# 15126 - Resolving the Abundance Discrepancy with HST/COS

Cycle: 25, Proposal Category: GO

(Availability Mode: SUPPORTED)

**INVESTIGATORS**



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|---|---|---|
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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) +164.6+9.9<br>(11) +164.6+9.9-OFFSET | COS/FUV<br>COS/NUV | 2 | 28-Jan-2019 15:00:13.0 | yes |
| 02 | (2) +189.2-136.3<br>(12) +189.2-136.3-OFFSET | COS/FUV<br>COS/NUV | 3 | 28-Jan-2019 15:00:15.0 | yes |
| 03 | (3) +254.6-107.2<br>(13) +254.6-107.2-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:16.0 | yes |
| 04 | (4) +354.1+71.2<br>(14) +354.1+71.2-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:17.0 | yes |
| 05 | (5) +360.9+75.3<br>(15) +360.9+75.3-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:18.0 | yes |
| 06 | (6) -209.1+311.8<br>(16) -209.1+311.8-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:19.0 | yes |

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 07 | (7) -368.3-285.6<br>(17) -368.3-285.6-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:20.0 | yes |
| 08 | (8) -392.0-270.1<br>(18) -392.0-270.1-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:21.0 | yes |
| 09 | (9) +509.5+264.1<br>(19) +509.5+264.1-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:21.0 | yes |
| 10 | (10) +667.9+174.1<br>(20) +667.9+174.1-OFFSET | COS/FUV<br>COS/NUV | 1 | 28-Jan-2019 15:00:22.0 | yes |

13 Total Orbits Used

**ABSTRACT**

A long-standing problem in nebular astrophysics is the discrepancy between abundances derived from collisionally-excited optical emission lines (CELs) and optical recombination emission lines (RLs). Because the optical RLs are intrinsically very faint, there is only a small collection of extragalactic HII regions for which abundances from RLs are available. C/O relative abundances are measured for a subset of these. By observing CIII] 1907,1909 and OIII] 1661,1666 in the ultraviolet, we can obtain a very secure measurement of the C/O ratio from CELs. Comparing the C/O relative abundances from UV CELs with those from optical RLs provides an independent test of the abundance discrepancy.

Using the LBT, we have obtained high quality optical spectra for a large sample of HII regions in M101. We have detected the C III 4267 line in 10 of these regions. By observing these 10 regions, which span nearly a dex in oxygen abundance, we can compare the C/O and C/H abundances in these regions to provide an independent test of the abundance discrepancy. This study will also result in the most accurately measured carbon abundance gradient in a spiral galaxy.

**OBSERVING DESCRIPTION**

Goal: We will obtain NUV target aquisiton images of nearby stars and then use blind offsests to our targets in orde to obtain FUV COS spectroscopy of 10 H II regions in the spiral galaxy M101. We will measurement the O III] 1661,1666 and C III] 1907,1909 emission lines in these regions in order to compare the C/O gradient from optical RLs, optical CELs, and UV CELs. By measuring the C/O ratios in these metal-rich HII regions, we will extend the scale of the UV C/O relationship 0.5 dex to higher oxygen abundances.

Targets: As part of the CHemical Abundances Of Spirals project (CHAOS; PIs E. Skillman & R. Pogge), we conducted a detailed study of the physical conditions and chemical abundances in the ISM of M101 using high S/N optical spectroscopy from LBT/MODS. As an extension of this project, we have examined the CHAOS spectra for the optical C II 4267 RL and have measured significant detections in 10 H II regions (Skillman et al. 2017, in prep.). These 10 H II regions are the targets we will study with this COS program.

Target Acquisition: Due to the proximity of M101, the large H II regions fill the COS aperture, however, target image acquisition can be efficiently achieved using a pointing offset from a nearby bright star. In order to achieve acquistion images in a short exposure time, we require stars that are bright in the NUV, as determined by their GALXEX magnitudes. We then select stars that are near to our HII regions that are also visible in the PanSTARRs g-band images of M101. The excellent astrometry of PanSTARRs provides precise catalog positions of our offset stars and allows us to accurately determine offsets from the PanSTARRs images.
We use the ACQ/IMAGE mode with the PSA aperture and MirrorB (due to the brightness of the offset stars) for the COS/NUV configuration.
For these acquitions, we have determined integration times necessary to reach a S/N = 40. We assume a flat spectral distribution normalized by the GALEX NUV magnitudes.

From our offset stars, we use the offsets determined form the PanSTARRs images to slew to our target HII regions. These offsets range between 0.75' to 2.38'. This is significantly larger than the recommended offset distance of 30", however, the exact pointing within the bright HII region is not critical. Additonally, our phase II support contact, William Januszewski, has confirmed that this acquisition plan will not cause any guide star or scheduling issues.

Science Exposures: We will use COS with the G140L grating with a central wavelength of 1280 angstroms in TIMETAGE mode in order to obtain simultaneous measurements of the CIV 1548,1550, HeII 1640, OIII] 1661,1666, and CIII] 1907,1909 emission lines in Detector segment A. We used the GALEX FUV surface brightnesses to estimate the exposure time using the PSA aperture in the FUV configuration, requiring each of our targets to achieve a S/N >= 3 per resolution element in the limiting OIII] 1666 line. This results in sinlge orbits for 8/10 targets, 1 target requiring 2 orbits, and 1 target requiring 3. For the FUV G140L configuration, no flats are available and so we use FP-POS=ALL, which takes 4 images offset from one another in the dispersion direction and increases S/N. These 4 positions allow a flat to be created and cosmic rays to be eliminated. Note that while the resolution of COS spectra is degraded for non-point sources, our experience in B16 and B17 has proven that the O III] doublet can be resolved and the C III] doublet can be deblended for targets with extended nebular emission that filled the COS aperture.

## Visit

**Proposal 15126, Visit 01, scheduling** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 01) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Exposure 2 (Same Guide Stars in Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 3 (Same Guide Stars in Visit 01)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

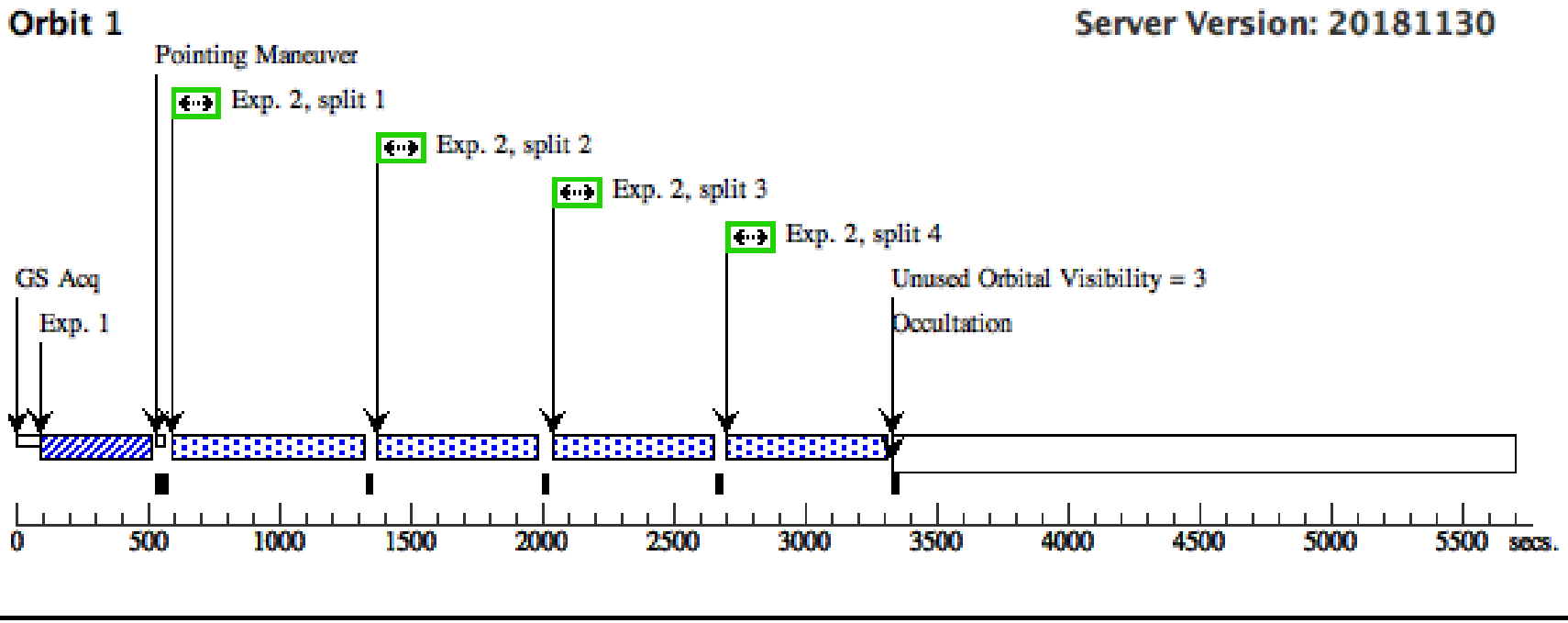
## Fixed Targets

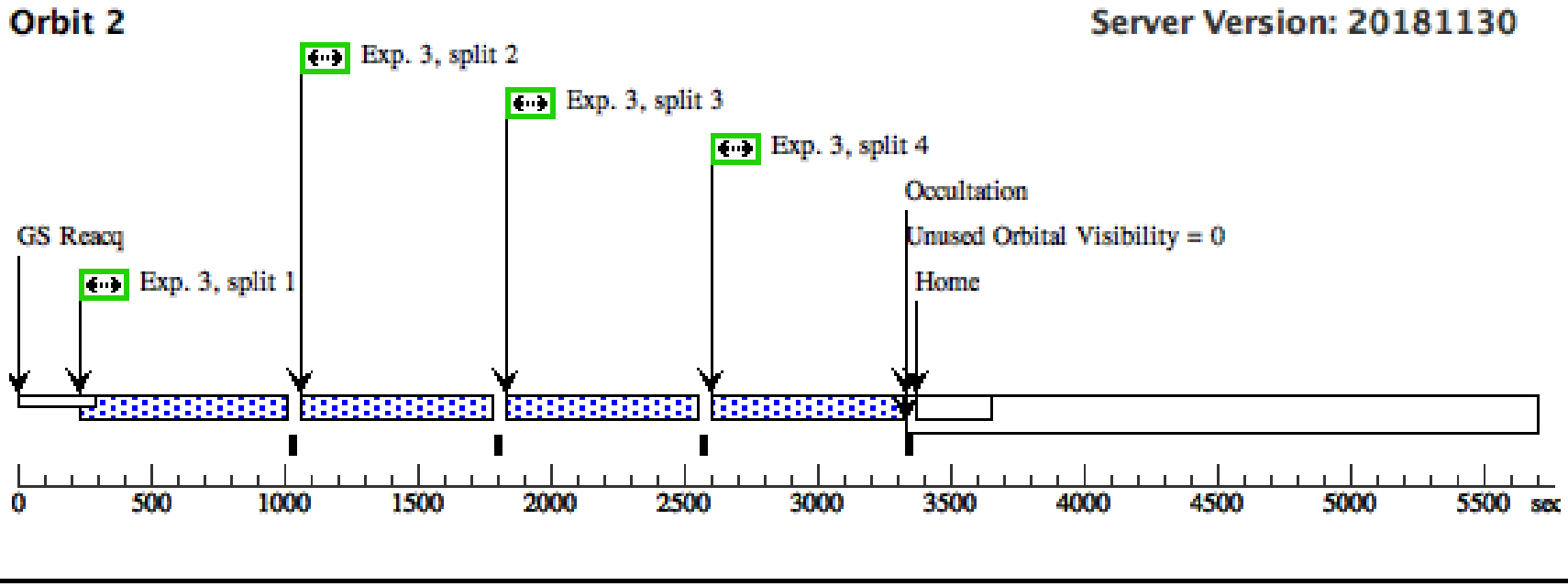
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | +164.6+9.9 | Offset from +164.6+9.9-OFFSET<br>RA Offset: -4.849 Secs<br>Dec Offset: 15.926 Arcsec | | V=7.77<br>FUV/arcsec squared = 22.139 | Offset Position (+164.6+9.9) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (11) | +164.6+9.9-OFFSET | RA: 14 03 36.1560 (210.9006500d)<br>Dec: +54 20 58.85 (54.34968d)<br>Equinox: J2000 | | V=15.55<br>NUV=17.34 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006906) | (11) +164.6+9.9-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 01 | 65 Secs (65 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006935) | (1) +164.6+9.9 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=20465 | | Same Guide Stars in Visit 01 | 250 Secs (2236 Secs)<br>*[==>559.0 Secs (Split 1)]*<br>*[==>559.0 Secs (Split 2)]*<br>*[==>559.0 Secs (Split 3)]*<br>*[==>559.0 Secs (Split 4)]* | <br>***[1]*** |
| 3 | (1006935) | (1) +164.6+9.9 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=20465 | | Same Guide Stars in Visit 01 | 400 Secs (2652 Secs)<br>*[==>663.0 Secs (Split 1)]*<br>*[==>663.0 Secs (Split 2)]*<br>*[==>663.0 Secs (Split 3)]*<br>*[==>663.0 Secs (Split 4)]* | <br>***[2]*** |

Orbit Structure



## Visit

**Proposal 15126, Visit 02, scheduling** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Visit 02) Warning (Orbit Planner): INEFFICIENT ORDERING OF FP-POS POSITIONS

(Exposure 2 (Same Guide Stars in Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 3 (Same Guide Stars in Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

(Exposure 4 (Same Guide Stars in Visit 02)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

