Development of an External Cavity Diode Laser (ECDL) to use as an injection seeding for OPOs.

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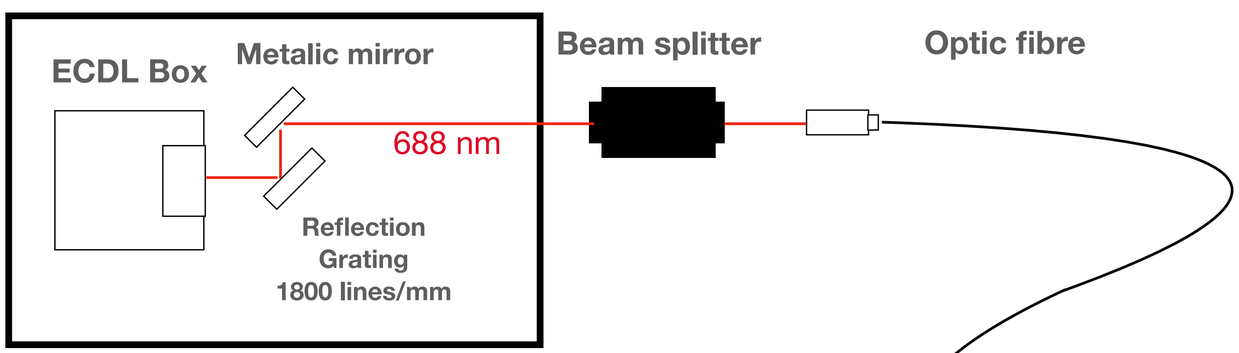
Motivation

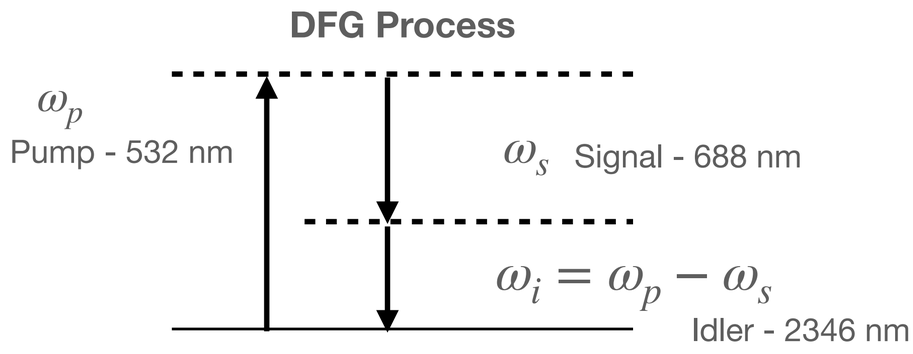
- We are interested in studying the long lived vibrationally excited states of molecules on the metal surfaces and to find out whether these states take part in indirect reactions.
- To selectively excite molecules we employ an OPO based non linear laser system.
- Our molecular source have a doppler spread of few MHz (5 - 6 MHz). Hence, A narrow radiation source is required for efficient excitation.
- Inspite of having a wide range of tunability, OPO has a broader line width.
- An injection seeding from an stable narrow line width external source can be used to solve this.
- The External Cavity Diode Laser (ECDL) is developed to act as injection seeding for the OPOs.

Our Experiment

- In the Experiment we are exciting CO molecule from vibration state v=0 to v=2 (2346.25 nm).
- An OPO having a pump of 532 nm with an ECDL at 688 nm as an external injection seeding source is used for the excitation of molecules.
- The difference frequency generation (DFG) process in the OPO can produce the required wavelength, 2346.25 nm

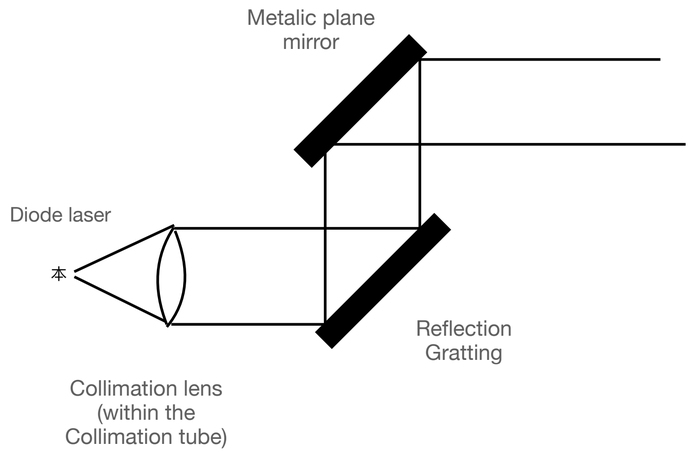


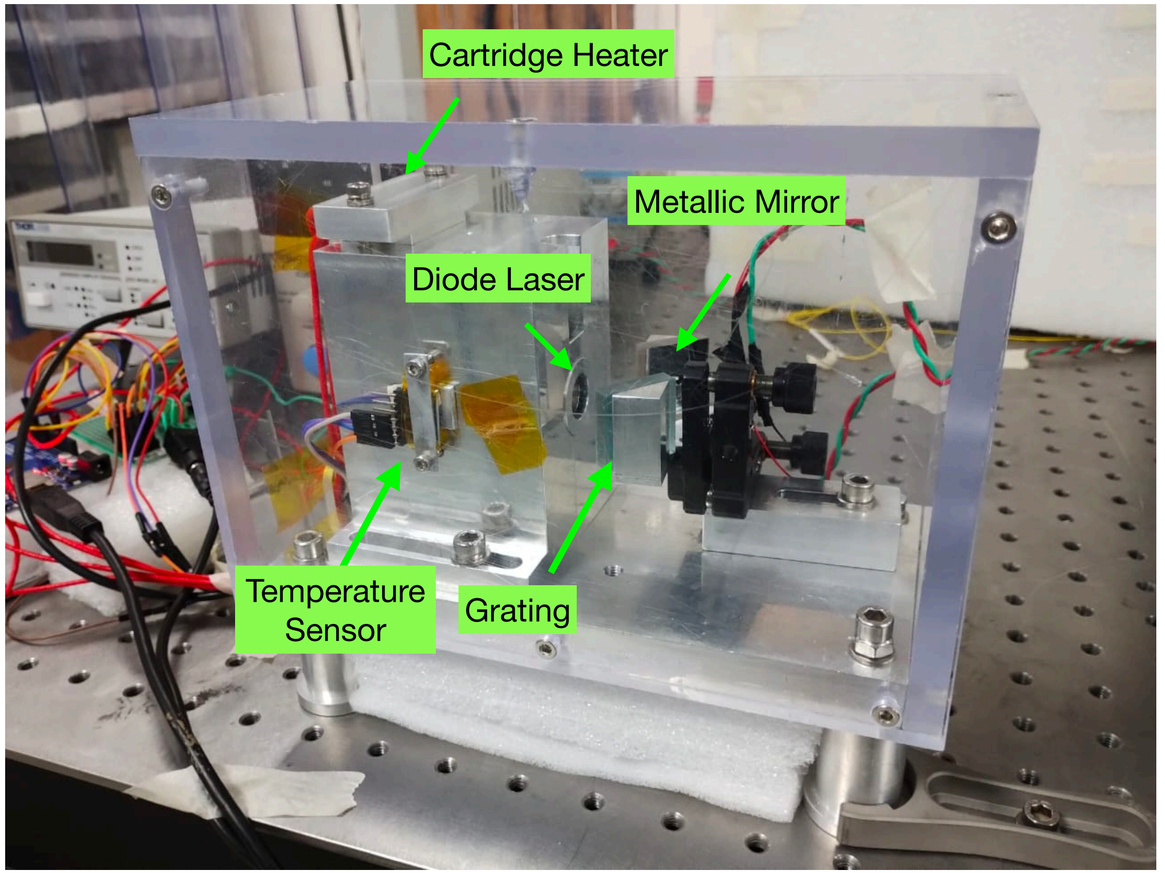
Littrow configuration



ECDL Design

- A longitudinal single mode is obtained by providing a frequency dependant optical feedback from the first order diffraction of the grating (Littrow configuration).
- A metallic mirror is placed parallel to the grating of the Littrow configuration so that the direction of the out coming beam is not effected by the laser tuning.



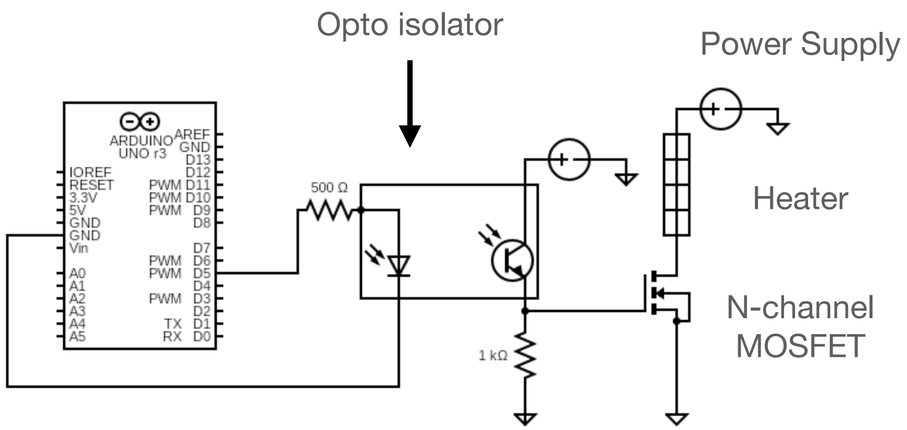


ECDL Box, Surface Dynamics Lab (SDL) TIFRH

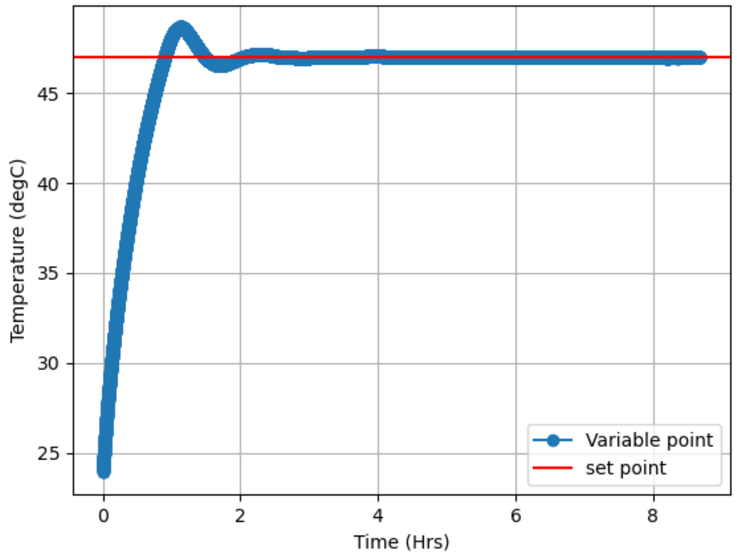
Reference: Wenxian Hong, Oskar J. Painter, “Design and Characterization of a Littrow Configuration External Cavity Diode Laser”, California Institute of Technology

Temperature Stabilisation

- The diode laser we employ gives 683 nm in room temperature. As the diode laser wavelength can be tuned using temperature, we heat the entire block to 47 degree Celsius to produce 688 nm (required wavelength).
- A PID controller is used for temperature stabilisation
- The entire box is covered with a double layer thermocol, for better thermal isolation.

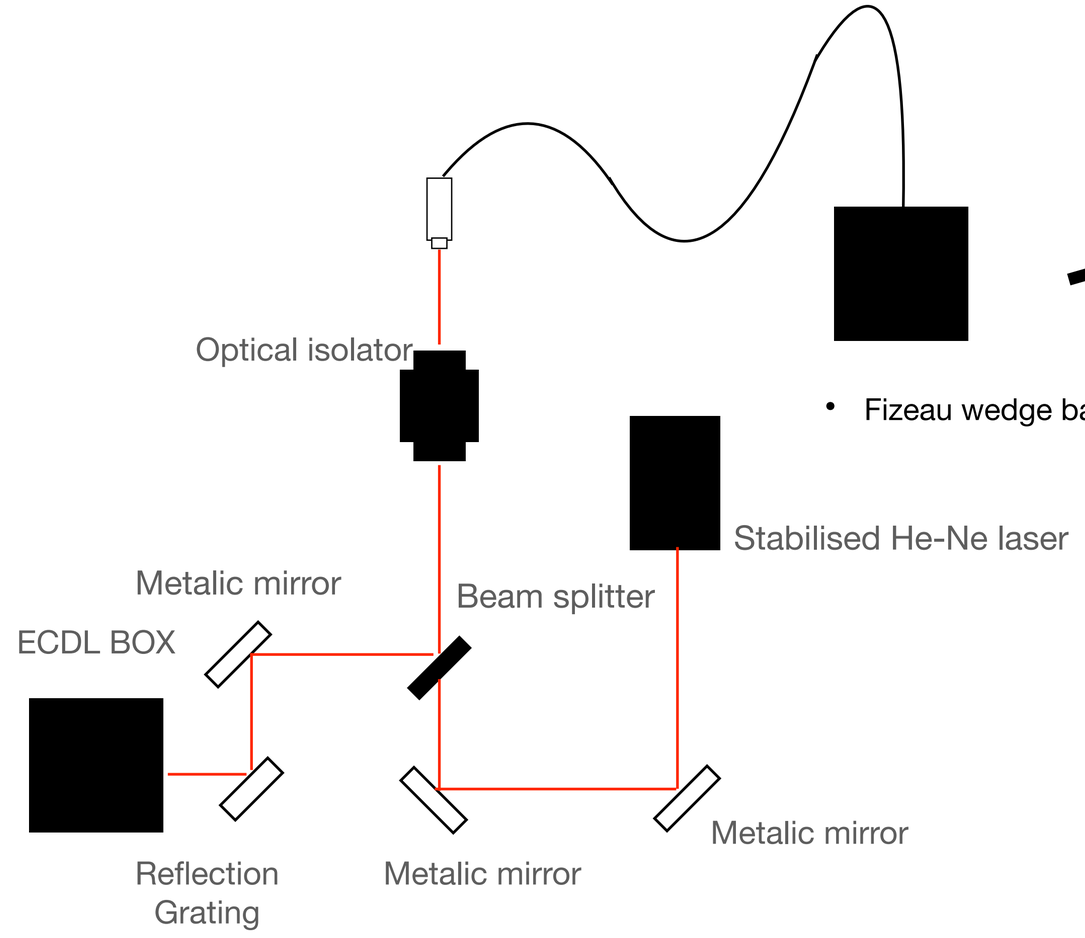


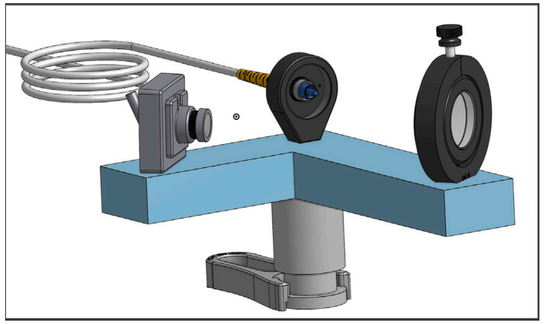
PID Circuit diagram drawn using circuit diagram website



Temperature Vs Time plot obtained, set point at 47 deg Celsius

Passive stability measurement

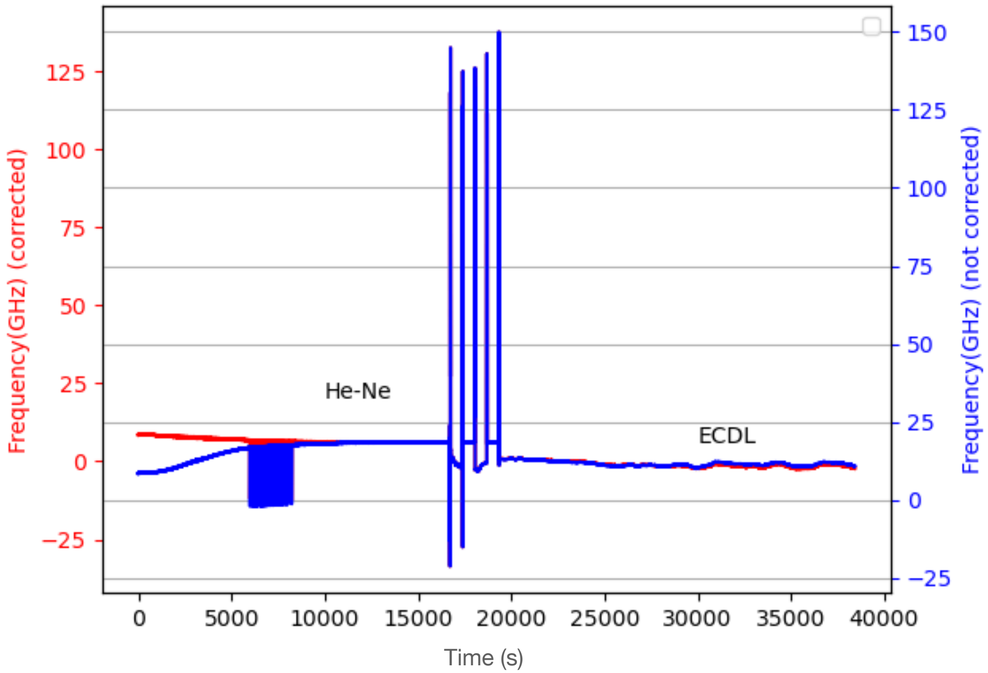




Auto cad drawing of interferometer arrangement.

- Fizeau wedge based interferometer.

Source: S. K. Singh, A. Kumar, and P. R. Shirhatti. “A simple and low-cost setup for part per billion level frequency stabilization and characterization of red he-ne laser” . HardwareX, page e00421, 2023.



Frequency drift Vs Time. Temperature corrected data is plotted in red and without correction is plotted in Blue.

Reference

[1] A. Arnold, J. Wilson, and M. Boshier. A simple extended-cavity diode laser. Review of Scientific Instruments, 69(3):1236–1239, 1998.

[2] Wenxian Hong, Oskar J. Painter, “Design and Characterization of a Littrow Configuration External Cavity Diode Laser”, California Institute of Technology

[3] W. Demtröder. Laser spectroscopy, volume 2. Springer, 2008.

[4] S. K. Singh, A. Kumar, and P. R. Shirhatti. “A simple and low-cost setup for part per billion level frequency stabilization and characterization of red he-ne laser” . HardwareX, page e00421, 2023.

THANK YOU !