



# 18035 - Direct search for Lyman continuum in a multiply-lensed low-mass high-redshift analog

Cycle: 33, Proposal Category: GO  
(Availability Mode: SUPPORTED)

## INVESTIGATORS

| <i>Name</i>                                     | <i>Institution</i>                             |
|---|--|
| <b>Dr. Lukas Jonathan Furtak (PI) (Contact)</b> | <b>Ben-Gurion University of the Negev</b>      |
| Prof. Adi Zitrin (CoI) (CoPI)                   | Ben-Gurion University of the Negev             |
| Prof. Daniel P. Stark (CoI) (AdminUSPI)         | University of California - Berkeley            |
| Adele Plat (CoI) (ESA Member)                   | Ecole Polytechnique Federale de Lausanne       |
| Dr. Michael Topping (CoI)                       | University of Arizona                          |
| Dr. Dan Coe (CoI) (ESA Member)                  | Space Telescope Science Institute - ESA - JWST |
| M. Riley Owens (CoI)                            | University of Cincinnati Main Campus           |

## 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) RXC0018-LAE1             | WFC3/UVIS                           | 2                  | 13-Aug-2025 16:00:38.0        | yes                           |
| 02           | (1) RXC0018-LAE1             | WFC3/UVIS                           | 2                  | 13-Aug-2025 16:00:38.0        | yes                           |
| 03           | (1) RXC0018-LAE1             | WFC3/UVIS                           | 2                  | 13-Aug-2025 16:00:39.0        | yes                           |
| 04           | (1) RXC0018-LAE1             | WFC3/UVIS                           | 2                  | 13-Aug-2025 16:00:39.0        | yes                           |
| 05           | (1) RXC0018-LAE1             | WFC3/UVIS                           | 2                  | 13-Aug-2025 16:00:39.0        | yes                           |

10 Total Orbits Used

## **ABSTRACT**

Early star-forming galaxies at high redshifts have been shown to most likely be the sources that drove the reionization of the Universe with deep JWST observations. Direct observation of their ionizing Lyman continuum (LyC) emission however remains impossible due to IGM opacity. Instead, low-redshift analogs of high-redshift galaxies are studied to constrain their LyC escape and link it to other observables, e.g. Lyman-alpha (Ly $\alpha$ ), the ultra-violet (UV) continuum slope, or rest-frame optical emission lines and line ratios. We here propose to use the HST's unrivaled UV sensitivity to directly detect the LyC emission of a particularly unique, gravitationally lensed, analog of the faint low-mass galaxy population that reionized the Universe. Situated at  $z=3$ , this galaxy has an unusual double-peaked Ly $\alpha$  emission profile where the blue peak is much stronger than the red peak which suggests a significant LyC escape fraction. It moreover presents an extremely blue UV continuum slope such as has thus far only been observed in the highest-redshift ( $z>10$ ) galaxies with JWST. Thanks to the strong lensing, we benefit from a factor  $\sim 10$  in flux magnification and will be able to stack the multiple images to achieve greater depth and probe LyC escape fractions as low as 0.015, establishing a link between this object's LyC escape fraction, the unique Ly $\alpha$  emission profile and other properties. The timing to conduct these observations in cycle 33 is ideal since the cluster will be imaged with JWST in cycle 4, which will add crucial additional constraints to our analysis. Our proposed deep UV observations will in turn ideally complement JWST near-infrared imaging of the lensing cluster.

## **OBSERVING DESCRIPTION**

This program aims at detecting the Lyman-Continuum emission from a multiply-imaged, double-peaked strong Lyman-alpha emitter at  $z=3.2$ , located in the strong lensing cluster RXC0018.

