SpectrumFactory

User Manual

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1. Installing SpectrumFactory

1.1 SpectrumFactory Installation

This section describes how to install and run the SpectrumFactory software on your computer.
If you have any questions about installing the SpectrumFactory software, you can email klaus@jnewtech.com for assistance.
There are two system requirements: the minimum system requirement is Windows 7 or later. Windows 98 and Windows XP are not supported by this software. This software does not support macOS.

1.2 System Requirements

The minimum system requirements for running SpectrumFactory software on your computer are as follows:
Supported operating systems:
- Windows 7 Professional, Enterprise, or Ultimate editions (Windows 7 Education edition is not recommended).
- Windows 10 Pro, Enterprise, or Ultimate editions (Windows 10 Education edition is not recommended).
- Windows 11 Professional, Enterprise, or Ultimate editions (Windows 11 Education edition is not recommended).

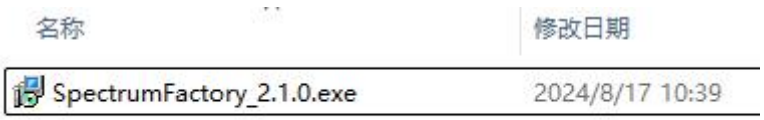
Minimum hardware requirements:
- Memory: 4 GB
- Available hard disk space: 200MB

1.3 Installation

Double-click the installation file to see the installation wizard. The following are the specific steps to install SpectrumFactory:
1. Double-click the SpectrumFactory_2.1.0.exe installer file.

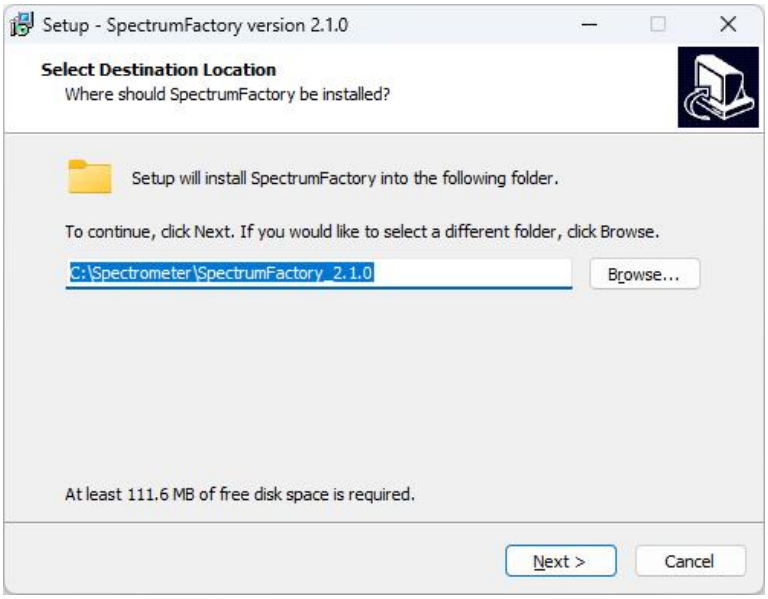
Windows 7 and later systems may require administrator privileges to install. If your

company has strict software management permissions, you will need to contact your IT department to help you install the software.

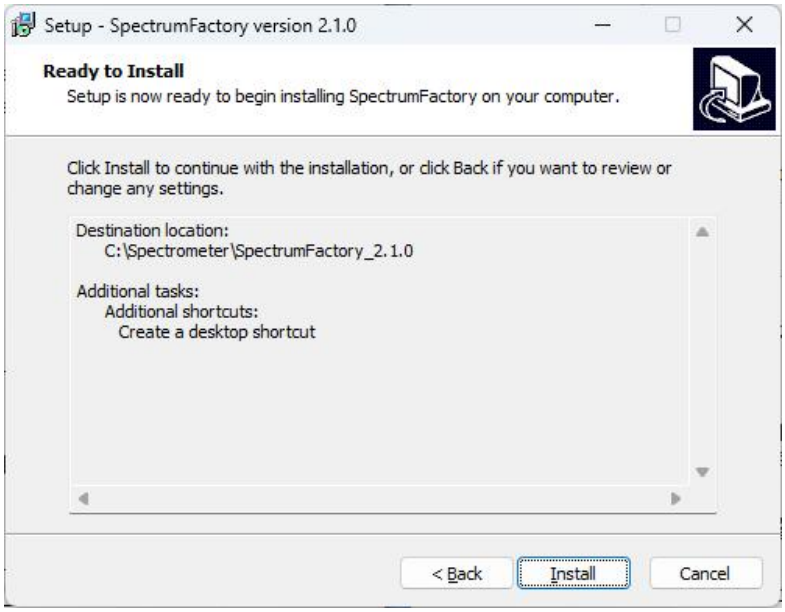


2. Welcome screen

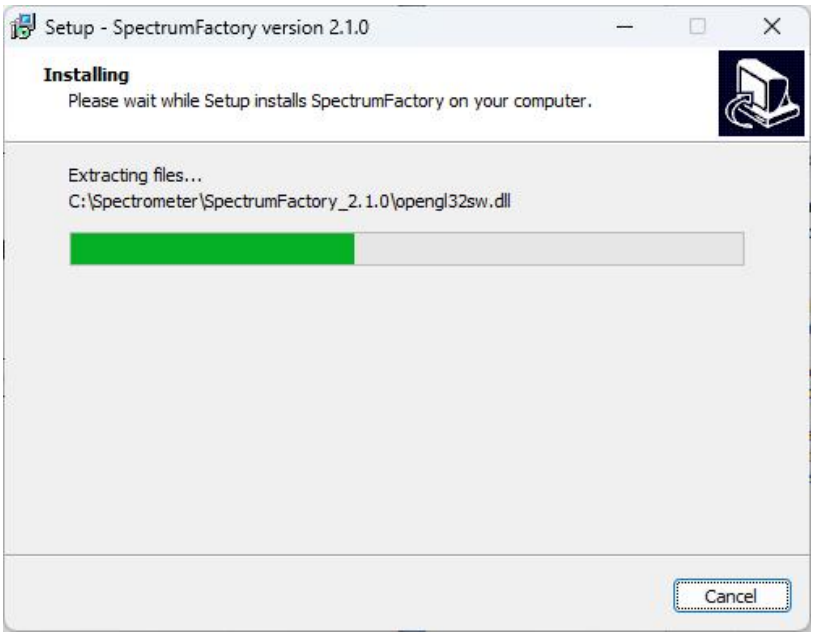
Below is the software installation path. Please confirm your installation path.



Confirm the installation path and click Install to proceed with the installation.

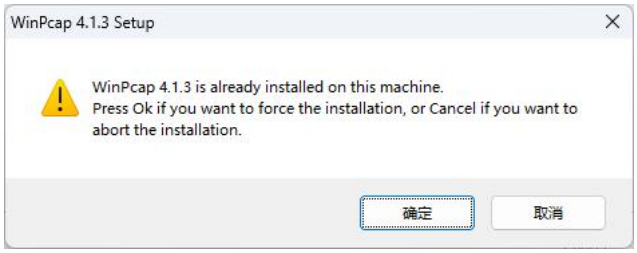


Software installation in progress

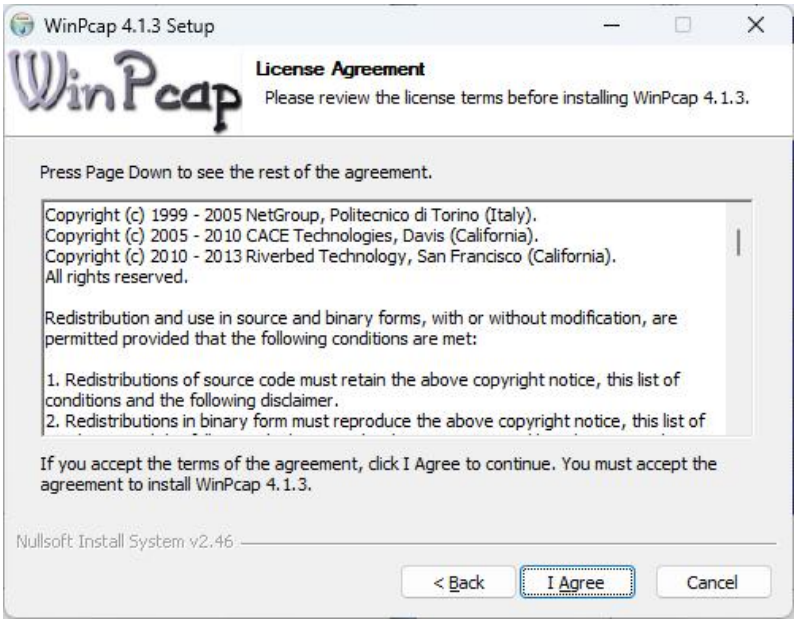


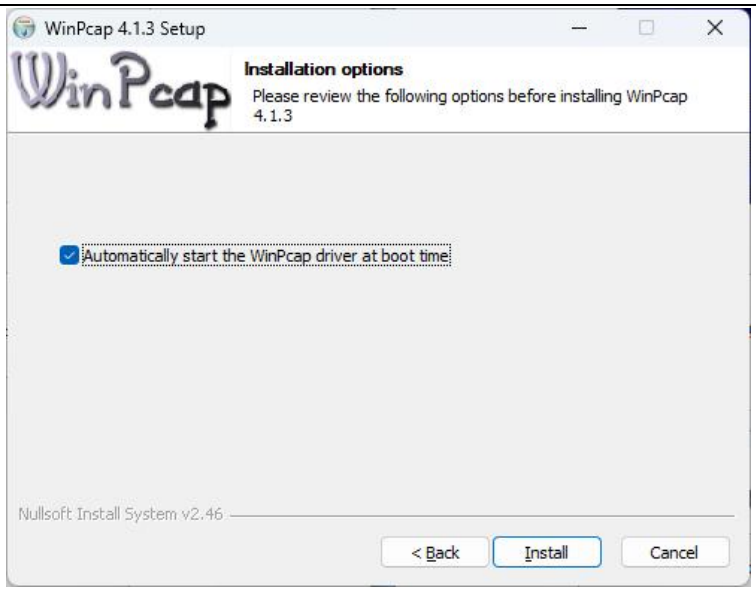
To install the spectrometer driver, please click "Always install driver".

The following is the installation of the motor platform driver . If you have already installed the motor driver, you can click Cancel . If you are updating the software , you can also click Do not install the motor driver .

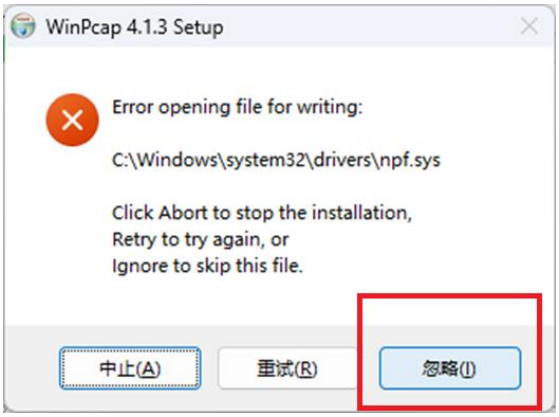


The motor driver uses WinPcap, so when the computer controls the motor, you don't need to enter the IP address, and you can also connect to the external network via WIFI.

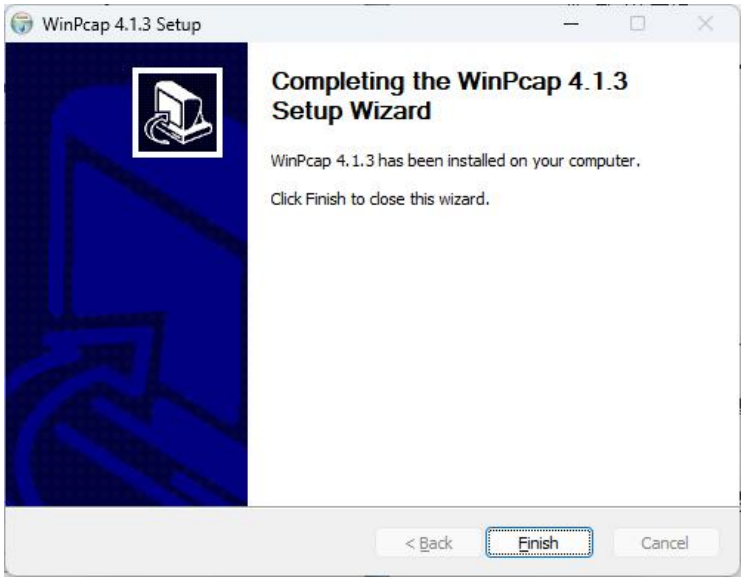




The message indicates that the motor driver nps.sys is already running. If you have already installed the motor driver, please click "Ignore".



Motor drive installation complete



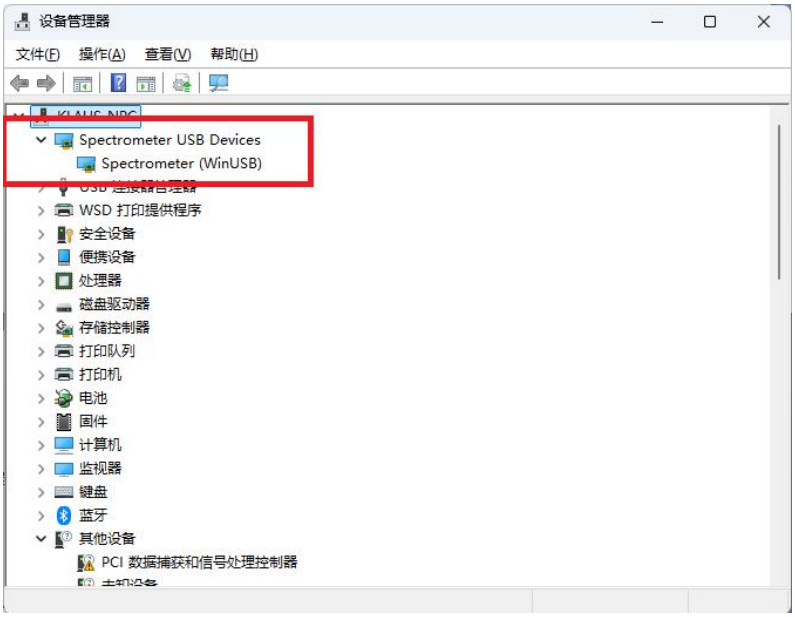
SpectrumFactory is fully installed, and the spectrometer driver is also installed.

1.4 Problems that may be encountered during driver installation

First, check in Device Manager whether the driver is installed.
A yellow exclamation mark will appear if the driver is not installed.

Please reinstall the SpectrumFactory_2.1.0 software. The driver will be installed automatically during the installation process.

After successful installation, the following example will appear.



On Linux systems, you also need to install USB drivers. Please install the libusb-compact package first.

2. Software Interface

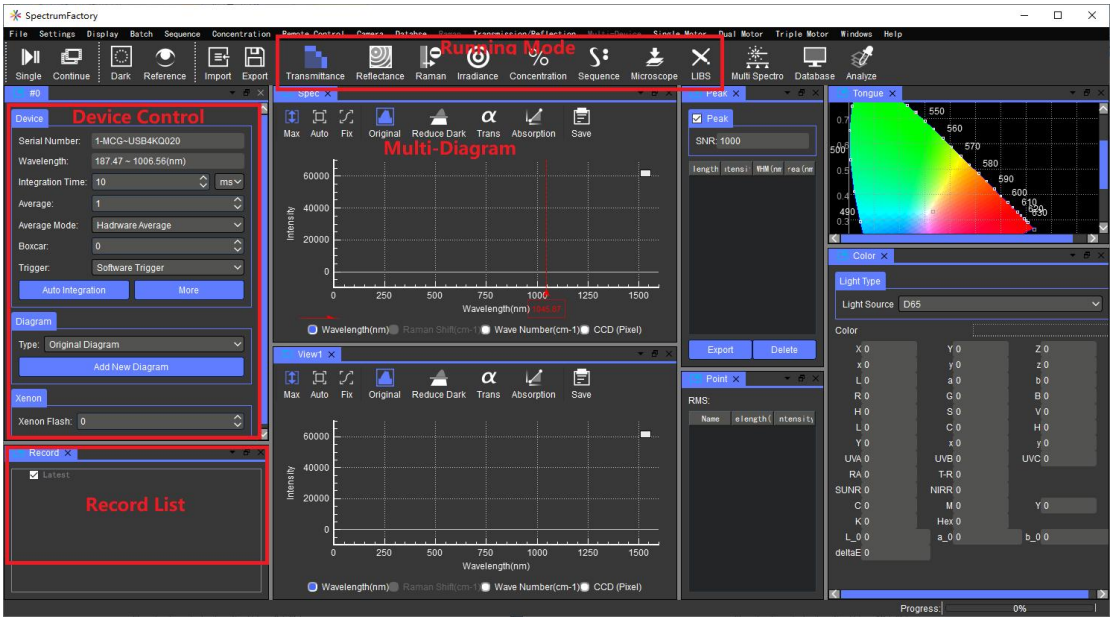
SpectrumFactory consists of multiple freely movable software windows.

2.1 Software Interface for 1000 Users

Users can freely arrange the layout of the window area according to their own preferences and habits, thereby achieving a customized software style for each user.

2.2 Multispectral images, displayed simultaneously

The software can simultaneously display the original spectrum, transmittance, and absorbance values on the same interface, thus avoiding the problem of abnormal reflectance or absorbance caused by raw data saturation when novice users take measurements.



2.3 Database

The software includes a user-defined database, which can be used to create a transmissive and reflective database or a Raman database, thus facilitating the analysis and comparison of the collected data later on.

2.4 Comprehensive software module functionality

It includes numerous modules such as film thickness measurement, colorimetry, Raman spectroscopy, transmission and reflection spectroscopy, and hyperspectral analysis.

2.5 Multispectral Support

The software can support up to 16 spectrometers simultaneously and can control multiple light sources at the same time, such as multiple lasers, multiple xenon lamps, and multiple LED lights.

1. The software is equipped with a powerful algorithm module.

Including normalization, differentiation, smoothing, and partial least squares method.

2. The software is equipped with multiple control methods.

Supports remote device control.

2.6 Software Operation Mode

SpectrumFactory supports the following features, allowing switching between different operating modes.

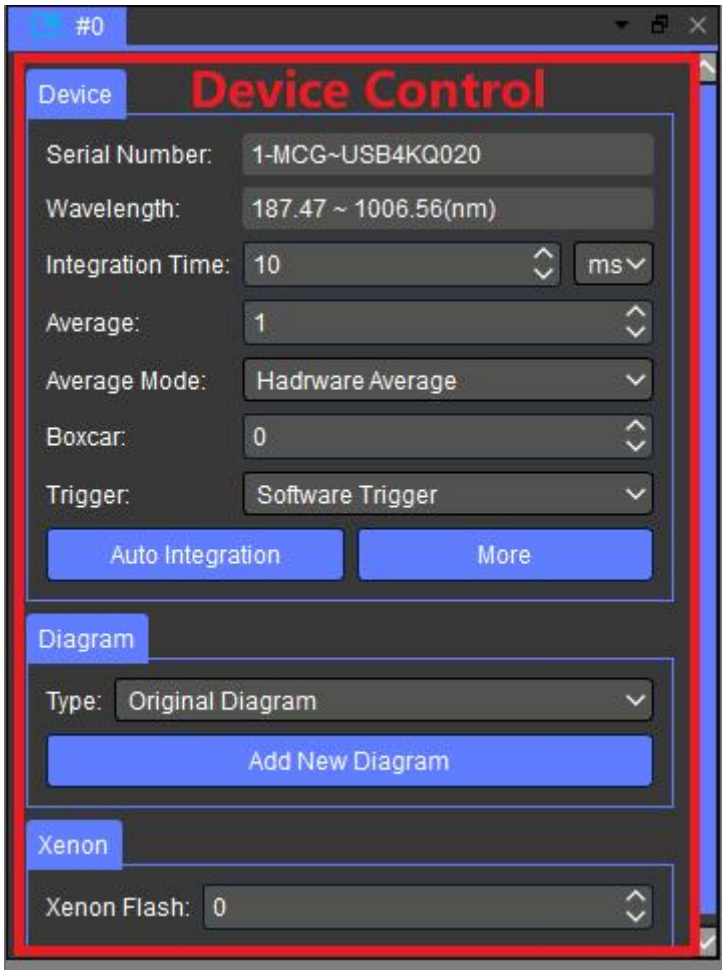
1. Transmission and reflection modes, the transmittance and reflectance of glass or transparent materials.
2. Raman mode, which can be combined with a laser to measure Raman spectra.
3. The concentration mode, when used in conjunction with a xenon lamp, measures absorbance at ultraviolet wavelengths, thereby determining the liquid concentration according to Beer-Lambert's law.
4. Fully automatic motor platform control, supporting single-axis motors, two-axis motors, three-axis motors, microscope motors, autofocus, camera support, spectrogram display support, and motion control such as circular arc acquisition and S-curve acceleration/deceleration.
5. The X-axis timing measurement mode can be used in conjunction with a mercury-argon lamp to test X-axis stability.
6. Y-axis timing measurement mode can be used in conjunction with a laser to test the stability of the laser center wavelength.

7. The microscopic mode, combined with a motor platform, can acquire hyperspectral images, supporting both transmission and reflection hyperspectral imaging and Raman hyperspectral imaging.
8. The LIBS mode, in conjunction with a 1064 Nd-YAG laser, can be used to measure the metal composition.
9. Film thickness measurement, capable of measuring film thickness from 5μm to 100μm.
10. Spectrophotometry can measure parameters such as XYZ, Lab, Yxy, HSV, LCH, and RGB.
11. Online measurement, allowing remote control of spectrometer measurement data.
12. Uniformity measurement can test the distribution uniformity of a sample, including the uniformity of drug particles or the uniformity of LED light.

3. Basic operation of a spectrometer

The left side is the basic operation area of the spectrometer.
Currently, SpectrumFactory software supports...

Spectrometer type:
USB spectrometer
Serial port spectrometer



3.1 Equipment Name:

Includes the spectrometer type and serial number. Note that the serial number is encrypted; an incorrect serial number will not be recognized by the software.

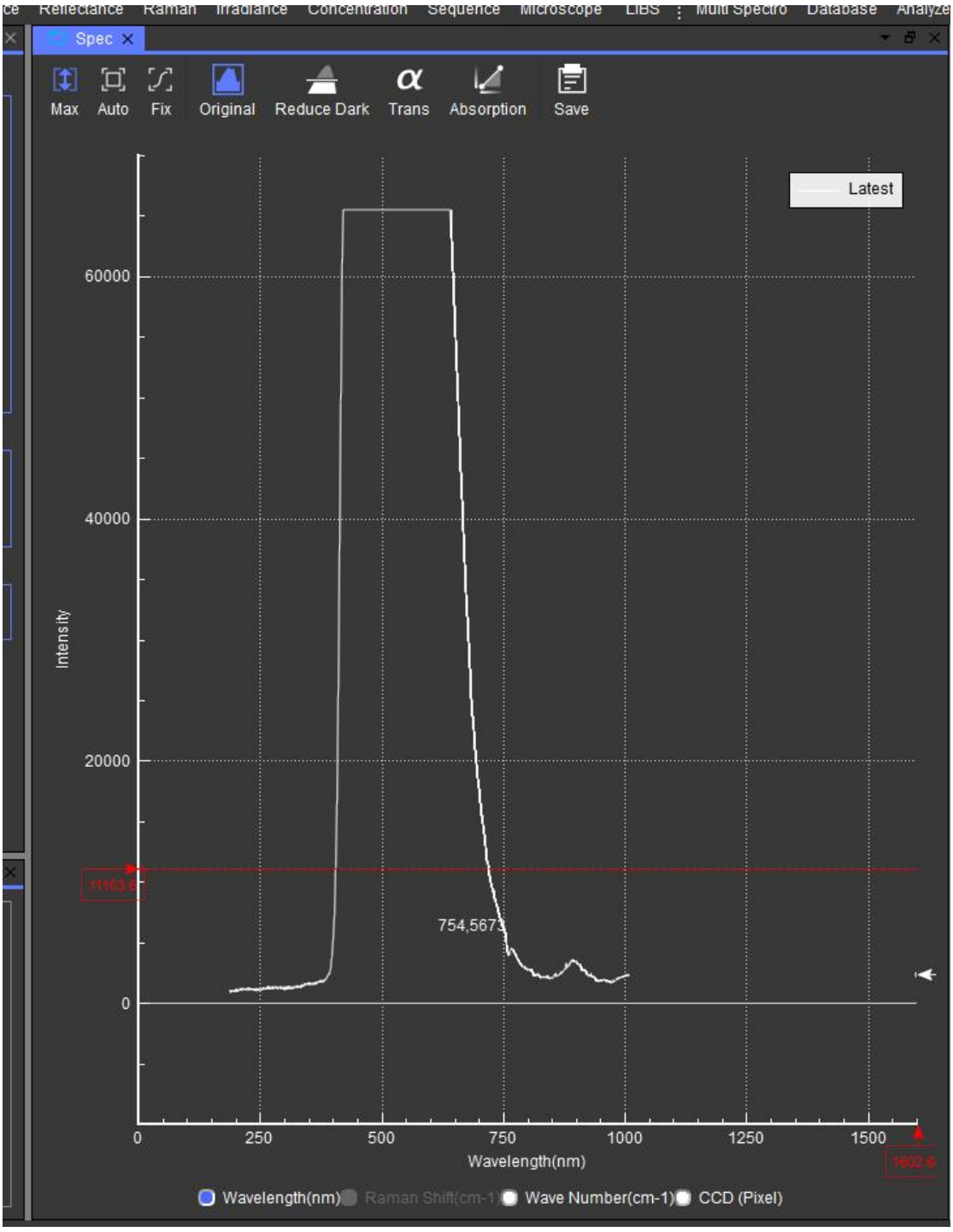
3.2 Wavelength range:

This spectrometer supports a wavelength range of

3.3 Exposure Time

Also known as integration time.
Currently, the spectrometer supports long exposure times ranging from 60 µs to 30 minutes. Typically, the exposure time for SPM3 should be less than 10 seconds, for SPM5 less than 40 seconds, and for SPM7 less than 5 minutes. Otherwise, excessive electronic noise will be generated.
Because the spectrometer uses a 16-bit AD converter, the maximum spectral value is 65535. Please ensure that this value is not included during measurement.

Unsaturated spectrum



3.4 Average Pattern

There are hardware averages and software averages.

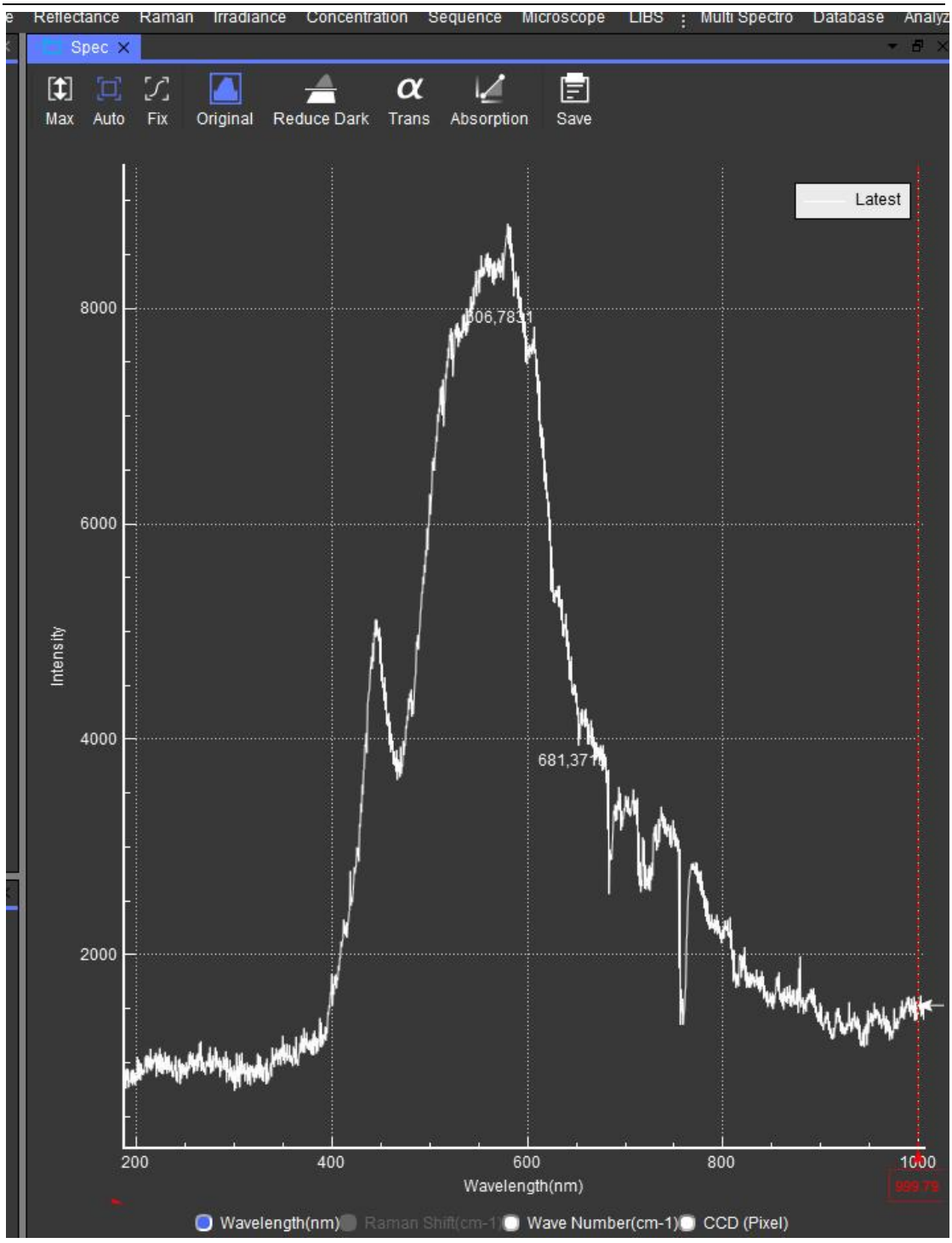
Averaging the number of times can effectively avoid data drift caused by

spectrometer noise, greatly improving the quality of the spectrum.
Hardware averaging: The spectrometer automatically performs multiple data acquisitions within the FPGA module and then outputs an averaged spectral value.
Software averaging: After each data acquisition, the spectrometer uploads the data to a PC, where SpectrumFactory software performs averaging.

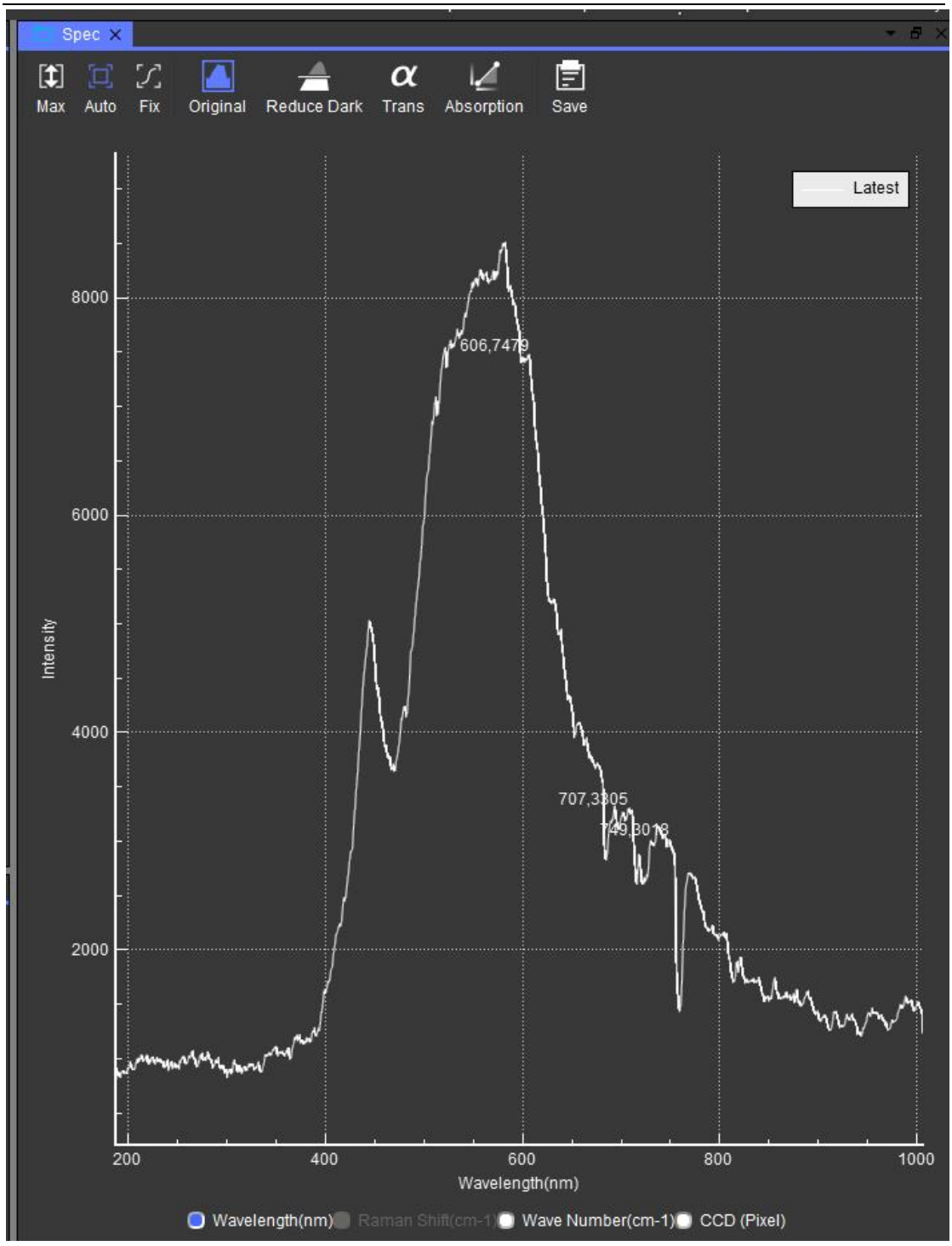
	10ms exposure time, time taken to process 100 images	accuracy	spectral values	Is it recommended?
Hardware average	1000ms	high	Integer	Recommended in 98% of scenarios
Software average	3000ms	higher	floating-point decimals	Not recommended for use except in special scenarios.

3.5 Window Smoothing

Theoretically, the values on both sides of the spectral curve should be continuous and smooth. However, in reality, noise causes the spectral curve to have jagged edges. We can solve the jagged edge problem by using window smoothing.



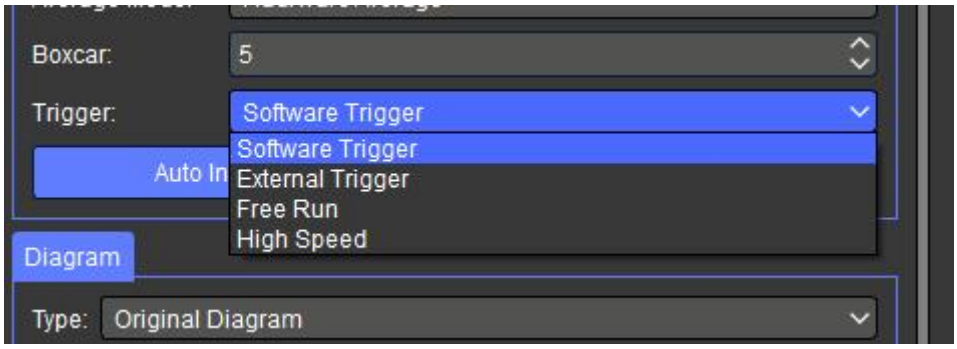
Below is the smoothed spectral curve.



Note: Spectral smoothing should only be used in transmission and reflection applications. It is absolutely not recommended for Raman applications because Raman peaks are very sharp, and spectral smoothing will severely distort the Raman peak display, leading to incorrect interpretations of Raman characteristics.

3.6 Exposure Mode

There are three exposure modes



Software exposure: This involves the PC software initiating an exposure request (integration request). Upon receiving the request, the spectrometer acquires the spectrum. After acquisition, the data is reported to the PC, which displays it. Then, the next frame of spectrum acquisition begins. The entire process is sequential and synchronous. In most cases, we use software exposure mode for spectral acquisition.

External signal triggers exposure:
This mode refers to a mode where an external laser or trigger circuit emits a trigger signal, and the spectrometer, upon receiving the signal, delays for a certain period before exposure. This mode is typically used to acquire the spectrum of a scintillation xenon lamp or for applications such as LIBS. This mode requires highly precise coordination between the spectrometer and external equipment to achieve the optimal acquisition time.
Typically, the minimum latency for external triggering can be as low as 100ns.

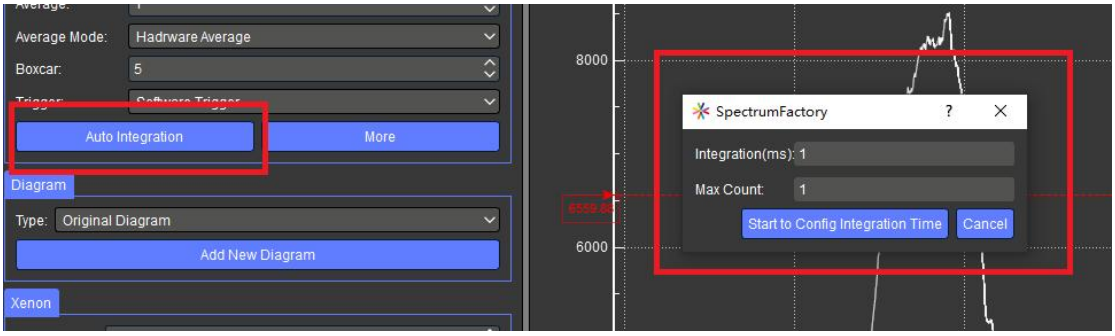
Loop exposure, Free Run
Cyclic exposure involves the spectrometer continuously acquiring spectra and storing the acquired data in its buffer. When the PC requests spectral data, the spectrometer automatically sends the buffered data to the PC. This method is typically suitable for high-speed acquisition. Cyclic exposure can be understood as asynchronous spectral acquisition, meaning the PC does not need to wait for the spectrometer to complete data acquisition before displaying the data. However, in cyclic exposure mode, some data will indeed be repeated.

3.7 Automatic Exposure

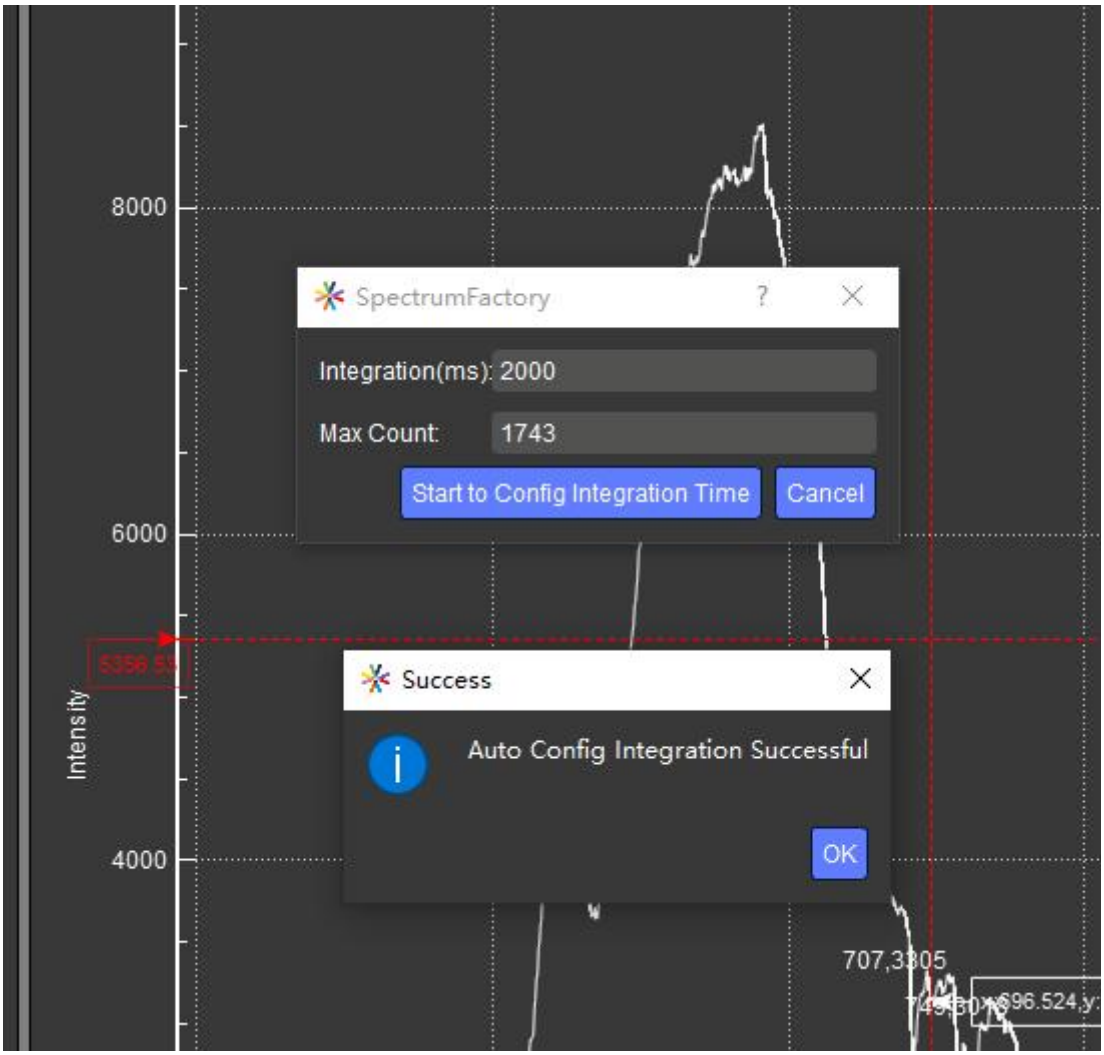
In the case of transmission and reflection measurements, we need to emphasize the

light to its brightest point, but without saturation. The specific reasons will be analyzed in later chapters.

We can use the automatic exposure button, which allows the software to determine the most suitable exposure time.

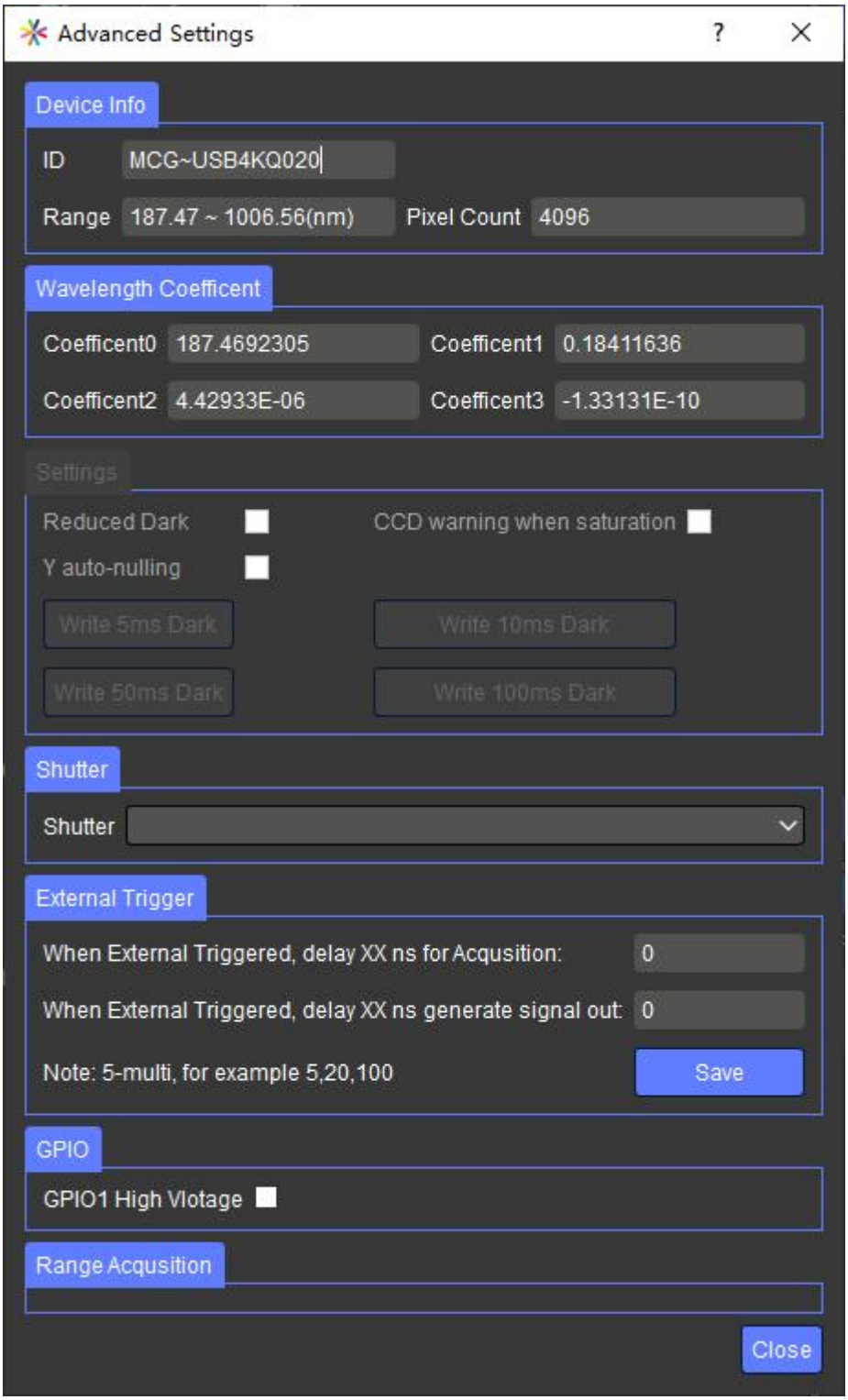


After setting



3.8 More Settings

More settings, including many advanced spectrometer settings options.



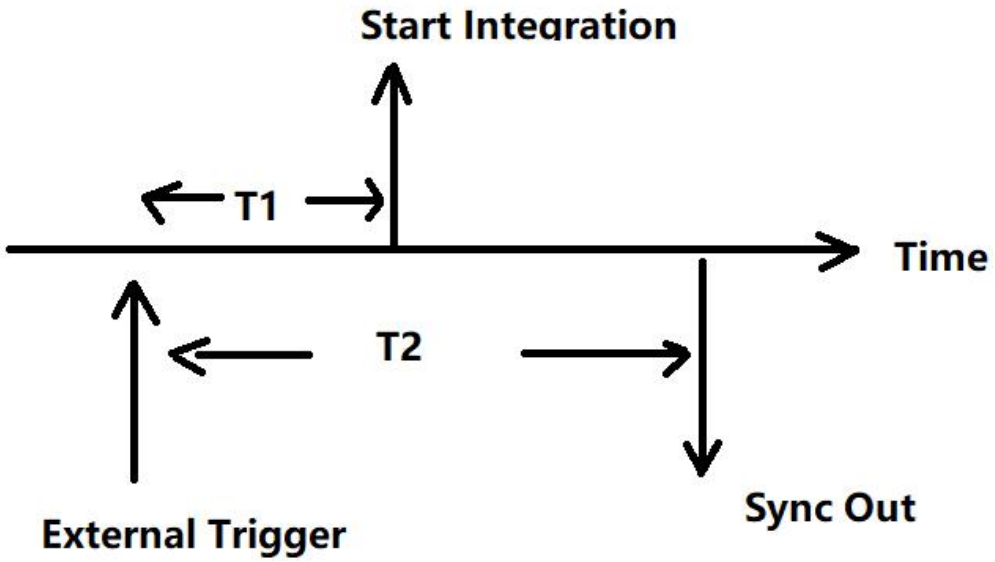
3.9 Wavelength coefficient

A spectrometer consists of 2048 pixels, each representing a specified wavelength. Writing all 2048 wavelengths into the spectrometer would require 16K of data. This makes reading and writing wavelength data inconvenient. Therefore, we use the following formula to calculate the wavelengths.
Wavelength (N-point value) = A0 + A1* i + A2*i*i + A3*i*i*i; i is the subscript of the spectrometer pixel, from 0 to 2047.
For example: the wavelength corresponding to the 78th pixel in the image above is
Wavelength = 346.918 + 0.315869*78 + (-0.00000576495*78*78) + (-0.00000000224346*78*78*78) = 371.5196

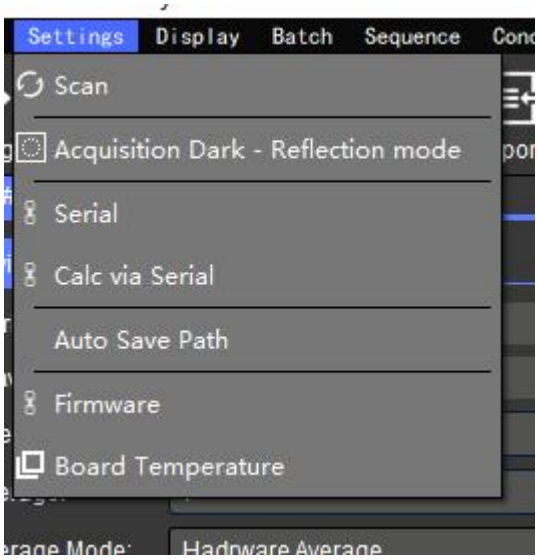
That is to say, the wavelength corresponding to the 78th pixel is 371.5196nm.

3.10 External Trigger Delay Settings

After receiving an external trigger, the spectrometer will begin exposure after a time interval T1. T1 can be 0, meaning exposure will begin immediately.
After receiving an external trigger, the spectrometer sends out another trigger after a time interval T2, such as triggering other spectrometers to expose. This is mainly used in cascaded LIBS applications to coordinate the simultaneous exposure of multiple spectrometers.



3.11 Reconnected Spectrometer

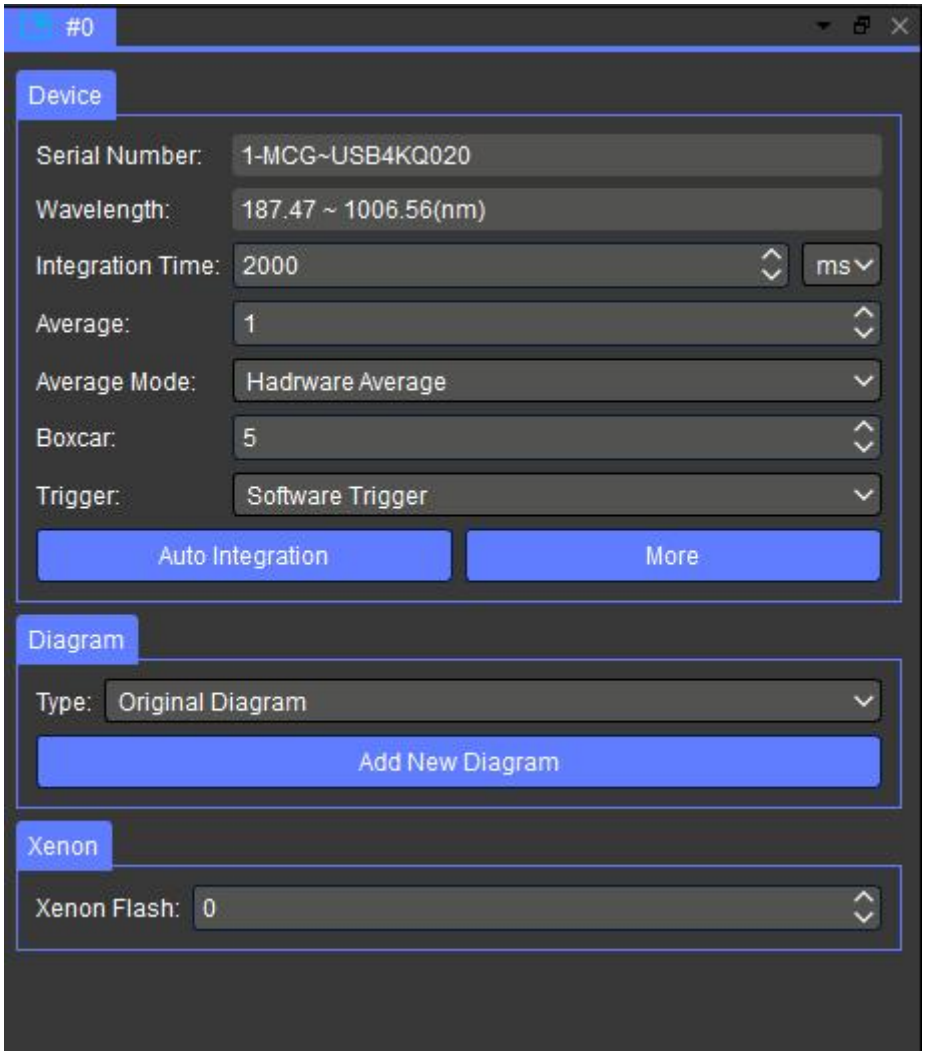


The USB-connected spectrometer will automatically reconnect. Alternatively, you can reconnect using the "Scan Spectrometer" option in the "Spectrometer Settings" menu. Note that you should not refresh the connection to connect two spectrometers with different wavelengths, as this will cause errors.

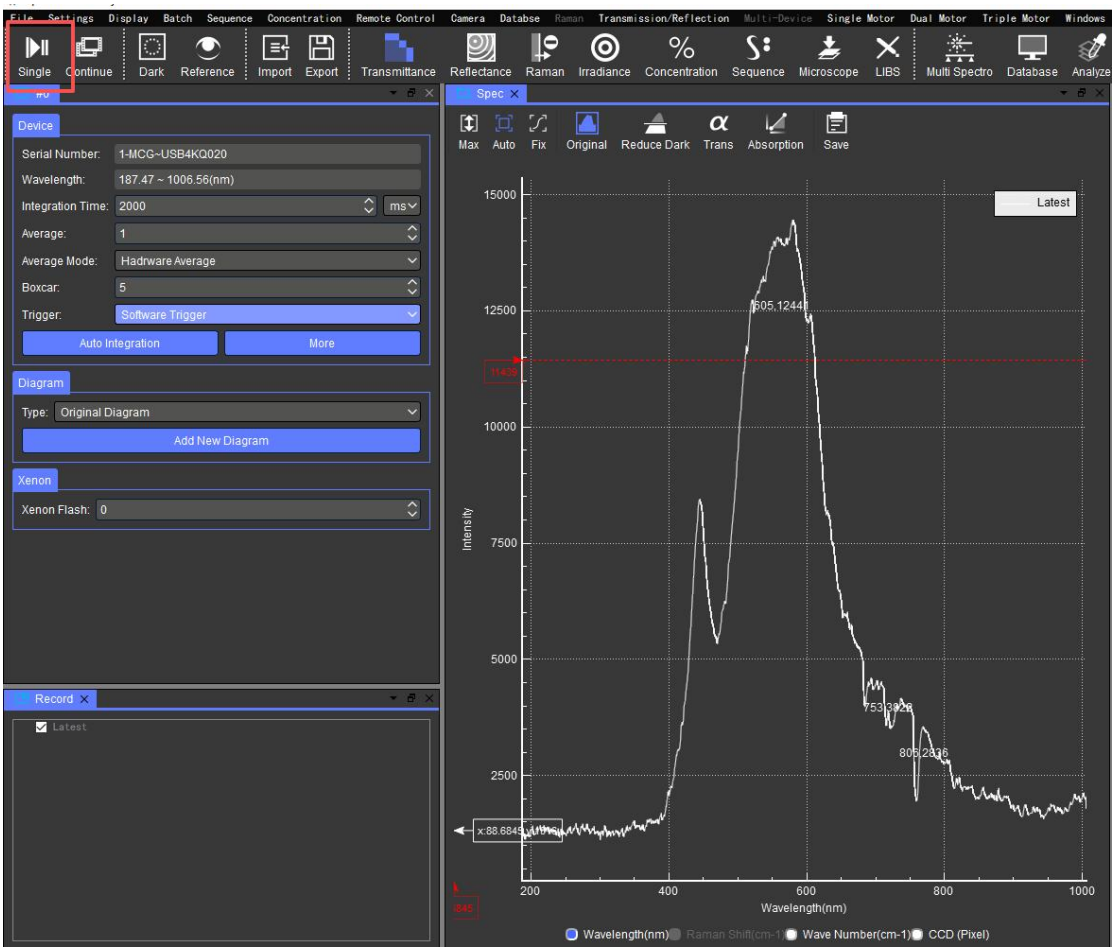
4. Spectral acquisition

4.1 Spectral Acquisition

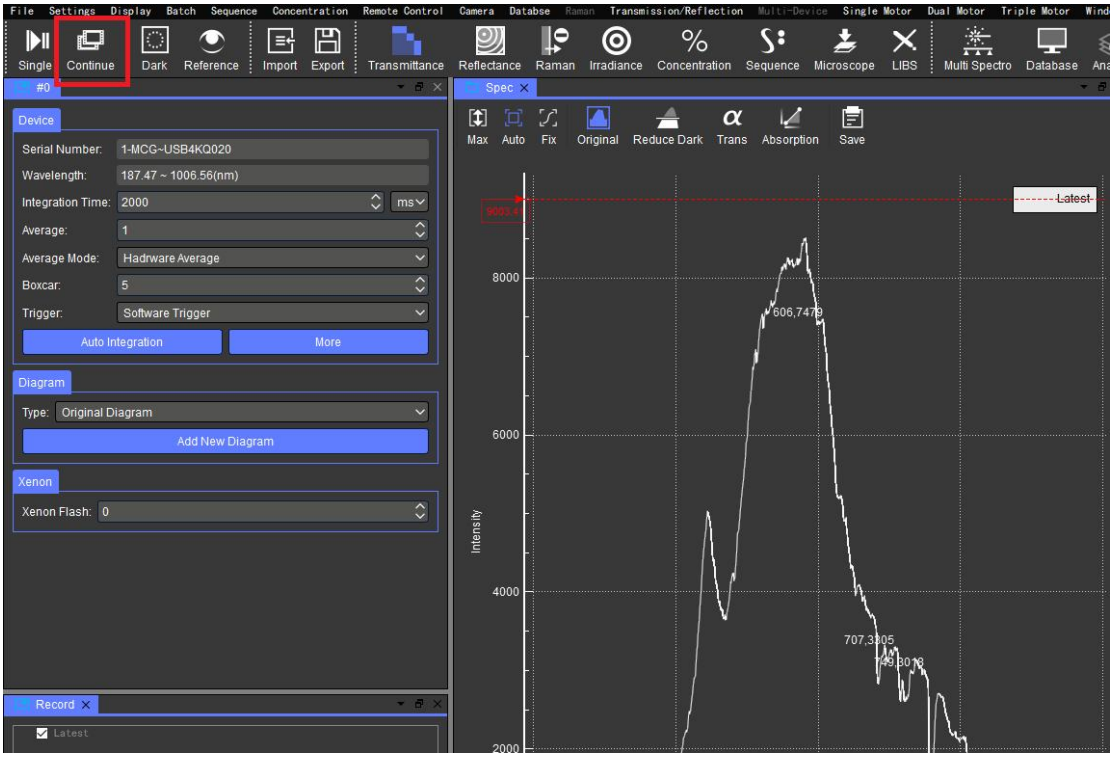
After setting the correct exposure time, we can either capture images in a single shot or continuously.



4.2 Single data collection

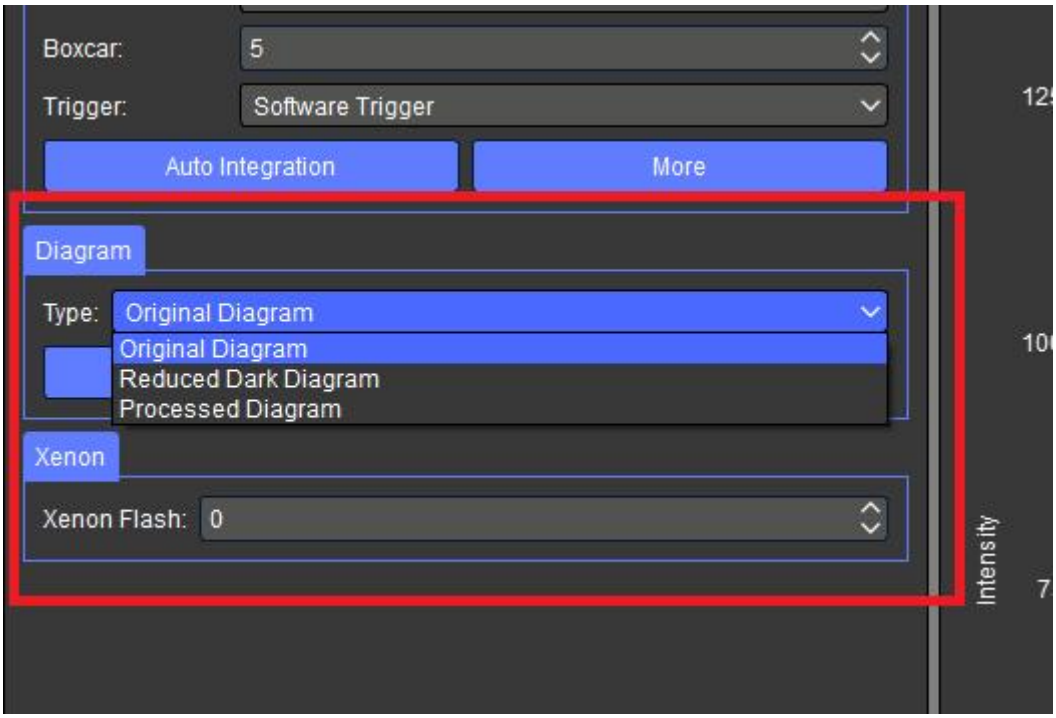


4.3 Continuous data acquisition

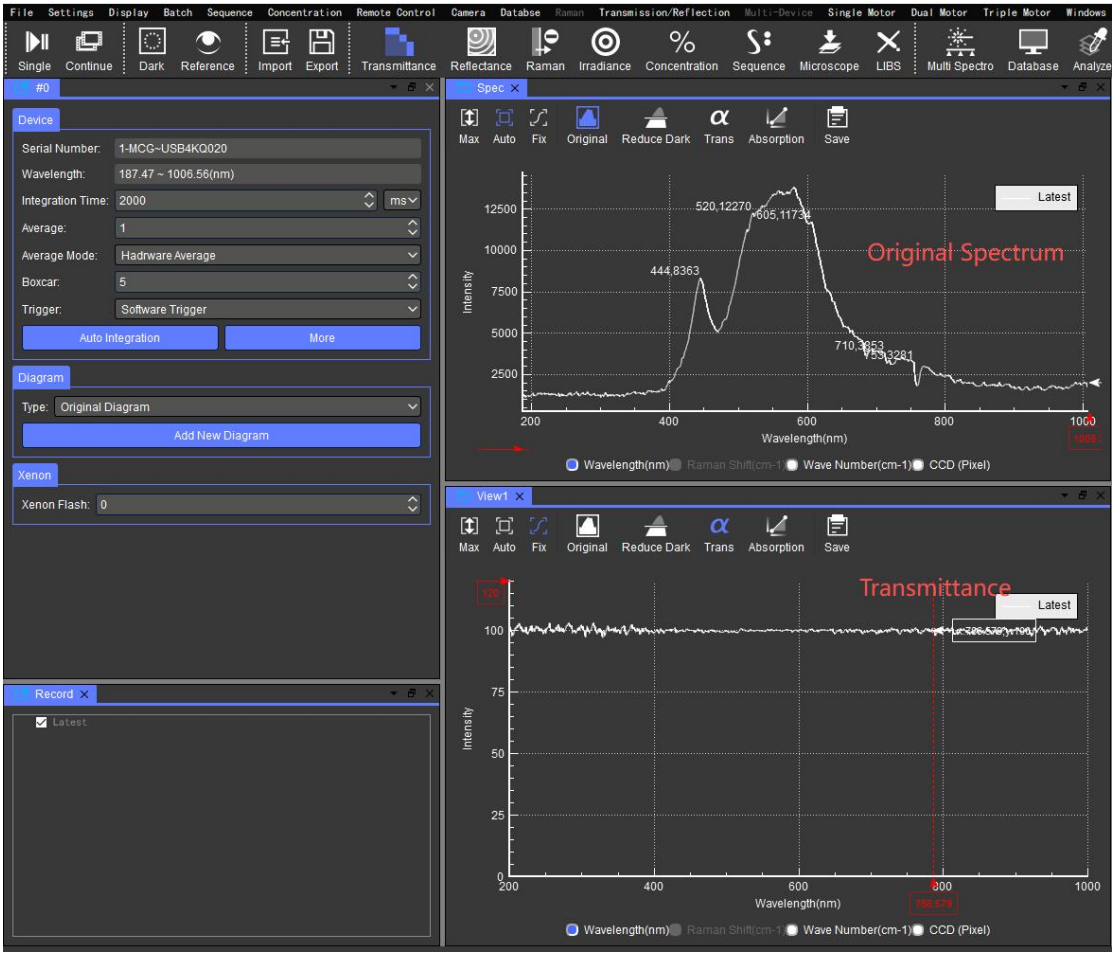


4.4 Spectral View

SpectrumFactory can support multiple spectral views simultaneously.



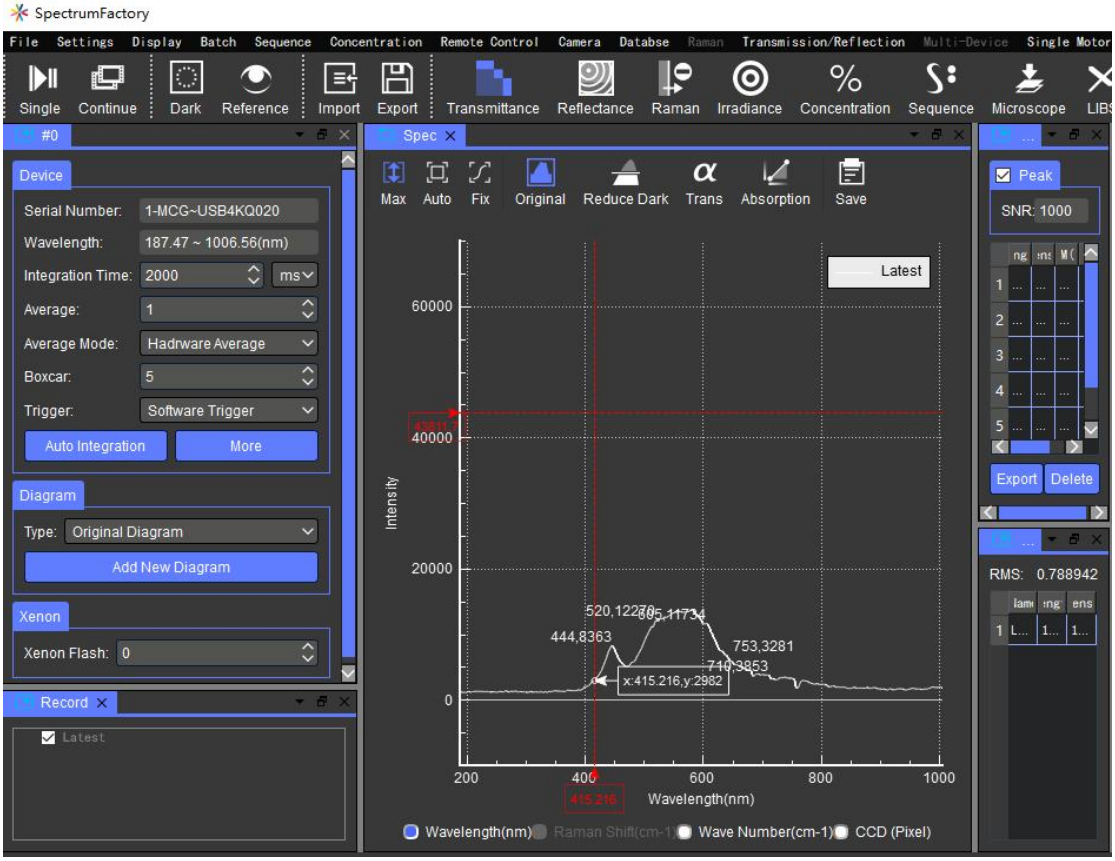
As shown in the figure below, the software can display both the original spectrum and the transmittance spectrum simultaneously, thus avoiding incorrect transmittance display caused by spectral saturation.



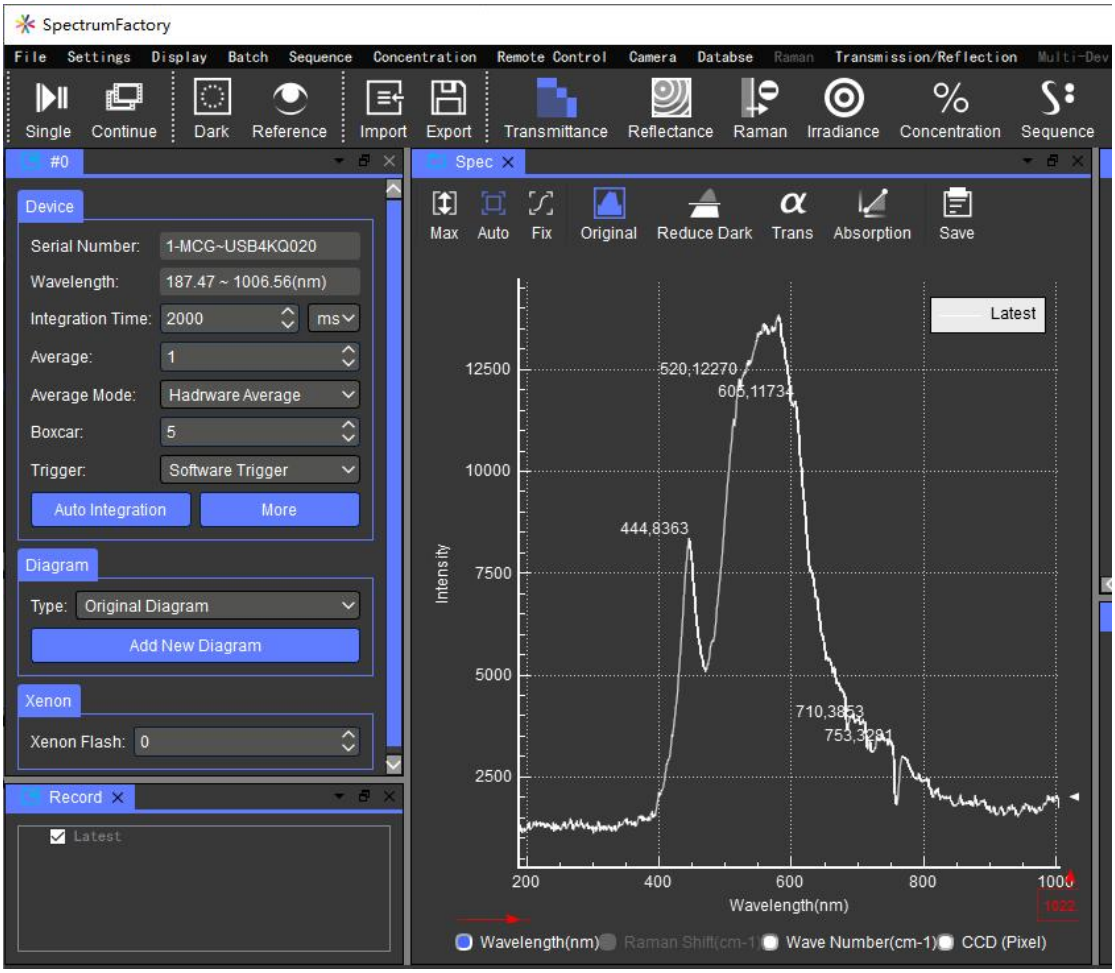
The image below shows a calculated transmittance value that is meaningless due to spectral saturation; this is a very common problem for beginners.

4.5 View Coordinate Scale

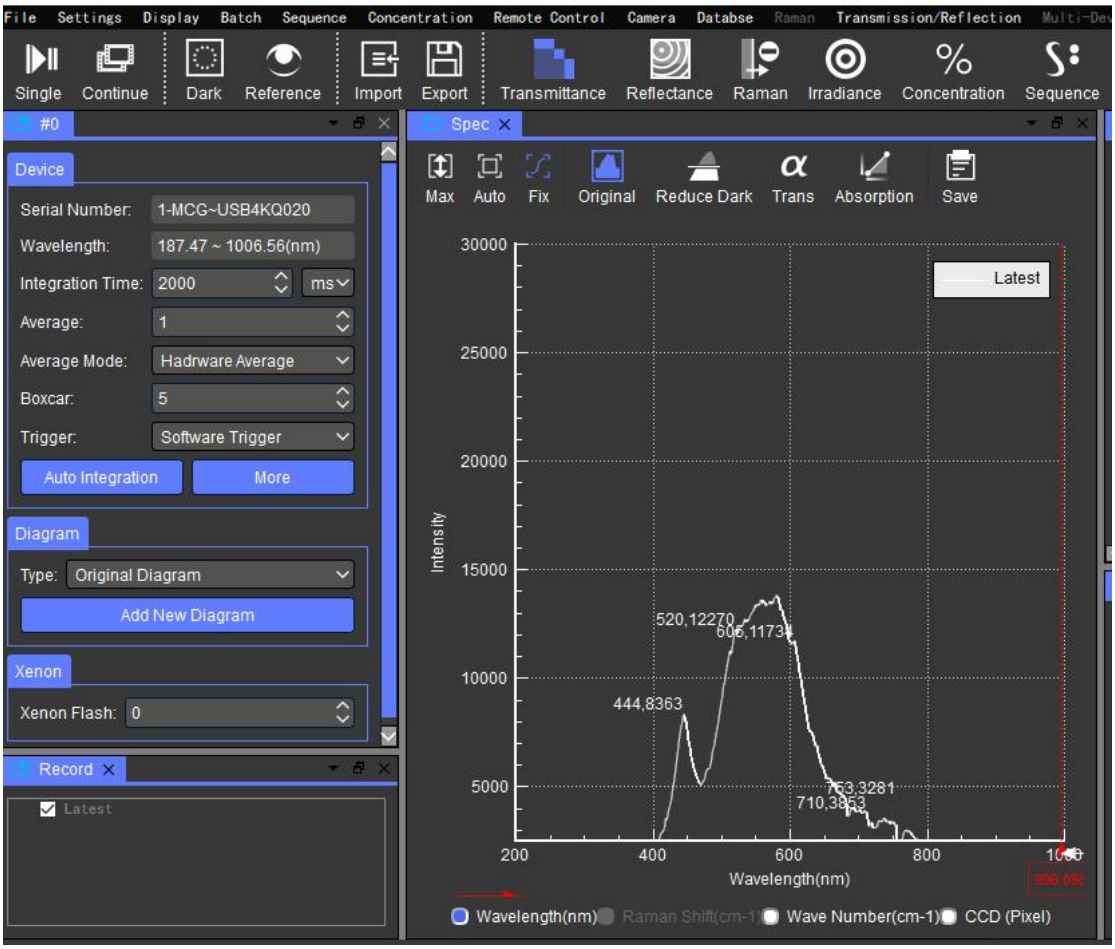
Maximize display, Y-axis range from 0 to 65535



1. Adaptive display , customizing the Y-axis coordinate based on the maximum and minimum spectral values .



2. Custom coordinates, allowing you to customize the X and Y axis coordinates.



3. Original Spectrum View

Actual Spectrum = Original Spectrum – Dark Spectrum

The raw spectrum refers to the spectrum measured under the current lighting conditions. This spectrum includes the spectrum of the measured object, background noise, and electronic noise.
Dark spectrum refers to the spectrum measured without lights, and includes background noise plus electronic noise.

Spectrum of analyte = Original spectrum – Dark spectrum

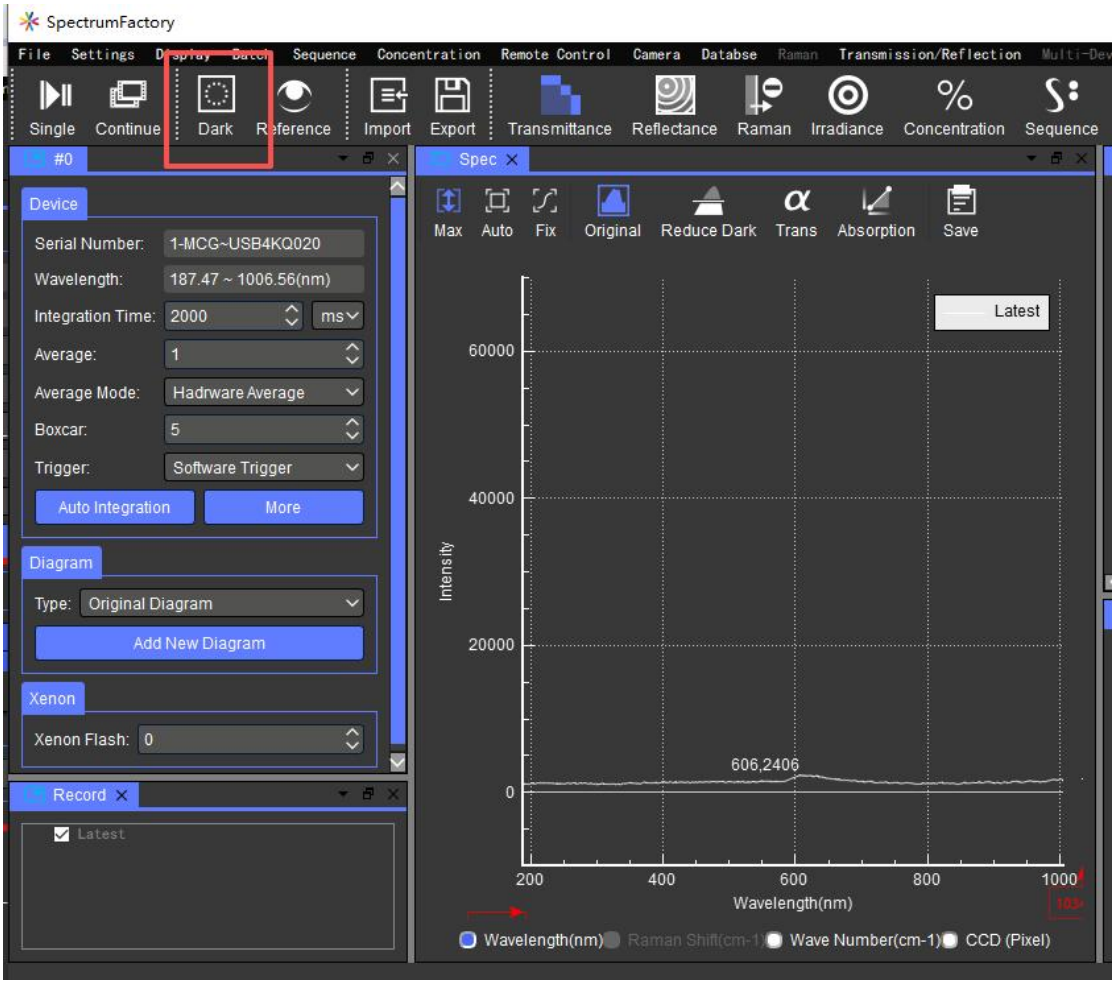
4. Darken view

Below is the noise spectrum.

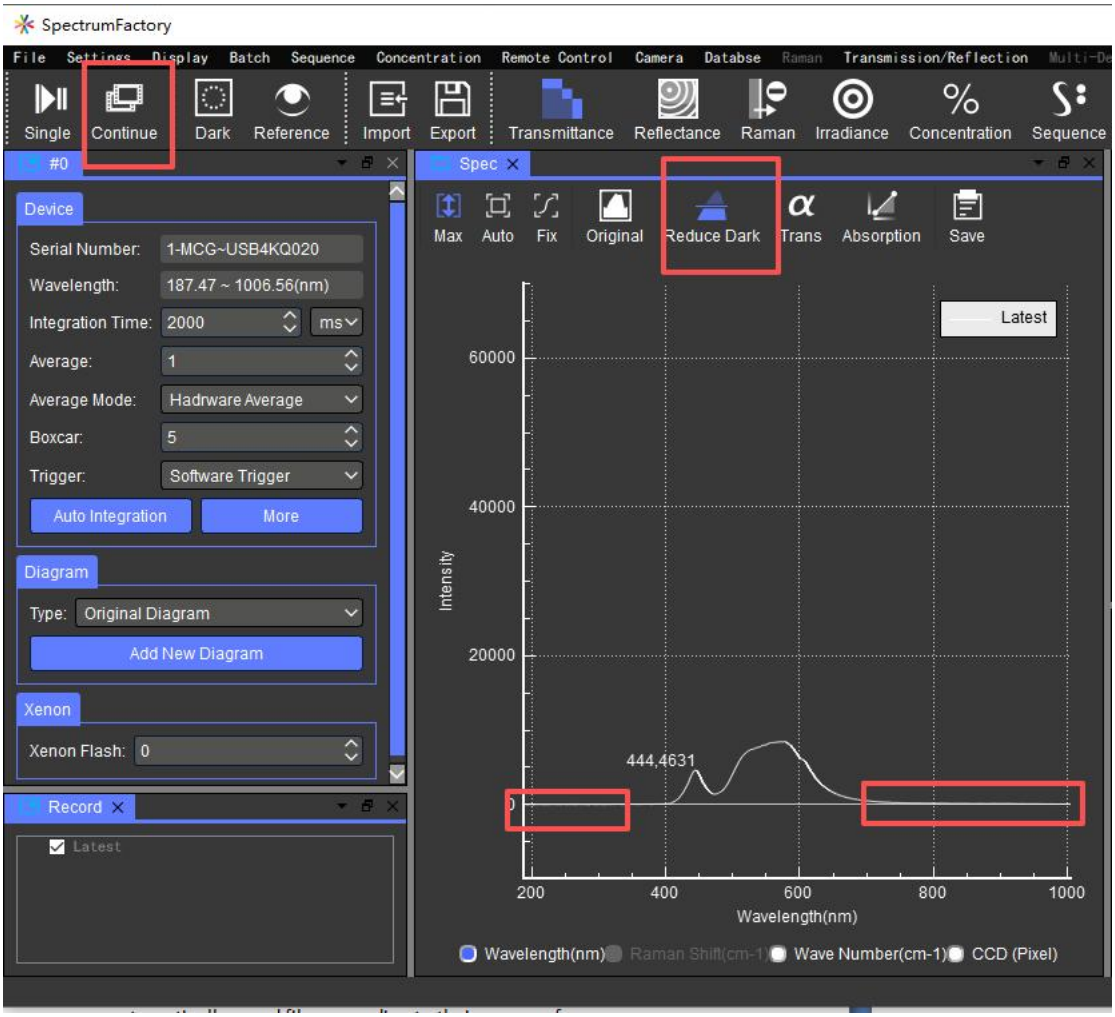
To save the dark spectrum, simply shade the light inlet of the SMA905 spectrometer,

click the "Acquire" button, and then click "Save Background."

On the view page, click Darken view.



It's clear that the spectrum is much closer to the x-axis now; this is the actual spectral curve.

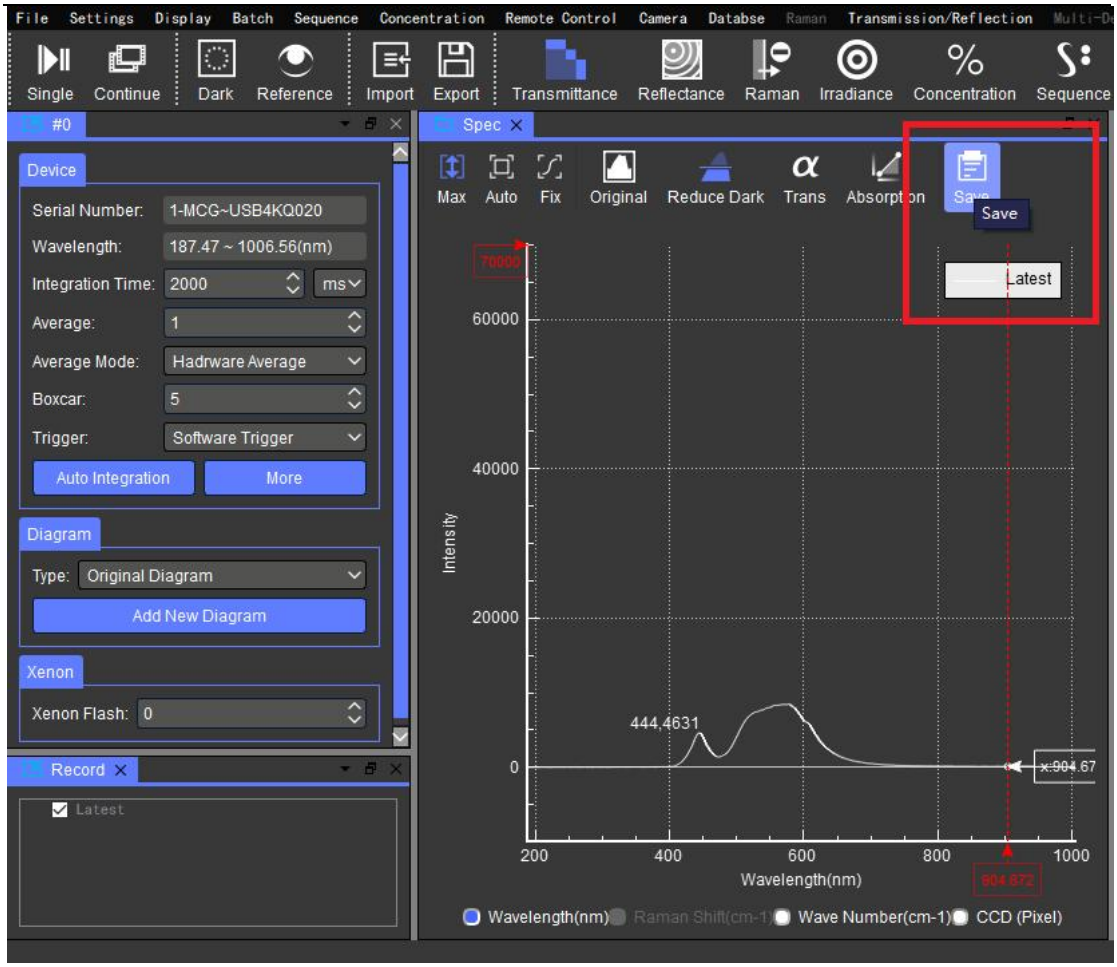


4.6 Save the spectrum

Clicking "Save Spectrum" in the view window will quickly save the spectrum based on the current time. An automatically saved file will appear in the record window on the left.

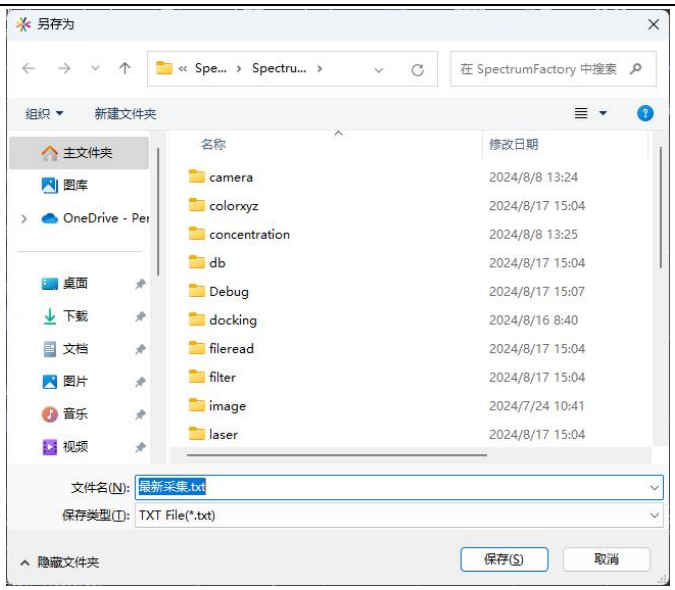
The saved format is WYSIWYG, which means it contains the content shown in the spectrum. If the spectrum shows the original spectrum, the saved file will be the original spectrum; if the spectrum shows transmittance, the saved file will be the transmittance spectrum.

Users can rename automatically saved files according to their own preferences.

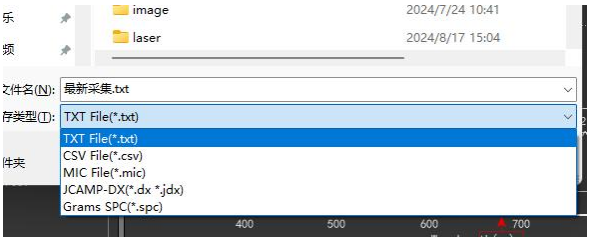


4.7 Export the spectrum

When users wish to export their own spectra, they can click "Export Spectrum," select their desired format, and choose the desired save path.

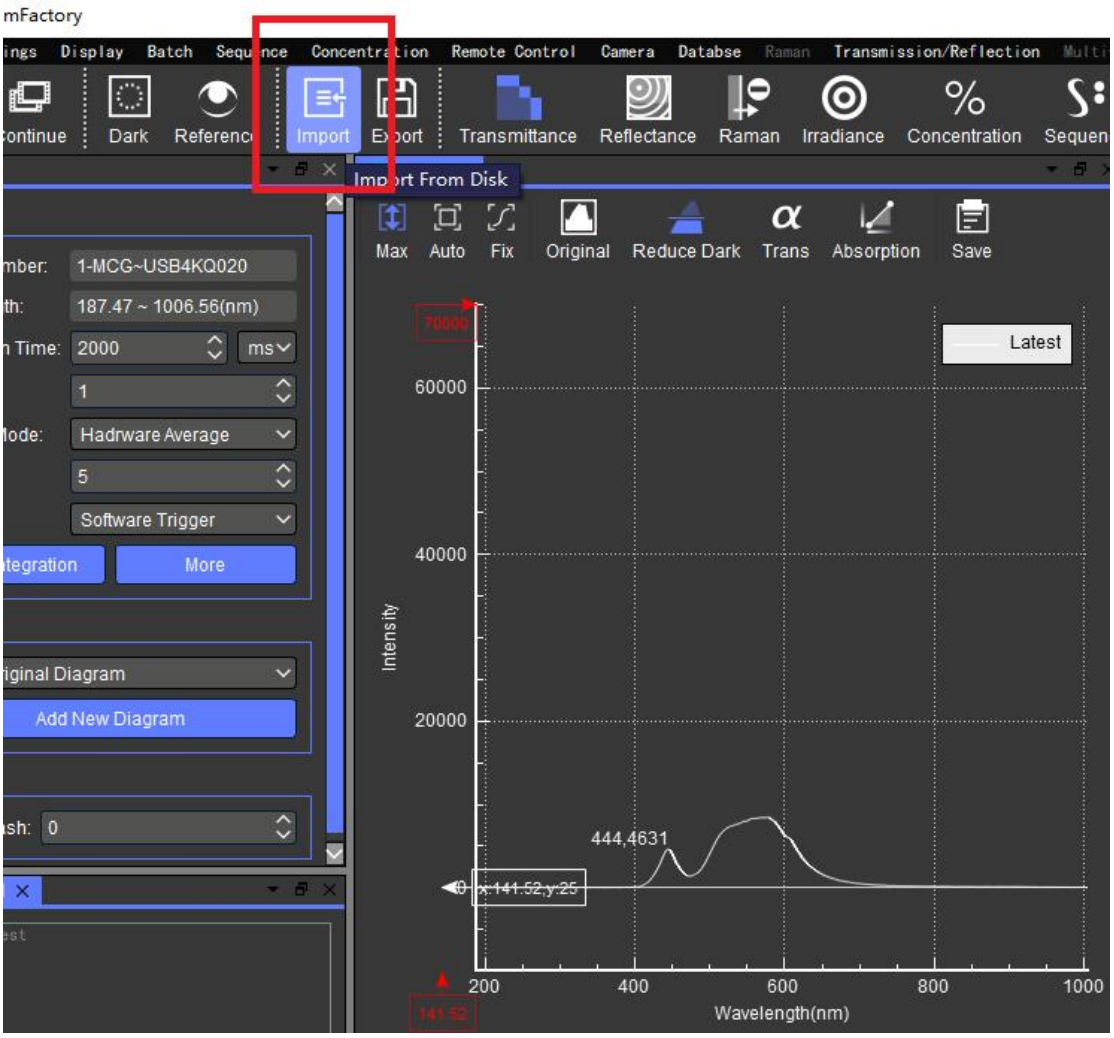


Supports standard formats such as TXT, CSV, JDX, and SPC.



4.8 Import Spectra

The software can import spectra and currently supports standard formats such as TXT, CSV, JDX, and SPC.


mFactory
Display
Batch
Remote Control
Camera
Database
Transmission/Reflection
Dark
Import
Export
Transmittance
Reflectance
Raman
Irradiance
Concentration
Import From Disk
Max
Auto
Fix
Original
Reduce Dark
Trans
Absorption
Save
1-MCG~USB4KQ020
187.47 ~ 1006.56(nm)
2000
ms
1
Hadrware Average
5
Software Trigger
More
Add New Diagram
0
Latest
60000
40000
20000
Intensity
444.4631
x:141.52,y:25
200
400
600
800
1000
Wavelength(nm)

5. Transmittance measurement

5.1 Fundamentals of Transmission Measurement

photons received by the spectrometer when there are obstructions
Transmittance = ----------
hotons received by the spectrometer when there is no obstruction

5.2 Test Principle:

photons received by the spectrometer when there are obstructions
Transmittance = ----------
hotons received by the spectrometer when there is no obstruction

Unobstructed, also known as the reference spectrum

Because the spectrum measured by the spectrometer equals the spectrum of the analyte plus the spectrometer's electronic noise plus ambient light, it's necessary to turn off the light source and collect the spectrum again. This is called the dark spectrum. Dark spectrum equals electronic noise plus ambient light.

$$T_n = 100 * \left(\frac{sample_n - dark_n}{ref_n - dark_n} \right)$$

Tn: Transmittance

Sample: Spectrum of the lens under test
Dark: Spectrometer electronic noise + ambient light
Ref: Reference spectrum, or 100% full-transmission light spectrum