SEC2020 SPECTROMETER SYSTEM
USER'S GUIDE
- SOFTWARE -

ALS Co., Ltd
Electrochemistry & Spectroelectrochemistry

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Contents

1. About SpectraSmart

SpectraSmart is a software program for the portable spectrometers system “SEC2020 Spectrometer system”. It offers a wide variety of optical measurements including spectrum, absorbance, transmittance, reflectance, emission intensity, and concentration.

2. Minimum System Requirements

Before installing SpectraSmart, ensure that your computer meets the following minimum requirements:

Minimum System Requirements	
Processor	1 GHz or higher
RAM	1 GB or higher
Hard Disk	100 MB or higher
Screen Resolution	1024 x 768 or higher
Operating System	Windows 10, Windows 8.1, Windows 7
Software	Microsoft .NET Framework 3.5

3. Installing SpectraSmart

Before Installation

Before installing SpectraSmart, ensure that you have the administrator privilege to the computer where SpectraSmart is being installed.

Installing SpectraSmart Software

Insert the software USB memory into the computer, and then the installation will start. If it doesn't start automatically, navigate to the USB memory. Double-click on the "**setup.exe**" file to start up the program installation.

Note: Before installing SpectraSmart, the setup program will check whether the "Microsoft .NET Framework 3.5" component is installed on the computer. If it is not installed, the following window will appear to help you install this component. Follow the instructions on the window to install ".NET Framework 3.5."

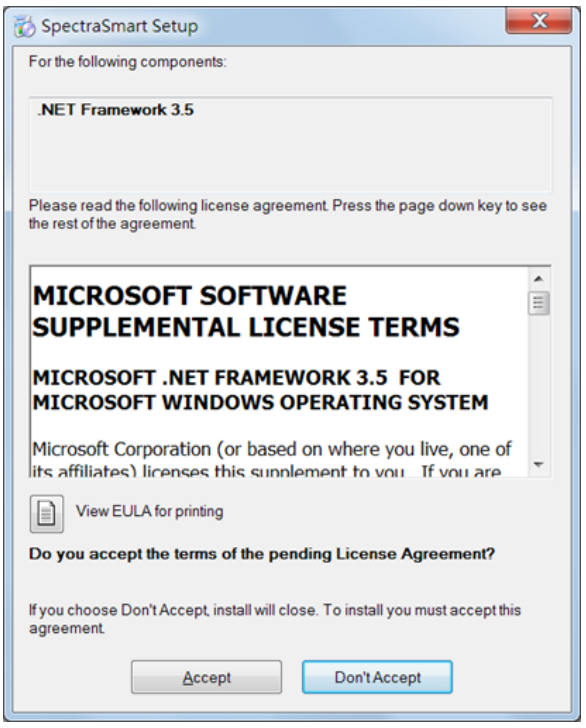


Figure 3-1: Installing ".NET Framework 3.5"

When the installation of Microsoft .NET Framework 3.5 is confirmed, the setup wizard starts up. Execute the installation by following the instructions on the screen.

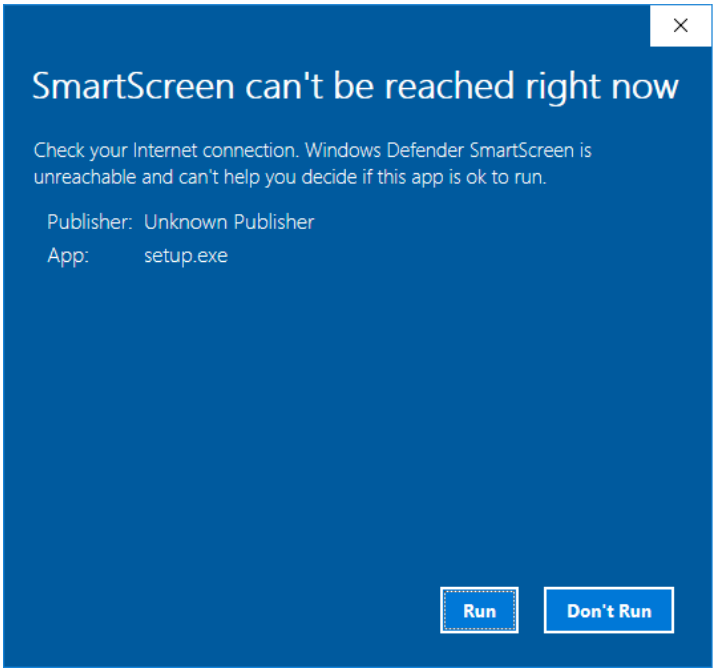


Figure 3-2: Windows Security Alert - select run

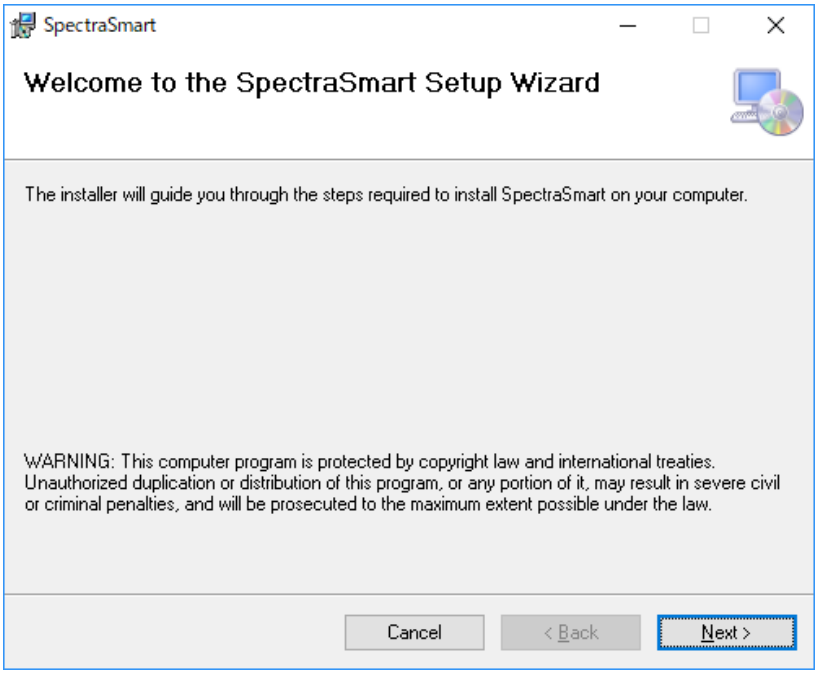


Figure 3-3: Setup Wizard -- **Welcome**

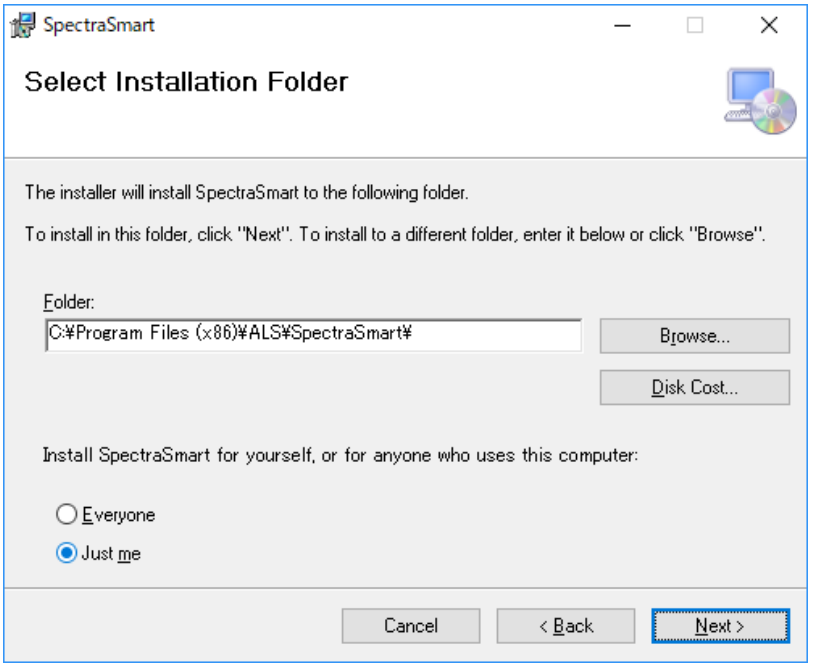


Figure 3-4: Setup Wizard -- **Select Installation Folder**

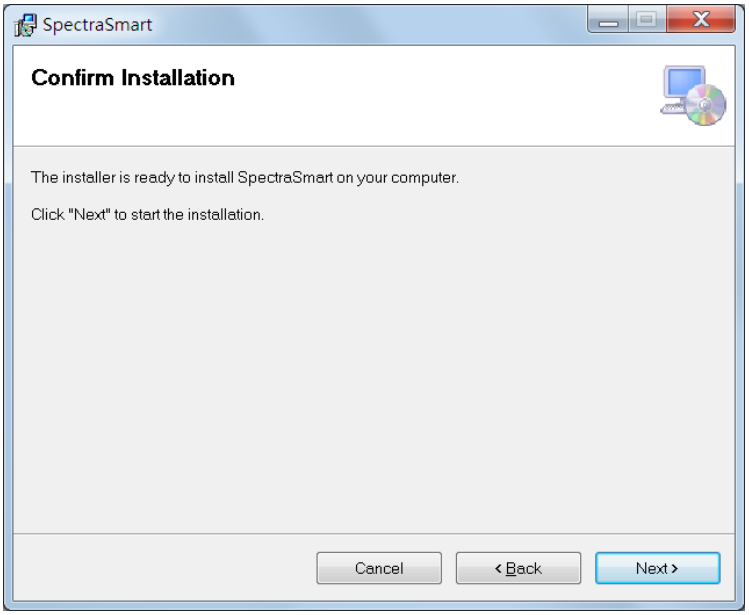


Figure 3-5: Setup Wizard -- **Confirm Installation**

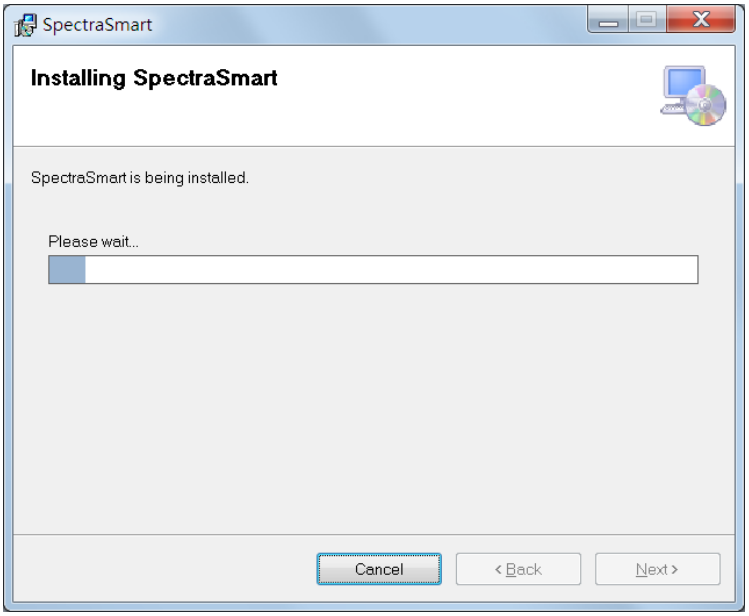


Figure 3-6: Setup Wizard -- **Installing SpectraSmart**

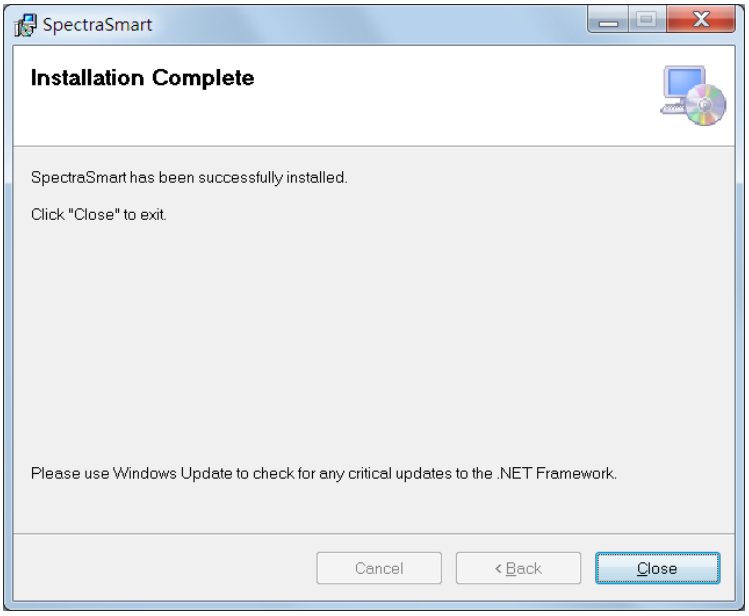


Figure 3-7: Setup Wizard -- **Installation Complete**

When you see the **Installation Complete** window, it means that SpectraSmart has been successfully installed. Click **Close** to finish.

Installing Device Drivers

Normally, device drivers for supported spectrometers will be installed with SpectraSmart as part of the setup process. If they are not installed due to unexpected errors, you need to install these drivers manually. Files for these drivers will be copied to the "**Driver**" folder under the installation path for SpectraSmart during the setup. If you have selected

the default path, the drivers will be in:

C:\Program Files\ALS\SpectraSmart\Driver\USB2.0 (32-bit systems) or
C:\Program Files (x86)\ALS\ SpectraSmart \Driver\USB2.0 (64-bit systems)

Under this folder, there are sub-folders for each series of spectrometers:

Windows 10/8.1/7

Please run the "DriverInstaller.exe" program on the USB memory or under the SpectraSmart installation folder to install the drivers. Or, connect the spectrometer to the computer, enter in the "Device Manager", manually specify the folder with the "TAURUS" device driver, and update the driver. Specify the folder location of the appropriate drivers, as shown in the following figure:

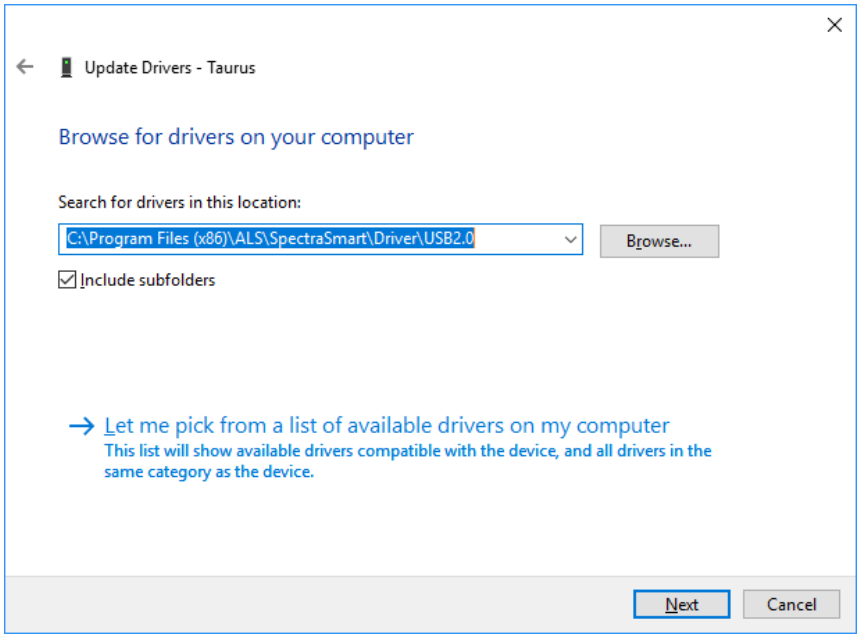


Figure 3-8: Manually specifying the location of drivers on 64-bit Windows 7

After you have specified the path, click **Next** to finish driver installation.

If you need more detailed explanation, please contact us.

4. Removing SpectraSmart

If you need to remove SpectraSmart, go to the **Control Panel** and follow the instructions below:

Note: To open the Control Panel on Windows 10, right-click on the "Start" button, and then select "Control Panel" from the pop-up menu.

Windows 10/8.1/7

Open the **Control Panel**. Navigate to **Programs** and then **Programs and Features**. Select **SpectraSmart** from the list, and then click **Uninstall**. The system will ask you to confirm the removal. After the confirmation, you will see a message box showing the removal progress. When it is finished, this message box will close.

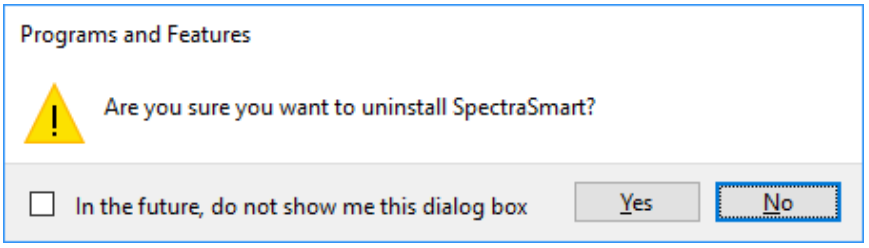


Figure 4-1: Confirming the removal of SpectraSmart (on Windows 10/8.1/7 systems)

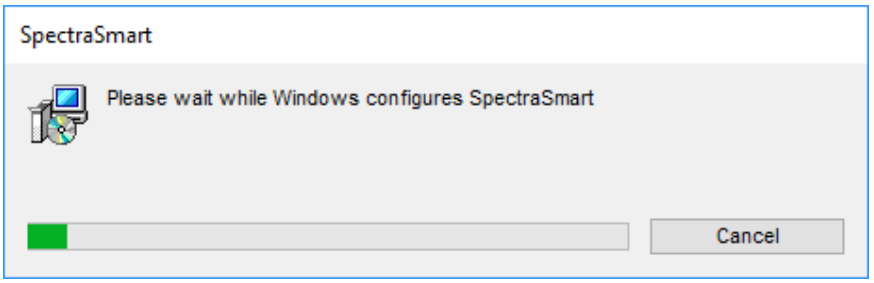


Figure 4-2: The system is removing SpectraSmart (on Windows 10/8.1/7 systems)

5. Getting Started with SpectraSmart

Starting SpectraSmart

A shortcut to the SpectraSmart program will be placed on your computer desktop during the installation. See the following figure:

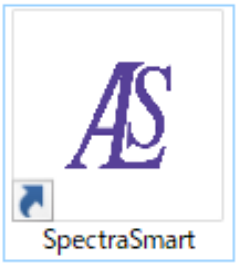


Figure 5-1: SpectraSmart program shortcut on the desktop

Double-click the shortcut to activate the Spectra Smart. After starting the program, the following screen will be displayed. When the spectrometer is not connected, the "Device list" frame at the bottom left is blank.

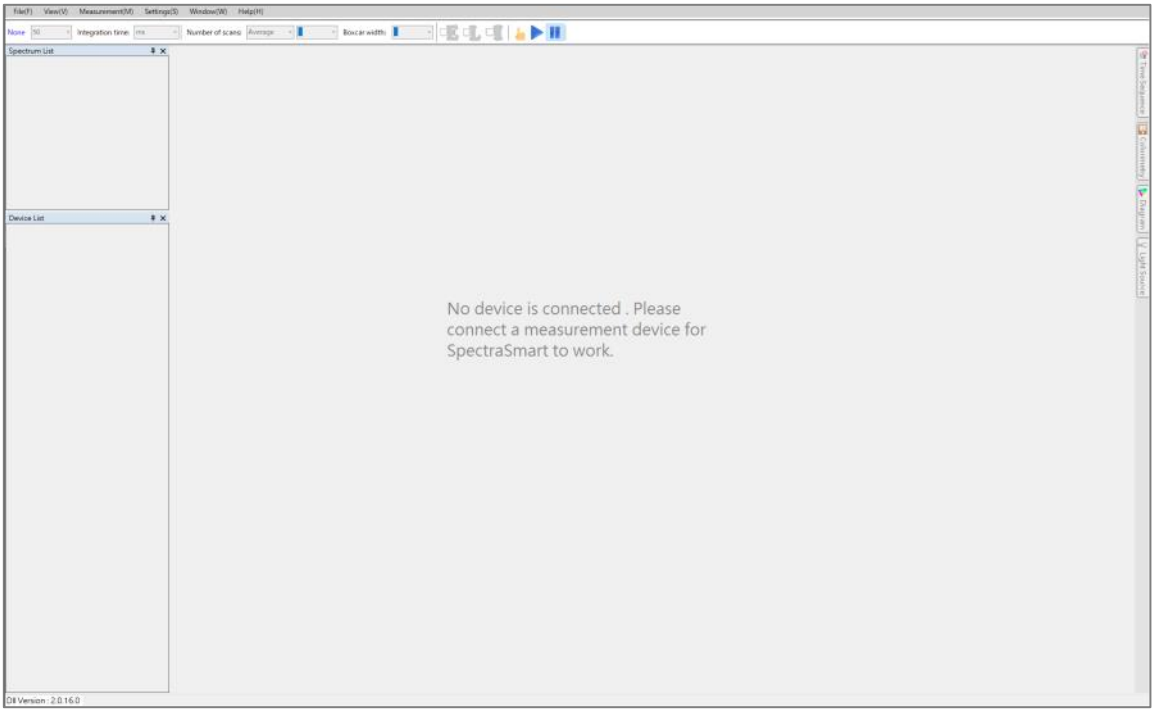


Figure 5-2: SpectraSmart not yet connected to the spectrometer

Next, connect the spectrometer to the computer where SpectraSmart is installed. When SpectraSmart detects the device, the following message will appear, indicating that the device is being initialized:

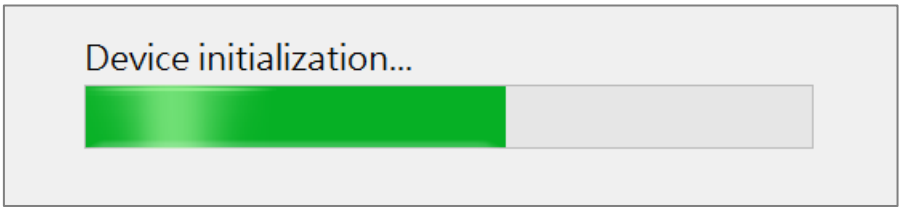


Figure 5-3: SpectraSmart is initializing the measurement device

After the device is initialized, you can use the device in SpectraSmart for a wide variety of spectral measurements. When you see the following, it means that SpectraSmart is ready for measurements:

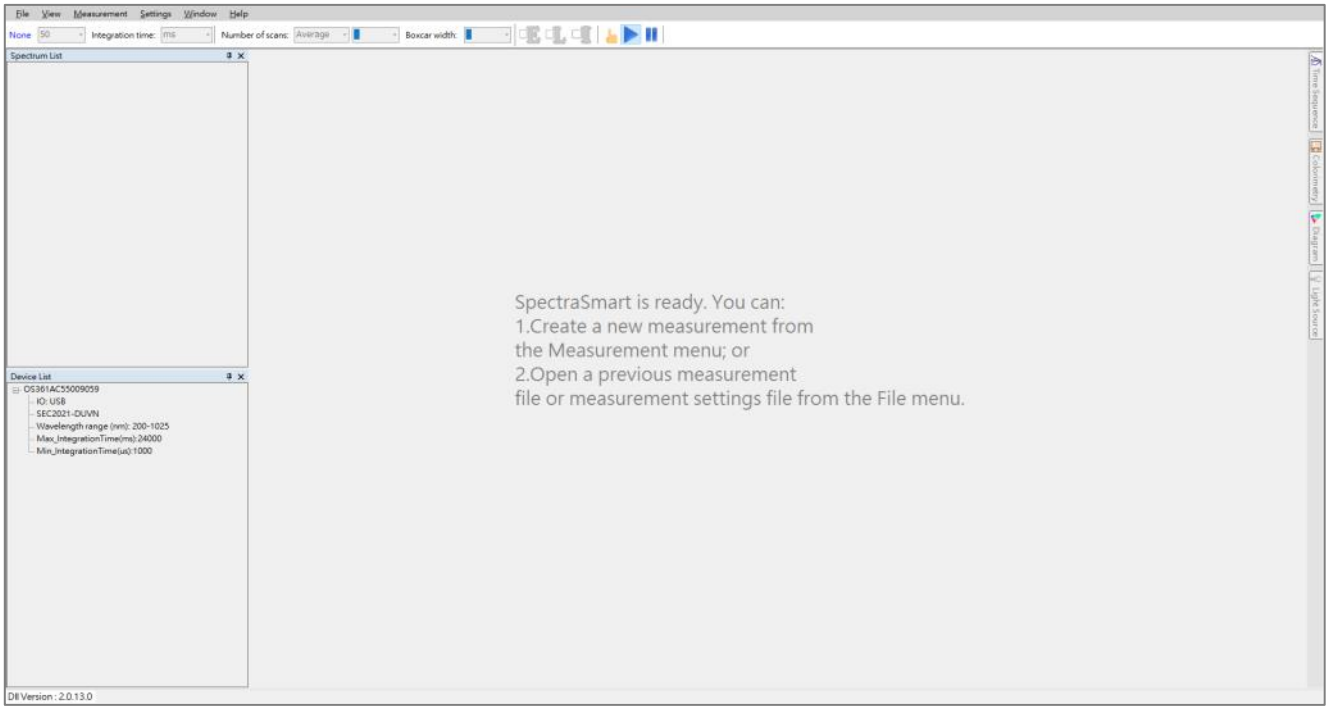


Figure 5-4: SpectraSmart is ready for measurement

Now, you can create a new measurement from the **Measurement** menu. Or, you can load a previously saved measurement or a set of measurement settings from the **File** menu.

If you connect the spectrometer first...

If you connect the spectrometer to your computer before you start SpectraSmart, it will create a default spectrum measurement for the connected device on startup, allowing you to ensure that the device is working properly. See the following figure:

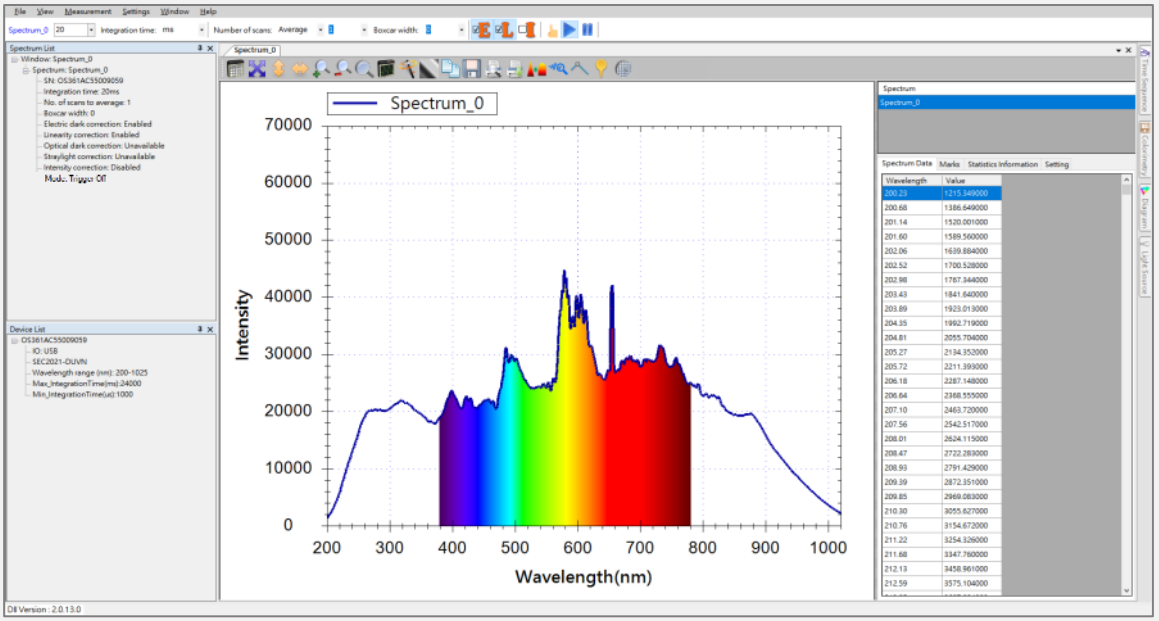


Figure 5-5: SpectraSmart creates a default spectrum measurement for the connected device on startup

If there is more than one spectrometer connected to your computer when SpectraSmart starts, it will create a default spectrum measurement for each device connected, and there will be more than one device in the **Device List**. See the red highlighted area in the figure below.

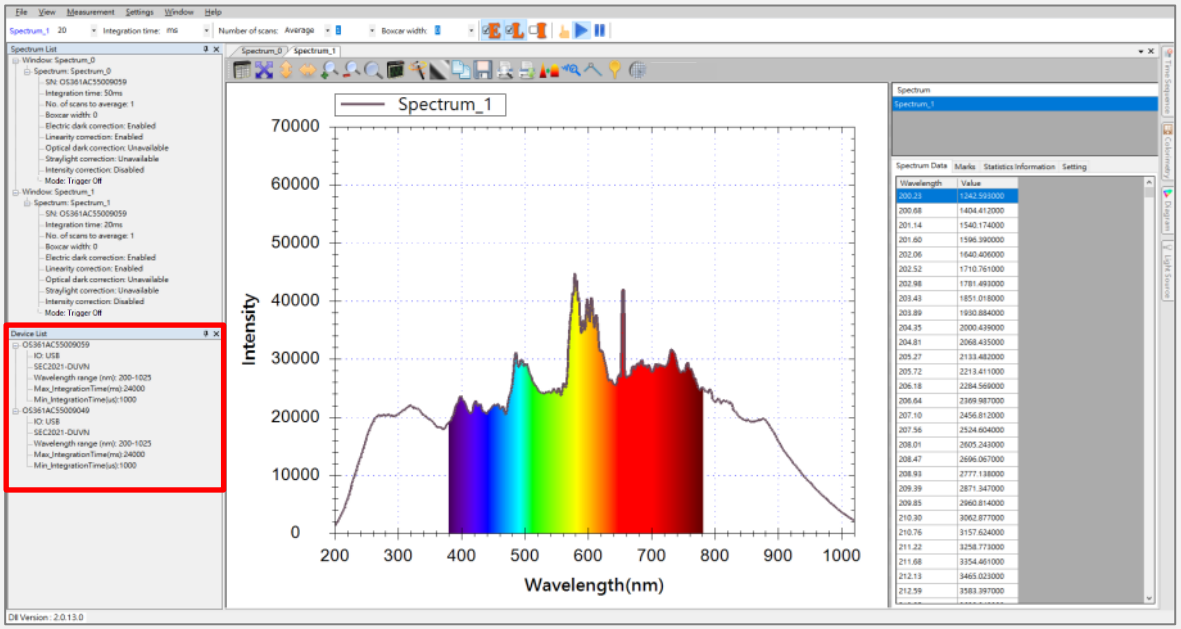


Figure 5-6: On startup, SpectraSmart creates a default spectrum measurement for each connected spectrometer (i.e.

Spectrum_0 and Spectrum_1)

Device List

When SpectraSmart recognizes the spectrometer, it will display it in the **Device List** pane on the left of SpectraSmart window, as shown in the following red highlighted area:

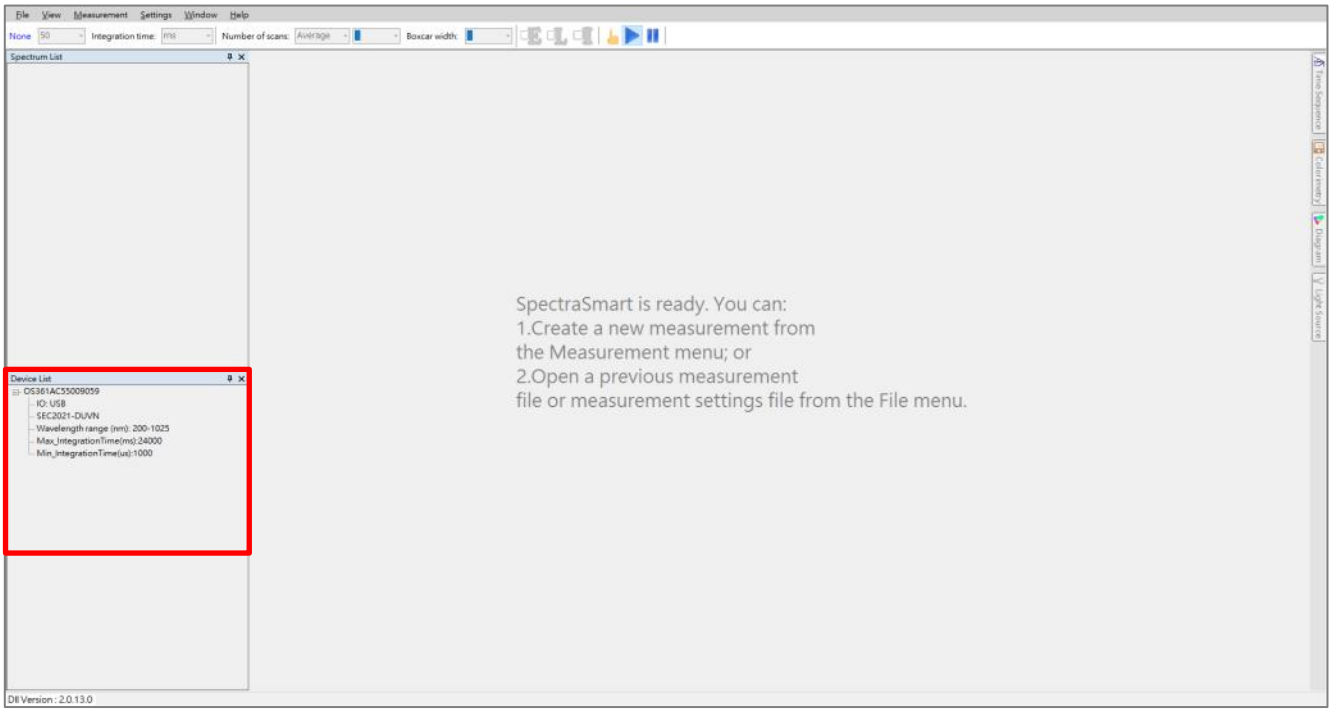


Figure 5-7: The **Device List** of SpectraSmart

The **Device List** shows the basic attributes of connected devices, such as models, serial numbers (SN), and wavelength ranges.

Note: The serial number is how SpectraSmart identifies each device. This number is also used in several windows where device selection is needed. For this reason, when you have multiple devices connected, please pay attention to their serial numbers so you can identify them.

Device Information Details

If you need to view detailed information about a connected device, go to the **File** menu, and then select **Device Information**, as shown in the following figure:

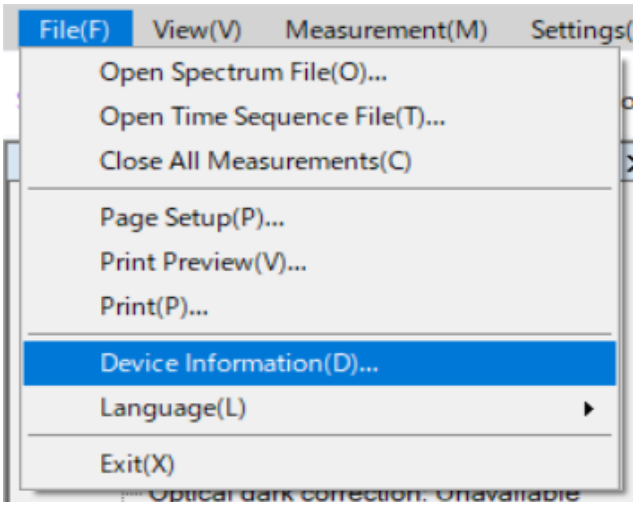


Figure 5-8: Selecting **Device Information** from the **File** menu

Then, the following window appears, showing details about the device:

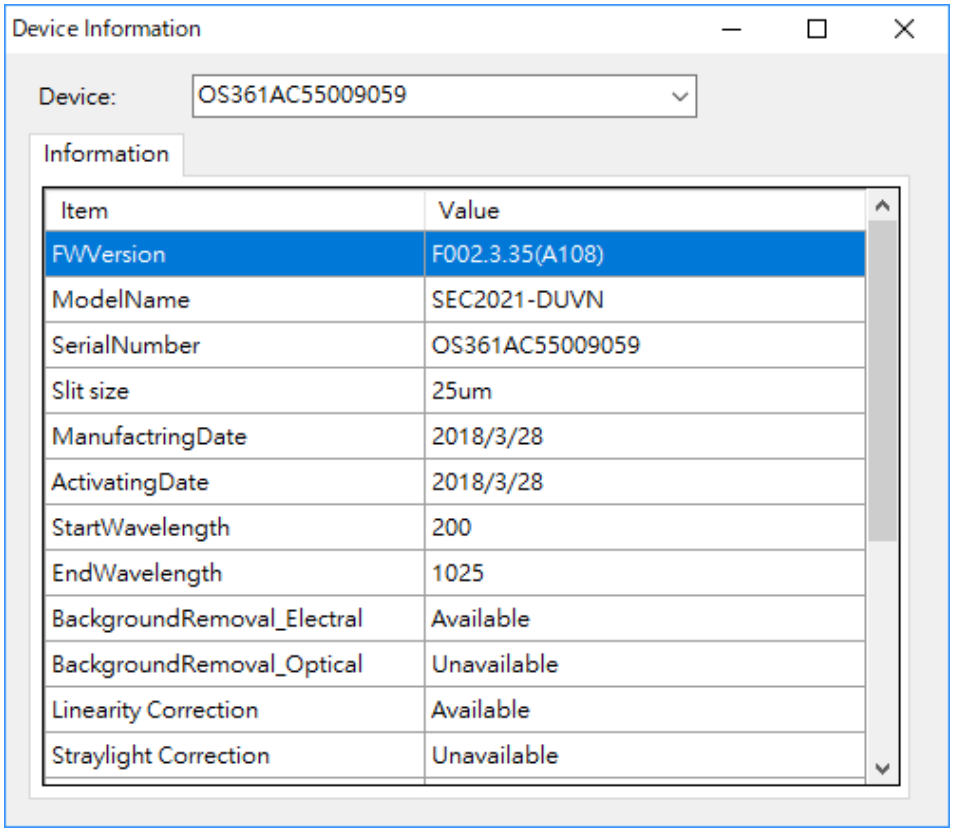


Figure 5-9: Device information details

6. Spectrum Measurement

SpectraSmart can work with portable spectrometers in a wide variety of spectral measurements including spectrum, strip chart, absorbance, transmittance, reflectance, emission intensity, and concentration. This chapter describes how to create basic spectrum measurements. The chapters that follow will describe how to create other spectrum-based measurements.

Before the Measurement

Before doing any measurements, you should set up the measurement environment, such as positioning the spectrometer on the measurement platform, connecting the light source to the spectrometer's input connector, placing the cuvette holder in position, etc. For details of the method of setting the measuring instrument, refer to "SEC 2020 Spectrometer System User's Guide - Device -".

Creating a Spectrum Measurement

To create a spectrum measurement, select **Spectrum** from the **Measurement** menu to open the **New Spectrum** window, as shown in the following:

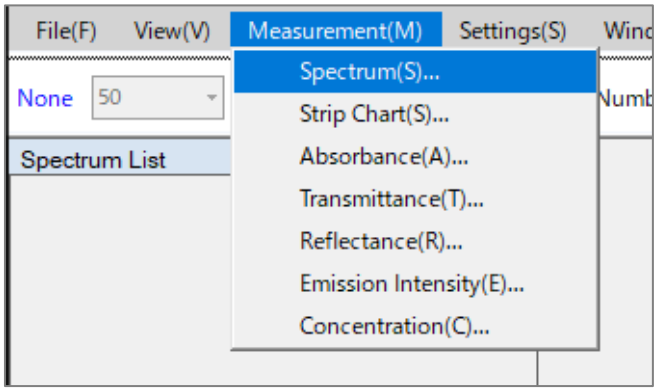


Figure 6-1: Selecting **Spectrum** from the **Measurement** menu to create a spectrum measurement

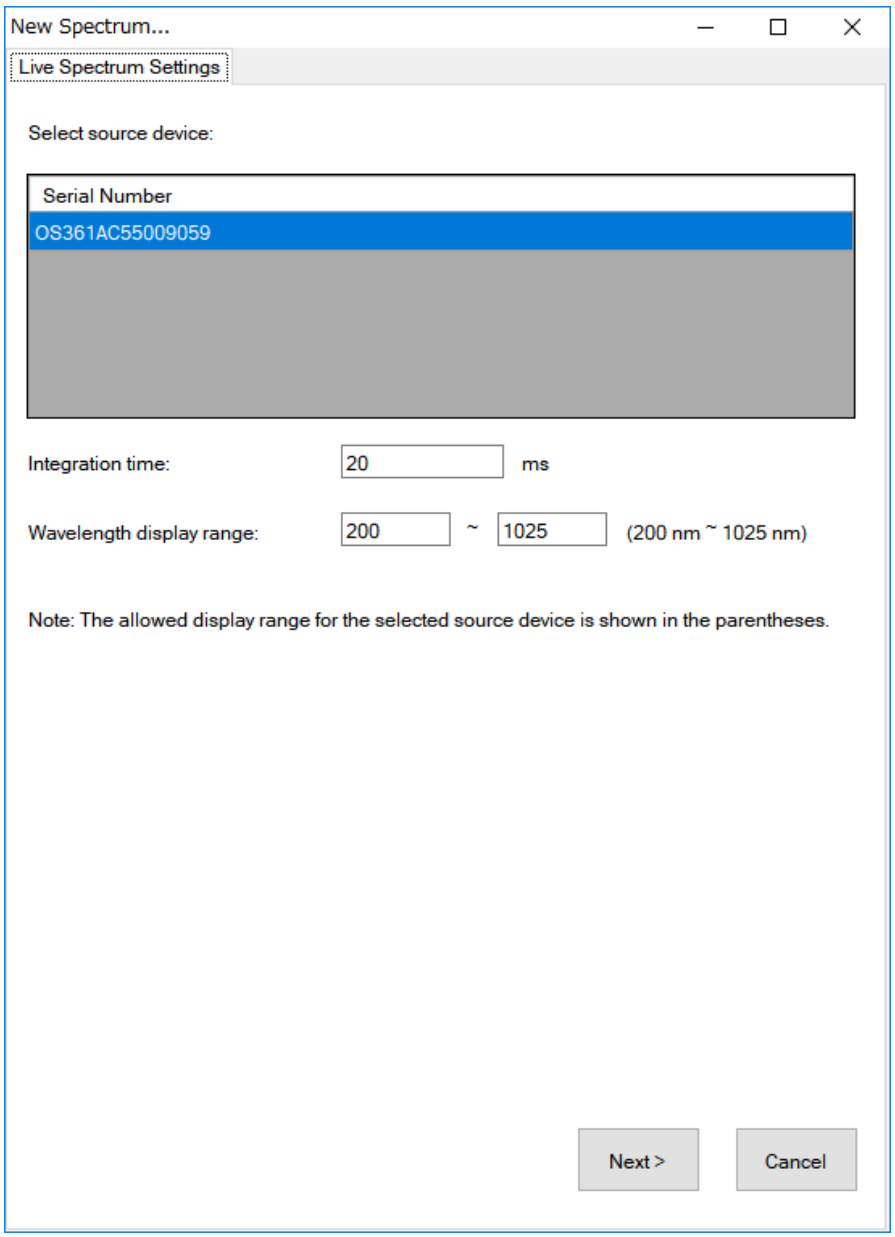


Figure 6-2: **New Spectrum** - **Live Spectrum Settings**

On the **New Spectrum--Live Spectrum Settings** window, select a source device (identified by its serial number). Then, enter an integration time (i.e. the exposure time for the light sensor) and a wavelength range to display on the X-axis (the range in the parentheses indicates the range supported by the selected device, in this case: 200 nm-1025 nm). Then, click **Next**.

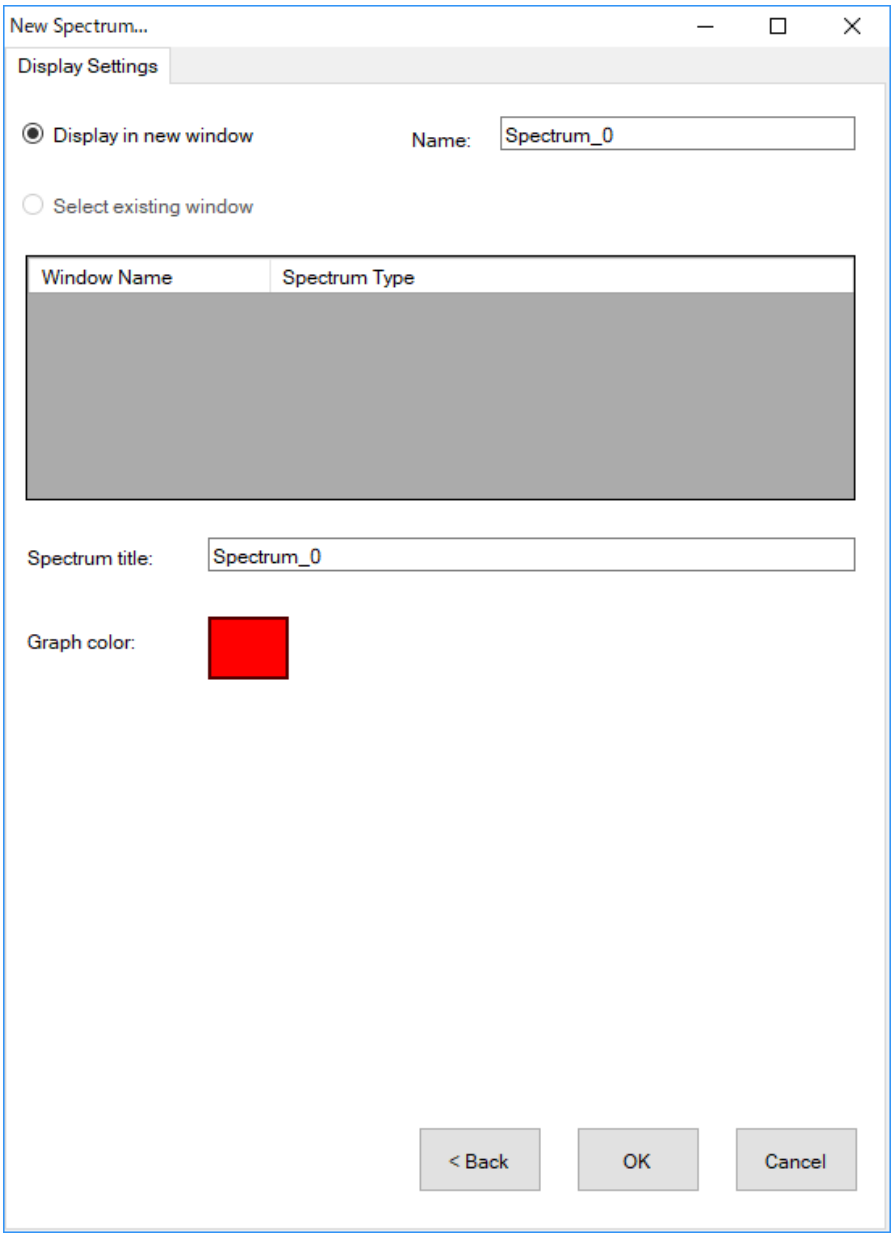


Figure 6-3: **New Spectrum** - **Display Settings**

On the **Display Settings** window, specify whether to display the new spectrum curve in a new or an existing window. If this is the first spectrum measurement you create, you can only select a new window. If you already have other spectrum measurements, you can choose to display this new spectrum curve in an existing window. That way you can compare how two spectrum curves differ from each other. This window also allows you to specify a name for the window, as well as a title and a color for the spectrum curve. You may simply leave the default names unchanged. When all settings are done, click **OK**. SpectraSmart will display the newly created spectrum measurement as follows:

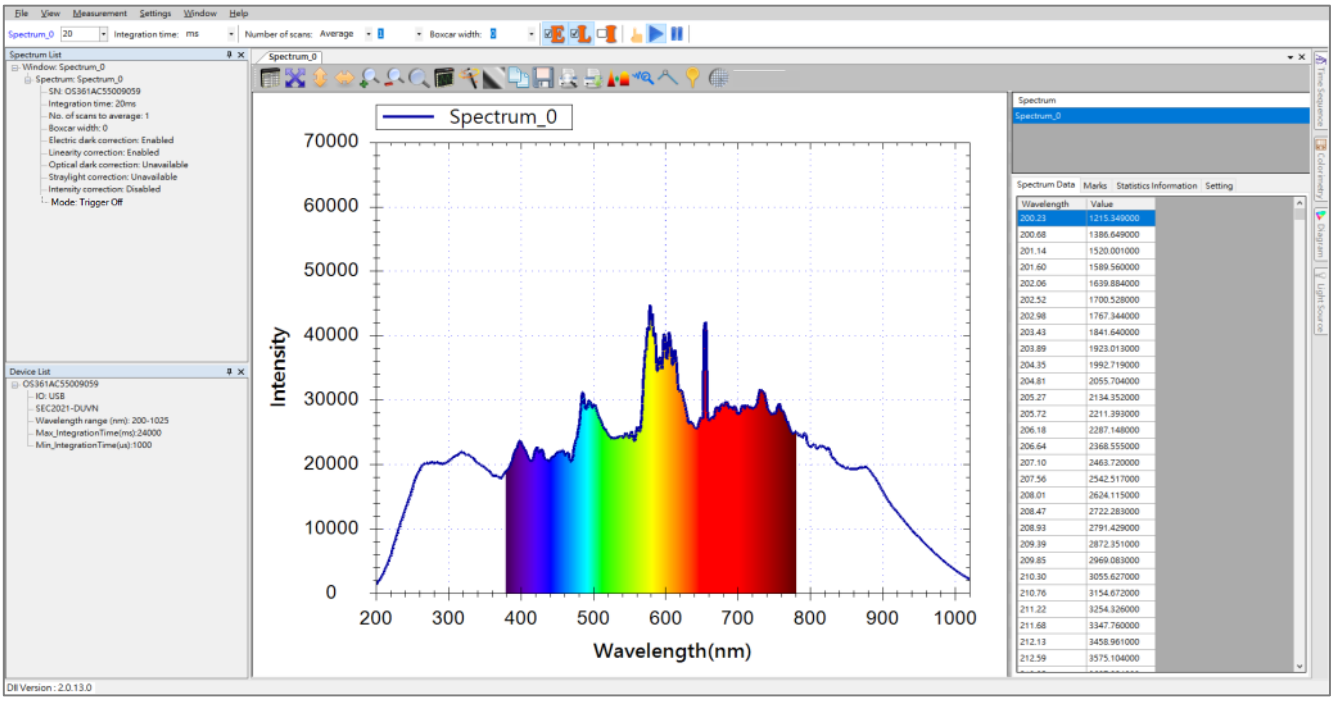


Figure 6-4: Newly created spectrum measurement (Spectrum_0)

Spectrum List

Whenever you create a measurement, the **Spectrum List** on the left-hand side of SpectraSmart window will show details about the underlying spectrum(s) of the created measurement.

Note: In addition to spectrum measurement, the setting conditions (eg. absorbance, transmittance, etc.) added in others measurements are also displayed.

Not Showing Human Visible Spectrum

For the user to read the spectrum graph more easily, SpectraSmart shows human visible spectrum on the graph by default. If you don't want to display visible spectrum, go to the **Settings** menu, and then select **Application Settings**. On the **Graph** tab, disable **Show human visible spectrum** and click **OK**, as shown in the following.

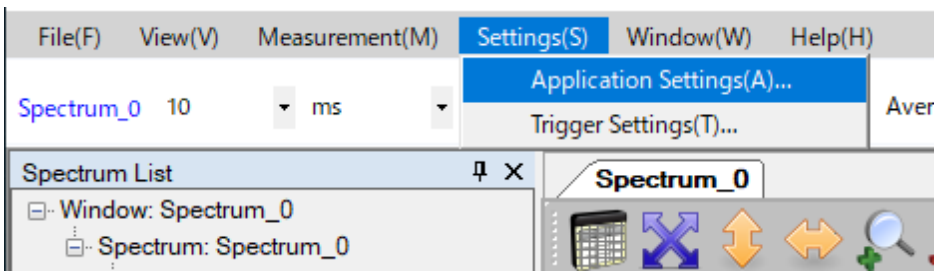


Figure 6-5: Selecting **Application Settings** from the **Settings** menu

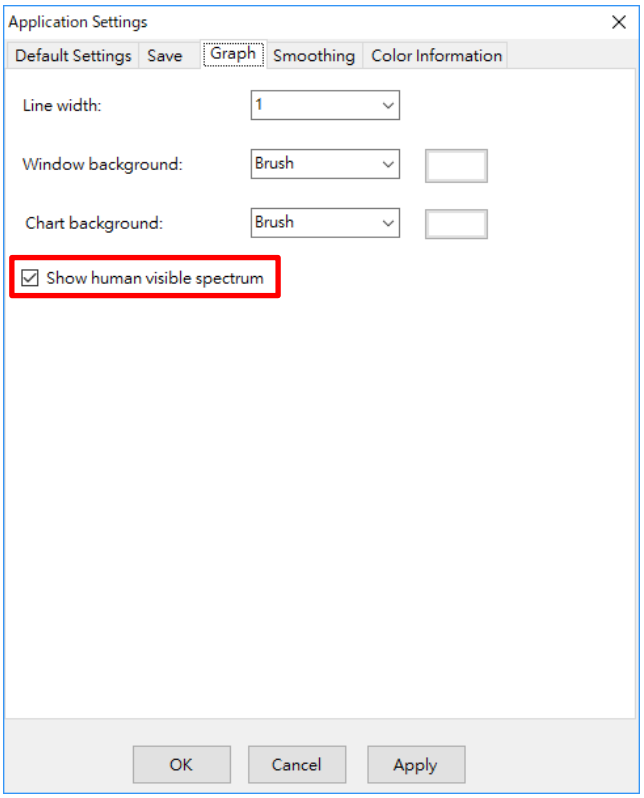


Figure 6-6: **Application Settings** -- Disabling **Show human visible spectrum**

You will see the effect after you disable **Show human visible spectrum**, as in the following:

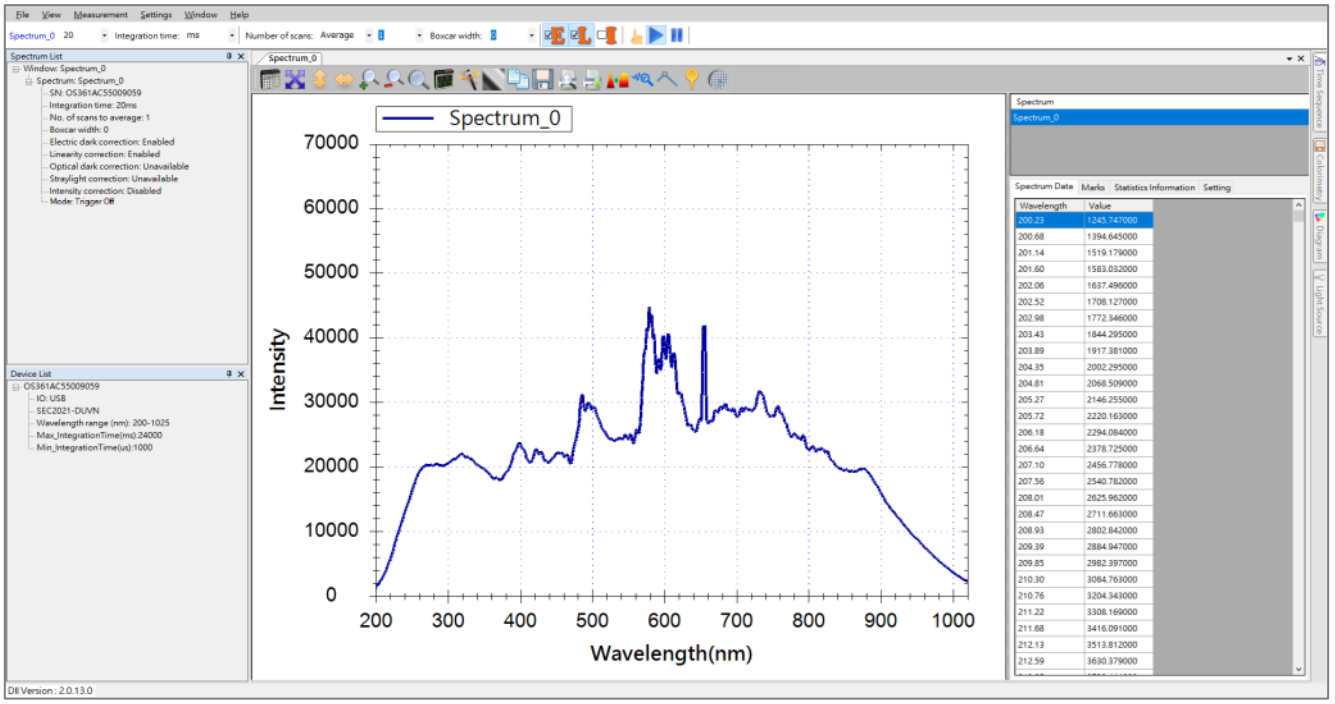


Figure 6-7: Not showing human visible spectrum on the spectrum graph

Modifying Data Acquisition Settings

If necessary, you can adjust the data acquisition settings after a measurement is created, such as the integration time, the number of scans to average, and the Boxcar width. You can do so with the quick adjustment toolbar right under the main menu. See the following red highlighted area:

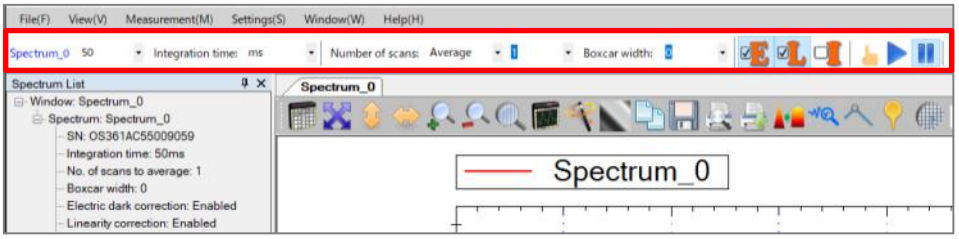


Figure 6-8: Modifying data acquisition settings

Additionally, the three buttons (**E**, **L**, and **I**) to the right of the **Boxcar width** allow you to enable or disable **Electronic Dark Correction**, **Linearity Correction**, and **Intensity Correction**, respectively. Refer to “Appendix A: Spectrometer Correction Features” for details. The last three buttons on the right allow you to take a **One Shot** measurement, and to **Start** and **Pause** the data acquisition, respectively. Refer to “

One-shot Measurement” for details.

Data Distorted

When adjusting the integration time, a warning message "Data distorted: The peak of the raw spectrum has exceeded..." is displayed, as shown below.

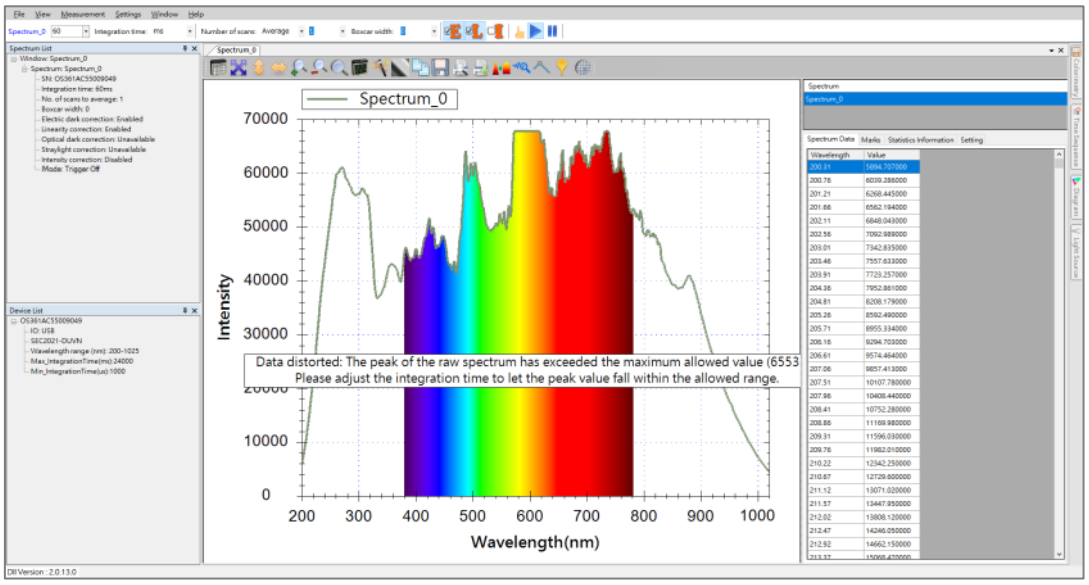


Figure 6-9："Data distorted" warning message

It means the integration time you specified is too long that the peak in the raw spectrum data acquired by SpectraSmart has exceeded the maximum allowed value (i.e. 65535). The captured data is meaningless now, and the spectrum curve appears distorted. You need to re-adjust the integration time to allow the peak to fall within the maximum range. Sometimes, the spectrum curve may seem normal when you see the "**Data distorted**" warning, as in the following:

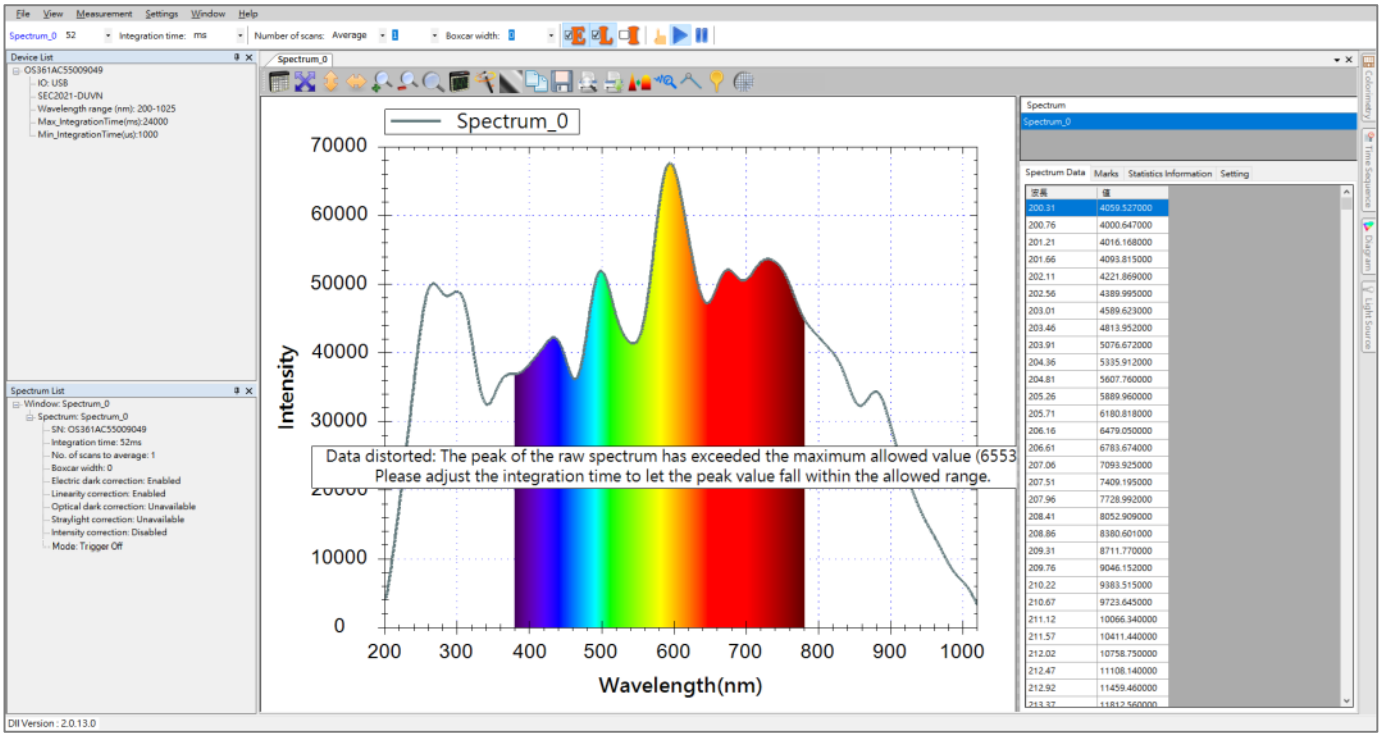


Figure 6-10: "**Data distorted**" warning appears on a seemingly normal curve

This is because the curve in the graph is the result of automatic corrections. In fact, the raw data is out of permitted range, although its curve looks normal. That is why you still need to adjust the integration time until the warning message disappears.

Note: If you don't want to see this warning message, you can turn it off in the Application Settings. Please refer to "Display a Message when the Peak Value in the Spectrum Exceeds 65535" for details.

Setting Integration Time Automatically by SpectraSmart

In addition to manually specifying an integration time, you can also use a toolbar button to let SpectraSmart set the integration time automatically for you. Please refer to "Setting Integration Time Automatically" for details.

Graph Toolbar Buttons

Every measurement graph has a toolbar of buttons right above it. They provide quick access to frequently used functions. See the following figure:

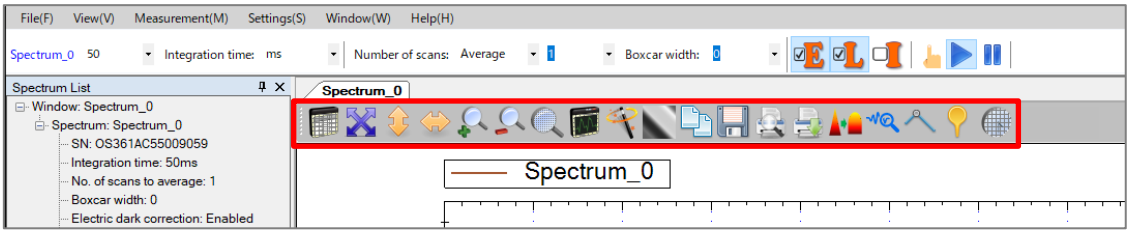


Figure 6-11: Graph toolbar buttons

These buttons are divided into two major groups: **Scale Adjustment Buttons** and **Other Easy Access Buttons**.

Scale Adjustment Buttons

By default, all measurement graphs (including spectrum graphs, strip charts, absorbance graphs, etc.) are created with optimal display scales for X- and Y-axes chosen by SpectraSmart. Sometimes, the scales may not fit your needs. So, SpectraSmart provides a set of toolbar buttons for you to customize the scales and display ranges. See the following red highlighted area:

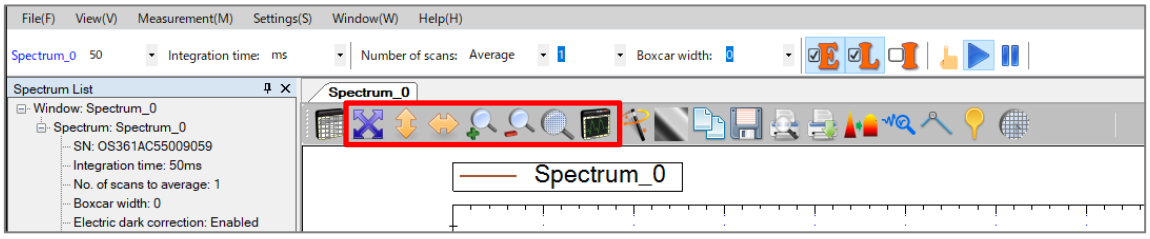


Figure 6-12: Scale adjustment buttons on the spectrum graph

These buttons are explained in details in the following.

Scale Graph Axes Automatically

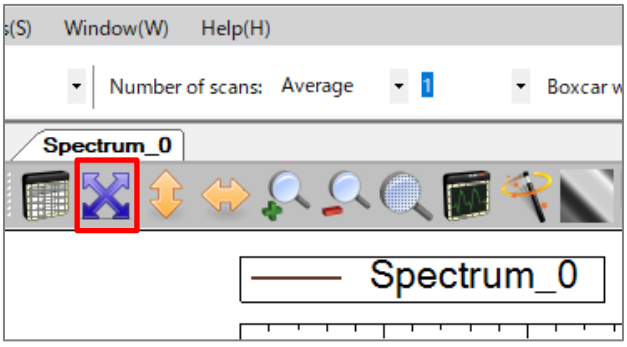


Figure 6-13: The **Scale graph axes automatically** button

This button automatically adjusts the X- and Y- axes to their optimal settings. The following figure shows the effect of this button. In the figure, the X-axis is adjusted to display the entire wavelength range supported by the device, while the Y-axis is adjusted so that the curve fills the entire graph as much as possible:

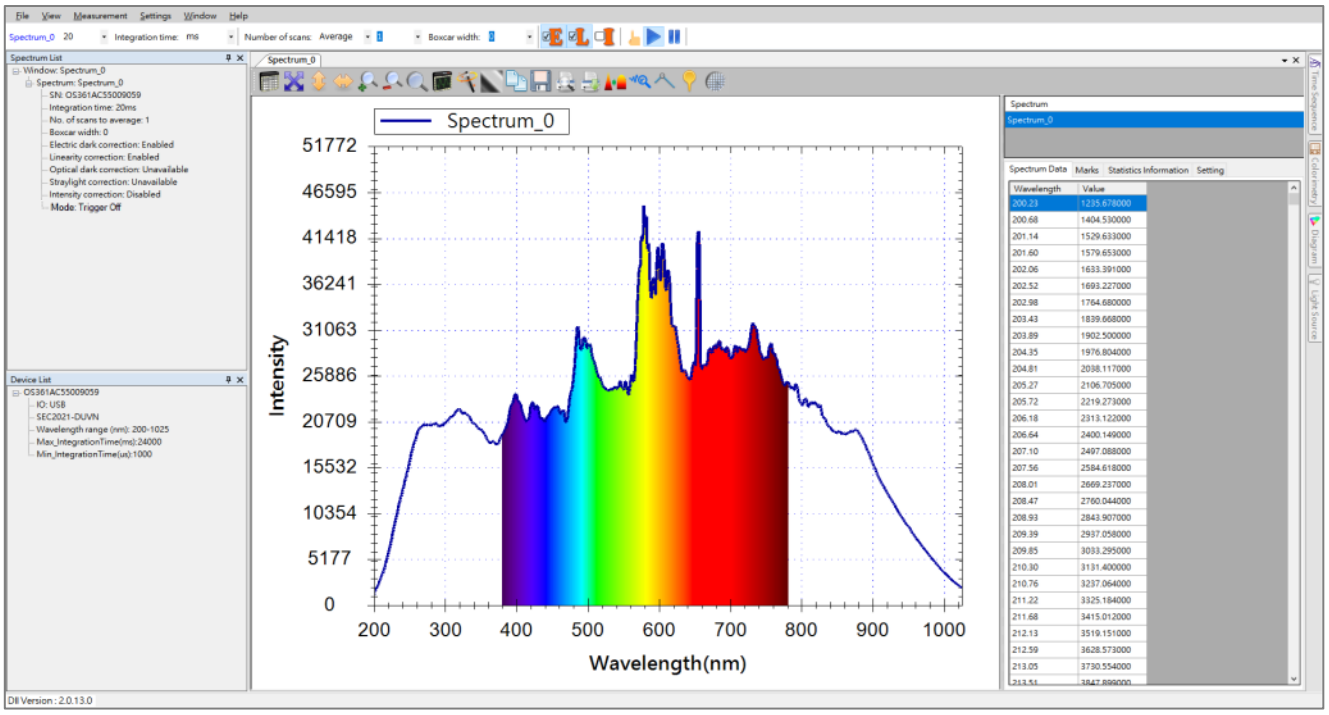


Figure 6-14: The effect of using **Scale graph axes automatically**

Scale Y-axis Automatically

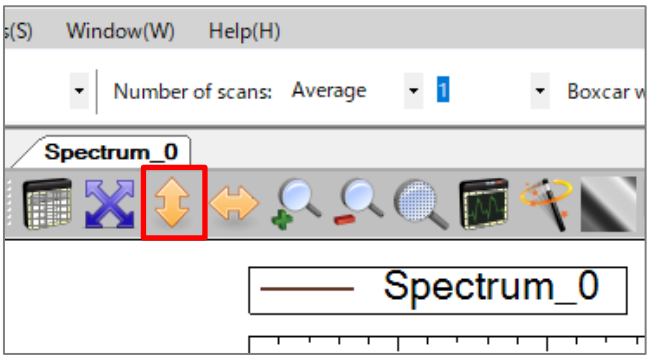


Figure 6-15: The **Scale Y-axis automatically** button

This button automatically adjusts the scale of Y-axis to show more details. The following figure shows the effect of this button. In the figure, the highest point on the curve is extended to the top of Y-axis:

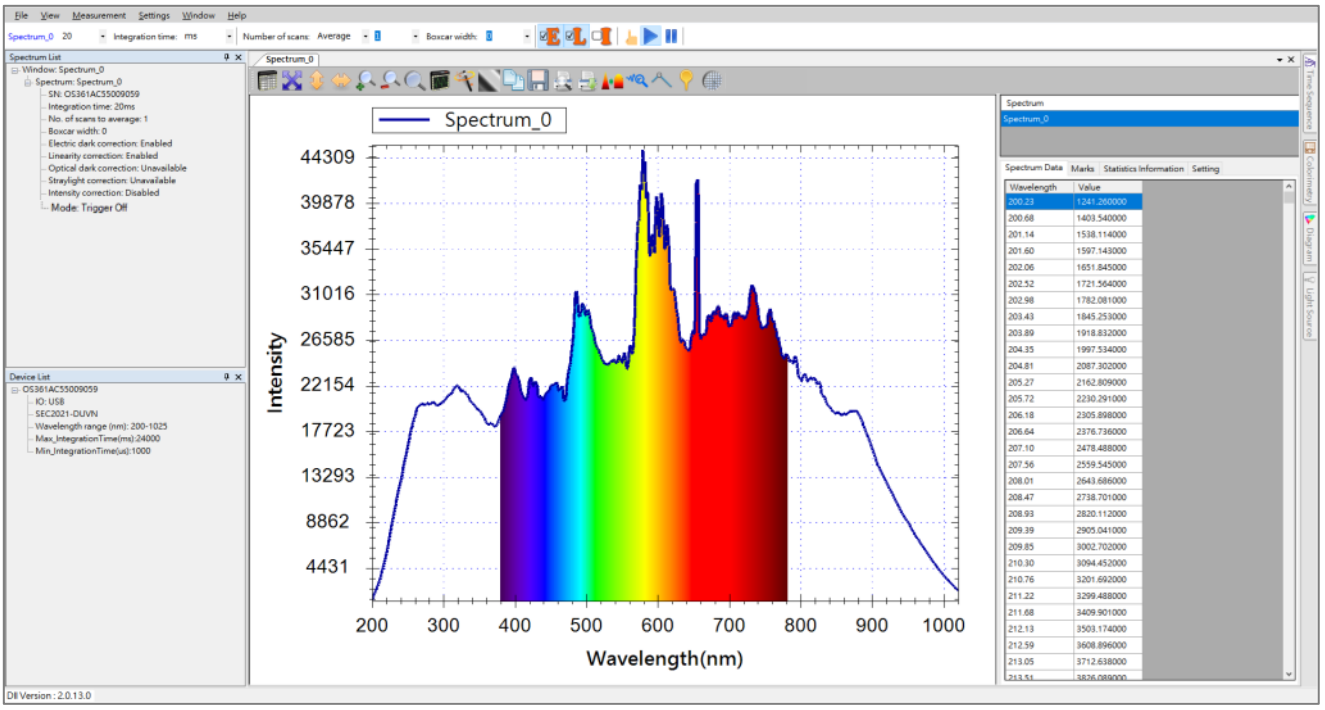


Figure 6-16: The effect of using **Scale Y-axis automatically**

Scale X-axis Automatically

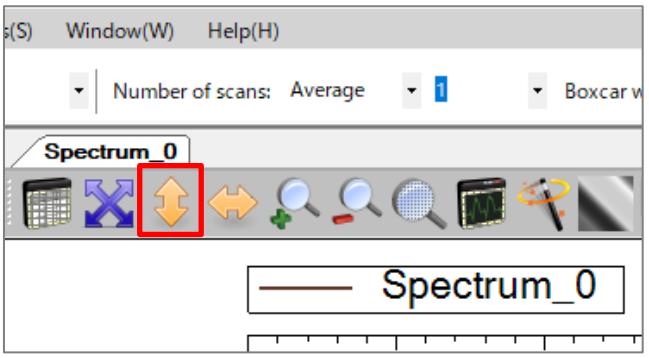


Figure 6-17: The **Scale X-axis automatically** button

This button automatically adjusts the scale of X-axis to show more details. Using this button will adjust the X-axis to display the internal wavelength range of the device, as in the following figure:

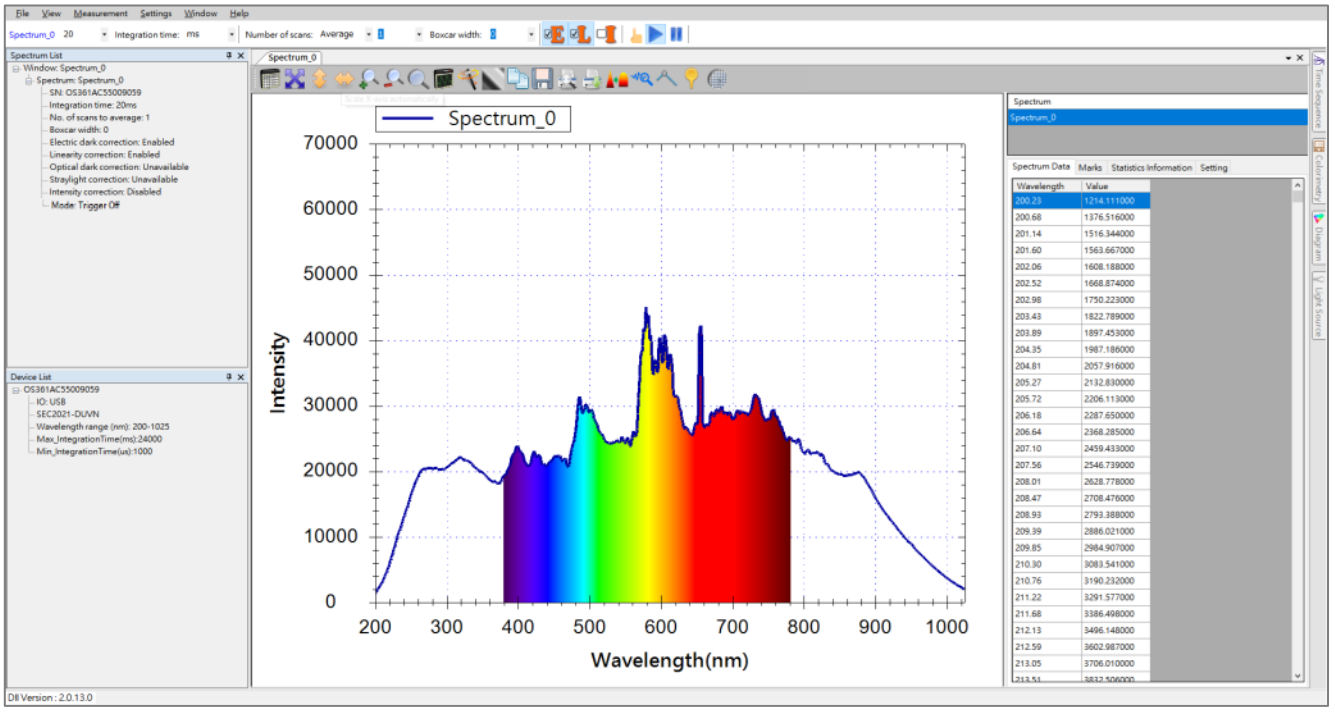


Figure 6-18: The effect of using **Scale X-axis automatically**

Note: If the original X-axis setting is already displaying the internal wavelength range of the device, pressing the "Scale X-axis automatically" button will not cause any change. You can try to zoom in on the graph, and then press the button to see its effect.

