FOS Red Detector Plate Scale and Orientation

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ABSTRACT

Revised plate scale factors, as determined from SV 1528 data, are presented. Analysis of these data indicates changes in plate scale of **-0.4% ± 0.53%** along the diode array and **2.9%** perpendicular to the array. The latter result is questionable due to the uncertainty in effective diode height. A negligible change in orientation of the x-y axis of $\mathbf{0.24^0 \pm 0.32^0}$ is found. These numbers indicate that the present scale factors of 1.43" per 256 y-base units and 0.357" per diode width are sufficiently accurate and do not need to be changed.

1. INTRODUCTION

The astrometric reference star NGC-188-031 was examined in October 1990 as a part of SV 1528, Aperture Locations - Phase IVB Precise Plate Scale. Using the red detector through the 4.3" aperture with the camera mirror, we obtained twenty four exposures in two consecutive raster scans. During the first scan, it became apparent that the target was not well-centered (the interactive target acquisition that was to precede it was lost), and a SIP was sent before execution of the second scan to improve target positioning. This report presents an analysis of aperture position between separate dwell points.

2. OBSERVATIONS AND REDUCTIONS

Two sets of 4 x 3 raster scans were performed in steps of 1 or 2 arcseconds along the diode array (x-direction) and steps of 1.33 arcseconds perpendicular to the array (y-direction). See Figure 1 for the scan pattern. Miscentering produced extremely low flux in several observations, and because we were unable to clearly locate their aperture centers, these points are not included in the analysis. For the purpose of producing Figure 1, the locations of low-flux data points have been roughly calculated by extrapolating from the well-known points.

Aperture centers were determined using the STSDAS tool APERLOCY. A 5x5 cross correlation template was used to locate the aperture center. Once the center coordinates were determined, it was necessary to correct for geomagnetically induced image drift in the Digicon detector. A "GIMP" offset was calculated using the IDL tool FOS_GIMP. This shift was

FOS_GIMP output was multiplied by 0.6 before applying, since these data were obtained in aperture imaging mode where sensitivity to the geomagnetic field is lower.

3. RESULTS

Analysis of the two scans indicated that offsets of 1.33" perpendicular to the diode height (y-direction) produced a shift of 232.142 y-base units. As a comparison, the pre-launch scale factor indicated that 1.33"= 238.098 y-base units. Constraints of binary search target acquisition require a YPITCH value such that the effective diode height corresponds to 256 y-base units. Scaling accordingly, we see that 256 y-base units = 1.47" now, as compared to the pre-launch value of 1.43", a difference of **+2.9%**. Using the conversion factor of 0.78125 microns per y-base unit, this translates to a difference of 4.65 microns. It is reasonable to attribute this difference to an extended 'effective' diode height from the nominal value of 200 microns, since diode response at the ends is not sharply delineated and is affected by the conductors.

Offsets of 1" and 2" were applied along the diode array (x-direction). We observed a mean shift of 2.789 diodes per arcsecond, as compared to a nominal shift of 2.801 diodes per arcsecond. Using a conversion factor of 50 microns/diode gives a difference of 0.60 microns. This translates into a plate scale change of **-0.4% ± 0.53%**. See Table 2.

No change in orientation was evident. With respect to the y-axis, a mean rotation of $\mathbf{0.24^0 \pm 0.32^0}$ was measured. See Table 3.

We have more confidence in measurements along the diode array, as the spacing between diodes is known exactly. The distance between diodes is guaranteed by the detector manufacturer, whereas the effective diode height is uncertain at the level of a few percent.

4. CONCLUSION

The shifts in orientation and in the x-direction are small enough to indicate that the present value of the plate scale factor on the red side is sufficiently accurate as it is. Plate scale and orientation error of the amount determined with this analysis would produce an offset error on the order of 10 milliarcseconds over the half-width the 4.3 arcsecond target acquisition aperture. As the plate scale factor is a function of the internal magnetic field of the Digicon and orientation of the detector, we recommend that the blue side portion of proposal SV 1528 be performed as soon as possible.

