DETECTOR METROLOGY

Spartan IR Camera for the SOAR Telescope

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The detector assembly will be designed to hold the edges of the detector carrier. What is the position of the detector surface with respect to the carrier? For the f/11 channel, the tolerance of the image is 30μ in the direction of the optic axis.

1 View Engineering

Tom Lisby of View Engineering measured the detectors on a Voyager 6×12. This machine projects a pattern onto a surface and images it. It finds focus by maximizing sharpness. The accuracy in the height is 3.0μ over distances of the detector size. The data are in SOAR IR Camera\Design\View\MSU.txt and MSU_Science_grade.txt.

The data are relative to a plane defined by three points (0,0), (0,54)mm, and (54,0)mm on the frame. The identifying mark is near the origin. Positive height is above the detector.

2 Results

2.1 Reproducibility and Accuracy

The reproducibility is likely to be better than 1μ. The RMS of the differences of the heights of the points (all on the carrier) that were measured twice is 2.9μ. The residual of the fit of the detector surface is 0.7-0.9μ. Since the carrier is rough and the detector smooth, the reproducibility found with the detector surface indicates the capability of the machine.

The specified accuracy of the machine is 4.5μ over the size of the carrier.

2.2 Detectors

The detectors are Pace-1 Hawaii-2. The science-grade detector is serial number 24, and the engineering-grade detector is serial number 14.

2.3 Carrier

The height of the frame deviates from the reference plane. The deviation of the two detectors is remarkably alike (Figure 1). The data are (76.1, 4.8, 64.3, 29., 84.7, 4.9, 60.1, -0.4)μ for the science grade detector and (70., 1., 87., 67., 93.9, 0.2, 56.4, -0.7)μ. The order is counter clockwise.

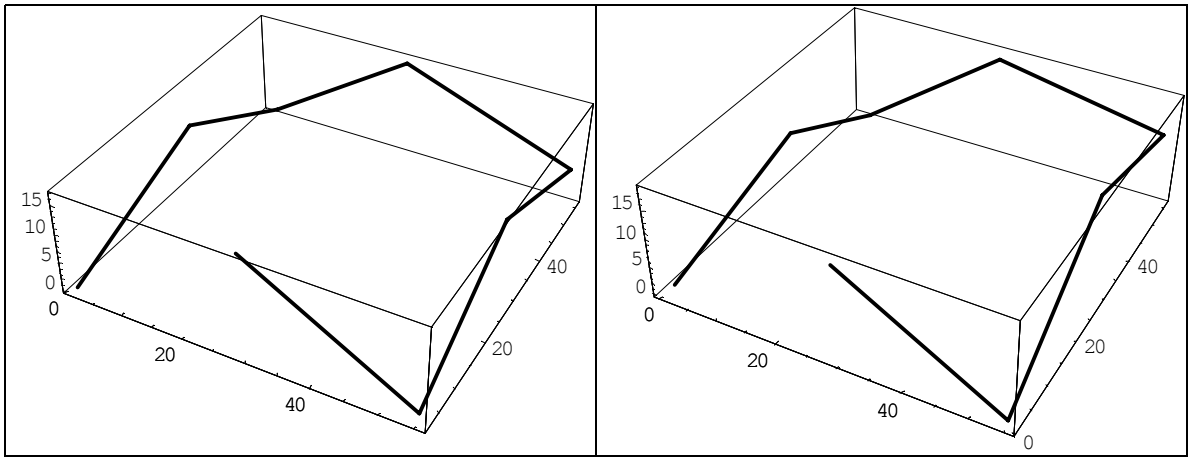

Figure 1 Height (in units of 5μ) of the frame of detector #24 (left) detector #14 (right) relative to the plane defined by the points at (0,0), (0, 54), and (54,0).

The fourth corners are 29 and 63 μ above the reference plane.

2.4 Light-sensing surface

The light-sensing surface is black. The first attempt to measure the surface with a laser coordinate measuring machine failed because the reflected laser light was undetectable.

The light-sensing surface, measured at the corners and the center, is tilted with respect to the reference plane defined by three corners of the carrier, and it is curved. See Figure 2. For detector #24, the best fitting curved surface is

$$1\mu - 1.3\mu/\text{mm}\, x + 0.8\mu/\text{mm}\, y + 0.048\ \mu/\text{mm}^2\ (x^2+y^2),$$

and the best fitting flat surface is

$$21\mu - 1.2\mu/\text{mm}\, x + 0.9\mu/\text{mm}\, y.$$

For detector #14 the best fitting surfaces are

$$-11\mu - 0.8\mu/\text{mm}\, x + 2.4\mu/\text{mm}\, y + 0.048\ \mu/\text{mm}^2\ (x^2+y^2)$$

and

$9\mu - 0.7\mu/\text{mm}\, x + 2.4\mu/\text{mm}\, y$.

The position x and y are measured from the center of the detector. The RMS residuals are 0.7μ for detector #24 and are 0.9μ for the detector #14. Without the spherical term the residuals are 10μ for both detectors. The shape of the residuals (Figure 3) is somewhat alike for the two detectors.

The quadratic term is equivalent to a sphere with a radius of 11m. The quadratic term is the same for the two detectors.

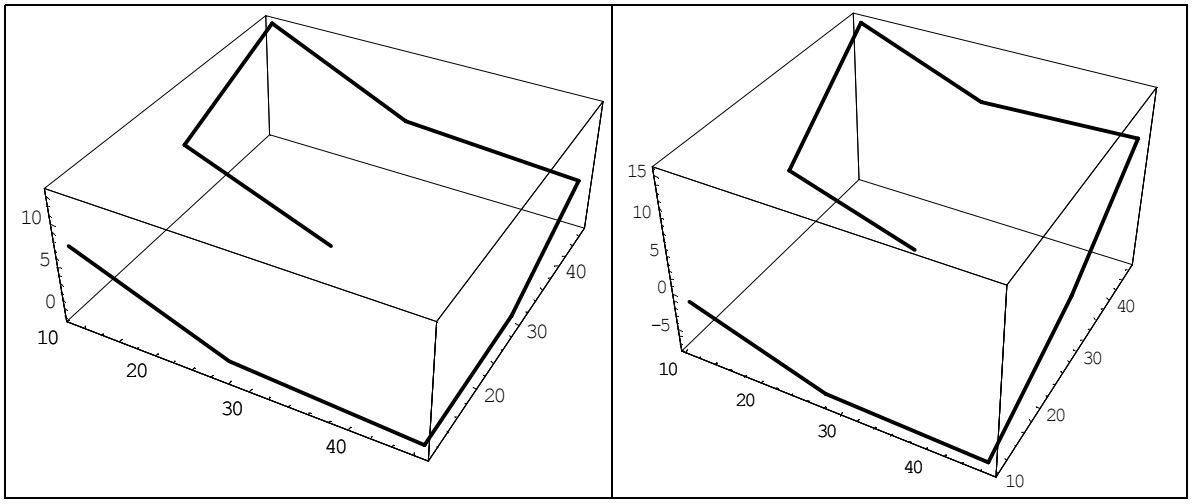

Figure 2 Height (in units of 5μ) of the light-sensing surface of detector #24 (left) and detector #14 (right) relative to the plane defined by the points at (0,0), (0, 54), and (54,0) on the carrier.

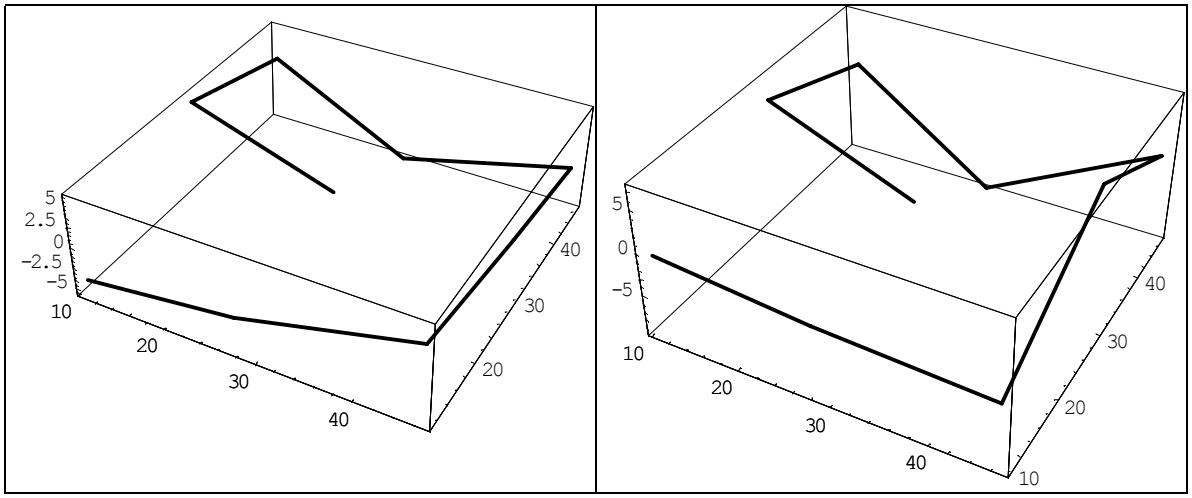

Figure 3 Residual height (in units of 200nm) of the light-sensing surface of detector #24 (left) and detector #14 (right).

3 Conclusion

1. The frame is not flat. With a plane defines by three corners, the fourth corner is 29μ (63μ) above for detector #24 (#14). The mount must be at three points in order not to stress the detector.

2. The detector is not parallel to the frame. With respect to the center, the heights of the four corners are (–6, 39, 6, –39)μ for detector #24 and (31, 59, –31, –59)μ for #14. This is out of tolerance (30μ). Each detector must have its specific tilt, which is or order ±100μ at the corners of the frame.

3. The detector surface is concave with a radius of curvature of 11m. This causes a difference in height of 15μ from center to edge. This can be ignored since it is within tolerance.