OSIRIS Multi-Object Spectroscopy

Observing modes

M. Sánchez-Portal, Herschel Science Centre, ESAC

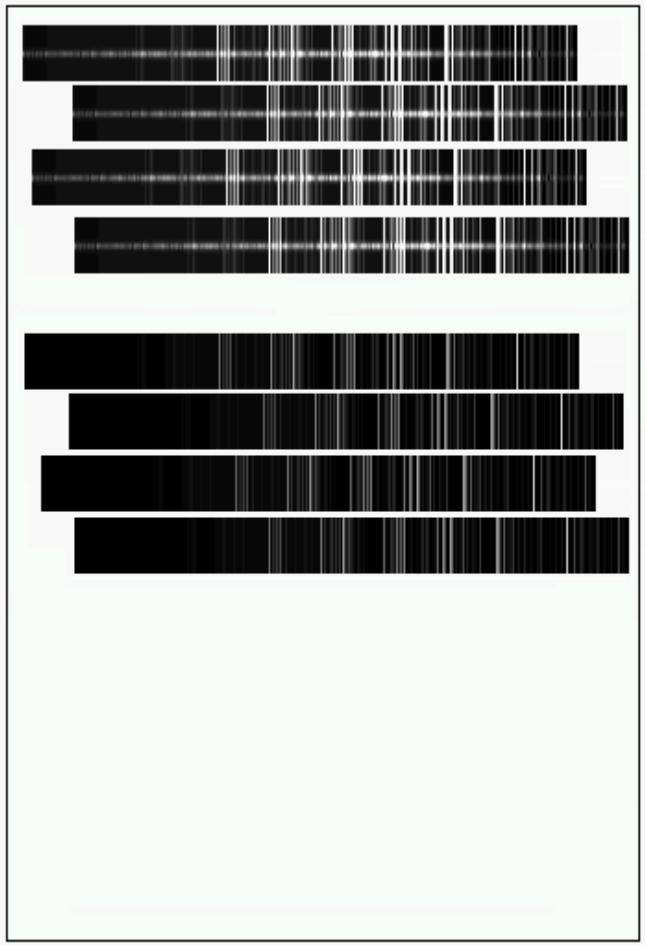
Basic MOS mode

- The whole spectroscopy field (about 8 x 6 arcmin) is used.
- Is a user responsibility to choose the slits long enough to allow for sky subtraction
- It is possible to include a *sorting filter* ▶ to reduce the spectral range (and hence the length of the spectrum in the dispersion direction)
- Good for bright objects, and generally when sky subtraction and flat field effects are not a concern.
- For faint objects, the brightness of the object is a small fraction of the sky, and subtraction becomes a critical step.
- Multiplicative sources of noise:
  - Flat-fielding residuals
  - Residuals due to spatial sky fluctuations
  - Spectral line sampling residuals in sky subtraction
- The lower the spectral resolution, the higher this effect is. Sky line saturation (S/N does not increase with exposure time) is reached relatively quickly.
- Therefore, in such cases (faint objects, low resolution), nod and shuffle becomes a recommended mode.

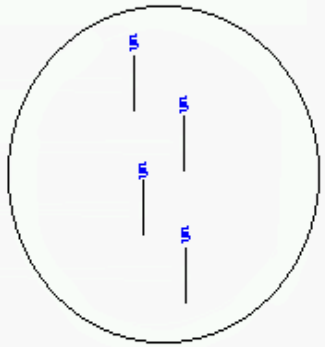
Nod and shuffling (va-et-vient)

- Based on the possibility of clocking the charge in large CCD chips
  - Takes only microseconds
  - Does not incur in readout noise penalty.
- This is combined with the coordinate shift in telescope position (nodding)
- Excellent sky subtraction of faint objects (R=24-26 magnitudes). All the systematic effects of sky subtraction are removed:
  - temporal variations of the sky → nodding-shuffling cycles must sample properly them
  - Flat-field errors (sky and object are measured in the same pixels),
  - Fringing
  - Instrumental flexure.
- Accurate sky subtraction is achievable, without need for perform long slit spectroscopy on small objects.
- In the 'standard' nod-and-shuffle, only the central one-third of the spectroscopy field can be used. The remaining area of the detectors is used for storage of the source and sky spectra.

Nod and shuffle schematics



CCD



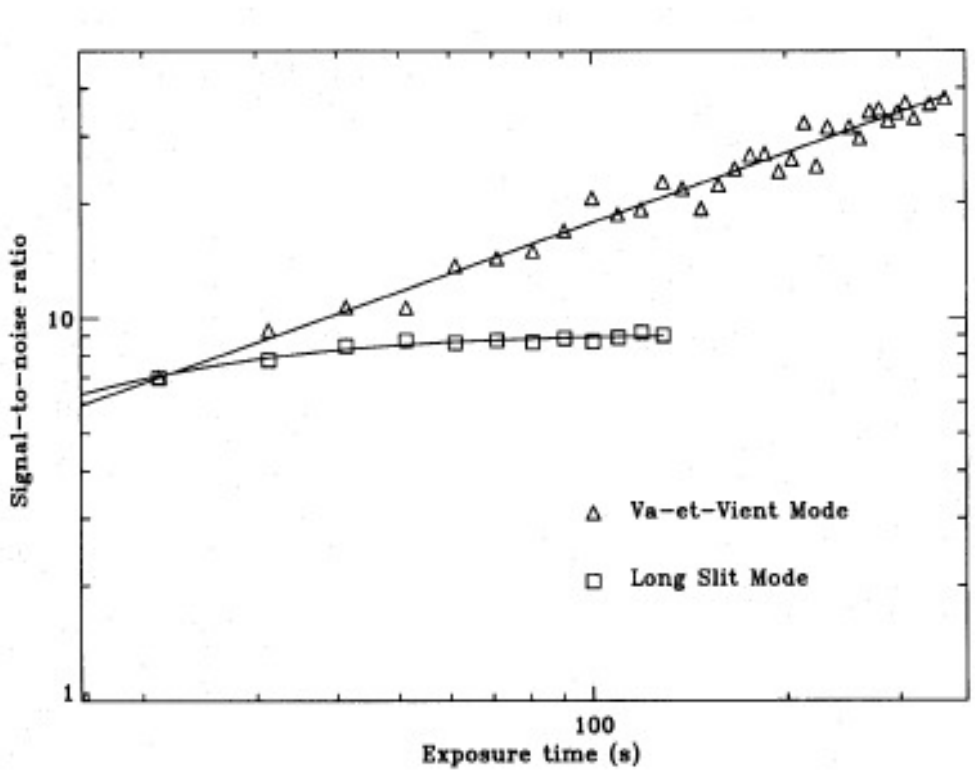
Glazebrook & Bland-Hawthorn PASP 113, 197 (2001)

Micro-shuffling

- Slits can be very small since no additional length for sky subtraction is required
- It is even possible to observe using microslit (1-2 arcsec sections of the mask, of circular or rectangular shape) apertures over small objects.
- In that case, the shuffling of the charge can be on a scale of a few pixels to blocks of spectra.

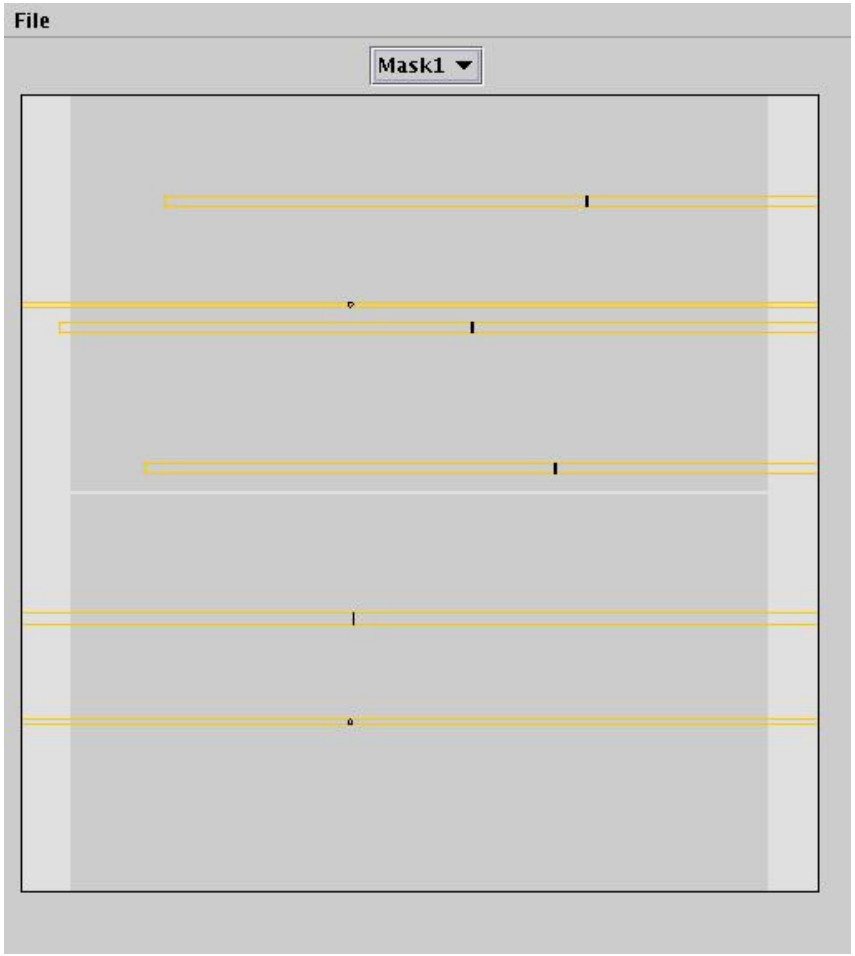
Nod and shuffling advantages

- At a 10-metre class telescope and R~300, saturation limit is reached in 30 min with S/N~2.5, while using nod and shuffle in a 2-hours exposure the S/N can be increased by a factor 3 or more. (Cuillandre et al. 1994, A&A 281, 503)

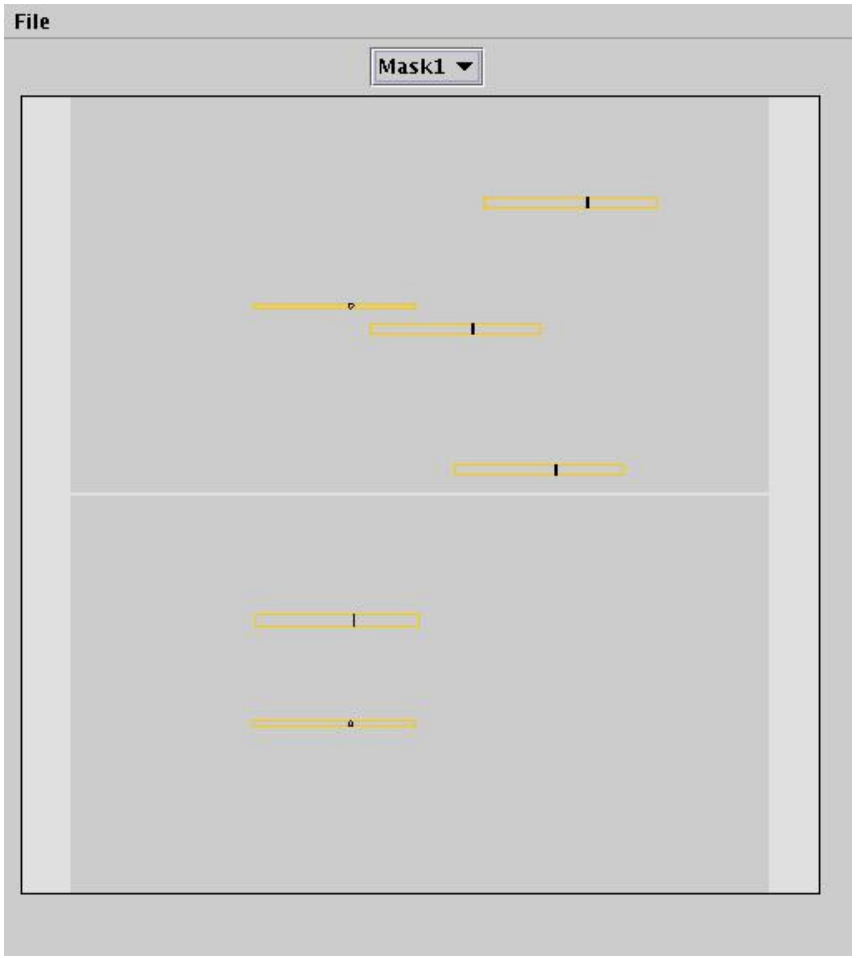


Point source – crowded field

- The principle is the same as for normal nod-and-shuffle:
  - Using pinholes (rather than rectangular slitlets) for each object over one section of the spectral usable FOV in the dispersion direction
  - Subtracting sky by combining telescope beam-switching with charge shuffling to obtain sky-spectra, through the same pinhole mask and physical pixels, of an adjacent field.
- operation of shutter, telescope beam switching and charge shuffling shall be needed.



Full spectrum



Restricted spectral range with order sorter

Check OSIRIS documentation
For available lambda-sorters!