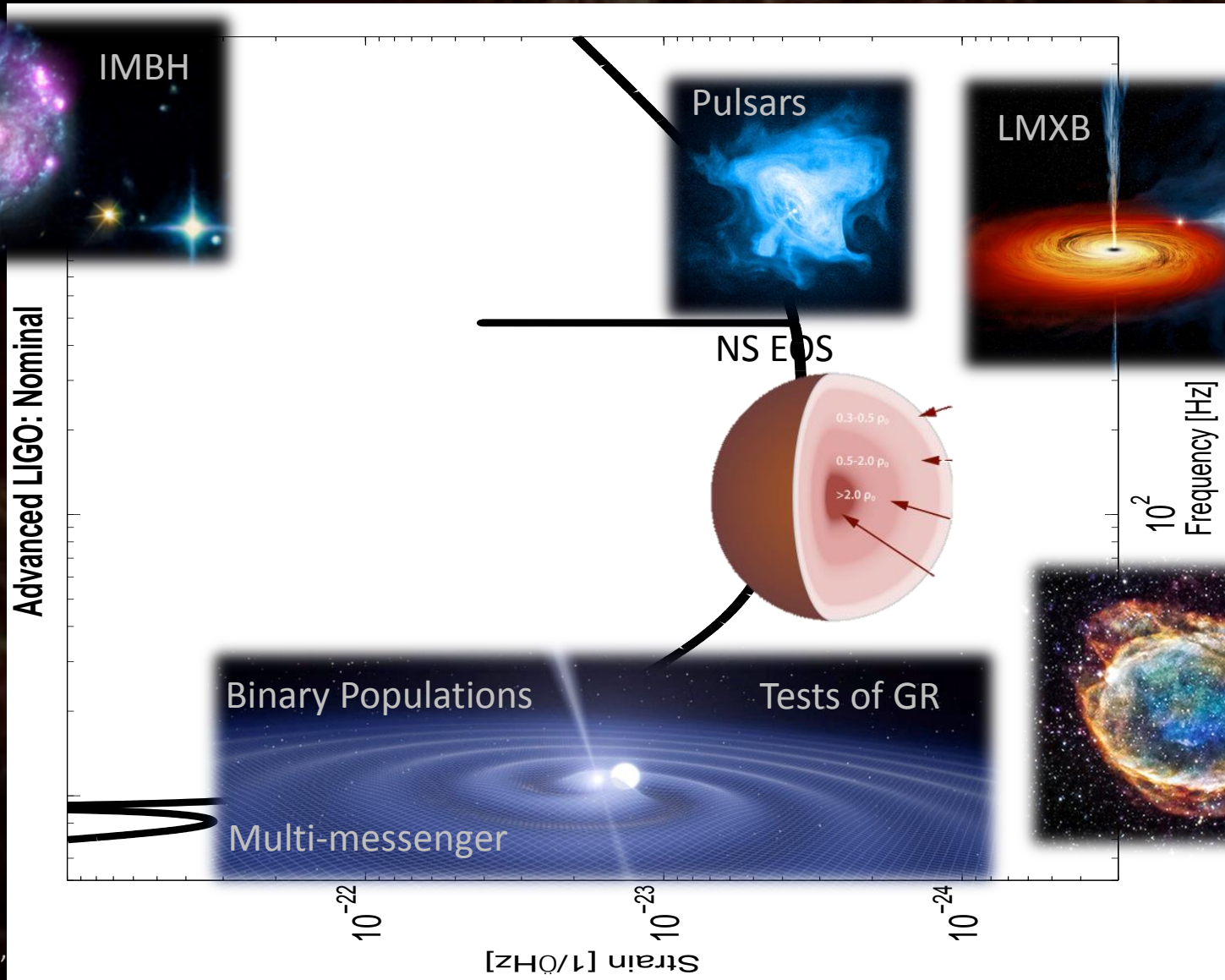


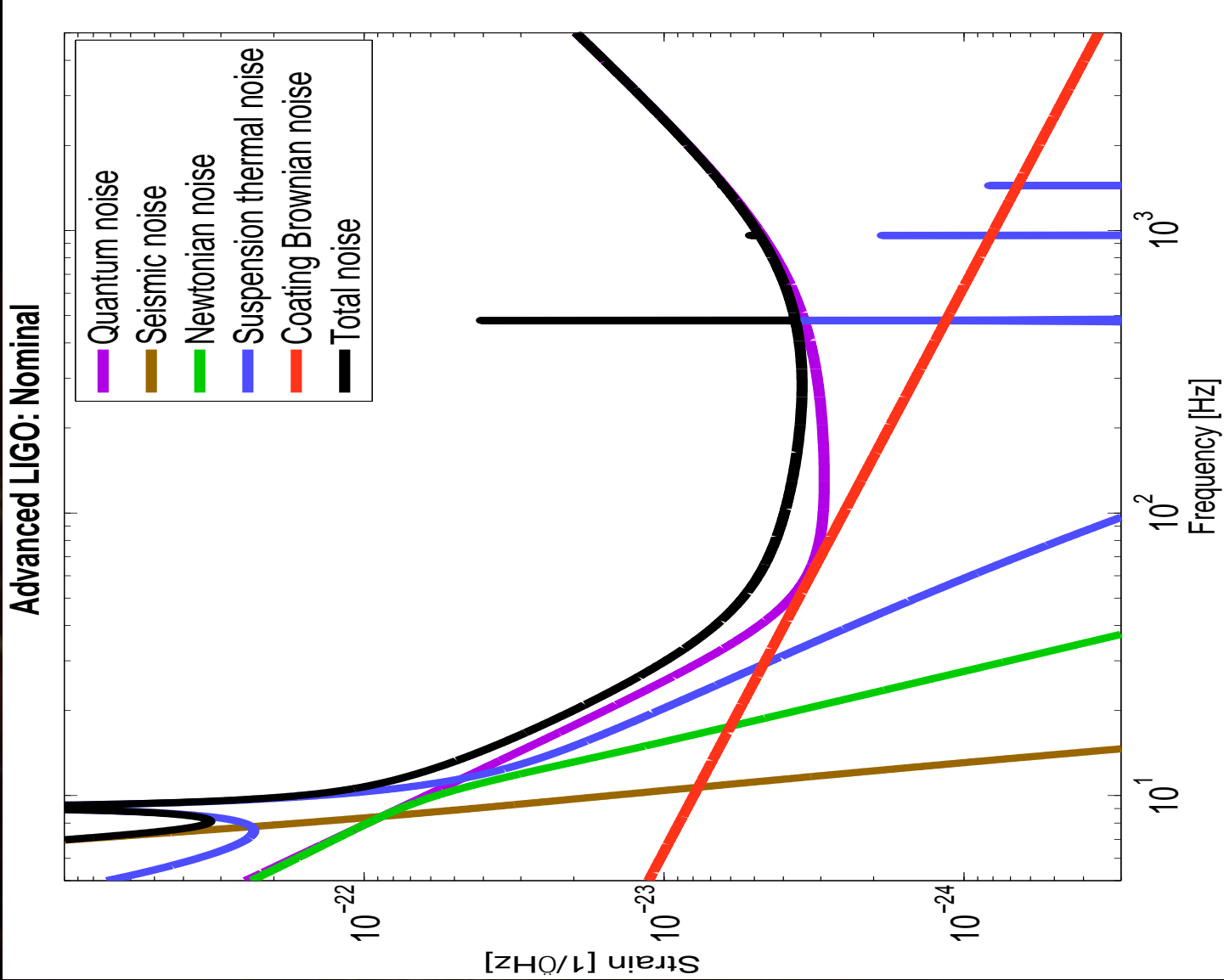


Advanced LIGO Improvements (and Risk Mitigation)

Different sources motivate different improvements



Advanced LIGO fundamental noises








Overview of possible improvements

- Squeezing
 - proven technology
 - possibly with a filter cavity for low frequencies
- Optical detuning to target specific sources
- New optics
 - better coatings
 - heavier masses, better suspensions ● ●
- Improved readout technique
- Newtonian noise cancellation

- quantum ●
- newtonian ●
- suspension ●
- coating ●
- technical ●






Many Improvements also Serve as Risk Mitigation

- High Power Operation Challenges
 - thermal effects, parametric instabilities, high loss
 - use squeezing to reach design sensitivity
- Excess Coating Thermal Noise
 - new coating materials
 - larger optics
- Excess Suspension Noise
 - longer suspensions, bigger gaps

quantum 
newtonian 
suspension 
coating 
technical 

New Designs Offer Flexibility

- This is research; things might come up
 - we have some known issues to address
 - gas damping, roll mode, scattered light, BS too small, ...
 - we have some potential issues
 - crackle noise, contamination driven losses, scattered light, technical noise couplings...
 - and then there are the surprises...
- It is good to have options
 - better suspensions
 - balanced homodyne readout

quantum 
newtonian 
suspension 
coating 
technical 

Agenda

- ✧ Lisa Barsotti
Focus on high-frequency sources
- ✧ Stefan Ballmer
Targeting mid-frequency sources
- ✧ Rana Adhikari
What can be done for low-frequency sources

Limitations

- We are limiting this discussion to short term
 - but we are thinking long term
 - all of these upgrades play a role in improving next generation detectors
- Time and cost estimates are rough
 - within a factor of 2-3 in most cases



M. Evans, May 2015

What comes next for LIGO?

X-ray: NASA/CXC/SAO/F.Seward
Optical: NASA/ESA/ASU/J.Hester & A.Loll
Infrared: NASA/JPL-Caltech/Univ. Minn./R.Gehrz