Low SWaP-C Modular Laser Architecture for Laser-Cooled Quantum Sensors and Atomic Clocks

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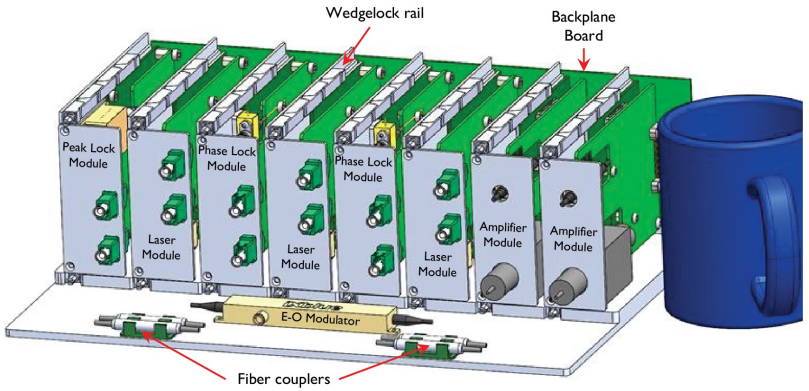
Objective

- Develop a low SWaP-C, highly-configurable laser system that will support cold-atom interferometry. This laser system will be able to support a wide variety of cold-atom-based quantum sensors and atomic clocks. Laser system performance goals include:
  - Output optical power > 60 mW per channel
  - Long term frequency instability < 10 kHz
  - Offset phase locking bandwidth > 9.2 GHz with kHz-level tuning resolution
  - Shuttering speeds of < 1 μs rise/fall time with > 60 dB extinction ratios
  - System volume < 8 L
  - Electrical power consumption < 30 W



Notional CAD model of the proposed modular laser system that will generate the requisite frequency-agile light for a Cs-based atom interferometer. (Optical fiber interconnects between the modules are not modeled.) The coffee cup illustrates the small scale of the proposed system (30 cm x 22 cm x 10 cm).

Approach

- Develop the high-level architecture for the laser system. Perform system modelling and laboratory bench studies to evaluate the fitness of candidate components and determine the feasibility of suggested development approaches.
- Design, build, and test a laser module that can output the 852 nm light required for the Cs atom interferometer. This development consists of designing a miniature laser package and its associated laser driver electronics.
- Develop phase lock module including phase-locking electronics.
- Develop amplifier module including intensity stabilization electronics.
- Demonstrate operation for all module types.
- Complete prototype laser system and evaluate performance.

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Key Milestones

• Complete requirements capture and architecture	06/23
• Complete test plan documentation	06/23
• Perform laboratory testing on cold atoms of selected modules	12/23
• Demonstrate operation of all module types	06/24
• Complete prototype laser system	09/24
• Demonstrate prototype laser system performance	02/25

TRL_{in} = 2 **$TRL_{current}$ = 2**