Advanced LIGO anticipated sensitivity curves

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Advanced LIGO is an upgrade to initial LIGO, leading to roughly a factor of 10 improvement in strain sensitivity and also a change in the lowest frequency with good sensitivity from 40 Hz in initial LIGO to ~10 Hz in Advanced LIGO. The projected started in April 2008, and the rough schedule as instruments ready to complete the Project phase (2-hour lock, no sensitivity goal) in 2014 or 2015. Models of the performance indicate that the instruments should be able to meet the sensitivity goals, and we are eager that the analysis community start to consider how to approach the data analysis process for Advanced LIGO. This note presents some curves, and data tables for the curves can be found where this document is stored – at https://dcc.ligo.org/cgi-bin/DocDB/ShowDocument?docid=2974 . (updated to point to public resource on 25 Jan 2010)

To address requests for noise curves for AdvLIGO, the program GWINC (http://lhocds.ligo-wa.caltech.edu:8000/advligo/GWINC) was run with the same basic parameters used for the plot in the Advanced LIGO Interferometer Sensing and Control conceptual design document (ISC CDD, http://www.ligo.caltech.edu/docs/T/T070247-01.pdf) on page 3 (Figure 1). The noise sources included in this model are

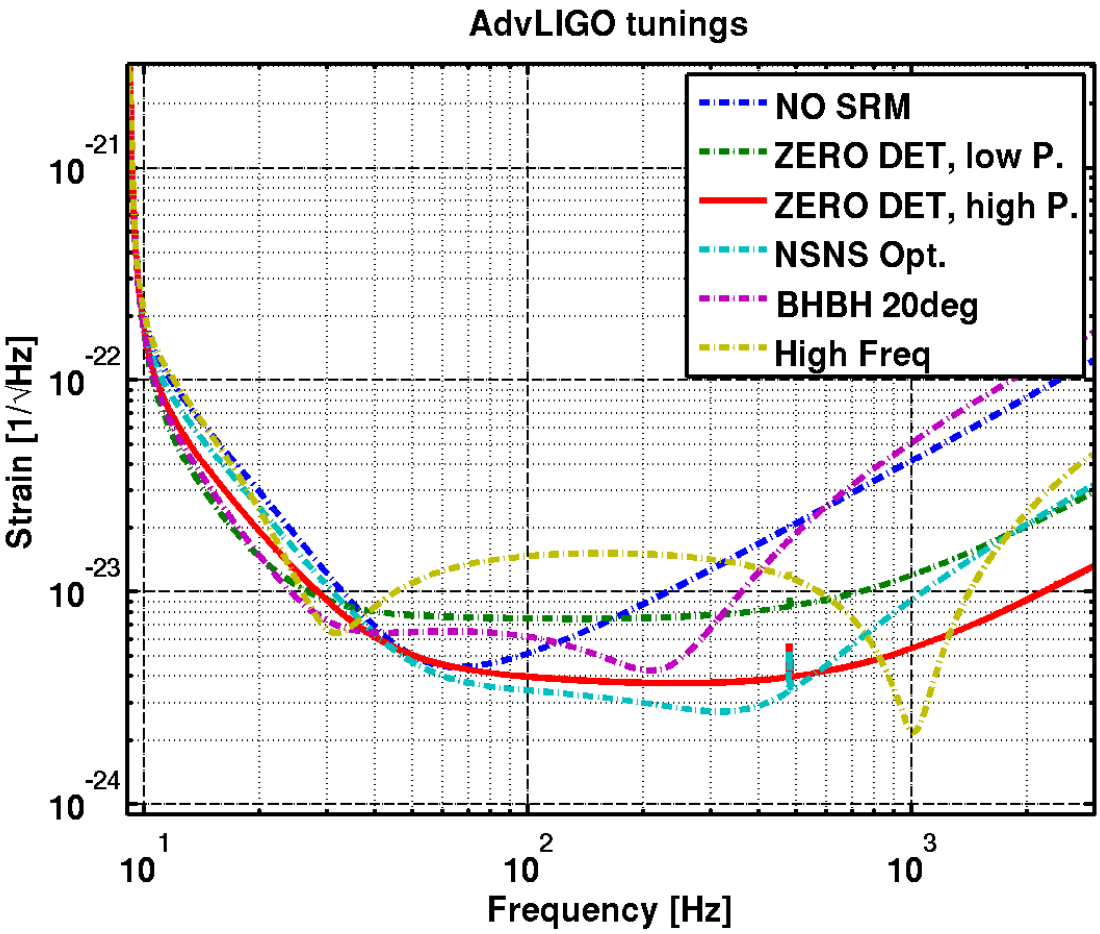
- Quantum noise – shot noise and radiation pressure noise, and their interaction due to the signal recycling mirror
- Seismic noise as filtered by the isolation and suspension systems
- Thermal noise in the test mass (substrate and coating), and the suspension system
    - Facility limits to performance – gravity gradient and fluctuations in the optical path due to residual gas in the beam tubes.

Note that the curves and data below are slightly different than the ones in the ISC CDD, as there have been improvements to the GWINC noise estimates or parameters since then. Please email the Advanced LIGO Interferometer Sensing and Control group (Aligo-isc@ligo.caltech.edu) if you have any questions about these curves; in addition please contact David Shoemaker (dhs@ligo.mit.edu) if you wish to publish using them.

These curves represent the incoherent sum of the principal noise sources as we best understand them at this time. There will be, in addition, technical noise sources. This is not a guaranteed performance, but a good guide to the overall curve and an early approximation to the anticipated sensitivity. These caveats need to be mentioned when describing these curves in presentations and publications.

- Zero Det, High Power: The red trace is for the AdvLIGO configuration of zero-detuning of the signal recycling mirror, with high laser power. This gives us most of the sensitivity with the fewest technical difficulties.
- No SRM: a possible early configuration, where no signal recycling mirror is used
- Zero Det, Low Power: a possible early configuration with zero-detuning of the signal recycling mirror, with low laser power

- Optimal NSNS: optimized for 1.4 solar mass neutron star. This is slightly more difficult from a control system point of view. The NSNS case gives ~200 Mpc reach for a single interferometer, SNR 8, averaged over directions and polarizations.
- BHBH 20deg: optimized for 30-30 solar mass black hole binary inspirals. This is slightly more difficult from a control system point of view.
- High Freq: The "High frequency" case is an example of a narrowband tuning at 1kHz. Note though that, unlike all the other tunings, it needs a recycling mirror with a higher reflectivity.
- Finally, we omitted the optimal BHBH curve that appears in the ISC CDD - it is technically a lot harder and offers only a very small increase in BHBH sensitivity, while giving very poor mid- and high-frequency performance.



Note that the plot in the ISC CDD was obtained with bench62. GWINC has an updated thermal noise estimate and supersedes bench62. Thus the curves are slightly different from the ones in the ISC CDD.

Further design work, in particular on the alignment control system, will modify the best estimates; please contact the Advanced LIGO Interferometer Sensing and Control group (Aligo-isc@ligo.caltech.edu) for updates and details.