# 13362 - Constraining the structure of the Kappa Cr B planetary system, a unique subgiant, orbited by two companions and a debris disc

Cycle: 21, Proposal Category: GO

(Availability Mode: SUPPORTED)

**INVESTIGATORS**



| *Name* | *Institution* | *E-Mail* |
|---|---|---|
| **Dr. Amy Bonsor (PI) (ESA Member) (Contact)** | **Institut de Planetologie et d'Astrophysique de Grenoble** | **amy.bonsor@gmail.com** |
| Dr. Grant Kennedy (CoI) (ESA Member) | University of Cambridge | grantkennedy@gmail.com |
| Prof. Mark Wyatt (CoI) (ESA Member) | University of Cambridge | wyatt@ast.cam.ac.uk |
| Dr. Paul Kalas (CoI) (AdminUSPI) (Contact) | University of California - Berkeley | kalas@astron.berkeley.edu |
| Dr. Steve Ertel (CoI) (ESA Member) | Institut de Planetologie et d'Astrophysique de Grenoble | steve.ertel@obs.ujf-grenoble.fr |



**VISITS**

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (1) KAPPACRB | STIS/CCD | 1 | 08-Oct-2013 21:37:30.0 | yes |
| 02 | (1) KAPPACRB | STIS/CCD | 1 | 08-Oct-2013 21:37:49.0 | yes |
| 03 | (1) KAPPACRB | STIS/CCD | 1 | 08-Oct-2013 21:38:05.0 | yes |
| 04 | (2) HD-139323 | STIS/CCD | 1 | 08-Oct-2013 21:38:21.0 | yes |

4 Total Orbits Used

**ABSTRACT**

We propose to use STIS to image, in scattered light, the debris disc orbiting the subgiant, kappa CrB, a multi-planet-hosting, 'retired' A star. Recently our Herschel imaging of the debris disc orbiting kappa Cr B, provided the first resolved images of a debris disc orbiting an evolved star. In addition, radial velocity observations have found two companions to this star, one giant planet with m sin I = 2.1MJ and a=2.8AU and a second companion, whose orbital parameters are poorly constrained. Modelling of the Herschel data was unable to distinguish between two possible distributions for the dust, one where it is distributed in a single wide belt and one in which it is split into two narrower rings. The increased angular resolution of HST will be used to determine the radial distribution of the dusty material in this planetary system, distinguishing between the two proposed scenarios, probing interactions between the planet(s) and the disc and further constraining the orbit of the second companion. In summary, Kappa CrB is a unique example of an intermediate mass star, evolved beyond the main-sequence and orbited by both planets and a debris disc, from which we can learn about the structure of planetary systems around intermediate mass stars, as well as probing their evolution beyond the main-sequence.

**OBSERVING DESCRIPTION**

This is a coronagraphic imaging with STIS of one science target, kappa CrB or HD 142091, in 3 orbits, and one PSF reference star HD 139384 in 1 orbit. The observations are patterned after Visit 91 of GO-12228 (PI Schneider), which targets HD 139664, a star that is 0.1 mag brighter than kappa CrB. A region of scientific interest for Kappa CrB is approximately 0.5" radius from the star. We therefore use the smallest wedge position WEDGEA0.6, in addition to WEDGEA2.0 for deeper imaging beyone the 1" radius region.

WEDGE POSITION: Within a single orbit, our exposure groups alternate between WEDGEA0.6 and WEDGEA2.0. The former consist of short exposures, the latter consist of long exposures, and the advantage is that buffer dumps of the short exposures occur during the first long exposure.

EXPOSURES: The GO-12228 data for HD 139664 showed successful short exposures at WEDGEA0.6 that did not saturate to the edge of the wedges. We therefore based our exposure time selections on the exposures for the HD 139664 STIS observations.

ORIENTs: The ORIENT constraints are due to the fact that the Kappa CrB debris disk is at PA=145 degrees. The constraints are therefore required to place the major axis of the disk away from the diffraction spikes and the wedge.

GROUP WITHIN: The four orbits should be executed in consecutive orbits in order to minimize breathing variations of the PSF. PSF subtraction is a critical step in the data analysis and requires thermal stability.

SCHEDULING: Due to the ORIENT and GROUP WITHIN constraints, the scheduling windows are hard to come by. The first narrow window is in February 26-27 2014.

## Visit

**Proposal 13362, Roll 1 (01), implementation** Wed Oct 09 01:38:31 GMT 2013

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 82.D TO 100 D; ORIENT 262D TO 280.0 D; SEQ 01,02,03,04 WITHIN 3.2 Orbits

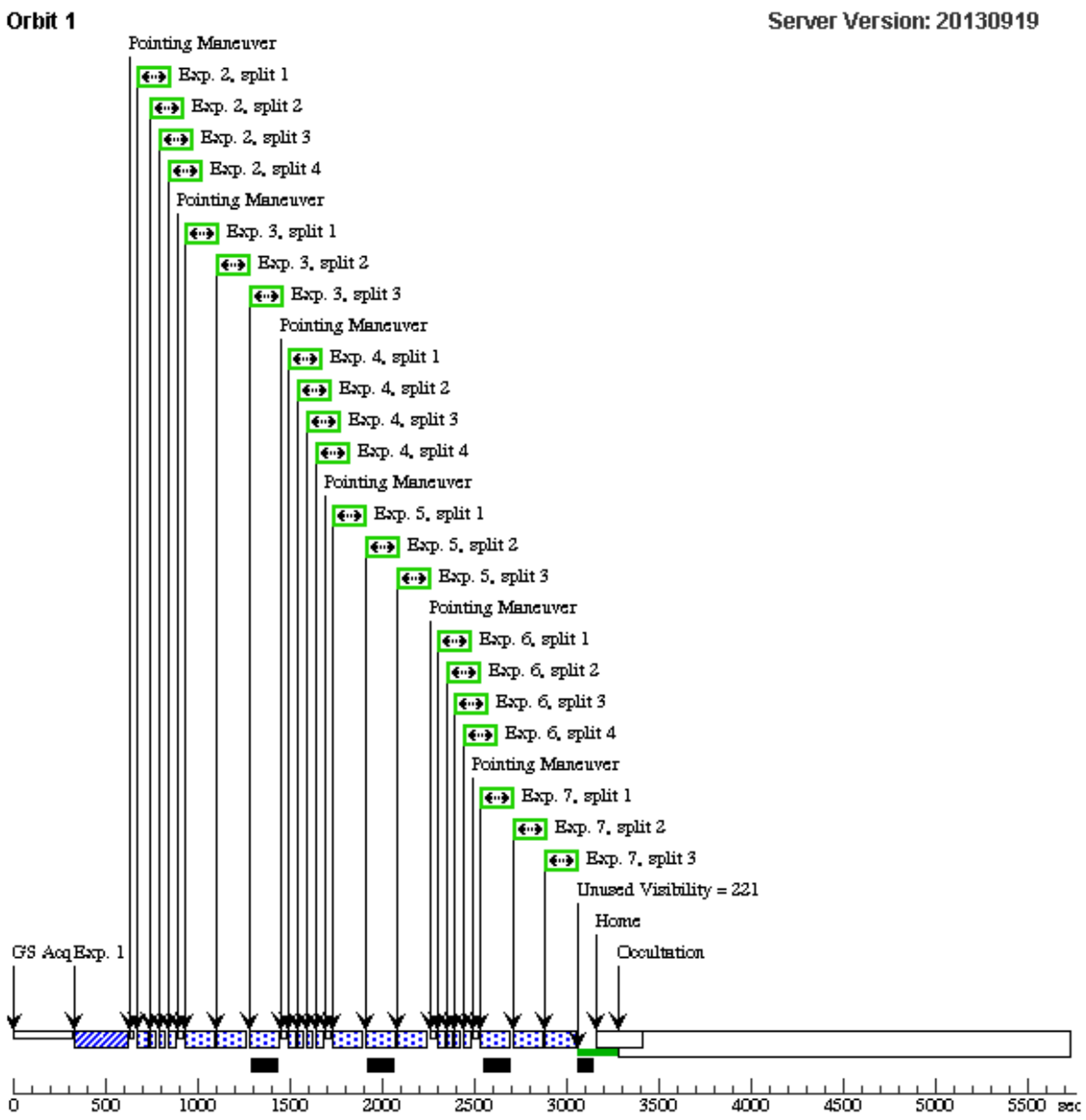
## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | KAPPACRB | RA: 15 51 13.9310 (237.8080458d) | Proper Motion RA: -8.55 mas/yr | V=4.796+/-0.009 | Reference Frame: ICRS |
| | Alt Name1: HD-142091 | Dec: +35 39 26.57 (35.65738d) | Proper Motion Dec: -348.44 mas/yr | B=5.81 R=4.2 | |
| | Alt Name2: HIP-77665 | Equinox: J2000 | Parallax: 0.032" | | |
| | | | Epoch of Position: 2000.0 | | |

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) KAPPACRB | STIS/CCD, ACQ, F25ND3 | MIRROR | | GS ACQ SCENARIO BASE1BN3 | | 0.1 Secs (0.1 Secs) | |
| | | | | | | | | *[==>]* | ***[1]*** |
| 2 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 3 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| 4 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 5 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| 6 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 7 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |

Orbit Structure



## Visit

**Proposal 13362, Roll 2 (02), implementation** Wed Oct 09 01:38:33 GMT 2013

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 15D TO 17D FROM 01

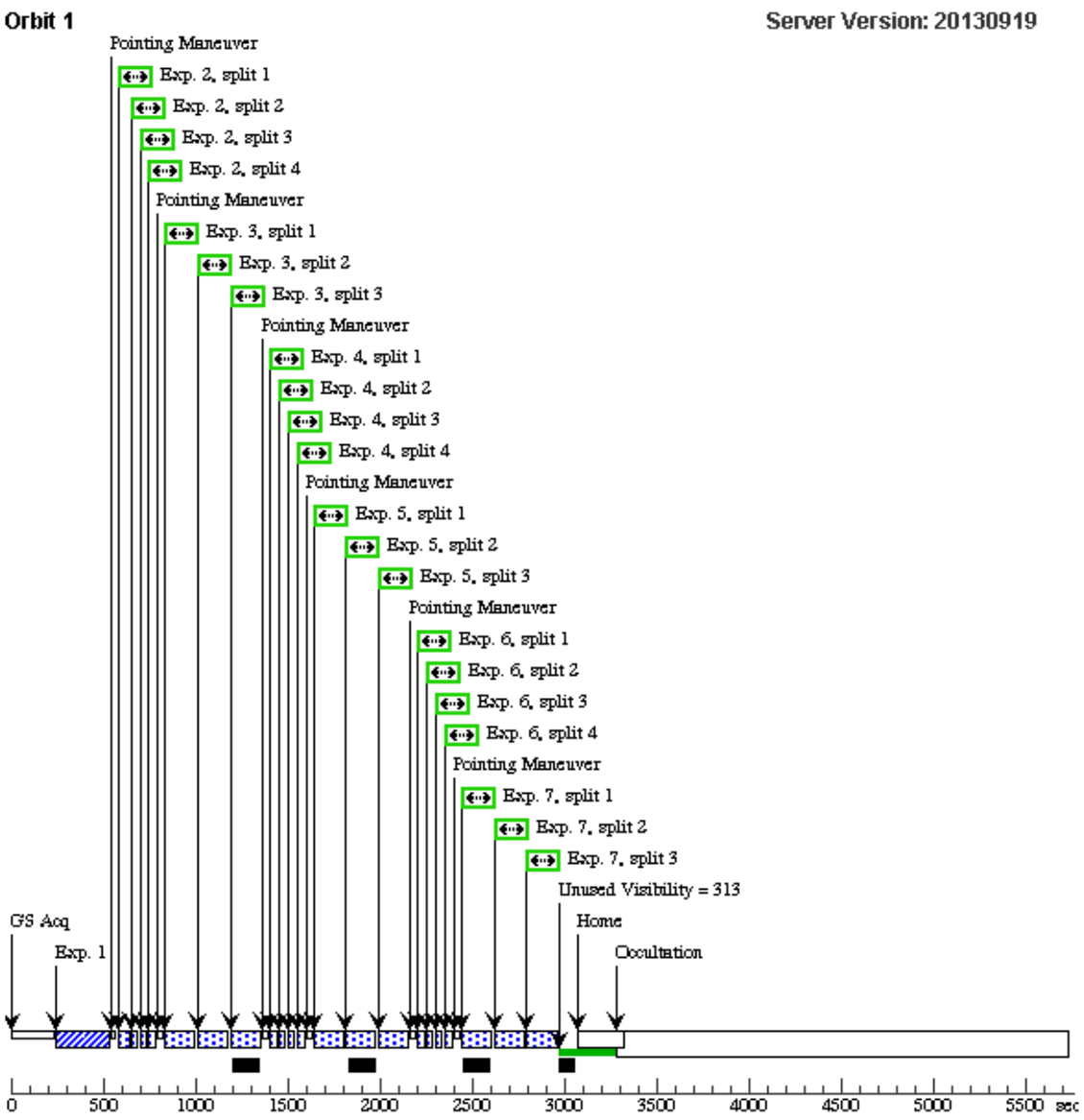
## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | KAPPACRB | RA: 15 51 13.9310 (237.8080458d) | Proper Motion RA: -8.55 mas/yr | V=4.796+/-0.009 | Reference Frame: ICRS |
| | Alt Name1: HD-142091 | Dec: +35 39 26.57 (35.65738d) | Proper Motion Dec: -348.44 mas/yr | B=5.81 R=4.2 | |
| | Alt Name2: HIP-77665 | Equinox: J2000 | Parallax: 0.032" | | |
| | | | Epoch of Position: 2000.0 | | |

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) KAPPACRB | STIS/CCD, ACQ, F25ND3 | MIRROR | | GS ACQ SCENARIO ONEB1BNS | | 0.1 Secs (0.1 Secs) | |
| | | | | | | | | *[==>]* | ***[1]*** |
| 2 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 3 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| 4 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 5 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| 6 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 7 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |

**Orbit Structure**



## Visit

**Proposal 13362, Roll 3 (03), implementation** Wed Oct 09 01:38:35 GMT 2013

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 28D TO 30D FROM 01

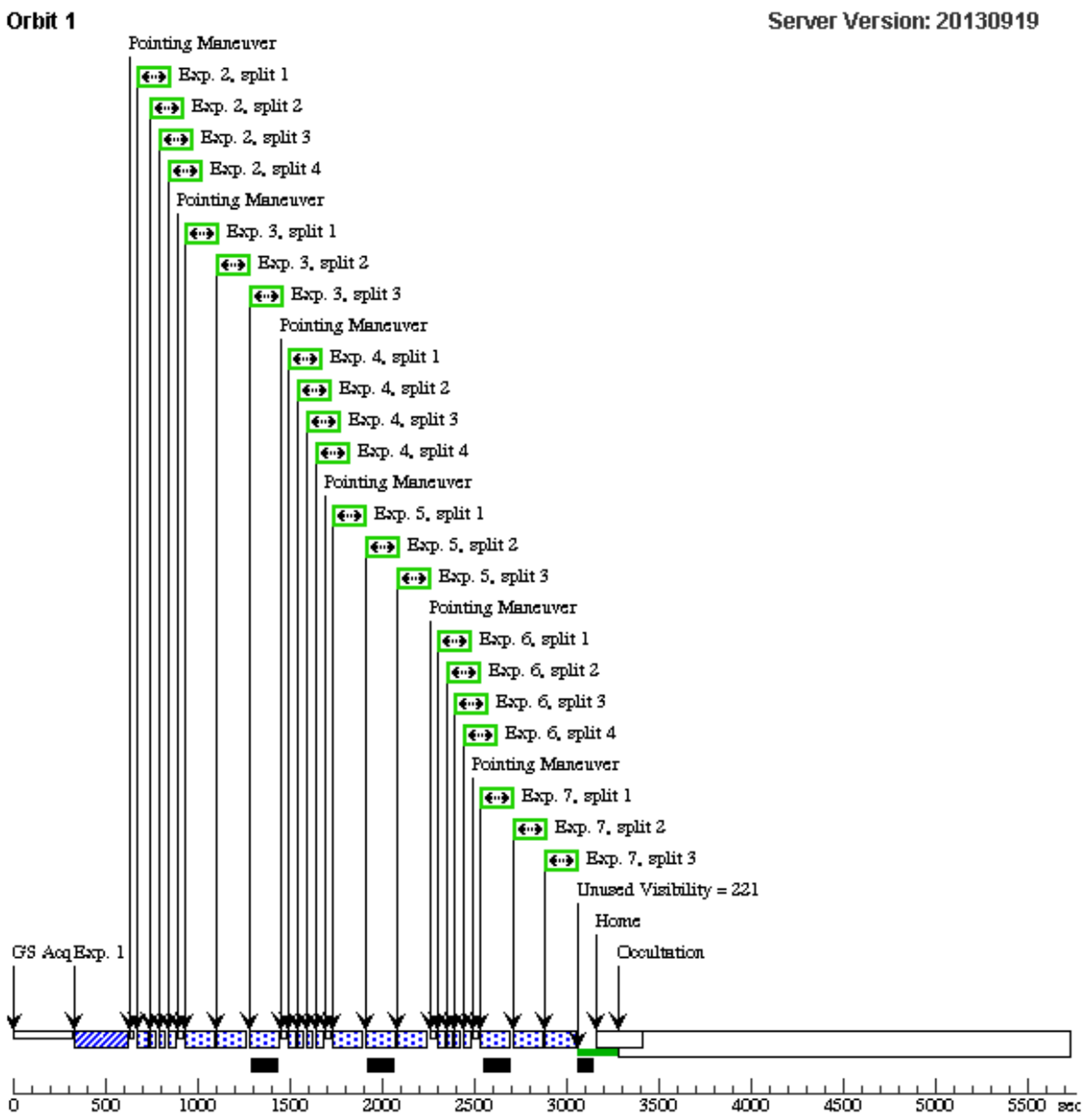
## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | KAPPACRB | RA: 15 51 13.9310 (237.8080458d) | Proper Motion RA: -8.55 mas/yr | V=4.796+/-0.009 | Reference Frame: ICRS |
| | Alt Name1: HD-142091 | Dec: +35 39 26.57 (35.65738d) | Proper Motion Dec: -348.44 mas/yr | B=5.81 R=4.2 | |
| | Alt Name2: HIP-77665 | Equinox: J2000 | Parallax: 0.032" | | |
| | | | Epoch of Position: 2000.0 | | |

