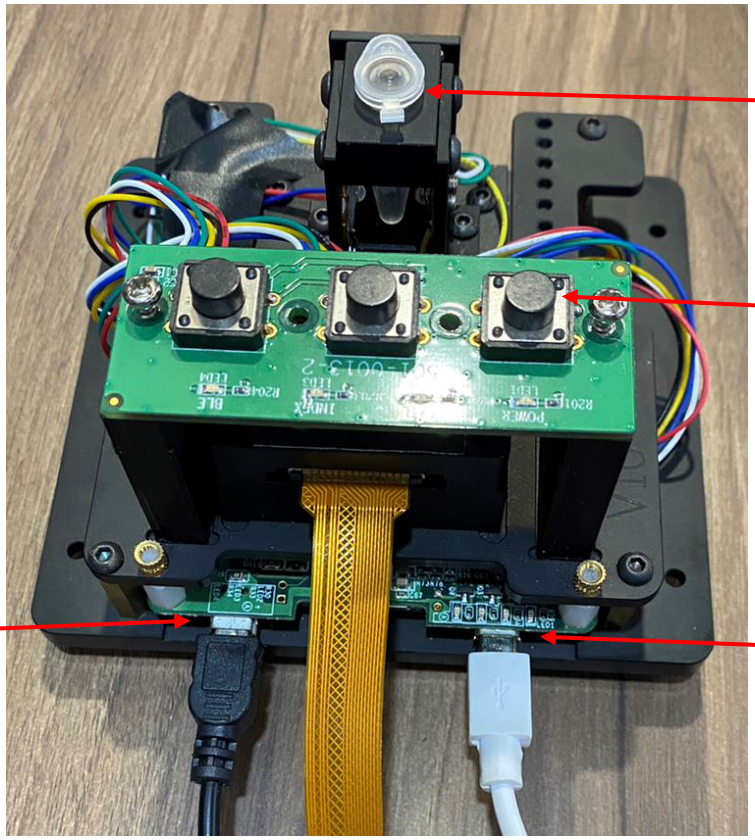
1.1 Hardware

If you will use Transmission Window (Please refer to section 2.3), Kindly take note of the hardware connection method depicted in the image below.



2. Window Contents

There are 3 windows in this application:

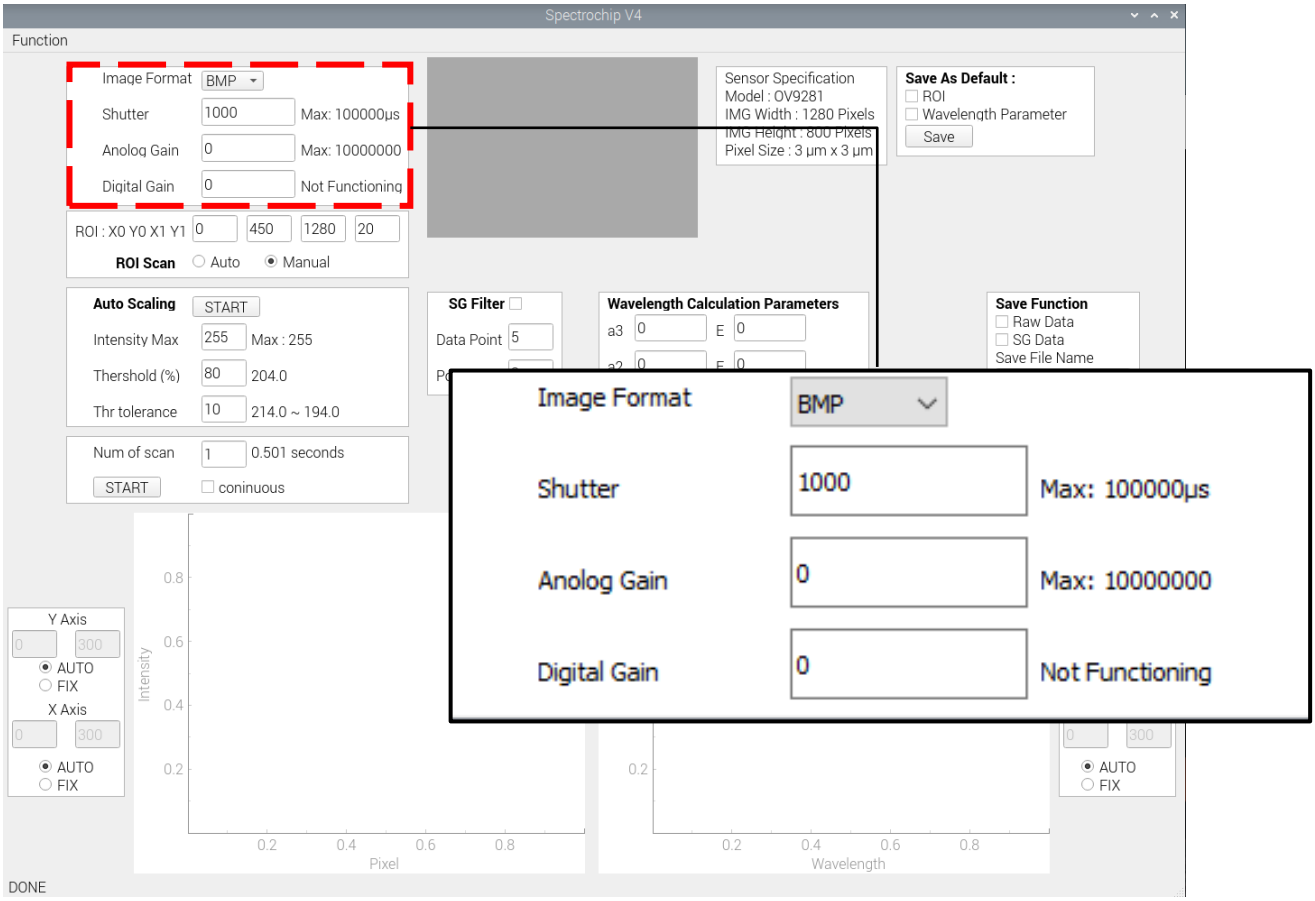
1. Spectrochip (Main Window)
2. Wavelength Calibration (Second Window)
3. Transmission (Third Window)
4. Thin Film (Four Window)

2.1 Main Window

This window will fulfil the needs for a simple spectrum capture.

2.1.1 Sensor Settings

You can change the sensor settings as needed.

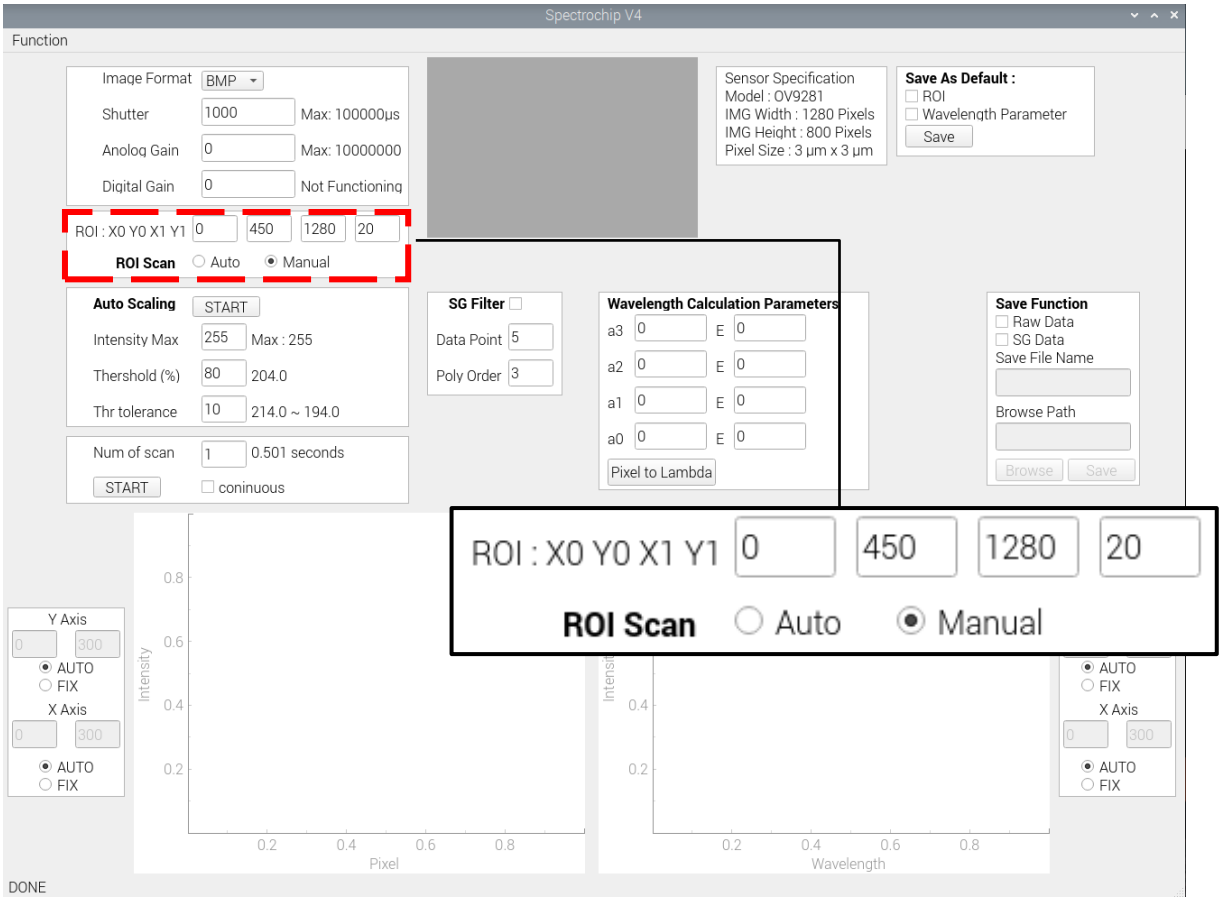


1. Image Format : Changes save file format.
2. Shutter : Change exposure time (microseconds) for the sensor.
3. Analog Gain : Change gain value for the sensor.

4. Digital Gain：Not functioning.

2.1.2 R.O.I Settings

You can change R.O.I. settings as needed.



1. ROI: X0 Y0 X1 Y1：Manual insert parameters for X0, Y0, X1 (Delta X) and Y1 (Delta Y), when change to AUTO, it will capture a new image and find the ROI, then the button will change back to Manual (X0, Y0, X1 will not be able to insert when ROI Scan mode is at AUTO).

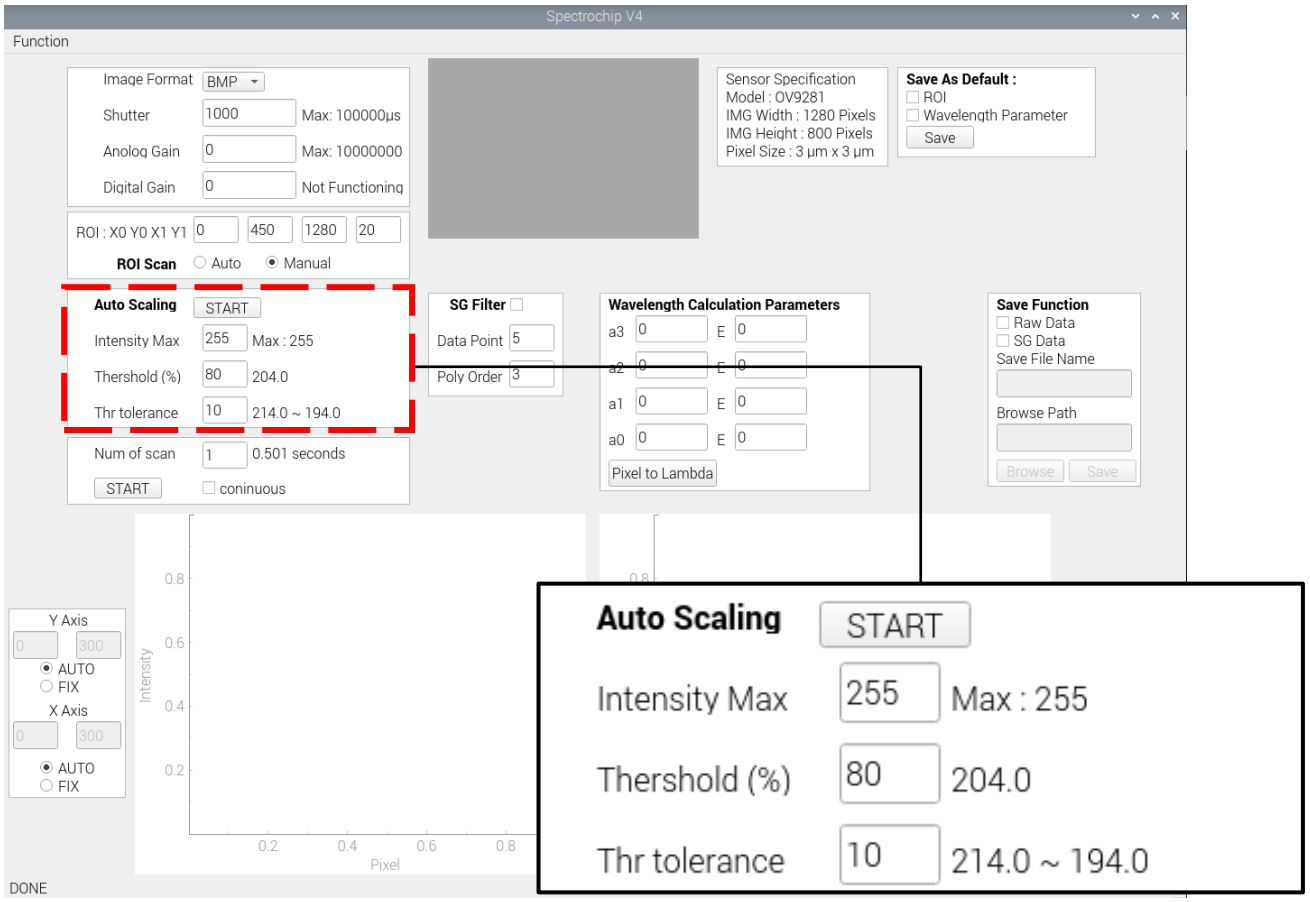
$$\begin{array}{c} \\ Y0 \\ \\ \\ \\ \\ \end{array}\overset{X0}{\begin{bmatrix} (0,0) & & (1279,0) \\ (0,1) & \cdots & (1279,1) \\ \vdots & \ddots & \vdots \\ (0,798) & \cdots & (1279,798) \\ (0,799) & & (1279,799) \end{bmatrix}}_{(800 \times 1280)}$$

(X0+X1, Y0+Y1)

2. ROI Scan：There were 2 modes
   A. AUTO：This mode it will auto find R.O.I., and then update the picture and graph.
   B. Manual：This mode will use the parameter that is fill in.

2.1.3 Auto Scaling

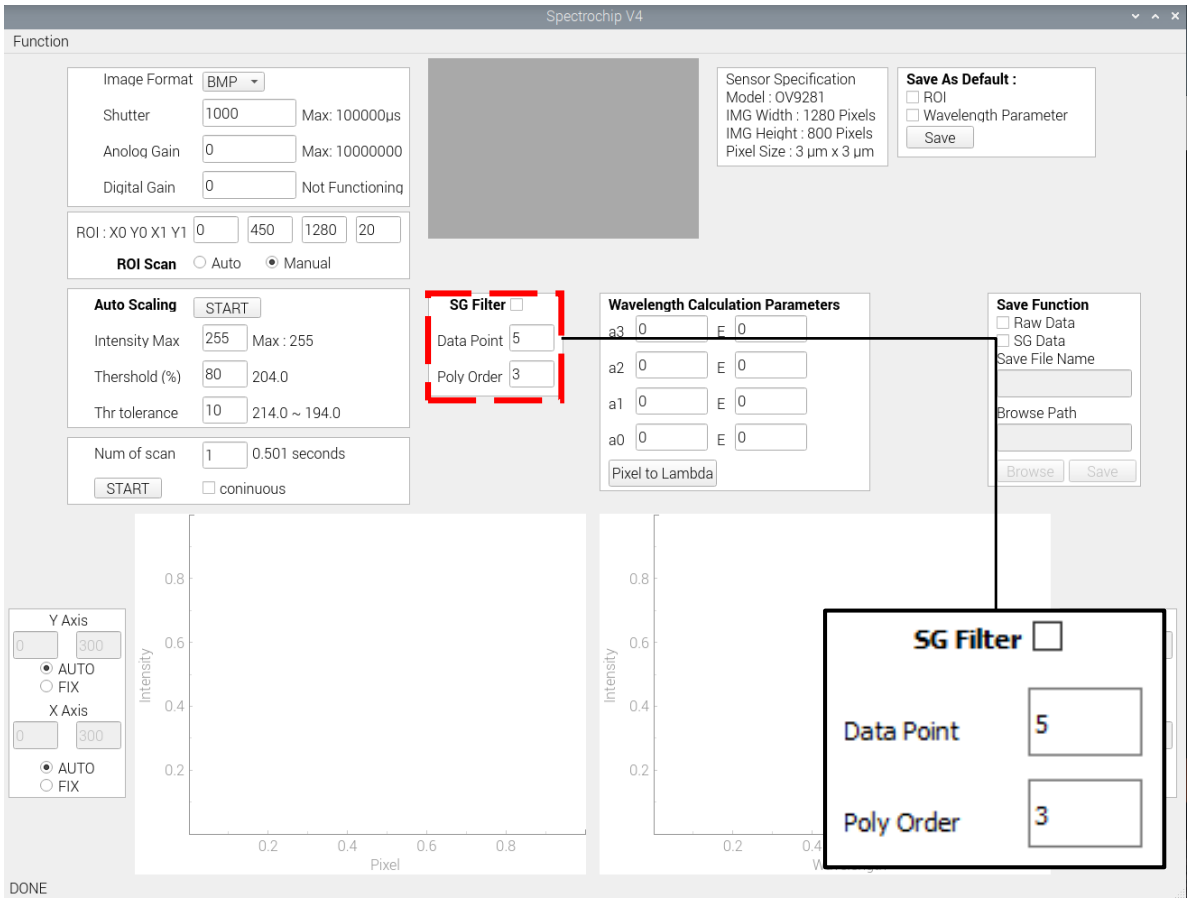
You can change Auto Scaling settings as needed.



1. Auto Scaling Button：Press to start auto scaling (For more information, please refer to Section 3.2)
2. Intensity Max：Set Max Intensity
3. Threshold (%)：Set threshold percentage
4. Thr tolerance：Set threshold tolerance

2.1.4 S.G. Settings

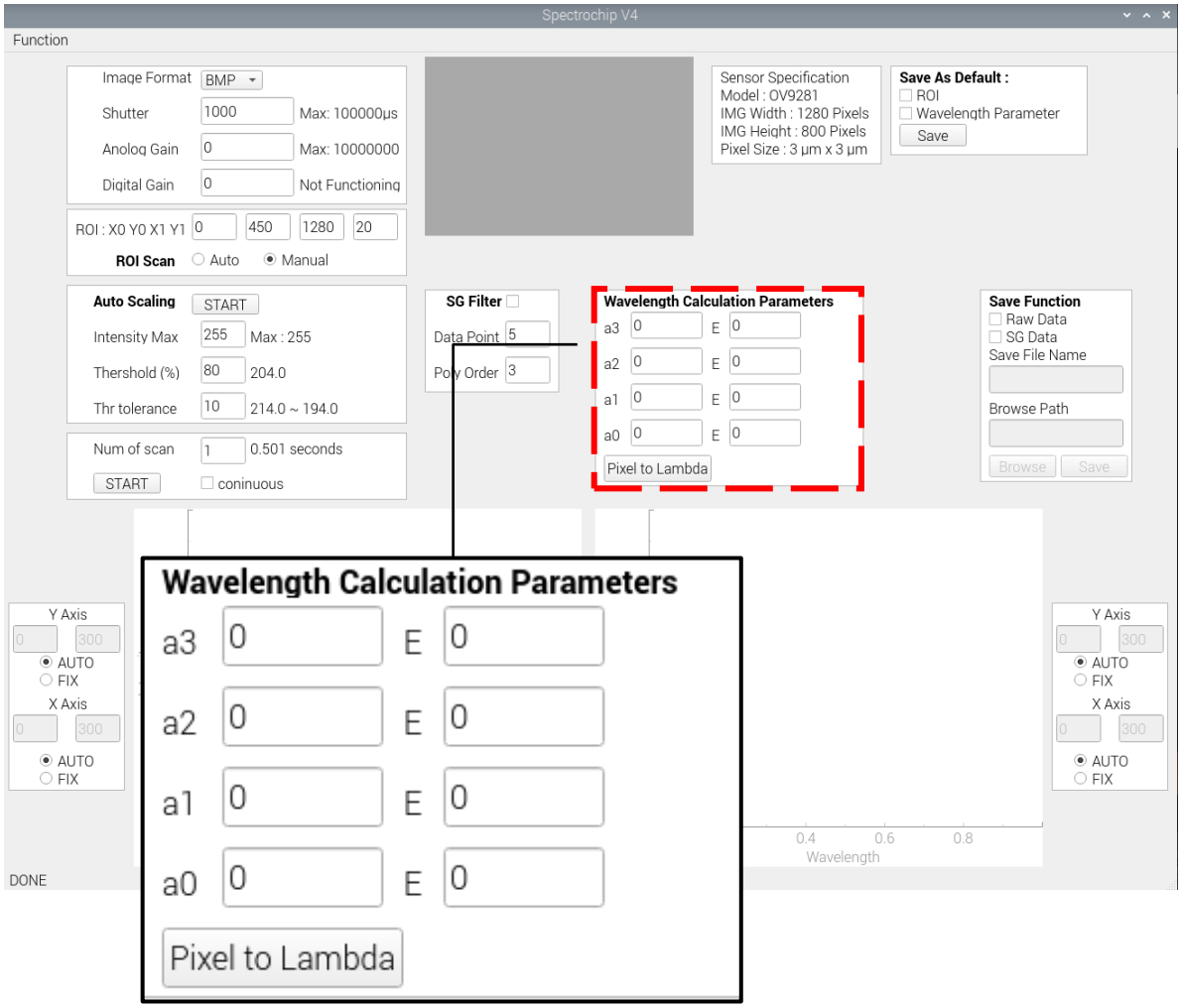
You can change Savitzky–Golay settings as needed.



