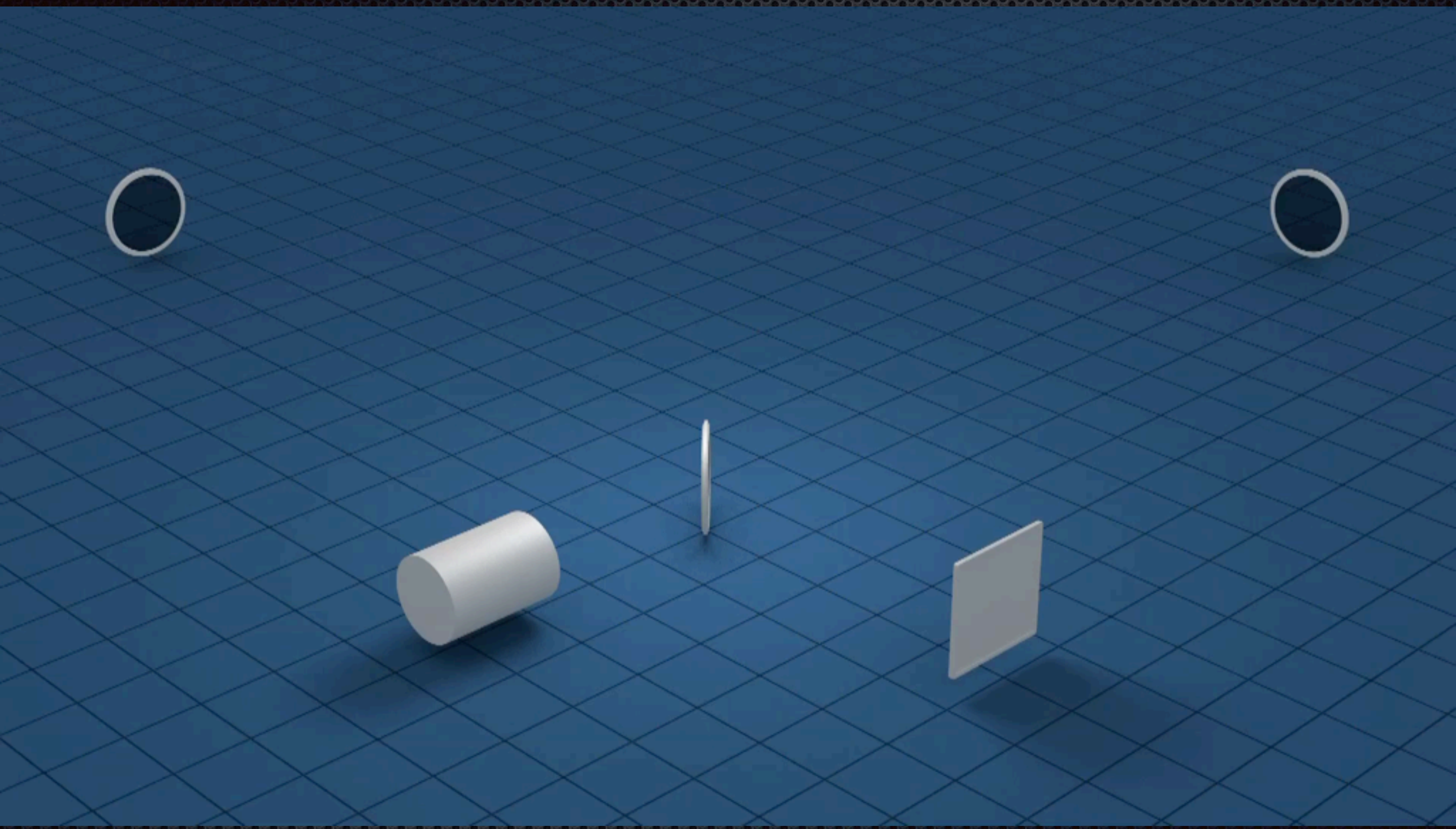
Intro

Rana Adhikari
(Caltech-LIGO)

