

Policy and Procedure for MAMA Targets Subject to Unpredictable Outbursts

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Abstract

The policy and procedure are described for the implementation of MAMA (currently, ACS/SBC) observations of targets subject to infrequent and unpredictable large outbursts, that would exceed the countrate limits should they occur during the observations. The proposers of such programs are required to provide either external or HST observations establishing quiescence of the targets within about 24 hours of the start of MAMA observations. Otherwise, a flag disabling MAMA turn-on will not be cleared via real-time command, and the observations will not occur. Targets with large outbursts on very short timescales, such as flare stars, should not be observed with the SBC MAMA.

1. Introduction

Some recent HST FUV programs have observed faint, quiescent states of objects that are far below the MAMA screening limits, but which are subject to improbable, unpredictable outbursts that would far exceed those limits. While such events are rare, they would safe or potentially even damage a MAMA should they unexpectedly occur during the observations. Even if significant damage is avoided, subsequent MAMA observations may

be disrupted for several days. Considerable discussion and effort have been applied to guard against such events in the recent cases (although similar or even the same objects had been observed in earlier cycles with no precautions). It has been suggested that a policy should be developed to standardize these procedures and avoid recurrent reconsideration of the basic issues (Appendix 1).

It can be shown (Appendix 2) that objects must be several magnitudes brighter than the conservative screening limits to shutter or safe the ACS/SBC, and several magnitudes beyond that to cause significant damage. Note that for Cycle 15, the applicable local rate limit for irregularly variable objects has been reduced to 20 cts/sec/pix, for consistency with the factor of 2.5 margin with respect to nonvariable objects adopted for the global rate limit. For SBC observations of single point sources, whether direct or spectroscopic, the limit is always determined by the local rate (unlike for STIS spectroscopy). It would be excessive to entirely exclude such observations, since the onboard protection mechanisms will most likely prevent damage from an undetected outburst. On the other hand, it is also reasonable to apply some effort to avoid such events, consistently with the policies for all MAMA programs.

2. Target Characteristics

All evolved massive stars are expected to explode as supernovae on a timescale of order 100,000 years, and the recurrence time of classical novae is believed to be of order 10,000 years. Clearly such objects are nonvariable for our purpose. The principal objects of concern (and the targets of all the recent programs) are short-period, mass-transfer binaries containing a collapsed component, i.e., black hole (BH), neutron star (NS), or white dwarf (WD). The first two classes have X-ray and optical novalike outbursts, while the heterogeneous third class, known as dwarf novae or cataclysmic variables (CV), are primarily optical (and UV) variables. A useful survey of CV zoology from the present perspective is in Appendix 3. Typical optical outburst amplitudes of all three classes are between 5 and 10 magnitudes, on timescales of decades. Rise times of the outbursts range from several days to less than a day, depending on the type of object.

Thus, the variability timescale of interest here is from about 10 to 100 years. Anything shorter is likely to be predictable, or at least so frequent that the known maximum fluxes can be used for Bright Object Protection (BOP) screening. Anything longer is so improbable that it is not a realistic concern. For reference, for a 10 yr timescale, the random probability of an event within 1 day of the observations is 1/3650, while within 0.1 day (i.e., ~ 2 HST orbits), it is 1/36,500.

Late-type flare stars can have large UV outbursts without warning and rise times of order seconds. They should probably not be observed with the SBC MAMA, which is after all designed for faint extragalactic targets. Its use for bright stars because of the current lack of an alternative exacerbates the present issue. This policy can be reconsidered when a more versatile UV spectrograph becomes available.

3. Recent Programs

For greater specificity regarding target properties and protection procedures, it is useful to consider three recent cases.

GO/Chandra 10007: The target of this STIS program was Cen X-4, a NS binary X-ray nova. Its quiescent magnitude is 18.5, but it has had two known outbursts to V of 11.5 and 12.8 in 1969 and 1979, respectively, and none since. The rise times were a few days to a week. Pre-HST observing monitoring was conducted with *XTE* and from the ground.

GO 10233: This program was originally intended for STIS, but was converted to ACS/SBC following the failure of the former. It observed three newly discovered CVs

with no known outburst history. However, they belong to a subclass that has outbursts of 6–9 mag with a rise time of 1–3 days, on timescales of 20–30 years. Pre-HST observing monitoring was conducted with a global array of professional and amateur (AAVSO) groundbased telescopes. The PI was requested to provide initial results a week before the HST observations, and required to provide confirmation within about 24 hours; otherwise, the HST observations (5 orbits each) would have been cancelled.

GO 10253: A NS binary was observed with both HRC and SBC. The HRC observations were scheduled 2 orbits before the SBC, and the results were reviewed in the interval. If the HRC had shown an outburst, the SBC would have been cancelled. Further details of this implementation are provided in Appendix 4.

4. Protection Procedures

Three mechanisms have been applied to this problem in the past.

1. A decision is based on purely external monitoring information, as for GO 10007 and 10233. An event flag is set to disable the SBC turn-on, which is then cleared if confirmation of quiescence is received from the proposers within about 24 hours in advance of the HST observations. A sample timeline is outlined below. Some effort is required from the Program Coordinator (PC) to prepare the Phase II program with Special Commanding (S/C) exposures (examples below); from ACS User Support to approve the critical, final proposer input; and finally from the STScI and GSFC engineers to send the time-critical, real-time commands to clear the flag. An obvious hazard is that circumstances (e.g., weather) might prevent the final confirmation, leading to an unnecessary cancellation and loss of HST time.

2. An HRC observation immediately precedes the SBC to confirm quiescence, as for GO 10253. The advantages are certainty of the input and minimum interval before the SBC observations, i.e., minimum probability of an undetected outburst. The disadvantage is the support effort required, which in addition to all that above, requires advance computation of an HRC maximum count value for the SBC observation to proceed, and time-critical, real-time verification of the result by operations personnel. (The HRC data analysis is done onboard and only the result appears in the telemetry stream, i.e., the data do not need to be downlinked in real time.) Also, the HRC time must be requested in Phase I, or otherwise sacrificed from the SBC allocation.

3. HST is pointed to nearby blank sky, and then moved to the target if external confirmation of quiescence is received. This may have been done at some time, but it doesn't offer any obvious advantages over the above procedures and will not be further

considered here.

5. Policy

It has been suggested (Appendix 1) that a quantitative algorithm might be devised based on the specific target properties discussed above (as well as perhaps the time since the last known outburst if applicable), to determine which of the above procedures should be followed; or, as extreme cases, whether no monitoring is required or the observation should be disallowed a priori. However, such a policy might prove to be illusory, because of (a) the substantial uncertainties in the actual behavior of an individual object, and (b) the arbitrariness of deciding what probability of an outburst is acceptable. Instead, the following formal policy statement has been adopted, which is consistent with the general policy that targets exceeding the screening limits for a given configuration may not be observed with it.

“For ACS/SBC observations of aperiodic variable objects with known properties, the maximum flux values must be applied for the BOP screening. For objects either known to be subject to unpredictable outbursts on a timescale less than 100 years, that would exceed the screening limit of the specified configuration, or belonging to a class of such objects, either external or HST data confirming quiescence within about 24 hours of the SBC observation must be provided by the proposers, or the SBC observation will be cancelled. The choice between external and HST confirmatory data is at the discretion of the proposers.”

A support concern may arise if the number of such targets approved exceeds about one per month. In that case, additional procedures or limitations may be required, in view of the level of effort involved. To summarize: at some time in advance, special commanding needs to be established and inserted into the Phase II program by the PC; the GOs do not have the information to do that. This special commanding is subject to review and approval by the STScI commanding personnel. Then, as soon as the actual HST schedule is known, the engineers here and at Goddard have to plan for the real-time interaction. In the case of groundbased input, the GO is asked to send data starting about a week in advance (to forestall the urgent procedures just before the observation, if the object is already in outburst), and then continue through the HST observation (so that if there were an outburst after the last 24-hr input, we have information about what flux the detector was subjected to). In the hours preceding the observation, ACS User Support and the engineers will be on call to receive and approve the final signoff and clear the flag. If the HRC is being used for the check, the result must be downlinked and analyzed asap. The

inconvenience of this stage depends on the time of day/week of the observation and the time zone of the groundbased observation, which could be any. Some of this effort can be distributed among different PCs and Instrument Scientists (IS) for different programs, but some of the engineers involved may be (nearly) unique.

6. Program Coordinator Procedure

S/C exposures must be inserted into the GO Phase II proposal by the PC. Examples from GO 10233 are as follows, but note that the details may vary among different programs. The details are provided by the STScI commanding group to the PC and their implementation will receive a final review by that group well in advance of scheduling.

Visit: 01

Visit Requirements: AFTER 06 BY 2 Orbits TO 5.5 Orbits

Additional Comments: AFTER BY requirement needed to verify the brightness of the target using ground observations. Also, uplink opportunities are needed in the ~ 2 orbit interval to clear the NSSC-I Event Flag 2 and allow high-voltage turn-on, if the target is determined to be safe.

Exposures

Exp Num	Target Name	Instr Config	Oper. Mode	Aper or FOV	Spectral Element	Num Exp	Exp Time	Special Requirements
1	SDSSJ013132.9-090122.3	ACS/SBC	ACCUM	SBC	F140LP	1	15 S	
7	DARK	S/C	DATA	NONE		1	10 S	SPEC COM INSTR EJFLAG2CLR

Comments: Clear NSSC-I Event Flag 2 to allow high-voltage turn-on. Insert SQL for quasi_states ACS start/end = WFHROPER, DOOR start/end = OPEN, HCOR start/end = HOLD, LAMP start/end = HOLD, and WCOR start/end = HOLD.

Visit: 06

Additional Comments: This Visit sets the NSSC-I Event Flag 2 that disables the high-voltage turn-on. The high-voltage will be enabled, to allow SBC observations in the corresponding Visit, using real-time commanding if the target is determined to be safe.

Exposures

Exp Num	Target Name	Instr Config	Oper. Mode	Aper or FOV	Spectral Element	Num Exp	Exp Time	Special Requirements
1	DARK	S/C	DATA	NONE		1	25 S	SPEC COM INSTR EJFLAG2

Comments: Set NSSC-I Event Flag 2 to prevent high-voltage turn-on. Insert SQL to ensure that the SBC is off when the flag is set, and for qasi_states ACS start/end = WFHROPER, DOOR start/end = OPEN, HCOR start/end = HOLD, LAMP start/end = HOLD, and WCOR start/end = HOLD.

7. Engineering Procedure

The nominal operating procedure allows the SBC to turn on. The following timeline for GO 10233, executed in 2005, illustrates the engineering procedures for potential outburst targets. An S/C visit disables the SBC turn-on; that status must be reverted by real-time commanding following confirmation of target quiescence within about 24 hours in advance. This action requires pre-arranged coordination between STScI and GSFC engineering personnel.

- June 17 21:35:57 UT: Disable the SBC turn-on.
- June 17 21:48:00 UT: Start of window to permit (i.e., via a flag) the SBC to turn on using real-time commands.
- June 18 01:22:36 UT: Start of SBC turn-on.
- June 18 01:32:56 UT: Start of SBC science activities for 10233.
- June 18 08:49:01 UT: End of SBC science activities for 10233.
- June 18 10:01:45 UT: Enable SBC turn-on (redundant if already enabled).

Other than the permission for the SBC turn-on at 21:48 UT, all other commands were stored in the HST computers and did not require any real-time interaction.

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Appendix 1: Policy Requirement and Possible Guidelines

The GO 10233 proposal raises the following issue: when should we take special precautions if we are dealing with a source that has some probability for going into outburst. We should take appropriate precautions, but shouldn't be overly worried either. The effort spent on GO 10253 may have been more conservative than necessary. Appendix 2 assesses the possible damage that might actually occur from a local rate violation. We should develop a policy statement, so that we don't need to have this same discussion at every occurrence. The policy should probably have the following variables:

- frequency of outburst behavior
- expected maximum brightness during outburst (relative to our screening limit)
- other?

And depending on the variables, the actions might include:

- determine from ground-based monitoring in the TBD days before the HST observation that the source is not in outburst (as done for 10233)
- perform an HRC observation just before the SBC observation to assure that the source is not in outburst (as done for 10253)
- require no special monitoring
- forbid the observation altogether (or suggest HRC instead)
- other?

Appendix 2: ACS/SBC Overlight Trigger and Damage Levels

The potential consequences of exceeding the SBC local rate limit with a very bright target have been investigated. In essence, all the relevant details are covered in STIS ISR 96-31 (M. Clampin), while the minor modifications for ACS are discussed in ACS ISR 98-03 (C. Cox). The main results are summarized here:

STScI screening limit: 50 cts/sec/pixel

Software Local Rate Check Limit: 200 cts/sec/pixel

CARD limit: 500 cts/sec/pixel

If a local rate violation occurs, then the filter wheel is rotated to an opaque position. The integration time over which light can reach the detector is at most some ~ 20 sec. The primary result of a high local count rate is a potential for causing a permanent decrease in local QE. Table 1 of the Clampin ISR lists how long one would need to integrate to cause a permanent QE loss of 1%. The last value in this table implies that even if a source were 6.7 mag brighter than the CARD limit, which is 9.2 mag brighter than our STScI screening limit, it would still require 90 sec of exposure time to cause a 1% permanent QE loss. This is still 4.5 times larger than the maximum illumination time of 20 sec given above. Such a source would have 238,000 cts/pixel, which is of the same order of magnitude where various global rate checks might be triggered.

The implication is that a point source would have to be much brighter than the screening limits before it would either cause significant permanent damage, or trigger a global rate violation and shut off the high voltage. There are various simplifying assumptions, but it is reasonable to conclude that we needn't be overly worried about an occasional BOP violation by targets that are only remotely likely to go into outburst.

Appendix 3: An Outburst Target Program Review

[Note: the following program was not executed because of the STIS failure. This detailed discussion gives a good idea of the complexity of and the resources required to screen such a program. It is questionable whether such a program should be approved or supported in the future.]

Subject: CV Snap Program GO 10194

For background, note that many CV accretion disks can switch between a high state and a low state. Classic “nova-like” variables spend most of their time in the high state, only occasionally dipping into the low state. Dwarf Novae (DN), on the other hand, spend most of their time in the low state, with outbursts at intervals that vary widely from one system to another. Most DN have outbursts of only 2–4 mag, but 5.5 mag outbursts are not unheard of, and a few rare systems (e.g., WZ Sge), can have outbursts of up to 8 mag. These latter systems are characterized by companions which have been stripped down to brown-dwarf mass. They tend to have orbital periods near 90 min, and very long intervals (years to decades) between their very bright outbursts. They are also known in the literature as TOADs (Tremendous Outburst Amplitude Dwarf-novae).

There are also magnetic CVs (polars and intermediate polars), where the strong field tends to regulate the accretion flow, inhibiting large outbursts. Note also that the intervals between full-blown thermonuclear nova explosions are between 10^4 and 10^6 years, so they are not a concern, even for historical novae.

Verbunt (1987, A&AS 71, 339) did a systematic review of the then available IUE observations of CVs, listing both visual and FUV fluxes for a variety of systems. The maximum FUV/visual ratios found for both nova-like systems and DN at the peak of outburst tend to have similar values. Most systems tend to have much lower peak FUV/visual ratios; the foregoing refers to the worst cases for each type of system.

Of these, the SS Cyg IUE low-dispersion, large-aperture observation on 6/23/79 (SWP 5603) will be adopted as the worst case. At this time, the visual magnitude as determined from IUE FES measurements was 8.8. Taking this spectrum as ETC input, and assuming G140L with the 0.2x0.2 aperture, one derives a global count rate of 541,557 cts/sec and a local rate of 363 cts/sec/pix (ETC ID STISSPEC13127).

For systems which are well observed in the optical, but for which no direct UV measurements within one magnitude of peak brightness are available, we shall require that the scaled SS Cyg spectrum be less than the irregularly variable limit of 12,000 cts/sec. This criterion gives a limit of $V = 8.8 + 2.5 \log_{10}(541557/12000)$, or $V = 12.9$. The

predicted peak local rate would then be only about 8 cts/sec. While these systems often have strong emission lines, in no case have we found an example where the local limit for G140L is more stringent than the global limit.

We could argue that, for very well observed systems, where the upper limit in outburst is exceptionally well determined, a worst case global limit of 30,000 cts/sec might be allowed. This criterion would increase all the limits discussed here by about 1 mag.

For systems that might exceed the 12,000 cts/sec limit, we may recommend that the PI switch to E140M. In this case the E140M 0.2×0.2 calculation of the same SS Cyg spectrum gives 172,900 cts/sec global, 2.35 cts/sec/pix local. Since the irregularly variable limit for the echelles is 80,000 cts/sec, this corresponds to $V = 8.8 + 2.5 \log_{10}(172900/80000) = 9.6$ (STISSPEC13126).

We also have to ensure that the underlying WD in any system is not so bright that it, by itself, exceeds the limits. The Kurucz O5 star brightness to give 12,000 cts/sec for G140L, 0.2×0.2 is just about $V = 14.4$ (12,100 cts/sec global, 7.1 cts/sec/pix local, STISSPEC13129); or for the E140M/ 0.2×0.2 to give 80,000 cts/sec it is $V = 11.1$ (78,695 cts/sec global, 0.91 cts/sec/pix local, STISSPEC13132). In the absence of direct UV measurements or other evidence, we shall require the system in quiescence to be fainter than these magnitudes.

The PI gave magnitudes with ranges of variability. Where possible we have checked the light curve in AAVSO (<http://www.aavso.org/data/lcg/>) and used the visual range found there instead. We also list GSC2 magnitudes. Where applicable, we list other UV observations and predicted peak rates. If other UV observations were taken within 1 mag of the system peak, we shall scale them to the peak magnitude. All IUE spectra referenced are SWP large aperture, low dispersion. For polars and nova-like variables, we shall accept PI mag estimates unless there is an obvious inconsistency with GSC2. For DN we shall require some kind of verification of the outburst amplitude. We also list GSC2 F and J plate mags. Targets that might be within 0.3 mag of a limit when assuming a worst case outburst or quiescent star are marked with an *. These should be signed off only with a formal secondary review.

The following should be cleared with the requested G140L 0.2×0.2 :

#	name/comment	type	range	GSC2 mags
2	V452 Cas	DN	14.7–18+	Fmag = 18.6, Jmag = 15.2
3	FO And	DN	13.3–18.5	Fmag = 15.23, Jmag = 15.04
	very well observed in AAVSO			
4	SDSS-J015543.40+002807.2	Polar	15.4±1	Fmag = 15.44, Jmag = 17.93
5	TT Tri	NL	15.1±0.3	Fmag = 15.19, Jmag = 16.14
6	AI Tri	Polar	15.5–18.5	Fmag = 15.41, Jmag = 15.80
	mag range from A&A 372, 945			
7	HS0218+3229	NL	15.8±0.5	Fmag = 15.18, Jmag = 17.04
8	HS0220+0603	NL	16.1±0.3	Fmag = 16.06, Jmag = 16.68
9	1RXS-J031525.1+410620	Polar	16.2±1	Fmag = 15.51, Jmag = 16.58
10	1RXS-J032540.0-081442	Polar	15.4±0.3	Fmag = 17.15, Jmag = 15.97
11	BPM71214	PC?	14.2±0.1	Fmag = 12.81, Jmag = 14.03
	“hibernating nova” “precataclysmic” with 17000 K WD, ETC calc $V = 13.6$, 17000 K BB gives global 2200 cts/sec, local 2.7 cts/sec/pix, STISSPEC13059			
12	1RXS-J052430.2+424449	Polar	16.3±1.0	Fmag = 17.02, Jmag = 17.69
13	BY Cam	Polar	13.9–15.5	Fmag = 15.23, Jmag = 15.29
	very well observed by AAVSO			
14	HS0506+7725	NL	15.4±0.3	Fmag = 14.67, Jmag = 15.07
15	BT Mon	NL	16.1±0.5	Fmag = 15.73, Jmag = 16.04
	Nova Mon 1939			
17	DM Gem	NL	17.4±0.5	Fmag = 17.14, Jmag = 17.6
	Nova Gem 1903			
18	HS0642+5049	NL	15.6±0.3	Fmag = 15.47, Jmag = 15.83
19	BX Pup	DN	13.1–16.5	Fmag = 14.6, Jmag = 17.06
20	DW Cnc	NL	14–15.5	Fmag = 14.96, Jmag = 16.02
	good AAVSO coverage			
23	1RXS-J085909.5+05	Polar	15.4±0.3	Fmag = 17.24, Jmag = 19.77
	GSC2 much fainter than PI estimate			
26	EI UMa	DN	13.4–15.7	Fmag = 14.68, Jmag = 14.99
	reasonable AAVSO coverage; 1 unvalidated point at 13.1, but adjacent upper limits are lower			
27	1RXS-J095308.6+145841	Polar	17.3±0.5	Fmag = 17.85, Jmag = 18.71
28	GZ Cnc	DN	13.1–16.7	Fmag = 14.73, Jmag = 15.23
29	H0928+50	NL	16.3±0.5	Fmag = 16.03, Jmag = 17.21
30	HS0943+1404	POLAR	16.3±1.0	Fmag = 18.79, Jmag = 16.17
32	SDSS-J092009.54+004244.9	NL	15.4±0.3	Fmag = 17.6, Jmag = 18.16
	GSC2 much fainter than PI estimate			
33	SDSS-J093249.57+472523.0	NL	17.8±0.3	Fmag = 19.74, Jmag = 19.1
	GSC2 much fainter than PI estimate			
37	LN UMa	NL	15.2±0.2	Fmag = 14.96, Jmag = 15.23
	AAVSO upper limits $\gtrsim 15.3$, SIMBAD 15.4			
38	RX-J1039.7-0507	Polar	18.5±0.3	Fmag = 19.06, Jmag = 18.06
39	SDSS-J102347.67+003841.2	Polar	18.0±0.3	Fmag = 16.91, Jmag = 17.80
40	SW Sex	NL	14.8–17.5	Fmag = 14.14, Jmag = 14.82
	IUE obs in ETC gives 1385 cts/sec global, 2.2 cts/sec/pix local, STISSPEC13036			
42	WX LMi	Polar	17.5±0.3	Fmag = 16.77, Jmag = 17.80
43	IR Com	DN	14.1–18.6	Fmag = 15.96, Jmag = 16.89
	fair AAVSO coverage			
45	SDSS-J124959.76+035726.6	NL	16.7±0.3	Fmag = 16.57, Jmag = 16.86
46	V1025 Cen	IP	16.1±0.3	Fmag = 15.91, Jmag = 17.18
47	CR Boo	NL	12.7–17	Fmag = 14.63, Jmag = 14.51,
	AAVSO mostly $\gtrsim 13.2$, IUE “outburst” spectrum (IUE PI’s mag estimate 12.5) gives global 2700 cts/sec, local 34 cts/sec/pix, STISSPEC13105			
48	HS Vir	DN	13.1–17	Fmag = 15.35, Jmag = 14.28

#	name/comment	type	range	GSC2 mags
50	LY Hya many AAVSO upper limits plus one outburst; star has bad coords in SIMBAD database (12 mag star?), but PI coords point to a very faint object which agrees with SIMBAD, AAVSO, and PI mag estimates.	DN	14.3+	Fmag = 17.4, Jmag = 18.52
51	1RXS-J154814.5-452845 not very variable (no outbursts), so OK even as O star	IP	14.6±0.3	Fmag = 14.42, no Jmag
52	HP Lib IUE gives 5287 cts/sec global, 3.2 cts/sec/pix local, STISSPEC13037	NL	13.5–13.9	Fmag = 13.69, Jmag = 13.63
53	NY Ser	DN	14–18.2	Fmag = 17.77, Jmag = 17.52
55	RX-J1610.1+0352	Polar	16.0±1.0	Fmag = 18.48, Jmag = 17.66
56	1RXS-J173021.5-055933	IP	16.5±0.3	Fmag = 15.39, Jmag = 16.74
57	V442 Oph IUE gives 1923 cts/sec global, 4.5 cts/sec/pix local, STISSPEC13044	NL	13.45–13.75	Fmag = 13.63, Jmag = 13.67
58	V478 Her 460 AAVSO obs \gtrsim 16 or upper lim \gtrsim 14	DN	\gtrsim 14	Fmag = 17.44, Jmag = 17.21
59	UZ Ser SWP 15078 at V = 12.6 gives 4900 cts/sec glob, 3.1 cts/sec/pix local, STISSPEC13106; scaling to V = 11.8 gives 9800 cts/sec global, \gtrsim 75% of 12,000	DN	11.8–17	Fmag = 15.44, Jmag = 13.83
60	V884 Her AAVSO CCD unfiltered range 13.5 : –17, IUE obs gives ETC 1500 cts/sec global, 3.6 cts/sec/pix local, STISSPEC13049 FES mag estimate was 14.6, so scale to global 3800 cts/sec if V = 13.5	Polar	15.4±1.5	Fmag = 14.75, Jmag = 15.16
61	V2306 Cyg	IP	15.4±0.3	Fmag = 15.59, Jmag = 16.69
62	V503 Cyg STIS G140L obs o6li36010 at V = 14.5, target rate = 808 cts/sec, but 3 mag below 12,000 cts/sec limit	DN	12.9–16.5	Fmag = 16.56, Jmag = 16.6
63	LQ Peg IUE SEP predicts 1260 cts/sec global, 2.4 cts/sec/pix local, 2.4 mag below limit	NL	14–17.5	Fmag = 14.29, Jmag = 15.02
64	1RXS-J221832.8+192527	Polar	17.3±0.3	Fmag = 17.01, Jmag = 17.25
66	SDSS-J225831.18-094931.7	NL	15.4±0.3	Fmag = 12.89, Jmag = 15.47
69	HS2331+3905	NL	16.5±0.3	Fmag = 15.98, Jmag = 16.40
70	V425 Cas IUE “outburst” spectrum gives 475 cts/sec global, 5 cts/sec/pix local, STISSPEC13081	NL	13.4–15.6	Fmag = 14.75, Jmag = 15.21

The following DN we recommend be done only with E140M. Most of these would be passed with G140L if we allowed the worst case estimate to be 30,000 cts/sec ($V = 11.9$ upper limit) rather than 12,000 cts/sec ($V = 12.9$ limit). No. 21 and 24 have especially good AAVSO coverage, so this would make the most sense for them. No. 31 and 68 have only limited visual coverage.

#	name/comment	type	range	GSC2 mags
16	CZ Ori SWP 7385 at $V = 12.3$ gives 11,800 cts/sec with G140L; scaled to peak V gives 27,000 cts/sec with G140L—so use E140M instead	DN	10.5–16.5	Fmag = 15.14, Jmag = 14.23
21	SV CMi well observed with AAVSO, no IUE	DN	12.2–16.7	Fmag = 15.59, Jmag = 13.81
22	UY Pup no IUE	DN	12.7–15.7	Fmag = 15.38, Jmag = 15.69
24	AT Cnc very good AAVSO, no IUE	DN	12.1–15.6	Fmag = 14.39, Jmag = 14.61
25	CU Vel IUE only between outbursts	DN	10.1–16	Fmag = 12.70/10.94, Jmag = 17.17
31	PG0935+075 SIMBAD B=13.0, M dwarf seen so not a TOAD and OK with E140M	DN	13 : –18	Fmag = 17.31, Jmag = 17.23
34	X Leo Jan 4, 1982 IUE @ $V = 12.5$ for G140L; this would give 11,100 cts/sec global, 7.2 cts/sec/pix local, STISSPEC13038 (G140L) would scale to 40,000 cts/sec global at $V = 11.1$, so use E140M	DN	11.1–17	Fmag = 15.96, Jmag = 16.63
41	SX LMi IUE only when faint	DN	12.8–18	Fmag = 16.02, Jmag = 17.21
68	CC Scl only 13 AAVSO measures plus about ~280 upper limits $\gtrsim 12.8$	DN	13.2–15.4	Fmag = 16.71, Jmag = 16.88

The following are mostly recently discovered DN without optical observations of even one outburst. This makes it difficult to judge the amplitude of any possible outburst. The PI seems to be assuming quiescence +4 mag as the range for those that have not been observed in outburst, but quiescence +5.5 mag would be more conservative or quiescence +8 mag for TOAD systems. Will query PI for justification of worst case outburst estimate for each system. No. 1 needs a CV type ID; anything other than DN should be OK with G140L. For other targets if we assume worst case 8 mag outburst, would require quiescent $V \geq 17.6$ for E140M. No. 49 and 67 have orbital periods too long for TOADs, so allow for 5.5 mag outburst. Under worst case outburst assumptions (8 mag outburst), No. 35 and 65 would exceed $V = 9.6$ (80,000 cts/sec with E140M), but not $V = 8.6$ (200,000 c/s), so perhaps OK with E140M?

