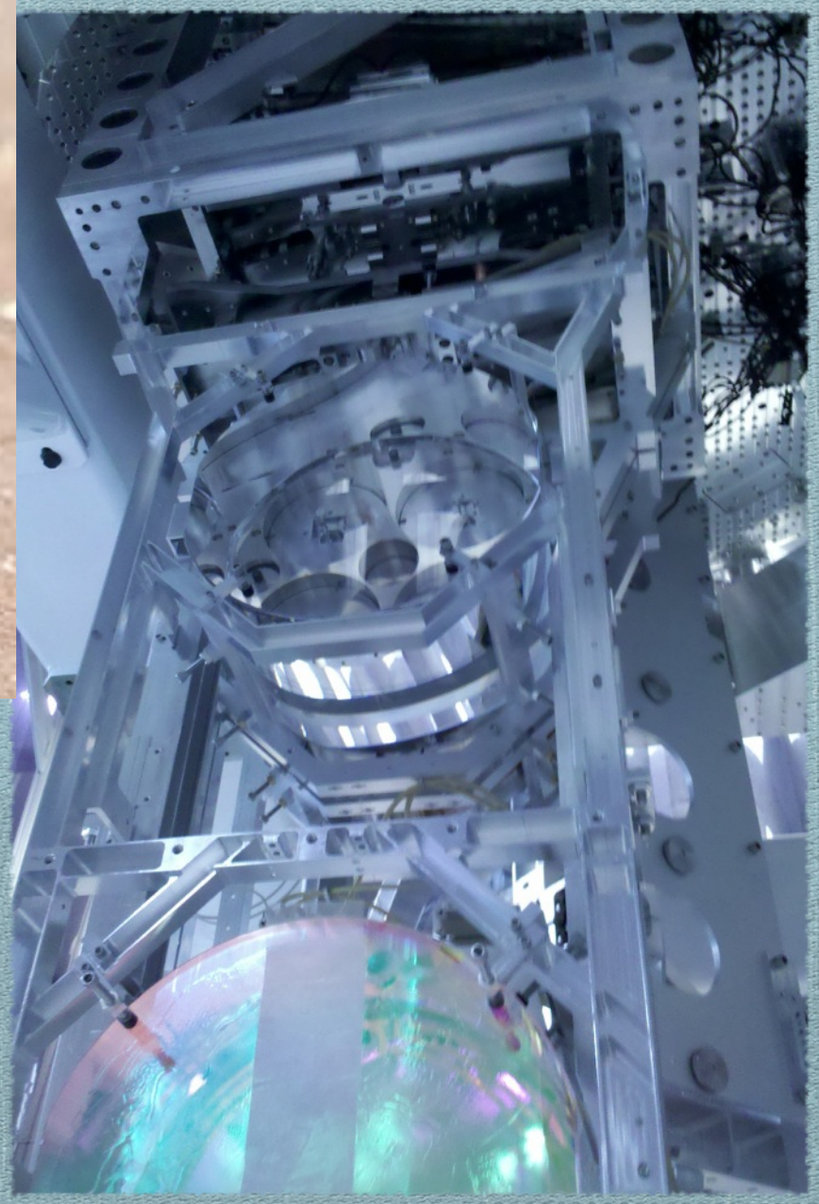
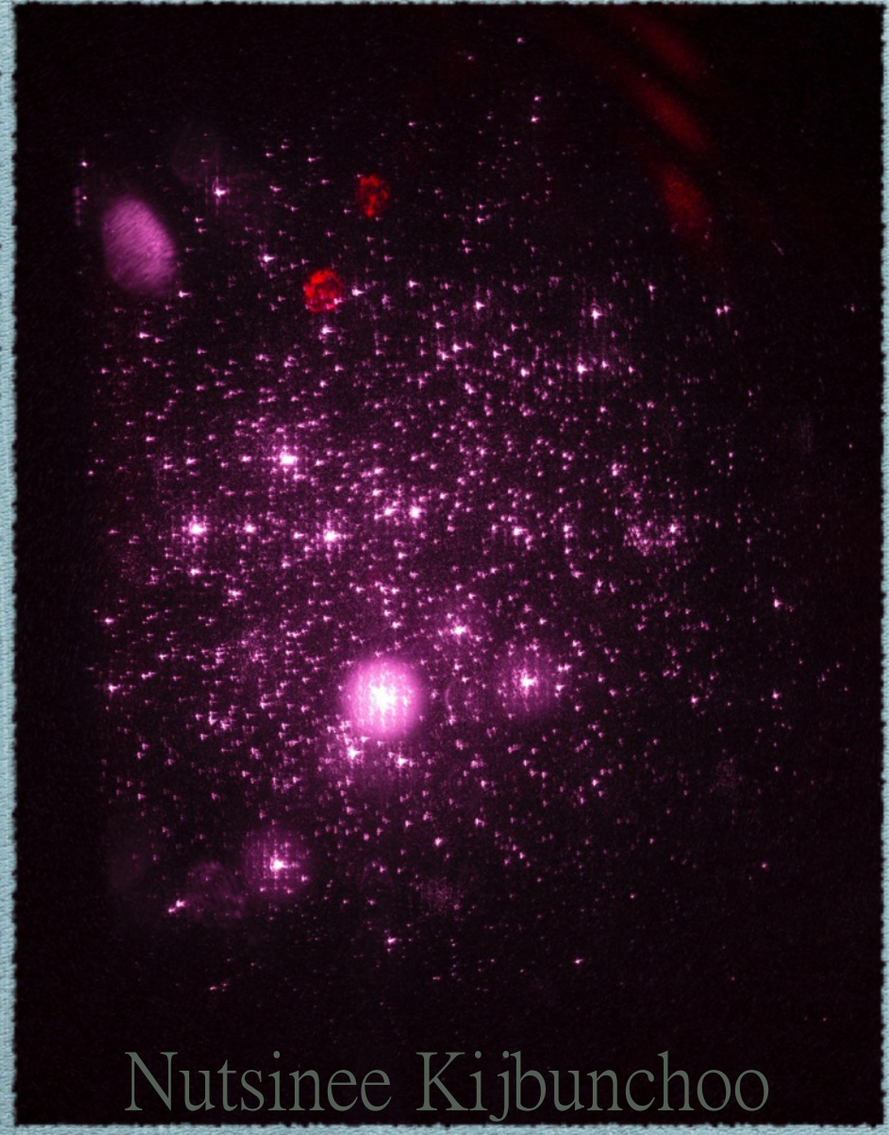