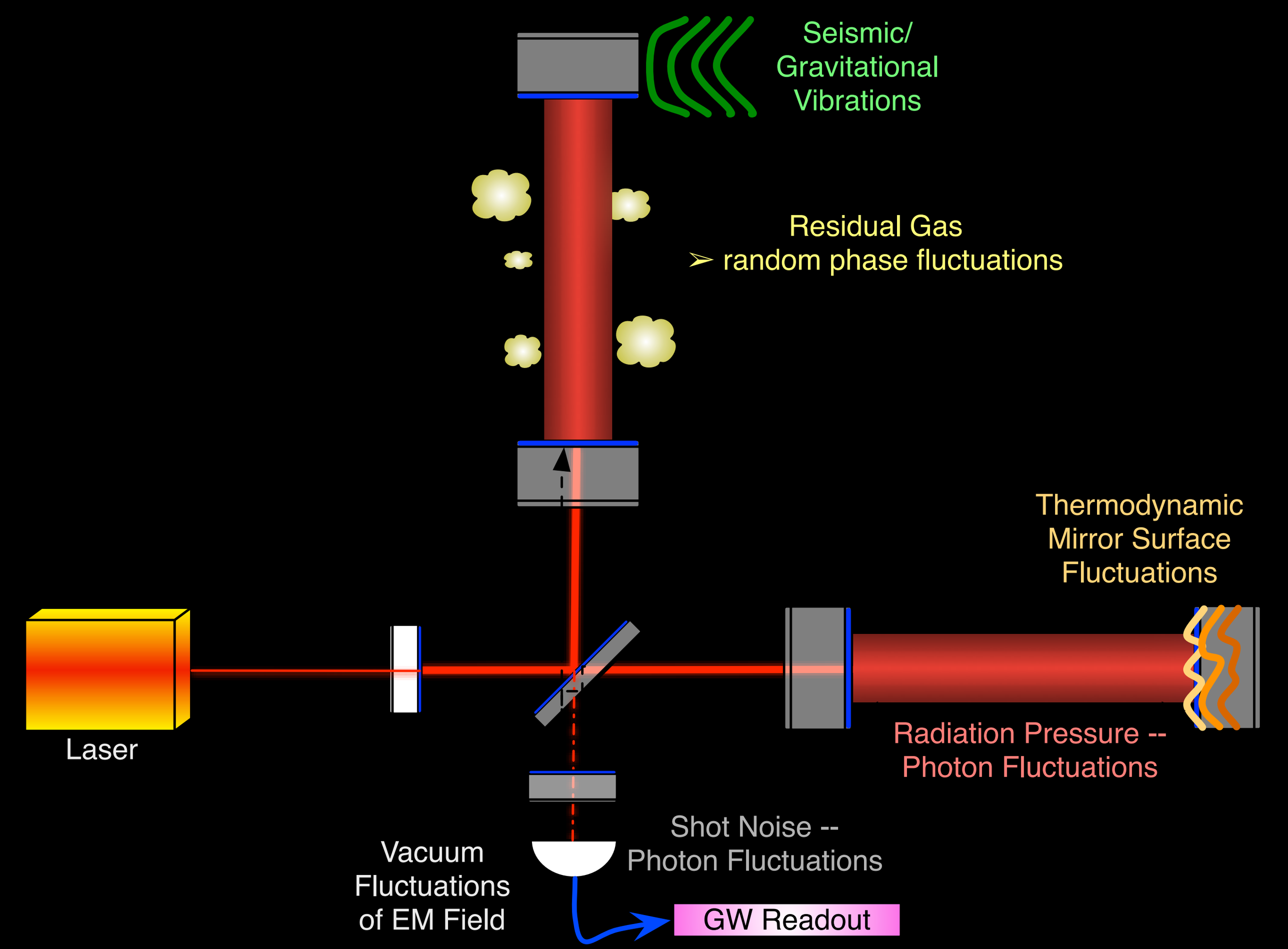
How the Michelson Interferometer Works:



Mirror motion -> Optical Phase Shift -> Light Power

Timeline of the GW Field

1. GR 1915
2. Einstein 1916
3. Einstein 1918
4. Rosen 1955
5. Pirani 1955
6. Feynman 1955
7. Wheeler 1960
8. Thorne 1965
1. Weber 1965
2. Weiss 1971
3. 1987 Blue Book
4. PNI MIT 1995
5. Caltech 40m 1981-
6. iLIGO 1997-2007
7. eLIGO 2007-2010
8. aLIGO 2010-2014
9. First lock 5/2014
10. O1 start 9/2015
11. GW150914


Seismic/
Gravitational
Vibrations
Residual Gas
➢ random phase fluctuations
Thermodynamic
Mirror Surface
Fluctuations
Laser
Radiation Pressure --
Photon Fluctuations
Vacuum
Fluctuations
of EM Field
Shot Noise --
Photon Fluctuations
GW Readout

Sensitivity Evolution of GW Detectors

Strain [$1/\sqrt{\text{Hz}}$]

10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
10^{-19}
10^{-20}
10^{-21}
10^{-22}
10^{-23}
10^{-24}
10^{-25}

Binary NS Range [Mpc]

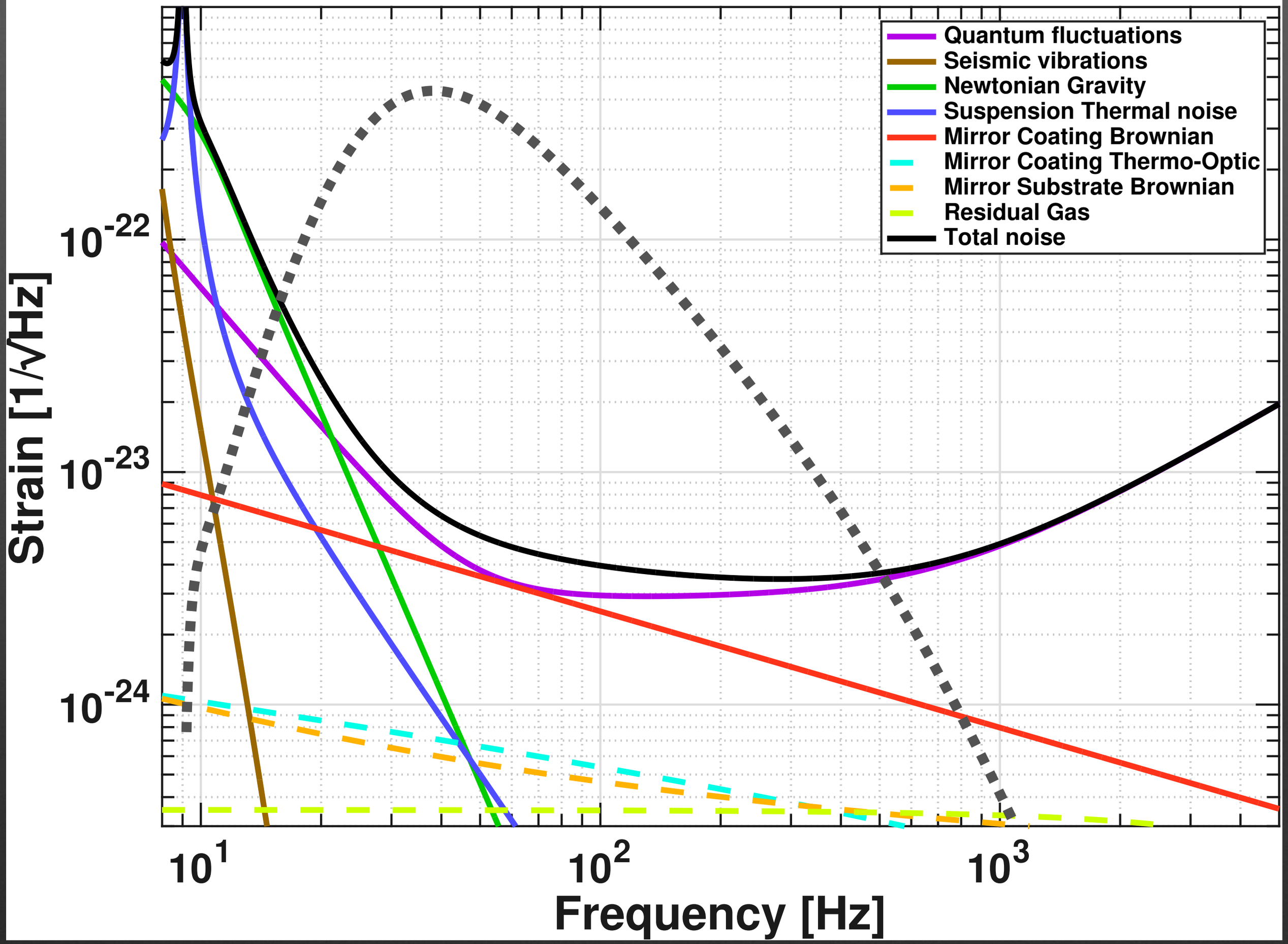
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}

