TECHNICAL NOTE TN-02

Problem	What is an Order Blocking Filter (OBF)? How to use and install with ImSpector imaging spectrographs? What OBF does Specim offer?	**Date**	2nd July 2015
Author(s)	JJU, EHE	Ver	1.2

1. Introduction

Spectral Imaging Ltd. can supply a special OBF (Order Blocking Filter) to avoid spectral overlapping of the different orders if spectral range is over one octave (doubling of wavelength). This document explains the concept of OBF, when it should be used and how it should be placed on the camera when using the ImSpector imaging spectrograph.

2. Why should an OBF be used?

The ImSpector spectrograph is based on a transmission diffraction grating where the different wavelengths are diffracted to angle β according to the grating equation:

$$m\lambda = d(\sin\alpha + \sin\beta), \qquad (1)$$

where *m* is the diffraction order (0, ±1, ±2…), λ is the wavelength, *d* is the groove spacing and α is the incoming angle to grating. It can be seen that there are more than one wavelength that satisfies this equation for a particular set of values of *d*, α and β In practice this means that there are overlapping orders of spectra that go to the same place on the detector surface.

The free spectral range $(\Delta\lambda)_{fsr}$ of an ImSpector spectrograph can be calculated from equation:

$$(\Delta\lambda)_{fsr} = \frac{\lambda_{\min}}{|m|} \qquad (2)$$

If the free spectral range of the spectrograph is smaller than the designed wavelength range of the spectrograph, an OBF should be used.

Example 1.

Let us assume that the spectrograph is designed so that it produces the first order (*m*=-1) spectrum in the range of 400 - 1000 nm across a specified detector surface. From equation (1) it can be seen that the second order (*m*=-2) spectrum from the range of 400-500 nm is diffracted to the same angle range as the first order spectrum in the range of 800-1000 nm. This superposition would lead to ambiguous spectroscopic data if suitable filtering is not applied preventing overlapping. It can also be seen from the Equation (2), that the free spectral range of the device is now 400 nm. This is less than the full range of the device, 600 nm, so an OBF should be used.

3. Available OBF types

Currently Specim can provide several types of OBF to be used with different spectrograph models. The table below shows the current possibilities for an OBF. The stock of OBFs changes constantly, so please, check the availability before ordering. In the OBFs 50% of the surface is coated with a long pass filter to block wavelengths below certain edge wavelength. The number part in the name of the OBF tells this edge wavelength in nanometers.

OBF model	Size	Mechanical C-mount holder available	Suitable ImSpector Model
OBF 57017	circular, Ø 17 mm	Yes (lockable)	V10E, V8(E)
OBF 57020	circular, Ø 20 mm	Yes (lockable)	V10(E), V8(E)
OBF 55014	rectangular, 14 mm * 12 mm	Yes (lockable)	V10(E), V8(E)
OBF 1400	rectangular, 18 mm * 18 mm		N25E

Table 1: Available OBFs

Depending on the cameras used, the OBF can be installed either as a plain filter or the filter can be installed first on a mechanical holder. Figure 1 shows the plain filter and a c-mount holder for it.

Figure 1: Circular OBF 570 and the mechanical C-mount holder

4. Positioning the OBF

A 50% of the surface of the OBF is coated. The filter should be positioned as close as possible to the detector surface and should be oriented so that the OBF coated half of the filter is in the higher wavelength side of the detector (see Fig. 2). In this way it prevents the short wavelengths below cut-off wavelength to overlap with the higher wavelengths.

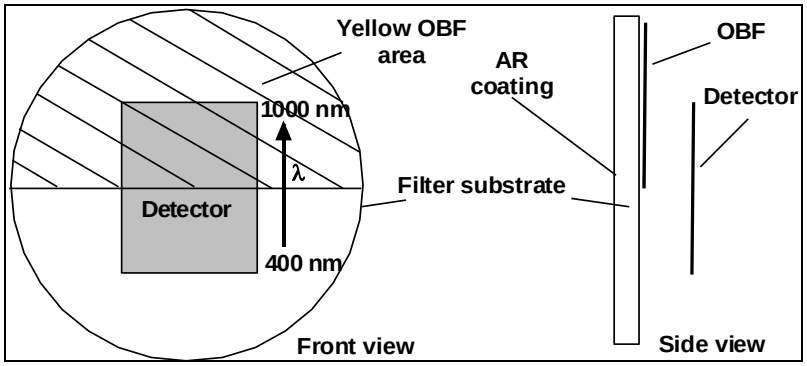

Figure 2: Positioning of the OBF on front of the sensor

5. Installing the OBF

Installing of the OBF may differ considerably depending on the camera type used! The two main possibilities to install the filter are: 1) mechanical holder or 2) gluing the filter substrate onto the body of the camera or to the detector window. In both cases the OBF should be as close as possible to the detector surface, in practice the distance should be less than 6 mm. We recommend testing the system by using a mechanical holder or gluing to the body of the camera before gluing the filter permanently to the detector window.

5.1 Mechanical holder

If the used camera has a C-mount which thread is long enough – i.e. continues almost all the way to the sensor protective window – a mechanical C-mount holder can be used. In this case the filter is first glued to the holder. Normally, if a C-mount holder is ordered together with the filter, the filter is glued to the holder before delivery. After this the holder is screwed all the way to the bottom or to the end of the C-mount threads. This should be done carefully avoiding harming the sensor protective window. After the OBF has reached the end of the threads, it is turned into correct position and locked. Some C-mount holders have a locking screw. If this is not available, a very small amount of instant adhesive can be used. When the OBF is on the correct position and locked/glued, the ImSpector can be connected to the camera. Figure 3 shows a series of pictures showing this procedure.

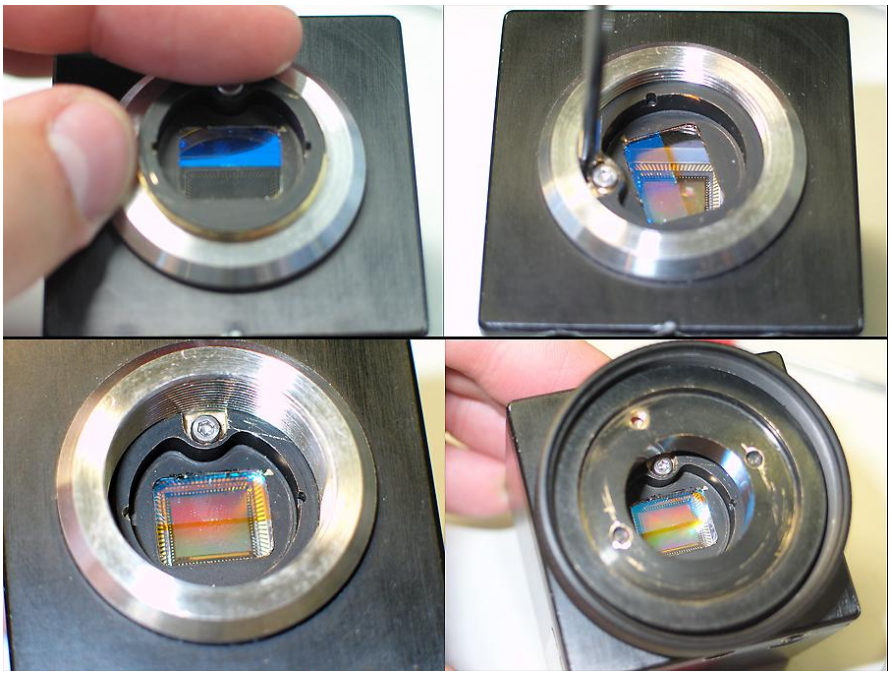

Figure 3: Installing OBF with a lockable C-mount holder.

In some cameras there is a mechanical holder available. This is normally reserved for an IR-cut filter, protective window or similar. In these cases, if a correct size OBF is available, the present filter can be removed and the OBF can be placed on the cameras own holder. Figure 4 shows an example of this.

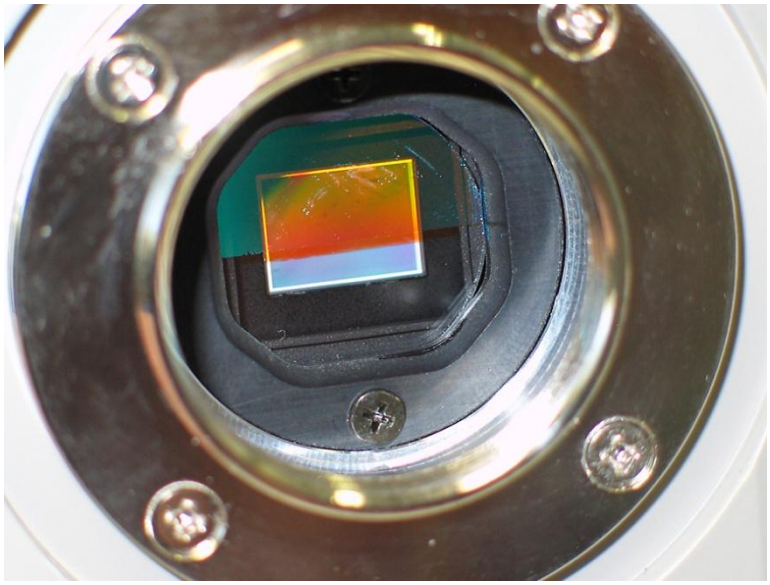

Figure 4: An OBF installed on cameras own filter holder.

5.2 Installing the OBF with glue

If there is no possibility to attach the OBF to the camera with a mechanical holder, it should be glued to the camera. One option to install the OBF is to glue it to the body of the camera if there is a suitable place close to the sensor. If this is the case, a two-component epoxy should be used.

One more possibility to attach the OBF is to glue it directly to the sensor window. If the OBF is installed directly to the sensor, the OBF side should be towards the sensor. The other side of the substrate is AR coated. If the OBF is glued directly to the sensor window, the used adhesive should be selected very carefully to not to affect to the optical and spectral properties of the system. Currently Specim Ltd is using Epo-Tek 301 Epoxy for gluing the OBF directly to the sensor window.