17150 - Targeted Observations of Ceres' Occator Crater with HST/STIS

Cycle: 30, Proposal Category: GO

(Availability Mode: AVAILABLE)

INVESTIGATORS

Name	*Institution*
Dr. Samantha Trumbo (PI) (Contact)	**Cornell University**

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) CERES-OCCATOR (2) CERES-ACQ NONE WAVE	STIS/CCD	1	04-Apr-2023 17:00:12.0	yes

1 Total Orbits Used

ABSTRACT

We propose targeted single-orbit STIS observations of Ceres' Occator crater in order to unambiguously confirm or reject the possible identification of sodium chloride color centers in Dawn visible-channel spectra of Occator's bright spots Cerealia and Vinalia Faculae. The Dawn visible channel was affected by perplexing artifacts resulting in anomalous spectral shapes that required improvised, empirical calibration steps, and the published visible-channel spectra of Cerealia Facula across different image cubes and reasonable reduction methods appear to disagree. Though some exhibit features potentially consistent with sodium chloride, others show a complete lack of visible spectral features altogether. As abundant sodium chloride is expected for faculae formation mechanisms involving a relict ocean brine reservoir, resolving this ambiguity would be an important step toward understanding not just the formation and evolution of Ceres' enigmatic bright spots, but also its potential status as a relict ocean world.

OBSERVING DESCRIPTION

We propose to obtain spectra in the G430L and G750L first-order spectroscopy modes using a single 0.05" slit position centered on Occator crater. We take the most conservative approach in estimating our required signal-to-noise ratio (SNR) and corresponding exposure times, based on the weaker M-center feature potentially seen in Dawn spectra. Despite the objective weakness of this potential feature, a 5-sigma detection is possible with an SNR of 185 per pixel, given the 0.09 micron FWHM of the feature and the 4.92 Angstrom/pixel dispersion in G750L. We then estimate the necessary exposure time in two ways. First, we scale from the SNR of 73 achieved by 6-second archival G750L exposures of Io with the 0.1" slit. Accounting for the slit change and the difference in brightness between Io and the expected brightness of an Occator pixel (given the relative sizes and albedos of the faculae and background), we estimate an exposure time of 180 seconds to achieve an SNR of 185 at 0.72 microns. Second, we independently estimate the time needed for our calculated SNR using the STIS exposure time calculator (using a 0.83" extended source and solar spectral shape normalized to the appropriate V-magnitude), which gives an exposure time of 209 seconds (with a time to saturation of 337 seconds) in very good agreement. As the possible F-center signatures on Ceres are at least 4.5 times as strong as their M-center counterparts, the same exposure time in G430L will provide an even stronger F-center detection, despite the slightly lower SNR (156 per pixel for a 180-second exposure) in this setting. A single orbit will allow for multiple such exposures, and therefore a higher SNR and even better detection/rejection limits.

We propose to place the 0.05" slit across Occator crater for the duration of one orbit to obtain the highest possible SNR spectra in G430L and G750L. Though the features we aim to constrain may appear quite weak by our conservative estimates, the combination of such high SNR and the knowledge of exactly in which pixel the features should be strongest will allow for strong constraints via the calculations laid out above and careful comparison to pixels away from the crater. Indeed, we anticipate that considered estimation of the background Ceres signal and ratios to off-crater pixels will allow for more robust detections and removal of any unanticipated systematics.

In the event of reduced-gyro operations, the main impacts to this program are expected to be reduced schedulability, as these observations are already time-constrained, and increased overheads for target acquisition, resulting in reduced science exposure times.

Visit

Proposal 17150, CERES-OCCATOR (01), implementation Tue Apr 04 21:00:13 GMT 2023

Diagnostic Status: Warning

Scientific Instruments: STIS/CCD

Special Requirements: PCS MODE FINE; BETWEEN 20-FEB-2023:00:00:00 AND 10-MAY-2023:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET

Comments: Timing windows are selected such that Ceres is near its maximum diameter of ~0.8" on the sky.

Diagnostics

(CERES-OCCATOR (01)) Warning (Orbit Planner): MISSING FRINGE FLAT CALIBRATION
(CERES-OCCATOR (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN
(CERES-OCCATOR (01)) Warning (Orbit Planner): STIS SCIENCE TOO FAR FROM WAVECAL
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Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=STIS-PERP-TO-SLIT Purpose=MOSAIC Number Of Points=3 Point Spacing=0.05 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=0.0 Angle Between Sides= Center Pattern=true		(3), (4)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	CERES-OCCATOR	STD=CERES	TYPE=PCENTRIC,LONG=239.33,LA T=19.82,RAD=477.4		NOT OCC OF CERES-OCCATOR BY CERES FROM EARTH, CML OF CERES FROM EARTH BETWEEN 96 146	EARTH

Comments: This is the science target, Occator crater on Ceres.
Description=FEATURE CERES

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	CERES-ACQ	STD=CERES				EARTH

Comments: This is the acquisition target, Ceres.
Description=DWARF-PLANET CERES
Extended=YES

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acq (STIS.ta.181 1583)	(2) CERES-ACQ	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; DIFFUSE-CENTER =GEOMETRIC-CENTER; CHECKBOX=19		Sequence 1-4 Non-Int in CERES-OCCATOR (01)	0.5 Secs (0.5 Secs) *[==>]*	***[1]***
2	wavecal for G430L	WAVE	STIS/CCD, ACCUM, 52X0.05	G430L 4300 A			Sequence 1-4 Non-Int in CERES-OCCATOR (01)	*[==>]*	***[1]***
3	3 slits with G430L (STIS.sp.18 14818)	(1) CERES-OCCATOR	STIS/CCD, ACCUM, 52X0.05	G430L 4300 A	WAVECAL=NO; SIZEAXIS2=80; CR-SPLIT=2		Sequence 1-4 Non-Int in CERES-OCCATOR (01) Pattern 1, Exps 3-3 in Sequence 1-4 Non-Int in CERES-OCCATOR (01) (1)	190 Secs (570 Secs) *[==>(Pattern 1, Split 1)]* *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]* *[==>(Pattern 3, Split 2)]*	***[1]***
4	3 slits with G750L (STIS.sp.18 11752)	(1) CERES-OCCATOR	STIS/CCD, ACCUM, 52X0.05	G750L 7751 A	WAVECAL=NO; SIZEAXIS2=80; CR-SPLIT=2		Sequence 1-4 Non-Int in CERES-OCCATOR (01) Pattern 1, Exps 4-4 in Sequence 1-4 Non-Int in CERES-OCCATOR (01) (1)	190 Secs (570 Secs) *[==>(Pattern 1, Split 1)]* *[==>(Pattern 1, Split 2)]* *[==>(Pattern 2, Split 1)]* *[==>(Pattern 2, Split 2)]* *[==>(Pattern 3, Split 1)]* *[==>(Pattern 3, Split 2)]*	***[1]***
5	wavecal for G750L	WAVE	STIS/CCD, ACCUM, 52X0.05	G750L 7751 A				*[==>]*	***[1]***
6	fringe flat	NONE	STIS/CCD, ACCUM, 52X0.05	G750L 7751 A	LAMP=TUNGSTEN; GAIN=4			100 Secs X 4 (400 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]*	***[1]***

Comments: More iterations and longer exposure times for increased S/N.

Orbit Structure