Instrument Science Report COS 2019-22(v1)

COS FUV Detector Gain Maps Obtained at the Time of the LP4 Move

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ABSTRACT

Program 15370 used the onboard deuterium lamp to illuminate the LP2, LP3, and LP4 regions of the COS FUV detector at the time of the move to LP4 on October 2, 2017. The gain maps calculated from these data provided snapshots of the modal gain values for the three Lifetime Positions currently being used. The data show that the modal gain for the deepest hole at LP3 was very close to three, and thus it was the appropriate time to move. The gain maps at LP4 show that the gain is consistent with what is expected from similar data taken in the enabling phase of the LP4 process, and there is no sign of a hole due to airglow.

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1. Introduction

Monitoring the gain (the number of electrons generated by the microchannel plate stack for each incident photon) of the COS FUV detector is crucial to ensure optimal performance. When the modal gain (the peak of the pulse height distribution) at a particular location on the detector drops below a value of about 3, approximately 5% of the counts there fall below the lower pulse height threshold, which leads to an apparent local loss of sensitivity (Sahnow et al. 2011). The amount of gain sag is a function of the number of photon events incident on the detector, the high voltage (HV), and other factors. The largest gain drops are seen in the regions of the detector where Lyman α airglow lines fall, since they have collected the most counts.

Each time the nominal Lifetime Position (LP) is changed for the spectra on the COS FUV detector, we obtain spectra of the internal deuterium lamp. These spectra are taken at HV and cross-dispersion settings that correspond to both the old and new nominal settings used during normal observing.

Because of the strongly varying intensity of the lamp as a function of wavelength, data are collected using both G130M/1309 and G160M/1600. The former is the best choice for obtaining approximately uniform coverage on Segment A, while the latter does the same for Segment B. In order to maximize the number of counts in the pulse height distribution (PHD), data from both lamps are combined when constructing the gain maps.

2. Execution

Program 15370 obtained deuterium data over five one-orbit visits, which are listed in Table 1; all visits successfully collected the expected data. Each visit followed a similar procedure:

- Adjust the HV values to the appropriate levels
- Adjust the aperture block in the cross-dispersion direction so that the deuterium lamp illuminates the appropriate region on Segment A when using G130M/1309
- Take a 400 s deuterium lamp exposure at FP-POS=1 using both detector segments
- Adjust the aperture to a second cross-dispersion location to obtain additional coverage on Segment A, and take a 400 s deuterium lamp exposure at FP-POS=4 using both detector segments
- Adjust the aperture in the cross-dispersion direction so that the deuterium lamp will illuminate the appropriate region on Segment B when using G160M/1600
- Take a 400 s deuterium lamp exposure using both detector segments
- Adjust the aperture to a second cross-dispersion location to obtain additional coverage on Segment B, and take another 400 s deuterium lamp exposure
- Return the HV to the nominal values for the standard observing modes

Exposures M3, M4, and M5 also included a final move to return the aperture to its nominal position before the HV was returned to its nominal value.

The two offset positions for each grating were chosen so that when the data from the exposures are combined, the count rate is roughly uniform in the cross-dispersion direction, and they overlap with the science spectra at the same LP. The commanded aperture offset values (LAPXSTP) are shown in Table 1; these were determined by measuring the position of spectra as a function of aperture position during previous deuterium observations.

Visits L1 and L2 executed at LP3 on October 1, 2017, immediately before the move from LP3 to LP4. L1 used the HV values for the Standard Modes (167/175 for Segment A/B), while L2 used the G130M/1222 values (171/175).

Visit M3 executed at LP2 with HV values of 173/175 on October 1, 2017. The location or HV values for the Blue Modes were not changing, so this visit served only as a snapshot of the Blue Modes modal gain.

Visits M4 and M5 were the post-move exposures corresponding to L1 and L2; they both executed at LP4 on October 2, 2017, immediately after the move. HV values were 163/163 for the former (Standard Modes), and 163/167 for the latter (1222).

Table 1. Visits Executed in Program 15370

Visit	Date	LP	Mode	HV (A/B)	LAPXSTP (G130M)	LAPXSTP (G160M)	Notes
L1	10/1/17	3	Standard	167/175	–72, –128	–84, –140	Before LP move
L2	10/1/17	3	1222	171/175	–72, –128	–84, –140	Before LP move
M3	10/1/17	2	Blue	173/175	–213, –267*	–225, –267*	~6 months after previous LP2/Blue Modes data
M4	10/2/17	4	Standard	163/163	–32, –86	–41, –95	After LP move
M5	10/2/17	4	1222	163/167	–32, –86	–41, –95	After LP move

* The commanded value of LAPXSTP for these positions was set to –267 in order to avoid the soft stop at –275.

3. Summary of Analysis and Results

The standard gain-map creation routines were used to make fits to the peak of the pulse height distibution for each binned pixel in order to calculate the modal gain across the detector.

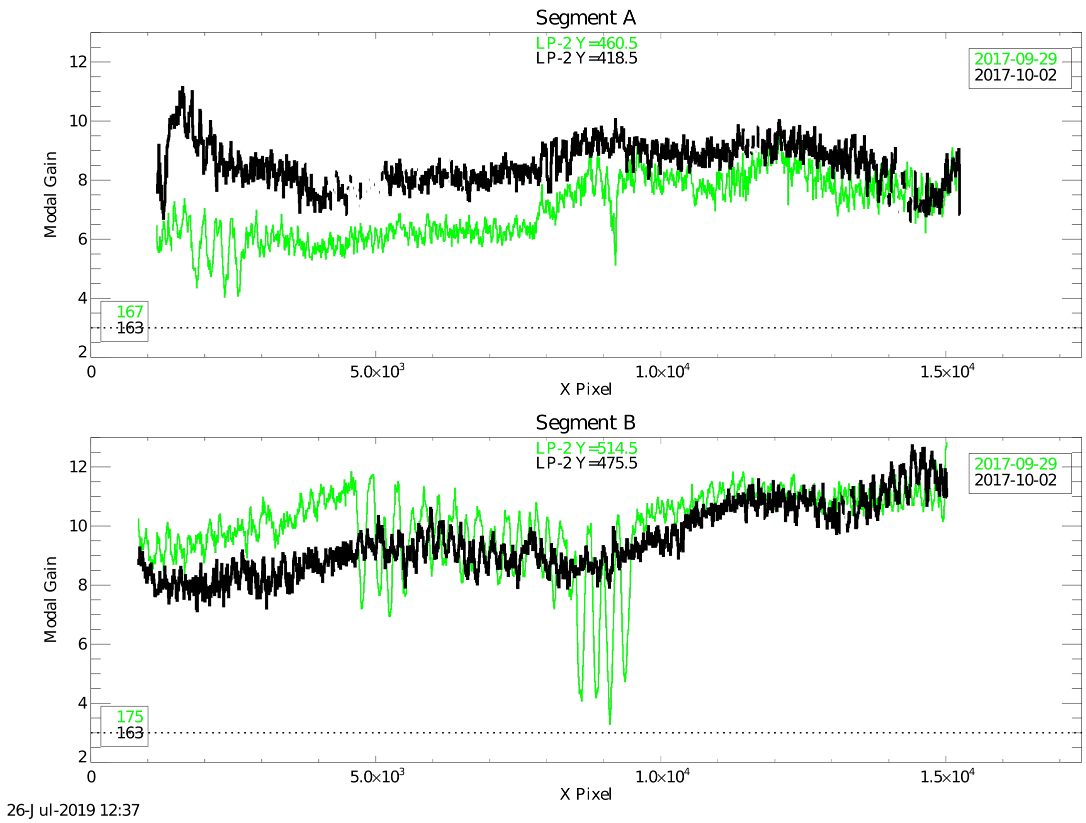

Figure 1. Modal gain as a function of X pixel at the center of the spectral region of the detector before (**green**) and after (**black**) the move to LP4 on October 2, 2017. The 'before' data were taken at LP3 with the nominal HV values for the standard modes of 167/175 on Segment A/B, while the 'after' data are at LP4 with a HV of 163/163.

Figure 1 and Figure 2 show the modal gain as a function of X pixel before (at LP3) and after (at LP4) the move on October 2, 2017. The decision to move to LP4 was based on the desire to move before the first holes appeared on Segment B (Roman-Duval et al. 2018), although it had to be scheduled well in advance, so the date was based on projections of the gain as a function of time. As the figures show, the modal gain in the deepest holes was very close to 3 at the time of the move, but had not yet reached that value.

Although data were also taken at the HV values used for G130M/1222 (visits L2 and M5), the corresponding figures for that central wavelength are not shown here since that mode was not the driver for the lifetime move, and it falls on the same regions of the detector. As noted above, the Blue Modes were not moved from LP2, so the LP2/Blue Mode data (visit M3) is shown in Sahnow (2019), where it is compared to the Cycle 25 gain maps.

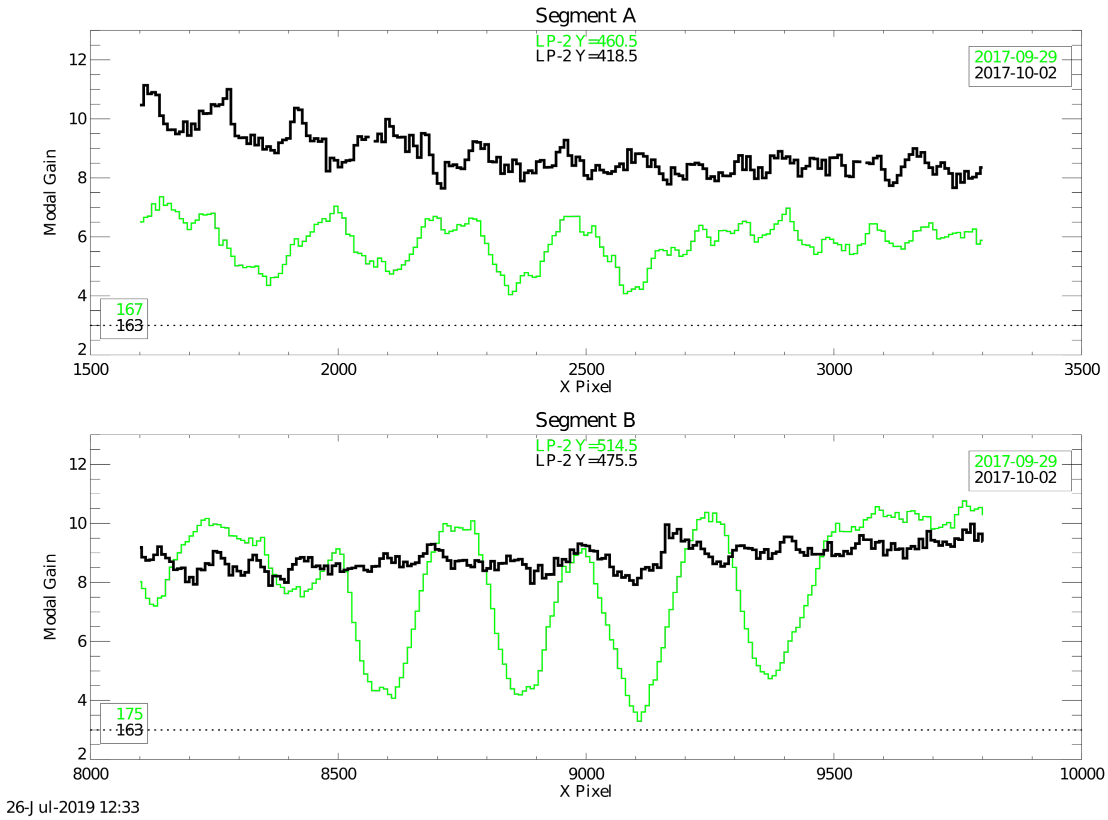

Figure 2. Expanded view of the data shown in Figure 1, with the X pixel range for each segment chosen to highlight the most sagged regions at LP3. At the time of the move, the deepest holes on Segment B were very close to a modal gain of 3, which was the target for the move. After the move, the gain is relatively flat in this region, and it is almost as high as the LP3 continuum level even though the voltage is lower.

Change History for COS ISR 2019-22

Version 1: 5 September 2019 – Original Document

References

Roman-Duval, J., Indriolo, N., De Rosa, G., et al. 2018, COS ISR 2018-14, "Exploratory Phase for Optimizing Lifetime Position 4 of the COS/FUV Detector"

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