Spectronon Outdoor System Quick Start Guide

This quick start guide will take you through essential steps to acquire scans and perform basic data analysis. It represents a small subset of the software's capabilities but includes tools to jumpstart productivity while getting you acquainted with the acquisition, processing, and analysis workflow.

 A full description of Spectronon' capabilities can be found in the User Manual:
https://docs.resonon.com/spectronon/SpectrononUserManual/SpectrononUserManual.pdf

Assembly

This guide assumes that your outdoor system has been previously assembled. The system should have come with assembly instructions when you purchased it. If you need help, contact support@resonon.com.

Preparing for scanning

1. The outdoor system tripod has a built-in shelf for your laptop. Adjust the shelf's angle. Attach the supplied battery pack to the bottom of the shelf with the hook-and-loop (Velcro) strap. Set your laptop on the shelf.

2. Ensure that all data cables and power cables are properly connected.
    a. The IR imagers are powered by the battery pack via a 12-pin round connector, and they connect to the computer with an ethernet cable.
    b. All other cameras are connected *and* powered via a MICRO-B USB 3.0 cable to the computer.
    c. The stage is powered from the battery pack. You should have a spliced power cable that distributes power from the battery pack to the stage *and* the imager (if using an IR imager).
    d. The stage is controlled by the software/computer via a USB cable.

3. Launch the Spectronon software.

4. Make sure that Spectronon has successfully recognized the imager and stage (the *Camera* and *Stage* tabs in the bottom right *Tools* panel are visible and *not* dimmed out). If not, check that all connections have been made according to the instructions above, and detect and re-load the imager or scanning stage via the *Spectrometer* menu.

5. Remove the lens cap from the imager's objective lens.

6. In Spectronon, click on the (F) *Focusing* icon on the toolbar. Once activated, the button should be red, and a live view of the sensor will show up in the *Image* panel. Note that the vertical

dimension of that image represents the <u>spatial</u> extent of the scanner's imaging line, while the horizontal dimension displays the <u>spectral</u> composition of each location along the vertical field of view.
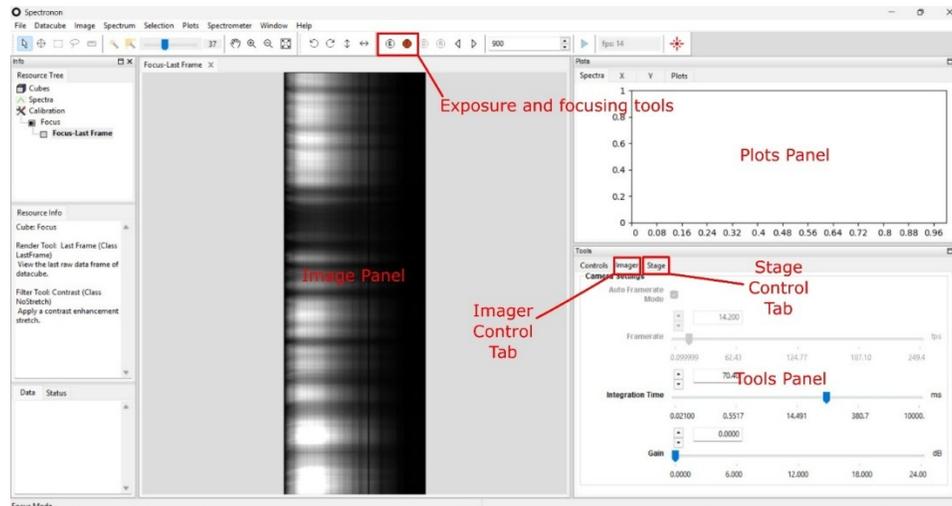
7. Point the imager in a direction that is representative of the scenery you wish to record. Select an area with some horizontally contrasting features, such as tree branches, or the horizontal roof line of a structure, mountain, or other objects. If the focusing image is dark, then the exposure time may be too low. If the image is extremely bright, the exposure time may be too long, causing pixel saturation. Click the (E) *Auto Exposure* icon on the toolbar to select an appropriate integration time. The integration can later be adjusted and optimized manually, but the auto-exposure should provide a reasonable integration time for focusing.

8. Focusing: Use procedure a **or** b below, depending on the type of lens you are using:

    a. <u>For the *Stingray* 25 mm lens, or one of our *Computar* lenses</u>, turn the focusing ring back and forth until the image comes into focus as illustrated on the right.

    b. <u>For all other Stingray lenses or Schneider lenses</u>, follow this procedure:
        i.   Use the supplied 2 mm Allen wrench to loosen the <u>silver lens collar</u> that secures the lens to the imager
        ii. Rotate the entire lens clockwise or counter-clockwise until you obtain the sharpest horizontal lines in the focusing image. Please note that focusing *farther away* requires screwing the lens *in* towards the imager, while focusing *closer* requires screwing the lens *out* and away from the imager. <u>Several full rotations may be required</u>.
        iii. Once in focus, re-tighten the lens collar to ensure that the focusing distance does not get accidentally changed.
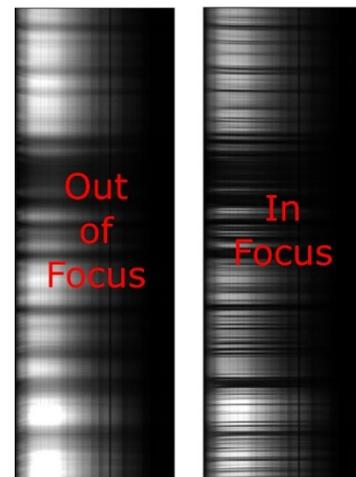
Warning: The *f*-number (aperture) on your lens has been locked to a value that is optimized for your imager. **Do not change the aperture setting**. This would not only compromise the optimal performance of the imager, it would also invalidate the radiometric calibration, forcing you to send the instrument and lens back to Resonon for a costly recalibration.

1. Ensure that the imager is pointed in the general direction that you will be imaging to make your definitive integration time adjustment, by one of two methods:

   a. Click the Auto Exposure icon in the upper tool bar again.

   b. Adjust the integration manually. In the *Tools* panel under the *Imager* tab. Click on the brightest pixel in the image using the *Inspection Tool* ⊕ . If the spectral shape in the plots panel has a flat top as shown below, that pixel is saturated. Re reduce the integration time and try again, until the spectrum's maximum is just below saturation. The number of counts to saturation depends on the imager model. Aim for *slightly below* saturation.
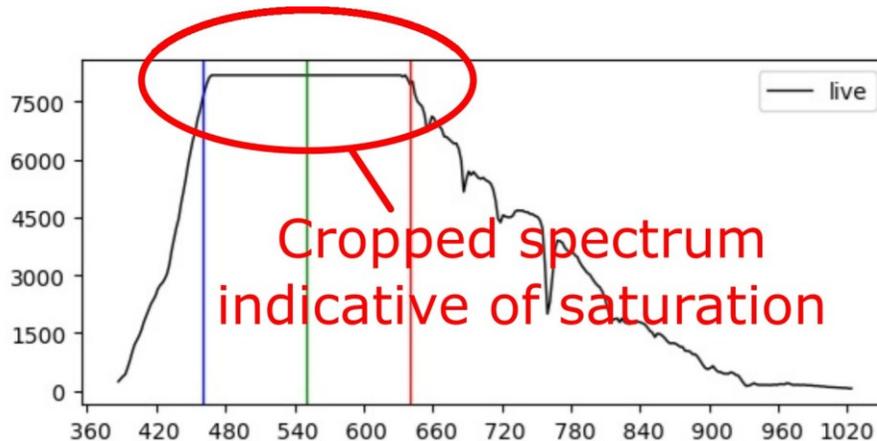
2. Click the *(F)* icon again to come out of focusing view.

3. In the *Tools* panel under the *Imager* tab, we recommend using the *Auto Framerate Mode*. This will select the maximum possible framerate, enabling the fastest possible scanning.

4. Also in the *Tools* panel, but under the *Stage* tab, we recommend using the *Auto Speed Mode* (check the box). Then, enter the imager/objective lens' *Field of View (FOV)*. If you do not know this value, you may look it up on the Resonon website page dedicated to your imager. For example, the Pika L with a 23 mm lens results in a FOV of 13.1 degrees. With Auto Speed Mode enabled, the software will automatically adjust the rotational stage scanning speed to obtain images with the correct aspect ratio.

5. Take a short scan to confirm that the integration time and scanning speed have been correctly set, generating a well exposed image with the correct aspect ratio.

Raw Data, Radiance, Reflectance

A complete explanation of raw data, radiance, and reflectance is beyond the scope of this Quick Start Guide. However, a quick explanation is in order. When you first record a scene, you will obtain raw data, which are a function not only of the surface that you are imaging, but also the instrument response AND the illumination conditions. You will first remove the instrument response from the data, so that your data does not depend on which instrument you used to measure them. You do this by applying the radiometric calibration file that was provided with your system. This will convert the raw data to radiance data, which is a physically meaningful measurement of the light intensity as a function of wavelength. Finally, to convert from radiance to reflectance, you must normalize the data with respect to incident light. It is therefore necessary to measure the incident light, which is inferred from the radiance of a target of known reflectance characteristics. This target is the grey tarp that was included with your outdoor scanning system. Please mount this tarp perpendicularly to the imaging plane somewhere in the scenery that you will be scanning.

Data Acquisition

Please refer to the figure below.

1. You are almost ready to start scanning. If you haven't done so yet, deploy the calibration panel in the area that you will be scanning, such that it is facing the imager.
2. You may use the left and right arrows to jog the stage to your location of choice before starting a scan.
3. Enter the number of lines that you wish to scan in the box to the left of the blue triangle at the top of the Spectronon window.

    Hint: You can estimate the number of lines you need based on the imager's spatial resolution and the FOV of your imager. Optionally you can set the Scan Size to 0 and manually stop the data acquisition whenever you want.

4. Click the blue triangle to start scanning.

    Note: Every time you press record, you will overwrite the previous scan. This allows you to reset the starting position or scan length until you have optimized the image. You can then save the current scan.
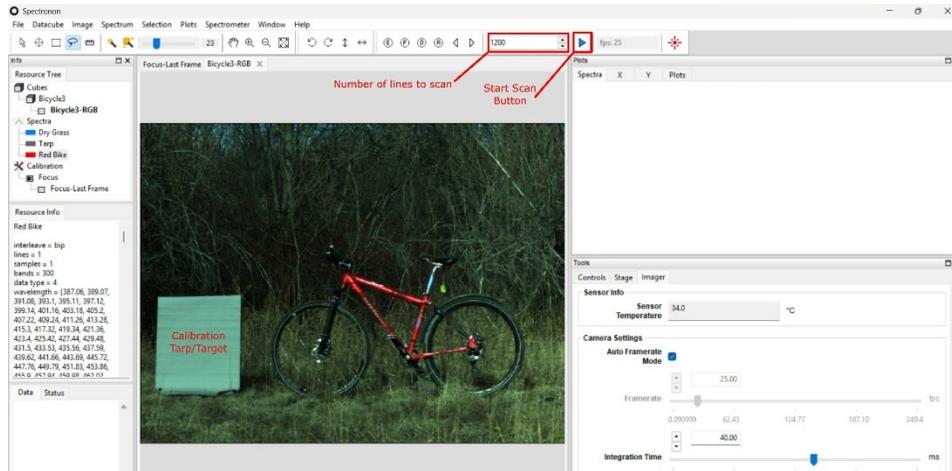
5. When you have recorded a suitable scan, go to the *Resource Tree* in the top left of your screen, right-click on the datacube that you have just acquired, click on *Save Cube As* in the drop menu, enter the file name of your choice, and click *Save*.

Data Processing

You are now ready to convert your data to reflectance.

1. Right-click the raw datacube in the Resource Tree (top left panel in Spectronon) and select *New Cube > Correct > Radiance from Raw Data*.
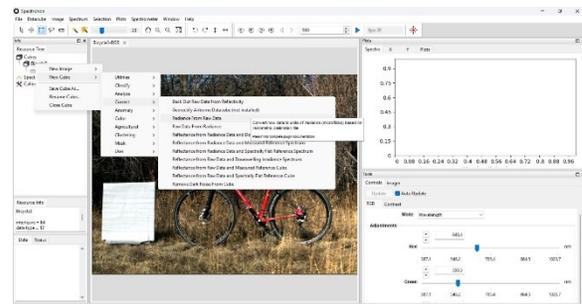

2. In the popup window, browse for the radiometric calibration file that was provided with your system on a thumb drive. Click *OK*. Your data are now in units of microflicks, a physically meaningful unit of illumination.

3. Use one of the *Region of Interest* selection tools in the top toolbar to select an area of your calibration target (tarp) <u>in the radiometrically calibrated image</u>. Right-click on the ROI selection and click *Mean Spectrum*. If you wish, you may rename the spectrum you just created as "Calibration Tarp" or something intuitive to find later.
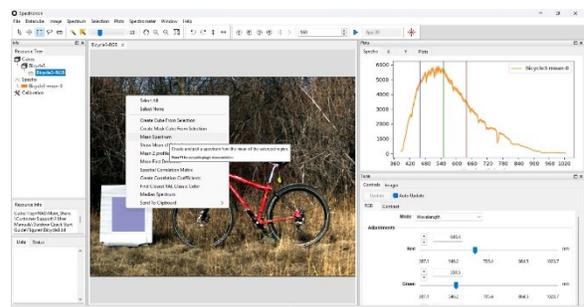
4. Right-click the <u>radiance datacube</u> that you created in steps 1 & 2 above. Select *New Cube > Correct > Reflectance from Radiance Data and Measured Reference Spectrum*.

5. In the *ROI Spec.* drop-down menu, select the spectrum that you created in step 3 above.

6. In the *Measured reflectivity* field, browse for the tarp reflectance data file provided on a thumb drive with your outdoor scanning system. This file is called "Tarp Reflectance 36 percent.txt."

7. Click *OK*. Your data are now in units of reflectance (corrected for instrument response and incident illumination). *By default, Spectronon records reflectance on a scale of 10,000.
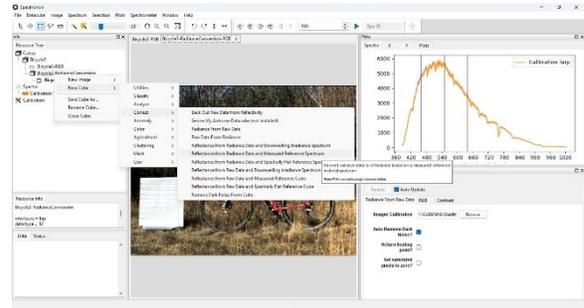
Data Analysis

Once you have acquired a datacube and converted it to reflectance, Spectronon allows you to perform many different analyses of the data.

> **Important Spectronon concept**: Please understand that <u>analysis operations imply the creation of a *new* datacube</u> that has been manipulated according to the chosen analysis. The new cube is listed in the resource tree as a branch below the original cube, but it is in fact a distinct and independent datacube. It can be saved, loaded, and manipulated independently of the original cube.

1. To perform an analysis, right-click a datacube in the *Resource Tree*, click *New Cube* in the Main Menu, and then click any of the available built-in tools in Spectronon (*Utilities*, *Classify*, *Analyze*, *Correct*, etc.)

> **Hint**: Equivalently, you can left-click a datacube to highlight it, and then click *Datacube* in the main menu to select an analysis step of your choice.
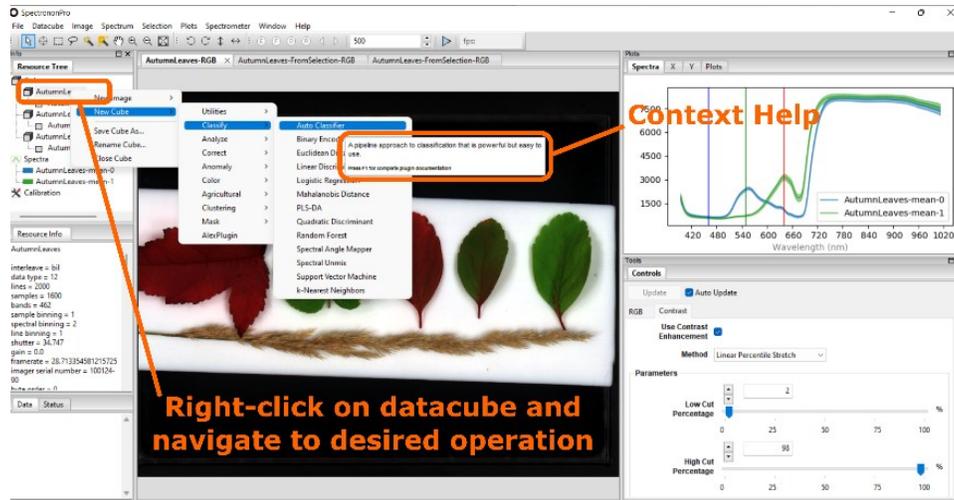
Hint: Whenever a menu item for data manipulation is highlighted in Spectronon, a short context help window opens. Clicking on F1 at this time will open an additional popup window with more detailed help and links for additional information.

2. Whenever a new cube is generated, an associated image is generated and presented under a new tab in the *Image* panel. The *Tools* panel at the bottom right of your screen allows you to manipulate that *image*. In the *Tools* panel you will find the following tabs:

   a. The *RGB* tab allows you to modify the wavelengths used to render the image
   b. The *Contrast* tab allows you to apply a contrast filter and adjust the parameters of that filter.
   c. If the cube was generated via a *New Cube* operation (e.g. a *Normalize datacube* operation), you can click on the tab associated with that operation and change the parameters of the operation.

   Note: the analysis tools available in Spectronon are too numerous to describe here but the same general principles apply to all.

   i. Select a cube.
   ii. Create a *new* cube based on a specific algorithm of your choice.
   iii. A new *datacube* and associate *image* are generated.

   Important Concept: Some operations, for example classification tasks, require you to have previously generated reference cubes or reference spectra. If so, when you select a *New Cube* operation, a popup window will ask you to select the cubes or spectra you wish to use to perform that operation. For example, select a cube in the *Resource Tree*, click *Datacube* in the main menu, then navigate to *New Cube*, *Classify*, and then *Auto Classifier*. This classifier sorts each pixel as

belonging to one of any number of classes, based on its spectral similarity to reference datacubes. A popup window opens asking you to specify how many classes you wish to use, and then to assign a cube for each of those classes. We will now learn how to generate those reference cubes.

Creating a reference cube (or spectrum)

If you need to create one or more reference cubes for future analysis, it will unlikely be a cube generated from a full scan. Instead, you will create a sub-cube from a part of a scan that is known to accurately represent an element of interest. For example, if you want to classify plant leaves as belonging to one of two types (A or B). You can acquire a scan that contains a leaf from each type and then follow the steps below:

1. While the image associated with your reference scan is open in the *Image* panel, click on one of the selection tools in the toolbar (for example the *select rectangle* selection tool).

2. Click and drag to delimit a region of the scan that is representative of type A leaves.

3. While hovering over the greyed-out area you selected, right-click and choose *Create Cube from Selection*. A new cube is created and appears in the *Resource Tree*. An image associated with this new cube shows up in the *Image* panel.

   Note: If the Free Form selection tool is used, the new cube's will be reorganized in a rectangular collection of pixels. The spatial information is lost, but that is ok because you are creating a simple library of pixels.

   Hint: The new cube has an automatically generated name with "-FromSelection" appended to the name of the cube it was generated from. You may want to rename it to something that is specifically meaningful to you, such as "Type A."
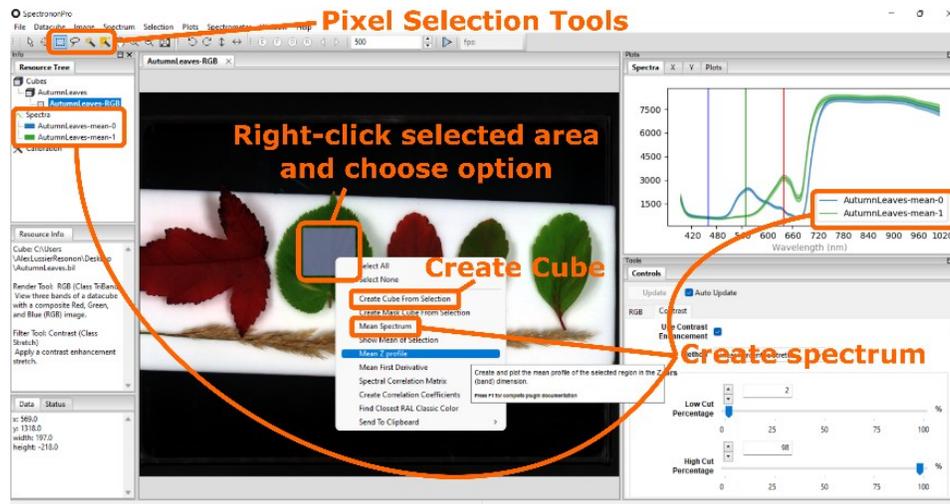
4. Go back to the original reference scan, select a region representative of type B, and generate a datacube from that region. Rename it "Type B." You now have reference datacubes for type A and type B plant leaves, which you can use to classify an unknown scan of type A and/or B leaves.

> **Note**: Some classification operations may require reference spectra (instead of reference datacubes). To create a reference spectrum, select an area of the scan, hover over the greyed-out area, right-click, and choose *Mean Spectrum*. A spectrum will appear in the *Plots* panel. It will have a spectral line and an envelope that spans plus and minus one standard deviation from the average spectrum in the selected area.

Note about closing Spectronon

1. <u>Remember that no datacube or image is saved to disk unless you explicitly do so</u>. When you exit Spectronon, the program will let you know about any unsaved cube, image, or spectrum. If there is something in that list that you wish to save, click *Cancel*, save the files you need, and then close Spectronon.