14596 - Is Lyman Alpha Emitter CR7 Powered by a Direct Collapse Black Hole?

Cycle: 24, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) CR7	WFC3/IR	2	29-Jul-2016 13:49:04.0	yes
02	(1) CR7	WFC3/IR	2	29-Jul-2016 13:49:06.0	yes

4 Total Orbits Used

ABSTRACT

Discoveries of luminous quasars powered by supermassive black holes (BH) with masses up to 10 billion solar masses challenge theories of early BH formation and growth, and suggests the existence of direct collapse black holes (DCBHs) with masses >10^4 solar masses as their initial seeds. CR7 (z=6.6) is the brightest Ly alpha emitter ever discovered, with strong HeII emission line and no metal lines, suggesting that it could be the first Population III galaxy formed in a metal-free environment. Alternatively, its properties can also be explained by an AGN powered by a DCBH in the last stage of its accretion at 10^(6-7) solar masses. If it is a DCBH-powered AGN, CR7 is expected to vary at >0.1 mag level in month to year timescales. We propose to carry out new HST/WFC3 F110W and F125W observations in two separate visits. This, combined with archival observations in 2012, will measure the variability of CR7 with rest-frame time lags ranging from 50 days to 300 days. If any significant variability is

detected, this will conclusively show that CR7 is a AGN, and is highly likely powered by a DCBH. Its variability property will put a first constraint on models of DCBH accretion; a lack of variability, on the other hand, would strongly suggest CR7 to be powered by Pop-III stars. This modest 4-orbit HST program could help identify either the first DCBH or the first Pop-III galaxy in the early universe, an exciting prospect for future investigations in the JWST era.

OBSERVING DESCRIPTION

PROGRAM GOALS:

Our goal is to measure the photometric variability of bright Ly alpha emitter CR7 at z=6.6 in order to test if it is a Pop-III galaxy or a direct collapse black hole powered AGN. If it is powered by a million solar mass BH and has similar variability properties as low-luminosity local AGNs, we expect it to show variability with rms amplitude of ~0.15 - 0.2 mag in the rest-frame UV at longer than a month timescale in the rest-frame. Theoretical model also suggests longer term variability on the feedback timescale of order a year or longer. We aim at measuring variability at both month and year timescales.

We will obtain deep F110W and F160W exposures of CR7 in two new epochs (two visits) in Cycle 24, separately by ~300 days (~40 days in the rest-frame). In each visit, we will obtain exposure for one orbit in each of the F110W and F160W filters. This, combined with archival data of the same field observed in 2012, we give us three epochs and test CR7 variability in both month and year timescales.

DITHERING AND EXPOSURE:

The CR7 field was observed in program 12578 (PI: Forster-Schreiber) by HST/WFC3 in F110W and F160W bands in 2012. In our program, we will adopt the same exposure and dithering part used in program 12578 (visit 3, orbits 2 and 3).

For each orbit, we will have four sub-exposures. We will use customized WFC3-IR-DITHER-BOX-MIN dither pattern with the same box size (~5") as used in program 12758. The sub-integer pixel offsets ensure sampling by 1/2 pixel in each of the x and y directions. Similarly, we will use the MULTIACCUM readout mode with SPARS50 and NSAMP = 14. This choice maximizes the use of the visibility period during each orbit, allows parallel buffer dumps, and provides a sufficient number of non-destructive reads to further mitigate the impact of cosmic rays.

TIME CONSTRAINTS:

This is a monitor program. We request the first visit to be in the early part of the window, before May 15, 2017, and the second visit to be separated by no less than 250 days (~one month in the rest frame at z=6.6).

In total, the program will have four orbits, with two visits of two orbits each.

Visit

Proposal 14596, CR7-epoch1 (01) Fri Jul 29 17:49:07 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: BEFORE 15-MAY-2017:00:00:00

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=4.92090 Line Spacing=4.69606	Coordinate Frame=POS-TARG Pattern Orientation=7.76885 Angle Between Sides=90.3118 Center Pattern=false		(1), (2)

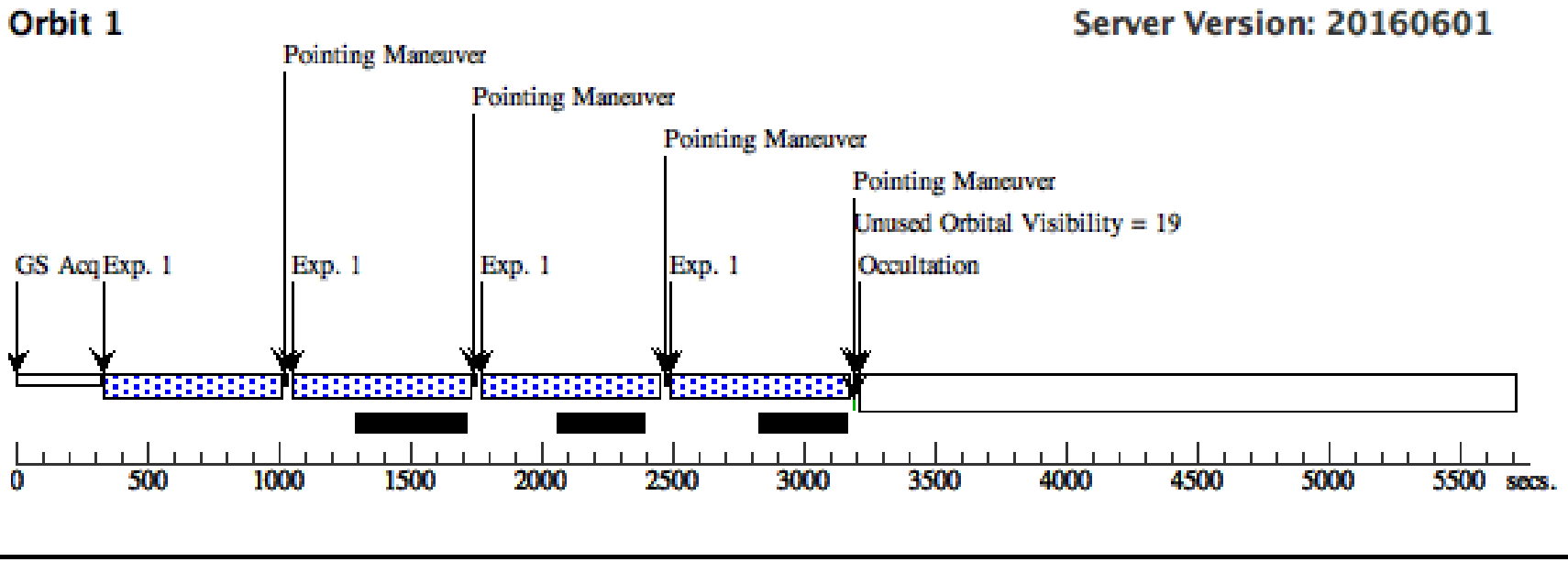
Fixed Targets

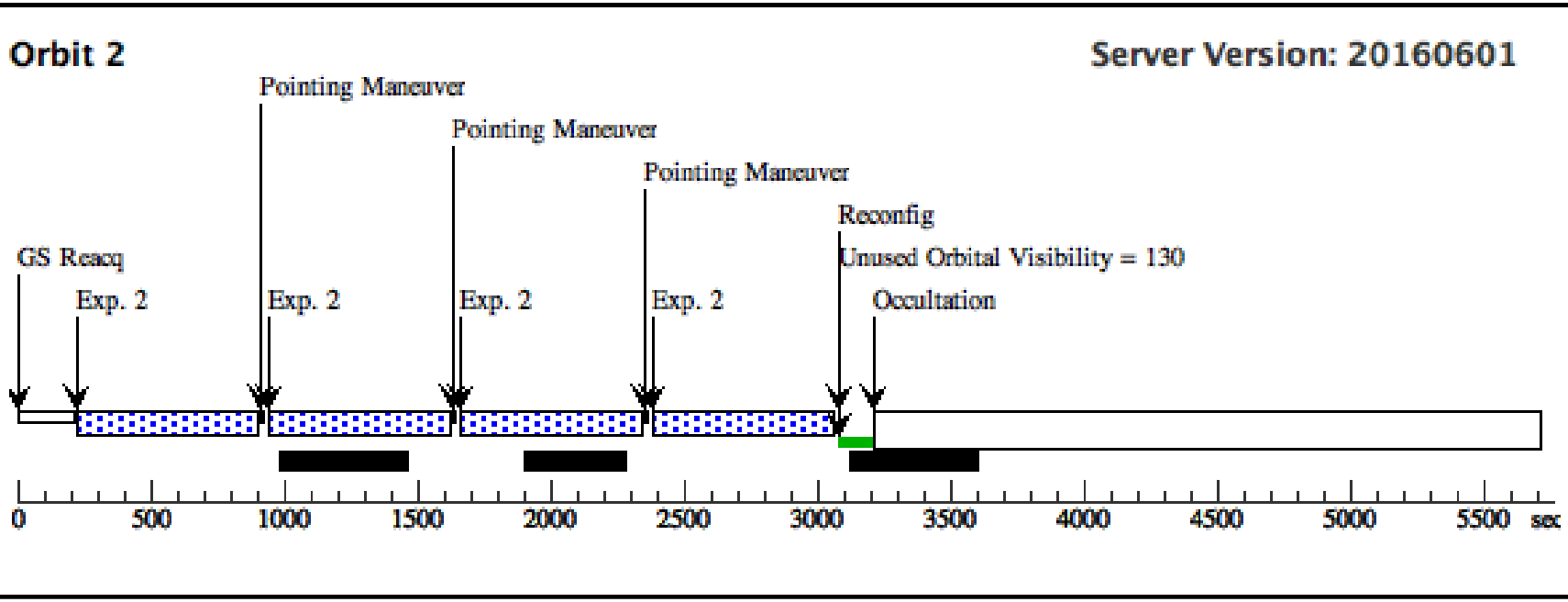
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	CR7	RA: 10 00 58.0050 (150.2416875d) Dec: +01 48 15.25 (1.80424d) Equinox: J2000		V=(?) J=24.6	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) CR7	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=14; SAMP-SEQ=SPARS50		Pattern 2, Exps 1-1 in CR7-epoch1 (01) (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***
2		(1) CR7	WFC3/IR, MULTIACCUM, IR-FIX	F110W	NSAMP=14; SAMP-SEQ=SPARS50		Pattern 2, Exps 2-2 in CR7-epoch1 (01) (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[2]***

Orbit Structure





Visit

Proposal 14596, CR7-epoch2 (02) Fri Jul 29 17:49:07 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: AFTER_01 BY 250 D TO 400 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=4.92090 Line Spacing=4.69606	Coordinate Frame=POS-TARG Pattern Orientation=7.76885 Angle Between Sides=90.3118 Center Pattern=false		(1), (2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	CR7	RA: 10 00 58.0050 (150.2416875d) Dec: +01 48 15.25 (1.80424d) Equinox: J2000		V=(?) J=24.6	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) CR7	WFC3/IR, MULTIACCUM, IR-FIX	F160W	NSAMP=14; SAMP-SEQ=SPARS50		Pattern 2, Exps 1-1 in CR7-epoch2 (02) (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[1]***
2		(1) CR7	WFC3/IR, MULTIACCUM, IR-FIX	F110W	NSAMP=14; SAMP-SEQ=SPARS50		Pattern 2, Exps 2-2 in CR7-epoch2 (02) (2)	652.938154 Secs (2611.753 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[2]***

Orbit Structure