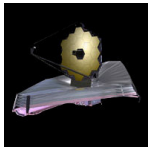

6779 - Pushing Boundaries: Unveiling the Most Distant Fast Radio Burst with JWST

Cycle: 3, Proposal Category: DD

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
NIRCam Imaging of the FRB region				
	1	Pre Imaging	NIRCam Imaging	(1) FRBLocation
NIRSPEC IFU spectroscopy of the FRB Host				
	2	IFU spectroscopy of host	NIRSpec IFU Spectroscopy	(3) FRBLocation-NIRSpec-Pointing

ABSTRACT

In the past seven years, the localization of fast radio bursts (FRBs) to their host galaxies has transformed from a novelty into a central focus of transient astronomy. The scientific exploration of FRBs has progressed remarkably, investigating their mysterious origins and their utility as probes of the universe. Nearly 100 FRBs have been associated with host galaxies and their corresponding redshifts. Among these, FRB 20220611A is the most distant source, with a redshift of 1.016, and the highest dispersion measure of 1458 pc cm-3. This aligns with the theoretical correlation between dispersion measure due to free electrons in the cosmic web and redshift (i.e. the Macquart relation).

Our proposal seeks to push these boundaries further by securing the redshift of FRB 20240304B, which has an even higher dispersion measure of 2641 pc cm-3 and was recently discovered by the MeerKAT telescope. Deep imaging of its field has not revealed any galaxy counterpart to stringent magnitude limits, suggesting the presence of either a very faint galaxy at $z < 1$ or a typical FRB host galaxy at $z > 3$.

With the advanced observational capabilities of JWST, we aim to identify the host galaxy and measure the redshift of FRB 20240304B. This effort will address three key scientific goals: refining our understanding of FRB progenitors and host galaxies, advancing the use of FRBs as cosmological probes, and exploring the extreme environments of these enigmatic sources. Given the rapid rate of progress in FRB astrophysics, it is crucial to undertake this research now, lest we risk making a potentially great discovery in a timely fashion.

OBSERVING DESCRIPTION

In this proposal, we request the following observations with the JWST:

1. NIRCam Imaging: We propose to use the F200W and F322W2 bands to detect the host galaxy of a Fast Radio Burst (FRB), which has been localised to better than 1" using radio observations. The host galaxy has not been detected with ground-based imaging up to $R < 26.8$ (3) and $J < 23.85$ (3) AB magnitudes. Our proposed JWST observations with NIRCam will achieve a F200W band limit of ~28 AB, providing the necessary sensitivity to detect the host galaxy.

2. NIRSpec IFU Spectroscopy: Upon localisation of the FRB host galaxy with NIRCam imaging, we request NIRSpec IFU observations in CLEAR/PRISM mode to determine its spectroscopic redshift. Our proposed observations will reach a 3-sigma line flux detection level of ~3.5×1019 erg/s/cm². Assuming the host galaxy is at z~3 (based on the dispersion measure), we anticipate detecting strong optical emission lines with the PRISM observations.

These observations will significantly enhance our understanding of the host galaxy's properties and its environment, contributing to the broader effort of characterising FRB sources.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	FRBLocation	RA: 12 11 59.3300 (182.9972083d) Dec: +11 48 46.79 (11.81300d) Equinox: J2000	Epoch of Position: 2000	
Comments: *Category=Unidentified* *Description=[Blank field, Variable radiation sources]*				
(2)	TA_for_IFU_WATA	RA: 12 11 57.9728 (182.9915533d) Dec: +11 48 41.42 (11.81151d) Equinox: J2000	Epoch of Position: 2000	
Comments: This is a star observed by the NIRCam pre-imaging. The star has a Gaia DR2 RP mag = 18.7520. *Category=Star* *Description=[A stars]* *Extended=NO*				
(3)	FRBLocation-NIRSpec-Pointing	RA: 12 11 59.3086 (182.9971192d) Dec: +11 48 46.80 (11.81300d) Equinox: J2000	Epoch of Position: 2000	
Comments: *Category=Galaxy* *Description=[Field galaxies, Low Surface Brightness galaxies]*				

Observation

Proposal 6779, Observation 1: Pre Imaging Mon Jan 13 15:00:34 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Comments: This NIRSpec IFU observation will follow a similar technique to NIRSpec/MSA pre imaging. Once the NIRCAM imaging is complete and the host is identified, the NIRSpec IFU TA + observations can be planned, thus we require at least 7 days window to do that. We apply an offset to the FRB location to obtain the host in NIRCam module B1 (which is least affected by persistence).

Diagnostics

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	FRBLocation	RA: 12 11 59.3300 (182.9972083d) Dec: +11 48 46.79 (11.81300d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Unidentified
Description=[Blank field, Variable radiation sources]

Template

Module	Subarray	Target Placement
ALL	FULL	Module Gap

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEX	4	SMALL-GRID-DITHER		2

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F200W	F322W2	MEDIUM8	9	1	8	8	7558.686	

Special Requirements

Between Dates 01-DEC-2024:00:00:00 and 28-FEB-2025:00:00:00
Offset 125.0 arcsec, 35.0 arcsec

2 After 1 by 7 Days to 365 Days

Observation

Proposal 6779, Observation 2: IFU spectroscopy of host Mon Jan 13 15:00:34 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Comments: This NIRSpec IFU observation will follow a similar technique to NIRSpec/MSA pre imaging. Once the NIRCAM imaging is complete and the host is identified, the NIRSpec IFU TA + observations can be planned, thus we require at least 7 days window to do that.

Diagnostics

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 2:1) 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.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	FRBLocation-NIRSpec-Pointing	RA: 12 11 59.3086 (182.9971192d) Dec: +11 48 46.80 (11.81300d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Galaxy
Description=[Field galaxies, Low Surface Brightness galaxies]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 TA_for_IFU_WATA	WATA	SUB2048	F110W	NRSRAPID	3	1	1	3.628	210496

Template

HFF Readout Mode
false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	PRISM/CLEAR	NRSIRS2	20	1	false	true	NONE	4	4	5893.912	
2	PRISM/CLEAR	NRSIRS2	20	1	false	true	NONE	4	4	5893.912	
3	PRISM/CLEAR	NRSIRS2	20	1	false	true	NONE	4	4	5893.912	
4	PRISM/CLEAR	NRSIRS2	20	1	false	true	NONE	4	4	5893.912	

Special Requirements	
	Between Dates 01-DEC-2024:00:00:00 and 28-FEB-2025:00:00:00 Aperture PA Range 60.37164917 to 64.27164917 Degrees (V3 281.4 to 285.3) 2 After 1 by 7 Days to 365 Days