14461 - Atmospheric Escape from the Closest Super-Earth

Cycle: 23, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

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) HR-8832 WAVE	STIS/CCD STIS/FUV-MAMA	5	12-Apr-2016 21:07:00.0	yes

5 Total Orbits Used

ABSTRACT

In July 2015, we announced the discovery of the super-Earth HD 219134b, orbiting a V = 5.57 star 6.5-pc away from us (Motalebi et al. 2015). This is the brightest and closest transiting system known so far. With Spitzer and HARPS-N, we measured the density of HD 219134b, which is compatible with a rocky planet, possibly containing a large amount of volatile species. The planet receives high stellar irradiation, which could significantly erode its atmosphere. Preliminary estimates indicate that this 4.5 Earth-mass object should nonetheless retain a substantial atmosphere. HD 219134b lies sufficiently far from its star to allow the formation of a hydrogen cloud with a detectable coma. HST is the only telescope able to detect, for the first time, atmospheric escape from a super-Earth, by observing a Lyman-alpha transit. The detection of escaping hydrogen will represent a smoking gun for the presence of water vapor in the lower atmosphere. Constraining the mass-loss rate will allow us to probe the evolution of super-Earths and assess whether hotter super-Earths can be evaporation remnants. Resolving the Lyman-alpha absorption signal will also bring new insights on the dynamics in the exospheric clouds, revealing interaction between the host star and its super-Earth through radiation pressure and stellar wind. A non-detection could hint at a CO/CO2-rich 'super-Venus' and will prepare for adapted follow-up observations. Both outcomes will thus motivate new proposals in Cycle 24.

OBSERVING DESCRIPTION

We are going to observe the UV transit of the brightest (V=5.6) and closest (6 pc) known transiting planet, which is a super-Earth. The star is a K2 dwarf and we estimated its Lyman-alpha emission line by scaling up the one of HD 189733 (K dwarf at 19 pc), taking into account the flux dilution due to the distance and the interstellar hydrogen column. Our target should bear the brightest Lyman-alpha flux ever observed for an exoplanet host-star. It should be at similar flux levels, though, as previously observed targets such as active M dwarfs AD Leo or HD 32008, and less intense than other observed targets such as 70 Oph or Xi Boo (see Wood et al. 2005, ApJS 159, 118). We seize this opportunity to observe during one HST orbit, before the planetary transit, with the E140H echelle grating, to access 100,000 spectral resolution and explore the FUV range to measure other possible chromospheric emission lines. The rest of the observations (4 HST orbits: 1 before, 1 during, and 2 after the optical transit) will be carried out with the more sensitive G140M grism. The peak flux is ~2.5x10-12 erg s-1 cm-2 A-1 at 1215.3 A: it is lower than the local limit point source flux for the MAMA with G140M (which is 9.4x10-11 erg s-1 cm-2 A-1 according to the Approximate MAMA Spectroscopic Bright-Object Limits, Table 13.45 of the STIS instrument handbook). The star is also well fainter than the bright object magnitude limit (V=1.3 for a K2V star) given for the MAMA/G140M.

Proposal 14461 - Visit 01 - Atmospheric Escape from the Closest Super-Earth

Visit

Proposal 14461, Visit 01, pi Wed Apr 13 01:07:02 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: SCHED 100%; Period 3.092926 D AND ZERO-PHASE HJD2457463.82884

Fixed Targets

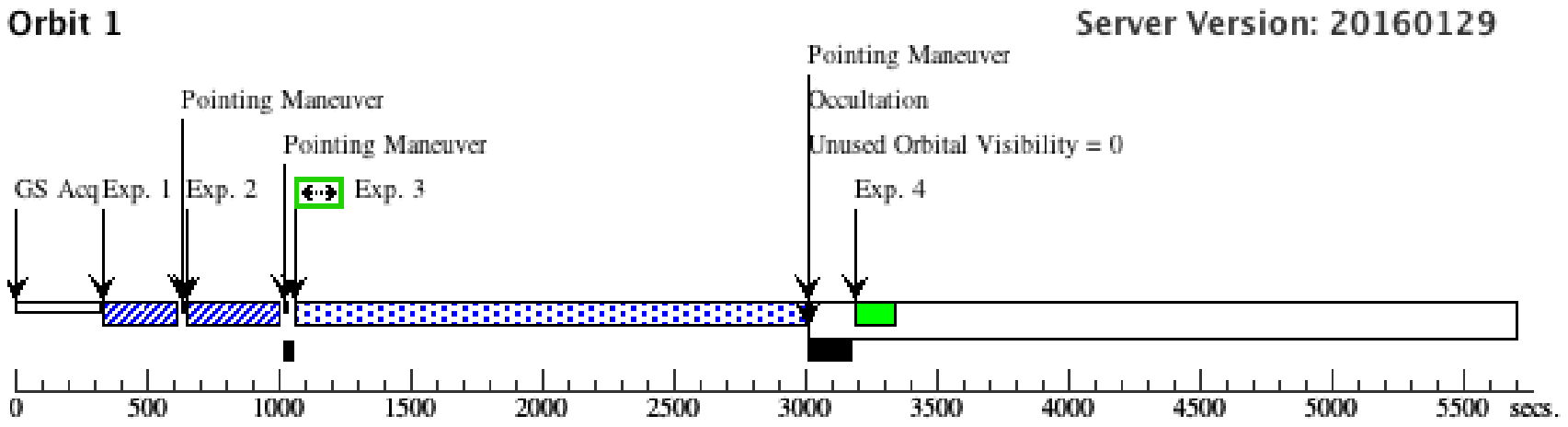
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HR-8832	RA: 23 13 16.9763 (348.3207346d)	Proper Motion RA: 2075.07 mas/yr	V=5.57+/-0.009	Reference Frame: ICRS
	Alt Name1: HD219134	Dec: +57 10 6.08 (57.16836d)	Proper Motion Dec: 295.45 mas/yr	U=7.460,	
		Equinox: J2000	Parallax: 0.15276"	B=6.560	
			Epoch of Position: 2000		

