18003 - A Spectacularly Polluted White Dwarf with Transits

Cycle: 33, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Prof. Jay Farihi (PI) (ESA Member) (Contact)	**University College London**
Prof. Boris T. Gaensicke (CoI) (ESA Member) (Contact)	University of Warwick
Prof. Seth Redfield (CoI) (AdminUSPI)	Wesleyan University

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) WDJ1013-0427	COS/FUV COS/NUV	3	20-Nov-2025 14:00:30.0	yes
02	(1) WDJ1013-0427	COS/FUV COS/NUV	3	20-Nov-2025 14:00:32.0	yes
03	(1) WDJ1013-0427	COS/FUV COS/NUV	4	20-Nov-2025 14:00:33.0	yes

10 Total Orbits Used

ABSTRACT

Planetary systems orbiting white dwarfs offer not only a glimpse into the future solar system, but also a test of long-term dynamical processes spanning major stellar evolutionary transitions. These dynamical changes are epitomized by ubiquitous dust variability in the infrared, and via rapidly evolving transits detected now in at least 14 systems. Critically, the polluted stellar atmospheres distill entire exoplanetary bodies into their

bulk chemical compositions, a phenomenon that is unavailable for main-sequence stars, and currently the only means to acquire empirical insight into exoplanetary surfaces and interiors.

Here, we propose to study an unprecedented source with long-term transits, extreme pollution, gaseous disk emission, and a color term in multi-band light curves. The near record-breaking abundances determined from low-resolution spectroscopy imply that myriad lines of many metal species will be detected in the ultraviolet. These include but are not limited to C, N, O, Al, Si, P, S, Cr, Mn, Fe, and Ni. Multiple lines of oxygen and carbon will be detected with high confidence, and possibly nitrogen if present in sufficient quantities. These abundances directly constrain the volatile content of the parent body, and to some degree, its birthplace in this exoplanetary system, in turn constraining its origin and nature. The observed, several year transit duration suggests the parent body was initially in a relatively distant orbit where water and other ices may persist. Volatile-rich debris pollution has only been observed previously in a single case, and requires the ultraviolet capacity of Hubble for an assessment of the bulk chemical composition.

OBSERVING DESCRIPTION

The goal is simply deep spectroscopy of this relatively faint targets, with the aim to detect myriad metal absorption lines from the stellar atmosphere and possbily from circumstellar material.

We use two central wavelngth settings: 1222A and 1291A.

The program is split into three visits: 4 orbits at 1222A, one orbit per FP-POS setting, 3 orbits at 1291A and FP-POS=3 and 3 orbits at 1291A and FP-POS=4 (for 1291A only FP-POS=3,4 are allowed).

The warning that comes up is a result of having the FP-POS=3 and 4 split over two visits, however, we will combine all spectroscopy in post-processing.

Visit

Proposal 18003, 1291A - FP-POS=3 (01), implementation Thu Nov 20 19:00:34 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(1291A - FP-POS=3 (01)) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions at a given COS cenwave (or 2 positions for certain exception cases). See extended explanation in the diagnostic browser.

Fixed Targets

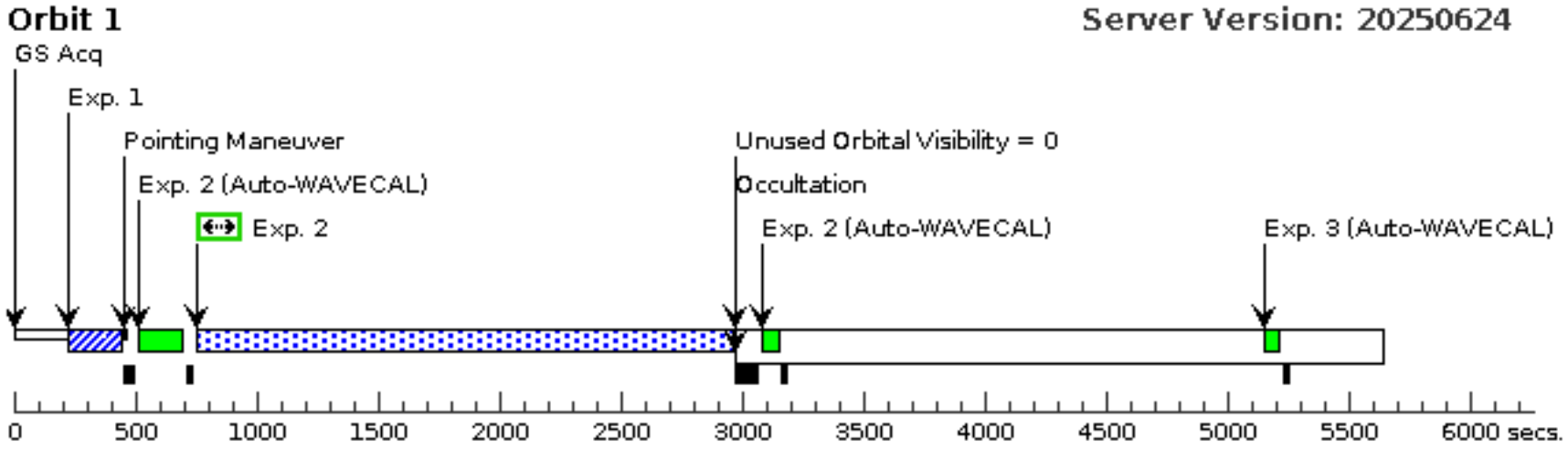
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	WDJ1013-0427	RA: 10 13 6.3239 (153.2763496d) Dec: -04 27 29.55 (-4.45821d) Equinox: J2000	Proper Motion RA: -1.754 mas/yr Proper Motion Dec: -19.873 mas/yr Parallax: 0.0032469" Epoch of Position: 2016.0	V=18.25+/-0.05 GALEX FUV=17.920	Reference Frame: ICRS

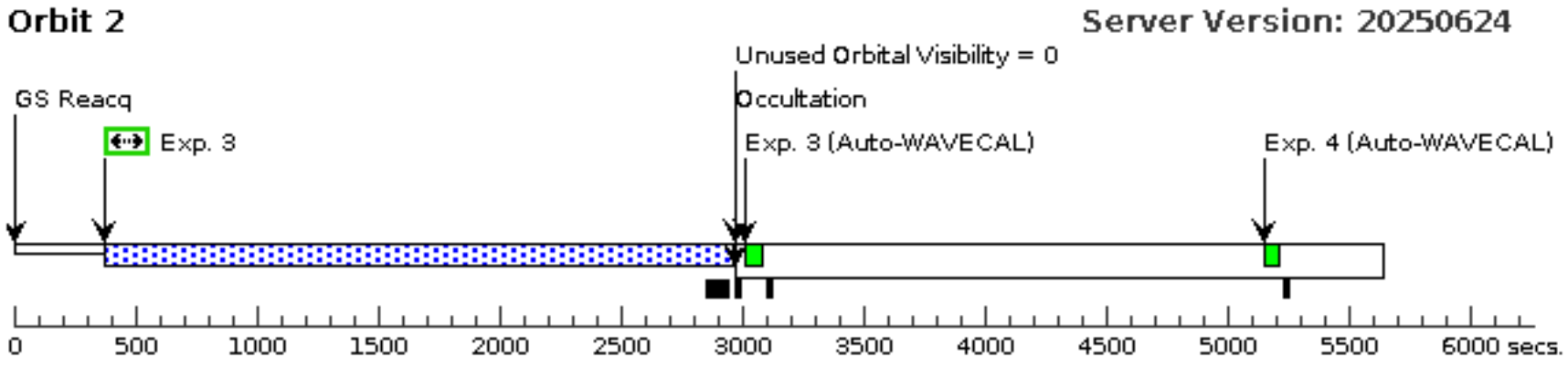
Comments: Coordinates and astrometry up to date using Gaia DR3
Category=STAR
Description=[DB, DZ]
Extended=NO

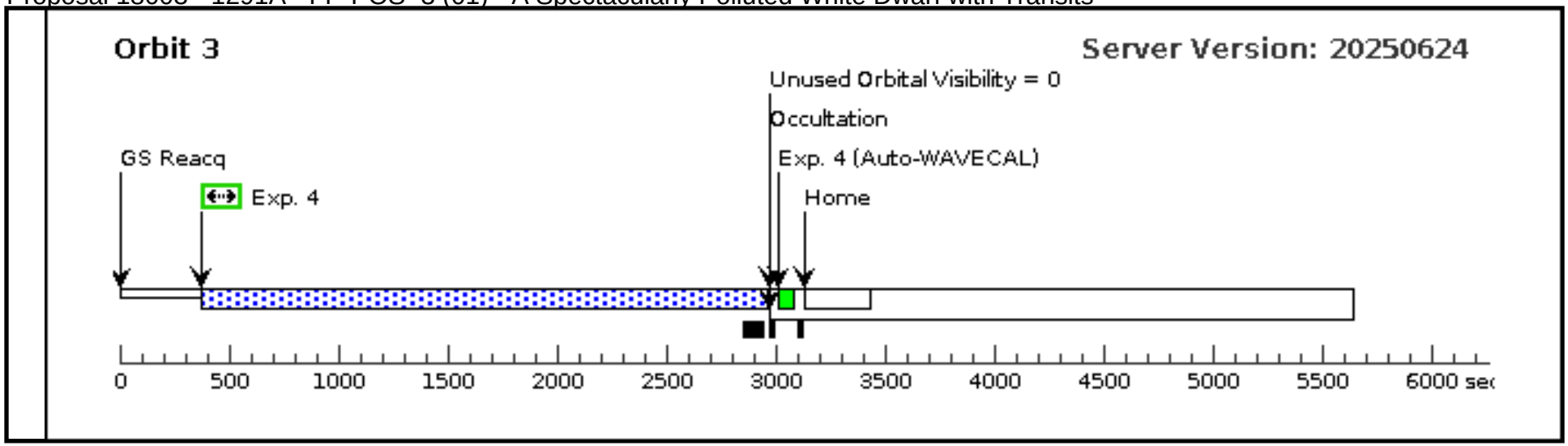
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target acq (COS.ta.2022801)	(1) WDJ1013-0427	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				3 Secs (3 Secs) *[==>]*	***[1]***
2	1291A - FP-POS=3 (#1) (COS.sp.2022803)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2445; FP-POS=3			2163 Secs (2163 Secs) *[==>]*	***[1]***
3	1291A - FP-POS=3 (#2) (COS.sp.2022803)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2445; FP-POS=3			2539 Secs (2539 Secs) *[==>]*	***[2]***
4	1291A - FP-POS=3 (#3) (COS.sp.2022803)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2445; FP-POS=3			2539 Secs (2539 Secs) *[==>]*	***[3]***

Orbit Structure






Orbit 3
Server Version: 20250624
Unused Orbital Visibility = 0
Occultation
GS Reacq
Exp. 4 (Auto-WAVECAL)
Exp. 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 18003, 1291A - FP-POS=4 (02), implementation Thu Nov 20 19:00:34 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Diagnostics

(1291A - FP-POS=4 (02)) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions at a given COS cenwave (or 2 positions for certain exception cases). See extended explanation in the diagnostic browser.

Fixed Targets

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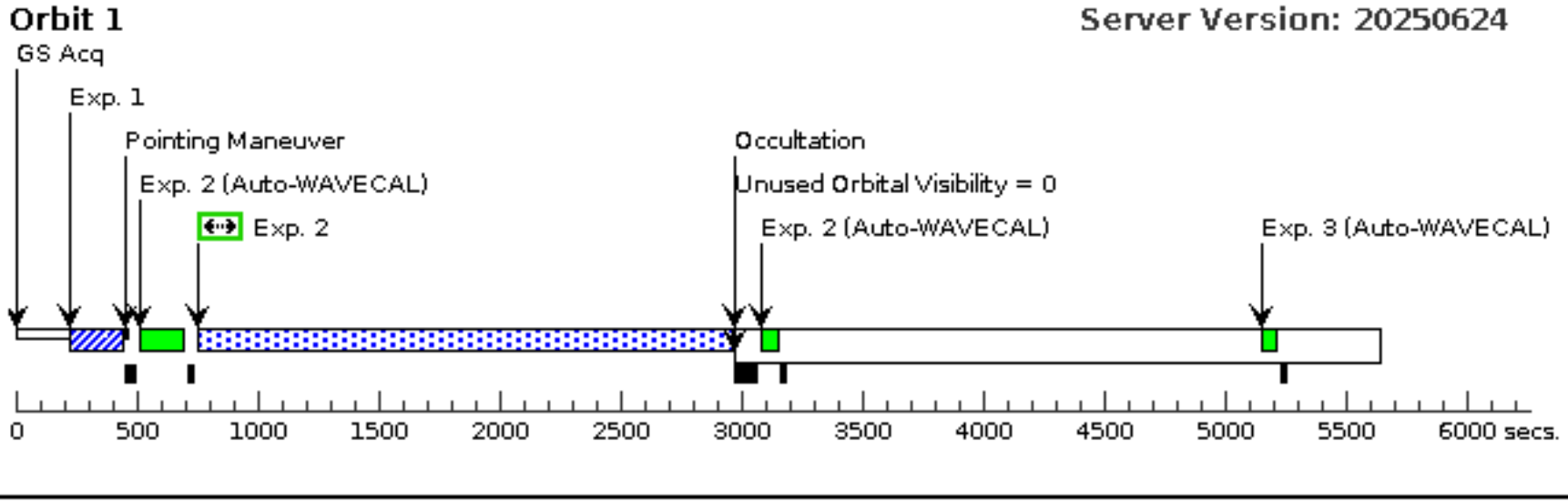
(1)	WDJ1013-0427	RA: 10 13 6.3239 (153.2763496d) Dec: -04 27 29.55 (-4.45821d) Equinox: J2000	Proper Motion RA: -1.754 mas/yr Proper Motion Dec: -19.873 mas/yr Parallax: 0.0032469" Epoch of Position: 2016.0	V=18.25+/-0.05 GALEX FUV=17.920	Reference Frame: ICRS

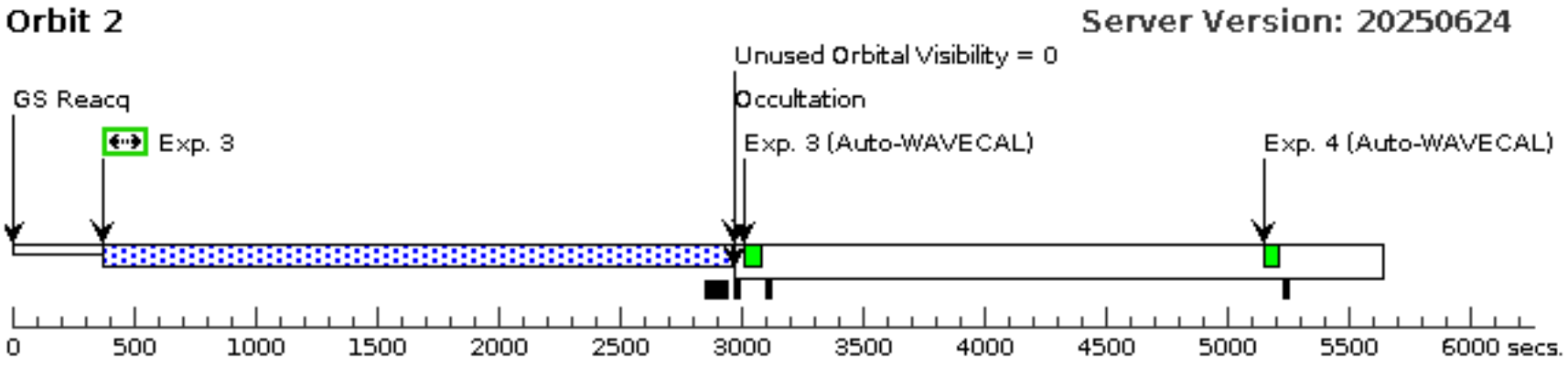
Comments: Coordinates and astrometry up to date using Gaia DR3
Category=STAR
Description=[DB, DZ]
Extended=NO

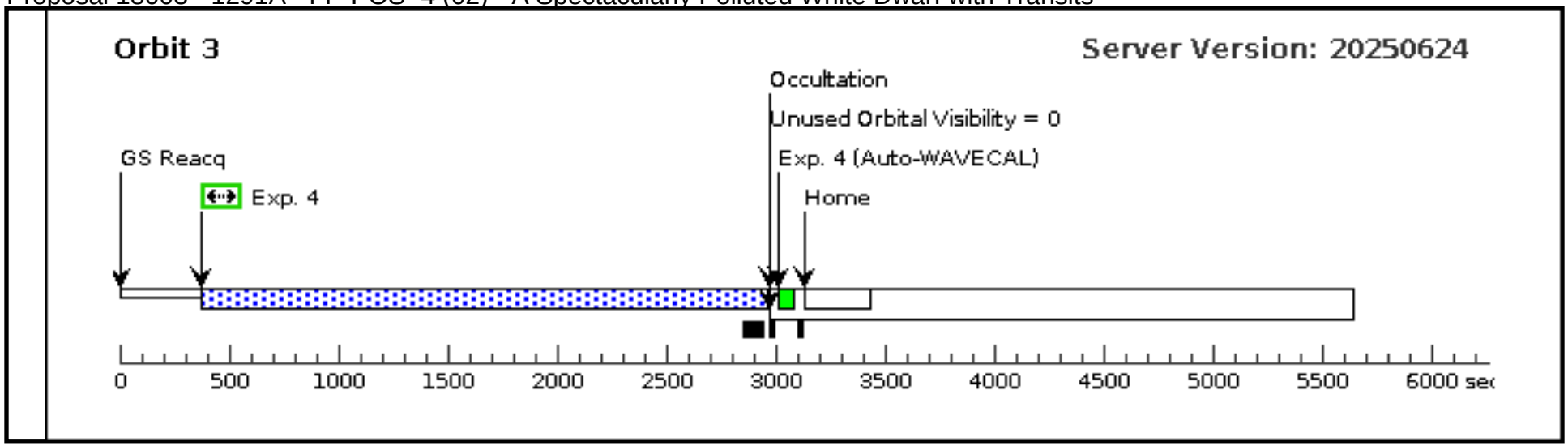
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target acq (COS.ta.2022801)	(1) WDJ1013-0427	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				3 Secs (3 Secs) *[==>]*	*[1]*
2	1291A - FP-POS=4 (#1) (COS.sp.2022803)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2445; FP-POS=4			2163 Secs (2163 Secs) *[==>]*	*[1]*
3	1291A - FP-POS=4 (#2) (COS.sp.2022803)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2445; FP-POS=4			2539 Secs (2539 Secs) *[==>]*	*[2]*
4	1291A - FP-POS=4 (#3) (COS.sp.2022803)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=2445; FP-POS=4			2539 Secs (2539 Secs) *[==>]*	*[3]*

Orbit Structure






Orbit 3
Server Version: 20250624
Occultation
Unused Orbital Visibility = 0
GS Reacq
Exp. 4 (Auto-WAVECAL)
Exp. 4
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec

Visit

Proposal 18003, 1222A - all four FP-POS (03), implementation Thu Nov 20 19:00:34 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

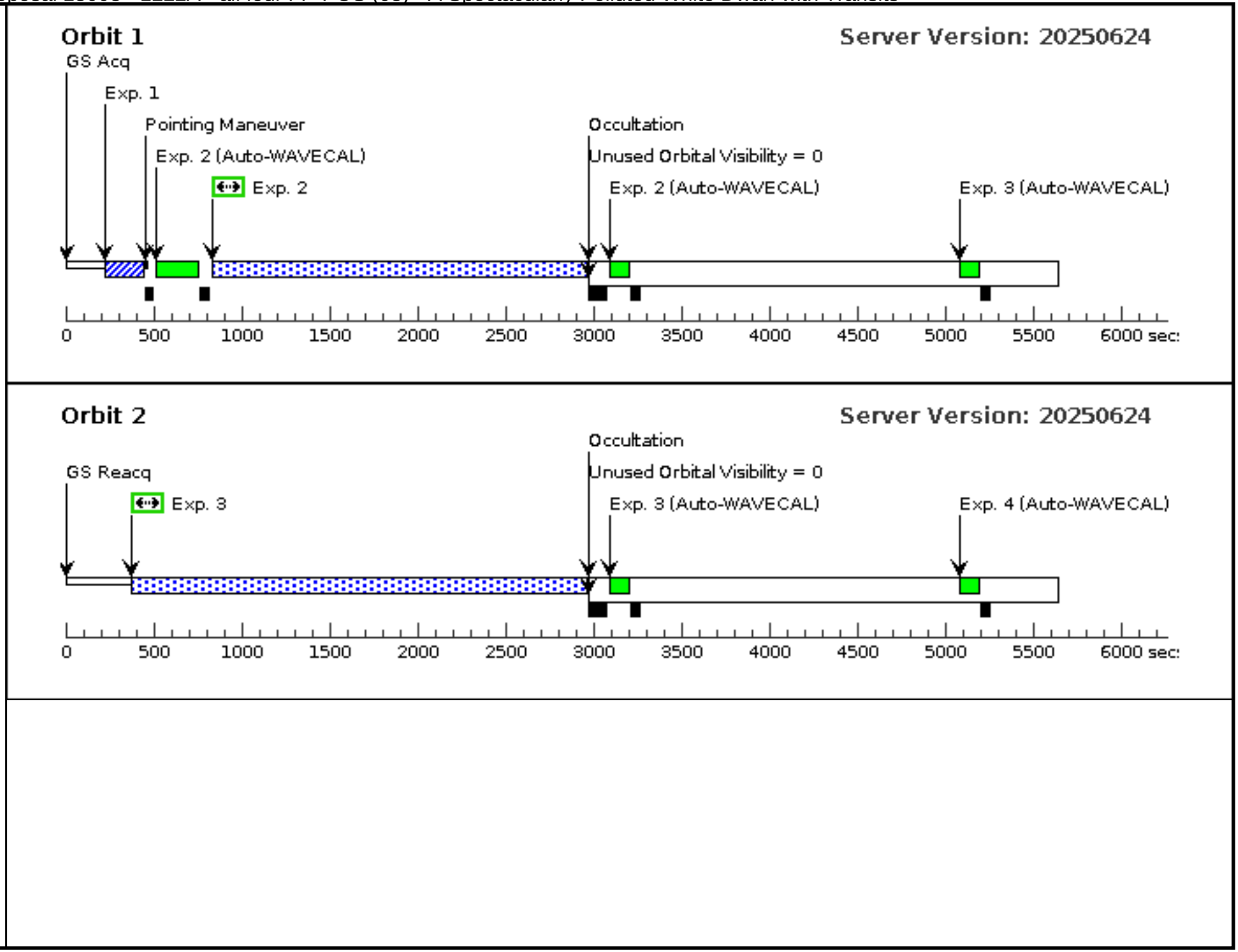
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	WDJ1013-0427	RA: 10 13 6.3239 (153.2763496d) Dec: -04 27 29.55 (-4.45821d) Equinox: J2000	Proper Motion RA: -1.754 mas/yr Proper Motion Dec: -19.873 mas/yr Parallax: 0.0032469" Epoch of Position: 2016.0	V=18.25+/-0.05 GALEX FUV=17.920	Reference Frame: ICRS

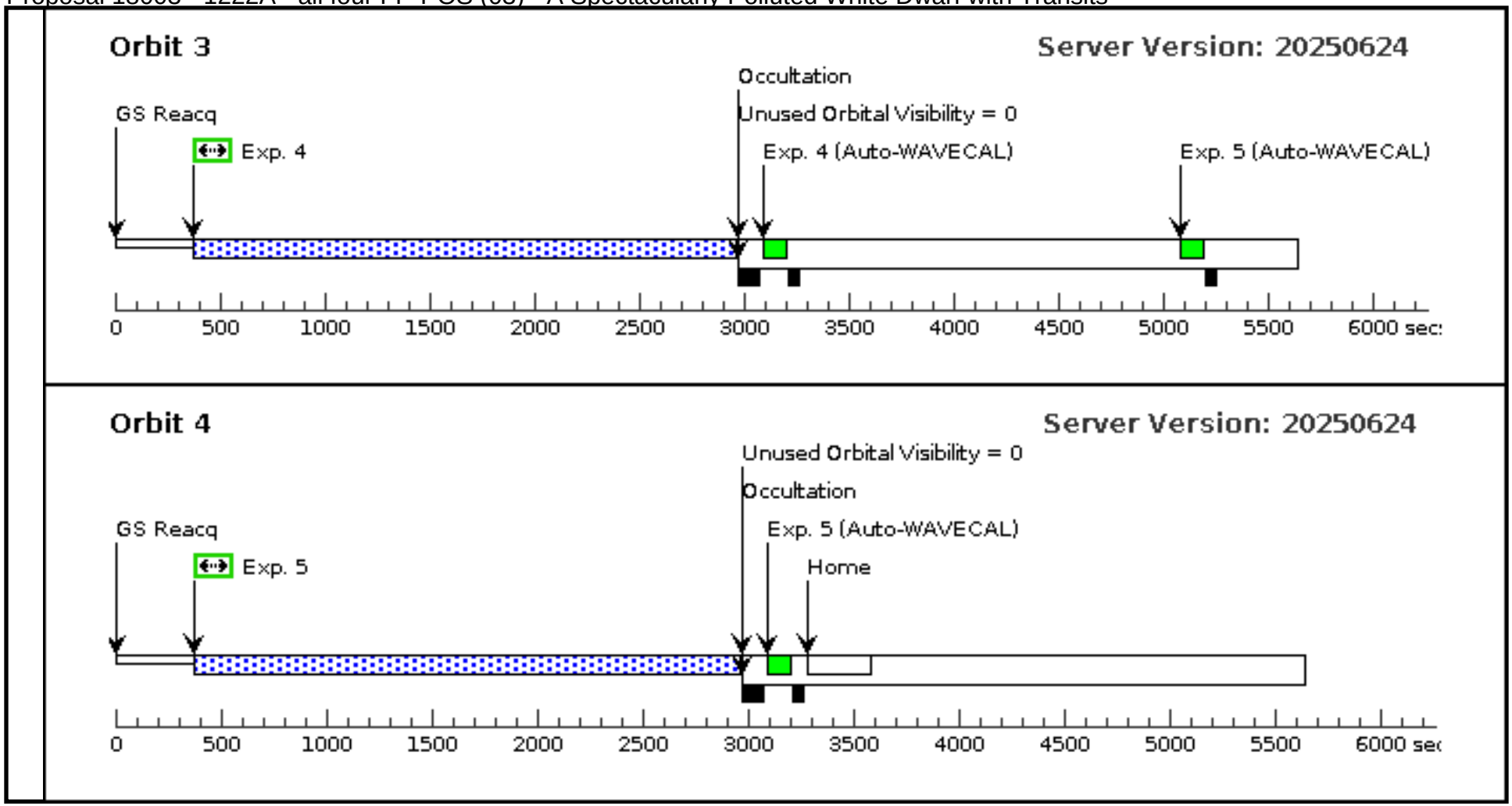
Comments: Coordinates and astrometry up to date using Gaia DR3
Category=STAR
Description=[DB, DZ]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Target acq (COS.ta.2022801)	(1) WDJ1013-0427	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				3 Secs (3 Secs) *[==>]*	*[1]*
2	1222A - FP-POS=1 (COS.sp.2022806)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2163; FP-POS=1			2077 Secs (2077 Secs) *[==>]*	*[1]*
3	1222A - FP-POS=2 (COS.sp.2022806)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2539; FP-POS=2			2539 Secs (2539 Secs) *[==>]*	*[2]*
4	1222A - FP-POS=3 (COS.sp.2022806)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2539; FP-POS=3			2539 Secs (2539 Secs) *[==>]*	*[3]*
5	1222A - FP-POS=4 (COS.sp.2022806)	(1) WDJ1013-0427	COS/FUV, TIME-TAG, PSA	G130M 1222 A	BUFFER-TIME=2539; FP-POS=4			2539 Secs (2539 Secs) *[==>]*	*[4]*

Orbit Structure




Orbit 3
Server Version: 20250624
Occultation
Unused Orbital Visibility = 0
GS Reacq
Exp. 4
Exp. 4 (Auto-WAVECAL)
Exp. 5 (Auto-WAVECAL)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec
Orbit 4
Server Version: 20250624
Unused Orbital Visibility = 0
Occultation
GS Reacq
Exp. 5
Exp. 5 (Auto-WAVECAL)
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000 sec