The recent commissioning of the Gemini MCAO system (GeMS) sets the stage for its use with the near-IR spectrometer F2. In this poster, we describe the upcoming work left to do to be able to start the commissioning of F2 with GeMS. This combination will provide the Gemini community with one of the few AO fed MOS near-IR spectrometers on a 8m class telescope. Preliminary performance tests of GeMS with GMOS-S indicate that the MCAO correction provides, over a 2’ field, images with a typical uniform PSF of 0.2” in the z band (from 0.08 to 0.35 depending on the natural seeing). Under similar conditions, the resulting Strehl ratio in GSAOI images is in the range 25-35% for the H band. At f/33 the FOV of F2 is 3’ and larger than the FOV at GSAOI (30”). F2 images during commissioning of the f16 mode have shown that the instrument can provide an image quality of 2 pixels, which correspond to 0.18” with the f/33 GeMS beam. As such, a typical 2-pixel slit would provide reasonable compromise to efficiently couple a large fraction (80%) of the incident starlight into the instrument during relatively long exposures. We are focusing on a few typical science cases in order to refine the requirements for commissioning. The cases are: spectroscopy of very faint source (f/16 slit mode) and spectroscopy of many faint sources (MOS). For both cases we have to determine suitable acquisition techniques and characterize the final throughout of the whole system. For longslits we will need to improve the blind offset acquisition to a precision of 0.1” for an offset star within 30”. For MOS, we need to characterize the differential refraction and atmospheric dispersion constraints, and refine the mask making process. In the future we would like to also implement changes in the readout so that fast MOS acquisitions can be achieved by reading subregions of the chip.

**Summary**

The recent commissioning of the Gemini MCAO system (GeMS) sets the stage for its use with the near-IR spectrometer F2. In this poster, we describe the upcoming work left to do to be able to start the commissioning of F2 with GeMS. This combination will provide the Gemini community with one of the few AO fed MOS near-IR spectrometers on a 8m class telescope. Preliminary performance tests of GeMS with GMOS-S indicate that the MCAO correction provides, over a 2’ field, images with a typical uniform PSF of 0.2” in the z band (from 0.08 to 0.35 depending on the natural seeing). Under similar conditions, the resulting Strehl ratio in GSAOI images is in the range 25-35% for the H band. At f/33 the FOV of F2 is 3’ and larger than the FOV at GSAOI (30”). F2 images during commissioning of the f16 mode have shown that the instrument can provide an image quality of 2 pixels, which correspond to 0.18” with the f/33 GeMS beam. As such, a typical 2-pixel slit would provide reasonable compromise to efficiently couple a large fraction (80%) of the incident starlight into the instrument during relatively long exposures. We are focusing on a few typical science cases in order to refine the requirements for commissioning. The cases are: spectroscopy of very faint source (f/16 slit mode) and spectroscopy of many faint sources (MOS). For both cases we have to determine suitable acquisition techniques and characterize the final throughout of the whole system. For longslits we will need to improve the blind offset acquisition to a precision of 0.1” for an offset star within 30”. For MOS, we need to characterize the differential refraction and atmospheric dispersion constraints, and refine the mask making process. In the future we would like to also implement changes in the readout so that fast MOS acquisitions can be achieved by reading subregions of the chip.

**Figure 2.** NGC1851, Y-band.

**Figure 3.** MOS spectrum test.

**Flamingos 2 Imaging commissioning results.**

The image quality analysis of data obtained through December and January commissioning run show that the instrument optics can provide stellar images with whole field averages in FWHM better than 2.5 pixels and ellipticities better than 0.09 (Figure 2). In particular, image S320111250088, obtained in the Y band with FWHM = 2.14±0.2 pixels, ellipticity = 0.089±0.03 across the whole 6” field (Figure 2). This means that, even assuming a super-seen effect (seeing at wavelength 0.9 mm about 1 pixel, 0.18”), the instrument aberrations are convolving images with a FWHM less than 1.8 pixels for an arbitrarily small point source.

**GSAO + GeMS performance tests.**

The tests of GeMS with GMOS-S indicate that a typical uniform PSF in the 2 band is achieved, with a variation of less than 10% FWHM up to a radius of 4”, with poor natural seeing conditions and up to a radius of 62” in IQ 70%-ile conditions. The typical FWHM is 0.2” in the 2 band (from 0.08 to 0.35 depending on the natural seeing when the images were taken, see report by B.Heichel et al.). Although the Strehl ratio of the images at these short wavelengths is low (about 5-10%), the experiments clearly indicated that the MCAO can provide a usable field of view of 2’ or more. Under similar natural seeing conditions (IQ85%-ile), the resulting Strehl ratio in GSAOI images is in the range 25-35% for the H-band.

Considering the previous results, we can expect that MCAO feeding Flamingos-2 will double or triple the FOV area respect to GSAOI maintaining a uniform PSF with a typical Strehl ratio of 30% in the H band. Moreover, the F/33 regime point source images would appear convolved with a FWHM smaller than 1 pixel by effect of the instrument aberrations, considering:

i) The f/33 mode of Flamingos-2 will use 1% of the area used by each optical element on the f/16 mode, being this reduced area at the axial part of the optics.

ii) All the angles of the incoming light from the focal plane will be reduced by half at the f/33 regime. Specifically, in a very first approximation spherical aberrations are proportional to (f/W)^2, as come to (f/H)^2, and astigmatism to (f/V)^2.

iii) The sampling provided by the F2 detector in the f/33 mode would be about 0.09 arcsec/pixel. Therefore, the pupil sampling is larger than the non-gaussian core of the image provided by the adaptive optics system. The Strehl ratio becomes only referential and in the spectroscopic mode, the point source will be convolved with the 2 pixels of the slit width.

Besides the larger field of view for imaging, the main advantages will come at the spectroscopy modes, which are being commissioned (Figure 3). If we consider a delivered FWHM of 0.1” with a Strehl ratio of 30% at the H band, a 2-pixel slit (0.18” in f/33) would efficiently get a large fraction (80%) of the incident starlight into the spectrometer. We run some tests with the F2 system and found that the typical gain will be 0.9 magnitudes at the H-band, when improving the image quality by the use of the MCAO. In particular, at the H band a natural seeing of 0.6” has large-slit losses when using the 2-pixel slit (0.36”). In comparison with having 80% of a point source flux inside 0.2” when using GeMS. In other words, the limiting magnitude for achieving 5/SN 3 in one hour will improve from 18.7 to 19.8 mag at the H spectral range, with the same spectral resolution R=1300. This would benefit the performance in spectroscopy of very faint sources in the long slit mode and particularly strengthen the multiplexing advantage of the MOS mode, considering that more resolved and faster targets will be observable.

For both operation cases we have to determine suitable acquisition techniques and characterize the final throughout of the whole system. For longslits we will need to improve the blind offset acquisition to a precision of 0.1” for an offset star within 30”. For MOS, we need to characterize the differential refraction and atmospheric dispersion constraints, and refine the mask making process. In the future we would like to also implement changes in the readout so that fast MOS acquisitions can be achieved by reading subregions of the chip.

A fair amount of work is ahead, but this work will make Flamingos-2 the only NIR multi-object spectrograph taking advantage of the unique GeMS capabilities in the near future.