MAMA Bright Object Checking: Experience from Cycle 7 and Recommendations for Cycle 8

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ABSTRACT

The observed maximum local and global count rates of all STIS MAMA exposures during SMOV and Cycle 7 until February 1998 have been analyzed. There are no exposures reaching the trigger limit of the onboard safety mechanisms. No local screening limit violations are found but two targets slightly exceed the echelle global screening limits of 200,000 counts/sec. No revisions to the existing screening procedures are necessary. We recommend somewhat less conservative local rate screening limits of 100 counts/sec/pixel and 75 counts/sec/pixel for both MAMAs in undispersed and dispersed modes during Cycle 8, respectively. No changes to the global screening limits are recommended.

1. Rationale for STIS Bright Object Protection

The STIS flight software and hardware are responsible for protecting the MAMA detectors from accidental over-illumination. Under certain circumstances (see ISR STIS 96-028) the protection mechanism may fail to detect an overlight condition, thereby risking damage to the detector. For this reason and to avoid unnecessary loss of telescope time and shut down of the MAMA High Voltage, STScI performs ground-screening of STIS targets in order to prevent overly bright objects from being scheduled.

Prior to Cycle 7, STScI stated its ground screening goals:

- No more than 1% of all MAMA observations should shutter due to a local rate check violation.
- No more than 0.1% of all MAMA observations should violate the global limit leading to a high-voltage turn-off.

Since it is often difficult to accurately predict the ultraviolet flux levels of a target, conservative screening limits were established. Targets above these screening limits must not

be observed, even if they are still below the flux levels where the onboard protection mechanism could trigger. The screening limits were stated in ISR STIS 96-024 and are repeated here in Tables 1 and 2. These tables also give the onboard flight software trigger limits. On average, the screening limits are about a factor of 4 fainter than the trigger limits for the onboard protection mechanisms.

Table 1. Mama count-rate limits for non-variable or regularly variable sources

Limit Type	Screening Limit	Onboard Trigger Limit	Applies to
Global	200,000 c/s	770,000 c/s	FUV and NUV, all modes
Global	30,000 c/s	120,000 c/s	FUV and NUV, 1st order
Local	50 c/s/p	160-470 c/s/p	NUV, all modes
Local	35 c/s/p	136-350 c/s/p	FUV, all modes

Table 2. Mama count-rate limits for irregularly variable sources

Limit Type	Screening Limit	Onboard Trigger Limit	Applies to
Global	80,000 c/s	770,000 c/s	FUV and NUV, all modes
Global	12,000 c/s	120,000 c/s	FUV and NUV, 1st order
Local	50 c/s/p	160-470 c/s/p	NUV, all modes
Local	35 c/s/p	136-350 c/s/p	FUV, all modes

A procedure was implemented to make a best effort to prevent any target exceeding the limits in Tables 1 and 2 from being scheduled (see STIS TIR 96-003). The screening procedure utilizes automatic bright object checking with the Guide Star Catalog by Presto (see STIS TIR 96-004) and manual proposal review by the Contact Scientist (see STIS TIR 96-005). This procedure was followed for all external calibration, GTO, and GO targets observed with the MAMAs from the beginning of SMOV until to date.

2. Count-Rate Statistics for Cycle 7 Observations

A database query was performed to obtain the maximum local and the global count rates of all external MAMA targets observed between the start of SMOV and February 1998. The observed maximum count rates may or may not validate our screening procedure. If a substantial number of observations around and somewhat above the trigger limits of the onboard mechanisms is found, more conservative screening limits or procedures may be required. On the other hand, if none of the observations comes even close to

the onboard limits, we may be too conservative in our screening and prevent feasible science observations from being executed.

The query returned 771 exposures. In Figures 1 and 2 we show histograms of the local and global count rate distributions, respectively. The mean maximum local and the mean global count rates are 3.9 ± 6.8 counts/s/pixel and 29970 ± 55990 count/s, respectively. The targets in the sample are heavily biased towards standard stars from SMOV and calibration programs, which are relatively bright but whose flux is extremely well predicted. The maximum local count rate of any target is 39 counts/s/p. This was a calibration observation of the globular cluster NGC6681 with the NUV-MAMA. We found no exposure in violation of any of the two local rate screening limits. About 50 exposures were within 30% of the applicable limits. They all had calibration targets with well-understood flux distributions.

