# 16042 - Do collapsars make the heavy elements: A sensitive search in a nearby gamma-ray burst?

Cycle: 27, Proposal Category: GO

(Availability Mode: SUPPORTED)

**INVESTIGATORS**


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| *Name* | *Institution* | *E-Mail* |
|---|---|---|
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**VISITS**

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (1) GRB190829A | WFC3/IR | 2 | 23-Jan-2020 18:00:19.0 | yes |
| 02 | (1) GRB190829A | WFC3/IR | 2 | 23-Jan-2020 18:00:20.0 | yes |
| 03 | (1) GRB190829A | WFC3/IR<br>WFC3/UVIS | 1 | 23-Jan-2020 18:00:21.0 | yes |
| 04 | (1) GRB190829A | WFC3/IR<br>WFC3/UVIS | 1 | 23-Jan-2020 18:00:22.0 | yes |
| 05 | (1) GRB190829A | WFC3/IR<br>WFC3/UVIS | 1 | 23-Jan-2020 18:00:23.0 | yes |

7 Total Orbits Used


**ABSTRACT**

The origin of half of the elements heavier than iron -- the so-called r-process elements -- is a central unsolved mystery in astrophysics. These atoms include both precious metals (e.g. gold) as well as radioactive elements required for geophysical processes on the Earth (e.g. thorium) and even some which are necessary on Earth for advanced life (e.g. iodine). Recent observations with both light and gravitational waves have demonstrated that at least some of these elements are formed through the merger of two neutron stars, but such a population struggles to reproduce the enrichment patterns seen in stars within the Milky Way as well apparent early enrichment in some dwarf galaxies. Instead, recent work implies that the accretion disks formed in the stellar collapse that powers a long duration gamma-ray burst could in-fact be a dominant site. If this is true we should be able to observe r-process synthesis in the associated supernovae. The presence of lanthanides in r-process material creates strong opacity, such that the signature of their synthesis should be a late time infrared component visible in the supernova light. Here we propose sensitive HST observations that will search for both spectroscopic and photometric evidence of the r-process, providing the opportunity to test, for the first time, if collapsars are responsible for heavy element production.

**OBSERVING DESCRIPTION**

This proposal seeks to obtain late time observations of GRB190829A with the aim of understanding if it creates heavy r-process elements. Our observational strategy has been chosen to map to observations taken at early times in terms of filters and so uses F140W rather than F160W as stated in the phase1.

With this programme we seek 3 epochs of observations. The first will be taken in Feb/March 2020. It will obtain grism spectroscopy (2 orbits) in both G102 and G141. It will also obtain deep imaging in F606W and F140W.

A second epoch of observations will be taken once the source emerges from the Sun in June 2020. This will consist only of F140W and F606W imaging. A third epoch should be taken in August/September 2020 and will also consist only of F606W/F140W imaging.

## Visit

**Proposal 16042, Visit 01, implementation** Thu Jan 23 23:00:24 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/IR

Special Requirements: BETWEEN 10-FEB-2020:00:00:00 AND 15-MAR-2020:00:00:00; SEQ 01,02,03 WITHIN 7 D

