12205 - Verifying the Dust-Gas Coupling in the AGB Wind of IRC+10216 via Differential Proper-Motion Measurements

Cycle: 18, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Toshiya Ueta (PI)	**University of Denver**	**tueta@du.edu**
Dr. Margaret Meixner (CoI)	Space Telescope Science Institute	meixner@stsci.edu
Mr. Brian A. Ferguson (CoI)	Space Telescope Science Institute	bferg@stsci.edu
Dr. David K. Fong (CoI)	Olympic College	dfong@olympic.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) CW-LEO	WFC3/UVIS	3	10-Sep-2010 21:20:04.0	yes

3 Total Orbits Used

ABSTRACT

We will undertake differential proper-motion measurements of the circumstellar dust shell of an asymptotic giant branch star, IRC +10 216, to understand kinematics and the dust-gas coupling in the shell. We will take the second-epoch long-exposure images of the so-called concentric arcs in F606W and short-exposure images of the central asymmetric lobes in F814W using WFC3 and compare them with the first-epoch archived WFPC2 images. These circular concentric arcs are enigmatic because their apparent time intervals (on the order of 100 yr) do not seem to be consistent with any obvious physical processes associated with the central star (pulsation of the star on the order of 1 yr and thermal pulses of 10,000 to 100,000 yr). With proximity to the target (~ 135 pc) and a relatively long interval between two-epoch observations (12-13 yr), we expect that these shells show translational shifts of at most 7-8 pixels measurable with the cross-correlational analysis of distinct local shell structure. With such measurements of

the translational shift of the shell structures, we can measure the expansion velocities of these concentric arcs and the central lobes directly. We will then compare the HST imaging results which probe the dust component of the shell with the previous CO mapping results which probe the gas component of the shell. Because the shell's 3-D kinematics is known from the CO data the concentric arcs can be deprojected to trace their true space motion, allowing us to disentangle the mysterious discordance of the arcs' apparent time intervals with respect to the time scales of relevant physical processes. By comparing the CO and HST results, we wil attempt to verify if the dust-gas coupling is indeed at work in AGB winds. This will be the first attempt to address observationally this one of the fundamental assumptions of dust-driven mass-loss.

OBSERVING DESCRIPTION

Because the proposed observations are the second-epoch imaging of the target star to enable differential proper-motion analysis, we will have to repeat two sets of the first-epoch observations (the central lobes with F814W and the concentric arcs with F606W). The only caveat is that the first-epoch observations were done with WFPC2, which is no longer available. Therefore, we will use WFC3, whose charge transfer efficiency the best among all optical imagers on-board HST. The same F606W and F814W filters will be used as in the first-epoch observations. To cover the concentric arcs extending out to 70 arcsec seen in the first-epoch WFPC2 images, we will use the full-detector field of view of WFC3. To bridge over the gap between the UVIS chips, we will use a 6-point dither in F606W (over 2 orbits) and a 4-point dither in F814W (over 1 orbit) following the WFC3-UVIS-MOS-DITH-LINE pattern. In both dither, we will step over in the direction diagonal to the detector arrays in which the geometric distortion change is the least. Each step size is set large enough to fill the chip-gap and to incorporate a sub-pixel stepping to improve the sampling. A larger dither step size is used in F814W because in this band our interests lie mainly in the central region of the nebulosity and so the chip-gap has to be moved off the nebulosity. We expect the surface brightness of 25 mag arcsec^2 in the concentric arcs in the optical. The WFPC2 ETC gives S/N of 2.7 per pixel (at 0.1 arcsec/pixel). This is indeed consistent with the reduced image of the epoch 1 WFPC2 images. Although the WFC3 detector is of about half the pixel scale (0.04 arcsec/pixel), the epoch 2 WFC3 image will be binned roughly at 2x2 to scale with the epoch 1 WFPC2 image for differential proper-motion analysis. The WFC3 ETC estimates that a similar S/N (2.6) can be achieved about the same amount of exposure time in 2x2 binning. The numbers of dither steps in two bands are set to achieve a good balance between a larger number of dithered exposures in mitigating cosmic rays/bad pixels and a smaller number of exposures in reducing overhead: the total exposure time is 5407 sec in F606W (indiv exposure is 883 sec in the first orbit and 920 in the second orbit) and 2631 sec in F814W (indiv exposure is 658 sec). These exposures would not saturate the central star whose peak surface brightness has been measured at 4.7e14 erg/s/cm2/A (Ueta et al. 2000).

ADDITIONAL COMMENTS

The objective of this program is to perform differential proper-motion study of the concentric arcs seen in the circumstellar shell of IRC +10 216 and determine the expansion velocities of individual arcs in the shell by direct observations. Therefore, the proposed observations, by construction, must duplicate the previous deep exposure observations (PIDs 6364, 6856, 8601 done with WFPC2) with a different instrument (WFC3). We have planned the observing program based on the previous WFPC2 program and the documented WFC3 performance characteristics.

Visit

Proposal 12205, Visit 01, implementation Sat Sep 11 01:20:12 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-MOS-DITH-LINE Purpose=DITHER Number Of Points=4 Point Spacing=5.22734 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=226.8398 Angle Between Sides= Center Pattern=false		(2)
(2)	Pattern Type=WFC3-UVIS-MOS-DITH-LINE Purpose=DITHER Number Of Points=6 Point Spacing=2.61628 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.8398 Angle Between Sides= Center Pattern=true		(1)

Fixed Targets

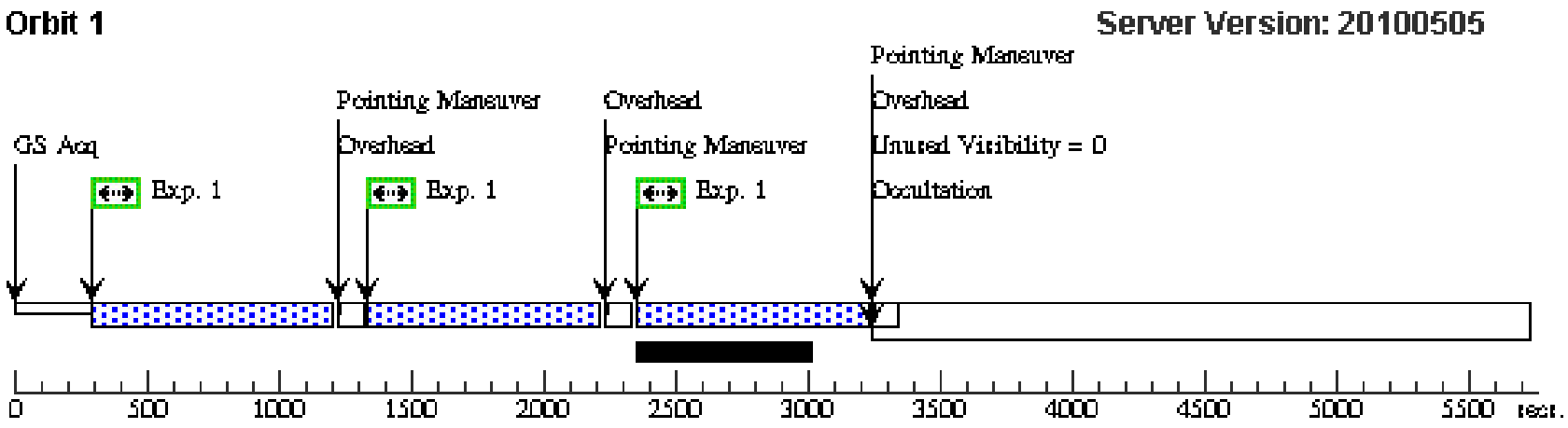
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	CW-LEO Alt Name1: AFGL1381 Alt Name2: IRC+10216	RA: 09 47 57.3820 (146.9890917d) Dec: +13 16 43.66 (13.27879d) Equinox: J2000		V=12+/-2 V surface brightness of arcs at 2 5 mag/arcsec2	Reference Frame: ICRS

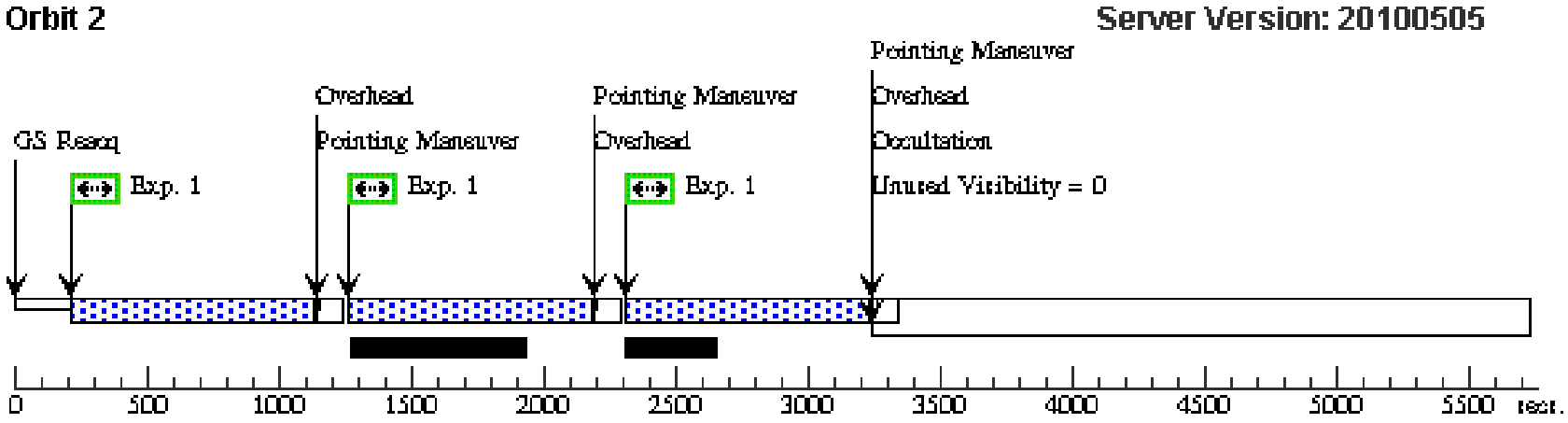
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

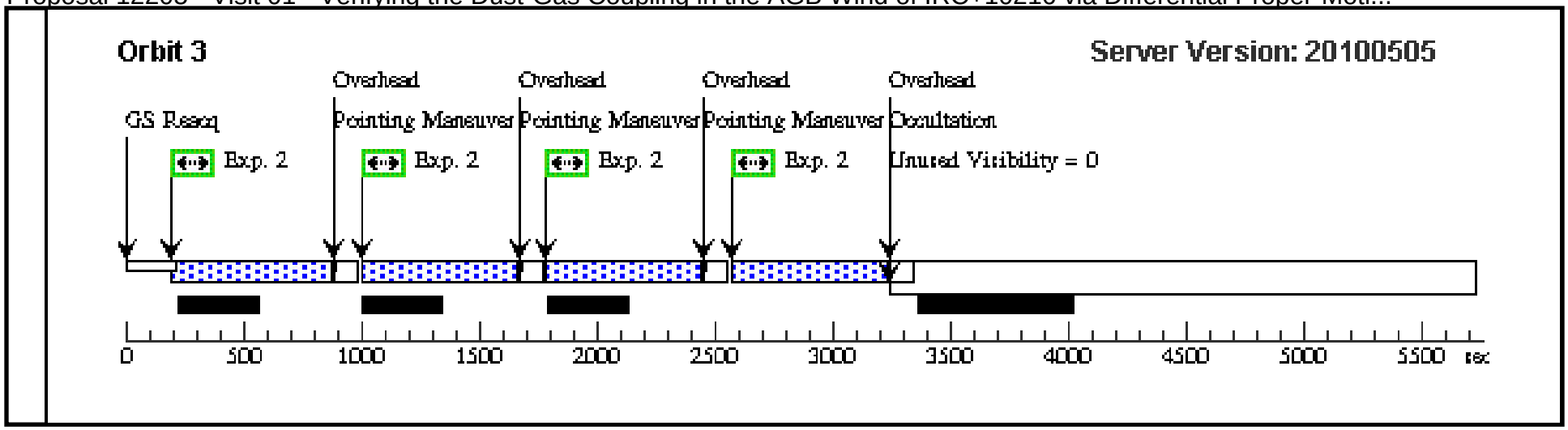
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	F606W	(1) CW-LEO	WFC3/UVIS, ACCUM, UVIS-CENTER	F606W			Pattern 2, Exps 1-1 (2)	500 Secs	
								[==>882.0 Secs (Pattern 1)] *[==>883.0 Secs (Pattern 2)]* *[==>883.0 Secs (Pattern 3)]*	***[1]***
								[==>919.0 Secs (Pattern 4)] *[==>920 Secs (Pattern 5)]* *[==>920 Secs (Pattern 6)]*	***[2]***
2	F814W	(1) CW-LEO	WFC3/UVIS, ACCUM, UVIS-CENTER	F814W		POS TARG 0,-5	Pattern 1, Exps 2-2 (1)	657 Secs	
								[==>657.0 Secs (Pattern 1)] *[==>658.0 Secs (Pattern 2)]* *[==>658.0 Secs (Pattern 3)]* *[==>658.0 Secs (Pattern 4)]*	***[3]***

Orbit Structure






Orbit 3
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Pointing Maneuver
Overhead
Pointing Maneuver
Overhead
Pointing Maneuver
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Occultation
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Exp. 2
Exp. 2
Exp. 2
Unused Visibility = 0
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sec