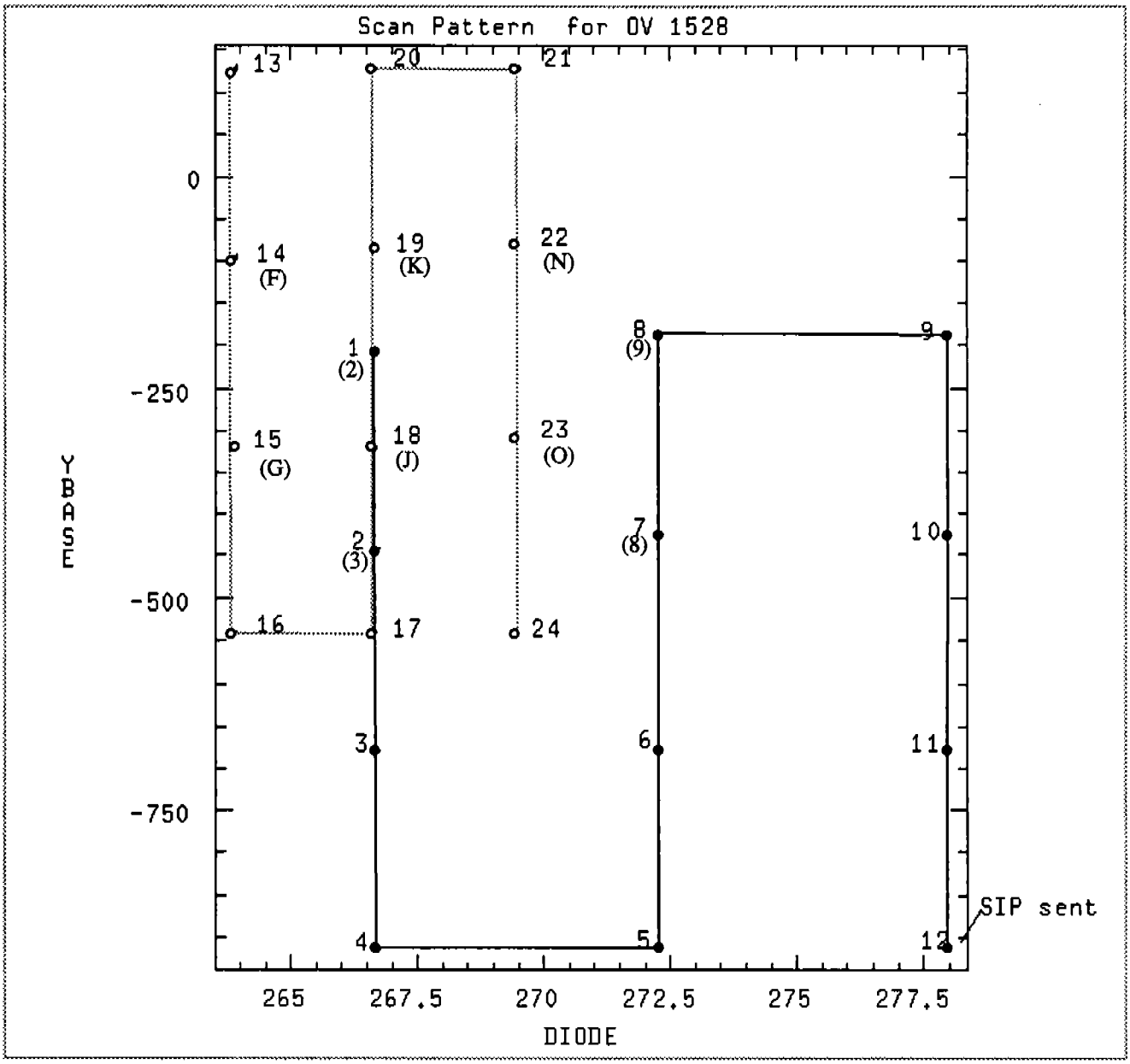

Figure 1. The two 4x3 raster scan patterns used. A SIP was sent to improve target position after the first scan. Observation numbers of points used in analysis are shown in ( ).

Table 1: Aperture centers

obs_id	x_crosscorr (diode no.)	y_crosscorr (y-base)	GIMP offset in x (microns)	GIMP offset in y (microns)	x_new (diode no.)	y_new (y-base units)
Y0D50202R	266.961334	-191.02829	-16.791	-13.852	266.626	-208.759
Y0D50203R	267.106140	-426.77404	-19.574	-13.073	266.715	-443.507
Y0D50208T	272.791931	-437.28411	-23.876	8.511	272.314	-426.39
Y0D50209T	272.660858	-207.31640	-18.734	8.789	272.29	-188.57
Y0D5020AT	273.980164	-173.80586	-12.756	4.307	273.725	-168.293
Y0D5020BT	273.831238	-378.21530	-8.124	-3.758	273.669	-383.025
Y0D5020DR	270.489136	-392.35473	-7.233	-20.552	270.344	-418.662
Y0D5020FT	264.358490	-78.166443	-21.841	-13.280	263.922	-95.1644
Y0D5020GT	264.373749	-307.56060	-23.982	-8.860	263.894	-318.902
Y0D5020JT	267.162170	-326.10696	-25.224	4.218	266.658	-320.708
Y0D5020KT	267.107788	-91.116890	-22.791	7.277	266.652	-81.8028
Y0D5020NT	269.621277	-79.378342	-7.822	-1.620	269.465	-81.4519
Y0D5020OT	269.543335	-293.00070	-4.448	-10.868	269.454	-306.912

Table 2: Actual displacements during raster scan.

Deflection Points	Commanded Shift	Actual shift	Nominal Shift
y-direction:			
F-G	1.33"	223.7376 y-b	238.098 y-b
J-K	1.33"	238.9052 y-b	238.098 y-b
N-0	1.33"	225.4601 y-b	238.098 y-b
2-3	1.33"	234.748 y-b	238.098 y-b
8-9	1.33"	237.82 y-b	238.098 y-b
x-direction:			
F-K	1.0"	2.73 diodes	2.801 diodes
K-N	1.0"	2.813 diodes	2.801 diodes
G-J	1.0"	2.764 diodes	2.801 diodes
J-O	1.0"	2.796 diodes	2.801 diodes
2-9	2.0"	5.664 diodes	5.602 diodes
3-8	2.0"	5.599 diodes	5.602diodes

Table 3: Shift in Orientation

Deflection Points	Δx (microns)	Δy (microns)	$\Theta = \text{atan}\frac{\Delta x}{\Delta y}$
F-G	-1.4	-179.28	+0.44
J-K	-0.3	+186.68	-0.09
2-3	+4.45	-183.40	-1.39
N-O	-0.55	-176.14	+0.18
8-9	-1.2	+185.80	-0.37