1. SG Filter checkbox : Check to activate S.G. Filter
2. Data Point : Change window length parameter
3. Poly Order : Change the order of polynomial

2.1.5 Wavelength Convert

You can change the parameter for the equation used to convert pixel to wavelength as needed.



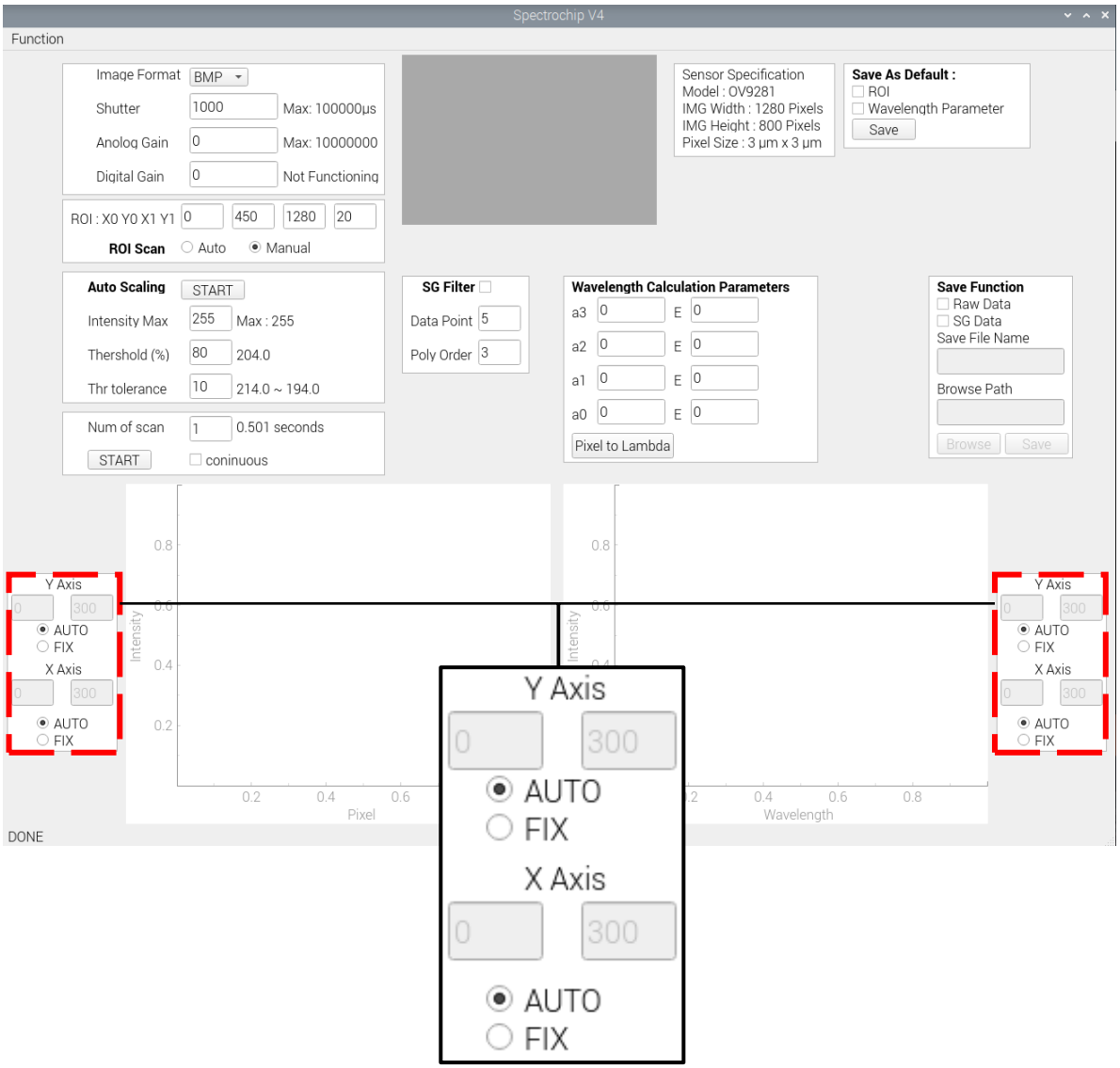
Equation used for wavelength convert :

$$\lambda_{(P)} = a_3P^3 \times a_2P^2 \times a_1P \times a_0$$

1. a_3 = a3(0)E(0), a_2 = a2(0)E(0), a_1 = a1(0)E(0), a_0 = a0(0)E(0)
2. Pixel to Lambda Button: After all parameter have been insert, press this button to update wavelength graph.

2.1.6 Graph

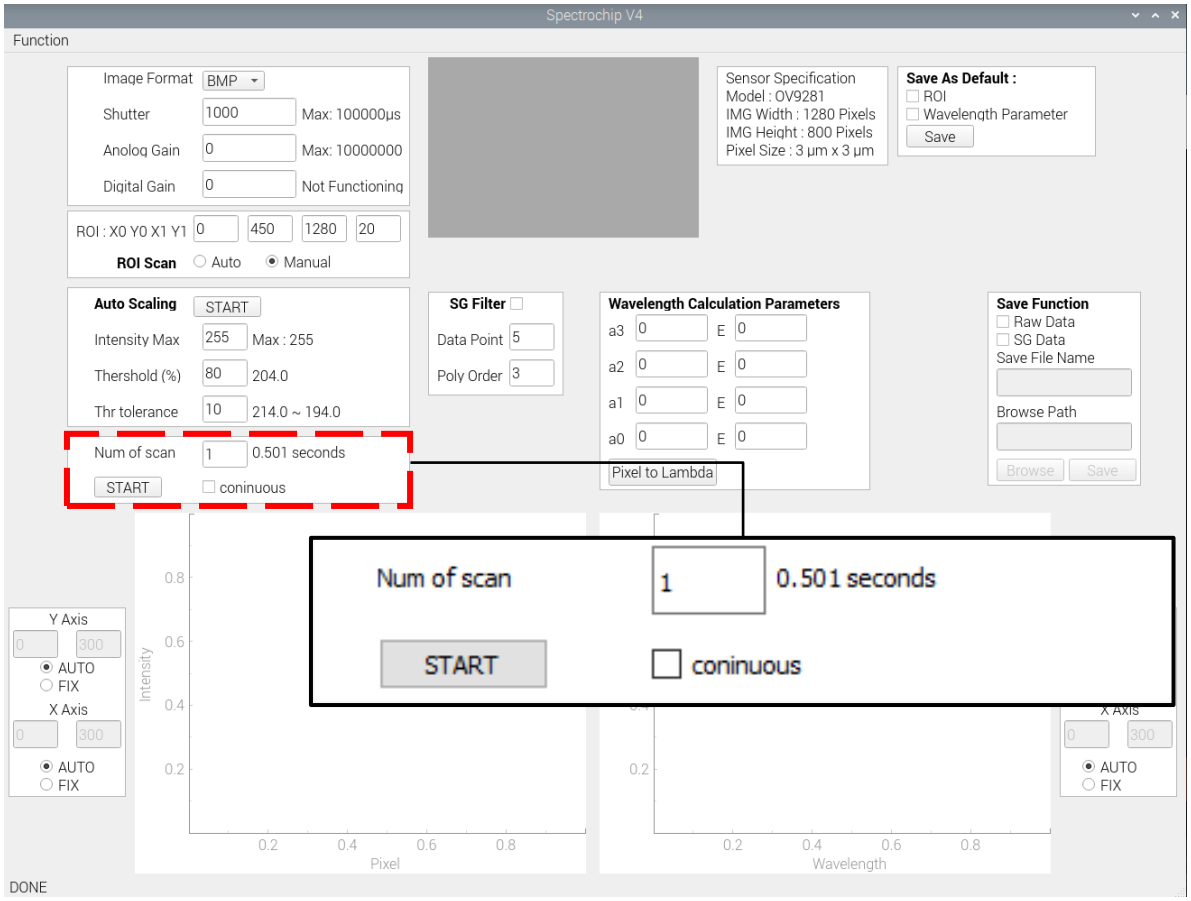
You can change the settings for X and Y axis for the both graphs as needed, left side is for pixel graph and right side is for wavelength graph.



1. Mode button：There were 2 modes
   A. AUTO：Auto scale the range for the axis.
   B. FIX：Fix the scale of the axis to the range that is input by the user.

2.1.7 Sensor Mode

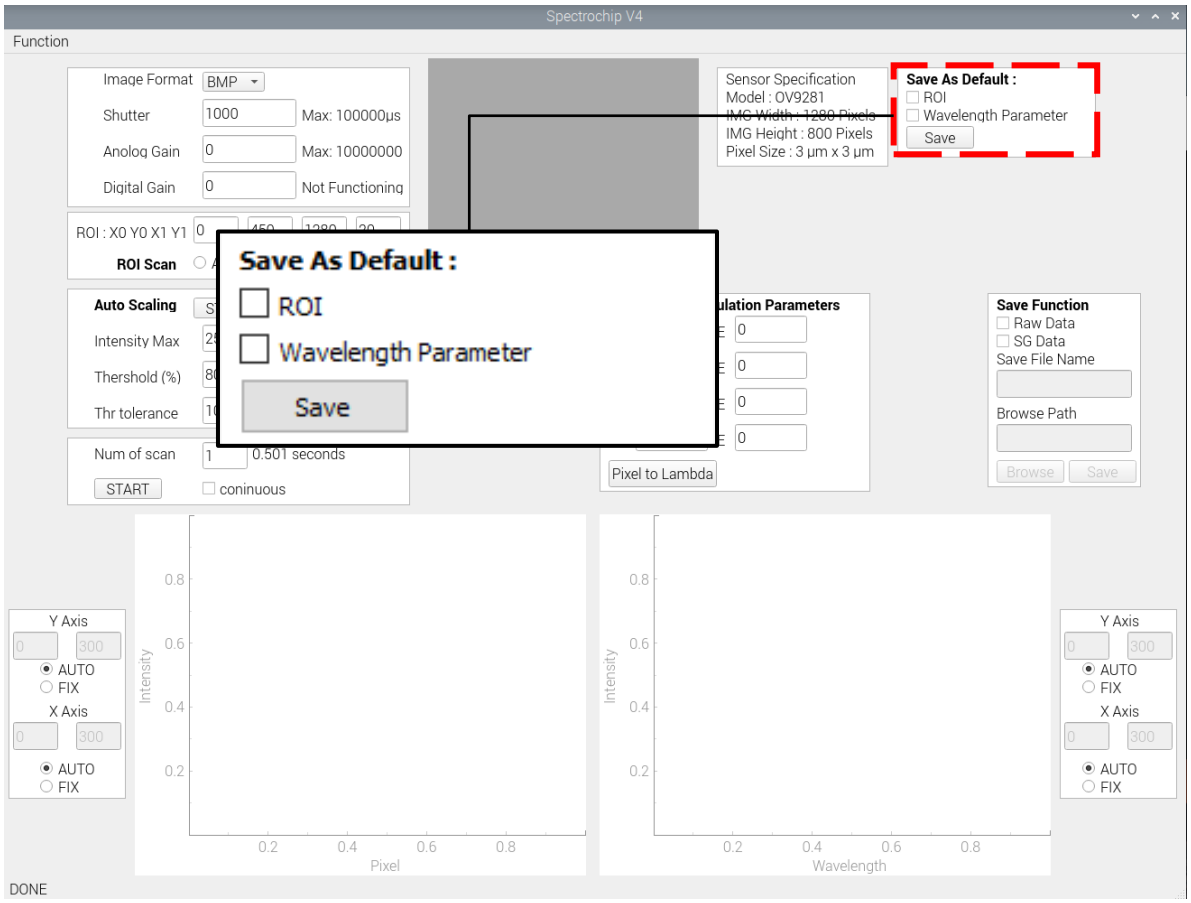
You can start the sensor and set how many times you wanted to scan.



1. Num of scan：Set the times you wanted the sensor to scan (Will count the average according to the number you set)
2. START button：Start the main function (For more information, please see Section 3.1.1)
3. continuous checkbox：Check for continuous data scan (For more information, please see Section 3.1.2)

2.1.8 Change Default

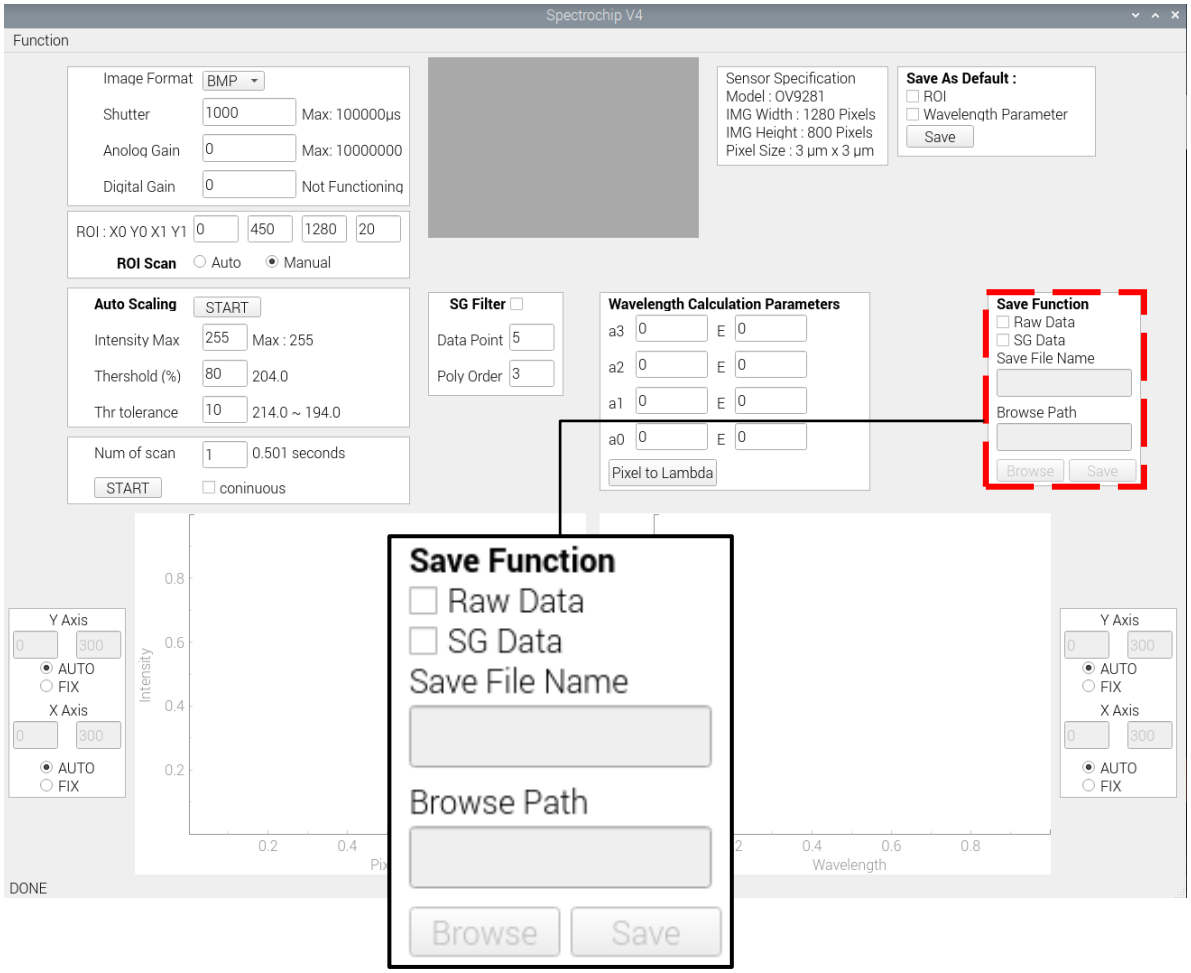
Change Default to your likes.



1. ROI: Change R.O.I default value.
2. Wavelength Parameter: Change Wavelength Parameters.

2.1.8 Save Function

Let the user to choose which and where to save.



1. Raw Data / SG Data tick box: Choose to save 1 or both data.
2. Save File Name: Type in the file name that the user wanted to save as. (Leave blank to use default, default name is date + time)
3. Browse Path: Type in the path that the user wanted to save at. (Leave blank to use default, default path is the script path)
4. Browse Button: Let the user choose the path he/she wants.
5. Save Button: Click it to save.

2.2 Second Window

This window will fulfil the needs for wavelength calibration.

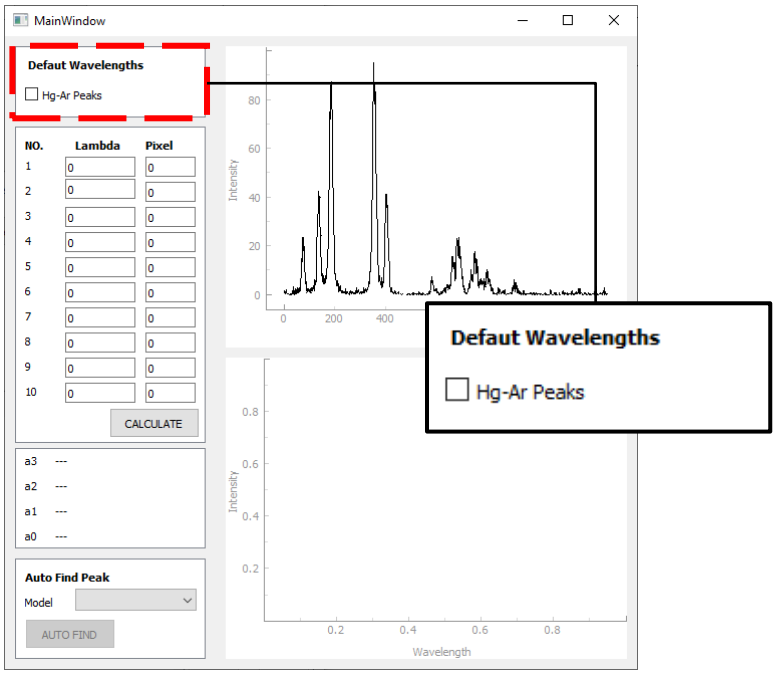
2.2.1 Calculate Equation

You can change the parameter for Lambda and Pixel as needed.

1. Lambda 1 ~ 10：Standard Lambda
2. Pixel 1 ~ 10：Pixel in the image which corresponding to the standard lambda

2.2.2 Default Wavelength

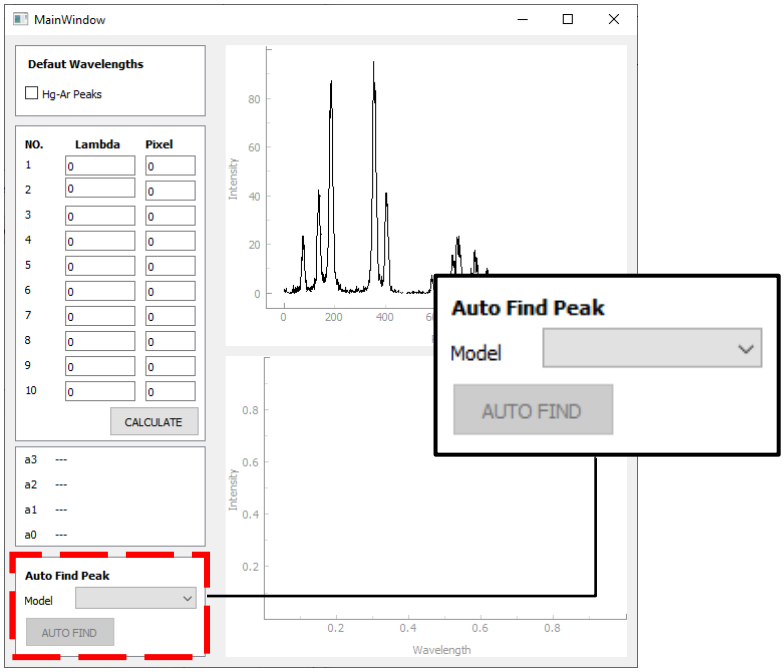
Use the default wavelength set by spectrochip.



1. Hg-Ar Peaks tick box: Tick this tick box to see/use the default wavelength that is set by spectrochip.

2.2.3 Auto Find Peaks

Can be used for automatically find Hg-Ar peaks with default wavelengths.

