Title: Welcome and Opening Remarks

Date: Jun 11, 2018 09:30 AM

URL: http://pirsa.org/18060065

Abstract:

Overview

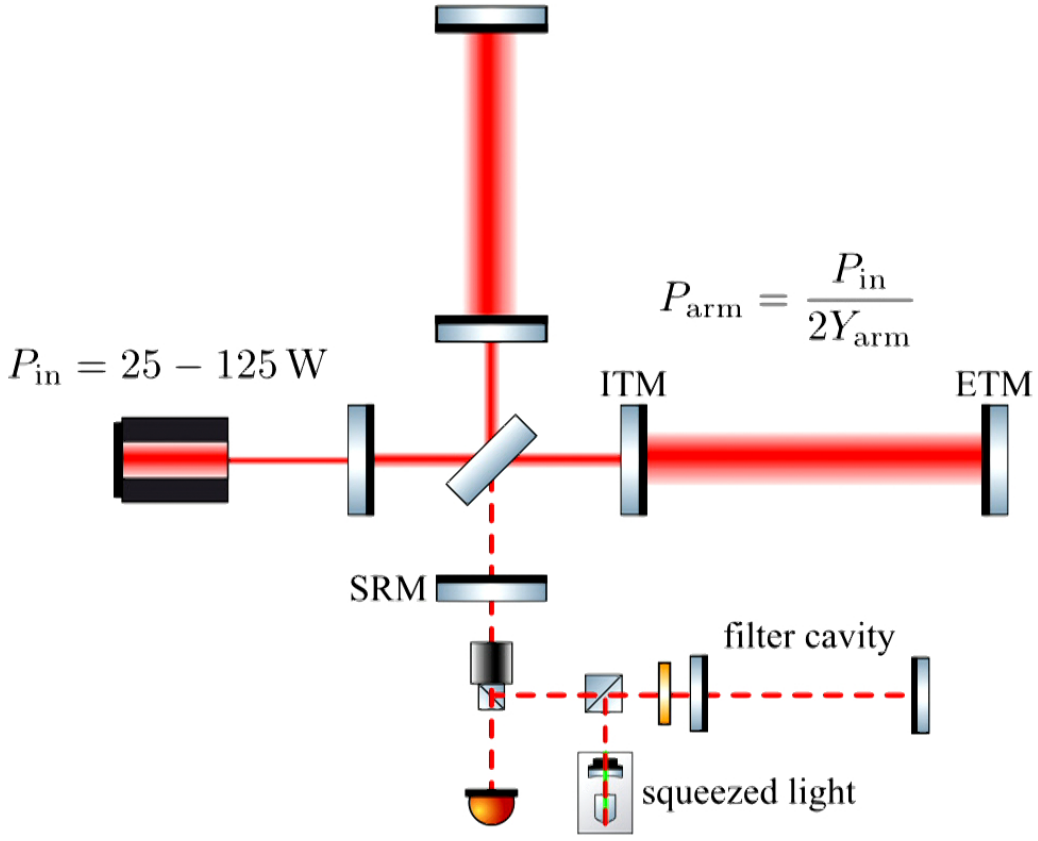
- Detector configuration
  - Current sensitivity
  - Ways to improve high frequency sensitivity
  - High power effects
- Science case
  - Neutron star and black hole physics
  - Cosmology
  - Multi-messenger astronomy
  - Ultralight particles
- Future facilities