## Fixed Targets

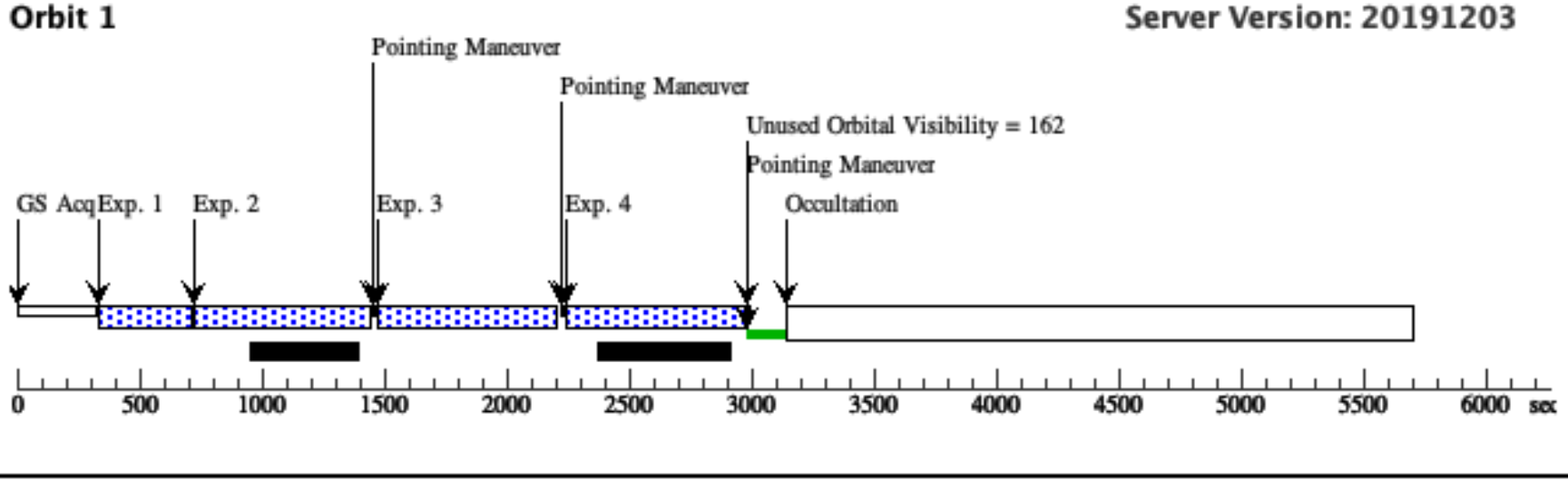
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | GRB190829A | RA: 02 58 10.5100 (44.5437917d)<br>Dec: -08 57 29.30 (-8.95814d)<br>Equinox: J2000 | | V=22+/-2 | Reference Frame: ICRS |

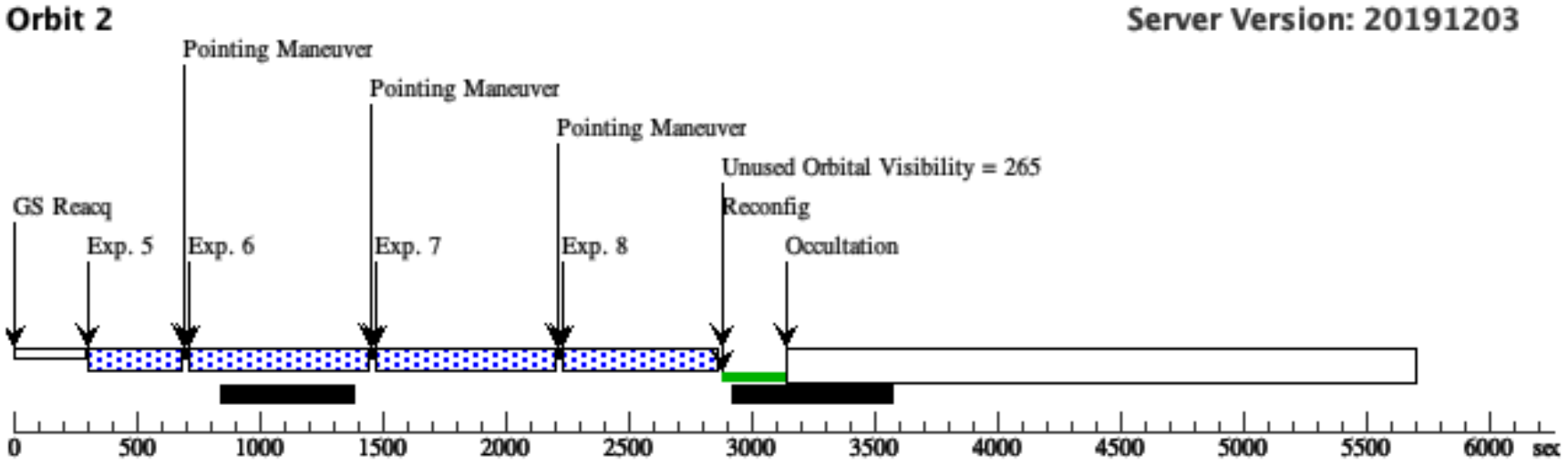
*Comments:*
*Category=UNIDENTIFIED*
*Description=[X-RAY EMITTER]*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | F125W | NSAMP=12; SAMP-SEQ=STEP50 | POS TARG -28.613 66496118098,-32.61113946018116; GS ACQ SCENARIO BASE1B3 | Sequence 1-4 Non-Int in Visit 01 | 349.232932 Secs (349.233 Secs)<br>*[==>]* | *[1]* |
| 2 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G102 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -28.613 66496118098,-32.61113946018116 | Sequence 1-4 Non-Int in Visit 01 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[1]* |
| 3 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G102 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -27.260 66496118098,-31.402139460181157 | Sequence 1-4 Non-Int in Visit 01 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[1]* |
| 4 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G102 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -25.907 66496118098,-30.193139460181158 | Sequence 1-4 Non-Int in Visit 01 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[1]* |
| 5 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | F125W | NSAMP=12; SAMP-SEQ=STEP50 | POS TARG -28.613 66496118098,-32.61113946018116 | Sequence 5-8 Non-Int in Visit 01 | 349.232932 Secs (349.233 Secs)<br>*[==>]* | *[2]* |
| 6 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G102 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -27.596 66496118098,-32.24813946018116 | Sequence 5-8 Non-Int in Visit 01 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[2]* |
| 7 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G102 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -26.243 66496118098,-31.039139460181158 | Sequence 5-8 Non-Int in Visit 01 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[2]* |
| 8 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G102 | NSAMP=12; SAMP-SEQ=STEP100 | POS TARG -24.890 66496118098,-29.827139460181158 | Sequence 5-8 Non-Int in Visit 01 | 599.232292 Secs (599.232 Secs)<br>*[==>]* | *[2]* |

Orbit Structure



## Visit

**Proposal 16042, Visit 02, implementation** Thu Jan 23 23:00:24 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/IR

Special Requirements: BETWEEN 10-FEB-2020:00:00:00 AND 15-MAR-2020:00:00:00

## Fixed Targets

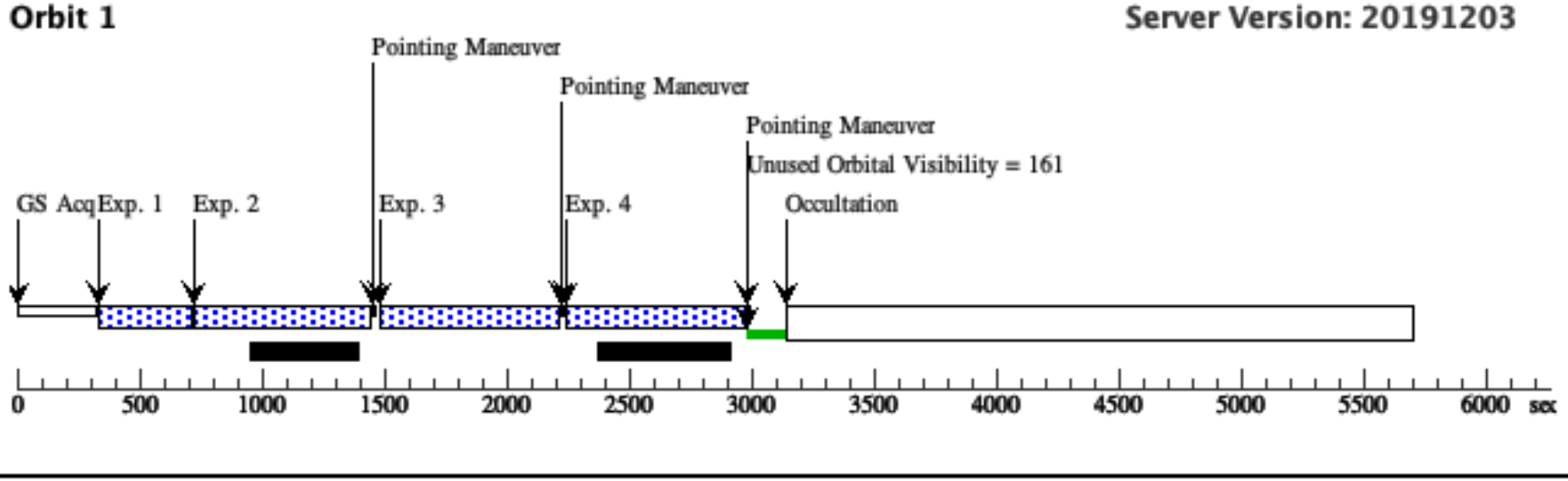
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | GRB190829A | RA: 02 58 10.5100 (44.5437917d)<br>Dec: -08 57 29.30 (-8.95814d)<br>Equinox: J2000 | | V=22+/-2 | Reference Frame: ICRS |

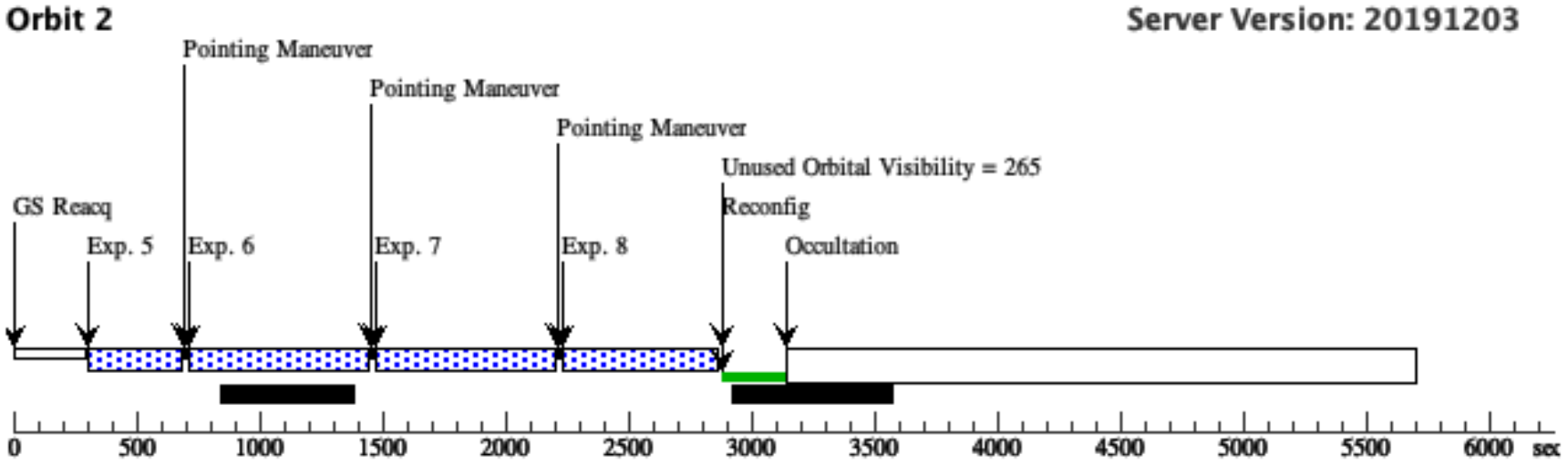
*Comments:*
*Category=UNIDENTIFIED*
*Description=[X-RAY EMITTER]*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | F140W | NSAMP=12; SAMP-SEQ=STEP50 | POS TARG -28.613 66496118098,-32.61113946018116; GS ACQ SCENARIO BASE1B3 | Sequence 1-4 Non-Int in Visit 02 | 349.232932 Secs (349.233 Secs)<br>*[==>]* | *[1]* |
| 2 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G141 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -28.613 66496118098,-32.61113946018116 | Sequence 1-4 Non-Int in Visit 02 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[1]* |
| 3 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G141 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -27.260 66496118098,-31.402139460181157 | Sequence 1-4 Non-Int in Visit 02 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[1]* |
| 4 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G141 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -25.907 66496118098,-30.193139460181158 | Sequence 1-4 Non-Int in Visit 02 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[1]* |
| 5 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | F140W | NSAMP=12; SAMP-SEQ=STEP50 | POS TARG -28.613 66496118098,-32.61113946018116 | Sequence 5-8 Non-Int in Visit 02 | 349.232932 Secs (349.233 Secs)<br>*[==>]* | *[2]* |
| 6 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G141 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -27.596 66496118098,-32.24813946018116 | Sequence 5-8 Non-Int in Visit 02 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[2]* |
| 7 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G141 | NSAMP=13; SAMP-SEQ=STEP100 | POS TARG -26.243 66496118098,-31.039139460181158 | Sequence 5-8 Non-Int in Visit 02 | 699.232615 Secs (699.233 Secs)<br>*[==>]* | *[2]* |
| 8 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, GRISM1024 | G141 | NSAMP=12; SAMP-SEQ=STEP100 | POS TARG -24.890 66496118098,-29.827139460181158 | Sequence 5-8 Non-Int in Visit 02 | 599.232292 Secs (599.232 Secs)<br>*[==>]* | *[2]* |

Orbit Structure



## Visit

**Proposal 16042, Visit 03, implementation** Thu Jan 23 23:00:24 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: BETWEEN 10-FEB-2020:00:00:00 AND 15-MAR-2020:00:00:00

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-IR-DITHER-LINE-3PT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.605<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=41.788<br>Angle Between Sides=<br>Center Pattern=false | | (1) |
| (2) | Pattern Type=WFC3-UVIS-DITHER-LINE-3PT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.135<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=46.84<br>Angle Between Sides=<br>Center Pattern=false | | (2) |

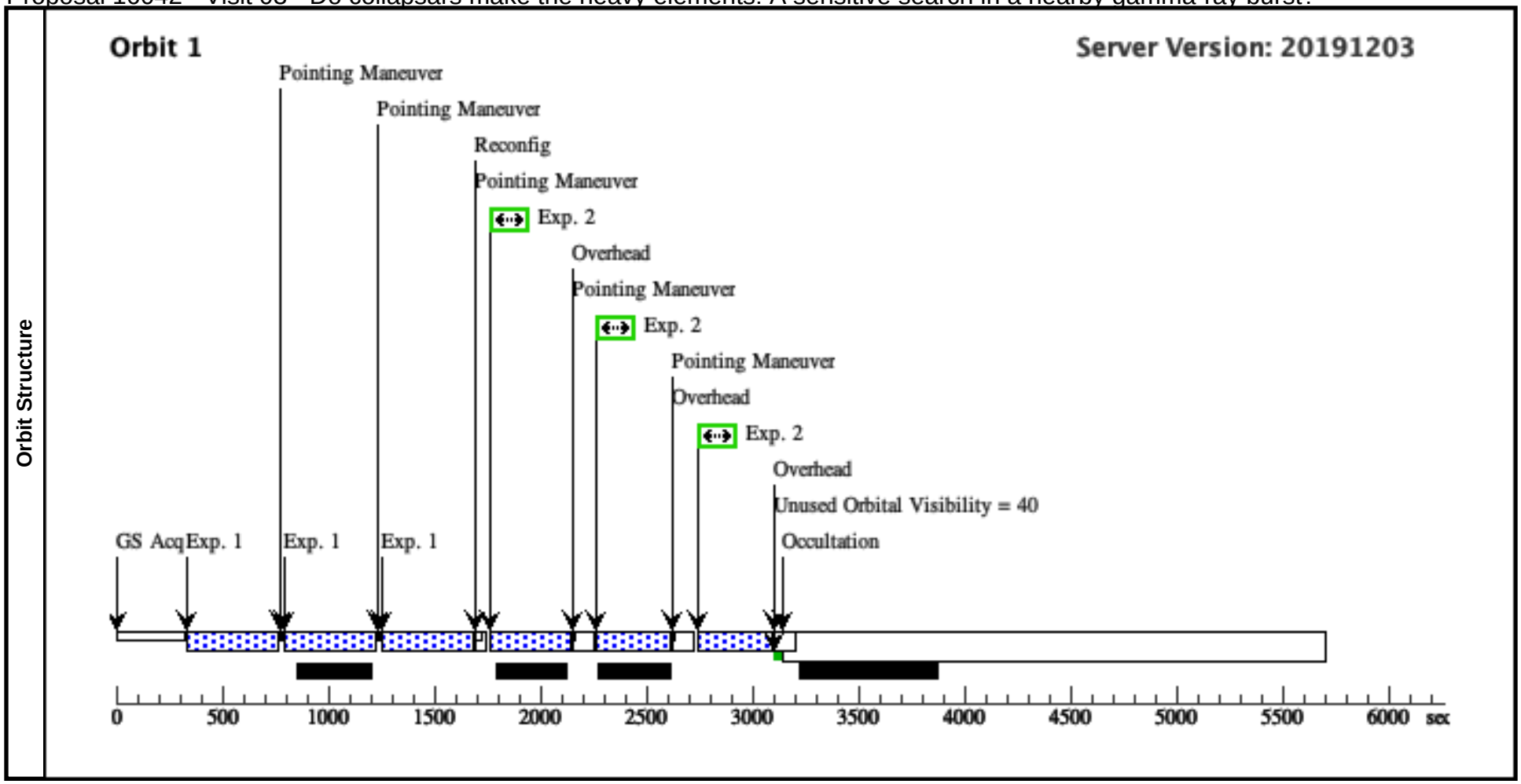
## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | GRB190829A | RA: 02 58 10.5100 (44.5437917d)<br>Dec: -08 57 29.30 (-8.95814d)<br>Equinox: J2000 | | V=22+/-2 | Reference Frame: ICRS |

*Comments:*
*Category=UNIDENTIFIED*
*Description=[X-RAY EMITTER]*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, IR | F140W | NSAMP=10;<br>SAMP-SEQ=STEP100 | GS ACQ SCENARIO BASE1B3 | Pattern 1, Exps 1-1 in Visit 03 (1) | 399.231646 Secs (1197.695 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]* | <br>***[1]*** |
| 2 | | (1) GRB190829A | WFC3/UVIS, ACCUM, UVIS1 | F606W | | | Pattern 2, Exps 2-2 in Visit 03 (2) | 348 Secs (1044 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20191203
Pointing Maneuver
Pointing Maneuver
Reconfig
Pointing Maneuver
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Pointing Maneuver
Overhead
Exp. 2
Overhead
Unused Orbital Visibility = 40
Occultation
GS Acq
Exp. 1
Exp. 1
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

## Visit

**Proposal 16042, Visit 04, implementation** Thu Jan 23 23:00:24 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: BETWEEN 15-JUN-2020:00:00:00 AND 30-JUN-2020:00:00:00

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-IR-DITHER-LINE-3PT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.605<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=41.788<br>Angle Between Sides=<br>Center Pattern=false | | (1) |
| (2) | Pattern Type=WFC3-UVIS-DITHER-LINE-3PT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.135<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=46.84<br>Angle Between Sides=<br>Center Pattern=false | | (2) |

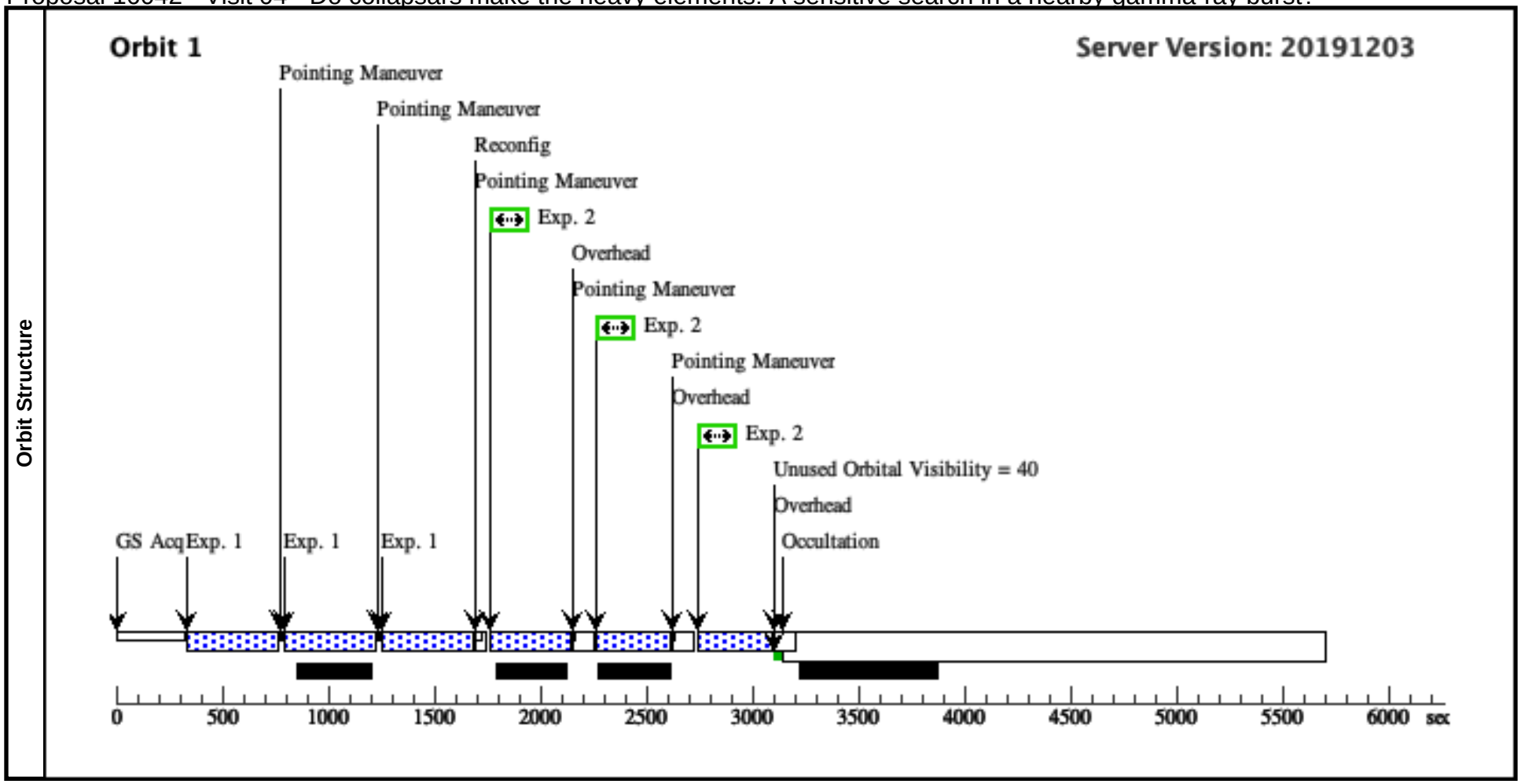
## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | GRB190829A | RA: 02 58 10.5100 (44.5437917d)<br>Dec: -08 57 29.30 (-8.95814d)<br>Equinox: J2000 | | V=22+/-2 | Reference Frame: ICRS |

*Comments:*
*Category=UNIDENTIFIED*
*Description=[X-RAY EMITTER]*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, IR | F140W | NSAMP=10;<br>SAMP-SEQ=STEP100 | | Pattern 1, Exps 1-1 in Visit 04 (1) | 399.231646 Secs (1197.695 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]* | <br>***[1]*** |
| 2 | | (1) GRB190829A | WFC3/UVIS, ACCUM, UVIS2 | F606W | | | Pattern 2, Exps 2-2 in Visit 04 (2) | 348 Secs (1044 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20191203
Pointing Maneuver
Pointing Maneuver
Reconfig
Pointing Maneuver
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Pointing Maneuver
Overhead
Exp. 2
Unused Orbital Visibility = 40
Overhead
Occultation
GS Acq
Exp. 1
Exp. 1
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

## Visit

**Proposal 16042, Visit 05, implementation** Thu Jan 23 23:00:24 GMT 2020

**Diagnostic Status: No Diagnostics**

Scientific Instruments: WFC3/IR, WFC3/UVIS

Special Requirements: BETWEEN 15-AUG-2020:00:00:00 AND 30-SEP-2020:00:00:00

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=WFC3-IR-DITHER-LINE-3PT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.605<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=41.788<br>Angle Between Sides=<br>Center Pattern=false | | (1) |
| (2) | Pattern Type=WFC3-UVIS-DITHER-LINE-3PT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.135<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=46.84<br>Angle Between Sides=<br>Center Pattern=false | | (2) |

