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Characterization of the COS FUV Detector Modal Gain at LP4

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ABSTRACT

Program 14525 used the onboard deuterium lamp to illuminate the LP2 and LP4 regions of the COS FUV detector in order to obtain gain maps where the LP4 science and wavelength calibration spectra will fall. These gain maps have been used to determine the initial high voltage values after the move to LP4, and to use as an initial point in the monitoring of gain vs. time that will be done after the move.

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1. Introduction

As part of the enabling phase for each new Lifetime Position (LP), we obtain spectra of the internal deuterium lamp on the COS FUV detector. These spectra are used to construct gain maps at the locations where the spectra will fall after the LP move. It is important to collect this data as one of the first of the enabling programs, since the

goal is to obtain the data while the detector is relatively pristine in that area and the gain is still relatively uniform, since later enabling and calibration programs have enough counts to cause noticeable gain sag.

By adjusting the aperture position, deuterium spectra can be taken at a range of Y positions on the detector, so that the gain can be measured over the full cross-dispersion profile for any likely LP4 spectral position. At LP4, there is the additional complication that the wavelength calibration spectra fall on the previously sagged LP2 region of the detector, and can therefore be compromised due to the existing gain sag holes; thus it is also helpful to obtain gain information at that location.

Because of the strongly varying intensity of the lamp as a function of wavelength, gain map data is collected using both G130M/1309 and G160M/1600 cenwaves. 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 is combined when constructing the gain maps.

2. Design and Execution

Program 14525 was designed to characterize the modal gain at a variety of detector locations over a range of possible initial HV settings for LP4 operations. The deuterium lamp was used to illuminate two regions of the detector covering the possible LP4 positions (between LP3 and the bottom of the detector), along with the LP2 position (where the LP4 wavecal spectrum will fall).

Spectra were taken at three different high voltage (HV) values on each segment, in order to bracket the likely initial LP4 HV values (163, 167, and 171 for FUVA; 159, 163, and 167 for FUVB). In order to most efficiently illuminate the two segments, the G130M/1309 setting was used to obtain uniform coverage on Segment A, and G160M/1600 was used for Segment B. However, both segments remained on at all times, since this provided additional counts for analysis.

The program consisted of six visits, listed in Table 1, with each collecting data at all three aperture positions for a single central wavelength and set of high voltages; the entire program successfully executed on July 4, 2016.

Table 1 Visits executed in Program 14525

Visit	HV (A/B)	Cenwave
13	163/159	G130M/1309
16	163/159	G160M/1600
23	167/163	G130M/1309
26	167/163	G160M/1600
33	171/167	G130M/1309
36	171/167	G160M/1600

Each visit had the following structure:

- Adjust the HV values on both segments
- Adjust the aperture in the cross-dispersion direction so that the deuterium lamp illuminates the LP2 region of the detector – on Segment A with FP-POS=1 when using G130M/1309 or Segment B and FP-POS=4 for G160M/1600.
- Take a 400 second deuterium lamp exposure using both detector segments
- Adjust the aperture in the cross-dispersion direction so that the deuterium lamp illuminates the lower portion of LP3 / upper portion of LP4 for the appropriate segment, and take a 400 second deuterium lamp exposure using both detector segments
- Adjust the aperture in the cross-dispersion direction so that the deuterium lamp illuminates the LP4 region for the appropriate segment and take a 400 second deuterium lamp exposure using both detector segments
- Return the HV to the nominal values for the standard LP3 observing modes

The aperture positions were adjusted via the XAPER optional parameter and XSTEPS QESIPARM in order to command the absolute aperture positions (LAPXSTP) listed in Table 2.

Table 2 Absolute aperture position for each detector location

Detector Location	**LAPXSTP-G130M**	**LAPXSTP-G160M**
LP2	-231	-243
Lower LP3/Upper LP4	-78	-85
LP4	-24	-33

3. Summary of Analysis and Results

A sum of all counts on the detector collected during visits 33 and 36 of this program is shown in Figure 1. The two lower regions overlap to provide continuous coverage from near the middle of the LP3 location to the bottom edge of the detector area. The LP2 region, where the wavelength calibration spectrum falls, is above the LP4 region.

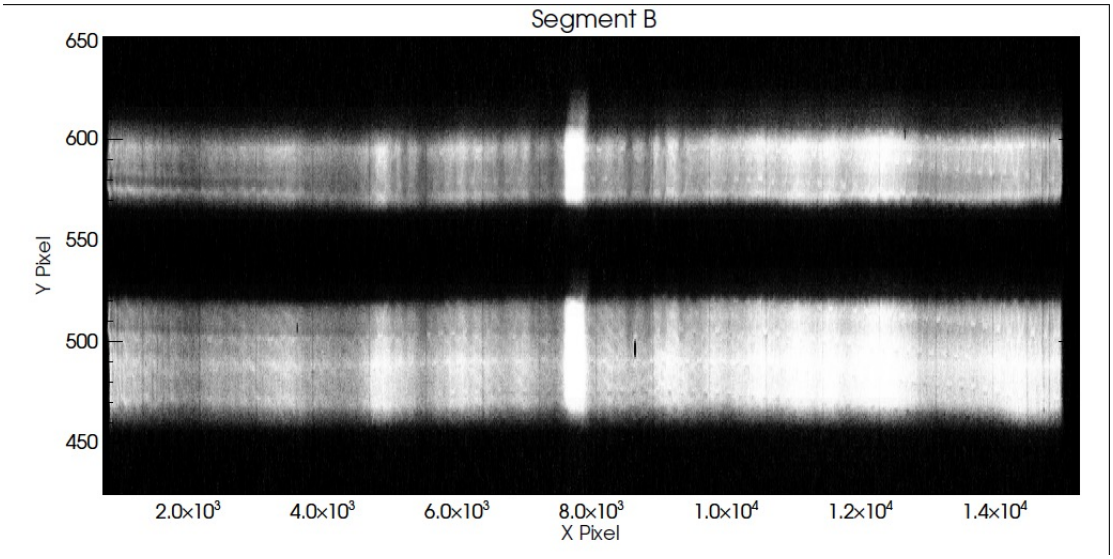

Figure 1 A two-dimensional count map showing the illumination of Segment B during visits 33 and 36. The upper spectrum, centered at Y = ~590, covers the LP2 region, which is where the LP4 wavecal spectra will fall. The wider region below is illuminated from approximately the middle of the LP3 region down to the bottom of the detector active area.

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 as a function of HV. Figure 2 shows the gain as a function of X pixel at a Y location in the region where the LP4 spectra will fall. All three HV values are displayed.

The figure shows that the gain map is relatively featureless and reasonably flat across most of the detector. Based on an examination of these data, a HV of 163 has been chosen as the starting value for both segments when the standard observing modes are moved to LP4.

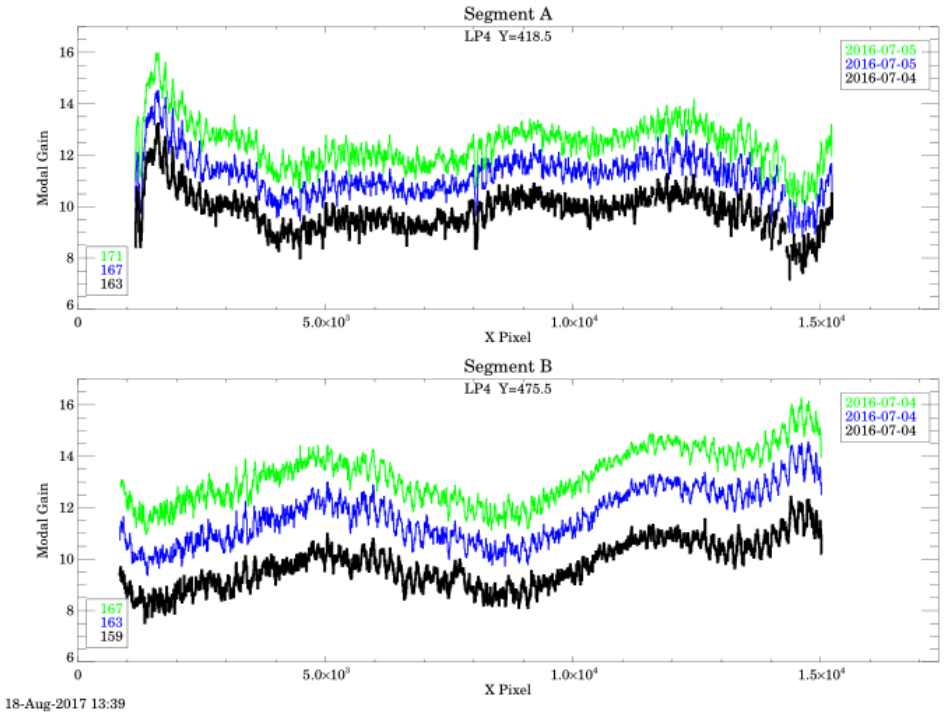

Figure 2 Gain as a function of x pixel at the center of the LP4 region on both detector segments.

References

D. Sahnow et al., 2011, Instrument Science Report COS 2011-05, "Gain sag in the FUV detector of the Cosmic Origins Spectrograph"