ENGINEERING CHANGE ORDER Center for Astrophysics & Space Astronomy University of Colorado, Boulder				**ECO No.** COS-086 Date 23 May 2003 Sheet 1 of 12
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OP-01	COS-01-0001	22	23	
				Stop Production Now ❑ Yes ❑ No

Description of Change:

1. **Page 29 (Rev. 22), Sec. 2.1.1.1 (middle of page): Replace the two paragraphs above the figure with the following text:**

The secondary motor is a fail-safe used to move the entire external shutter assembly out of the optical path in the event of a primary motor failure that would leave the shutter in the closed position. To move the increased mass, the secondary motor has a 100:1 gear ratio associated with it, and the flight software will command the motor to move 946 steps, the full range of the mechanism, to open the shutter. At the nominal rate of 78 steps per second, the move with the secondary motor takes approximately 12 seconds to complete.

An isometric drawing of the external shutter is shown in Figure 2.1-1. Properties of the external shutter, and parameters supplied to the FSW to operate it, are listed in the LSHUTTER macro sheet of DM-05. Additional information may be found in Appendix A of the Flight Software User's Manual (Control Section Hardware/Software Interface).

2. **Page 30 (Rev. 22), Sec. 2.1.1.1 (top of page): Replace the paragraph at the top of the page with the following text, which contains several modifications:**

The external shutter's position is sensed via non-redundant Reed switches. There is a Reed switch in both the Open and Closed shutter positions. When the shutter moves into position, the permanent magnet on the

Reason for Change: Updates to COS operations in OP-01.	Disposition/Effectivity				
	To Comply With ECO				
	Use As Is				
	Rework To ECO				
	Scrap And Rebuild				
	Record change Only				
	Other (See Above)				

Prepared By:	Jon Morse	Date	23 May 2003	CCB Required	❑Approved
Approved By:		Date		❑Yes ❑No	❑NotApproved
Approved By:		Date			Immediate
Approved By:		Date		❑Class I	Incorporation
Approved By:		Date		❑Class II	❑Yes ❑No
Approved By:		Date		Completion	
Project Mgr:		Date		Date	

shutter comes in close proximity with the Reed switch. The magnet's field closes the switch contacts indicating the shutter is in that position. Since the Reed switches are not redundant, the sense signals must be relay switched to the MEB that is on. The relays reside in MEB1 but the relays can be commanded via a macro using either MEB. Both the open and closed switch positions are stored in a latch as a separate digital 1 or 0 to be read by the FSW. A digital value of one indicates that the switch is in position. A digital value of zero indicates that the switch is not in position. Therefore, a one value for the open bit indicates that the shutter is open and a one value for the closed bit indicates that the shutter is closed. A value of zero in both locations is invalid and a value of one in both locations would indicate that the shutter is positioned somewhere in-between open and shut (possibly via a motor 2 move).

3. Page 32 (Rev. 22), Sec. 2.1.2.1: Replace the paragraph just above the figure with the following text:

The aperture mechanism is shown in Figure 2.1-2, and the placement of the science and calibration apertures on the aperture block is portrayed in Figure 1.3-8. Properties of the aperture mechanism, and parameters supplied to the FSW to operate it, are listed in the macro sheets LAPERINI, LAPERREL, and LAPER and Section 6.1 (Mechanism Limits and Settings) of DM-05.Additional information may be found in Appendix A of the Flight Software User's Manual (Control Section Hardware/Software Interface).

4. Page 32 (Rev. 22), Sec. 2.1.2.1: Replace Figure 2.1-2 with the following drawing:

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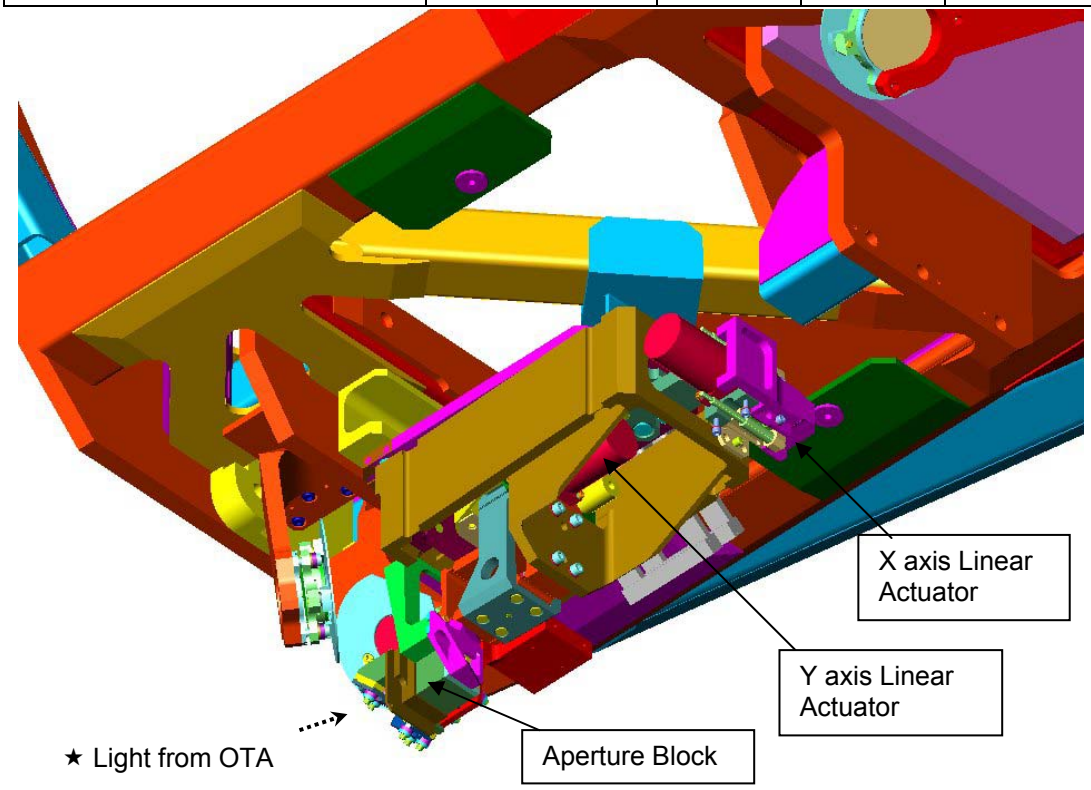

5. **Page 34 (Rev. 22), Sec. 2.1.2.3.1: From the bulleted list, delete the line "Motor current selection" and put a period at the end of "Motor hold-off count."**

6. **Page 35 (Rev. 22), Sec. 2.1.2.3.1: Delete the paragraph beginning "The motor current selection selects the current level…"**

7. **Page 36 (Rev. 22), Sec. 2.1.3: At the top of the page in the middle of the continuing paragraph, replace the sentence "The OSM1 rotates through 360 degrees to place the desired optic in the beam path" with the following text:**

Because of soft stops which limit the range of motion of the OSM1 to just under 360 degrees, the OSM1 rotates up to ~270 degrees to place the desired optic in the beam path.

8. **Page 36 (Rev. 22), Sec. 2.1.3: In the last paragraph at the bottom of the page, delete the second sentence beginning "Their corresponding steps in the OSM1 …"**

9. Page 38 (Rev. 22), Sec. 2.1.4: Replace the paragraph at the top of the page with the following text:

The five optics on OSM2 are distributed at 72-degree intervals, thus each rotational transition is at least ~72 degrees. Because of soft stops which limit the range of motion of the OSM2 to just under 360 degrees, the OSM2 rotates up to ~288 degrees to place the desired optic in the beam path. Table 2.1-2 lists the central wavelengths for each NUV grating mode. Note that a central wavelength is commanded and the FSW knows how to convert the commanded wavelength to the appropriate OSM2 step.

10. Page 39 (Rev. 22), Sec. 2.1.5: In the second paragraph at the bottom of the page, replace the second sentence with the following text:

Properties of the optical select mechanisms and parameters supplied to the FSW to operate them are listed in the LOSMINIT, LOSMREL, AND LOSM macro sheets and Section 6.1 (Mechanism Limits and Settings) of DM-05.

11. Page 41 (Rev. 22), Sec. 2.1.5.1: Replace the first paragraph with the following text:

Although the rotational motors on the optics select mechanisms have unlimited rotation, soft stops have been implemented to limit the motion to slightly under 360 degrees. The soft stop (or "breakpoint") for OSM1 is between the G140L and G160M optics, and for OSM2 between the G185M and G230L optics. There are both hardware and software travel limits for the OSM1 focus drive. These limits are listed in Section 6.1 (Mechanism Limits and Settings) of DM-05. Software limits are checked by the FSW. I f a move command would send a motor beyond its software limits, the move is not performed and an error is reported with a status buffer message.

12. Page 42 (Rev. 22), Sec. 2.1.5.2.1: From the bulleted list, delete the line "Motor current selection" and put a period at the end of "Motor hold-off count."

13. Page 42 (Rev. 22), Sec. 2.1.5.2.1: Replace the "motor home position" paragraph with the following text:

The **motor home position** option, when enabled, returns the selected motor to a home position during motor initialization. Under normal operations this option will be enabled. The home position for each motor is a patchable constant. The home position for OSM1 rotation will be the 1230Å central wavelength position of G140L. The home position of the OSM1 focus motor will be the optimized focus position for NCM1. The home position for the OSM2 rotational motor will be the TA1 mirror. Note that the home option must be enabled for the OSM rotational axes to accurately determine the motor position. Subsequent absolute moves will not be allowed of the rotational motors were not sent to their home position during initialization.

14. Page 42 (Rev. 22), Sec. 2.1.5.2.1 (bottom of page): Delete the paragraph beginning "The motor current selection selects the current level…"

15. Page 43 (Rev. 22), Sec. 2.1.5.2.3: Replace the existing paragraph with the following text:

The "Move OSM to Absolute Position" macro specifies the motor and the desired optical element. The FSW will move to the desired optical element taking into consideration the soft stop motion limits. With absolute moves, overshoot processing is incorporated into a multi-step move sequence performed by the FSW in order to increase mechanism stability and repeatability. This is the macro that will be used during normal operations to control the motors. Absolute moves of the OSM are done using look-up tables for each optical element on the OSM (see Tables 2.1-1 and 2.1-2). The table has separate entries for FUV and NUV optics positions.

16. Page 44 (Rev. 22), Sec. 2.1.6: Replace the text in item 2) in the middle of the page with the following text:

As a second level of protection, the hardware overheat protection circuitry automatically disables an ApM or OSM motor when its temperature rises above 62° C by opening its motor winding relay. Any attempt to move the motor when in a hardware overheat condition will be ignored by the FSW. Before a motor that is in an overheat condition can be re-enabled, the LOVHTCLR macro must be issued followed by the LRELAY macro. The "Clear Overheat" macro will not be allowed to clear the overheat status bit until the motor has cooled to a temperature which is lower than the shutdown threshold. This automatic overheat protection is enabled upon power-on, but may be disabled via a ground macro. Under normal conditions, it will remain enabled.

17. Page 49 (Rev. 22), Sec 2.2.1: The first three words, "Stability and repeatability" should be in italics.

18. Page 50 (Rev. 22), Sec. 2.2.1: In the "*Multiple power settings*" paragraph, replace the text beginning "In general, the MEDIUM…" to the end of the paragraph with the following text:

Schematic diagrams for safe usage of the Pt-Ne and deuterium lamps are shown in Figures 2.2-3 and 2.2-4 in the following subsections, including current levels for the aperture location phases of target acquisition (Sec. 5.2). These recommended settings will be tested during ground calibration.

19. Page 52 (Rev. 22), Sec. 2.2.2: Insert the following text and figure after the paragraph that ends "… over the life of the mission."

Figure 2.2-3 shows a schematic of Pt-Ne lamp current settings versus optic configuration to be used as a guide in assessing safe usage of the wavelength calibration lamps, particularly applicable to the beginning of the mission life.

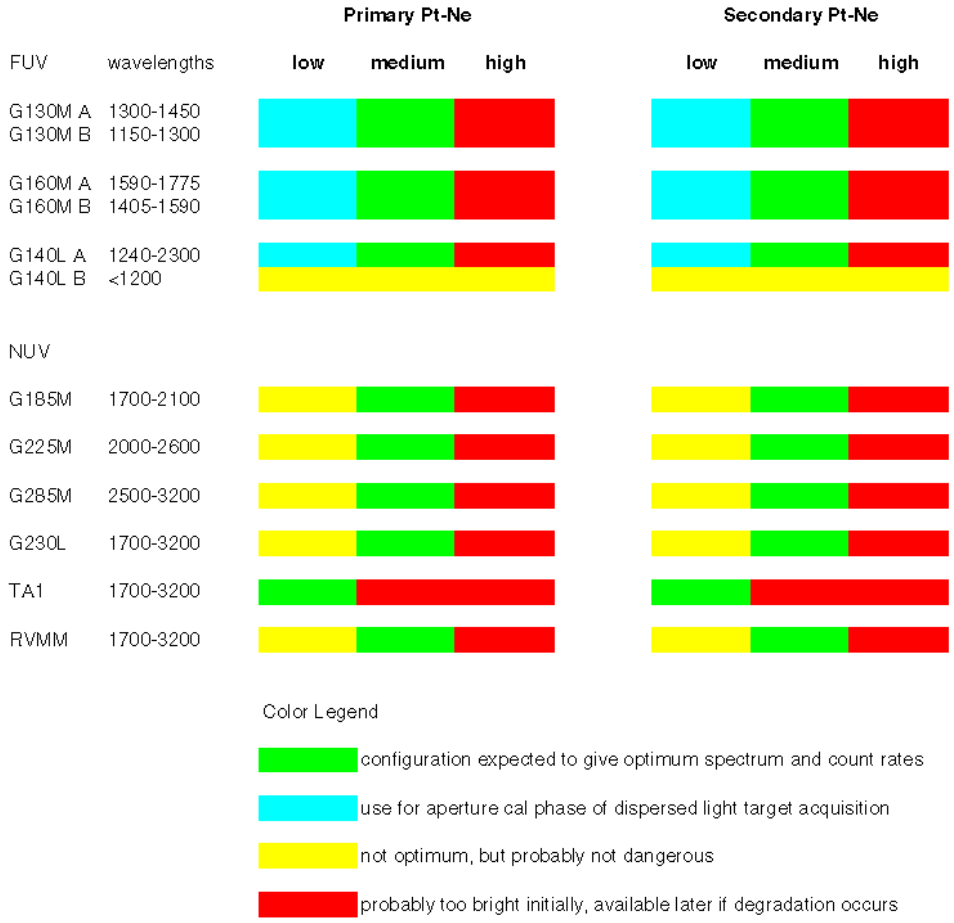

Figure 2.2-3: *Color-coded schematic of safe and unsafe usage configurations for the Pt-Ne wavelength calibration lamps with the various COS gratings and mirrors.*

20. Page 53 (Rev. 22), Sec. 2.2.3: In the lower-middle of the first paragraph, change "Point Source Aperture" to "Primary Science Aperture".

21. Page 54 (Rev. 22), Sec. 2.2.3: At the bottom of the page just after Table 2.2-3, replace the one sentence paragraph beginning "The current levels…" with the following text:

There are two deuterium flat-field lamps, each with three current settings. For both lamps the levels are 3, 7, and 17 milli-amps. In general, either the low or medium setting should be used with the FUV gratings G130M and G160M. G130M will be used to flat-field segment A of the FUV detector using the medium setting. G160M will be used to flat-field segment B of the FUV detector using the low setting. For the NUV channel, the total throughput is low and G185M will be used with the high setting to flat-field the three science stripes on the NUV detector. Figure 2.2-4 shows a schematic of deuterium lamp current settings versus optic configuration to be used as a guide in assessing safe usage of the wavelength calibration lamps, particularly applicable to the beginning of the mission life.

22. Page 54/55 (Rev. 22), Sec. 2.2.3: Delete Table 2.2-4, and rename Table 2.2-5 to 2.2-4. In place of Table 2.2-4, insert the following figure and caption:

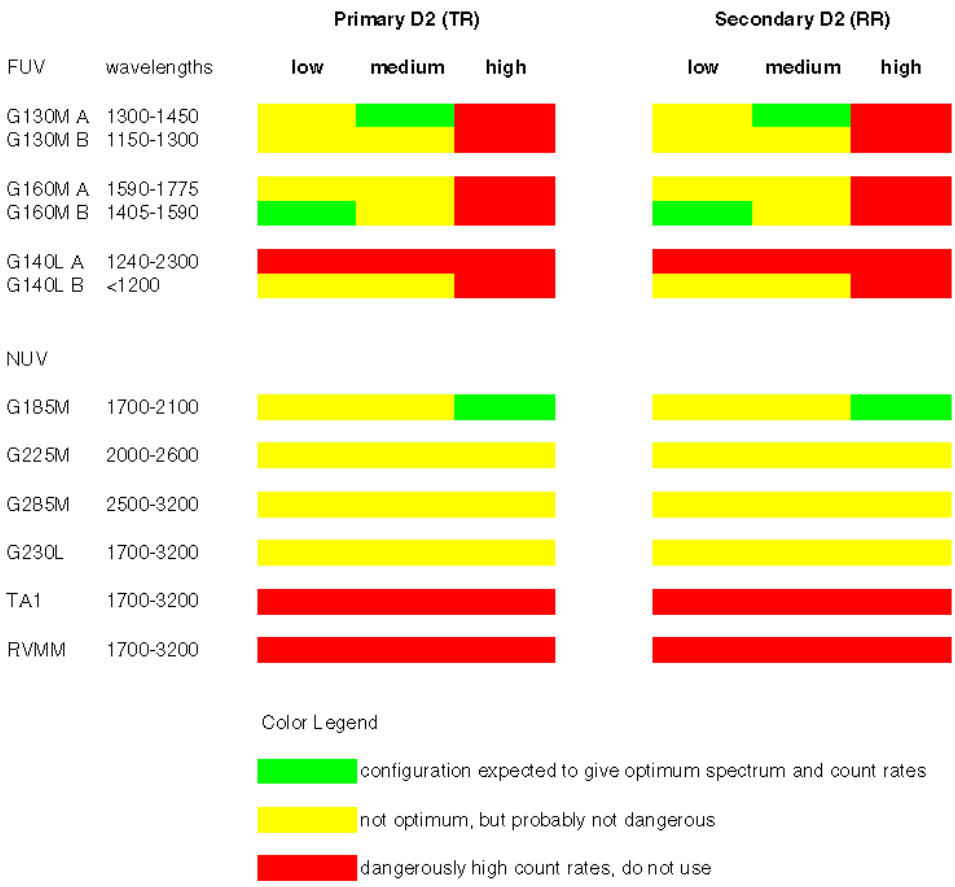

Figure 2.2-4: *Color-coded schematic of safe and unsafe usage configurations for the deuterium flat-field calibration lamps with the various COS gratings and mirrors.*

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23. Page 122 (Rev. 22), Sec. 5.2.2.1: Replace Table 5.2-1 with the following version. The new version includes the new wavelength settings for each FUV grating.

Aperture/Grating	**Central λ (Å)**	**Sub-array Sizes (pixels)**	**Pixel Coordinates of FUV Sub-array Vertices (segment specified)**
WCA/G130M	1291	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G130M	1300	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G130M	**1309**	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G130M	1318	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G130M	1327	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G160M	1577	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G160M	1589	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G160M	**1600**	(14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1:

		(14468 × 32)	(958,612),(958,643),(15425,643),(15425,612)
WCA/G160M	1611	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G160M	1623	(14468 × 32) (14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612)
WCA/G140L	1105	(14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B: (no sub-array, high-voltage to low)
WCA/G140L	**1230**	(14468 × 32)	Segment A, Sub-array 1: (958,612),(958,643),(15425,643),(15425,612) Segment B: (no sub-array)

24. Page 123 (Rev. 22), Sec. 5.2.2.1: Replace Table 5.2-2 with the following version. The new version includes the new wavelength settings for each FUV grating.

Aperture/Grating	**Central λ (Å)**	**Sub-array Sizes (pixels)**	**Pixel Coordinates of FUV Sub-array Vertices (segment specified)**
WCA/G130M	1291	(7451 × 64) (6670 × 64) (5710 × 64) (8411 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(8408,544),(8408,481) Segment A, Sub-array 2: (8756,481),(8756,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(6667,544),(6667,481) Segment B, Sub-array 2: (7015,481),(7015,544),(15425,544),(15425,481)
WCA/G130M	1300	(8433 × 64) (5688 × 64) (6692 × 64) (7429 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(9390,544),(9390,481) Segment A, Sub-array 2: (9738,481),(9738,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(7649,544),(7649,481) Segment B, Sub-array 2: (7997,481),(7997,544),(15425,544),(15425,481)

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WCA/G130M	**1309**	(9415 × 64) (4706 × 64) (7674 × 64) (6447 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(10372,544),(10372,481) Segment A, Sub-array 2: (10720,481),(10720,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(8631,544),(8631,481) Segment B, Sub-array 2: (8979,481),(8979,544),(15425,544),(15425,481)
WCA/G130M	1318	(10397 × 64) (3724 × 64) (7674 × 64) (5465 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(11354,544),(11354,481) Segment A, Sub-array 2: (11702,481),(11702,544),(15425,544),(15425,481) Segment B, Sub-array 1: (1940,481),(1940,544),(9613,544),(9613,481) Segment B, Sub-array 2: (9961,481),(9961,544),(15425,544),(15425,481)
WCA/G130M	1327	(11379 × 64) (2742 × 64) (7674 × 64) (4483 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(12336,544),(12336,481) Segment A, Sub-array 2: (12684,481),(12684,544),(15425,544),(15425,481) Segment B, Sub-array 1: (2922,481),(2922,544),(10595,544),(10595,481) Segment B, Sub-array 2: (10943,481),(10943,544),(15425,544),(15425,481)
WCA/G160M	1577	(14468 × 64) (14468 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481)
WCA/G160M	1589	(14468 × 64) (14468 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481)
WCA/G160M	**1600**	(14468 × 64) (14468 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481)
WCA/G160M	1611		Segment A, Sub-array 1:

		(14468 × 64) (14468 × 64)	(958,481),(958,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481)
WCA/G160M	1623	(14468 × 64) (14468 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481) Segment B, Sub-array 1: (958,481),(958,544),(15425,544),(15425,481)
WCA/G140L	1105	(11409 × 64) (534 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(12366,544),(12366,481) Segment A, Sub-array 2: (13392,481),(13392,544),(13925,544),(13925,481) Segment B: (no sub-array, high-voltage to low)
WCA/G140L	**1230**	(12698 × 64) (961 × 64)	Segment A, Sub-array 1: (958,481),(958,544),(13655,544),(13655,481) Segment A, Sub-array 2: (14465,481),(14465,544),(15425,544),(15425,481) Segment B: (no sub-array)

25. Page 125 (Rev. 22), Sec. 5.2.2.2: In Table 5.2-3, change the range of "Central λ" for "WCA/G185M" to 1700-2100, and for "WCA/G225M" to 2100-2500.

26. Page 126 (Rev. 22), Sec. 5.2.2.2: In Table 5.2-4, change the range of "Central λ" for "PSA or BOA/G185M" to 1700-2100, and for "PSA or BOA/G225M" to 2100-2500.

27. Page 127 (Rev. 22), Sec. 5.2.2.2: In Table 5.2-5, change the range of "Central λ" for "PSA or BOA/G185M" to 1700-2100, and for "PSA or BOA/G225M" to 2100-2500.