DIFFRACTION

Experimental Collaboration From University of Colorado Denver

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OUTLINE

- Introduction
- Core Ideas
  - The Diffraction Pattern
    - The wave aspects of light
    - Effects of aperture width
    - Optical geometry and optical wavelength
    - The location of peaks
    - Fresnel (or Near) Field and Fraunhofer (or Far) Field
  - Other Aspects of the Light Source
    - Wavelength
    - The light source may effect a diffraction pattern
    - The aperture and the coherence of the source
    - The light intensity
- Experiment
  - CCDs
  - Laser
- Data Analysis
  - Data fitting to the curves or Newton's method
  - Determining the angles of diffracted light without damaging the CCD

CORE IDEAS

The diffraction pattern

Other aspects of the light source

THE DIFFRACTION PATTERN

- The wave aspects of light
- Effects of aperture width
- Optical geometry and optical wavelength
- The location of peaks

$$\frac{D}{2}\sin\theta = \frac{\lambda}{2}$$

- Fresnel or near field and Fraunhofer or far field

$$F = \frac{R^2}{D\lambda}$$

OTHER ASPECTS OF THE LIGHT SOURCE

- Wavelength
  - $y = A\ \sin(kx - \omega t)$
- The light source may effect a diffraction pattern
- The aperture and the coherence of the source
- The light intensity
  - Beam Quality

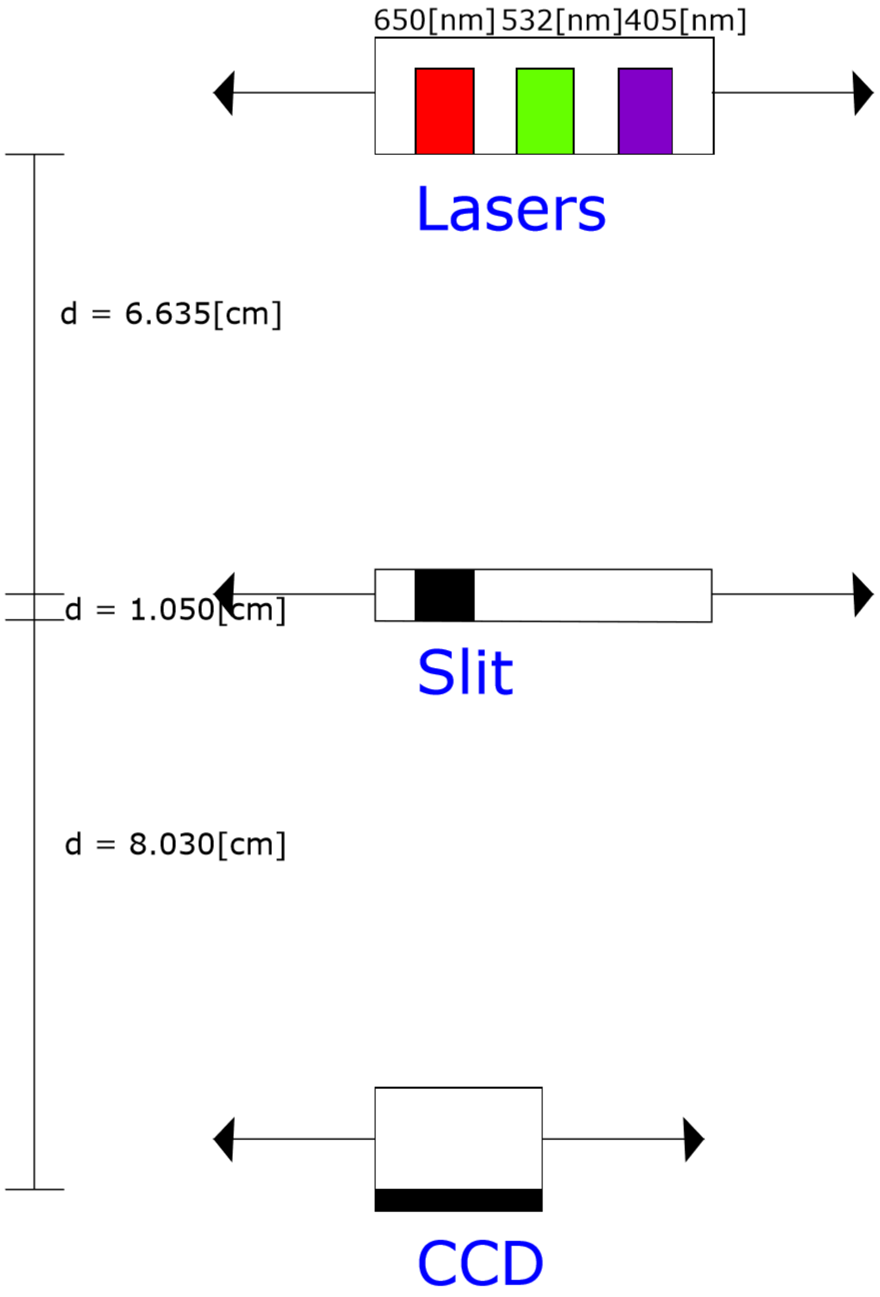
EQUIPMENT

CCD Detectors

Laser

EQUIPMENT AND EXPERIMENTAL SETUP

CCDS
LASERS

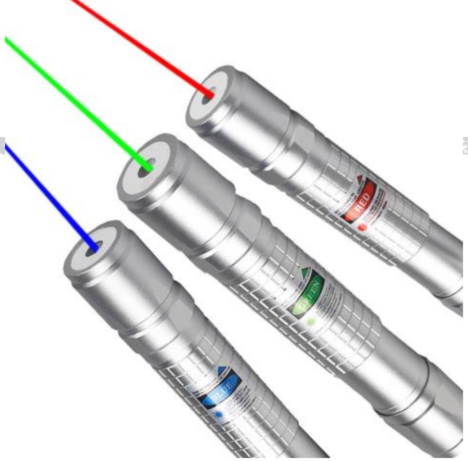


What is not listed here is our computer setup. The CCD we used was a webcam with the lens removed; this plugged directly into the computer, which we used to operate it and save our data. This data was then translated into a matrix by MatLab, which we used to do our data analysis.

Distances were measured externally to avoid damaging any of the equipment.

CCD'S

- Measure intensity of light
- Multiple electrodes per pixel measure different colors
- Potential wells attract electrons – more electrons at brighter regions
- Quantum Efficiency
- Noise – Physical damage, Thermal



LASER

- Source which produces a very narrow beam of light
- It is different from a light bulb or a flash light
- Beam Quality
  - $I(r) = I_0\ e^{-2(\frac{r}{w})^2}$
  - I= peak intensity (in the center of spot)
  - W= beam radius (1/e^2)

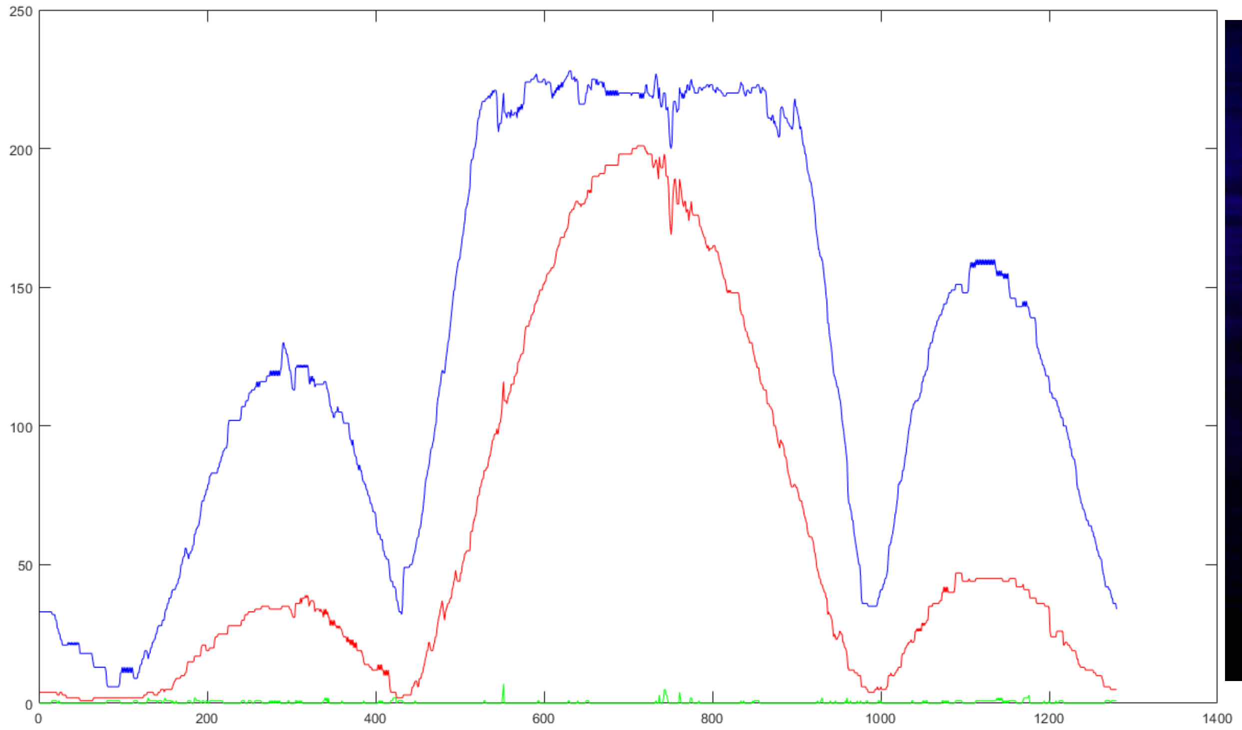
DATA ANALYSIS

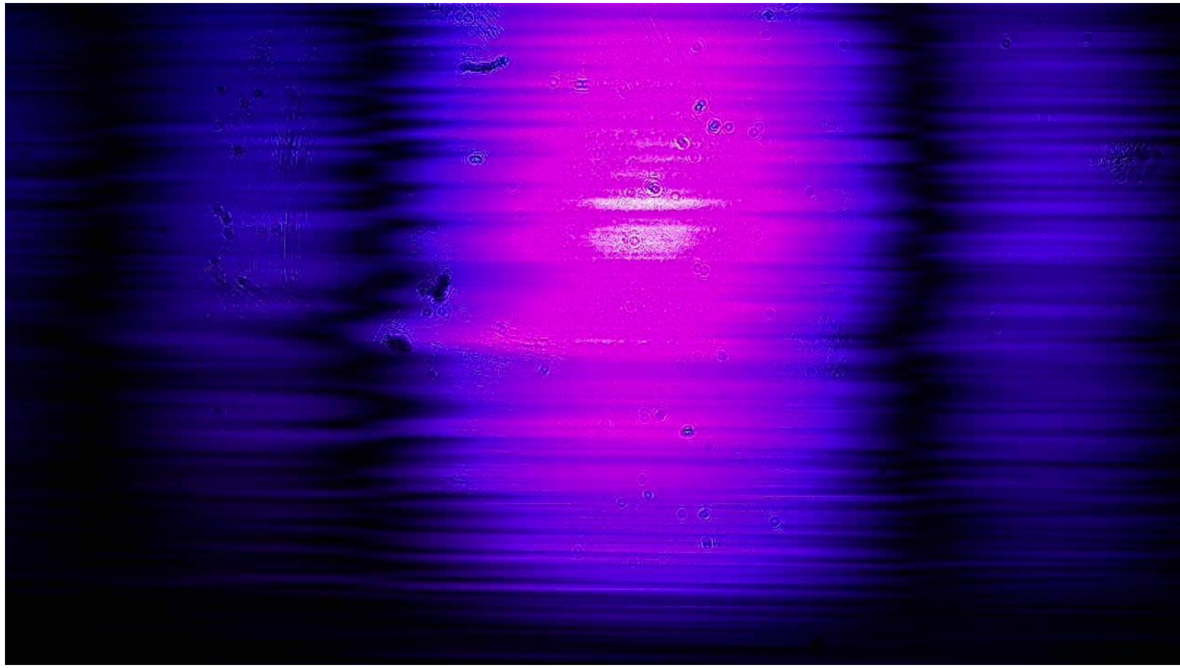
CALCULATED PIXEL SIZES USING ANGLES

Slit:/Wavelength:	650[nm] (R)	532[nm] (G)	405[nm] (V)
0.04[mm]	18[μm]±6[μm]	29[μm]±10[μm]	1.6[μm]±0.2[μm]
0.08[mm]	11[μm]±3[μm]	6.4[μm]±2.1[μm]	1.6[μm]±0.1[μm]
0.16[mm]	1.8[μm]±0.6[μm]	2.4[μm]±0.9[μm]	2.1[μm]±0.5[μm]

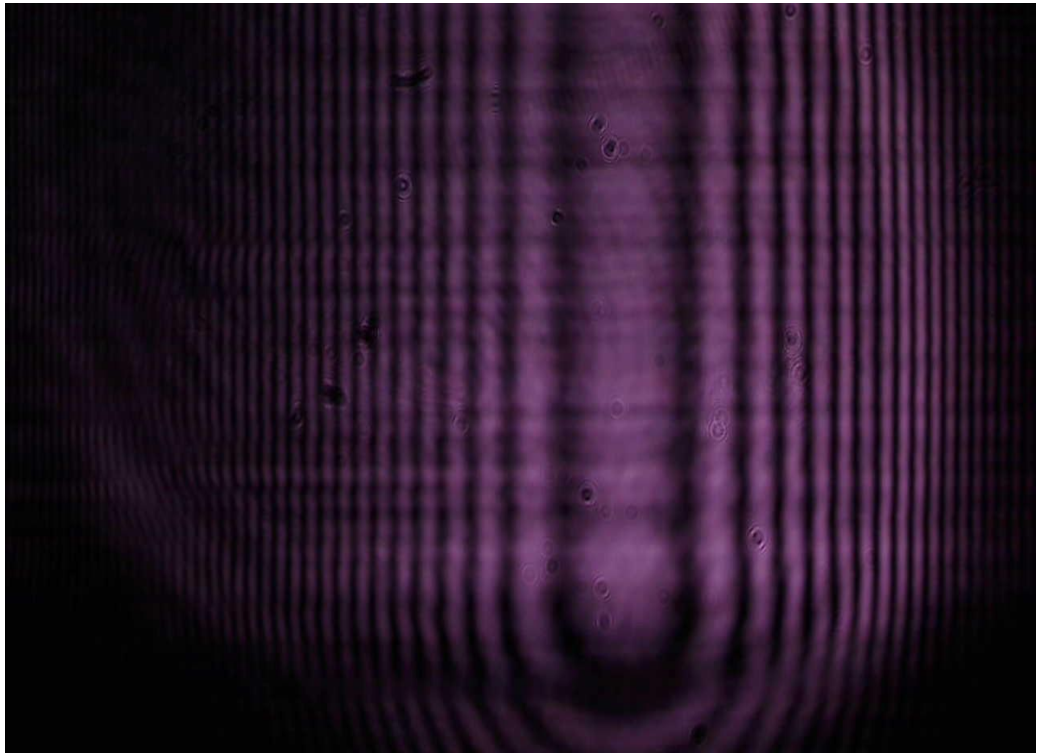
$\frac{D}{2}\sin\theta = n\frac{\lambda}{2}$ Substitutes into $\frac{ns}{d} = \sin\theta$ Which we can average to get our pixel size.

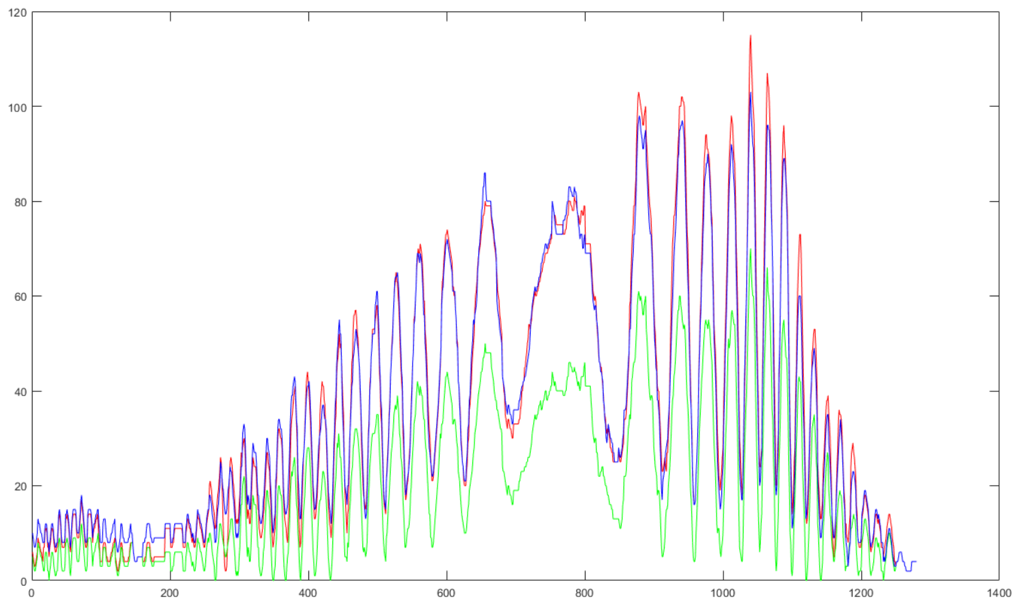
V 0.04





G 0.04





REFERENCES

- CCDs:
  - McFee, Chris. "An Introduction to CCD Operation." *UCL Department of Space & Climate Physics Mullard Space Science Laboratory*, www.mssl.ucl.ac.uk/www_detector/ccdgroup/optheory/ccdoperation.html
- Near and Far Fields:
  - Laserist. "Optics Notes." *Near Field and Far Field*, 1 Jan. 1970, laseristblog.blogspot.com/2011/12/near-field-and-far-field.html