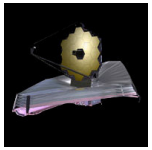

1349 - Establishing Extreme Dynamic Range with JWST: Decoding Smoke Signals in the Glare of a Wolf-Rayet Binary

Cycle: 1, Proposal Category: ERS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
WR 140 - MRS				
	1	WR 140 Offset 1	MIRI Medium Resolution Spectroscopy	(2) WR140-OFFSET-1
	10	WR 140 Offset 2	MIRI Medium Resolution Spectroscopy	(3) WR140-OFFSET-2
	2	WR 140 MRS CAL	MIRI Medium Resolution Spectroscopy	(4) WR140MRSCAL
WR 140 - MIRI Imager				
	8	WR 140 - MIRI Imager	MIRI Imaging	(1) WR140
WR 137 - AMI				
	3	WR 137 AMI Dither	NIRISS Aperture Masking Interferometry	(5) WR137
	4	WR 137 AMI PSF REF Dither	NIRISS Aperture Masking Interferometry	(6) WR137AMIREFPSF

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
	5	WR 137 AMI PSF REF Stare	NIRISS Aperture Masking Interferometry	(6) WR137AMIREFPSF
	6	WR 137 AMI Stare	NIRISS Aperture Masking Interferometry	(5) WR137

ABSTRACT

Dust is a key ingredient in the formation of stars and planets. However, the dominant channels of dust production throughout cosmic time are still unclear. With its unprecedented sensitivity and spatial resolution in the mid-IR, the James Webb Space Telescope (JWST) is the ideal platform to address this issue by investigating the dust abundance, composition, and production rates of various dusty sources. In particular, colliding-wind Wolf-Rayet (WR) binaries are efficient dust producers in the local Universe, and likely existed in the earliest galaxies. We purpose JWST observations of the colliding-wind binaries WR 140 and WR 137 to investigate dust composition, abundance, and formation mechanisms in this dust-forming colliding-wind process. We will utilize three key JWST observing modes with the medium-resolution spectrometer (MRS) and imager on the Mid-Infrared Instrument (MIRI) and the Aperture Masking Interferometry (AMI) mode with the Near Infrared Imager and Slitless Spectrograph (NIRISS).

Our proposed observations will yield high impact scientific results on the dust forming properties WR binaries, and establish a benchmark for key observing modes for imaging bright sources with faint extended emission. This will be valuable in various astrophysical contexts including mass-loss from evolved stars, dusty tori around active galactic nuclei, and protoplanetary disks. We are committed to designing and delivering science-enabling products for the JWST community that address technical issues such as bright source artifacts that will limit the maximum achievable image contrast.

(NoI Ref. #180)

OBSERVING DESCRIPTION

We will perform a total of 15.9 hours of MIRI MRS and Imager observations of the dust-forming Wolf-Rayet (WR) binary WR 140 and NIRISS/AMI observations of the dust-forming WR binary WR 137. These observations include two calibrators for each instrument mode: HD 193090 and HD 228337.

In the MIRI MRS mode, we will obtain the full 5 - 28 micron spectral coverage (Ch1 - Ch4) of WR 140 out to 3 fossil dust arcs. We will perform MRS observations at two pointings: one offset from WR 140 by 0.4 arcseconds, and one offset by 2.7 arcseconds to cover the bright regions in the 1st, 2nd, and 3rd fossil dust arcs. Both MRS pointings will utlize the 4-point dither pattern optimzed for extended sources.

We will observe a mid-IR PSF reference star selected from the JMMC stellar diameter catalog (Bourges et al. 2017) with a nearly identical 12 micron flux as WR 140. Comparing the spectra from the reference star and WR 140 will allow us to differentiate the artifacts and the bright source from faint extended emission around WR 140. Importantly, HD 193090 is located within 2 degrees of WR 140, which requires only a ~5 min JWST slew overhead. We will perform the same dither pattern as our central WR 140 pointing but with a shorter exposure time per dither position.

In the MIRI Imager mode, we will perform short, several minute-long exposures with the F1500W, F2100W, and F2550W filters centered on WR 140 using the 4-point dither strategy optimized for extended sources. Although the bright central source of WR 140 and possibly the 1st and 2nd dust arcs will saturate the Imager, we will be able to probe out to 7 or more fossil dust arcs with the Imager sensitivity and field of view in the "FULL" subarray mode.

In the NIRISS/AMI mode, we propose F380M and F480M observations of WR 137 in a 4-point dither and undithered mode. At the anticipated timing of Cycle 1 ERS, WR 137 will be exhibiting enhanced dust-formation due to the orbital confirguration of the central binary system and thus provides an ideal target for NIRISS/AMI to achieve our science and technical goals. The goal of performing the two different observations will be to investigate and attempt to mitigate the NIRISS/AMI persistence effects from bright sources. We will perform dithered and undithered ("stare" mode) with the same on-source exposure time. Both modes have advantages and disadvantages for imaging the faint emission around WR 137. With no dithers, WR 137 will remain in the same position on the detector and persistence will therefore not significantly affect the resulting data. However, bad pixels on the detector cannot be corrected. The 4-point primary dither mode will allow us to remove the bad pixels but persistent images from the bright central source of WR 137 will affect the image reconstruction. One of our goals in this proposal is to determine which method is best suited for performing observations of faint extended emission around bright sources. Additionally, we will investigate how to calibrate for the persistence in the dithered observations. After the last "stare"observation, we will take two short exposure direct images with the F380M and F480M filters.

We will observe a PSF calibrator of similar 3.8 and 4.8 micron flux as the bright central core of WR 137 with NIRISS/AMI in order to characterize the interferometric transfer function and ultimately for the reconstruction of WR 137. Our PSF calibrator, HD 228337, will be observed in the same dither and no-dither observations that we plan for WR 137 with the same exposure depth to compare the persistence effects.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WR140	RA: 20 20 27.9761 (305.1165671d) Dec: +43 51 16.28 (43.85452d) Equinox: J2000		
Comments: This object was generated by the target selector and retrieved from the SIMBAD database. *Category=Star* *Description=[WC stars]* *Extended=YES*				
(2)	WR140-OFFSET-1	RA: 20 20 27.9851 (305.1166046d) Dec: +43 51 15.90 (43.85442d) Equinox: J2000		
Comments: 1st offset pointing *Category=Star* *Description=[WC stars]* *Extended=YES*				
(3)	WR140-OFFSET-2	RA: 20 20 28.0553 (305.1168971d) Dec: +43 51 13.74 (43.85382d) Equinox: J2000		
Comments: 2nd offset pointing *Category=Star* *Description=[WC stars]* *Extended=YES*				
(4)	WR140MRSCAL	RA: 20 16 35.9811 (304.1499212d) Dec: +45 20 20.87 (45.33913d) Equinox: J2000		
Comments: MIRI MRS PSF calibrator for WR140 *K5III Star (W3 = 3.454 mag)* *Category=Calibration* *Description=[Point spread function]* *Extended=NO*				
(5)	WR137	RA: 20 14 31.7632 (303.6323467d) Dec: +36 39 39.51 (36.66098d) Equinox: J2000	Proper Motion RA: -2.2621618417001282E-4 sec of time/yr Proper Motion Dec: -0.005663000001732144 arcsec/yr Epoch of Position: 2015.5	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[WC stars]* *Extended=YES*				
(6)	WR137AMIREFPSF	RA: 20 12 57.8919 (303.2412162d) Dec: +35 45 46.45 (35.76290d) Equinox: J2000	Proper Motion RA: -5.562111937378841E-5 sec of time/yr Proper Motion Dec: -0.004101000013179146 arcsec/yr Epoch of Position: 2015.5	
Comments: W1 = 5.290, W2 = 5.223 *0.952 Degrees from WR137* *Category=Calibration* *Description=[Point spread function]*				

Observation

Proposal 1349, Observation 1: WR 140 Offset 1

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Diagnostics

(WR 140 Offset 1 (Obs 1)) Warning (Form): Imager Filter overlap.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	WR140-OFFSET-1	RA: 20 20 27.9851 (305.1166046d) Dec: +43 51 15.90 (43.85442d) Equinox: J2000		

Comments: 1st offset pointing
Category=Star
Description=[WC stars]
Extended=YES

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 WR140	FND	FAST	4	1	1	11.1	50357.16

Template

Primary Channel	Simultaneous Imaging	Imager Subarray
ALL	YES	FULL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1		IMAGER	F560W	FAST	15	19	1	Dither 1	4	76	3163.546	
1	SHORT(A)	MRSLONG		FAST	15	19	1	Dither 1	4	76	3163.546	
1	SHORT(A)	MRSSHORT		FAST	15	19	1	Dither 1	4	76	3163.546	
2		IMAGER	F1000W	FAST	15	19	1	Dither 1	4	76	3163.546	
2	MEDIUM(B)	MRSLONG		FAST	15	19	1	Dither 1	4	76	3163.546	
2	MEDIUM(B)	MRSSHORT		FAST	15	19	1	Dither 1	4	76	3163.546	
3		IMAGER	F2100W	FAST	15	19	1	Dither 1	4	76	3163.546	
3	LONG(C)	MRSLONG		FAST	15	19	1	Dither 1	4	76	3163.546	
3	LONG(C)	MRSSHORT		FAST	15	19	1	Dither 1	4	76	3163.546	

Special Requirements	Sequence Observations 1, 10, Non-interruptible Same Aperture PA 1, 2

Observation

Proposal 1349, Observation 10: WR 140 Offset 2

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Diagnostics

(WR 140 Offset 2 (Obs 10)) Warning (Form): Imager Filter overlap.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	WR140-OFFSET-2	RA: 20 20 28.0553 (305.1168971d) Dec: +43 51 13.74 (43.85382d) Equinox: J2000		

Comments: 2nd offset pointing
Category=Star
Description=[WC stars]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray
FND	ALL	YES	FULL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1		IMAGER	F560W	FAST	15	19	1	Dither 1	4	76	3163.546	
1	SHORT(A)	MRSLONG		FAST	15	19	1	Dither 1	4	76	3163.546	
1	SHORT(A)	MRSSHORT		FAST	15	19	1	Dither 1	4	76	3163.546	
2		IMAGER	F1000W	FAST	15	19	1	Dither 1	4	76	3163.546	
2	MEDIUM(B)	MRSLONG		FAST	15	19	1	Dither 1	4	76	3163.546	
2	MEDIUM(B)	MRSSHORT		FAST	15	19	1	Dither 1	4	76	3163.546	
3		IMAGER	F2100W	FAST	15	19	1	Dither 1	4	76	3163.546	
3	LONG(C)	MRSLONG		FAST	15	19	1	Dither 1	4	76	3163.546	
3	LONG(C)	MRSSHORT		FAST	15	19	1	Dither 1	4	76	3163.546	

Special Requirements	Sequence Observations 1, 10, Non-interruptible

Observation

Proposal 1349, Observation 2: WR 140 MRS CAL Mon May 24 11:42:48 GMT 2021

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Diagnostics

(WR 140 MRS CAL (Obs 2)) Warning (Form): Imager Filter overlap.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(4)	WR140MRSCAL	RA: 20 16 35.9811 (304.1499212d) Dec: +45 20 20.87 (45.33913d) Equinox: J2000		

Comments: MIRI MRS PSF calibrator for WR140
K5III Star (W3 = 3.454 mag)
Category=Calibration
Description=[Point spread function]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	4 WR140MRSCAL	FND	FAST	4	1	1	11.1	50357.17

Template

Primary Channel	Simultaneous Imaging	Imager Subarray
ALL	YES	FULL

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1		IMAGER	F560W	FAST	15	3	1	Dither 1	4	12	499.507	
1	SHORT(A)	MRSLONG		FAST	15	3	1	Dither 1	4	12	499.507	
1	SHORT(A)	MRSSHORT		FAST	15	3	1	Dither 1	4	12	499.507	
2		IMAGER	F1000W	FAST	15	3	1	Dither 1	4	12	499.507	
2	MEDIUM(B)	MRSLONG		FAST	15	3	1	Dither 1	4	12	499.507	
2	MEDIUM(B)	MRSSHORT		FAST	15	3	1	Dither 1	4	12	499.507	
3		IMAGER	F2100W	FAST	15	3	1	Dither 1	4	12	499.507	
3	LONG(C)	MRSLONG		FAST	15	3	1	Dither 1	4	12	499.507	
3	LONG(C)	MRSSHORT		FAST	15	3	1	Dither 1	4	12	499.507	

Special Requirements	Same Aperture PA 1, 2

Observation

Proposal 1349, Observation 8: WR 140 - MIRI Imager

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: No Diagnostics

Observing Template: MIRI Imaging

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	WR140	RA: 20 20 27.9761 (305.1165671d) Dec: +43 51 16.28 (43.85452d) Equinox: J2000		

Comments: This object was generated by the target selector and retrieved from the SIMBAD database.
Category=Star
Description=[WC stars]
Extended=YES

Template

Subarray
FULL

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	4-Point-Sets				5	3	EXTENDED SOURCE	POSITIVE	DEFAULT

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F1500W	FAST	10	1	1	Dither 1	12	12	333.005	
2	F2100W	FAST	10	1	1	Dither 1	12	12	333.005	
3	F2550W	FAST	10	1	1	Dither 1	12	12	333.005	

Observation

Proposal 1349, Observation 3: WR 137 AMI Dither

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: No Diagnostics

Observing Template: NIRISS Aperture Masking Interferometry

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(5)	WR137	RA: 20 14 31.7632 (303.6323467d) Dec: +36 39 39.51 (36.66098d) Equinox: J2000	Proper Motion RA: -2.2621618417001282E-4 sec of time/yr Proper Motion Dec: -0.005663000001732144 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[WC stars]
Extended=YES

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	AMIBRIGHT	F480M	NISRAPID	5	1	1	0.321	50283.1

Template

Subarray	Direct Image
SUB80	false

Dithers

#	Primary Dithers	Subpixel Positions
1	4	NONE

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F480M	NISRAPID	4	400	4	1600	636.288	50283
2	F380M	NISRAPID	2	680	4	2720	671.296	50283

PSF References

WR 137 AMI PSF REF Dither (Obs 4) (PSF Reference; Filters [F380M, F480M])

Additional Justification: false

Special Requirements	Sequence Observations 3, 4, Non-interruptible

Observation

Proposal 1349, Observation 4: WR 137 AMI PSF REF Dither

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: No Diagnostics

Observing Template: NIRISS Aperture Masking Interferometry

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(6)	WR137AMIREFPSF	RA: 20 12 57.8919 (303.2412162d) Dec: +35 45 46.45 (35.76290d) Equinox: J2000	Proper Motion RA: -5.562111937378841E-5 sec of time/yr Proper Motion Dec: -0.004101000013179146 arcsec/yr Epoch of Position: 2015.5	

Comments: W1 = 5.290, W2 = 5.223
0.952 Degrees from WR137
Category=Calibration
Description=[Point spread function]

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	AMIBRIGHT	F480M	NISRAPID	5	1	1	0.321	50283.6

Template

Subarray	Direct Image
SUB80	false

Dithers

#	Primary Dithers	Subpixel Positions
1	4	NONE

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F480M	NISRAPID	8	225	4	900	629.496	50283
2	F380M	NISRAPID	2	680	4	2720	671.296	50283

PSF References

PSF Reference: true

Special Requirements	Sequence Observations 3, 4, Non-interruptible

Observation

Proposal 1349, Observation 5: WR 137 AMI PSF REF Stare

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: No Diagnostics

Observing Template: NIRISS Aperture Masking Interferometry

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(6)	WR137AMIREFPSF	RA: 20 12 57.8919 (303.2412162d) Dec: +35 45 46.45 (35.76290d) Equinox: J2000	Proper Motion RA: -5.562111937378841E-5 sec of time/yr Proper Motion Dec: -0.004101000013179146 arcsec/yr Epoch of Position: 2015.5	

Comments: W1 = 5.290, W2 = 5.223
0.952 Degrees from WR137
Category=Calibration
Description=[Point spread function]

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	AMIBRIGHT	F480M	NISRAPID	5	1	1	0.321	50283.6

Template

Subarray	Direct Image
SUB80	false

Dithers

#	Primary Dithers	Subpixel Positions
1	NONE	NONE

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F480M	NISRAPID	8	900	1	900	629.496	50283
2	F380M	NISRAPID	2	2720	1	2720	671.296	50283

PSF References

PSF Reference: true

Special Requirements	Sequence Observations 5, 6, Non-interruptible

Observation

Proposal 1349, Observation 6: WR 137 AMI Stare

Mon May 24 11:42:48 GMT 2021

Diagnostic Status: No Diagnostics

Observing Template: NIRISS Aperture Masking Interferometry

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(5)	WR137	RA: 20 14 31.7632 (303.6323467d) Dec: +36 39 39.51 (36.66098d) Equinox: J2000	Proper Motion RA: -2.2621618417001282E-4 sec of time/yr Proper Motion Dec: -0.005663000001732144 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[WC stars]
Extended=YES

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	AMIBRIGHT	F480M	NISRAPID	5	1	1	0.321	50283.1

Template

Subarray	Direct Image
SUB80	true

Dithers

#	Primary Dithers	Subpixel Positions
1	NONE	NONE
2	4	NONE

Direct Image

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F480M	NISRAPID	5	21	4	84	39.742	
2	F380M	NISRAPID	2	40	4	160	39.488	

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F480M	NISRAPID	4	1600	1	1600	636.288	50283
2	F380M	NISRAPID	2	2720	1	2720	671.296	50283

PSF References	WR 137 AMI PSF REF Stare (Obs 5) (PSF Reference; Filters [F380M, F480M]) Additional Justification: false
Special Requirements	Sequence Observations 5, 6, Non-interruptible