



# 15975 - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing the Merger Hypothesis

Cycle: 27, Proposal Category: GO

(Availability Mode: SUPPORTED)

## INVESTIGATORS

| <i>Name</i>                       | <i>Institution</i>                                  | <i>E-Mail</i>                |
|-----------------------------------|-----------------------------------------------------|------------------------------|
| <b>Dr. Xin Liu (PI) (Contact)</b> | <b>University of Illinois at Urbana - Champaign</b> | <b>xinliuxl@illinois.edu</b> |
| Dr. Yue Shen (CoI)                | University of Illinois at Urbana - Champaign        | shenyue@illinois.edu         |

## 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) BSBH1                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:31.0        | yes                           |
| 02           | (2) BSBH2                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:34.0        | yes                           |
| 03           | (3) BSBH3                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:37.0        | yes                           |
| 04           | (4) BSBH4                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:39.0        | yes                           |
| 05           | (5) BSBH5                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:42.0        | yes                           |
| 06           | (6) BSBH6                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:44.0        | yes                           |
| 07           | (7) BSBH7                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:47.0        | yes                           |
| 08           | (8) BSBH8                    | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:50.0        | yes                           |
| 09           | (9) EGGR-67                  | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:52.0        | yes                           |
| 10           | (10) EGGR-102                | WFC3/IR                             | 1                  | 03-Sep-2019 10:01:54.0        | yes                           |

10 Total Orbits Used

## ABSTRACT

Sub-parsec (sub-pc) binary supermassive black holes (BSBHs) should be common from galaxy mergers, yet direct evidence has been elusive. We propose WFC3/IR imaging for a sample of 8 candidate sub-pc BSBHs at redshifts  $z \sim 0.1-0.5$ . The targets were identified from ordinary quasars and kinematically offset quasars whose broad H-beta lines are significantly offset (by  $> \sim$  a few hundred km/s) from the systemic redshifts. The offsets may be signposts for BSBHs, but they could also originate in broad-line region (BLR) kinematics or gravitational wave recoils. Using long-term spectroscopic monitoring, 8 strong BSBH candidates have been selected whose broad H-beta radial velocity (RV) shifts are consistent with binary orbital motion without line profile changes. However, complementary tests are necessary, because the time baselines required to cover a full binary cycle are typically much longer than human lifetimes. The proposed observations will directly test the prediction that the host galaxies of BSBHs should have a higher fraction of disturbed morphologies and younger stellar bulges (with low Sersic indices) from recent interactions than those of control quasars. The results will test the merger hypothesis, potentially providing supporting evidence for these sub-pc BSBH candidates, which are important as the progenitors of low-frequency gravitational wave sources. If confirmed, the results will help validate and improve the spectroscopic RV technique for selecting sub-pc BSBHs.

## OBSERVING DESCRIPTION

Our program includes 10 orbits, of which 8 orbits are for 8 science targets, and 2 orbits are for PSF stars.

Our science targets are a sample of 8 SDSS quasars at redshifts  $0.1 < z < 0.5$ . They are currently the strongest candidates known for hosting sub-pc BSBHs. They were selected from long-term, spectroscopic monitoring studies using the largest sample of quasars with multi-epoch spectra. To ensure robust measurements of host properties of our targets at  $0.1 < z < 0.5$ , we need both deep exposures and high imaging resolution. HST WFC3 is the ideal instrument for our scientific goals, given its superb sensitivity and diffraction-limited imaging quality.

We choose the WFC3/IR channel with the F160W (H) filter, which samples the rest-frame  $\sim 1$   $\mu$ m and probes the old stellar population. Working at 1  $\mu$ m has the advantage over shorter wavebands of reducing the impact of dust extinction and massive star forming regions on morphological measurements. The host-quasar contrast is also close to maximum at this wavelength and no strong quasar emission lines are included, optimal for the measurements of host morphologies. To detect the host and to obtain robust morphological measurements of its surface brightness profile, deep exposures are required. Studies have shown that shallow imaging data (HST SNAP or ground-based) make light profile fitting ambiguous, and are unable to detect low surface brightness features (such as extended disks, tidal features and faint companions), especially in the presence of a bright

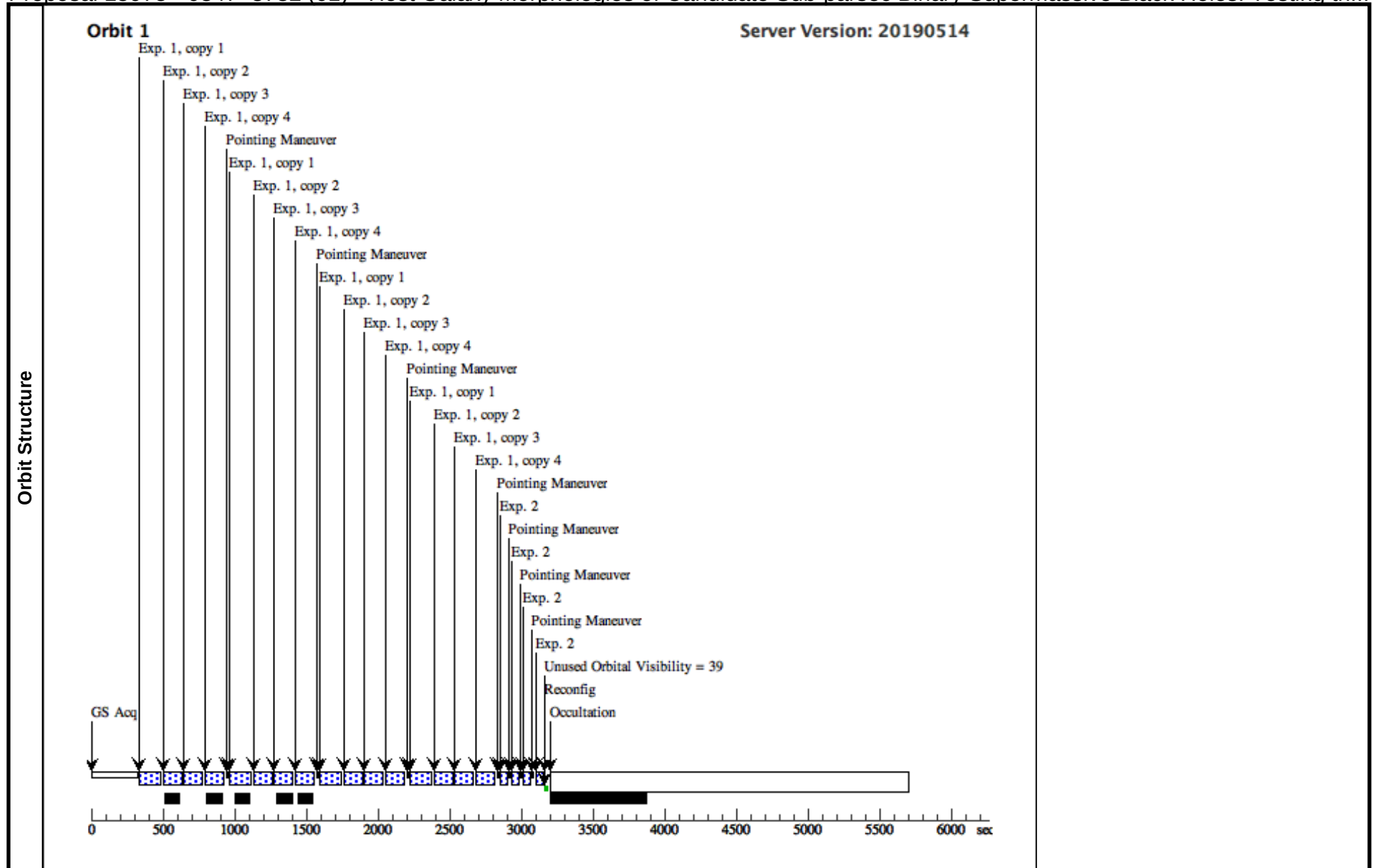
We use the 512x512 subarray to reduce readout and buffer dump. This provides a field-of-view (FOV) of 60"x60", or 400 kpc at  $z \sim 0.5$ , enough to cover the host and close companions. The control quasar sample has a median redshift  $z \sim 0.2$  observed to a surface brightness limit of  $H \sim 22$  mag arcsec $^{-2}$  (Vega) with NICMOS. Accounting for surface brightness dimming for the targets at higher redshifts,  $H \sim 23.5$  mag arcsec $^{-2}$  is needed for a fair comparison. For the faintest target with  $H \sim 16.3$  mag, we will take 12 exposures each using STEP25 with NSAMP=10 (total exposure time  $\sim 30$  min). We will use the 4-step BOX dither pattern for cosmic-ray and hot-pixel rejection, and to better sample the PSF. We will reach  $H \sim 24$  mag arcsec $^{-2}$  (Vega, for a  $3\sigma$  detection within a 0.65"x0.65" aperture, assuming an elliptical galaxy SED at  $z \sim 0.5$ ), needed for detecting extended disks and tidal features. We need a full orbit for each target accounting for overhead.

