# Preparing for LISA in the post-detection era

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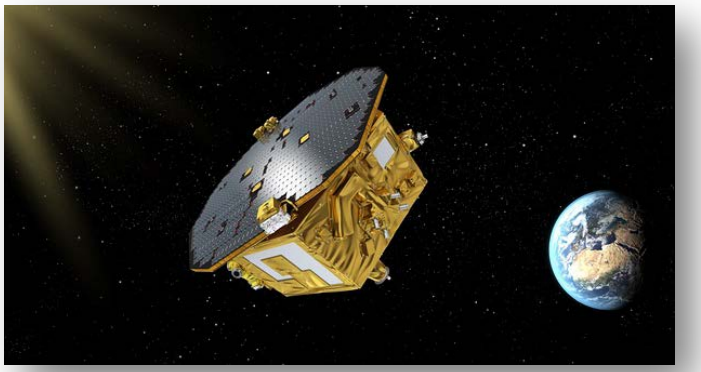
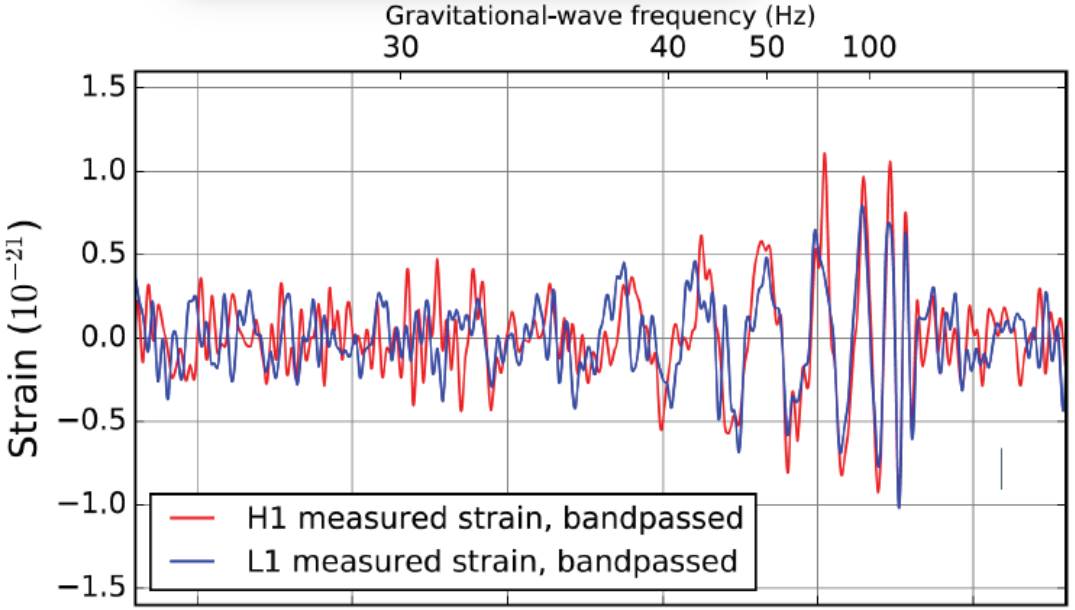
# 2016(!)

