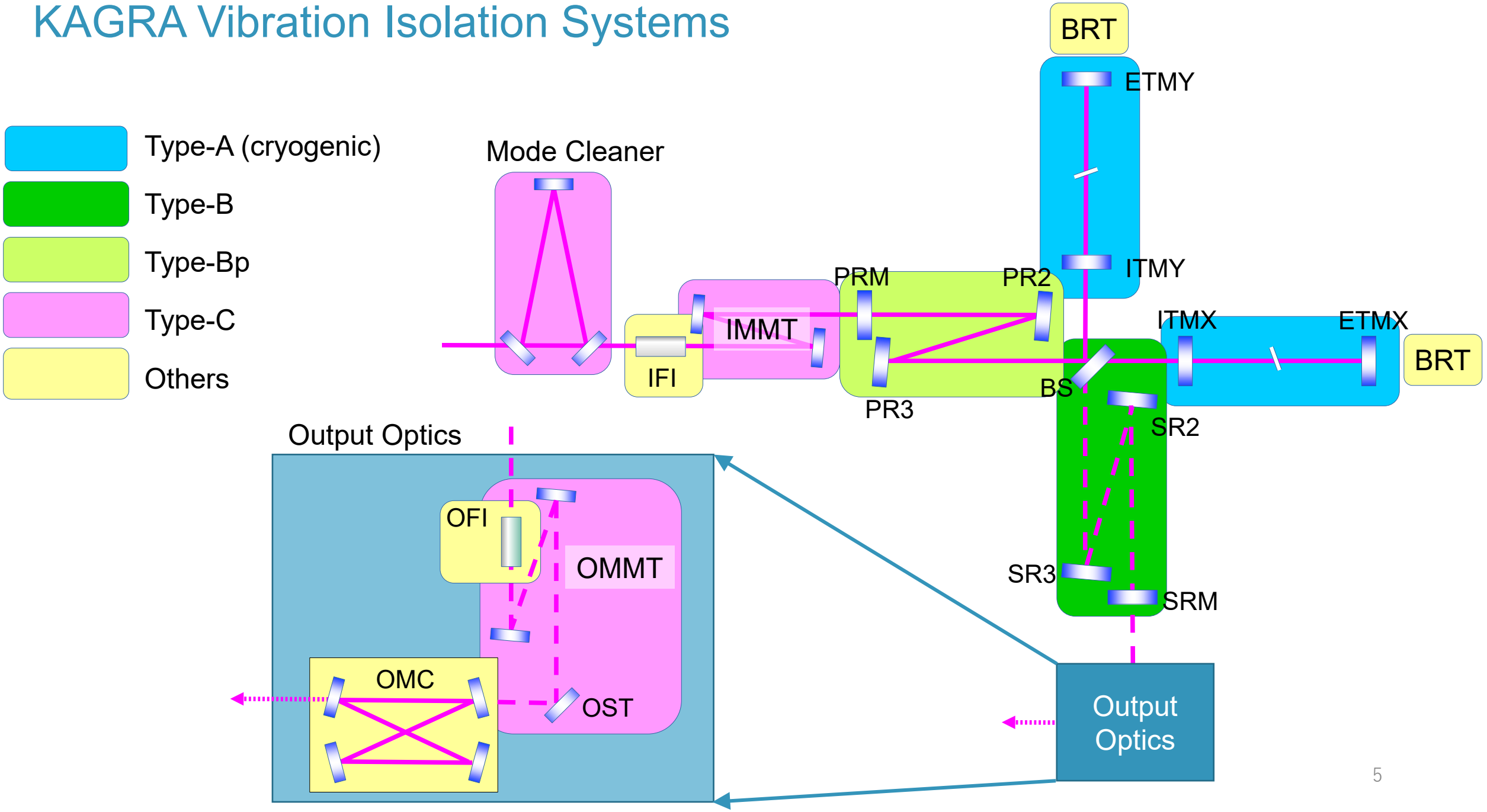
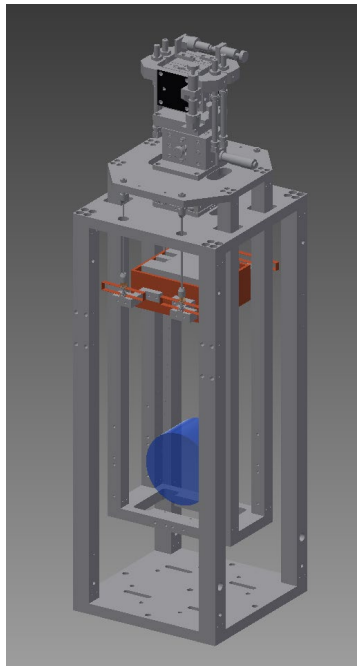


