16754 - Decoding the clouds on an irradiated inflated brown dwarf

Cycle: 29, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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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) 2QZ-J103448.9+005200	WFC3/IR	1	29-Sep-2021 13:01:44.0	yes
02	(1) 2QZ-J103448.9+005200	WFC3/IR	1	29-Sep-2021 13:01:45.0	yes
03	(1) 2QZ-J103448.9+005200	WFC3/IR	1	29-Sep-2021 13:01:45.0	yes
04	(1) 2QZ-J103448.9+005200	WFC3/IR	1	29-Sep-2021 13:01:46.0	yes
05	(1) 2QZ-J103448.9+005200	WFC3/IR	1	29-Sep-2021 13:01:47.0	yes
06	(1) 2QZ-J103448.9+005200	WFC3/IR	1	29-Sep-2021 13:01:47.0	yes

6 Total Orbits Used

ABSTRACT

We propose HST time-resolved spectroscopy of a rare, eclipsing white dwarf-brown dwarf binary. The brown dwarf in the binary is a mid-L dwarf and is irradiated by its 10,000 K white dwarf companion. The brown dwarf totally eclipses the white dwarf and the white dwarf parameters are well defined, meaning there is a directly measured radius of the brown dwarf, which is inflated compared to models of field dwarfs at the same age. As such this is the only inflated, irradiated cloudy L dwarf where atmospheric characterisation is possible, leading to insights into the processes occurring in the atmosphere.

We will obtain phase resolved spectra between 1.1 and 1.7 microns using WFC3 with the G141 set up in time-series mode.
We will combine our spectra with global circulation models and atmospheric models to:
1) Determine the effective temperature of the brown dwarf,
2) Study day-night heat redistribution in unprecedented detail
3) Determine if there are significant nightside clouds.

HST can uniquely obtain the high-precision, time-resolved, near-infrared spectroscopy required by our science goals.

OBSERVING DESCRIPTION

Observing Mode:

The observations will use the WFC3/IR G141 instrument in time-series mode, similar to the observations performed for the similar systems in HST Program 15947. The instrument's high throughput from 1.1 to 1.7 microns, the remarkable sensitivity in the 1.4~m water absorption band, and the extraordinary photometric stability make WFC3/IR G141 the best and, indeed, the only choice to achieve our goals. Due to the relative faintness of the target, we will to conduct the observations in staring mode. We will use the sub256 array and SPARS25, NSAMP=15 setup, which resulting in a cadence of 313 seconds, and 25s for each non-destructive read. The light curves at this cadence will resolve the spectral modulations at sample rates greater than ten per brown dwarf orbit.

We have specified 2 orient windows as we need to ensure light from a nearby, brighter star(J= 15.026 and H=14.4580) does not contaminate our data. We have specified orients so that the brighter star is well separated in the Y direction.

Exposure Time Calculation and Signal-to-Noise Ratio Estimate:
We estimate the required exposure times and SNR achieved using the WFC3 Exposure Time Calculator. For WD1032+011 we will achieve an SNR=216 in a single G141 exposure in white light. With 10 pixel-wide
spectral bins, typical in exoplanet transmission spectroscopy, the average SNR in each bin will exceed 60. We calculated the SNR requirements on the basis of distinguishing spectral modulations assuming a difference between the day and nightside spectra of 4% and a J-band modulation amplitude of 2%. WD1032+011 has a precise period measurement and ephemeris from radial velocity and lightcurve measurements, allowing us to phase-fold the light curves, further increasing the precision.

Reduced Gyro mode: We do not anticipate reduced gyro mode will affect this programme other than perhaps in reducing schedulability due to our Orient constraints. A smaller field of view is fine.

Visit

Proposal 16754, Visit 01, implementation Wed Sep 29 17:01:48 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: PCS MODE FINE; GUID TOL 0.005"; GYRO MODE 3GOBAD; ORIENT 302.5D TO 62.5 D; ORIENT 122.5D TO 242.5 D; SEQ 01,02,03,04,05,06 WITHIN 5.5 Orbits

Comments: 2

Fixed Targets

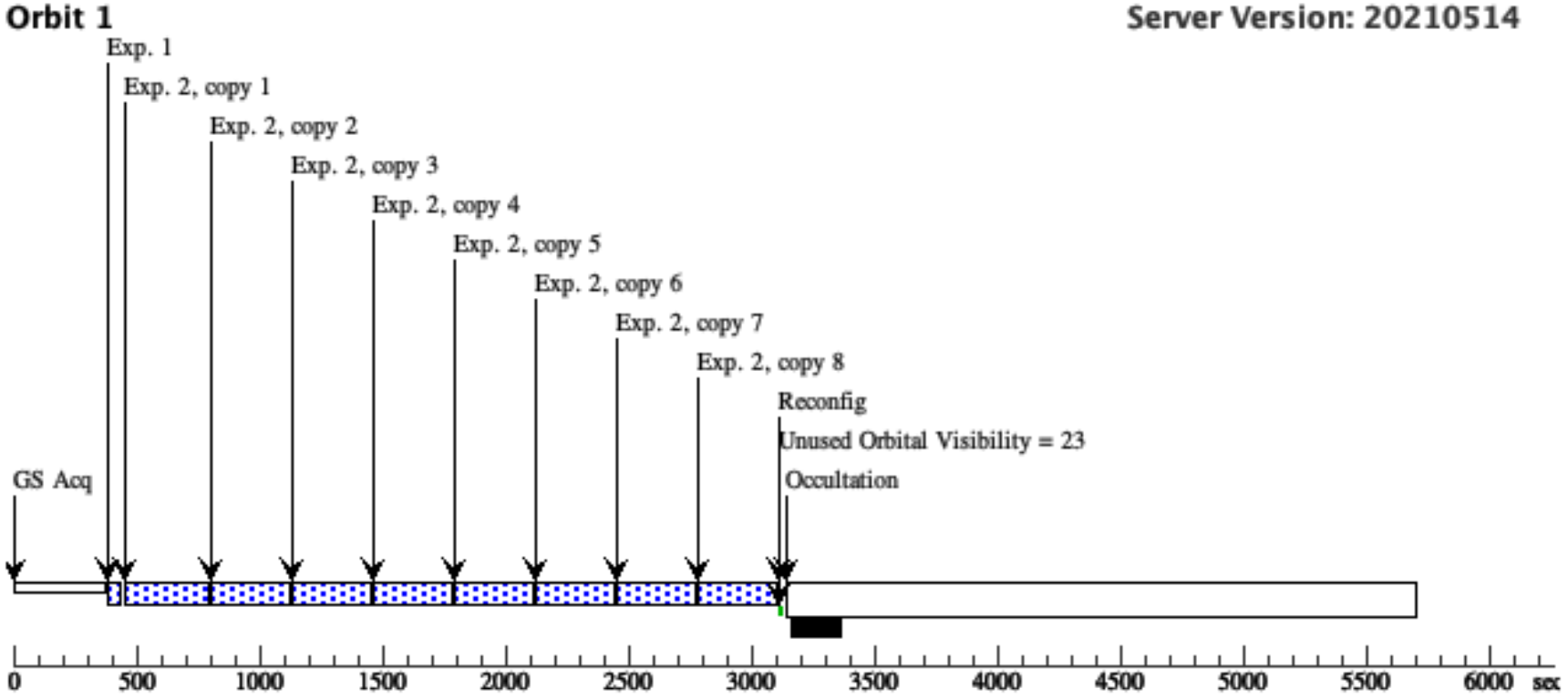
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2QZ-J103448.9+005200 Alt Name1: WD1032	RA: 10 34 48.8350 (158.7034792d) Dec: +00 52 1.68 (.86713d) Equinox: J2000	Proper Motion RA: -0.006373663258326685 sec of time/yr Proper Motion Dec: 0.020327 arcsec/yr Epoch of Position: 2015.5	V=19.2 z=19.29, Y=18.82, J=18.68, H=18.20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[BROWN DWARF, DA]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Direct Imaging (WFC3IR.im.1524257)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	F127M	NSAMP=5; SAMP-SEQ=SPARS10			29.663763 Secs (29.664 Secs) *[==>]*	***[1]***
2	Spectroscopy (WFC3IR.sp.1524255)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS25			313.122361 Secs X 8 (2504.979 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***

Orbit Structure



Visit

Proposal 16754, Visit 02, implementation Wed Sep 29 17:01:48 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: PCS MODE FINE; GUID TOL 0.005"; GYRO MODE 3GOBAD; SAME ORIENT AS 01

Comments: 2

Fixed Targets

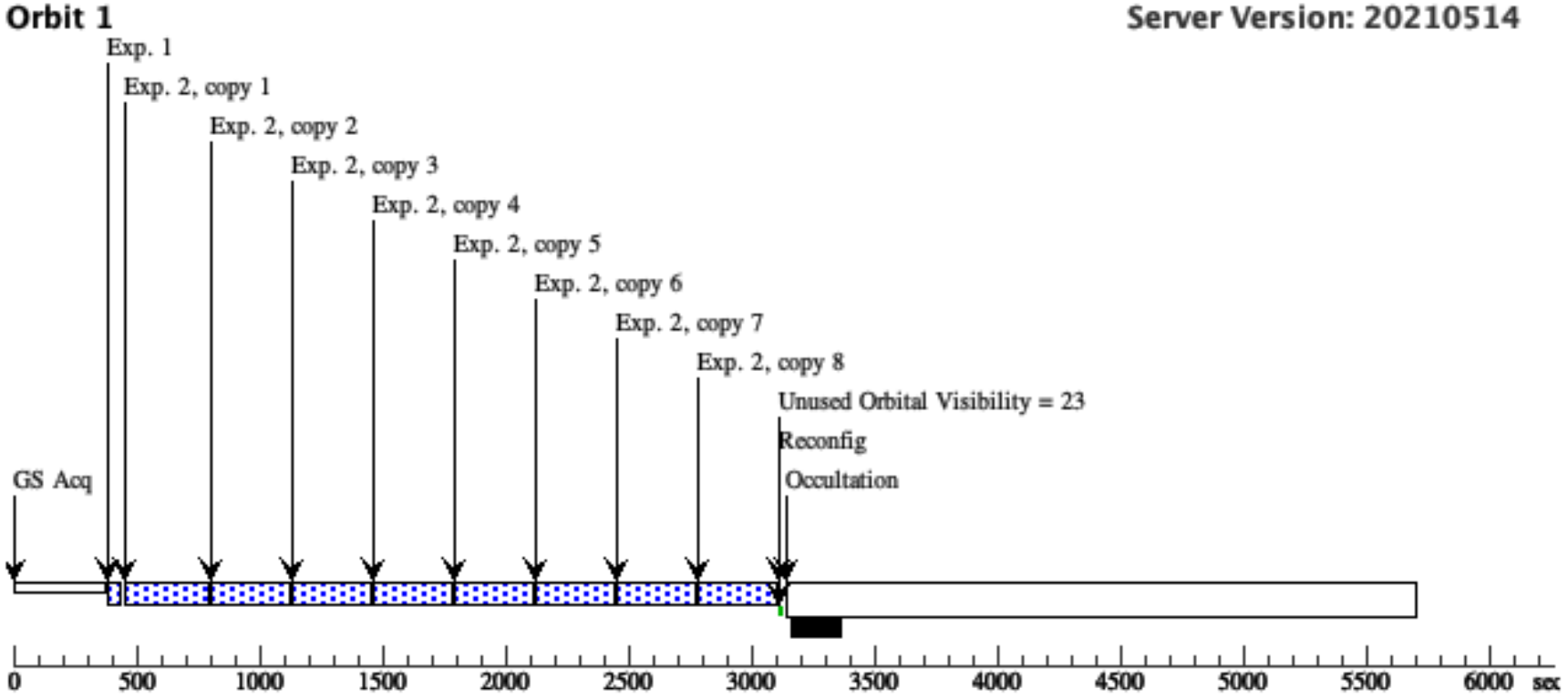
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2QZ-J103448.9+005200 Alt Name1: WD1032	RA: 10 34 48.8350 (158.7034792d) Dec: +00 52 1.68 (.86713d) Equinox: J2000	Proper Motion RA: -0.006373663258326685 sec of time/yr Proper Motion Dec: 0.020327 arcsec/yr Epoch of Position: 2015.5	V=19.2 z=19.29, Y=18.82, J=18.68, H=18.20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[BROWN DWARF, DA]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Direct Imaging (WFC3IR.im.1524257)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	F127M	NSAMP=5; SAMP-SEQ=SPARS10			29.663763 Secs (29.664 Secs) *[==>]*	***[1]***
2	Spectroscopy (WFC3IR.sp.1524255)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS25			313.122361 Secs X 8 (2504.979 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***

Orbit Structure



Visit

Proposal 16754, Visit 03, implementation Wed Sep 29 17:01:48 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: PCS MODE FINE; GUID TOL 0.005"; GYRO MODE 3GOBAD; SAME ORIENT AS 01

Comments: 2

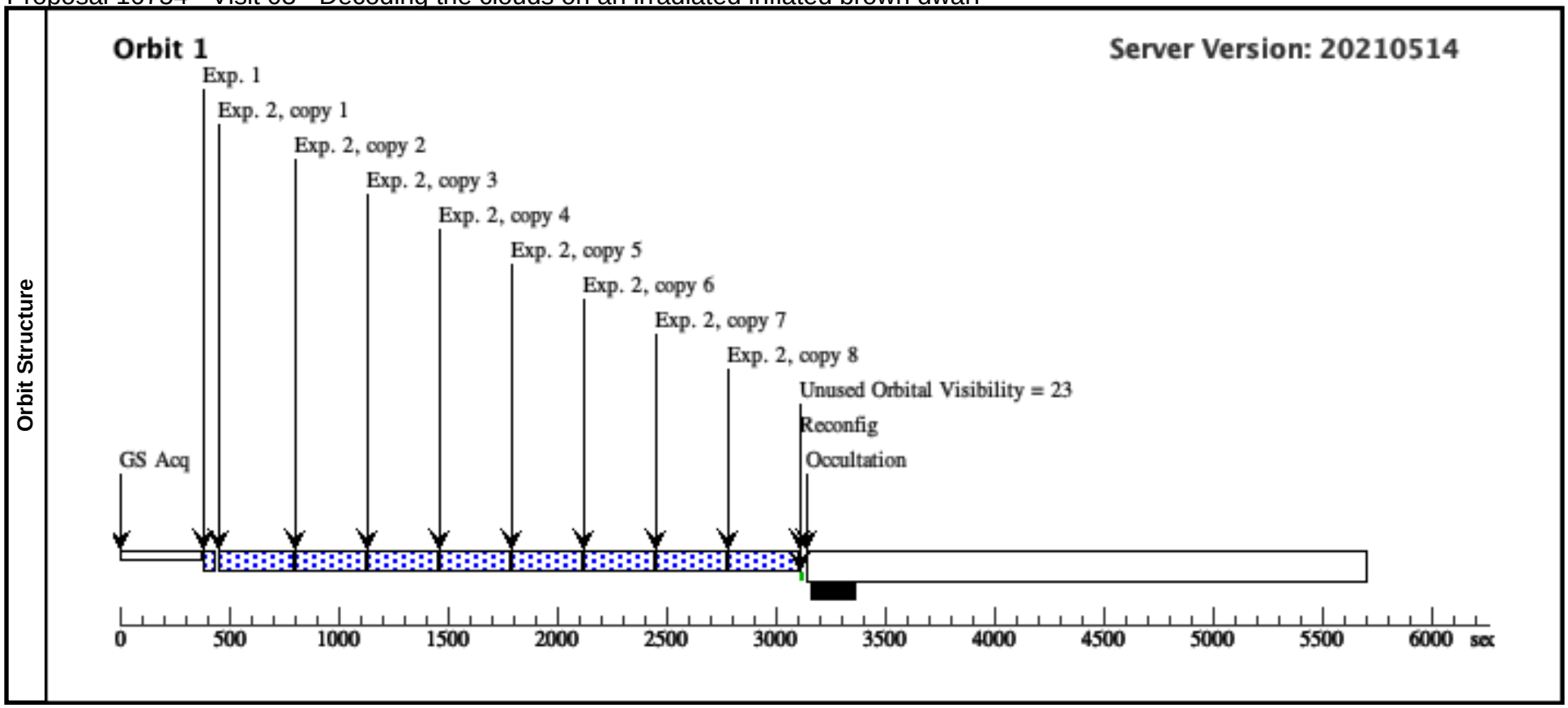
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2QZ-J103448.9+005200 Alt Name1: WD1032	RA: 10 34 48.8350 (158.7034792d) Dec: +00 52 1.68 (.86713d) Equinox: J2000	Proper Motion RA: -0.006373663258326685 sec of time/yr Proper Motion Dec: 0.020327 arcsec/yr Epoch of Position: 2015.5	V=19.2 z=19.29, Y=18.82, J=18.68, H=18.20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[BROWN DWARF, DA]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Direct Imaging (WFC3IR.im.1524257)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	F127M	NSAMP=5; SAMP-SEQ=SPARS10			29.663763 Secs (29.664 Secs) *[==>]*	 ***[1]***
2	Spectroscopy (WFC3IR.sp.1524255)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS25			313.122361 Secs X 8 (2504.979 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	 ***[1]***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Exp. 2, copy 7
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Occultation
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1500
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4500
5000
5500
6000
sec

