NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Odyssey Research Programme
School of Physical and Mathematical Sciences

Optical Multiplexer for Laser Phase Locking

Ho Cheong Wei
Supervised by Assoc Prof David Wilkowski and Dr Das Swarup

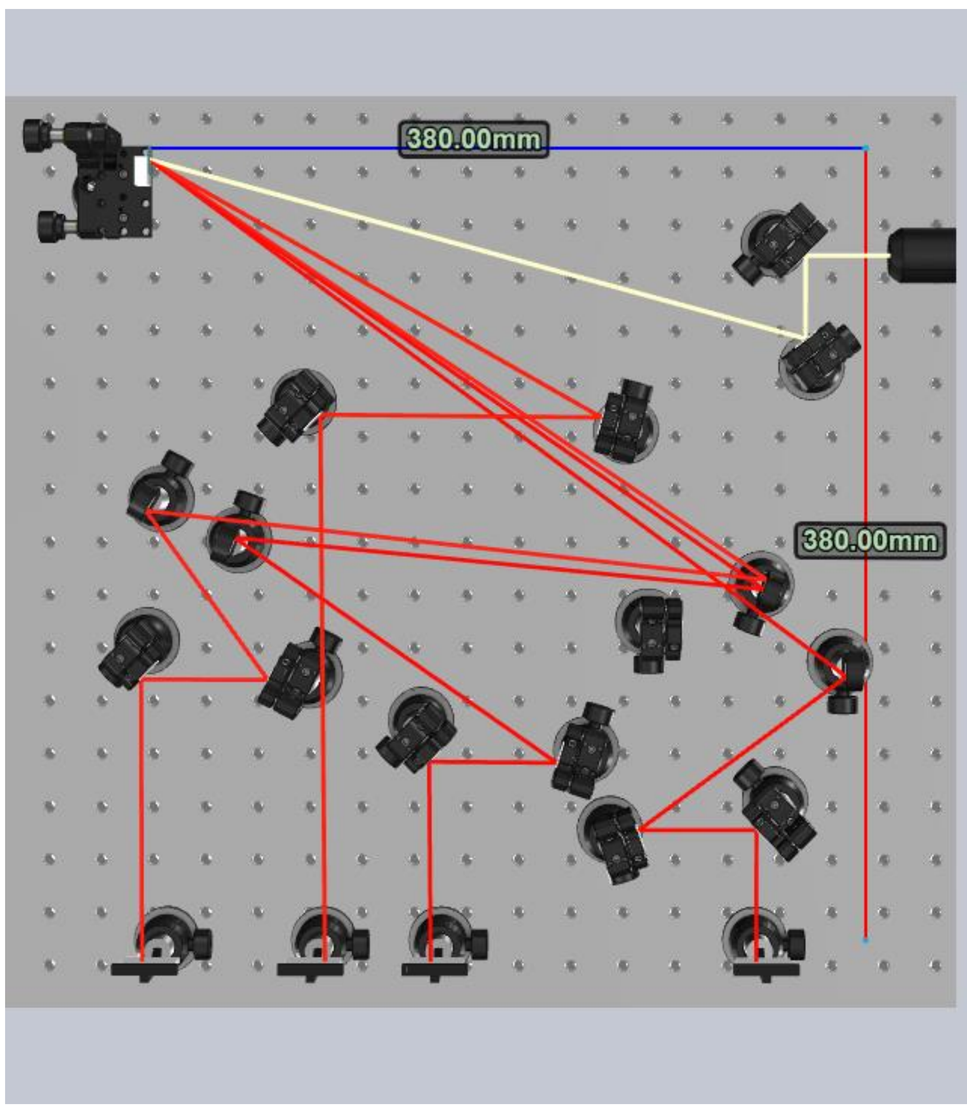
Introduction

The basic idea of this project is to measure certain wavelengths with a high level of precision. This is done using a self-referenced frequency comb. It references its own frequency to self-generated laser pulses. It doubles the lower frequencies of the comb, so it creates a 'comb' of frequencies with the same frequency difference. Overlapping the comb with a continuous wave laser allows us to phase lock to laser beam to a frequency of the comb. To a comb line, so to speak.

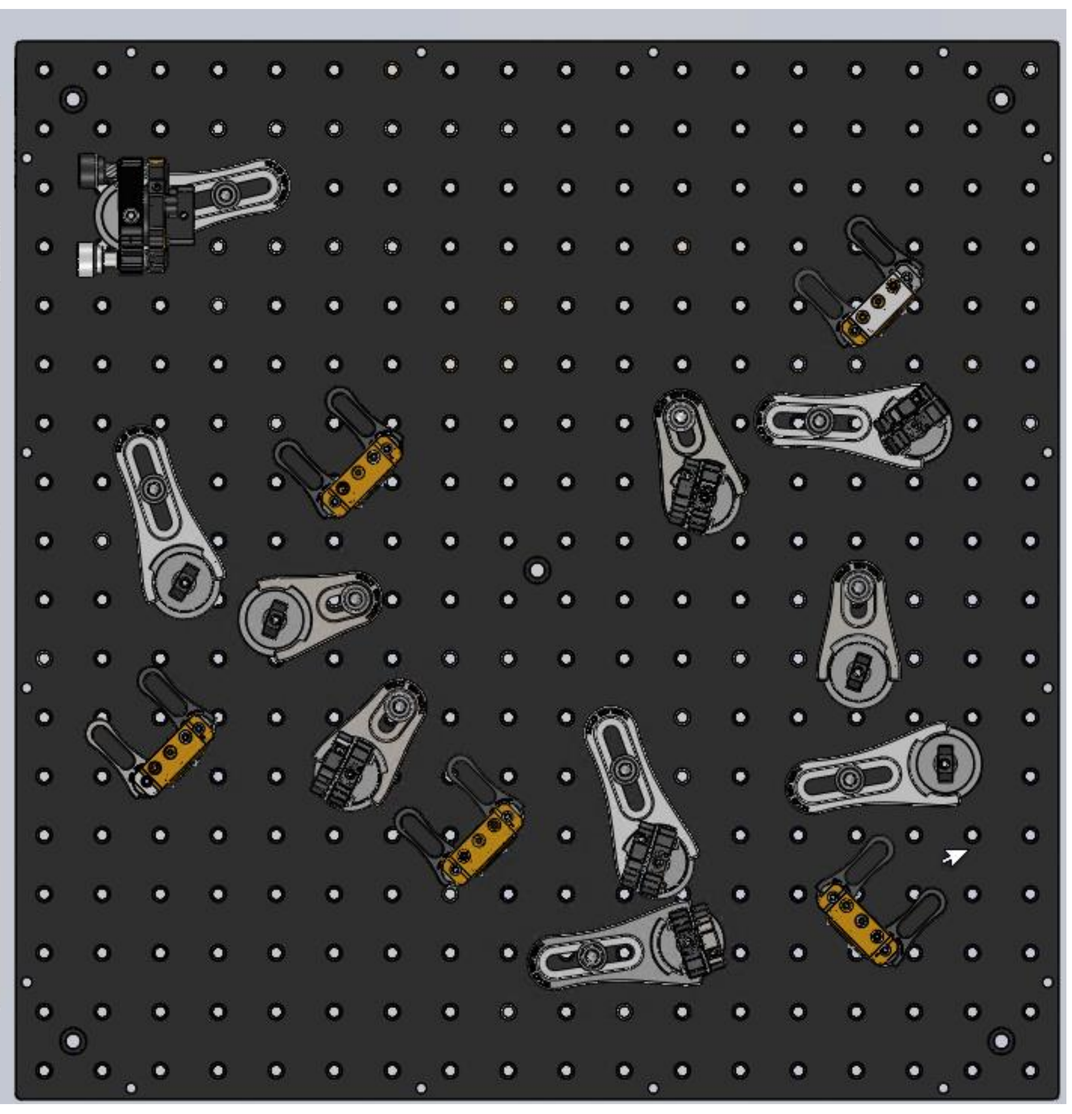
Practicality

There are a few things to consider when considering the practicality of the project. A frequency comb is expensive and 4 wavelengths are required. So, a setup would be needed to serve our purposes for more than 1 wavelength. There also needs to be a way to merge or separate the lasers' wavelengths from the frequency combs. The reversibility makes it so that the same design can be used for both merging and separating wavelengths.

3D Optix Model



Solidworks Model



3DOptix and Solidworks model side by side. 3DOptix was used for laser positions and Solidworks was used for proper mirror positions as well as output.

Graph of GR13-1205 Littrow angle efficiency curve. [**1**]

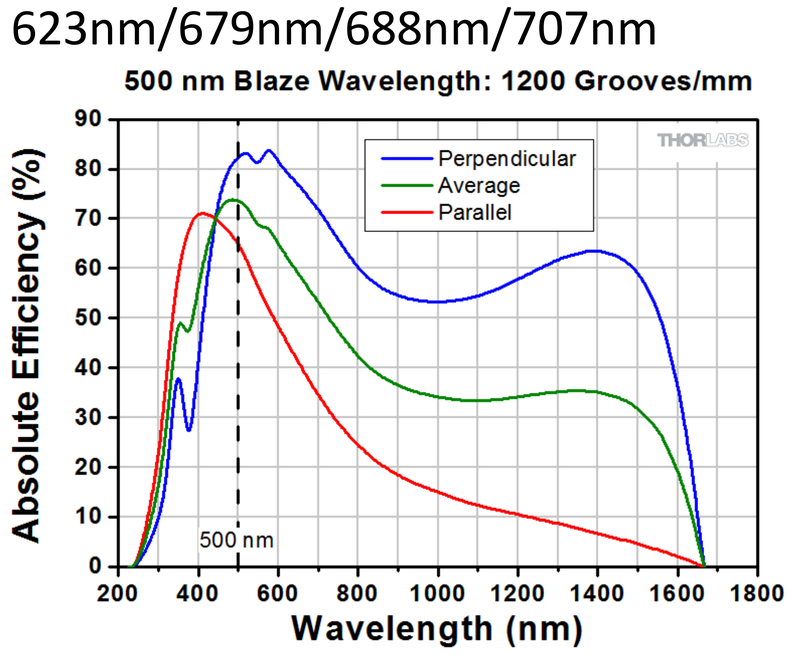
Details

The setup uses a diffraction grating and mirrors that are meant to be as energy efficient with the wavelengths used as possible. Precautions also have to be made with the diffraction grating so that it does not have unwanted orders of refraction from the grating. In this case, the incoming beam is at an angle of 15 degrees.

Uses

High precision measurements are useful for many things, as the device we are using is meant to supplement a larger project. Currently, said project is able to achieve a relative precision of 10^-10, but improvements are able to be made to this.

Frequencies used -
623nm/679nm/688nm/707nm



The frequencies should match with a diffraction grating with the highest efficiency curve, the GR13-1205 mirror satisfies this requirement the best.

Graph of GR13-1205 Littrow angle efficiency curve. [**1**]

References

[**1**] "Visible Ruled Reflective Diffraction Gratings", Thorlabs.com. [Online]. Available: https://www.thorlabs.com/images/tabImages/500_1200_Ruled_Grating_Efficiency_Graph_780.gif