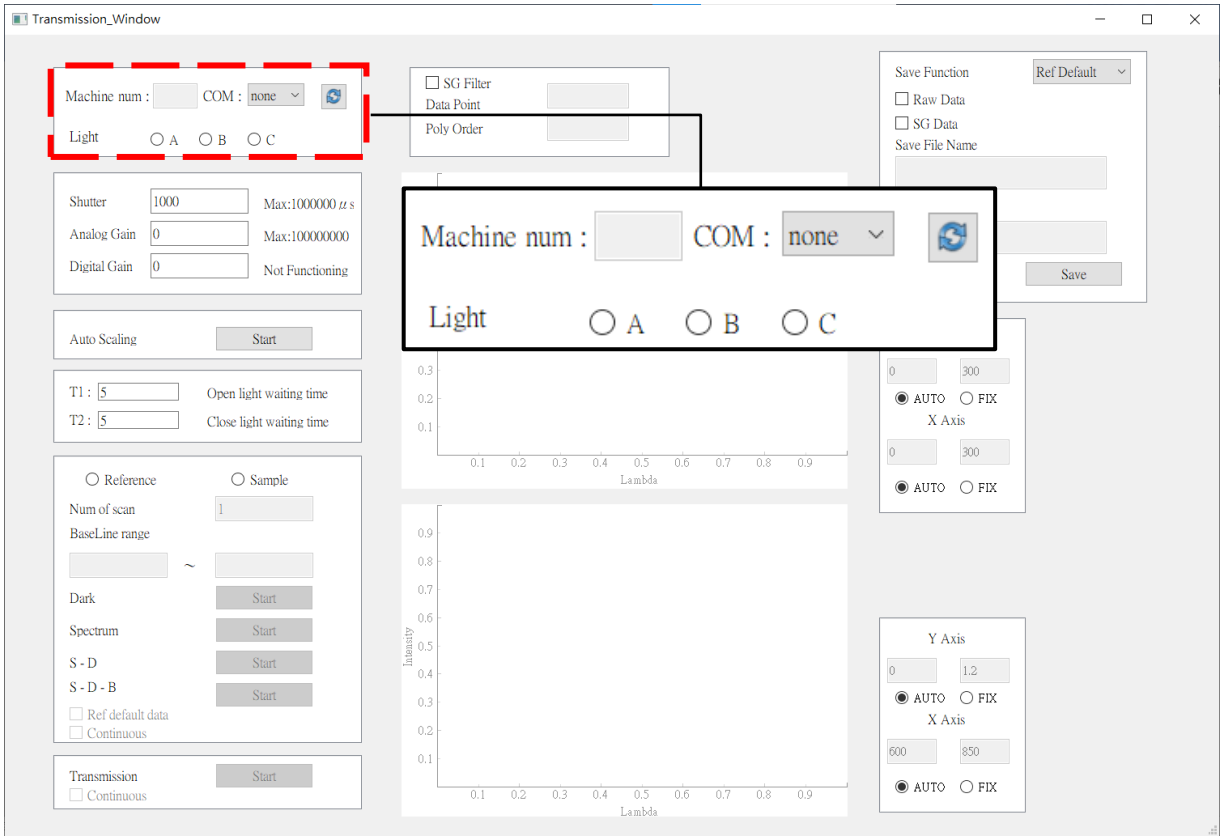


1. Model drop down menu: Let the user choose which light source model the user use. (Now only have 1 model, will update more in the future)
2. Auto Find Button: Press this button to activate auto find peak.

2.3 Transmission Window

2.3.1 Machine Control Area

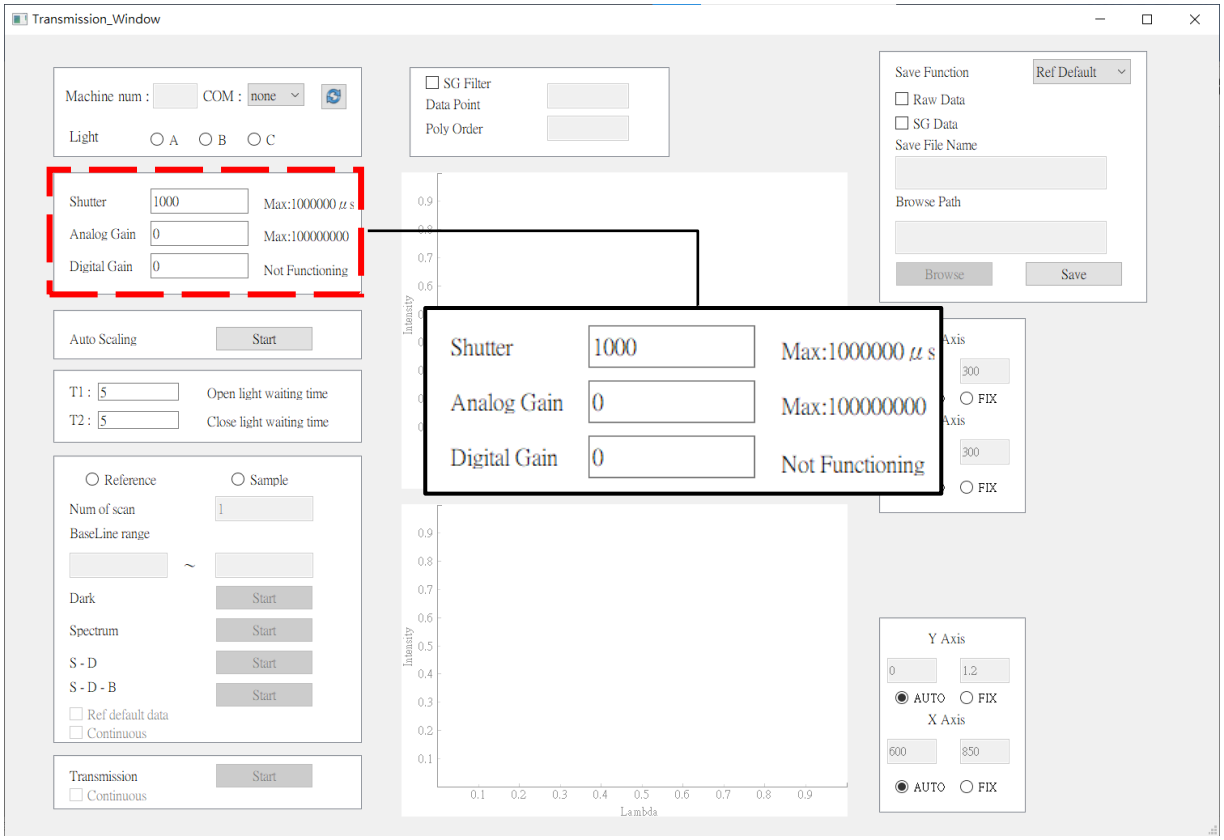
The control area of the machine.



1. Machine num: Not functioning.
2. COM: Select the port to connect the spectrometer and Raspberry pi.
3. Light: You can choose different light sources to measure the spectral data of different substances.
    A. Fluorescent.
    B. Laser.
    C. White light.

2.3.2 Sensor Settings

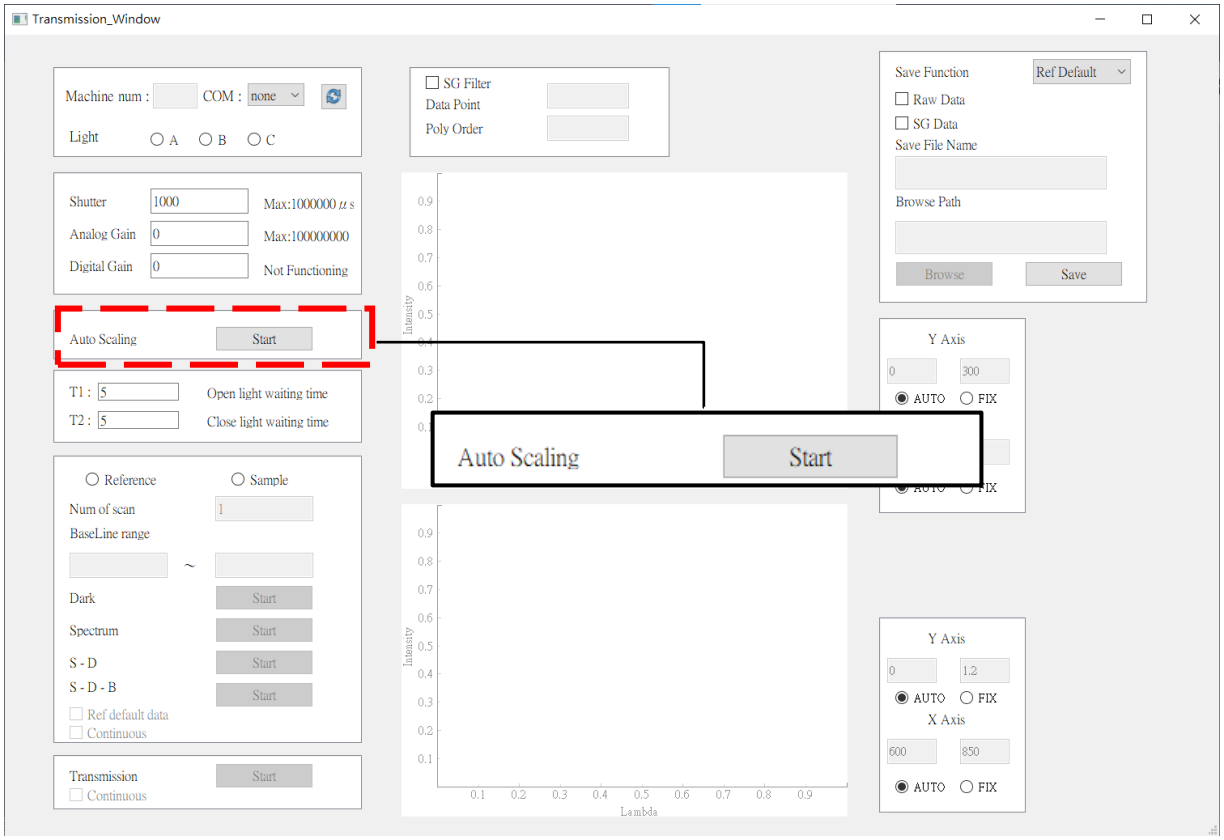
You can change the sensor settings as needed



For more information, please refer to section 2.1.1.

2.3.2 Auto Scaling

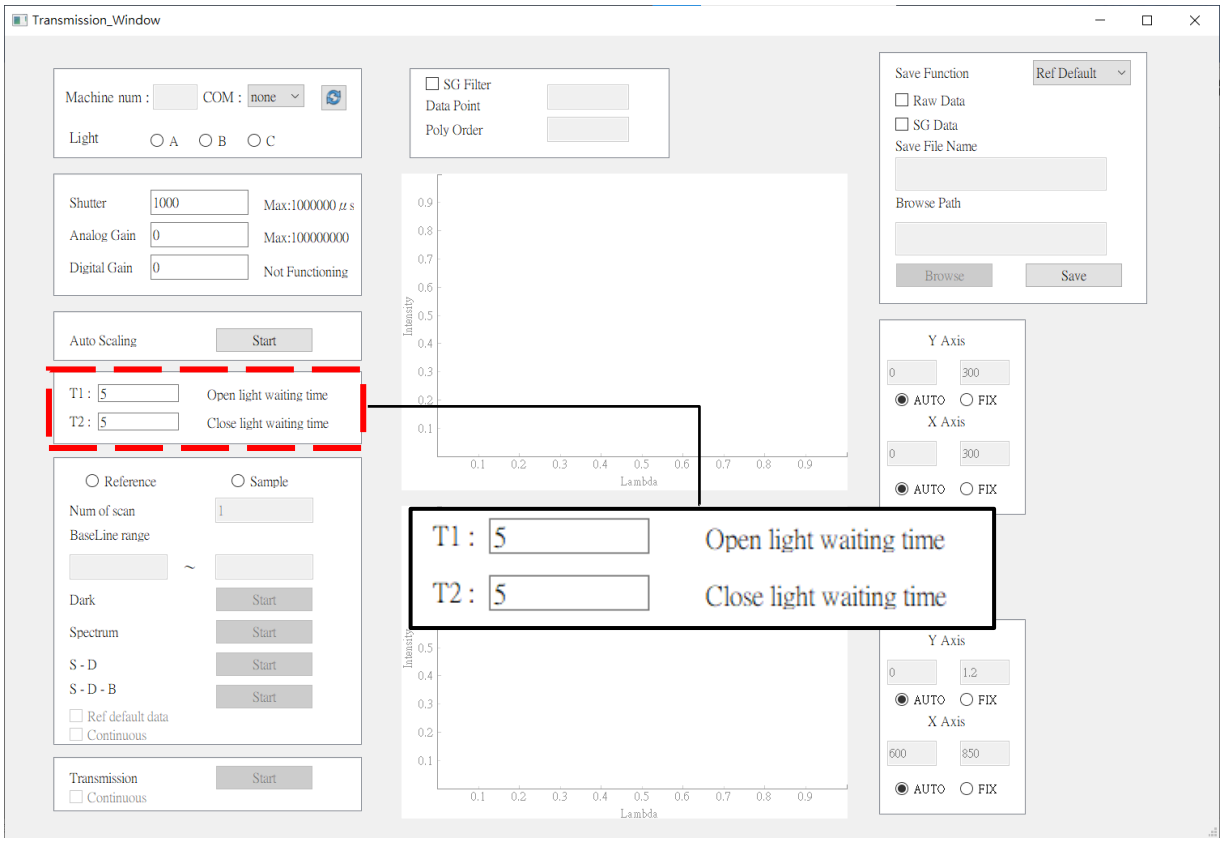
Click to perform Auto Scaling.



For more information, please refer to section 2.1.3.

2.3.3 Time Parameter

You can change time parameter settings as needed.

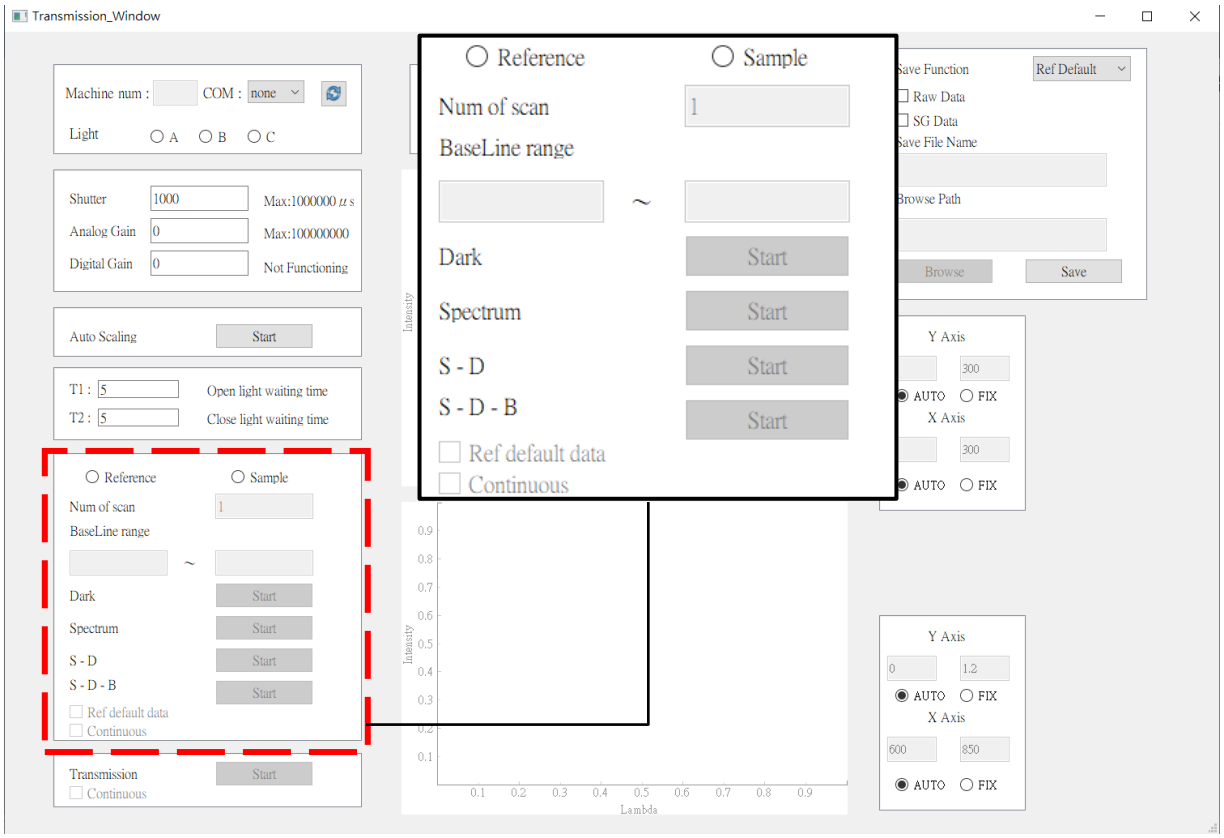


In order for the light source to be stable when scanning the spectrum. Therefore, as long as the light source is turned on, it will be limited by T1 and T2.

1. T1: Set a period for the light source to stabilize before taking an image.
2. T2: Set a period for the light source to stabilize before taking the next image capture.

2.3.4 Scan Spectrum (Reference and Sample)

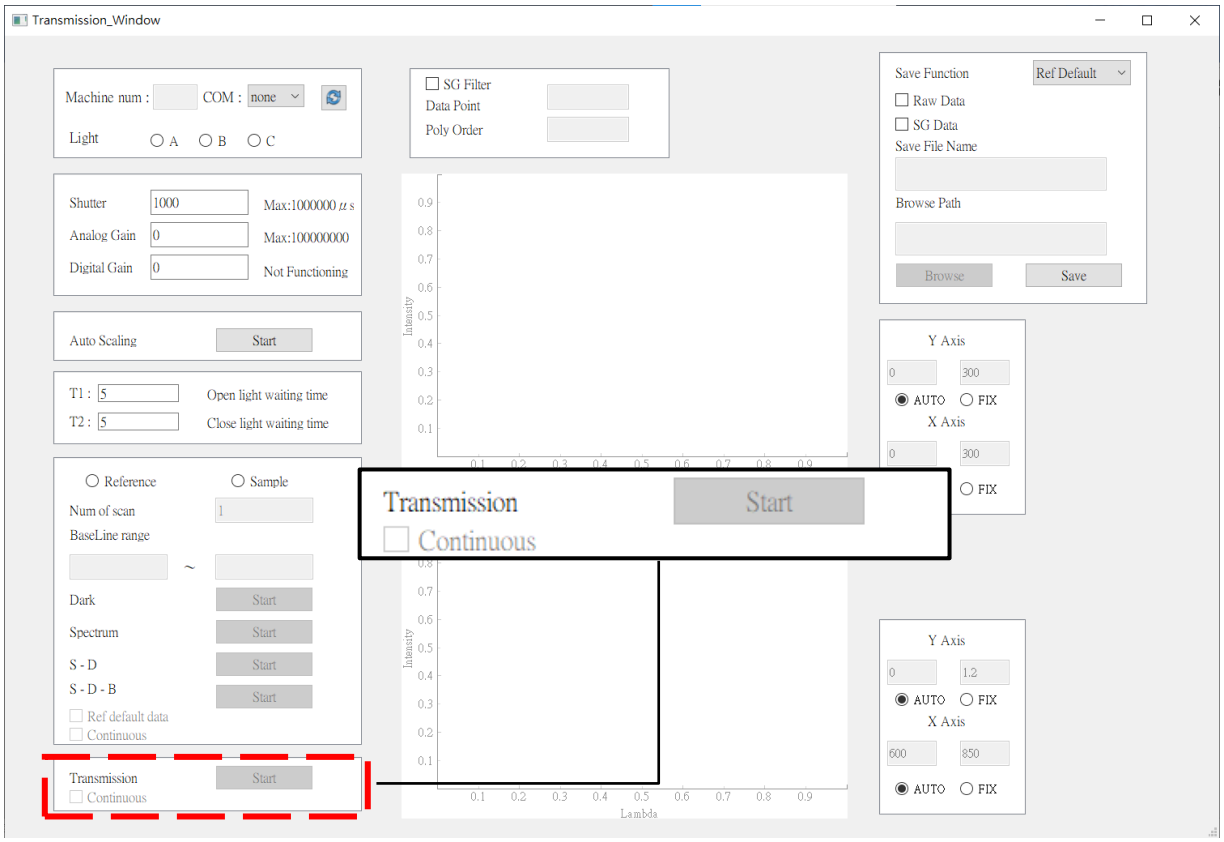
You can choose to scan reference spectrum or sample spectrum.



1. Dark button (Dark Spectrum) : The dark spectrum is electrical noise, which must be subtracted for the accuracy of the spectral signal.
2. Spectrum button : You can choose to take spectrum of reference material or sample material.
3. S-D button (Spectrum Subtract Dark Spectrum) : This button performs spectral deduction dark spectrum.
4. S-D-B button (Spectral Subtract Dark Spectrum and Subtract Baseline): Subtracting the baseline value can enhance the accuracy of the data.
5. Num of scan : Set the times you wanted the sensor to scan (Will count the average according to the number you set)
6. BaseLine range : Input the maximum and minimum values of the spectrum range interval. Sum the data within that range, calculate the average, and subtract that average from the spectrum data.
7. Ref default data : Access a CSV file and set as reference spectrum.
8. continuous checkbox : Check for continuous data scan.

