



6154 - Enabling accurate velocities for science with the NIRSpec MSA: simultaneous wavelength and LSF calibration

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	NIRCam preimaging	NIRCam Imaging	(6) newloc-preimage
	3	Omega Cen	NIRSpec MultiObject Spectroscopy	(12) OCen_APT_merged_ref1_v5

ABSTRACT

Multi-object spectroscopy with the NIRSpec microshutter array (MSA) has proven to be one of the most popular modes on JWST for extragalactic science. By the end of Cycle 2, 15,000 MSA spectra will have been obtained across $0 < z < 13$. Moving beyond initial studies that focused primarily on redshift confirmation and the detection of individual emission lines, recent studies have started to exploit the full sensitivity and resolving power of NIRSpec. This science pushes the limits of the instrument capabilities and calls for precise calibrations. Currently, differences in line wavelengths

between gratings exceed nominal calibration uncertainties by a factor 5, and prevent simultaneous modeling of multiple observations. The instrument line spread function has also been reported to differ from expectations by up to a factor 2. Calibration programs thus far have focused on single stars or planetary nebulae, which suffer from the severe undersampling of the PSF by the large detector pixels. We propose to exploit the multiplexing power of the MSA by observing 20-25 red giant stars within a crowded region on the sky with all medium- and high-resolution gratings. The large number of narrow absorption features will mitigate undersampling issues that affect individual line centroid and width measurements, providing wavelength and LSF calibration with the high precision needed to enable velocity measurements of high-redshift galaxies (black hole masses, kinematics, outflows, and halo masses) with the MSA. These data will also provide first insight into distortion of the PSF across the MSA and its effect on flux calibration.

OBSERVING DESCRIPTION

We will observe red giant stars in Omega Centauri with the NIRSpec MSA to calibrate the trace model and line spread function of NIRSpec. We have selected stars from the Gaia ESA archive that are bright ($G < 18.5$) and have well-determined proper motions. The source density in the region is sufficiently high to fill the MSA with 20-25 targets without overlapping traces in the high-resolution gratings.

We will observe these stars using 3-shutter slitlets and a 3-nod pattern, for all six medium- and high-resolution gratings. We tailor exposure times to the individual filter/grating pairs, to ensure sufficient continuum SNR needed to robustly measure velocity offsets and the LSF from the several thousand faint absorption features present in the stellar spectra. We will use the NRSIRS2RAPID readout mode and 2 integrations per exposure, to avoid saturation for the brightest stars. With this set-up we will observe 5, 10, 12, 15, 15, 20 groups per integration for the G140M, G140H, G235M, G235H, G395M and G395H gratings, respectively.

One of the primary goals of this program is wavelength calibration. Targets will fall within the microshutters with random intrashutter offsets, which will lead to small offsets in the dispersion direction. This needs to be corrected for to be able to calibrate the trace model. We therefore require accurate target acquisition using the MSATA. However, the calibration targets are brighter than the saturation limit for MSATA. The quality of the proper motion measurements for fainter stars in the field is not sufficient for the accuracy needed in this program. Existing HST imaging in this field covers the very dense center of the globular cluster, which is too crowded for successful MSATA. Therefore, we will obtain NIRCам pre-imaging of fainter stars in the outskirts of the globular cluster to obtain accurate astrometry for the MSATA. We will use the 8NIRSPEC dither pattern and observe with the F150W and F277W filters, with 5 groups per integration using the BRIGHT1 readout mode.

We have uploaded an example placement of the pre-imaging location and mask design. This will be altered depending on the assigned observing

window to optimize the number of red giant stars in the mask.

Proposal 6154 - Targets - Enabling accurate velocities for science with the NIRSpec MSA: simultaneous wavelength and LSF calibration

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	eMPT_OCen_prioritised	RA: 13 26 58.7753 (201.7448971d) Dec: -47 28 50.23 (-47.48062d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				
(6)	newloc-preimage	RA: 13 26 16.1700 (201.5673750d) Dec: -47 34 35.00 (-47.57639d) Equinox: J2000		
<i>Comments:</i> <i>Category=Stellar Cluster</i> <i>Description=[Globular star clusters]</i>				
(12)	OCen_APT_merged_ref1_v5	RA: 13 26 58.7753 (201.7448971d) Dec: -47 28 50.23 (-47.48062d) Equinox: J2000		
<i>Comments:</i> <i>Description=[]</i>				

Proposal 6154 - Observation 1 - Enabling accurate velocities for science with the NIRSpec MSA: simultaneous wavelength and LSF c...

Tue May 27 13:00:19 GMT 2025

Observation	<p>Proposal 6154, Observation 1: NIRCam preimaging</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Imaging</p>									
Diagnostics	<p>(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p> <p>(Visit 1:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(6)	newloc-preimage	RA: 13 26 16.1700 (201.5673750d) Dec: -47 34 35.00 (-47.57639d) Equinox: J2000							
	<p><i>Comments:</i> <i>Category=Stellar Cluster</i> <i>Description=[Globular star clusters]</i></p>									
Template	Module		Subarray			Target Placement				
	ALL		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type		Dither Size	Subpixel Positions		
	1	FULLBOX		8NIRSPEC	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	F115W	F277W	BRIGHT1	5	1	8	8	773.047	
Special Requirements	<p>Group Visits within 53.0 Days Visits Same PA Guide Star in Guider 2</p>									

Proposal 6154 - Observation 3 - Enabling accurate velocities for science with the NIRSpec MSA: simultaneous wavelength and LSF c...

Tue May 27 13:00:19 GMT 2025

Observation	<p>Proposal 6154, Observation 3: Omega Cen</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec MultiObject Spectroscopy</p>										
Diagnostics	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous		
	(12)	OCen_APT_merged_ref1_v5	RA: 13 26 58.7753 (201.7448971d) Dec: -47 28 50.23 (-47.48062d) Equinox: J2000								
	<i>Comments:</i> 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: F110W; Readout: NRSRAPID; 8 sources in 3 quads; [Optimal TA Accuracy]	SAME	F110W	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
Template	TA Method	HFF Readout Mode	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold			
	MSATA	false	No	MSA Center	hv5 (474 sources)	lv5 (4676 sources)	jwst-nirspec-hr	1.5			
Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
	1	9012	201.592044	-47.606005	19.938	1	9032	201.582044	-47.598675	19.985	
	1	9015	201.547563	-47.616974	19.9062	1	9038	201.562507	-47.599901	19.832	
	1	9016	201.545324	-47.616933	19.8528	1	9044	201.514509	-47.606429	19.895	
	1	9022	201.517903	-47.619696	19.9405	1	9058	201.533969	-47.582570	19.9105	

Proposal 6154 - Observation 3 - Enabling accurate velocities for science with the NIRSpec MSA: simultaneous wavelength and LSF c...

	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
Spectral Elements	1	5 (G395H/F290LP)	c1_mod2	3 Shutter Slitlet	201.54838533333 336 Degrees - 47.587239722222 19 Degrees	256.05169244428 214			3	6	1838.2
	2	6 (G395M/F290LP)	c1_mod2	3 Shutter Slitlet	201.54838533333 336 Degrees - 47.587239722222 19 Degrees	256.05169244428 214			3	6	1400.533
	3	1 (G140H/F100LP)	c1_mod2	3 Shutter Slitlet	201.54838533333 336 Degrees - 47.587239722222 19 Degrees	256.05169244428 214			3	6	962.867
	4	2 (G140M/F100LP)	c1_mod2	3 Shutter Slitlet	201.54838533333 336 Degrees - 47.587239722222 19 Degrees	256.05169244428 214			3	6	525.2
	5	3 (G235H/F170LP)	c1_mod2	3 Shutter Slitlet	201.54838533333 336 Degrees - 47.587239722222 19 Degrees	256.05169244428 214			3	6	1400.533
	6	4 (G235M/F170LP)	c1_mod2	3 Shutter Slitlet	201.54838533333 336 Degrees - 47.587239722222 19 Degrees	256.05169244428 214			3	9	1181.7
Special Requirements	MSA Scheduled Aperture PA 255.9065 to 255.9065 Degrees (V3 117.33192 to 117.33192)										