CAPTURING LASERS IN A MARITIME ENVIRONMENT

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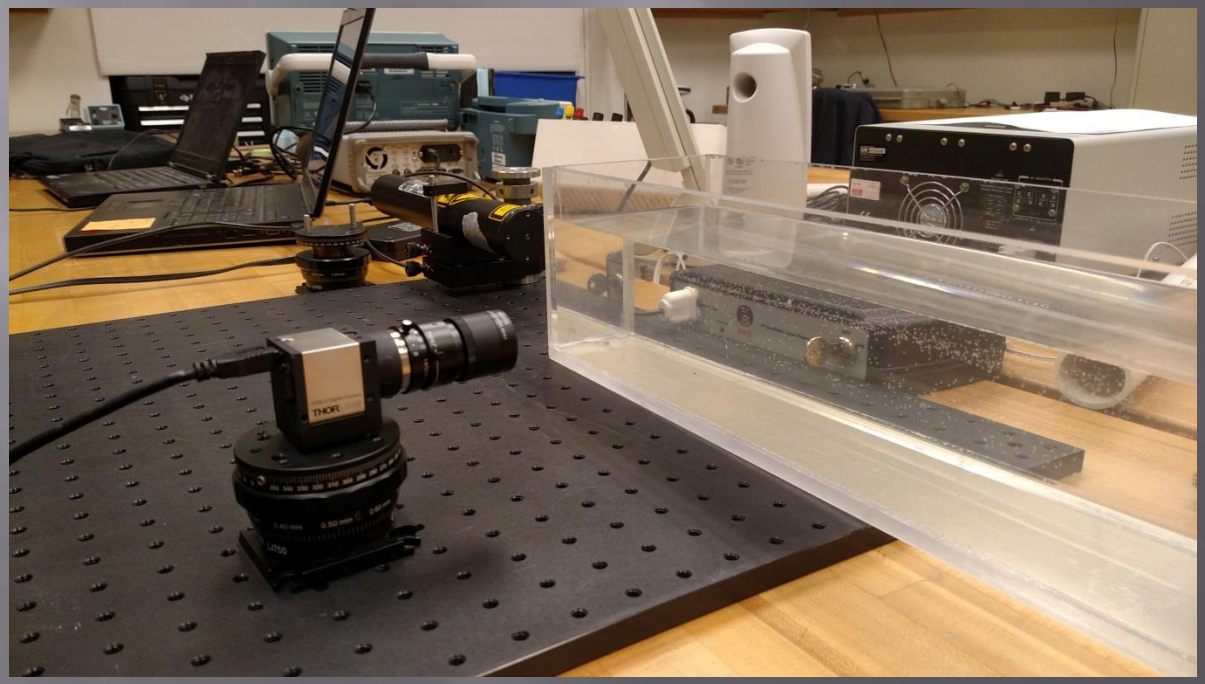
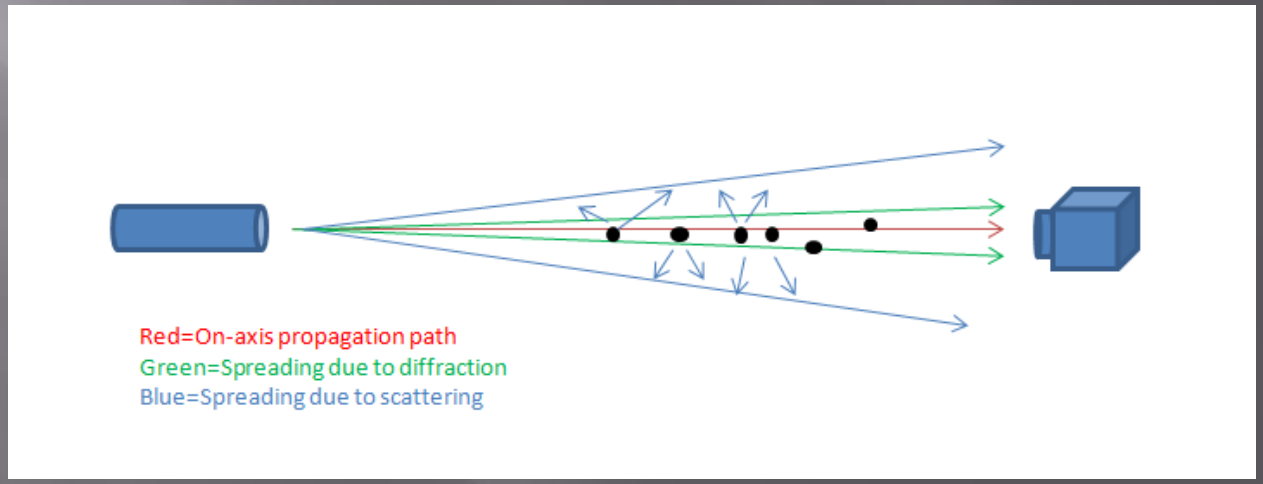
OBJECTIVE

- Find the beam from 1 camera location
- Determine propagation in xyz plane
- Extrapolate beam to find source



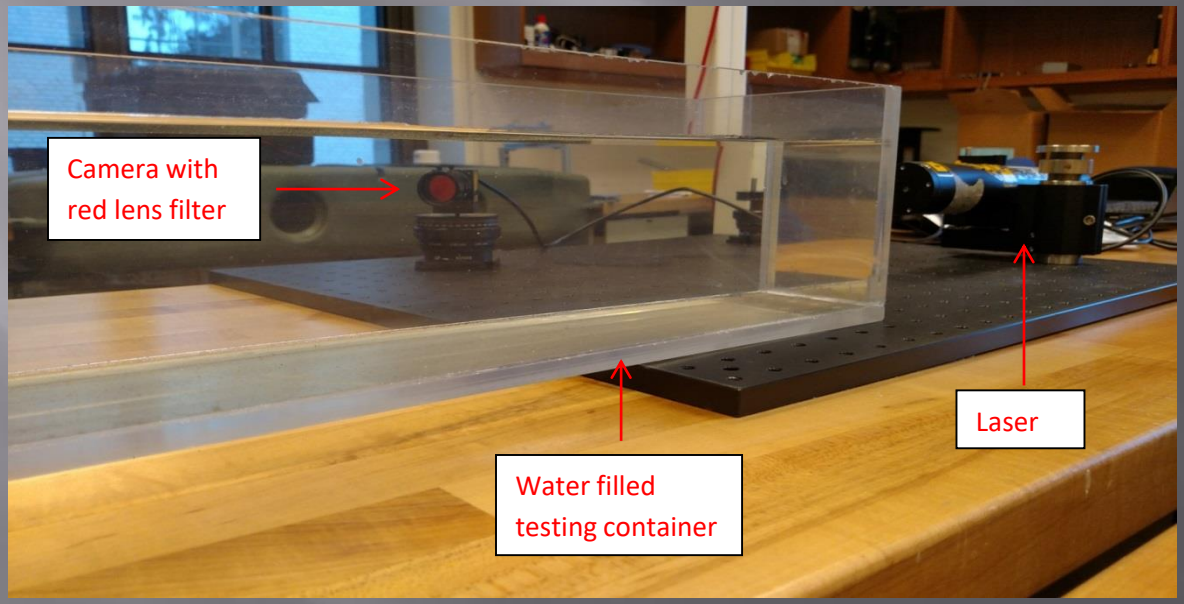
BACKGROUND

- Directed energy weapons of increased interest
- Necessary to find laser source
  - On-axis or off-axis detection
- Laser light spreads via 2 methods
  - Diffraction
  - Spreading



METHOD-FALL

- Use 2 camera locations
  - Allowed for use of plane geometry



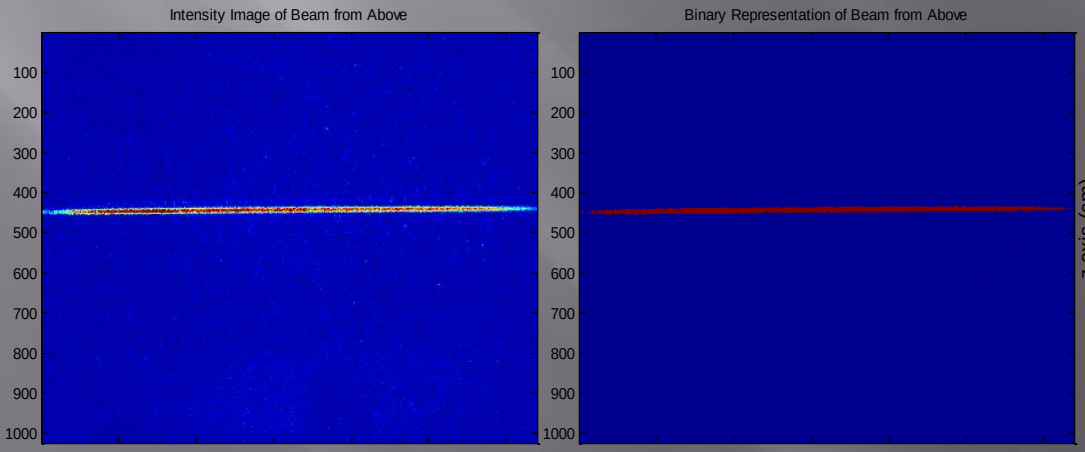
Side View x-z plane

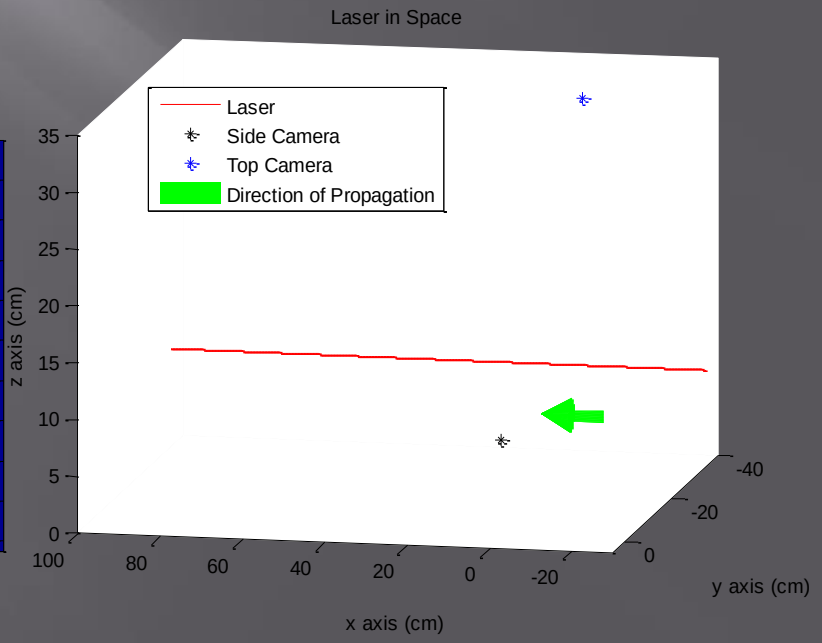
$$slope = \frac{\Delta z}{\Delta x}$$

Top View x-y plane

$$slope = \frac{\Delta y}{\Delta x}$$

How the code calculates beam slope



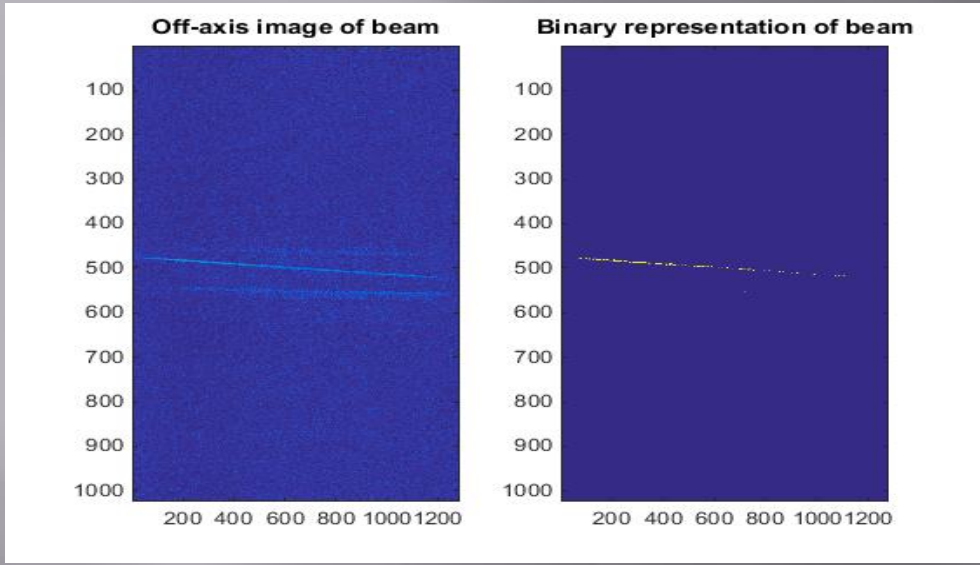


CONSTRAINTS AND METRICS

- Size of testing environment
  - Camera distance from laser
  - Size of testing compartments
- Laser power
  - Safety concerns limited to 2 mW

- Error within 0.5 cm
  - 0.5% of camera distance from laser

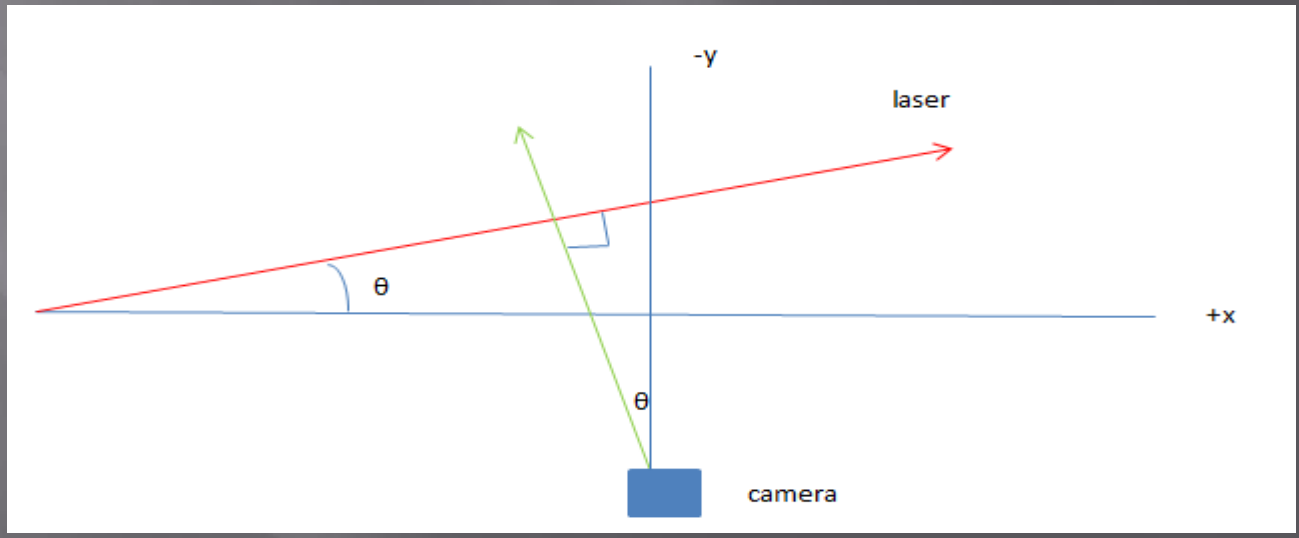
METHOD-SPRING

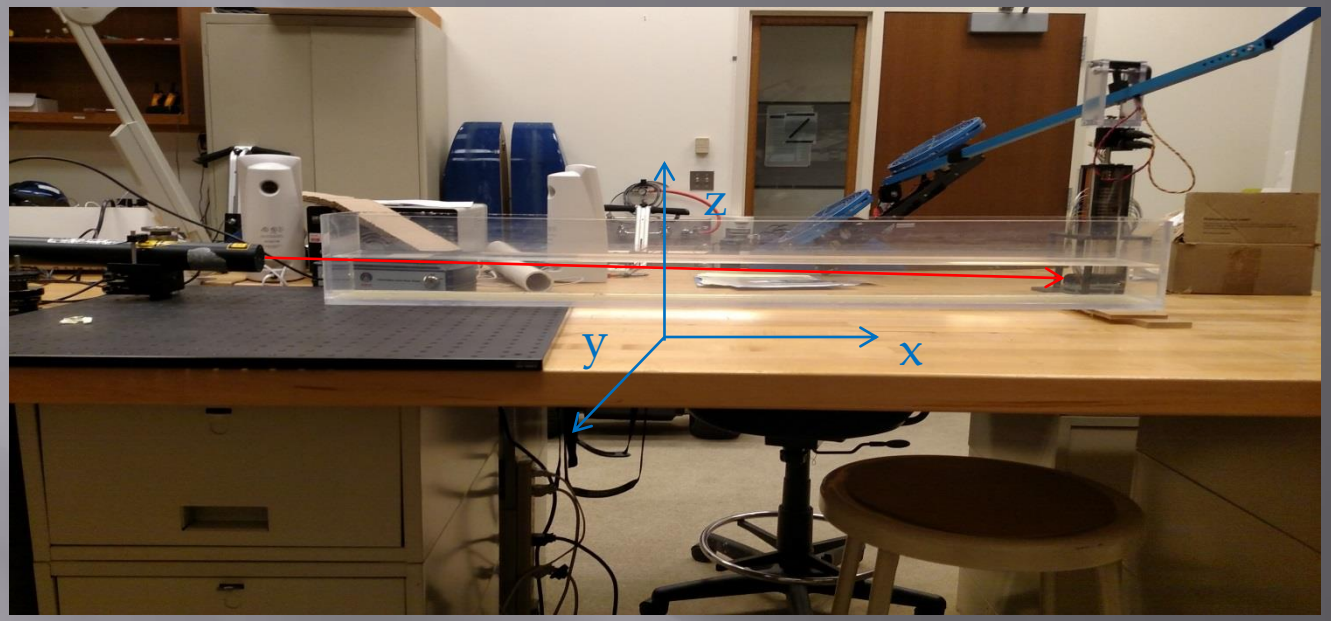


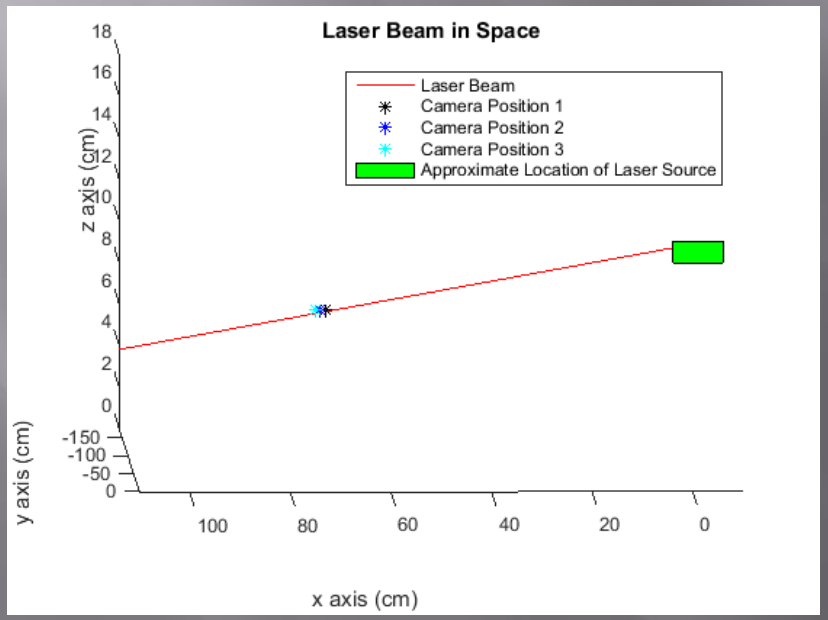
Slope and Direction for x-z plane based off intensity

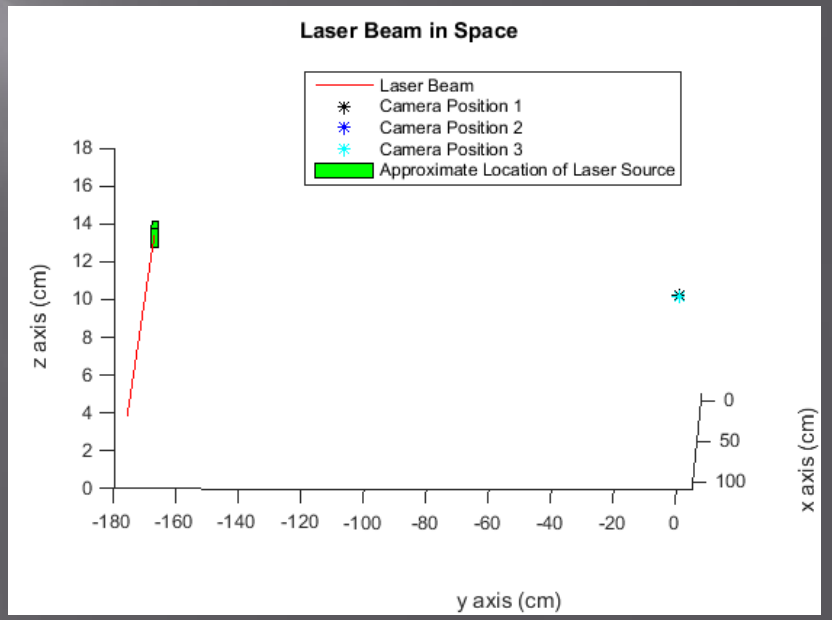
Similar Angles for x-y plane

$y=x*\tan(\theta)$





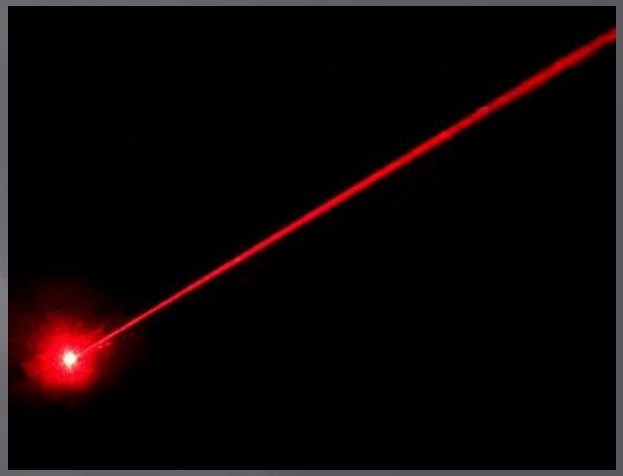




Absolute Error: 0,9 cm or 0.55%

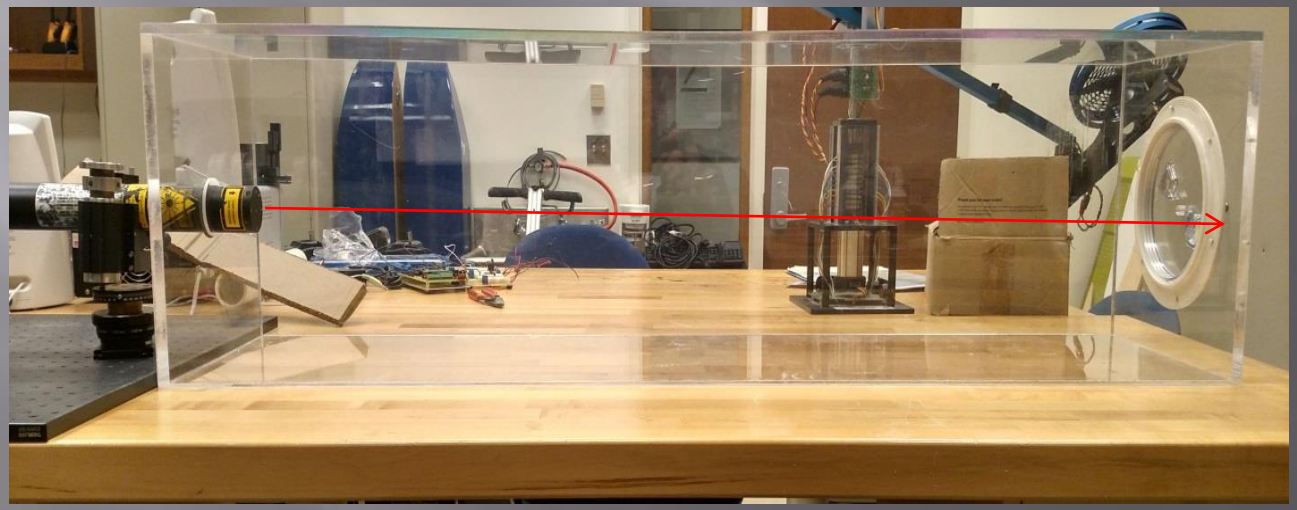
ANALYSIS AND LIMITS

- Determine slope of beam
  - 'polyfit' command used on intensity images
- Determine x-y component
  - Utilizes similar angle of two perpendicular lines
- Static environment
  - Water provides unrealistic stability in environment
  - Laser easily seen
  - Limited testing distance
- Error slightly larger than desired metric



ATMOSPHERIC TESTING

- Testing in more dynamic environment
  - Utilize smoke machine
  - Determine error in distance measurement

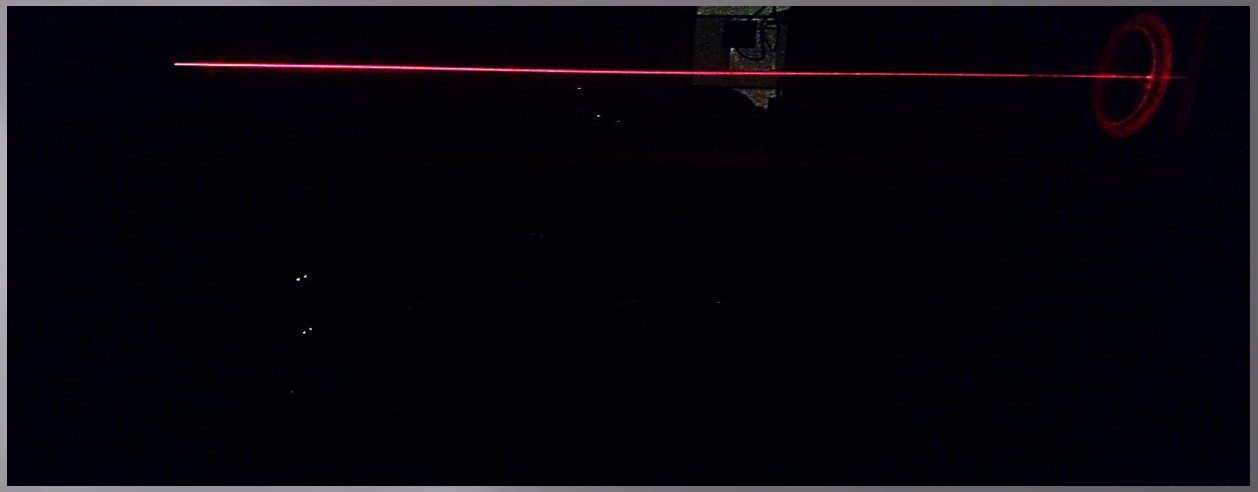


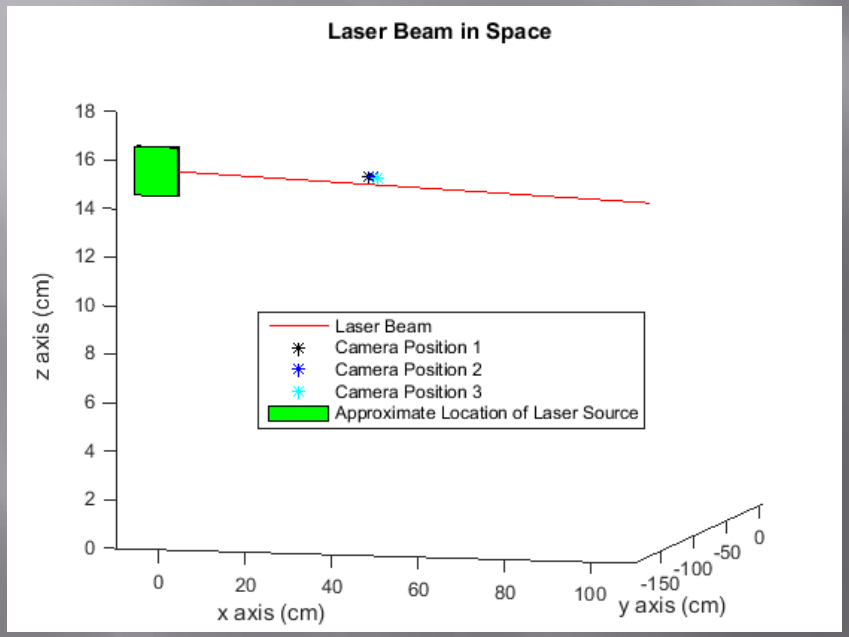
Compartmentalized Atmospheric Tank (CAT)

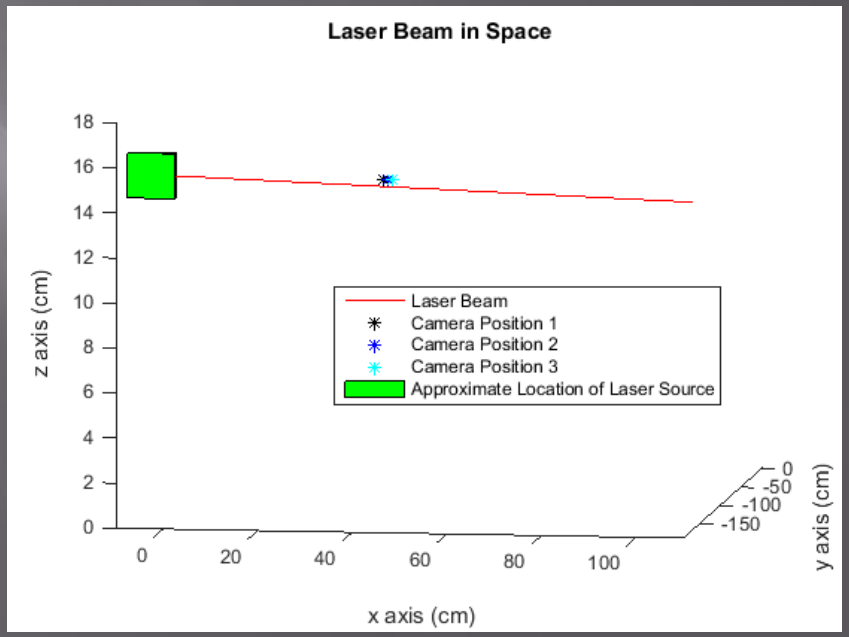
ATMOSPHERIC DATA

- Outside
  - 61°F
  - 58% humidity
  - 30.3 inHg
- Inside Tank
  - 75°F
  - 36% humidty
  - 29.92 inHg

Weather@Home Multi Channel Sensor from OregonScientific







Absolute Error at 1.6 m : 0.16 cm

Absolute Error at 1.8 m : 0.15 cm

Errors Extrapolated to 1 km : 100 m and 83.33 m respectively

ANALYSIS AND LIMITS

- Almost met metric for lab environment
  - Inaccurate at longer distances
- Unable to vary conditions inside CAT
- Showed need for improvement
  - More precise distance measurement
  - Less reliance on similar angles
    - Potential solution: power vs distance relationship

PARTS LIST

- Water Tank
- CAT
- 2 mW HeNe Laser
- DCU223M Camera
- Red Notch Filter
- Weather@Home Sensor
- Laptop

TIMELINE

- Geometric and Trigonometric Equations (4 wks)
  - One camera perspective
  - Theoretical phase
- Laser Testing in Lab Environment (10 wks)
  - Determine beam slope in 3 dimensions
  - Minimize variation
  - Compare computations to actual measurements

QUESTIONS?