



## 15104 - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

### INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
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### VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) HD217943	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2018 16:01:03.0	yes
02	(2) HD147196	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2018 16:01:04.0	yes
03	(3) HD4768	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2018 16:01:05.0	yes
04	(4) HD94414	STIS/CCD STIS/FUV-MAMA	2	12-Dec-2018 16:01:05.0	yes
05	(5) HD220058	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2018 16:01:06.0	yes
06	(6) HD236101	STIS/CCD STIS/FUV-MAMA	1	12-Dec-2018 16:01:07.0	yes

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
07	(7) HD334041	STIS/CCD STIS/FUV-MAMA	3	12-Dec-2018 16:01:08.0	yes

10 Total Orbits Used

## **ABSTRACT**

The Planck Catalogue of Galactic Cold Clumps (PGCC) has identified the coldest regions of interstellar dust across the entire sky based on submillimeter emission. These sources range from relatively diffuse cold clouds to pre-stellar cores embedded in giant molecular clouds. In recent years, theoretical and observational evidence has shown that there exists a component of the cold molecular ISM that is "CO-dark" - that is, it contains very little carbon monoxide, the most common tracer of molecular hydrogen, and thus is hidden and unaccounted for in our measurements of the molecular content of the ISM. The PGCC represents an excellent test bed to probe for this CO-dark gas. To do so, we can use the high-resolution UV absorption line capabilities of the STIS instrument to probe for CO at higher sensitivities than CO emission line surveys. Furthermore, we can independently measure both the molecular hydrogen and total hydrogen content, which have been shown to correlate well with Cl I and O I absorption, respectively. As part of a previous archival survey, we identified existing STIS sightlines in the sky vicinity of PGCC objects, and found that a surprisingly small number of these sightlines displayed strong CO absorption. This general lack of CO absorption directly indicates the presence of CO-dark gas near these cold dust emission sources. However, our archival study found no high-resolution far-UV STIS spectra of any stars that lie directly behind a PGCC source. We now propose to observe seven sightlines that probe the central cores of these regions, allowing us to better characterize the prevalence and nature of CO-dark gas in these sources.

## **OBSERVING DESCRIPTION**

We propose to obtain high-resolution ( $R \sim 110,000$ ) STIS observations of selected inter-stellar UV absorption lines that were chosen based on their close vicinity on the sky to cold, dusty environments detected by Planck. Furthermore, we only selected sightlines that are clearly behind these regions, as determined by comparing Gaia parallax measurements for the stars to Planck distance estimates for the PGCC sources. We can address all of our stated scientific goals with the E140H echelle grating centered on 1343 Å (covering the wavelength interval 1242-1444 Å), and using the 0.2x0.2" slit (except for the case of HD 217943, whose UV flux requires the use of 31x0.05NDB neutral density filter to avoid the MAMA bright limits). This setup will simultaneously capture the O I line at 1355.60 Angstroms, the Cl I lines at 1347.24, 1373.11, 1379.53, 1389.69 Angstroms, and the C I multiplets near 1277, 1280, 1329 Angstroms. It will also capture eight bands of molecular CO absorption between 1263 and 1419 Angstroms. We aim to achieve a spectral sensitivity of  $S/N \sim 20$  for the Cl I line near the center of the bandpass.