KAGRA Vibration Isolation Systems

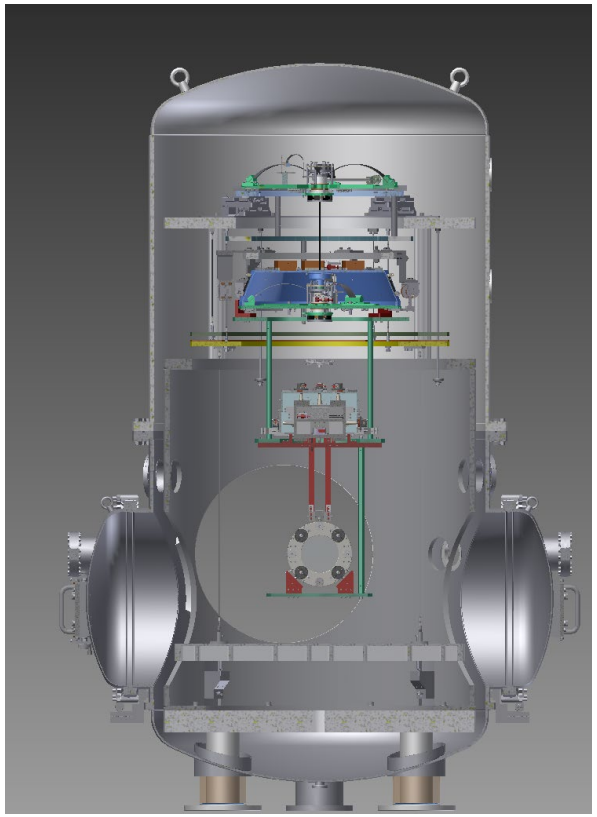


KAGRA Suspension Types

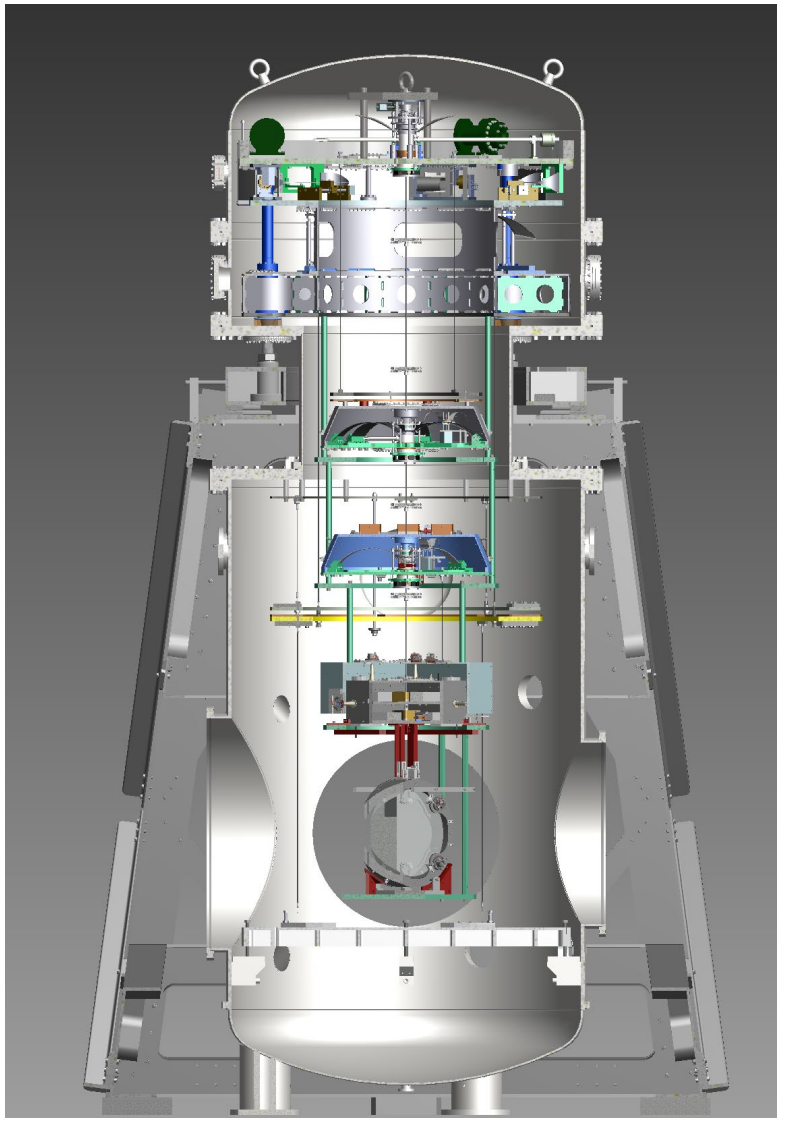
Type-C



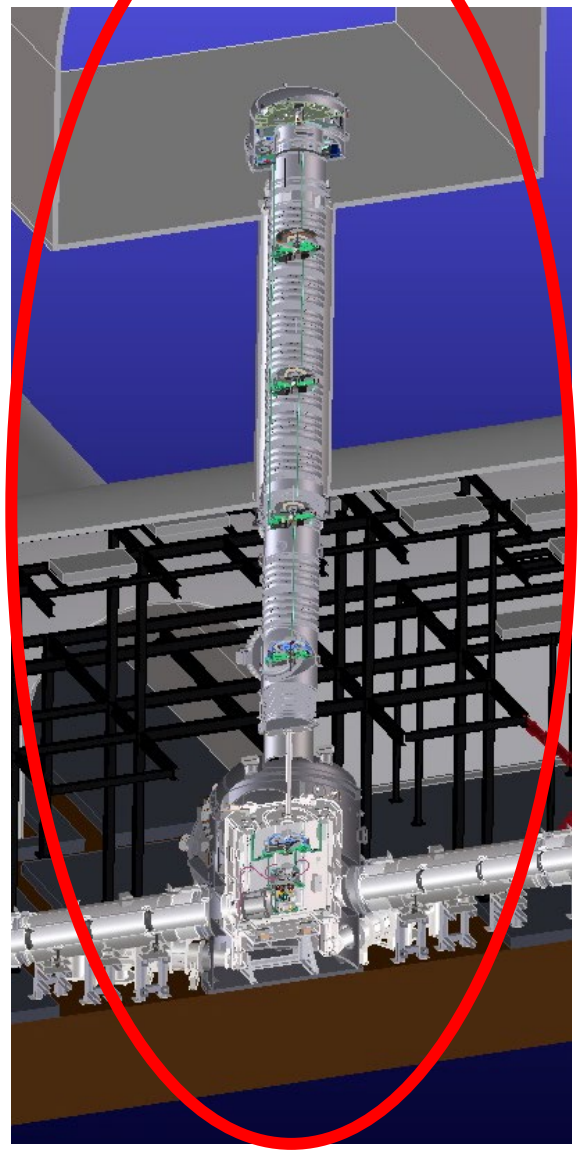
Type-Bp



Type-B

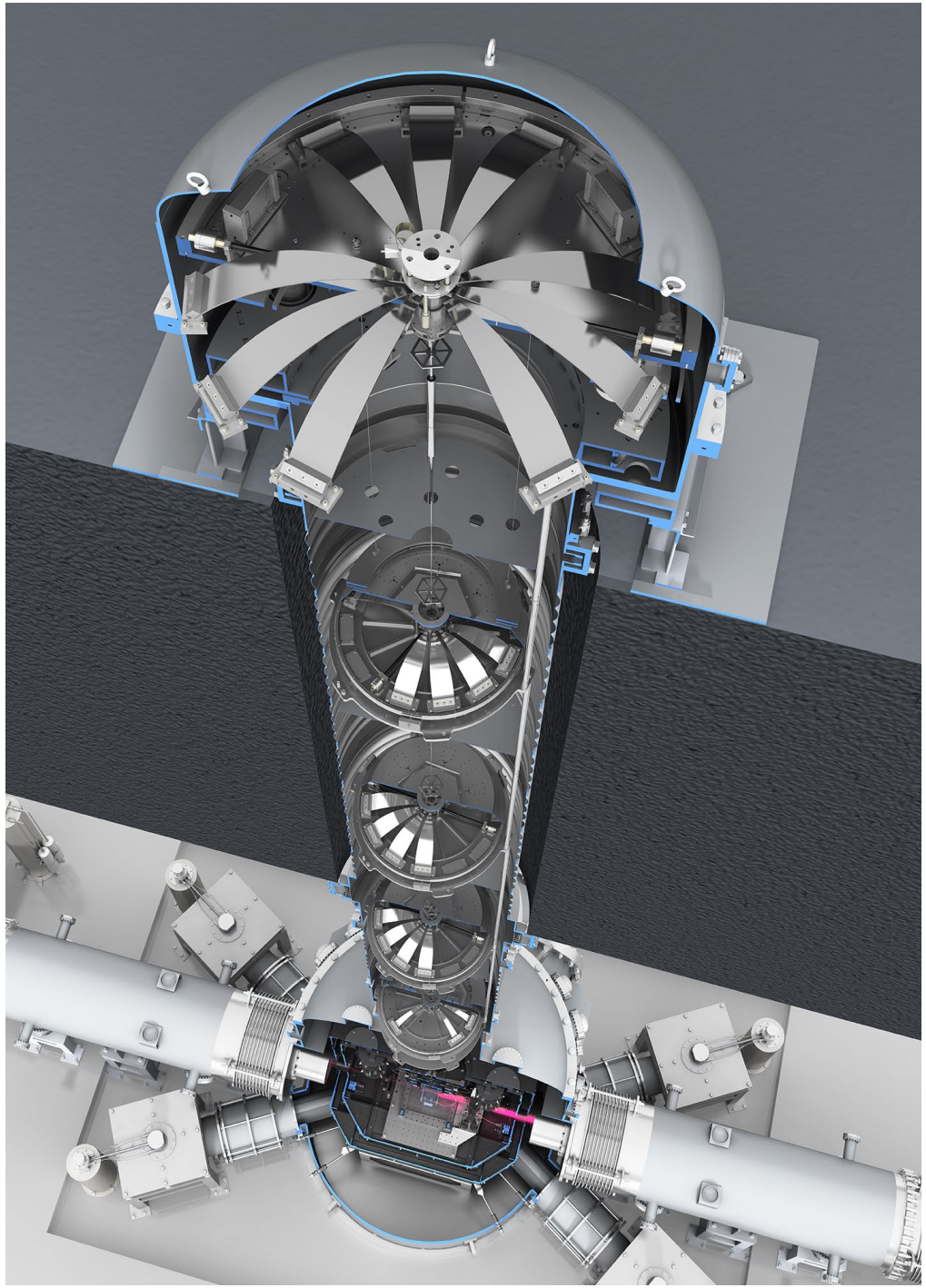


Type-A

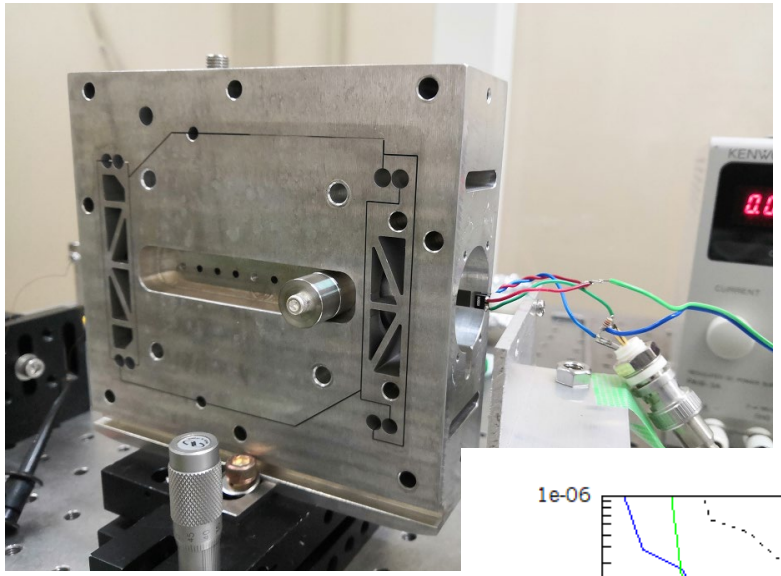


Fixed a number of issues with the room temperature part

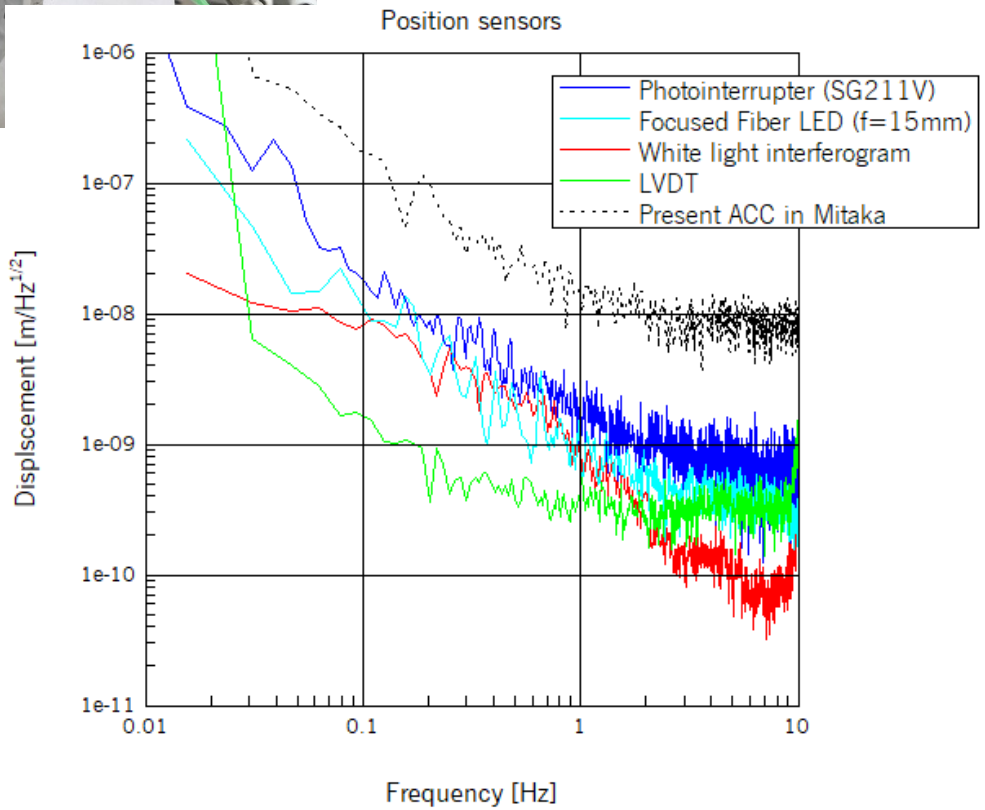
- Some of the filters were stuck in O3GK
  - We fixed most of them
- ITM top GAS filter blades were replaced
- New accelerometers for the top stages
- LVDT driver coupling reduction
- Many more messy problems small and large ...

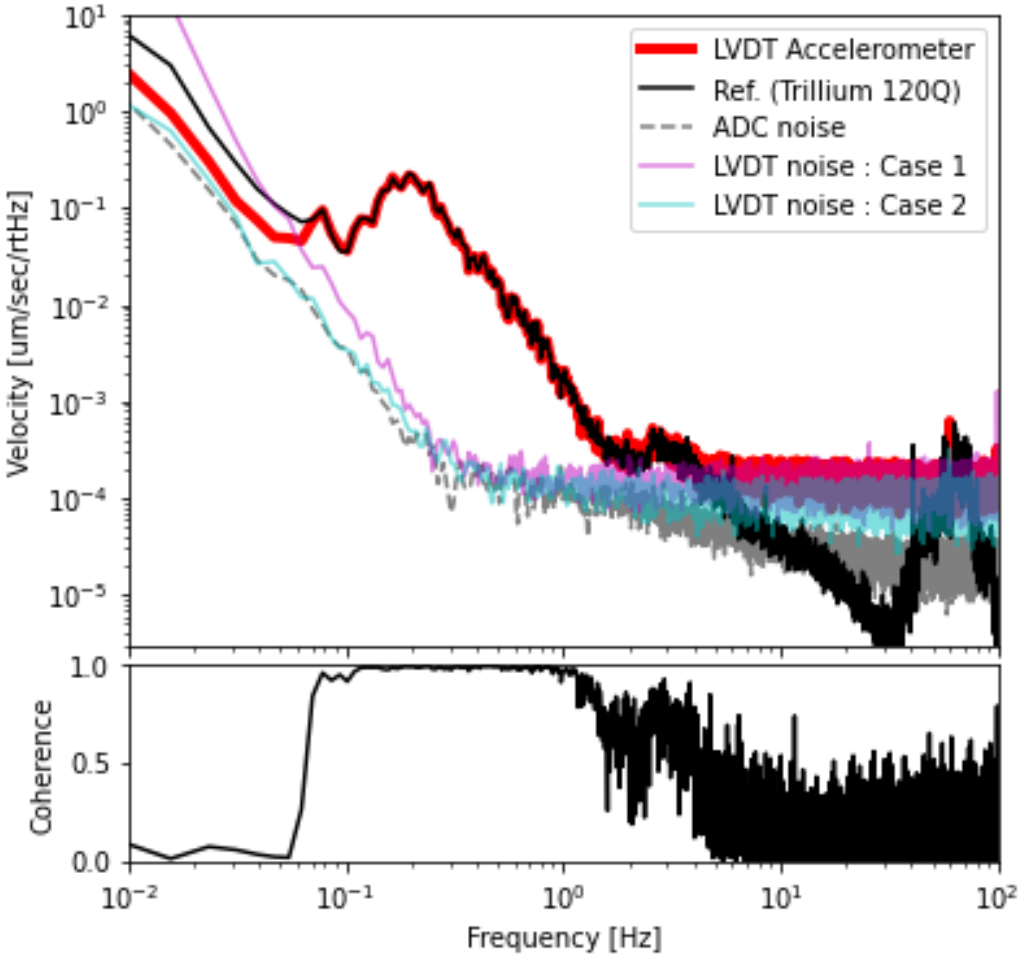


New accelerometers in place of geophones

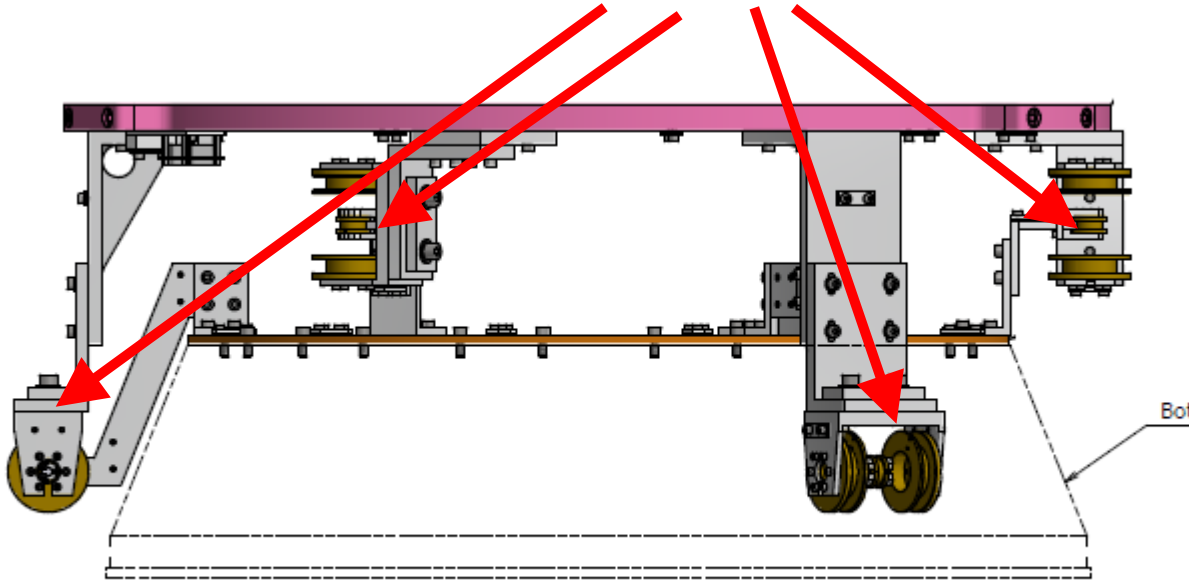


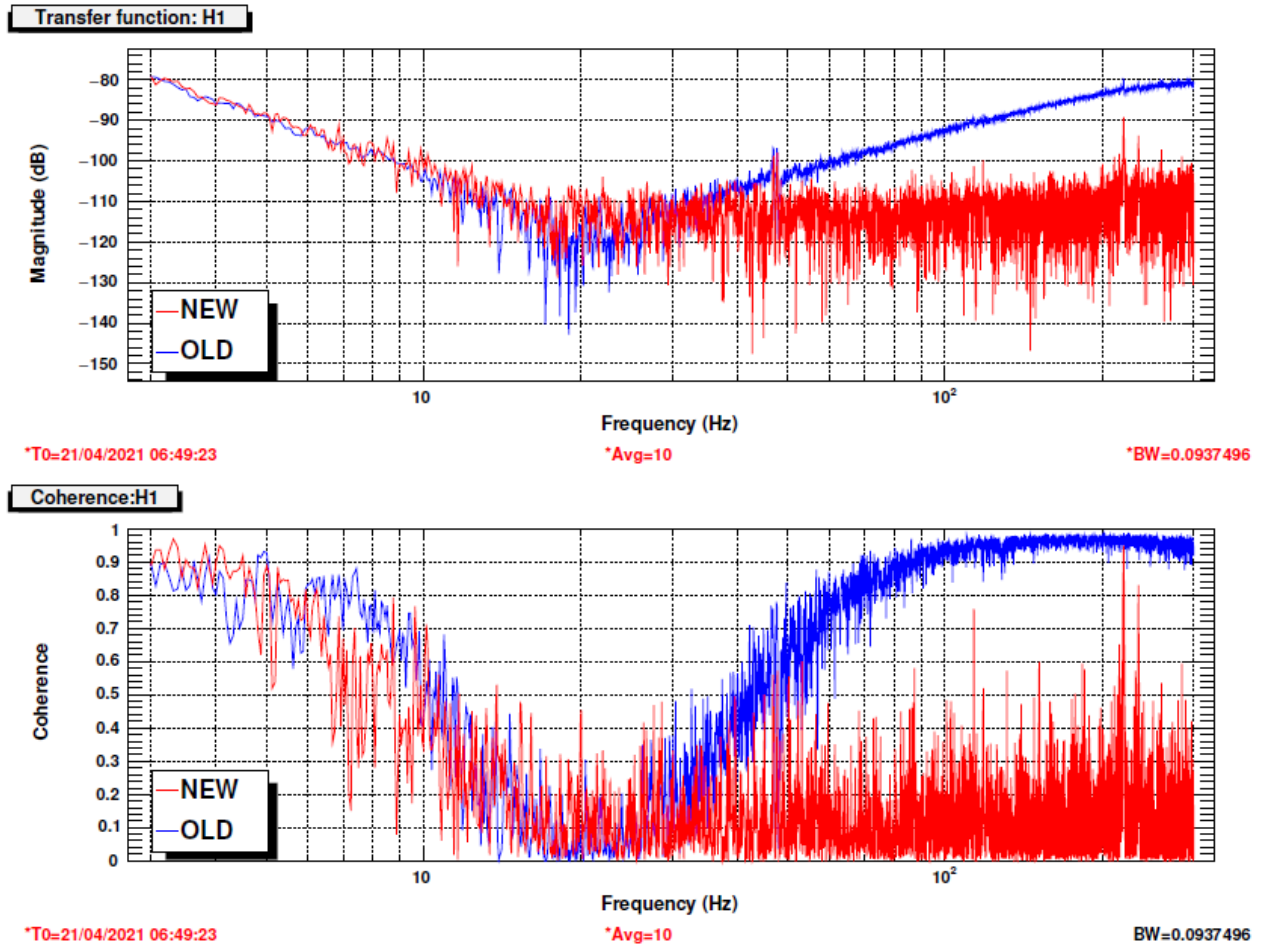
- Folded pendulum accelerometers
- LVDT sensors



