Pre-stabilized laser system at a wavelength of 1550 nm for future gravitational-wave detectors

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To reduce thermal noise in next generation gravitational-wave detectors (GWDs), like the Einstein Telescope[1] or LIGO Voyager[2], the use of cryogenic mirrors is proposed. Silicon is a promising material for these test masses, due to its high mechanical quality factor and the good thermal conductivity at cryogenic temperatures. However as silicon is not transparent at the currently used wavelength of 1064 nm a laser source at a wavelength of 1550 nm or longer is requires.

Currently commercial available laser systems at this wavelength do not fulfill the demanding requirements of future GWDs concerning the laser power, frequency noise, power noise and the spatial beam profile.

As a first step towards a pre-stabilized laser system (PSL) at 1550 nm wavelength. We characterized the free running power and frequency noise of different commercial available single mode, single frequency seed lasers.

The implementation of active and passive laser stabilization are necessary to reach the required performance for a GWD PSL. We present a scheme of such stabilization for laser power and frequency. First tests results of the laser system as well as the characterization of components for the high power system will be shown.

[1] ET Science Team, ET conceptual design document ET-0106C-10, `http://www.et-gw.eu/index.php/etdsdocument`
[2] LIGO Scientic Collaboration, Instrument Science White Paper 2018, `https://dcc.ligo.org/public/0151/T1800133/004/T1800133-instrument-science-white-v4.pdf`