BENTHAM

Monochromators Selection Guide

Bentham manufactures a range of monochromators with associated accessories to cover a very considerable range of measurements.

In selecting the most appropriate monochromator model and accessories for a given application, the following 3 principal (but by no means sole) considerations should broadly be taken into account :

- spectral range of operation
- required spectral resolution
- consideration of the application with regards to stray light performance of the monochromator

Several models are available as spectroradiometers, with integrated detection electronics, to provide a complete measurement solution.

Spectral Range

Diffraction gratings are specified by a line density in grooves per millimetre. The higher the density, the greater light is dispersed resulting in a relatively limited spectral extent. Furthermore, in general , the higher line density gratings are optimised for short wavelength use and vice versa. One must take into account the available grating(s) and the operation range of such before deciding how many gratings are required to cover a given range. Where multiple gratings are required, one can opt for a multiple-grating monochromator which would allow performing a spectral measurement over a great range, or whether a single (interchangeable) grating monochromator is used and the measurement performed in two or more parts.

For measurements performed over a very wide spectral range, interchangeable turrets can be purchased for multiple grating monochromators.

Order Sorting

To ensure that only the first diffraction order is measured, long-pass order sorting filters should be inserted at various points throughout. The standard filter wheel has six positions (of which one is occupied by a blank disk to act as a shutter). For wider spectral range applications, an eight-position filter wheel is available. For very wide spectral range applications, and in certain cases of those having multiple entrance and exit slits, an external filter wheel may be used. This filter wheel may also accommodate neutral density filters for the purpose of optical attenuation or band-pass filters to aid the improvement of stray light performance.

Number of Entrance/Exit Ports

Where multiple inputs to the monochromator or multiple outputs/multiple detectors to cover a wide spectral range are required, the monochromator can be provided with up to two entrance and two exit slits, with a solenoid-based swing away mirror (SAM) positioned between the two for the purposes of automated selection.

Slits

The bandwidth of the monochromator is defined by rectangular slits (defined by width). The simplest option is the fitting of fixed rectangular apertures to the entrance and exit ports of which a set of three are provided. Where a greater degree of freedom is required there is an option of micrometer adjustable or motorised slits. The particular benefits of the latter are that one can vary the instrument bandwidth through the spectral range of interest, and, where multiple gratings are employed, or where a double as one migrates from grating to grating and the dispersion changes, the motorised slits can be automatically modified to maintain a given bandwidth. The motorised slits can replace the slit or be integrated in the monochromator.

There are options on the position of the slits according to requirements in terms of space, minimising the use of mirrors etc.

Preparation for use with Array Detectors

When using the monochromator in array detector mode, as opposed to spectral scanning mode, it is typical to employ diffraction gratings having less dispersion to enable the presentation of a wider spectral range across the array, and to remove the fold mirror at the monochromator exit to preserve the image quality. Since the vertical extent of the array is limited, one would typically replace the spherical mirrors of the monochromator with toroidal mirrors to improve the images at the plane of the exit slit. The exit, camera mirror, may be mounted on a manual translation stage (fine focus option) to allow adjustment of the monochromator imaging plane to that of the various array detectors which may be mounted on the exit slit (each of which would typically have differing mechanical construction).

Stray Light Performance

Whilst the essential purpose of a monochromator is to act as a tuneable filter, presenting the desired wavelength at the exit port, some of the broad band spectral input may scattered by imperfection or contamination on the optics in an uncontrolled manner, resulting in the presentation at the exit slit of stray broadband light in addition to light at the selected wavelength. Holographic diffraction gratings present less stray light due to the manufacturing technique used yet have lower efficiency than mechanically ruled diffraction gratings.

Whilst in many cases this effect may be ignored, where the signal to be measured at the given wavelength may be small with respect to stray light contribution, either a second monochromator must be used, thereby constituting a double monochromator, in which the selected wavelength and the stray light are again diffracted and the stray light taken under control. In certain circumstances, a mid-point may be adopted between single and double monochromator stray light performance in using a single monochromator with a selection of band pass filters. Such filters have a limited use in the sense that they may not be available for the spectral range of interest, and they may have transmission windows at longer wavelengths which will, to a certain extent, compromise their function.

Double Monochromator Mode

In additive dispersion mode (by far the most common) the dispersion of the diffraction grating in the first monochromator is enhanced by that in the second monochromator. In certain applications, the resulting dispersion of wavelengths across the exit slit cannot be tolerated, in which case, the second diffraction grating is configured to act in opposition to the first to yield zero net dispersion at the exit slit. Applications for which subtractive dispersion is important include the measurement of detector spectral response, high echelon systems, such as those employed by calibration laboratories, where the uncertainty contribution of dispersion across the exit slit is unacceptable and for the measurement of very fast pulsed sources since the path length between exit and entrance slit is the same in this case for all wavelengths

Internal Optical Chopper

In situations where the optical signal to be measured may be confounded with a background optical signal, whether from ambient lighting, or, in the infrared, heat (infrared radiation) emitted by instrumentation and the background, an optical chopper is employed to modulate the said signal on a known carrier wave, allowing discrimination of the two contributions. In some instances, it is convenient to have the optical chopper mounted internally to the monochromator.

Other Considerations

In applications in the UV below 200nm and in the IR, atmospheric gases which may absorb light, should be excluded from the monochromator. This may be effected by passing nitrogen (or other) gas through the monochromator, for which purpose the option to adapt purge ports is provided.