Instrument Science Report COS 2011-04

Details of COS TAGFLASH Execution

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ABSTRACT

The primary procedure used to obtain COS wavelength calibration observations for TIME-TAG science data-taking with the PSA aperture utilizes flashes of the wavelength calibration lamp during science exposures via the FLASH=YES (or so-called TAGFLASH) specification. Description of the characteristics of TAGFLASH exposures, particularly how to determine a priori the automatic placement of lamp flashes in the exposure timeline, is the primary purpose of this document. We provide a thorough description of the timing and duration of TAGFLASH exposures for all cases in which they may be obtained (see especially Table 2). Brief descriptions of the characteristics of other methods of obtaining COS wavelength calibration exposures are also given. Lastly, an appendix provides a complete chronology of wavelength calibration exposure characteristics (lamp current, exposure durations) for all COS spectral elements from initial development prior to the 2003 Thermal-vacuum testing through current on-orbit operations.

This ISR expands upon and supersedes a discussion found in Chapter 13 of the COS Instrument Handbook (IHB) version 1 which is not included in later versions of the COS IHB. Specifications of current on-orbit operational characteristics are identical with values found in the Cycle 19 Proposal Instructions.

Contents:

1. Introduction and Overview

Wavelength calibration for externally targeted exposures obtained with the Cosmic Origins Spectrograph (COS) through either of its science apertures (Primary Science Aperture, PSA, or Bright Object Aperture, BOA) is accomplished by recording the spectrum of an internal PtNe lamp directed through a separate aperture (Wavelength Calibration Aperture, WCA). The lamp spectrum is dispersed by the same optics as the science spectrum, but is recorded in a location on the detector displaced in the cross-dispersion direction. Wavelength calibration lamp observations are always recorded in TIME-TAG mode. Specification of optional parameter FLASH=YES or NO allows the choice between two separate methods for acquiring the lamp observations.

FLASH=YES (so-called "TAGFLASH") is the default and most efficient choice for TIME-TAG spectroscopic science observations with the PSA aperture, which comprise the overwhelming majority of COS spectroscopic observations. TAGFLASH is the only method that allows precise characterization of Optic Select Mechanism (OSM) drifts that can cause the science spectrum to shift along dispersion during an exposure; as such, the pipeline calibration of TAGFLASH observations generally provides the most accurate wavelength calibration and the highest spectral resolution and purity possible with COS. TAGFLASH is also the recommended (but not the default) choice for TIME-TAG imaging observations with the PSA aperture. Description of the characteristics of TAGFLASH exposures, particularly how to determine a priori the placement of lamp flashes in the exposure timeline, is the primary purpose of this document.

FLASH=NO is required for all ACCUM mode observations and for all observations that use the BOA aperture, and is the default for imaging TIME-TAG mode observations. This method may be chosen with spectroscopic TIME-TAG mode observations, however for data quality and observing efficiency reasons its usage with spectroscopic PSA TIME-TAG exposures is strongly discouraged. Though not the focus of this document, Section 1.2 below provides a brief overview of FLASH=NO characteristics; additional detailed information may be found in the current version of the COS Instrument Handbook (IHB).

1.1 FLASH=YES (TAGFLASH) Overview

Optional parameter FLASH=YES (spectroscopy default) indicates whether or not to "flash" the wavelength calibration lamp during TIME-TAG exposures (so-called TAGFLASH mode). These flashes provide information to accomplish wavelength calibration of the science spectrum and are the only way to allow correction in the pipeline of the effect of post-mechanism-move drift by the OSMs on wavelength, spectral purity, and resolution. The flashes are used by CALCOS to correct observations in the spectroscopic pipeline, but at present no automatic corrections are applied to imaging observations.

W*ith the external shutter open*, the wavecal lamp is turned on briefly at the start of an externally targeted exposure, and, in most cases, at intervals later in the exposure. In this mode, photons from the external science target and the internal wavelength calibration source are recorded concurrently on different portions of the detector. Other than the flash at the start of each exposure, the actual timing of flashes is determined by the elapsed time since the last spectral-element-to-spectral-element OSM move, the so-called "t_{since}" time. (The t_{since} -dependent flash intervals and associated parameters used by instrument commanding are found in Table 1.) As a consequence, flashes may occur at different time-points in different exposures that have identical exposure times (see Table 2). The grating-dependent flash durations are given in Table 3 below. In addition to the usual prohibition on specification of flash duration or lamp current setting, science program observers may not specify the flash interval, although all of these quantities may be specified manually in STScI calibration programs.

FLASH=YES TIME-TAG sequences provide the highest amount of on-target exposure time per orbital visibility as no on-target time is lost due to separate instrumental calibration exposures. When flashing is enabled, the exposure time must be at least as long as a single flash. Flash duration as a function of grating and central wavelength is provided in Table 3.

1.2 FLASH=NO Overview

FLASH=NO produces a separate exposure of the lamp by itself to provide wavelength calibration data for spectroscopic observations. The lamp exposure is generated automatically by the ground system using the same grating/central wavelength/FP-POS as the science exposure, and will normally immediately follow the science exposure. Special scheduling rules are used by the ground system to regulate the frequency of these automatically-generated lamp exposures. In general, a lamp exposure will not be inserted if less than 90 minutes has passed since the previous lamp exposure using the same grating/central wavelength/FP-POS combination ***and*** no change of grating/central wavelength/FP-POS/target setup has occurred in that period of time. Otherwise, a new lamp exposure will be automatically generated. (This 90-minute "clock" is reset to zero after any wavecal lamp exposure.) These automatically-generated lamp exposures are often referred to as AUTO-wavecal exposures and are designated as EXP-AWAVE in the `memtype` column of the pipeline-produced association table file for the observation, *association-name_asn*.

For completeness, we note that proposers may also specify additional FLASH=NO spectroscopic wavecal exposures by using target=WAVE at any time in an observing sequence. These so-called GO-wavecals (`memtype` EXP-GWAVE), will also reset the 90-minute AUTO-wavecal timing "clock." Please refer to the COS IHB version 2 or later and the COS Data Handbook version 1 or later for more information concerning AUTO and GO wavecal exposures.

For imaging mode science exposures FLASH=NO is the default and does NOT generate an automatic following imaging lamp exposure. Imaging mode lamp exposures may be generated by specification of a separate imaging exposure with target=WAVE. These exposures, which are not used at this time by the standard pipeline calibration will be identified in the _asn table file as `memtype` EXP-IWAVE.

Finally, note that STScI calibration or engineering programs may specify FLASH=YES with target=WAVE in either spectroscopic or imaging mode whereas GO programs are always restricted to use FLASH=NO with target=WAVE.

2. TAGFLASH Execution in Detail

2.1 Overview

When an object is observed through the PSA, light from the Pt-Ne lamps can pass through the WCA and illuminate a portion of the detector separate from the science spectrum. When an external source is observed through the BOA, the Pt-Ne wavecal beam is blocked from reaching the active area of the detector, hence TAGFLASH is available only for PSA observations.

The lamp flash durations required to obtain a sufficient signal level to determine a usable wavelength calibration offset are grating dependent. The current values are listed in Table 3 and also at the end of the COS chapter in the *Phase II Proposal Instructions*. Typical durations are of order 7-12 seconds, with some longer than 30 seconds.

Every COS TAGFLASH exposure begins with a lamp flash. Depending upon the length of the exposure and the time, t_{since}, since the last "major" (spectral element to spectral element) OSM movement, one or more lamp flashes may be inserted automatically at intermediate times during an exposure. Also, depending upon the proximity of the most recent flash, a lamp flash may be inserted at the very end of an exposure.

In addition to t_{since}, several quantities must be defined prior to description of the process for specifying the placement of lamp flashes within any particular science exposure. The actual structure of the placement is determined by application of a detailed set of rules involving these quantities.

The following section provides important definitions and describes the detailed rules employed for the automatic placement of lamp flashes within a TAGFLASH exposure.

2.2 Detailed Definitions and Rules for Automatic Lamp Flash Sequences

Definitions:

t_{exp} : duration of science exposure

t_{since} : time-index that represents estimate of wall-clock time since last major (grating-grating) OSM move (note: t_{since} is not reset after central wavelength changes or FP-POS moves

t_{since} int : the t_{since} time-line is divided into j quantized t_{since} int(ervals)

t_j : time at beginning of t_{since} time interval j; flashes are scheduled at the start of each interval within an exposure (see Table 1)

f_j : fraction of interval j to be used to check if a flash at exposure end is needed; $0 \le f_j \le 1$

Δt_j : duration of interval j and nominal time between scheduled flashes j and j+1

Figure 1: Schematic of a TAGFLASH t_{since} interval timeline; t_1 initially coincides with end of major OSM movement, but is reset to start of first science exposure.

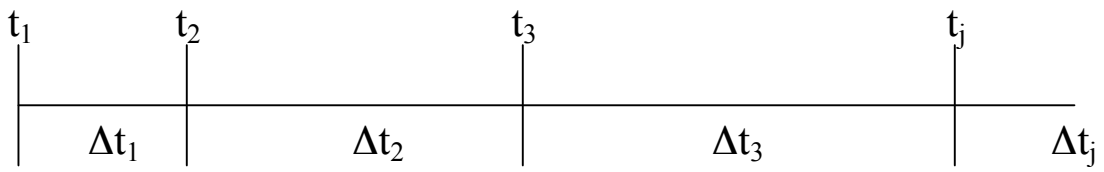

Table 1: TAGFLASH t_{since} interval properties needed to implement rules for lamp flash sequences. Interval times and relative interval times are in seconds.

TAGFLASH t_{since} Interval Table			
t_{since} int	**t_j**	**Δt_j**	**f_j**
1	0	600	0.33
2	600	1800	0.20
3	2400	2400	0.33
4	4800	2400	0.33
j	t_4 + 2400(j-4)	2400	0.33

Rules:

1. Evaluate t_{since} at the start of the *first* science exposure after a major OSM move (optic-to-optic movement), determine t_{since} as the intercept of the timeline shown in Figure 1 such that $t_j \le t_{since} < t_{j+1}$; (that is, determine the interval (1, 2, 3, …, *n*) from Table 1 in which the start of the exposure occurs).

2. Next, conservatively minimize t_{since} for the first science exposure by shifting the timeline such that t_j marks the beginning of the science exposure; that is adjust t_{since} such that $t_{since} = t_j$. For all subsequent exposures with the same optical

element, again determine the t_{since} time interval, j, from Table 1 in which the start of the exposure occurs and reset the timeline to align the exposure start with the t_j of that interval, but *do not* reset t_{since}. (In nearly all cases for COS, the initial t_{since} of the first exposure will fall in the first interval of Table 1, such that the value of the t_{since} for the initial exposure will be reset to the start of interval 1 or to a value of 0.)

3. Flash the lamp at the beginning of each science exposure (i.e., at t_j). The beginning of the lamp flash should coincide as closely as possible with the beginning of the science exposure. Due to latency in lamp discharges, some flashes may be delayed approximately one second. (Note: lamp flash durations in Table 3 have been modified to account for this delay in lamp discharge; for example, it is anticipated that a 7-second flash will include approximately 6 seconds of actual lamp signal.)

4. Insert intermediate lamp flashes as scheduled in the TAGFLASH Interval Table (Table 1) at the start of all t_{since} intervals that begin prior to the end of the science exposure. A caveat to this rule concerns the case where an intermediate lamp flash might extend past the end of an exposure. In that case, the start of the lamp flash is moved earlier such that its end coincides as closely as possible to the end of the science exposure.

5. Insert a special flash at the end of the science exposure only if $(t_{exp} - t_j) \geq f_j \, \Delta t_j$. Note that the interval fraction, f, is not the same for all intervals in Table 1. The end of the lamp flash should coincide as closely as possible with the end of the science exposure.

6. The minimum allowable TAGFLASH science exposure duration is the duration of a single flash for the grating/central wavelength configuration used in the exposure.

7. If these rules produce two lamp flashes that overlap in time, only the later flash should be executed at its nominal time of execution.

At present t_{since} is reset to 0. only for the first exposure after a major OSM move (rule 1), i.e., an optic-to-optic OSM movement, and *not* for a simple central wavelength or FP-POS movement. Therefore, the internal flash patterns of identical exposures obtained consecutively may be different, as later exposures in the sequence start in later t_{since} intervals, such that more flashes potentially may occur in the earlier exposures of the sequence. This flexibility allows efficient tracking of the anticipated, approximately exponential, decay of the OSM drift while minimizing the number of flashes in order to preserve lamp lifetime.

2.3 TAGFLASH Lamp Flash Placement

A complete list of the possible times of automatically-generated TAGFLASH lamp flashes, in exposure elapsed time, is given in Table 2 below as a function of exposure duration for science exposures starting in each t_{since} interval. In Table 2, lamp flashes at t="end" are flashes whose start time has been altered such that they end as closely as possible to the end of the science exposure.

Table 2: Start times of TAGFLASH lamp flashes (in exposure elapsed time) as a function of exposure duration for exposures that begin in the specified t_{since} interval.

Exposure starts in Interval 1			Exposure starts in Interval 2			Exposure starts in Interval ≥3		
Exp time (sec)		Lamp flash(es)	Exp time (sec)		Lamp flash(es)	Exp time (sec)		Lamp flash(es)
From	To	at t =	From	To	at t =	From	To	at t =
0	200	0	0	360	0	0	800	0
> 200	600	0,end	> 360	1800	0,end	> 800	2400	0,end
> 600	960	0,600	>1800	2600	0,1800	>2400	3200	0,2400
> 960	2400	0,600,end	>2600	4200	0,1800,end	>3200	4800	0,2400,end
>2400	3200	0,600,2400	>4200	5000	0,1800,4200	>4800	5600	0,2400,4800
>3200	4800	0,600,2400,end	>5000	6500	0,1800,4200,end	>5600	6500	0,2400,4800,end
>4800	5600	0,600,2400,4800	>6500		not allowed	>6500		not allowed
>5600	6500	0,600,2400,4800,end						
>6500		not allowed						

2.4 TAGFLASH Exposure Parameters

Table 3, whose values are identical to those in the Cycle 19 *Phase II Proposal Instructions,* lists the current default wavelength calibration lamp exposure duration (EXPTIME), associated BUFFER-TIME, lamp current setting, and the duration of a wavelength calibration lamp "flash" in TAGFLASH mode (FLASHDUR) as a function of COS spectral element and central wavelength. Table 3 is repeated in Appendix A as Table A.7. These values have been in use since 30 January 2010, except for G130M 1055 and G130M 1096 which were added to the table on 18 February 2011.

Table 3: COS WAVECAL and TAGFLASH Default Exposure Durations

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G130M	1055	MEDIUM	102	510	102
G130M	1096	MEDIUM	35	180	35
G130M	1291	MEDIUM	12	120	12
G130M	1300	MEDIUM	12	120	12
G130M	1309	MEDIUM	12	120	12
G130M	1318	MEDIUM	12	120	12
G130M	1327	MEDIUM	12	120	12
G160M	1577	MEDIUM	12	120	12
G160M	1589	MEDIUM	12	120	12
G160M	1600	MEDIUM	12	120	12
G160M	1611	MEDIUM	12	120	12
G160M	1623	MEDIUM	12	120	12
G140L	1105	MEDIUM	7	120	7
G140L	1230	MEDIUM	7	120	7
G140L	1280	MEDIUM	7	120	7

Table 3 (cont): COS WAVECAL and TAGFLASH Default Exposure Durations

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G185M	1786	MEDIUM	12	220	12
G185M	1817	MEDIUM	12	220	12
G185M	1835	MEDIUM	12	240	12
G185M	1850	MEDIUM	22	180	22
G185M	1864	MEDIUM	32	180	32
G185M	1882	MEDIUM	17	120	17
G185M	1890	MEDIUM	12	120	12
G185M	1900	MEDIUM	22	140	22
G185M	1913	MEDIUM	17	140	17
G185M	1921	MEDIUM	12	140	12
G185M	1941	MEDIUM	12	180	12
G185M	1953	MEDIUM	17	180	17
G185M	1971	MEDIUM	17	180	17
G185M	1986	MEDIUM	12	180	12
G185M	2010	MEDIUM	12	180	12
G225M	2186	MEDIUM	7	120	7
G225M	2217	MEDIUM	12	120	12
G225M	2233	MEDIUM	7	120	7
G225M	2250	MEDIUM	22	120	22
G225M	2268	MEDIUM	12	120	12
G225M	2283	MEDIUM	12	120	12
G225M	2306	MEDIUM	12	120	12
G225M	2325	MEDIUM	12	280	12
G225M	2339	MEDIUM	12	280	12
G225M	2357	MEDIUM	12	240	12
G225M	2373	MEDIUM	22	240	22
G225M	2390	MEDIUM	7	240	7
G225M	2410	MEDIUM	7	280	7
G285M	2617	MEDIUM	12	300	12
G285M	2637	MEDIUM	12	300	12
G285M	2657	MEDIUM	7	300	7
G285M	2676	MEDIUM	22	300	22
G285M	2695	MEDIUM	22	330	22
G285M	2709	MEDIUM	12	330	12
G285M	2719	MEDIUM	7	330	7
G285M	2739	MEDIUM	7	430	7
G285M	2850	MEDIUM	22	430	22
G285M	2952	MEDIUM	7	430	7
G285M	2979	MEDIUM	17	430	17
G285M	2996	MEDIUM	17	140	17
G285M	3018	MEDIUM	22	140	22
G285M	3035	MEDIUM	27	160	27
G285M	3057	MEDIUM	32	160	32
G285M	3074	MEDIUM	32	160	32
G285M	3094	MEDIUM	32	160	32
G230L	2635	MEDIUM	7	100	7
G230L	2950	MEDIUM	7	180	7
G230L	3000	MEDIUM	7	180	7
G230L	3360	MEDIUM	12	140	12
MIRRORA	0	LOW	7	80	7
MIRRORB	0	LOW	27	80	27

3. COS Wavecal Exposure Parameter Update Summary

Table 4 provides a chronology of important updates to the COS wavelength calibration system, lists relevant PRs and brief descriptions, and refers to Appendix sections of this document that provide detailed descriptions of these changes including complete listings of the actual lamp exposure table updates.

Table 4: COS Wavecal Exposure and TAGFLASH Duration Update History

Update	Effective Date	PR	Comment / Description	Appendix Listing Values Employed
1	03/12/2002	PR 45271	Initial delivery of central wavelengths and wavecal exp times	
2	07/01/2002	PR 46078	Changed central wavelengths; added new central wavelengths	
3	04/19/2003	PR 48390	Changed central wavelengths; added new central wavelengths; these values used in 2003 ambient and TV03	A.1
4	03/07/2006	PR 55208	Added column for flash duration (same as wavecal exp duration); specified preliminary flash duration values	
5	05/16/2006	PR 55852	Updated EXPTIME & FLASHDUR values to COS TIR 2006-01(v1) Table 5; values used in TV06	A.2
6	03/02/2007	PR 57294	Changed G285M HIGH current to MEDIUM; Changed MIRROR to MIRRORA; available for SMGT and other tests	A.3
7	01/26/2009	PR 61409	Updated exposure times for delayed lamp turn-on and based on recent count rate information; launch values; used in SMOV and early cycle 17	A.4
8	01/18/2010	PR 64298	Added G140L central wavelength 1280; updated others; post-SMOV update used after January 2010	A.5
9	01/24/2011	PR 67203	Added new G130M central wavelengths 1055 and 1096; no other changes; available 18 February 2011 and in cycle 19	A.6 (also Table 3)

4. Change History for COS ISR 2011-04

Version 1: 07 September 2011 – Original Document

5. References

COS IDT, 2003, Cosmic Origins Spectrograph (COS) Science Operations Requirements Document (OP-01).

COS PR 45271 initiated 19 Feb 2002, "COS Wavecal Exposure Times Table"

COS PR 46078 initiated 28 Jun 2002 "Phase V COS SCIOPSDB - Update COS Wavecal Exposure Times Table"

COS PR 48390 initiated 18 Apr 2003, "Phase VII COS SCIOPSDB - Update Wavecal Exposure Times Table," (2003 ambient testing and TV03 values)

COS PR 55208 initiated 13 Feb 2006, "2006 COS SCIOPSDB Updates - Tag-Flash," (preliminary TAGFLASH values)

COS PR 55852 initiated 16 May 2006, "2006 COS SCIOPSDB Updates - Tag-Flash #2," (TV06 values)

COS PR 57294 initiated 12 Jan 2007, "2007 COS SCIOPSDB - Misc Updates to wavecal table" (SMGT and other ground test values)

COS PR 61409 initiated 8 Dec 2008, "2008 COS Wavecal Exposures - Requested Updates," (launch values)

COS PR 64298 initiated 14 Jan 2010, "2010 COS Wavecal Exposures - New G140L wavelength," (post-SMOV update)

COS PR 67203 initiated 12 Jan 2011, "2011 COS Wavecal Exposure Times - New G130M Wavelengths," (mid-Cycle 18 update)

Dixon, W.V. and Niemi, S.-M., 2009, Cosmic Origins Spectrograph Instrument Handbook, Version 2.0 (Baltimore: STScI)..

Sembach, K., 2006, COS TIR 2006-01(v1), "Cosmic Origins Spectrograph PtNe Wavelength Calibration Exposure Times".

Shaw, B., Massa, D., Kaiser, M.E. et al, 2009, "COS Data Handbook," Version 1.0, (Baltimore: STScI)

Soderblom, D.R., et al, 2007, Cosmic Origins Spectrograph Instrument Handbook, Version 1.0 (Baltimore: STScI).

Younger, J. and Rose, S., 2011, HST Phase II Proposal Instructions," GO and ENG version 19.0

Acknowledgements

Alan Welty provided PR reference information and a number of details found in the COS commanding.

Appendix A: Wavecal Exposure Development Chronology

Over the course of COS development, including initial ground system definition, ground testing in TV03, TV06, SMGT and other tests, and finally on-orbit operation, several updates have been made to operational parameters associated with COS wavelength calibration exposures. For example new central wavelengths, component names, and the actual lamp flash capability have been added. In addition significant revisions of AUTO and GO wavecal exposure times and flash durations have been implemented. As noted in Section 3, Table 4 provides a chronology of these updates, lists relevant PRs, and gives brief descriptions of the content of the updates. The following Appendix sections describe each of the important updates in detail and provide the complete updated table of lamp exposure information as a function of grating, central wavelength, and current for each delivery of operational changes listed in the Table 4 chronology.

A.1 Original Wavelength Calibration Lamp Exposure Times (AUTO and GO wavecals)

In February and July 2002 PR45271 and PR46078 established the baseline and initial expanded sets of central wavelengths then planned for use with each grating. Detailed updates made in April 2003 (PR 48390 and PR 48392) listed in Table A.1 below established the set of operational central wavelengths that were used by commanding for all ground SI testing, SMOV, and cycle 17. The values of lamp current, BUFFER-TIME, and default wavelength calibration lamp exposure duration established in this update were used for the initial ambient SI alignment testing in late spring 2003, subsequent thermal balance testing, and all phases of 2003 Thermal-vacuum (TV03) testing. Note that TAGFLASH had not been implemented at this point, so no flash durations are included in Table A.1.

Table A.1: Initial COS Wavecal Lamp Exposure Table

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME
G130M	All	MEDIUM	60	120
G160M	All	MEDIUM	60	120
G140L	All	MEDIUM	60	120
G185M	1786	MEDIUM	110	220
	1817	MEDIUM	110	220
	1835	MEDIUM	120	240
	1850	MEDIUM	90	180
	1864	MEDIUM	90	180
	1882	MEDIUM	60	120
	1890	MEDIUM	60	120
	1900	MEDIUM	70	140
	1913	MEDIUM	70	140
	1921	MEDIUM	70	140
	1941	MEDIUM	90	180
	1953	MEDIUM	90	180
	1971	MEDIUM	90	180
	1986	MEDIUM	90	180
	2010	MEDIUM	90	180
G225M	2186	MEDIUM	60	120
	2217	MEDIUM	60	120
	2233	MEDIUM	60	120
	2250	MEDIUM	60	120
	2268	MEDIUM	60	120
	2283	MEDIUM	60	120
	2306	MEDIUM	60	120
	2325	MEDIUM	140	280
	2339	MEDIUM	140	280
	2357	MEDIUM	120	240
	2373	MEDIUM	120	240
	2390	MEDIUM	120	240
	2410	MEDIUM	140	280

Table A.1 (cont): Initial COS Wavecal Lamp Exposure Table

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME
G285M	2617	MEDIUM	150	300
	2637	MEDIUM	150	300
	2657	MEDIUM	150	300
	2676	MEDIUM	150	300
	2695	HIGH	165	330
	2709	HIGH	165	330
	2719	HIGH	165	330
	2739	HIGH	215	430
	2850	HIGH	215	430
	2952	HIGH	215	430
	2979	HIGH	215	430
	2996	MEDIUM	70	140
	3018	MEDIUM	70	140
	3035	MEDIUM	80	160
	3057	MEDIUM	80	160
	3074	MEDIUM	80	160
	3094	MEDIUM	80	160
G230L	2635	MEDIUM	50	100
	2950	MEDIUM	90	180
	3000	MEDIUM	90	180
	3360	MEDIUM	70	140

A.2 First Update of Wavecal and Flash Exposure Durations (operational values used in TV06)

Table A.2 lists the first set of flash durations to be established; these values are based on recommendations of the COS TIR 2006-01(v1) (Sembach) wavecal exposure quality study. These values were used for all TV06 TAGFLASH exposures including the special SMS-based "TAGFLASH" tests.

Table A.2: TV06 Update to COS Wavecal Lamp Exposure Table to Include Lamp Flash Durations

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G130M	1291	MEDIUM	5	120	5
G130M	1300	MEDIUM	10	120	10
G130M	1309	MEDIUM	5	120	5
G130M	1318	MEDIUM	5	120	5
G130M	1327	MEDIUM	5	120	5
G160M	1577	MEDIUM	5	120	5
G160M	1589	MEDIUM	5	120	5
G160M	1600	MEDIUM	10	120	10
G160M	1611	MEDIUM	5	120	5
G160M	1623	MEDIUM	5	120	5
G140L	1105	MEDIUM	5	120	5
G140L	1230	MEDIUM	5	120	5
G185M	1786	MEDIUM	10	220	10
G185M	1817	MEDIUM	5	220	5
G185M	1835	MEDIUM	10	240	10
G185M	1850	MEDIUM	20	180	20
G185M	1864	MEDIUM	30	180	30
G185M	1882	MEDIUM	15	120	15
G185M	1890	MEDIUM	10	120	10
G185M	1900	MEDIUM	20	140	20
G185M	1913	MEDIUM	10	140	10
G185M	1921	MEDIUM	10	140	10
G185M	1941	MEDIUM	10	180	10
G185M	1953	MEDIUM	15	180	15
G185M	1971	MEDIUM	15	180	15
G185M	1986	MEDIUM	10	180	10
G185M	2010	MEDIUM	10	180	10
G225M	2186	MEDIUM	5	120	5
G225M	2217	MEDIUM	10	120	10
G225M	2233	MEDIUM	5	120	5
G225M	2250	MEDIUM	10	120	10
G225M	2268	MEDIUM	10	120	10
G225M	2283	MEDIUM	5	120	5
G225M	2306	MEDIUM	10	120	10
G225M	2325	MEDIUM	10	280	10
G225M	2339	MEDIUM	5	280	5
G225M	2357	MEDIUM	10	240	10
G225M	2373	MEDIUM	5	240	5
G225M	2390	MEDIUM	5	240	5
G225M	2410	MEDIUM	5	280	5

Table A.2 (cont): TV06 Update to COS Wavecal Lamp Exposure Table to Include Lamp Flash Durations

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G285M	2617	MEDIUM	5	300	5
G285M	2637	MEDIUM	5	300	5
G285M	2657	MEDIUM	5	300	5
G285M	2676	MEDIUM	10	300	10
G285M	2695	HIGH	5	330	5
G285M	2709	HIGH	5	330	5
G285M	2719	HIGH	5	330	5
G285M	2739	HIGH	5	430	5
G285M	2850	HIGH	5	430	5
G285M	2952	HIGH	5	430	5
G285M	2979	HIGH	15	430	15
G285M	2996	MEDIUM	5	140	5
G285M	3018	MEDIUM	10	140	10
G285M	3035	MEDIUM	5	160	5
G285M	3057	MEDIUM	5	160	5
G285M	3074	MEDIUM	5	160	5
G285M	3094	MEDIUM	10	160	10
G230L	2635	MEDIUM	5	100	5
G230L	2950	MEDIUM	5	180	5
G230L	3000	MEDIUM	5	180	5
G230L	3360	MEDIUM	5	140	5
MIRROR	0	LOW	2	80	2
MIRRORB	0	LOW	5	80	5

A.3 Updates to Change Lamp CURRENT and some component designations; used in SMGT and subsequent ground testing

This update (see Table A.3) was initiated immediately following TV06, although none of these changes were based upon TV06 results. Lamp current for several G285M central wavelengths was changed from HIGH to MEDIUM, and the component name MIRROR was changed to MIRRORA. These values were available for use in ground-testing conducted between January 2007 and January 2009, e.g., SMGT.

Table A.3: SMGT Update to COS Wavecal Lamp Exposure Table

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G130M	1291	MEDIUM	5	120	5
G130M	1300	MEDIUM	10	120	10
G130M	1309	MEDIUM	5	120	5
G130M	1318	MEDIUM	5	120	5
G130M	1327	MEDIUM	5	120	5
G160M	1577	MEDIUM	5	120	5
G160M	1589	MEDIUM	5	120	5
G160M	1600	MEDIUM	10	120	10
G160M	1611	MEDIUM	5	120	5
G160M	1623	MEDIUM	5	120	5
G140L	1105	MEDIUM	5	120	5
G140L	1230	MEDIUM	5	120	5
G185M	1786	MEDIUM	10	220	10
G185M	1817	MEDIUM	5	220	5
G185M	1835	MEDIUM	10	240	10
G185M	1850	MEDIUM	20	180	20
G185M	1864	MEDIUM	30	180	30
G185M	1882	MEDIUM	15	120	15
G185M	1890	MEDIUM	10	120	10
G185M	1900	MEDIUM	20	140	20
G185M	1913	MEDIUM	10	140	10
G185M	1921	MEDIUM	10	140	10
G185M	1941	MEDIUM	10	180	10
G185M	1953	MEDIUM	15	180	15
G185M	1971	MEDIUM	15	180	15
G185M	1986	MEDIUM	10	180	10
G185M	2010	MEDIUM	10	180	10
G225M	2186	MEDIUM	5	120	5
G225M	2217	MEDIUM	10	120	10
G225M	2233	MEDIUM	5	120	5
G225M	2250	MEDIUM	10	120	10
G225M	2268	MEDIUM	10	120	10
G225M	2283	MEDIUM	5	120	5
G225M	2306	MEDIUM	10	120	10
G225M	2325	MEDIUM	10	280	10
G225M	2339	MEDIUM	5	280	5
G225M	2357	MEDIUM	10	240	10
G225M	2373	MEDIUM	5	240	5
G225M	2390	MEDIUM	5	240	5
G225M	2410	MEDIUM	5	280	5

Table A.3 (cont): SMGT Update to COS Wavecal Lamp Exposure Table

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G285M	2617	MEDIUM	5	300	5
G285M	2637	MEDIUM	5	300	5
G285M	2657	MEDIUM	5	300	5
G285M	2676	MEDIUM	10	300	10
G285M	2695	MEDIUM	5	330	5
G285M	2709	MEDIUM	5	330	5
G285M	2719	MEDIUM	5	330	5
G285M	2739	MEDIUM	5	430	5
G285M	2850	MEDIUM	5	430	5
G285M	2952	MEDIUM	5	430	5
G285M	2979	MEDIUM	15	430	15
G285M	2996	MEDIUM	5	140	5
G285M	3018	MEDIUM	10	140	10
G285M	3035	MEDIUM	5	160	5
G285M	3057	MEDIUM	5	160	5
G285M	3074	MEDIUM	5	160	5
G285M	3094	MEDIUM	10	160	10
G230L	2635	MEDIUM	5	100	5
G230L	2950	MEDIUM	5	180	5
G230L	3000	MEDIUM	5	180	5
G230L	3360	MEDIUM	5	140	5
MIRRORA	0	LOW	2	80	2
MIRRORB	0	LOW	5	80	5

A.4 Update Based upon TV06 Results; Launch values used in SMOV and early C17

This update (see Table A.4) increased all wavecal exposure times and flash durations by 2 seconds in order to adjust times to accommodate delayed lamp turn-on that was discovered in TV06 TAGFLASH implementation tests. Some exposure times and flash durations were increased more substantially on the basis of TV06 results. These values were implemented by 30 January 2009, and were used for all on-orbit observations until implementation of the post-SMOV January 2010 update (see Appendix A.5).

Table A.4: Pre-launch Update to COS Wavecal Lamp Exposure Table to Include Lamp Flash Delay Time

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G130M	1291	MEDIUM	7	120	7
G130M	1300	MEDIUM	12	120	12
G130M	1309	MEDIUM	7	120	7
G130M	1318	MEDIUM	7	120	7
G130M	1327	MEDIUM	12	120	12
G160M	1577	MEDIUM	7	120	7
G160M	1589	MEDIUM	7	120	7
G160M	1600	MEDIUM	12	120	12
G160M	1611	MEDIUM	7	120	7
G160M	1623	MEDIUM	7	120	7
G140L	1105	MEDIUM	7	120	7
G140L	1230	MEDIUM	7	120	7
G185M	1786	MEDIUM	12	220	12
G185M	1817	MEDIUM	12	220	12
G185M	1835	MEDIUM	12	240	12
G185M	1850	MEDIUM	22	180	22
G185M	1864	MEDIUM	32	180	32
G185M	1882	MEDIUM	17	120	17
G185M	1890	MEDIUM	12	120	12
G185M	1900	MEDIUM	22	140	22
G185M	1913	MEDIUM	17	140	17
G185M	1921	MEDIUM	12	140	12
G185M	1941	MEDIUM	12	180	12
G185M	1953	MEDIUM	17	180	17
G185M	1971	MEDIUM	17	180	17
G185M	1986	MEDIUM	12	180	12
G185M	2010	MEDIUM	12	180	12
G225M	2186	MEDIUM	7	120	7
G225M	2217	MEDIUM	12	120	12
G225M	2233	MEDIUM	7	120	7
G225M	2250	MEDIUM	22	120	22
G225M	2268	MEDIUM	12	120	12
G225M	2283	MEDIUM	12	120	12
G225M	2306	MEDIUM	12	120	12
G225M	2325	MEDIUM	12	280	12
G225M	2339	MEDIUM	12	280	12
G225M	2357	MEDIUM	12	240	12
G225M	2373	MEDIUM	22	240	22
G225M	2390	MEDIUM	7	240	7
G225M	2410	MEDIUM	7	280	7

Table A.4 (cont): Pre-launch Update to COS Wavecal Lamp Exposure Table to Include Lamp Flash Delay Time

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G285M	2617	MEDIUM	12	300	12
G285M	2637	MEDIUM	12	300	12
G285M	2657	MEDIUM	7	300	7
G285M	2676	MEDIUM	22	300	22
G285M	2695	MEDIUM	22	330	22
G285M	2709	MEDIUM	12	330	12
G285M	2719	MEDIUM	7	330	7
G285M	2739	MEDIUM	7	430	7
G285M	2850	MEDIUM	22	430	22
G285M	2952	MEDIUM	7	430	7
G285M	2979	MEDIUM	17	430	17
G285M	2996	MEDIUM	12	140	12
G285M	3018	MEDIUM	12	140	12
G285M	3035	MEDIUM	7	160	7
G285M	3057	MEDIUM	12	160	12
G285M	3074	MEDIUM	7	160	7
G285M	3094	MEDIUM	12	160	12
G230L	2635	MEDIUM	7	100	7
G230L	2950	MEDIUM	7	180	7
G230L	3000	MEDIUM	7	180	7
G230L	3360	MEDIUM	7	140	7
MIRRORA	0	LOW	5	80	5
MIRRORB	0	LOW	17	80	17

A.5 Update Based on SMOV Results: available for late Cycle 17, used in Cycle 18

The updated values listed in Table A.5 were based upon the results of SMOV testing. Updates were implemented by the end of January 2010 and included lengthening default flash and wavecal exposure durations for many central wavelengths. Additionally, the first new central wavelength setting since 2003 (G140L 1280) was added to the table, although this setup was not generally available until cycle 18. As this major update affected many central wavelengths, Table A.6 specifically lists the before and after values for all changes made in the January 2010 update.

Table A.5: Post-SMOV Update to COS Wavecal Lamp Exposure Table

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G130M	1291	MEDIUM	12	120	12
G130M	1300	MEDIUM	12	120	12
G130M	1309	MEDIUM	12	120	12
G130M	1318	MEDIUM	12	120	12
G130M	1327	MEDIUM	12	120	12
G160M	1577	MEDIUM	12	120	12
G160M	1589	MEDIUM	12	120	12
G160M	1600	MEDIUM	12	120	12
G160M	1611	MEDIUM	12	120	12
G160M	1623	MEDIUM	12	120	12
G140L	1105	MEDIUM	7	120	7
G140L	1230	MEDIUM	7	120	7
G140L	1280	MEDIUM	7	120	7
G185M	1786	MEDIUM	12	220	12
G185M	1817	MEDIUM	12	220	12
G185M	1835	MEDIUM	12	240	12
G185M	1850	MEDIUM	22	180	22
G185M	1864	MEDIUM	32	180	32
G185M	1882	MEDIUM	17	120	17
G185M	1890	MEDIUM	12	120	12
G185M	1900	MEDIUM	22	140	22
G185M	1913	MEDIUM	17	140	17
G185M	1921	MEDIUM	12	140	12
G185M	1941	MEDIUM	12	180	12
G185M	1953	MEDIUM	17	180	17
G185M	1971	MEDIUM	17	180	17
G185M	1986	MEDIUM	12	180	12
G185M	2010	MEDIUM	12	180	12
G225M	2186	MEDIUM	7	120	7
G225M	2217	MEDIUM	12	120	12
G225M	2233	MEDIUM	7	120	7
G225M	2250	MEDIUM	22	120	22
G225M	2268	MEDIUM	12	120	12
G225M	2283	MEDIUM	12	120	12
G225M	2306	MEDIUM	12	120	12
G225M	2325	MEDIUM	12	280	12
G225M	2339	MEDIUM	12	280	12
G225M	2357	MEDIUM	12	240	12
G225M	2373	MEDIUM	22	240	22
G225M	2390	MEDIUM	7	240	7
G225M	2410	MEDIUM	7	280	7

Table A.5 (cont): Post-SMOV Update to COS Wavecal Lamp Exposure Table

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G285M	2617	MEDIUM	12	300	12
G285M	2637	MEDIUM	12	300	12
G285M	2657	MEDIUM	7	300	7
G285M	2676	MEDIUM	22	300	22
G285M	2695	MEDIUM	22	330	22
G285M	2709	MEDIUM	12	330	12
G285M	2719	MEDIUM	7	330	7
G285M	2739	MEDIUM	7	430	7
G285M	2850	MEDIUM	22	430	22
G285M	2952	MEDIUM	7	430	7
G285M	2979	MEDIUM	17	430	17
G285M	2996	MEDIUM	17	140	17
G285M	3018	MEDIUM	22	140	22
G285M	3035	MEDIUM	27	160	27
G285M	3057	MEDIUM	32	160	32
G285M	3074	MEDIUM	32	160	32
G285M	3094	MEDIUM	32	160	32
G230L	2635	MEDIUM	7	100	7
G230L	2950	MEDIUM	7	180	7
G230L	3000	MEDIUM	7	180	7
G230L	3360	MEDIUM	12	140	12
MIRRORA	0	LOW	7	80	7
MIRRORB	0	LOW	27	80	27

Table A.6: Actual Values Modified in January 2010 Update

After Update						Before Update					
GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASH DURATION	GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASH DURATION
G130M	1291	MEDIUM	12	120	12	G130M	1291	MEDIUM	7	120	7
G130M	1309	MEDIUM	12	120	12	G130M	1309	MEDIUM	7	120	7
G130M	1318	MEDIUM	12	120	12	G130M	1318	MEDIUM	7	120	7
G160M	1577	MEDIUM	12	120	12	G160M	1577	MEDIUM	7	120	7
G160M	1589	MEDIUM	12	120	12	G160M	1589	MEDIUM	7	120	7
G160M	1611	MEDIUM	12	120	12	G160M	1611	MEDIUM	7	120	7
G160M	1623	MEDIUM	12	120	12	G160M	1623	MEDIUM	7	120	7
G140L	1280	MEDIUM	7	120	7	< setup not available prior to this update					
G285M	2996	MEDIUM	17	140	17	G285M	2996	MEDIUM	12	140	12
G285M	3018	MEDIUM	22	140	22	G285M	3018	MEDIUM	12	140	12
G285M	3035	MEDIUM	27	160	27	G285M	3035	MEDIUM	7	160	7
G285M	3057	MEDIUM	32	160	32	G285M	3057	MEDIUM	12	160	12
G285M	3074	MEDIUM	32	160	32	G285M	3074	MEDIUM	7	160	7
G285M	3094	MEDIUM	32	160	32	G285M	3094	MEDIUM	12	160	12
G230L	3360	MEDIUM	12	140	12	G230L	3360	MEDIUM	7	140	7
MIRRORA	0	LOW	7	80	7	MIRRORA	0	LOW	5	80	5
MIRRORB	0	LOW	27	80	27	MIRRORB	0	LOW	17	80	17

A.6 Latest Values as of mid-January 2011

Based upon results from special Cycle 18 calibration programs, two new G130M central wavelengths (G130M 1055 and G130M 1096) were added to the operational wavecal lamp exposure table in January 2011, effective 18 February 2011 although the setups were not generally available for use until cycle 19.

Apart from the two new G130M entries, exposure values for all other setups remain unchanged by this update.

Table A.7: Mid-Cycle 18 Update to COS Wavecal Lamp Exposure Table (same as Table 3)

GRATING	CENWAVE	CURRENT	EXPTIME	BUFFER-TIME	FLASHDUR
G130M	1055	MEDIUM	102	510	102
G130M	1096	MEDIUM	35	180	35
G130M	1291	MEDIUM	12	120	12
G130M	1300	MEDIUM	12	120	12
G130M	1309	MEDIUM	12	120	12
G130M	1318	MEDIUM	12	120	12
G130M	1327	MEDIUM	12	120	12
G160M	1577	MEDIUM	12	120	12
G160M	1589	MEDIUM	12	120	12
G160M	1600	MEDIUM	12	120	12
G160M	1611	MEDIUM	12	120	12
G160M	1623	MEDIUM	12	120	12
G140L	1105	MEDIUM	7	120	7
G140L	1230	MEDIUM	7	120	7
G140L	1280	MEDIUM	7	120	7

Table A.7 (cont): Mid-Cycle 18 Update to COS Wavecal Lamp Exposure Table (same as Table 3)

G185M	1786	MEDIUM	12	220	12
G185M	1817	MEDIUM	12	220	12
G185M	1835	MEDIUM	12	240	12
G185M	1850	MEDIUM	22	180	22
G185M	1864	MEDIUM	32	180	32
G185M	1882	MEDIUM	17	120	17
G185M	1890	MEDIUM	12	120	12
G185M	1900	MEDIUM	22	140	22
G185M	1913	MEDIUM	17	140	17
G185M	1921	MEDIUM	12	140	12
G185M	1941	MEDIUM	12	180	12
G185M	1953	MEDIUM	17	180	17
G185M	1971	MEDIUM	17	180	17
G185M	1986	MEDIUM	12	180	12
G185M	2010	MEDIUM	12	180	12
G225M	2186	MEDIUM	7	120	7
G225M	2217	MEDIUM	12	120	12
G225M	2233	MEDIUM	7	120	7
G225M	2250	MEDIUM	22	120	22
G225M	2268	MEDIUM	12	120	12
G225M	2283	MEDIUM	12	120	12
G225M	2306	MEDIUM	12	120	12
G225M	2325	MEDIUM	12	280	12
G225M	2339	MEDIUM	12	280	12
G225M	2357	MEDIUM	12	240	12
G225M	2373	MEDIUM	22	240	22
G225M	2390	MEDIUM	7	240	7
G225M	2410	MEDIUM	7	280	7
G285M	2617	MEDIUM	12	300	12
G285M	2637	MEDIUM	12	300	12
G285M	2657	MEDIUM	7	300	7
G285M	2676	MEDIUM	22	300	22
G285M	2695	MEDIUM	22	330	22
G285M	2709	MEDIUM	12	330	12
G285M	2719	MEDIUM	7	330	7
G285M	2739	MEDIUM	7	430	7
G285M	2850	MEDIUM	22	430	22
G285M	2952	MEDIUM	7	430	7
G285M	2979	MEDIUM	17	430	17
G285M	2996	MEDIUM	17	140	17
G285M	3018	MEDIUM	22	140	22
G285M	3035	MEDIUM	27	160	27
G285M	3057	MEDIUM	32	160	32
G285M	3074	MEDIUM	32	160	32
G285M	3094	MEDIUM	32	160	32
G230L	2635	MEDIUM	7	100	7
G230L	2950	MEDIUM	7	180	7
G230L	3000	MEDIUM	7	180	7
G230L	3360	MEDIUM	12	140	12
MIRRORA	0	LOW	7	80	7
MIRRORB	0	LOW	27	80	27