11736 - The Nearest Cold Interstellar Cloud

Cycle: 17, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. David M. Meyer (PI)	**Northwestern University**	**davemeyer@northwestern.edu**
Dr. James T. Lauroesch (CoI)	University of Louisville Research Foundation, Inc.	jtlaur01@louisville.edu
Dr. Carl E. Heiles (CoI)	University of California - Berkeley	heiles@astro.berkeley.edu
Mr. Joshua E. G. Peek (CoI)	University of California - Berkeley	goldston@astro.berkeley.edu
Ms. Katie Peek (CoI)	University of California - Berkeley	kpeek@astro.berkeley.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HD83023	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	3	26-Jun-2008 21:18:46.0	yes
02	(2) HD84722	STIS/CCD STIS/NUV-MAMA	1	26-Jun-2008 21:18:53.0	yes
03	(3) HD85259	STIS/CCD STIS/FUV-MAMA STIS/NUV-MAMA	3	26-Jun-2008 21:19:02.0	yes

7 Total Orbits Used

ABSTRACT

Optical observations of interstellar Na I absorption have recently discovered that a cold (20 K) diffuse cloud stretching over 10 degrees across the constellation Leo is nearby (d < 45 pc) and thus, deep inside the Local Bubble of hot, tenuous gas surrounding the Sun out to distances of ~100 pc. Assuming thermal pressure equilibrium under these conditions leads to an extremely thin, sheetlike geometry for the cold Leo cloud. Such a cold cloud could also be the overpressured interface between colliding flows of warm gas in the Local Bubble. The keys to evaluating the gas pressure and other physical characteristics of the cold Leo cloud lie in the ultraviolet with its rich diversity of interstellar diagnostic transitions. Due in part to a lack of bright UV background sources, there has been no previous UV absorption line study of this cloud. We have identified 3 stars exhibiting Na I absorption from the cold Leo cloud that are suitable for such a study with STIS onboard HST. The main goals of our proposed observations are to: (1) determine the cloud's gas pressure through measurements of its C I fine-structure excitation, (2) assess the dust contribution to the cloud heating by measuring the depletion-sensitive Cr/Zn gas-phase abundance ratio, and (3) evaluate the cloud cooling rate and electron density through measurements of its C II fine-structure excitation.

OBSERVING DESCRIPTION

We propose to obtain STIS high-resolution spectra of the stars HD 83023, HD 84722, and HD 85259 in order to study selected UV interstellar absorption lines arising from the intervening gas of the cold Leo cloud. These stars have been targeted because: (1) they are the brightest UV background sources with appreciable intervening H I column densities due to this cloud (N(H I) > 1.0e19 cm-2), (2) they exhibit narrow, single-component interstellar Na I absorption at the H I 21 cm velocity of this cloud, and (3) they are all rapid rotators suitable for UV interstellar absorption line studies (vsini > 100 km/s). HD 83023 and HD 85259 have sky positions behind the periphery of the cold Leo cloud while HD 84722 is located behind the cloud interior about 52 arc min away from HD 85259 (which corresponds to a sightline separation of 0.3 pc at the cloud distance of ~20 pc). The UV fluxes listed for our targets are based on low-dispersion IUE observations of HD 84722 and, in the cases of HD 83023 and HD 85259, on IUE spectra of stars of similar spectral type and low E(B-V). The specific UV interstellar absorption lines of C I, C I*, C I**, C II, C II*, Al II, Cr II, and Zn II that we are targeting to achieve our main scientific goals can all be observed with single setups of the E140H and E230H echelle gratings centered at 1343 and 1963 A, respectively. Although our proposed HD 84722 observations will be limited to the Al II, Cr II, and Zn II lines covered by the E230H setup (due to the faintness of the star in the far-UV), this sightline is important in that it explores an

appreciably higher H I column density than the other two and it is the only viable UV target for a Cr/Zn dust content assessment through the heart of the cold Leo cloud.

