# 15365 - COS FUV Dispersion Solutions at LP4

Cycle: 24, Proposal Category: CAL/COS

(Availability Mode: RESTRICTED)

**INVESTIGATORS**


| *Name* | *Institution* | *E-Mail* |
|---|---|---|
| **Rachel Plesha (PI) (Contact)** | **Space Telescope Science Institute** | **rplesha@stsci.edu** |
| Dr. Thomas B. Ake (CoI) | Space Telescope Science Institute | take@stsci.edu |
| Dr. Cristina Oliveira (CoI) | Space Telescope Science Institute | oliveira@stsci.edu |
| Dr. Steven V. Penton (CoI) | Space Telescope Science Institute | penton@stsci.edu |


**VISITS**

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (1) EPSILON-ERI | COS/FUV<br>COS/NUV | 4 | 27-Jul-2017 17:00:57.0 | yes |
| 02 | (1) EPSILON-ERI | COS/FUV<br>COS/NUV | 4 | 27-Jul-2017 17:00:59.0 | yes |
| 03 | (1) EPSILON-ERI | COS/FUV<br>COS/NUV | 4 | 27-Jul-2017 17:01:00.0 | yes |

12 Total Orbits Used

**ABSTRACT**


The goal of this program is to obtain external data to allow us to derive updated FUV dispersion solutions for COS/FUV LP4.

The G130M and G160M dispersion solutions are 1st or 2nd order polynomials and the goal of this program is to

1) derive updated dispersion coefficients and

2) derive updated zero points.

The emission-line target epsilon Eridani is used. Visit 01 is designed to derive wavelength calibrations for G130M/FUVA (1291, 1300, 1309, 1327). Visit 02 is designed to derive the wavelength calibration for G130M/FUVA (1318), G160M/FUVA/B (1611), and G130M/FUVA/B (1222, 1223). Observations at both 1222 and 1223 are needed since the wavelength dispersion is a function of focus and the two settings are taken at different focus positions to optimize resolution in FUVB (1222) and FUVA (1223). Visit 03 is designed to derive the wavelength calibrations for G160M/FUVA/B (1577, 1589, 1600, 1623).

The exposure times, and the number of orbits requested, are driven by the number of counts needed to achieve good correlations. The Eps Eri spectrum contains many chromospheric emission lines across the FUV region, but Lyman alpha is too bright for G130M FUVB. The Eps Eri spectrum needs to achieve at least S/N ~5 (~25 counts) in the peak of the weaker emission lines to allow good cross correlation for the primary cenwaves. Different weak features across the difference G130M and G160M cenwaves were used to calculate the exposure times needed and, it was determined that a full orbit exposure will give us the needed S/N needed.

**OBSERVING DESCRIPTION**

This program is essentially the same program as 14909 (LP3 wavelegth calibration), with a few tweaks:
1) Full-orbit exposures of 1222 and 1223 were added to better calibrate these modes at LP4, as they will be used more frequently.
2) Visit 03 (from 14909) is no longer included because the only standard cenwave that will be used for G130M/FUVB is 1291, and the AV75 data for that program was already observed in program 14842.

The exposure times were tweaked by a few seconds for all standard modes. For 1222 and 1223, a new ETC run was using combined FUSE and STIS data of Eps Eri. This produced results that we would still get 30 counts at the lower wavelengths (He II; 1085A) with a full-oribt exposure of 2748 seconds.
G130M, 1222/1223 FUVA 1085A -> 0.012 counts/s -> 2500s

Unchanged items from LP3 program 14909:

The primary goal of this proposal is to obtain spectra at the central and extreme nominal cenwaves for each grating at FP-POS=3 for eps Eri to determine the dispersion vs focus relation and initial zero points for G130M/FUVA and G160M/FUVAB.  We will also obtain spectra of the

intermediate cenwaves to derive zero points for these settings.

Double BOA NUV ACQ/IMAGE target acquisitions will be performed to insure the best possible target centering for the zero-point measurement. We confirmed this sequence of target acquisitions is 2 to 3 times more accurate than having just a single NUV ACQ/IMAGE from looking at the ACQs performed in program 14909.

For eps Eri, we have designated the following lines as fiducials for our correlations:

G130M FUVA 1360.3 (primary) or 1357.7 (secondary)
G160M FUVA 1681.4 & FUVB 1485.7

According to the current ETC, the peak count rates in our fiducial lines, and exposure times to obtain 25+1-sigma = 30 counts are :
G130M FUVA 1360.3 -> 0.0175 counts/s, or for 30 counts, we need -> 1715s
G130M FUVA 1357.7 -> 0.011 counts/s, or for 30 counts, we need -> 2728s

G160M FUVA 1681.4 -> 0.015 counts/s, or for 30 counts, we need -> 2000s
G160M FUVB  1485.7 -> 0.025 counts/s, or for 30 counts, we need -> 1200s

## Visit

**Proposal 15365, G130M/FUVA/Eps Eri (01), implementation** Thu Jul 27 21:01:01 GMT 2017

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 80%

*Comments: These G130M Eps Eri observations must be able to achieve 25 peak counts (~100 total) in the following faint lines (per FP)*

*G130M FUVA 1360.3 (primary) or 1357.7 (secondary)*

## Diagnostics

(G130M/FUVA/Eps Eri (01)) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | EPSILON-ERI | RA: 03 32 55.8450 (53.2326875d) | Proper Motion RA: -975.17 mas/yr | V=3.73 | Reference Frame: ICRS |
| | Alt Name1: HD22049 | Dec: -09 27 29.73 (-9.45826d) | Proper Motion Dec: 19.49 mas/yr | | |
| | Alt Name2: GJ144 | Equinox: J2000 | Parallax: 0.31094" | | |
| | | | Epoch of Position: 2000 | | |
| | | | Radial Velocity: 16.43 km/sec | | |