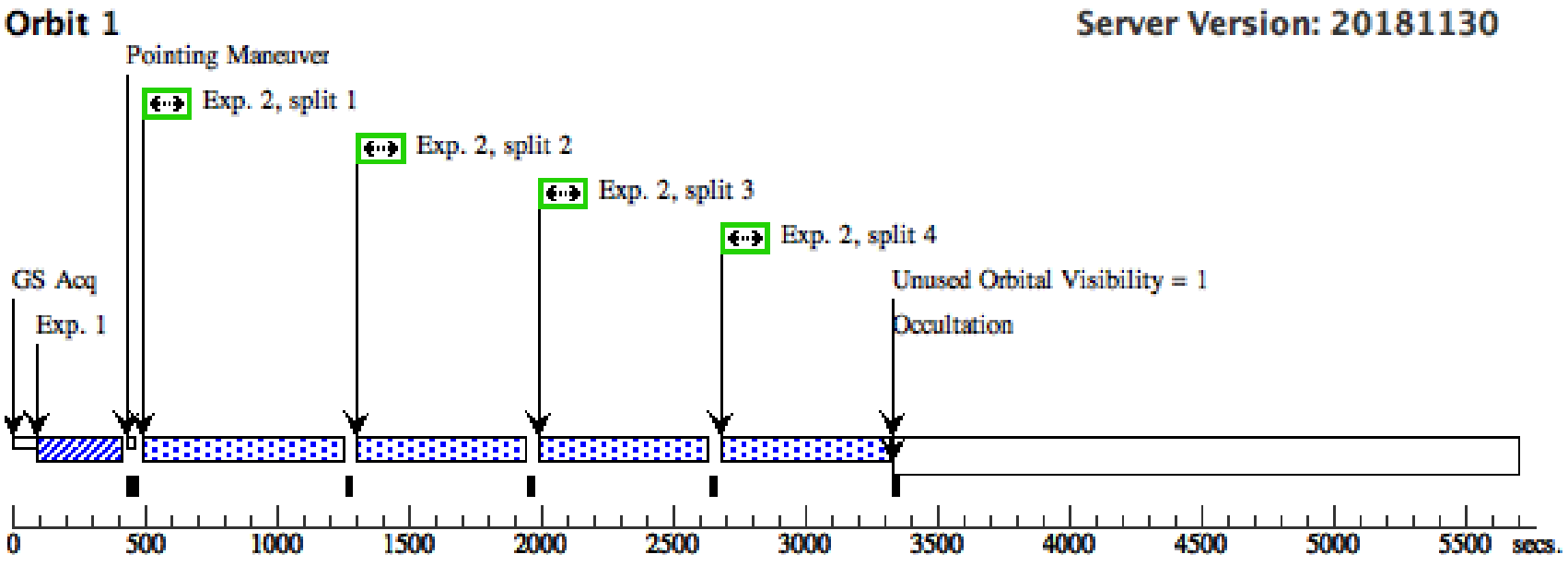
## Fixed Targets

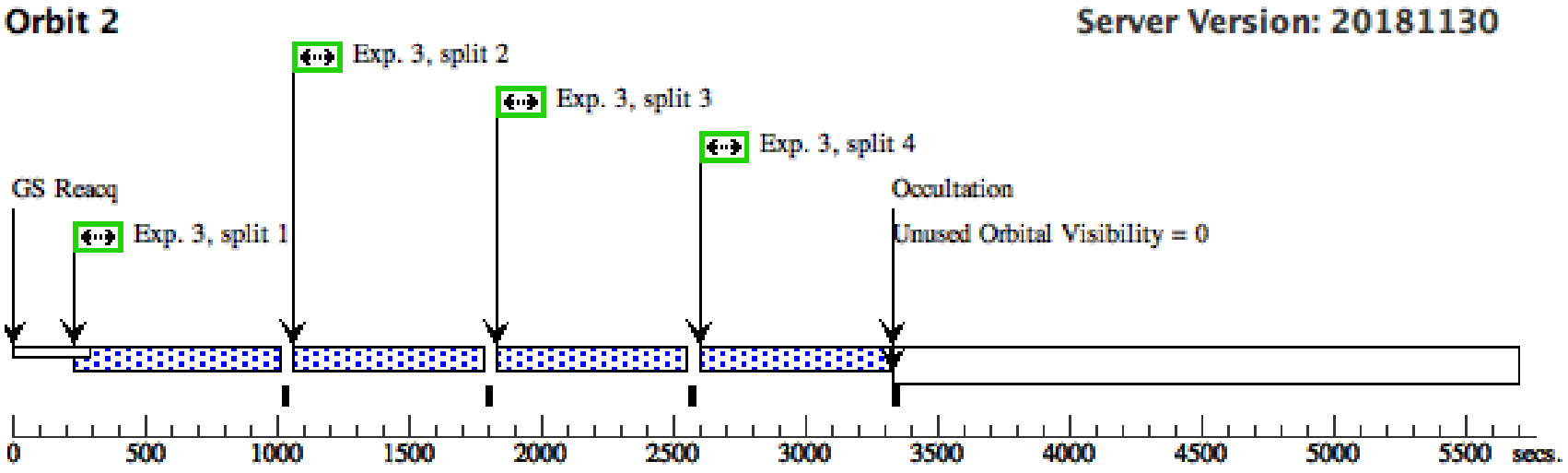
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | +189.2-136.3 | Offset from +189.2-136.3-OFFSET<br>RA Offset: -1.732 Secs<br>Dec Offset: 37.23 Arcsec | | V=7.77<br>FUV/arcsec squared = 22.669 | Offset Position (+189.2-136.3) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (12) | +189.2-136.3-OFFSET | RA: 14 03 35.7480 (210.8989500d)<br>Dec: +54 17 59.82 (54.29995d)<br>Equinox: J2000 | | V=17.70<br>NUV=15.67 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

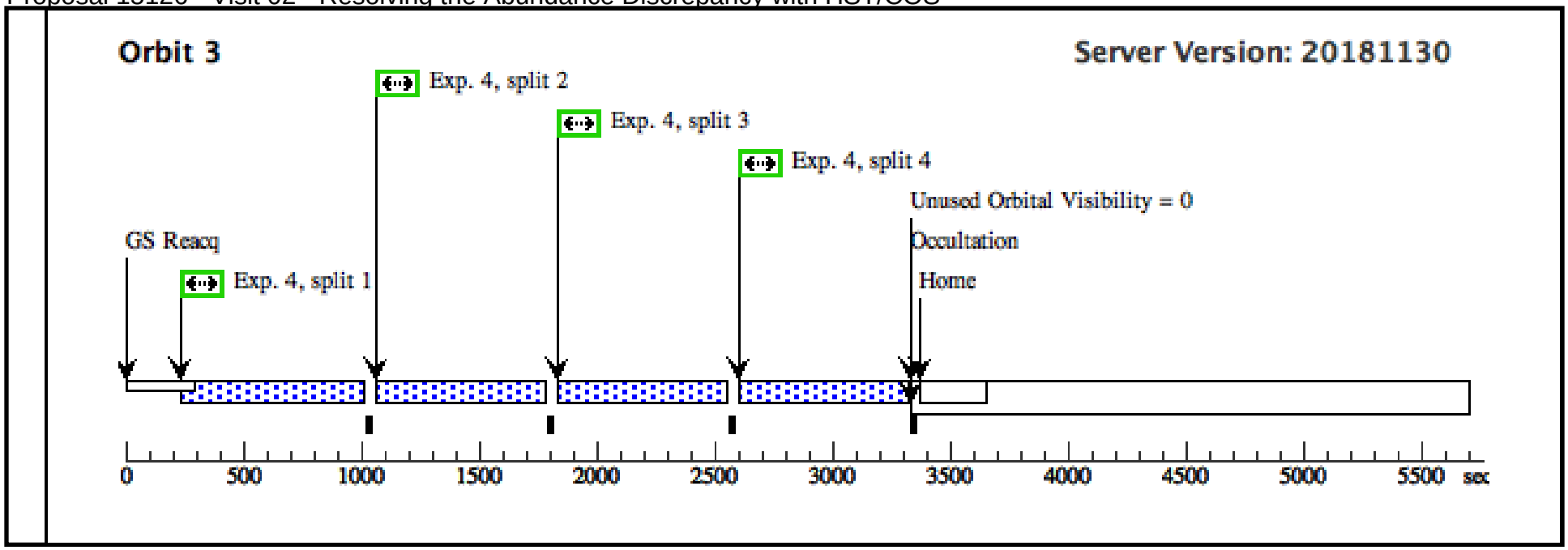
## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006913) | (12) +189.2-136.3-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 02 | 14 Secs (14 Secs)<br>*[==>]* | *[1]* |
| 2 | (1006936) | (2) +189.2-136.3 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=21185 | | Same Guide Stars in Visit 02 | 325 Secs (2340 Secs)<br>*[==>585.0 Secs (Split 1)]*<br>*[==>585.0 Secs (Split 2)]*<br>*[==>585.0 Secs (Split 3)]*<br>*[==>585.0 Secs (Split 4)]* | *[1]* |
| 3 | (1006936) | (2) +189.2-136.3 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=21185 | | Same Guide Stars in Visit 02 | 400 Secs (2652 Secs)<br>*[==>663.0 Secs (Split 1)]*<br>*[==>663.0 Secs (Split 2)]*<br>*[==>663.0 Secs (Split 3)]*<br>*[==>663.0 Secs (Split 4)]* | *[2]* |
| 4 | (1006936) | (2) +189.2-136.3 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=21185 | | Same Guide Stars in Visit 02 | 400 Secs (2652 Secs)<br>*[==>663.0 Secs (Split 1)]*<br>*[==>663.0 Secs (Split 2)]*<br>*[==>663.0 Secs (Split 3)]*<br>*[==>663.0 Secs (Split 4)]* | *[3]* |

Orbit Structure




Orbit 3
Server Version: 20181130
Exp. 4, split 2
Exp. 4, split 3
Exp. 4, split 4
Unused Orbital Visibility = 0
GS Reacq
Occultation
Exp. 4, split 1
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 03, implementation** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 03) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

(Visit 03) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

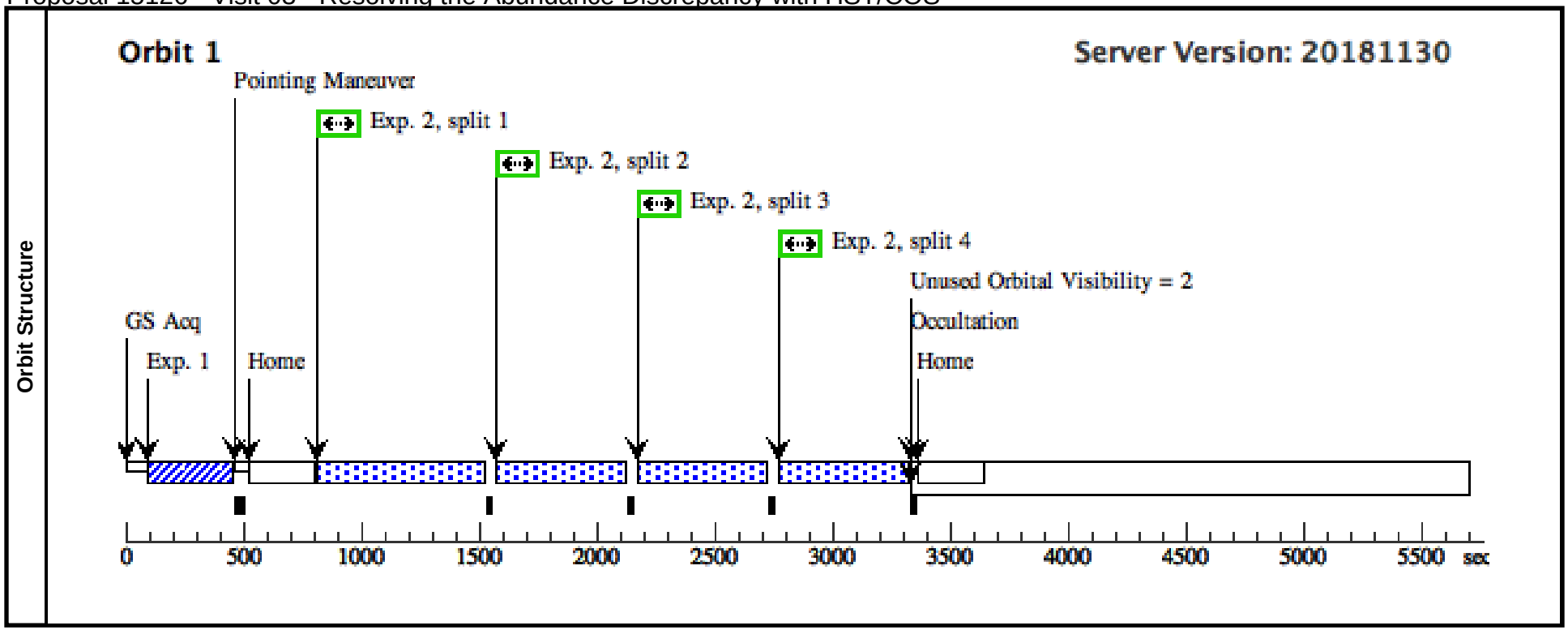
(Exposure 2 (Same Guide Stars in Visit 03)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (3) | +254.6-107.2 | Offset from +254.6-107.2-OFFSET<br>RA Offset: -16.273 Secs<br>Dec Offset: 8.396 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.397 | Offset Position (+254.6-107.2) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (13) | +254.6-107.2-OFFSET | RA: 14 03 57.6260 (210.9901083d)<br>Dec: +54 18 56.11 (54.31559d)<br>Equinox: J2000 | | V=7.77<br>NUV =17.6 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006916) | (13) +254.6-107.2-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 03 | 31 Secs (31 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006937) | (3) +254.6-107.2 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=18560 | | Same Guide Stars in Visit 03 | 400 Secs (1972 Secs)<br>*[==>493.0 Secs (Split 1)]*<br>*[==>493.0 Secs (Split 2)]*<br>*[==>493.0 Secs (Split 3)]*<br>*[==>493.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Unused Orbital Visibility = 2
GS Acq
Exp. 1
Home
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 04, implementation** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 04) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

(Visit 04) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

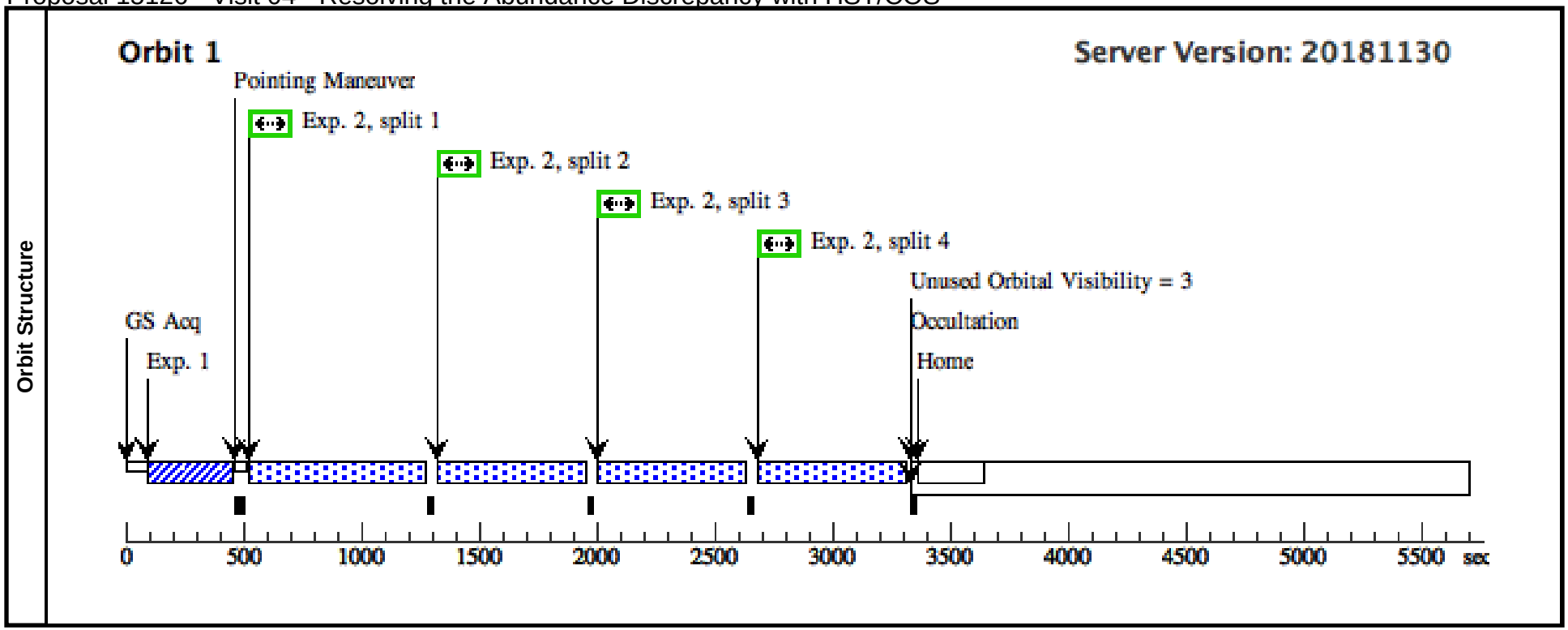
(Exposure 2 (Same Obset in Visit 04)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (4) | +354.1+71.2 | Offset from +354.1+71.2-OFFSET<br>RA Offset: -14.106 Secs<br>Dec Offset: 58.97 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.284 | Offset Position (+354.1+71.2) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (14) | +354.1+71.2-OFFSET | RA: 14 04 7.2390 (211.0301625d)<br>Dec: +54 21 7.52 (54.35209d)<br>Equinox: J2000 | | V=7.77<br>U=15.05 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006916) | (14) +354.1+71.2-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Obset in Visit 04 | 31 Secs (31 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006940) | (4) +354.1+71.2 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=18513 | | Same Obset in Visit 04 | 400 Secs (2304 Secs)<br>*[==>576.0 Secs (Split 1)]*<br>*[==>576.0 Secs (Split 2)]*<br>*[==>576.0 Secs (Split 3)]*<br>*[==>576.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Unused Orbital Visibility = 3
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 05, implementation** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 05) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

(Visit 05) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

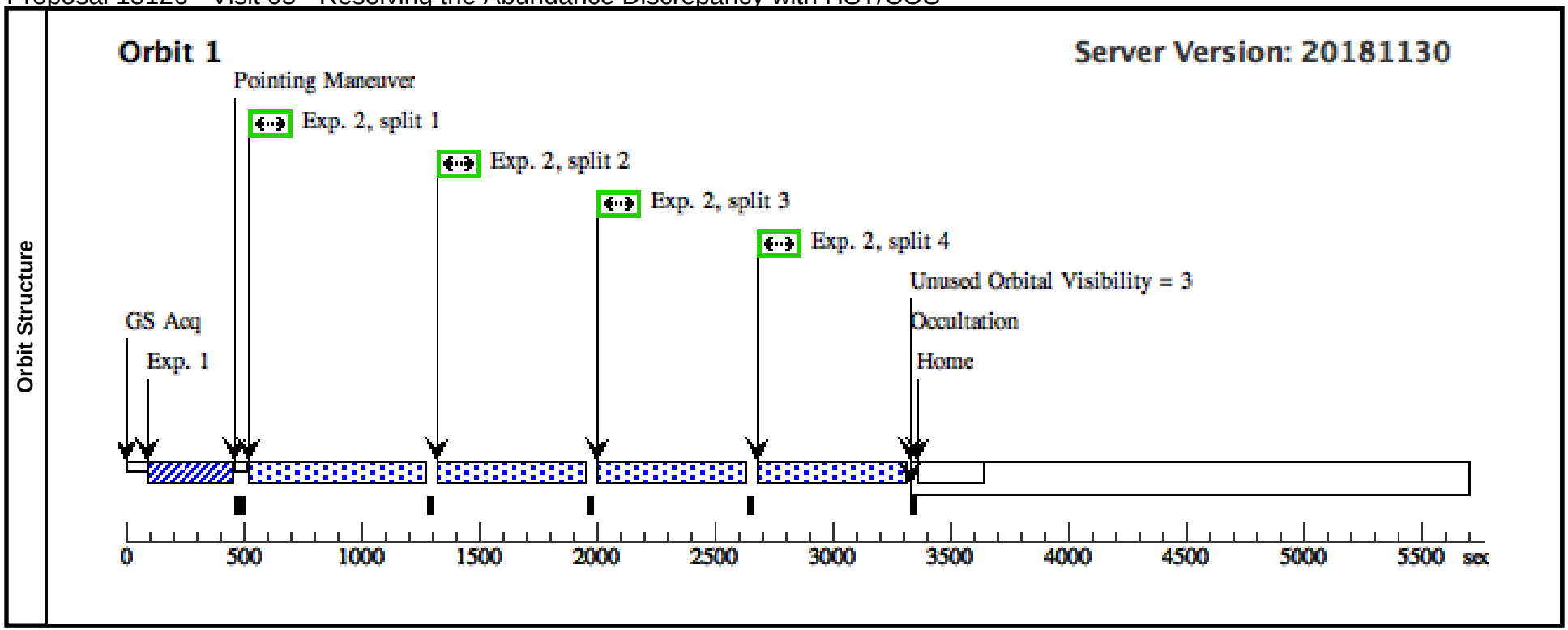
(Exposure 2 (Same Obset in Visit 05)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (5) | +360.9+75.3 | Offset from +360.9+75.3-OFFSET<br>RA Offset: -13.313 Secs<br>Dec Offset: 63.615 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.298 | Offset Position (+360.9+75.3) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (15) | +360.9+75.3-OFFSET | RA: 14 04 7.2390 (211.0301625d)<br>Dec: +54 21 7.52 (54.35209d)<br>Equinox: J2000 | | V=7.77<br>U=15.05 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006916) | (15) +360.9+75.3-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Obset in Visit 05 | 31 Secs (31 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006941) | (5) +360.9+75.3 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=18375 | | Same Obset in Visit 05 | 400 Secs (2304 Secs)<br>*[==>576.0 Secs (Split 1)]*<br>*[==>576.0 Secs (Split 2)]*<br>*[==>576.0 Secs (Split 3)]*<br>*[==>576.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Unused Orbital Visibility = 3
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 06, scheduling** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 06) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

(Visit 06) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

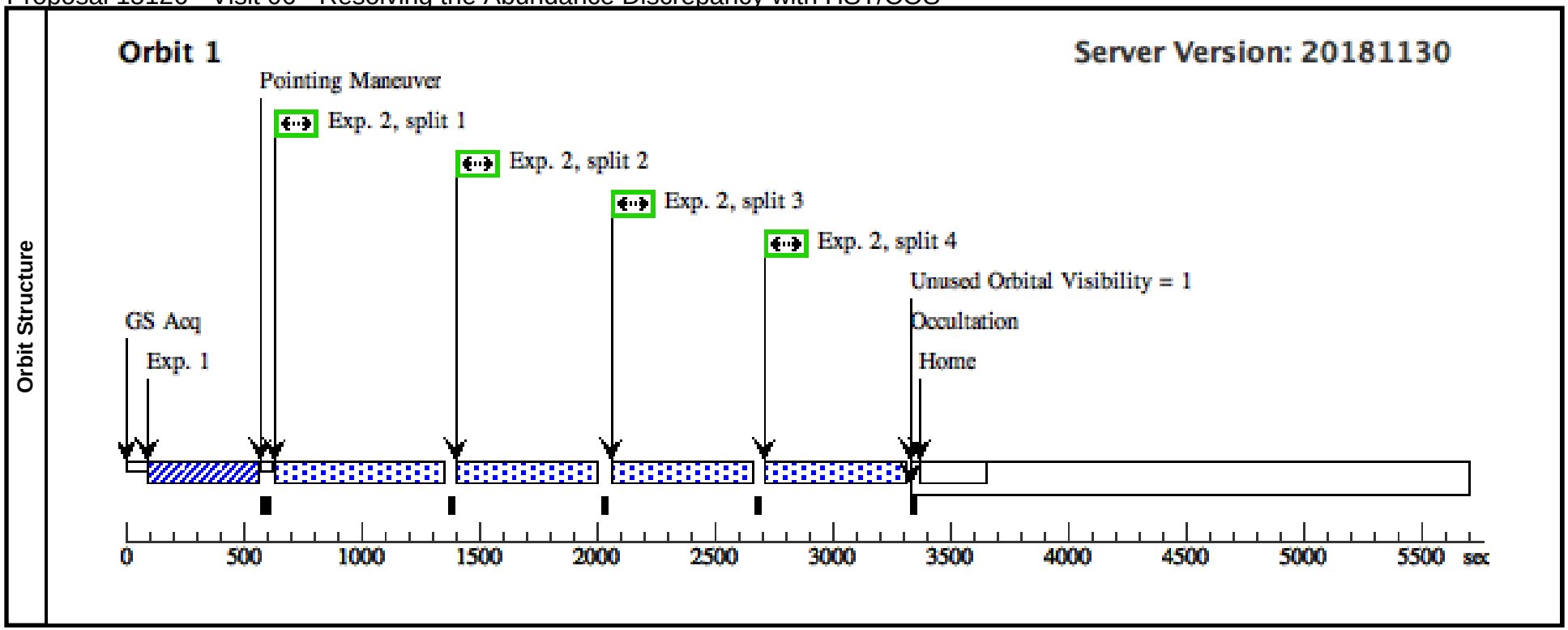
(Exposure 2 (Same Obset in Visit 06)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (6) | -209.1+311.8 | Offset from -209.1+311.8-OFFSET<br>RA Offset: 7.049 Secs<br>Dec Offset: -119.974 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.070 | Offset Position (-209.1+311.8) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (16) | -209.1+311.8-OFFSET | RA: 14 02 54.1150 (210.7254792d)<br>Dec: +54 16 29.13 (54.27476d)<br>Equinox: J2000 | | V=13.6<br>NUV=17.64 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006919) | (16) -209.1+311.8-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Obset in Visit 06 | 86 Secs (86 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006942) | (6) -209.1+311.8 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=17793 | | Same Obset in Visit 06 | 400 Secs (2196 Secs)<br>*[==>549.0 Secs (Split 1)]*<br>*[==>549.0 Secs (Split 2)]*<br>*[==>549.0 Secs (Split 3)]*<br>*[==>549.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Unused Orbital Visibility = 1
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 07, scheduling** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

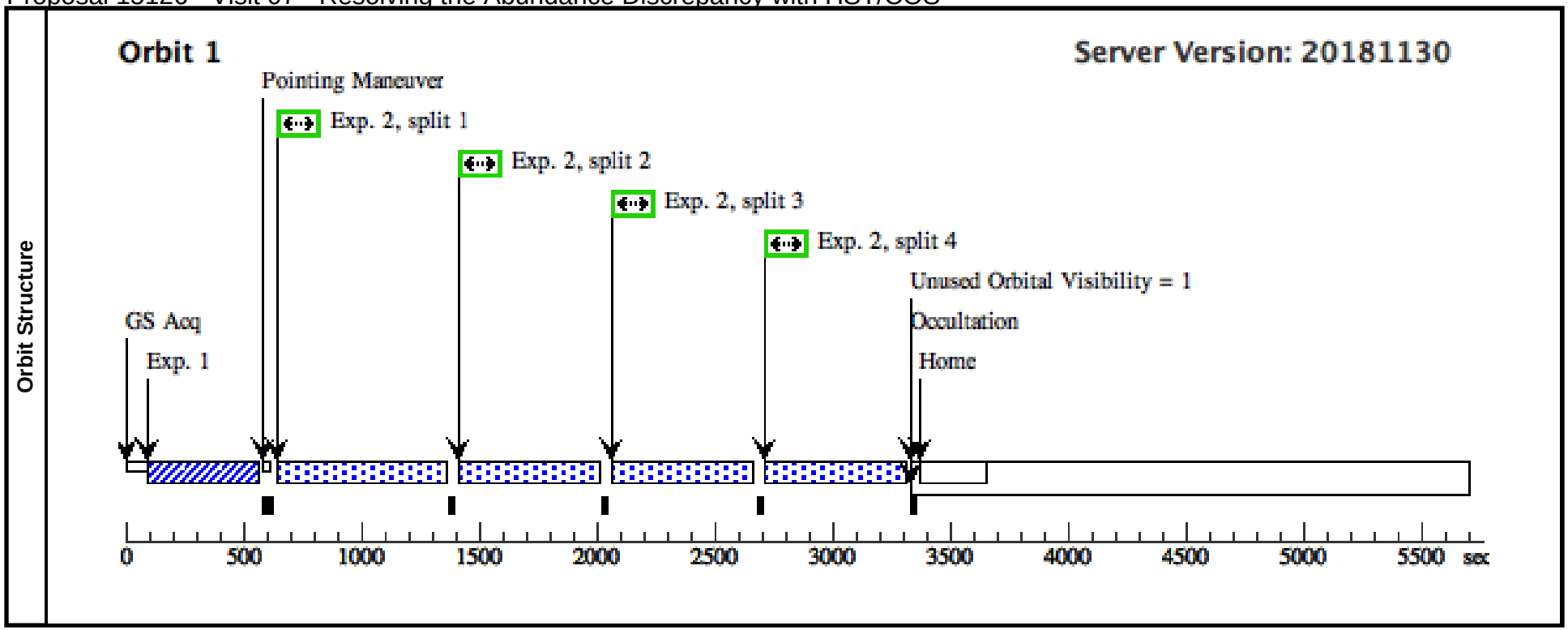
(Exposure 2 (Same Guide Stars in Visit 07)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (7) | -368.3-285.6 | Offset from -368.3-285.6-OFFSET<br>RA Offset: 1.03 Secs<br>Dec Offset: -45.776 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.816 | Offset Position (-368.3-285.6) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (17) | -368.3-285.6-OFFSET | RA: 14 02 29.5710 (210.6232125d)<br>Dec: +54 16 55.49 (54.28208d)<br>Equinox: J2000 | | V=7.77<br>U=15.26 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006921) | (17) -368.3-285.6-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 07 | 90 Secs (90 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1012028) | (7) -368.3-285.6 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=19897 | | Same Guide Stars in Visit 07 | 350 Secs (2188 Secs)<br>*[==>547.0 Secs (Split 1)]*<br>*[==>547.0 Secs (Split 2)]*<br>*[==>547.0 Secs (Split 3)]*<br>*[==>547.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Unused Orbital Visibility = 1
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 08, scheduling** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

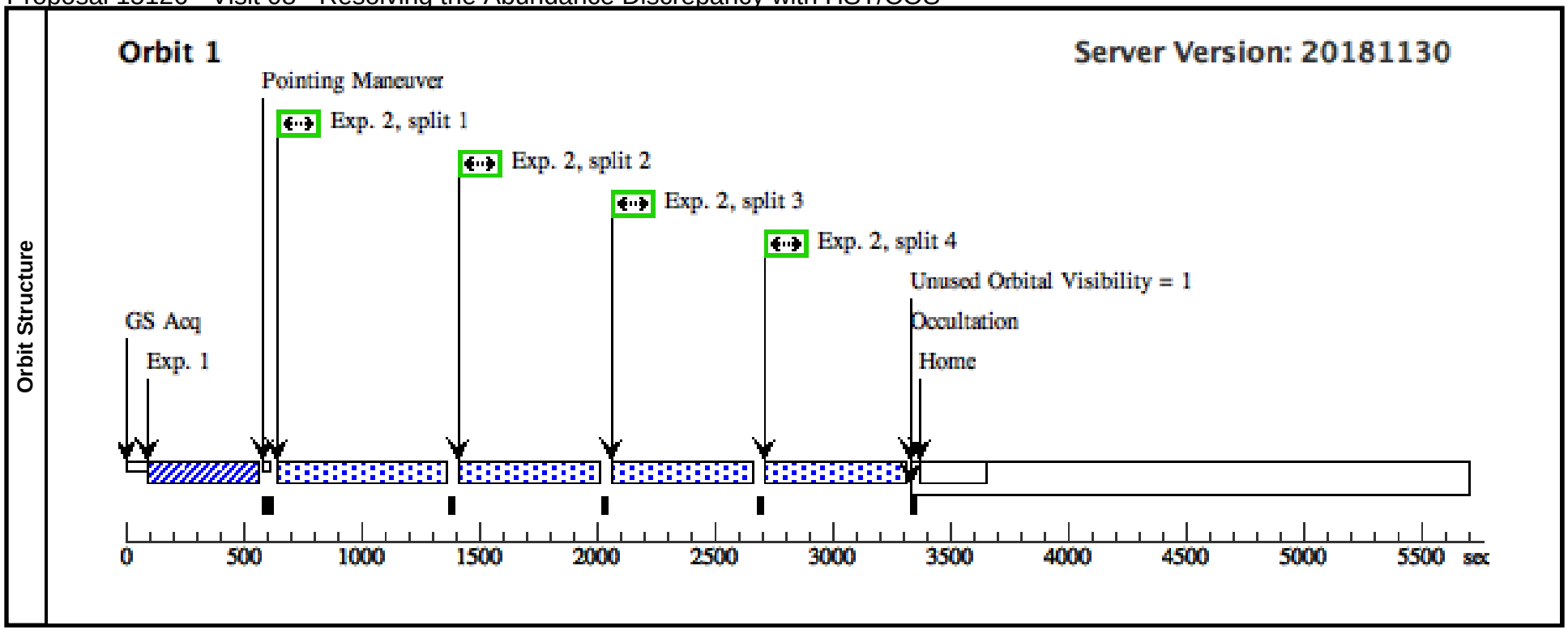
(Exposure 2 (Same Guide Stars in Visit 08)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (8) | -392.0-270.1 | Offset from -392.0-270.1-OFFSET<br>RA Offset: -1.351 Secs<br>Dec Offset: -29.094 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.250 | Offset Position (-392.0-270.1) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (18) | -392.0-270.1-OFFSET | RA: 14 02 29.5710 (210.6232125d)<br>Dec: +54 16 55.49 (54.28208d)<br>Equinox: J2000 | | V=7.77<br>U=15.26 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006921) | (18) -392.0-270.1-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 08 | 90 Secs (90 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006944) | (8) -392.0-270.1 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=18131 | | Same Guide Stars in Visit 08 | 350 Secs (2188 Secs)<br>*[==>547.0 Secs (Split 1)]*<br>*[==>547.0 Secs (Split 2)]*<br>*[==>547.0 Secs (Split 3)]*<br>*[==>547.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
Unused Orbital Visibility = 1
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 09, completed** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 09) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

(Visit 09) Warning (Orbit Planner): MERGING RULE VIOLATED DURING AUTOMATIC MERGING

(Visit 09) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

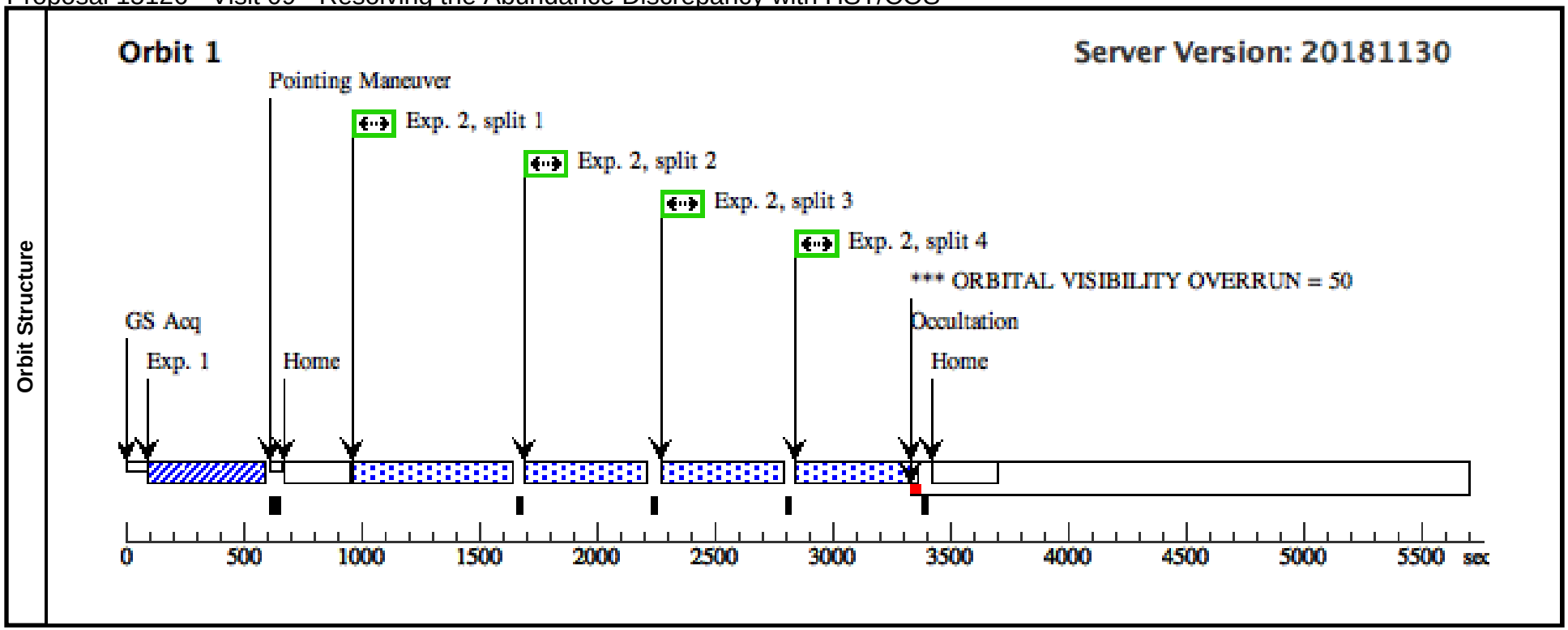
(Exposure 2 (Same Guide Stars in Visit 09)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (9) | +509.5+264.1 | Offset from +509.5+264.1-OFFSET<br>RA Offset: -9.213 Secs<br>Dec Offset: 113.605 Arcsec | | V=7.77<br>FUV/arcsec squared = 21.673 | Offset Position (+509.5+264.1) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (19) | +509.5+264.1-OFFSET | RA: 14 04 20.4240 (211.0851000d)<br>Dec: +54 23 24.55 (54.39015d)<br>Equinox: J2000 | | V=13.85<br>NUV=17.85 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006924) | (19) +509.5+264.1-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 09 | 105 Secs (105 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006945) | (9) +509.5+264.1 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=19339 | | Same Guide Stars in Visit 09 | 350 Secs (1876 Secs)<br>*[==>469.0 Secs (Split 1)]*<br>*[==>469.0 Secs (Split 2)]*<br>*[==>469.0 Secs (Split 3)]*<br>*[==>469.0 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
*** ORBITAL VISIBILITY OVERRUN = 50
GS Acq
Exp. 1
Home
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

## Visit

**Proposal 15126, Visit 10, completed** Mon Jan 28 20:00:23 GMT 2019

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

## Diagnostics

(Visit 10) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

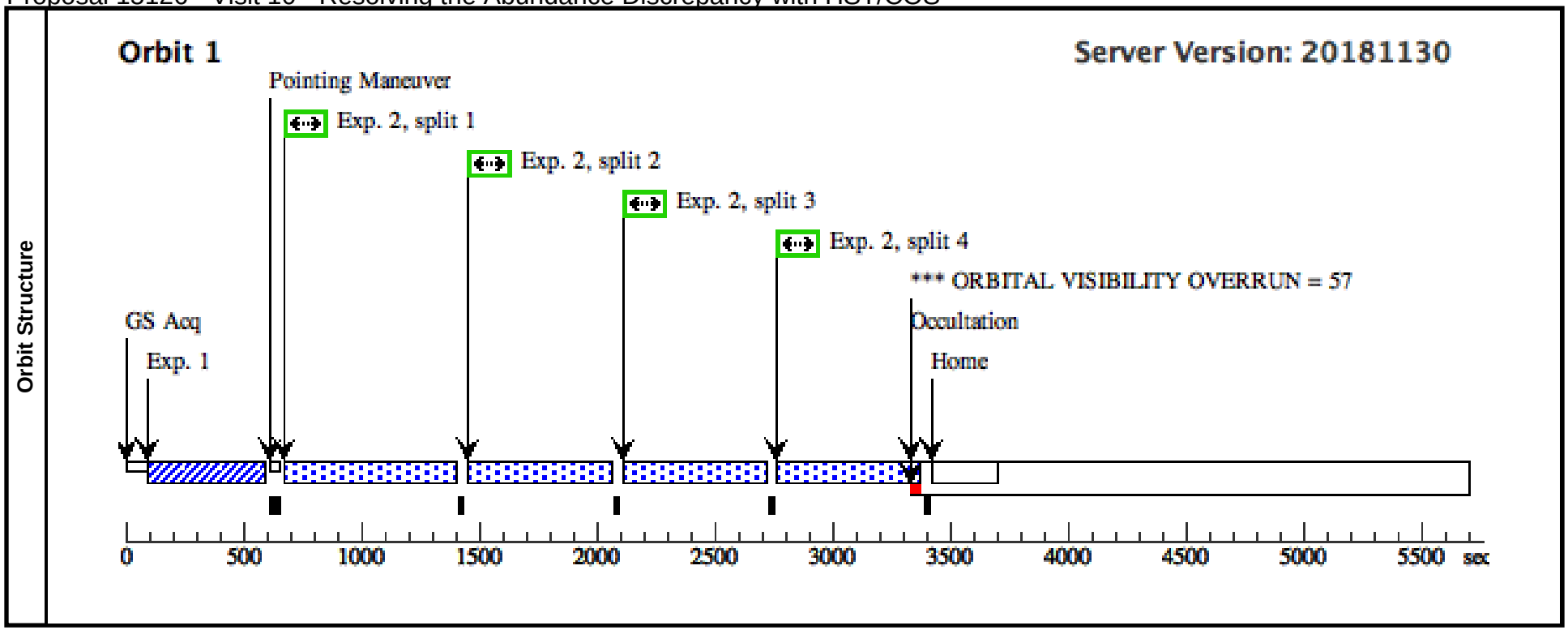
(Exposure 2 (Same Guide Stars in Visit 10)) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (10) | +667.9+174.1 | Offset from +667.9+174.1-OFFSET<br>RA Offset: 8.982 Secs<br>Dec Offset: 22.595 Arcsec | | V=7.77<br>FUV/arcsec squared = 20.224 | Offset Position (+667.9+174.1) |
| *Comments: Magnitude of M101<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=YES* | | | | | |
| (20) | +667.9+174.1-OFFSET | RA: 14 04 20.4240 (211.0851000d)<br>Dec: +54 23 24.55 (54.39015d)<br>Equinox: J2000 | | V=13.85<br>NUV=17.85 | Reference Frame: ICRS |
| *Comments:<br>Category=EXT-MEDIUM<br>Description=[HII REGION]<br>Extended=NO* | | | | | |

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1006924) | (20) +667.9+174.1-OFFSET | COS/NUV, ACQ/IMAGE, PSA | MIRRORB | | GS ACQ SCENARIO BASE1B3 | Same Guide Stars in Visit 10 | 105 Secs (105 Secs)<br>*[==>]* | <br>***[1]*** |
| 2 | (1006946) | (10) +667.9+174.1 | COS/FUV, TIME-TAG, PSA | G140L<br>1280 A | FLASH=YES;<br>FP-POS=ALL;<br>SEGMENT=BOTH;<br>BUFFER-TIME=14283 | | Same Guide Stars in Visit 10 | 350 Secs (2216 Secs)<br>*[==>554 Secs (Split 1)]*<br>*[==>554 Secs (Split 2)]*<br>*[==>554 Secs (Split 3)]*<br>*[==>554 Secs (Split 4)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20181130
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Exp. 2, split 4
*** ORBITAL VISIBILITY OVERRUN = 57
GS Acq
Exp. 1
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec