Laser Propagation in an Ocean Environment

Midshipmen 4/C Mary Kelsey and Robert Rosenthal

Professors Reza Malek-Madani and Svetlana Avramov-Zamurovic, Mathematics Department

UNITED STATES NAVAL ACADEMY

Abstract

Observe the effects of salinity and temperature on laser propagation in an ocean environment.

Determine percent loss of transmission due to saline and turbulent factors.

Background

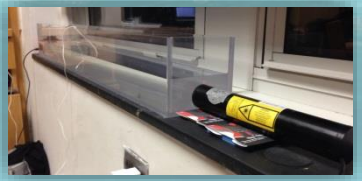
The group wanted to find out if using lasers underwater for data transmission, target painting, or obstacle detection could be feasible replacements for wire-guided systems and sonar.

Lab Materials:

- 110 g of table salt
- He-Ne THORLABS Laser
- Water Tank
- 12 L water
- Thermometer
- Coherent® Digital Camera
- THORLABS Neutral Density Filters
- MATLAB and BeamView software

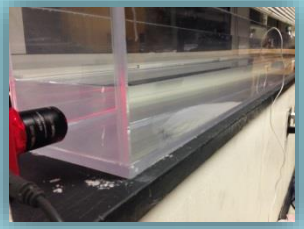
Methods

Water tank filled with fresh- and 18 ppt salt-water. Water temperature measured with thermometer ranged from 46-86°F.



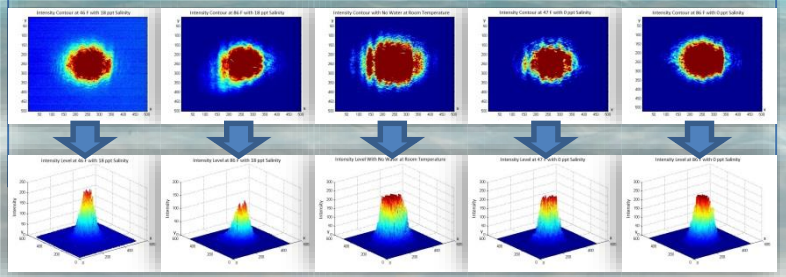
Laser is aimed at the camera from across the tank. The beam is allowed to propagate through the water into the filtered camera lens.

10-15 beam images on average were captured on camera and then saved. Data was collected over the 40-degree temperature range. Beam data was imported into MATLAB and analyzed.



Results

Raw beam images were cropped, laid on top of each other, and averaged to get a intensity contour. The third dimension was added based on the averaged intensity of the beam.



Conclusion

Salinity affects laser propagation loss more than temperature differences.

Lasers not yet feasible because 50-75% of signal loss occurs within one meter, and would be much greater through hundreds of meters of seawater!

References

Oceanic Salinity Data: http://www.onr.navy.mil/focus/ocean/water/salinity1.htm

Laser Specifications: http://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=1516&pn=HNL020L-JP

Acknowledgements

Professors Malek-Madani and Avramov-Zamurovic for help with data analysis, MATLAB scripts, and lab materials.

MGC for their help with creating the poster.