

Echelle Neutral Density Slit Throughputs

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July 16, 1998

ABSTRACT

The analysis of the results of proposal 7943 is presented. Transmissions of the filtered echelle slits 0.2x0.05ND and 0.3x0.05ND have been derived. The logarithmic attenuation factors are about 2.3 and 3.3 for 0.2x0.05ND and 0.3x0.05ND, respectively, in reasonable agreement with pre-flight measurements. The data show evidence for PSF variations. Such variations are typically expected for observations through small slits and set the ultimate limits to the achievable photometric precision.

1. Introduction

The 0.2x0.05ND and 0.3x0.05ND filtered apertures are available (but not supported) for observations of overly bright targets with all STIS echelle modes. They are 0.05" wide and have heights of 0.2" (0.2x0.05ND) and 0.3" (0.3x0.05ND). The approximate ND factors for the 0.2x0.05ND and 0.3x0.05ND apertures are 100 and 1000, respectively. The filtered echelle apertures may be considered by observers whose targets can not be safely observed with any other supported unfiltered aperture. Since the filtered echelle slits are used to protect the MAMA detectors, their transmissions were measured in-orbit.

2. Observations

An on-orbit throughput test was initially performed as part of proposal 7096. However, the derived transmissions differed from the ground-test values by up to a factor of a few. The concern was raised that an imperfect peak-up may have led to a light loss during the observations. The peak-up was not done with the filtered echelle slit itself but with an unfiltered aperture whose location in the focal plane may not be known to the required 0.005" precision.

A repeat of the filtered slit transmissions was done in proposal 7943 (see Table 1). The standard star BD+75D325 was acquired with a peak-up and observed with the G140L and G230L gratings. The 0.2x0.05ND and the 0.3x0.05ND apertures were measured. The peak-up was performed with the same 0.2x0.05ND aperture as the science exposure to

minimize the risk of imperfect centering. The observations were spread out over two orbits. The exposures of ACQ + F28x500II + MIRROR, ACQ/PEAK + 0.2x0.05ND + MIRROR, ACCUM + 0.2x0.05ND + G140L, ACCUM + 0.3x0.05ND + G140L, and ACCUM + 0.2x0.05ND + G230L were executed in this order in orbit 1. The final exposure, ACCUM + 0.3x0.05ND + G230L, was done in the second orbit. An additional echelle observation with an unfiltered slit was added to fill the orbit. No anomalies during the observations were reported.

3. Analysis

The data analysis was performed with the IDL software of the STIS IDT. The transmission of the 0.2x0.05ND slit shows no apparent anomalies. The transmission is within the uncertainty of the ground measurements. In contrast, the FUV and NUV measurements of the 0.3x0.05ND slit are inconsistent. The long wavelength end of the FUV measurement (the ACCUM + 0.3x0.05ND + G140L exposure) is about 30% lower than the short wavelength end of the NUV measurement (the ACCUM + 0.3x0.05ND + G230L exposure).

The most plausible explanation is due to PSF variations and/or recentering errors after the guide-star re-acquisition. This would imply that the initial exposure series in the first orbit had a somewhat imperfect PSF, which then improved during the second orbit. PSF variability over timescales of minutes to hours which could cause the observed flux variation in the 0.3x0.05ND aperture is consistent with the results of the STIS Monthly Monitor using the 0.2x0.09 slit and with theoretical modeling. Since both the FUV and the NUV measurements of the 0.2x0.05ND aperture were close in time to the FUV measurement of the 0.3x0.05ND aperture, it is reasonable to assume that they are affected by an imperfect PSF, as well.

We adopted the following procedure. The NUV measurement of the 0.3x0.05ND aperture was assumed to have the sharper PSF. We scaled the FUV measurement of the aperture by a factor of 1.3 at all wavelengths so that the overlapping wavelength regions of the FUV and NUV parts agreed. The two data sets were then combined by fitting a single spline function through them. The same procedure was applied to the 0.2x0.05ND data. For the reasons given above, we consider both the FUV and the NUV measurements through the 0.2x0.05ND aperture a lower limit to the actual transmission. Therefore, we first combined the two wavelength regions with a spline fit and then scaled the transmission over the full combined wavelength range by a factor of 1.3 for this slit, as well. The final transmissions of both apertures are shown in Figure 1 and compared with the pre-launch predictions.

4. Recommendations

The new throughputs for the 0.2x0.05ND and 0.3x0.05ND apertures will be installed in the pipeline, synphot, and the exposure time calculator. The results of proposal 7943 suggest that observations through slits with widths of 0.05" and smaller are sensitive to PSF variations. Imperfect knowledge of the PSF during the observations set the sensitivity uncertainty because of the inaccuracies in the adopted transmissions. The major purpose of the filtered echelle slits is for bright object protection. Photometric precision is poor. Following this prioritization, we have derived transmissions for the 0.2x0.05ND and 0.3x0.05ND apertures which reflect the situation of approaching a perfect PSF. In practice, an observer may achieve about 30% lower transmissions. However, PSF variations should not lead to *higher* throughputs than adopted in the delivered reference files; and, therefore our main goal of protecting the instrument from an oversight condition is reached.

Figure 1: Transmission of the 0.2x0.05ND (solid) and 0.3x0.05ND (dashed) filters versus wavelength. The depression around 2000 Å might be due to interference in the filters. The filled circles indicate the pre-flight measurements.

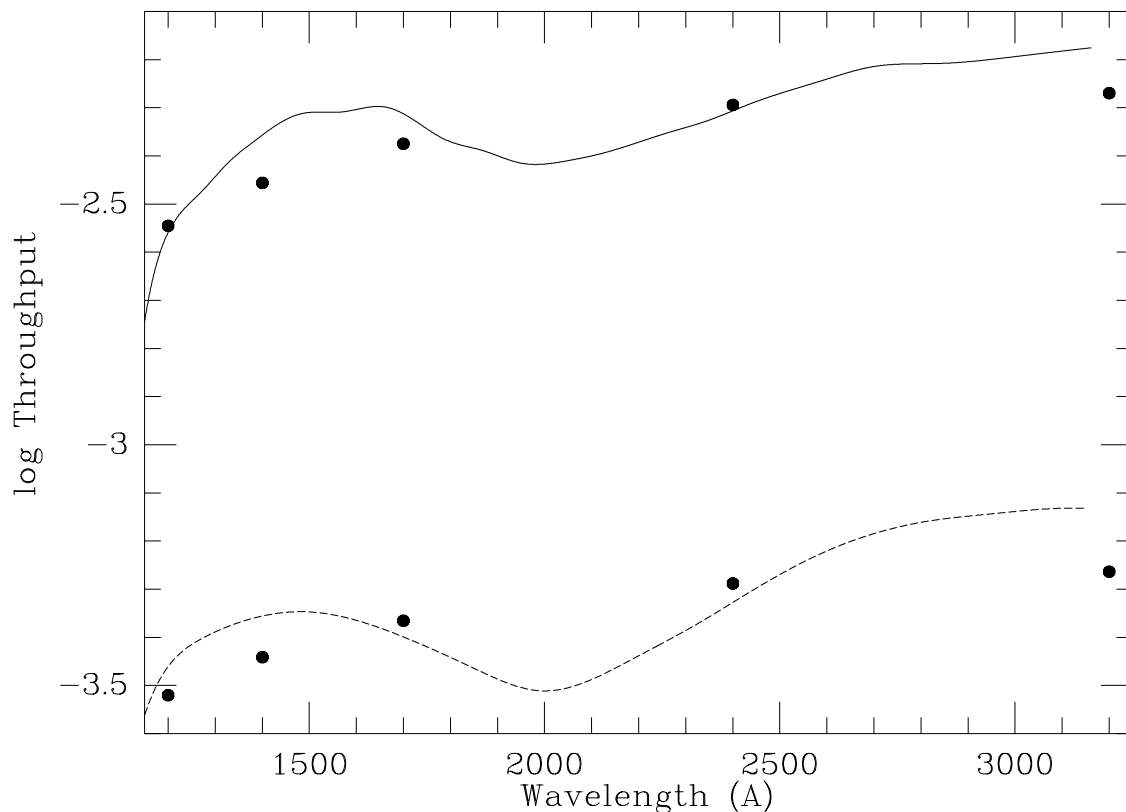


Table 1. Exposure logsheet of proposal 7943

Exposure Number	Target Name	Inst. Conf.	Oper. Mode	Aper. or FOV	Spectral Element	Central Wavelength	Time
10	BD+75D325	STIS/CCD	ACQ	F28X50OII	MIRROR		.2 S
15	BD+75D325	STIS/CCD	ACQ/PEAK	0.2X0.05ND	MIRROR		5 S
20	NONE	STIS/FUV-MAMA	ACCUM	52X0.2	G140L	1425	22.2 S
30	BD+75D325	STIS/FUV-MAMA	ACCUM	0.2X0.05ND	G140L	1524	120 S
40	BD+75D325	STIS/FUV-MAMA	ACCUM	0.3X0.05ND	G140L	1425	660 S
50	NONE	STIS/FUV-MAMA	ACCUM	52X0.2	G140L	1425	22.2 S
60	NONE	STIS/NUV-MAMA	ACCUM	52X0.2	G230L	2376	11.2 S
70	BD+75D325	STIS/NUV-MAMA	ACCUM	0.2X0.05ND	G230L	2376	120 S
80	BD+75D325	STIS/NUV-MAMA	ACCUM	0.3X0.05ND	G230L	2376	1000 S
90	NONE	STIS/NUV-MAMA	ACCUM	52X0.2	G230L	2376	11.2 S
100	BD+75D325	STIS/FUV-MAMA	ACCUM	0.2X0.09	E140H	1416	20 M