



## 7033 - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

Cycle: 4, 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>
Observation Folder				
	1		NIRCam Imaging	(1) NGC-1275
	2		NIRCam Imaging	(1) NGC-1275
	3	NewPlanBg_4_Stel_fl2	NIRSpec MultiObject Spectroscopy	(7) new_coords_bg_wts_stel_rand2

## ABSTRACT

We propose multi-filter NIRCam imaging and NIRSpec/MOS observations of the Perseus cluster of galaxies. Perseus is the archetype for radio-mode feedback and has been considered the best laboratory for understanding the complex interactions between radio jets and the hot X-ray-emitting intracluster medium for decades. It contains a spectacular nebula of multiphase gas that spans the inner 100 kpc. The most important and unanswered question about this multiphase gas is its unknown origin. Here, we target the fine structures and subtleties in dust emission within this multiphase gas, aiming to achieve the first in-depth mapping of the dust in any cluster core. NIRSpec/MOS will also, for the first time, map the 1000–4000 K phase for the entire nebula, the last phase without spectroscopic data. By leveraging the JWST’s unique capabilities and drawing on extensive multiwavelength observations from Chandra, Hitomi, ALMA, JVLA, HST, Herschel, Spitzer, CFHT, and others, we aim to deliver an unprecedented, in-depth analysis of all gas phases in Perseus and decipher the origin of the dust and multiphase gas in cluster cores. In just 12.4 hours, this study will therefore significantly enhance our understanding of how black hole radio jets shape and influence their surrounding gas environments.

## OBSERVING DESCRIPTION

We request NIRCAM imaging of the filamentary nebula in the Perseus cluster of galaxies, centered on NGC 1275, with the F335M/F300M/F360M filters. These will be observed with the long wavelength channel. The F335M will probe the strong 3.28 micron PAH emission feature. The F300M

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and F360M filters will be used to remove the stellar continuum. Combined, these will provide the first detailed view of the dust in the multiphase gas of Perseus.

Simultaneously, using the short wavelength channel, we will image the cluster with the F162M, F150W and F182M filters. F162M will target the [Fe II] emission. F182M will image the Pa-alpha emission, probing the 2000 K gas phase. The F150W filter will be used to remove the stellar continuum.

We split the observations into 2 visits to not exceed the data limit.

NIRCAM's field of view is also perfectly suited to the extent of the nebula (~2.2 by 2.2 arcmin). Module B will be used to image the target. As one of the out of field impact goals, Module A will be pointed outside of NGC 1275 to maximise globular cluster coverage. We use the 4-point INTRAMODULEBOX dithering pattern as suggested by the JWST documentation for extended sources.

We also request NIRSpec/MOS observation of 52 selected regions in the filamentary nebula in the Perseus cluster of galaxies. The grating and filter combination of G235H/F170LP will be used to observe 1.66 to 3.05 micron where we aim to detect molecular and vibro-rotational emission lines from hydrogen with ~100 km/s resolution. We will use a 3-shutter slitlet for each source, coupled with a 3-position nod pattern and a 2-point Fixed Dither to mitigate detector effects and to improve spatial and spectral sampling. The observation contains 2 MSA configurations generated from the MSA Planning Tool.

Finally, we included coordinated parallel observation using NIRCAM with NIRSpec MOS as the primary. We will use F300M, F360M, F150W, and F182M filters for long wavelength and short wavelength channels, respectively. These observations will be used to probe distant globular clusters (~100 kpc from the central galaxy NGC 1275).

With JWST's unmatched sensitivity and spatial resolution, it is the only telescope capable of reaching our scientific goals.

Proposal 7033 - Targets - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous	
<b>Fixed Targets</b>	(1)	NGC-1275	RA: 03 19 48.1608 (49.9506700d) Dec: +41 30 42.12 (41.51170d) Equinox: J2000			
	<i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i> Category=Clusters of Galaxies Description=[Brightest cluster galaxies, Perseus Cluster] Extended=YES					
	(4)	new_coords_bg_and_weights_stel	RA: 03 19 47.2094 (49.9467058d) Dec: +41 30 48.79 (41.51355d) Equinox: J2000			
<i>Comments:</i> Description=[]						
(7)	new_coords_bg_wts_stel_rand 2	RA: 03 19 47.3928 (49.9474700d) Dec: +41 30 46.95 (41.51304d) Equinox: J2000				
<i>Comments:</i> Description=[]						

# Proposal 7033 - Observation 1 - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

Thu Dec 18 18:00:36 GMT 2025

<b>Observation</b>	<p><b>Proposal 7033, Observation 1</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCcam Imaging</p>									
<b>Diagnostics</b>	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>		<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(1)	NGC-1275	RA: 03 19 48.1608 (49.9506700d) Dec: +41 30 42.12 (41.51170d) Equinox: J2000							
	<p><i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i></p> <p><i>Category=Clusters of Galaxies</i></p> <p><i>Description=[Brightest cluster galaxies, Perseus Cluster]</i></p> <p><i>Extended=YES</i></p>									
<b>Template</b>	<b>Module</b>		<b>Subarray</b>			<b>Target Placement</b>				
	ALL		FULL			Module B center (small extended source)				
<b>Dithers</b>	<b>#</b>	<b>Primary Dither Type</b>		<b>Primary Dithers</b>	<b>Subpixel Dither Type</b>		<b>Dither Size</b>	<b>Subpixel Positions</b>		
	1	INTRAMODULEBOX		4	STANDARD			1		
<b>Spectral Elements</b>	<b>#</b>	<b>Short Filter</b>	<b>Long Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Dithers</b>	<b>Total Exposure Time</b>	<b>Optional ETC ID</b>
	1	F162M+F150W2	F335M	SHALLOW4	8	1	4	4	1674.936	171717
	2	F150W	F300M	SHALLOW4	7	1	4	4	1460.201	171717
<b>Special Requirements</b>	<p>Aperture PA Range 0 to 80 Degrees (V3 359.94737309 to 79.94737309)</p> <p>Aperture PA Range 83 to 216 Degrees (V3 82.94737309 to 215.94737309)</p> <p>Aperture PA Range 226 to 359 Degrees (V3 225.94737309 to 358.94737309)</p> <p>Fiducial Point Override NRCBS_FULL</p>									

# Proposal 7033 - Observation 2 - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

Thu Dec 18 18:00:36 GMT 2025

<b>Observation</b>	<p><b>Proposal 7033, Observation 2</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCcam Imaging</p>									
<b>Diagnostics</b>	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>		<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(1)	NGC-1275	RA: 03 19 48.1608 (49.9506700d) Dec: +41 30 42.12 (41.51170d) Equinox: J2000							
	<p><i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i></p> <p><i>Category=Clusters of Galaxies</i></p> <p><i>Description=[Brightest cluster galaxies, Perseus Cluster]</i></p> <p><i>Extended=YES</i></p>									
<b>Template</b>	<b>Module</b>		<b>Subarray</b>			<b>Target Placement</b>				
	ALL		FULL			Module B center (small extended source)				
<b>Dithers</b>	<b>#</b>	<b>Primary Dither Type</b>		<b>Primary Dithers</b>	<b>Subpixel Dither Type</b>		<b>Dither Size</b>	<b>Subpixel Positions</b>		
	1	INTRAMODULEBOX		4	STANDARD			1		
<b>Spectral Elements</b>	<b>#</b>	<b>Short Filter</b>	<b>Long Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Dithers</b>	<b>Total Exposure Time</b>	<b>Optional ETC ID</b>
	1	F182M	F360M	SHALLOW4	8	1	4	4	1674.936	
<b>Special Requirements</b>	<p>Aperture PA Range 0 to 217 Degrees (V3 359.94737309 to 216.94737309)</p> <p>Aperture PA Range 226 to 359 Degrees (V3 225.94737309 to 358.94737309)</p> <p>Fiducial Point Override NRCBS_FULLL</p>									

# Proposal 7033 - Observation 3 - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

Thu Dec 18 18:00:36 GMT 2025

<b>Observation</b>	<b>Proposal 7033, Observation 3: NewPlanBg_4_Stel_fl2</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec MultiObject Spectroscopy Coordinated Parallel Template(s): NIRCam Imaging								
	(NewPlanBg_4_Stel_fl2 (Obs 3)) Warning (Form): Verification imaging with an ALLOPEN MSA configuration may cause persistence from bright sources in the field of view. (Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 3:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.								
<b>Diagnosics</b>									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(7)	new_coords_bg_wts_stel_rand 2	RA: 03 19 47.3928 (49.9474700d) Dec: +41 30 46.95 (41.51304d) Equinox: J2000						
<i>Comments:</i> Description=[]									
<b>Template</b>	<b>NIRSpec MultiObject Spectroscopy</b>				<b>NIRCam Imaging</b>				
	TA Method: VERIFY_ONLY HFF Readout Mode: false Obtain Confirmation Images: No Science Aperture: MSA Center Primary Candidate List: primary (322 sources) Filler Candidate List: filler (74 sources) Spectral Overlap Map: jwst-nirspec-g235h Spectral Overlap Threshold: 1.5				Module: ALL Subarray: FULL				
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>							
	1	NONE							
<b>Pointing Verification</b>	<b>NIRSpec MultiObject Spectroscopy</b>	<b>PV MSA Configuration</b>	<b>Filter</b>	<b>PV Readout Pattern</b>	<b>PV Groups/Int</b>	<b>PV Integrations/Exp</b>	<b>PV Total Dithers</b>	<b>PV Total Integrations</b>	<b>PV Total Exposure Time</b>
	1	ALLOPEN	F140X	NRSIRS2	6	1	1	1	452.256

Proposal 7033 - Observation 3 - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

	NIRSpec MultiObject Spectroscopy	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	1 (G235H/F170LP)	c1		49.951657125 Degrees 41.495589722222 22 Degrees	219.14408113804 768			1	2	1779.845
	2	1 (G235H/F170LP)	c1		49.951657125 Degrees 41.495589722222 22 Degrees	219.14408113804 768			1	2	1779.845
	3	1 (G235H/F170LP)	c2		49.951887875 Degrees 41.495448888888 89 Degrees	219.14423441731 253			1	2	1779.845
	4	1 (G235H/F170LP)	c2		49.951887875 Degrees 41.495448888888 89 Degrees	219.14423441731 253			1	2	1779.845
	5	1 (G235H/F170LP)	c3		49.952118583333 33 Degrees 41.495308333333 334 Degrees	219.14438766840 078			1	2	1779.845
	6	1 (G235H/F170LP)	c3		49.952118583333 33 Degrees 41.495308333333 334 Degrees	219.14438766840 078			1	2	1779.845
	7	1 (G235H/F170LP)	c4		49.955409708333 33 Degrees 41.520164444444 45 Degrees	219.14651935943 215			1	2	1779.845
	8	1 (G235H/F170LP)	c4		49.955409708333 33 Degrees 41.520164444444 45 Degrees	219.14651935943 215			1	2	1779.845
	9	1 (G235H/F170LP)	c5		49.9556405 Degrees 41.520023611111 11 Degrees	219.14667267921 89			1	2	1779.845
	10	1 (G235H/F170LP)	c5		49.9556405 Degrees 41.520023611111 11 Degrees	219.14667267921 89			1	2	1779.845
	11	1 (G235H/F170LP)	c6		49.955871291666 66 Degrees 41.519882777777 774 Degrees	219.14682599901 04			1	2	1779.845
	12	1 (G235H/F170LP)	c6		49.955871291666 66 Degrees 41.519882777777 774 Degrees	219.14682599901 04			1	2	1779.845

Proposal 7033 - Observation 3 - Mapping the Dust and Multiphase Gas in the Perseus Cluster of Galaxies

	NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	Optional ETC ID
<b>Spectral Elements</b>	1	F182M	F360M	MEDIUM8	8	2	2	1	1685.673	
	2	F150W	F300M	MEDIUM8	8	2	2	1	1685.673	
	3	F182M	F360M	MEDIUM8	8	2	2	1	1685.673	
	4	F150W	F300M	MEDIUM8	8	2	2	1	1685.673	
	5	F182M	F360M	MEDIUM8	8	2	2	1	1685.673	
	6	F150W	F300M	MEDIUM8	8	2	2	1	1685.673	
	7	F182M	F360M	MEDIUM8	8	2	2	1	1685.673	
	8	F150W	F300M	MEDIUM8	8	2	2	1	1685.673	
	9	F182M	F360M	MEDIUM8	8	2	2	1	1685.673	
	10	F150W	F300M	MEDIUM8	8	2	2	1	1685.673	
	11	F182M	F360M	MEDIUM8	8	2	2	1	1685.673	
	12	F150W	F300M	MEDIUM8	8	2	2	1	1685.673	
<b>Special Requirements</b>	Group Visits within 53.0 Days Visits Same PA No Parallel Attachments MSA Scheduled Aperture PA 219.1413 to 219.1413 Degrees (V3 80.5667 to 80.5667)									