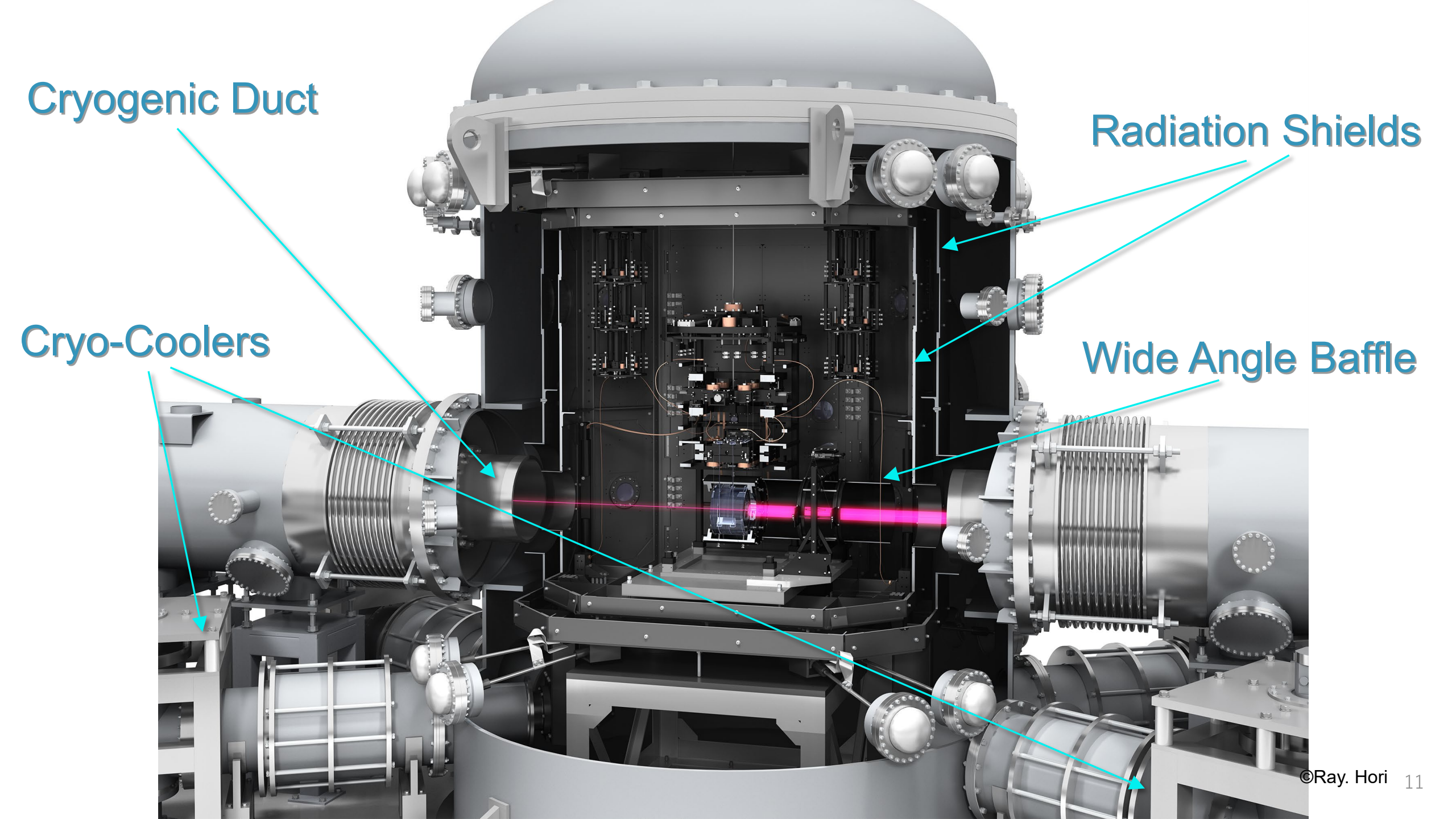


Bottom Filter LVDTs for local damping



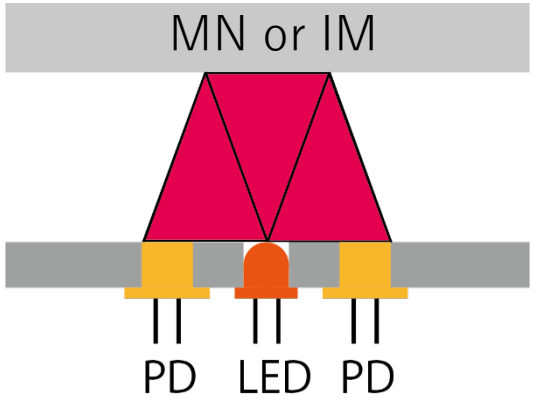


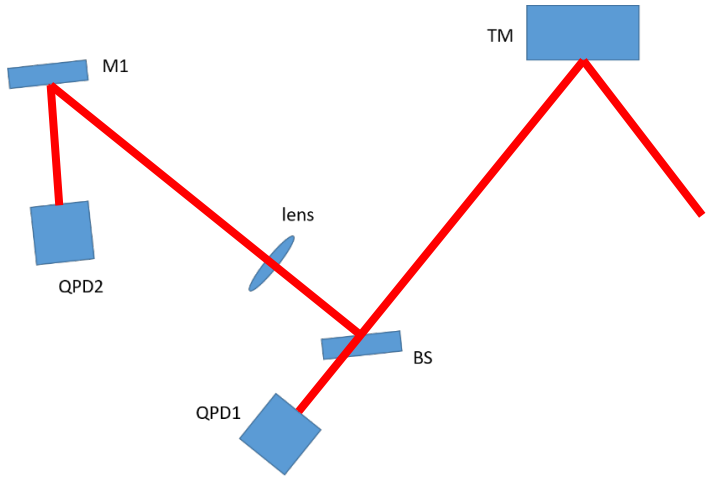
- Fixed an error in the driver circuit
- Significantly reduced the cross-coupling between the driving signal and sensor output

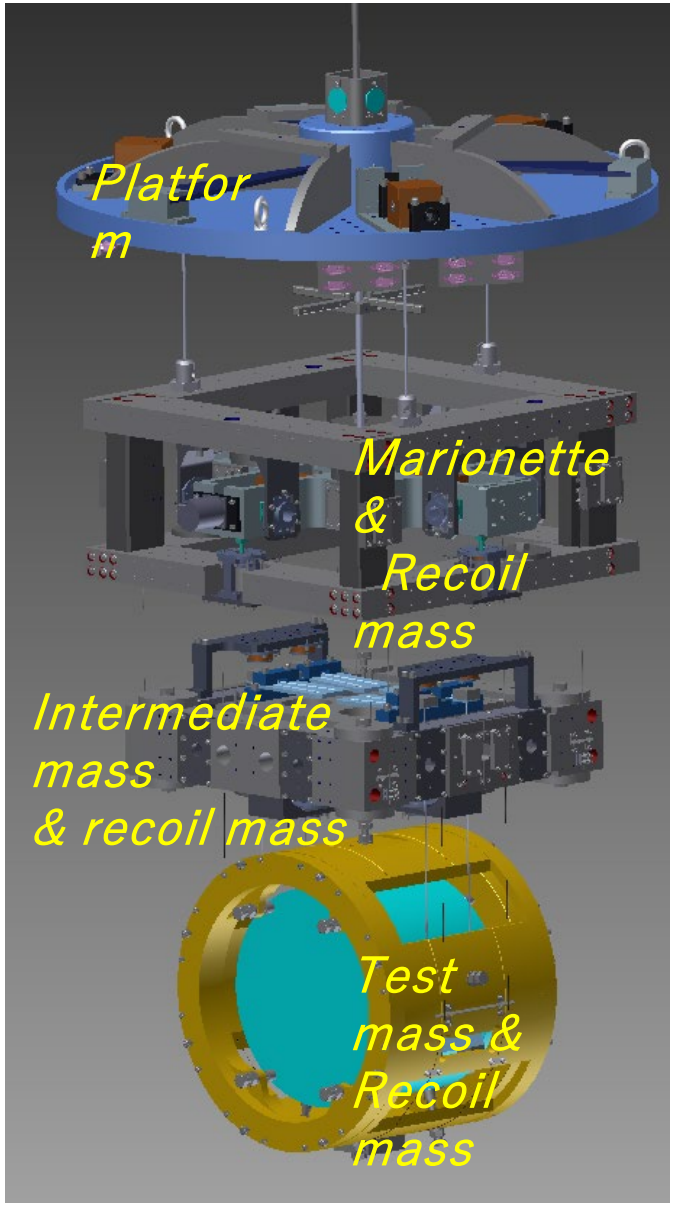

Cryogenic Duct
Radiation Shields
Cryo-Coolers
Wide Angle Baffle

Modifications of the cryogenic payload

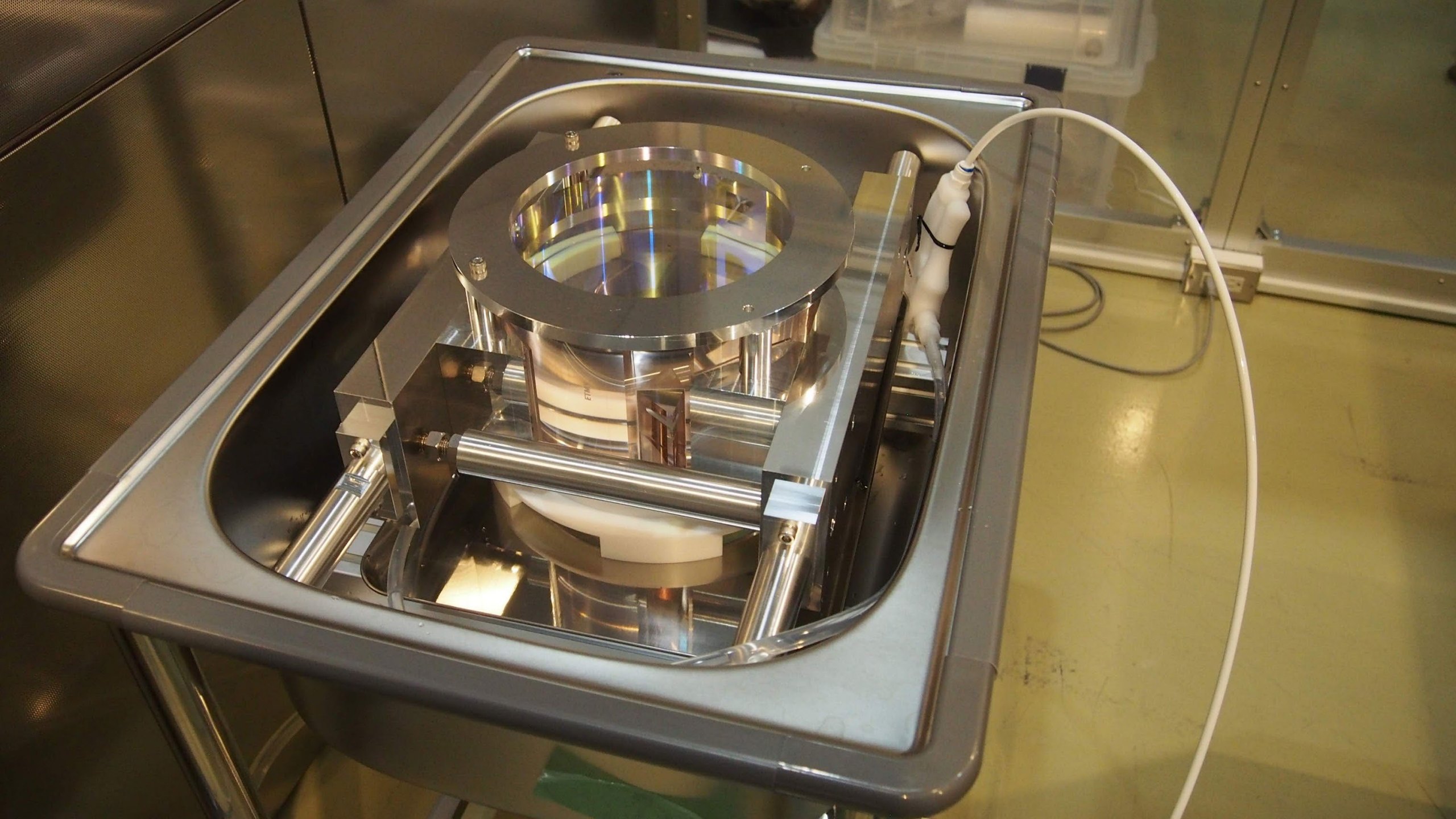
- Actuator hierarchy was not right
  - Increased the size of the magnets for upper stages
- Photo sensors were noisy
  - Added optical levers for upper stages
  - Tilt & Length sensing



