Revisiting the Impact of Atmospheric Effects on VIMOS Multi-Object Spectroscopic Observations

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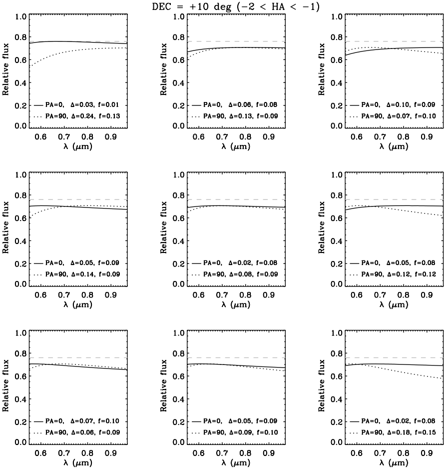
A model to address slitlosses in VIMOS-MOS

Parameter	Value
Site Properties	
Paranal Observatory	$\phi = -24.5$ deg
Atmospheric Pressure	743 mbar
Temperature	12 °C
FWHM	1 arcsec
Observational Setup	
Slit Width	1 arcsec
Slit Length	10 arcsec
Slit Orientation	North-South (PA = 0 deg) East-West (PA = 90 deg)
Target Declination	$-75 < \delta < +25$ deg
Hour Angle	$0 < \lvert\mathrm{HA}\rvert < 4$ deg
t_{exp}	3600 sec
Figures of Merit	
Spectral Distortion	$\Delta = (f_{max} - f_{min})/f_{max}$
Relative Flux Loss	$\int f_\lambda \;/\; \int f_{\lambda,76\%}$

Table : Simulations assume a flat input spectrum and 9 slits regularly distributed across the entire VIMOS FoV, from the centre to the corners, and with relative separations of 7 arcmin. Slit orientation is defined at meridian crossing, and follows the usual on-sky convention – i.e., this is **not** the rotator $\mathrm{PA}_{\mathrm{rot}}$ described in the VIMOS manual, where the default $\mathrm{PA}_{\mathrm{rot}} = 90$ deg corresponds to a N-S on-sky orientation. Alignment and guiding are assumed to be done at either 450 nm (blue grisms) or 700 nm (the rest), and the seeing FWHM is considered to be wavelength- and airmass-independent. This setup results in 24% fiducial flux losses due to finite seeing and slit width.

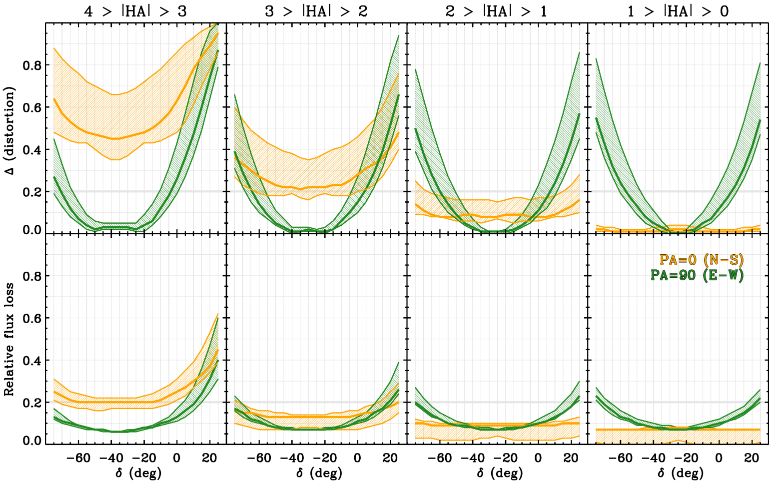
Explored VIMOS-MOS Setups

Grism	Filter	λ_{min} (nm)	λ_{max} (nm)	R (1" slit)	Dispersion (Å/pix)
HR blue	Free	370	552	1150	0.7
LR blue	OS blue	370	670	180	5.3
HR orange	GG435	515	760	2150	0.6
MR	GG475	480	1000	580	2.5
HR red	GG475	650	875	2500	0.6
LR red	OS red	550	950	210	7.3



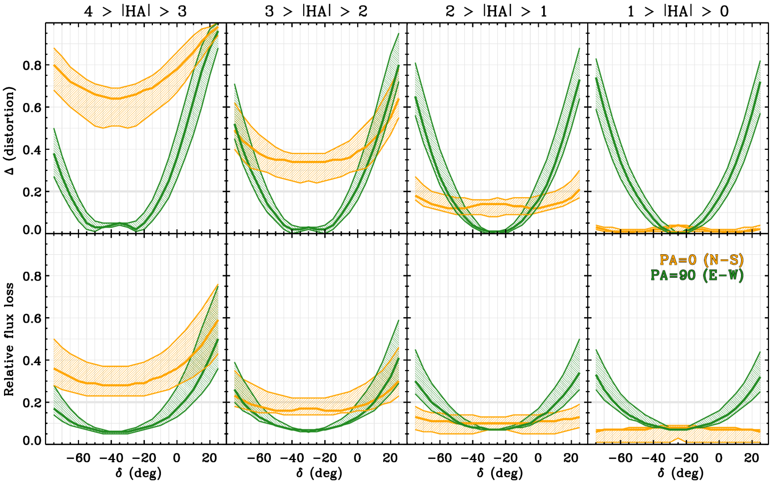
Each panel shows, for the 9 different positions across the VIMOS FoV, the flux obtained after a 1 h-long integration on a $\delta = +10$ deg field using the MR grism. A flat input spectrum was assumed. Solid (dotted) lines correspond to slits oriented along the N-S (E-W) direction at meridian crossing. The dashed lines indicate the fiducial maximum flux, given the assumed FWHM and slit width. Values for relative flux loss (f) and spectral distortion (Δ) at each position are also provided. A N-S slit orientation is clearly preferred in this case.

HR-blue: dependence on δ, HA and FoV orientation



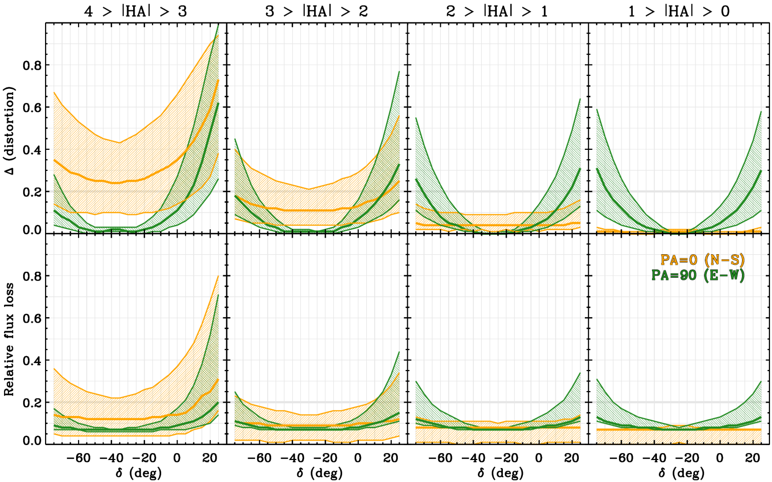
Curves show the minimum, median and maximum flux losses and spectral distortions of the 9 simulated slits as a function of target declination, and for two different slit orientations at meridian crossing. Each column corresponds to a 1 h integration in the $4 > |\mathrm{HA}| > 0$ range.

LR-blue: dependence on δ, HA and FoV orientation



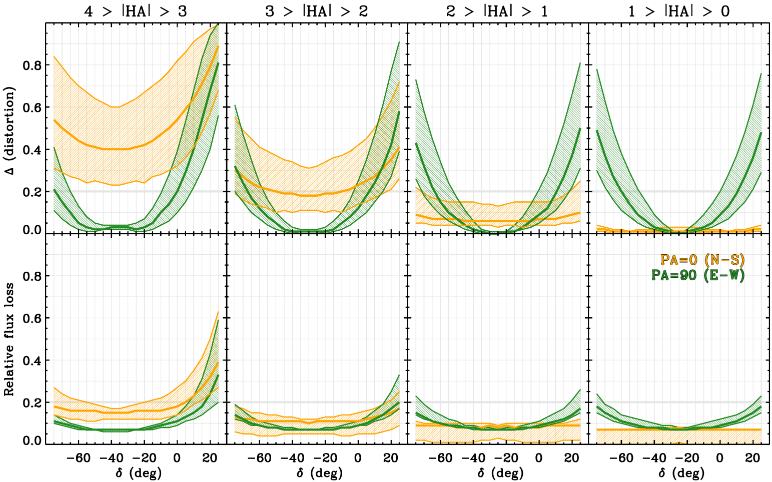
Curves show the minimum, median and maximum flux losses and spectral distortions of the 9 simulated slits as a function of target declination, and for two different slit orientations at meridian crossing. Each column corresponds to a 1 h integration in the $4 > |\mathrm{HA}| > 0$ range.

HR-orange: dependence on δ, HA and FoV orientation



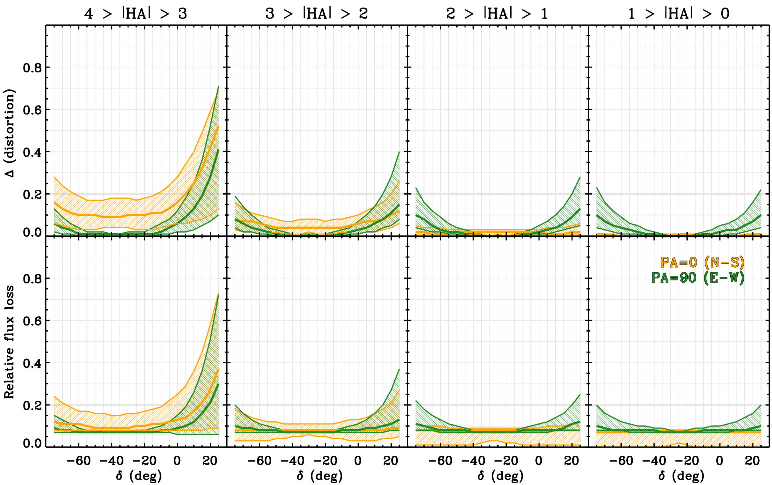
Curves show the minimum, median and maximum flux losses and spectral distortions of the 9 simulated slits as a function of target declination, and for two different slit orientations at meridian crossing. Each column corresponds to a 1 h integration in the $4 > |\mathrm{HA}| > 0$ range.

MR: dependence on δ, HA and FoV orientation



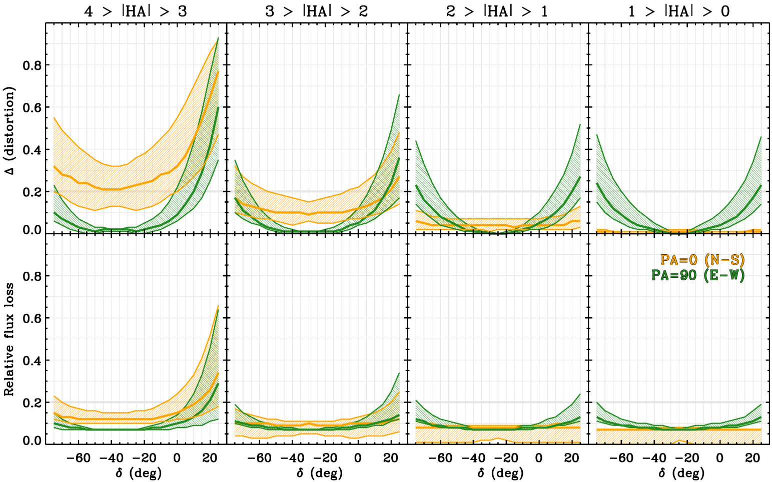
Curves show the minimum, median and maximum flux losses and spectral distortions of the 9 simulated slits as a function of target declination, and for two different slit orientations at meridian crossing. Each column corresponds to a 1 h integration in the $4 > |\mathrm{HA}| > 0$ range.

HR-red: dependence on δ, HA and FoV orientation



Curves show the minimum, median and maximum flux losses and spectral distortions of the 9 simulated slits as a function of target declination, and for two different slit orientations at meridian crossing. Each column corresponds to a 1 h integration in the $4 > |\mathrm{HA}| > 0$ range.

LR-red: dependence on δ, HA and FoV orientation

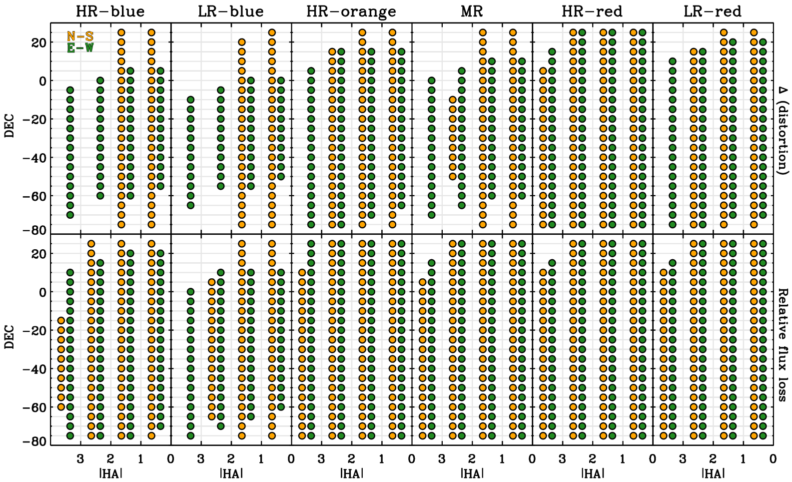


Curves show the minimum, median and maximum flux losses and spectral distortions of the 9 simulated slits as a function of target declination, and for two different slit orientations at meridian crossing. Each column corresponds to a 1 h integration in the $4 > |\mathrm{HA}| > 0$ range.

General Trends

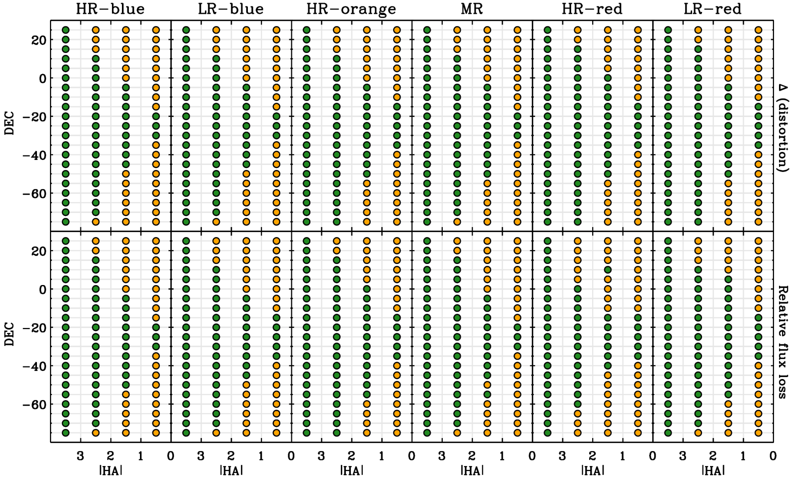
- North-South (PA $= 0$) slit orientation
  - At fixed HA, very weak dependence on δ (except for HA $> 2\,$h and bluest wavelengths).
  - The minimum of the losses distribution increases and moves towards southern δs at larger HAs.
  - For any given grism, there is a strong dependence with HA, such that larger distortions and flux losses occur at larger HAs.
  - Both the amount of distortion/loss and the dependence on δ increase for bluer wavelengths.
- East-West (PA $= 90$) slit orientation
  - At fixed HA, very strong dependence on δ, but the behaviour flattens towards redder wavelengths.
  - The minimum of the losses distribution slightly decreases and moves towards southern δs at larger HAs.
  - For any given grism, very little dependence with HA (except for extreme δs).
  - The δ-dependence of distortion/losses increases towards bluer wavelengths.

Summary: dependence on grism, δ, HA and FoV orientation



Filled circles show the declination-hour angle pairs (colour-coded according to slit orientation) for which the *median* spectral distortion (top row) or *median* flux loss (bottom row) across the VIMOS FoV remain below the 20% value during a 1 h-long integration.

Summary: N-S vs E-W orientation



Orange (green) circles show the declination-hour angle pairs for which the *median* spectral distortion (top row) or *median* flux loss (bottom row) across the VIMOS FoV are lower with slits oriented along the N-S (E-W) direction at meridian crossing. A 1 h-long integration is assumed.

Recommendations for VIMOS-MOS users

- The **two-HA rule**, together with the **default N-S slit orientation**, provide rather stable results, with flux losses *and* spectral distortions below 20% – almost independent of target declination. This should always be the **preferred option** for users having targets at $\delta \gtrsim -5$ deg or $\delta \lesssim -45$ deg.

- However, for targets in the $-45 \lesssim \delta\,(deg) \lesssim -5$ range the **E-W orientation** is generally **preferred**. This slit orientation allows for observations to be effectively extended to $|\mathrm{HA}| \approx 3\,\mathrm{h}$ (or even beyond). This **holds for all grisms** currently offered in VIMOS, provided the acquisition is done with a filter that closely matches the grism wavelength range.

- To define the optimal slit position angle for any specific target declination and observational setup, we refer the users to the summary plots in the previous pages of this document.