13451 - A Study of PG Quasar-Driven Outflows with COS

Cycle: 21, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. Frederick Hamann (PI) (Contact)	**University of Florida**	**fhamann@ufl.edu**
Prof. Todd Tripp (CoI)	University of Massachusetts - Amherst	tripp@astro.umass.edu
Prof. David Rupke (CoI)	Rhodes College	rupked@rhodes.edu
Dr. Stacy Teng (CoI)	NASA Goddard Space Flight Center	stacy.h.teng@nasa.gov
Kathryn Grasha (CoI)	University of Massachusetts - Amherst	kgrasha@astro.umass.edu
Hanna Herbst (CoI)	University of Florida	hannaherbst@astro.ufl.edu
Prof. Sylvain Veilleux (CoI)	University of Maryland	veilleux@astro.umd.edu
Dr. Margaret Trippe (CoI)	University of Maryland	trippe@astro.umd.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) PG0923+201	COS/FUV COS/NUV	1	03-Feb-2015 21:00:31.0	yes
02	(2) PG1309+355	COS/FUV COS/NUV	1	03-Feb-2015 21:00:33.0	yes
03	(3) PG1351+640	COS/FUV COS/NUV	1	03-Feb-2015 21:00:34.0	yes
04	(4) PG1411+442	COS/FUV COS/NUV	4	03-Feb-2015 21:00:36.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
05	(5) PG2214+139	COS/FUV COS/NUV	1	03-Feb-2015 21:00:38.0	yes
06	(6) PG1049-005	COS/FUV COS/NUV	3	03-Feb-2015 21:00:40.0	yes

11 Total Orbits Used

ABSTRACT

Quasar outflows are an important part of the quasar phenomenon, but many questions remain about their energetics, physical properties and the role they might play in providing feedback to host galaxy evolution. We searched our own COS far-UV observations from the QUEST survey and other large COS programs to find a sample of 6 bright PG quasars with broad (FWHM > 400 km/s) high velocity (v > 1000 km/s) absorption lines that clearly form in quasar-driven winds. These quasars can fill an important gap in our understanding between local Seyferts with low-speed winds and high-redshift quasars with extreme BAL outflows. They are also well-studied at other wavelengths, with some evidence for the quasars driving galaxy-scale blowouts and shutting down star formation. But almost nothing is known about the quasar outflows themselves.

We propose a detailed study of these 6 outflow quasars using new COS FUV observations to 1) expand the existing wavelength coverage across critical lines that are diagnostic of the outflow physical conditions, kinetic energies, and metallicities, and 2) check for line variability as an indicator of the outflow structure and locations. This quasar sample includes unusual cases with many low-abundance (PV 1118,1128 and SIV 1063) and excited-state lines (SIV 1073*, CIII* 1175, CII* 1335) that will provide unprecedented constraints on the outflow properties, plus the first known OVI-only mini-BAL outflow (no lower ions detected) for which we will cover NeVIII 770,780 to probe the highest ionization gas. The high FUV sensitivity of COS is uniquely able to measure this wide range of outflow lines in low-redshift quasars with no Lya forest contamination.

OBSERVING DESCRIPTION

We propose to observe 5 of the 6 quasars in our sample for 1 orbit each with the COS G140L grating. The exception to this is PG1411+442, described below. This setting will obtain maximum wavelength coverage across all of the lines of interest, including everything from CIV 1549A and below, at a spectral resolution R ~ 1800-3000 (170-100 km/s) and easily resolve the mini-BALs in these sources (Table 1). We estimate the signal-to-noise per resolution element in our exposures using the online COS ETC with fluxes from the existing G130M spectra, extrapolated to shorter wavelengths with a simple powerlaw. Figure 4 shows the signal-to-noise predicted for a typical 1-orbit observation, in this case for PG 1351+640

whose UV flux is intermediate in our sample (Table 1). A sufficient minimum SNR > 15 will be achieved across all of the lines of interest. For PG0923+201 and PG1309+355 we will split the orbit to use two G140L settings to fill the detector gap at 1200-1240A (Fig. 4, which includes OVI and Lya in both quasars) while also reaching CIII 977 at roughly 1100-1150A. For the others, we will use only the G140L-1280 setting (as shown in Figure 4) because the gap is not important.

PG1411+442 is a special case because it has many useful lines at wavelengths down to ~1000A (SVI 933,944), including some that are too narrow to measure with G140L (see Fig. 1). We request 2 orbits with G130M-1096 to cover difficult wavelengths 940-1236A, 1 orbit with G130M-1309 to cover 1153-1449A, and 1 orbit with G160M-1589 to cover 1398-1761A. This will be a unique amazing dataset covering all available outflow lines for maximum constraints on the outflow properties. Figure 4 shows ETC results for PG1411+442 with G130M-1096 and a 2- orbit observation totaling ~6000 sec. This exposure time is driven by our signal-to-noise requirements below 1100A. The predicted values of SNR ~ 5 per resolution element at these wavelengths are sufficient considering that the resolution is ~30 km/s and there will be ~10-40 resolution elements across the main outflow lines. (Note that G140L is much less sensitive below 1100A. It yields roughly the same SNR per resolution element as G130M, but with the major disadvantage that the resolution is ~6 times lower. We are much better off with G130M and binning pixels as needed.) For the other grating settings, single orbit exposures will provide SNR > 20 across important wavelengths, with binning as needed.

For PG1049-005, in addition to the 1-orbit G140L exposure, we request 2 orbits with COS G130M-1096 to cover the critical wavelengths 940-1236A at high sensitivity. This will measure the NeVIII 770,780A outflow line to test the hypothesis based on the OVI mini-BAL that this is an exceptionally high ionization outflow. The ETC predicts a slightly lower SNR compared to PG1411+442 but still sufficient for our purposes. We will combine the G130M and G140L spectra with binning as needed to maximize the SNR. We expect the NeVIII line to be deep and wide based on the appearance of OVI, and therefore pixel binning by factors of 4-10 are reasonable to yield a firm detection or a very interesting upper limit. We also note that the existing COS spectrum shows clearly that there are no strong Lya forest systems that could block our view of the NeVIII with Lyman Limit absorption.

Altogether, our request is for 4 orbits on PG1411+442, 3 orbits on PG1049-005, and 4 orbits on each of the remaining 4 quasars, totaling just 11 orbits for a important study of quasar outflows that takes advantage of the unique sensitivity of COS and the unique opportunity to study these flows at low redshifts without Lya forest contamination.

Visit

Proposal 13451, PG0923+201 (01), completed Wed Feb 04 02:00:41 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(PG0923+201 (01)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

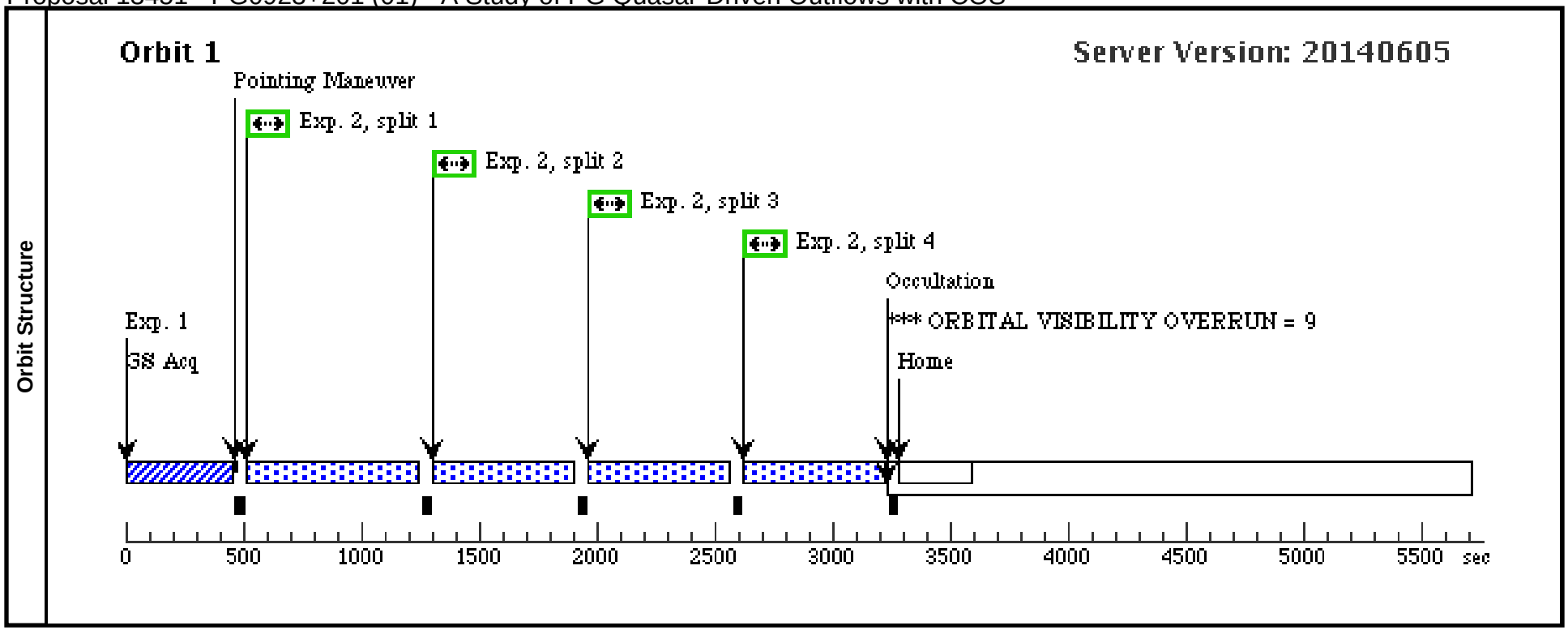
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	PG0923+201	RA: 09 25 54.7200 (141.4780000d) Dec: +19 54 5.00 (19.90139d) Equinox: J2000		V=15.89	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(513931)	(1) PG0923+201	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				12 Secs (12 Secs) *[==>]*	 ***[1]***
Comments: F_lam = 1.3e-14 at 1320 from previous COS									
2	(513930)	(1) PG0923+201	COS/FUV, TIME-TAG, PSA	G140L 1105 A	SEGMENT=A; BUFFER-TIME=4065; FP-POS=ALL			550 Secs (2180 Secs) *[==>545.0 Secs (Split 1)]* *[==>545.0 Secs (Split 2)]* *[==>545.0 Secs (Split 3)]* *[==>545.0 Secs (Split 4)]*	 ***[1]***


Orbit Structure
Orbit 1
Server Version: 20140605
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Occultation
*** ORBITAL VISIBILITY OVERRUN = 9
Exp. 1
GS Acq
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13451, PG1309+355 (02), completed Wed Feb 04 02:00:42 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(PG1309+355 (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

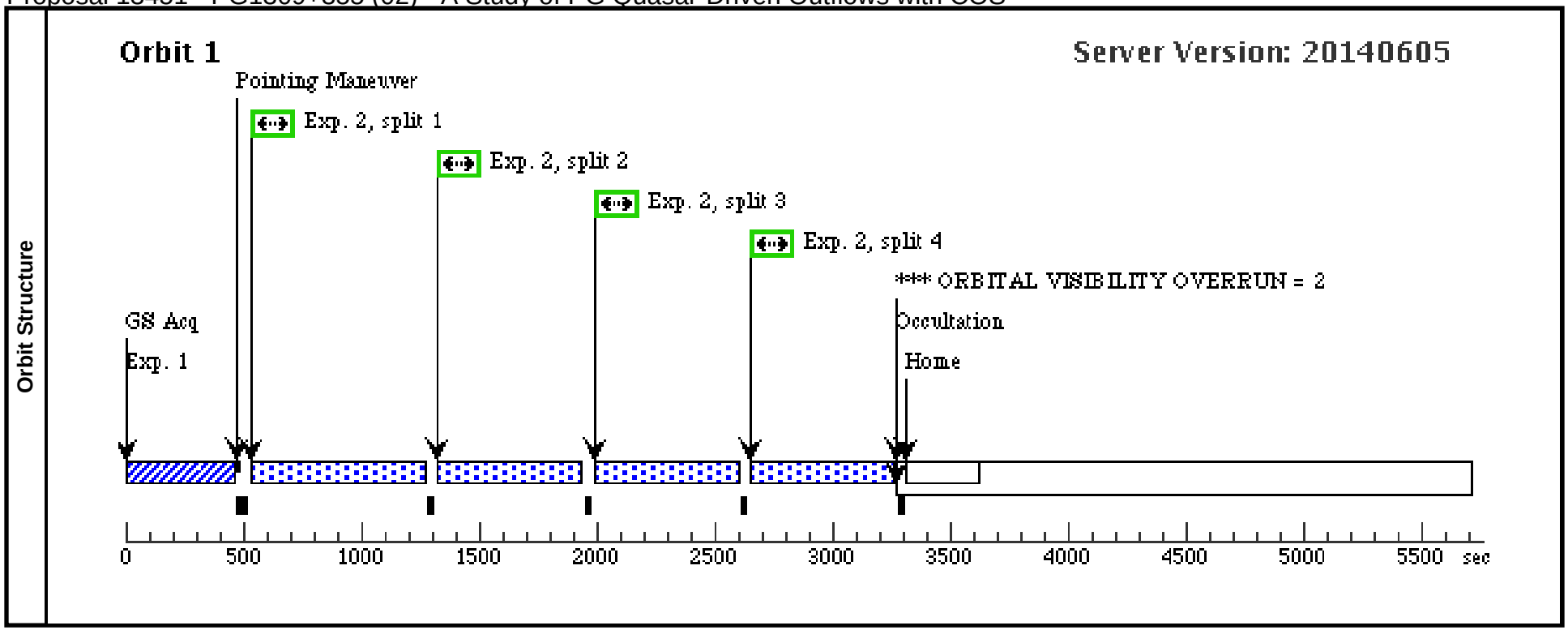
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	PG1309+355	RA: 13 12 17.7500 (198.0739583d) Dec: +35 15 21.10 (35.25586d) Equinox: J2000		V=15.64	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(513933)	(2) PG1309+355	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				19 Secs (19 Secs)	
								[==>]	***[1]***
2	(513934)	(2) PG1309+355	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=5558; FP-POS=ALL; SEGMENT=A			550 Secs (2236 Secs)	
								[==>559.0 Secs (Split 1)] *[==>559.0 Secs (Split 2)]* *[==>559.0 Secs (Split 3)]* *[==>559.0 Secs (Split 4)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20140605
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
*** ORBITAL VISIBILITY OVERRUN = 2
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13451, PG1351+640 (03), completed Wed Feb 04 02:00:42 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(PG1351+640 (03)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

