18100 - Characterization of a new class of white dwarfs with line emission

Cycle: 33, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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Prof. Pier-Emmanuel Tremblay (CoI) (ESA Member) (CoPI) (Contact)	University of Warwick

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) UCAC4-830-006897	STIS/CCD STIS/NUV-MAMA	3	11-Aug-2025 20:01:08.0	yes
02	(1) UCAC4-830-006897	STIS/CCD STIS/NUV-MAMA	3	11-Aug-2025 20:01:09.0	yes

6 Total Orbits Used

ABSTRACT

Two white dwarfs within 40 pc present currently unexplainable characteristics - pure-hydrogen atmospheres, H-alpha and H-beta line emission, anti-phase photometric and emission-line variability, and lack of an observable magnetic field (< 0.05 MG). These stars are similar to an emerging class of 26 white dwarfs that share the same properties except that they have large magnetic fields (> 5 MG) detected through Zeeman-split emission lines. These white dwarfs closely cluster on the Hertzsprung Russell diagram, suggesting than an intrinsic process is responsible for their emission - possibly through a new short-lived evolutionary stage. We propose time-resolved ultraviolet spectrophotometric observations of the emission line white dwarf WDJ0412+7549 to test whether one or two regions of the star have inhibited convection resulting from a small magnetic field, while

other regions are able to remain convective. The impact of even small (< 0.05 MG) magnetic fields is expected to be important on atmospheric temperature stratification, resulting in a radiative temperature structure and an anti-phase between UV and optical photometric variability. It is crucial to test whether a small magnetic field could generate an active chromosphere which consequently causes Balmer line emission. This is only possible with Hubble, as the ultraviolet spectral energy distribution is the only way to test against other scenarios. These observations will be integral to our understanding of DAe white dwarfs, atmospheric structures of magnetic stars, and what mechanism drives line emission variability.

OBSERVING DESCRIPTION

We propose time-resolved UV spectrophotometry of WDJ0412+7549 over two full TESS variability cycles (136 min) using STIS MAMA G230L in TIME-TAG mode. This setup provides high-cadence, low-dispersion spectrophotometry, ideal for distinguishing radiative (magnetic) from convective atmospheric structures. G230L is centered on the key wavelength region for diagnosing the time variability of both spectral slope and absolute flux. Using the precise and stable TESS ephemeris (Nov 2019-Dec 2022, six Sectors), along with new TESS data (Dec 2023-Nov 2024, three Sectors), we will determine the phase difference between TESS optical observations and our new UV time-domain data.

We require a signal-to-noise ratio >35 in broad ~200 AA wavelength bands and time-averaged ~10 min data points extracted from longer time-tagged exposures, which is necessary to constrain the flux better than the 3% level and differentiate between magnetic and convective structures at >3sigma for multiple phases during the 136 min cycle.

We used the best fit spectral models of the optical spectral and photometric data and fed them into the STIS Exposure Time Calculator (ETC) using the Gaia G-band magnitude of 15.8. We obtain signal-to-noise ratios of 5-15 per 10 min bins and per resolution element over the range 1900-3100 AA. Considering a resolution of R~500 and approximately 500 elements, it is possible to re-bin the whole spectrum in ~ 4 photometric bands each with signal-to-noise ratios 50-150 per 10 min, sufficient to distinguish between the convective and radiative scenarios at 5sigma for each 10 min bin. We require observations over two periods to confirm the result of the first period, which fits in a total of two visits, each with three consecutive orbits. This will create a UV light curve with ~25 data points at 1% flux precision, more than enough to compare with the TESS light curve and distinguish between the convective and radiative scenarios.

Visit

Proposal 18100, Visit 1 (01) Tue Aug 12 00:01:09 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	UCAC4-830-006897	RA: 04 12 46.8458 (63.1951908d) Dec: +75 49 42.26 (75.82841d) Equinox: J2000	Proper Motion RA: -140.899 mas/yr Proper Motion Dec: 26.114 mas/yr Epoch of Position: 2000	V=15.73	Reference Frame: ICRS

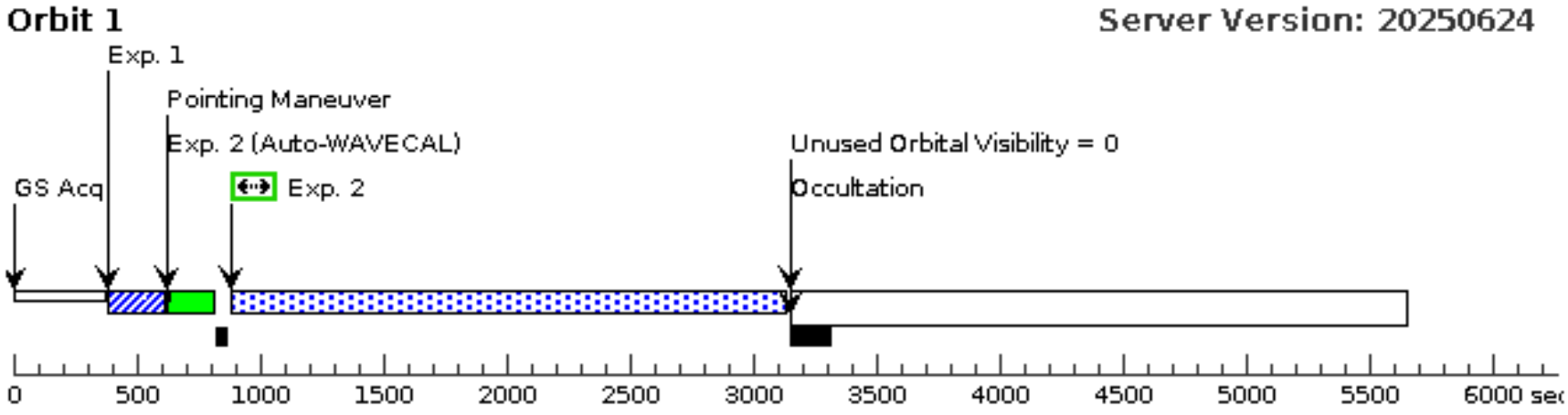
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

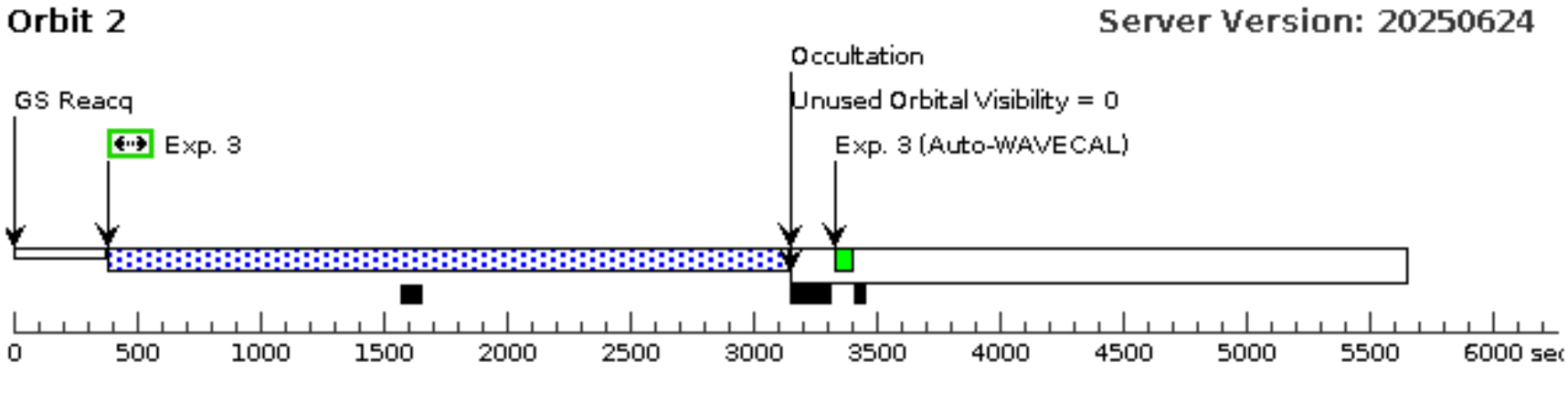
SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.
Category=STAR
Description=[DA]
Extended=NO

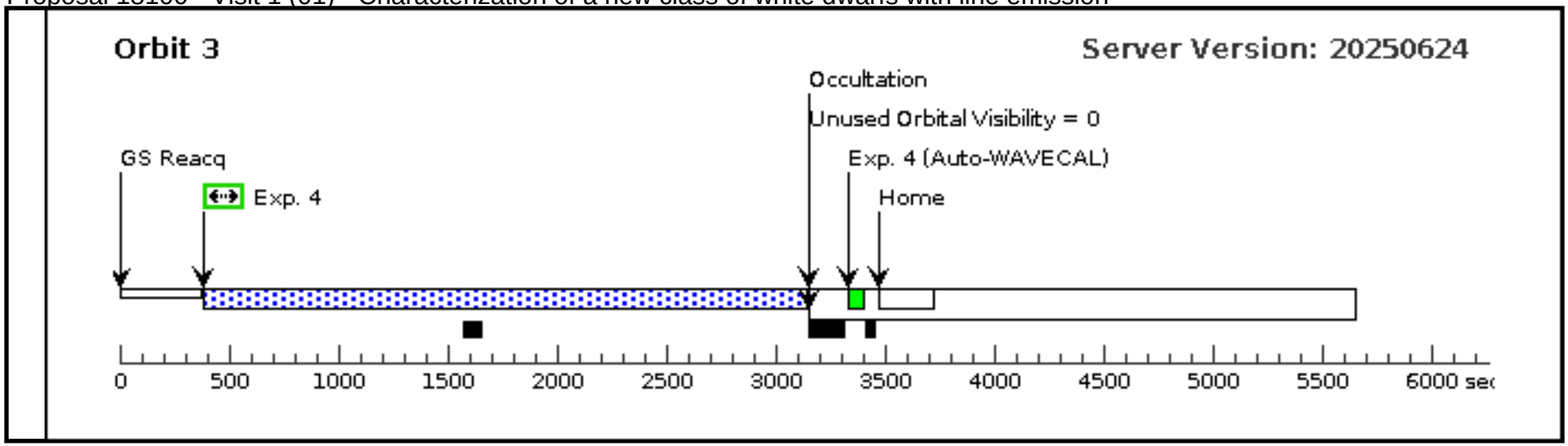
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (STIS.ta.2025198)	(1) UCAC4-830-006897	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			2 Secs (2 Secs) *[==>]*	*[1]*
2	Ex1 (STIS.sp.2025197)	(1) UCAC4-830-006897	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1200			2237 Secs (2237 Secs) *[==>]*	*[1]*
3	Ex2 (STIS.sp.2025210)	(1) UCAC4-830-006897	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1200			2744 Secs (2744 Secs) *[==>]*	*[2]*
4	Ex3 (STIS.sp.2025210)	(1) UCAC4-830-006897	STIS/NUV-MAMA, TIME-TAG, 52X0.2	G230L 2376 A	BUFFER-TIME=1200			2744 Secs (2744 Secs) *[==>]*	*[3]*

Orbit Structure



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GS Reacq
Exp. 4 (Auto-WAVECAL)
Exp. 4
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1000
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3000
3500
4000
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5000
5500
6000 sec

Visit

Proposal 18100, Visit 2 (02) Tue Aug 12 00:01:09 GMT 2025

Diagnostic Status: No Diagnostics

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

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
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Description=[DA]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
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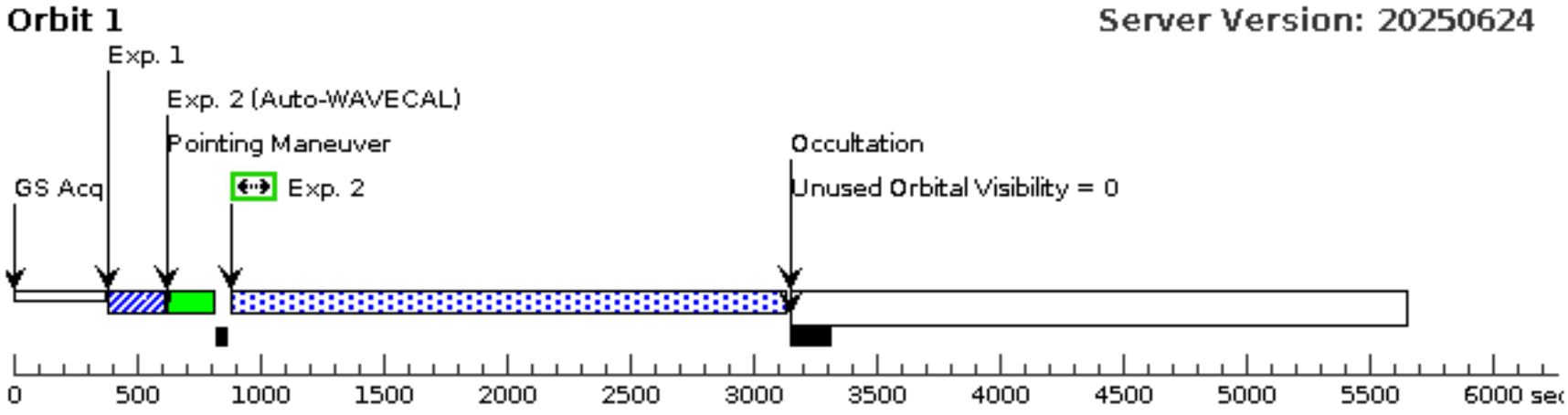
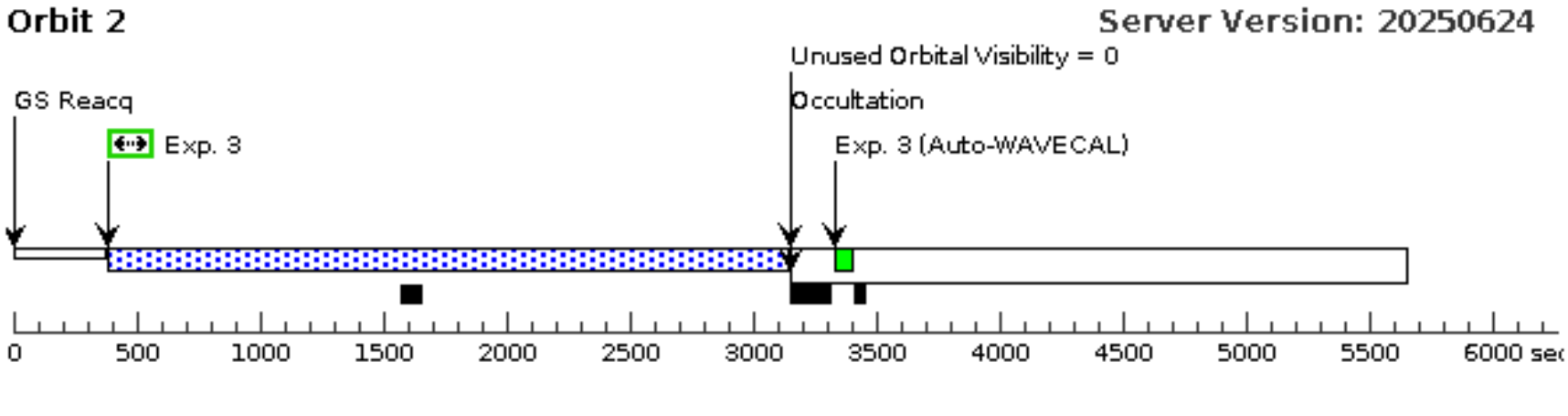
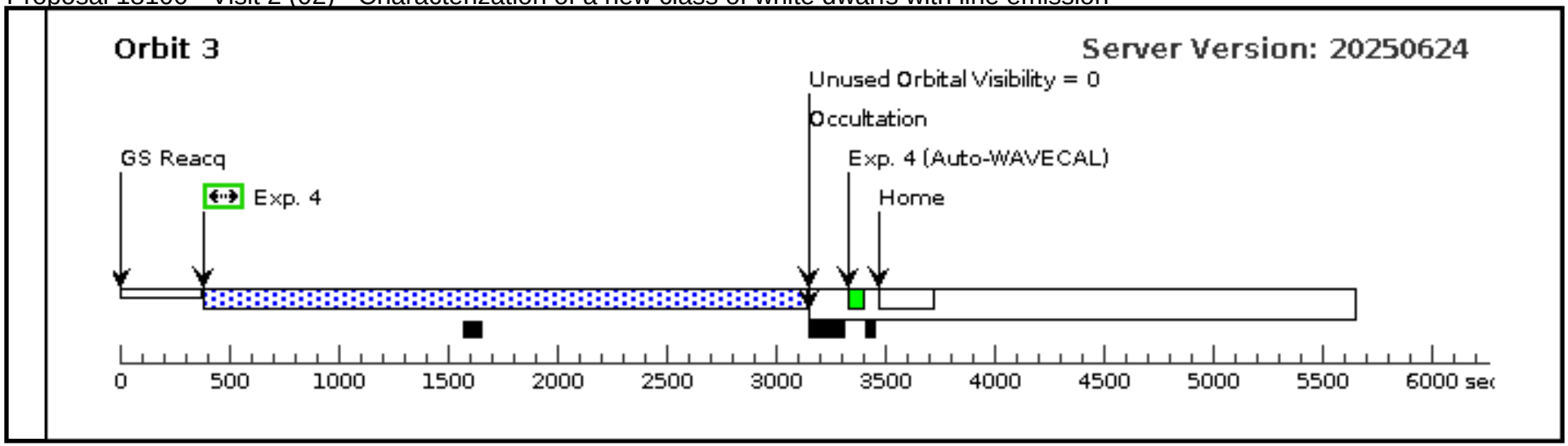
Orbit Structure






Orbit 3
Server Version: 20250624
Unused Orbital Visibility = 0
Occultation
GS Reacq
Exp. 4
Exp. 4 (Auto-WAVECAL)
Home
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5000
5500
6000 sec