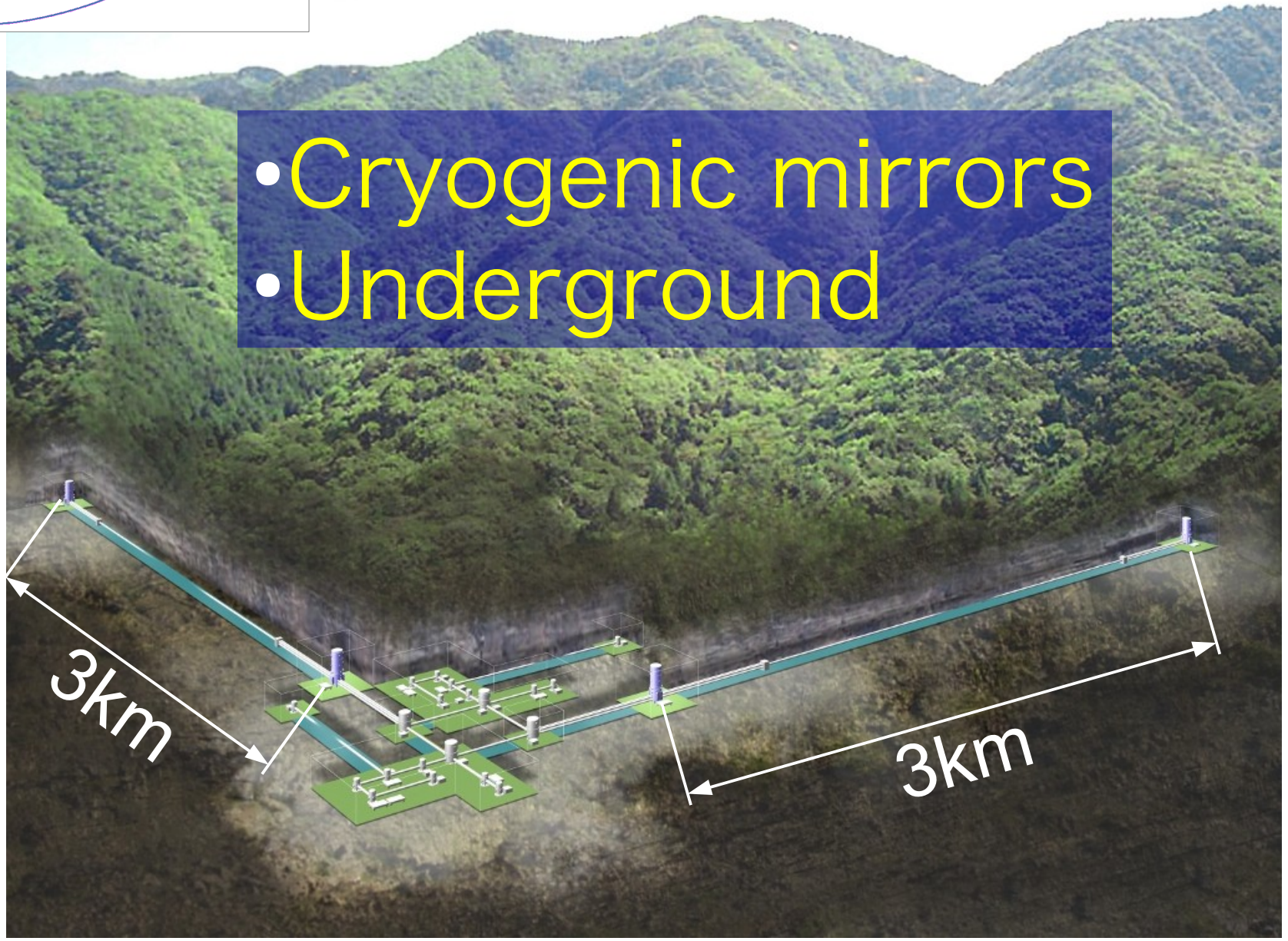
R&D for the gravitational wave detector KAGRA

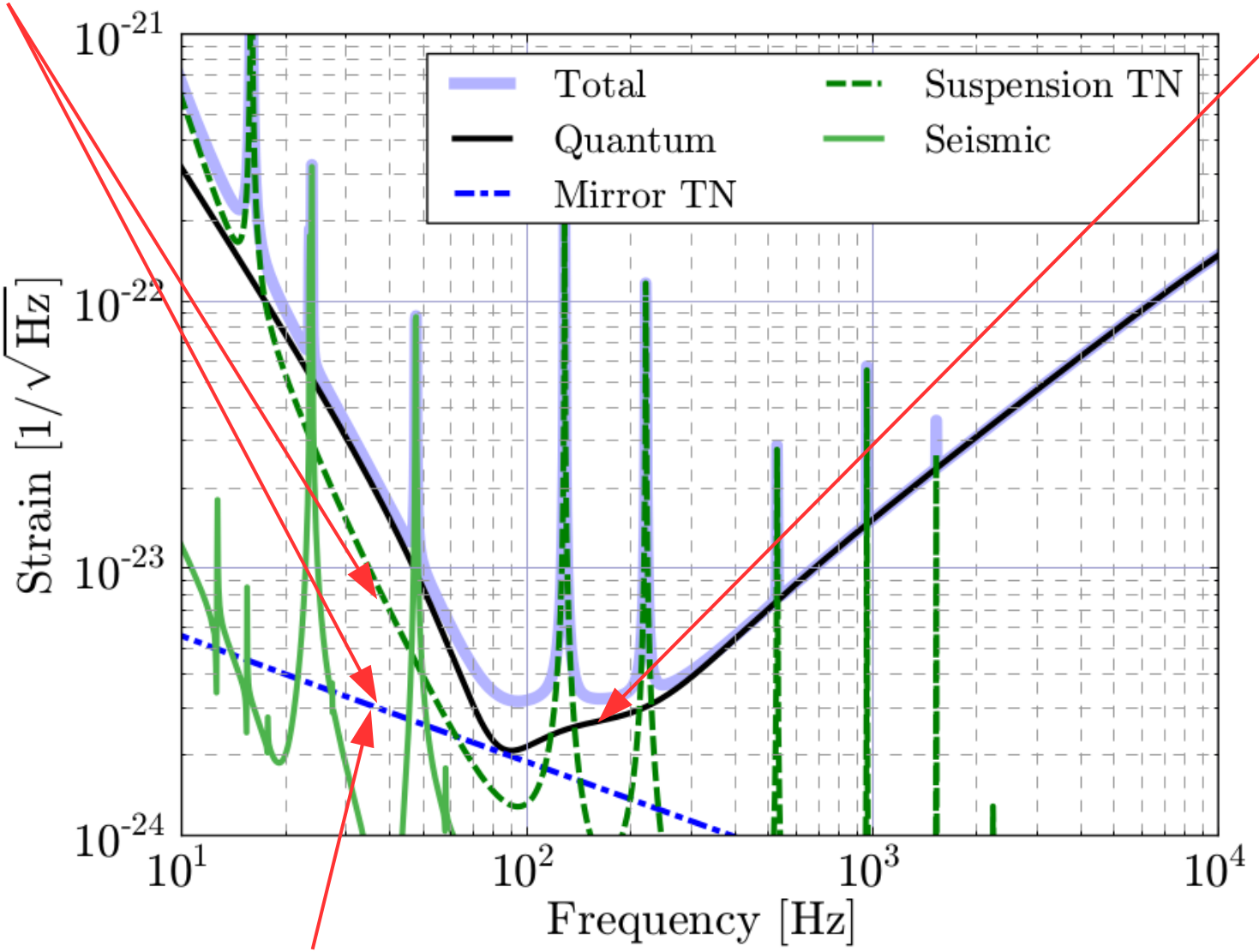
Yoichi Aso for the KAGRA collaboration
National Astronomical Observatory of Japan
2016/7/13 @ GR21, Columbia University

KAGRA



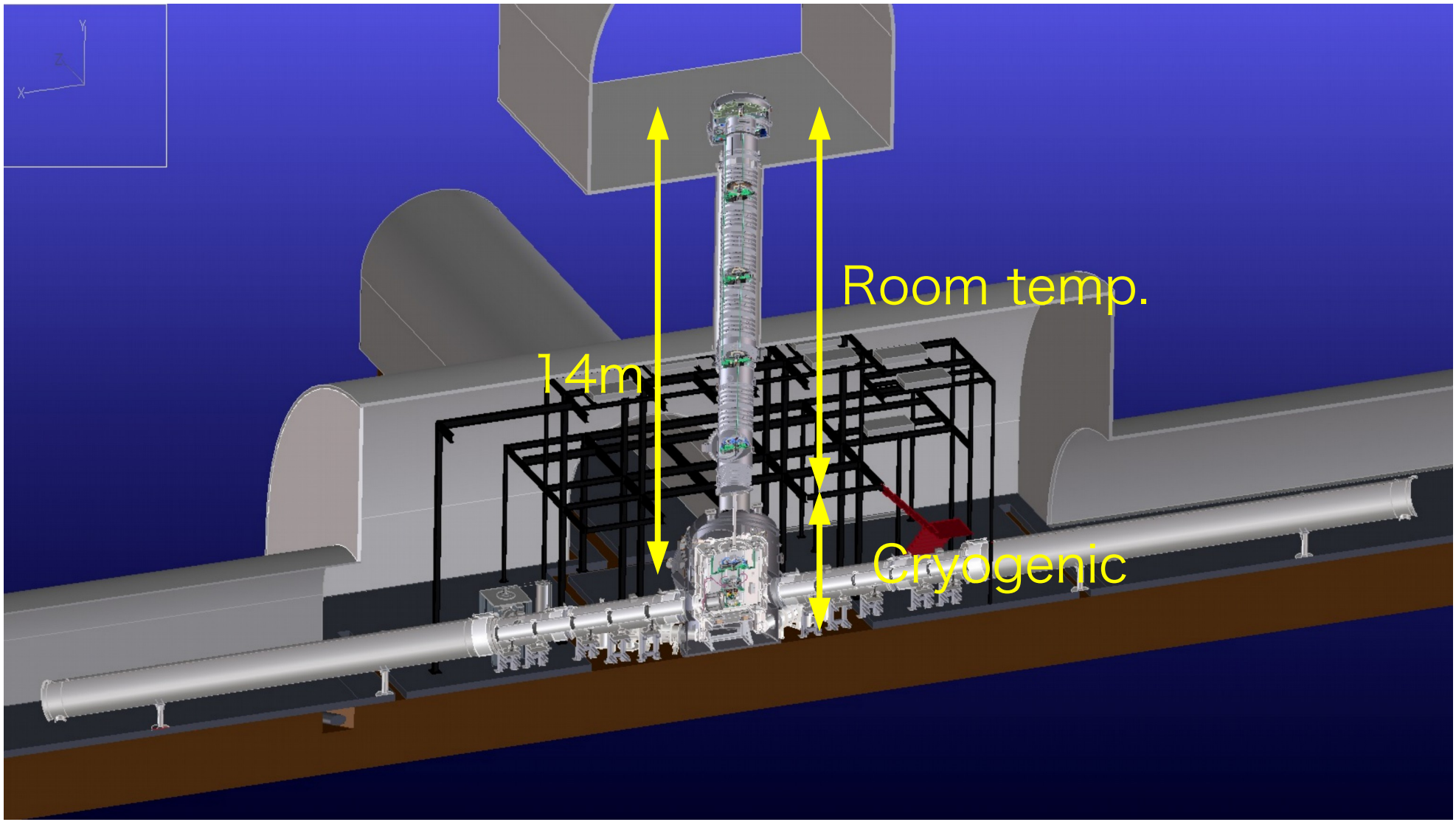
Cryogenic Suspension
Mirror Absorption Measurements

300m Filter Cavity

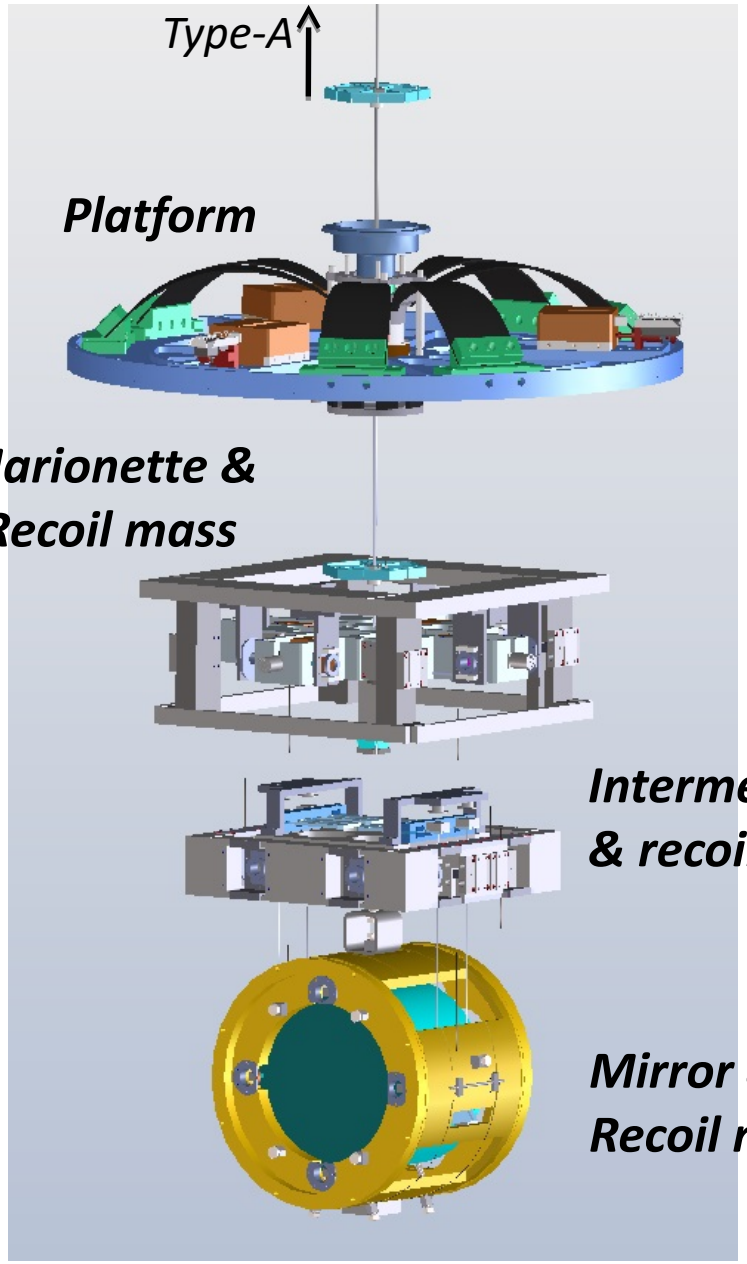


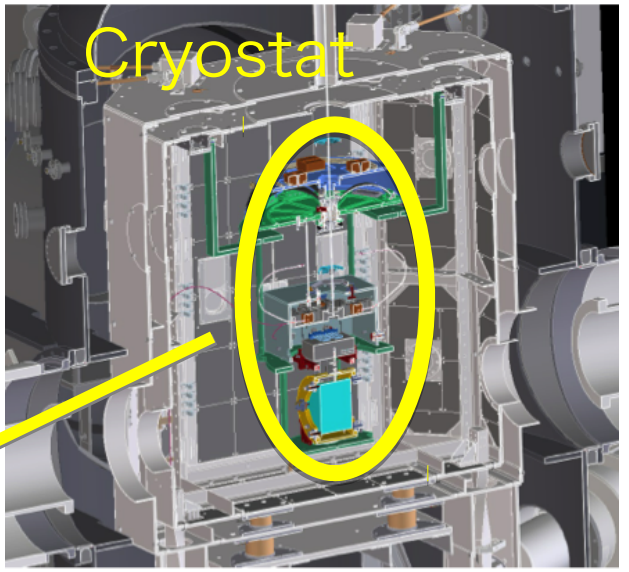
Crystalline Coatings
Cryogenic Thermal Noise Measurements

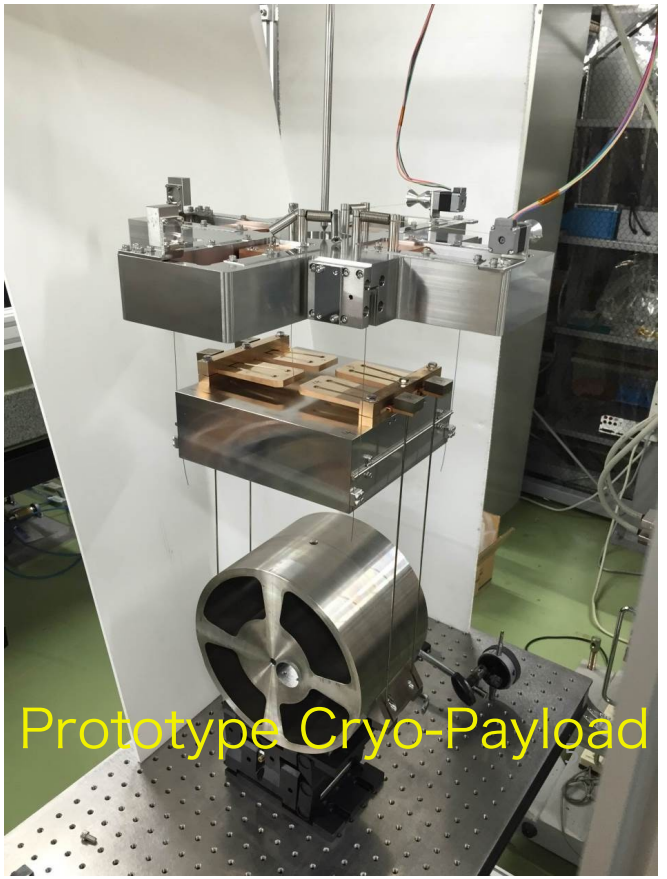
Cryogenic Suspensions



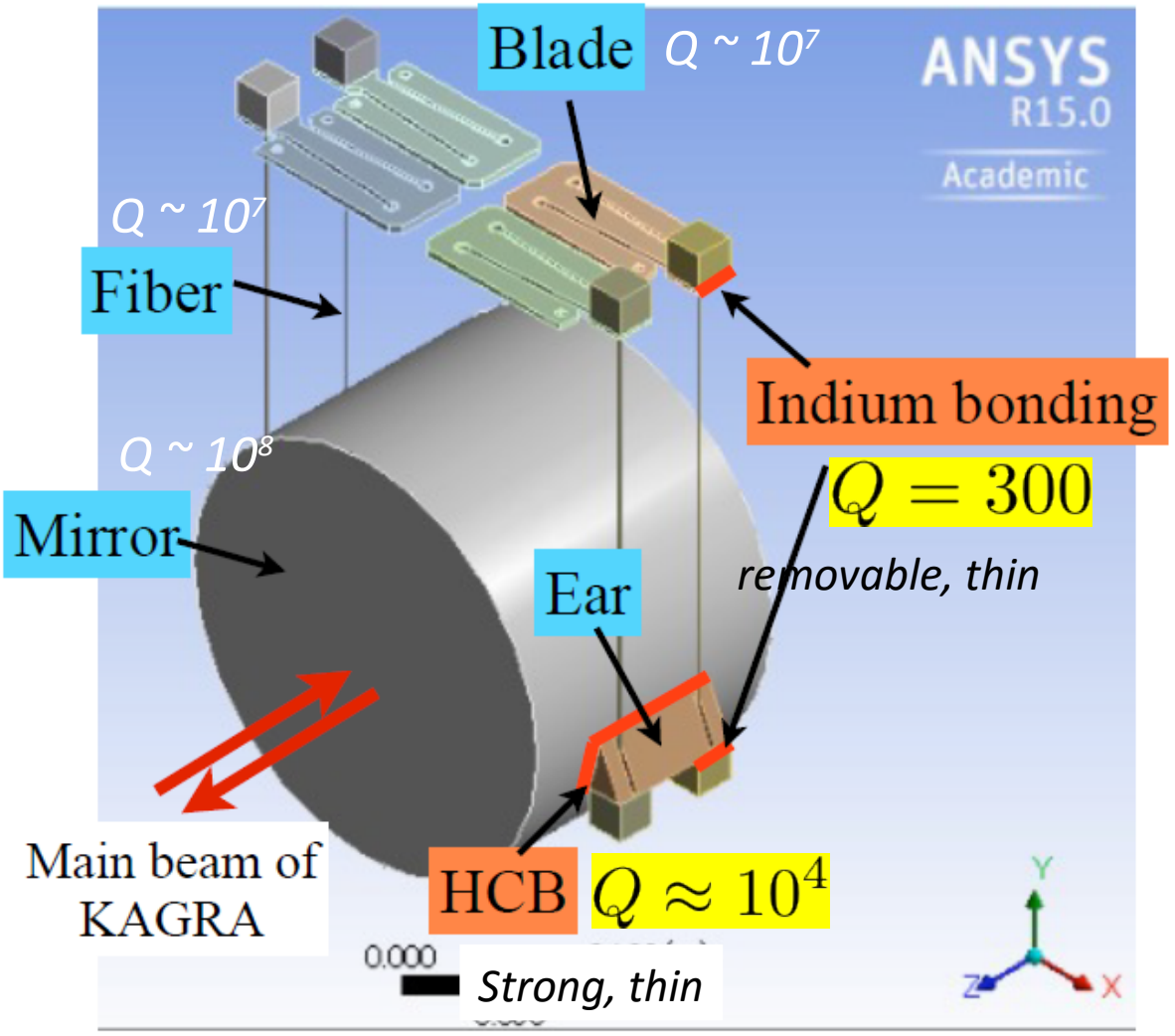
Cryogenic Payload (KEK and ICRR)







Bonding techniques



Semi-monolithic sapphire suspension must be realized to be sufficiently small thermal noises.

HCB and Indium bonding on sapphire satisfies requirements of mechanical Q.

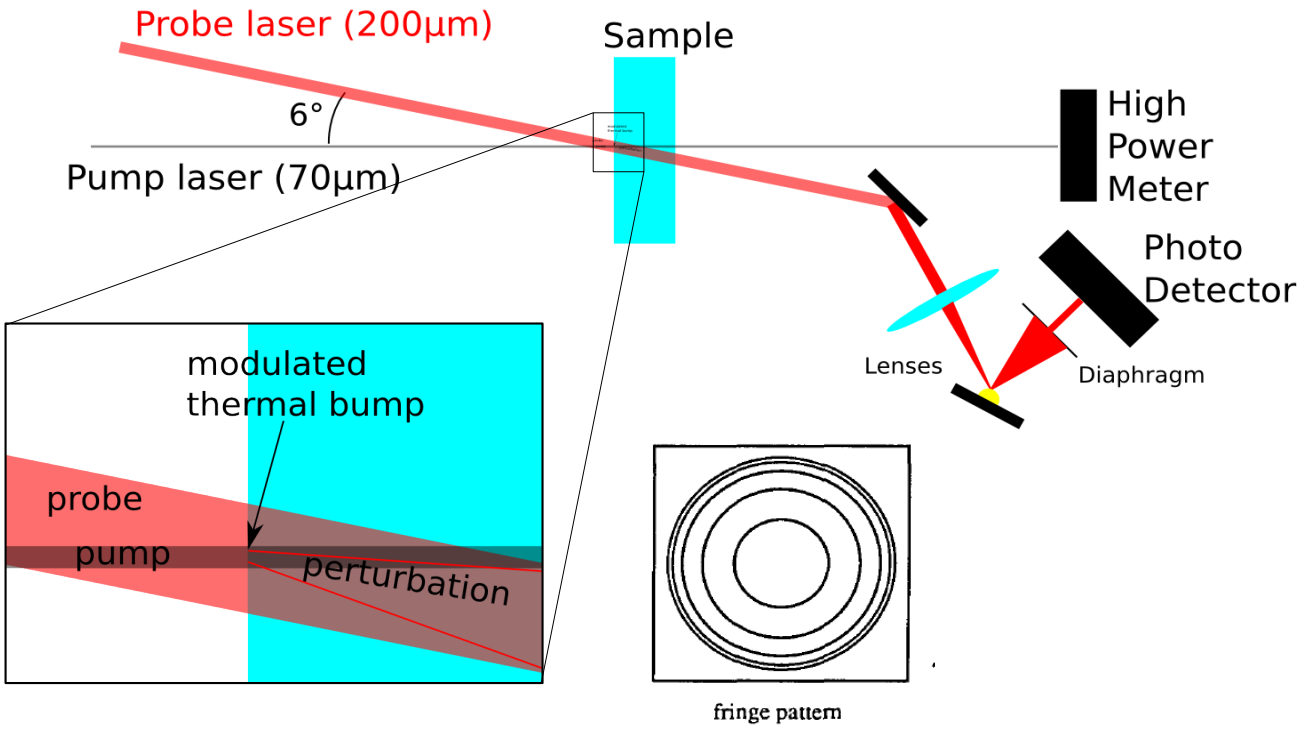
Practical way to do these bonding is under testing.

Installation into KAGRA: 2017 Summer

Characterizing mirror absorption

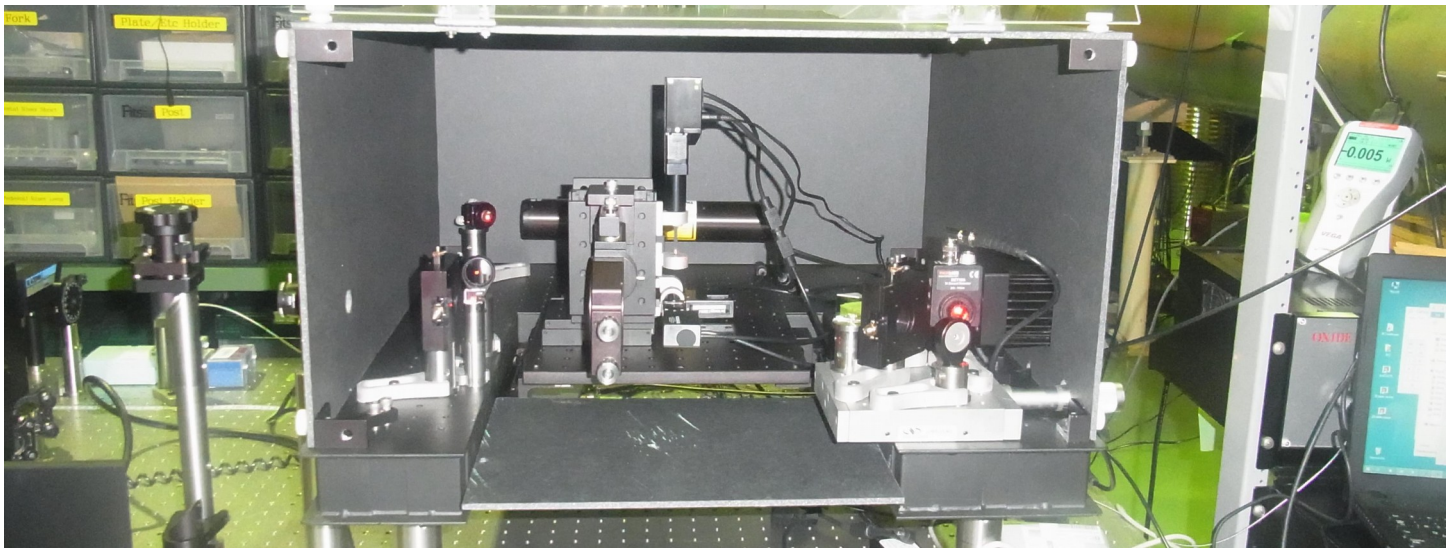
M. Marchio, D. Tatsumi, R. Flaminio

Photo-thermal
Common-path
Interferometry



Sensitivity

- 1ppm/cm substrate
- 0.1ppm in coating



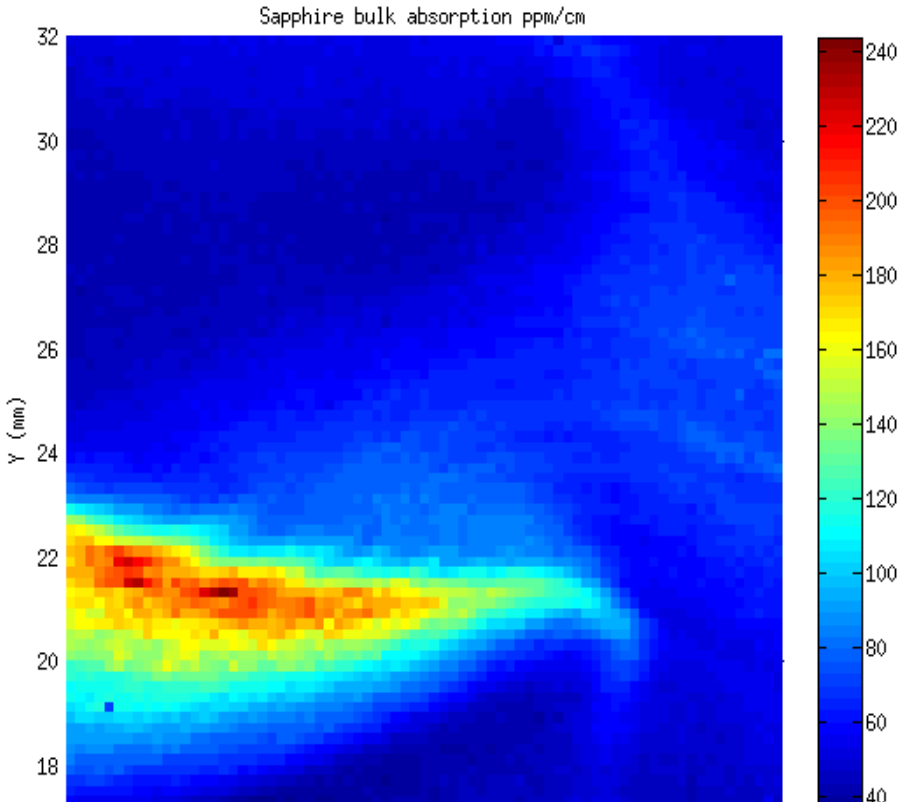
Current status

- System calibration/verification measurements: done
- Large sample holder is ready

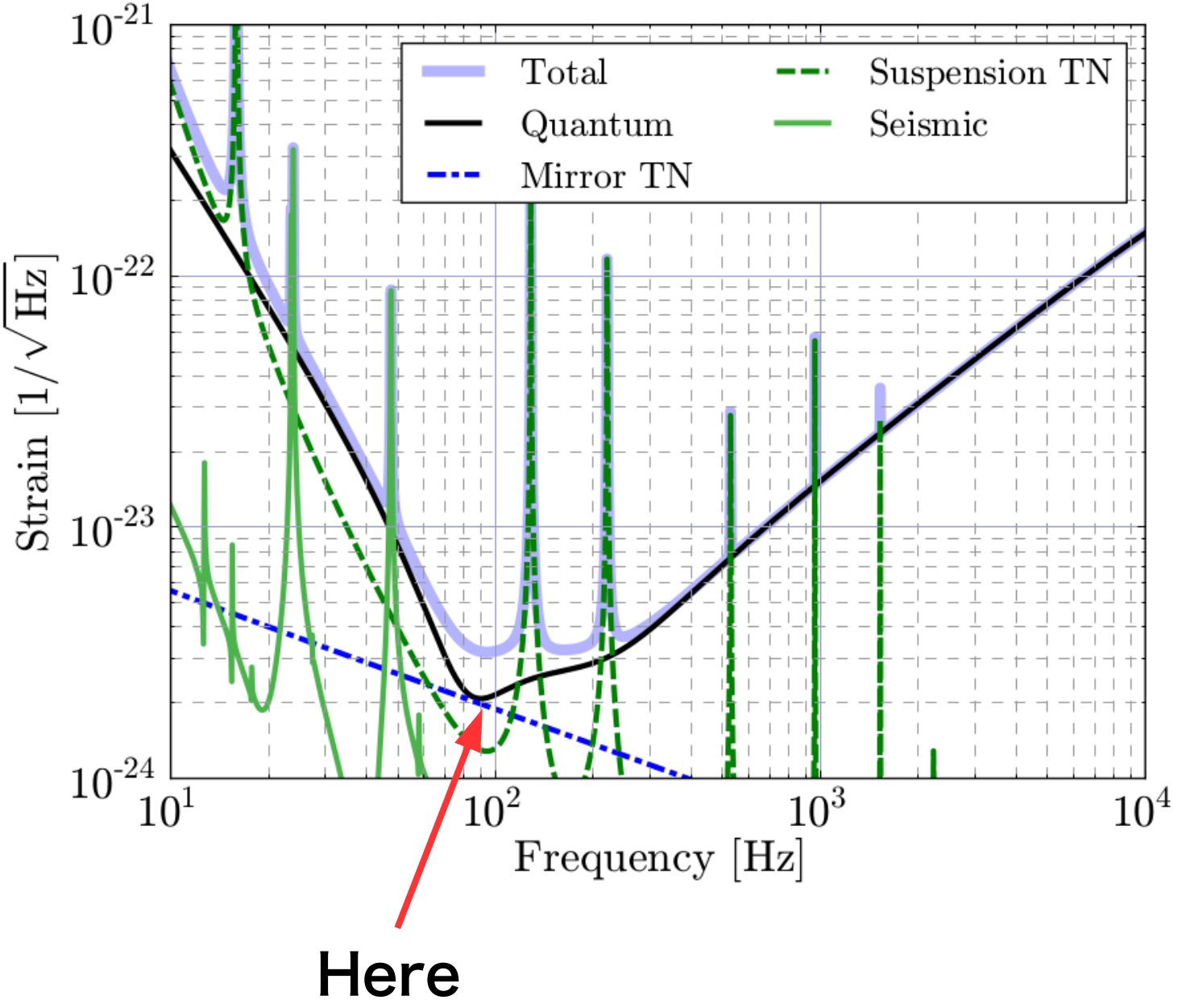
Measurement of sapphire samples

A small sample
- Absorption ranging 30-240ppm
- Strong inhomogeneity

Preparing for large samples

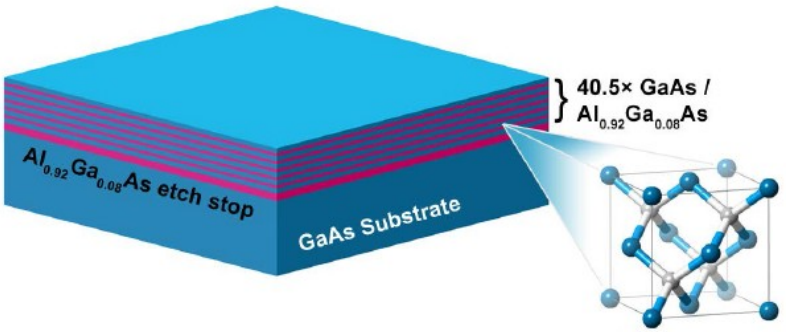


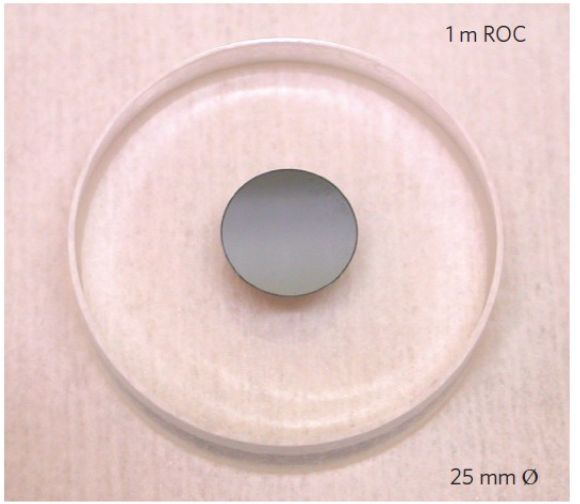
Coating thermal noise matters



Crystalline Coatings

- Conventional amorphous coating: high mechanical loss
- Low loss coating with high optical performance necessary





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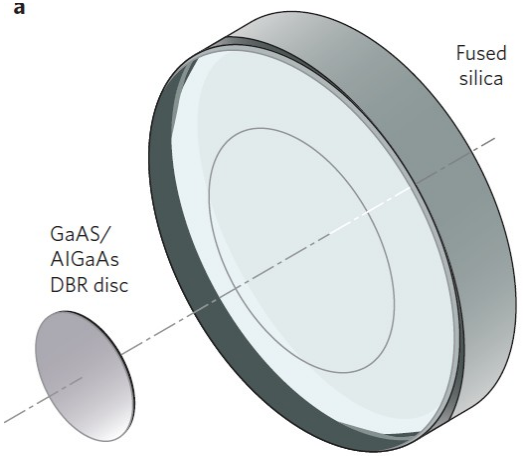
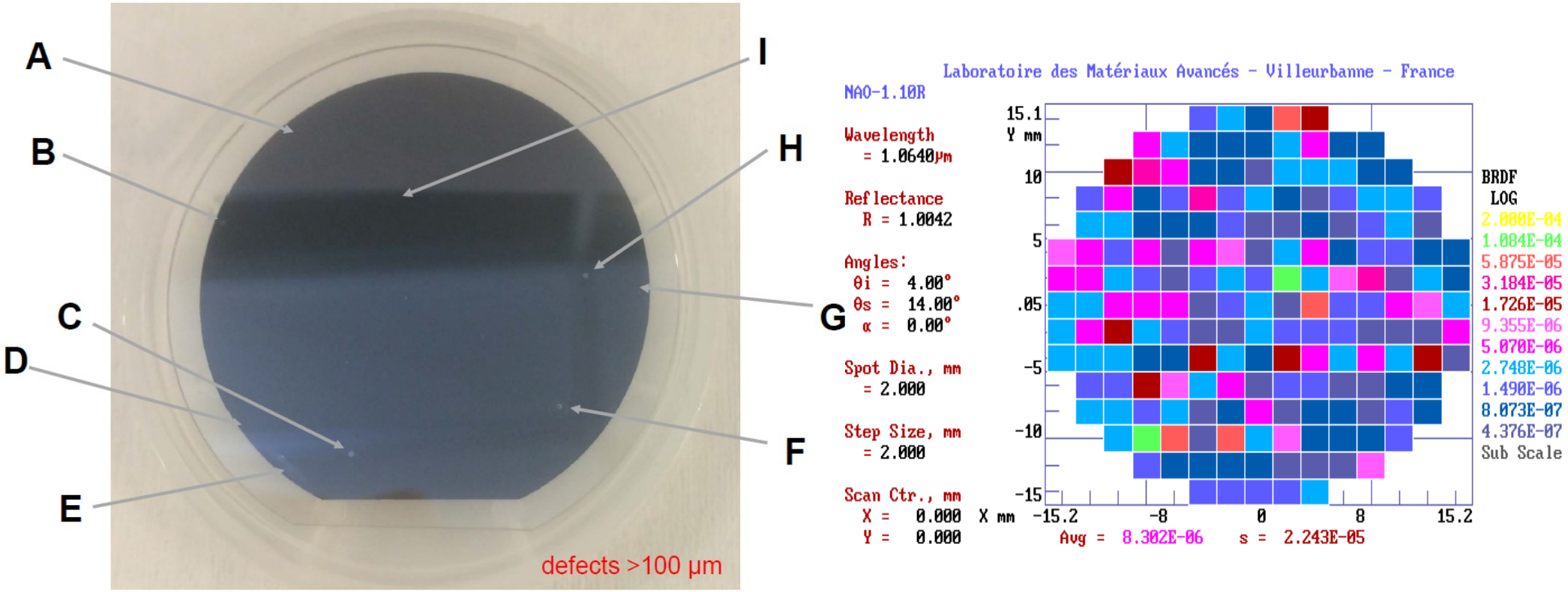


G.Cole et al. Nature Photonics 2013

2-inch GaAs/AlGaAs transferred to a sapphire substrate

- Largest crystalline coating on Sapphire
- 6ppm scattering
- 9 large defects

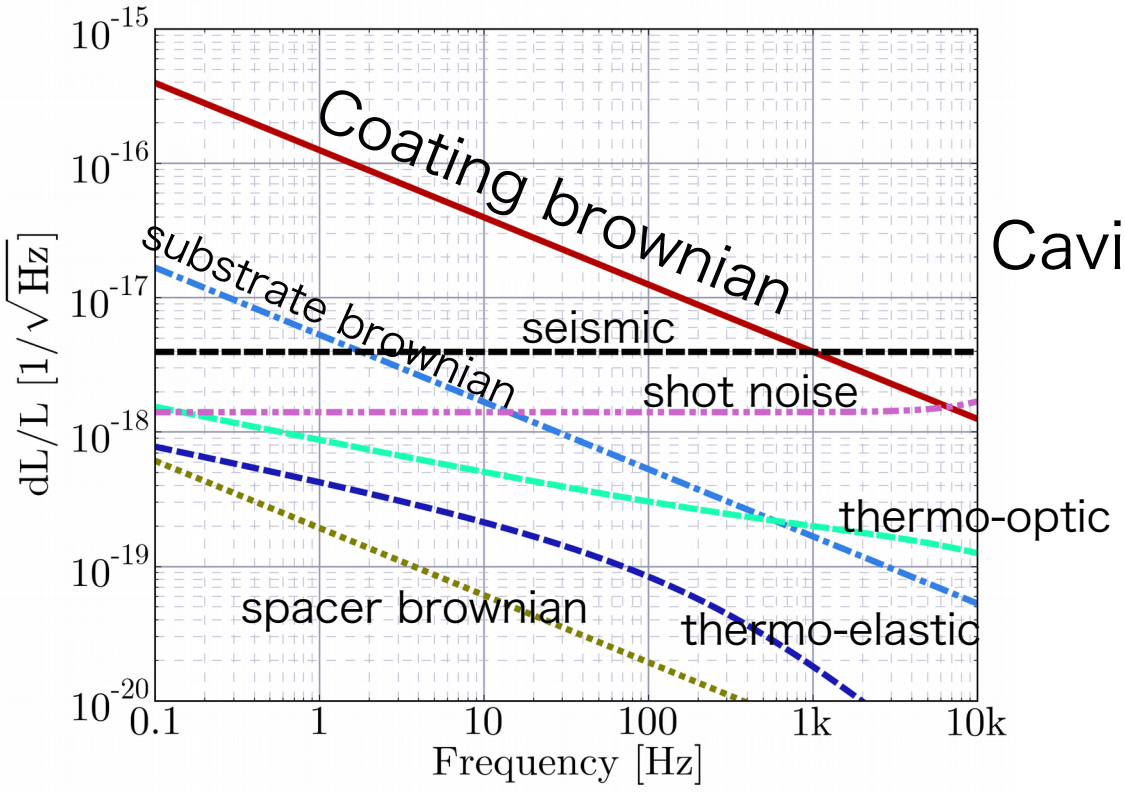


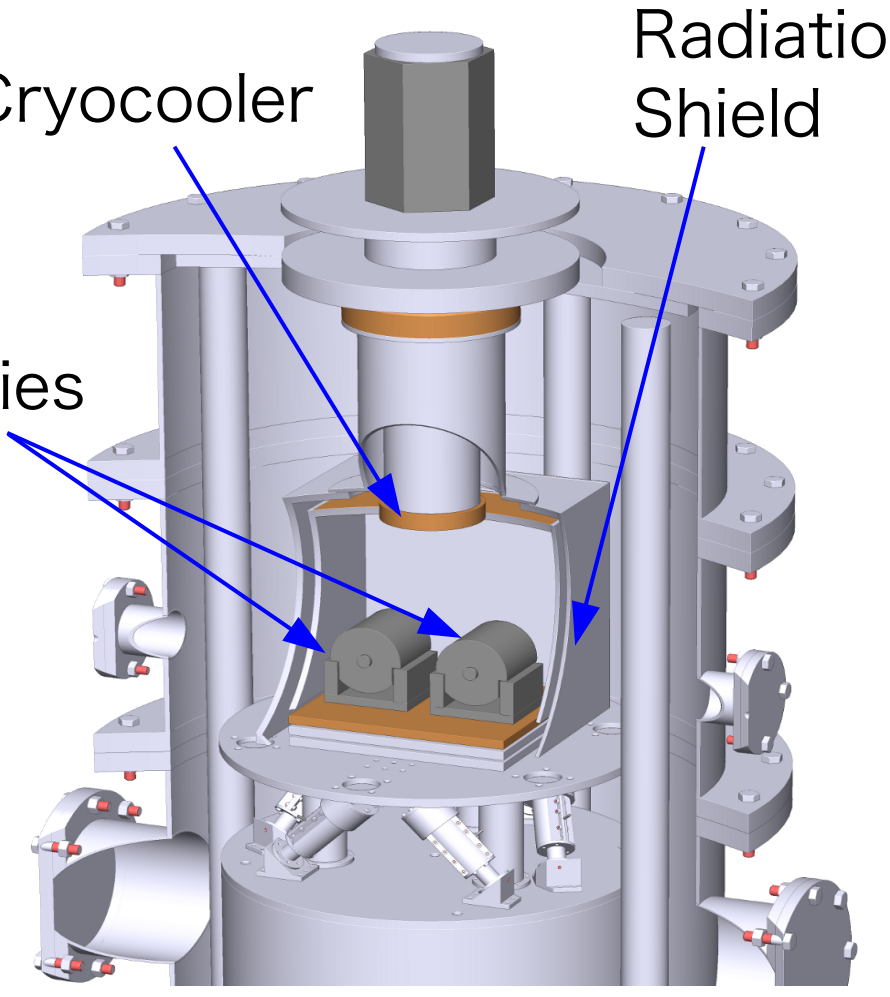
R. Flaminio, Crystalline Mirror Systems, LMA

Cryogenic cavities for thermal noise measurement

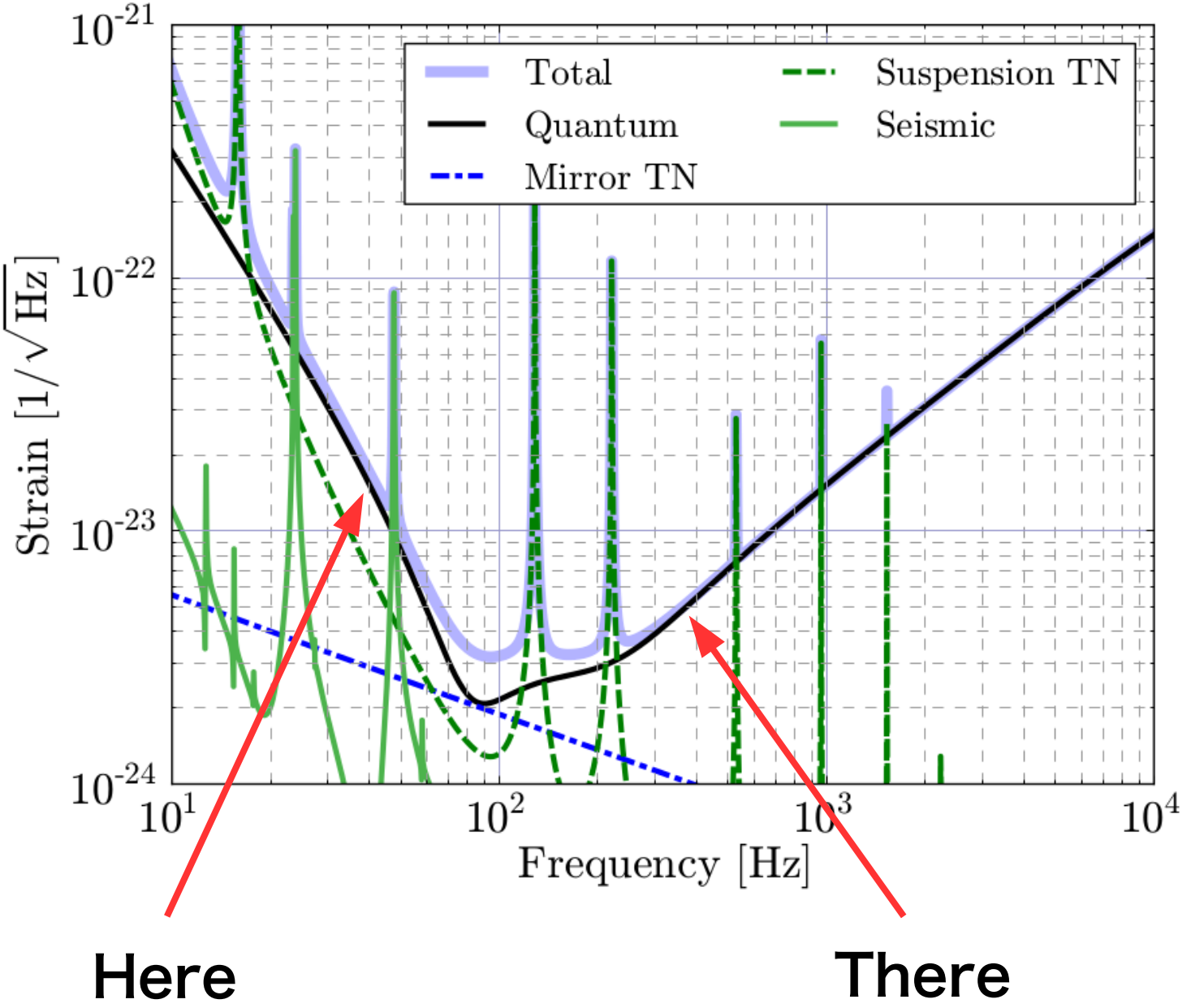
- Mono-crystalline silicon cavities (1550nm)
- Cooled down to 5K
- Cryogenic operation successful with a large (20cm) cavity
- Working on a twin-cavity configuration

Noise estimates @ 20K

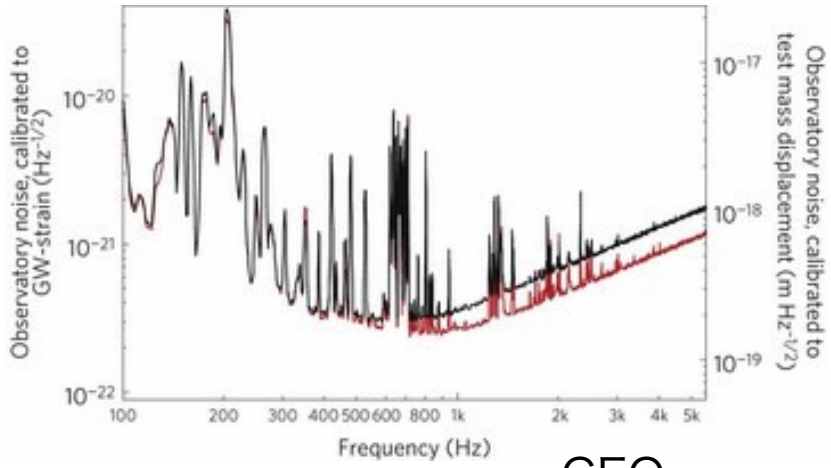




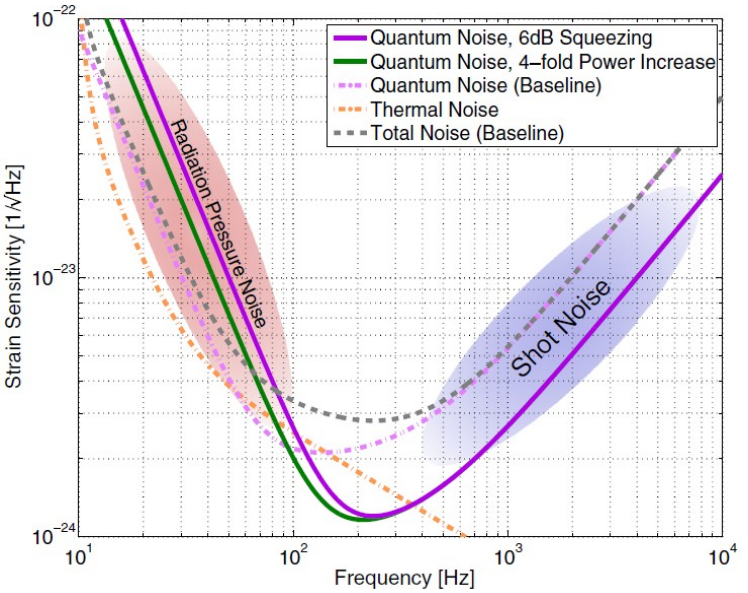
Squeezing more out of our detectors



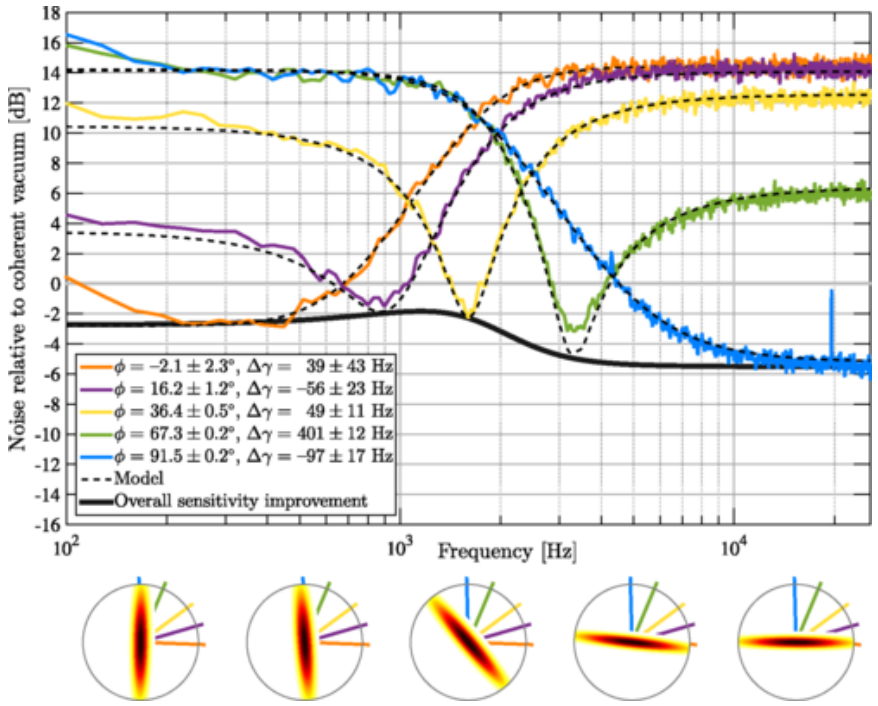
Squeezing: a promising path forward for tackling quantum noises



GEO



M. Evans et al. 2013



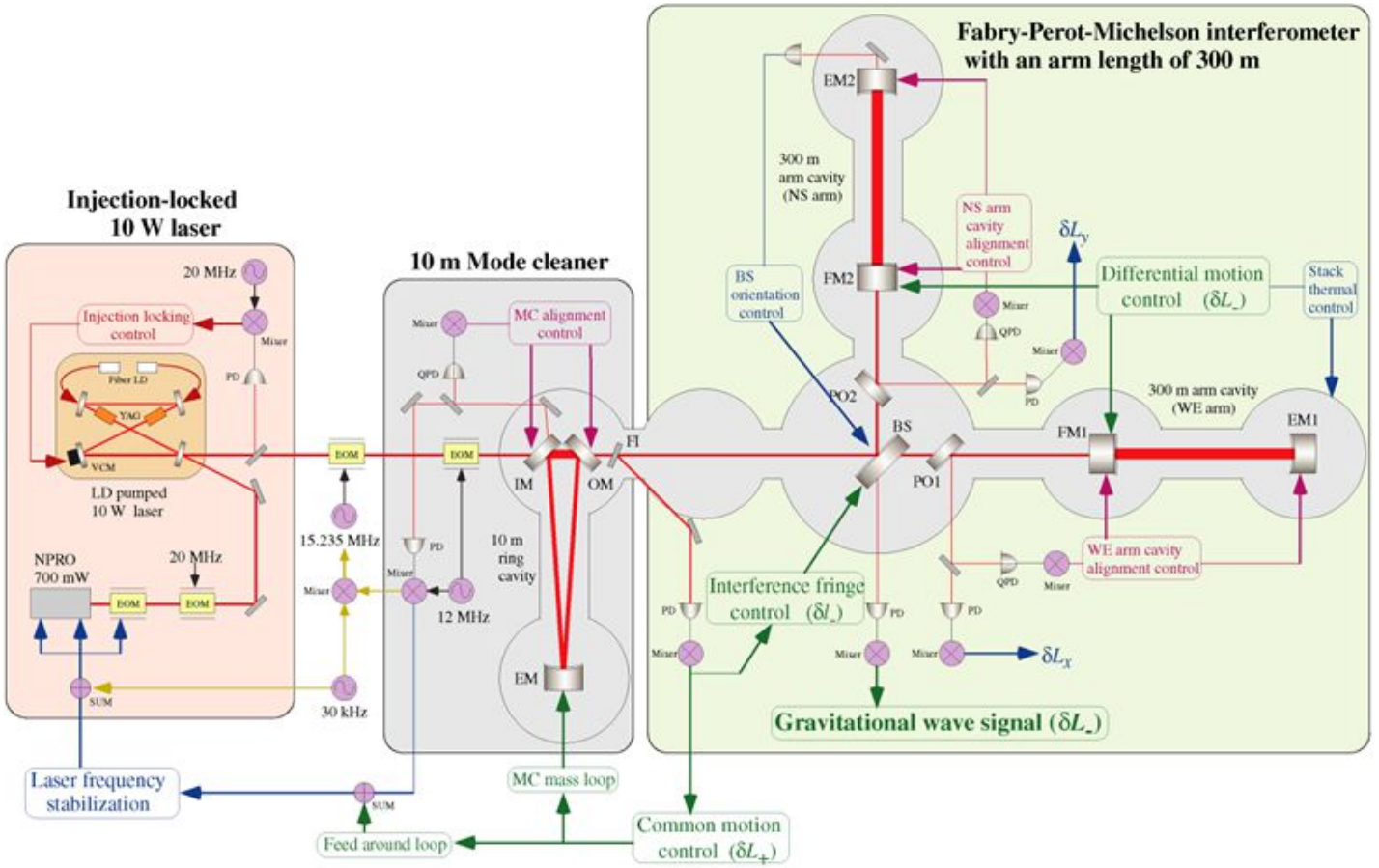
E. Oelker et al. 2016

Frequency dependent rotation of squeezing angle

Necessary for full band sensitivity improvement

TAMA300

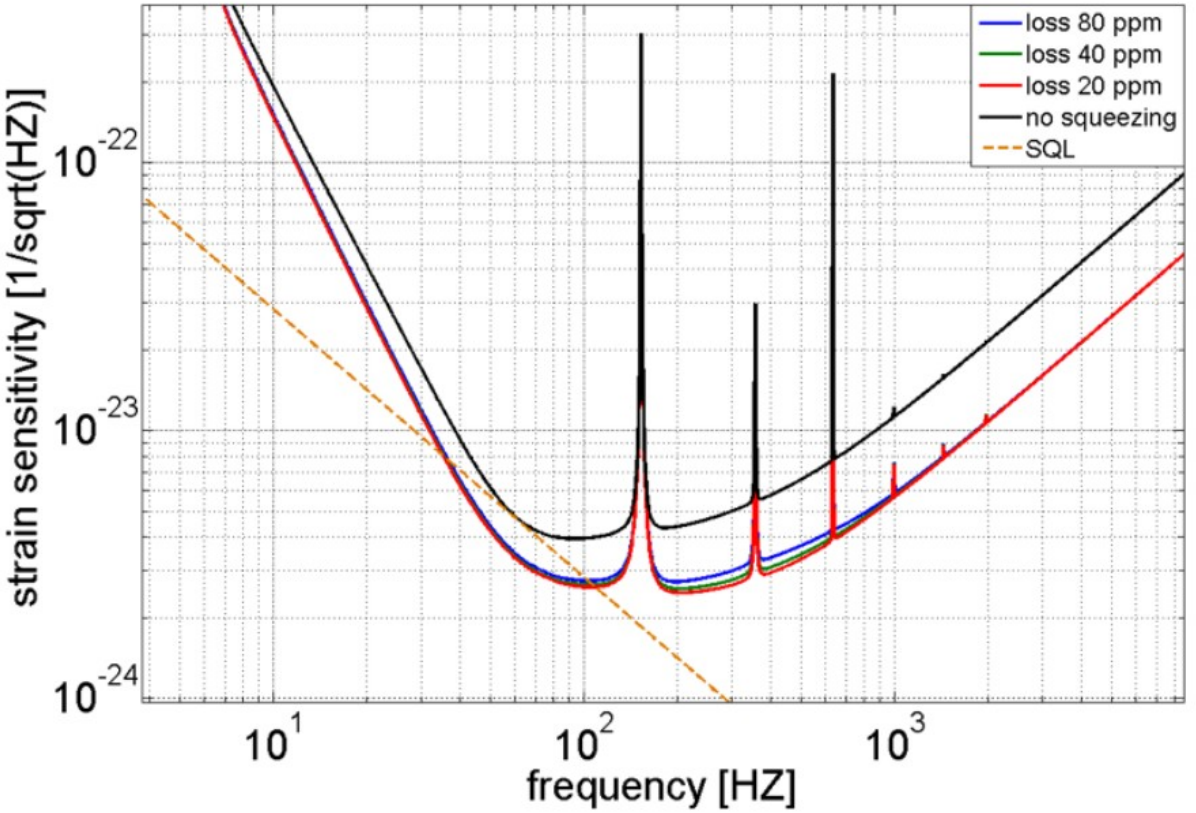
- 300m prototype interferometer
- NAOJ Mitaka Campus



300m Filter Cavity Experiment

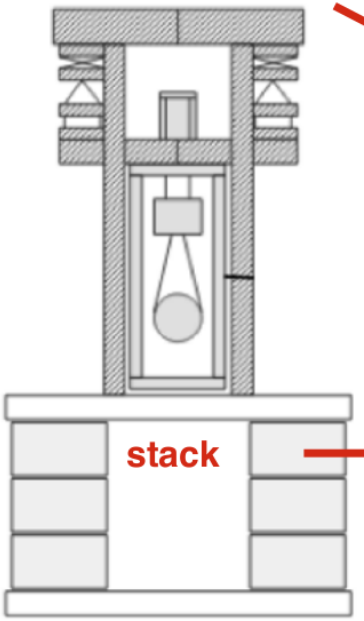
Daisuke Tatsumi, Eleonora Capocasa, Raffaele Flaminio, Matteo Barsuglia, Jérôme Degallaix
Laurent Pinard, Nicolas Straniero, Roman Schnabel, Kentaro Somiya, Yoichi Aso

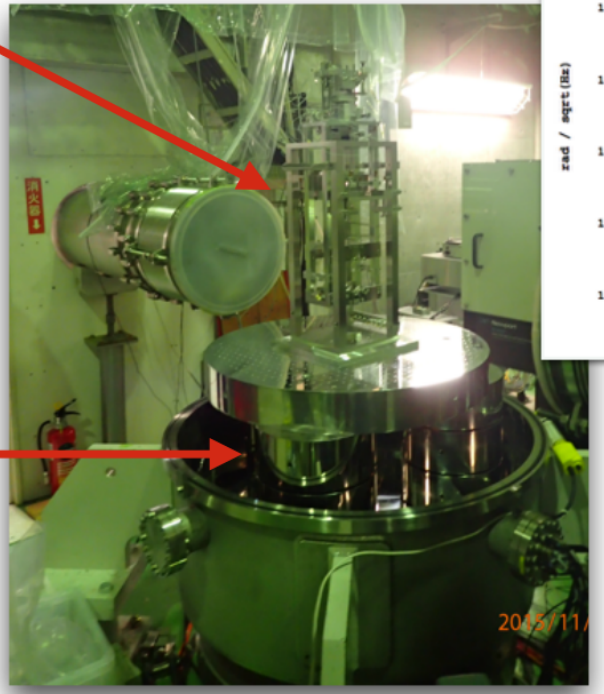
- 300m long
- 10cm diameter mirrors
- Finesse ~ 4500
- Round trip loss ~ 80ppm

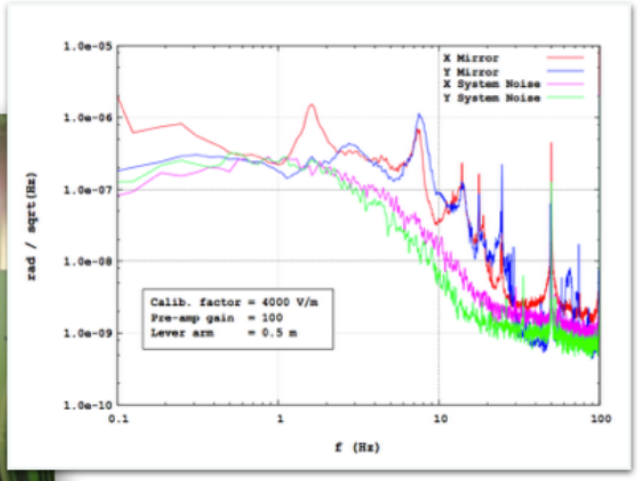


Current Status

Suspensions being installed

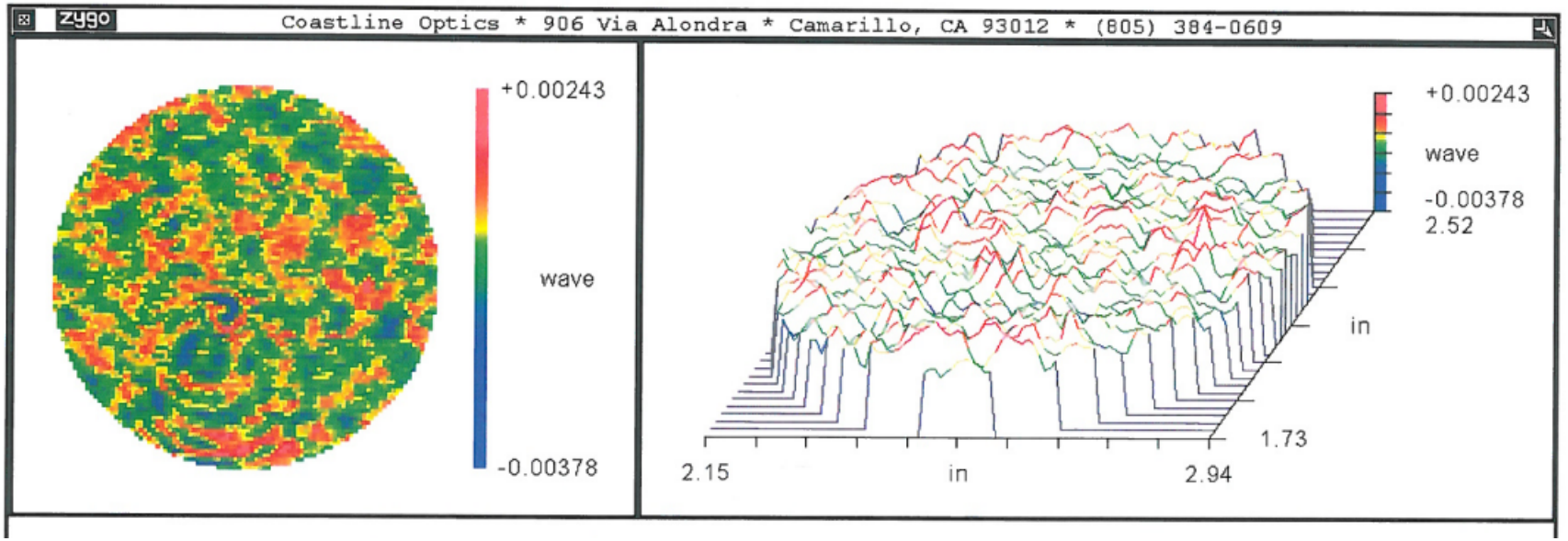






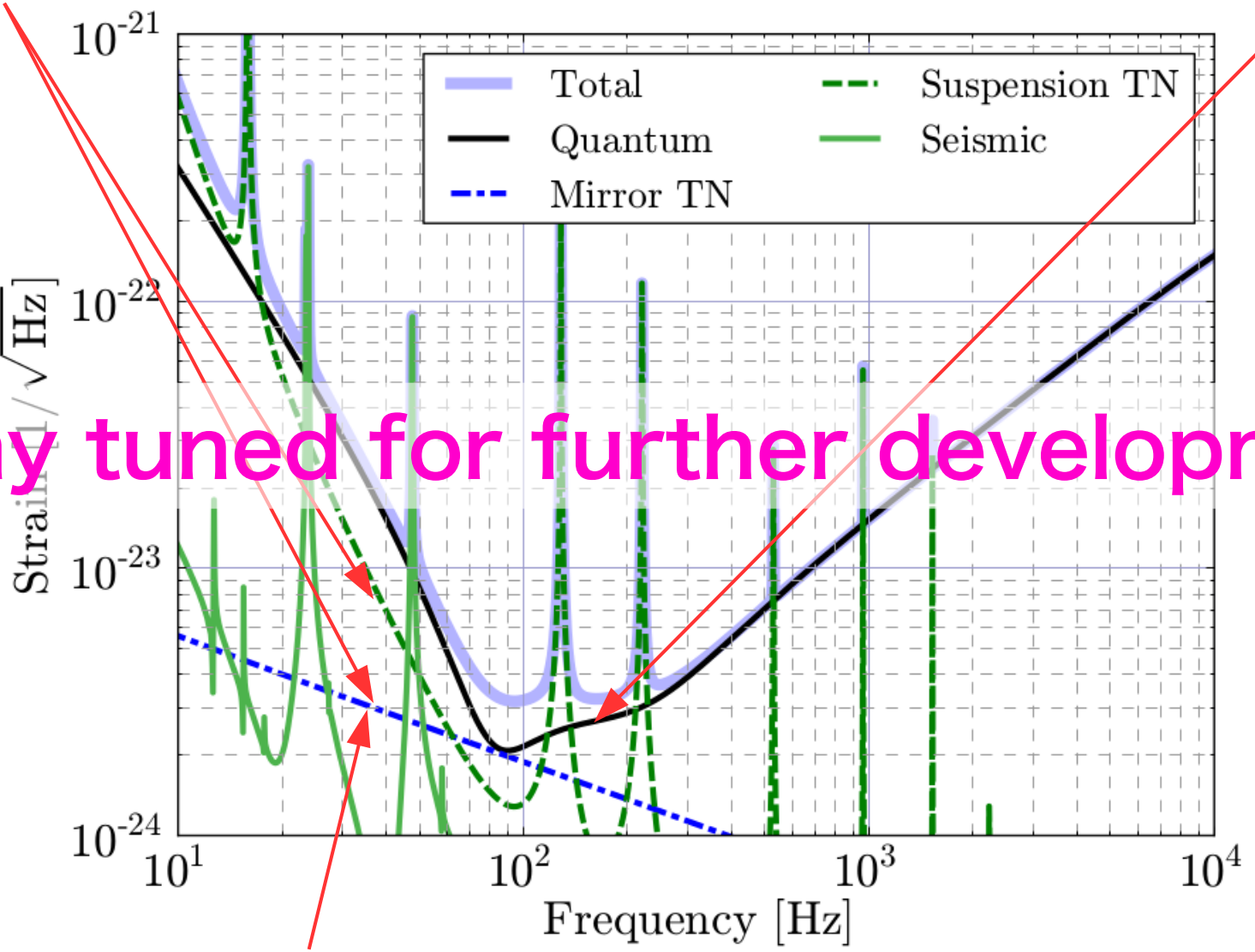
- First measurements of the mirror motion performed

Mirrors Polished



Cryogenic Suspension
Mirror Absorption Measurements

300m Filter Cavity



Stay tuned for further developments

Crystalline Coatings
Cryogenic Thermal Noise Measurements