HSR1 prototype Spectrometer

Rev	Date	By	Reason
1	30 Sept 19	John	Creation
2	24 Oct 2020	John	Enclosure change

Equipment supplied

- Spectrometer unit based on SPN1 optics and multi-channel spectrometer.

- Small form factor PC included

- Power cables for spectrometer system

- Ethernet and power cable to connect spectrometer to network / internet

System connection

- Connect power cable to 12V mains supply capable of 1.5A peak current.

- Connect to a local network or via e.g. GSM router to internet.

- The internal PC also has a WiFi connection for close-range use.
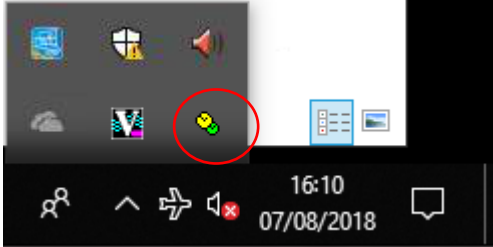
Power-up and login

- The PC has been set to boot up automatically when power is connected.

- The PC is set up for operation using TightVNC (www.tightvnc.com) to log in to it via an external PC. You will need to install TightVNC on your remote PC, and know the IP address for the HSR1. The built-in PC is set to receive its IP address from the GSM router or network. It identifies as XXXX

- Connect to the local WiFi - XXXX password XXXX

- Run TightVNC Viewer and connect to 192.168.0.X or 192.168.0.XXX

- The TightVNC password is XXXX,

The spectrometer identifies as SN nn Serial Number NNNN.

Time synchronisation

The PC is set up with NetTime synchronisation software. This is accessed from the Green & yellow clock icons in the taskbar extension.

Spectrometer software
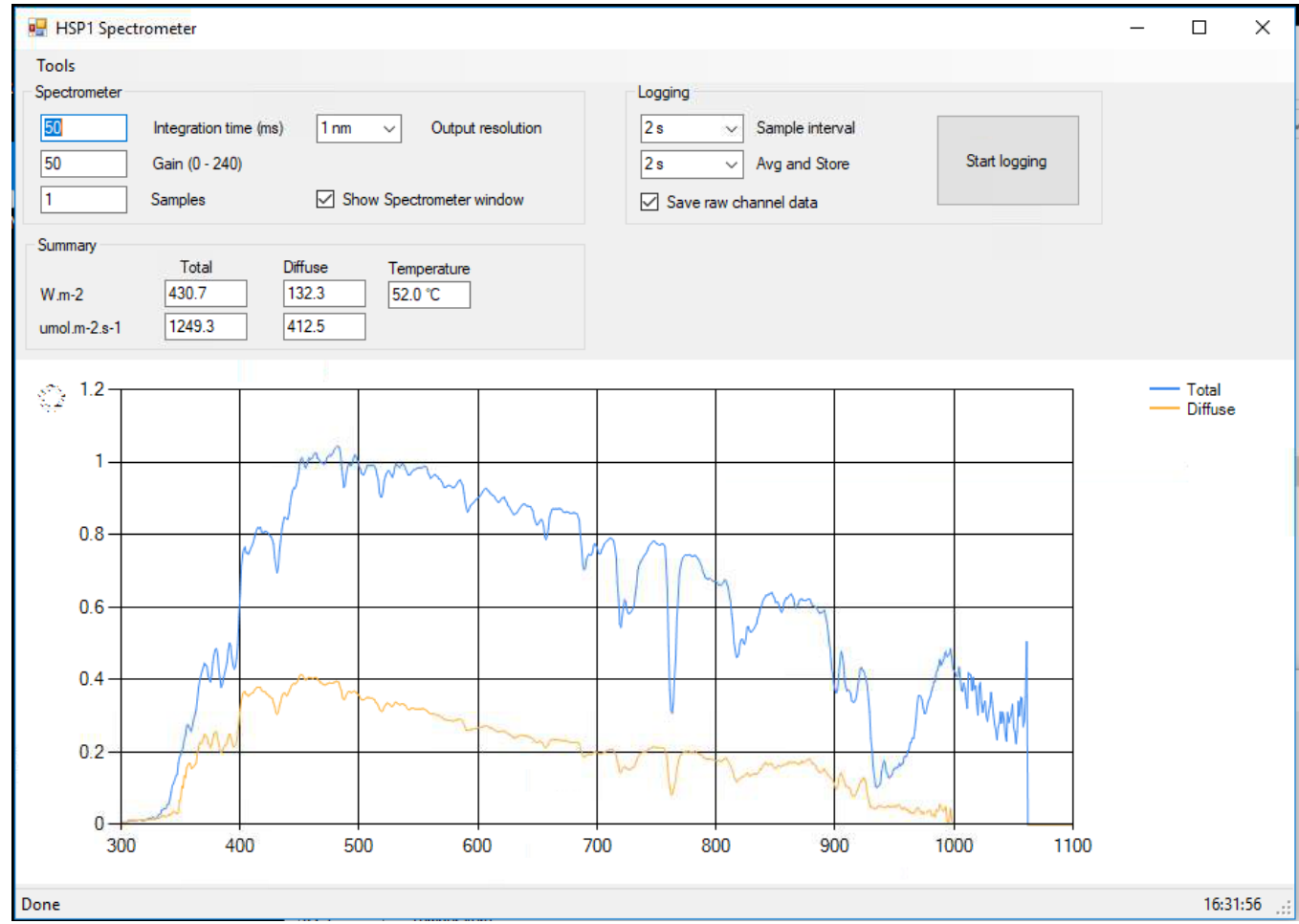
Run the **BaslerSpect** program.

Output resolution: This doesn't do anything yet, your outputs are at 1nm resolution regardless.

Show spectrometer window brings up a more detailed window of spectrometer parameters (next page).

Logging: You can select a sampling interval, and how often readings are stored. If the store interval is longer, then samples are averaged before storing.

Save raw channel data. Leave this checked – it stores the raw channel data, which will enable recalculation of final values is needed.

The PC is comfortable sampling at 2s, but sometimes gets left behind at 1s.

Integration time: Sets the sensitivity of the spectrometer. 30ms should give you full scale in bright clear-sky sun overhead.

Gain – leave this set at 50.

Samples – This sets the number of consecutive samples integrated into each reading. Use 1 for highest speed, more to reduce noise in stable conditions.

Summary: Total & Diffuse outputs integrated as energy over 400nm to 1000nm, or as PAR over 400nm – 700nm.

Temperature is taken from the spectrometer internal sensor.

The graph shows Total (Global) & Diffuse spectra for the current reading. X-axis in nm, Y-axis in W.m-2.nm-1

Accuracy is poor below 400nm and above 1000nm.

HSP1 Spectrometer   — □ ✕

Tools

Spectrometer

50	Integration time (ms)	1 nm ▾	Output resolution
50	Gain (0 - 240)		
1	Samples	☑ Show Spectrometer window	

Logging

2 s ▾	Sample interval	
2 s ▾	Avg and Store	Start logging
☑ Save raw channel data		

Summary

W.m-2	Total	Diffuse	Temperature
	430.7	132.3	52.0 ℃
umol.m-2.s-1	1249.3	412.5	

— Total
— Diffuse

Done   16:31:56

Spectrometer camera window

This shows more detailed information on the basic spectrometer outputs.

Exposure & Gain are set from the main operating window. They can be changed here, but don't persist.

Black level: This is normally set automatically to give a dark reading close to 1.0. If for some reason a manual setting was needed, it could be set here.

View image window: Checking this will show the raw camera image, but also uses up more computer resources. Leave unchecked in normal use.

The information pane shows camera details, and also any ongoing error reports.

The graph shows the 8 spectrometer channels in raw output units.

The maximum value is 256, so watch out for saturation above ~230.
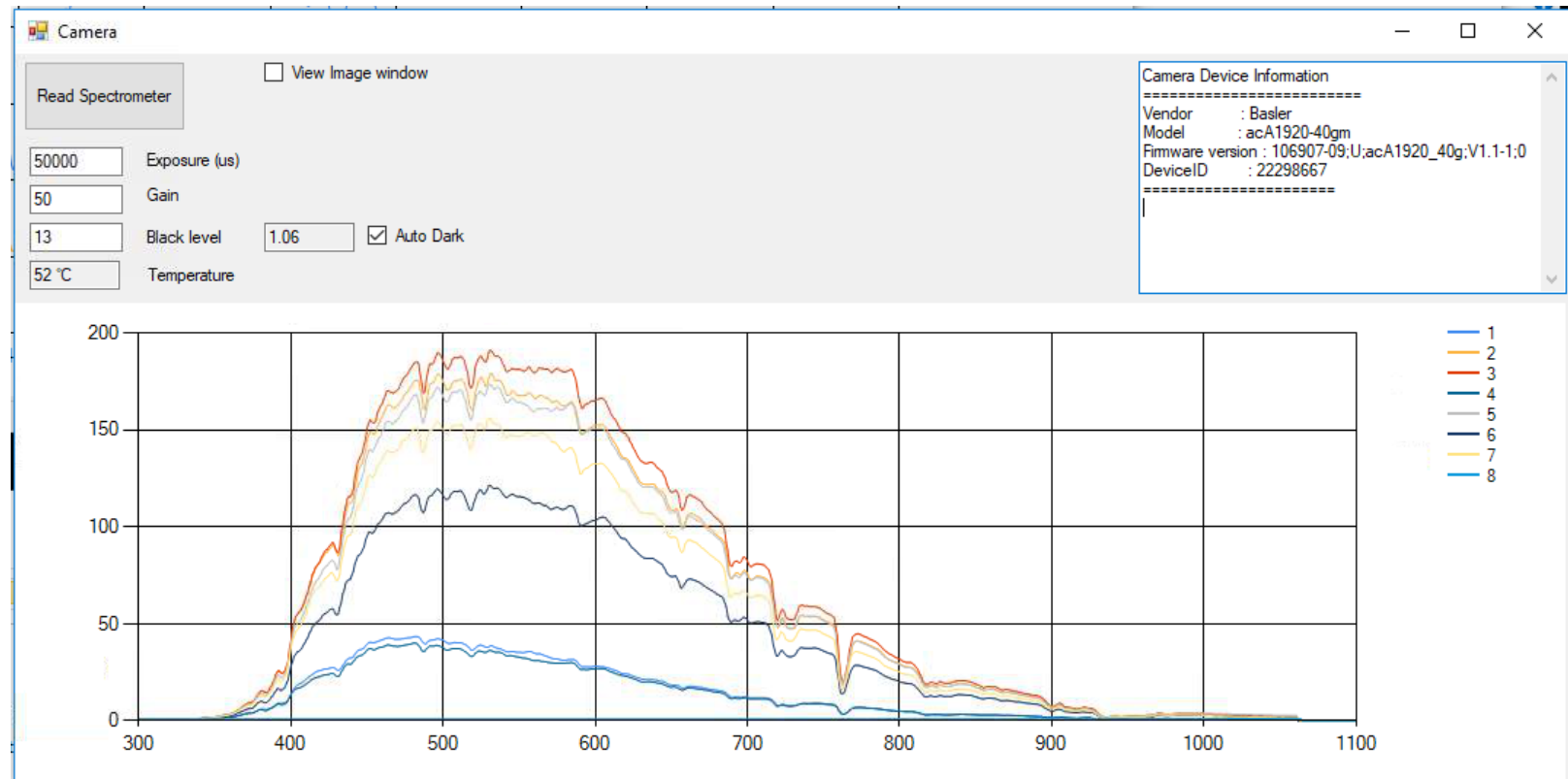
Spectrometer software – Tools menu

This menu is primarily for setup & calibration purposes.

- Calibrate – Calibrates the spectrometer to a known light source. You need to provide a file giving the wavelength & intensity profile.

- Read – takes a single reading & displays the spectrum graphs.

- Save Spectrum – saves the light spectrum measured by this spectrometer for use in calibrating another unit.

- Set Folders – sets the file position for the output file structure, and the two calibration files required. A Camera Calibration file is required to give wavelength calibration details, and define positions in the recorded image used for the different channels. A Spectrometer Calibration file is then required to match up the 7 channels, and calibrate the spectrometer intensity.
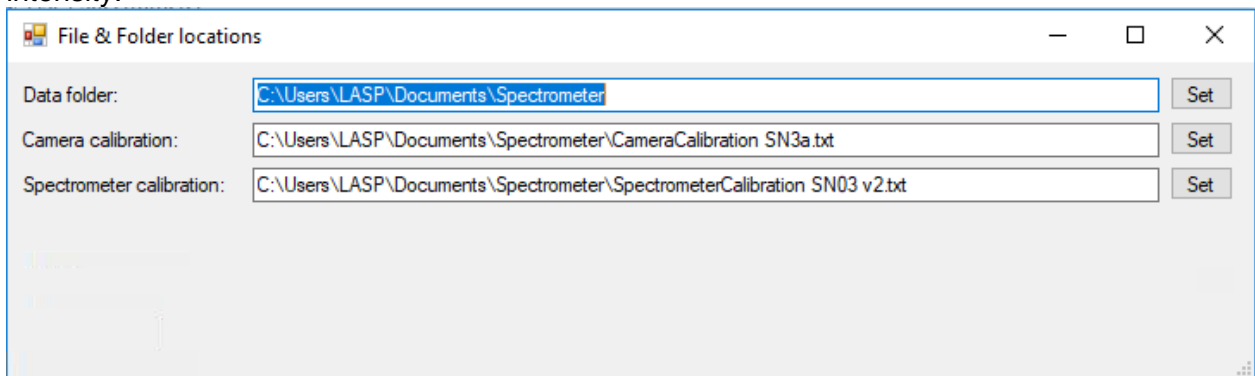
- Shadowmask on – this must be checked when a shadowmask is fitted, unchecked when it is removed for calibration. This controls the internal calculations which are different in the two cases.

- The AccessoryLogger panel displays and stores readings from the onboard GPS and internal RH% & Temperature measurements.
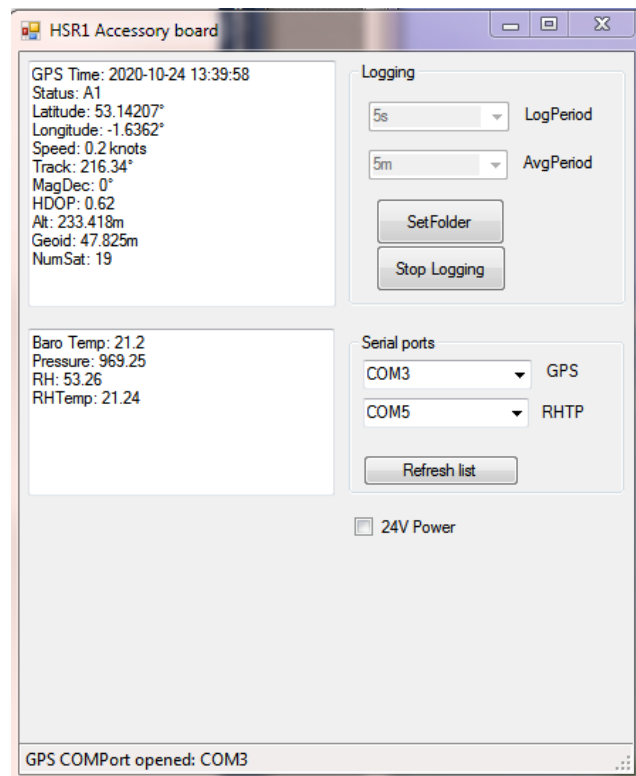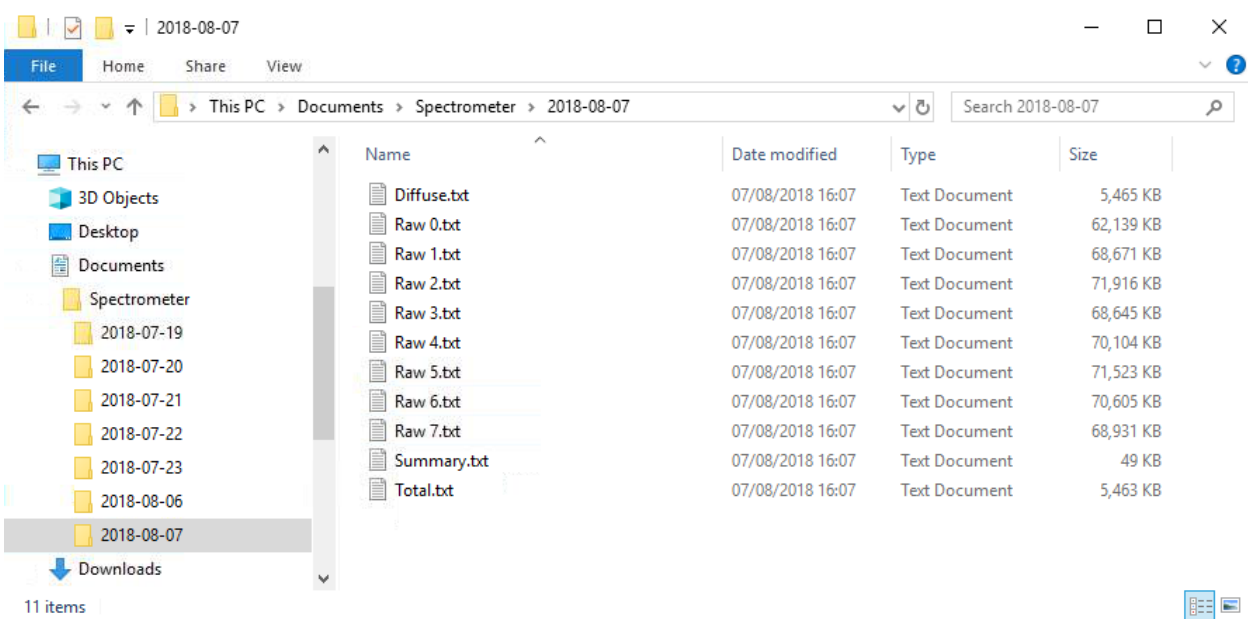
File structure
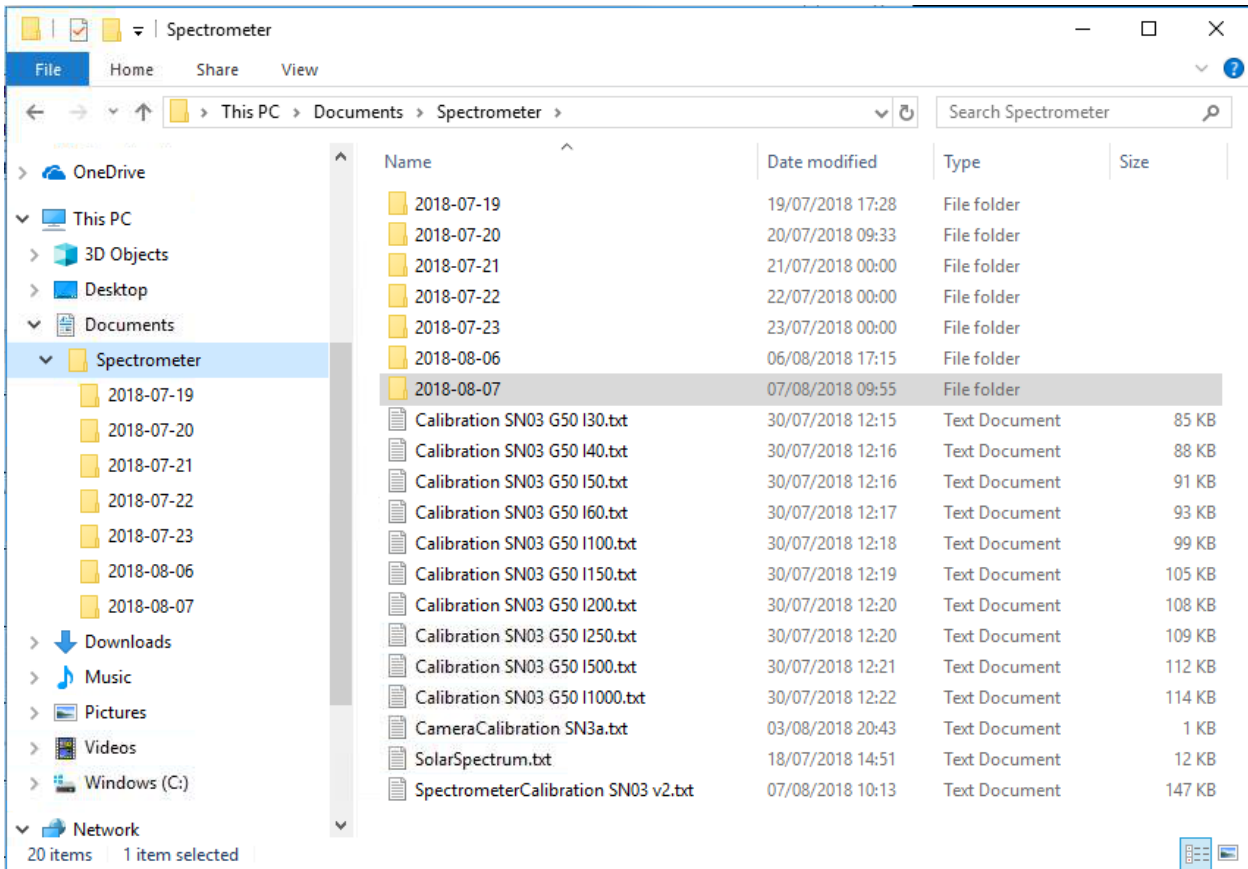
The folder set by the 'Data folder' setting contains the spectrometer calibration files. There is then one subfolder for each day's readings, which is named for the date of the readings.

Each daily subfolder contains an identical set of files:

All the files contain one or more header rows, followed by a table of tab-separated text data. If logging is restarted, the file contains a break and a new header row.

Raw0 to **Raw7** contains the raw data values from the spectrometer if these are set for saving. It's worth saving these unless you are pushed for space, as the subsequent readings can be recalculated if necessary due to recalibration or better algorithms. These are saved for each sample, so may get quite large at high sampling rates

Summary contains the integrated energy & PAR values shown in the Summary pane of the main window, along with the temperature. This is useful for a quick look at what sort of day it was.

Total & **Diffuse** contain the calculated Total & Diffuse spectra for each reading (at the average & store interval). These are recorded at 1nm intervals, in W.m-2.nm-1. These will be your primary output files.

Calibration

The spectrometer has been calibrated against a tungsten 'FEL' lamp, which is calibrated at NPL.

The light output from the FEL lamp is significantly lower than full daylight, which means that at suitable settings for daylight measurement, the output signal during calibration can be too low, especially at the ends of the spectrum.

The spectrometer is supplied with fixed setting calibration files for a variety of integration times to cover the range of intensities between the lamp output and the solar output. However, this means that at some settings the ends of the spectrum are not resolved, and at other settings the middle of the spectrum saturates. These are named as **Calibration SNnn Gxx Iyy.txt** where xx is the gain setting (always 50), and yy is the integration time setting. They can be chosen using the Spectrometer calibration field in the folder locations dialog. For better usability, I have also created a combined file **SpectrometerCalibration SNnn v2.txt** which combines all these values with the linear response to integration time. This file gives the most usable output across the full spectral range, although clearly the UV & IR tails are inaccurate. With this calibration, the spectrometer can be used at integration times different to those at calibration, so you can set the integration time to suit the conditions. I would recommend this initially. Integration times between 30ms & 50ms seem well suited to normal daylight, though you may need to reduce down to 25ms if you are operating at high altitude in clear air near noon.

Maintenance

Keep the dome clean with a soft cloth, or water & mild detergent or Isopropyl alcohol if necessary.

If the humidity indicator in the dome turns pale blue or pink, the internal desiccant should be replaced. This is a 25g to 100g sachet of silica gel which is placed in the inside of the enclosure lid.

The enclosure internal humidity is also available from the AccessoryLogger control panel. Desiccant should be replaced if this rises above ~40%RH.

Recalibration

As this is a prototype, I don't yet have any information on likely drift or recalibration intervals. It may be best to return it to me for recalibration, but I will be happy to discuss the process if you want to attempt this yourselves.

JW Oct 2020