14173 - A Multiwavelength Study of the Nature of Diffuse Atomic and Molecular Gas

Cycle: 23, Proposal Category: GO

(UV Initiative)

(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) HD-165783	STIS/CCD STIS/FUV-MAMA	2	28-Mar-2016 10:32:08.0	yes
02	(1) HD-165783	STIS/CCD STIS/FUV-MAMA	2	28-Mar-2016 10:32:09.0	yes
03	(2) HD-165918	STIS/CCD STIS/FUV-MAMA	2	28-Mar-2016 10:32:10.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(3) HD-174509	STIS/CCD STIS/FUV-MAMA	3	28-Mar-2016 10:32:11.0	yes
05	(3) HD-174509	STIS/CCD STIS/FUV-MAMA	3	28-Mar-2016 10:32:12.0	yes

12 Total Orbits Used

ABSTRACT

Our proposed observations under the UV Initiative form a key component of a multiwavelength study of diffuse atomic and molecular clouds. The Herschel GOT C+ survey associated [C II] emission at 158 microns with emission from H I at 21 cm and CO at 2.6 mm, revealing the presence of warm neutral gas, cold neutral gas, CO-dark H2 gas, and molecular clouds. Ground-based measurements of Ca II, CH+, CH, and CN at visible wavelengths show absorption at the same velocities as the components seen in the GOT C+ survey. A main focus of our project is a detailed investigation of the nature of CO-dark H2 gas, interstellar material not associated with H I and CO emission. The presence of this additional material alters our view of molecular gas in galaxies and its connection to star formation rates. We propose ultraviolet observations of three targets with STIS that probe two of the pointings in the GOT C+ survey. Absorption from CO, at much greater sensitivies than is possible from surveying CO emission, will be sought. Analysis of CO, C I, and C2 absorption will yield the physical conditions (gas density and temperature) along the sight lines. The results will be compared with those inferred from CN chemistry based on the observations at visible wavelengths. Other probes seen at UV wavelengths, such as O I, Cu II, and Cl I, will provide a more complete picture of the environment seen in the atomic components of the GOT C+ survey. The outcome of the project will be the most detailed study of diffuse atomic and molecular gas from spectral measurements spanning nearly seven orders of magnitude in wavelength.

OBSERVING DESCRIPTION

We plan to obtain high-resolution (~ 2.8 km/s) far-UV STIS spectra with moderately high S/N ratio (20-40) of three targets, whose sight lines pass near pointings in the Herschel GOT C+ survey showing the presence of warm neutral gas, cold neutral gas, CO-dark H2 gas, and molecular clouds. The UV data will provide key information on the physical conditions for the diffuse atomic and molecular material through correspondences between velocity components seen in emission (GOT C+) and absorption (our HST study).

The targets were selected based on the facts that they had a range of atomic and molecular probes seen in absorption at visible wavelengths against

the continuum of the star and that they were bright enough for observations with E140H. The ground-based spectra at visible wavelengths from McDonald Observatory provide velocity structure for the atomic species Ca I and Ca II and the molecules CH, CH+, and CN; these high-resolution spectra will be useful in analyzing the absorption profiles seen in our UV data.

The observations will be based on data acquired with STIS/E140H grating and the 0.2x0.2 arcsecond aperture. The resolving power of E140H (R=114,000) provides a nice match to the spectra acquired at McDonald Observatory (R=135,000). To accomplish our goals, we require two grating settings, the ones at 1343 and 1380 A. Based on spectra available in the HST archive, these settings provide spectral bandpasses of 1242 to 1440 A and 1280 to 1475 A, respectively. Our previous studies indicate that absorption from the (3-0) band at 1447 A to the (12-0) band at 1246 A in the A-X system for CO may be present in HST spectra, depending on the amount of CO along the sight line. Absorption from C I arises from a series of lines from each fine structure level near 1260, 1280, and 1329 A. The spectral region also includes two bands of the F-X system in C2 at 1314 and 1342 A. Analysis of the observed excitation for the three species yields information on the density, temperature, and strength of the radiation permeating the gas. The combination of ground-based data on CH and HST data on C2 provides another measure of the density from chemical modeling. We will take advantage of the wavelength overlap region by combining the signal acquired at each setting to improve the S/N ratio, thereby allowing us to seek absorption from especially weak features. Since the CO band oscillator strengths are smaller at the shortest wavelengths covered by our planned observations, the added focus of spectra acquired with the 1343 A setting will improve the likelihood of detecting these weaker bands.

The observations will be obtained with the 0.2x0.2 arcsecond slit, providing a spectral resolution of about 2.8 km/s. The high resolution is needed to disentangle overlapping absorption features in CO, C I, and C2, especially when multiple diffuse clouds are present along the line of sight. Only HST/STIS can cover all the UV lines of interest at the required resolution.