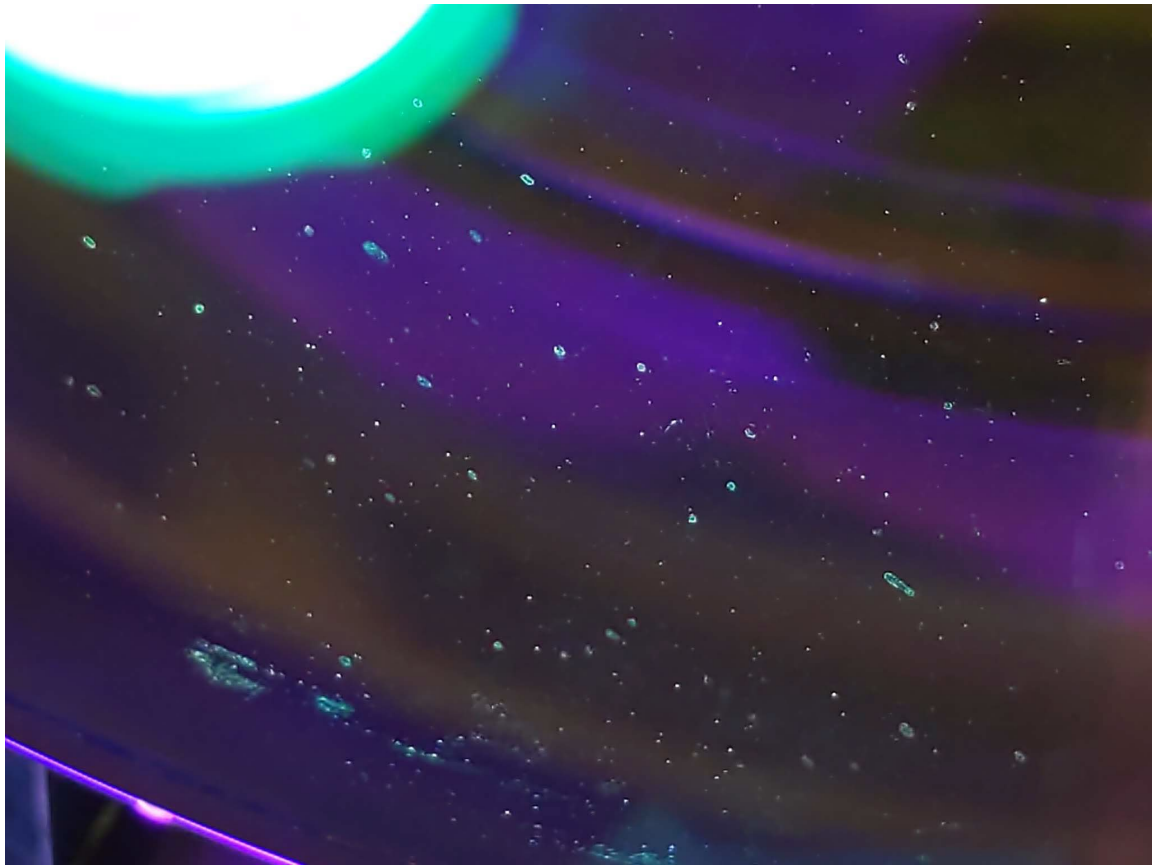




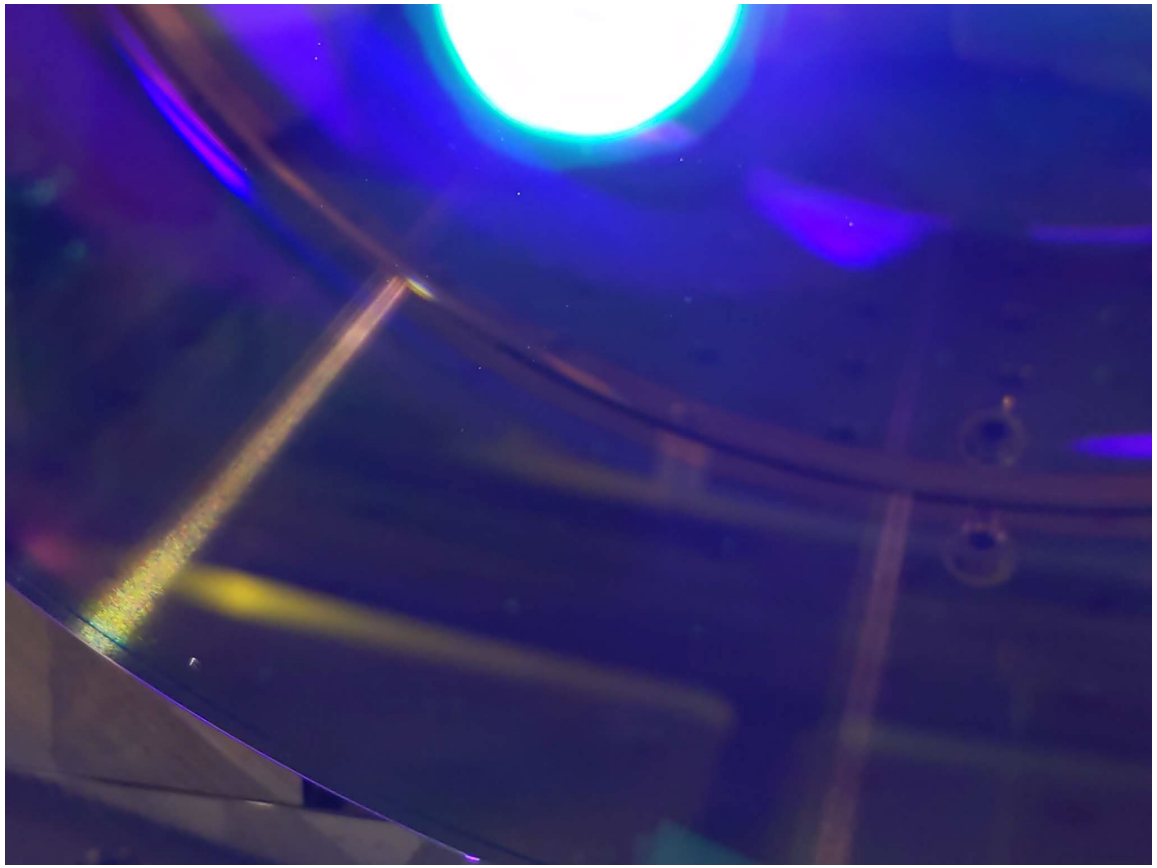
Contamination of the ETMY cryostat and mirror



