



12987 - Possible Disintegrating Short-Period Super-Mercury Orbiting KIC 12557548

Cycle: 20, Proposal Category: GO
(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) KIC12557548B (2) KIC12557548-OFF	WFC3/IR WFC3/UVIS	5	09-Nov-2012 21:46:40.0	yes

5 Total Orbits Used

ABSTRACT

We recently identified a star in the Kepler database with a unique light curve, featuring periodic transit-like events with unusual and highly variable characteristics. We suspect that we are witnessing

the destruction of a strongly irradiated rocky exoplanet, with the "transits" being due to extinction by dust ejected from the planet.

If we are correct, then this object would be the first known case of a geologically active rocky exoplanet, undergoing significant mass loss.

We will utilize 5 orbits of HST observations to test this idea by helping to answer two crucial questions: (1) do the observed 0.5% flux dips really represent transits of the Kepler target star, or are they larger-amplitude occultations of a fainter, accidentally aligned, background star or binary?, and (2) are the dips really due to attenuation by dust? The observations would comprise a single visit of 5 orbits utilizing WFC3 visible and NIR imaging. The direct imaging data during the first orbit will identify any neighboring stars. Four orbits of precision photometry with the F140W filter across a transit will enable us to detect the wavelength dependence of the transit depth, expected under the dust hypothesis, and to test whether any neighboring stars are the source of the flux variations. Only HST can achieve both the high spatial resolution and precise spectrophotometry that are required for these goals.

OBSERVING DESCRIPTION

We propose to observe KIC 12557548 - a magnitude $V = 16.2$ star with a spectral type of about K4V - over 5 orbits during one visit to the object.

In what follows, we have used the WFC3 ETC to provide detailed checks of exposures times and resulting SNRs for all filters and detectors of interest.

We have used APT to test exposure sequences to be assured that overheads are accounted for. The first orbit of an HST visit is reputedly prone to being affected by small but significant photometric systematic effects compared to subsequent orbits. This has led most other programs desiring ultra-high signal-to-noise time series photometric observations to drop the first orbit, or to use it to obtain non-

photometry results while the spacecraft and instrument reach equilibrium at the new pointing. For KIC 1255b the presence of some out-of-occultation features also argues for adopting 5 HST orbits to fully obtain baseline controls for the in-transit changes. Thus orbit 1 will be scheduled to start before an occultation, while orbits 2-5 will respectively cover the pre-transit bump, the transit dip, the post-transit "depression", and a region after the transit.

Visit 1 (5 HST orbits):

The scientific goals of the observations are to provide high resolution imaging at 5 different wavelengths from the visible to the near-infrared so as to yield the most sensitive limits at a variety of wavelengths on the presence of nearby stars unrelated to KIC 12557548, and to check whether any nearby star that is detected might be the source of the observed dips in flux. To achieve these goals we will obtain high resolution imaging of the target followed by accurate NIR (F140W filter) photometry.

We will obtain high resolution imaging of KIC 12557548 by taking dithered images using the C1K1C-subarray on UVIS2 in the visible, thus providing the best possible sensitivity to nearby objects - see ISR WFCR 2011-3, Gilliland and Rajan (2011) for a thorough discussion of sensitivity limits that can be reached as a function of offset distance from a target.

In the first half of the first HST orbit, we will observe in two visible wavelength filters (the F555W and F775W filters). High SNR F555W and F775W observations will allow the detection of background stars up to 9 magnitudes fainter than KIC 12557548 at and beyond separations of 1 arcsec. At 0.5" a delta-mag of 8 is reached, while at 0.2" a delta-mag of at least 4 is reached. For F555W 80% of saturation is reached in 40s, SNR = 420, while for F775W 80% of saturation is reached in 50s, SNR = 440.

In each filter we will take an exposure reaching to 80% of saturation for each step in the 4 points of a WFC3-UVIS-DITHER-BOX pattern. An additional exposure to 2-3 times saturation will be used to bring up the wings in each filter.

