Session 5 - Task 10 - 11 again

Tuesday, January 10, 2023 9:00 AM

After the debacle of last lab session- the goals for this session are:
Successfully take the long interferograms for green and yellow filters.
Analyse data - outside of lab time

Task 10

Given what we learnt last session and how we altered the gain and our set up as stated. We
long interferogram for the green filter.

This is shown in **fig 44.**

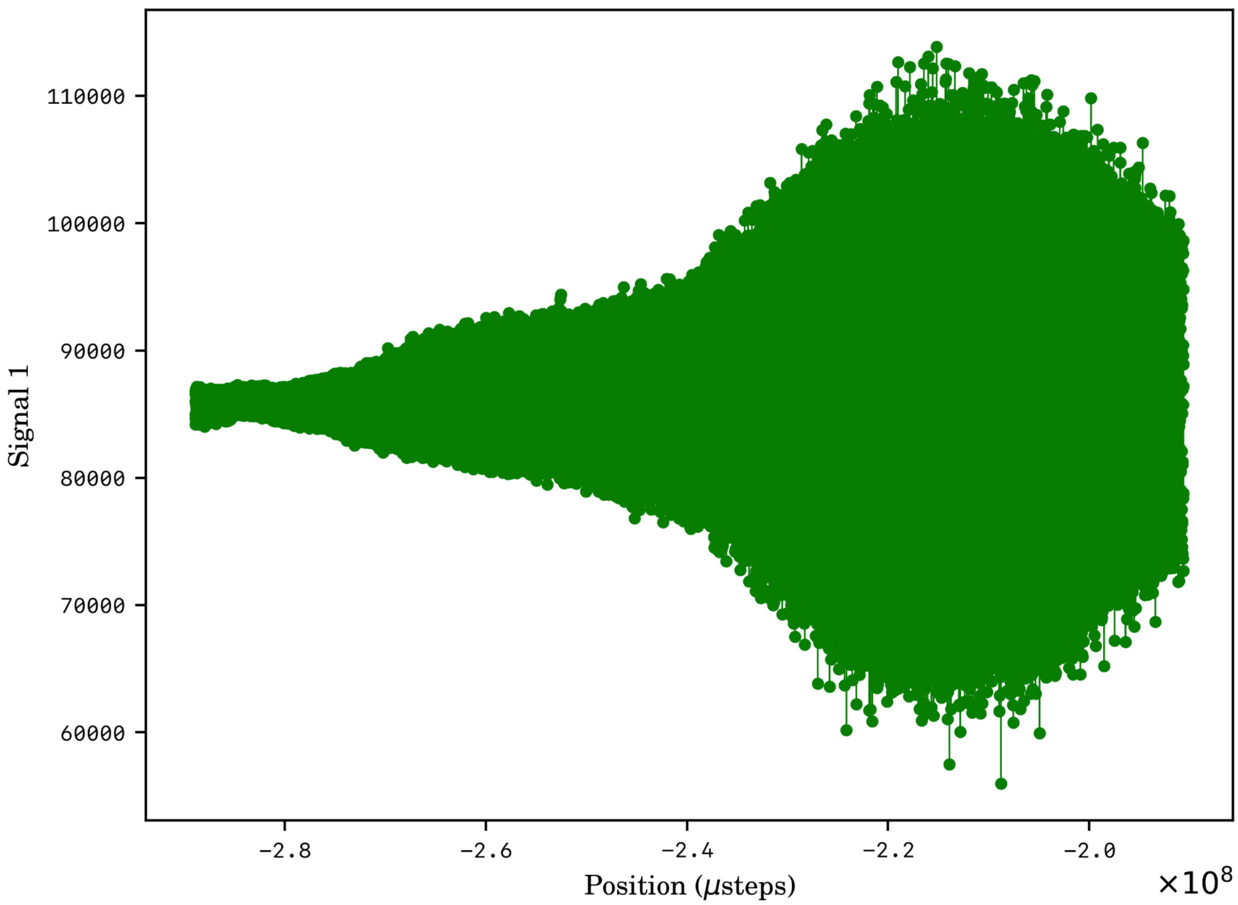


Fig 44. quickplot of signal (intensity) against position for the mercury lamp with the green

Now that we have got data we can analyse in the same fashion as task 9, adding a Gaussian 're now ready to take a

filter.

to work out the spectral

width, this is demonstrated in **fig 45.**

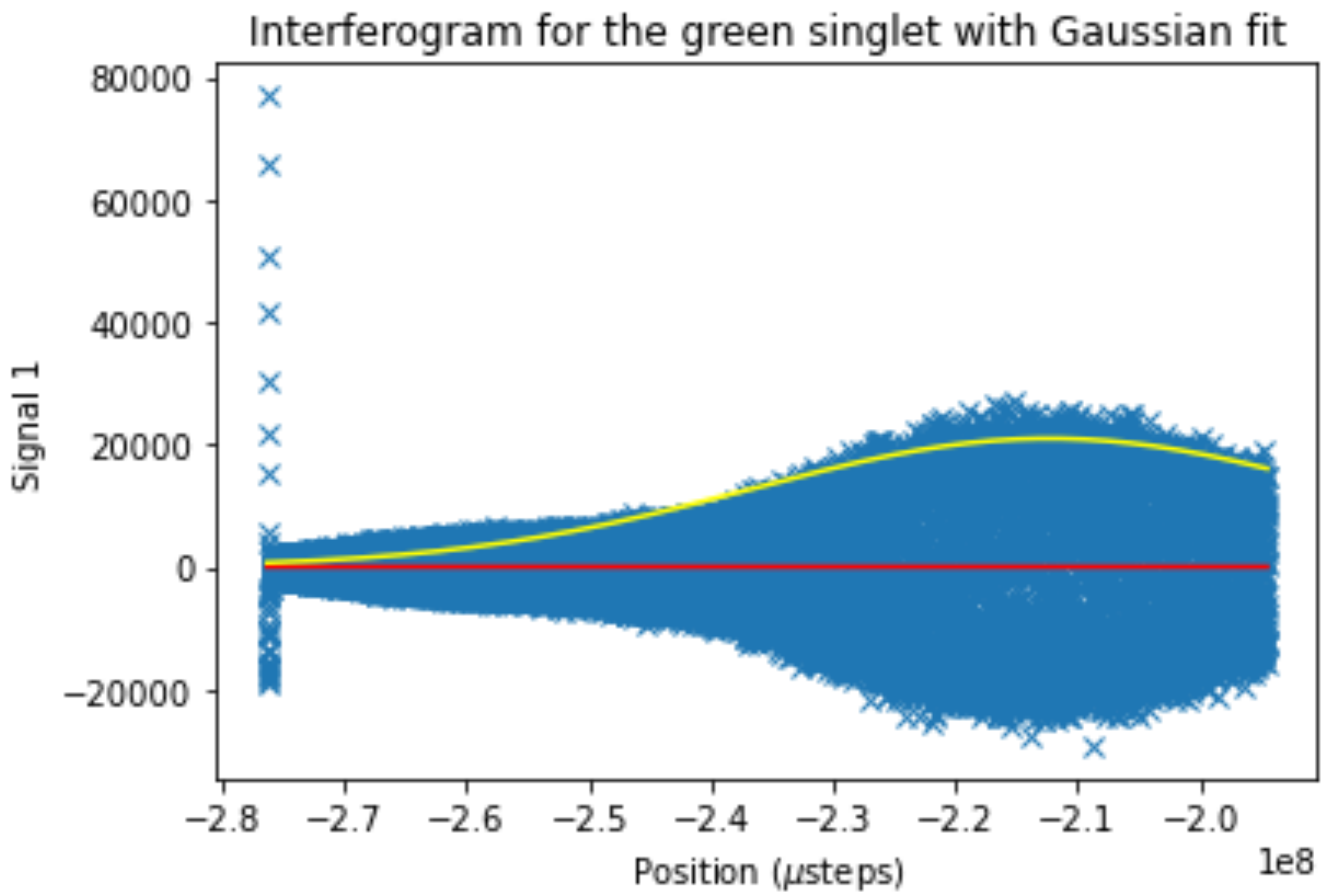


Fig 45. plot of signal (intensity) against position for the green singlet from the mercury lan
fitted using scipy.optimise. Curvefit

In the same fashion as task 9, we use the coherence length obtained from the Gaussian fit a
(4) and (5) in the lab script to obtain the spectral width. This was found to be **0.02182003891**
0.011967596550760384 nm which is remarkably small. Much smaller than we anticipated.

To investigate the reproducibility of the stage movement, we plotted the histogram of cross
taken in **fig 44.** this is plotted in **fig 46.** from which we can clearly see that distances betwee
a very narrow spread. The vast majority of entries lying between 200 - 300. However, there
between 300 - 400 nm, we think this could be due to the motor first beginning to spin. The r
lubricated meaning that when it first starts turning it encounters frictional resistance. This is
distance between crossing points.

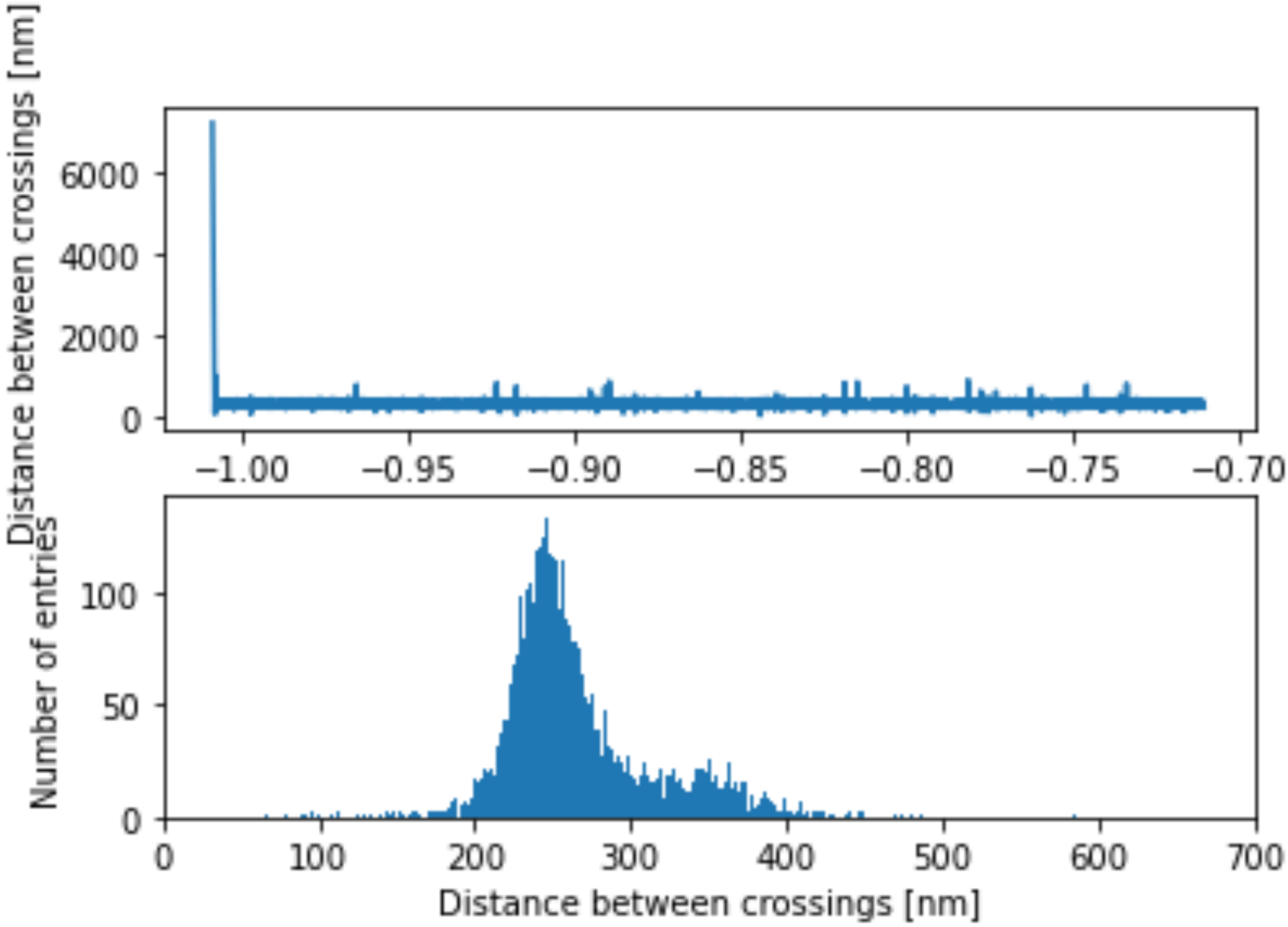
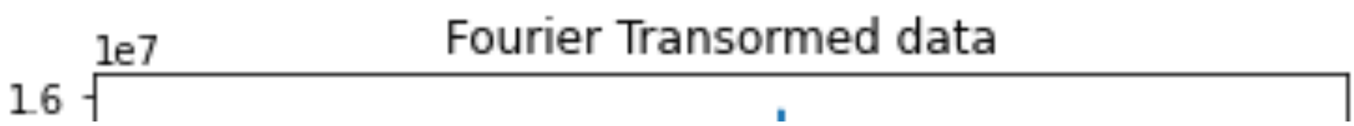


Fig 46. the resulting histogram plot for the distance between crossings for the green mercury singlet.

we also thought it prudent to look at the wavelength calculation from the crossing points of the interferogram compared to the given true value of **460 nm.**
Using the code which we described in task 9 analysis and took from the calibration.py file we obtain **fig 46.** and we find the wavelength of our source to be **535.4561383546313 +/- 1.595263491457144 nm.** This is significantly far removed from the true value since it doesn't lie within the experimental data's error (error was propagated in the same way as task 9 for finding the wavelength using the covariance matrix of our Gaussian fit in **fig 45**).

Interestingly though, when we conduct our Fourier transform as shown in **fig 47.** and fit a Gaussian we obtain the wavelength to be **532.3109635085652 +/- 7.52982284923793 nm** which also disagrees with the true value but



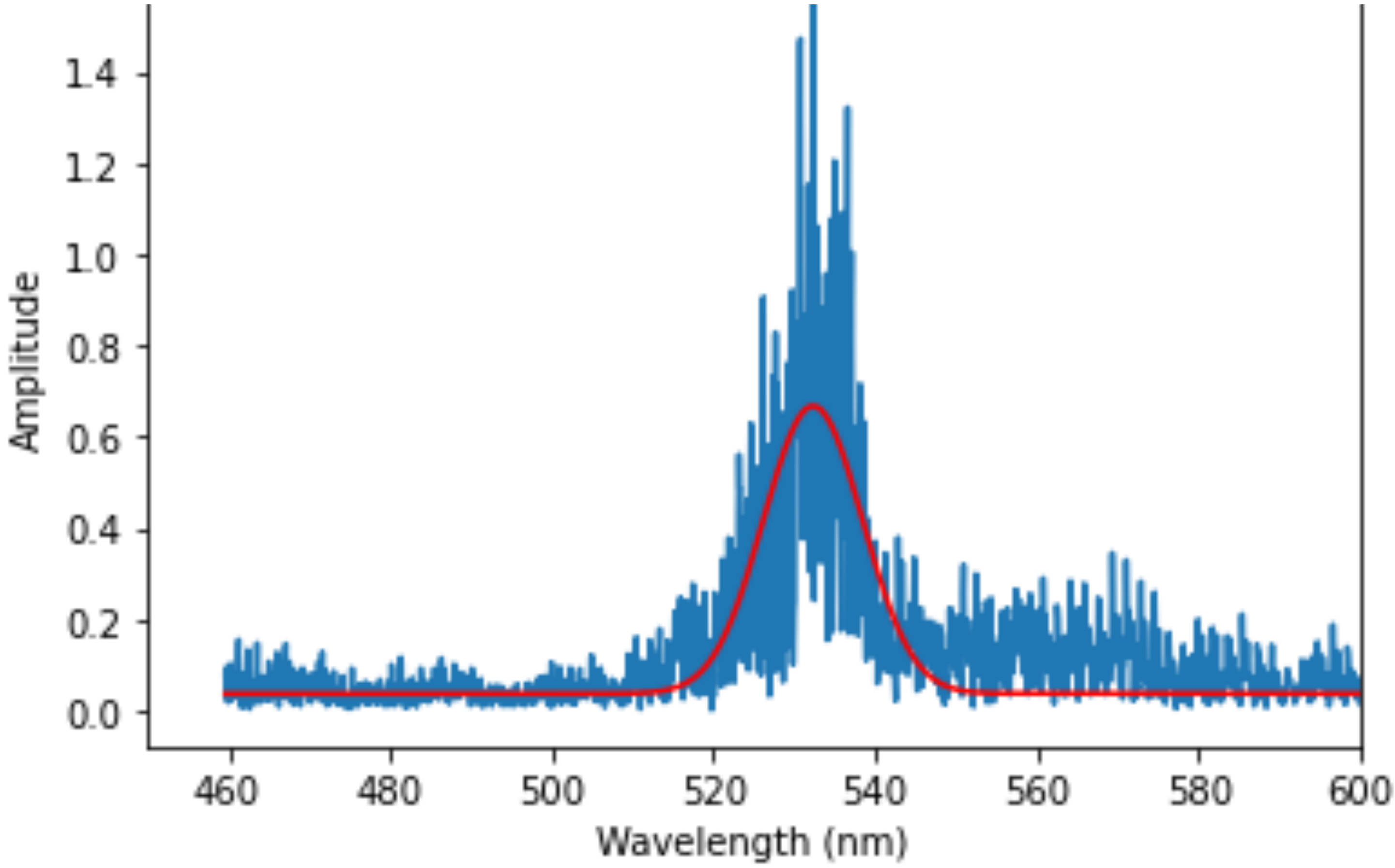


fig 47. plot of amplitude (intensity) against wavelength. Is the fourier transformed data for the mercury lamp with a green filter representing its spectrum.

Agrees with our experimental. This suggests that there is something fundamentally wrong with how our interferometer is calibrated. In addition, whilst we do observe the singlet we expect, it is clearly significantly wider then the spectral width that we calculated, taking the spectral width to be the FWHM of our Gaussian fit in **fig 47.** we find it to be **14.363384346732813 +/- 0.17852863314175804 nm** (analysis done using the fit and covariance of our Gaussian). This seems significantly larger than we would expect it to be.

Task 11

Using the exact same set up as task 10 but replacing the green filter with the yellow filter we investigate the yellow doublet and obtained the long interferogram shown in **fig 47.**

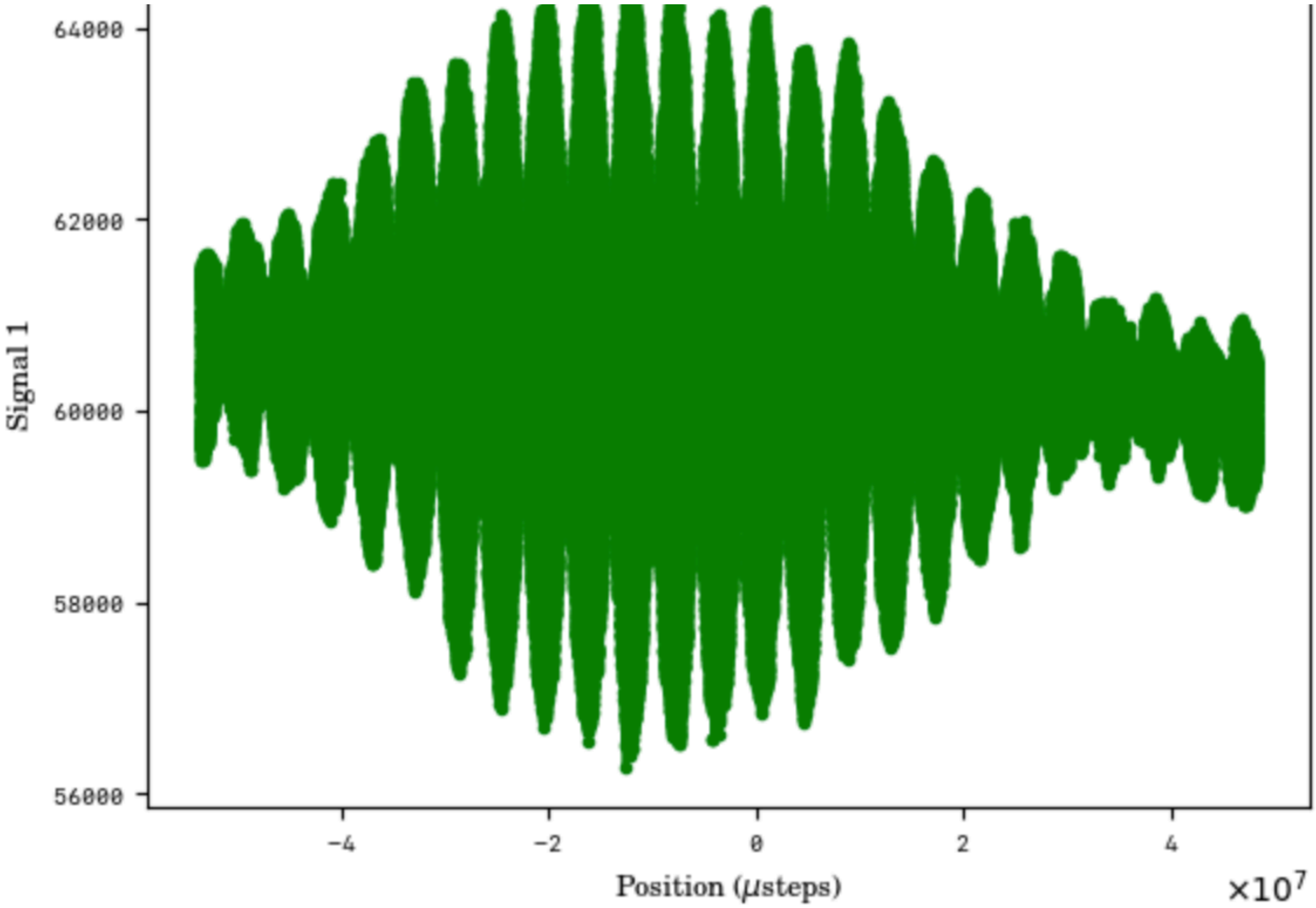
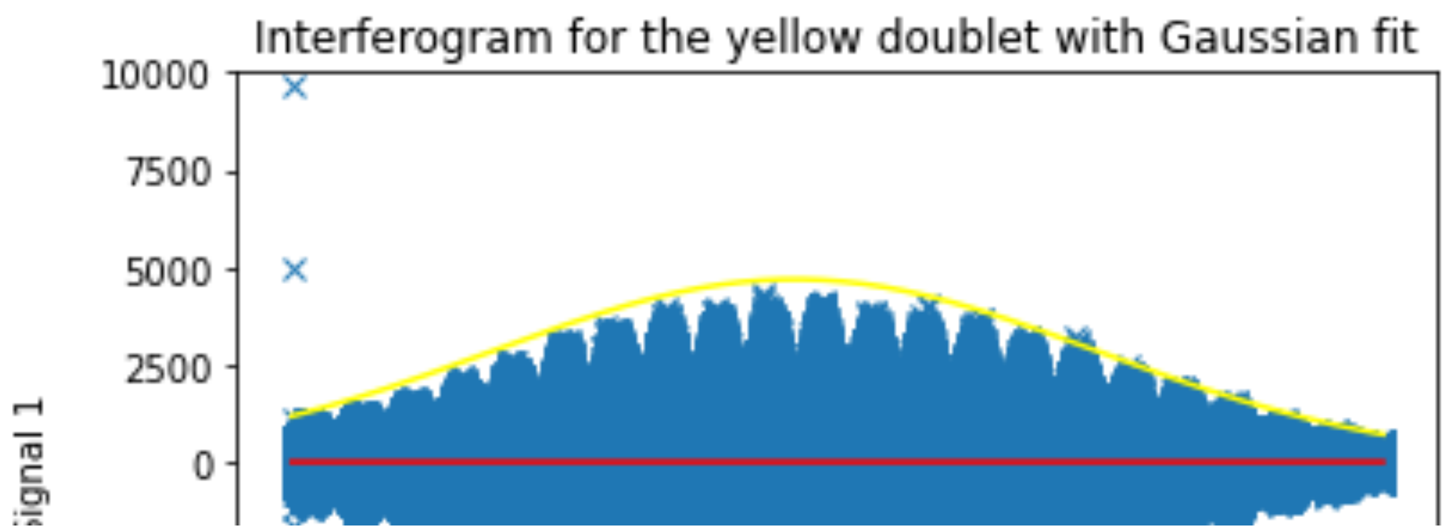


Fig 47. plot of signal (intensity) against position for the mercury lamp with a yellow filter applied.

Fig 47. does show the expected pattern given that we expect there to be two distinct wavelengths and therefore should look similar to **fig 2.** when we ran the simulation which it does.

We then proceed to add a gaussian function to the data as shown in **fig 48.** where we have filtered the data. This is shown in **fig 48**. using the same code as task 9.



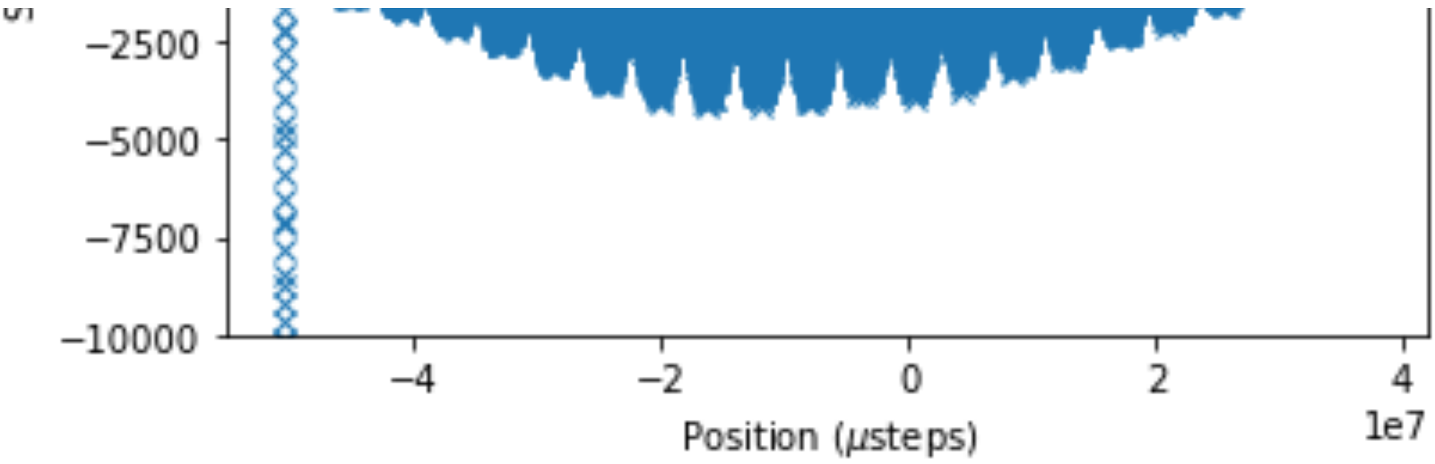


Fig 48. plot of signal (intensity) against position for the mercury lamp with a yellow filter applied.

Doing the exact same process as the previous task we find the wavelength to be **553.2122790349067 +/- 3.2039046769995236 nm** which is lower than either of the two peaks we are expecting.

From **fig 48.** and using the Gaussian fit in the same way we find the spectral width to be **0.023131711168024417 +/- 0.003881825803371819 nm** which is again really small. This is because it depends on the coherence length which we're taking to be the FEHM and in task 10 and 11 we've found that the interferogram is considerably longer than the earlier tasks and we're still seeing a coherent source for substantially longer.

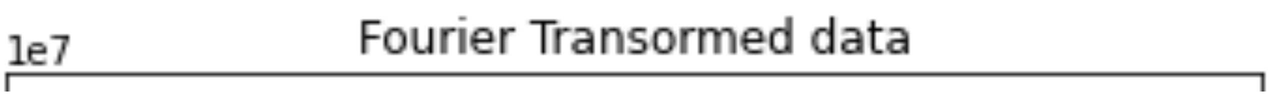
To find the line seperation we used equation 3 from the lab script: (λ1 − λ2) = λ^2 /4t

Where λ1 and λ2 are the two different wavelengths and λ is the wavelength that we have calculated from the mean crossing points. T is the position from the null point to the next peak. We found t by finding the number of peaks within the FWHM (which we found to be 21 when rounded) and then divided the FWHM by 21 to find t.

We then substituted into the equation and propagated errors to find the line separation to be

0.754239880368512 +/- 0.39142502903872 nm. This seems really small given that we expect the line separation to be about 10 nm.

We then take a fourier transform and fit two Gaussian functions (since we expect two distinct peaks) similar to task 10. this is shown in **fig 49.**



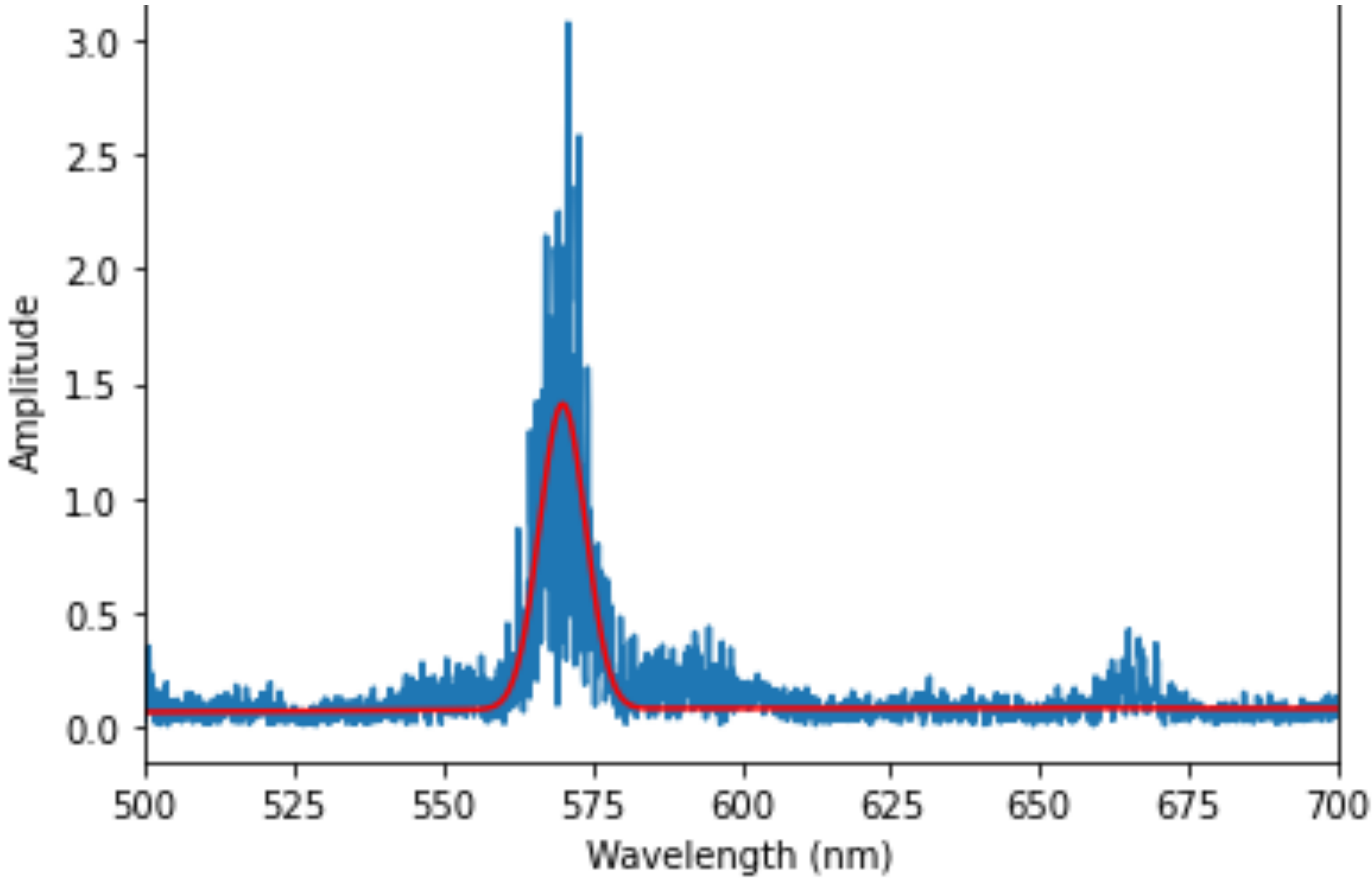


Fig 49. plot of amplitude (intensity) against wavelength. Is the fourier transformed data for the mercury lamp with a yellow filter representing its spectrum. Clearly cannot see two distinct peaks even though our interferogram suggests there will be.

From **fig 49.** we now understand that our transformations doesn't reveal two distinct peaks, actually making our calculated value for line separation seem more plausible. The wavelength is calculated to be **570.0118810940075 +/- 1.2362884270724537 nm** for the first Gaussian and the second is not able to fit as there isn't another distinguishable peak. This is suitably higher than the calculated wavelength from the mean distance between crossing points.

The spectral width is also substantially higher at **9.037312136417668 +/- 0.02941303666009961 nm**

From these two tasks it seems apparent that some sort of calibration or alternative data analysis is necessary in order to get the expected results.