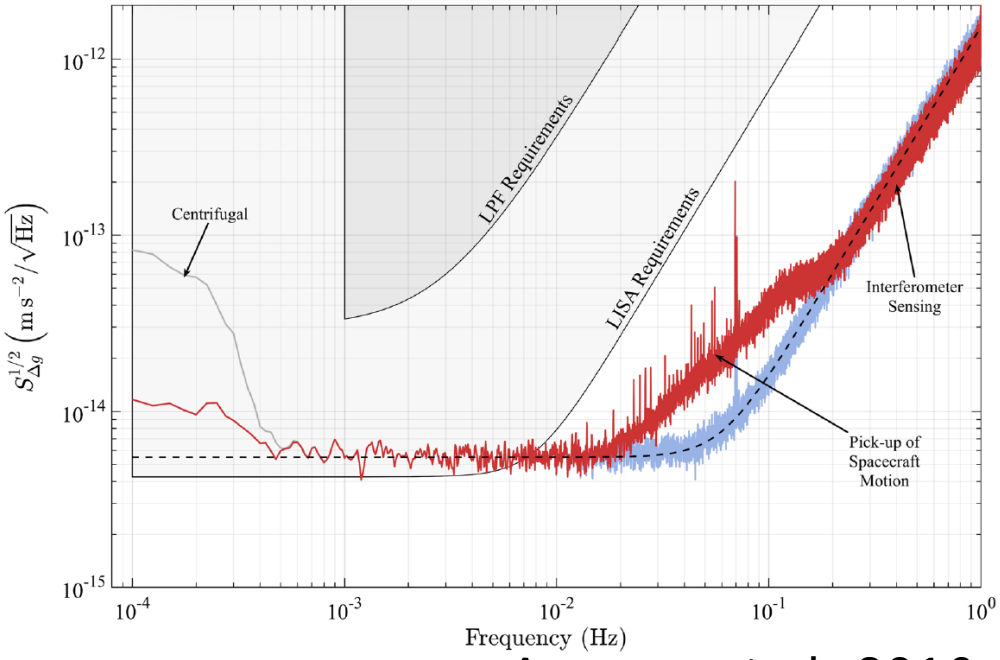
- GW150914, aLIGO

- Initial results, Pathfinder





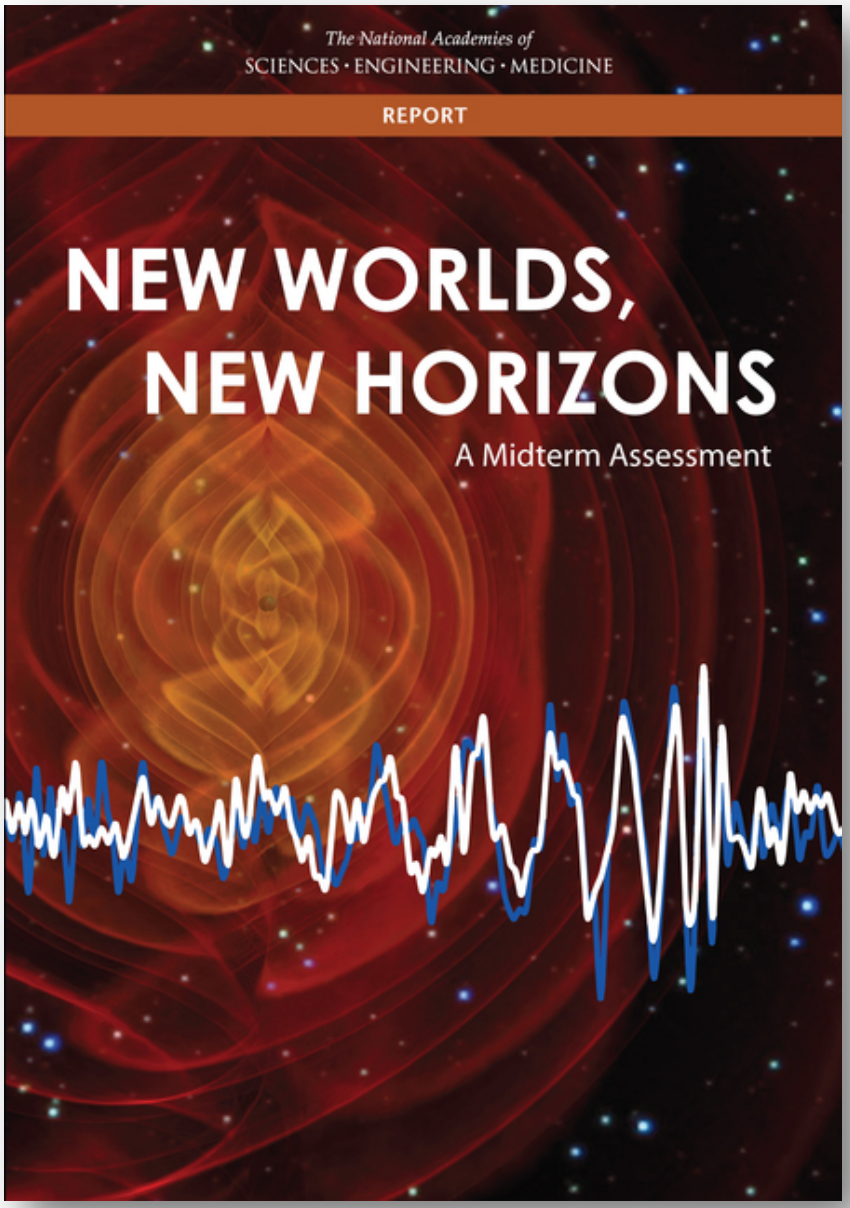

Abbott et al. 2016



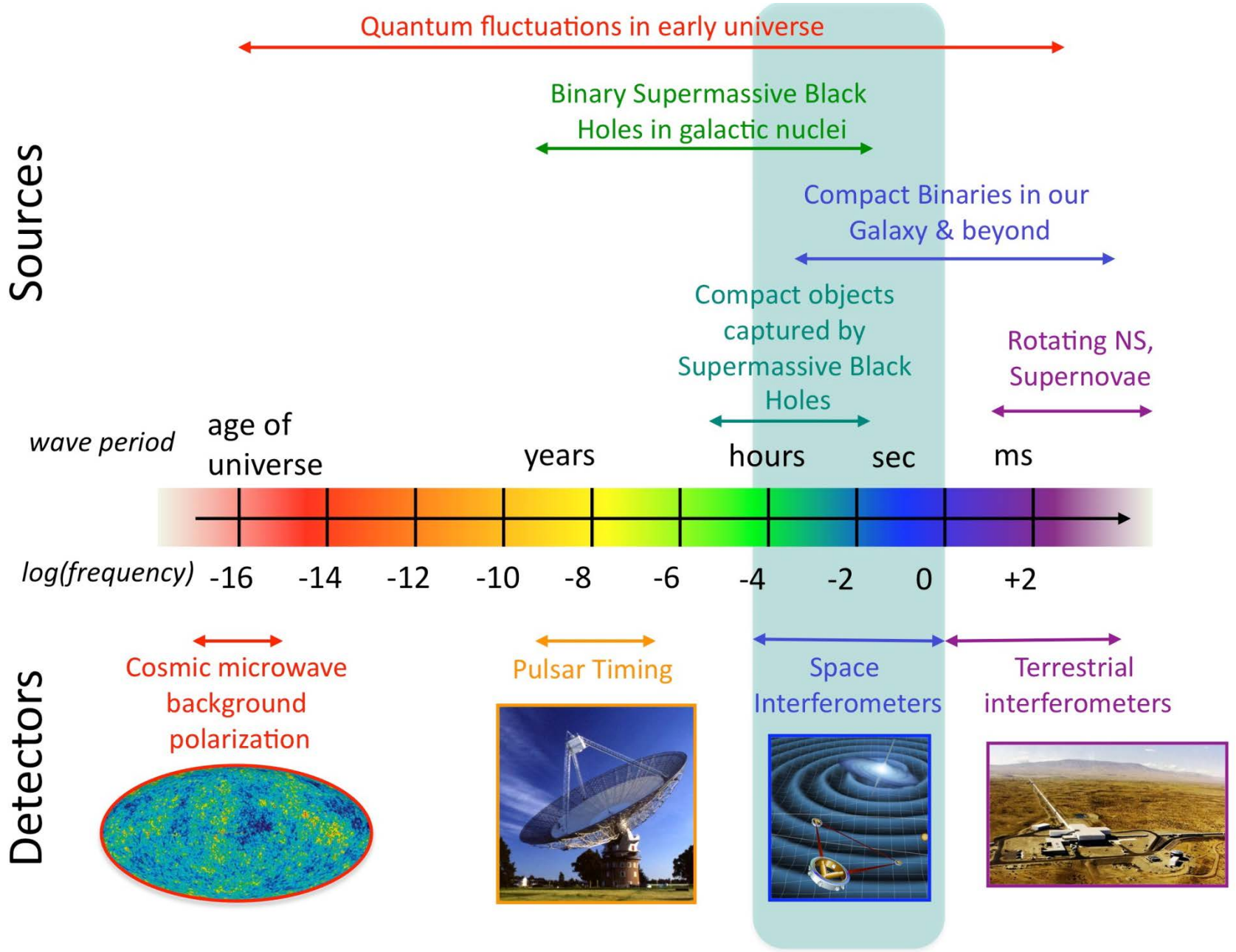

Armano et al. 2016

# The Midterm Assessment

- *RECOMMENDATION 4-4:*
  *"NASA should restore support this decade ... enables the U.S. community to be a strong technical and scientific partner in ... (ESA)-led L3 mission ...".*
- *"One goal of U.S. participation should be the restoration of the full scientific capability of the mission as envisioned by NWNH."*



# The GW Spectrum



# NASA L3 Study

- Formed in Jan 2016, Purposes of the study:
  - Phase 1 - FY16-17: Analyze the options for NASA participation in the L3 & work with the eLISA → LISA consortium on proposals to ESA
  - Phase 2 - FY17-18: Prepare report for 2020 decadal survey on NASA's participation in L3 as a minority partner

- Members L3ST and TAG
