

Field Guide for the ASD FieldSpec Pro – Radiance/Irradiance Measurements in Raw DN Mode

Version 2(2007) Alasdair Mac Arthur

PC version: Dell latitude

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These tips provide reminders of the key processes involved in the setting up and use of the ASD FieldSpec Pro spectrometer for measuring radiance/irradiance in raw DN mode in the field. You should discuss your data requirements with the Operations Manager at your training session to decide whether this mode of operation is best suited to your application.

The ASD FieldSpec is full-range computer-controlled spectroradiometer, whereby a portable PC is used to control the scans collected by the instrument, while also allowing real-time on-screen visualisation of the data collected.

1. Power

Ensure all batteries (12V cells and internal batteries for the FieldSpec and Computer) are fully charged before departing into field. Ideally we recommend that you take a Voltmeter with you to check the charge of the 12V batteries, which should bear a charge of ~13V when fully charged.

Computer

Charge the Dell Latitude PC on the mains prior to use in the field. It is recommended that the PC be charged overnight after a full day's use in the field. When in use in the field, always use the Dell car charger with 12V battery converter to provide power to the computer, as the internal battery is unlikely to last very long without an external source plugged into it¹. A fully charged 12V battery providing power to a fully charged computer should provide a full day's power. If you do not connect an external 12V battery to the computer, the computer's internal power supply will last no more than approximately 1 hour in the field, because the software and spectrometer communications are very power-hungry.

Spectrometer

To provide power to the spectroradiometer¹, use one of the following:

- ◆ ASD ac adapter
- ◆ ASD 12V battery converter cable

When charging, the battery status LED on the front of the spectrometer housing will appear red in colour. When fully charged, this light will turn green. You should make sure that the spectrometer's internal battery is fully charged before going into the field. The internal battery takes ~4 hours to charge from flat status on a mains adapter. In the field you should always connect a 12V battery to the spectrometer to ensure that you will not be limited by battery problems.

2. Spectrometer Warm-up

It is recommended that you "warm up" the ASD FieldSpec prior to use for spectral radiance or irradiance measurements. We strongly recommend a warm up time of 90 minutes. This means

¹ Refer to the FSF *Power and Cabling Schematic* diagrams for the ASD FieldSpec Pro.

that you should attach the mains supply or 12V battery and switch the spectrometer on, so that both lights appear on the front panel of the radiometer at least 90 minutes before use.

The reason for the long warm up time required for this instrument is that the three spectrometer arrays warm up at different rates once they have been powered up. This can result in spectral phenomena occurring in Users data, if an appropriate warm up time is not used. The main areas of concern are the overlap regions between the VNIR Silicon photodiode detector array and the SWIR1 InGaAs array; and at the SWIR1:SWIR2 detector overlay region. If a warm up time of less than 90 minutes is used, it is common to find that spectral steps will occur at the wavelength regions associated with the detector overlap regions described above (i.e. 1000nm and 1800nm). This is due to the fact that ASD and FSF derive all wavelength and radiometric calibrations after a 90 minute warm up. By using the appropriate warm up period, you will significantly increase the quality of your data and will minimise errors caused by warming of the spectrometer array inside, which are later difficult to rectify. Please note that a similar phenomenon may be noted while measuring heterogeneous surfaces as each fibre in the fibre optic bundle has its own field of view and the fibres are randomly distributed between each of the three detectors².

TIP - before leaving to go into the field, plug the spectrometer into the mains and power it up to begin the warm up period. This will ensure that you do not waste valuable battery power on warming the spectrometer up. Before leaving to go into the field, connect a 12V battery and leave the spectrometer switched on and warming up. By the time you reach your field site, the required 90 minute warm up period will be complete and you can commence your measurements straight away.

3. Setup RS³ software

1. Attach the parallel cable to the parallel port at the back of the spectrometer.
2. Attach the other end of the parallel cable to the printer port of the Dell PC.
3. Ensure that the spectrometer is powered up and that an external battery source is connected
4. Power up the Dell PC, ensuring that you have a 12V battery connected to it.

NOTE that the spectrometer must always be switched on before the computer. Failing to do this when the parallel cable is connected can cause irreparable damage to the spectrometer arrays which can result in instrument malfunction.

5. Open Windows Explorer. Create a directory for yourself in the "Users" folder.
6. Start the ASD data collection software from the desktop icons. The two versions relate to the colour screen for use in the lab 1) RS³, and 2) - a high contrast version for ease of use in the field (High Contrast RS³). Both operate in exactly the same way apart from the colour of the display.
7. Select the menu at the top of the screen called **SPECTRUM SAVE**.
8. Type the full drive and path name of the folder in which to save your data (i.e. the folder you just created in Windows Explorer).
9. In the box labelled **File Base**, think of a suitable root name for your spectra (up to 8 letters). This could be a site name, or surface type for instance "beach1a" for site 1a on the beach.
10. Set the **Starting Spectrum** to 0
11. Set the **Number of Spectra to be Saved** option to 1
12. Note that you can also perform timed measurements.
13. When the above parameters are set, click **OK**.
14. Now choose the menu option named **CONTROL** and select the submenu called **Adjust Configuration**.

² See - Determining the FOV and directions response field of spectroradiometers (2007) Proceedings of the EARSel conference, Brugge.

15. Set the foreoptic selection to the appropriate setting (i.e. according to the optic you have attached). If using the cosine diffuser, choose **RCR**³.
16. Change the **Averaging** to at least 25 for all three options (spectrum, dark current and white reference).
17. **Averaging** sets the spectrum averaging for each scan. Increasing the averaging improves the signal:noise ratio of your spectra, but be aware that more averaging means longer scan times. For field use it is recommended that you use a setting of 50 for each of the three options. 25 is the absolute minimum as below this, signal:noise ratios in the SWIR will fall to a level that spectra collected will be mostly dominated by noise.
18. In the pull-down menu at the top of the screen set the data type to **RAW DN** (default).

You are now ready to begin collecting data.

4 ASD instrument set up

4.1 Fore optic/receptor selection

Select the fore optic/receptor that appropriate is appropriate for your intended measurements. Attach the Remote Cosine Receptor (RCR) to the fibre optic for spectral irradiance measurement and mount the RCR on a tripod using the integral spirit levels to correctly level the RCR or attach the appropriate lens for spectral radiance measurements.

The ASD FieldSpec has a very fragile fibre optic configuration. The fibre optic bundle is connected internally to each of the three instrument detectors and is therefore very expensive to replace and recalibrate if it should become damaged. A few tips on fibre care are provided below for your reference:

- ◆ Do not bend, crush or pull the fibre
- ◆ To store the fibre, coil it up gently and stow it away in the fibre compartment at the bottom of the carry case or onto the special fibre cable bobin
- ◆ When connecting the fibre optic to the fore optic or cosine diffuser, take care not to over tighten the screw mounting as this can crimp the fibre and cause irreparable damage.
- ◆ Take care, however, that the fibre optic tip is **fully seated** in the lens or cosine diffuser and is not drawn back from its seating during operations. It is advisable to **check** that the fibre optic tip is fully seated each time you **reposition** the lens or cosine diffuser.
- ◆ Always cover the fibre tip with the supplied plastic sleeve when not in use
- ◆ The fibre must remain dry so be sure to keep it away from damp/wet areas

Note the lens/ASD or RCR/ASD combination selected should be in calibrated pairs and are not interchangeable.

4. Data collection

To collect a scan with the ASD instrument, you must first position the pistol grip with the desired optic attachment or the cosine diffuser. The pistol grip can be stabilised on a tripod, or hand held but the cosine diffuser is best on a stable mount such as a tripod.

4.1 Optimisation

Optimisation adjusts the sensitivity of the instrument's detectors according to the specific illumination conditions at the time of measurement. Therefore it is necessary to optimise the detectors regularly under field conditions to ensure that changing levels of downwelling irradiance do not cause the detectors to saturate.

³ If the drop down list does not include "RCR" please contact FSF

To optimise, point the fore optic or cosine diffuser at the brightest area to be measure at a time of maximum solar illumination. Press the **OPT** button on the top left hand side of the screen. (Alternatively, press the **CTRL** and **O** keys on the keyboard.) The instrument should now optimise, and you will be able to visualise this process on-screen. Following this, you will hear a slight audible click within the instrument, and a prompt window will appear in the FR programme. This will prompt you to prepare for **dark current collection**. Click **OK**. The instrument will proceed with dark current collection (see section 4.2), and at the end of the measurement, the screen will return to a normal measurement screen where the raw signal (DN) is displayed as a function of the sensitivity of the three detectors.

You should optimise the instrument at the start of each day's measurements, and repeat as necessary according to the changing irradiance conditions. As irradiance increases towards Solar noon, you may notice the detectors saturating. You must re-optimize at this point, and make a note on your instrument log sheet of the time of the optimisation.

4.2 Dark Current (DC)

A certain amount of electrical current generated by electrons within the ASD is always added to that generated by incoming photons of light. This electrical component of the signal is false data, and is referred to by ASD as **DARK CURRENT**. The two SWIR detectors have an automatic dark current correction, performed on each measurement as it is collected by means of a dark pixel on the end of each array. However, the VNIR array does not have this facility and DC must be subtracted on a channel-by-channel basis.

As we have already shown, DC is automatically collected during every optimisation. We also recommend collecting additional DC measurements every 20 minutes in order to take into account the changing state of the VNIR detector. The DC is not saved as an actual measurement you can see, but is stored in the PC's memory and applied to every subsequent measurement. Use the **DC** button on the top toolbar to collect a DC measurement. The timer in the top left hand box will remind you of how recently your last DC measurement was collected.

Again, it is very important to make a note of the time when you collect DC measurements on your log sheet.

4.3 Spectral Measurement

Please allow for 2 screen refreshes of the Spectrum Avg status bar to allow the spectrometer to adjust to the radiance/irradiance level. When the graph on the screen remains stable, press the **SPACE BAR** to collect a scan. The computer will beep twice to confirm that the file has been saved, and the scan name in the bottom left hand corner of the screen will advance by one file (i.e. from *beach1a.000* to *beach1a.001*; where *beach1a.001* is the next scan to be saved). You have now collected your first spectral measurements.

After the beeps, prepare to take the next measurements, wait for two screen refreshes and press the **SPACE BAR** again. You should hear two beeps again indicating that measurement is complete. Repeat this sequence as required.

Alternatively timed measurements can be used. In the Spectrum Save dialogue box set the Starting Spectrum Number, set the number of file that you wish to save and the time interval between measurements in hours:minutes:seconds ????. remember however that the spectra if it saturates.

IMPORTANT

If using timed data collection bare in mind that changing solar irradiance may cause the instrument to saturate and the instrument will **stop** recording spectra. In addition **NO** dark current measurements are being taken during the timed measurements.

4.4 Weather conditions

Unless your intention is to measure variations in irradiance it is recommended that you only collect field spectral measurements when the weather is fine and stable. Even hazy conditions can cause significant changes in irradiance which will have an impact on spectra collected using the ASD FieldSpec system. If there are clouds passing overhead, wait for a large enough clear spell before collecting measurements. Do not be surprised if your data are of sub-optimal quality if collected under changeable conditions.

Ideally you should work when the sun is highest in the sky to minimise the effects of shadowing and solar zenith changes. Ideally 2 hours either side of Solar noon are perfect. (Solar noon = 1pm BST)

You should not conduct fieldwork with the ASD in wet conditions as the electronic equipment is very sensitive to damp and **must** not be exposed to wet conditions.

4.5 Sampling Strategies

FSF cannot recommend particular sampling strategies as the ideal sampling will vary from project to project, and is under the responsibility of the PI. However, we can recommend that for each point measured, a number of spectra be collected. These can then be averaged to provide a certainty measure of the spectral variability over a fixed point in space. It is up to the PI to determine the most appropriate method for sampling.

4.6 Mounting

The pistol grip or cosine diffuser should ideally be mounted securely during field deployment, and this can be performed using a tripod arrangement. There are levelling bubbles on the cosine diffuser housing, on some of the FSF supplied tripods and a spirit level supplied with the loan if required. You can also hand-hold the pistol grip, but this is not likely to be so stable.

4.7 Field Of View (FOV)

For measurements with the lens fore optics, it is VERY important to accurately define the instantaneous field-of-view (IFOV) of the sensor before going into the field. You need to make sure that the size of the area you wish to measure is LARGE relative to the IFOV of the sensor. The FOV is approximately circular and will be 8, 18, or 23 (bare fibre) degrees depending on the optic attachment used. However, the sensitivity across the FOV is not uniform⁽¹⁾ and you should adopt a measurement procedure to take account of this. You should work out the range of heights you intend to use for the target radiometer mounting and then work out the diameter of the area to be measured. The reason that this is important is that if you measure an area which is infringed by an area of contrasting reflectance, it can lead to confusing spectra which are very difficult to analyse and correct after the event.

4.8 Log Sheets

It is immensely important to keep accurate log sheets when in the field. Document any changes in solar irradiance and also make a note of every filename and the corresponding surface.

4.9 Processing

If you are out in the field for more than 1 day, it is recommended that you process a couple of spectra of each measurement sequence in the evening (FSF Post Processing Templates can be downloaded from <http://fsf.nerc.ac.uk/resources/post-processing>). At least if you spot problems which might indicate a problem in data collection you will have a chance to rectify these on succeeding days. If you don't understand something, please contact FSF to discuss the problem, so that mistakes can be rectified quickly and easily.

It is always easier to resolve problems before you collect spectra, rather than trying to make sense of spectra collected using incorrect methods.

5. SUMMARY of key points to remember in field

1. Always connect a 12V battery to the Dell computer using the car adapter and 12V converter, as the computer's internal batteries are not sufficient for a day in the field.
2. Beware of damage to the fibre optic when using the instrument.
3. Do not over tighten the threaded fitting for the fibre optic.
4. Do not stretch the fibre or pull it.
5. Only work when solar conditions are optimal - 2/3 hours either side of Solar noon and when it is sunny and clear. Be extra careful about working in sub-optimal conditions.
6. Warm up the instrument prior to use (90 minutes is recommended)
7. Keep accurate log sheets
8. Accurately determine the size of the FOV at a given height before going into field.
9. Make sure that the FOV is completely filled with the target of interest.
10. Wait for two screen refreshes before saving a scan, as the ASD takes a few seconds to stabilise between measurements.
11. Collect more than 1 spectrum over each target to get an idea of the spectral variability of each surface.
12. Don't be shocked to see atmospheric water absorption features in your spectra at 1400 and 1800nm
13. Process and examine a few spectra each evening to check that they are correct and of good quality.
14. Lack of power is actually one of the most common problems so....

MOST IMPORTANTLY - CHARGE YOUR BATTERIES EVERY NIGHT

Remember if you are not sure about something, ring FSF as most problems can be easily rectified over the telephone.

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References

- 1 Mac Arthur, Maclellan & Malthus, 2007. Determining the FOV and directional response of field spectroradiometers. Proceedings 5th EARSeL Workshop on Imaging Spectroscopy. Bruges, Belgium, April 23-25 2007