



17522 - Betelgeuse: The Great Dimming Redux?

Cycle: 31, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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Dr. Andrea Dupree (PI) (Contact)	Smithsonian Institution Astrophysical Observatory
Thomas Calderwood (CoI)	American Association Of Variable Star Observers
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Dr. Lynn D Matthews (CoI)	Massachusetts Institute of Technology
Dr. Miguel Montarges (CoI) (ESA Member)	Observatoire de Paris - Section de Meudon
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Michael Weber (CoI) (ESA Member)	Leibniz-Institut für Astrophysik Potsdam (AIP)
Prof. Pierre Kervella (CoI) (ESA Member)	Observatoire de Paris
Dr. Morgan MacLeod (CoI)	Smithsonian Institution Astrophysical Observatory
Dr. alain jorissen (CoI) (ESA Member)	Universite Libre de Bruxelles

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) -ALF-ORI	STIS/CCD STIS/NUV-MAMA	4	22-Oct-2024 17:00:31.0	yes
02	(1) -ALF-ORI	STIS/CCD STIS/NUV-MAMA	4	22-Oct-2024 17:00:32.0	yes

8 Total Orbits Used

ABSTRACT

The historic Great Dimming of the red supergiant Betelgeuse in 2020 was initiated at a propitious confluence of maximum outflow of the 400-day fundamental mode of pulsation and the 2200-day Long Secondary Period. This condition will occur again sometime between Fall 2024 and Spring 2025. We propose to follow its behavior. Spatially resolved ultraviolet spectra of the star achievable with STIS can provide the connecting link between the convective activity on the stellar surface and the formation of a dust cloud in the outer atmosphere. This campaign will probe the entire atmosphere, from the photosphere to the circumstellar environment, with a combination of ground-based interferometric/AO imaging, radio observations, and optical and UV spectroscopy, creating a comprehensive contemporaneous sampling of the star, its variation with time, and the effects on its extended atmosphere. We should learn whether the event of 2019-2020 was a 'random' occurrence or results from oscillation phase superposition.

Two visits are requested during Cycle 31, and 4 visits during Cycle 32 to obtain spatially resolved ultraviolet spectra at this unique time.

OBSERVING DESCRIPTION

We propose to obtain short slit echelle spectra of Betelgeuse with the medium resolution E230M grating in the wavelength range of 2303 to 3111Å. We will use the small (0.1" x 0.025") slit for maximum spatial resolution. Only with this supported slit can we take full advantage of the STIS/HST resolution. Betelgeuse has no record of flaring and previous STIS observations demonstrate that the STIS detectors are not subject to any danger.

For a 4 orbit visit:

In order to execute the tomographic studies, we require a S/N of ~50 at 2800Å. The S/N will be higher at longer wavelengths. MARCS models demonstrate that there are 615 photospheric lines in the spectral region 2800-3100Å that can be used to develop masks selecting features from different photospheric layers. In addition, the chromospheric

emission lines reveal dynamics, densities, and emission measures of the chromospheric plasma. We plan to cover the optical diameter of the star (42 mas) with a center pointing, and offsets at ± 25 mas with deep exposures.

Then followed by pointing off the optical disk and offset to ± 50 mas for an exposure yielding S/N ~ 20 . We have used the ETC for STIS, assuming a Castelli/Kurucz model of a M2 supergiant, and normalizing it to the observed STIS flux (from MAST) near 2786A (to avoid Mg II emission) for various pointing offsets on the star at different dates. We used spectra from the 'normal' state of Betelgeuse (not the spectra taken during 2019 Sep-Nov). Ideally a range of exposure times would be used in response to the varying stellar flux. However, we cannot predict the ultraviolet flux level a priori, as it is not related to the optical V-magnitude. We therefore have selected an average value. To achieve the desired S/N, the center exposure requires 34 minutes; the offset at ± 25 mas requires 42 to 50 minutes, and the lower S/N off the optical disk requires 10 minutes. At the declination of Betelgeuse, each HST orbit allows 49-52 minutes on target.

These spectra will require guide star acquisition, target acquisition, and two peak ups with the small slit (0.1" x 0.025") in the first orbit of a visit. This takes 31.7 minutes; then we offset to +50 mas for a 9.45 min exposure, followed by offset to -50 mas for a 8.5 minute exp. In the following 3 orbits we will continue the offset points. Orbits following the first require ~ 6.7 min for reacquisition, leaving 45.2 minutes for exposures and readout. Orbit 2: Spectrum at center (45.2 min exp) Orbit 3: spectrum at +25 mas (44.5 min exp.) Orbit 4: spectrum at -25 mas (44.5 min exp)

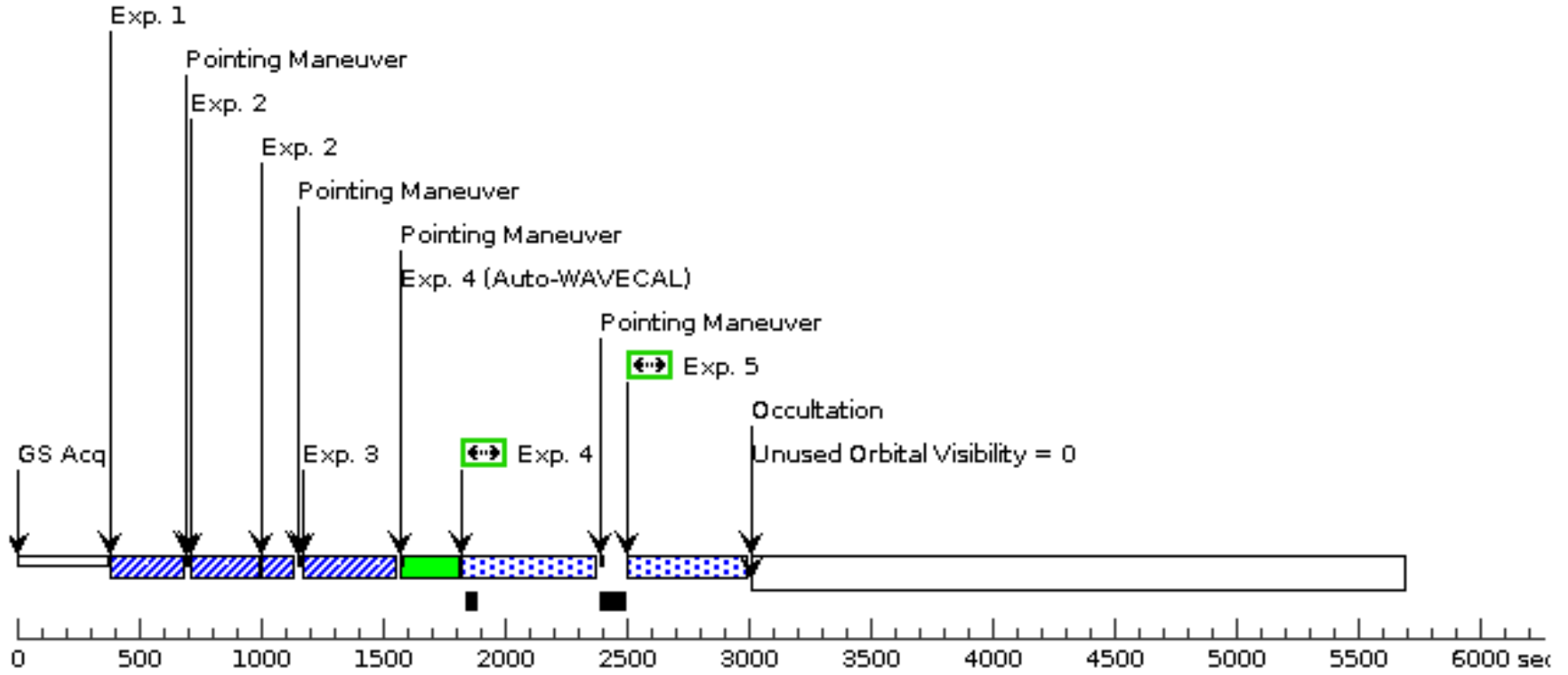
Proposal 17522 - Visit 01 - Betelgeuse: The Great Dimming Redux?

Tue Oct 22 21:00:33 GMT 2024

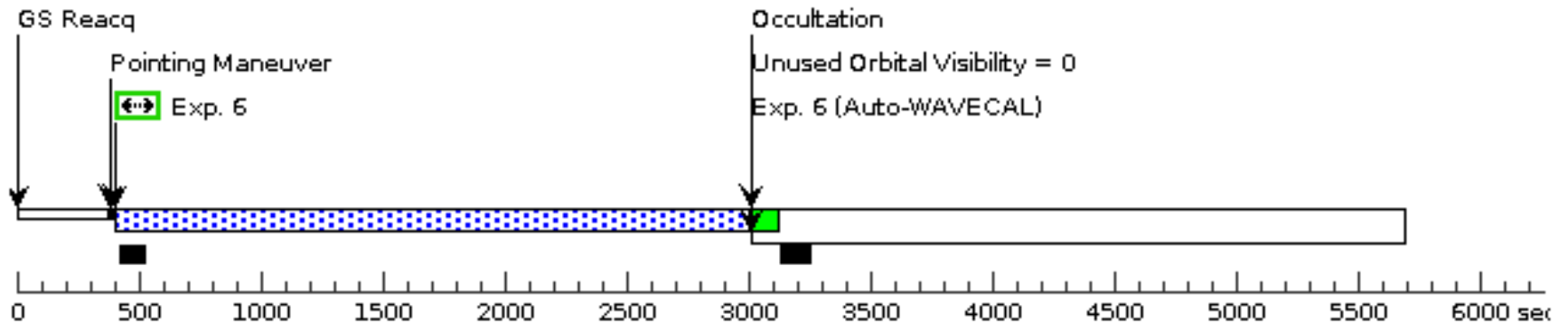
Visit	Proposal 17522, Visit 01, implementation Diagnostic Status: Warning Scientific Instruments: STIS/NUV-MAMA, STIS/CCD Special Requirements: BETWEEN 01-NOV-2024:00:00:00 AND 01-JAN-2025:00:00:00																																																																																																																													
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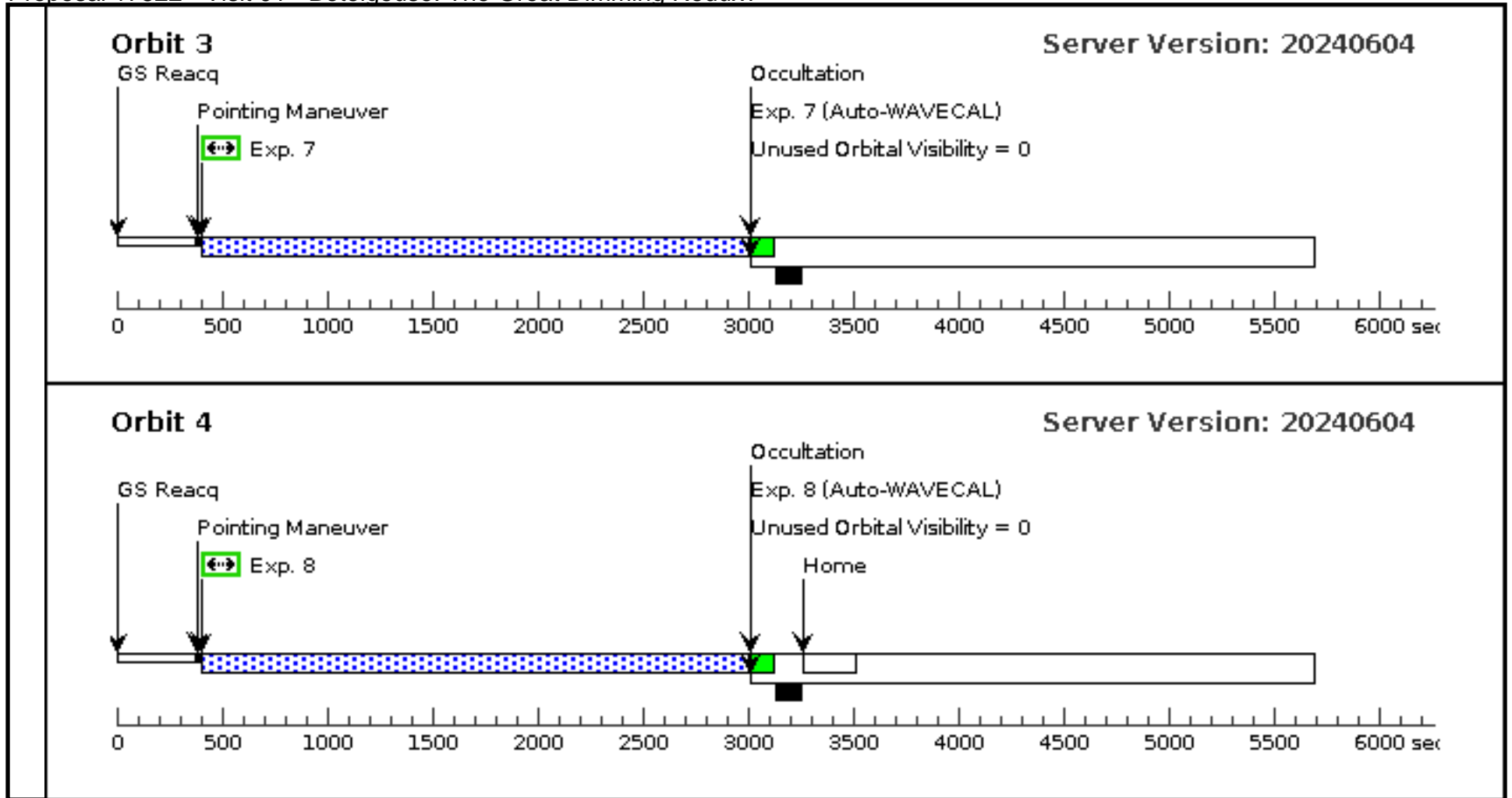
Orbit Structure

Orbit 1



Orbit 2





Proposal 17522 - Visit 02 - Betelgeuse: The Great Dimming Redux?

Tue Oct 22 21:00:33 GMT 2024

Visit	Proposal 17522, Visit 02, implementation Diagnostic Status: Warning Scientific Instruments: STIS/NUV-MAMA, STIS/CCD Special Requirements: AFTER 01 BY 30 D TO 60 D; BEFORE 01-JAN-2025																																																																																																																													
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		1		(1) -ALF-ORI	STIS/CCD, ACQ, F25ND5	MIRROR				1 Secs (1 Secs) [==>]	[1]																																																																																																																			
	2		(1) -ALF-ORI	STIS/CCD, ACQ/PEAK, 0.2X0.09	G230LB 2375 A				1 Secs (1 Secs) [==>]	[1]																																																																																																																				
	<i>Comments: 3 pt linear pickup; telescope returned to central dwell position.</i>																																																																																																																													
	3		(1) -ALF-ORI	STIS/CCD, ACQ/PEAK, 0.1X0.03	G230LB 2375 A				1 Secs (1 Secs) [==>]	[1]																																																																																																																				
	<i>Comments: Spiral in 0.1X0.03 aperature.</i>																																																																																																																													
	4	(1526014)	(1) -ALF-ORI	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230M 2707 A		POS TARG +0.050, null		567 Secs (536 Secs) [==>536.0 Secs]	[1]																																																																																																																				
5	(1526014)	(1) -ALF-ORI	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230M 2707 A		POS TARG -0.050,n ull		507 Secs (476 Secs) [==>476.0 Secs]	[1]																																																																																																																					
6	(1525642)	(1) -ALF-ORI	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230M 2707 A				2713 Secs (2580 Secs) [==>2580.0 Secs]	[2]																																																																																																																					
<i>Comments: Center point</i>																																																																																																																														
7	(1525642)	(1) -ALF-ORI	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230M 2707 A		POS TARG +0.025, null		2713 Secs (2580 Secs) [==>2580.0 Secs]	[3]																																																																																																																					
8	(1525642)	(1) -ALF-ORI	STIS/NUV-MAMA, ACCUM, 0.1X0.03	E230M 2707 A		POS TARG -0.025,n ull		2713 Secs (2580 Secs) [==>2580.0 Secs]	[4]																																																																																																																					

Orbit Structure

