

# Revised Bright Object Protection Policies for MAMA Observations

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## ABSTRACT

*Investigation of the high-voltage shutdown of the STIS NUV MAMA in September 1999 led to new information on the potential pointing errors associated with HST observations. We have also re-examined the intrinsic protection capabilities of the STIS MAMAs. Based on these considerations, we are implementing new bright object protection policies for the STIS MAMAs. Once FGS 2r is put into regular service, we will henceforth require that MAMA snapshots be done using two guide stars. For all observations, those that place a target or field object that violates current ground-screening limits for the STIS MAMAs (see ISR STIS 98-08) within 5 arc seconds of the edge of the highest throughput aperture visible in the field of a MAMA observation are not allowed. Targets or field objects falling in an annular region extending from 5 to 13.5 arc seconds from the edge of the highest throughput aperture used in a MAMA observation also have additional restrictions. Any object in this zone producing either a real global count rate in excess of  $1.5 \times 10^6$  cts  $s^{-1}$  or a local count rate greater than  $500$  cts  $s^{-1}$  pixel $^{-1}$  is not permitted.*

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## Introduction

An imaging observation with the NUV-MAMA/F25QTZ in the Orion Nebula near the Trapezium on 1999 September 20 resulted in a global count rate exceeding the FSW threshold of 770,000 cts/s. The NUV MAMA HV was shut down within 100 ms of the start of the observation. Analysis of pointing data and parallel WFPC2 images showed that the pointing was better than 1", and that any bright star should have been at least 2" away

from the edge of the field of view. Further investigation showed that the high count rate was likely due to diffuse UV light from the nebula itself, as revealed in 1978 rocket observations by Bohlin et al. (1982). The predicted surface brightness would have produced ~1 million cts/s integrated over the field of view. (This region was safely observed with the FOC earlier. The surface brightness is simply too low for the FOC to have seen it.) The NUV MAMA was restored to service via the anomalous recovery procedure on 1 October 1999, and all detector performance was nominal.

Since an accidental pointing at one of the Trapezium stars was a potential cause for the global count-rate violation, and since such a pointing could have caused serious local damage to the detector, we examined the potential pointing errors associated with this observation in detail. As a consequence, we discovered that the allowable pointing errors permitted after successful one and two-guide-star acquisitions were substantially larger than previously thought. For a one-guide-star acquisition, telescope pointing errors of up to 50" are deemed acceptable. This is to accommodate the residual pointing errors largely due to the uncertainties in the gyros, which are on the order of 15", rms. For a two-guide-star acquisition, errors of up to 6" are permissible. While such large pointing errors were not the cause for the HV shutdown of September 20, they raise the possibility that current bright-object-protection (BOP) screening procedures are insufficient to prevent accidental exposure to an overly bright target. In particular, snap-shot observations are currently done using single guide-star acquisitions, primarily to ease mechanism wear on the FGSs. This ISR defines more stringent criteria for BOP checking that take these potential pointing errors into account.

## **Revised Ground-Screening Procedures**

The baseline bright object protection plan for STIS as outlined in ISR 96-28 (Leitherer, Baum, & Clampin 1996) allows for 1 HV shutdown per year and 10 LRC violations per year on external targets. Only one of each has occurred in the nearly 3 years STIS has been in orbit, and on both occasions the self-protection mechanisms of the instrument worked as intended. The revised procedures detailed here will provide for greater instrument safety by avoiding "killer" stars that might accidentally leak through current ground-screening procedures and also circumvent the built-in flight protection mechanisms of STIS.

Effective with the review of Cycle 9 Phase II proposals, we will implement these changes to the ground-screening criteria:

1. Targets or field objects that violate current ground screening limits for the STIS MAMAs (as summarized in ISR STIS 98-08 by Leitherer, 1998) within 5 arc seconds of the edge of the highest throughput aperture visible in the field of a MAMA observation are not allowed. Note that this applies to *all* apertures. An especially tricky situation to consider carefully is the use of the quad filters. In such a case

one must look carefully at objects falling within 5" of any border with an adjacent higher throughput quadrant.

2. Note that an object centered in one quadrant of the quad filter is only 6" from the edge of adjacent quadrants. We therefore will require a target acquisition if the target exceeds the ground screening limits for the ND1 quadrant
3. Targets or field objects falling in an annular region extending from 5" to 13.5" from the edge of the highest throughput aperture visible in the field of a MAMA observation have additional restrictions. Any object in this zone producing either a real global count rate in excess of  $1.5 \times 10^6$  cts  $s^{-1}$  or a local count rate greater than  $500$  cts  $s^{-1}$  pixel $^{-1}$  is not permitted.

The rationale for the added screening region and the associated count-rate limits are as follows. The original screening region of 5" surrounding an aperture was intended to protect STIS in the event of a STIS target acquisition failure. Since the target acquisition aperture is a square of 5" in width, and since two recenterings are involved in each target acquisition, the largest a pointing could be in error if the acquisition failed would be the twice the half-width of the aperture. This budget failed to take into account the actual error of up to 6" allowed by the guide-star acquisition process and the distance to the *corner* of the target acquisition aperture. A more correct error budget is 6" for GS-Acq errors,  $2\sqrt{2} \times 2.5"$  for STIS target acquisition errors, plus an allowance of 0.4" to cover the bright core of the point-spread function. This gives a revised total of 13.5 arc seconds.

The count-rate rationale is that targets brighter than  $2 \times 10^6$  cts  $s^{-1}$  are highly non-linear. At such levels the actual number of detected counts *decreases* with an increase in count rate, thereby potentially fooling the global s/w rate check into thinking the target is safe. Count rates exceeding real rates of  $2 \times 10^6$  cts  $s^{-1}$  actually produce a detected rate that is  $< 7 \times 10^5$  cts  $s^{-1}$ . The Global Software Monitor would not detect this as a bright object, and the detector would be left unprotected. To allow for uncertainties in the count-rate estimation process, we set a ground-screening limit that is 25% lower than this allowed peak rate, or  $1.5 \times 10^6$  cts  $s^{-1}$ .

At the local rate-check level, note that targets brighter than  $500$  cts  $s^{-1}$  pixel $^{-1}$ , if accidentally observed, will produce a measurable local decrease in quantum efficiency in 30 minutes or less. Thus, a single-orbit observation accidentally performed on such a bright target would produce a noticeably detrimental effect on the detector. We wish to keep objects this bright from accidentally illuminating the detector due to any accidental failure of the various protection mechanisms.

## Revised Snap-Shot Guide Star Policy

So that these same criteria can be equally effectively applied to snap-shot observations, we will also require that all STIS MAMA snap-shot observations be performed

using a two-guide-star acquisition as soon as the newly installed FGS 2r is available for use. The process for implementing this change has already been started with the Guide Star Working Group.

### **Scientific Impact**

The expected scientific impact of these revisions is nil. As an empirical basis for comparison, current BOP ground-screening criteria applied to 2237 Cycle 8 STIS MAMA observations (of which 519 were imaging) resulted in only 2 having to be disallowed due to a bright field star. Three (3) other observations were accommodated by moving the field center slightly. Increasing the buffer region surrounding the aperture in use from 5" to 13.5" roughly triples the area of sky that would be excluded. Thus we would expect about triple the number of targets would be excluded under the revised criteria. Given that less stringent screening criteria are applied to this larger region, the actual effect is likely to be less than a factor of three. Thus, much less than 1% of potential science targets are affected by these changes.

### **References**

- Bohlin, R., et al. 1982, ApJ, 255, 87.
- Leitherer, C., "MAMA Bright Object Checking Experience from Cycle 7 and Recommendations for Cycle 8", Instrument Science Report STIS 98-08.
- Leitherer, C., Baum, S., Clampin, M. 1996, "STIS Bright Object Protection Observing Policies for the MAMA Detectors", Instrument Science Report STIS 96-28.