Accurate PSFs are crucial for our science goals. Studies have shown that the PSFs vary from weeks to months, and the rms difference between PSFs taken 6 months apart can be as large as 20%. Thus ideally we want simultaneously observing PSF stars and science targets. In practice, we will divide the targets into two groups by RA, and request block visits for each. In each block we will observe one additional orbit for a PSF star, with the same filters and dither patterns as our targets, to create high dynamic range PSFs. As a backup, we will utilize archival PSFs and stars within the FOVs of our targets to monitor the spatial, temporal and color variations of the PSFs.

The impact of reduced-gyro operations on our program is likely to be significant. Given the rarity of our targets as the best 8 BSBH candidates, we need to observe all of them, if not more, to put the comparative study on firm statistical ground. Completing only part of our program will make the interpretation of the results more difficult.

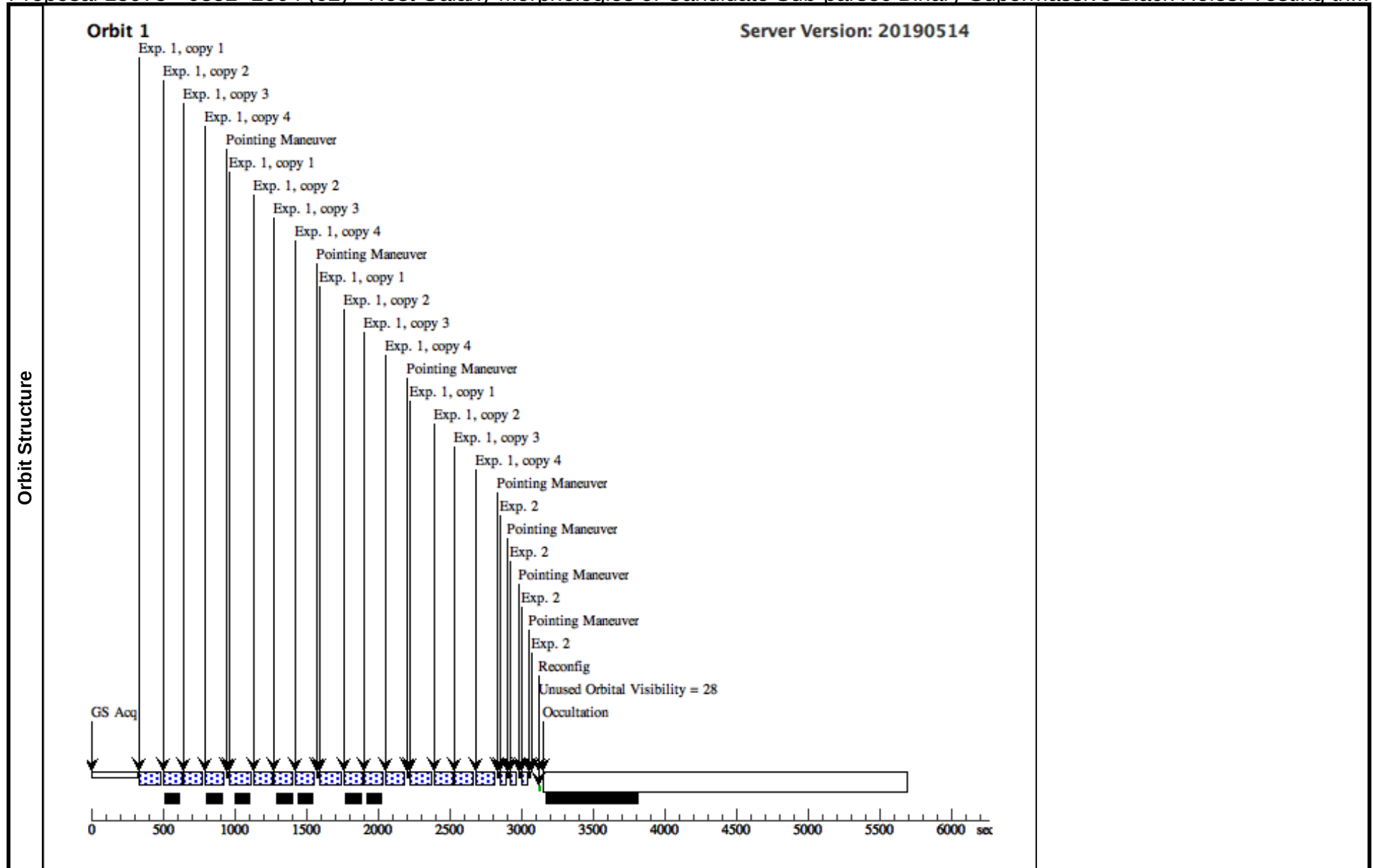
# Proposal 15975 - 0847+3732 (01) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|-------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|--|
| Visit         | Proposal 15975, 0847+3732 (01), implementation                       |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Tue Sep 03 14:01:55 GMT 2019 |           |  |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Special Requirements: (none)                                         |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                               |                                                                                     |                                                                                                               |                             | Secondary Pattern            |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Exposures |  |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                               |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | (1), (2)  |  |
| Fixed Targets | #                                                                    | Name                                                                                                                     |                               | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections    |                              | Fluxes                                    |                                                                              | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |           |  |
|               | (1)                                                                  | BSBH1                                                                                                                    |                               | RA: 08 47 16.0400 (131.8168333d)<br>Dec: +37 32 18.10 (37.53836d)<br>Equinox: J2000 |                                                                                                               | Parallax: 0"                |                              | V=18.51<br>H = 16.00                      |                                                                              | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |           |  |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                        | Config,Mode,Aperture                                                                |                                                                                                               | Spectral Els.               | Opt. Params.                 | Special Reqs.                             | Groups                                                                       | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Orbit     |  |
|               | 1                                                                    |                                                                                                                          | (1) BSBH1                     | WFC3/IR, MULTIACCUM, IRSUB512                                                       |                                                                                                               | F160W                       | NSAMP=10;<br>SAMP-SEQ=STEP25 |                                           | Pattern 1, Exps 1-1 in 0847+3732 (01) (1)                                    | 128.439646 Secs X 4 (2055.034 Secs)                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |                              | [1]       |  |
| 2             |                                                                      | (1) BSBH1                                                                                                                | WFC3/IR, MULTIACCUM, IRSUB512 |                                                                                     | F160W                                                                                                         | NSAMP=8;<br>SAMP-SEQ=SPARS5 |                              | Pattern 1, Exps 2-2 in 0847+3732 (01) (1) | 21.303576 Secs (85.214 Secs)                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]                          |           |  |



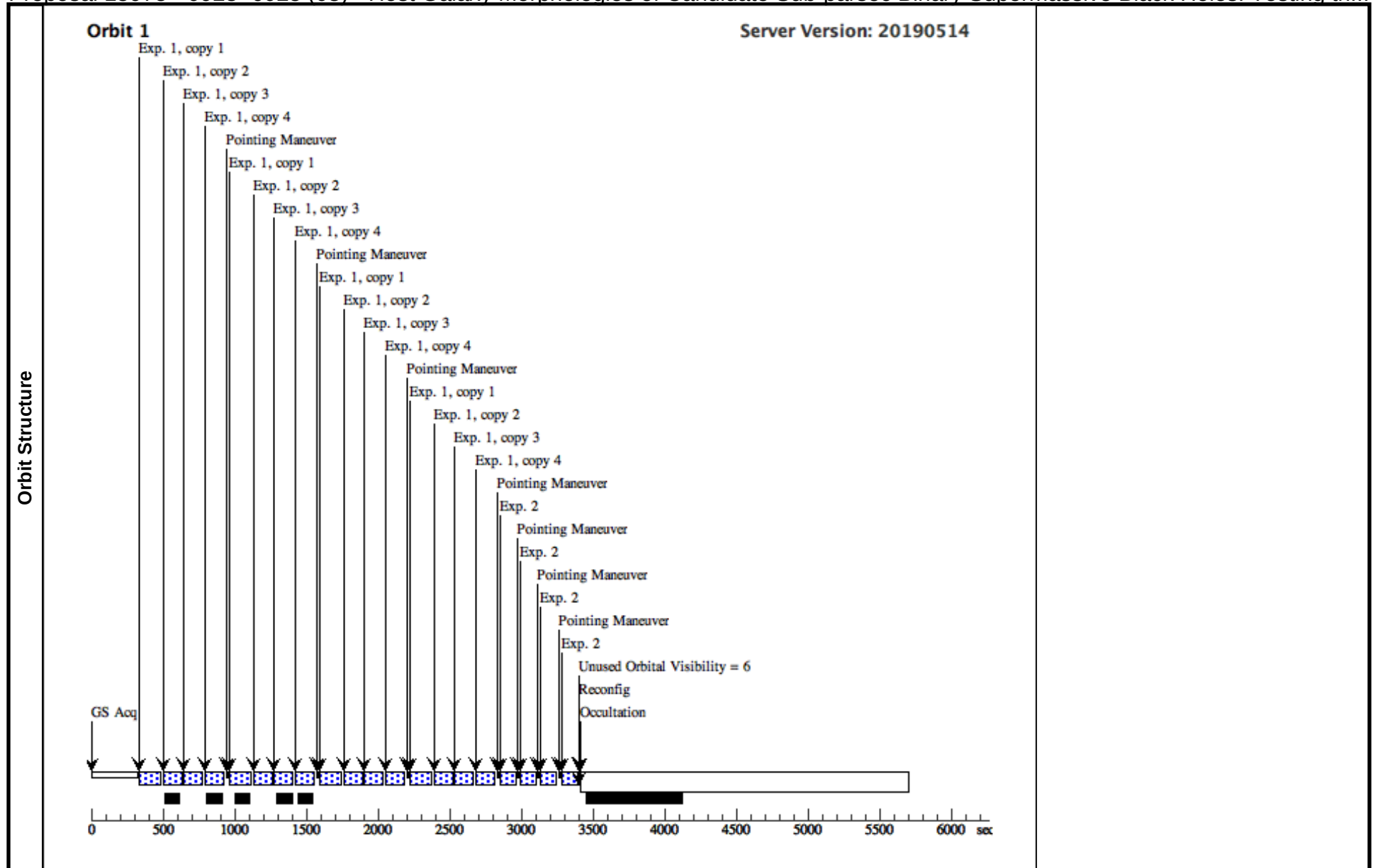
# Proposal 15975 - 0852+2004 (02) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |           |  |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------------|----------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|--|
| Visit         | Proposal 15975, 0852+2004 (02), implementation                       |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Tue Sep 03 14:01:55 GMT 2019 |           |  |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |           |  |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |           |  |
|               | Special Requirements: (none)                                         |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |           |  |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |           |                                                                                     |                                                                                                               |                          | Secondary Pattern            |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              | Exposures |  |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |           |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              | (1), (2)  |  |
| Fixed Targets | #                                                                    | Name                                                                                                                     |           | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections |                              | Fluxes               |                                           | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |           |  |
|               | (2)                                                                  | BSBH2                                                                                                                    |           | RA: 08 52 37.0200 (133.1542500d)<br>Dec: +20 04 11.00 (20.06972d)<br>Equinox: J2000 |                                                                                                               |                          |                              | V=18.27<br>H = 16.07 |                                           | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |           |  |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |           |  |
|               |                                                                      |                                                                                                                          |           |                                                                                     |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |           |  |
| Exposures     | #                                                                    | Label                                                                                                                    | Target    | Config,Mode,Aperture                                                                |                                                                                                               | Spectral Els.            | Opt. Params.                 | Special Reqs.        | Groups                                    | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              | Orbit     |  |
|               | 1                                                                    |                                                                                                                          | (2) BSBH2 | WFC3/IR, MULTIACCUM, IRSUB512                                                       |                                                                                                               | F160W                    | NSAMP=10;<br>SAMP-SEQ=STEP25 |                      | Pattern 1, Exps 1-1 in 0852+2004 (02) (1) | 128.439646 Secs X 4 (2055.034 Secs)<br>[==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |                              | [1]       |  |
|               | 2                                                                    |                                                                                                                          | (2) BSBH2 | WFC3/IR, MULTIACCUM, IRSUB512                                                       |                                                                                                               | F160W                    | NSAMP=15;<br>SAMP-SEQ=RAPID  |                      | Pattern 1, Exps 2-2 in 0852+2004 (02) (1) | 12.795405 Secs (51.182 Secs)<br>[==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)]                                                                                                                                                                                                                                                                                                                                                                                        |                              | [1]       |  |



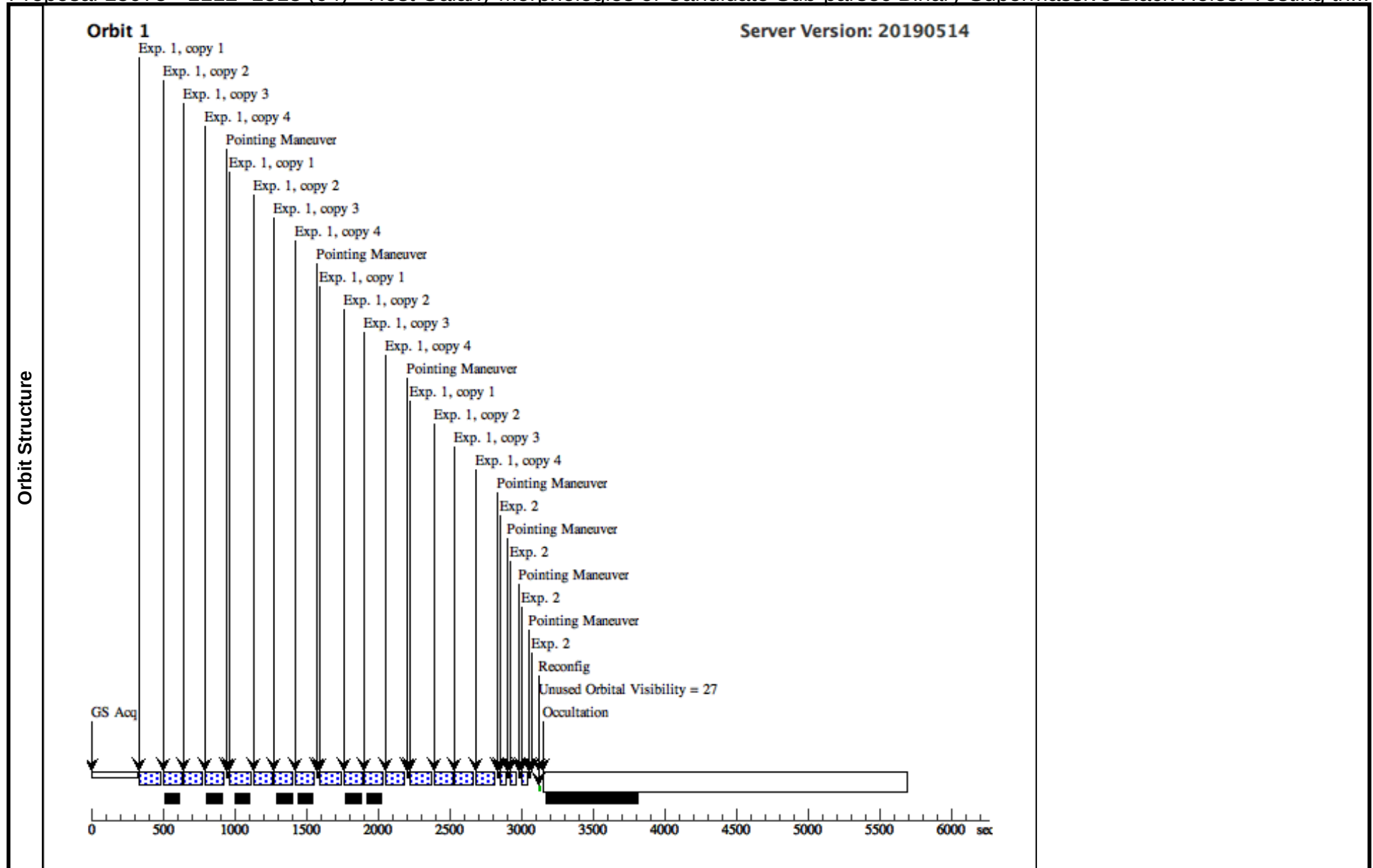
# Proposal 15975 - 0928+6025 (03) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------|-------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|--|
| Visit         | Proposal 15975, 0928+6025 (03), implementation                       |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              | Tue Sep 03 14:01:55 GMT 2019 |           |  |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Special Requirements: (none)                                         |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                               |                                                                                     |                                                                                                               |                                 | Secondary Pattern                |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Exposures |  |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                               |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | (1), (2)  |  |
| Fixed Targets | #                                                                    | Name                                                                                                                     |                               | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections        |                                  | Fluxes                                    |                                                                          | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |           |  |
|               | (3)                                                                  | BSBH3                                                                                                                    |                               | RA: 09 28 37.9800 (142.1582500d)<br>Dec: +60 25 21.00 (60.42250d)<br>Equinox: J2000 |                                                                                                               |                                 |                                  | V=17.20<br>H = 14.73                      |                                                                          | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |           |  |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                        | Config,Mode,Aperture                                                                |                                                                                                               | Spectral Els.                   | Opt. Params.                     | Special Reqs.                             | Groups                                                                   | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Orbit     |  |
|               | 1                                                                    |                                                                                                                          | (3) BSBH3                     | WFC3/IR, MULTIACCUM, IRSUB512                                                       |                                                                                                               | F160W                           | NSAMP=10;<br>SAMP-SEQ=STEP2<br>5 |                                           | Pattern 1, Exps 1-1 in 0928+6025 (03) (1)                                | 128.439646 Secs X 4 (2055.034 Secs)                                                                                                                                                                                                                                                                                                                                                                                                          |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           |                                                                          | [=>(Pattern 1, Copy 1)]<br>[=>(Pattern 1, Copy 2)]<br>[=>(Pattern 1, Copy 3)]<br>[=>(Pattern 1, Copy 4)]<br>[=>(Pattern 2, Copy 1)]<br>[=>(Pattern 2, Copy 2)]<br>[=>(Pattern 2, Copy 3)]<br>[=>(Pattern 2, Copy 4)]<br>[=>(Pattern 3, Copy 1)]<br>[=>(Pattern 3, Copy 2)]<br>[=>(Pattern 3, Copy 3)]<br>[=>(Pattern 3, Copy 4)]<br>[=>(Pattern 4, Copy 1)]<br>[=>(Pattern 4, Copy 2)]<br>[=>(Pattern 4, Copy 3)]<br>[=>(Pattern 4, Copy 4)] |                              | [1]       |  |
| 2             |                                                                      | (3) BSBH3                                                                                                                | WFC3/IR, MULTIACCUM, IRSUB512 |                                                                                     | F160W                                                                                                         | NSAMP=8;<br>SAMP-SEQ=STEP2<br>5 |                                  | Pattern 1, Exps 2-2 in 0928+6025 (03) (1) | 82.597144 Secs (330.389 Secs)                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                                 |                                  |                                           | [=>(Pattern 1)]<br>[=>(Pattern 2)]<br>[=>(Pattern 3)]<br>[=>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]                          |           |  |



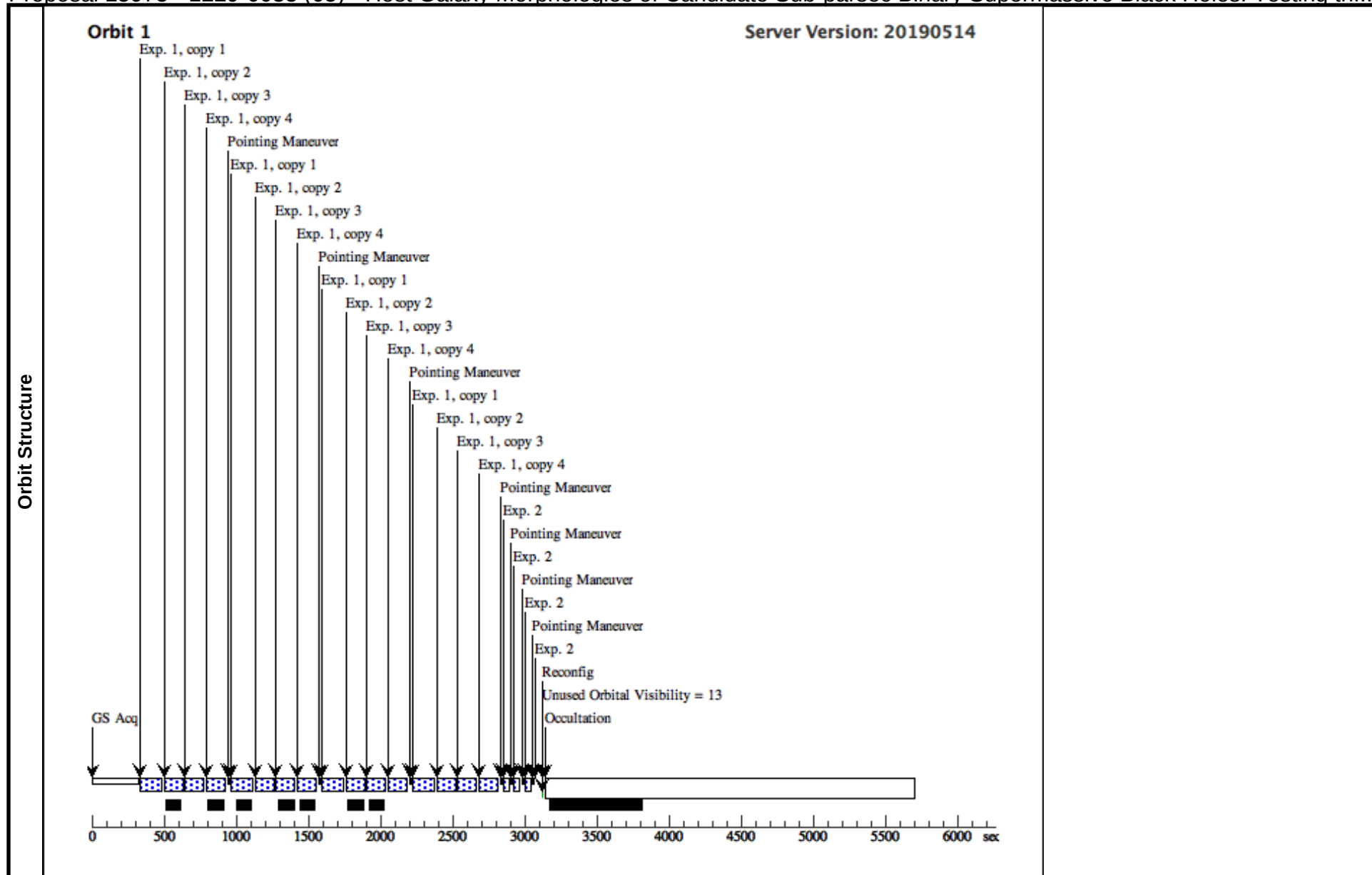
# Proposal 15975 - 1112+1813 (04) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|-------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|--|
| Visit         | Proposal 15975, 1112+1813 (04), implementation                       |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Tue Sep 03 14:01:55 GMT 2019 |           |  |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Special Requirements: (none)                                         |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                               |                                                                                     |                                                                                                               |                             | Secondary Pattern            |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Exposures |  |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                               |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | (1), (2)  |  |
| Fixed Targets | #                                                                    | Name                                                                                                                     |                               | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections    |                              | Fluxes                                    |                                                                              | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |           |  |
|               | (4)                                                                  | BSBH4                                                                                                                    |                               | RA: 11 12 30.9000 (168.1287500d)<br>Dec: +18 13 11.40 (18.21983d)<br>Equinox: J2000 |                                                                                                               |                             |                              | V=18.43<br>H = 15.39                      |                                                                              | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |           |  |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                        | Config,Mode,Aperture                                                                |                                                                                                               | Spectral Els.               | Opt. Params.                 | Special Reqs.                             | Groups                                                                       | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Orbit     |  |
|               | 1                                                                    |                                                                                                                          | (4) BSBH4                     | WFC3/IR, MULTIACCUM, IRSUB512                                                       |                                                                                                               | F160W                       | NSAMP=10;<br>SAMP-SEQ=STEP25 |                                           | Pattern 1, Exps 1-1 in 1112+1813 (04) (1)                                    | 128.439646 Secs X 4 (2055.034 Secs)                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |                              | [1]       |  |
| 2             |                                                                      | (4) BSBH4                                                                                                                | WFC3/IR, MULTIACCUM, IRSUB512 |                                                                                     | F160W                                                                                                         | NSAMP=15;<br>SAMP-SEQ=RAPID |                              | Pattern 1, Exps 2-2 in 1112+1813 (04) (1) | 12.795405 Secs (51.182 Secs)                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]                          |           |  |



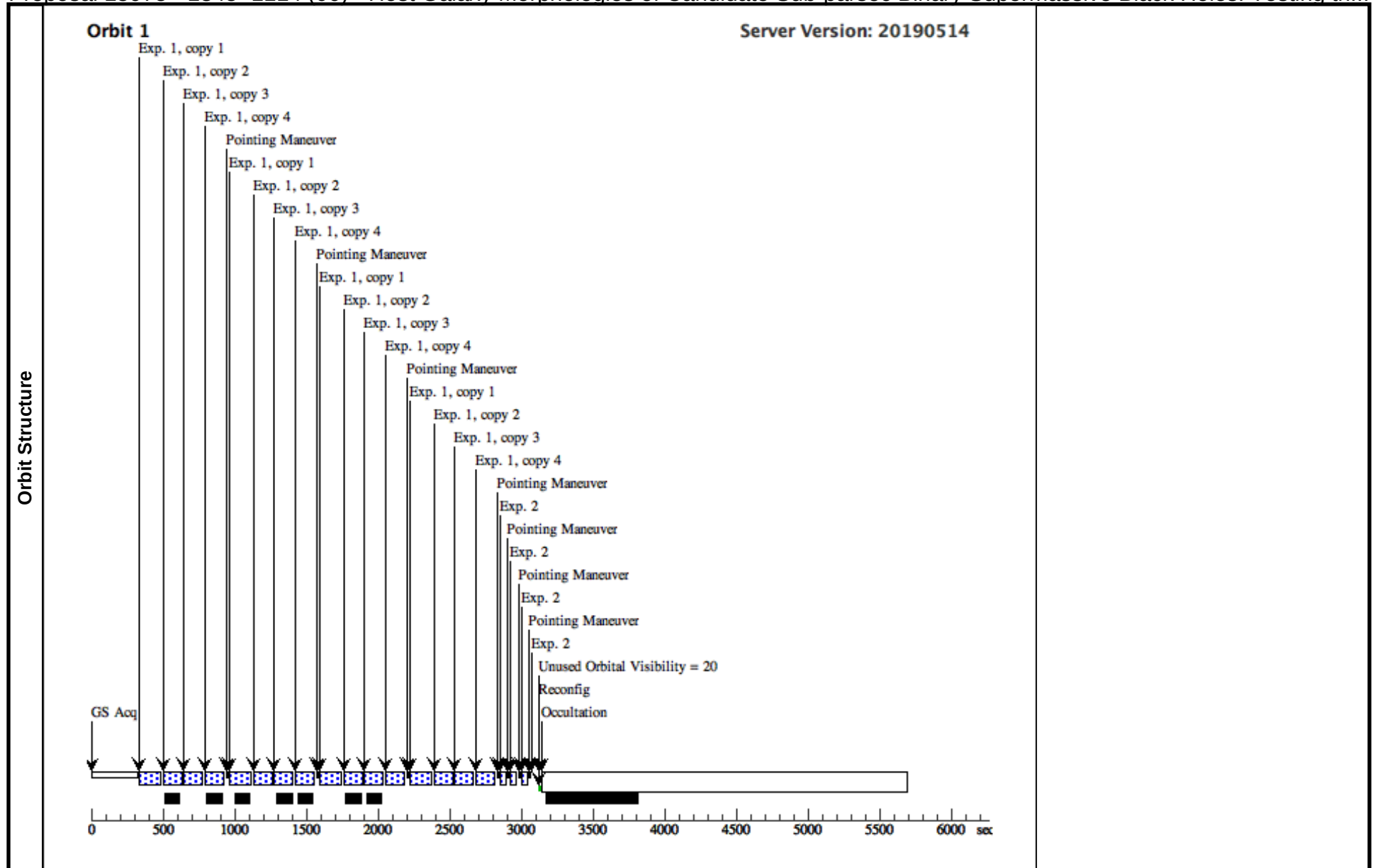
Proposal 15975 - 1229-0035 (05) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                              |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|------------------------------|----------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------|
| Visit         | Proposal 15975, 1229-0035 (05), implementation                       |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           | Tue Sep 03 14:01:55 GMT 2019 |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                              |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                              |
|               | Special Requirements: (none)                                         |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                              |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                                                                                   |                                                                                                               |                          | Secondary Pattern            |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Exposures |                              |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                                                                                   | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | (1), (2)  |                              |
| Fixed Targets | #                                                                    | Name                                                                                                                     | Target Coordinates                                                                |                                                                                                               | Targ. Coord. Corrections |                              | Fluxes               |                                           | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |                              |
|               | (5)                                                                  | BSBH5                                                                                                                    | RA: 12 29 9.5200 (187.2896667d)<br>Dec: -00 35 30.00 (-.59167d)<br>Equinox: J2000 |                                                                                                               |                          |                              | V=18.39<br>H = 16.32 |                                           | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                              |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                              |
|               |                                                                      |                                                                                                                          |                                                                                   |                                                                                                               |                          |                              |                      |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                              |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                                                                            | Config,Mode,Aperture                                                                                          | Spectral Els.            | Opt. Params.                 | Special Reqs.        | Groups                                    | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           | Orbit                        |
|               | 1                                                                    |                                                                                                                          | (5) BSBH5                                                                         | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                    | NSAMP=10;<br>SAMP-SEQ=STEP25 |                      | Pattern 1, Exps 1-1 in 1229-0035 (05) (1) | 128.439646 Secs X 4 (2055.034 Secs)<br>[==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |           | [1]                          |
|               | 2                                                                    |                                                                                                                          | (5) BSBH5                                                                         | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                    | NSAMP=15;<br>SAMP-SEQ=RAPID  |                      | Pattern 1, Exps 2-2 in 1229-0035 (05) (1) | 12.795405 Secs (51.182 Secs)<br>[==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)]                                                                                                                                                                                                                                                                                                                                                                                        |           | [1]                          |



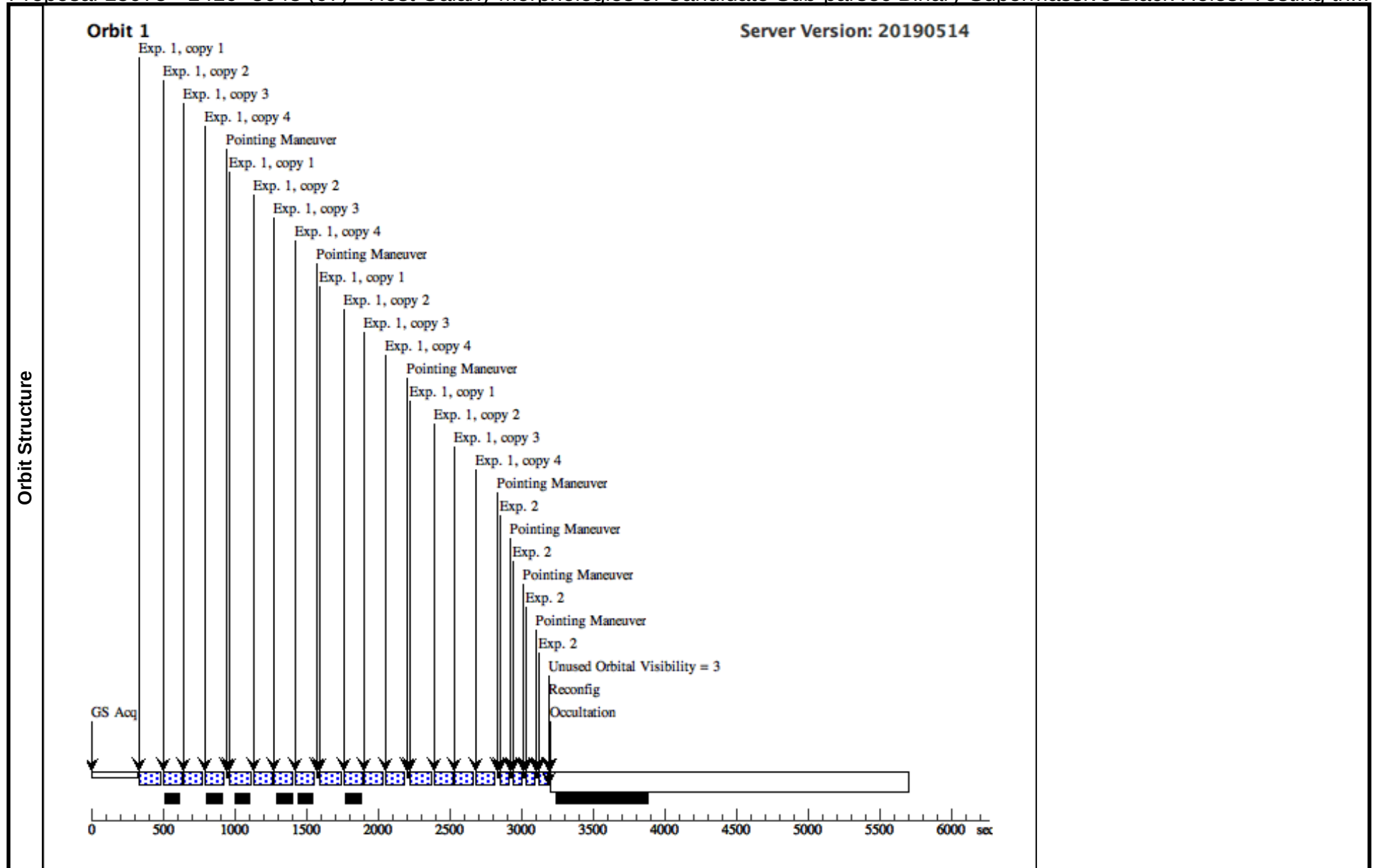
# Proposal 15975 - 1345+1114 (06) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|-------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|--|
| Visit         | Proposal 15975, 1345+1114 (06), implementation                       |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Tue Sep 03 14:01:56 GMT 2019 |           |  |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               | Special Requirements: (none)                                         |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                               |                                                                                     |                                                                                                               |                             | Secondary Pattern            |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Exposures |  |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                               |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | (1), (2)  |  |
| Fixed Targets | #                                                                    | Name                                                                                                                     |                               | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections    |                              | Fluxes                                    |                                                                              | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |           |  |
|               | (6)                                                                  | BSBH6                                                                                                                    |                               | RA: 13 45 48.5000 (206.4520833d)<br>Dec: +11 44 43.50 (11.74542d)<br>Equinox: J2000 |                                                                                                               |                             |                              | V=17.43<br>H (AB) = 15.85                 |                                                                              | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |           |  |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                        | Config,Mode,Aperture                                                                |                                                                                                               | Spectral Els.               | Opt. Params.                 | Special Reqs.                             | Groups                                                                       | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                              |                              | Orbit     |  |
|               | 1                                                                    |                                                                                                                          | (6) BSBH6                     | WFC3/IR, MULTIACCUM, IRSUB512                                                       |                                                                                                               | F160W                       | NSAMP=10;<br>SAMP-SEQ=STEP25 |                                           | Pattern 1, Exps 1-1 in 1345+1114 (06) (1)                                    | 128.439646 Secs X 4 (2055.034 Secs)                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           |                                                                              | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |                              | [1]       |  |
| 2             |                                                                      | (6) BSBH6                                                                                                                | WFC3/IR, MULTIACCUM, IRSUB512 |                                                                                     | F160W                                                                                                         | NSAMP=15;<br>SAMP-SEQ=RAPID |                              | Pattern 1, Exps 2-2 in 1345+1114 (06) (1) | 12.795405 Secs (51.182 Secs)                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |           |  |
|               |                                                                      |                                                                                                                          |                               |                                                                                     |                                                                                                               |                             |                              |                                           | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]                          |           |  |



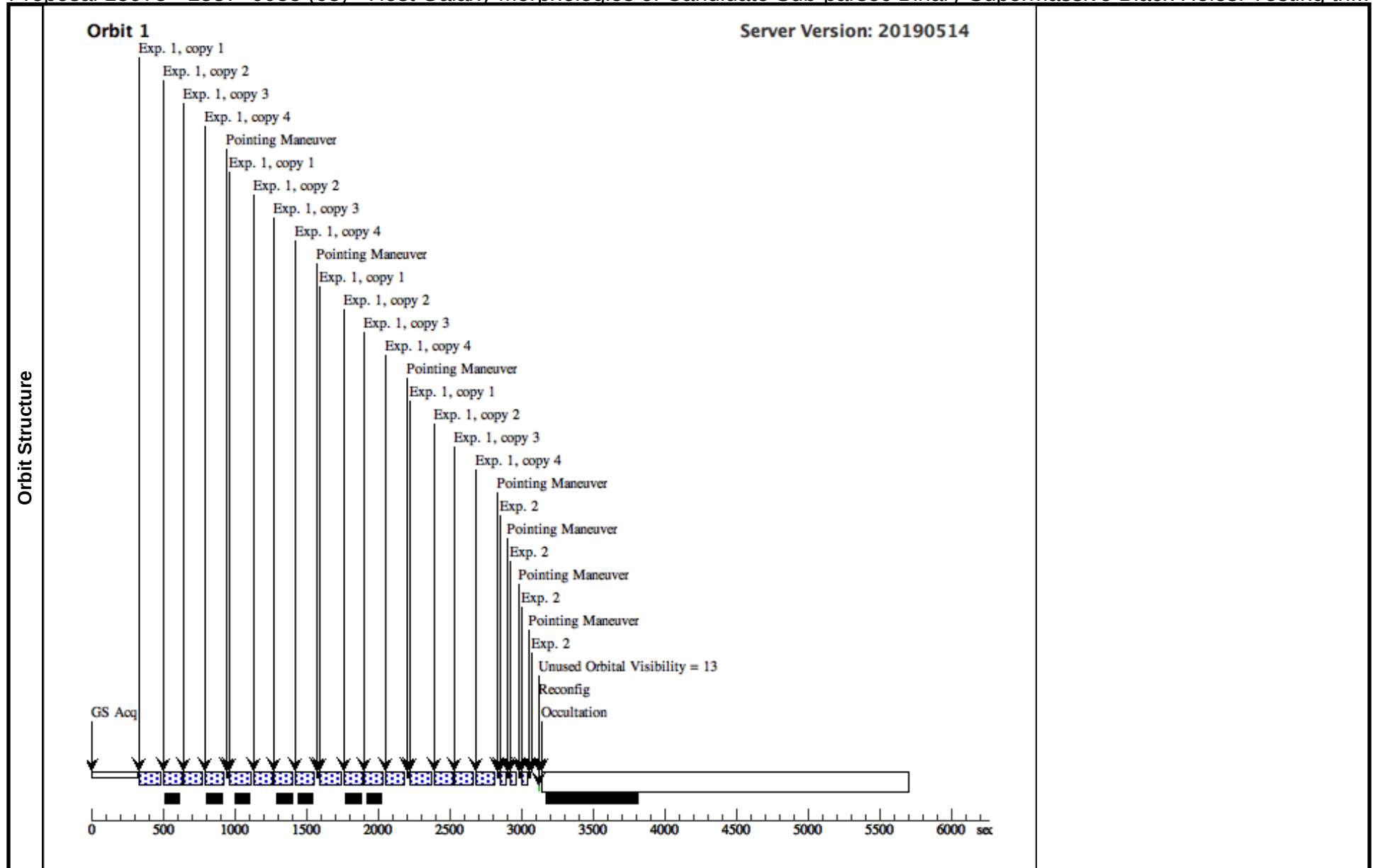
Proposal 15975 - 1410+3643 (07) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|-------------------------------|----------------------|-------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Visit         | Proposal 15975, 1410+3643 (07), implementation                       |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Tue Sep 03 14:01:56 GMT 2019 |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | Special Requirements: (none)                                         |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                                                                                     |                                                                                                               |                          | Secondary Pattern             |                      |                                           |                                                                              | Exposures                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                          |                               |                      |                                           |                                                                              | (1), (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |
| Fixed Targets | #                                                                    | Name                                                                                                                     | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections |                               | Fluxes               |                                           | Miscellaneous                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | (7)                                                                  | BSBH7                                                                                                                    | RA: 14 10 20.5700 (212.5857083d)<br>Dec: +36 43 22.70 (36.72297d)<br>Equinox: J2000 |                                                                                                               |                          |                               | V=18.56<br>H = 16.02 |                                           | Reference Frame: ICRS                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               |                                                                      |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                                                                              | Config,Mode,Aperture                                                                                          | Spectral Els.            | Opt. Params.                  | Special Reqs.        | Groups                                    | Exp. Time (Total)/[Actual Dur.]                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Orbit                        |
|               | 1                                                                    |                                                                                                                          | (7) BSBH7                                                                           | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                    | NSAMP=10;<br>SAMP-SEQ=STEP25  |                      | Pattern 1, Exps 1-1 in 1410+3643 (07) (1) | 128.439646 Secs X 4 (2055.034 Secs)                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               |                                                                      |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           |                                                                              | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |                              |
|               | 2                                                                    |                                                                                                                          | (7) BSBH7                                                                           | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                    | NSAMP=11;<br>SAMP-SEQ=SPAR S5 |                      | Pattern 1, Exps 2-2 in 1410+3643 (07) (1) | 30.068097 Secs (120.272 Secs)                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               |                                                                      |                                                                                                                          |                                                                                     |                                                                                                               |                          |                               |                      |                                           | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]                          |



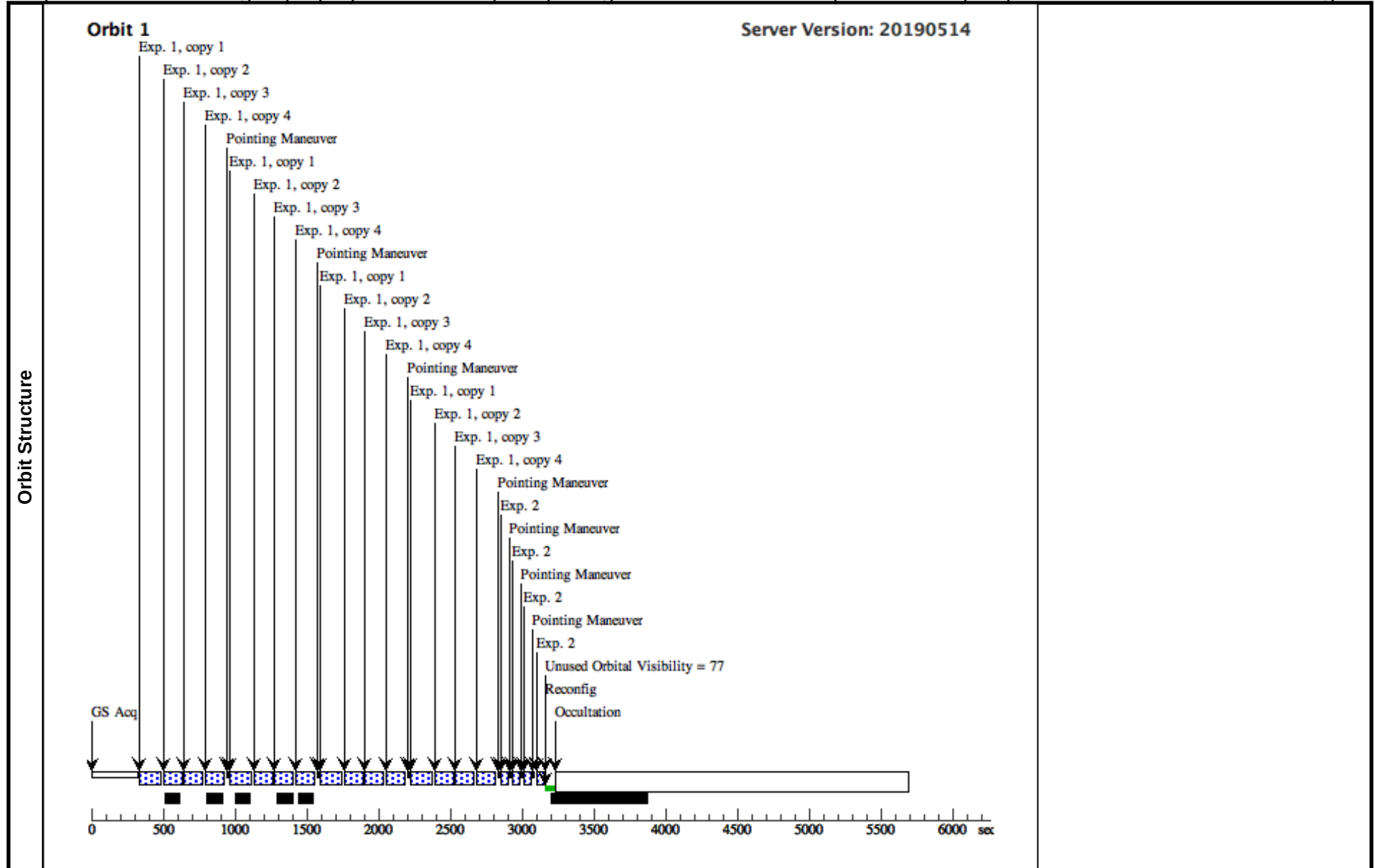
Proposal 15975 - 1537+0055 (08) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing th...

|               |                                                                      |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
|---------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|-------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------------------------------------------------------|-----|
| Visit         | Proposal 15975, 1537+0055 (08), implementation                       |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           | Tue Sep 03 14:01:56 GMT 2019                                                 |     |
|               | Diagnostic Status: No Diagnostics                                    |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
|               | Scientific Instruments: WFC3/IR                                      |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
|               | Special Requirements: (none)                                         |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
| Patterns      | #                                                                    | Primary Pattern                                                                                                          |                                                                                  |                                                                                                               |                             | Secondary Pattern            |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Exposures |                                                                              |     |
|               | (1)                                                                  | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                                                                                  | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | (1), (2)  |                                                                              |     |
| Fixed Targets | #                                                                    | Name                                                                                                                     | Target Coordinates                                                               |                                                                                                               | Targ. Coord. Corrections    |                              | Fluxes                                    |                                           | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                                                              |     |
|               | (8)                                                                  | BSBH8                                                                                                                    | RA: 15 37 5.9500 (234.2747917d)<br>Dec: +00 55 22.80 (.92300d)<br>Equinox: J2000 |                                                                                                               |                             |                              | V=17.28<br>H = 14.25                      |                                           | Reference Frame: ICRS                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |                                                                              |     |
|               | Comments:<br>Category=GALAXY<br>Description=[QUASAR]<br>Extended=YES |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
|               |                                                                      |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
| Exposures     | #                                                                    | Label                                                                                                                    | Target                                                                           | Config,Mode,Aperture                                                                                          | Spectral Els.               | Opt. Params.                 | Special Reqs.                             | Groups                                    | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                              |           | Orbit                                                                        |     |
|               | 1                                                                    |                                                                                                                          | (8) BSBH8                                                                        | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                       | NSAMP=10;<br>SAMP-SEQ=STEP25 |                                           | Pattern 1, Exps 1-1 in 1537+0055 (08) (1) | 128.439646 Secs X 4 (2055.034 Secs)                                                                                                                                                                                                                                                                                                                                                                                                                          |           | [1]                                                                          |     |
|               |                                                                      |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |           |                                                                              |     |
| 2             |                                                                      | (8) BSBH8                                                                                                                | WFC3/IR, MULTIACCUM, IRSUB512                                                    | F160W                                                                                                         | NSAMP=15;<br>SAMP-SEQ=RAPID |                              | Pattern 1, Exps 2-2 in 1537+0055 (08) (1) | 12.795405 Secs (51.182 Secs)              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                                                              |     |
|               |                                                                      |                                                                                                                          |                                                                                  |                                                                                                               |                             |                              |                                           |                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] | [1] |



# Proposal 15975 - PSF-group1 (09) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing t...

|               |                                                                                                                                                                                                       |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                              |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|--------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------|
| Visit         | Proposal 15975, PSF-group1 (09), implementation                                                                                                                                                       |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           | Tue Sep 03 14:01:56 GMT 2019 |
|               | Diagnostic Status: No Diagnostics                                                                                                                                                                     |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                              |
|               | Scientific Instruments: WFC3/IR                                                                                                                                                                       |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                              |
|               | Special Requirements: (none)                                                                                                                                                                          |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                              |
| Patterns      | #                                                                                                                                                                                                     | Primary Pattern                                                                                                          |                                                                                     |                                                                                                               |                             | Secondary Pattern            |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Exposures |                              |
|               | (1)                                                                                                                                                                                                   | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                                                                                     | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | (1), (2)  |                              |
| Fixed Targets | #                                                                                                                                                                                                     | Name                                                                                                                     | Target Coordinates                                                                  |                                                                                                               | Targ. Coord. Corrections    |                              | Fluxes                                     |                                                                              | Miscellaneous                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                              |
|               | (9)                                                                                                                                                                                                   | EGGR-67                                                                                                                  | RA: 09 46 39.0736 (146.6628067d)<br>Dec: +43 54 52.24 (43.91451d)<br>Equinox: J2000 |                                                                                                               |                             |                              | V=13.8                                     |                                                                              | Reference Frame: SIMBAD                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |                              |
|               | Comments: This is a PSF star which was approved as two, generic PSF star targets in phase 1.<br>It is NOT a new target different from what was already approved.<br>Category=STAR<br>Description=[DA] |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                              |
| Exposures     | #                                                                                                                                                                                                     | Label                                                                                                                    | Target                                                                              | Config,Mode,Aperture                                                                                          | Spectral Els.               | Opt. Params.                 | Special Reqs.                              | Groups                                                                       | Exp. Time (Total)/[Actual Dur.]                                                                                                                                                                                                                                                                                                                                                                                                                              |           | Orbit                        |
|               | 1                                                                                                                                                                                                     |                                                                                                                          | (9) EGGR-67                                                                         | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                       | NSAMP=10;<br>SAMP-SEQ=STEP25 |                                            | Pattern 1, Exps 1-1 in PSF-group1 (09) (1)                                   | 128.439646 Secs X 4 (2055.034 Secs)                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                              |
|               |                                                                                                                                                                                                       |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            |                                                                              | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |           | [1]                          |
| 2             |                                                                                                                                                                                                       | (9) EGGR-67                                                                                                              | WFC3/IR, MULTIACCUM, IRSUB512                                                       | F160W                                                                                                         | NSAMP=8;<br>SAMP-SEQ=SPARS5 |                              | Pattern 1, Exps 2-2 in PSF-group1 (09) (1) | 21.303576 Secs (85.214 Secs)                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                              |
|               |                                                                                                                                                                                                       |                                                                                                                          |                                                                                     |                                                                                                               |                             |                              |                                            | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]       |                              |



# Proposal 15975 - PSF-group2 (10) - Host Galaxy Morphologies of Candidate Sub-parsec Binary Supermassive Black Holes: Testing t...

|               |                                                                                                                                                                                                       |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|----------------------------------|----------------|--------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Visit         | Proposal 15975, PSF-group2 (10), implementation                                                                                                                                                       |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Tue Sep 03 14:01:56 GMT 2019 |
|               | Diagnostic Status: No Diagnostics                                                                                                                                                                     |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | Scientific Instruments: WFC3/IR                                                                                                                                                                       |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | Special Requirements: (none)                                                                                                                                                                          |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| Patterns      | #                                                                                                                                                                                                     | Primary Pattern                                                                                                          |                                                                                    |                                                                                                               |                          | Secondary Pattern                |                |                                            |                                                                              | Exposures                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |
|               | (1)                                                                                                                                                                                                   | Pattern Type=WFC3-IR-DITHER-BOX-MIN<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=1.716<br>Line Spacing=1.095 |                                                                                    | Coordinate Frame=POS-TARG<br>Pattern Orientation=18.528<br>Angle Between Sides=74.653<br>Center Pattern=false |                          |                                  |                |                                            |                                                                              | (1), (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |
| Fixed Targets | #                                                                                                                                                                                                     | Name                                                                                                                     | Target Coordinates                                                                 |                                                                                                               | Targ. Coord. Corrections |                                  | Fluxes         |                                            | Miscellaneous                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | (10)                                                                                                                                                                                                  | EGGR-102                                                                                                                 | RA: 13 38 50.4781 (204.7103254d)<br>Dec: +70 17 7.64 (70.28546d)<br>Equinox: J2000 |                                                                                                               |                          |                                  | V=12.60+/-0.01 |                                            | Reference Frame: ICRS                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               | Comments: This is a PSF star which was approved as two, generic PSF star targets in phase 1.<br>It is NOT a new target different from what was already approved.<br>Category=STAR<br>Description=[DA] |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
| Exposures     | #                                                                                                                                                                                                     | Label                                                                                                                    | Target                                                                             | Config,Mode,Aperture                                                                                          | Spectral Els.            | Opt. Params.                     | Special Reqs.  | Groups                                     | Exp. Time (Total)/[Actual Dur.]                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Orbit                        |
|               | 1                                                                                                                                                                                                     |                                                                                                                          | (10) EGGR-102                                                                      | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                    | NSAMP=10;<br>SAMP-SEQ=STEP2<br>5 |                | Pattern 1, Exps 1-1 in PSF-group2 (10) (1) | 128.439646 Secs X 4 (2055.034 Secs)                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               |                                                                                                                                                                                                       |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            |                                                                              | [==>(Pattern 1, Copy 1)]<br>[==>(Pattern 1, Copy 2)]<br>[==>(Pattern 1, Copy 3)]<br>[==>(Pattern 1, Copy 4)]<br>[==>(Pattern 2, Copy 1)]<br>[==>(Pattern 2, Copy 2)]<br>[==>(Pattern 2, Copy 3)]<br>[==>(Pattern 2, Copy 4)]<br>[==>(Pattern 3, Copy 1)]<br>[==>(Pattern 3, Copy 2)]<br>[==>(Pattern 3, Copy 3)]<br>[==>(Pattern 3, Copy 4)]<br>[==>(Pattern 4, Copy 1)]<br>[==>(Pattern 4, Copy 2)]<br>[==>(Pattern 4, Copy 3)]<br>[==>(Pattern 4, Copy 4)] |                              |
|               | 2                                                                                                                                                                                                     |                                                                                                                          | (10) EGGR-102                                                                      | WFC3/IR, MULTIACCUM, IRSUB512                                                                                 | F160W                    | NSAMP=8;<br>SAMP-SEQ=STEP2<br>5  |                | Pattern 1, Exps 2-2 in PSF-group2 (10) (1) | 82.597144 Secs (330.389 Secs)                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |
|               |                                                                                                                                                                                                       |                                                                                                                          |                                                                                    |                                                                                                               |                          |                                  |                |                                            | [==>(Pattern 1)]<br>[==>(Pattern 2)]<br>[==>(Pattern 3)]<br>[==>(Pattern 4)] |                                                                                                                                                                                                                                                                                                                                                                                                                                                              | [1]                          |