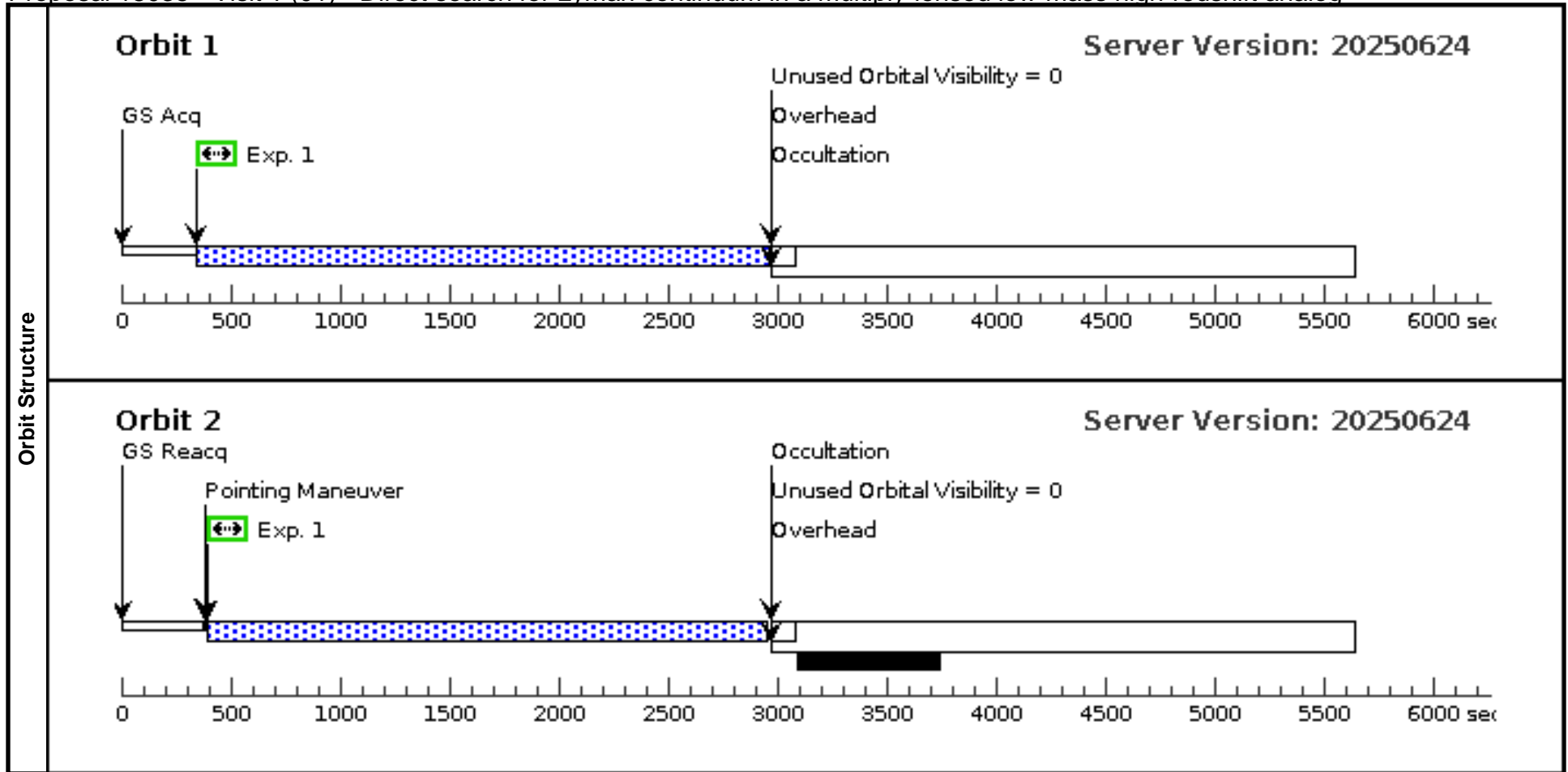
To this end, we will image the RXC0018 cluster field with WFC3/UVIS over 10 orbits in order to achieve sufficient depth in the F336W-band. The target is placed optimally on the UVIS2 detector. Note that this set-up covers the entire RXC0018 cluster field, including the positions where our lens model predicts the counter images of our target. The observations are split into five visits, with exposures of  $2 \times 2058$ s split over two orbits each. This is to maximize depth and minimize overheads.

We apply a simple, standard UVIS dither pattern to bridge the detector gap, in order to provide uniform imaging of the RXC0018 lensing cluster field, and thus leverage the legacy value of our observations.

Proposal 18035 - Visit 1 (01) - Direct search for Lyman continuum in a multiply-lensed low-mass high-redshift analog

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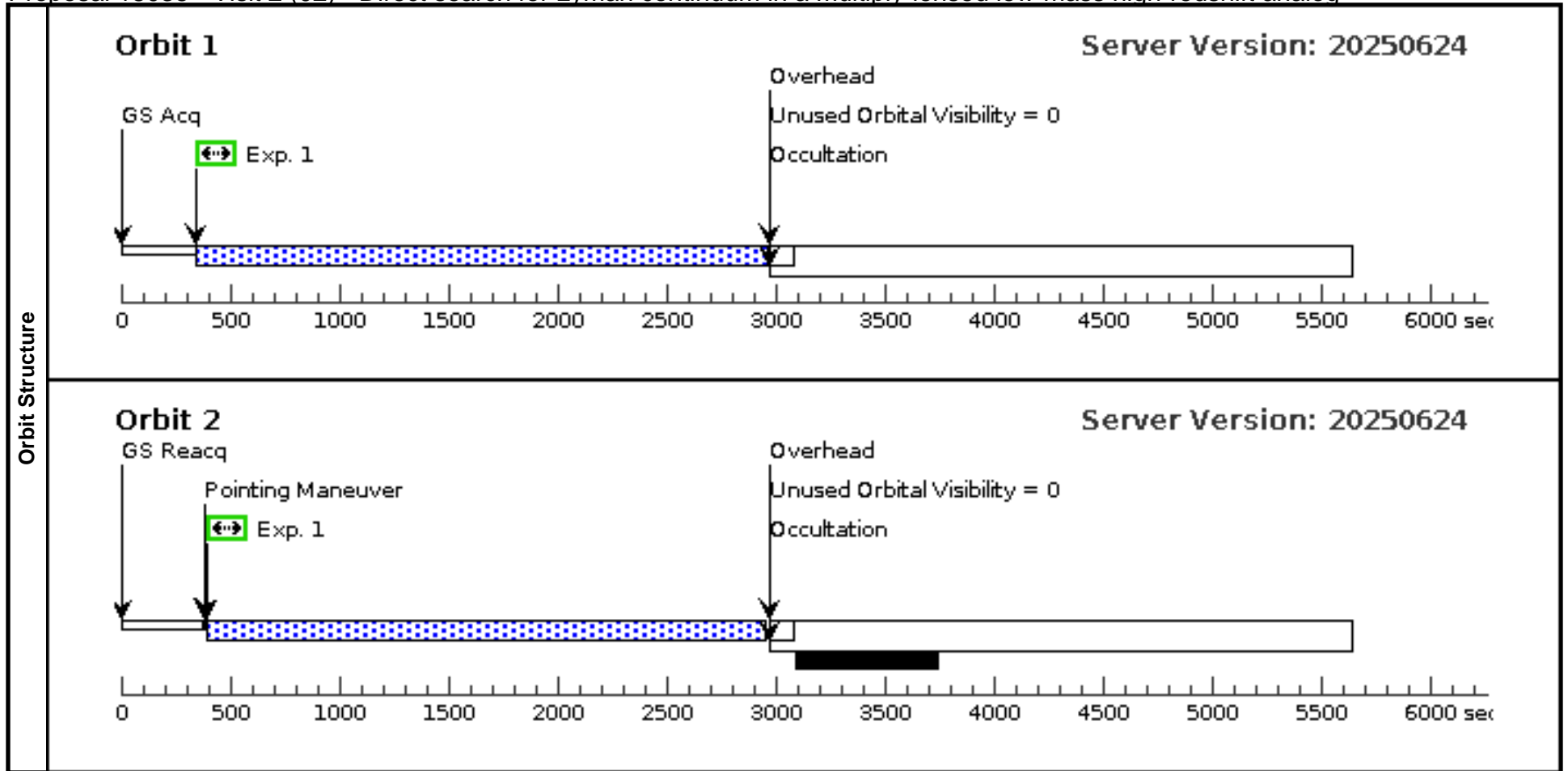
|                      |  |   |                                |                                 |                      |                     |                          |   |  |                  |              |
|----------------------|--|---|--------------------------------|---------------------------------|----------------------|---------------------|--------------------------|---|--|------------------|--------------|
| <b>Visit</b>         | <b>Proposal 18035, Visit 1 (01)</b><br><b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: WFC3/UVIS<br>Special Requirements: (none)   |   |                                |                                 |                      |                     |                          |   |  |                  |              |
|                      | <b>Patterns</b>  | <b>#</b>  | <b>Primary Pattern</b>         |                                 |                      |                     | <b>Secondary Pattern</b> |   |  | <b>Exposures</b> |              |
| (1)                  |  | Pattern Type=WFC3-UVIS-GAP-LINE Coordinate Frame=POS-TARG<br>Purpose=MOSAIC Pattern Orientation=85.759<br>Number Of Points=2 Angle Between Sides=<br>Point Spacing=2.414 Center Pattern=true<br>Line Spacing= |                                |                                 |                      |                     |                          |   | (1)                                    |                  |              |
| <b>Fixed Targets</b> | <b>#</b>   | <b>Name</b>   | <b>Target Coordinates</b>      | <b>Targ. Coord. Corrections</b> |                      | <b>Fluxes</b>       | <b>Miscellaneous</b>     |   |  |                  |              |
|                      | (1)  | RXC0018-LAE1  | RA: 00 18 33.5539 (4.6398079d) | Epoch of Position: 2015.5       |                      | V=24.5+/-0.05       | Reference Frame: ICRS    |   |  |                  |              |
|                      |  | Alt Name1:<br>RXCJ0018.5+1626   | Dec: +16 26 2.14 (16.43393d)   | Redshift: 3.22                  |                      |                     |                          |   |  |                  |              |
|                      |  | Alt Name2:<br>CL0016+1609   | Equinox: J2000                 |                                 |                      |                     |                          |   |  |                  |              |
|                      | Comments: This object was initially generated by the targetselector and retrieved from the SIMBAD database, and then adjusted to newer (HST-based) coordinates, magnitudes etc.<br>Category=GALAXY<br>Description=[GRAVITATIONAL LENS, IONIZATION FRONT, LYMAN ALPHA CLOUD, STARBURST] |   |                                |                                 |                      |                     |                          |   |  |                  |              |
| <b>Exposures</b>     | <b>#</b>   | <b>Label (ETC Run)</b>  | <b>Target</b>                  | <b>Config,Mode,Aperture</b>     | <b>Spectral Els.</b> | <b>Opt. Params.</b> | <b>Special Reqs.</b>     | <b>Groups</b>                           | <b>Exp. Time (Total)/[Actual Dur.]</b> |                  | <b>Orbit</b> |
|                      | 1  | (WFC3UVI S.im.2025353)  | (1) RXC0018-LAE1               | WFC3/UVIS, ACCUM, UVIS2         | F336W                | FLASH=9             |                          | Pattern 1, Exps 1-1 in Visit 1 (01) (1) | 2568 Secs (5153 Secs)                  |                  |              |
|                      |  |   |                                |                                 |                      |                     |                          |   | [=>2588.0 Secs (Pattern 1)]            |                  | [1]          |
|                      |  |   |                                |                                 |                      |                     |                          | [=>2565.0 Secs (Pattern 2)]             |  | [2]              |              |



Proposal 18035 - Visit 2 (02) - Direct search for Lyman continuum in a multiply-lensed low-mass high-redshift analog

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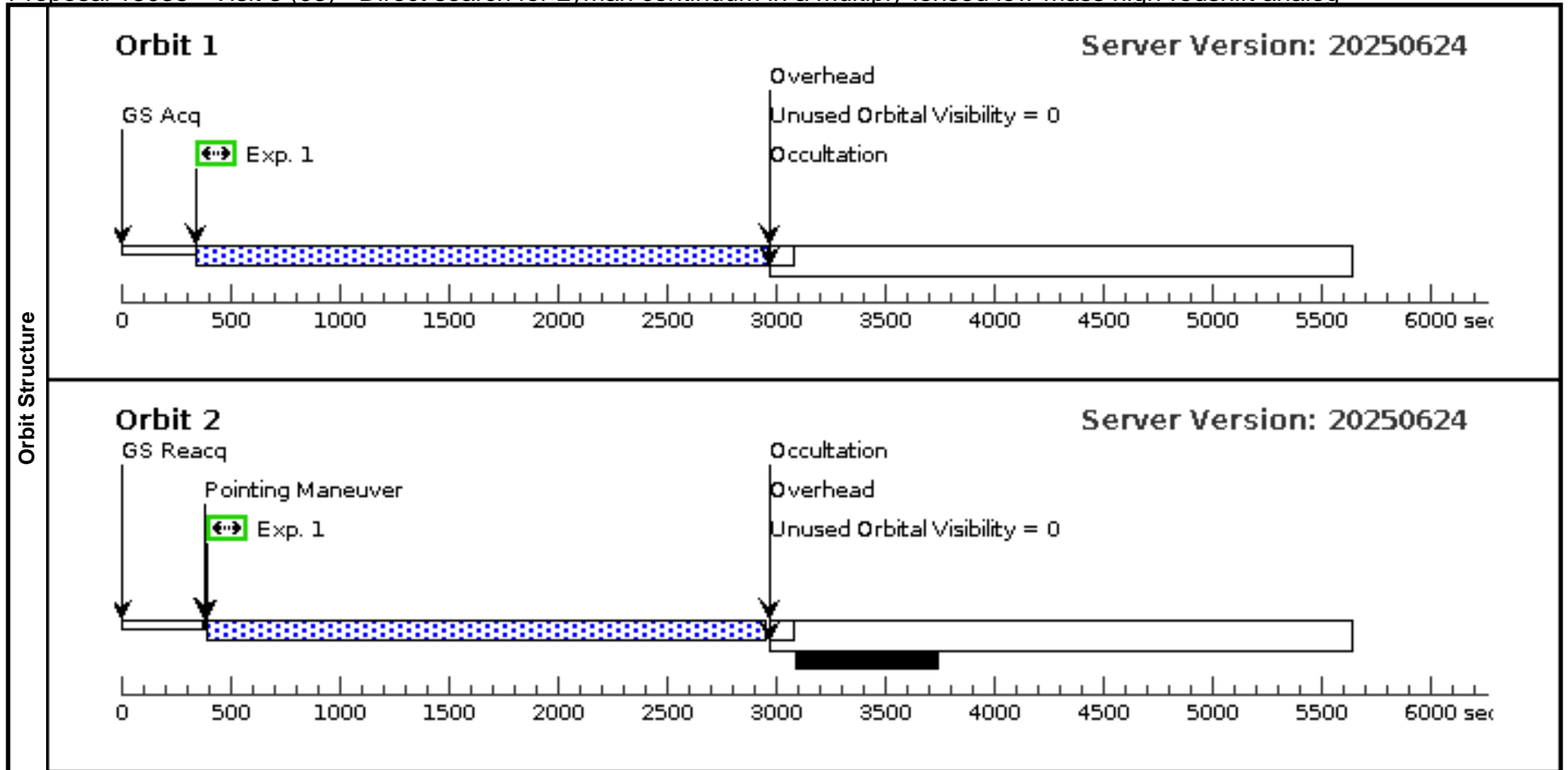
|                      |  |   |                                |                                 |                      |                     |                          |   |  |                  |              |
|----------------------|--|---|--------------------------------|---------------------------------|----------------------|---------------------|--------------------------|---|--|------------------|--------------|
| <b>Visit</b>         | <b>Proposal 18035, Visit 2 (02)</b><br><b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: WFC3/UVIS<br>Special Requirements: (none)   |   |                                |                                 |                      |                     |                          |   |  |                  |              |
|                      | <b>Patterns</b>  | <b>#</b>  | <b>Primary Pattern</b>         |                                 |                      |                     | <b>Secondary Pattern</b> |   |  | <b>Exposures</b> |              |
| (1)                  |  | Pattern Type=WFC3-UVIS-GAP-LINE    Coordinate Frame=POS-TARG<br>Purpose=MOSAIC                            Pattern Orientation=85.759<br>Number Of Points=2                        Angle Between Sides=<br>Point Spacing=2.414                        Center Pattern=true<br>Line Spacing= |                                |                                 |                      |                     |                          |   | (1)                                    |                  |              |
| <b>Fixed Targets</b> | <b>#</b>   | <b>Name</b>   | <b>Target Coordinates</b>      | <b>Targ. Coord. Corrections</b> |                      | <b>Fluxes</b>       | <b>Miscellaneous</b>     |   |  |                  |              |
|                      | (1)  | RXC0018-LAE1  | RA: 00 18 33.5539 (4.6398079d) | Epoch of Position: 2015.5       |                      | V=24.5+/-0.05       | Reference Frame: ICRS    |   |  |                  |              |