  - John Baker (GSFC), Peter Bender (UC Boulder), Emanuele Berti (Mississippi), John Conklin (Florida), Neil Cornish (Montana State), Curt Cutler (JPL), Kelly Holley-Bockelman (Vanderbilt), Scott Hughes (MIT), Shane Larson (Northwestern), Sean McWilliams (W Virginia U), Cole Miller (Maryland), Norna Robertson (Caltech), David Shoemaker (*chair*, MIT), Michele Vallisneri ( JPL) Jordan Camp (GSFC), William Klipstein (JPL), Jeffrey Livas (GSFC), Kirk McKenzie (JPL), Guido Mueller (Florida), John Ziemer (JPL)
  - Study Scientist: Ira Thorpe (GSFC)
  - Ex-Officio: Rita Sambruna (HQ), Ann Hornschemeier (GSFC), …

# L3ST Interim Report (June 2016)

https://pcos.gsfc.nasa.gov/studies/L3/L3ST_Interim_Report-Final.pdf

- 1st L3ST deliverable:
  - Analysis of candidate U.S. hardware contributions to L3
- Team focusing on various types of contribution
  1. Major subsystems
     - Laser, Telescope, Phasemeter, Micronewton Thrusters, Optical Bench
  2. Subassemblies
     - Charge Management System, Optical Cavity, Photoreceivers

# L3 Mission Concept Proposal: ~~eLISA~~ LISA

THE GRAVITATIONAL UNIVERSE

A science theme addressed by the *eLISA* mission observing the entire Universe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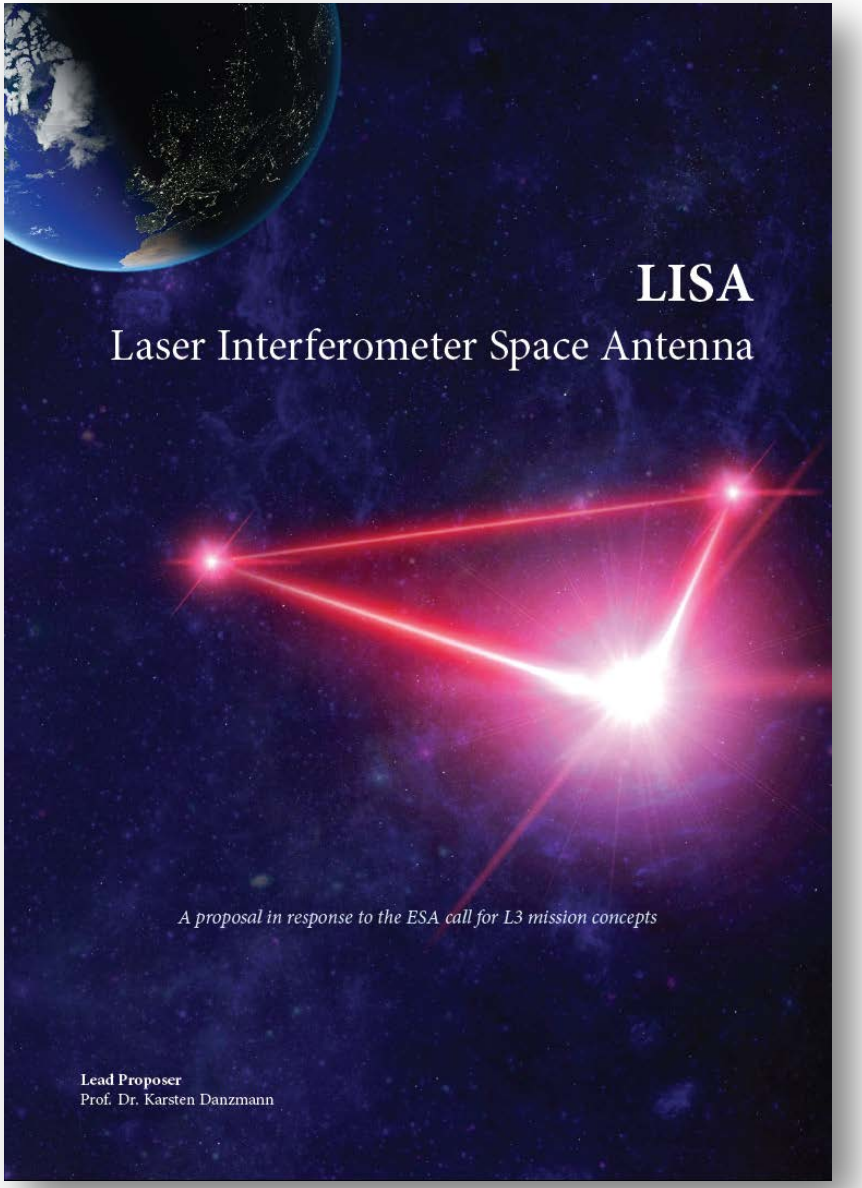
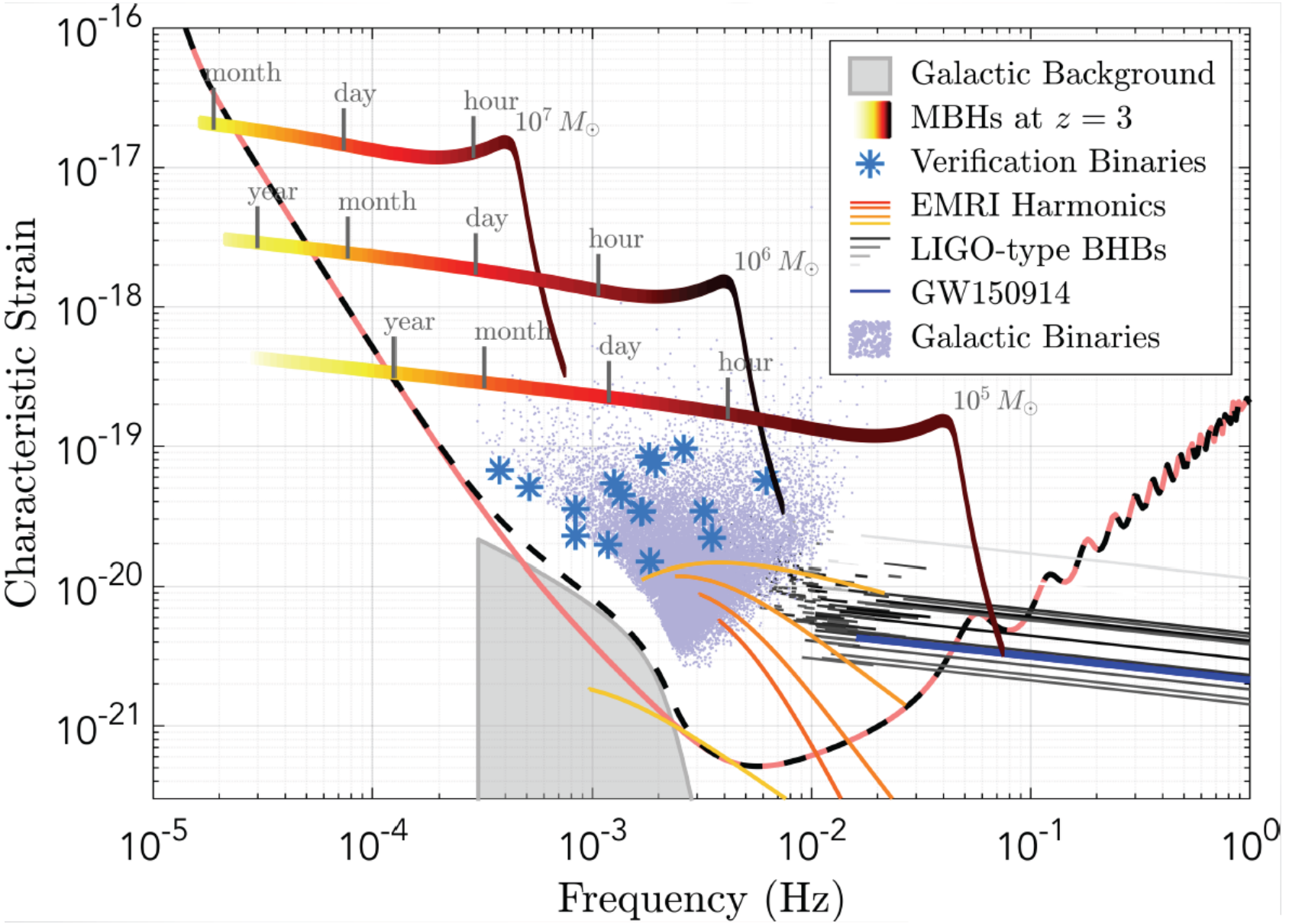
Detailed information at
http://elisascience.org/whitepaper

