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

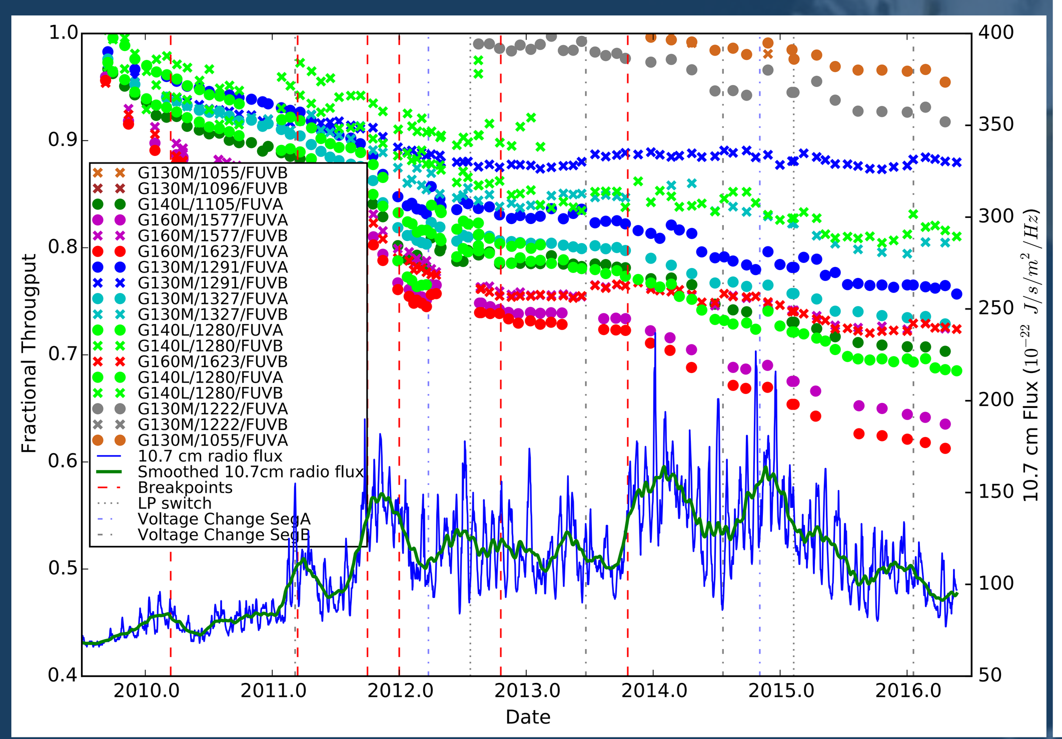
Joanna M. Taylor[1], G. De Rosa[1], J. Debes[1], J. Ely[1], M. Fix[1], A. Fox[1], R. Jedrzejewski[1], S. Lockwood[1], T. Monroe[1], C. Oliveira[1], M. S. Peeples[1], S. Penton[1], R. Plesha[1], C. Proffitt[1], J. Roman-Duval[1], D. Sahnow[1], P. Sonnentrucker[1,2], N. Walborn[1], J. White[1]
[1]Space Telescope Science Institute, [2]European Space Agency

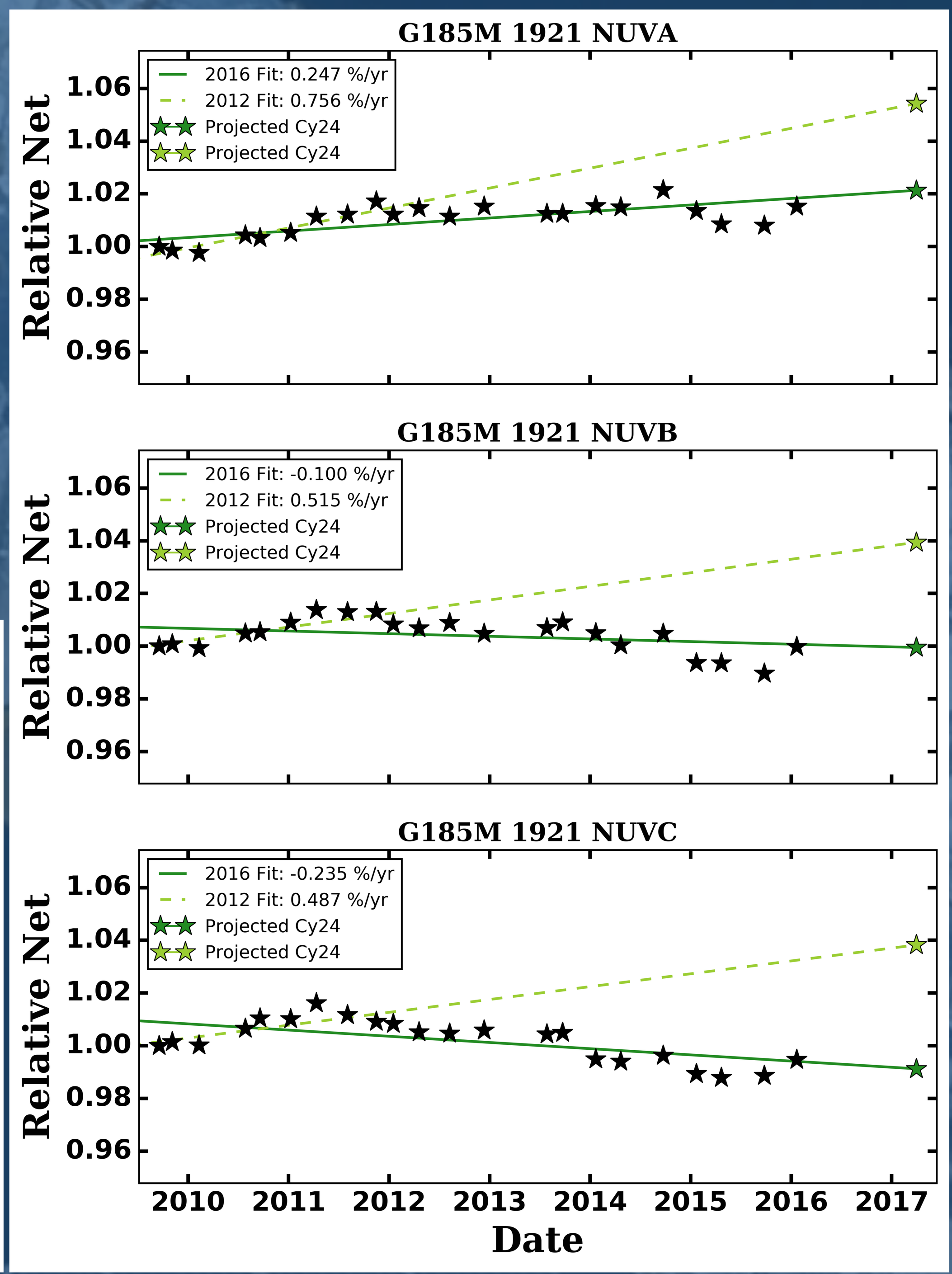
FUV and NUV Time-Dependent Sensitivity

Regular monitoring of HST spectrophotometric primary standard stars has shown that there is a time dependence to the spectroscopic sensitivity of COS observing modes. The COS FUV Time-Dependent Sensitivity (TDS) initially showed steep declines, some of which correlated with the solar cycle. However, the sensitivity loss slowed dramatically in January 2012 and we now see stable trends between ~1%/year and ~5%/year (*Figure 1*), with steeper declines at longer wavelengths. A new FUV TDS reference file, TDSTAB, that takes into account updated TDS slopes was delivered in May 2016. This new reference file applies to all COS FUV settings except for G130M/1055 and G130M/1096, for which the TDS trends remain unchanged.

Projected NUV ETC calculations for Cycle 24 revealed that the NUV TDS values were outside defined accuracy limits (*Figure 2*). To address this issue, new synphot files were delivered that contain updated TDS slopes and Y-intercepts. We are actively working on creating a new NUV TDS reference file with updated trends.

Figure 1 (below): FUV TDS for all modes.
Figure 2 (right): NUV TDS for G185M.

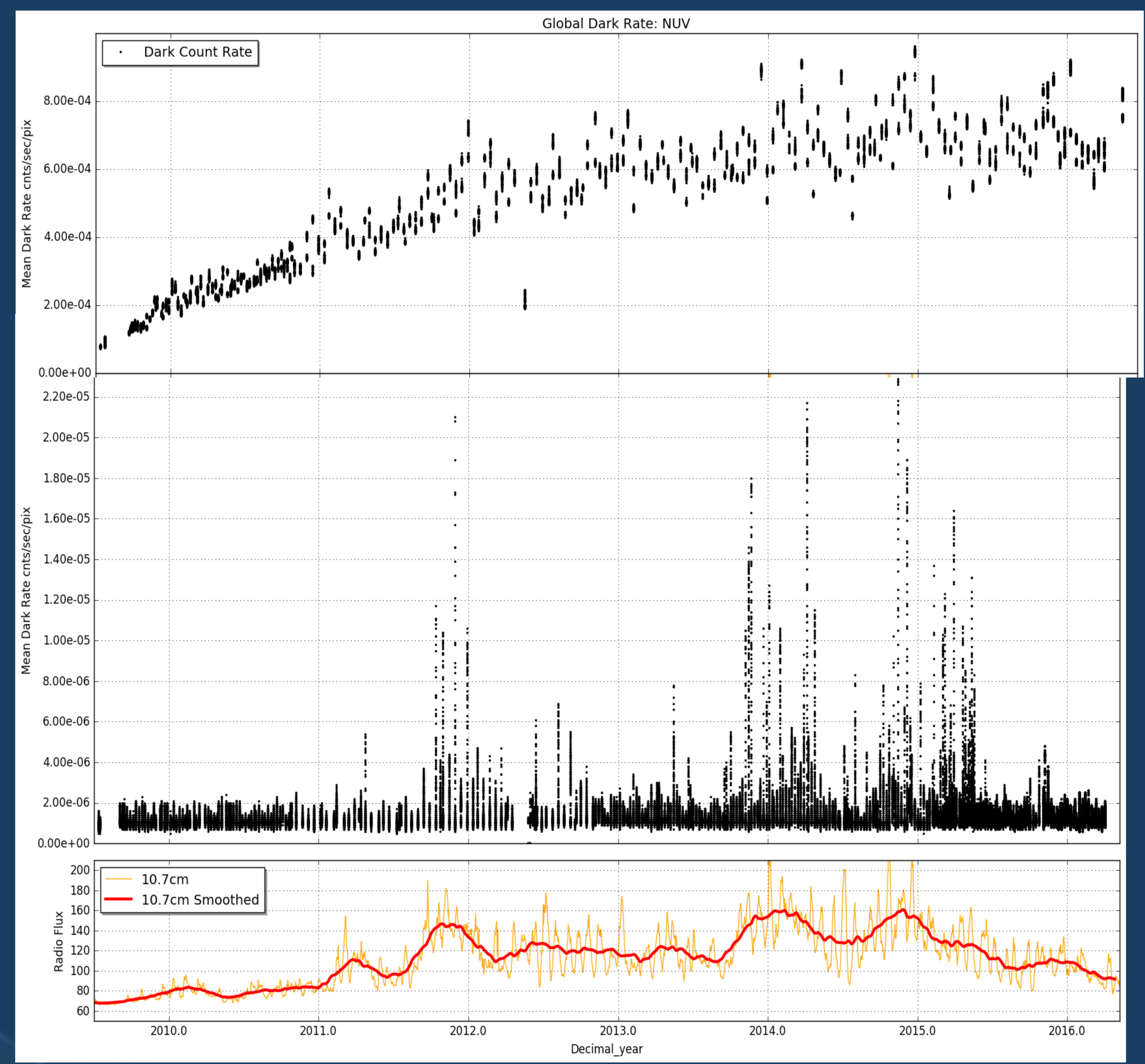




FUV and NUV Dark Rates

The COS NUV dark rate has recently begun to level off, after steadily increasing for approximately 4 years (*Figure 3*). As a result, the average NUV dark rate used by the ETC has been decreased to 8.3e-4 counts/s/pixel. For the FUV detector, the scatter in the dark rate has been decreasing since the solar maximum in 2014. The average FUVA dark rate decreased to 2.78e-6 counts/s/pixel and the FUVB to 2.57e-6 counts/s/pixel (*Figure 4*). The new NUV and FUV rates have been adopted for use in the Cycle 24 ETC.

Figure 3 (top): Mean dark rates vs. time for the NUV channel.
Figure 4 (bottom): Mean dark rate vs. time for the FUVB segment.



CalCOS Updates

A new version of the CalCOS is due to be installed in July 2016. This new version allows the walk correction to be performed in 64-bit, or double precision, format. This is a necessary precursor to support a forthcoming WALKTAB reference file that enables X-walk correction. In addition, several updates were made in December 2015 when CalCOS version 3.1 was installed. V3.1 includes minor bug fixes from CalCOS 3.0, the most significant of which was a slight misalignment in the cross-dispersion direction between the two-dimensional COUNTS image and data quality (DQ) arrays in _FLT files. Additionally, CalCOS v3.1 implemented code changes that support the use of the new SPOTTAB reference file, which flags any hotspot regions with DQ=2. Users wishing to take advantage of these new updates should re-retrieve their data from the MAST archive.

NUV Wavelength Calibration

The long-term drift of the Optics Select Mechanism 2 (OSM2) slowly shifts the wavelength ranges of the COS/NUV channel, resulting in a shift of lamp flash data as compared to NUV lamp templates. The search range in the wavecal parameter reference file, WCPTAB, was updated in March 2016 to account for this drift.

Additionally, the zero-points of the NUV dispersion solutions were updated with a new dispersion reference file, DISPTAB, in May 2016. The new DISPTAB includes preliminary updates to the zero-points for select G225M, G285M, and G230L settings, while G185M remains to be updated. In summer 2016, the COS team will obtain calibration data to update the zero-points of all affected NUV settings to within mission specification. Once the analysis is complete, a new DISPTAB will be delivered a STAN will be published to inform the community.

FUV "Hot Spots"

In 2015, monitoring activities identified transient, isolated regions of increased count rates on the COS FUV detector. These so-called "hot spots" are relatively rare, and so far have had minimal impact on science spectra due to their location (below LP3), but future spots could potentially impinge on the spectral extraction region (*Figure 5*). To mitigate the effects of such hot spots, CalCOS now allows the exclusion of known features using a new reference file (SPOTTAB) which contains the physical location and duration of these transient regions. CalCOS will flag affected detector events with DQ=2 if the temporal duration overlaps with the time of observation. Because the magnitude of the detected spots is occasionally comparable to observed spectra, any columns flagged with DQ=2 will be completely discarded from the extracted spectrum.

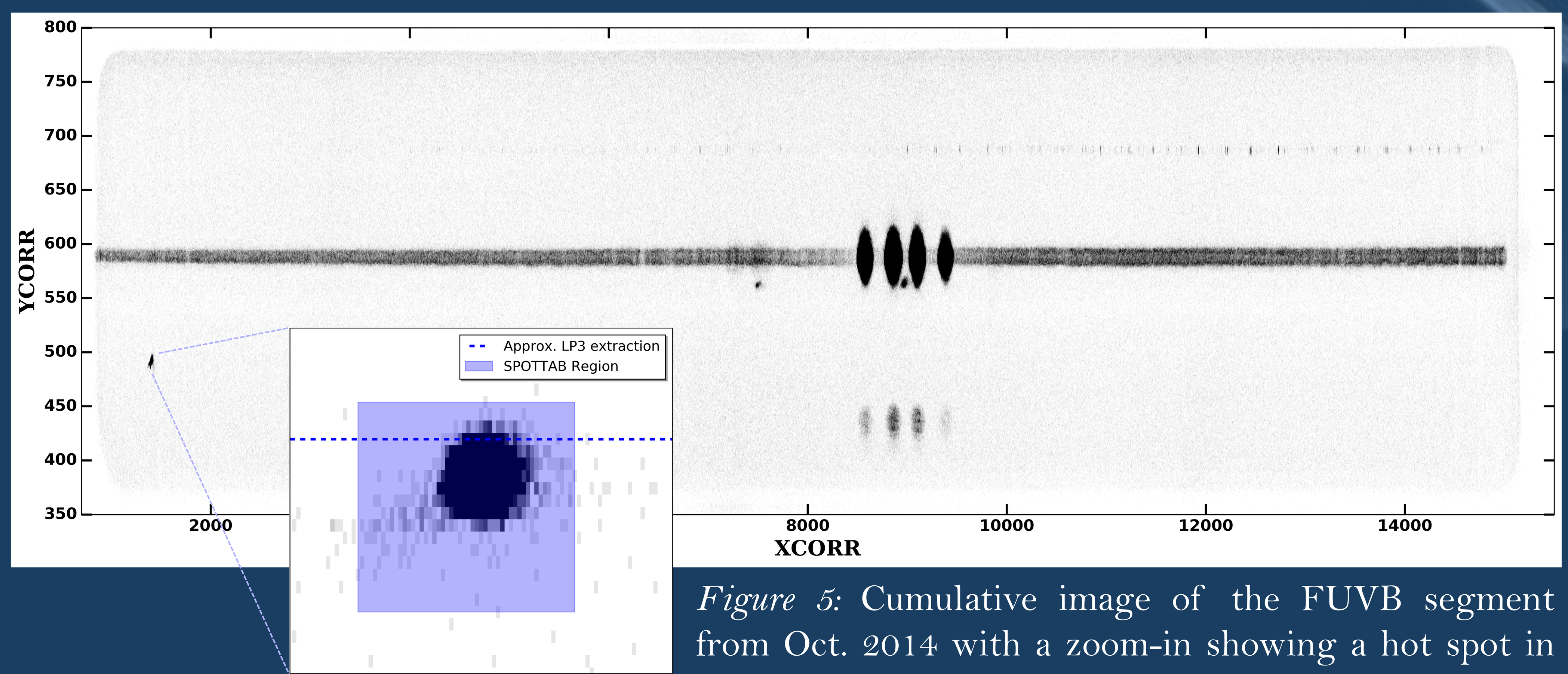


Figure 5: Cumulative image of the FUVB segment from Oct. 2014 with a zoom-in showing a hot spot in detail.

COS LSFs

New COS/FUV Line Spread Functions (LSF) and Cross-dispersion Spread Functions (CDSF) for LP3 are now available on the COS website. Additionally, LP2 LSFs and CDSFs were re-computed with a finer wavelength sampling of 1Å. LP3 LSFs and CDSFs were also computed with 1Å sampling. All LSFs and CDSFs were generated using Code V and an optical model of the COS/FUV instrument that includes the mid-frequency wave front errors of the optical telescope assembly.

NUV Imaging: More Than Just A Pretty Target Acquisition

Even though COS was designed to do primarily spectroscopy, the COS NUV detector provides higher spatial resolution than ACS, STIS, or WFC3, with a plate scale of 23.5 mas/pixel. Imaging acquisitions (acq) using the NUV channel can provide interesting information on extended targets such as the one shown in Figure 6 below.

Figure 6: NUV/ACQ images of a star-forming region from visit 03 of program 13367 (Donahue). The green "X" refers to the target that was acquired. On the left, the unsmoothed acq image; on the right, the acq image smoothed using a Gaussian with FWHM=9 pix.