NLIzeR

Software Manual

Version: 1.2 – Rev 2

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This manual applies to software version a.b.X, covering all minor and patch updates within this range (e.g., a.b.1, a.b.2, etc.), as well as any future updates under a.b.X.

To run the NLIR Spectrometer software, use the provided *NLIzeR.exe* file. No installation is required.

Note: On first launch, Windows may show a SmartScreen warning. Click "More info" to view the publisher; this should match our company name. Then click "Run anyway" to continue. The application is signed with an EV code-signing certificate, but SmartScreen reputation may still be building for new releases.

1. Connecting to Spectrometer

When the spectrometer is turned on and connected to a computer with the USB cable, the computer should recognize the device as "Spectrometer".

As soon as the spectrometer is recognized by the computer, the NLIzeR software can be started. If the connection to the spectrometer is not properly established, the software will display "Attempting connection to device" and will continuously attempt to reconnect. The user can either close the software or dismiss the pop-up message, but the software's functionalities will be limited until a successful connection is made. The main interface of the NLIzeR looks like this:

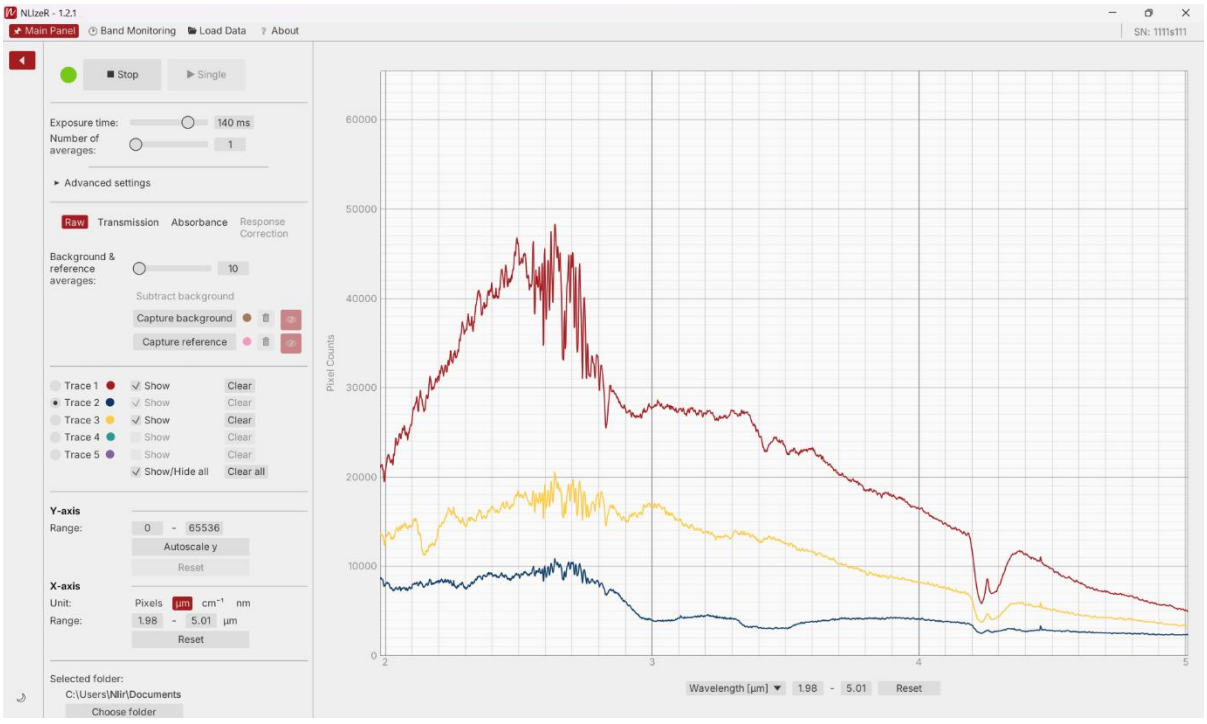

Figure 1: NLIzeR's Main Tab

If the software closes even though the spectrometer is connected and turned on, check that a COM port on the computer is allocated to the spectrometer by inspecting the Device Manager on Windows. If there are one or more active COM ports, try and unplug the spectrometer and observe if one active COM port disappears. If no COM port is

allocated for the spectrometer even though it is connected and turned on, check if the computer is running Windows 10. If this is the case, contact NLIR for support.

The software supports multiple instrument connections. If only one instrument is connected, the software will automatically connect to it without requiring user input. When multiple instruments are detected, the user will be prompted to select which one to use. To operate more than one instrument simultaneously, users can launch a new instance of the application and connect it to a different instrument. The instrument selection list displays all connected devices. A device appears as disabled if it is actively in use by another running instance of the application. Additionally, each instance of the application is linked to a specific instrument. If that instrument becomes disconnected, the application instance will pause and wait until the same instrument is reconnected before resuming operation.

Note: Instrument temperature monitoring is not available when multiple instruments are connected.

Note: Status logging (including the instrument status indicator and temperature readout) is only available for instruments manufactured after December 2025.

2. Main Tab

2.1. Basic Settings and Operation

When the software is successfully started, the spectrometer is ready to measure. The software detects what specific spectrometer the computer is connected to and adjusts the interface accordingly.

An indicator in the top-left corner mirrors the spectrometer's LED, changing color to reflect its status. Hover over the indicator to see detailed status information. Green color indicates normal operation; blinking should be temporary. Dark red indicates that the device is absent. Please refer to the hardware manual for a detailed list of error codes.

The far-left panel features two buttons: one at the top to toggle the settings panel visibility [Figure 2*: left*] and the other at the bottom to switch between dark and light themes [Figure 2*: right*].

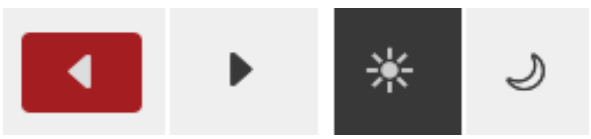

Figure 2: The buttons for toggling the settings panel and for switching themes

The top panel contains different tabs that are explained in the next sections and at its far-right corner, user messages are displayed, providing real-time updates, such as "File

saved successfully," "Waiting for device," and other relevant notifications. Additionally, the device's serial number is shown in this corner for quick reference.

Figure 3: The Top Panel

The left panel contains all the settings needed for a measurement, allowing you to configure and adjust parameters as needed before starting or during the measurement process.

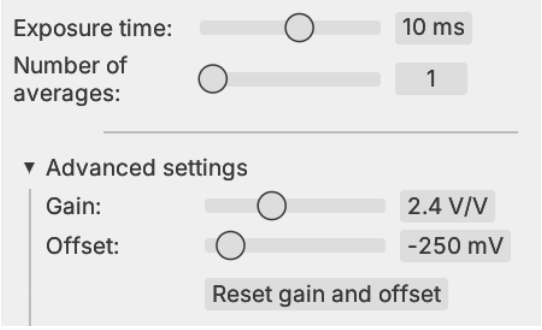

Figure 4: Settings block

Exposure Time

The ***Exposure time*** is the period in which the spectrometer pixel array collects light. The minimum and maximum values are shown in the specifications above. It is recommended to set the exposure time as high as possible without saturating the sensor to achieve the best signal-to-noise ratio.

Number of Averages

For better data quality, the spectrometer can do averaging of measured spectra. The ***Number of averages*** is the number of spectra subsequently measured, and the average spectrum is shown on the graph. The output is still a 16-bit value.

Gain and Offset

In the advanced settings block, the ***Gain*** (1 – 5) and ***Offset*** (-0.3 – 0.3) can be adjusted. The gain and offset apply to the analog signal before AD convention.

Suggested usage:

1. With minimum exposure time: Block the input and adjust the offset until all pixels show a value slightly above zero.
2. With a “long” exposure time: Saturate the input and adjust the gain until the highest pixel values are just below 65535.

The factory setting of gain and offset are already adjusted for the instrument.

Measure Spectrum

To measure a spectrum, press ***Single***, which will immediately capture a single spectrum with the chosen exposure time and number of averages, or press the Space key (view all keyboard shortcuts in *Section 7*).

To continuously acquire spectra (not saved), press ***Continuous*** (or *CTRL+Space*).

Use the ***Stop*** button to stop acquiring spectra, (or *Space / CTRL+Space*).

Note: While measuring in continuous mode, if the settings cause the application to lag (e.g., setting a very high exposure time or averaging), you can press the spacebar once to stop the continuous acquisition and halt the lagging application.

For an exposure time and averaging combination that leads to a long measurement time (≥ 1 second), the continuous mode is automatically disabled and only single acquisition is available.

Choose Active Trace

Measurements can be made with up to five different traces. A non-active trace is still shown in the graph. To activate a trace, click its corresponding radio button (or *Ctrl+1, Ctrl+2*, and so on, for the desired trace). Check the ***Show*** box to see the respective trace or uncheck it to hide them. Use the ***Show/Hide all*** box to toggle visibility for all traces at once. To zero all values for a specific trace, click ***Clear*** next to it (or right-click it), or select ***Clear all*** (or *Ctrl+0*) to clear all traces.

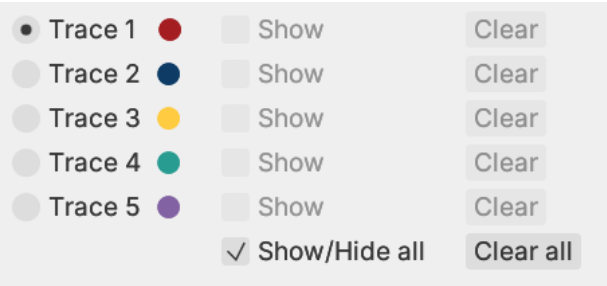

Figure 5: Traces block

Note: Only values from the currently shown traces are saved when pressing the save button.

Plot Axes

The axes on the graph are controlled through the block shown in *Figure 6.*

By default, the x-axis is displayed in wavelength [µm], but it can be switched to wavelength [nm], wavenumber [cm^{-1}] or pixel numbers by selecting the corresponding unit. The same x-axis settings are available below the graph for easy adjustments [*Figure 7*].

Both axes can be reset to their default values using the ***Reset*** button, and the y-axis can be auto scaled by clicking the ***Autoscale*** button.

The x-range and y-range values are interactive and allow to manually set the axis limits. They can be dragged left (down) or right (up), or clicked and then filled with a desired value directly.

Note: The signal is only valid within the wavelength range of 1.93–5.4 µm (corresponding to wavenumbers 5183–1851 cm^{-1}, 1930-5400 nm or pixels 22–2025). Outside this range, the signal is set to zero. These values are instrument-specific and may vary slightly between different instruments.

Figure 6: Axes settings on the left panel

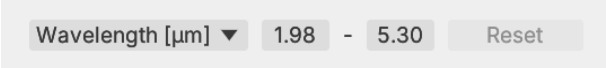

Figure 7: X-axis settings below the graph

Transmission Options

It is possible to measure a background to subtract intrinsic noise from the spectrometer and measurement setup. The background is measured using the chosen exposure time and averaging settings.

Note: "Background & Reference averages" in transmission block not to be confused with "Number of averages" in the settings block [Figure 4].

*Note 2: It is recommended that the **Background & Reference** averages number is set higher than the signal average number (Number of averages).*

By measuring a reference, the spectrometer can perform transmission (relative) measurements directly. You can switch between **Raw** (counts), **Transmission**, and **Absorbance** view.

Like the background, the reference is measured using the active exposure time and averaging settings. The transmission (T) is calculated as

$$T = \frac{D-B}{R-B},$$

where B is the background and R is the reference. The absorbance (A) is calculated as

$$A = -\log_{10}(T).$$

Note: When capturing the background and reference, it may prove advantageous to use a high number of averages to avoid their noise contributions in all subsequent measurements.

Subtract background in *Raw* mode: If selected, the measured background is subtracted from all count values shown in the graph when measuring.

Toggle the visibility of background and reference data by clicking the corresponding 👁 button and clear them by clicking the 🗑 button.

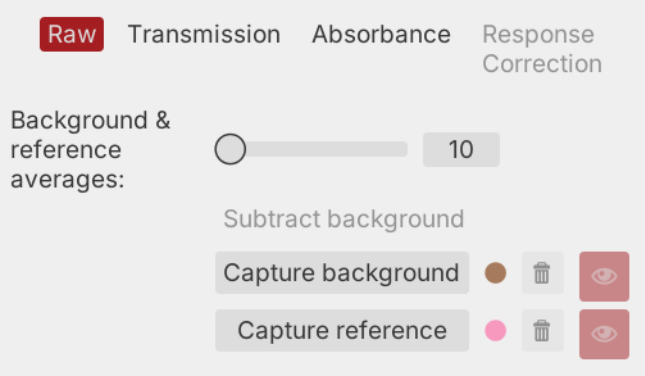

Figure 8: Transmission block

Save Data Options

The default save location is the Documents folder and the file format is csv.

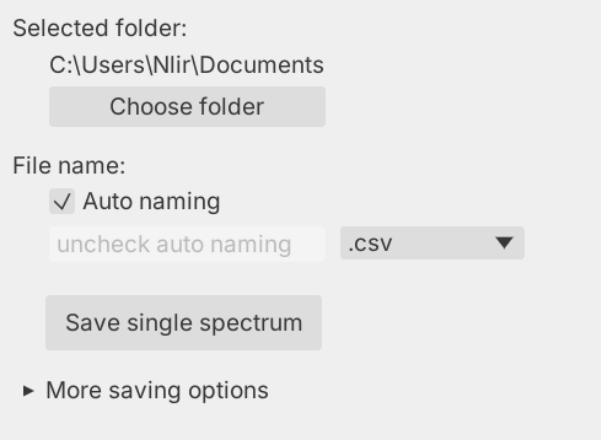

Figure 9: Save File block

If ***Auto naming*** is enabled, the file will automatically be named in the format "NLIR-*Type_Year-Month-Day-Time.csv*" (e.g., "***NLIR-Spectra_****2025-01-01_18-30-55.csv*", ensuring each file is uniquely identified by its creation timestamp. If auto-naming is disabled, the user must manually enter the desired file name. If a file with the selected name already exists in the chosen directory, an index will be appended to the file name to prevent overwriting. For example, the file "*File_name.csv*" will be saved as "*File_name(1).csv*". If another file with the same name already exists, the index will

increment accordingly, ensuring each file has a unique name. In addition, to ensure compatibility with Windows, the application enforces Windows file naming conventions. File names cannot contain prohibited characters (e.g. ?, /) or reserved system names (e.g. CON, COM1).

By default, the raw input data of the active traces, along with the wavelength axis, background (if any), reference (if any), and instrument temperatures (if available) are saved. You can modify the save file settings by expanding the ***More saving options*** and selecting from the available options.

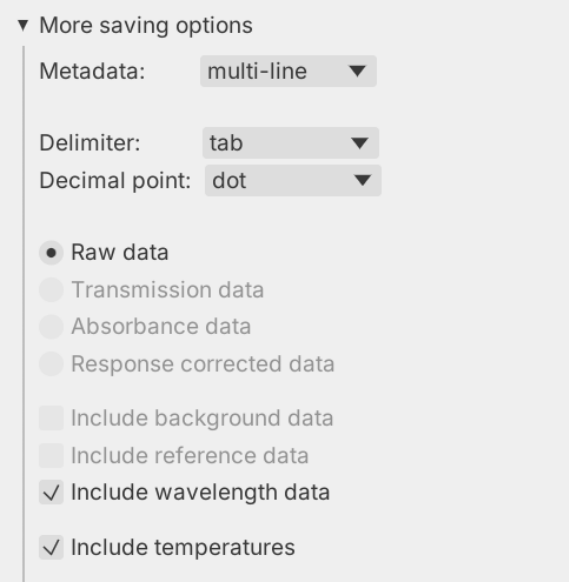

Figure 10: More Saving options

Note: The data will be saved in the unit selected for the x-axis in the Axes settings, which corresponds to the unit displayed on the plot.

A file can then be saved by pressing the ***Save single spectrum*** button (or *Ctrl+S*). As previously mentioned, only values from the currently shown traces are saved when pressing the save button. The date and time are saved as metadata, along with the software version, device serial number, exposure time, number of averages, trace mode and instrument temperatures (if available). The saved file starts with the metadata line(s) starting with "#", followed by rows of captured data. The metadata can be displayed either as multi-line, as shown in *Figure 11*, or in a single line as JSON, shown in *Figure 12*.

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, NaN, 10, 10, 50, 50, 50
# Number of Averages: 1
# Trace Mode: Raw
# Rows: Wavelength [pixels], Background, !Reference, Trace*
# Columns: Pixel[0:2047]
#
0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15     16     17     18     ...
0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      ...
NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    ...
10056  10104  10124  10197  10125  10024  10073  10149  10114  10043  10060  10054  10107  10056  10055  10104  9993   10054  9993   ...
12095  12030  12070  12119  12079  11986  12153  12113  12119  12094  12085  12099  11959  12087  12057  12099  12030  12027  12034  ...
15121  15092  15093  15103  15050  15171  15004  15038  15050  14973  14986  15008  14901  14932  14999  15056  15165  15099  14917  ...
17199  17196  17209  17098  17111  17230  17292  17163  17288  17258  17309  17248  17099  17121  17164  17163  17220  17126  17150  ...
23027  23024  23095  23117  23221  23290  23101  23019  23062  23094  23080  23167  23023  23016  22960  23120  23186  23170  23104  ...
```

Figure 11: "Save Single Spectrum" output file example, with multi-lined metadata

```
# {"Software":"NLIzeR v1.2.0","DeviceSerialNumber":"1111s111","StartDateTime":"2025-11-01T00:00:00+01:00","ExposureTimeMs":...}
#
0     1     2     3     4     5     6     7     8     9     10    11    12    13    14    15    16    17    18    ...
0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     ...
NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   ...
10056 10104 10124 10197 10125 10024 10073 10149 10114 10043 10060 10054 10107 10056 10055 10104 9993  10054 9993  ...
12095 12030 12070 12119 12079 11986 12153 12113 12119 12094 12085 12099 11959 12087 12057 12099 12030 12027 12034 ...
15121 15092 15093 15103 15050 15171 15004 15038 15050 14973 14986 15008 14901 14932 14999 15056 15165 15099 14917 ...
17199 17196 17209 17098 17111 17230 17292 17163 17288 17258 17309 17248 17099 17121 17164 17163 17220 17126 17150 ...
23027 23024 23095 23117 23221 23290 23101 23019 23062 23094 23080 23167 23023 23016 22960 23120 23186 23170 23104 ...
```

Figure 12: "Save Single Spectrum" output file example, with JSON metadata

Note that depending on the saved file type, the exposure time field may contain a list of values. Specifically, single-spectrum files list exposure times for background, reference, and all traces individually (e.g. "Exposure Time [us]: <background>, <reference>, <trace1>, ..., <trace5>"). Multi-spectra, calibration (.bb.csv) and band-monitoring-raw-data files, list exposure times for background, reference, and the current trace. Finally, band-monitoring files list only the exposure time of the current trace.

The metadata includes two additional fields, "*Rows*" and "*Columns*," which define the structure of the subsequent data. A prefix of "!" in the *Rows* field indicates that no data is available for that entry (NaN value), while a prefix of "*" signifies that multiple rows follow for that entry.

As an example, in the file above, the first data row contains the wavelength data in pixels, the second row represents the background, the third row holds the reference data (NaN), followed by the trace data.

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, NaN, 10, 10, 50, 50, 50
# Number of Averages: 1
# TempUpcon [C]: 24.56
# TempLaser [C]: 27.41
# TempAmbient [C]: 24.52
# Trace Mode: Raw
# Rows: Wavelength [um], Background, !Reference, Trace*
# Columns: Pixel[0:2047]
#
1.9269 1.928  1.9292 1.9303 1.9314 1.9326 1.9337 1.9349 1.936  1.9371 1.9383 1.9394 1.9406 1.9417 1.9429 1.9487 1.9498 1.951  1.9521 ...
0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      ...
NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    NaN    ...
10056  10104  10124  10197  10125  10024  10073  10149  10114  10043  10060  10054  10107  10056  10055  10104  9993   10054  9993   ...
12095  12030  12070  12119  12079  11986  12153  12113  12119  12094  12085  12099  11959  12087  12057  12099  12030  12027  12034  ...
15121  15092  15093  15103  15050  15171  15004  15038  15050  14973  14986  15008  14901  14932  14999  15056  15165  15099  14917  ...
17199  17196  17209  17098  17111  17230  17292  17163  17288  17258  17309  17248  17099  17121  17164  17163  17220  17126  17150  ...
23027  23024  23095  23117  23221  23290  23101  23019  23062  23094  23080  23167  23023  23016  22960  23120  23186  23170  23104  ...
```

Figure 13: "Save Single Spectrum" file containing instrument temperatures

2.2. Advanced Features

Response Correction

Saving a calibration file

It is possible to save a trace from a black body calibration source and later load and use it for response correction. This is done using the save file options. Click on the file extension and select the *.bb.csv* format. Before saving, ensure a background is captured and the temperature of the black body is provided.

Note: Ensure that the given temperature matches the actual temperature of the black body source under measurement.

In the *.bb.csv* file, the active trace will be saved in the *Reference* column, along with the captured background (*Background* column) and the response function normalized to 1 (*ResponseFunction* column). The response function is calculated using the formula

$$R(\lambda) = \frac{\text{Reference-Background}}{B_\lambda(\lambda,T)}$$

where $B_\lambda(\lambda,T)$ is the Planck's Law at a given temperature T and wavelength λ

$$B_\lambda(\lambda,T) = \frac{2hc^2}{\lambda^5}\frac{1}{e^{hc/(\lambda k_B T)}-1}$$

where h is the Planck constant, k_B is the Boltzmann constant, c is the speed of light in vacuum, and T the temperature in °C.

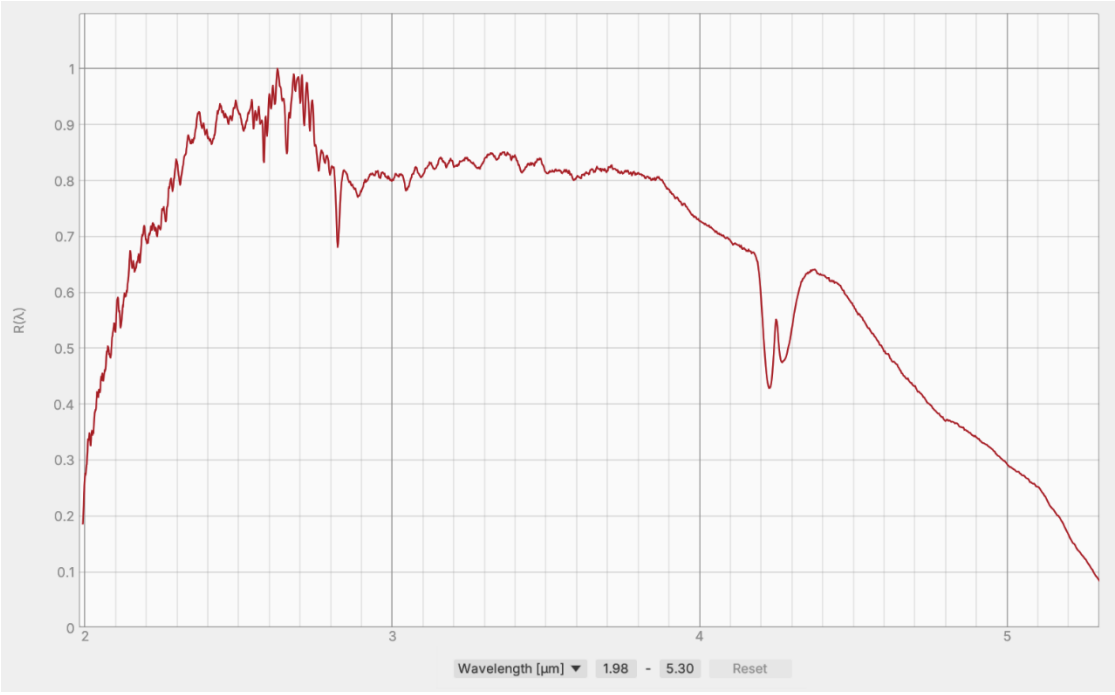

Figure 14: Example of a typical response function R(λ) using a 300µm fiber

The default file name follows the format "NLIR-*BlackBody_Year-Month-Day-Time.csv*" (e.g., "***NLIR-BlackBody_****2025-01-01_18-30-55.csv*") with an example file shown in Figure 15, containing the metadata shown in Figure 16.

```
# {"Software":"NLIzeR v1.2.1","DeviceSerialNumber":"1111s11","StartDateTime":"2025-11-01T00:00:00+01:00","ExposureTimeMs":"0.1, 0.1, 0.1","NumberOfAverages":1,"BlackBodyTemperatureC":330,...}
#
1.9269  1.928   1.9292  1.9303  1.9314  1.9326  1.9337  1.9349  1.936   1.9371  1.9383  1.9394  1.9406  1.9417  1.9429  1.944   1.9452  1.9463  1.9475  1.9487  1.9498  1.951   ...
3180    3174    3165    3165    3159    3172    3162    3154    3165    3152    3168    3161    3163    3160    3171    3152    3141    3164    3170    3178    3171    3149    ...
29104   29335   29257   29448   29307   29304   29114   29159   29416   29150   29188   29476   29254   29176   29368   29384   29325   29308   29368   29392   29365   29302   ...
1       0.9988  0.9859  0.983   0.9679  0.9573  0.941   0.9332  0.9324  0.9139  0.9053  0.9061  0.8892  0.8775  0.8745  0.8667  0.8562  0.8461  0.8391  0.8309  0.8218  0.812   ...
```

Figure 15: A .bb.csv output file example


```
{
    "Software":"NLIzeR v1.2.1",
    "DeviceSerialNumber":"1111s11",
    "StartDateTime":"2025-11-01T00:00:00+01:00",
    "ExposureTimeMs":"0.1, 0.1, 0.1",
    "NumberOfAverages":1,
    "BlackBodyTemperatureC":500,
    "Rows":"Wavelength [um], Background, Reference, ResponseFunction",
    "Columns":"Pixel[0:2047]"
}
```


Figure 16: Example of the metadata of a .bb.csv file

Once a *.bb.csv* file is saved, it can be loaded for response correction. This option is available under the ***Advanced settings*** block.

Applying the response correction

- **Raw:** Default option, applying no response correction.
- **Response Correction:** The *.bb.csv* file can be loaded and the correction will be applied to the data. A background capture is required.

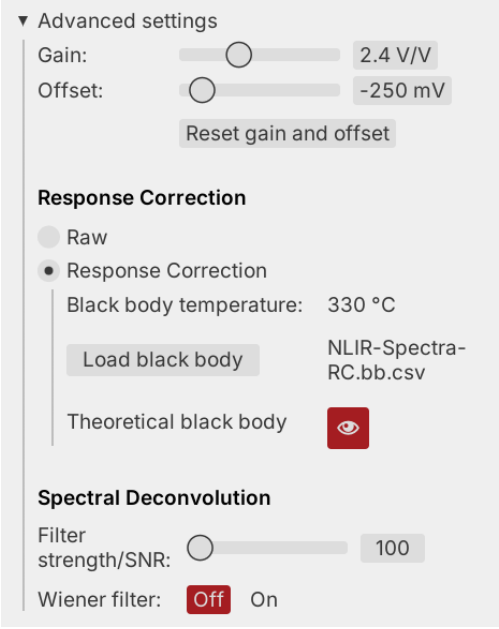

Figure 17: Advanced settings block

Once the file is loaded, the correction is applied to the raw input data according to the following formula:

$$\text{Trace} = \frac{\text{Raw-Background}}{\textit{ResponseFunction}}$$

where *ResponseFunction* is the response function R(λ) loaded from the *.bb.csv* file.

Additionally, you can toggle the 👁 button to display the theoretical black body curve corresponding to the loaded wavelength and temperature.

Note:

- *Only .bb.csv files can be loaded as a black body for response correction.*
- *The Load Data tab is not available when in Response Correction mode.*
- *The response correction is applied to all traces, as well as in the band monitoring tab.*

Response correction output file

When in Response Correction mode, the output files include the black body temperature metadata field imported from the *.bb.csv* file. The response function loaded from the same *.bb.csv* file is saved in place of the reference trace. All subsequent traces have been corrected using this response function and therefore represent the response-corrected measurements.

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 0.1, 0.1, 0.1, NaN, NaN, NaN, NaN
# Number of Averages: 1
# Black Body Temperature [C]: 500
# Trace Mode: ResponseCorrection
# Rows: Wavelength [um], Background, ResponseFunction, Trace*
# Columns: Pixel[0:2047]
#
1.9269  1.928   1.9292  1.9303  1.9314  1.9326  1.9337  1.9349  1.936   1.9371  1.9383  1.9394  1.9406  1.9417  1.9429  1.9487  1.9498  1.951   1.9521  ...
3180    3174    3165    3165    3159    3172    3162    3154    3165    3152    3168    3161    3163    3160    3171    3152    3141    3164    3170    ...
1       0.9988  0.9859  0.983   0.9679  0.9573  0.941   0.9332  0.9324  0.9139  0.9053  0.9061  0.8892  0.8775  0.8745  0.8667  0.8562  0.8461  0.8391  ...
12431   12478   12489   12541   12553   12569   12548   12622   12675   12649   12690   12738   12711   12745   12736   12839   12877   12860   12865   ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
```

Figure 18: Example of an output file when in Response Correction mode

Spectral Deconvolution

Using specific instrument functions, the software offers the ability to improve the spectral resolution on the fly.

One such option is the Wiener Deconvolution, an advanced signal processing method to improve the spectral resolution of the spectrometer down to ≈ 5 cm^{-1}. In this context, the purpose of this widely used method is to sharpen spectral features with certain widths, depending on the optical system, signal and noise characteristics.

Given the following system:

$$y[n] = h[n]*x[n]+v[n]$$

where n is the pixel number, y[n] is the actual measured signal at pixel n, x[n] is the "true" underlying signal or our desired signal, h[n] is the point spread function/impulse

response of the spectrometer and v[n] is the noise. Note that the operator between h[n] and x[n] is a convolution.

We seek a solution such that:

$$\hat{x}[n] = g[n]*y[n]$$

where $\hat{x}[n]$ is the estimate of x[n]. The solution in Fourier space is then given as:

$$G[k] = \frac{1}{H[k]}\left(\frac{1}{1 + \frac{1}{|H[k]|^2 \cdot SNR[k]}}\right)$$

where G[k] and H[k] are the Fourier transforms of g[n] and h[n], k is the discrete frequency index and SNR[k] is the signal to noise ratio.

The estimated signal is finally obtained as:

$$\hat{X}[k] = G[k]\cdot Y[k] \Rightarrow \hat{x}[n] = \mathrm{F}\{G[k]\cdot Y[k]\}$$

where $\hat{X}[k]$ is the spectrally improved data and Y[k] the raw data.

Implementation

The method requires knowledge of h[n] and the SNR[k]. In this implementation, for simplicity, we have assumed a constant SNR[k] across all frequencies such that SNR[k] → SNR, and it is reduced to a scalar value. In order not to introduce too many artifacts in the original data, we recommend using 50% of the measured SNR as the SNR setting on the Wiener deconvolution.

The point spread function or impulse response h[n] has been measured with a HeNe laser with a central wavelength of 3.39 µm, and is shown in the figure below:

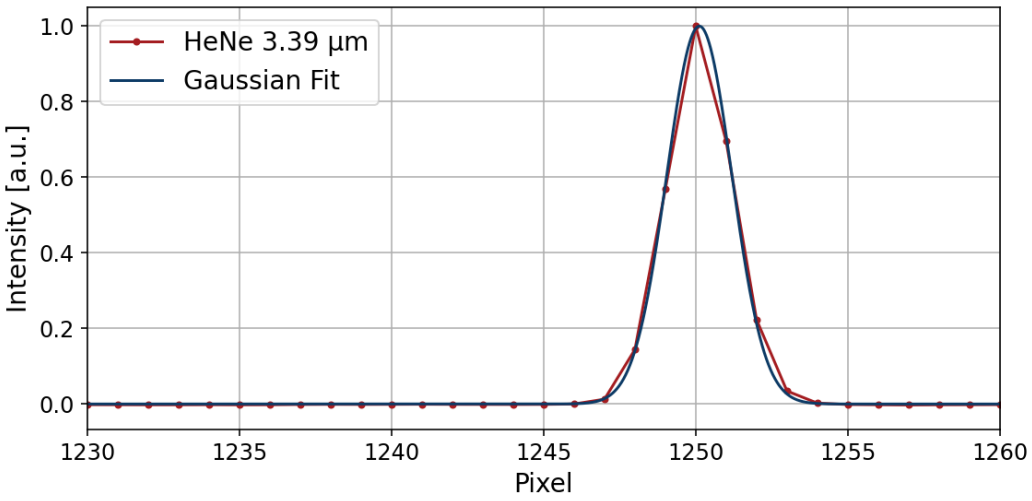

Figure 19: An example of a typical point spread function

Furthermore, a gaussian fit has been made and it is described by:

$$h[n] = \frac{1}{\sqrt{\pi\sigma^2}} e^{\frac{-\pi^2}{2\sigma^2}}$$

Where σ = 1.07 px. Specific value may deviate slightly from one instrument to another.

Output files containing filtered data

The output files include both unfiltered and filtered spectral data within a single file for ease of comparison and analysis. An additional metadata field, "Filter", holds the name of the applied filter along with relevant function parameters.

Data is organized as follows:

- *Columns Pixel[0:2047] contain unfiltered values*.
- Columns *FilteredPixel[2048:4095]* contain the corresponding filtered values after Wiener deconvolution.

*Note: The first three rows - wavelength, background and reference - **always contain unfiltered data in both sections**. All other subsequent data rows represent unfiltered values on the left and filtered values on the right.*

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 0.1, NaN, 0.1, 0.1, 0.1, 0.1, NaN
# Number of Averages: 1
# Filter: Wiener(snr=100, psf=(gaussian, sigma=1.2126))
# Trace Mode: Raw
# Rows: Wavelength [um], Background, !Reference, Trace*
# Columns: Pixel[0:2047], FilteredPixel[2048:4095]
#
1.9269  1.928   1.9292  1.9303  1.9314  1.9326  1.9337  1.9349  1.936   1.9371  1.9383  1.9394  1.9406  1.9417  1.9429  1.9487  1.9498  1.951   1.9521  ...
0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
10056   10104   10124   10197   10125   10024   10073   10149   10114   10043   10060   10054   10107   10056   10055   10104   9993    10054   9993    ...
12095   12030   12070   12119   12079   11986   12153   12113   12119   12094   12085   12099   11959   12087   12057   12099   12030   12027   12034   ...
15121   15092   15093   15103   15050   15171   15004   15038   15050   14973   14986   15008   14901   14932   14999   15056   15165   15099   14917   ...
17199   17196   17209   17098   17111   17230   17292   17163   17288   17258   17309   17248   17099   17121   17164   17163   17220   17126   17150   ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
```

Figure 20: Example of output file containing filtered data

Multi-Spectra Capture

Aside *Single* capture mode, the spectrometer can capture data in a second mode, which is available under ***Time series of spectra*** in the ***More saving options*** section. The different modes are *Burst, Periodic* and *External Trigger*.

*Note: The **Number of averages** is not considered in Burst and External Trigger modes. This means that regardless of the user's setting, it is always fixed to 1.*

Burst

Acquires and saves spectra as fast as possible. Set ***Number of measurements*** to how many spectra the device is to capture with the chosen exposure time and press ***Save multi spectra*** (or *Ctrl+M*). The device doesn't show the spectra in this mode but saves them in a buffer internally and finally to a file when it has finished capturing.

Note: The device is inaccessible when capturing the chosen number of spectra.

For the above reason, if the total time to acquire the desired number of data with the given settings is long (more than 1s), a confirmation message is shown together with the estimated time of this action, as shown in the next picture.

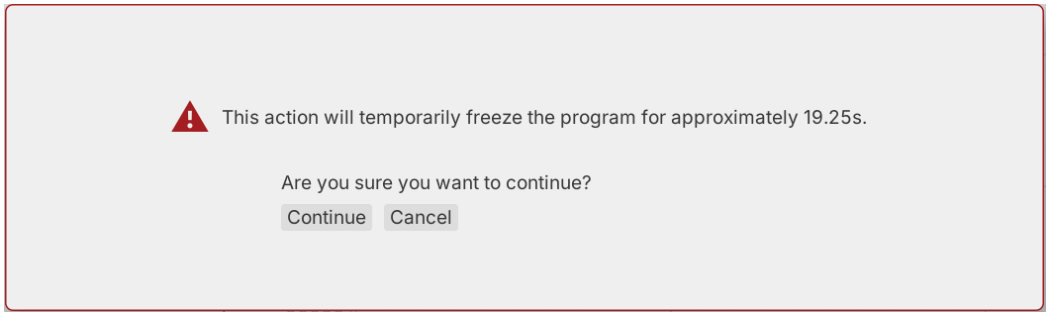

Figure 21: The confirmation message in burst mode

Periodic

The device will capture spectra with the frequency set by the ***Interval*** field. Since the read-out and saving times are system-dependent and include significant jitter, the *Periodic Mode* is not recommended for measurements that require millisecond precision; instead use the *External Trigger Mode*. This is because in the *Periodic Mode*, the spectra are shown live on the screen which results on each spectrum of the captured data introduces a delay on the order of tens of milliseconds to the minimum achievable time between measuring two spectra. This means that if the chosen *Exposure time* is close to the value of the *Interval*, the device might not be able to keep that value. In any case where the value does not match the device, the device measures as often as possible.

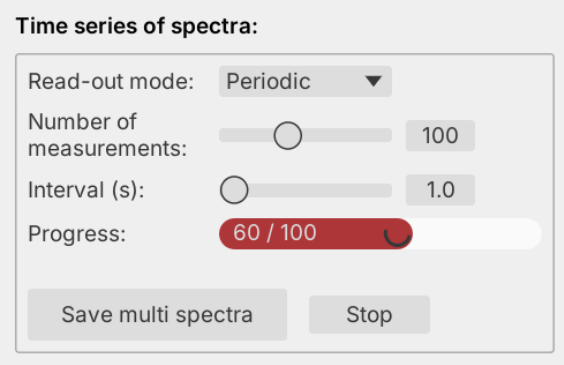

Figure 22: The Periodic Mode options

External Trigger

Allow the user to control the measurement timing with a signal connected to the trigger port on the spectrometer. Make sure to connect the trigger cable and have the trigger ready before starting trigger mode. In external trigger mode, the device only measures a spectrum when it receives a trig, i.e. a TTL pulse.

Note: The device is inaccessible when capturing the chosen number of spectra and waits until it receives all of them or until ***Time-out*** *seconds have passed.*

Note 2: In external trigger mode, the maximum acquisition rate is 160 Hz.

Note 3: Trigger slope setting (rising or falling edge) is only available for serial numbers where the first two digits are 24 or higher (e.g., 2400s000).

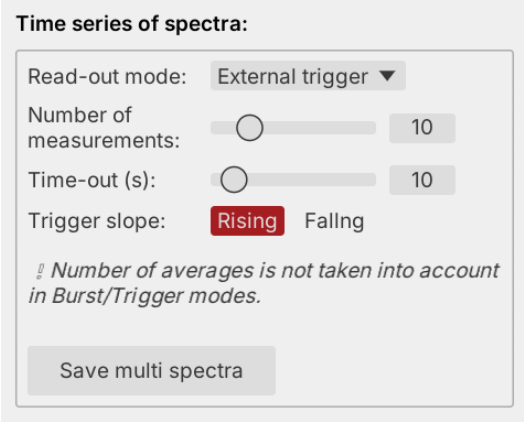

Figure 23: The External Trigger Mode options

Save Multi-Spectra

To save multi-spectra data press the ***Save multi spectra*** button (or *Ctrl+M*). The metadata of a multi-spectra file includes all the information described in *2.8*, along with an additional field called "*Capture Mode*", which can be set to either "*Burst*", "*Periodic*", or "*Triggered*". If the capture mode is set to "*Periodic*", the interval will also be saved.

An example file, with 10 spectra and auto naming "***NLIR-MultiSpectra_2025****-01-22_09-12-15.csv*" is shown below:

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, 10, 10
# Number of Averages: 1
# Trace Mode: Raw
# Capture Mode: Periodic (1 s)
# Rows: Wavelength [um], Background, Reference, Trace*
# Columns: Pixel[0:2047]
#
1.9269  1.928   1.9292  1.9303  1.9314  1.9326  1.9337  1.9349  1.936   1.9371  1.9383  1.9394  1.9406  1.9417  1.9429  1.9487  1.9498  1.951   1.9521  ...
419     408     406     412     411     409     400     404     418     399     407     414     386     397     404     414     415     420     405     ...
12431   12478   12489   12541   12553   12569   12548   12622   12675   12649   12690   12738   12711   12745   12736   12839   12877   12860   12865   ...
10500   10458   10422   10388   10273   10340   10288   10337   10353   10291   10424   10500   10438   10382   10402   10297   10305   10264   10277   ...
10884   10893   10910   10874   10910   10885   10847   10772   10724   10788   10950   10871   10777   10797   10924   10901   10802   10771   10759   ...
12919   12809   12821   12871   12992   12923   12883   12831   12762   12884   12918   12827   12770   12885   12921   12977   12862   12836   12851   ...
919     875     881     905     923     871     891     899     939     883     883     935     883     894     866     899     903     870     852     ...
11153   11290   11231   11263   11251   11118   11148   11230   11187   11255   11341   11312   11188   11210   11291   11354   11157   11205   11261   ...
10399   10389   10468   10422   10384   10238   10175   10264   10337   10308   10428   10414   10409   10387   10341   10313   10328   10242   10099   ...
10009   9995    10102   10097   10097   10043   10042   10032   10135   10119   10035   9985    9912    9950    9938    9926    9926    9901    9981    ...
9754    9708    9683    9605    9508    9609    9692    9727    9714    9609    9587    9580    9571    9705    9715    9710    9749    9678    9591    ...
9007    8988    8989    9000    9007    9027    8969    8986    9024    8991    9014    9022    9048    8981    8962    8985    8936    8988    8919    ...
7519    7629    7643    7551    7551    7462    7451    7631    7535    7523    7577    7586    7510    7363    7422    7631    7608    7541    7498    ...
```

Figure 24: Multi-spectra output file example with number of measurements set at 10

If instrument temperature data is available and selected for saving in the *More Saving Options* section, it will be stored as metadata when the capture mode is set to *Burst* or *Triggered*, similar to saving a single file. For *Periodic* capture mode, an additional column will be added for each temperature field, as shown in the following example files.

Note: When capturing and saving data in Burst Mode, the the first two values in each frame are reserved for metadata as part of the electronics design. Together, they form a 32-bit frame index.

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, 10, 10
# Number of Averages: 1
# TempUpcon [C]: 24.56
# TempLaser [C]: 27.41
# TempAmbient [C]: 24.52
# Trace Mode: Transmission
# Capture Mode: Burst
# Rows: Wavelength [um], Background, Reference, Trace*
# Columns: Pixel[0:2047]
#
...
```

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, 10, 10
# Number of Averages: 1
# TempUpcon [C]: 24.56
# TempLaser [C]: 27.41
# TempAmbient [C]: 24.52
# Trace Mode: Transmission
# Capture Mode: Triggered
# Rows: Wavelength [um], Background, Reference, Trace*
# Columns: Pixel[0:2047]
#
...
```

Figure 25: Example of multi-spectra output files, with Burst mode (left) and Triggered mode (right), including instrument temperatures as metadata fields

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, 10, 10
# Number of Averages: 1
# Trace Mode: Raw
# Capture Mode: Periodic (1 s)
# Rows: Wavelength [um], Background, Reference, Trace*
# Columns: TempUpcon [C], TempLaser [C], TempAmbient [C], Pixel[0:2047]
#
NaN     NaN     NaN     1.9269  1.928   1.9292  1.9303  1.9314  1.9326  1.9337  1.9349  1.936   1.9371  1.9383  1.9394  1.9406  1.9417  1.9429  1.9487  ...
NaN     NaN     NaN     419     408     406     412     411     409     400     404     418     399     407     414     386     397     404     414     ...
NaN     NaN     NaN     12431   12478   12489   12541   12553   12569   12548   12622   12675   12649   12690   12738   12711   12745   12736   12839   ...
24.56   27.41   24.52   10500   10458   10422   10388   10273   10340   10288   10337   10353   10291   10424   10500   10438   10382   10402   10297   ...
24.56   27.41   24.52   10884   10893   10910   10874   10910   10885   10847   10772   10724   10788   10950   10871   10777   10797   10924   10901   ...
24.56   27.41   24.52   12919   12809   12821   12871   12992   12923   12883   12831   12762   12884   12918   12827   12770   12885   12921   12977   ...
...
```

Figure 26: Example of a multi-spectra output file in Periodic mode, including instrument temperature data as additional columns

3. Band Monitoring tab

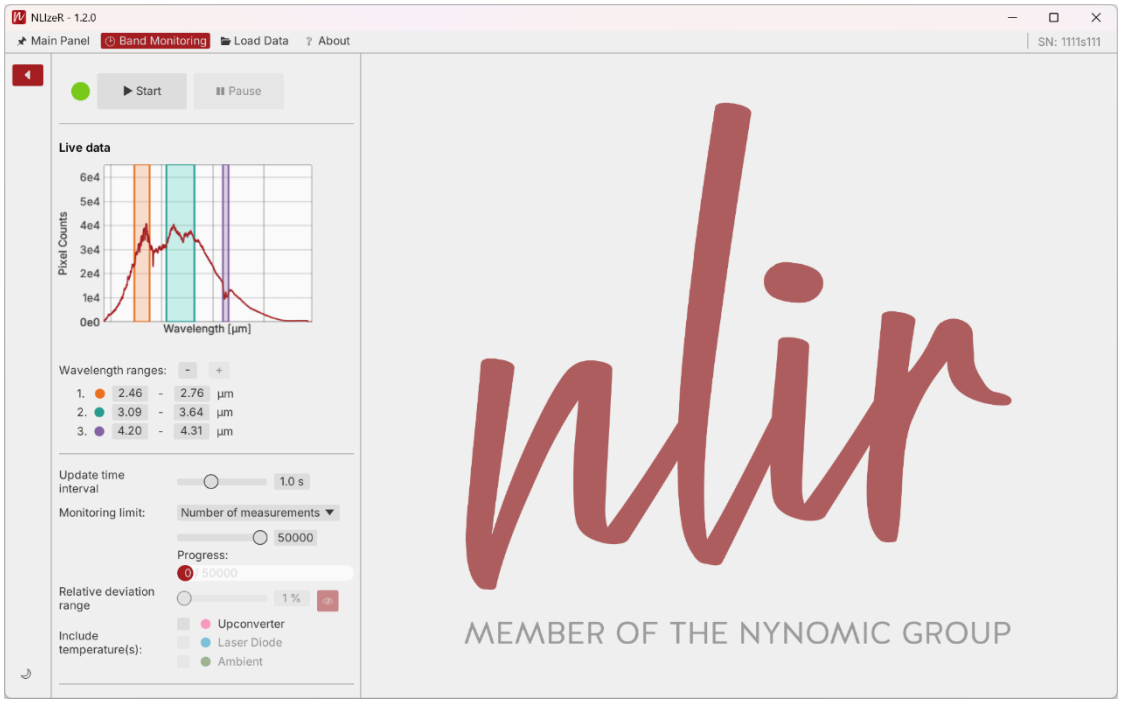

Figure 27: The Band Monitoring tab

The Band Monitoring tab allows you to track the average of a selected spectral range over time.

In the upper-left corner of the panel, you'll find the ***Start***/***Stop*** (or *Ctrl+Space*) and ***Pause***/***Continue*** (or *Space*) buttons for initiating and controlling band monitoring. Below, a small graph provides a live representation of the input data. The pink-highlighted area indicates the selected spectral range for the band monitoring.

You can track up to three different ranges. Use the **+** and **-** buttons to add or remove ranges. The two values represent the range limits, which can be adjusted by dragging them left (down) or right (up), or by clicking and entering a specific number.

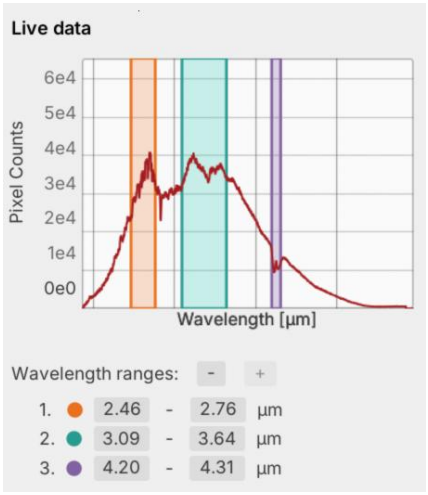

Figure 28: Live data graph and selection of bands

The monitoring process collects new data at each ***Update time interval*** and will stop either when the ***Maximum number of measurements*** entries is reached or when the ***Stop*** button is pressed. The ***Pause*** button temporarily halts the monitoring—while no new data is recorded (nor saved) until the ***Continue*** button is pressed. When resumed, the monitoring picks up from the current time and continues collecting data.

Note: During a paused state, no data is saved to the file.

Additionally, a progress bar is displayed to track the status of the current band monitoring, showing how much data has been acquired relative to the ***Maximum number of measurements***. The user also has the option to monitor until the ***Total monitoring time*** is reached. The ***Relative deviation range*** slider creates a highlighted area on the graph to visualize the relative deviation range specified.

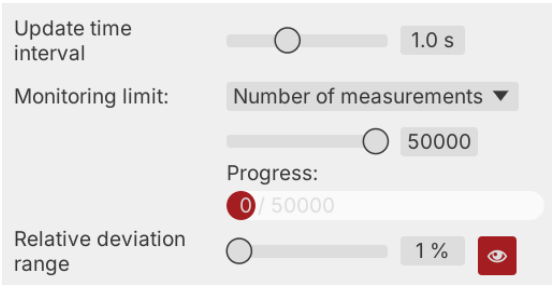

Figure 29: Band monitoring options

During a band monitoring, the instantaneous average of the selected spectral range is logged ("*Value*"). In addition, mean, max, min, relative deviation and standard deviation of the *Value* are displayed.

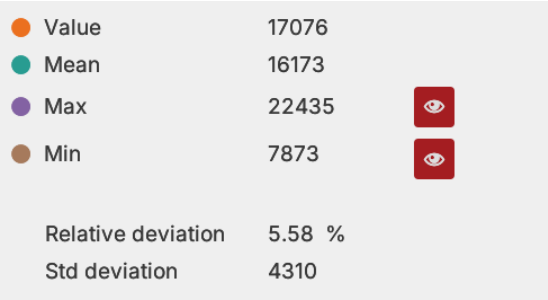

Figure 30: The statistical measures that are monitored when one wavelength range is selected

The table in *Figure 30* is displayed when only one wavelength range is selected. However, if multiple ranges are selected, the monitoring process will keep track of the mean band values (*Value*) for each range over time, as shown in *Figure 31*.

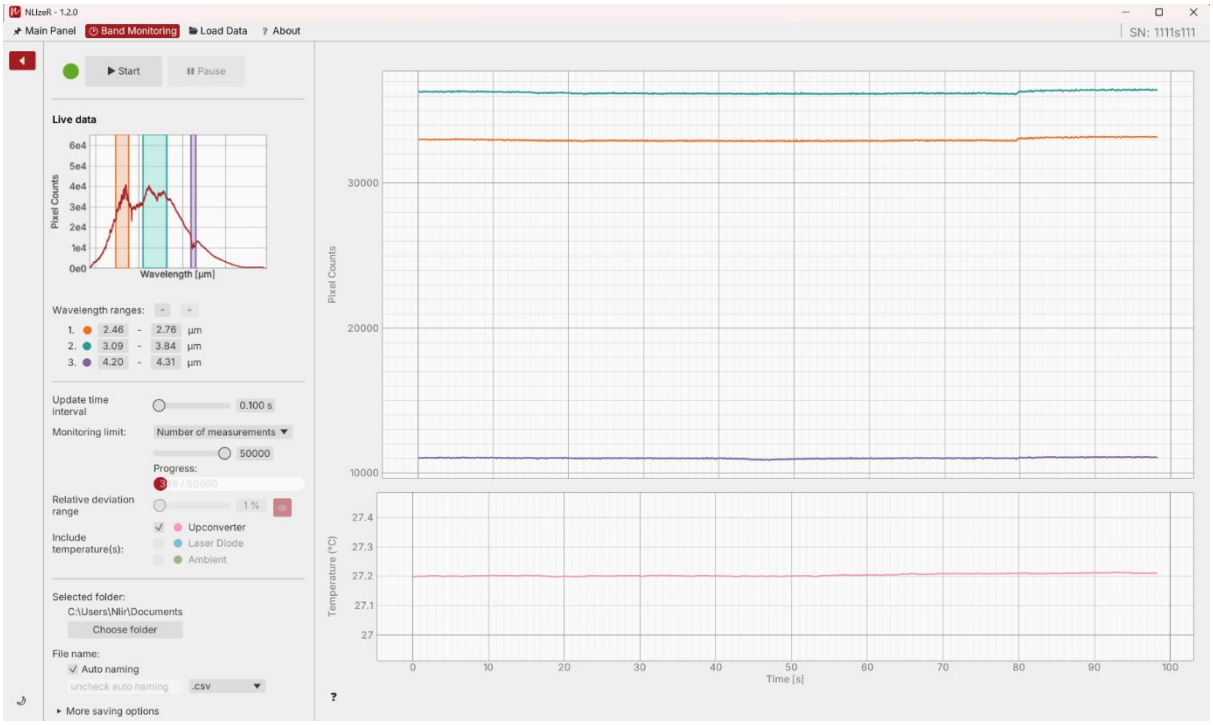

Figure 31: Band monitoring of three selected wavelength ranges

If instrument temperature data is available, temperature monitoring can be accessed in this tab. By default, no temperatures are selected for monitoring. However, if at least one temperature is selected, a second graph will appear, displaying the temperature data. Both the band monitoring graph and the temperature graph share the same x-axis (time), meaning their data progresses simultaneously over time.

Note: Temperature selection should be made before starting the monitoring session. Once monitoring begins, the selected temperatures cannot be changed unless the monitoring is restarted.

Note: The temperatures that are checked for monitoring are also the ones that will be saved to the file (see section below).

3.1. Save Band Monitoring Data

When band monitoring is initiated, a new file is created in the selected folder using the specified name and settings. As the monitoring process continues, data is automatically appended to this file in real-time, ensuring that all captured information is stored, until ***Maximum number of data*** is reached or until ***Stop*** button is pressed.

The automatic file name follows the format "***NLIR-BandMonitoring_****Year-Month-Day_Time*.csv". The file contains metadata, followed by the data that are stored in columns. The metadata fields *Columns* and *Bands* provide explanations for the data structure. An example of a band monitoring file is shown below.

```
# Software: NLIzeR v1.2.0
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10
# Number of Averages: 1
# Trace Mode: Raw
# Bands: 2.35:2.88
# Columns: Time [s], MeanBand1
#
0.1     21333
0.2     17642
0.3     20762
...
```

Figure 32: Example of band monitoring output file with a 0.1s update time interval

In this file, the first column contains the time data in seconds, while the second column holds the mean values of only one band, Band 1, which corresponds to the wavelength range of 1.980–3.034. Each subsequent column represents additional bands.

In the *More saving options,* there is an additional setting for the band monitoring called ***Save all data***. When enabled, a second file that contains all the spectral data will be created, with the suffix "raw", e.g. "***NLIR-BandMonitoring_raw_****Year-Month-Day_Time*.csv" or "*File_name****_raw****.csv*".

If instrument temperature data is available, only the selected temperatures that appear on the plot will be saved in the band monitoring file. In this case, an additional column for each selected temperature will be included. However, the band monitoring raw file always contains all available temperature data, regardless of which temperatures are selected for monitoring.

```
# Software: NLIzeR v1.2.0
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10
# Number of Averages: 1
# Trace Mode: Raw
# Bands: 2.35:2.88
# Columns: Time [s], MeanBand1, TempUpcon [C], TempAmbient [C]
#
0.1     21333   24.7    24.52
0.2     17642   24.7    24.52
0.3     20762   24.7    24.52
...
```

Figure 33: Example of band monitoring output file including instrument temperatures with a 1s update time interval

```
# Software: NLIzeR v1.2.1
# Device Serial Number: 1111s111
# Start DateTime: 2025-11-01T00:00:00+01:00
# Exposure Time [ms]: 10, NaN, 10
# Number of Averages: 1
# Trace Mode: Raw
# Rows: Wavelength [um], Background, !Reference, Trace*
# Columns: TempUpcon [C], TempLaser [C], TempAmbient [C], Pixel[0:2047]
#
NaN     NaN     NaN     1.9269  1.928   1.9292  1.9303  1.9314  1.9326  1.9337  1.9349  1.936   1.9371  1.9383  1.9394  1.9406  1.9417  1.9429  1.9487  ...
NaN     NaN     NaN     419     408     406     412     411     409     400     404     418     399     407     414     386     397     404     414     ...
NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     NaN     ...
24.56   27.41   24.52   10500   10458   10422   10388   10273   10340   10288   10337   10353   10291   10424   10500   10438   10382   10402   10297   ...
24.56   27.41   24.52   10884   10893   10910   10874   10910   10885   10847   10772   10724   10788   10950   10871   10777   10797   10924   10901   ...
24.56   27.41   24.52   12919   12809   12821   12871   12992   12923   12883   12831   12762   12884   12918   12827   12770   12885   12921   12977   ...
...
```

Figure 34: Example of band monitoring raw output file including all spectral data and the instrument temperatures

4. Load Data tab

This tab serves as a data viewer and can also be used to compare the spectrometer's live data with data loaded from a file for reference. It can also be used as a data viewer when no instrument is connected, by loading data from a file.

The first three blocks of the left panel refer to the spectrometer settings, as explained in *Section 2*. In the fourth block of this panel, you can load a file's data by clicking ***Import file***. If the ***Import settings*** box is checked, the settings from the loaded file (exposure time and number of averages) will be automatically imported into the app. The ***Reload file settings*** button allows loading the settings from the imported file at any time.

Once the file is successfully loaded, the imported file's metadata will be displayed in the ***Imported file metadata*** table, and the corresponding data will appear on the graph.

Note: Only the exposure time of the first available (non-None) saved trace is shown in the metadata table. Therefore, this is the exposure time that will be imported when the "Import settings" box is selected or when the "Reload file settings" button is clicked.

Up to five different traces can be loaded, as well as a background and a reference, alongside the live data. You can toggle the visibility of those by using the 👁 button or the ***Show/Hide all*** checkbox. Additionally, the ***Target range*** slider shows an area corresponding to values within ± *x*% of the currently selected trace.

Figure 35: The Load Data tab

5. About tab

The About page provides details about the software version you're using, update information (see *Updates* section for details), documentation link, and contact information.

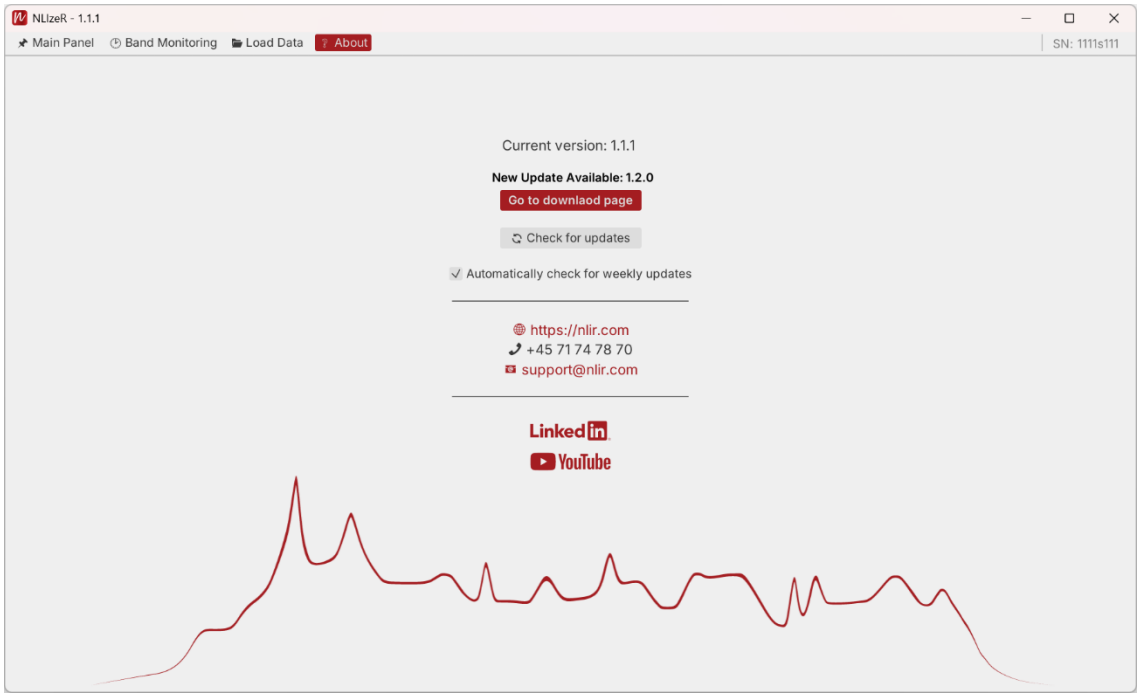

Figure 36: The About tab

6. Updates

By default, the software checks for updates weekly. If a new update is available, a pop-up message will appear as shown below.

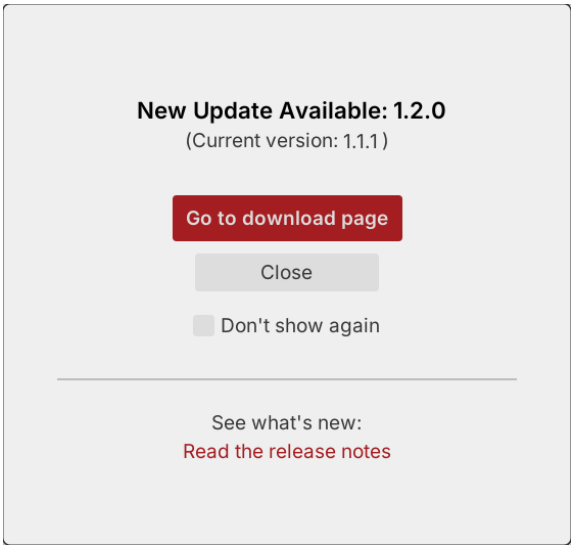

Figure 37: New update available pop-up message

You can disable future update notifications by checking the ***Don't show again*** box. This setting can be changed at any time on the *About* tab by toggling the ***Automatically check for weekly updates*** checkbox. You can also manually check for updates at any time using the ***Check for updates*** button on the *About* tab.

7. Keyboard Shortcuts

App	
Esc / Ctrl+Q	Quit
F1/F2/F3/F4	Switch to the respective tab
Ctrl+F	Full screen on/off
Ctrl+H	Show/hide left panel

Main tab	
Ctrl+Space	Start/Stop continuous acquisition
Space	Capture single spectra
Ctrl+1/2/3/4/5	Switch between traces
Ctrl+0	Clear all traces
Ctrl+S	Save single spectra
Ctrl+M	Save multi spectra

Band Monitoring tab	
Ctrl+Space	Start/Stop band monitoring
Space	Pause/continue

Load Data tab	
Ctrl+Space	Start/Stop continuous acquisition
Space	Capture single spectra
Ctrl+1/2/3/4/5	Switch between traces

8. Contact

In case of malfunction or questions, contact NLIR at:

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Security vulnerabilities

Please report any suspected security vulnerabilities to support@nlir.com. Our vulnerability disclosure policy is available at nlir.com/security.