Onderwerp:

Datum:

05-06-2023

Introduction spectrometer

3 diff part

work with CCD lichtsensor!

high ~~vo~~ voltage magnets

function variables

wavelength

line density

incoming angle

2 cases to consider

fixed deviation : fixed angle

free deviation

function needs to consider both cases

monochromatic = multiple wavelengths

$\alpha - \beta = 2\phi$

$\frac{\alpha}{2} - \frac{\beta}{2} = \phi$

$\frac{\alpha}{2} = \phi + \frac{\beta}{2}$

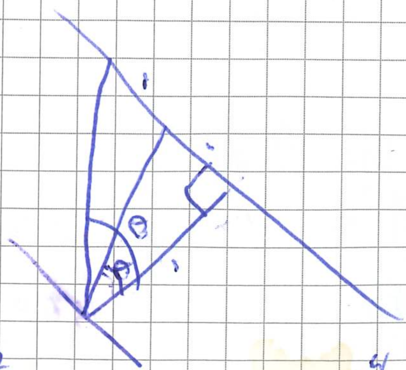
$\alpha = \phi + \beta$

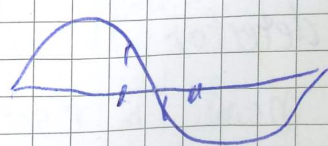
$\frac{\alpha}{2} + \frac{\beta}{2} = \phi + \beta$

$$\sin\beta = \frac{m\lambda}{d_0} - d_0 \sin\alpha$$

$$\beta = \sin^{-1}\left(\frac{m\lambda}{d_0} - d_0 \sin\alpha\right)$$

$$d_0 = \frac{m\lambda}{\sin\alpha + \sin\beta}$$





$7{,}5 \cdot 10^{-7}\ m = 7{,}5 \cdot 10^{-4}\ mm$

$(7{,}5 \pm 4{,}5) \cdot 10^{-7}$

3,24

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$$\alpha = \arcsin\left(\frac{m\lambda}{d_0} - \sin\beta\right)$$

$$\beta = \arcsin\left(\frac{m\lambda}{d_0} - \sin\alpha\right)$$

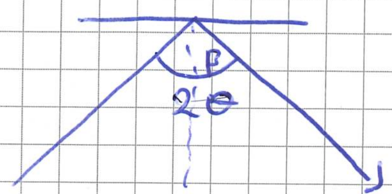
$$\cancel{\alpha = \arcsin\left(\frac{m\lambda}{d_0} - \sin(\beta\right.}$$

$$\cancel{\beta = \arcsin\left(\frac{m\lambda}{d_0} - \sin\right.}$$

$$m\lambda = d_0(\sin\alpha + \sin\beta)$$

$$m\lambda = d_0(\sin(\alpha + \theta_g) + \sin(\beta \mp \theta_g))$$

$$\alpha - \beta = 2\theta$$



~~07-06~~ 07-06-2023

I set up the Czerny-Turner setup with a 75,0 mm focus point redirecting the light from the flashlight to the diffraction grating, where the white light that is neither converging nor diverging will diffract. The first order (m=1) diffracted light will then be redirected by a 100 mm focus point mirror to the ccd detector. note that the light ~~from~~ after the first mirror is a parralel beam. It should stay that way after diffraction but it doesn't. as long as all the light ends up on the ccd detector, it should be fine.

now im setting up the ~~ss~~ ccd detector

08-06

Today we were mostly concerned about the sensor giving the ~~stuff~~ right signals to the oscilloscope. We noticed flickering in the signal given to the oscilloscope. To stop this we tried changing some possibly faulty cables, then when we didn't see a change we tried to ground the pins of the modules connected to the inverter, that also didn't work. Then we tried to change the timing of the ICG and the masterclock. Then we noticed that the output from the clocks were too wavy, when they should have the shape of a block.

To change this we will change the setup to skip the inverter, because we suspect this changes the signal apart from just inverting it.

This thus far succesfully ~~changed~~ ~~the~~ stopped the flickering *

*False

~~if it is~~

if the ccd is on for a longer periodt of time it will flikker more

now the problem is that the Ne light is not bright enough for the ccd to pick up

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Things to do:

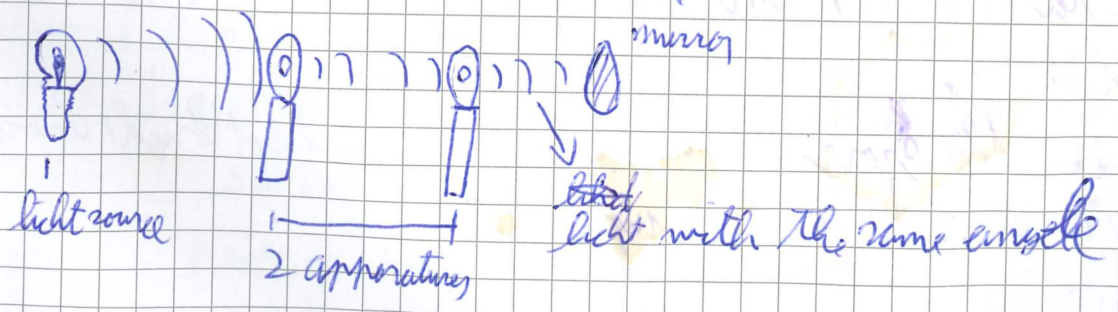
1 ccd 6 volts instead of 5
2 try to put in a capacitor in the circuit
3 better allign the incomming light with the ccd
4 solding the boards

13-08

The ~~a~~ capacitor helped, we spent the day figuring out how to theoritally figure out what the wavelength spread is. we also talked to max who gave us ~~an~~ a long explanation on how the cdk worked and how it was ~~[illegible]~~ like a particle in a box situation. we, after rebuilding the setup also figured out the noise in the signal was from the lamps above our heads.

14-08

we rebuilt the system and put two aperatures in front of the incoming light so every new lichtsource was comming in at the same direction



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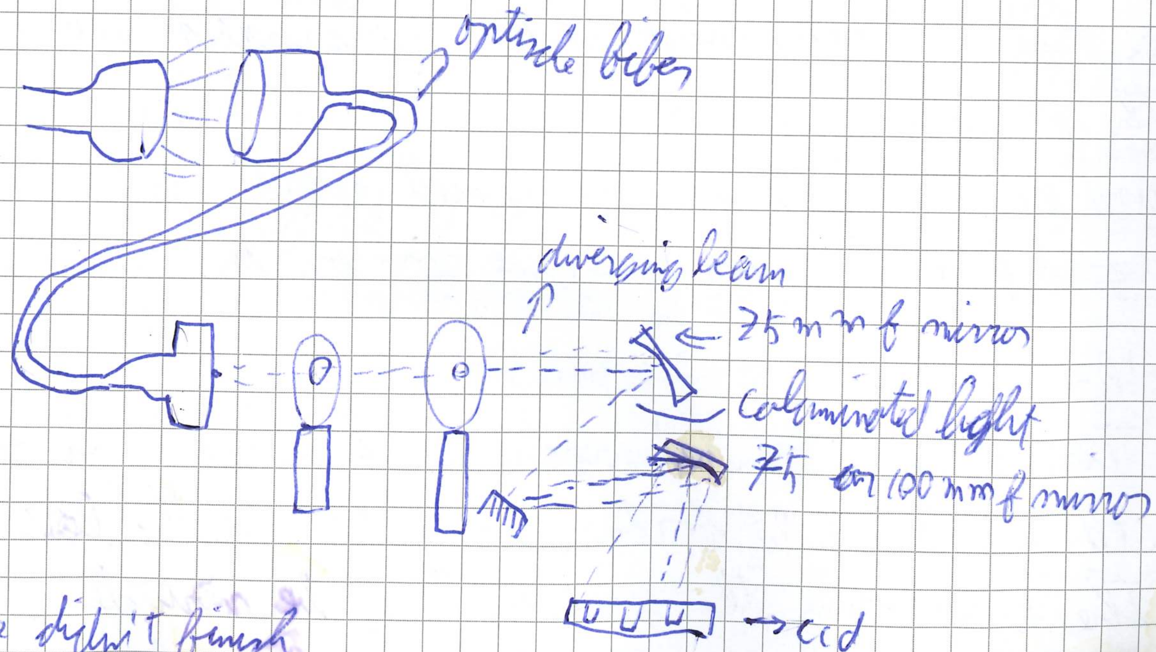
Datum:

In the proces of putting the two appuratures there we found out the flashlight was causing the flickering problem. The flashlight was giving light with a certain frequency that was different from the frequency of the ccd. So the ccd could be measuring the light right after the light turned off for a split second and then measuring again when the light just turned on. this was causing a flickering in the signal. we changed the lightsource and it was fixed.

Then we ~~pu~~ fixed a fiber coupler as light incoming source and shined a flashlight into the fiber cable that then shined into the setup



we didn't finish setting it up on 13-06

gratis collegeblok

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~~14-06~~
15 - 06

Today I spent a lot of time setting up the ccd ~~with~~ at the right length so the light is converging in the ccd. This morning emils changed the fiber copler to one that according to him sent out more light. What it also did was ~~getting a colluminated bea~~ shining out the light as a colluminating beam. This caused the first mirror to converge the beam. Because the first mirror was over 75 mm away from the grating and had a focuspoint of 75 mm, the light hitting the ~~mirro~~ grating was diverging. After changing the setup a couple of times we decided to change the first mirror to one without a focuspoint, so that collaminated light is hitting the grating, then we put the ccd at the correct length and had a discussion with Daniel about what wavelengths ~~we so~~ from the neon-laser we saw on the spectrometer.

16 - 06

Today we determined again at what length the ~~setup~~ ccd should be at for the measurement to be the best. The light from the grating should be vertically normal. So when the second mirror has a focus length of 100 mm the ccd should be at 100 mm, yet ~~the~~ at 100 mm length the flux of the light in the ccd isn't at its maximum.

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~~Wea~~ We have mounted the ccd on, something that can horizontally change its position precisely, (I forgot the name) with we used to change the length and look at the output on the oscillator. Where the flux would be the biggest is where we put the ccd. Then we looked at the neonlaser to callibrate the ccd. It's important to not move any pieces when or after callibrating the system. we used the formula

$$\lambda_p = S + A_1 p + A_2 p^2 + A_3 p^3$$

where λ_p is the wavelength and p the corresponding amount of pixels from left to right. S is the wavelength at $p=0$, so at the leftmost point on the ccd, and A_1, A_2 and A_3 are all constants we are trying to figure out.

we determined 4 wavelengths and the corresponding pixels from the neon-lazer. Because the ccd sees V as wavelengths when it should be V^* we gave the pixels an error and because some wavelengths are really ~~cl~~ close together that they both create one dip we also gave an error to some wavelengths

	wavelength,	wavelength error	pixels,	pixels error
1	585,25	± 0,1	1736,72	± 18
2	614,31	± 2	2198,79	± 20
3	640,23	± 2	2756,45	± 20
4	650,75	± 5	2968,9	± 20

using lmfit, we fitted these values with the according formules ~~ex~~ and got:

name	value	σ standard ~~relative~~ error
S	243,395535	$1,5092 \cdot 10^{-11}$
A_1	0,36473827	$2,0190 \cdot 10^{-14}$
A_2	$-1,2492 \cdot 10^{-4}$	$8,7829 \cdot 10^{-18}$
A_3	$1,6262 \cdot 10^{-8}$	$1,2530 \cdot 10^{-21}$

as you can see, these errors are insanely small.
~~To calculate correctly~~ This is probably because we only had 4 known wavelengths and 4 variables to fit them. The S starting wavelength might also be smaller then expected but thats debateable.
The known λ_p are at the right halve of the sensor, so the farther you go left, the higher the error should be

20-06

Een manier om toch de error te bepalen is X
a way to still determine the error is to fit the datapoint + the error and fit the datapoints. ~~St~~ The function that the fit from the datapoints + error is the error above the normal fit function and the fit from datapoints − error is the error below the function fitted on 16-06.

The above error function has a downward slope from 0 pixels to around 600 pixels if you plot the wavelength on the y-axis and the pixels on the x-axis. This is not physically possible in our experiment. So we know that the S value is incorrect. ~~Luckily we only~~

	values above error$_1$	values below error$_2$	std$_1$	std$_2$
S	571,336	385,16	$3,7 \cdot 10^{-4}$	$35 \cdot 10^{-4}$
A_1	−0,0699	0,205	$7,4 \cdot 10^{-19}$	$4,51 \cdot 10^{-14}$
A_2	$6,095 \cdot 10^{-5}$	$-7,082 \cdot 10^{-5}$	$3,14 \cdot 10^{-17}$	$1,9 \cdot 10^{-17}$
A_3	$-9,5671 \cdot 10^{-9}$	$1,0638 \cdot 10^{-8}$	$4,38 \cdot 10^{-21}$	$2,675 \cdot 10^{-21}$

Around the red laser the error from going from pixel to wavelength is ± 10 nm