17421 - Shocking detections: Characterising exocometary shock fronts by tracking star-grazing comets using the UV AlIII line

Cycle: 31, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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Isabel Rebollido (CoI) (ESA Member) (AdminUSPI)	ESA-European Space Astronomy Centre
Dr. Grant Kennedy (CoI) (ESA Member)	The University of Warwick
Dr. Vincent Bourrier (CoI) (ESA Member)	University of Geneva, Department of Astronomy
Mr. Ben Davies (CoI) (ESA Member)	The University of Warwick
Ms. Cristina Madurga Favieres (CoI) (ESA Member)	Universidad Complutense
Mr. Theo Vrignaud (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) BETA-PIC WAVE	STIS/CCD STIS/NUV-MAMA	3	20-Jun-2024 15:05:00.0	yes
02	(1) BETA-PIC WAVE	STIS/CCD STIS/NUV-MAMA	3	20-Jun-2024 15:05:04.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
03	(1) BETA-PIC WAVE	STIS/CCD STIS/NUV-MAMA	4	20-Jun-2024 15:05:07.0	yes

10 Total Orbits Used

ABSTRACT

Exocomets are small icy bodies, which orbit stars other than the Sun and sublimate when close to their star, producing a tail of dust and gas (like solar system comets). During transit, the gas causes spectroscopic absorption signatures that are routinely detected in several systems. The most prolific case is beta Pic, which continuously displays narrow, variable, non-photospheric absorption features superimposed on the much broader stellar lines. The features vary on short timescales (hours) and are seen at optical (e.g. CaII) and UV (e.g. FeII, SiIV) wavelengths.

Previous HST observations of beta Pic in the UV showed the presence of AlIII lines in the exocomet gas. The mere existence of AlIII is puzzling as beta Pic is unable to twice photoionise Al. Hydrodynamical models suggest that these highly-ionised species are formed in a shock where compression and thus collisions within the shock surface are sufficient to generate AlIII. This is theorised to occur when the exocomets get sufficiently close to the star (a few stellar radii).

We propose to monitor beta Pic to characterise the doppler movement of the AlIII lines and from this directly measure the exocomets' acceleration. This we use to calculate the comet-star distances. The highly ionised species are thought only to be present in the shock fronts of exocomets close to the star. Measuring the distance between the star and the exocomets will allow us to directly test this hypothesis. The observations cover a wavelength range with other species thought to only emerge in shocks. Measuring the transit ingress/egress times of these species will give us the composition of the shock as a function of radial distance.

OBSERVING DESCRIPTION

One line summary: We plan to observe exocometary absoprtion events in the beta Pictoris planetary system with STIS and to track these features by monitoring how the Al III absoprtion line varies as a function of time.

The AlIII line is the only line capable of unequivocally detecting an exocometary shocks, given that the second most favourable line (SiIV, which we previously analysed) yields results right at the edge of statistical significance.

In order to measure the acceleration as accurately as possible and to avoid blended absorption features, we will use the higher resolution and sensitivity of STIS (compared to COS) using the E230H setup giving. Our setup with the central wavelength set at 1763 Ang, will provide a wavelength coverage from 1624 to 1901Ang. This wavelength range includes many very interesting lines, in which GHRS data has shown detections of transiting exocomets. The line list in this wavelength range includes Fe II, Al II, SI, SiII}, CI, and NiII. Due to the brightness of beta Pic (our target), STIS is in addition required to avoid saturating the detector. Due to the brightness of the object we will be observing in ACCUM mode.

Justification for visits and orbits:

To ensure the two main science goals (1. Test the hypothesis that AlII are caused by shocks and 2. Measure the species dependent size of the shock front) are met we deem it necessary to obtain observations on three separate visits. Three visits ensures completely different exocometry absorption signatures and would avoid the possible conclusion that a detections from a single visit is an outlier. We would further avoid the blending of exocometary signatures. We initially wrote two visits, but believe it is more important to have three visits (with less orbits) than 2 visits with more orbits due to the upredictable nature of the exocomet absorption features. This change was also in part motivated by the strong encouragement from STSci to avoid 3+ orbit visits.

There will in total be three visits. The two first visits will consist of 3 orbits and the last visit will consist of 4 orbits.

Visit

Proposal 17421, Visit 01, completed Thu Jun 20 19:05:08 GMT 2024

Diagnostic Status: Warning

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

Special Requirements: BETWEEN 16-APR-2024:23:00:00 AND 17-APR-2024:04:00:00

Diagnostics

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 01) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BETA-PIC	RA: 05 47 17.0953 (86.8212304d) Dec: -51 03 58.15 (-51.06615d) Equinox: J2000	Proper Motion RA: 4.932985550191305E-4 sec of time/yr Proper Motion Dec: 0.0831 arcsec/yr Epoch of Position: 2015.5	V=3.86	Reference Frame: ICRS

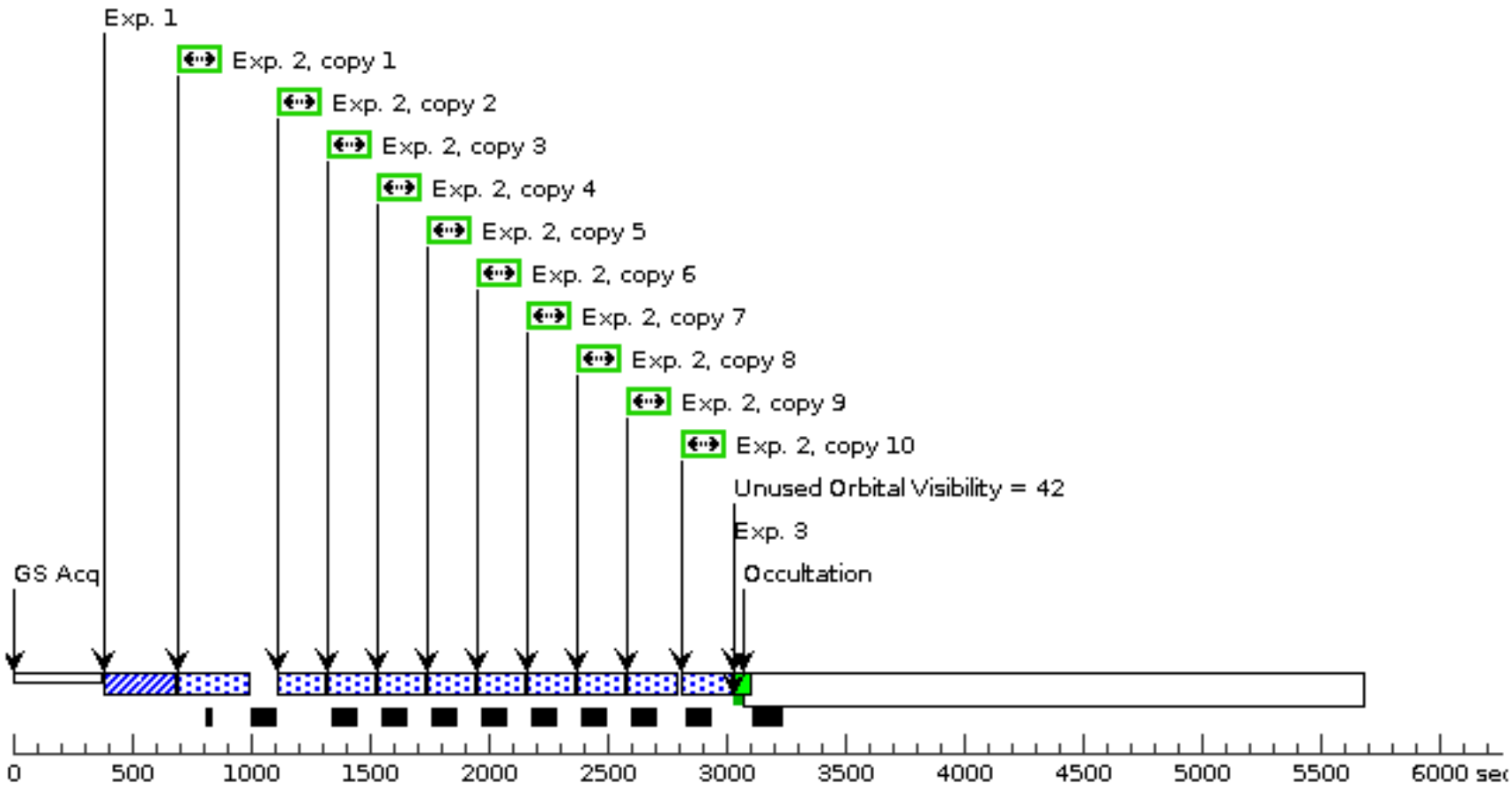
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[A4-A9 V-IV, DISK, EXTRA-SOLAR PLANETARY SYSTEM]
Extended=NO

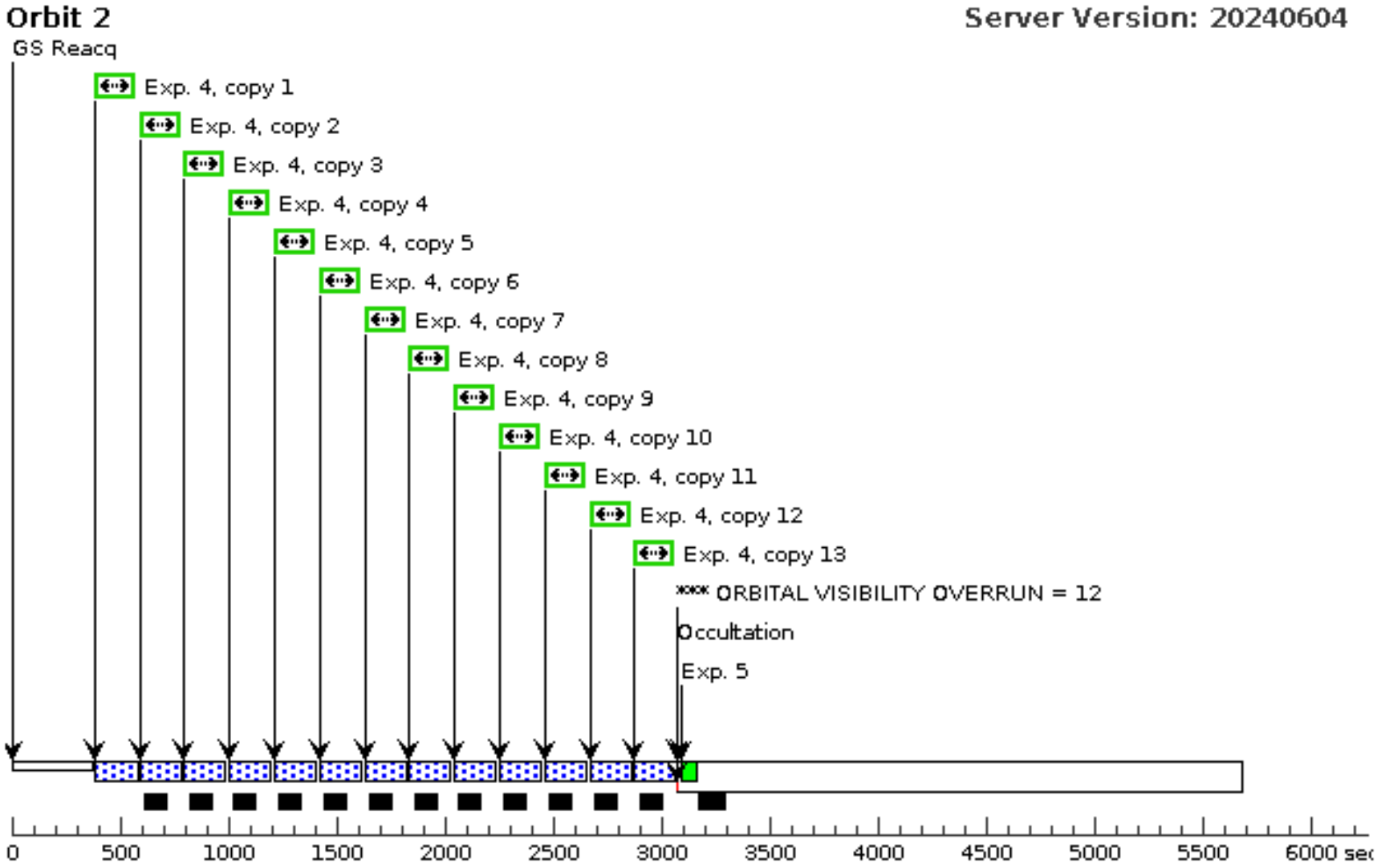
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (1890147)	(1) BETA-PIC	STIS/CCD, ACQ, F25ND5	MIRROR			Sequence 1-3 Non-Int in Visit 01	1 Secs (1 Secs) *[==>]*	***[1]***
2	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO		Sequence 1-3 Non-Int in Visit 01	200 Secs X 10 (1886 Secs) *[==>186.0 Secs (Copy 1)]* *[==>186.0 Secs (Copy 2)]* *[==>186.0 Secs (Copy 3)]* *[==>186.0 Secs (Copy 4)]* *[==>186.0 Secs (Copy 5)]* *[==>186.0 Secs (Copy 6)]* *[==>186.0 Secs (Copy 7)]* *[==>186.0 Secs (Copy 8)]* *[==>199.0 Secs (Copy 9)]* *[==>199.0 Secs (Copy 10)]*	***[1]***
3	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A			Sequence 1-3 Non-Int in Visit 01	*[==>]*	***[1]***
4	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO		Sequence 4-5 Non-Int in Visit 01	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	***[2]***
5	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A			Sequence 4-5 Non-Int in Visit 01	*[==>]*	***[2]***

	6	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO	Sequence 6-7 Non-Int in Visit 01	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	***[3]***
	7	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A		Sequence 6-7 Non-Int in Visit 01	*[==>]*	***[3]***

Orbit Structure

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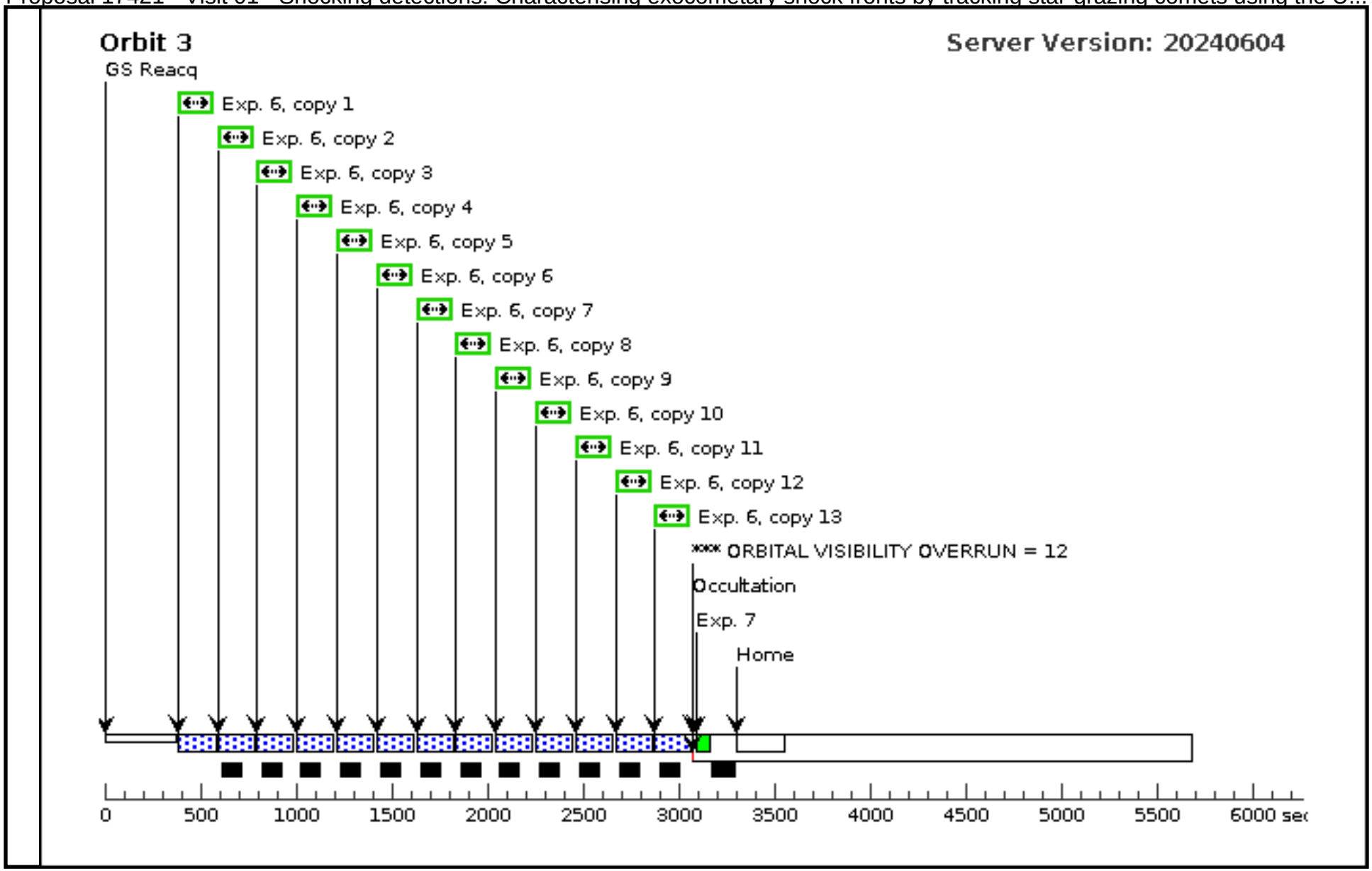
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Visit

Proposal 17421, Visit 02, implementation

Thu Jun 20 19:05:09 GMT 2024

Diagnostic Status: Warning

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

Special Requirements: AFTER_01 BY 5 D TO 1000 D

Diagnostics

(Visit 02) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 02) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BETA-PIC	RA: 05 47 17.0953 (86.8212304d) Dec: -51 03 58.15 (-51.06615d) Equinox: J2000	Proper Motion RA: 4.932985550191305E-4 sec of time/yr Proper Motion Dec: 0.0831 arcsec/yr Epoch of Position: 2015.5	V=3.86	Reference Frame: ICRS

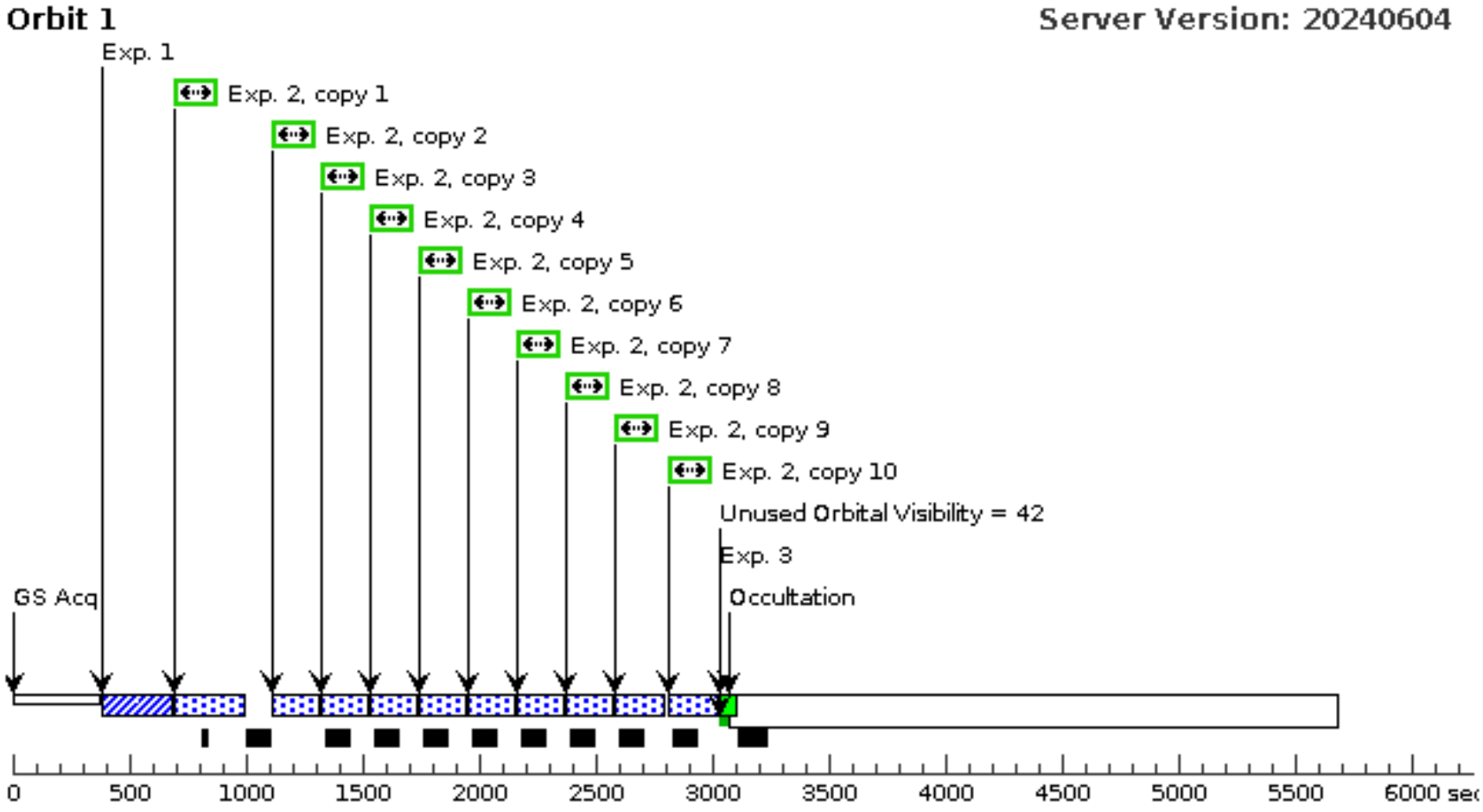
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[A4-A9 V-IV, DISK, EXTRA-SOLAR PLANETARY SYSTEM]
Extended=NO

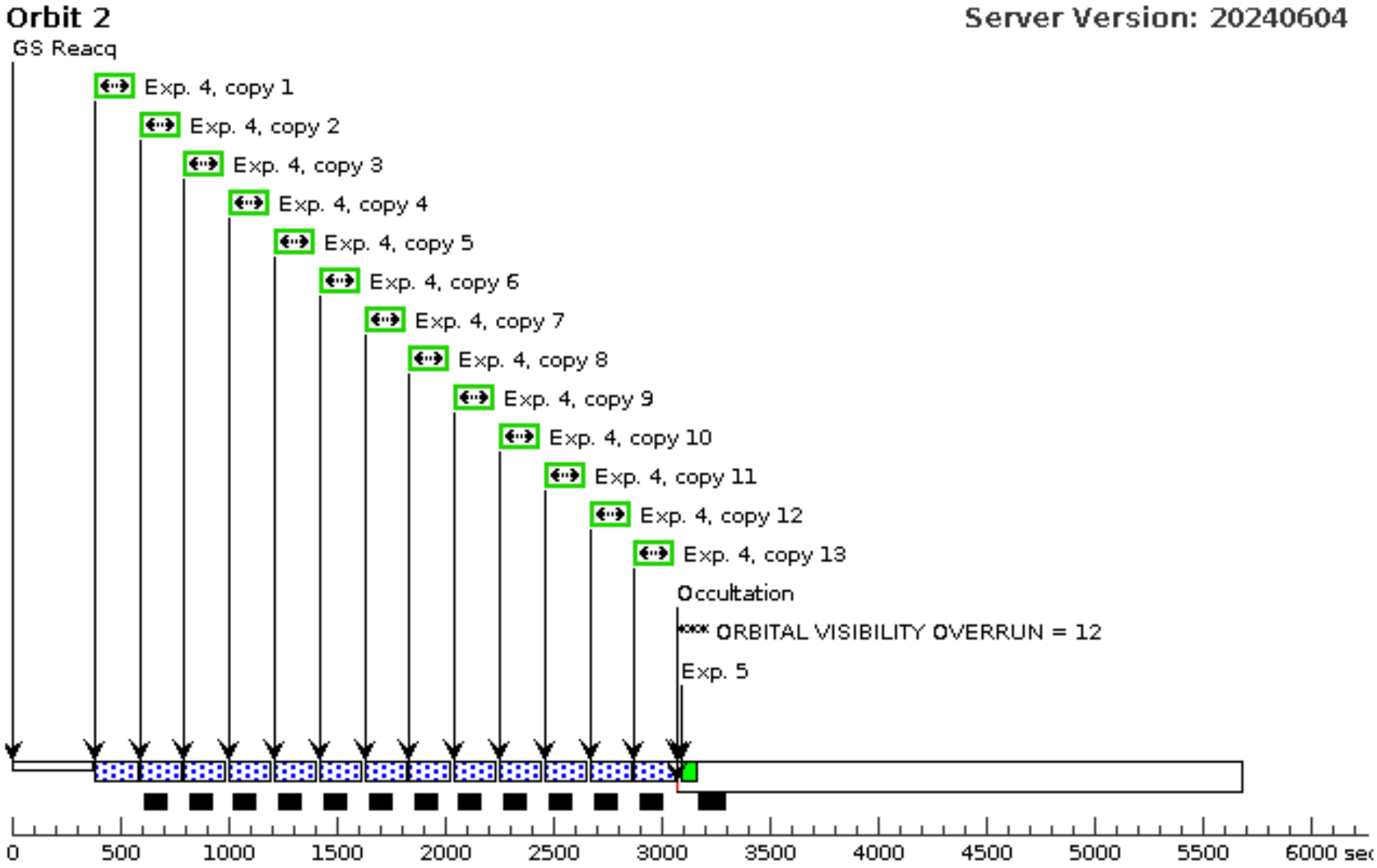
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (1890147)	(1) BETA-PIC	STIS/CCD, ACQ, F25ND5	MIRROR			Sequence 1-3 Non-Int in Visit 02	1 Secs (1 Secs) *[==>]*	*[1]*
2	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO		Sequence 1-3 Non-Int in Visit 02	200 Secs X 10 (1886 Secs) *[==>186.0 Secs (Copy 1)]* *[==>186.0 Secs (Copy 2)]* *[==>186.0 Secs (Copy 3)]* *[==>186.0 Secs (Copy 4)]* *[==>186.0 Secs (Copy 5)]* *[==>186.0 Secs (Copy 6)]* *[==>186.0 Secs (Copy 7)]* *[==>186.0 Secs (Copy 8)]* *[==>199.0 Secs (Copy 9)]* *[==>199.0 Secs (Copy 10)]*	*[1]*
3	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A			Sequence 1-3 Non-Int in Visit 02	*[==>]*	*[1]*
4	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO		Sequence 4-5 Non-Int in Visit 02	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	*[2]*
5	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A			Sequence 4-5 Non-Int in Visit 02	*[==>]*	*[2]*

	6	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO	Sequence 6-7 Non-Int in Visit 02	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	***[3]***
	7	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A		Sequence 6-7 Non-Int in Visit 02	*[==>]*	***[3]***

Orbit Structure

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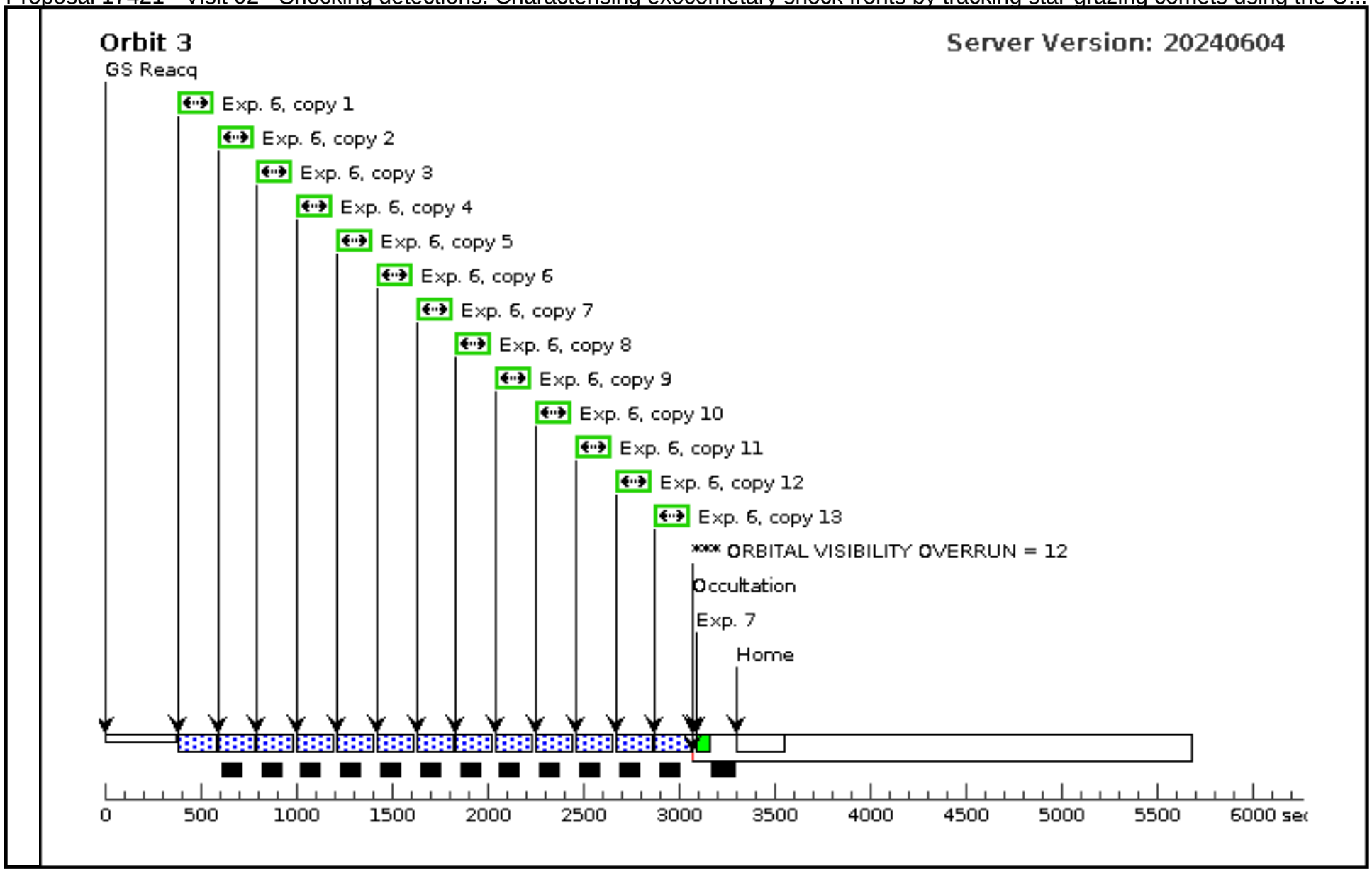
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Visit

Proposal 17421, Visit 03, implementation

Thu Jun 20 19:05:09 GMT 2024

Diagnostic Status: Warning

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

Special Requirements: AFTER_02 BY 5 D TO 1000 D

Diagnostics

(Visit 03) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 03) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 03) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	BETA-PIC	RA: 05 47 17.0953 (86.8212304d) Dec: -51 03 58.15 (-51.06615d) Equinox: J2000	Proper Motion RA: 4.932985550191305E-4 sec of time/yr Proper Motion Dec: 0.0831 arcsec/yr Epoch of Position: 2015.5	V=3.86	Reference Frame: ICRS

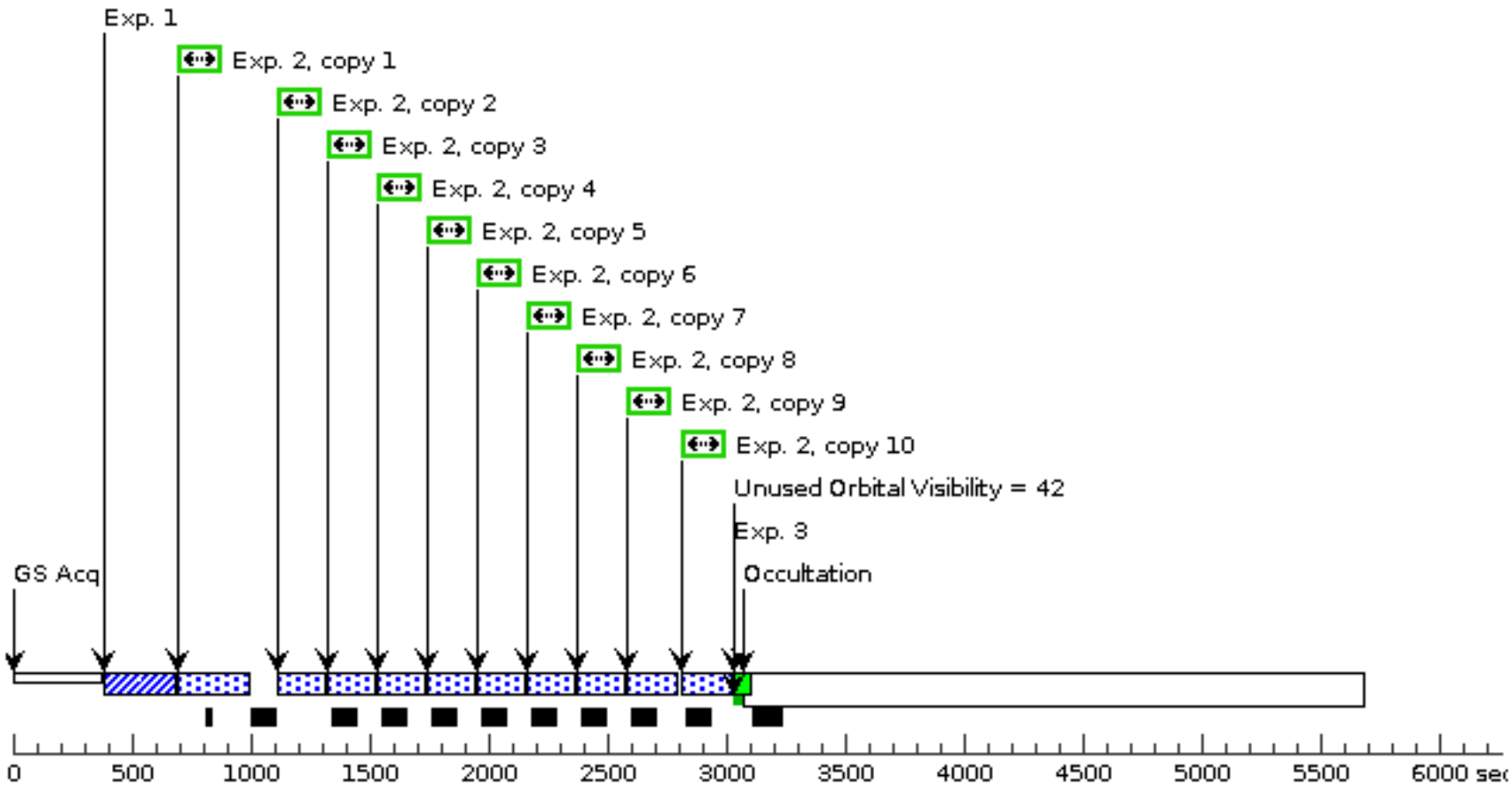
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[A4-A9 V-IV, DISK, EXTRA-SOLAR PLANETARY SYSTEM]
Extended=NO

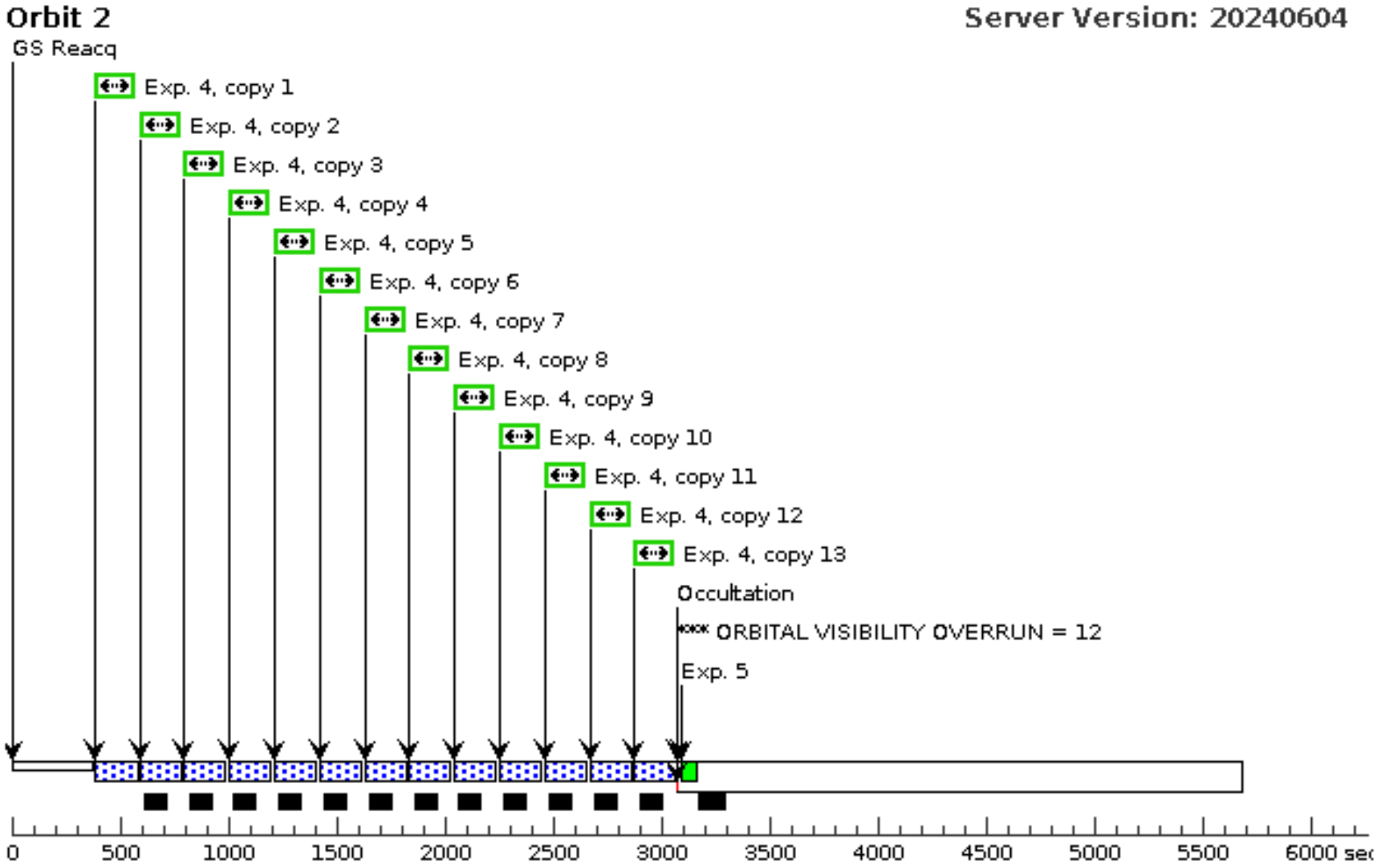
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (1890147)	(1) BETA-PIC	STIS/CCD, ACQ, F25ND5	MIRROR			Sequence 1-3 Non-Int in Visit 03	1 Secs (1 Secs) *[==>]*	*[1]*
2	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO		Sequence 1-3 Non-Int in Visit 03	200 Secs X 10 (1886 Secs) *[==>186.0 Secs (Copy 1)]* *[==>186.0 Secs (Copy 2)]* *[==>186.0 Secs (Copy 3)]* *[==>186.0 Secs (Copy 4)]* *[==>186.0 Secs (Copy 5)]* *[==>186.0 Secs (Copy 6)]* *[==>186.0 Secs (Copy 7)]* *[==>186.0 Secs (Copy 8)]* *[==>199.0 Secs (Copy 9)]* *[==>199.0 Secs (Copy 10)]*	*[1]*
3	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A			Sequence 1-3 Non-Int in Visit 03	*[==>]*	*[1]*
4	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO		Sequence 4-5 Non-Int in Visit 03	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	*[2]*
5	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A			Sequence 4-5 Non-Int in Visit 03	*[==>]*	*[2]*

	6	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO	Sequence 6-7 Non-Int in Visit 03	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	***[3]***
	7	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A		Sequence 6-7 Non-Int in Visit 03	*[==>]*	***[3]***
	8	(1890162)	(1) BETA-PIC	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A	WAVECAL=NO	Sequence 8-9 Non-Int in Visit 03	200 Secs X 13 (2392 Secs) *[==>184.0 Secs (Copy 1)]* *[==>184.0 Secs (Copy 2)]* *[==>184.0 Secs (Copy 3)]* *[==>184.0 Secs (Copy 4)]* *[==>184.0 Secs (Copy 5)]* *[==>184.0 Secs (Copy 6)]* *[==>184.0 Secs (Copy 7)]* *[==>184.0 Secs (Copy 8)]* *[==>184.0 Secs (Copy 9)]* *[==>184.0 Secs (Copy 10)]* *[==>184.0 Secs (Copy 11)]* *[==>184.0 Secs (Copy 12)]* *[==>184.0 Secs (Copy 13)]*	***[4]***
	9	WAVECAL	WAVE	STIS/NUV-MAMA, ACCUM, 0.2X0.2	E230H 1763 A		Sequence 8-9 Non-Int in Visit 03	*[==>]*	***[4]***

Orbit Structure

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Occultation
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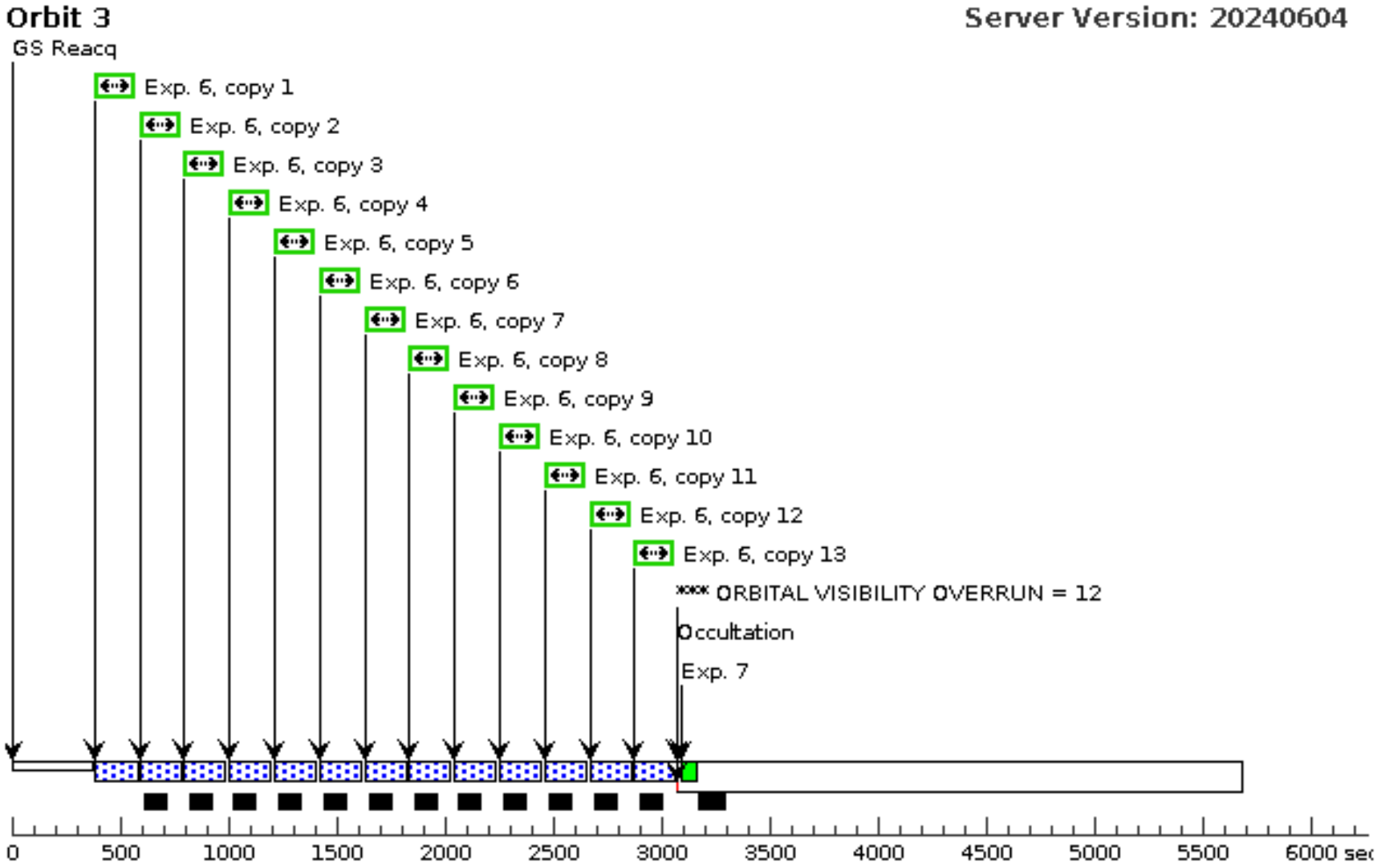
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Server Version: 20240604
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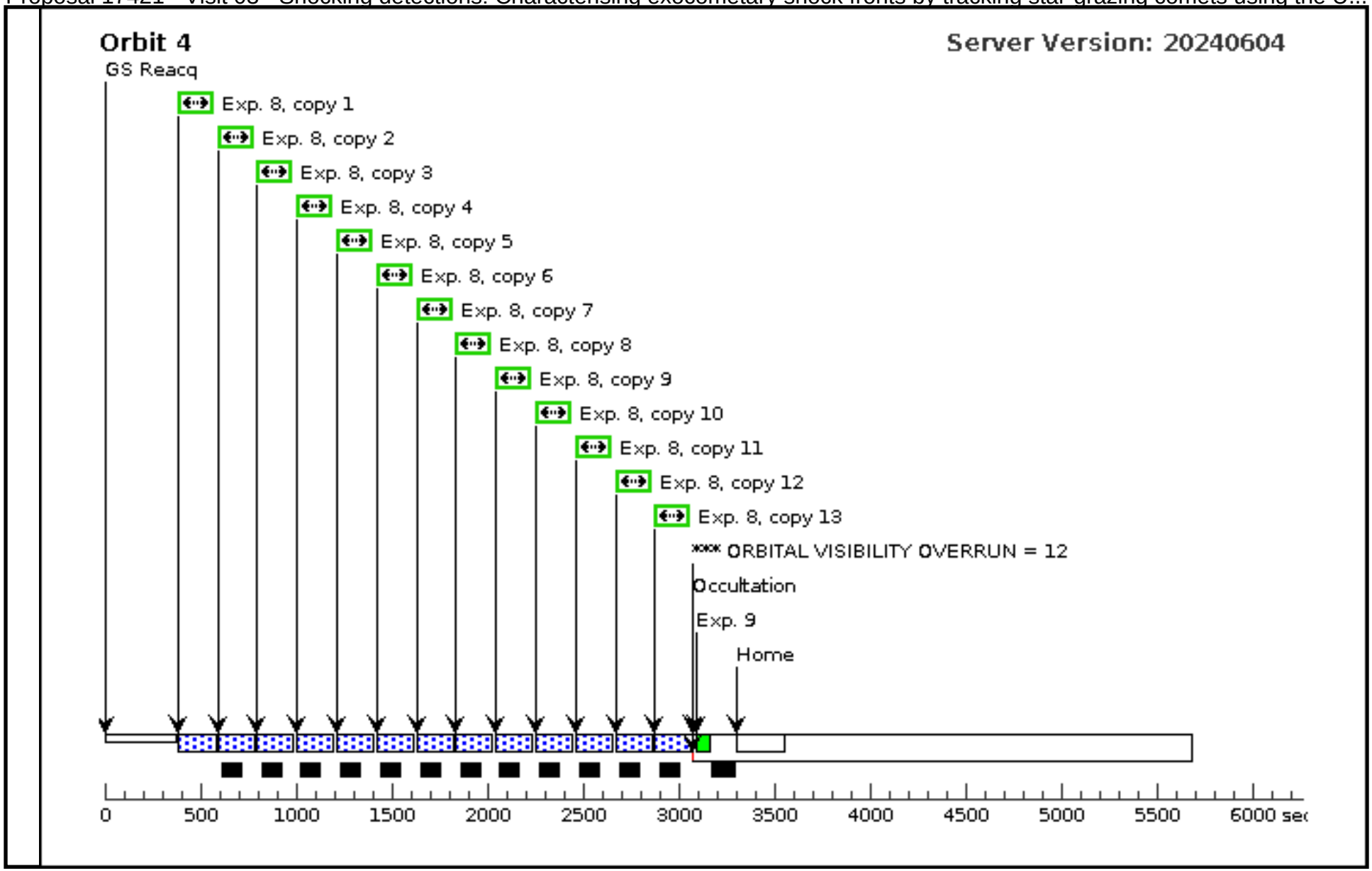
5500
6000 sec


Orbit 4
Server Version: 20240604
GS Reacq
Exp. 8, copy 1
Exp. 8, copy 2
Exp. 8, copy 3
Exp. 8, copy 4
Exp. 8, copy 5
Exp. 8, copy 6
Exp. 8, copy 7
Exp. 8, copy 8
Exp. 8, copy 9
Exp. 8, copy 10
Exp. 8, copy 11
Exp. 8, copy 12
Exp. 8, copy 13
*** ORBITAL VISIBILITY OVERRUN = 12
Occultation
Exp. 9
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec