



12954 - A New Instability Strip in the HR Diagram of Massive Globular Clusters

Cycle: 20, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Thomas M. Brown (PI) (Contact)	Space Telescope Science Institute	tbrown@stsci.edu
Dr. Allen V. Sweigart (CoI)	NASA Goddard Space Flight Center	sweigart@bach.gsfc.nasa.gov
Dr. Wayne B. Landsman (CoI)	Science Systems and Applications, Inc.	landsman@milkyway.gsfc.nasa.gov
Dr. Suzanna Randall (CoI) (ESA Member)	European Southern Observatory - Germany	srandall@eso.org
Dr. Thierry Lanz (CoI) (ESA Member)	Observatoire de la Cote d'Azur	thierry.lanz@oca.eu
Dr. Ivan Hubeny (CoI)	University of Arizona	hubeny@as.arizona.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) NGC-2808	STIS/FUV-MAMA	5	06-Jul-2012 21:58:36.0	yes

5 Total Orbits Used

ABSTRACT

We propose far-UV time-series imaging of the core of NGC 2808, a massive globular cluster exhibiting a triple main sequence, in order to search for pulsators among its large population of hot subdwarfs (a.k.a. extreme horizontal branch stars). For more than a decade, pulsating subdwarfs were only found in the Galactic field population, where they have enabled precise measurements of stellar parameters through asteroseismology. However, recent observations of the massive globular cluster omega Cen have revealed pulsating subdwarfs clustered at a temperature (~50,000 K) much hotter than those found in the field (~30,000 K). Globular clusters offer a superior laboratory for studying such pulsators because they avoid the uncertainties in distance, reddening, age, and initial chemical composition that plague the field population. NGC 2808 is the prime target to search for these new pulsators and to characterize their instability strip, given its size, distance, low reddening, and wealth of extant UV data. Our

previous UV imaging and spectroscopy of NGC 2808 found a large population of hot subdwarfs with temperatures that span those of both the omega Cen pulsators and the field pulsators. Far-UV time-tag imaging with STIS is the only way that these short-period (~100 sec) pulsators can be found in the NGC 2808 core. The discovery of this new class of pulsators opens the exciting possibility of using asteroseismology to constrain the formation mechanisms of hot subdwarfs (binary mass transfer, mergers, flash mixing, helium-rich subpopulations), and of exploring the role of iron enhancement via radiative levitation as the driving mechanism for the pulsations.

OBSERVING DESCRIPTION

Our proposed field for STIS far-UV time-tag imaging in the core of NGC~2808 is shown in Figure 2 of the Phase I proposal. To meet our goals, we need to robustly characterize (at >99% significance) a short-period (~100 sec) pulsator with an amplitude of 2% or larger. STIS time-tag photometry in the far-UV offers the only hope of achieving this goal. We considered sub-array readout modes for other HST instruments (e.g., WFC3/UVIS), but even with small subarrays (512x512 or 1024x1024), the buffer dumps (44-79 sec) preclude time-series photometry on the short timescales we need, and badly alias the data on a timescale similar to the pulsation periods expected. While it would be simplest to use the same exact STIS band (FUV/F25QTZ) employed previously in our UV imaging of the cluster core (Brown et al. 2001), this band is less sensitive than our proposed band here (FUV/F25SRF2), and would require ~3x the exposure time to detect 2% pulsations in these hot subdwarfs. Moving to a STIS near-UV band is also impractical, because the global countrate is too high to manage effectively in time-tag mode, given the increased contribution from cooler stars. The STIS/FUV/F25SRF2 band enables characterization of any pulsators within a single 5-orbit visit.

Due to the wealth of extant UV imaging and spectroscopy in the NGC~2808 core, we can demonstrate conclusively that our proposed observations will be safe. The global rate in our images will be smaller than 5000 cts/sec, which is well below the safety limit of 200,000 cts/sec. Only one object in the vicinity of our field is a concern for bright object protection (labeled "BOP" in Figure 2 of the Phase I proposal), specifically for the local rate limit. This is a post-asymptotic giant branch star that already has STIS UV imaging and spectroscopy (Brown et al. 2001). According to the STIS handbook, any object that exceeds a peak pixel rate of 100 cts/sec/pix must be placed at least 5" beyond the detector edge, and those that exceed 500 cts/sec/pix must be placed at least 13.5" beyond the detector edge. If we provide the STIS spectrum of this star to the STIS ETC, it reports a gross (source & background) peak countrate of 262 cts/sec/pixel, which violates this local limit, so we have specified the position and orientation constraints to place this star more than 5" from the detector edge. The STIS ETC is understandably conservative, but note that if we actually inspect the onboard local rate check in detail (see Clampin 2006, STIS ISR 96-31), we find that the star barely exceeds the limit. The local rate check bins a 1024x1024 image of 0.3 sec duration to 256x256, then passes a 2x2 checkbox over this image to see if the checkbox exceeds 180 counts anywhere. In the previous FUV/F25QTZ imaging of the field, that local rate check reached 60 counts in the checkbox (i.e., 1/3 of the local limit). Given the UV

Proposal 12954 (STScI Edit Number: 0, Created: Friday, July 6, 2012 8:58:46 PM EST) - Overview

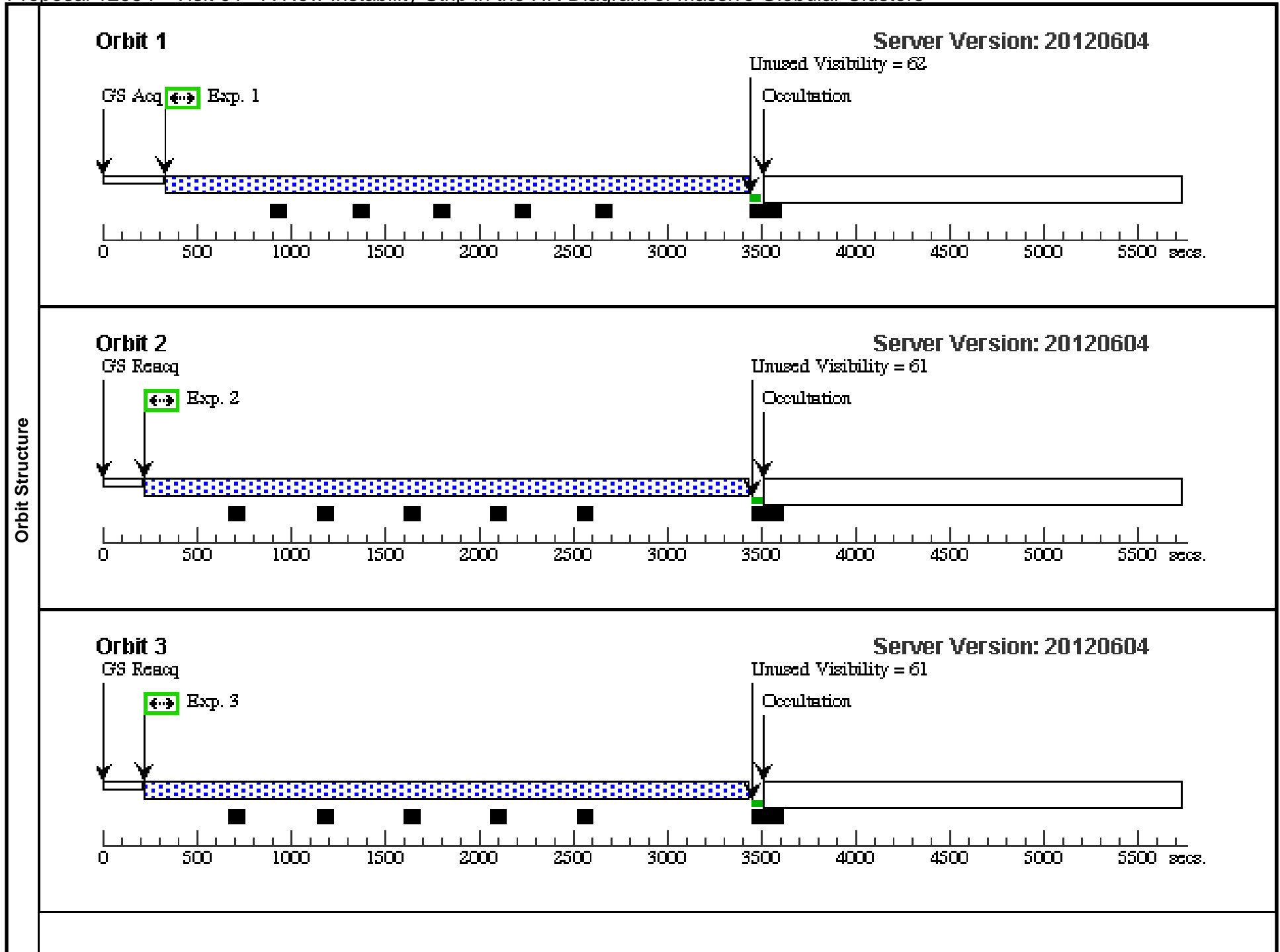
spectrum of the star in question, the FUV/F25SRF2 countrate will be 3.1x higher than the FUV/F25QTZ countrate, meaning the checkbox would measure 186 \pm 14 counts for this star (i.e., barely exceeding the local limit of 180). Either way (by the conservative ETC or the detailed inspection of the onboard rate check), we should put this star more than 5" from the detector.

With these considerations in mind, the observations are straightforward. We will obtain a single 5-orbit visit of STIS/FUV/F25SRF2 time-tag observations, with an orientation range of 40.5-73.5 degrees. This visit has ample opportunities for scheduling. The sky background in the image will vary strongly with airglow (and thus will vary with the day and night portions of the orbit). The STIS ETC demonstrates that the background is completely insensitive to zodiacal background assumption and Earthshine assumption, but depending upon the airglow setting, the sky background will be somewhere between low (180 cts/sec), average (1500 cts/sec), and high (2900 cts/sec). Note that these ETC values are twice as large those values in the STIS Instrument Handbook (Table 6.3), which claims that the sky background will be somewhere between low (84 cts/sec), average (680 cts/sec), and high (1360 cts/sec). We assume the higher ETC values for the sky background, both to be conservative and because archival STIS/FUV/F25SRF2 imaging occasionally reaches the high levels reported by the ETC. If we look at the total countrate from all sources that may fall within our field (depending upon orientation), we see that the countrate from these sources will be between 2245 and 2465 cts/sec (with the exact amount depending upon which sources fall within the field of view). Thus, the countrate will be somewhere between 2425 cts/sec and 5365 cts/sec, implying a buffer time between 370 and 820 seconds. If we were to choose a buffer time of 370 seconds to be conservative, we would exceed 30 buffer dumps in the visit, which is more than the number of buffer dumps normally allowed. Thus, we have set the buffer time to 430 seconds in Orbit 1 and 460 seconds in Orbits 2 through 5. This means that if the sky background exceeds 1900 cts/sec in one of the 460-second periods between buffer dumps, the counts in that period will fill the buffer prematurely, leaving a small gap (of order a minute) in the time series. Such exceedances should be rare (the STIS Instrument Handbook claims the sky never exceeds 1900 cts/sec, but the ETC and some images in the archive imply it happens rarely), creating perhaps one such gap per orbit.

Proposal 12954 - Visit 01 - A New Instability Strip in the HR Diagram of Massive Globular Clusters

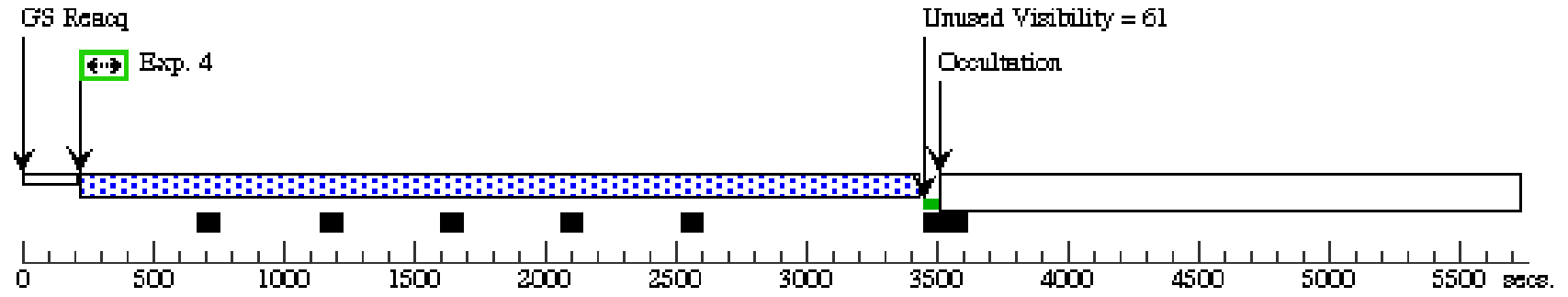
Sat Jul 07 01:58:47 GMT 2012

Visit	Proposal 12954, Visit 01 Diagnostic Status: Warning Scientific Instruments: STIS/FUV-MAMA Special Requirements: ORIENT 40.5D TO 73.5 D									
	(Visit 01) Warning (Orbit Planner): STIS TIME-TAG EXPOSURE GENERATES HEAVY DATA VOLUME									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes	Miscellaneous		
	(1)	NGC-2808	RA: 09 12 3.4330 (138.0143042d) Dec: -64 51 50.93 (-64.86415d) Equinox: J2000				V=6.89+/-0.1 flux(1595)=4.6E-15 erg/s/cm2/A for brightest star that will be imaged at any orientation in our range	Reference Frame: ICRS		
<i>Comments: The V magnitude is the total magnitude of the cluster. More relevant for bright-object protection is the far-UV flux of the star that will be brightest within the STIS/FUV field of view, and that is reported under "Other Fluxes".</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(STIS.im.40 6279)	(1) NGC-2808	STIS/FUV-MAMA, TIME-TAG, F25SRF2	MIRROR	BUFFER-TIME=430			2950 Secs [==>]	[1]
	2	(STIS.im.40 6279)	(1) NGC-2808	STIS/FUV-MAMA, TIME-TAG, F25SRF2	MIRROR	BUFFER-TIME=460			3200 Secs [==>]	[2]
	3	(STIS.im.40 6279)	(1) NGC-2808	STIS/FUV-MAMA, TIME-TAG, F25SRF2	MIRROR	BUFFER-TIME=460			3200 Secs [==>]	[3]
	4	(STIS.im.40 6279)	(1) NGC-2808	STIS/FUV-MAMA, TIME-TAG, F25SRF2	MIRROR	BUFFER-TIME=460			3200 Secs [==>]	[4]
	5	(STIS.im.40 6279)	(1) NGC-2808	STIS/FUV-MAMA, TIME-TAG, F25SRF2	MIRROR	BUFFER-TIME=460			3200 Secs [==>]	[5]



Orbit 4

Server Version: 20120604



Orbit 5

Server Version: 20120604