Zoom In

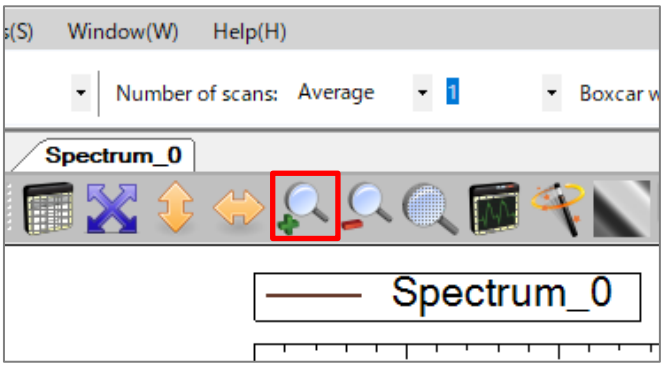


Figure 6-19: The **Zoom In** button

This button enlarges the graph (pulling it closer to you). Here we press **Scale graph axes automatically** to restore the graph to its optimal display settings, and then press **Zoom In** to demonstrate its effect. The following figure shows the result of pressing **Zoom In** three times (to make it more apparent):

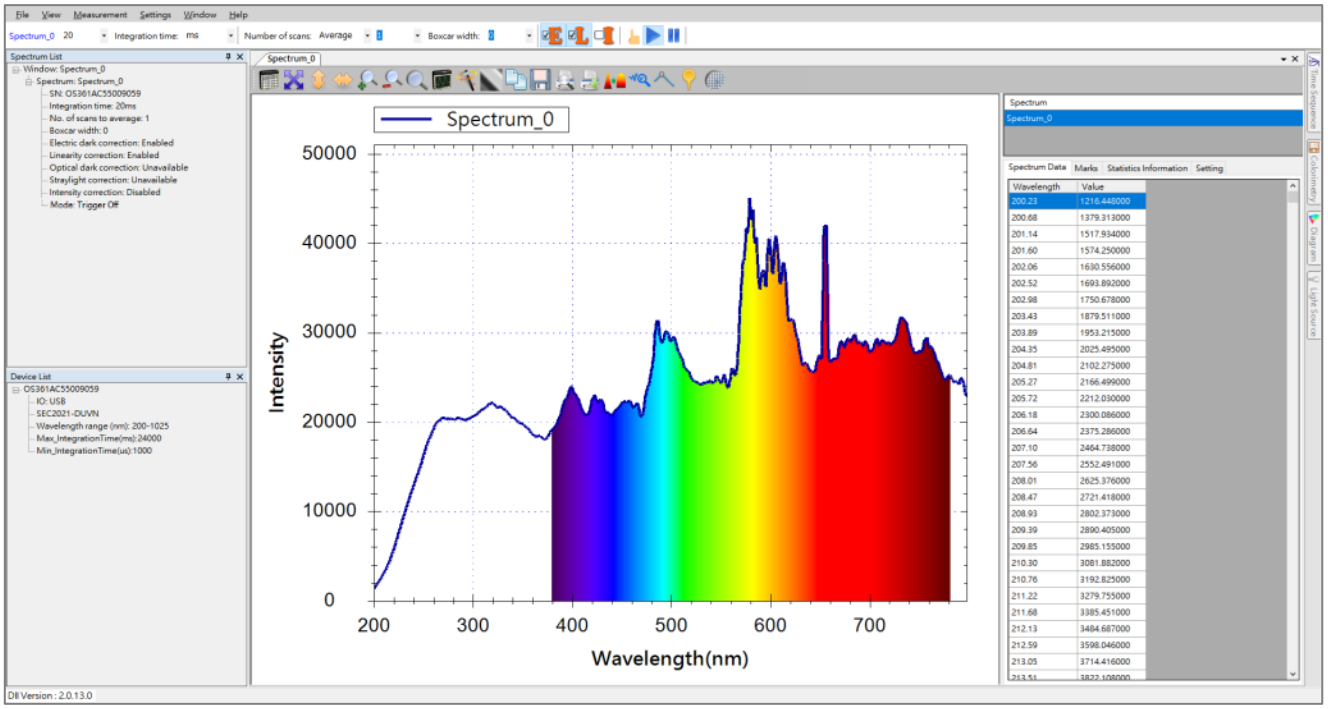


Figure 6-20: The effect of pressing **Zoom In**

Zoom Out

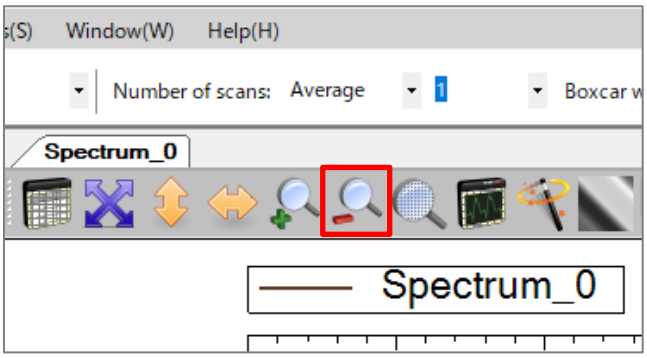


Figure 6-21: The **Zoom Out** button

This button shrinks the graph (pushing it away from you). Here we first zoom in on the graph three times, and then press **Zoom Out** twice to demonstrate its effect. See the following figure:

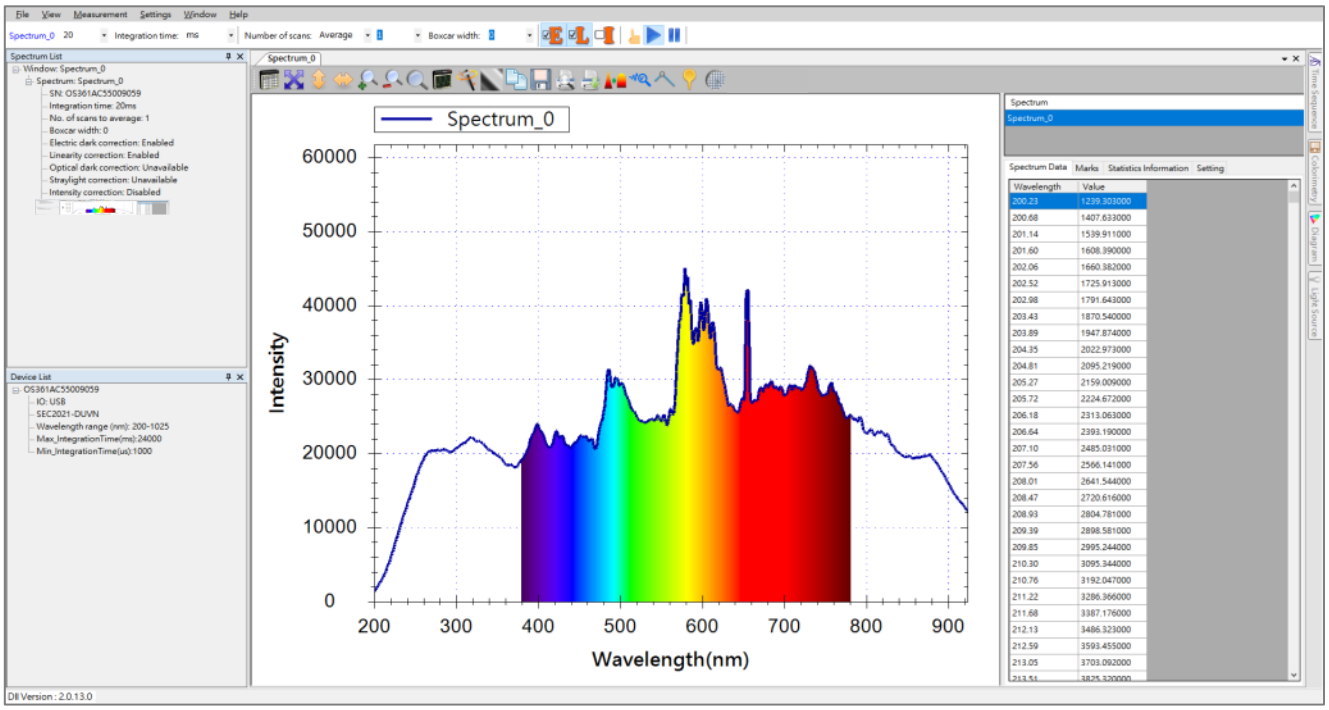


Figure 6-22: The effect of pressing **Zoom Out**

Note: Keep pressing the "Zoom Out" button will bring the graph back to its default settings, and the graph will not shrink any further.

Revert Graph Settings to Application Defaults

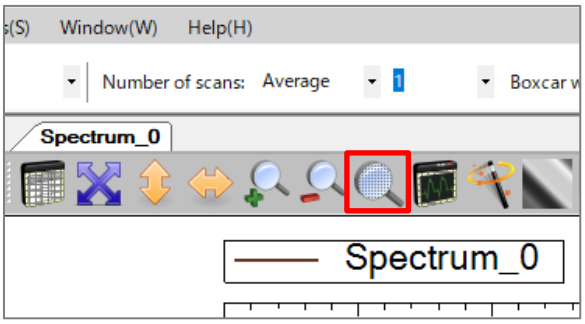


Figure 6-23: The **Revert graph settings to application defaults** button

This button restores the graph display settings to application defaults (i.e. the original settings when the graph is created). To demonstrate, we press this button to restore the graph in the former example to its default settings. See the following figure:

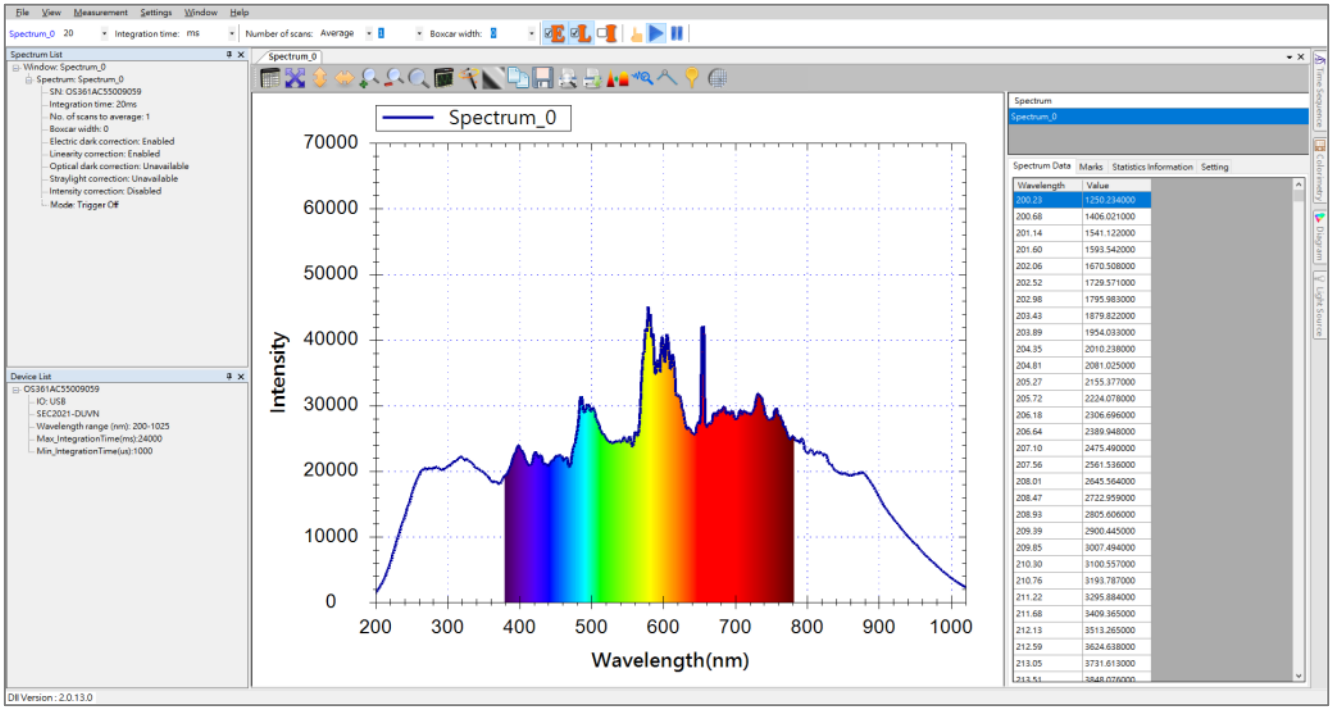


Figure 6-24: The effect of reverting graph settings to application defaults

Graph Settings

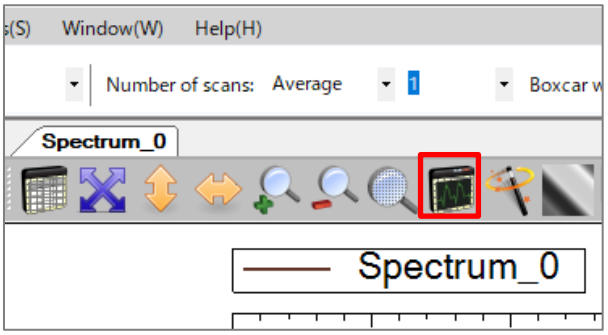


Figure 6-25: The **Graph Settings** button

This button opens the setting details of X- and Y-axes, as shown in the following:

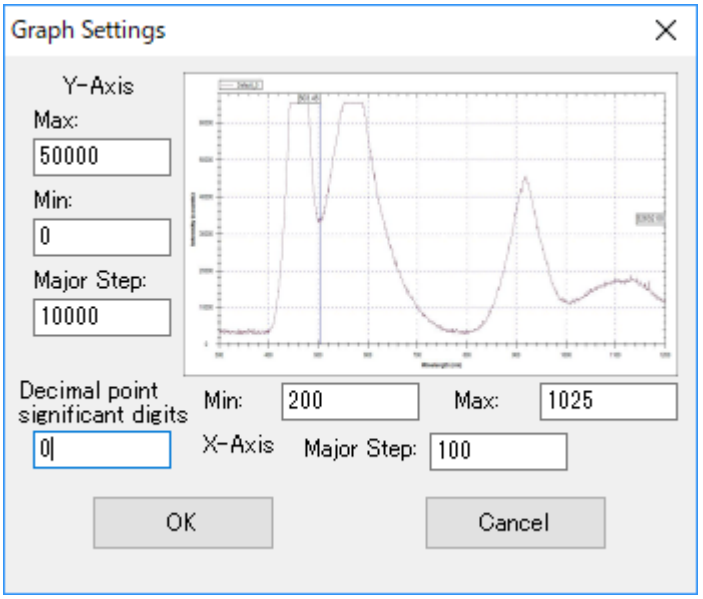


Figure 6-26: The **Graph Settings** window

The Graph Settings window allows the user to customize the minimum and maximum values for X- and Y-axes, as well as the size of a major step. Here we configure the X-axis (wavelength) range to fall within 200 to 1025 (nm), with a major step of 100. Then, we configure the Y-axis (signal intensity) range as 0 to 50000, with a major step of 5000. See the following figure for the result:

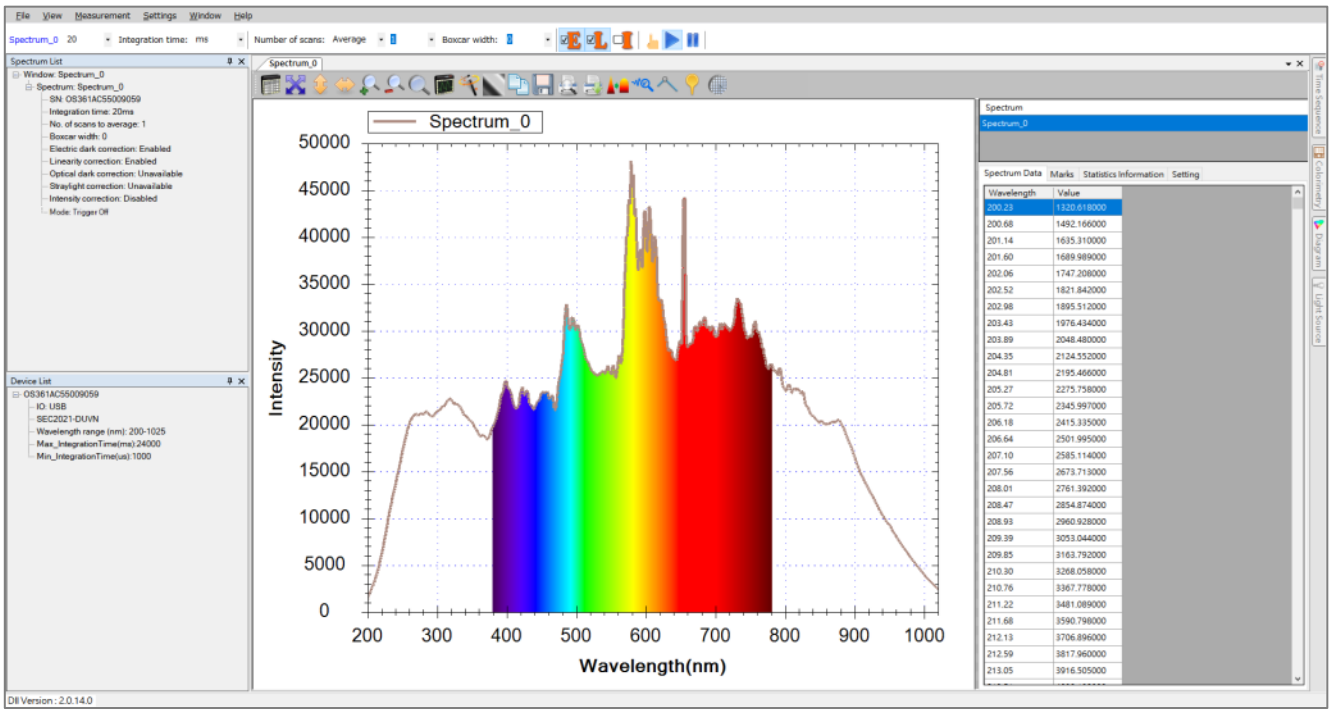


Figure 6-27: Using custom X-, Y-axes

Other Easy Access Buttons

The following sections describe the other easy access buttons on the toolbar.

Checking Spectrum Values

The spectrum curve gives you a quick glimpse of the characteristics of the light being measured. In addition, you can check the actual value of a specific wavelength by placing the mouse cursor over a point on the curve. As shown in the figure below, when you move the mouse cursor to the bright line derived from D2, the actual wavelength (655.91) is displayed at the top of the graph and the data value (42109.15) is displayed on the right side of the graph.

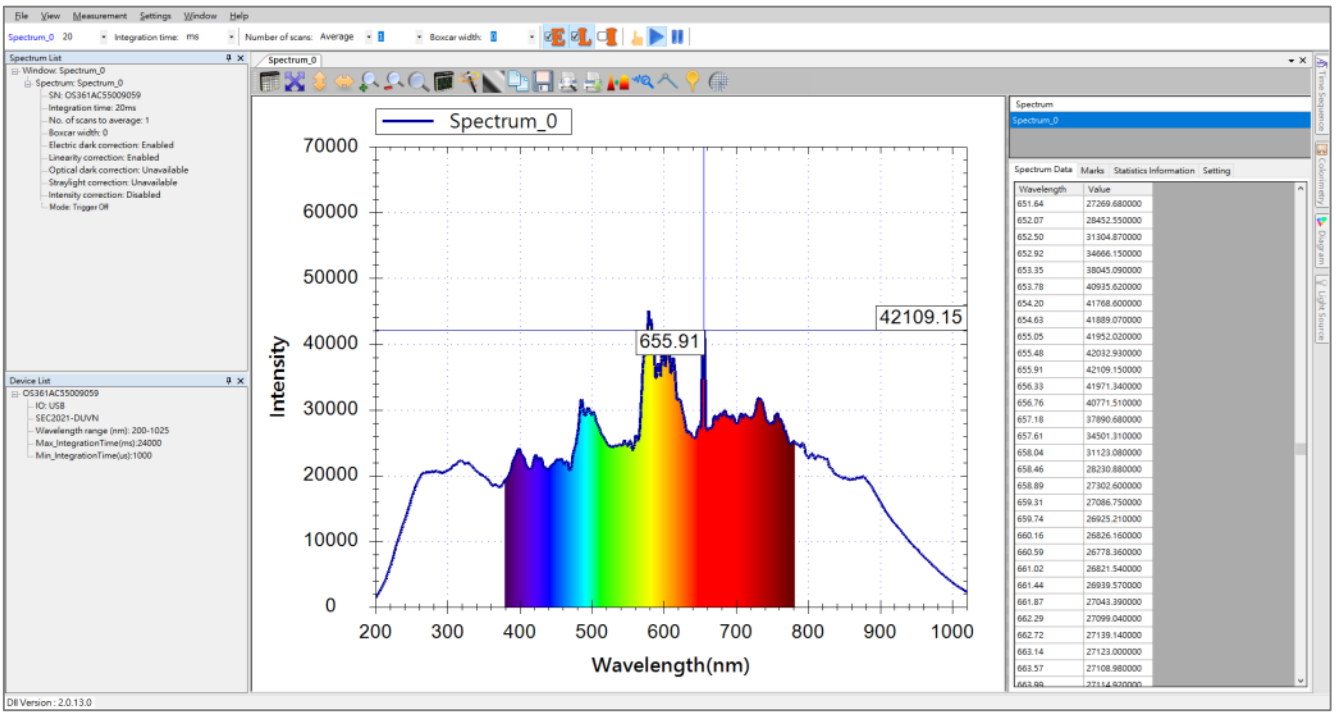


Figure 6-28: Checking the value of a specific wavelength with the mouse

Although the mouse cursor offers a handy way to check specific values, it does not let you see all the data at a glance. SpectraSmart provides a tabular spectrum data pane to the right of the spectrum graph to let you see all captured data in details, as in the previous figure. The upper half of the pane consists of a list of the underlying spectrum curves of this measurement ("Spectrum_0" is the only spectrum curve for this case). The lower half of the pane consists of two tabs. The first tab is the **Spectrum Data** tab that we want. It shows a scrollable table, which allows you to view the desired wavelength range by using the scrollbar on its right.

Closing Spectrum Data Pane

If you don't want to see this spectrum data pane, just click on the **Show spectrum data** button on the toolbar. This button allows you to turn this pane on or off:

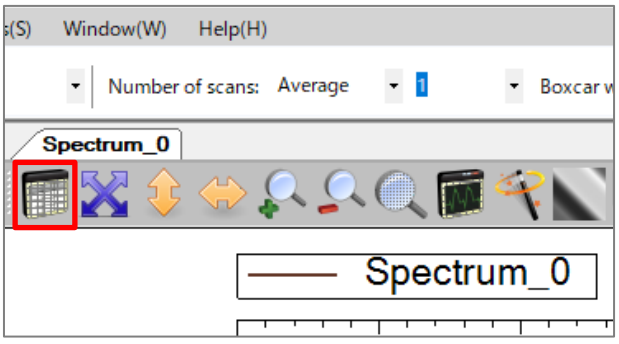


Figure 6-29: The **Show spectrum data** button

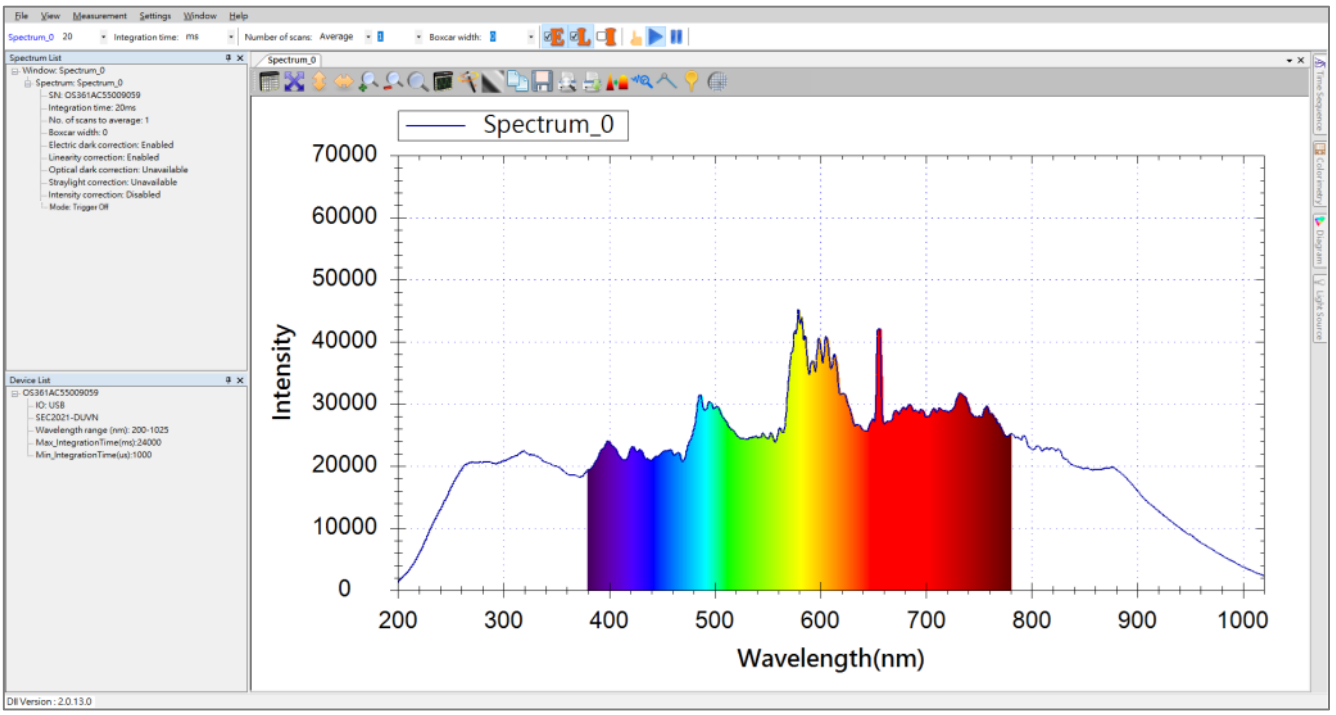


Figure 6-30: How it looks when the **Spectrum Data** Pane is closed

Placing Marks on the Graph

Placing Marks with the Mouse

Although it is very handy to use the mouse cursor to check values of specific wavelengths, you may want to keep the values displayed on the graph so you can observe their variations over time or capture screenshots. SpectraSmart provides a toolbar button to let you place marks on the graph for this purpose:

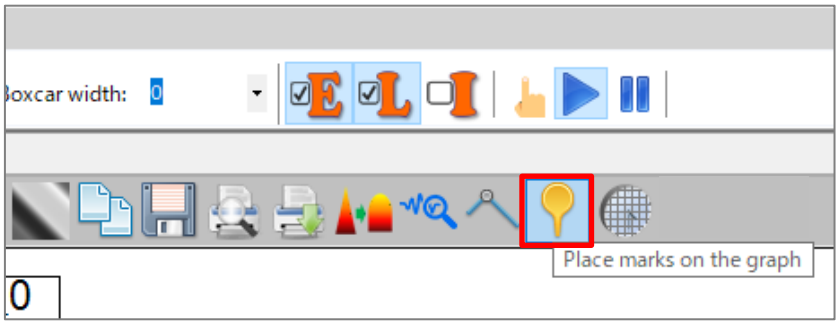


Figure 6-31: The **Place marks on the graph** button

When you press the **Place marks on the graph** button and double click the left button of the mouse at the position where you want to mark, the data value on the graph is fixed and displayed. See the following figure:

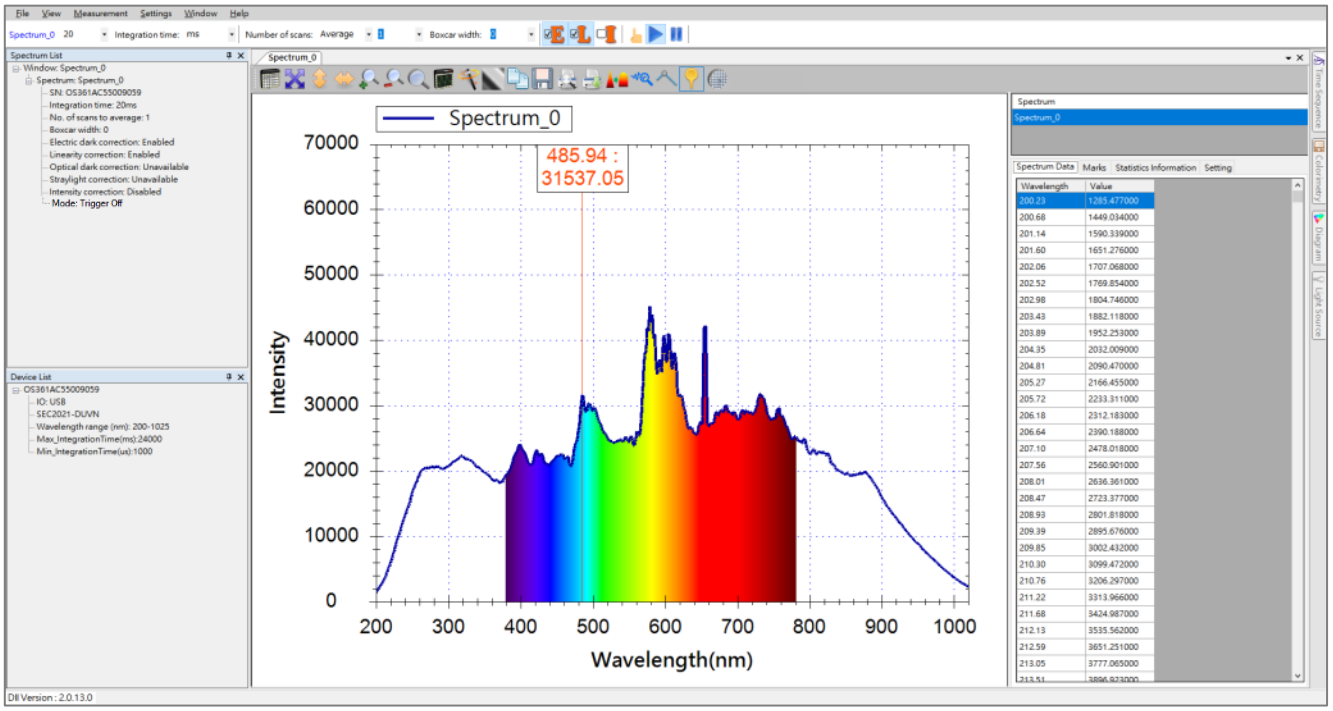


Figure 6-32: The effect of placing marks on the graph

In the example, a mark is placed at a wavelength of 485.94 nm (red vertical line), and its data value is 31537.05.

Note: When you place a mark with the mouse, the program automatically finds the peak value on the curve near the location you click and places the mark there. As such, it is better to click on the curve at the wavelength position where you want to observe, rather than clicking on the empty space on the graph. Otherwise, the mark may go to where the peak value appears, instead of the X position you click.

Placing Marks with the Spectrum Data Pane

In addition to using the mouse, you can also use the spectrum data pane to put marks on the graph, with the benefit of better accuracy in selecting the exact wavelengths you want. First, press the **Show spectrum data** button on the toolbar if you have closed the spectrum data pane:

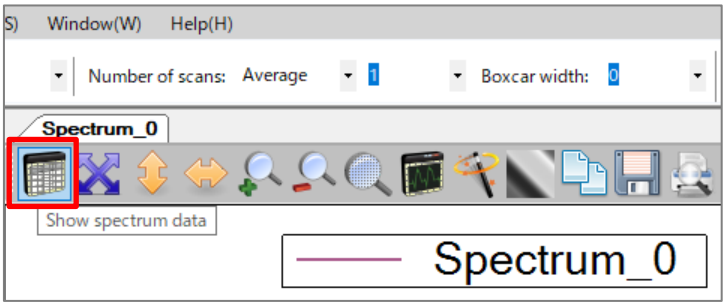


Figure 6-33: The **Show spectrum data** button

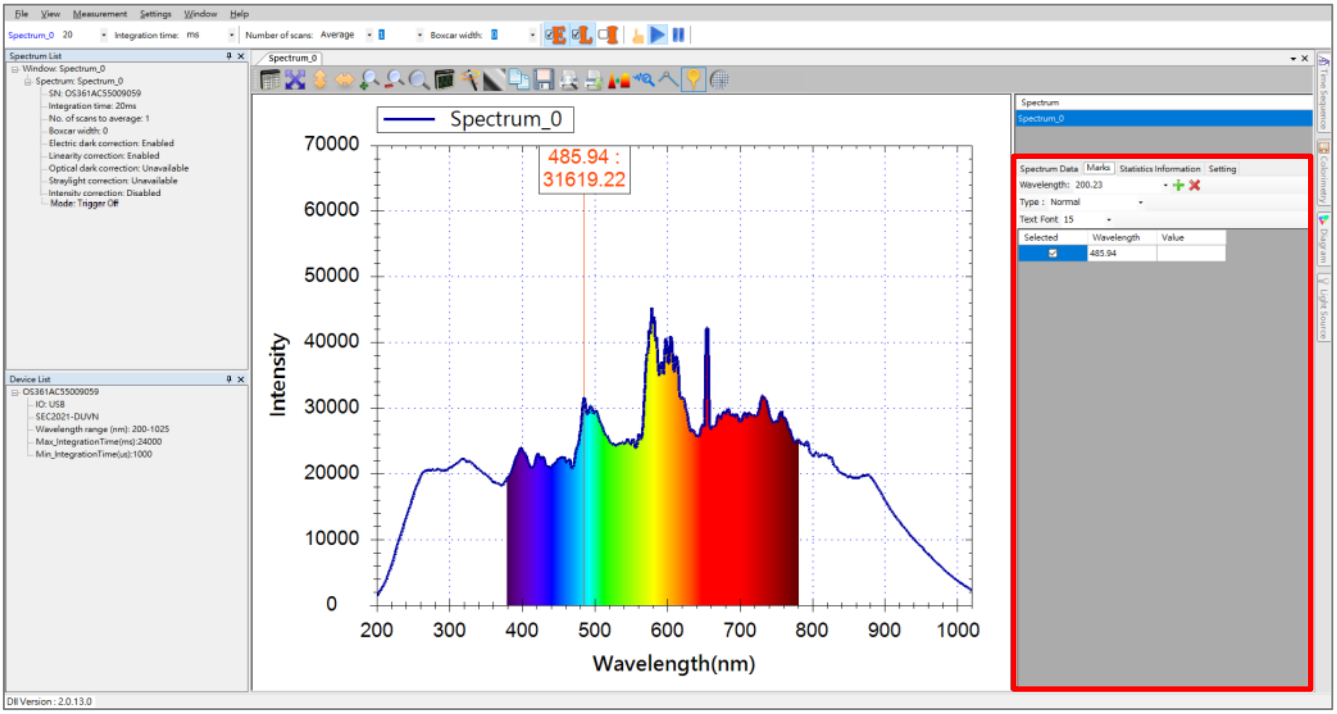


Figure 6-34: The **Marks** tab of the spectrum data pane

The upper half of the spectrum data pane consists of a list of the underlying spectrum curves of this measurement ("Spectrum_0" is the only spectrum curve for this case). The lower half of the pane consists of two tabs. The first tab is **Spectrum Data**. The second tab is the **Marks** tab that we want.

In the **Marks** tab, we can see the mark we created earlier is already in the list. Now, let's add another mark using this tab. Please enter or select a wavelength (nm) in the **Wavelength** field, and then select the mark type you want in the **Type** field. The available mark types include **Normal**, **Peak_Intensity**, **Peak_Lamda**, and **Peak_FWHM**.

The available four mark types are explained in the following:

Normal:	Shows the intensity of the marked position
Peak_Intensity:	Shows the intensity of the nearest peak
Peak_Lamda:	Shows the wavelength of the nearest peak
Peak_FWHM:	Shows the full width at half maximum of the nearest peak

After specifying **Wavelength** and **Type**, click on the green '+' sign (i.e. the **Add** button). A new mark will appear at the specified wavelength position. See the following figure:

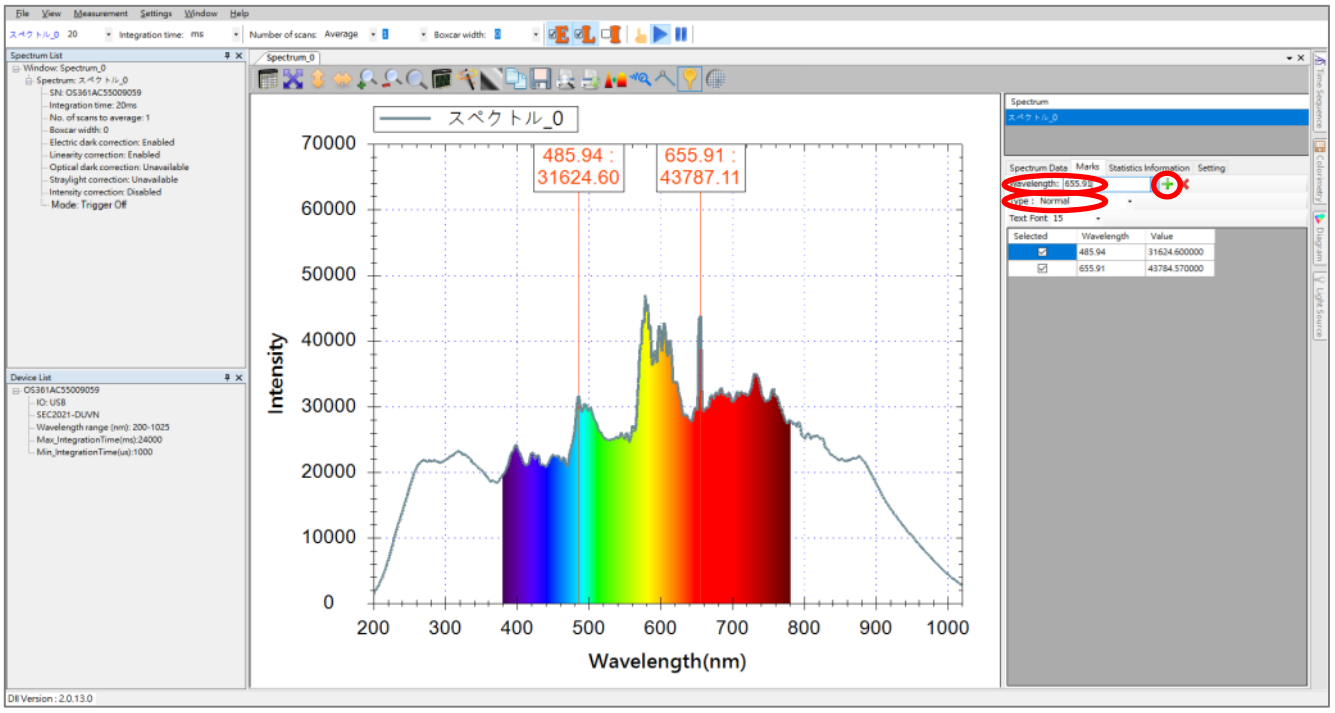


Figure 6-35: Adding a mark on the **Marks** tab.

Note: The makeable positions of SpectraSmart are located at specific intervals. As a result, the program automatically places the mark at the position closest to the specified wavelength position.

Deleting Marks

If you want to delete a mark, you can select the mark you want to delete on the **Marks** tab (multiple choices can be selected at a time), and then click on the red 'X' sign (i.e. the **Delete** button) to delete it. See the following figure:

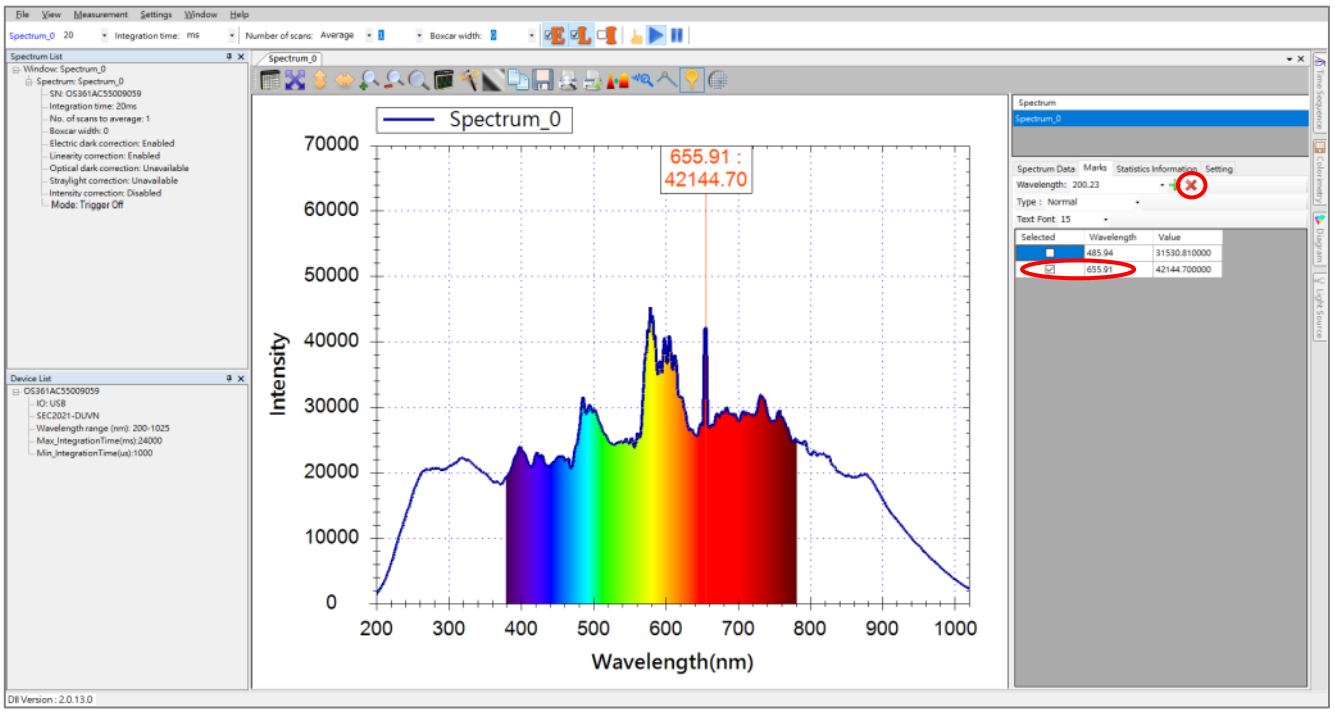


Figure 6-36: Click the **Delete** button after selection.

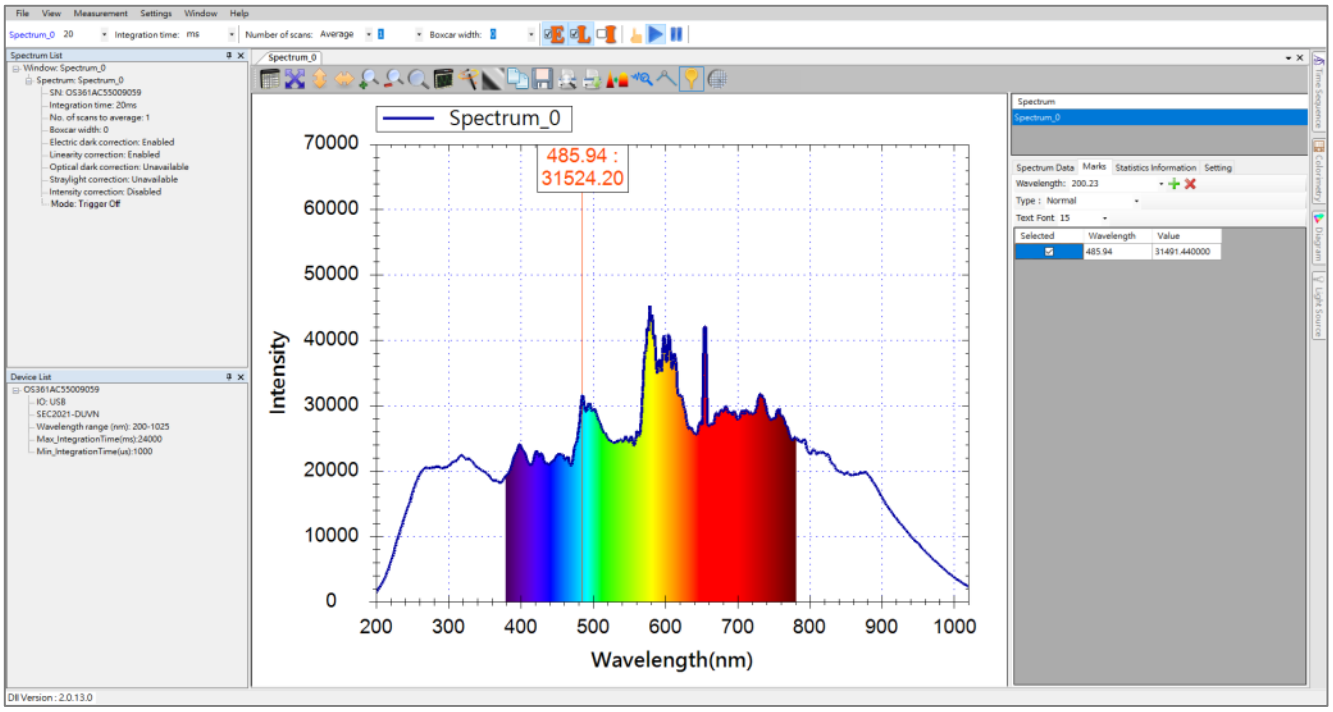


Figure 6-37: The effect of deleting a mark.

Switching back to Spectrum Data Tab

After adding or deleting marks on the **Marks** pane, you can click on the **Spectrum Data** tab to switch back to spectrum data pane.

Turning Off Marks Temporarily

If you want to turn of the marks temporarily without deleting the marks, you can press the **Place marks on the graph** button once again to turn off marks. The marks you placed before will still exist when they are turned off. You can simply press **Place marks on the graph** button again to see them.

Statistical information

Change the wavelength range to get the information

Statistic Information gives you very clear characteristic of the spectrum under test, for example: Average, Min, Max & Centroid, and if you want to check the exact data for a particular wavelength range, by changing the calculated wavelength range, you can read the information data in the table depends on your selection. In the red frame in the figure below, we can read in the table: current Average, Min, Max and Centroid.

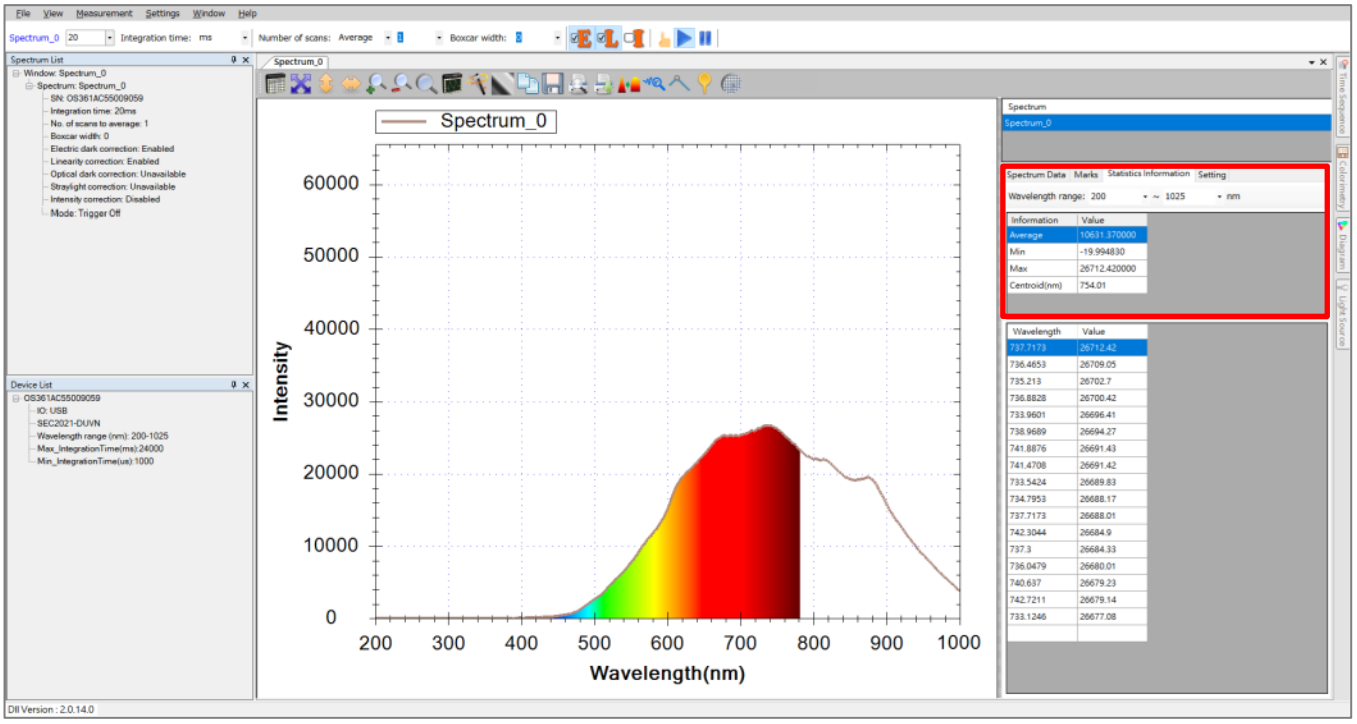


Figure 6-38: Statistics Information shows the information after changing the wavelength range

Smoothing

A raw spectrum curve tends to be jagged and spiky, due to the inevitable noises in the original signal. SpectraSmart provides a feature to eliminate such noises and smooth out the curve. This is a button called **Smoothing** on the graph toolbar. See the following figure:

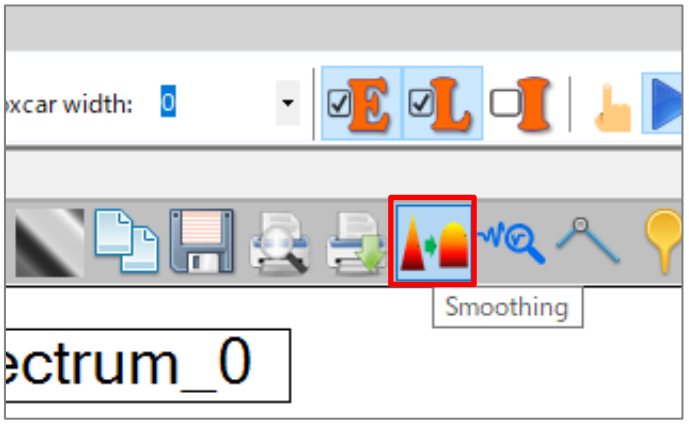


Figure 6-39: The **Smoothing** button

Pressing this button opens the **Smoothing Settings** window:

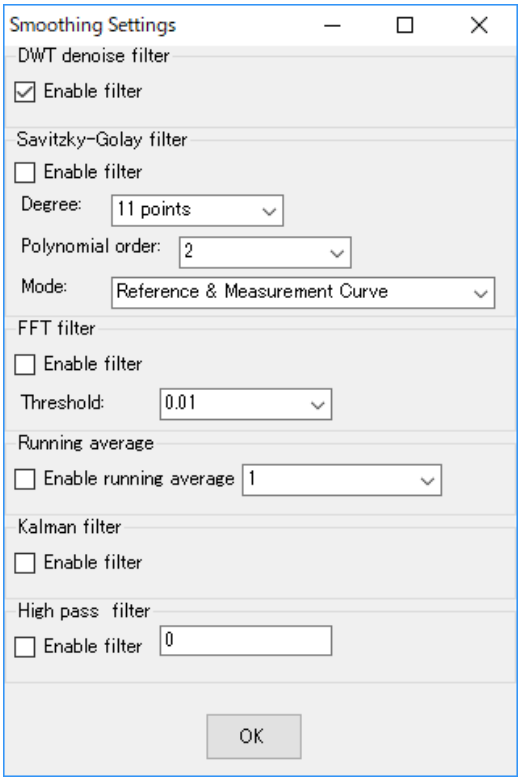


Figure 6-40: The **Smoothing Settings** window

On the **Smoothing Settings** window, several options can be selected: **DWT noise filter**, **Savitzky-Golay filter**, **FFT filter, running average, Kalman filter**, and **High pass filter**. You can enable one or all of them.

Note: Most examples in this chapter have turned on the Savitzky-Golay filter with its default settings, i.e. "11 points" and "Reference & Measurement Curve." If all filters are disabled, the spectrum curve should look like the following:

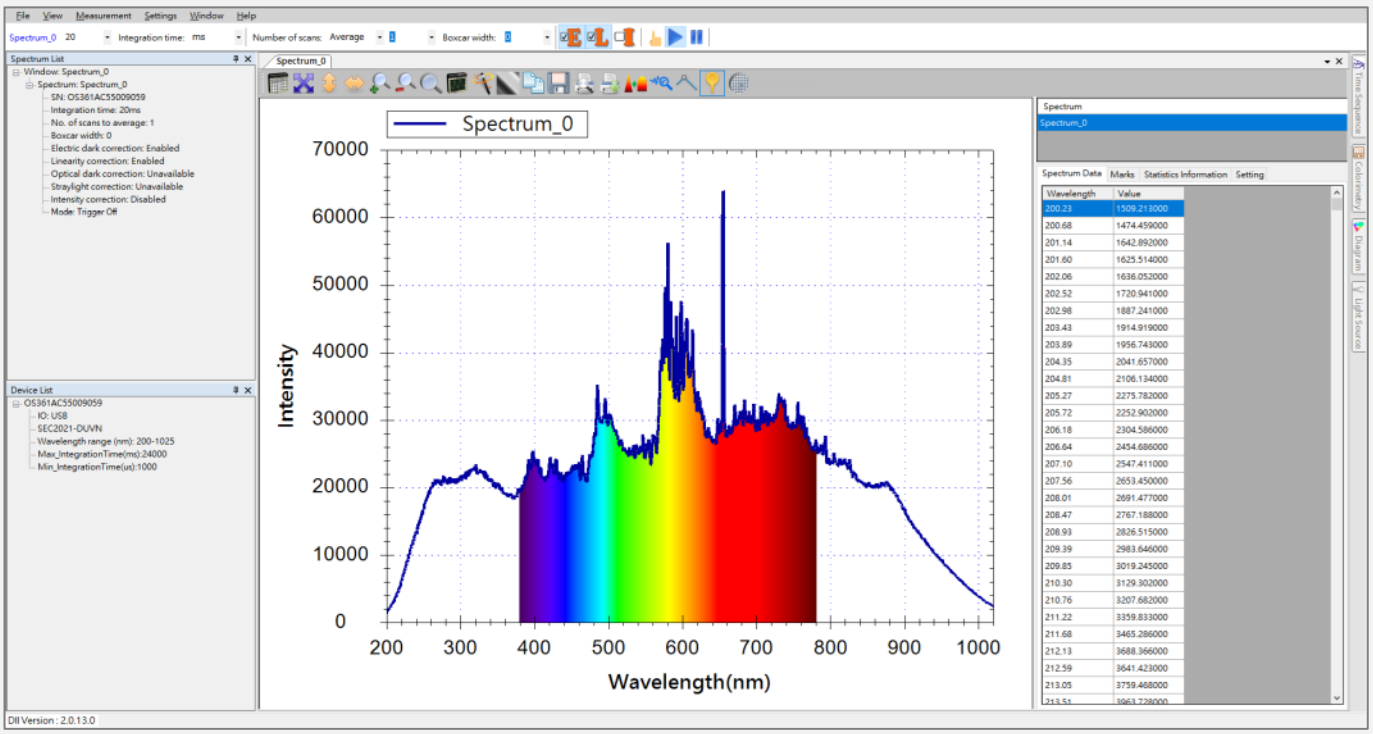


Figure 6-41: The result of disabling "Smoothing"

With smoothing disabled, the spectrum curve looks jagged.

Showing Peak Values

Sometimes you need to know the peak values on the curve when you are viewing a measurement graph. SpectraSmart provides a feature to automatically identify the peaks and show their values on the graph. Here is the button to show the peak values:

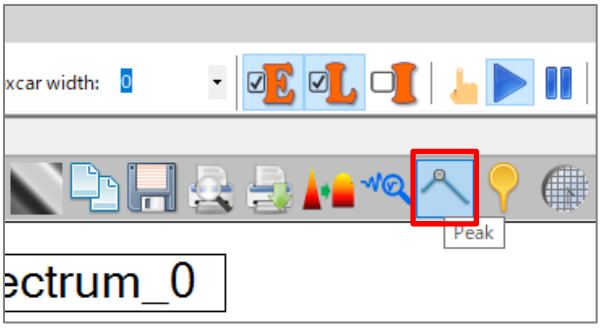


Figure 6-42: **Peak** button

When pressed, the **Peak** button opens the **Peak Information** window:

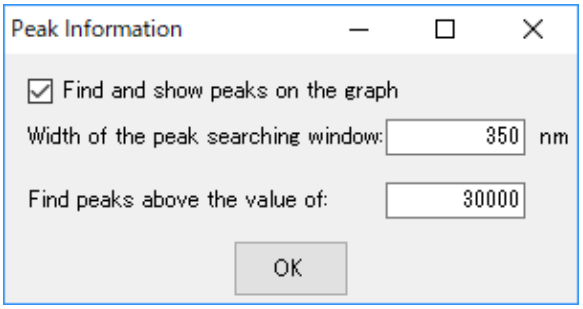


Figure 6-43: The **Peak Information** window

Select **Find and show peaks on the graph** and set the **Width of the peak searching window** as well as a minimum value for the peak. Search for all wavelength regions with the set peak value search width and search the maximum value each time. If you increase the width of the search peak, the number of peaks to be searched will decrease. For the minimum value of the peak to be searched, set the lower limit of the peak to be searched. In this example, set the width to 350 nm and the minimum value of the peak to 30000. Click **OK**, and you will see the following result:

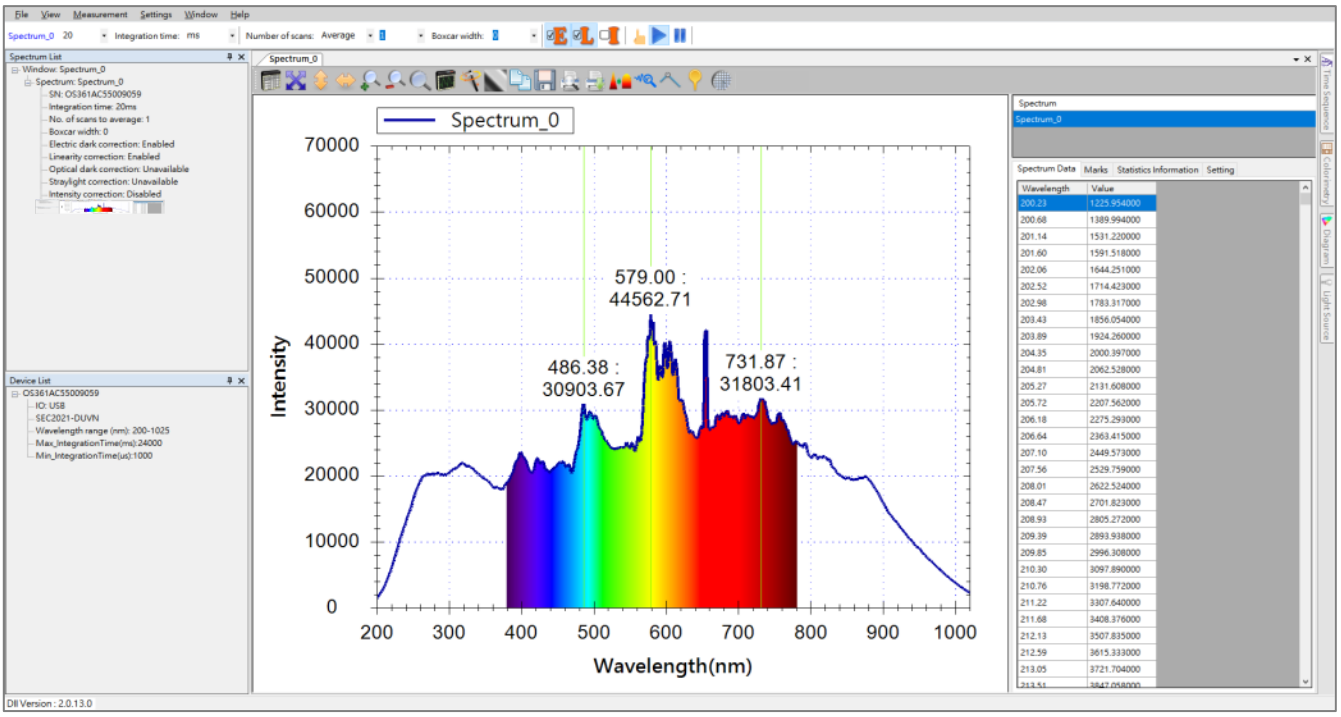


Figure 6-44: The result of enabling **Peak Information**

As shown in the above figure, SpectraSmart searches for peak values around wavelengths 486, 579, 731 nm and displays data. The number before the colon (:) indicates the wavelength of the peak, and the number after the colon (:) indicates the intensity of the peak value. This intensity is the output value of the sensor, in particular there is no unit.

Since the minimum value of the peak to be searched is set to 30000, other peak values are not detected. If you lower the baseline of the peak to be searched to 20000, four peaks are detected as shown in the figure below.

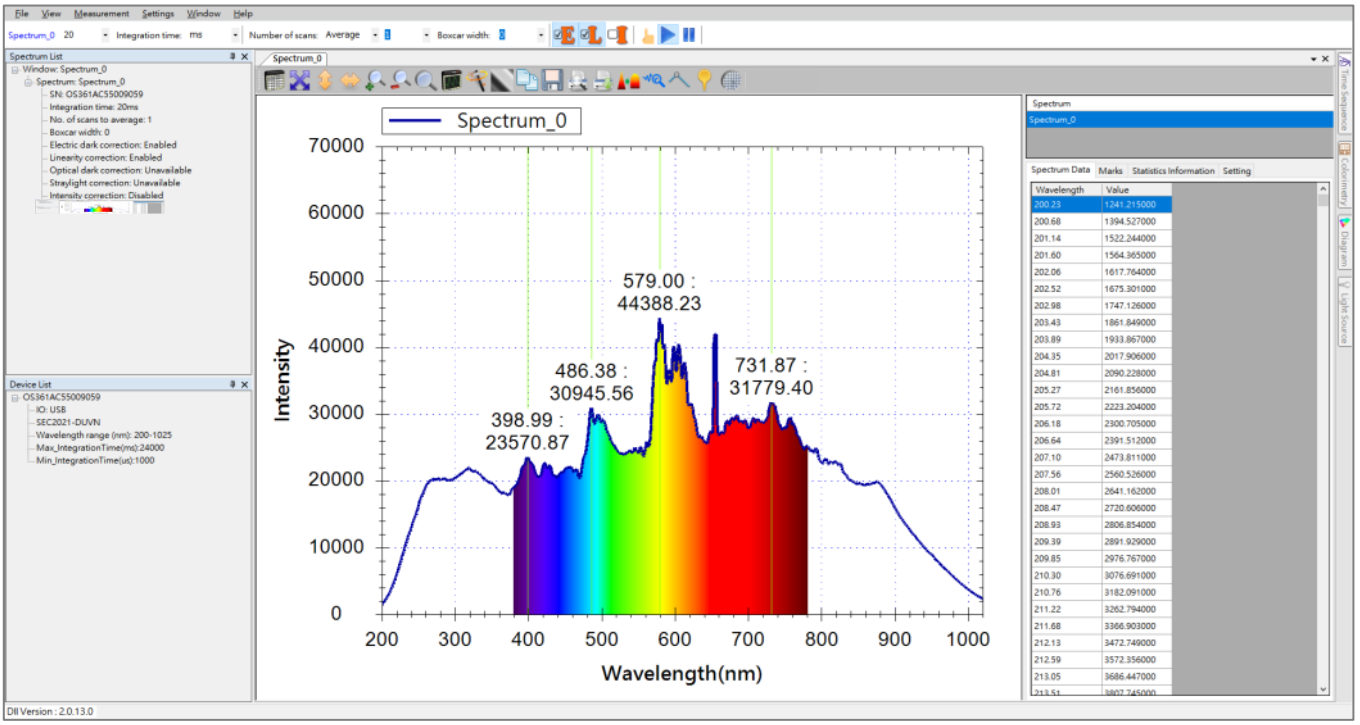


Figure 6-45: The result of lowering the minimum peak value (i.e. **Find peaks above the value of**) to 2000

Saving the Current Spectrum Measurement

Saving Individual Spectrum Curves from the Toolbar

If you want to save the current spectrum measurement to a file for future reference, you can use the **Save selected spectrum as** button on the toolbar. See the following figure:

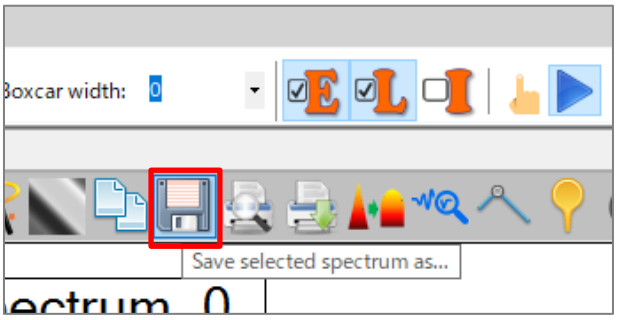


Figure 6-46: The **Save selected spectrum as** button

Pressing this button shows the **Select Spectrum** window for you to choose the spectrum curve that you want to save:

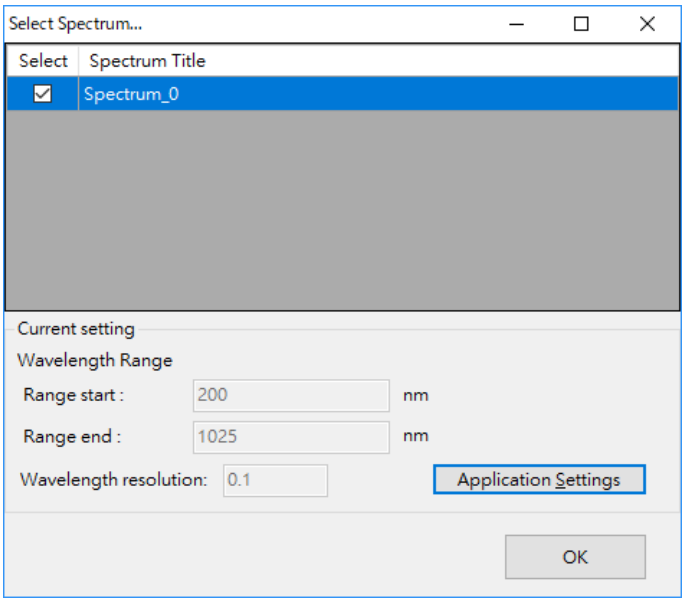


Figure 6-47: The **Select Spectrum** window

If there are multiple spectral curves in the same window, save the spectrum individually. Please select the spectrum you want to save and click **OK**. The **Save As** window appears, which allows you to specify the destination folder and the filename (with ".sps" as the default extension name). See the following figure:

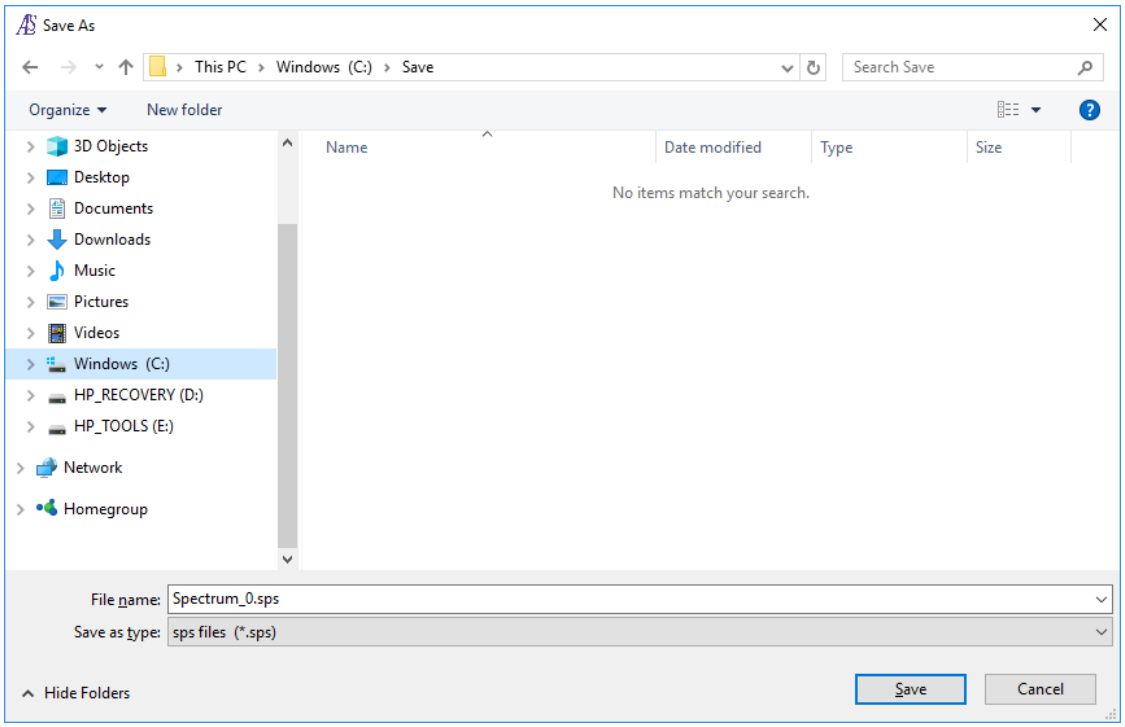


Figure 6-48: The **Save As** window

After specifying the desired folder and filename , click **Save**. Spectrum file is saved. The default for saving uses Spectrasmart's proprietary file format (.sps). You can also save in

CSV or TXT format. To save in CSV format or TXT format, in the **Save as type** of the **Save as** screen, choose [csv file (*. Csv)] or [[text file (*. Txt)].

Note: CSV or TXT format can only be used for other software. SpectraSmart can not read spectrum curves in CSV or TXT format.

Saving Individual Spectrum Curves from the Spectrum Data Pane

In addition to saving spectrum curves from the **Save selected spectrum as** toolbar button, you can also save individual spectrum curves from the spectrum data pane. The upper half of the pane consists of a list of the underlying spectrum curves of this measurement. Click on the spectrum curve that you want to save, and then right-click in the list to open the pop-up menu. Next, select **Save selected spectrum as**. See the following figure:

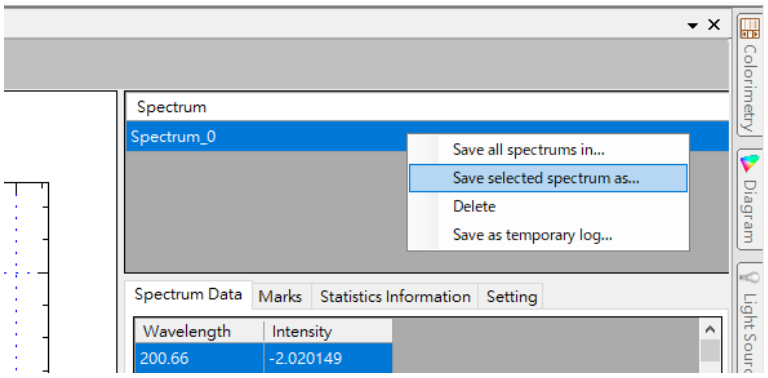


Figure 6-49: Selecting **Save selected spectrum as** on the pop-up menu

Next, the **Save As** window will appear. As in the previous section, please specify the destination folder and the filename, and then press **Save** to save the spectrum as a file.

Saving All Spectrum Curves in the Current Window

SpectraSmart allows you to display a new spectrum curve in an existing window when you create the spectrum measurement so that you can do comparisons. Accordingly, if you have two or more spectrum curves in a window, you might want to save them all at once, instead of saving them individually. First, press the **Show spectrum data** button on the toolbar (if you have closed the spectrum data pane). Right-click in the **Spectrum** list of the upper half of the spectrum data pane to open the pop-up window, and then select **Save all spectrums in**. See the following figure:

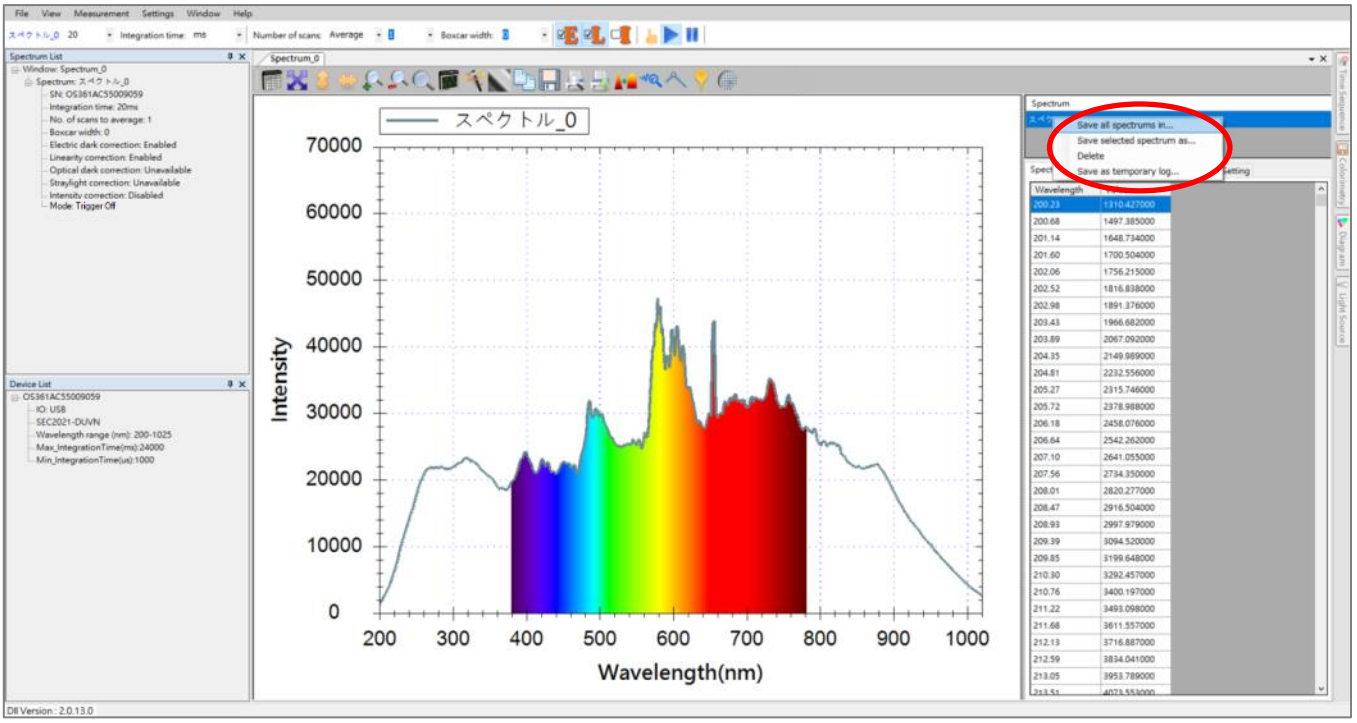


Figure 6-50: Selecting **Save all spectrums in** on the pop-up menu

Next, you will see the **Browse For Folder** window, which allows you select the destination folder for the spectrums to be saved:

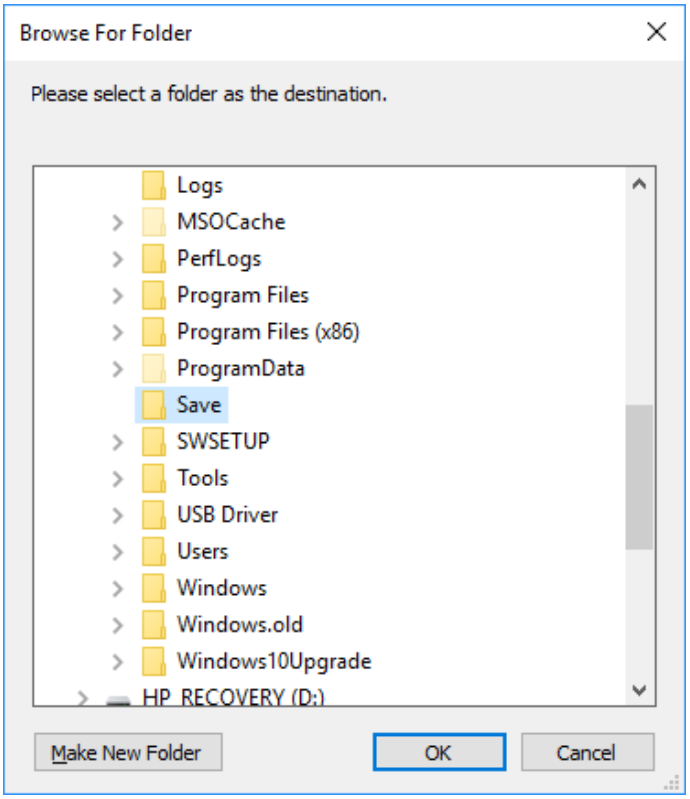


Figure 6-51: The **Browse For Folder** window

When all selections are done, click **OK**. Then, you will see that all spectrums in the current measurement are saved as individual files in the specified folder. The filenames will be their spectrum titles, and the file extensions will always be ".sps" (in our example here, the saved file is "**Specturm_0.sps**").

Saving the Current Spectrum Curve as a Temporary Log

In addition to saving spectrum curves as files, SpectraSmart allows you to save the current spectrum curve as a temporary log. It is like a snapshot of the current state, and it is kept in the same measurement graph for your reference. For example, we can create a spectrum graph to measure the spectrum of a certain light source. Then, under the same conditions, we switch in another light source to observe the differences between the two light sources. To demonstrate, here we create a spectrum graph to measure the spectrum of a white LED light source. We save its spectrum curve as a temporary log. Then, we switch in another light source, also a white LED, to compare their difference. Here is the spectrum of the first white LED:

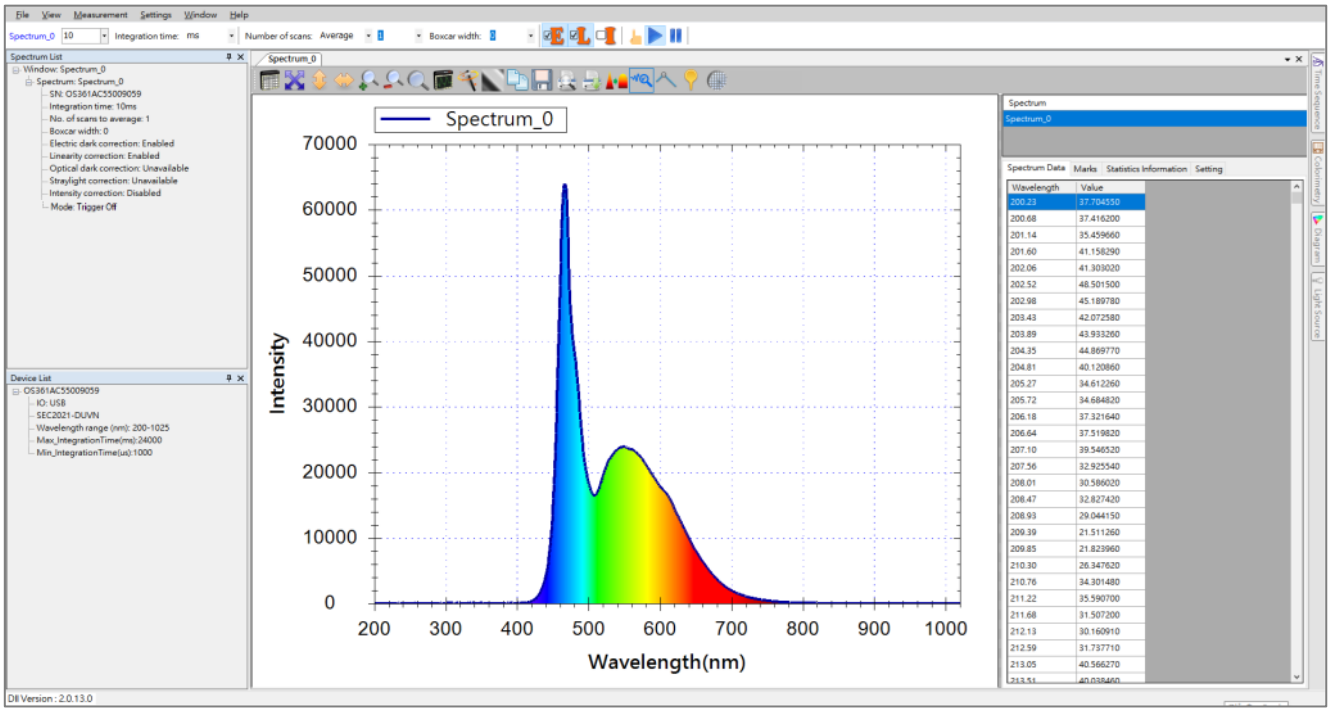


Figure 6-52: The spectrum of the first white LED

Next, right-click on the **Spectrum** list in the spectrum data pane to bring up the pop-up menu, and then select **Save as temporary log**. See the following figure:

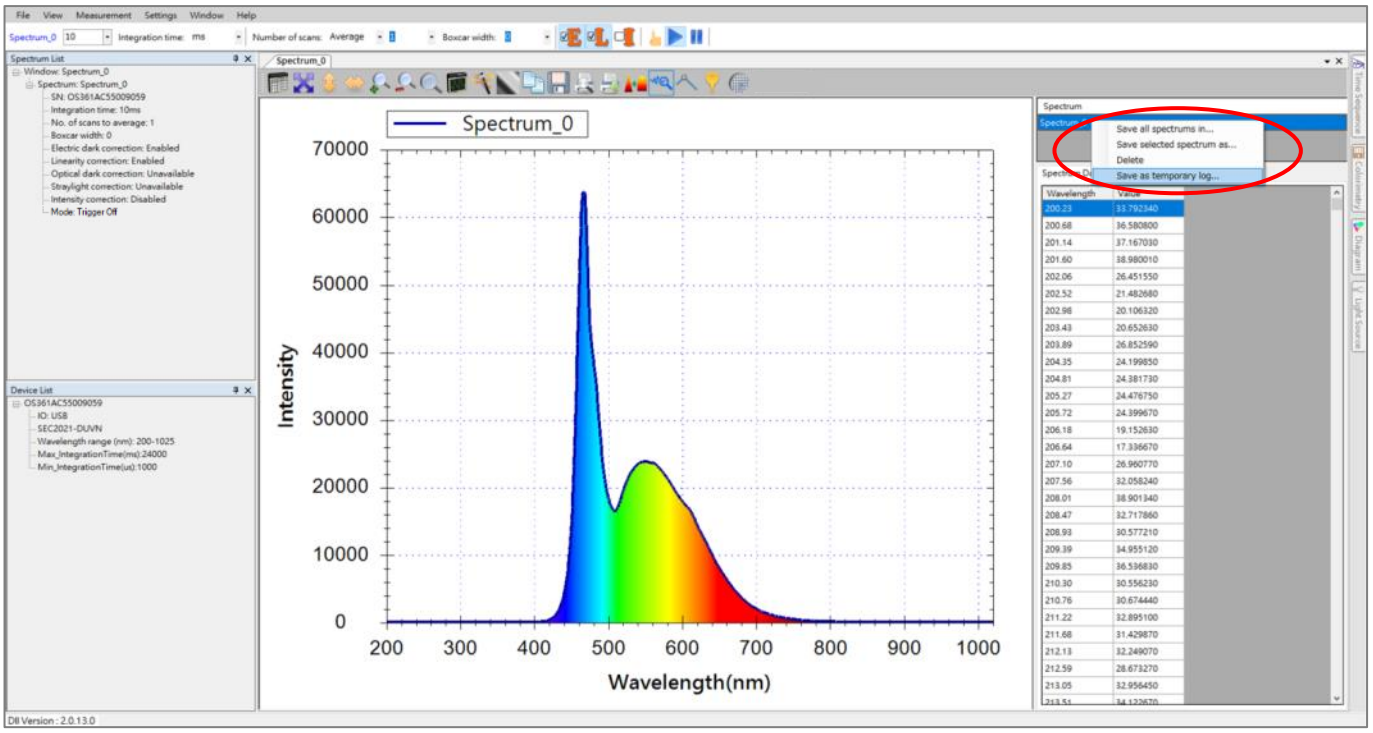


Figure 6-53: Selecting **Save as temporary log** on the pop-up menu

Next, you will see a **Please enter the temporary log spectrum name** message box, as in the following:

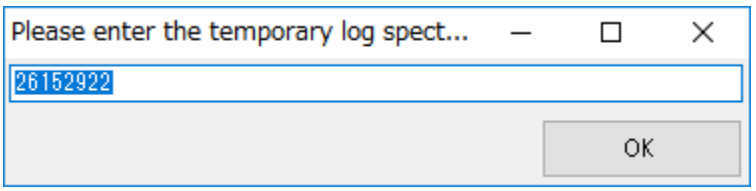


Figure 6-54: **Please enter the temporary log spectrum name** message box

You can specify a name for the temporary log spectrum or simply use the default number as the name. For example, change the default numeric number to **"LED 1"**. See the following figure:

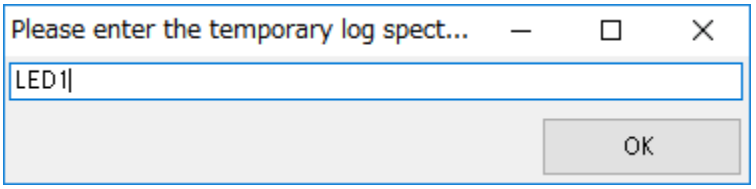


Figure 6-55: Renaming the temporary log spectrum as "**LED1**"

Press **OK**. A new spectrum curve will be created in the spectrum graph (i.e. the "**LED 1**"):

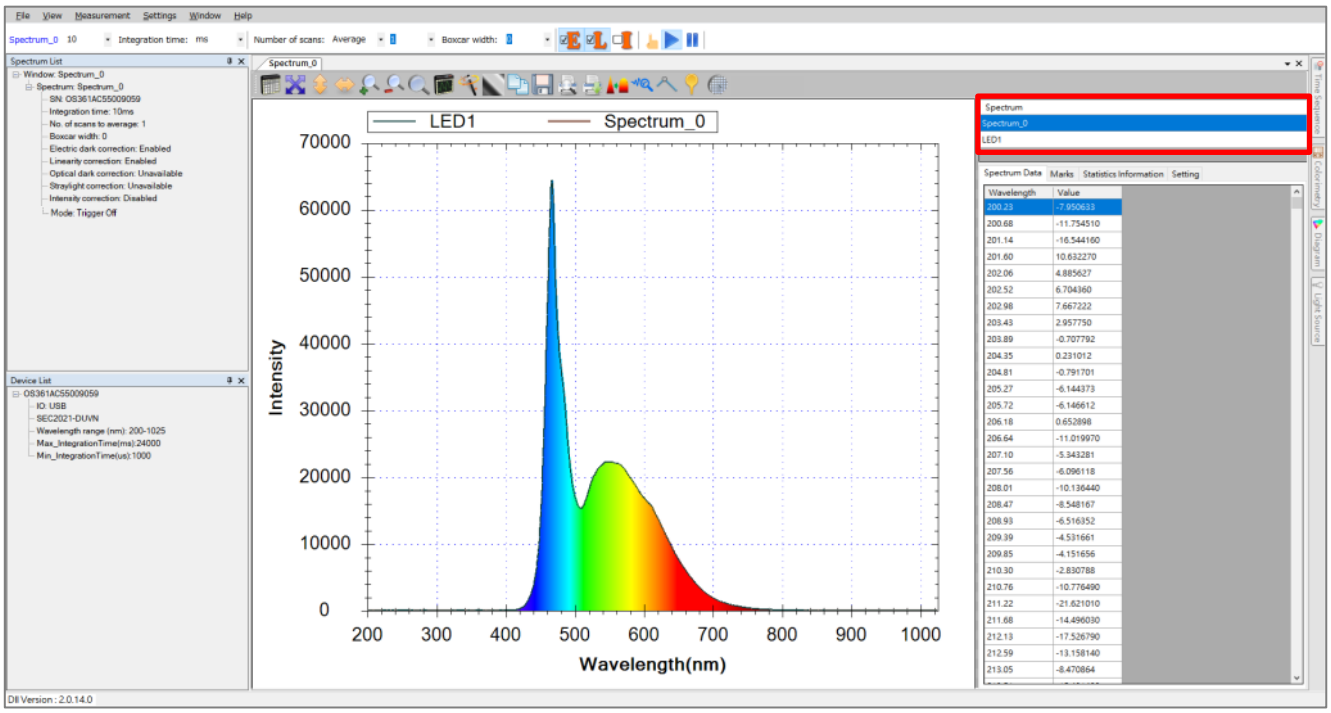


Figure 6-56: A new spectrum curve called " **LED1**" appears in the list

You will not see any changes on the graph because two spectrum curves now completely overlap. Next, for easier observation, go to **Settings, Application Settings,** and then **Graph** to turn off **Show human visible spectrum**. See the following figure:

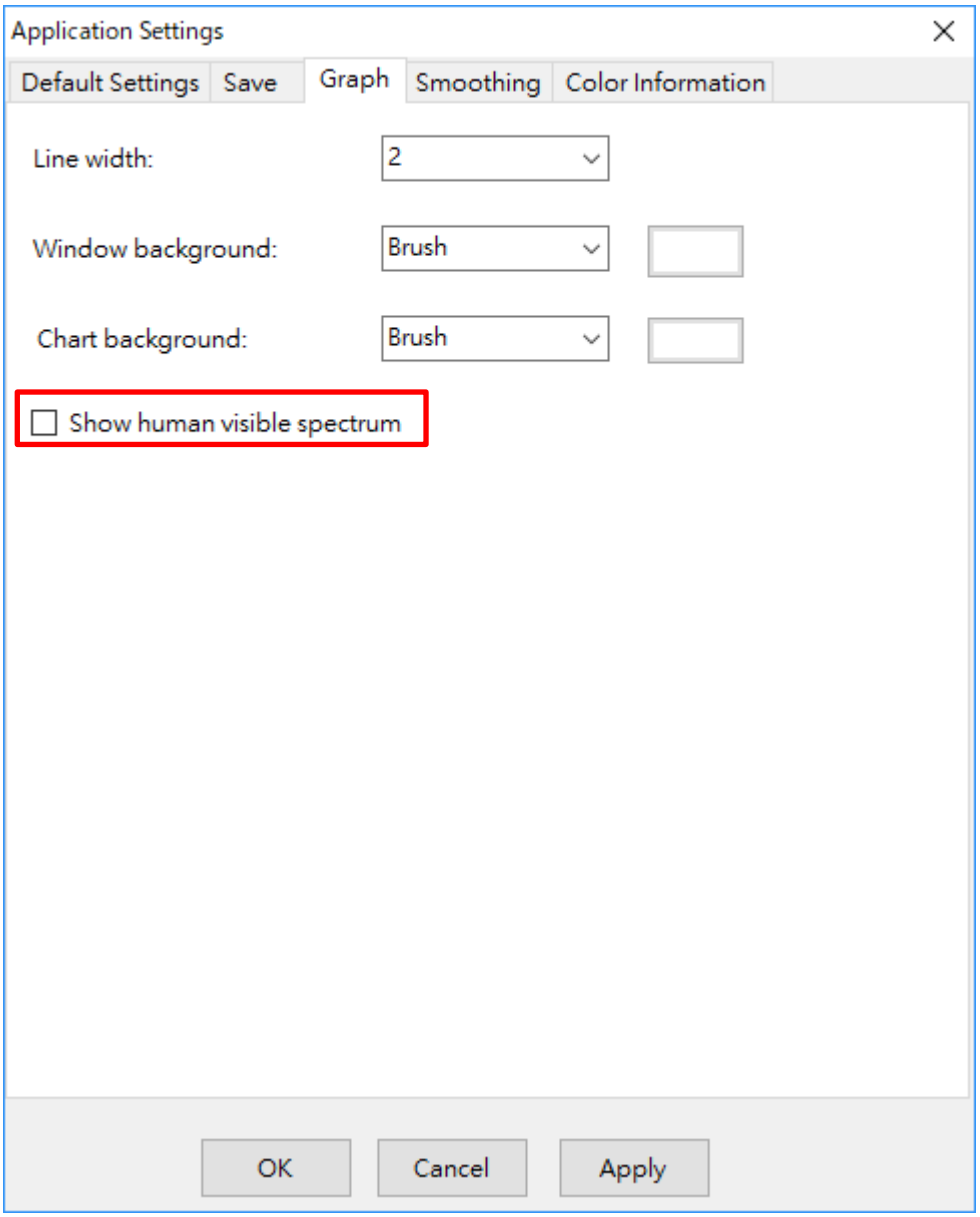


Figure 6-57: Turning off **Show human visible spectrum**

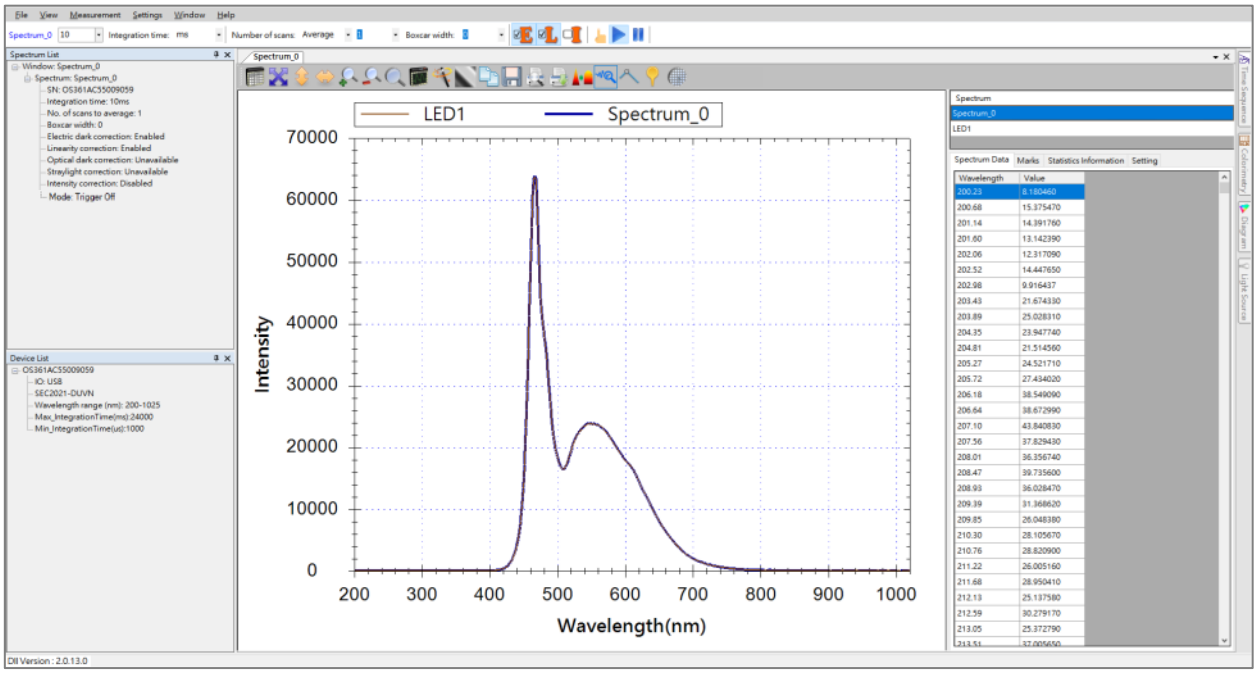


Figure 6-58: The effect of turning off **Show human visible spectrum**

Next, switch the light source to the second white LED, and the result looks like this:

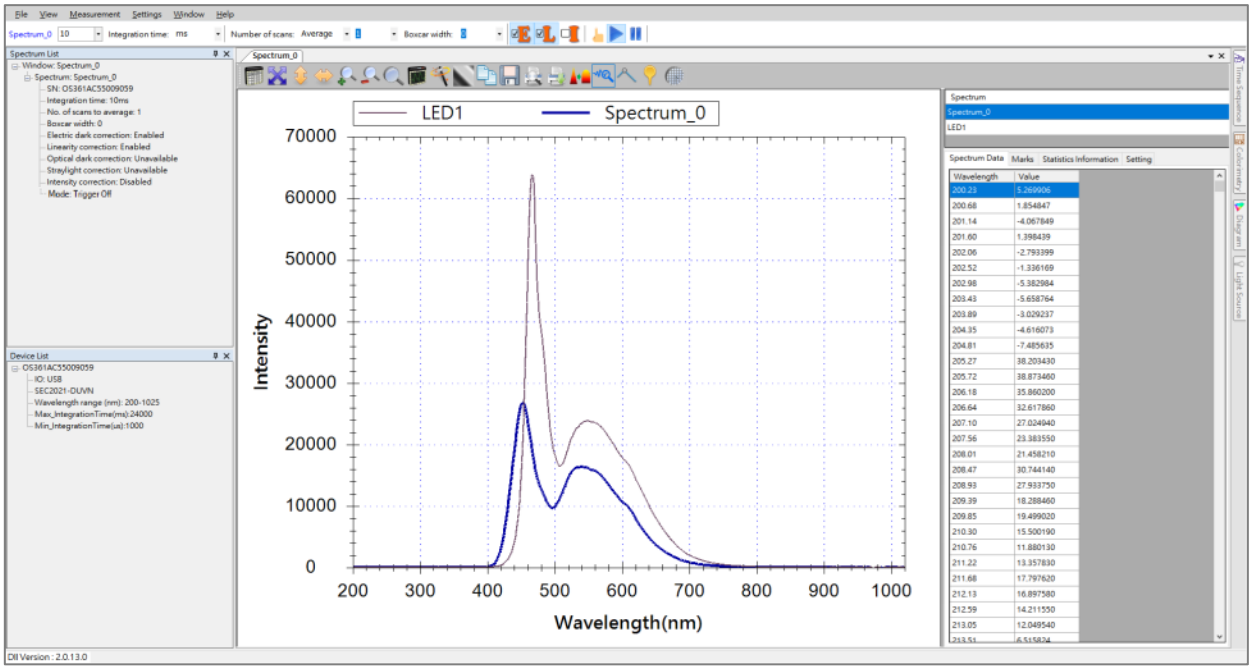


Figure 6-59: The result of switching the light source to the second white LED

As you can see in the figure, although both are white LEDs, two light sources may still be different in their spectrums. The thinner line on the graph is the temporary log we saved earlier (i.e. **LED 1**), while the bolder line is the current **Spectrum_0** (i.e. the spectrum

curve of the second LED). When you are done with the temporary log spectrum, you can delete it from the spectrum data pane. Refer to "Deleting Individual Spectrum Curves" for details.

Loading Saved Spectrum Curve

Load a previously saved spectrum curve to compare with the current spectrum curve being captured to see their differences. For demonstration purpose, we keep our sample spectrum measurement ("**Spectrum_0**") on the screen but place an orange translucent film in front of the light source to modify its color. The acquired spectrum then changes accordingly as the following figure shows:

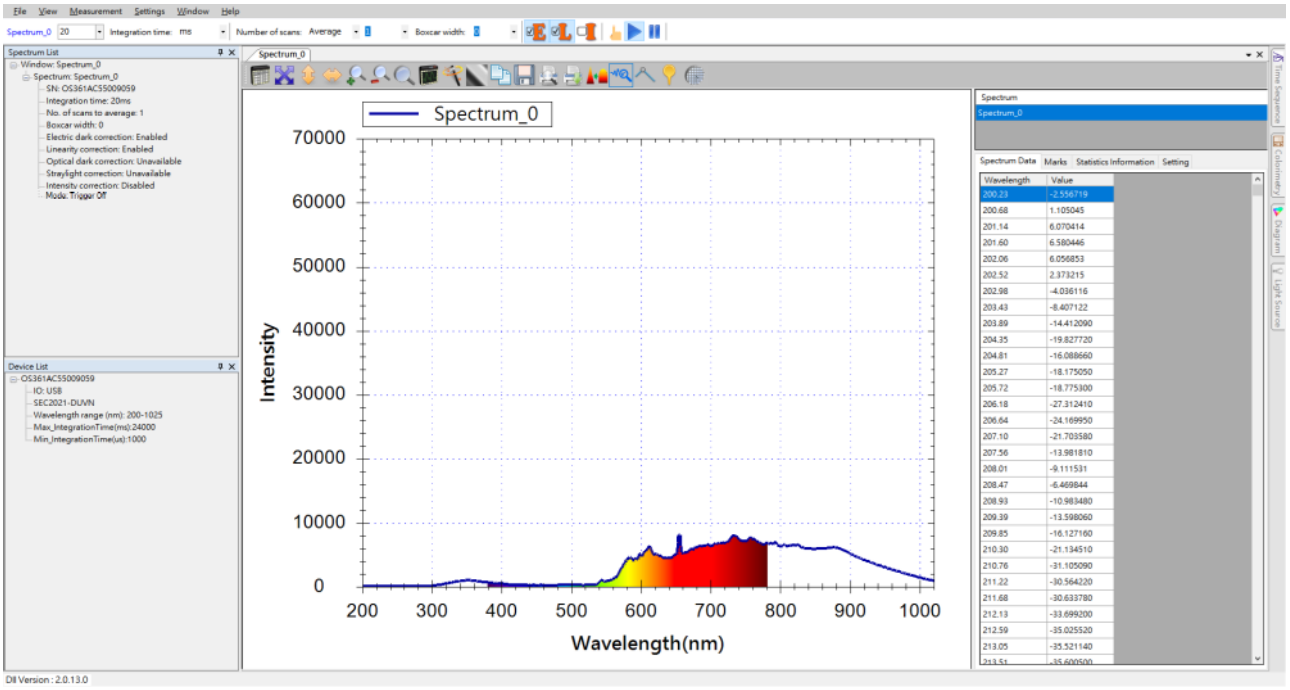


Figure 6-60: Using an orange translucent filter to modify the current spectrum curve

Next, we load the spectrum file we saved earlier (i.e. "**Spectrum_0.sps**"). Go to the **File** menu, and then select **Open Spectrum File**:

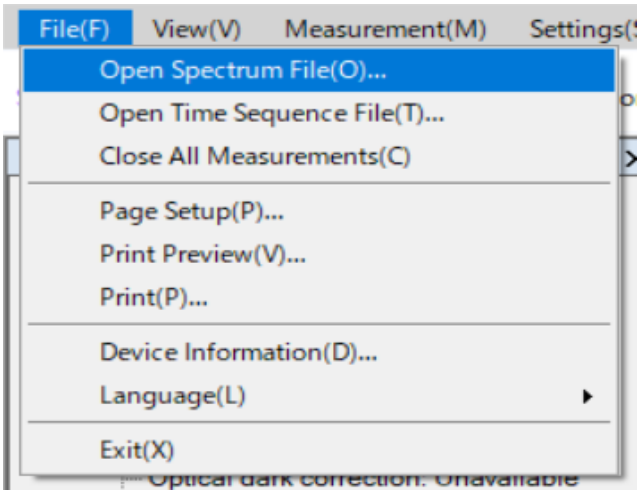


Figure 6-61: Opening a previously saved spectrum by selecting **Open Spectrum File** from the **File** menu

The **Open Existing File** window will appear:

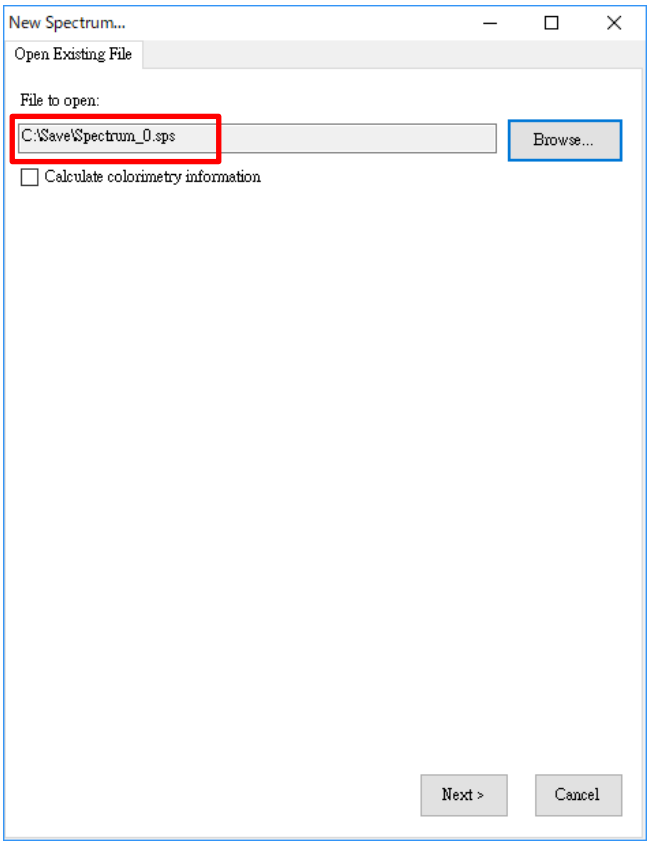


Figure 6-62: **New Spectrum** - **Open Existing File**

Use the **Browse** button next to the **File to open** field to locate the file we saved earlier ("**C:\Save\Spectrum_0.sps**"). Then, click **Next**, and the **Display Settings** window will appear:

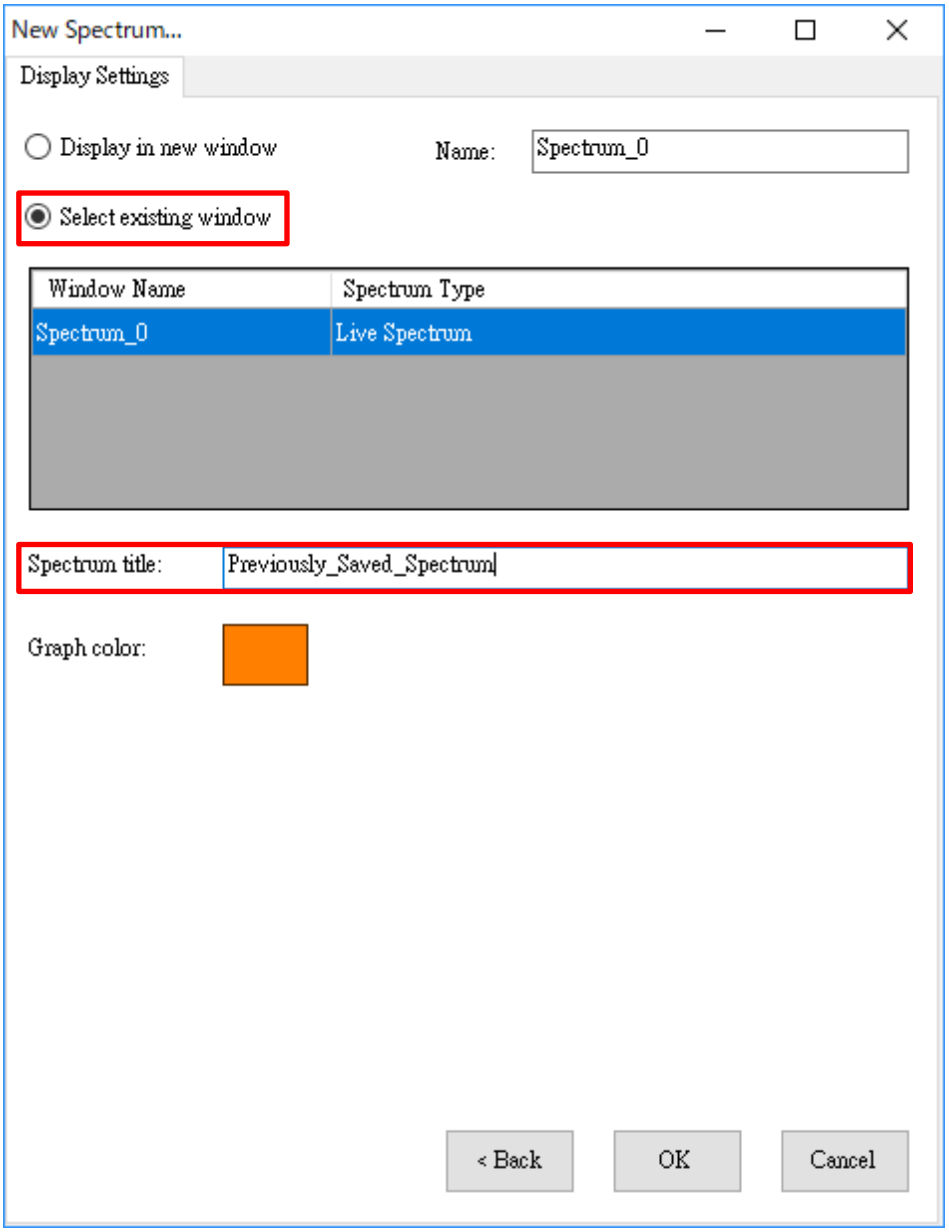


Figure 6-63: **New Spectrum** - **Display Settings**

On the **Display Settings** window, choose **Select existing window** to load the spectrum curve into the current "**Spectrum_0**" window. This allows us to see two superimposed spectrum curves so that we can compare their differences easily. Additionally, specify an obvious name ("**Previously_Saved_Spectrum**") for the spectrum to be loaded so that we can recognize it right away (see the red highlighted area in the former figure). Click **OK** and you will see something like:

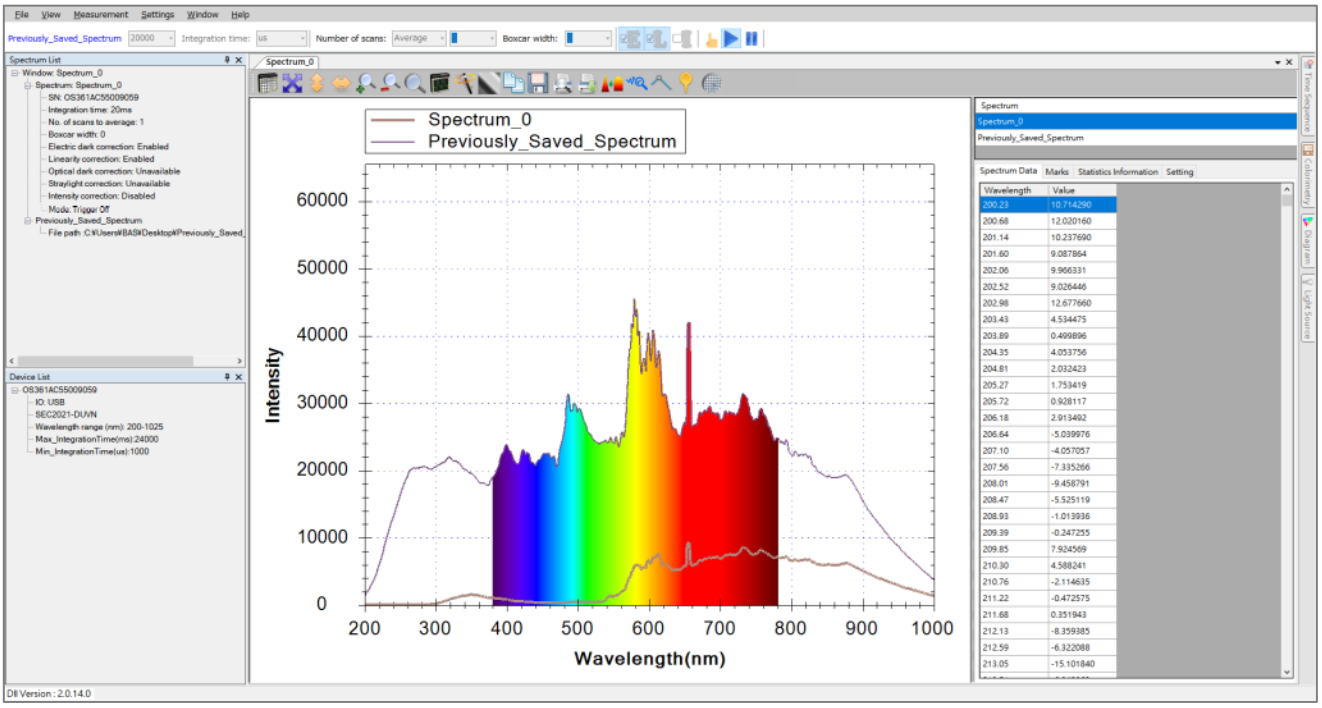


Figure 6-64: Loading the previously saved spectrum curve to compare with the current spectrum curve

In this example, the previously stored spectral curve (the orange line) covers the entire range of visible spectrum, but the current spectrum "**Spectrum_0**", after adding the orange translucent filter, only cover the orange to red wavelength range. Turn off the **Show human visible spectrum** feature to make the differences more apparent:

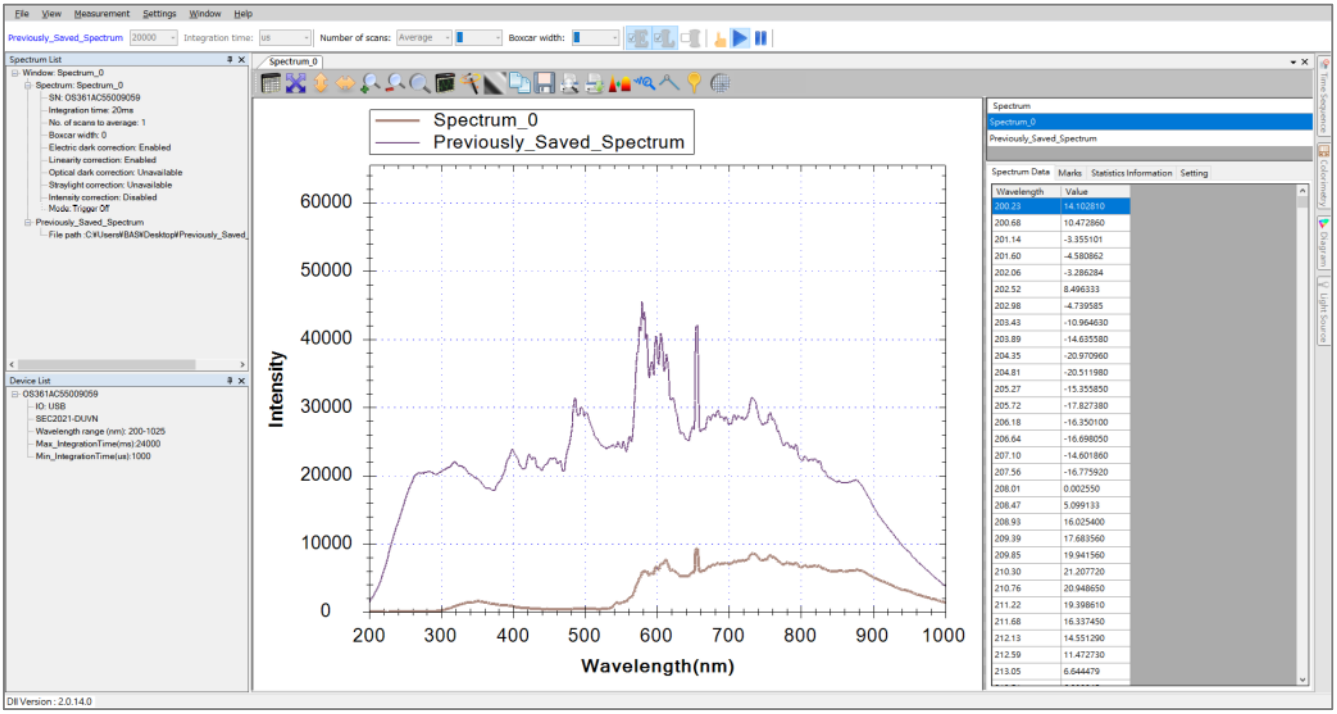


Figure 6-65: Turning off the **Show human visible spectrum** feature to make spectrum curve comparison easier

Deleting Individual Spectrum Curves

When there are more than one spectrum curves in a spectrum graph, you can delete the curve that is no longer needed. Here we demonstrate the steps to delete the curve we loaded in our previous example. First, in the **Spectrum** list of the spectrum data pane, select "**Previously_Saved_Spectrum**."

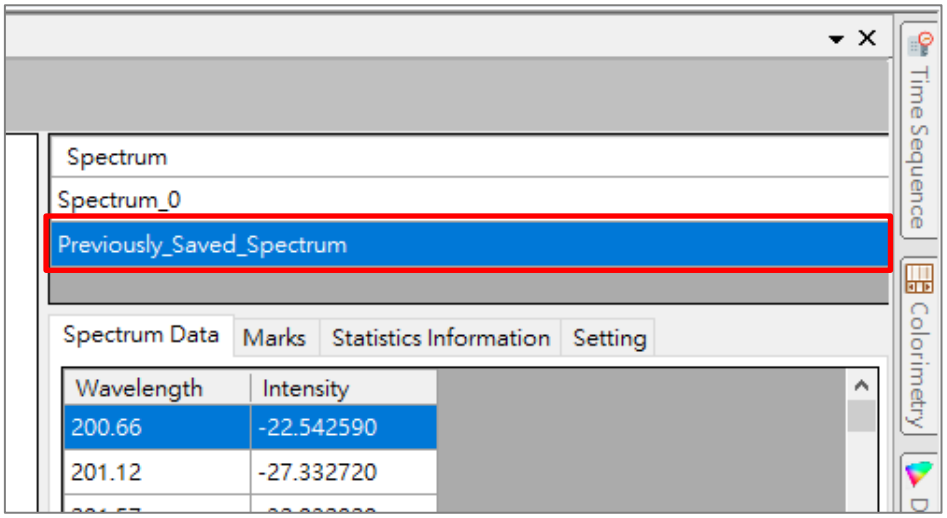


Figure 6-66: Select "**Previously_Saved_Spectrum**" in the spectrum data pane

Right-click in the spectrum data pane to open the pop-up menu, and then select **Delete** from the menu. See the following figure:

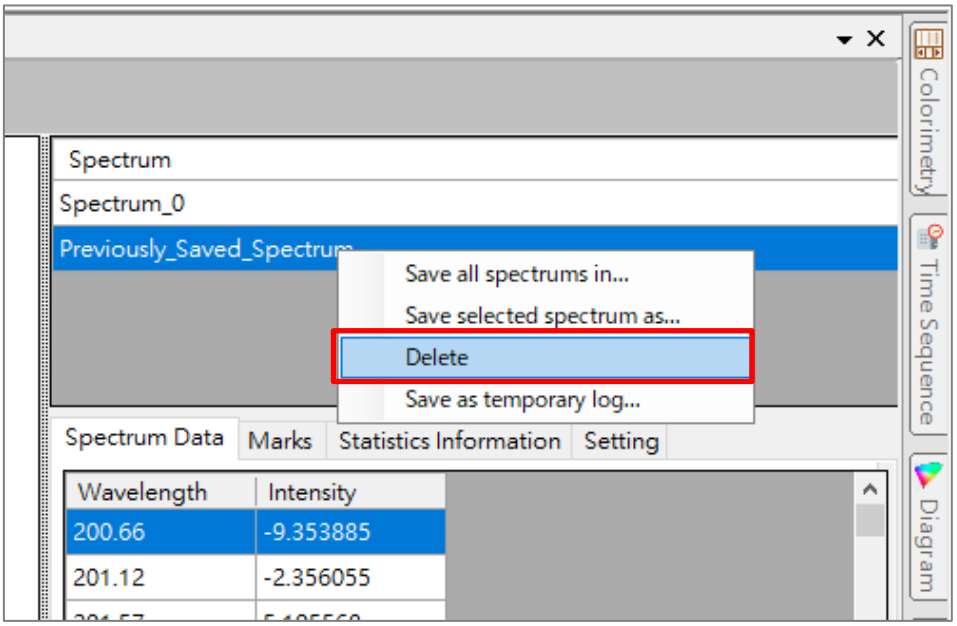


Figure 6-67: Right-clicking in the **Spectrum** list to open the pop-up menu, and then select **Delete**

This will delete the selected spectrum curve. See the following figure:

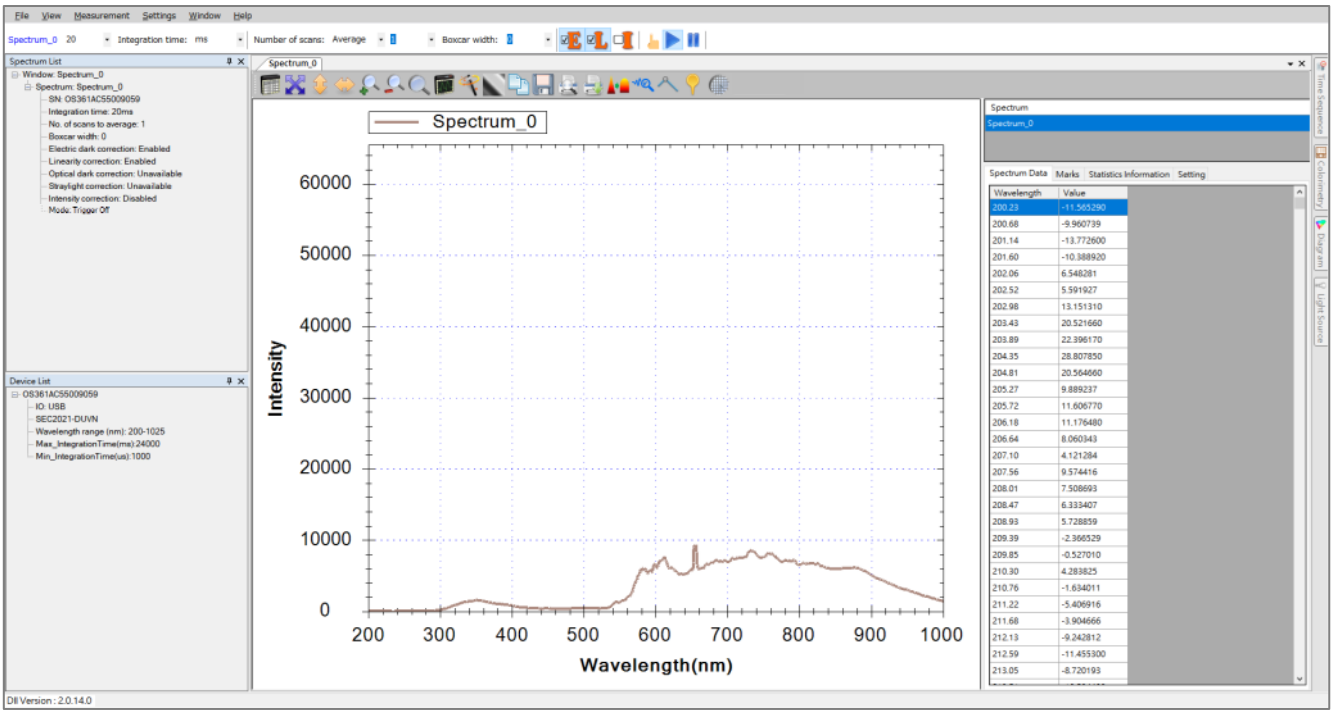


Figure 6-68: The "**Previously_Saved_Spectrum**" is now deleted

Printing and Previewing a Spectrum Measurement

In addition to saving the spectrum measurement to a file, you can also print it out to preserve it. To print the current spectrum measurement, you can use the **Print Preview** or the **Print** button on the toolbar. See the following figure:

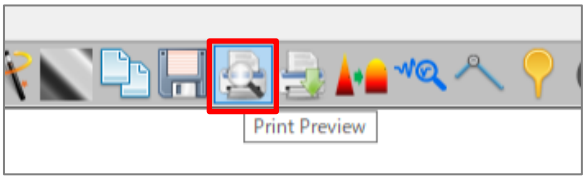


Figure 6-69: The **Print Preview** button

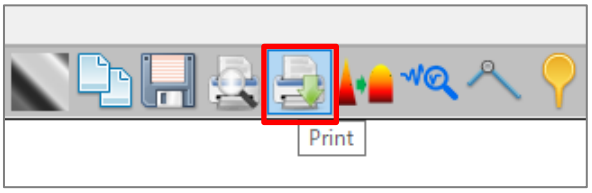


Figure 6-70: The **Print** button

Pressing the **Print Preview** button displays a standard **Print Preview** window, which shows the current spectrum measurement in SpectraSmart:

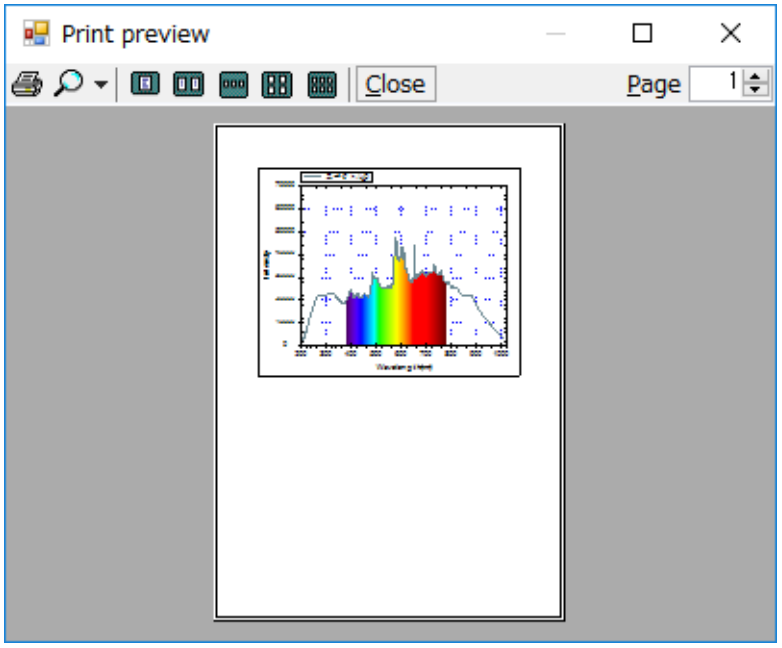


Figure 6-71: The **Print Preview** window

You can zoom in to check the details and make sure this is the way you like it. Click the printer icon on the upper-left corner of the **Print Preview** window to start printing. If you don't need to preview the graph before you print it, you can simply press the **Print** button on SpectraSmart's graph toolbar to open the standard **Print** window:

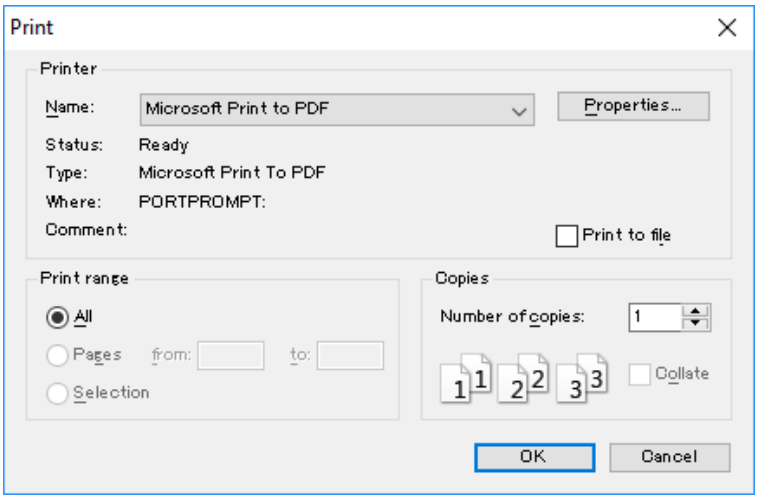


Figure 6-72: The **Print** window

The **File** menu also provides the **Print** and the **Print Preview** options, and they open the same windows as the corresponding toolbar buttons, so we will not repeat the details again. In addition, the **File** menu also provides a **Page Setup** option:

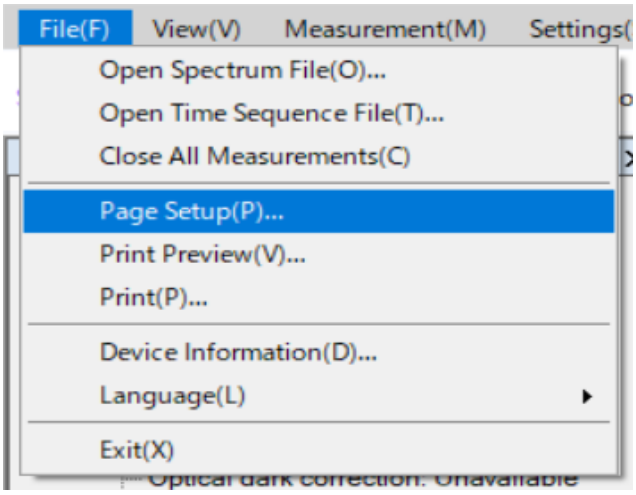


Figure 6-73: Choosing **Page Setup** from the **File** menu

This feature lets you select the desired paper, orientation, and margins:

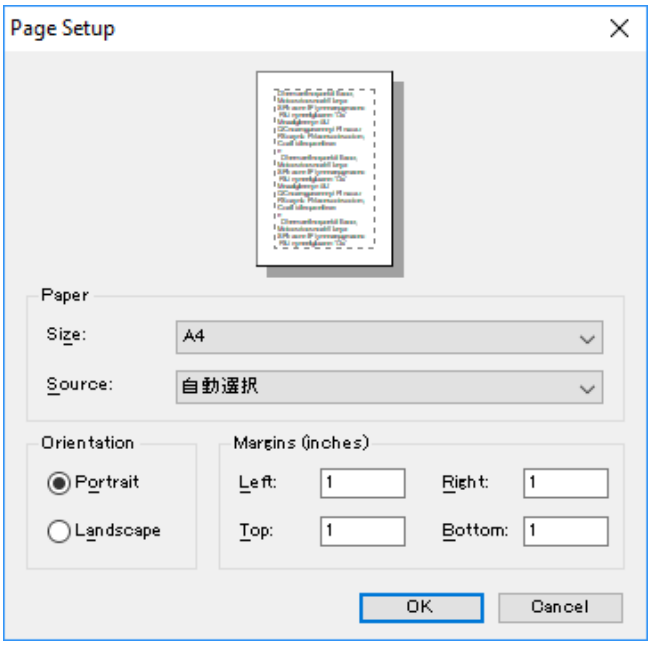


Figure 6-74: The **Page Setup** window

Lamp Control

SpectraSmart can control the on/off states of an external light source via I/O signals. The lamp control button is right edge of the window. When this is pressed, the light source frame is diplayed.

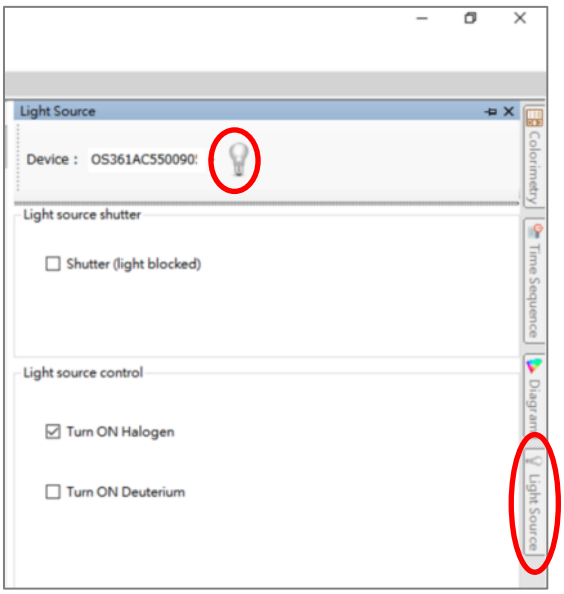


Figure 6-75: The **Lamp** button

The operation mode of the "light source" button has two modes of "active" and "inactive". Press it once to activate it, press it again to deactivate it.

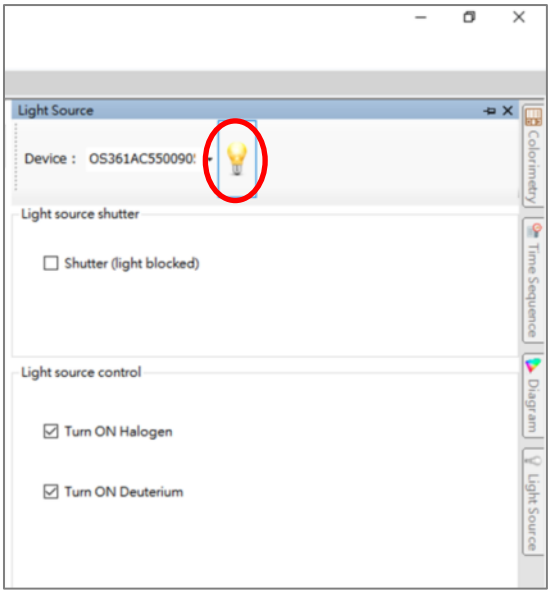


Figure 6-76: The **Lamp** button in active and inactive states

Spectrum Scanning Interval

By default, SpectraSmart captures continuous spectrum data at an interval determined by the user-specified integration time plus around 30 ms, depending on the processor speed inside the spectrometer device and the performance of the computer running the SpectraSmart software. As a result, if the user-specified integration time is 50 ms, the

spectrum data will be captured once every 80 ms. However, the user can modify this interval if necessary. You can find the **Spectrum Scanning Interval** button on the graph toolbar:

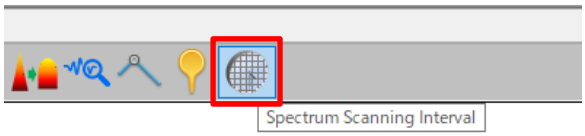


Figure 6-77: The **Spectrum Scanning Interval** button

Pressing the **Spectrum Scanning Interval** button shows the **Spectrum Scanning Interval** window:

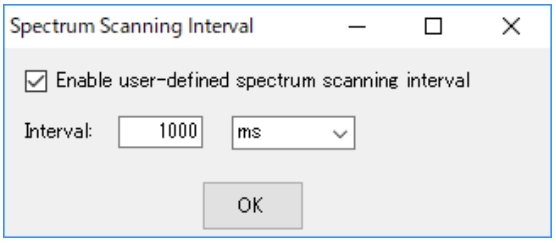


Figure 6-78: The **Spectrum Scanning Interval** window (at 1000 ms)

Select **Enable user-defined spectrum scanning interval**, and then specify the desired **Interval** in the text box. Click **OK** when done. After the change, you will notice that the spectrum graph refreshes at a different speed. If you set the interval to 1000 ms, as in our example, the graph will refresh approximately once every second.

Setting Integration Time Automatically

You need to specify an integration time (i.e. the exposure time for the light sensor) when you create a spectrum graph. Sometimes, you may not know the best integration time to use for the optimal result. For this, you can create the spectrum graph with the default setting (i.e. 50 ms), and then use the **Set integration time automatically** button on the toolbar to let SpectraSmart determine and set the optimal integration time for you. The new setting will reflect on the graph after you press the button. See the following figures:

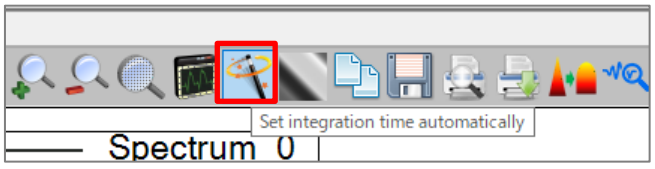


Figure 6-79: The **Set integration time automatically** button

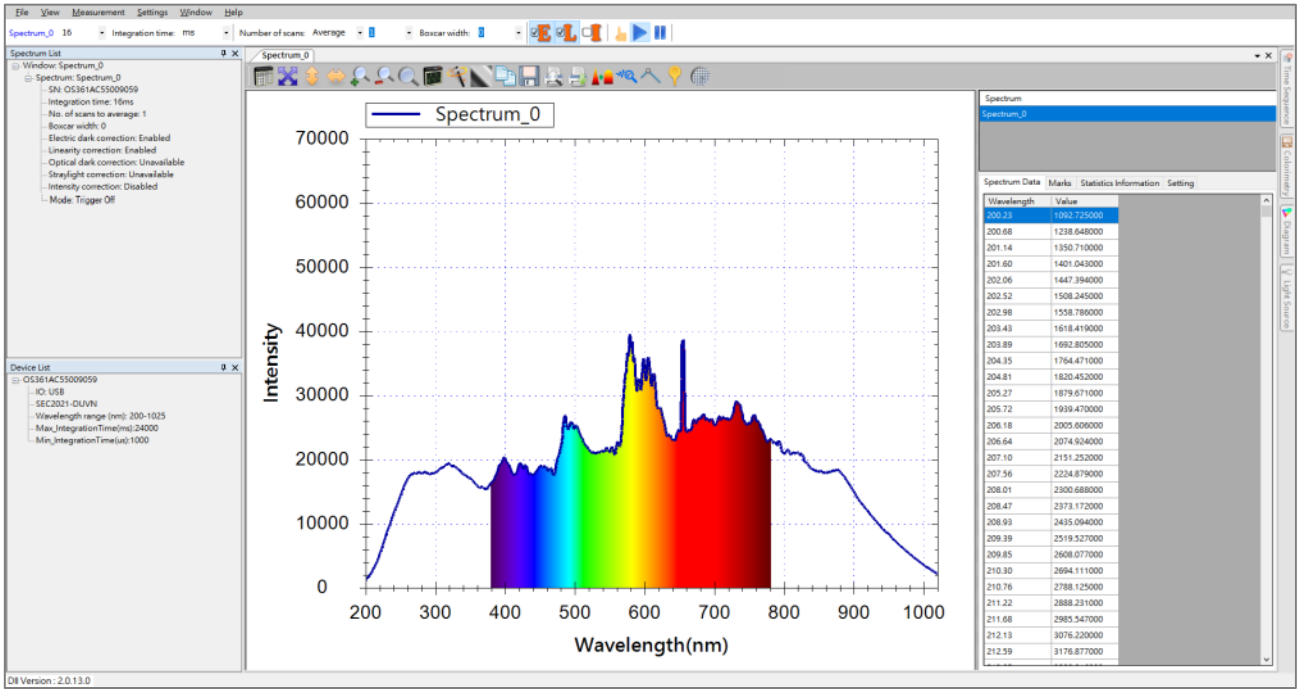


Figure 6-80: The effect of using the **Set integration time automatically** button

The integration time has changed from 50 ms to 16 ms after the **Set integration time automatically** button is pressed. And the spectrum is corrected slightly downward.

Setting as Dark Spectrum

Set as dark spectrum is in the right of the **Set integration time automatically** button:

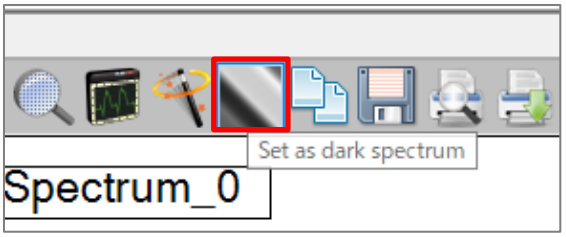


Figure 6-81: The **Set as dark spectrum** button

Refer to "Setting a New Reference Spectrum or Dark Spectrum" for details on its purpose.

FWHM

SpectraSmart offers the function of displaying FWHM in real time. You can click the FWHM button and click on any wavelength of the spectrum. The program will automatically find the highest peak nearby and measure its FWHM and reflect it in the spectrum as following shown:

Figure 6-82: The FWHM button

Copying Spectrum Data to Clipboard

Sometimes you might want to copy and paste the spectrum data into other applications. You can do this by using the **Copy to clipboard** button on the toolbar:

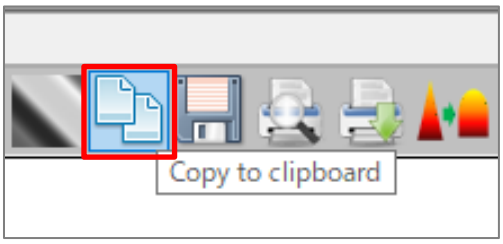


Figure 6-83: The **Copy to clipboard** button

As you press this button, all data in the spectrum data pane will be copied to the system clipboard. You can then paste the data into the application you want. For illustration, we paste the data into Windows Notepad and Microsoft Excel in the following figures:

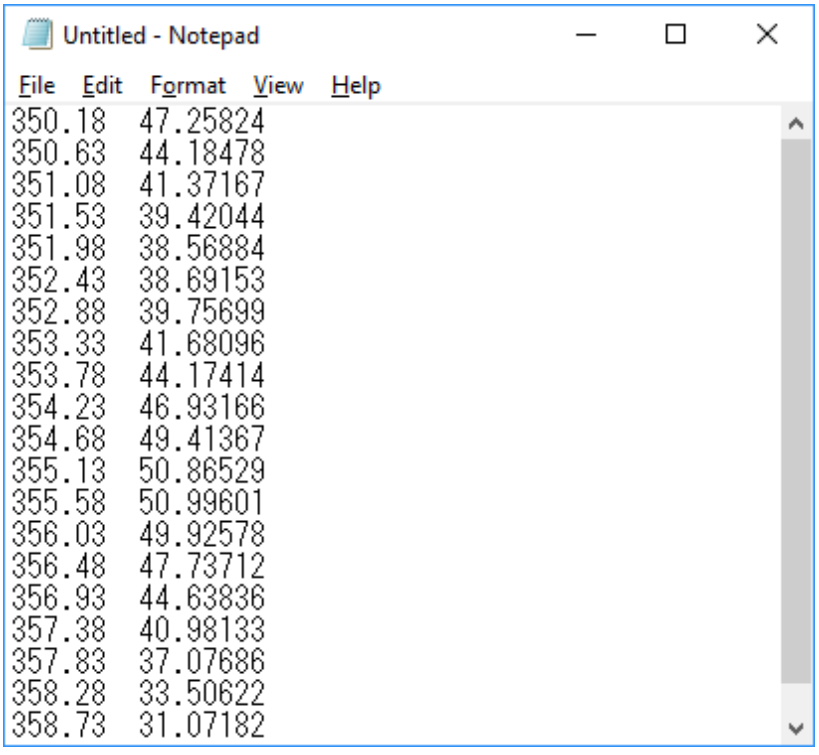
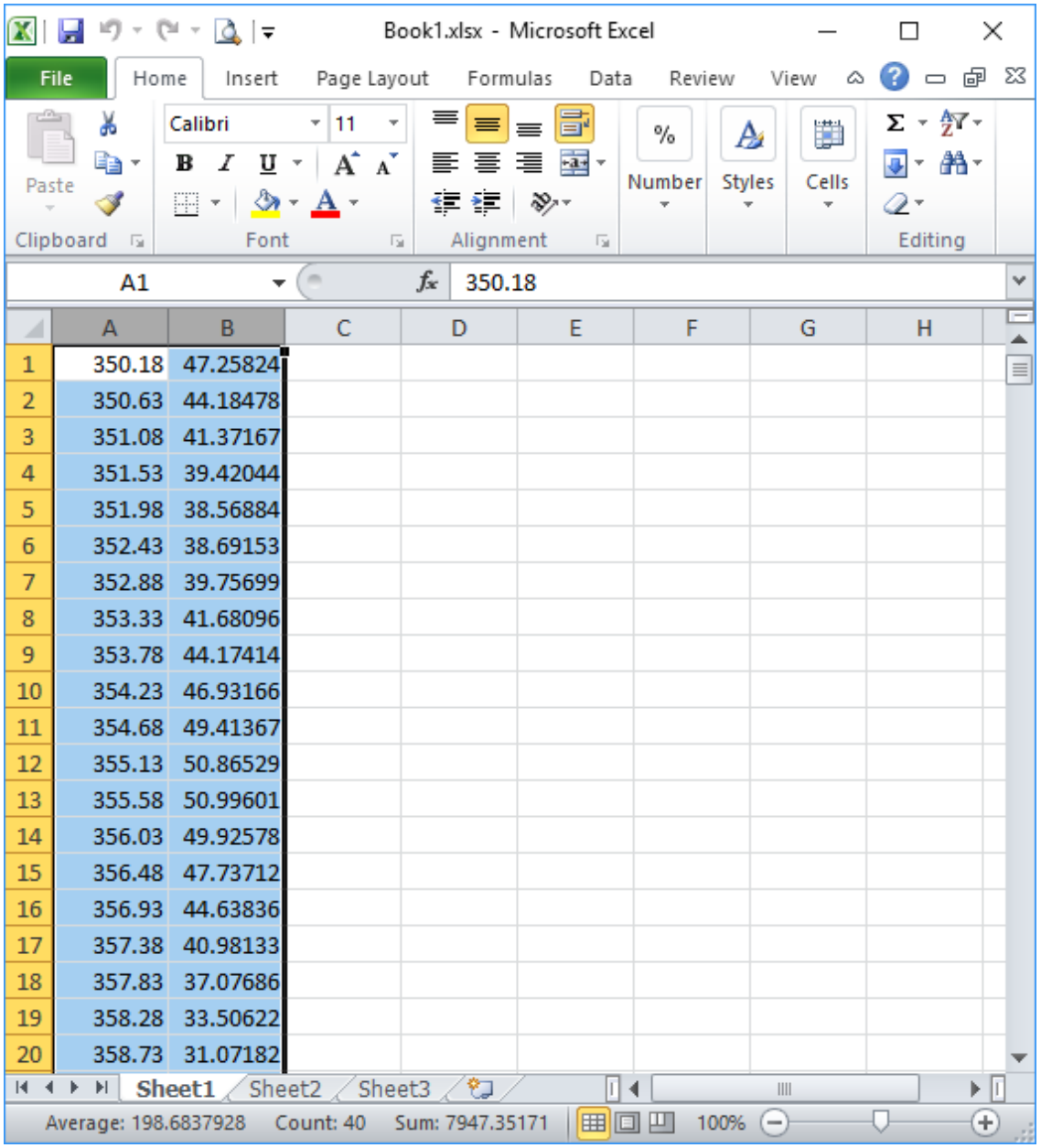


Figure 6-84: Pasting spectrum data into Windows Notepad



	A	B
1	350.18	47.25824
2	350.63	44.18478
3	351.08	41.37167
4	351.53	39.42044
5	351.98	38.56884
6	352.43	38.69153
7	352.88	39.75699
8	353.33	41.68096
9	353.78	44.17414
10	354.23	46.93166
11	354.68	49.41367
12	355.13	50.86529
13	355.58	50.99601
14	356.03	49.92578
15	356.48	47.73712
16	356.93	44.63836
17	357.38	40.98133
18	357.83	37.07686
19	358.28	33.50622
20	358.73	31.07182

Figure 6-85: Pasting spectrum data into Microsoft Excel

One-shot Measurement

In most cases, SpectraSmart acquires data continuously from the spectrometer while the measurement is in progress. If only one number is enough, use the **One Shot** button on the toolbar.

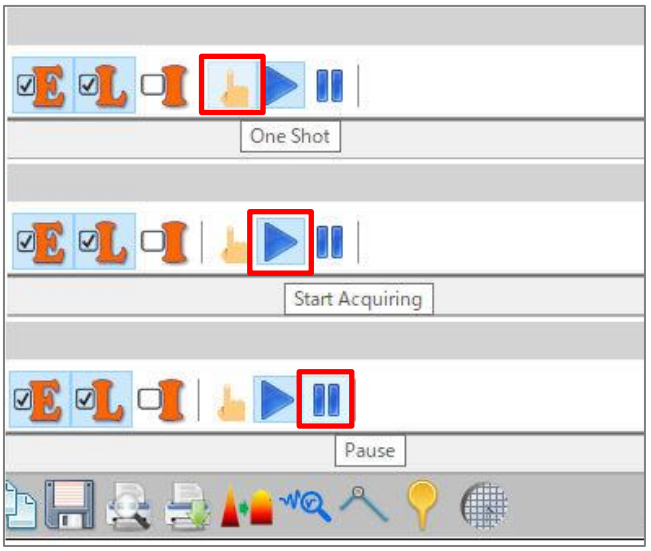


Figure 6-86: The **One Shot**, **Start Acquiring**, and **Pause** buttons

Before you do one-shot measurement, be sure to temporarily stop continuous acquisition with the "Pause" button. After that, every time you press **One Shot** button, data will be captured. To return to continuous capture, press **Start Acquiring** button.

Closing a Measurement

To end the measurement such as spectrum, strip chart, absorbance, etc., you can close it by pressing the **X** button on the upper right corner of the graph:

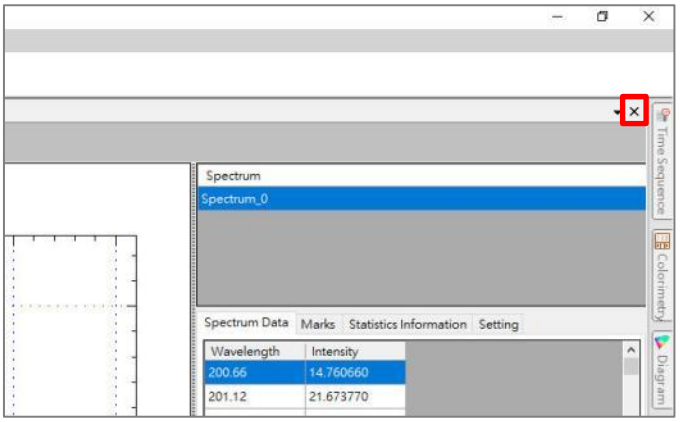


Figure 6-87: The button to close a measurement

Note: When you close the graph, the measurement is also closed. If you need the same measurement later (such as spectrum), you need to create it again.

Closing All Measurements Together

In addition, SpectraSmart also provides a **Close All Measurements** option, which is handy when you need to close multiple measurements together. Please go to the **File** menu, and then select **Close All Measurements**:

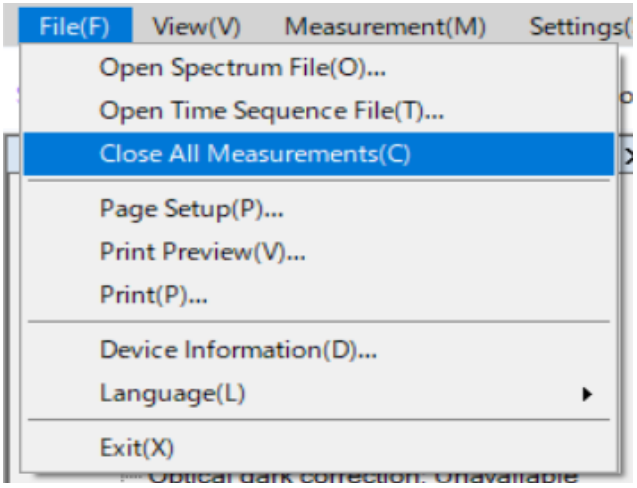


Figure 6-88: Selecting **Close All Measurements** from the **File** menu

All measurements will be closed after you select the option.

7. Strip Chart (Tracking Specific Wavelengths)

In order to continuously observe numerical changes of a specific wavelength or wavelength range, a strip chart (Strip Chart) is prepared for SpectraSmart. For the following explanation, first set up spectrum measurement.

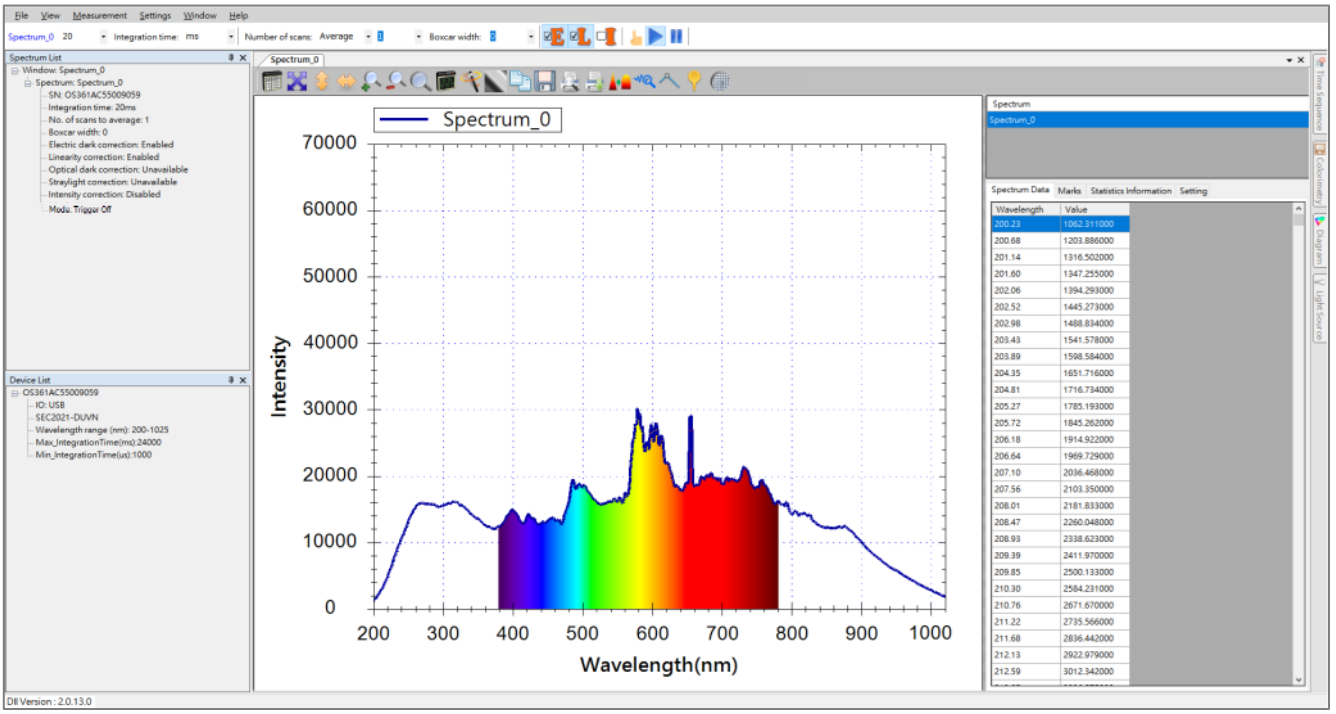


Figure 7-1: Creating a spectrum measurement first

Striping chart setting

Next, create the strip chart. From the **Measurement** menu, select **Strip Chart** to open a **New Strip Chart** window:

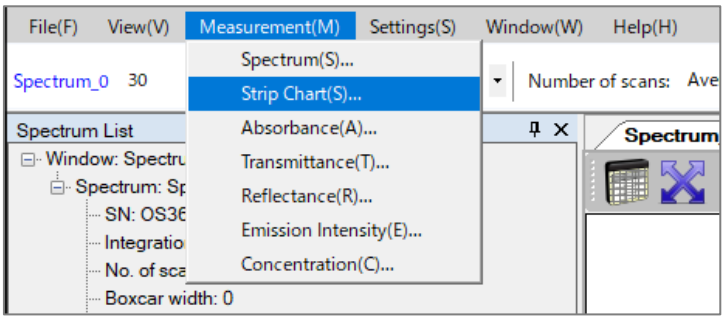


Figure 7-2: Selecting **Strip Chart** from the **Measurement** menu

The **New Strip Chart** window will be displayed:

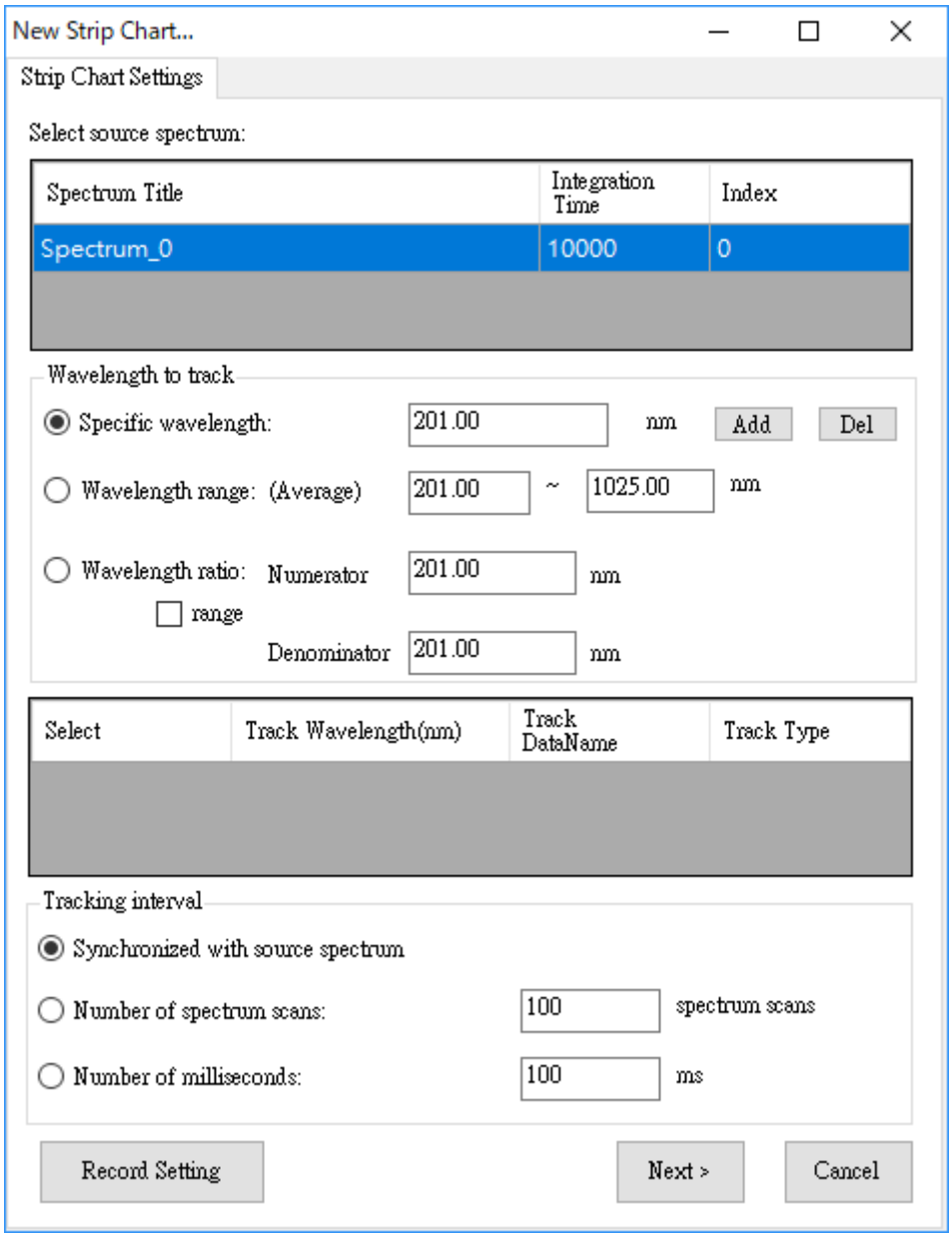


Figure 7-3: New Strip Chart - Strip Chart Settings

First select the desired source spectrum from the **New Strip Chart-Strip Chart Settings** window. In this case, "**Spectrum_0**" is selected. Then, select the wavelength or wavelength range and press **Add**. If you want to add multiple wavelengths, repeat the operation selecting the desired wavelengths and press **Add**. Then, specify **Tracking interval** on the displayed window. Select whether to synchronize with the data acquisition interval of the source spectrum, specify the number of scans, or specify the scan interval.

When you press Record Setting, the **Record Setting** window is displayed, and you can set **When to start**, **Interval** for recording, and **When to stop**. After completing the settings,

press **OK** and then **OK** on the dialog box that appears.

After completing the settings, click **Next** on the **New Strip Chart-Strip Chart Settings** window.

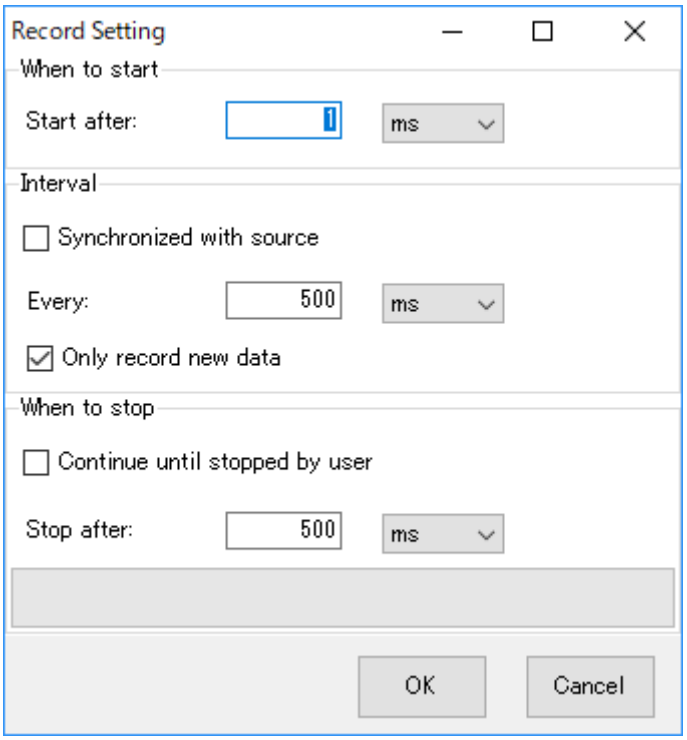


Figure 7-4: New Strip Chart - Strip Chart Settings - Record Setting

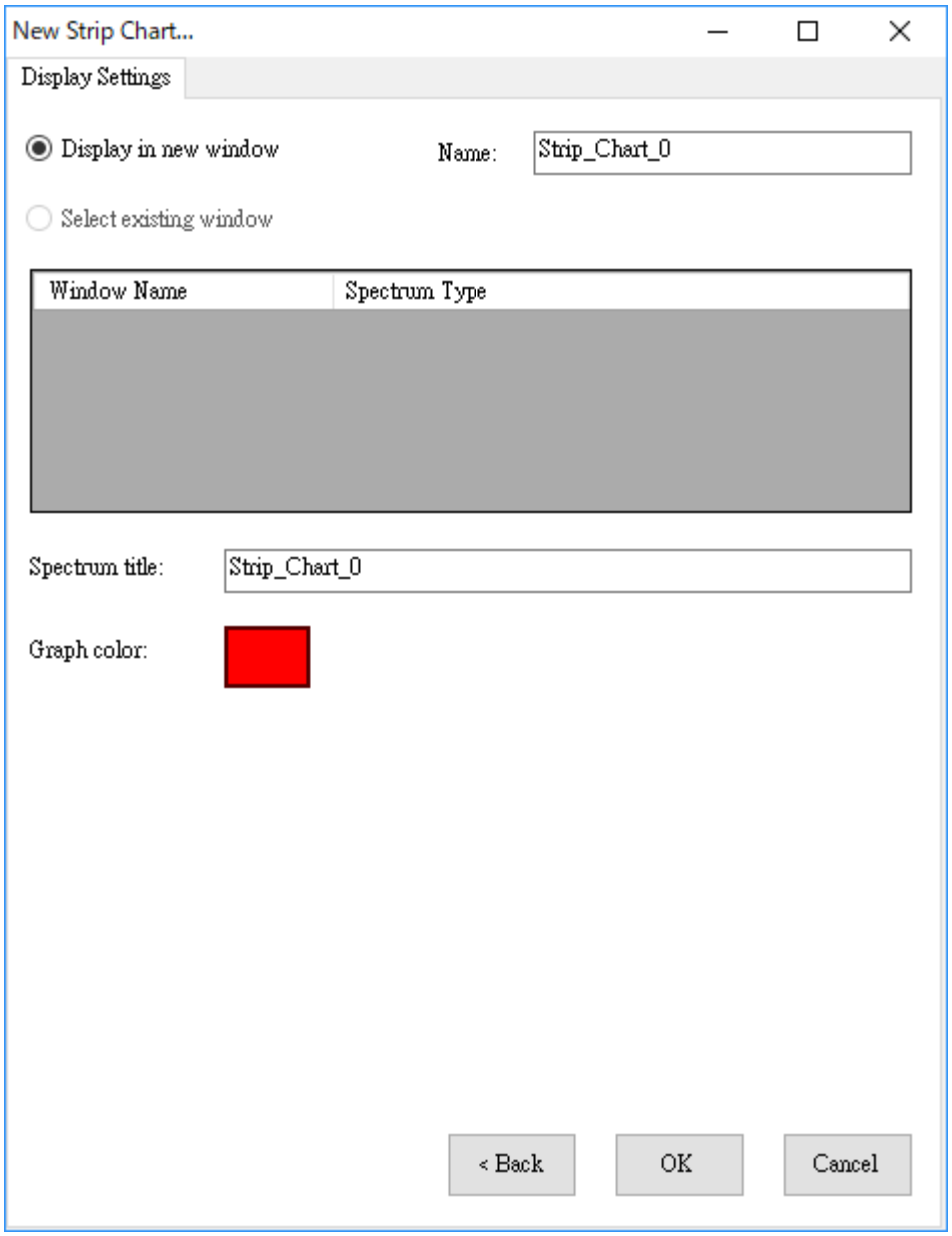


Figure 7-5: New Strip Chart - Display Settings

Now, on the **Display Settings** window, specify whether you want to display the new strip chart in a new window or an existing window. If this is the first strip chart you create, you can only select a new window. If you have any existing strip chart, you can display the new strip chart in the existing window for comparison. This window also allows you to specify a name for the window, as well as a title and a color for the curve. When all settings are done, click **OK**. SpectraSmart will display the newly created strip chart, as in the following figure:

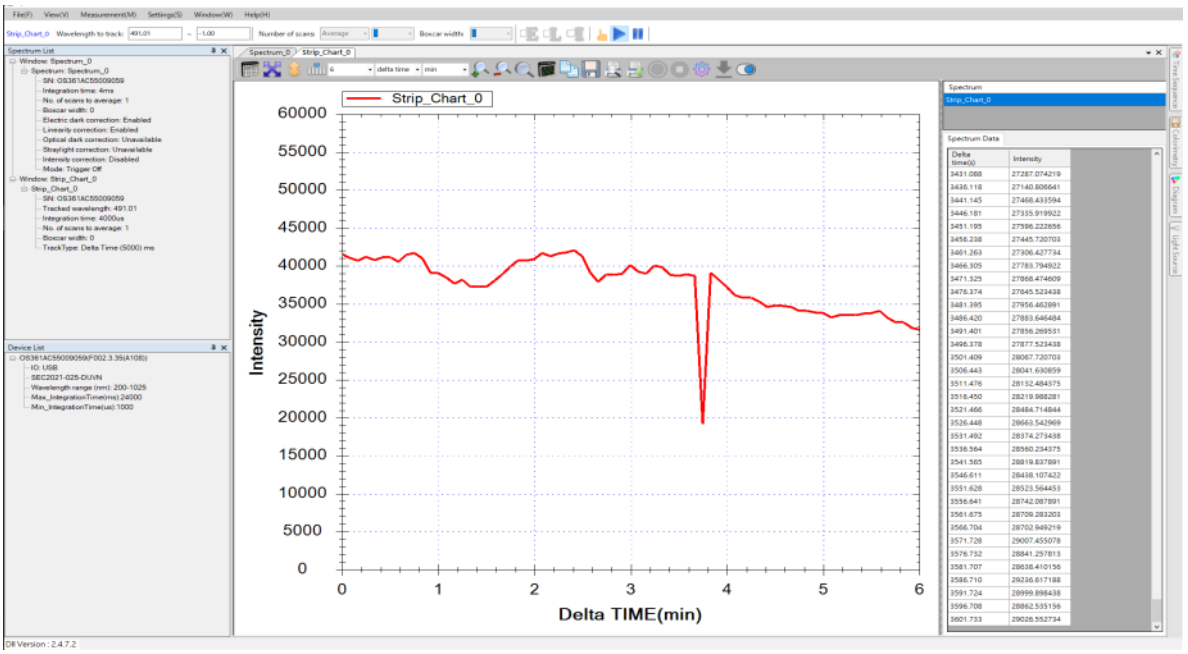


Figure 7-6: The newly created strip chart (Strip_Chart_0)

In the above figure, strip chart curves are displayed at 10-minute intervals. The X axis scale is the default 10 minutes. When it exceeds 10 minutes it will automatically scroll to the left (Figure 7-7).

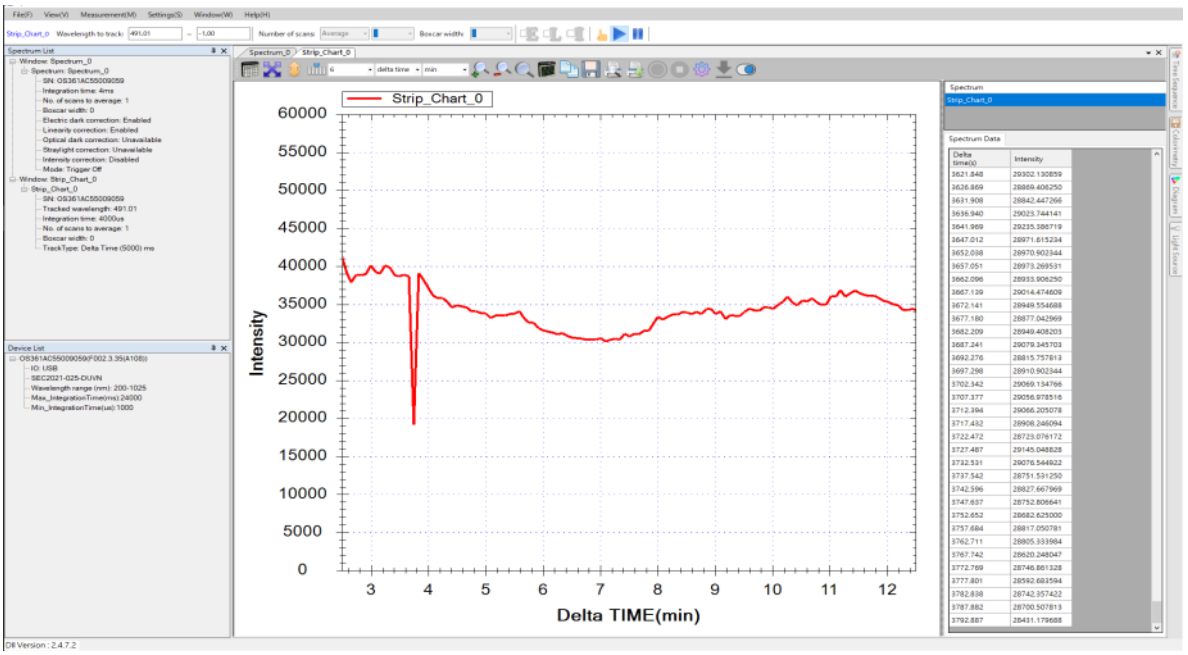


Figure 7-7: The chart starts scrolling after ten minutes

In the figure, the scale of the start of the X axis is 2 minutes and 30 seconds, and it has been changed from 0 second at the start of the strip chart.

Tracking Multiple Wavelengths on a Single Strip Chart

By pressing the **Add** button from the **Strip Chart Settings** window, it is possible to display multiple wavelengths. Here, spectrum intensity at 485.94 nm and 655.91 nm are displayed. See the following figure:

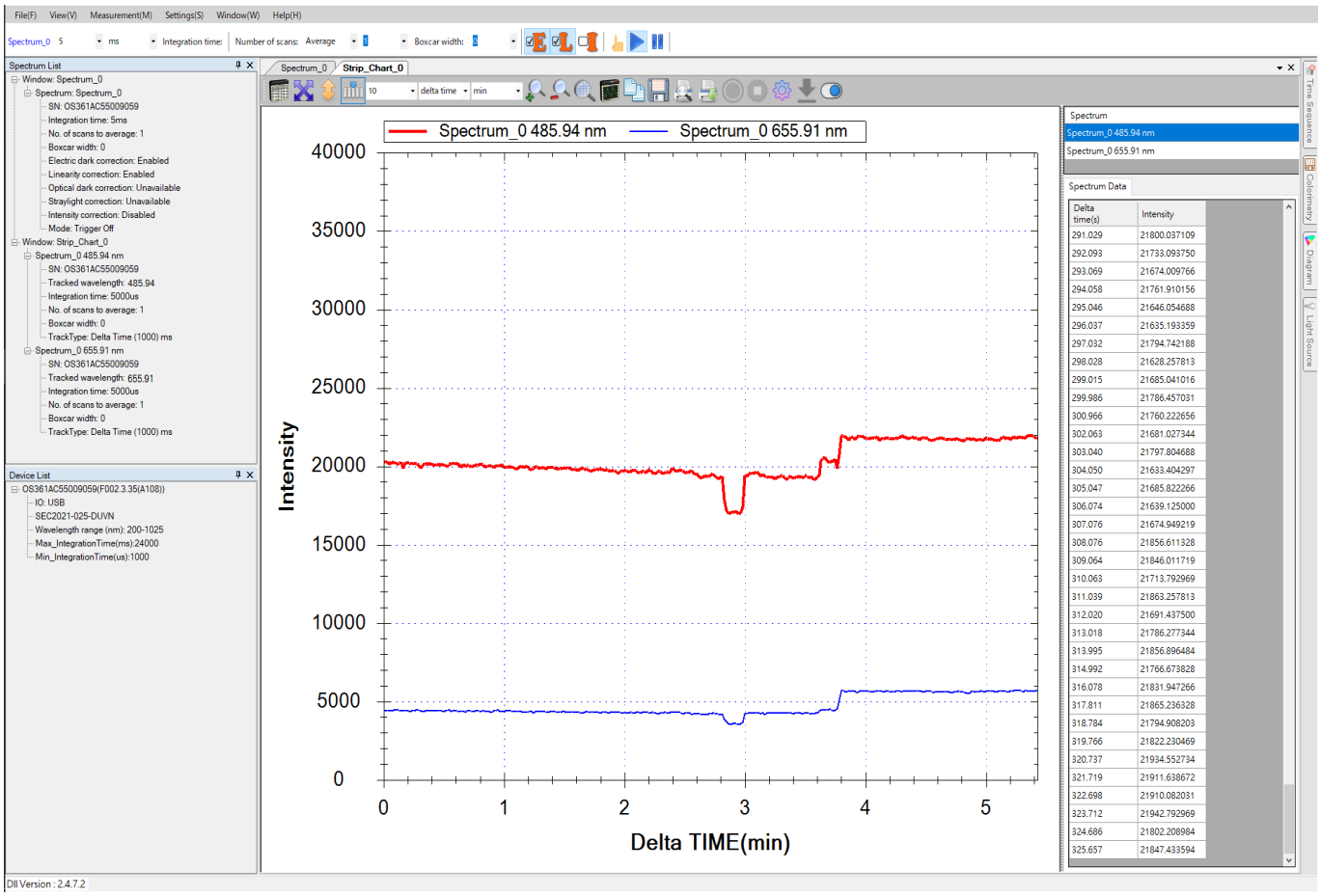


Figure 7-8: Tracking multiple wavelengths on a single strip chart

Note: When two or more waveforms are displayed, the second curve may not be displayed. This is because the Y axis is adjusted to the scale of the first curve. In this case, press the "Scale graph automatically" button on the tool bar to display both curves at the same time as shown above.

You can also mark the original spectrum if necessary (see "Placing Marks on the Graph"). The figure below shows the two wavelengths intensities tracked by the strip chart.

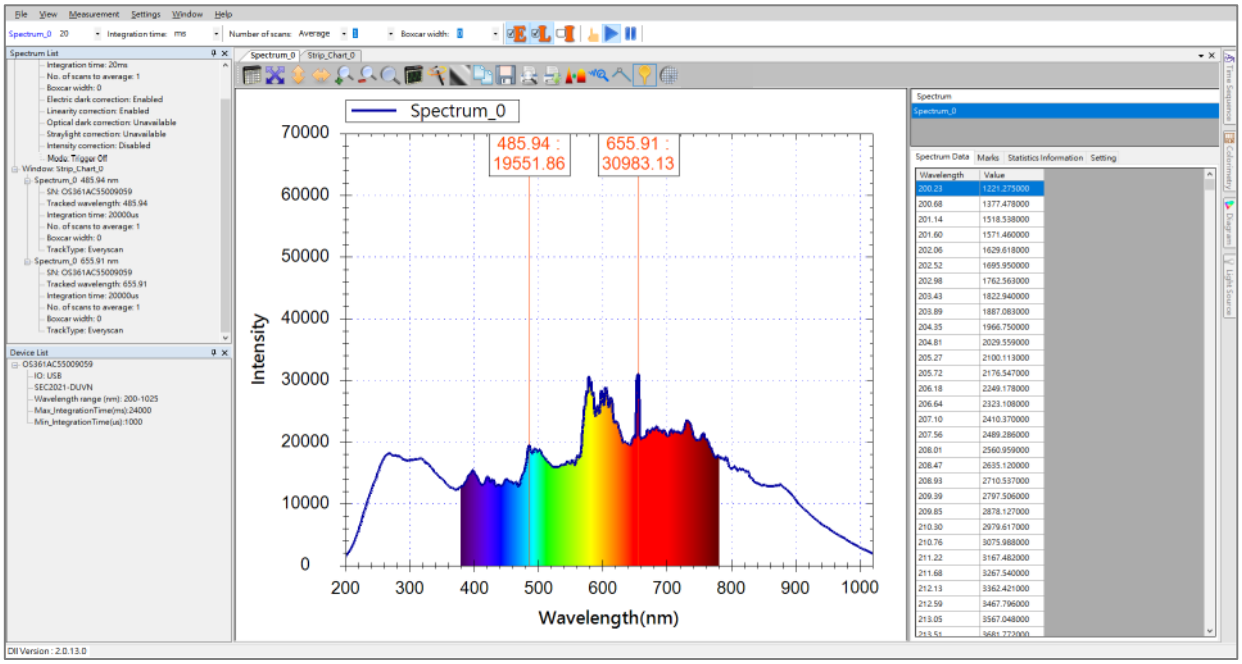


Figure 7-9: Multiple wavelengths marked on spectrum with the intensity displayed

Graph Toolbar Buttons

In the graph toolbar buttons at the top of the graph, you can adjust the scale of the graph, save the graph, print a strip chart, etc. (the place marked with the red border).

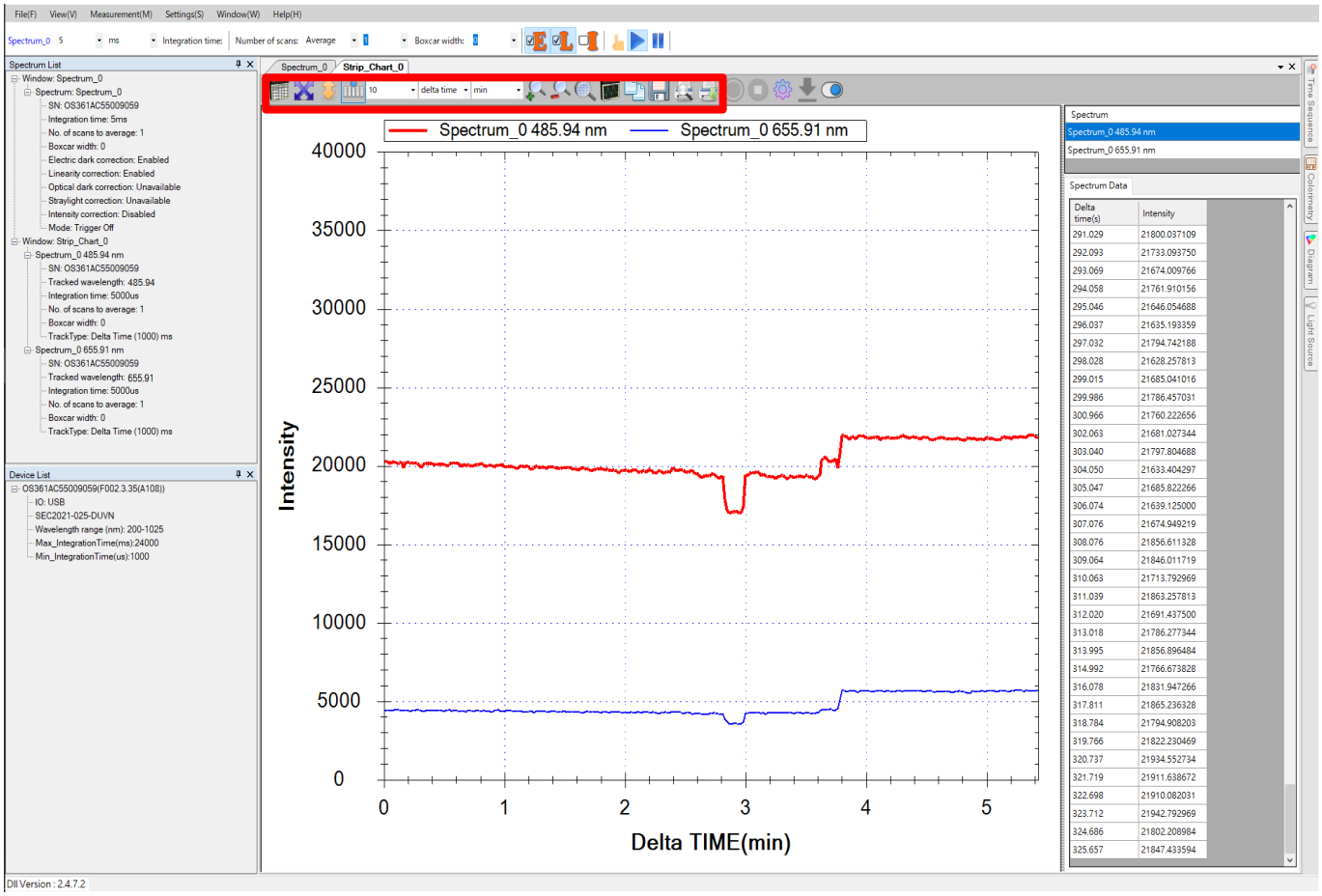


Figure 7-10: The toolbar buttons of the strip chart

Scale Adjustment Buttons

In the graph scale adjustment, there are two differences in the strip chart and spectrum diagram. First, the strip chart has a unique button that can temporarily freeze the chart (the **Strip Chart View** button). Second, the **Scale X-axis automatically** button. The other functions are the same as the spectrum diagram.

Strip Chart View

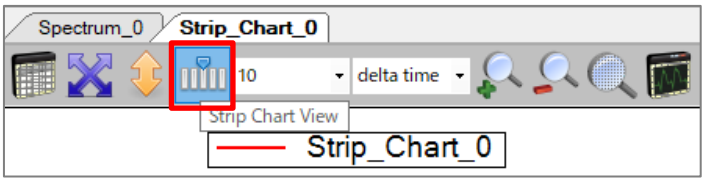


Figure 7-11: The **Strip Chart View** button

This button allows you to freeze the strip chart. As the strip chart emulates the action of a

physical strip of paper recording continuous data from left to right, the graph will scroll to the left as it charts new data at end of the graph. Pressing this button temporarily freezes the scrolling so that you can examine the data closely. When you are finished, you can press the button again to unfreeze it. Freezing the strip chart will not stop it from capturing new data. The software will keep recording new data in the background, so you will see continuous data when you unfreeze the chart.

A strip chart has two states ("active" and "inactive"), which you can tell from the appearance of this button. When a strip chart is active, this button has a blue border around it. When the strip chart is inactive, it lacks the border. See the following figure:

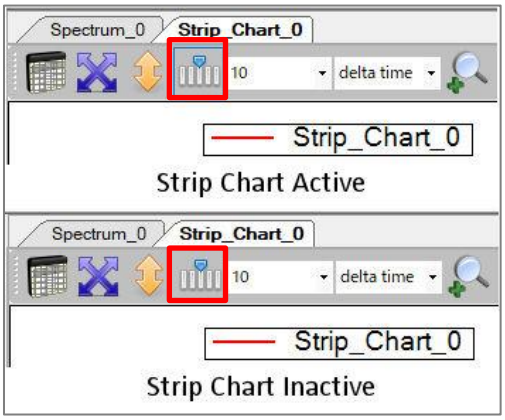


Figure 7-12: The "active" and "inactive" states of the Strip Chart View button

Time Period for Data Display (X-axis)

Figure 7-13: The control for modifying the time period for data display

Here, you specify the width of the strip chart display time. The default display time width is 10 minutes. The example in the figure has been changed to 30 minutes. The display time can be set to the elapsed time (delta time) from the start of acquisition, the number of data from the acquisition start (delta data), and the time (min, hour, day).

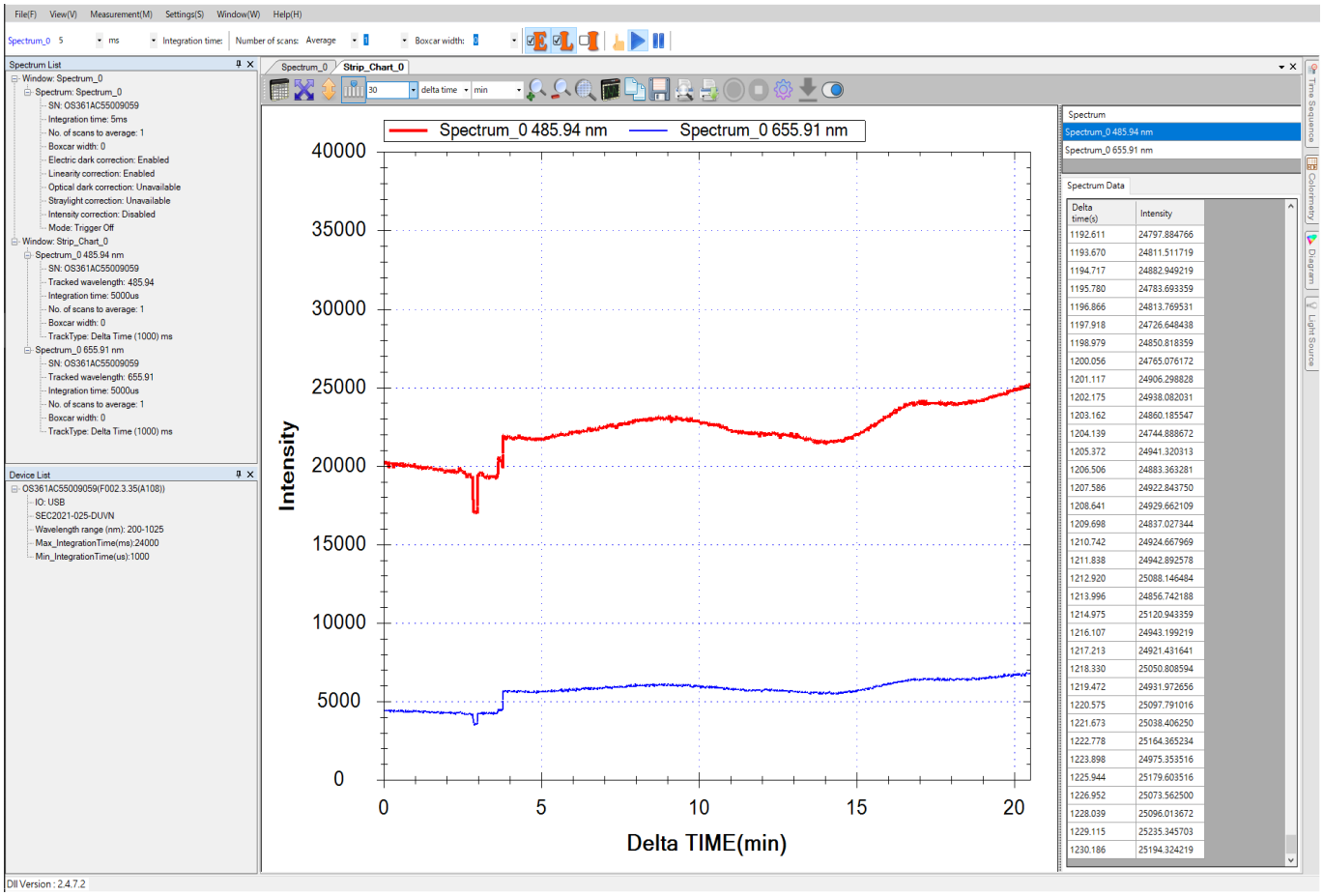


Figure 7-14: Changing the time period for data display to thirty minutes

Record Setting Buttons

In addition, the graph toolbar at the top of the graph has a button for recording setting (marked with a red border).

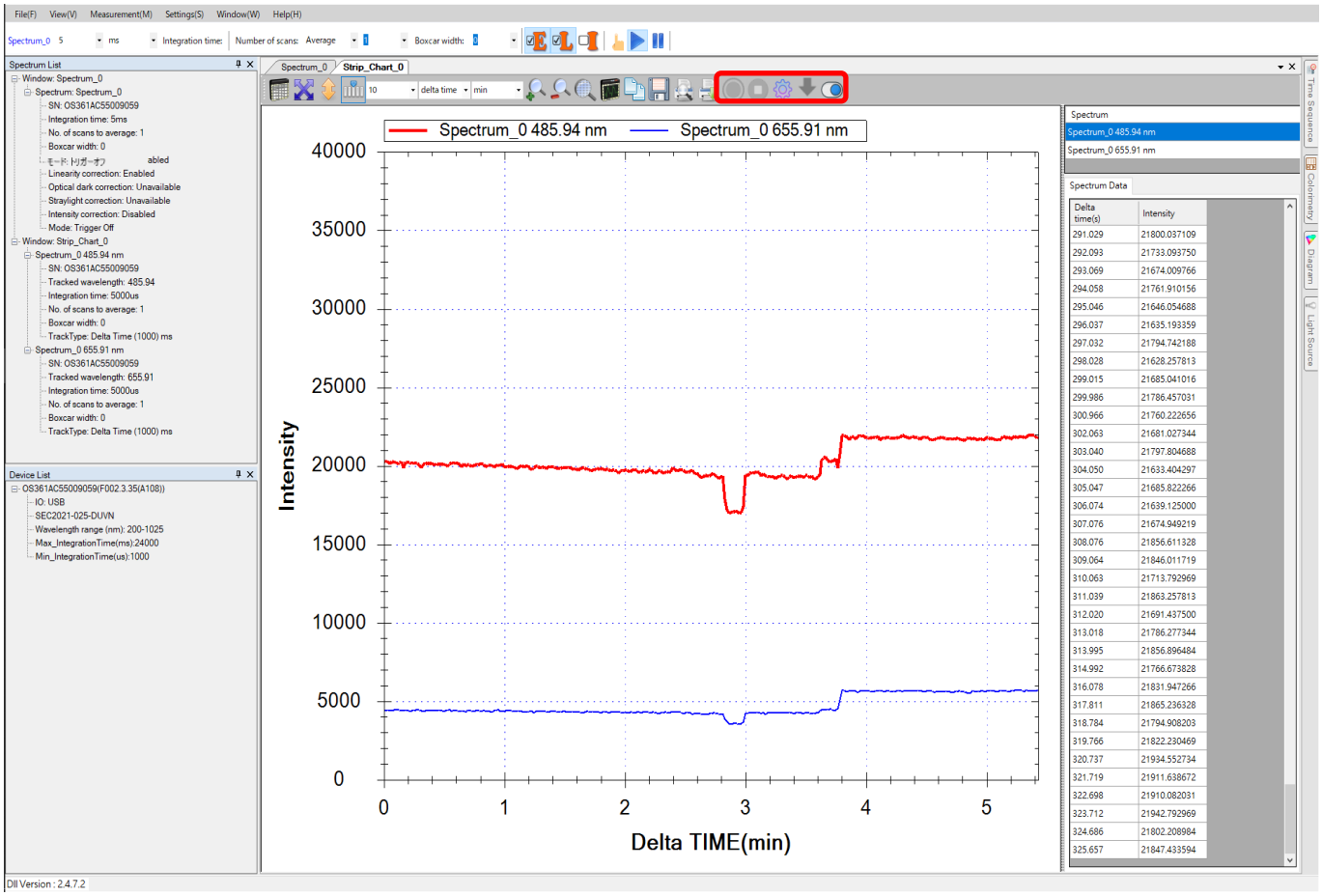


Figure 7-15: Record Setting toolbar button above strip chart.

Record

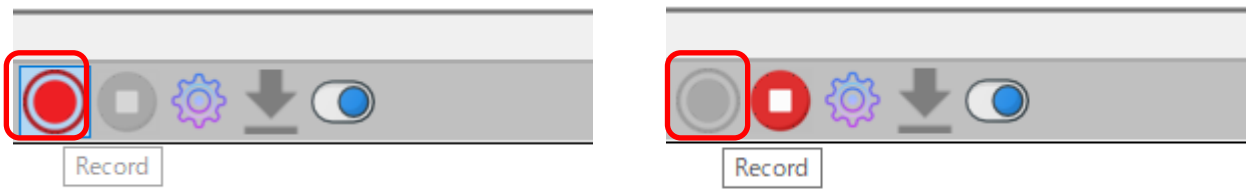


Figure 7-16: When **Record** button (left) is pressed, record starts. When record is in progress, the **Record** button is not active.

When you press the **Record** button, the previously recorded data will be erased and new data will be recorded. The previous graph on the Strip Chart's window will be erased and new graph will started

Stop

Figure 7-17: **Stop** button, when the record is in progress, Stop button is active.

Press the **Stop** button to stop the record.

Record Setting

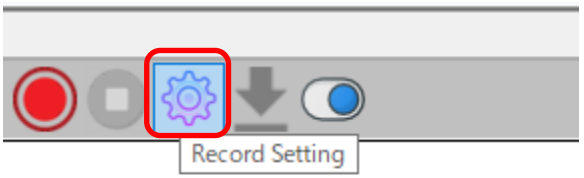


Figure 7-18: Record Setting button

By pressing the **Record Setting** button, the **Record Setting** window showed in Figure 7-4 will be displayed, and you can change the record conditions.

Save Record

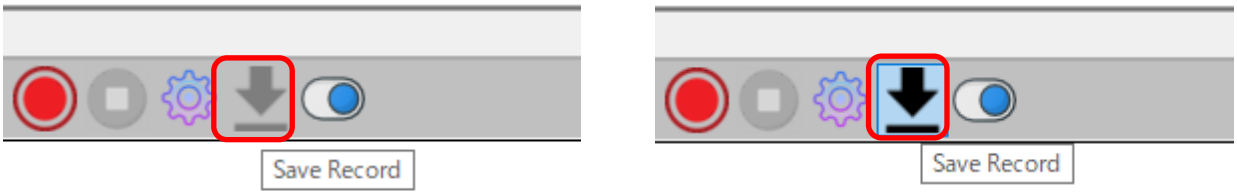


Figure 7-19: **Save Record** button

Records can be saved when the button is active.

By pressing the **Save Record** button, you can save the data from **Start** to **Stop** by specifying the save destination.

Scroll Bar State

Figure 7-20: Scroll Bar State button

The arrangement of spectrum data is ascending in case of left and descending in case of right

Press the Scroll Bar State button to display the spectrum data frame in descending order, and pressing it again will be in ascending order.

Other Easy Access Buttons

Other toolbar buttons work exactly the in same way they do for the spectrum measurement. For details, refer to ″Other Easy Access Buttons″ in the chapter of spectrum measurement.

Saving a Strip Chart

Saving a strip chart follows a similar procedure for saving a spectrum measurement. For details, refer to "Saving the Current Spectrum Measurement" in the chapter of spectrum measurement.

Loading Saved Strip Chart

If you need to load a previously saved strip chart curve, you can follow the same steps for loading a saved spectrum curve. For details, refer to "Loading Saved Spectrum Curve" in the chapter of spectrum measurement.

Deleting Individual Strip Chart Curves

When you have multiple curves on the same strip chart, you might want to delete one of

them. You delete individual strip chart curves in the same way you delete spectrum curves. For details, refer to "Deleting Individual Spectrum Curves" in the chapter of spectrum measurement.

Printing and Previewing a Strip Chart

The steps for printing and previewing a strip chart are the same as in printing and previewing a spectrum measurement. For details, refer to "Printing and Previewing a Spectrum Measurement" in the chapter of spectrum measurement.

8. Absorbance Measurement

Absorbance is calculated from the spectrum of the light source and the spectrum of light passing through the object to be measured. Therefore, to measure the absorbance, first measure the spectrum of the light source, then set the object to be measured and measure the light that passed through the object. When the measurement is completed, the program automatically calculates the absorbance spectrum.

Creating an Absorbance Measurement

For the measurement of the absorbance, select **Absorbance** from the **Measurement** menu and open the **New Absorbance Measurement** window, as shown below:

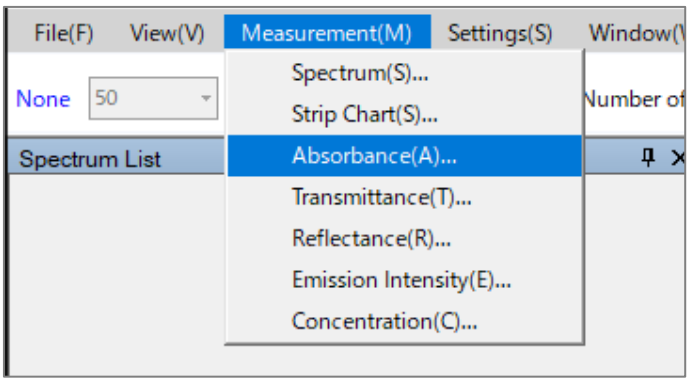


Figure 8-1: Selecting **Absorbance** from the **Measurement** menu to create a new absorbance measurement

Then, you will see the following window:

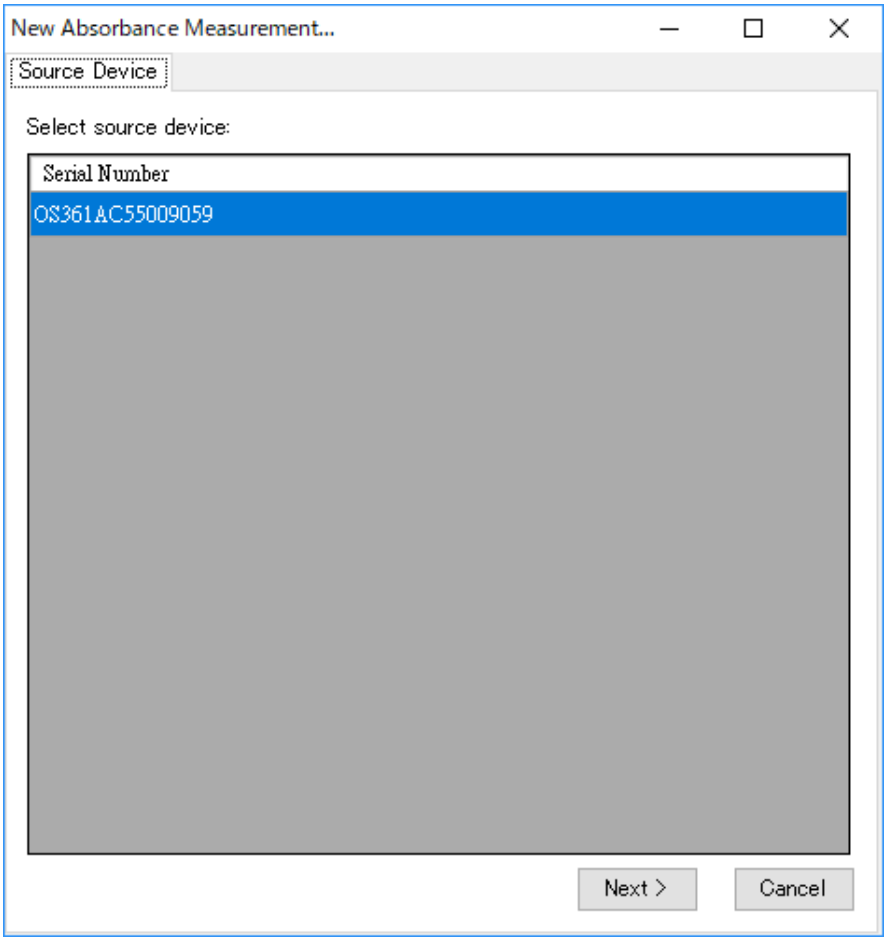


Figure 8-2: **New Absorbance Measurement** - **Source Device**

Selecting a Source Device

On the **Source Device** window, please select a source device (identified by its serial number). Then, click **Next**.

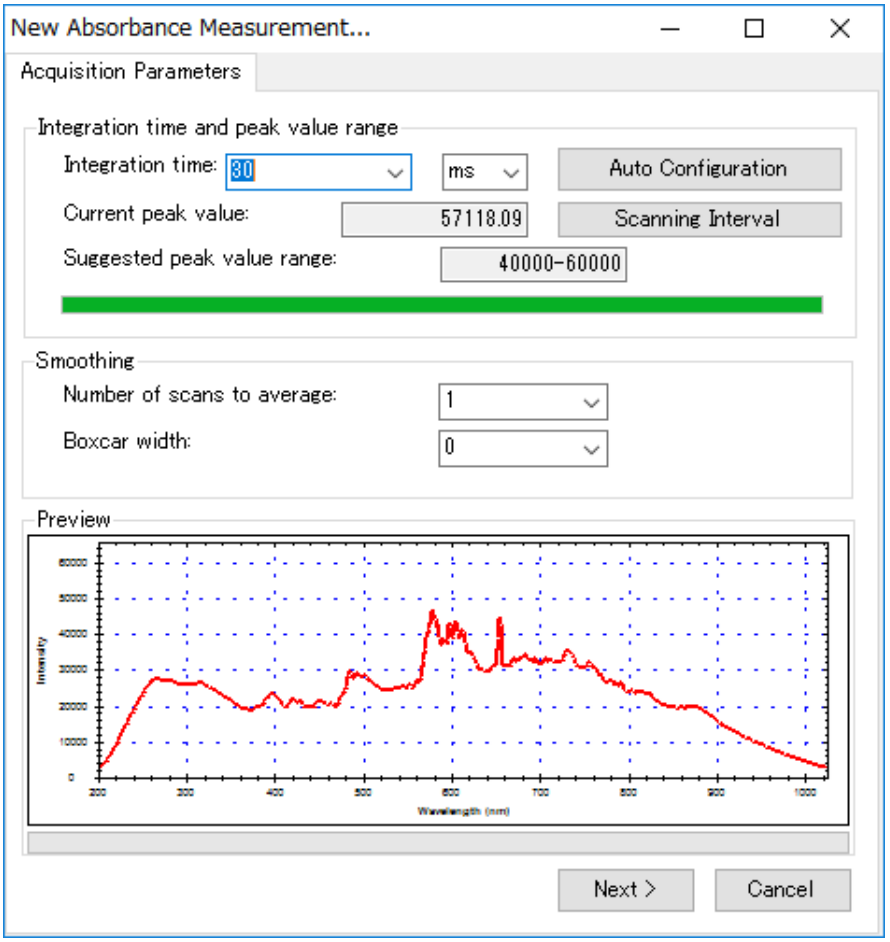


Figure 8-3: **New Absorbance Measurement** - **Acquisition Parameters**

Specifying Integration Time

Then specify the integration time (sensor exposure time) on the **Acquisition Parameters** window. In the program, the default integration time is set automatically when the window is opened. Adjust the integration time while referring to the preview at the bottom of the screen as necessary. The preview will change as you adjusted, so set the peak value within the **Suggested peak value range** on the window. In the example, the peak value is set within the range of **40000-60000**.

If the adjustment is not successful, you can press the **Auto Configuration** button to have the program automatically recovered to default setting.

After setting the integration time, set the spectrum scanning interval if you need. Press **Spectrum Scanning Interval**, select **Enable user-defined spectrum scanning interval**, and

then specify the interval you want (the default is 500ms), as in the following:

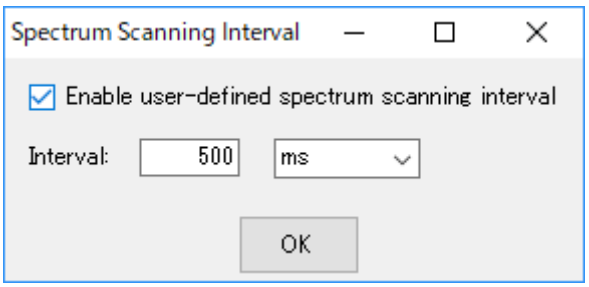


Figure 8-4: Spectrum Scanning Interval

Smoothing

In addition to the integration time and the scanning interval, you can also choose whether to smooth out the curve. Specify the number of scans to calculate the average value for "Average count". This makes it possible to reduce curvature fluctuation more than a single data acquisition. In the **Boxcar width**, specify the number of data used for moving average calculation. This smooths out the sharp variations on the curve: the bigger the Boxcar width of, the smoother the curve. The following figure demonstrates the smoothing effect when Boxcar width is 10 (maximum value). Compare it with the original Figure 8-3 without smoothing.

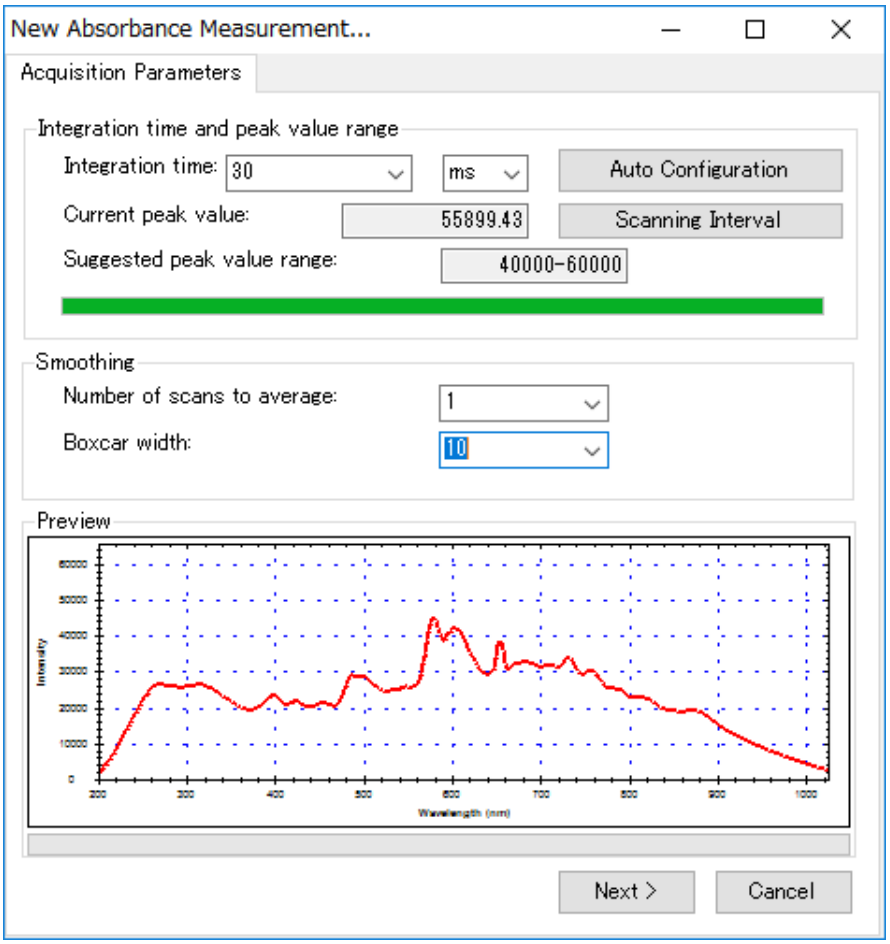


Figure 8-5: **New Absorbance Measurement** - the smoothing effect

Note: The following example uses the default settings, i.e. no smoothing (Number of scans to average=1, Boxcar width=0).

When all acquisition parameters are set, click **Next**.

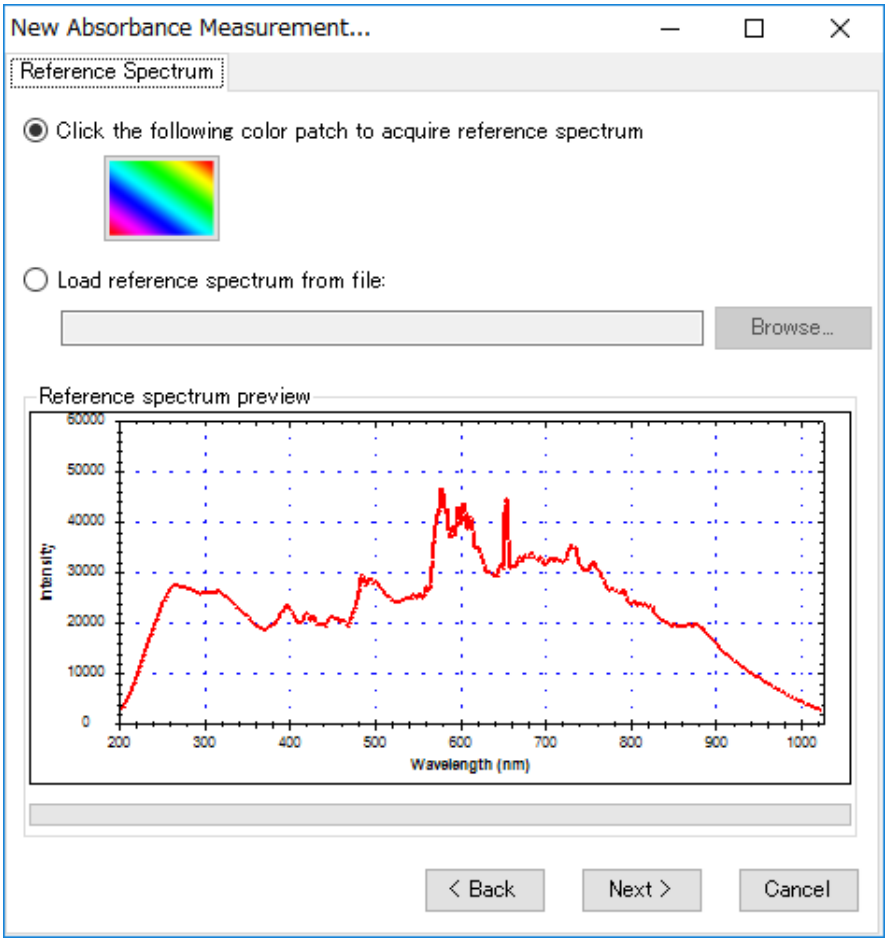


Figure 8-6: **New Absorbance Measurement** - **Reference Spectrum**

Setting Reference Spectrum

Next, you need to set a "reference spectrum," which is basically the spectrum of the light source before set the test object in place. Here, you can click on the color patch on the window to acquire the live spectrum as the reference. Or, if you previously saved the reference spectrum file you can read it using the **Browse** button. In this example, the current light source is being read as a reference spectrum (**as such, please don't put the test object in place**). Once the reference spectrum is captured, you can check the spectral data in the preview at the bottom of the screen. Then press **Next**.

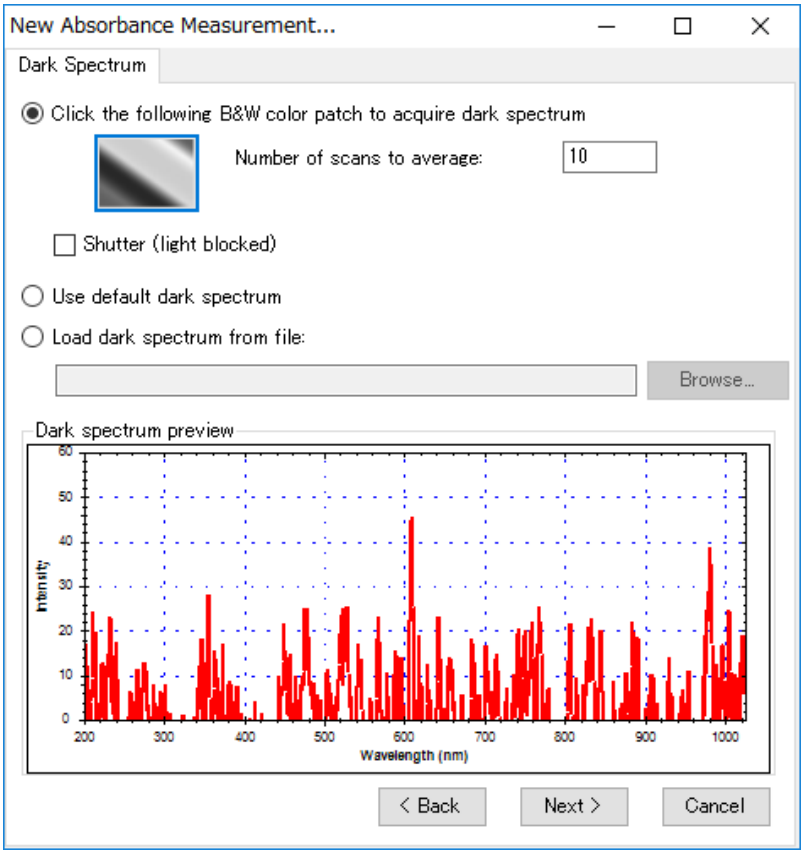


Figure 8-7: **New Absorbance Measurement** - **Dark Spectrum**

Setting Dark Spectrum

After setting the reference spectrum, set the measurement value when light sensor is not exposed to light to establish a baseline, i.e. the "dark spectrum." So, please cut off or block the light source connected to the spectrometer. Then, click on the black-and-white patch on the window to acquire the dark spectrum. It is possible to calculate and set the average value by multiple acquisitions rather than one acquisition. For the example 10 is used, instead of the default 1. Once the dark spectrum is acquired, you can check the spectrum graph on the lower half of the window, as in the former figure. In addition, you will see an "**Acquiring dark spectrum...**" message window. See the following figure:

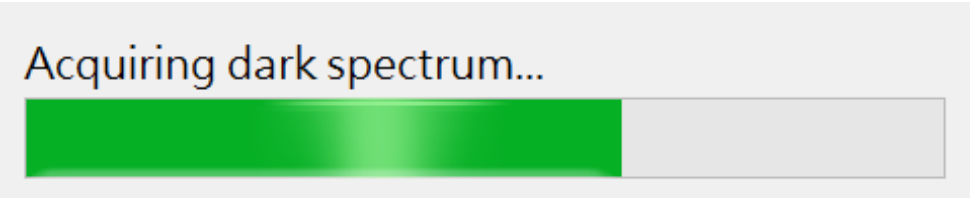


Figure 8-8: Acquiring dark spectrum...

Other than actually acquired dark spectrum, it is also possible to use the default dark spectrum, or to use a previously saved dark spectrum file. The default dark spectrum is for test purposes only, please be carefully when using. The following figure shows the case when **Use default dark spectrum** is selected.

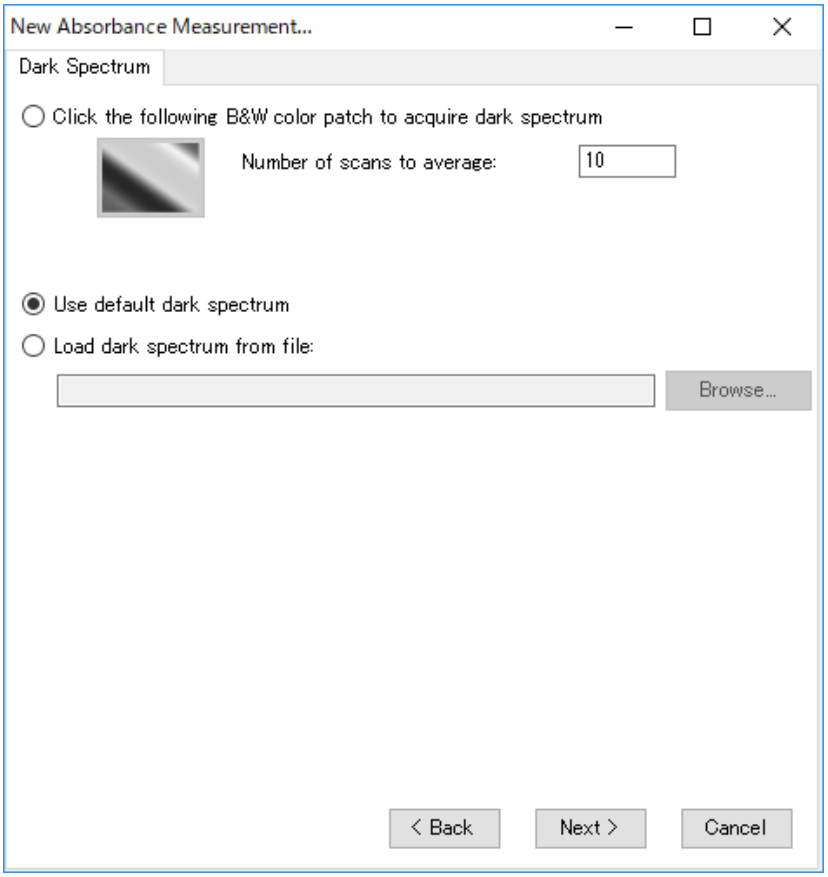


Figure 8-9: **New Absorbance Measurement** - Using the default dark spectrum

Note: This example uses the dark spectrum captured in real-time (not the default dark spectrum).

Once the dark spectrum is set, click **Next**.

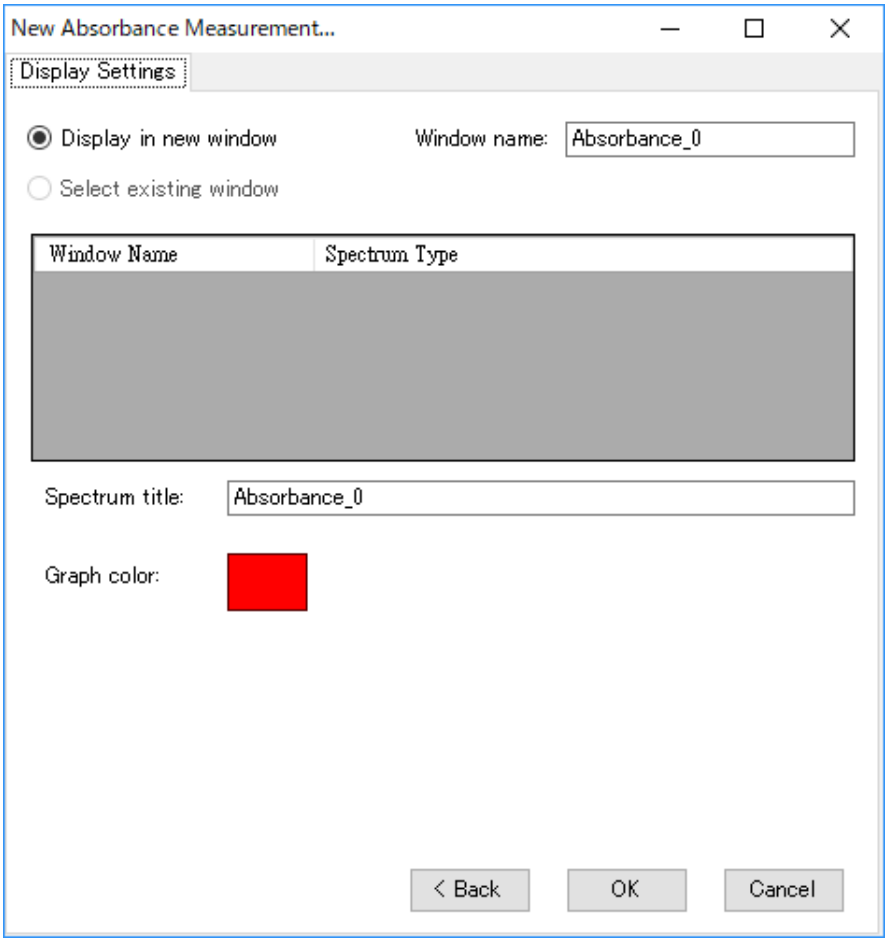


Figure 8-10: **New Absorbance Measurement** - **Display Settings**

Display Settings

Next, you can specify a name for the measurement graph window, as well as a spectrum title and a color for the graph, as in the former figure. To specify the color, you can click on the color patch and select the desired color from the palette:

Figure 8-11: **Display Settings** – **Color**

When you finish setting the display, click **OK**. The measurement graph is displayed as shown below.

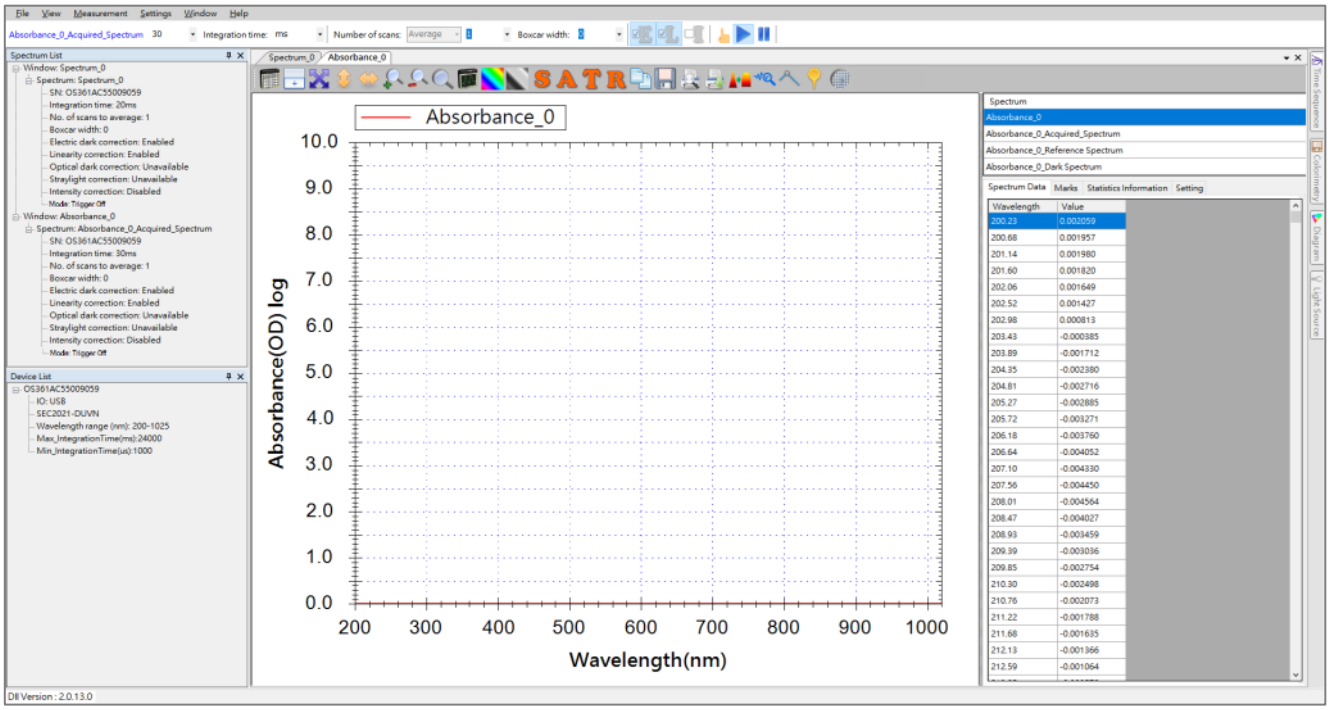


Figure 8-12: Newly created absorbance measurement graph

Start Measuring the Absorbance of the Test Object

After setting the absorbance measurement graph, set the objet to be measured. Here we measure the absorbance curve of a white transparent filter for demonstration. Its absorbance measurement graph looks like the following:

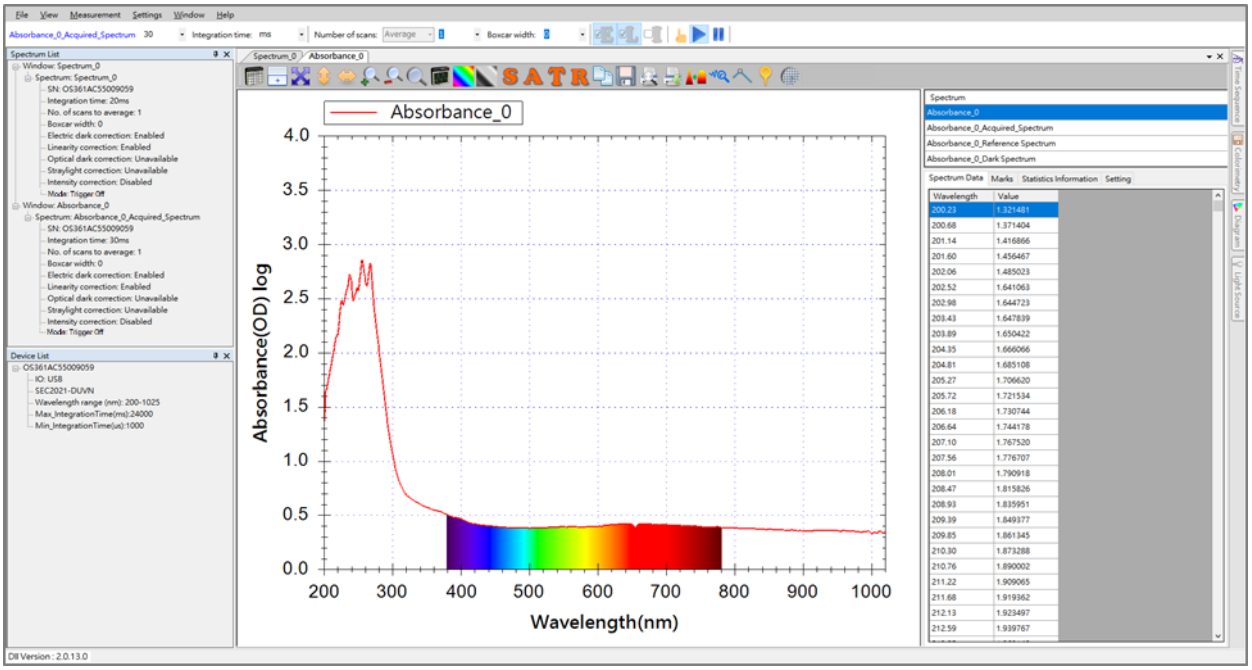


Figure 8-13: The absorbance graph of a white transparent filter

As shown in the above figure, the white transparent filter absorbs light of all visible wavelengths, and absorption was observed over a wavelength in general.
When placing a blue transparent filter, the absorbance in the blue wavelength range of the spectrum becomes lower than the absorbance in the other wavelength range (meaning that more blue light passes through the filter) as shown in the figure.

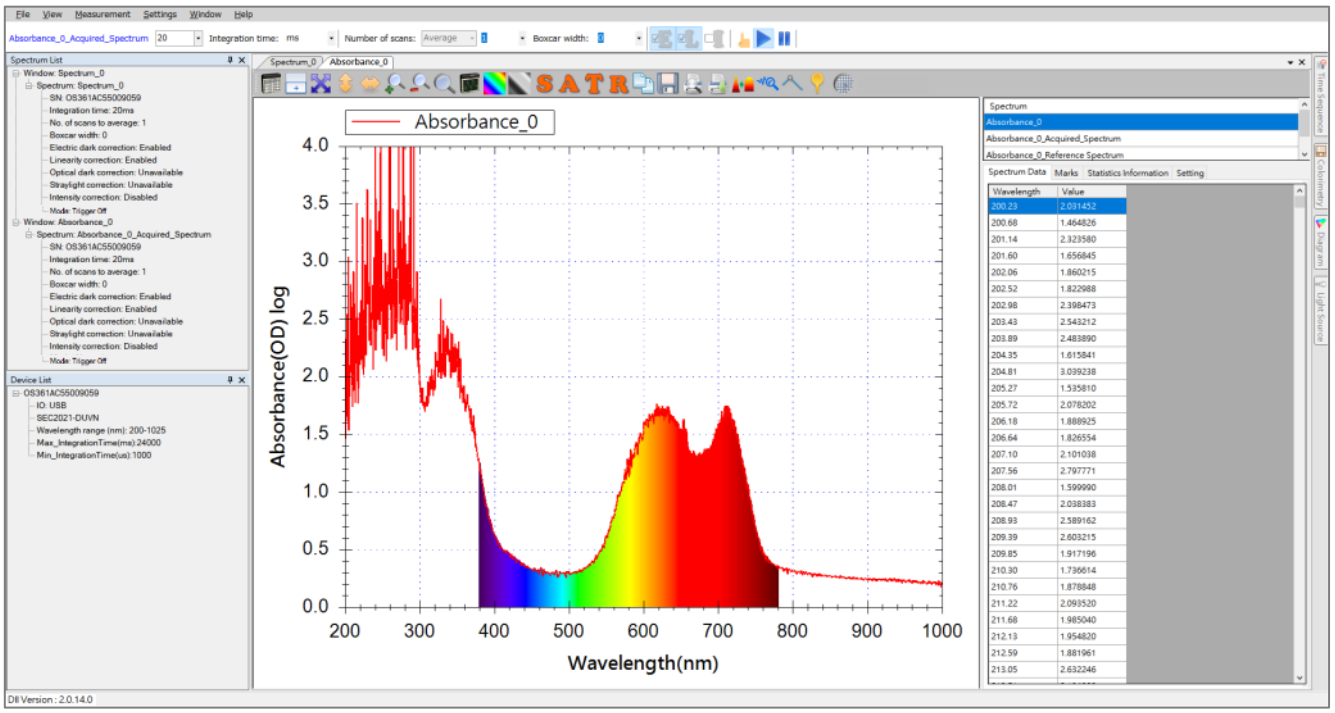


Figure 8-14: The absorbance graph of a blue transparent filter

Checking the Acquired Spectrum Curve

The absorbance curve is calculated from multiple spectrums. SpectraSmart has a function to examine the original spectrum curve. This function is activated clicking the **Acquired Spectrum** button on the toolbar, as shown in the following figure.

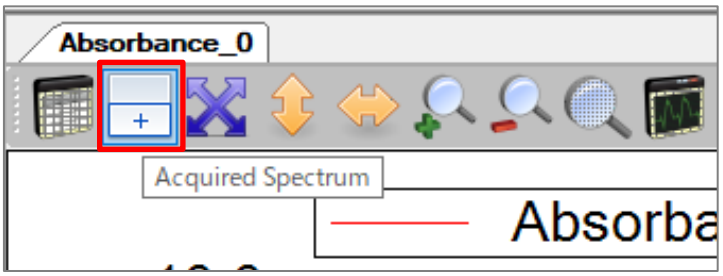


Figure 8-15: The **Acquired Spectrum** button

The following three figures show the absorbance graphs with their acquired spectrums for the original light source, the white transparent filter, and the blue transparent filter, respectively:

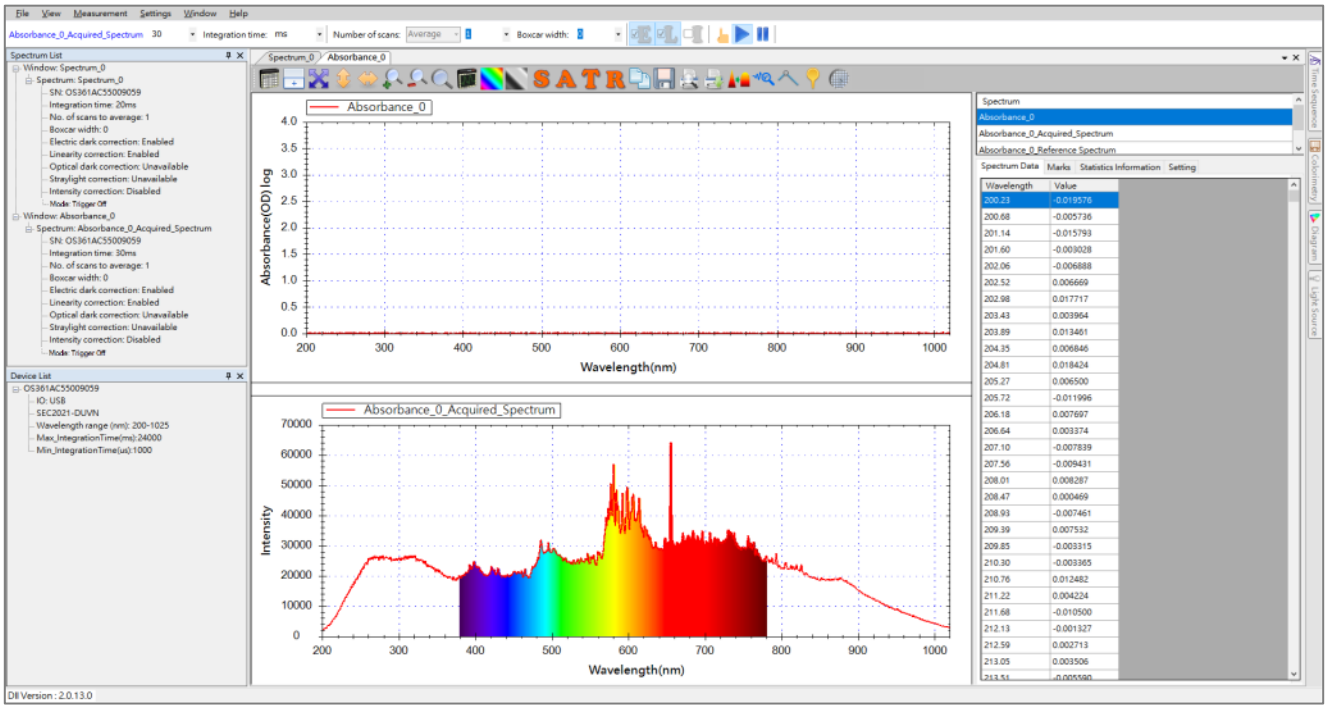


Figure 8-16: The acquired spectrum of the absorbance measurement for the original light source

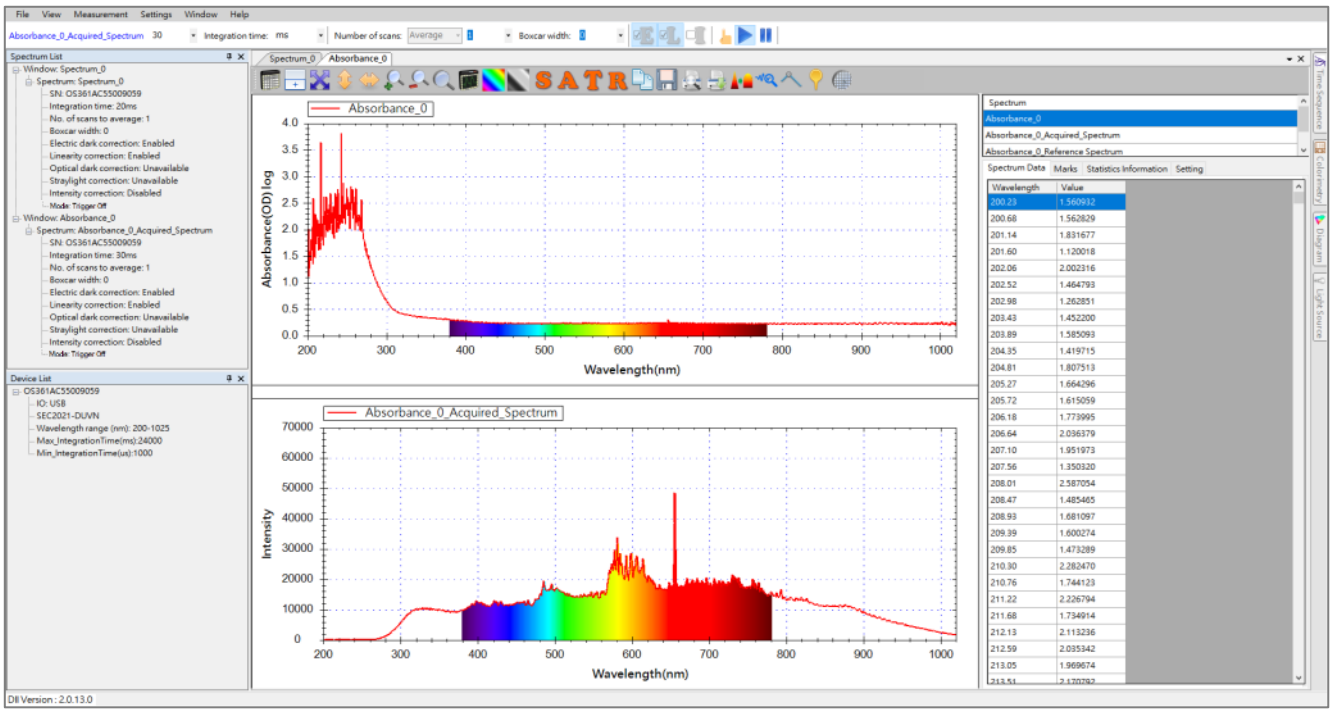


Figure 8-17: The acquired spectrum of the absorbance measurement for the white transparent filter

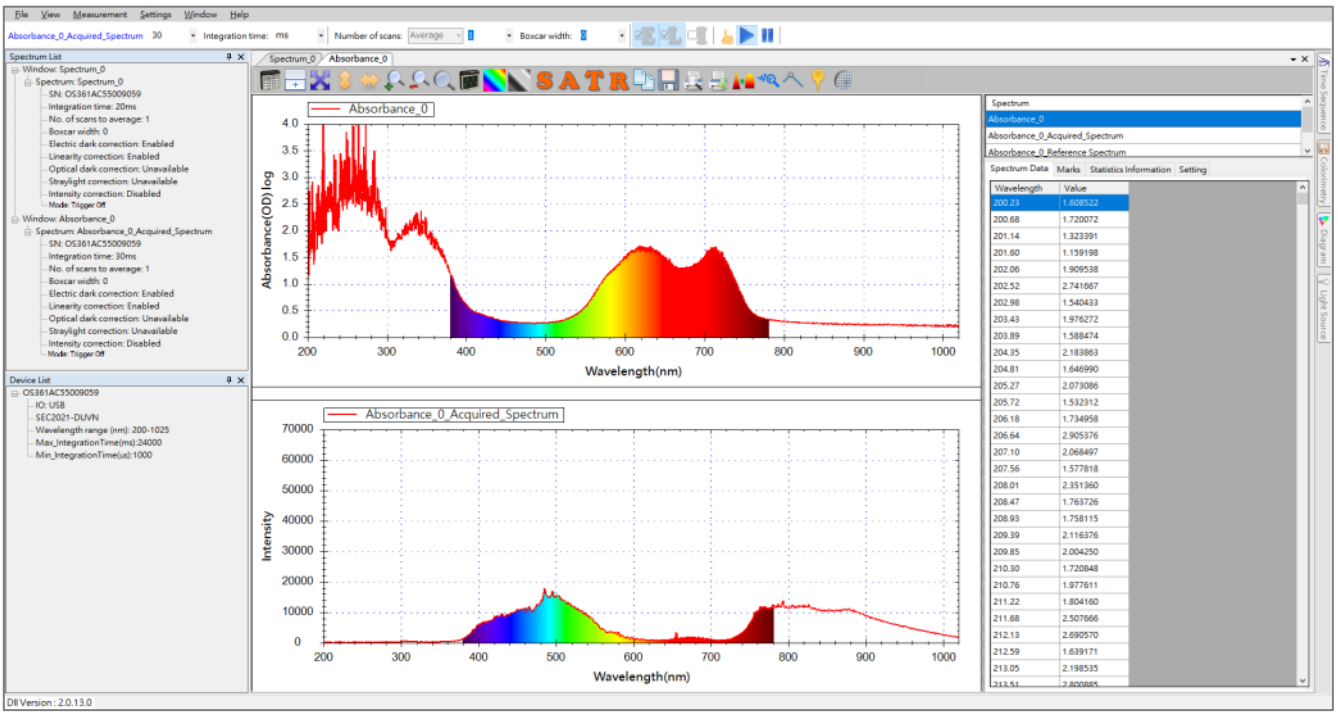


Figure 8-18: The acquired spectrum of the absorbance measurement for the blue transparent filter

From the above figure, it can be seen that the curve of the white transparent filter dropped significantly compared to the curve of the light source. The lowered part is the amount of light absorbed by the filter. In the curve of the blue transparent filter, the blue visible region remains, and almost all the light in the other wavelength region is absorbed.

Graph Toolbar Buttons

The toolbar button of the absorbance measurement graph is almost the same as the toolbar of the spectrum measurement graph.

Smoothing

In the absorbance measurement, **Smoothing** is often used. For example, you can see a large jaggy in the absorbance curve of the previous blue transparent filter. If you apply smoothing with the **Smoothing** button at the top of the graph this jaggedness will be improved.

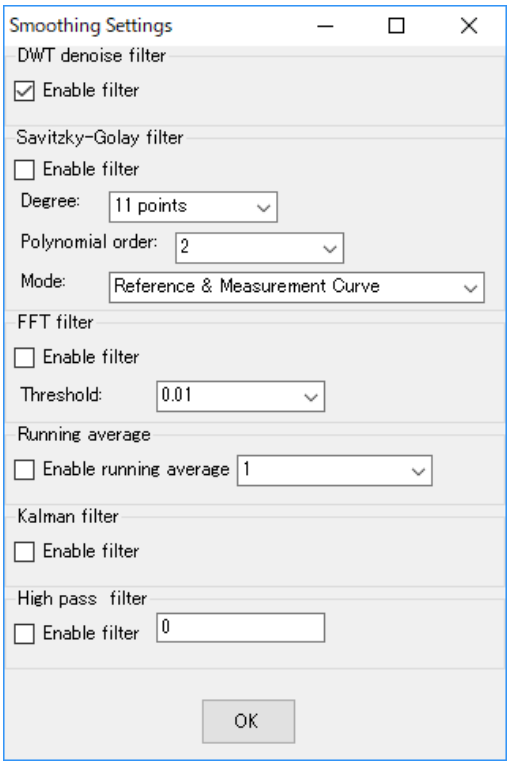


Figure 8-19: The **Smoothing Settings** window

Here we enable the **Savitzky-Golay filter** and select **11 points** for the smoothing **Degree**. Then, click **OK** to see its effect:

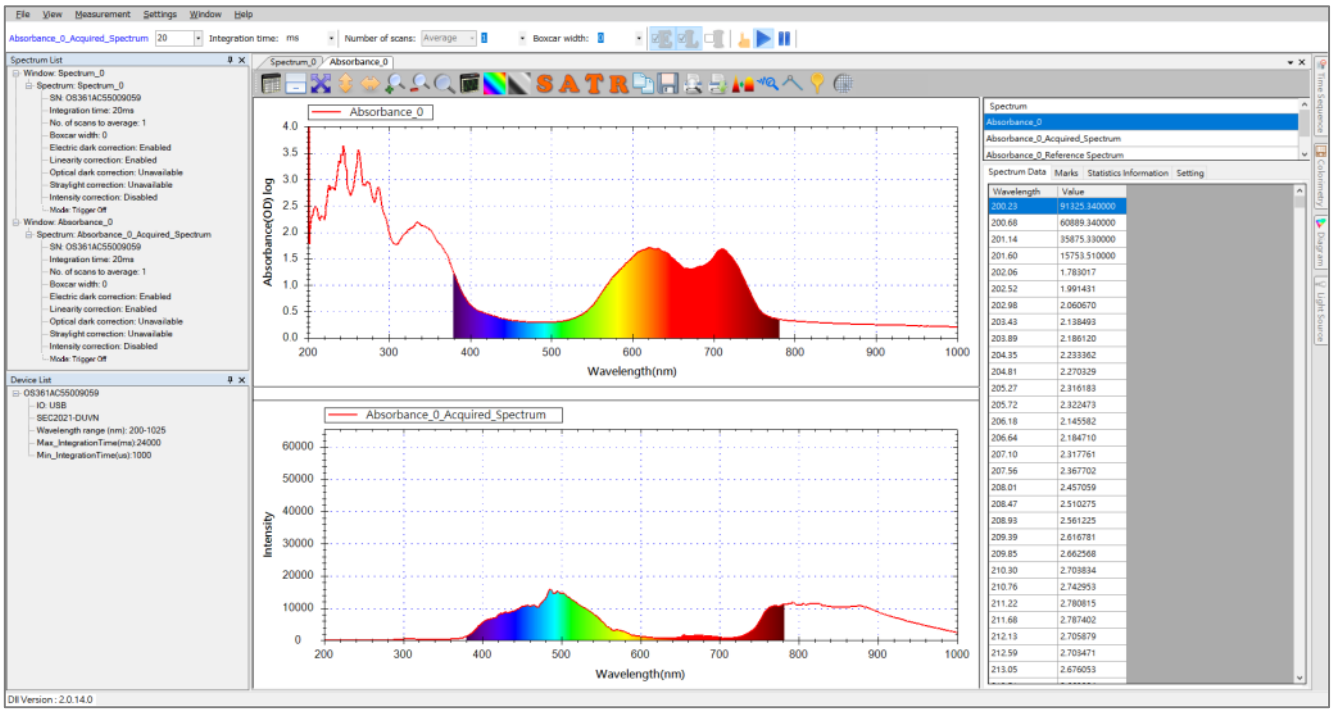


Figure 8-20: Enabling **Smoothing** effect for the absorbance graph of the blue transparent filter

As the figure shows, smoothing has made the curve more continuous and smoother.

Measurement Mode Switching Buttons

In addition to the toolbar buttons described in the chapter of spectrum measurement, the absorbance, transmittance, and reflectance measurements all have a set of measurement mode switching buttons:

Figure 8-21: Measurement mode switching buttons

When measuring absorbance, transmittance, and reflectance, SpectraSmart allows you to switch among four measurement modes: **S** (spectrum), **A** (absorbance), **T** (transmittance), and **R** (reflectance). Therefore, this set of buttons is available on the toolbar of these three measurement graphs. The following four figures show the absorbance graphs of the blue filter glass in four different modes (**S**, **A**, **T**, **R**), respectively:

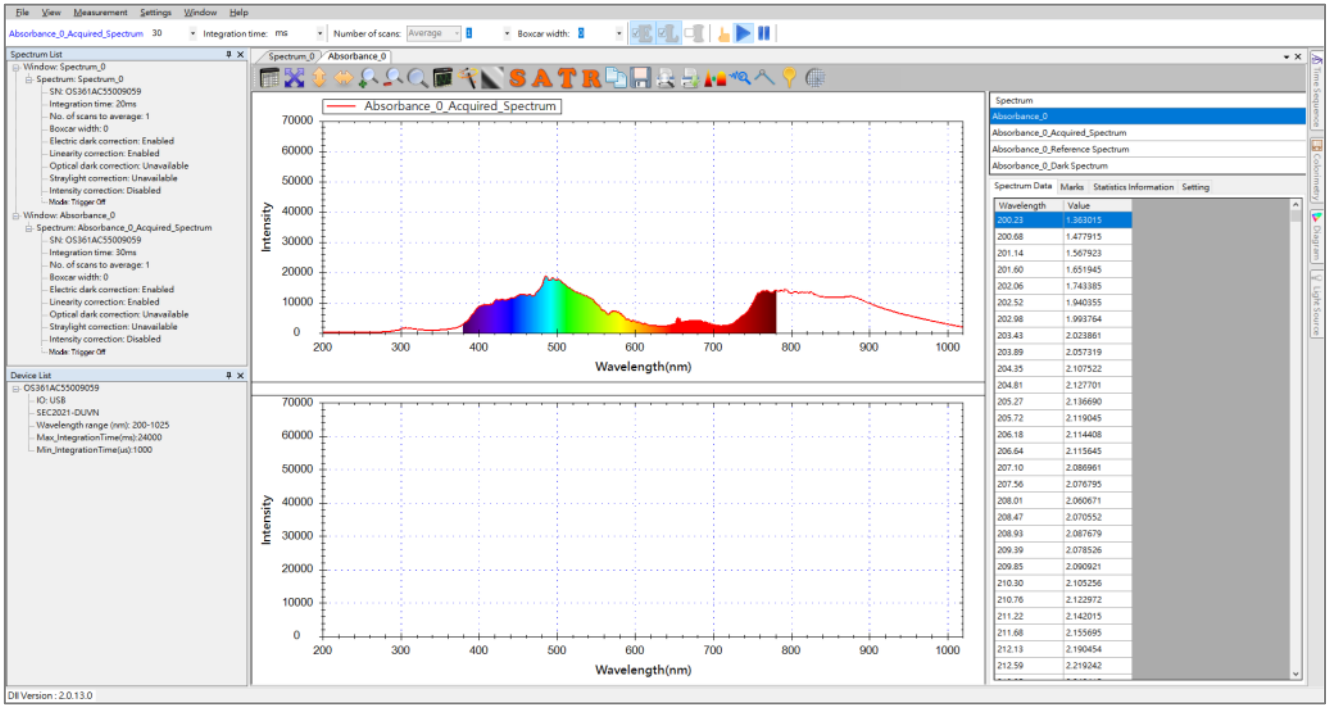


Figure 8-22: Mode switching - **S** (spectrum) mode button

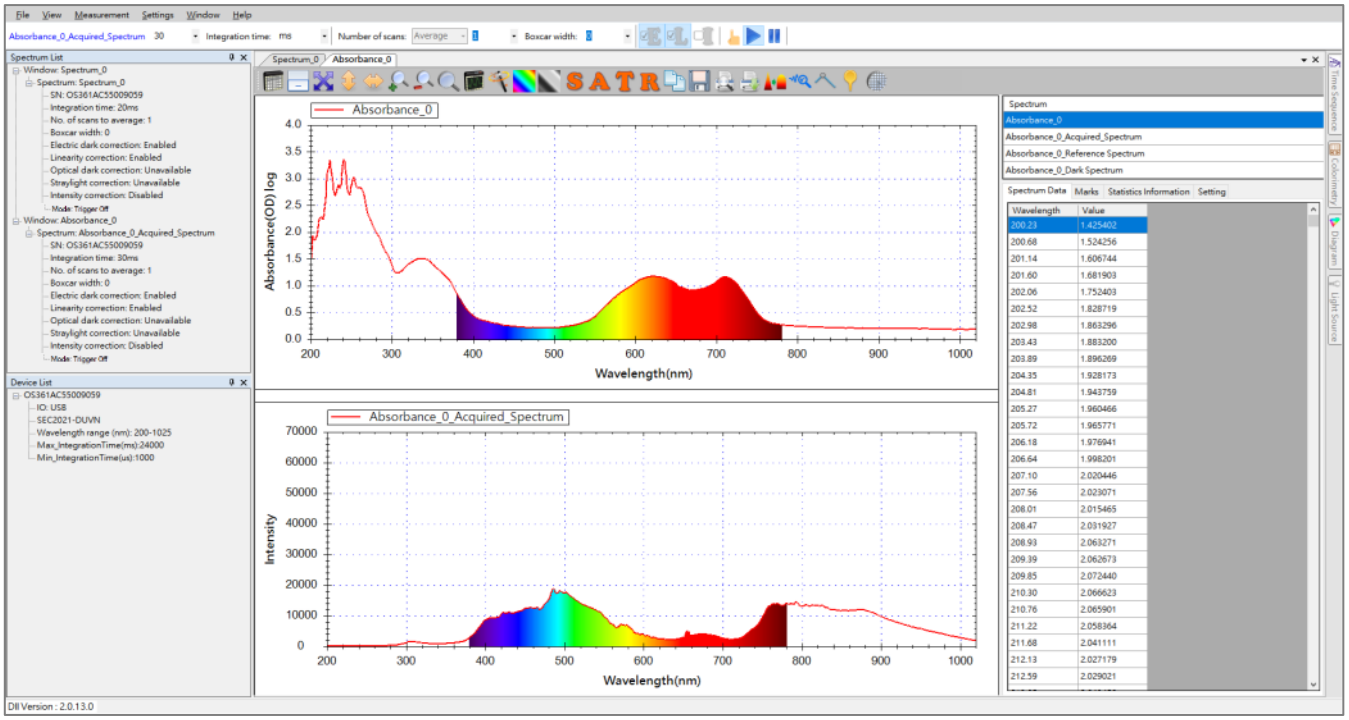


Figure 8-23: Mode switching - **A** (absorbance) mode button

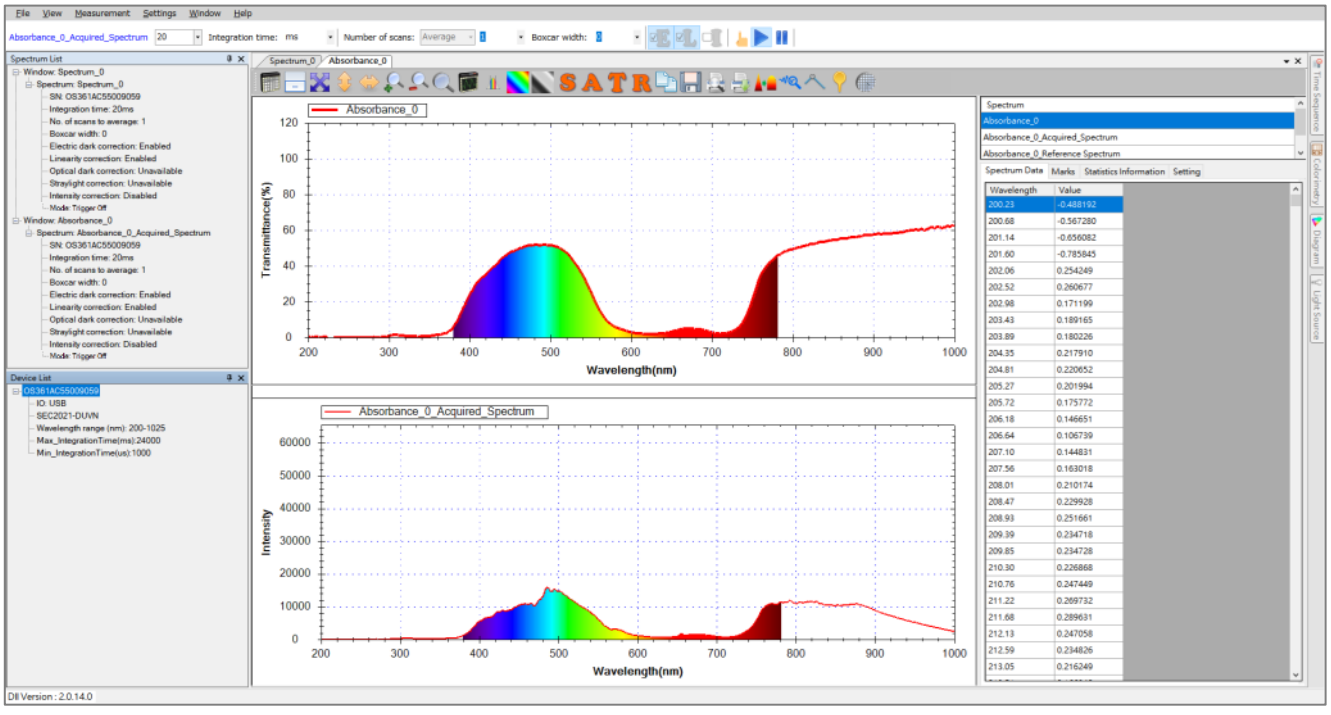


Figure 8-24: Mode switching - **T** (transmittance) mode button

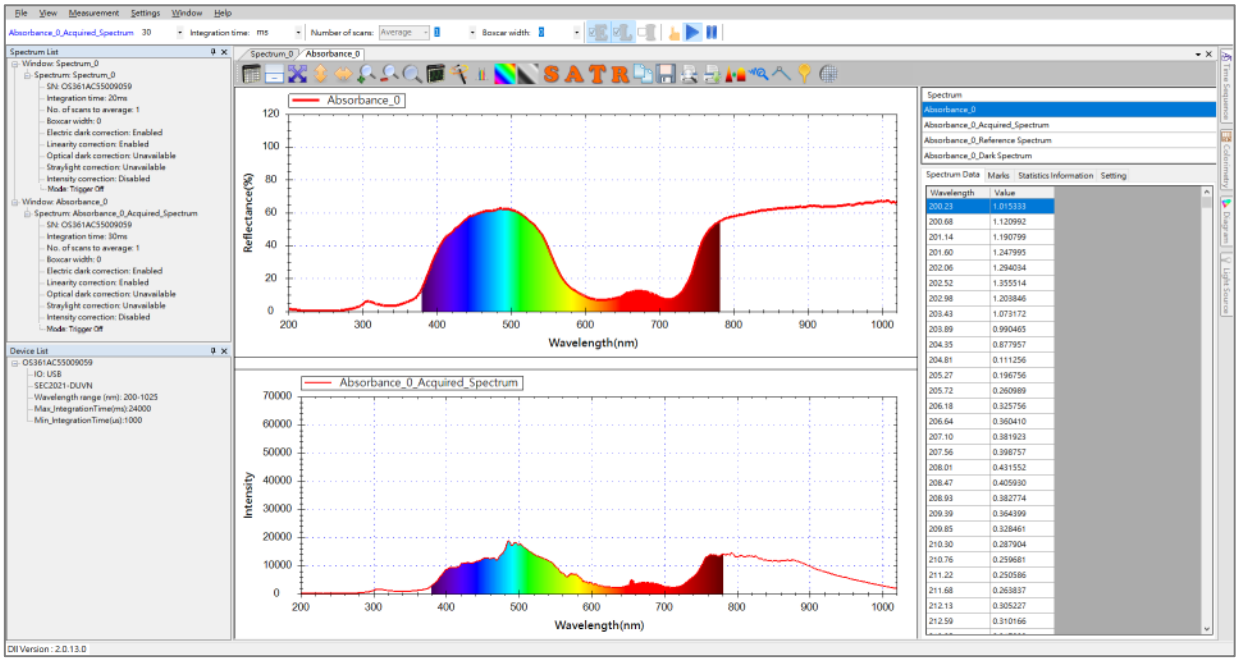


Figure 8-25: Mode switching - **R** (reflectance) mode button

S (spectrum) mode graph corresponds to the "acquired spectrum" of the absorbance measurement. Since we are using the blue transparent filter as an example, the blue lights of the spectrum becomes particularly strong. On the other hand, **T** (transmittance) and **R** (reflectance) modes are opposite of the absorbance. This is because the absorbance mode measures the amount of light absorbed by the filter, while the transmittance mode measures the amount light pass through the filter. Furthermore, the reflectance curve and the transmittance curve look very similar, the reflectance mode measures the light reflected from the test object, it virtually equals to the remaining light after being absorbed by the test object.

Setting a New Reference Spectrum or Dark Spectrum

In some cases, it may be necessary to set a new reference spectrum or a new dark spectrum during the measurement. Even without the re-measuring, you can reset the reference and dark spectrum on the toolbar button provided in the SpectraSmart. See the following figure:

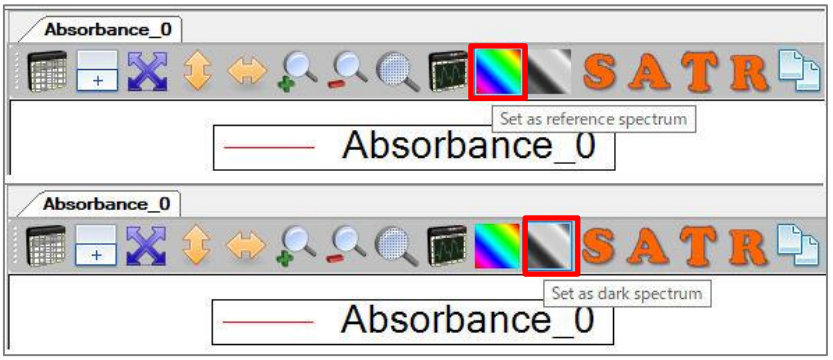


Figure 8-26: **Set as reference spectrum** and **Set as dark spectrum** buttons

Switch the current reference light source to the new light source, and then press **Set as reference spectrum**. The spectrum captured from the new light source will now be the new reference spectrum. Similarly, you can simply block the current light source or switch to another light source as the baseline, and then press **Set as dark spectrum** to capture and set the new dark spectrum.

Basically, whenever a measurement needs a reference spectrum to work, the **Set as reference spectrum** button will appear on the toolbar. This includes measurements for absorbance, transmittance, reflectance, and concentration. If you can reset the dark spectrum as well, the **Set as dark spectrum** button on the toolbar will be displayed automatically. This is the same for transmittance, absorption rate, reflectance, and concentration measurement.

Saving Absorbance Measurement

Saving an absorbance measurement is similar to saving a spectrum measurement, except that the spectrum measurement only one spectrum curve is saved, while for the absorbance measurement, four spectrum curves: reference spectrum, dark spectrum, absorbance curve, and the acquired spectrum are saved.

Using the **Save selected spectrum as**, on the toolbar button, only one spectrum curve is saved at a time. To save all the spectrum curves in a measurement, you need to use the **Save all spectrums in** option in the pop-up menu of the spectrum data frame. Once saved, you will see all four spectrum curves in the specific folder.

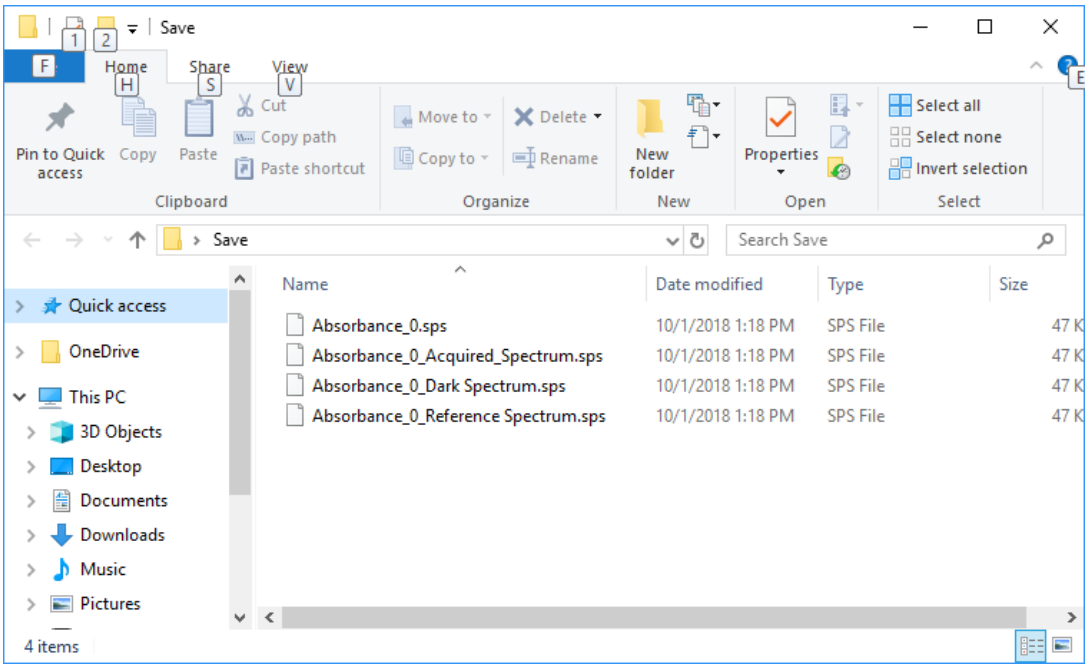


Figure 8-27: Saving all spectrums in an absorbance measurement using the **Save all spectrums in** option

For more details, please refer to "Saving the Current Spectrum Measurement" in the chapter of spectrum measurement.

Loading Saved Spectrum Curve of an Absorbance Measurement

In order to read the previously saved absorbance spectrum, you can only read one spectrum curve at a time just like "Loading Saved Spectrum Curve". For details, refer to "Loading Saved Spectrum Curve" of spectrum measurement.

Deleting Individual Spectrum Curves of an Absorbance Measurement

An absorbance measurement is composed of multiple spectrum curves. As such, **please don't delete any individual curve from the measurement as they function as one. Doing so will destroy the entire measurement.**

Printing and Previewing an Absorbance Measurement

The method of printing and previewing a absorbance measurement is the same as the spectrum measurement. Please refer to "Printing and Previewing a Spectrum Measurement" in the chapter of spectrum measurement.

9. Transmittance Measurement

The transmittance is calculated from the spectrum of the light source and the spectrum after it has passed through the object to be measured. Therefore, similarly to the measurement of absorbance, in order to measure the transmittance, first measure the spectrum of the light source, then measure the light transmitted through the object to be measured. When the measurement is completed, the program automatically calculates the transmittance spectrum.

Creating a Transmittance Measurement

For the transmittance measurement, select **Transmittance** from the **Measurement** menu and open the **New Transmittance Measurement** window, as shown below.

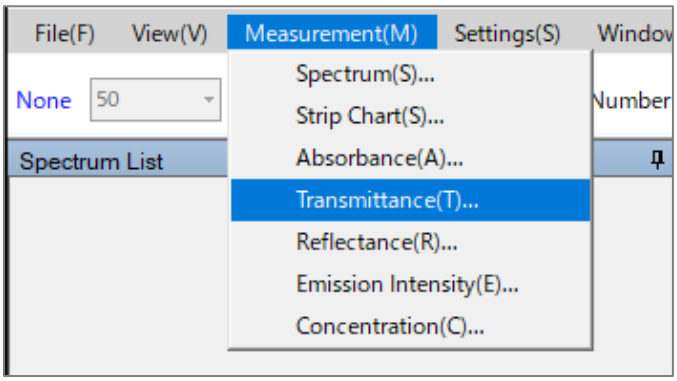


Figure 9-1: Select **Transmittance** from the **Measurement** menu and open a new transmittance measurement

Then, you will see the following window:

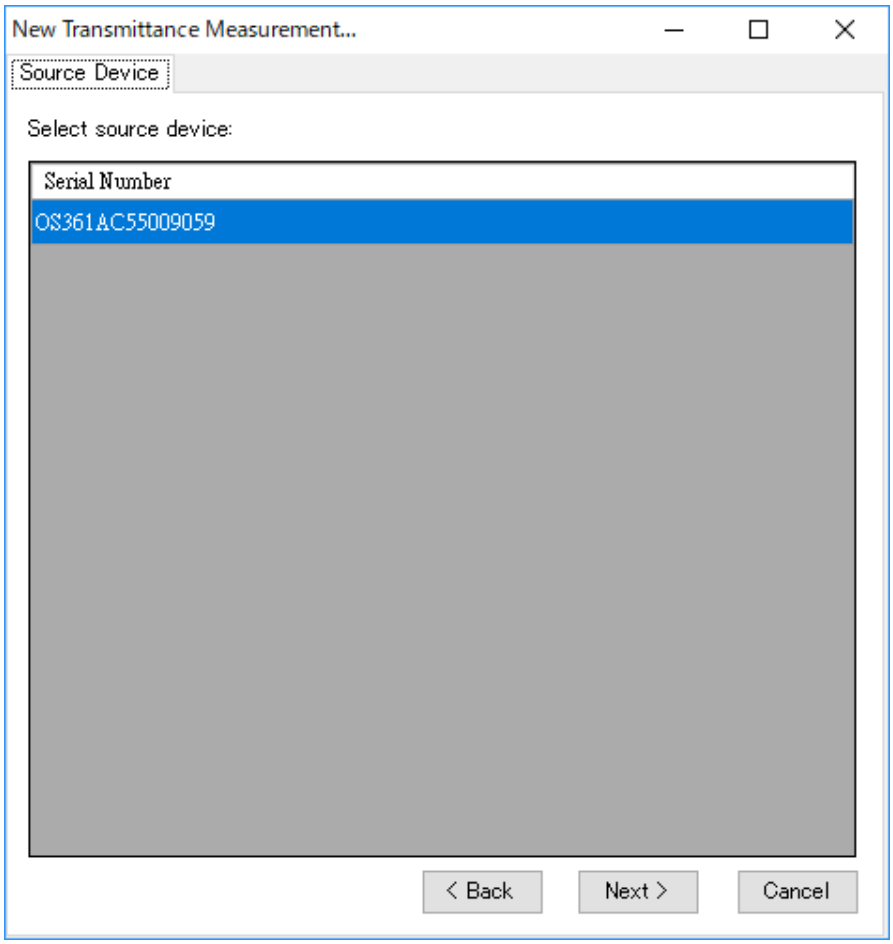


Figure 9-2: **New Transmittance Measurement** - **Source Device**

Selecting the Source Device

First, select the source device (identified by the device serial number) on the **Source Device** window. Then, click **Next**.

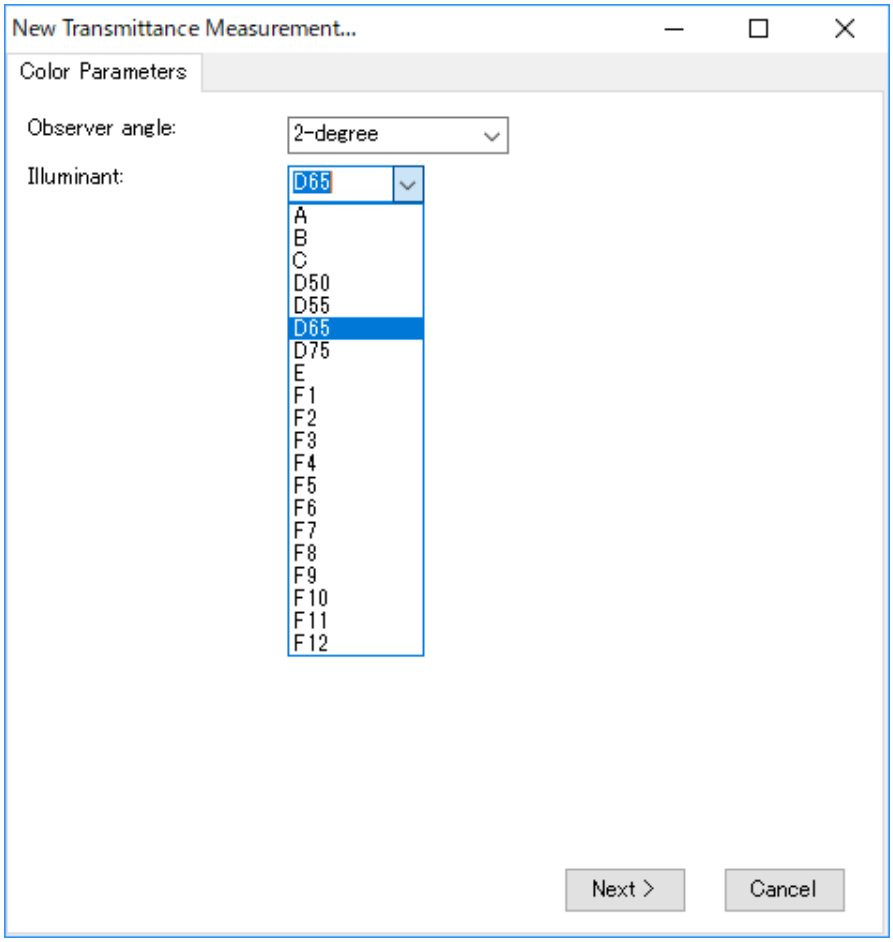


Figure 9-3: **New Transmittance Measurement** - **Color Parameters**

Setting Color Parameters

For transmittance measurement, specify the viewing angle of CIE Standard Observer (**Observer angle**) and the type of light source (**Illuminant**) for accurate color measurement. SpectraSmart supports two standard observer viewing angles: 2-degree and 10-degree (corresponding to CIE 1931 and CIE 1964 standards, respectively), and number of standard light sources. In this example, two viewing angles and a D65 light source are specified. After finishing the select, click **Next**.

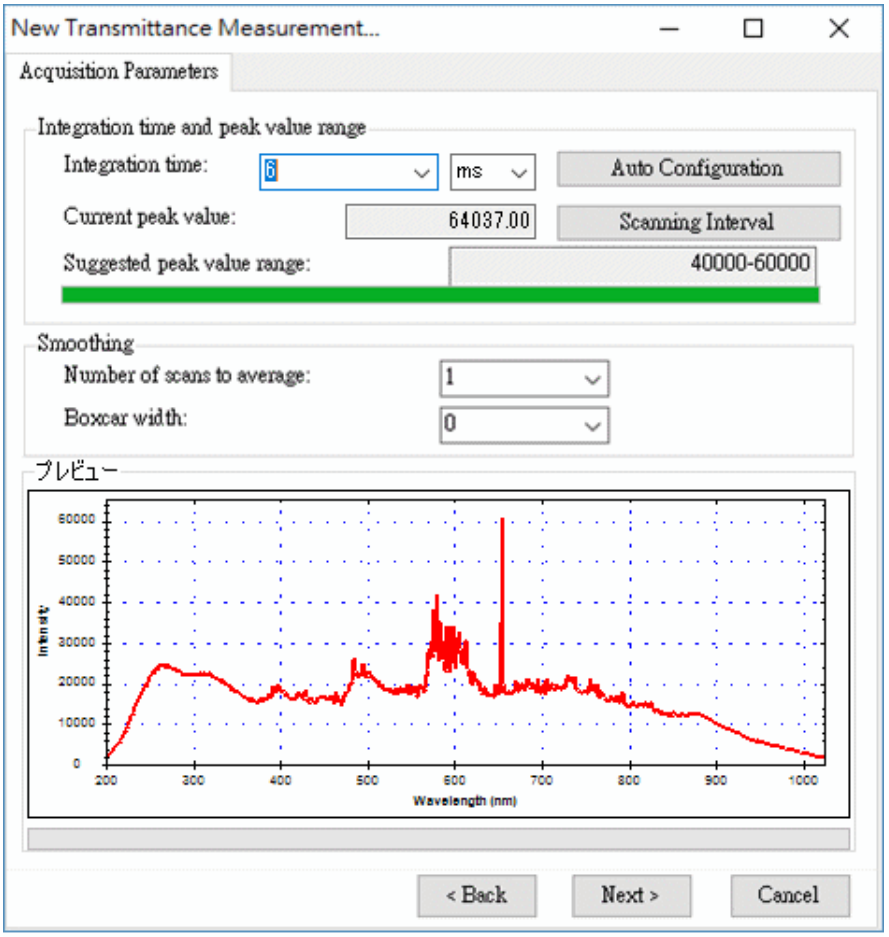


Figure 9-4: **New Transmittance Measurement** - **Acquisition Parameters**

Specifying Integration Time

Then specify the integration time (i.e. the exposure time for the light sensor) on the **Acquisition Parameters** window. In the program, the default integration time is set automatically when the window is opened. Adjust the integration time while referring to the preview at the bottom of the screen as necessary. The preview will change as you adjusted, so set the peak value within the **Suggested peak value range** on the window. In the example, the peak value is set within the range of **40000-60000**.

If the adjustment is not successful, you can press the **Auto Configuration** button to have the program automatically recovered to default setting. After setting the integration time, set the interval of the spectrum scan as necessary. Click the **Scanning Interval** button, then on the **Spectrum Scanning Interval** window, select **Enable user-defined spectrum scanning interval**, and specify the interval required (the default is 500 ms), as in the following:

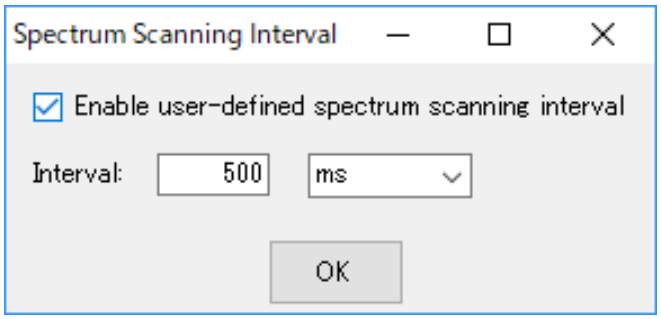


Figure 9-5: Spectrum Scanning Interval

Smoothing

Smoothing processing can be performed on the spectrum curve. Specify the number of scans to calculate the average value for "Number of scans to average". This makes possible to reduce the fluctuation of the curve even for only one acquisition data. For **Boxcar Width**, specify the number of data points on both side of the point of interest to include in the calculation of the moving average. This can reduce the sudden change of the curve. This smooths out the sharp variations on the curve: the bigger the Boxcar width, the smoother the curve. The following figure demonstrates the smoothing effect of a Boxcar width of 10 (maximum value). You can compare it with the former curve without smoothing to see the difference (see the red curve in the preview graph).

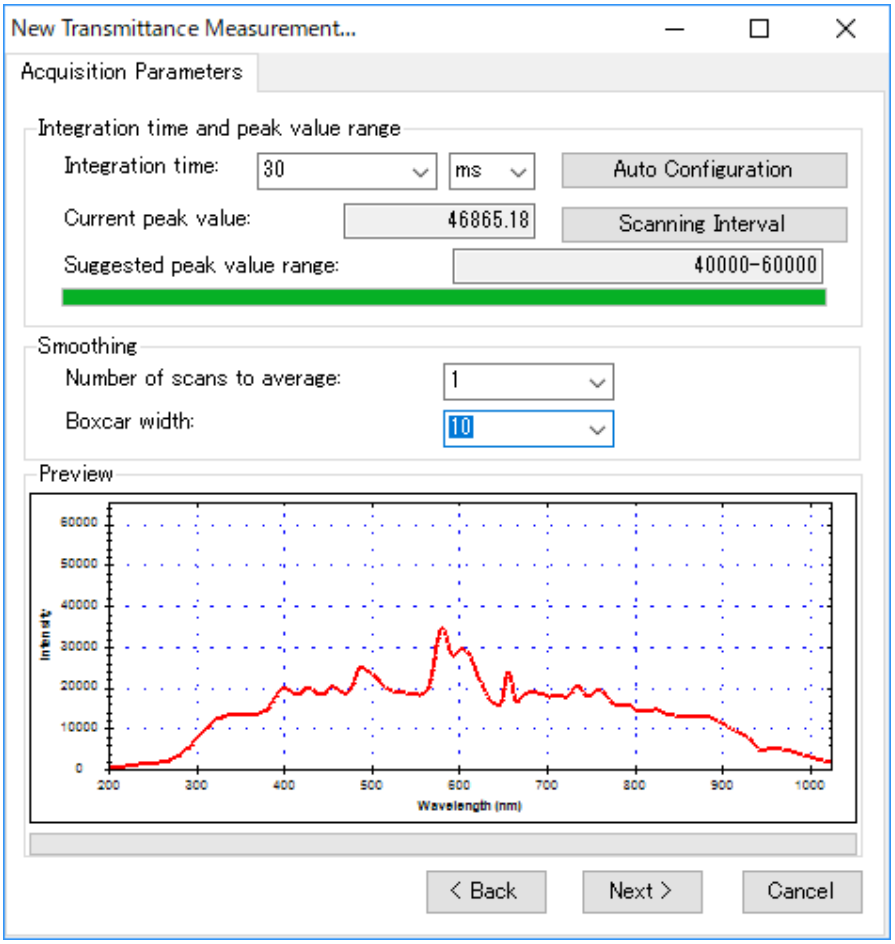


Figure 9-6: **New Transmittance Measurement** - the smoothing effect

When all acquisition parameters are set, click **Next**.

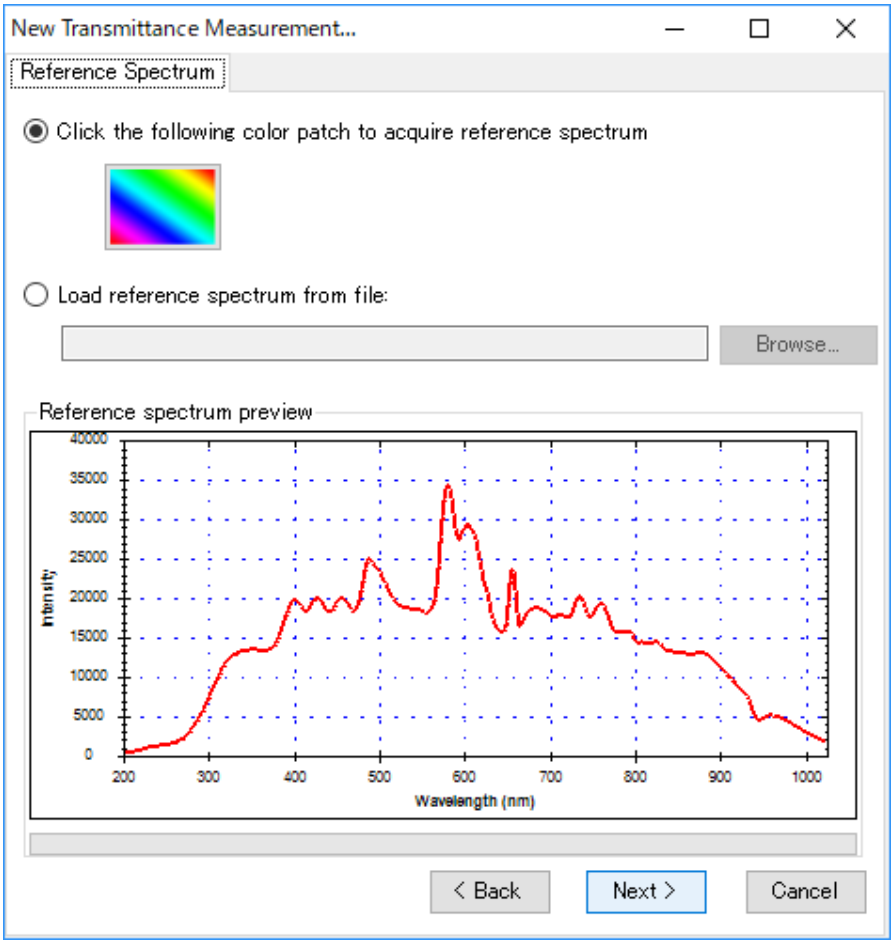


Figure 9-7: **New Transmittance Measurement** - **Reference Spectrum**

Setting Reference Spectrum

Set the light source spectrum where the object to be measured is not placed, that is, "reference spectrum". Here, you can click on the color patch on the window to acquire the live spectrum as the reference spectrum. Or, you can use the **Browse** button to load a previous reference spectrum file. In this example, we use the default option, that is acquiring the current live spectrum of the light source (**as such, please don't put the test object in place**). Once the reference spectrum is captured, you will see it in the preview graph on the lower half of this window. Then, click **Next**.

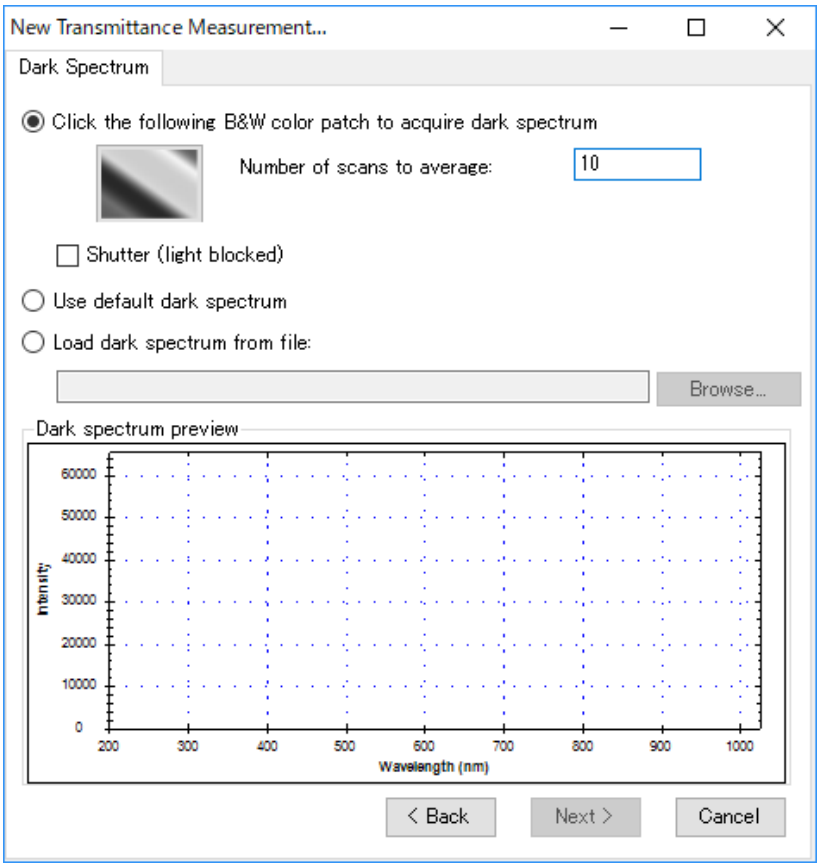


Figure 9-8: **New Transmittance Measurement** - **Dark Spectrum**

Setting Dark Spectrum

After setting the reference spectrum, set the measurement value when light does not hit the sensor, ie "dark spectrum". So, please cut off or block the light source connected to the spectrometer. Then, click on the black-and-white patch on the window to acquire the dark spectrum. It is possible to calculate and set the average value by multiple acquisition rather than one acquisition. The default is 1 time. For the example is 10 times. After acquiring the dark spectrum, you can check the spectrum acquired in the preview at the bottom of the screen. In addition, you will see an "**Acquiring dark spectrum...**" message window. See the following figure:

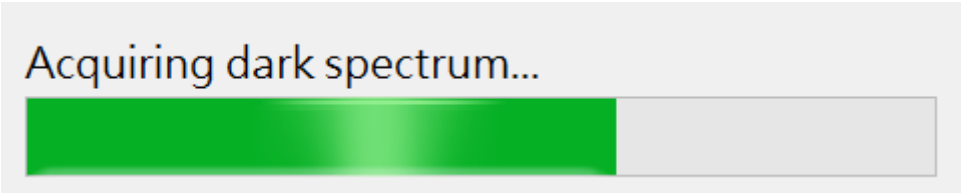


Figure 9-9: Acquiring dark spectrum...

In addition to capture the dark spectrum in real time, it is possible to select the program's

default dark spectrum or load a previous dark spectrum file. Please note that the default dark spectrum is a set of built-in data which is handy for testing purposes. It may not be suitable for your current measurement environment. The following figure shows the case when you choose to **Use default dark spectrum**:

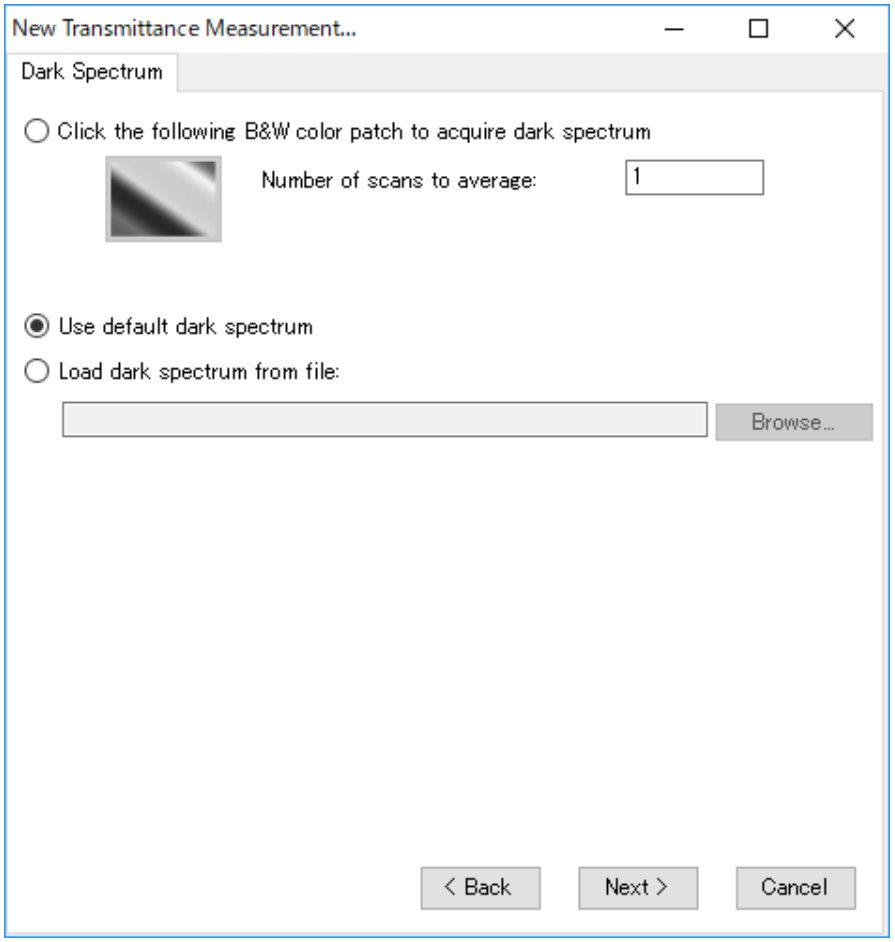


Figure 9-10: **New Transmittance Measurement** - Using the default dark spectrum

Note: This example uses the dark spectrum captured in real-time (not the default dark spectrum).

Once the dark spectrum is set, click **Next**.

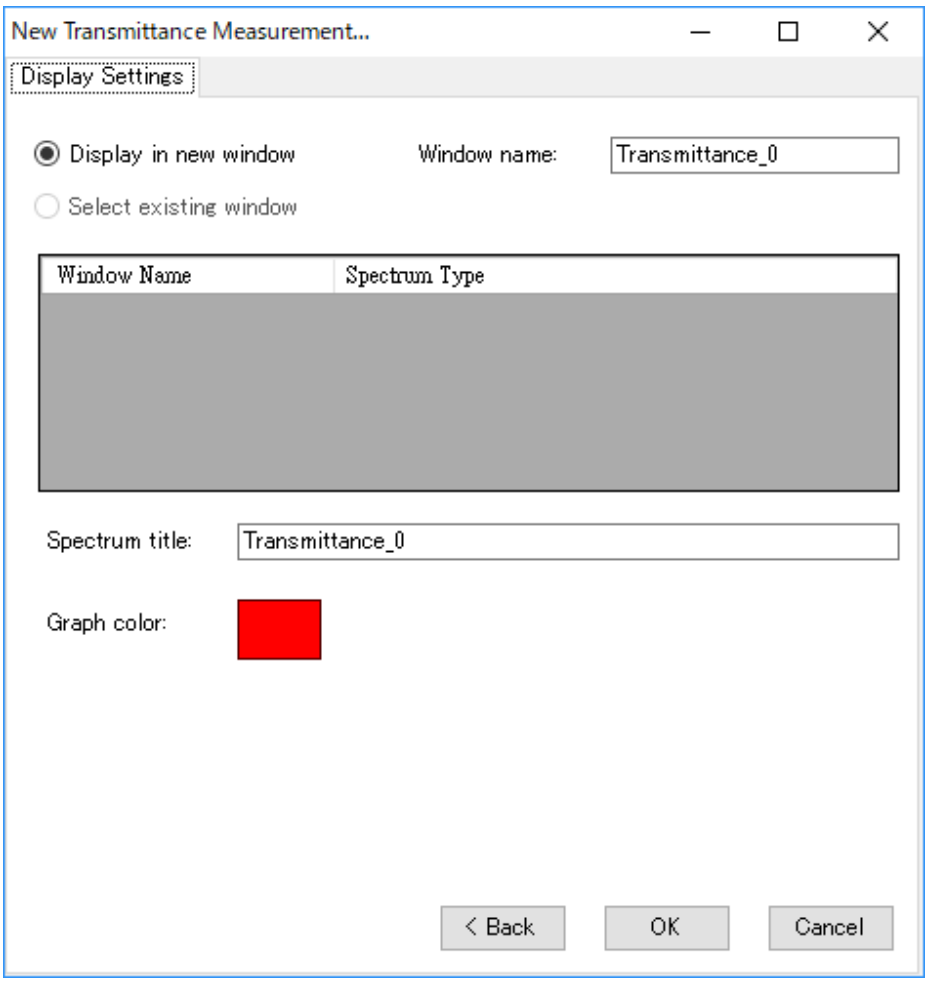


Figure 9-11: **New Transmittance Measurement** - **Display Settings**

Display Settings

Next, you can specify a name for the measurement graph window, as well as a spectrum title and a color for the graph, as in the former figure. To specify the color, you can click on the color patch and select the desired color from the palette:

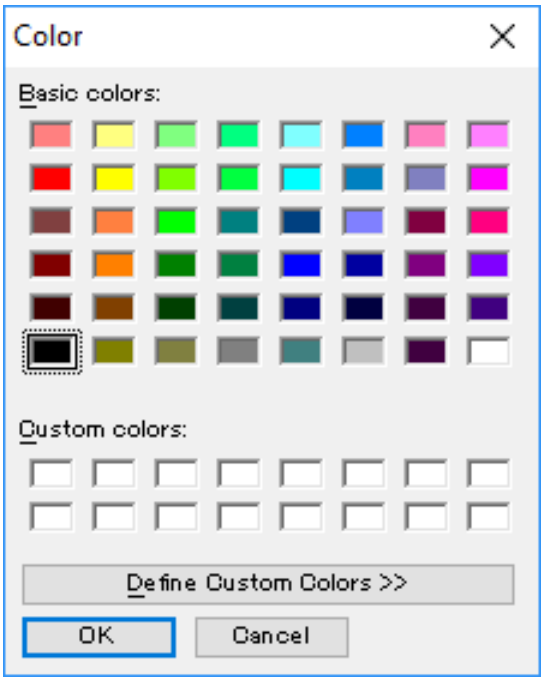


Figure 9-12: **Display Settings** - **Color**

When you finish setting the display, click **OK**. The measurement graph is displayed as shown below.

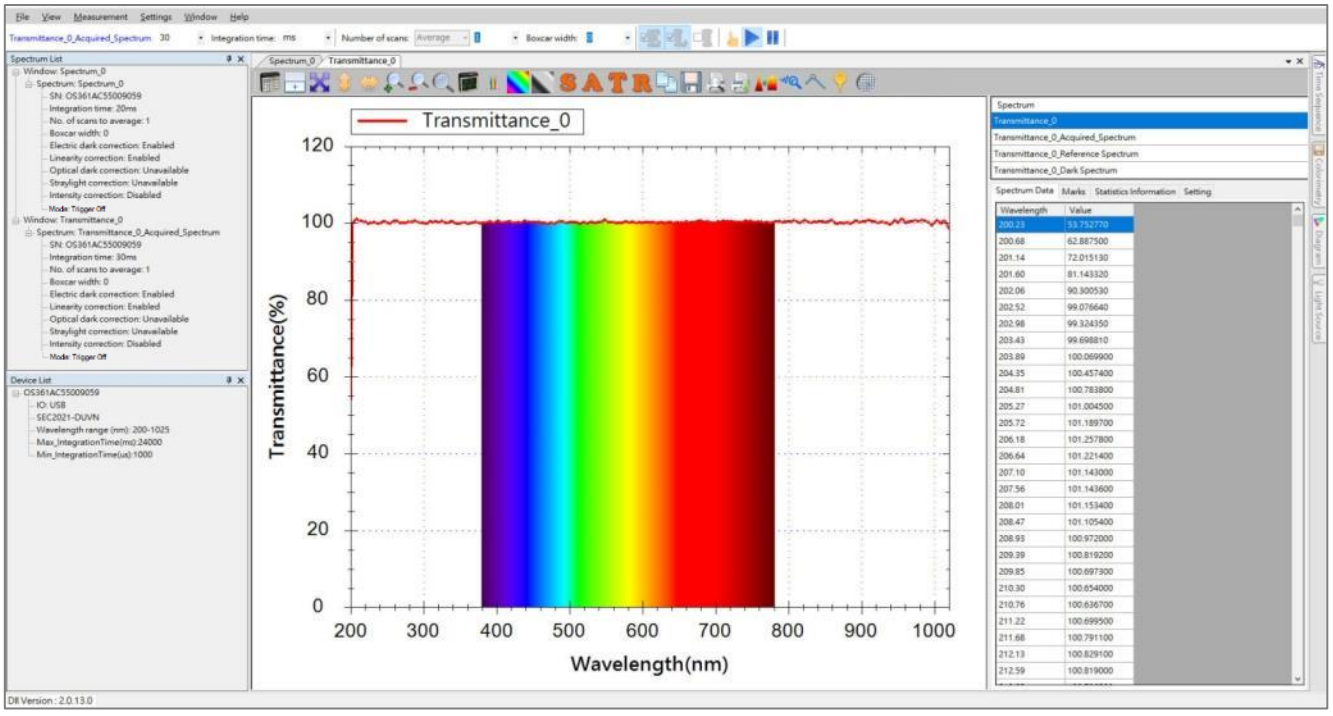


Figure 9-13: Newly created transmittance measurement graph

In the figure above, the transmittance is almost 100% in the entire visible range because the object to be measured is not set. As a reference light source, a deuterium halogen light source of 200 to 1700 nm is used, and by adjusting the display range of the graph to 380 to 780 nm, it is possible to make the graph in the visible region easier to view (see "Graph Settings" for details). The adjusted graph is shown below:

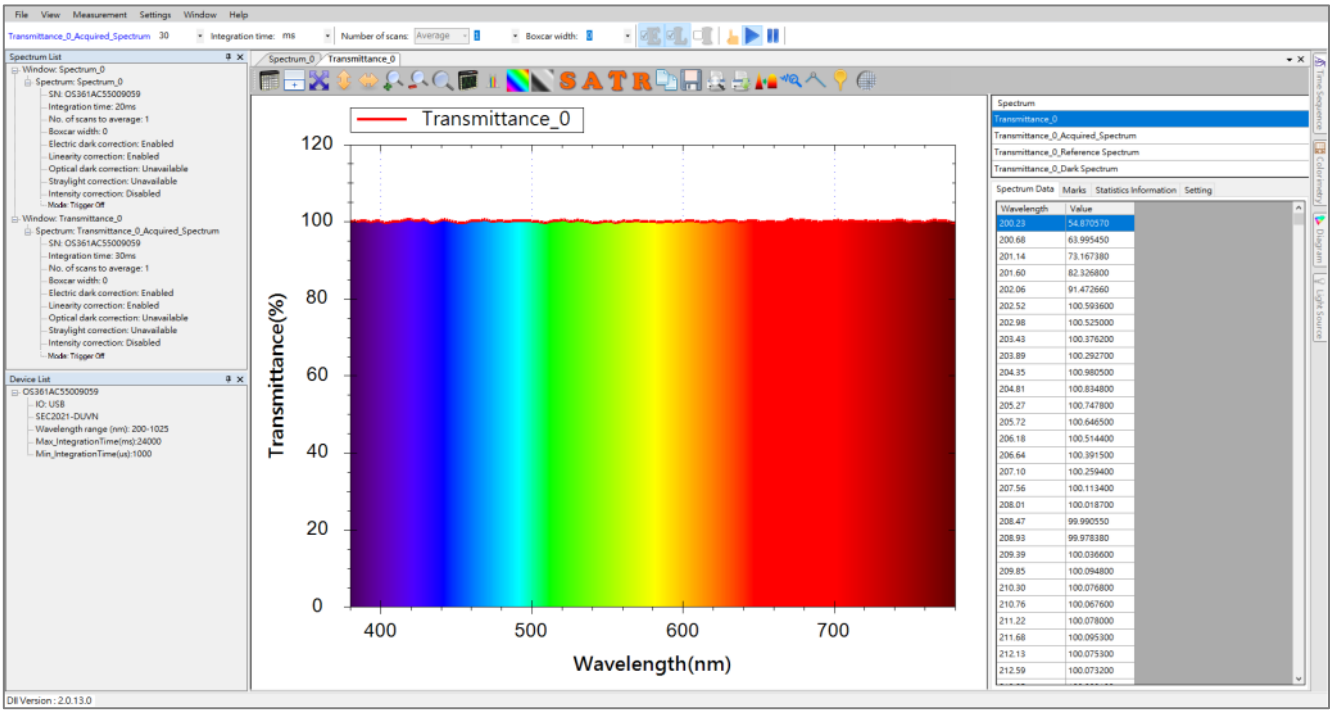


Figure 9-14: Transmittance measurement graph with adjusted wavelength range in the visible region

Start Measuring the Transmittance of the Test Object

Next, set the object to be measured and measure the transmittance. The transmittance result of a white transparent filter is shown in the figure below.

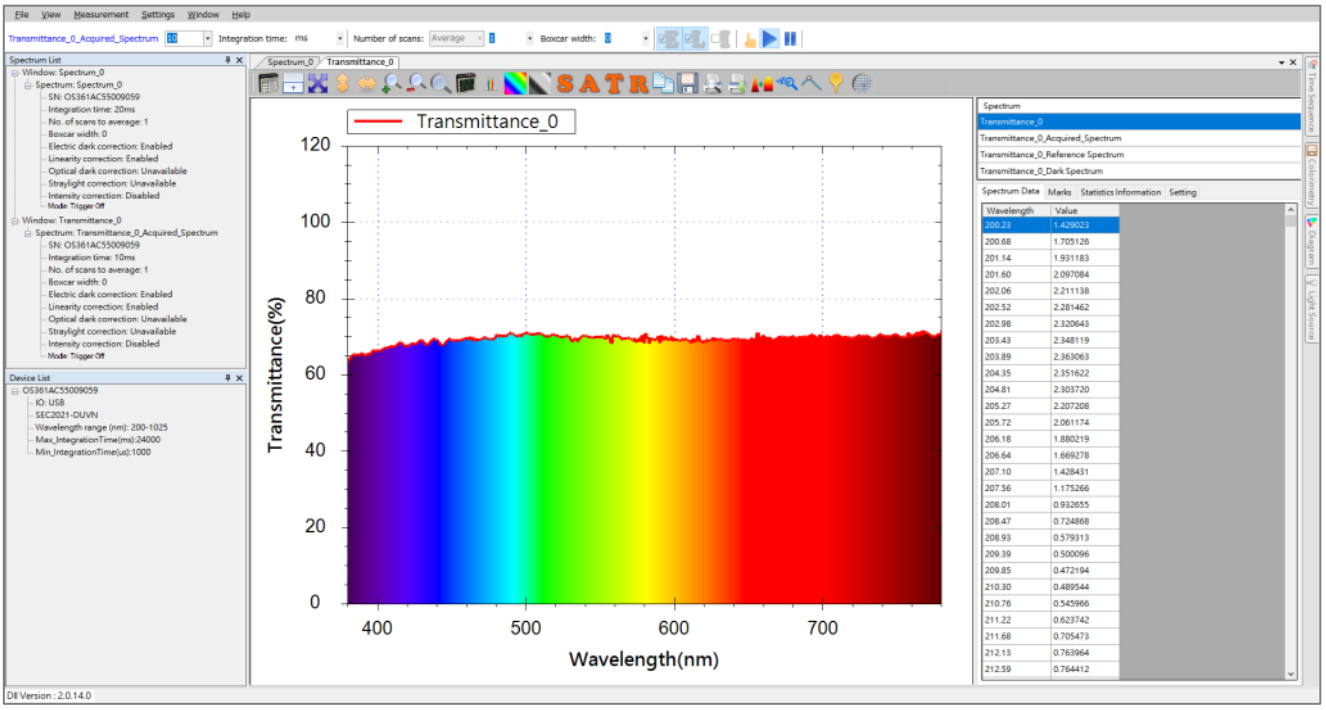


Figure 9-15: The transmittance graph of a white transparent filter

As shown above, the white transparent filter absorbs light of all visible wavelengths, so the transmittance decreases throughout the wavelength. In the case of a blue transparent filter, the transmittance of the blue visible light portion becomes high as shown in the figure below.

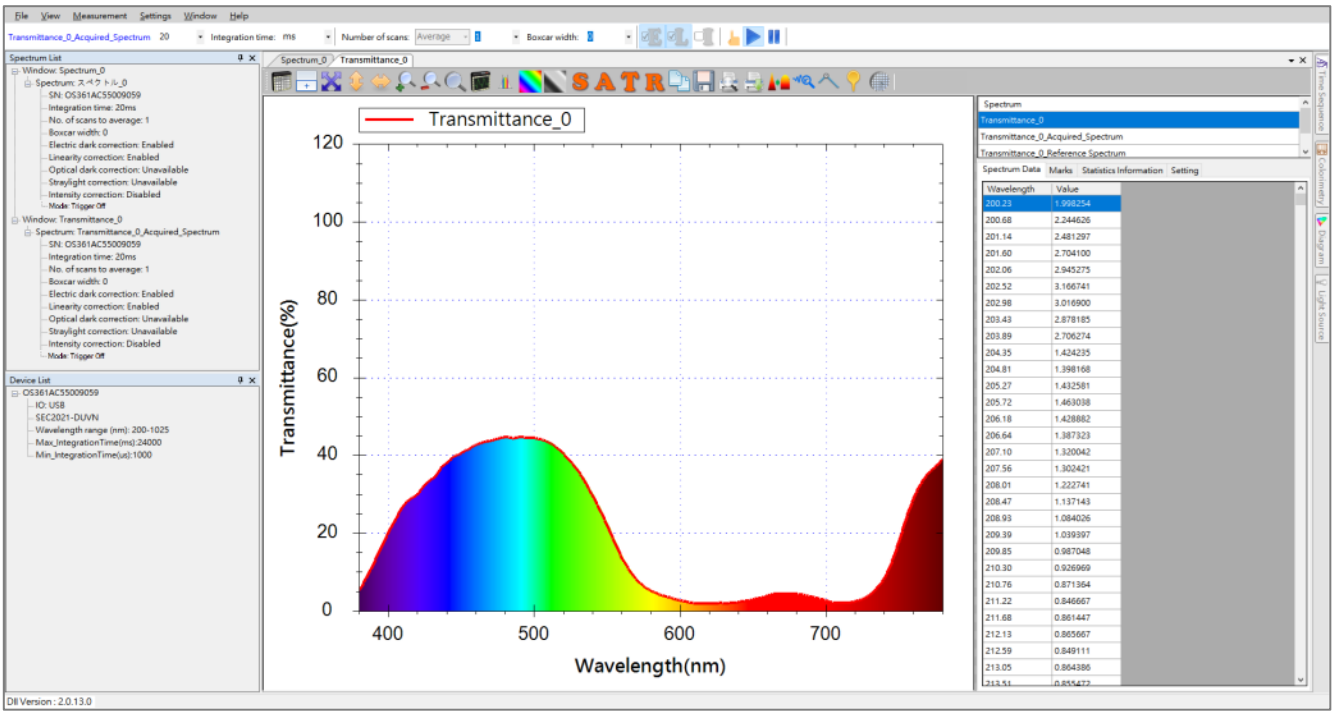


Figure 9-16: The transmittance graph of a blue transparent filter

Checking the Acquired Spectrum Curve

The transmittance curve is calculated from multiple spectra. Spectra smart has the function of examining the original spectral curve in order to check whether the measured value is correct or not. You can activate this function by pressing the **Acquired Spectrum** button on the toolbar.

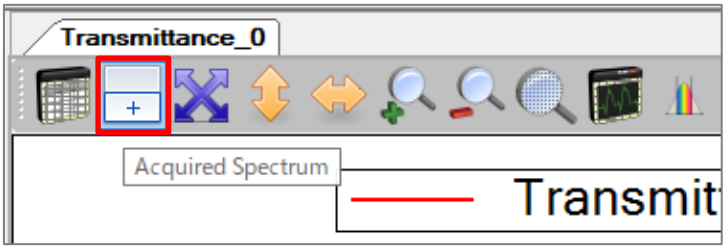


Figure 9-17: The **Acquired Spectrum** button

The following three figures show the transmittance graphs with their acquired spectrums for the original light source, the white transparent filter, and the blue transparent filter, respectively:

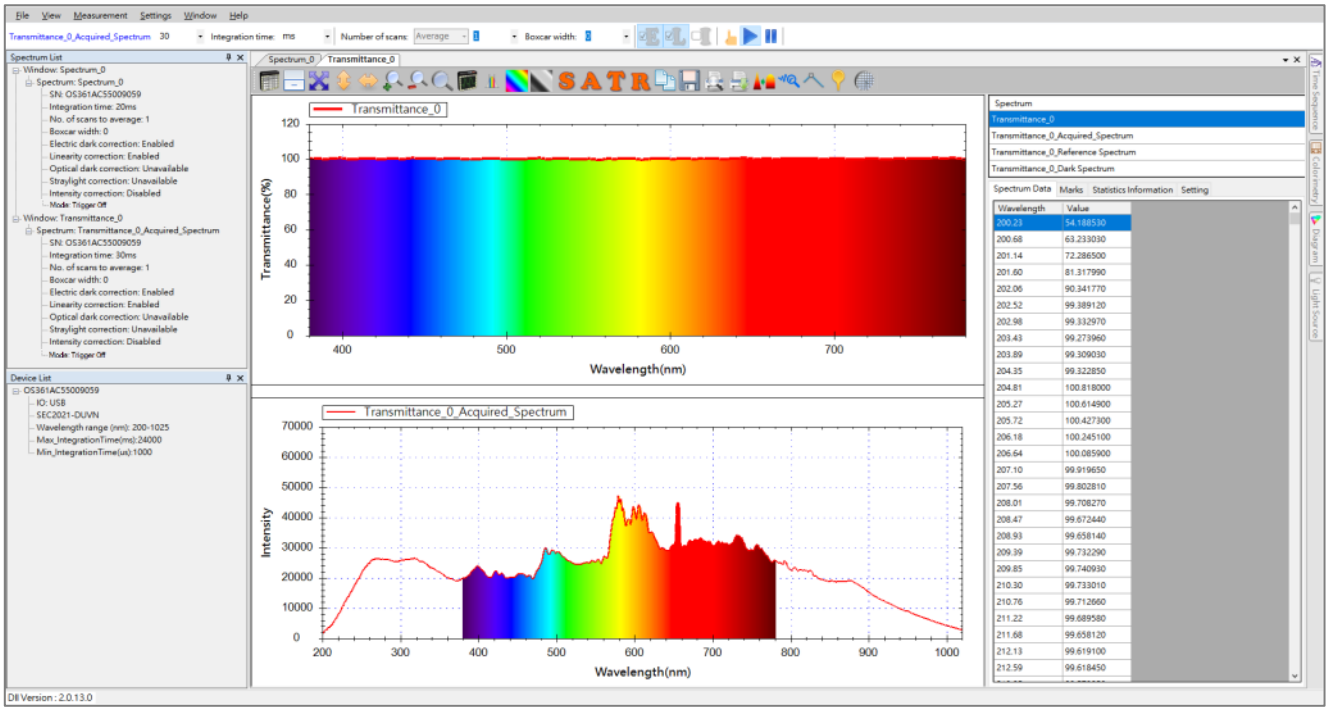


Figure 9-18: The acquired spectrum of the transmittance measurement for the original light source

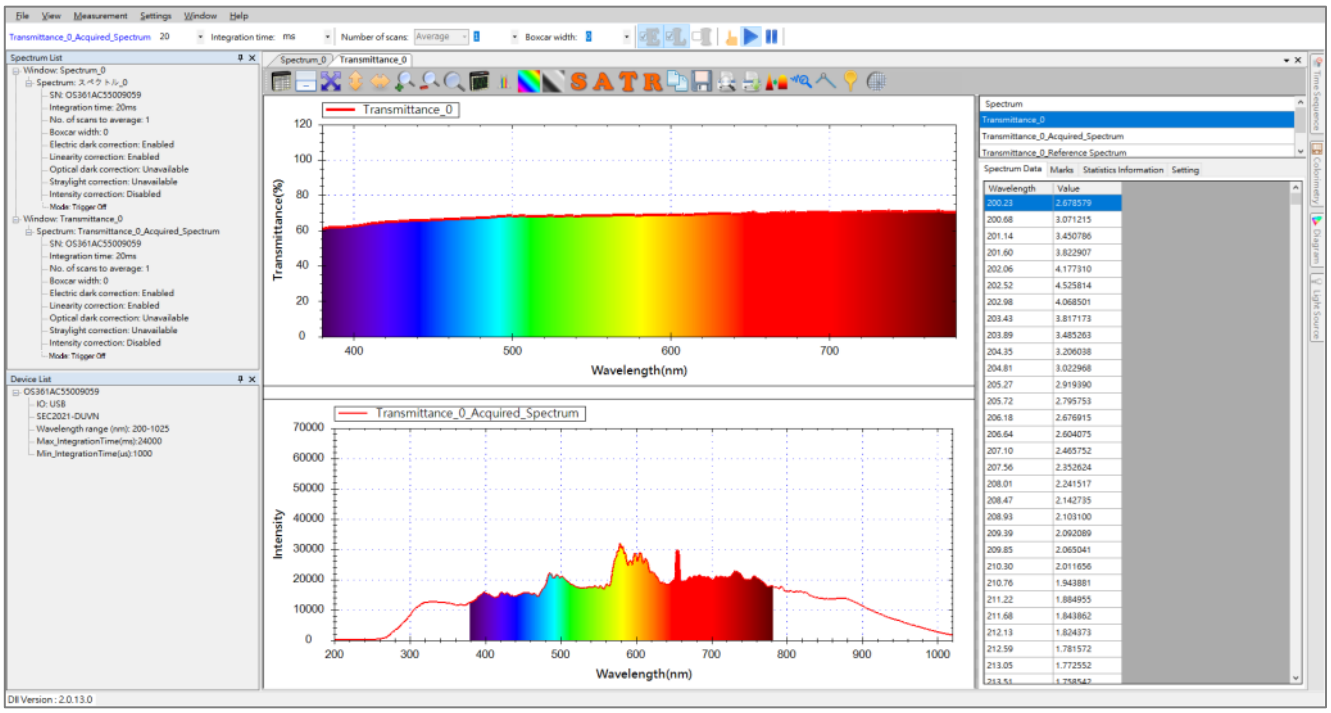


Figure 9-19: The acquired spectrum of the transmittance measurement for the white transparent filter

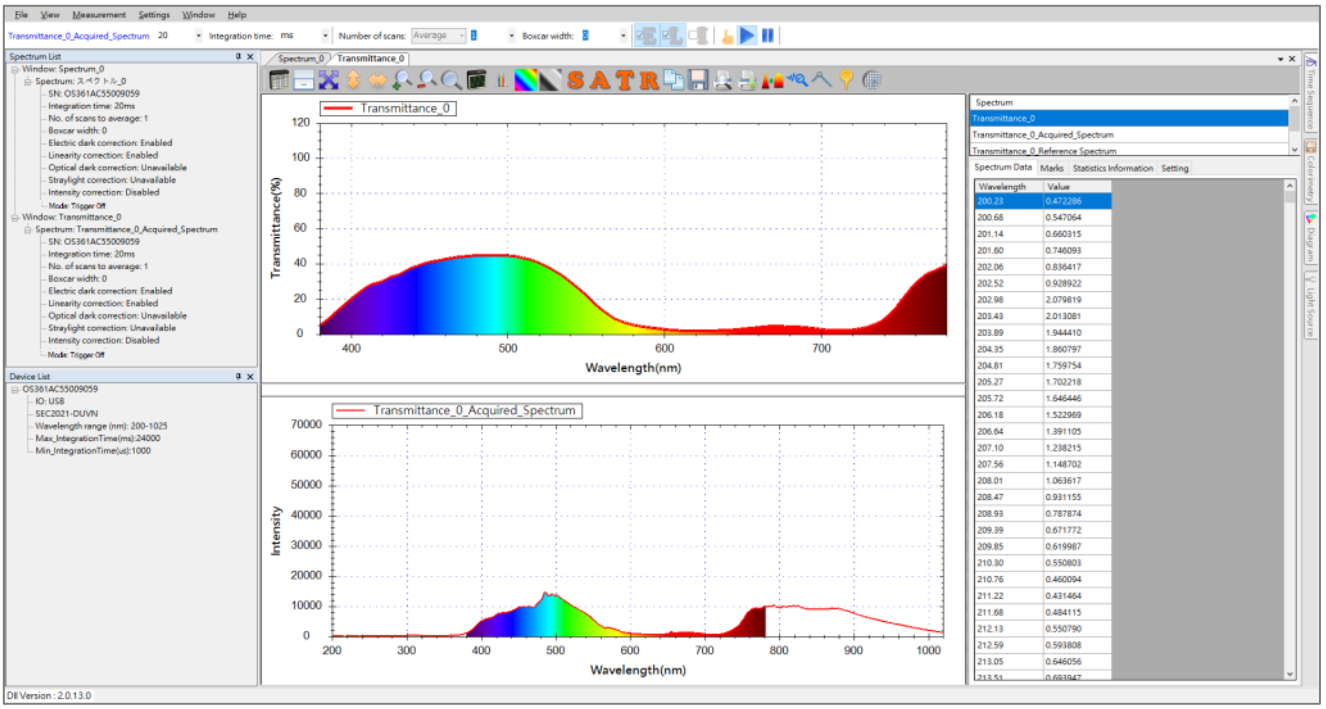


Figure 9-20: The acquired spectrum of the transmittance measurement for the blue transparent filter

From the above figure, it can be seen that the spectrum curve of the white transparent filter transmits all wavelengths in visible light. It can be seen that the spectrum curve of the blue transparent filter passes most blue visible light.

Checking Colorimetry Information

In the measurement of transmittance, reflectance and emission intensity, it is possible to investigate not only the spectrum but also color information. When you press the vertical **Colorimetry** button on the right side of the spectrum data window, the **Colorimetry** screen opens.

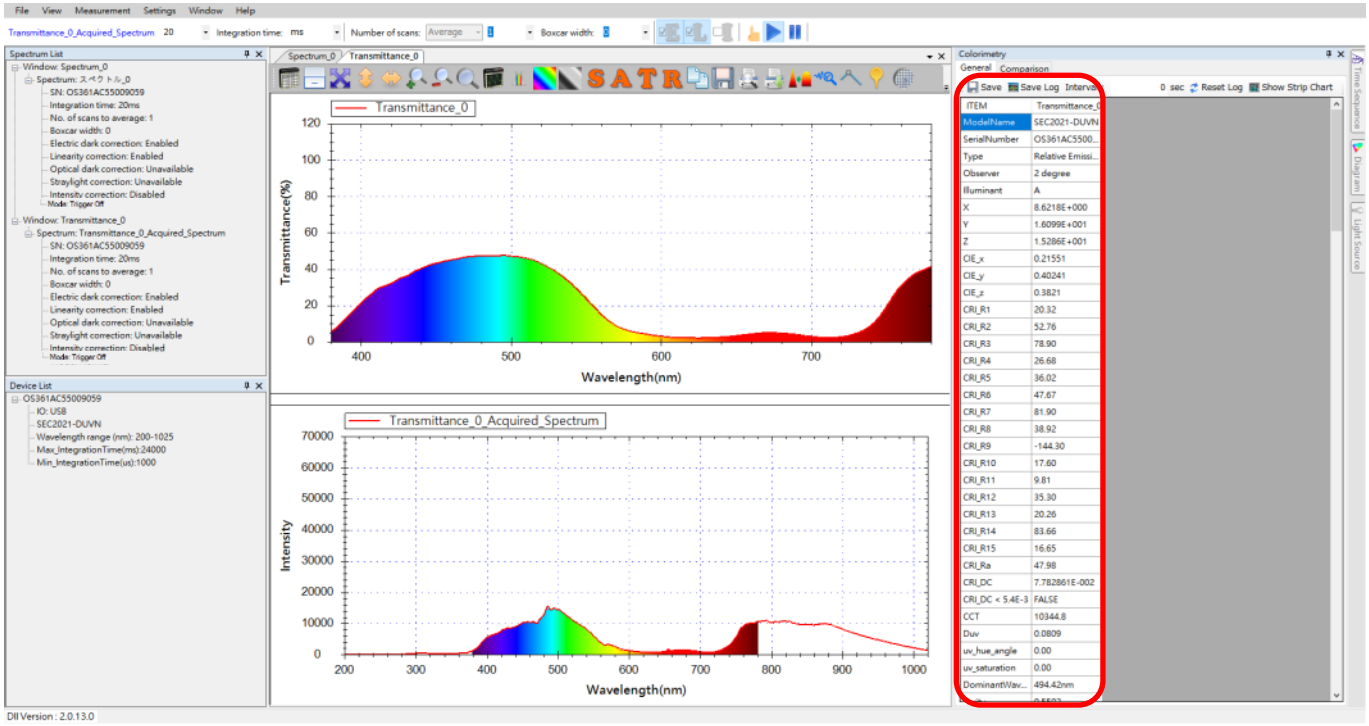


Figure 9-21: The **Colorimetry** button and the **Colorimetry** pane

As in the figure above, this window shows details about the **Acquired Spectrum**, including standard observer's viewing angle, illuminant, CIE X, Y, Z coordinates, etc.

Colorimetry Toolbar Buttons

Save, **Save Log**, **Interval**, **Reset Log**, and **Show Strip Chart** are displayed on the toolbar butto of the **Colorimetry** window.

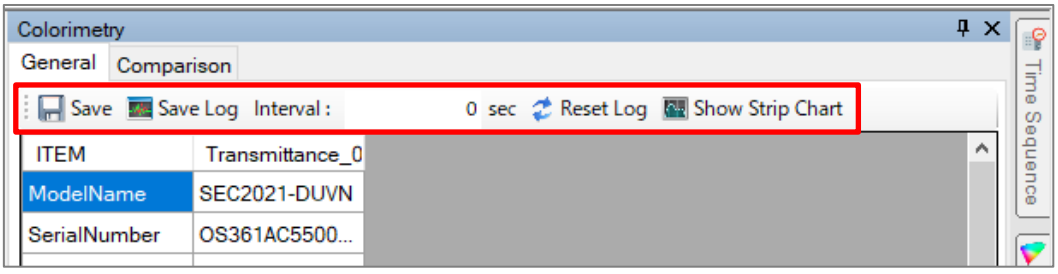


Figure 9-22: **Colorimetry** toolbar buttons

These buttons functions are explained below.

1. **Save:** Save the current colorimetry information as a text (CSV) file. Its content is exactly like what you see in the previous figure.
2. **Save Log**: This button allows you to keep track of colorimetry changes over a period of time by saving SpectraSmart's internal log of accumulated colorimetry data to a file.
3. **Interval:** This setting allows you to set the update interval for the colorimetry information.
4. **Reset Log**: The currently accumulated internal data is deleted and new recording is started. When you want to record the colorimetry changes over a period of time, first clear the internal log by using the **Reset Log** button, and then, press the **Save Log** button after the measurement is completed, the data is saved as test file.
5. **Show Strip Chart**: This button allows you to keep track of a single colorimetry value and see its changes over time. For example, to display the change in X value, select "X" and press the **Show Strip Chart** button to show a pop-up window with a strip chart that tracks the changes of this value over time. See the figure below:

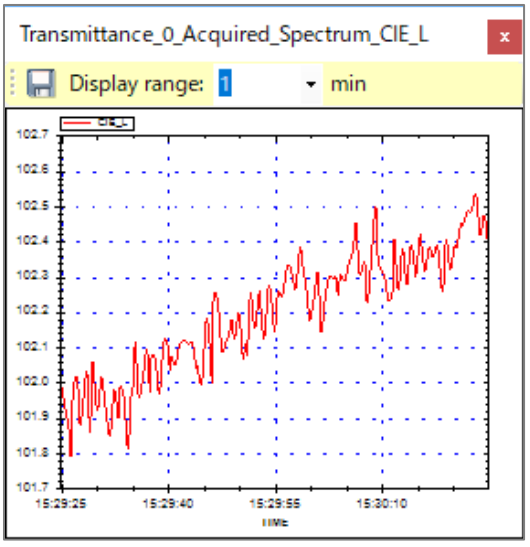


Figure 9-23: The strip chart for tracking colorimetry information

Comparing Colorimetry Information

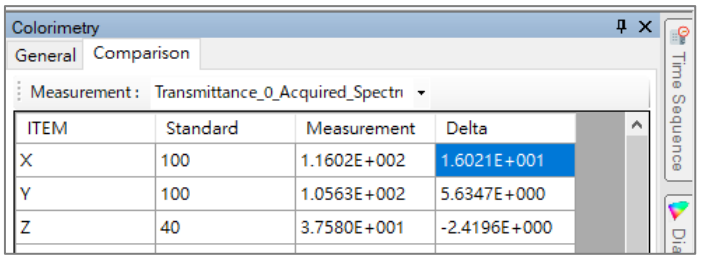


Figure 9-24: Comparing colorimetry information

When the color **Comparison** function is used, the difference between the current measured value and the standard value entered for comparison is displayed.

Note: In the comparison table, if you enter a numerical value in the Standard field, the difference will be calculated automatically.

Checking Diagrams

In addition to colorimetry information, SpectraSmart also provides diagrams for the user to check the color coordinates and the dominant wavelength of the test object. Press the **CIE Diagram** button along the right edge of the measurement graph to enable this feature. See the figure below:

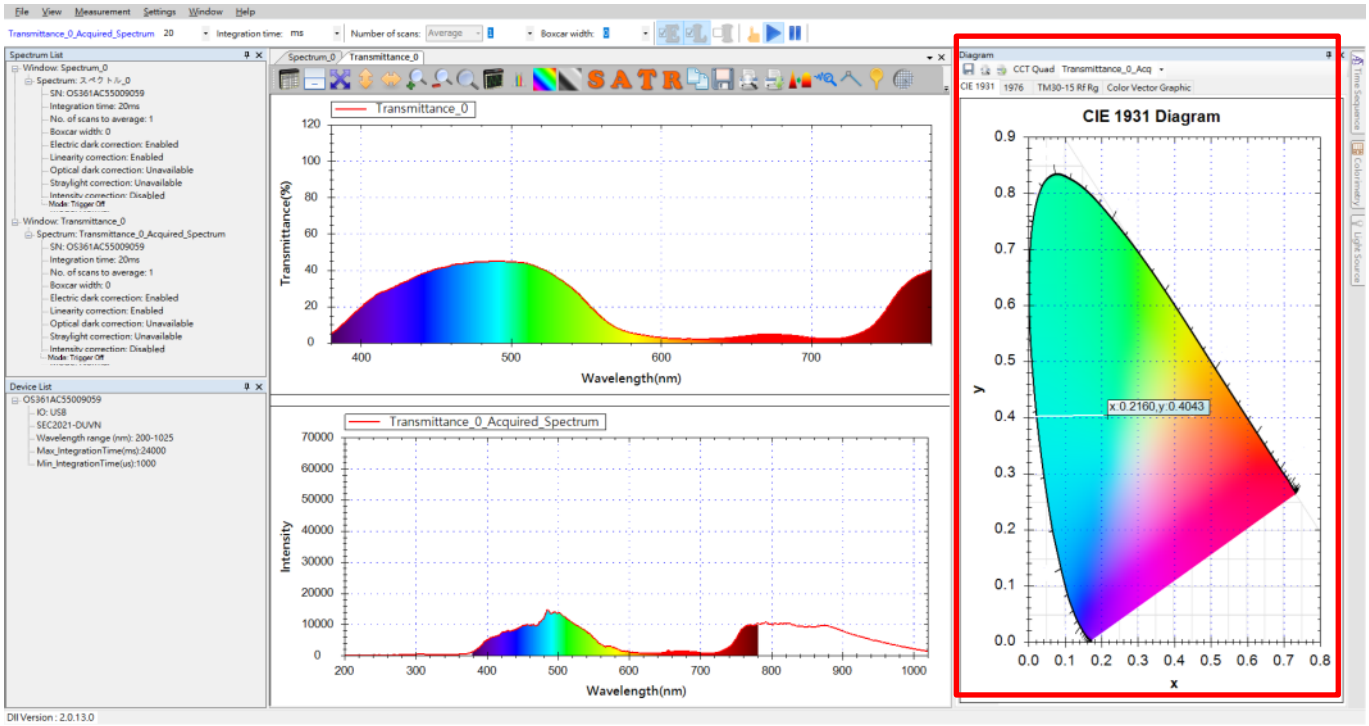


Figure 9-25: The **CIE Diagram** button and the **CIE Diagram** pane

Switching Colorimetry Diagrams

SpectraSmart provides four types CIE diagrams: CIE 1931 ,CIE 1976, TM 30-15 RfRg and TM 30-15 Color Vector Graphic. You can switch between them by clicking the respective tab.

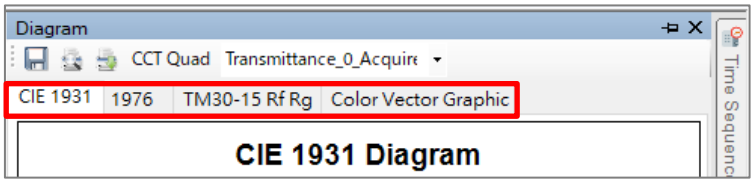


Figure 9-26: **CIE 1931**,**CIE 1976**, **TM 30-15 Rf & Rg** and **TM 30-15 Color Vector Graphic** diagram switching tabs

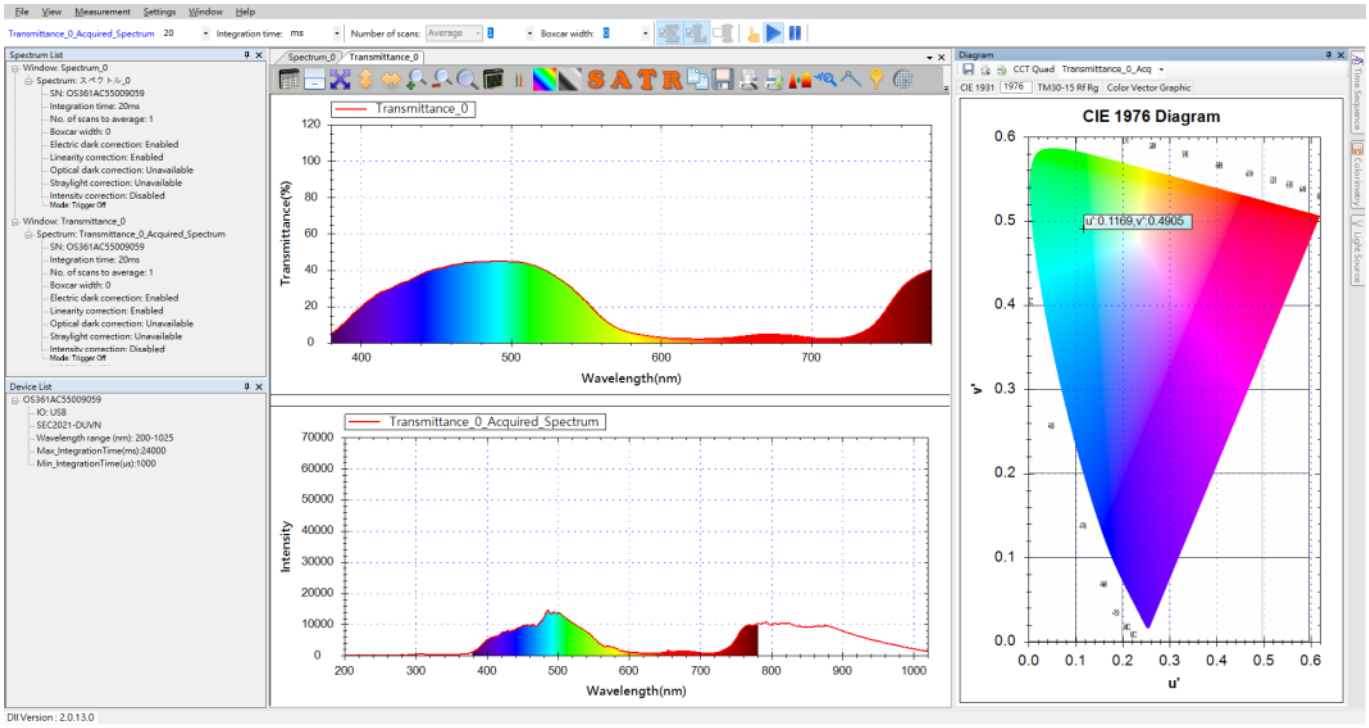


Figure 9-27: The CIE 1976 diagram

CIE Diagram Toolbar Buttons

The CIE 1931 diagram provides a toolbar with a few function buttons: **Save as image, Print Preview**, **Print**, and **CCT Quad**, as shown in the following:

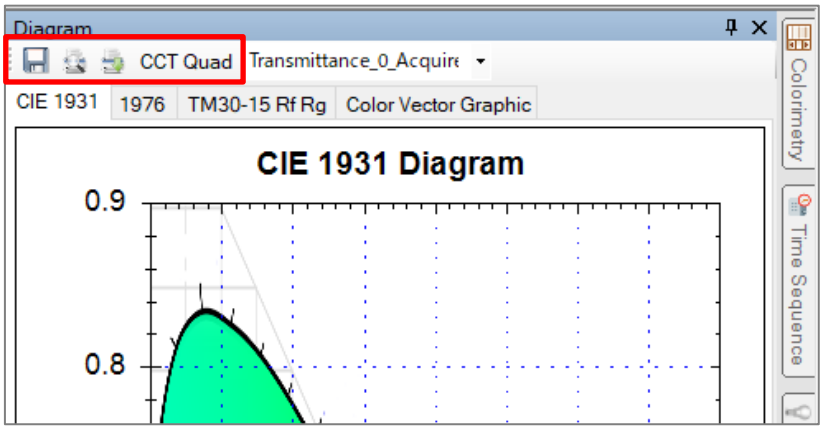


Figure 9-28: The CIE Diagram toolbar

Saving Colorimetry diagram

The **Save as image** button saves the currently displayed CIE diagram to an image file. Pressing this button shows a standard **Save As** window. Specify the destination folder and the filename, and then press **Save** to save the file. See the following:

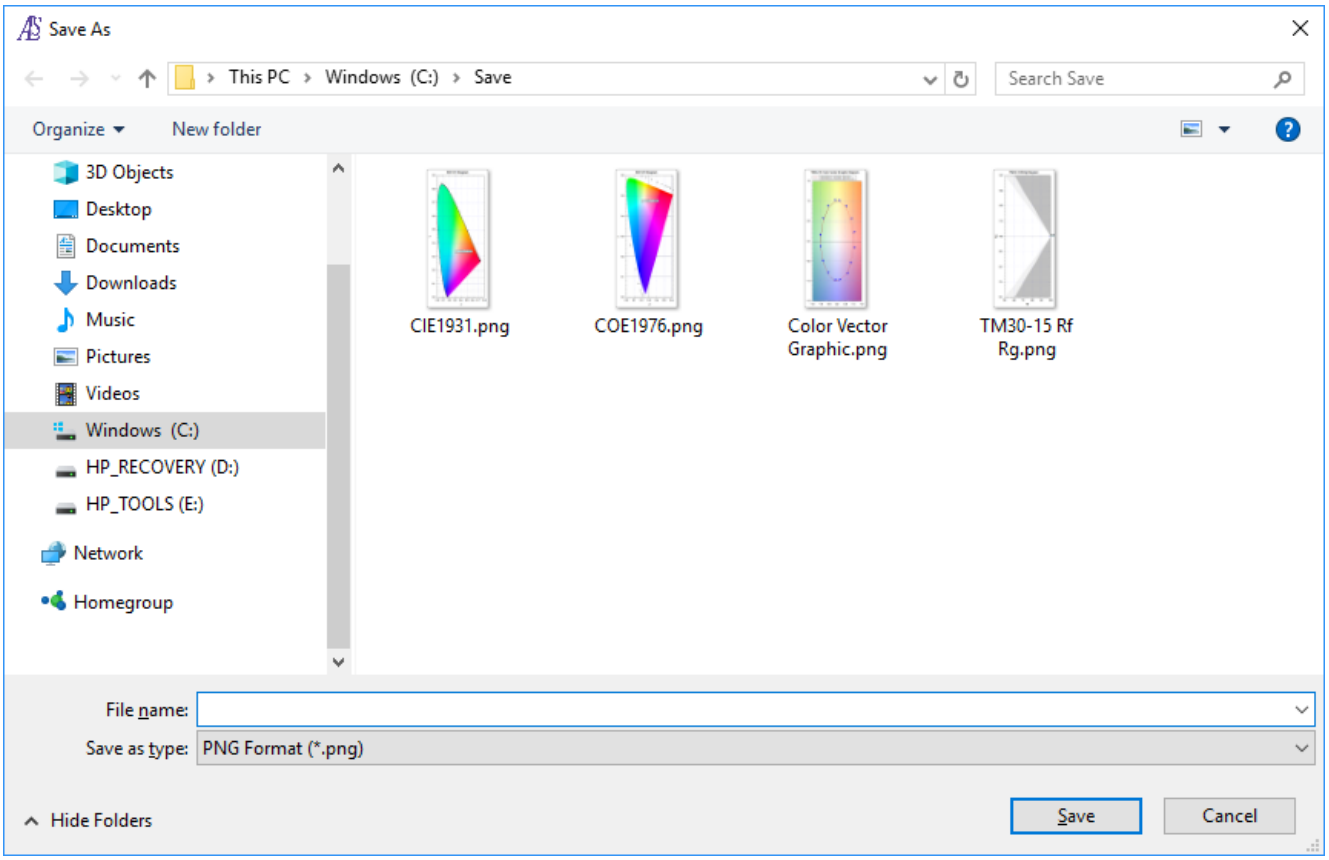


Figure 9-29: Pressing **Save as image** opens the **Save As** window

Printing Colorimetry Diagram

The **Print Preview** and **Print** buttons allow you to preview and print the currently displayed diagram. When pressed, they show the standard **Print Preview** and **Print** dialogs, respectively.

CCT Quad

The **CCT Quad** button allows you to show correlated color temperature (CCT) lines on the CIE 1931 diagram (not applicable to the CIE 1976 diagram), as shown in the following:

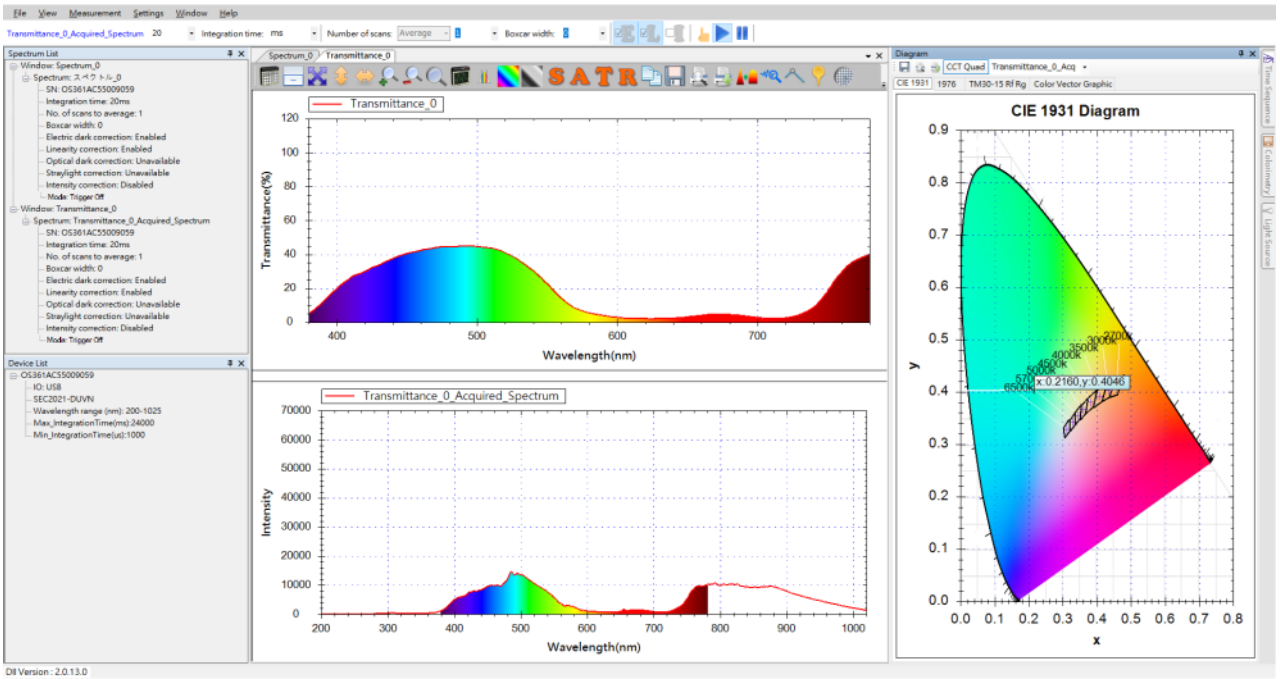


Figure 9-30: Showing correlated color temperature (CCT) lines on the CIE diagram

Graph Toolbar Buttons

Calculated Color Range

When the user only wants to observe a particular color range, instead of the entire visible spectrum, by measuring transmittance, reflectance and emission intensity, **Calculated Color Range** button, can be used to specify the wavelength range.

Figure 9-31: The Calculated Color Range button

Select **Limit the wavelength range for color calculation**, and then specifies the range in **Wavelength range**, as shown below.

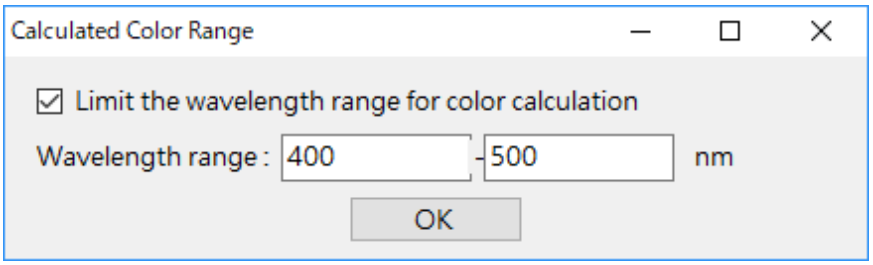


Figure 9-32: Specifying **Calculated Color Range**

In the example, the range from 400 nm to 500 nm is setting. Pressing **OK**, the measurement graph will display only the curve within the specified range.

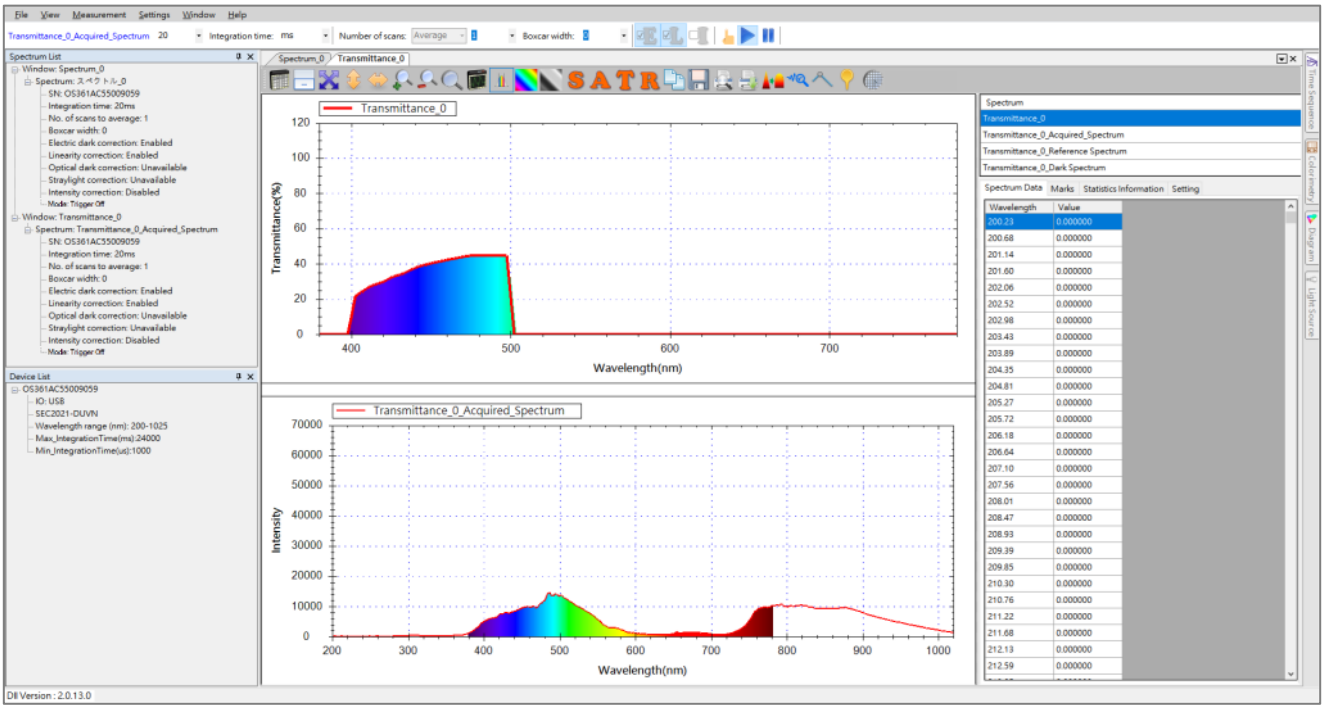


Figure 9-33: The effect of specifying calculated color range

Except for the **Calculated Color Range** button, the toolbar button of the transmittance measurement graph is almost the same as the absorbance measurement graph. Please refer to "Graph Toolbar Buttons" in the chapter of absorbance measurement.

Saving Transmittance Measurement

The method of saving the transmittance measurement is the same as saving the absorbance measurement. Please refer to "Saving Absorbance Measurement" in the

chapter of absorbance measurement.

Loading Saved Transmittance Measurement Spectrum Curve

The method of loading the saved transmittance measurement spectrum curve is almost the same as the absorbance measurement. However, when loading the transmittance measurement spectrum curve, select whether or not calculate the colorimetry information.

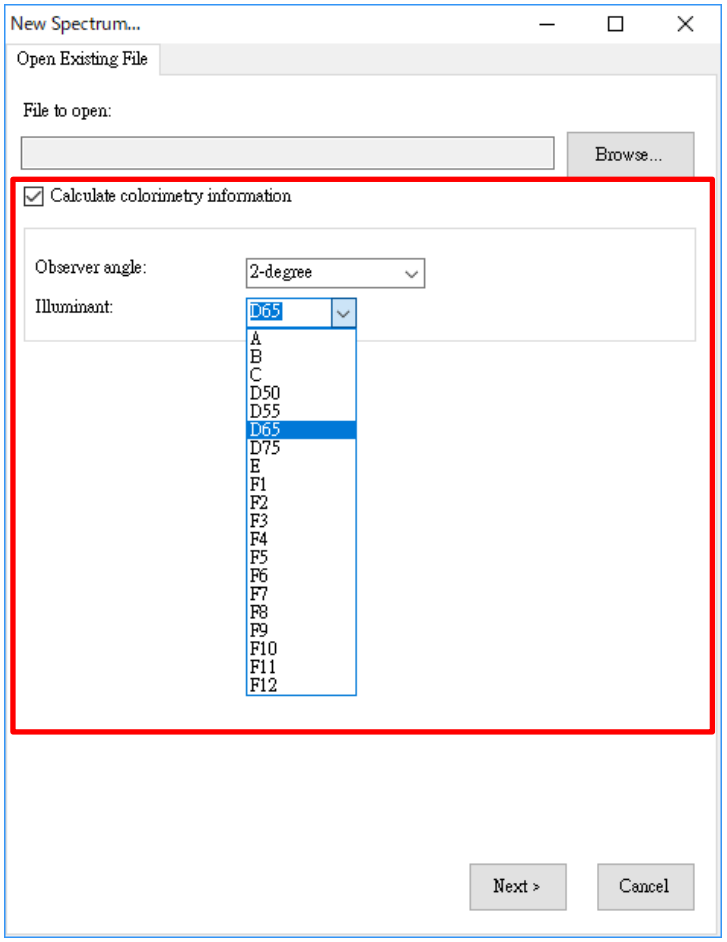


Figure 9-34: Choosing **Calculate colorimetry information** when loading of the transmittance measurement spectrum curve

As the former figure shows, after selecting **Calculate colorimetry information**, you need to specify **Observer angle** and **Illuminant** next. With this information provided, you will be able to see corresponding data in the **Colorimetry** and **Diagram** panes. Apart from this difference, all other details are identical to loading a spectrum curve of an absorbance measurement. Please refer to "Loading Saved Spectrum Curve of an Absorbance Measurement" in the chapter of absorbance measurement.

Deleting Individual of Transmittance Measurement Spectrum Curves

The result of the transmittance measurement is calculated form multiple spectrum curves. Therefore, **please do not delete any of the curves. If one of the curves is deleted, the result is not calculated correctly.**

Printing and Previewing Transmittance Measurement Spectrum

The steps for printing and previewing transmittance measurement spectrum are the same as in printing and previewing spectrum measurement. Please refer to "Printing and Previewing a Spectrum Measurement" in the chapter of spectrum measurement.

10. Reflectance Measurement

Reflectance is calculated from the spectrum of the light source and the spectrum reflected on the object to be measured. Therefore, similarly to the measurement of absorbance, in order to measure the reflectance, first measure the spectrum of the light source and then measure the light reflected on the object to be measured. When the measurement is completed, the program automatically calculates the reflectance spectrum.

Reflectance measurement setting

For reflectance measurement, select **Reflectance** from the **Measurement** menu to open the **New Reflectance Measurement** window, as shown below.

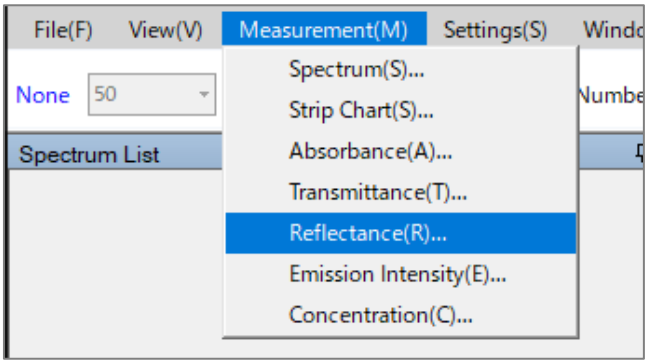


Figure 10-1: Selecting **Reflectance** from the **Measurement** menu to open the new reflectance measurement

Then, you will see the following window:

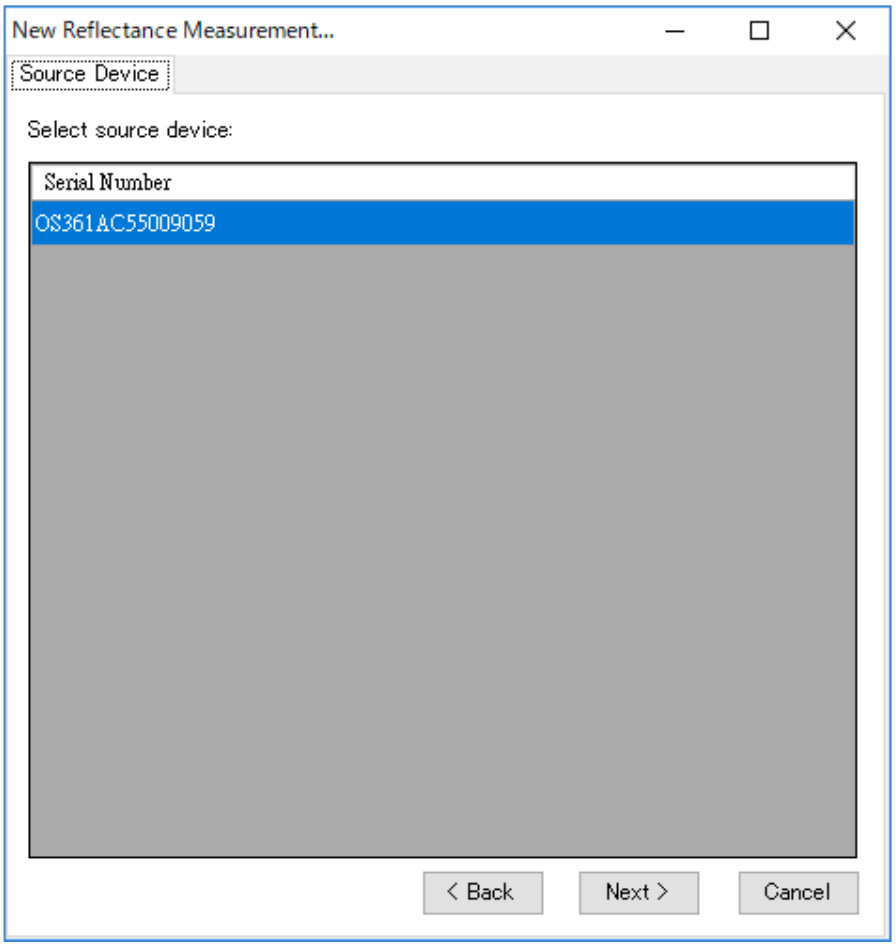


Figure 10-2: **New Reflectance Measurement** - **Source Device**

Selecting a Source Device

On the **Source Device** window, please select a source device (identified by its serial number). Then, click **Next**.

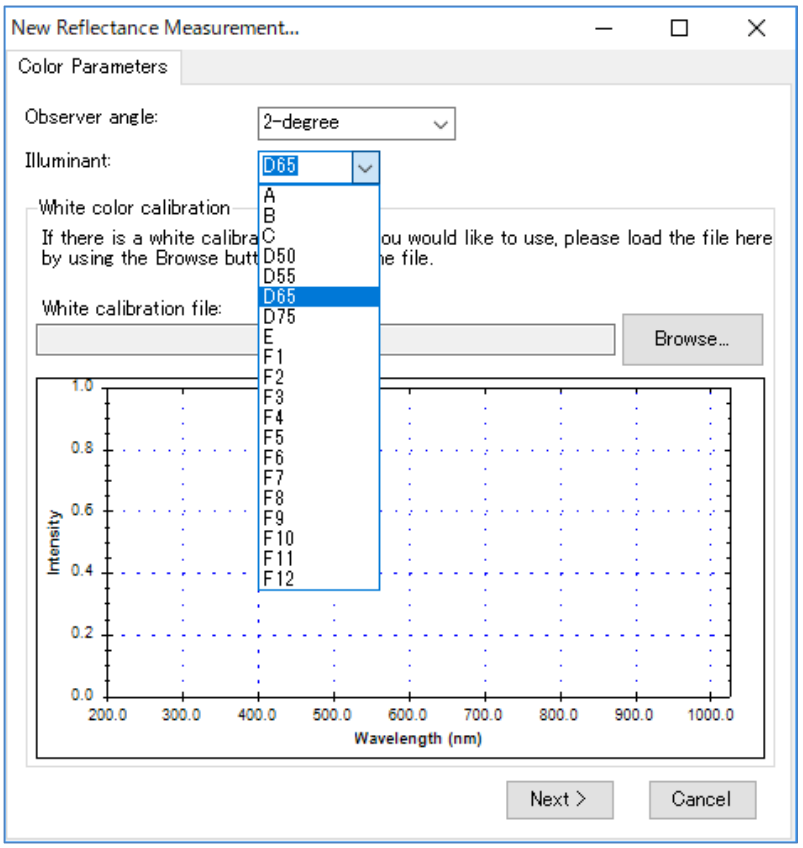


Figure 10-3: **New Reflectance Measurement** - **Color Parameters**

Setting Color Parameters

For reflectance measurement, specify the viewing angle of CIE standard observer and the type of light source. It corresponds to viewing angle of 2 degrees and 10 degrees (corresponding to CIE 1931 and CIE 1964 respectively) and multiple standard light sources. Here we choose **2-degree** and **D65**, and then click **Next**.

Specifying Standard White Reflectance

For reflectance measurement, you can enter the standard white reflection coefficient by inserting a white calibration file. When the standard white reflection coefficient is not input, the standard white board is calculated as 100% total reflection, not the actual reflectance of the object to be measured. By inputting the standard white reflection coefficient, absolute reflectance of the object to be measured can be calculated.
To specify a white calibration file, click on the **Browse** button and navigate to your white calibration file. After it is specified, you will see the white calibration curve in the preview chart. See the following figure:

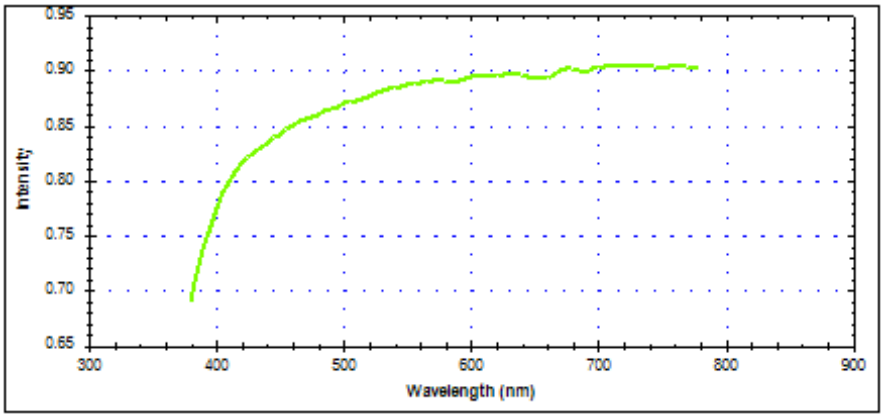


Figure 10-4: **New Reflectance Measurement** - **White Calibration**

The following figure shows the format of a white calibration file. The first field represents the wavelength, and the second field represents the reflectance.

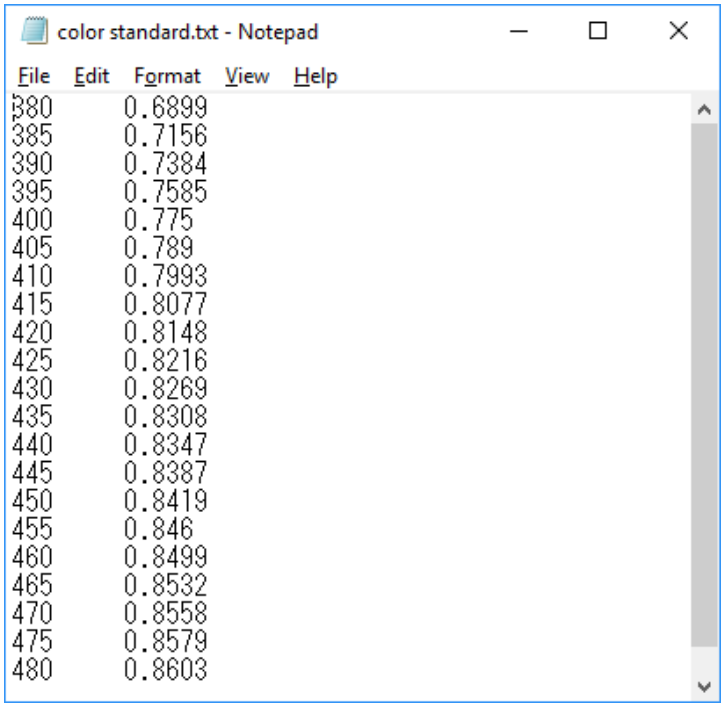


Figure 10-5: The format of a white calibration file

Note: The default setting (i.e. no white calibration file) is used in our following example.

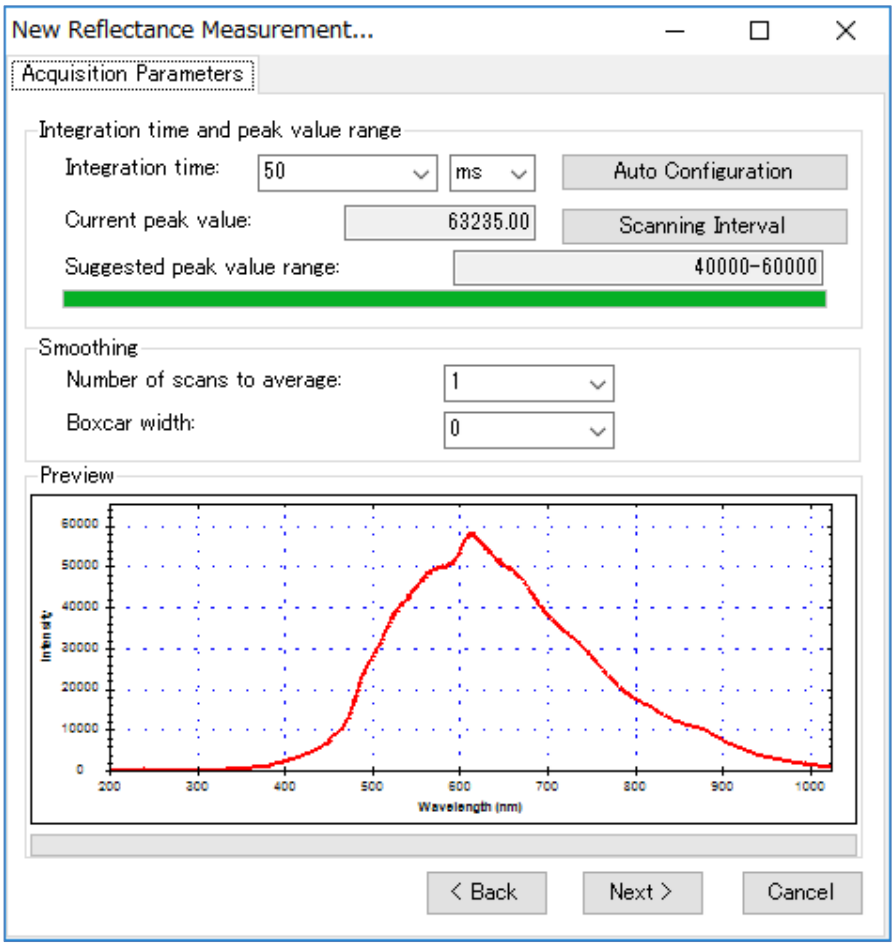


Figure 10-6: **New Reflectance Measurement** - **Acquisition Parameters**

Specifying Integration Time

Then specify the integration time (i.e. the exposure time for the light sensor) on the **Acquisition Parameters** window. In the program, the default integration time is set automatically when the window is opened. Adjust the integration time while referring to the preview at the bottom of the screen as necessary. The preview will change as you adjusted, so set the peak value within the **Suggested peak value range** on the window. In the example, the peak value is set within the range of **40000-60000**.

If the adjustment is not successful, you can press the **Auto Configuration** button to have the program automatically recovered to default setting.

Once the integration time is set, you can continue to set the spectrum scanning interval if you need. Please click the **Scanning Interval** button. On the **Spectrum Scanning Interval** window, select **Enable user-defined spectrum scanning interval**, and then specify the

interval you want (the default is 500 ms), as in the following figure:

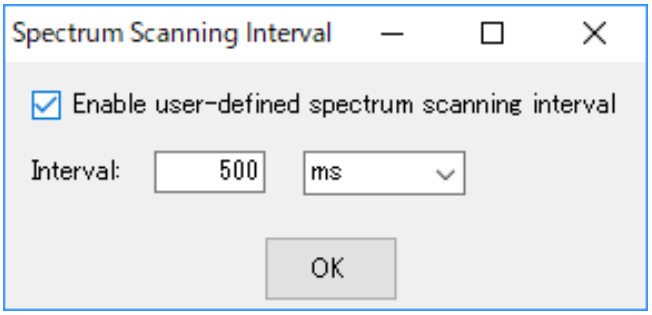


Figure 10-7: Spectrum Scanning Interval

Smoothing

Smoothing processing can be performed on the spectrum curve. Specify the number of scans to calculate the average value for "Number of scans to average". This makes possible to reduce the fluctuation of the curve even for only one acquisition data. For **Boxcar Width**, specify the number of data points on both side of the point of interest to include in the calculation of the moving average. This can reduce the sudden change of the curve. This smooths out the sharp variations on the curve: the bigger the Boxcar width, the smoother the curve. The following figure demonstrates the smoothing effect of a Boxcar width of 10 (maximum value). You can compare it with the former curve without smoothing to see the difference (see the red curve in the preview graph).

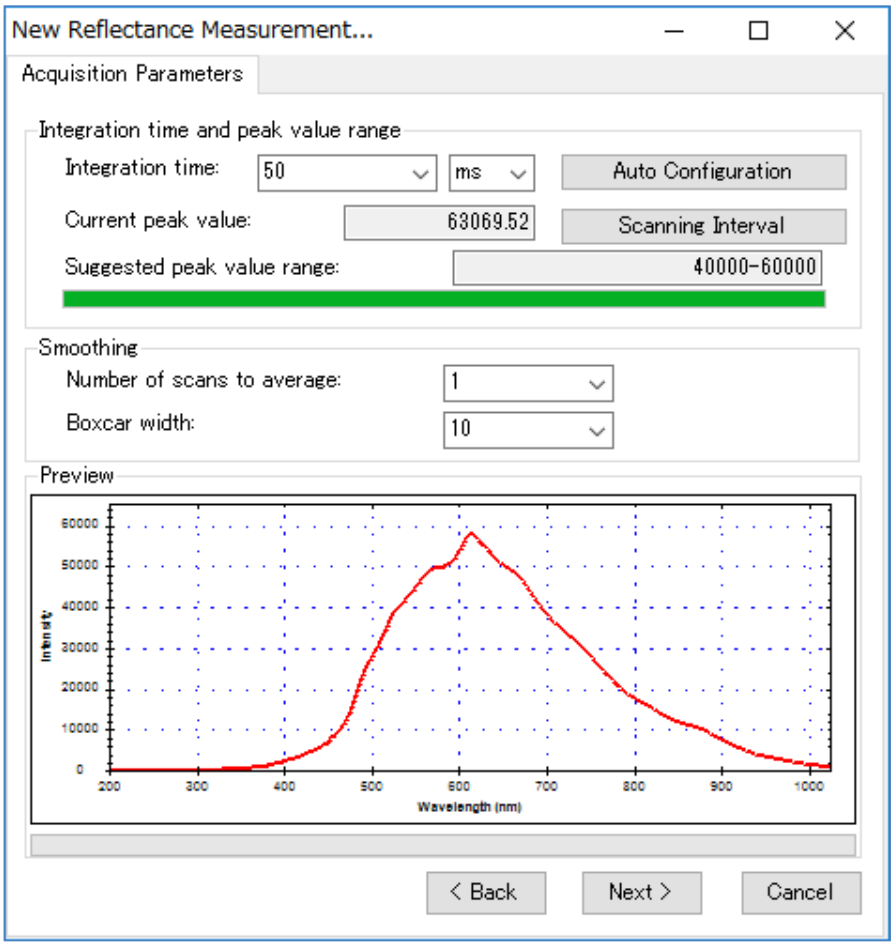


Figure 10-8: **New Reflectance Measurement** - the smoothing effect

Note: The following example uses the default settings, i.e. no smoothing (Number of scans to average=1, Boxcar width=0).

When all acquisition parameters have been set, click **Next**.

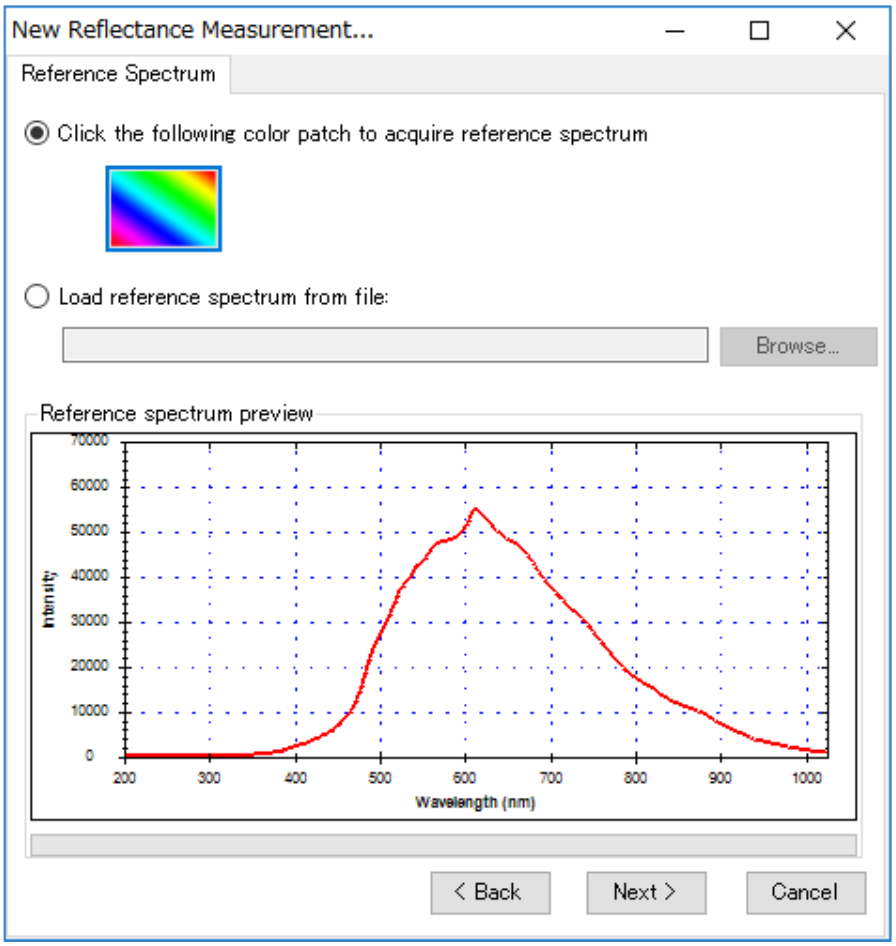


Figure 10-9: **New Reflectance Measurement** - **Reference Spectrum**

Setting Reference Spectrum

Set the light source spectrum where the object to be measured is not placed, that is, "reference spectrum". Here, you can click on the color patch on the window to acquire the live spectrum as the reference spectrum. Or, you can use the **Browse** button to load a previous reference spectrum file. In this example, we use the default option, that is acquiring the current live spectrum of the light source (**as such, please don't put the test object in place**). Once the reference spectrum is captured, you will see it in the preview graph on the lower half of this window. Then, click **Next**.

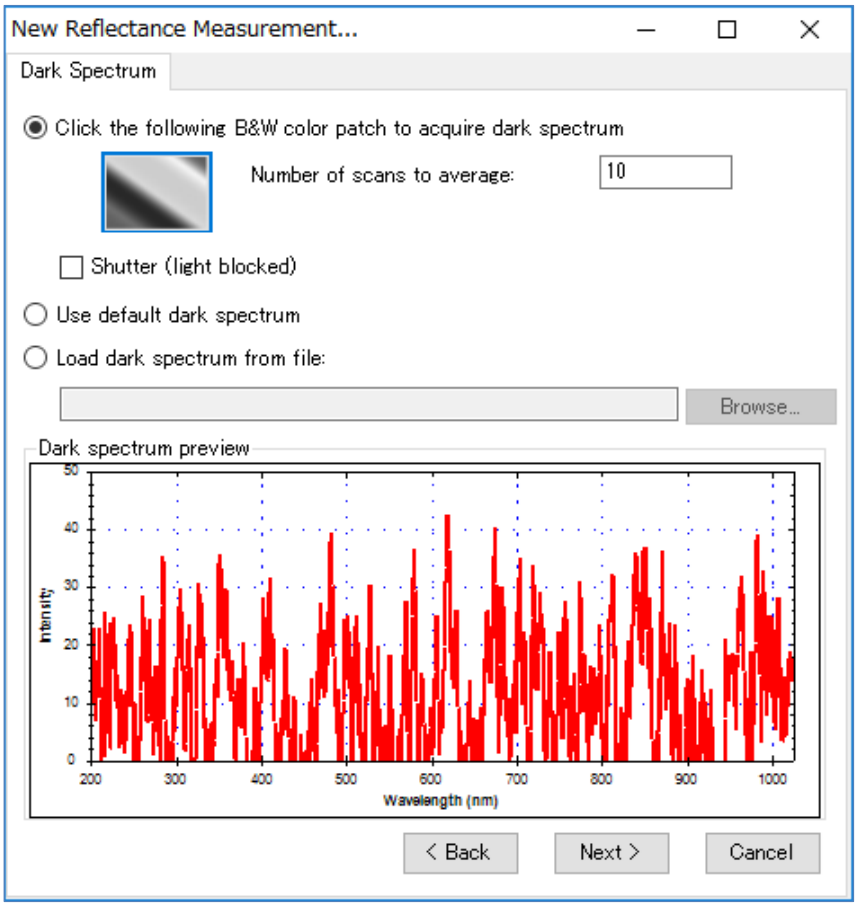


Figure 10-10: **New Reflectance Measurement** - **Dark Spectrum**

Setting Dark Spectrum

After setting the reference spectrum, set the measurement value when light does not hit the sensor, ie "dark spectrum". So, please cut off or block the light source connected to the spectrometer. Then, click on the black-and-white patch on the window to acquire the dark spectrum. It is possible to calculate and set the average value by multiple acquisition rather than one acquisition. The default is 1 time. For the example is 10 times. After acquiring the dark spectrum, you can check the spectrum acquired in the preview at the bottom of the screen. In addition, you will see an "**Acquiring dark spectrum...**" message window. See the following figure:

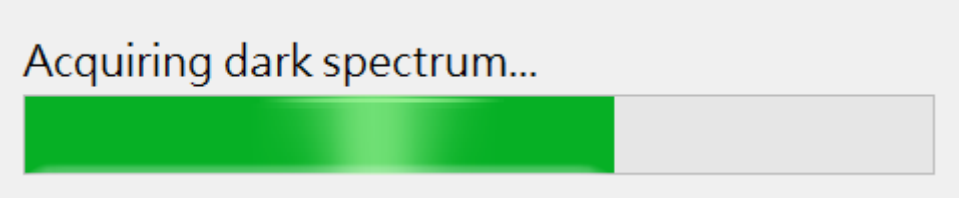


Figure 10-11: Acquiring dark spectrum...

In addition to capture the dark spectrum in real time, it is possible to select the program's default dark spectrum or load a previous dark spectrum file. Please note that the default dark spectrum is a set of built-in data which is handy for testing purposes. It may not be suitable for your current measurement environment. The following figure shows the case when you choose to **Use default dark spectrum**:

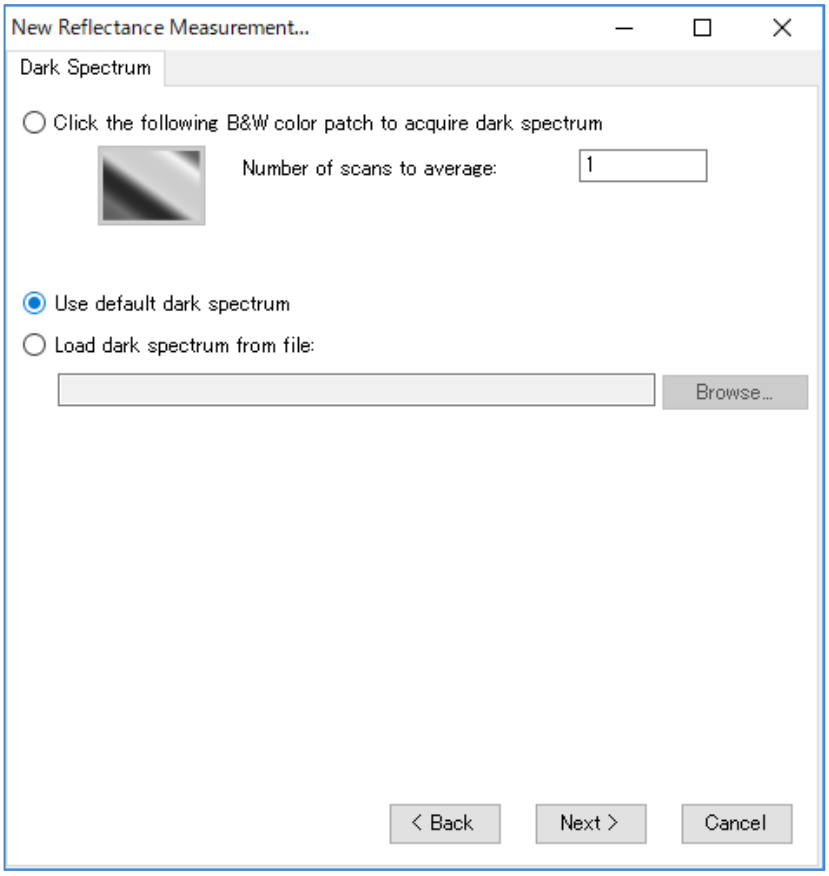


Figure 10-12: **New Reflectance Measurement** - Using the default dark spectrum

Note: This example uses the dark spectrum captured in real-time (not the default dark spectrum).

Once the dark spectrum is set, click **Next**.

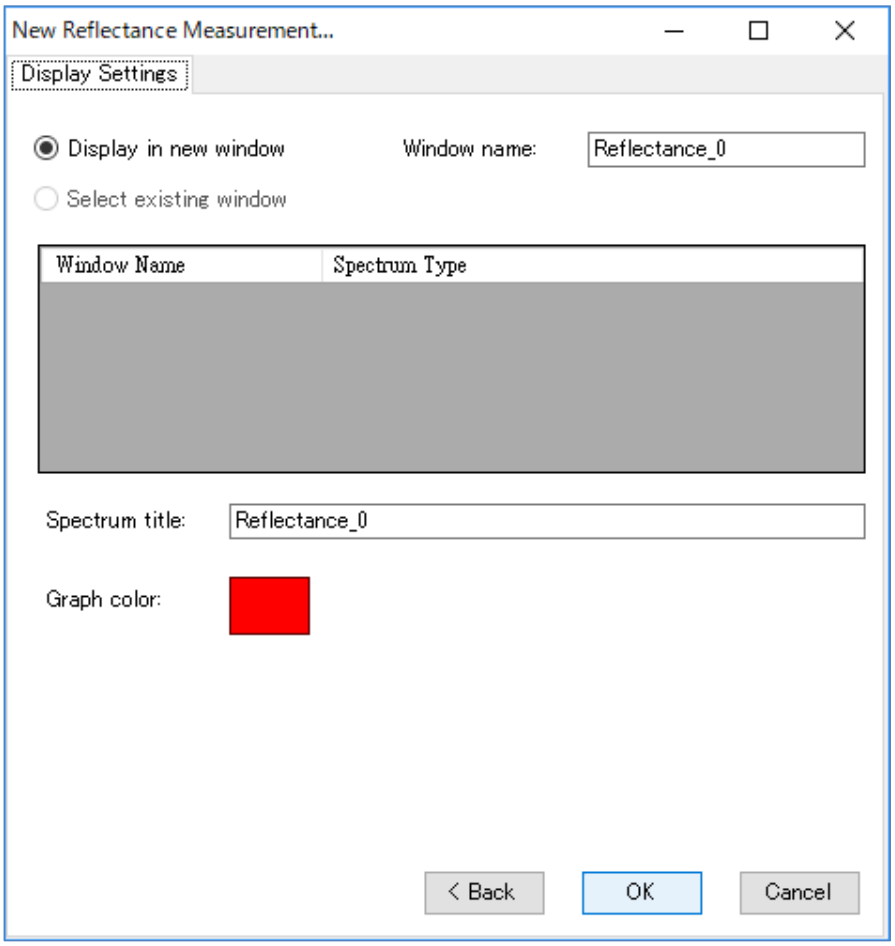


Figure 10-13: **New Reflectance Measurement** - **Display Settings**

Display Settings

Next, you can specify a name for the measurement graph window, as well as a spectrum title and a color for the graph, as in the former figure. To specify the color, you can click on the color patch and select the desired color from the palette:

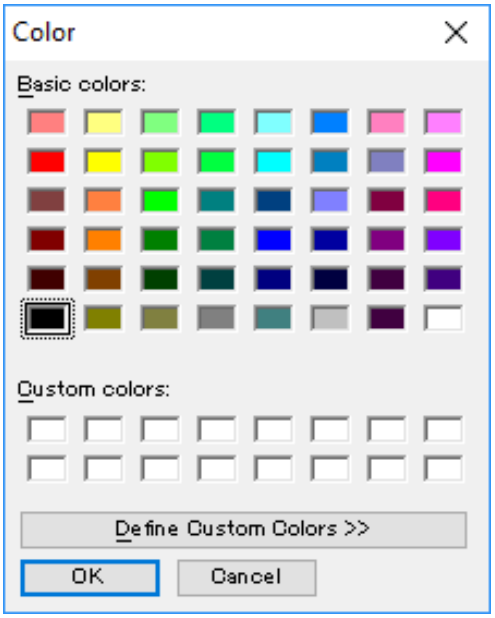


Figure 10-14: **Display Settings** – **Color**

When you finished the display settings, click **OK**, and then SpectraSmart will display the measurement graph, as shown below:

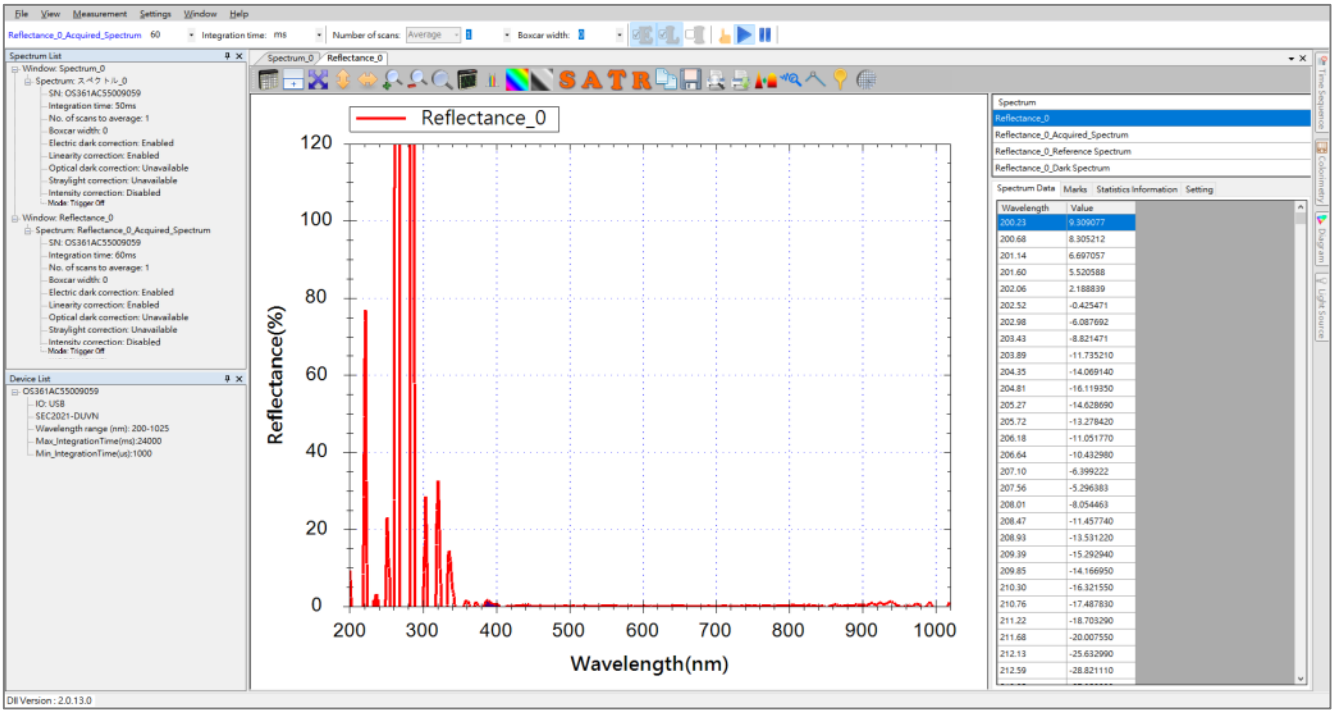


Figure 10-15: Newly created reflectance measurement graph

Since the object to be measured has not been set yet, the reflectance in the visible range is almost zero. Furthermore, since the reference light source is a halogen light source, its wavelength range is approximately 400 nm or more, and adjusting the display range to 400 to 780 nm makes the graph easier to see (see "Graph Settings" for details). The

adjusted graph looks like the following:

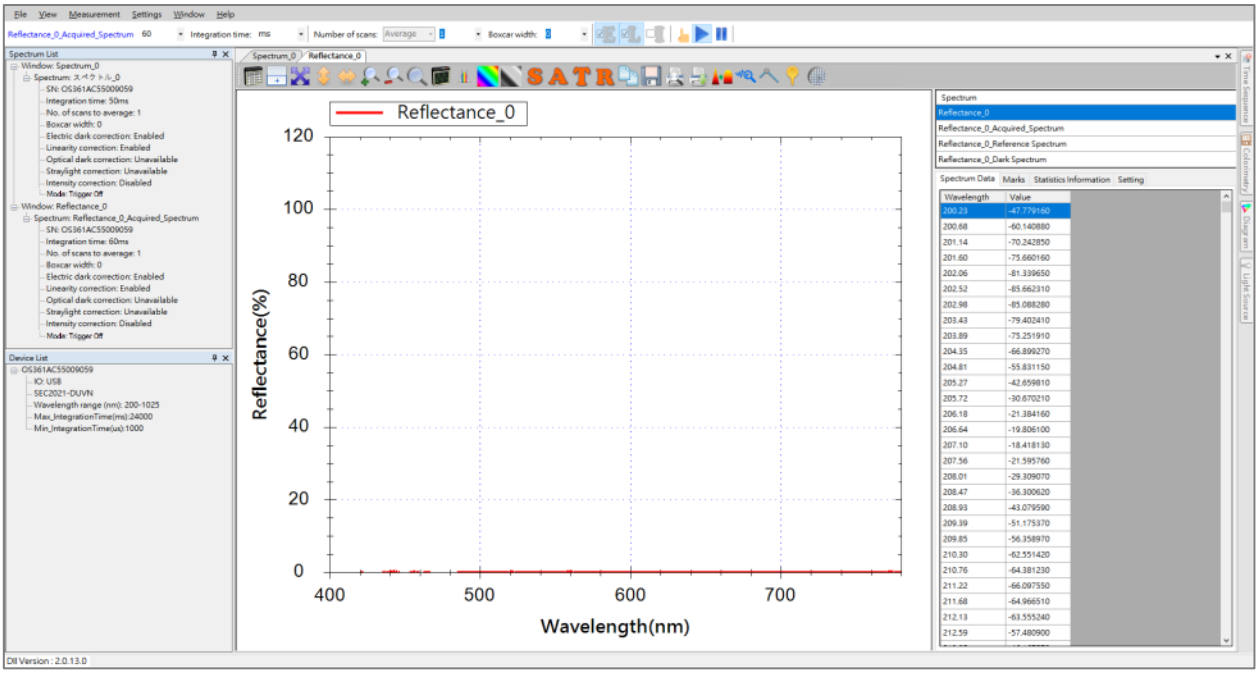


Figure 10-16: Reflectance measurement graph adjusted to the wavelength range

Start Measuring the Reflectance of the Test Object

Next, set the test object to measure the reflectance. Here silver metal sheet reflectance was measured for demonstration. The result is shown below:

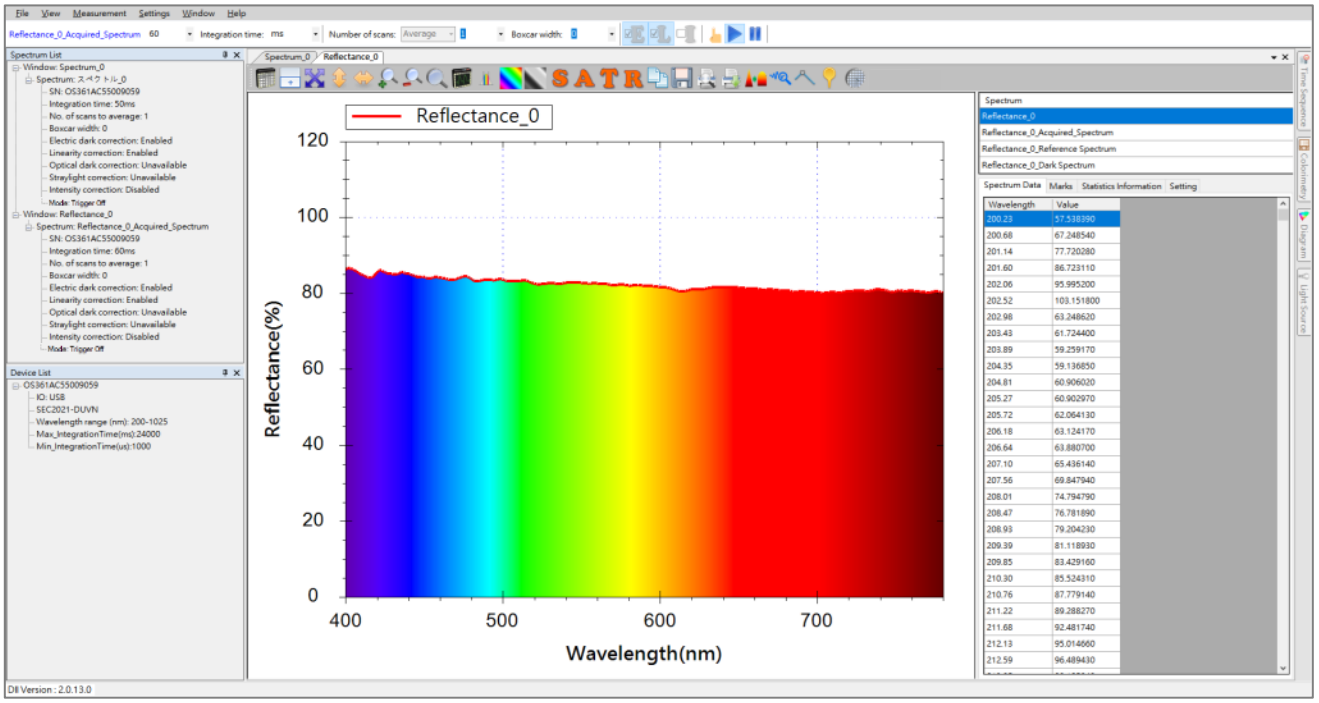


Figure 10-17: The reflectance measurement graph of a silver metal plate

In the figure, because the silver metal sheet reflects light over all visible wavelengths, the curve has the full range of visible light.

Subsequently, when it is changed to a silver-blue metal sheet, its reflectance curve is measured, the reflectance of blue visible light is still high as shown below, and the reflectance of yellow light to red light is low.

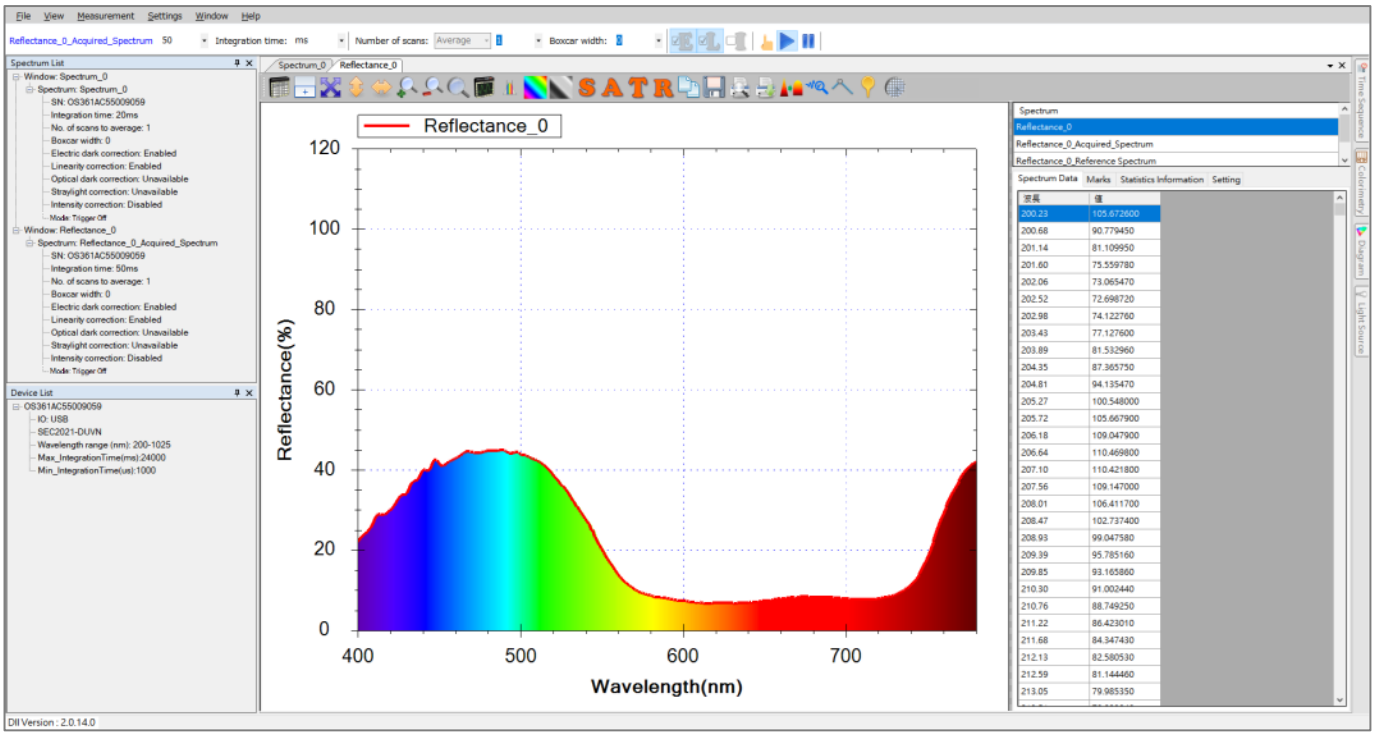


Figure 10-18: The reflectance measurement graph of a silver-blue metal sheet

Checking the Acquired Spectrum Curve

Since the reflectance curve is calculated based on the spectrum acquired by the software, SpectraSmart provides a feature for the user to see the original acquired spectrum curve so it can be verified against the reflectance curve. Click on the **Acquired Spectrum** button on the toolbar to enable this feature, as shown in the following figure:

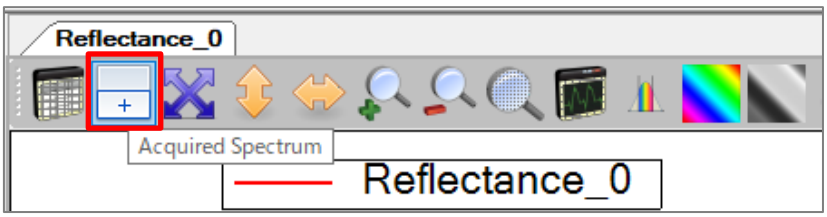


Figure 10-19: The **Acquired Spectrum** button

The following three figures show the reflectance graphs with their acquired spectrums for the original light source, the silver metal sheet, and the silver-blue metal sheet, respectively:

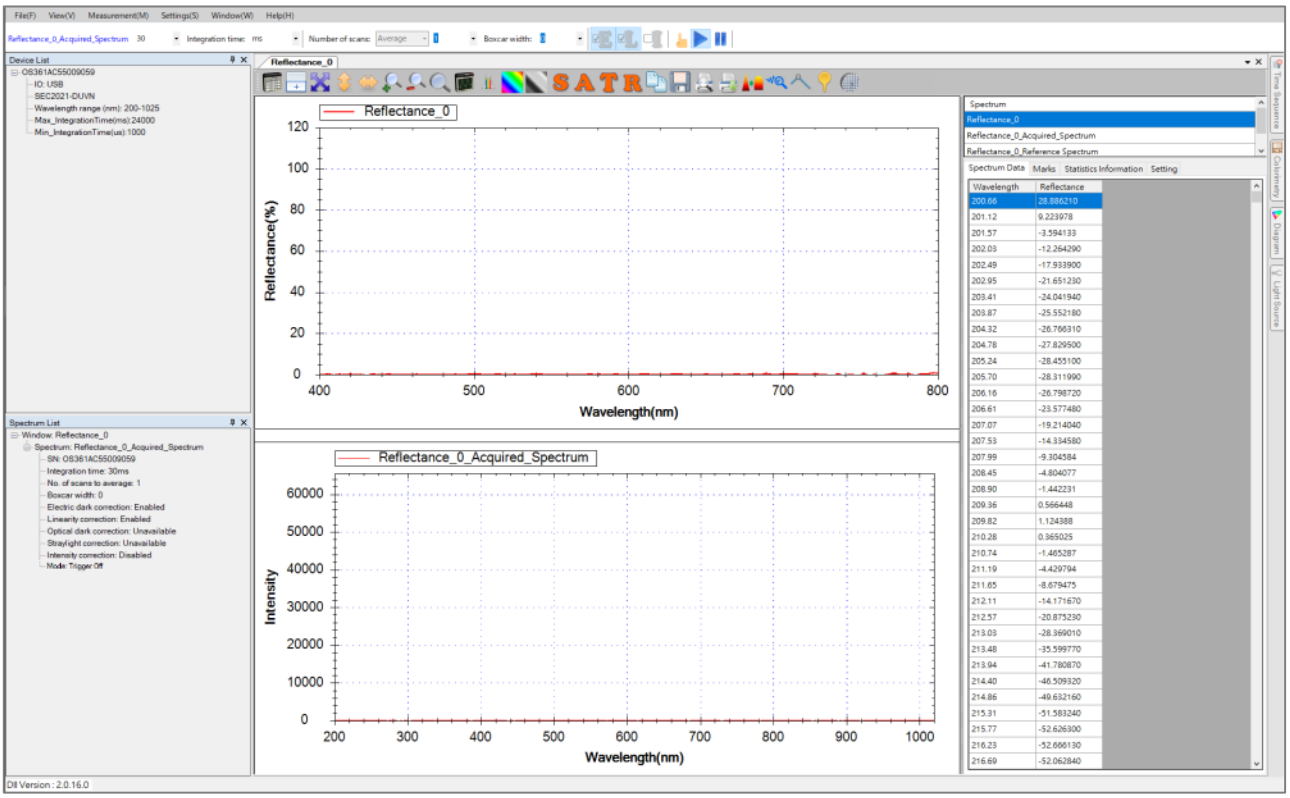


Figure 10-20: Reflectance measurement light source acquired spectrum when the objet to be measured is not set

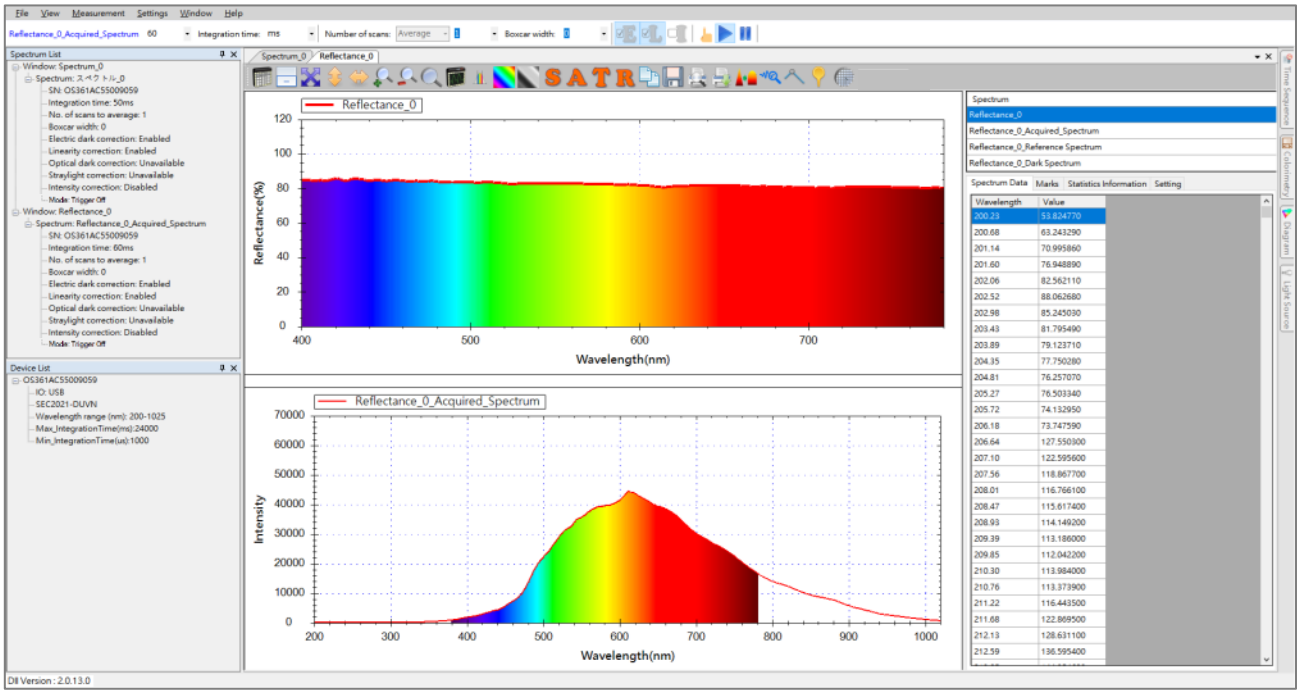


Figure 10-21: Reflectance measurement acquired spectrum for the silver metal sheet

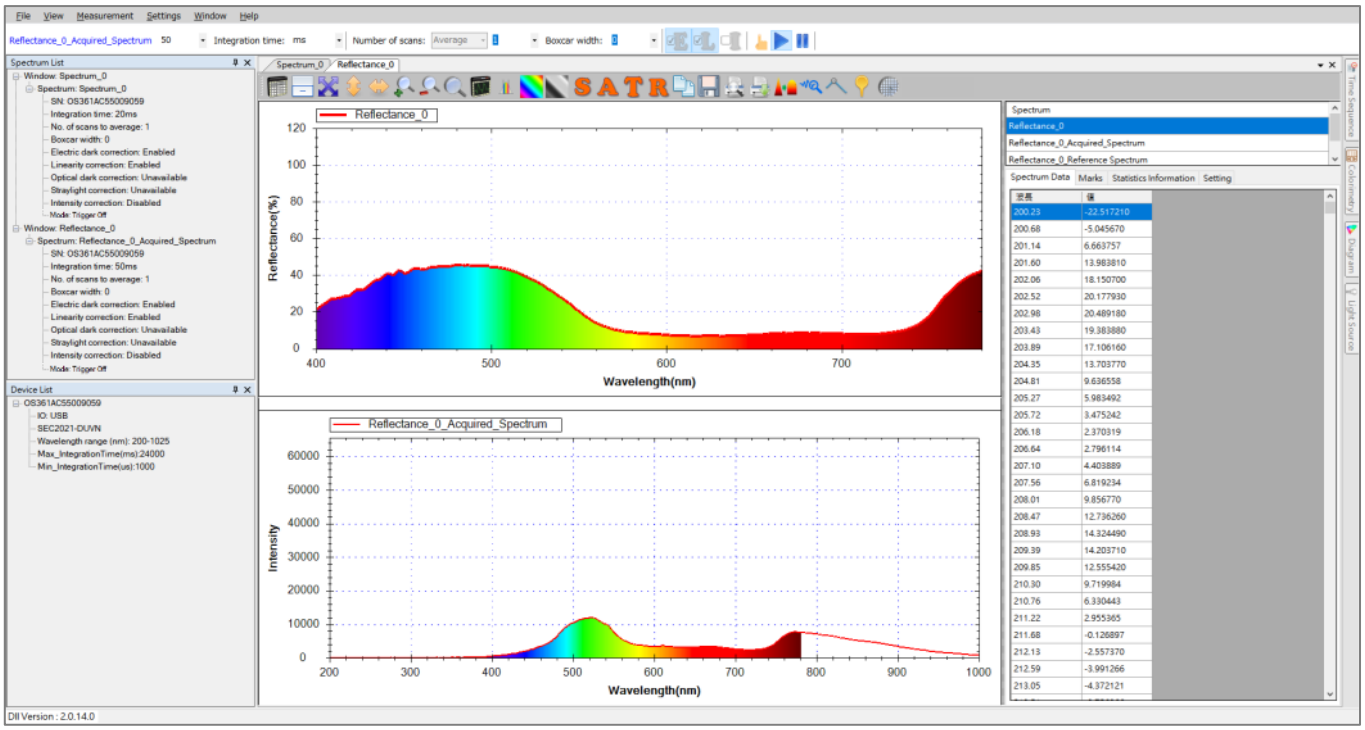


Figure 10-22: The acquired spectrum of the reflectance measurement for the silver-blue metal sheet

As we can see in the figures above, the silver metal sheet reflects most of the visible light, while the silver-blue metal sheet mainly reflects the red light.

Checking Colorimetry Information

When measuring transmittance, reflectance, and emission intensity, SpectraSmart also provides colorimetry information in addition to the measurement graph and the **Acquired Spectrum**. Please refer to "Checking Colorimetry Information" in the chapter of transmittance measurement.

Checking Diagrams

In addition to colorimetry information, SpectraSmart also provides diagrams for the user to check the color coordinates and the dominant wavelength of the test object. Please refer to "Checking Diagrams" in the chapter of transmittance measurement.

Graph Toolbar Buttons

The toolbar buttons above the reflectance measurement graph are identical to those on the transmittance measurement graph, and they work the same way, so we will not repeat the details here. Please refer to "Graph Toolbar Buttons" in the chapter of

transmittance measurement.

Saving a Reflectance Measurement

Saving a reflectance measurement follows the same steps for saving an absorbance measurement, so we will not repeat the details here. Please refer to "Saving Absorbance Measurement" in the chapter of absorbance measurement.

Loading Saved Spectrum Curve of a Reflectance Measurement

Loading a spectrum curve of a reflectance measurement is similar to loading that of an absorbance measurement, with the same limitation(s), but there is one little difference. When loading a spectrum curve from a reflectance measurement, the user can specify whether to calculate colorimetry information:

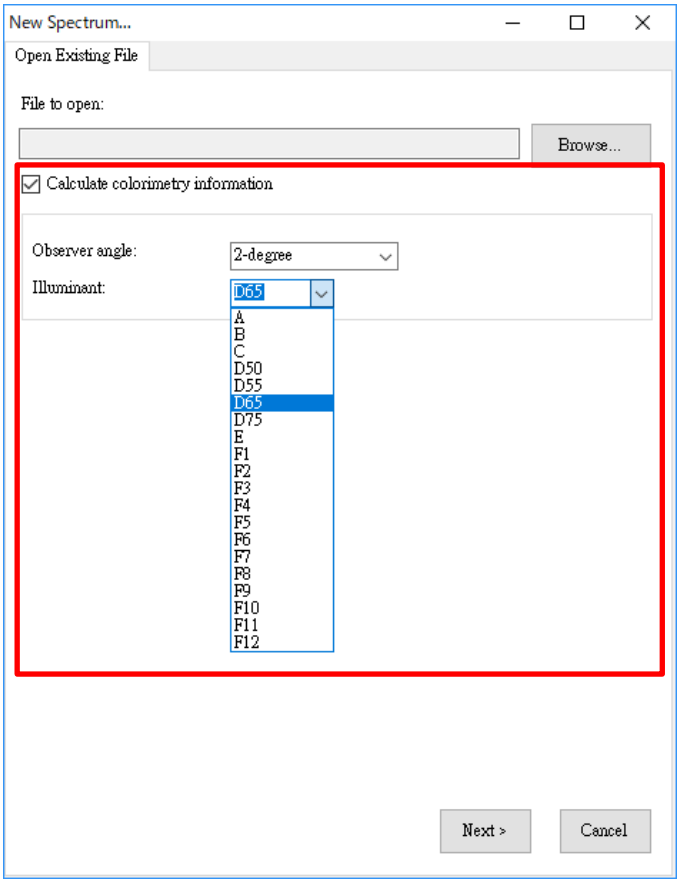


Figure 10-23: Choosing **Calculate colorimetry information** when loading a spectrum curve of a reflectance measurement

As the former figure shows, after selecting **Calculate colorimetry information**, you need to specify **Observer angle** and **Illuminant** next. With this information provided, you will be able to see corresponding data in the **Colorimetry** and **CIE Diagram** panes. Apart from

this difference, all other details are identical to loading a spectrum curve of an absorbance measurement. We will not repeat them here. Please refer to "Loading Saved Spectrum Curve of an Absorbance Measurement" in the chapter of absorbance measurement.

Deleting Individual Spectrum Curves of a Reflectance Measurement

A reflectance measurement is composed of multiple spectrum curves. As such, **please don't delete any individual curve from the measurement as they function as one. Doing so will destroy the entire measurement.**

Printing and Previewing a Reflectance Measurement

The steps for printing and previewing a reflectance measurement are the same as in printing and previewing a spectrum measurement. So, we will not repeat the details here. Please refer to "Printing and Previewing a Spectrum Measurement" in the chapter of spectrum measurement.

11. Emission Intensity Measurement

Emission intensity measurement measures the light source directly. Therefore, there is not a need of the reference light source. Once the emission intensity measurement is carried out, the program automatically creates the light source spectrum.

Set and measure the conditions of Emission Intensity Measurement

For the measurement of the emission intensity, select **Emission Intensity** from the **Measurement** menu and open the **New Emission Intensity Measurement** window.

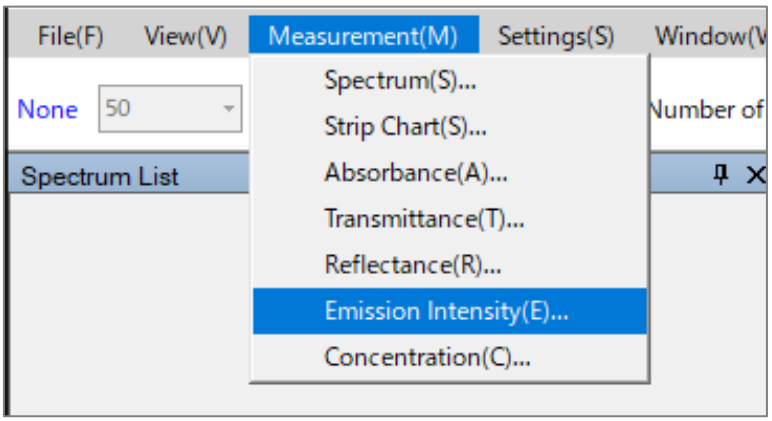


Figure 11-1: Selecting **Emission Intensity** from the **Measurement** menu to create a emission intensity measurement

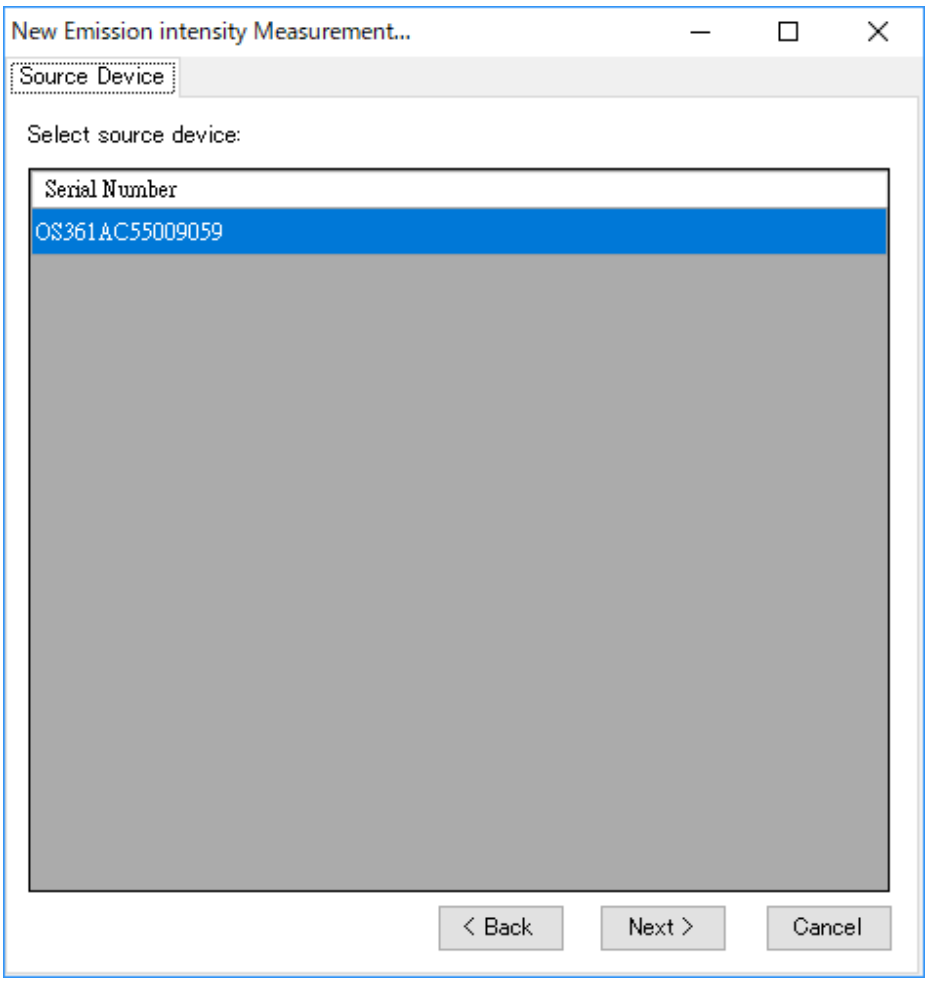


Figure 11-2: **New Light Source Measurement** - **Source Device**

Selecting a Source Device

Next, please select a source device (identified by its serial number) on the **Source Device** window. Then, click **Next**.

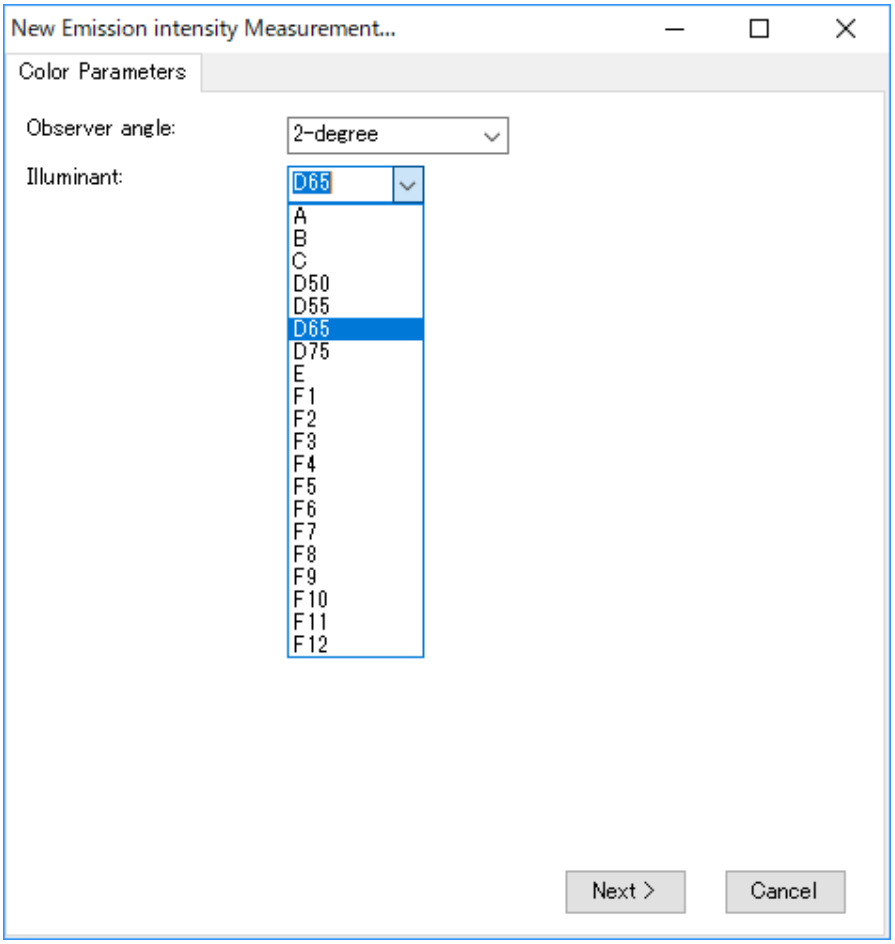


Figure 11-3: **New Emission Intensity Measurement** - **Color Parameters**

Setting Color Parameters

For the emission intensity measurement, specify the view angle of the CIE standard Observer (**Observer angle**) and the type of the light source (**Illuminant**). SpectraSmart supports two standard observer viewing angles: 2 degree and 10 degree (corresponding to CIE 1931 and CIE 1964 standards, respectively) and to multiple standard light sources. In this example, **2-degree** and **D65** are specified. When you have finished selecting it, press [Next].

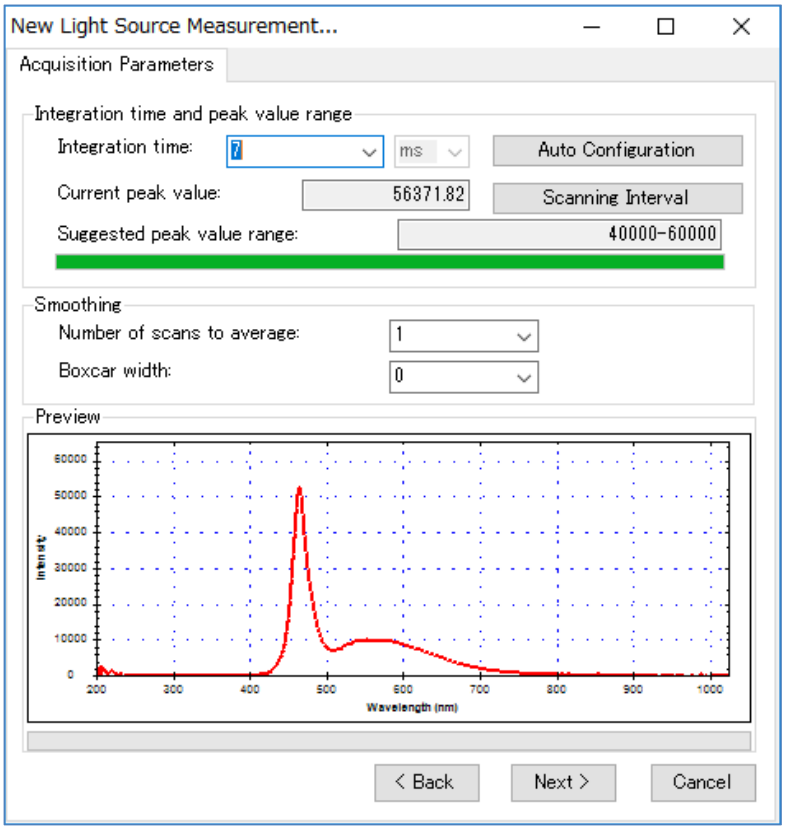


Figure 11-4: **New Emission Intensity Measurement** - **Acquisition Parameters**

Specifying Integration Time

Then specify the integration time (i.e. the exposure time for the light sensor) on the **Acquisition Parameters** window. In the program, the default integration time is set automatically when the window is opened. Adjust the integration time while referring to the preview at the bottom of the screen as necessary. The preview will change as you adjusted, so set the peak value within the **Suggested peak value range** on the window. In the example, the peak value is set within the range of **40000-60000**.

Note: "Electronic Dark Correction", "Linearity Correction" and "Intensity Correction" are applied to the spectral display of the emission intensity measurement. For this reason, the intensity of the preview curve here will be obviously lower than those in other measurements. Therefore, when you are adjusting the acquisition parameters to make the highest peak fall within the suggested 40000-60000 range, please refer to the "Current peak value" field instead of the preview chart on this dialog.

If the adjustment is not successful, you can press the **Auto Configuration** button to have the program automatically recovered to default setting.After setting the integration time, set the interval of the spectrum scan as necessary. Click the **Scanning Interval** button, then on the **Spectrum Scanning Interval** window, select **Enable user-defined spectrum scanning interval**, and specify the interval required (the default is 500 ms).

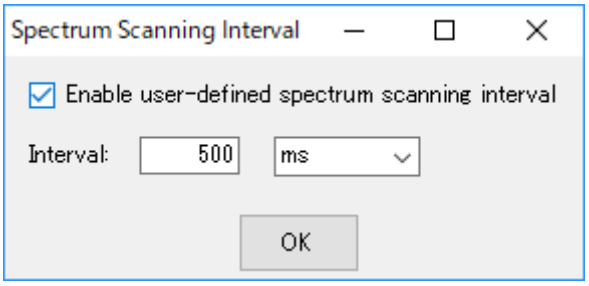


Figure 11-5: Spectrum Scanning Interval

Smoothing

Smoothing processing can be performed on the spectrum curve. Specify the number of scans to calculate the average value for "Number of scans to average". This makes possible to reduce the fluctuation of the curve even for only one acquisition data. For **Boxcar Width**, specify the number of data points on both side of the point of interest to include in the calculation of the moving average. This can reduce the sudden change of the curve. This smooths out the sharp variations on the curve: the bigger the Boxcar width, the smoother the curve. The following figure demonstrates the smoothing effect of a Boxcar width of 10 (maximum value). You can compare it with the former curve without smoothing to see the difference (see the red curve in the preview graph).

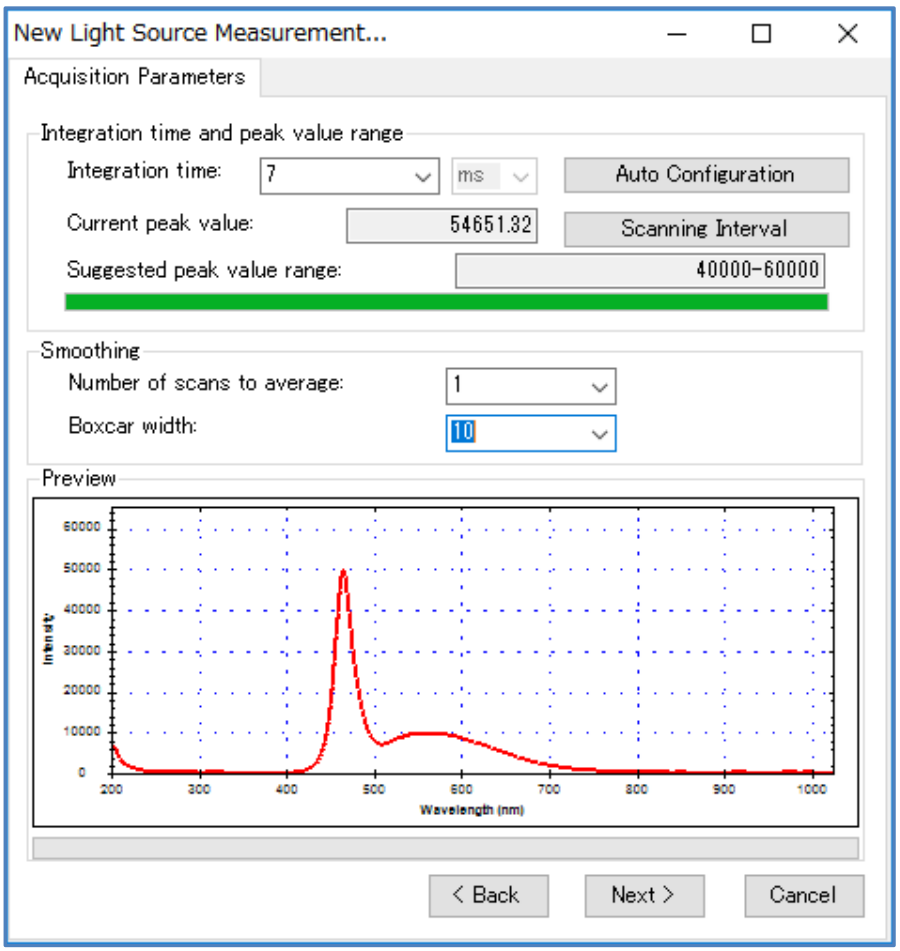


Figure 11-6: **New Emission Intensity Measurement** - the smoothing effect

Note: The following example uses the default settings, i.e. no smoothing (Number of scans to average=1, Boxcar width=0).

