# 17717 - Resolving the Origins of Extraplanar Dust using UV Reflection Nebulae

Cycle: 32, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

**INVESTIGATORS**



| *Name* | *Institution* |
|---|---|
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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) NGC4517 | WFC3/UVIS | 2 | 14-Jan-2025 11:00:46.0 | yes |
| 02 | (2) NGC4565 | WFC3/UVIS | 2 | 14-Jan-2025 11:00:46.0 | yes |
| 03 | (3) NGC3044 | WFC3/UVIS | 2 | 14-Jan-2025 11:00:47.0 | yes |
| 04 | (4) NGC4217 | WFC3/UVIS | 2 | 14-Jan-2025 11:00:47.0 | yes |
| 05 | (5) NGC2683 | WFC3/UVIS | 2 | 14-Jan-2025 11:00:47.0 | yes |
| 06 | (2) NGC4565 | WFC3/UVIS | 1 | 14-Jan-2025 11:00:48.0 | yes |

11 Total Orbits Used

**ABSTRACT**

Dusty outflows from star-forming regions trace the circulation of mass and metals between galaxy disks and their gaseous environments. As much as half of the dust in the local universe may be found outside of galaxy disks, but we do not know what physical mechanisms dominate the dust transport. The morphology of the extraplanar dust is a key indicator of dust transport by ejective feedback through galactic chimneys (clumpy/filamentary) or by radiation pressure (smooth). However, the dust morphology is unknown at distances of more than a kiloparsec from the

disks of normal, star-forming galaxies. At these distances, UV light scattered by dust grains provides a powerful tool for detecting the dust, but these reflection nebulae are unresolved by GALEX and Swift observations. We propose to resolve these nebulae using HST/WFC3 F225W imaging of six nearby, normal ~L* galaxies (five new observations, one archival). These observations will determine whether ejective feedback or radiation pressure dominates the dust transport out of galaxy disks with and without active chimney-mode feedback, as seen in H-alpha images. This pilot program will also enable efficient and precise measurements of the metal mass found in the expelled dust in a future program. These objectives are essential for understanding the physical processes that regulate star formation by coupling the mass and metal reservoirs of the interstellar and circumgalactic media.

**OBSERVING DESCRIPTION**

Scientific goals: This program will study ejective and radiative stellar feedback in star-forming disk galaxies by measuring the morphology of extraplanar dust detected via scattered UV light. If ejective feedback dominates the dust transport out of galaxy disks, then the extraplanar dust morphology is expected to be clumpy. In contrast, if radiative feedback is important, then the morphology will be smoother. Our observing strategy is therefore designed to detect scattered light from dust on scales as small as l = 100 pc at the disk-halo interfaces of five nearby (D = 10 - 20 Mpc), edge-on disk galaxies. These obseravtions will also inform the best strategy for obtaining accurate measurements of the total extraplanar dust mass in future observing programs.

Observing strategy: We use WFC3-UVIS and the F225W filter to image extraplanar dust via scattered near-UV light in high SNR images. Our exposure times are chosen to detect extraplanar dust in regions of size l = 100 pc (1" - 2", or 25 - 50 pixels) at z = 3 kpc with SNR = 3, if the dust is smooth. The choice of z = 3 kpc is based on the typical extent of extraplanar reflection nebulae, and we use GALEX/NUV images to determine the typical NUV surface brightnesses of the sample galaxies at these distances from the disk. If the dust is clumpy instead of smooth, we will achieve a higher SNR in the clumps, and we will enlarge the aperture as needed to achieve significant detections of any residual, diffuse emission. The exposure time requirements result in two orbits allocated to each of the five galaxies for a total of ten orbits.

We center the WFC3-UVIS pointings on the galaxy centers, where the NUV halos tend to be brightest, to optimize the SNR. The WFC3-UVIS FOV spans 8 - 18 kpc at the distances of the sample galaxies, allowing the extraplanar NUV surface brightness profile to be measured within at least twice the characteristic scale height of the NUV nebulae (typically a few kiloparsecs). We use the two-point WFC3-UVIS-GAP-LINE pattern to fill in the chip gap and remove cosmic rays and detector artifacts. As the scales that we aim to resolve (~ 1") are larger than the PSF, we do not dither further to resample the PSF. We employ a post-flash of 9 or 10 e- to mitigate CTE effects in the faint regions of the images. We thus obtain two full-orbit

exposures for each galaxy, which optimizes the SNR of faint extraplanar structures.

## Visit

**Proposal 17717, NGC4517 Visit (01), implementation** Tue Jan 14 16:00:48 GMT 2025

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 10D TO 275 D

*Comments: A bright star within the FOV (RA = 188.20335d, dec = 0.12584d; V ~ 10.9 mag) may produce figure-8 ghosts in quadrant A if it falls on quadrant D. We restrict the ORIENT to ensure that the star does not fall on quadrant D.*

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-UVIS-GAP-LINE | Coordinate Frame=POS-TARG | | (1) |
| | Purpose=MOSAIC | Pattern Orientation=85.759 | | |
| | Number Of Points=2 | Angle Between Sides= | | |
| | Point Spacing=2.414 | Center Pattern=true | | |
| | Line Spacing= | | | |

## Fixed Targets

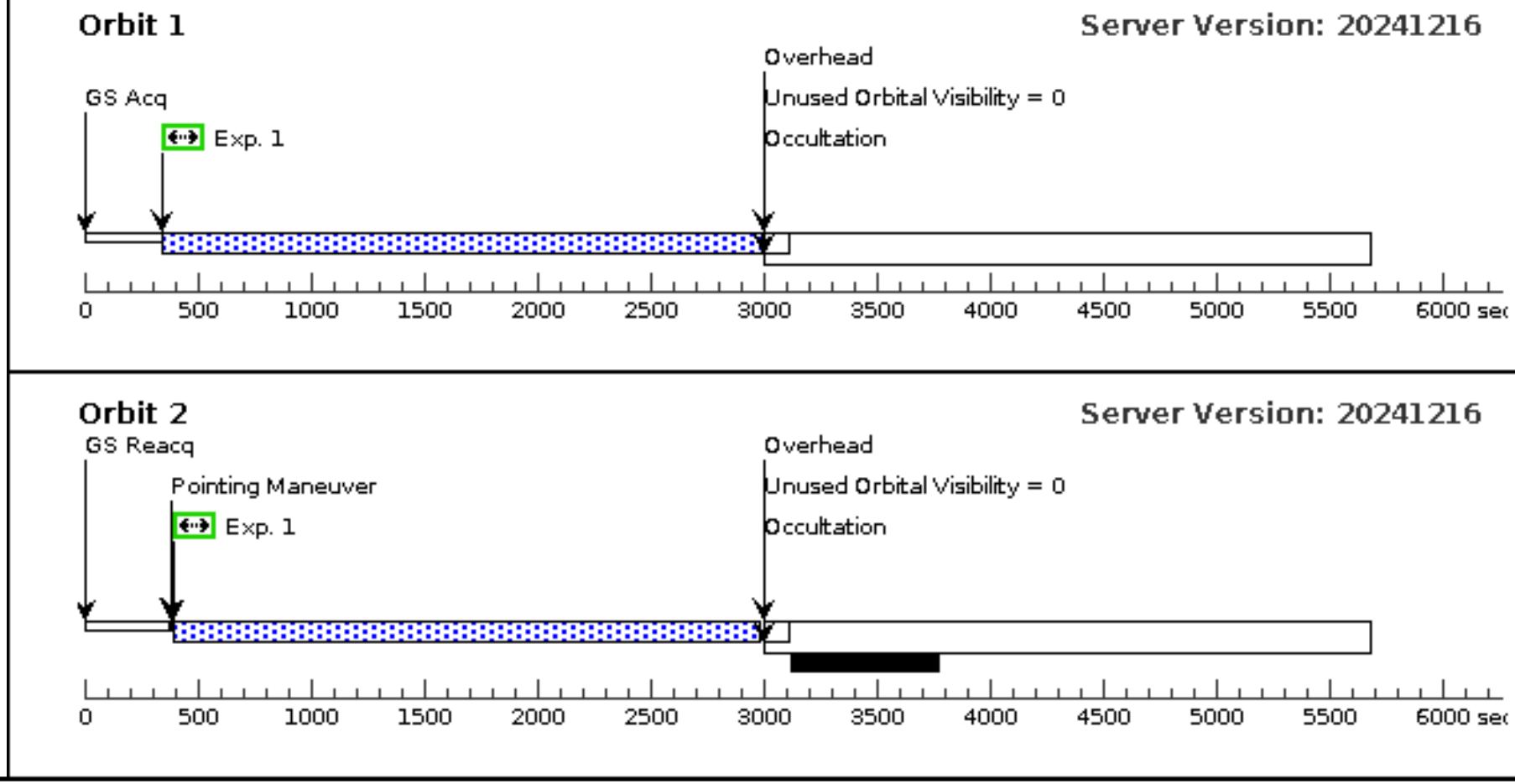
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | NGC4517 | RA: 12 32 45.5904 (188.1899600d) | Epoch of Position: 2000 | V=10.4 | Reference Frame: NED |
| | | Dec: +00 06 54.11 (.11503d) | Redshift: 0.003756 | SURF-NUV-AB = 25.3 mag/sqarc | |
| | | Equinox: J2000 | | | |

*Comments: This object was generated by the targetselector and retrieved from the NED database.*
*Category=GALAXY*
*Description=[SPIRAL]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NGC4517-CEN (WFC3UVIS.im.1933608) | (1) NGC4517 | WFC3/UVIS, ACCUM, UVIS-FIX | F225W | FLASH=10 | | Pattern 1, Exps 1-1 in NGC4517 Visit (01) (1) | 2500 Secs (5211 Secs) | |
| | | | | | | | | *[==>2617.0 Secs (Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>2594.0 Secs (Pattern 2)]* | ***[2]*** |

Orbit Structure



## Visit

**Proposal 17717, NGC4565 Visit (02), failed** Tue Jan 14 16:00:48 GMT 2025

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-UVIS-GAP-LINE | Coordinate Frame=POS-TARG | | (1) |
| | Purpose=MOSAIC | Pattern Orientation=85.759 | | |
| | Number Of Points=2 | Angle Between Sides= | | |
| | Point Spacing=2.414 | Center Pattern=true | | |
| | Line Spacing= | | | |

## Fixed Targets

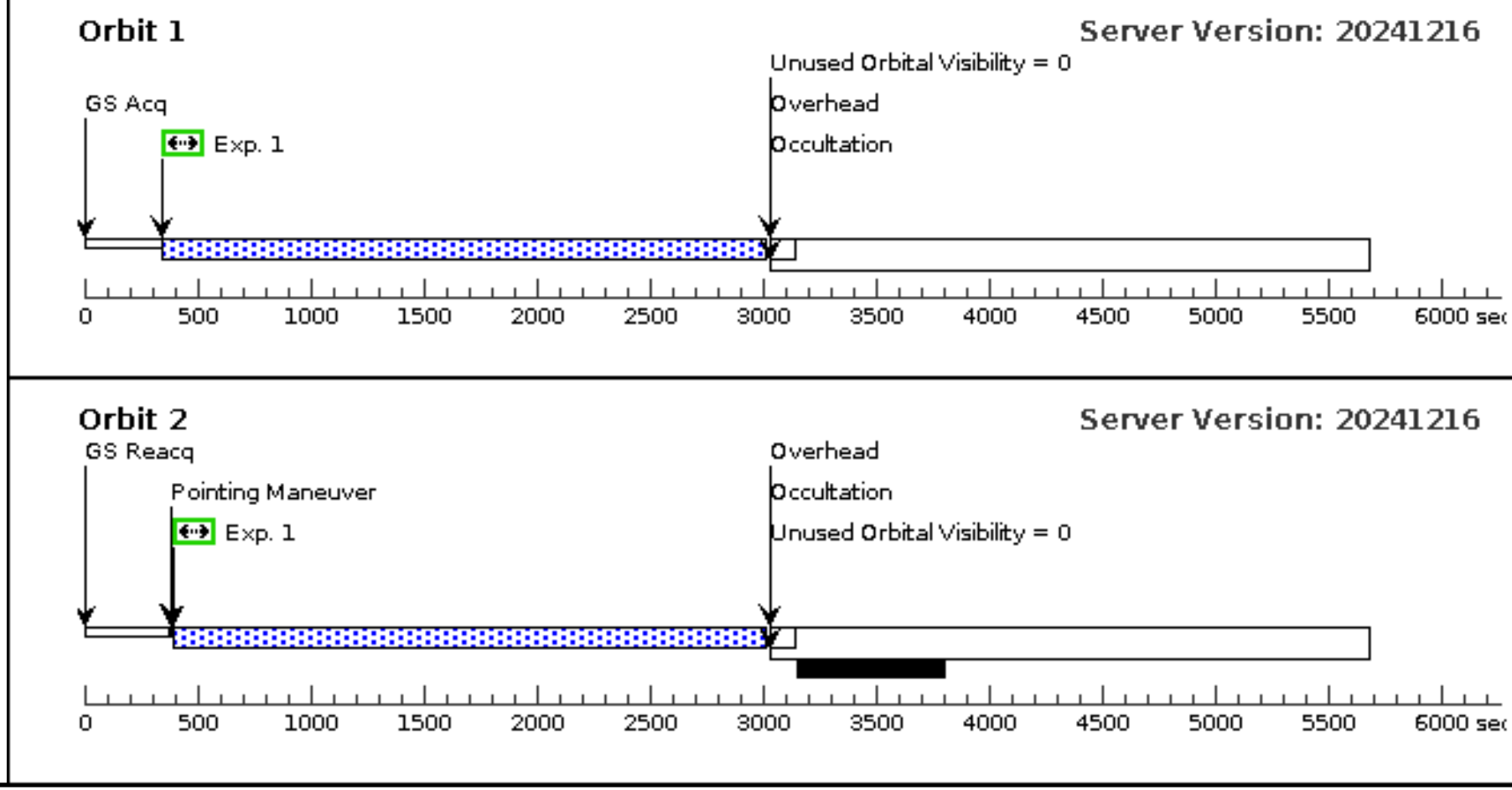
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | NGC4565 | RA: 12 36 20.8040 (189.0866833d) | Epoch of Position: 2015.5 | V=9.6 | Reference Frame: SIMBAD |
| | | Dec: +25 59 14.61 (25.98739d) | Redshift: 0.004276 | SURF-NUV-AB = 25.5 mag/sqarc | |
| | | Equinox: J2000 | | | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=GALAXY*
*Description=[SPIRAL]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NGC4565-CEN (WFC3UVIS.im.1933627) | (2) NGC4565 | WFC3/UVIS, ACCUM, UVIS-FIX | F225W | FLASH=9 | | Pattern 1, Exps 1-1 in NGC4565 Visit (02) (1) | 2620 Secs (5265 Secs) | |
| | | | | | | | | *[==>2644.0 Secs (Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>2621.0 Secs (Pattern 2)]* | ***[2]*** |

Orbit Structure



## Visit

**Proposal 17717, NGC3044 Visit (03), implementation** Tue Jan 14 16:00:48 GMT 2025

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-UVIS-GAP-LINE | Coordinate Frame=POS-TARG | | (1) |
| | Purpose=MOSAIC | Pattern Orientation=85.759 | | |
| | Number Of Points=2 | Angle Between Sides= | | |
| | Point Spacing=2.414 | Center Pattern=true | | |
| | Line Spacing= | | | |

## Fixed Targets

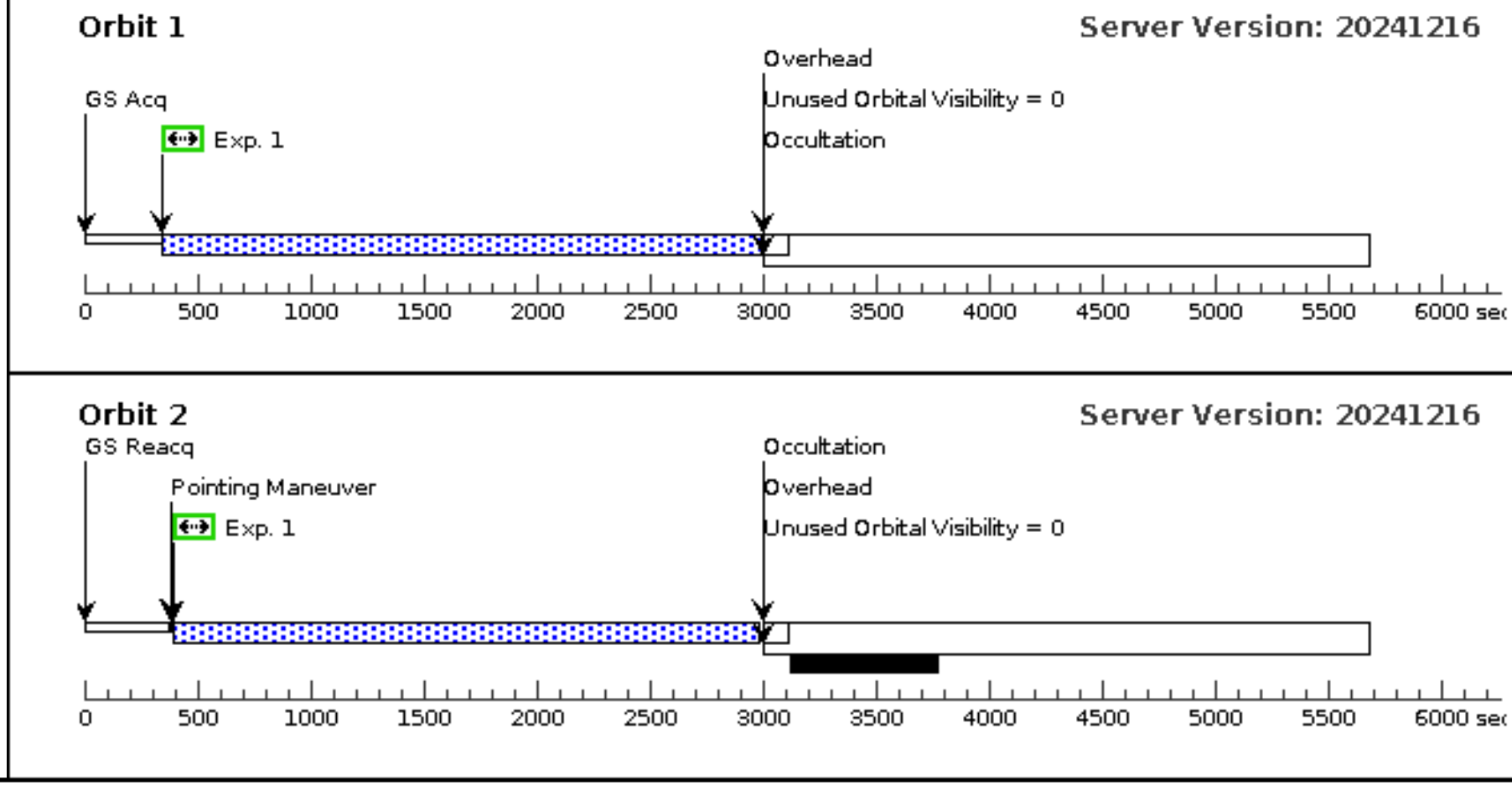
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (3) | NGC3044 | RA: 09 53 40.8840 (148.4203500d) | Epoch of Position: 2015.5 | V=11.9 | Reference Frame: SIMBAD |
| | | Dec: +01 34 46.74 (1.57965d) | Redshift: 0.0043 | mu_NUV_AB = 24.5 mag/sqarc | |
| | | Equinox: J2000 | | | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=GALAXY*
*Description=[SPIRAL]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NGC3044-CEN (WFC3UVIS.im.1933640) | (3) NGC3044 | WFC3/UVIS, ACCUM, UVIS-FIX | F225W | FLASH=10 | | Pattern 1, Exps 1-1 in NGC3044 Visit (03) (1) | 2590 Secs (5211 Secs) | |
| | | | | | | | | *[==>2617.0 Secs (Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>2594.0 Secs (Pattern 2)]* | ***[2]*** |

Orbit Structure



## Visit

**Proposal 17717, NGC4217 Visit (04), implementation** Tue Jan 14 16:00:48 GMT 2025

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 30D TO 275 D; ORIENT 310D TO 350 D

*Comments: A very bright star just outside of the FOV (RA = 183.97958d, dec = 47.12711d; V ~ 9 mag) may cause a dragon's breath artifact for certain ORIENTs. Based on the examples of this artifact provided in the WFC3-UVIS handbook for 9th magnitude stars, we exclude ORIENTs where the bright star falls < 30" from the edge of the FOV. Please include two ranges of ORIENTs as permissible: MinORIENT = 30 degrees, MaxORIENT = 275 degrees and MinORIENT = 310 degrees, MaxORIENT = 350 degrees.*

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-UVIS-GAP-LINE | Coordinate Frame=POS-TARG | | (1) |
| | Purpose=MOSAIC | Pattern Orientation=85.759 | | |
| | Number Of Points=2 | Angle Between Sides= | | |
| | Point Spacing=2.414 | Center Pattern=true | | |
| | Line Spacing= | | | |

## Fixed Targets

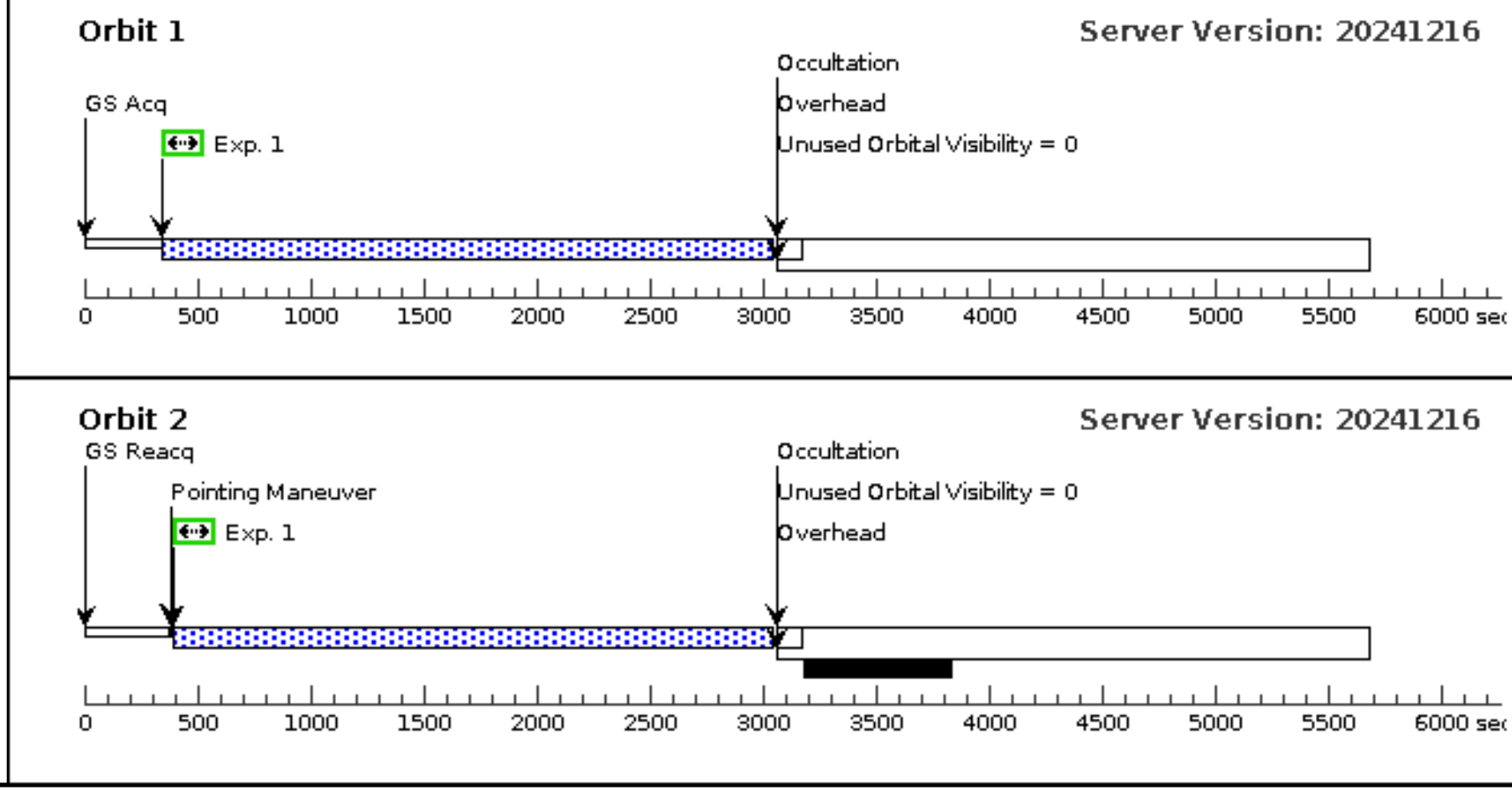
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (4) | NGC4217 | RA: 12 15 50.9000 (183.9620833d) | Epoch of Position: 2015.5 | V=11.2 | Reference Frame: SIMBAD |
| | | Dec: +47 05 30.44 (47.09179d) | Redshift: 0.003429 | mu_NUV_AB = 25.6 mag/sqarc | |
| | | Equinox: J2000 | | | |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=GALAXY*
*Description=[SPIRAL]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NGC4217-CEN (WFC3UVIS.im.1933652) | (4) NGC4217 | WFC3/UVIS, ACCUM, UVIS-FIX | F225W | FLASH=9 | | Pattern 1, Exps 1-1 in NGC4217 Visit (04) (1) | 2650 Secs (5325 Secs) | |
| | | | | | | | | *[==>2674.0 Secs (Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>2651.0 Secs (Pattern 2)]* | ***[2]*** |

Orbit Structure



## Visit

**Proposal 17717, NGC2683 Visit (05), implementation** Tue Jan 14 16:00:48 GMT 2025

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-UVIS-GAP-LINE | Coordinate Frame=POS-TARG | | (1) |
| | Purpose=MOSAIC | Pattern Orientation=85.759 | | |
| | Number Of Points=2 | Angle Between Sides= | | |
| | Point Spacing=2.414 | Center Pattern=true | | |
| | Line Spacing= | | | |

## Fixed Targets

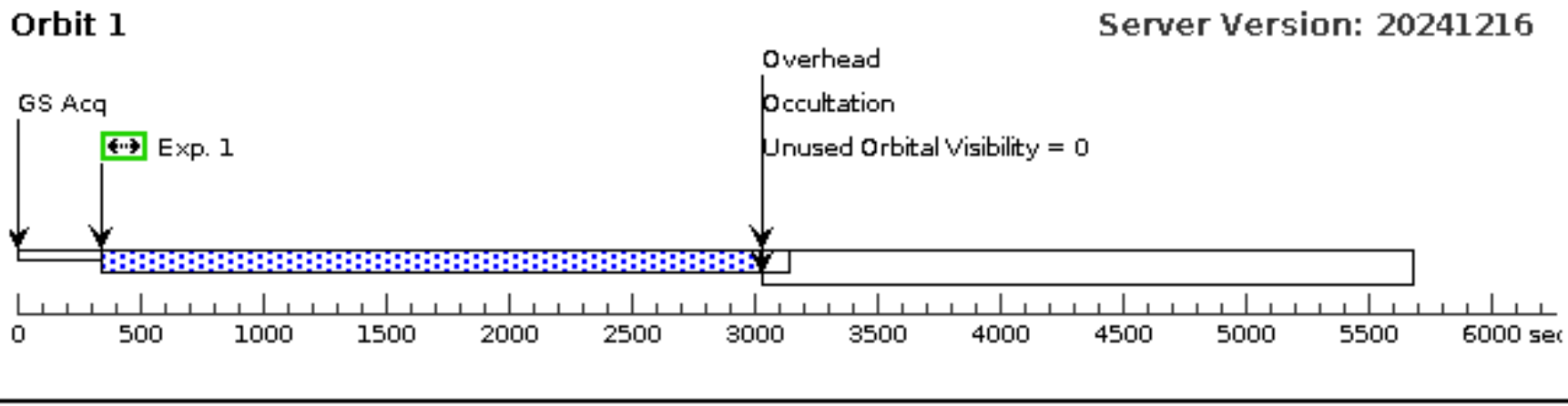
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (5) | NGC2683 | RA: 08 52 41.3065 (133.1721104d) | Epoch of Position: 2000 | V=9.79 | Reference Frame: SIMBAD |
| | | Dec: +33 25 18.60 (33.42183d) | Redshift: 0.001371 | mu_NUV_AB = 25.3 mag/sqarc | |
| | | Equinox: J2000 | | | |

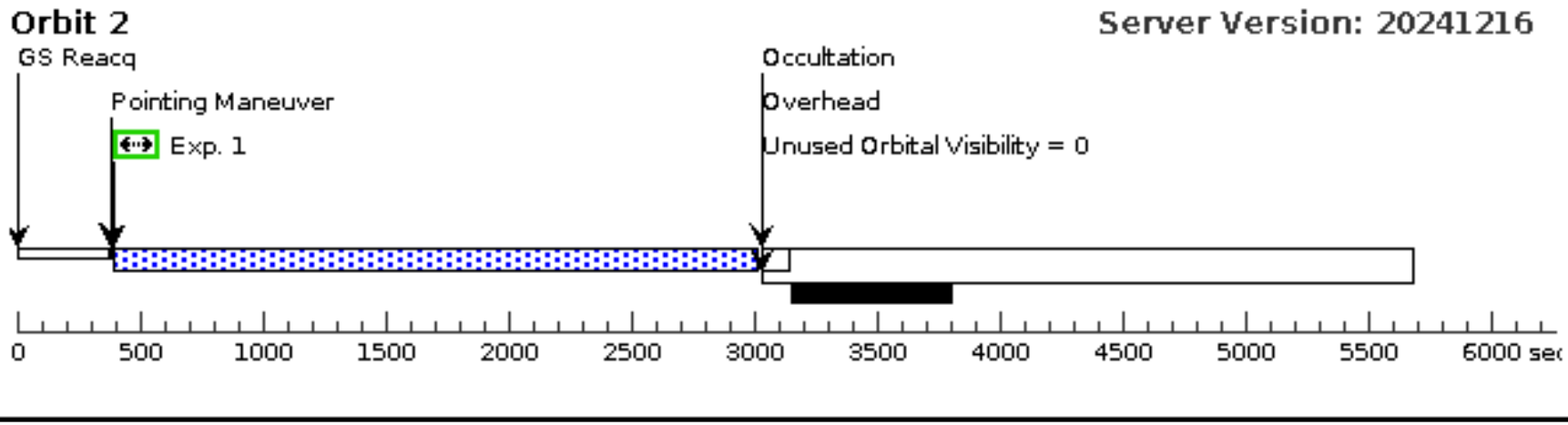
*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=GALAXY*
*Description=[SPIRAL]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NGC2683-CEN (WFC3UVIS.im.1933666) | (5) NGC2683 | WFC3/UVIS, ACCUM, UVIS-FIX | F225W | FLASH=9 | | Pattern 1, Exps 1-1 in NGC2683 Visit (05) (1) | 2600 Secs (5269 Secs) | |
| | | | | | | | | *[==>2646.0 Secs (Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>2623.0 Secs (Pattern 2)]* | ***[2]*** |

Orbit Structure



## Visit

**Proposal 17717, Repeat of NGC4565, Orbit 2 (06)** Tue Jan 14 16:00:48 GMT 2025

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

*Comments: This is a repeat of the second orbit of Visit 02, which had degraded data quality due to a guide star reacquisition failure. We do not attempt to reproduce the orient angle from Visit 02 in order to maximize the schedulability.*

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | NGC4565 | RA: 12 36 20.8040 (189.0866833d)<br>Dec: +25 59 14.61 (25.98739d)<br>Equinox: J2000 | Epoch of Position: 2015.5<br>Redshift: 0.004276 | V=9.6<br>SURF-NUV-AB = 25.5 mag/sqarc | Reference Frame: SIMBAD |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*
*Category=GALAXY*
*Description=[SPIRAL]*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | NGC4565-CEN | (2) NGC4565 | WFC3/UVIS, ACCUM, UVIS-FIX | F225W | FLASH=9.0 | | | 2620 Secs (2644 Secs)<br>*[==>2644.0 Secs ]* | *[1]* |

## Orbit Structure