Photoluminescence Spectrometer Drift Behaviour

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June 2020

1 Where to access calibration files:

https://github.com/simwat/symphony/tree/master/PLE

2 June 15

The spectrometer was run for the first time since the COVID-19 shut down.
LabVIEW parameters: step size is 0.005 nm.
Fig. 1 shows the calibration by dial (shown in blue) and the subsequent fine calibration to the Hg lamp (shown in red). The peak had shifted to exactly the Hg line at 365.016 (365.015 by measurement capabilities).

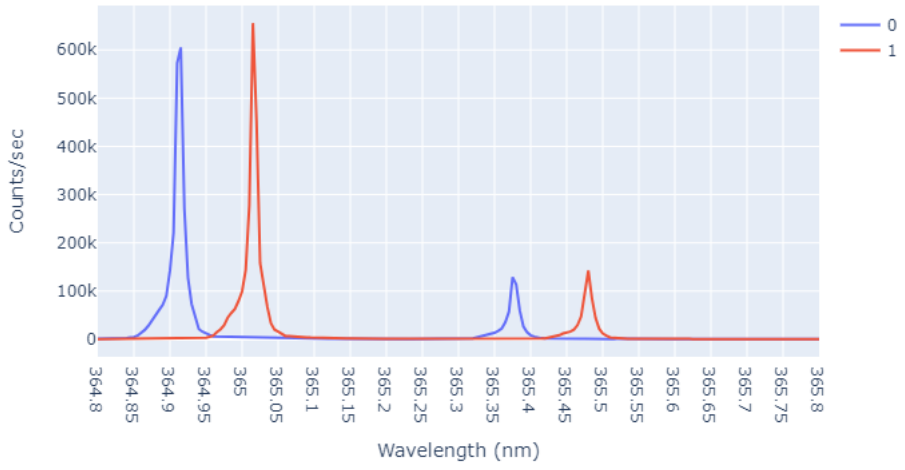

Figure 1: June 15: PL calibration spectrum

3 June 16

The spectrometer began to show drifting behaviour while calibrating to the Hg lamp.

The shifts range from an interval of 0.1 to 0.11 nm.
We tried an unsystematic investigation, alternating between calibrations and letting it run. Spectra are shown in Fig. 2.
We tried rebooting the LabVIEW program, but to no evident effect.
The dial was monitored for its starting and ending position of the consecutive scans. Fig. 3 shows the drift in the dial as a function of the number of repeated runs. It also shows the position of the peak, which is drifting with the opposite direction and same speed as the dial.

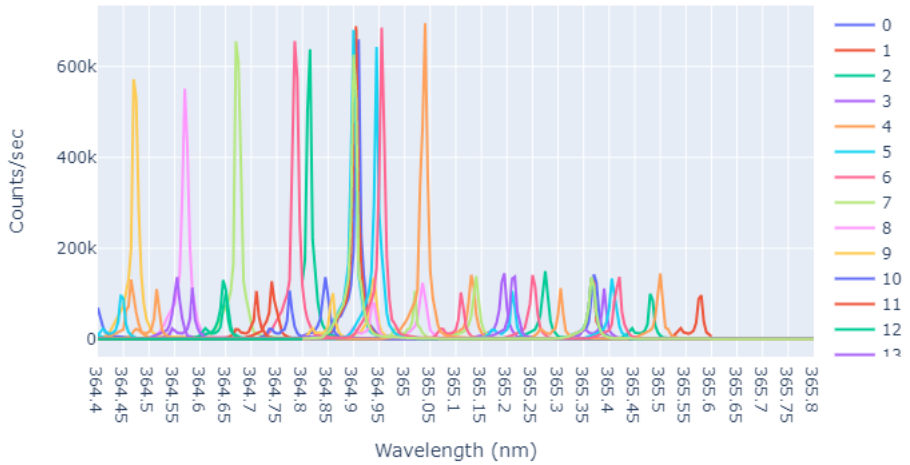

Figure 2: June 16: PL calibration spectrum

4 June 18

We ran a more systematic investigation.

The spectrometer was run continuously with the Hg lamp, interrupted by 2 intermittent calibrations. Fig. 4 to June18.3 show the Hg spectra, each graph showing a sequence of un-interrupted scans. With Fig. June18.1, the shifts began with intervals of 0.01 to 0.015 nm. Then they decreased to 0.005 nm by

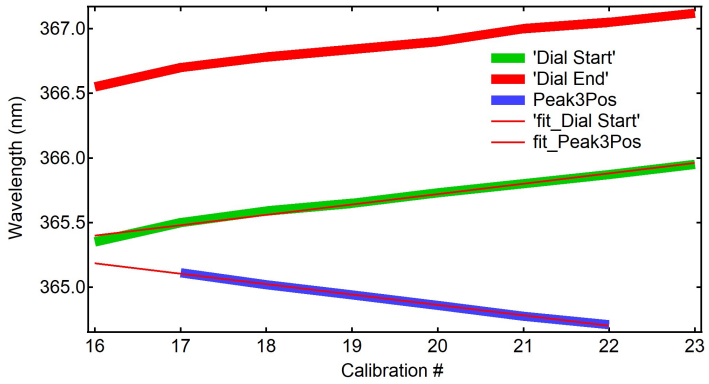

Figure 3: June 16: Dial and peak position behaviour

iteration 12. The shifts are always in the same direction, decreasing. By iteration 20, the peak would stabilize for another run before shifting 0.005 nm again.

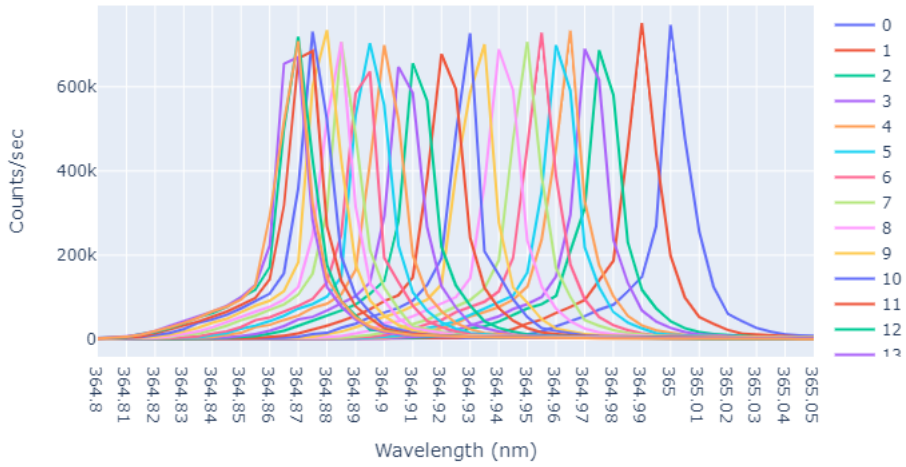

Figure 4: June 18: PL calibration spectrum

With Fig. 5, the first peak was a recalibration. The peak decreases steadily but stays in each wavelength for 2 or 3 runs. All the shifts are 0.005 nm in interval. At iteration 21 (of this graph), the peak stays at the same wavelength for 5+ runs. Then it shifts down another 0.005 nm, where it stays for another

20+ runs. At one point (iteration 35 of this graph), the peak shifted up 0.005 nm for one run before shifting back down to 364.97 nm. This is likely due to temperature effects.

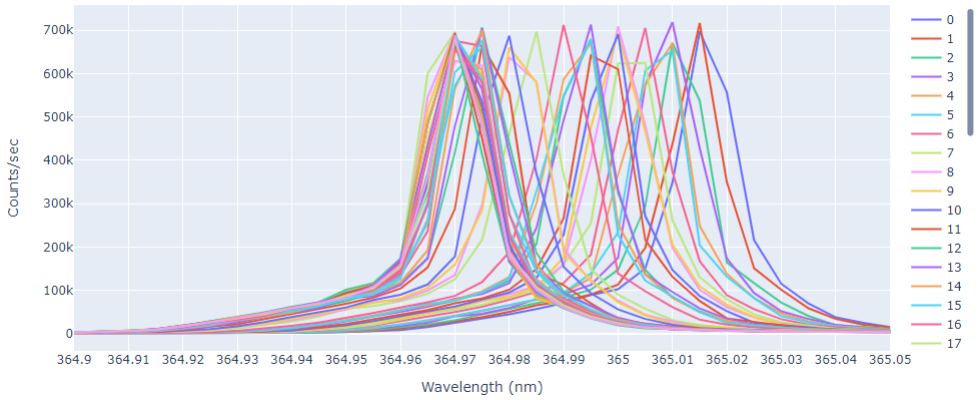

Figure 5: June 18: PL calibration spectrum after first calibration

With Fig. 6, again the first peak was a recalibration. The peak goes between 365.015 and 365.02 for 30 runs. Then it drifts towards lower wavelengths at intervals of 0.005 nm. It starts by staying at each wavelength for 8-9 runs, but the repetition in each position decreases as the peak shifts to lower positions. At iteration 94 of this graph, the drift occurs at every run.

5 June 19

We had run the calibration overnight. We also ran a spectrum for our ZnO baseline growth.

Fig. 7 shows the peak drifting. The first peak is after a recalibration. At first, it drifts down in wavelength by 0.02 nm. By iteration 3, the shifting intervals decrease to 0.01 nm, and by iteration 8, the intervals decrease to 0.005. This continues until iteration 29, after which no peaks are visible. Iteration 36 and onward is seen by the second (smaller) peaks to the right of the graph. The movement rate is still at 0.005 nm per run.

Fig. 8 shows the three spectra of the ZnO baseline growth crystal (H1100). The first iteration was run after a dial calibration. The second was run after a fine calibration, and the third was a subsequent run which shifted 0.035 nm.

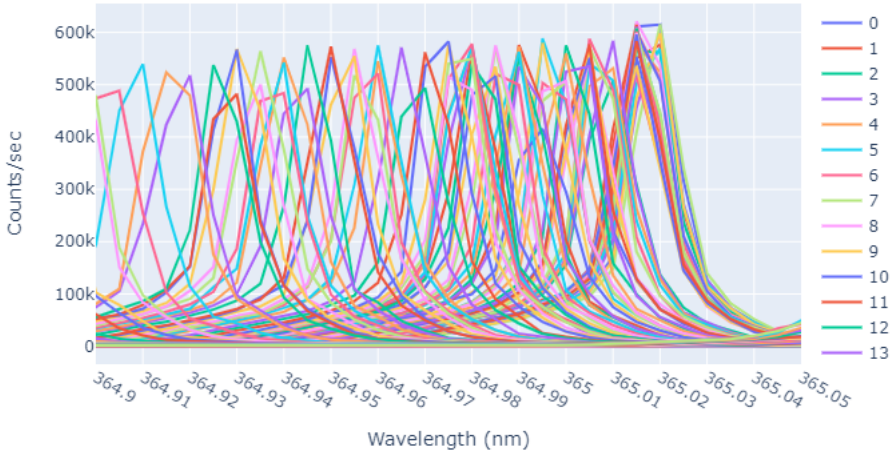

Figure 6: June 18: PL calibration spectrum after second calibration

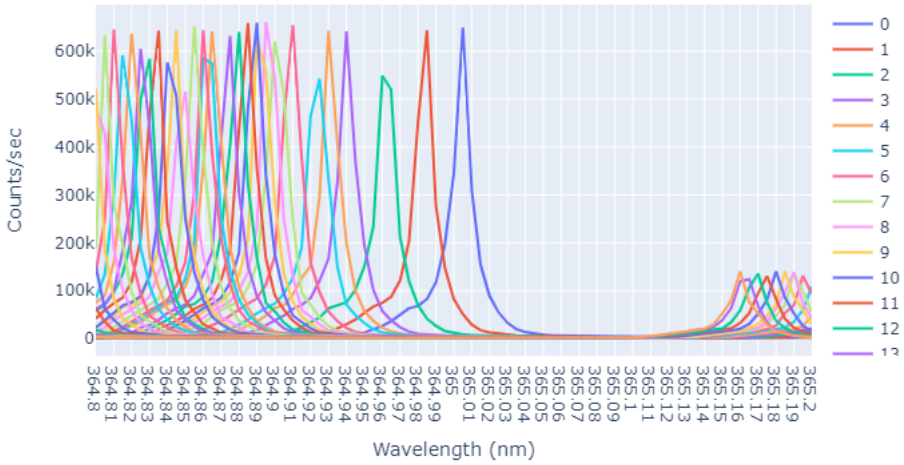

Figure 7: June 19: PL calibration spectrum

6 June 22

We ran the program to the Hg lamp continuously to get more data.

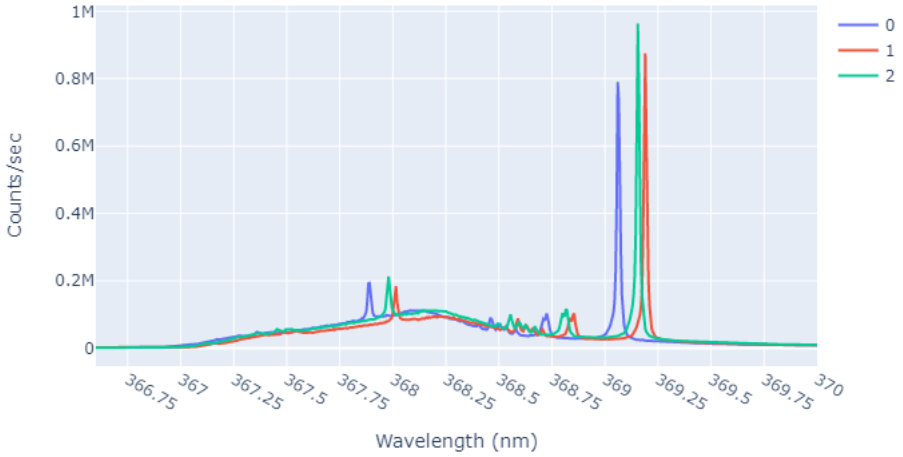

Figure 8: June 19: PL spectrum of baseline growth ZnO H1100

Fig. 9 shows the subsequent shifting after the first calibration. The downward shifts are at an interval of 0.01 nm. At iteration 11, there were two shifts of 0.025 nm, then the shifts returned to 0.01 nm intervals.

Fig. 10 shows the subsequent shifting after another calibration. The shifts are still in the same direction (decreasing) and vary from 0.005 nm (run 0 to run 4) to 0.025 nm (run 5 to run 8) to 0.01 nm (rest of the runs here). There are no repeated wavelength positions.

Fig. 11 shows another set after another calibration. The shifts vary between an interval of 0.01 and 0.005 nm. The interesting shape of the last run is likely due to noise.

7 June 23

We hooked up another DAQ to act as a counter using another LabVIEW program.

We found that for each nm of movement, there are 4000 step signals given by the LabVIEW. When the program rewinds the spectrometer, it rewinds 20 nm each time. The time it takes to rewind is 1:56 mins.

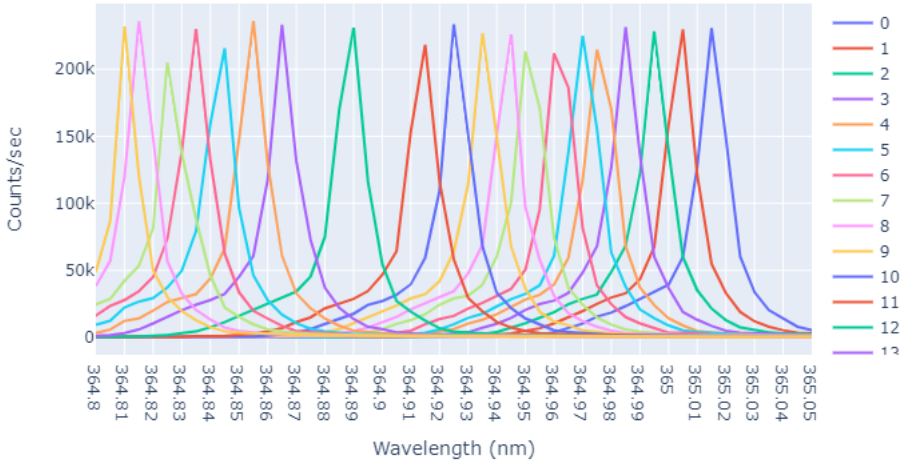

Figure 9: June 22: PL calibration spectrum

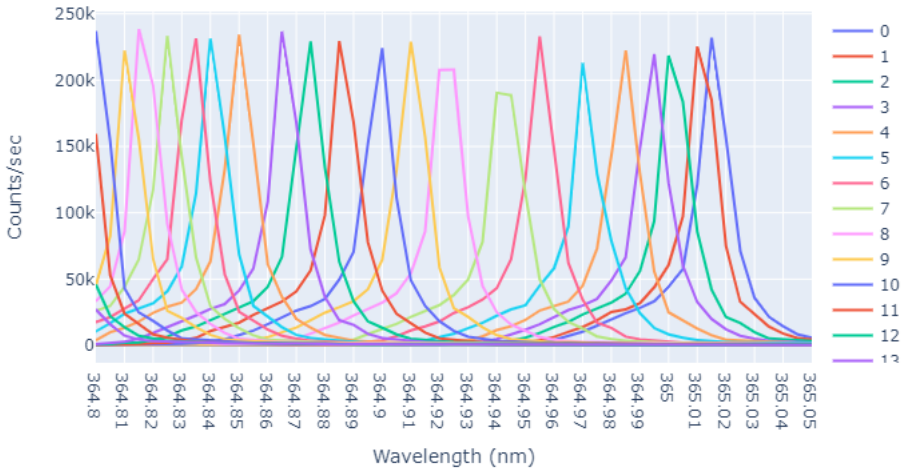

Figure 10: June 22: PL calibration spectrum after first calibration

8 June 24

The calibration peaks seem to stay at each position for many more runs.

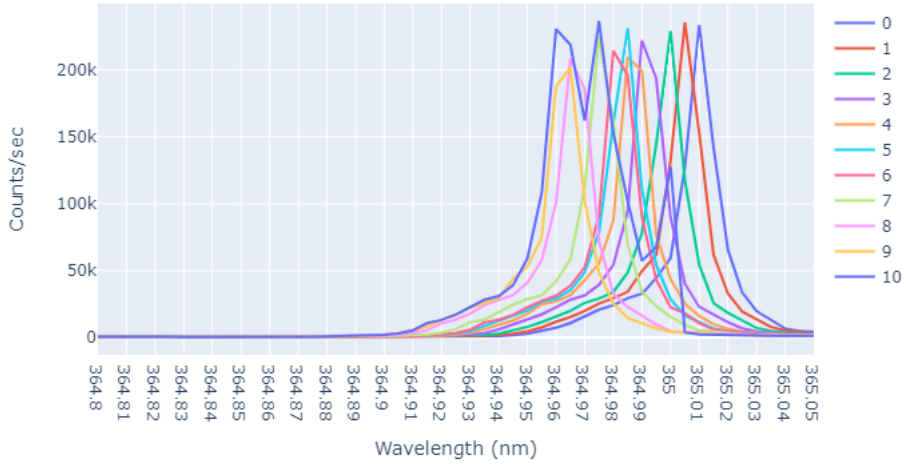

Figure 11: June 22: PL calibration spectrum after second calibration

Fig. 12 shows the progression of the peak position. The first two iterations moved down 0.01 nm after which the shifting is at 0.005. However, it stayed at each position for increasingly more runs, moving 0.015 nm in 120 runs.

9 June 25

We ran the program to the Hg lamp over night.

Fig. 13 shows that the peak shifted continuously by 0.005 nm. Before iteration 40, the peak had stuck to each wavelength for 20+ runs. After iteration 40, each run shifted by 0.005 nm.

Fig. 14 shows three runs, each separated by an hour. There is no shifting other than from temperature. This proves that the shifts happen with the number of runs, not with time.

10 June 26

We had put sample H1101b and H1101e in the chamber. We calibrated and took spectra of the sample.

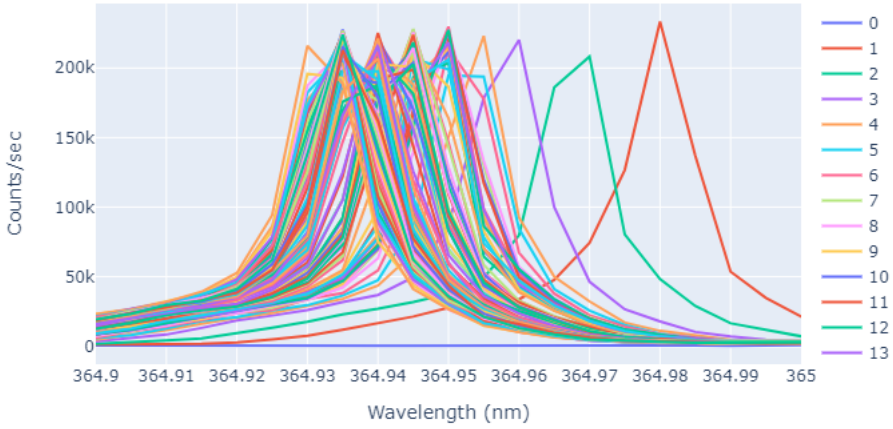

Figure 12: June 24: PL calibration spectrum

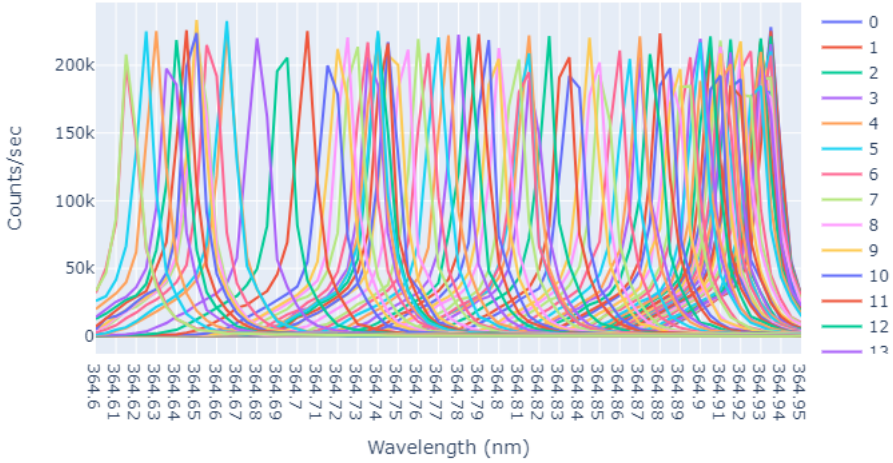

Figure 13: June 25: PL calibration spectrum

Fig. 15 shows the calibration using the Hg lamp. The peak had not shifted

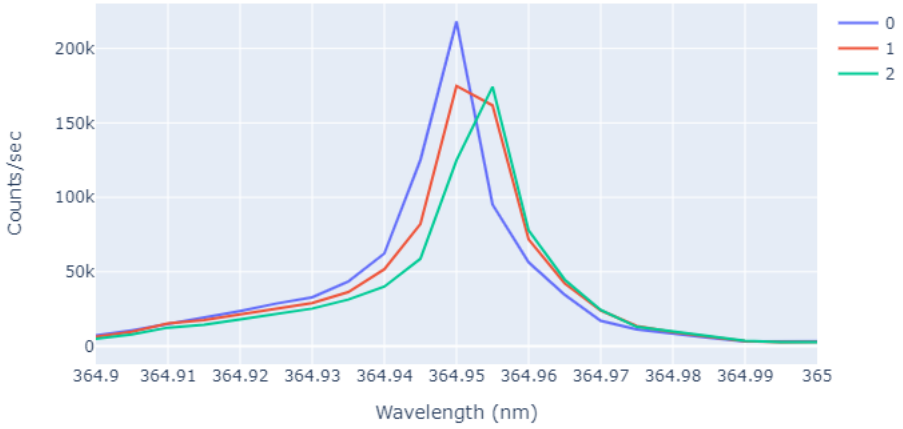

Figure 14: June 25: PL calibration spectrum, separated by an hour each

out of the range of error since the calibration at the beginning. Run 8 and 9 were run at a step size of 0.001 nm. These peaks are at higher wavelengths at around 365.028 nm. The final iteration, iteration 10, has the peak returned to 365.02 nm as it was run at a step size of 0.005.

11 Summary of Drifting Movement

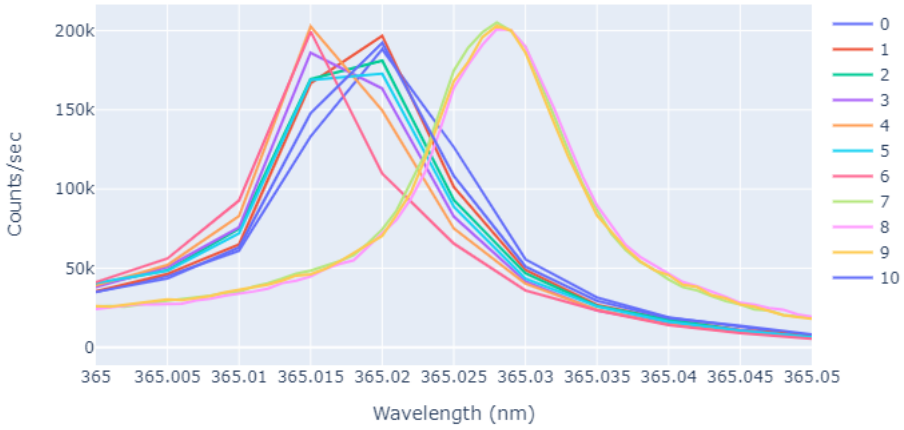

Figure 15: June 26: PL calibration spectrum with run 7, 8, 9 at 0.001 nm LabVIEW step siz

Table 1: Summary of this report in table form - Spectrometer movement and additional information

Date	Movement Summary	Additional Information
June 15	Calibrated once, moved to the Hg line at 365.015 immediately. No further calibrations/spectra were run.	LabVIEW step size of 0.005 nm
June 16	Unsystematic investigation. Shifting around 0.1 nm each calibration run.	Rebooted LabVIEW. Monitored the dial.
June 18	Monotonic shifts (decreasing wavelengths) of 0.01 nm to 0.015 nm. Decrease to less than 0.005 nm (due to repeats of peak position). Then 30 repeated peak positions before shifting each run by 0.005 nm again.	Recalibrated twice
June 19	Monotonic shifts of 0.02 nm to 0.01 nm to 0.005 nm.	Ran overnight, did H1100 spectra
June 22	Monotonic shifts of 0.01 nm to 0.025 nm back to 0.01 nm. This oscillates before decreasing to a 0.005 nm shift.	-
June 23	-	measured 4000 step signals for each nm of movement. Rewinds 20 nm each time for 1:56 mins.
June 24	Moved 0.015 nm in 120 runs	-
June 25	Two repeated peaks for 20+ runs, then 0.005 nm shifts. 3 runs shifting 0.005 nm, each an hour apart.	-
June 26	Shifts to higher wavelength after decreasing LabVIEW step size of 0.001.	LabVIEW step size of 0.001.