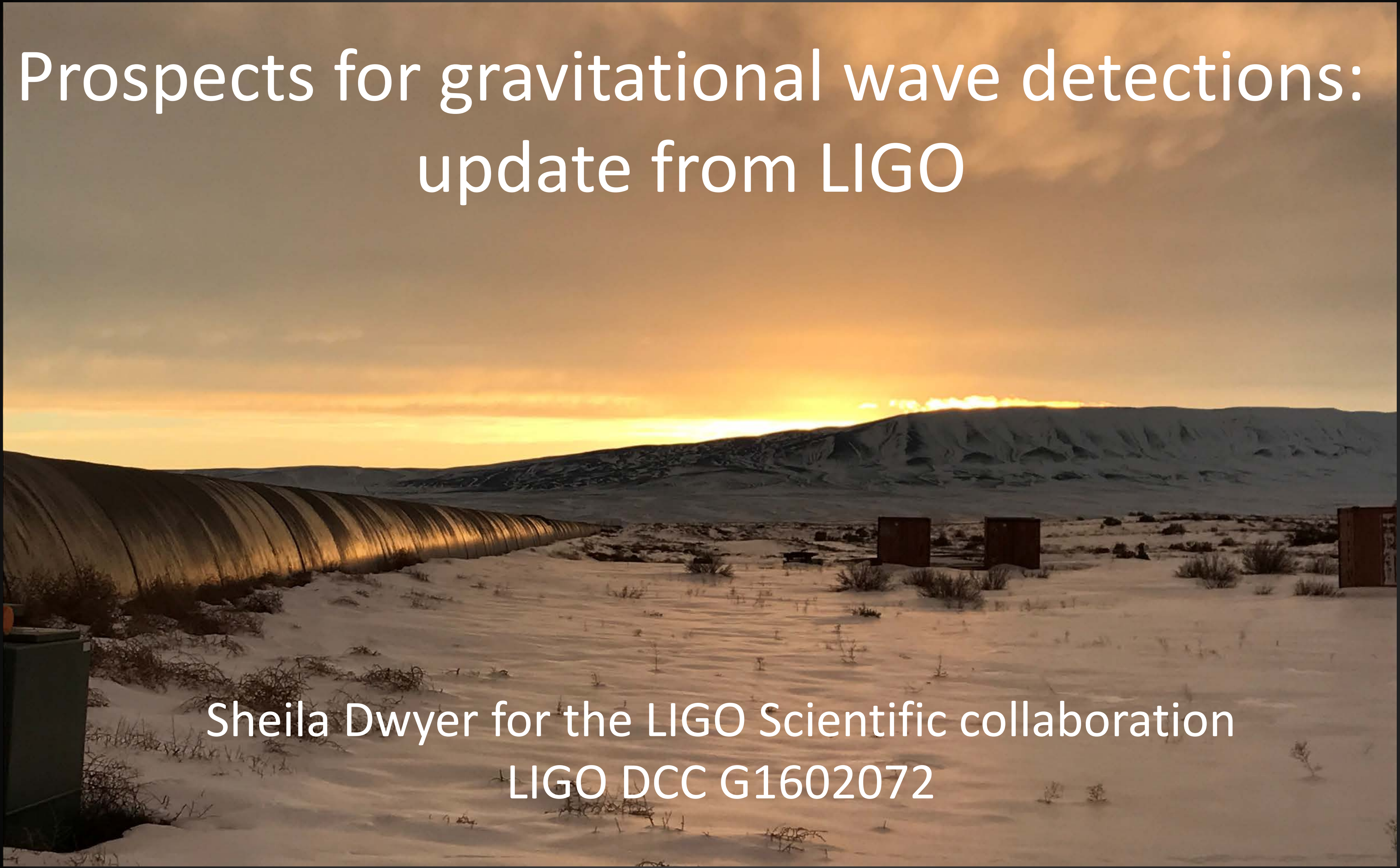
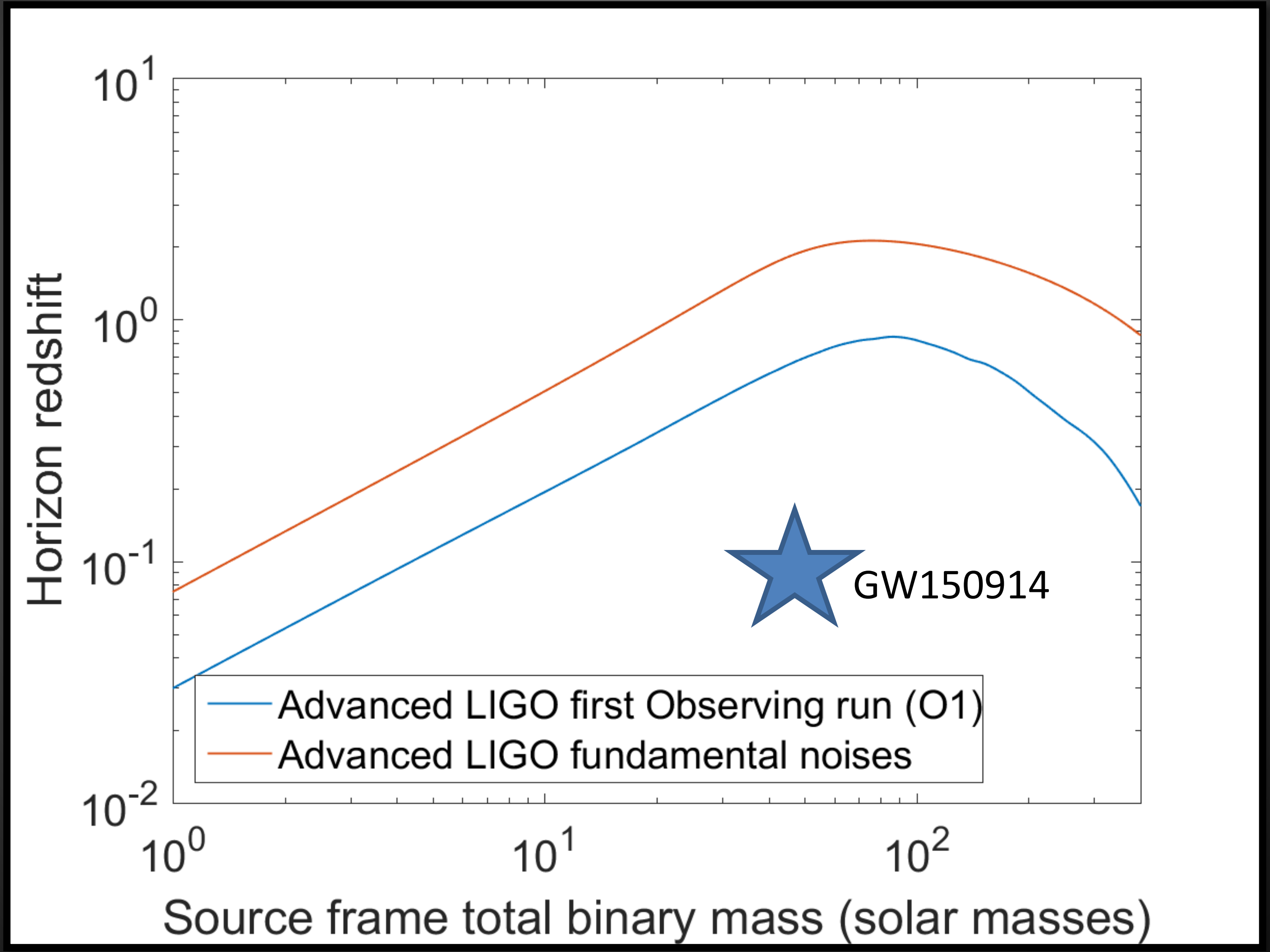
Prospects for gravitational wave detections: update from LIGO

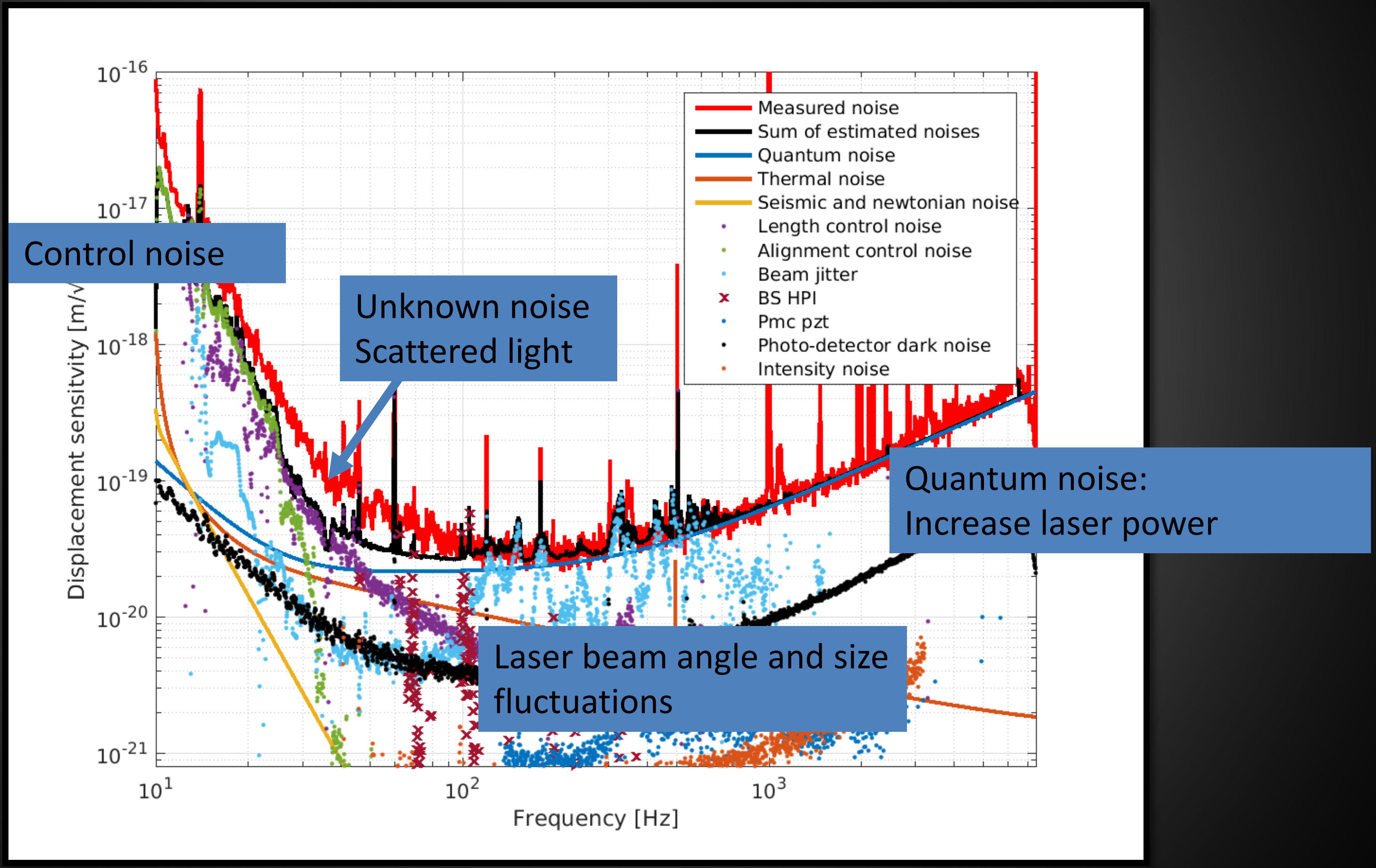


Sheila Dwyer for the LIGO Scientific collaboration
LIGO DCC G1602072

The reach of ground based gravitational wave detectors

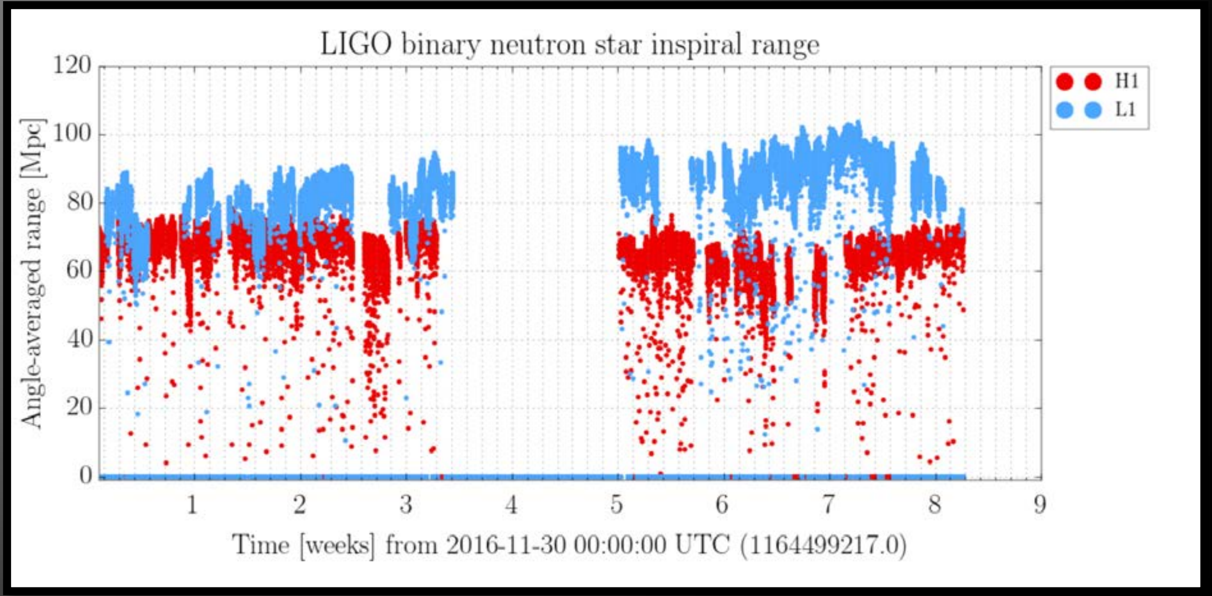


Displacement sensitivity

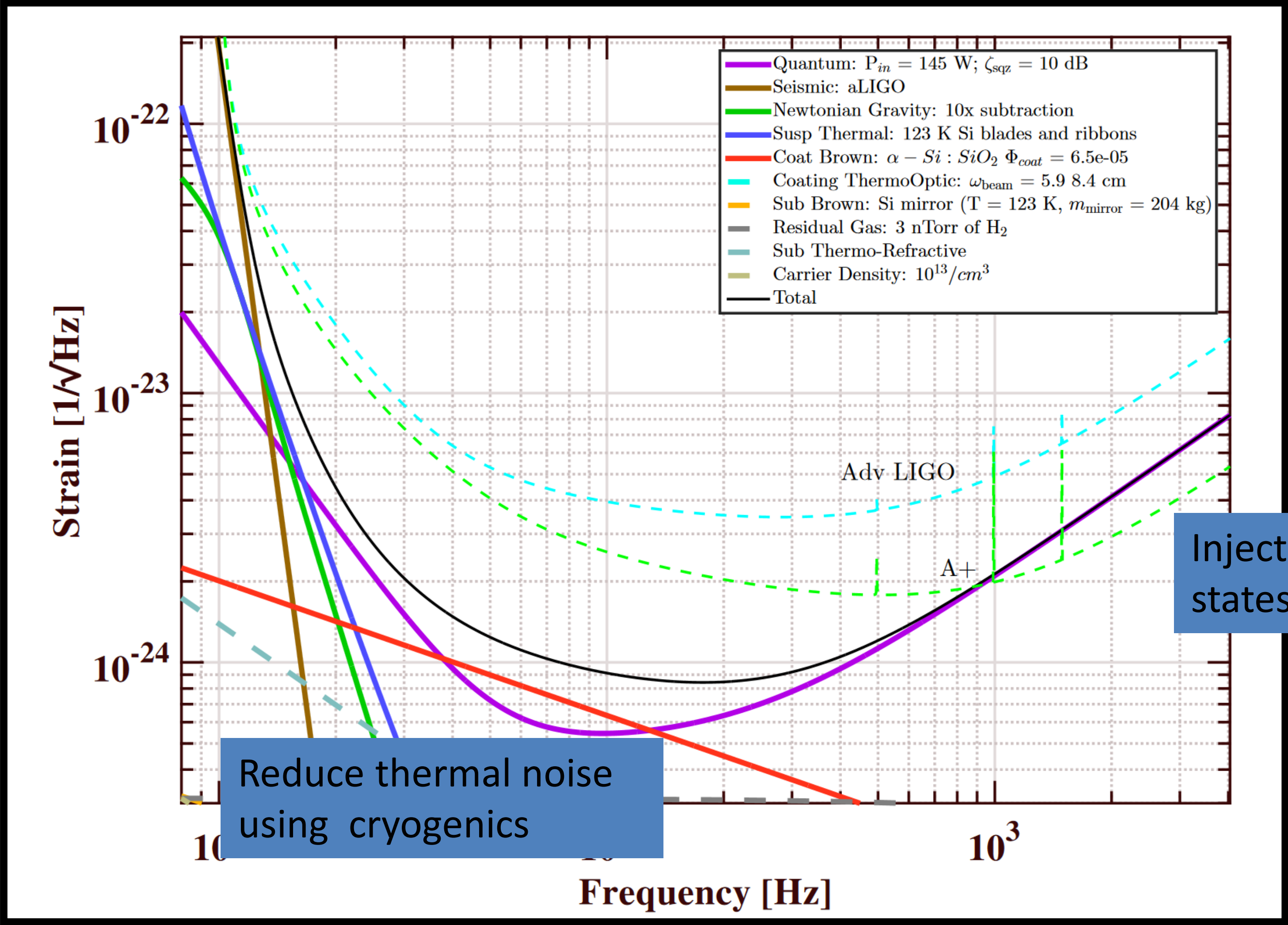


Observing break for instrument work February-November 2106

- High power operation –one of Advanced LIGO's largest technical risks
  - Hanford turned on the high power laser, increased laser intensity, jitter, and beam size noise
  - Stable operation at 50 Watts achieved, not an improved noise performance
- Livingston-
  - In vacuum hardware upgraded
  - Reduced scattered light noise
- Started our second observing run in November