When all acquisition parameters are set, click **Next**.

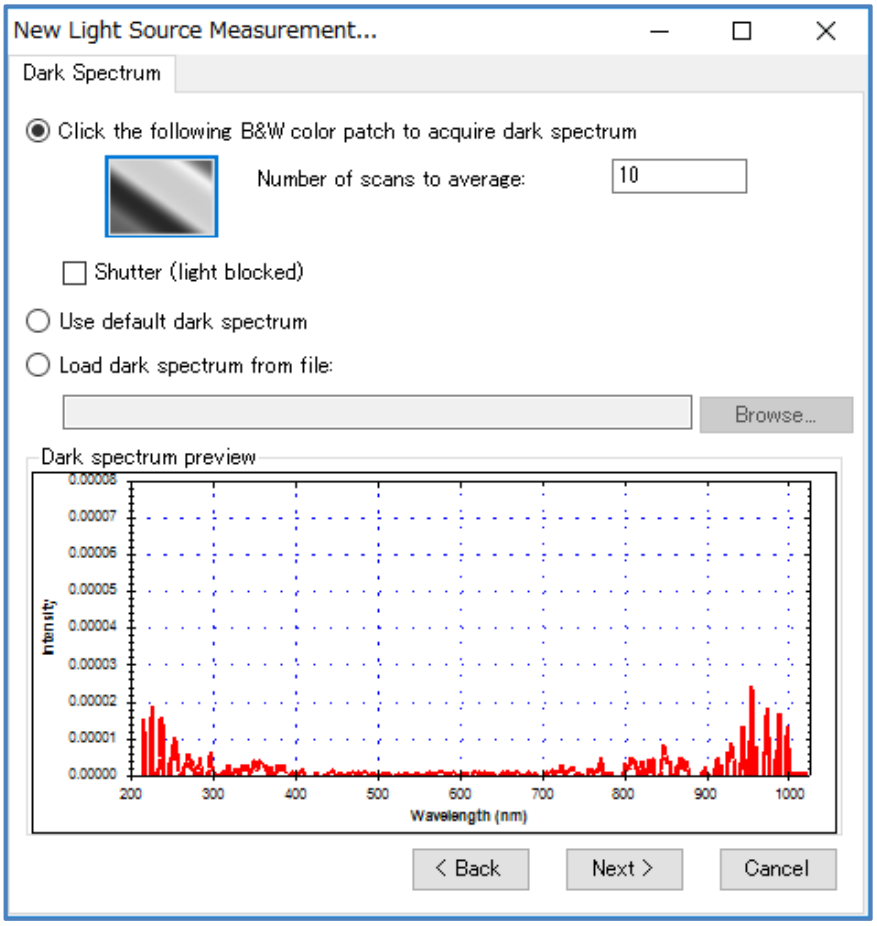


Figure 11-7: **New Emission Intensity Measurement** - Dark Spectrum

Setting Dark Spectrum

Set the measurement value when light does not hit the sensor, ie "dark spectrum". So, please cut off or block the light source connected to the spectrometer. Then, click on the black-and-white patch on the window to acquire the dark spectrum. It is possible to calculate and set the average value by multiple acquisition rather than one acquisition. The default is 1 time. For the example is 10 times. After acquiring the dark spectrum, you can check the spectrum acquired in the preview at the bottom of the screen. In addition, you will see an "**Acquiring dark spectrum...**" message window. See the following figure:

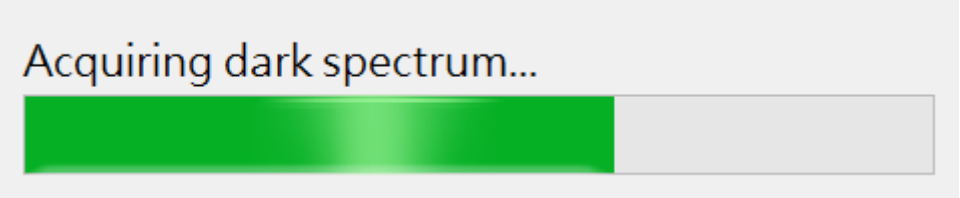


Figure 11-8: Acquiring dark spectrum...

In addition to capture the dark spectrum in real time, it is possible to select the program's default dark spectrum or load a previous dark spectrum file. Please note that the default dark spectrum is a set of built-in data which is handy for testing purposes. It may not be suitable for your current measurement environment. The following figure shows the case when you choose to **Use default dark spectrum**:

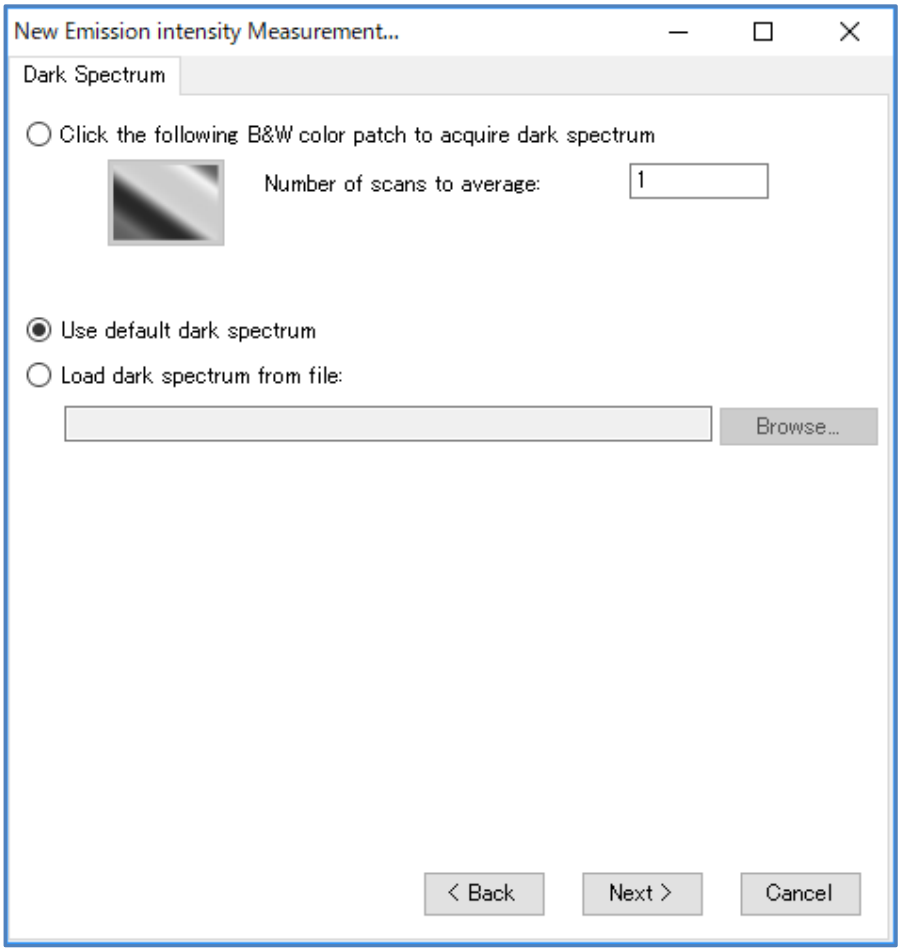


Figure 11-9: **New Emission Intensity Measurement** - Using the default dark spectrum

Note: This example uses the dark spectrum captured in real-time (not the default dark spectrum).

Once the dark spectrum is set, click **Next**.

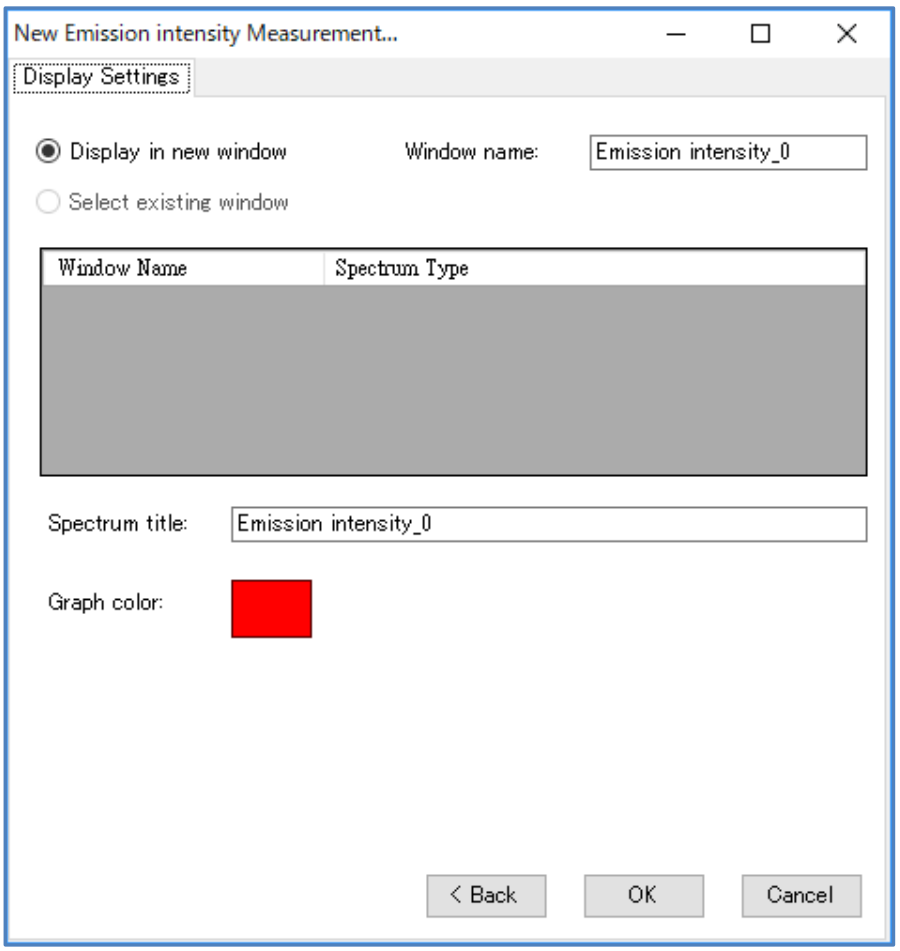


Figure 11-10: **New Emission Intensity Measurement** - **Display Settings**

Display Settings

Next, you can specify a name for the measurement graph window, as well as a spectrum title and a color for the graph, as in the former figure. To specify the color, you can click on the color patch and select the desired color from the palette:

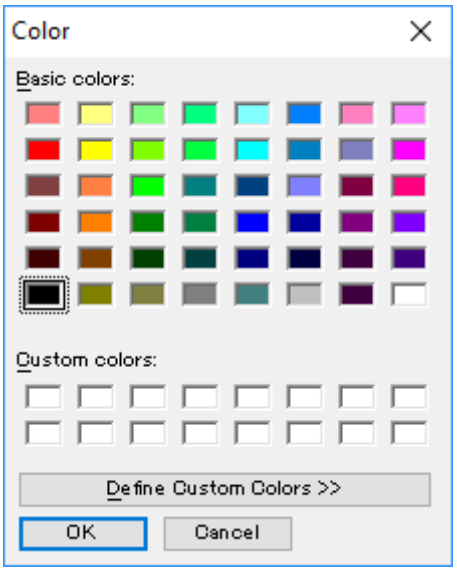


Figure 11-11: **Display Settings** - **Color**

When you are done with the display settings, click **OK**, and then SpectraSmart will display the measurement graph.

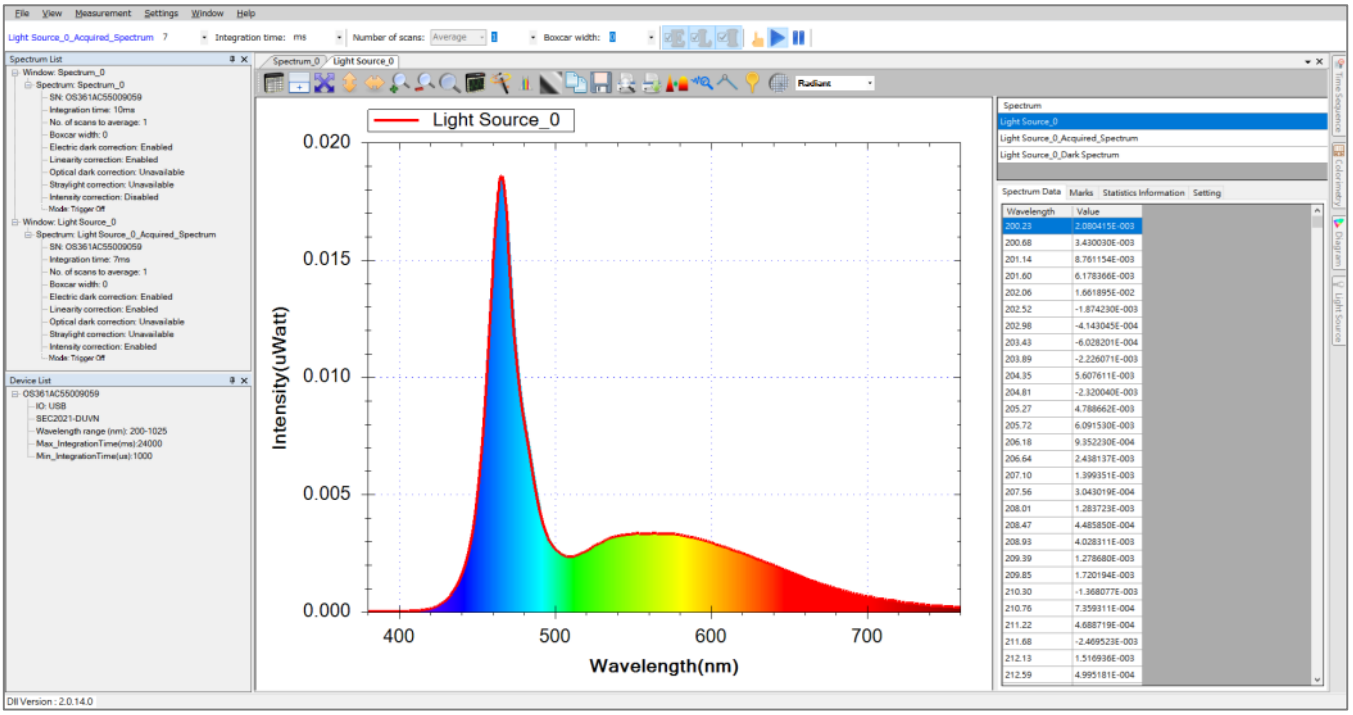


Figure 11-12: Newly created emission intensity measurement graph

The spectrum of the measured emission intensity is shown in the figure above. Since D65 is specified as the emission intensity during measurement conditions setting, SpectraSmart will automatically adjust the wavelength range (380 to 760 nm) of the displayed light source range.

Switching to Another Light Source

An example is the result of measuring the emission intensity with red color.

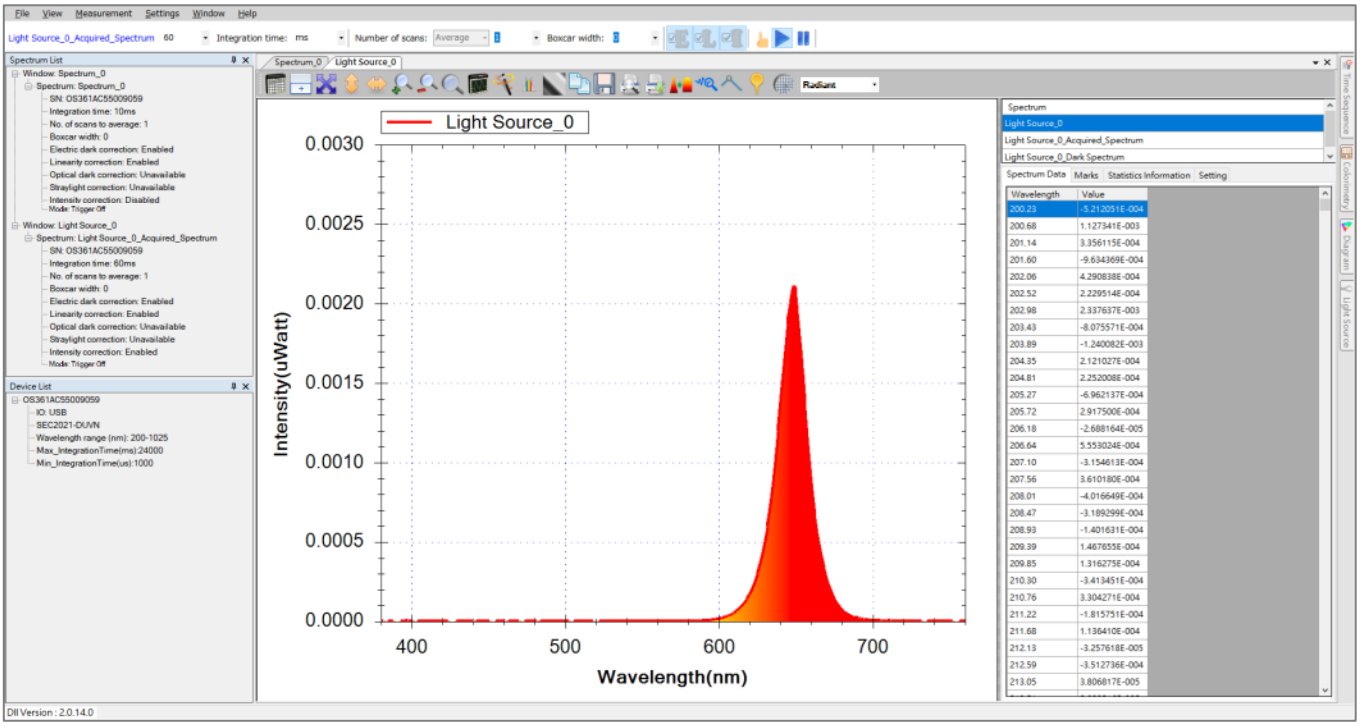


Figure 11-13: The measurement graph for the red light

Checking the Acquired Spectrum Curve

The emission intensity curve is calculated from multiple spectra. Spectra smart has a function to examine the original spectral curve. You can activate this function by clicking the **Acquired Spectrum** button on the toolbar to enable this feature.

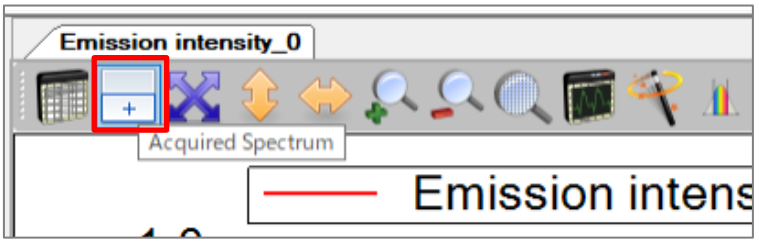


Figure 11-14: The **Acquired Spectrum** button

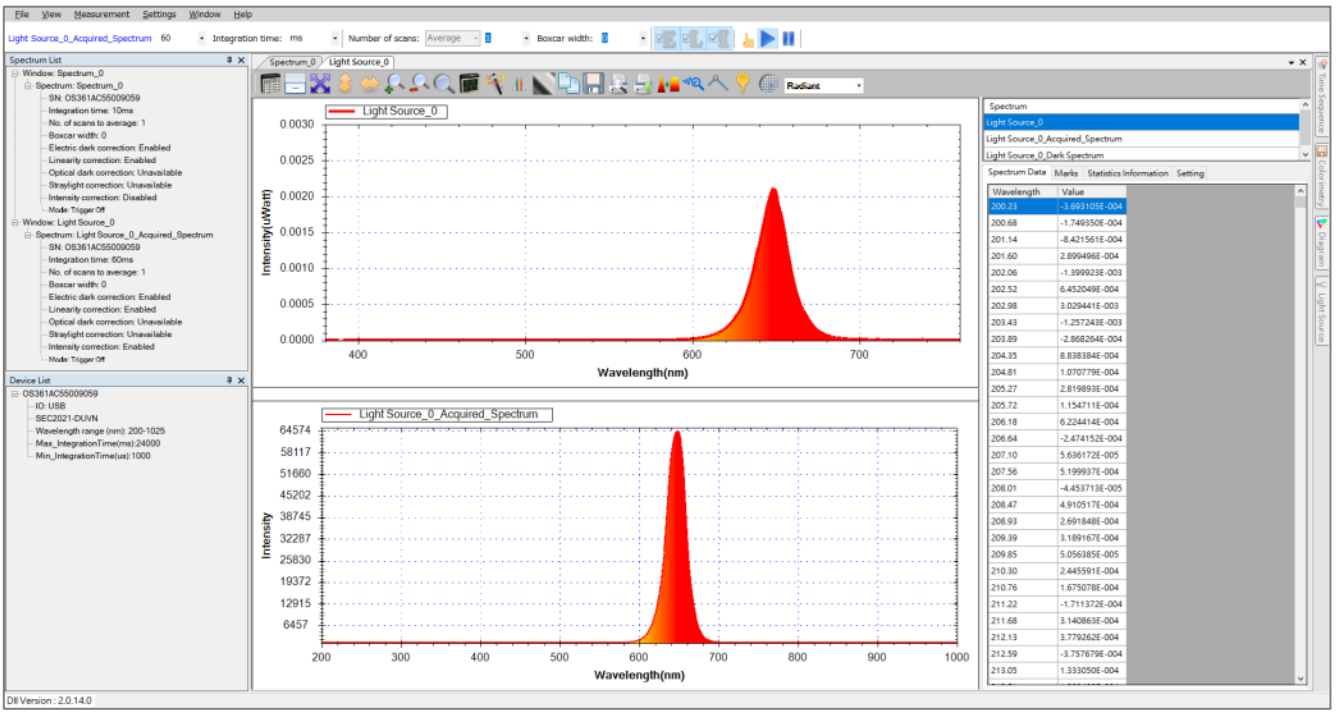


Figure 11-15: The acquired spectrum of the red light source measurement

Checking Colorimetry Information

In the measurement of transmittance, reflectance, and emission intensity, it is possible to investigate not only the spectrum but also provides colorimetry information. Please refer to "Checking Colorimetry Information" in the chapter of transmittance measurement.

Checking Diagrams

In addition to colorimetry information, CIE chromaticity diagram is provided to check the color coordinates and the dominant wavelength of the test object. Please refer to "Checking Diagrams" in the chapter of transmittance measurement.

Graph Toolbar Buttons

The toolbar buttons of the emission intensity measurement graph and spectrum graph are basically identical. **Calculated Color Range** button is added in the emission intensity measurement.

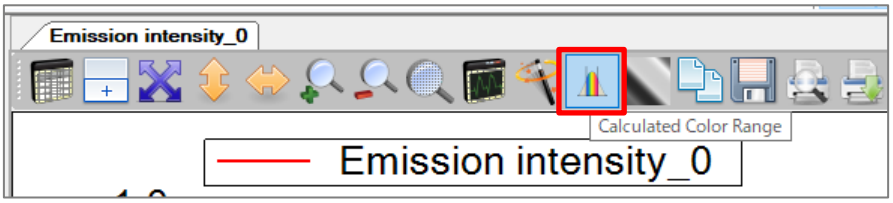


Figure 11-16: The Calculated Color Range button

For details on how the **Calculated Color Range** button works, refer to "Graph Toolbar Buttons" in the chapter of transmittance measurement. For details on other toolbar buttons, refer to "Graph Toolbar Buttons" in the chapter of spectrum measurement.

Saving a Emission Intensity Measurement

Saving the current emission intensity measurement follows the same steps for saving the current absorbance measurement. Please refer to "Saving Absorbance Measurement" in the chapter of absorbance measurement.

Loading Saved Spectrum Curve of a Emission Intensity Measurement

Loading a spectrum curve of emission intensity measurement is similar to loading that of an absorbance measurement. When loading a spectrum curve from emission intensity measurement, the user can specify whether to calculate colorimetry information.

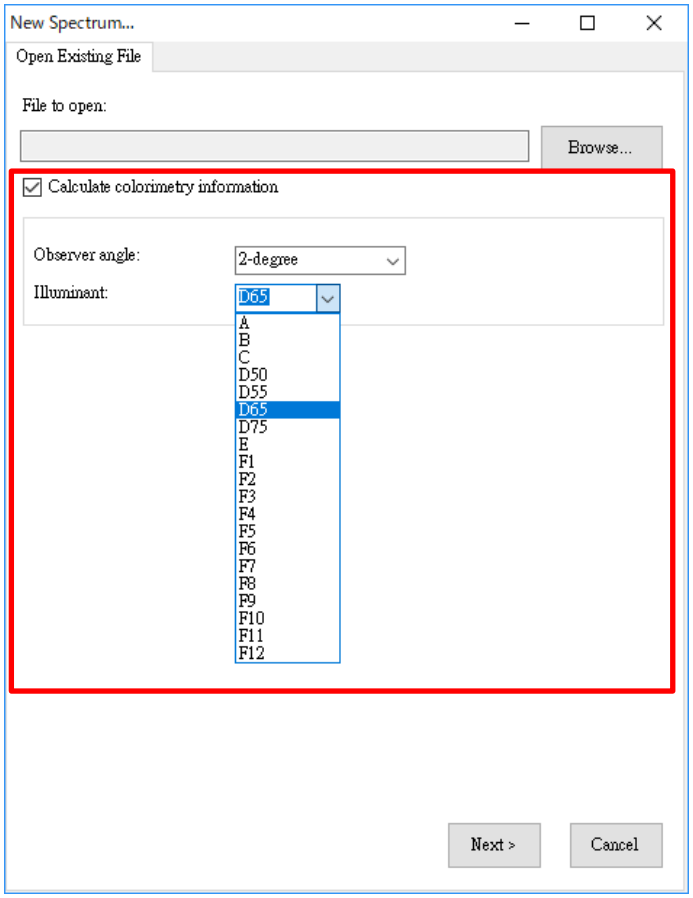


Figure 11-17: Choosing **Calculate colorimetry information** when loading a spectrum curve

As the former figure shows, after selecting **Calculate colorimetry information**, you need

to specify **Observer angle** and **Illuminant** next. With this information provided, you will be able to see corresponding data in the **Colorimetry** and **CIE Diagram** panes. Apart from this difference, all other details are identical to loading a spectrum curve of an absorbance measurement. We will not repeat them here. Please refer to "Loading Saved Spectrum Curve of an Absorbance Measurement" in the chapter of absorbance measurement.

Deleting Individual Spectrum Curves of Emission Intensity Measurement

A light source measurement is composed of multiple spectrum curves. As such, **please don't delete any individual curve from the measurement as they function as one. Doing so will destroy the entire measurement.**

Printing and Previewing a Emission Intensity Measurement

The steps for printing and previewing emission intensity measurement are the same as in printing and previewing a spectrum measurement. So, we will not repeat the details here. Please refer to "Printing and Previewing a Spectrum Measurement" in the chapter of spectrum measurement.

12. Concentration Measurement

Spectrum-based concentration measurement captures the spectrum of a light source after it passes through the test solution, and then compares the spectrum with the light source's original spectrum to come up with the concentration of the solution by applying a known calibration table or the Beer's Law. Accordingly, as in the transmittance measurement, the user needs to first set up the measurement environment, measure the original spectrum of the light source, and then put the test solution in place and measure the spectrum of the light passing through the solution. SpectraSmart provides a straightforward procedure to measure concentration. All you have to do is follow the step-by-step windows to create a concentration measurement.

Creating a Concentration Measurement

To create a concentration measurement, please select **Concentration** from the **Measurement** menu to open the **New Concentration Measurement** window, as shown in the following:

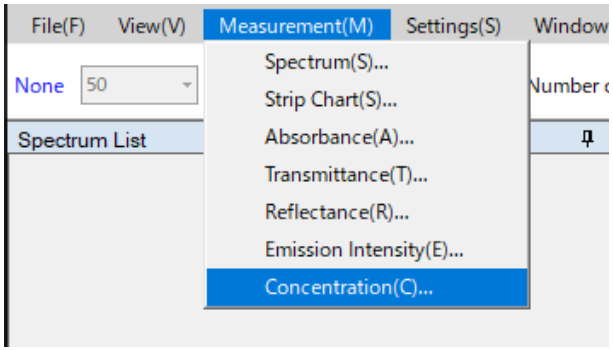


Figure 12-1: Selecting **Concentration** from the **Measurement** menu to create a new concentration measurement

Then, you will see the following window:

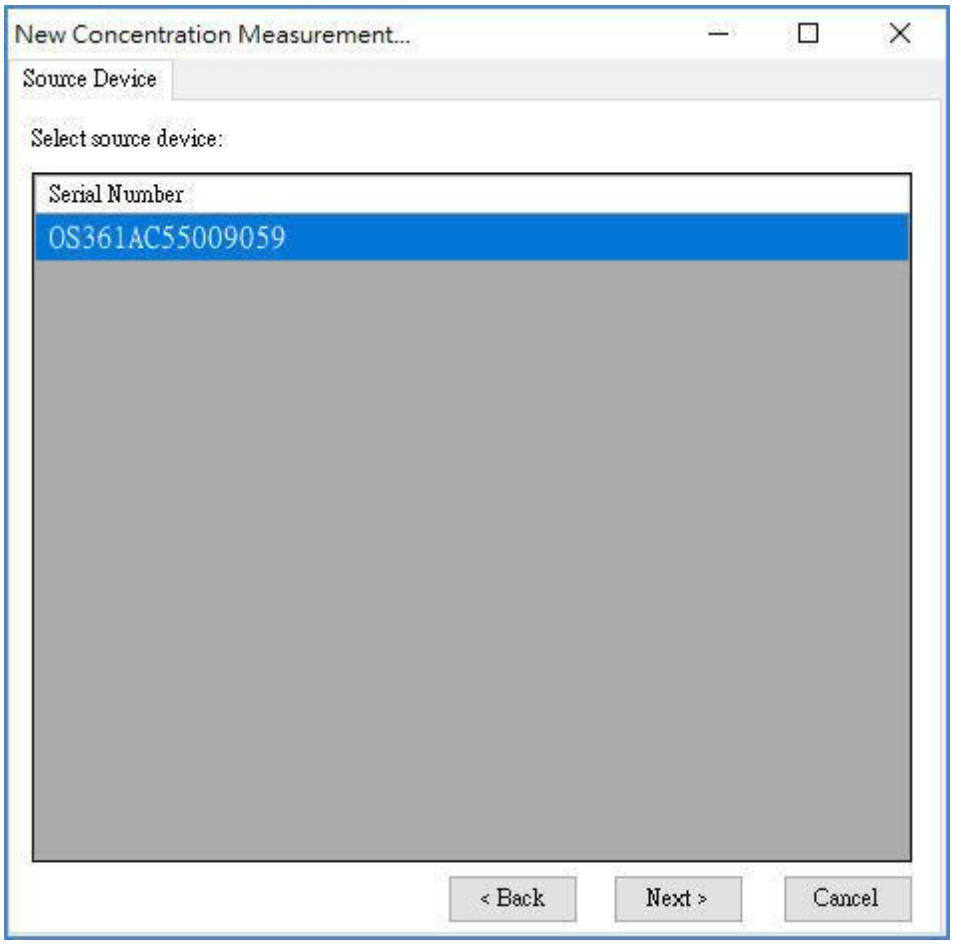


Figure 12-2: **New Concentration Measurement** - **Source Device**

Selecting a Source Device

On the **Source Device** window, please select a source device (identified by its serial number). Then, click **Next**.

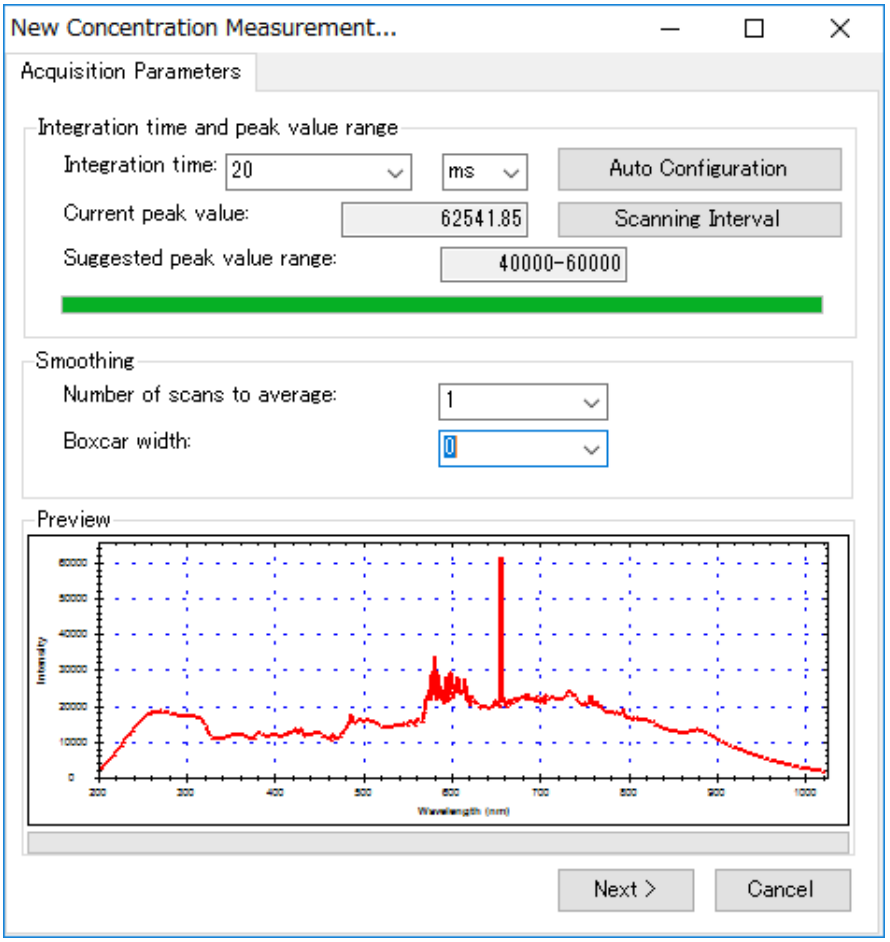


Figure 12-3: **New Concentration Measurement** - **Acquisition Parameters**

Specifying Integration Time

Then specify the integration time (i.e. the exposure time for the light sensor) on the **Acquisition Parameters** window. In the program, the default integration time set for absorbance measurement is set automatically when the window is opened. Adjust the integration time while referring to the preview at the bottom of the screen as necessary. The preview will change as you adjusted, so set the peak value within the **Suggested peak value range** on the window. In the example, the peak value is set within the range of **40000-60000**.

If the adjustment is not successful, you can press the Auto Configuration button to have the program automatically recovered to default setting.
Once the integration time is set, you can continue to set the spectrum scanning interval if you need. Please click the **Scanning Interval** button. On the **Spectrum Scanning Interval** window, select **Enable user-defined spectrum scanning interval**, and then specify the

interval you want (the default is 500ms), as in the following:

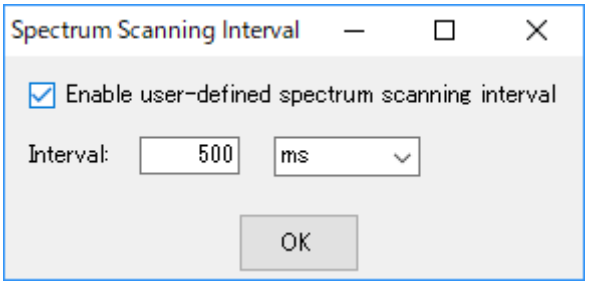


Figure 12-4: Spectrum Scanning Interval

Smoothing

Smoothing processing can be performed on the spectrum curve. Specify the number of scans to calculate the average value for "Number of scans to average". This makes possible to reduce the fluctuation of the curve even for only one acquisition data. For **Boxcar Width**, specify the number of data points on both side of the point of interest to include in the calculation of the moving average. This can reduce the sudden change of the curve. This smooths out the sharp variations on the curve: the bigger the Boxcar width, the smoother the curve. The following figure demonstrates the smoothing effect of a Boxcar width of 10 (maximum value). You can compare it with the former curve without smoothing to see the difference (see the red curve in the preview graph).

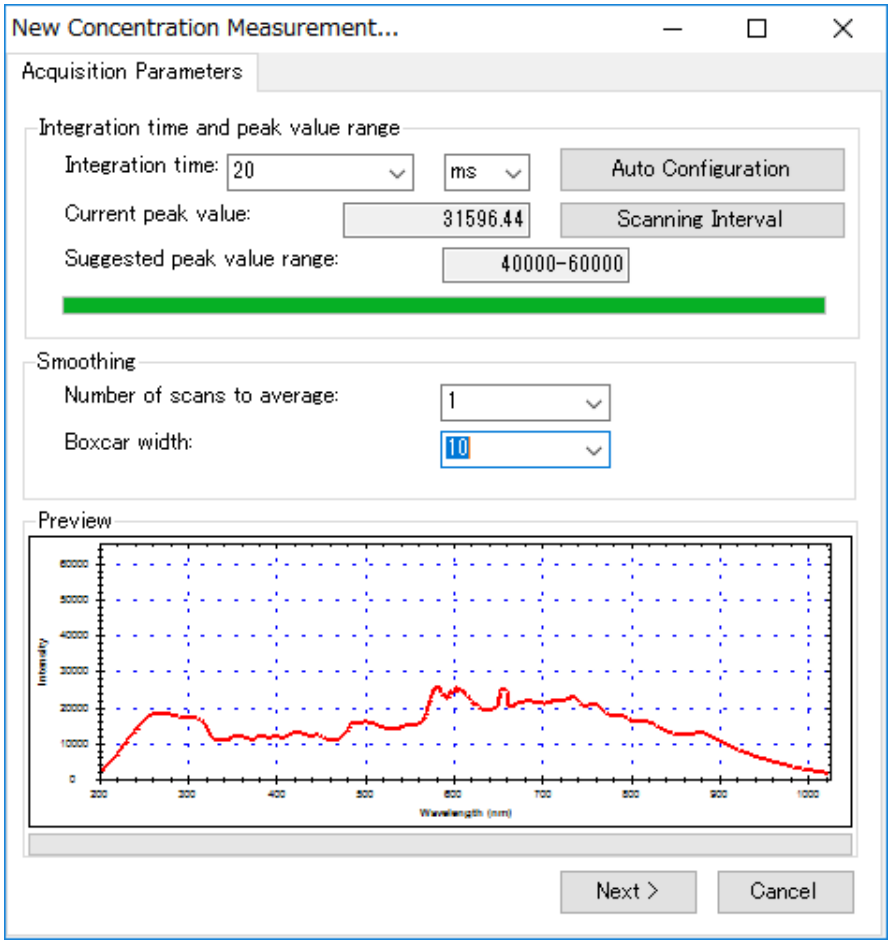


Figure 12-5: **New Concentration Measurement** - the smoothing effect

Note: The following example uses the default settings, i.e. no smoothing (Number of scans to average=1, Boxcar width=0).

When all acquisition parameters are set, click **Next**.

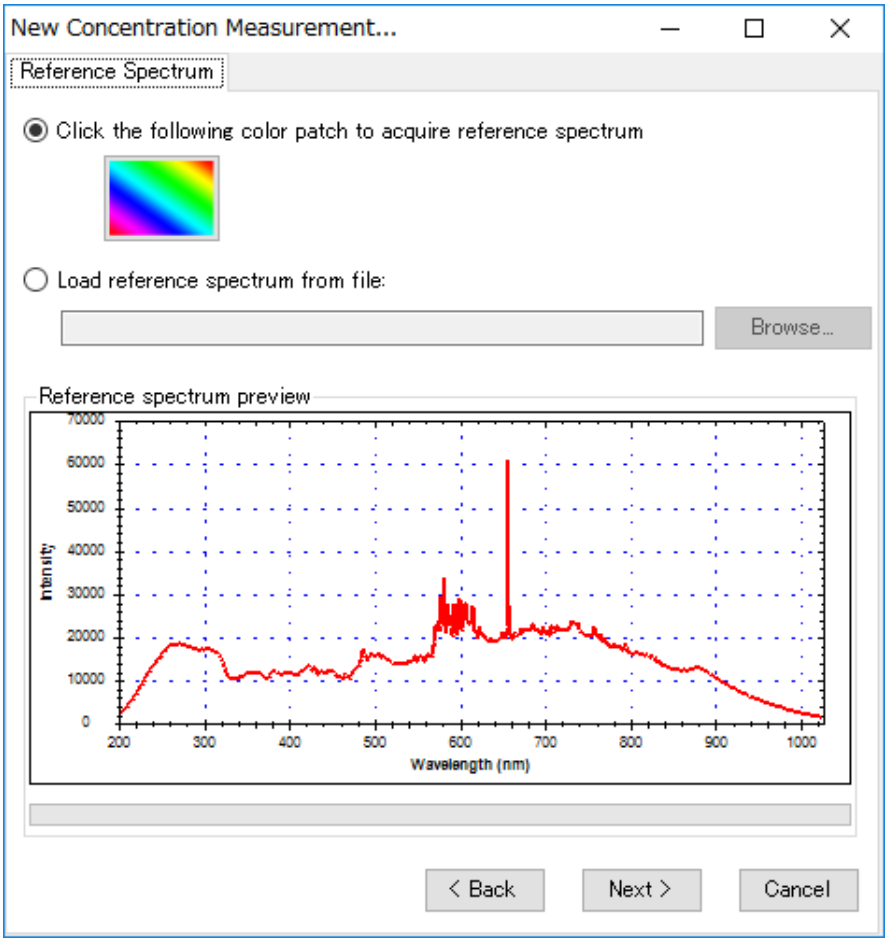


Figure 12-6: **New Concentration Measurement** - **Reference Spectrum**

Setting Reference Spectrum

Next, you need to set a "reference spectrum," which is basically the spectrum of the light source before you put the test solution in place. Here, you can click on the color patch on the window to acquire the live spectrum as the reference. Or, you can use the **Browse** button to load a previous reference spectrum file you saved with SpectraSmart. In this example, we use the default option, that is, acquiring the current live spectrum of the light source (**as such, please don't put the test object in place**). Once the reference spectrum is captured, you will see it in the preview graph on the lower half of this window. Then, click **Next**.

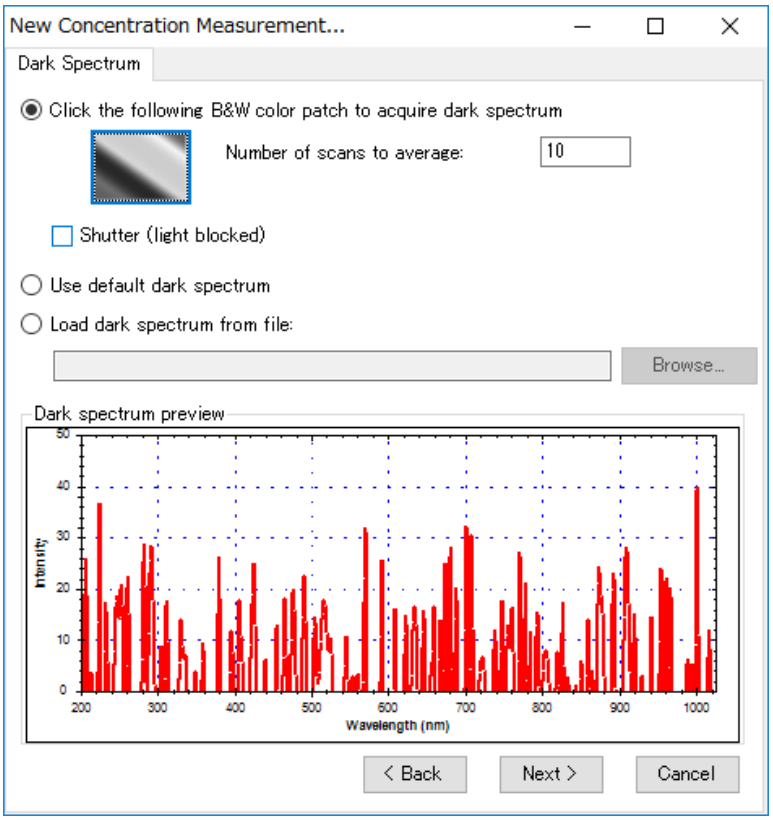


Figure 12-7: **New Concentration Measurement** - **Dark Spectrum**

Setting Dark Spectrum

In addition to the reference spectrum, the software also needs know the readings of the light sensor when it is not exposed to light to establish a baseline, i.e. the "dark spectrum." So, please cut off or block the light source connected to the spectrometer. Then, click on the black-and-white patch on the window to acquire the dark spectrum. You can specify the number of scans to average to avoid aberrations of individual scans. The default is 1, and we use 10 for example here. Once the dark spectrum is acquired, you will see it in the spectrum graph on the lower half of the window, as in the former figure. In addition, you will see an "**Acquiring dark spectrum...**" message window. See the following figure:

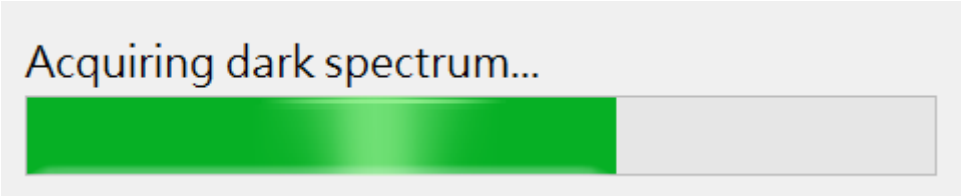


Figure 12-8: Acquiring dark spectrum...

Aside from capturing the real-time dark spectrum, you can also select the program's default dark spectrum or load a previous dark spectrum file you saved with SpectraSmart. Please note that the default dark spectrum is a set of built-in data which is handy for testing purposes. It may not be suitable for your current measurement environment. The following figure shows the case when you choose to **Use default dark spectrum**:

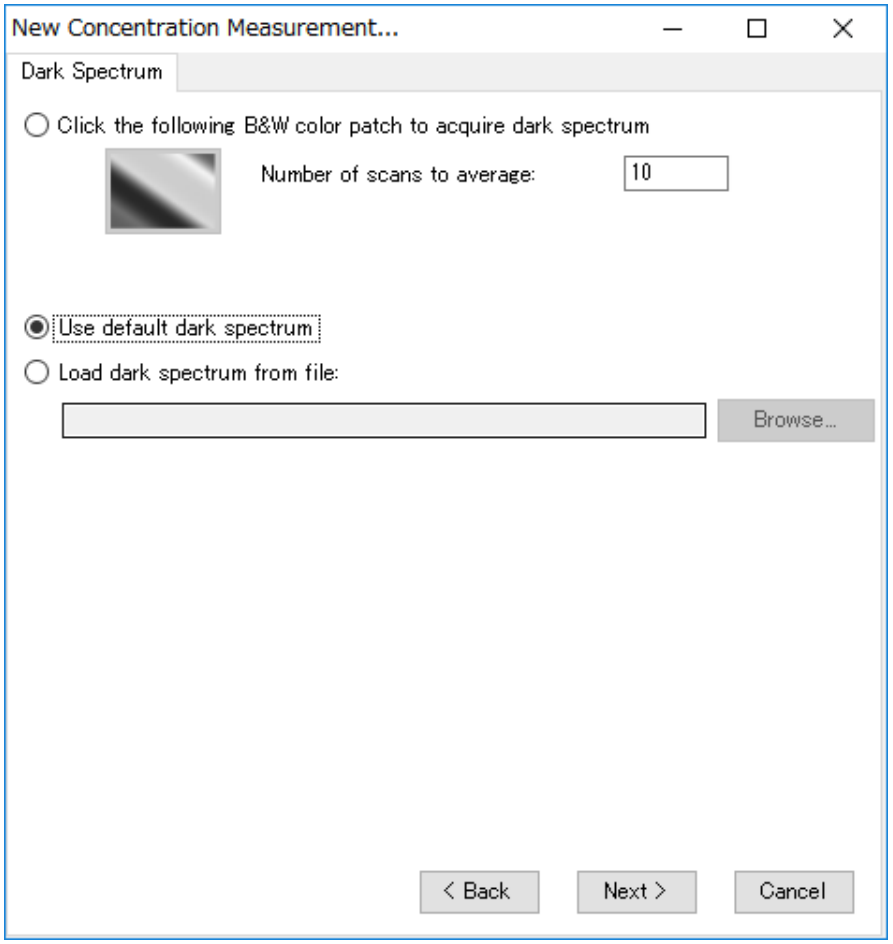


Figure 12-9: **New Concentration Measurement** - Using the default dark spectrum

Note: This example uses the dark spectrum captured in real-time (not the default dark spectrum).

Once the dark spectrum is set, click **Next**.

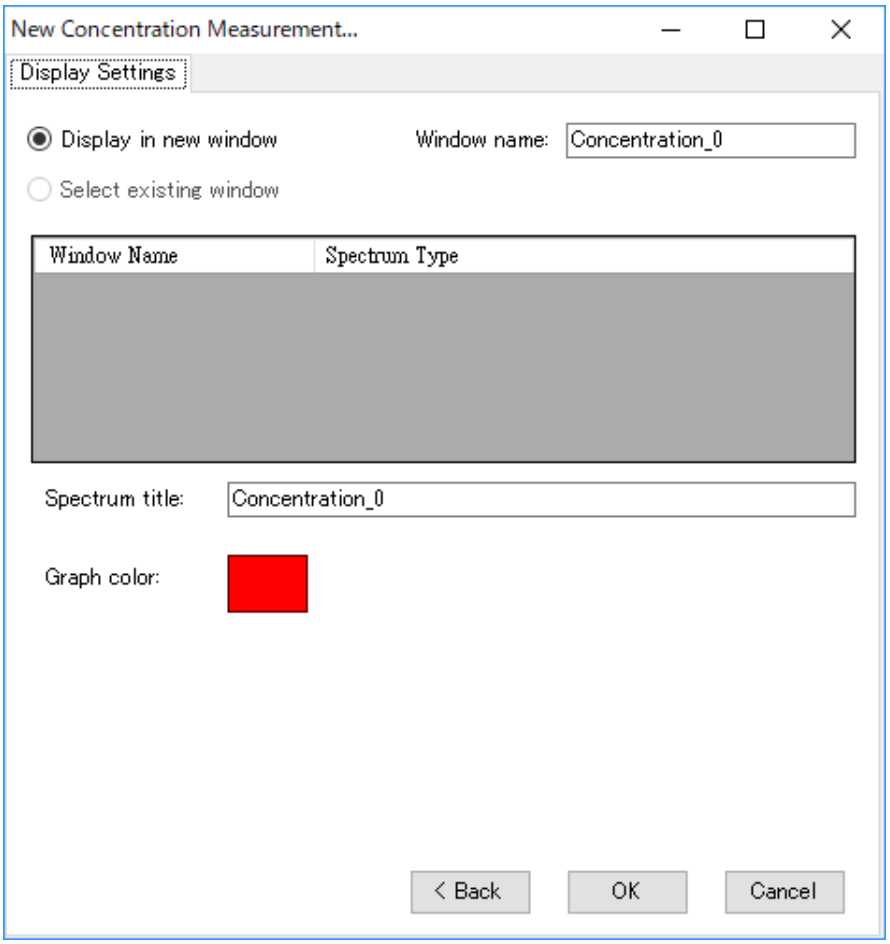


Figure 12-10: **New Concentration Measurement** - **Display Settings**

Display Settings

Next, you can specify a name for the measurement graph window, as well as a spectrum title and a color for the graph, as in the former figure. To specify the color, you can click on the color patch and select the desired color from the palette:

Figure 12-11: **Display Settings** – **Color**

When you are done with the display settings, click **OK**. SpectraSmart then opens the **Concentration Settings** window, which allows you to specify a known concentration response curve or the parameters of Beer's Law for the solution being tested, as shown in the following figure:

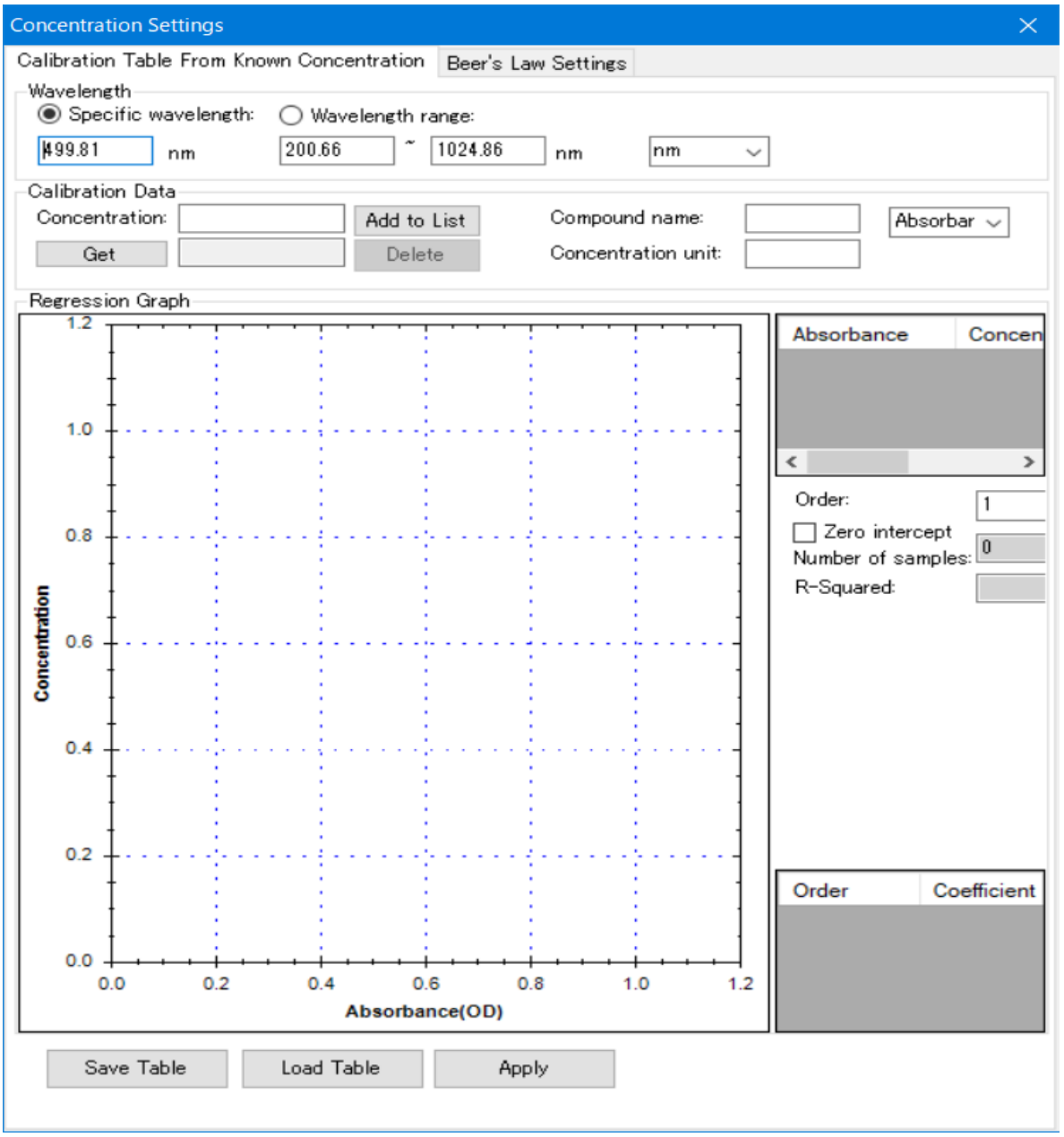


Figure 12-12: **New Concentration Measurement** - **Concentration Settings** - **Calibration Table From Known Concentration**

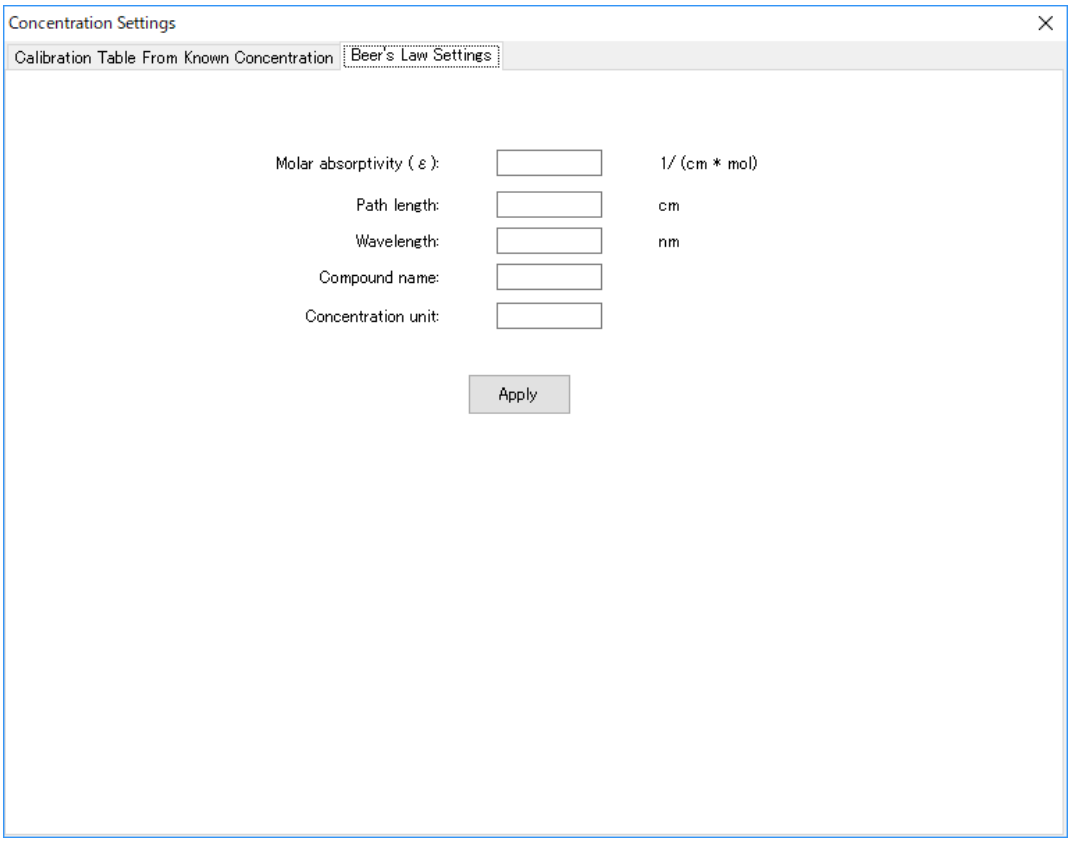


Figure 12-13: **New Concentration Measurement** - **Concentration Settings** - **Beer's Law Settings**

Specifying a Known Concentration Response Curve

Set information for calculating concentration from the measured spectrum. There are two ways to do this, either by specifying a calibration table (i.e. the response curve) from known concentration or specifying the parameters for the Beer's Law. The following example will demonstrate how to create a calibration table:

1. Place the blue solution of known concentration (assumed to be 1) on the measurement holder and select **Wavelength** on **Calibration Table from Known Concentration** window, and set the **Specific wavelength** (for the blue solution is blue, so it is assumed to be **500** nm) select **Wavelength range**.
2. On the **Concentration Settings** window, input 1 to the **Concentration** of the **Calibration Data**, and then click **Get** button to measure the absorbance.
3. Click **Add to List** button to add this absorbance to the table on the right.
4. Next, place another blue solution with a known concentration at the measurement holder. Then set the **Concentration** value as 2, and press the **Get** button again to acquire the absorbance.

5. Click the **Add to List** button to add this absorbance to the table on the right.

Now, you will see a curve in the **Regression Graph**. This will be the known concentration response curve for the solution to be tested:

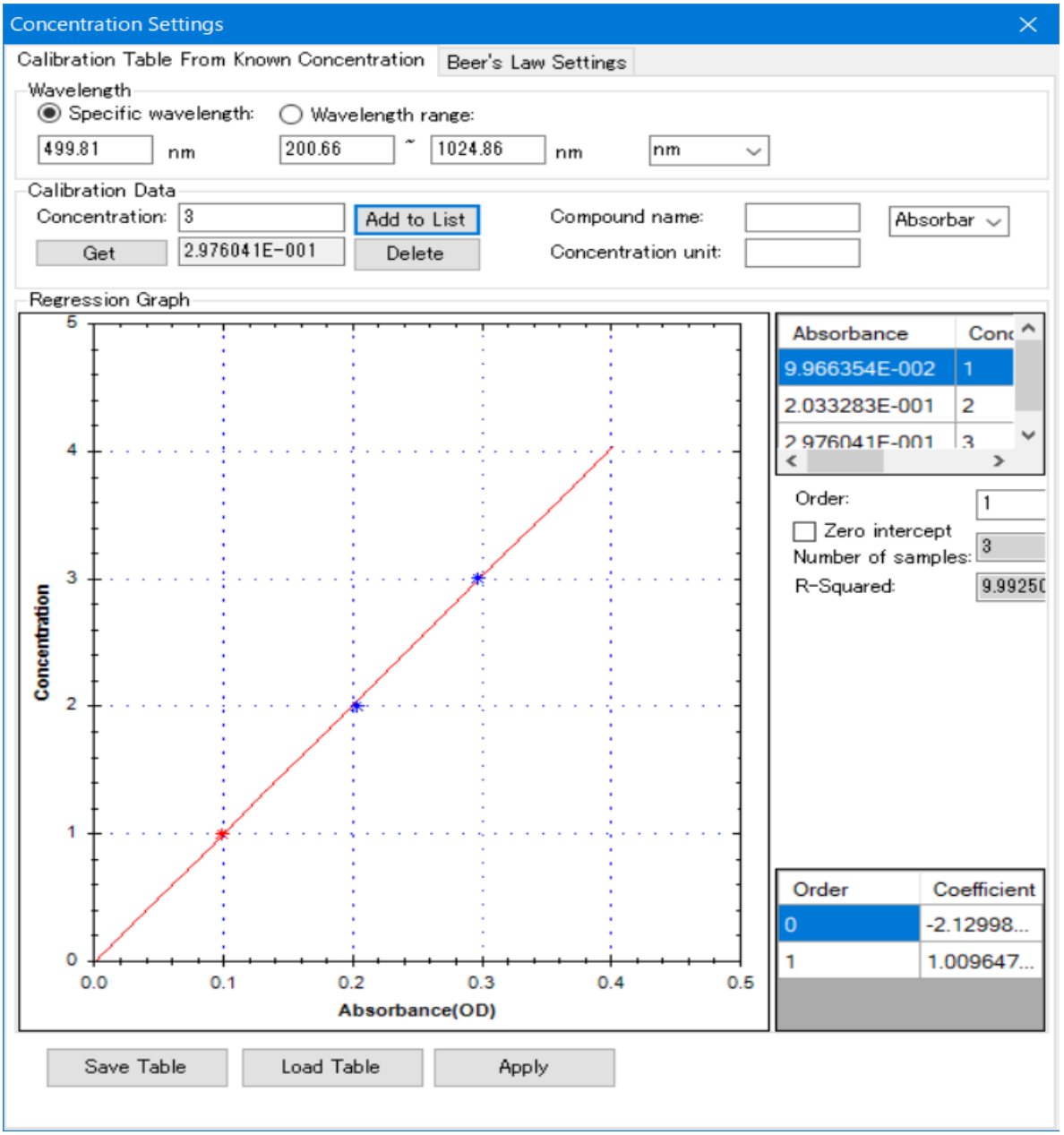


Figure 12-14: Configuration of **New Concentration Measurement** - **Concentration Settings**

After the response curve is created, you can use the **Save Table** button on the bottom of the window to save this response curve for future use. When you need this curve again, just use the **Load Table** button to load it back. When all settings are done, click **Apply** to apply the settings and the concentration measurement graph will show:

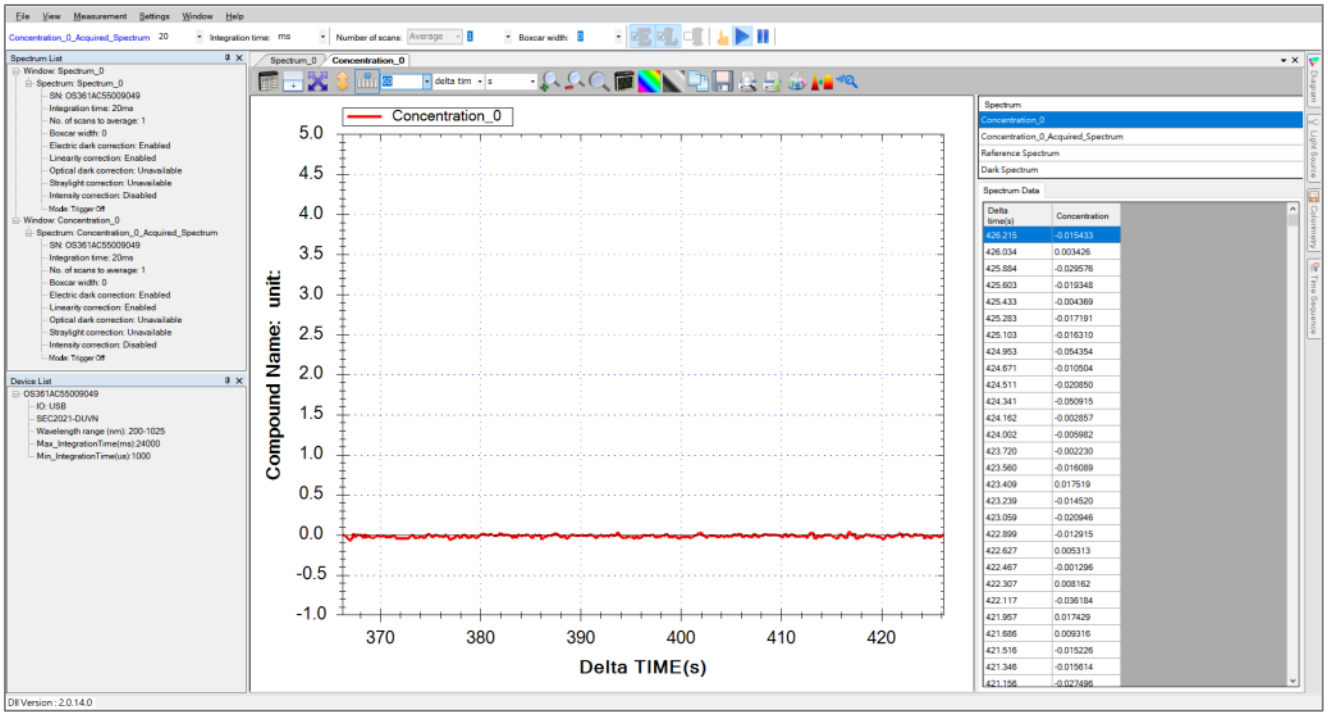


Figure 12-15: Newly created concentration measurement graph

As we haven't put the test solution in place, what we see on the graph is noise.

Start Measuring the Concentration of the Test Solution

Next, we put the test solution in place to measure its concentration. As a demonstration, we measure the blue solution we used earlier when we created the calibration table. Its concentration graph looks like the following:

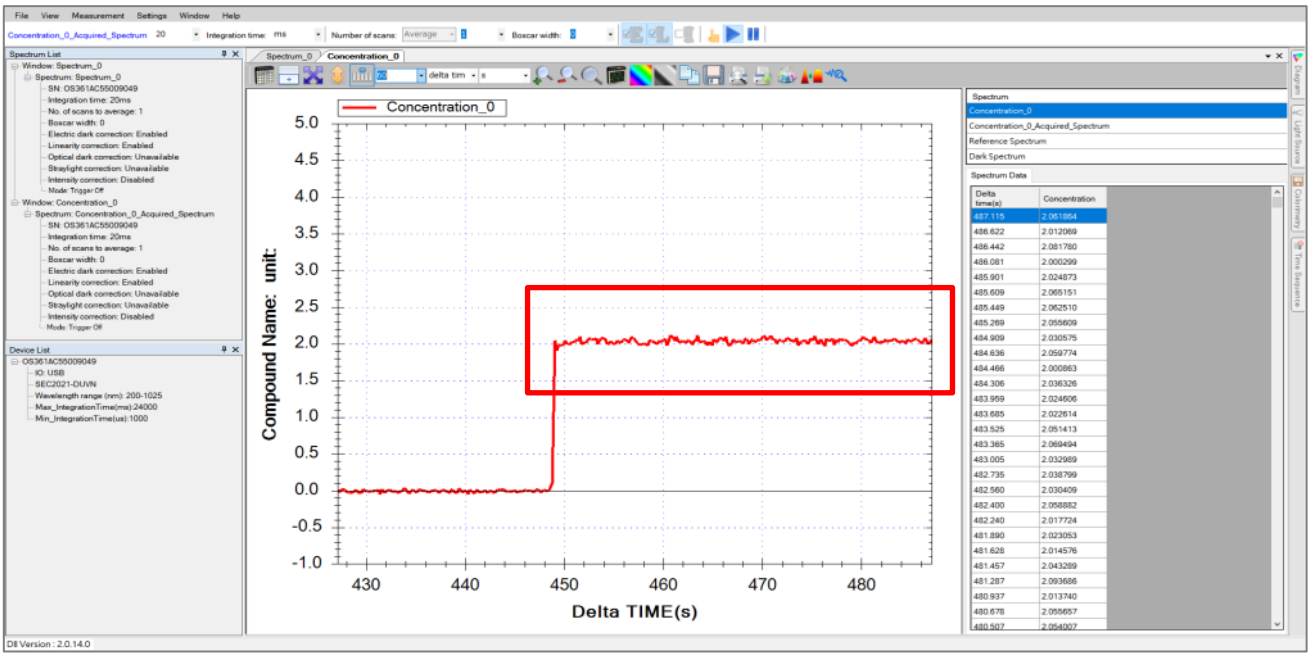


Figure 12-16: The concentration graph of the test solution

The concentration graph in SpectraSmart is basically a real-time strip chart which tracks the concentration of the test solution. The former picture shows the tracking of about 1 minute. The red highlighted area is the measured concentration, while the lower part to its left is the initial noise. If it is left to keep running, the entire graph will start to scroll to the left when the curve hits the right edge. In the figure, the concentration of the test solution varies between 0.5 and 0.6. This looks a little bit unstable. So, we can turn on smoothing to smooth out the noises in the acquired data and hence stabilize the curve.

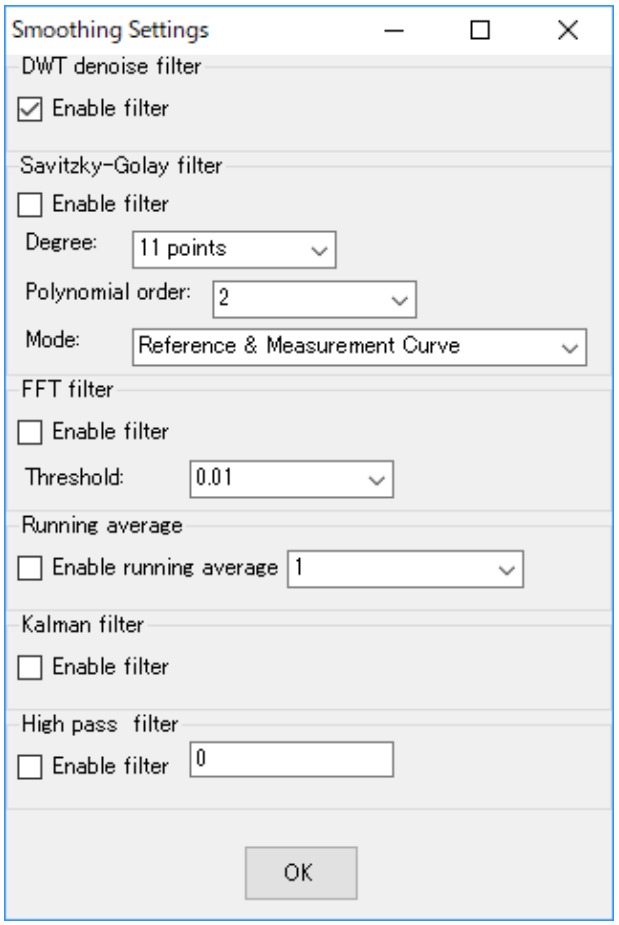


Figure 12-17: Turning on smoothing

Apparently, the smoothing does help reduce fluctuations, as shown in the red highlighted area below:

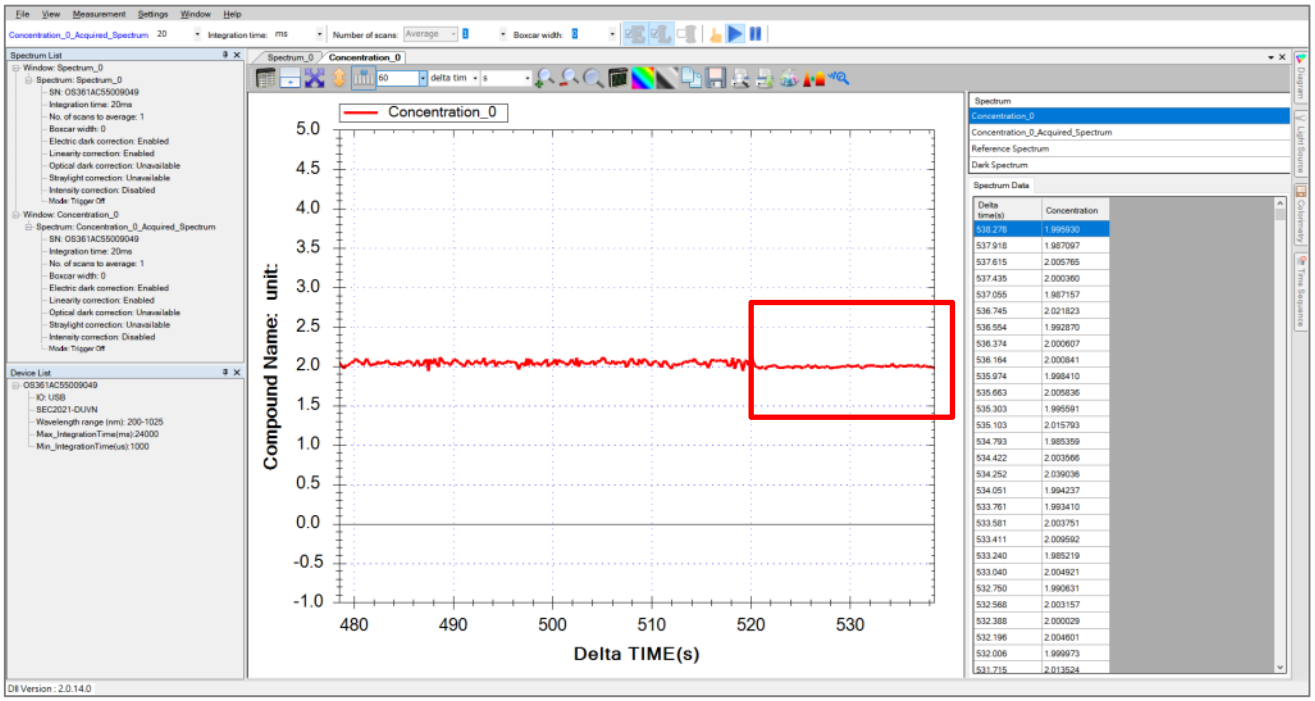


Figure 12-18: The effect of turning on smoothing

Checking the Acquired Spectrum Curve

The concentration curve is calculated from multiple spectrum. SpectraSmart has a function to verify the original acquired spectrum curve. Click on the **Acquired Spectrum** button on the toolbar to enable this function, as shown in the following figure:

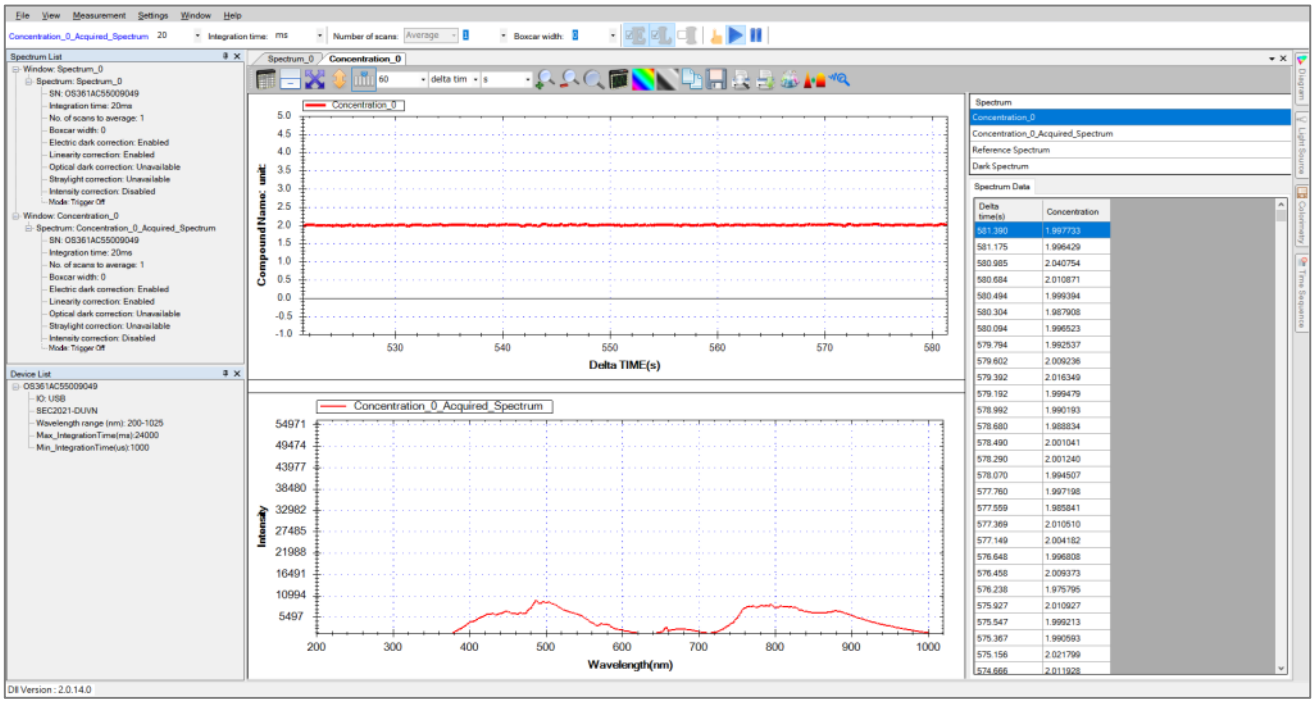


Figure 12-19: The acquired spectrum of the concentration measurement

Graph Toolbar Buttons

Toolbar button of the density measurement graph and the toolbar of the strip chart are basically the same. Please refer to "Graph Toolbar Buttons" in the chapter of strip chart.

Concentration-related Toolbar Button

Except for the same toolbar button as the strip chart, there is a button dedicated to **Concentration Setting** for density measurement. See the following figure:

Figure 12-20: The **Concentration Setting** button

Concentration Setting button opens the window for you to specify the **Calibration Table From Known Concentration** and **Beer's Law Settings**.

Saving the Current Concentration Measurement

Saving procedure of concentration measurement spectrum is same as absorbance spectrum. Please refer to "Saving Absorbance Measurement".

Loading Saved Concentration Measurement Spectrum

Loading the concentration measurement spectrum is similar to loading the absorbance measurement spectrum. Please refer to "Loading Saved Spectrum Curve of an Absorbance Measurement Spectrum".

Deleting Individual Spectrum of Concentration Measurement

The result of one concentration measurement is calculated by multiple spectrum curves. Therefore, **please do not delete either curve. If one of the curves is deleted, the result is not calculated correctly.**

Concentration Measurement Print and Preview

Concentration measurement printing and previewing are the same as spectrum measurement. Please refer to "Printing and Previewing a Spectrum Measurement Print and Preview".

13. Trigger Mode Settings

The spectrometers come with an I/O port to support the "trigger mode". In the trigger mode, the control of spectrometer is controlled with external I/O signal.
The user can trigger multiple devices simultaneously, instead of sending multiple commands the devices through API, triggering through I/O signals can capture data with instructions to multiple spectrometers at the same time without being influenced by the computer performance.

Enabling the Trigger Mode (I/O Signal)

Before using the trigger mode, you need to enable it in SpectraSmart. First, create a spectrum measurement.

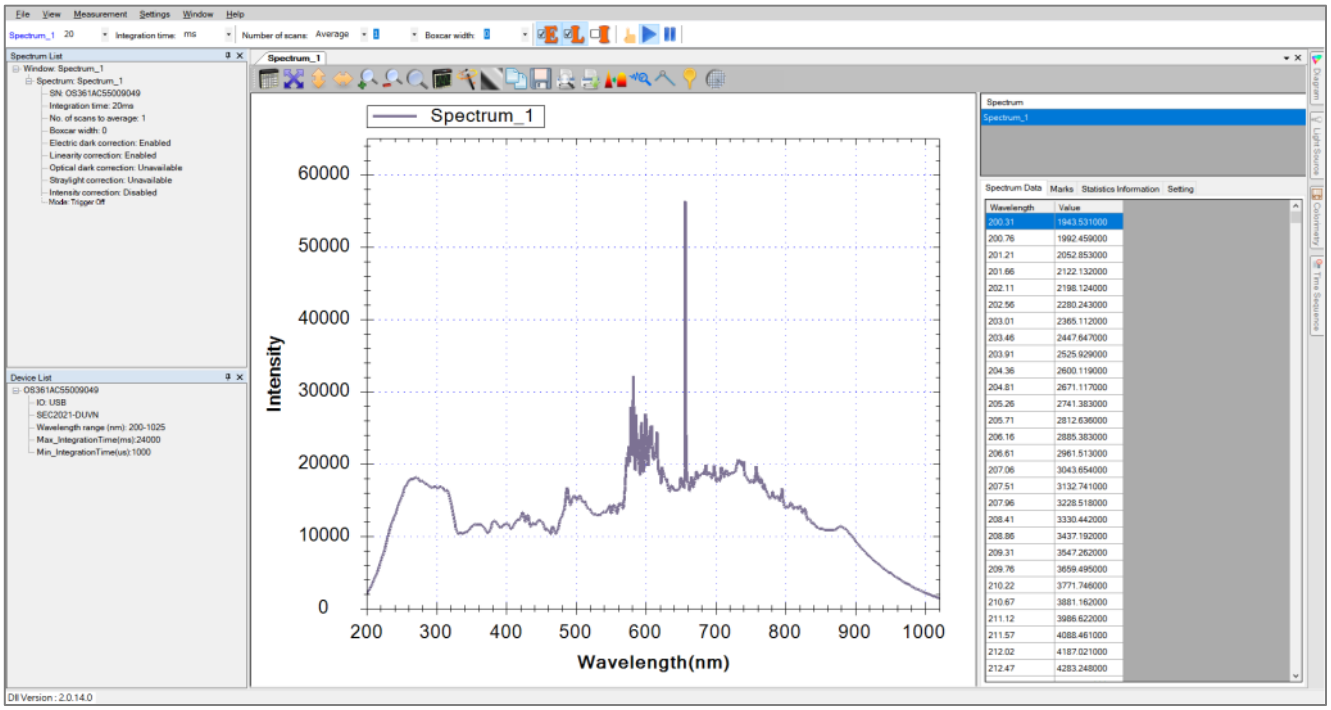


Figure 13-1: Create a new spectrum measurement

In the **Spectrum List** pane on the left side of the screen, check to see if the current acquisition mode is Trigger Off(by default), as in the following picture:

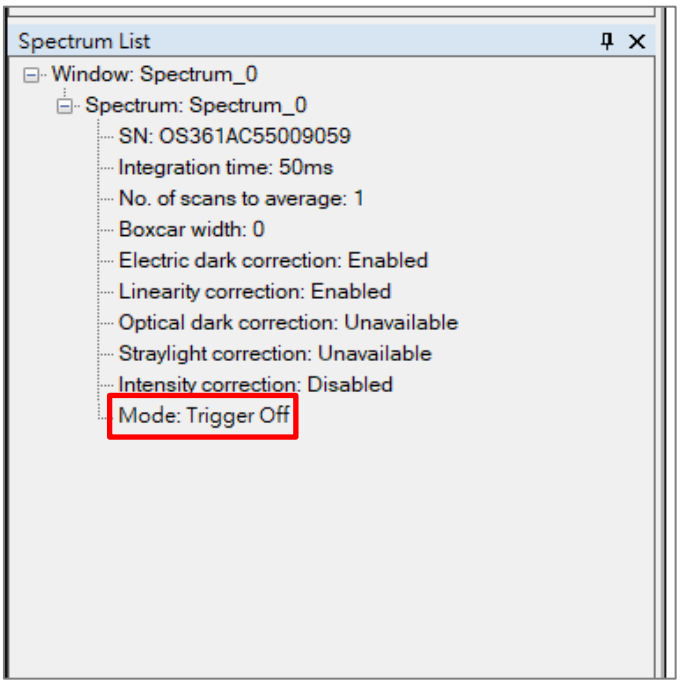


Figure 13-2: The acquisition mode in the **Spectrum List** shows **Trigger Off**

Next, select **Trigger Settings** from the **Settings** menu:

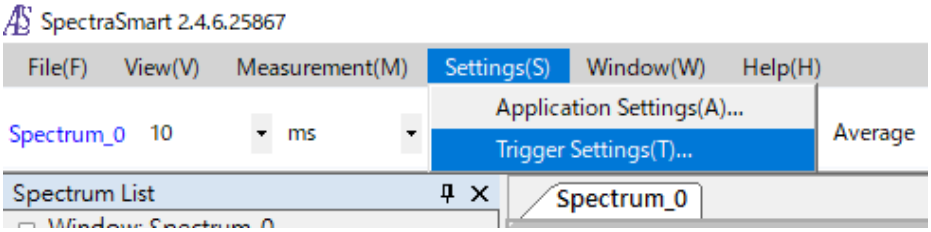


Figure 13-3: Select **Trigger Settings** from the **Settings** menu

The **Trigger Settings** window shows:

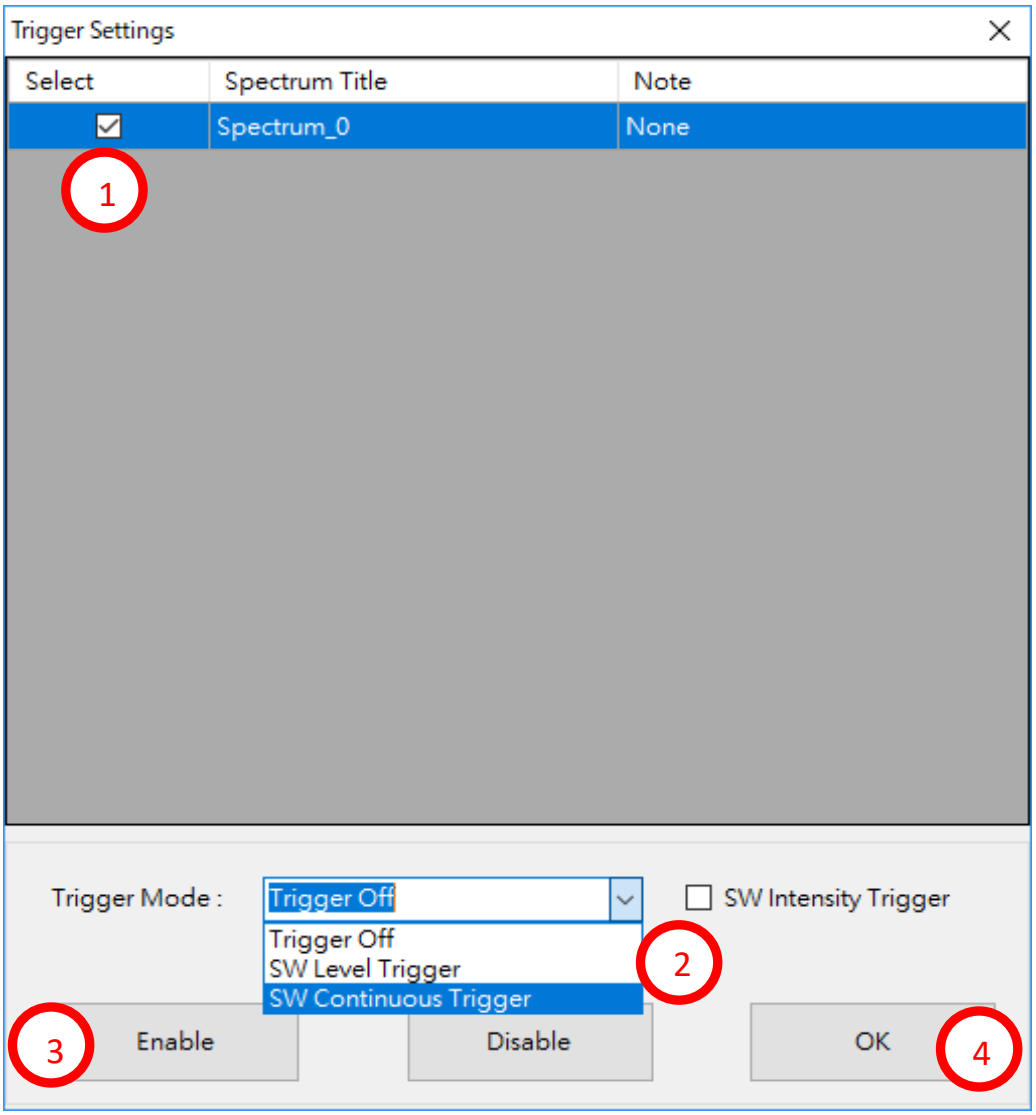


Figure 13-4: Enabling the trigger mode (I/O Signal)

Now, follow these steps:

1. Select the spectrum measurement for which you want to enable the trigger mode ("Spectrum_0" in this case).
2. Select your **Trigger Mode** (In this case is **SW Continuous Trigger mode**).
3. Click the **Enable** button to put the measurement into the trigger mode.
4. Click **OK** to exit this window.

Now the spectrum acquisition mode should show **Trigger Mode**, as in the following picture:

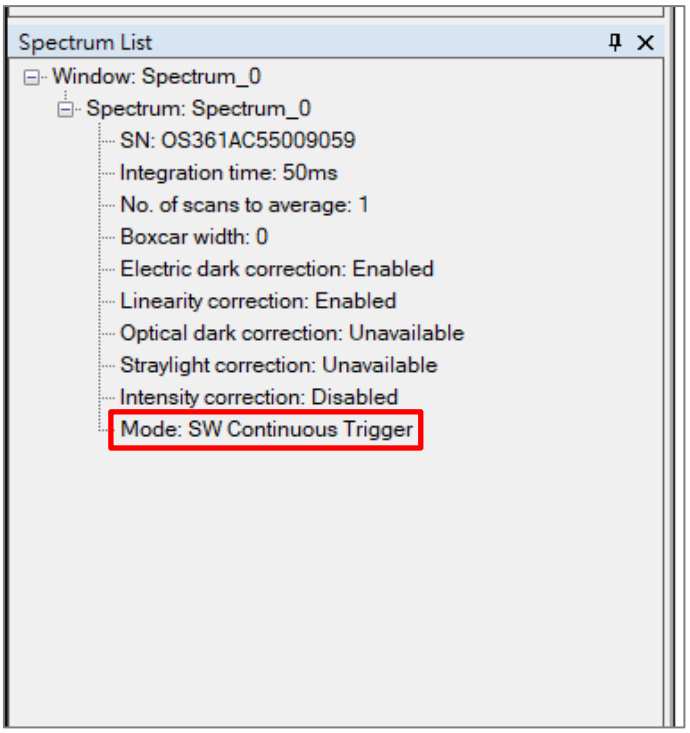


Figure 13-5: Confirming if the spectrum acquisition mode is now in **Trigger Mode**

In addition, you will notice that the spectrum graph is not updating anymore because it is waiting on the external I/O signal to start data acquisition.

Activation of trigger mode (spectrum intensity)

When this mode is used, start/stop control of measurement can be performed depending on the set spectrum intensity. Measurement is started when the set spectrum intensity exceeds a certain point, and measurement is stopped when the intensity increased below the set intensity at all measurement points.

From the **Trigger setting** screen, follow the procedure below to make settings.

1. Select the spectrum measurement for which you want to enable the trigger mode ("Spectrum_0" in this case).
2. Check **SW Intensity Trigger**.
3. Set the spectrum intensity to **Counter** (i.e. 50000).
4. Click the **Enable** button to put the measurement into the trigger mode.
5. Click **OK** to exit this window.

This sets the spectrum acquisition mode to the intensity trigger mode.

By enabling **Raw data**, raw data not subjected to correction and smoothing processing will be reflected in the trigger.

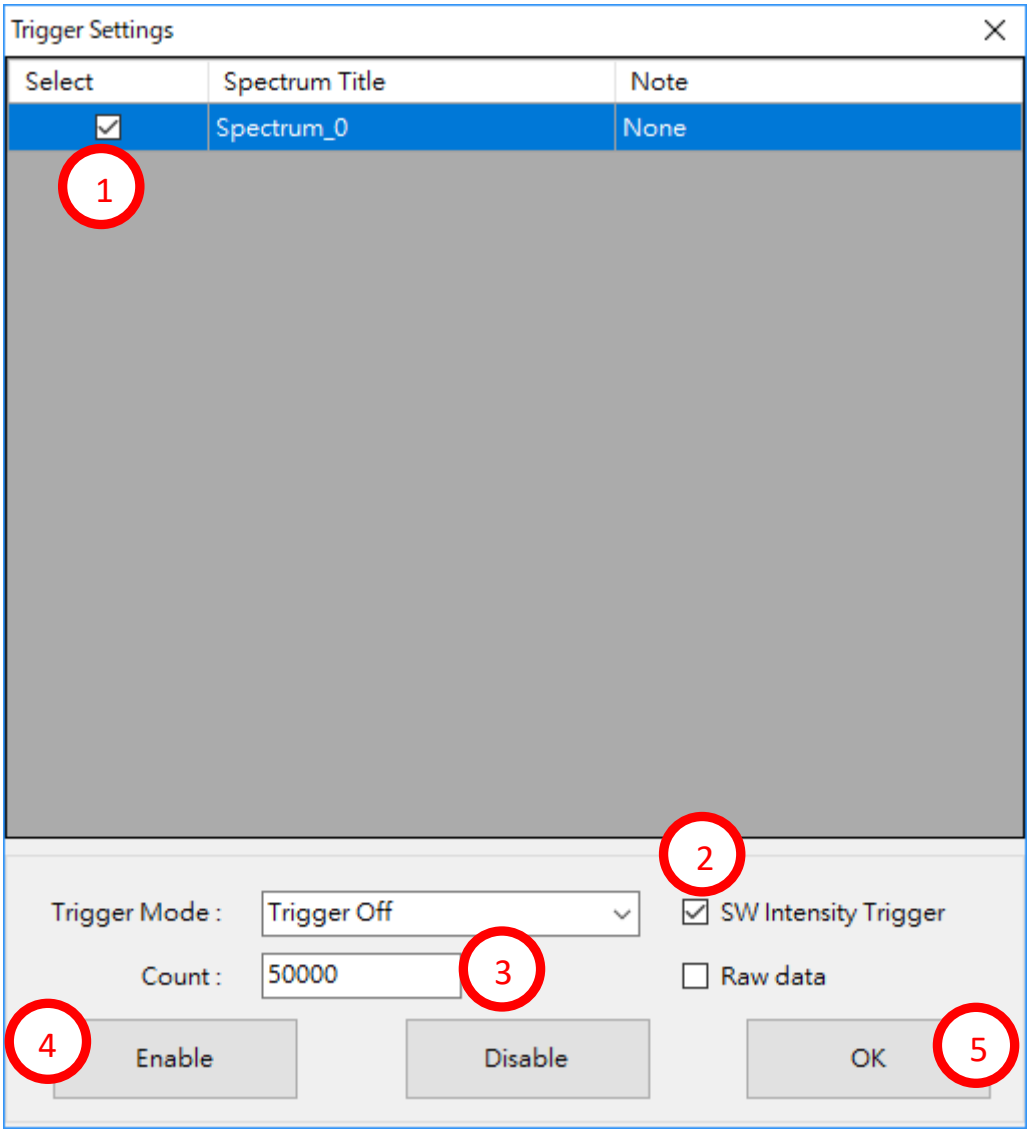


Figure 13-6: Disabling the trigger mode

Disabling the Trigger Mode

To disable the trigger mode, select **Trigger Settings** from the **Settings** menu. Then, in the **Trigger Settings** windows, follow the steps below:

1. Select the spectrum measurement for which you want to "disable" the trigger mode ("Spectrum_0" in this case).
2. Select **Trigger Mode** in **Trigger Off mode.**
3. Click **Enable** to put the measurement back to the trigger off mode.
4. Click **OK** to exit this window.

See the following figure:

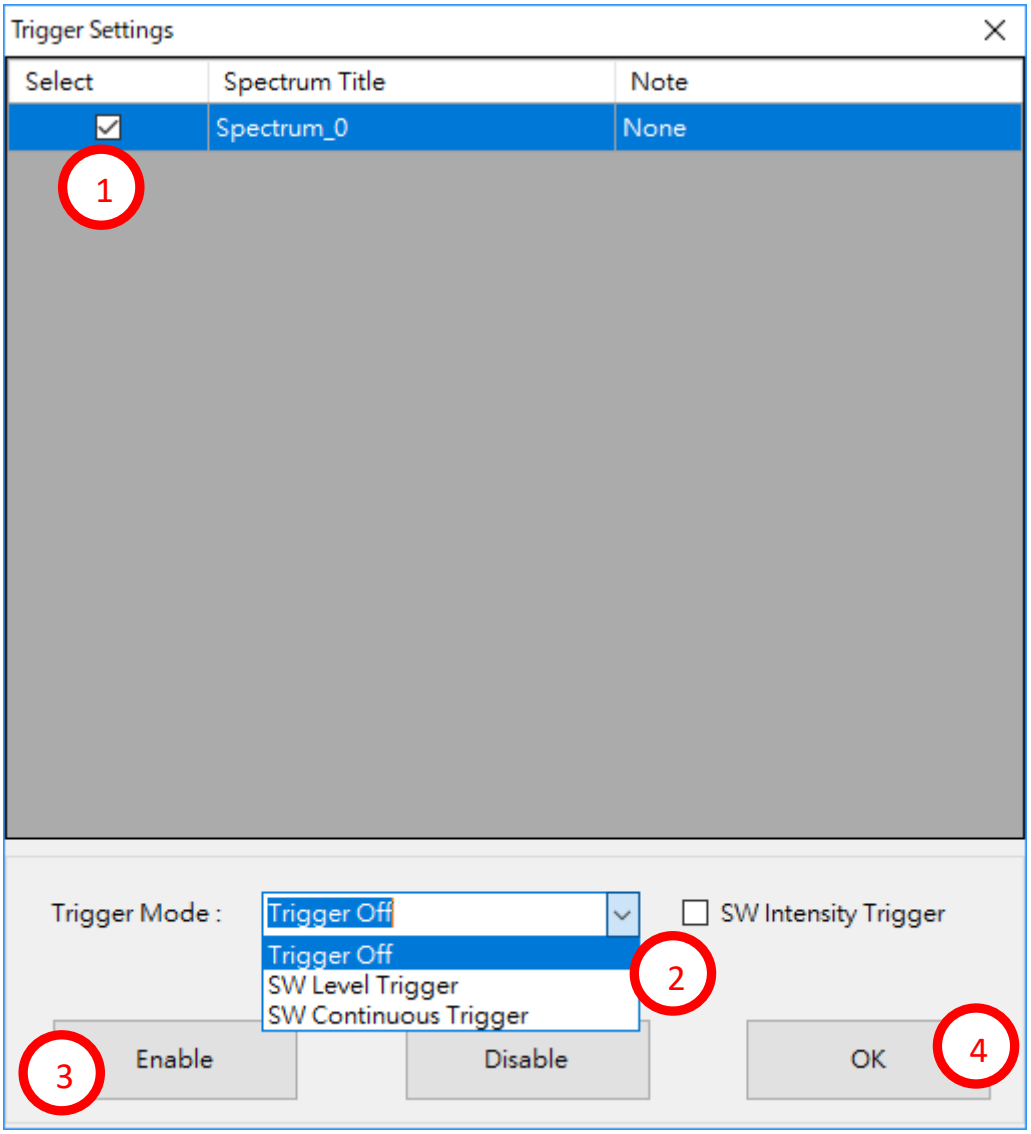


Figure 13-7: Disabling the trigger mode

Now, in the **Spectrum List** pane, you will find that the acquisition mode is back to**Trigger Off**.

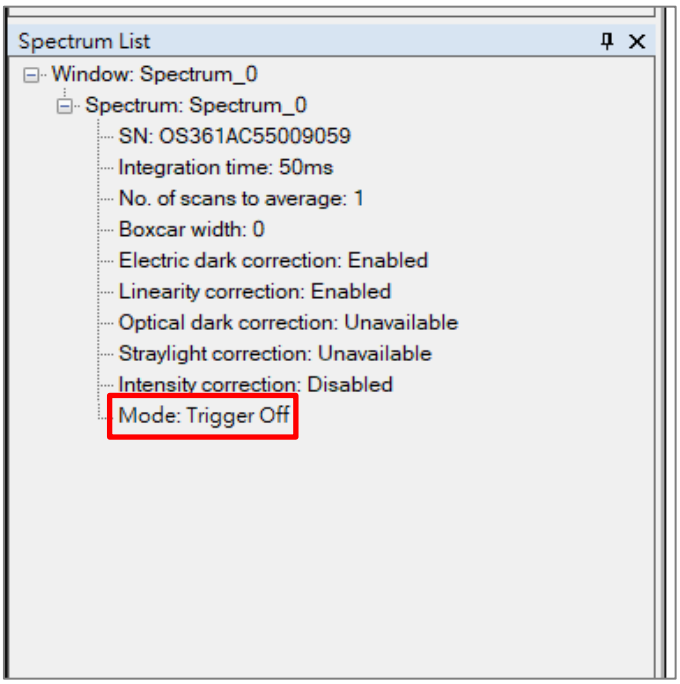


Figure 13-8: Confirming if the spectrum acquisition mode is Trigger Off

14. Time Sequence

SpectraSmart has the **Time Sequence** function that monitors changes in measured values over certain period of time. When you move the mouse cursor over the vertical **Time Sequence** button on the right and of the SpectraSmart window, the **Time Sequence** window opens.

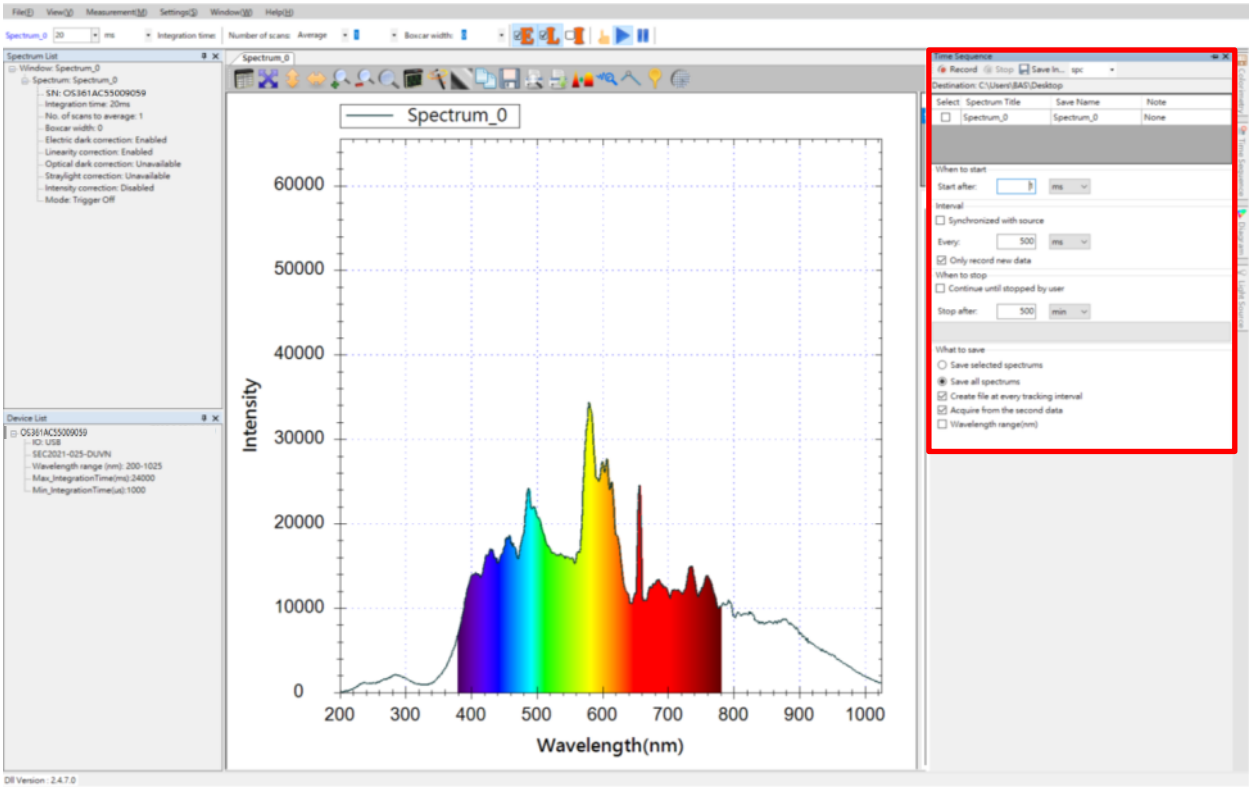


Figure 14-1: The **Time Sequence** button and the **Time Sequence** pane

When you move the mouse, the window closes automatically. If you want it to stay on the screen, you can click on the push-pin icon on the upper-right corner of the pane to fix it. See the following figure:

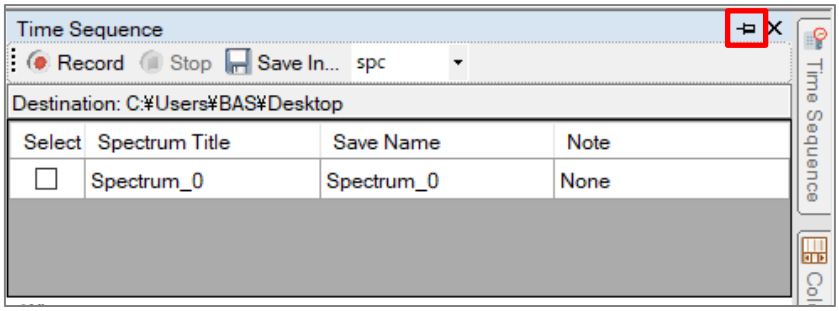


Figure 14-2: The push-pin for pinning the **Time Sequence** pane

Click the pin icon to display the "Time Sequence" pane, which size has been adjusted.

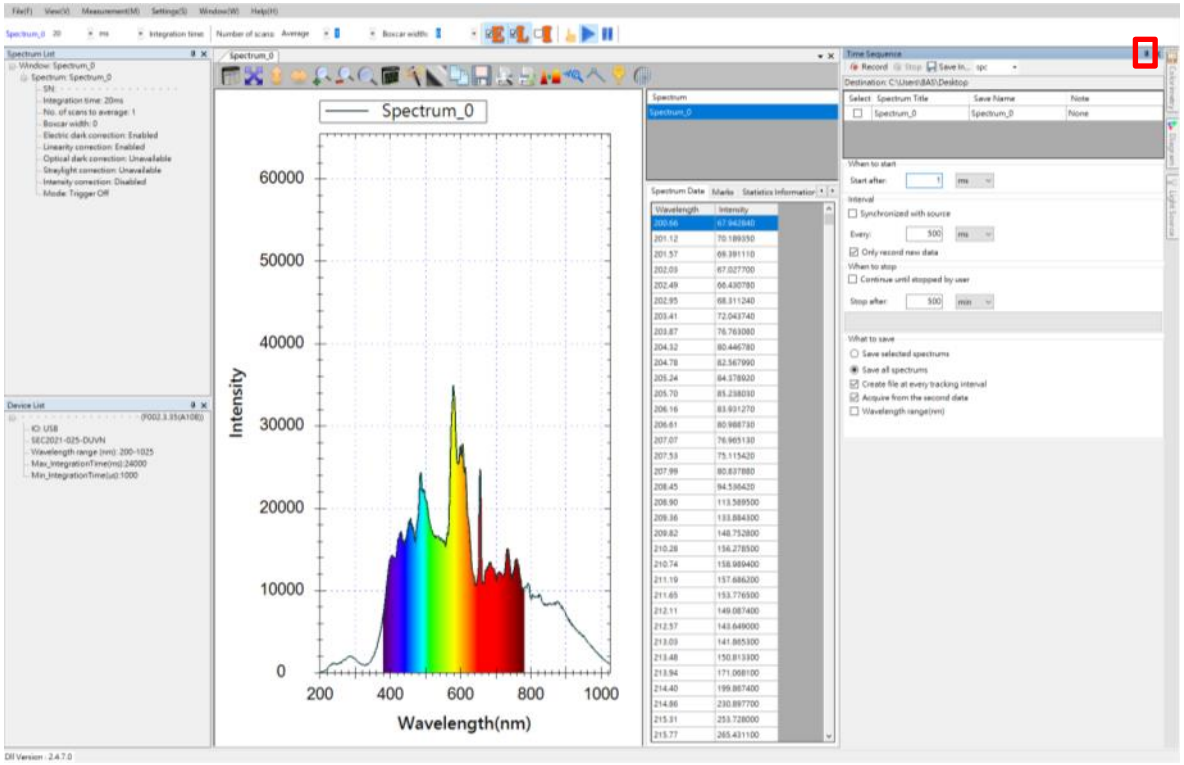


Figure 14-3: The pinned **Time Sequence** pane

Start Recording Continuous Changes

Refer to the figure above. Now we demonstrate how to use the **Time Sequence** feature in a spectrum measurement.

Specifying a Folder to Save the Captured Data

First, you need to specify the folder to save the recorded data. The default is the desktop. If necessary, it is possible to change it using the **Save In** button on the top of this pane.

Specifying When to Start

Next, set the start time. The default is 1 millisecond (ms) after you chick the **Record** button, recording starts. **Never set zero (0) here, or there will be an error.**
If you want to start record immediately, press the **Record** button, and check **Start**.

Specifying the Acquisition Interval

You can set an acquisition interval for the recording. The default interval is 500 ms, if necessary, it can be changed. Alternatively, you can choose "Synchronize with source" to keep an equal acquisition interval of the original spectrum.

Specifying When to Stop

Next, specify the stop time. The default is until click the **Stop** button, or stop can be setting.

Specifying What Spectrum Curves to Record

Last, specify the spectrum to be saved. The default is all the measured spectrum curves. A typical spectrum measurement (as in this case) has only one spectrum curve, but other measurements including absorbance, transmittance, reflectance, light source, and concentration have four spectrum curves in a single measurement. In the spectrum list on the upper part of this pane, please select the spectrum curves to be recorded.
If **Create file at every tracking interval** is not checked, it will be saved as a file format dedicated to time series measurement (extension spc), and can be played from **File -> Open Time Sequence File**. If **Open Time Sequence File** is not checked, it is saved in file format according to each measurement mode at each data acquisition interval (extension: sps), which can be open from **File -> Open Spectrum File**.

Start Recording

After setting the above options, if **Only record new data** is checked, pressing the **Record** button (red point), at the top of the window, the following prompt message will be displayed. Press **OK** to start record.

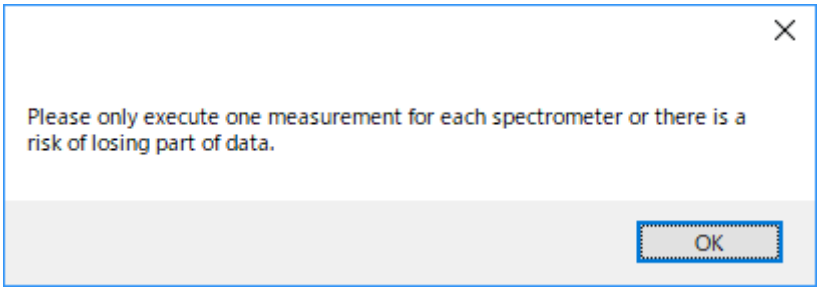


Figure 14-4: If you enable **Only record new data** while performing multiple measurements, the message **Please only execute one measurement for each spectrometer or there is a risk of losing part of data** is displayed

Stop Recording

If you have specified the time of recording, it automatically stops at the set time. For the stop of the recording, press the **Stop** button at the top of the pane to stop recording.

Loading and Playing Back a Previous Recorded Time Sequence

The data saved without checking **Create file at every tracking interval** can be read from **Open Time Sequence File** in the File menu.

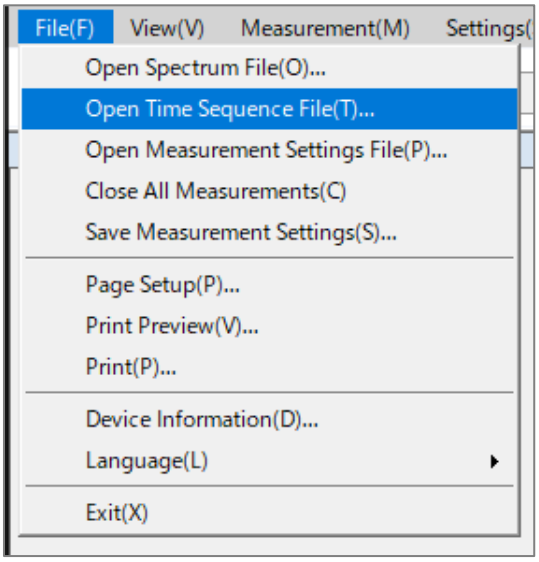


Figure 14-5: Selecting **Open Time Sequence File** from the **File** menu

This opens the system standard **Open** window. Now locate the file you saved earlier, and then click the **Open** button.

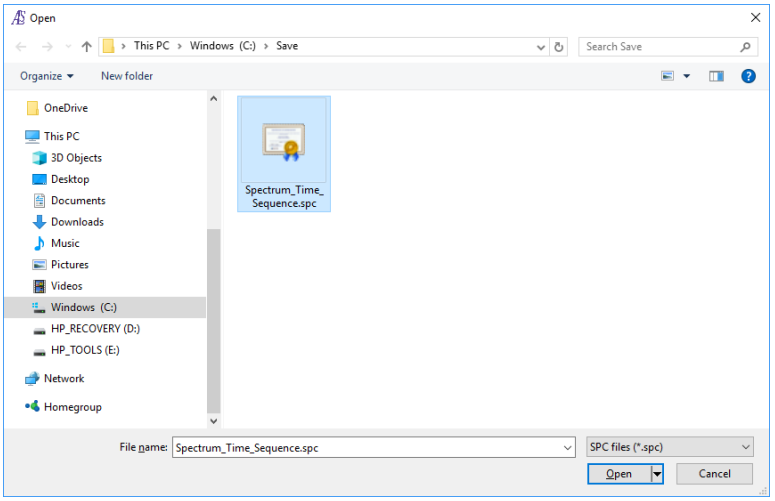


Figure 14-6: Selecting previously saved file in the **Open** window

Once the file is opened, SpectraSmart will display the playback tools for the time sequence file.

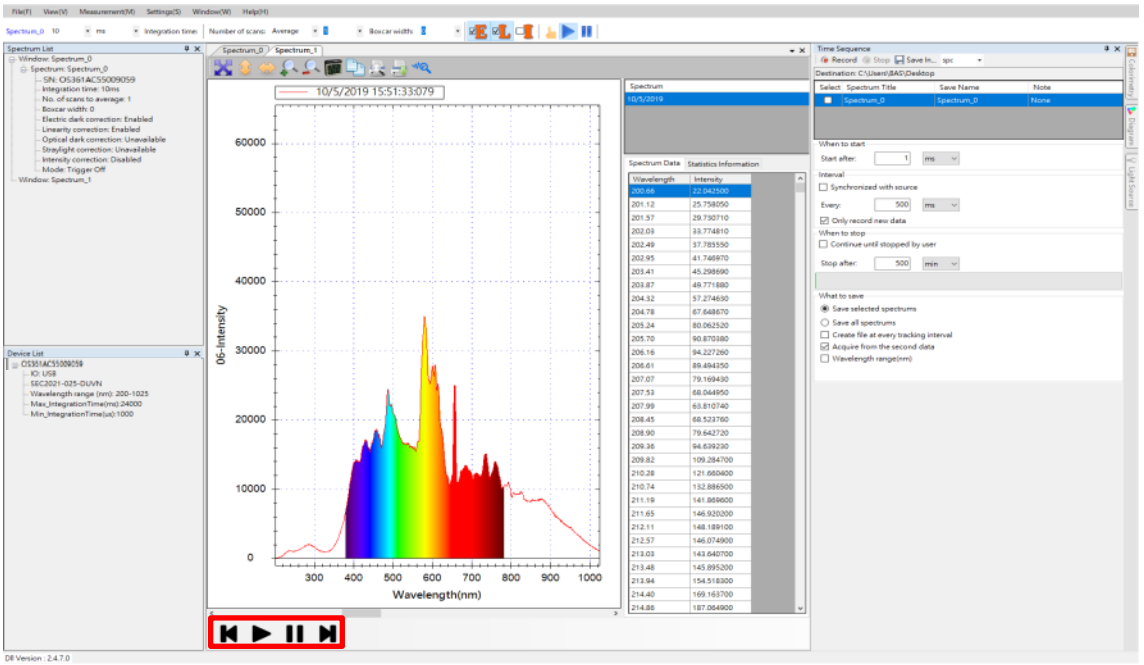


Figure 14-7: The playback tools for the time sequence file

As shown in the above figure, there are buttons that allows the user to **Rewind**, **Play**, **Pause**, and **Fast-forward** the playback of time sequence (see the red highlighted area near the bottom). These buttons work just like the way they do in video playback. Through playback, you can easily go back and forth to find out how the measurement reading changes. Moreover, you will notice that the time sequence file will keep playing over and over again once it is loaded until you press the **Pause** button.

15.Application Settings

In Spectra Smart, you can customize default values such as wavelength display range, background color of a measurement graph, the default smoothing settings, etc.
To change these settings, select **Application Settings** from the **Settings** menu.

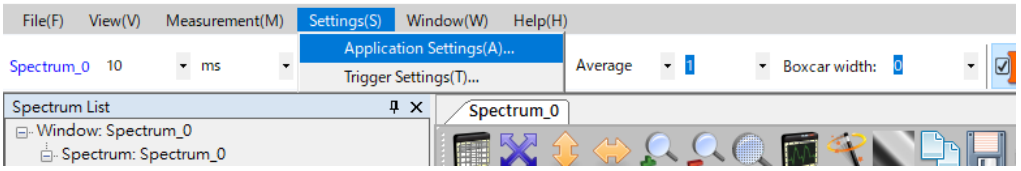


Figure 15-1: Selecting **Application Settings** from the **Settings** menu

Next, the **Application Settings** window opens.

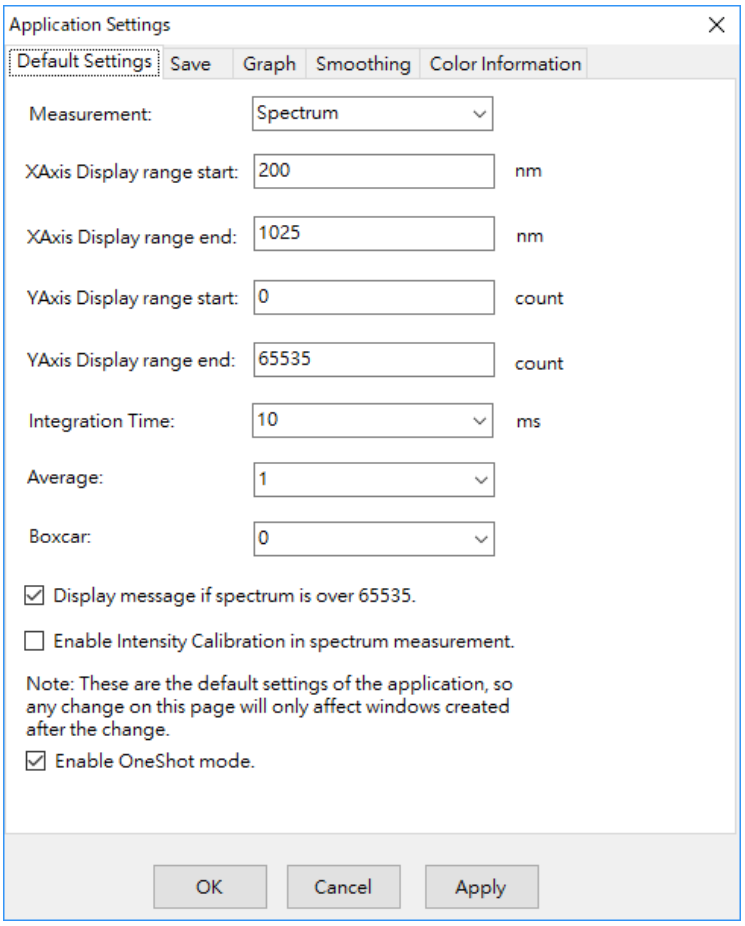


Figure 15-2: The **Default Settings** tab of the **Application Settings**

Default Settings

Default Settings it allows the configuration of some default.

Display Range: Start and End

In the **Application Settings, Default Settings** window, **Display range start** and **Display range end** of the X-axis can be configured.

Average

This setting allows specifying the default number of scan average number. This averaging reduces the influence of noise.

Boxcar

This setting allows specifying the default for the Boxcar smoothing. It varies from 0 to 10, the higher the number, the smoother the curve. The default value is 0, i.e. no smoothing.

Display a Message when the Peak Value in the Spectrum Exceeds 65535

The maximum value supported in the spectrum data is 65535. Therefore, when the "peak value" of the spectrum exceeds this value, the spectrum curve will not be accurate, and a warning message is displayed on the spectrum diagram.

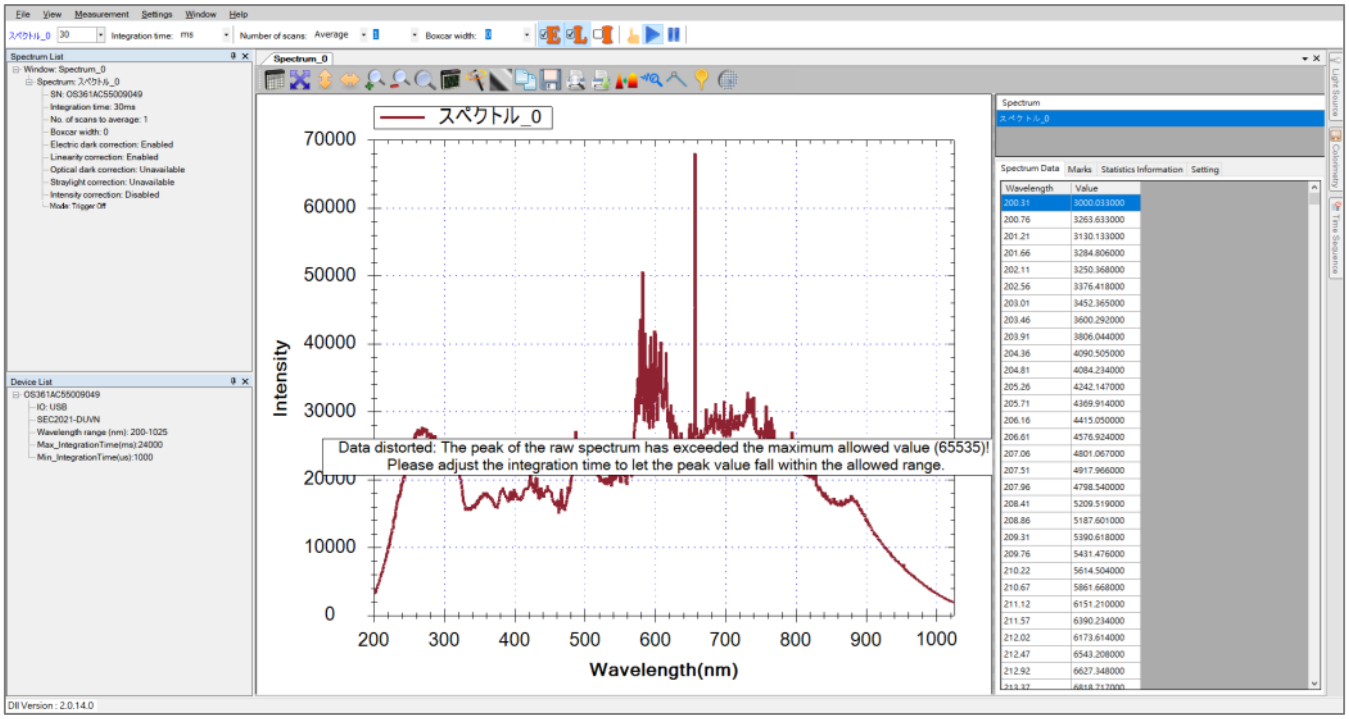


Figure 15-3: The data distorted warning message

Save

You can set the method of saving measurement data in **Save**.

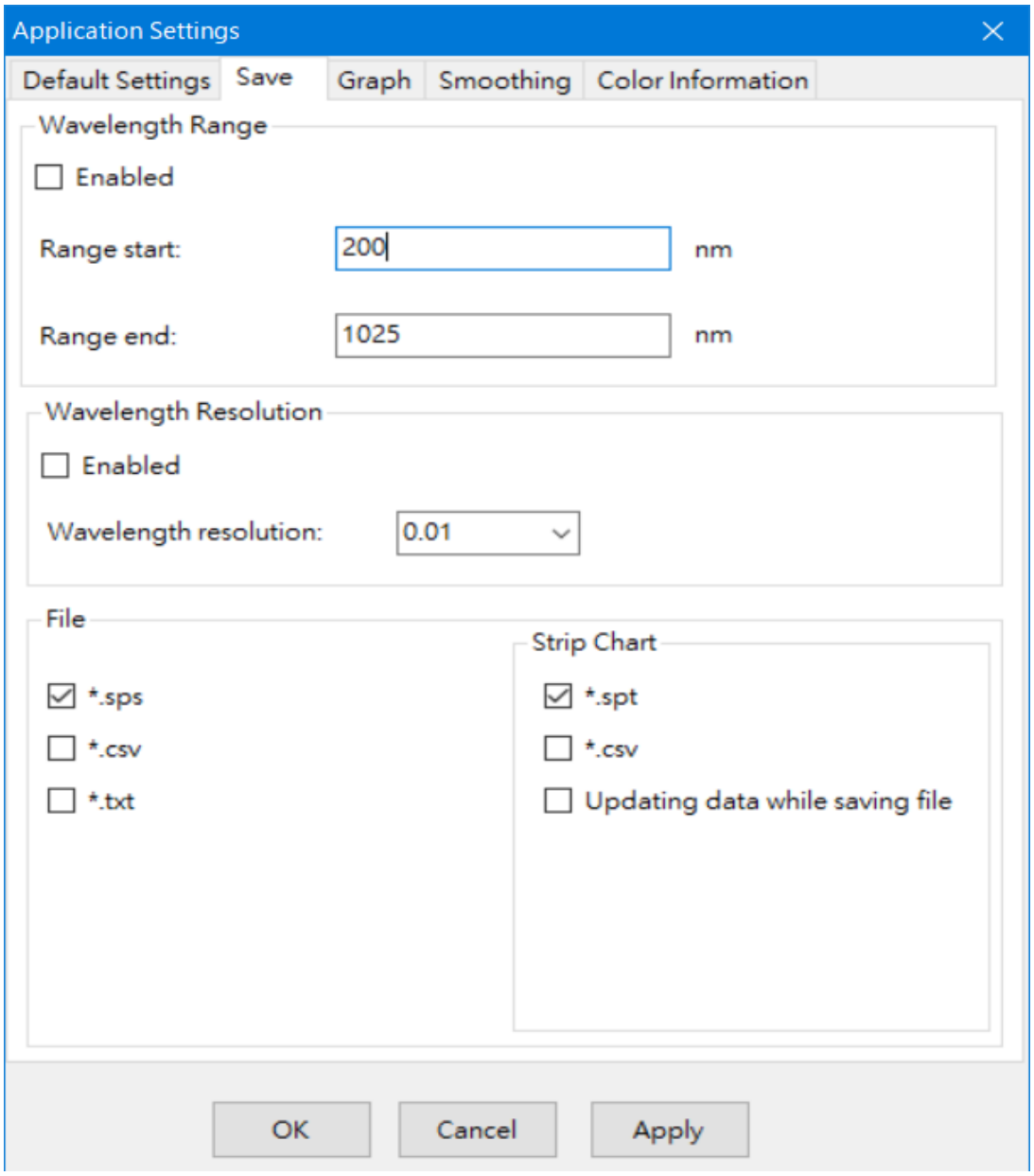


Figure 15-4: The Save tab of the Application Settings

Wavelength Range

The start and end points can be changed by checking **Enabled**. If **Enabled** is not checked, a wavelength range of 200 to 1025 nm, specific of the device, is setting.

Wavelength Resolution

Check Enabled and specify the wavelength resolution from among 0.01, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 5, 10. If **Enabled** is not checked, 0.01 will be setting.

File

When right-click in the spectrum data frame and you can select one or more file format as, **Save all spectra in ...** (refer to 6. **Spectrum measurement -> Save current spectrum diagram -> Save all spectra in current window**) and, when using Record setting of Script chart, **Save record** (refer to 7. 7. **Strip Chart (Tracking Specific Wavelengths) -> Record Setting Buttons**).

Graph

This tab allows adjusting the graph display on the window.

Line Width

This controls the line width of the curve on a graph.

Window Background and Chart Background

These two control the background styles and colors of the measurement window and the measurement graph, respectively. The available styles are **None**, **Brush**, and **Solid**:

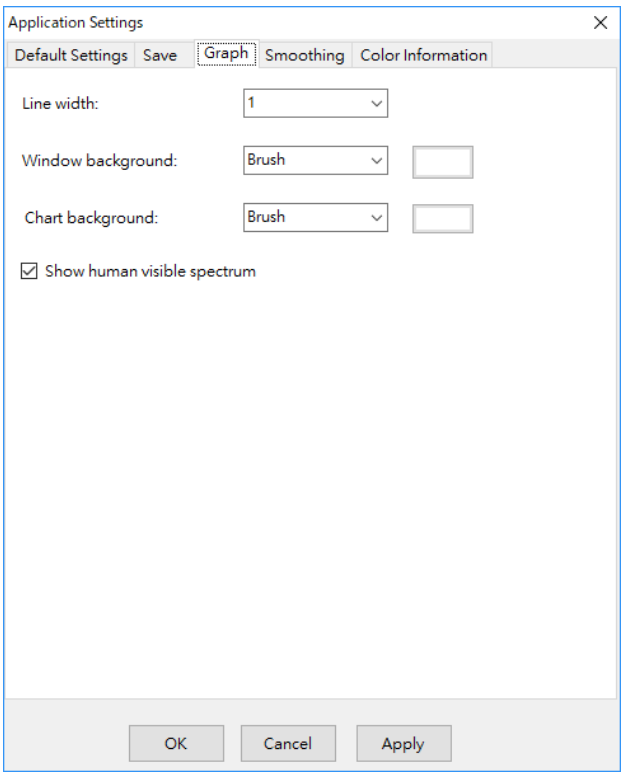


Figure 15-5: The **Graph** tab of **Application Settings** - **Window background**

The following figure demonstrates a **Window background** in solid gray and a **Graph background** in brushed light blue:

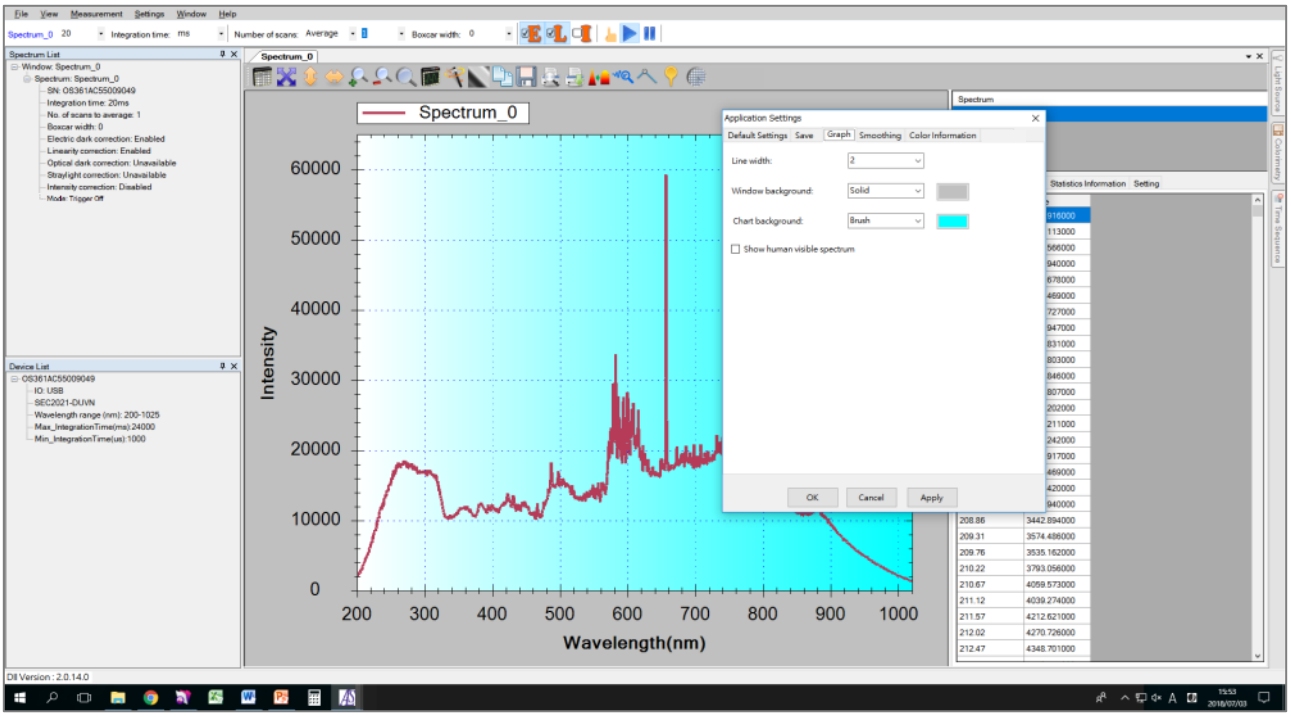


Figure 15-6: Demonstrating background effects in the **Application Settings**

Human Visible Spectrum

This allows you to show the visible spectrum on the graph along with the measurement curve. See the former figure.

Note: For these graph settings, you can click "Apply" to see the effect of a change immediately.

Smoothing

This tab lets you control whether you want to enable smoothing by default.

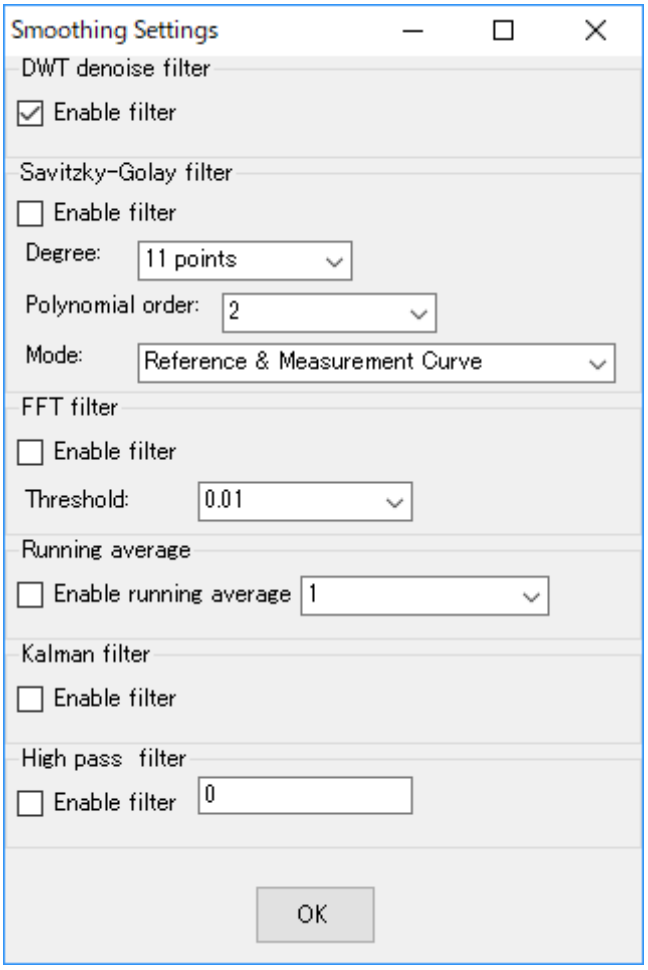


Figure 15-7: The **Smoothing** tab of **Application Settings**

DWT Denoise Filter

Here you specify whether to use the Discrete wavelet transform denoise filter (DWT Denoise Filter). To use it, simply select the **Enable Filter** check box.

Savitzky-Golay Filter

Here you specify whether to use the Savitzky-Golay filter. To use it, select the **Enable filter** check box, and then specify the smoothing **Degree** and the smoothing **Mode**. The available modes are **Reference Curve**, **Reference & Measurement Curve**, and **Measurement Curve**.

FFT Filter

Here you specify whether to use the Fast Fourier Transform (FFT) filter. To use it, select the **Enable filter** check box, and then specify a **Threshold** value.

Running Average

Here you specify whether to use the running average algorithm. To use it, select **Enable running average**, and then specify the number of points to include in the average.

Kalman Filter

Here you specify whether to use the Kalman filter. To use it, simply select the **Enable filter** check box.

Long Pass Filter

Here you specify whether to use the long pass filter. To use it, simply select the **Enable filter** check box.

Note: You can click "Apply" to see the effect immediately after you change these smoothing settings.

Color Information

Here you can customize the fields displayed in the **Colorimetry** pane. See the following figure:

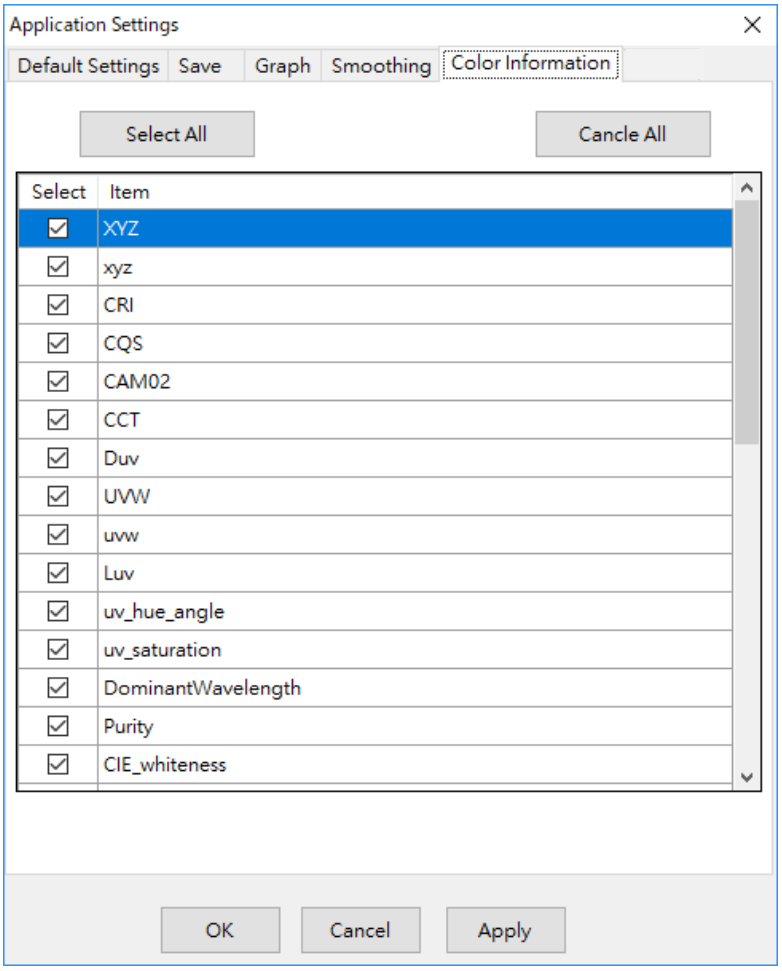


Figure 15-8: The **Color Information** tab of **Application Settings**

16.Other Miscellaneous Features

In addition to the main features described in previous chapters, there are a few other miscellaneous features that allow you to work more easily.

Language

The language used in the program interface can be changed. In the **File** menu, select **Language**:

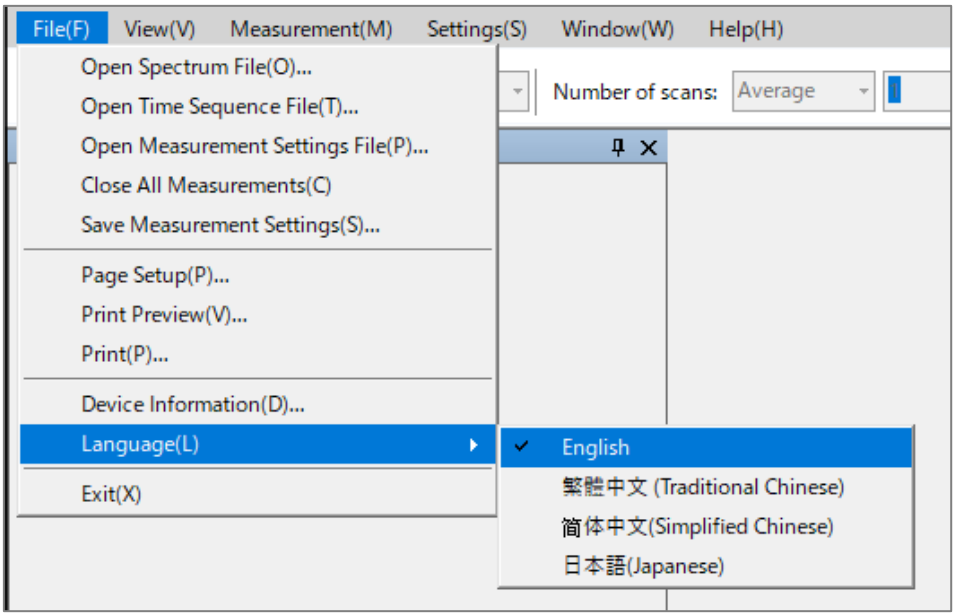


Figure 16-1: Selecting **Language** from the **File** menu

When you finished selecting it, the program window will change to the corresponding language immediately. For demonstration, we change the language to Japanese in the following figure:

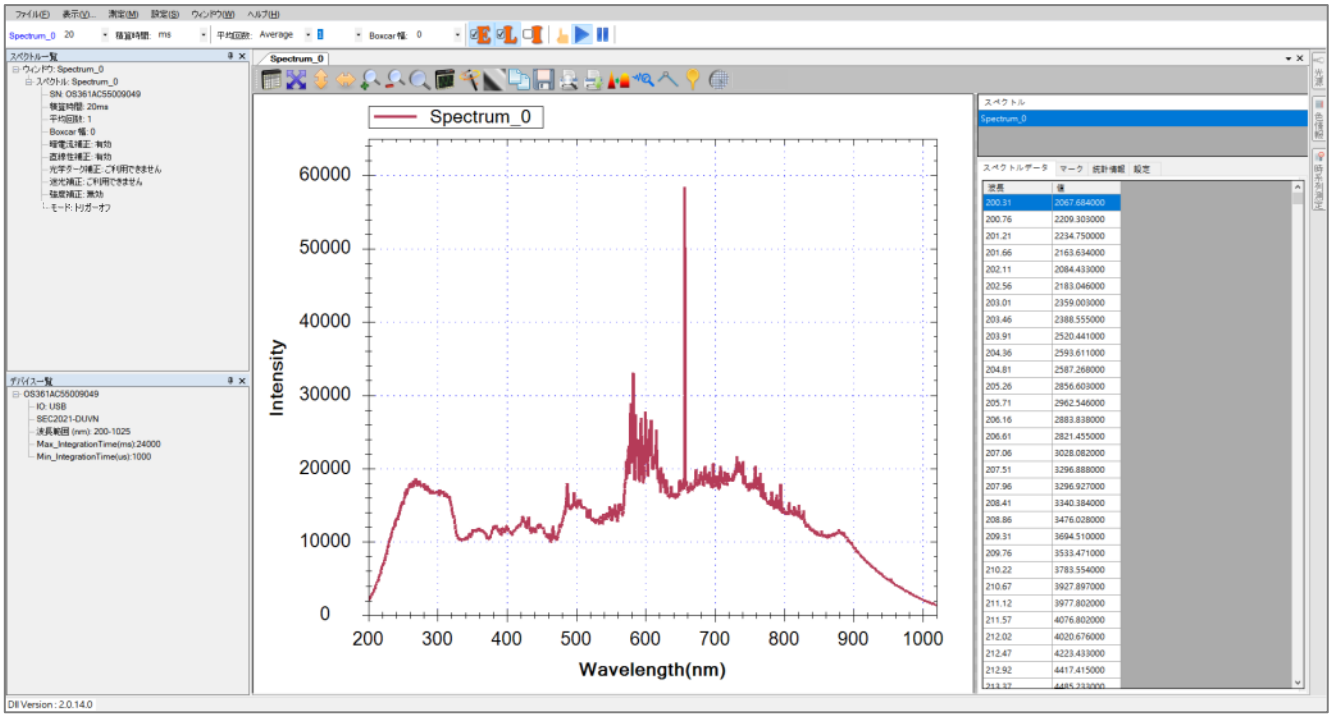


Figure 16-2: The effect of switching the display language to Japanese

Font

In addition to the display language, you can also adjust the size of the font for the user interface. Go to the **View** menu, and then select the **Font**:

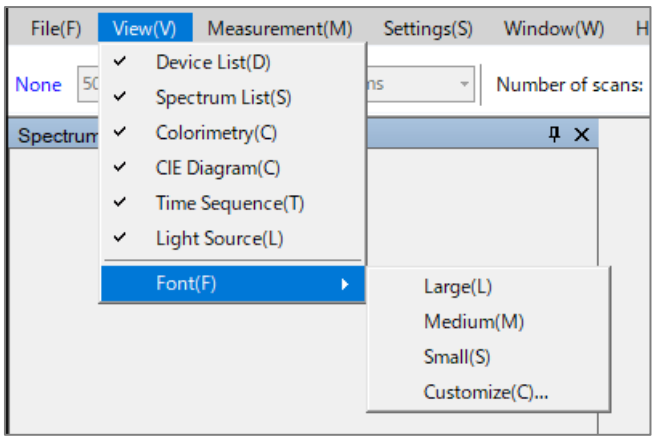


Figure 16-3: Selecting **Font** from the **View** menu

You can choose the font size that best fits your needs.

Default Layout

Once you have more than one measurement windows and you have moved the windows around, you can go to the **Window** menu and select **Default Layout** to revert to their default layout:

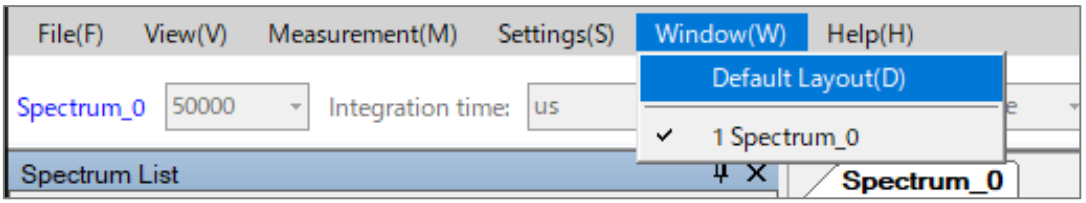


Figure 16-4: Selecting **Default Layout** from the **Window** menu

The window layout now reverts back to the way it originally was:

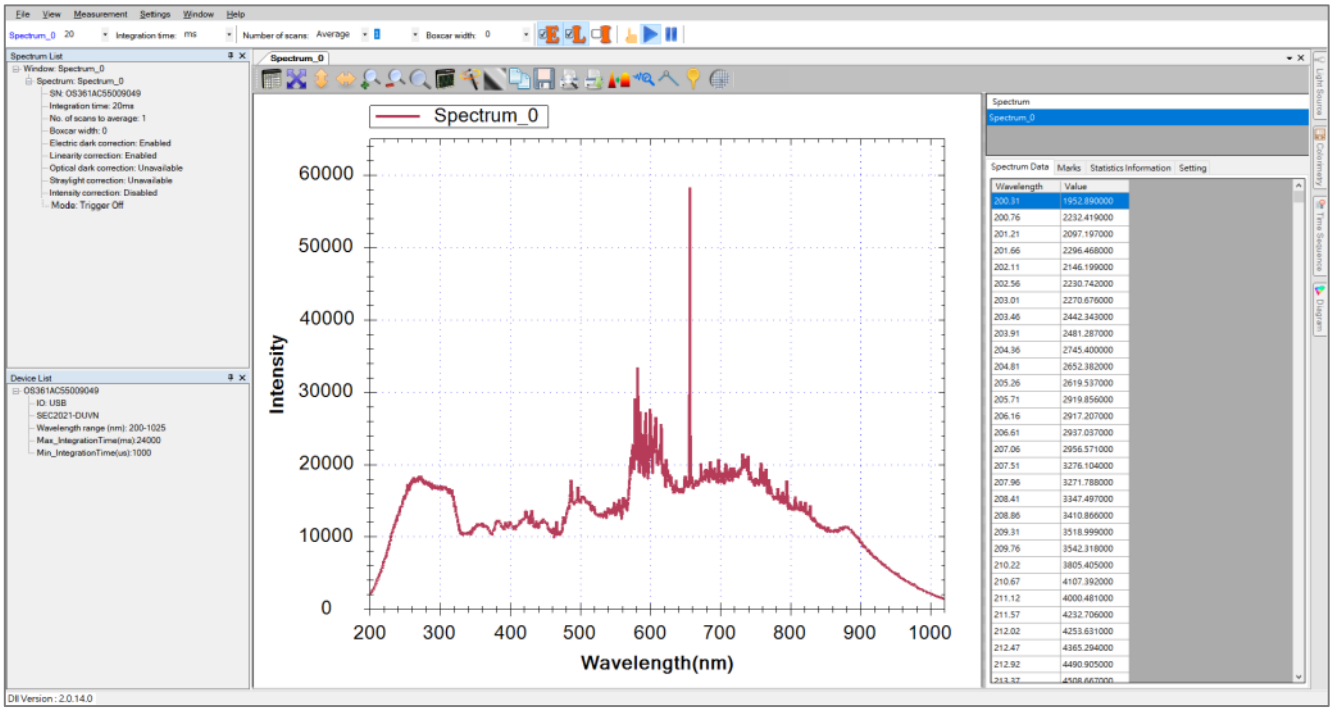


Figure 16-5: The default window layout of the program

17.Program Version and Contact Information

This concludes our introduction to all features of SpectraSmart. Hopefully, these chapters will help you get up to speed with SpectraSmart as a new user. If you have any further questions about SpectraSmart or any suggestions to this guide, please do not hesitate to let us know. You can find our contact information in SpectraSmart by going to the **Help** menu then selecting **About**. You will see the version information of your SpectraSmart as well as our contact information:

Manufactured by:

ALS Co., Ltd

Exclusive distributor:

BAS Inc.

Address: 1-28-12, Mukojima, Sumida-ku, Tokyo 131-0033, JAPAN
Phone: +81-3-3624-0331
Fax: +81-3-3624-3387
URL: https://www.als-japan.com/
Email: sales@als-japan.com

Appendix A: Spectrometer Correction Features

Electronic Dark Correction

A basic electric current constantly flows through the electronic systems (such as the main board and the CCD sensor) of the BAS spectrometer whenever the spectrometer is on. This is called the "dark current," meaning this current exists even though no light enters the spectrometer. The analog-to-digital converter (ADC) will also convert this dark current into measurement readings across the entire spectrum, forming the baseline. Before shipment, BAS spectrometer will be factory-calibrated to an assumed baseline of 1,000 as the dark current. Since the dark current is not triggered by the light entering the spectrometer, this baseline needs to be deducted from the readings. As the level of the dark current can be affected by the device temperature, BAS has designed an algorithm to dynamically correct the readings in relation to the dark current. This is called the "electronic dark correction," a process which each BAS spectrometer must go through before shipment, and the correction data is directly stored within the spectrometer. When the electronic dark correction is enabled in the SpectraSmart software, the dark current will be dynamic removed from the measurement curve. The following figures show two different measurement curves without and with electronic dark correction, respectively:

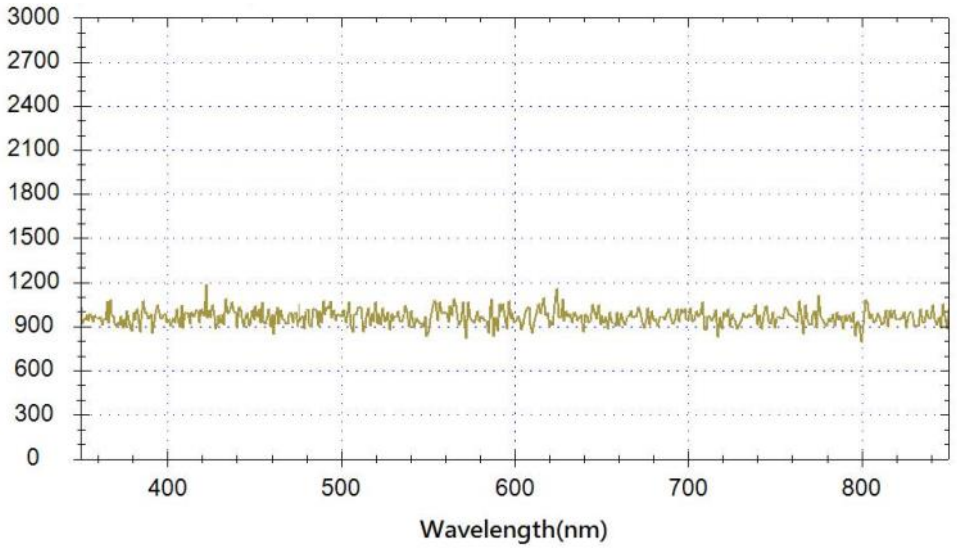


Figure A-1: Without electronic dark correction

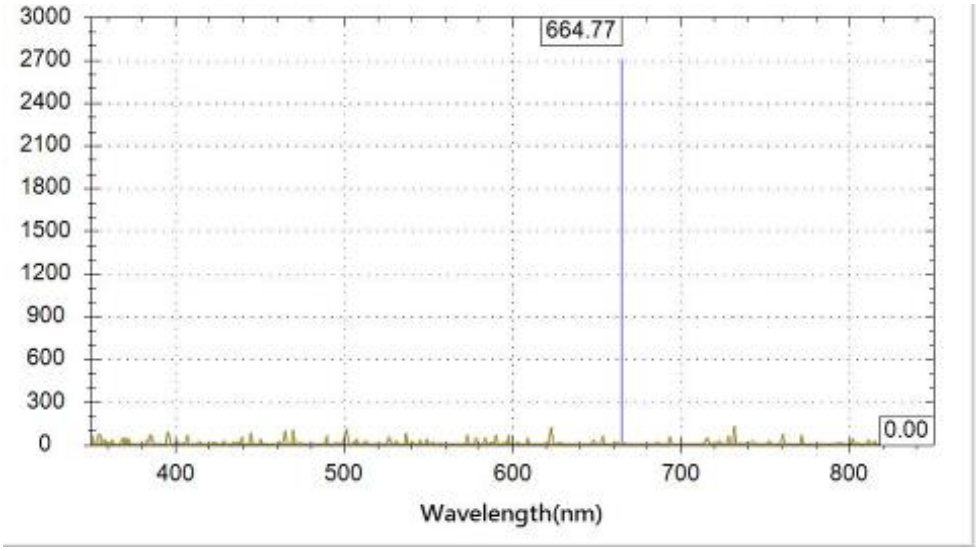


Figure A-2: With electronic dark correction

To enable electronic dark correction, click on the **Electronic Dark Correction** button above the toolbar. To disable it, just click on the button again. See the following figure:

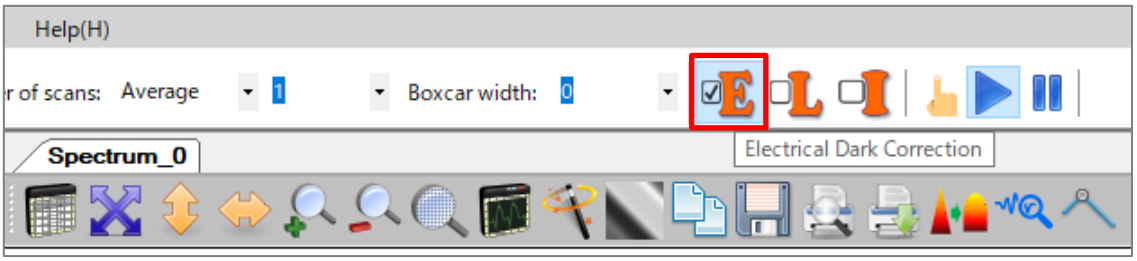


Figure A-3: The **Electronic Dark Correction** button

Linearity Correction

The response curve of the CCD sensor in relation to the light intensity is not a perfect straight line. In addition, the response curve of each CCD sensor will not be identical to each other. For this reason, each BAS spectrometer will go through a "linearity correction" process before it is shipped, with its own correction table store within the spectrometer. As BAS spectrometer uses a 16-bit ADC internally, its output readings will be calibrated to the range between 0 and 65535. When linearity correction is enabled in the SpectraSmart software, the reading for each pixel will be corrected using this table. See the following figure for the difference:

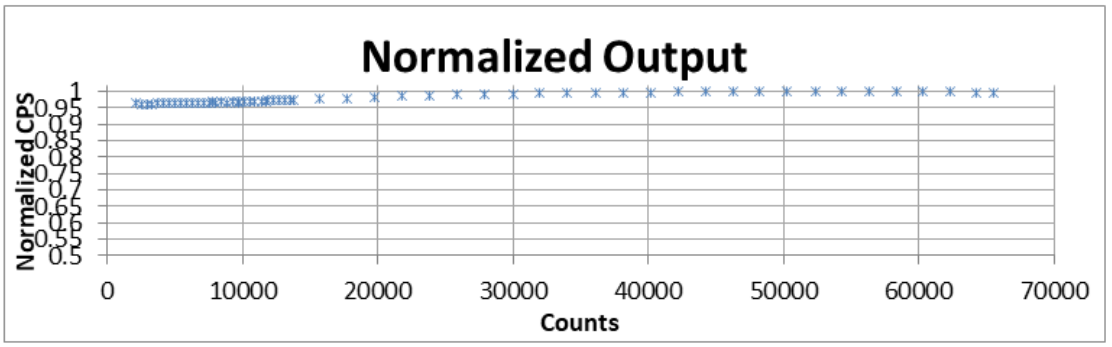


Figure A-4: Without linearity correction

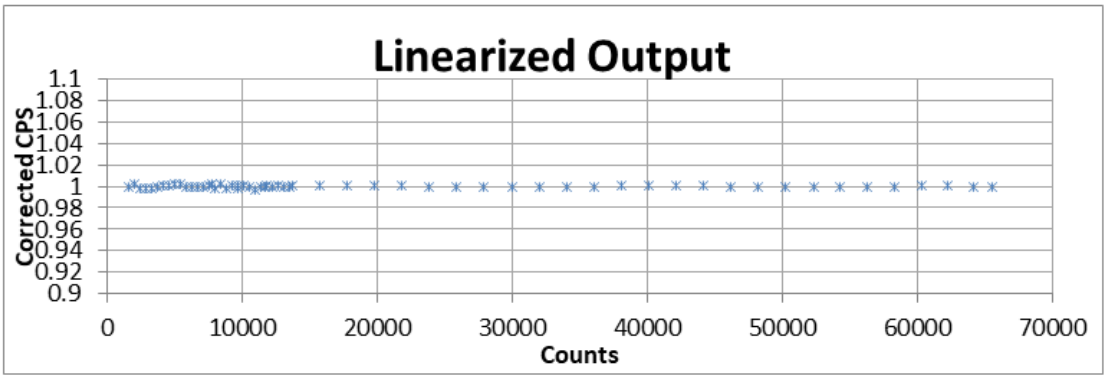


Figure A-5: With linearity correction

To enable linearity correction in SpectraSmart, click on the **Linearity Correction** button (next to the **Electronic Dark Correction**) above the toolbar. To disable it, just click on the button again. See the following figure:

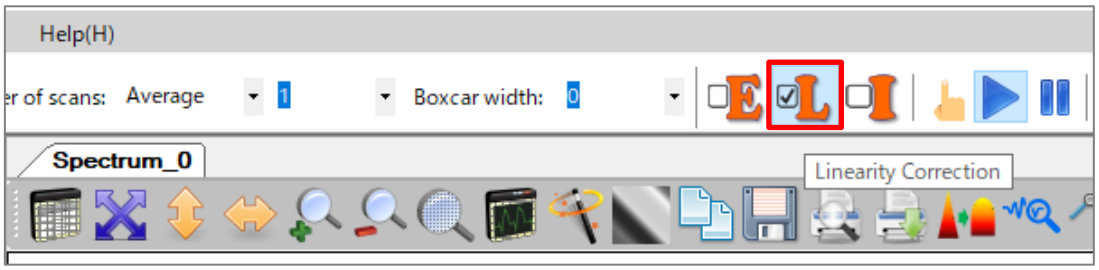


Figure A-6: The **Linearity Correction** button

Intensity Correction

The spectrometer CCD sensor has different response to wavelength. Therefore, before shipping the spectrometer to the factory, we save the correction table in the spectrometer to correct the intensity. Standard intensity light source is used for strength correction. In addition, intensity correction (350 to 900 nm) is also performed at the SMA

905 connector end. In order to independently measure the light source intensity by the user, it is necessary to build an independently system.

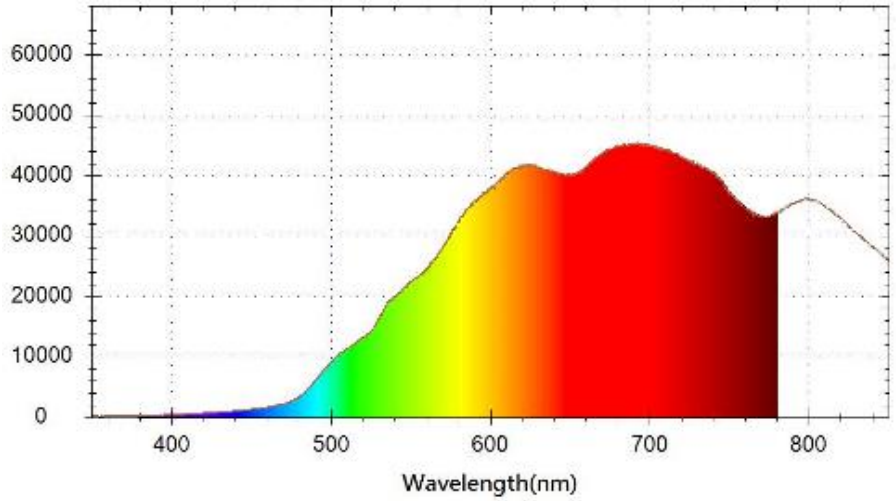


Figure A-7: Without intensity correction

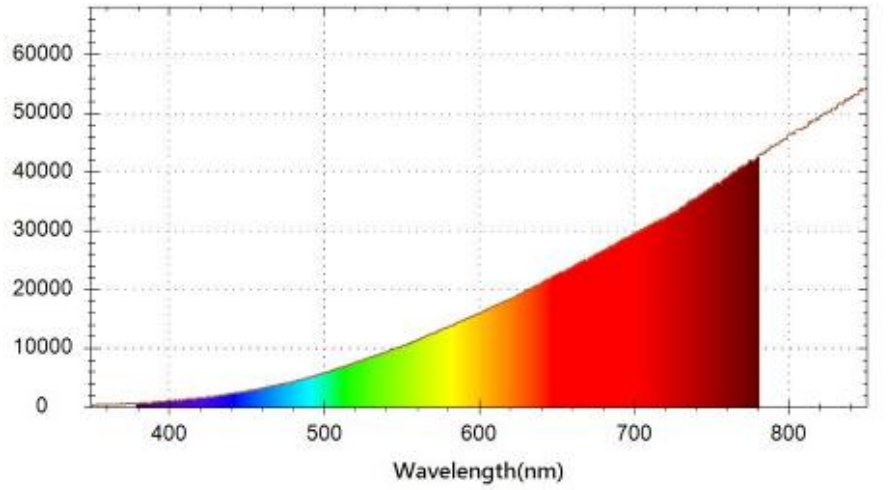


Figure A-8: With intensity correction

To enable intensity correction in the SpectraSmart software, click on the **Intensity Correction** button above the toolbar. See the following figure:

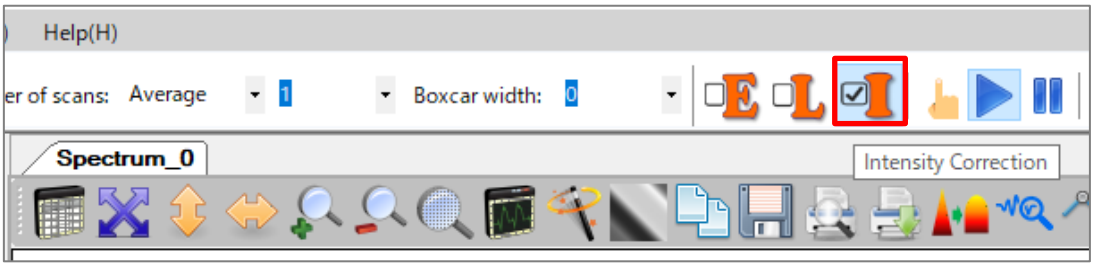


Figure A-9: The **Intensity Correction** button