Guidelines for Post Processing SVC HR-1024i Spectral Data Files using a FSF Excel Template

Document No. 300-007
Version 04 (Sept 2015)
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The NERC Field Spectroscopy Facility has created an Excel 2013 template which can be used to post process the spectral data files from SVC HR-1024i spectroradiometers acquired using the PC Data Acquisition Software V1.17.3 or later. This will allow multiple spectral data files to be compiled into a single spreadsheet, interpolated to 1 and 2nm[1] intervals and scaled for relative and absolute reflectance values. Note: to ensure that the macros in the templates run correctly please close all other excel spreadsheets while you use the template.

Contents:

1. Installation of Xlxtrfun Excel Add-In

The Excel templates for processing the SVC 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`.

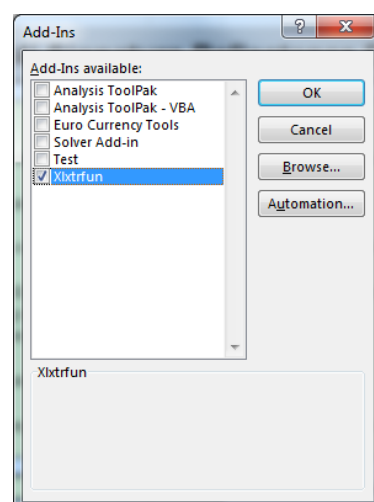For further information refer to the file `ReadMeXlxtrfunAnd SurfGen.html`

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[1] 1 nm from 350 to 990nm; 2nm from 990 to 2500nm.

From the File/Options dialog (Excel 2013), select manage Excel Add-ins and click on Go button.
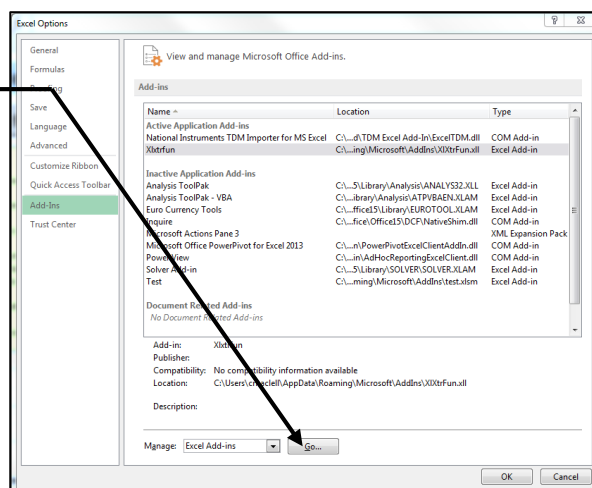
Confirm that *Xlxtrfun* is listed and checked in Excel Add-Ins dialog.

Click OK to close the Add-In dialog.

2. Post Processing Reflectance Data Files

The SVC HR-1024i reflectance data (.SIG) files always include both the reference and target scans in each Signature data file, this allows for retrospective calculations and adjustment when ratioing the two scans to obtain relative reflectance values.

Excel Macro Security Level

The FSF Excel template (*.xlst) has embedded macros. Excel's security features will typically show a security warning when opening the template indicating that the macros have been disable. Click the Enable Content button below the menu bar.

With some versions of Excel a Security Dialog appears when opening the template. Click on the Enable Macros button.
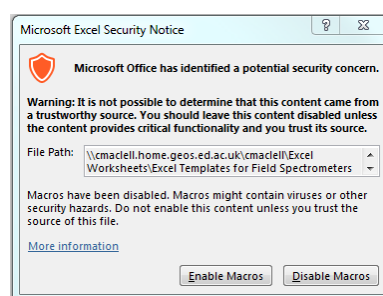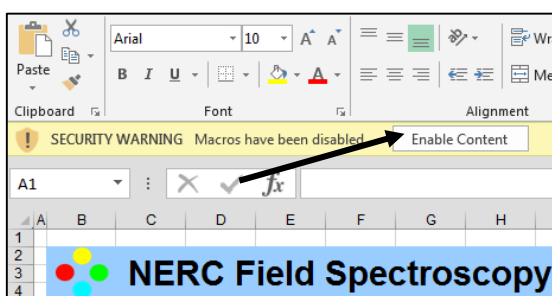
Opening and Saving the SVC HR-1024i Reflectance Template

- From Excel's File menu Open and select the FSF Excel template:

  SVC HR-1024i Reflectance Template_Ver 04.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 XLSM type macro enabled worksheet prior to running the macros.

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

- Save the spreadsheet as an XLSM document with a name and in a directory of your choice. The new name is displayed in cell H36 of the Input Parameter worksheet.

Setting up the Input Parameters

The **Input Parameter** worksheet allows the user to select the reflectance panel used and specify the path\directory and root filename for the reflectance panel data files.
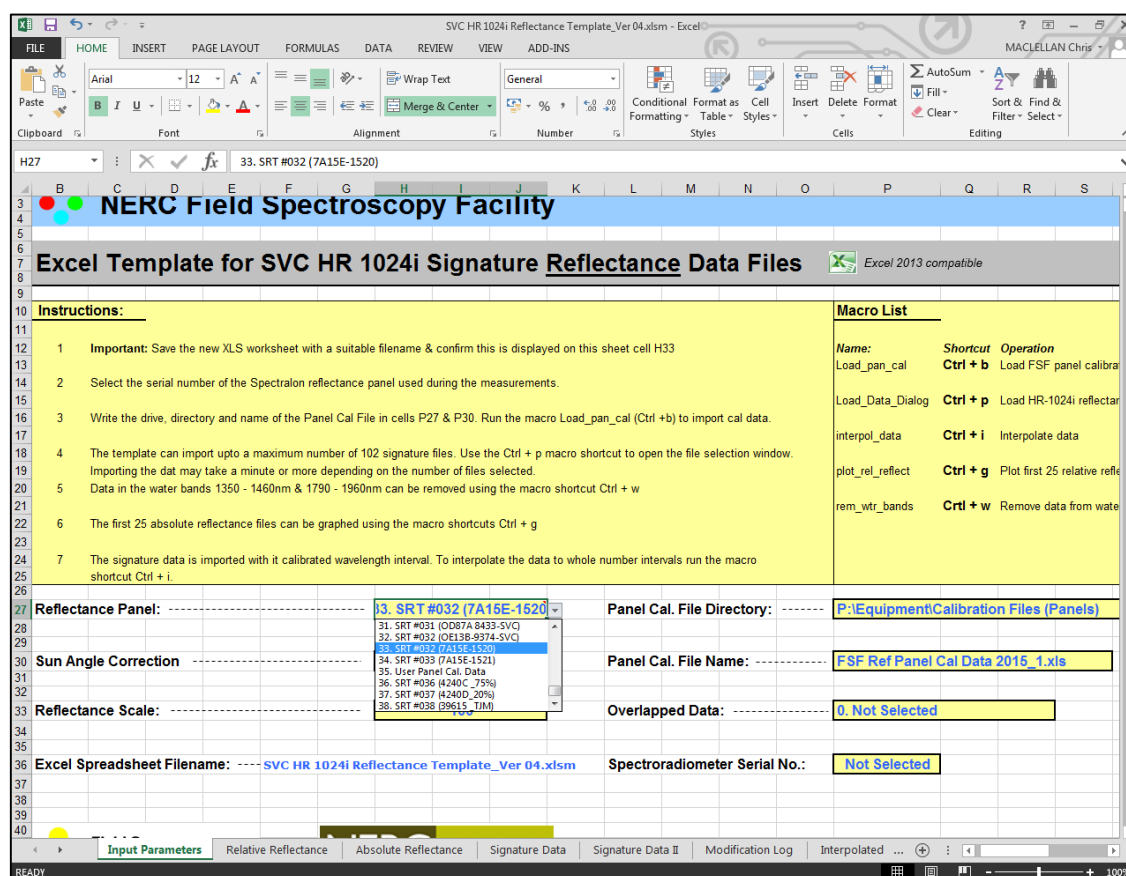
- Click on cell **H27** to bring up the pop down menu button. Click on the button to display the serial numbers of the NERC FSF or User calibrated Reference panels.

- Scroll the list and select the serial number of the panel used during the reference measurements. *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.*

- The calibration data for the Reflectance panels is stored in a separate Excel spreadsheet. Enter into cell **P27** the directory path where this spreadsheet is located on your computer

- Enter into cell **P30** the name of the Reference panel calibration spreadsheet file. **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.

- Sun Angle Correction has not been implemented into the template at this stage.

- Set the Reflectance Scale (cell **H33**) to the desired level. Typically this is 1 or 100.

- The HR-1024i can save data files with either the overlap data removed or preserved. The template will identify the Sig file format and import only the matching type. Set the Overlapped Data format (cell **P33**).

- Set the Serial Number of the spectroradiometer (cell **P36**) to the desired level. Typically this is 1 or 100.

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 cell H27 and import the calibration data from the panel calibration spreadsheet into column B of the *Absolute Reflectance* worksheet.

The Excel spreadsheet is now ready to import data.

Importing Data with the SVC HR-1024i template Macro

The Excel template can import up to a maximum of 102 SVC reflectance data files from the selected directory.

Signature reflectance data from the SVC HR-1024i spectroradiometer is assembled from the instrument's three spectrometers and covers the spectral range 350 to 2500nm. The silicon detector has a spectral range 350 – 990nm with a sampling interval[2] of approximately 1.5nm. An InGaAs and extended InGaAs detector arrays cover the spectral ranges 990 – 1900m and 1900 – 2500nm with wavelength resolutions of 9.5 and 6.5 nm, respectively. The Sig data files can also be interpolated to 1 & 2nm intervals using the interpolation macro – ref later in this guide.

- Start the ***open_files_dialog*** macro from the View\Macro menu or use the short cut keys ***Ctrl + p***
- Note if the Overlapped Data option (*Removed or Preserved*) Cell P33 has not been selected the Open Files macro will not run.

A 'File open' dialogue box will prompt you to select all the .sig files that you wish to import into the template. Highlight these and then click 'open'. The template and its Macro \ Visual Basic code import all the signature data files[3] that were selected in the dialogue box.
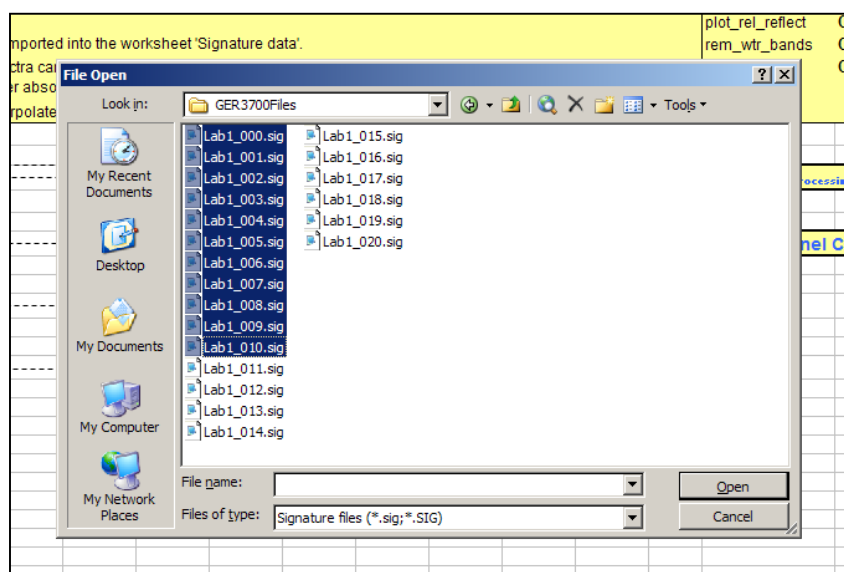
When the open files macro is running the data file names will appear and disappear from the Windows task bar. The procedure can take several minutes depending on the number of data files selected and the speed of your computer. A further delay is to be expected as Excel interpolates the relative reflectance values for each of the spectral data files.

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[2] Note this is not equivalent to the optical resolution or bandwidth but represents the wavelength separation of each of the detector's pixels.

[3] Note only Preserved or Removed Overlap data files will be imported – ref cell P33 on Input Parameter worksheet.

The Signature Data Worksheet

The Signature Data worksheet(s) shows up to 51 data files[4] with the header slightly reformatted. A fourth column is added to each file to show the calculated reflectance 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.

File header information includes:
- Date & time stamps,
- Integration times and co-adds
- Array detector temperatures
- Radiometric calibration (fore-optic)
- External sensor data
- Battery voltage
- GPS co-ordinates & time
- Matching type (none, radiance, reflectance)
- Overlap data (Removed or Preserved)

Four columns of data per file[5]:
- Wavelength (non-interpolated scale)
- Reference data (radiance or raw DN)
- Target data (radiance or raw DN)
- (Relative) Reflectance data

	A	B	C	D	E
1	/***	Spectra	Vista	SIG	
2	Filename=	**QA_040.sig**			
3	h_name=	0.80.8			
4	instrument=	1132003			
5	target time=	16:25:19			
6	ref time=	16/07/2015	16:20:56		
7	Si Int. Time (Ref, Target)=	40	50		
8	InGaAs1 Int. Time=	20	20		
9	InGaAs2 Int. Time=	10	10		
10	Fore optic (Ref, Target)=	SPARE6(6), SI,			
11	Silicon temp.=	40.4	40.5		
12	InGaAs1 temp.=	-5	-5.1		
13	InGaAs2 temp.=	-10.1	-10.1		
14	scan method=	Time-based	Time-based		
15	scan coadds=	20, 43, 78	25, 43, 78		
16	scan time=	1	1		
17	scan settings=	AI	AI		
18	external data Ref-A=	0, 0, 0, 0, 0, 0, 0, 0			
19	external data Ref-B=	0, 0, 0, 0, 0, 0, 0, 0			
20	external data Target-A=	0, 0, 0, 0, 0, 0, 0, 0			
21	external data Target-B=	0, 0, 0, 0, 0, 0, 0, 0			
22	External Data Dark=	0, 0, 0, 0, 0, 0, 0, 0			
23	External Data Mask=	255			
24	error=	3	3		
25	Battery (V)=	7.51	7.52		
26	units=	Radiance	Radiance		
27	longitude=				
28	latitude=				
29	gpstime=				
30	comm=				
31	memory slot=	0	0		
32	matchfactors=	0.8	0.8	0.808	
33	matching type=	Reflectance			
34	overlap=	[Overlap: Remove @ 990 1901			
35	data=	Reference	Target	Reflectance	
36	339.8	127549.82	71026.62	55.69	
37	341.3	131352.62	74055.52	56.38	
38	342.8	138912.79	76085.56	54.77	
39	344.2	153990.61	76114.13	49.43	
40	345.7	169080.23	83155.86	49.18	

The Non Interpolated Worksheets

The **Relative Reflectance** worksheet provides a tabular summary of non interpolated data from the full spectral range of the signature files.

	A	B	C
1	**Filename:**	**QA_040.sig**	**QA_041.sig**
2	**Overlap data:**	Remove	Remove
3	**Matching type:**	Reflectance	Reflectance
4		**Relative**	**Relative**
5	**Wavelength**	**Reflectance**	**Reflectance**
6	339.80	55.69	55.69
7	341.30	56.38	54.09
8	342.80	54.77	54.05
9	344.20	49.43	52.68
10	345.70	49.18	49.18
11	347.10	46.99	46.43

The **Absolute Reflectance** worksheet has its minimum wavelength set to 330nm The Xlxtrfun spline function calculates the reference panel calibration file (column B) for the wavelength scale of the SVC HR-1024i. This is used to calculate the absolute reflectance values from the relative reflectance worksheet values.

|	A	B	C	D	E
1		Filename:	QA_040.sig	QA_041.sig	QA_042.sig
2					
3		19/02/2015			
4		Ref. Panel	Absolute	Absolute	Absolute
5	Wavelength	SRT #039 (7A41B-4463-SV	Reflectance	Reflectance	Reflectance
6	339.80	98.3%	54.74	54.74	55.50
7	341.30	98.3%	55.41	53.16	53.92
8	342.80	98.3%	53.83	53.12	53.12
9	344.20	98.3%	48.58	51.77	50.50
10	345.70	98.3%	48.33	48.33	46.58
11	347.10	98.3%	46.18	45.63	45.63
12	348.60	98.3%	44.41	43.39	43.39
13	350.10	98.3%	43.10	42.63	43.10
14	351.50	98.3%	41.52	42.85	42.40
15	353.00	98.3%	40.53	42.56	40.93
16	354.50	98.3%	40.04	40.04	40.04
17	356.00	98.3%	38.82	38.15	38.82
18	357.40	98.3%	39.16	38.50	39.49
19	358.90	98.3%	38.53	39.81	39.48
20	360.40	98.3%	39.47	39.18	38.88

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[4] Additional files, up to a total of 102 are stored in the Signature II worksheet.
[5] Note the data tools in the SVC HR-1024i application include merging, resampling (interpolation) and absolute reflectance scaling.

Plotting the HR-1024i data

The graphing macro **plot_rel_reflect** (shortcut **Ctrl + g**) can be used to graph the first 25 spectra in the *Relative Reflectance* worksheet. Use the Excel Chart Wizard or edit the source data to select your own data plots.

Note that this plotting macro only runs on non-interpolated data, even if the interpolation macro (Ctrl + I, see below) has been run. The interpolation macro has its own chart plotting function built in which does plot the interpolated data.
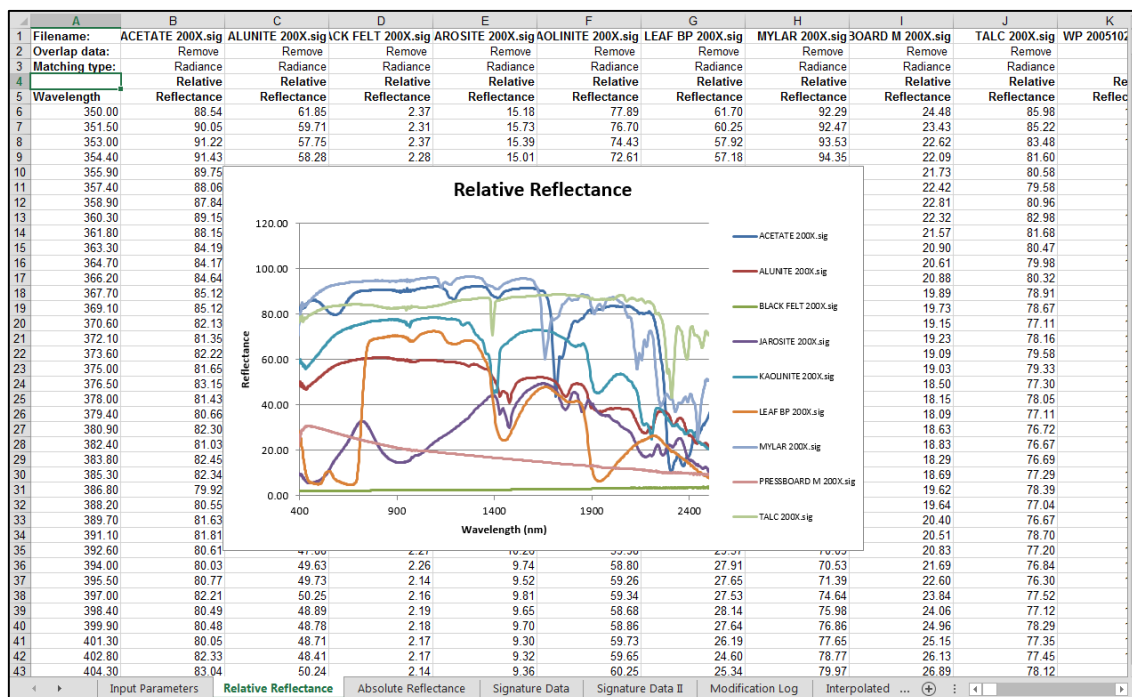
*X-Y scatter plot of relative reflectance data using the plot_rel_reflect macro (short-cut keys Ctrl + g)*

Interpolating the SVC HR-1024i data

Interpolating across the joins in this spectral data from two different spectometers within the HR_1024i can give erroneous results. Thus the data from each of spectrometers has to be processed separately. In addition the macro has to recognise when data files preserve or remove the overlap data.

Range (nm)	Interpolation
350 - 990	1 nm
990 - 1900	2 nm
1900 - 2500	2 nm

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

During this macro the worksheets **Interpolate Rel Reflect** and **Interpolated Abs Reflect** are created to the right of the **Relative** and **Absolute Reflectance** tabs. The procedure can take several seconds due to the three stage interpolation and the number of data files to be interpolated. A further delay is to be expected as Excel creates the Interpolated Relative Reflectance plot.
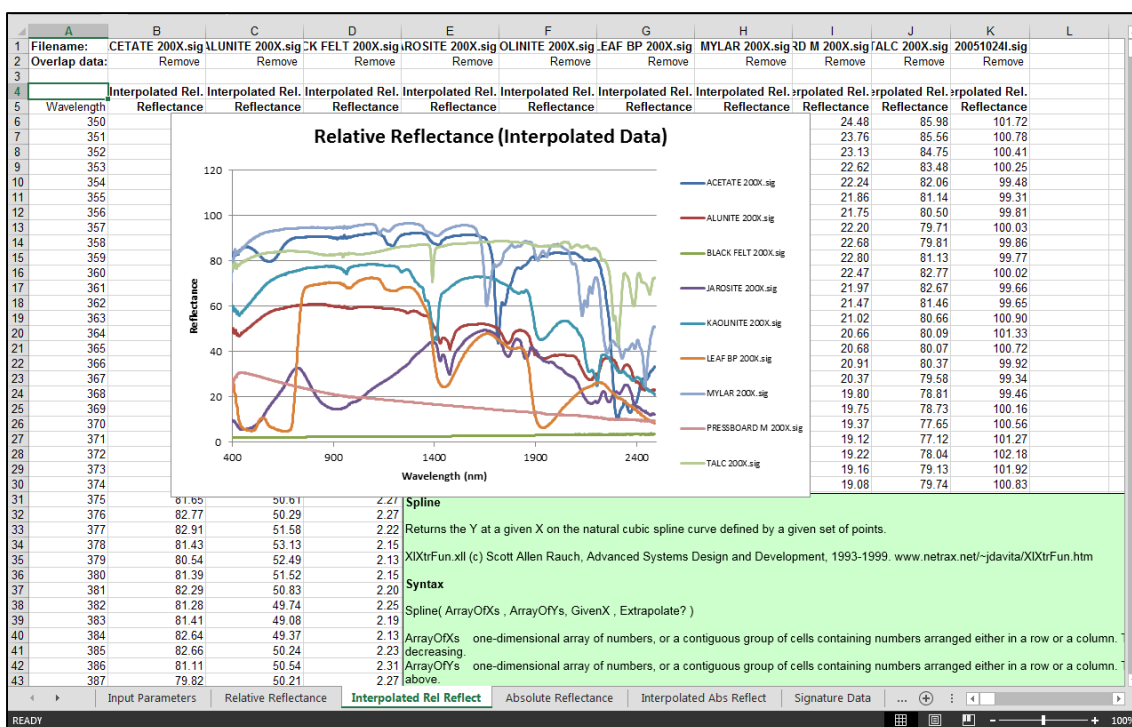
> ### Note:
> The **Interpolated Rel Reflect** worksheet reads data directly from the **Signature Data** worksheets and it is therefore possible to delete the non-interpolated **Relative** and **Absolute Reflectance** data worksheets.

Removing data from the Atmospheric Water Absorption Bands

Under certain measurement conditions the atmosphere can strongly absorb the incident downwelling radiation in two bands (1350-1520nm & 1790-1960nm) of the shortwave infrared region. As a result the reflectance data can appear very noisy in these regions. The template macro **rem_wtr_bands** deletes data across these bands in all four of the Reflectance and Interpolated Reflectance worksheets.

Note:
The Signature Data worksheet and the Signature data files remain untouched when this macro is run.

- Start the ***rem_wtr_bands*** Macro from the Tools \ Macro\ Macros menu or use the short cut keys ***Ctrl + w***
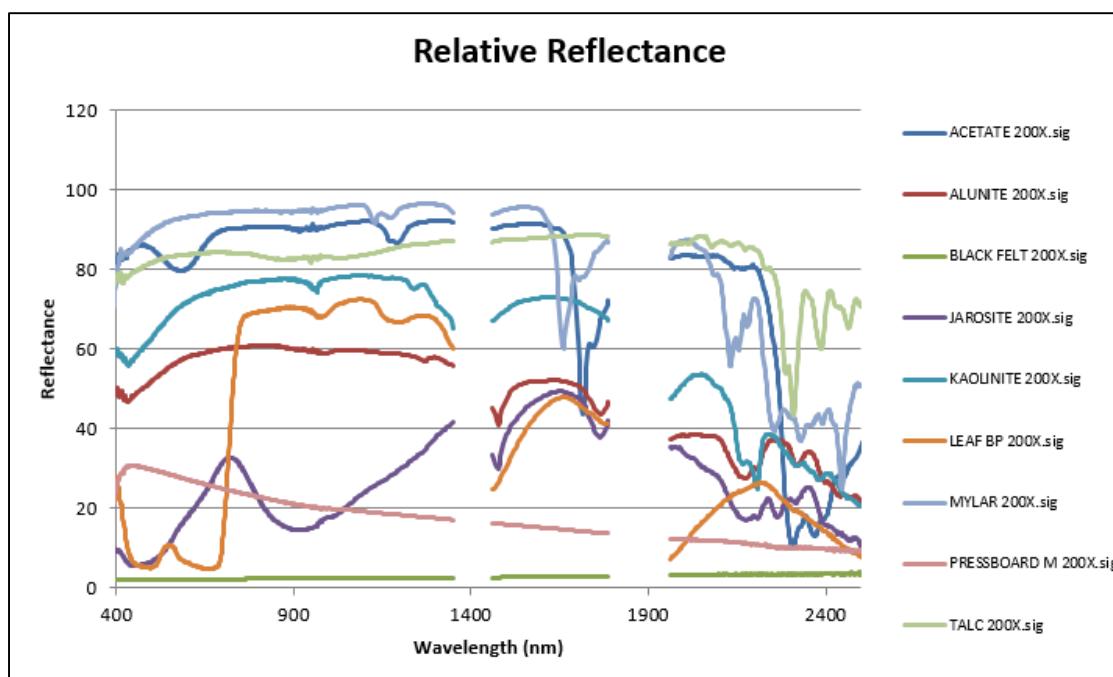
Note:
It may be necessary to run the macro a second time if the interpolated data is created after the macro was run

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The spreadsheet can now be saved for further processing.