|                      |  | Alt Name1:<br>RXCJ0018.5+1626   | Dec: +16 26 2.14 (16.43393d)   | Redshift: 3.22                  |                      |                     |                          |   |  |                  |              |
|                      |  | Alt Name2:<br>CL0016+1609   | Equinox: J2000                 |                                 |                      |                     |                          |   |  |                  |              |
|                      | Comments: This object was initially generated by the targetselector and retrieved from the SIMBAD database, and then adjusted to newer (HST-based) coordinates, magnitudes etc.<br>Category=GALAXY<br>Description=[GRAVITATIONAL LENS, IONIZATION FRONT, LYMAN ALPHA CLOUD, STARBURST] |   |                                |                                 |                      |                     |                          |   |  |                  |              |
| <b>Exposures</b>     | <b>#</b>   | <b>Label (ETC Run)</b>  | <b>Target</b>                  | <b>Config,Mode,Aperture</b>     | <b>Spectral Els.</b> | <b>Opt. Params.</b> | <b>Special Reqs.</b>     | <b>Groups</b>                           | <b>Exp. Time (Total)/[Actual Dur.]</b> |                  | <b>Orbit</b> |
|                      | 1  | (WFC3UVI S.im.2025353)  | (1) RXC0018-LAE1               | WFC3/UVIS, ACCUM, UVIS2         | F336W                | FLASH=9             |                          | Pattern 1, Exps 1-1 in Visit 2 (02) (1) | 2568 Secs (5153 Secs)                  |                  |              |
|                      |  |   |                                |                                 |                      |                     |                          |   | [=>2588.0 Secs (Pattern 1)]            |                  | [1]          |
|                      |  |   |                                |                                 |                      |                     |                          | [=>2565.0 Secs (Pattern 2)]             |  | [2]              |              |



Proposal 18035 - Visit 3 (03) - Direct search for Lyman continuum in a multiply-lensed low-mass high-redshift analog

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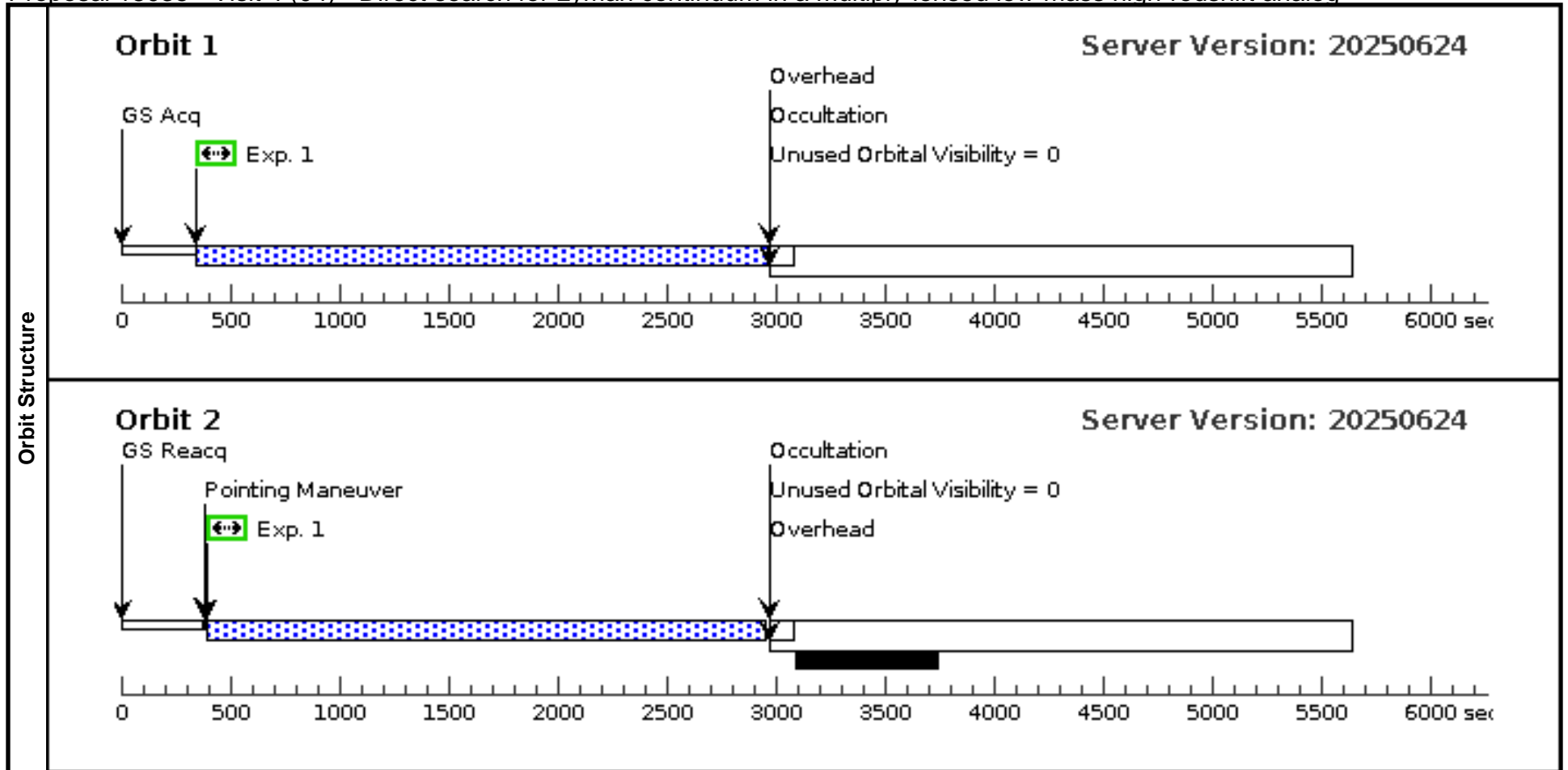
|                      |   |   |                                |                             |                                 |                     |                          |   |  |                  |              |
|----------------------|---|---|--------------------------------|-----------------------------|---------------------------------|---------------------|--------------------------|---|--|------------------|--------------|
| <b>Visit</b>         | <b>Proposal 18035, Visit 3 (03)</b><br><b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: WFC3/UVIS<br>Special Requirements: (none)  |   |                                |                             |                                 |                     |                          |   |  |                  |              |
|                      | <b>Patterns</b>   | <b>#</b>  | <b>Primary Pattern</b>         |                             |                                 |                     | <b>Secondary Pattern</b> |   |  | <b>Exposures</b> |              |
| (1)                  |   | Pattern Type=WFC3-UVIS-GAP-LINE    Coordinate Frame=POS-TARG<br>Purpose=MOSAIC                            Pattern Orientation=85.759<br>Number Of Points=2                        Angle Between Sides=<br>Point Spacing=2.414                        Center Pattern=true<br>Line Spacing= |                                |                             |                                 |                     |                          |   | (1)                                    |                  |              |
| <b>Fixed Targets</b> | <b>#</b>  | <b>Name</b>   | <b>Target Coordinates</b>      |                             | <b>Targ. Coord. Corrections</b> |                     | <b>Fluxes</b>            | <b>Miscellaneous</b>                    |  |                  |              |
|                      | (1)   | RXC0018-LAE1  | RA: 00 18 33.5539 (4.6398079d) |                             | Epoch of Position: 2015.5       |                     | V=24.5+/-0.05            | Reference Frame: ICRS                   |  |                  |              |
|                      |   | Alt Name1:<br>RXCJ0018.5+1626   | Dec: +16 26 2.14 (16.43393d)   |                             | Redshift: 3.22                  |                     |                          |   |  |                  |              |
|                      |   | Alt Name2:<br>CL0016+1609   | Equinox: J2000                 |                             |                                 |                     |                          |   |  |                  |              |
|                      | <i>Comments: This object was initially generated by the targetselector and retrieved from the SIMBAD database, and then adjusted to newer (HST-based) coordinates, magnitudes etc.</i><br>Category=GALAXY<br>Description=[GRAVITATIONAL LENS, IONIZATION FRONT, LYMAN ALPHA CLOUD, STARBURST] |   |                                |                             |                                 |                     |                          |   |  |                  |              |
| <b>Exposures</b>     | <b>#</b>  | <b>Label (ETC Run)</b>  | <b>Target</b>                  | <b>Config,Mode,Aperture</b> | <b>Spectral Els.</b>            | <b>Opt. Params.</b> | <b>Special Reqs.</b>     | <b>Groups</b>                           | <b>Exp. Time (Total)/[Actual Dur.]</b> |                  | <b>Orbit</b> |
|                      | 1   | (WFC3UVI S.im.2025353)  | (1) RXC0018-LAE1               | WFC3/UVIS, ACCUM, UVIS2     | F336W                           | FLASH=9             |                          | Pattern 1, Exps 1-1 in Visit 3 (03) (1) | 2568 Secs (5153 Secs)                  |                  |              |
|                      |   |   |                                |                             |                                 |                     |                          |   | [=>2588.0 Secs (Pattern 1)]            |                  | [1]          |
|                      |   |   |                                |                             |                                 |                     |                          | [=>2565.0 Secs (Pattern 2)]             |  | [2]              |              |



Proposal 18035 - Visit 4 (04) - Direct search for Lyman continuum in a multiply-lensed low-mass high-redshift analog

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|                      |   |   |                                |                             |                                 |                     |                          |   |  |                  |              |
|----------------------|---|---|--------------------------------|-----------------------------|---------------------------------|---------------------|--------------------------|---|--|------------------|--------------|
| <b>Visit</b>         | <b>Proposal 18035, Visit 4 (04)</b><br><b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: WFC3/UVIS<br>Special Requirements: (none)  |   |                                |                             |                                 |                     |                          |   |  |                  |              |
|                      | <b>Patterns</b>   | <b>#</b>  | <b>Primary Pattern</b>         |                             |                                 |                     | <b>Secondary Pattern</b> |   |  | <b>Exposures</b> |              |
| (1)                  |   | Pattern Type=WFC3-UVIS-GAP-LINE    Coordinate Frame=POS-TARG<br>Purpose=MOSAIC                            Pattern Orientation=85.759<br>Number Of Points=2                        Angle Between Sides=<br>Point Spacing=2.414                        Center Pattern=true<br>Line Spacing= |                                |                             |                                 |                     |                          |   | (1)                                    |                  |              |
| <b>Fixed Targets</b> | <b>#</b>  | <b>Name</b>   | <b>Target Coordinates</b>      |                             | <b>Targ. Coord. Corrections</b> |                     | <b>Fluxes</b>            | <b>Miscellaneous</b>                    |  |                  |              |
|                      | (1)   | RXC0018-LAE1  | RA: 00 18 33.5539 (4.6398079d) |                             | Epoch of Position: 2015.5       |                     | V=24.5+/-0.05            | Reference Frame: ICRS                   |  |                  |              |
|                      |   | Alt Name1:<br>RXCJ0018.5+1626   | Dec: +16 26 2.14 (16.43393d)   |                             | Redshift: 3.22                  |                     |                          |   |  |                  |              |
|                      |   | Alt Name2:<br>CL0016+1609   | Equinox: J2000                 |                             |                                 |                     |                          |   |  |                  |              |
|                      | <i>Comments: This object was initially generated by the targetselector and retrieved from the SIMBAD database, and then adjusted to newer (HST-based) coordinates, magnitudes etc.</i><br>Category=GALAXY<br>Description=[GRAVITATIONAL LENS, IONIZATION FRONT, LYMAN ALPHA CLOUD, STARBURST] |   |                                |                             |                                 |                     |                          |   |  |                  |              |
| <b>Exposures</b>     | <b>#</b>  | <b>Label (ETC Run)</b>  | <b>Target</b>                  | <b>Config,Mode,Aperture</b> | <b>Spectral Els.</b>            | <b>Opt. Params.</b> | <b>Special Reqs.</b>     | <b>Groups</b>                           | <b>Exp. Time (Total)/[Actual Dur.]</b> |                  | <b>Orbit</b> |
|                      | 1   | (WFC3UVI S.im.2025353)  | (1) RXC0018-LAE1               | WFC3/UVIS, ACCUM, UVIS2     | F336W                           | FLASH=9             |                          | Pattern 1, Exps 1-1 in Visit 4 (04) (1) | 2568 Secs (5153 Secs)                  |                  |              |
|                      |   |   |                                |                             |                                 |                     |                          |   | [=>2588.0 Secs (Pattern 1)]            |                  | [1]          |
|                      |   |   |                                |                             |                                 |                     |                          |   | [=>2565.0 Secs (Pattern 2)]            |                  | [2]          |



Proposal 18035 - Visit 5 (05) - Direct search for Lyman continuum in a multiply-lensed low-mass high-redshift analog

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|                      |  |   |                                |                             |                                 |                     |                          |   |  |              |
|----------------------|--|---|--------------------------------|-----------------------------|---------------------------------|---------------------|--------------------------|---|--|--------------|
| <b>Visit</b>         | <b>Proposal 18035, Visit 5 (05)</b><br><b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: WFC3/UVIS<br>Special Requirements: (none)   |   |                                |                             |                                 |                     |                          |   |  |              |
|                      | <b>Patterns</b>  | <b>#</b>  | <b>Primary Pattern</b>         |                             |                                 |                     | <b>Secondary Pattern</b> |   |  |              |
| (1)                  |  | Pattern Type=WFC3-UVIS-GAP-LINE Coordinate Frame=POS-TARG<br>Purpose=MOSAIC Pattern Orientation=85.759<br>Number Of Points=2 Angle Between Sides=<br>Point Spacing=2.414 Center Pattern=true<br>Line Spacing= |                                |                             |                                 |                     |                          |   |  | (1)          |
| <b>Fixed Targets</b> | <b>#</b>   | <b>Name</b>   | <b>Target Coordinates</b>      |                             | <b>Targ. Coord. Corrections</b> |                     | <b>Fluxes</b>            | <b>Miscellaneous</b>                    |  |              |
|                      | (1)  | RXC0018-LAE1  | RA: 00 18 33.5539 (4.6398079d) |                             | Epoch of Position: 2015.5       |                     | V=24.5+/-0.05            | Reference Frame: ICRS                   |  |              |
|                      |  | Alt Name1:<br>RXCJ0018.5+1626   | Dec: +16 26 2.14 (16.43393d)   |                             | Redshift: 3.22                  |                     |                          |   |  |              |
|                      |  | Alt Name2:<br>CL0016+1609   | Equinox: J2000                 |                             |                                 |                     |                          |   |  |              |
|                      | Comments: This object was initially generated by the targetselector and retrieved from the SIMBAD database, and then adjusted to newer (HST-based) coordinates, magnitudes etc.<br>Category=GALAXY<br>Description=[GRAVITATIONAL LENS, IONIZATION FRONT, LYMAN ALPHA CLOUD, STARBURST] |   |                                |                             |                                 |                     |                          |   |  |              |
| <b>Exposures</b>     | <b>#</b>   | <b>Label (ETC Run)</b>  | <b>Target</b>                  | <b>Config,Mode,Aperture</b> | <b>Spectral Els.</b>            | <b>Opt. Params.</b> | <b>Special Reqs.</b>     | <b>Groups</b>                           | <b>Exp. Time (Total)/[Actual Dur.]</b> | <b>Orbit</b> |
|                      | 1  | (WFC3UVI S.im.2025353)  | (1) RXC0018-LAE1               | WFC3/UVIS, ACCUM, UVIS2     | F336W                           | FLASH=9             |                          | Pattern 1, Exps 1-1 in Visit 5 (05) (1) | 2568 Secs (5153 Secs)                  |              |
|                      |  |   |                                |                             |                                 |                     |                          |   | [=>2588.0 Secs (Pattern 1)]            | [1]          |
|                      |  |   |                                |                             |                                 |                     |                          | [=>2565.0 Secs (Pattern 2)]             | [2]                                    |              |