We found a large number of exposures exceeding the global screening limits for the echelles and first-order gratings by up to a factor of 2.5. They were all caused by five calibration stars with well known ultraviolet fluxes, and the observations of these targets for calibration purposes had been explicitly signed-off by the STIS Group Lead. These count rates were expected a priori (see below). A summary of representative instrument configurations of all five targets is in Table 3. The first two entries are for echelle observations of BD+75D325 and BD+28D4211, for which the screening limit is 200,000 counts/sec. The observed count rates were higher than expected since the inflight sensitivities were not measured at the time of the bright object review. The actual count rates with the E140H/M modes are now known to be higher by about a factor of two due to scattering. However, when the bright object review was performed, the expectation was to observe about 100,000 counts/sec.

Table 3. Exposures with observed count rates above the applicable screening limits

Target	Configuration	Aperture	Grating	Global Rate	Local Rate	Proposal
BD+75D325	STIS/FUV-MAMA	2X2	E140H	251131	2.538	7096
BD+28D4211	STIS/FUV-MAMA	0.2X0.2FPB	E140M	230249	2.148	7091
GD71	STIS/FUV-MAMA	25MAMA	G140L	77829	28.949	7657
GD153	STIS/FUV-MAMA	52X2	G140L	64071	25.617	7097
GRW+70D582	STIS/FUV-MAMA	52X2	G140L	35960	15.050	7064

GD71, GD153, and GRW+70D582 exceed the first-order global limit by up to about a factor of 2.5. This was expected and within 10% of the prediction of the bright object review. All three targets are well-observed flux standards. Despite being above the screening limit, there was no concern that they could reach any safety limits. The selection of

these targets was driven by the scarcity of ultraviolet standards with suitable flux levels, and an explicit decision to allow their observation was made.

Twenty-four targets in the list of exposures were not calibration standards. Only one of them had a count rate within a factor of 5 of the screening limits. NGC4151 had a local rate of 14 counts/sec/pixel. The predicted rate was 15 counts/sec/pixel, in very good agreement with the observed rate. Typically the agreement is worse if the target is known a priori to be much fainter than the applicable screening limits since less time is spent on the bright object review. This is the case of many GO targets. We plan to repeat this analysis later in Cycle 7 when more GO targets have been observed and better statistics are available. Presently the analysis of the actual and predicted rates of the non-calibration targets is not very revealing.

3. Recommendations for Cycle 8

The screening procedures appear to have been successful in Cycle 7. No observation to date has exceeded any screening limit because of an error in the review process. We had several instances of unexpected global screening limit violations for calibration targets but they could all be traced back to modified echelle sensitivities due to the scatter. At no point were the detectors put in any danger or were any onboard trigger limits approached. Such occurrences are expected to disappear in Cycle 8 when the instrument is fully characterized. We note that there were several (about 5) instances where violations were caught during the screening process.

We found about 10 GO/GTO programs during the Contact Scientist review which required modification due to a possible overlight condition. In no case was the science significantly compromised as a result of the modification. However, there were instances when somewhat lower S/N resulted due to the modification.

Observations exceeding the global triggering limits will cause STIS to safe and can in the worst case permanently damage the instrument. This risk outweighs the benefit of a moderate improvement of achievable science by relaxing the screening limits somewhat. In addition there is a limitation of about 285,000 counts/sec for the rate at which the MCE can process events. If the count rate is higher, some events will not be processed and are lost. For the observer this means the detector becomes non-linear and it would be undesirable to operate in this regime. Above approximately 350,000 counts/sec the instrument will shutter. This is the result of an additional safety precaution to address the FIFO overflows at high count rates (see STIS TIR 96-16). Therefore it is recommended to adopt the same global screening limits during Cycle 8 as we had in Cycle 7, since the current safety margin of 350,000/200,000 = 1.75 is not excessively large.

If the local rate exceeds a certain threshold value, STIS will shutter. The threshold value is target and mode dependent. Ground tests suggest threshold values of 150 and 200

counts/sec/pixel for the NUV and the FUV MAMA, respectively (ISR STIS 96-31). There is some spread around these values, and minimum and maximum values of 136 and 350 counts/sec/pixel for the NUV and the FUV MAMA have been measured on the ground. The uncertainty is largest for targets with complex spectra (e.g., emission lines) observed in dispersed modes. Note that the CARD limit is 500 counts/sec/pixel for the NUV and the FUV MAMA in dispersed and undispersed modes. We recommend to raise the local rate screening limits for undispersed (=imaging) modes from their current values to 100 counts/sec/pixel for both the NUV and the FUV MAMAs. Screening limits for dispersed modes (=all first-order gratings, echelles, and prism) should be raised to 75 counts/sec/pixel for both MAMAs. A summary of the new screening limits for Cycle 8 is in Table 4. The new sceening limits are well below the onboard local rate check trigger value, and they are a factor of 5 lower than the CARD limit. The MAMA sensitivities have now been measured onboard and are verified to better than ~10%, further reducing the risk of accidental overillumination. If the local rate check trigger value is exceeded, STIS will shutter. This will cause the loss of the exposure but will otherwise not damage the instrument.

Table 4. Revised screening limits for Cycle 8

Target	Limit Type	Mode	Channel	Screening Limit
Non-variable	Global	All modes	FUV and NUV	200,000 c/s
Non-variable	Global	1st-order spectroscopy	FUV and NUV	30,000 c/s
Non-variable	Local	Imaging	FUV and NUV	100 c/s/p
Non-variable	Local	Spectroscopy	FUV and NUV	75 c/s/p
Variable	Global	All modes	FUV and NUV	80,000 c/s[a]
Variable	Global	1st-order spectroscopy	FUV and NUV	12,000 c/s[a]
Variable	Local	Imaging	FUV and NUV	100 c/s/p[a]
Variable	Local	Spectroscopy	FUV and NUV	75 c/s/p[a]

a. Applies to the phase when the target is brightest.

Given our limited experience in Cycle 7, we expect few exposures to be lost due to shuttering if the screening limits are increased. As was the case in Cycle 7, the observer is responsible for lost exposures even if the target appeared to be below the screening limit. Should an exposure be lost due to shuttering, the observer would not be compensated. The policy will be described to observers in the *STIS Instrument Handbook*. We will continue to monitor the maximum local rates of exposures accumulating in the Archive and, if necessary, revise our analysis of the Cycle 7 data. We expect the amount of GO MAMA data in the Archive to increase dramatically between now and June 1998 and further between now and Phase 2 for Cycle 8.

4. Figures

Figure 1: Histogram showing the observed maximum local count rates of all exposures studied (total of 771). Bin size is 0.5 dex.

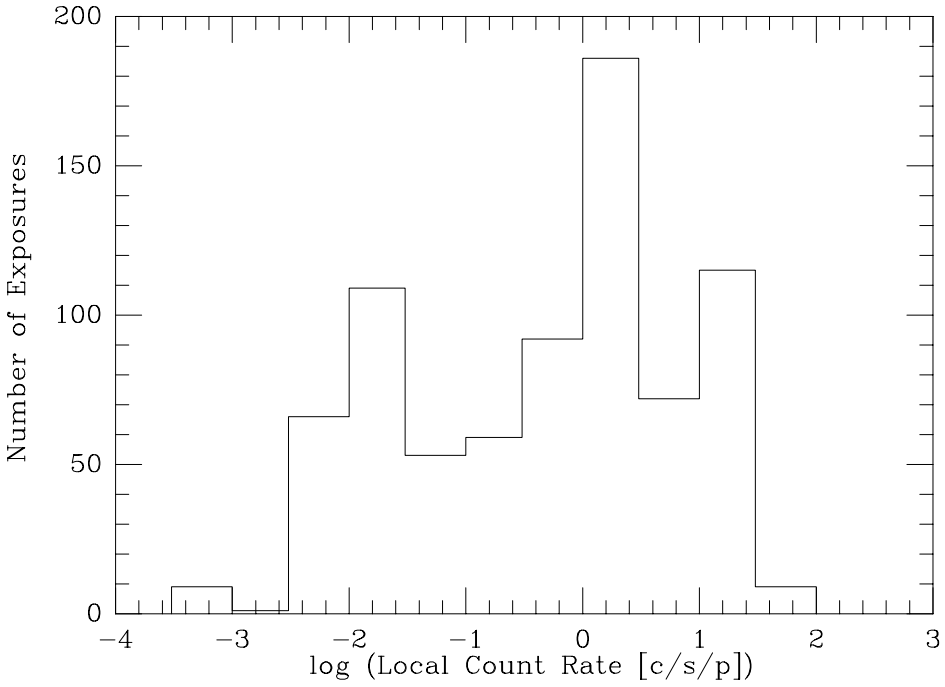

Figure 2: Histogram showing the observed global count rates of all exposures studied (total of 771). Bin size is 0.5 dex.