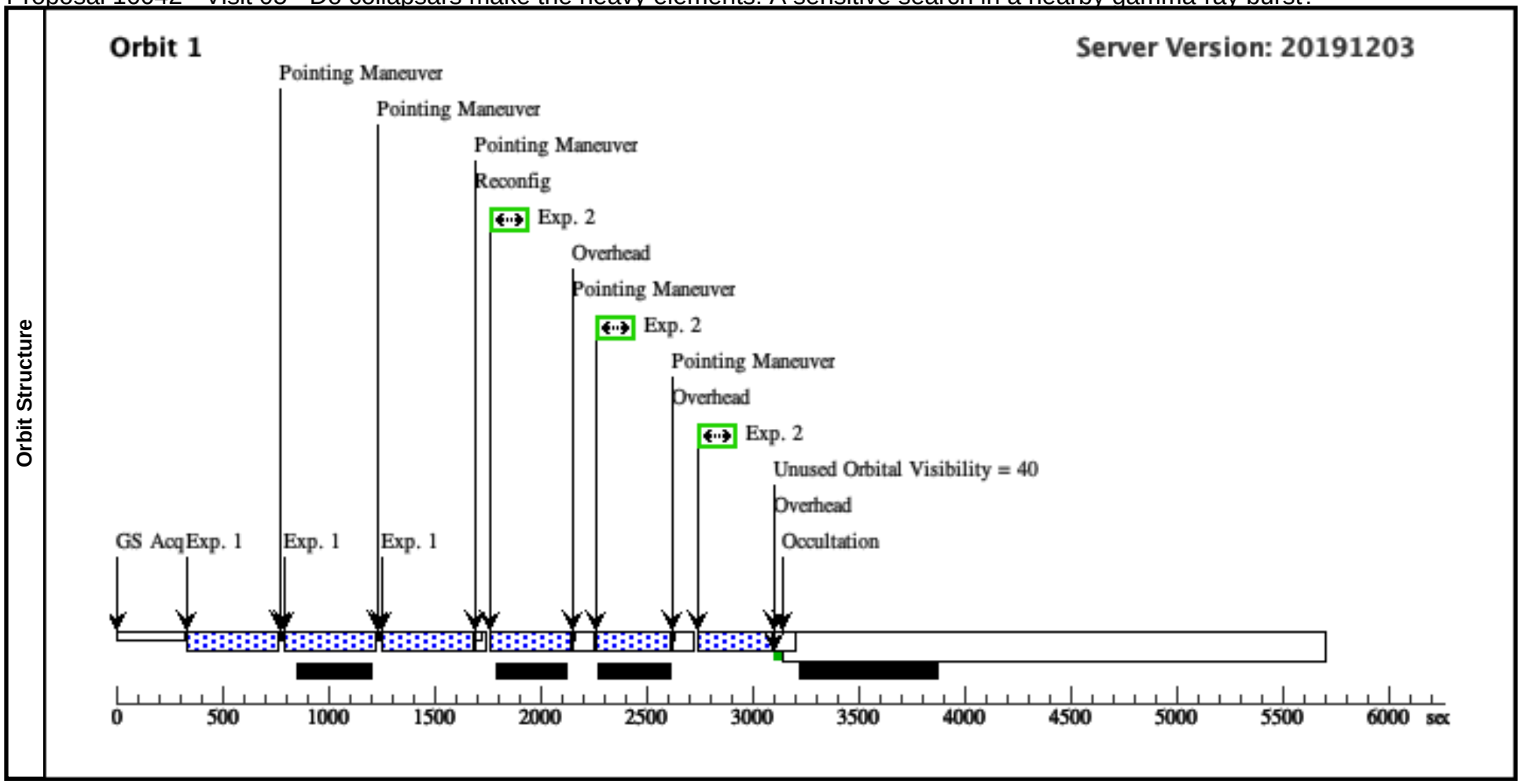
## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | GRB190829A | RA: 02 58 10.5100 (44.5437917d)<br>Dec: -08 57 29.30 (-8.95814d)<br>Equinox: J2000 | | V=22+/-2 | Reference Frame: ICRS |

*Comments:*
*Category=UNIDENTIFIED*
*Description=[X-RAY EMITTER]*

## Exposures

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | (1) GRB190829A | WFC3/IR, MULTIACCUM, IR | F140W | NSAMP=10;<br>SAMP-SEQ=STEP100 | | Pattern 1, Exps 1-1 in Visit 05 (1) | 399.231646 Secs (1197.695 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]* | <br>***[1]*** |
| 2 | | (1) GRB190829A | WFC3/UVIS, ACCUM, UVIS2 | F606W | | | Pattern 2, Exps 2-2 in Visit 05 (2) | 348 Secs (1044 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]* | <br>***[1]*** |


Orbit Structure
Orbit 1
Server Version: 20191203
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Reconfig
Exp. 2
Overhead
Pointing Maneuver
Exp. 2
Pointing Maneuver
Overhead
Exp. 2
Unused Orbital Visibility = 40
Overhead
Occultation
GS Acq
Exp. 1
Exp. 1
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec