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ASD FieldSpec3 field measurement protocols

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ABSTRACT

The following protocol describes best practices for collecting field spectrometer measurements with an ASD Fieldspec 3 spectroradiometer. In order to determine absolute reflectance users are urged to follow the calibration and analytical theory described in Soffer et al (2019). Processing of the files collected by the ASD following the theory presented in Soffer et al. (2019) can be carried out with the ASDtoolkit (Elmer et al. 2019).

Soffer R., Ifimov G., Arroyo-Mora J.P., Kalacska M. 2019 Validation of Airborne Hyperspectral Imagery from Laboratory Panel Characterization to Image Quality Assessment: Implications for an Arctic Peatland Surrogate Simulation Site. Canadian Journal of Remote Sensing. DOI: 10.1080/07038992.2019.1650334

Elmer K, Soffer R, Kalacska M, Schaaf ES, Arroyo-Mora JP. (2019) ASDtoolkit for reflectance measurements dx.doi.org/10.17504/protocols.io.6pahdie

SAFETY WARNINGS

1. The Spectralon panel is fragile. Do not touch its surface.
2. Do not bend the fibre optic cable or the fibre optic cable extension with a diameter less than 5" - doing so can introduce longitudinal fractures in the fibres
3. The fibre optic cable is attached to the insturment by the factory. It is very expensive to replace a broken cable and takes several weeks.

BEFORE STARTING

Ensure the 12V batteries of the instrument and the laptop batteries are fully charged.

Equipment set up

1   1. Connect one of the 12V batteries to the ASD, turn on the instrument and allow it to warm up for **at least 30 min**. This is important because each of the three detector arrays warm up at different rates. Erroneous spectral features such as spectral steps can occur at the overlap regions between the detectors: 1000 nm (VNIR:SWIR1) and 1800 nm (SWIR1:SWIR2) if a proper warm up period is not provided.

See Pages 14-16 and 38-39 in the FieldSpec3 Manual for power supply details. Note the table below from page 38 of the FieldSpec3 Manual:

The battery charger specifications:

Type:	External Desktop
AC Input:	90-240 VAC, 50/60 Hz
DC Input:	12 V 1.5 A
Charge Time:	under 8 hours for a fully discharged 9 AH battery

Note: Do not unplug the charger and leave the batteries in the charger. Remove the batteries first, or they will discharge through the charger.

The battery charger is designed for indoor use and should not come in contact with water or dust.

Review the charger instruction manual for details.

LED Status indicator:

- The LED will be ORANGE if the battery is not connected.
- The LED will be ORANGE during initialization and analysis.
- The LED will be RED during a fast charge.
- The LED will turn GREEN with intermittent ORANGE flash when in top-off charge.
- The LED will be GREEN during trickle charge.
- The LED will be alternating ORANGE-GREEN when there is an error.

2. Check the integrity of the fibres with the 'Fibre Checker' and magnifier according to pages 30-32 of the FieldSpec3 Manual.

3. Assemble the two tripods, the larger one to hold the pistol grip and the smaller one for the Spectralon panel.

4. Connect the fiber optic extension cable to the fiber optic cable from the spectrometer. The small Allen key is used to tighten the screws that hold the two cables together.

5. Mount the pistol grip at the end of the large tripod arm

6. Insert the end of the fibre optic extension cable into the pistol grip and secure with the grey nut and strain relief as shown in Figure 2-14 and 2-15 below from the FieldSpec3 Manual. Do not over tighten the strain relief.

The pistol grip is standard with the FieldSpec spectroradiometer, as shown in Figure 2-14. The pistol grip has a 25 degree field-of-view, full conical angle.
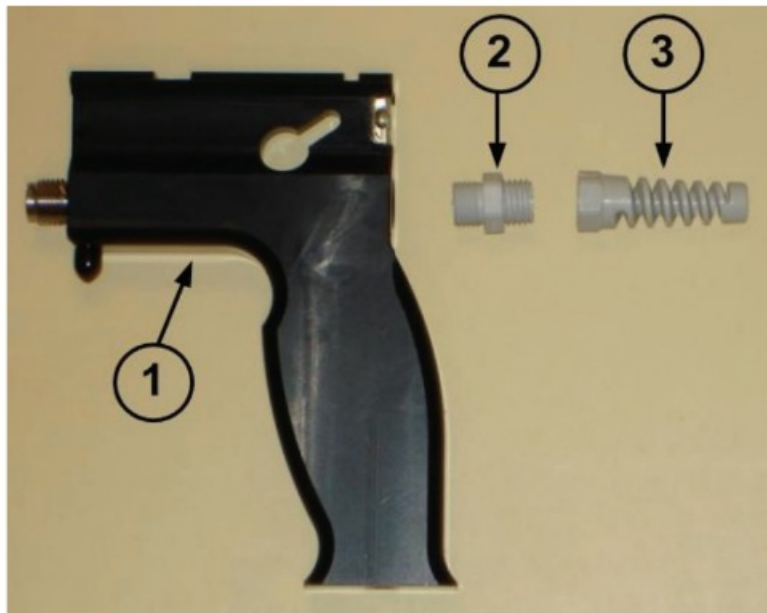

Figure 2-14   Pistol grip components

Components of the pistol grip (from left) (1) modified ASD pistol grip, (2) grey nut and (3) strain relief.
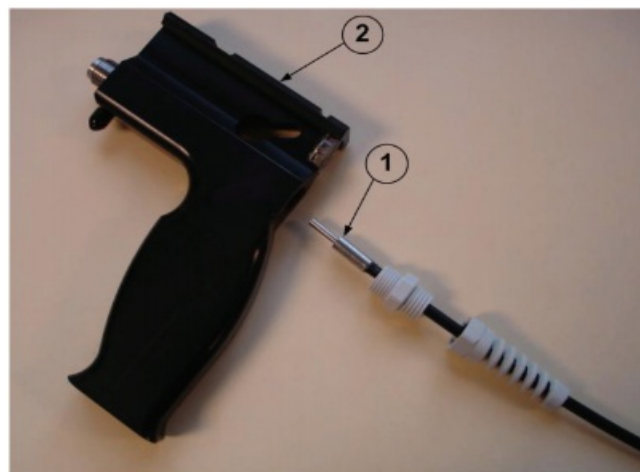

Figure 2-15   Using the fiberoptic cable with the pistol grip.

Notice that when the fibre optic is properly seated, the end should be visible outside of the pistol grip (FieldSpec3 Manual Figure 2-16):
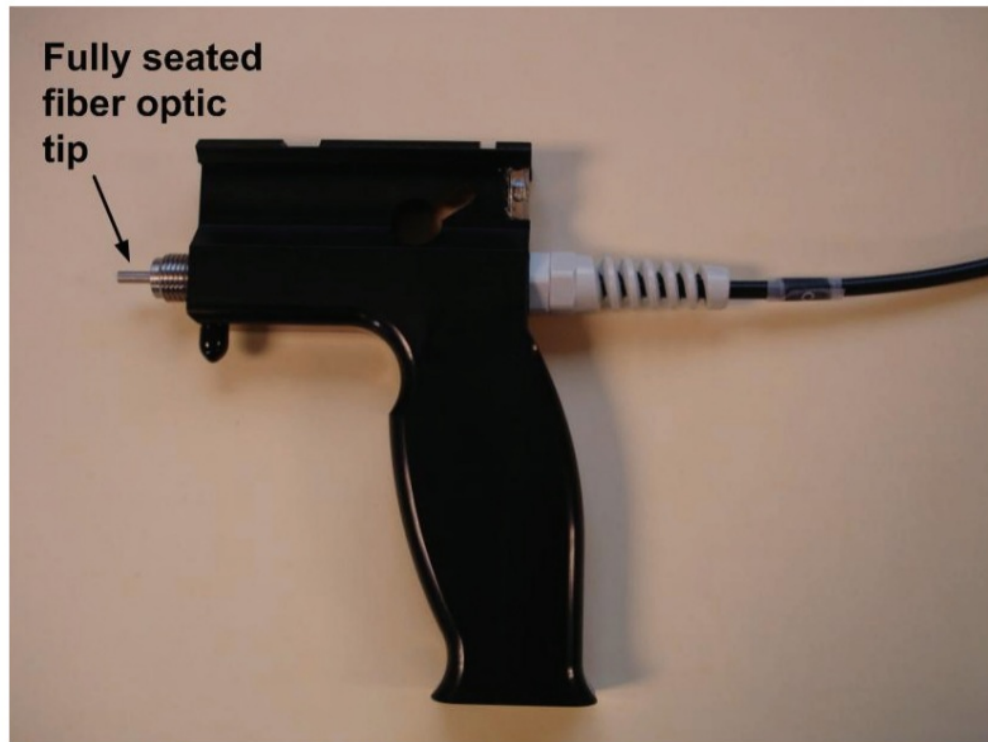
Figure 2-16   Fully assembled pistol grip

7. Using cable ties, secure the fibre optic extension cable to the tripod to avoid entanglement. **Be extremely careful** – no tight bends that could crack the fibres.

8. Attach the Spectralon panel onto the small tripod using the velcro attachement points. Make sure the panel is fully level, even a 1 degree tilt in any direction will introduce errors into the data. Handle the Spectralon panel very carefully - **DO NOT touch the surface of the panel (If necessary wear dust free gloves).** If dust, insects or other particles land on the surface gently blow them away with canned air (make sure it does not contain Freon), do not brush them off or crush them into the panel.

> This protocol is based on the use of the ASD Fieldspec 3 for collection in 'reflectance mode' outdoors for plot level spectra. Prior to using the instrument ensure the 12V batteries and the laptop batteries are fully charged.
>
> In this setup the instrument is used with the 25 deg FOV (bare fibre).

fieldspec3manual.pdf

> ⚠ The fibre optic cable should not be stored or set up with a bend less than 5" diameter. Doing so can cause undetectable longitudinal fractures which lead to lower signal levels and light leakage.

> ⚠ DO NOT lose the small screws or the Allen key.

⚠️ The Spectralon panel is fragile - DO NOT touch its surface.

Spectrometer set up

2   1. Power on the laptop

2. In Windows Explorer create a folder in the Users folder (project name/date/measurement: CABO/2018-01-01/fieldspec) where the spectra will be saved

3. Connect to the Spectrometer either through its wireless network or via crossover cable. If connecting wirelessly ensure the 'wireless radio button' on the laptop is switched to 'on' and select the network '16478'. See Page 16 in the FieldSpec3 Manual for a photograph of the crossover cable.

4. Launch either RS^3 or RS^3 High Contrast - both of these softwares are identical except for the colour display

5. Select 'Control' -> 'Spectrum save' from the main menu.

Path Name: The directory folder where files are to be saved (created in step 2.2 above).
Base Name: The name used for each data file collected. A unique spectrum number will be appended to this base name. Maximum 8 characters. It is recommended to write the basename in a field notebook for future reference.
Starting Spectrum Number: First number appended to the base name - Set this value to 0
Number of files to save: Number of spectra each time the spacebar is pressed - Set this value to 1
Comments: Brief comments that will appear in file header

Select **OK** to accept details.

6. Select 'Control' -> 'Adjust Configuration' from the main menu.

Choose '**Bare fibre**' in the foreoptic setting.
Change the **Averaging** to at least 25-50 scans for all three settings: dark current, white reference, spectrum.   **25 scans is the absolute minimum under ideal bright conditions** - below this value the SNR in the SWIR 2 region will be dominated by noise. For outdoor applications a higher value such as **50 is recommended**. The higher the value, the higher the SNR will be, but a larger number of scans results in a longer time of acquisition.

⚠️ Do not substitute the crossover cable with a regular ethernet cable.

3   1. With the pistol grip level and centered over the Spectralon panel click on 'Opt' to optimize the instrument. This will allow the FieldSpec to calculate the appropriate integration time given the lighting conditions.   Do not move the pistol grip during this process. When optimization is complete a spectrum in DN will appear on the screen showing the sensitivity of the three detectors under current conditions. Due to inherent changes in irridiance throughout the day, optmize the instrument regularly. Carrying out an optimization before collecting data at each plot is recommended.

2. Press 'DC' to record a dark current measurement - this is especially important the VNIR detector. The DC measurement records electrical current generated by the thermal electrons within the instrument. This false signal is inherent in the measurements and must subtracted. The SWIR detectors automatically remove the DC from each measurement, but the VNIR does not do this correction automatically and therefore the DC must be characterized on a regular basis. It should be carried out every 15-20 min if there is no optimization performed during that time. A DC is carried out by the optimization process.

3. With the pistol grip still level and centered over the Spectralon panel, click on 'WR' to collect a white reference measurement. Do not move the pistol grip or approach the Spectralon panel during this process. This scan of the panel will be stored in the computer's memory in order to calculate relative reflectance of target spectra (i.e. the ratio between the DN of the white panel to the DN of the target). Following the the WR collection, the spectrum on the screen should be a straight line at 1 (i.e. 100% reflectance). Press space bar to save a WR spectrum.

4. With the pistol grip still level and centered over the Spectralon panel, shade the spectralon panel. WAIT for a minimum of one full set of scans (set in section 2.7 above: 25-50) to be collected of the target. The spectrum on the screen should not be changing following the full set of scans. Do not move the pistol grip or approach the Spectralon panel during this process. **Press the space bar to save the spectrum**. This spectrum indicates the amount of diffuse illumination that is present in the spectra that will be collected.

4. Turn the tripod arm so that the pistol grip is above the targe of interest. WAIT for a minimum of one full set of scans (set in section 2.7 above: 25-50) to be collected of the target. The spectrum on the screen should not be changing following the full set of scans. Ensure there are no or only minimal steps between the two detector cross over points (1000 and 1800 nm). Readjust the position of the pistol grip if needed and/or reoptimize with the spectralon panel if there are large steps present. **Press the space bar to save the spectrum**. It is good practice to collect at least 5-20 spectra in rapid succession of the same target without moving the pistol grip.

5. Turn the tripod arm back so that the pistol grip is centered above the Spectralon panel. WAIT for a minimum of one full set of scans (set in section 2.7 above: 25-50) to be collected of the target. The spectrum on the screen should not be changing following the full set of scans. **Press the space bar to save the spectrum**. This spectrum provides a white reference check. The spectrum on the screen should be close to 1 (i.e. 100%) without substantial deviation since the panel is being ratioed to itself. Deviations from 1 (i.e. 100%) indicate changes in atmospheric and/or illumination conditions

6. Repeat steps 1-5 for subsequent targets. It is also recommended to change the base name between targets in order to make the QA and processing of the data more straightfoward.

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> Every time the space bar is pressed to record a spectrum the computer will beep and the spectrum base name in the lower left hand corner of the screen will advance by 1, for example from *Spect.001* to *Spect.002*
>
> Very high levels of noise at 1400 nm and 1900 nm are normal. This noise is due to atmospheric water absorbing the radiation in these wavelength regions.
>
> It is very important to understand the FOV of the instrument. The spot size can be calculated for the given height of the fibre above the target. But it is important to remember that while the FOV is generally circular, the sensitivity of the 3 detectors is not uniform within the FOV. The target should be homogenous within the FOV (and ideally an area larger than the IFOV) in order to avoid contrasting reflectance contributing to the three detectors.