Test of New Interferometric Sensors in the AEI 10 m Prototype

Johannes Lehmann

Matteo Carlassara, Firoz Khan, Sina M. Köhlenbeck, Alexandra L. Mitchell, Conor M. Mow-Lowry, Juliane von Wrangel, David Wu

Outline

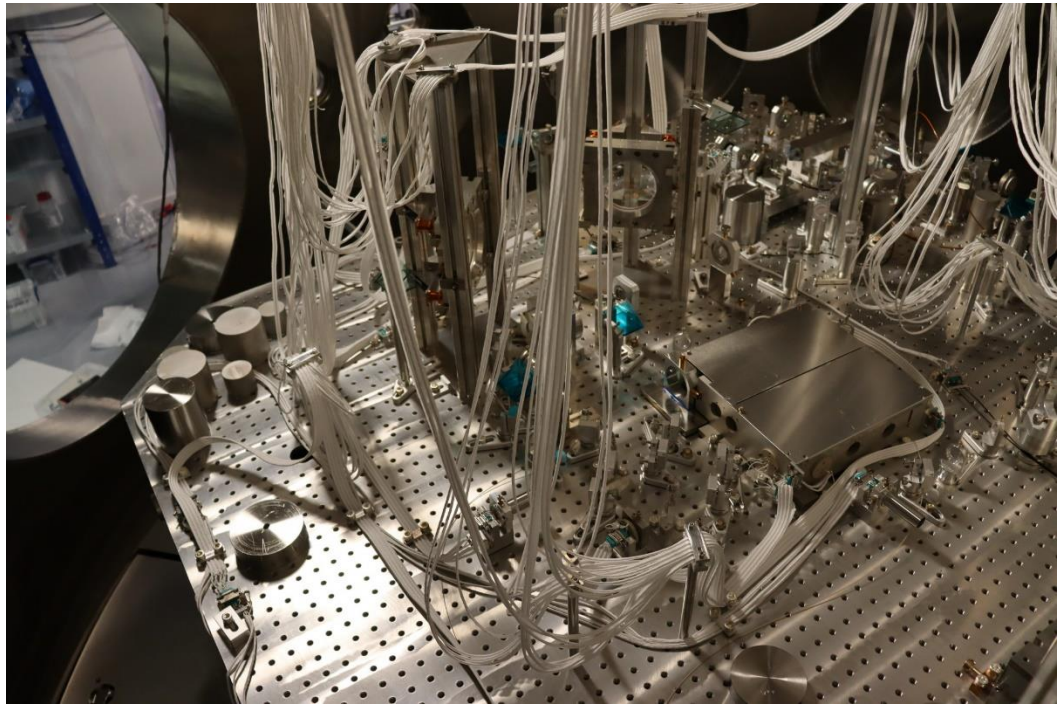
- Introduction
  - 10 m prototype
- Suspension platform interferometer (SPI)
  - Integration of phasemeter in CDS
  - Performance
- Homodyne quadrature interferometers (HoQI)
  - Installation
  - Signal processing
  - Performance (in air)

10 m Prototype

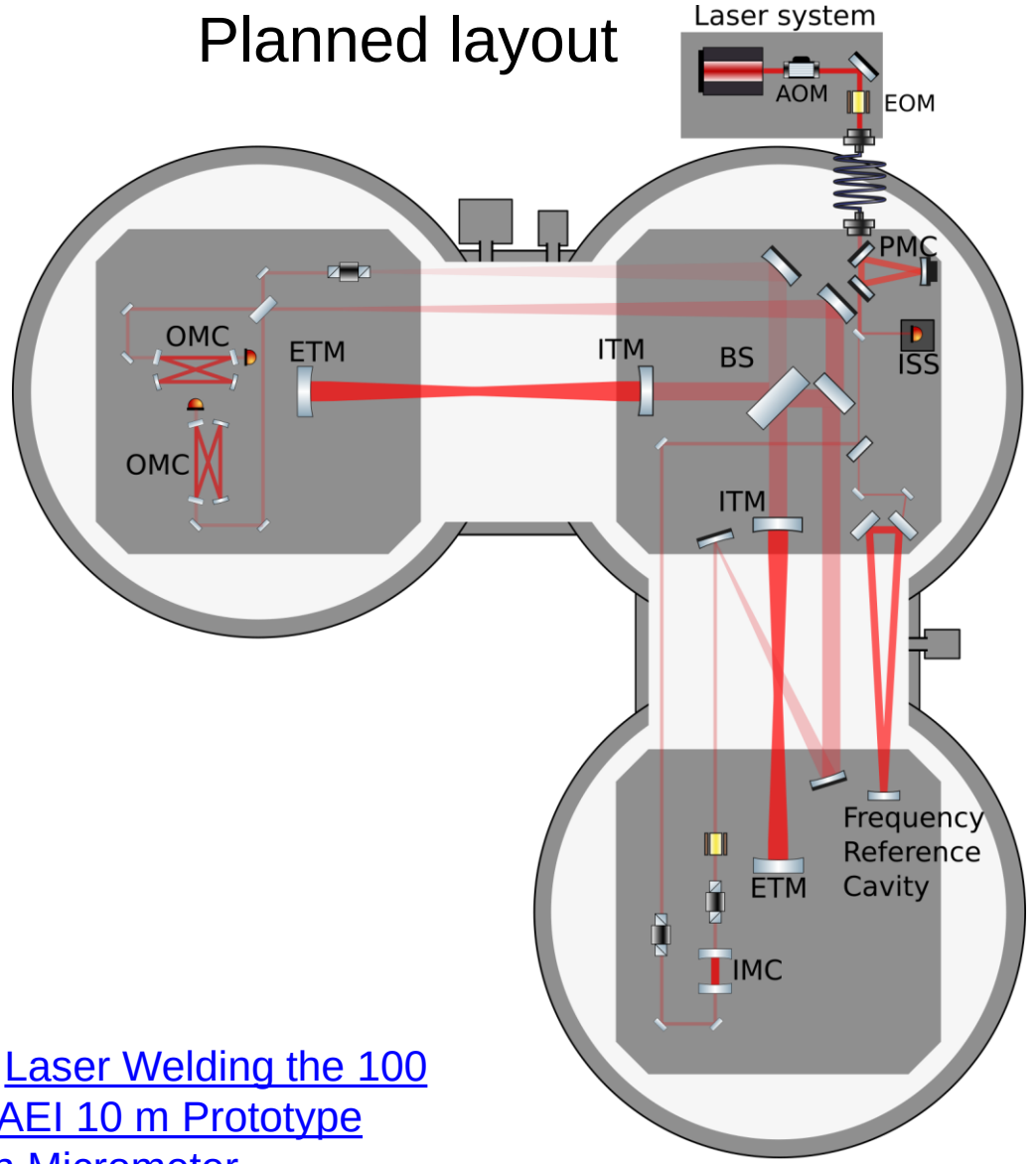
- FPMI limited by quantum noise over range of input powers
- Test new technology for GW detectors

Overview

- Pre isolation (AEI-SAS)
- Laser stabilisation (ISS, RC)
- Mode cleaners (PMC, IMC, OMC)
- Main beam splitter (BS)
- SPI and optical lever



Planned layout



See also poster: Laser Welding the 100 g Mirrors for the AEI 10 m Prototype Suspensions with Micrometer Precision #14 (Juliane von Wrangel)

