12250 - Irradiated Jets and Proplyds in NGC 1977, Orion Nebula's Cousin

Cycle: 18, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. John Bally (PI)	**University of Colorado at Boulder**	**john.bally@colorado.edu**
Mr. Adam Ginsburg (CoI)	University of Colorado at Boulder	adam.ginsburg@colorado.edu
Dr. Nathan Smith (CoI)	University of California - Berkeley	nathans@astro.berkeley.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC1977P2042	ACS/WFC WFC3/UVIS	1	10-Dec-2010 21:32:36.0	yes
02	(1) NGC1977P2042	ACS/WFC WFC3/UVIS	1	10-Dec-2010 21:32:41.0	yes
03	(1) NGC1977P2042	ACS/WFC WFC3/UVIS	1	10-Dec-2010 21:32:44.0	yes
04	(1) NGC1977P2042 (2) NGC1977HH45	ACS/WFC WFC3/UVIS	1	10-Dec-2010 21:32:47.0	yes
05	(1) NGC1977P2042 (2) NGC1977HH45	ACS/WFC WFC3/UVIS	1	10-Dec-2010 21:32:50.0	yes
06	(3) NGC1977HH45B	ACS/WFC WFC3/UVIS	1	10-Dec-2010 21:32:53.0	yes

6 Total Orbits Used

ABSTRACT

We propose to use WFC3 and coordinated parallel observations with ACS to study a cluster of irradiated jets, photo-ablating disks (proplyds), and clouds in the low excitation HII region NGC 1977. Located 30' north of the Orion Nebula at a distance of about 410 pc , NGC 1977 contains over 100 young stellar objects identified by Spitzer and a half-dozen outflows found on ground-based narrow-band H-alpha images. The star Parenago 2042 powers a knotty jet and a bipolar chain of bow shocks with a C-shaped bend indicating deflection by a side-wind. We will take advantage of the new WFC3 capability to image [MgII] and [OII], species that can outshine Halpha in UV-dominated shocked environments, to study the structure and excitation conditions in these jets with unprecedented resolution. H-alpha observations with WFC3, and ACS in coordinated parallel mode, will be used to study giant proplyds detected in ground-based images, to search for embedded protoplanetary disks, and to find additional proplyds and micro-jets among the dozens of Spitzer-detected young stars in this field. NGC 1977 is an ideal laboratory for the study of disk survival and evolution in a soft-UV dominated environment lit up by an early B star. Disk sizes and ionization fronts are expected to be larger than in Orion. In the Orion Nebula, photo-ablating plasma flows from the ionization front towards our line-of-sight, making it difficult to determine the distance between any disk and the ionization front. In NGC 1977, the plasma flow is closer to the plane of the sky. Thus, for a constant velocity ionization front, the projected distance of a proplyd from the front is expected to be proportional of its UV exposure-time. A study of disk-size versus distance from the front can be related to the disk photo-erosion rate. This study will make important contributions to our understanding of the impacts of the environment on protostellar jet and proto-planetary disk evolution.

OBSERVING DESCRIPTION

We propose WFC3 imaging of two fields (Figure 4 in Phase I proposal) containing a cluster of jets, a large irradiated bow shock, HH 45, and a number of candidate proplyds and externally irradiated proto-stellar envelopes. WFC3 mages will be obtained in the [MgII] doublet near 2,800 Angstroms, in the [OII] doublet near 3,730 Angstroms, and in H at 6563 Angstroms. These emission lines are known to be the brightest tracers of shocks and ionization fronts in UV-irradiated outflows (Walsh et al. 1992; Morse et al. 1993). HST's 0.04" to 0.07" angular resolution (20 to 30 AU at d ~ 414 pc) is needed to resolve the shocks and their post-shock cooling layers, and to distinguish shocks from ionization fronts. The [MgII] and [OII] imaging will test the utility of these tracers for the investigation of nearby HII regions.

ACS will be used in coordinated parallel mode to observe two additional portions of the NGC 1977 cluster and HII region in the F658N filter that transmits H and [NII]. These fields contain a half-dozen irradiated outflow candidates detected from the ground, several giant proplyds, several

externally ionized proto-stellar envelopes, and several dozen young stars with large infrared excess emission in the Spitzer Space Telescope survey of the Orion A molecular cloud. The NGC 1977 HST study promises to deliver the richest harvest of externally irradiated proto-planetary disks (proplyds) and irradiated jets outside of the Orion Nebula.