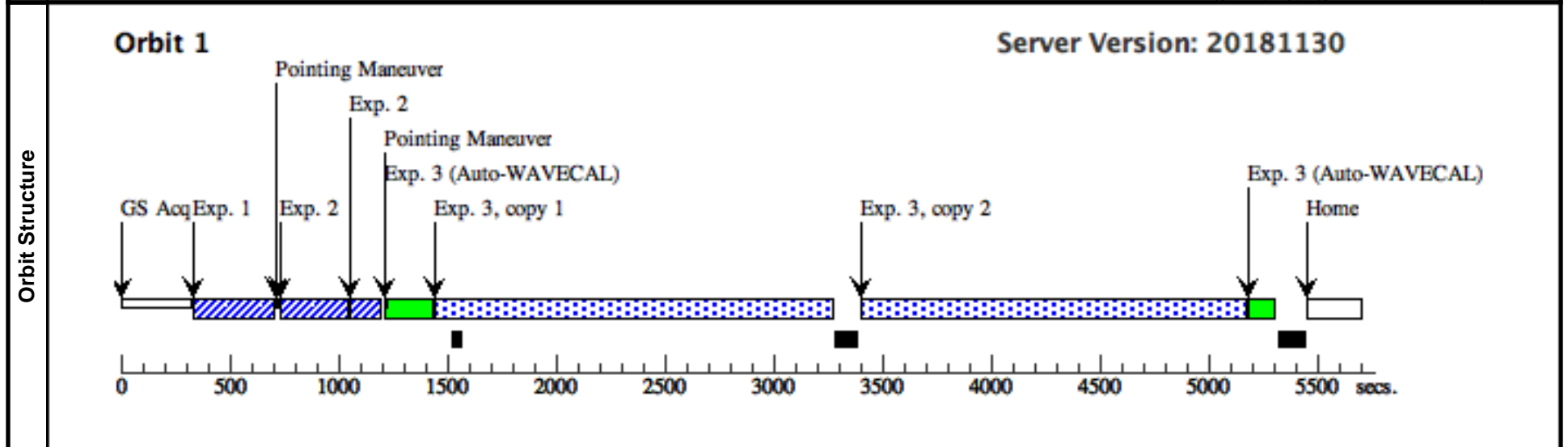
Proposal 15104 - HD217943 (01) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

<b>Visit</b>	<b>Proposal 15104, HD217943 (01), completed</b>				
	<b>Diagnostic Status: No Diagnostics</b>				
	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA				
	Special Requirements: CVZ				

<b>Fixed Targets</b>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	HD217943	RA: 23 03 23.7148 (345.8488117d)	Proper Motion RA: 6.98 mas/yr	V=6.733+/-0.01	Reference Frame: ICRS
		Alt Name1: HR8777	Dec: +60 26 43.47 (60.44541d)	Proper Motion Dec: -1.10 mas/yr		
		Alt Name2: HIP113853	Equinox: J2000	Parallax: 0.00209"		
				Epoch of Position: 2000		
<i>Comments: Coordinates, PMs, parallax and magnitude (and their associated errors) taken from the SIMBAD Database, when available. Listed as pulsating variable - analysis of Hipparcos light curve shows variability of order 0.02 mag (Dubath et al 2011).</i> Category=STAR Description=[B0-B2 V-IV, PULSATING VARIABLE] Extended=NO						

<b>Exposures</b>	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	Target Acquisition (1006683)	(1) HD217943	STIS/CCD, ACQ, F25ND5	MIRROR				20 Secs (20 Secs) [==>]	[1]
	2	Acquisition Peakup (1006700)	(1) HD217943	STIS/CCD, ACQ/PEAK, 0.3X0.05ND	MIRROR				0.7 Secs (0.7 Secs) [==>]	[1]
	3	Science Exposure (1006787)	(1) HD217943	STIS/FUV-MAMA, ACCUM, 31X0.05NDB	E140H 1343 A				1759 Secs X 2 (3518 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]



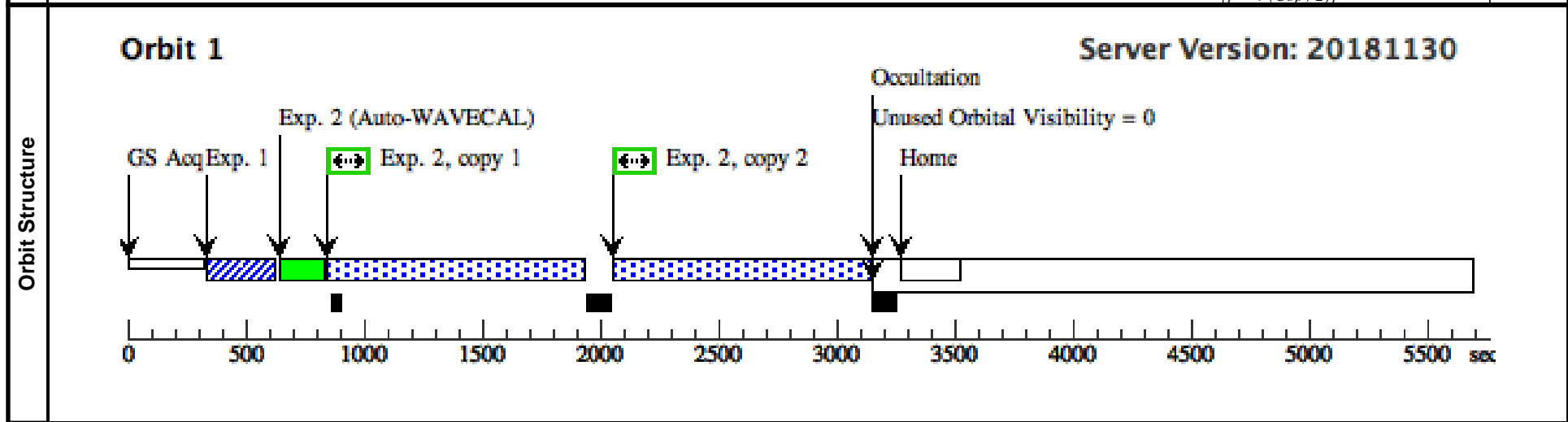
Proposal 15104 - HD147196 (02) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

<b>Visit</b>	<b>Proposal 15104, HD147196 (02), implementation</b>				
	<b>Diagnostic Status: No Diagnostics</b>				
	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA				
	Special Requirements: (none)				

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	HD147196 Alt Name1: HIP80126	RA: 16 21 19.1913 (245.3299637d) Dec: -23 42 28.75 (-23.70799d) Equinox: J2000	Proper Motion RA: -10.74 mas/yr Proper Motion Dec: -25.51 mas/yr Parallax: 0.00664" Epoch of Position: 2000	V=7.04+/-0.02	Reference Frame: ICRS
<i>Comments: Coordinates, PMs, parallax and magnitude (and their associated errors) taken from the SIMBAD Database, when available. V magnitude error taken from Tycho-2 VT and BT magnitudes</i>					
Category=STAR Description=[B6-B9.5 V-IV, BE] Extended=NO					

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target Acquisition (1006655)	(2) HD147196	STIS/CCD, ACQ, F25ND3	MIRROR		GS ACQ SCENARIO BASE1B3		0.3 Secs (0.3 Secs) [==>]	[1]
<i>Comments: Previously observed in 2015 in the optical with STIS - used same target acquisition exposure settings as that visit.</i>									
2	Science Exposure (1006790)	(2) HD147196	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1074 Secs X 2 (2148 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]



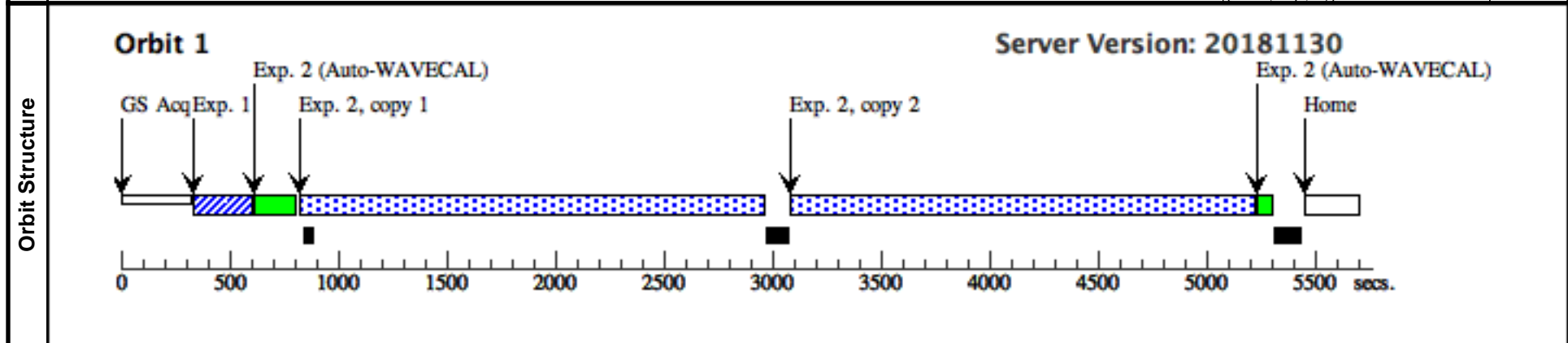
Proposal 15104 - HD4768 (03) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

<b>Visit</b>	<b>Proposal 15104, HD4768 (03), completed</b>				
	<b>Diagnostic Status: No Diagnostics</b>				
	Scientific Instruments: STIS/CCD, STIS/FUV-MAMA				
	Special Requirements: CVZ				

<b>Fixed Targets</b>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(3)	HD4768	RA: 00 50 27.9210 (12.6163375d)	Proper Motion RA: -2.86 mas/yr	V=7.57+/-0.01	Reference Frame: ICRS
		Alt Name1: HIP3932	Dec: +59 40 18.30 (59.67175d)	Proper Motion Dec: -0.71 mas/yr		
			Equinox: J2000	Parallax: 0.00094"		
				Epoch of Position: 2000		
<i>Comments: Coordinates, PMs, parallax and magnitude (and their associated errors) taken from the SIMBAD Database, when available. Error in V magnitude determined from Tycho-2 VT and BT magnitudes.</i> Category=STAR Description=[B6-B9.5 III-I, EMISSION LINE STAR] Extended=NO						

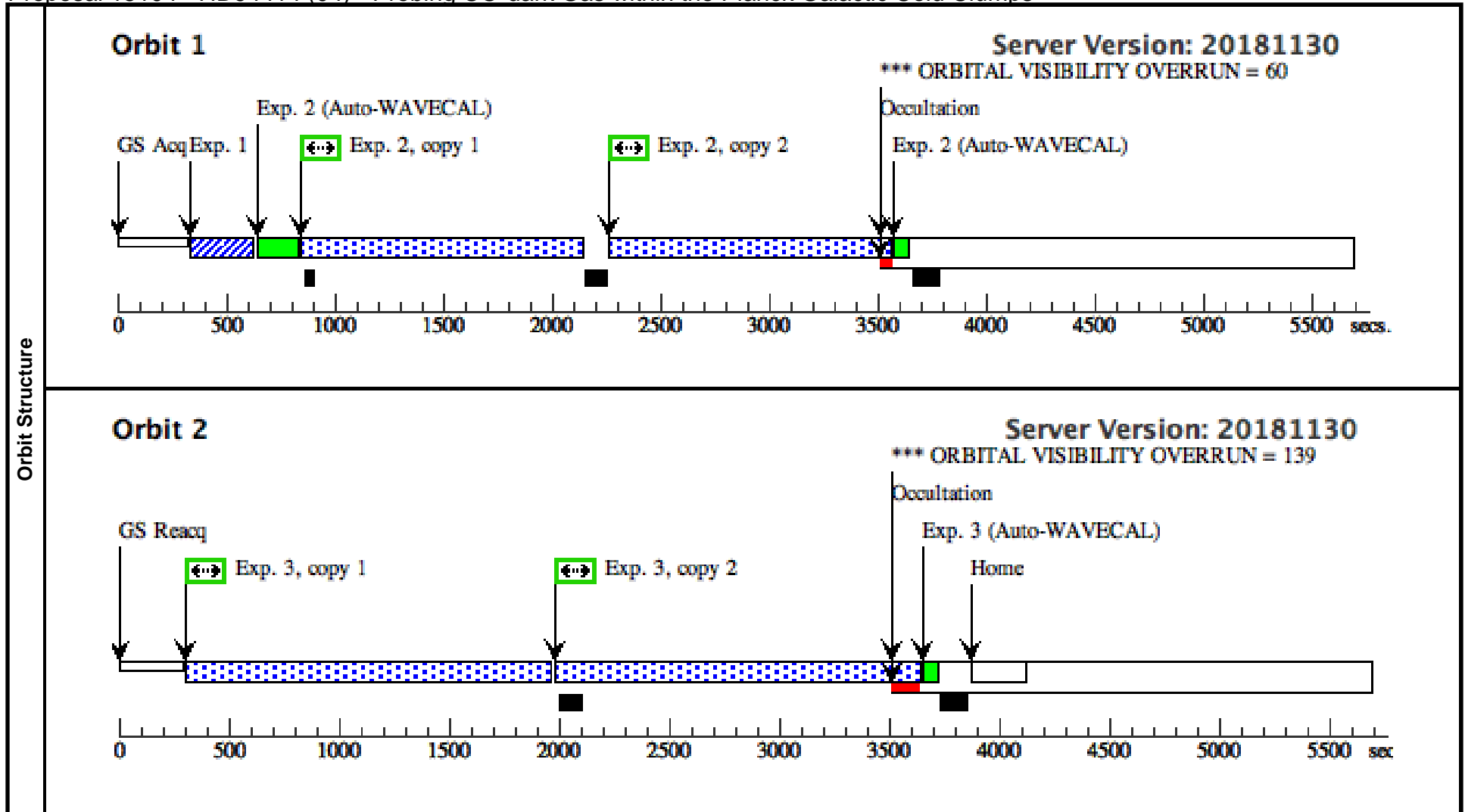
<b>Exposures</b>	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	Target Acquisition (1006664)	(3) HD4768	STIS/CCD, ACQ, F28X50OIII	MIRROR				0.3 Secs (0.3 Secs)	[1]
									[==>]	
<i>Comments: Listed as emission line star in SIMBAD. No optical data is currently available to gauge strength of emission lines, so we choose the O III filter to minimize wavelength coverage.</i>										
	2	Science Exposure (1006791)	(3) HD4768	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H	1343 A			2125 Secs X 2 (4250 Secs)	[1]
									[==>(Copy 1)] [==>(Copy 2)]	



Proposal 15104 - HD94414 (04) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

<b>Visit</b>	<b>Proposal 15104, HD94414 (04), implementation</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: (none)									
	(HD94414 (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN (HD94414 (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN									
<b>Diagnosics</b>										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(4)	HD94414 Alt Name1: HIP53024	RA: 10 50 55.9455 (162.7331063d) Dec: -77 07 28.58 (-77.12461d) Equinox: J2000	Proper Motion RA: -18.95 mas/yr Proper Motion Dec: -1.20 mas/yr Parallax: 0.0028" Epoch of Position: 2000	V=8.01+/-0.01	Reference Frame: ICRS				
<i>Comments: Coordinates, PMs, parallax and magnitude (and their associated errors) taken from the SIMBAD Database, when available.                  Category=STAR                  Description=[B3-B5 V-IV]                  Extended=NO</i>										
<b>Exposures</b>	<b>#</b>	<b>Label (ETC Run)</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	Target Acquisition (Orbit 1) (1006667)	(4) HD94414	STIS/CCD, ACQ, F25ND3	MIRROR				0.3 Secs (0.3 Secs) [==>]	[1]
	2	Science Exposure (Orbit 1) (1006792)	(4) HD94414	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1285 Secs X 2 (2570 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]
	3	Science Exposure (Orbit 2) (1006793)	(4) HD94414	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1651 Secs X 2 (3302 Secs) [==>(Copy 1)] [==>(Copy 2)]	[2]



Proposal 15104 - HD220058 (05) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

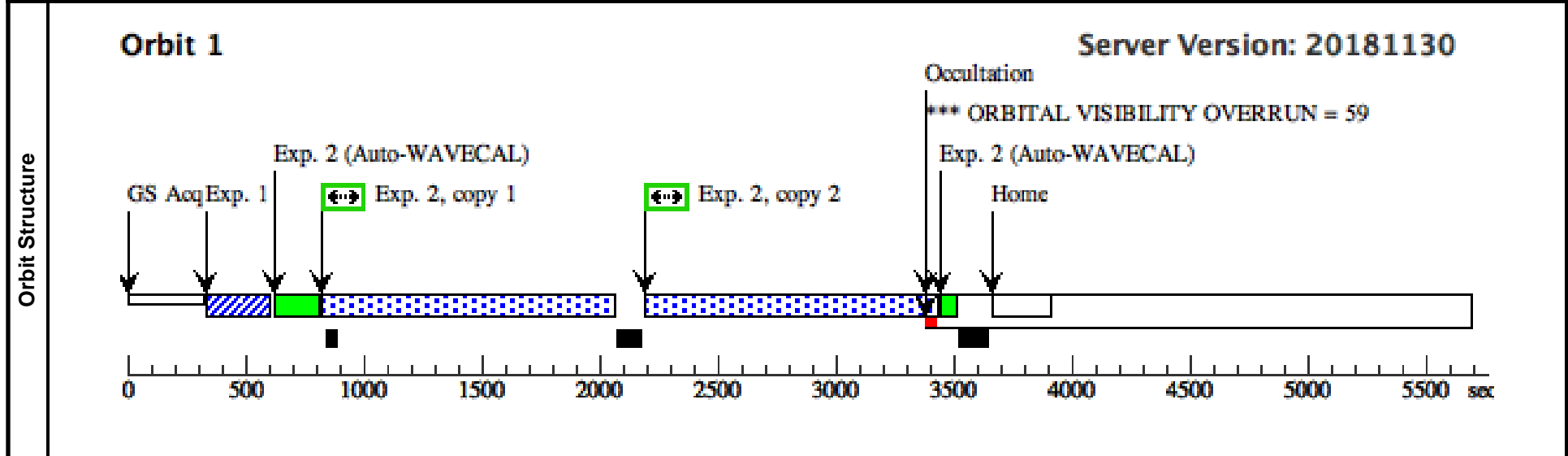
<b>Visit</b>	Proposal 15104, HD220058 (05), completed <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: (none)
	(HD220058 (05)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

<b>Diagnostics</b>	(HD220058 (05)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	HD220058	RA: 23 20 19.0165 (350.0792354d)	Proper Motion RA: -2.69 mas/yr	V=8.59+/-0.02	Reference Frame: ICRS
	Alt Name1: HIP115224	Dec: +55 48 28.08 (55.80780d)	Proper Motion Dec: -0.87 mas/yr		
		Equinox: J2000	Parallax: 0.0014"		
			Epoch of Position: 2000		

*Comments: Coordinates, PMs, parallax and magnitude (and their associated errors) taken from the SIMBAD Database, when available. Error in V magnitude determined from Tycho-2 VT and BT magnitudes. Category=STAR  
Description=[B0-B2 V-IV, BE]  
Extended=NO*

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target Acq isition (1006671)	(5) HD220058	STIS/CCD, ACQ, F28X500III	MIRROR				0.7 Secs (0.7 Secs) [==>]	[1]
<i>Comments: Listed as Be star in SIMBAD. No optical data is currently available to gauge strength of emission lines, so we choose the O III filter to minimize wavelength coverage.</i>									
2	Science Exposure (1006794)	(5) HD220058	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1229 Secs X 2 (2458 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]



Proposal 15104 - HD236101 (06) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

<b>Visit</b>	Proposal 15104, HD236101 (06), completed <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: (none)																																		
<b>Diagnostics</b>	(HD236101 (06)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN																																		
<b>Fixed Targets</b>	# (6) Name HD236101 Target Coordinates RA: 23 20 29.4492 (350.1227050d) Dec: +54 34 39.97 (54.57777d) Equinox: J2000 Comments: Coordinates, PMs, parallax and magnitude (and their associated errors) taken from the SIMBAD Database, when available. Category=STAR Description=[B6-B9.5 V-IV] Extended=NO	Targ. Coord. Corrections Proper Motion RA: 0.2 mas/yr Proper Motion Dec: 0.5 mas/yr Epoch of Position: 2000	Fluxes V=9.39+/-0.02	Miscellaneous Reference Frame: ICRS																															
<b>Exposures</b>	<table border="1"> <thead> <tr> <th>#</th> <th>Label (ETC Run)</th> <th>Target</th> <th>Config,Mode,Aperture</th> <th>Spectral Els.</th> <th>Opt. Params.</th> <th>Special Reqs.</th> <th>Groups</th> <th>Exp. Time (Total)/[Actual Dur.]</th> <th>Orbit</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Target Acq isition (1006673)</td> <td>(6) HD236101</td> <td>STIS/CCD, ACQ, F25ND3</td> <td>MIRROR</td> <td></td> <td></td> <td></td> <td>1.0 Secs (1 Secs) [==&gt;]</td> <td>[1]</td> </tr> <tr> <td>2</td> <td>Science Exposure (1006795)</td> <td>(6) HD236101</td> <td>STIS/FUV-MAMA, ACCUM, 0.2X0.2</td> <td>E140H 1343 A</td> <td></td> <td></td> <td></td> <td>1190 Secs X 2 (2380 Secs) [==&gt;(Copy 1)] [==&gt;(Copy 2)]</td> <td>[1]</td> </tr> </tbody> </table>	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	1	Target Acq isition (1006673)	(6) HD236101	STIS/CCD, ACQ, F25ND3	MIRROR				1.0 Secs (1 Secs) [==>]	[1]	2	Science Exposure (1006795)	(6) HD236101	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1190 Secs X 2 (2380 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]				
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit																										
1	Target Acq isition (1006673)	(6) HD236101	STIS/CCD, ACQ, F25ND3	MIRROR				1.0 Secs (1 Secs) [==>]	[1]																										
2	Science Exposure (1006795)	(6) HD236101	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1190 Secs X 2 (2380 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]																										
<b>Orbit Structure</b>	<div style="display: flex; justify-content: space-between;"> <span>Orbit 1</span> <span>Server Version: 20181130</span> </div> <p>The diagram shows a timeline from 0 to 5500 seconds. Key events include: GS Acq (0-50s), Exp. 1 (50-100s), Exp. 2 (Auto-WAVECAL) (100-2000s), Exp. 2, copy 1 (2000-2100s), Exp. 2, copy 2 (2100-3300s), Occultation (3300-3400s), Exp. 2 (Auto-WAVECAL) (3400-3500s), and Home (3500-3600s). A red vertical bar at 3300s indicates the occultation event. A warning message states: '*** ORBITAL VISIBILITY OVERRUN = 60'.</p>																																		

Proposal 15104 - HD334041 (07) - Probing CO-dark Gas within the Planck Galactic Cold Clumps

Wed Dec 12 21:01:09 GMT 2018

<b>Visit</b>	<b>Proposal 15104, HD334041 (07), implementation</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD, STIS/FUV-MAMA Special Requirements: (none)									
	(HD334041 (07)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN (HD334041 (07)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN (HD334041 (07)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN									
<b>Diagnosics</b>										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>	<b>Targ. Coord. Corrections</b>	<b>Fluxes</b>	<b>Miscellaneous</b>				
	(7)	HD334041	RA: 20 17 51.5088 (304.4646200d) Dec: +30 57 38.05 (30.96057d) Equinox: J2000	Proper Motion RA: 0.0 mas/yr Proper Motion Dec: -3.9 mas/yr Epoch of Position: 2000	V=10.36+/-0.05	Reference Frame: ICRS				
<i>Comments: Coordinates, PMs, and parallax (and their associated errors) taken from the SIMBAD Database. V magnitude and its associated error determined from Tycho-2 VT and BT magnitudes.</i> Category=STAR Description=[B6-B9.5 V-IV, EMISSION LINE STAR] Extended=NO										
<b>Exposures</b>	<b>#</b>	<b>Label (ETC Run)</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time (Total)/[Actual Dur.]</b>	<b>Orbit</b>
	1	Target Acquisition (Orbit 1) (1006678)	(7) HD334041	STIS/CCD, ACQ, F25ND3	MIRROR				3.0 Secs (3 Secs) [==>]	[1]
	2	Science Exposure (Orbit 1) (1006797)	(7) HD334041	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1109 Secs X 2 (2218 Secs) [==>(Copy 1)] [==>(Copy 2)]	[1]
	3	Science Exposure (Orbit 2) (1006799)	(7) HD334041	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1372 Secs X 2 (2744 Secs) [==>(Copy 1)] [==>(Copy 2)]	[2]
	4	Science Exposure (Orbit 3) (1006799)	(7) HD334041	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140H 1343 A				1372 Secs X 2 (2744 Secs) [==>(Copy 1)] [==>(Copy 2)]	[3]

