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Instrument Science Report COS 2022-06(v1)

Cycle 28 COS FUV Dark Monitor Summary

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ABSTRACT

Here we summarize the Cycle 28 FUV Dark Monitoring Program for the Cosmic Origins Spectrograph (COS) on the Hubble Space Telescope (HST) covering dates November 2020 to October 2021. We provide an overview of the calibration plan and summary for this calibration program. The Cycle 28 spectroscopic and target acquisition dark rates decreased by 14-17% for FUVA and 4% for FUVB compared to Cycle 27.

Contents

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1. Introduction

Program 16322 ("Cycle 28 COS FUV Detector Dark Monitor," PI D. Dashtamirova) was designed to perform routine monitoring of the FUV XDL detector dark rate. The main purpose was to look for evidence of a change in the dark rate, both to track on-orbit time dependence and to check for any developing detector problems. Results from this program are used to update the COS/FUV Exposure Time Calculator (ETC). Every week, five 22-minute exposures were taken with the shutter closed for a total of 260 internal orbits throughout Cycle 28, from November 2, 2020 to October 31, 2021.

2. Analysis and Results

For each dark exposure, a mean dark rate (counts pixel^{-1} second^{-1}) is calculated in 25 second intervals for five different regions on the FUVA and FUVB detector segments. More information on how these five regions were defined can be found in COS ISR 2019-11 (Dashtamirova et al. 2019). The mean dark rate is then plotted over time in decimal year as shown in the figures below. Due to an extended Hubble Space Telescope safing event, several weeks of dark exposures in the May-July 2021 time frame were skipped for Cycle 28. The missing data do not significantly impact the measured and reported dark rates.

The overall dark rate trends have been approximately constant for Segments A and B over the last several years, except for a small number of brief (1-3 month) higher excursions that later returned to their nominal lower levels. In Figures 1 and 2, we show the dark rate versus time for each of the five regions tracked for FUVA and FUVB, respectively. We also show similar plots for only Cycle 28 data in Figures 3 and 4 for FUVA and FUVB, respectively.

During Cycle 28, there was a relatively small, temporary increase in the dark rate for the FUVA segment between 2021.2 and 2021.4 that is most obviously seen in the bottom, left, and top region panels of Figure 3. Similar events of this magnitude have occurred in the past (e.g., see Dashtamirova 2022) and are not unusual. The dark rate for FUVA has since returned to a nominal lower level. During Cycle 28, both segments experienced brief rate increases that varied significantly above the baseline dark rate, which has also been observed in past cycles.

The ETC estimate for the dark rate is calculated by creating a distribution of dark measurements that exclude the enhanced edges 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 2σ 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 rates adopted for the FUV detector in the ETC for Cycle 28 proposals are listed below in Table 1. Figures 5-6 show the actual distributions of dark rates for FUVA and FUVB, throughout all of

Table 1. COS FUV Dark Rates used in ETC v28.2

Detector	Mode	Dark Rate (counts pix^{-1} sec^{-1})
FUVA	Spectroscopic	2.01e-06
FUVA	Target ACQ	3.02e-06
FUVB	Spectroscopic	1.85e-06
FUVB	Target ACQ	2.97e-06

Cycle 28. Compared to Cycle 27 (Table 1 of Dashtamirova 2022), the FUVA dark rates for spectroscopic and target acquisition modes decreased by 14-17% for FUVA and 4% for FUVB.

3. Summary

The COS FUV XDL detector dark rate continues to follow former trends. The FUVA segment experienced a mild increase in the dark rate between 2021.2 and 2021.4, but the mean dark rate has since returned to its lower nominal level. Except for a small number of brief excursions to higher dark rate levels, FUVB experienced little variability over Cycle 28. The FUVA and FUVB dark rates both declined relative to Cycle 27.

Change History for COS ISR 2022-06

Version 1: 1 August 2022- Original Document

References

Dashtamirova, D., White, J., Sahnow, D., 2019, COS Instrument Science Report 2019-11, "Changes in the COS/FUV Dark Rate: Impact on the Monitoring Program and Background Extraction Regions"

Dashtamirova, D., 2022, COS Instrument Science Report 2022-01, "Cycle 27 COS FUV Dark Monitor Summary"

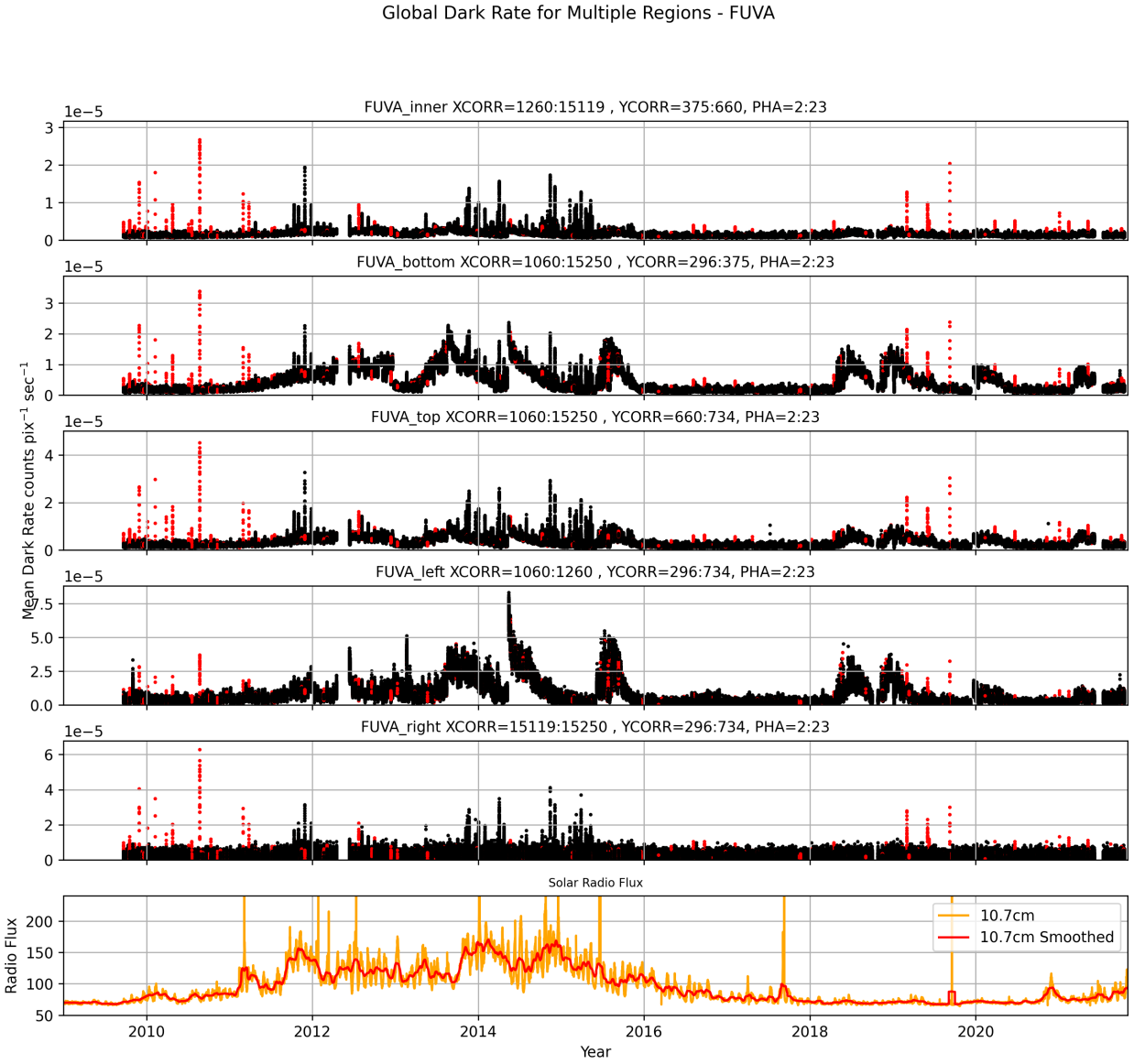


Figure 1. COS/FUV dark rates on FUVA as a function of time for each of the different areas on the detector monitored. The top 5 panels show the measured dark rate in 25 second increments throughout every exposure. The red dots represent dark rates that were observed close to when HST was passing over the South Atlantic Anomaly. The bottom panels display the 10.7 cm solar radio emission tracking the solar cycle.

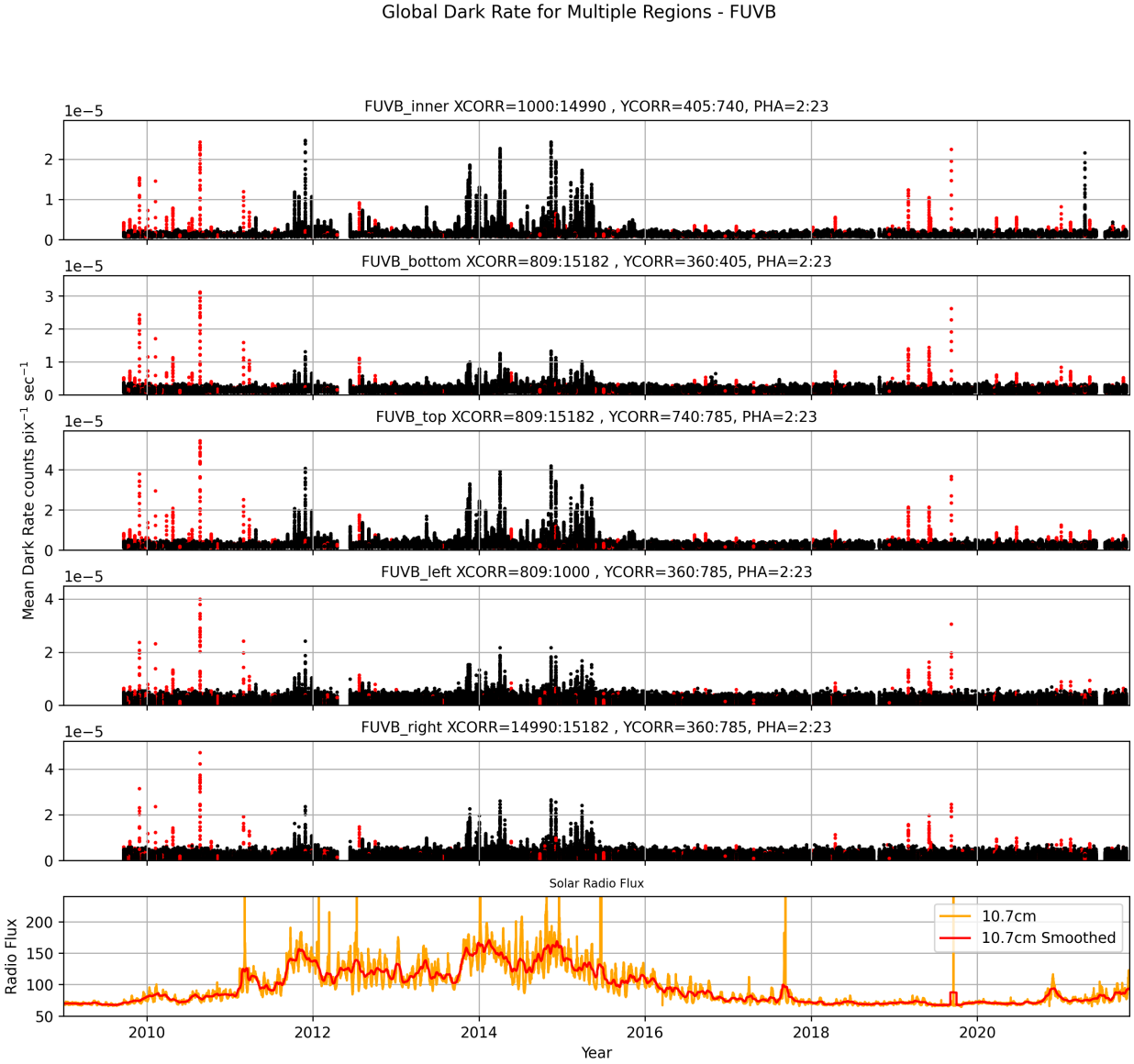


Figure 2. Same as Figure 1 but for FUVB.

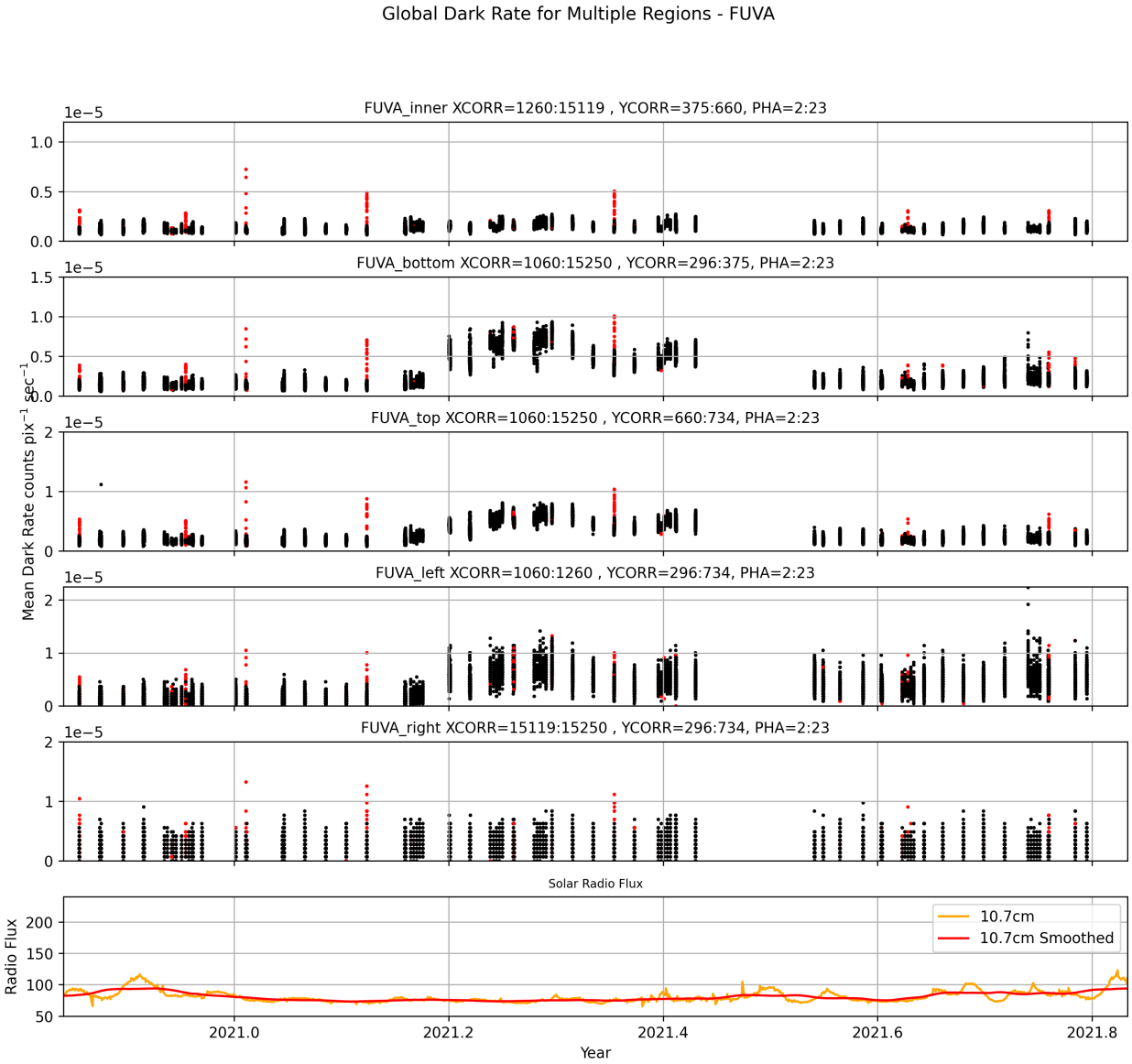


Figure 3. Same as Figure 1 for Cycle 28 data only.

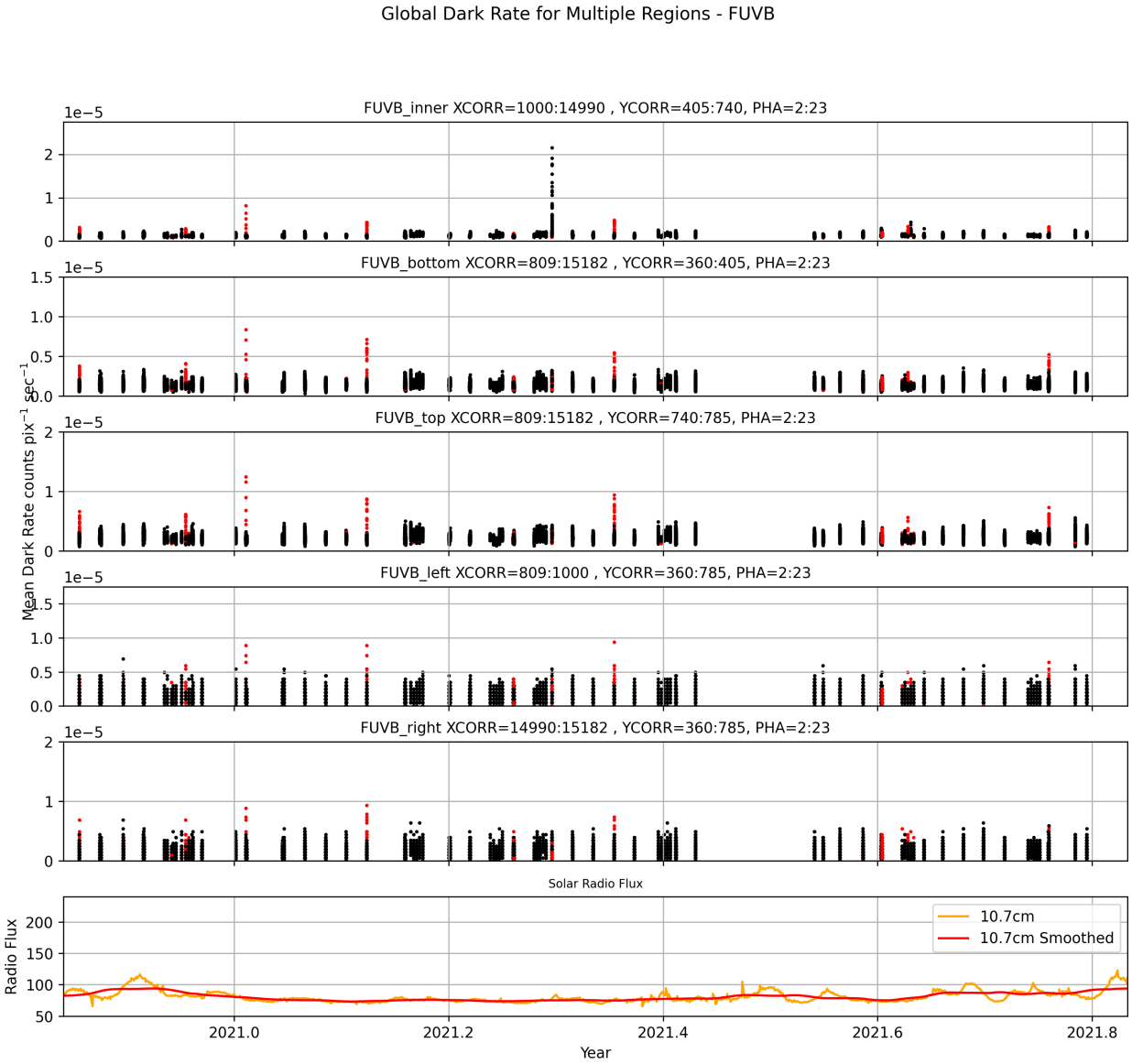


Figure 4. Same as Figure 2 for Cycle 28 data only.

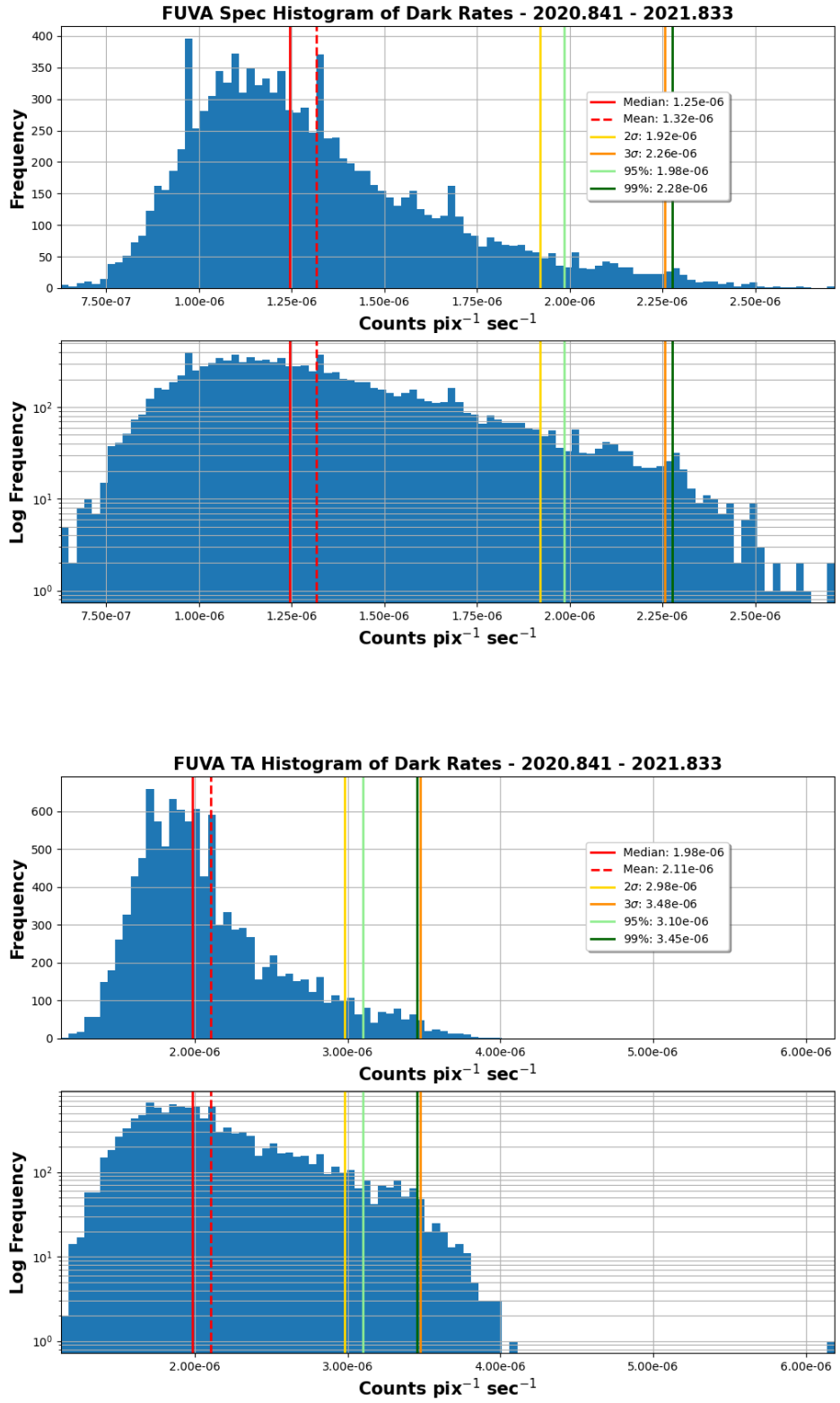
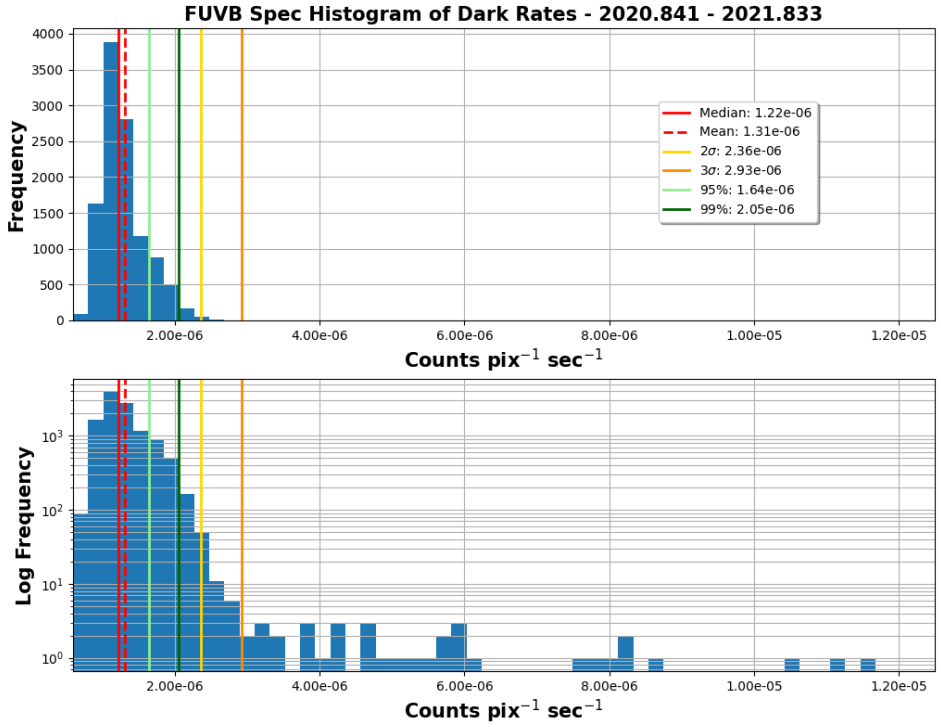


Figure 5. *Top:* The COS FUVA dark rate distribution for all of Cycle 28 PHA filtered 2:23, which is standard for spectroscopic observations. *Bottom:* Similar to the top panel but for target acquisitions, which do not utilize PHA filtering.



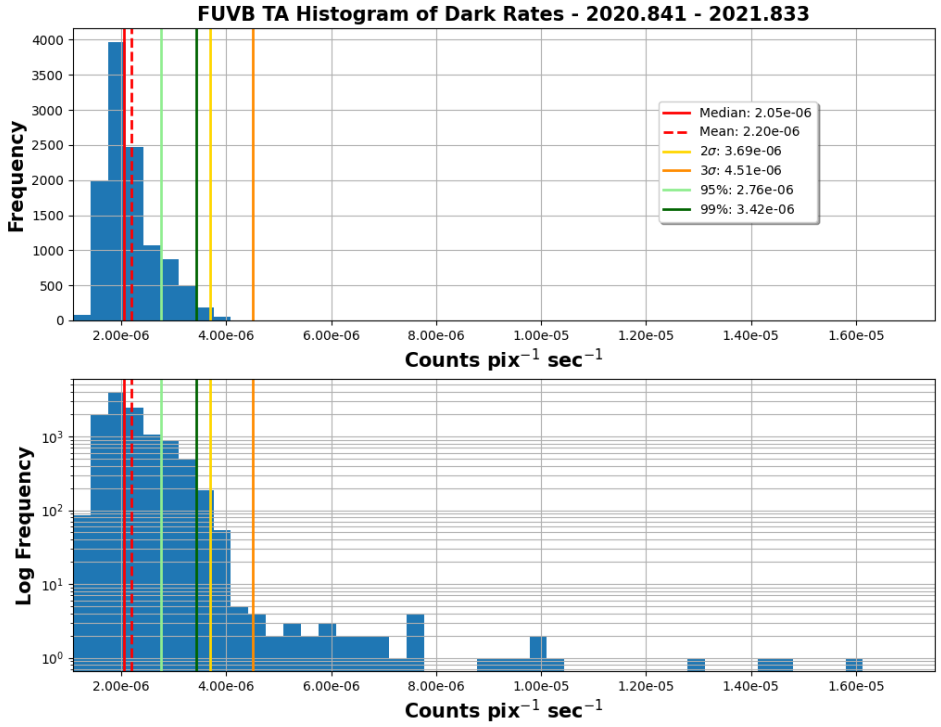


Figure 6. Similar to Figure 5 but for FUVB. The horizontal axes have been truncated to highlight the main distributions; however, fewer than 10 events have count rates exceeding 1.25e-5 counts pix^{-1} sec^{-1} and 1.75 counts pix^{-1} sec^{-1} for the spectroscopic and target acquisition observations, respectively.