12560 - COS spectra of a Filament in NGC1275 - Testing the Particle Heating Mechanism

Cycle: 19, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC-1275-NUCLEUS (2) HORSESHOE	COS/FUV COS/NUV	4	22-Mar-2012 21:12:56.0	yes
02	(1) NGC-1275-NUCLEUS (2) HORSESHOE	COS/FUV COS/NUV	3	22-Mar-2012 21:13:08.0	yes

7 Total Orbits Used

ABSTRACT

Halpha filaments are common in and around the brightest central galaxy in cool-core clusters of galaxies. A spectacular example occurs around NGC1275 in the nearby Perseus cluster. The low ionization spectrum of the filaments does not match that of any Galactic nebula and is not explained by any plausible photoionizing source. We have shown that the spectrum can be accounted for by ionization and excitation by ionizing particles, produced as the surrounding hot gas particles interpenetrate the cold atomic and molecular filament gas. Strong CI 1656A emission is predicted, as is

HeII 1640A and a distinctive continuum. These, and other lines in the UV are sensitive to the energy injection mechanism. We propose to obtain a FUV spectrum of the outer horseshoe filament in the Perseus Cluster, using COS, to detect and measure these lines and the continuum to determine how these filaments are powered.

OBSERVING DESCRIPTION

We propose to obtain a deep COS FUV spectrum of the well-studied bright knot at the base of the horseshoe filament (red circle, Fig.~2). We have much supporting data for this region. The G140L grating will allow us to cover the wavelength region from 1120-2246\AA. This broad coverage is crucial since it contains the Lyα He\,II 1640\AA\ and C\,I 1656\AA, lines which our models predict will be present, as well as the distinctive 2-photon continuum. We expect many other lines such as C\,II 1335\AA, C\,III 1909\AA, C\,IV 1150\AA, Si\,II 1335\AA, Si\,IV 1498\AA, N\,V 1240\AA, O\,I 1308\AA\ to be absent. It is important to check that they are not seen as they could be formed by other heating mechanisms such as shocks or photoionization.

Our particle heating model predicts that Lyα will be the strongest line in our waveband. However the flux from Lyα is difficult to predict robustly because of the sensitivity of resonant scattering to the turbulent velocity field. Resonant scattering of Lyα in a dusty line forming region (which our models are) leads to photon destruction on dust grains. We therefore use the predicted strength of the C\,I 1656\AA\ and the continuum to calculate exposure times.

Our particle heating model predicts the C\,I line to be approximately 30\% of the brightness of Hβ. The work of Conselice et al (2001)

(their Table 1, region number 11) indicates that the horseshoe knot
has a (extinction corrected) surface brightness of
7.2×10^{-15}\ergpspscmpsas in Hα+[N\,II] in an aperture
of 1 arcsec radius. We scale this flux by a factor of 0.5 to obtain the
Hα surface brightness, a factor of 0.27 (Ferland et al 2009,
Appendix A) to obtain the Hβ surface brightness, a factor of 0.3
to obtain the CI surface brightness and a factor of 0.28 to account
for reddening assuming E(B-V)=0.17 (Conselice et al 2001 and Fig 11.3
of the COS Instrument Handbook for Cycle 19). This yields a predicted
surface brightness of 8.3×10^{-17}\ergpspscmpsas. The predicted
continuum surface brightness is 4.2×10^{-18}\ergpspscmpapsas.

Setting these surface brightness into the COS ETC with a source
diameter of 2 arcsec gives the following counts at
1685\AA\ (the redshifted wavelength of the C\,I line) in a 20000~sec
observation, per cross-dispersion resolution element of 47 pixels,
per 0.08\AA\ pixel in the wavelength direction; Line: 1.56 cts, Continuum: 0.61 cts,
Dark: 2.15 cts.

In the line we get a signal-to-noise ratio (SNR) of 0.75 per wavelength bin.
Since our target essentially fills the COS aperture the C\,I line is spread
out over 100 wavelength bins which combine to increase the SNR to 7.5,
allowing a flux measurement to 13\% accuracy. If the He\,II line is as strong
as in the HUT spectrum we would expect to detect this with a SNR of about 5.

Binning up over 50\AA\ allows us
to detect the continuum at an SNR of 10 at the wavelength if C\,I. More
counts will be detected at shorter wavelengths allowing a finer grained
definition of the continuum near the short wavelength turnover.

This 20000 sec exposure can be obtained in 7 orbits of telscope time assuming 56 minutes of visibility per orbit and the standard guide star and target acquisitions and published detector overheads.

Visit

Proposal 12560, Visit 01, implementation Fri Mar 23 01:13:15 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

(Visit 01) Warning (Form): If the target coordinates are not known to 0.4" (or better) an ACQ/SEARCH should precede the ACQ/IMAGE.

(Visit 01) Warning (Orbit Planner): VISIBILITY OVERRUN

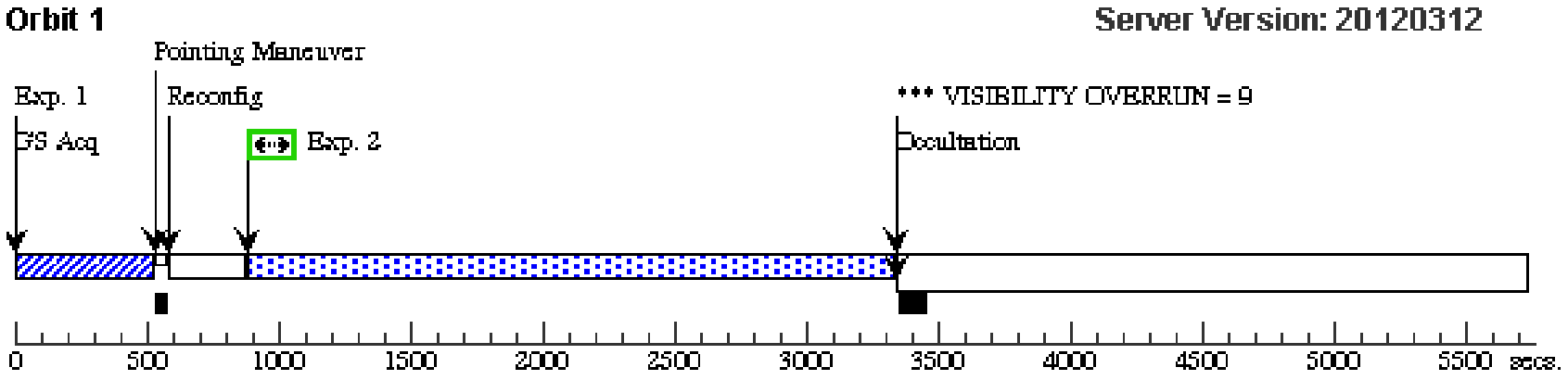
Fixed Targets

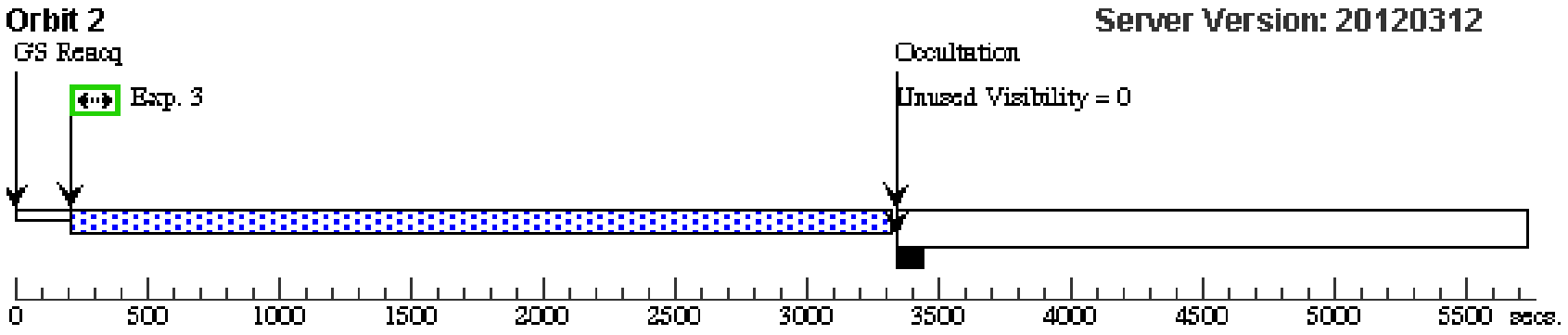
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC-1275-NUCLEUS	RA: 03 19 48.1600 (49.9506667d) Dec: +41 30 42.11 (41.51170d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Redshift: 0.0176	V=13+/-2 1+/-0.2 e-15 erg/cm/cm/s/A at 1600A, 3.2e-15 erg/cm/cm/s/A at 2300A	Reference Frame: ICRS
		Comments: Position is from VLBI from Ma et al 1998, AJ 116, 516 *Flux at 1600 (FOS 0.21x1.23 aperture) from Johnstone + Fabian 1995 MNRAS 273, 625.* *Flux at 2300A confirmed from small extrapolation of preview data for HST dataset O62O05010 (2000-08-18) STIS 52x0.2. That spectrum is largely in agreement with F320W columns in Table 5 of Zirbel + Baum 1998, ApJ, 114, 177 when only point source component is taken into account.*			
(2)	HORSESHOE	Offset from NGC-1275-NUCLEUS by RA Offset: -2.947 Secs Dec Offset: 50.74 Arcsec	Proper Motion RA: 0 Proper Motion Dec: 0	V=35	Offset Position (HORSESHOE) Reference Frame: ICRS

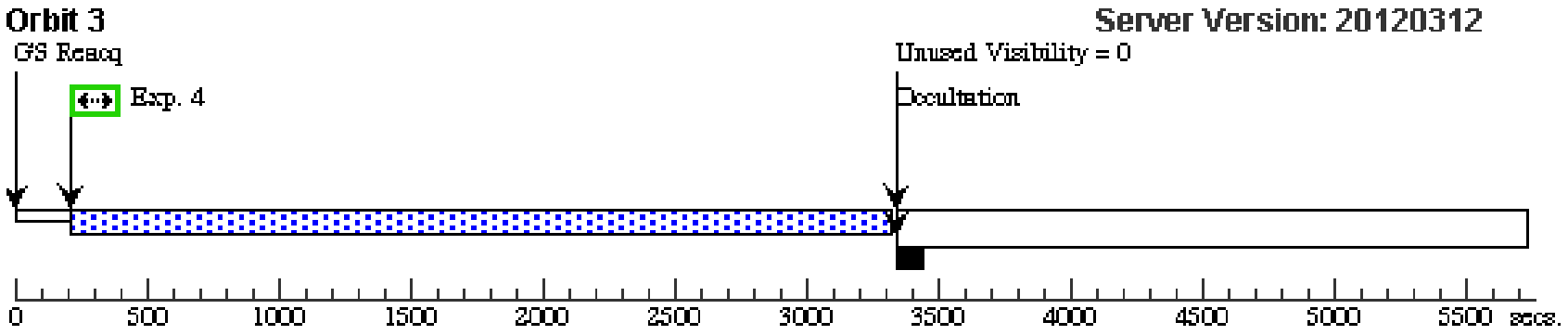
Exposures

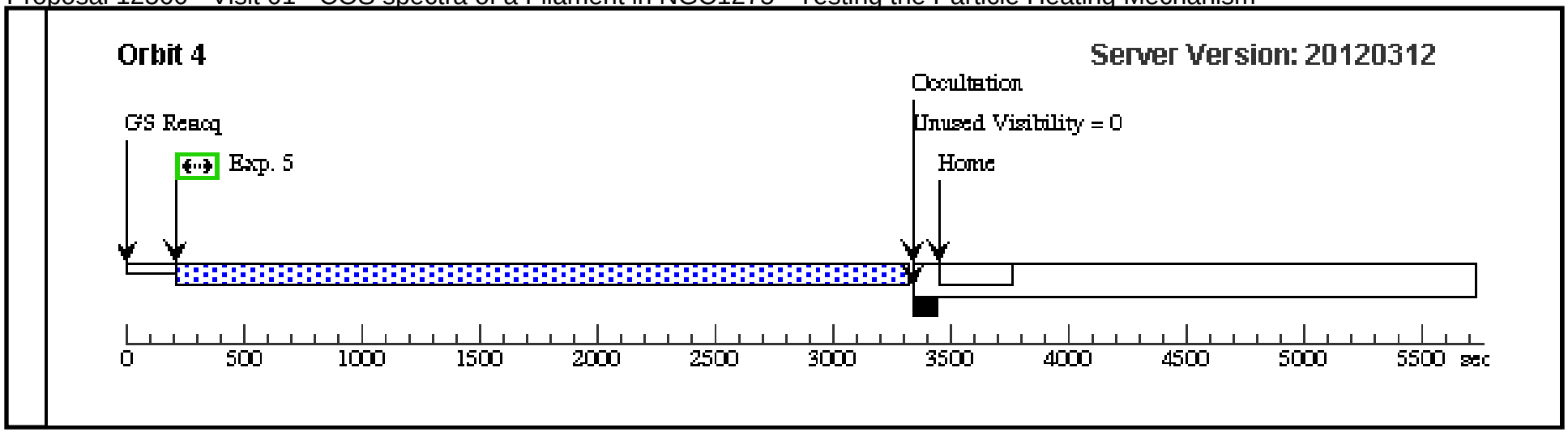
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	Acquisition for NGC1275 nucleus (184007)	(1) NGC-1275-NUCLEUS	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				45 Secs *[==>]*	*[1]*
2	Horseshoe 1/4 (393608)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1105 A	FP-POS=1; BUFFER-TIME=2271; EXTENDED=YES			2271 Secs *[==>]*	*[1]*
3	Horseshoe 2/4 (393608)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1105 A	EXTENDED=YES; FP-POS=2; BUFFER-TIME=3055			3055 Secs *[==>]*	*[2]*
4	Horseshoe 3/4 (393608)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1105 A	EXTENDED=YES; FP-POS=3; BUFFER-TIME=3055			3055 Secs *[==>]*	*[3]*
5	Horseshoe 4/4 (393608)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1105 A	EXTENDED=YES; FP-POS=4; BUFFER-TIME=3055			3055 Secs *[==>]*	*[4]*

Orbit Structure





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Visit

Proposal 12560, Visit 02, completed Fri Mar 23 01:13:17 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: COS/NUV, COS/FUV

Special Requirements: (none)

Diagnostics

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1	Acquisition for NGC1275 nucleus (184007)	(1) NGC-1275-NUCLEUS	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				45 Secs *[==>]*	***[1]***
2	Horseshoe 1 /5 (184002)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1280 A	EXTENDED=YES; FP-POS=1; BUFFER-TIME=2569			2569 Secs *[==>]*	***[1]***
3	Horseshoe 2 /5 (184002)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1280 A	EXTENDED=YES; FP-POS=2; BUFFER-TIME=1914			1914 Secs *[==>]*	***[2]***
4	Horseshoe 3 /5 (184002)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1280 A	EXTENDED=YES; FP-POS=3; BUFFER-TIME=956			956 Secs *[==>]*	***[2]***
5	Horseshoe 4 /5 (184002)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1280 A	EXTENDED=YES; FP-POS=3; BUFFER-TIME=956			956 Secs *[==>]*	***[3]***
6	Horseshoe 5 /5 (184002)	(2) HORSESHOE	COS/FUV, TIME-TAG, PSA	G140L 1280 A	EXTENDED=YES; FP-POS=4; BUFFER-TIME=1914			1914 Secs *[==>]*	***[3]***

Orbit Structure