INSTRUMENT SCIENCE REPORT

#CAL/FOS-030

Limiting Magnitudes for FOS Target Acquisition

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Introduction

As a general rule, targets brighter than 10.3 magnitudes should not be acquired with standard target acquisition software because of the possibility of damaging the photocathode with high count rates. Targets brighter than 15.3 magnitude should be acquired with modes other than binary search (i.e. make-a-picture or firmware) because of the pulse coincidence problem. These limits vary with spectral type, as summarized in Table 1.

Damage Limit

When acquiring targets, the camera mirror is in place and the stellar image is focused onto a relatively small area of the photocathode. Very high count rates must be avoided to avoid damage to the photocathode. The damage threshold is 10^7 counts/sec on an area the size of the smallest aperture, $0''.1$. The magnitude limits recommended here are based on a count rate that is one-tenth of that value, or 10^6 cts/s.

The magnitude limit depends on the type of object observed. Table 1 lists magnitude limits for a sample of stellar types and for a power law of $F_\nu \propto \nu^{-1}$. Note that for most cases the limits are lower than cited above.

You too can estimate limiting magnitudes for objects of interest! By setting up the FOSSIMX program with the desired magnitude, type of object, detector, and exposure time and using the command ACQUIRE, the total counts in the point source are calculated. To avoid the possibility of damage to the photocathode, 10^6 cts/s should not be exceeded.

Pulse Coincidence Limit

Pulse coincidence (see FOS Instrument Handbook, H.C. Ford, p. 68) can have an effect on the accuracy of target acquisition. The binary search mode of TA finds the total number of counts in a point source and then moves the diode array until half of that number (within some tolerance) is counted on the diode array. If the total number in the point source is significantly lowered because of pulse coincidence, then binary search will place the source more than half off the diode.

For example, 30,000 counts on the diode are detected as 23,000 counts (CAL/FOS-025, Lindler and Bohlin, 1986). Binary search will be looking for counts in the range 9,950 to 12,050 to determine that the source is half on, while it should be looking for counts in the range 14,300 to 15,700. It will place the source more than half off the diode to satisfy the criteria based on the incorrect total count.

If count rates are kept below 10,000 per second, the pulse coincidence problem is small enough that it wil not compromise the accuracy of binary search. Listed in Table 1 are the magnitudes that result in count rates of $\leq$ 10,000 cts/s as a function of stellar type, plus one case of a power law, with $F_\nu \propto \nu^{-1}$.

For lower magnitudes than these (but higher than the limit set by the damage threshold), firmware target acquisition should be used in place of binary search. The firmware finds the positions of peaks in a map of the large aperture and doesn't care if an observed peak is not as tall as it should be. Firmware is a little less efficient, taking typically 16 Y-steps to complete a map where binary search would take a maximum of 11 Y-steps. Firmware is otherwise just as good as binary search.

Table 1

Magnitude Limits for Target Acquisition

Type	RED SIDE Damage Limit	RED SIDE Pulse Coincidence	BLUE SIDE Damage Limit	BLUE SIDE Pulse Coincidence
B5I	10.3	15.3	9.9	15.0
A5V	9.4	14.4	8.7	13.7
F5I	9.1	14.1	8.2	13.2
G5III	8.6	13.6	7.3	12.3
$F \propto \nu^{-1}$	9.8	14.8	9.4	14.4

The magnitudes listed are the nearest tenth of a magnitude having counts per second of $\leq 100,000$ and $\leq 10,000$ for damage limit and pulse coincidence, respectively.