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Cycle 24 COS/FUV Spectroscopic Sensitivity Monitor

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ABSTRACT

We summarize the Cycle 24 COS/FUV spectroscopic sensitivity monitor that ran from November 2016 to October 2017. We give an overview of the program and a summary of the analysis of the data.

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1. Introduction

The COS/FUV spectroscopic sensitivity program is designed to monitor changes in the sensitivity of the 3 FUV gratings. The temporal sensitivity variations are modeled as a function of wavelength, grating and segment. Information to correct the data for time sensitivity variations is included in the time dependent sensitivity (TDS) reference files (TDSTAB, to be used with calCOS in association with the corresponding FLUXTABS). The reference files are updated when the slope of the TDS changes.

The Cycle 24 FUV TDS monitor program (PID: 14854, PI: Gisella De Rosa) took monthly exposures of two standard flux calibration stars (WD 0308-565, and GD71) from November 2016 to October 2017.

2. Program design

The program is designed to periodically monitor the bluest and reddest central wavelength of each grating with additional coverage of the G130M blue modes (G130M/1055, G130M/1096 and G130M/1222). Two white dwarf standard stars are used during cycle 24: WD0308-565 and GD 71 (same as cycle 23). Different settings are monitored with different standard stars in order to optimize the S/N of the mode while minimizing the impact on the detector lifetime. The target used to monitor each cenwave is detailed in Table 1.

Table 1. Targets used to monitor different COS FUV modes.

Grating	Cenwave	FUVA Target	FUVB Target
G130M	1055	WD0308-565	N/A
	1096	N/A	GD71
	1222	WD0308-565	WD0308-565
	1291	WD0308-565	WD0308-565
	1327	WD0308-565	WD0308-565
G160M	1577	GD71	WD0308-565
	1623	GD71	WD0308-565
G140L	1105	WD0308-565	N/A
	1280	WD0308-565	WD0308-565

Exposure times were set to obtain a signal to noise ratio (S/N) of 15 per resel at the wavelength of least sensitivity for all the standard modes. For the blue modes, we aimed at obtaining S/N~25 per resel at the wavelength of most sensitivity. This ensured S/N >15 for λ>1030 Å for 1096/FUVB, for λ>1130 Å for 1055/FUVA and 1222/FUVB.

Since there are no wavelength calibration lamp lines available in the wavelength range covered by G130M/1096/FUVB, the visits include a wavelength calibration lamp observation that is taken at the same OSM position right after the science exposure.

3. Execution

All the FUV gratings were monitored monthly. Two types of monitoring sequence, *complete* and *reduced*, occurred on alternating months.

The *complete* monitoring sequence (first visit on December 2016, occurring every other month except May-Jul when GD71 is unavailable) consists of 3 orbits in 2 visits. The one orbit visit covers the G130M/1096/FUVB, G160M/1577/FUVA, and G160M/1623/FUVA modes. The two orbits visit covers G130M/1222, G130M/1291, G130M/1327, G130M/1055/FUVA, G160M/1577/FUVB, G160M/1623/FUVB, G140L/1105, G140L/1280 modes.

The reduced monitoring sequence (first visit on November 2016, occurring every other month) consists of one orbit visit to monitor the complete wavelength range of the standard modes using one central wavelength per grating. The modes covered are G130M/1291, G160M/1623, and G140L/1280.

The transition from COS/FUV lifetime position 3 (LP3) to lifetime position 4 (LP4) happened at the beginning of Cycle 25 (1 October, 2017). To allow for the LP3-LP4 reconnection, that consists of a zero point ratio between the net counts at the two LPs, "simultaneous" complete monitoring sequences (within 1 week) were obtained to bracket the LP move (LP3: 25 September, 2017; LP4: 02 October, 2017).

All data were successfully acquired and archived.

4. Summary of analysis and Results

Data were analyzed using the *cos_tds_analysis.py* script as described in Boestroem, 2014. Net counts were binned over 5 Å for the medium resolution modes, and over 20 Å for the low resolution ones. A linear trend is fit to LP1 data and scaled LP2 and LP3 data. The overall relation is scaled such that the relative sensitivity is equal to 1 at May 01, 2009 (MJD=54952, first light). The analysis uses breakpoints of 2010.2, 2011.2, 2011.75, 2012.0, 2012.8, 2013.8 and 2015.5. The last breakpoint was introduced at the end of Cycle 24. Figure 1 shows a summary plot of the sensitivity vs time compared with the solar activity directed towards earth (created with the *make_solar_cycle_plot.py* script).

The TDS slope during cycle 24 was very stable and varied between ~0% per year and ~4% per year, with steeper declines at longer wavelengths for each of the gratings. Trends per mode are summarized in Figure 1, where we are showing the TDS slope express in percent per year as a function of wavelength for each grating.

A new COS/FUV TDS reference file, 23n1744nl_tds.fits, was delivered on March 2018 to account for shallower TDS slopes than the ones modeled in the reference file (a new break point was introduced at 2015.5). The new reference file, obtained using TDS monitoring observations up to October 2017, applies to all the COS FUV settings with the exception of G130M/1055 and 1096, for which the TDS reference file was left unchanged. The resulting absolute and relative flux accuracy is within 5% and 2%, respectively, for all modes except for the G130M 1055 and 1096 CENWAVE settings, and for G140L data on Segment B. The absolute flux accuracy for the 1055/1096 settings is 20% while it was 40% is G140L/1280 FUVB**.**

5. Accuracy achieved

For the standard modes, a S/N of 15 at the wavelength of least sensitivity is reached with the exception of G140L FUVA whose sensitivity is extremely low at the long wavelength edge. For G140L FUVA the S/N <15 for wavelengths greater than 1840 Å. The blue modes (1096 and 1222) achieve the required signal to noise ratio of 25 at the wavelength of most sensitivity.

6. Reference Files Delivered

23n1744nl_tds.fits

8. Continuation plan

This program continued in Cycle 25 as program 15384. The monitoring was moved from monthly to bimonthly cadence by removing the reduced monitoring sequence. The complete monitoring sequence was adapted to comply to the COS 2025 observing policies.

9. Supporting details

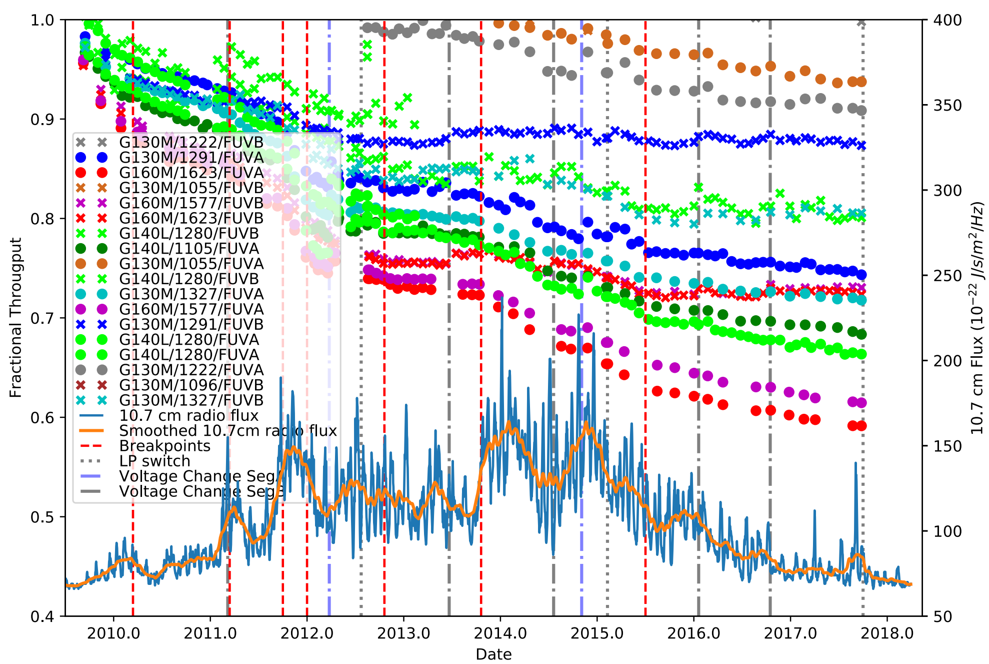

Figure 1. Decline of the COS FUV spectroscopic sensitivity over time (symbols, see legend) compared to the solar activity directed at Earth as tracked by the 10.7 cm flux (blue solid line original data; green solid line smoothed data). The dashed red vertical lines represent breakpoints in the piece-wise function used to model the TDS. The dotted grey vertical lines mark the LP move, and the dot-dashed vertical lines corresponds to change in operational voltage.

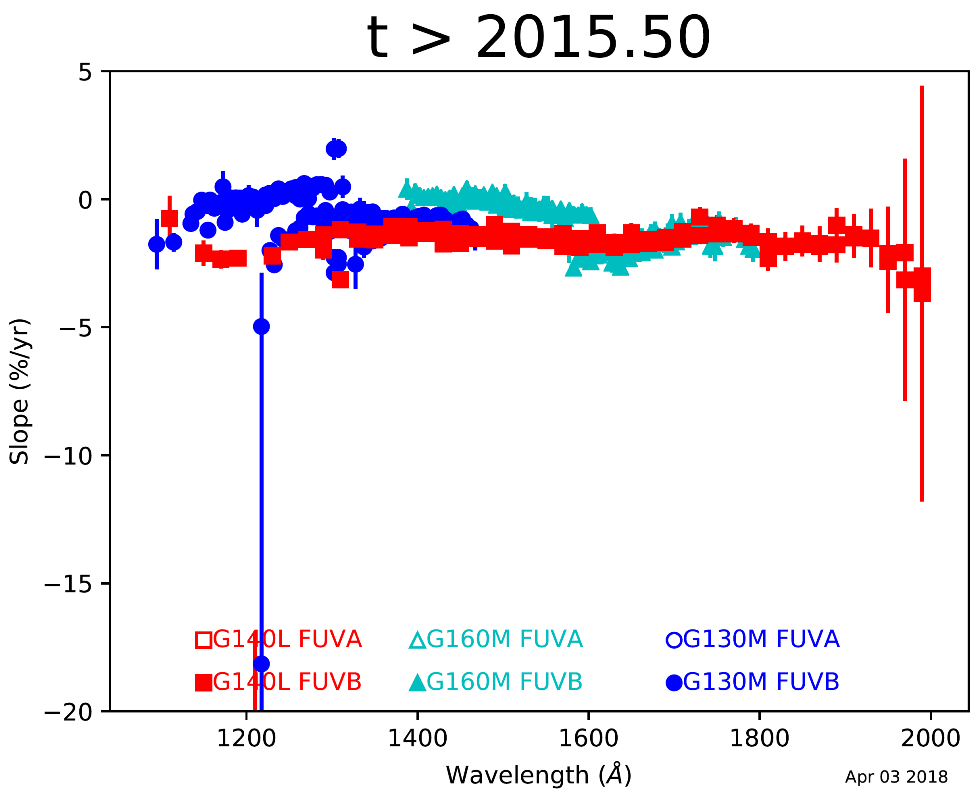

Figure 2. COS FUV TDS slope during Cycle 24, expressed in percent per year and plotted as a function of wavelength for the different gratings (see legend). G130M is represented with blue circles, G160M with cyan triangles, and G140L with red squares. The TDS slope during cycle 24 was very stable and varied between ~0% per year and ~4% per year, with steeper declines at longer wavelengths for each of the gratings.

Change History for COS ISR 2018-09

Version 1: 03 May 2018 – Original Document

References

Bostroem, A., COS Technical Instrument Reports 2014-05