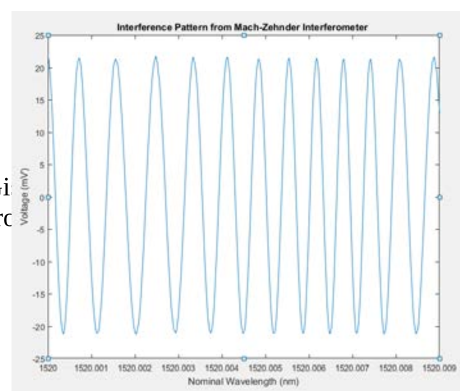
High Precision Linear Correction for Imperfect Laser Scans in the Mid-IR

Vignesh Gopal[1, 2], Erik Wendt[2], Jeff Thompson[2]
[1] University of Illinois at Urbana Champaign, Urbana, Illinois, 61801, USA
[2] Princeton University, Princeton, NJ, 08540, USA
email: vvgopal2@illinois.edu

For decades, traditional computers have operated by using classical bits, 0s and 1s, to perform all of its computation and processing. While these classical computers have shaped modern technology in extraordinary ways, such methods of computation fall short of expectation in a few different areas. For instance, though in practice, breaking methods of encryption such as RSA is quite difficult, it is not theoretically impossible. However, a new brand of computation that employs the laws of quantum mechanics aptly known as quantum computing has the power to ensure secure encryption and exponentially greater computation speeds than modern computers [1]. Like any extraordinary technology, however, building quantum computers and quantum memory devices are quite difficult to implement. An area of difficulty related to our research is finding a robust method for controlling the quantum state of an atom or ion. Our research focuses on developing ways to trap Erbium ions inside a YSO lattice and manipulate their quantum states with focused laser beams.

In order to aptly characterize these crystals, laser scans are essential in order to assess the erbium doping inside these YSO crystals. While most lasers have motor scans that are linear to some extent, when classifying the spectral linewidth inside the YSO crystal a precision in the sub-nanometer scale is necessary [2]. To complete the linear correction, we have implemented a Mach-Zehnder interferometer with a free spectral range of about 500 MHz to calculate the relative frequency of light emitted from the laser as well as an Acetylene reference cell to measure the absolute frequency of of light emitted from the laser. Using these two devices, we were able to quantify the light emitted at all times with precision of ± 1.5 picometers. Finally, once our nanofabricated optical devices are used to focus light onto the erbium atoms, this system will be used to determine the spectrum of the light transmitted and/or reflected.

A



B

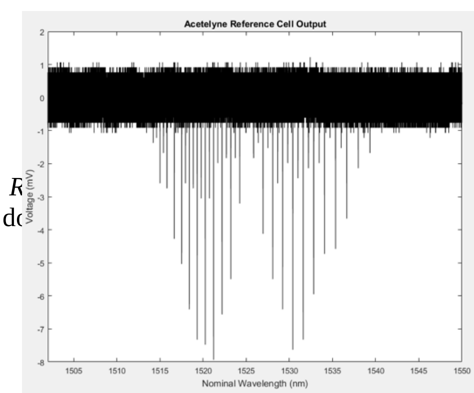


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Fig. 1 **(A)** interference pattern from interferometer. As seen, frequency is not perfectly constant. **(B)** Spectral pattern from acetylene cell. The peaks are used to find absolute position of wavelength scan from laser.