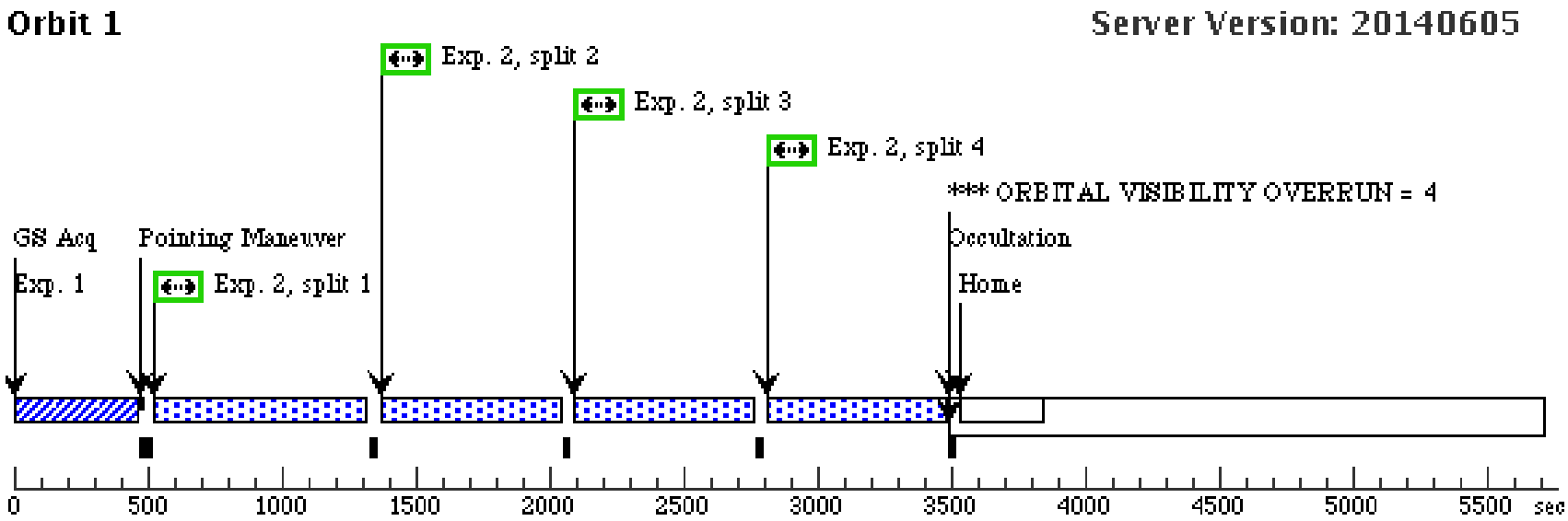
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	PG1351+640	RA: 13 53 15.8352 (208.3159800d) Dec: +63 45 45.70 (63.76269d) Equinox: J2000		V=14.28	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(513992)	(3) PG1351+640	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				16 Secs (16 Secs) *[==>]*	*[1]*
2	(513994)	(3) PG1351+640	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=7060; FP-POS=ALL; SEGMENT=BOTH			550 Secs (2468 Secs) *[==>617.0 Secs (Split 1)]* *[==>617.0 Secs (Split 2)]* *[==>617.0 Secs (Split 3)]* *[==>617.0 Secs (Split 4)]*	*[1]*

Orbit Structure



Visit

Proposal 13451, PG1411+442 (04), implementation Wed Feb 04 02:00:42 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(PG1411+442 (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(PG1411+442 (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(PG1411+442 (04)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

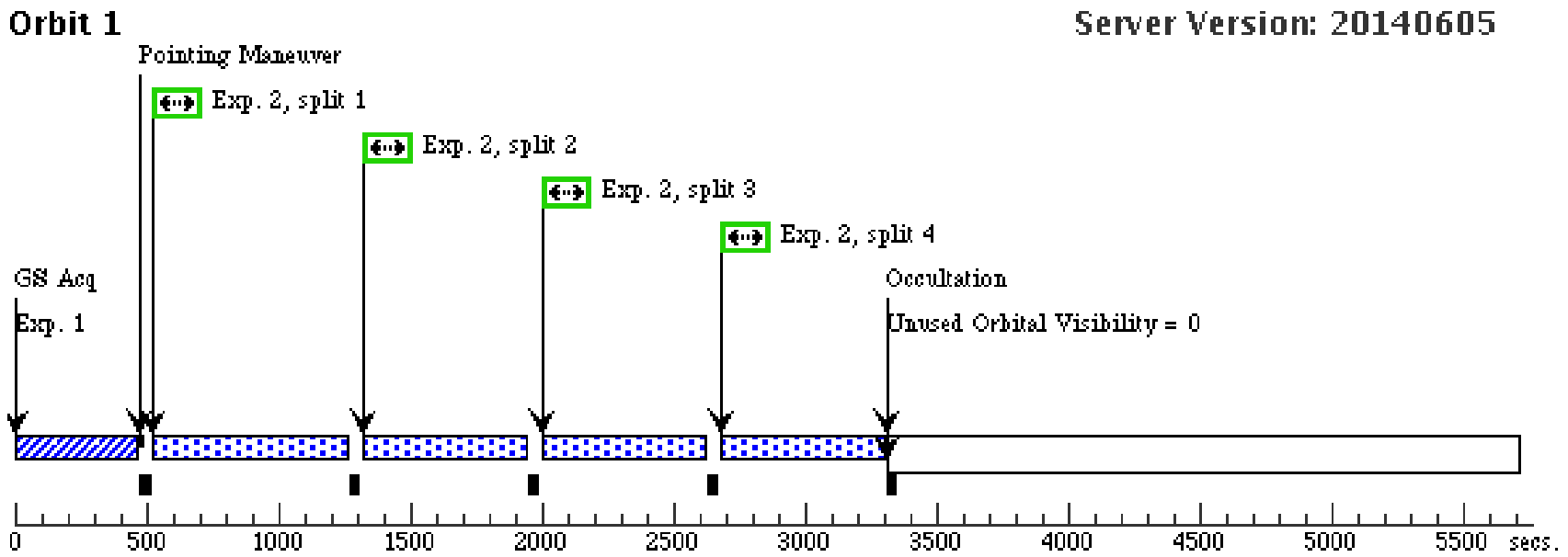
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(4)	PG1411+442	RA: 14 13 48.3291 (213.4513713d) Dec: +44 00 14.09 (44.00391d) Equinox: J2000		V=14.99	Reference Frame: ICRS

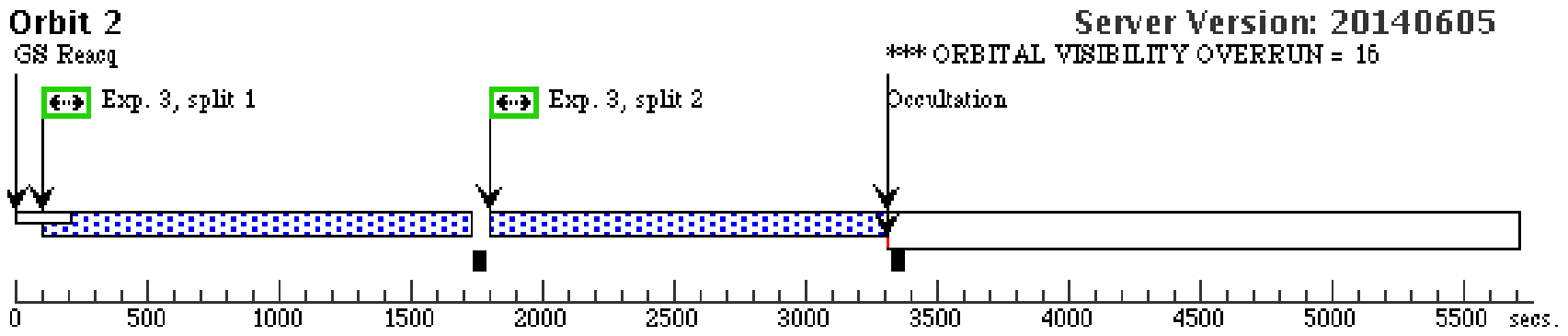
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

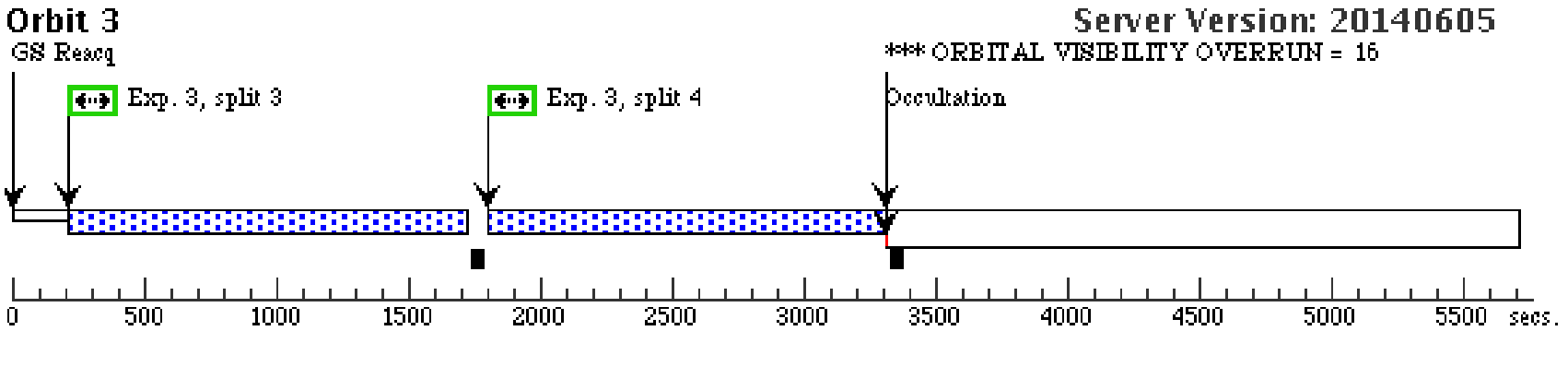
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(514012)	(4) PG1411+442	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARIO BASE1B3		16 Secs (16 Secs)	
								[==>]	***[1]***
2	(514018)	(4) PG1411+442	COS/FUV, TIME-TAG, PSA	G130M 1309 A	BUFFER-TIME=2611; FP-POS=ALL			550 Secs (2256 Secs)	
								[==>564.0 Secs (Split 1)] *[==>564.0 Secs (Split 2)]* *[==>564.0 Secs (Split 3)]* *[==>564.0 Secs (Split 4)]*	***[1]***
3	(514026)	(4) PG1411+442	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=6205; FP-POS=ALL; SEGMENT=BOTH			1450 Secs (5844 Secs)	
								[==>1461.0 Secs (Split 1)] *[==>1461.0 Secs (Split 2)]*	***[2]***
								[==>1461.0 Secs (Split 3)] *[==>1461.0 Secs (Split 4)]*	***[3]***
4	(514028)	(4) PG1411+442	COS/FUV, TIME-TAG, PSA	G160M 1589 A	BUFFER-TIME=6037; FP-POS=ALL; SEGMENT=BOTH			670 Secs (2700 Secs)	
								[==>675.0 Secs (Split 1)] *[==>675.0 Secs (Split 2)]* *[==>675.0 Secs (Split 3)]* *[==>675.0 Secs (Split 4)]*	***[4]***

Orbit Structure






Orbit 3
Server Version: 20140605
GS Reacq
*** ORBITAL VISIBILITY OVERRUN = 16
Exp. 3, split 3
Exp. 3, split 4
Occultation
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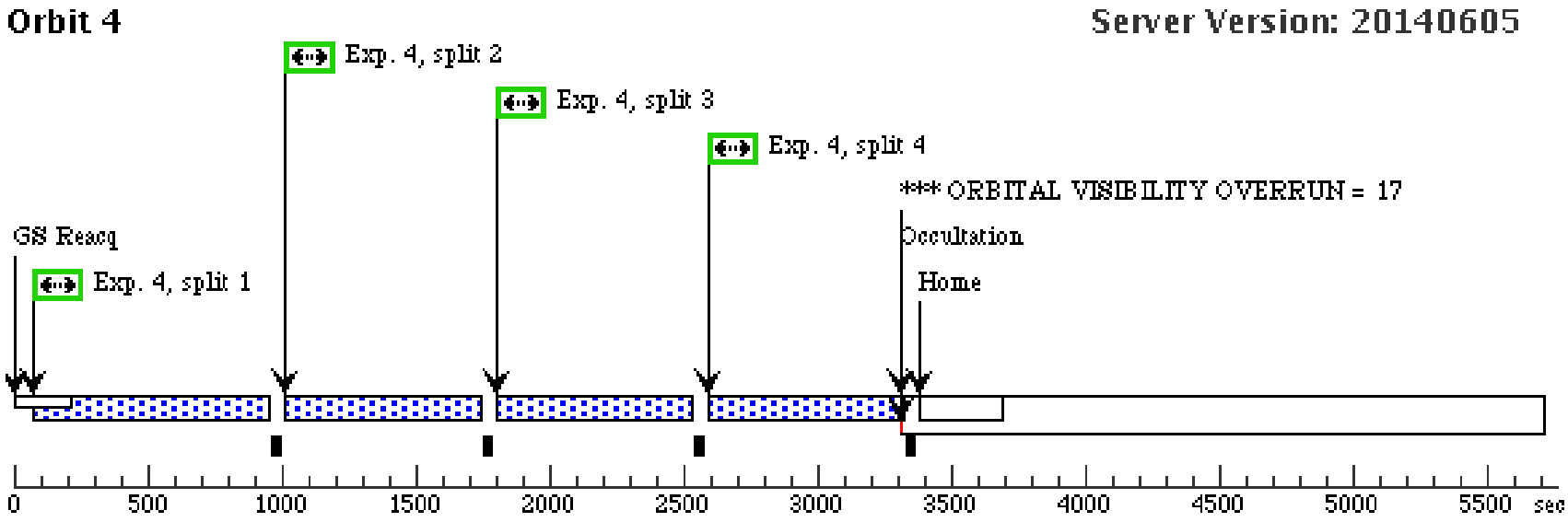
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 4
Server Version: 20140605
Exp. 4, split 2
Exp. 4, split 3
Exp. 4, split 4
*** ORBITAL VISIBILITY OVERRUN = 17
GS Reacq
Occultation
Exp. 4, split 1
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 13451, PG2214+139 (05), completed Wed Feb 04 02:00:42 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Fixed Targets

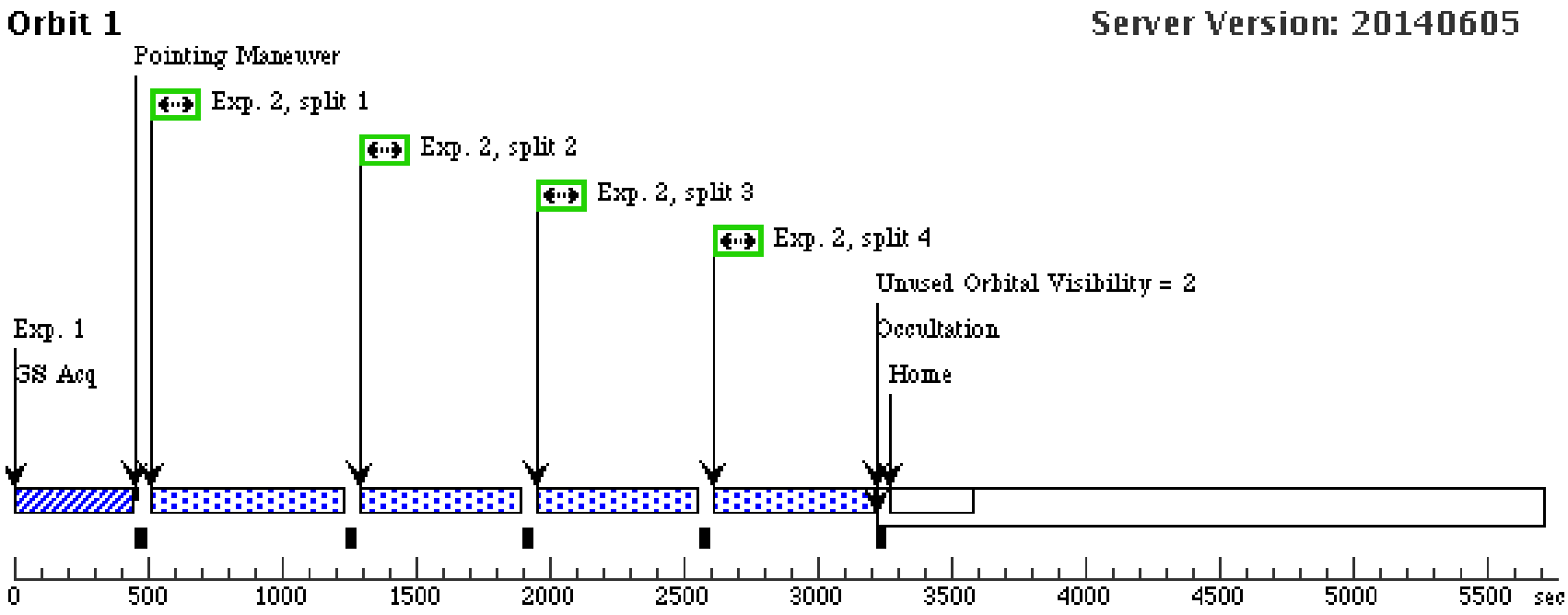
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(5)	PG2214+139	RA: 22 17 12.2739 (334.3011412d) Dec: +14 14 20.93 (14.23915d) Equinox: J2000		V=14.66	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(513998)	(5) PG2214+139	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				10 Secs (10 Secs) *[==>]*	*[1]*
2	(514007)	(5) PG2214+139	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=4125; FP-POS=ALL; SEGMENT=BOTH			500 Secs (2176 Secs) *[==>544.0 Secs (Split 1)]* *[==>544.0 Secs (Split 2)]* *[==>544.0 Secs (Split 3)]* *[==>544.0 Secs (Split 4)]*	*[1]*

Orbit Structure



Visit

Proposal 13451, PG1049-005 (06), completed Wed Feb 04 02:00:42 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(PG1049-005 (06)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(PG1049-005 (06)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

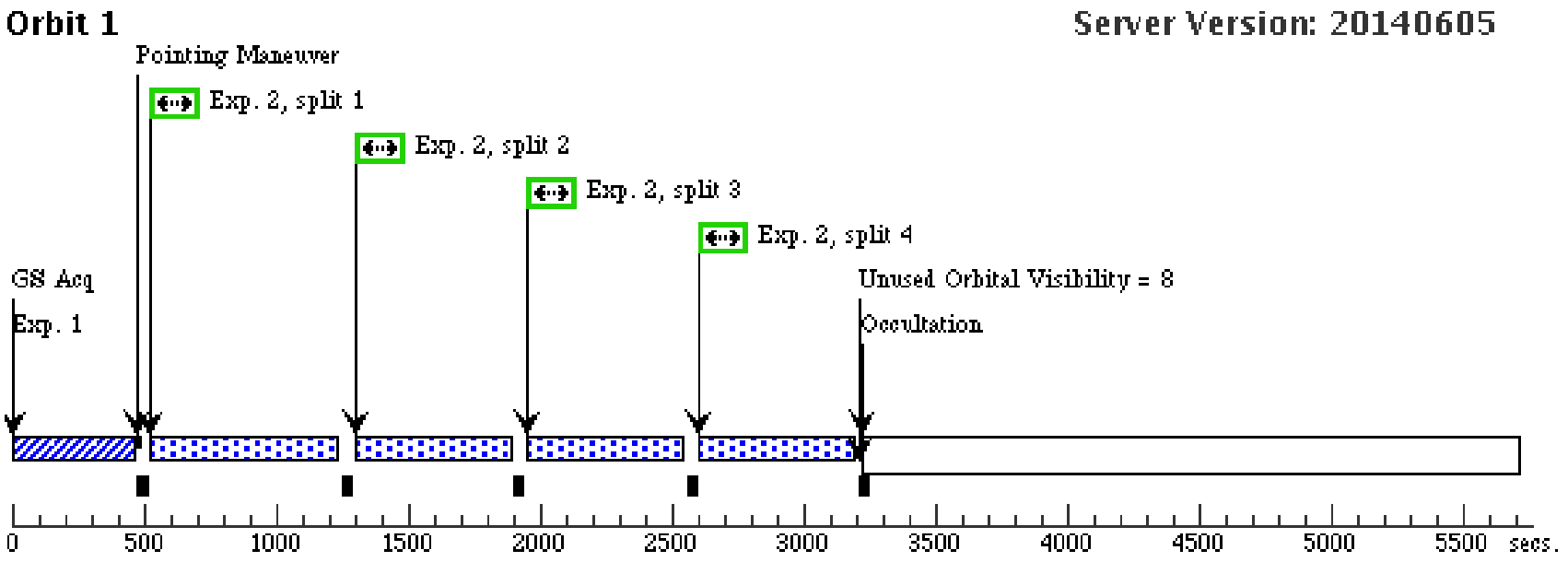
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(6)	PG1049-005	RA: 10 51 51.4404 (162.9643350d) Dec: -00 51 17.73 (-.85492d) Equinox: J2000		V=15.78	Reference Frame: ICRS

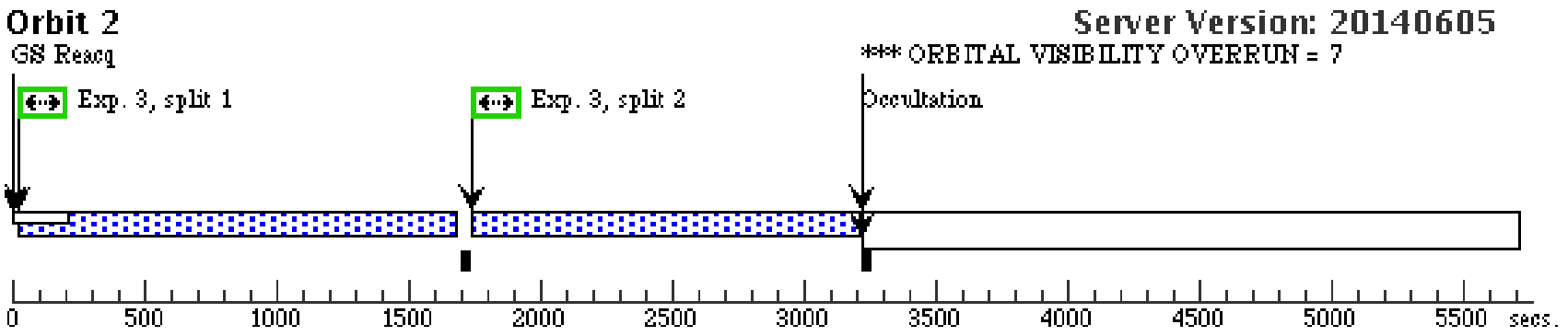
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

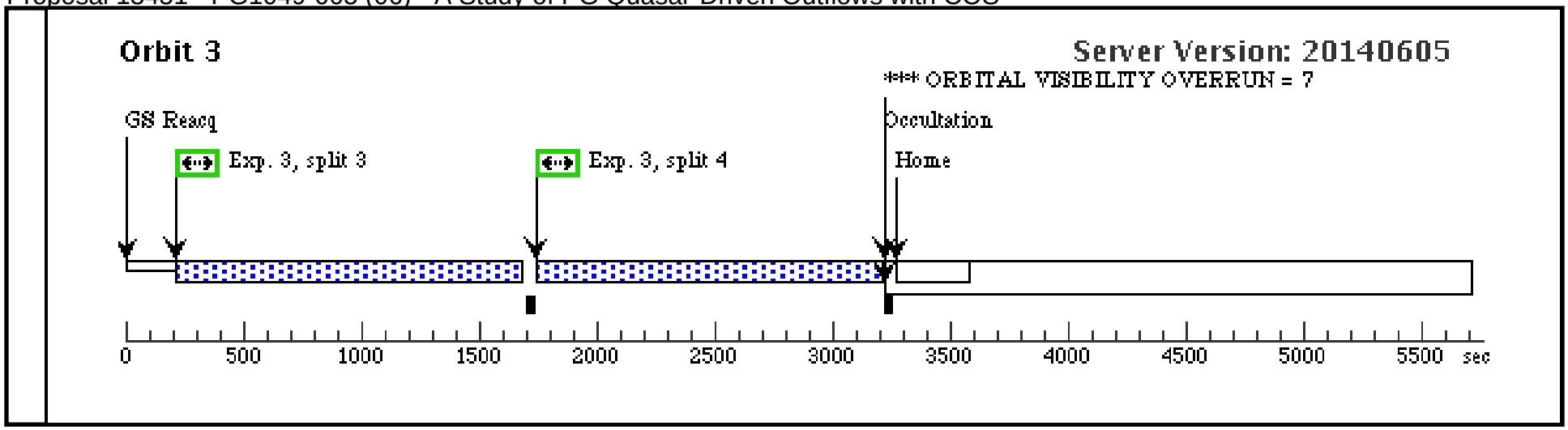
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(514029)	(6) PG1049-005	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				17 Secs (17 Secs)	
								[==>]	***[1]***
2	(514031)	(6) PG1049-005	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=4657; FP-POS=ALL; SEGMENT=BOTH			530 Secs (2152 Secs)	
								[==>538.0 Secs (Split 1)] *[==>538.0 Secs (Split 2)]* *[==>538.0 Secs (Split 3)]* *[==>538.0 Secs (Split 4)]*	***[1]***
3	(514033)	(6) PG1049-005	COS/FUV, TIME-TAG, PSA	G130M 1096 A	BUFFER-TIME=6603; FP-POS=ALL; SEGMENT=BOTH			1400 Secs (5654 Secs)	
								[==>1413.0 Secs (Split 1)] *[==>1413.0 Secs (Split 2)]*	***[2]***
								[==>1414.0 Secs (Split 3)] *[==>1414.0 Secs (Split 4)]*	***[3]***

Orbit Structure






Orbit 3
Server Version: 20140605
*** ORBITAL VISIBILITY OVERRUN = 7
GS Reacq
Exp. 3, split 3
Exp. 3, split 4
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec