Séminaire projets APC 2023

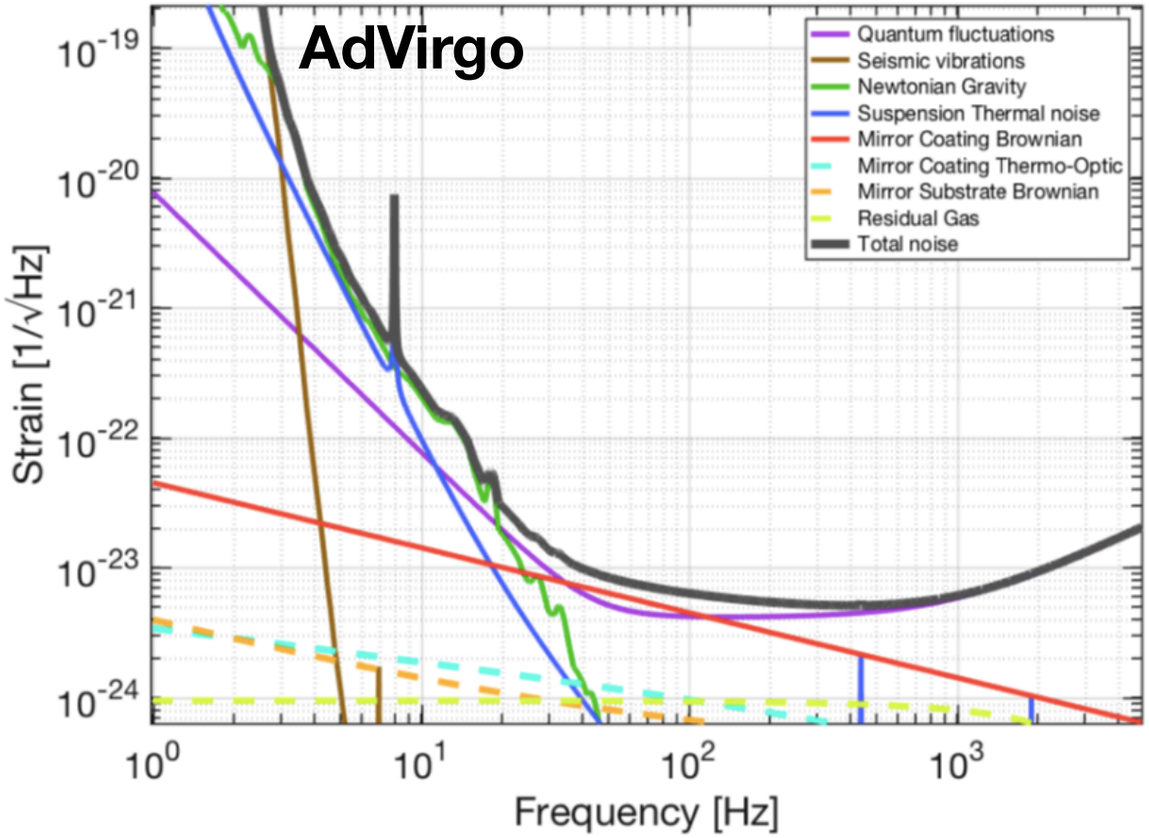
Squeezing for future GW detectors

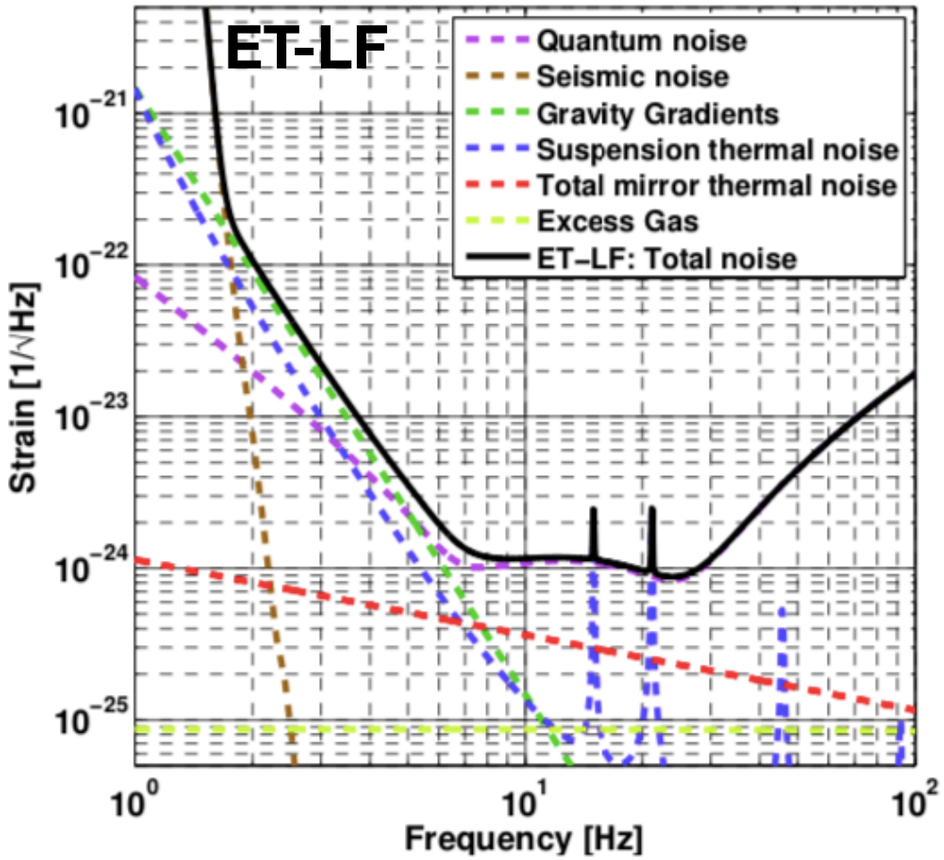
Eleonora Capocasa

24 March 2023

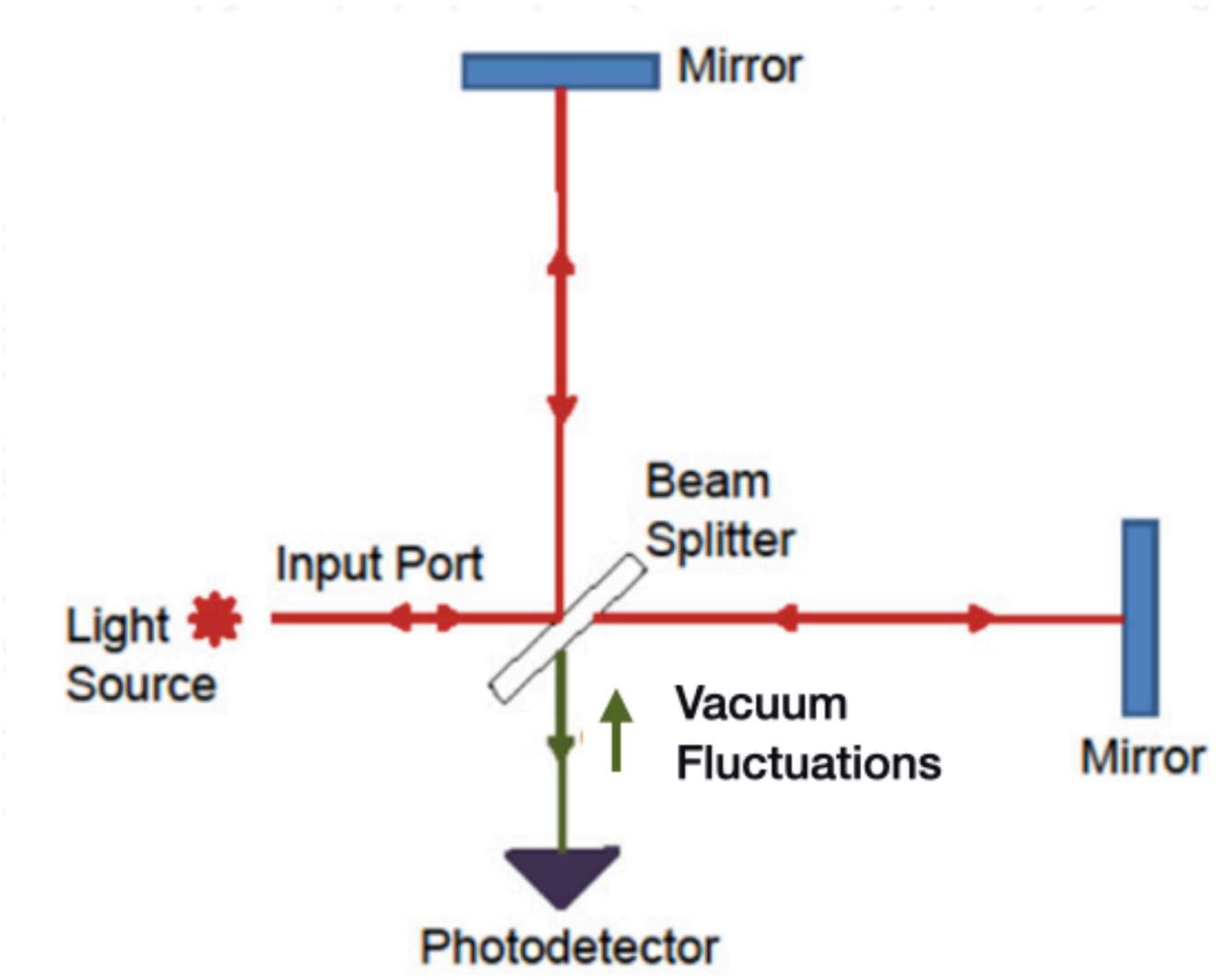
Context: Quantum noise in GW detectors

- Main limiting noise of current and future GW detectors



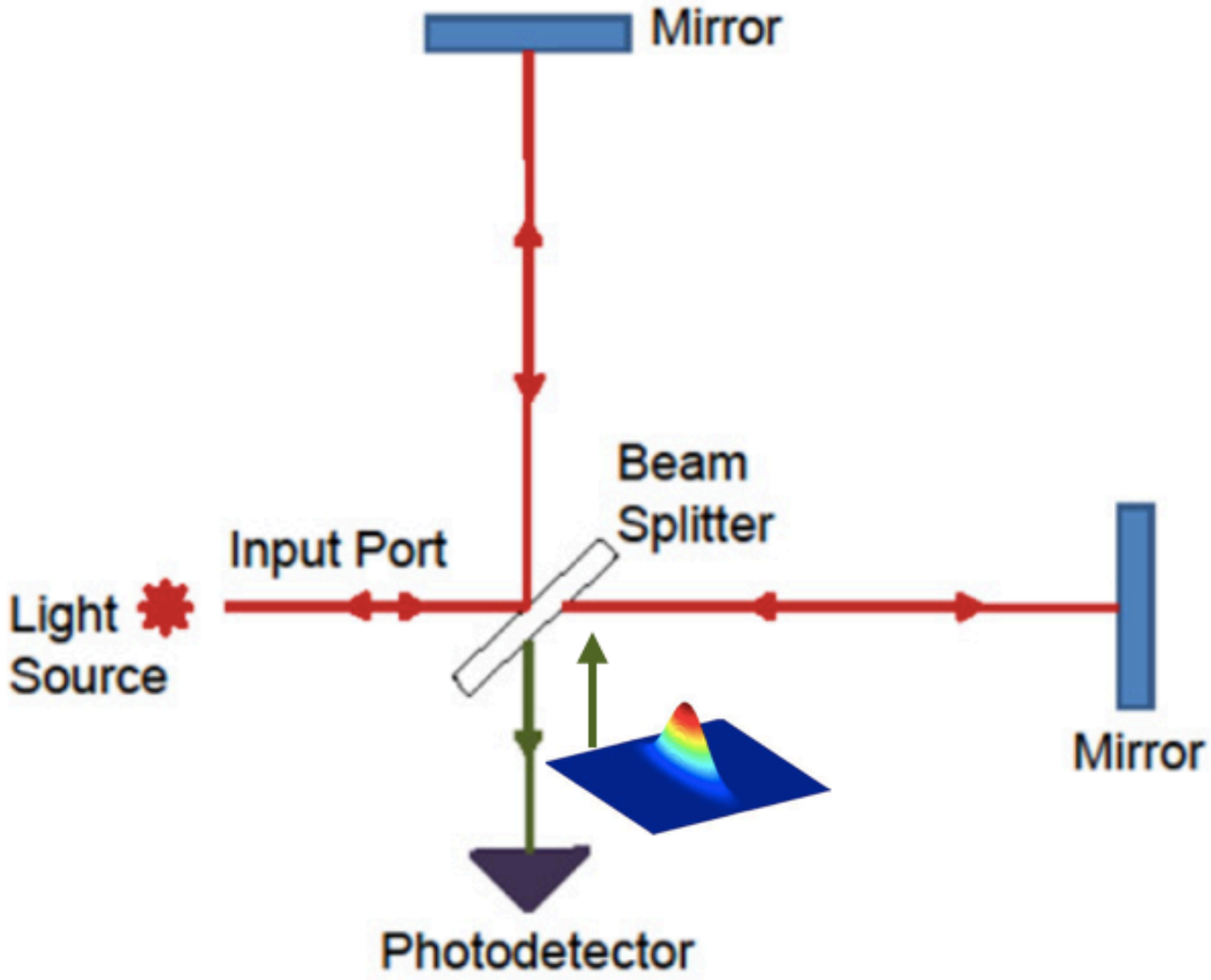


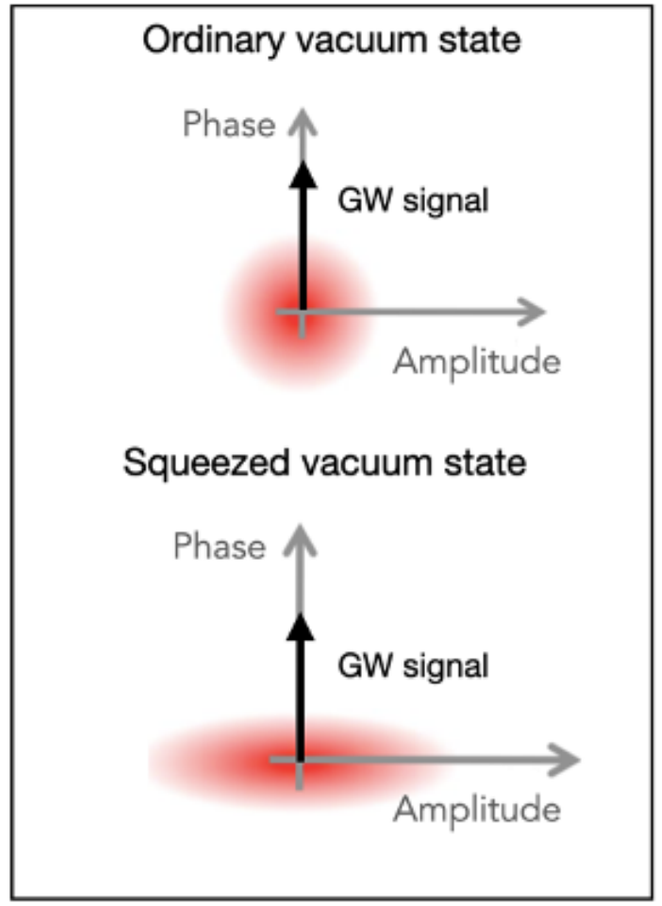
Quantum noise in GW interferometers



[1]C.Caves “Quantum-mechanical noise in an interferometer”
Phys. Rev. D 23 (1981)

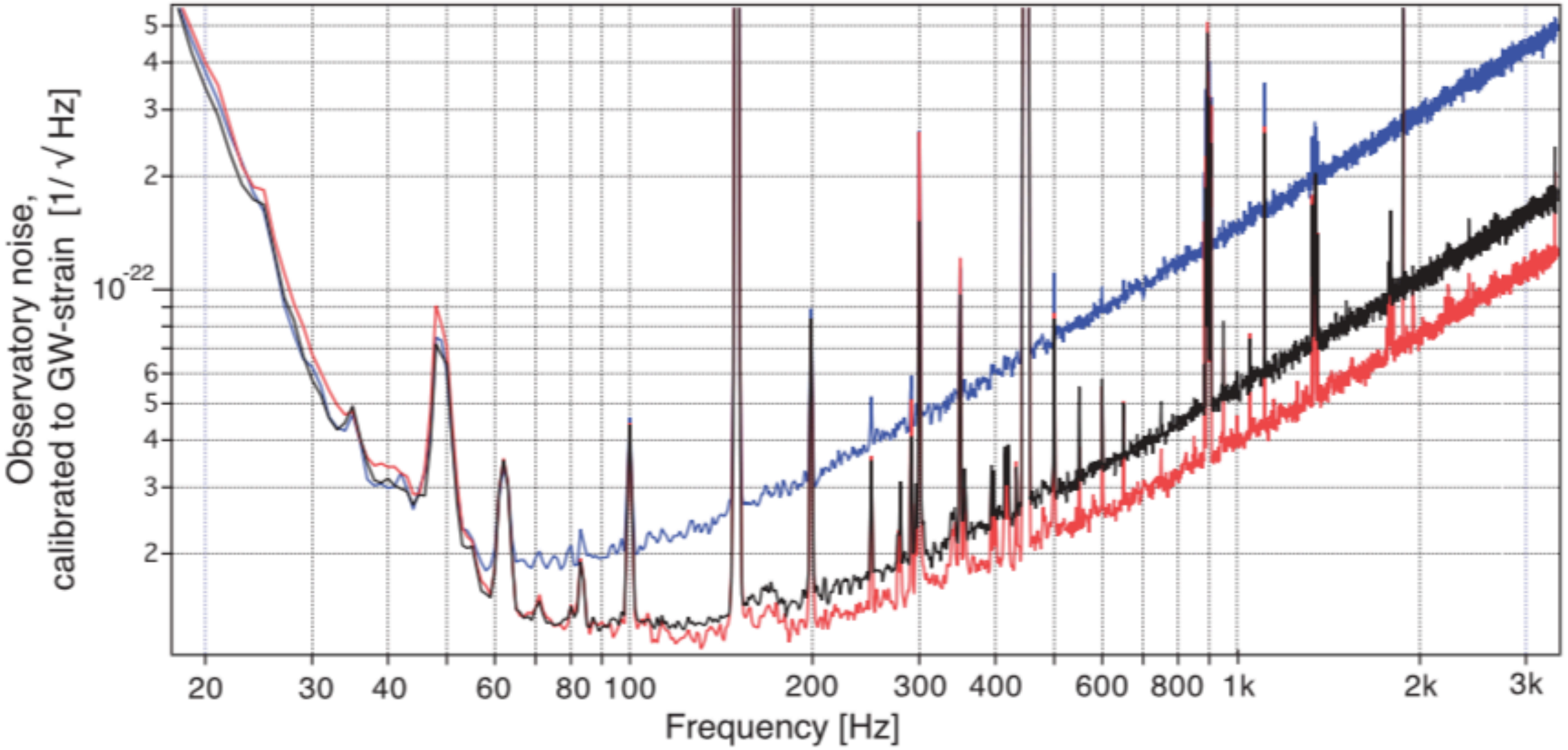
Quantum noise reduction using squeezed light





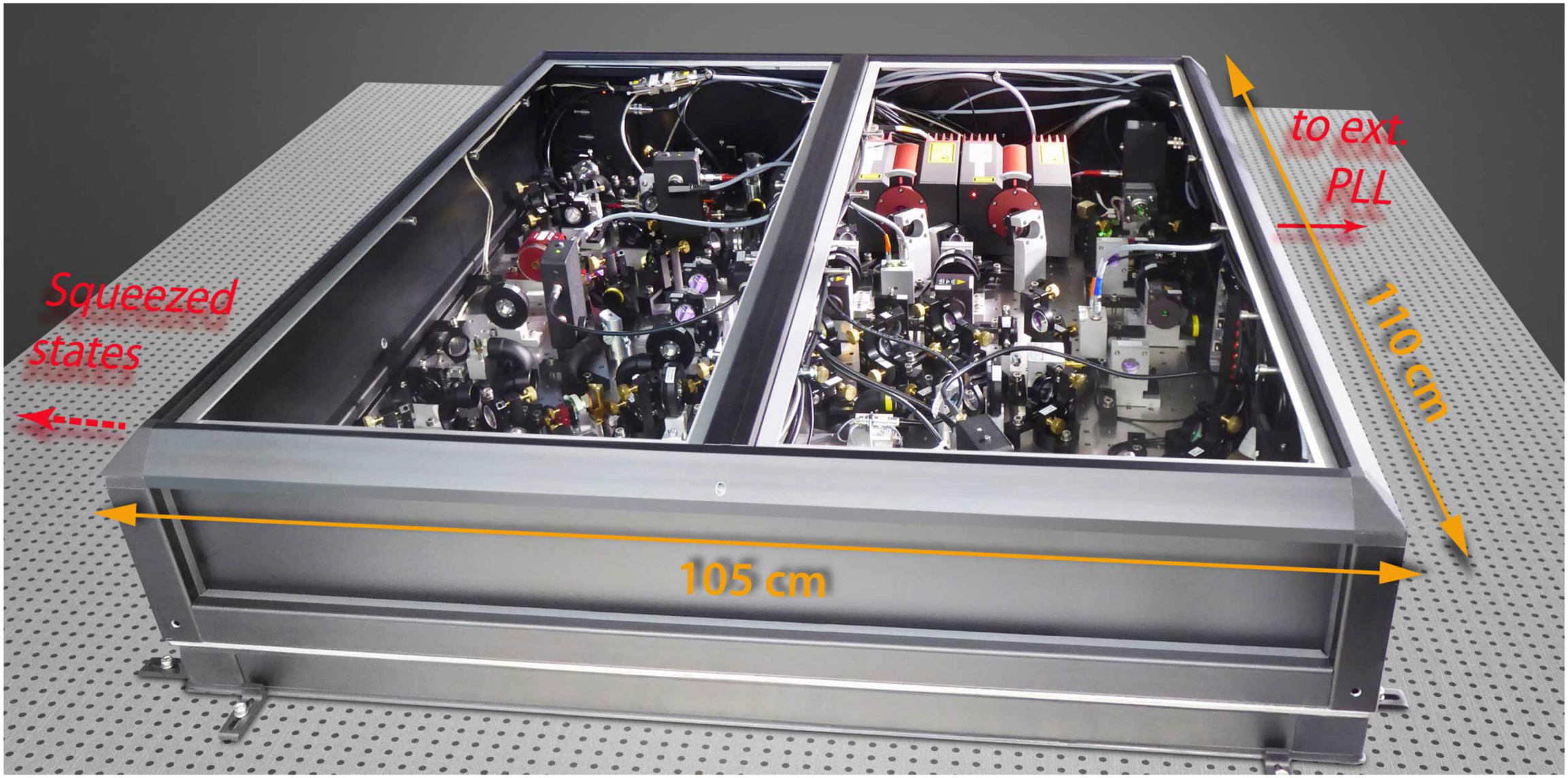
Squeezed source integrated in GW detectors

- Operating in both LIGO and Virgo since the beginning of O3

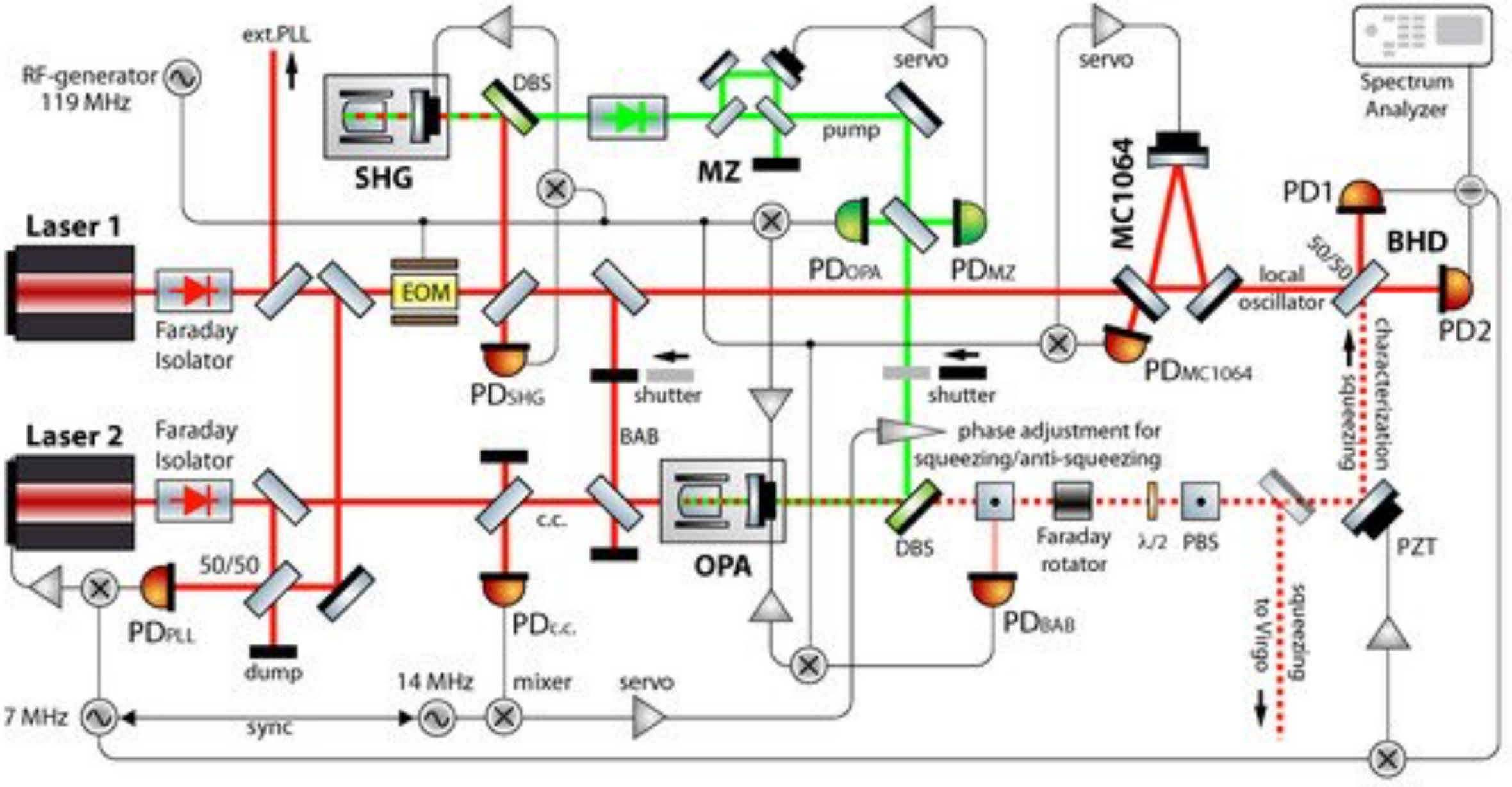


- About 3 dB of squeezing measured
- Between 25-40% of losses measured

Vacuum squeezed source

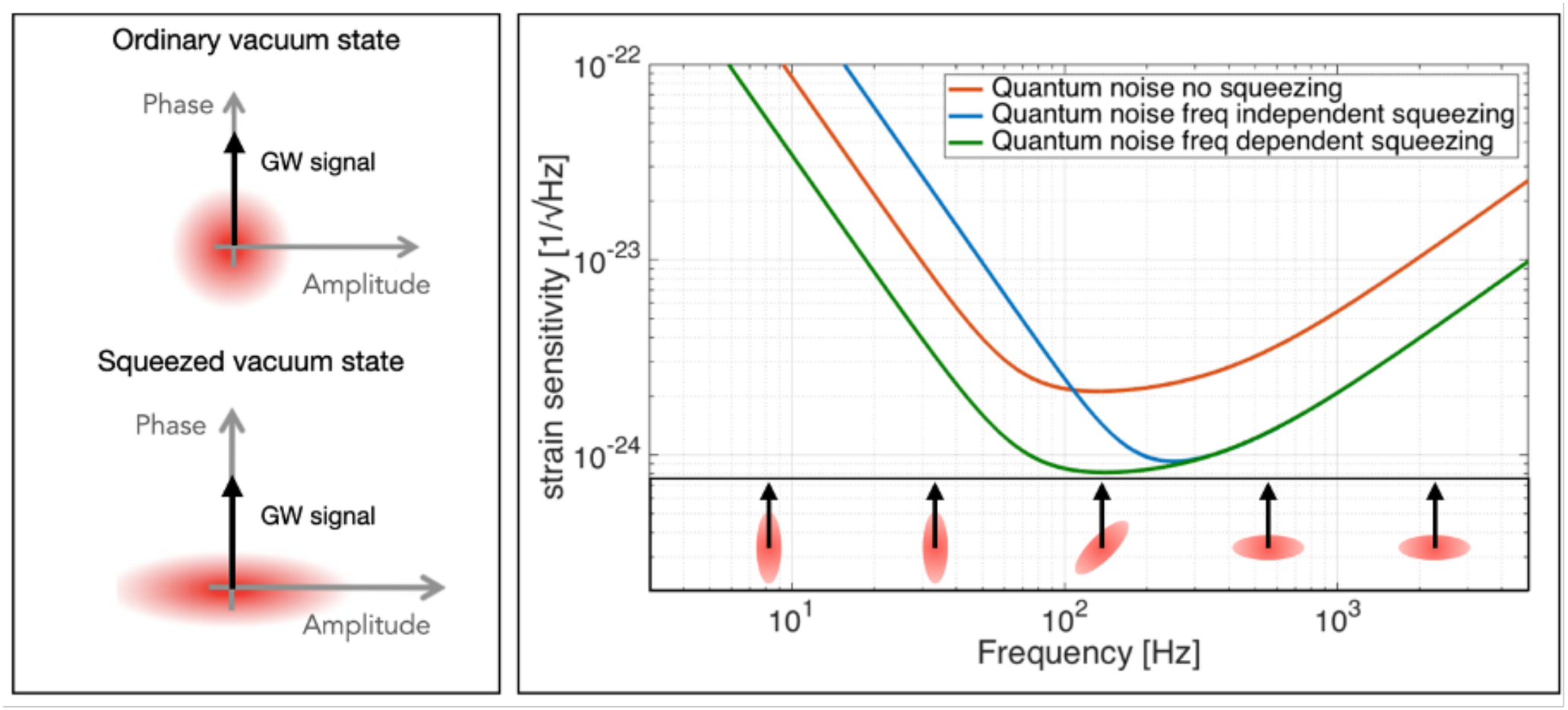


Vacuum squeezed source



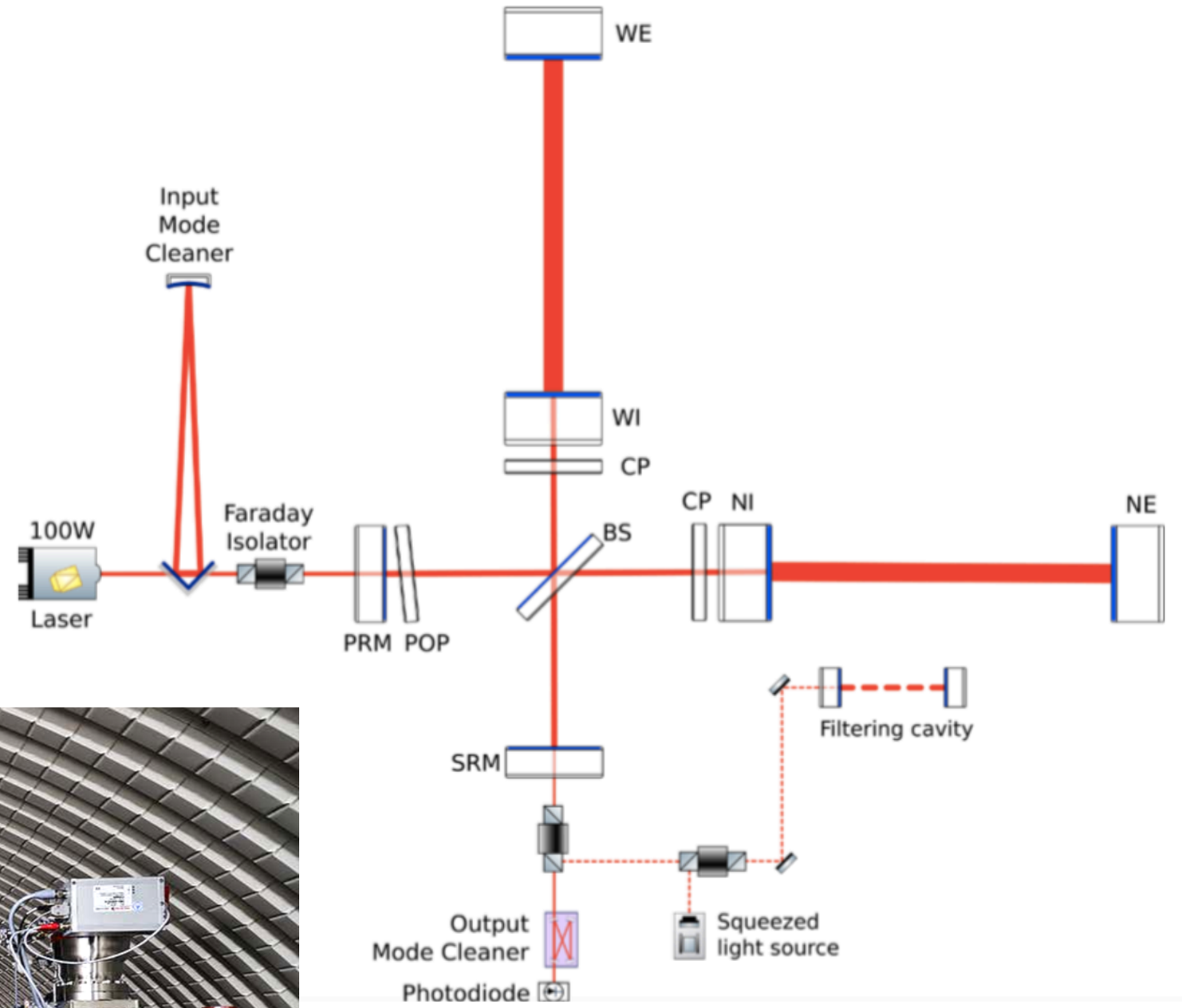
Broadband quantum noise reduction

- Squeezing ellipse undergoes a rotation inside the interferometer
- Squeezing angle should change with the frequency for optimal noise reduction



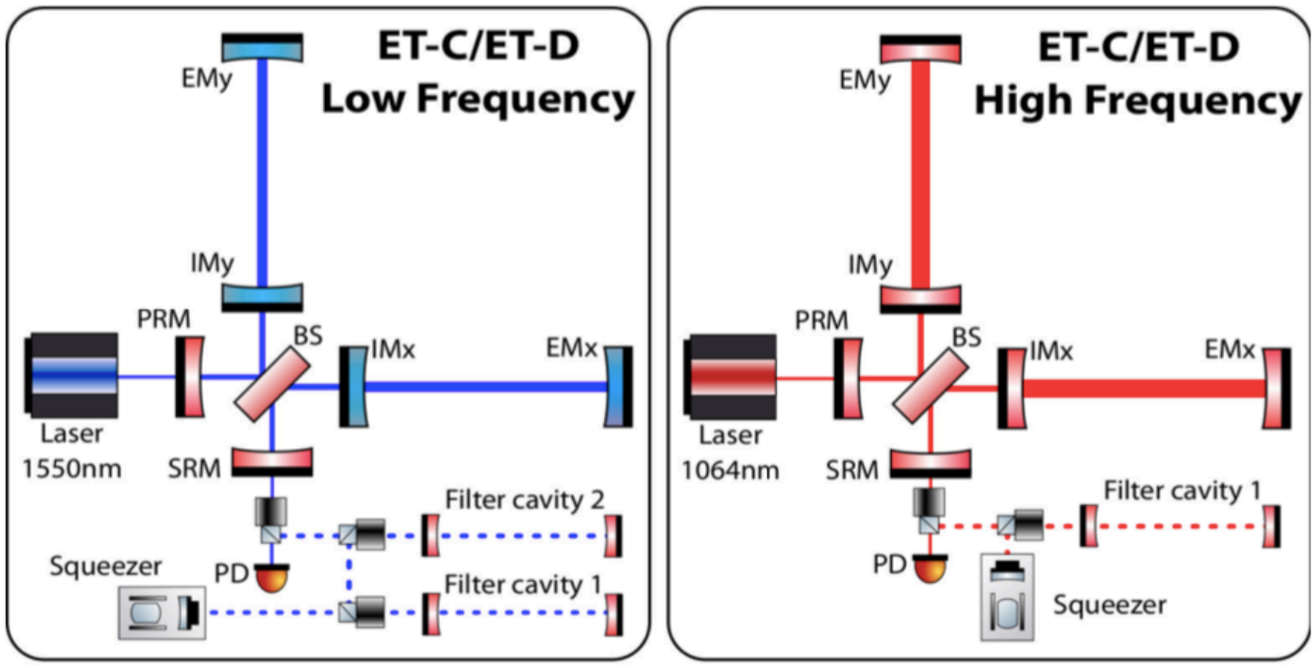
Filter cavity implementation for O4

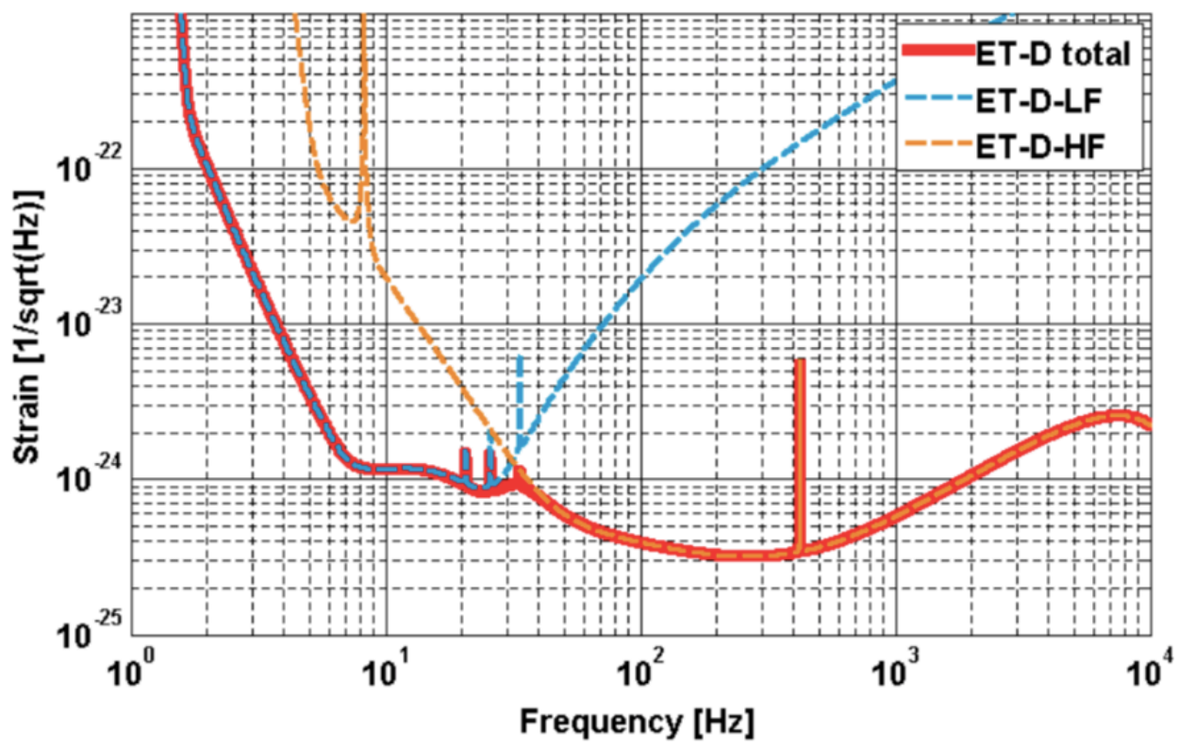
- Length: ~300 m



Squeezing for Einstein Telescope

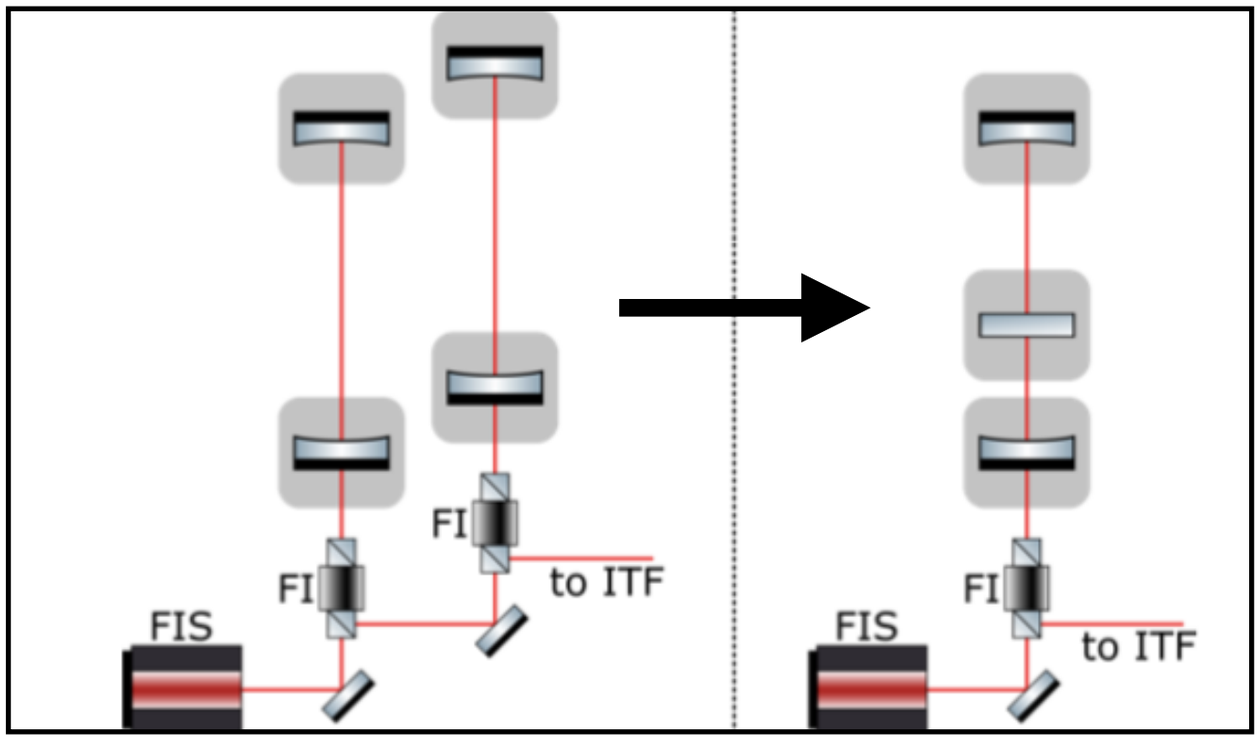
- **Goal:** 10 dB of broadband quantum noise reduction
- 2 filter cavity fo ET-LF





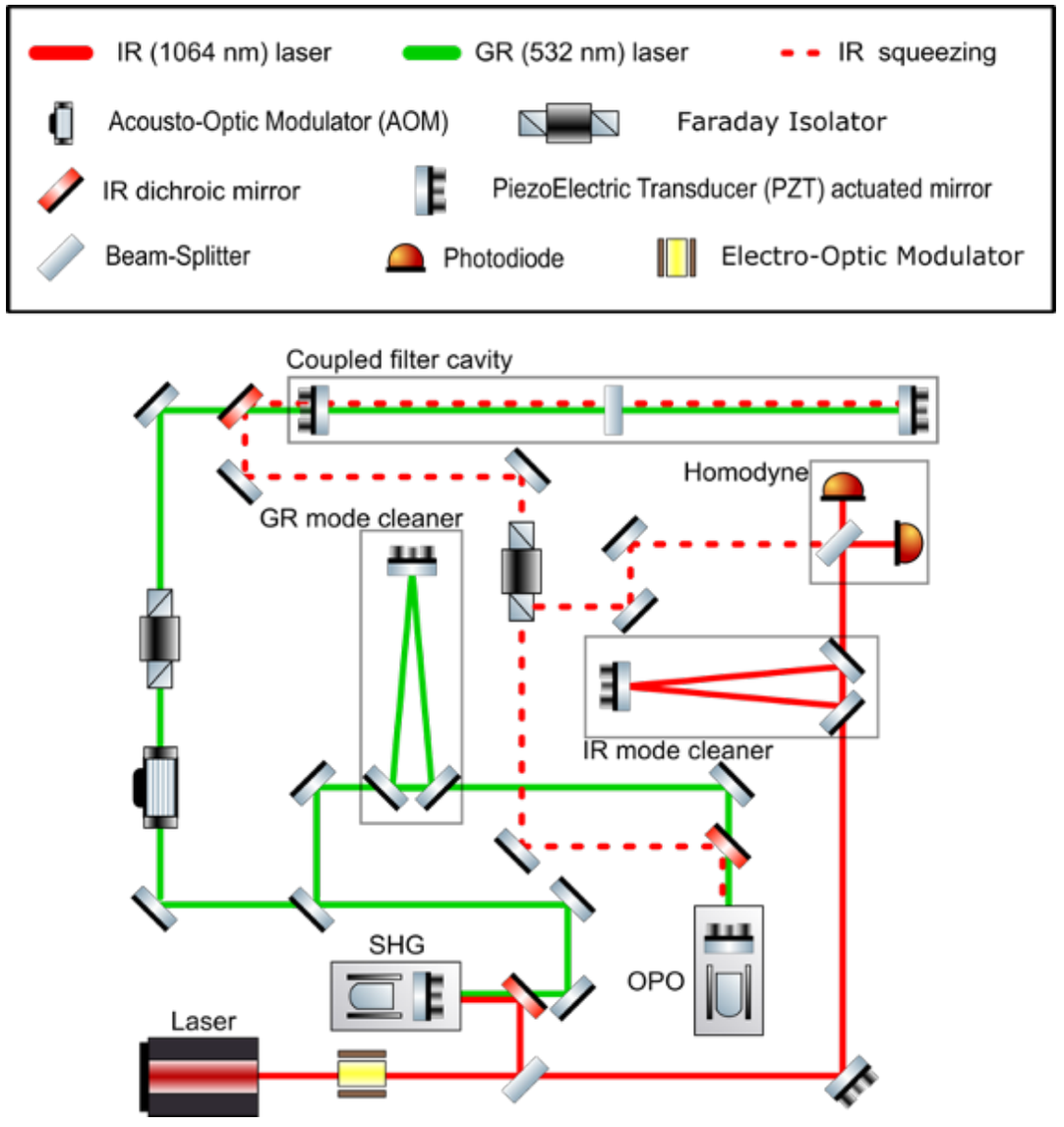
Project: frequency dependent squeezing for ET

- Design of optimal filter cavities
- Possible replacement of two filter cavity with a double filter cavity ->simulation and table top experiment



APC table top experiment milestones

- Experiment design
- Squeezing source realisation
- Double cavity control and characterisation
- Demonstration of FDS with non-trivial rotation



Team

- E.Capocasa
- M. Barsuglia
- Y. Zhao
- A. Daumas
- J. Ding
- P. Prat
- K. Biernacki
- M. Karakuc