*The last century has seen enormous progress in our understanding of the Universe. We know the life cycles of stars, the structure of galaxies, the remnants of the big bang, and have a general understanding of how the Universe evolved. We have come remarkably far using electromagnetic radiation as our tool for observing the Universe. However, gravity is the engine behind many of the processes in the Universe, and much of its action is dark. Opening a gravitational window on the Universe will let us go further than any alternative. Gravity has its own messenger: Gravitational waves, ripples in the fabric of spacetime. They travel essentially undisturbed and let us peer deep into the formation of the first seed black holes, exploring redshifts as large as $z \sim 20$, prior to the epoch of cosmic re-ionisation. Exquisite and unprecedented measurements of black hole masses and spins will make it possible to trace the history of black holes across all stages of galaxy evolution, and at the same time constrain any deviation from the Kerr metric of General Relativity. eLISA will be the first ever mission to study the entire Universe with gravitational waves. eLISA is an all-sky monitor and will offer a wide view of a dynamic cosmos using gravitational waves as new and unique messengers to unveil The Gravitational Universe. It provides the closest ever view of the early processes at TeV energies, has guaranteed sources in the form of verification binaries in the Milky Way, and can probe the entire Universe, from its smallest scales around singularities and black holes, all the way to cosmological dimensions.*

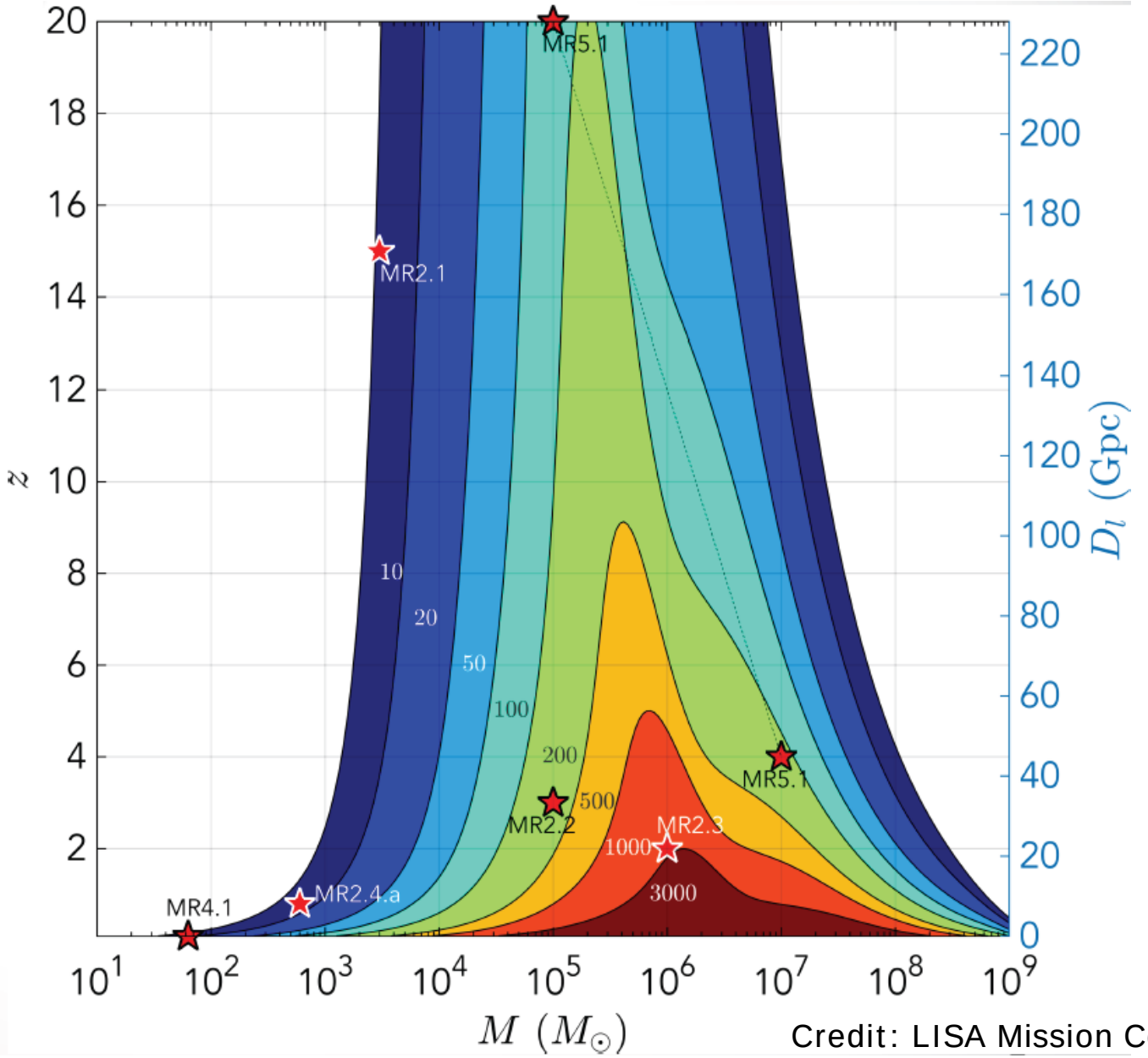


# LISA Sources



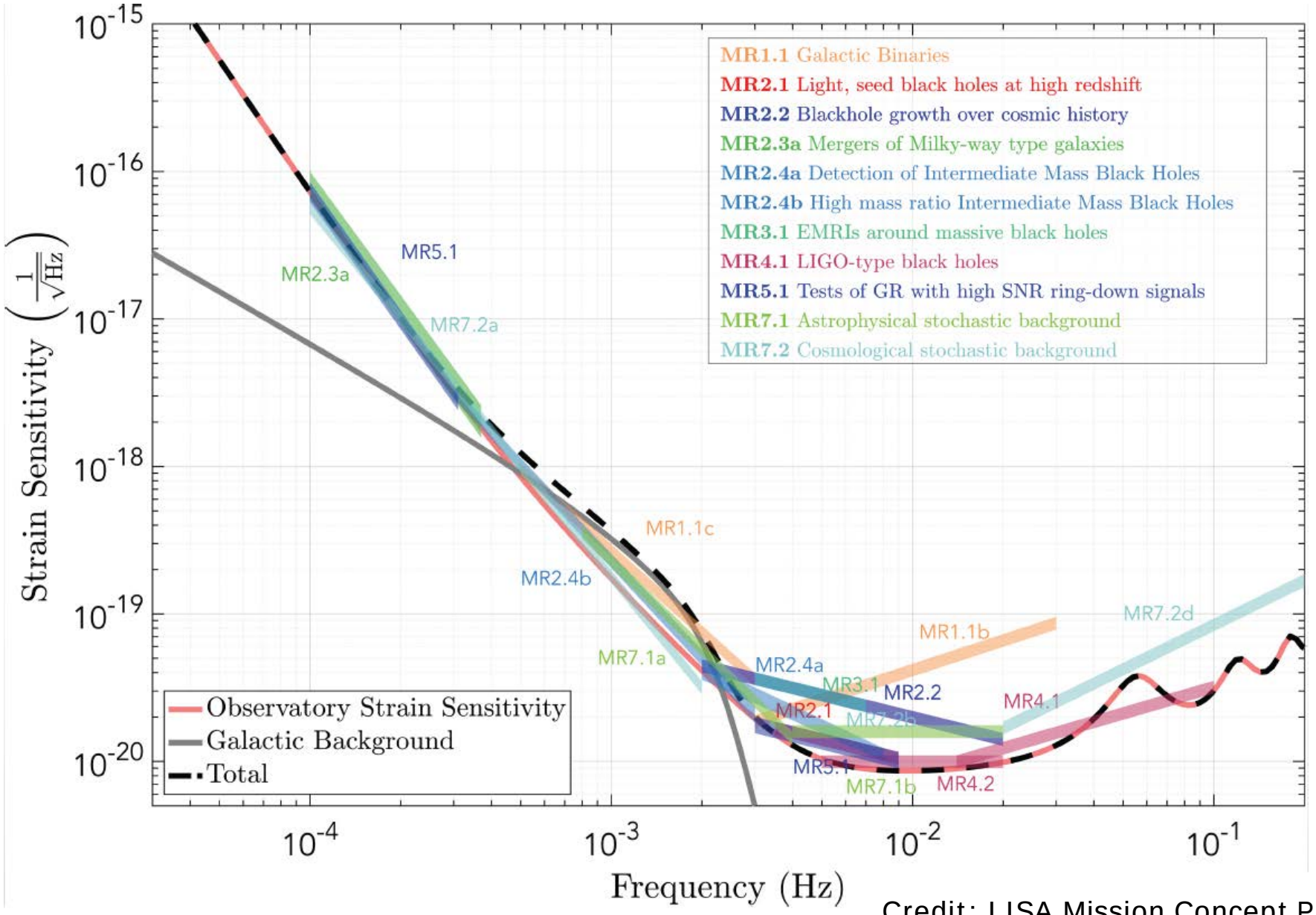

Credit: LISA Mission Concept Proposal

# LISA's Reach for Black Hole Binaries




Credit: LISA Mission Concept Proposal

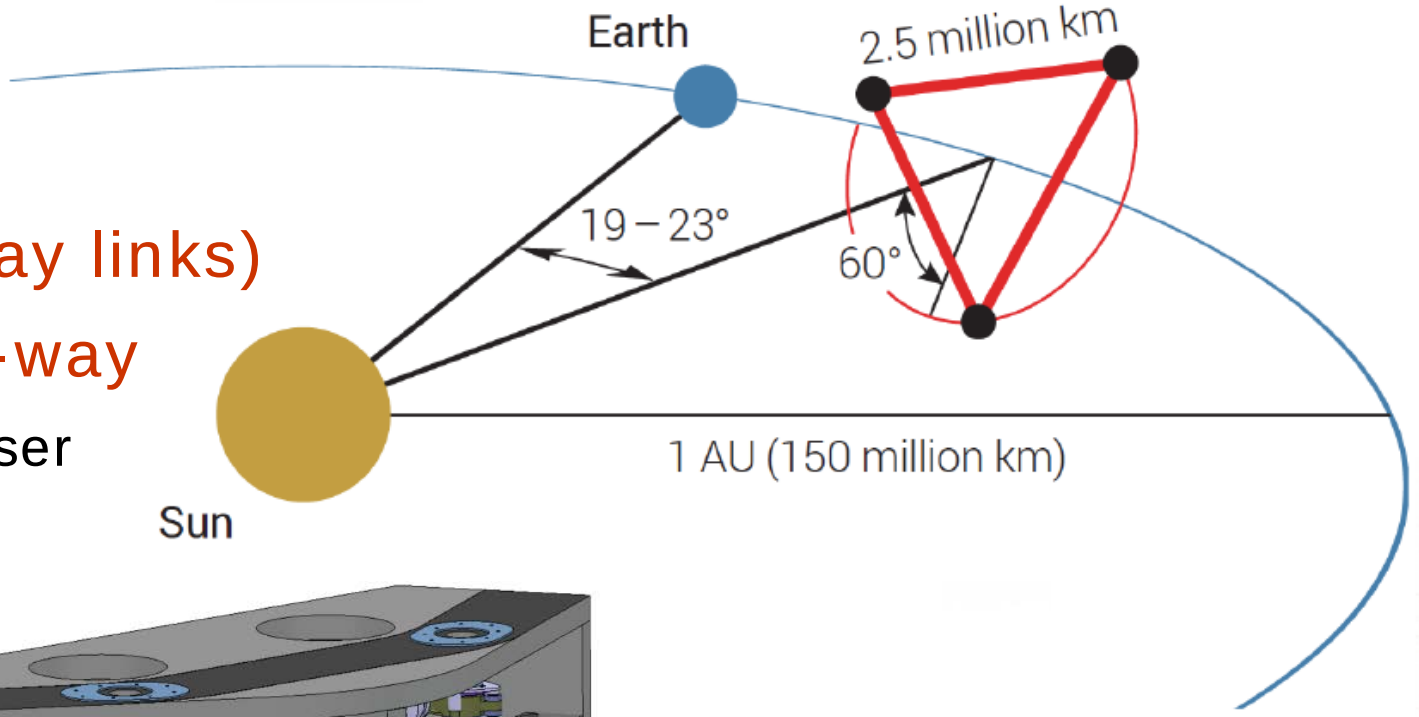
# Science Goals → Strain Curve

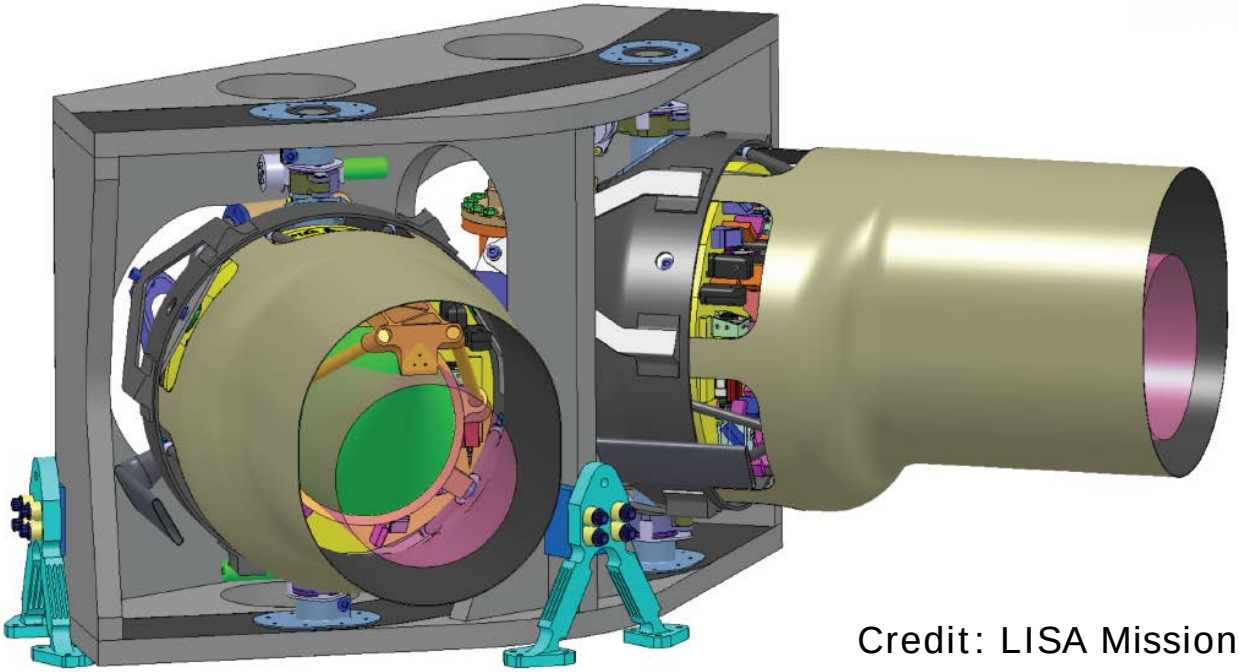



Credit: LISA Mission Concept Proposal

# Strain Curve → Orbit & Metrology Design

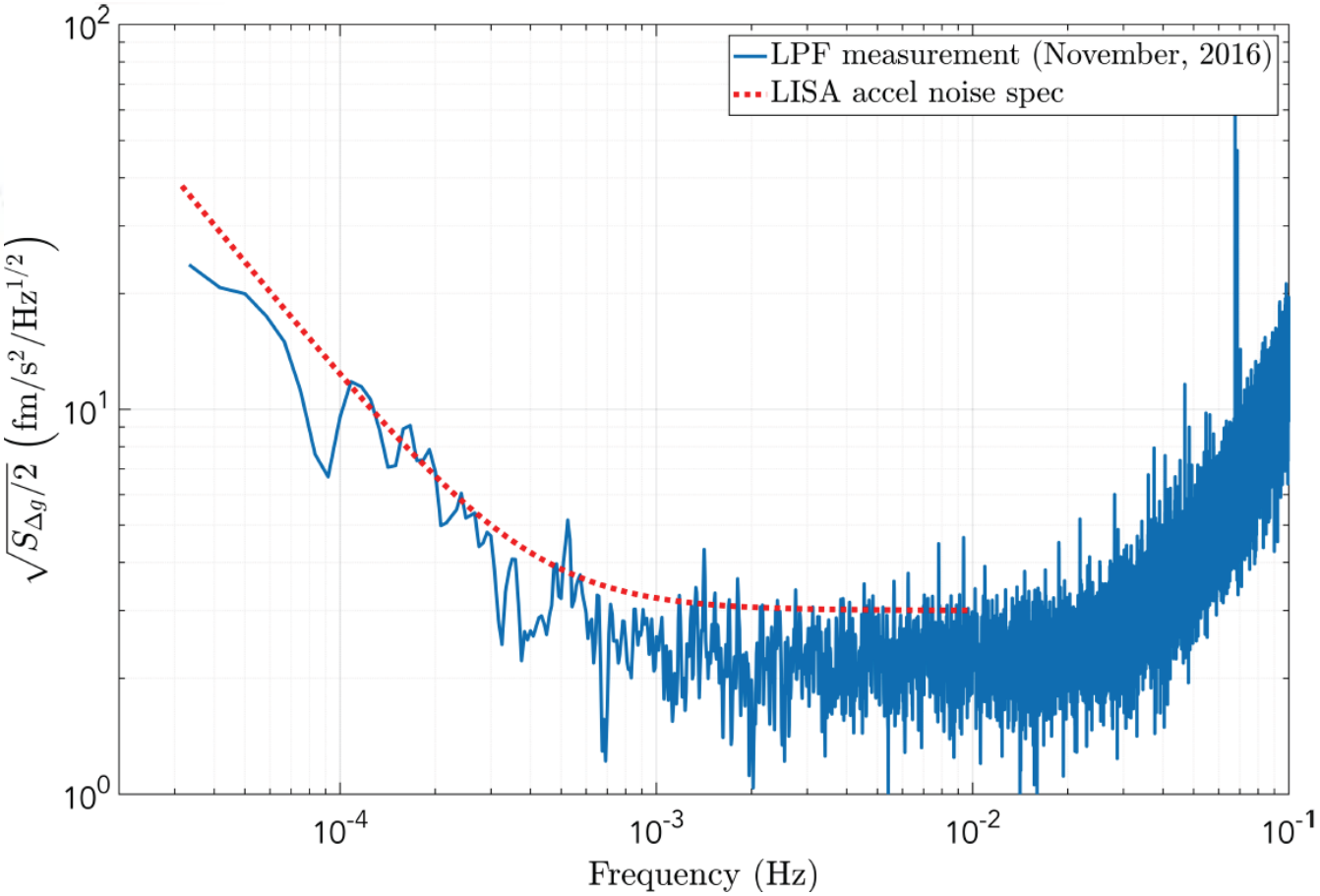
- 4 yr mission
  - 10 yr extension
- 3 arms (6 one-way links)
- 10 pm/Hz$^{1/2}$ one-way
  - 2 W, 1064 nm laser
  - 30 cm telescope



Credit: LISA Mission Concept Proposal

# LISA Pathfinder → Acceleration Noise




Credit: LISA Mission Concept Proposal

# Future Events / How to get involved

- The L3ST
  - Next L3ST face-to-face meeting is Tues-Wed, here in DC.
    - If you would like to attend, fill out the form @ https://goo.gl/forms/ITmUN5JTyt7GoeAo2 (or ask me)
  - L3ST website
    - http://pcos.gsfc.nasa.gov/studies/L3/
- The GWSIG
  - Kelly Holley-Bockelmann is new Vice-Chair
  - Thanks to Neil Cornish for leadership over past three years
  - GWSIG email list
    - http://pcos.gsfc.nasa.gov/sags/gwsag/gwsag-maillist.php
- Next LISA Symposium: Summer 2018, Chicago
  - Shane Larson organizing