



# 12948 - Late Time STIS Spectroscopy of the Extremely Nearby Type Ia SN 2011fe

Cycle: 20, Proposal Category: GO

(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) SN2011FE                 | STIS/CCD<br>STIS/NUV-MAMA           | 5                  | 25-Jun-2012 21:56:31.0        | yes                           |
| 02           | (1) SN2011FE                 | STIS/CCD<br>STIS/NUV-MAMA           | 4                  | 25-Jun-2012 21:56:45.0        | yes                           |
| 03           | (1) SN2011FE<br>CCDFLAT      | STIS/CCD                            | 1                  | 25-Jun-2012 21:56:55.0        | yes                           |

10 Total Orbits Used

## ABSTRACT

In the first 2-3 months after the explosion of a Type Ia supernova, the innermost layers of the ejecta are concealed from view by a brilliant pseudo-photosphere. Observations obtained many months later, when the ejecta become nebular, enable us to peer deep into these layers and probe different explosion physics than is possible earlier on --- but at a cost. By this point, the supernova has faded dramatically, so only the closest events may be observed. SN 2011fe is the nearest Type Ia supernova discovered in a quarter century. We propose to obtain STIS spectroscopy of this remarkable supernova, a year after explosion, and combine these space-based observations with ground-based optical and near-infrared spectroscopy for analysis. Using the focusing lens of radiative transfer simulations, we will constrain the amount of radioactive nickel produced in the explosion, explore the extent of large-scale hydrodynamical mixing, and reconstruct the abundance stratification of the innermost ejecta. SN 2011fe represents a unprecedented opportunity to study how Type Ia supernovae explode, and is likely to remain so for decades to come.

## **OBSERVING DESCRIPTION**

Our goal is to obtain ultraviolet spectroscopy of the extremely nearby Type Ia supernova 2011fe in M101 using STIS, 13 months after it reached peak luminosity. We hope our observations can be carried out at the very start of Cycle 20, since the supernova will only continue to fade. We will combine these observations with complementary, time-coordinated ground-based optical and near-infrared observations, and analyze them together using comprehensive radiative transfer simulations. Comparing synthetic spectra to late-time observations will allow us to explore the extent of large-scale hydrodynamic mixing during the explosion, constrain the amount of radioactive nickel produced, and reconstruct the multi-dimensional distribution of the innermost ejecta. Careful examination of nebular phase lines will provide constraints on large-scale explosion asymmetry.

We plan a total of 10 orbits split into 3 visits. Our strategy is to maximize S/N we can get in the NUV, but also obtain some optical spectroscopy that can retire risk associated with constraints on ground-based visibility of the target in late September.

