



# 1611 - A chemical census of volatile ices in protostellar envelopes

Cycle: 1, Proposal Category: GO

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## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Pre-imaging				
	2	NIRCam pre-image	NIRCam Imaging	(4) SERPENS-MAIN
NIRSpec MSA				

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	7	Serpens_North_Plan_Correct	NIRSpec MultiObject Spectroscopy	(1) Serpens_Targets
	8	Serpens_South	NIRSpec MultiObject Spectroscopy	(1) Serpens_Targets

## ABSTRACT

We propose to obtain an inventory of bulk volatiles in the youngest protostellar envelopes, just prior to the final assembly of protoplanetary disks. This will trace late-stage chemical evolution of young stellar envelopes, and establish the initial conditions of water and organics for comparison to observations of protoplanetary disk chemistry. To accomplish this goal, we will take advantage of the dense cluster of class 0 protostellar envelopes in the Serpens Main cloud. This cluster is sufficiently dense, and is located at a near-optimum distance and low galactic latitude, to allow us to use the multi-object spectroscopy mode of NIRSpec to obtain 2-5 micron ice absorption spectra toward ~150 highly extincted field stars, including at least ~30 sightlines directly through the protostellar envelopes. Using the incredible sensitivity of NIRSpec, we will be able to probe extinctions as high as  $A_V \sim 75$  mag needed to reveal rare ice species. We estimate that we will obtain ~5 lines of sight through each of 6-8 protostellar envelopes, providing radial maps of relative ice abundances on scales of a few thousand au. The column densities of bulk ices are readily observed in the 2-5 micron region, including much of the oxygen-bearing inventory, as well as simple organics (e.g, H<sub>2</sub>O, CO<sub>2</sub>, CO, CH<sub>3</sub>OH). Particularly methanol ice is a critical, yet poorly understood, cornerstone of pre-planetary organic chemistry. The high column densities also allows for sensitive searches for the rare isotopologues <sup>13</sup>CO, <sup>13</sup>CO<sub>2</sub>, and HDO. The two former enables studies of dust grain shapes, while the latter may yield the first robust measurements of the deuteration fraction of pre-planetary material.

## OBSERVING DESCRIPTION

This proposal consists of 4 NIRSpec MSA pointings/configurations, as well as a set of NIRCам pre-imaging observations.

**NIRSpec MSA:** The observational plan follows the standard procedure for NIRSpec MSA with pre-imaging. The 4 NIRSpec MSA configurations use the G235M and G395H gratings to be observed for each configuration. Because the objective of the proposal is to observe absorption bands, rather than emission features, it is not critical that all the targets are centered in shutters to high precision. Consequently, the MSA Planning Tools is configured to consider the full shutter area for target selection, to maximize the number of targets that can be observed in each configuration. Similarly, we allow for background contamination by failed open shutters.

**NIRCам pre-imaging:** The pre-imaging uses 2 mosaic tiles, 4 NIRCам filters, all to be observed with the BRIGHT2 readout pattern and 7 groups. These are coupled with the 6TIGHT dither pattern to ensure spatial coverage of the full Serpens Main cluster, and obtain good quality astrometry and

## JWST Proposal 1611 (Created: Monday, July 17, 2023 at 1:06:56 PM Eastern Standard Time) - Overview

photometry. The 4 filters and associated colors will be used to select a final MSA candidate list of extincted background field stars. The imaging is designed to obtain point source images for astrometry of stars in the 18-25 mag range, using the natural extinction of the cloud to image the brightest stars at short wavelengths, where extinction prevents them from saturating.

We use the default special timing requirements for NIRSpec MSA observations with pre-imaging. We impose a PA range requirement of the pre-imaging to ensure that our field will be appropriately covered with the given mosaic parameters.

# Proposal 1611 - Targets - A chemical census of volatile ices in protostellar envelopes

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	Serpens_Targets	RA: 18 29 56.1883 (277.4841179d) Dec: +01 14 33.49 (1.24264d) Equinox: J2000		
	Comments: Description=[/]				
	(4)	SERPENS-MAIN	RA: 18 29 55.8463 (277.4826929d) Dec: +01 14 33.96 (1.24277d) Equinox: J2000	Epoch of Position: 2015.5	
	Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. Category=Stellar Cluster Description=[Young star clusters]				

# Proposal 1611 - Observation 2 - A chemical census of volatile ices in protostellar envelopes

Observation	Proposal 1611, Observation 2: NIRCcam pre-image								Mon Jul 17 18:06:56 GMT 2023	
	Diagnostic Status: Warning									
Observing Template: NIRCcam Imaging										
Diagnostics	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
	(Visit 2:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Miscellaneous			
	(4)	SERPENS-MAIN	RA: 18 29 55.8463 (277.4826929d)		Epoch of Position: 2015.5					
			Dec: +01 14 33.96 (1.24277d)							
			Equinox: J2000							
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.										
Category=Stellar Cluster										
Description=[Young star clusters]										
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module Gap				
Mosaic	Rows	Columns	Row Overlap %	Column Overlap %	Row shift (deg)	Column shift (deg)	Tile Order			
	2	1	10.0	10.0	20.0	0.0	DEFAULT			
Dithers	#	Primary Dither Type		Primary Dithers		Subpixel Dither Type		Dither Size	Subpixel Positions	
	1	FULLBOX		6TIGHT		STANDARD			1	
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F140M	F360M	BRIGHT2	7	1	6	6	901.889	
	2	F210M	F480M	BRIGHT2	7	1	6	6	901.889	
Special Requirements	Group Visits within 53.0 Days Aperture PA Range 79.88744876 to 109.88744876 Degrees (V3 79.95880186 to 109.95880186) Aperture PA Range 239.88744876 to 269.88744876 Degrees (V3 239.95880186 to 269.95880186) Visits Same PA									

# Proposal 1611 - Observation 7 - A chemical census of volatile ices in protostellar envelopes

Observation	Proposal 1611, Observation 7: Serpens_North_Plan_Correct										Mon Jul 17 18:06:56 GMT 2023	
	Diagnostic Status: Warning											
	Observing Template: NIRSspec MultiObject Spectroscopy											
Diagnostics	(Visit 7:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous			
	(1)	Serpens_Targets	RA: 18 29 56.1883 (277.4841179d) Dec: +01 14 33.49 (1.24264d) Equinox: J2000									
	Comments: Description=[]											
Acquisition	#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	Filter: F140X; Readout: NRSRAPIDD6; 8 sources in 2 quads; [ Reduced Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153		
Template	TA Method		Obtain Confirmation Images	Science Aperture		Primary Candidate List		Filler Candidate List		Spectral Overlap Map		Spectral Overlap Threshold
	MSATA		After Target ACQ and New MSA Config	MSA Center		Primary F360M 21 ABmag Filter (1030 sources)		Serpens_Targets (3000 sources)		jwst-nirspec-hr		1.5
Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude		
	1	689	277.496398	1.276432	22.4515	1	778	277.487533	1.274926	22.3737		
	1	731	277.491065	1.274161	22.3068	1	782	277.499073	1.272057	22.3484		
	1	749	277.464263	1.247604	22.3806	1	812	277.484120	1.274270	22.4328		
	1	758	277.501847	1.272320	22.3947	1	835	277.497118	1.277397	22.4578		
Confirmation	#	Confirmation Type		Conf. Readout Pattern		Conf. Groups/Int		Conf. Integrations/Exp		Conf. Total Integrations		Conf. Total Exposure Time
	1	c1		NRSIRS2RAPID		8		1		1		131.3
	2	c2		NRSIRS2RAPID		8		1		1		131.3

Proposal 1611 - Observation 7 - A chemical census of volatile ices in protostellar envelopes

Spectral Elements	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
	1	1 (G235M/F170LP)	c1	3 Shutter Slitlet	277.47351875000 004 Degrees 1.2745794444444 445 Degrees	247.73091651014 954			3	6	2713.534
	2	2 (G395H/F290LP)	c1	3 Shutter Slitlet	277.47351875000 004 Degrees 1.2745794444444 445 Degrees	247.73091651014 954			3	6	4026.534
	3	1 (G235M/F170LP)	c2	3 Shutter Slitlet	277.47851708333 33 Degrees 1.2709525 Degrees	247.73102858190 42			3	6	2713.534
	4	2 (G395H/F290LP)	c2	3 Shutter Slitlet	277.47851708333 33 Degrees 1.2709525 Degrees	247.73102858190 42			3	6	4026.534
Special Requirements	MSA Scheduled Aperture PA 247.7312 to 247.7312 Degrees (V3 109.15665 to 109.15665)										

# Proposal 1611 - Observation 8 - A chemical census of volatile ices in protostellar envelopes

Observation	Proposal 1611, Observation 8: Serpens_South										Mon Jul 17 18:06:56 GMT 2023	
	Diagnostic Status: Warning											
	Observing Template: NIRSspec MultiObject Spectroscopy											
Diagnostics	(Visit 8:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous			
	(1)	Serpens_Targets	RA: 18 29 56.1883 (277.4841179d) Dec: +01 14 33.49 (1.24264d) Equinox: J2000									
	Comments: Description=[]											
Acquisition	#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	Filter: F140X; Readout: NRSRAPIDD6; 8 sources in 3 quads; [ Reduced Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153		
Template	TA Method		Obtain Confirmation Images	Science Aperture		Primary Candidate List		Filler Candidate List		Spectral Overlap Map		Spectral Overlap Threshold
	MSATA		After Target ACQ and New MSA Config	MSA Center		Primary F360M 21 ABmag Filter (1030 sources)		Serpens_Targets (3000 sources)		jwst-nirspec-hr		1.5
Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude		
	1	704	277.464675	1.199382	22.3006	1	784	277.472793	1.197158	22.4337		
	1	715	277.470257	1.196013	22.4054	1	791	277.455213	1.215741	22.4279		
	1	746	277.470948	1.196462	22.3044	1	826	277.478027	1.245071	22.4652		
	1	774	277.458104	1.215538	22.363	1	859	277.466044	1.204083	22.473		
Confirmation	#	Confirmation Type		Conf. Readout Pattern		Conf. Groups/Int		Conf. Integrations/Exp		Conf. Total Integrations		Conf. Total Exposure Time
	1	c1		NRSIRS2RAPID		8		1		1		131.3
	2	c2		NRSIRS2RAPID		8		1		1		131.3



# Proposal 1611 - Observation 8 - A chemical census of volatile ices in protostellar envelopes

Spectral Elements	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
	1	1 (G235M/F170LP)	c1	3 Shutter Slitlet	277.48413 Degrees 1.2165502777777 777 Degrees	247.70695327484 881			3	6	2713.534
	2	2 (G395H/F290LP)	c1	3 Shutter Slitlet	277.48413 Degrees 1.2165502777777 777 Degrees	247.70695327484 881			3	6	4026.534
	3	1 (G235M/F170LP)	c2	3 Shutter Slitlet	277.49229041666 666 Degrees 1.2342155555555 556 Degrees	247.70708807168 597			3	6	2713.534
	4	2 (G395H/F290LP)	c2	3 Shutter Slitlet	277.49229041666 666 Degrees 1.2342155555555 556 Degrees	247.70708807168 597			3	6	4026.534
Special Requirements	MSA Scheduled Aperture PA 247.7069 to 247.7069 Degrees (V3 109.13236 to 109.13236)										