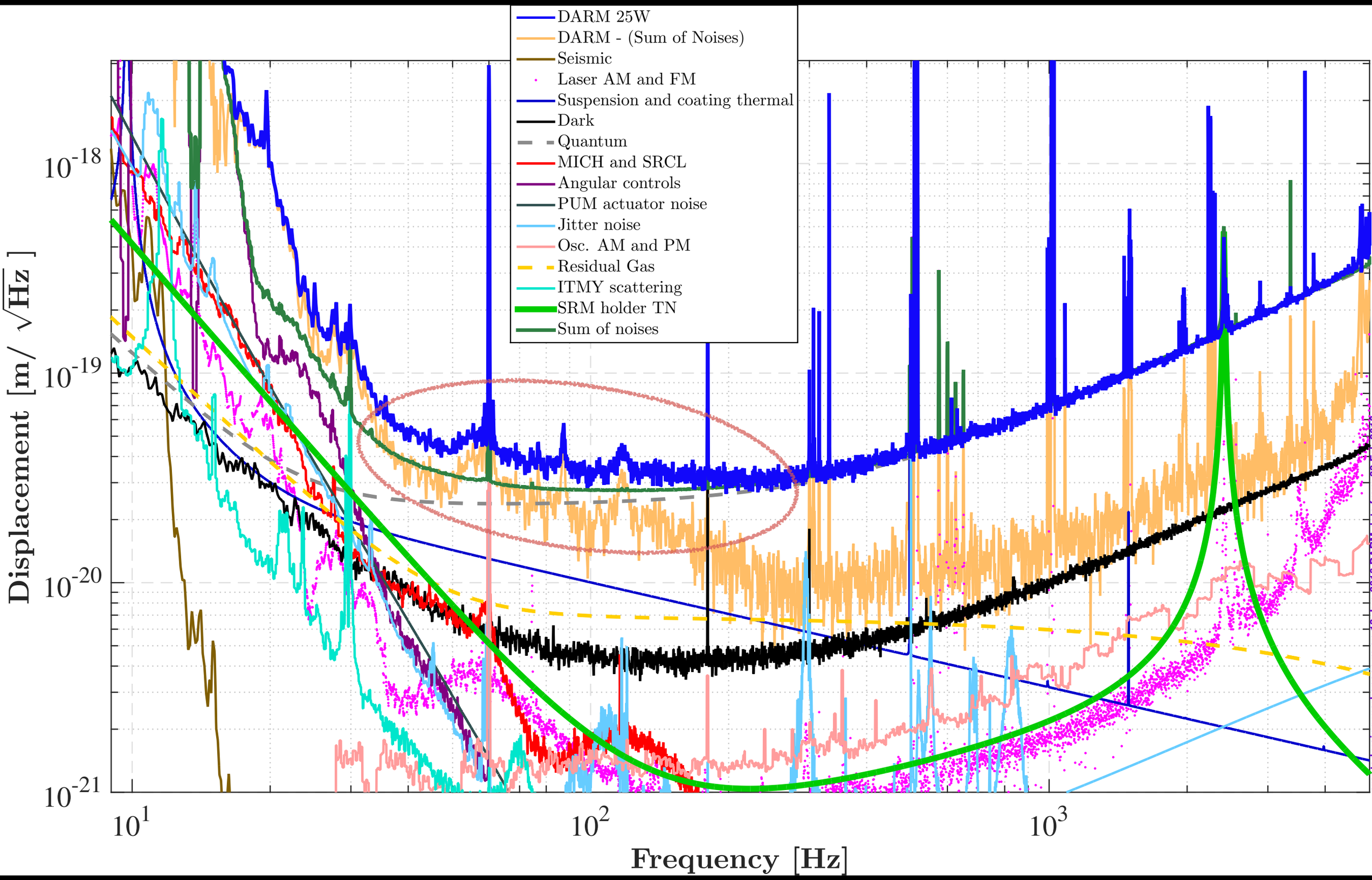
Resonant Bars
Past Interferometers
Future Interferometers

Resonant Bars
Past Interferometers
Future Interferometers

1960 1970 1980 1990 2000 2010 2020 2030 2040

Time [y]