For most of the remaining half of the first HST orbit we will obtain imaging in the IR at F125W, F140W, and F160W using the WFC3-IR-DITHER-BOX pattern. The 512 subarray will be used along with the RAPID MULTIACCUM readout mode giving, with NSAMP= 5, 5, and 7 for F125W, F140W, and F160W, respectively. Exposure times of 4.3 s, 4.3 s, and 6 s will yield images of the target star at ~80% of saturation. The signal to noise ratios, per exposure, are expected to be close to 350 for each of these filters. One image taken to twice saturation will be recorded for both the F125W and F160W filters to bring up the wings. Finally, near the end of Orbit 1, we will take a sequence of three more exposures in the F555W filter to take another careful look for background blended objects with the highest angular resolution.

Orbits 2-5 will observe in the F140W filter to provide extremely accurate photometry after the instabilities that may affect orbit 1 have abated. They will comprise time series observations with F140W RAPID, NSAMP=5 using the 512 subarray. This photometry will obtain an SNR of 350 per exposure. A total of 63 exposures will be obtained in time series mode per HST orbit. This will allow tests of in- versus out-of-transit centroid motion of order the PSF width divided by the raw SNR of the transit itself. For a 0.6% transit, this results in a 3-sigma exclusion radius of 0.05". This limit compares to the 2" available from the Kepler observations.

There is a star with nearly equal brightness in the near-IR at 39" separation - we will utilize offset pointing so both are within the IR subarray. This will allow control of HST guiding systematics, which can be as large as a few times 0.01", in analyses of the centroid of the target star.

Therefore, this 5-orbit visit will have provided high resolution imaging with excellent photometric precision at 0.55, 0.78, 1.25, 1.4 and 1.6 microns in order

to place limits on possible nearby unrelated background or foreground stars. In addition, the precise high-cadence photometry at 1.4 microns with excellent spatial resolution will allow us: (i) to perform centroiding tests to ensure that the source of the occultations is centered on the target; and (ii) to provide for an accurate comparison with the simultaneously observed Kepler occultation profiles.

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Sat Nov 10 02:47:39 GMT 2012

Visit	Proposal 12987, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: Period 0.65356 D AND ZERO-PHASE HJD2455400.327					
	#	Primary Pattern	Secondary Pattern	Exposures		
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1), (3)		
	(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365 Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(5), (7), (9)		
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	KIC12557548B	RA: 19 23 51.8900 (290.9662083d) Dec: +51 30 17.00 (51.50472d) Equinox: J2000		V=16.2+/-0.1	Reference Frame: ICRS
	(2)	KIC12557548-OFF	RA: 19 23 49.8000 (290.9575000d) Dec: +51 30 17.30 (51.50481d) Equinox: J2000		V=18	Reference Frame: ICRS
<i>Comments: This location is midway between our actual target star and a star of similar magnitude and color that we want to use as a reference star. The second star will help in determining precise relative centroid motion in the target star during transit, and as a consistency check on photometric precision.</i>						

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#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
Exposures	1	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F555W	FLASH=13	PHASE 0.757 TO 0.777	Pattern 1, Exps 1-1 in Visit 01 (1)	40 Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	2	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F555W	FLASH=10			120 Secs [==>]	[1]
	3	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F775W	FLASH=13		Pattern 1, Exps 3-3 in Visit 01 (1)	50 Secs [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	4	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F775W	FLASH=11			130 Secs [==>]	[1]
	5	(1) KIC12557548B	WFC3/IR, MULTIACCUM, IRSUB512	F125W	NSAMP=5; SAMP-SEQ=RAPID		Pattern 2, Exps 5-5 in Visit 01 (2)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	6	(1) KIC12557548B	WFC3/IR, MULTIACCUM, IRSUB512	F125W	SAMP-SEQ=RAPID ; NSAMP=12			[==>]	[1]
	7	(1) KIC12557548B	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=7; SAMP-SEQ=RAPID		Pattern 2, Exps 7-7 in Visit 01 (2)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	8	(1) KIC12557548B	WFC3/IR, MULTIACCUM, IRSUB512	F160W	NSAMP=15; SAMP-SEQ=RAPID			[==>]	[1]
	9	(1) KIC12557548B	WFC3/IR, MULTIACCUM, IRSUB512	F140W	NSAMP=5; SAMP-SEQ=RAPID		Pattern 2, Exps 9-9 in Visit 01 (2)	[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)] [==>(Pattern 4)]	[1]
	10	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F555W	FLASH=13			40 Secs [==>]	[1]
	11	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F555W	FLASH=12			60 Secs [==>]	[1]
	12	(1) KIC12557548B	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F555W	FLASH=11			80 Secs [==>]	[1]