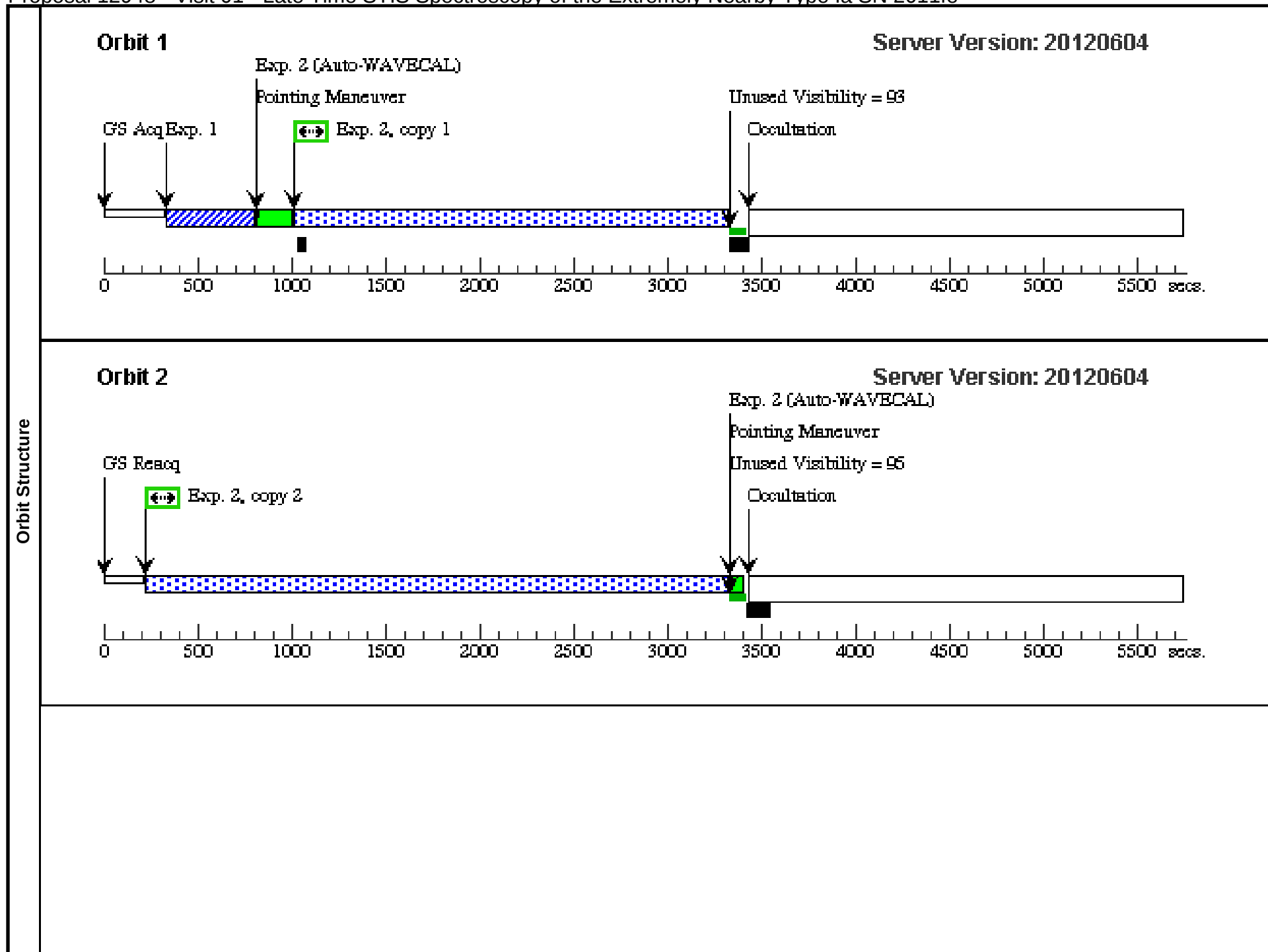
The first 2 visits are in the STIS/NUV-MAMA configuration. The first visit uses 5 orbits, the second uses 4. We dither along the slit at the end of every few orbits by 11 pixels to reduce the impact of hot pixels. The third and final visit uses the STIS/CCD G430L and G750L configurations in sequence in a single orbit. Exposure time and S/N are estimated by rescaling fluxes estimated from an HST spectrum of SN1992A obtained 291 days past peak and using the appropriate online STIS ETC's. We account for the fact that SN2011fe was over 10 times brighter than SN1992A at peak since it was much closer, and we also account for an additional ~100 days of decline in flux since our observations are later on the light curve of SN2011fe than those of SN1992A.

**REAL TIME JUSTIFICATION**

Our observations need to come as close to the beginning of Cycle 20 as possible. If the observations can be scheduled in September, this is not a problem for us at all. All 3 visits need to be scheduled as close together in time as is feasible. We understand the MAMA observing constraints prevent those visits from taking place in the same day.

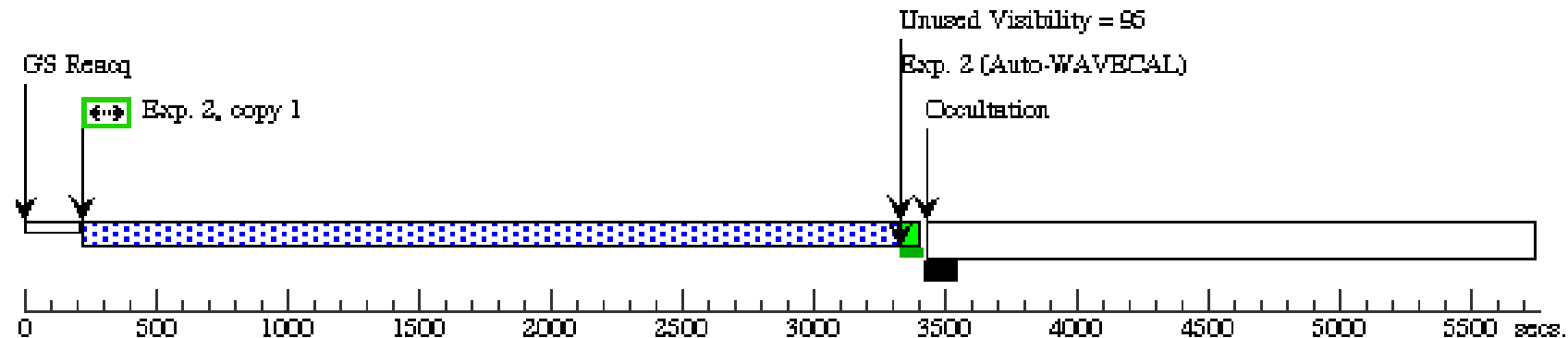
# Proposal 12948 - Visit 01 - Late Time STIS Spectroscopy of the Extremely Nearby Type Ia SN 2011fe

|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     |                                      |       |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------|--------------------------|-------------------|---------------|-------------------------------------|--------------------------------------|-------|
| Visit         | <b>Proposal 12948, Visit 01</b> <span style="float: right;">Tue Jun 26 01:57:02 GMT 2012</span>                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     |                                      |       |
|               | <b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: STIS/CCD, STIS/NUV-MAMA<br>Special Requirements: PCS MODE FINE; BEFORE 03-OCT-2012:00:00:00; SEQ 01,02,03 WITHIN 3 D<br>Comments: <i>Nebular UV STIS Spectroscopy of SN2011fe Visit 1</i> |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     |                                      |       |
| Patterns      | #                                                                                                                                                                                                                                                             | Primary Pattern                                                                                                                                                                                                                                                       |                                                                                    |                              |                          | Secondary Pattern |               |                                     | Exposures                            |       |
|               | (1)                                                                                                                                                                                                                                                           | Pattern Type=STIS-ALONG-SLIT      Coordinate Frame=POS-TARG<br>Purpose=DITHER                      Pattern Orientation=90.0<br>Number Of Points=2                  Angle Between Sides=<br>Point Spacing=0.275                  Center Pattern=false<br>Line Spacing= |                                                                                    |                              |                          |                   |               |                                     | (2)                                  |       |
| Fixed Targets | #                                                                                                                                                                                                                                                             | Name                                                                                                                                                                                                                                                                  | Target Coordinates                                                                 |                              | Targ. Coord. Corrections |                   | Fluxes        |                                     | Miscellaneous                        |       |
|               | (1)                                                                                                                                                                                                                                                           | SN2011FE<br>Alt Name1: PTF11KLY                                                                                                                                                                                                                                       | RA: 14 03 5.8130 (210.7742208d)<br>Dec: +54 16 25.36 (54.27371d)<br>Equinox: J2000 |                              | Redshift: 0.0008         |                   | V=19.5+/-0.3  |                                     | Reference Frame: ICRS                |       |
| Exposures     | #                                                                                                                                                                                                                                                             | Label (ETC Run)                                                                                                                                                                                                                                                       | Target                                                                             | Config,Mode,Aperture         | Spectral Els.            | Opt. Params.      | Special Reqs. | Groups                              | Exp. Time/[Actual Dur.]              | Orbit |
|               | 1                                                                                                                                                                                                                                                             | TargetAcquisition                                                                                                                                                                                                                                                     | (1) SN2011FE                                                                       | STIS/CCD, ACQ, F28X50LP      | MIRROR                   | ACQTYPE=POINT     |               |                                     | 60 Secs                              |       |
|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     | [==>]                                | [1]   |
|               | 2                                                                                                                                                                                                                                                             | MAMA Spectrum (STIS.sp.407505)                                                                                                                                                                                                                                        | (1) SN2011FE                                                                       | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A          |                   |               | Pattern 1, Exps 2-2 in Visit 01 (1) | 2000 Secs X 2                        |       |
|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     | [==>2295.0 Secs (Pattern 1, Copy 1)] | [1]   |
|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     | [==>3085 Secs (Pattern 1, Copy 2)]   | [2]   |
|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     | [==>3085.0 Secs (Pattern 2, Copy 1)] | [3]   |
|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     | [==>3085 Secs (Pattern 2, Copy 2)]   | [4]   |
|               | 3                                                                                                                                                                                                                                                             | MAMA Spectrum (STIS.sp.407505)                                                                                                                                                                                                                                        | (1) SN2011FE                                                                       | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A          |                   |               |                                     | 3085 Secs                            |       |
|               |                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       |                                                                                    |                              |                          |                   |               |                                     | [==>]                                | [5]   |



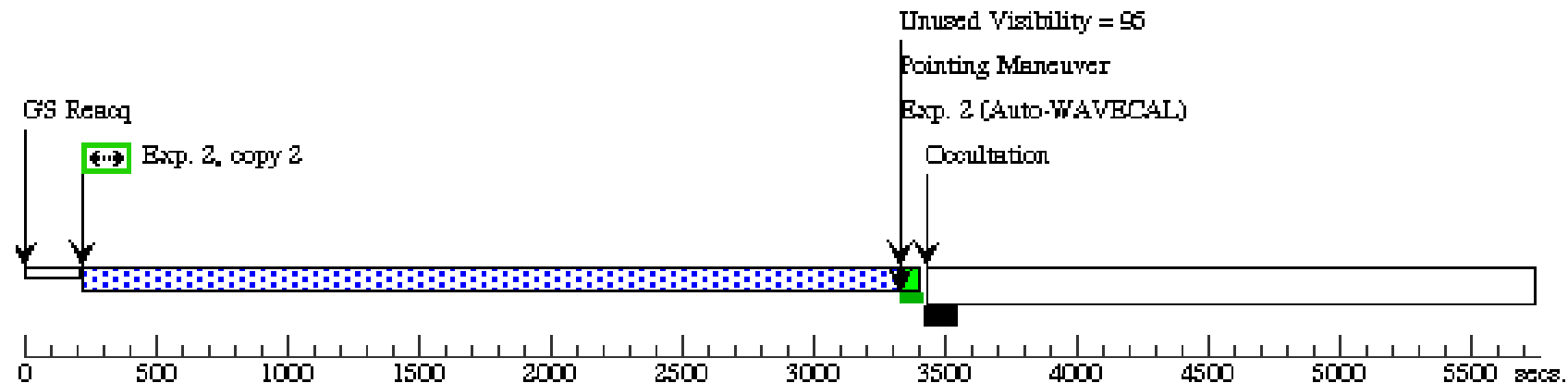
### Orbit 3

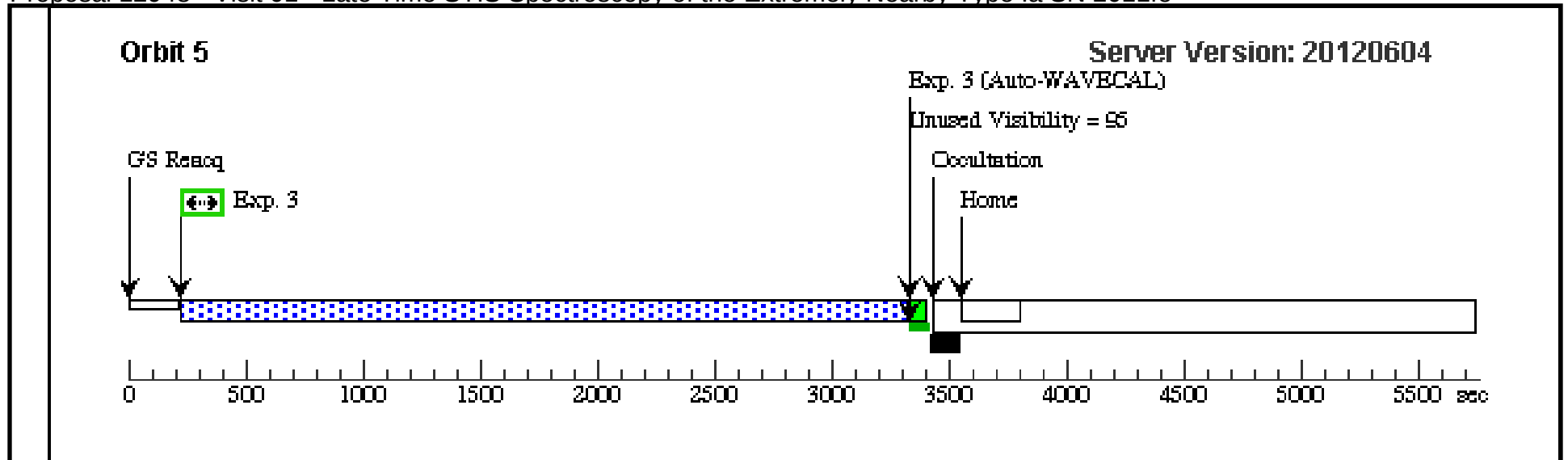
Server Version: 20120604



### Orbit 4

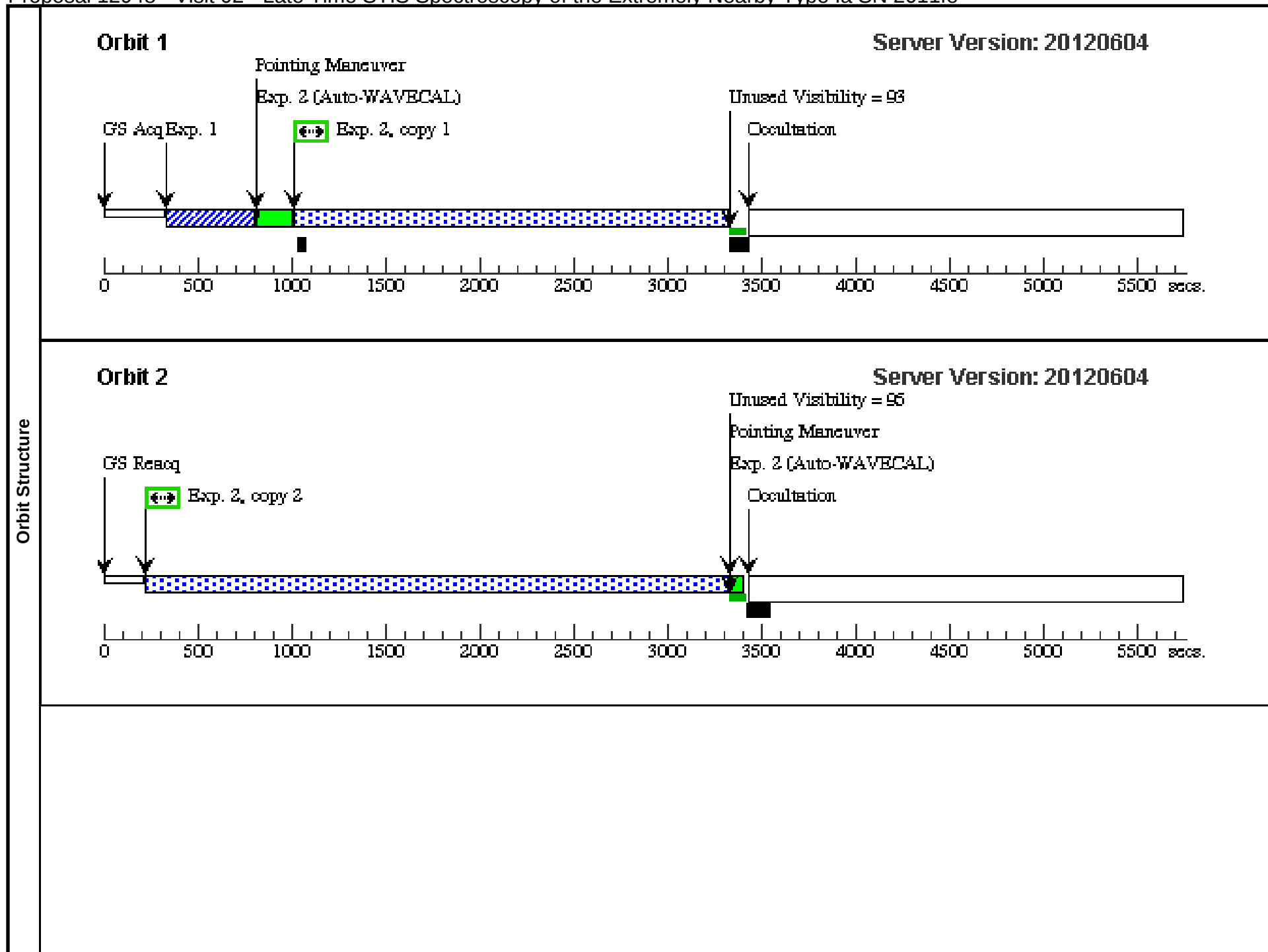
Server Version: 20120604





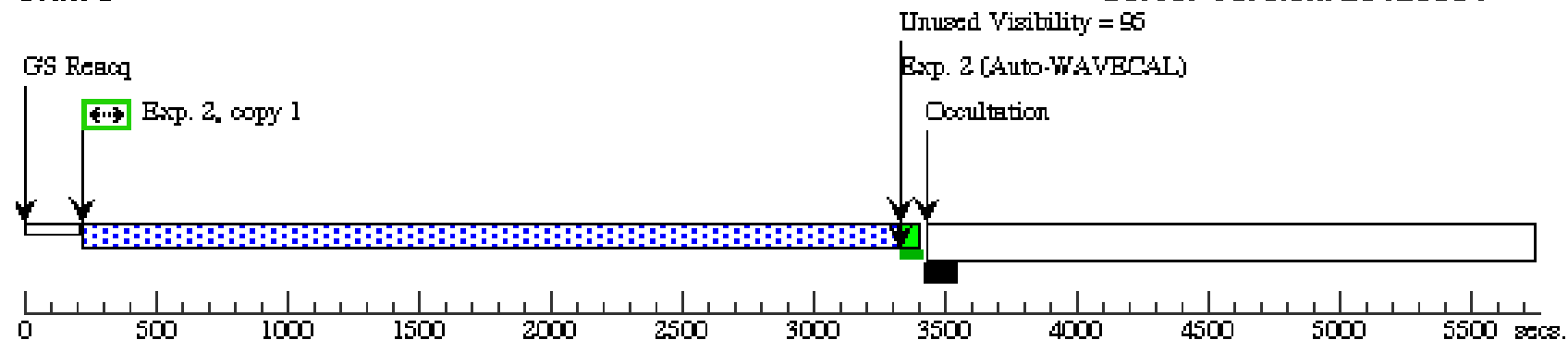
# Proposal 12948 - Visit 02 - Late Time STIS Spectroscopy of the Extremely Nearby Type Ia SN 2011fe

|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     |                                      |       |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------|--------------------------|-------------------|---------------|-------------------------------------|--------------------------------------|-------|
| Visit         | <b>Proposal 12948, Visit 02</b> <span style="float: right;">Tue Jun 26 01:57:08 GMT 2012</span>                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     |                                      |       |
|               | <b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: STIS/CCD, STIS/NUV-MAMA<br>Special Requirements: PCS MODE FINE; BEFORE 03-OCT-2012:00:00:00<br>Comments: <i>Nebular UV STIS Spectroscopy of SN2011fe Visit 2</i> |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     |                                      |       |
| Patterns      | #                                                                                                                                                                                                                                    | Primary Pattern                                                                                                                                                                                                                                                     |                                                                                    |                              |                          | Secondary Pattern |               |                                     | Exposures                            |       |
|               | (1)                                                                                                                                                                                                                                  | Pattern Type=STIS-ALONG-SLIT      Coordinate Frame=POS-TARG<br>Purpose=DITHER                      Pattern Orientation=90.0<br>Number Of Points=2                  Angle Between Sides=<br>Point Spacing=0.275                Center Pattern=false<br>Line Spacing= |                                                                                    |                              |                          |                   |               |                                     | (2)                                  |       |
| Fixed Targets | #                                                                                                                                                                                                                                    | Name                                                                                                                                                                                                                                                                | Target Coordinates                                                                 |                              | Targ. Coord. Corrections |                   | Fluxes        |                                     | Miscellaneous                        |       |
|               | (1)                                                                                                                                                                                                                                  | SN2011FE<br>Alt Name1: PTF11KLY                                                                                                                                                                                                                                     | RA: 14 03 5.8130 (210.7742208d)<br>Dec: +54 16 25.36 (54.27371d)<br>Equinox: J2000 |                              | Redshift: 0.0008         |                   | V=19.5+/-0.3  |                                     | Reference Frame: ICRS                |       |
| Exposures     | #                                                                                                                                                                                                                                    | Label (ETC Run)                                                                                                                                                                                                                                                     | Target                                                                             | Config,Mode,Aperture         | Spectral Els.            | Opt. Params.      | Special Reqs. | Groups                              | Exp. Time/[Actual Dur.]              | Orbit |
|               | 1                                                                                                                                                                                                                                    | TargetAcquisition                                                                                                                                                                                                                                                   | (1) SN2011FE                                                                       | STIS/CCD, ACQ, F28X50LP      | MIRROR                   | ACQTYPE=POINT     |               |                                     | 60 Secs                              |       |
|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     | [==>]                                | [1]   |
|               | 2                                                                                                                                                                                                                                    | MAMA Spectrum (STIS.sp.407505)                                                                                                                                                                                                                                      | (1) SN2011FE                                                                       | STIS/NUV-MAMA, ACCUM, 52X0.2 | G230L<br>2376 A          |                   |               | Pattern 1, Exps 2-2 in Visit 02 (1) | 2000 Secs X 2                        |       |
|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     | [==>2295.0 Secs (Pattern 1, Copy 1)] | [1]   |
|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     | [==>3085 Secs (Pattern 1, Copy 2)]   | [2]   |
|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     | [==>3085.0 Secs (Pattern 2, Copy 1)] | [3]   |
|               |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |                                                                                    |                              |                          |                   |               |                                     | [==>3085 Secs (Pattern 2, Copy 2)]   | [4]   |



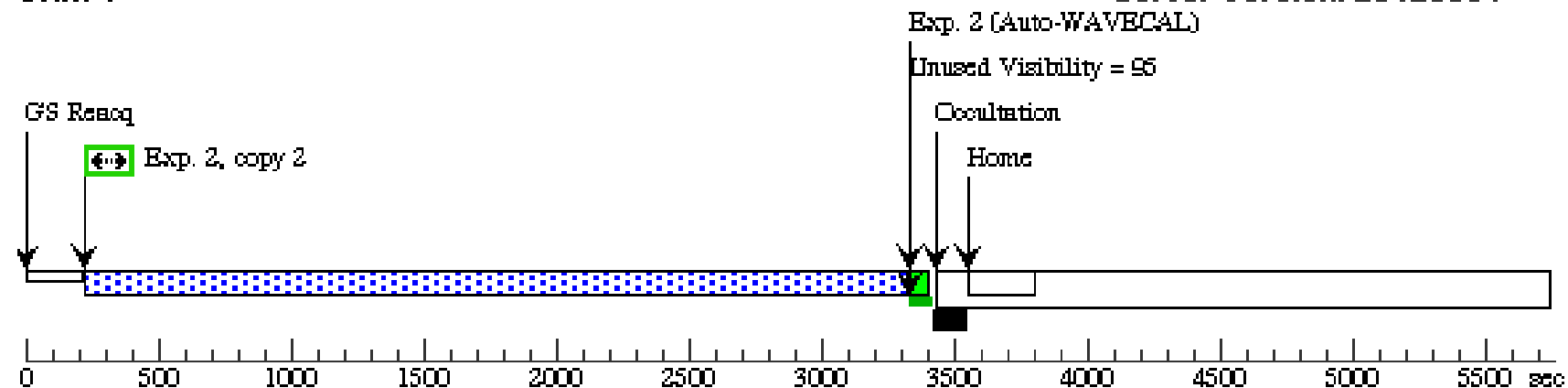
### Orbit 3

Server Version: 20120604



### Orbit 4

Server Version: 20120604



# Proposal 12948 - Visit 03 - Late Time STIS Spectroscopy of the Extremely Nearby Type Ia SN 2011fe

|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        |                         |       |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------------------|---------------------------|-----------------|-----------------------|---------------|--------|-------------------------|-------|
| Visit         | <b>Proposal 12948, Visit 03</b> <span style="float: right;">Tue Jun 26 01:57:14 GMT 2012</span>                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        |                         |       |
|               | <b>Diagnostic Status: No Diagnostics</b><br>Scientific Instruments: STIS/CCD<br>Special Requirements: BEFORE 03-OCT-2012:00:00:00<br>Comments: <i>Nebular UV STIS Spectroscopy of SN2011fe Visit 3</i> |                                   |                                                                                    |                           |                 |                       |               |        |                         |       |
| Fixed Targets | #                                                                                                                                                                                                      | Name                              | Target Coordinates                                                                 | Targ. Coord. Corrections  | Fluxes          | Miscellaneous         |               |        |                         |       |
|               | (1)                                                                                                                                                                                                    | SN2011FE<br>Alt Name1: PTF11KLY   | RA: 14 03 5.8130 (210.7742208d)<br>Dec: +54 16 25.36 (54.27371d)<br>Equinox: J2000 | Redshift: 0.0008          | V=19.5+/-0.3    | Reference Frame: ICRS |               |        |                         |       |
| Exposures     | #                                                                                                                                                                                                      | Label (ETC Run)                   | Target                                                                             | Config,Mode,Aperture      | Spectral Els.   | Opt. Params.          | Special Reqs. | Groups | Exp. Time/[Actual Dur.] | Orbit |
|               | 1                                                                                                                                                                                                      | TargetAcquisition                 | (1) SN2011FE                                                                       | STIS/CCD, ACQ, F28X50LP   | MIRROR          | ACQTYPE=POINT         |               |        | 60 Secs                 |       |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>]                   | [1]   |
|               | 2                                                                                                                                                                                                      | UV CCD Spectrum (STIS.sp.407506)  | (1) SN2011FE                                                                       | STIS/CCD, ACCUM, 52X0.2E1 | G430L<br>4300 A | CR-SPLIT=3            |               |        | 1236 Secs               |       |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Split 1)]          |       |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Split 2)]          | [1]   |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Split 3)]          |       |
|               | 3                                                                                                                                                                                                      | Red CCD Spectrum (STIS.sp.407507) | (1) SN2011FE                                                                       | STIS/CCD, ACCUM, 52X0.2   | G750L<br>7751 A | CR-SPLIT=3            |               |        | 660 Secs                |       |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Split 1)]          |       |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Split 2)]          | [1]   |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Split 3)]          |       |
|               | 4                                                                                                                                                                                                      | FringeFlat                        | CCDFLAT                                                                            | STIS/CCD, ACCUM, 0.3X0.09 | G750L<br>7751 A |                       |               |        | [==>(Copy 1)]           |       |
|               |                                                                                                                                                                                                        |                                   |                                                                                    |                           |                 |                       |               |        | [==>(Copy 2)]           | [1]   |

