Portable laser system for atom interferometric gravimeters targeting inertial navigation applications

Inês Faria Mendes,[1,*] Monika Pietrzyk,[1] Vineetha Naniyil,[1]
Sachin Kinge,[2] Michael Holynski,[1] and Yu-Hung Lien[1]

[1] *Quantum Sensing Group, School of Physics and Astronomy, University of Birmingham, Birmingham, UK*
[2] *Toyota Motor Europe, Brussels, Belgium*

Light-pulse atom interferometers use light pulses to split and recombine atomic wave packets, producing interference patterns. When these interactions occur while the atoms are in free fall, precise gravity measurements can be extracted from the resulting interference. Combined with gravity map-matching, these measurements can enhance navigation systems, providing a passive and reliable alternative to conventional satellite-based tools such as GPS, which are vulnerable to spoofing, jamming, and environmental limitations [1]. Our research focuses on the development of a high bandwidth quantum inertial sensor targeting a sensitivity of 10^{-7} g/$\sqrt{\text{Hz}}$ at 100 Hz, with month-long stability of 10^{-9} g [2].

A key challenge for practical implementation is the complex, phase-coherent laser architecture required to generate multiple pulses for both laser cooling and atom interferometry. We have realised a single-seed, high-power and compact laser system using two-tone carrier-suppressed single-sideband modulation to deliver all the required frequencies. We achieve >20 dB suppression of undesired frequencies, significantly reducing unwanted parasitic transitions that limit current deployable laser systems [3, 4].

In this talk I will present the high bandwidth quantum sensor and detail the methods behind the development of the laser system. A numerical model exploring theoretical limits of the system will also be discussed. Finally, I will highlight the advantages this system offers for improved robustness in dynamic environments, focusing on real-world applications.

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* mif970@student.bham.ac.uk