

Guidelines for Post Processing GER 1500 Dual Field of View Data Files using a FSF Excel Template

Version 03 (March 2009) By Peter Walker

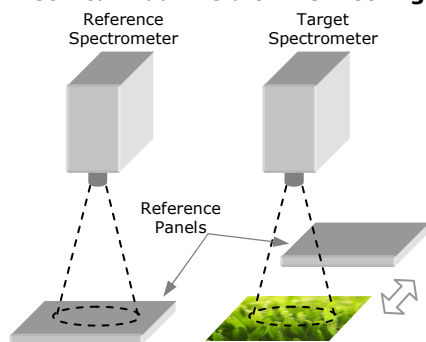
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Original Created by: Chris MacLellan, May 2006, FSF Edinburgh

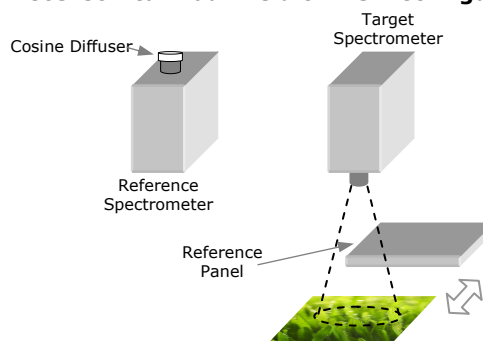
The NERC Field Spectroscopy Facility has created an Excel template which can be used to post process the spectral reflectance data files collected simultaneously from two GER 1500 spectroradiometers in a dual field of view (DFOV) configuration using the GER 1500 DFOV application software.

In Dual Field of View DFOV operation the *Reference* channel can be mounted in the Nadir orientation to continually view a reference panel (Bi-Conical configuration) or is orientated vertically upwards with a cosine diffuser fitted over the foreoptic (Cos-Conical configuration). The *Target* channel is typically orientated in a Nadir position to measure the reflectance of the test samples or target surface area.

Bi-Conical Dual Field of View Configuration



Cos-Conical Dual Field of View Configuration



However, before the DFOV system is ready to take relative or absolute reflectance measurements an Inter-Calibration [Rollin, E.M. et al 1998] between the two spectrometers is required. During an Inter-Calibration sequence the Target spectrometer is mounted in Nadir orientation to view the *Target's* reference panel. This should be repeated at regular intervals throughout the day and validated by viewing the *Target* reference panel at the end of the reflectance measurement sequence.

This guideline outlines the steps required to generate the Inter-Calibration file and calculate reflectance data from two GER 1500 spectrometers when they are configured to take *Bi-Conical* or *Cos-Conical* dual field of view measurements. The template will allow multiple spectral data files to be compiled into a single spreadsheet, interpolated to a 1nm interval, scaled for relative and absolute reflectance values or converted to spectral radiance or irradiance values.

Note:

Only one set of Inter-Calibration and DFOV reflectance files can be imported and processed by this Excel template.

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1. Installation of XlXtrfun Excel Add-In

The Excel templates for processing the GER signature or ASCII data use an *Add-In* feature called XlXtrfun. This Add-In includes math functions such as linear or cubic spline interpolation and is available as a free download from the internet. Instructions are given below for installing and activating this *Add-Ins*.

This free download is available from Advanced Systems Design and Development at their website:

<http://www.xlXtrfun.com/XlXtrFun/XlXtrFun.htm>

- Click on the **Download now** button and complete the optional registration form or click on the **Continue to Download XlXtrfun->** button.
- Save the 739 Kbyte file xlXtrfunDistribution.zip to your computer.

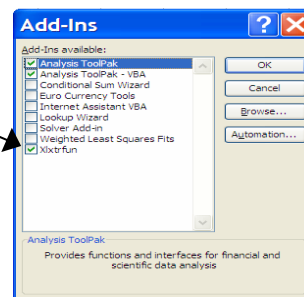
To install the program follow the notes below:

1. Exit (shut down, quit, stop) Excel.
2. Unzip `XlXtrFun.zip`.
3. Put `XlXtrFun.xll` wherever you want and use Excel's Add-In Manager to install `XlXtrFun.xll`.
 1. Start Excel.
 2. If a workbook is not already showing, open or create a new workbook.
 3. Click on `Tools - Add-Ins - Browse` to wherever you put `XlXtrFun.xll` - `OK` - `OK`.

For further information refer to the file [ReadMeXlXtrfunAnd SurfGen.html](#)

From the Tools/Add-Ins menu in Excel ensure that the new *XlXtrfun* Add-In is listed and activated.

Click OK to close the Add-In dialog.



2. Post Processing DFOV Reflectance Data Files

The procedure for processing the Excel template is as follows:-

- Open the template and set up the Input Parameters
- Import the raw GER 1500 Inter-Calibration data files and generate an Inter-Calibration file
- Import the Target data, calculate their ratio and interpolate to 1nm interval
- Calculate Relative and Absolute reflectance values using the Inter-Calibration file and panel calibration data.

Excel Macro Security Level

Before the Excel templates can be opened it is necessary for the Macro Security level to be set to allow the template's macro and Visual Basic code to be enabled.

- From the Excel *Tools* menu select *Options* and the *Security* tab.
- Click on the *Macro Security* button and change the *Security Level* to *Medium*.
- If using **Excel 2007** click on the 'office' button in the top left corner of the screen. Excel options – Trust center. Trust center settings – macro settings – enable all macros – OK.

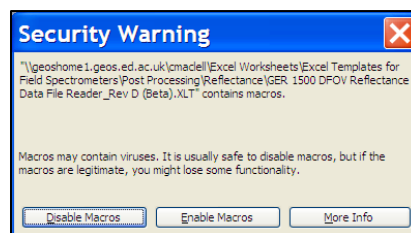
This will allow the macros to be manually enabled when opening the Excel template.

Opening and Saving the GER 1500 DFOV Reflectance Template

- Open Excel and from the File menu Open and select the FSF Excel template:

GER 1500 DFOV Reflectance Template_Ver 03.XLT

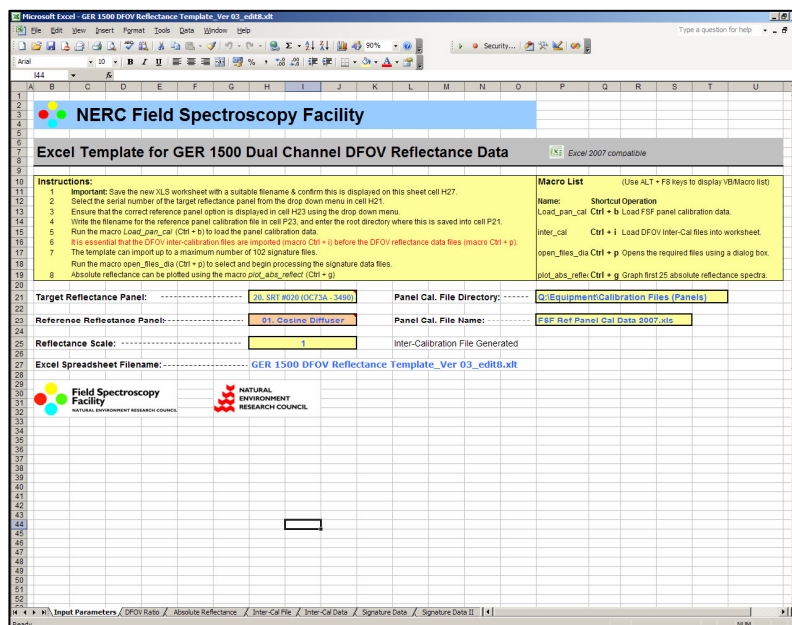
- In the Security Warning dialog click the **Enable** **Macros** button.



Note:

As the template is a read only document it needs to be opened and renamed as an Excel XLS worksheet prior to running the macros.
If using Excel 2007, it will need to be saved as a .xlsm (macro enabled excel worksheet).

The new spreadsheet will open on its *Input Parameters* worksheet as shown below:

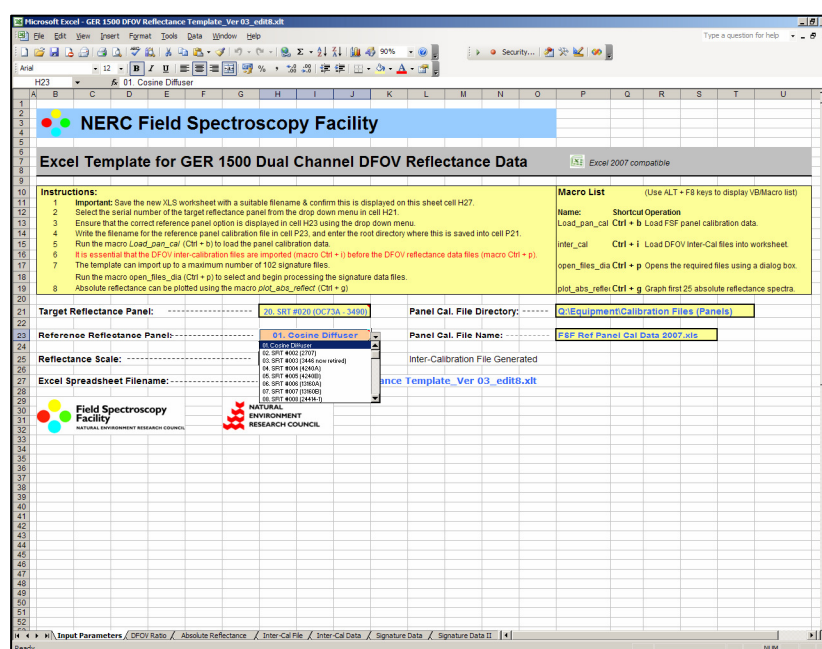


- Save the spreadsheet as an XLS document (or .xlsm if using Excel 2007) with a name and in a directory of your choice. The new name is displayed in cell H27 of the Input Parameter worksheet.

Setting up the Input Parameters

The **Input Parameter** worksheet allows the user to select the path\directories and root filenames for your GER reflectance data files and inter-calibration files. The reflectance panel used for the reference measurement should be selected within this worksheet.

- Click on cell **H21** to bring up the pop down menu button. Click on the button to display the serial numbers of the NERC FSF calibrated reference reflectance panels. Select the serial number of the panel placed below the Target spectrometer lens. *This will be used to convert the relative reflectance values into absolute spectral reflectance data. If you do not require absolute reflectance data select "Panel Not Selected" from the list.*
- Click on cell **H23** to bring up the pop down menu button. Click on the button to display the serial numbers of the NERC FSF calibrated reference reflectance panels.



- For a Bi-Conical configuration select the serial number of the panel placed below the Reference spectrometer lens. *This will be used to convert the relative reflectance values into absolute spectral reflectance data. If you do not require absolute reflectance data select "Panel Not Selected" from the list.*
- For a Cos-Conical configuration select the 'Cosine Diffuser' from the Reference Reflectance Panel drop down list.
- Set the Reflectance Scale (cell H25) to the desired level. Typically this is 1 or 100.
- Write the filename for the reference panel calibration file into cell **P23**. **NOTE:** It is important to ensure that the Reference panel calibration file corresponds to the same year that the measurements were taken. Files from previous years are archived on the FSF website, please contact FSF for further advice on this.
- Enter the root directory where you have saved the reference panel calibration file into cell **P21**.

Macro for Importing the selected reference panel Calibration Data

Before the data can be processed it is necessary to run the macro *load_pan_cal*. This will read the selection in cells P21 & P23 and import the calibration data from the panel calibration spreadsheet into columns C & D of the Inter-Cal File worksheet.

- Use the short-cut keys **Ctrl + b** to load the selected panel calibration data.

Import Inter-Calibration Files

These files are recorded by placing a calibrated reference panel into the field of view of the Target spectrometer. This process should be repeated periodically throughout the day (Anderson, K. et al 2006).

Note:

Only one set of Inter-Calibration and DFOV reflectance files can be imported and processed by this Excel template.

It is essential that all the Input Parameters are correctly installed and the Reference panel(s) serial numbers selected before running the template macros. The Excel template can import up to a maximum of 102 GER reflectance data files from the selected directory.

Signature reflectance data from the GER spectroradiometers comprises of a file header with measurement parameters, and three columns of data with the wavelength scale, target spectral data and reference spectral data.

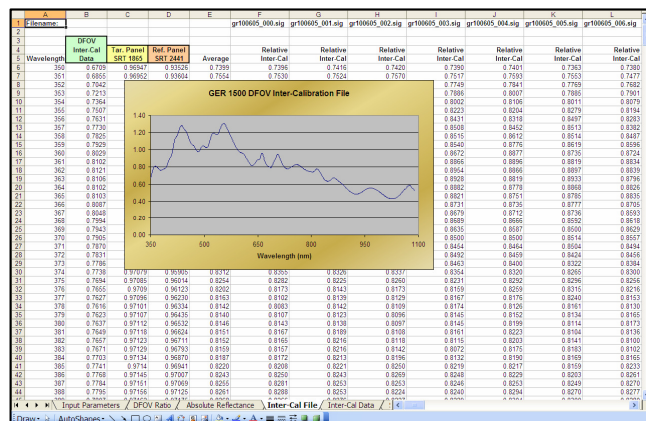
- Start the *inter_cal* Macro from the Tools \ Macro\ Macros menu or use the short cut keys **Ctrl + i**

A 'File open' dialogue box will prompt you to select all the .sig files that you wish to import into the template, navigate to the directory where these DFOV *inter-calibration* files are saved, highlight these and then click 'open'.

A prompt box will open showing the number of files selected for import. Click ok to this and the files will begin to be imported. During the importation procedure the data file names will appear and disappear from the Windows task bar. The procedure can take several minutes depending on the number of data files selected and the speed of your computer. A further delay is to be expected as Excel interpolates the relative reflectance values for each of the spectral data files.

Cell L25 on the Input Parameters sheet will display "**Inter-Calibration File Generated**" when the Inter-Calibration files have been successfully imported.

- Select the Inter-Cal File worksheet tab to display the data and to graph it.



Inter-Cal worksheet with spectral plot of the Inter-Calibration file

Importing DFOV Reflectance Data

Signature reflectance data from the DFOV GER spectroradiometers comprises of a file header with measurement parameters, a column with the wavelength scale¹ and two columns of Target and Reference spectral data².

- Start the **open_files_dia** Macro from the Tools \ Macro\ Macros menu or use the short cut keys **Ctrl + p**

As for 'importing the inter-calibration' files above, follow the prompt boxes to select the DFOV reflectance data files and click ok to the file count pop-up box.

During the importation procedure the data file names will appear and disappear from the Windows task bar. The procedure can take several minutes depending on the number of data files selected and the speed of your computer. A further delay is to be expected as Excel interpolates the DFOV ratio values for each of the spectral data files.

The Signature Data Worksheet

The Signature Data (Signature Data II) worksheet(s) shows the original data with the file header slightly reformatted. A fourth column is added to each file to show the calculated DFOV ratio values taken from the ratio of the raw target and reference data. When the reference data value is zero the reflectance value is set to zero.

Note:

The wavelength scale of the Reference spectrometer (s/n 2039) is automatically interpolated to match the scale of the Target spectrometer (s/n 2038).

	A	B	C	D
1	///GER	SIGNATUR	FILE///	
2	Filename	gr093005_000.sig		
3	h_name=	gr093005_000.sig		
4	instrument=		2038	2039
5	target time=	30/09/2005	12:15:42	
6	ref time=	30/09/2005	12:15:35	
7	long=			
8	lati=			
9	gpstime=			
10	comm=			
11	memory slot=			
12	averaging=	4	4	
13	int. speed=	6	6	
14	optic=	1	1	
15	data=	Target	Reference	DFOV Ratio
16		272.95	-0.01	-0.29 0.03448276
17		274.99	0.01	-0.25 -0.04
18		277.01	-0.02	-0.21 0.0952381
19		279.03	0.02	-0.17 -0.1176471
20		281.05	-0.03	-0.13 0.23076923
21		283.06	0.02	-0.09 -0.2222222
22		285.06	-0.03	-0.05 0.6

The DFOV Ratio worksheet

This worksheet uses the *xlxtrfun spline* interpolation to expand the Signature Data DFOV Ratio values to a 1nm spectral interval and restrict the spectral range to 350 – 1100nm.

	A	B	C
1	Filename:	gr093005_000.sig	gr093005_001.sig
2			
3			
4		Interpolated	Interpolated
5	Wavelength	DFOV Ratio	DFOV Ratio
6	350	-3.75	0.90
7	351	0.30	0.97
8	352	2.80	0.60
9	353	0.49	0.78
10	354	-1.92	1.08
11	355	1.15	0.78
12	356	4.61	0.40
13	357	4.20	0.46
14	358	5.12	0.72

The Absolute Reflectance Worksheet

Spectral reflectance data from the DFOV Ratio worksheet is multiplied with the newly generated Inter-Calibration File (column B) to give the *absolute spectral reflectance* values for the target.

	A	B	C	D
1		Filename:	gr093005_000.sig	gr093005_001.sig
2				
3				
4			Absolute	Absolute
5	Wavelength	Inter-Cal/Scale	Reflectance	Reflectance
6	350	1.6721	-627.2%	150.0%
7	351	0.1774	5.4%	17.2%
8	352	-0.7100	-199.0%	-42.8%
9	353	0.9846	48.3%	76.4%
10	354	2.1517	-413.8%	231.4%
11	355	-0.6201	-71.0%	-48.4%
12	356	-2.7710	-1278.7%	-110.5%
13	357	-0.6309	-264.7%	-29.3%
14	358	1.4751	755.7%	105.9%

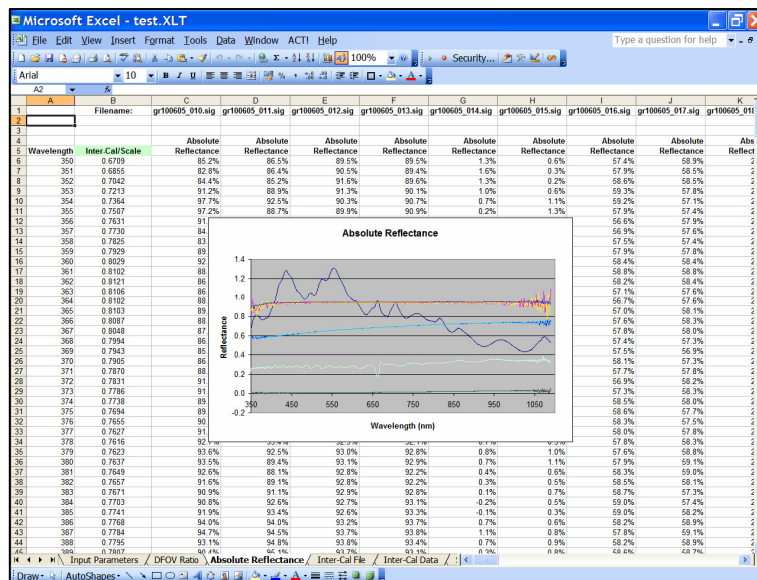
¹ The wavelength scale is taken from the *Target* spectrometer.

² The spectral data from the *Reference* spectrometer is automatically adjusted to the wavelength scale of the *Target* spectrometer.

Graphing Relative Reflectance data with the template Macro

The simple graphing macro **plot_abs_reflect** plots the first 25 spectra in the **Absolute Reflectance** worksheet.

- Select from the Tools\Macro\Macros menu the **plot_abs_reflect** macro or use the macro shortcut keys **Ctrl + g** to plot up to 25 spectra in the Absolute Reflectance worksheet.



X-Y scatter plot of calculated absolute reflectance data using the **plot_abs_reflect** macro (short-cut keys Ctrl + g)

Note:

The spreadsheet can now be saved for further processing.

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.