16317 - A Quantitative HeII Lyman Alpha Absorption Spectrum of the Newly Discovered Highest-Redshift UV-bright Quasar

Cycle: 28, 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) QSO-045011-432429	COS/FUV COS/NUV	4	18-Nov-2021 10:00:34.0	yes

4 Total Orbits Used

ABSTRACT

The advent of GALEX and COS have revolutionized our view of HeII reionization, the final major phase transition of the intergalactic medium. Efficient COS surveys have provided a statistical sample of strongly fluctuating HeII Lyman alpha absorption at 2.7<z<3, evoking a picture of overlapping HeIII zones around quasars at the end of HeII reionization. Unexpectedly, the seven rare quasars probing z>3.5 have revealed a set of HeII transmission 'spikes' and larger regions with nonzero transmission that suggest HeII reionization was well underway by z=4. This is in striking conflict with radiative transfer simulations of a HeII reionization driven by bright quasars. Explaining these measurements may require either faint quasars or more exotic sources of hard photons at z>4, with concomitant implications for HI reionization. A recent survey for high-redshift quasars in the southern hemisphere has uncovered the highest-redshift far-UV-bright quasar known (z=3.95, FUV=21.7). We propose here for COS G140L follow-up spectroscopy to (i) confirm its utility for HeII absorption studies by identifying possible interloping low-z HI absorbers, (ii) provide accurate measurements of the HeII Lyman alpha effective optical depth that are limited by systematics for much fainter already observed quasars, and (iii) constrain the lifetime of the background quasar from its ionized proximity zone. Moreover, the proposed observations would provide only the third z>3.5 sightline that would allow for high-resolution G130M spectroscopy before the end of HST's mission.

OBSERVING DESCRIPTION

We will obtain a COS FUV G140L spectrum of the recently discovered highest-redshift UV-bright quasar at z=3.95 to characterize intergalactic HeII Lyman alpha absorption along its sightline. Our target has a sufficiently accurate flux in the quasar continuum just redward of the HeII break (GALEX FUV=21.7+/-0.4), and is safe to observe with COS. Its precision Gaia astrometry enables efficient acquisition with ACQ/IMAGE. The target is not detected in GALEX NUV, and its spectral energy distribution suggests NUV~23.9 (Fig. 5 in the proposal). With the COS ETC we estimate a NUV imaging acquisition exposure time of 400 seconds to reach the recommended S/N=20.

The G140L grating provides the wavelength coverage to define the quasar continuum and the necessary resolution to measure the HeII absorption on scales of ~40 comoving Mpc. We require a S/N~3 per resolution element at 1500A, which results in a total request of 4 orbits. Continuous wavelength coverage at good sensitivity (lambda>1100A) is required to maximize the coverage of the HeII Lyman series absorption, only provided by the G140L 800A setup. In accord with our Phase I proposal and considering the significant acquisition overhead, the target will be observed in a single 4-orbit visit, using all FP-POS offsets in consecutive orbits. Spectra will be recorded in TIME-TAG mode with concurrent wavelength calibration (TAGFLASH). Time intervals spent in the Earth's shadow will be used to correct for geocoronal OI and NI emission. Given our faint source, airglow will dominate the COS count rates. However, even at the high airglow conditions conservatively assumed in our ETC calculations, the buffer time is longer than the exposure time. All exposure times have been adjusted to use the full visibility period in each orbit.

In order to limit detector gain sag and contamination of the HeII absorption region by scattered geocoronal Lyman alpha emission, the observations should not be scheduled in visibility periods with large daytime portions. We have selected suitable time windows from the target viewing time report using BETWEEN constraints and setting the schedulability to 100%.

Gain sag limits the accuracy of the COS dark current subtraction, which is critical to reach our science goals. We have developed a custom pipeline to determine the dark current in the COS PSA by post-processing COS dark monitoring exposures (Worseck et al. 2016, ApJ, 825, 144). For this calibration we require COS dark monitoring exposures taken at the same detector voltage as the science observations. Fortunately, up to now G140L science exposures are being taken at the same detector voltage as the dark monitoring exposures, such that special calibrations are unlikely to be required (see our program GO-15356).

Reduced gyro operations will not affect our program, because we do not have orientation constraints (other than the BETWEEN constraints above). APT indicates a sufficient number of scheduling windows for our 4-orbit visit.

Visit

Proposal 16317, Visit 01, completed Thu Nov 18 15:00:35 GMT 2021

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%; BETWEEN 30-OCT-2020:00:00:00 AND 05-FEB-2021:00:00:00; BETWEEN 01-OCT-2021:00:00:00 AND 20-OCT-2021:00:00:00; BETWEEN 12-NOV-2021:00:00:00 AND 17-FEB-2022:00:00:00; BETWEEN 12-MAR-2021:00:00:00 AND 20-MAR-2021:00:00:00

Diagnostics

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

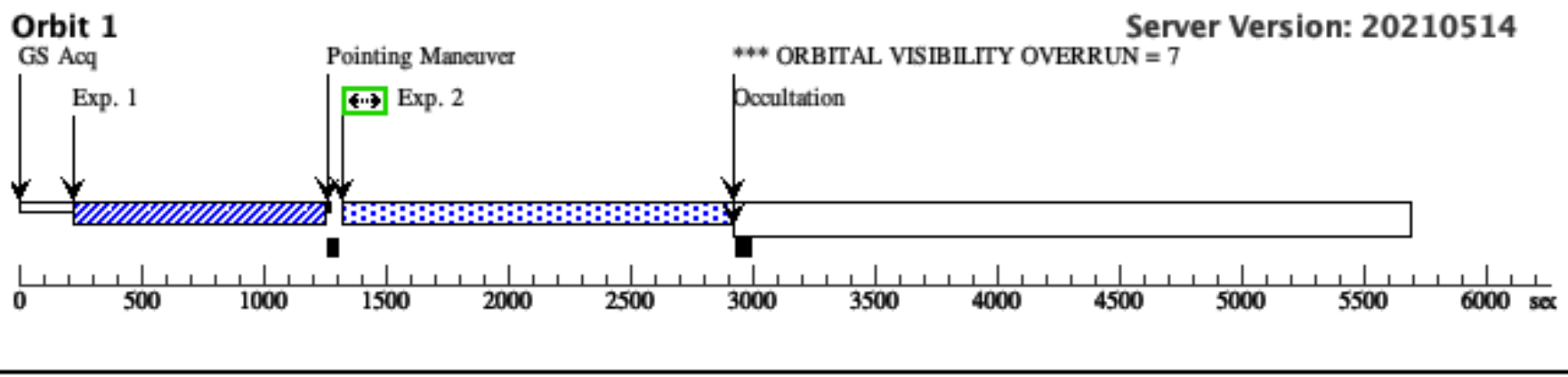
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	QSO-045011-432429	RA: 04 50 11.3700 (72.5473750d) Dec: -43 24 29.75 (-43.40826d) Equinox: J2000	Redshift: 3.95	V=17.8+/-0.1 GALEX FUV=21.73+/-0.40 NU V~23.9	Reference Frame: ICRS

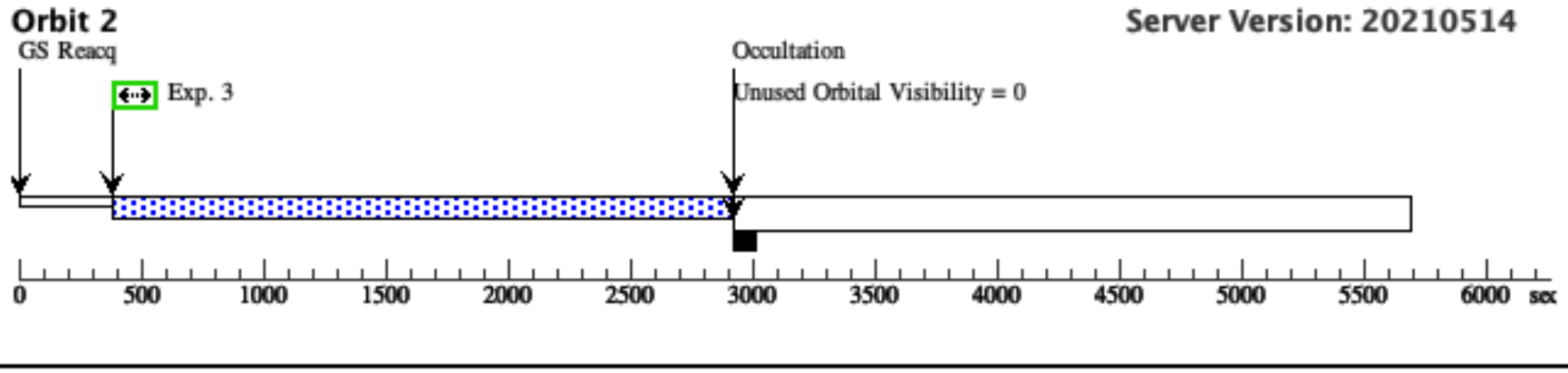
Comments:
Category=EXT-MEDIUM
Description=[ABSORPTION LINE SYSTEM, IGM]
Extended=NO

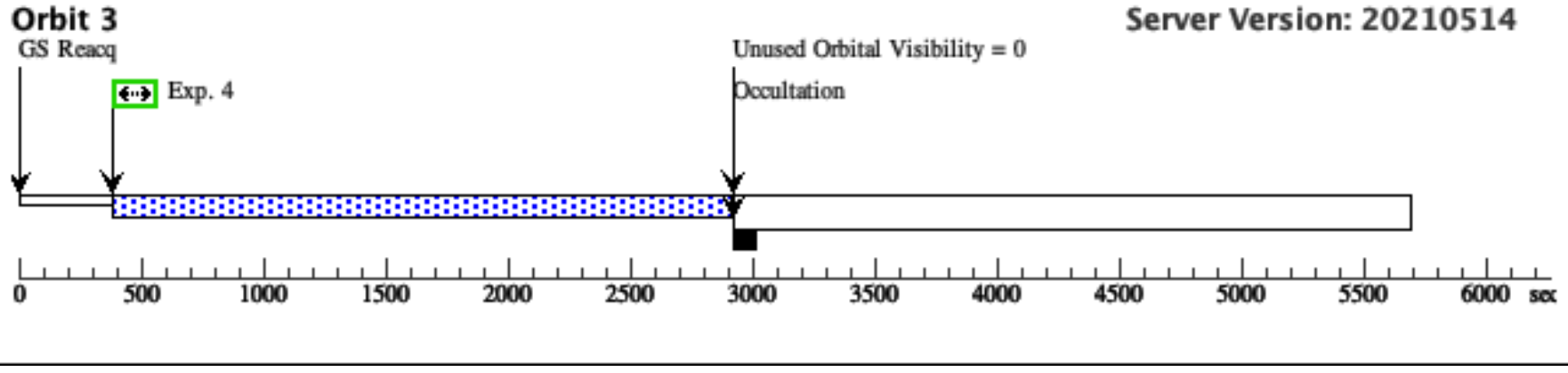
Exposures

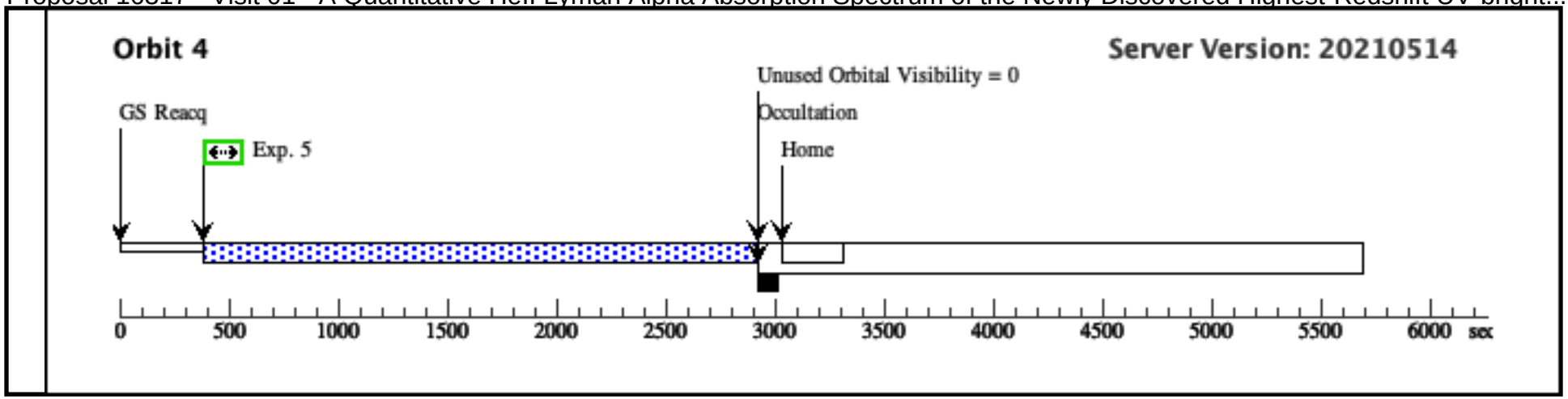
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(COS.ta.1447228)	(1) QSO-045011-432429	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				400 Secs (400 Secs) *[==>]*	 ***[1]***
2	(COS.sp.1447251)	(1) QSO-045011-432429	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=3000; FP-POS=1			2700 Secs (1393 Secs) *[==>1393.0 Secs]*	 ***[1]***
3	(COS.sp.1447251)	(1) QSO-045011-432429	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=3000; FP-POS=2			2700 Secs (2473 Secs) *[==>2473.0 Secs]*	 ***[2]***
4	(COS.sp.1447251)	(1) QSO-045011-432429	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=3000; FP-POS=3			2700 Secs (2473 Secs) *[==>2473.0 Secs]*	 ***[3]***
5	(COS.sp.1447251)	(1) QSO-045011-432429	COS/FUV, TIME-TAG, PSA	G140L 800 A	BUFFER-TIME=3000; FP-POS=4			2700 Secs (2473 Secs) *[==>2473.0 Secs]*	 ***[4]***

Orbit Structure





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