*Comments: This from SIMBAD: eps Eri -- Variable of BY Dra type*

*ICRS coord. (ep=J2000) : 03 32 55.84496 -09 27 29.7312 (Optical) [ 1.84 1.75 90 ] A 2007A&A...474..653V*
*Proper motions mas/yr : -975.17 19.49 [0.21 0.20 0] A 2007A&A...474..653V*
*Radial velocity : V(km/s) 16.43 [0.09] / z(~) 0.000055 [0.000000] / cz 16.43 [0.09]*

*Spectral type: K2Vk: C 2006AJ....132..161G*

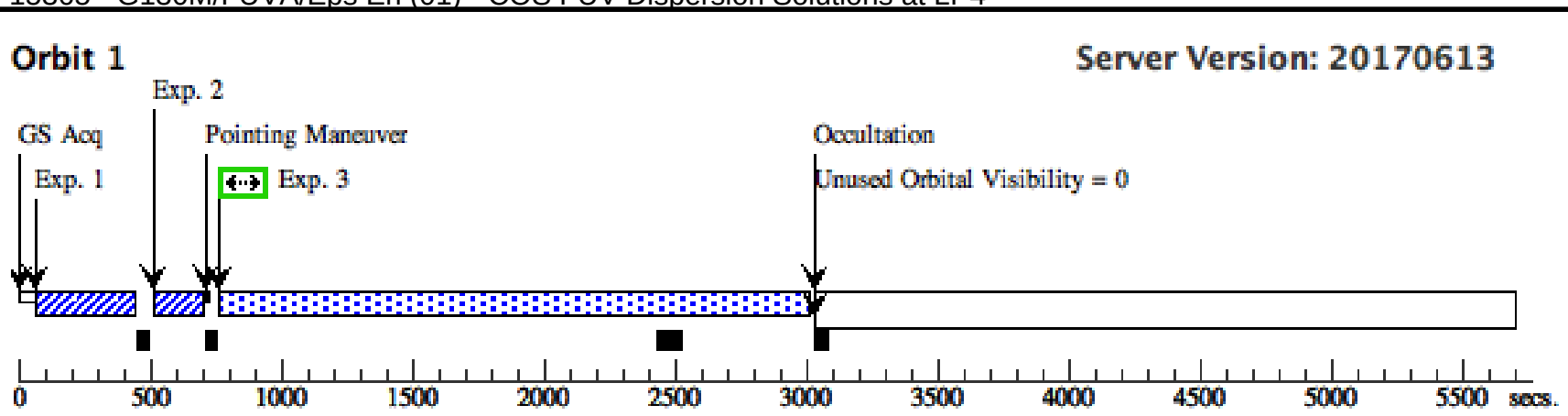
*U 5.19 [~] C 2002yCat.2237....0D*
*B 4.61 [~] C 2002yCat.2237....0D*
*V 3.73 [~] C 2002yCat.2237....0D*
*R 3.00 [~] C 2002yCat.2237....0D*
*I 2.54 [~] C 2002yCat.2237....0D*
*J 2.23 [~] C 2002yCat.2237....0D*
*H 1.75 [~] C 2002yCat.2237....0D*
*K 1.67 [~] C 2002yCat.2237....0D*
*Extended=NO*

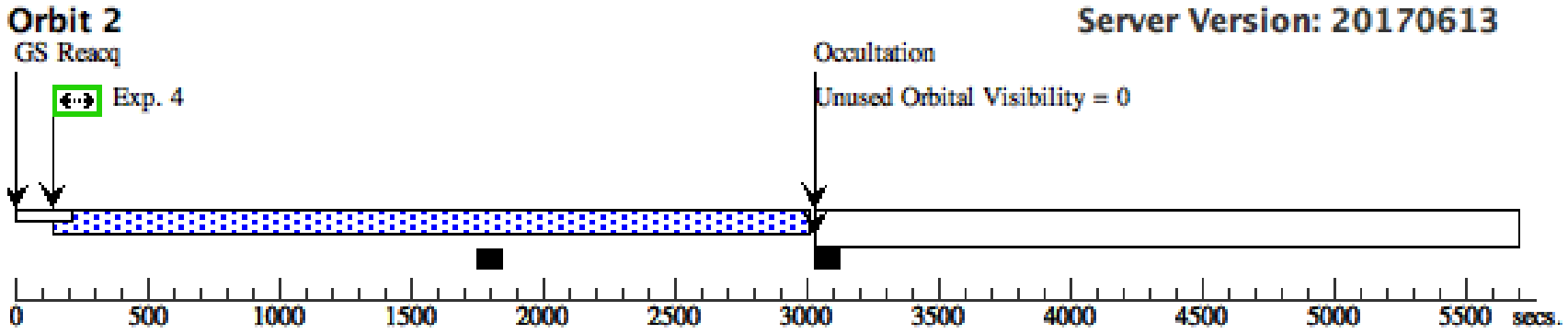
## Exposures

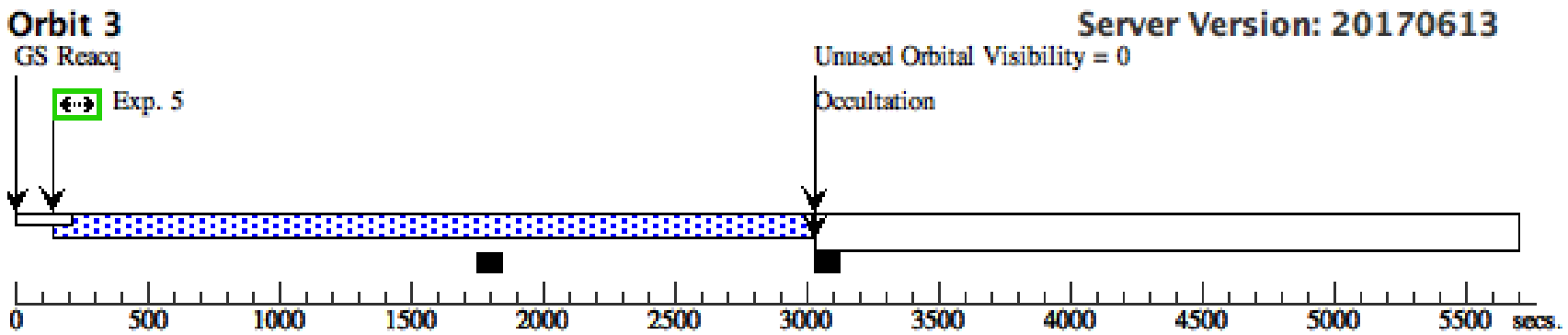
| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | BOA+MIRRORB ACQ/IMAGE (COS.ta.903046) | (1) EPSILON-ERI | COS/NUV, ACQ/IMAGE, BOA | MIRRORB | | | | 25 Secs (25 Secs)<br>*[==>]* | ***[1]*** |
| | *Comments: In Visit 01 of 13650, this target gave the following results for a 20 s exposure (COS.ta.615844)*<br>*-> Bck subtracted counts in second image = 2986 ; S/N = 54.64*<br>*We want S/N = 60 (3600 counts) so ET = 3600./2986. = 24 seconds*<br><br>*This is a K2Vk star, we use a standard model in the ETC Run. We use the U-band magnitude in the ETC as it gives the brightest result to show that it is safe. (Brightest Pixel - 29.725)*<br>*We use the 13650 exposure time as it agrees with an actual COS ACQ/IMAGE.* | | | | | | | | |
| 2 | 2nd BOA+MIRRORB ACQ/IMAGE to optimize centering (COS.ta.903046) | (1) EPSILON-ERI | COS/NUV, ACQ/IMAGE, BOA | MIRRORB | | | | 30 Secs (30 Secs)<br>*[==>]* | ***[1]*** |
| | *Comments: Identical to TA of previous exposures , see 01.001 for full comments. We do this twice to ensure the best possible centering with BOA+B.* | | | | | | | | |
| 3 | C1300-3 (FUVA-only) (COS.sp.902282) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M<br>1300 A | SEGMENT=A;<br>FP-POS=3;<br>BUFFER-TIME=1500;<br>LIFETIME-POS=LP4 | | | 2073 Secs (2073 Secs)<br>*[==>]* | ***[1]*** |
| | *Comments: BT=2/3 * 3500 = 2333. So, anything less is ok. Here we use ET-100s* | | | | | | | | |
| 4 | C1291-3 (FUVA-only) (COS.sp.902282) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M<br>1291 A | SEGMENT=A;<br>FP-POS=3;<br>BUFFER-TIME=1500;<br>LIFETIME-POS=LP4 | | | 2748 Secs (2748 Secs)<br>*[==>]* | ***[2]*** |
| | *Comments: BT=2/3 * 3500 = 2333. So, anything less is ok. To be safe, we'll use 1500s.*<br><br>*Our goal here is to get 25 counts in the peak of the following (weak) lines: G130M FUVA 1360.3 or 1357.7*<br><br>*The peak count rates in the ETC are :*<br>*1360.3 -> 0.0175 counts/s*<br>*1357.7 -> 0.011 counts/s*<br><br>*According to the current ETC, the peak count rates in our fiducial lines, and exposure times to obtain 25+1-sigma = 30 counts are :*<br>*G130M FUVA 1360.3 -> 0.0175 counts/s, or for 30 counts, we need -> 1715s*<br>*G130M FUVA 1357.7 -> 0.011 counts/s, or for 30 counts, we need -> 2728s*<br><br>*So, we ~meet the goal for both lines with the ~2720 s exposures in 01.005-01.007* | | | | | | | | |
| 5 | C1309-3 (FUVA-only) (COS.sp.902282) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M<br>1309 A | SEGMENT=A;<br>FP-POS=3;<br>BUFFER-TIME=1500;<br>LIFETIME-POS=LP4 | | | 2748 Secs (2748 Secs)<br>*[==>]* | ***[3]*** |
| | *Comments: See comments in 01.005* | | | | | | | | |

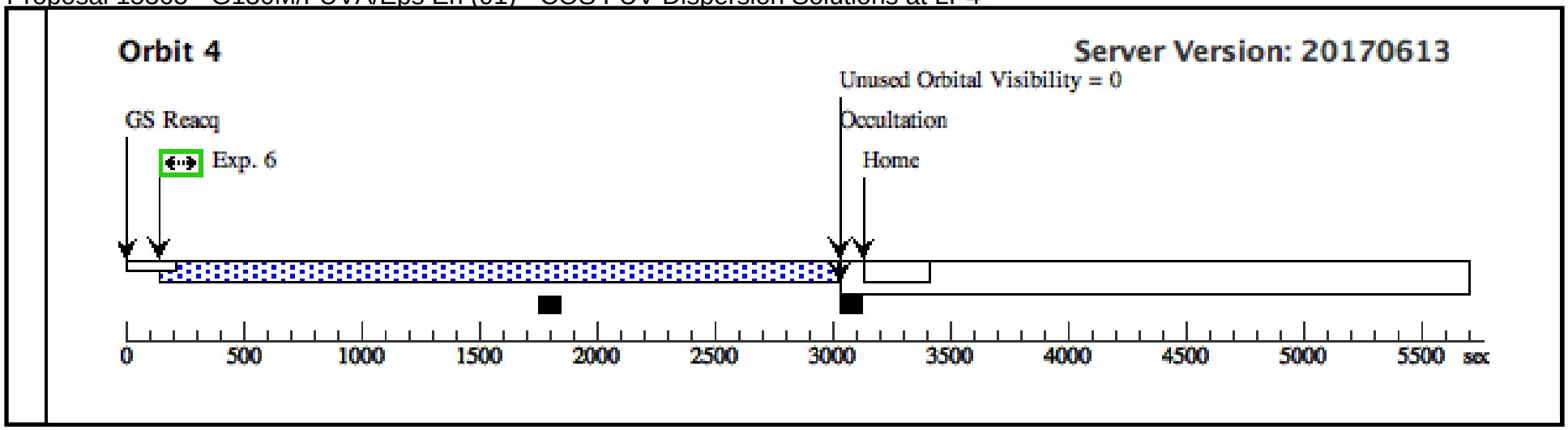
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 6 | C1327-3 (F UVA-only) (COS.sp.902 282) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M 1327 A | SEGMENT=A; FP-POS=3; BUFFER-TIME=1500; LIFETIME-POS=LP4 | 2748 Secs (2748 Secs)<br>*[==>]* | ***[4]*** |
| | *Comments: See comments in 01.005* | | | | | | | |

Orbit Structure

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sec

## Visit

**Proposal 15365, G130M 1222/1223 (02), implementation** Thu Jul 27 21:01:02 GMT 2017

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 80%

*Comments: This visit includes the G130M cenwave 1318, as well as the G160M cenwave 1611 as full-orbit exposures to better constrain possible quadratic relationships in the dispersion solutions.*

*Full orbit 1222 and 1223 exposures are also included in this visit so we can derive solutions for these cenwaves at LP4.*

## Diagnostics

(G130M 1222/1223 (02)) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | EPSILON-ERI | RA: 03 32 55.8450 (53.2326875d) | Proper Motion RA: -975.17 mas/yr | V=3.73 | Reference Frame: ICRS |
| | Alt Name1: HD22049 | Dec: -09 27 29.73 (-9.45826d) | Proper Motion Dec: 19.49 mas/yr | | |
| | Alt Name2: GJ144 | Equinox: J2000 | Parallax: 0.31094" | | |
| | | | Epoch of Position: 2000 | | |
| | | | Radial Velocity: 16.43 km/sec | | |

*Comments: This from SIMBAD: eps Eri -- Variable of BY Dra type*

*ICRS coord. (ep=J2000) : 03 32 55.84496 -09 27 29.7312 (Optical) [ 1.84 1.75 90 ] A 2007A&A...474..653V*
*Proper motions mas/yr : -975.17 19.49 [0.21 0.20 0] A 2007A&A...474..653V*
*Radial velocity : V(km/s) 16.43 [0.09] / z(~) 0.000055 [0.000000] / cz 16.43 [0.09]*

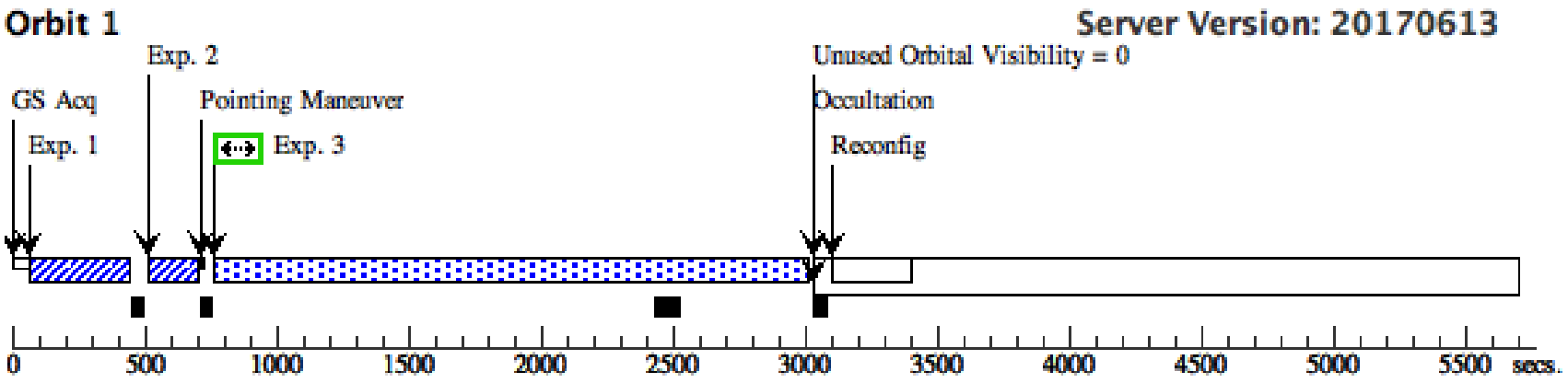
*Spectral type: K2Vk: C 2006AJ....132..161G*

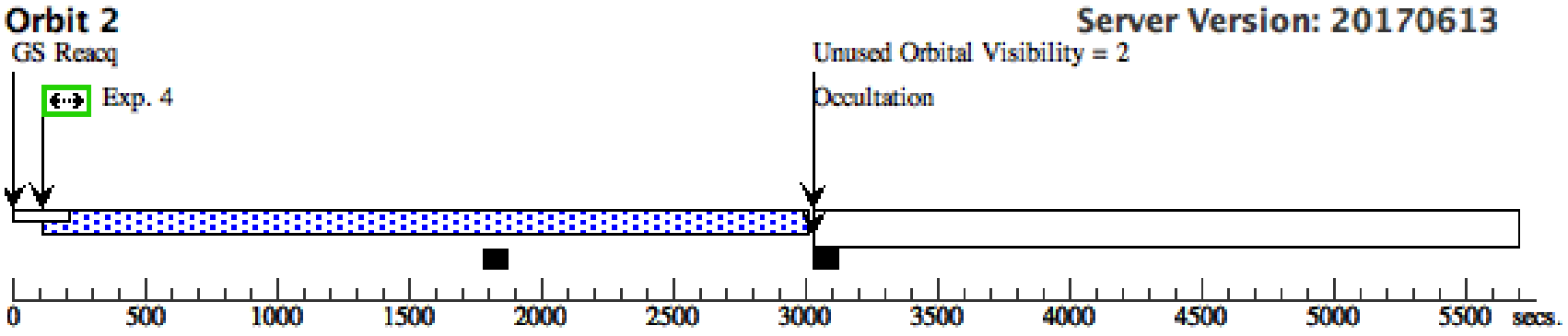
*U 5.19 [~] C 2002yCat.2237....0D*
*B 4.61 [~] C 2002yCat.2237....0D*
*V 3.73 [~] C 2002yCat.2237....0D*
*R 3.00 [~] C 2002yCat.2237....0D*
*I 2.54 [~] C 2002yCat.2237....0D*
*J 2.23 [~] C 2002yCat.2237....0D*
*H 1.75 [~] C 2002yCat.2237....0D*
*K 1.67 [~] C 2002yCat.2237....0D*
*Extended=NO*

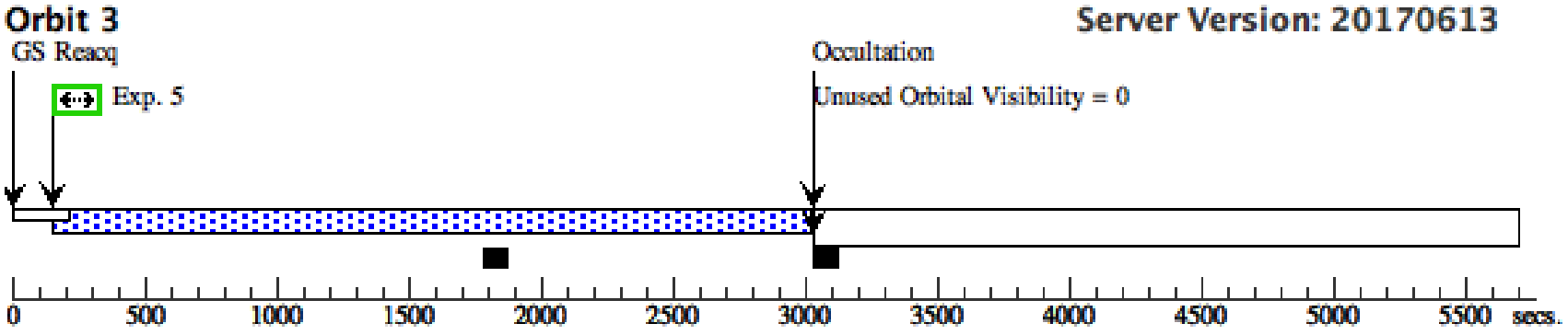
**Exposures**

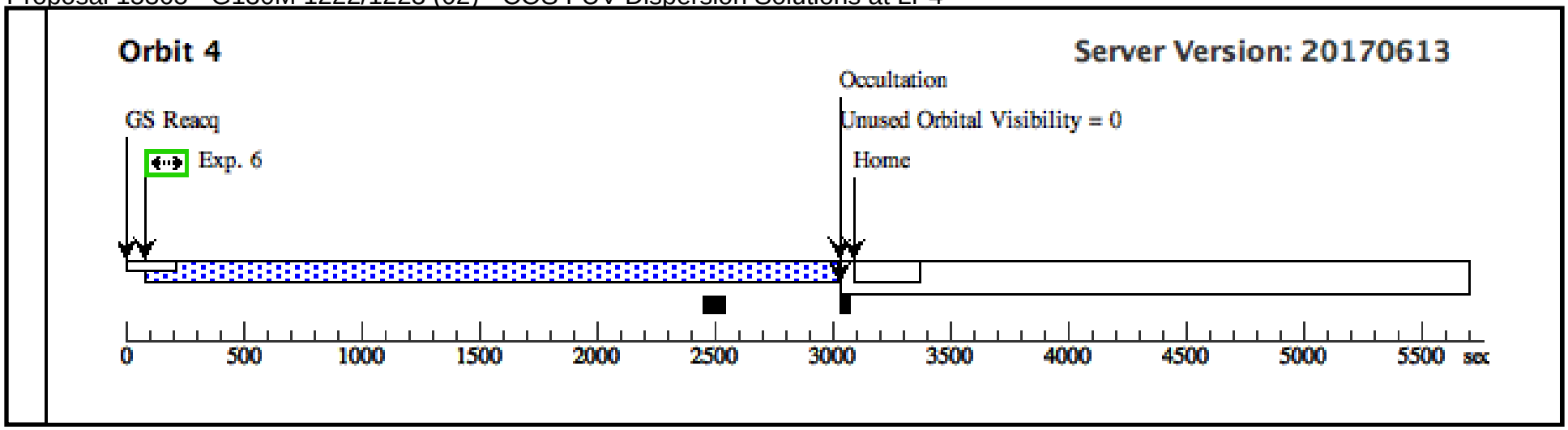
| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | BOA+MIRRORB ACQ/IMAGE (COS.ta.903046) | (1) EPSILON-ERI | COS/NUV, ACQ/IMAGE, BOA | MIRRORB | | | | 25 Secs (25 Secs)<br>*[==>]* | ***[1]*** |
| | *Comments: In Visit 01 of 13650, this target gave the following results for a 20 s exposure (COS.ta.615844)*<br>*-> Bck subtracted counts in second image = 2986 ; S/N = 54.64*<br>*We want S/N = 60 (3600 counts) so ET = 3600./2986. = 24 seconds*<br><br>*This is a K2Vk star, we use a standard model in the ETC Run. We use the U-band magnitude in the ETC as it gives the brightest result to show that it is safe. (Brightest Pixel - 29.725)*<br>*We use the 13650 exposure time as it agrees with an actual COS ACQ/IMAGE.* | | | | | | | | |
| 2 | 2nd BOA+MIRRORB ACQ/IMAGE to optimize centering (COS.ta.903046) | (1) EPSILON-ERI | COS/NUV, ACQ/IMAGE, BOA | MIRRORB | | | | 30 Secs (30 Secs)<br>*[==>]* | ***[1]*** |
| | *Comments: Identical to TA of previous exposures , see 01.001 for full comments. We do this twice to ensure the best possible centering with BOA+B.* | | | | | | | | |
| 3 | C1318-3 (FUVA-only) (COS.sp.902282) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M<br>1318 A | SEGMENT=A;<br>FP-POS=3;<br>BUFFER-TIME=1500;<br>LIFETIME-POS=LP4 | | | 2067 Secs (2067 Secs)<br>*[==>]* | ***[1]*** |
| | *Comments: BT=2/3 * 3500 = 2333. So, anything less is ok. To be safe, we'll use 1500s for all the G130M exposures from here onward.* | | | | | | | | |
| 4 | 1222 (COS.sp.1002959) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M<br>1222 A | FP-POS=3;<br>SEGMENT=BOTH;<br>BUFFER-TIME=1533;<br>LIFETIME-POS=LP4 | | | 2746 Secs (2746 Secs)<br>*[==>]* | ***[2]*** |
| | *Comments: 0.012 cnts/s -> for 30 counts at 1085 leads to 2500 seconds.*<br><br>*sp. 1005175 - as an example of S/N of 13 at 1085*<br><br>*The IUE spectrum gives a buffer time of 2300s, so to be safe we will use 2300* 2/3=1533s (sp.1015056)* | | | | | | | | |
| 5 | 1223 (COS.sp.1002757) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G130M<br>1223 A | FP-POS=3;<br>SEGMENT=BOTH;<br>BUFFER-TIME=1533;<br>LIFETIME-POS=LP4 | | | 2748 Secs (2748 Secs)<br>*[==>]* | ***[3]*** |
| | *Comments: 0.012 cnts/s -> for 30 counts at 1085 leads to 2500 seconds.*<br><br>*The IUE spectrum gives a buffer time of 2300s, so to be safe we will use 2300* 2/3=1533s (sp.1015056)* | | | | | | | | |
| 6 | C1611 FP-3 (FUVAB) (COS.sp.902283) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G160M<br>1611 A | FP-POS=3;<br>BUFFER-TIME=2200;<br>SEGMENT=BOTH;<br>LIFETIME-POS=LP4 | | | 2746 Secs (2746 Secs)<br>*[==>]* | ***[4]*** |
| | *Comments: BT=2/3 * 7,172 = 4783. So, anything less is ok. To be safe, we'll use 2200 for all the remaining G160m exposures* | | | | | | | | |

Orbit Structure

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4000
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## Visit

**Proposal 15365, G160M/Eps Eri (03), implementation** Thu Jul 27 21:01:02 GMT 2017

**Diagnostic Status: Warning**

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: SCHED 100%

*Comments: These Eps Eri observations must be able to achieve ~25 peak counts (~100 total) in the following faint lines for G160M per FP-POS (3)*

*G160M FUVA 1681.4 & G160M FUVB 1485.7*

## Diagnostics

(G160M/Eps Eri (03)) Warning (Form): For the best data quality, it is strongly recommended that the maximum number of allowed FP-POS positions is used when observing at a given COS CENWAVE setting. See full description for details.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | EPSILON-ERI | RA: 03 32 55.8450 (53.2326875d) | Proper Motion RA: -975.17 mas/yr | V=3.73 | Reference Frame: ICRS |
| | Alt Name1: HD22049 | Dec: -09 27 29.73 (-9.45826d) | Proper Motion Dec: 19.49 mas/yr | | |
| | Alt Name2: GJ144 | Equinox: J2000 | Parallax: 0.31094" | | |
| | | | Epoch of Position: 2000 | | |
| | | | Radial Velocity: 16.43 km/sec | | |

*Comments: This from SIMBAD: eps Eri -- Variable of BY Dra type*

*ICRS coord. (ep=J2000) : 03 32 55.84496 -09 27 29.7312 (Optical) [ 1.84 1.75 90 ] A 2007A&A...474..653V*
*Proper motions mas/yr : -975.17 19.49 [0.21 0.20 0] A 2007A&A...474..653V*
*Radial velocity : V(km/s) 16.43 [0.09] / z(~) 0.000055 [0.000000] / cz 16.43 [0.09]*

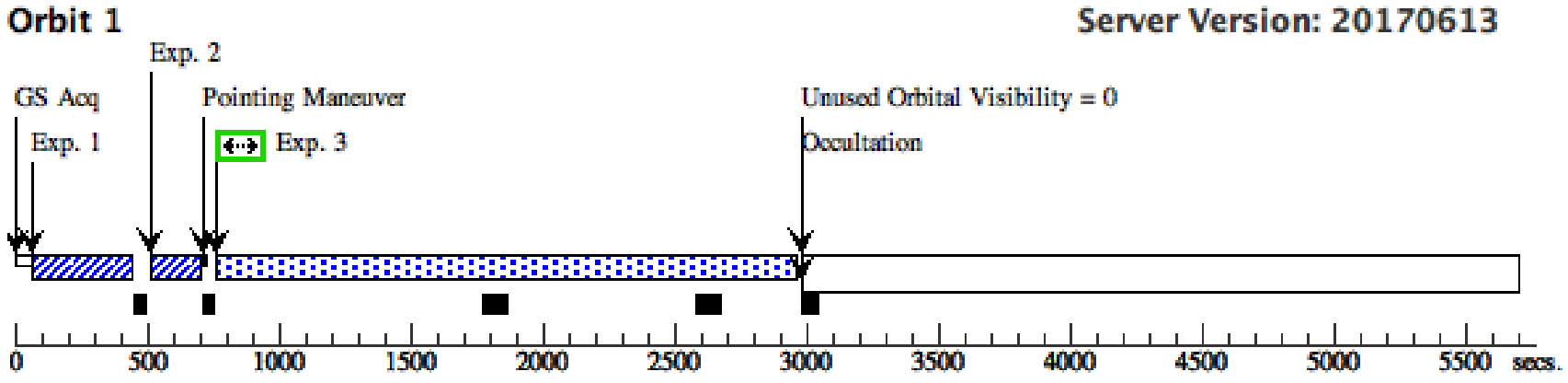
*Spectral type: K2Vk: C 2006AJ....132..161G*

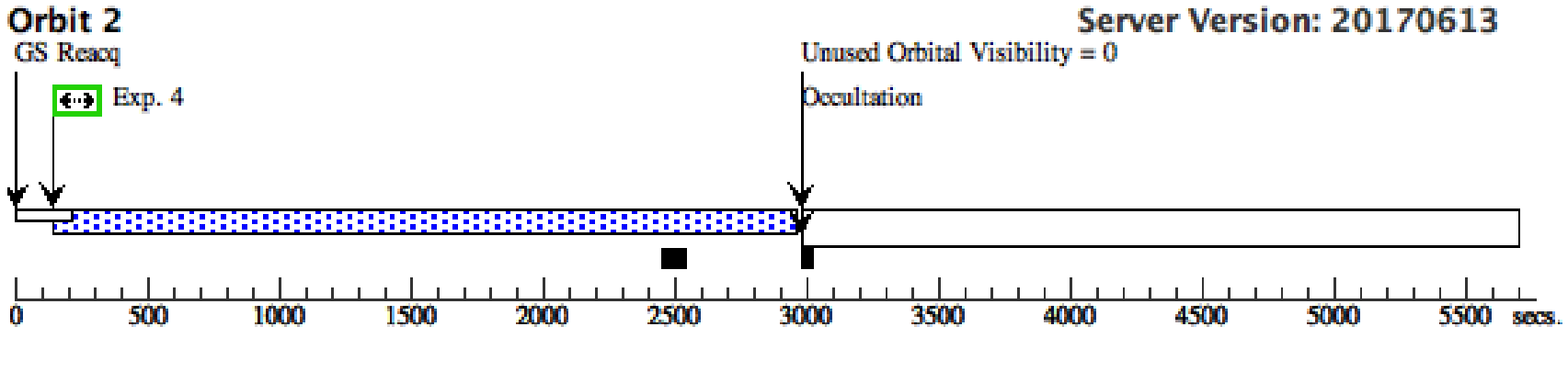
*U 5.19 [~] C 2002yCat.2237....0D*
*B 4.61 [~] C 2002yCat.2237....0D*
*V 3.73 [~] C 2002yCat.2237....0D*
*R 3.00 [~] C 2002yCat.2237....0D*
*I 2.54 [~] C 2002yCat.2237....0D*
*J 2.23 [~] C 2002yCat.2237....0D*
*H 1.75 [~] C 2002yCat.2237....0D*
*K 1.67 [~] C 2002yCat.2237....0D*
*Extended=NO*

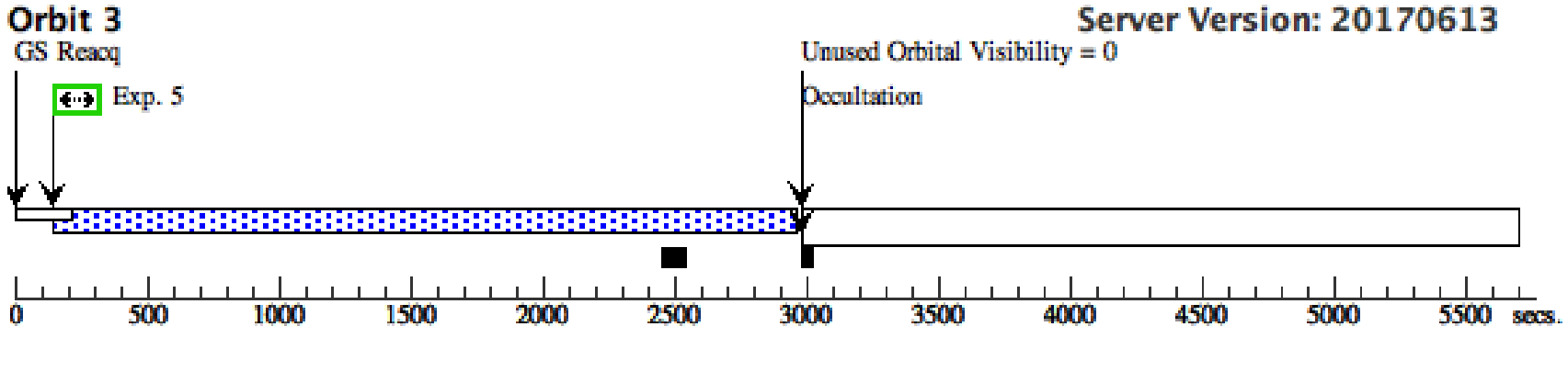
**Exposures**

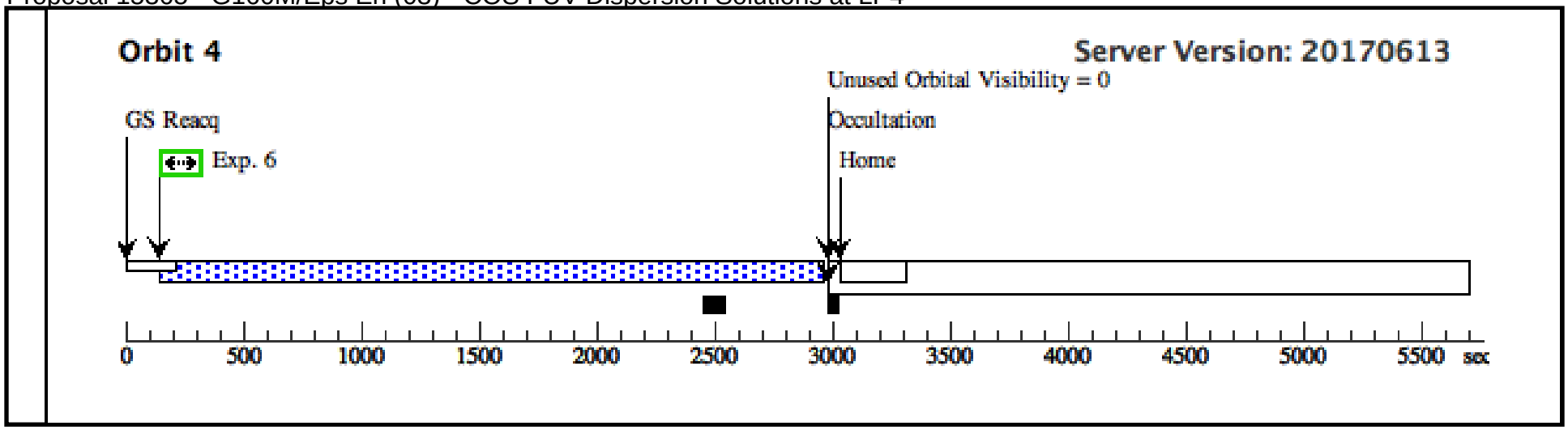
| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | BOA+MIRRORB ACQ/IMAGE (COS.ta.903046) | (1) EPSILON-ERI | COS/NUV, ACQ/IMAGE, BOA | MIRRORB | | | | 25 Secs (25 Secs)<br>*[==>]* | ***[1]*** |
| *Comments: Identical to TA of Visit 01, see 01.001 for full comments.* | | | | | | | | | |
| 2 | 2nd BOA+MIRRORB ACQ/IMAGE to optimize centering (COS.ta.903046) | (1) EPSILON-ERI | COS/NUV, ACQ/IMAGE, BOA | MIRRORB | | | | 30 Secs (30 Secs)<br>*[==>]* | ***[1]*** |
| *Comments: Identical to TA of previous exposures , see 01.001 for full comments. We do this twice to ensure the best possible centering with BOA+B.* | | | | | | | | | |
| 3 | C1589 FP-3 (FUVAB) (COS.sp.902283) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G160M<br>1589 A | FP-POS=3;<br>BUFFER-TIME=8088;<br>SEGMENT=BOTH;<br>LIFETIME-POS=LP4 | | | 1981 Secs (1981 Secs)<br>*[==>]* | ***[1]*** |
| *Comments: BT=2/3 * 7,172 = 4783. So, anything less is ok. Here we use ET-100s* | | | | | | | | | |
| 4 | C1577 FP-3 (FUVAB) (COS.sp.902283) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G160M<br>1577 A | FP-POS=3;<br>BUFFER-TIME=2200;<br>SEGMENT=BOTH;<br>LIFETIME-POS=LP4 | | | 2696 Secs (2696 Secs)<br>*[==>]* | ***[2]*** |
| *Comments: BT=2/3 * 7,172 = 4783. So, anything less is ok. To be safe, we'll use 2200s.*<br><br>*Our goal here is to get 25 counts in the peak of the following (weak) lines: G160M FUVA 1681.4 & FUVB 1485.7*<br><br>*According to the current ETC, the peak count rates in our fiducial lines, and exposure times to obtain 25+1-sigma = 30 counts are :*<br><br>*G160M FUVA 1681.4 -> 0.015 counts/s, or for 30 counts, we need -> 2000s*<br>*G160M FUVB 1485.7 -> 0.025 counts/s, or for 30 counts, we need -> 1200s*<br><br>*So, we exceed the goal for both lines with the ~2720 s exposures in 02.005-02.007* | | | | | | | | | |
| 5 | C1600 FP-3 (FUVAB) (COS.sp.902283) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G160M<br>1600 A | FP-POS=3;<br>BUFFER-TIME=2200;<br>SEGMENT=BOTH;<br>LIFETIME-POS=LP4 | | | 2696 Secs (2696 Secs)<br>*[==>]* | ***[3]*** |
| *Comments: See comments in 02.005* | | | | | | | | | |
| 6 | C1623 FP-3 (FUVAB) (COS.sp.902283) | (1) EPSILON-ERI | COS/FUV, TIME-TAG, PSA | G160M<br>1623 A | FP-POS=3;<br>BUFFER-TIME=2200;<br>LIFETIME-POS=LP4;<br>SEGMENT=BOTH | | | 2696 Secs (2696 Secs)<br>*[==>]* | ***[4]*** |
| *Comments: See comments in 02.005* | | | | | | | | | |

Orbit Structure

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