Ultimate performance in current facilities: LIGO Voyager



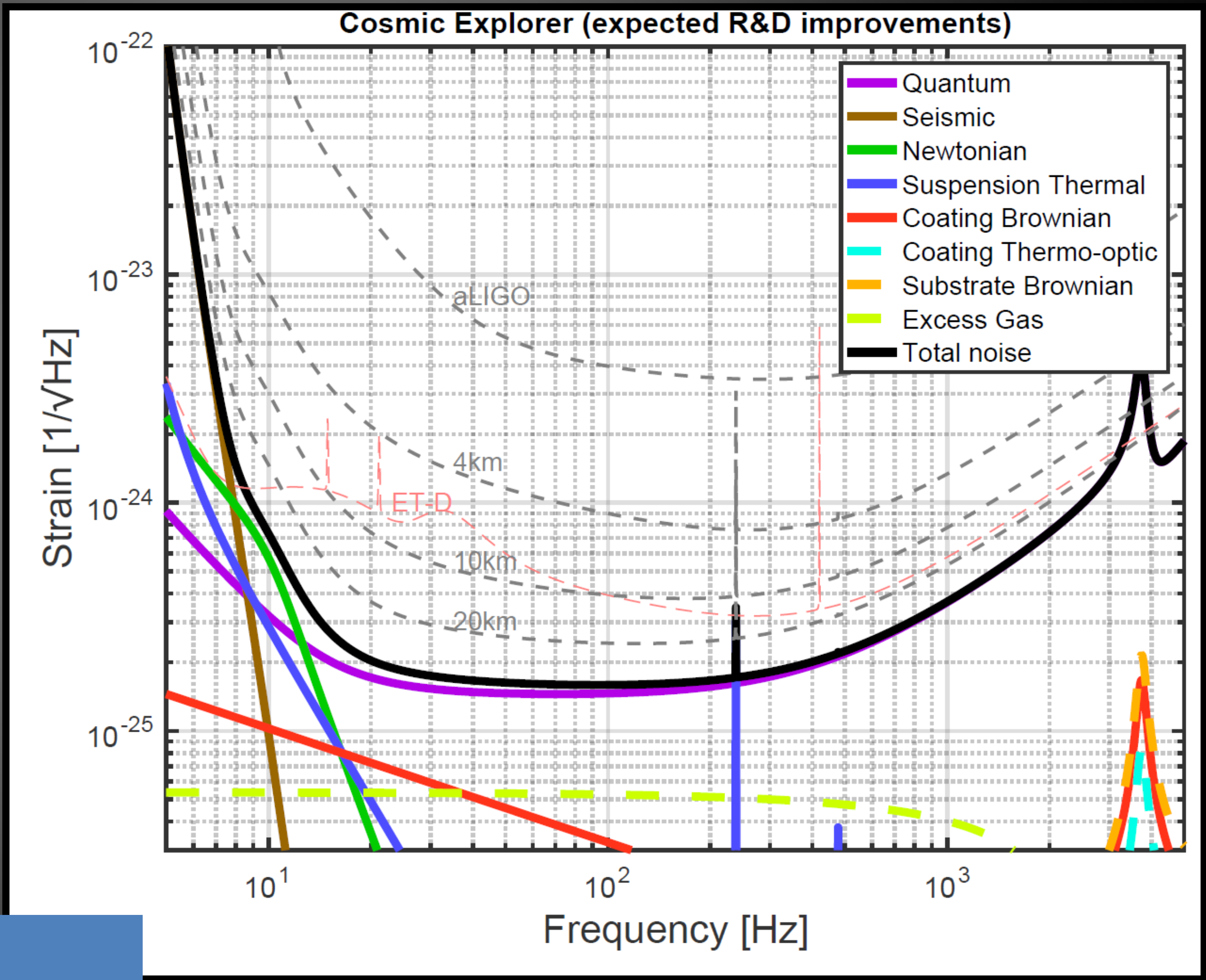
Inject squeezed states of light

Reduce thermal noise using cryogenics

Combining improved technology and new facility

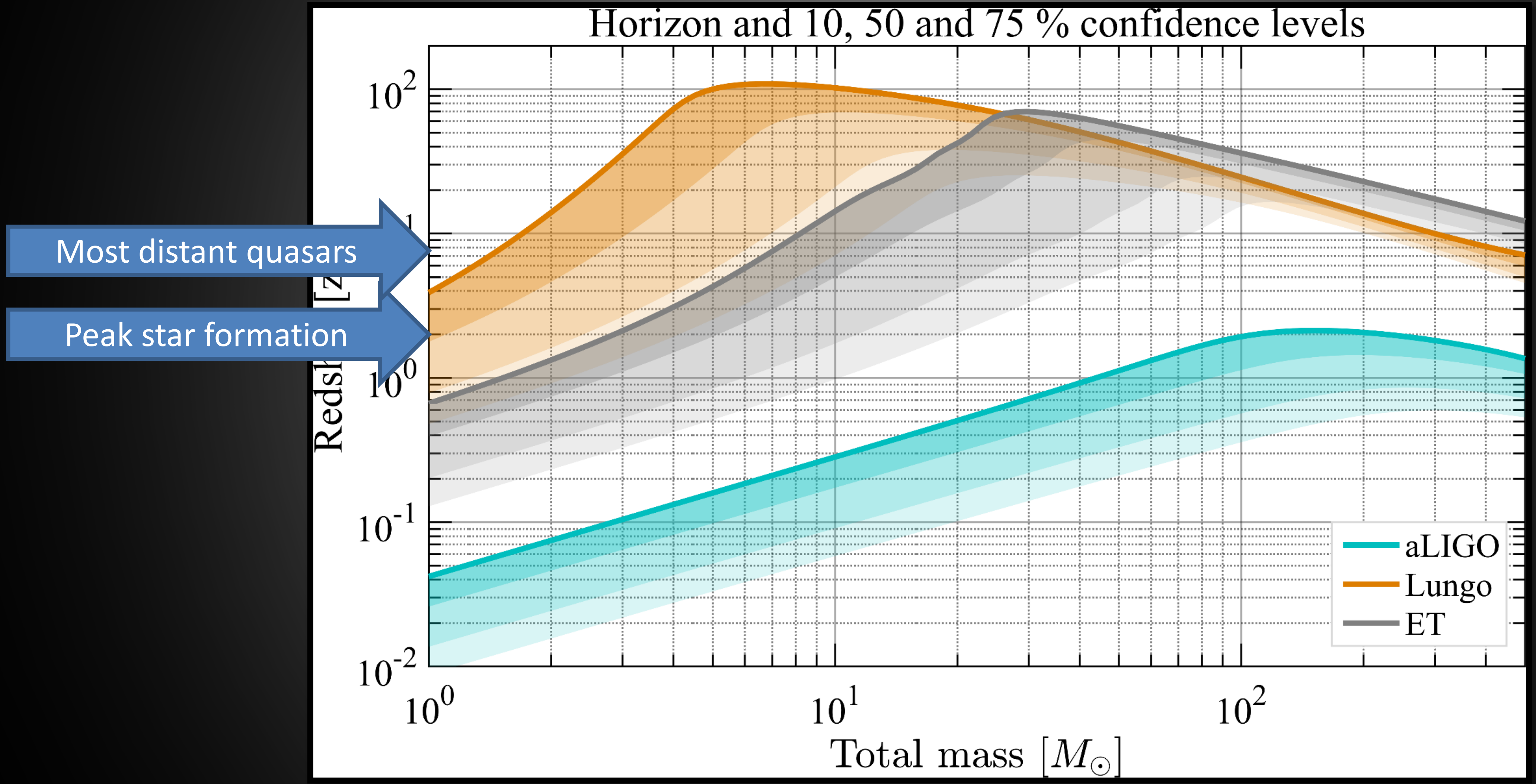
$$\delta h = \delta L/2L$$

Sensitivity to displacement noises are reduced as arm length increases



LIGO Scientific collaboration arXiv:1607.08697

Extending the reach of GW observatories



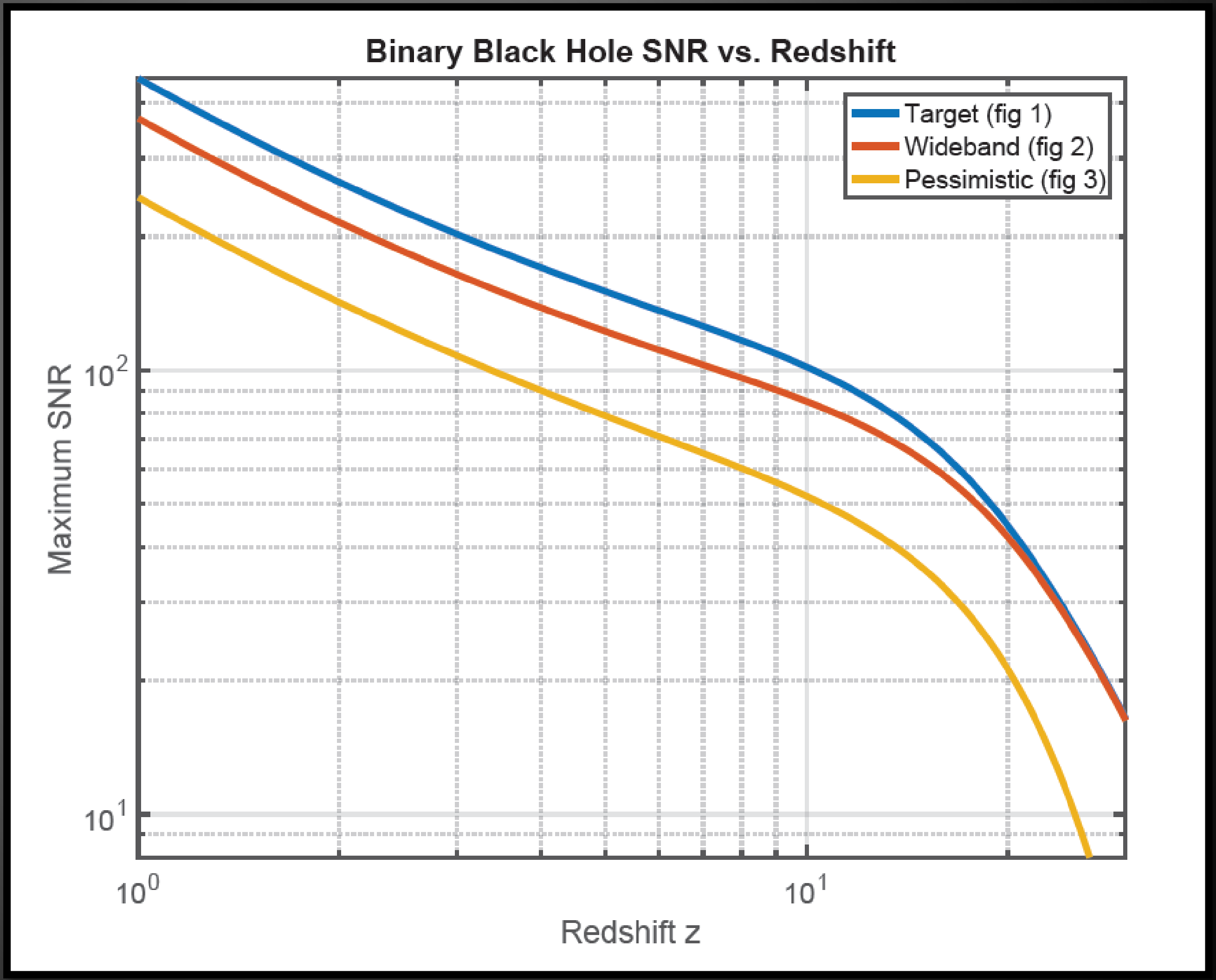
LSC-VIRGO Instrument science white paper: T1600119