#	name/comment	type	range	GSC2 mags
1	HS0002+0901 need type of CV—no SIMBAD ID	??	16.3±0.3	Fmag = 15.17, Jmag = 16.24
35	1RXS-J105010.3-140431 AAVSO 1045-13 83 upper limits ≥ 13.8 , brown dwarf comp, possible TOAD! 87 min orbit—assume worst case outburst is $V = 8.8$	DN	16.0±2.0	Fmag = 16.49, Jmag = 16.81
36	HS 1016+3412 assume worst case outburst is 18.6–8.0 gives $V = 10.6$ —OK with E140M	DN	16.0±2.0	Fmag = 17.92, Jmag = 18.60
44	SDSS-J123813.73-033933.0 76 min orbit, need light curve! no SIMBAD info; E140M OK	DN	16.0±2.0	Fmag = 17.83, Jmag = 17.94
49	HS1340+1524 need light curve for DN; 213 min orbit (too long for TOAD), so allow 5.5 mag for outburst, implies if $V = 11.5$ in outburst, then OK with E140M	DN	15.0±2.0	Fmag = 16.36, Jmag = 16.90
54	SDSS-J155644.24-000950.2 18 in quiescence? AAVSO 1551+00 8 obs $\gtrsim 13.8$; OK with E140M	DN	16.0±2.0	Fmag = 17.73, Jmag = 18.38
65	HS2219+1824 ROSAT source, 94 min orbit	DN	17.3±2.0	Fmag = 16.40, Jmag = 17.13
67	1RXS-J230950.6+213523 M dwarf companion seen, so not a TOAD, 228 min orbit; 5.5 mag outburst would give $V = 11.4$, OK with E140M	DN	16.5±1.0	Fmag = 15.85, Jmag = 17.39

Appendix 4: Implementation of an HRC Check Program

For GO 10253, several telemetry values from the HRC target acquisition image were also checked in real-time to verify the quiescent state of the target.

Real-time telemetry is available on the “CCS Desktop” utility for the PC, which displays a number of “pages” that show telemetry mnemonics and corresponding values. Relevant telemetry mnemonics include JCHBXSUM (target acquisition checkbox sum value), JMEVENTS (MAMA events counter) and JMGLEVIP (MAMA global event integration period). These telemetry items are on the CCS Desktop page: JALLTLM.ccs, under the tab “Observe.” Refer to the “Target Acquisition” section for JCHBXSUM, “Event Status” section for JMEVENTS, and “Global Events” section for JMGLEVIP. Note that the ratio of JMEVENTS and JMGLEVIP is used to populate the GLOBRATE keyword in the science data header.

The target pass criteria are JMEVENTS $\lesssim 77,000$ cts/0.1 sec and JMGLEVIP ~ 99.93 msec.

For GO 10253, the pass criterion for JCHBXSUM ($\lesssim 140$ for the GO 10253 target) was supplied by John Biretta in an email dated 11/04/04:

“Here are details of bright-object limit calculation for the HRC F250W preliminary observation (HRC/ACQ image) in GO 10253 Visit 5, which provides checking for the SBC F140LP image in Visit 51:

Assume a target at the SBC brightest pixel limit of 50 cts/sec. For F140LP and assuming target temperature $T = 30000$ K the limit is at $V = 17.73$ (ACS ETC run ID ACSIMAG19494).

The HRC/ACQ observation proceeds as follows. Two 60 sec images are taken at gain = 4 with the coronagraph occulting mask “in.” The pixel-wise minimum between the two images is calculated to remove cosmic rays, then 1185 is subtracted (approximate bias level) with zero as the lowest result. The total counts in a 5×5 pixel check box around the brightest feature is then reported in the telemetry stream as parameter JCHBXSUM.

Hence the model source above will give
22800 e- in the checkbox or
5700 DN or
2850 DN allowing for the mask
(ACS ETC run ID ACSIMAG19496).

Some other assumed target spectra give slightly different results for the SBC limit:

Blackbody $T = 100,000$ K gives $V = 18.93$ and 1425 DN (mask in, ACSIMAG19508 and ACSIMAG19503).

An O5 V star gives $V = 18.54$ and 1805 DN (mask in, ACSIMAG19507 and ACSIMAG19504).

It is also interesting to consider what count rate is expected for the target in its quiescent state. For $V = 22.7$, $B - V = 1.1$, $E(B - V) = 0.1$ we have 7 e- (mostly dark current) or 1 DN (mask in, ACSIMAG19505).

HENCE WE WILL ALLOW A MAXIMUM COUNT LEVEL OF JCHBXSUM = 140 IN THE ACQUISITION IMAGE. THIS PROVIDES A FACTOR OF 10 SAFETY MARGIN FROM THE SBC LIMIT (ASSUMING A 100,000 K SPECTRUM) AND IS A FACTOR OF 140 ABOVE THE QUIESCENT LEVEL.”