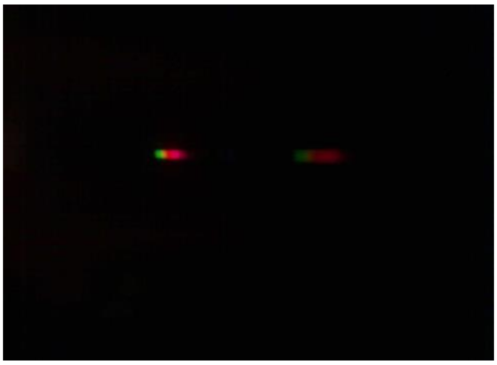
GROUP: C3 NAME: LEROY Gaspard 287178 and SLEZAK Filip 286557

Spectrometer

5. Summary of tasks of the experimental work

4.2 Calibration (75 min)

Show example pictures of your calibration for two different filters (i.e. 590 nm and 630 nm, two images). Measure a wavelength calibration curve with a minimum of 4 points for the first **and** the second diffraction order (for instance: 570 nm, 590 nm, 610 nm, 630 nm, 645 nm, wavelength versa position). Put it in a tabular form as shown (table). Fit a second order polynomial and give the equation and plot the curves (two plots, calibration equations). Comment your results.

Picture 1 Filter: 590 nm 	Picture 2 Filter: 630 nm 

Measure a wavelength calibration curve with a minimum of 4 points for the first **and** the second diffraction order (for instance: 570 nm, 590 nm, 610 nm, 630 nm, 645 nm, wavelength versa position). Put it in a tabular form as shown (table).

Calibration wavelengths (nm)	First order edge position (px)	Second order edge position (px)
570	483	926
590	502	959
610	516	989
630	537	1025
645	550	1051

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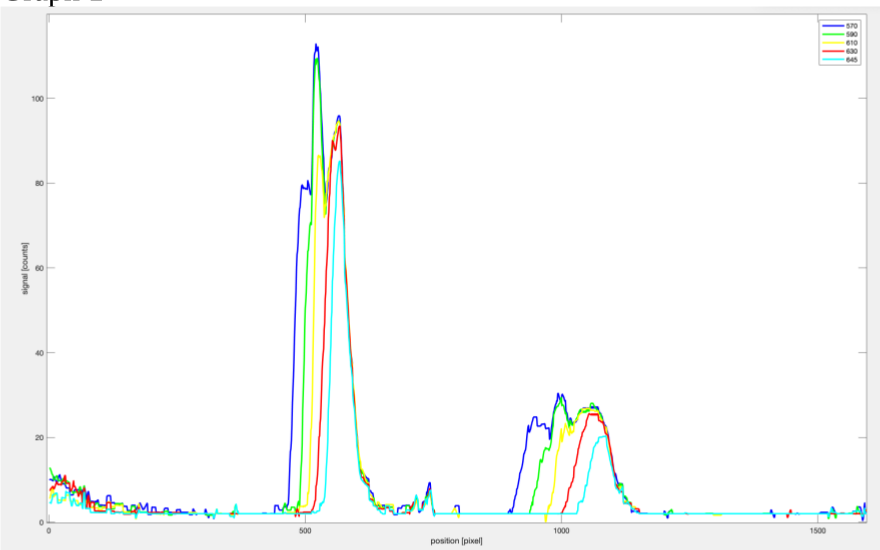
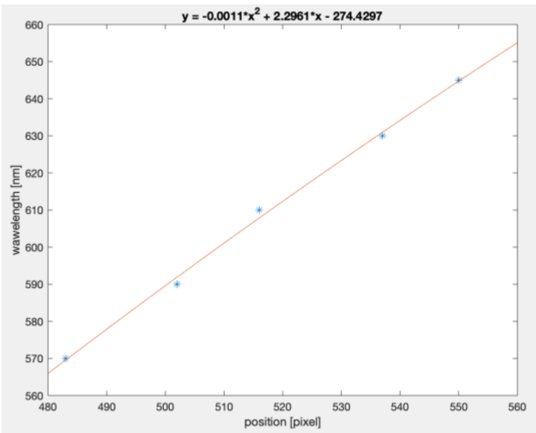
Give combined plot of your calibration

Graph 1

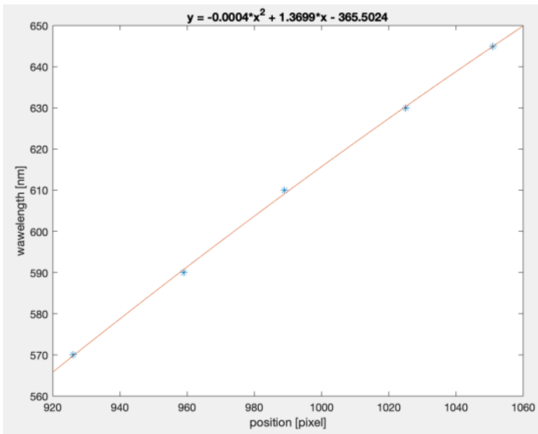


Fit a second order polynomial and give the equation and plot the curves (two plots, calibration equations).

Graph 2–
First order calibration plot



Graph 3–
Second order calibration plot



Calibration equation **first order** diffraction (y wavelength, x position in pxl)

y(wavelength) = -0.0011*x2 + 2.2961*x - 274.4297

Calibration equation **second order** diffraction (y wavelength, x position in pxl)

y(wavelength) = -0.0004*x2 + 1.3699*x - 365.5024

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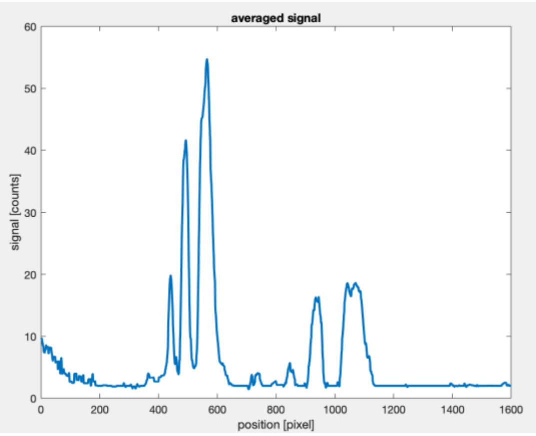
Discussion (compare and interpret):
To select the points for our tabular we chose the pixels' coordinates at the half of the maximum intensity.
The calibration curves are second order polynomials, but they look really linear.
From Graph 1 we notice intensity of the second order is much smaller than that of the first order, so we get fewer details, the image is not very sharp.

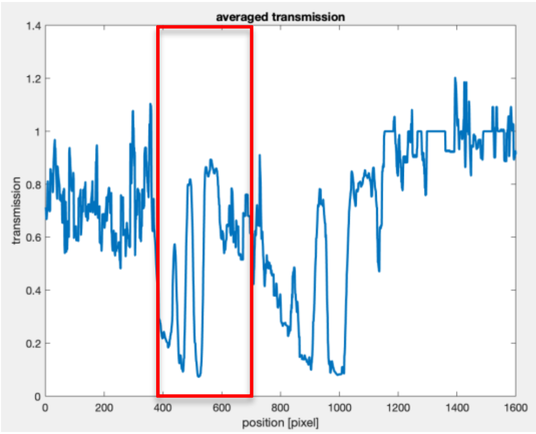
4.3 Transmission of a band pass filter (15 min)

Show the spectra and the transmission measurement for the filter BG36 (two plots). Interpret the spectra with the help of the transmission line plot. Remember that transmission has values between one and zero. Compare the curve with the transmission of the filter as given by SCHOTT (Annex) and comment and find similarities.

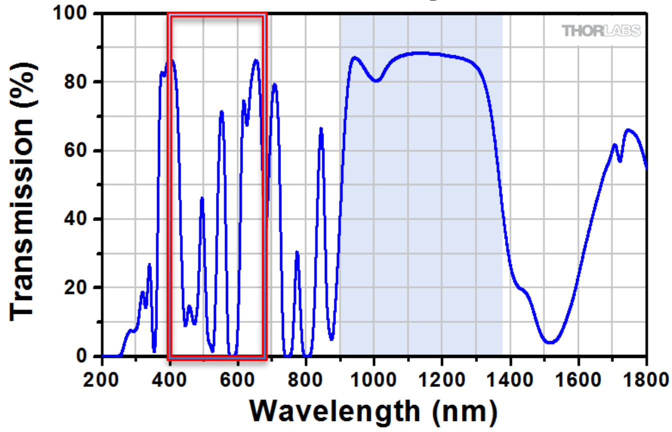
Graph 1–
Spectra (raw signal)



Graph 2–
Transmission



Graph 3– Transmission of OF BG36 for comparison



Discussion. Compare the curve with the transmission of the filter as given by SCHOTT (Graph as plotted above) and find similarities. Please note that the spectral range of our spectrometer is given by the NIR filter and limited between 400-700 nm!

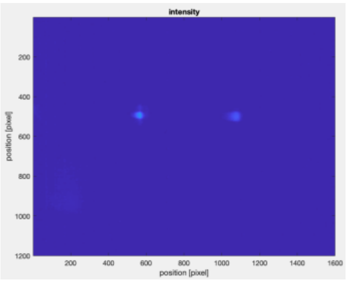
The pixels are related to the wavelength so we can legitimately compare the transmission curve we get to the one from of BG36's datasheet.

We clearly see that in the range of 400-700nm there are similarities in the curves. For example, the peaks are similar and in the range of 600-700 nm the transmission is about 0.8 in both cases.

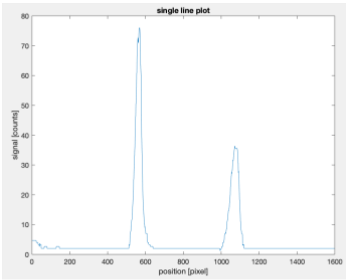
4.4. Spectral measurement of an LED (30 min)

Show images to document the evaluation (spectra, line plot, averaged line plot as shown above, one images and two line plots). Present a table that resumes the spectral measurement for the first and second order: centre wavelength and spectral width (table).

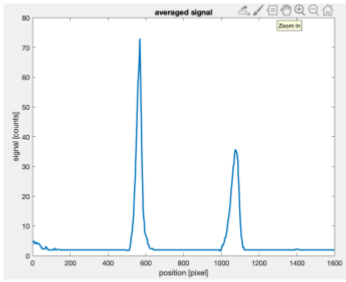
Graph 1–
Spectra (raw signal)



Graph 1–
Spectra (raw signal)



Graph 1–
Spectra (raw signal)



	First order	FWHM	Second order	FWHM
peak position (px)	568	[548;577] → 29	1073	[1048;1096] → 48
Wavelength (nm) (1px = 1.26 nm)	716	37	1352	60

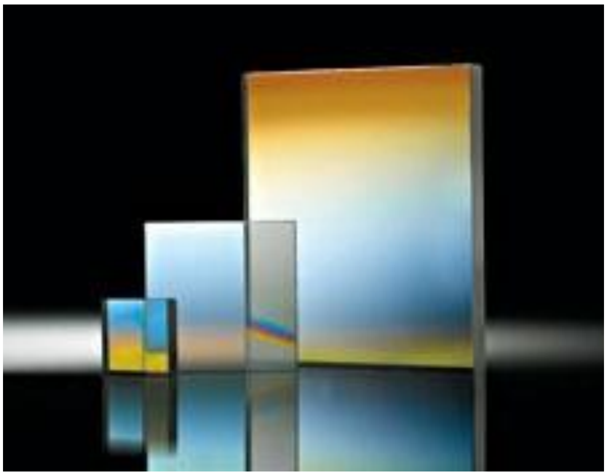
Compare with literature values and comment your results.

From slide 9 of the lecture we get that 1 pixel = 1.26 nm. From the datasheet of the LED we know that the peak position is located at 624 nm, yet with the previous conversion we get a peak at 716 nm - maybe the angles from slide 9 do not correspond to these measures, 1 pixel should correspond to 624/568 = 1.10 nm instead. The FWHM measure corresponds to the one given in the datasheet with little error with this pixel to wavelength conversion.

For the second order we see that there is less intensity because the reflection angle from the grating is bigger and the signal diffracts and spreads over a greater area.

4.5 Example from the web

Search the web for a grating spectrometer, copy a photo of a sample spectrometer (not a spectra) in your report and note its spectral range and resolution (at this spectral range). Find out the operation principle (scanning or static) and write it down. Try to find a model that not everybody of your fellow students has.



https://www.edmundoptics.com/p/1200-grooves-50mm-sq-369deg-blaze-angle-grating/10099/

Wavelength range : 400-700 nm
Resolution : $\Delta\lambda$

We do the same calculation as in slide 9 of the TP description.

$$\frac{\Delta\lambda}{\lambda} > \frac{\Lambda}{D}\frac{\cos\alpha}{m}$$

The groove density is about 1200 grooves/mm → 833 nm spacing periodicity. By taking D = 10 mm (beam size), m = 1 (diffraction order) and an incident angle α = 30 degrees we obtain a grating resolution of 7.2 10^{-5} so with a wavelength λ = 500 nm we obtain a **resolution of $\Delta\lambda$ = 0.036 nm**

Personal feedback:

Was the amount of work adequate? Yes

What is difficult to understand? No

What did you like about it? Was interesting to know more about how works spectrometers

How can we do better? By doing real TP ☺ (just joking)

MORE : We are part of the group of people that due to the shutdown caused by coronavirus didn't do TP4. Will we have to catch up on that? If so, when and how? Turns out moodle still expects us to hand that I, maybe you should reset that deadline for us :/