RELATIVE ORIENTATION OF THE FUV G130M, G160M, & G140L SPECTRA AS ACQUIRED DURING PRE-ALIGNMENT CHARACTERIZATION

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Relative Orientation of the FUV G130M, G160M, & G140L Spectra as Acquired During Pre-Alignment Characterization

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1. BACKGROUND INFORMATION

Starting on October 4, 2001 and proceeding through to the end of October a series of alignment tests were conducted at BATC to measure the relative focus positions of the three FUV gratings. The purpose of these tests was to determine the shims required for each grating to make them confocal once the optics are installed onto the OSM1 mechanism.

During the focus measurements quick calculations were done that indicated that the G140L grating dispersion plane was rotated with respect to the G130M and G160M channels. A more careful analysis, presented here, indicates that the dispersion planes of the three gratings are equally rotated within error bars. This report documents this analysis.

The rotations of the dispersion planes were computed by measuring the centroids of bright emission lines in each window on a given segment. In some cases this was not possible as there were no bright lines available through the window. The data and computed rotations are presented in Table 1 presented at the end of this document. In addition, the location of the upper and lower detector edges were measured by eye and the apparent rotation of the edge calculated. This is an indication of whether the measured rotation is really a rotation of the dispersion plane or a rotation of the active area of the detector in pixel space.

The analysis shows several things. One, both segments A and B are rotated (~0.03, ~0.2 degrees) with respect to digital space. This was not apparent in the first look at the data. Two, the spectra are all rotated an equal amount relative to the detector active area (~0.12 degrees), suggesting that the detector may be rotated slightly.

An initial analysis of an individual emission line from G140L found a rotation of the image 4.6 degrees in the clockwise direction. Using a raytrace model of the G140L channel the G140L grating was rotated in increments and the rotation of the line was measured. However, another look at the G140L emission lines indicates that the lines are not necessarily rotated. Figure 1 shows three emission lines within one window of the detector door. The shapes of the lines are significantly different and show that the "rotation" is not necessarily a true rotation, but is due to an asymmetry in the line. Therefore, there is no corroborating evidence suggesting the G140L is rotated.

It is also apparent from the data in Table 1 that the G140L and G160M spectra fall on the same region of the detector in the spatial dimension. The G130M spectrum is offset 34 pixels higher than the G160M spectrum. This corresponds to 0.4 mm. This offset should be corrected.

In conclusion, a careful re-analysis of the alignment images indicate that within error bars that none of the gratings are unacceptably rotated about the z-axis. However, the G130M spectrum needs to be adjusted to bring it closer to the G140L and G160M spectra.

2. RECOMMENDATIONS

The data show that there is a need to adjust the tip/tilt of the G130M grating to bring the spectrum closer to the G140L and G160M spectra. There is no need to rotate the gratings about the local z-axis.

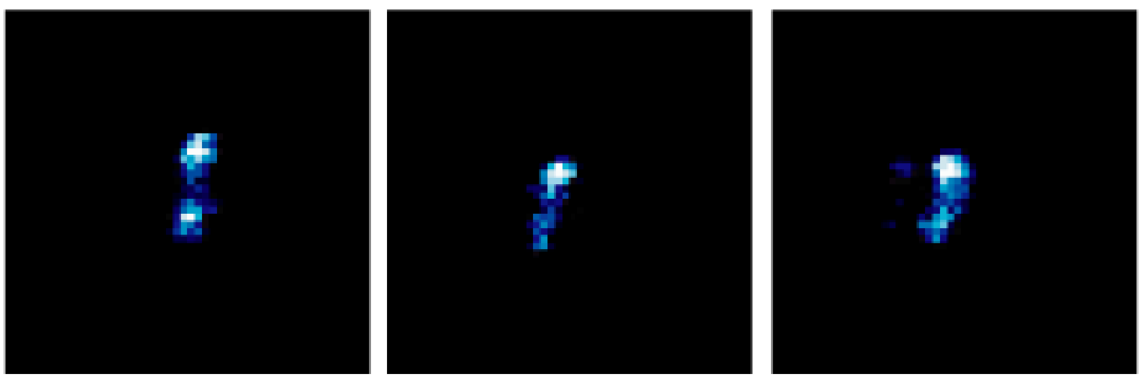

Figure 1: Three emission lines from the G140L channel. Note that there is not a clear indication of a rotation of the emission lines, but a redistribution of the light.

Table 1

Grating Rotation Data and Results

Spectra

Grating	File	Line 1 x	Line 1 y	Line 2 x	Line 2 y	Δx	Δy	Angle
G130M	fcs90m011017_080059_B	9074	595	14735	591	-5661	4	-0.169
G160M	fcs120m01109_094501_A	2457	492	9223	483	-6766	9	-0.318
G140L	fcs60011011_142329_A	3745	491	8905	484	-5160	7	-0.324

Upper Detector Edge

Grating	File	x	y	x	y	Δx	Δy	Angle
G130M	fcs90m011017_080059_B	1161	759	14989	757	-13828	2	-0.0345
G160M	fcs120m01109_094501_A	1693	677	14298	666	-12605	11	-0.208
	fcs120m01109_094501_B	2259	757	14913	755	-12654	2	-0.0377
G140L	fcs60011011_142329_A	1499	675	14613	666	-13114	9	-0.164

Lower Detector Edge

Grating	File	x	y	x	y	Δx	Δy	Angle
G130M	fcs90m011017_080059_B	1657	363	14804	361	-13147	2	-0.0363
G160M	fcs120m01109_094501_A	1677	273	14296	264	-12619	9	-0.170
	fcs120m01109_094501_B	2248	362	14716	360	-12468	2	-0.0383
G140L	fcs60011011_142329_A	1504	274	14627	260	-13123	14	-0.255

Grating	File	Rotation (degrees) Spect.	Upper	Lower	Δ's
G130M	fcs90m011017_080059_B	-0.169	-0.0346	-0.0363	-0.133
G160M	fcs120m01109_094501_B	na	-0.0377	-0.0383	
G160M	fcs120m01109_094501_A	-0.318	-0.2088	-0.1708	-0.128
G140L	fcs60011011_142329_A	-0.324	-0.164	-0.255	-0.115

Notes:

1) For segment B the slopes of the upper and lower edges of the detector are equivalent.

2) For segment A the slopes of the upper and lower edges of the detector are about the same when averaged. It is not clear that the differences are not due to measurement errors. The differences in the angles are due to 1-2 pixel differences in the cross dispersion direction and are thus highly variable depending upon how one defines the edge of the detector. It is a very subjective measurement

3) The slopes of each spectra above and beyond the natural slope of the detector active area - as defined by the detector - edges are consistent, suggesting that the spectra rotated equal amounts. This suggests that the detector may be the source of the rotation.

4) x and y are in pixels. Angle rotations assume an x pixel is 6 microns and a y pixel is 25 microns. All angles are in degrees.