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13	(2) KIC12557548-O WFC3/IR, MULTIACCUM, FF IRSUB512	F140W	NSAMP=5; SAMP-SEQ=RAPI D		
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14	(2) KIC12557548-O WFC3/IR, MULTIACCUM, FF IRSUB512	F140W	NSAMP=5; SAMP-SEQ=RAPI D		
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15	(2) KIC12557548-O WFC3/IR, MULTIACCUM, FF IRSUB512	F140W	NSAMP=5; SAMP-SEQ=RAPI D		
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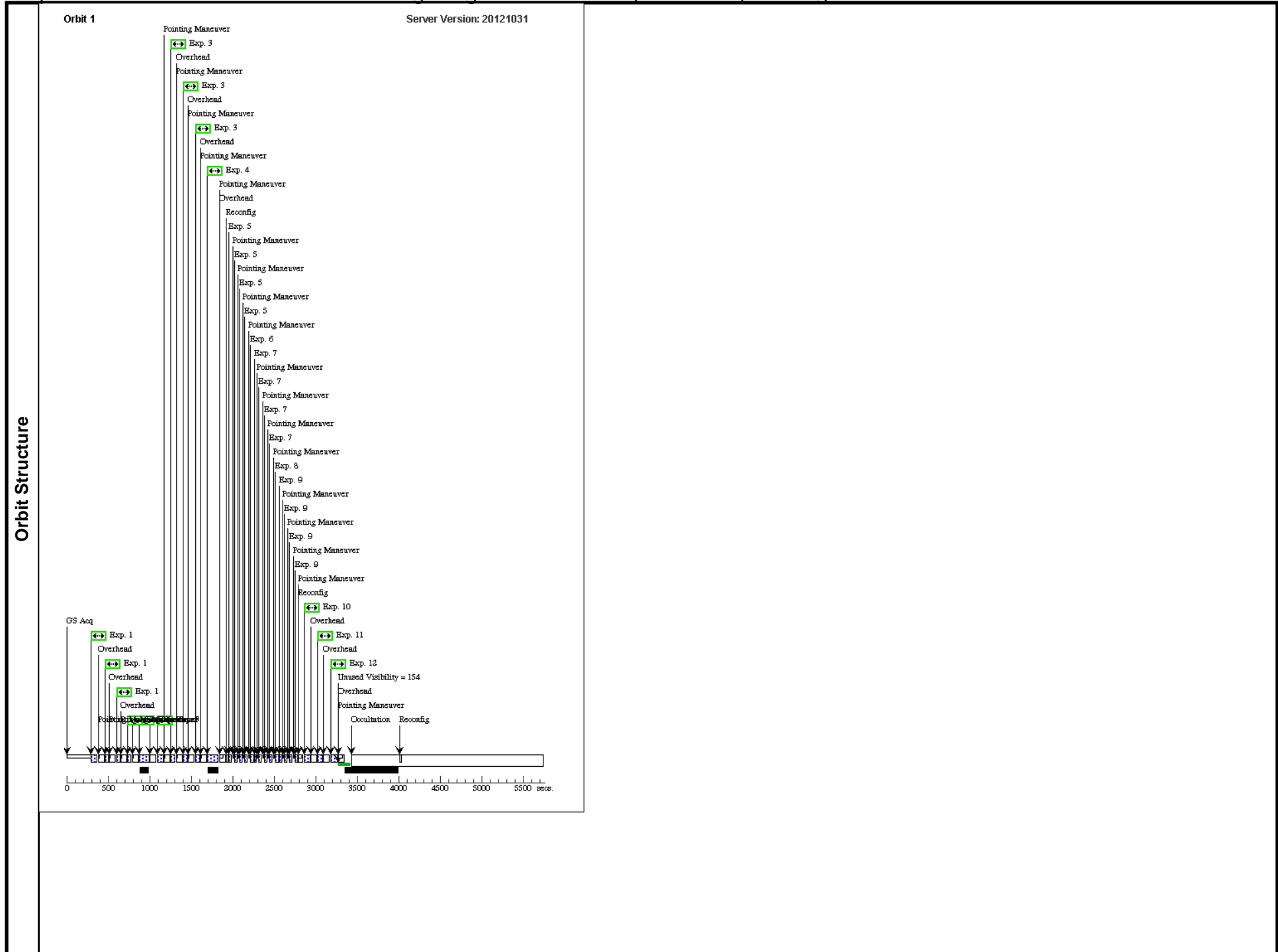
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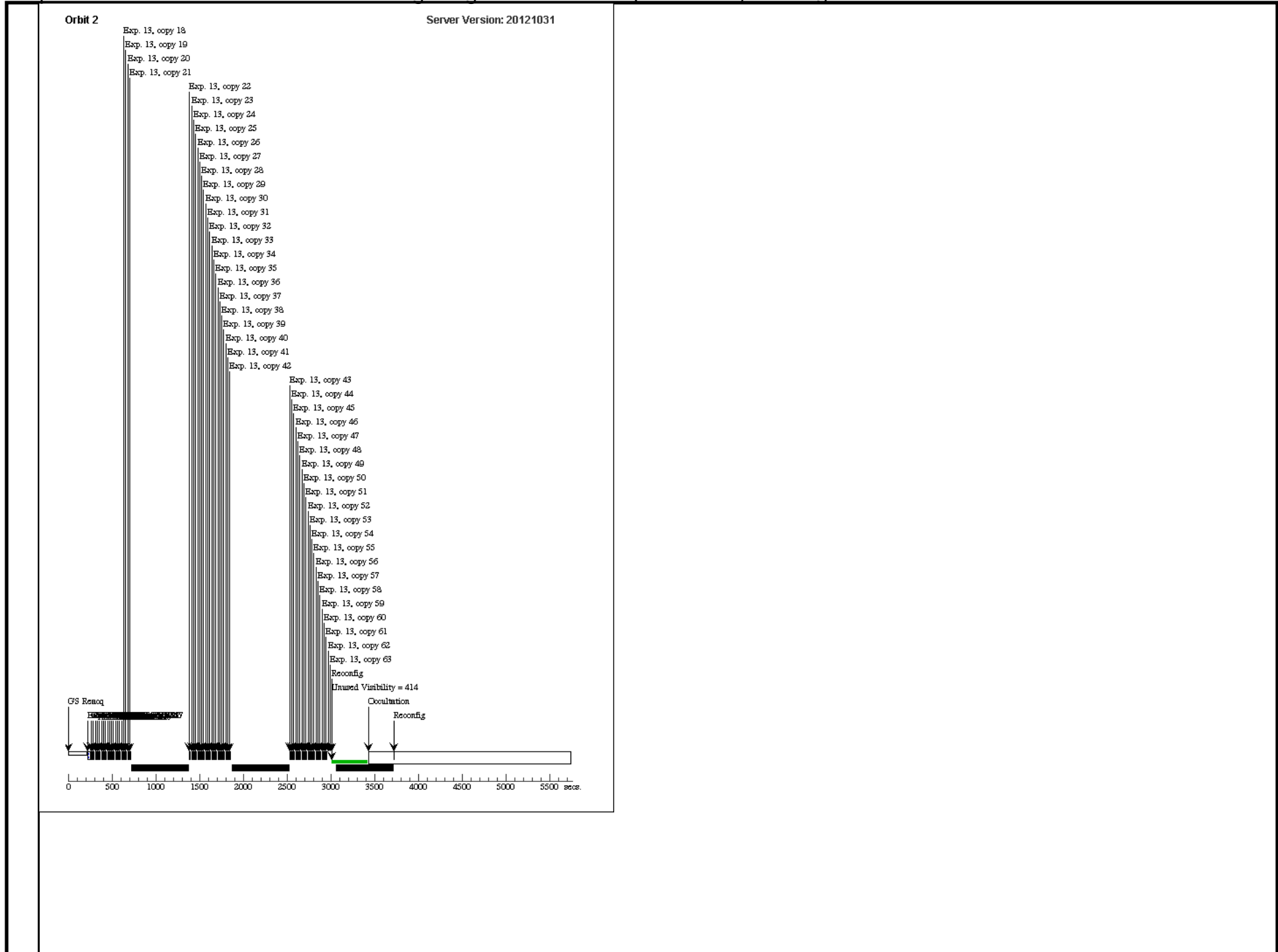
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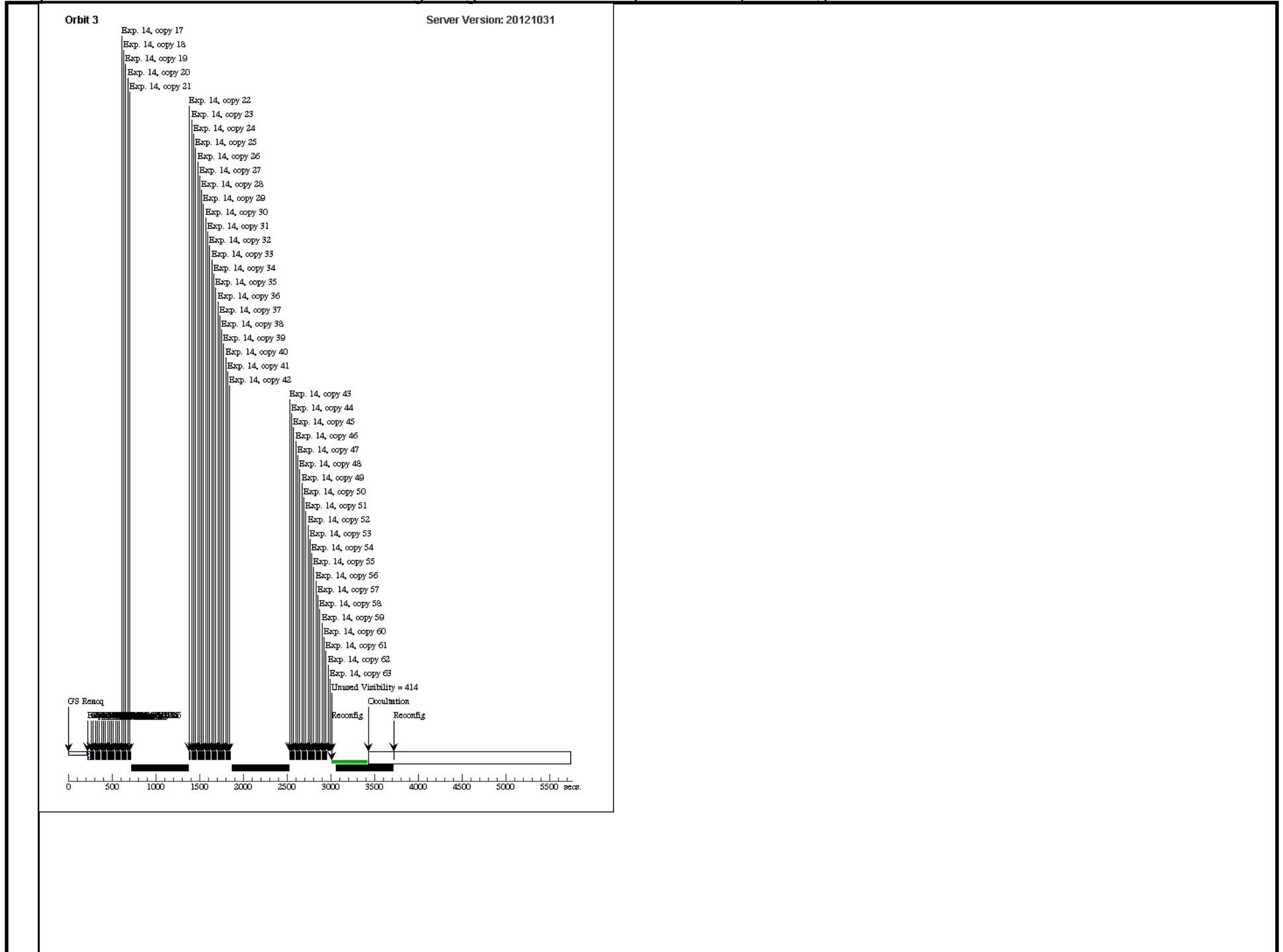
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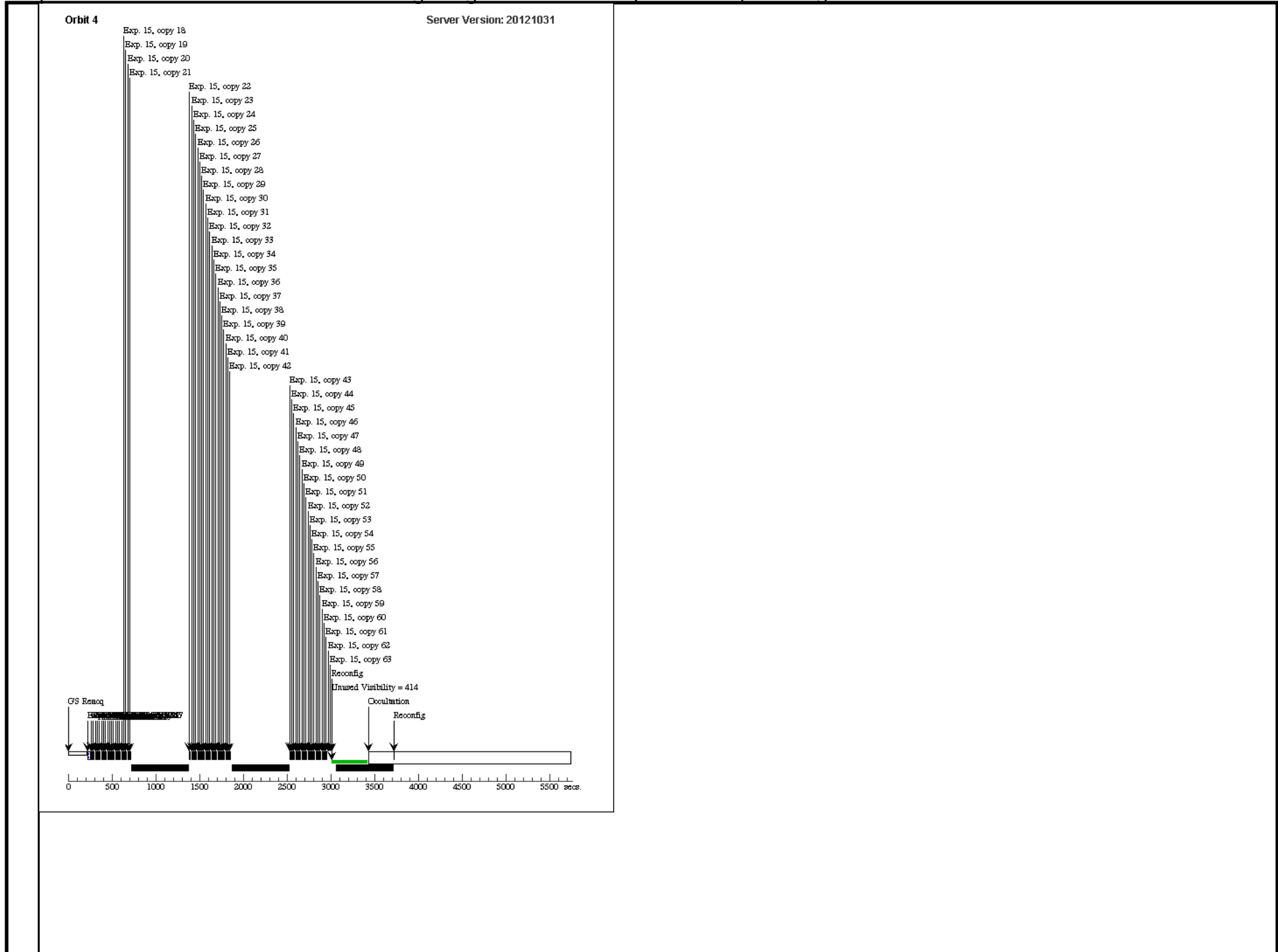
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