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NIRSpec Technical Note
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Spectral intensity of the MSA glow sources

Abstract:

We use measurements obtained during NIRSpec's FM2 cycle-1 test campaign to derive a first order estimate of the spectral intensity of the some MSA glow sources.

Change log		
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1	29.11.2013	Creation

1 INTRODUCTION AND SCOPE OF THE NOTE

During NIRSpec's FM2 cycle-1 it was realised that tiny areas of the micro-shutter arrays associated to shorts were "glowing". The light emitted by these localised regions was easily detected in NIRSpec imaging mode. In order to characterise these "glow" sources, we obtained spectroscopic exposures at low spectral resolution using NIRSpec's prism.
In the following, we present the results of a first order derivation of the spectra of 4 of these glow sources to assess the magnitude of their spectral intensity so the micro-shutter team can check if they could be detected in their infrared contrast measurement setup.

2 FROM COUNT RATES TO SPECTRAL INTENSITY

The conversion from the measured count-rate values to spectral intensities was performed in the following simple way. First we converted the measured integrated count rates per unit of wavelength (in ADU s^{-1} μm^{-1}; as generated by the extraction pipeline) in photon rates per unit of wavelength in the MSA plane (in photon s^{-1} μm^{-1}).

$$\Gamma(\lambda)[photon\ s^{-1}\ \mu m^{-1}] = \mathrm{N}_{ADU}(\lambda)[ADU\ s^{-1}\ \mu m^{-1}] \times \frac{g}{\epsilon(\lambda)}$$

Where g is the detector conversion gain in electron per ADU; and $\epsilon(\lambda)$ is the photon conversion efficiency of NIRSpec's optical train downstream from the MSA (in electron per photon; including the detector quantum efficiency). Note that we did not account for any pixel-to-pixel response variations and used an average detector quantum efficiency curve.

Assuming that these sources were emitting isotropically, we then derived the corresponding spectral intensity.

$$I(\lambda)[photon\ s^{-1}\ \mu m^{-1}\ sr^{-1}] = \Gamma(\lambda)[photon\ s^{-1}\ \mu m^{-1}] \times \frac{f_{collimator}^2}{\delta x_{prism} \times \delta y_{prism}}$$

Where $f_{collimator}$ is the equivalent focal length of the collimator and $\delta x_{prism} \times \delta y_{prism}$ is the surface of prism (for the computation of the solid angle). See Table 1.

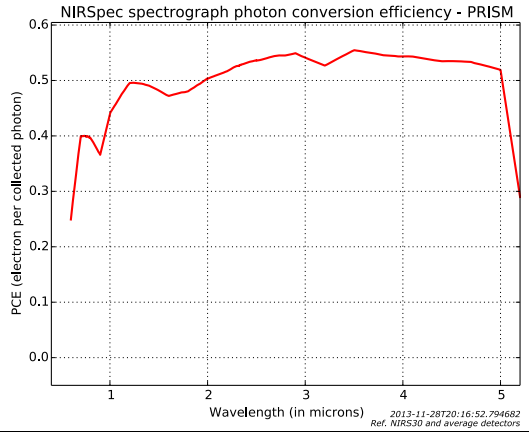
Parameter	Value	Comments
g	Detector conversion gain: approximately 1.34 electron per ADU.	
$f_{collimator}$	The collimator equivalent length: approximately 0.62 m.	
$\delta x_{prism} \times \delta y_{prism}$	The prism size: approximately 67 by 69 mm.	
$\epsilon(\lambda)$		All optical elements downstream from the MSA and the detectors.

Table 1 Parameters used for the computation of the spectral intensity of the glowing shutters

3 THE EXTRACTED SPECTRA

In order to achieve a reasonable spectral to noise ratio even in spectroscopic mode, we observed the glow sources when the micro-shutter array was in the so-called "LATCHED" configuration corresponding to the strongest (worst-case) glow intensity. As the glow sources that we can see are located on the "back" side of the MSA (toward the detectors), no masking was possible and we used NIRSpec's prism configuration to minimize the length of the spectra and hence the level of overlap between the spectra. The low spectral resolution was also the best possible choice in terms of sensitivity.

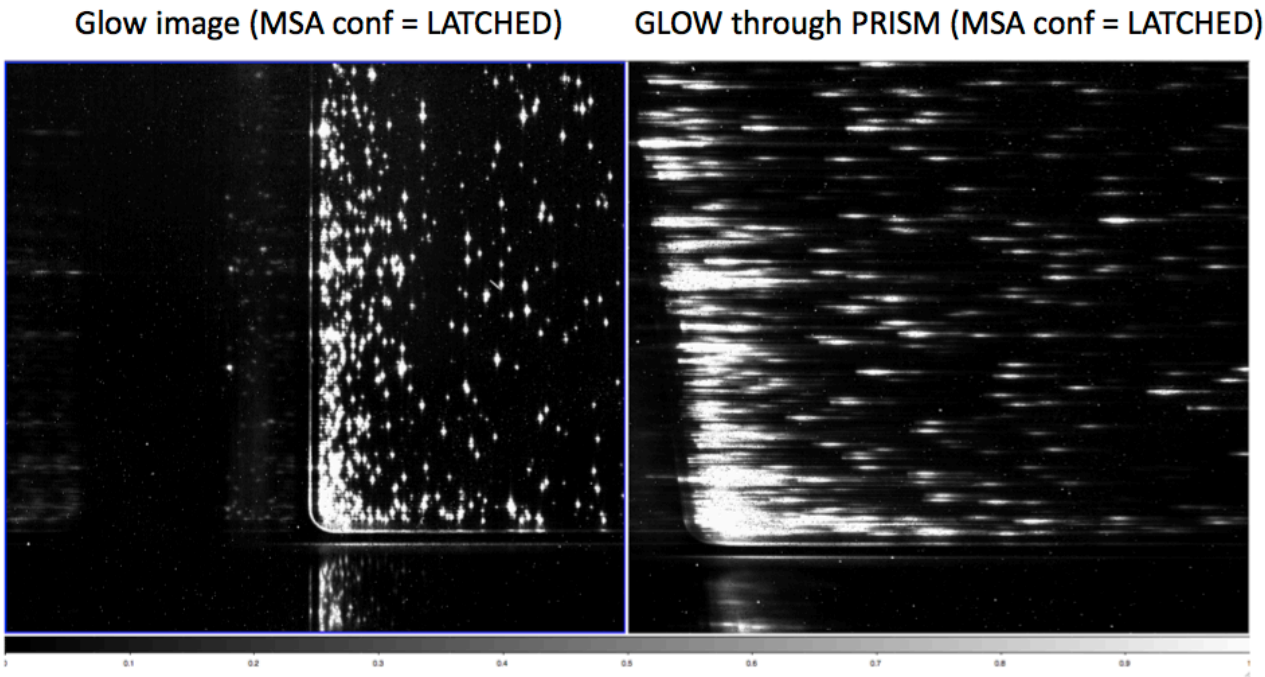


Figure 1 Count-rate maps before spectrum extraction: the glowing shutters displayed short and strongly peaked spectra.

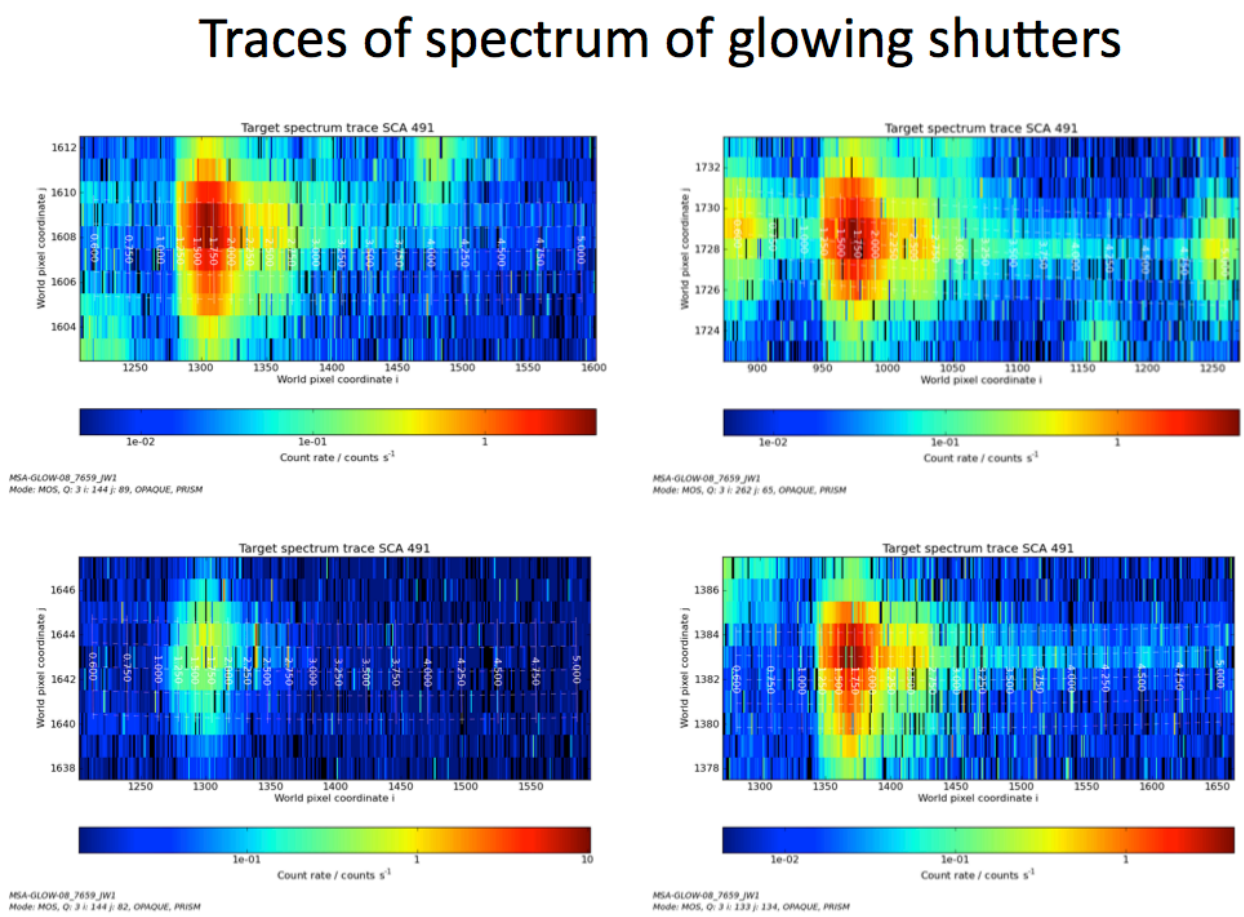


Figure 2 The traces of the spectra of four reasonably isolated glowing shutters

After extraction and conversion from units of count rates per pixel into integrated count rates per unit of wavelength, we can see that the spectrum is still peaked and that this peak is located in the 1.5-2.0 μm wavelength range.
Note: this is an arbitrary selection of spectra (the main constraint was to find “clean” spectra free of overlap).

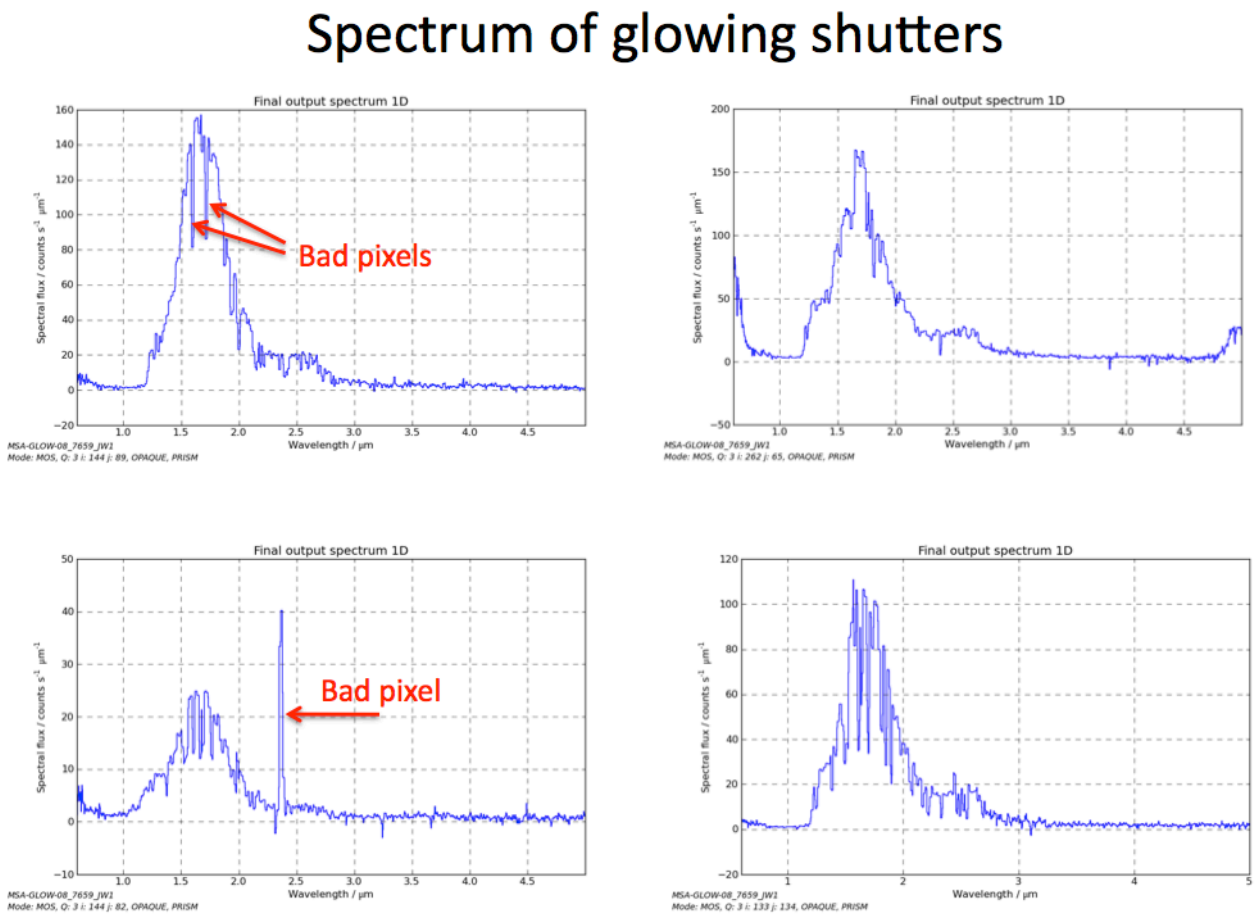
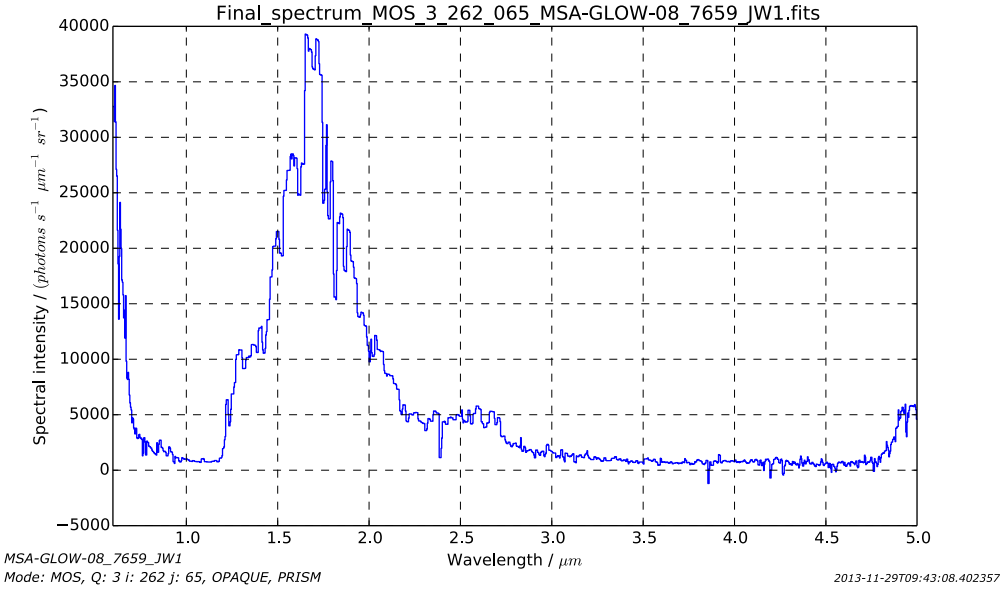


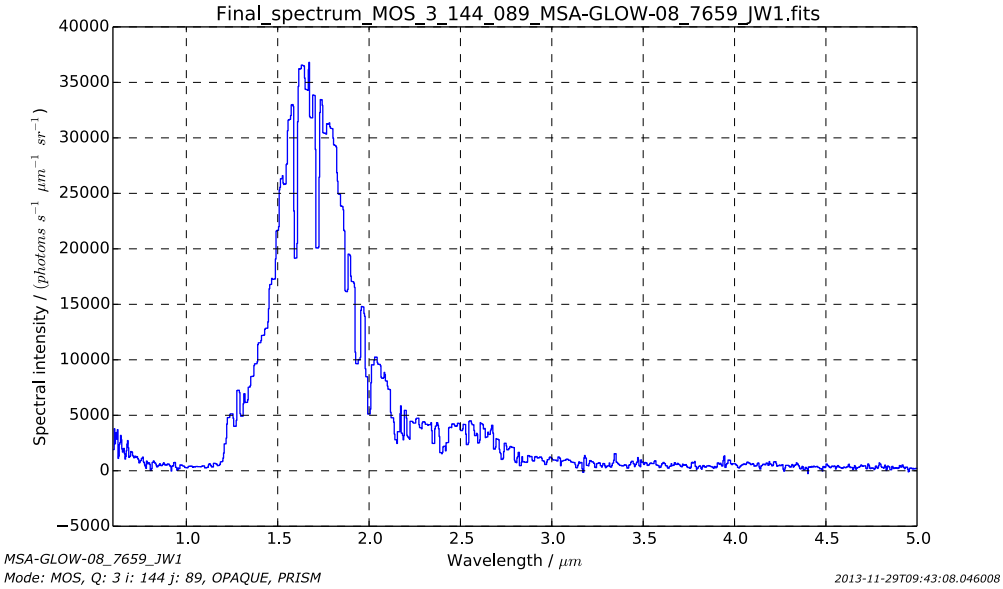
Figure 3 Spectra of the four glowing shutters in units of counts s^{-1} μm^{-1}, as computed by the extraction pipeline

4 THE CALIBRATED SPECTRA

These 4 extracted spectra were converted into spectral intensity units using the relations described in section 2. The resulting spectra are shown in Figure 4.
Important notes:

- The steep increase in intensity at the short and long wavelength ends that can be seen in some spectra is in artefact (mainly from the PCE correction and from contamination by other spectra).
- Some strong "absorption" or "emission"-like features are due to bad pixels (see the count-rate spectra in the previous section).


Final_spectrum_MOS_3_262_065_MSA-GLOW-08_7659_JW1.fits
Spectral intensity / ($photons\ s^{-1}\ \mu m^{-1}\ sr^{-1}$)
Wavelength / μm
MSA-GLOW-08_7659_JW1
Mode: MOS, Q: 3 i: 262 j: 65, OPAQUE, PRISM
2013-11-29T09:43:08.402357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Spectral intensity / ($photons\ s^{-1}\ \mu m^{-1}\ sr^{-1}$)
Wavelength / μm
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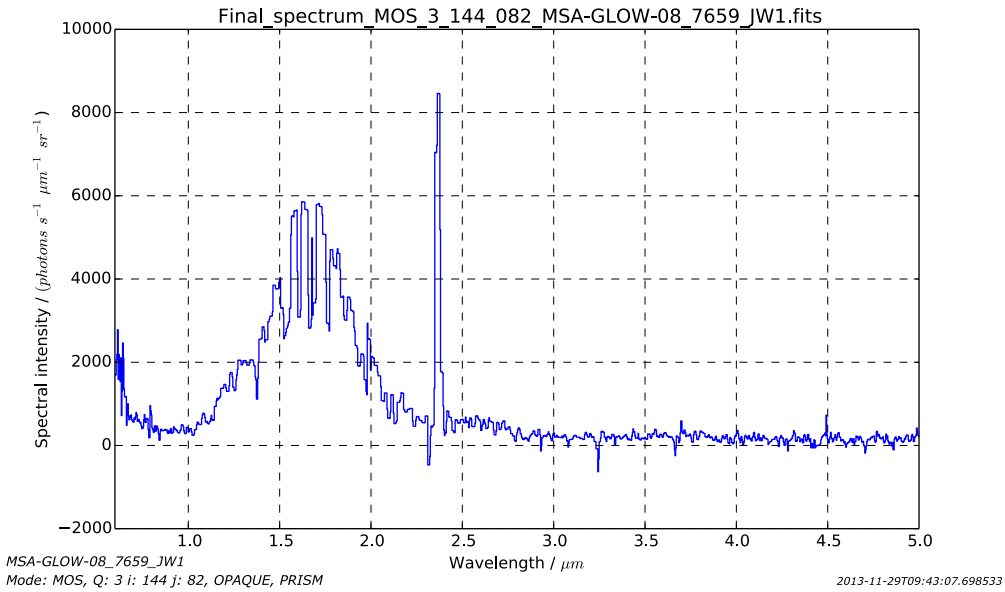
2013-11-29T09:43:08.046008



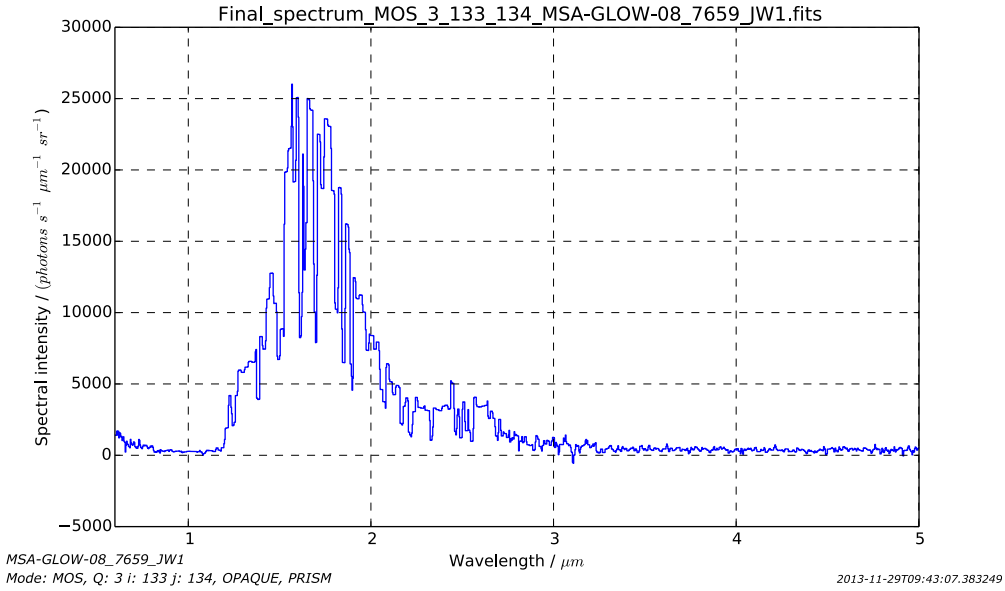


Figure 4 The glowing shutters spectral intensity.