Summary

- You can expect a trickle of detections as we work towards aLIGO design sensitivity over next few years
- It is possible to observe black hole binaries from the entire history of star formation, with high SNR

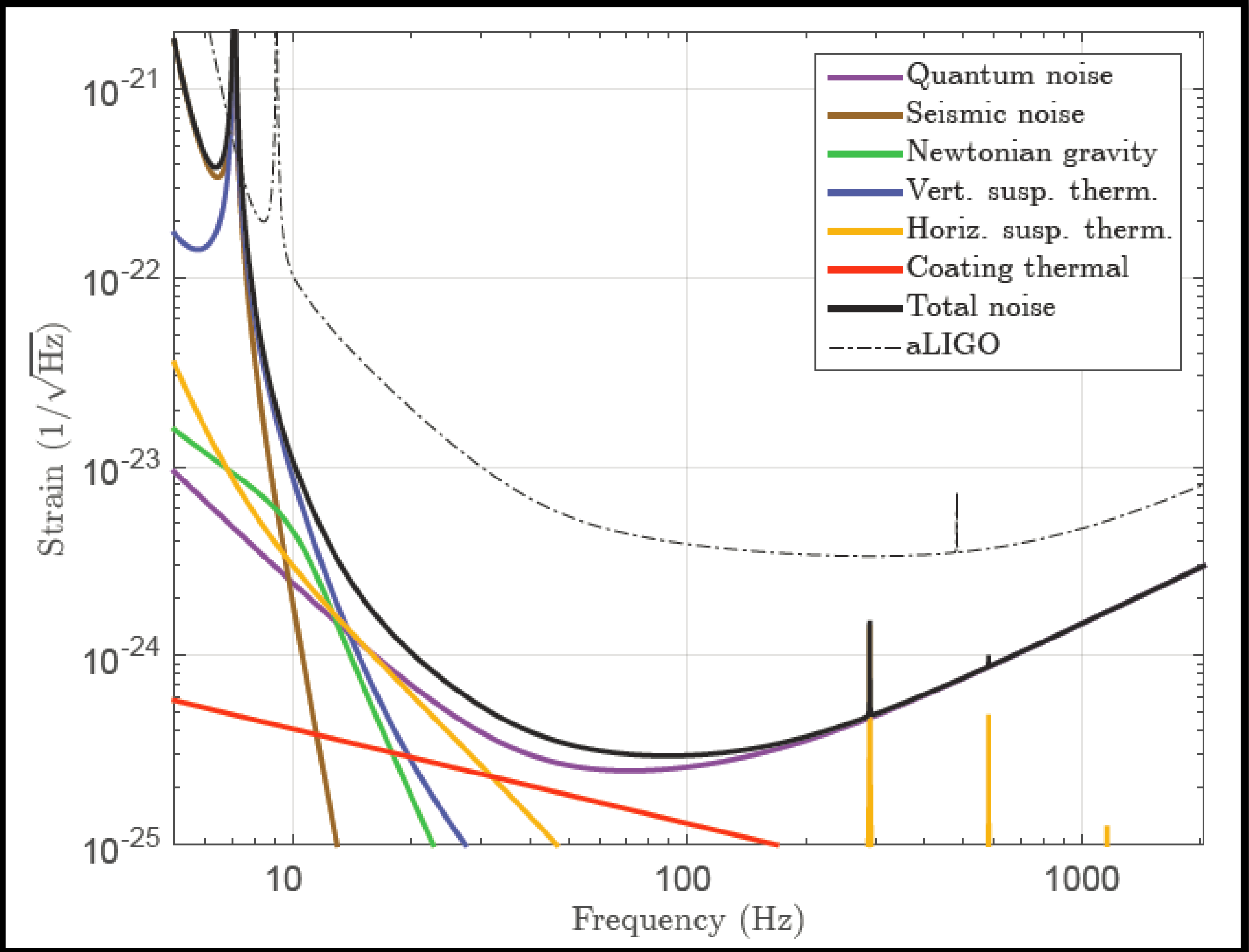
Sensitivity curves publicly available:

https://dcc.ligo.org/LIGO-P1600143



LIGO Scientific collaboration arXiv:1607.08697

Ultimate displacement noise reduction technique: Long arms



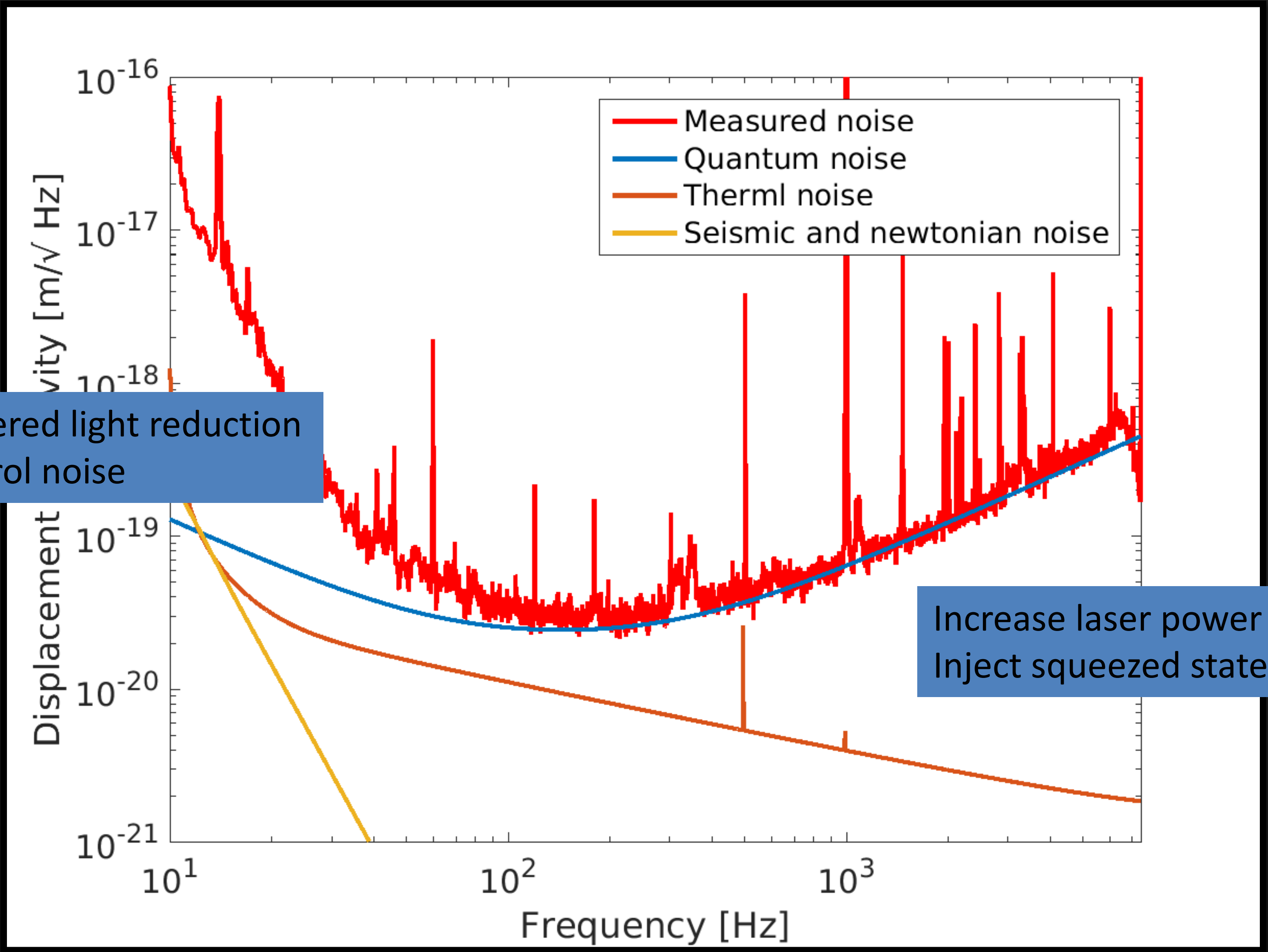
$$\delta h = \delta L/2L$$

Sensitivity to displacement noises are reduced as arm length increases

Even if **most** noise reduction techniques don't work out, 40km arms can improve over advanced LIGO sensitivity by a factor of ~10

Dwyer *et al* 2014 Phys. Rev. D **91**, 082001

Towards design sensitivity



Scattered light reduction
control noise

Increase laser power
Inject squeezed states of light