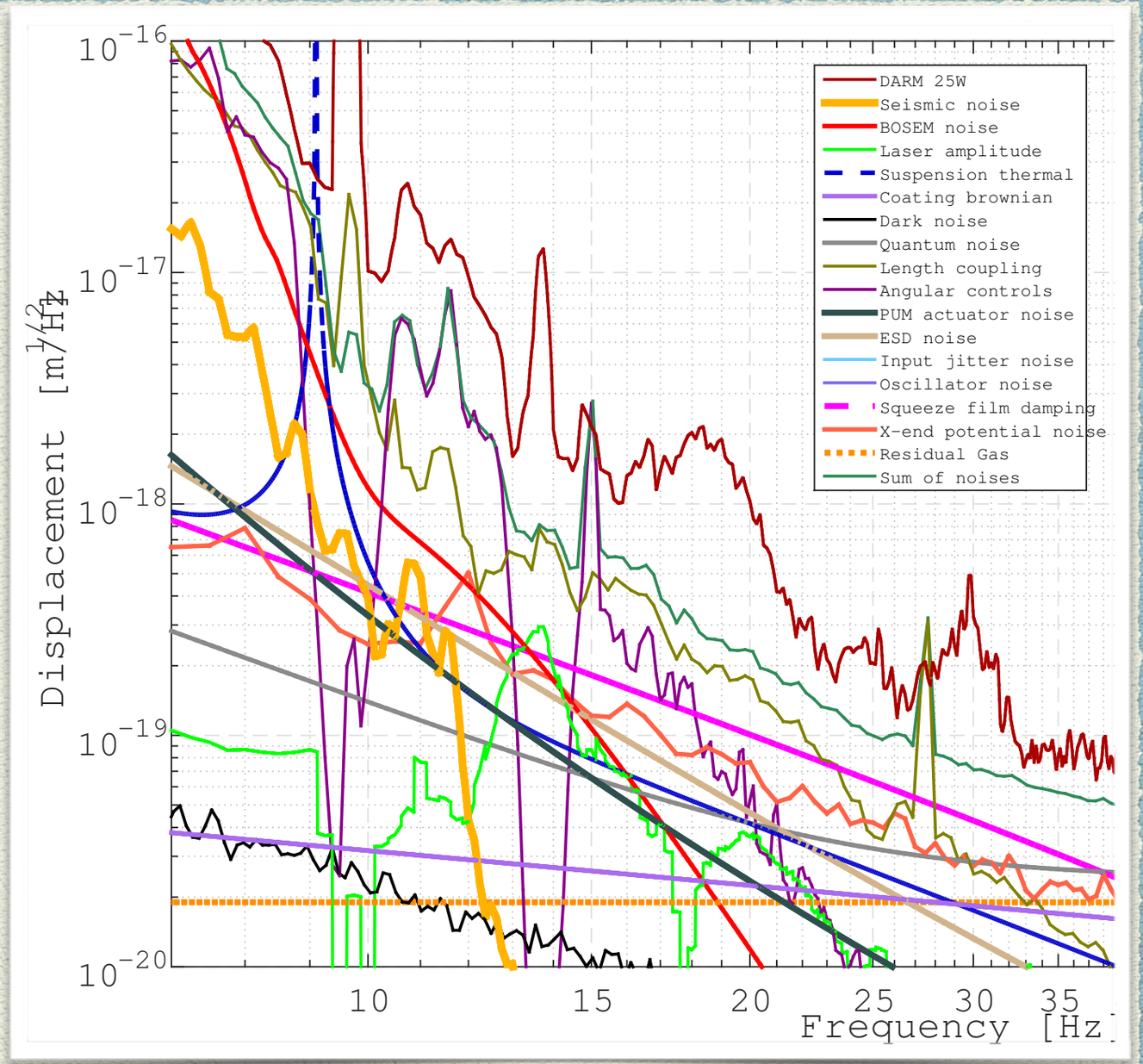
Prospects for Low Frequency Enhancements

Rana Adhikari
for the Advanced Interferometer Configurations WG

G1500615

Synopsis

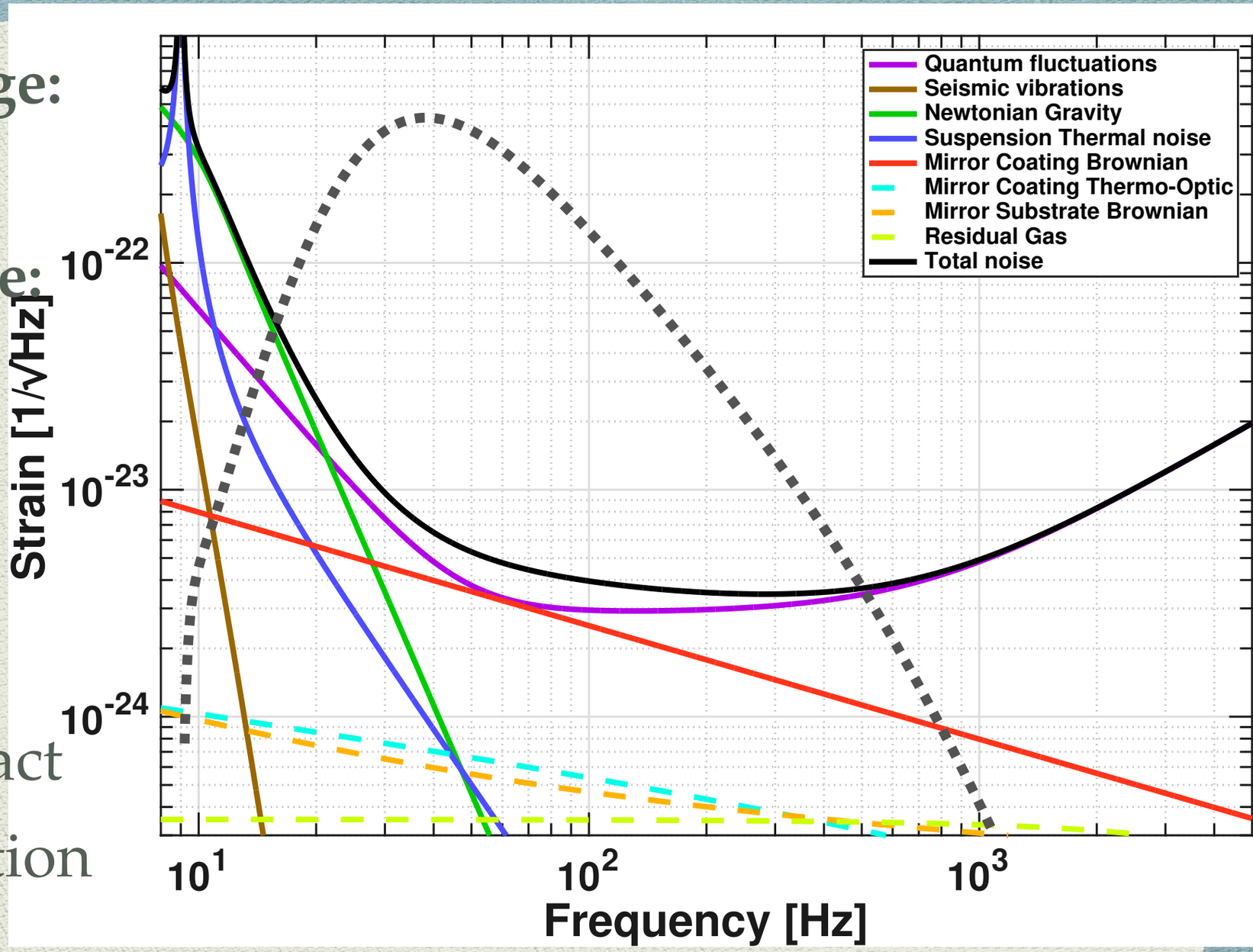
- Impact on Astrophysics
- Summary of Noise sources
- Noise Mitigation Strategies
- Budget/ Schedule estimates



Low Frequency Noise Budget

Impact on Detection Rates

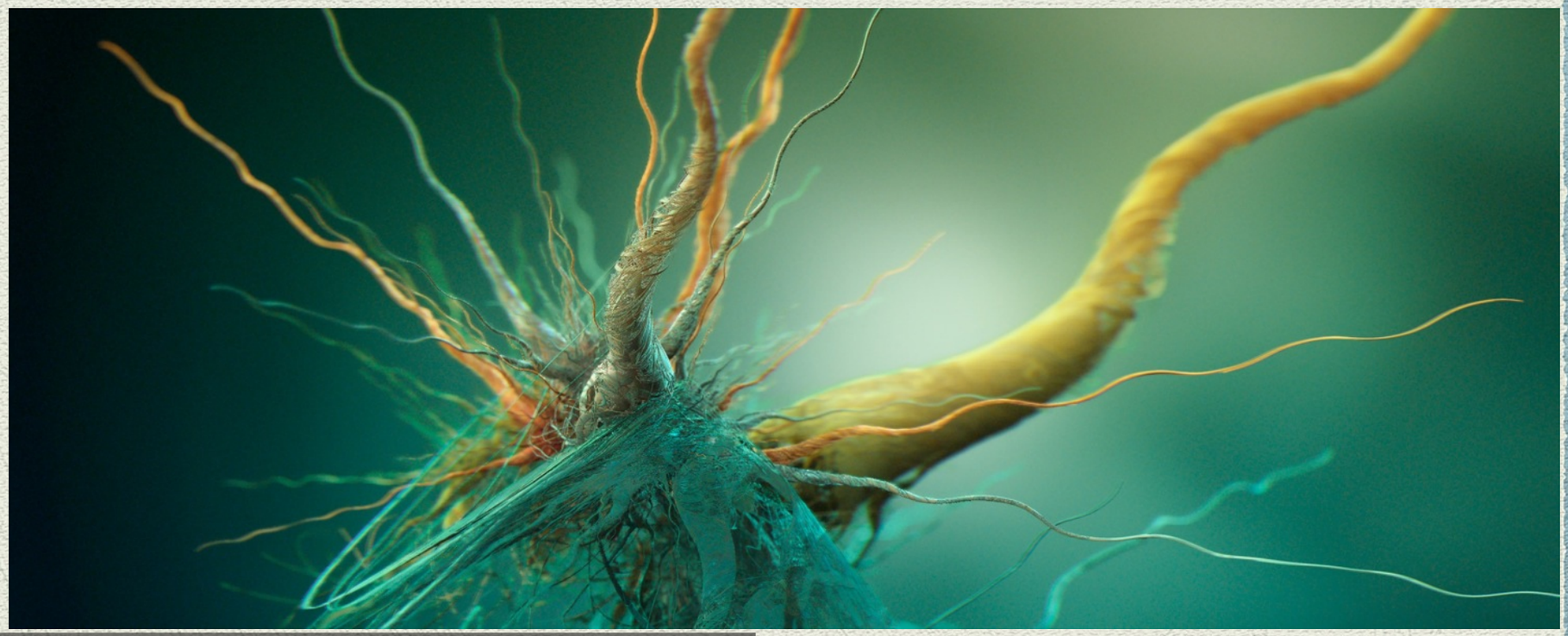
- **BNS Detection Range:**
  200 - 250 Mpc
- **BH/BH Detect Range:**
  1.7 - 3.4 Gpc
- Assumptions
  - All upgrades - 1
  - No upgrades + 1
- not considering impact on parameter estimation



LIGO Voyager Science Case: https://dcc.ligo.org/LIGO-T1200099
Einstein Telescope Science Case: http://arxiv.org/abs/1206.0331

Impact on Localization

1. Low frequency improvement leads to more low f SNR

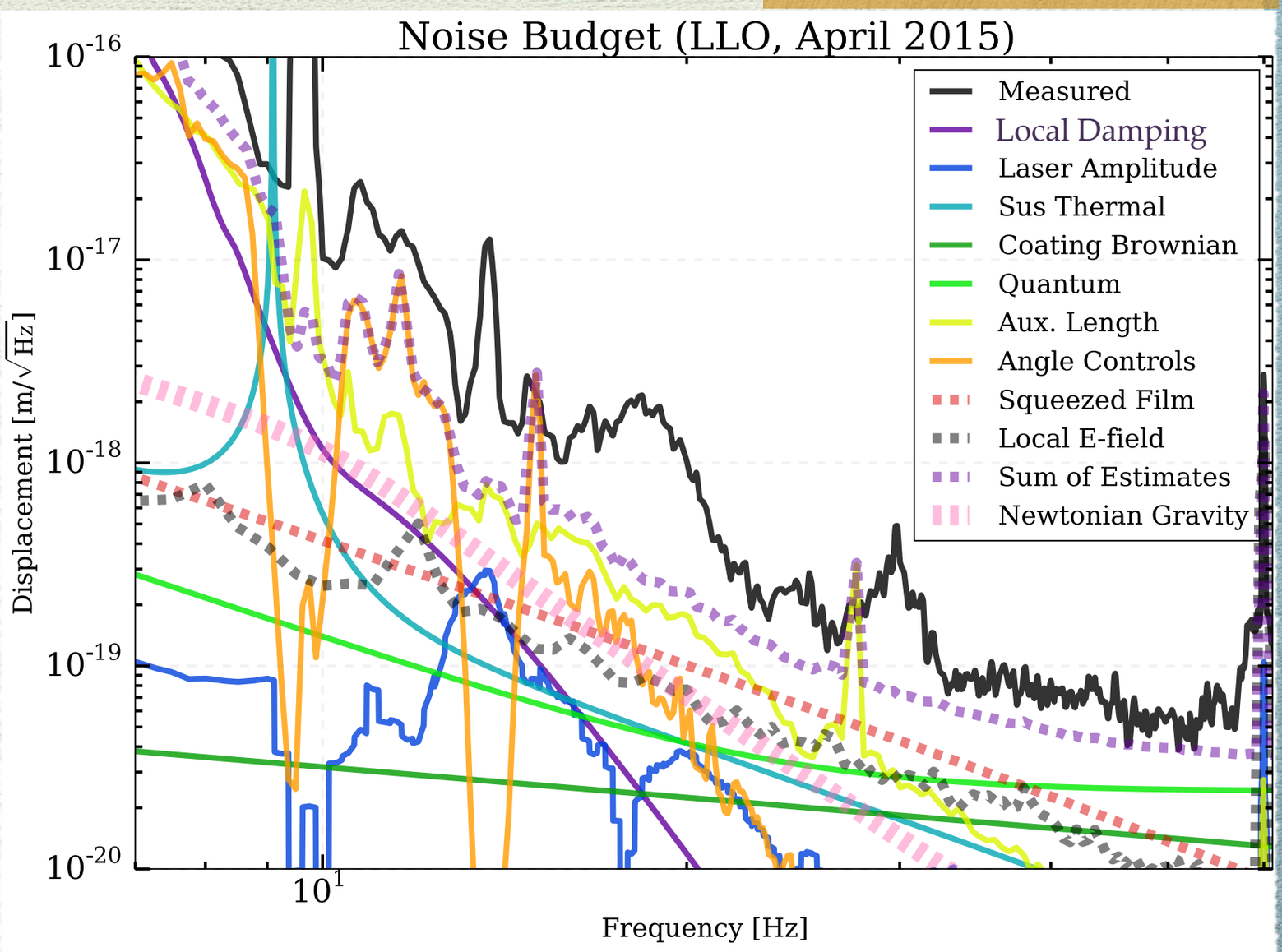


LIGO Voyager Science Case: https://dcc.ligo.org/LIGO-T1200099
Einstein Telescope Science Case: http://arxiv.org/abs/1206.0331

Low Frequency Noise Budget

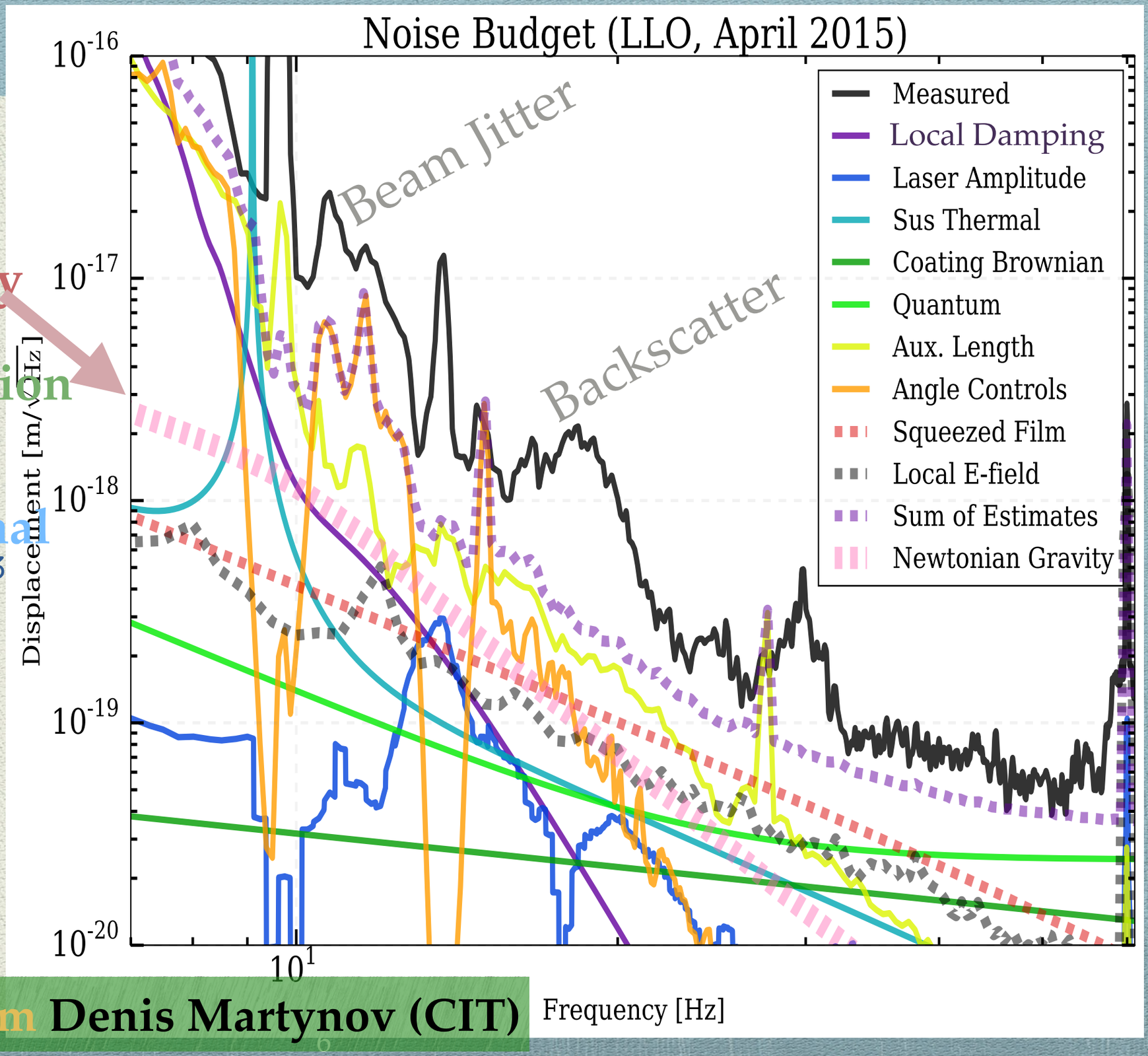
- Noise source population grows at low frequency
- Mix of ‘fundamental’ and technical limits.
- All can be surpassed; costs, tradeoffs

from Denis Martynov (**Caltech**)



Low Frequency Noise Budget

- **Fundamentals:**
  - **Newtonian gravity**
  - **Quantum backaction**
    (Lisa Barsotti's talk)
  - **Suspension thermal**
    G. Hammond: G1500233
- **Technicals:**
  - ~~Seismic~~
  - Scattered Light
  - Aux. Controls



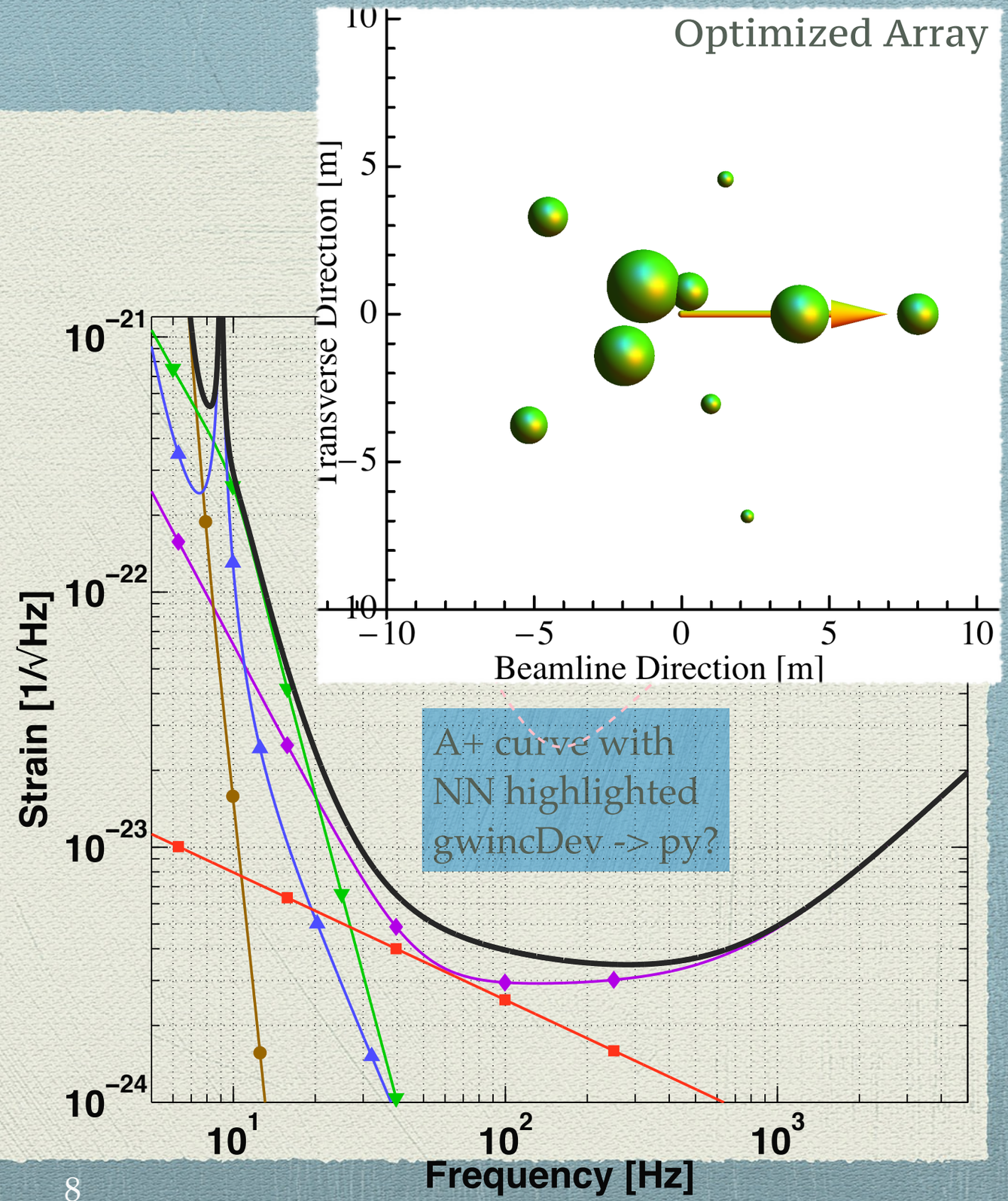
from **Denis Martynov (CIT)**

“Ignore” some noise sources

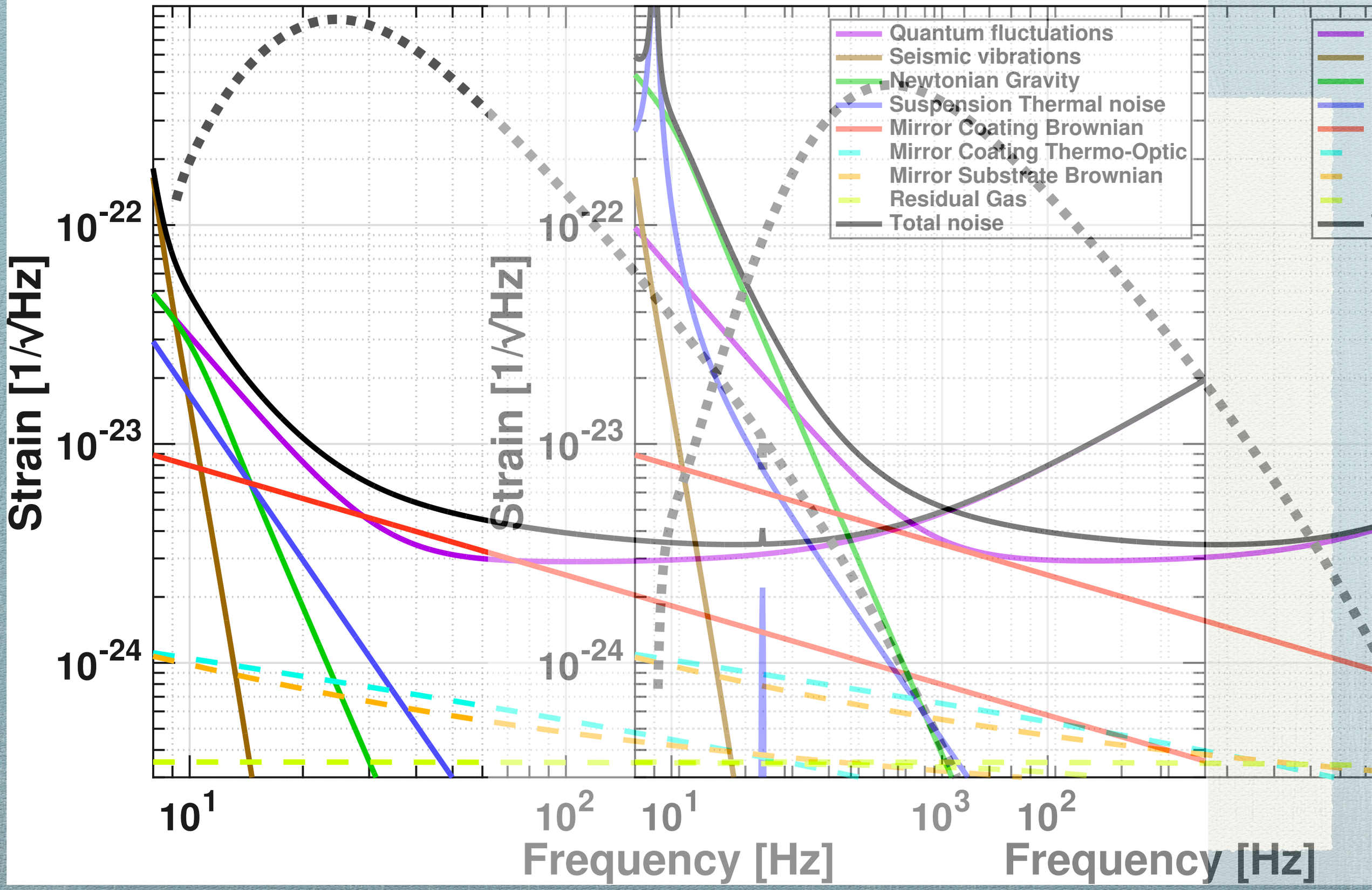
- **Local Damping** noise is nearly limiting, but can ‘easily’ be reduced by better filtering.
- **Input Beam Jitter** can be actively suppressed (**UF - design**)
- **Squeezed film damping** can be mitigated through increasing the gap sizes and reshaping the reaction mass.
- We have plans to reduce the **Aux. controls noise** in a few ways.
- **Charging:** larger gaps, discharging, and (future) conductive coatings.

Low Frequency Noise Budget

- **Newtonian Gravity:**
  - Accelerometer array (~10-20 per test mass)
    - Offline signal subtraction (Driggers et al., PRD 2012)
    - has been demonstrated for seismic / acoustic signals (cf. Driggers, Klimenko)
- **Tradeoffs:**
  - ~$1500 / sensor
  - 10x subtraction feasible
  - More subtraction is not cost effective (units of Mpc / $)



All the changes together:



ACDM

	GWINC (low NN)	aLIGO	10x NN	+SUS m=40kg	All 50 W	All 125 W
BNS Range	203	197	**211**	212	218	249
30/30 Range	1957	1777	**2147**	2187	3400	3195
dBNS	+3%	0	**+7%**	+7%	+13%	+22%
dBBH	+9%	0	**+21%**	+23%	+30%	+63%

Costs, Schedule, etc.

- Newtonian Gravity array: ~150k$, 4 months prep, 1 months install, 3-6 months shakedown
- Suspension Upgrades: Giles, Sheila, Norna
- Heavier Test mass: Sheila
- **Scattered Light:** Baffling