Field Guide for the GER1500 – Dual Beam Mode: - Bi-Conical and Cos-Conical

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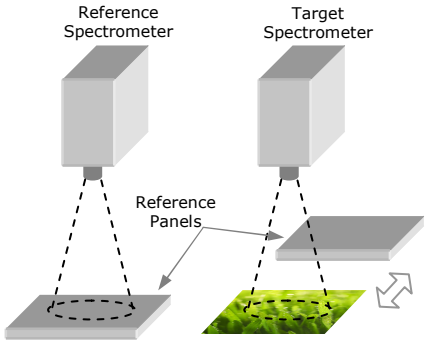
PC version: Panasonic Toughbook

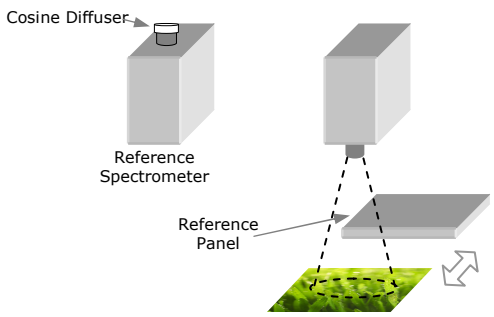
Original created by: Karen Anderson, EPFS Southampton, 2002

Introduction

This Field Guide provides reminders of the key processes involved in the setting up and use of the GER1500 spectrometer in dual-beam mode. This mode is where the computer is used to control the scans collected by two spectrometer heads, simultaneously. Operating the spectrometer in this mode offers advantages over stand-alone and single-beam modes, since it allows immediately coincident reference and target measurements to be collected. This allows for minimisation of spectral uncertainties related to changes in irradiance between reference and target scans. This mode also offers on-screen real-time visualisation of the data. There are two approaches to measurement in Dual beam mode. Bi-Conical and Cos-Conical



Bi-Conical



Cos-Conical

In **Dual-beam Bi-Conical** mode both spectroradiometer heads have lens fore optics fitted. The reference head is continuously pointed at a reference panel, the target head is used to first take a reference measurement either of the same or another reference panel to general an inter-calibration file. The Target head is then used to take measurements of the target surface of interest while the reference head takes concurrent reference panel measurements.

In **Dual-beam Cos-Conical** mode the reference head has a cosine diffuser fitted. The reference head is continuously pointing towards the illumination source or, if the sky is the illumination source, vertically up. The target head is used to first take a measurement of a reference panel to general an inter-calibration file. The Target head is then used to take measurements of the target surface of interest while the reference head takes concurrent measurements of the illumination source.

In Dual-beam Cos-conical there are two possible configurations for attaching a cosine diffuser.
1 – mount a cosine diffuser directly over the GER1500 fore optic standard lend lens or
2 – replace the GER1500 fore optic lens with a 3.5m long fibre optic which has a cosine diffuser attached

Using GER1500 spectroradiometers in Dual-Beam mode.

1. Power

Ensure all batteries (12V and 6V smartpack cells) 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.

2. Computer

Charge the Panasonic Toughbook on the mains computer prior to use in the field. This is best done overnight on mains power supply. When in use in the field, always use the Panasonic car charger with 12V battery converter to provide power to the computer, as the internal battery is only likely to last between 2 and 4 hours without an external source plugged into it. A fully charged 12V battery providing power to a fully charged computer should provide a full day's power.

3. Spectrometer Warm up

It is recommended that you "warm up" both GER1500's prior to use for spectral measurement collection. Ideally, we recommend at least 15 minutes. This means that you should attach the 12V battery/6V smartpack cell and switch the spectrometers on, so that the red lights appear at least 15 minutes before use. This will minimise errors caused by warming of the spectrometer array inside.

4. Setup

To provide power to the spectrometers, use a power converter insert or 6V smartpack battery. If using the power converter connect a 12V gel cell using the cables provided. Switch the spectrometer on using the Power switch. The red power light will now switch on.

On both spectrometer heads do the following:

- Use the MENU button on the spectrometer's front panel to navigate through the various menu options. There are five options, repeatedly pressing the menu button will take you through all five options. For use in dual-beam mode, you only need to adjust two of these options, the others will be set in the collection software.

- Press the MENU key until you reach a menu option called INTSP. This sets the integration speed for the spectrometer head, which is comparable to the shutter speed on a camera. The darker the surface, the longer integration speed should be used. We recommend that you leave this set to AUTOMATIC. This will enable the spectrometer to adjust the integration speed according to the surface being measured without you having to adjust it every time yourself. If an "A" is displayed on the LCD screen, then it is set to automatic. Ignore the number displayed next to the "A", this is the integration speed used at the last scan and is not relevant at this stage. If an "A" is not displayed, you will need to set this. To do so, press the EDIT key followed by the MENU key. This should cause the "A" to be displayed on the screen. When this happens, press the EDIT key again to set this parameter.

- Press the MENU key again. You will now see a menu called "TRG". This sets the functioning for the red trigger button on the front of the spectrometer head. You can set this to "Laser", "Scan" or "Both". This is set using the EDIT key followed by the up or down arrow keys, followed by EDIT again to set the trigger function. For dual-beam

use, it is recommended that you use "Laser", as this will enable you to position the spectrometer head accurately using the laser pointer before collecting a scan.

The Panasonic Toughbook Computer - Setup Procedure

1. Connect the spectrometer to a power supply and switch on.
2. Take 2 serial cable and connect both serial cables to each of the spectrometer's COM2 ports.
3. For the following instruments, the configuration provided below should be used, with respect to the computer connections and reference/target configurations.

Spectrometer pairing #2002/2003			**Spectrometer pairing #2038/2039**		
Target Head	2002	Computer COM1	Target Head	2038	Computer COM1
Reference Head	2003	Computer COM5 or 6 (use USB port)*	Reference Head	2039	Computer COM5 or 6 (use USB port)*

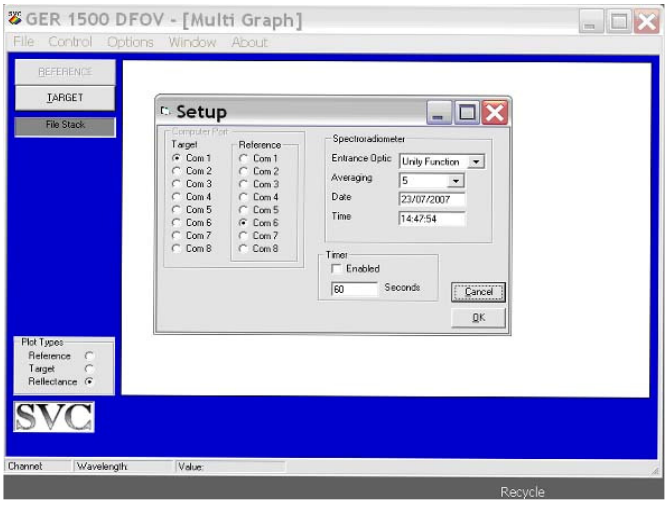
*Note. Use the Serial to USB connector provided.

You must ensure that the above configuration is always adhered to. Any deviation from the above setup will result in major errors arising in your spectra.

4. Power up the computer, ensuring that it is connected to an external power supply (Mains/12V). See the Panasonic Toughbook General Instructions at the end of this document for more details.
5. Log on as "FSF User."
6. Open Windows Explorer. Using the touchpad or touchscreen pen, go to 'My computer, C-drive:/FSF/ and create a directory for yourself in the "users" folder.
7. Launch the DFOV1500.exe software

Check that the opening prompt box which appears on launch of the software displays the correct serial numbers for your spectrometer configuration. The serial numbers should appear in the order of target, reference (2038, 2039). If this is not the case, you will need to edit the program's initialisation file (dfov.ini). Before doing this, you should contact FSF for instructions. At your training session, FSF staff will make sure that the dfov.ini file is set to the correct configuration, so there should be no need to change this.

8. Once you have clicked **OK** and the software has launched. Select 'Control' then 'Setup' to open the setup dialogue shown below. If you get an error message still 'click' OK and select 'Control' then 'Setup' to open the setup dialogue shown below.



SETUP Menu

9. The Serial connection on the back of the Toughbook is for the Target head and is Com 1. If the USB on the left hand side of the Toughbook is being used for the Reference head it is Com 6. The USB at the back of the Toughbook is Com 5. Ensure the appropriate radio buttons are checked.

10. The next option that you need to select is labelled as ***Entrance Optic.*** This does not refer to the optic that you have attached to the front of the spectrometer, as one might suggest. It is actually asking the user to set the format in which you wish to save your data. Here, we require an option known as "**Unity Function**", which means that we wish to save the data as raw Digital Numbers (DN). Choose this option from the drop down menu. The reason for using a DN save option is because all of the FSF post-processing software is designed to work on raw DN GER Sig files.

11. The third option that you will need to set is called ***Averaging*** and this 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. Remember that the averaging is actually 2^{x-1} where x is the averaging setting selected. So a setting of 5 here is actually averaging 16, and 6 is actually averaging 32 scans. It is recommended that you use an averaging of 5 or 6 under field conditions. Change the setting by choosing an option from the drop down menu. A conversion table for converting the averaging settings is provided below.

Computer averaging setting	**Actual number of scans averaged**
1	1
2	2
3	4
4	8
5	16
6	32
7	64
8	128
9	256

12. In the same menu box, you can set the date and time (these are not always accurate, due to a bug in the software). Note that you can also do timed measurements if required and these are often appropriate for dual field of view (DFOV) reflectance or radiance measurements over a fixed surface. Click **OK** when finished the above options have been set.
13. Finally go to the ***DISPLAY*** menu and click ***Options***. Turn off ***multigraph***, leave only a tick next to ***single graph***.
14. Choose ***FILE*** and then ***New.*** Choose the folder in which to save your data (i.e. the folder you just created in Windows Explorer) and give a root name for your spectra (up to 8 letters) – (**N.B**. Note. You will need to be able to differentiate between your inter calibration spectra and your target spectra for post processing) click ***OK***.
15. Check ***FILE, Data Options*** - check that there is a tick next to the ***Autosave*** option.
16. On the same menu bar, check that ***File Format*** is set to ***Sig File***.
17. There should be two buttons r to the left hand side of the screen, one labelled "reference" and one labelled "target". The "reference" button maybe greyed out.
18. The spectrometer is now set up ready for data collection.

TIP - IF THE SETUP BOX DOES NOT APPEAR SOON AFTER SELECTING ***Control, Setup*** THEN THERE IS LIKELY TO BE A CONNECTION PROBLEM. CHECK THE SERIAL CABLE CONNECTION, AND CHECK THAT THE RADIOMETER IS SWITCHED ON.

5. Data collection

To collect a scan with the GER1500 head, you must position the head over the target of interest. The head can be stabilised on a tripod, or hand held.

When you are positioned over the surfaces that you wish to measure, press the red trigger button on the front of the spectrometer. If you set the trigger function (TRG) to "laser" during the previous stage, pressing the red button will result in the laser pointer being activated. Use this to position the target and reference radiometers over your desired surfaces for measurement.

The reference sensor (#2003 or #2039) should always be measuring the Spectralon reference panel. It is recommended that the best method of setting this up is to fix the reference sensor using a tripod over a Spectralon panel which is also fixed to a tripod using a panel mounting clamp. The reference sensor can then remain at a fixed point collecting measurements over the Spectralon, while you are free to move the target sensor (#2002 or #2038) over a range of surfaces with ease.

If in Bi-conical mode - First acquire your reference spectra by using both heads simultaneously to measure the reference reflectance. It maybe the same panel measured simultaneously (**but pay attention to avoiding shadowing the panel with the heads**) or two separate panels with one head measuring the reflectance of each.

If in Cos-conical mode –First acquire your reference spectra by using both heads simultaneously to measure the reflectance from a reference panel with the 'target' head and irradiance with the 'reference' head.

In the GER1500 collection software, press either button marked ***REFERENCE*** or ***TARGET*** (on the left hand side of the screen). This will trigger a simultaneous scan from both heads. The spectrometers' shutters will open. You will hear two clicks of the shutter from each head, and these should be almost coincident. Between these two clicks, the radiometers must remain in a static position over the surfaces being measured. After the second click, it is safe to move the target radiometer to a new target surface (i.e. grass, soils, rock samples).

Once the spectrometer is stabilised over the surface press the ***REFERENCE*** or ***TARGET*** button again to collect another pair of scans.

After each pair of measurements, a graph will be displayed on screen. The black line is a quick ratio between the reference and target scans and gives an idea of the quality of the spectra that has been collected. However, this is not saved to disk; only the two spectral curves representing the raw DN measured by the sensor is written to file.

5.1 Intercalibration

At the start and then frequently throughout the target measurement sequence, you should perform a series of intercalibration measurements. (See References at the end of this paper for discussion on stability of intercalibration.) These measurements characterise the differences in the spectral response of the reference and target spectrometer heads, and the intercalibration function derived from these is then used during post-processing to generate absolute reflectance values for each surface measured.

In each intercalibration sequence, you should collect at least 10 ref-tar pairs, where both heads are measuring a Spectralon panel. Both heads can be measuring the same panel, or different panels, if two are available for loan from FSF. Point both sensors at the panel(s) and collect ten scans using the method described above. Make a note on your log sheets of the filenames that correspond to the intercalibration measurements. Use the FSF program Dual Field of View Excel Template to derive the intercalibration function for subsequent spectral processing.

5.2 Spectralon Panel Care

Handle the spectralon panel carefully - do not touch the surface. Mount the spectralon on a tripod using the panel mounting clamp. If insects or dirt land on the surface gently blow them away, preferably using an air duster - do not squash, crush, swipe as this will impair the surface of the panel. Pay particular attention when transferring the panel or putting it back into its case as the surface will dent very easily if it comes into contact with hard surfaces or corners. If the panel becomes dirty, please contact FSF for instructions on how to clean it.

5.3 Weather conditions

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 GER1500 system. If it is necessary to sample in sub-optimal conditions, the DFOV method will minimise errors caused by changes in irradiance. However, you must pay extra attention to the quality of the spectra collected, and if possible, increase the averaging in order to improve the signal:noise ratio of your spectra. If poor weather persists, cease data collection until sunny conditions return. 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 GER1500 in wet conditions as the electronic equipment is very sensitive to damp and should not be exposed to wet conditions.

5.4 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 (i.e. a number of Ref-Tar pairs). 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 the surfaces of interest with respect to spatial coverage.

5.5 Mounting

The spectroradiometer should be mounted securely during field deployment, and this can be performed using a tripod arrangement. Try to mount the radiometer so that it is viewing from nadir. The levelling device on the radiometer head will allow you to do this. You can also hand-hold the radiometer with the carrying handle, but this is not likely to be so stable.

5.6 Field Of View

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. This is true for both reference and target sensors. For the reference, the head must be mounted close enough to the panel that the panel completely fills the FOV. The FOV is approximately circular and is 3 degrees. 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.

5.7 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.

5.8 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 surface in the evening using the Dual Field of View Excel Template for

intercalibration function derivation and for reflectance calibration (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.

6. General notes on the Panasonic Toughbook PC

1. Always charge the internal battery from the mains overnight before use
2. Always connect a 12V battery to the computer using the car adapter and 12V converter, as the computer's internal batteries are not sufficient for a full day in the field
3. Take care if using the pen, as it takes a while to get used to the way that it operates. Watch out when using it within Windows Explorer as it is very easy to move files around that are critical to the operating system, which may cause major problems with the computer.
4. DO NOT INSTALL ANY EXTRA DEVICES ONTO THE PC. This has been known to confuse the serial port settings and prevent communication with the spectrometer.
5. In case of a major technical difficulty with the Panasonic, you should always phone FSF to ask advice.

7. SUMMARY of key points to remember in field

1. Always connect 12V battery to computer using the car adapter and 12V converter, as the computer's internal batteries are not sufficient for a day in the field
2. 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.
3. Warm up the instrument prior to use (15 mins is ideal)
4. Keep accurate log sheets
5. Accurately determine the size of the IFOV at a given height before going into field.
6. Make sure that the IFOV is completely filled with the target of interest.
7. Collect more than 1 spectrum over each target to get an idea of the spectral variability of each surface.
8. Process and examine a few spectra each evening to check that they are correct and of good quality
9. Lack of power is actually one of the most common problems so….

MOST IMPORTANTLY - CHARGE YOUR BATTERIES EVERY NIGHT

FSF staff have experienced most technicalities with this system and will normally be able to offer advice over the telephone. So remember, if you are not sure about anything, ring FSF.

Tel: + 44 131 6505926

References

Anderson, K., Milton, E.J. and Rollin, E.M., 2006. Calibration of dual-beam spectroradiometric data. International Journal of Remote Sensing, Vol. 27 No.5, pp 975-986

Rollin, E.M., Emery, D.R., Kerr, C.H. and Milton, E.J., 1998. Dual beam reflectance measurements and the need for a field intercalibration procedure. . *Developing International Connections. Proceedings of the 24th Annual Conference of the Remote Sensing Society.* Remote Sensing Society, Nottingham, UK, 552-558.

MacLellan, C. 2006. Guidelines for Post Processing GER 1500 Dual Field of View Data Files using a FSF Excel Template Version 02 (2007). ©NERC Field Spectroscopy Facility, Edinburgh