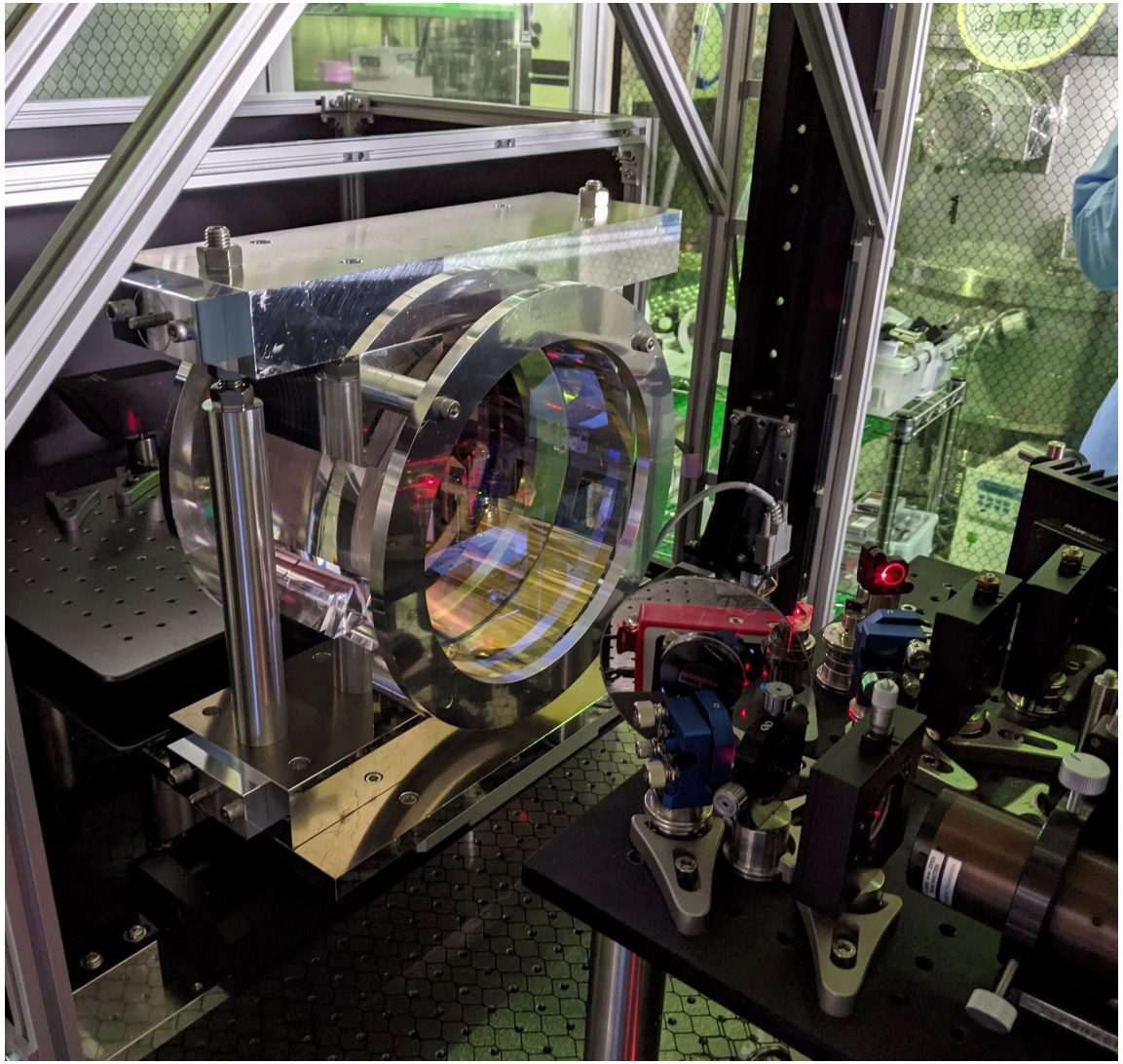
Before

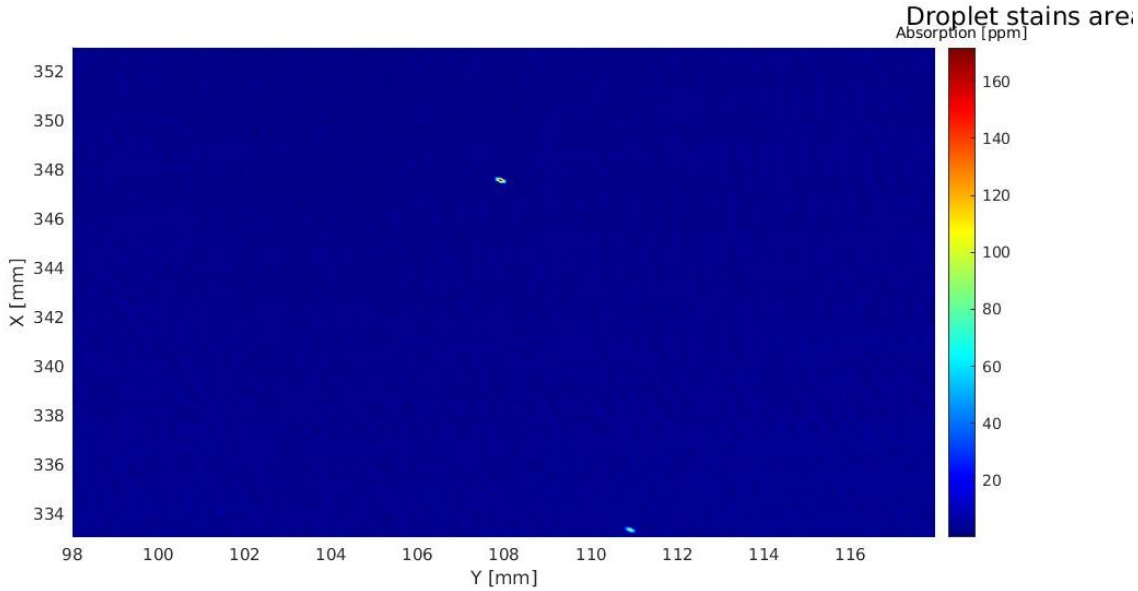


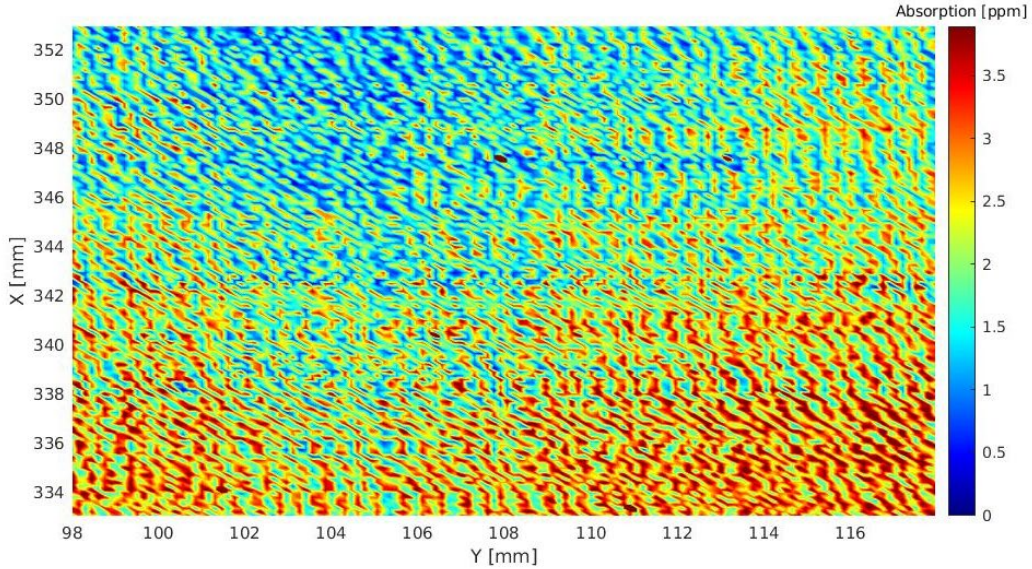
After



Surface Absorption Measurement of the Cleaned Mirror

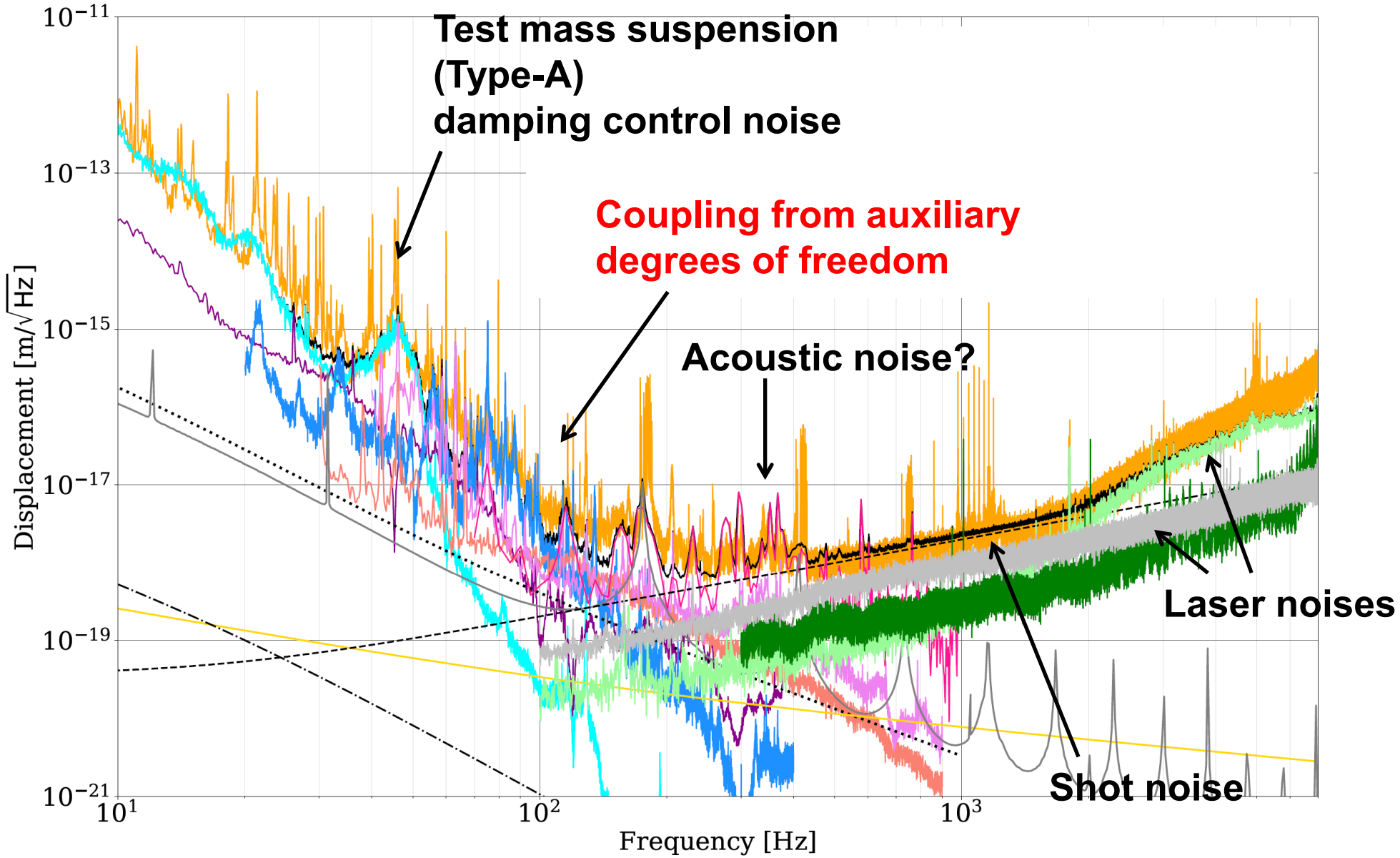




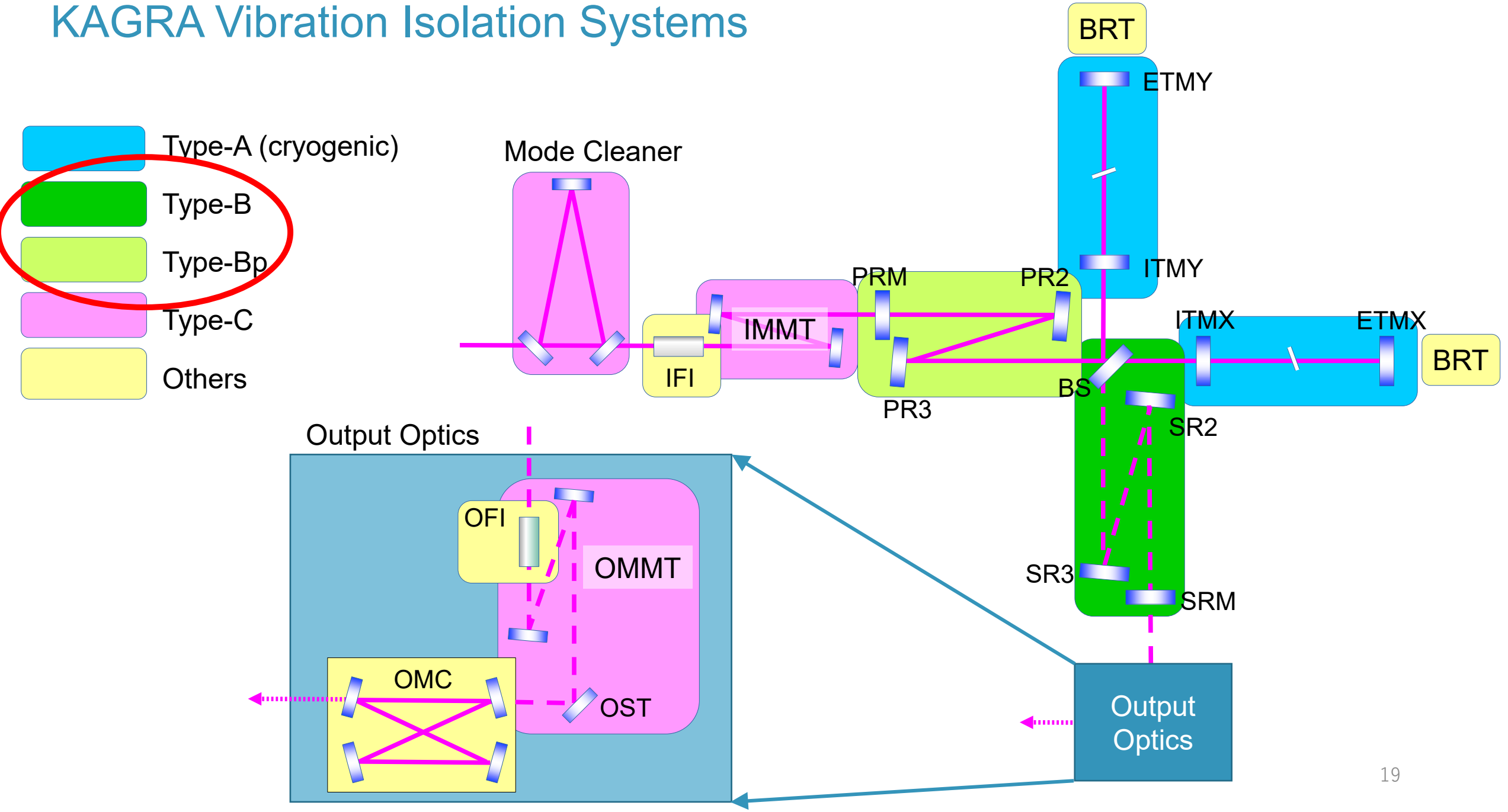


O3GK Noise Budget

arXiv:2203.07011



KAGRA Vibration Isolation Systems

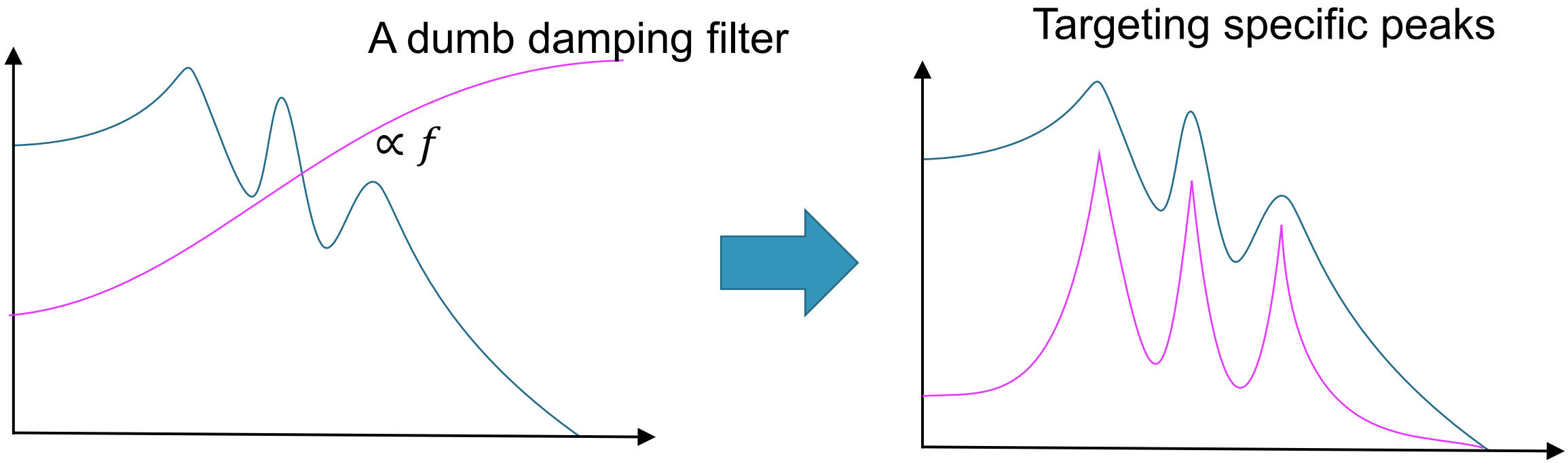


Many repair items and improvements for Type-B/Bp

- Fixed jammed fishing rods
- Introduction of limit switches to avoid future jamming
- Ballast adjustments
- Careful height adjustments
- Reduced the pitch jump problem
- Heaters for temperature stabilization
  (also for Type-A)

Heater elements installed
on a Type-Bp chamber

Suspension Damping Control Optimization



Peak frequencies change over time, especially when suspensions are cooled down
Manual optimization of the damping filters is unrealistic

PreQua (Phase-locking Real-time Quality-factor estimator)

- Realtime monitoring of peak frequency and Q-factor
- Using phase-lock to keep track of resonant signals
- Automation of suspension characterization and filter optimization

O3GK Noise Budget

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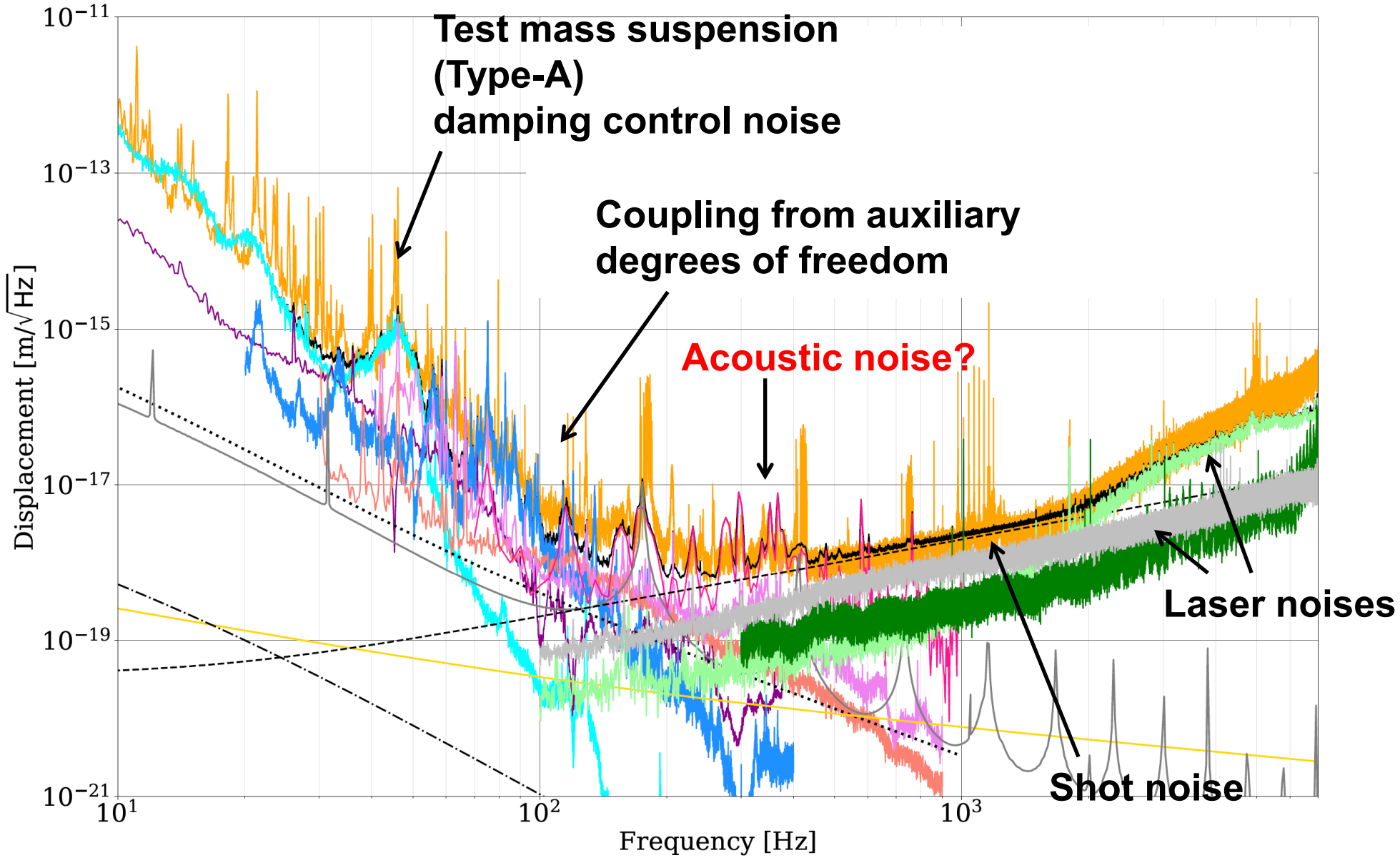
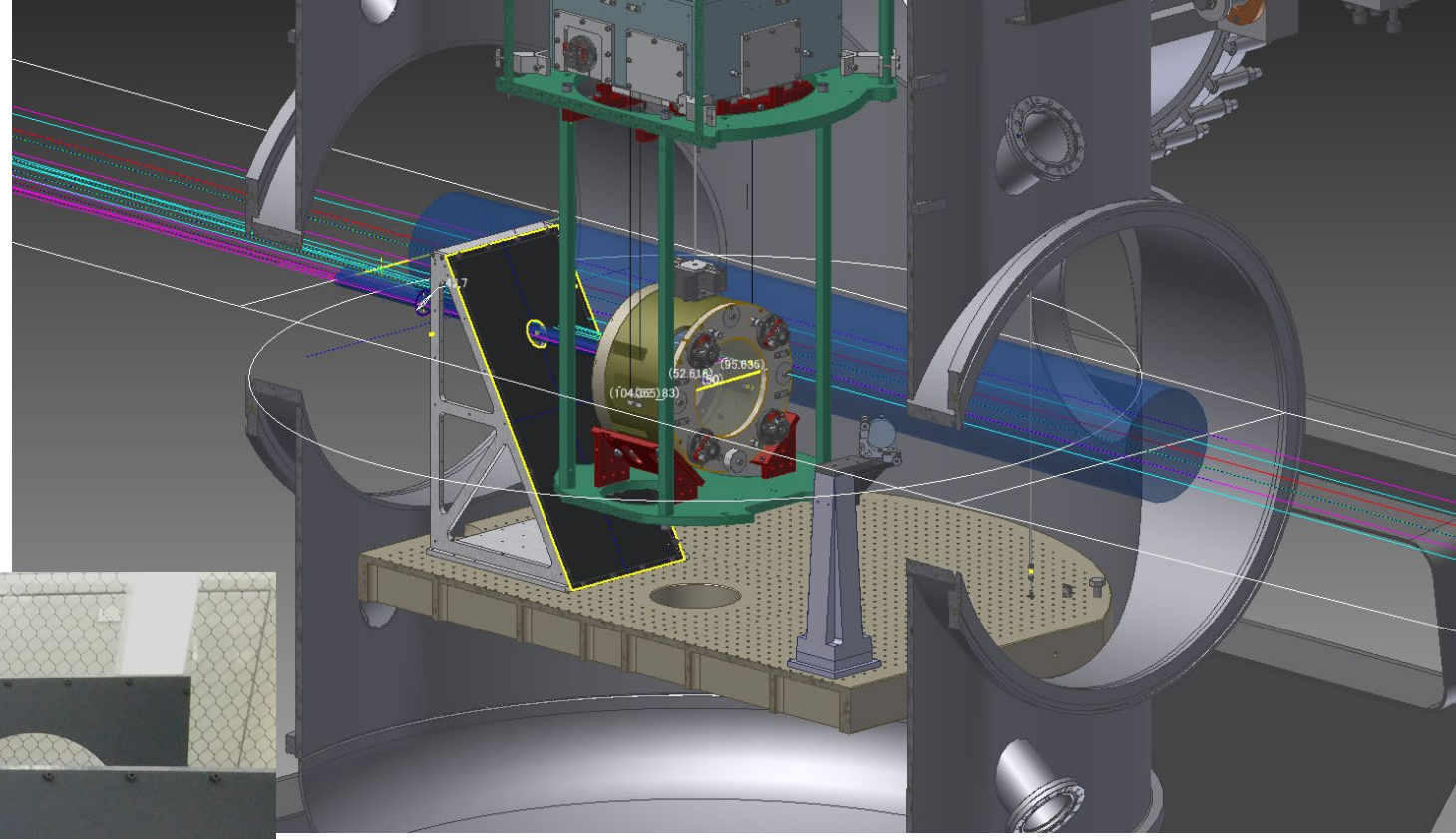
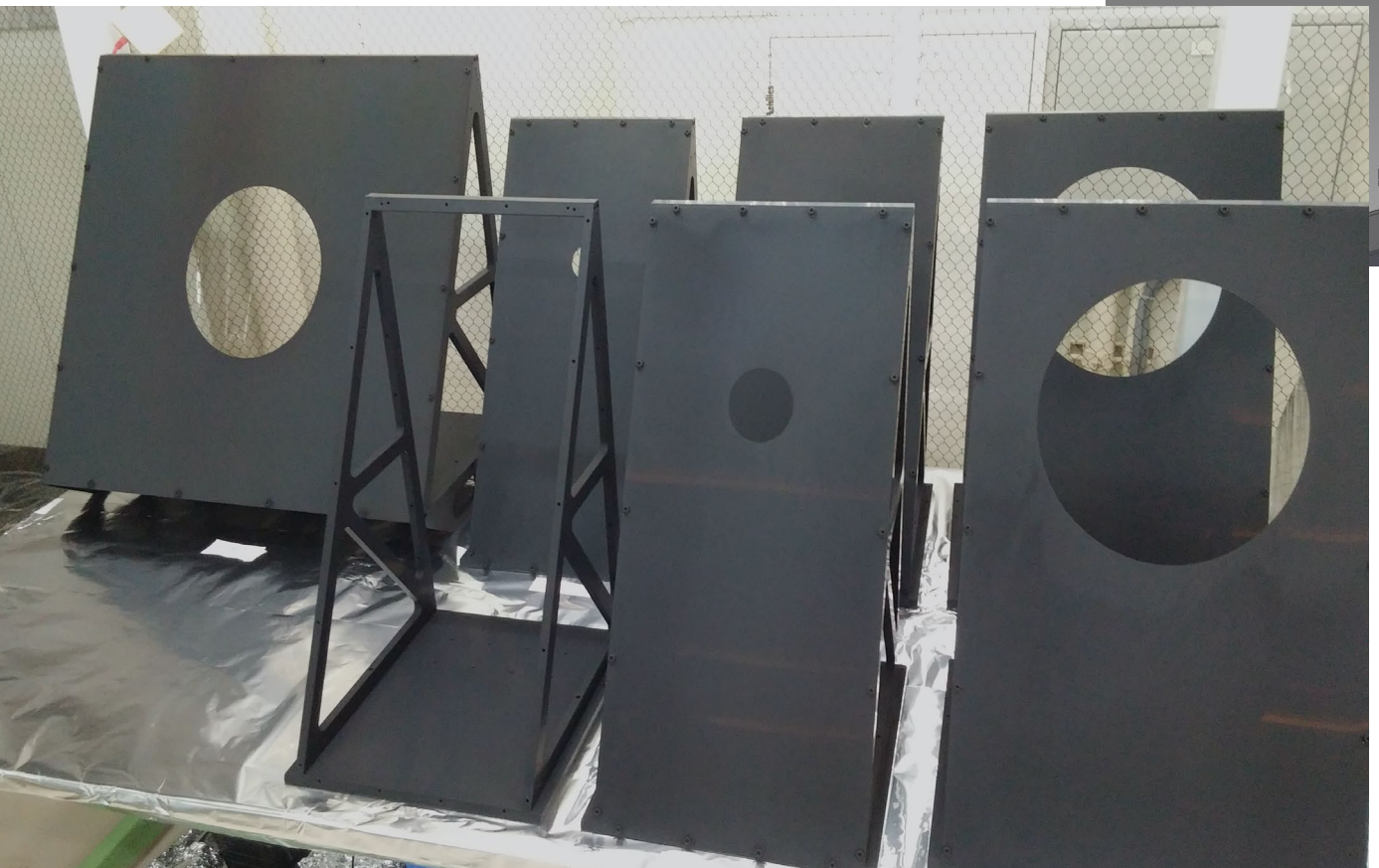


Additional Baffles





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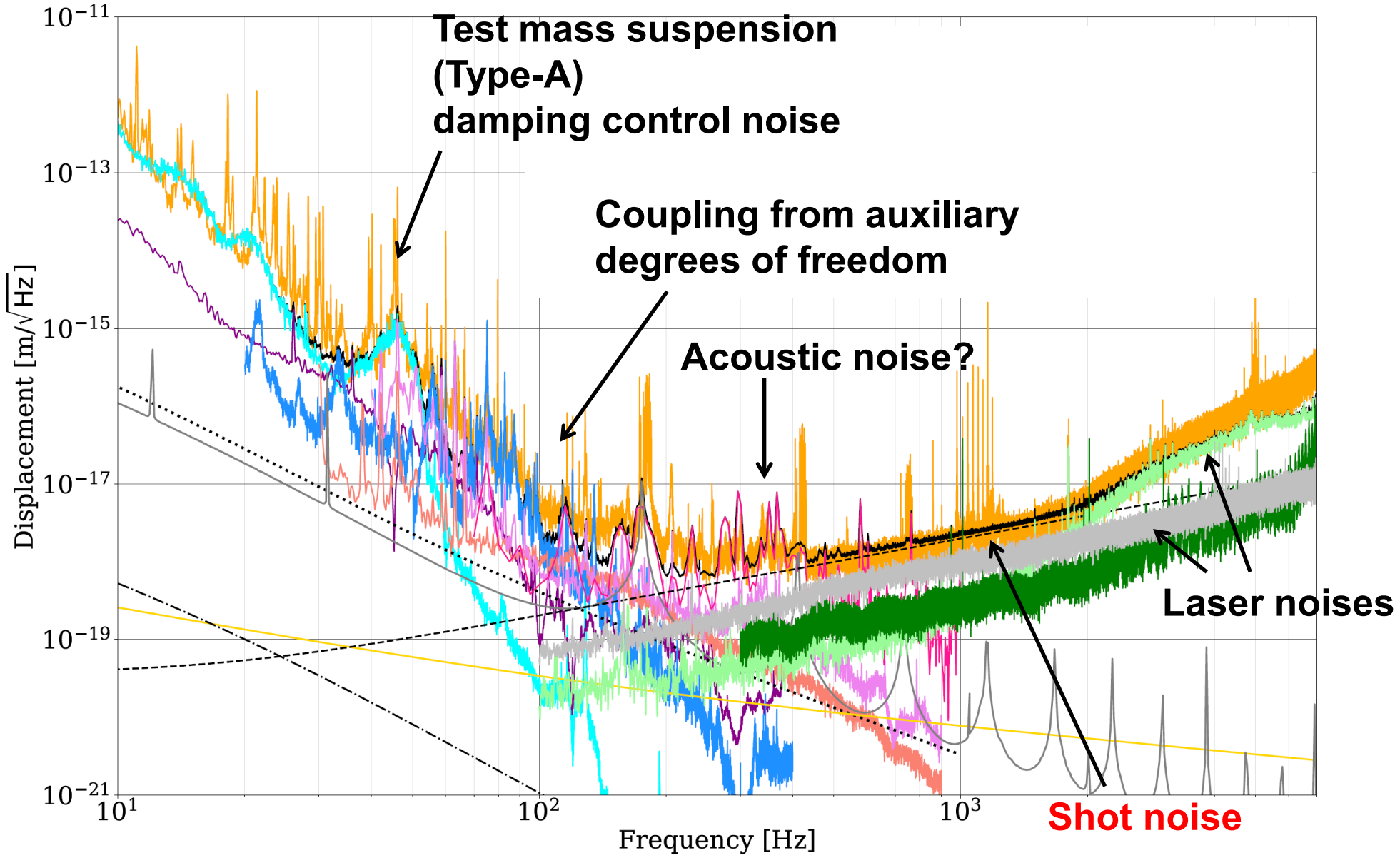
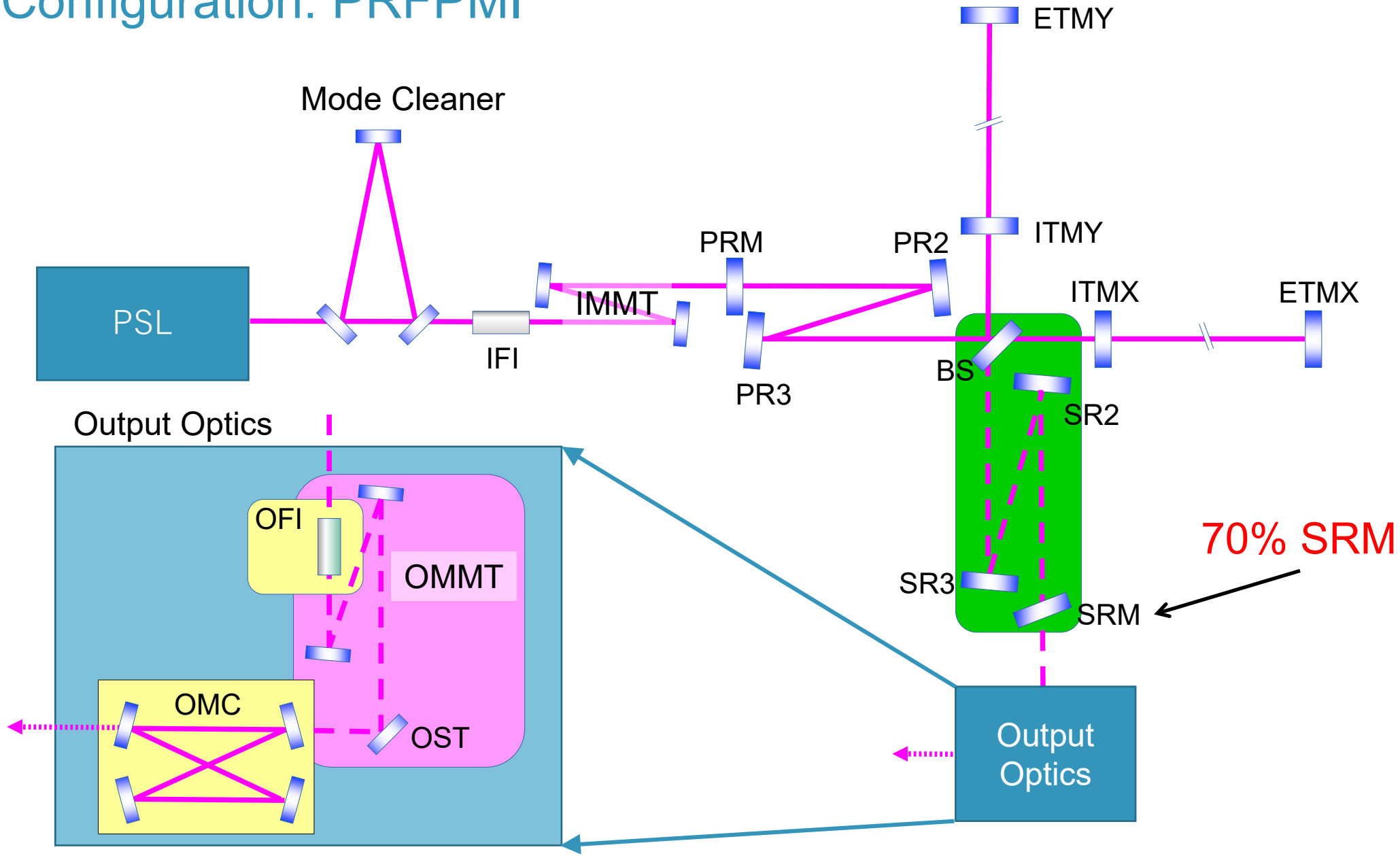
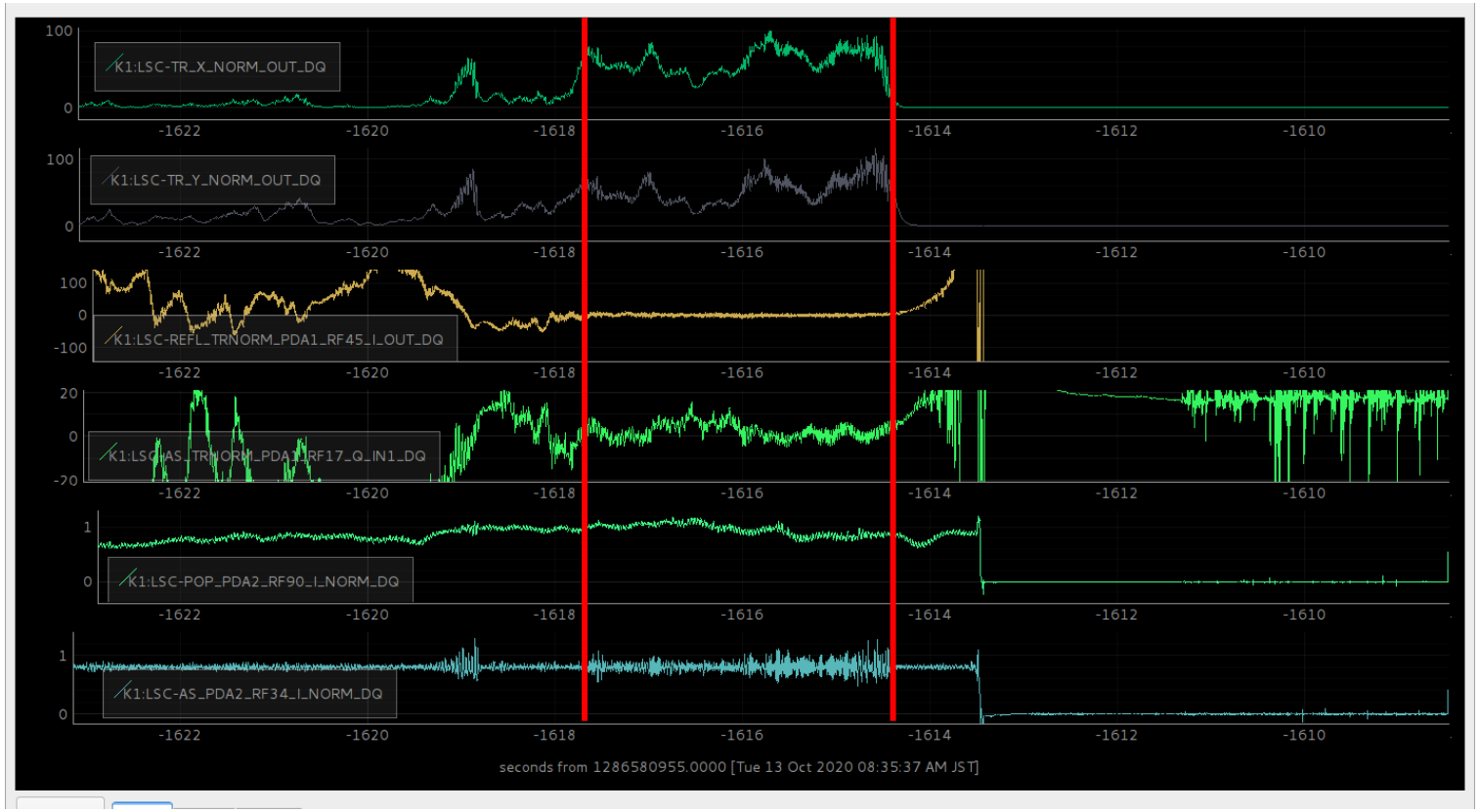


O3GK Configuration: PRFPMI



RSE lock trial

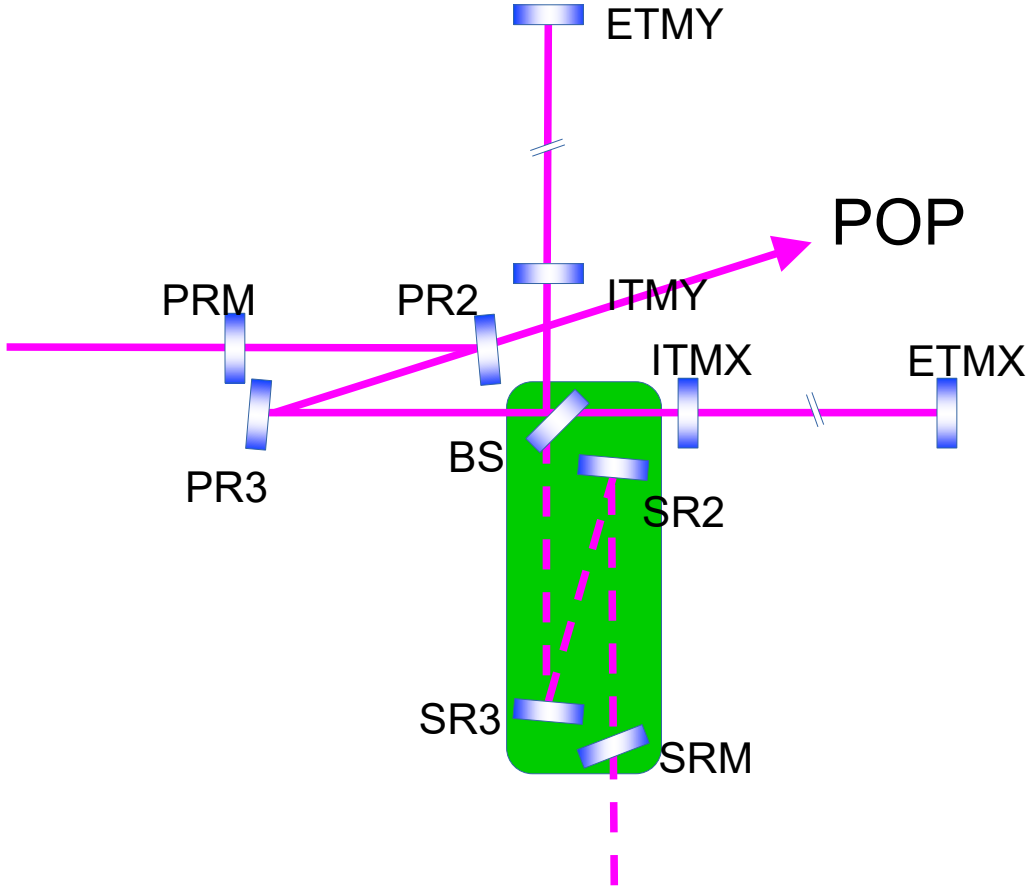
RSE lock ~ 2 sec

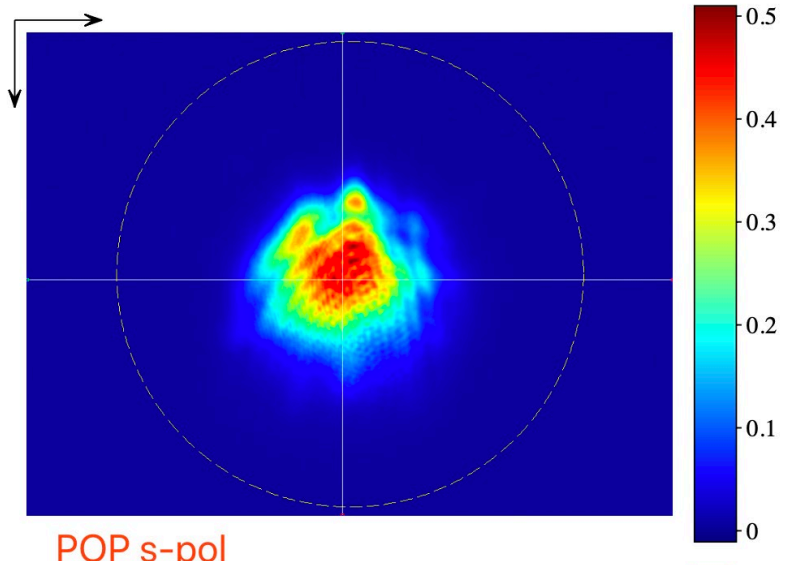


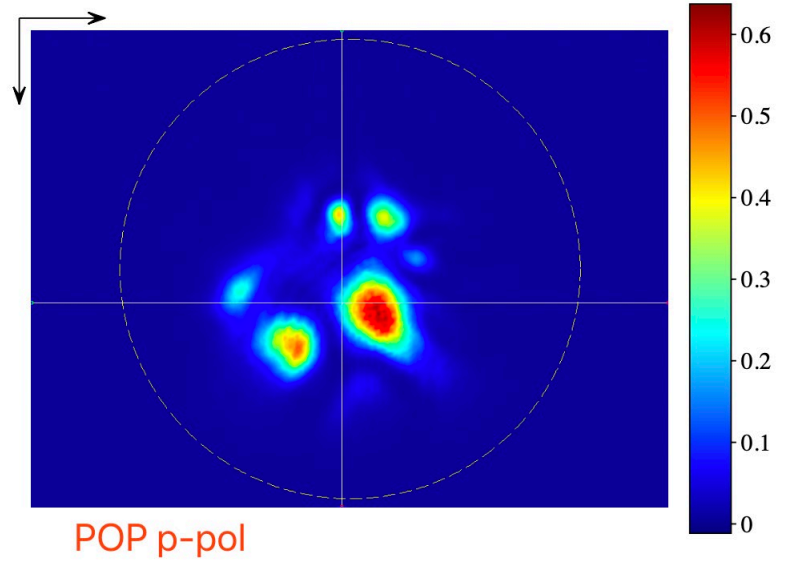
- Suspensions were not quiet enough
- No WFS implemented
- Not enough time to tune feedback filters

Alignment Sensing and Control

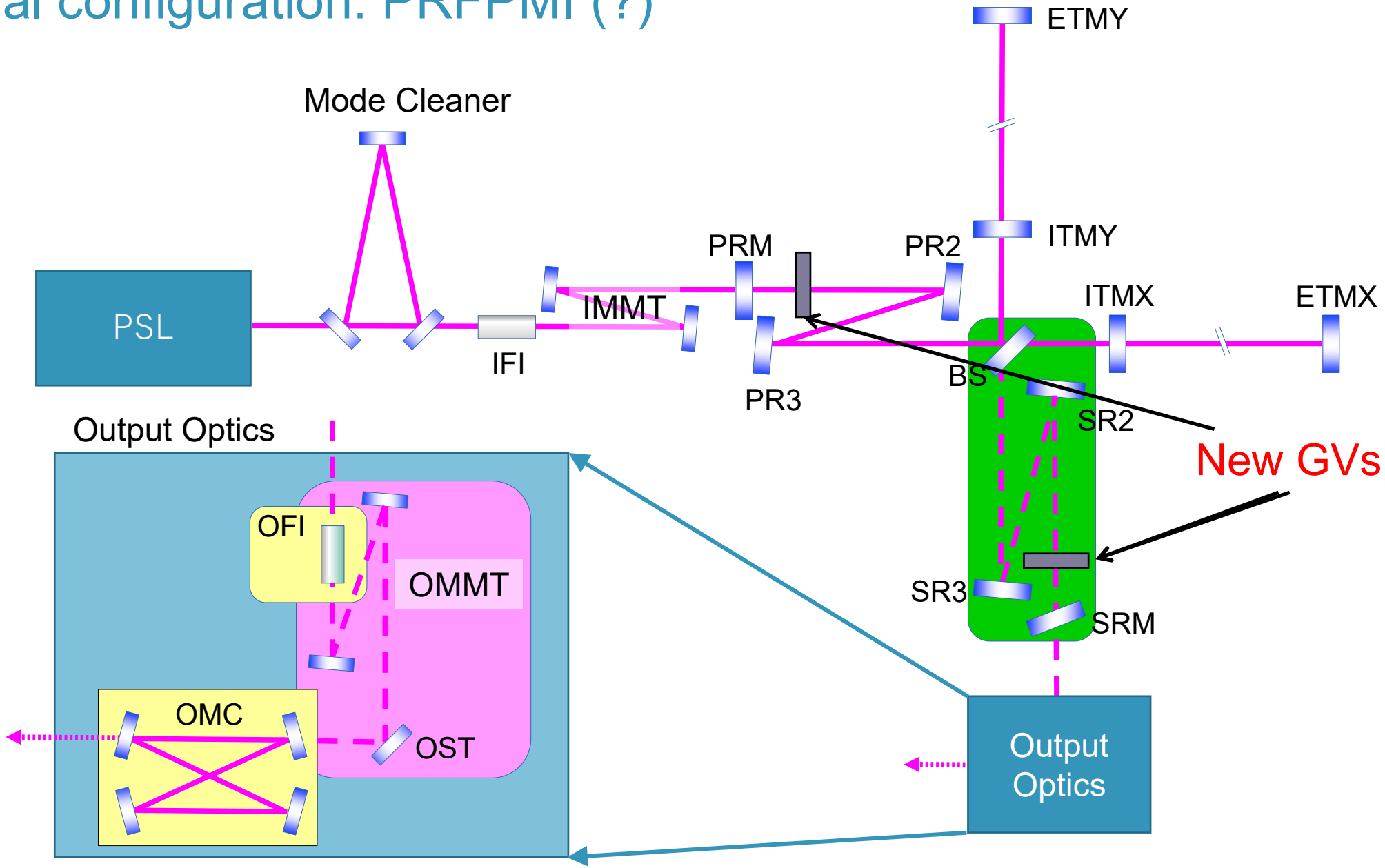
- ASC is much more difficult and messier than LSC (Universal Truth)
- It is especially hard for KAGRA because of the birefringence







O4 initial configuration: PRFPMI (?)

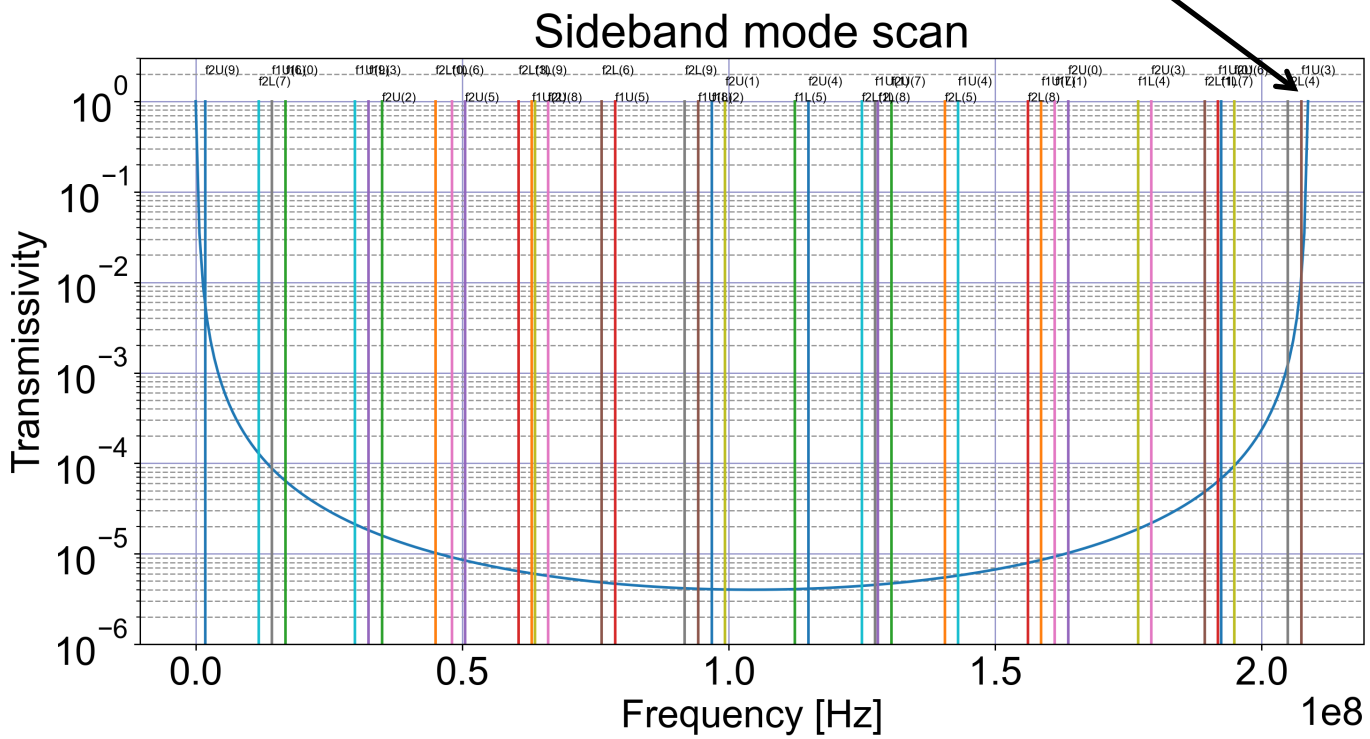


OMC Update

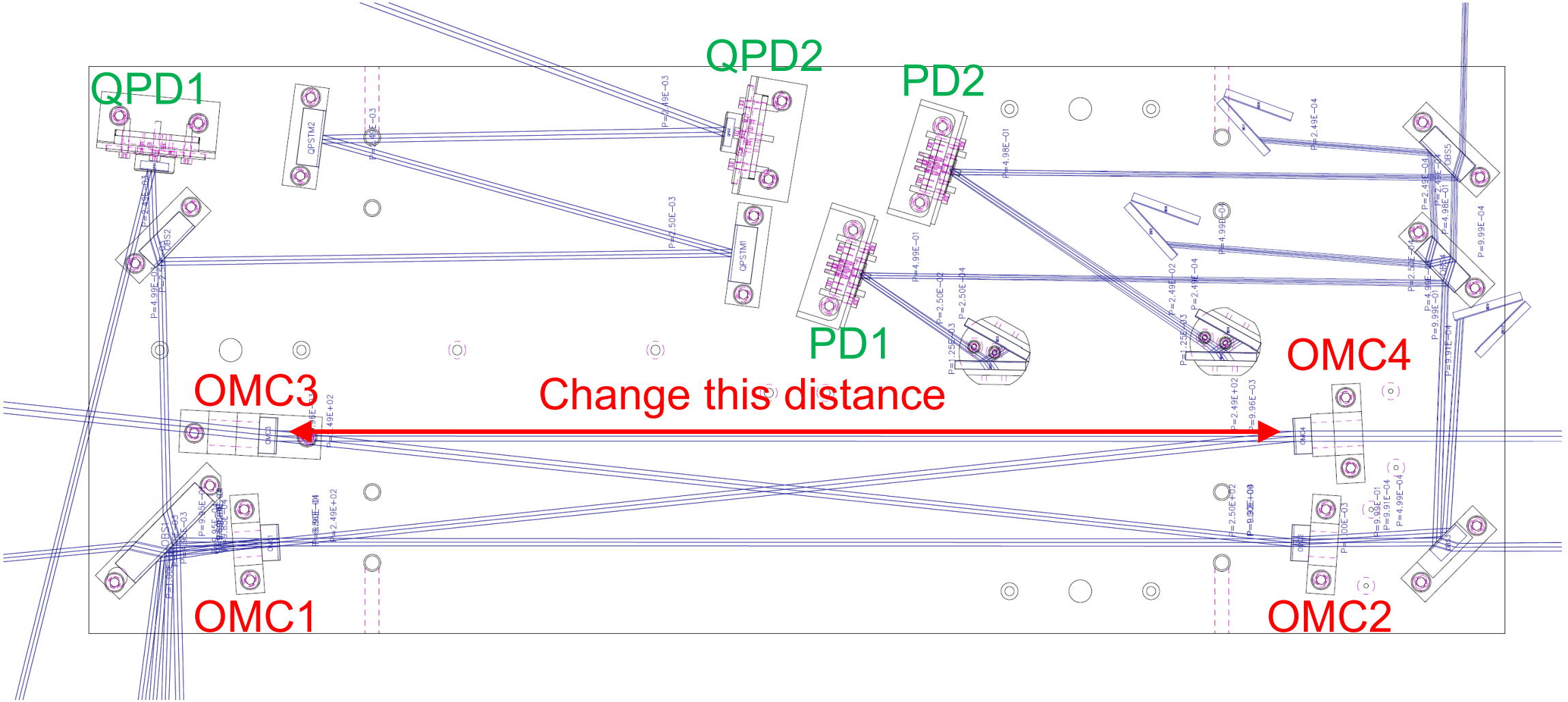
Problems with the current OMC

- Low transmissivity ~ 80%
- One of the DC PD is broken
- A higher order mode is close to resonance
- QPD noise

3rd order HOM of f2 SB

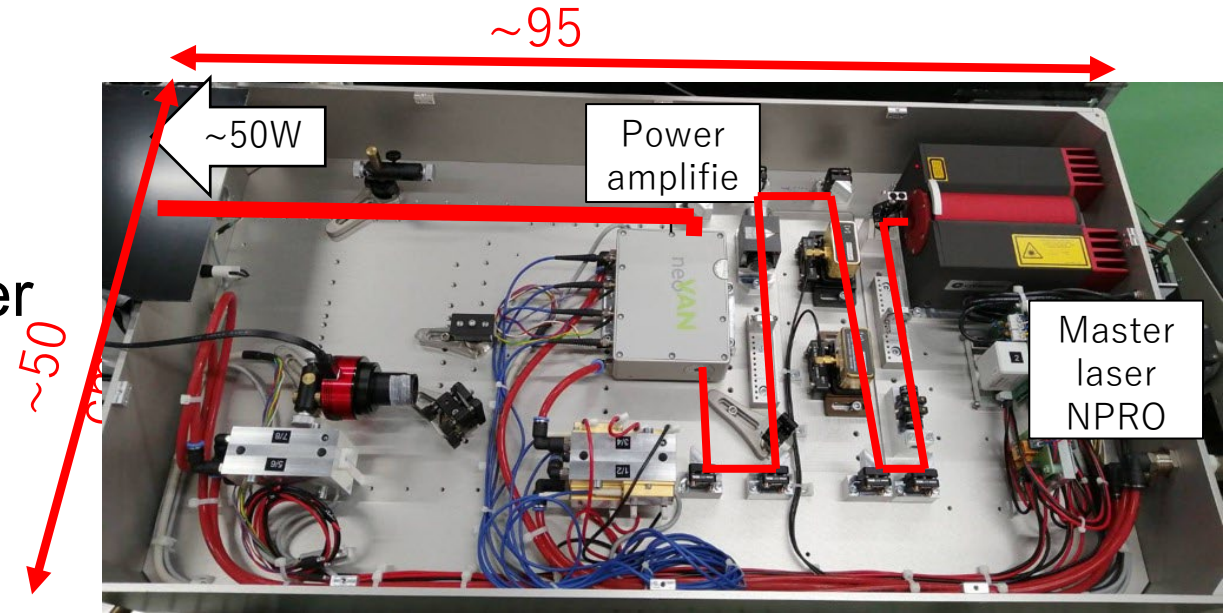


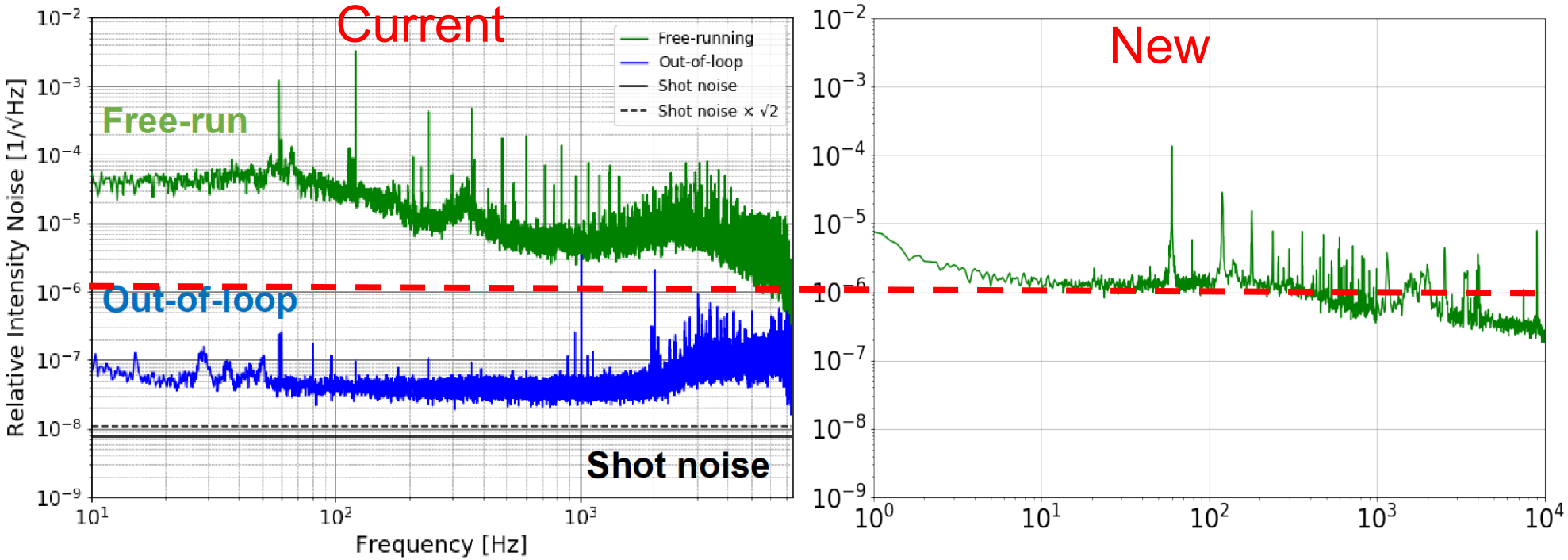
- Low transmissivity: New mirrors -> Now about 95% transmission
- Broken DCPD: fix it
- HOM resonance: adjust the OMC length
- Noisy QPD: In-vac electronics ?



High power laser

- 60W amplifier (neoLASE)
- Lower intensity noise than the current laser
- Mode shape is not great
  - 80% transmission of a test cavity

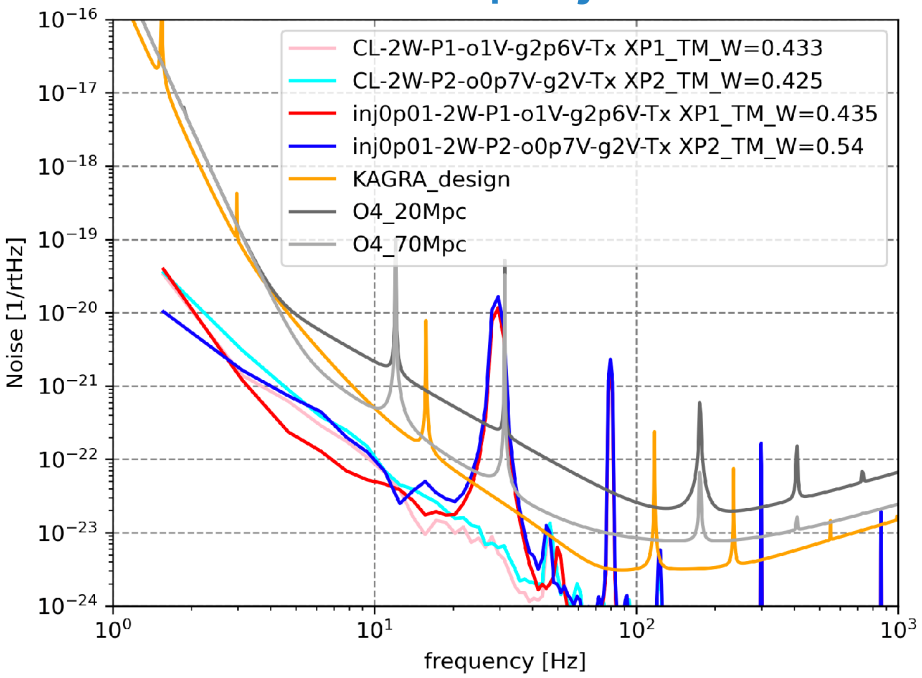




Calibration

- Fixed Y-end PCal
- PCal noise has been improved
- Absolute accuracy improvement foreseen

PCal noise projection



PEM

- More systematic deployment of sensors
- Underground environment study
  - Infrasound monitor
  - Schuman resonance monitor
  - Water flow monitor