The Visit 1 and 2 primary exposures contain the deflected jet (jet 1) from Parenago 2042 that propagates on a nearly east-west axis. This field contains several additional YSOs surrounded by circular arcs of H emission reminiscent of the H+[OIII] arcs surrounding proplyds located close to the Trapezium stars in the Orion Nebula.

The coordinated parallel observation associated with Visits 1 and 2 use ACS/WFC F658N to target the top field in Phase I Figure 4. This field contains a large disk-shadow and a compact reflection nebula which powers a 2' long jet towards the south-west (right panel in Figure 4). The visit 1 and 2 coordinated parallel imaging with ACS/WFC targets the south-west portion of the outflow in H + [NII] needed to record this relatively faint outflow.

The primary exposure in Visit 3 uses WFC3 to target the source of the northern jet in H. Jet 1 from P2042 is now targetted with ACS in H + [NII]. This observation is conducted with a nearly 180 degree rotation with respect to Visits 1 and 2. The reason for this is that it was impossible to observe the source of the nothern jet with WFC3 prime observation targetting P2041 (as was intended in the Phase I proposal) due to orientation constraints. This configuration takes advantage of the larger FOV of ACS, providing wider coverage of NGC1977 in H.

Visits 4 and 5 target the field containing the giant bow shock HH 45. The [MgII] and [OII] images will be the first ever HST observations of a large bow shock in an irradiated environment. The right side of the WFC3 field contains a giant proplyd facing 42 Ori (marked in Phase I Fig. 2). This object has been detected in X-rays, has an IR excess (source #1237 in Rebull et al 2000) and exhibits a faint, 5" long H tail pointing away from 42 Ori.

The coordinated parallel observation associated with Visits 3 and 4 use ACS/WFC F658N to widen our coverage of the field west of the P2042 jet (jet 1) in H + [NII].

Visit 6 targets the HH45 bow shock and vicinity in H + [NII] using ACS/WFC. WFC3 is now used to target the field north-east of jet1 from P2042, including jet4 (Phase I figure 3) and V056 Ori which is surrounded by a 1000 AU ionization front.

The Mosaic CCD survey of the entire Orion A cloud, including the Orion Nebula and NGC 1977 demonstrates that the surface brightness of NGC 1977 in the target region is identical to the outer portions of the Orion Nebula imaged in our Cycle 12 ACS/WFC survey (e.g. Bally et al. 2006). Thus, sufficient signal/noise imaging of the irradiated jets and shocks in NGC 1977 requires a full orbit per pointing for each WFC3 filter. For a surface brightness of 2x10-14 erg s-1 cm-2 in [MgII], a S/N ratio of 5 in 2x2 pixel bines will be reached in about 1,000 seconds. Thus full orbit integrations are required in this and the [OII] filter.

We will take two dithered exposures during each orbit that can be drizzled to remove cosmic rays, hot pixels, and blemishes. The total exposure time will be about 2700 seconds for the image in each filter in WFC3, and 2700 or 5400 seconds in ACS F658N. According to the ETC, we will reach a 5 sigma sensitivity of about than 10-16 ergs cm-2 s-1 arcsec-2 sufficient to record the features in the ground-based images. Our experience with HST imaging of HH objects indicates that most of the emission seen in ground-based images is produced in sub-arc-second structures with considerably larger fluxes. ACS will reach about a factor of 3 deeper in the fainter northern fields due to its greater sensitivity and three-orbit integrations.

