# 10806 - Accretion in the closest binary systems known

Cycle: 15, Proposal Category: GO

(Availability Mode: SUPPORTED)


**INVESTIGATORS**

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**VISITS**

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (1) ES-CET | ACS/SBC<br>WFPC2 | 2 | 09-Apr-2008 21:00:49.0 | yes |
| 02 | (2) RX-J0806.3+1527 | ACS/HRC<br>ACS/SBC | 3 | 09-Apr-2008 21:01:28.0 | yes |

5 Total Orbits Used


**ABSTRACT**

Recently, three variable stars have been identified as likely accreting binary systems with ultra-short orbital periods. Optical and X-ray observations have revealed periodicities of 5-10 minutes, making them the closest binaries known as well as strong sources of gravitational wave emission. Such

short-period accreting binaries form the cornerstone to our understanding of binary formation and evolution, in particular of the large double white dwarf population in our galaxy, a candidate progenitor population for Type Ia supernovae. We propose to obtain the first UV spectroscopy of these objects using the ACS prisms in order to (i) determine the temperature of the primary and the composition of their donor stars, (ii) correlate the UV variability with other wavebands and determine if the periods are indeed orbital. These UV observations are essential in order to unequivocally determine whether these are indeed the most compact binaries known.

**OBSERVING DESCRIPTION**

Our targets are ultra-compact binary systems containing an accreting white dwarf feeding off a low mass degenerate companion, which is likely another white dwarf. We propose to employ the prisms on ACS to obtain time resolved UV spectroscopy of our two targets which have binary periods of 5-10 minutes only. By using both the SBC PR110L prism as well as the HRC PR200L, we will cover a wide wavelength range from 1150-3600A. This is essential to ensure we can account for the effect of modest reddening and derive a well constrained temperature for the accreting white dwarf. A large number of strong emission lines are also expected across this wavelength range as well as Ly-alpha. We need to establish the UV variations as a function of the proposed orbital periods, so we will take a series of identical short exposures covering several binary periods. This will allow us to fold the UV time-series on the accurately known periods and study the wavelength dependence of the orbital modulations. These have amplitudes of 15-20% in the optical range but are expected to be higher in the UV. The exposure times have been optimised to ensure efficient orbit packing yet at the same time adequately sample the short orbital periods. For ES Cet, with a period of 10.3 minutes, the exposures are close to 90s, whereas for RXJ0806 we drop them to 60s to accomodate its 5 minute orbit. Each set of prism spectra is preceded by a short imaging observations to serve as a reference. We have used a manual image here to optimise the orbit usage and have set the AUTOIMAGE flag to no. The image is then followed by a series of identical prism exposures that fill the remainder of the orbit. The observations are split into two visits, one visit per object. Within each visit, we acquire both HRC and SBC spectroscopy to provide the required wavelength range. For ES Cet, the UV flux is well established thanks to IUE fluxes, providing a good S/N of 50-60 per exposure. One orbit each in HRB/SBC will suffice. For RXJ0806, we expect a S/N of 7-15 per exposure, and we thus spend two SBC orbits on RXJ0806, and one orbit on the HRC exposures. For our brighter target, ES Cet, SBC-MAMA count-rates are in a safe regime. Although the source is variable with expected amplitudes of 20-30%, the system has never shown any large amplitude brightness variations since its discovery. It is persistently accreting at high rates, and thus one does not expect it to exhibit accretion driven outburst events. We aim to obtain supporting observations near any scheduled HST visits to provide additional constraints on its flux.

## Visit

**Proposal 10806, Visit 01, pi** Thu Apr 10 01:01:40 GMT 2008

**Diagnostic Status: No Diagnostics**

Scientific Instruments: ACS/SBC, WFPC2

Special Requirements: PCS MODE FINE

*Comments: WFPC2 and SBC prism observations are combined in 1 visit. The object is variable, and we need to obain both wave-bands at the same time so that the two spectral bands can be fitted jointly.*

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | ES-CET | RA: 02 00 52.2100 (30.2175417d)<br>Dec: -09 24 31.60 (-9.40878d)<br>Equinox: J2000 | | V=16.9+/-0.1<br>U-B=-1.1,<br>E(B-V)=0.025,<br>F_lambda=5e-14 at 1200A (IUE ) | Reference Frame: ICRS |

*Comments: UV flux is well characterised thanks to an IUE spectrum (flux levels of 2-5e-14 across IUE wavebands) as well as GALEX imaging (corresponding to flux levels of 2.8-3.6e-14). Object is variable at 20% level but intensive monitoring shows no large-amplitude variations or outbursts.*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ESCET WF PC2 image | (1) ES-CET | WFPC2, IMAGE, PC1 | F218W | | | | 40.0 Secs X 6 | |
| | | | | | | | | *[==>(Copy 1)]*<br>*[==>(Copy 2)]*<br>*[==>(Copy 3)]*<br>*[==>(Copy 4)]*<br>*[==>(Copy 5)]*<br>*[==>(Copy 6)]* | ***[1]*** |
| 2 | ESCET WF PC2 image | (1) ES-CET | WFPC2, IMAGE, PC1 | F255W | | | | 40.0 Secs X 6 | |
| | | | | | | | | *[==>(Copy 1)]*<br>*[==>(Copy 2)]*<br>*[==>(Copy 3)]*<br>*[==>(Copy 4)]*<br>*[==>(Copy 5)]*<br>*[==>(Copy 6)]* | ***[1]*** |
| 3 | ESCET WF PC2 image | (1) ES-CET | WFPC2, IMAGE, PC1 | F336W | | | | 40.0 Secs X 6 | |
| | | | | | | | | *[==>(Copy 1)]*<br>*[==>(Copy 2)]*<br>*[==>(Copy 3)]*<br>*[==>(Copy 4)]*<br>*[==>(Copy 5)]*<br>*[==>(Copy 6)]* | ***[1]*** |
| 4 | ESCET SBC image | (1) ES-CET | ACS/SBC, ACCUM, SBC | F122M | | | | 26.0 Secs | |
| | | | | | | | | *[==>]* | ***[2]*** |

*Comments: Manual zero-point instead of autoimage, use of narrow band Ly-alpha filter to keep countrates low*

**Exposures (continued)**

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 5 | ESCET SBC | (1) ES-CET | ACS/SBC, ACCUM, SBC | PR110L | | | | 91.0 Secs X 20 | |
| | | | | | | | | *[==>(Copy 1)]* | ***[2]*** |
| | | | | | | | | *[==>(Copy 2)]* | |
| | | | | | | | | *[==>(Copy 3)]* | |
| | | | | | | | | *[==>(Copy 4)]* | |
| | | | | | | | | *[==>(Copy 5)]* | |
| | | | | | | | | *[==>(Copy 6)]* | |
| | | | | | | | | *[==>(Copy 7)]* | |
| | | | | | | | | *[==>(Copy 8)]* | |
| | | | | | | | | *[==>(Copy 9)]* | |
| | | | | | | | | *[==>(Copy 10)]* | |
| | | | | | | | | *[==>(Copy 11)]* | |
| | | | | | | | | *[==>(Copy 12)]* | |
| | | | | | | | | *[==>(Copy 13)]* | |
| | | | | | | | | *[==>(Copy 14)]* | |
| | | | | | | | | *[==>(Copy 15)]* | |
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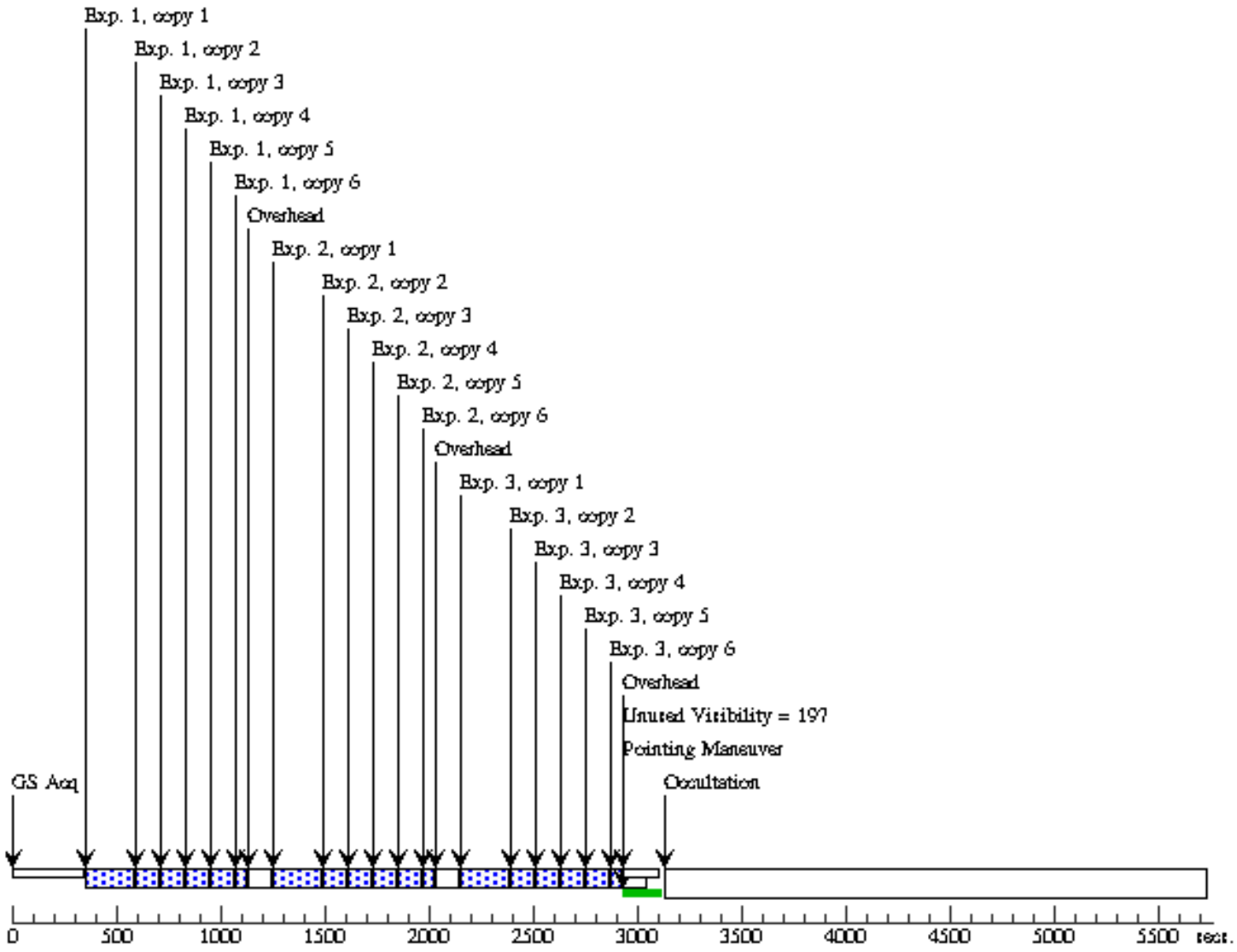
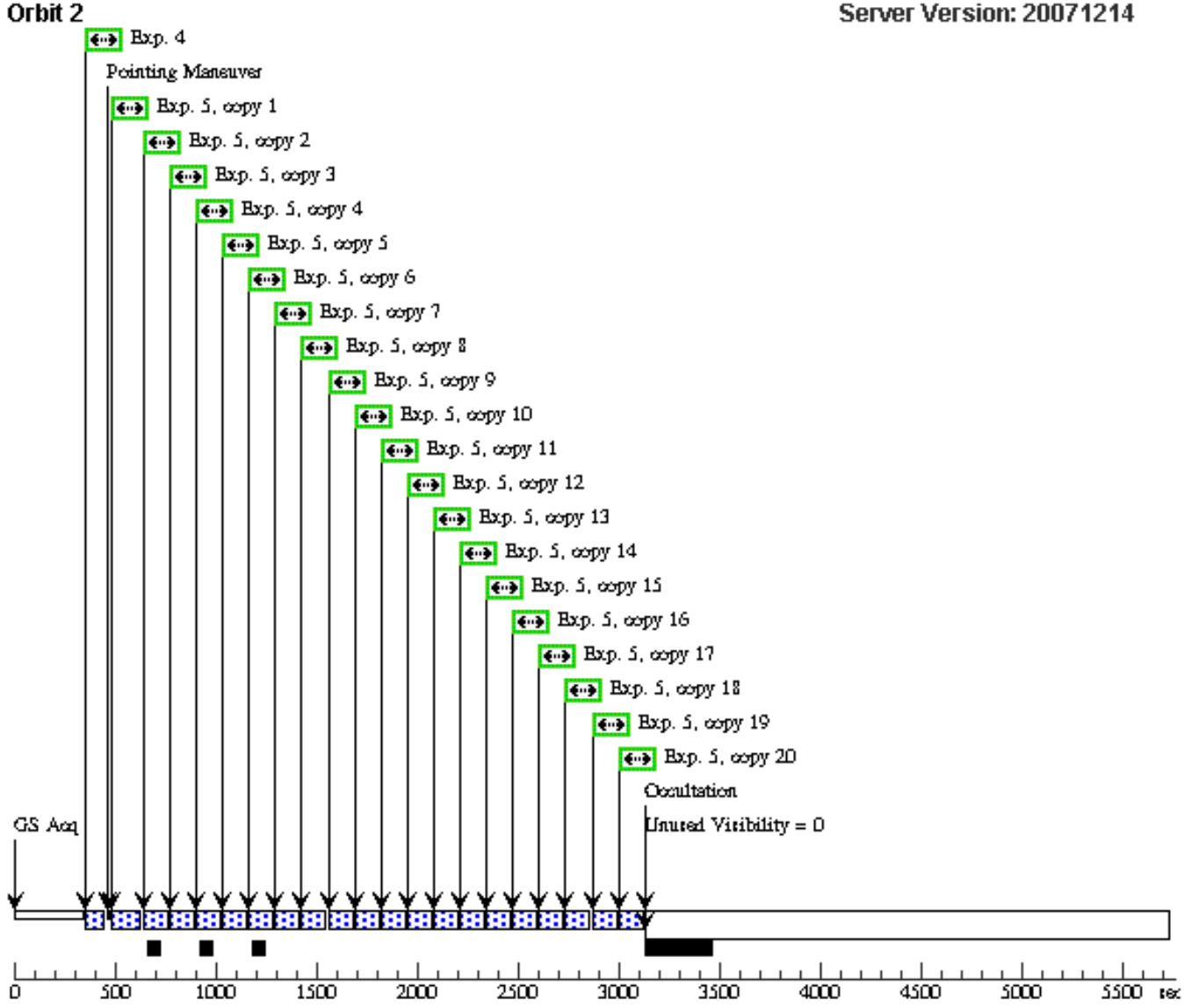
| | | | | | | | | *[==>(Copy 17)]* | |
| | | | | | | | | *[==>(Copy 18)]* | |
| | | | | | | | | *[==>(Copy 19)]* | |
| | | | | | | | | *[==>(Copy 20)]* | |

**Orbit Structure**



**Orbit Structure (continued)**



## Visit

**Proposal 10806, Visit 02, completed** Thu Apr 10 01:01:41 GMT 2008

**Diagnostic Status: No Diagnostics**

Scientific Instruments: ACS/SBC, ACS/HRC

Special Requirements: (none)

*Comments: HRC and SBC prism observations are combined in 1 visit. The object is variable, and we need to obain both wave-bands at the same time so that the two spectral bands can be fitted jointly.*

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | RX-J0806.3+1527 | RA: 08 06 22.9500 (121.5956250d)<br>Dec: +15 27 31.10 (15.45864d)<br>Equinox: J2000 | | V=21.1+/-0.1<br>B-V=-0.2,<br>E(B-V)=0.025 | Reference Frame: ICRS |

*Comments: No UV observations exist for this target. However the SED has been characterised well both in the soft X-rays and the blue end of the optical range. Its faintness ensures that the SBC countrates will be far removed from the limits. The source is variable at a level of 10-20%, but repeated observations over many years show no large amplitude variations.*

## Exposures

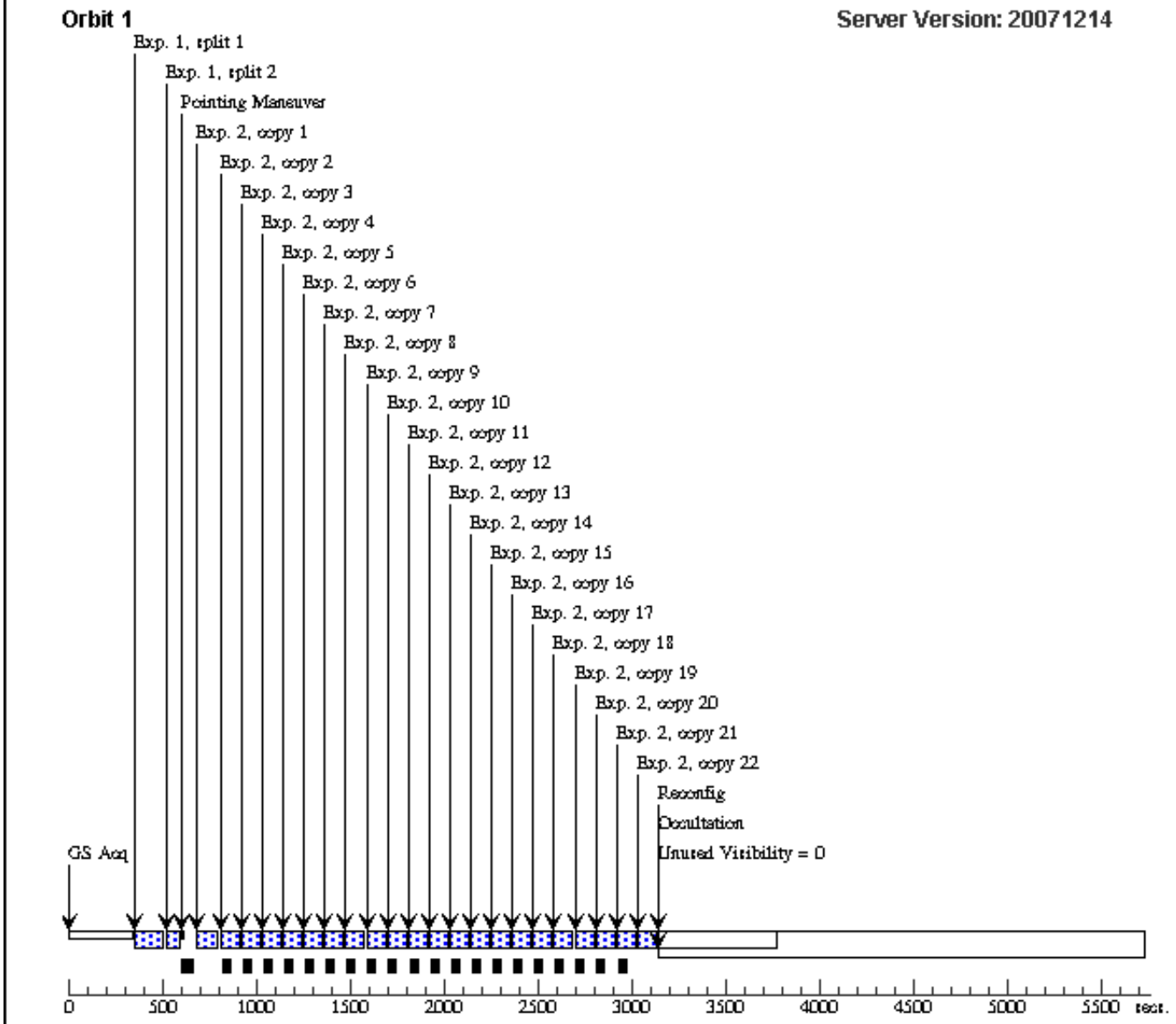
| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | RXJ0806 HRC image | (2) RX-J0806.3+1527 | ACS/HRC, ACCUM, HRC | F250W | | | | 66.0 Secs<br>*[==>(Split 1)]*<br>*[==>(Split 2)]* | <br>***[1]*** |
| *Comments: Zeropoint image instead of AUTOIMAGE* | | | | | | | | | |
| 2 | RXJ0806 HRC | (2) RX-J0806.3+1527 | ACS/HRC, ACCUM, HRC | PR200L | CR-SPLIT=NO;<br>AUTOIMAGE=NO | | | 60.0 Secs X 22<br>*[==>(Copy 1)]*<br>*[==>(Copy 2)]*<br>*[==>(Copy 3)]*<br>*[==>(Copy 4)]*<br>*[==>(Copy 5)]*<br>*[==>(Copy 6)]*<br>*[==>(Copy 7)]*<br>*[==>(Copy 8)]*<br>*[==>(Copy 9)]*<br>*[==>(Copy 10)]*<br>*[==>(Copy 11)]*<br>*[==>(Copy 12)]*<br>*[==>(Copy 13)]*<br>*[==>(Copy 14)]*<br>*[==>(Copy 15)]*<br>*[==>(Copy 16)]*<br>*[==>(Copy 17)]*<br>*[==>(Copy 18)]*<br>*[==>(Copy 19)]*<br>*[==>(Copy 20)]*<br>*[==>(Copy 21)]*<br>*[==>(Copy 22)]* | <br>***[1]*** |

**Exposures (continued)**

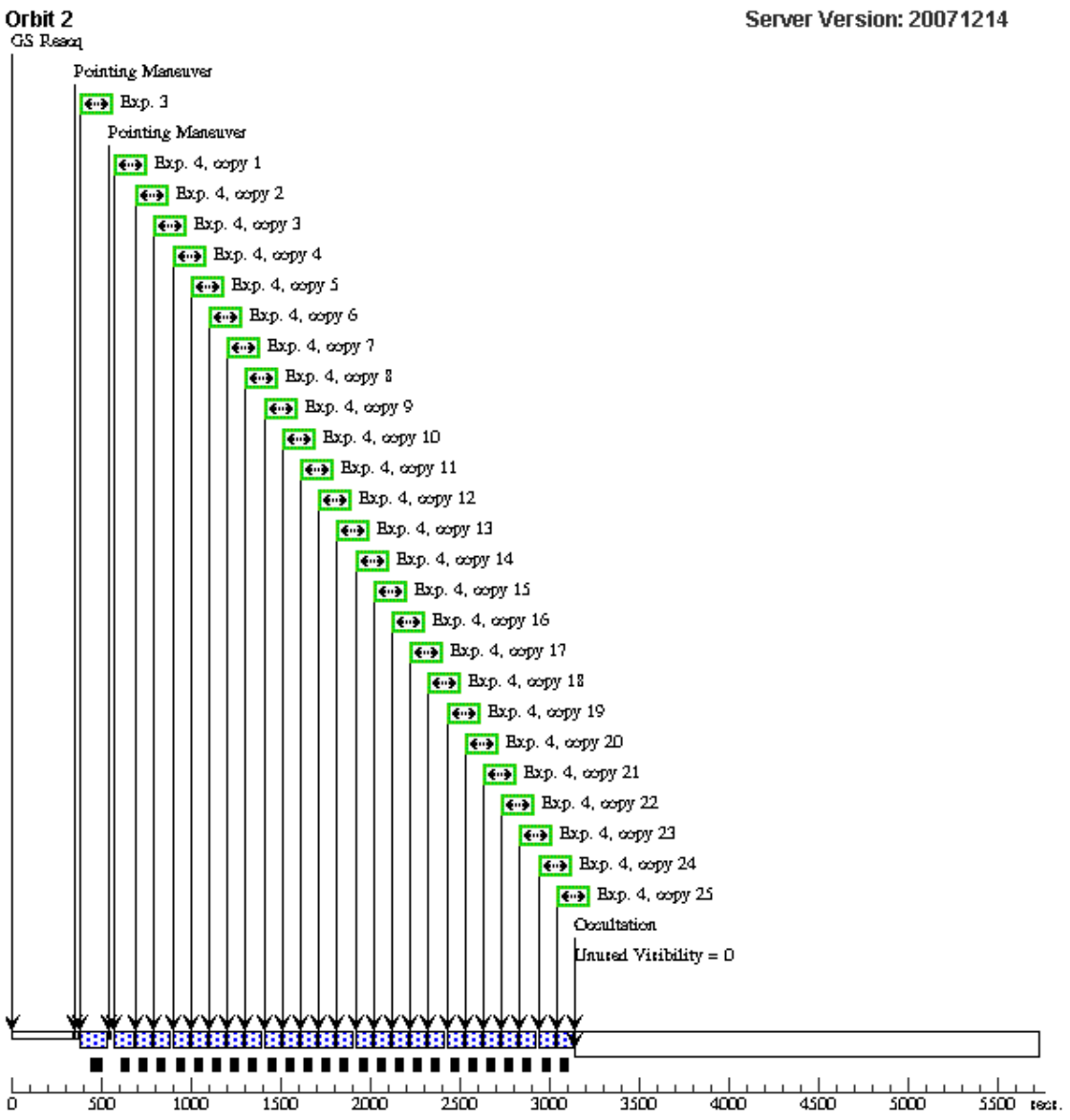
| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 3 | RXJ0806 SBC image | (2) RX-J0806.3+1527 | ACS/SBC, ACCUM, SBC | F115LP | | | | 82.0 Secs<br>*[==>]* | <br>***[2]*** |

*Comments: Zeropoint image instead of AUTOIMAGE*

**Orbit Structure**



**Orbit Structure (continued)**



**Orbit Structure (continued)**