**Optrode User Guide:**

Physical Setup:

* Ensure all of the devices are turned on (Green Laser, Blue Laser, both Shutters, Photodiode) and the devices that need to be are connected to the laptop (Spectrometer, Power meter, DAQ card).
* Ensure the correct light filters are in place for the particular laser that is going to be used (Green Laser – Orange filters, Blue Laser – Yellow Filters).

To run the program, execute the "Optrode\_Version7.py" file. To do this in the linux OS:

* Open a terminal.
* Change to the directory that contains the program - "cd PhysicsLabPythonCodes/Optrode/".
* Execute the program - "python Optrode\_Version7.py".

When performing tests:

* Specify the desired parameters, select the “Setup” option and once this is complete, select the “Start” option.
* For the Continuous Integration mode:
* The recording duration is the total time and the integration time determines how often each measurement is taken. Hence, the total number of measurements is recording time divided by integration time.
* For the Multi Integration mode:
* The first multi integration will be at 8ms, the second at 16ms, then 32ms and so on. The number of multi integrations determines how many there will be. The default number is 8, which means the default integration times will be 8, 16, 32, 64, 128, 256, 512, 1024 ms.
* If something goes wrong with the test and you wish to repeat the test, select the “Re-run” option when the test is finished. Or if you want to do another measurement with the same parameters, choose the “Re-run” option and change the file name.
* If you wish to proceed with the next test, select the “Change” option, change the desired parameters, select the “Setup” option and once the test is setup, select the “Start” option.

Performing tests with samples:

* First test with the fibre connected to the Power meter to get a background reading.
* Next test with the fibre dipped in a sample.
* Generally, take all measurements with one laser before moving on to another laser. Start with the lowest concentration sample and work your way up to the most concentrated, testing both the continuous and multi-integration paradigms. Generally, repeat this loop of samples multiple times.
* When changing samples, it is necessary to clean the fibre. Do this by dipping the fibre in water and cleaning the tip, then dipping it in isopropanol and again cleaning the tip.

Potential Complications:

* Generally, when the Power meter is first used after it has been plugged in, the computer needs permission to access the Power meter - To resolve this, enter the Sudo password (the same password that is used to log into the laptop).
* After the initial tests with the Power meter, unplug the Power meter and restart the program.
* Errors when reading the DAQ card - To resolve, simple exit the program and execute it again.
* If the program runs into an error while taking the measurement (i.e. the laser is on and the shutter is open), it is most likely necessary to unplug and plug the spectrometer in again.

Output:

This program gives three plots of output, these are the Photodiode Readings (1), the Photodiode and Spectrometer Latencies (2), and the Power Meter Readings and latencies (3). Additionally, the program will always output the Spectrometer Readings. Select the boxes of the plots you would like to see, before running the program.

Select the suffix box if you would like a timestamp to be saved to the filename. The filename will be saved to the records folder, with the title format:

“Laser Mode – filename.hdf5”

This data is saved in an HDF5 file under the title specified in the program’s GUI. The components of this file are:

* Photodiode:
* Readings (as an array).
* Time each reading was taken at.
* Power meter (If it is connected):
* Readings (as an array).
* Time each reading was taken at.
* Spectrometer:
* Readings (as a matrix where each column represents a different measured spectrum and each row in that column represents the intensity at a certain wavelength).
* Time each reading was taken at.
* Wavelength range for each spectrum.

The beginning/trailing values for the photodiode and powermeter will be taken while the shutter is closed.

The program should automatically cut off any trailing zeroes from the data.

Sometimes, really small values may look strange in the HDF5 viewer. For example, the value 9.23457836e-4 is the same as 0.000923457836, but if you don’t click on the value to get the full display, it will look like 9.234, which will look strange next to other small numbers.

**Optrode Analysis Guide:**

To run the program:

* Open a terminal.
* Change to the directory that contains the program - "cd PhysicsLabPythonCodes/Optrode/".
* Execute the program - "python Optrode\_Analysis.py".

Doing the Analysis:

* Specify how many samples you want to compare.
* Select the name of the output file.
* Select the samples – Hold the “Ctrl” button to select all the files together.
* Select the background sample – This should be one of the Power meter readings.
* Click the “Start” option.

Potential Complications:

* Based on how the file format is saved (i.e. the order of saved data), it may be necessary to change the indices in the ‘generate\_output’ function, to match the order of the data saved in the files.
* The number of samples and wavelengths should be the same, this is for the net readings.
* Try not to save extremely long filenames, as the legend may mask the plot. If needed, you can run the code once, and make a note of the legend, and then run the code again without the legend plot (Comment out the “plt.legend()” line). The colours for each line will stay the same.
* You may need to change fontsizes here and there for optimal plots.

**Notes:**

Its always possible you may need to install new modules when running programs on a new computer. Generally, google the name of the module and find the command to install it through the linux command line.

Exiting out of a program: Usually, the best option to exit out of a program is to hit the “Ctrl-C” keys. This should allow you to then restart the program. However, at times the program will continue to run in the background and restarting the program won’t work. To see if a program is running in the background, enter the “ps aux” command, and any python programs should be near the bottom of the list. If there is a program still running that you would like to close, enter the “pkill -f program\_name.py” command. Note, you do not need to precede the program name with ‘python’.

Darkcounts/Non-Linearity: When both of these parameters are set to True - “(Spec1.readIntensity(True, True))” – The program will read the specifications hard coded into the spectrometer and will adjust the intensities to account for these. The Darkcounts adjustment is quite small, but the Non-linearity adjustment moves it so that the spectra is centered around zero.

Differences between some of the programs:

* “Optrode\_Version7.py”

Used for the City dip probe Optrode.

Compared to the Grafton Optrode, this one will do speed tests to determine the number of measurements to take. Additionally, it uses multiprocessing to synchronise the measurements, which makes the multi integration different to the other programs. The Spectrometer for this system is a bit faster, generally works well around 10ms integration times.

* “Grafton\_Optrode2.py”

Used for the Grafton dip probe Optrode.

The Spectrometer for this system is a bit slower, works well around 20-25ms integration times.

* “Optrode\_Version4.2.py”

Used for the Linear Flow Optrode.

Has better real time plots. Similar continuous integration compared to the other programs. Multi integration works similarly to the Grafton Optrode, using a loop instead of multiprocessing.