# Image Slicers in Integral Field Spectroscopy

PRECISION-OPTICAL ENGINEERING

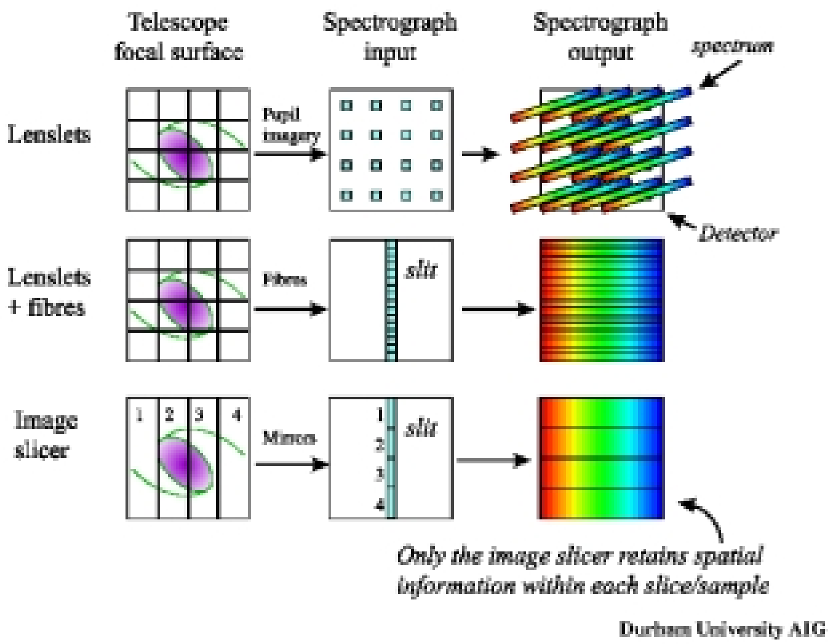
DM 002

Application Note

Traditional spectroscopy in astronomy applications is based on dispersing the image of a slit (single or multiple) so that a spectrum is produced for whatever fraction of the light from the target of interest falls within the aperture defined by the slit. If the slit is extended in length beyond the confines of the target, then it is also possible to record the spectrum of adjacent sky to subtract from that of the object - particularly important if the object is fainter than the sky, which is very frequently the case. While this is satisfactory for many applications, it makes poor use of the incident light when the object is extended, either intrinsically or due to poor seeing. In these cases, what is really required is the ability to record a spectrum from each part of an extended object. Techniques which record spectra from each part of an object simultaneously are termed *Integral Field Spectroscopy*

**Basic techniques**

There are three main techniques.




• *Lenslet arrays*. The input image is formed at the input surface of a microlens array (MLA). These form images of the telescope pupil which are then dispersed by the spectrograph.

• *Fibre bundles*. The input image is formed at the entrance to a bundle of fibres which transfer the light to the slit of the spectrograph.


PRECISION-OPTICAL ENGINEERING
Wilbury Way, Hitchin, Hertfordshire,
SG4 OTP, United Kingdom.

Tel: +44 (0)1462 440328  Fax: +44 (0)1462 440329
Website: www.p-oe.co.uk

# Image Slicers in Integral Field Spectroscopy



• *Image slicers* . The input image is formed at a mirror segmented in thin horizontal sections which are then sent in slightly different directions. A second segmented mirror is arranged to reformat the slices so that, instead of being above each other they are now laid out end to end to form the slit of the spectrograph (actually a virtual slit).

The advantage of this technique is that Focal Ratio Degradation (which causes the focal ratio of the beam emerging from the fibre to be faster than that at the input) is avoided and the slicing arrangement gives contiguous coverage of the field. Because this system uses only mirrors, it is especially suitable for the infrared since it is inherently achromatic and can be cooled to cryogenic temperatures.

## Image Slicer Production

Since the mirror systems are required to operate at cryogenic temperatures, aluminium is chosen as the preferred material for the mirrors and their mounts, and diamond turning as the preferred manufacturing method. The optical systems use many long narrow slices in order to split the field into multiple parts. These slices can be spherical or aspherical in form each with a different tilt. The mirrors are butted up against each other to ensure that there is no gap. P-OE can provide consultancy on the manufacture of these systems and our diamond turning group at P-OE has manufactured a number of components for the following systems:

**NGST** - Next Generation Space Telescope. Prototype slices and mounts.
**GNIRS** - Gemini near infrared spectrometer. Prototype slicer array and mounts.
**UKIRT** - UK infrared telescope. (UIST). All optical components within the system.

## Image Slicer examples

One of the systems currently in its prototype phase has 75 slices. Each slice is 0.9mm wide and 70mm long. Another system has 18 slices, 0.5mm wide and 35mm long. Each slice also requires an equal number of small mirrors, perhaps 1-3mm square to re-image the light onto the spectrograph slit.

Acknowledgements
Thanks are due to D. J. Robertson at Durham University's Astronomical Instrumentation Group (http:// star-www.dur.ac.uk/~jra/spectroscopy.html) for permission to reproduce the information in this datasheet.

***PRECISION-OPTICAL ENGINEERING***
Wilbury Way, Hitchin, Hertfordshire,
SG4 OTP, United Kingdom.

Tel: +44 (0)1462 440328 Fax: +44 (0)1462 440329
Website: www.p-oe.co.uk