17595 - A X-ray through Radio Exo-Space Weather Campaign to Study the Young Sun, EK Dra

Cycle: 31, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Prof. Kevin France (PI) (Contact)	**University of Colorado at Boulder**
Dr. Vladimir Airapetian (CoI)	American University
Dr. Kosuke Namekata (CoI)	Kyoto University

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) V-EK-DRA	COS/FUV COS/NUV	3	01-Feb-2024 16:00:41.0	yes
02	(1) V-EK-DRA	COS/FUV COS/NUV	3	01-Feb-2024 16:00:42.0	yes
03	(1) V-EK-DRA	COS/FUV COS/NUV	3	01-Feb-2024 16:00:42.0	yes
04	(1) V-EK-DRA	COS/FUV COS/NUV	3	01-Feb-2024 16:00:43.0	yes

12 Total Orbits Used

ABSTRACT

The focus of the proposed study is the magnetic activity of the young (50 -125 Myr) Sun-like star, EK Draconis. This nearby star thought to be an ideal proxy of the infant Sun at a near-zero-age main-sequence epoch, when the Earth's atmosphere transitioned from the primary to the secondary nitrogen and carbon dioxide rich atmosphere. Thus, the knowledge of the stellar ionizing radiation in the form of quiescent and flare X-ray and EUV emission, stellar wind and CME pressure that can affect the atmospheric escape and its chemistry is of critical importance for the study of early Venus, Earth and Mars environments. EK Dra is the subject of a recently-approved multi-wavelength ground- and space-based observing campaign and we propose to obtain new HST far-UV (FUV) spectra and light curves and combine these with scheduled optical spectropolarimetry (SEIMEI), TESS, and NICER X-ray observations, while radio (GMRT) radio observations of EK Dra have been proposed. Most importantly, the contemporaneous nature of these observations will provide a physically consistent picture of the drivers and outputs of the magnetically driven stellar coronal and wind structures of infant suns. We will use these observations as inputs to a fully thermodynamic model of the corona-wind system of EK Dra using the AWSoM code. AWSoM will output the missing EUV and stellar wind parameters that are required to predict the atmospheric evolution of terrestrial planets orbiting young suns.

OBSERVING DESCRIPTION

FUV Spectra: The HST data will use COS with G130M, CENWAVE=1309 to record the emission lines of C III (117.5 nm), Si III (120.6 nm), N V (123.8nm), Fe XII (124.2, 134.9nm), C I (132.9nm), C II (133.5 nm), Fe XXI (135.4nm), O V (137.1nm), O IV] (140.1nm), and Si IV (139.4, 140.3 nm). To resolve the physical processes relevant to chromospheric and coronal heating, we require R ~ 15,000. To constrain the stellar wind density of EK Dra, we require signal-to-noise ~ 10 at the peak of the O IV] 140.1 nm line. By comparing to archival HST FUV spectra of EK Dra (Ayres & France 2010; Ayres 2015), we estimate that three orbits per visit will be sufficient for detection of S/N > 10 per resolution element in the peak of the density-sensitive O IV] features (COS.sp.1684389). We calculate S/N between 10 and 20 in the peak of several C I lines and the coronal iron lines, S/N between 20 and 30 in Si IV and N V, and S/N > 30 in Si III and C II. This highfidelity spectrum will allow us to identify temporal variability and will provide robust line-fit measurements of thermal and non-thermal widths and line kinematics.

Given the observed UV flare rate from EK Dra, we expect to observe 2 - 3 multi-wavelength flares in a 12 orbit HST campaign (3 orbits per visits x 4 visits). Each 3-orbit visit is sufficient for a high-S/N stellar spectrum (see next sub-section) that will provide the quiescent stellar baseline and rotational modulation between flare events.

Target Acquisition: We performed a quantitative ETC target acquisition calculation using the STScI online tools, we scaled observed solar-type star to an average magnitude of V = 7.6, and we find that an exposure time of approximately 3.2s are required (COS.ta.1684394), using an imaging target acquisition in BOA+MIRRORA.

Instrument Safety: An ETC calculation using the observed EK Dra Lyman-alpha flux (the brightest stellar line in the FUV spectrum of EK Dra; Ayres et al. 2015), multiplied by 1.5 for conservatism, find no bright object violations using the COS G130M mode (COS.sp.1895208), therefore these observations present no risk to the instrument and are consistent with the COS 2025 observing guidelines.

Coordinated Observations: Simultaneous observations from space- and ground-based telescopes using X-ray spectroscopy (NICER), optical spectroscopy/photometry (TESS, Seimei telescope), and radio telescope (GMRT) will complement the HST time. TESS will be pivotal for the calculation of global energies. These observatories have a long record of providing flexible scheduling to provide supporting ground-based observations for approved space-based flare campaigns.

Visit

Proposal 17595, Visit 01, implementation Thu Feb 01 21:00:43 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%; BETWEEN 27-MAR-2024:00:00:00 AND 14-APR-2024:00:00:00

Diagnostics

(Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

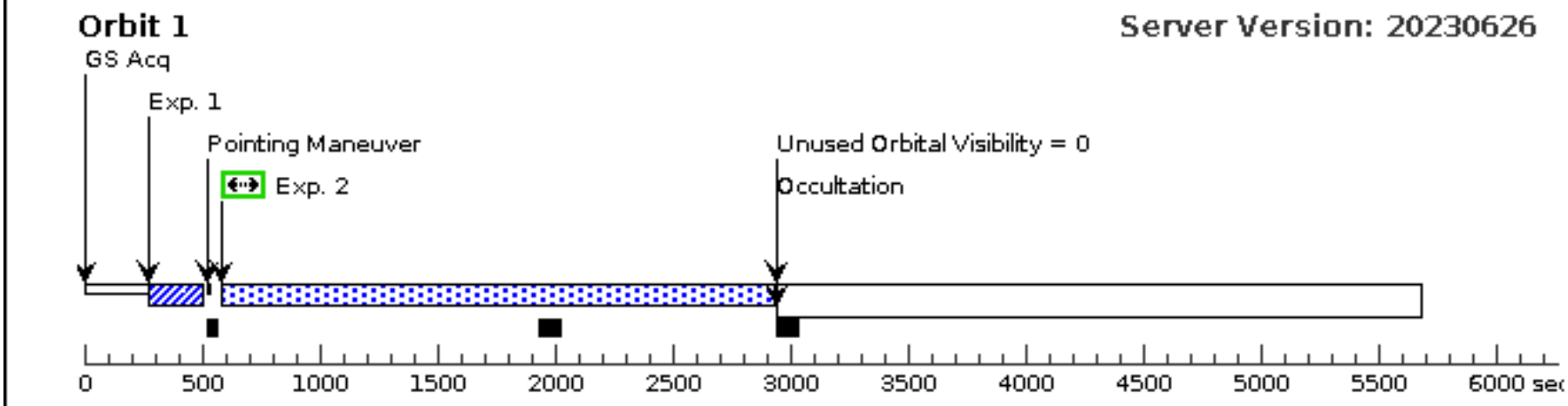
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EK-DRA	RA: 14 39 0.2104 (219.7508767d) Dec: +64 17 29.98 (64.29166d) Equinox: J2000	Proper Motion RA: -135.751 mas/yr Proper Motion Dec: -37.089 mas/yr Parallax: 0.0290661" Epoch of Position: 2000 Radial Velocity: -20.687 km/sec	V=7.604+/-0.05	Reference Frame: ICRS

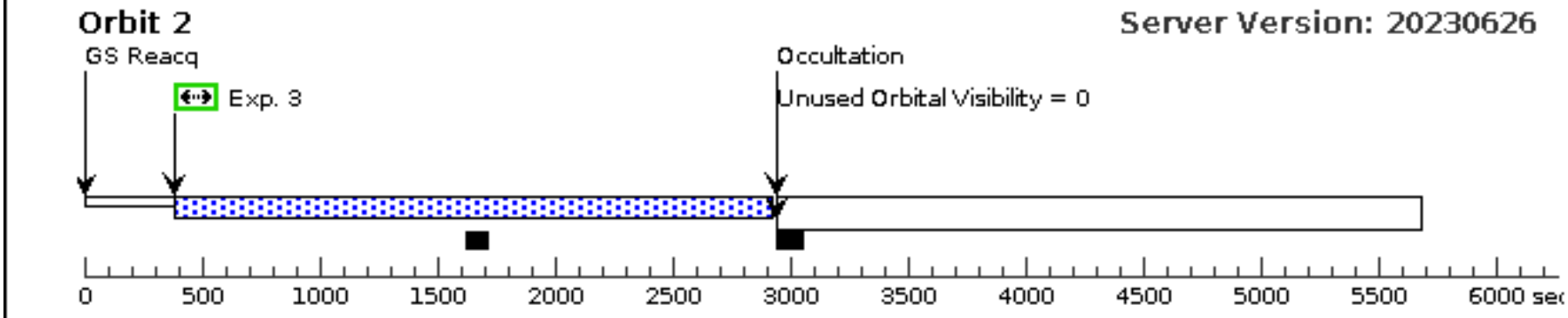
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[G V-IV]
Extended=NO

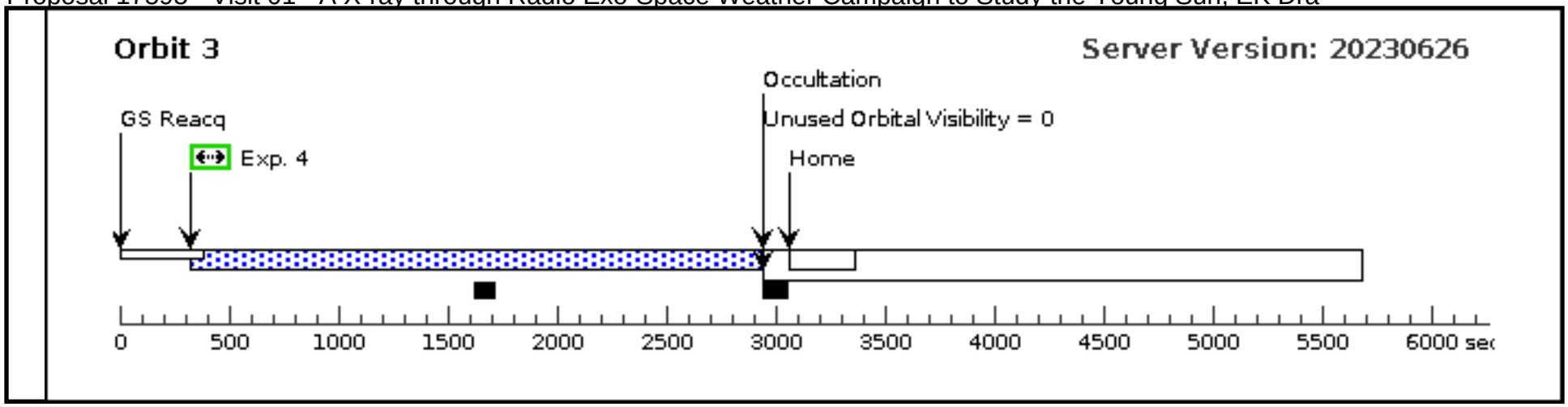
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	EKDra_ACQIMG1 (COS.ta.1684394)	(1) V-EK-DRA	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				5 Secs (5 Secs) *[==>]*	*[1]*
2	EKDra-G130M_v1_1 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2176 Secs (2176 Secs) *[==>]*	*[1]*
3	EKDra-G130M_v1_2 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=4			2486 Secs (2486 Secs) *[==>]*	*[2]*
4	EKDra-G130M_v1_3 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2486 Secs (2486 Secs) *[==>]*	*[3]*

Orbit Structure






Orbit 3
Server Version: 20230626
Occultation
GS Reacq
Unused Orbital Visibility = 0
Exp. 4
Home
0
500
1000
1500
2000
2500
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3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 17595, Visit 02, implementation Thu Feb 01 21:00:43 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%; AFTER 01 BY 12 H TO 48 H

Diagnostics

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

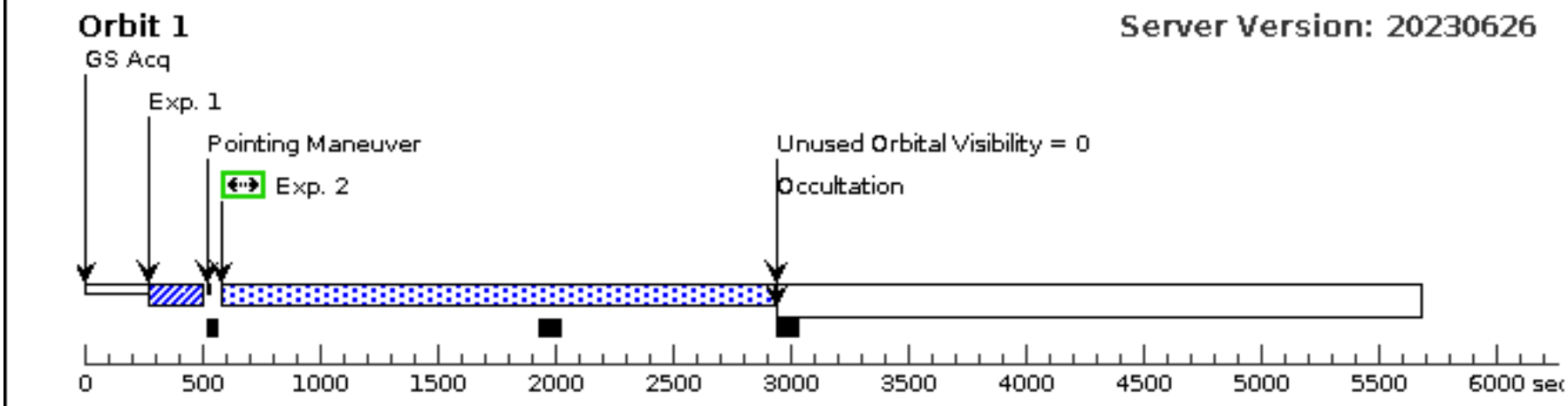
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EK-DRA	RA: 14 39 0.2104 (219.7508767d) Dec: +64 17 29.98 (64.29166d) Equinox: J2000	Proper Motion RA: -135.751 mas/yr Proper Motion Dec: -37.089 mas/yr Parallax: 0.0290661" Epoch of Position: 2000 Radial Velocity: -20.687 km/sec	V=7.604+/-0.05	Reference Frame: ICRS

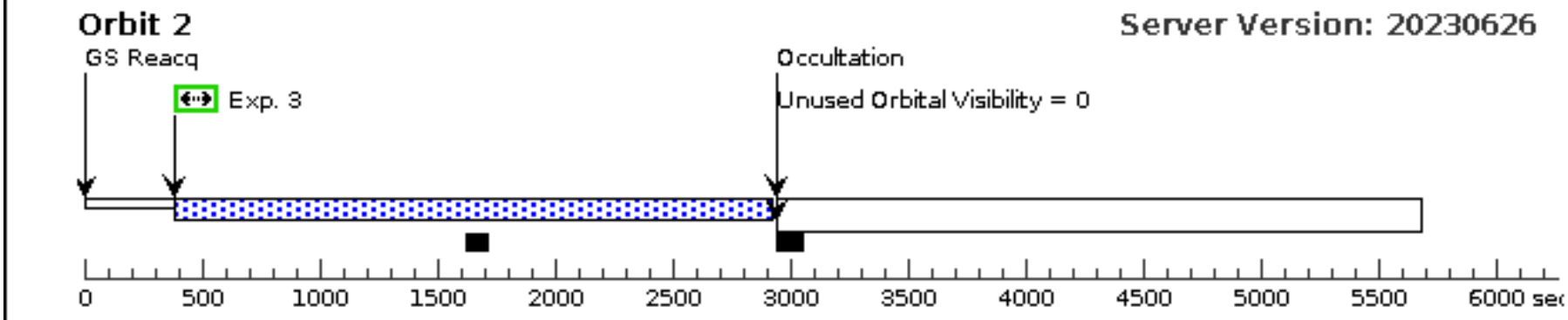
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[G V-IV]
Extended=NO

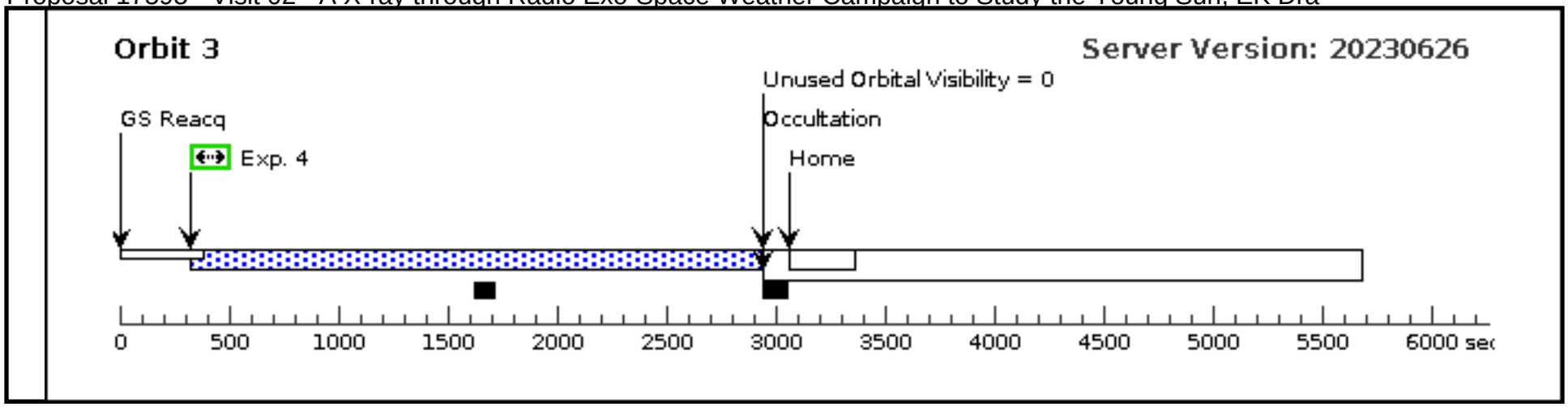
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	EKDra_ACQIMG2 (COS.ta.1684394)	(1) V-EK-DRA	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				5 Secs (5 Secs) *[==>]*	*[1]*
2	EKDra-G130M_v2_1 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2176 Secs (2176 Secs) *[==>]*	*[1]*
3	EKDra-G130M_v2_2 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=4			2486 Secs (2486 Secs) *[==>]*	*[2]*
4	EKDra-G130M_v2_3 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2486 Secs (2486 Secs) *[==>]*	*[3]*

Orbit Structure






Orbit 3
Server Version: 20230626
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 4
Home
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6000 sec

Visit

Proposal 17595, Visit 03, implementation Thu Feb 01 21:00:43 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%; AFTER 02 BY 12 H TO 48 H

Diagnostics

(Visit 03) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

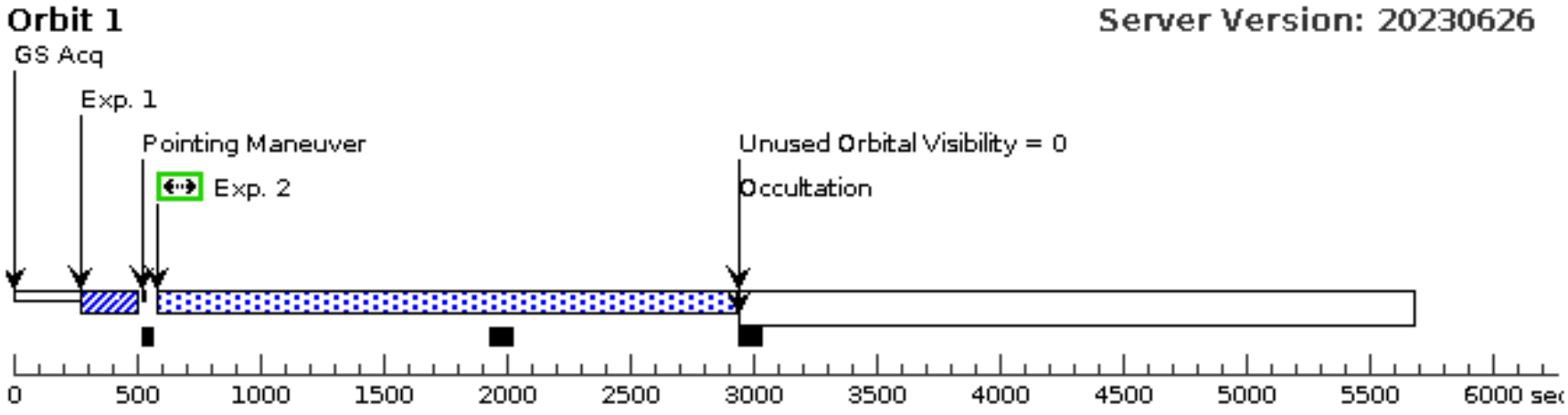
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EK-DRA	RA: 14 39 0.2104 (219.7508767d) Dec: +64 17 29.98 (64.29166d) Equinox: J2000	Proper Motion RA: -135.751 mas/yr Proper Motion Dec: -37.089 mas/yr Parallax: 0.0290661" Epoch of Position: 2000 Radial Velocity: -20.687 km/sec	V=7.604+/-0.05	Reference Frame: ICRS

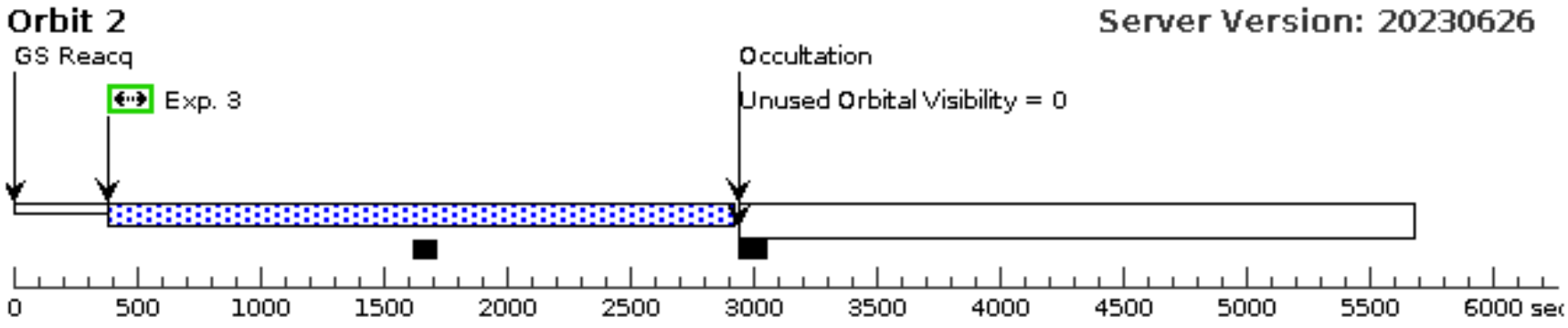
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[G V-IV]
Extended=NO

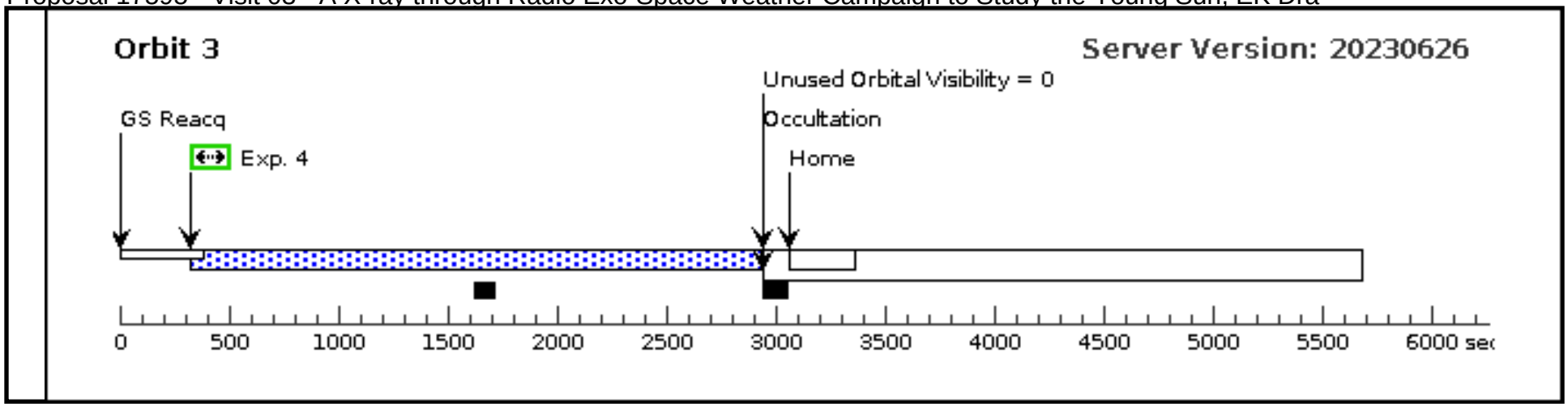
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	EKDra_ACQIMG3 (COS.ta.1684394)	(1) V-EK-DRA	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				5 Secs (5 Secs) *[==>]*	*[1]*
2	EKDra-G130M_v3_1 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2176 Secs (2176 Secs) *[==>]*	*[1]*
3	EKDra-G130M_v3_2 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=4			2486 Secs (2486 Secs) *[==>]*	*[2]*
4	EKDra-G130M_v3_3 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2486 Secs (2486 Secs) *[==>]*	*[3]*

Orbit Structure






Orbit 3
Server Version: 20230626
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 4
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Visit

Proposal 17595, Visit 04, implementation Thu Feb 01 21:00:44 GMT 2024

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%; AFTER 03 BY 12 H TO 48 H

Diagnostics

(Visit 04) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

Fixed Targets

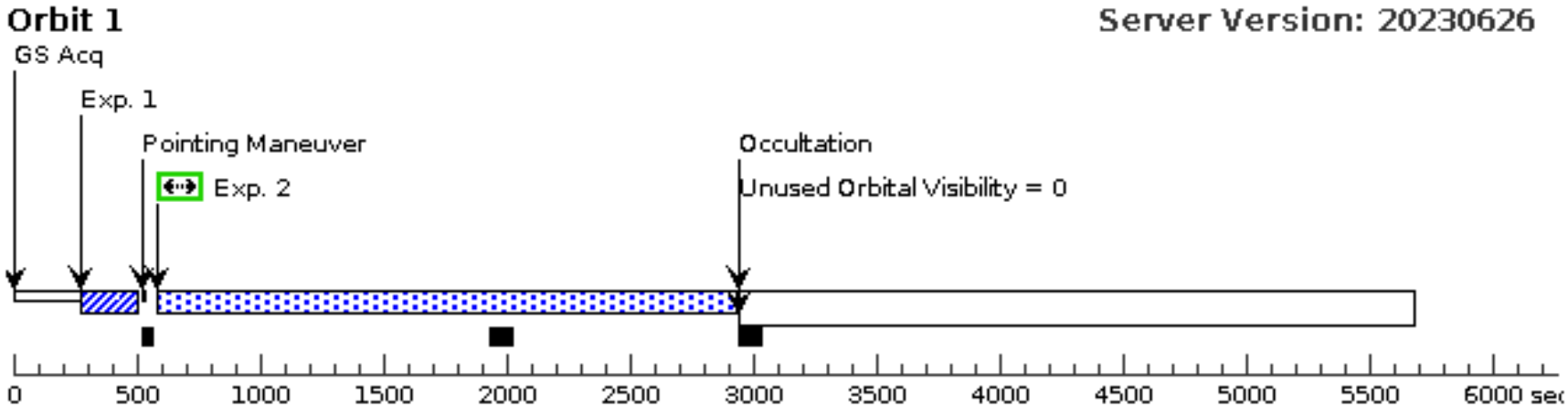
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-EK-DRA	RA: 14 39 0.2104 (219.7508767d) Dec: +64 17 29.98 (64.29166d) Equinox: J2000	Proper Motion RA: -135.751 mas/yr Proper Motion Dec: -37.089 mas/yr Parallax: 0.0290661" Epoch of Position: 2000 Radial Velocity: -20.687 km/sec	V=7.604+/-0.05	Reference Frame: ICRS

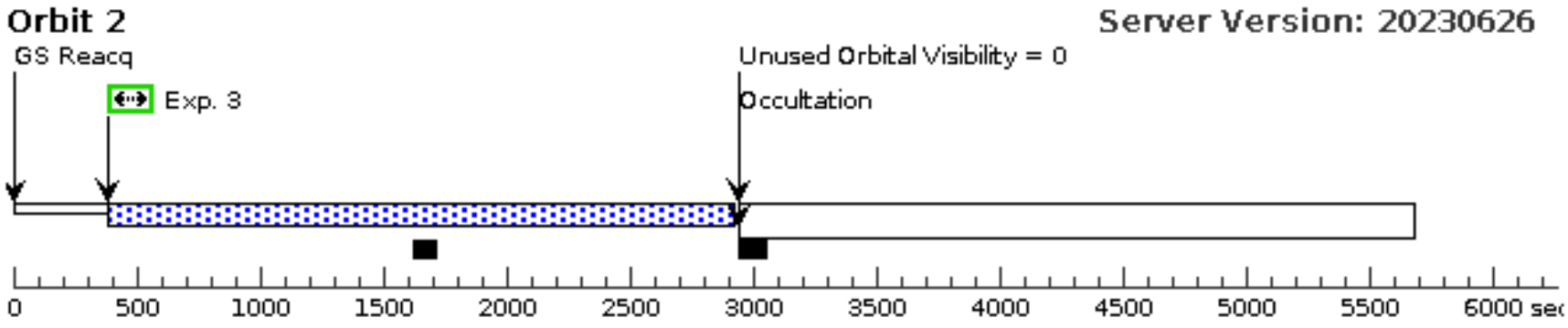
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=EXT-STAR
Description=[G V-IV]
Extended=NO

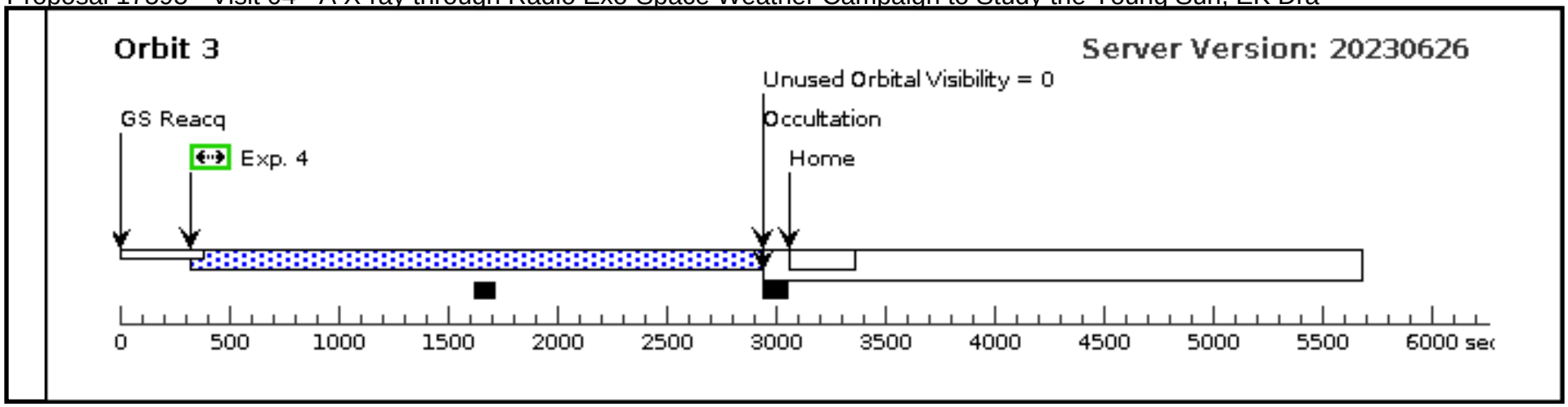
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	EKDra_ACQIMG4 (COS.ta.1684394)	(1) V-EK-DRA	COS/NUV, ACQ/IMAGE, BOA	MIRRORA				5 Secs (5 Secs) *[==>]*	*[1]*
2	EKDra-G130M_v4_1 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2176 Secs (2176 Secs) *[==>]*	*[1]*
3	EKDra-G130M_v4_2 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=4			2486 Secs (2486 Secs) *[==>]*	*[2]*
4	EKDra-G130M_v4_3 (COS.sp.1841043)	(1) V-EK-DRA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=1200; FP-POS=3			2486 Secs (2486 Secs) *[==>]*	*[3]*

Orbit Structure






Orbit 3
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Occultation
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