Gravitational-Wave-Mission Phasemeter Technology Development

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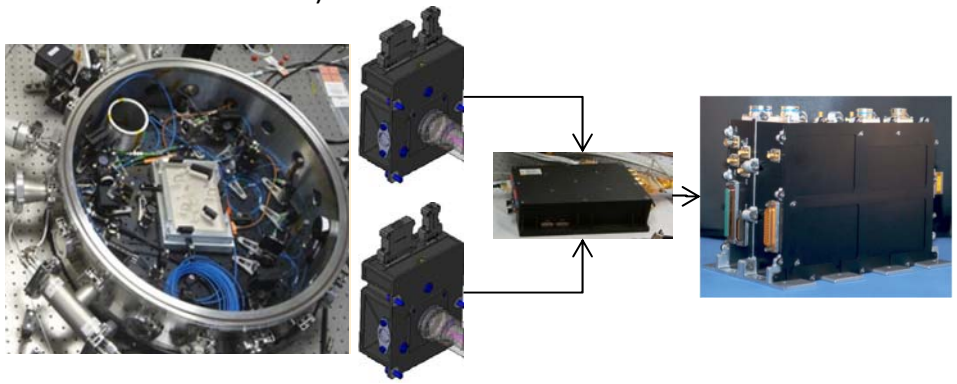
Objectives and Key Challenges:

- Advance our phase-measurement system from TRL 4 to 5 through significant system-level hardware fidelity increase and greater fidelity of signal test environment by adding low light levels
- Mature the TRL of phase readout with high strain sensitivity through micro-cycle/√Hz precision on a 4-16 MHz beat-note in the presence of laser frequency noise and local clock noise, already demonstrated in a lab testbed

Significance of Work:

- High-performance phase readout is an enabling technology for multi-spacecraft laser-interferometer-based missions such as LISA-like gravitational-wave missions

EM Hardware (QPD Photoreceivers, Pre-Amp, and Phasemeter) infused into the LISA Testbed



Approach:

- Advance component technologies
  - Infuse compatible EM hardware from GRACE Follow-On Laser-Ranging Interferometer (LRI)
  - Demonstrate wavefront sensing with quadrant photoreceivers
- System-level testing
  - Modify interferometer testbed to include low-light signals
  - Replace COTS components in interferometer testbed with LRI EM hardware and demonstrate performance

Key Collaborators:

- Jeff Dickson, Brent Ware, Bob Spero, Kirk McKenzie, Andrew Sutton, and Chris Woodruff (JPL)

Current Funded Period of Performance:

Apr 2014 – Sep 2016

Recent Accomplishment:

✓ Demonstrated phase readout with micro-cycle/√Hz precision in the presence of laser frequency noise and local clock noise in an interferometer testbed

Next Milestones:

- Incorporate Quadrant Photoreceivers into testbed *FY16 Q2*
- Demonstrate wave-front sensing *FY16 Q2*
- Migrate additional photoreceiver algorithms from LabView phasemeter to EM *FY16 Q4*
- Demonstrate tracking of low visibility signals with EM Phasemeter *FY16 Q3*
- Incorporate EM photoreceivers and signal chain *FY16 Q4*
- Demonstrate testbed performance at TLR 5 or better *FY17 Q1*

Applications:

- Inter-spacecraft laser interferometry and pm-precision interferometer readout electronics for future missions, *e.g.*, LISA
- Other interferometry concepts (*e.g.*, planet searches)

$TRL_{In} = 4$ $TRL_{Current} = 4$ $TRL_{Target} = 5$