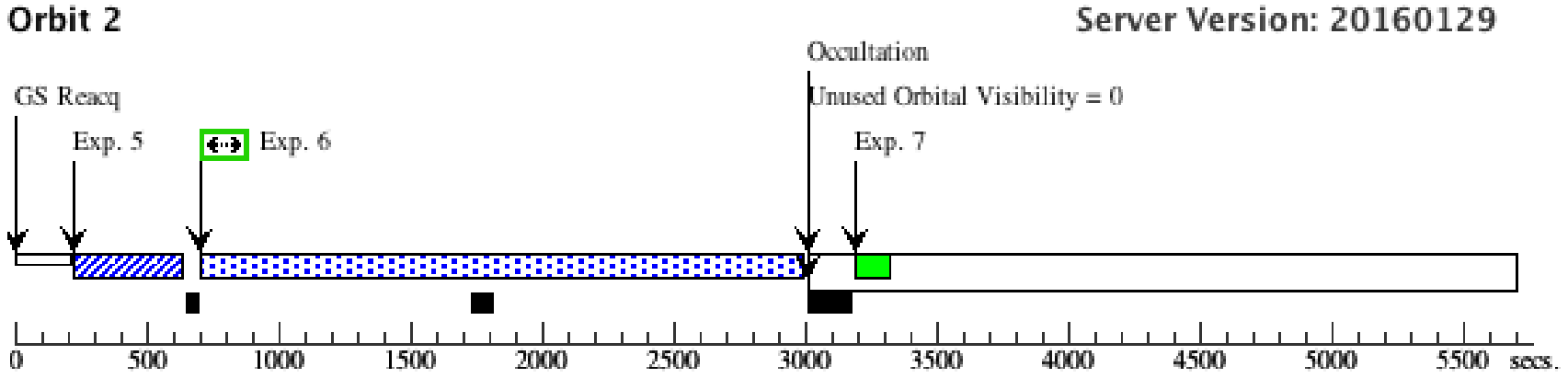
Comments: Extended=NO

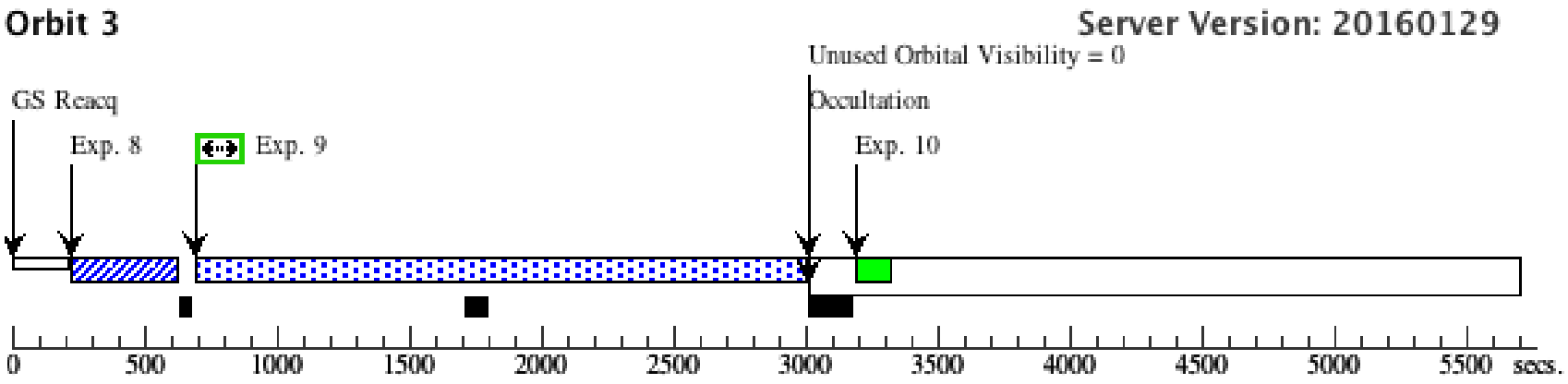
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.ta.757128)	(1) HR-8832	STIS/CCD, ACQ, F28X50OIII	MIRROR		PHASE 0.945 TO 0.955	Sequence 1-4 Non-Int in Visit 01	3 Secs (3 Secs) *[==>]*	*[1]*
2	ACQ/PEAK (STIS.sp.757130)	(1) HR-8832	STIS/CCD, ACQ/PEAK, 52X0.05	G430L 4300 A			Sequence 1-4 Non-Int in Visit 01	1 Secs (1 Secs) *[==>]*	*[1]*
3	SCI E140H (STIS.sp.757134)	(1) HR-8832	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140H 1271 A	BUFFER-TIME=900; WAVECAL=NO		Sequence 1-4 Non-Int in Visit 01	1792 Secs (1792 Secs) *[==>]*	*[1]*
	Comments: Using our scaled Lyman-alpha line model, the count rate for the entire detector in 2127s is 182 counts/s. The maximum buffer time should thus be 2x10^6 / 182 ~ 11,000s. Because of other chromospheric emission in the range of the echelle grism, we consider a factor of 10x as a margin, so we keep on using our "classic" 900-s buffer time setting.								
4	GO-WAVE CAL E140H	WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1271 A			Sequence 1-4 Non-Int in Visit 01	100 Secs (100 Secs) *[==>]*	*[1]*
5	ACQ/PEAK (STIS.sp.757130)	(1) HR-8832	STIS/CCD, ACQ/PEAK, 52X0.05	G430L 4300 A			Sequence 5-7 Non-Int in Visit 01	1 Secs (1 Secs) *[==>]*	*[2]*
6	SCI G140M (STIS.sp.757137)	(1) HR-8832	STIS/FUV-MAMA, TIME-TAG, 52X0.05	G140M 1222 A	BUFFER-TIME=900		Sequence 5-7 Non-Int in Visit 01	2147 Secs (2147 Secs) *[==>]*	*[2]*
	Comments: The count rate on the entire detector is 200 counts/s.								
7	GO WAVE CAL G140M	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140M 1222 A			Sequence 5-7 Non-Int in Visit 01	*[==>]*	*[2]*
8	ACQ/PEAK (STIS.sp.757130)	(1) HR-8832	STIS/CCD, ACQ/PEAK, 52X0.05	G430L 4300 A			Sequence 8-10 Non-Int in Visit 01	1 Secs (1 Secs) *[==>]*	*[3]*
9	SCI G140M (STIS.sp.757137)	(1) HR-8832	STIS/FUV-MAMA, TIME-TAG, 52X0.05	G140M 1222 A	BUFFER-TIME=900		Sequence 8-10 Non-Int in Visit 01	2171 Secs (2171 Secs) *[==>]*	*[3]*
	Comments: The count rate on the entire detector is 200 counts/s.								
10	GO WAVE CAL G140M	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140M 1222 A			Sequence 8-10 Non-Int in Visit 01	*[==>]*	*[3]*
11	ACQ/PEAK (STIS.sp.757130)	(1) HR-8832	STIS/CCD, ACQ/PEAK, 52X0.05	G430L 4300 A			Sequence 11-13 Non-Int in Visit 01	1 Secs (1 Secs) *[==>]*	*[4]*
12	SCI G140M (STIS.sp.757137)	(1) HR-8832	STIS/FUV-MAMA, TIME-TAG, 52X0.05	G140M 1222 A	BUFFER-TIME=900		Sequence 11-13 Non-Int in Visit 01	2171 Secs (2171 Secs) *[==>]*	*[4]*
	Comments: The count rate on the entire detector is 200 counts/s.								
13	GO WAVE CAL G140M	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140M 1222 A			Sequence 11-13 Non-Int in Visit 01	*[==>]*	*[4]*
14	ACQ/PEAK (STIS.sp.757130)	(1) HR-8832	STIS/CCD, ACQ/PEAK, 52X0.05	G430L 4300 A			Sequence 14-16 Non-Int in Visit 01	1 Secs (1 Secs) *[==>]*	*[5]*
15	SCI G140M (STIS.sp.757137)	(1) HR-8832	STIS/FUV-MAMA, TIME-TAG, 52X0.05	G140M 1222 A	BUFFER-TIME=900		Sequence 14-16 Non-Int in Visit 01	2171 Secs (2171 Secs) *[==>]*	*[5]*
	Comments: The count rate on the entire detector is 200 counts/s.								
16	GO WAVE CAL G140M	WAVE	STIS/FUV-MAMA, ACCUM, 52X0.05	G140M 1222 A			Sequence 14-16 Non-Int in Visit 01	*[==>]*	*[5]*

Orbit Structure



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Occultation
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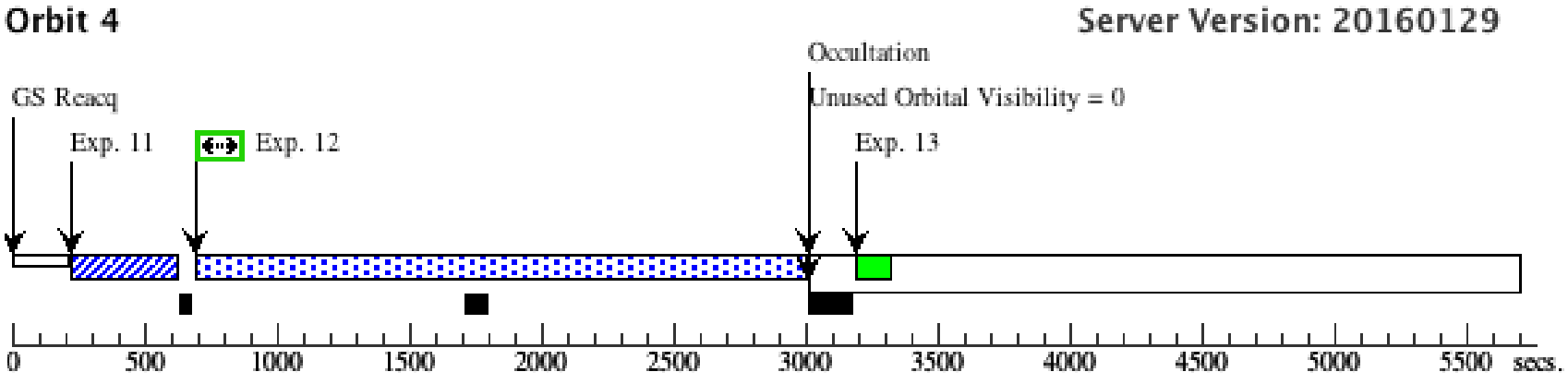
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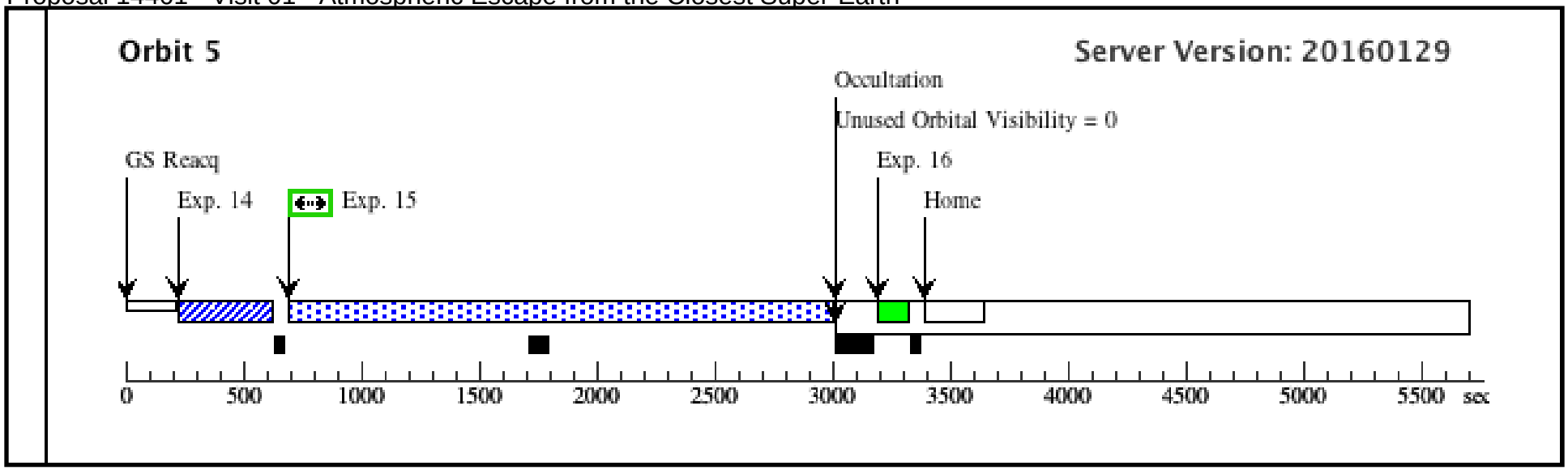
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Occultation
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GS Reacq
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Exp. 15
Exp. 16
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5500
sec