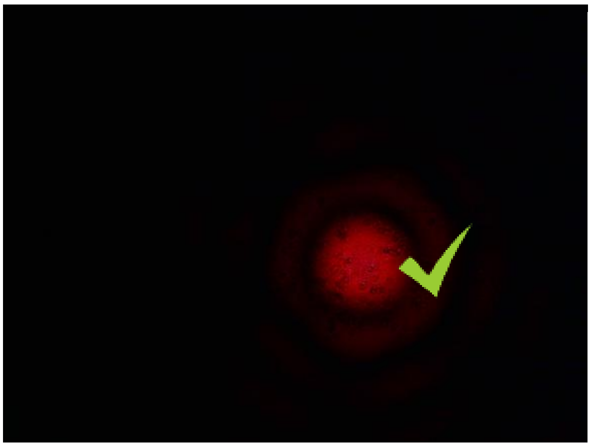
GROUP: C03 NAME: LEROY Gaspard 287178 and SLEZAK Filip 286557

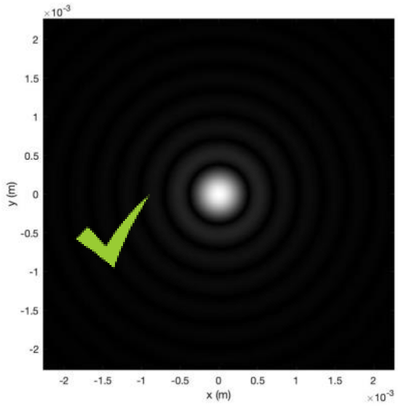
Diffraction

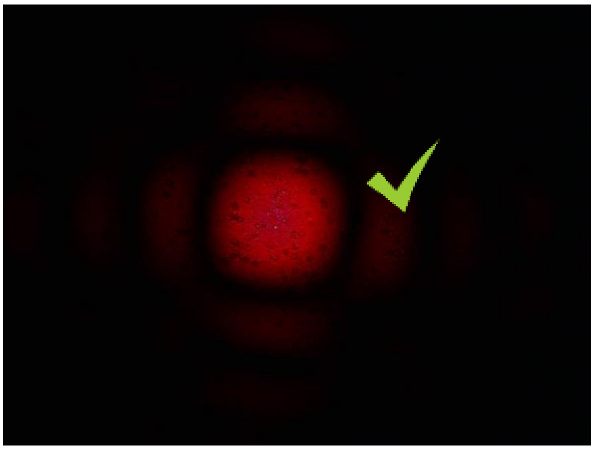
5. Summary of tasks of the experimental work

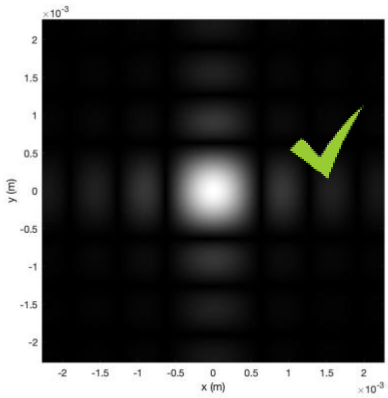
4.3 Diffraction with a collimated beam setup and verification

Take pictures of the diffraction pattern for the 100 micron pinhole and 100 micron rectangle. Measure the distance from the diffracting object to the camera chip (usually 100mm). Calculate the theoretical 2 dimensional diffraction pattern with Matlab and plot it aside to the measured ones. Write your simulation parameters in the report.









Simulation parameters

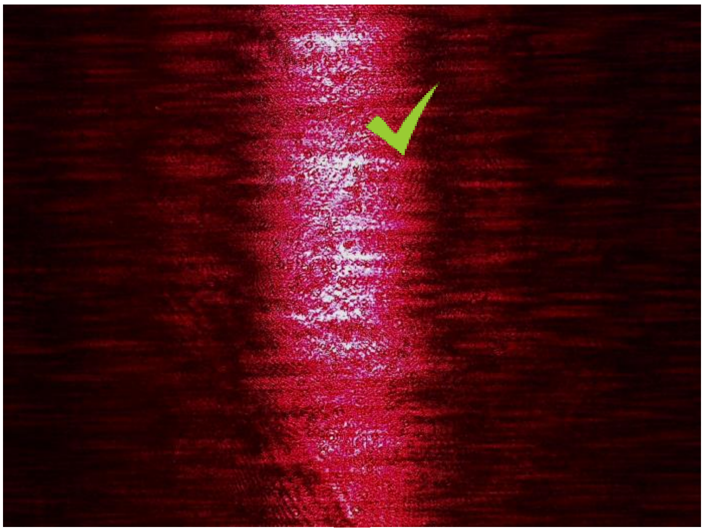
	W [um]	Z [mm]	Lambda [nm]
pinhole	100	100	635
rectangle	50	100	635

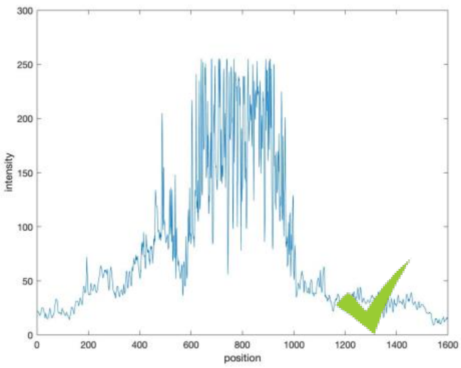
Comment about the quality how measurement and simulation compare!

The simulation fits well with the measurements.
The distance from the diffracting object to the camera chip fits well too, as we measure approximately a width of 800 um for the first order.
We got less details in measurements because of light intensity.

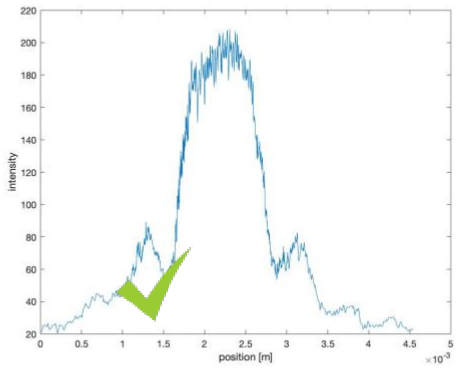
4.4. Fraunhofer diffraction and application of the Fourier transform

Take a picture of the diffraction pattern for the 100 micron slit. Measure the distance of the slit to the camera chip (usually about 100mm). Simulate the diffraction pattern with Fraunhofer diffraction, Fourier transform and Matlab and plot it aside to the measured ones.





raw data single line



averaged data

Calculate the Fresnel number for your experiment and write your simulation parameters in the report.

Fresnel number

$$N_F = \frac{w^2}{\lambda z}$$

w = 50 um

z= 100 mm

M (number of averages) = 100 lines of 1600 pixels

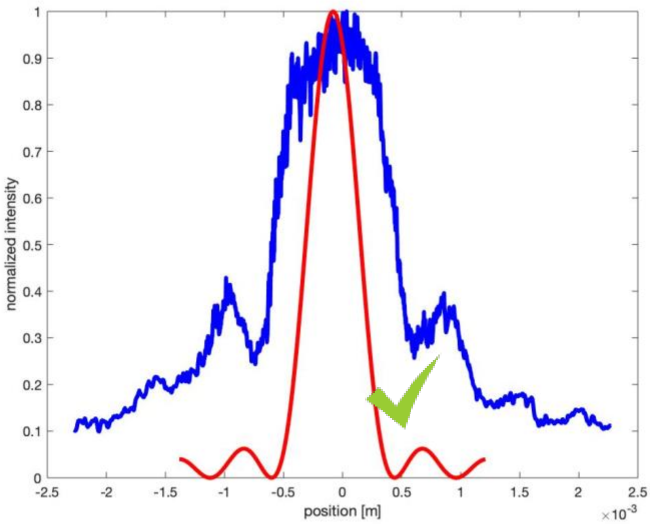
NF = 0.157

With the help of the Fresnel number judge if the Fraunhofer approximation is valid in our case.

Is the Fraunhofer approximation valid?

Yes because NF < 1 which means that we are in a far field situation, like for the Fraunhofer approximation.

Present diffraction pattern line-plots and compare the position of minimum intensity for measurement and theory. Compare the first minimum of measured diffraction curve with theory.



For the slit we can use the analytical diffraction equation to control our results. The zeros of intensity for the first order diffraction minima for a slit are given by the equation

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

where θ is the diffraction angle, 2w is the slit width and λ is the wavelength.

In the experiment the distance from the slit to the camera is z and with position. On our camera image the position x of the minimum are given by the relation

$\tan\theta = \frac{x}{z}$ and with the diffraction angle θ from above

$$x = z\tan\theta = z\tan\left(\arcsin\left(\frac{\lambda}{2w}\right)\right)$$

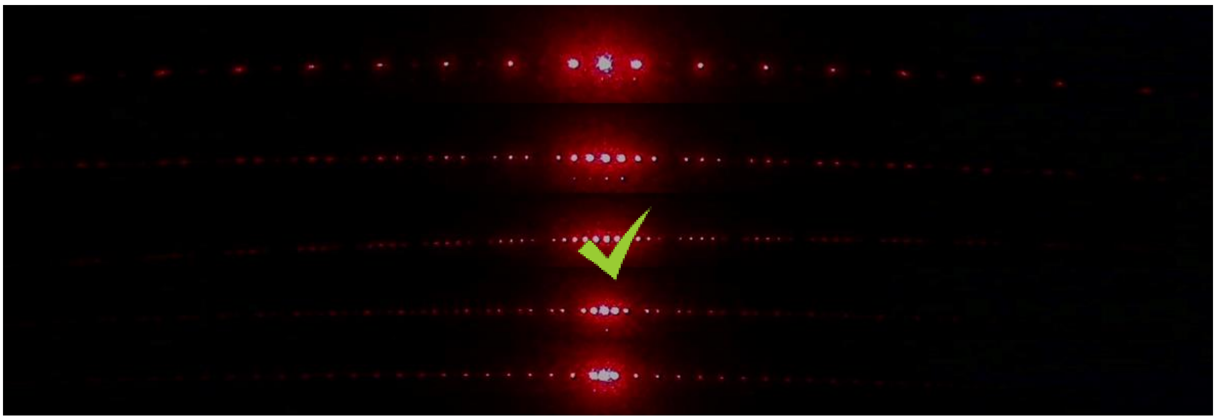
Calculate the value for x and compare them with your measurement and simulation!

We find x = 635 um and in our measurement we find -x = 660 um and +x = 687 um

Comment about the quality how measurement and simulation compare! The measurements fit well with the theory, the camera and matlab did nice job. We still have few imprecisions which are due to z, w and λ which are may not perfectly same as taken in theory.

4.5 Grating diffraction and Fourier transform

Present an image of the measured diffracted intensity for each grating similar to that given in Figure 40.



Simulate the diffraction pattern for the grating geometries and show your own simulation results similar to this in Figure 41.

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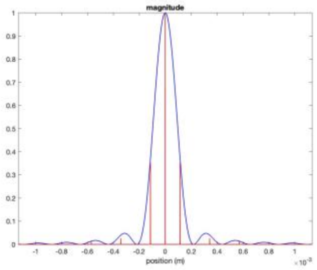
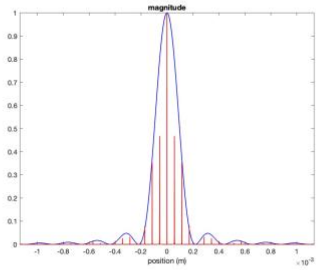
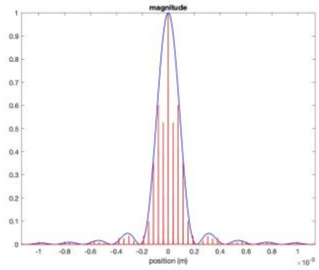


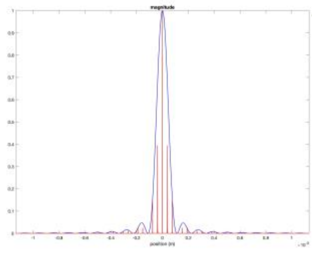
Λ=20µm, a=10 µm,



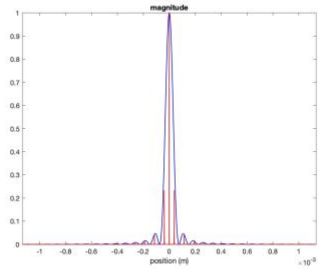
Λ=40µm, a=10 µm,



Λ=60µm, a=10 µm,



Λ=60µm, a=20 µm,



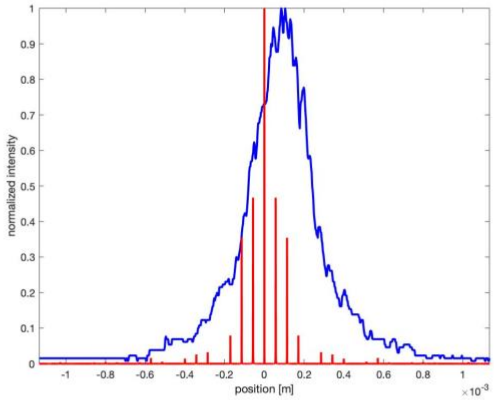
Λ=60µm, a=30 µm

<u>Simulated diffraction patterns for different situations. In Blue the diffraction of a single rectangle is shown. In red the grating diffraction is given. On the top the grating period is changed and below the slit width is modified.</u>

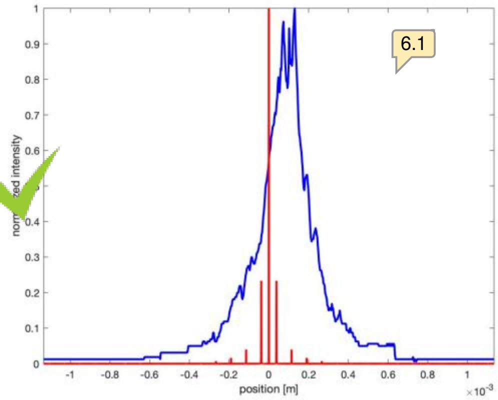
Explain what happens if you change the period of the grating at constant rectangle (slit) width. (one or two sentences) The period doesn't change the global intensity but affects the number of destructive interferences inside.

Explain what happens if you change the rectangle (slit) width and keep the period of the grating constant. (one or two sentences) The rectangle slit width change the global repartition of light intensity because it is more or less diffracted.

Compare the measurements with simulations for two grating configurations and plot a Figure similar to Figure 44.



Λ=40μm and a=10 μm



Λ=60μm and a=30 μm

Discuss briefly features like spacing and height of diffraction peaks.

The light intensity decreases while being far from the center.
For bigger splits the light is less diffracted.
The spacing is homogenous. The greater the density of lines of the grating there is, the more destructive interferences there are.

The simulations and measurements fit well, there is a shift between them, it is due to the image which is not correctly centered; there is a difference of light intensity which is due to ambient light.

Personal feedback:

Was the amount of work adequate? Yes

What is difficult to understand? No

What did you like about it? Good review

How can we do better? By doing real TP ☺

Index of comments

6.1 Have you checked the best ROI?