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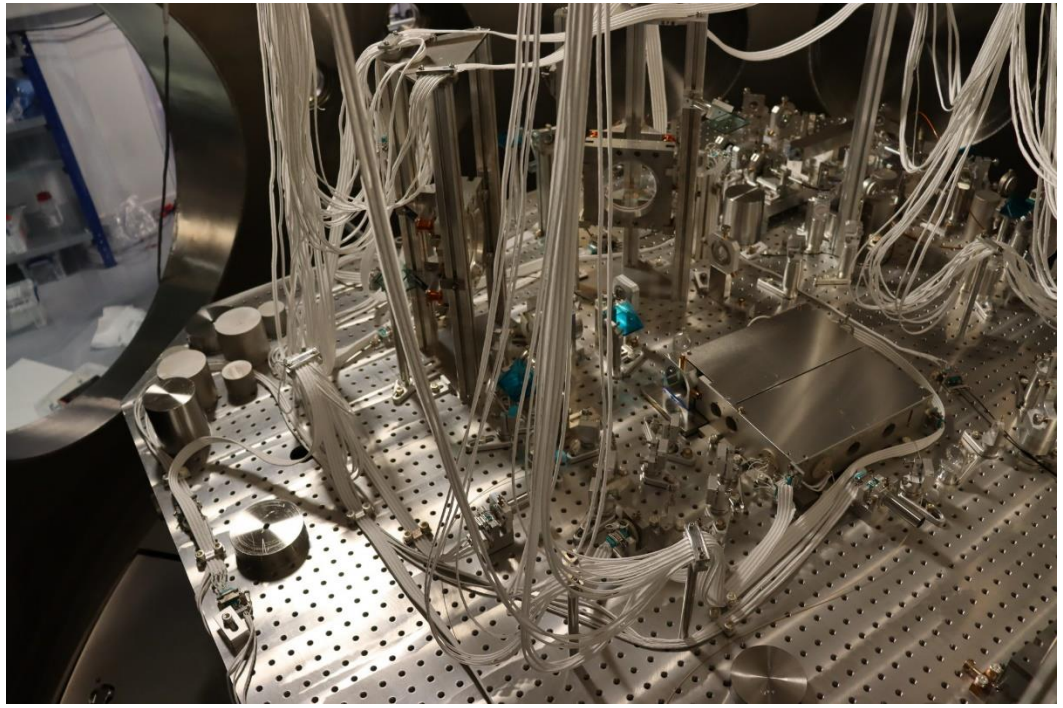
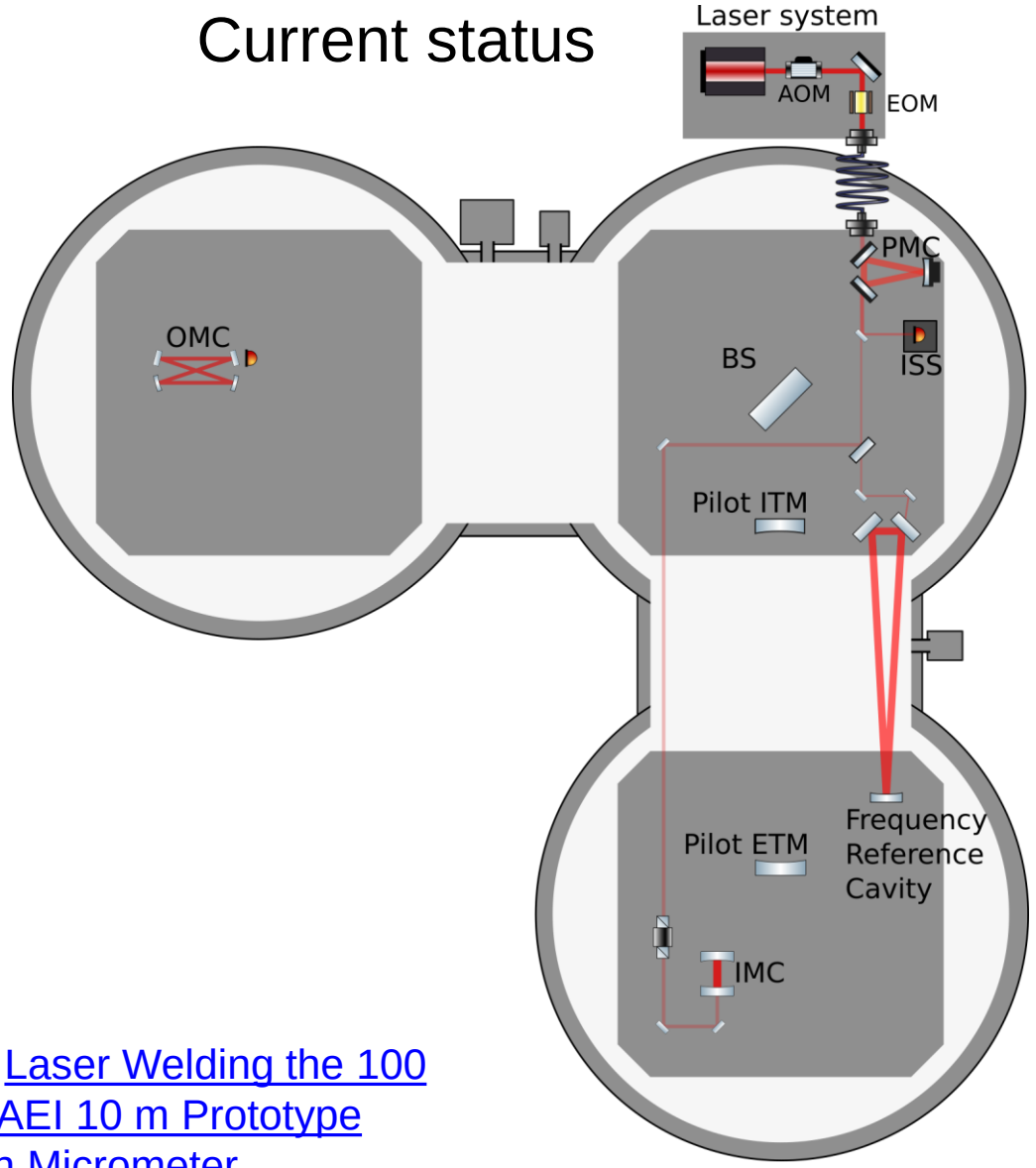


Current status



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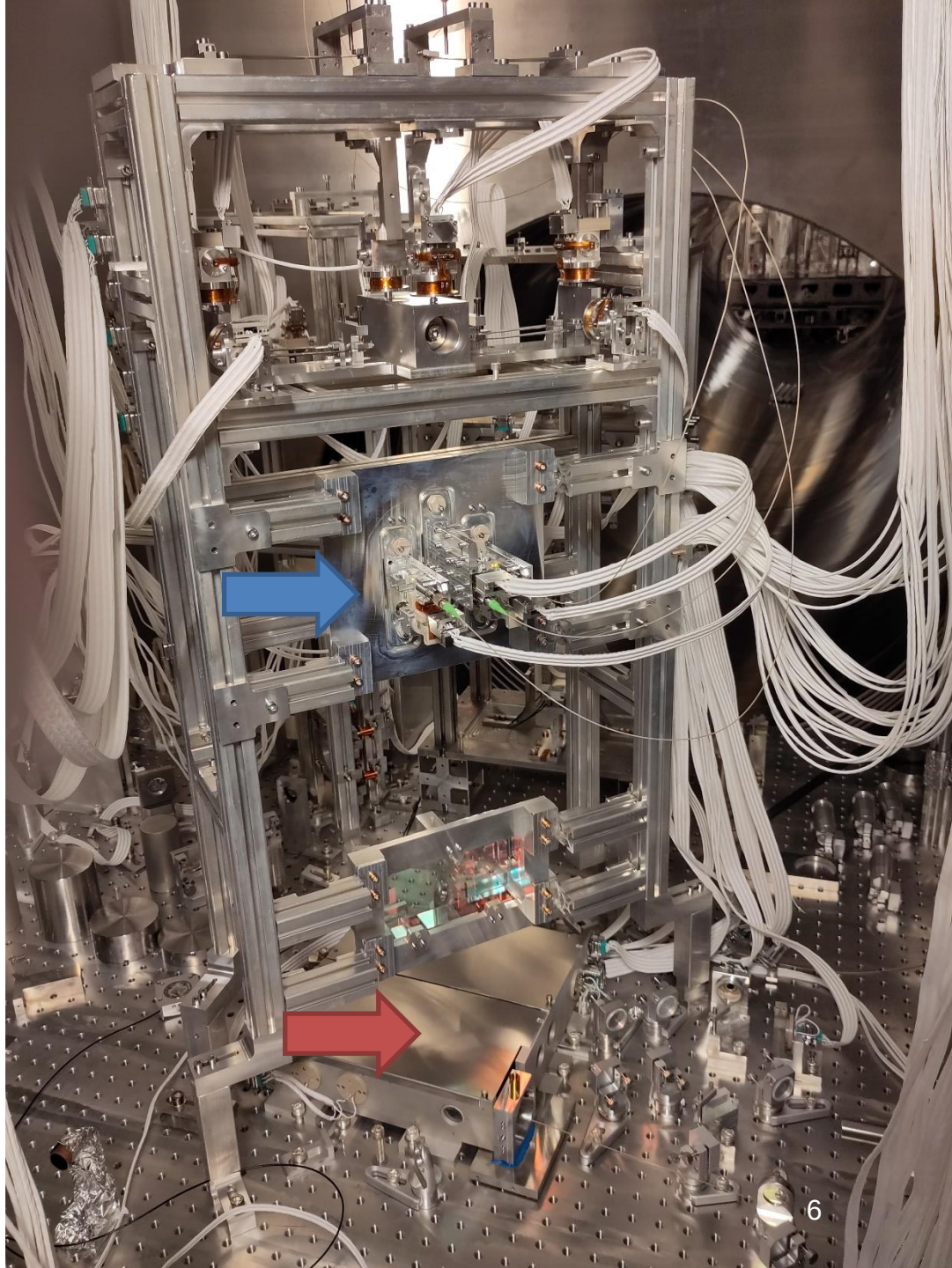
Test facility

- Test low frequency techniques
- Compare against existing sensors
- Measure effect on interferometer
- Gain practical experience with sensors

→SPI running for a long time

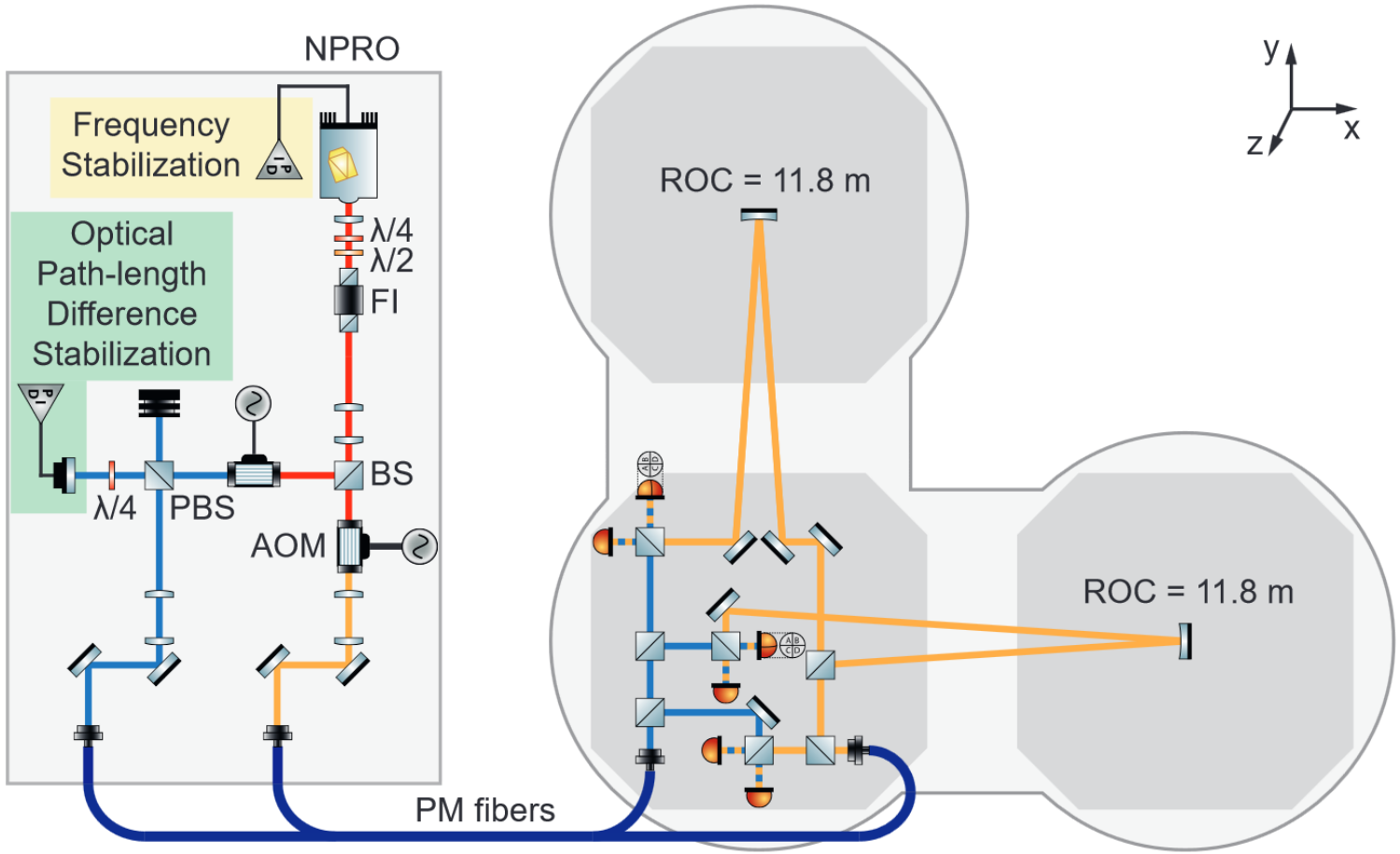
→HoQIs installed at BS



Suspension platform interferometer (SPI)

- Heterodyne interferometer
- Measure differential platform motion
- Digital demodulation
- Active OPD stabilization

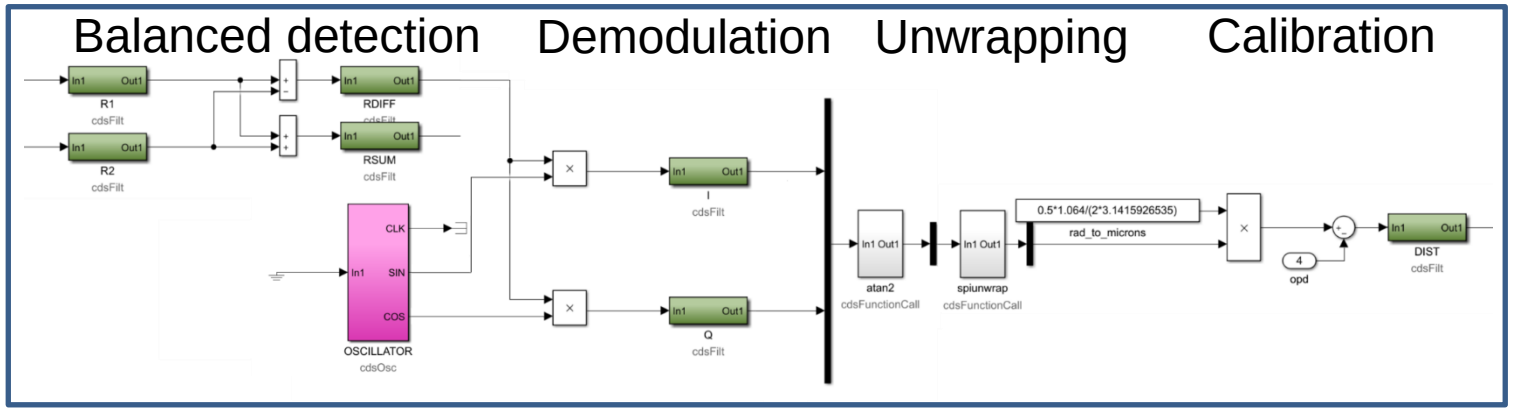
- *Keep in-air fibres short (and away from people) for new setups!*

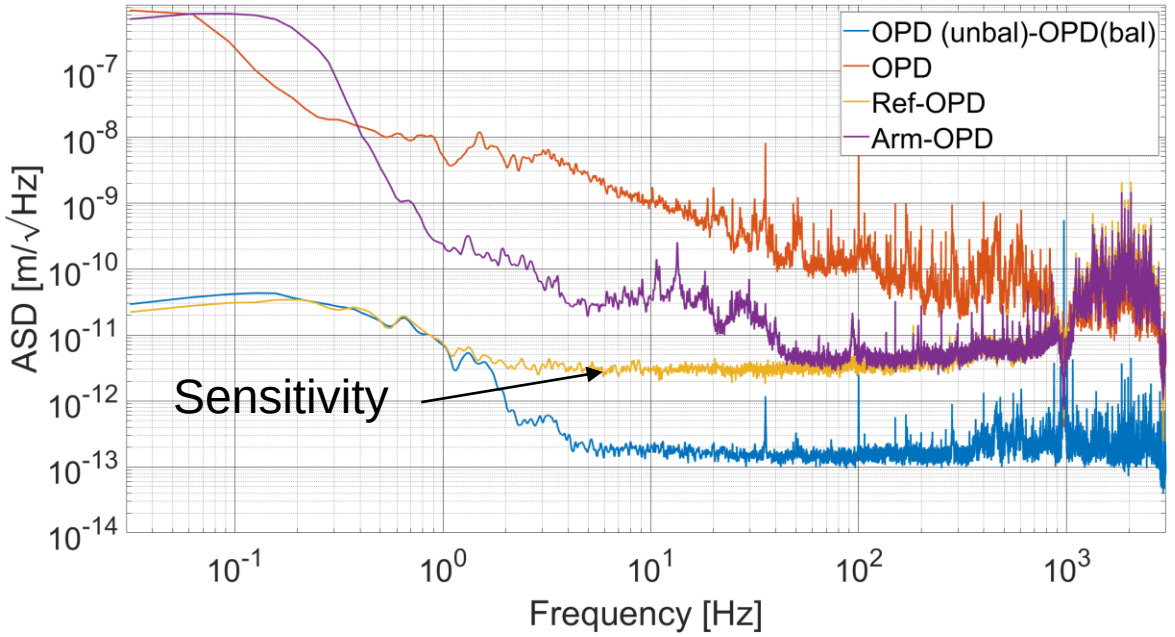


Source: Sina Maria Köhlenbeck (PhD thesis)

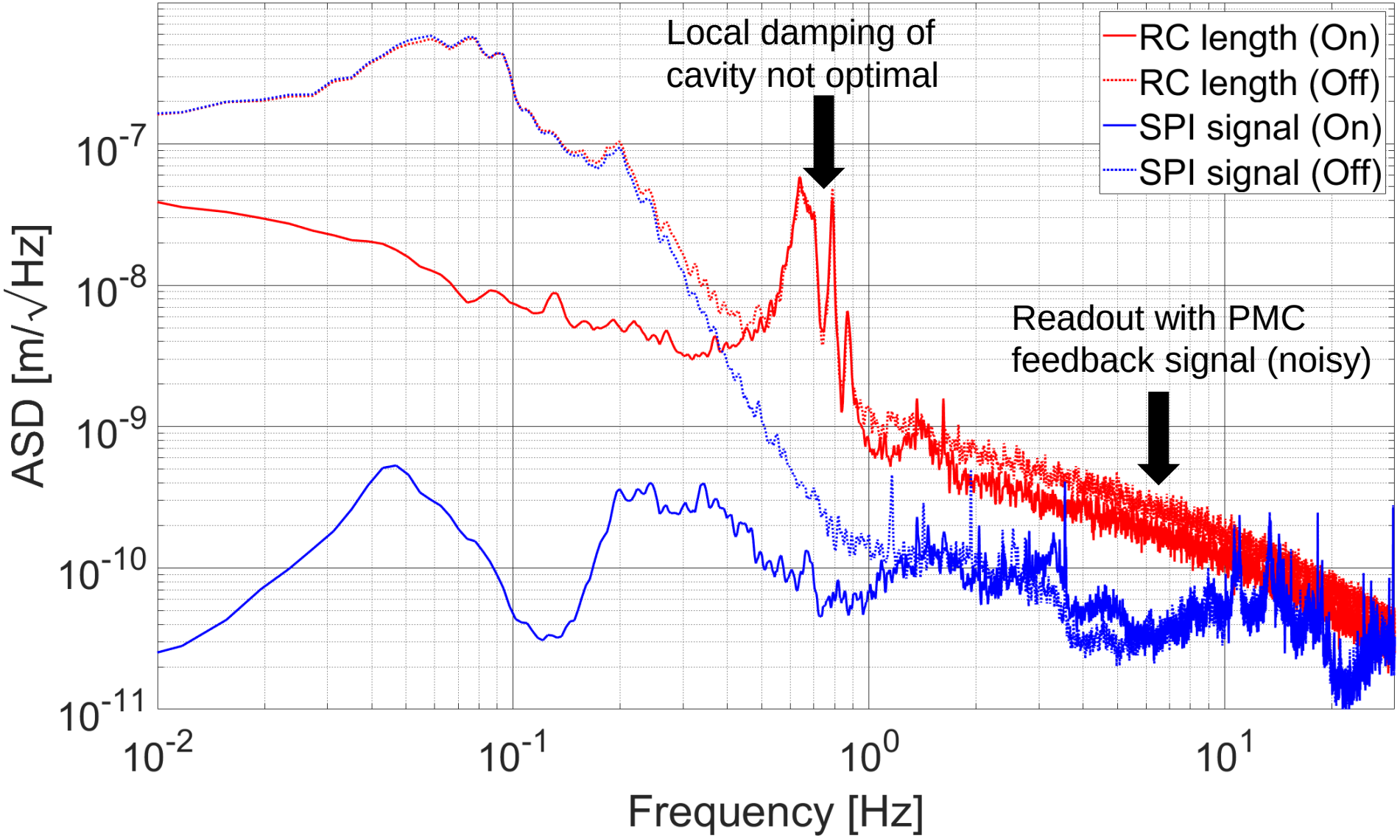
Integration of phasemeter in CDS

- Separate FPGA based phasemeter was difficult to maintain
- Reduced f_{het} from 15kHz to 1kHz and connected PDs directly to CDS
- Demodulated with CDS-generated LO
- Subtraction of OPD signal is better than before → no active suppression needed





Performance (effect on suspended cavity)



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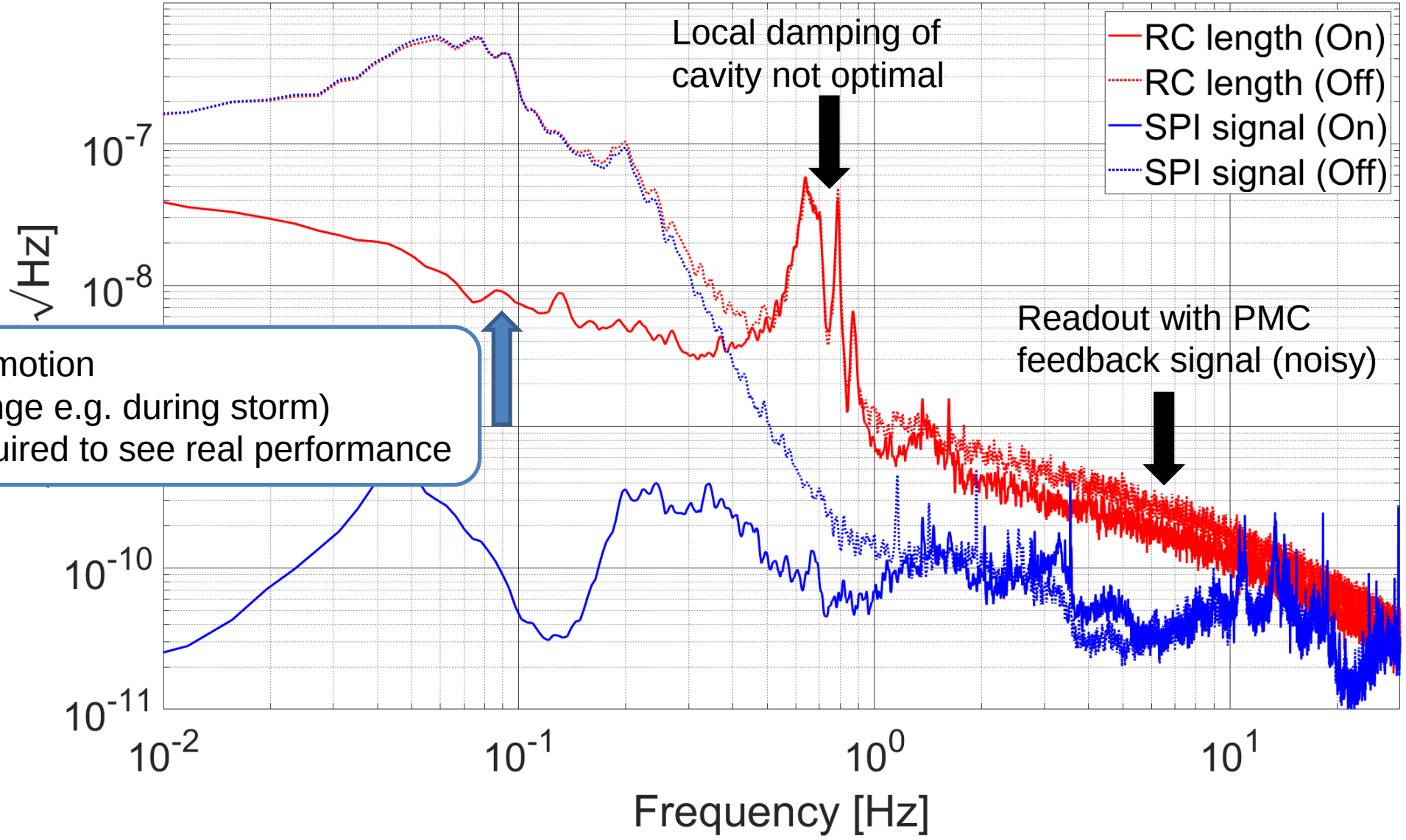
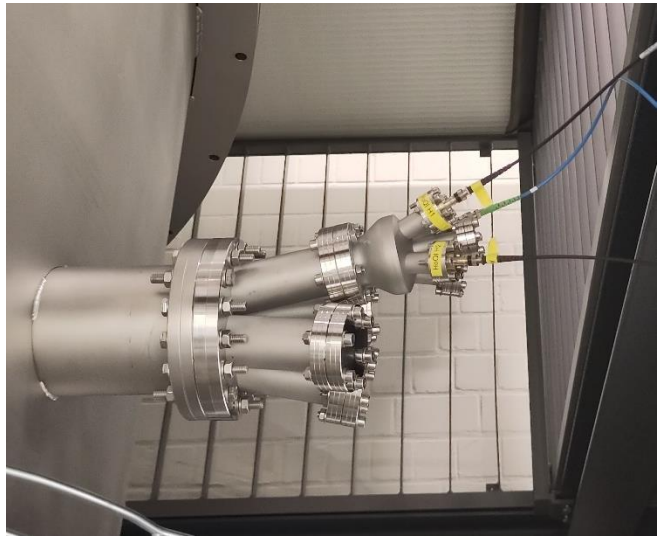
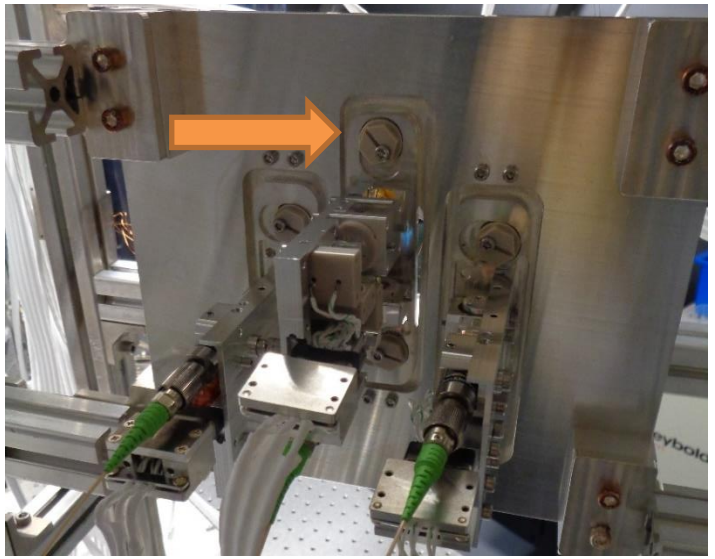


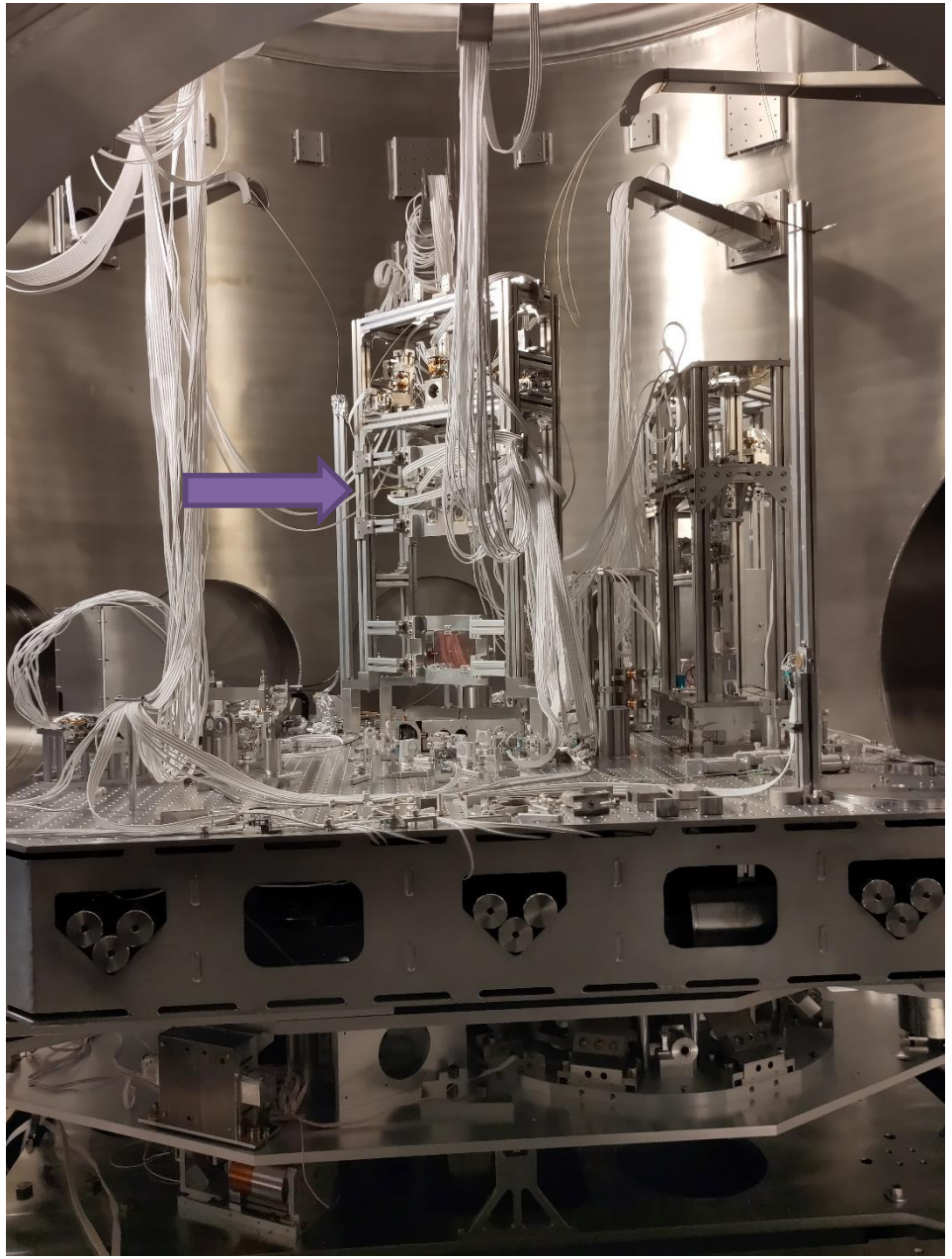
Upper limit of motion
(does not change e.g. during storm)
Michelson required to see real performance

HoQIs at beam splitter

- Intermediate mass readout
- First tests before BS was installed
- Transport with HoQIs attached
- Minor realignment (same style as HRTS BOSEMs)

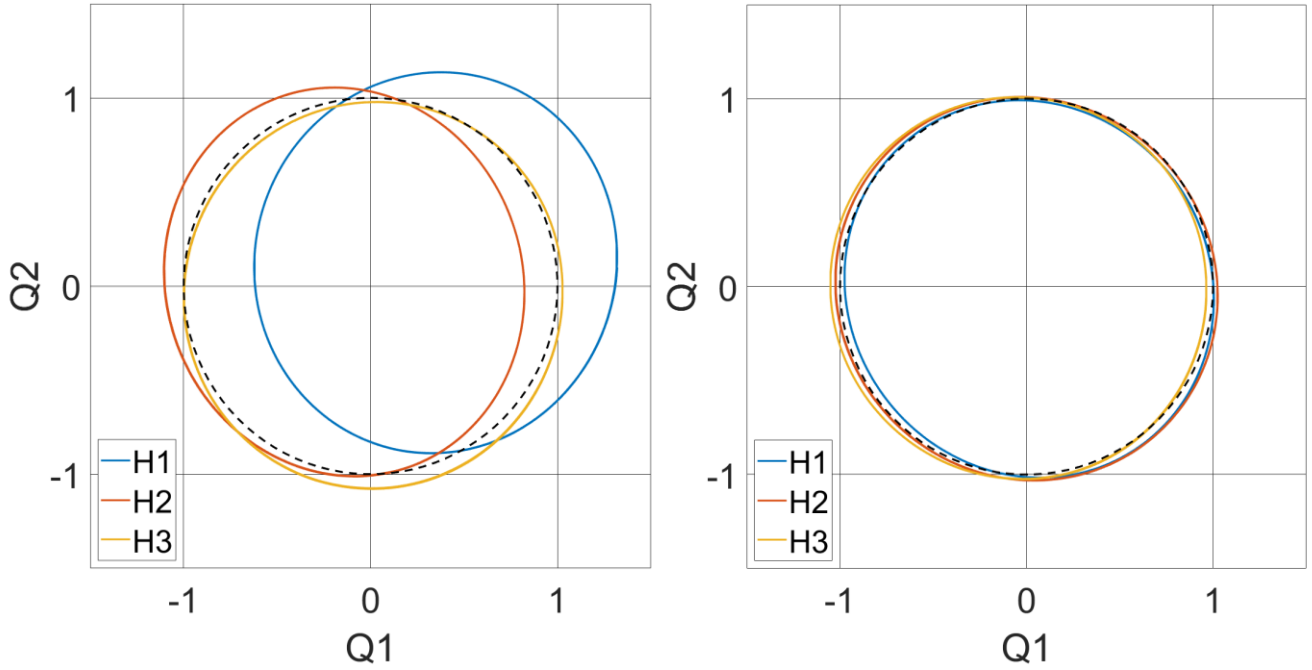


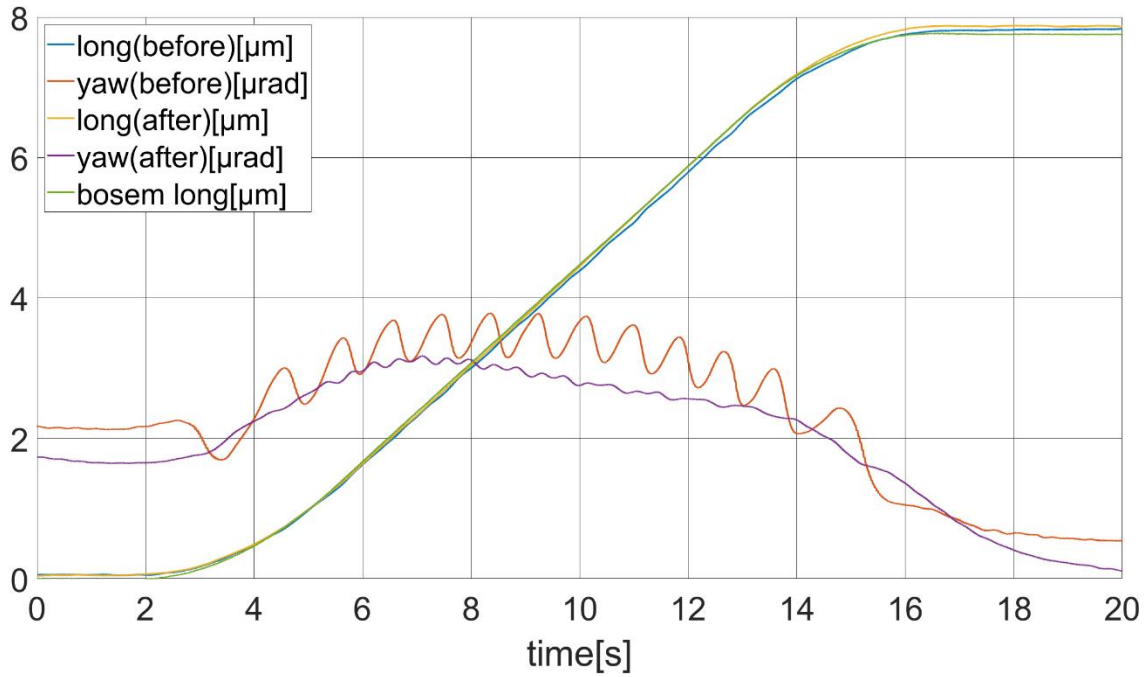




Signal processing

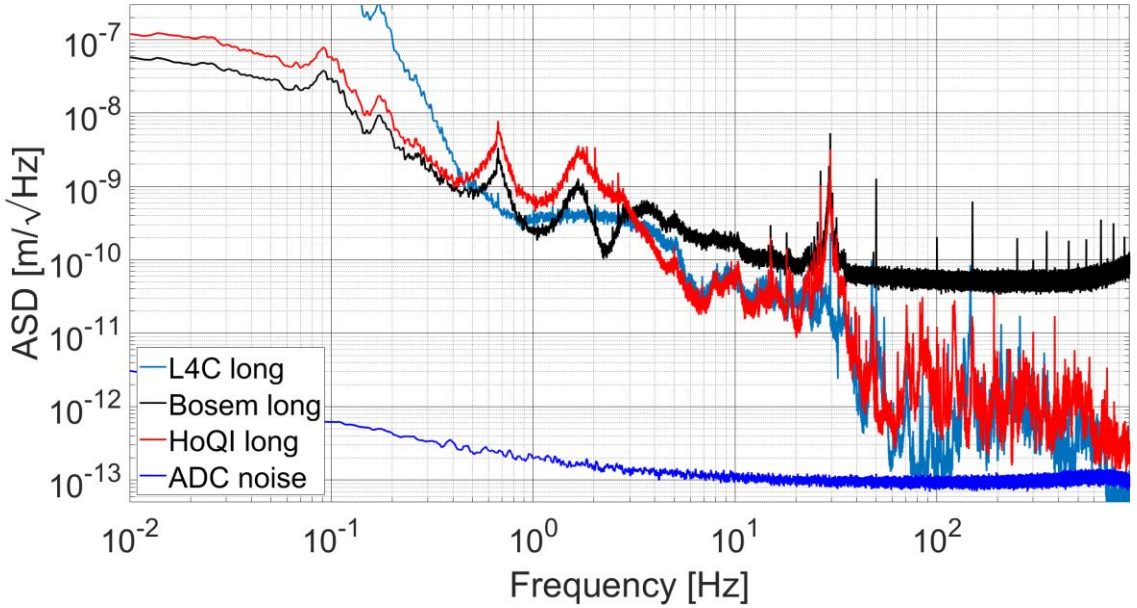
- Calibration changed with operating point
- Digital gain of PD channels adapted
- Offsets in quadrature signals removed
- Cross coupling into yaw signal strongly reduced

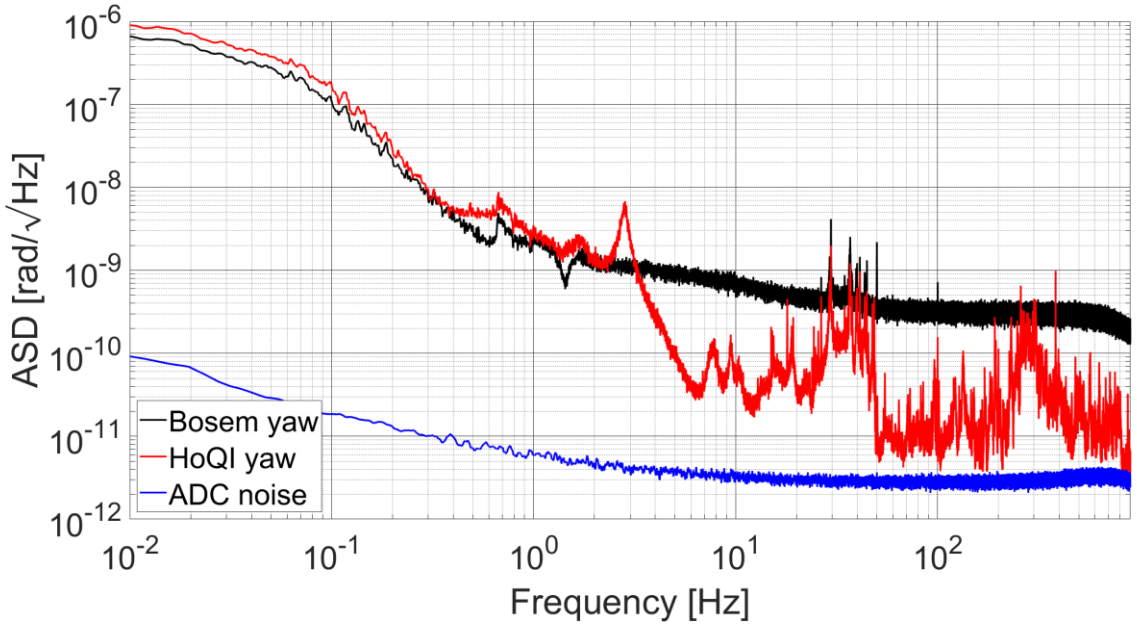


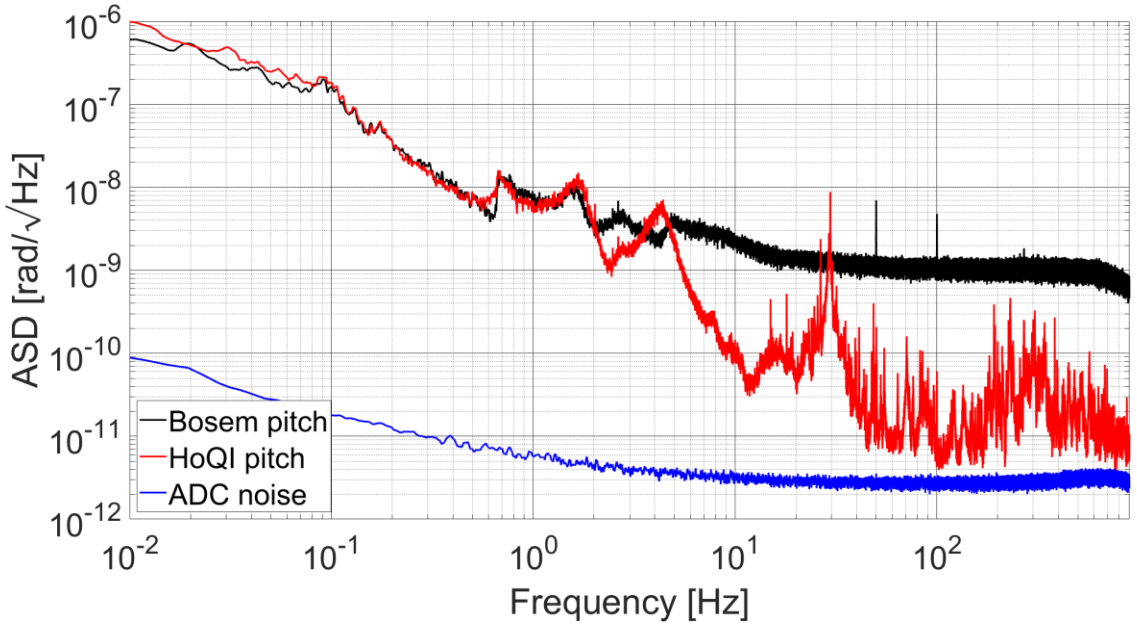


Performance (in air)

- HoQIs and BOSEMs mostly measure suspension frame motion
- Acoustics, structural resonances and table motion dominate signal



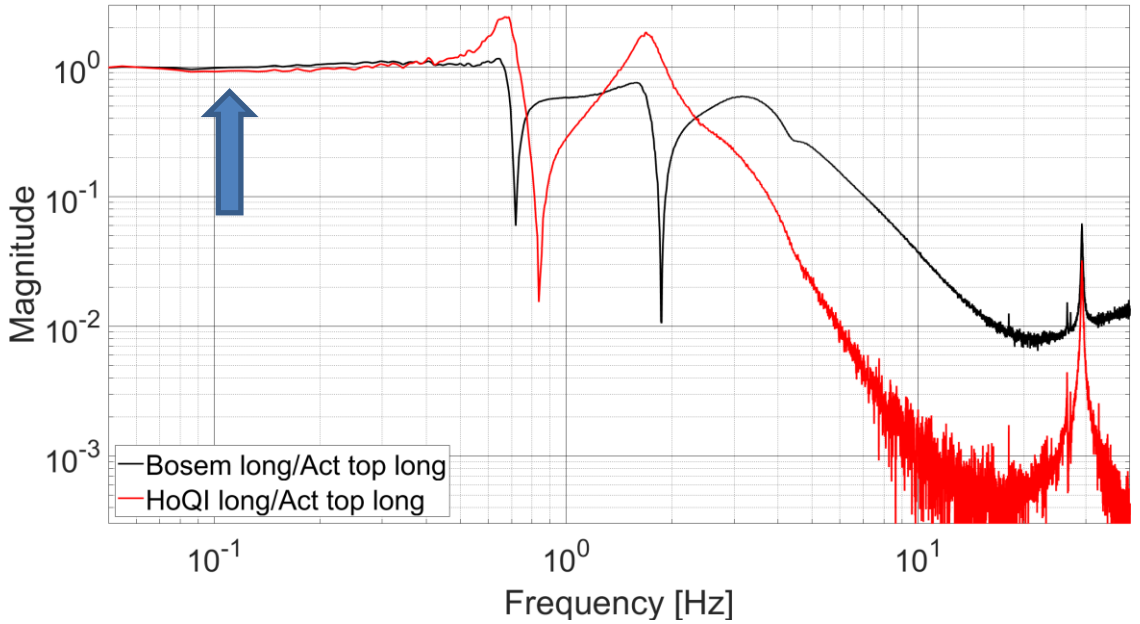


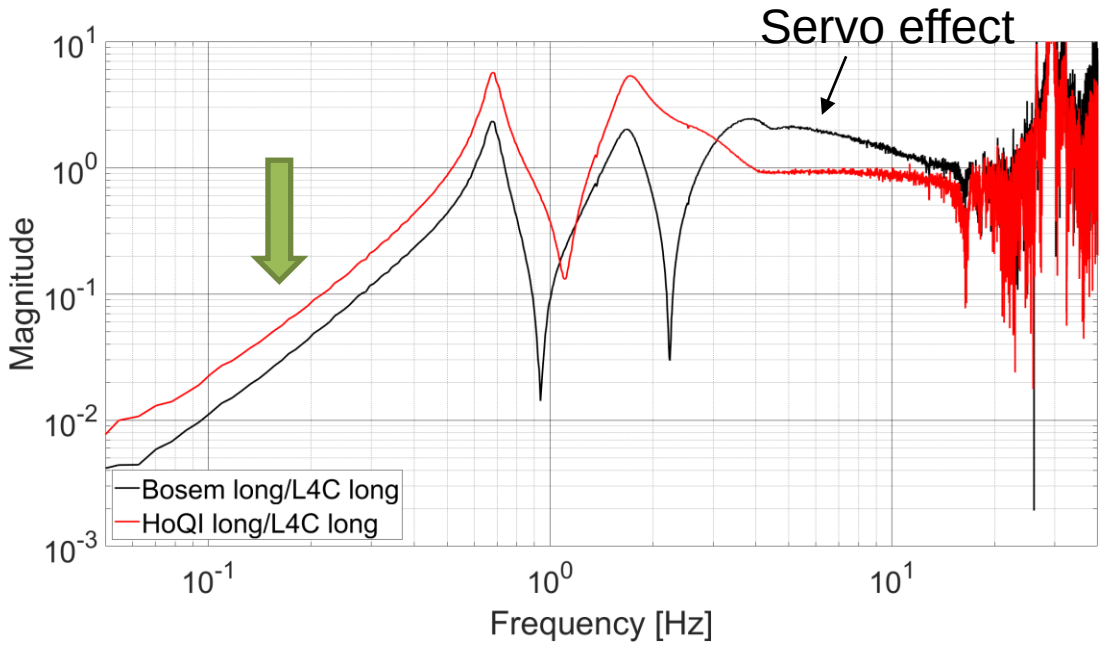


Actuated transfer functions

- BOSEMs are fairly well calibrated
- Difference between HoQIs and BOSEMs seems mechanical (IM vs TOP)

- Ready to be used in-loop





Conclusion

- ✓ SPI suppresses differential cavity motion and is also low-maintenance now
- ✓ HoQIs are working well, easy to set up and ready to be used in-loop
- Influence on main interferometer will be tested

Thank you for your attention!

Reducing fibre disturbances

- Modulation bench far away from interferometer
- Fibres routed through floor
- Fast disturbances not measured properly → interpreted as signal >10µm
- Digital filters (LP and 1/LP) help a lot
- OPD signal still sees disturbance but subtraction almost perfect
- High frequency residual → Blending with L4Cs could also help