



# 5557 - Deep imaging for the ring-shaping planet in orbit around Fomalhaut

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 Imaging	(1) -ALF-PSA
	2		NIRCam Imaging	(1) -ALF-PSA

## ABSTRACT

Fomalhaut hosts a well studied circumstellar disk, consisting of several rings that are thought to be separated and shaped by a system of planets in orbit around the central star. The widest of the rings is most intensively studied, and its sharp edges and eccentric shape are considered as particularly strong indicators of being sculpted by a planet. A visible-light point source (Fomalhaut b) detected with HST was originally thought to correspond to this planet, but follow-up studies concluded that this point source was on a ring-crossing orbit, and therefore could not correspond to the ring-shaping planet. The planet therefore remains undetected, but it has a predictable brightness and location, based on its impact on its surroundings. JWST images have recently been acquired of Fomalhaut, but are not deep enough to detect the predicted brightness of the planet. Here, we propose an imaging campaign of Fomalhaut designed specifically for reaching the necessary sensitivity to detect the planet. A detection would provide the first direct images of a sub-Saturn-mass planet, and the presence or absence of such a planet would in either case shed light on the nature of the mysterious Fomalhaut b visible-light source. The observations would also serve as an instrument- and strategy demonstrator for high-contrast

imaging deep into the PSF wings of a bright star, which has never been probed before to any comparable depth, and which is necessary to detect the coldest and smallest planets that are within the sensitivity range of JWST.

## **OBSERVING DESCRIPTION**

The observations consist of a deep set of imaging sequences close to the bright star Fomalhaut, with a few special considerations to account for the large brightness of the star, and the very much fainter brightness of the planet we aim to detect.

Despite the high-contrast nature of the observations, they will not use a coronagraph. This is necessary since the sensitivity limit of the coronagraph is simply not compatible with the expected faintness of the planet, and is possible since, thanks to the close proximity of the Fomalhaut system to us, the angular separation between the star and expected planet is very large ( $>13$  arcsec).

In order to prevent extreme saturation at the PSF core, which is associated with worries about long-term memory effects on the detector based on consultations with JWST technical staff, the star itself will be offset to slightly outside the detector, in such a way that the field of view is placed on the side of the star where the planet is expected to reside.

Observations will be acquired in two sequences separated by a  $\sim 10$  deg rotation of the telescope, in order to allow for characterization and subtraction of the stellar PSF wings through an Angular Differential Imaging (ADI)-based scheme. Due to the large star-planet separation, self-subtraction effects normally associated with ADI will be entirely negligible in this context. Since the center of the stellar PSF is outside of the field of view, other PSF features (diffraction spiders, etc) will be used for registering the PSF locations in the different imaging sequences. In order to prevent overlap between the expected planet position and the diffraction spikes at any point, we have imposed an absolute aperture PA constraint which avoids the days in which such an overlap would have occurred.

The observations use dual-band imaging, with the F200W filter in the short band and the F444W filter on the long band. A five-point standard dithering pattern will be applied to each of the two sequences, and the SHALLOW4 readout setting with 10 groups/int is used since this offers the best trade-off between imaging depth and avoiding excessive saturation, as provided by ETC calculations.

Proposal 5557 - Targets - Deep imaging for the ring-shaping planet in orbit around Fomalhaut

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	-ALF-PSA	RA: 22 57 39.4373 (344.4143221d)	Proper Motion RA: 0.025227280068212916 sec of time/yr	
		Dec: -29 37 22.61 (-29.62295d)	Proper Motion Dec: -0.16467000000375265 arcsec/yr		
		Equinox: J2000	Epoch of Position: 2015.5		
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>				
	Category=Star				
	Description=[A stars]				

Proposal 5557 - Observation 1 - Deep imaging for the ring-shaping planet in orbit around Fomalhaut

Fri Mar 01 03:02:29 GMT 2024

<b>Observation</b>	<p><b>Proposal 5557, Observation 1</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCam Imaging</p>									
<b>Diagnostics</b>	<p>(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p> <p>(Observation 1) Informational (Form): The Visit Planner and Spike may produce different schedulability results.</p>									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>		<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(1)	-ALF-PSA	RA: 22 57 39.4373 (344.4143221d) Dec: -29 37 22.61 (-29.62295d) Equinox: J2000		Proper Motion RA: 0.025227280068212916 sec of time/yr Proper Motion Dec: -0.16467000000375265 arcsec/yr Epoch of Position: 2015.5					
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p>Category=Star Description=[A stars]</p>									
<b>Template</b>	<b>Module</b>		<b>Subarray</b>			<b>Target Placement</b>				
	B		FULL			Module Gap				
<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	NONE				STANDARD				5
<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	F200W	F444W	SHALLOW4	10	1	5	5	2630.509	
<b>Special Requirements</b>	<p>Aperture PA Range 45 to 65 Degrees (V3 44.94737309 to 64.94737309) Offset -60.0 arcsec, 4.0 arcsec</p> <p>Group Observations 1, 2, Non-interruptible Aperture PA Offset 1 from 2 by 9 to 10 Degrees (Same offsets in V3)</p>									

Proposal 5557 - Observation 2 - Deep imaging for the ring-shaping planet in orbit around Fomalhaut

Fri Mar 01 03:02:29 GMT 2024

<b>Observation</b>	<p><b>Proposal 5557, Observation 2</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCam Imaging</p>									
<b>Diagnostics</b>	<p>(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p> <p>(Observation 2) Informational (Form): The Visit Planner and Spike may produce different schedulability results.</p>									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>		<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(1)	-ALF-PSA	RA: 22 57 39.4373 (344.4143221d) Dec: -29 37 22.61 (-29.62295d) Equinox: J2000		Proper Motion RA: 0.025227280068212916 sec of time/yr Proper Motion Dec: -0.16467000000375265 arcsec/yr 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=Star</i></p> <p><i>Description=[A stars]</i></p>									
<b>Template</b>	<b>Module</b>		<b>Subarray</b>			<b>Target Placement</b>				
	B		FULL			Module Gap				
<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	NONE				STANDARD				5
<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	F200W	F444W	SHALLOW4	10	1	5	5	2630.509	
<b>Special Requirements</b>	<p>Aperture PA Range 45 to 65 Degrees (V3 44.94737309 to 64.94737309) Offset -60.0 arcsec, 4.0 arcsec</p> <p>Group Observations 1, 2, Non-interruptible Aperture PA Offset 1 from 2 by 9 to 10 Degrees (Same offsets in V3)</p>									