Fraunhofer Diffraction: Young's Single Slit Experiment

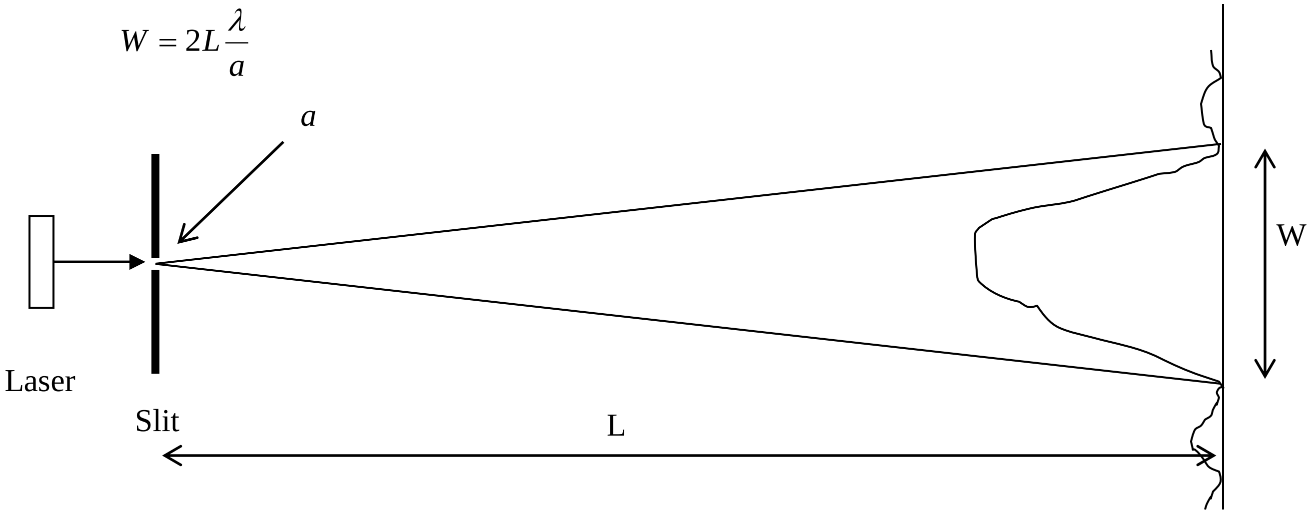
History:
In 1802, Thomas Young showed with his double-slit experiment the interference pattern of two light sources, which could be explained only by assuming a **wave nature of light**, with the superposition principle for electric field at its foundation.

1) Diffraction at a Single Slit: Quantitative Experiment:

Diffraction, itself, is an interference effect. In this case, a beam partially blocked by an aperture **interferes with itself** and forms a pattern.

The relationship between the beam width (*W*), the distance to the screen (*L*), the wavelength (λ=650 nm) for red and (λ=532 nm) for green, and the slit width (*a*) is given by:

$$W = 2L\frac{\lambda}{a}$$



Measurement:

1) Leave the screen distance L fixed (~80 cm) and vary the slit size (three slit sizes), while you measure the beam size, *W*, from first minimum to minimum with a ruler.
2) Compare your experimental values with corresponding calculations.
3) Now repeat 1-2 for two *hole* (not slit) sizes. Make sure you align the detector at maximum width.
4) Calculate the diameters of the Airy disks produced by the holes.
5) Discuss your results, comment on errors.

	Distance (*L*)	Slit Width (*a*)	*W*, experimental	*W*, theoretical
Slits				
Holes				

2) Further Diffraction Experiments:

Now put the Line/Slit into the laser beam.
Sketch the pattern you see:

What pattern does this pattern resemble? What is your explanation?

3) Single Slit diffraction as a function of wavelength

- Record two diffraction patterns for the same slit, once with the red laser and once with the green laser.
- Print your graph, label it, and discuss your result.
- Measure the width of your main maxima (from minimum m=+1 to m=-1) for both wavelengths
- Calculate the ratio of widths for red/green and compare to the theoretical value.

4) Intensity and the sinc(β)-function

We will focus on the sinc-function, especially the adjacent maxima, where β has the values β=+/-1.43π and β=+/-2.46π.
- Choose a small slit size. Set your detector to maximum gain. Adjust the aperture and alignment so that center maximum is saturated but side maxima are also well resolved.
- Scan the intensity pattern, including the next intensity maximum on either side
- Print results
- Analyze the peak heights in DataStudio and put the values in the table.

Background:

I_0 =	I for pos. side	I for neg. side	I_{ave} – backg.	$I_{1.43}$ / $I_{2.46}$	$I_{1.43}$ / $I_{2.46}$ theo
β = +/-1.43π					
β = +/-2.46π					

Also measure UNITS!! slit width a = Distance L = λ =532nm

Analysis:
Give the formula you use for calculating for $I_{1.43}$ / $I_{2.46}$ theoretical:

Question:
Discuss your results, give error and discuss possible sources of error.