2.3.5 Scan Spectrum (Transmission)

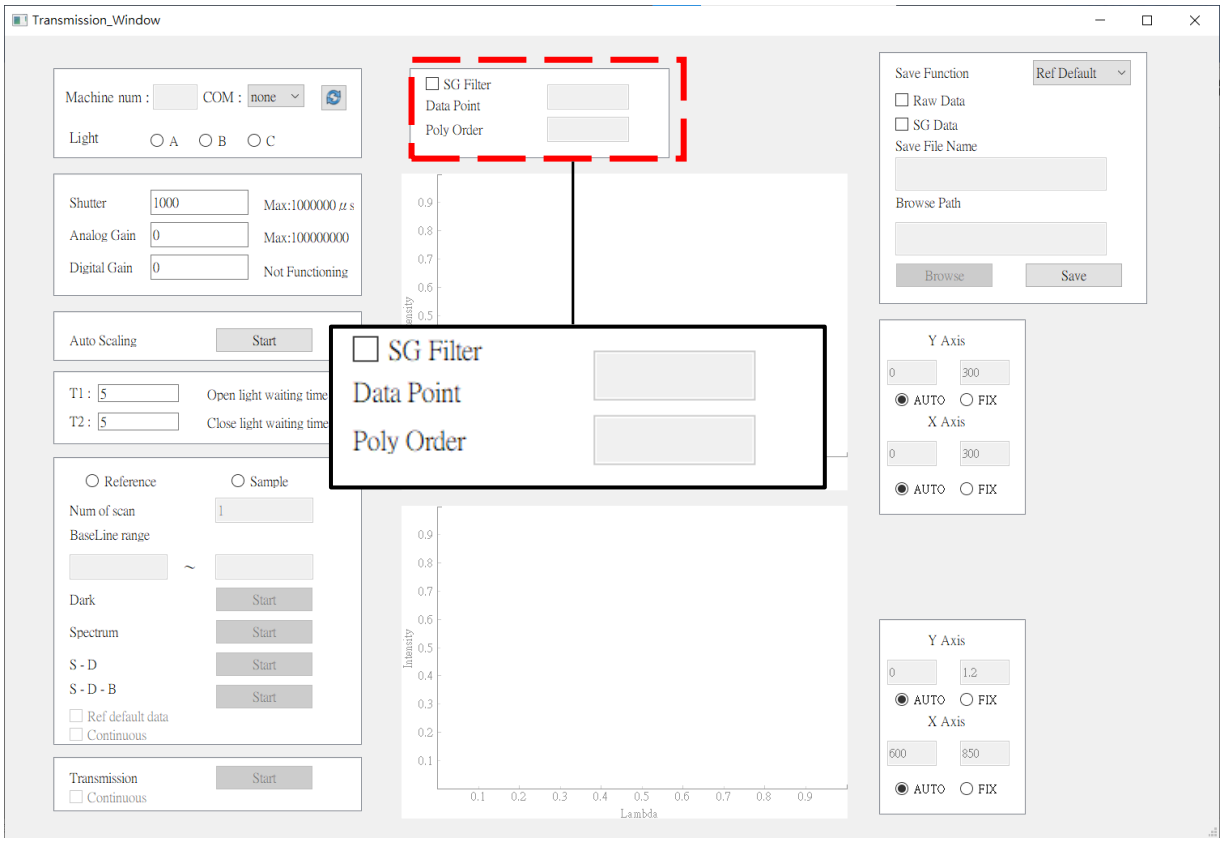
Calculation of transmission spectrum.



1. Transmission button：When the reference spectrum and sample spectrum are known, the transmission spectrum can be calculated with them.
2. continuous checkbox：Check for continuous data scan (For more information, please see Section 3.1.2)

2.3.6 S.G. Settings

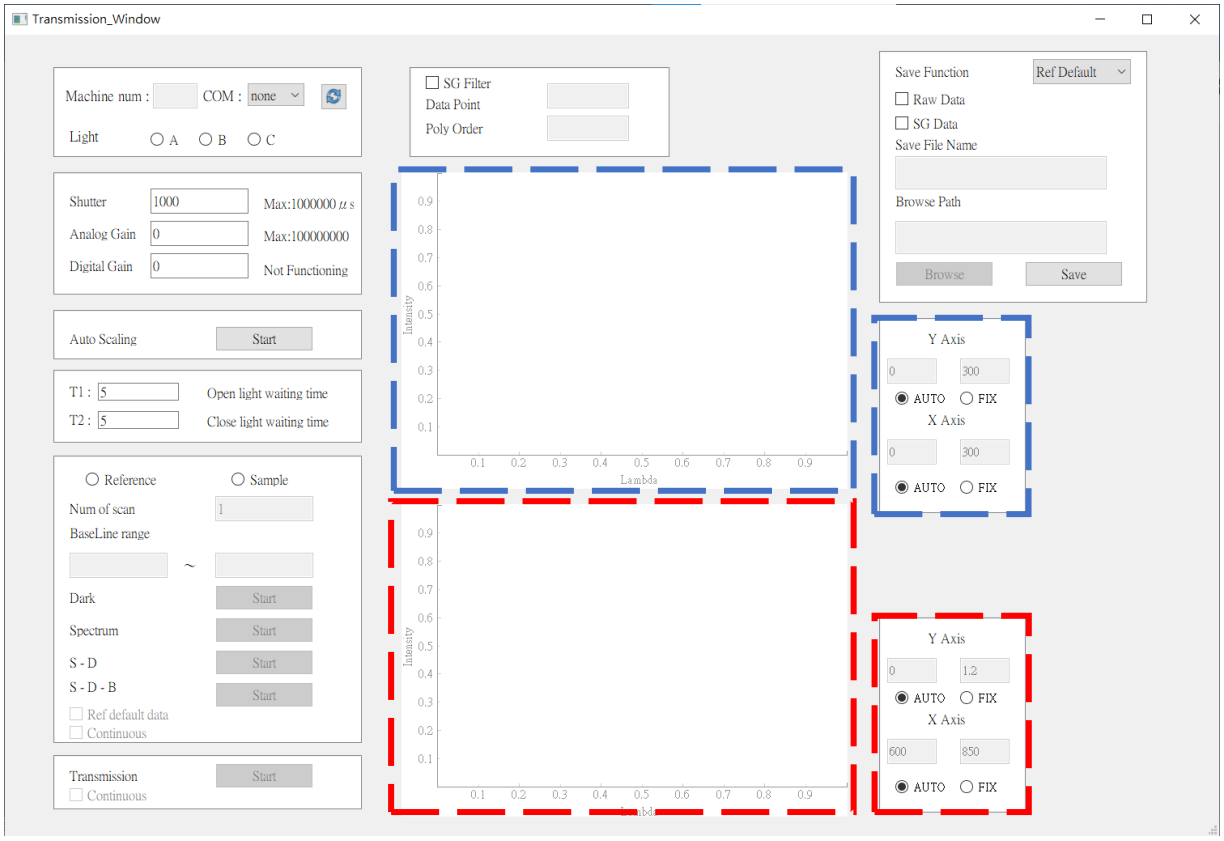
You can change Savitzky–Golay settings as needed.



For more information, please refer to section 2.1.4.

2.3.7 Graph

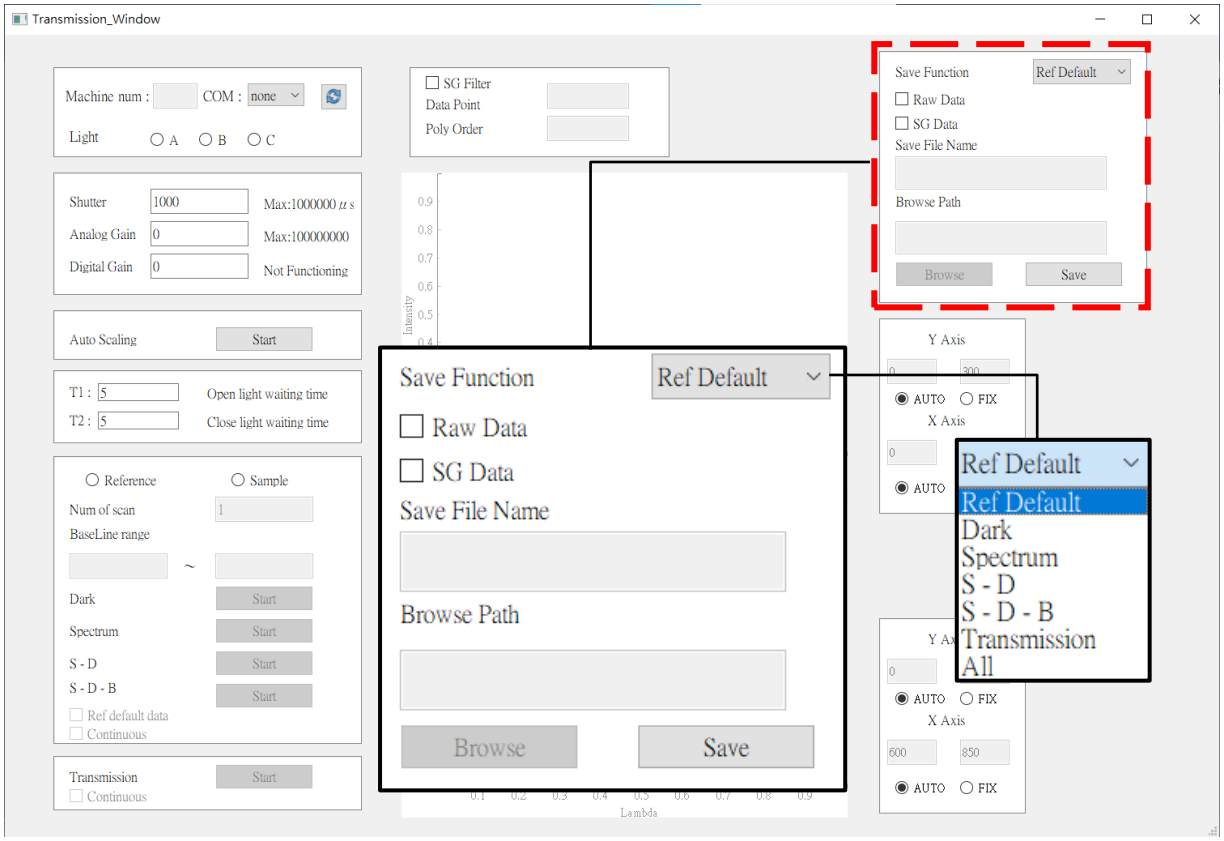
You can change the settings for X and Y axis for the both graphs as needed, above is reference spectrum and sample spectrum graph and below is transmission graph.



1. Mode button：There were 2 modes
   A. AUTO：Auto scale the range for the axis.
   B. FIX：Fix the scale of the axis to the range that is input by the user.

2.3.8 Save Function

Let the user to choose which and where to save.



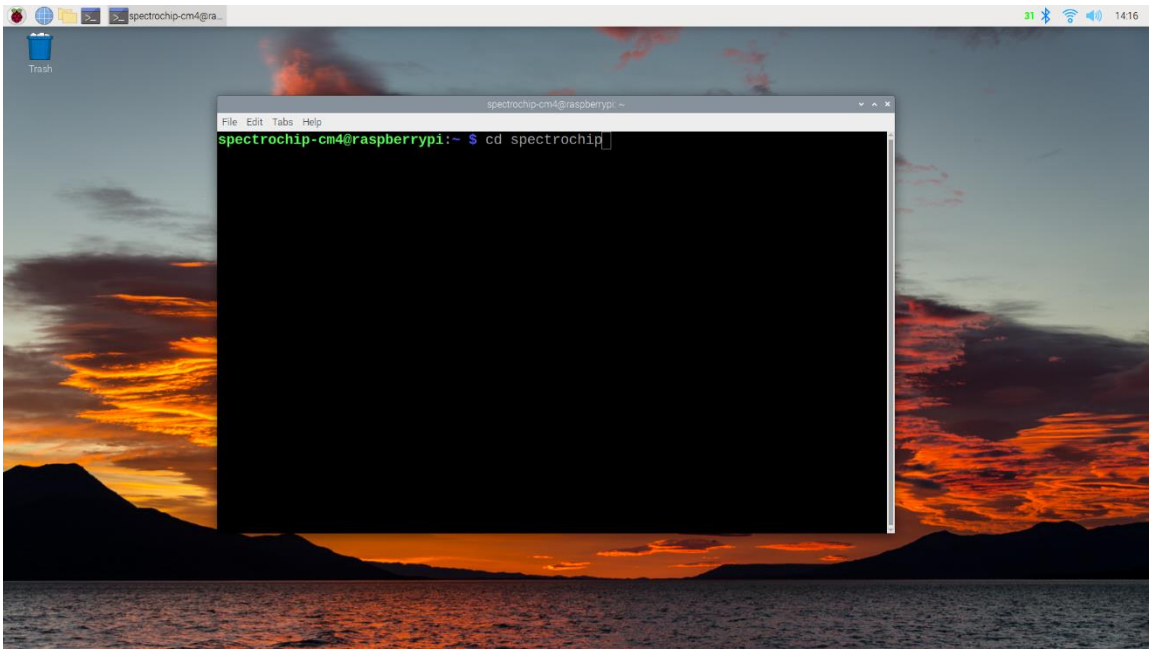
1. ComboBox : You can choose which data to save.The file name and path of Ref Default are fixed, so user cannot input.
2. Raw Data / SG Data tick box: Choose to save 1 or both data.
3. Save File Name: Type in the file name that the user wanted to save as. (Leave blank to use default, default name is date + time)
4. Browse Path: Type in the path that the user wanted to save at. (Leave blank to use default, default path is the script path)
5. Browse Button: Let the user choose the path the user wants.
6. Save Button: Click it to save.

3. How to use

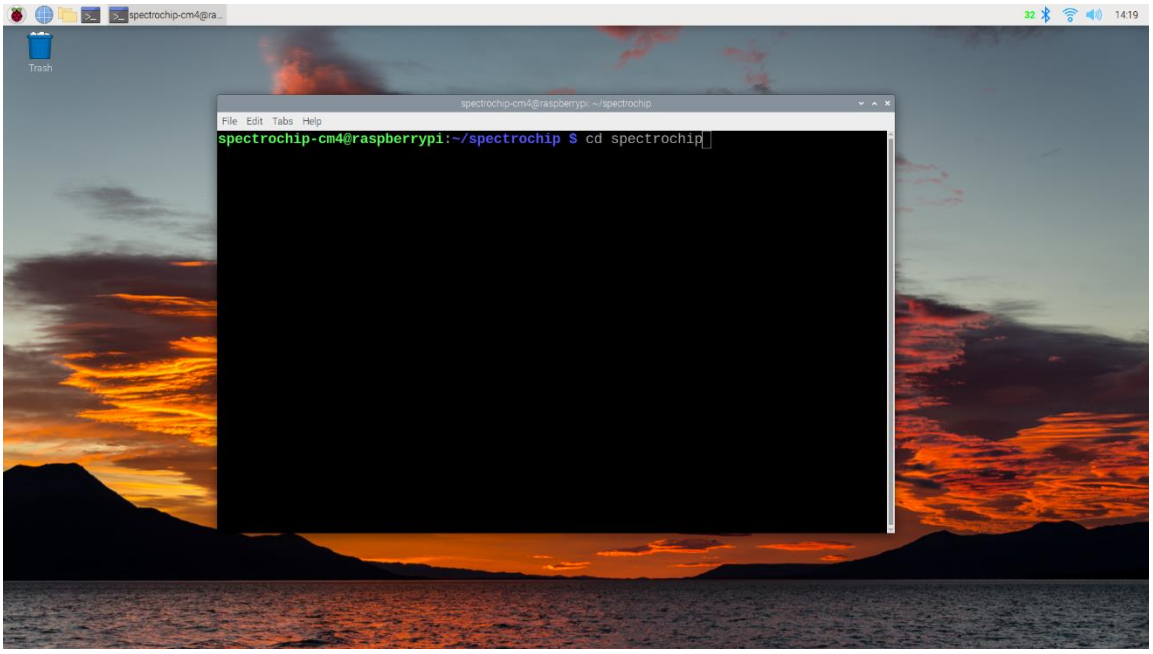
Before you start using, please make sure you have fulfilled the requirements for the software and have the hardware connected properly. To run the program, please follow the step below:

1. Open terminal

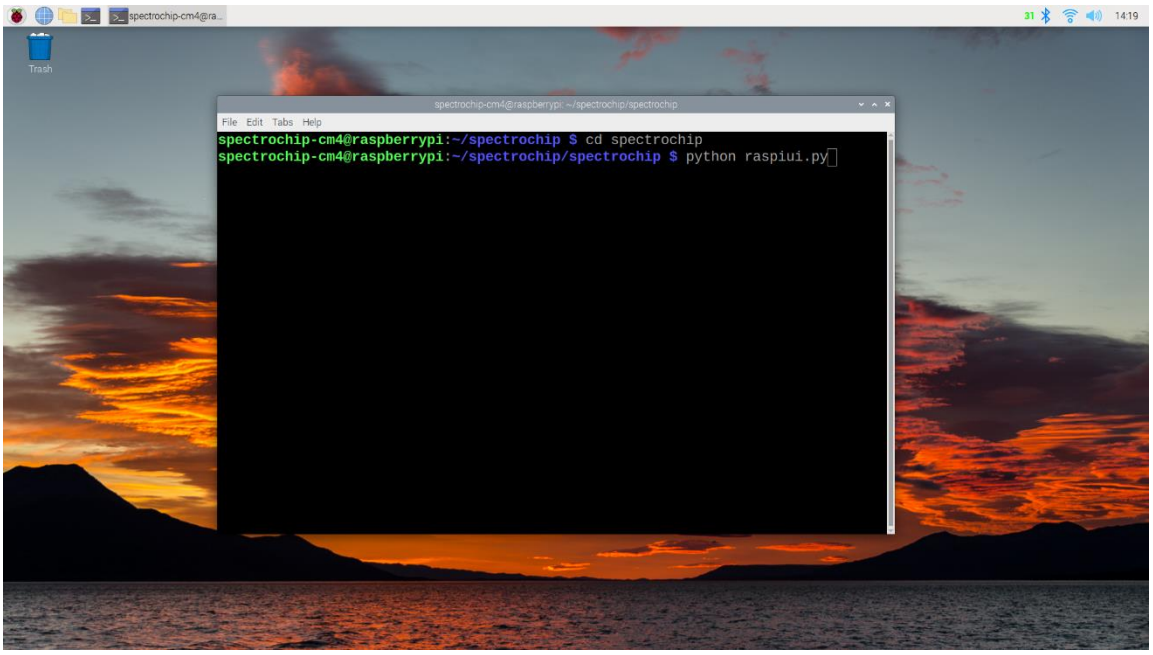
2. Go to the folder location



3. Go to the script location



4. Run the script by typing python raspiui.py



3.2 Main Function

This function is used to take spectrum.

There were 2 modes:

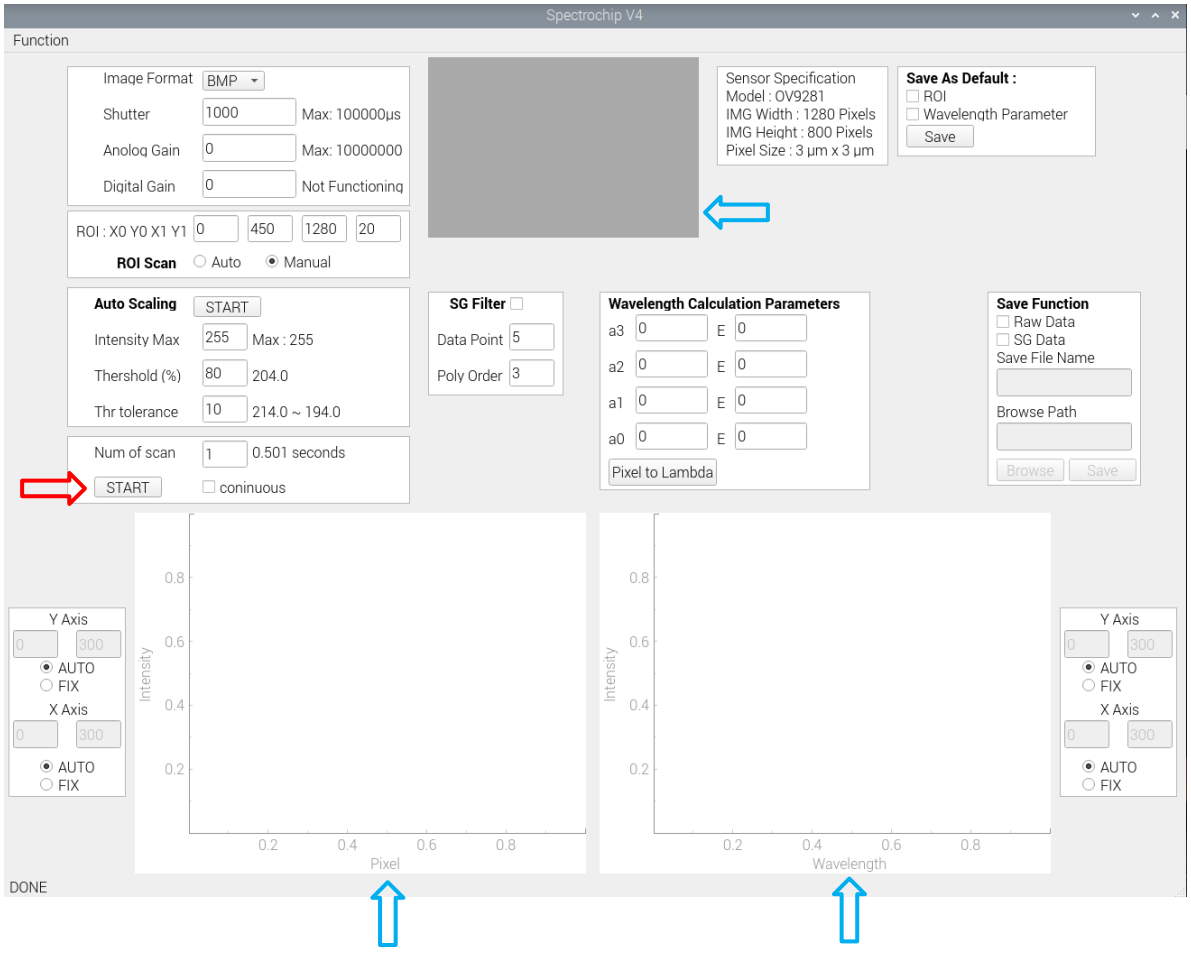
1. Single capture mode
2. Continuous capture mode

3.2.1 Single Capture Mode

This mode is used for single captures.

Step 1

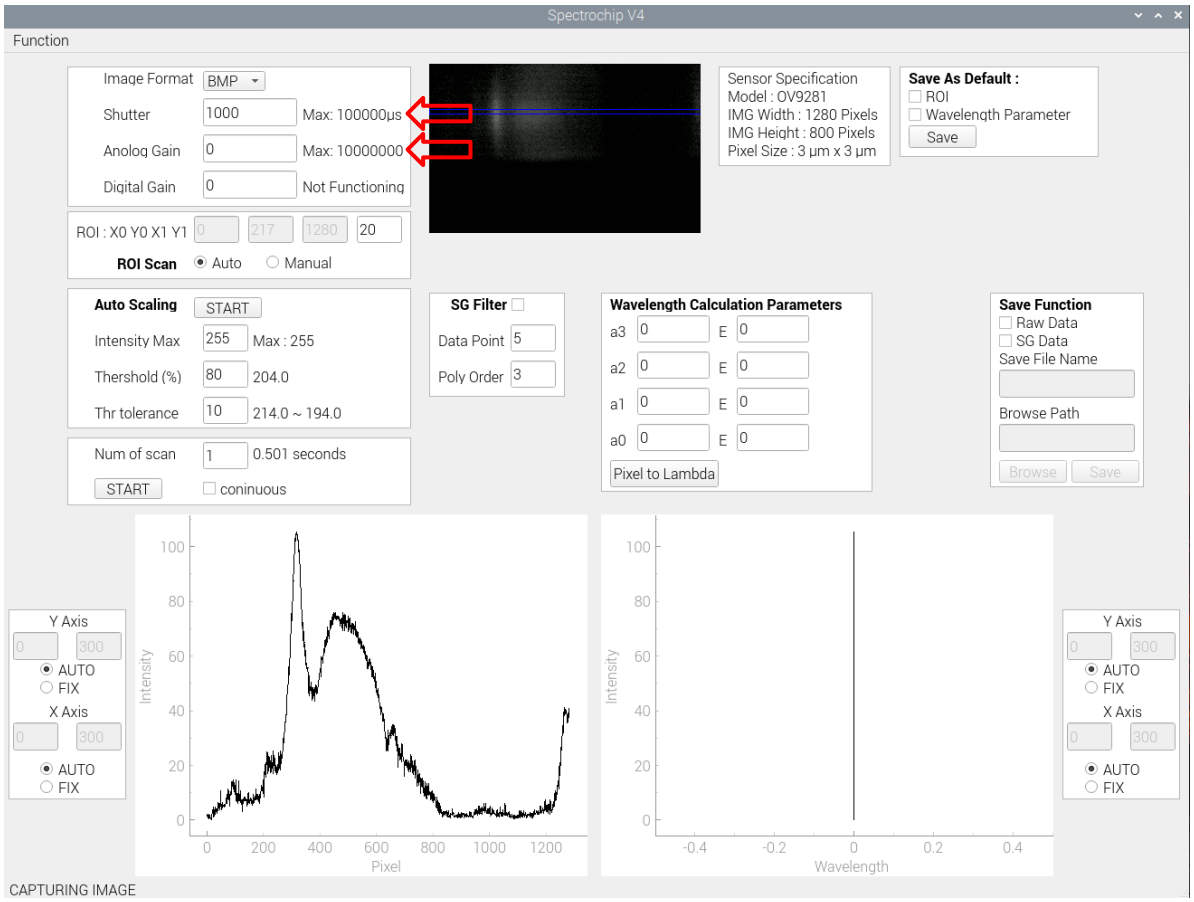
Press the start button and wait for it to complete. The image, pixel graph and wavelength graph will show the results upon completion.



Step 2

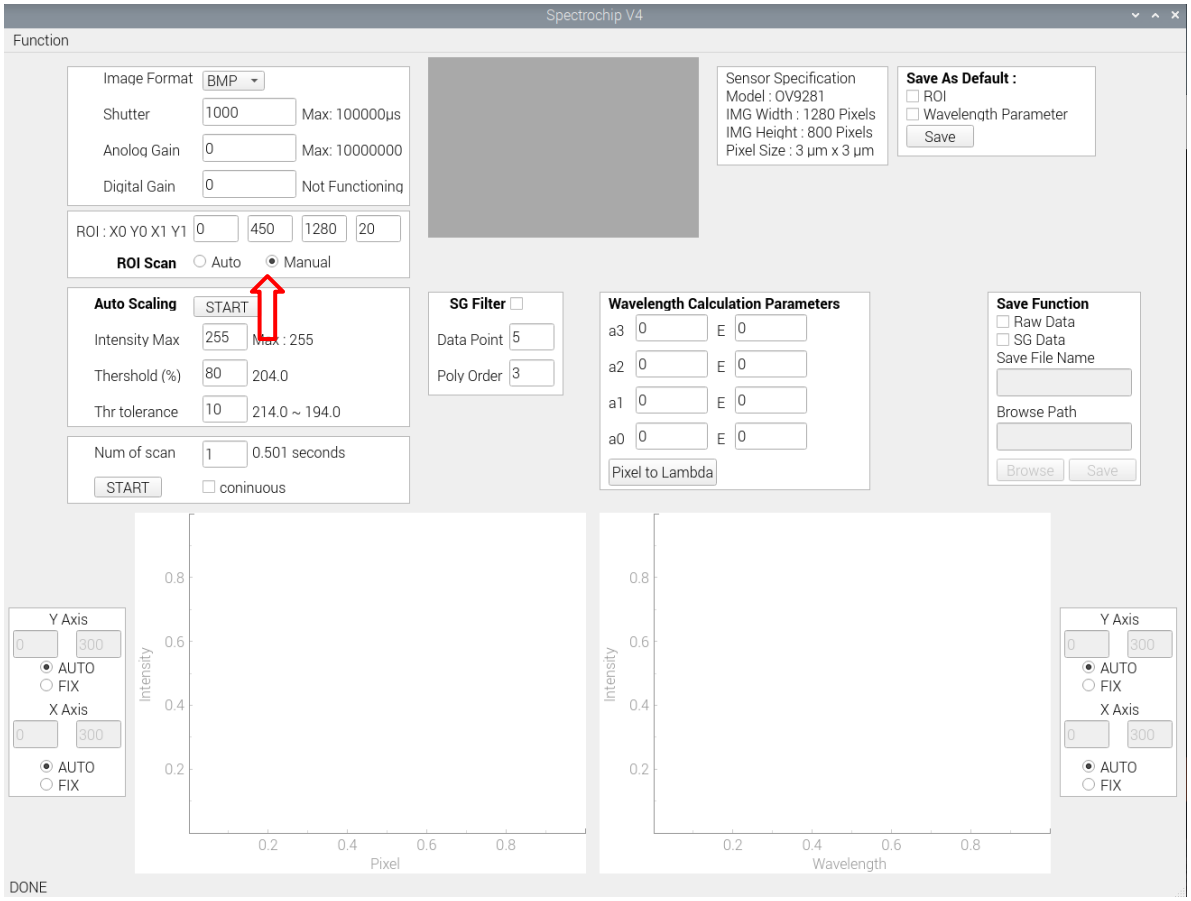
After it’s complete,

1. If you are not satisfied with the result,
   A. If the result intensity is too low or too high,
      i. You can change the Shutter or Analog Gain value to increase the intensity of the spectrum (Shutter is recommended as priority), then back to step 1.
      ii. If you don’t know which Shutter or Analog Gain value to use, you can press the Auto Scaling Button (For more information, please refer to section 3.2).
   B. If the auto R.O.I. range is not the one you want, proceed to step 3 (Optional).
   C. If you want to reduced noise, please proceed to step 4 (Optional) or step 5 (Optional).
2. If you are satisfied with the result, you can use the data that is save as a txt file for your research.



Step 3 (Optional)

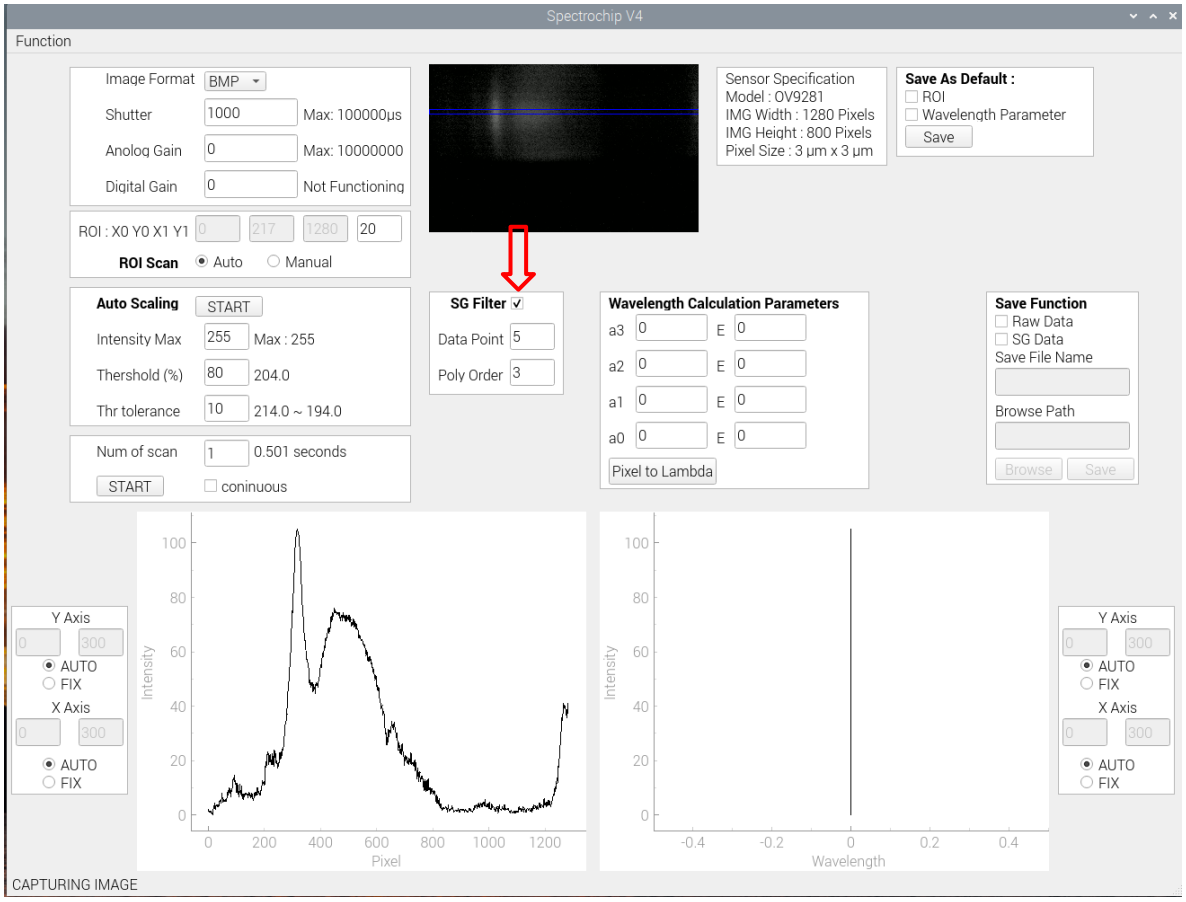
You can change the R.O.I by clicking the ROI Scan button to change from auto to manual, then you can edit the R.O.I. of the picture. Then proceed back to step 1.



Step 4 (Optional)

You can reduce the noise of the data by ticking the SG Filter checkbox, or you can proceed to step 5 for the other option to reduced noise.

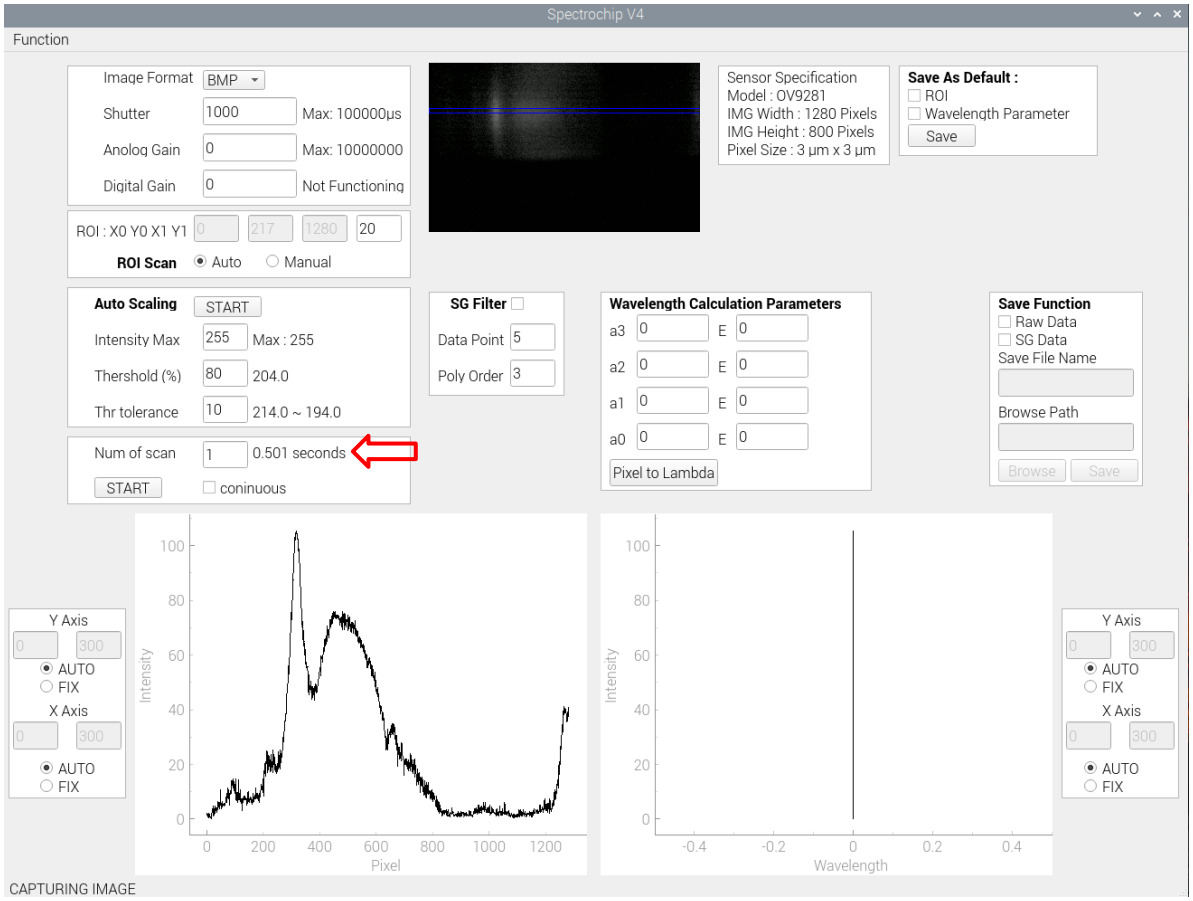
You can change the parameter for the filter (For more information, please refer to Section 2.1.4).



Step 5 (Optional)

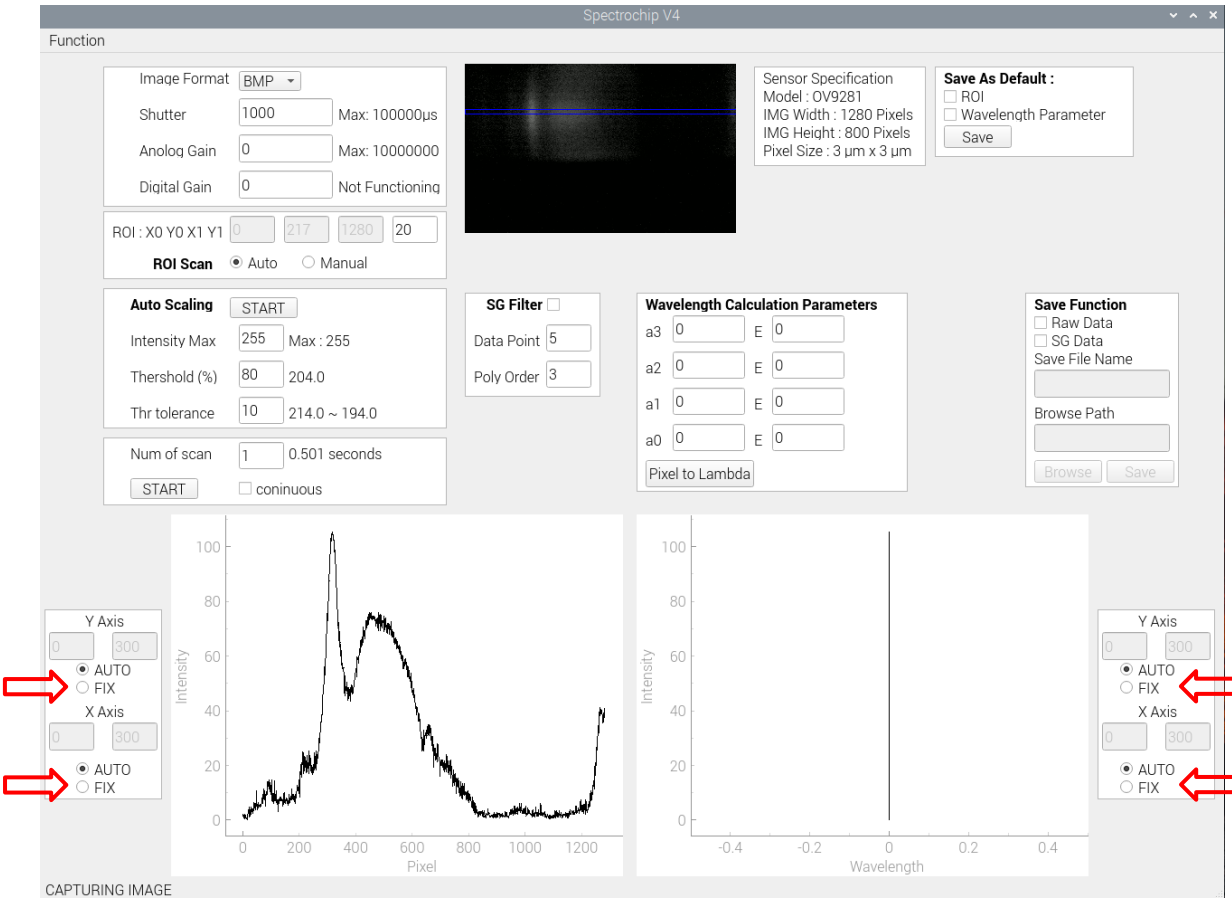
You can increase the number of scans to reduce the noise. Number of scans calculates by averaging all the data captured.

This step can also be used with step 4 to minimize the noise.



Additional Options

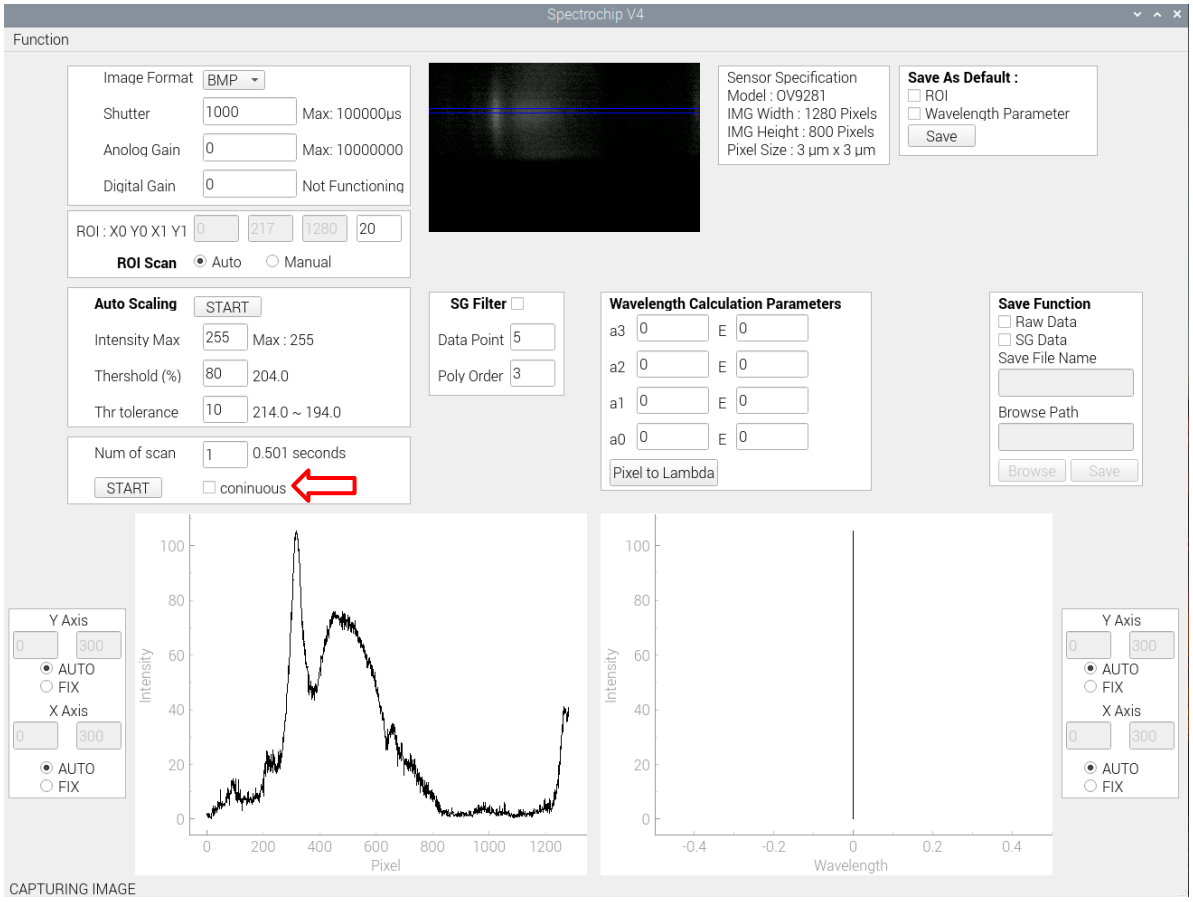
1. Fix Y-Axis to your own scale favor
   A. Click Fix radio Button to change from automatically scale to fix scale.
   B. You can edit the axis parameter to your own needs.



3.2.2 Continuous capture mode

This mode is used for continuous capture.
Please note that the data.txt will only save the last data captured.

Step 1
Tick the continuous checkbox, the step afterward is same as Section 3.1.1, so proceed to Section 3.1.1 step 1.

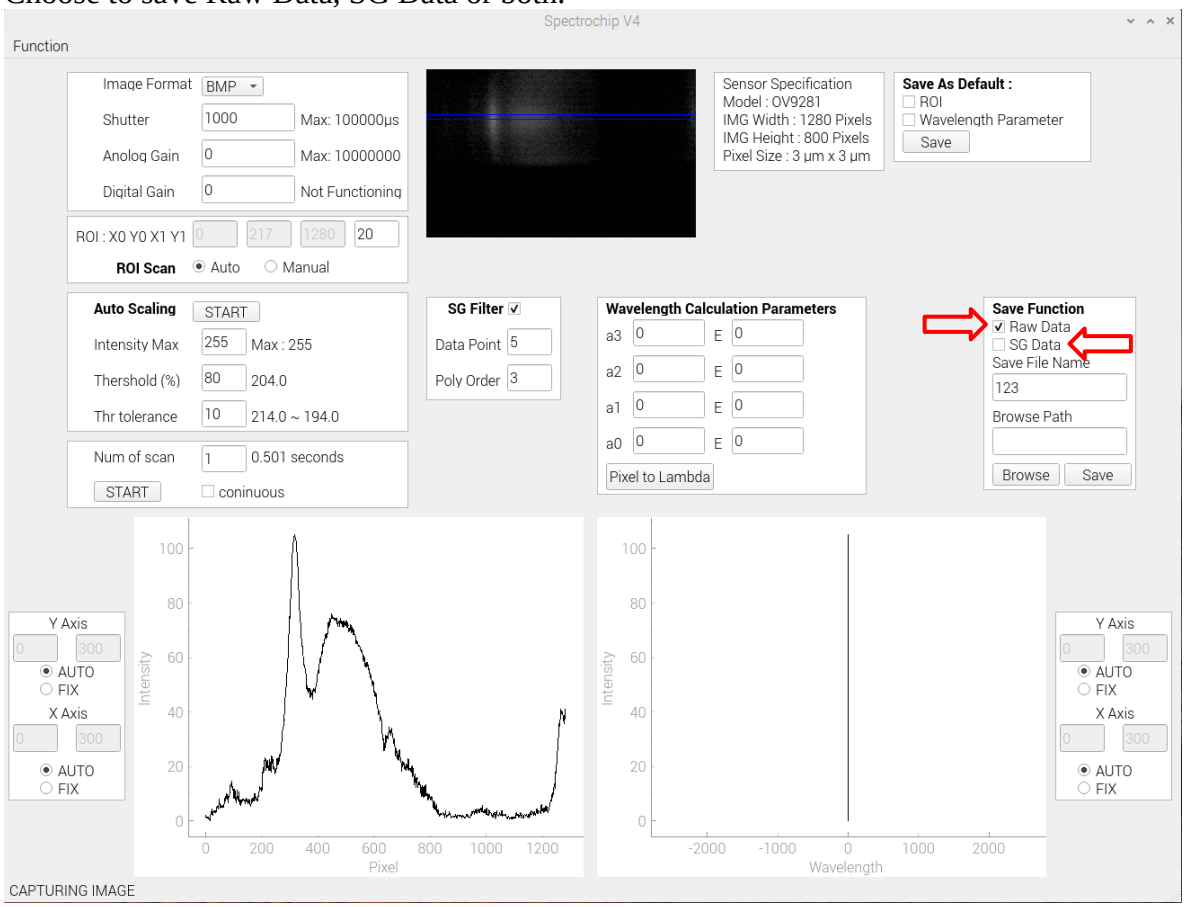


3.2.3 Save Function

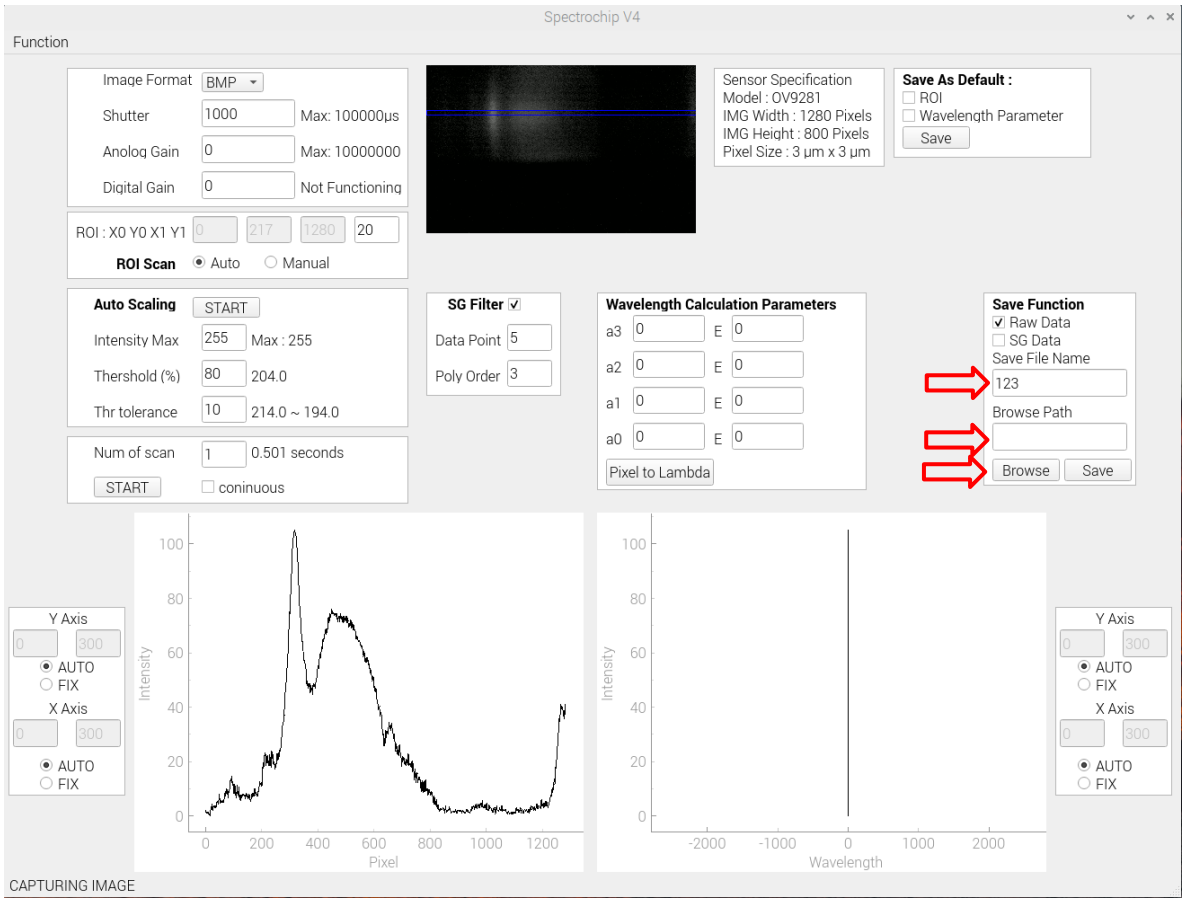
This Function is to let the user to save the data for experiment or analysis use.

Step 1

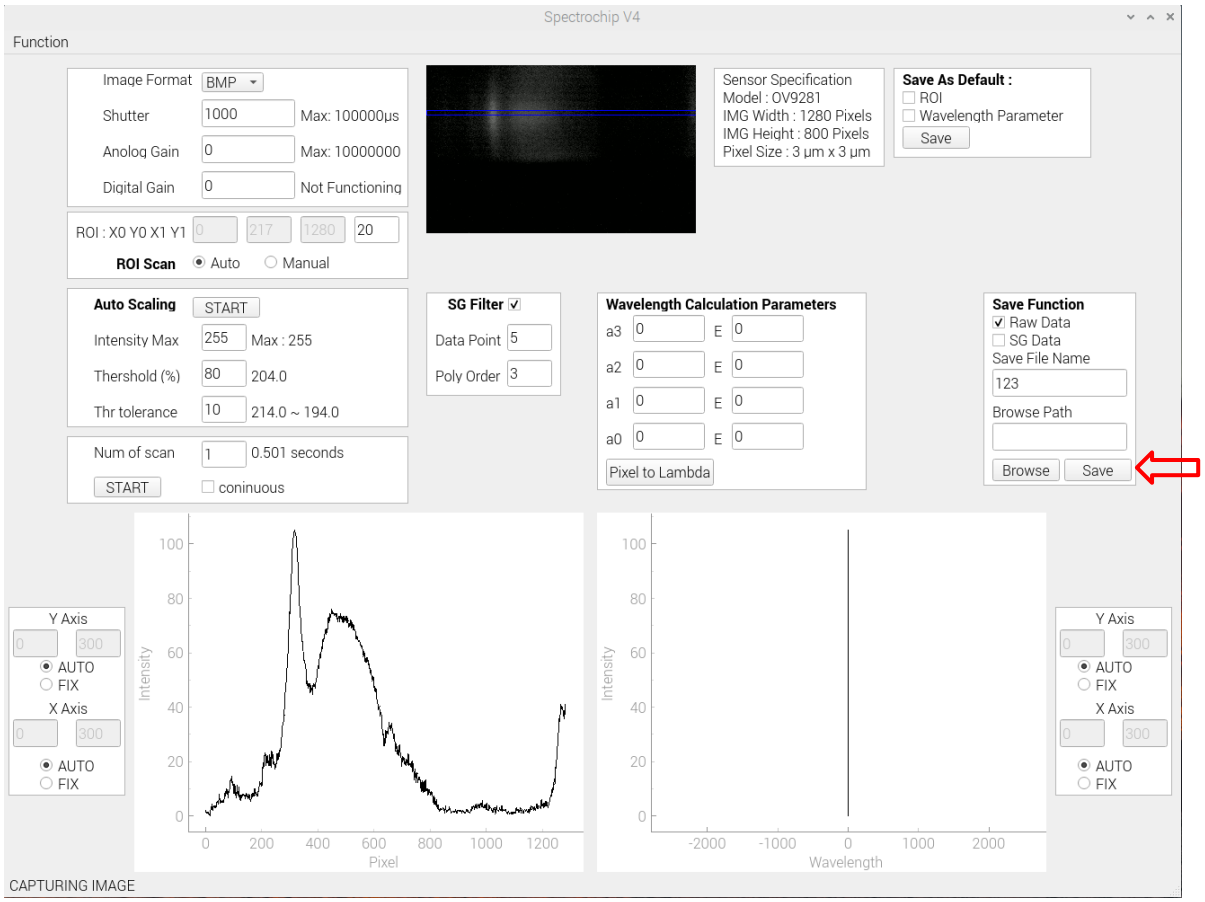
Choose to save Raw Data, SG Data or both.



Step 2
Type in the file name (shown as 123 as the bellow photo) and save path. If don't know save path, can press the Browse button bellow to find the path.
(If Save File Name is empty, it will save as default name: date + time)
(If Browse Path is empty, the save path will set as the same as the script location)



Step 3
Press the Save Button to save.

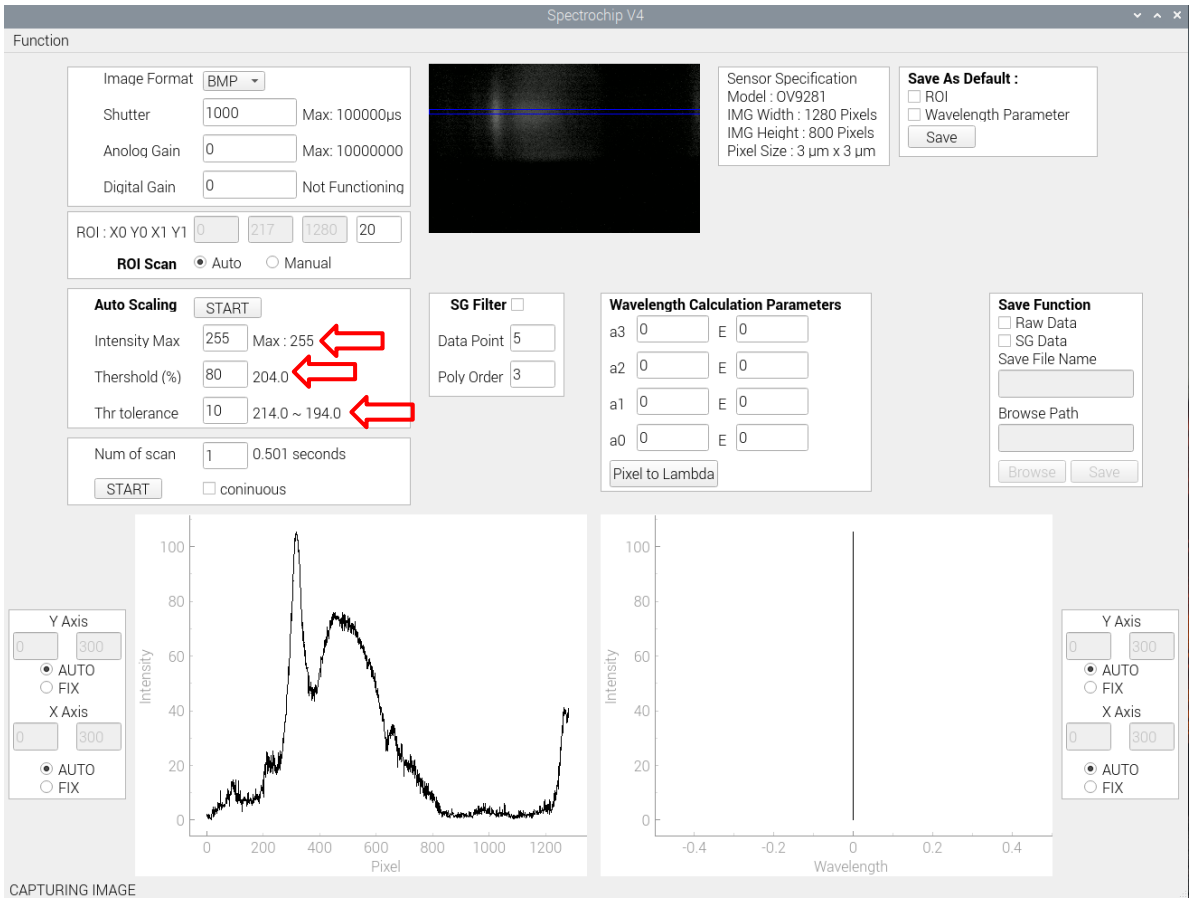


3.3 Auto Scaling

This function is to automatically calculate the required shutter.

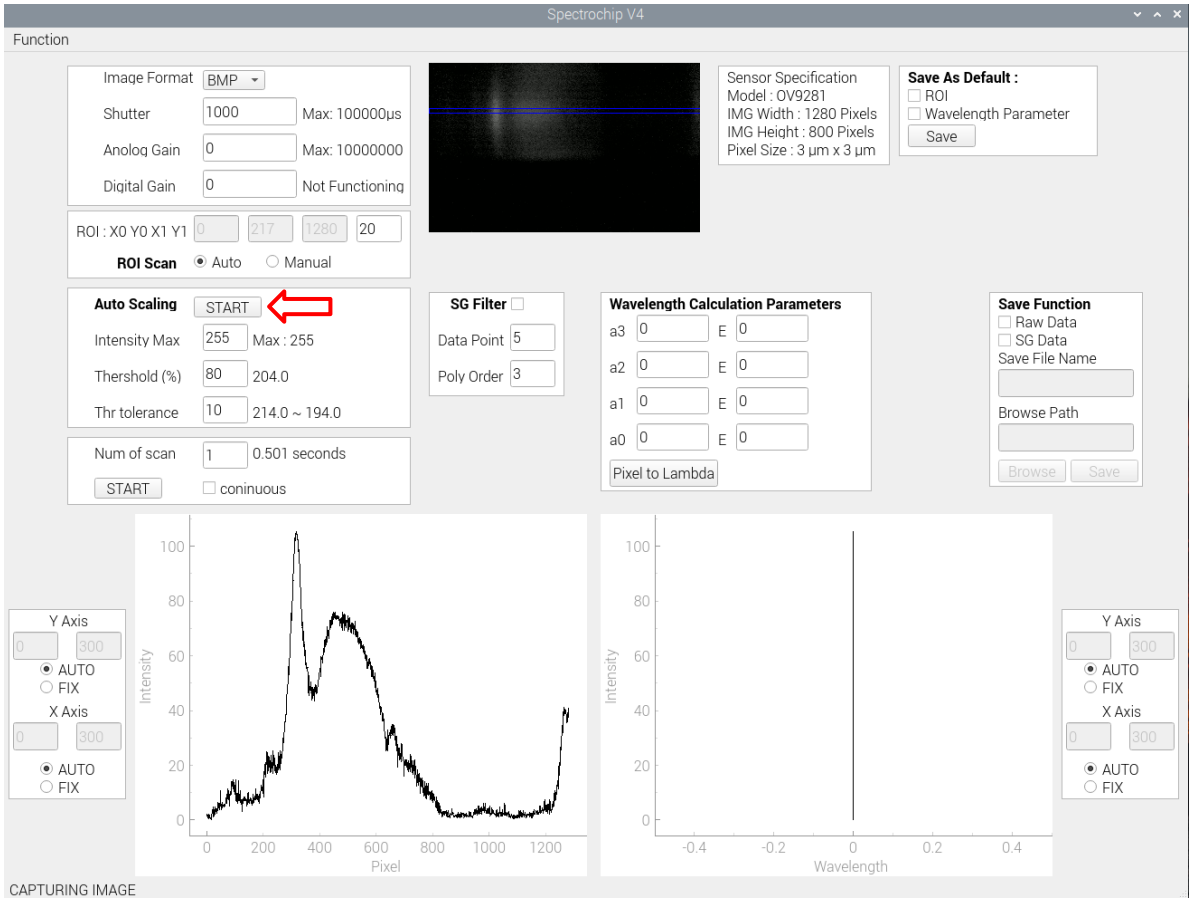
Step 1

Set the parameter that is needed (Have default value).



Step 2

Press the Auto Scaling START Button to start auto scaling, then wait for it to complete (May take a few minutes).



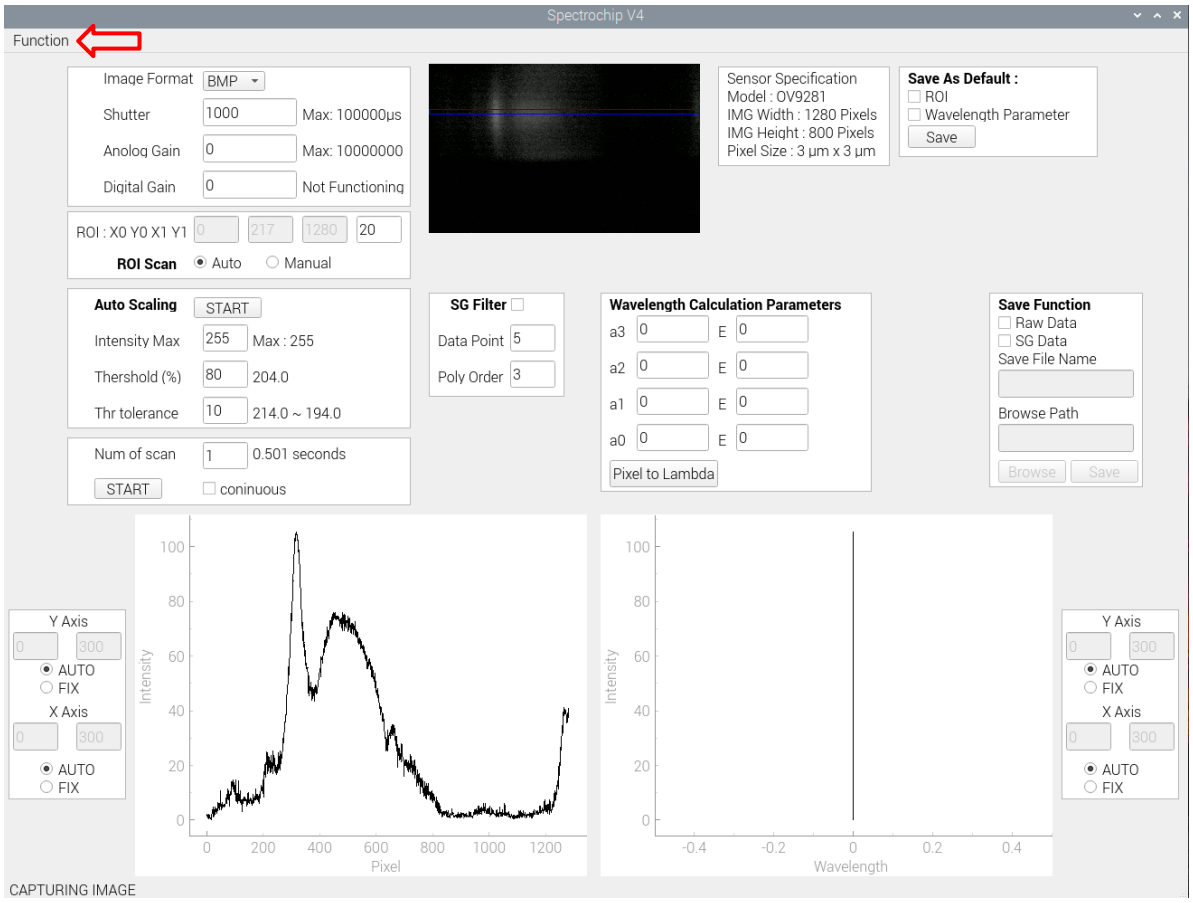
3.4 Wavelength Calibration

This Function is to calculate the equation that is required to convert pixels to wavelengths.

Before proceed to step 1, please make sure you've followed Section 3.1 Main Function steps.

Step 1

Press Function > Calculate Wavelength Parameter to open Wavelength Calibration Window. If you already have the parameter can skip to step 5.

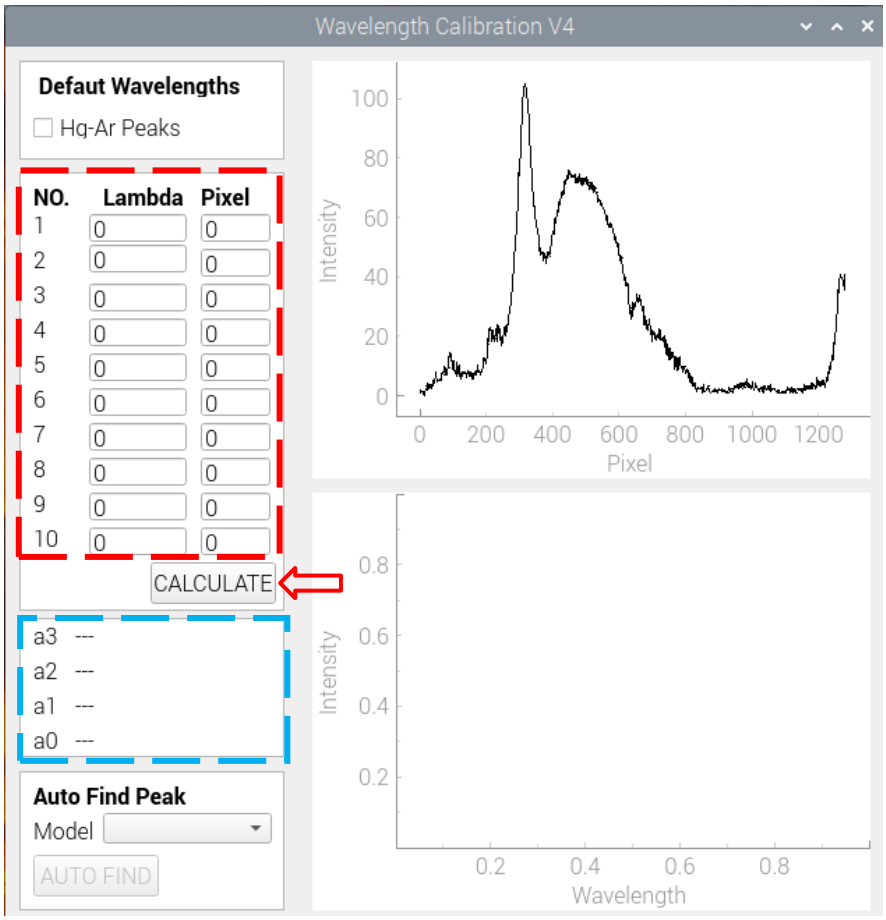


Step 2

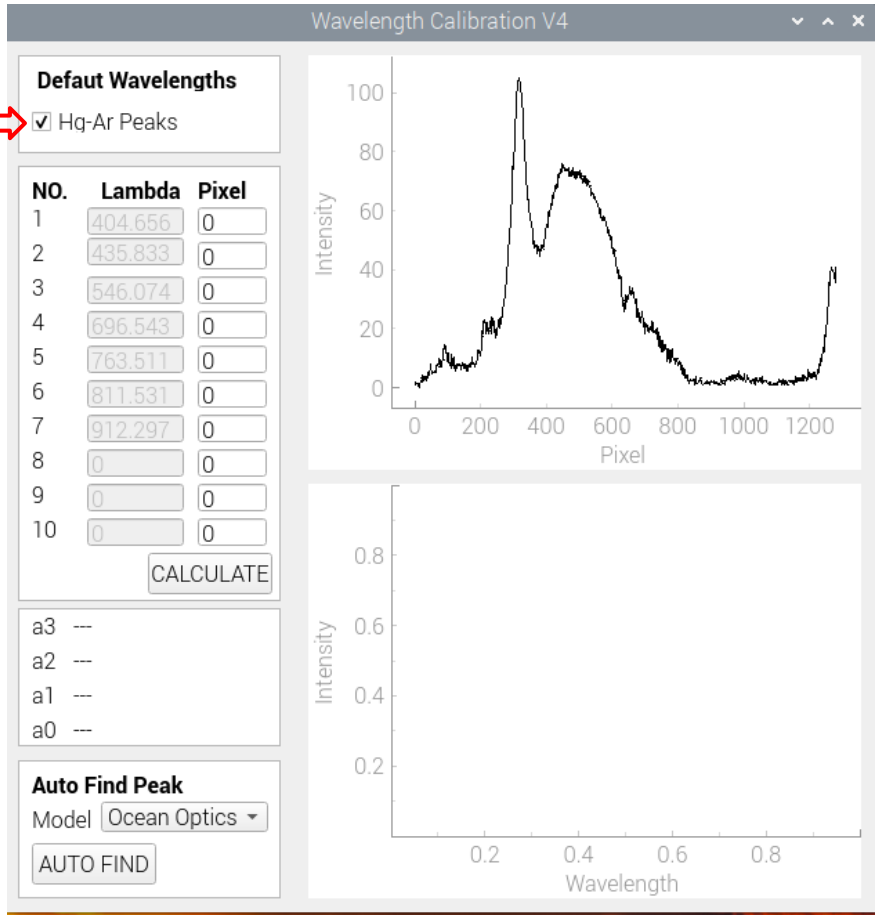
You can input the parameter you want into the lambda or pixel textbox, after all parameter have been input, press the CALCULATE Button to calculate the required a3, a2, a1 and a0.

After the calculation is completed, the result will be displayed in the blue box, and the wavelength parameters in the main window will also be updated.

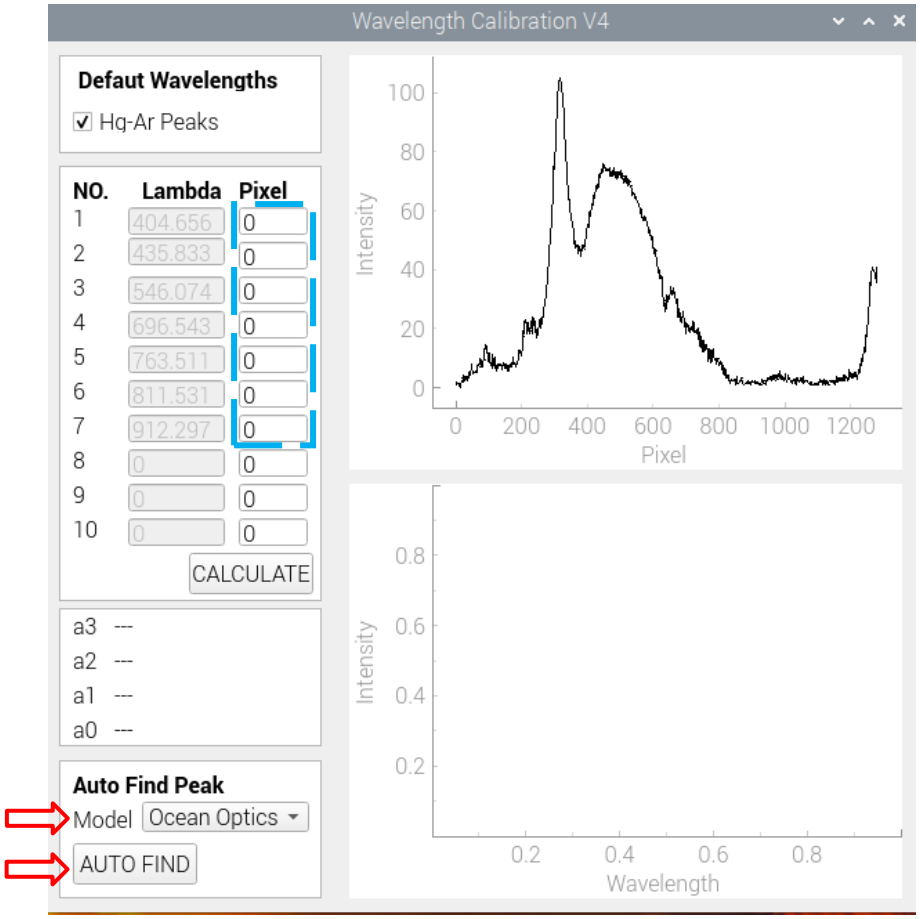
Please note that you have to type 0 into the textbox that's not in use.



Step 3 (Optional)
User can check the corresponding checkbox to see default wavelength that is set by spectrochip, and also use auto find peak.
Please note that it will use the default wavelengths and find the corresponding peaks.



Step 4
The model will be available after the checkbox is check (step 3), choose the model that you wanted to use, then press AUTO FIND button. When the action is complete, the peaks will appear at the corresponding pixel box.
Then procced back to step 1 to calculate wavelength.



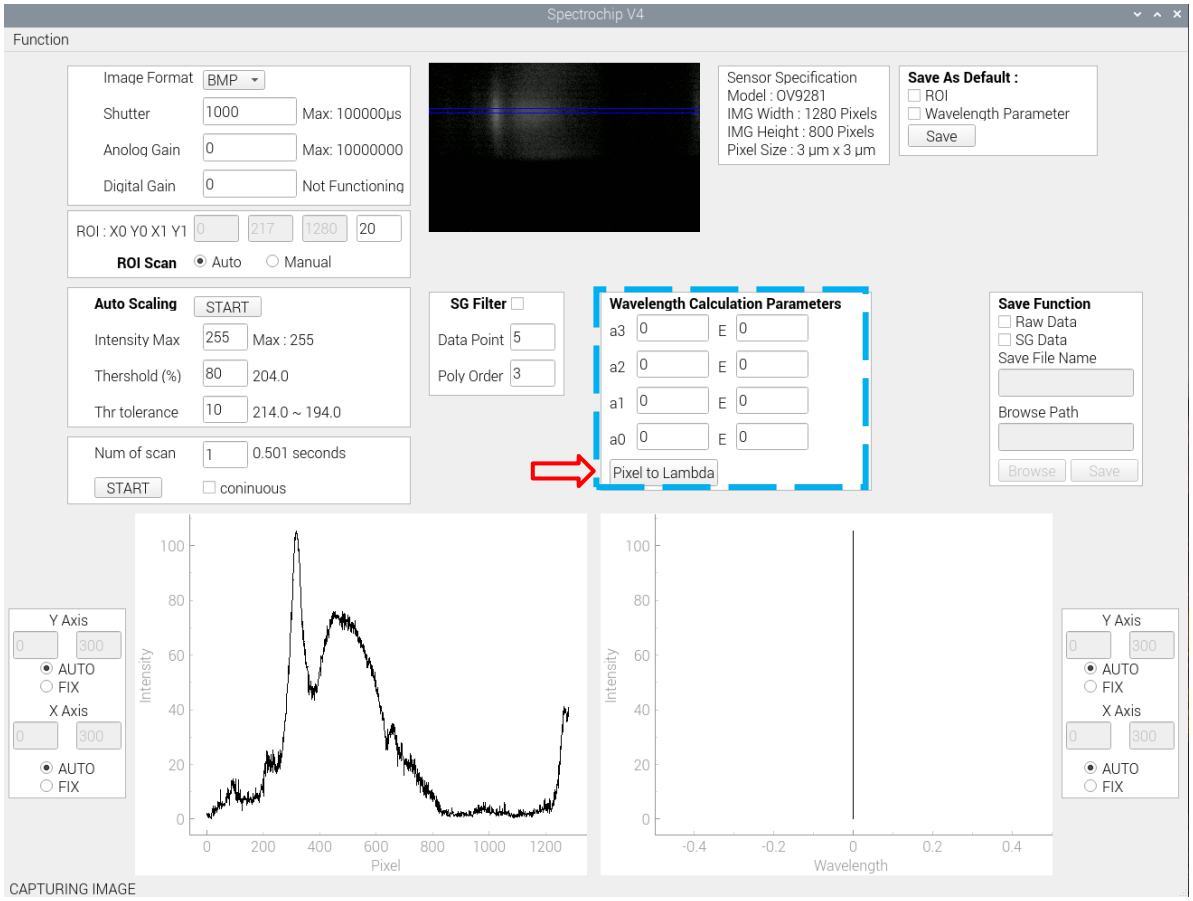
Step 5

If you follow step by step watch here:

close the Wavelength Calibration Window and head back to the main window, the Calculated wavelength parameter will appear, then press Pixel to Lambda button to update wavelength graph.

If you skip the step above:

Insert the parameter accordingly, then press Pixel to Lambda button to update the wavelength graph.



3.5 Transmission Window

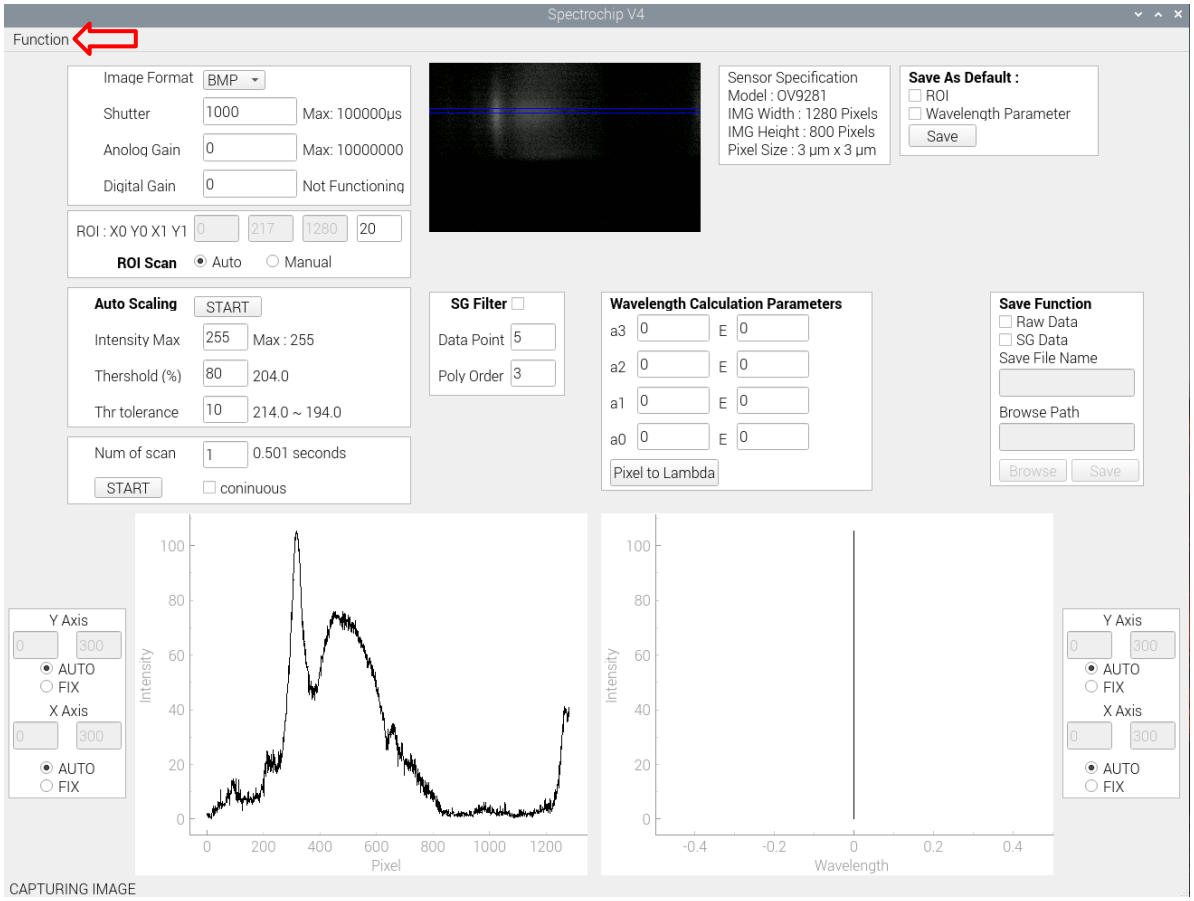
This program is an extension of the previous program for obtaining the transmission spectrum. Please make sure the hardware is connected before use (Please refer to section 1.2).

In the following steps, water will be used as a reference and tea will be used as the sample to calculate the transmission spectrum.

3.5.1 Connect to the machine and machine parameter setting

Step 1

Press Function > Transmission Mode to open Transmission Window.

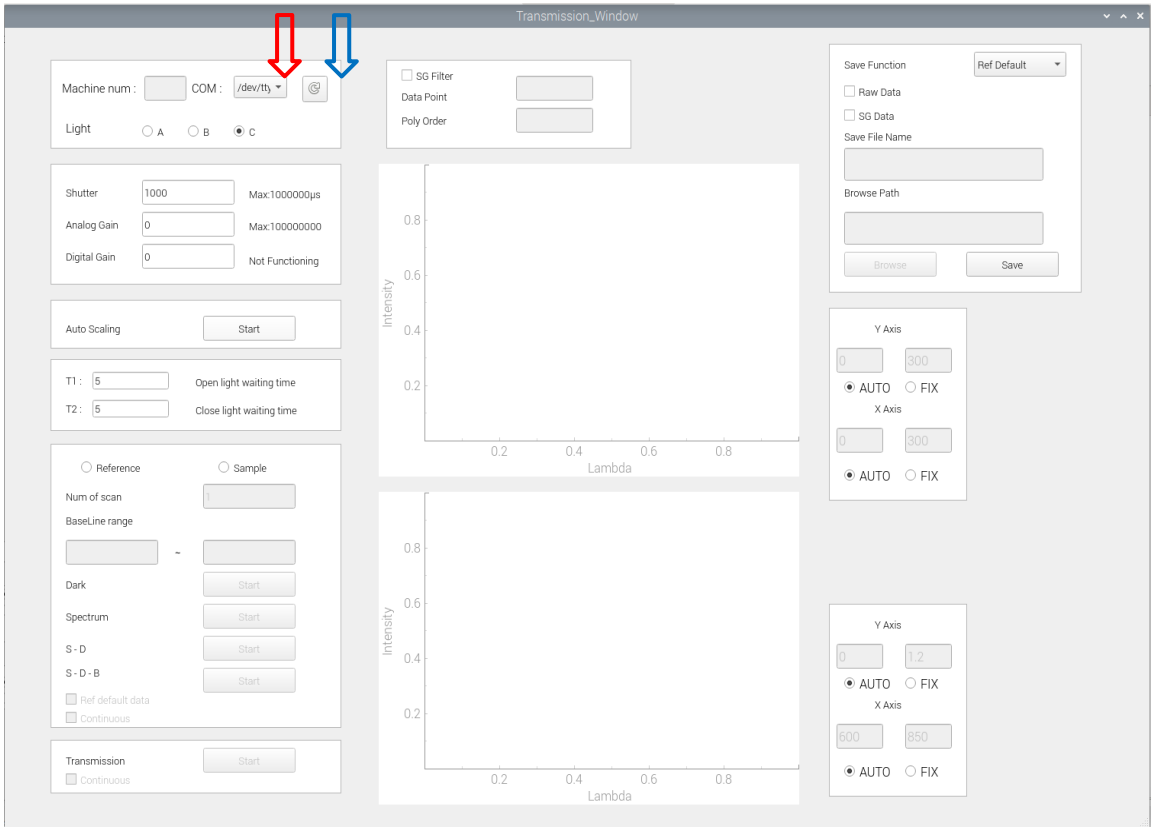


Step 2

Click on the comboBox (red arrow) belonging to COM and select the port you want to connect to. If you can’t find any connection ports, please restart the machine first, and then click the reset button (blue arrow).

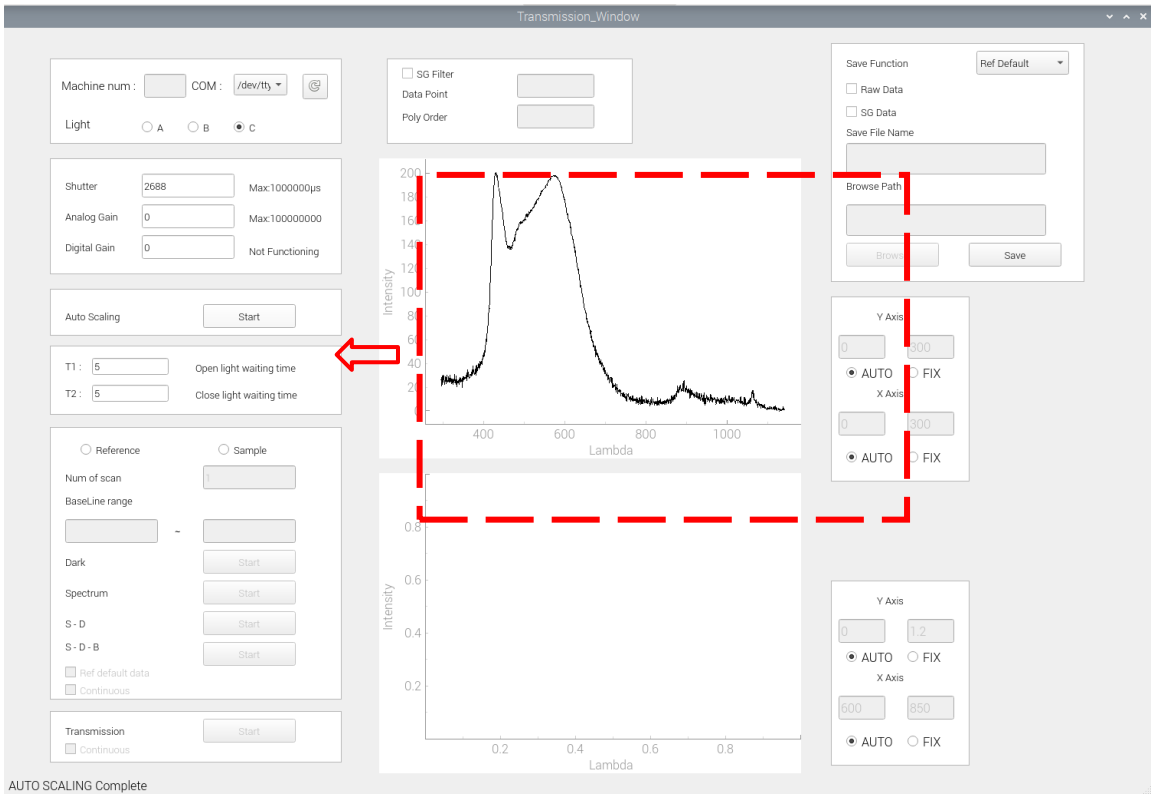
Step 3

After connecting the machine, please choose which light source to use for the experiment. (For more information, please refer to 2.3.1)



3.5.2 Auto Scaling

This function is to automatically calculate the required shutter. But different from section 3.3, the Auto Scaling parameter value cannot be changed here.
After clicking the Auto Scaling START Button, the graph framed in red line will show the result.