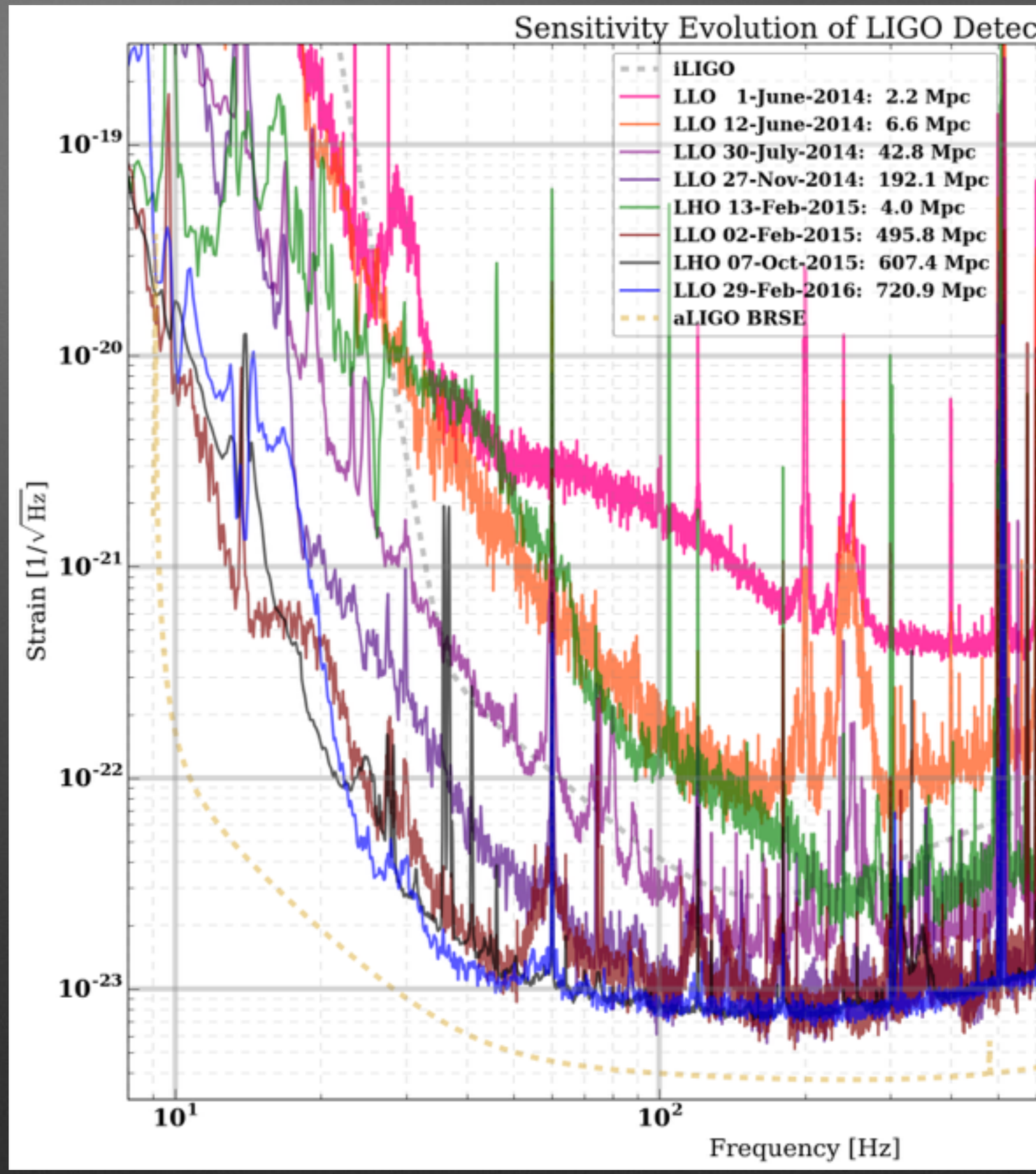

Quantum fluctuations
Seismic vibrations
Newtonian Gravity
Suspension Thermal noise
Mirror Coating Brownian
Mirror Coating Thermo-Optic
Mirror Substrate Brownian
Residual Gas
Total noise
Strain [1/√Hz]
10^-22
10^-23
10^-24
10^1
10^2
10^3
Frequency [Hz]



by R. deRosa: LLO budget; Feb 23, 2016 w/ SRM thermal noise estimate added

Some Workshop Goals

- Description of LIGO Installation, Commissioning, and Operations challenges
- How LIGO-India will be different from LIGO-2015
- R&D for upgrades: 2018-2028



Time Lines

- How much of the installation will be the same?
  - Less contamination? Better Baffling? Less fiber breaking?
- How will the integration be different?
  - Less bad ideas, try right ideas first
- How much of the 2016 hardware will be obsolete?
  - Computers, ADC/DAC, laser, DC PDs, Transmons

possible upgrades

- Different coatings on ETMs
  - T_{532}: 30% -> 1%
  - Less ripple on surface
    - Less point defects
- Redesign of SRC
- new BBPDs
- passive damping of Quad modes
- passive damping of ISI blades
- Squeezed light
  - + 16m or 300m filter cavity
- RFI shielding in PSL
- ASC redesign
- balancing of SUS drives
- intelligent PI damping
- dynamic Lock Acquisition
- state switching in Control systems