# Capturing Lasers in a Maritime Environment


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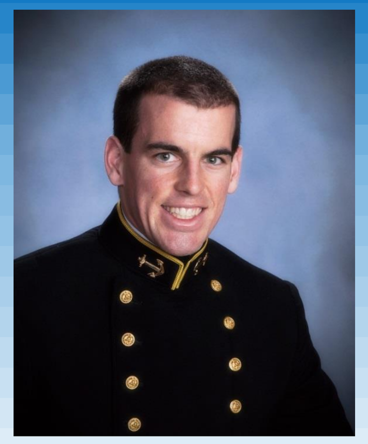


## Abstract


The need for laser detection is critical for today's military. On axis detection is the easiest method of detection, but is impractical in a combat environment. Instead, since lasers scatter due to particles in the atmosphere, a method of off-axis detection is preferred. This project experimented with a method to detect lasers from an off-axis position, and to map its trajectory in various environments.


## Background

Lasers can spread in several different methods. Diffraction occurs from the natural spreading of the laser as it propagates farther distances from the source. Scattering occurs when laser light hits particles in the atmosphere and reflects off of them. This project focused on using the principles of scattering to detect laser beams.

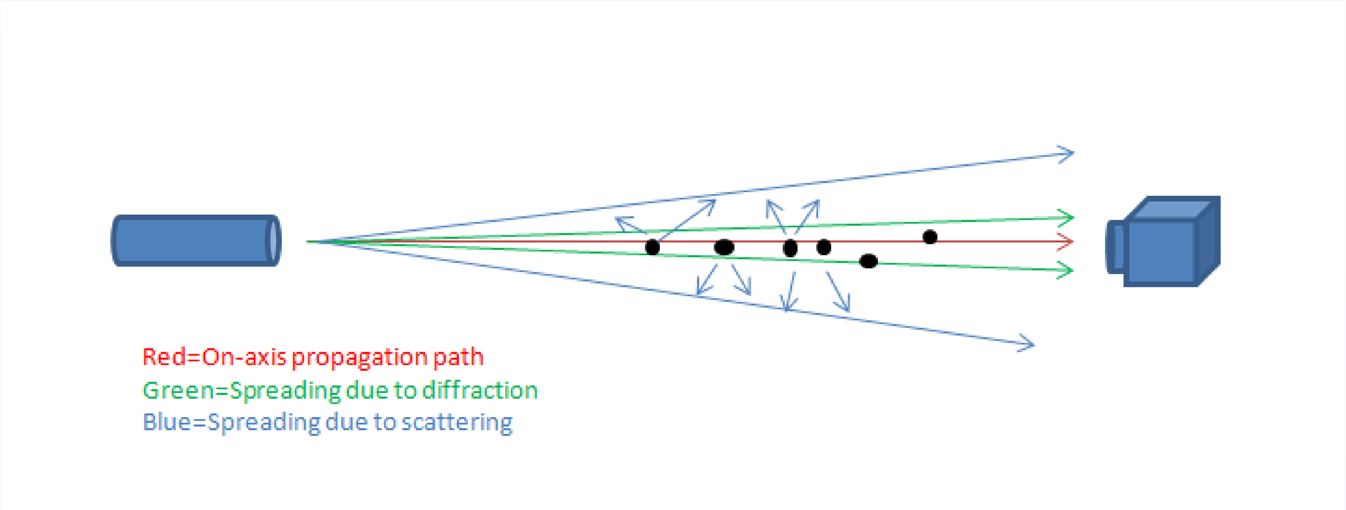



**Figure 1:** Different types of laser spreading

Slopes were used to determine 2 dimensions, and similar angles were used for 3rd dimension of travel.

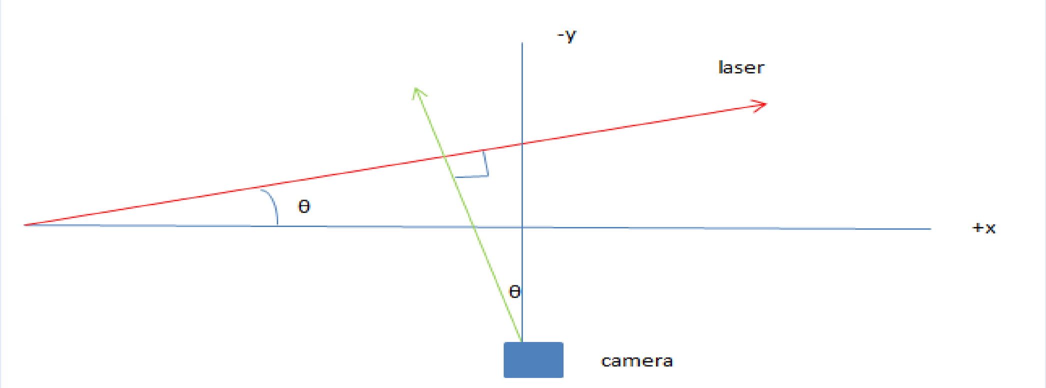



**Figure 2:** Illustration of Similar Angles

## Proof of Concepts

The initial experiments were conducted in a water tank.

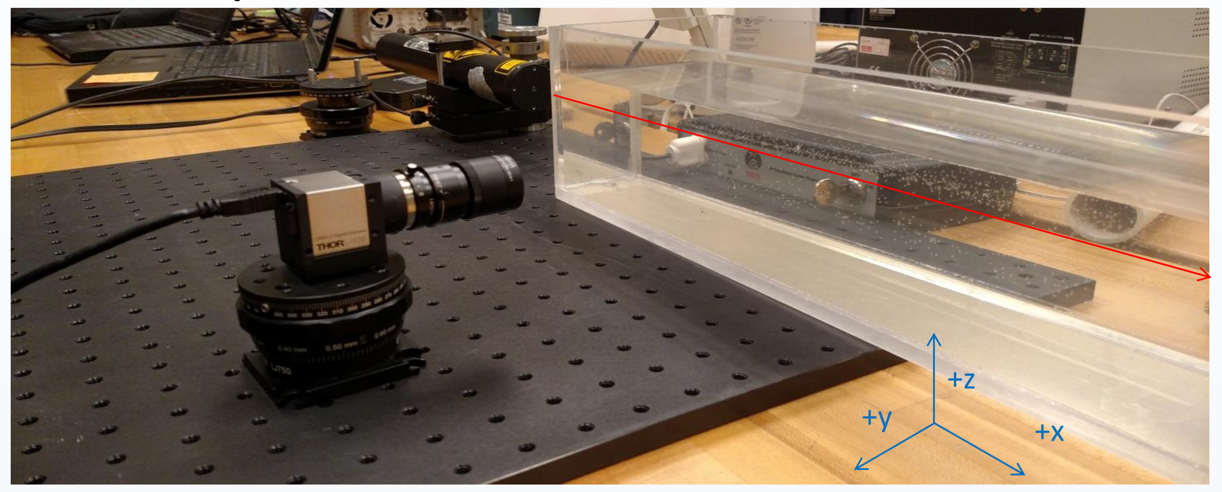
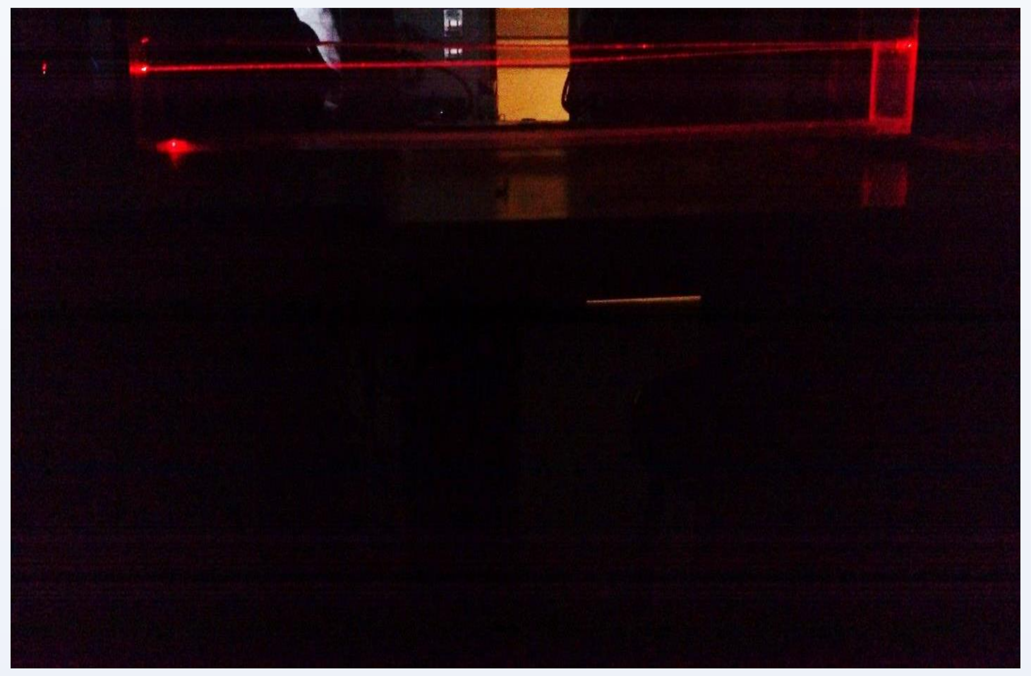
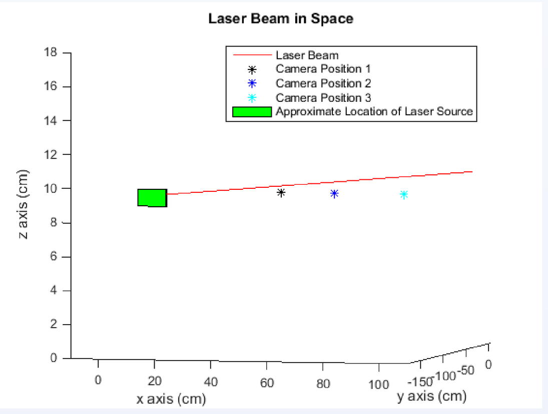



**Figure 3**: Setup for initial experiments

The code imported 3 images from a DCU223M CCD camera from Thorlabs to calculate the slope and direction of laser propagation.





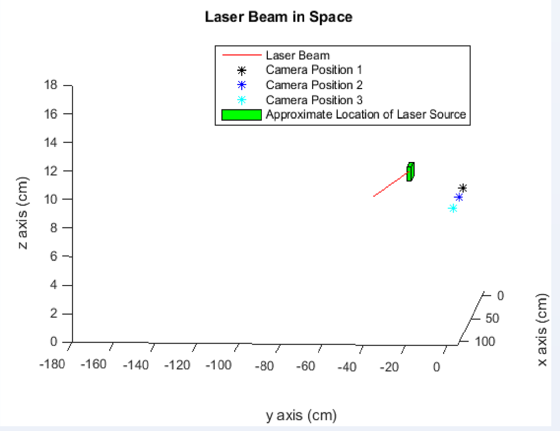
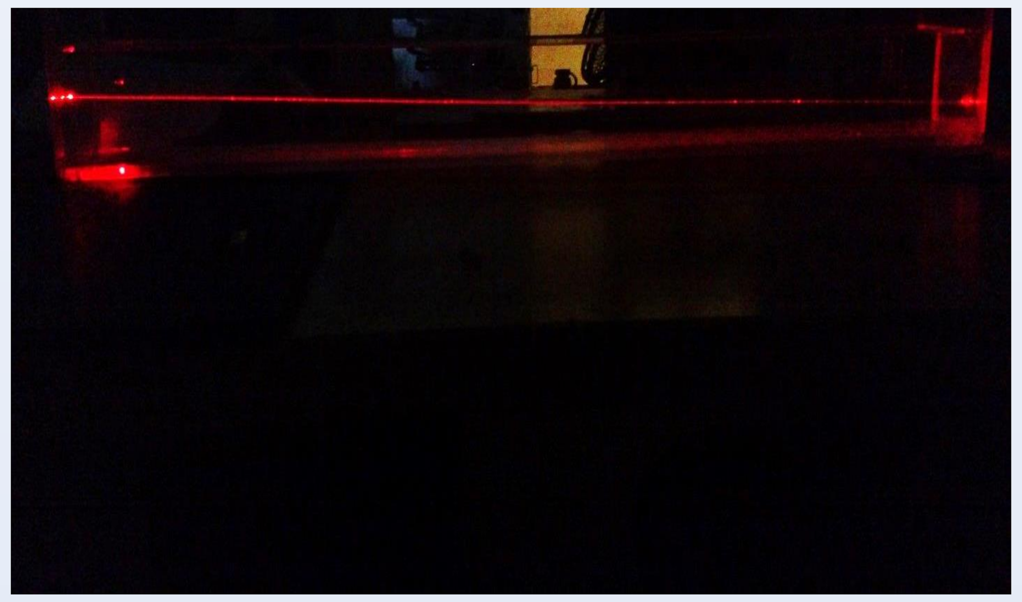
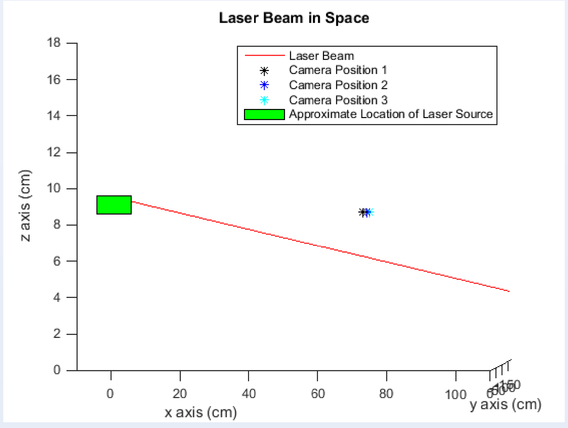




**Figure 4**: Laser Analysis for First Set of Tests

Error value of 0.25 cm or 0.83%

The camera distance from the laser was then increased and the lateral difference between images was decreased





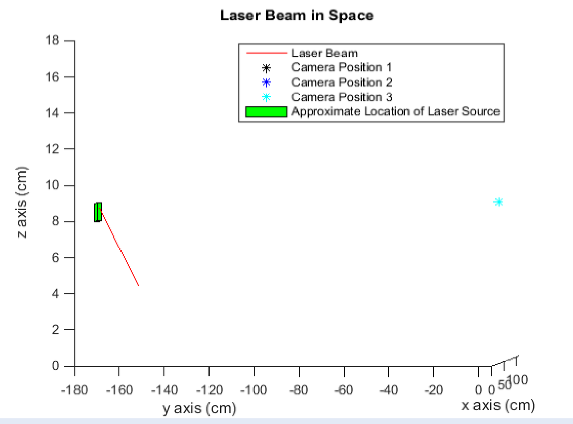




**Figure 5**: Laser Analysis for Second Set of Tests

Error value of 0.9 cm or 0.55%

## Atmospheric Testing

Tests were then moved to the Compartmentalized Atmospheric Tank (CAT)

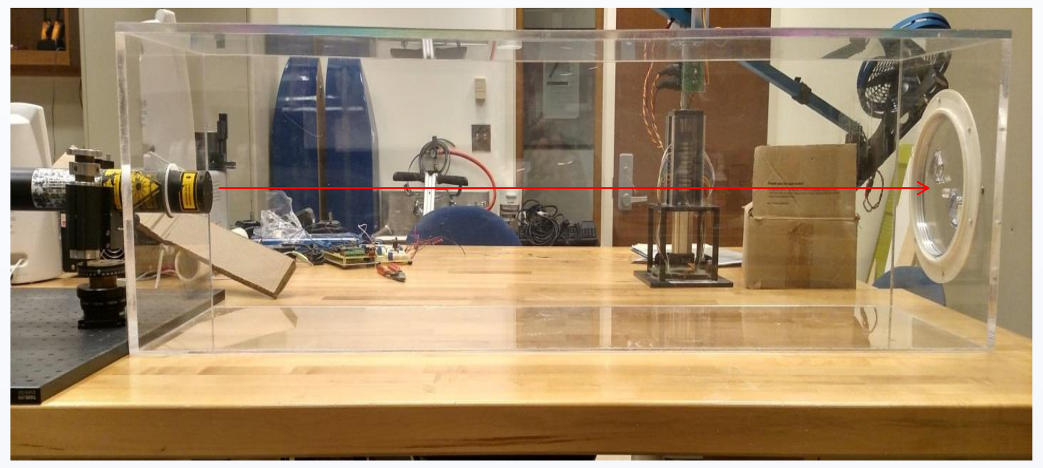
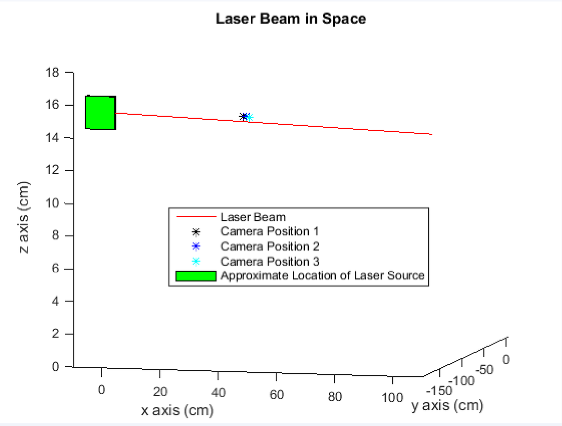
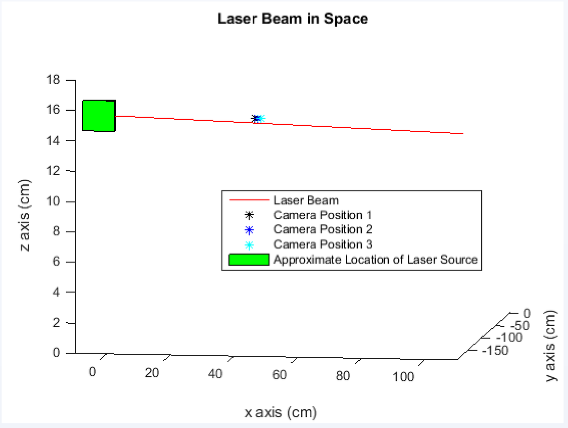


**Figure 6**: Setup for CAT Experiments




Analysis at 1.6 m

Analysis at 1.8 m

Errors extrapolated to 1 km: 100 m and 83.33 m

**Figure 7**: Laser Analysis for CAT Tests

## References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[4] Sprangle, Phillip, Joseph Penano and Bahman Hafizi. *Optimum Wavelength and Power for Efficient Laser Propagation in Various Atmospheric Environments*. Washingotn, DC, 25 October 2005. Journal.

[5] Hanson, Frank, et al. "Off-axis detection and characterization of laser beams in the maritime atmosphere." *Applied Optics* (2011): 3050-56.


## Acknowledgements


Prof. Svetlana Avramov-Zamurovic

Stephen Guth