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Instrument Science Report COS 2021-05(v1)

Cycle 26 COS NUV Detector Dark Monitor

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ABSTRACT

Here we summarize the Cycle 26 NUV Dark Monitoring Program for the Cosmic Origins Spectrograph (COS) on the Hubble Space Telescope (HST) covering dates November 2018 to October 2019. We give an overview of the calibration plan and summary for this calibration program. We also provide an update to the NUV dark monitoring code and calculation of the NUV dark rate reported to the Exposure Time Calculator (ETC)

Contents

1. Introduction

Program 15538 ("COS/NUV Detector Dark Monitor," PI C. Magness) is designed for routine monitoring of the NUV MAMA detector, which is then analyzed to produce a dark rate for use in the Exposure Time Calculator (ETC). The main purpose is to look

for evidence of a change in the dark rate, both to track on-orbit time dependence and to check for variations that may be due to anomalies or new features of the detector. For the NUV program, two 22 minute exposures were taken with a regular cadence every two weeks for a total of 52 orbits throughout Cycle 26, from 2018 November to 2019 October. All observations were taken successfully. Since the completion of program 15538, a minor error has been uncovered and corrected in the NUV dark rate calculations that had resulted in a slight underestimation of the NUV dark rate since Cycle 22.

2. Analysis and Results

For each observation, the dark rate was measured and compared to all other Cycle 26 observations to monitor the rate as a function of time. Originally following commission, the dark rate of the NUV MAMA was increasing along a fairly consistent linear slope, but in recent years the increase has slowed dramatically. Figure 1 shows that increase in mean dark rate over time since commissioning has slowed significantly since about 2012 but continues to steadily increase with a slightly greater variability.

A mean dark rate (counts/second/pixel) is calculated in 25 second increments for each individual dark exposure, which is then plotted again the time in decimal year. The ETC estimate for the dark rate is calculated by creating a distribution of these mean dark rate values from observations over a period of the previous 6 months to 1 year and fitting a standard probability distribution to the data; the value corresponding to the level enclosing 95% of the distribution is then reported to the ETC. The dark rate can vary significantly throughout an observation so the 95% level, or about 2-sigma above the mean, is chosen so that the vast majority of users can expect to have a mean dark rate at or below the value used in the ETC calculations. The dark rate adopted for the NUV detector in ETC v26.1 for use in Cycle 26 proposals was 8.77e-4 counts/sec/pixel.

After completion of the Cycle 26 COS NUV dark rate monitoring program, a minor error was corrected in the NUV dark rate calculations that had resulted in a slight underestimation of the NUV dark rate that was reported to the ETC. After a thorough code review, we discovered the area in number of pixels of the NUV detector used in the calculation was incorrect. This was subsequently fixed in the code. Prior to the fix, the dark rate corresponding to the 95% level for the entire Cycle 26 period was originally calculated to be 9.53e-4 counts/sec/pixel. Figure 2 shows a histogram of the distribution of mean dark rate values for Cycle 26 prior to the code fix with number of bins equal to 100 and markers showing the median, mean, 2-sigma, 3-sigma, 95%, and 99% values. With the fix, the 95% dark rate value is 1.12e-03 counts/sec/pixel (Figure 3). The dark rate prior to the fix as a function of time is also shown in Figure 4. The error is small compared to the natural variations in the dark rate, so there were no significant consequences.

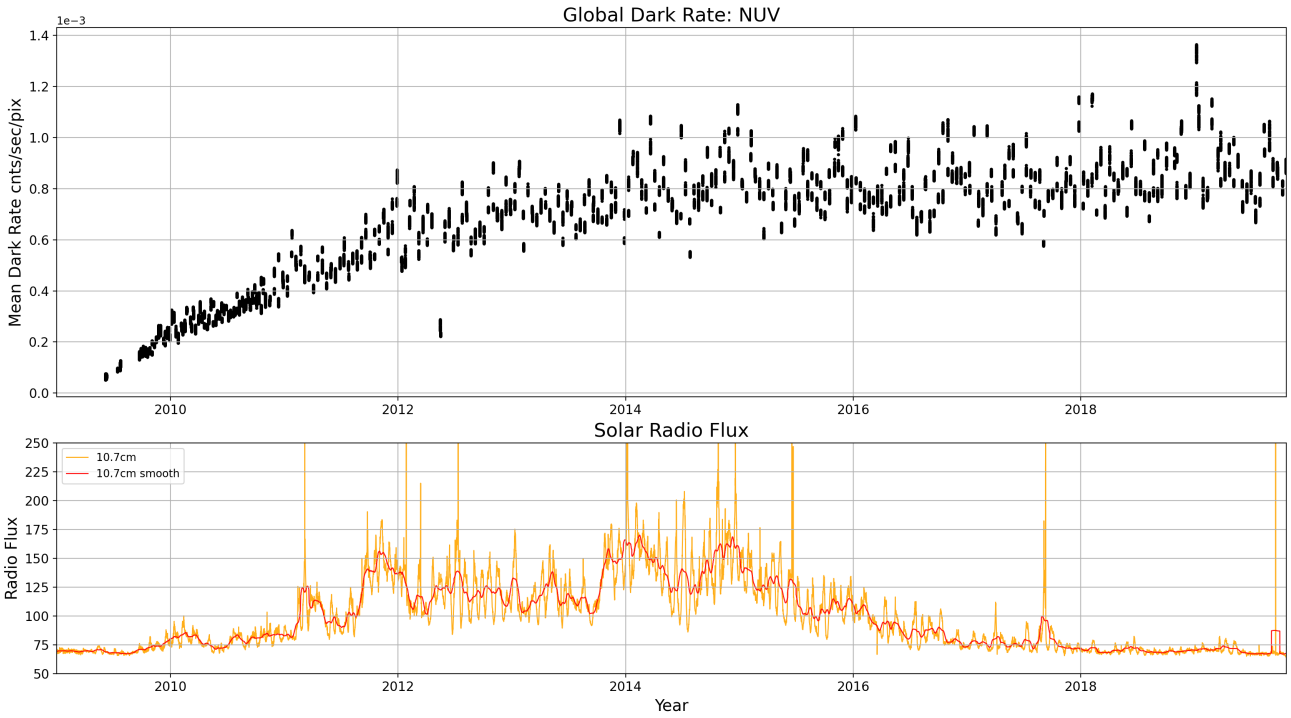

Figure 1. Dark Rate vs. Time: The COS NUV dark rate as a function of time, spanning from installation through Cycle 26. The dark rate is measured in 25 s increments, which is then plotted against the time in decimal year (*top*). Groupings of points occur naturally, as they correspond to the individual exposures of their origin, also displaying the natural variation within an exposure. We also plot these trends against the 10.7 cm radio flux, used as a signifier of the solar cycle (*bottom*).

3. Summary

The COS NUV MAMA detector continues to follow former trends of a slight linear increase with larger variability than originally seen. We will continue this monitoring program into future cycles and perform new analysis as necessary.

Change History for COS ISR 2021-05

Version 1: 30 June 2021 – Original Document

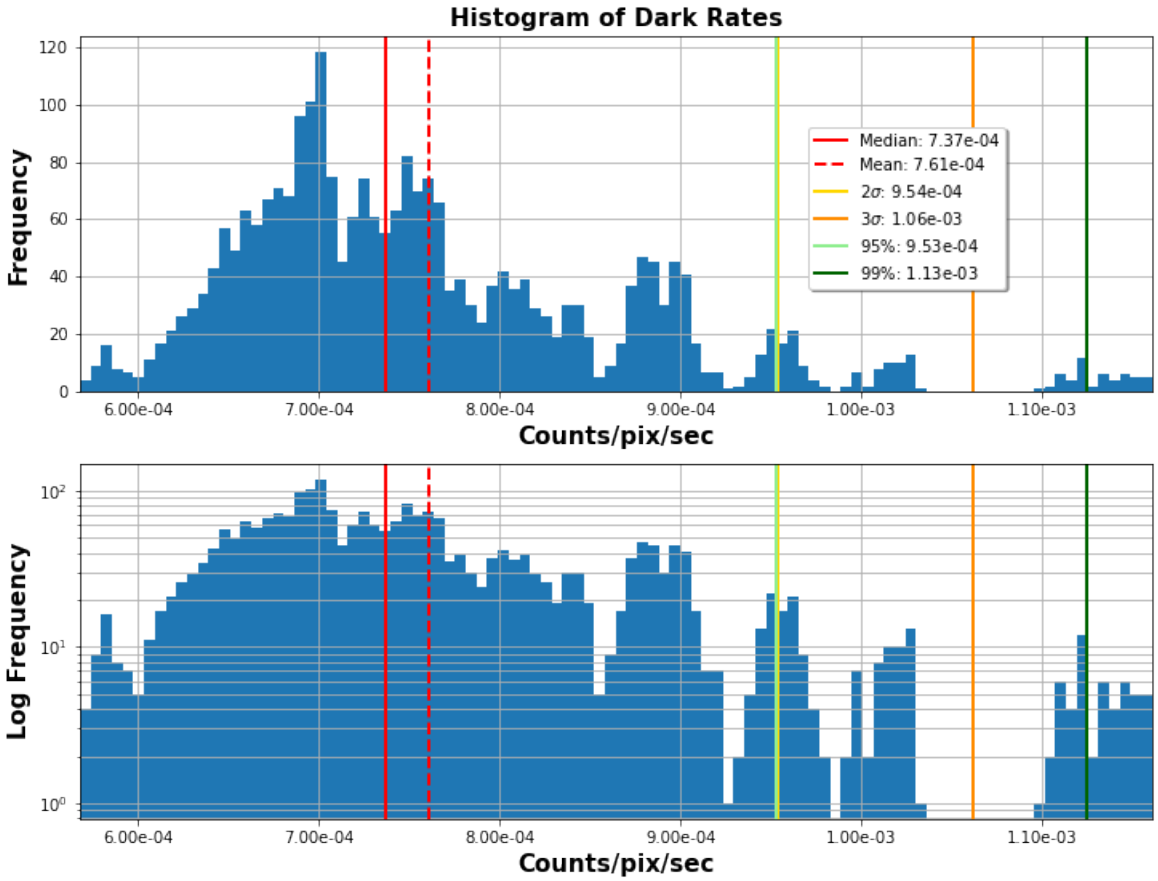

Figure 2. Dark Rate Distribution: The COS NUV dark rate from Cycle 26 prior to the calculation error fix, binned and then fit with a standard probability distribution to determine the value below which 95% of measured values fall.

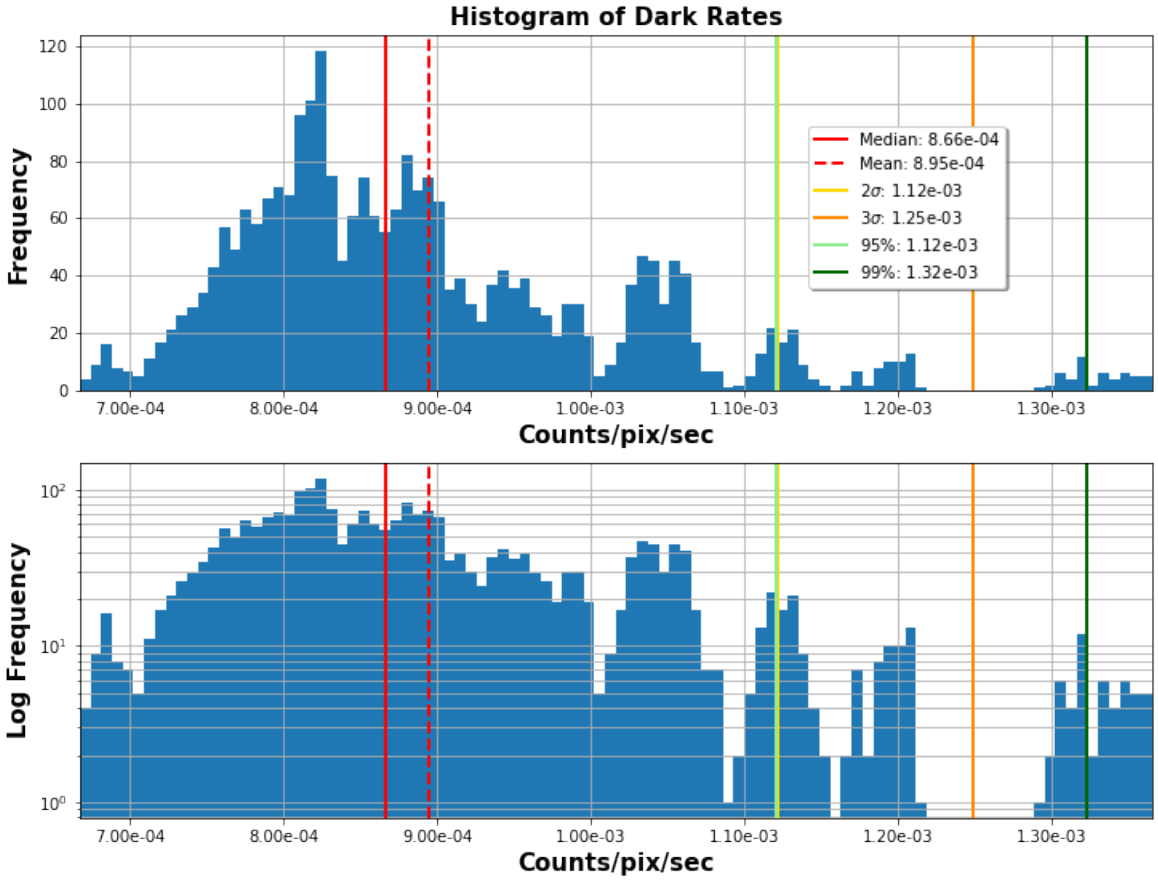

Figure 3. Dark Rate Distribution: The actual COS NUV dark rate from Cycle 26 with corrected calculation, binned and then fit with a standard probability distribution to determine the value below which 95% of measured values fall. Similar to Figure2.

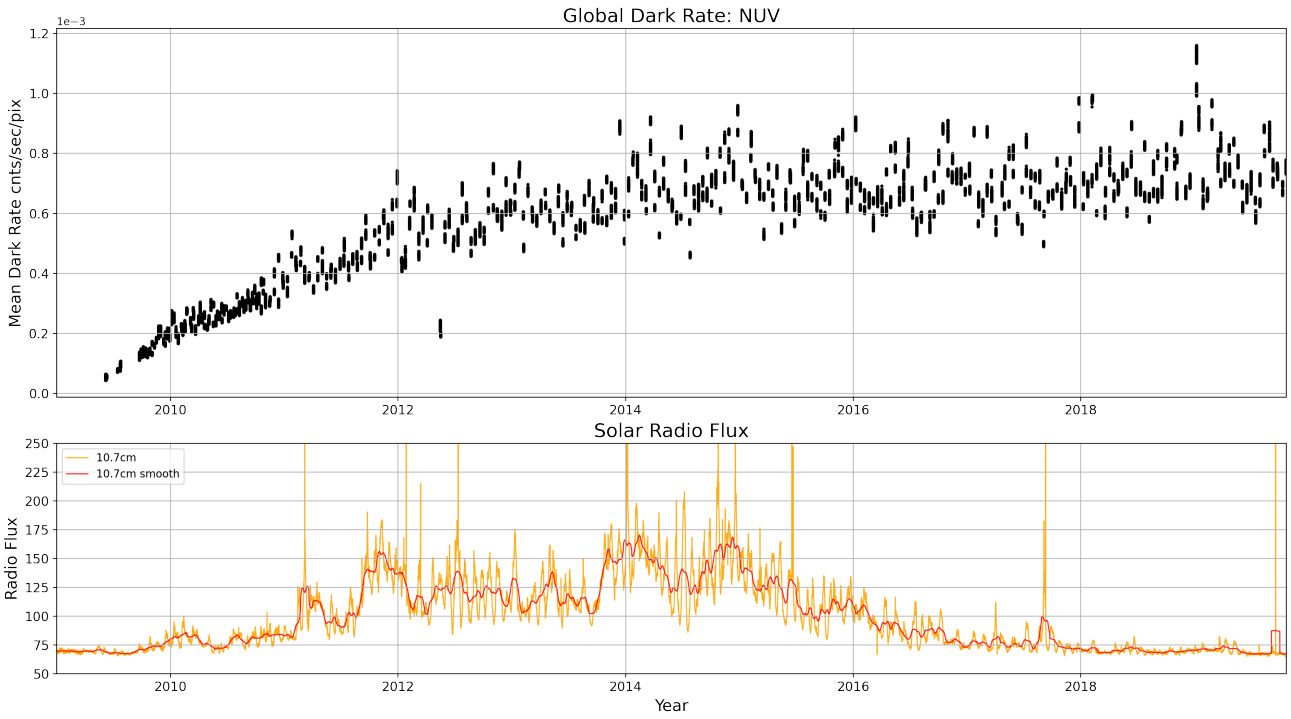

Figure 4. Dark Rate vs. Time: The COS NUV dark rate as a function of time through Cycle 26 prior to correcting the dark rate calculation. Similar to Figure1.