Compact Diode Laser for Near Infrared Methane Spectroscopy

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August 5, 2016

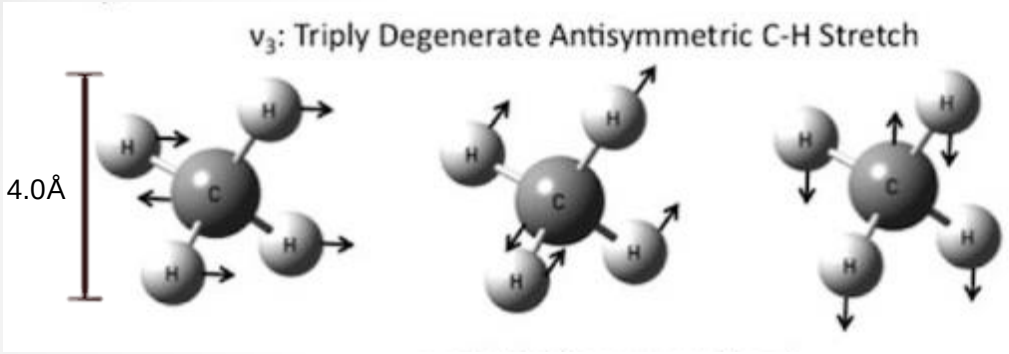
Motivation

- Expand gas-filled hollow fiber references to 1.6 microns wavelengths.
  - Absorption spectroscopy and sub-Doppler spectroscopy in methane-filled hollow fibers

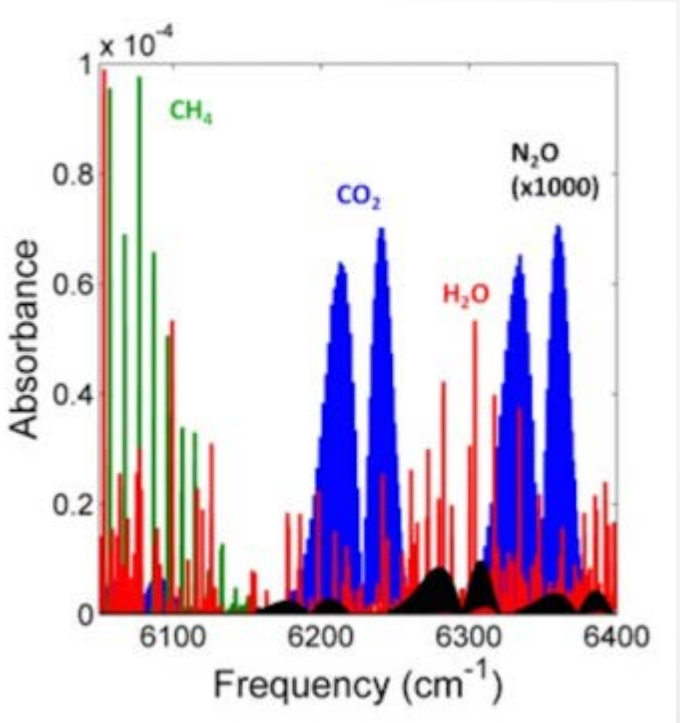
Challenges of the Diode Laser

- Using the Littrow configuration to calculate the diffraction angle off the diffraction grating.
- Reconstructing and machining of an adapted diode laser design at the new grating angle.
- Redesigning the mirror mount to avoid beam clipping, passing a beam radius 4x the full width half maximum (FWHM).
- Needing high power to saturate methane for sub-Doppler spectroscopy

Methane (CH_4)



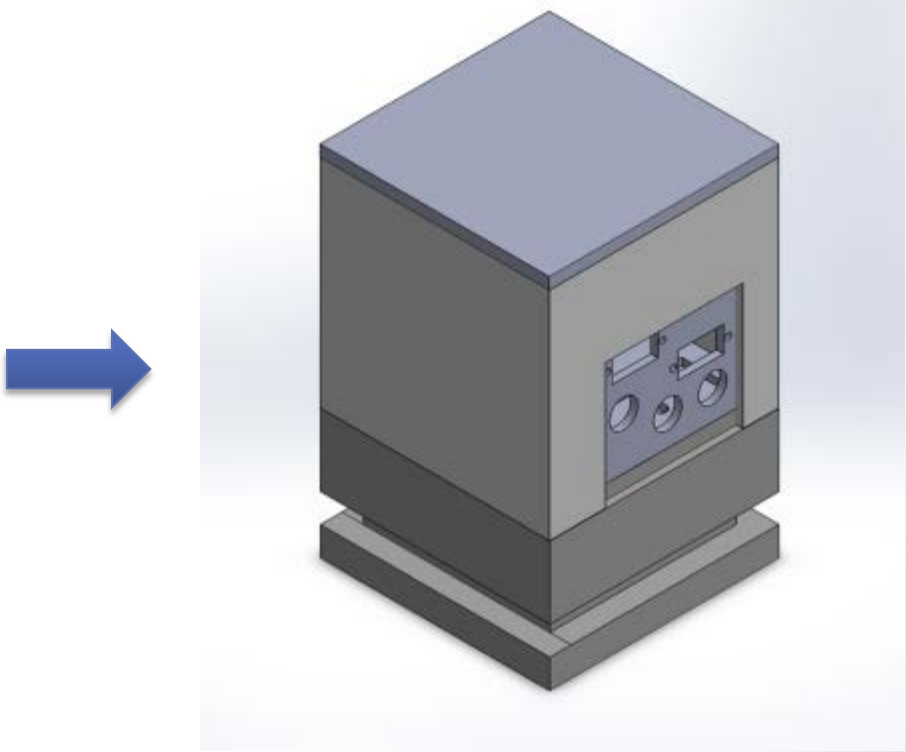
v_3= 3158.6 cm^{-1}, 2v_3= 6317.2 cm^{-1}



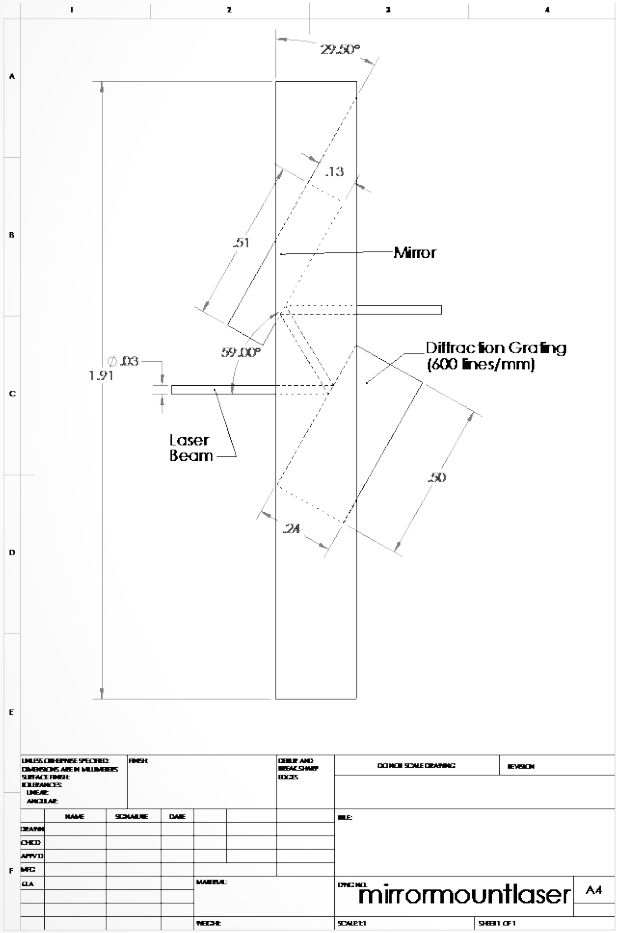
https://www.researchgate.net/figure/278652214_fig4_Figure-18-18-Methane-vibrational-normal-modes

http://www.nist.gov/pml/electromagnetics/grp05/other-activities.cfm

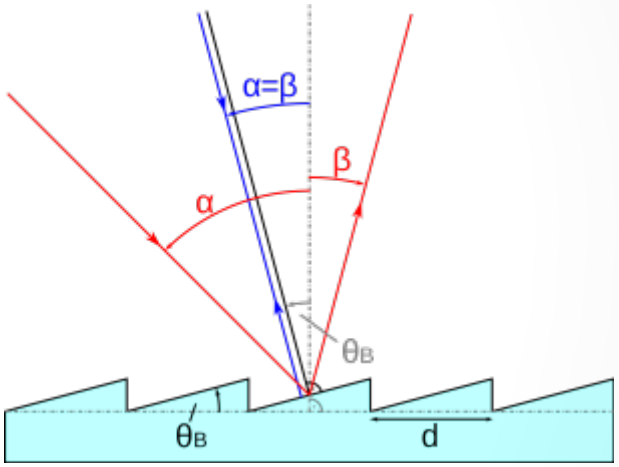
Assembling a Compact Diode Laser



Interior of the Diode Laser



Littrow Configuration

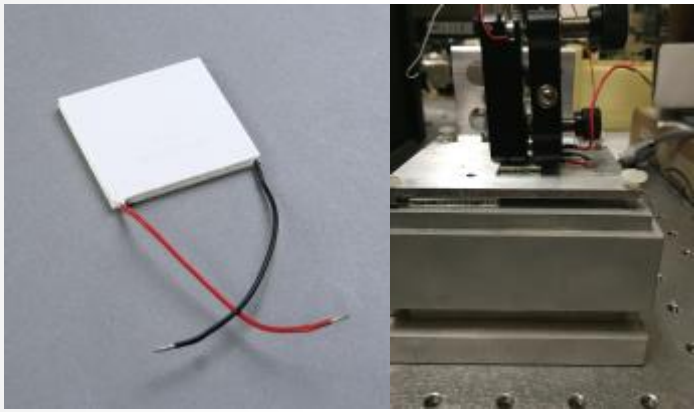


d= line spacing
α= incidence angle
β= diffraction angle
Θ_B= blazed angle

https://en.wikipedia.org/wiki/Blazed_grating

Laser Parts

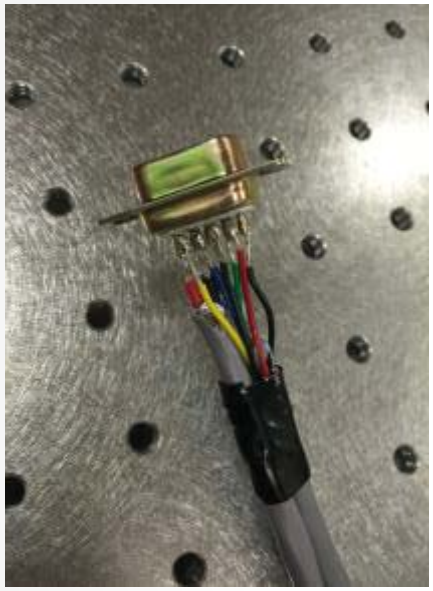
- Thermoelectric coolers (TECs) - heat pumps used to cool systems.



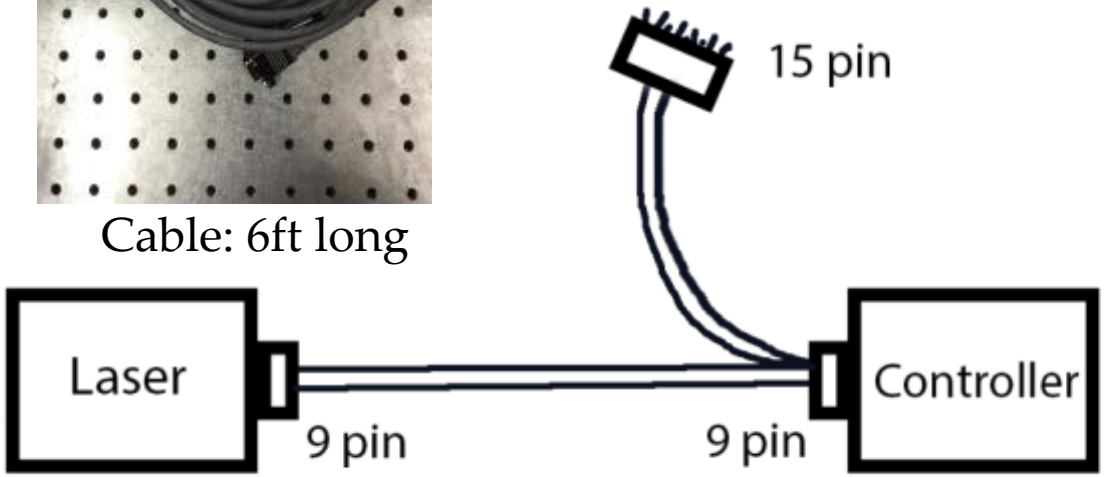
- PZT – fine tune position of the the laser
- Thermistor- electrical resistor used for measurement and heat control
- Temperature Chip – determines the temperature of laser

http://www.ebay.com/itm/400W-12V-Thermoelectric-Cooler-Peltier-Plate-TEC-NEW-/111201613218

Powering the diode laser

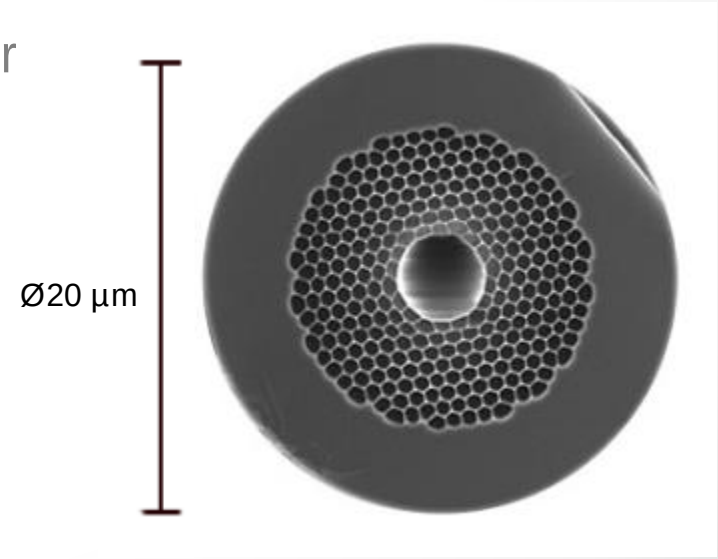


Cable: 6ft long



Future Works

- Align and fiber-couple the laser, fill a hollow core fiber with methane, and tune the laser to the resonance of the methane line
- Conduct absorption spectroscopy and sub-Doppler spectroscopy at 1.6 microns
- Develop sealed hollow-core fibers filled with methane absorbing laser light as a frequency reference.



https://www.thorlabs.com/thorproduct.cfm?partnumber=HC19-1550

Acknowledgements

Special thanks to:

- Dr. Kristan Corwin
- Dr. Brett DePaola
- Dr. Brian Washburn
- Ryan Luder
- Sajed Hosseini-Zavareh, Neda Dadashzadeh, Kushaan Weerasinghe, Manasa Thirugnanasambandam
- Fellow Physics REU Peers
- Dr. Brett Flanders
- Kim Coy

This work is partially funded by the National Science Foundation (NSF) and the Air Force Office of Scientific Research (AFOSR) through NSF grant number PHYS-1461251.

Questions?