First direct observation of GW from the BNS

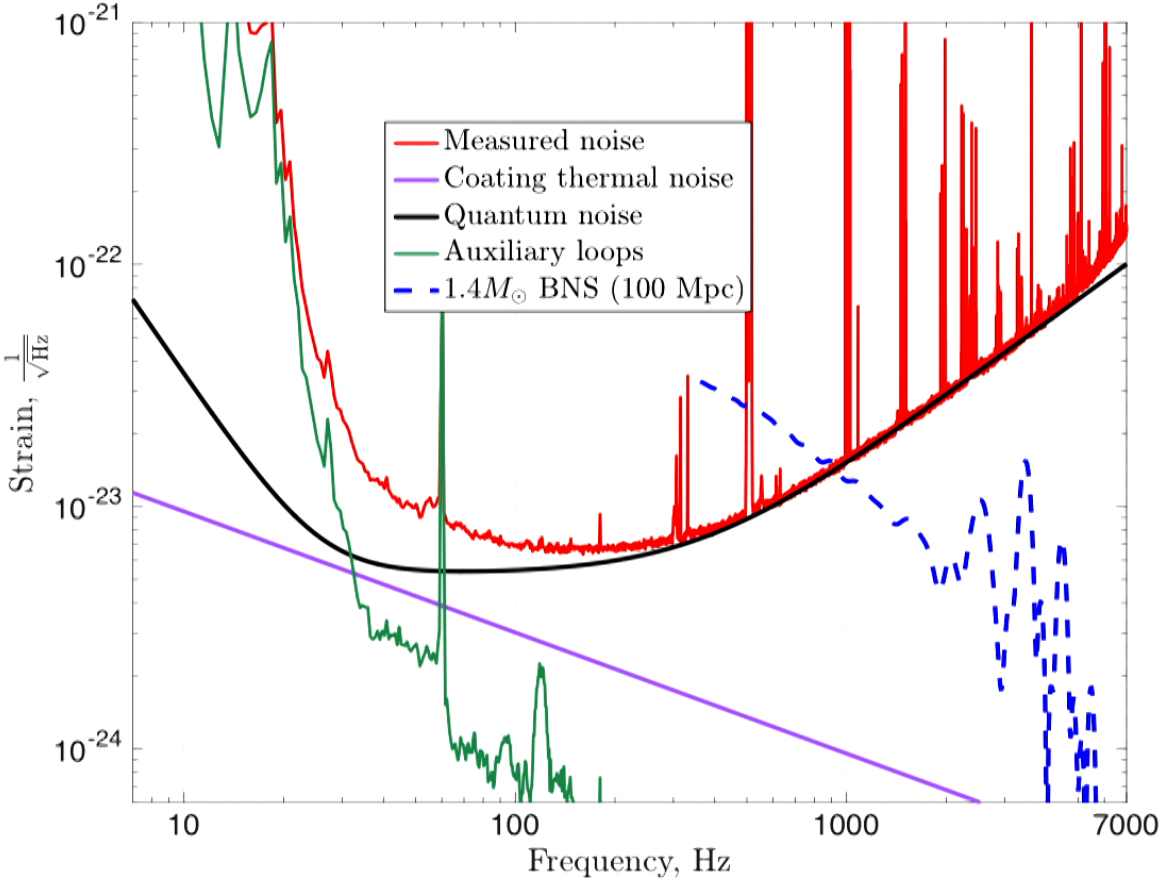
	Low-spin priors ($\lvert\chi\rvert \leq 0.05$)
Primary mass m_1	1.36–$1.60\ M_\odot$
Secondary mass m_2	1.17–$1.36\ M_\odot$
Chirp mass $\mathcal{M}$	$1.188^{+0.004}_{-0.002} M_\odot$
Mass ratio m_2/m_1	0.7–1.0
Total mass $m_{\rm tot}$	$2.74^{+0.04}_{-0.01} M_\odot$
Radiated energy $E_{\rm rad}$	$> 0.025 M_\odot c^2$
Luminosity distance $D_{\rm L}$	40^{+8}_{-14} Mpc
Viewing angle Θ	$\leq 55°$
Using NGC 4993 location	$\leq 28°$
Combined dimensionless tidal deformability $\tilde{\Lambda}$	≤ 800
Dimensionless tidal deformability $\Lambda(1.4 M_\odot)$	≤ 800

- Astrophysical rate is $R = 1540^{+3200}_{-1220}\ \mathrm{Gpc^{-3}\,yr^{-1}}$
- Tests of gravity: speed of graviton was constrained using GRB
- Cosmology: $H_0 = 70^{+12}_{-8}\ \mathrm{km\,s^{-1}\,Mpc^{-1}}$
- Remnant is unknown