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) KAPPACRB | STIS/CCD, ACQ, F25ND3 | MIRROR | | GS ACQ SCENARIO BASE1BN3 | | 0.1 Secs (0.1 Secs) | |
| | | | | | | | | *[==>]* | ***[1]*** |
| 2 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 3 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| 4 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 5 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| 6 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=4; GAIN=4 | | | 10 Secs (10 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |
| | | | | | | | | *[==>(Split 4)]* | |
| 7 | | (1) KAPPACRB | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4; CR-SPLIT=3 | | | 390 Secs (390 Secs) | |
| | | | | | | | | *[==>(Split 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Split 2)]* | |
| | | | | | | | | *[==>(Split 3)]* | |

Orbit Structure



## Visit

**Proposal 13362, PSF Reference (04), implementation** Wed Oct 09 01:38:36 GMT 2013

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD

Special Requirements: (none)

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (2) | HD-139323 | RA: 15 35 56.5666 (233.9856942d)<br>Dec: +39 49 52.03 (39.83112d)<br>Equinox: J2000 | Proper Motion RA: -448.39 mas/yr<br>Proper Motion Dec: 51.25 mas/yr<br>Parallax: 0.04469"<br>Epoch of Position: 2000.0 | V=7.56 | Reference Frame: ICRS |

*Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (2) HD-139323 | STIS/CCD, ACQ, F25ND3 | MIRROR | | GS ACQ SCENARIO BASE1BN3 | | 1.0 Secs (1 Secs)<br>*[==>]* | *[1]* |
| 2 | | (2) HD-139323 | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=3;<br>GAIN=4 | | | 75 Secs (75 Secs)<br>*[==>(Split 1)]*<br>*[==>(Split 2)]*<br>*[==>(Split 3)]* | *[1]* |
| 3 | | (2) HD-139323 | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4;<br>CR-SPLIT=3 | | | 390 Secs (390 Secs)<br>*[==>(Split 1)]*<br>*[==>(Split 2)]*<br>*[==>(Split 3)]* | *[1]* |
| 4 | | (2) HD-139323 | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=3;<br>GAIN=4 | | | 75 Secs (75 Secs)<br>*[==>(Split 1)]*<br>*[==>(Split 2)]*<br>*[==>(Split 3)]* | *[1]* |
| 5 | | (2) HD-139323 | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4;<br>CR-SPLIT=3 | | | 390 Secs (390 Secs)<br>*[==>(Split 1)]*<br>*[==>(Split 2)]*<br>*[==>(Split 3)]* | *[1]* |
| 6 | | (2) HD-139323 | STIS/CCD, ACCUM, WEDGEA0.6 | MIRROR | CR-SPLIT=3;<br>GAIN=4 | | | 75 Secs (75 Secs)<br>*[==>(Split 1)]*<br>*[==>(Split 2)]*<br>*[==>(Split 3)]* | *[1]* |
| 7 | | (2) HD-139323 | STIS/CCD, ACCUM, WEDGEA2.0 | MIRROR | GAIN=4;<br>CR-SPLIT=3 | | | 390 Secs (390 Secs)<br>*[==>(Split 1)]*<br>*[==>(Split 2)]*<br>*[==>(Split 3)]* | *[1]* |

Orbit Structure