Optics Lab: An overview

List of Experiments

- Optical Activity
- Faraday's Effect
- Michelson Interferometer
- Ellipsometery

- Reflection, Transmission and Fresnel's coefficients
- Interference and Diffraction
- Scanning Fabry Perot interferometer
- Basic properties of Laser diode
- Polarization

- Debye Spear's velocity of sound
- Diffraction Grating
- Frustrated Total Internal Reflection
- Zeeman Effect
- Optical Pumping

Reflection, Transmission and Fresnel's coefficients

Experimental Objectives:

- Working with optical components
- Investigation of polarization by reflection
- Verification of Fresnel's equations
- Finding the Brewster's angle
- Finding the Refractive index of thin micro scope slide

Experiment

- Drive Fresnel's Coefficients, r_s, t_s, r_p and t_p

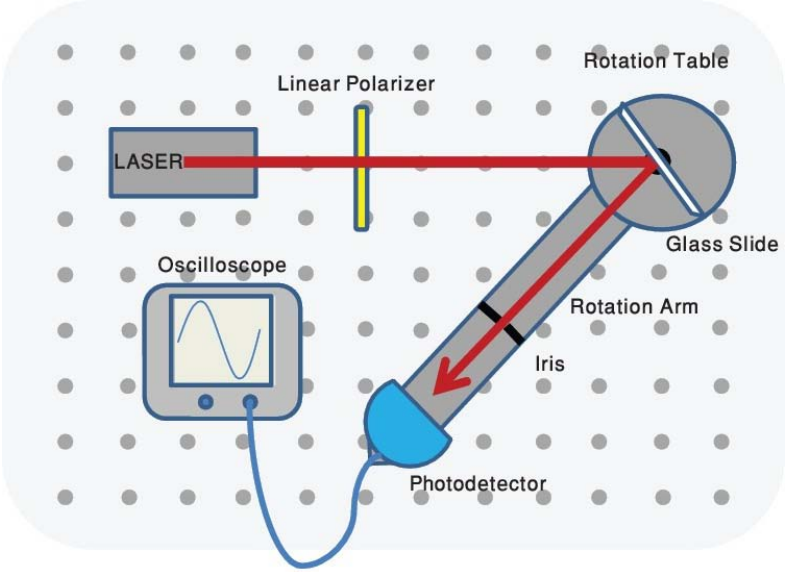
$$r_s = \frac{E\_rs}{E\_is} = \frac{n_i cos\theta_i - n_t cos\theta_t}{n_i cos\theta_i + n_t cos\theta_t}$$

$$r_p = \frac{E\_rp}{E\_ip} = \frac{n_i cos\theta_t - n_t cos\theta_i}{n_i cos\theta_t + n_t cosi}$$

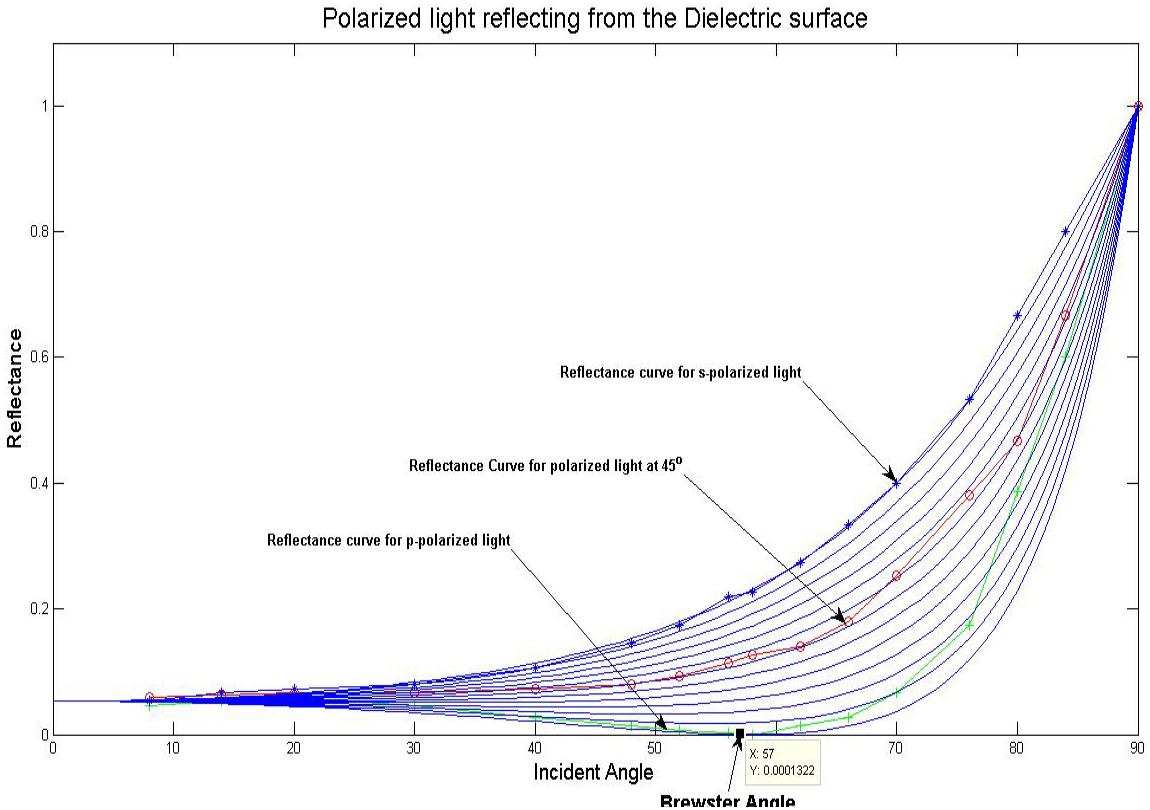
$$t_p = \frac{E\_tp}{E\_tp} = \frac{2n_i cos\theta_i}{n_i cos\theta_t + n_t cos\theta_i}$$

$$t_s = \frac{E\_ts}{E\_ts} = \frac{2n_i cos\theta_i}{n_i cos\theta_t + n_t cos\theta_i}$$

- Find the Brewster angle for p- polarized light
- Find index of refraction
- Predict the reflectance curves by Matlab simulations
- Collect the data for Rp, Rs, R_{45} for all possible incident angles
- Plot data


Rotation Table
Linear Polarizer
LASER
Glass Slide
Oscilloscope
Rotation Arm
Iris
Photodetector

Results


Polarized light reflecting from the Dielectric surface
Reflectance
Incident Angle
Reflectance curve for s-polarized light
Reflectance Curve for polarized light at 45°
Reflectance curve for p-polarized light
X: 57
Y: 0.0001322
Brewster Angle
0
0.2
0.4
0.6
0.8
1
0
10
20
30
40
50
70
80
90

Interference and Diffraction

Experimental Objectives:

- Superposition of waves
- Interference condition
- Fraunhoufer diffraction
- Single slit and double slit diffraction patterns
- Babinet's principle: opposite of a slit

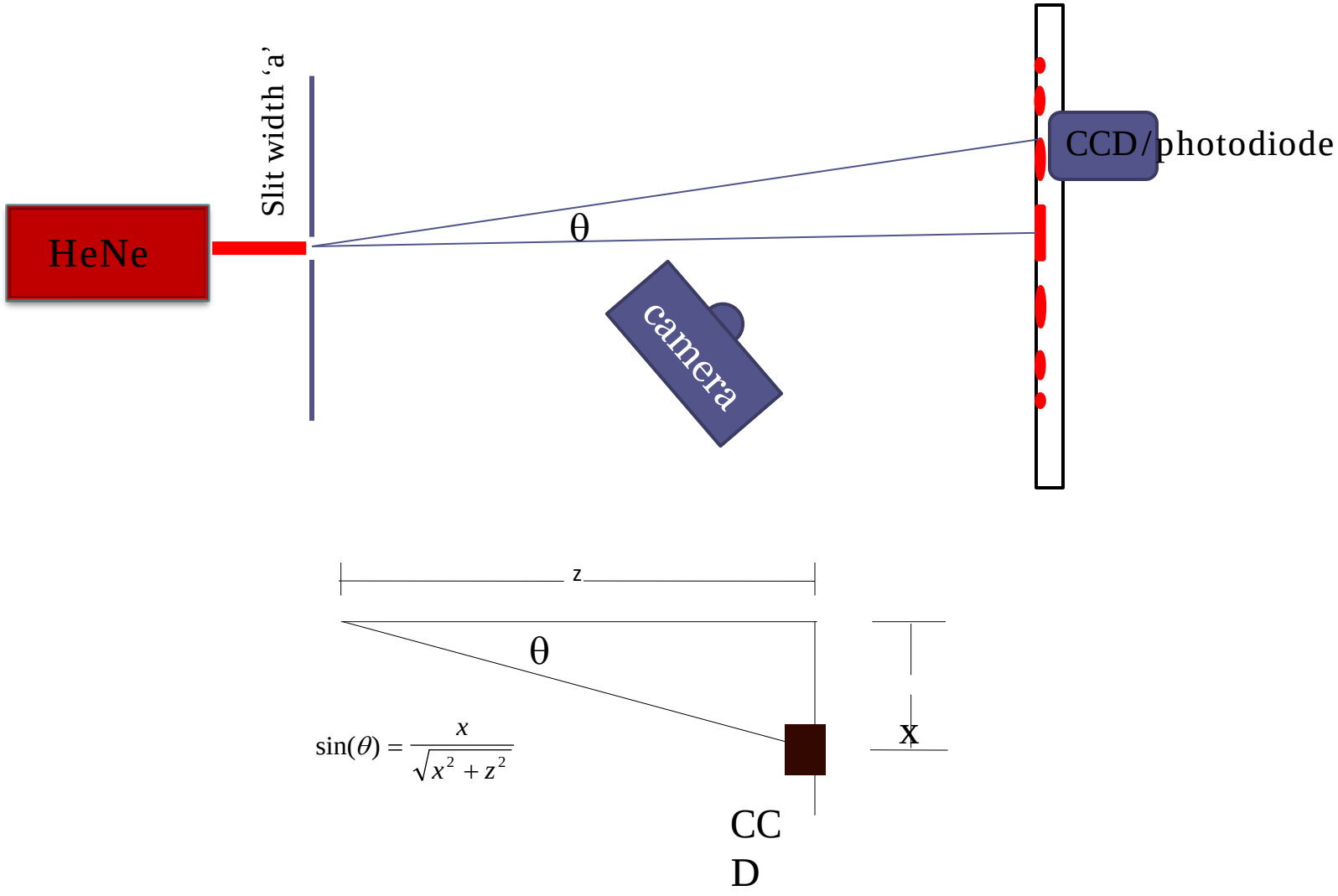
Experiment

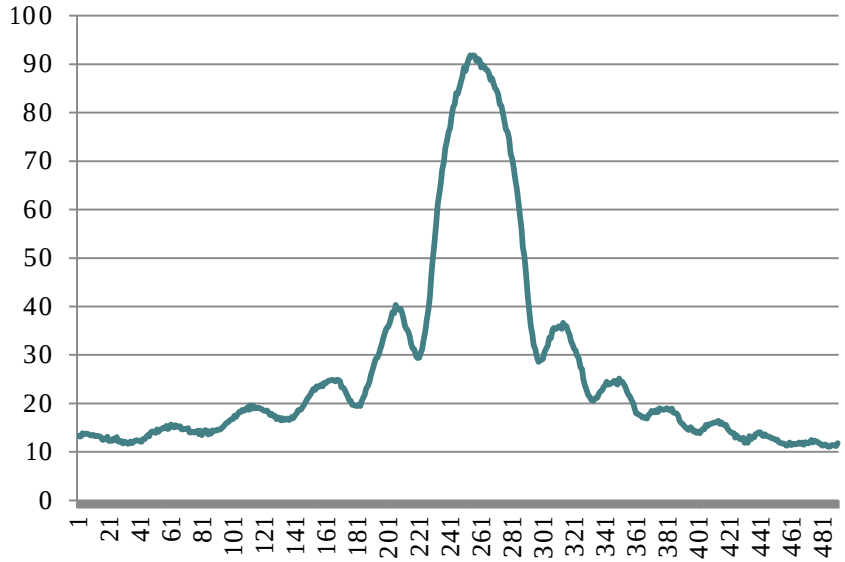
- Predict the angular dependence of intensity of the diffracted light

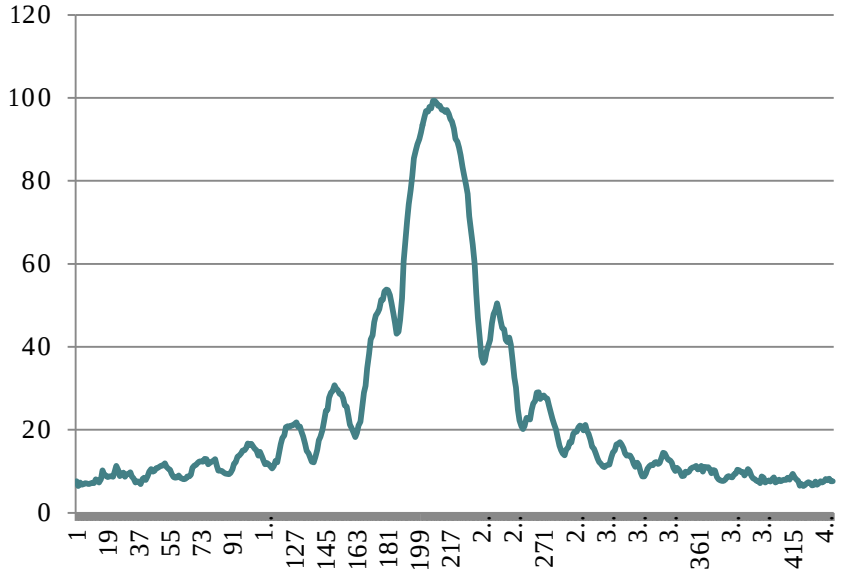
$$I = I_0 \frac{\sin^2(\beta)}{\beta^2}$$

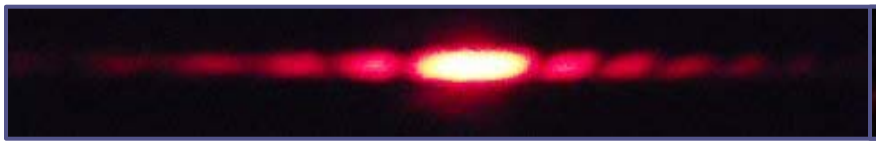
where, $\beta = \frac{2\pi}{\lambda}\frac{a}{2}\sin(\theta)$, a is the slit width and θ is the angle between the normal to the slit and the distance to the observation point.

- Measure the angular dependence of intensity of diffracted light for different slit widths
- Calculate the width of the central maximum $\Delta x_0 = \frac{2\lambda z}{a}$
- Do the same for double slit diffraction patterns
- Analysis of interference pattern for double slit
- Verification of Babinet's principle


Slit width 'a'
HeNe
θ
camera
CCD/photodiode
z
θ
x
$\sin(\theta) = \frac{x}{\sqrt{x^2 + z^2}}$
CC
D

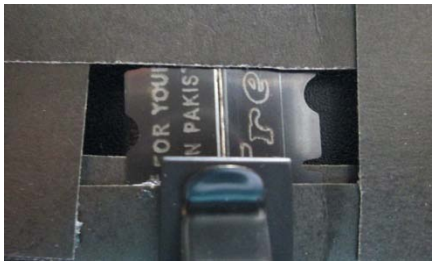


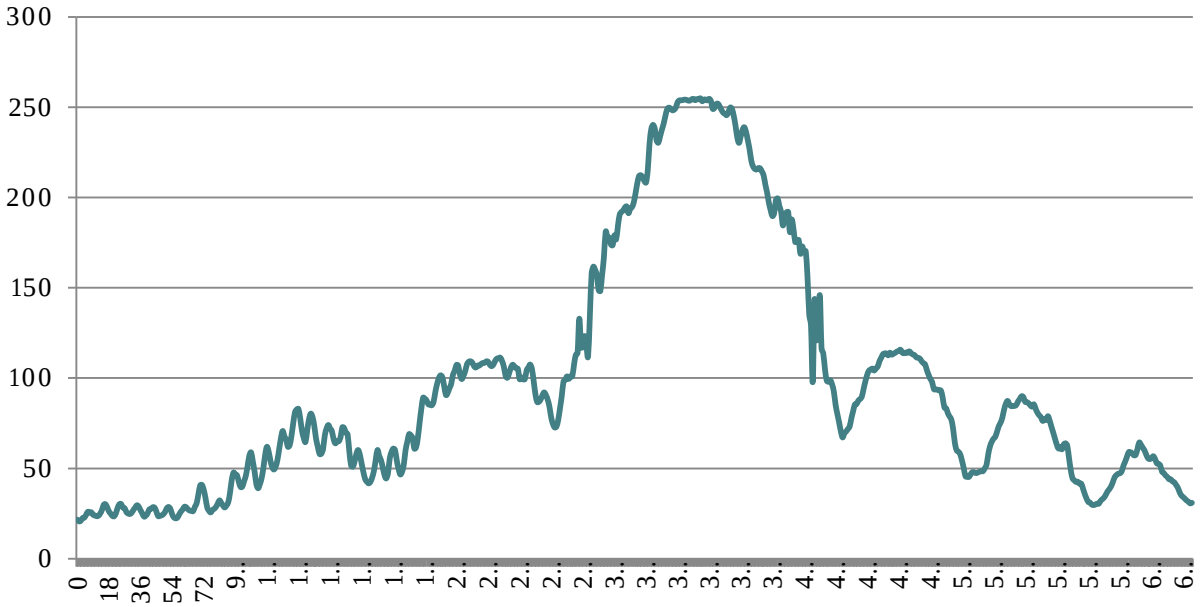


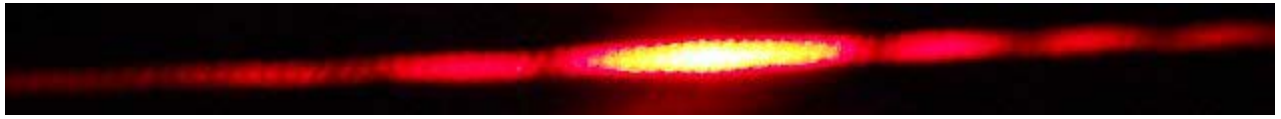


Single slit diffraction pattern

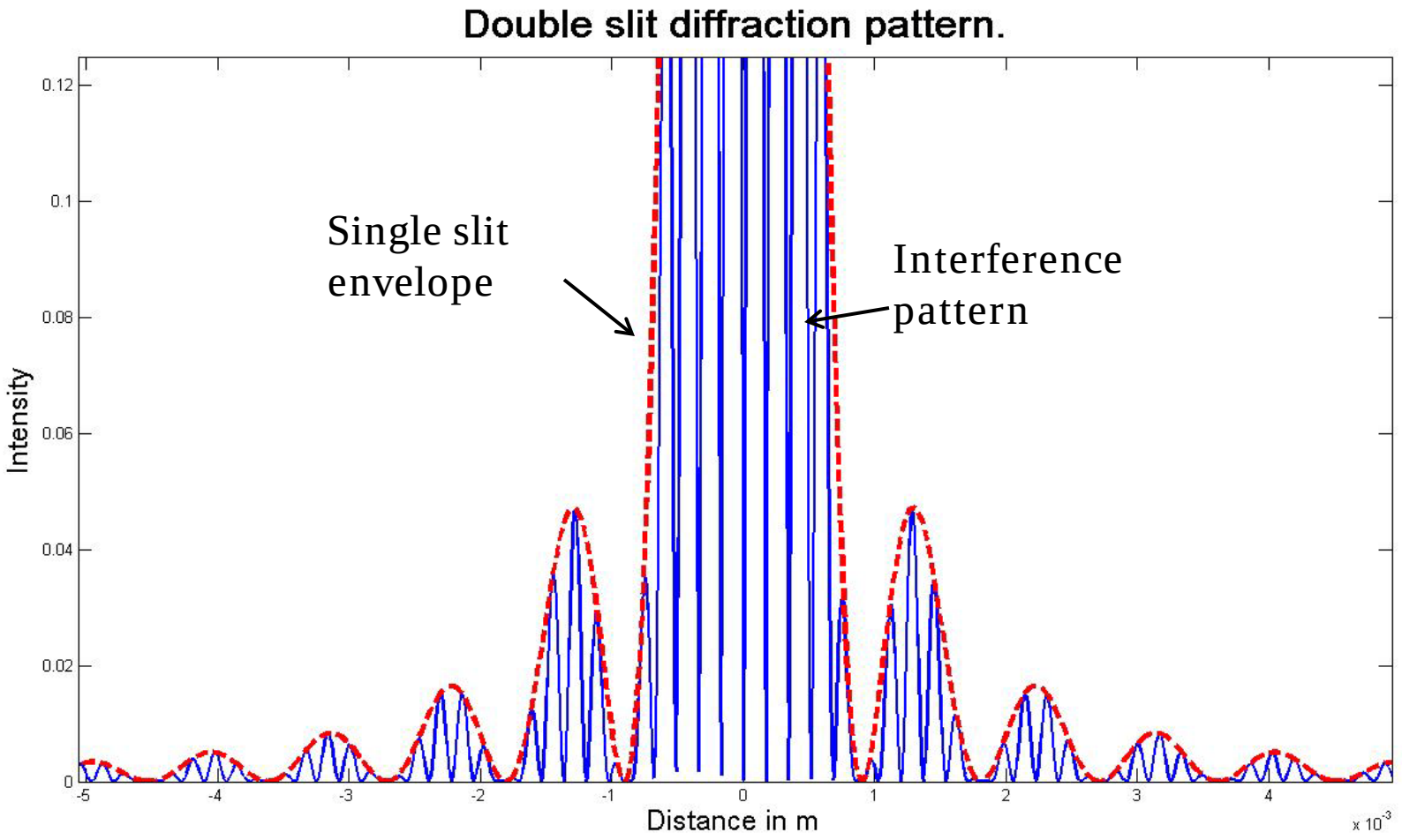
Diffraction pattern of my hair







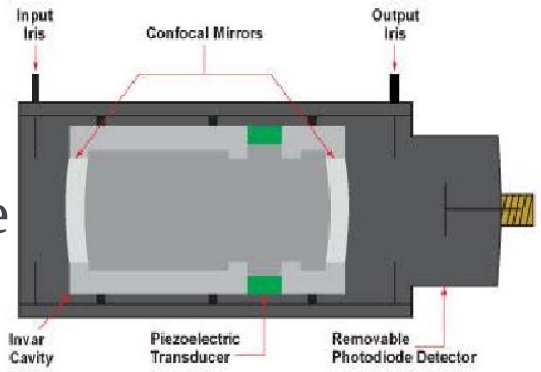
Interference and diffraction pattern of double slit

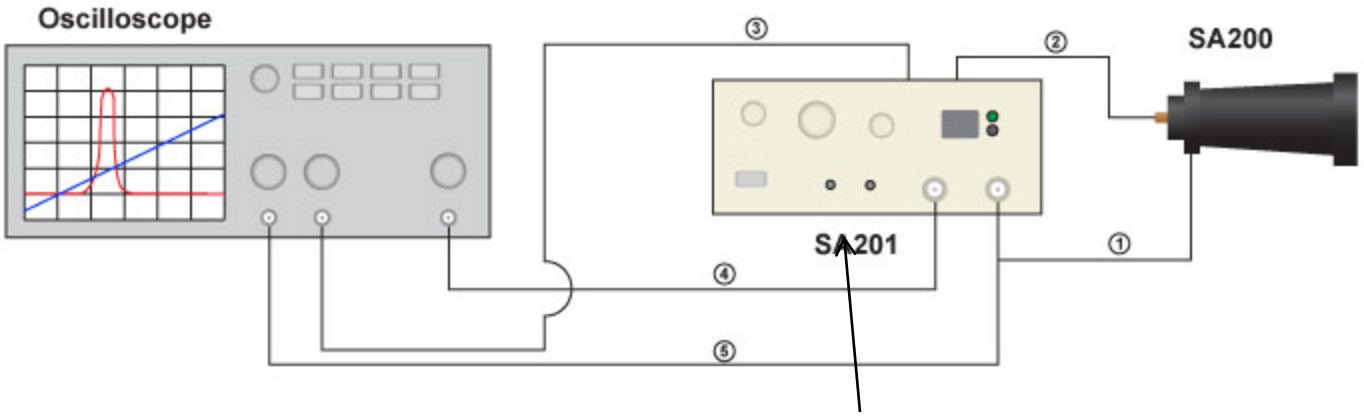

Double slit diffraction pattern.
Single slit envelope
Interference pattern
Intensity
0.12
0.1
0.08
0.06
0.04
0.02
0
-5
-4
-3
-2
-1
0
1
2
3
4
Distance in m
x 10^-3

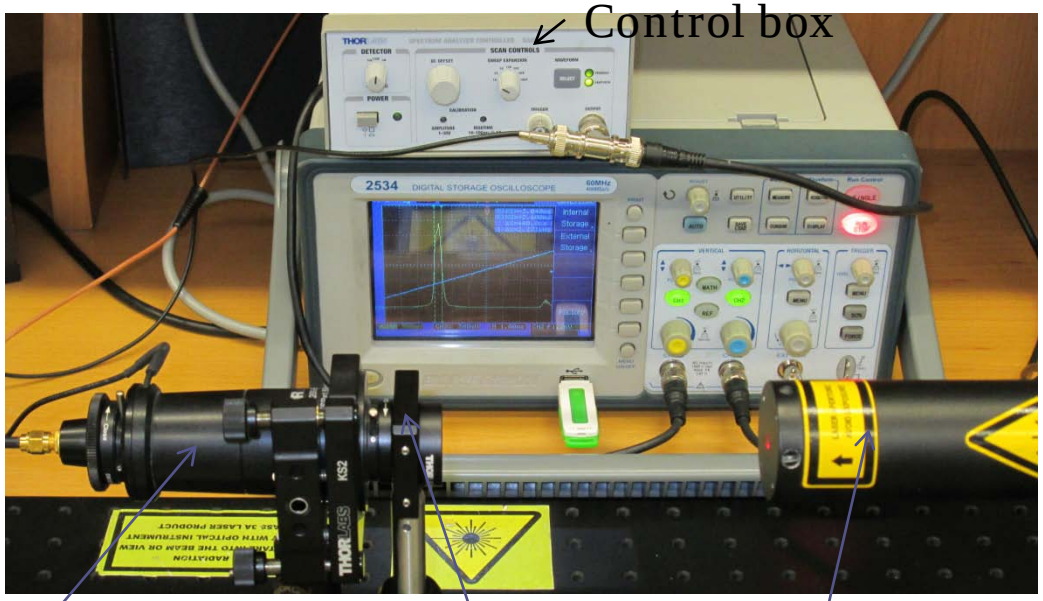
Scanning Fabry Perot Interferometer

Experimental objectives:

- To understand the basics of SFPI
- To align the instrument to perfection
- To investigate the longitudinal modes of HeNe







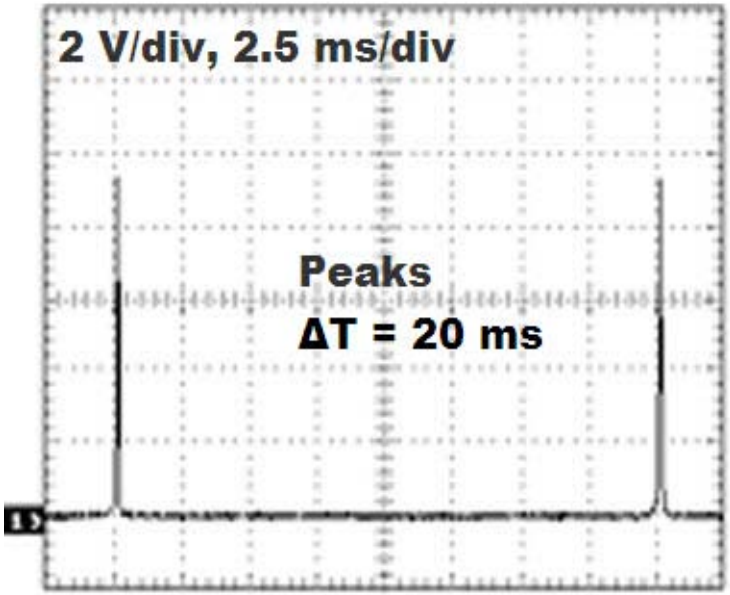
Fabry Perot interferometer

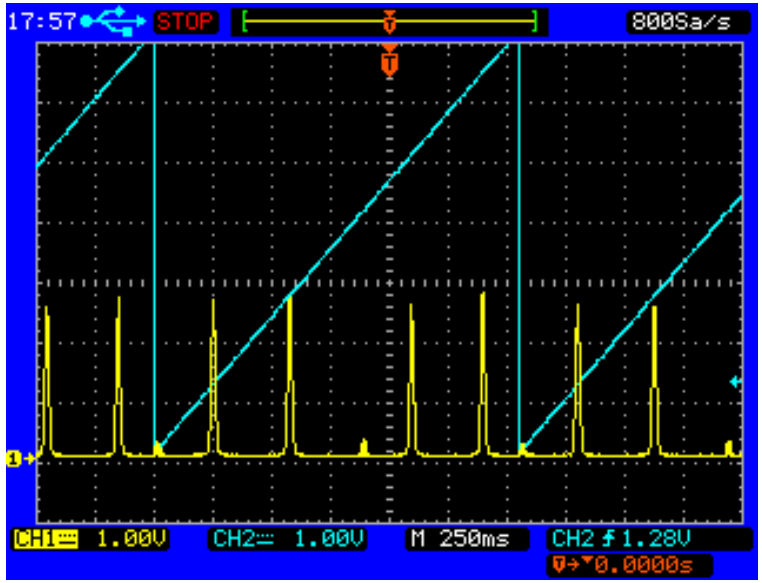
Plano convex lens

HeNe Laser

Free spectral range

$$FSR = c/4nd = 1.5\ GHz$$

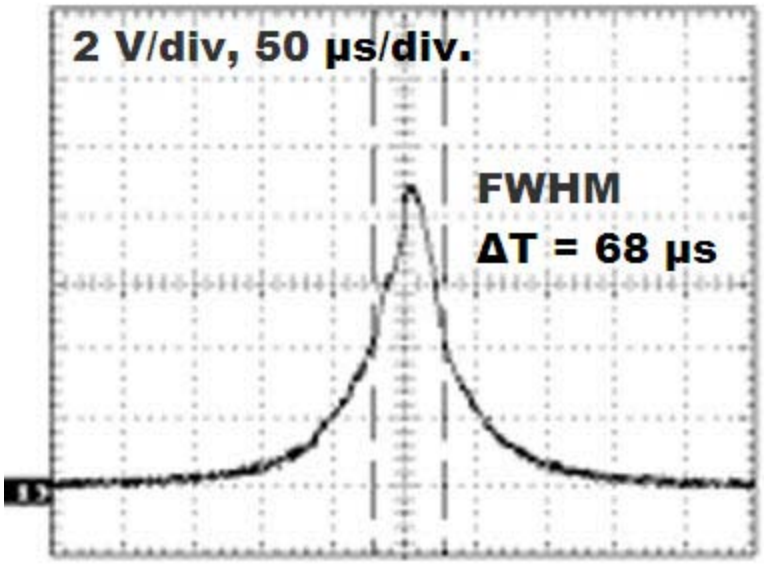


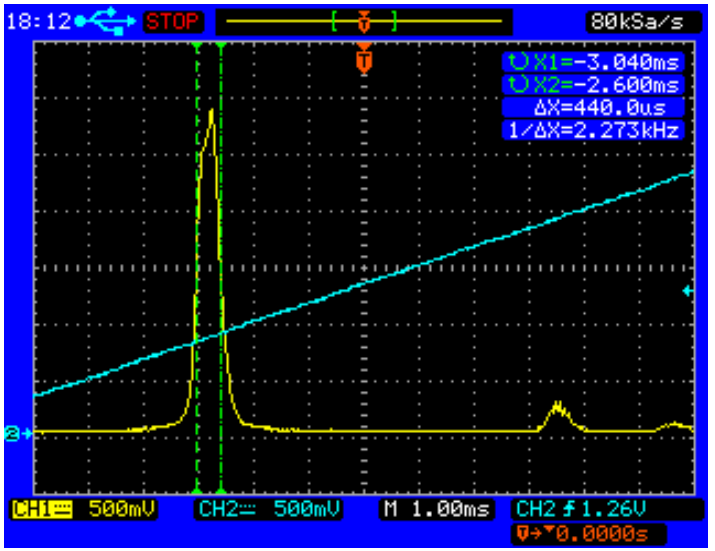


FWHM=.44ms x calibration factor

Finesse (the resolution of the instrument) = FSR/FWHM

>150



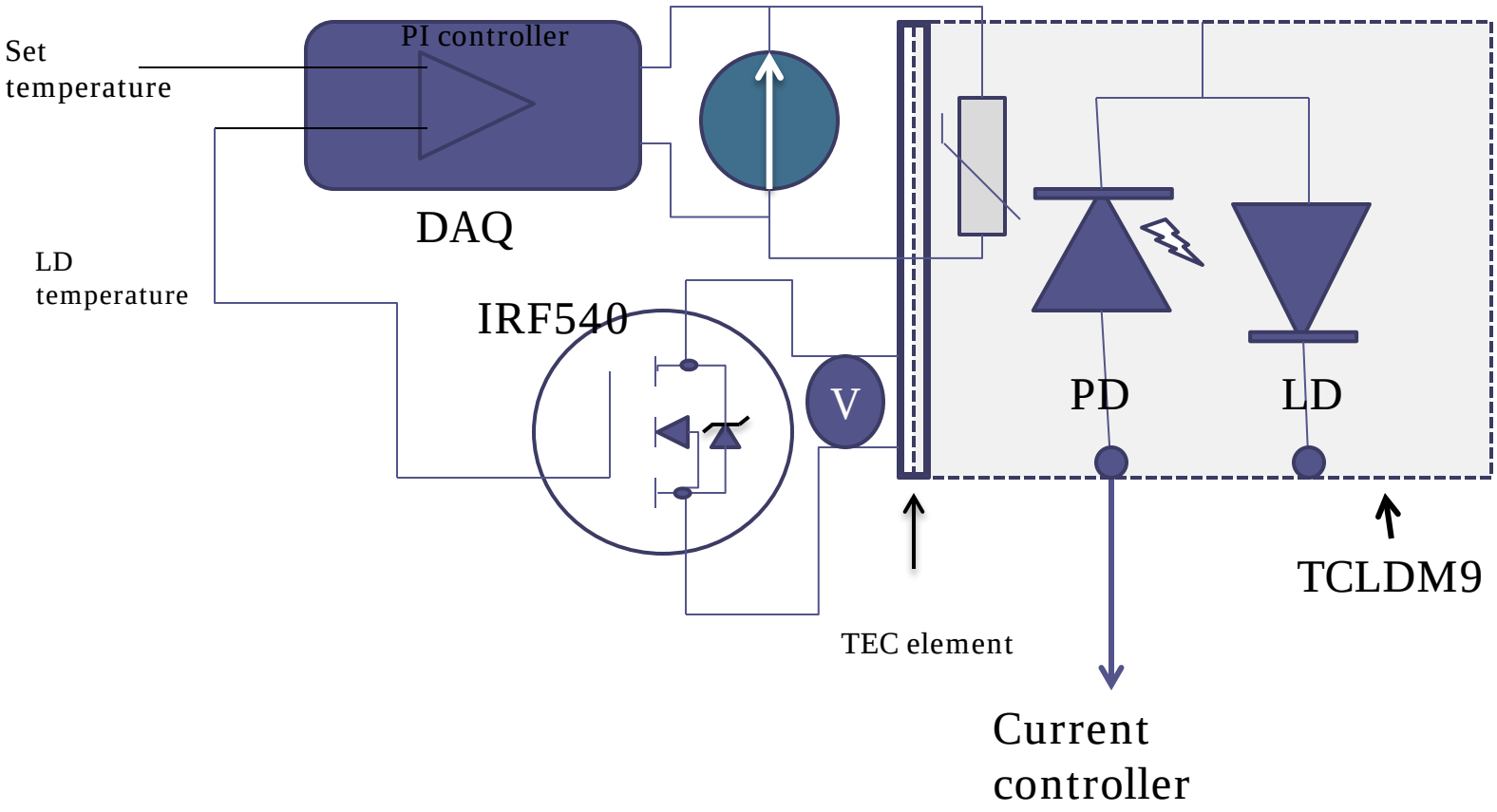


Basic properties of Laser Diodes

Experimental objectives:

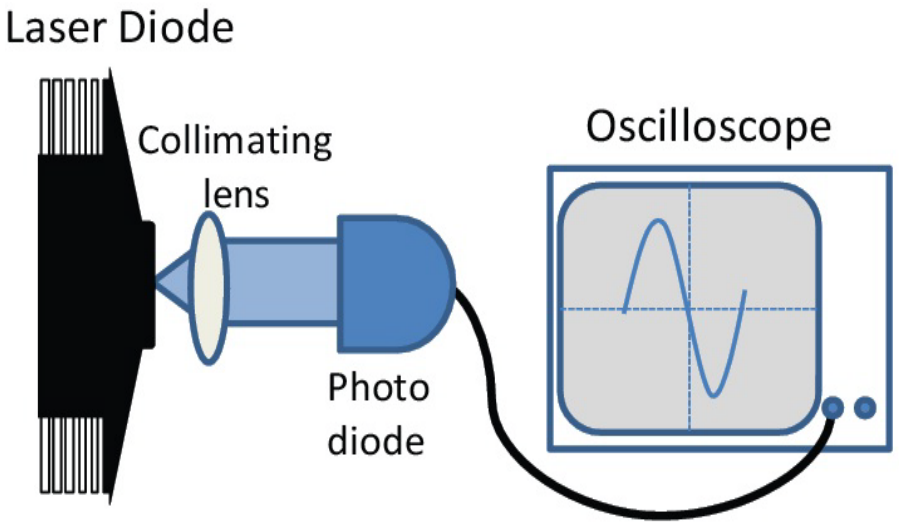
- Laser diode collimation
- Understand the concept of PI controller
- Use PI controller for tuning of laser diode
- Optical spectrum of laser diode

Temperature controller circuit

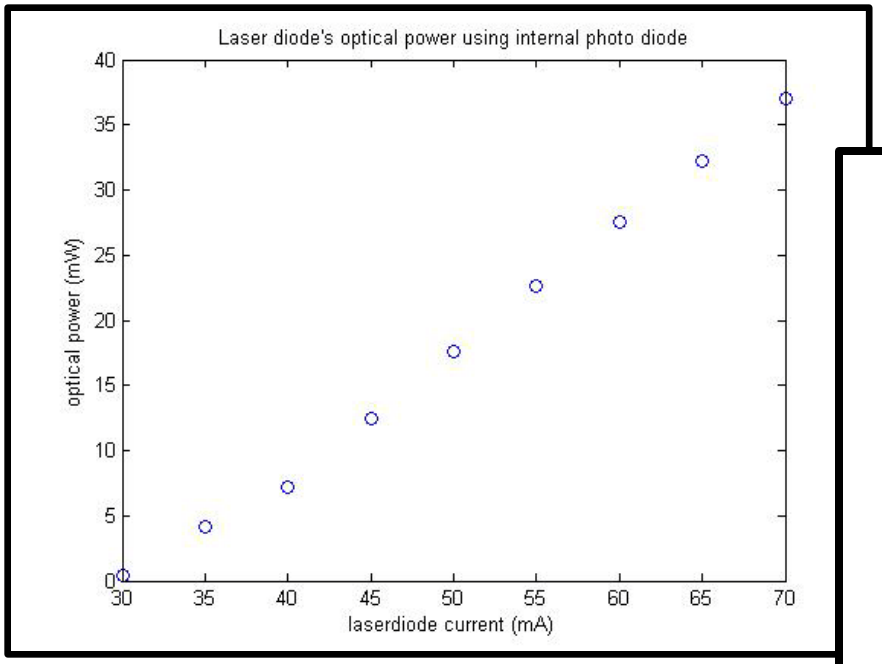


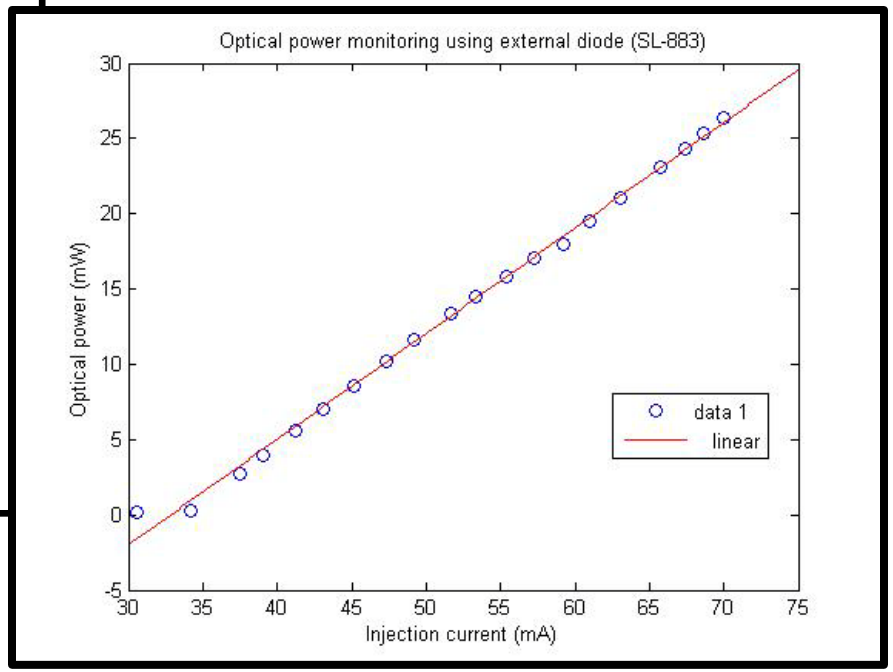
Tuning of laser diode

Optical power tuning by changing the injection current

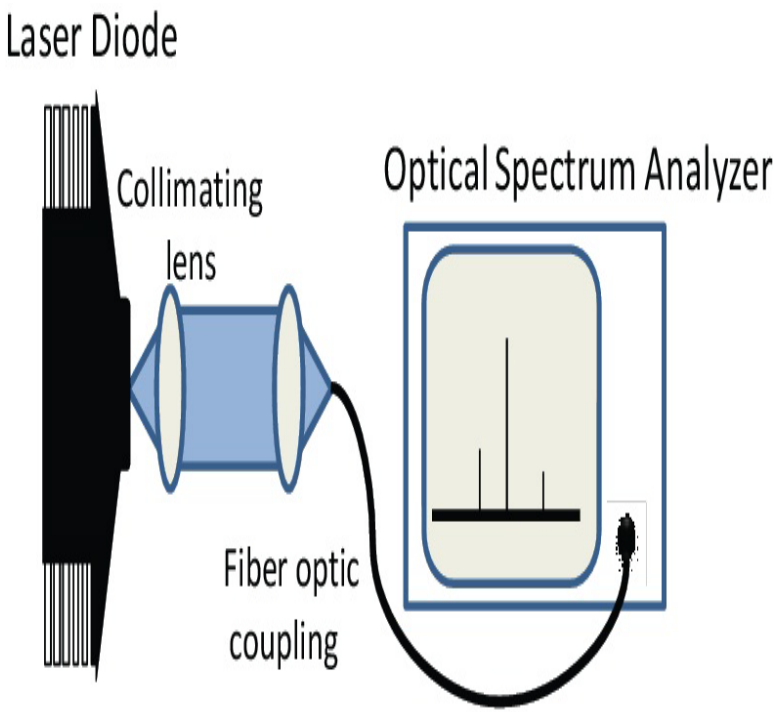


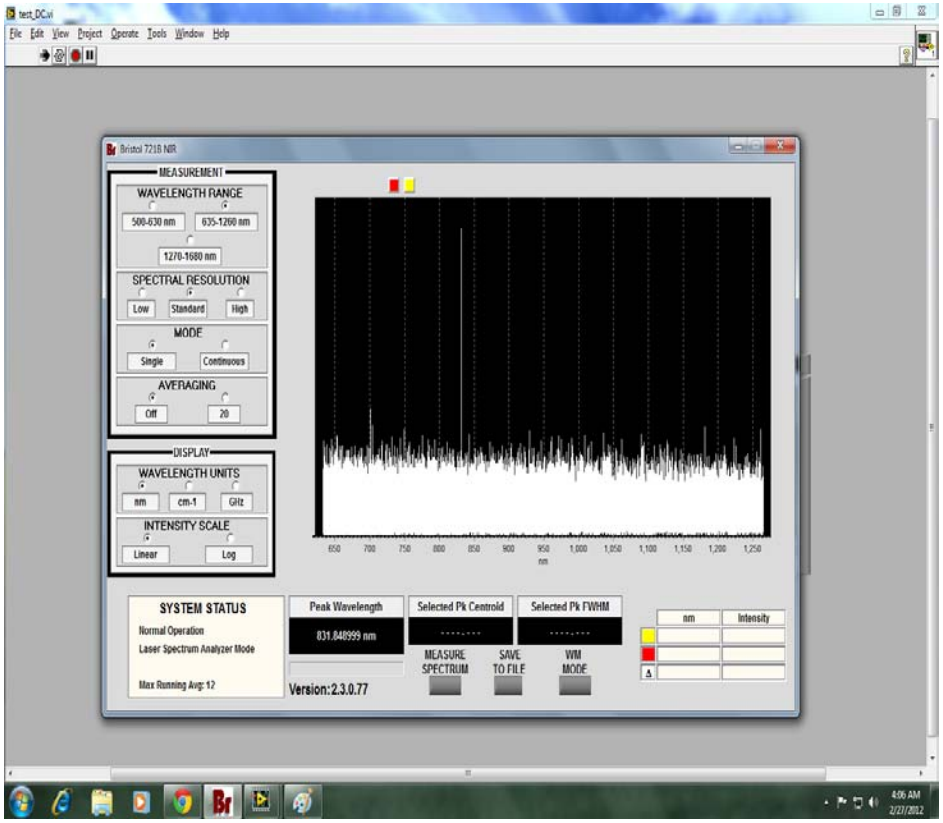
Characteristic of Laser diode



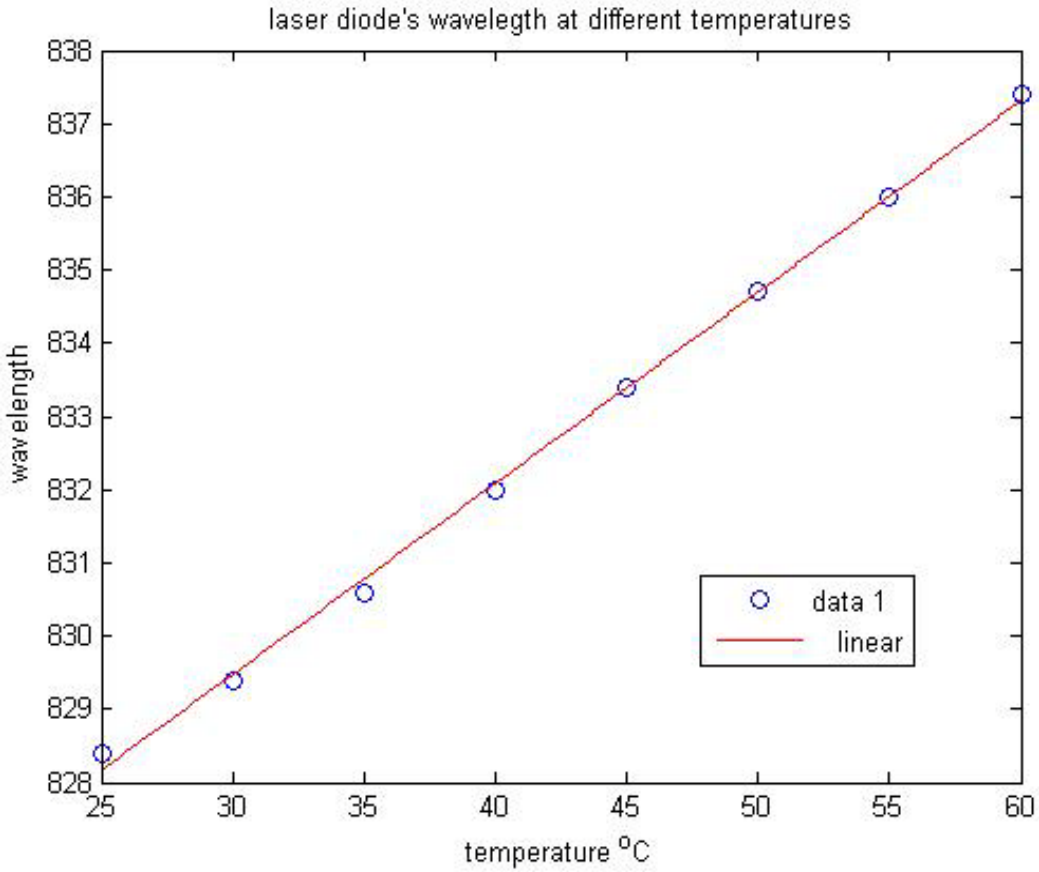


Wavelength tuning

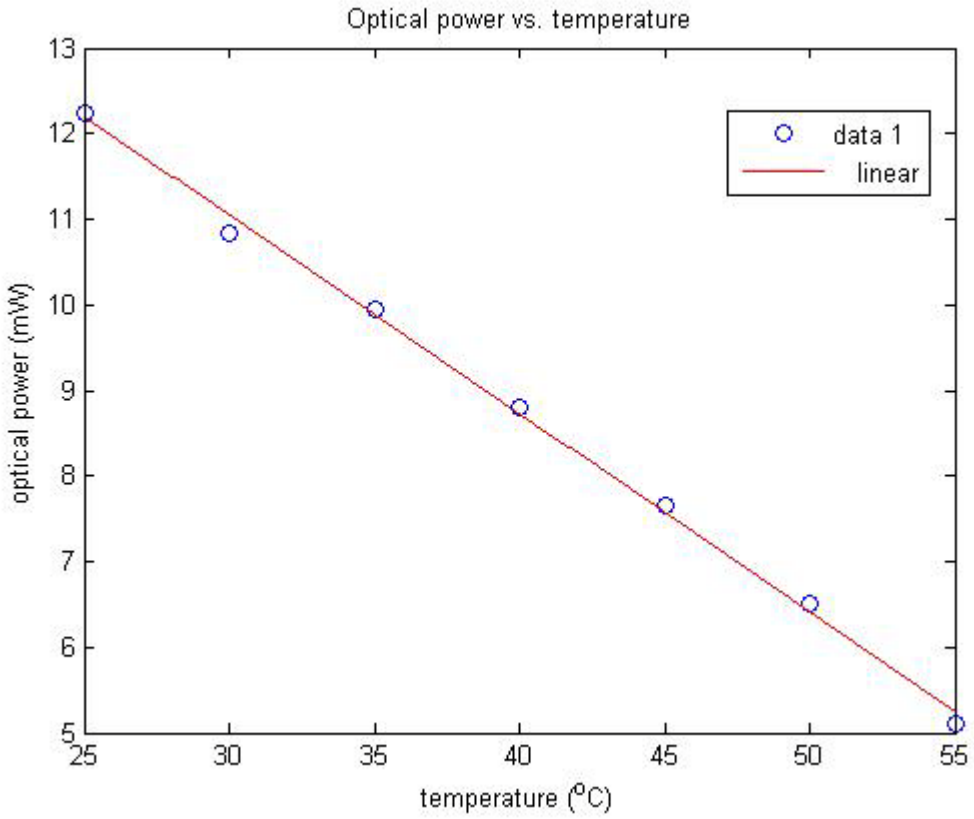




Wavelength tuning



Optical power of laser diode reduces with temperature



References

- “Introduction to optics”; Frank L. Pedrotti
- “Optics”; Eugene Hecht
- www.thorlabs.com

To be continued…..