



# 13947 - An X-ray, UV, and radio probe of the PG 1211+143 inflow-outflow dynamics

Cycle: 22, Proposal Category: GO  
(Availability Mode: SUPPORTED)

## INVESTIGATORS

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## 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) PG1211+143	COS/FUV COS/NUV	1	04-Nov-2014 21:09:14.0	yes
02	(1) PG1211+143	COS/FUV COS/NUV	2	04-Nov-2014 21:09:16.0	yes
04	(1) PG1211+143	COS/FUV COS/NUV	1	04-Nov-2014 21:09:18.0	yes

4 Total Orbits Used

## **ABSTRACT**

We will study the QSO PG 1211+143 using a joint award of time from Chandra HETGS (450ks), HST COS (4 orbits), and JVLA (5 hrs JVLA-A). With Chandra, we will measure the kinematics of the ionized wind to establish energetics. Contemporaneous Chandra-HST observations will be necessary for determining thermodynamic stability conditions and wind-driving mechanisms. JVLA observations will enhance the outflow studies by identifying the radio emission (possibly from a jet) associated with PG1211, to tie in with HETGS studies of its ionized wind(s). Strong gravity signatures in PG 1211 using traditional methods and new probes will also be assessed. Existing Chandra LETGS, XMM RGS, Suzaku spectra lack the spectral resolution and S/N to enable a clear picture of the PG1211 inflow-outflow dynamics.

## **OBSERVING DESCRIPTION**

To obtain the most accurate spectral energy distribution for PG1211+143, and to maximize our possibility of detecting simultaneous UV and X-ray absorption in any ultra-fast outflow, we will observe PG1211+143 in three separate visits coordinated with our Chandra X-ray observations. The Chandra observations are currently planned as three observations of 90 ks+180 ks+180 ks in February 2015. We will observe PG1211+143 once with HST in coordination with each visit.

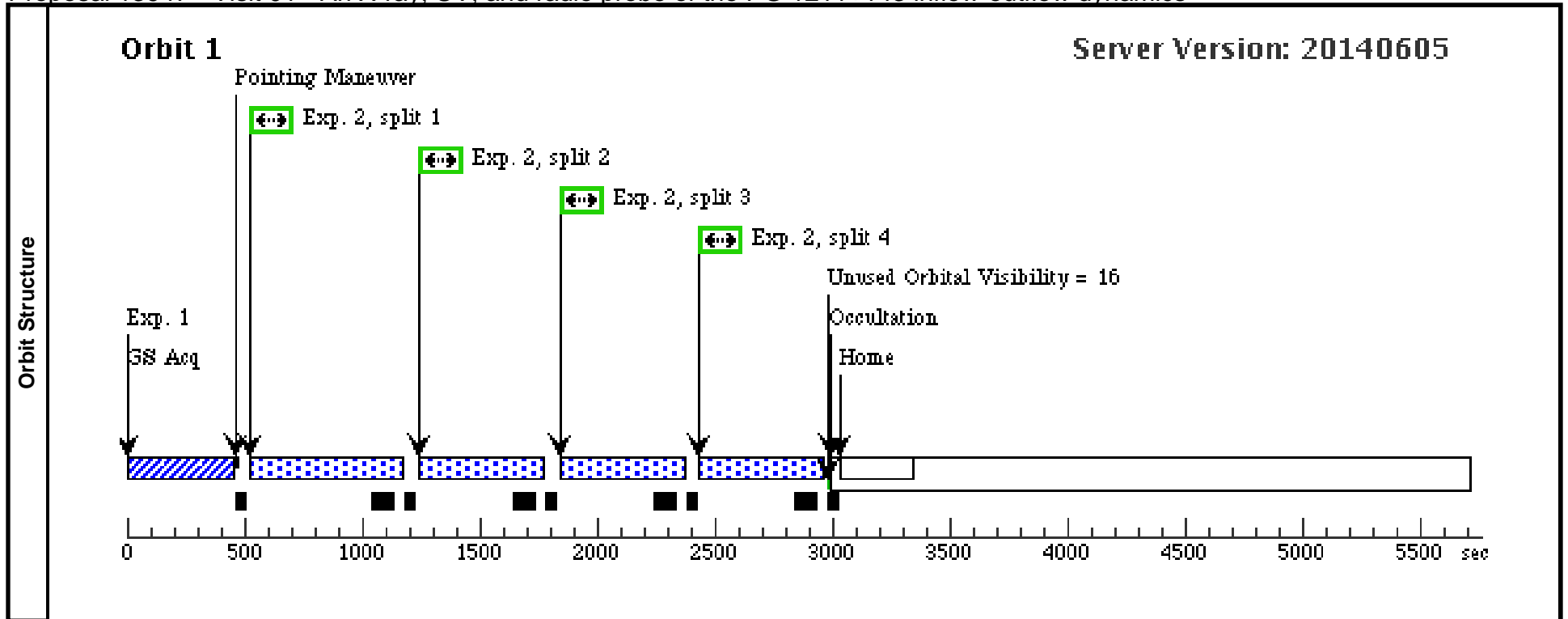
Our HST observations will use the COS G140L grating with a 1280 Å central wavelength setting to cover the far-UV continuum from 1000 Å to 2000 Å in a single orbit on each visit. On the second visit we will also use grating G130M, so that we get complete velocity coverage across the detector segment gaps for the blue wing of the Lyman alpha profile in PG1211+143. The G140L exposures will also cover the brightest UV emission lines: O VI, Ly $\alpha$ , NV and CIV, which are also tracers of the shape of the unobservable extreme UV continuum beyond the Lyman limit. Historically, the PG 1211 UV flux at 1465 Å has ranged from  $(1.9-4.5)e-14$  ergs cm $^{-2}$  s $^{-1}$  Å $^{-1}$  (Dunn et al., 2006). Using the mean HST FOS QSO spectrum normalized to the highest flux level ( $4.5e-14$  ergs cm $^{-2}$  s $^{-1}$  Å $^{-1}$ ), the Exposure Time Calculator v22.2 predicts for each orbit a S/N per resolution element of  $> 10$  between 1100-1800 Å, with a peak continuum S/N $\sim$ 25 at 1400 Å. This observation is also safe for COS. Given the G140L resolving power of 2000-3000, this is adequate to avoid intervening interstellar absorption features and bin the continuum measurements to a S/N $>$ 50 across most of the HST-COS spectral range. Presuming outflow velocities of 3000 km s $^{-1}$  (i.e., as reported in the X-ray by Kaspi et al. 2006), this will allow us to detect weak UV absorption lines at the expected wavelengths for Ly $\alpha$ , NV 1238,1242 and CIV 1548,1550 with 3-sigma EWs of  $<25$  mÅ in each HST orbit. This corresponds to optically thin column densities of  $< 2e13$  cm $^{-2}$ . The HST-COS spectrum will also cover the higher ionization O VI doublet at 1032,1038 Å, but at a lower S/N of 10, yielding a limiting equivalent width of 100 mÅ and a limiting column density of  $< 2e14$  cm $^{-2}$ .

These limits are much lower than the predictions for such ions in the low  $\xi$  photoionization models for the X-ray transitions seen by Kaspi et al. (2006).

Proposal 13947 - Visit 01 - An X-ray, UV, and radio probe of the PG 1211+143 inflow-outflow dynamics

Wed Nov 05 02:09:19 GMT 2014

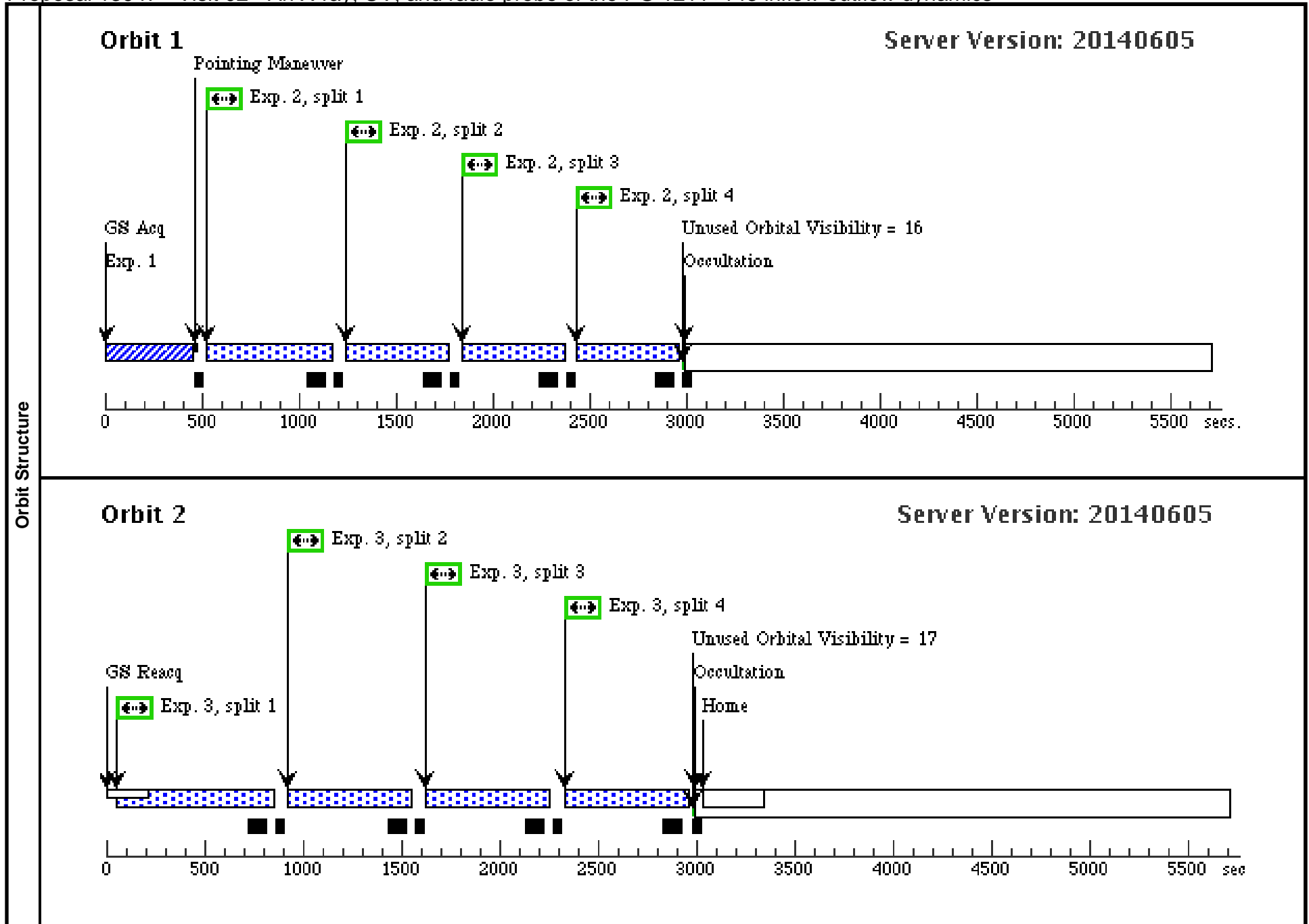
Visit	<b>Proposal 13947, Visit 01, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/NUV, COS/FUV Special Requirements: SCHED 100% <i>Comments: To be coordinated with Chandra observation 1.</i>									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(1)	PG1211+143	RA: 12 14 17.6674 (183.5736142d) Dec: +14 03 13.15 (14.05365d) Equinox: J2000	Redshift: 0.0809	V=14.19+/-0.5 3.5e-14 at 1465 A	Reference Frame: ICRS				
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(COS.ta.638 682)	(1) PG1211+143	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARI O BASE1B3		12.3 Secs (12.3 Secs) [==>]	[1]
	<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS.                      ETC run #638681.                      For observation planning, we used the *lowest* flux ever observed, 1.9e-14, in order to ensure the success of our target acquisition, ETC run #638682.</i>									
2	(COS.ta.638 688)	(1) PG1211+143	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=36 5; FP-POS=ALL		475 Secs (1900 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]	[1]	
	<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS.                      ETC run #638688. (We used the FOS-based QSO spectrum, z=0.0809, and E(B-V)=0.03.)</i>									



Proposal 13947 - Visit 02 - An X-ray, UV, and radio probe of the PG 1211+143 inflow-outflow dynamics

Wed Nov 05 02:09:20 GMT 2014

Visit	<b>Proposal 13947, Visit 02, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/NUV, COS/FUV Special Requirements: SCHED 100% <i>Comments: To be coordinated with Chandra observation 2.</i>									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(1)	PG1211+143	RA: 12 14 17.6674 (183.5736142d) Dec: +14 03 13.15 (14.05365d) Equinox: J2000	Redshift: 0.0809	V=14.19+/-0.5 3.5e-14 at 1465 A	Reference Frame: ICRS				
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(COS.ta.638 682)	(1) PG1211+143	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARI O BASE1B3		12.3 Secs (12.3 Secs)	
	<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS. ETC run #638681. For observation planning, we used the *lowest* flux ever observed, 1.9e-14, in order to ensure the success of our target acquisition, ETC run #638682.</i>									[1]
	2	(COS.ta.638 688)	(1) PG1211+143	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=36 5; FP-POS=ALL			475 Secs (1900 Secs)	
<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS. ETC run #638688. (We used the FOS-based QSO spectrum, z=0.0809, and E(B-V)=0.03.)</i>									[1]	
3	(COS.ta.644 855)	(1) PG1211+143	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=47 0; FP-POS=ALL			580 Secs (2320 Secs)		
<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS. ETC run #644855. (We used the FOS-based QSO spectrum, z=0.0809, and E(B-V)=0.03.)</i>									[2]	



Proposal 13947 - Visit 04 - An X-ray, UV, and radio probe of the PG 1211+143 inflow-outflow dynamics

Wed Nov 05 02:09:20 GMT 2014

Visit	<b>Proposal 13947, Visit 04, implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: COS/NUV, COS/FUV Special Requirements: SCHED 100% <i>Comments: To be coordinated with Chandra observation 3.</i>									
	Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous			
	(1)	PG1211+143	RA: 12 14 17.6674 (183.5736142d) Dec: +14 03 13.15 (14.05365d) Equinox: J2000	Redshift: 0.0809	V=14.19+/-0.5 3.5e-14 at 1465 A	Reference Frame: ICRS				
	<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(COS.ta.638 682)	(1) PG1211+143	COS/NUV, ACQ/IMAGE, PSA	MIRRORB		GS ACQ SCENARI O BASE1B3		12.3 Secs (12.3 Secs) [==>]	[1]
	<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS.                      ETC run #638681.                      For observation planning, we used the *lowest* flux ever observed, 1.9e-14, in order to ensure the success of our target acquisition, ETC run #638682.</i>									
2	(COS.ta.638 688)	(1) PG1211+143	COS/FUV, TIME-TAG, PSA	G140L 1280 A		BUFFER-TIME=36 5; FP-POS=ALL		475 Secs (1900 Secs) [==>(Split 1)] [==>(Split 2)] [==>(Split 3)] [==>(Split 4)]	[1]	
	<i>Comments: Using the brightest flux ever observed, 4.5e-14 at 1465 A, this observation is still safe for COS.                      ETC run #638688. (We used the FOS-based QSO spectrum, z=0.0809, and E(B-V)=0.03.)</i>									