LIGO optical layout



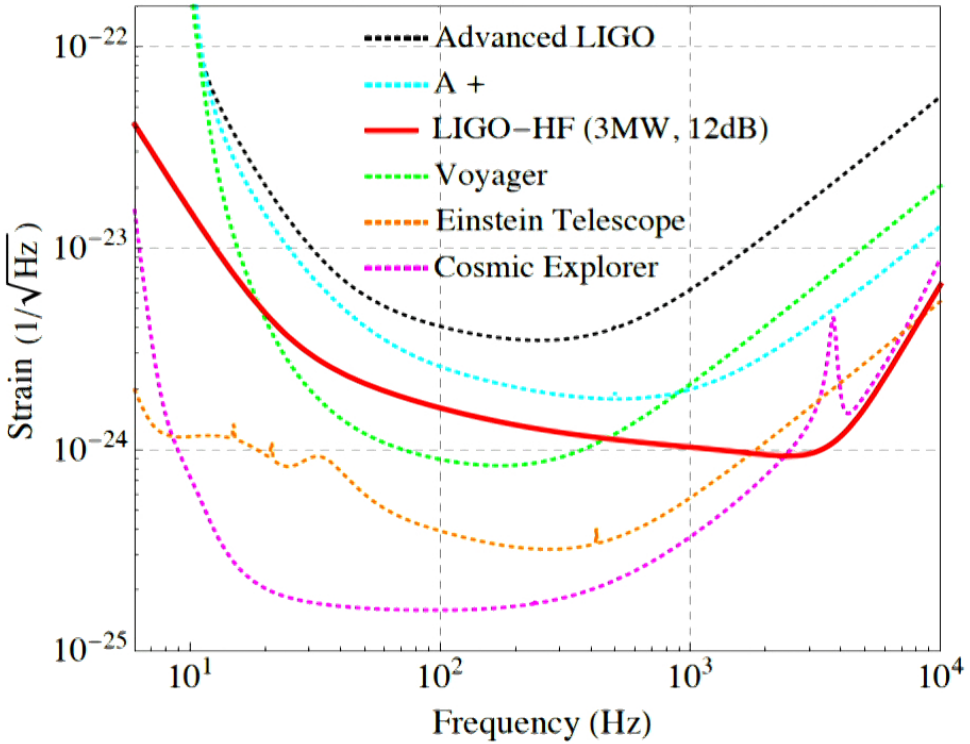
Current sensitivity



Ways to improve the quantum noise

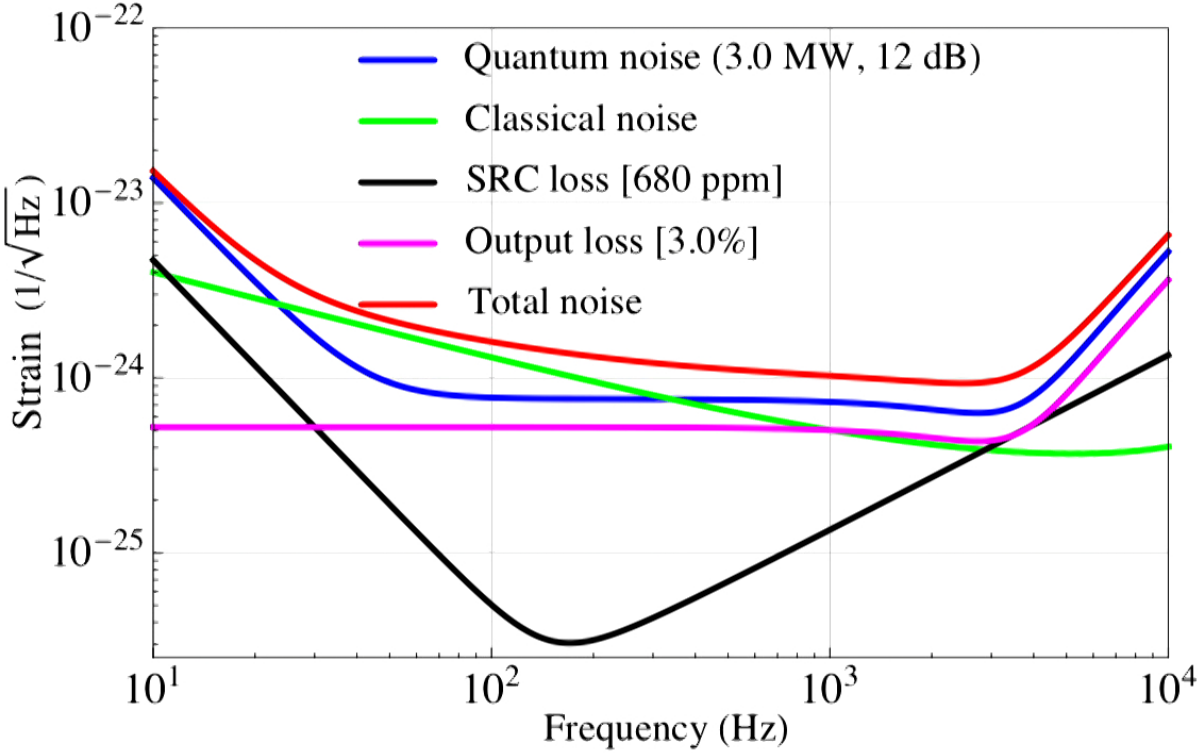
- Use white light cavities, i.e. increase the gain-bandwidth product of the interferometer using Haixing's unstable filter
  - Design of a table-top experiment at University of Birmingham
  - Zhao and Co models high-quality mechanical oscillator at UWA
  - Thomas does opto-mechanics at LSU (see his talk tomorrow)
  - MIT thinks about a proof-or-principle experiment; recently, McGill has joined the effort
- Use conventional approach
  - Increase arm power and squeezing level (see Aidan's talk)
  - Optimize signal recycling cavity for high frequencies

High frequency extension of LIGO



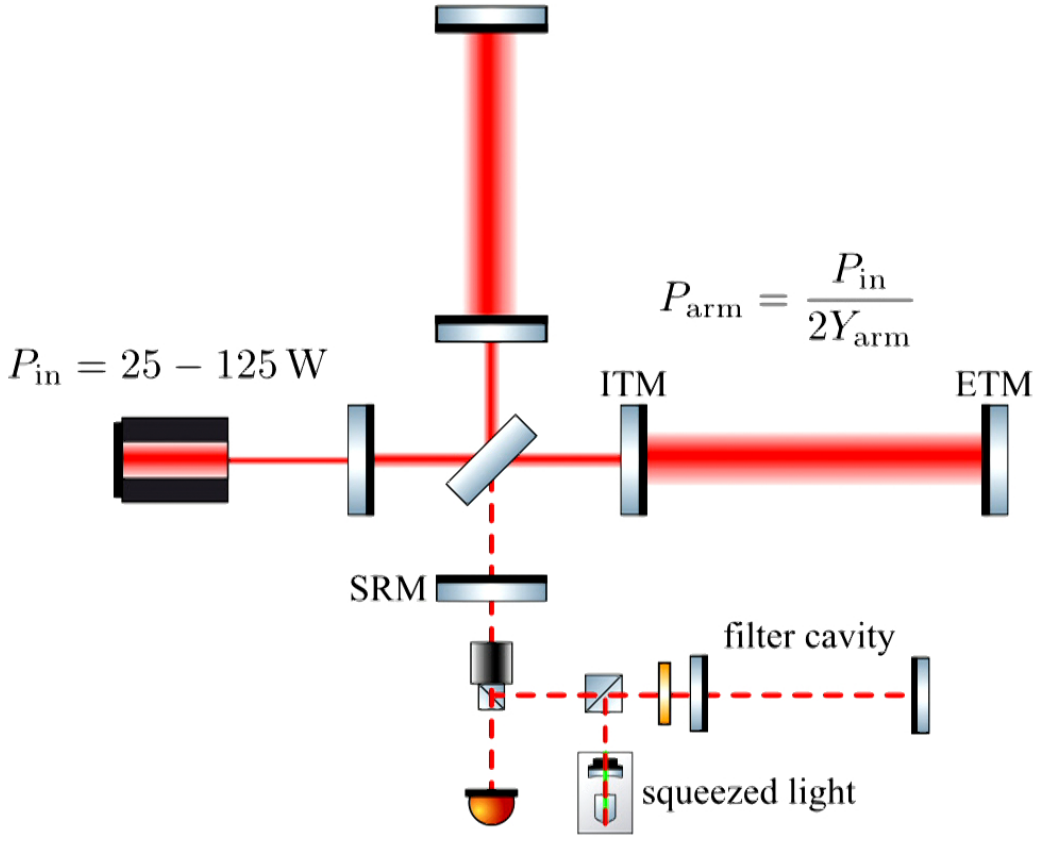
See Francisco's talk about the science case for the red curve

High frequency extension of LIGO

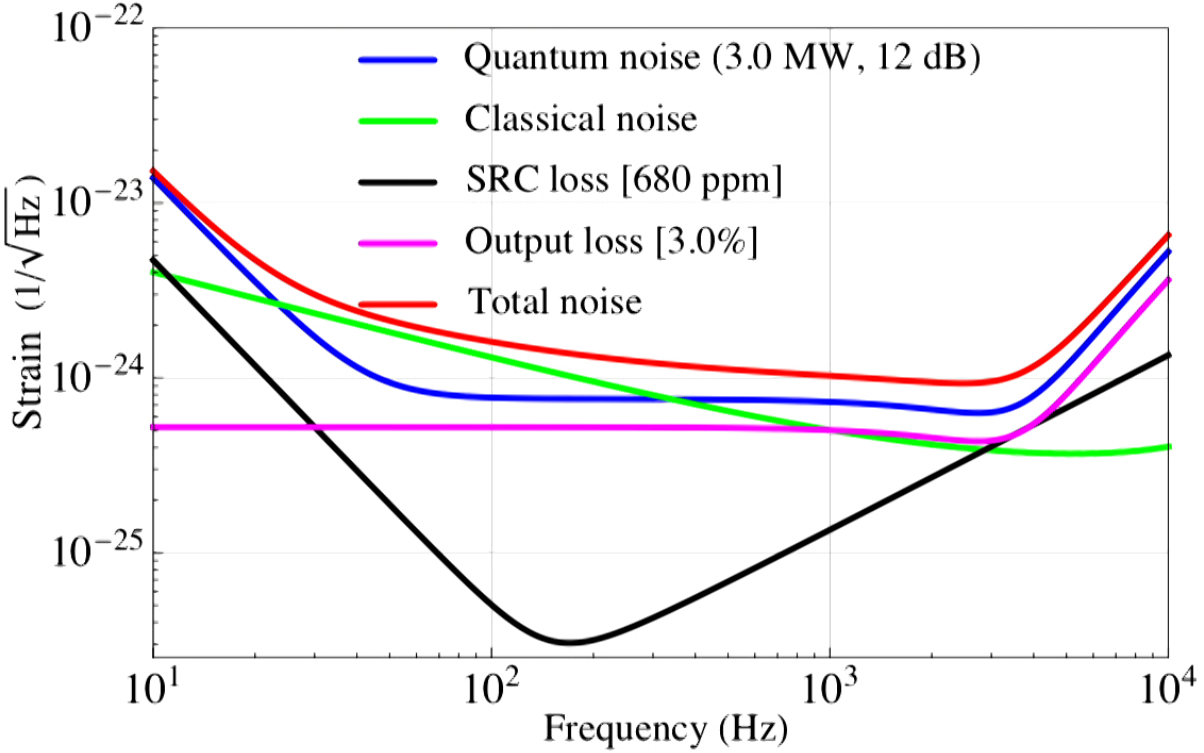


Loss in the signal recycling cavity $Y_{\text{itmx,y}} = 1000\,\text{ppm} \times \left(\frac{P_{\text{arm}}}{1\,\text{MW}} \frac{\alpha_{x,y}}{0.5\,\text{ppm}} \frac{30}{\kappa_{\text{itm}}} \right)^2$

LIGO optical layout



High frequency extension of LIGO



Loss in the signal recycling cavity $Y_{\text{itmx,y}} = 1000\,\text{ppm} \times \left(\frac{P_{\text{arm}}}{1\,\text{MW}} \frac{\alpha_{x,y}}{0.5\,\text{ppm}} \frac{30}{\kappa_{\text{itm}}} \right)^2$

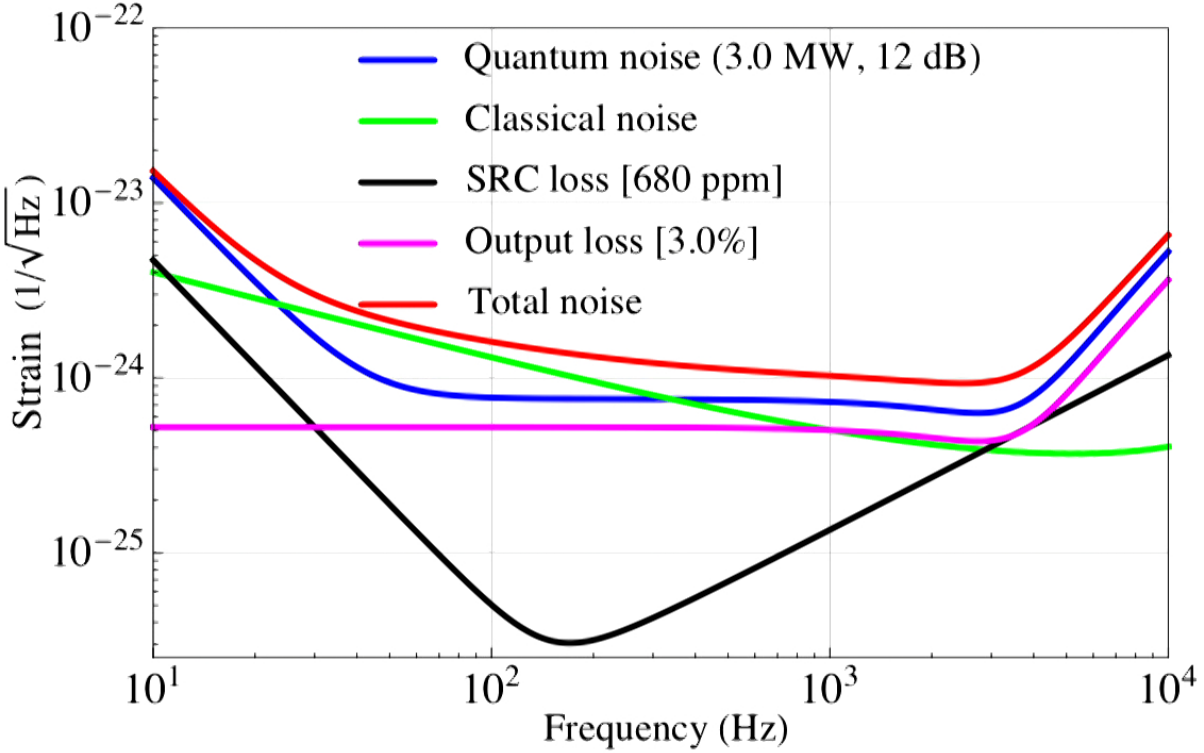
Problems at high power

- Parametric instabilities
  - Body modes of the mirrors are excited by radiation pressure
  - See Zhao's talk on passive damping of the modes
  - Can we passively damp parametric instabilities without increasing thermal noise below 5 kHz?
- Thermal lenses in the fused silica mirror substrates
  - See Hartmut's talk about high power operation in GEO
  - See Aidan's talk about thermal compensation in LIGO
  - What is the maximum suppression of the wave-front-distortion can we achieve?

Silicon: no thermal effects (see Rana's talk today)

- What is the maximum power that Voyager can resonate?
  - In the case of radiative cooling
  - In the case of cooling through the suspension fibres/ribbons
- Loss in the signal recycling cavity should be smaller than in Advanced LIGO
- Can we have good high and low frequency sensitivity at the same time?
- What is the relevant frequency range and the cost function for optimising detector sensitivity?

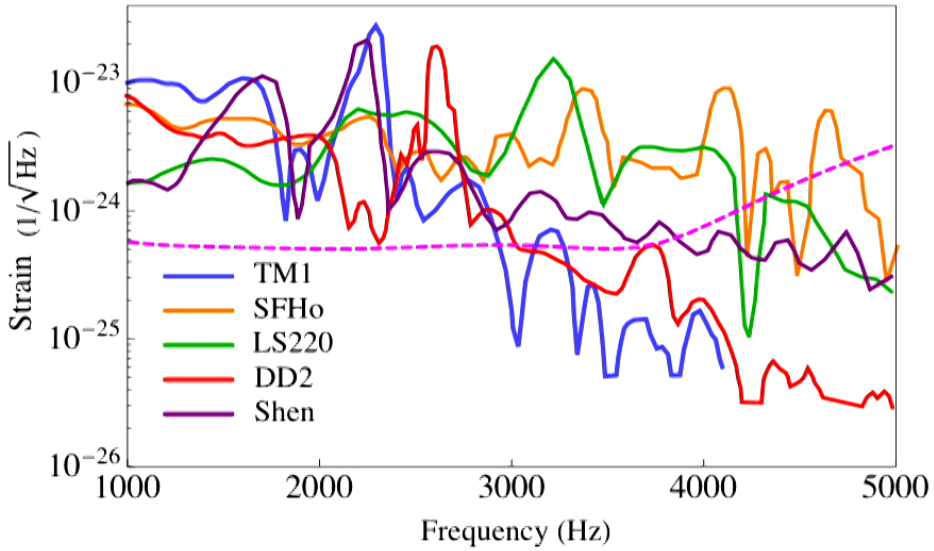
High frequency extension of LIGO



Loss in the signal recycling cavity $Y_{\text{itmx,y}} = 1000\,\text{ppm} \times \left(\frac{P_{\text{arm}}}{1\,\text{MW}} \frac{\alpha_{x,y}}{0.5\,\text{ppm}} \frac{30}{\kappa_{\text{itm}}} \right)^2$

Science case for high frequency detectors

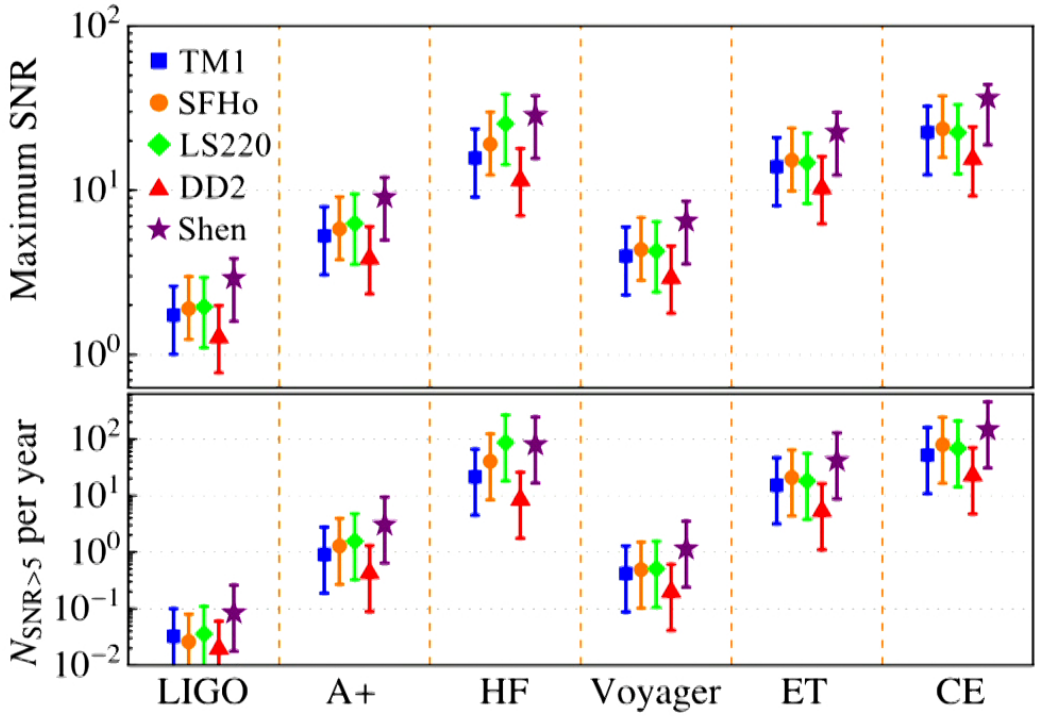
- How to convert detected spectrum into the physics behind it?



Science case for high frequency detectors

- Neutron star equation of state (see William's and Andreas' talks)
  - Which mode(s) are more sensitive to the inner-core QCD physics?
  - Can we isolate different effects, e.g. EOSs, finite temperature, magnetic field, and neutrino transport from the spectroscopic measurement of different modes of the merger remnant?
  - Can we determine the NS collapse time?

Future detectors



Future facilities

- What is the optimal arm length to study NS?
- How to deal with classical noise around free spectral range of the arms cavities?
- 4-km detectors might not be useless in the 3g era