11004 - The 2006 outburst of RS Oph - A rapidly evolving SNR analogue with jets

Cycle: 15, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets*	*Configurations*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(2) HD162215 (1) V-RS-OPH	ACS/HRC	1	07-Jul-2006 21:13:57.0	yes
02	(2) HD162215 (1) V-RS-OPH	ACS/HRC	2	07-Jul-2006 21:14:22.0	yes

3 Total Orbits Used

ABSTRACT

We propose to use HST DD time to perform high resolution optical imaging of the 2006 outburst of the Recurrent Nova RS Ophiuchi, which underwent its last recorded outburst in 1985. In this system, high velocity ejecta impact a red giant wind setting up shock systems analogous to a SNR, but evolving on months timescales. HST observations will complement our multi-frequency observing campaign, in particular our unrivalled coverage of this event with VLBI. In the radio, we have resolved on AU scales the expanding shock front responsible for the X-ray emission seen in the data from 4 satellites. We have also detected jets on 0.1 arcsec scales. HST ACS HRC imaging will be uniquely valuable in disentangling different emission components and deriving physical conditions.

OBSERVING DESCRIPTION

Our radio observations indicate that the radio lobes will have extent approximately 300 m.a.s at the time of the next available HST observing window for RS Oph (see figure in Phase 1 case). We have therefore chosen the HRC of the ACS to conduct these observations. We will observe the remnant in the Halpha, [OIII] and [NeV] emission lines using narrow band filters F658N, F502N and F344N respectively.

We have used optical line fluxes from Bohigas et al. (1989) from the later stages of the 1985 outburst (evolution similar to the present one in the optical), and assumed that the optical flux follows that in the radio (where roughly 10% of the flux is in the lobes (see Taylor et al. 1989). This gives us line fluxes as follows (in units of 1e-12 erg/s/cm^2):

	[NeV]3426	[OIII]5007	Halpha
Central Source	0.66	4	13
Each Lobe	0.033	0.2	0.65

FWHM of Halpha for e.g. is ~20A.

The central source is bright (V=11.3 currently, from AAVSO) comprising strong lines plus M0III-M4III stellar continuum dominating lambda>4000A with an additional blue continuum source (Bohigas et al. 1989).

We explored the use of occulting discs or finger, but these are too large for our application and our original notion of offsetting is apparently not feasible. We will therefore perform direct imaging and explore extended structures by means of PSF subtraction. We have therefore used the ACS ETC to help ensure that our images do not saturate the detector in a given exposure time.

Using twice the central source line fluxes above (as the Bohigas et al. fluxes were taken on day 210 after outburst, compared to t~150 days when we expect the HST observations to be conducted), plus M0III/M4III (for [OIII], Halpha) or flat continuum (for NeV, F= 2e-14 erg/s/cm^2) we derived times to saturation of 80s (NeV), 38s (OIII) and 6s (Halpha). The factor ~2 decrease in line fluxes between days 150 and 210 is in line with expectations from the previous (1985) outburst (Anupama, private communication). In addition, using V=11.3 in the ETC for the M0III/M4III continuum gives an overestimate of the brightness of this component, particularly by day 210. We therefore set RS Oph individual exposure times as 60s (NeV), 30s (OIII) and 5s (Halpha).

In order to derive higher spatial resolution and reject hot pixels, but bearing in mind our time limitations, we have used a standard 2 point line dither. We have not used CR-Split. To reject spurious ghosts etc, we repeat the RS Oph observations at a position 5 arcsec offset in both X and Y. Total observing times for each filter on the target are then 240s (NeV), 120s (OIII) and 30s (Halpha). As a check on feasibility, simple assumption of point source flux in each lobe, but not taking into account the central source PSF, suggests SNRs of 118, 278 and 223 respectively for each line.

In order to accomplish effective PSF subtraction, we have chosen a bright reference source near to RS Oph, and although we are using narrow band imaging where colour effects should not be so great (plus it would be very difficult to choose a source with very similar colour to RS Oph), this is also a late-type stellar source (HD162215, K0V, V=9.32, B=10.52). We therefore propose to perform a similar set of dithered observations to those of RS Oph, again looking to get as good SNR as we can but taking care not to saturate the individual exposures. Exposure times of 83s (NeV), 5s (OIII) and 2s (Halpha) compare to times to saturation of 224s, 11s and 4s for each line respectively using the ETC.

Finally, to optimize the time requirement, we have used the standard HRC 512 sub-array (we are only interested in features at sub-arcsecond scales from HST). We have also tried to optimize the order of spacecraft and filter-wheel moves for example to fit our programme within the required single orbit.

References:

Bohigas et al., 1989, MNRAS, 238, 1395
Taylor et al., 1989, MNRAS, 237,81

Visit

Proposal 11004, Visit 01 Sat Jul 08 01:14:28 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-HRC-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.198 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=44.3 Angle Between Sides= Center Pattern=false		(1), (2), (3), (4), (5), (6), (7), (8), (9)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-RS-OPH	RA: 17 50 13.2020 (267.5550083d) Dec: -06 42 28.48 (-6.70791d) Equinox: J2000		V=11.3+/-0.1	Reference Frame: ICRS
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					
(2)	HD162215	RA: 17 50 12.7160 (267.5529833d) Dec: -06 47 25.45 (-6.79040d) Equinox: J2000		V=9.3+/-0.1	Reference Frame: ICRS

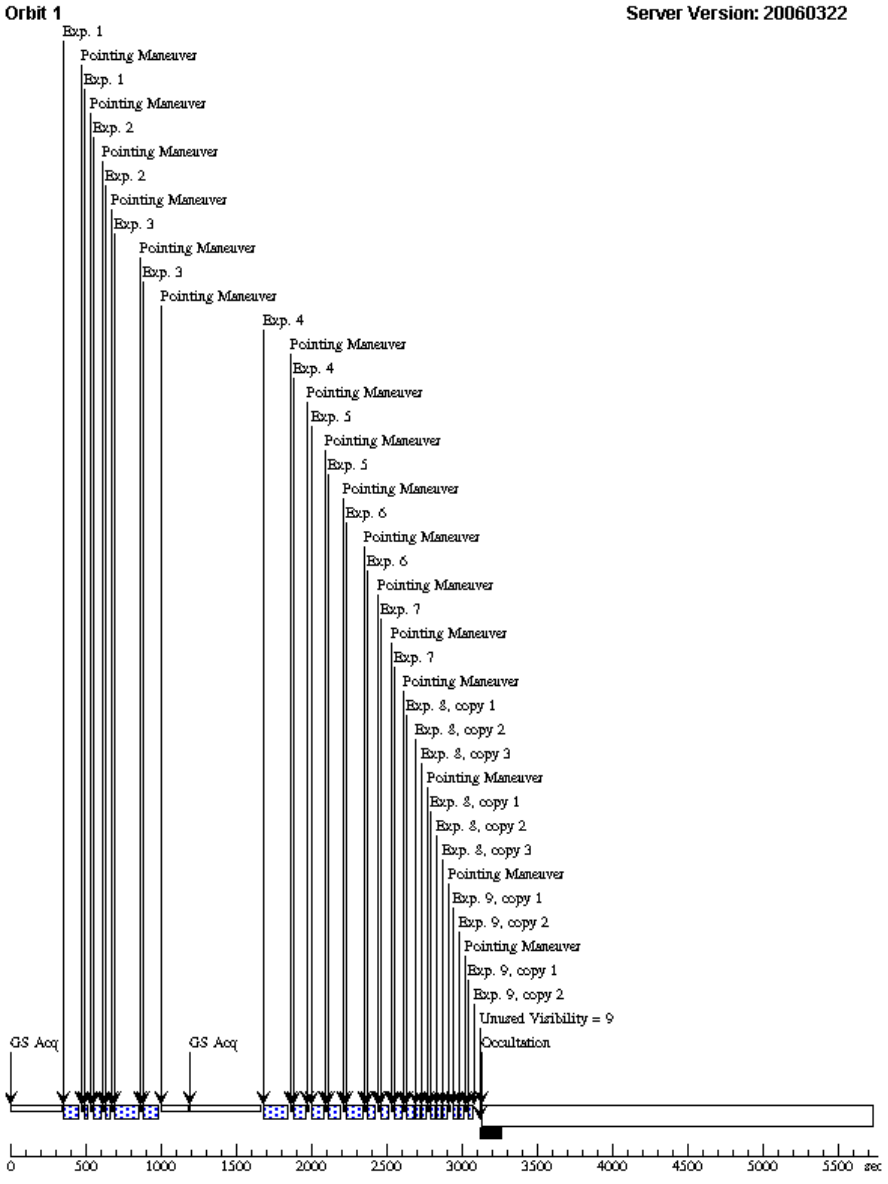
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	HD162215 (H alpha)	(2) HD162215	ACS/HRC, ACCUM, HRC-512	F658N	CR-SPLIT=NO		Pattern 1-1 (1)	2.0 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2	HD162215 (OIII)	(2) HD162215	ACS/HRC, ACCUM, HRC-512	F502N	CR-SPLIT=NO		Pattern 2-2 (1)	5.0 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
3	HD162215 (NeV)	(2) HD162215	ACS/HRC, ACCUM, HRC-512	F344N	CR-SPLIT=NO		Pattern 3-3 (1)	83.0 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
4	RS Oph pos 1 (NeV)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F344N	CR-SPLIT=NO		Pattern 4-4 (1)	60.0 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
5	RS Oph pos 2 (NeV)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F344N	CR-SPLIT=NO	POS TARG 3,3	Pattern 5-5 (1)	60.0 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
6	RS Oph pos 2 (OIII)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F502N	CR-SPLIT=NO	POS TARG 3,3	Pattern 6-6 (1)	30.0 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***

Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
7	RS Oph pos 1 (OIII)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F502N	CR-SPLIT=NO		Pattern 7-7 (1)	30.0 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
8	RS Oph pos 1 (H alpha)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F658N	CR-SPLIT=NO		Pattern 8-8 (1)	5.0 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]*	***[1]***
9	RS Oph pos 2 (H alpha)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F658N	CR-SPLIT=NO	POS TARG 3,3	Pattern 9-9 (1)	5.0 Secs X 2	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]*	***[1]***

Orbit Structure



Visit

Proposal 11004, Visit 02 Sat Jul 08 01:14:30 GMT 2006

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/HRC

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-HRC-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.198 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=44.3 Angle Between Sides= Center Pattern=false		(1), (2), (3), (4), (5), (6), (7), (8), (9)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-RS-OPH	RA: 17 50 13.2020 (267.5550083d) Dec: -06 42 28.48 (-6.70791d) Equinox: J2000		V=11.3+/-0.1	Reference Frame: ICRS
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					
(2)	HD162215	RA: 17 50 12.7160 (267.5529833d) Dec: -06 47 25.45 (-6.79040d) Equinox: J2000		V=9.3+/-0.1	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	HD162215 (H alpha)	(2) HD162215	ACS/HRC, ACCUM, HRC-512	F658N	CR-SPLIT=NO		Pattern 1-1 (1)	2.0 Secs X 4	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 1, Copy 4)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 2, Copy 4)]*	***[1]***
2	HD162215 (OIII)	(2) HD162215	ACS/HRC, ACCUM, HRC-512	F502N	CR-SPLIT=NO		Pattern 2-2 (1)	5.0 Secs X 4	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 1, Copy 4)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 2, Copy 4)]*	***[1]***

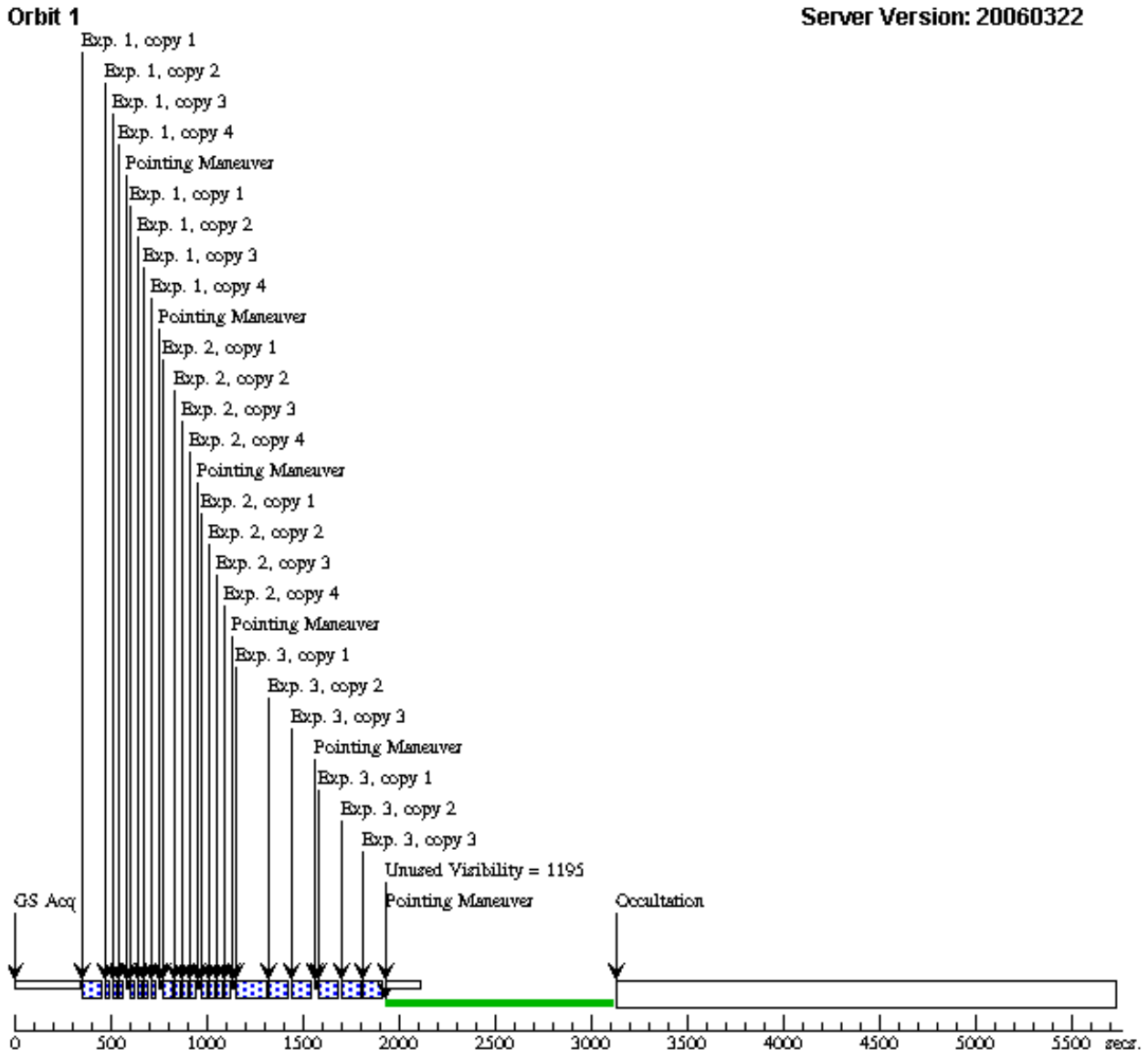
Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
3	HD162215 (NeV)	(2) HD162215	ACS/HRC, ACCUM, HRC-512	F344N	CR-SPLIT=NO		Pattern 3-3 (1)	83.0 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]*	***[1]***
4	RS Oph pos 1 (NeV)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F344N	CR-SPLIT=NO		Pattern 4-4 (1)	60.0 Secs X 2	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]*	***[2]***
5	RS Oph pos 2 (NeV)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F344N	CR-SPLIT=NO	POS TARG 3,3	Pattern 5-5 (1)	60.0 Secs X 2	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]*	***[2]***
6	RS Oph pos 2 (OIII)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F502N	CR-SPLIT=NO	POS TARG 3,3	Pattern 6-6 (1)	30.0 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]*	***[2]***
7	RS Oph pos 1 (OIII)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F502N	CR-SPLIT=NO		Pattern 7-7 (1)	30.0 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]*	***[2]***

Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
8	RS Oph pos 1 (H alpha)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F658N	CR-SPLIT=NO		Pattern 8-8 (1)	5.0 Secs X 4	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 1, Copy 4)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 2, Copy 4)]*	***[2]***
9	RS Oph pos 2 (H alpha)	(1) V-RS-OPH	ACS/HRC, ACCUM, HRC-512	F658N	CR-SPLIT=NO	POS TARG 3,3	Pattern 9-9 (1)	5.0 Secs X 3	
								[==>(Pattern 1, Copy 1)] *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]*	***[2]***

Orbit Structure



Orbit Structure (continued)