15957 - Imaging the Size of a Quasar BALR with Synthesized HST-ACS-SBC Narrow Passbands

Cycle: 27, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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) Q0759+651	ACS/SBC	1	26-Dec-2019 14:00:10.0	yes
02	(1) Q0759+651	ACS/SBC	1	26-Dec-2019 14:00:11.0	yes
03	(1) Q0759+651	ACS/SBC	1	26-Dec-2019 14:00:12.0	yes

3 Total Orbits Used

ABSTRACT

Modern indirect attempts to constrain quasar broad absorption line region (BALR) sizes have resulted in significantly discrepant results. The various models of the BALR are consistent with a large range of size scales. Some models, such as the accretion disk wind model, predict size scales < 1 pc. Models of time variability in some observed BAL profiles place size scales up to 10 pc. However, other observations, using excited-state fine-structure absorption lines to determine BALR densities in photoionization models, indicate that some BALRs must have size scales > 500 pc and

sometimes much larger. There are no firm conclusions based on direct observation. Importantly, the UV resonance lines giving rise to the BALs will scatter central light and cause an emission component to appear on the long wavelength side of a BAL. The intensity of the scattered light emission depends on the outflow velocity extent, covering factor, and amount of interior light available to scatter.

If the BALR is as large as some results suggest, then high spatial resolution UV imaging can resolve the BALR at low redshift ($z < 0.2$). We propose imaging observations of 0759+651 ($z = 0.14$) with three HST-ACS-SBC longpass filters that will allow us to synthesize narrow passbands and search for resolved scattered broad emission, especially emanating in the NV broad emission line due to scattering of inner Lyman-alpha broad emission. We will be able to detect scattered emission from its BAL outflow down to a scale of 160 pc. This has never been tried. A positive result will be breakthrough in understanding the BALR. Any outcome will constrain models and connections between BAL outflows and AGN feedback.

OBSERVING DESCRIPTION

We will make 3 orbits of imaging observations of the Broad Absorption Line (BAL) quasar and IRAS source 0759+651 ($z = 0.14$) with three HST-ACS-SBC longpass filters that will allow us to synthesize narrow passbands and search for resolved scattered broad emission, especially emanating in the NV broad emission line due to scattering of inner Lyman-alpha broad emission; scattered broad emission emanating in the CIV broad emission may also be detected. We will be able to detect scattered emission from its BAL outflow down to a scale as small as160 pc (0.13 arcsec). This has never been tried. A positive result will be breakthrough in understanding the scale of the BAL region, but any outcome will constrain models and connections between BAL outflows and AGN feedback. The observations will be made with three ACS-SBC longpass filters (F140LP, F150LP, and F165LP). For the first two orbits, F165LP and F150LP will both be used in each orbit (visits 2 and 3). The F140LP will only be used during the third orbit (visit 1). In the end we will obtain 2 box dithers per filter-orbit so that we can improve resolution and evaluate any random dark hits that may contaminate a single sub-exposure image. For this two-box-dither per orbit strategy per filter-orbit, this will maximize HST efficiency (maximize signal-to-noise and minimize overheads). Each of the 8 sub-exposures in F165LP and F150LP will be about 311 sec, giving a total exposure time in each of these two filters over 41 min. Each of the 8 sub-exposures in F140LP will be about 331 sec, giving a total exposure time over 44 min.

In consultation with STScI((Avila), the agreed to sequence is to schedule visit 3, wait to look at the count rates in F165LP and F150LP, and then schedule visits 2 and 1 back to back within a month.

For each of the 3 single orbit visits, the ACS-SBC should be powered off and be nominally cool prior to starting the visit observations. ISR ACS 2018-7 (Avila et al. 2018) indicates that the best procedure would be to allow the temperature of the SBC to cool to its stable off-mode temperature

of approximately 14 deg C prior to commencing the visit observations. Once the SBC is powered off, it may take up to 5 orbits (8 hours) to cool, depending on its temperature when it was powered off. Our contact scientist (Avila) indicated we will have low dark using the APT reference SBC aperture (no need to use the SBC-LODARK aperture), providing the SBC is nominally cool at the beginning of our visit. We have put in a timing requirement to make sure that an SBC visit is not executed until 8 hours after our previous SBC visit, but this could be less than 8 hours if the SBC has cooled to its nominl powered-off temperature. Of course, this does not preclude the possibility that another GO will use the SBC immediately before our scheduled SBC visits, so care needs to be taken when scheduling.

The SAA must be avoided during the SBC observations, which we understand is standard procedure for the SBC.

Through subtraction of appropriate filter images, we will synthesize the narrow passband images needed for our analysis. Since Tiny Tim does not adquately model SBC PSFs, we will have to form the needed PSFs using real observations available in the HST archives for use in our analysis.

Based on ETC count rates (see ETC run #s), the formal signal-to-noise per pixel will be large (by forcing larger pixels at larger radii) even if the source is more extended than expected. If the BALR radial size scale is 3 kpc, this would corresponds to a diameter of 2.4 arcsec at z=0.14. When running ETCs, point sources were used to be conservative about count rate expectations, but the source is expected to be extended, especially in the F140LP filter (see above). The source's host galaxy is seen to contribute to the observed flux in the optical and IR. The source has been previously observed in the UV with HST, and we used its actual spectrum as input for the ETCs.

For the BOT investigations, comparison of the GSC-II predicted SBC count rates to the GALEX predicted SBC count rates in the F140LP, F150LP, and F165LP filters shows that the GSC-II assumption of **OV** spectral types for sources in the SBC FOV is wrong. The GALEX predicted SBC count rates show no bright object saftey concerns.

Visit

Proposal 15957, F140LP (01), implementation Thu Dec 26 19:00:13 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: AFTER 02 BY 8 H TO 365 D

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.
Updated ETC ID is 1395133.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=1.79 Line Spacing=1.16	Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	Q0759+651	RA: 08 04 30.4900 (121.1270417d) Dec: +64 59 52.43 (64.99790d) Equinox: J2000		V=15.9+/-0.1 FUV=17.56 +/- 0.07	Reference Frame: ICRS

Comments: This QSO shows strong broad absoprtion lines (BALs) due to an outflowing wind. It is also a reddened IRAS source with STIS and IUE spectra.
Category=GALAXY
Description=[BLR, QSO, WIND]
Extended=YES

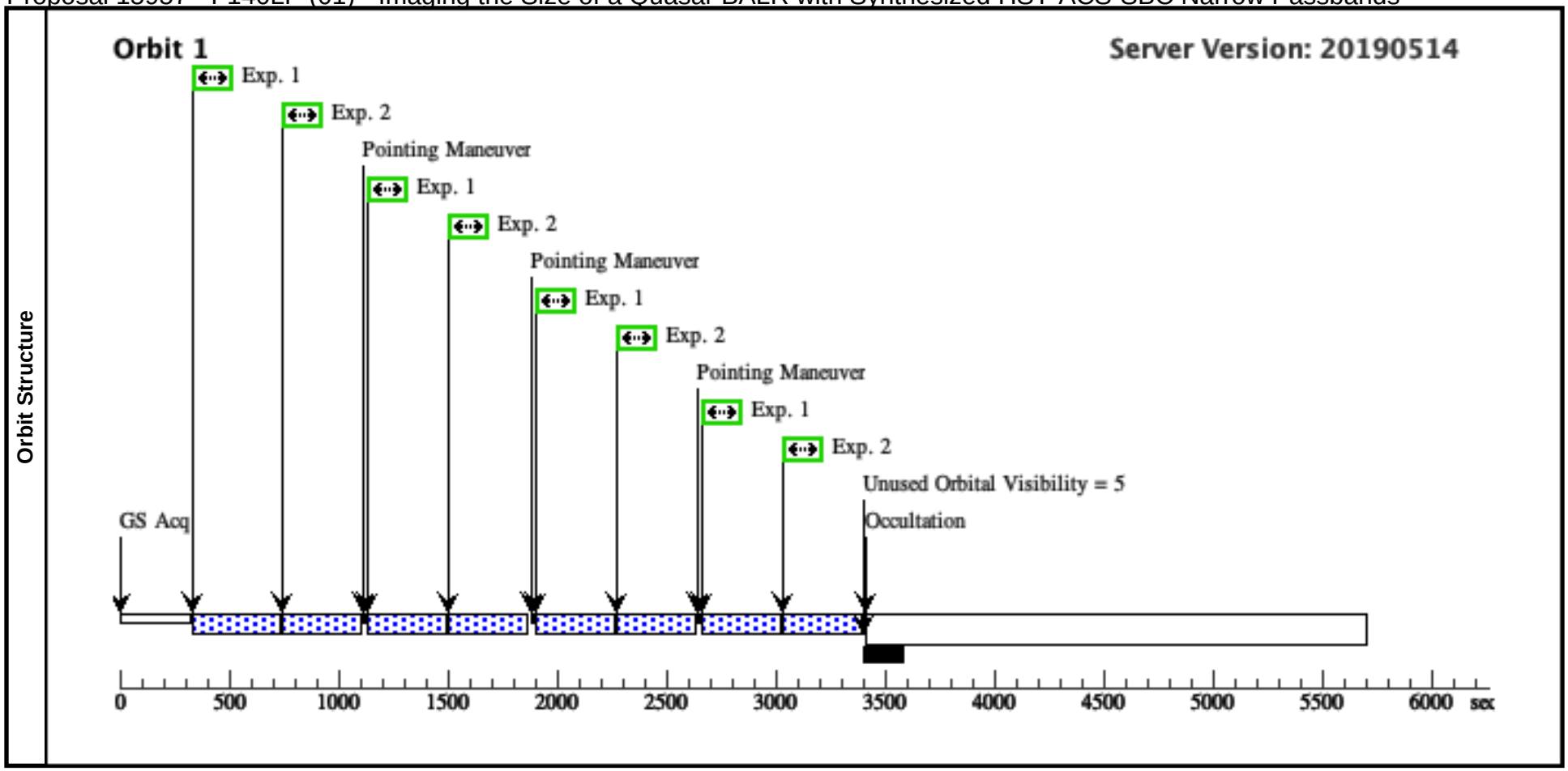
Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(ACS.im.13 71570)	(1) Q0759+651	ACS/SBC, ACCUM, SBC	F140LP			Pattern 1, Exps 1-2 in F140LP (01) (1)	331 Secs (1324 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	(ACS.im.13 71570)	(1) Q0759+651	ACS/SBC, ACCUM, SBC	F140LP			Pattern 1, Exps 1-2 in F140LP (01) (1)	331 Secs (1324 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[1]***

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.


Orbit Structure
Orbit 1
Server Version: 20190514
Exp. 1
Exp. 2
Pointing Maneuver
Exp. 1
Exp. 2
Pointing Maneuver
Exp. 1
Exp. 2
Pointing Maneuver
Exp. 1
Exp. 2
Unused Orbital Visibility = 5
GS Acq
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 15957, F165LP+F150LP_1st (02) Thu Dec 26 19:00:13 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: (none)

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.
Updated ETC IDs are 1395131 and 1395132.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=1.79 Line Spacing=1.16	Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	Q0759+651	RA: 08 04 30.4900 (121.1270417d) Dec: +64 59 52.43 (64.99790d) Equinox: J2000		V=15.9+/-0.1 FUV=17.56 +/- 0.07	Reference Frame: ICRS

Comments: This QSO shows strong broad absoprtion lines (BALs) due to an outflowing wind. It is also a reddened IRAS source with STIS and IUE spectra.
Category=GALAXY
Description=[BLR, QSO, WIND]
Extended=YES

Exposures

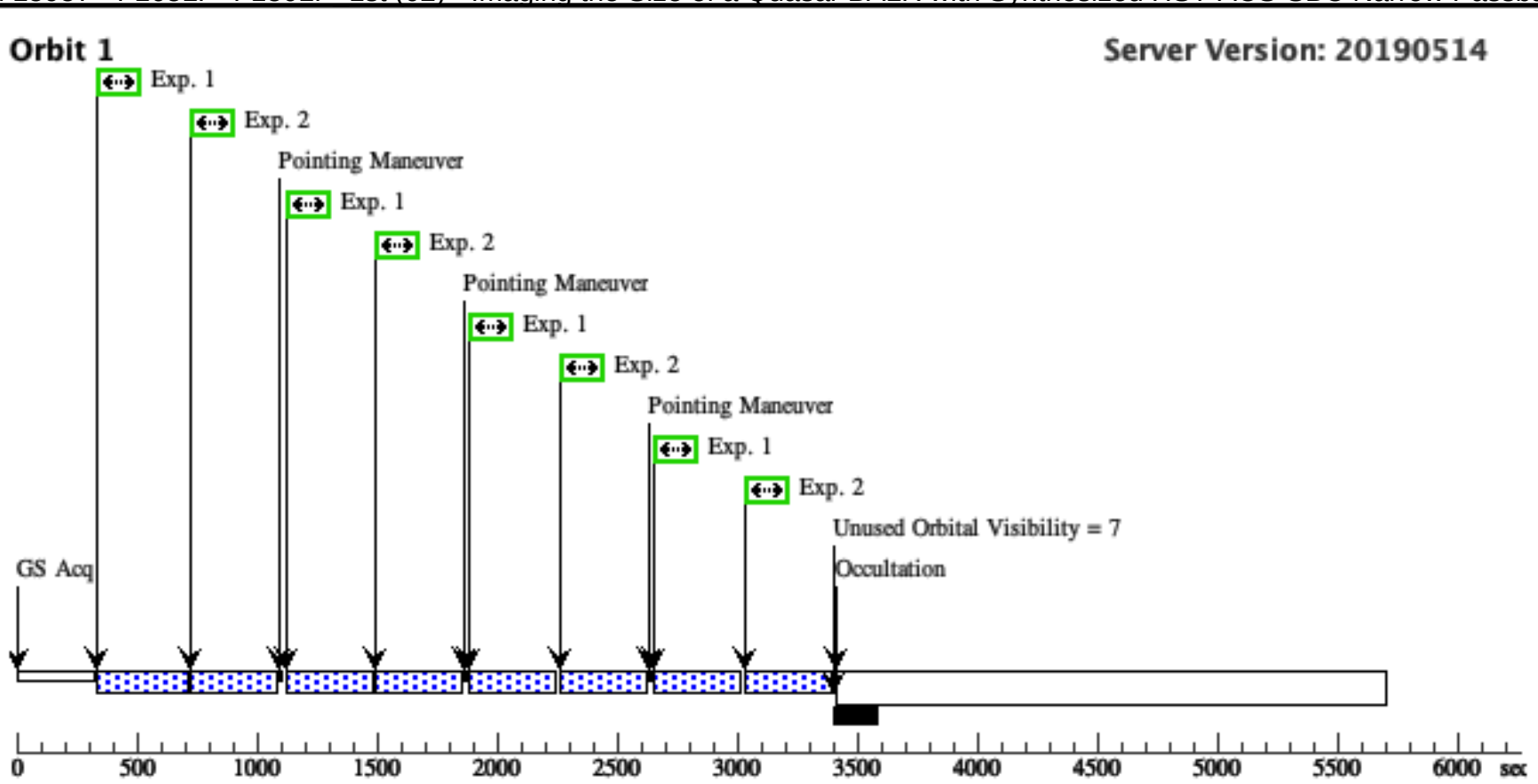
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(ACS.im.13 71572)	(1) Q0759+651	ACS/SBC, ACCUM, SBC	F165LP			Pattern 1, Exps 1-2 in F165LP+F150LP_1st (02) (1)	331 Secs (1244 Secs) *[==>311.0 Secs (Pattern 1)]* *[==>311.0 Secs (Pattern 2)]* *[==>311.0 Secs (Pattern 3)]* *[==>311.0 Secs (Pattern 4)]*	***[1]***

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	(ACS.im.13 71572)	(1) Q0759+651	ACS/SBC, ACCUM, SBC	F150LP			Pattern 1, Exps 1-2 in F165LP+F150LP_1st (02) (1)	331 Secs (1244 Secs) *[==>311.0 Secs (Pattern 1)]* *[==>311.0 Secs (Pattern 2)]* *[==>311.0 Secs (Pattern 3)]* *[==>311.0 Secs (Pattern 4)]*	***[1]***

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.

Orbit Structure



Visit

Proposal 15957, F165LP+F150LP_2nd (03) Thu Dec 26 19:00:13 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: ACS/SBC

Special Requirements: (none)

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.
Updated ETC IDs are 1395131 and 1395132.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=ACS-SBC-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=1.79 Line Spacing=1.16	Coordinate Frame=POS-TARG Pattern Orientation=20.02 Angle Between Sides=63.65 Center Pattern=false		(1-2)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	Q0759+651	RA: 08 04 30.4900 (121.1270417d) Dec: +64 59 52.43 (64.99790d) Equinox: J2000		V=15.9+/-0.1 FUV=17.56 +/- 0.07	Reference Frame: ICRS

Comments: This QSO shows strong broad absoprtion lines (BALs) due to an outflowing wind. It is also a reddened IRAS source with STIS and IUE spectra.
Category=GALAXY
Description=[BLR, QSO, WIND]
Extended=YES

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(ACS.im.13 71572)	(1) Q0759+651	ACS/SBC, ACCUM, SBC	F165LP			Pattern 1, Exps 1-2 in F165LP+F150LP_2nd (03) (1)	331 Secs (1244 Secs) *[==>311.0 Secs (Pattern 1)]* *[==>311.0 Secs (Pattern 2)]* *[==>311.0 Secs (Pattern 3)]* *[==>311.0 Secs (Pattern 4)]*	 ***[1]***

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
2	(ACS.im.13 71572)	(1) Q0759+651	ACS/SBC, ACCUM, SBC	F150LP			Pattern 1, Exps 1-2 in F165LP+F150LP_2nd (03) (1)	331 Secs (1244 Secs) *[==>311.0 Secs (Pattern 1)]* *[==>311.0 Secs (Pattern 2)]* *[==>311.0 Secs (Pattern 3)]* *[==>311.0 Secs (Pattern 4)]*	 ***[1]***

Comments: Avoid SAA.
To avoid high dark in the SBC reference aperture, the SBC should be at its nominal powered-off temperature before taking exposures during the visit.

Orbit Structure