



## 5718 - A Spectroscopic Census of Faint, Broad-Line AGN at $z > 5$

Cycle: 3, Proposal Category: GO

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>
<b>Prof. Dale D. Kocevski (PI)</b>	<b>Colby College</b>
Mr. Jingsong Guo (CoI) (CoPI)	Peking University
Prof. Masafusa Onoue (CoI)	Waseda University
Dr. Kohei Inayoshi (CoI)	Peking University
Prof. Steven L. Finkelstein (CoI)	University of Texas at Austin
Dr. Casey Papovich (CoI)	Texas A & M University
Dr. Jeyhan Kartaltepe (CoI)	Rochester Institute of Technology
Prof. Jonathan R Trump (CoI)	University of Connecticut
Dr. Guillermo Barro (CoI)	University of the Pacific
Dr. Norman Grogin (CoI)	Space Telescope Science Institute
Dr. Taylor Alexandra Hutchison (CoI)	NASA Goddard Space Flight Center
Dr. Mark Dickinson (CoI)	NOIRLab - (AZ)
Dr. Allison Kirkpatrick (CoI)	University of Kansas Center for Research, Inc.
Mr. Zhengrong Li (CoI)	Peking University
Dr. Michaela Hirschmann (CoI) (ESA Member)	Ecole Polytechnique Federale de Lausanne
Dr. Gene C K Leung (CoI)	Massachusetts Institute of Technology
Prof. Pablo G. Perez Gonzalez (CoI) (ESA Member)	Centro de Astrobiologia - CAB
Dr. Pablo Arrabal Haro (CoI)	NASA Goddard Space Flight Center
Kelcey Davis (CoI)	University of Connecticut
Dr. Nimish P. Hathi (CoI)	Space Telescope Science Institute
Dr. Nikko J. Cleri (CoI)	The Pennsylvania State University
Dr. Stephen Matthew Wilkins (CoI) (ESA Member)	University of Sussex
Dr. Anton M. Koekemoer (CoI)	Space Telescope Science Institute

<i>Name</i>	<i>Institution</i>
Ms. Wenxiu Li (CoI)	Peking University

### OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	Quasars_wHighz_Filler	NIRSpec MultiObject Spectroscopy	(2) Skyfire_Primary_wFillers+Stars
	101	Quasars_wHighz_Filler 2	NIRSpec MultiObject Spectroscopy	(3) Skyfire_Primary_wFill+Stars2

### ABSTRACT

One of the more surprising results from Cycle 1 was the discovery of broad-line AGN at  $z > 5$  with luminosities and black hole (BH) masses that are 2-3 dex below those of bright quasars found from the ground. These faint quasars are more representative of the underlying BH population and are the key to constraining models of BH seeding, the contribution of AGN to reionization, and the early coevolution of galaxies and BHs. What we currently know about these sources is based on a limited sample (~20 broad-line AGN with  $R > 1000$  spectroscopy) that is likely biased toward the most massive and active BHs due to non-uniform target selection in Cycle 1 that favored observing brighter sources. We request 20.5 hours of NIRSpec observations to carry out a systematic census of both unobscured and obscured low-luminosity quasars at  $z > 5$  via the detection of their broad-line emission. We have compiled a target sample of 55 unobscured AGN candidates and 77 dust-reddened AGN candidates (sources known as “little red dots”). We will observe 55 of these sources in 6 MSA pointings, which will quadruple the current sample of faint quasars with  $R > 1000$  spectroscopy. Our requested 2 hour exposures will be sensitive to BH masses down to  $1.7 \times 10^6 M_{\text{sol}}$ . We will use our resulting sample to: (1) make the most robust estimate yet of the BH mass function at the low-mass end, which constrains models of BH seeding and their growth history, (2) constrain the evolution of the local  $M_{\text{BH}}-M^*$  relationship at the lowest BH masses yet probed, and (3) determine the fraction of little red dots that host broad-line AGN with the most sensitive spectroscopic follow-up of these enigmatic sources yet carried out.

### OBSERVING DESCRIPTION

We will perform a spectroscopic census of faint quasars using the NIRSpec G395M/F290LP grating/filter pair in order to detect the Ha line out to  $z=6.7$  and the Hb line to  $z=9.4$ . Our target field is the portion of the Extended Groth Strip imaged by the CEERS survey. In order to detect a broad emission line with a FWHM=1000 km/s from a  $1.7 \times 10^6 M_{\text{sol}}$  black hole, we require an exposure time of 7090.2 seconds (~2 hours). To achieve this integration time, we will use a detector setup of 16 groups/integration and 2 integrations/exposure with the NRSIRS2 readout pattern. We will use a 3-shutter slitlet for each source, coupled with a 3-position nod pattern, following the strategy that the CEERS survey. We find we can observe roughly 9-10 of our primary targets per MSA pointing. In order to achieve our required sample size, we will observe 6 separate MSA pointings over

## JWST Proposal 5718 (Created: Monday, December 1, 2025, 2:01:12PM Eastern Standard Time) - Overview

the CEERS field. To decide on field centers, we prioritize AGN candidates with compact morphologies, with lower weights used for extended sources. Filler targets are chosen from the CEERS dataset, with the highest filler priority given to a sample of sources at  $z > 8.5$ , then galaxies with photometric redshifts that would place Ha or Hb visible in the G395M spectrum, and finally progressively lower weights assigned to sources with increasing F444W magnitude and decreasing redshift.

Proposal 5718 - Targets - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
<b>Fixed Targets</b>	(1)	Quasars_wHighz_Filler	RA: 14 19 42.0881 (214.9253671d)		
			Dec: +52 52 37.48 (52.87708d)		
			Equinox: J2000		
		<i>Comments:</i>			
		<i>Description=[]</i>			
<b>Fixed Targets</b>	(2)	Skyfire_Primary_wFillers+Stars	RA: 14 19 47.0971 (214.9462379d)		
			Dec: +52 53 33.64 (52.89268d)		
			Equinox: J2000		
		<i>Comments:</i>			
		<i>Description=[]</i>			
<b>Fixed Targets</b>	(3)	Skyfire_Primary_wFill+Stars2	RA: 14 19 47.2008 (214.9466700d)		
			Dec: +52 53 34.20 (52.89283d)		
			Equinox: J2000		
		<i>Comments:</i>			
		<i>Description=[]</i>			

Proposal 5718 - Observation 1 - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

Mon Dec 01 19:01:12 GMT 2025

<b>Observation</b>	<p><b>Proposal 5718, Observation 1: Quasars_wHighz_Filler</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec MultiObject Spectroscopy</p> <p><i>Comments: This program aims to perform a spectroscopic census of faint quasars using the NIRSpec G395M/F290LP grating/filter pair in order to detect the Ha line out to <math>z=6.7</math> and the Hb line to <math>z=9.4</math>. Our target field is the portion of the Extended Groth Strip imaged by the CEERS survey. In order to detect a broad emission line with a FWHM=1000 km/s from a <math>1.7 \times 10^6</math> Msol black hole, our exposure time of 7090.2 seconds (~2 hours). To achieve this integration time, we use a detector setup of 16 groups/integration and 2 integrations/exposure with the NRSIRS2 readout pattern. We use a 3-shutter slitlet for each source, coupled with a 3-position nod pattern, following the strategy that the CEERS survey. We find we can observe roughly 9-10 of our primary targets per MSA pointing. In order to achieve our required sample size, we will observe 6 separate MSA pointings over the CEERS field. To decide on field centers, we prioritize AGN candidates with compact morphologies, with lower weights used for extended sources. Filler targets are chosen from the CEERS dataset, with the highest filler priority given to a sample of sources at <math>z &gt; 8.5</math>, then galaxies with photometric redshifts that would place Ha or Hb visible in the G395M spectrum, and finally progressively lower weights assigned to sources with increasing F444W magnitude and decreasing redshift.</i></p>			
	<b>Diagnosics</b>	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.		
(Visit 1:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.				
(Visit 1:3) Warning (Form): Overheads are provisional until the Visit Planner has been run.				
(Visit 1:3) Warning (Form): The recommended value is 8 Reference Stars for this template.				
(Visit 1:4) Warning (Form): Overheads are provisional until the Visit Planner has been run.				
(Visit 1:5) Warning (Form): Overheads are provisional until the Visit Planner has been run.				
(Visit 1:6) 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>
	(2)	Skyfire_Primary_wFillers+Stars	RA: 14 19 47.0971 (214.9462379d) Dec: +52 53 33.64 (52.89268d) Equinox: J2000	
<p><i>Comments:</i> Description=[]</p>				

Proposal 5718 - Observation 1 - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

	<b>Acquisition</b>										
	#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
	1	Filter: F140X; Readout: NRSRAPID; 8 sources in 3 quads; [ Optimal TA Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
	2	Filter: F140X; Readout: NRSRAPID; 8 sources in 4 quads; [ Optimal TA Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
	3	Filter: F140X; Readout: NRSRAPID; 7 sources in 3 quads; [ Optimal TA Accuracy ]	SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
	4	Filter: F110W; Readout: NRSRAPIDD6; 8 sources in 4 quads; [ Optimal TA Accuracy ]	SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
	5	Filter: CLEAR; Readout: NRSRAPID; 8 sources in 4 quads; [ Optimal TA Accuracy ]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
	6	Filter: CLEAR; Readout: NRSRAPID; 8 sources in 4 quads; [ Optimal TA Accuracy ]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
<b>Template</b>	TA Method	HFF Readout Mode	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold			
	MSATA	false	No	MSA Center	Primary Targets (456 sources)	Filler Targets (133507 sources)	jwtst-nirspec-g395m	1.5			

Proposal 5718 - Observation 1 - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
	1	521731	214.927108	52.914474	21.1334	1	527645	214.857044	52.896396	22.1636
	1	523864	214.923006	52.923628	21.6816	1	528345	214.904258	52.947927	22.3358
	1	525196	214.906045	52.918429	21.9554	1	530866	214.865927	52.906931	22.0172
	1	526980	214.866369	52.898351	22.1717	1	531063	214.916102	52.942596	22.2268
	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
	2	516216	214.871980	52.848165	21.3942	2	520494	214.840280	52.844788	21.3975
	2	516421	214.840714	52.826493	21.1750	2	521861	214.810768	52.833321	22.2645
	2	517527	214.894450	52.871102	20.8041	2	524018	214.840389	52.865781	22.3441
	2	518135	214.829256	52.827825	22.2065	2	527504	214.820676	52.869793	21.5079
Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
3	507857	214.978131	52.879513	20.6273	3	510795	214.972399	52.890035	22.0659	
3	508609	214.990083	52.892315	21.7273	3	510904	214.971679	52.891067	21.5404	
3	508895	214.933558	52.852714	21.0487	3	511158	214.949232	52.876327	21.3959	
3	510712	214.974568	52.891962	20.7481						
Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
4	502003	214.947171	52.823750	21.7421	4	508305	214.909463	52.832255	23.1236	
4	504332	214.955145	52.843143	22.2536	4	511914	214.888668	52.837147	23.3857	
4	505869	214.883667	52.799558	22.3197	4	512785	214.875943	52.831872	22.5916	
4	506253	214.884701	52.803532	23.0646	4	630784	214.940929	52.819740	23.3029	
Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
5	505838	214.876693	52.795568	22.4884	5	518135	214.829256	52.827825	22.0625	
5	510629	214.858335	52.808937	22.9677	5	519773	214.823669	52.832016	22.1969	
5	512586	214.833649	52.801718	21.7155	5	520290	214.808566	52.824042	23.2881	
5	513314	214.862527	52.825834	23.3214	5	653521	214.879048	52.827181	21.6141	
Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
6	506122	214.808671	52.748751	21.8585	6	512386	214.805031	52.780090	21.9054	
6	510613	214.759378	52.737033	21.9526	6	516329	214.791290	52.790712	21.4818	
6	510812	214.759348	52.738045	21.8281	6	519555	214.746264	52.774378	21.6488	
6	511585	214.810245	52.779801	21.7491	6	639737	214.737506	52.776323	21.8199	

Proposal 5718 - Observation 1 - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
<b>Spectral Elements</b>	1	1 (G395M/F290LP)	Mask11	3 Shutter Slitlet	214.89140083333 334 Degrees 52.926402777777 774 Degrees	267.66814840686 87			3	6	7090.201
	2	1 (G395M/F290LP)	Mask13	3 Shutter Slitlet	214.85373125 Degrees 52.854466666666 67 Degrees	267.63826768141 8			3	6	7090.201
	3	1 (G395M/F290LP)	Mask17	3 Shutter Slitlet	214.96261458333 33 Degrees 52.864861111111 11 Degrees	267.72499326597 466			3	6	7090.201
	4	1 (G395M/F290LP)	Mask21	3 Shutter Slitlet	214.92081041666 668 Degrees 52.828230555555 56 Degrees	267.69176889578 12			3	6	7090.201
	5	1 (G395M/F290LP)	Mask83	3 Shutter Slitlet	214.84342875000 002 Degrees 52.813655555555 556 Degrees	267.63016182676 77			3	6	7090.201
	6	1 (G395M/F290LP)	Mask75	3 Shutter Slitlet	214.77508708333 332 Degrees 52.765616666666 666 Degrees	267.57586039437 564			3	6	7090.201
<b>Special Requirements</b>	Group Visits within 53.0 Days Visits Same PA MSA Planned Aperture PA 267.7119 to 267.7119 Degrees (V3 129.1373303 to 129.1373303)										

Proposal 5718 - Observation 101 - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

Mon Dec 01 19:01:12 GMT 2025

<b>Observation</b>	<b>Proposal 5718, Observation 101: Quasars_wHighz_Filler2</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 101:1) 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>		
	(3)	Skyfire_Primary_wFill+Stars2	RA: 14 19 47.2008 (214.9466700d) Dec: +52 53 34.20 (52.89283d) Equinox: J2000								
<i>Comments: Description=[]</i>											
<b>Acquisition</b>	<b>#</b>	<b>Reference Star Bin</b>	<b>Target</b>	<b>Filter</b>	<b>MSA Configuration</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>Optional ETC ID</b>
	1	Filter: F110W; Readout: NRSRAPIDD6; 8 sources in 4 quads; [ Reduced Accuracy ]	SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
<b>Template</b>	<b>TA Method</b>	<b>HFF Readout Mode</b>	<b>Obtain Confirmation Images</b>	<b>Science Aperture</b>	<b>Primary Candidate List</b>	<b>Filler Candidate List</b>	<b>Spectral Overlap Map</b>	<b>Spectral Overlap Threshold</b>			
	MSATA	false	No	MSA Center	Primary Targets (403 sources)	Filler Targets (133335 sources)	jwst-nirspec-g395m	1.5			
<b>Reference Stars</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	
	1	502461	214.945796	52.822696	22.0917	1	508209	214.926536	52.843978	22.9413	
	1	502779	214.939062	52.821622	22.9968	1	508887	214.872372	52.806892	21.4049	
	1	504000	214.957811	52.842266	23.2991	1	511415	214.926507	52.860811	23.0473	
	1	504105	214.925643	52.819365	23.2796	1	513098	214.885840	52.839729	22.9572	
<b>Spectral Elements</b>	<b>#</b>	<b>Exposure Specification</b>	<b>MSA Configuration</b>	<b>Nod Pattern</b>	<b>Pointing</b>	<b>Aperture PA</b>	<b>Dispersion Offset (Shutters)</b>	<b>Cross-Dispersion Offset (Shutters)</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>
	1	1 (G395M/F290LP)	c1	3 Shutter Slitlet	214.91126291666 666 Degrees 52.833188888888 89 Degrees	89.205262142483 8			3	6	7090.201

Proposal 5718 - Observation 101 - A Spectroscopic Census of Faint, Broad-Line AGN at  $z > 5$

Special Requirements

MSA Scheduled Aperture PA 89.2336 to 89.2336 Degrees (V3 310.65903 to 310.65903)