

# Updated Status and Performance for the Cosmic Origins Spectrograph Onboard the Hubble Space Telescope

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## Abstract

The Cosmic Origins Spectrograph (COS) was installed on the Hubble Space Telescope (HST) in May 2009. Although COS was initially designed to perform high-sensitivity medium- and low-resolution spectroscopy of astronomical objects in the 1150-3200 Å wavelength range, new wavelength settings have recently become available that allow medium-resolution spectroscopy down to 900 Å, at effective areas comparable to those of FUSE. Here we provide an update on the implementation of the new short wavelength settings G130M/1222, 1096, and 1055. We discuss changes to the Far-Ultraviolet (FUV) and Near-Ultraviolet (NUV) dark rates, FUV pulse height filtering, new and improved flux calibrations for FUV Lifetime Positions 1 and 2, changes in sensitivity for both the NUV and FUV channels, and give a general overview of the calibration projects undertaken in Cycles 19 and 20.

## New FUV Observing Modes: G130M/1222, 1096, 1055

The recently added G130M/1222, 1096, and 1055 central wavelengths allow observations from the hydrogen Lyman limit (912 Å) to Ly $\alpha$  (1216 Å), with resolution of  $R = 8000 - 12,000$  below 1100 Å and an effective area comparable to that of FUSE at similar wavelengths. Recent adjustments of the focus positions for the 1055 and 1096 modes has allowed their resolution to be substantially increased relative to that offered in previous cycles with no loss in throughput.

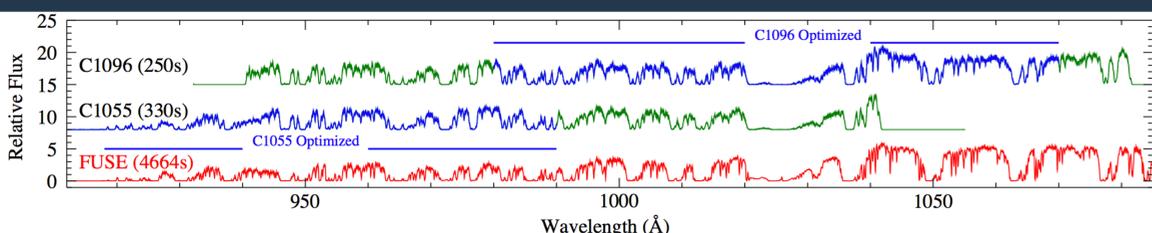


Figure 1: Relative flux vs. wavelength for G130M/1096, 1055 and FUSE spectra. The regions plotted in blue show the wavelengths for which the resolution is optimized; regions plotted in green have substantially reduced resolution.

## ETC Updates

Previously, the Exposure Time Calculator (ETC) applied the same dark rate of  $4.37 \times 10^{-6}$  counts/s/pixel to both the A and B segments of the FUV detector. The new Cycle 21 Phase II ETC (version 21.2) is now updated with segment-dependent dark rates. Additionally, the extraction heights and resolution element sizes of the new blue modes were updated in the ETC to reflect optimized performance at the new focus value.

## FUV Flux Calibration

New response curves for the COS FUV flux calibration at both the current and previous lifetime positions (LP) are being derived. While differences between the two positions are expected to be small, the new curves will account for any potential changes due to the new spectral location and high-voltage setting. Additionally, the discovery of a low-order flat-field effect common to all FUV gratings and LPs has enabled a new flat-field reference file that greatly improves the alignment of the NET spectra taken at different FP-POS and CENWAVE settings. By deriving response curves from data corrected of this flat-field effect, the flux calibrated spectra taken at different CENWAVE/FPPOS show a much improved agreement and overall accuracy. Development of these corrections is underway, and they are expected to be implemented within the next few months. See Poster 316.05, Ely for more details.

## Time Dependent Sensitivity

Regular monitoring of HST spectrophotometric primary standard stars has shown that there is a time dependence to the spectroscopic sensitivity of COS observing modes. While the COS FUV Time-Dependent Sensitivity (TDS) initially showed steep declines (as large as 30 %/year), some of which correlated with the solar cycle, the sensitivity loss slowed dramatically in January 2012 and we now see stable trends between 0 – 5 %/year. While it is still too early to say, it appears that the degradation has come to a halt. However, additional monitoring data is required to confirm this trend. Additionally the correlation with the solar cycle appears to be more complicated than originally thought. The NUV TDS continues to follow the same trends seen in previous cycles: the bare aluminum gratings are declining at  $\sim 10\%/yr$  while the other gratings show trends of less than 2%/yr.

## FUV Pulse Height Filtering

A new Pulse Height Parameters Table reference file (PHATAB) has been delivered for use in On the Fly Reprocessing (OTFR). This table lowers the upper limit for pulse-height amplitude (PHA) screening in CalCOS from 30 to 23. This change is the result of analysis showing that COS Pulse Height Distributions (PHD) have always been below a modal PHA gain of 21, and that an upper limit of 23 will keep  $>99\%$  of source counts while removing approximately 20% of the observed dark counts. The actual amount of the dark rate reduction depends on the PHD of the dark counts in each observation, which varies between observations and with solar cycle activity. Because of the incredibly low dark rate of COS FUV, the effect on most observations is very small. However, observations of spectral features that are background limited should see a moderate improvement. See Poster 316.04, Sahnou for more details.

## FUV and NUV Dark Rates

The COS FUV dark rates have recently decreased; coupled with the improved methods of filtering out background counts as a function of pulse height, the FUV dark rate has decreased by a factor of two from values observed  $\sim 1$  year ago. The FUV A dark rate has decreased to  $3.0 \times 10^{-6}$  and the FUV B to  $2.0 \times 10^{-6}$  counts/s/pixel. The NUV dark rate is currently  $8 \times 10^{-4}$  and has been increasing steadily since launch at a rate of  $1.6 \times 10^{-4}$  counts/s/year.

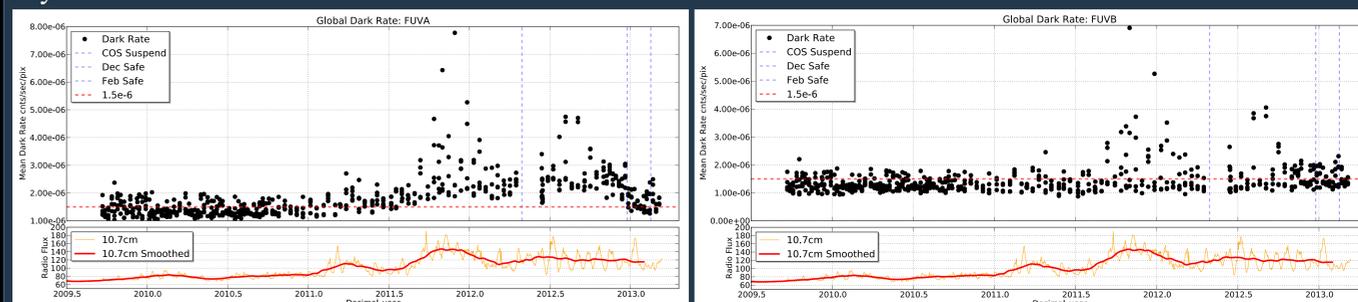


Figure 2: The mean dark rates vs. time for both the FUV A and B segments. Notice the large scatter in some regions correlates in some way with solar activity.

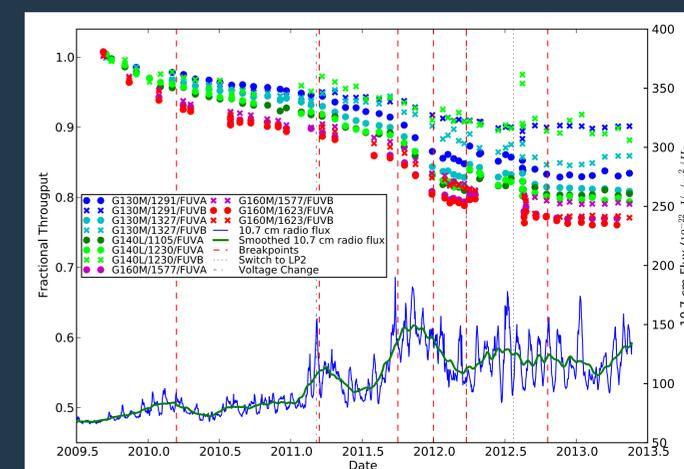


Figure 3: Fractional throughput vs. time for all FUV gratings as well as the 10.7cm radio flux (a proxy for solar activity).