The E140H and E230H exposure times were calculated from the stellar UV fluxes and our desired S/N ratios using the STIS Spectroscopic Exposure Time Calculator. In the case of the E230H setup, our desired S/N ratios will yield 5 sigma equivalent width detection thresholds of 3.5, 1.5, and 1.0 mA in the vicinity of the Zn II and Cr II lines toward HD 84722, HD 85259, and HD 83023, respectively. Based on the H I column densities in these sightlines and the typically low Zn dust depletions in diffuse clouds (Roth & Blades 1995), we would expect respective Zn II 2062.66 A (f = 0.253) equivalent widths of 22.0, 5.0, and 3.0 mA toward HD 84722, HD 85259, and HD 83023. If the N(Cr II)/N(Zn II) ratio is near solar (reflecting a lack of dust in the cold Leo cloud), the corresponding equivalent widths for the Cr II 2066.16 A line (f = 0.0518) would be 49.0, 11.0, and 6.5 mA. On the other hand, if Cr exhibits its typical high dust depletion, the corresponding strengths of the Cr II 2056.25 A (f = 0.106) line would be about 5.5, 1.5, and 1.0 mA. Although these line strengths have all been computed for the optically thin case and the expected presence of line saturation will depress the equivalent widths of the stronger lines somewhat, the measurement of multiple Zn II and Cr II lines of varying f-value at our desired spectral sensitivity will yield accurate column densities through curve-of-growth analyses. Also, our very high resolution E230H observations of HD 83023 may allow us to partially resolve and model the intrinsic interstellar line profiles in this sightline.

In the case of the E140H setup, our desired S/N ratios will yield 5 sigma equivalent width detection thresholds of 1.5 and 1.0 mA in the vicinity of the C I 1329 A multiplet and the C II and C II* lines toward HD 85259 and HD 83023. Based on the high N(Na I)/N(H I) ratio in the cold Leo cloud (due at least in part to the cloud's cold temperature), we can expect that the column densities of other neutral species such as C I are likely to be appreciable in this cloud (Welty 2007). Indeed, even allowing for some line saturation, it is quite likely that the equivalent width of the interstellar C I 1328.83 A line will be greater than 10 mA toward both HD 85259 and HD 83023. Consequently, our measurements of the corresponding C I* 1329.10 A absorption line strengths with a 1 sigma precision of 0.2 - 0.3 mA will yield C I J = 0 : 1 fine-structure population ratios that are sensitive enough to evaluate the gas pressure of the cold Leo cloud in both sightlines. In combination with the other C I multiplets measureable in our E140H spectra, it should be possible to easily resolve any line saturation issues and perhaps determine the C I** column densities arising from the weakly-populated J = 2 fine-structure state.

In summary, given the STIS exposure times listed in Table 1, the 54 minute orbital visibility for each target, and the appropriate HST acquisition and

STIS exposure overheads, we can accomplish the scientific goals of this proposal with a total allocation of 7 HST orbits (3 orbits each for HD 83023 and HD 85259 and 1 orbit for HD 84722).

Visit

Proposal 11736, Visit 01 Fri Jun 27 01:19:06 GMT 2008

Diagnostic Status: No Diagnostics

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

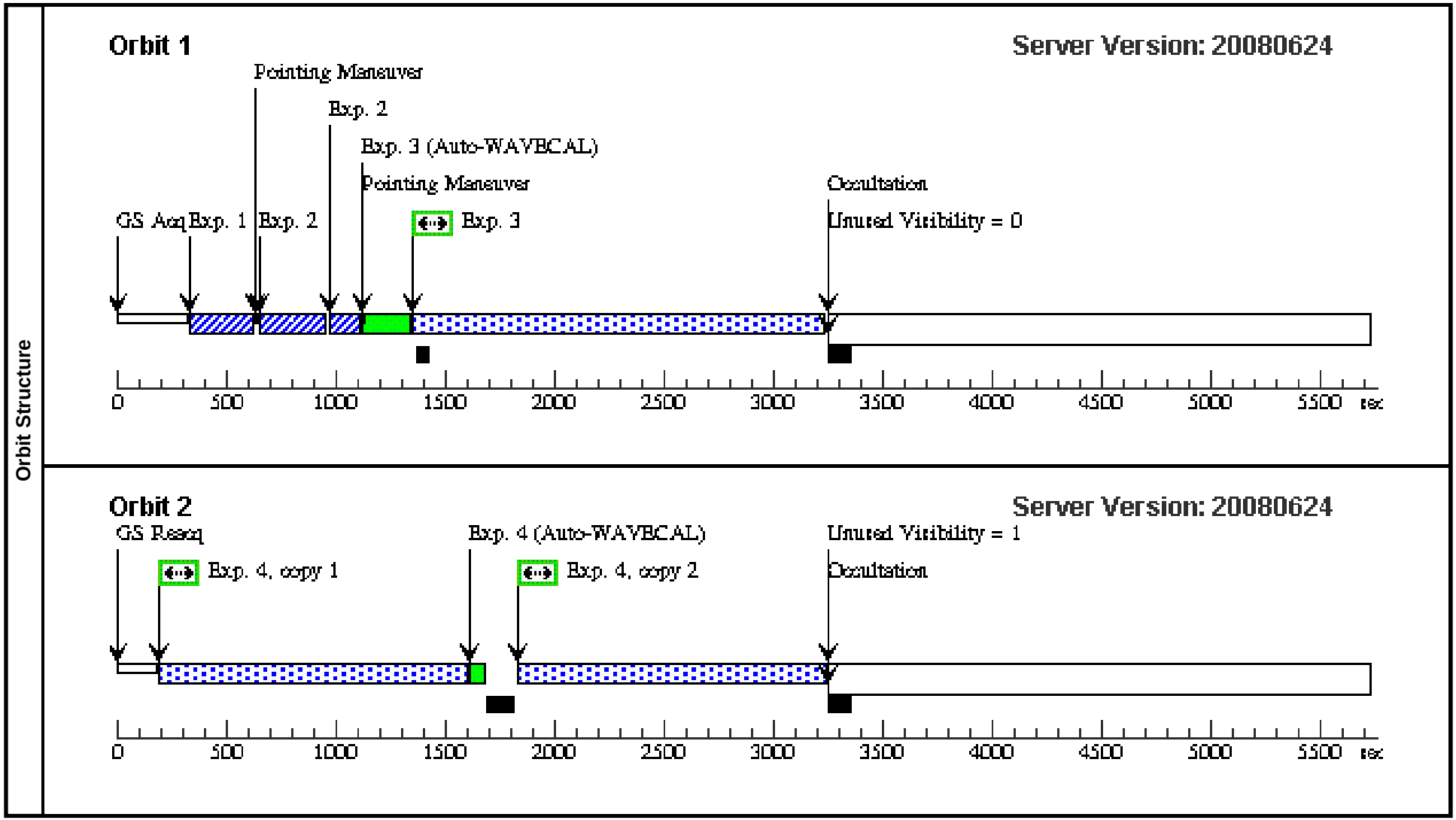
Special Requirements: (none)

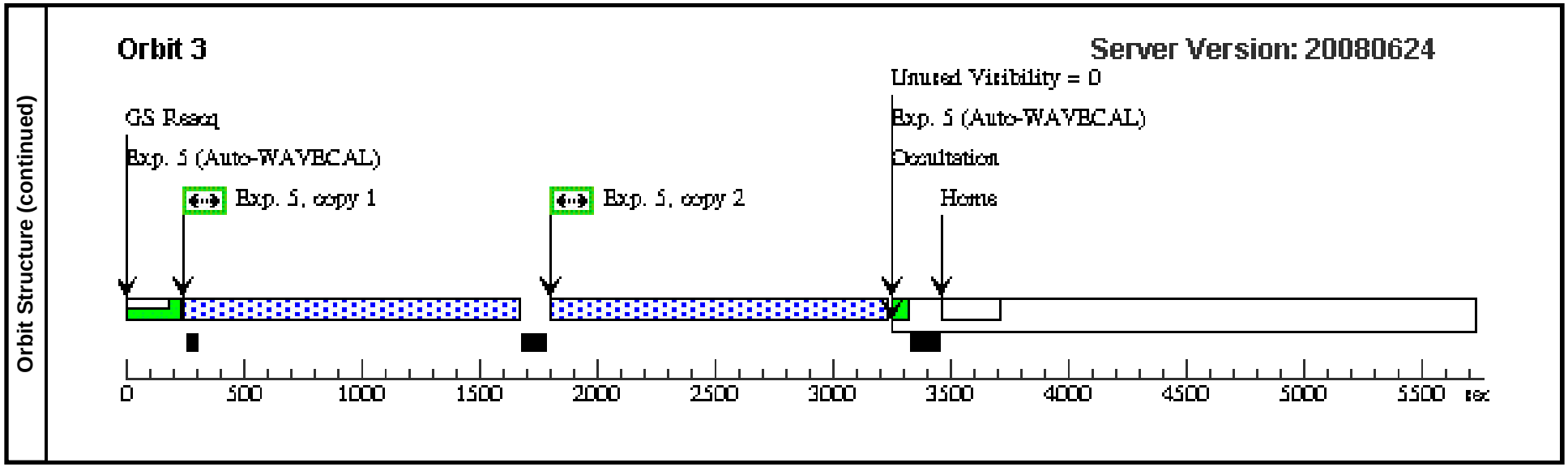
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD83023	RA: 09 35 52.8841 (143.9703504d) Dec: +14 22 46.52 (14.37959d) Equinox: J2000	Proper Motion RA: -0.00284s/yr Proper Motion Dec: -0.00222"/yr Parallax: 0.00639" Epoch of Position: 1991.25	V=6.29+/-0.2 TYPE=A1V, E(B-V)=0.03, F(1330)=1.0E-11, F(2050)=1.6E-11	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) HD83023	STIS/CCD, ACQ, F25ND3	MIRROR				0.2 Secs	
								[==>]	***[1]***
2		(1) HD83023	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.2 Secs	
								[==>]	***[1]***
3		(1) HD83023	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1343 A				1868.0 Secs	
								[==>]	***[1]***
4		(1) HD83023	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1343 A				1390.0 Secs X 2	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[2]***
5		(1) HD83023	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 1963 A				1420.0 Secs X 2	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[3]***


Orbit Structure
Orbit 1
Server Version: 20080624
Pointing Maneuver
Exp. 2
Exp. 3 (Auto-WAVECAL)
Pointing Maneuver
Occultation
GS Acq
Exp. 1
Exp. 2
Exp. 3
Unused Visibility = 0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Orbit 2
Server Version: 20080624
GS Reacq
Exp. 4 (Auto-WAVECAL)
Unused Visibility = 1
Exp. 4, copy 1
Exp. 4, copy 2
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec


Orbit Structure (continued)
Orbit 3
Server Version: 20080624
Unused Visibility = 0
GS Reacq
Exp. 5 (Auto-WAVECAL)
Exp. 5, copy 1
Exp. 5, copy 2
Exp. 5 (Auto-WAVECAL)
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 11736, Visit 02 Fri Jun 27 01:19:08 GMT 2008

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

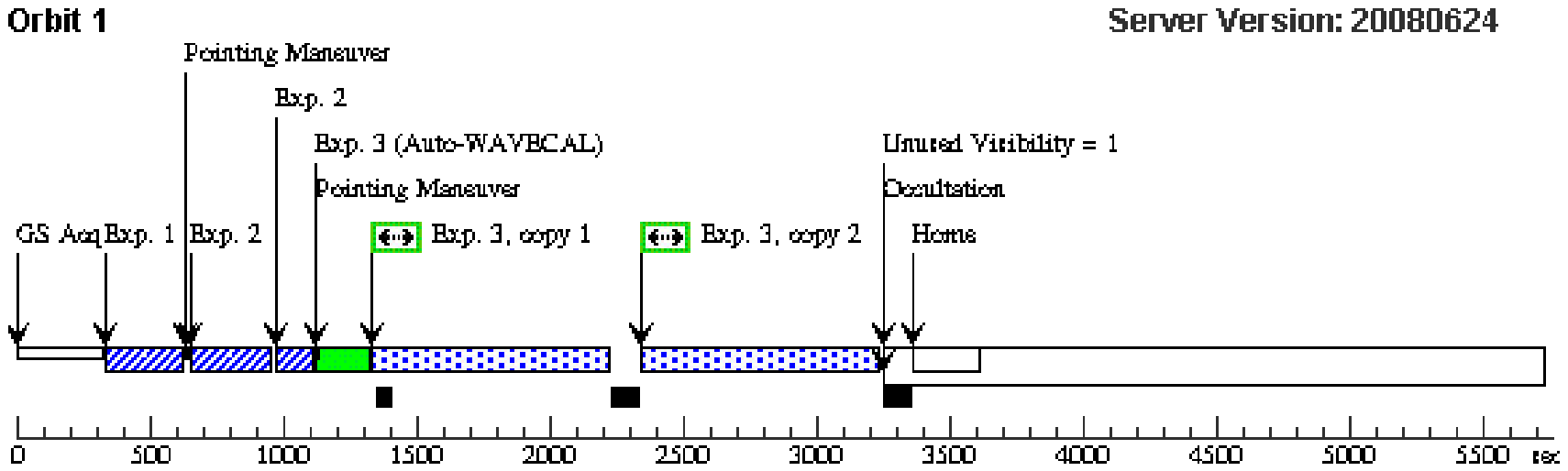
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	HD84722	RA: 09 47 25.9651 (146.8581879d) Dec: +11 34 5.40 (11.56817d) Equinox: J2000	Proper Motion RA: -0.00340s/yr Proper Motion Dec: -0.00483"/yr Parallax: 0.01114" Epoch of Position: 1991.25	V=6.45+/-0.02 TYPE=A7V, E(B-V)=0.04, F(2050)=4.0E-12	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(2) HD84722	STIS/CCD, ACQ, F25ND3	MIRROR				0.2 Secs *[==>]*	*[1]*
2		(2) HD84722	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.2 Secs *[==>]*	*[1]*
3		(2) HD84722	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 1963 A				874.0 Secs X 2 *[==>(Copy 1)]* *[==>(Copy 2)]*	*[1]*

Orbit Structure



Visit

Proposal 11736, Visit 03 Fri Jun 27 01:19:08 GMT 2008

Diagnostic Status: No Diagnostics

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

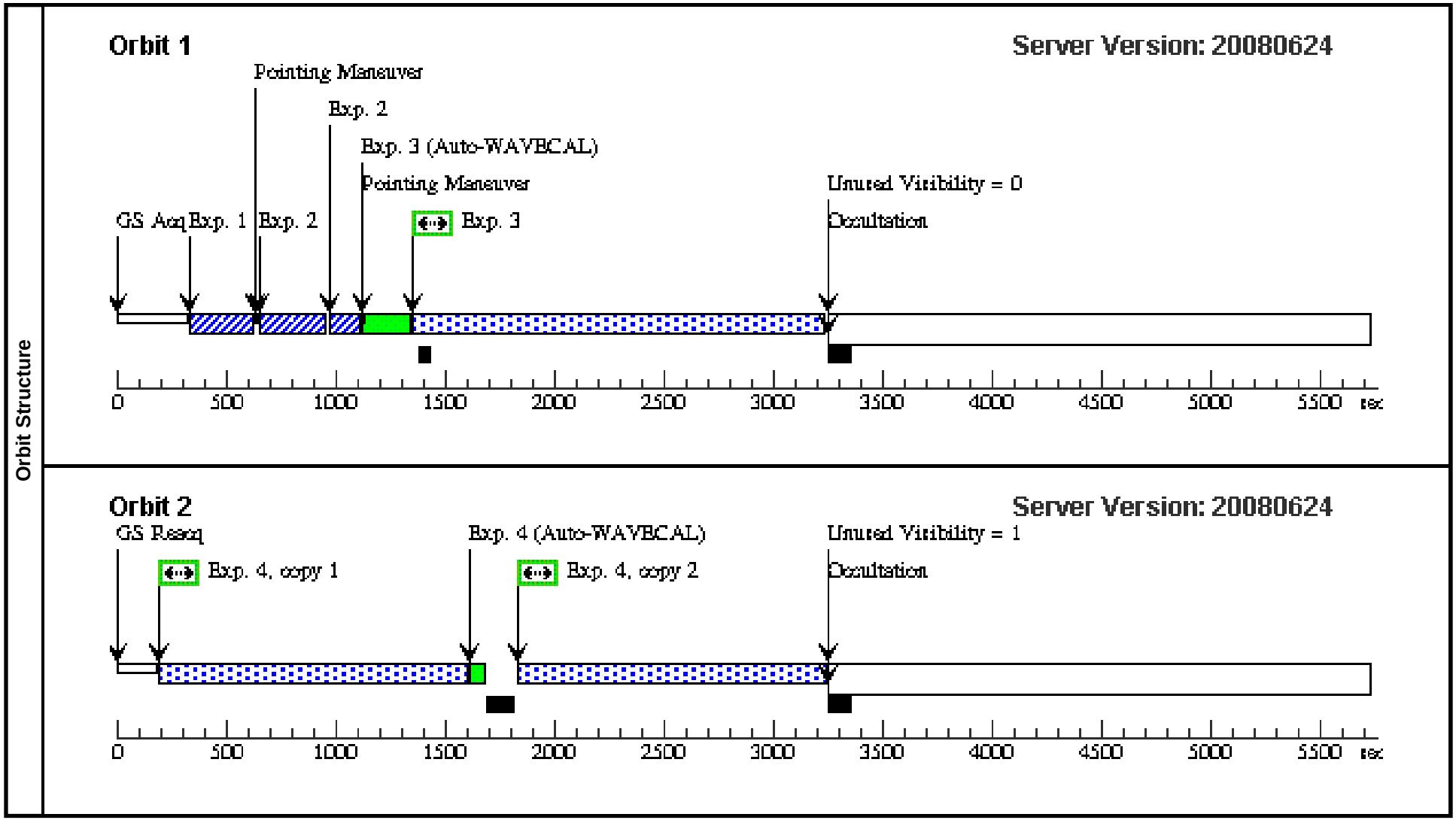
Special Requirements: (none)

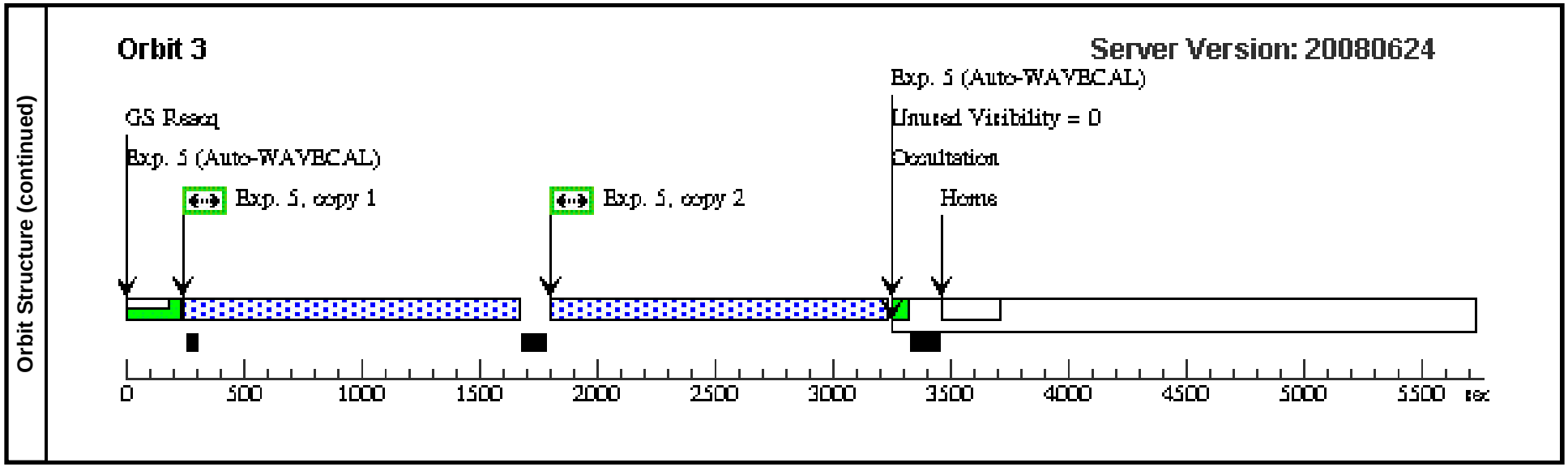
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	HD85259	RA: 09 50 49.2702 (147.7052925d) Dec: +11 50 32.71 (11.84242d) Equinox: J2000	Proper Motion RA: -0.000900s/yr Proper Motion Dec: 0.00075"/yr Parallax: 0.00363" Epoch of Position: 1991.25	V=6.86+/-0.02 TYPE=A0V, E(B-V)=0.00, F(1330)=8.0E-12, F(2050)=9.0E-12	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(3) HD85259	STIS/CCD, ACQ, F25ND3	MIRROR				0.3 Secs	
								[==>]	***[1]***
2		(3) HD85259	STIS/CCD, ACQ/PEAK, 0.2X0.05ND	MIRROR				0.3 Secs	
								[==>]	***[1]***
3		(3) HD85259	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1343 A				1865.0 Secs	
								[==>]	***[1]***
4		(3) HD85259	STIS/FUV-MAMA, ACCUM, 0.2X0.09	E140H 1343 A				1390.0 Secs X 2	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[2]***
5		(3) HD85259	STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 1963 A				1420.0 Secs X 2	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[3]***


Orbit Structure
Orbit 1
Server Version: 20080624
Pointing Maneuver
Exp. 2
Exp. 3 (Auto-WAVECAL)
Pointing Maneuver
Unused Visibility = 0
GS Acq
Exp. 1
Exp. 2
Exp. 3
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Orbit 2
Server Version: 20080624
GS Reacq
Exp. 4 (Auto-WAVECAL)
Unused Visibility = 1
Exp. 4, copy 1
Exp. 4, copy 2
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec


Orbit Structure (continued)
Orbit 3
Server Version: 20080624
GS Reacq
Exp. 5 (Auto-WAVECAL)
Exp. 5, copy 1
Exp. 5, copy 2
Exp. 5 (Auto-WAVECAL)
Unused Visibility = 0
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec