TECHNICAL NOTE TN-03

Problem	What is spectral calibration? How to make spectral calibration? How to verify spectral calibration?	Date	2nd July 2015
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1. Introduction

With spectral axis calibration of the ImSpector spectrograph or spectral camera one defines the exact centre wavelength and bandwidth seen by each pixel on the imaging detector. Spectral calibration is performed by comparing measured calibration spectra, pixel by pixel, in selected spectral windows with known theoretical spectra of the same source.

Whenever the spectrograph is assembled to the camera (to a common base plate or directly to the rear end of the camera) the proper alignment should be checked and adjusted and new wavelength calibration should be performed.

2. Possible calibration sources

Calibration can be based on known spectral peaks of emission or absorption of atoms or molecules. These are mostly usable in the VNIR (400-1000 nm) and SWIR (1000-2500 nm) regions.

There are different special calibration lamps that can be used for this purpose. Most common spectral calibration lamps produce discrete, narrow and intense emission lines based on the excitation of various rare gases and metal vapours. Typical gases are Argon (Ar), Neon (Ne), Krypton (Kr) and Xenon (Xe). Most common metal vapours are Mercury (Hg), Cadmium (Cd) and Tallium (Tl).

However, also quite cheap solution – common fluorescence lamp – can sometimes be successfully utilized. This lamp contains Mercury that has number of good recognizable peaks in the visible range and NIR region (CCD and CMOS) and also in the InGaAs range from 900-1700 nm. See separate Technical Note TN14.

In the MWIR (2 – 5 um) and LWIR (8-14 um) region one can use absorption from polyprophene, polystyrene and Mylar. Also narrow band interference filters with black body light source can be used.
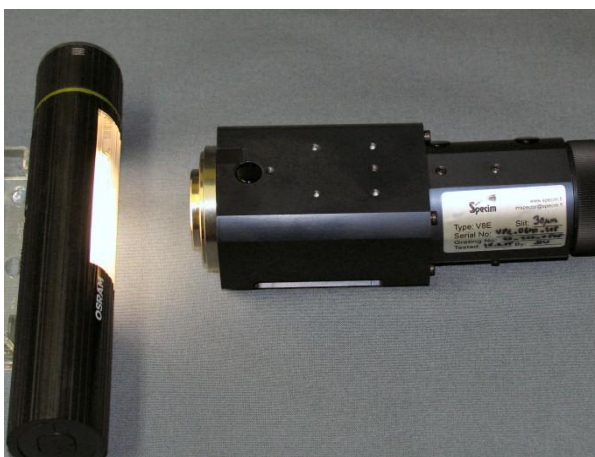
3. Procedure

It is important to have the whole slit area and whole NA of the spectrograph evenly illuminated. If possible use integrating sphere or other diffuser.
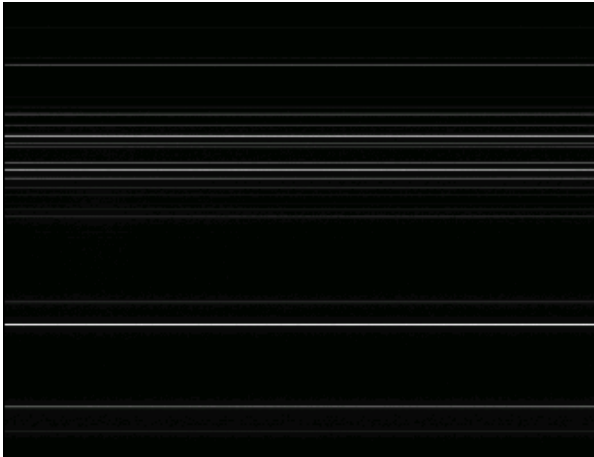
Attach the camera to the spectrograph as described in other documents. It is assumed here that the spectrograph is adjusted so that the spectral and spatial axes are orientated correctly to detector rows and columns.
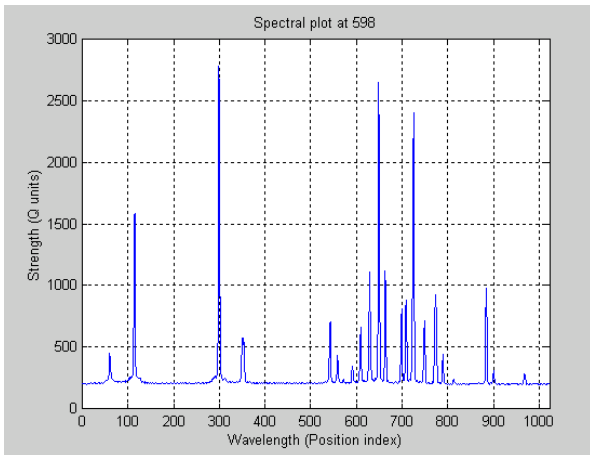

Adjust the back focal length of the spectrograph if needed. For this one should check the document "TN07_Adjustment_of the_back_focal_length (BFL)"

Position the calibration lamp vertically along the slit approximately 5 cm in front of the slit. Check the image that there are spectral lines vertically on the screen and that the lines are not too dim or saturated. Adjust integration time accordingly. In this example hand held fluorescent lamp is used. Peaks emitting source inside integrating sphere is recommended if available.
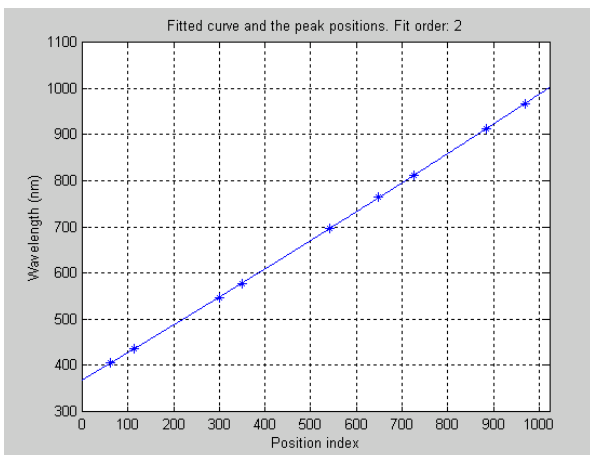
Record an image frame and save this to file in raw or bmp format depending on later use.
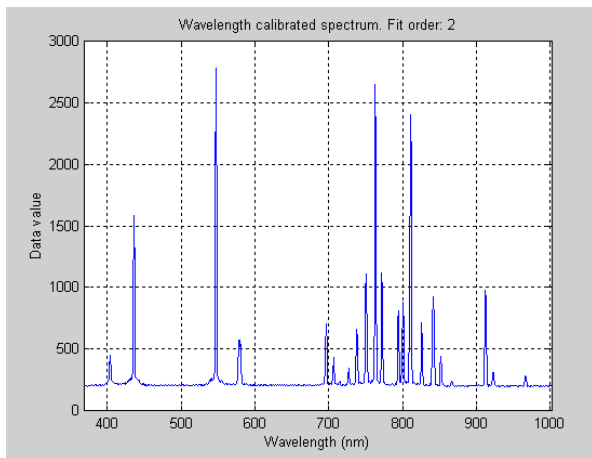

Use Matlab or other software to read the image file and make the calibration. The example spectral profile is taken with Matlab from spatial column 598. Note that *x axis* is still in pixels.

For calibration find the positions of the spectral peaks as a unit of pixels of the row and fit these positions to the *known wavelengths* of the peaks.

Second order fitting of wavelengths to the measured peak positions is recommended. For that more than five peaks should be recognized.

If the discrete spectral sampling is low the peak positions should be determined using suitable fitting technique.

The result from the second order fit plotted as a function of wavelengths (spectrum) looks like this. Note that now *x axis* is wavelength in nanometers. From this image one can validate the calibration when detecting the known emission peaks.

Using the wavelength fitting parameters, calculate the central wavelength and bandwidth of each pixel (row) and save it as a .wls file. The structure of the wls-file is such that first column is for central wavelengths of each pixel and second column is showing the sampling of each pixel. Sampling means the wavelength bandwidth which is hitting each pixel. In first order fit sampling is constant but in second and higher order fits it is changing.