



# 2114 - MIR Spectroscopy of Type Ia Supernovae: The Key to Unlocking their Explosions and Element Production

Cycle: 1, 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>
MIRI				
	1	100-200d SNe Ia	MIRI Medium Resolution Spectroscopy	(4) 2022XKQ
	4	400-500d medium	MIRI Medium Resolution Spectroscopy	(3) 2021AEFX
	5	LRS 2021aefx	MIRI Low Resolution Spectroscopy	(3) 2021AEFX

## ABSTRACT

Type Ia Supernovae (SNe Ia) are the thermonuclear explosions of white dwarf stars, which originate from binary star systems and synthesize roughly half of the iron-group elements in the universe. The nature of the progenitors and the explosion mechanism is an open question. Understanding SNe Ia is foundational for: the late stages of stellar evolution, the origins of the elements, and controlling systematic errors related to the use of SNe Ia as cosmological rulers. Observational estimates of the nuclear burning products in SNe Ia probe the progenitor and explosion. JWST provides an entirely new window of opportunity as there are spectral lines with unique information in the MIR. We request 21.1 hours of time to obtain 3 Medium resolution MIRI spectra 100--500d past maximum light for the nearest SNe Ia discovered in 2021-2022. The progenitor and explosion mechanism will be constrained using spectra acquired in three physical regimes: 1) 100-200d which measures radioactive Co and the intermediate mass elements, 2) 200-300d where hard gamma-rays, non-local effects, and the appearance of forbidden lines of neutron rich elements probe the progenitor density, 3) 400-500d where positrons deposit energy locally revealing the radioactive cobalt distribution. One of goals of JWST is to reveal the origin of heavy elements and how they feedback into the universe. The sensitivity and resolution of MIRI produce resolved line profiles, probing the element distribution. MIRI spectra will also show many isolated forbidden lines of isotopes with known wavelengths. The

atomic physics learned will provide insight into many transients to come.

### **OBSERVING DESCRIPTION**

We request ~21.1 hours of time to obtain 3 Medium resolution MIRI spectra of SNe Ia between 100-500d past maximum light. As our targets are not yet known we request non disruptive ToO time. For all phases we will use the medium resolution spectrometer on MIRI, and observe in all sub-bands (A, B & C) and all channels. Our target acquisition images will be taken in F1000W, and we will obtain simultaneous imaging in F770W, F1000W and F1130W. The third MIRI spectra will be split into three observations, one per sub-band, to ensure the data volume limits are not exceeded.

Proposal 2114 - Targets - MIR Spectroscopy of Type Ia Supernovae: The Key to Unlocking their Explosions and Element Production

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(3)	2021AEFX	RA: 04 19 53.4000 (64.9725000d) Dec: -54 56 53.09 (-54.94808d) Equinox: J2000		
	<i>Comments: This is a type Ia supernova in the galaxy NGC 1566</i> <i>Category=Star</i> <i>Description=[Supernovae]</i> <i>Extended=NO</i>				
(4)	2022XKQ	RA: 05 05 23.7110 (76.3487958d) Dec: -11 52 56.05 (-11.88224d) Equinox: J2000			
<i>Comments:</i> <i>Category=Star</i> <i>Description=[Supernovae]</i> <i>Extended=NO</i>					
Generic Targets	#	Name	Criteria	Description	
	(1)	SUPERNOVA1	SN Ia with pre-peak data which exploded within 20Mpc with a LC peak 100 days before May 2022		
	(2)	SUPERNOVA2	SN Ia with pre-peak data which exploded within 20Mpc in spring 2021		

Proposal 2114 - Observation 1 - MIR Spectroscopy of Type Ia Supernovae: The Key to Unlocking their Explosions and Element Produ...

Fri Jan 20 20:02:44 GMT 2023

<b>Observation</b>	<b>Proposal 2114, Observation 1: 100-200d SNe Ia</b> <b>Diagnostic Status: Warning</b> Observing Template: MIRI Medium Resolution Spectroscopy												
	(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>				
	(4)	2022XKQ	RA: 05 05 23.7110 (76.3487958d) Dec: -11 52 56.05 (-11.88224d) Equinox: J2000										
<i>Comments:</i> Category=Star Description=[Supernovae] Extended=NO													
<b>Acquisition</b>	<b>#</b>	<b>Target</b>	<b>Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>				
	1	SAME	F1000W	FAST	10	1	1	27.75	60728				
<b>Template</b>	<b>Primary Channel</b>				<b>Simultaneous Imaging</b>				<b>Imager Subarray</b>				
	ALL				YES				FULL				
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>			<b>Optimized For</b>			<b>Direction</b>					
	1	4-Point			POINT SOURCE			NEGATIVE					
<b>Spectral Elements</b>	<b>#</b>	<b>Wavelength Range</b>	<b>Detector</b>	<b>Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Exposures/Dith</b>	<b>Dither</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1		IMAGER	F770W	FASTR1	5	2	1	Dither 1	4	8	122.102	86820
	1	LONG(C)	MRSLONG		SLOWR1	36	1	1	Dither 1	4	4	3440.148	86820
	1	LONG(C)	MRSSHORT		SLOWR1	36	1	1	Dither 1	4	4	3440.148	86820
	2		IMAGER	F1130W	FASTR1	10	2	1	Dither 1	4	8	233.103	86820
	2	MEDIUM(B)	MRSLONG		SLOWR1	36	1	1	Dither 1	4	4	3440.148	86820
	2	MEDIUM(B)	MRSSHORT		SLOWR1	36	1	1	Dither 1	4	4	3440.148	86820
	3		IMAGER	F1000W	FASTR1	5	2	1	Dither 1	4	8	122.102	86820
	3	SHORT(A)	MRSLONG		SLOWR1	36	1	1	Dither 1	4	4	3440.148	86820
	3	SHORT(A)	MRSSHORT		SLOWR1	36	1	1	Dither 1	4	4	3440.148	86820

Special Requirements

Between Dates 19-JAN-2023:00:00:00 and 01-MAR-2023:00:00:00

Proposal 2114 - Observation 4 - MIR Spectroscopy of Type Ia Supernovae: The Key to Unlocking their Explosions and Element Produ...

Fri Jan 20 20:02:44 GMT 2023

<b>Observation</b>	Proposal 2114, Observation 4: 400-500d medium Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy												
	(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
<b>Fixed Targets</b>	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous				
	(3)	2021AEFX	RA: 04 19 53.4000 (64.9725000d) Dec: -54 56 53.09 (-54.94808d) Equinox: J2000 Comments: This is a type Ia supernova in the galaxy NGC 1566 Category=Star Description=[Supernovae] Extended=NO										
<b>Acquisition</b>	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID				
	1	SAME	F1000W	FAST	10	1	1	27.75	62481				
<b>Template</b>	Primary Channel				Simultaneous Imaging				Imager Subarray				
	ALL				YES				FULL				
<b>Dithers</b>	#	Dither Type			Optimized For			Direction					
	1	4-Point			POINT SOURCE			NEGATIVE					
<b>Spectral Elements</b>	#	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	F770W	FASTR1	20	2	1	Dither 1	4	8	455.107	81816
	1	SHORT(A)	MRSLONG		SLOWR1	35	3	1	Dither 1	4	12	10224.886	81816
	1	SHORT(A)	MRSSHORT		SLOWR1	35	3	1	Dither 1	4	12	10224.886	81816
	2		IMAGER	F1000W	FASTR1	20	2	1	Dither 1	4	8	455.107	81816
	2	MEDIUM(B)	MRSLONG		SLOWR1	35	3	1	Dither 1	4	12	10224.886	81816
	2	MEDIUM(B)	MRSSHORT		SLOWR1	35	3	1	Dither 1	4	12	10224.886	81816
	3		IMAGER	F1130W	FASTR1	20	2	1	Dither 1	4	8	455.107	81816
	3	LONG(C)	MRSLONG		SLOWR1	36	3	1	Dither 1	4	12	10511.565	81816
	3	LONG(C)	MRSSHORT		SLOWR1	36	3	1	Dither 1	4	12	10511.565	81816

Proposal 2114 - Observation 5 - MIR Spectroscopy of Type Ia Supernovae: The Key to Unlocking their Explosions and Element Produ...

Fri Jan 20 20:02:44 GMT 2023

<b>Observation</b>	<p><b>Proposal 2114, Observation 5: LRS 2021aefx</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: MIRI Low Resolution Spectroscopy</p> <p><i>Comments: These observations were originally planned to be observed in the MRS mode but this mode is no longer available. Therefore I have switched them to the LRS mode and recalculated the exposure time.</i></p>								
<b>Diagnostics</b>	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.								
<b>Fixed Targets</b>	#	Name	Target Coordinates	Targ. Coord. Corrections			Miscellaneous		
	(3)	2021AEFX	RA: 04 19 53.4000 (64.9725000d) Dec: -54 56 53.09 (-54.94808d) Equinox: J2000						
	<i>Comments: This is a type Ia supernova in the galaxy NGC 1566</i>								
	<i>Category=Star</i>								
	<i>Description=[Supernovae]</i>								
	<i>Extended=NO</i>								
<b>Acquisition</b>	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	F1000W	FASTGRPAVG8	4	1	1	88.801	123541
<b>Template</b>	Subarray				Obtain Verification Image?				
	FULL				true				
<b>Dithers</b>	#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset			
	1	ALONG SLIT NOD							
<b>Pointing Verification</b>	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID		
	1	FASTGRPAVG8	4	1	1	88.801	123541		

Proposal 2114 - Observation 5 - MIR Spectroscopy of Type Ia Supernovae: The Key to Unlocking their Explosions and Element Produ...

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	FASTR1	134	2	4	1	2	1492.972	123541
Special Requirements	Between Dates 14-SEP-2022:00:00:00 and 22-OCT-2022:00:00:00								