Visit

Proposal 12250, Visit 01, implementation Sat Dec 11 02:32:57 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC, WFC3/UVIS

Special Requirements: ORIENT 107D TO 107 D

Patterns

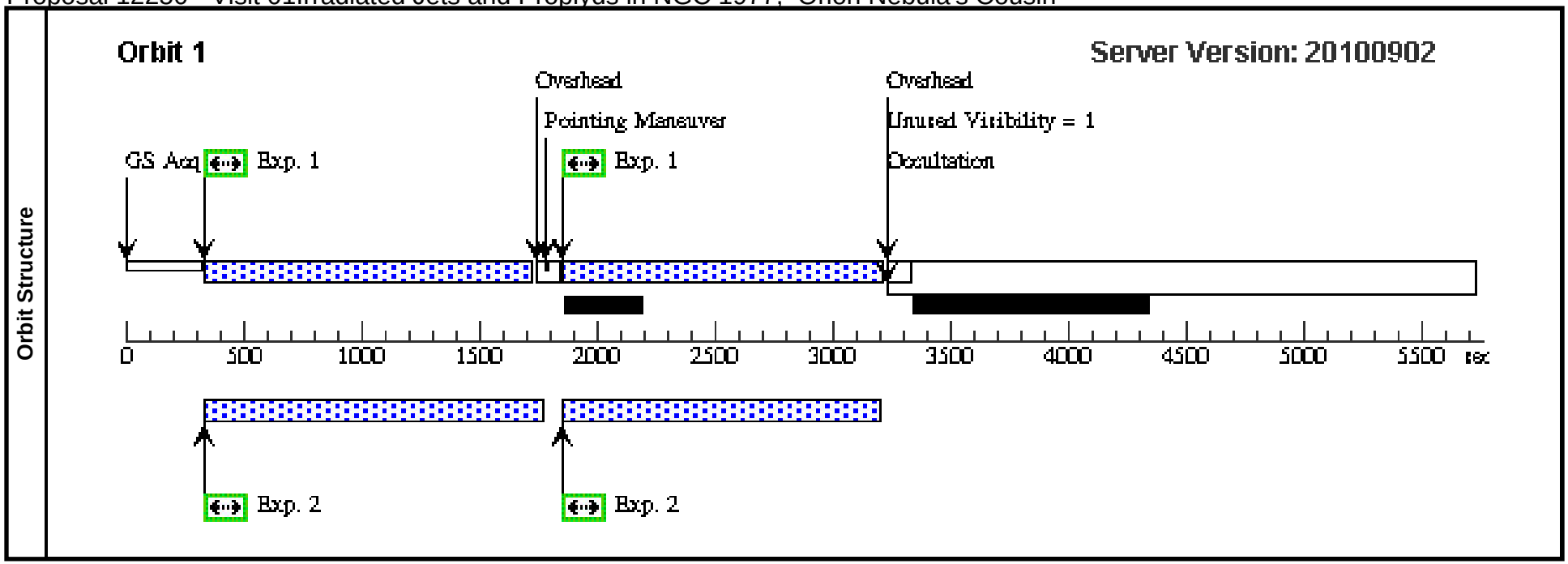
#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-MOSAIC-LINE Purpose=MOSAIC Number Of Points=2 Point Spacing=3.264 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=63.697 Angle Between Sides= Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1977P2042	RA: 05 35 26.9000 (83.8620833d) Dec: -04 47 36.00 (-4.79333d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=17+/-	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) NGC1977P2042	WFC3/UVIS, ACCUM, UVIS-CENTER	F280N			Pattern 1, Exps 1-2 in Visit 01 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 01	1364 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) NGC1977P2042	ACS/WFC, ACCUM, WFC	F658N			Pattern 1, Exps 1-2 in Visit 01 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 01	1230 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20100902
Overhead
Pointing Maneuver
Overhead
Unused Visibility = 1
GS Acq
Exp. 1
Exp. 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Exp. 2
Exp. 2

Visit

Proposal 12250, Visit 02, implementation Sat Dec 11 02:32:58 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC, WFC3/UVIS

Special Requirements: ORIENT 107D TO 107 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-MOSAIC-LINE Purpose=MOSAIC Number Of Points=2 Point Spacing=3.264 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=63.697 Angle Between Sides= Center Pattern=false		(1-2)

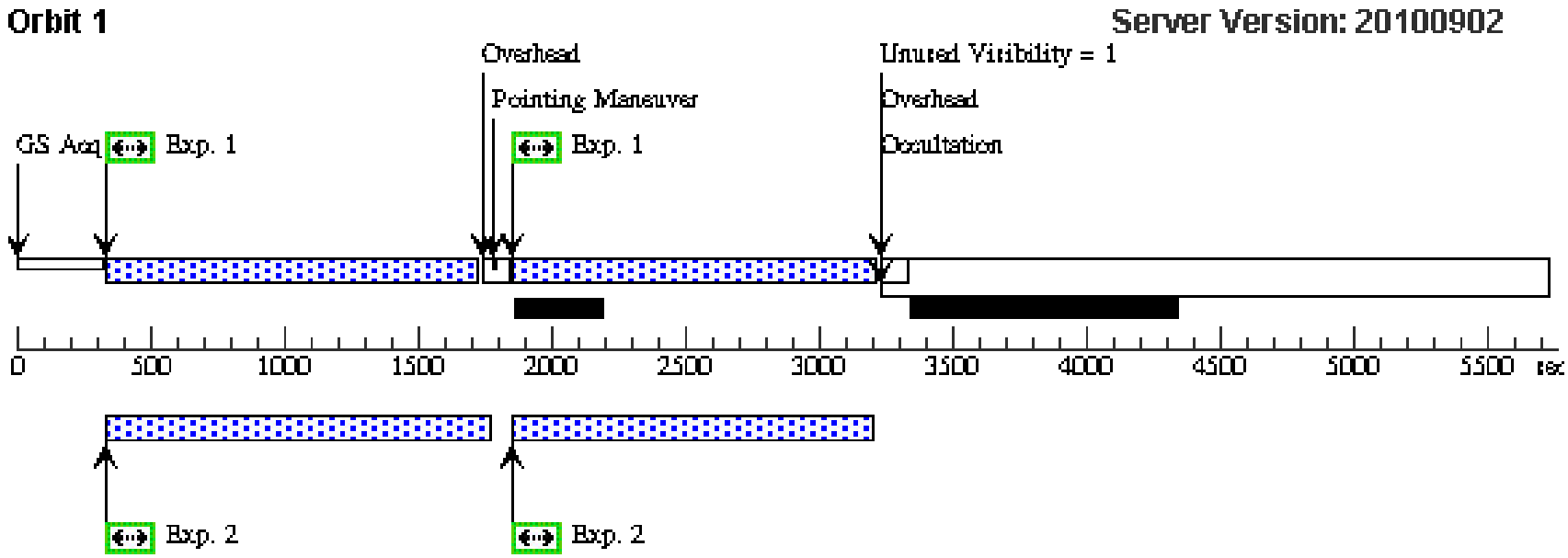
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1977P2042	RA: 05 35 26.9000 (83.8620833d) Dec: -04 47 36.00 (-4.79333d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=17+/-	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) NGC1977P2042	WFC3/UVIS, ACCUM, UVIS-CENTER	F373N			Pattern 1, Exps 1-2 in Visit 02 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 02	1364 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) NGC1977P2042	ACS/WFC, ACCUM, WFC	F658N			Pattern 1, Exps 1-2 in Visit 02 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 02	1230 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***

Orbit Structure



Visit

Proposal 12250, Visit 03, completed Sat Dec 11 02:32:59 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC, WFC3/UVIS

Special Requirements: ORIENT 306D TO 306 D

Patterns

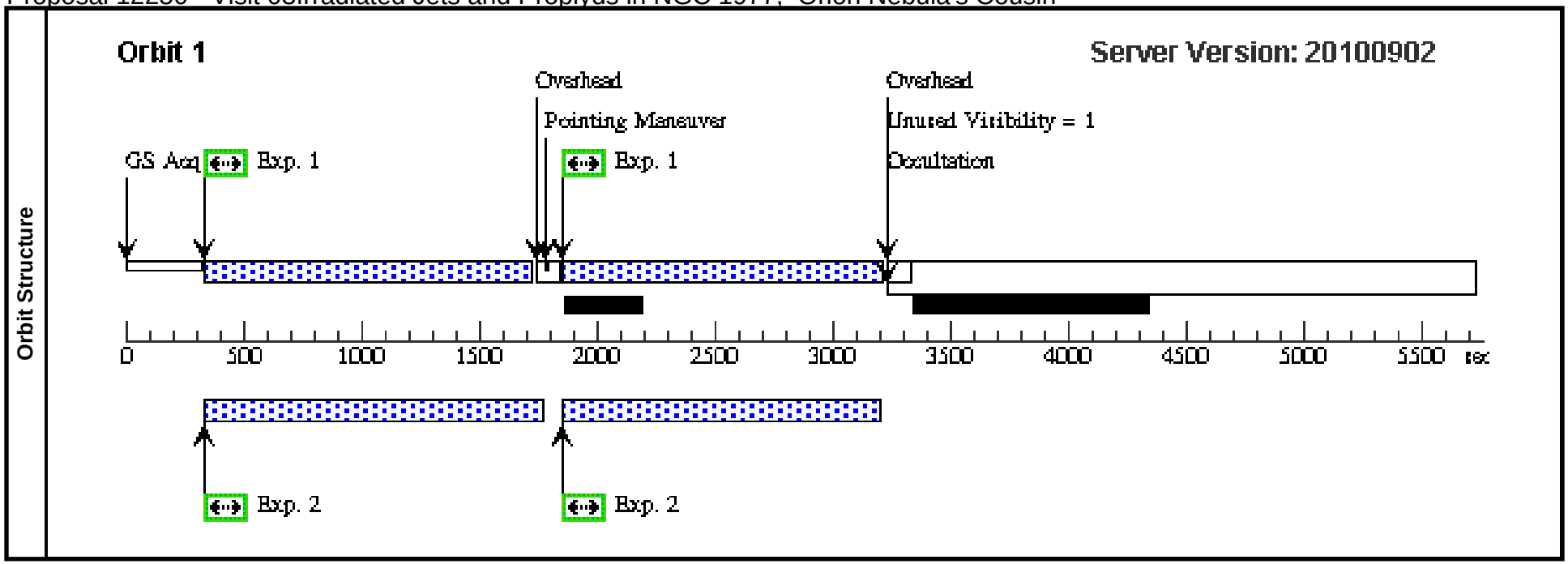
#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-MOSAIC-LINE Purpose=MOSAIC Number Of Points=2 Point Spacing=3.264 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=63.697 Angle Between Sides= Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1977P2042	RA: 05 35 26.9000 (83.8620833d) Dec: -04 47 36.00 (-4.79333d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=17+/-	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) NGC1977P2042	WFC3/UVIS, ACCUM, UVIS-CENTER	F656N		POS TARG -20.608948200806694,385.3181373134232	Pattern 1, Exps 1-2 in Visit 03 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 03	1364 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) NGC1977P2042	ACS/WFC, ACCUM, WFC	F658N			Pattern 1, Exps 1-2 in Visit 03 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 03	1230 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20100902
Overhead
Pointing Maneuver
Overhead
Unused Visibility = 1
GS Acq
Exp. 1
Exp. 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Exp. 2
Exp. 2

Visit

Proposal 12250, Visit 04, implementation Sat Dec 11 02:32:59 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC, WFC3/UVIS

Special Requirements: ORIENT 295D TO 295 D

Patterns

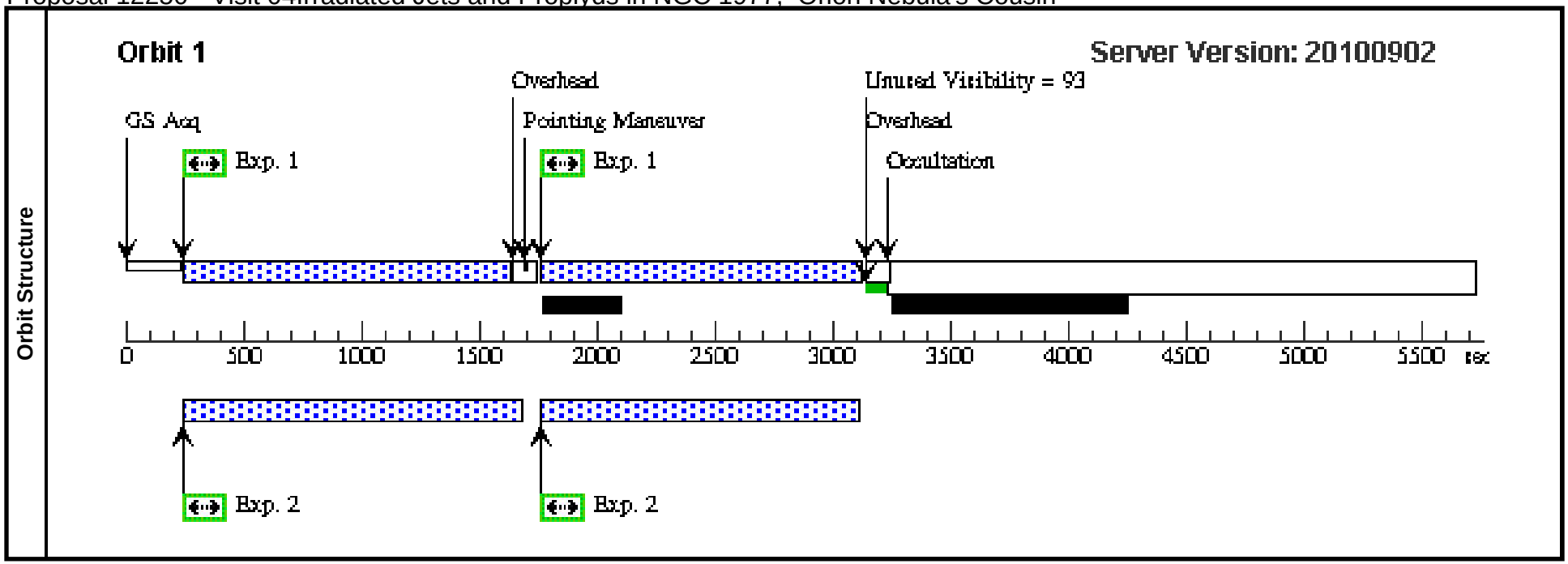
#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-MOSAIC-LINE Purpose=MOSAIC Number Of Points=2 Point Spacing=3.264 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=63.697 Angle Between Sides= Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1977P2042	RA: 05 35 26.9000 (83.8620833d) Dec: -04 47 36.00 (-4.79333d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=17+/-	Reference Frame: ICRS
(2)	NGC1977HH45	RA: 05 35 31.6337 (83.8818071d) Dec: -04 52 5.30 (-4.86814d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=15+/-	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(2) NGC1977HH45	WFC3/UVIS, ACCUM, UVIS-CENTER	F280N		GS ACQ SCENARIO SINGLE	Pattern 1, Exps 1-2 in Visit 04 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 04	1364 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***
2		(1) NGC1977P2042	ACS/WFC, ACCUM, WFC	F658N			Pattern 1, Exps 1-2 in Visit 04 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 04	1230 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	***[1]***


Orbit Structure
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Server Version: 20100902
GS Acq
Exp. 1
Overhead
Pointing Maneuver
Exp. 1
Unused Visibility = 93
Overhead
Occultation
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500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec
Exp. 2
Exp. 2

Visit

Proposal 12250, Visit 05, implementation Sat Dec 11 02:33:00 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC, WFC3/UVIS

Special Requirements: ORIENT 295D TO 295 D

Patterns

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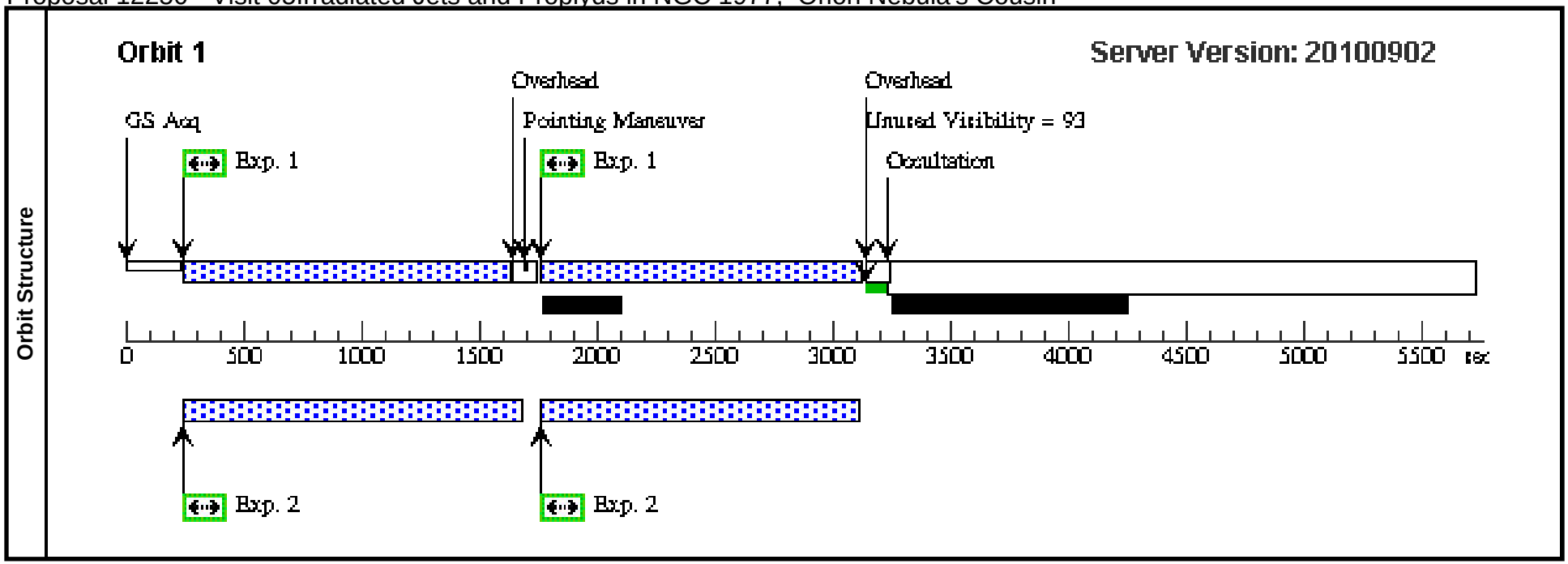
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC1977P2042	RA: 05 35 26.9000 (83.8620833d) Dec: -04 47 36.00 (-4.79333d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=17+/-	Reference Frame: ICRS
(2)	NGC1977HH45	RA: 05 35 31.6337 (83.8818071d) Dec: -04 52 5.30 (-4.86814d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=15+/-	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(2) NGC1977HH45	WFC3/UVIS, ACCUM, UVIS-CENTER	F373N		GS ACQ SCENARIO SINGLE	Pattern 1, Exps 1-2 in Visit 05 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 05	1364 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***
2		(1) NGC1977P2042	ACS/WFC, ACCUM, WFC	F658N			Pattern 1, Exps 1-2 in Visit 05 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 05	1230 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***


Orbit Structure
Orbit 1
Server Version: 20100902
GS Acq
Exp. 1
Overhead
Pointing Maneuver
Exp. 1
Overhead
Unused Visibility = 93
Occultation
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500
1000
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3500
4000
4500
5000
5500
sec
Exp. 2
Exp. 2

Visit

Proposal 12250, Visit 06, implementation Sat Dec 11 02:33:01 GMT 2010

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/WFC, WFC3/UVIS

Special Requirements: ORIENT 300D TO 300 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-MOSAIC-LINE Purpose=MOSAIC Number Of Points=2 Point Spacing=3.264 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=63.697 Angle Between Sides= Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	NGC1977HH45B	RA: 05 35 30.8400 (83.8785000d) Dec: -04 51 39.00 (-4.86083d) Equinox: J2000	Proper Motion RA: null Proper Motion Dec: null Epoch of Position:	V=15+/-	Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(3) NGC1977HH45B	WFC3/UVIS, ACCUM, UVIS-CENTER	F656N		POS TARG 12.3225 56440845297,356.6122637812912; GS ACQ SCENARIO SINGLE	Pattern 1, Exps 1-2 in Visit 06 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 06	1364 Secs *[==>(Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***
2		(3) NGC1977HH45B	ACS/WFC, ACCUM, WFC	F658N			Pattern 1, Exps 1-2 in Visit 06 (1) Prime + Parallel Group 1-2 in Pattern 1, Exps 1-2 in Visit 06	1230 Secs *[==>1280.0 Secs (Pattern 1)]* *[==>(Pattern 2)]*	 ***[1]***

Orbit Structure