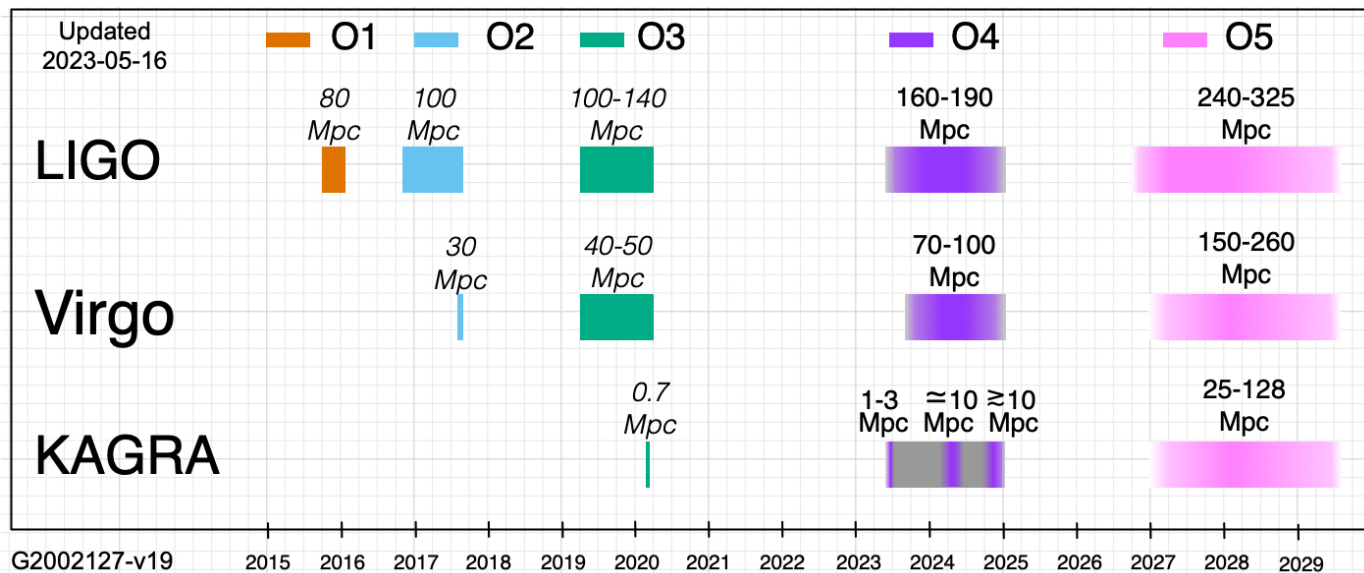


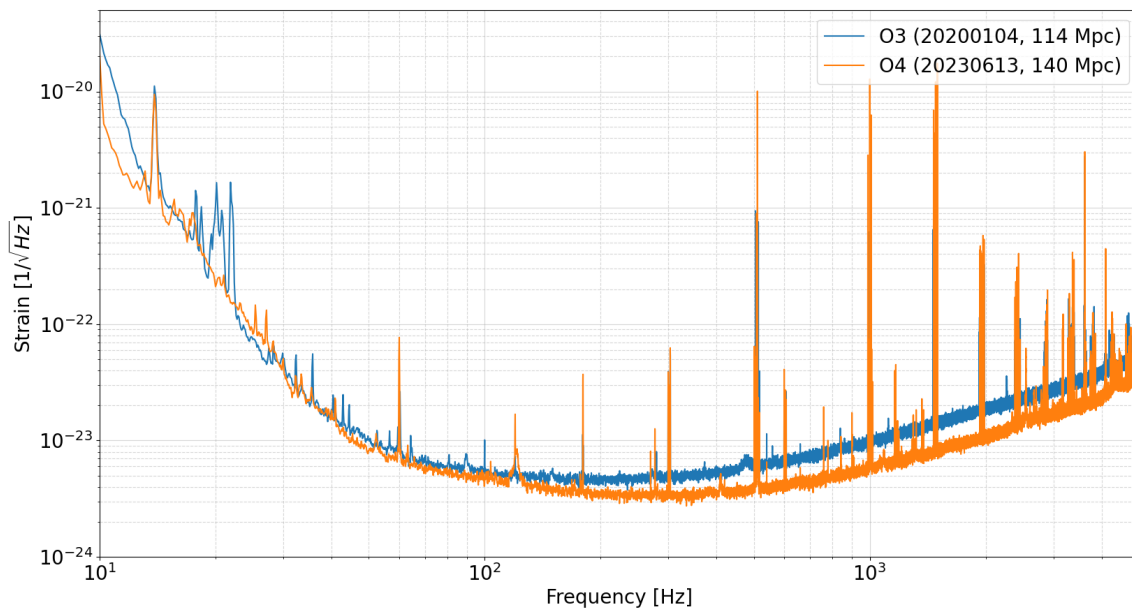
Status of LIGO Hanford Observatory

Naoki Aritomi (LHO, Caltech)

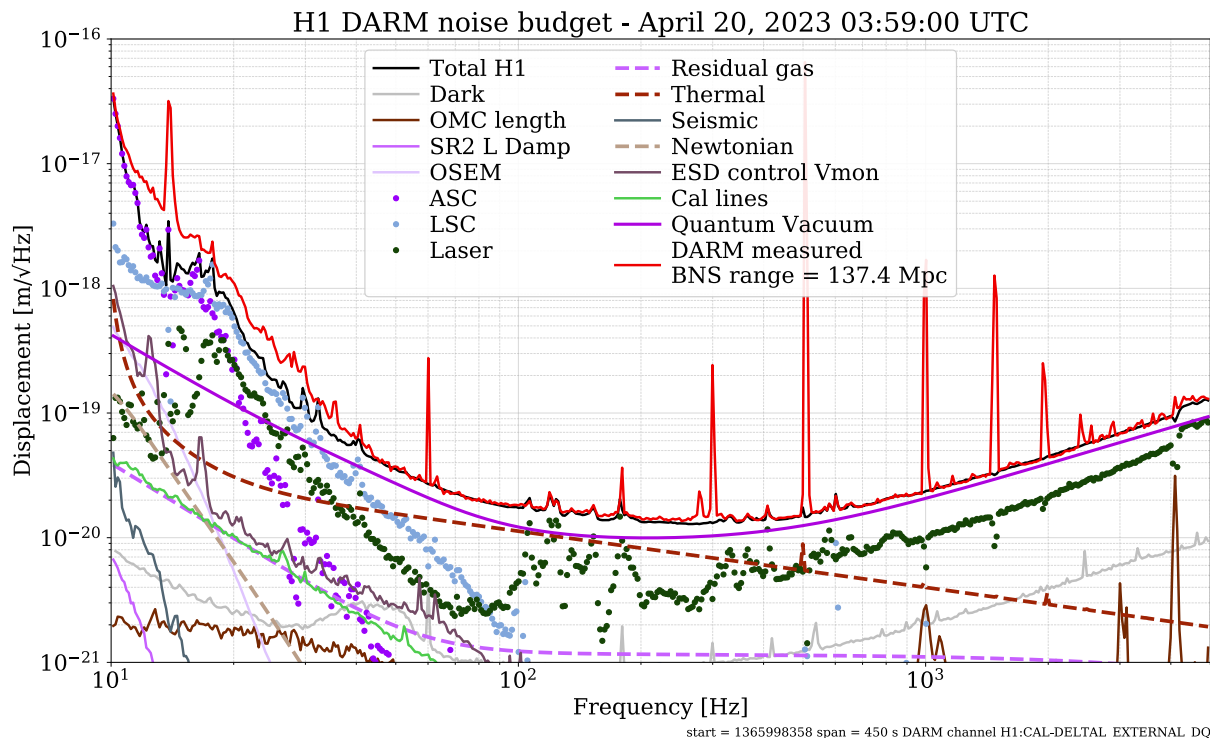
- O4 started on May 24 by LHO, LLO, KAGRA
- 18 months observation + 2 months break
- Virgo continues commissioning and will join in fall
- KAGRA joined for a month and will rejoin in next spring with better sensitivity



- LHO: 130-140 Mpc (LLO: 140-160 Mpc)
- High frequency: high power, more squeezing
- Low frequency: frequency dependent squeezing, technical noise reduction

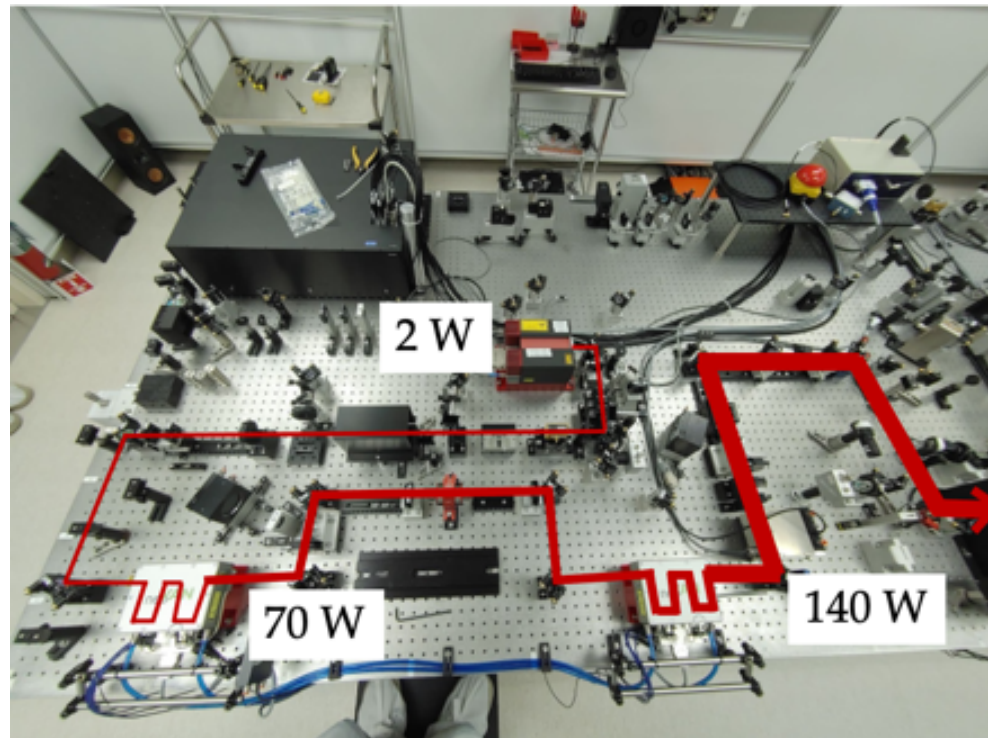


- High frequency: quantum
- Mid frequency: quantum, jitter, coating thermal
- Low frequency: **unknown noise**, ASC/LSC



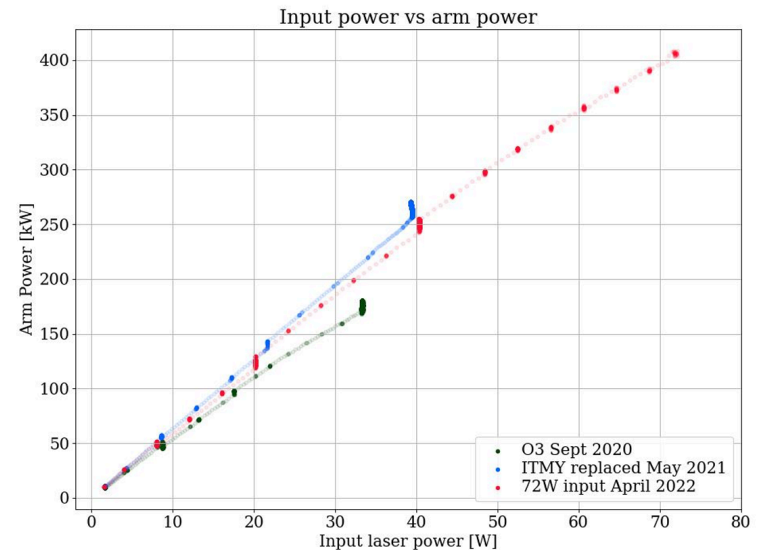
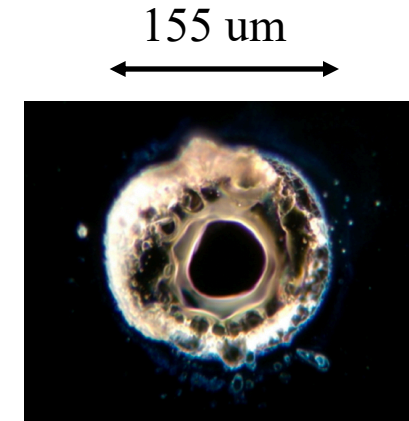
- **75 W** input power, **430 kW** arm circulating power
(O3: 34 W input power, 200 kW arm circulating power)
- Pre-stabilized laser upgrade
- Test mass replacement
- Damping of parametric instability

- Seed laser (NPRO): 2 W
- Amplifier (2 neoVAN-4S-HP): 2 W \rightarrow 140 W (O3: 70 W)



J. Driggers

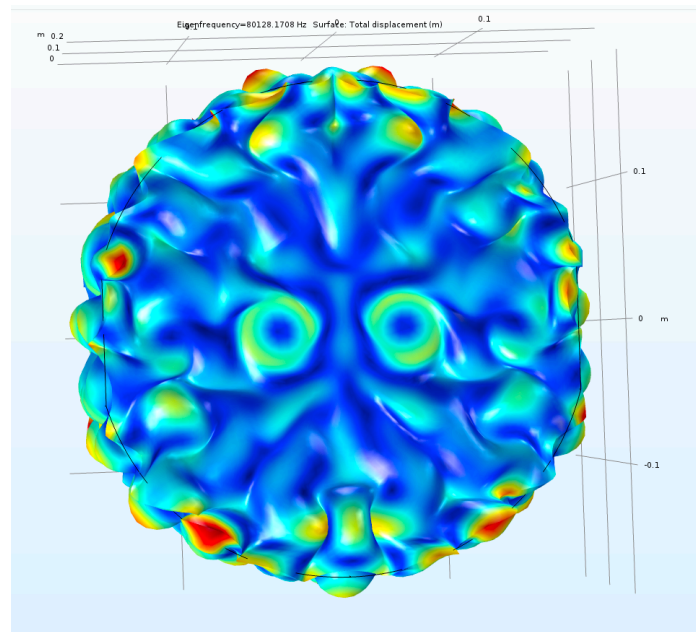
- Replacement of ITMY to remove point absorbers which limit the high power operation
- After the replacement, PRG improved from 43 to 57 for ~ 40 W input power
- Beam jitter coupling was reduced



C. Cahillane

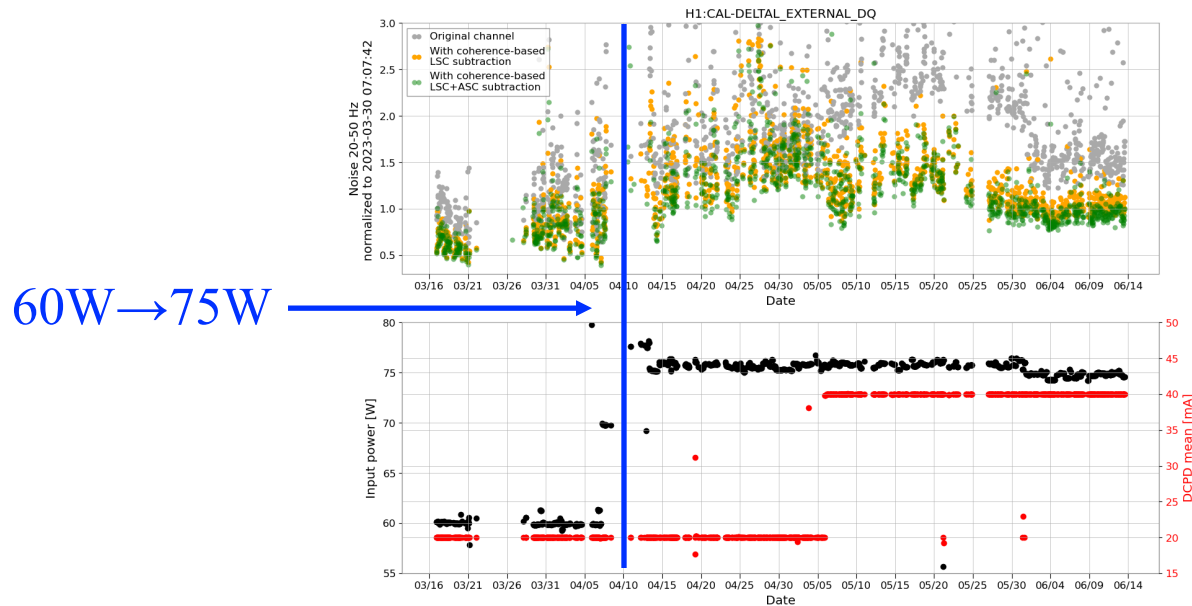
- PI ring up in O4: 10.4 kHz, 80.3 kHz
- Active PI damping by electrostatic driving of test masses

80 kHz PI by COMSOL simulation



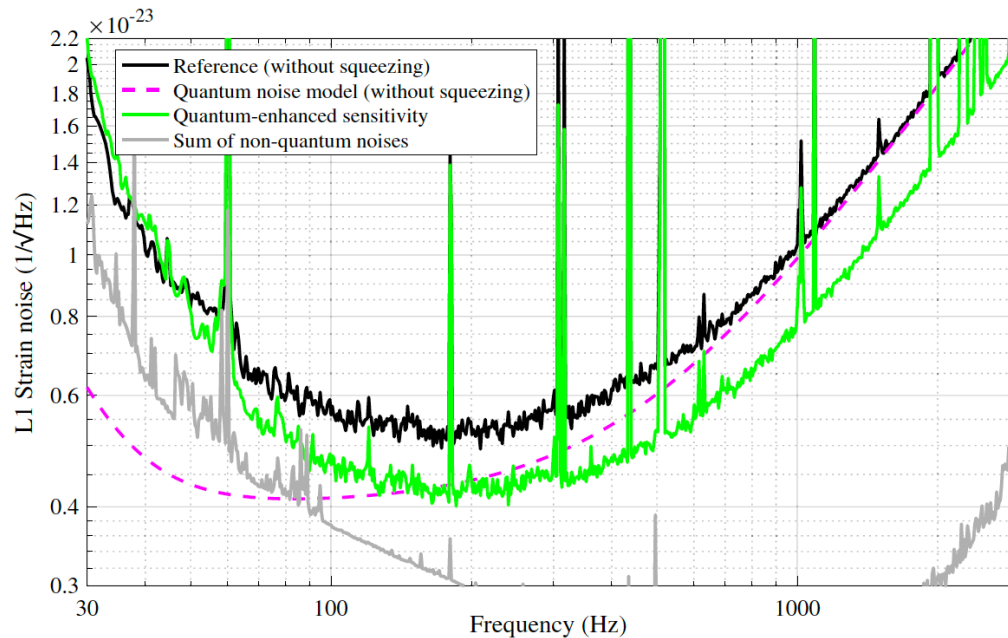
A. Brooks

- Thermalization of interferometer (sideband buildup, SRCL detuning, cross coupling of LSC)
- Sensitivity degradation at low frequency
- Less stability?
- Ongoing discussion of 75W vs 60W



G. Vajente

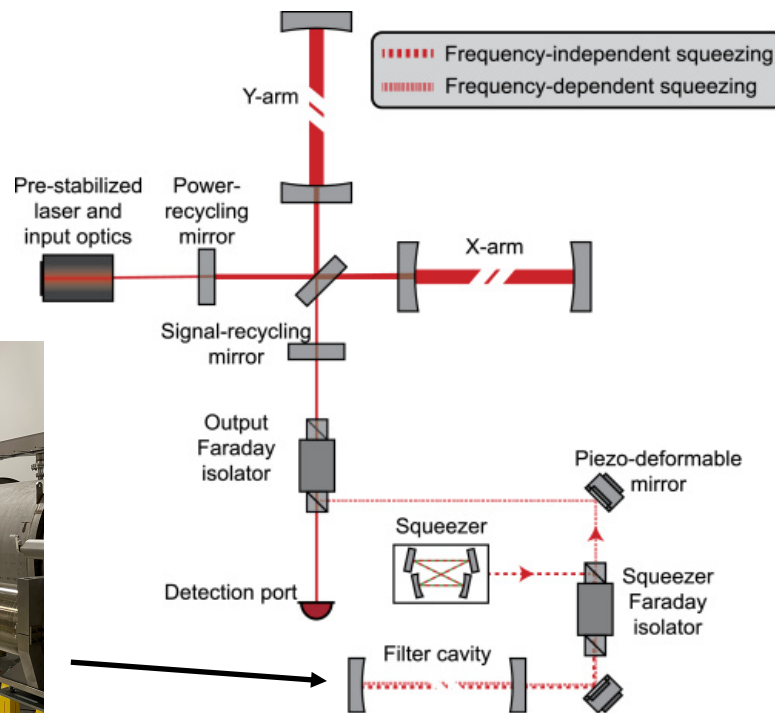
- O3: increase of quantum radiation pressure noise, squeezing level $\sim 3\text{dB}$



Phys. Rev. Lett. 123,
231107 (2019)

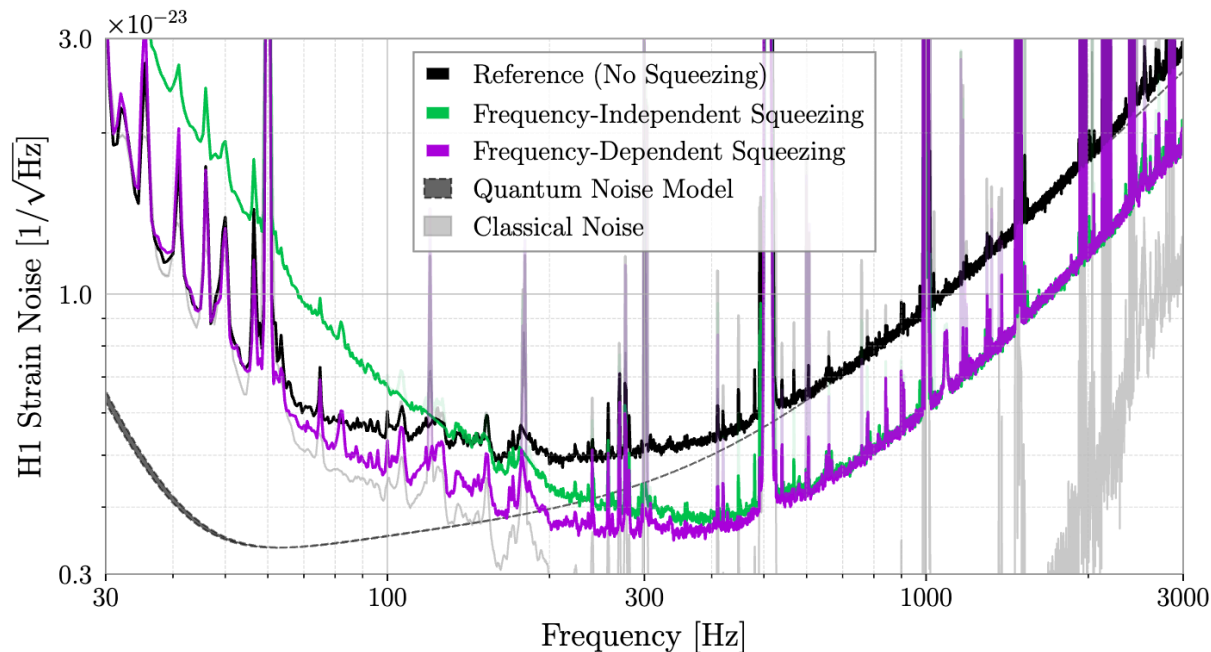
- Upgrade in O4: frequency dependent squeezing with 300 m filter cavity, low loss Faraday isolator, active mode matching

- 300 m filter cavity
- Low loss Faraday isolator
- Piezo-deformable mirror for active mode matching

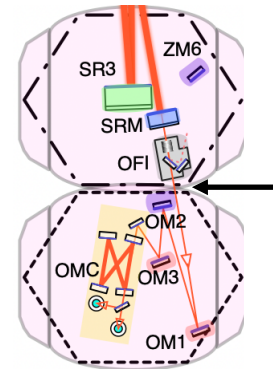
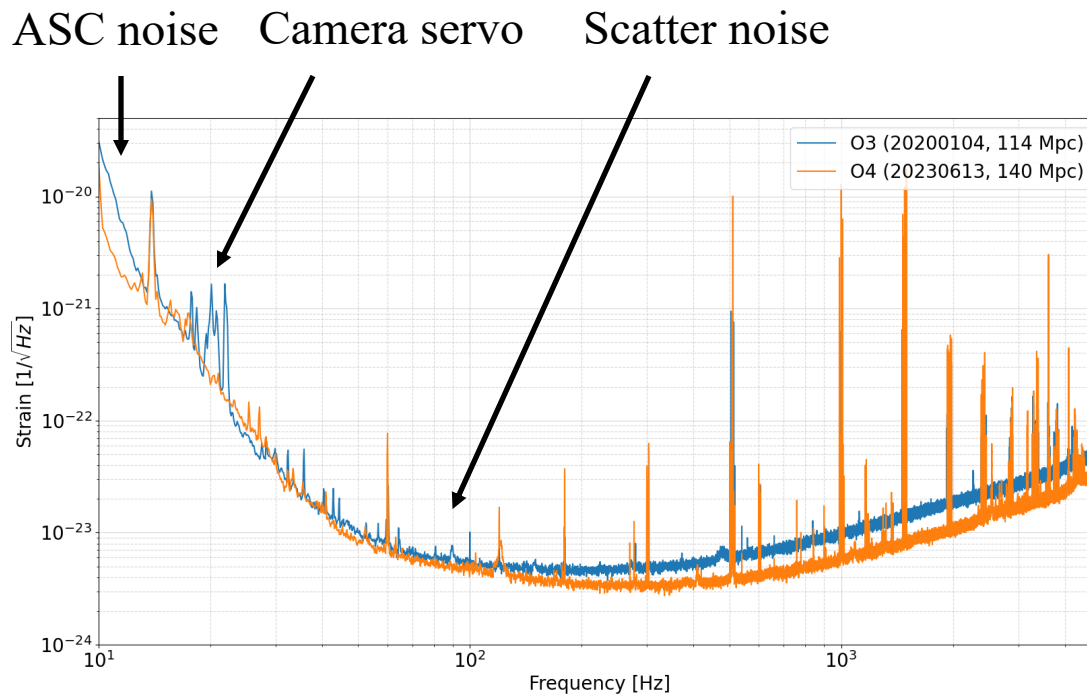


Opt. Express 30,
10491 (2022)

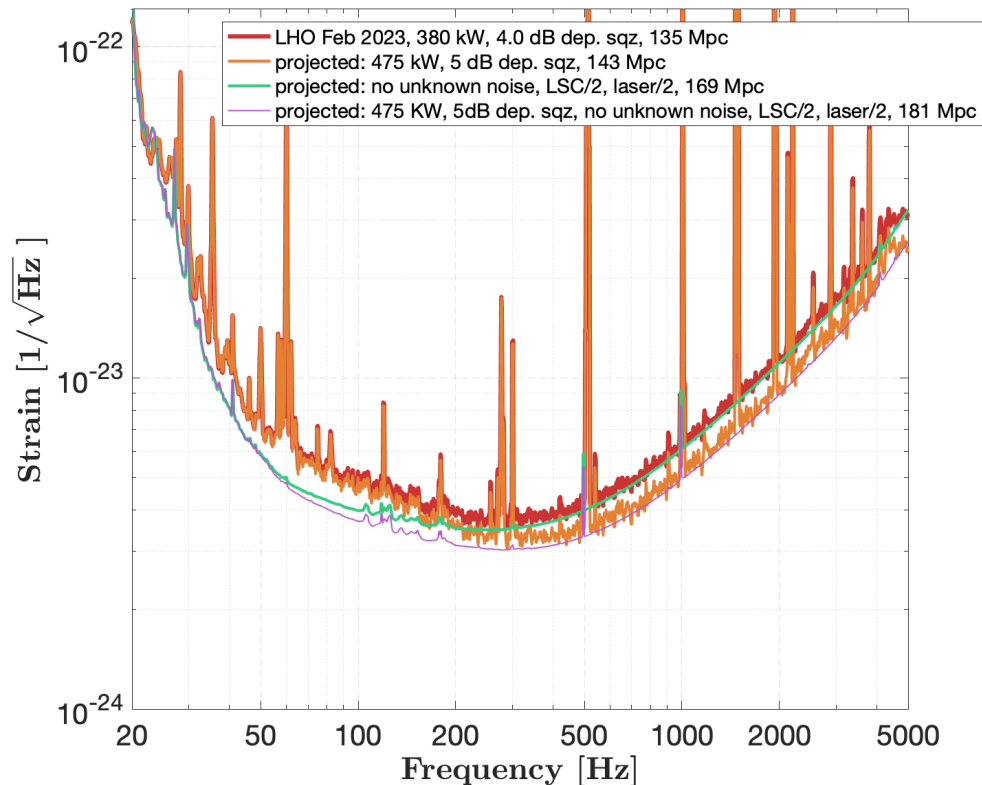
- Reduction of quantum radiation pressure noise has been realized
- 4dB squeezing at 1kHz
- BNS range improved from 120 Mpc (no sqz) to 140 Mpc



- Scatter noise: removal of window between HAM 5/6
- Camera servo: no alignment dither system
- ASC noise: improvement of ASC



- To increase BNS range significantly, it is important to reduce the technical noise at low frequency



- 75W vs 60W
- Improvement of sensitivity, duty cycle
- Investigation of unknown noise
- Plan of commissioning break