STABILIZATION OF A TUNABLE DIODE LASER

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Introduction

- Silicon Vacancy (SiV) centers and Nitrogen Vacancy (NV) centers can potentially be implemented as single photon sources and quantum memories
- Silicon or Nitrogen ions are enclosed in a diamond lattice
- We use spectroscopy to study the behaviour of NV and SiV centers
- We then set the wavelength of the scanning laser to the wavelength of a Zero Phonon Lines (ZPL)
- It it difficult to set the wavelength of the laser to exactly the intended value
- Wavelength of the laser drifts over time

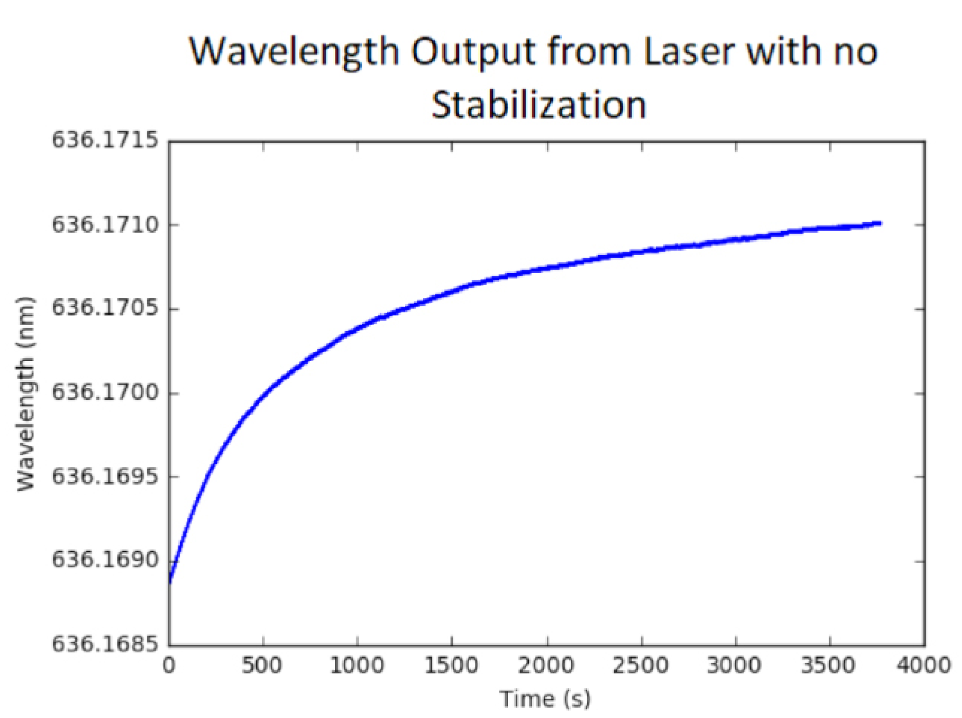


Fig 1:
- *Initial Wavelength: 636.16885 nm*
- *Final Wavelength: 636.17101nm*
- *Difference: 0.00216 nm*

- Drift in wavelength will decrease number of counts from the vacancy center
- The goal of this project is to develope software to Lock on to an intended Wavelength and Stabilize the output
- The functions of the software is accessible through a Graphical User Interface

Methods

- An understanding of how the tunable diode laser works is crucial for determining a way to stabilize the wavelength of the laser
- Newport TLB-6700 Model lasers are used in the Lab
- The laser's output is monitored with an Optical wavemeter

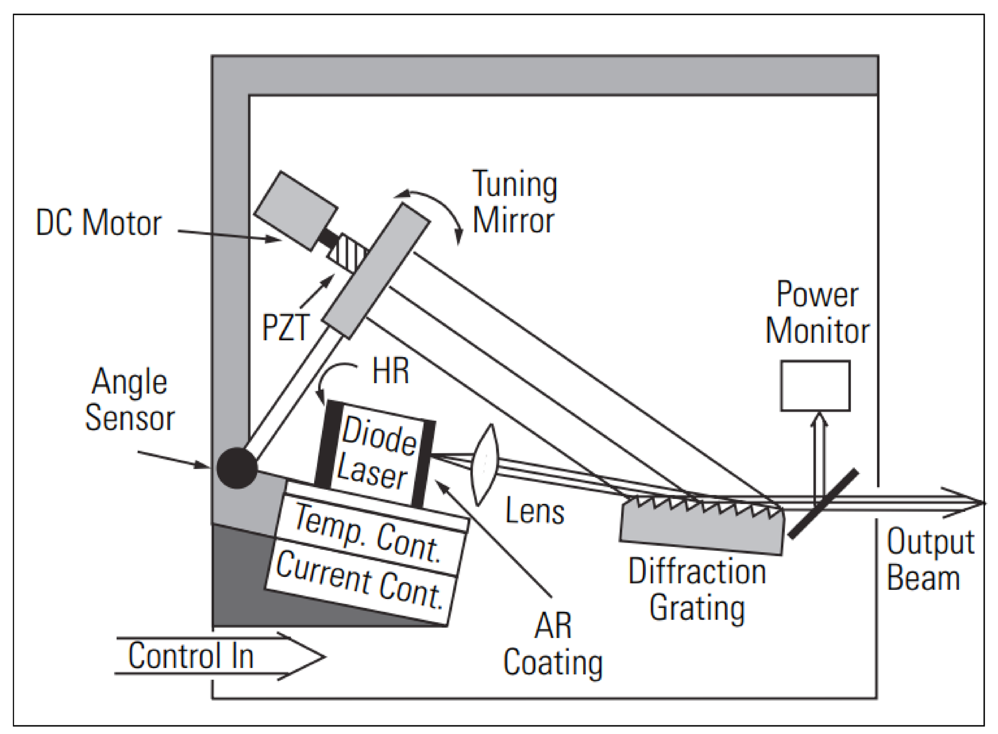


Fig 2: Diagram showing how the Laser functions. This suggests that the wavelength can by controlled by the position of the tuning mirror

- Wavemeter data can be received by one of the lab's computers
- Piezo transducer can be controlled by USB connection with the Computers, or by applying Voltage signal
- Stabilization software tested by performing spectroscopy on SiV center
- We expected to see a constant photon count rate after stabilizing the wavelength of the laser

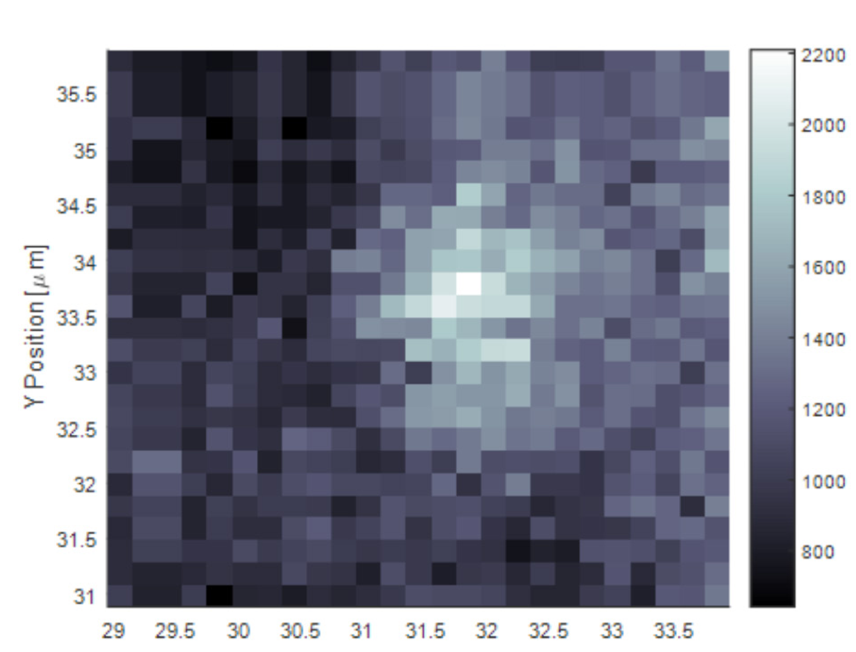


Fig 3: Close up picture of a Silicon Vacancy center. The Bright spot is where we are seeing the most photon emisson so we will set the laser position at that position

Results

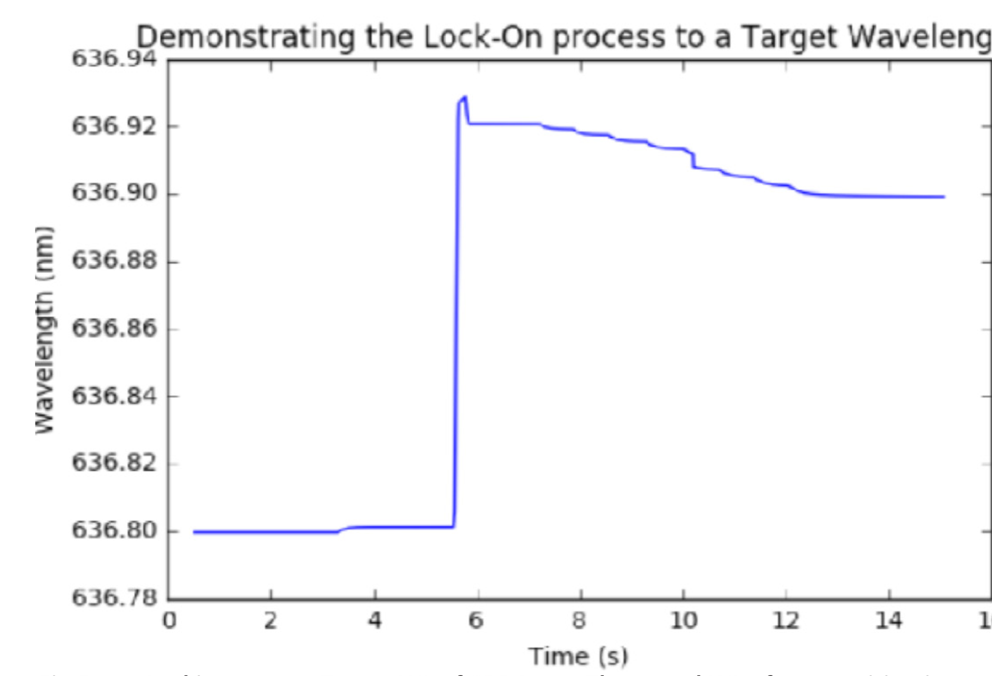
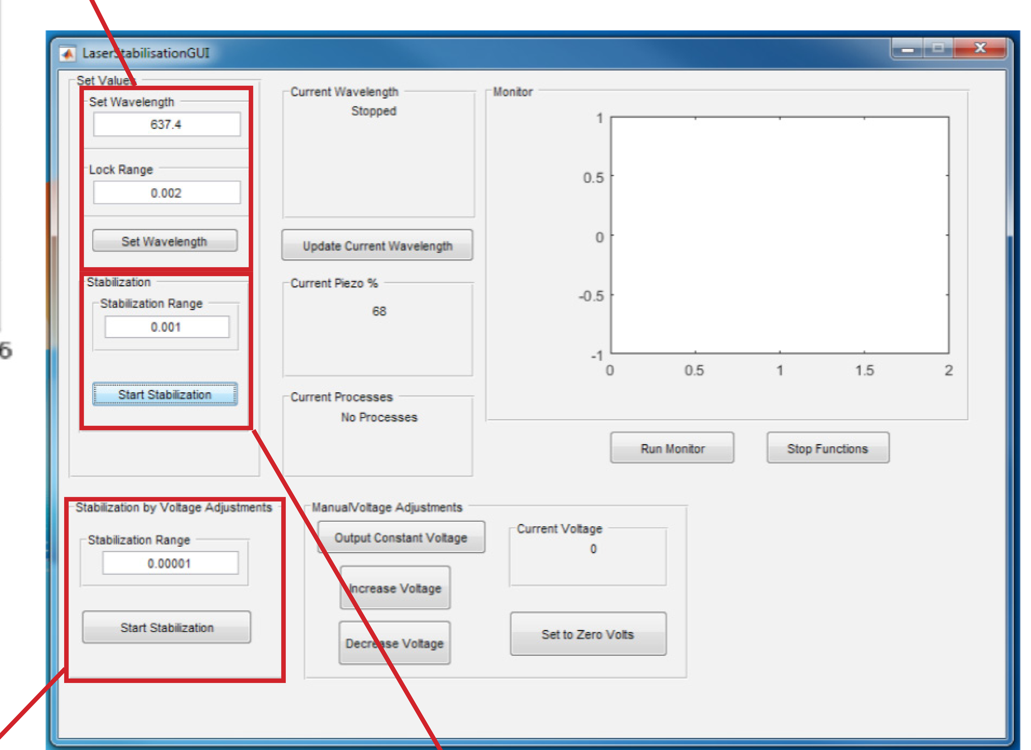


Fig 5: Locking on to a Target WL of 636.9 nm. The actual WL after transition is 636.8999 nm

Fig 4: The GUI that implements the Lock-on and the Stabilization functions. Additional features added for convenience.



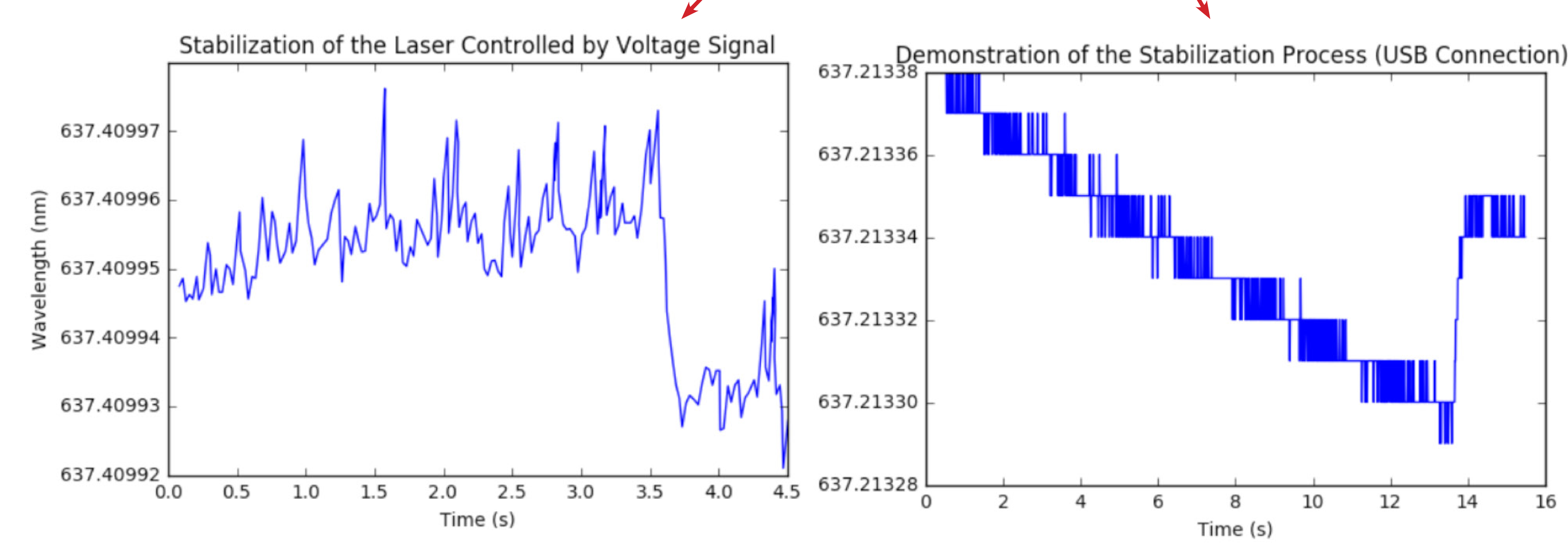


Fig 6: Both plots show that stabilization system works in detecting drifts and making appropriate adjustments. Left plot shows the stabilization of the wavelength by adjusting the piezo by applying a voltage signal

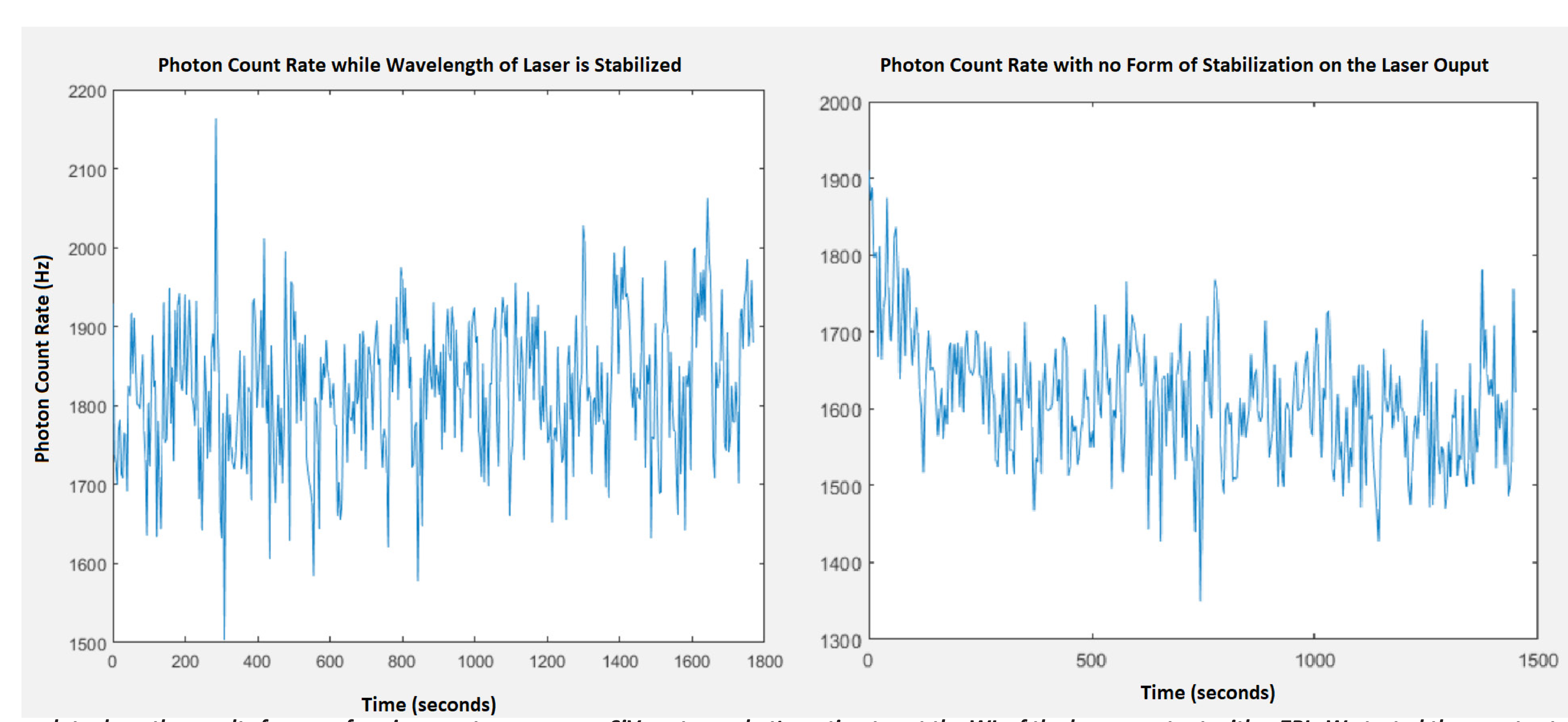


Fig 7: These plots show the results from performing spectroscopy on a SiV center and attempting to set the WL of the laser constant with a ZPL. We tested the count rate of photons in the cases where the laser was stabilized with the system, and when the laser was not stabilized.

Conclusions

- The software was able to accurately lock-on to a wavelength intended by the user
- The software successfully detects drifts in WL and adjusts the WL back so that it remains within the precision range
- While testing the stabilization system, we noticed that noise is dependend on the connection method with the laser
- Experimentally, we can main a constant photon detection rate to study NV and SiV centers
- Future work can focus on exploiting advantages in the stabilization methods (USB or Voltage Signal)

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