17881 - Far-UV detection of the low-mass companion responsible for Betelgeuse's long secondary period

Cycle: 31, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

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Dr. Maxwell Moe (CoI)	University of Wyoming

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) -ALF-ORI	STIS/CCD STIS/FUV-MAMA	1	25-Oct-2024 18:00:16.0	yes
02	(1) -ALF-ORI	STIS/CCD STIS/FUV-MAMA	1	25-Oct-2024 18:00:17.0	yes
03	(1) -ALF-ORI	STIS/CCD STIS/FUV-MAMA	1	25-Oct-2024 18:00:17.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(1) -ALF-ORI	STIS/CCD STIS/FUV-MAMA	1	25-Oct-2024 18:00:17.0	yes

4 Total Orbits Used

ABSTRACT

The approximately 2100-day cycle of variability exhibited by the nearby red supergiant Alpha Orionis, popularly known as Betelgeuse, has become the subject of scrutiny after Betelgeuse's sudden, 1.6 V-mag brightness drop in late 2019. The nature of this 2100-day periodicity is closely tied to Betelgeuse's time-until-explosion: if it is the fundamental mode (FM), the star might be close to becoming a supernova. Recent studies, however, have converged instead on the conclusion that the 2100-day variability cycle is actually a Long Secondary Period, or LSP. The origins of the LSP phenomenon are unknown, but consensus is building that LSPs are caused by low-mass companions around the star. Since late August of 2024, two independent studies have proposed such an orbital companion, alpha Ori B, as the cause of Betelgeuse's LSP. The combination of photometric, radial velocity, and astrometric observations indicates a minimum mass of either 0.6 or 1.2 solar mass, and a separation of 2.4 stellar radii from Betelgeuse, which makes direct detection of the companion challenging due to an expected luminosity contrast of >10^4. However, by exploiting the strategic timing of maximum orbital separation occurring on Dec 6, 2024, this observational campaign proposes to find alpha Ori B via far-UV excess, using STIS with the E140M grating. This campaign will yield either the direct discovery of the hidden companion or provide an important constraint on the mass of alpha Ori B, shedding light on the nature of the LSP phenomenon and massive star multiplicity. An additional outcome will be the benchmarking of the chromospheric properties of our nearest RSG.

OBSERVING DESCRIPTION

The target will be suitable for observation during the time frame of November 6, 2024 to January 6, 2025, when alpha Orionis B is most likely to be detected. The optimal date of observation, corresponding to maximum orbital separation between Betelgeuse and the companion from our vantage point, is December 6th.

We divide four orbits across four visits, one orbit per visit. We do not require the visits to be consecutive, but it is helpful if they take place close in time.

Into a single orbit, we fit one imaging acquisition on Betelgeuse (alpha Ori) and two 1000-second science exposures.

From each acquisition, we pivot 0.084 (-0.084) arcsec in x and 0.084 (-0.084) arcsec in y. Each visit has one pointing, tiling Betelgeuse in a 2x2 square with the 0.2x0.2 slit.

No special orientation is required.

No background requirements.

This campaign does not require coordination with any other observations, but it will supplement observations from Chandra scheduled around December 9th, 2024.

Visit

Proposal 17881, quadrant1 (01), implementation Fri Oct 25 22:00:18 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 06-NOV-2024:00:00:00 AND 06-JAN-2025:00:00:00

Comments: first of four visits, one pointing per visit

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	-ALF-ORI	RA: 05 55 10.3054 (88.7929392d) Dec: +07 24 25.43 (7.40706d) Equinox: J2000	Proper Motion RA: 27.54 mas/yr Proper Motion Dec: 11.3 mas/yr Parallax: 0.006549999999999999" Epoch of Position: 2000	V=0.42	Reference Frame: ICRS

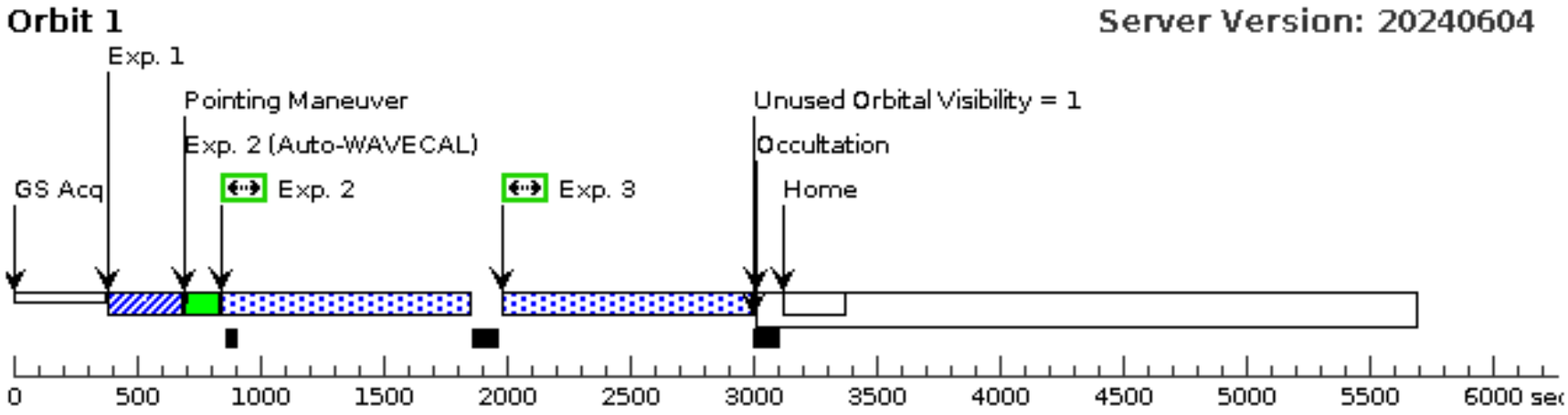
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

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=[SUPERGIANT O]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	target_acquisition (STIS.im.1940102)	(1) -ALF-ORI	STIS/CCD, ACQ, F25ND5	MIRROR				1 Secs (1 Secs) *[==>]*	*[1]*
2	science_exposure (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG 0.084,0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*
3	science_exposure2 (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG 0.084,0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*

Orbit Structure



Visit

Proposal 17881, quadrant2 (02), implementation Fri Oct 25 22:00:18 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 06-NOV-2024:00:00:00 AND 06-JAN-2025:00:00:00

Comments: first of four visits, one pointing per visit

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	-ALF-ORI	RA: 05 55 10.3054 (88.7929392d) Dec: +07 24 25.43 (7.40706d) Equinox: J2000	Proper Motion RA: 27.54 mas/yr Proper Motion Dec: 11.3 mas/yr Parallax: 0.006549999999999999" Epoch of Position: 2000	V=0.42	Reference Frame: ICRS

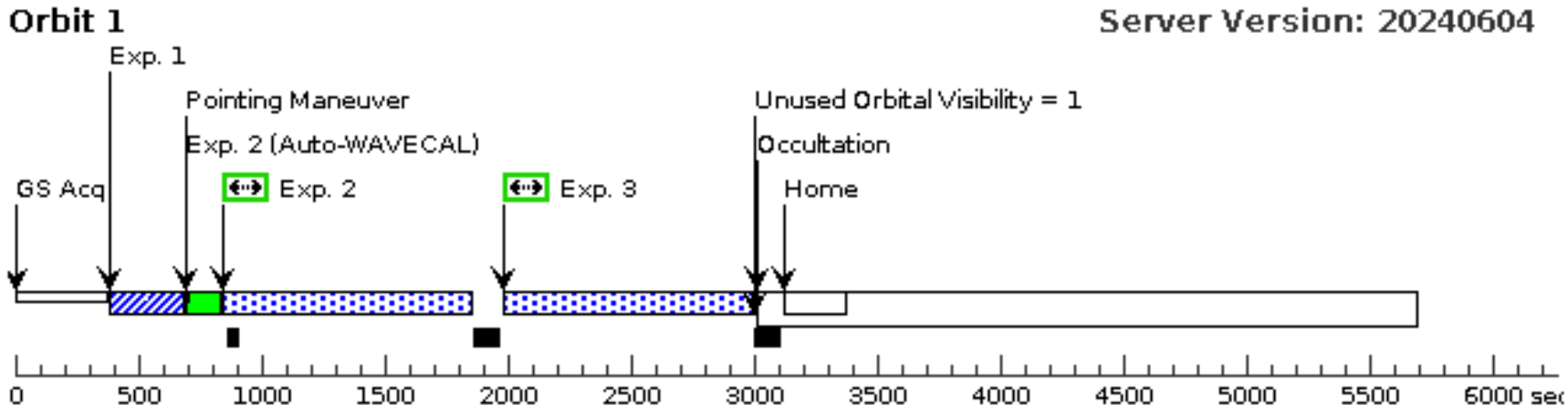
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

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=[SUPERGIANT O]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	target_acquisition (STIS.im.1940102)	(1) -ALF-ORI	STIS/CCD, ACQ, F25ND5	MIRROR				1 Secs (1 Secs) *[==>]*	*[1]*
2	science_exposure (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG -0.084,0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*
3	science_exposure2 (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG -0.084,0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*

Orbit Structure



Visit

Proposal 17881, quadrant3 (03), implementation Fri Oct 25 22:00:18 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 06-NOV-2024:00:00:00 AND 06-JAN-2025:00:00:00

Comments: first of four visits, one pointing per visit

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	-ALF-ORI	RA: 05 55 10.3054 (88.7929392d) Dec: +07 24 25.43 (7.40706d) Equinox: J2000	Proper Motion RA: 27.54 mas/yr Proper Motion Dec: 11.3 mas/yr Parallax: 0.006549999999999999" Epoch of Position: 2000	V=0.42	Reference Frame: ICRS

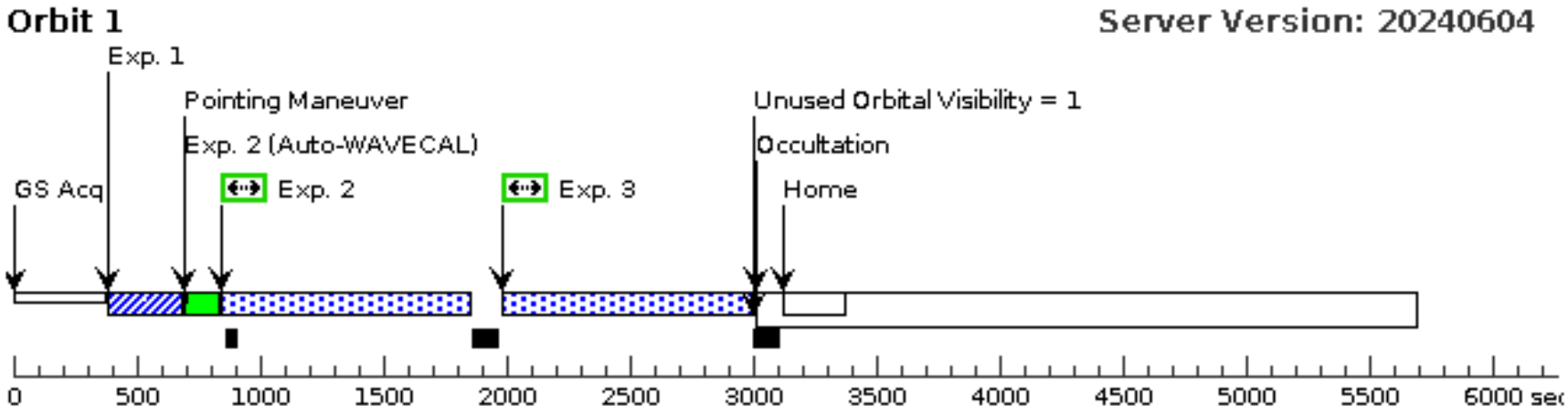
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

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=[SUPERGIANT O]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	target_acquisition (STIS.im.1940102)	(1) -ALF-ORI	STIS/CCD, ACQ, F25ND5	MIRROR				1 Secs (1 Secs) *[==>]*	*[1]*
2	science_exposure (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG -0.084,-0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*
3	science_exposure2 (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG -0.084,-0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*

Orbit Structure



Visit

Proposal 17881, quadrant4 (04), implementation Fri Oct 25 22:00:18 GMT 2024

Diagnostic Status: No Diagnostics

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

Special Requirements: BETWEEN 06-NOV-2024:00:00:00 AND 06-JAN-2025:00:00:00

Comments: first of four visits, one pointing per visit

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	-ALF-ORI	RA: 05 55 10.3054 (88.7929392d) Dec: +07 24 25.43 (7.40706d) Equinox: J2000	Proper Motion RA: 27.54 mas/yr Proper Motion Dec: 11.3 mas/yr Parallax: 0.006549999999999999" Epoch of Position: 2000	V=0.42	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=[SUPERGIANT O]

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	target_acquisition (STIS.im.1940102)	(1) -ALF-ORI	STIS/CCD, ACQ, F25ND5	MIRROR				1 Secs (1 Secs) *[==>]*	*[1]*
2	science_exposure (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG 0.084,-0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*
3	science_exposure2 (STIS.sp.1940106)	(1) -ALF-ORI	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A		POS TARG 0.084,-0.084		1000 Secs (1000 Secs) *[==>]*	*[1]*

Orbit Structure