SPECTRORADIOMETER UTILITY

Alan Roberts © 2014-08-01. Version 2.0

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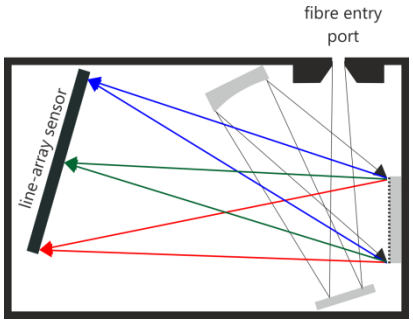
1 OVERVIEW

This program is intended to be used for the processing of text files saved by the ASEQ LR1 spectroradiometer, or any other entry-level device which does not perform full amplitude calibration.



The light-paths inside small spectroradiometers are all very similar, but may have variations. Typically, light enters from an optical fibre, and through a narrow slit, and is reflected from one or more mirrors to form a parallel beam of light which illuminates a grating mirror. One of the mirrors must be concave to do this. Light from the grating is spread to forma spectral distribution, a rainbow, and is directed onto a line-array sensor. There may be one or more mirrors in this light path as well.

The software for the LR1 contains calibration data which ensures that the wavelengths are accurate, but not for the amplitude at each wavelength. The data files it creates are simple text listings with no headers, containing a response value as each wavelength. Typically, there are over 3,500 values recorded between 200~1200nm or 300~1000nm depending on the model. The values recorded are the outputs of the individual CCD cells in the line-array sensor and are at incredibly fine intervals, although the basic bandwidth of the results is about 2.5nm.

This program will apply a normalisation to the data values, derived from a reference calibration file (e.g. ASEQ LR1 calibration.lmp) such as is supplied by the manufacturer of a calibrated source, and from a measurement of such a calibrated source using the LR1. In this respect, it is not specific to the LR1, and can be used for normalising the data from any spectroradiometer which does not have such normalisation built into its software. The software also has facilities for removing any background signal, such as the dark-current of the sensor and/or flare generated internally.

There will be two output files, one having the extension spd, which can be used in my TLCI-2012 software, but still needs to be converted to conform to the '380-760nm in 5nm steps' format. The spd file will preserve the fine structure of the LR1 data. The other file has the extension lum and is fully ready for use in TLCI calculations without further processing, it is subsampled from 380 to 760nm in 5nm steps. Both file names are derived from the source file, with the extra extension added, thus for a source file called 'Test.txt', the output files will be called 'Test.txt.spd' and 'test.txt.lum'. You can delete the internal extensions if you wish to, but retaining the original extension can be useful as an audit trail to identify the source material.

As well as measuring luminaires or light sources, the data files can be used to measure transmissive filters: first measure a light source with a well-filled spectrum (e.g. tungsten halogen), and then measure the same source with the filter inserted in the light path. Make certain that there is no change either to the light source or the spectroradiometer settings. Then a file containing the filter transmissivity can be generated in a spread-sheet by importing these two files and deriving the ratio for each wavelength:

$$Filter_{\lambda} = FilteredSource_{\lambda} / Source_{\lambda}$$

… but the filter file must, if it is to be used in the TLCI software for calculating the TLMF-2013 (Television Luminaire Matching Function), start with this identifying line:

```
//Filter data file
```

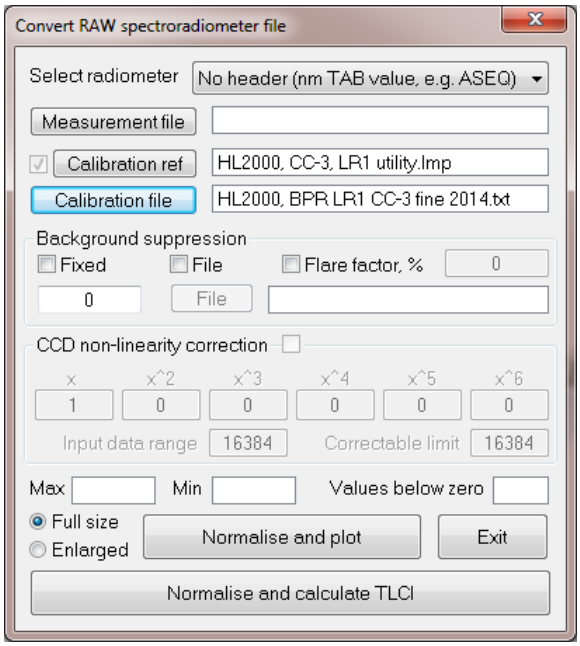
… and conform to TAB-separated rules and have the file extension .flt.

Some program features are unavailable in User mode. They are greyed out in the menus and dialogs.

2 PROGRAM MENU STRUCTURE

2.1 File menu

2.1.1 Convert raw text file



This does the work. The User version is a highly simplified version of that in the Engineering version, where many more facilities are available for manipulating the data.

2.1.1.1 Select radiometer

This is not available in User mode.

2.1.1.2 Measurement file

The check box is automatically checked and can be unchecked only by special arrangement, contact me (roberts.mugswell@btinternet.com) is you wish to do this. You will need a good reason.

Click this to select a file to process, its name will appear in the box, you cannot edit it. The data listing must consist only of data values with no header lines at all. Data lines are TAB (¬ symbol) separated and consist simply of wavelength and value or values, e.g.:

```
380 ¬ 0.123
```

2.1.1.3 Calibration ref

Click this to select a file calibration file. It must conform to a standard format. The data listing must consist of a heading line followed by data values. The contents of the heading line are crucial, this line is used in the software to identify it. Data lines are TAB (¬ symbol) separated and consist simply of wavelength and value or values, e.g.:

```
//Calibration data file
//
350 ¬ 0.010572
360 ¬ 0.011025
…
```

Data values need not be equally spaced by wavelength, the program will linearly interpolate missing values. Lines starting with double *slash (//) will be ignored.*

If the available calibration data does not match or exceed the wavelength range of the spectroradiometer, then you should place dummy values at either end of the range to suppress the conversion process, e.g.:

```
//Calibration data file
//
250 ¬ 0
350 ¬ 0.010572
360 ¬ 0.011025
…
780 ¬ 1.253467
```

800 ¬ 0
1050 ¬ 0

… will limit the converted spd files to 350 to 780nm.

2.1.1.4 Calibration file

Click this to select a calibration file, a measurement of the calibration source specified above. The data listing must consist only of data values with no header lines at all. Data lines are TAB (¬ symbol) separated and consist simply of wavelength and value or values, e.g.:

287.36 ¬ 0.123456

Note that the wavelengths must precisely match those of the file to be processed. Any error will be reported and will cause processing to be aborted. It is extremely unlikely that two spectroradiometers will deliver data files with identical wavelength values, they are unique to each unit.

2.1.1.5 Background suppression and non-linear correction

These are not available in User mode.

2.1.1.6 Normalise and Plot

Click this to do the conversion. Two files will be generated, both in the same folder as the RAW file, and with the same file name but with the extension changed to '.spd' and '.lum'. The lum file name will be automatically sent to the TLCI-2012 software for use in analysis.

The maximum and minimum values in the output file are reported, together with a count of the number of samples falling below zero (i.e. negative), if any. Beware that negative values in a file will not cause it to be rejected in the TLCI program's calculations.

The calculation will look for two files, which must be in the same folder as the program exe file, e.g. 'ASEQ LR1 calibration.lmp' (the reference data supplied with the calibrated source) and a measurement of the calibrated source, e.g. 'ASEQ LR1 calibration.txt'. Both are normal text files. When these file are found and used, the calibration process will take values as follows:

$$SPD = Input\frac{lmp}{txt}$$

… where *lmp* is a value from the calibration data file (*.lmp) and *txt* is a value from measurement of that light source (*.txt). The value *fixed* is the entered value for a fixed offset, *file* is the background data from a named file, and *flare* is an amount proportional to the area under the spd itself.

The .lmp file is a normal text file and the first line must be:

//Calibration data file

… in order that the program can recognise it. This is followed by data lines of the form:

300 ¬ 1.2065E-03
310 ¬ 1.9767E-03
320 ¬ 2.3077E-03
…

… i.e. Tab separated variables, wavelength first. The data values need not be at 5nm intervals but must be monotonic. Values will be linearly interpolated for use. The .txt file must be a conventional measurement of the light source for which the .lmp file is the numerical data.

The output file will contain a header line:

```
//Spectral Power Distribution file
```

… and data listing:

```
278.36 ¬ 0.000316244453
278.53 ¬ 0.000306955886
278.70 ¬ 0.000320991311
278.87 ¬ 0.000316226494
279.03 ¬ 0.000315719263
```

… which will be at the same spectral resolution as the original measurement file. At the end of the file, there will be colorimetric reports on the data.

The colorimetric data will also be reported in the dialog, including the maximum and minimum values, which can be useful when trying to estimate the background offset value.

On completion, the output file will be plotted on-screen.

2.1.2 Load spd file

This will load a previously converted spd file and plot it.

2.1.3 Save bitmap screen image

A Windows standard dialog appears, for you to select a Windows bitmap file for saving. Only files with .bmp extension are allowed. The saved file will be of the client area of the program's window, everything you see except the menu bar and the outline. This will be a normal, standard bitmap file, 8-bit 3-layer, uncompressed.

2.1.4 Exit

Exits the program. What did you expect it to do?

2.1.5 Run TLCI-2012 software

Runs the TLCI software, taking with it the name of the last file processed, ready for use there. The program will immediately open the latest file you converted and show the TLCI report using whichever algorithm has most recently been selected.

2.2 Explore

A small dialog appears, reporting the wavelength and value at the cursor position. If the cursor is outside the plot area, values will not be reported. The active part of the cursor is the top tip.

2.3 Help

Shows this file, 'Spectroradiometer utility.pdf' in Adobe Acrobat or equivalent.

2.4 About

Reports the software version.