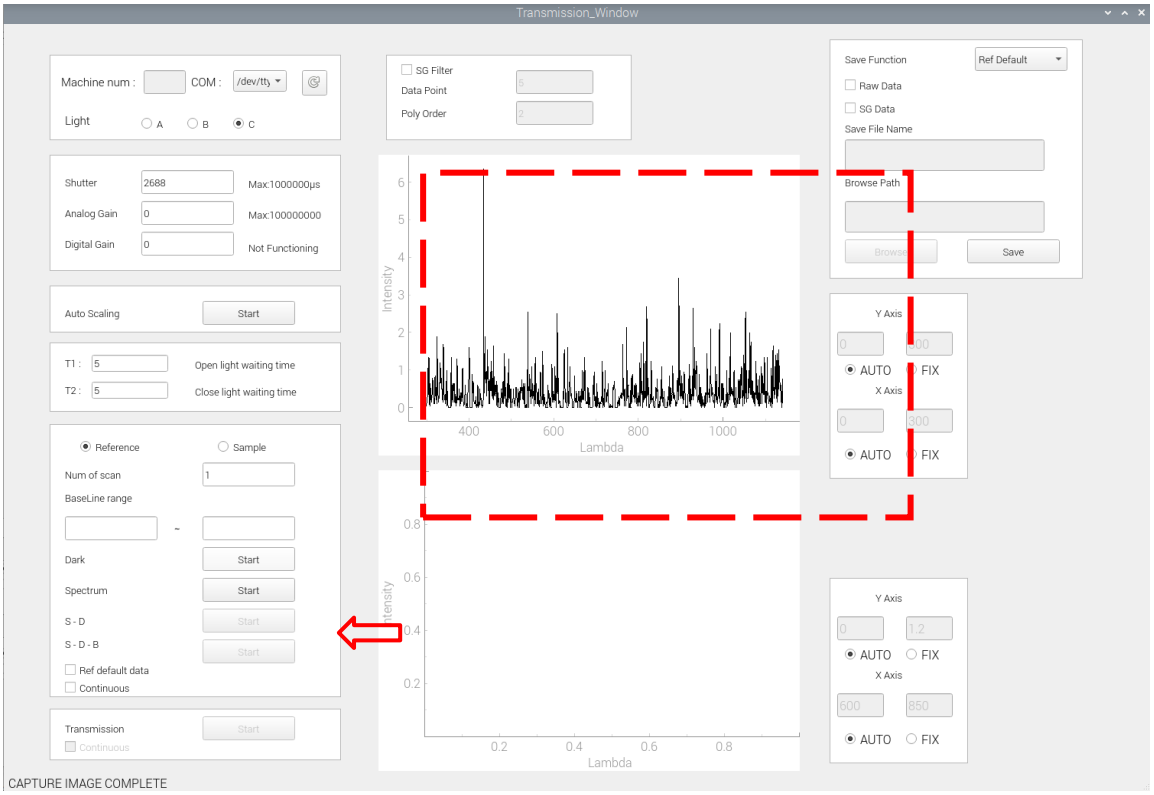


3.5.3 Scan Spectrum

This section will introduce the steps to scan the spectrum.

3.5.3.1 Scan Dark Spectrum

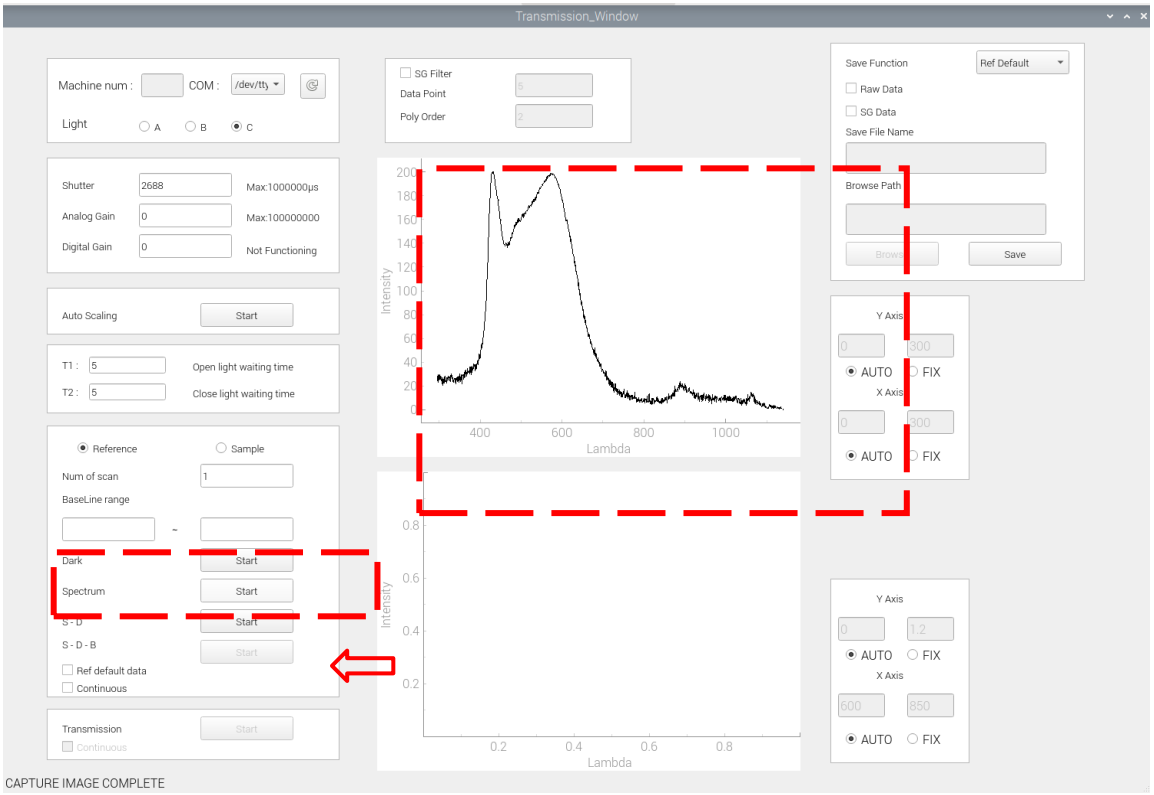
After selecting the reference or sample spectrum, you can scan the dark spectrum. The result after scanning the spectrum will be presented in the graph above.



3.5.3.2 Scan Reference Spectrum

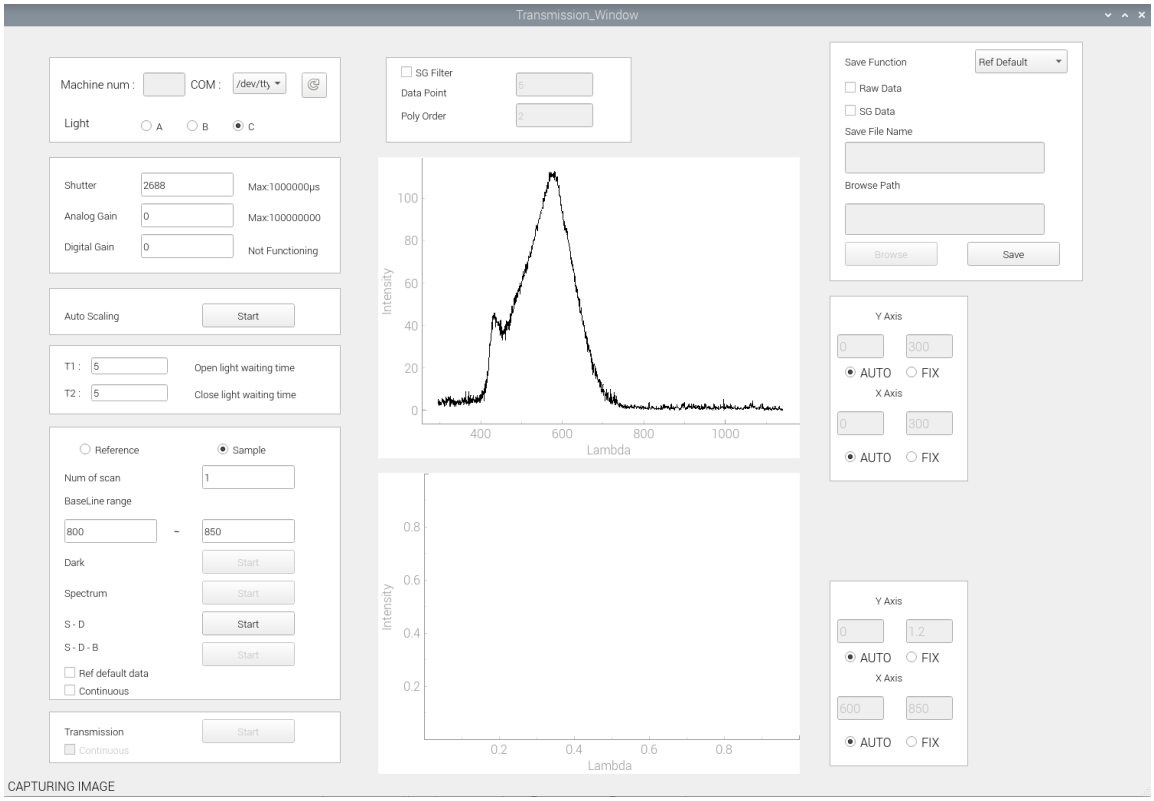
In the reference spectrum we used water as the measurement and tea in the sample spectrum. Note that it is necessary to confirm that the cuvette with the object to be tested is placed on the machine.

The result after scanning the spectrum will be presented in the graph above. After scanning the spectrum, users can input the maximum and minimum values of the Baseline range and click the S-D Button and S-D-B Button to subtract noise.



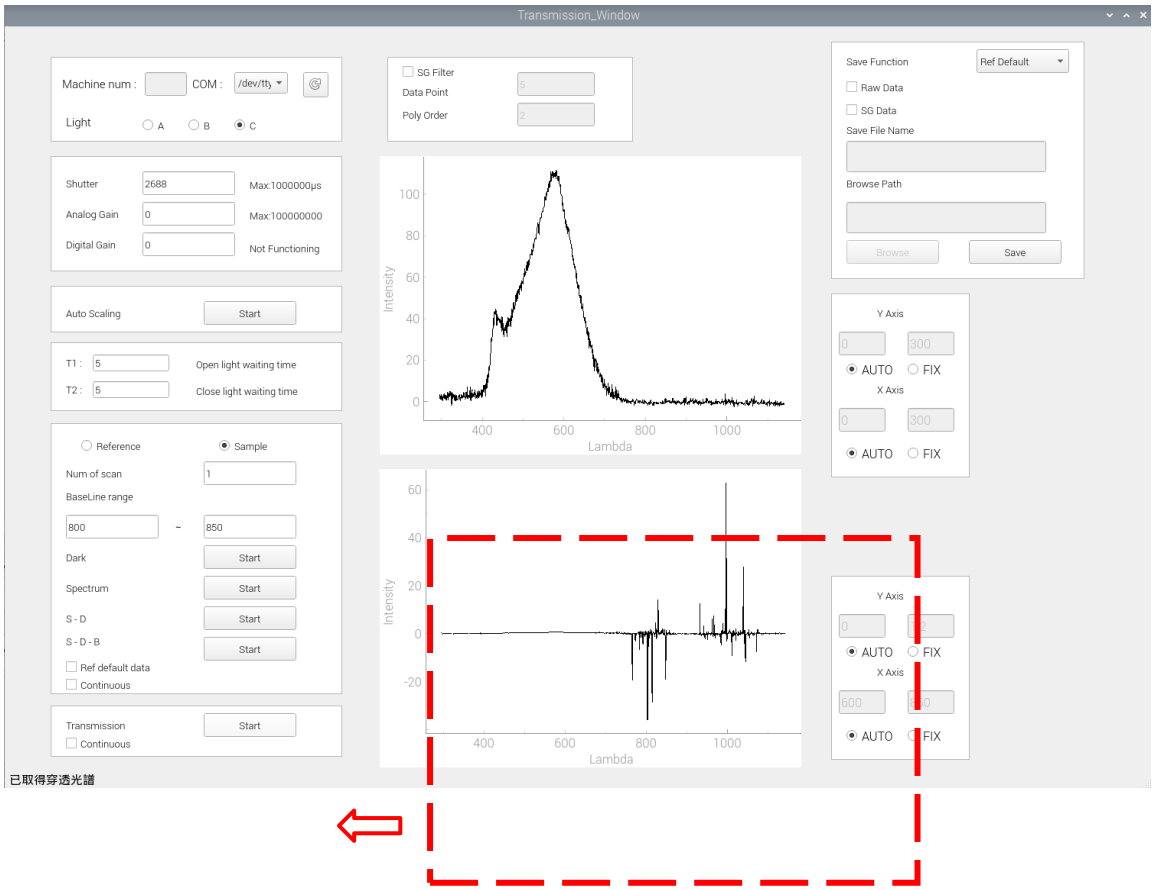
3.5.3.3 Scan Sample Spectrum

The steps of scanning sample spectrum are the same as section 3.5.3.2. The figure below shows after scanning the sample spectrum. And in this figure, the Dark Button and Spectrum Button cannot be clicked because of the limitation of T2.



3.5.3.4 Scan Transmission Spectrum

When the reference and sample spectrum are taken, the transmission spectrum can be calculated.



3.5.3.5 Continuous Mode

This mode is used for continuous capture.

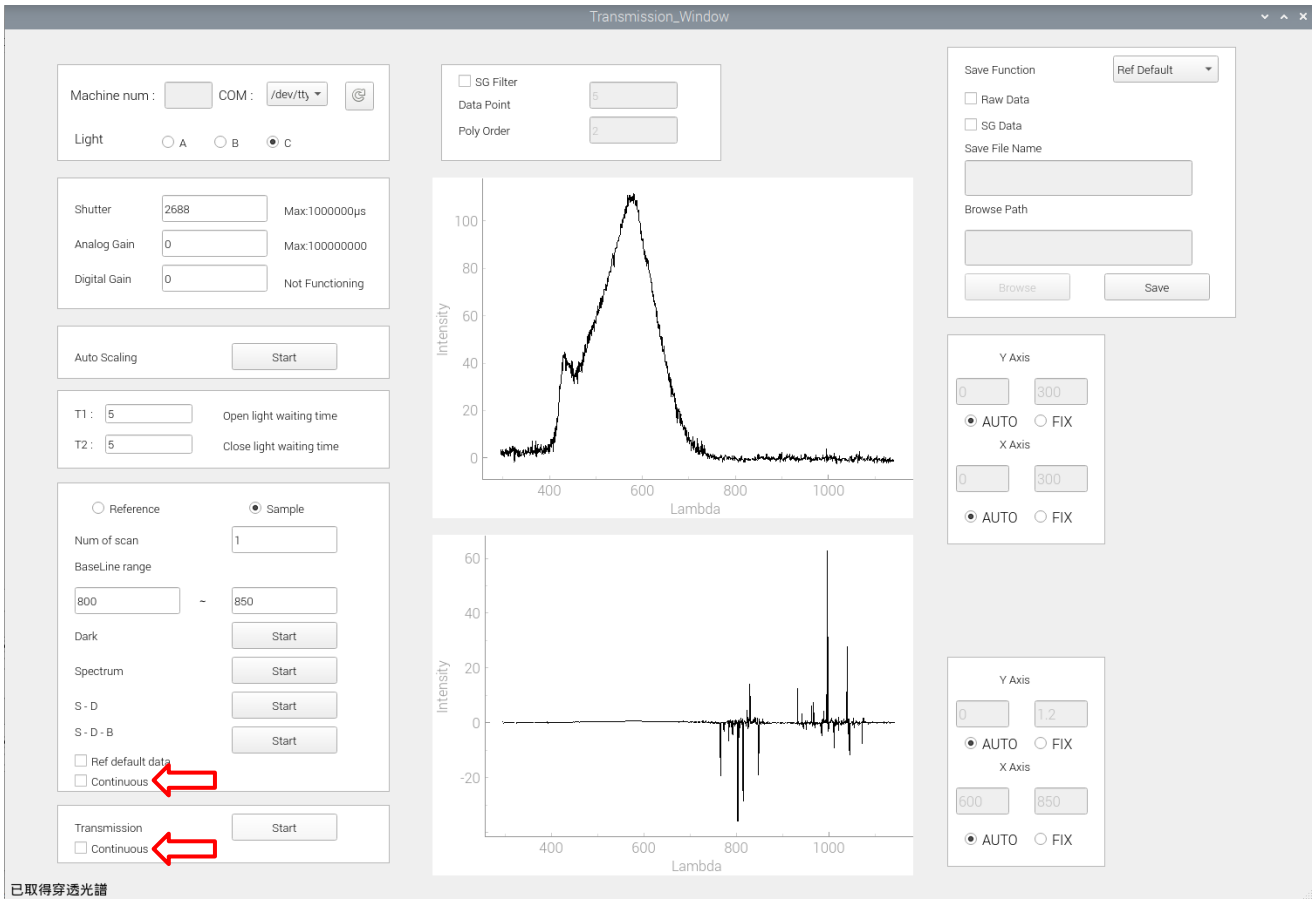
Please note that the data.txt will only save the last data captured.

Step 1

First select which spectrum to perform (Ex. Dark button、Spectrum button…)

Step 2

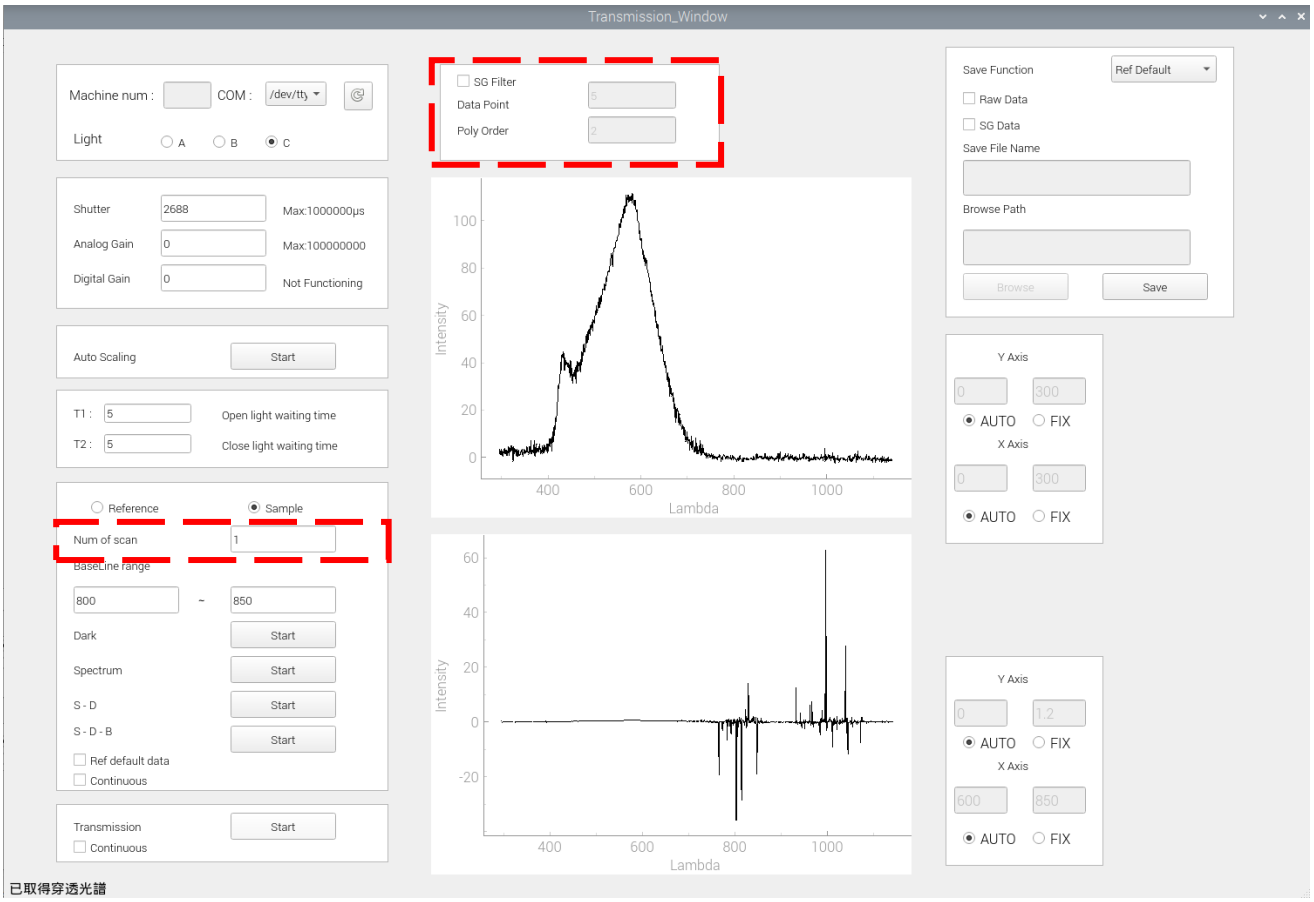
Clicking the continuous checkbox will execute the dynamic spectrum.



3.5.3.6 Num of scan and SG Filter

These two functions can be used to effectively reduce noise.

For more information, please refer to section 3.2.1 step4 (SG Filter) and section 3.2.1 step5 (Num of scan).



3.5.4 Save function

This Function is to let the user to save the data for experiment or analysis use.

Click the Save Function comboBox and select the data to save. Then the steps are the same as section 3.2.3