Visit

Proposal 16754, Visit 04, implementation Wed Sep 29 17:01:48 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: PCS MODE FINE; GUID TOL 0.005"; GYRO MODE 3GOBAD; SAME ORIENT AS 01

Comments: 2

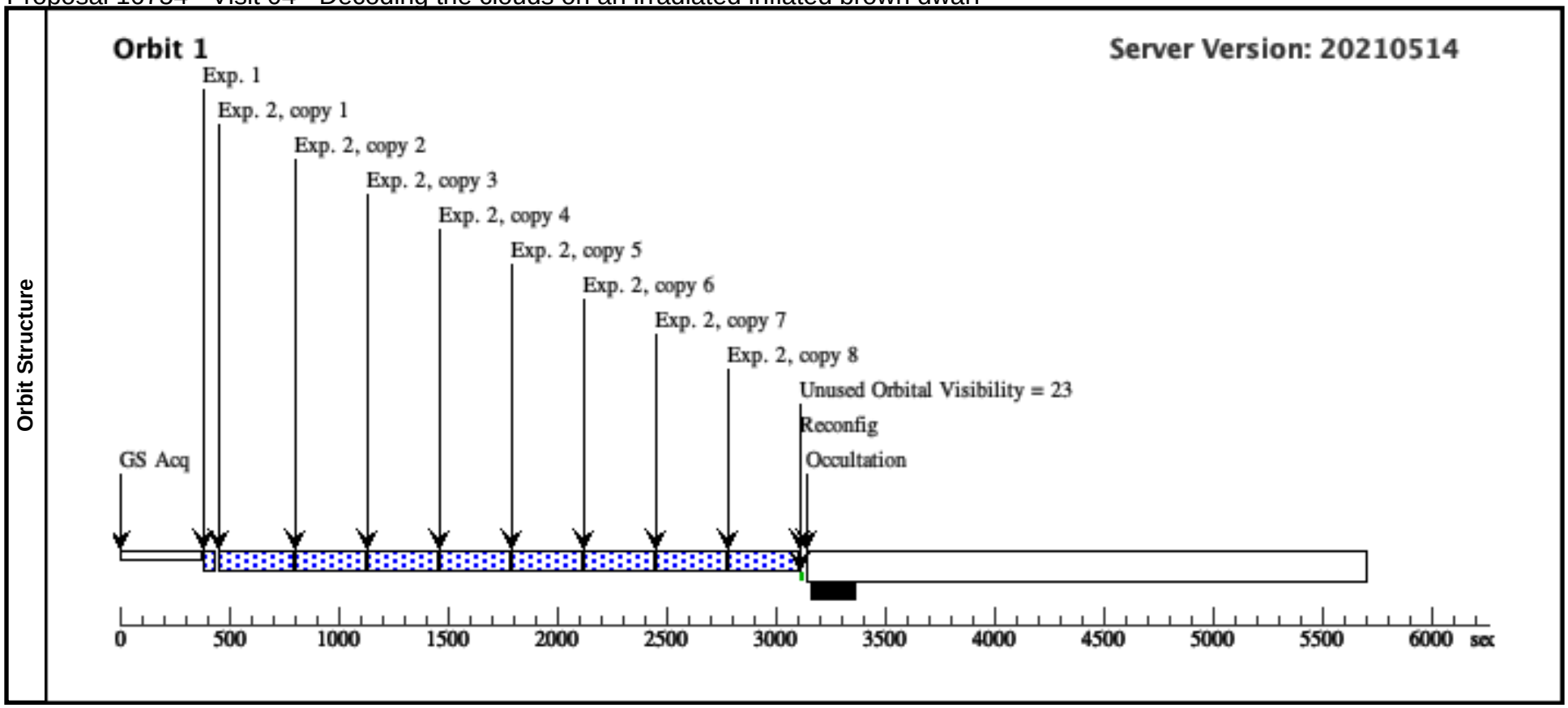
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2QZ-J103448.9+005200 Alt Name1: WD1032	RA: 10 34 48.8350 (158.7034792d) Dec: +00 52 1.68 (.86713d) Equinox: J2000	Proper Motion RA: -0.006373663258326685 sec of time/yr Proper Motion Dec: 0.020327 arcsec/yr Epoch of Position: 2015.5	V=19.2 z=19.29, Y=18.82, J=18.68, H=18.20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[BROWN DWARF, DA]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Direct Imaging (WFC3IR.im.1524257)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	F127M	NSAMP=5; SAMP-SEQ=SPARS10			29.663763 Secs (29.664 Secs) *[==>]*	***[1]***
2	Spectroscopy (WFC3IR.sp.1524255)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS25			313.122361 Secs X 8 (2504.979 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***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Exp. 2, copy 8
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Reconfig
Occultation
GS Acq
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1000
1500
2000
2500
3000
3500
4000
4500
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6000
sec

Visit

Proposal 16754, Visit 05, implementation Wed Sep 29 17:01:48 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: PCS MODE FINE; GUID TOL 0.005"; GYRO MODE 3GOBAD; SAME ORIENT AS 01

Comments: 2

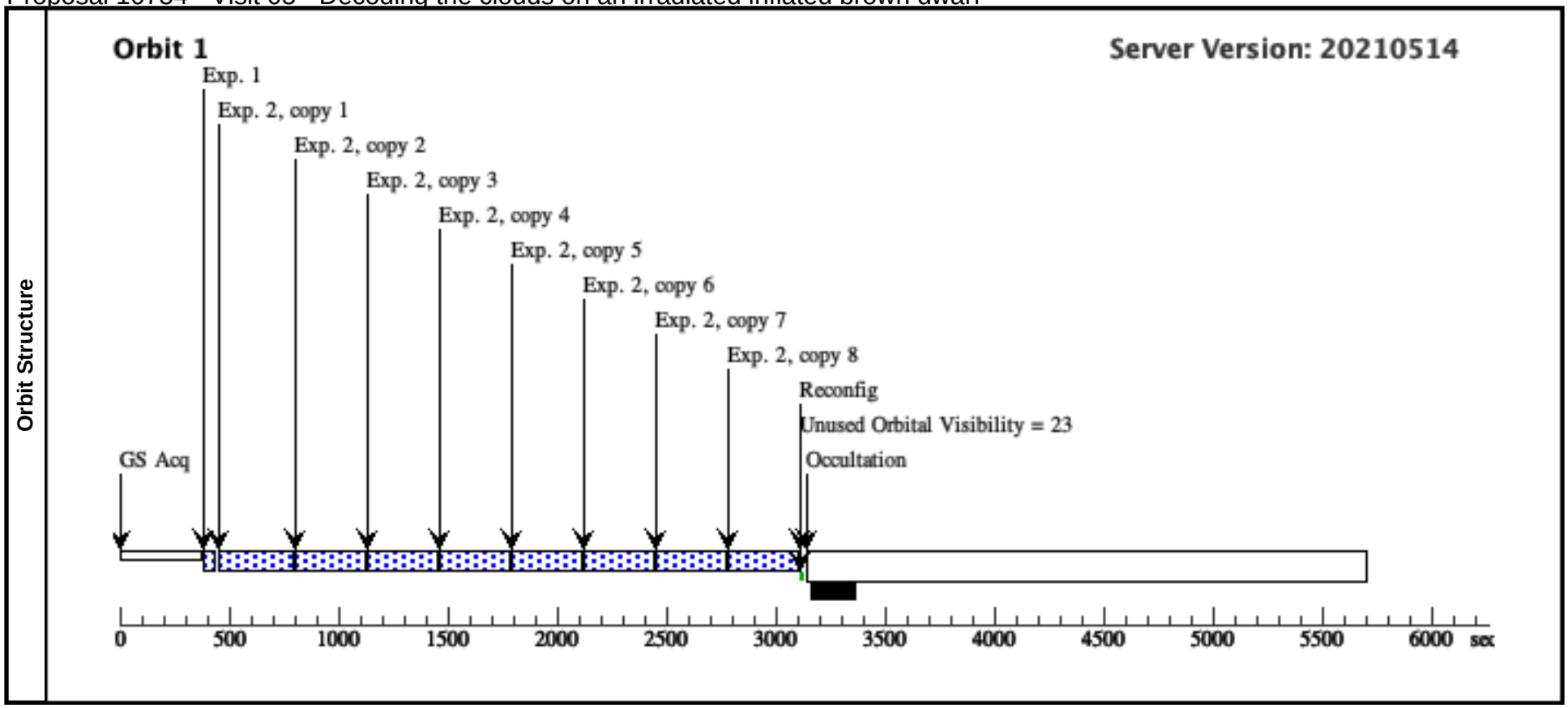
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2QZ-J103448.9+005200 Alt Name1: WD1032	RA: 10 34 48.8350 (158.7034792d) Dec: +00 52 1.68 (.86713d) Equinox: J2000	Proper Motion RA: -0.006373663258326685 sec of time/yr Proper Motion Dec: 0.020327 arcsec/yr Epoch of Position: 2015.5	V=19.2 z=19.29, Y=18.82, J=18.68, H=18.20	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[BROWN DWARF, DA]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Direct Imaging (WFC3IR.im.1524257)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	F127M	NSAMP=5; SAMP-SEQ=SPARS10			29.663763 Secs (29.664 Secs) *[==>]*	***[1]***
2	Spectroscopy (WFC3IR.sp.1524255)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS25			313.122361 Secs X 8 (2504.979 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	***[1]***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Reconfig
Unused Orbital Visibility = 23
Occultation
GS Acq
0
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1000
1500
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3000
3500
4000
4500
5000
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6000
sec

Visit

Proposal 16754, Visit 06, implementation Wed Sep 29 17:01:48 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: PCS MODE FINE; GUID TOL 0.005"; GYRO MODE 3GOBAD; SAME ORIENT AS 01

Comments: 2

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	2QZ-J103448.9+005200 Alt Name1: WD1032	RA: 10 34 48.8350 (158.7034792d) Dec: +00 52 1.68 (.86713d) Equinox: J2000	Proper Motion RA: -0.006373663258326685 sec of time/yr Proper Motion Dec: 0.020327 arcsec/yr Epoch of Position: 2015.5	V=19.2 z=19.29, Y=18.82, J=18.68, H=18.20	Reference Frame: SIMBAD

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Description=[BROWN DWARF, DA]
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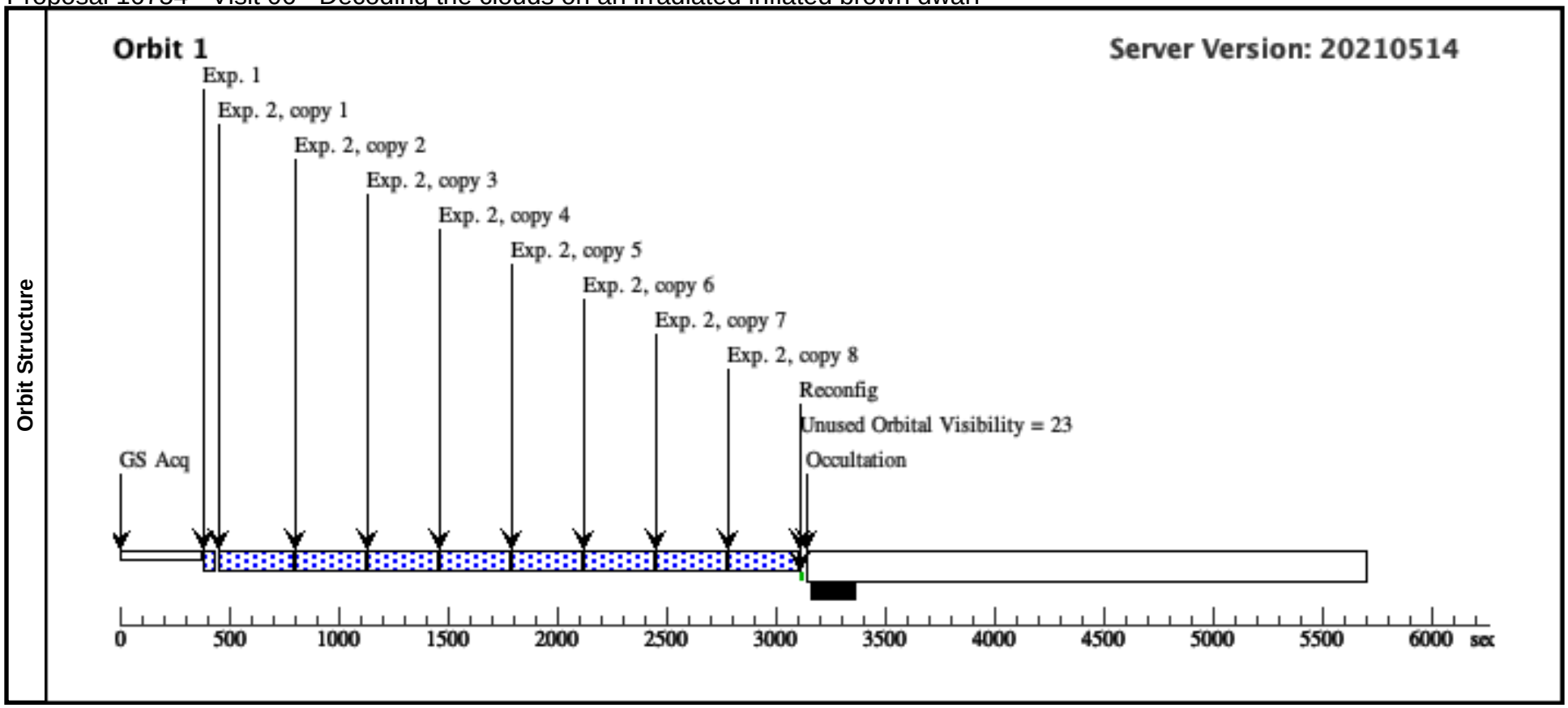
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Direct Imaging (WFC3IR.im.1524257)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	F127M	NSAMP=5; SAMP-SEQ=SPARS10			29.663763 Secs (29.664 Secs) *[==>]*	 ***[1]***
2	Spectroscopy (WFC3IR.sp.1524255)	(1) 2QZ-J103448.9+005200	WFC3/IR, MULTIACCUM, GRISM256	G141	NSAMP=15; SAMP-SEQ=SPARS25			313.122361 Secs X 8 (2504.979 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]* *[==>(Copy 3)]* *[==>(Copy 4)]* *[==>(Copy 5)]* *[==>(Copy 6)]* *[==>(Copy 7)]* *[==>(Copy 8)]*	 ***[1]***


Orbit Structure
Orbit 1
Server Version: 20210514
Exp. 1
Exp. 2, copy 1
Exp. 2, copy 2
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Reconfig
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sec