



# 12309 - Calibration of the WFC3 Emission-Line Filters and Application of the Results to the Greatest Source of Uncertainties in Determining Abundances in Gaseous Nebulae

Cycle: 18, Proposal Category: GO

(Calibration)

(Availability Mode: SUPPORTED)

## INVESTIGATORS

| <i>Name</i>                      | <i>Institution</i>                             | <i>E-Mail</i>                  |
|----------------------------------|------------------------------------------------|--------------------------------|
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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) M-57<br>(2) M-57QUADS    | ACS/WFC<br>WFC3/UVIS                | 5                  | 20-Dec-2010 21:31:57.0        | yes                           |
| 02           | (2) M-57QUADS                | ACS/WFC<br>WFC3/UVIS                | 4                  | 20-Dec-2010 21:32:41.0        | yes                           |

9 Total Orbits Used

## ABSTRACT

The WFC3 is arguably the most powerful camera that has been used on the HST. This capability arises in part from the uniquely complete set of narrow-band filters that were incorporated for making images of nebulae in emission-lines. Turning these oft-times beautiful images into scientifically useful information requires accurate flux calibration of the filters, which is the first subject of this proposal. The present plan is that WFC3 calibration will be done from pre-launch properties of the filters and observations of stars. The WFC3 filters transmission profiles were measured pre-launch in a different optical configuration and temperature than applies within the WFC3, thus rendering uncertain any flux calibrations tied to those pre-launch measurements. We propose to perform a “ground-truth” calibration of the WFC3 narrow-band filters using NGC 6720 as a reference source, in much the same manner that the PI did when calibrating similar filters in the WFPC2 and the ACS.

These new calibrations will then be used to address the  $t^2$  problem in Gaseous Nebulae. This is the source of uncertainties in the relative abundances of factors 1.1 to 10 and undermines efforts to trace the abundance variations within our Galaxy and other galaxies. The  $t^2$  problem remains unresolved after four decades and the NGC 6720 images used for the filter calibration may resolve the problem if they show that regions of small-scale temperature fluctuations arise from low-temperature shadow-zones behind knots that are known to exist within the nebula or from high-temperature shocks that have been posited. Unlike the case of the Orion Nebula, where we have addressed this problem with fewer diagnostic filters, the geometry of NGC 6720 is ideally favorable for seeing these temperature variations and identifying their cause.

## **OBSERVING DESCRIPTION**

WFC3/UVIS imaging will be made of NGC 6720, the Ring Nebula. A set of full field images will be made centered on the central star and a set of quadrant filter images will be made in a portion of the nebula centered west of the central star. Coordinated parallel images will be made with the ACS.

# Proposal 12309 - Visit 01 Calibration of the WFC3 Emission-Line Filters and Application of the Results to the Greatest Source of Uncer...

|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                   |                                                 |                                               |                                                                                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------|
| Visit         | Proposal 12309, Visit 01, scheduling <span style="float: right;">Tue Dec 21 02:32:58 GMT 2010</span>                                                                                                                                 |                                                                                                                                                                                                                                   |                                                 |                                               |                                                                                            |
|               | <b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: ACS/WFC, WFC3/UVIS<br>Special Requirements: ORIENT 20D TO 40 D; ORIENT 290D TO 310 D; ORIENT 200D TO 220 D; ORIENT 110D TO 130 D<br><i>Comments: First Visit</i> |                                                                                                                                                                                                                                   |                                                 |                                               |                                                                                            |
| Patterns      | #                                                                                                                                                                                                                                    | Primary Pattern                                                                                                                                                                                                                   | Secondary Pattern                               |                                               | Exposures                                                                                  |
|               | (1)                                                                                                                                                                                                                                  | Pattern Type=WFC3-UVIS-MOSAIC-<br>LINE<br>Purpose=MOSAIC<br>Number Of Points=2<br>Point Spacing=3.264<br>Line Spacing=<br>Coordinate Frame=POS-TARG<br>Pattern Orientation=63.697<br>Angle Between Sides=<br>Center Pattern=false |                                                 |                                               | (1), (2-3), (4), (5-6), (7), (8-9), (10), (11-12), (13)                                    |
| Fixed Targets | #                                                                                                                                                                                                                                    | Name                                                                                                                                                                                                                              | Target Coordinates                              | Targ. Coord. Corrections                      | Fluxes                                                                                     |
|               | (1)                                                                                                                                                                                                                                  | M-57                                                                                                                                                                                                                              | RA: 18 53 35.0790 (283.3961625d)                | Proper Motion RA: null                        | V=15.6+/-                                                                                  |
|               |                                                                                                                                                                                                                                      | Alt Name1:<br>NGC6720STAR                                                                                                                                                                                                         | Dec: +33 01 45.03 (33.02918d)<br>Equinox: J2000 | Proper Motion Dec: null<br>Epoch of Position: | 15.6 is for the central star,<br>which is not important for this e<br>mission-line object. |
|               | (2)                                                                                                                                                                                                                                  | M-57QUADS                                                                                                                                                                                                                         | RA: 18 53 32.9400 (283.3872500d)                | Proper Motion RA: null                        | V=15.6+/-0.1                                                                               |
|               |                                                                                                                                                                                                                                      | Alt Name1: SAMPLE-<br>QUADS                                                                                                                                                                                                       | Dec: +33 01 48.90 (33.03025d)<br>Equinox: J2000 | Proper Motion Dec: null<br>Epoch of Position: | 15.6 is for the central star,<br>which is not important for this e<br>mission-line object. |
|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                   |                                                 |                                               | Reference Frame: FK5                                                                       |

Proposal 12309 - Visit 01 Calibration of the WFC3 Emission-Line Filters and Application of the Results to the Greatest Source of Uncer...

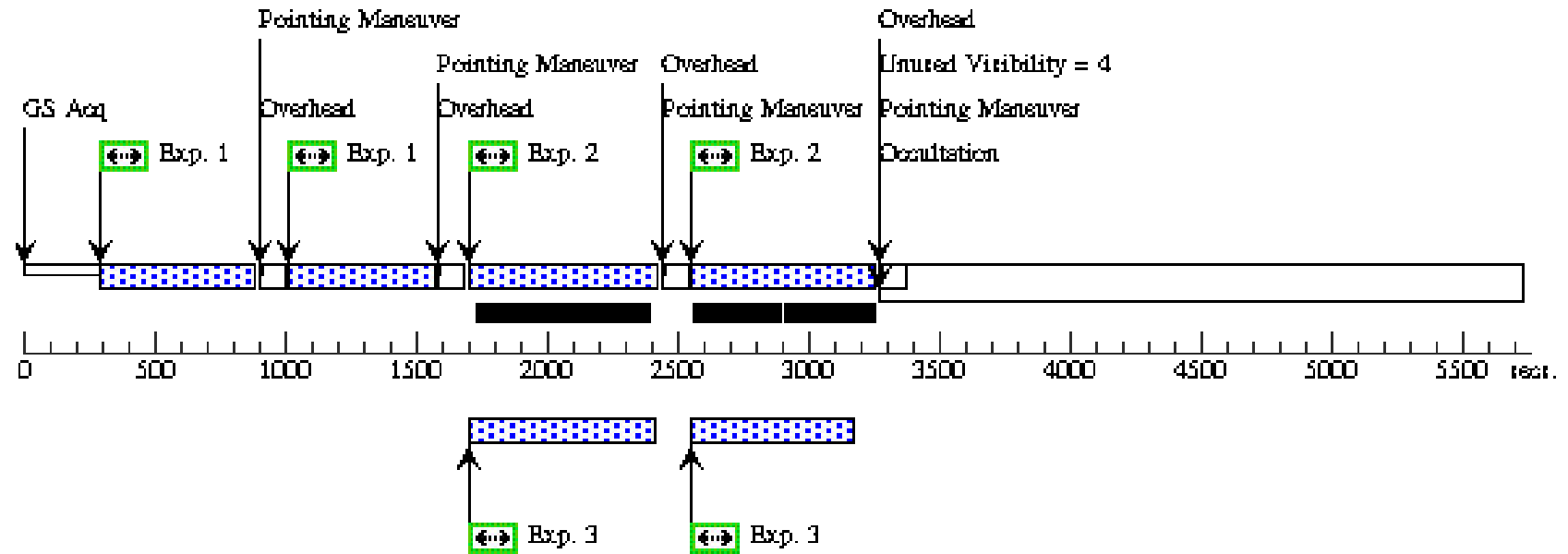
| Exposures | #  | Label    | Target   | Config, Mode, Aperture        | Spectral Els. | Opt. Params. | Special Reqs. | Groups                                                                                                     | Exp. Time/[Actual Dur.]                        | Orbit |
|-----------|----|----------|----------|-------------------------------|---------------|--------------|---------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------|
|           | 1  | F656N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F656N         |              |               | Pattern 1, Exps 1-1 in Visit 01 (1)                                                                        | 560 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [1]   |
|           | 2  | F658N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F658N         |              |               | Pattern 1, Exps 2-3 in Visit 01 (1)<br>Prime + Parallel Group 2-3 in Pattern 1, Exps 2-3 in Visit 01       | 700 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [1]   |
|           | 3  | ParF502N | (1) M-57 | ACS/WFC, ACCUM, WFC-FIX       | F502N         |              |               | Pattern 1, Exps 2-3 in Visit 01 (1)<br>Prime + Parallel Group 2-3 in Pattern 1, Exps 2-3 in Visit 01       | 500 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [1]   |
|           | 4  | F502N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F502N         |              |               | Pattern 1, Exps 4-4 in Visit 01 (1)                                                                        | 615 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [2]   |
|           | 5  | F487N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F487N         |              |               | Pattern 1, Exps 5-6 in Visit 01 (1)<br>Prime + Parallel Group 5-6 in Pattern 1, Exps 5-6 in Visit 01       | 700 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [2]   |
|           | 6  | ParF550M | (1) M-57 | ACS/WFC, ACCUM, WFC-FIX       | F550M         |              |               | Pattern 1, Exps 5-6 in Visit 01 (1)<br>Prime + Parallel Group 5-6 in Pattern 1, Exps 5-6 in Visit 01       | 500 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [2]   |
|           | 7  | F673N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F673N         |              |               | Pattern 1, Exps 7-7 in Visit 01 (1)                                                                        | 615 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [3]   |
|           | 8  | F953N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F953N         |              |               | Pattern 1, Exps 8-9 in Visit 01 (1)<br>Prime + Parallel Group 8-9 in Pattern 1, Exps 8-9 in Visit 01       | 700 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [3]   |
|           | 9  | ParF658N | (1) M-57 | ACS/WFC, ACCUM, WFC-FIX       | F658N         |              |               | Pattern 1, Exps 8-9 in Visit 01 (1)<br>Prime + Parallel Group 8-9 in Pattern 1, Exps 8-9 in Visit 01       | 500 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [3]   |
|           | 10 | F547M    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F547M         |              |               | Pattern 1, Exps 10-10 in Visit 01 (1)                                                                      | 615 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [4]   |
|           | 11 | F469N    | (1) M-57 | WFC3/UVIS, ACCUM, UVIS-CENTER | F469N         |              |               | Pattern 1, Exps 11-12 in Visit 01 (1)<br>Prime + Parallel Group 11-12 in Pattern 1, Exps 11-12 in Visit 01 | 700 Secs<br>[=>(Pattern 1)]<br>[=>(Pattern 2)] | [4]   |

Proposal 12309 - Visit 01 Calibration of the WFC3 Emission-Line Filters and Application of the Results to the Greatest Source of Uncer...

|  |    |          |               |                               |        |                                                                                                            |                                      |     |
|--|----|----------|---------------|-------------------------------|--------|------------------------------------------------------------------------------------------------------------|--------------------------------------|-----|
|  | 12 | ParF660N | (1) M-57      | ACS/WFC, ACCUM, WFC-FIX       | F660N  | Pattern 1, Exps 11-12 in Visit 01 (1)<br>Prime + Parallel Group 11-12 in Pattern 1, Exps 11-12 in Visit 01 | 500 Secs                             |     |
|  |    |          |               |                               |        |                                                                                                            | [==>(Pattern 1)]<br>[==>(Pattern 2)] | [4] |
|  | 13 | F645N    | (1) M-57      | WFC3/UVIS, ACCUM, UVIS-CENTER | F645N  | Pattern 1, Exps 13-13 in Visit 01 (1)                                                                      | 615 Secs                             |     |
|  |    |          |               |                               |        |                                                                                                            | [==>(Pattern 1)]<br>[==>(Pattern 2)] | [5] |
|  | 14 |          | (2) M-57QUADS | WFC3/UVIS, ACCUM, UVIS-QUAD   | FQ750N | CR-SPLIT=2                                                                                                 | 1400 Secs                            |     |
|  |    |          |               |                               |        |                                                                                                            | [==>(Split 1)]<br>[==>(Split 2)]     | [5] |

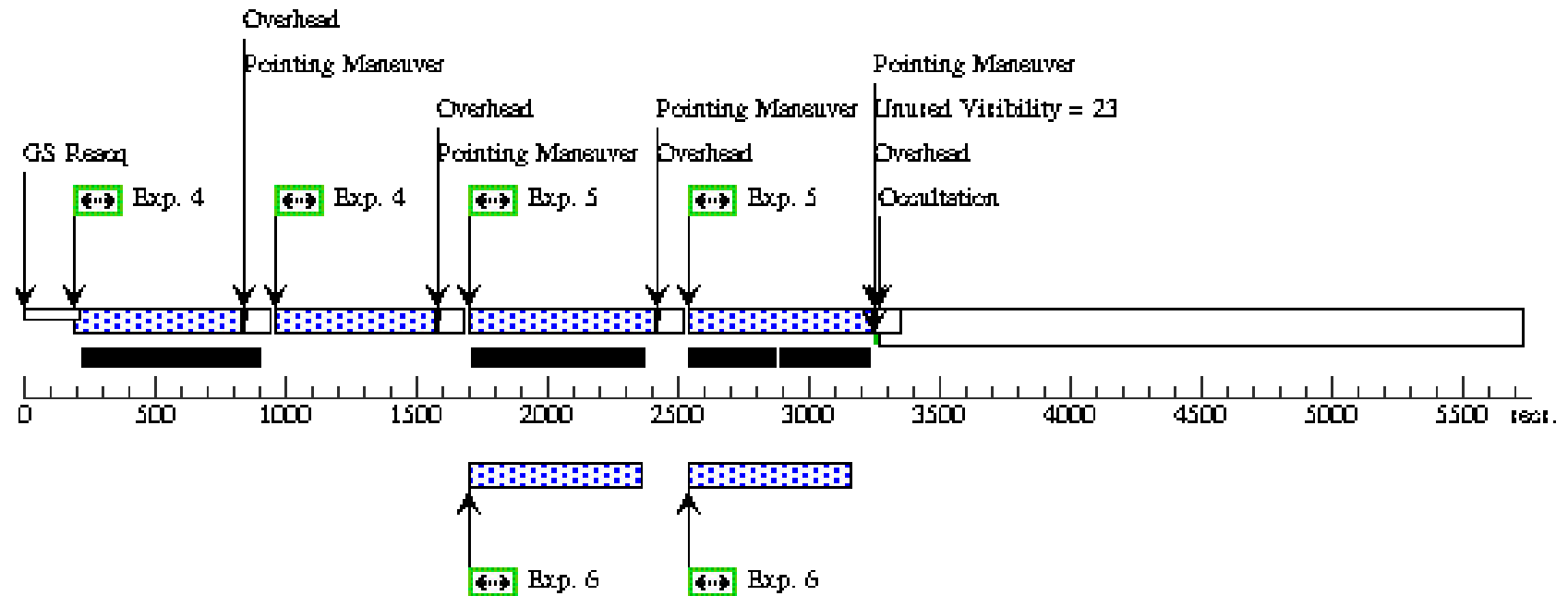
## Orbit 1

Server Version: 20100902



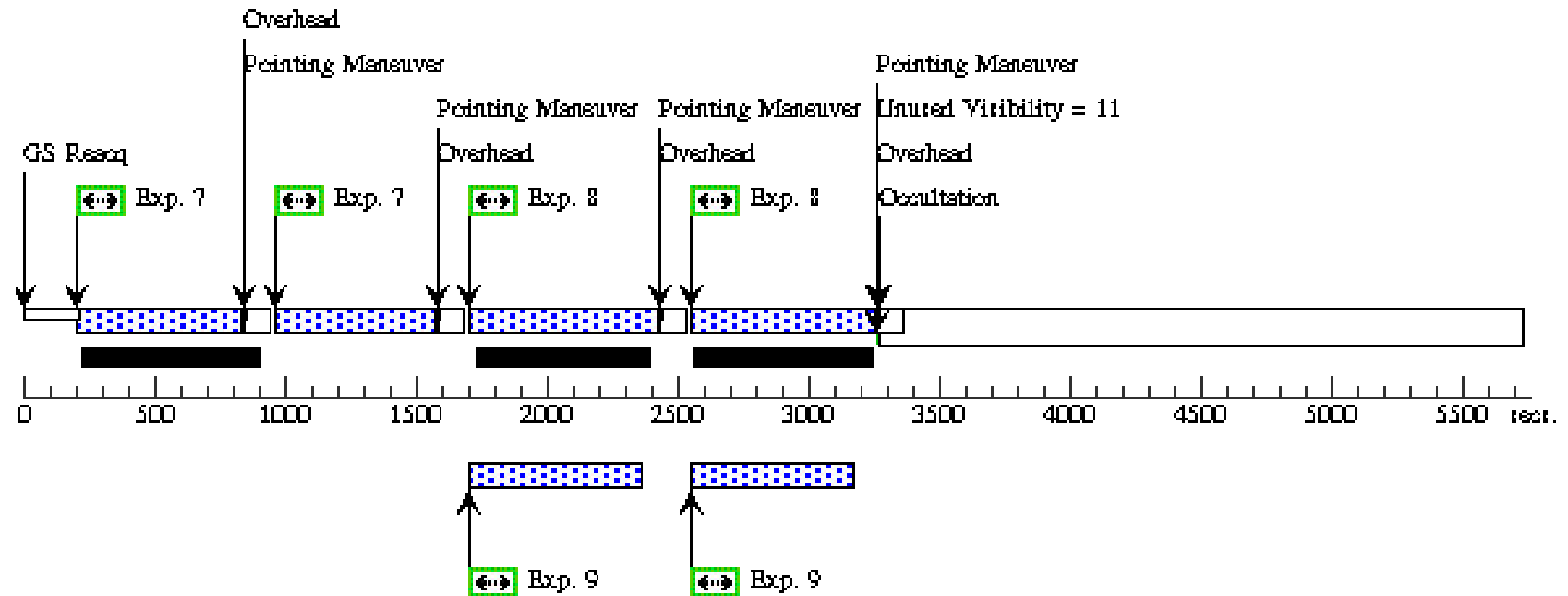
Orbit 2

Server Version: 20100902



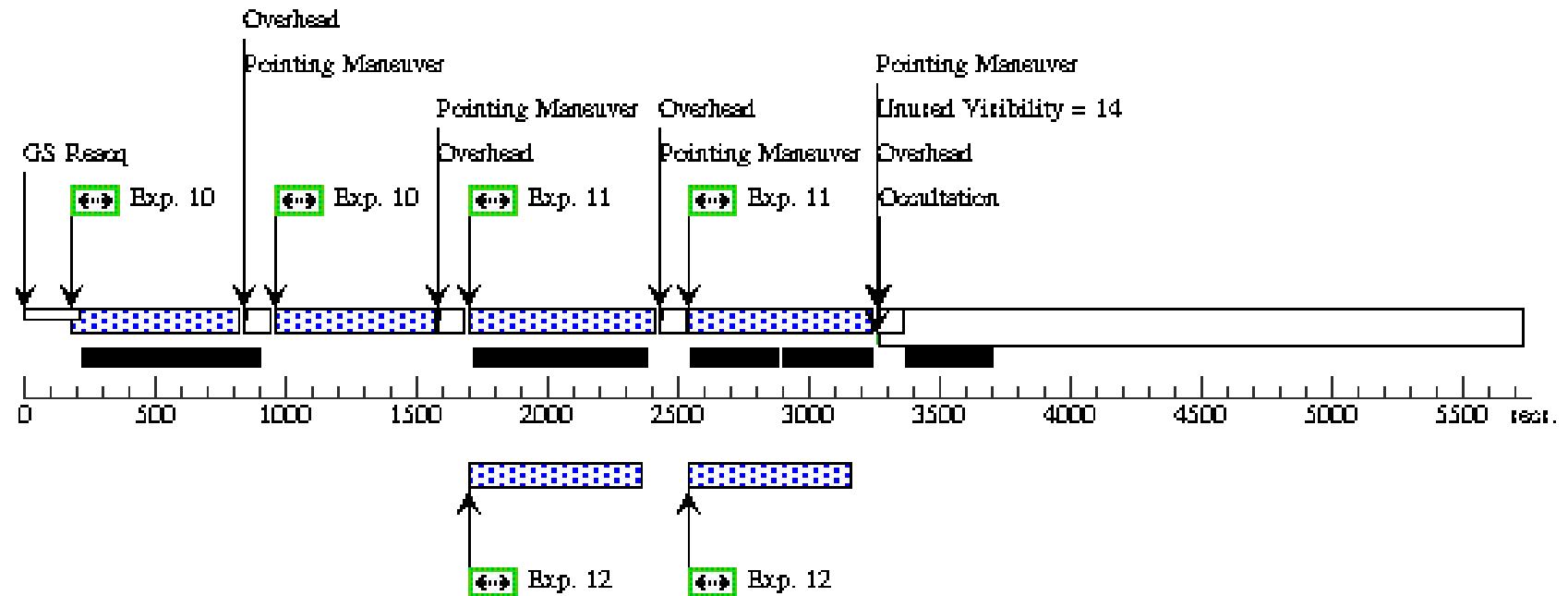
## Orbit 3

Server Version: 20100902



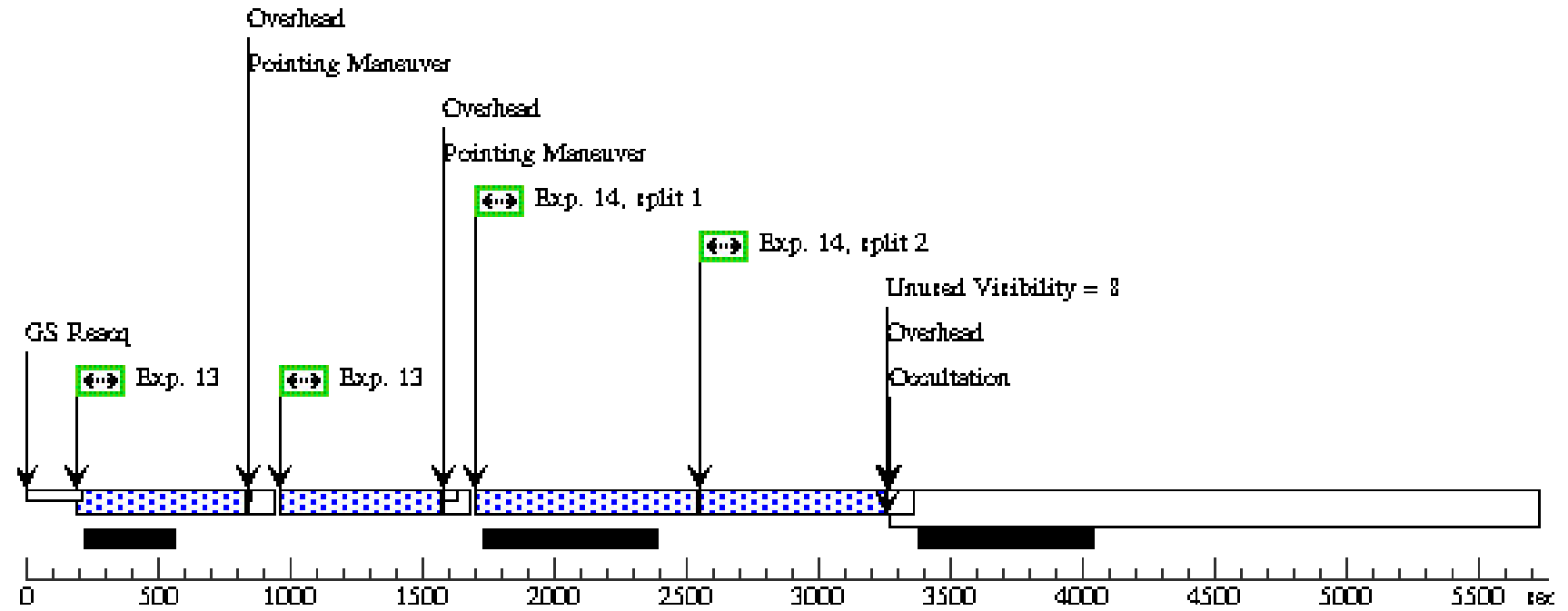
Orbit 4

Server Version: 20100902



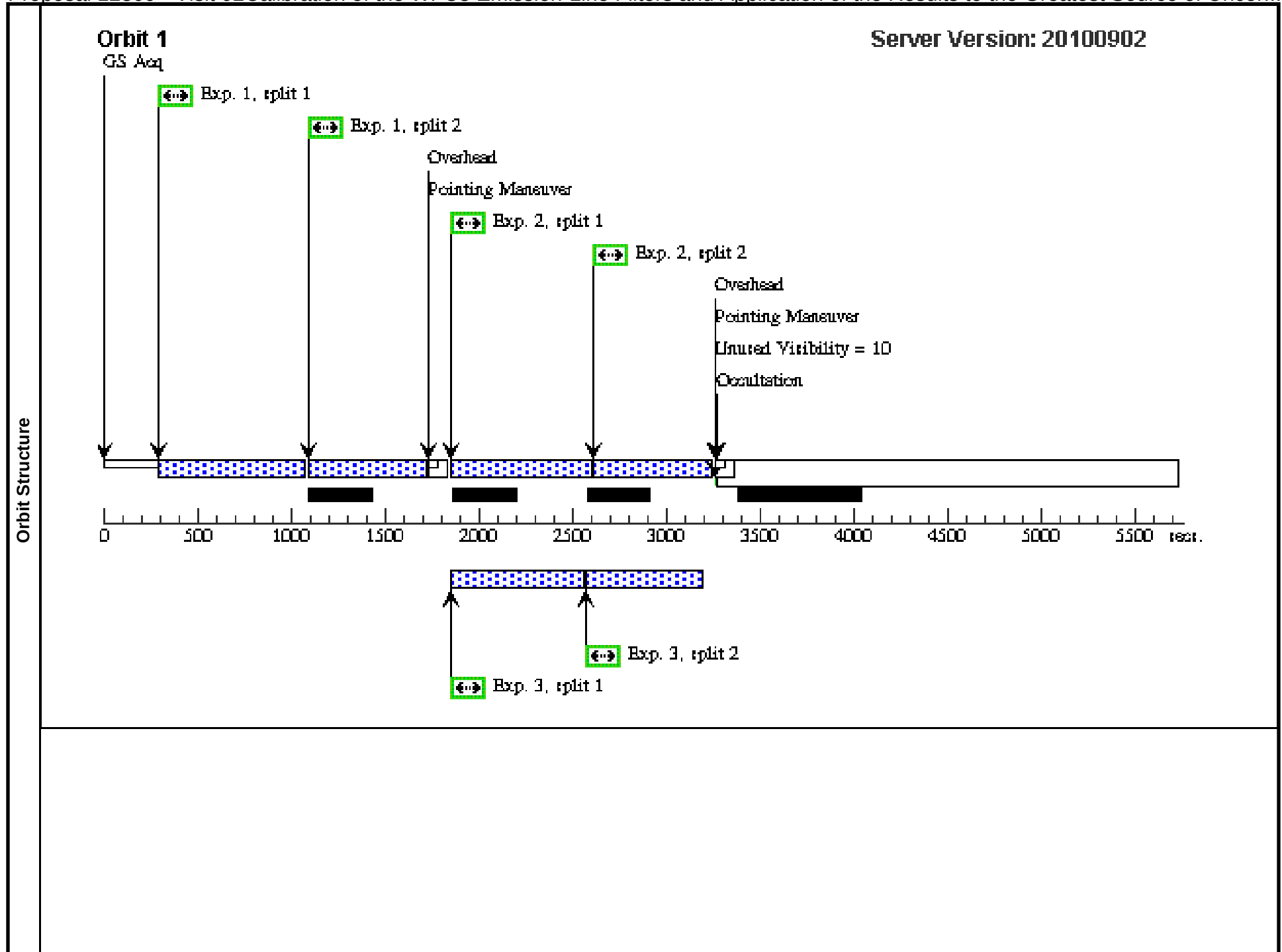
## Orbit 5

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# Proposal 12309 - Visit 02 Calibration of the WFC3 Emission-Line Filters and Application of the Results to the Greatest Source of Uncer...

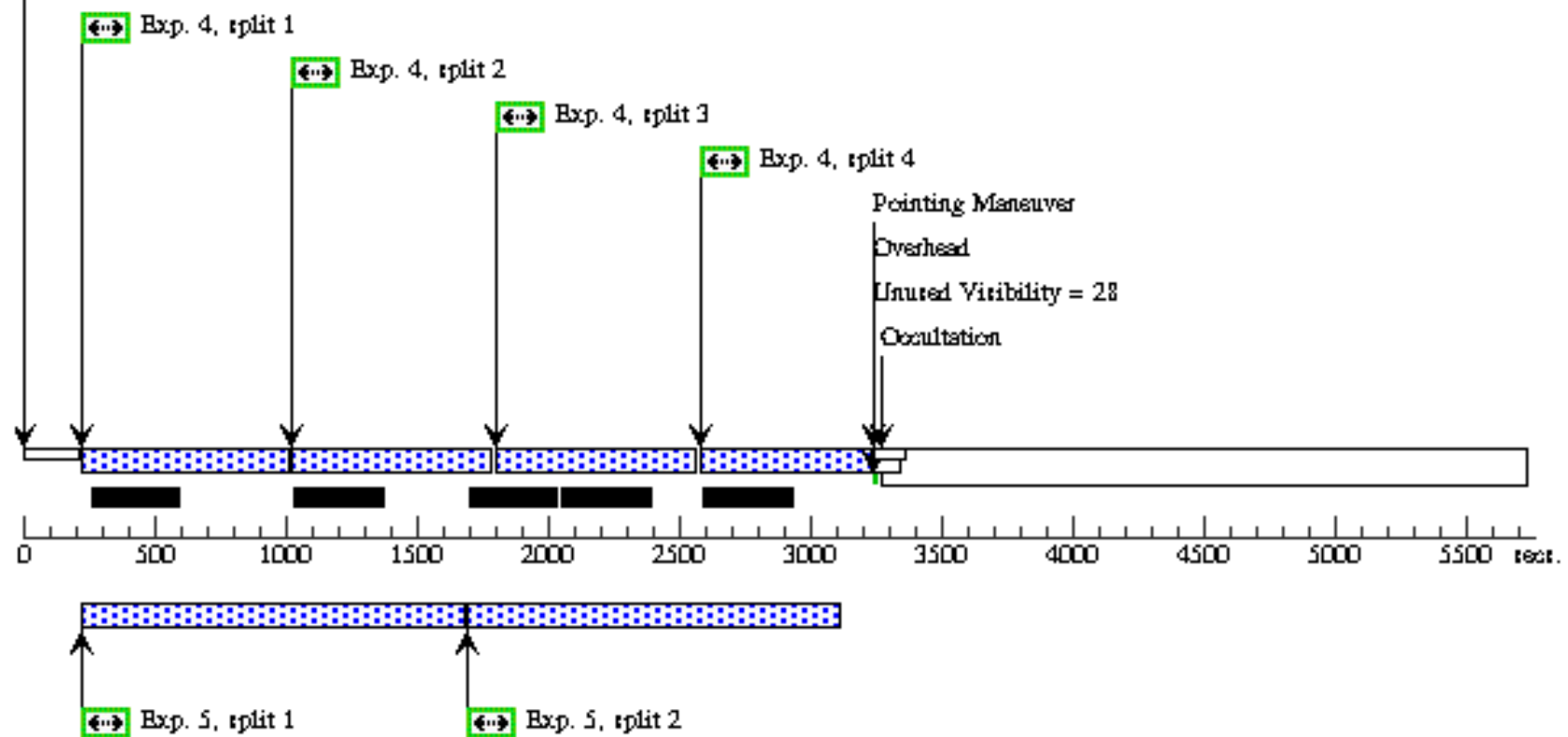
|               |                                                                                                                                                                                                      |                                      |                                                                                     |                                                                         |                                                                                                        |                      |               |                                        |                                                                               |       |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------|---------------|----------------------------------------|-------------------------------------------------------------------------------|-------|
| Visit         | <div> <div>Proposal 12309, Visit 02, scheduling</div> <div>Tue Dec 21 02:33:05 GMT 2010</div> </div>                                                                                                 |                                      |                                                                                     |                                                                         |                                                                                                        |                      |               |                                        |                                                                               |       |
|               | <div> <div>Diagnostic Status: No Diagnostics</div> <div>Scientific Instruments: ACS/WFC, WFC3/UVIS</div> <div>Special Requirements: SAME ORIENT AS 01</div> <div>Comments: Second Visit</div> </div> |                                      |                                                                                     |                                                                         |                                                                                                        |                      |               |                                        |                                                                               |       |
| Fixed Targets | #                                                                                                                                                                                                    | Name                                 | Target Coordinates                                                                  | Targ. Coord. Corrections                                                | Fluxes                                                                                                 | Miscellaneous        |               |                                        |                                                                               |       |
|               | (2)                                                                                                                                                                                                  | M-57QUADS<br>Alt Name1: SAMPLE-QUADS | RA: 18 53 32.9400 (283.3872500d)<br>Dec: +33 01 48.90 (33.03025d)<br>Equinox: J2000 | Proper Motion RA: null<br>Proper Motion Dec: null<br>Epoch of Position: | V=15.6+/-0.1<br>15.6 is for the central star,<br>which is not important for this emission-line object. | Reference Frame: FK5 |               |                                        |                                                                               |       |
| Exposures     | #                                                                                                                                                                                                    | Label                                | Target                                                                              | Config,Mode,Aperture                                                    | Spectral Els.                                                                                          | Opt. Params.         | Special Reqs. | Groups                                 | Exp. Time/[Actual Dur.]                                                       | Orbit |
|               | 1                                                                                                                                                                                                    |                                      | (2) M-57QUADS                                                                       | WFC3/UVIS, ACCUM, UVIS-QUAD                                             | FQ672N                                                                                                 | CR-SPLIT=2           |               |                                        | 1270 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]                                   | [1]   |
|               | 2                                                                                                                                                                                                    | FQ674N                               | (2) M-57QUADS                                                                       | WFC3/UVIS, ACCUM, UVIS-QUAD                                             | FQ674N                                                                                                 | CR-SPLIT=2           |               | Prime + Parallel Group 2-3 in Visit 02 | 1270 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]                                   | [1]   |
|               | 3                                                                                                                                                                                                    | ParFQ674N F550M                      | (2) M-57QUADS                                                                       | ACS/WFC, ACCUM, WFC                                                     | F550M                                                                                                  | CR-SPLIT=2           |               | Prime + Parallel Group 2-3 in Visit 02 | 1000 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]                                   | [1]   |
|               | 4                                                                                                                                                                                                    | FQ436N                               | (2) M-57QUADS                                                                       | WFC3/UVIS, ACCUM, UVIS-QUAD                                             | FQ436N                                                                                                 | CR-SPLIT=4           |               | Prime + Parallel Group 4-5 in Visit 02 | 2600 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]<br>[=>(Split 3)]<br>[=>(Split 4)] | [2]   |
|               | 5                                                                                                                                                                                                    | ParFQ436N F502N                      | (2) M-57QUADS                                                                       | ACS/WFC, ACCUM, WFC                                                     | F502N                                                                                                  | CR-SPLIT=2           |               | Prime + Parallel Group 4-5 in Visit 02 | 2600 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]                                   | [2]   |
|               | 6                                                                                                                                                                                                    | FQ437N                               | (2) M-57QUADS                                                                       | WFC3/UVIS, ACCUM, UVIS-QUAD                                             | FQ437N                                                                                                 | CR-SPLIT=3           |               | Prime + Parallel Group 6-7 in Visit 02 | 2640 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]<br>[=>(Split 3)]                  | [3]   |
|               | 7                                                                                                                                                                                                    | ParFQ437N F658N                      | (2) M-57QUADS                                                                       | ACS/WFC, ACCUM, WFC                                                     | F658N                                                                                                  | CR-SPLIT=2           |               | Prime + Parallel Group 6-7 in Visit 02 | 2550 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]                                   | [3]   |
|               | 8                                                                                                                                                                                                    | FQ575N                               | (2) M-57QUADS                                                                       | WFC3/UVIS, ACCUM, UVIS-QUAD                                             | FQ575N                                                                                                 | CR-SPLIT=4           |               | Prime + Parallel Group 8-9 in Visit 02 | 2640 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]<br>[=>(Split 3)]<br>[=>(Split 4)] | [4]   |
|               | 9                                                                                                                                                                                                    | ParFQ575N F660N                      | (2) M-57QUADS                                                                       | ACS/WFC, ACCUM, WFC                                                     | F660N                                                                                                  | CR-SPLIT=2           |               | Prime + Parallel Group 8-9 in Visit 02 | 2600 Secs<br>[=>(Split 1)]<br>[=>(Split 2)]                                   | [4]   |



## Orbit 2

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GS Reseq



# Orbit 3

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