The stars in our program were not observed with the IUE satellite, nor with other spectroscopic missions including ORFEUS. Therefore, we relied on the magnitudes and spectral types found in SIMBAD for our estimates of exposure times with the ETC. From these data we derived values for E(B-V) that are used in our estimates.

We investigated the possibility of safety concerns. HD 165783 is a Be star; IUE spectra of stars of similar spectral type (Psi Per, B5Ve and 6 Cep, B3 IVe) indicate that enhancements in the stellar flux from emission lines is much less than a factor of two. We note that all three stars are in the Guide Star Catalog. We also used the Aladin tool in the APT, and our targets are the brightest FUV sources within about a radius of 30 arcseconds. No warnings were given in the ETC outputs for ACQ or ACCUM.

The stars have declinations less than 30 degrees, and so 54 minutes are available per orbit. Because we will use the 0.2x0.2 arcsecond slit, the targets will be acquired with an ACQ. Taking overheads and target acquisition into account, the necessary observations can be obtained in 4/2/6 orbits for HD 165783/HD 165918/HD 174509. The observations will be acquired during a single visit for HD 165918 and during 2 visits for HD 165783 and HD 174509, thus within the requested length of 2 to 3 orbits per visit for Cycle 23. Individual orbits will contain a single spectroscopic observation at one of the two grating settings.

Visit

Proposal 14173, HD-165783-1 (01), completed Mon Mar 28 14:32:12 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

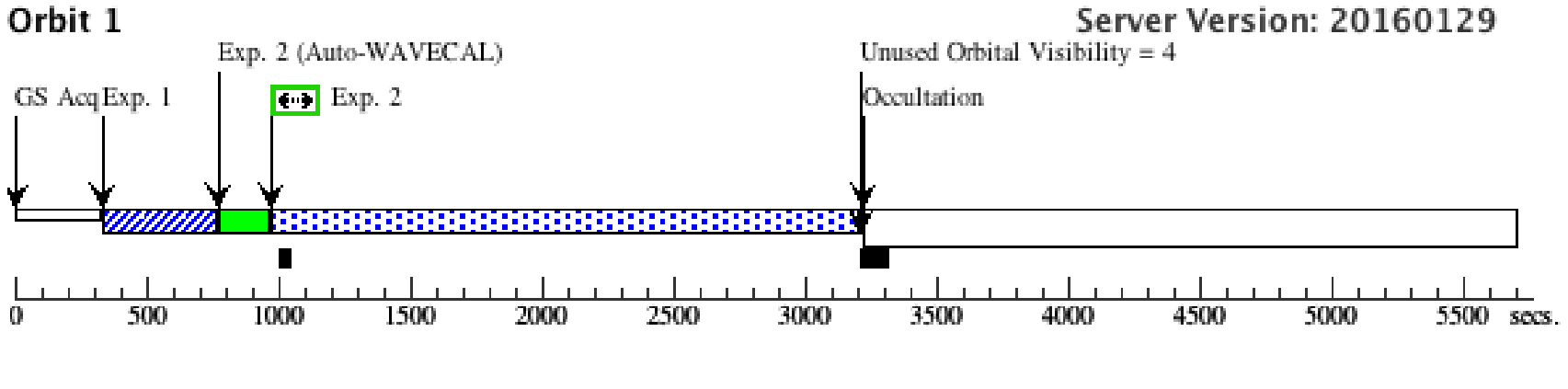
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-165783	RA: 18 08 27.0910 (272.1128792d) Dec: -19 52 7.96 (-19.86888d) Equinox: J2000	Proper Motion RA: -2.5 mas/yr Proper Motion Dec: -5.2 mas/yr Epoch of Position: 2000	V=8.33 B-V=0.27, E(B-V)=0.46, B3/5V	Reference Frame: ICRS

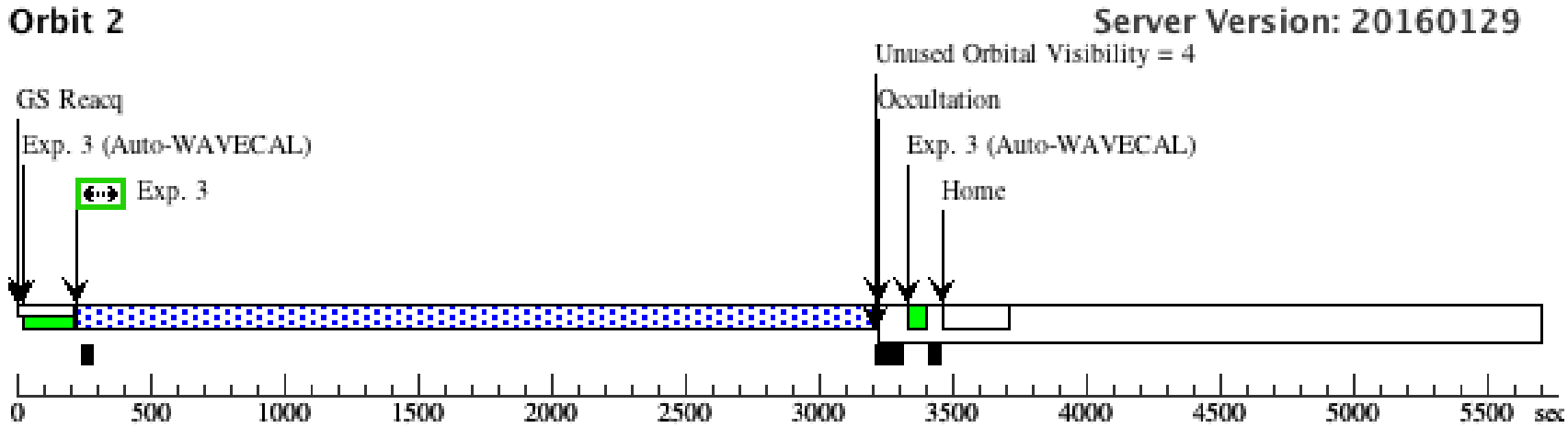
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	HD-165783-ACQ (STIS.ta.683082)	(1) HD-165783	STIS/CCD, ACQ, F25ND5	MIRROR				34 Secs (34 Secs) *[==>]*	*[1]*
Comments: Since this star has a spectral type B3V/B5V, I also used STIS.ta.683086.									
2	HD-165783-ACCUM1 (STIS.sp.733761)	(1) HD-165783	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1380 A				2210 Secs (2210 Secs) *[==>]*	*[1]*
Comments: Because this is a B3V/B5 V star, I also used STIS.sp.733762.									
3	HD-165783-ACCUM2 (STIS.sp.733763)	(1) HD-165783	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2965 Secs (2965 Secs) *[==>]*	*[2]*
Comments: Because this is a B3V/B5V star, I also used STIS.sp.733764.									

Orbit Structure





Visit

Proposal 14173, HD-165783-2 (02), completed Mon Mar 28 14:32:13 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

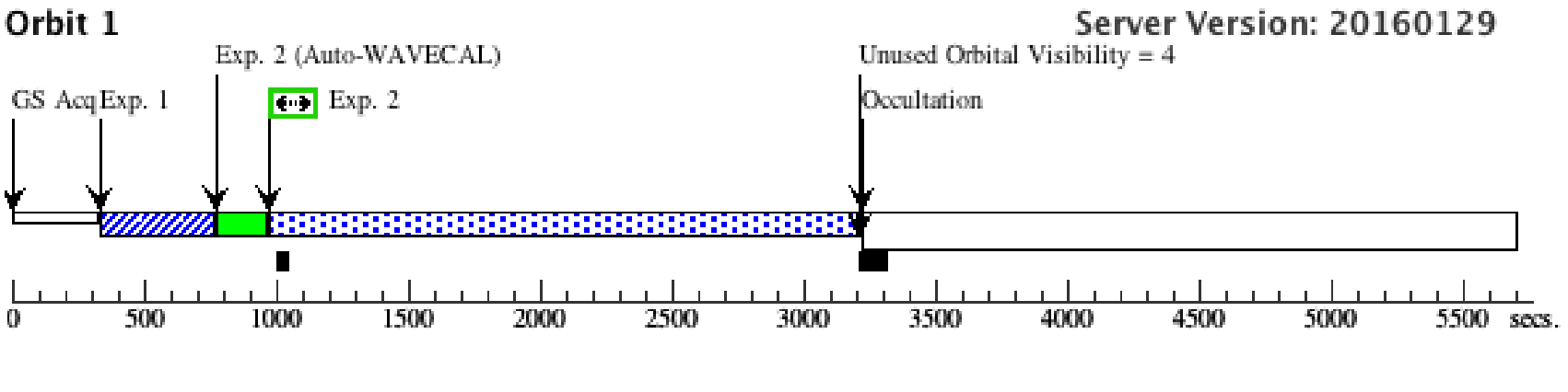
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-165783	RA: 18 08 27.0910 (272.1128792d) Dec: -19 52 7.96 (-19.86888d) Equinox: J2000	Proper Motion RA: -2.5 mas/yr Proper Motion Dec: -5.2 mas/yr Epoch of Position: 2000	V=8.33 B-V=0.27, E(B-V)=0.46, B3/5V	Reference Frame: ICRS

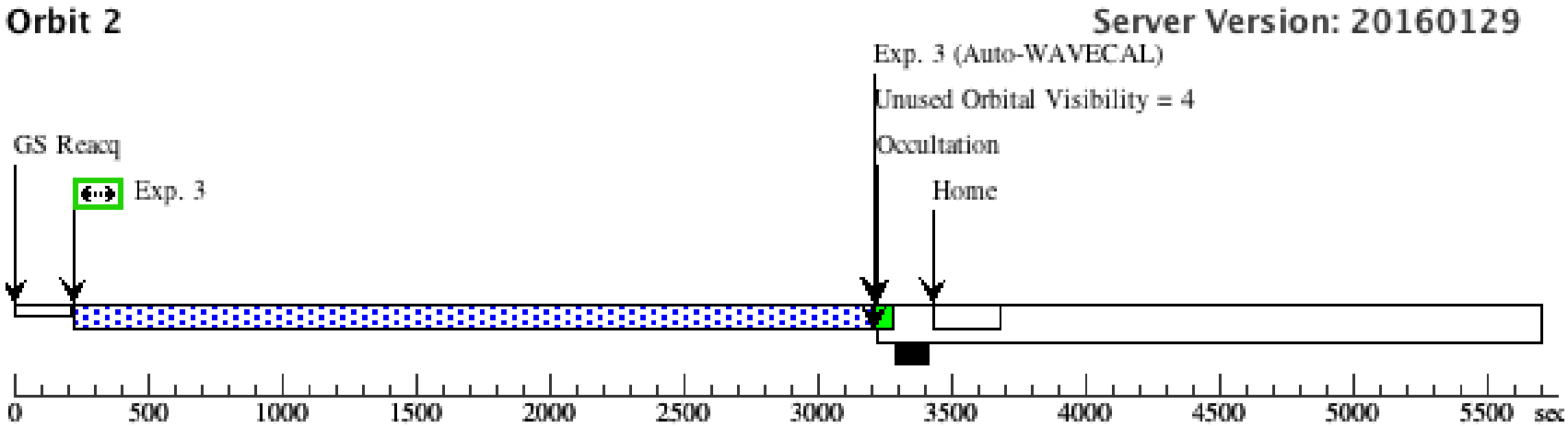
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	HD-165783-ACQ (STIS.ta.683082)	(1) HD-165783	STIS/CCD, ACQ, F25ND5	MIRROR				34 Secs (34 Secs) *[==>]*	***[1]***
Comments: Since this star has a spectral type B3V/B5V, I also used STIS.ta.683086.									
2	HD-165783-ACCUM1 (STIS.sp.733763)	(1) HD-165783	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2210 Secs (2210 Secs) *[==>]*	***[1]***
Comments: Because this is a B3V/B5V star, I also used STIS.sp.733764.									
3	HD-165783-ACCUM2 (STIS.sp.733763)	(1) HD-165783	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2965 Secs (2965 Secs) *[==>]*	***[2]***
Comments: Because this is a B3V/B5V star, I also used STIS.sp.733764.									

Orbit Structure





Visit

Proposal 14173, HD-165918-1 (03), completed Mon Mar 28 14:32:13 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

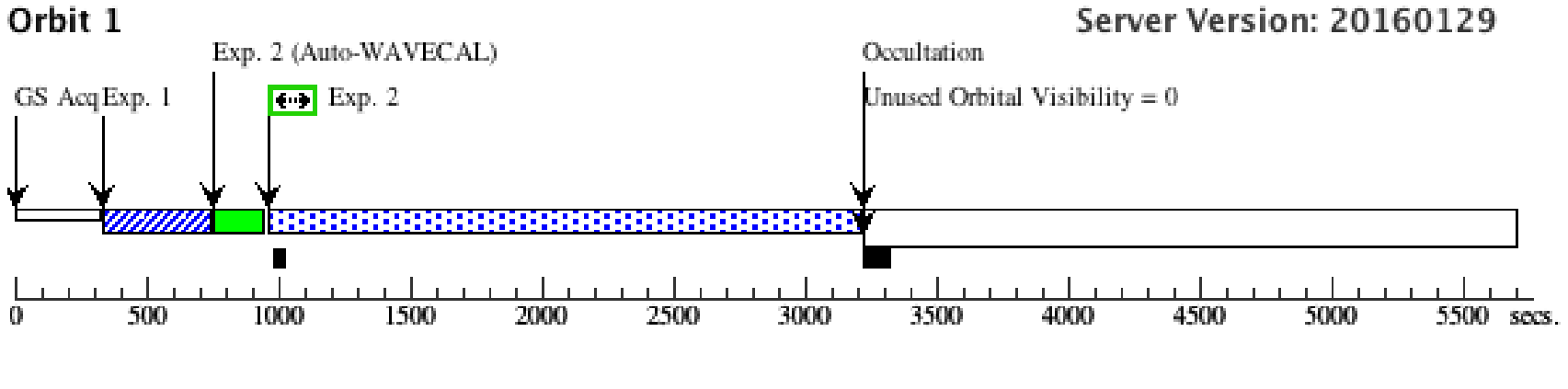
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	HD-165918	RA: 18 09 4.6439 (272.2693496d) Dec: -19 52 30.83 (-19.87523d) Equinox: J2000	Proper Motion RA: 0.8 mas/yr Proper Motion Dec: -7.3 mas/yr Epoch of Position: 2000	V=8.11+/-0.01 B-V=0.11, E(B-V)=0.26, B5IV/V	Reference Frame: ICRS

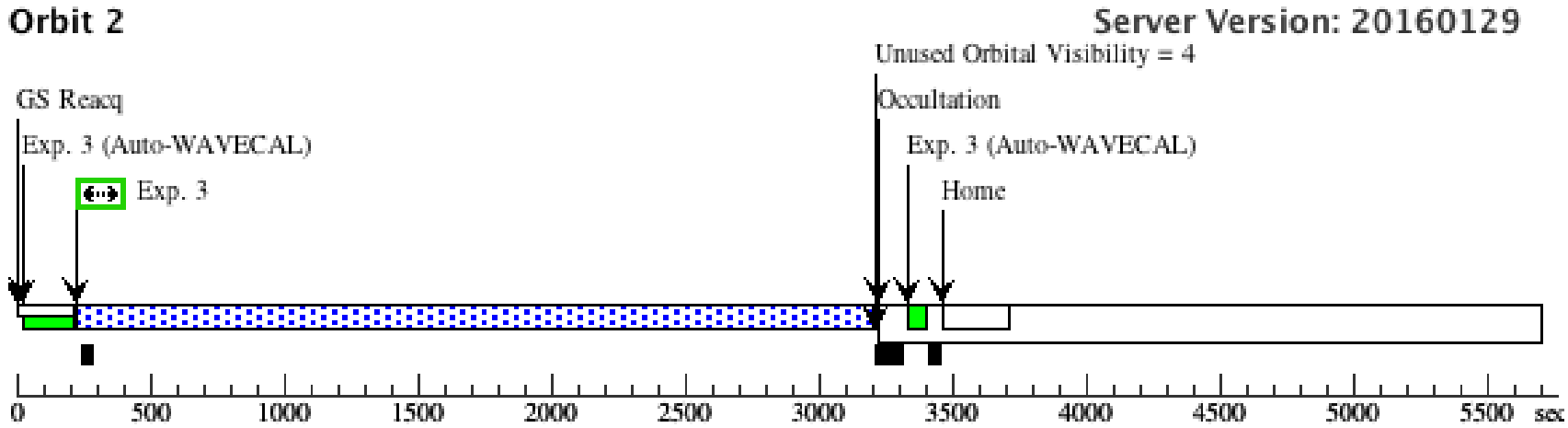
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	HD-165918-ACQ (STIS.ta.683092)	(2) HD-165918	STIS/CCD, ACQ, F25ND5	MIRROR				30 Secs (30 Secs) *[==>]*	*[1]*
2	HD-165918-ACCUM1 (STIS.sp.732764)	(2) HD-165918	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1380 A				2230 Secs (2230 Secs) *[==>]*	*[1]*
	Comments: Consistent with original calculation from STIS.sp.667418.								
3	HD-165918-ACCUM2 (STIS.sp.732749)	(2) HD-165918	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2965 Secs (2965 Secs) *[==>]*	*[2]*
	Comments: Consistent with original calculation from STIS.sp.679075.								

Orbit Structure





Visit

Proposal 14173, HD-174509-1 (04), implementation Mon Mar 28 14:32:13 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: ORIENT 1D TO 130 D; ORIENT 160D TO 360 D

Comments: ORIENT required because unknown object near target.

Fixed Targets

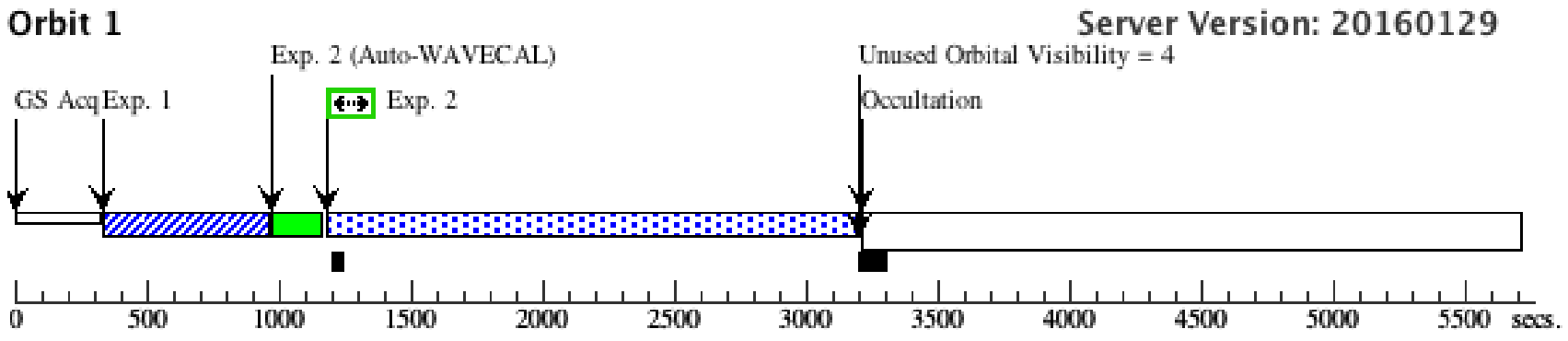
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	HD-174509	RA: 18 50 49.2820 (282.7053417d) Dec: -00 33 29.60 (-.55822d) Equinox: J2000	Proper Motion RA: 2.4 mas/yr Proper Motion Dec: -4.5 mas/yr Epoch of Position: 2000	V=9.27 B-V=0.21, E(B-V)=0.32, B8V	Reference Frame: ICRS

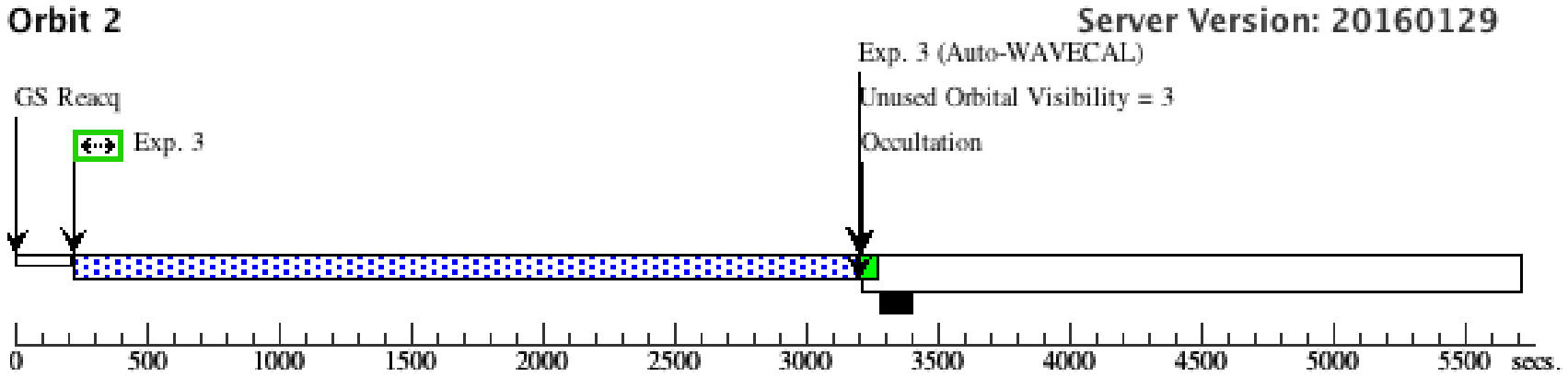
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

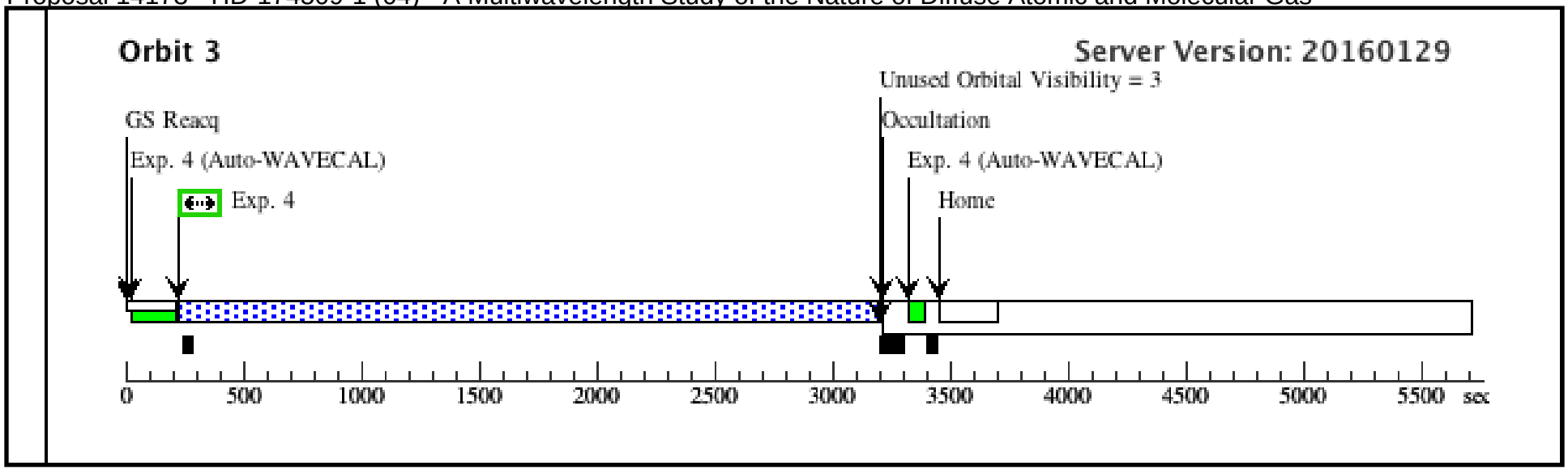
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	HD-174509-ACQ (STIS.ta.683105)	(3) HD-174509	STIS/CCD, ACQ, F25ND5	MIRROR				85 Secs (85 Secs) *[==>]*	***[1]***
2	HD-174509-ACCUM1 (STIS.sp.679234)	(3) HD-174509	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1380 A				1995 Secs (1995 Secs) *[==>]*	***[1]***
3	HD-174509-ACCUM2 (STIS.sp.679234)	(3) HD-174509	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1380 A				2955 Secs (2955 Secs) *[==>]*	***[2]***
4	HD-174509-ACCUM3 (STIS.sp.679224)	(3) HD-174509	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2955 Secs (2955 Secs) *[==>]*	***[3]***

Orbit Structure



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Occultation
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Exp. 4 (Auto-WAVECAL)
Exp. 4
Home
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500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14173, HD-174509-2 (05), implementation Mon Mar 28 14:32:13 GMT 2016

Diagnostic Status: No Diagnostics

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

Special Requirements: SAME ORIENT AS 04

Comments: ORIENT needed because unknown object near target.

Fixed Targets

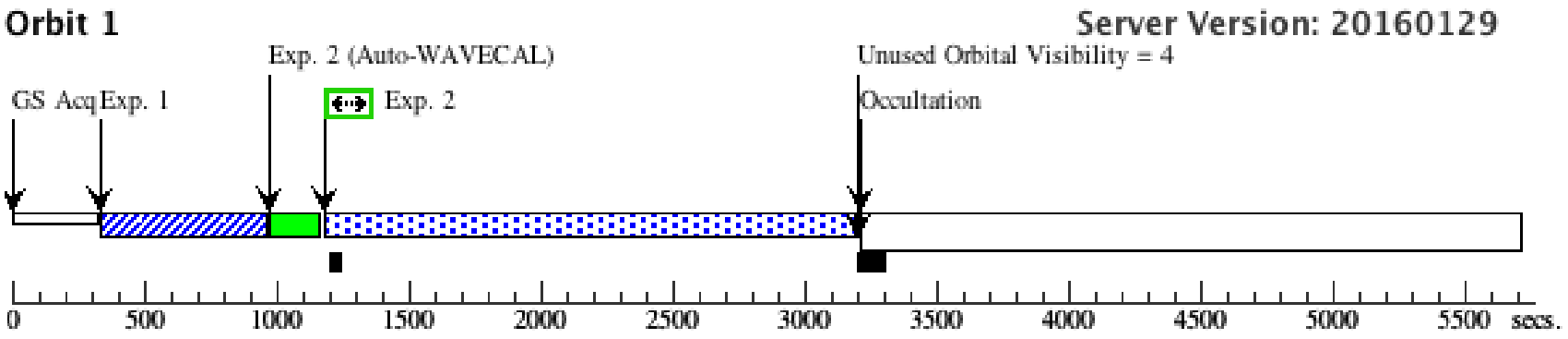
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	HD-174509	RA: 18 50 49.2820 (282.7053417d) Dec: -00 33 29.60 (-.55822d) Equinox: J2000	Proper Motion RA: 2.4 mas/yr Proper Motion Dec: -4.5 mas/yr Epoch of Position: 2000	V=9.27 B-V=0.21, E(B-V)=0.32, B8V	Reference Frame: ICRS

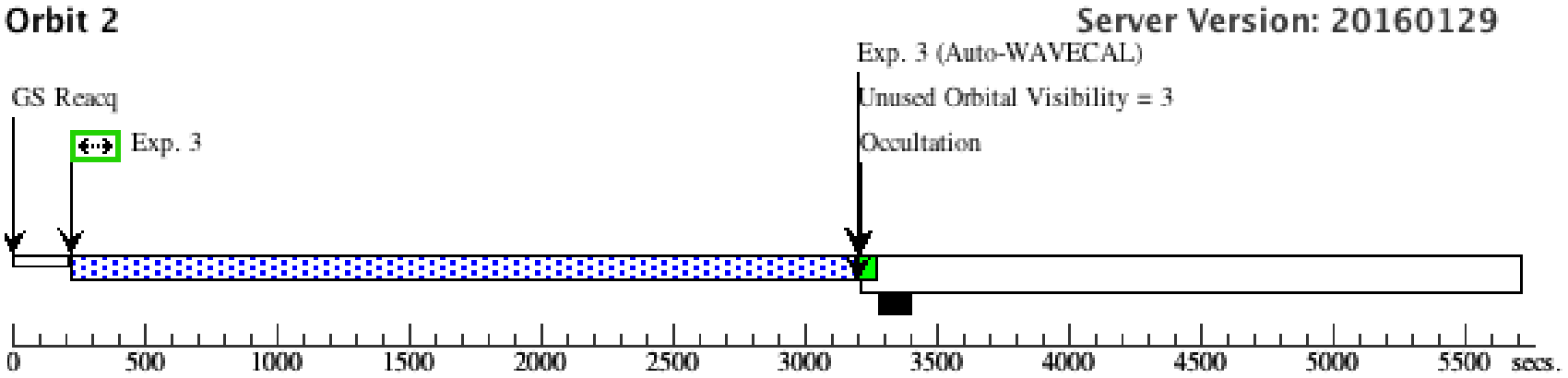
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

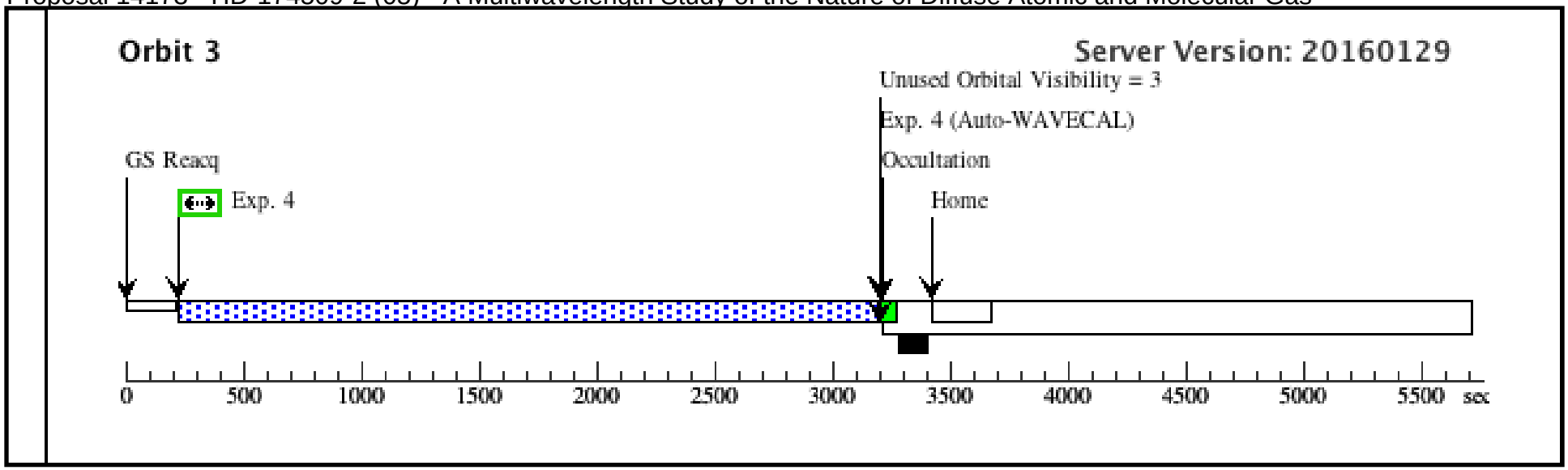
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	HD-174509-ACQ (STIS.ta.683105)	(3) HD-174509	STIS/CCD, ACQ, F25ND5	MIRROR				85 Secs (85 Secs) *[==>]*	***[1]***
2	HD-174509-ACCUM1 (STIS.sp.679224)	(3) HD-174509	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1995 Secs (1995 Secs) *[==>]*	***[1]***
3	HD-174509-ACCUM2 (STIS.sp.679224)	(3) HD-174509	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2955 Secs (2955 Secs) *[==>]*	***[2]***
4	HD-174509-ACCUM3 (STIS.sp.679224)	(3) HD-174509	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				2955 Secs (2955 Secs) *[==>]*	***[3]***

Orbit Structure



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GS Reacq
Occultation
Exp. 4
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2000
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3000
3500
4000
4500
5000
5500
sec