



# 1939 - The Galactic Center

Cycle: 1, Proposal Category: GO

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Jessica Ryan Lu (PI)</b>	<b>University of California - Berkeley</b>	<b>jlu.astro@berkeley.edu</b>
Dr. Tuan Do (CoI)	University of California - Los Angeles	tdo@astro.ucla.edu
Dr. Andrea M. Ghez (CoI)	University of California - Los Angeles	ghez@astro.ucla.edu
Dr. Anna Ciurlo (CoI)	University of California - Los Angeles	ciurlo@astro.ucla.edu
Dr. Mark R. Morris (CoI)	University of California - Los Angeles	morris@astro.ucla.edu
Prof. Smadar Naoz (CoI)	University of California - Los Angeles	snaoz@astro.ucla.edu
Dr. Rainer Schoedel (CoI) (ESA Member)	Instituto de Astrofísica de Andalucía (IAA)	rainer@iaa.es
Dr. Devin Chu (CoI)	University of California - Los Angeles	dchu@astro.ucla.edu
Dr. Abhimat Krishna Gautam (CoI)	University of California - Los Angeles	abhimat@astro.ucla.edu
Dr. Matthew Hosek Jr. (CoI)	University of California - Los Angeles	mwhosek@gmail.com
Dr. Zhuo Chen (CoI)	University of Washington	zczhuo@uw.edu
William Blake Drechsler (CoI)	The University of Virginia	khj5gf@virginia.edu
Ruoyi Yin (CoI)	University of California - Berkeley	ruoyiyin_2022@berkeley.edu

## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	Images	NIRCam Imaging	(1) GALCEN
	2	Spectra	NIRSpec IFU Spectroscopy	(1) GALCEN
	12	Spectra Repeat of Observation 2	NIRSpec IFU Spectroscopy	(1) GALCEN
	3	Images	NIRCam Imaging	(1) GALCEN
	4	Images	NIRCam Imaging	(1) GALCEN

## **ABSTRACT**

Studies of the Galactic Center routinely deliver breakthrough discoveries. However, our picture is far from complete. Webb is uniquely poised to answer a number of remaining questions including: (1) How do stars form so close to the super-massive black hole (SMBH) and do they have an unusual initial mass function? (2) Are the old stars missing or have they been tidally stripped, making them faint and hard to detect? (3) How are binary systems, including those with compact objects, created, destroyed, and merged around a SMBH? and (4) Is there a cusp of dark matter and stellar mass black holes around the SMBH? To address these questions, we require a thorough and accurate census of the different populations of stars within the nuclear star cluster, including spectral types and 3D kinematics. We propose to obtain NIRCcam imaging of the central 2' (4.8 pc) and NIRSspec IFU spectroscopy of the central 9" (0.36 pc) in order to study the nuclear star cluster and its co-evolution with the SMBH.

## **OBSERVING DESCRIPTION**

We propose to obtain NIRCcam imaging of the central 2' (4.8 pc) and NIRSspec IFU spectroscopy of the central 9" (0.36 pc) of our Galaxy in order to study the nuclear star cluster and its co-evolution with the supermassive black hole.

The NIRCcam imaging includes 4 filters (F115W, F212N, F323N, F405N) to provide deep, precise photometry used for distinguishing young and old stars, constructing precise reddening maps and reddening laws, and measuring the structure, IMF, and star formation history of the old and young nuclear star clusters. The F212N images will be repeated 3 times over cycle 1 to measure proper motions for stars down to  $K=20$  at better than 0.5 mas/yr (20 km/s). The astrometry will be used to measure the positions, proper motions, accelerations, and orbits of stars around the supermassive black hole and to measure the astrometric wobble of stars in binary systems. The three epochs of F212N imaging should be spread over cycle 1.

The NIRSspec IFU spectroscopy uses the higher-resolution G235H grating in the F170LP filter to obtain spectra from 1.6 - 3.3 microns for a 3x3 mosaic at the Galactic Center. The spectra will be used to precisely identify young and old stars and measure their radial velocities and metallicities. These observations will be used to construct the IMF for different dynamical sub-groups, to confirm binary candidates identified from astrometry, and measure the structure, dynamics, and metallicity distribution of the nuclear star cluster.

## Proposal 1939 - Targets - The Galactic Center

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000  <i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Stellar Cluster</i> <i>Description=[Stellar associations, Young star clusters]</i> <i>Extended=YES</i>	Epoch of Position: 2015.5	

# Proposal 1939 - Observation 1 - The Galactic Center

Fri Feb 03 21:01:02 GMT 2023

<b>Observation</b>	<p><b>Proposal 1939, Observation 1: Images</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCcam Imaging</p> <p><i>Comments: Offset requirement will need to be changed when PA of observation is known.</i></p>									
<b>Diagnostics</b>	<p>(Visit 1:1) Warning (Form): Data Excess over lower threshold</p> <p>(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>		<b>Miscellaneous</b>		
	(1)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000			Epoch of Position: 2015.5				
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Stellar Cluster</i></p> <p><i>Description=[Stellar associations, Young star clusters]</i></p> <p><i>Extended=YES</i></p>									
<b>Template</b>	<b>Module</b>					<b>Subarray</b>				
	ALL					FULL				
<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			3		
<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>ETC Wkbk.Calc ID</b>
	1	F115W	F323N+F322W2	BRIGHT2	5	2	24	12	2705.666	
	2	F212N	F405N+F444W	BRIGHT2	5	1	12	12	1288.412	
<b>Special Requirements</b>	<p>Aperture PA Range 86.8 to 95.90063957 Degrees (V3 86.8713531 to 95.97199267)</p> <p>Offset 70.0 arcsec, 17.0 arcsec</p> <p>3 After 1 by 60 Days to &lt;None specified&gt;</p>									

Proposal 1939 - Observation 2 - The Galactic Center

Fri Feb 03 21:01:02 GMT 2023

<b>Observation</b>	<b>Proposal 1939, Observation 2: Spectra</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec IFU Spectroscopy											
<b>Diagnostics</b>	(Visit 2:1) Warning (Form): Data Excess over middle threshold (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)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000			Epoch of Position: 2015.5						
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Stellar Cluster</i> <i>Description=[Stellar associations, Young star clusters]</i> <i>Extended=YES</i>											
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Mosaic</b>	<b>Rows</b>	<b>Columns</b>	<b>Row Overlap %</b>	<b>Column Overlap %</b>	<b>Row shift</b>	<b>Column shift</b>	<b>Tile Order</b>					
	3	3	3.0	3.0	0.0	0.0	DEFAULT					
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>	<b>Size</b>	<b>Starting Point</b>	<b>Number of Points</b>	<b>Points</b>						
	1	NONE										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235H/F170LP	NRSRAPID	25	9	false	false	NONE	1	9	2512.404	
	2	G235H/F170LP	NRSRAPID	25	3	true	false	NONE	1	3	837.468	

# Proposal 1939 - Observation 12 - The Galactic Center

<b>Observation</b>	<b>Proposal 1939, Observation 12: Spectra Repeat of Observation 2</b> <span style="float: right;">Fri Feb 03 21:01:02 GMT 2023</span> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec IFU Spectroscopy											
	(Visit 12:1) Warning (Form): Data Excess over middle threshold (Visit 12:1) 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)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000			Epoch of Position: 2015.5						
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Stellar Cluster</i> <i>Description=[Stellar associations, Young star clusters]</i> <i>Extended=YES</i>												
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Mosaic</b>	<b>Rows</b>	<b>Columns</b>	<b>Row Overlap %</b>	<b>Column Overlap %</b>	<b>Row shift</b>	<b>Column shift</b>	<b>Tile Order</b>					
	3	3	3.0	3.0	0.0	0.0	DEFAULT					
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>	<b>Size</b>	<b>Starting Point</b>	<b>Number of Points</b>	<b>Points</b>						
	1	NONE										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235H/F170LP	NRSRAPID	25	9	false	false	NONE	1	9	2512.404	
	2	G235H/F170LP	NRSRAPID	25	3	true	false	NONE	1	3	837.468	

Proposal 1939 - Observation 3 - The Galactic Center

Fri Feb 03 21:01:02 GMT 2023

<b>Observation</b>	<p><b>Proposal 1939, Observation 3: Images</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCcam Imaging</p> <p><i>Comments: Offset requirement will need to be changed when PA of observation is known. Note, PA of Image (Obs 3) should be equal to or flipped by 180 of PA (Obs 2) in order to produce multi-epoch astrometry over a maximal field of view. Changes of ~3 degrees in PA off of this requirement is fine. This requirement is not easily enterable when we don't know the PA of the first epoch. We will enter the PA constraints once the observing schedule is known.</i></p>									
	<p>(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p> <p>(Visit 3:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.</p>									
<b>Diagnosics</b>										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>		<b>Miscellaneous</b>		
	(1)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000			Epoch of Position: 2015.5				
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Stellar Cluster</i></p> <p><i>Description=[Stellar associations, Young star clusters]</i></p> <p><i>Extended=YES</i></p>										
<b>Template</b>	<b>Module</b>					<b>Subarray</b>				
	ALL					FULL				
<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			3		
<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>ETC Wkbk.Calc ID</b>
	1	F212N	F405N+F444W	BRIGHT2	5	1	12	12	1288.412	
<b>Special Requirements</b>	Aperture PA Range 266.9286469 to 281.9286469 Degrees (V3 267.0 to 282.0) Offset 70.0 arcsec, 17.0 arcsec									
	3 After 1 by 60 Days to <None specified> 4 After 3 by 60 Days to <None specified>									

# Proposal 1939 - Observation 4 - The Galactic Center

<b>Observation</b>	<b>Proposal 1939, Observation 4: Images</b> <span style="float: right;">Fri Feb 03 21:01:02 GMT 2023</span> <b>Diagnostic Status: Warning</b> Observing Template: NIRCcam Imaging <i>Comments: Offset requirement will need to be changed when PA of observation is known. Note, PA of Image (Obs 3) should be equal to or flipped by 180 of PA (Obs 2) in order to produce multi-epoch astrometry over a maximal field of view. Changes of ~3 degrees in PA off of this requirement is fine. This requirement is not easily enterable when we don't know the PA of the first epoch. We will enter the PA constraints once the observing schedule is known.</i>																													
	(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.																													
<b>Diagnosics</b>																														
<b>Fixed Targets</b>	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>GALCEN</td> <td>RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000</td> <td>Epoch of Position: 2015.5</td> <td></td> </tr> </tbody> </table>	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous	(1)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000	Epoch of Position: 2015.5		<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.                  Category=Stellar Cluster                  Description=[Stellar associations, Young star clusters]                  Extended=YES</i>																		
	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous																									
(1)	GALCEN	RA: 17 45 40.0410 (266.4168375d) Dec: -29 00 28.12 (-29.00781d) Equinox: J2000	Epoch of Position: 2015.5																											
<b>Template</b>	<b>Module</b>					<b>Subarray</b>																								
	ALL					FULL																								
<b>Dithers</b>	<table border="1"> <thead> <tr> <th>#</th> <th>Primary Dither Type</th> <th>Primary Dithers</th> <th>Subpixel Dither Type</th> <th>Dither Size</th> <th>Subpixel Positions</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>INTRAMODULEBOX</td> <td>4</td> <td>STANDARD</td> <td></td> <td>3</td> </tr> </tbody> </table>	#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions	1	INTRAMODULEBOX	4	STANDARD		3																	
	#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions																								
1	INTRAMODULEBOX	4	STANDARD		3																									
<b>Spectral Elements</b>	<table border="1"> <thead> <tr> <th>#</th> <th>Short Filter</th> <th>Long Filter</th> <th>Readout Pattern</th> <th>Groups/Int</th> <th>Integrations/Exp</th> <th>Total Integrations</th> <th>Total Dithers</th> <th>Total Exposure Time</th> <th>ETC Wkbk.Calc ID</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>F212N</td> <td>F405N+F444W</td> <td>BRIGHT2</td> <td>5</td> <td>1</td> <td>12</td> <td>12</td> <td>1288.412</td> <td></td> </tr> </tbody> </table>	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID	1	F212N	F405N+F444W	BRIGHT2	5	1	12	12	1288.412										
	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID																				
1	F212N	F405N+F444W	BRIGHT2	5	1	12	12	1288.412																						
<b>Special Requirements</b>	Aperture PA Range 78.9286469 to 95.9286469 Degrees (V3 79.0 to 96.0) Offset 70.0 arcsec, 17.0 arcsec  4 After 3 by 60 Days to <None specified>																													