Demonstration of a TRL 5 Laser System for LISA
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Objectives and Key Challenges:
- Develop 2.5W light source for the LISA gravitational wave mission using a Master Oscillator Power Amplifier design with a novel diode laser oscillator (External Cavity Laser, ECL) followed by a 2.5W Yb fiber amplifier, providing a highly stable, compact, and reliable system
- Test the laser system for reliability, and for amplitude and frequency stability, achieving the required noise performance
- Demonstrate system TRL 5

Significance of Work:
- Development, with industrial partner (Redfern Integrated Optics), of space qualified, ultra low-noise oscillator
- Demonstration of low-noise power amplifier with servo controls
- Noise and reliability tests of full laser system

Approach:
- Noise optimization of 1064 nm External Cavity Laser (RIO)
- Reliability study of External Cavity Laser
- Implementation of amplitude and frequency servo controls on full laser system, achieving RIN=10^{-4} at 10^{-3} Hz, frequency noise = 300 Hz / Hz^{1/2} at 10^{-2} Hz, and differential phase noise = 6x10^{-4} rad/Hz^{1/2} at 10^{-2} Hz

Key Collaborators:
- Kenj Numata, Mike Krainak (NASA/GSFC)
- Lew Stolpner (Redfern Integrated Optics)

Current Funded Period of Performance:
- April 2014 – April 2016

Accomplishments and Next Milestones:
- Fabricated world’s first butterfly package layout 1064 nm ECL
- Procurement of long lead items: fiber splicers and coaters
- Developed and constructed 2.5 W laser amplifier
- Preliminary laser system test with External Cavity Laser (ECL)
- Noise optimization of ECL optical cavity
- ECL reliability tests
- Amplifier reliability tests
- Full laser system reliability testing

Applications:
- Laser source for LISA Gravitational Wave mission
- Oscillator for ground-based GW LIGO project
- Oscillator for GRACE-II mission

Master Oscillator / Power Amplifier (MOPA) configuration of LISA laser, including ECL, preamp, and diode pumped Ytterbium (Yb) fiber amplifier

TRL\text{\textsubscript{in}} = 3  \quad TRL\text{\textsubscript{Current}} = 3  \quad TRL\text{\textsubscript{Target}} = 5