Hawkeye Image Spot Sizes

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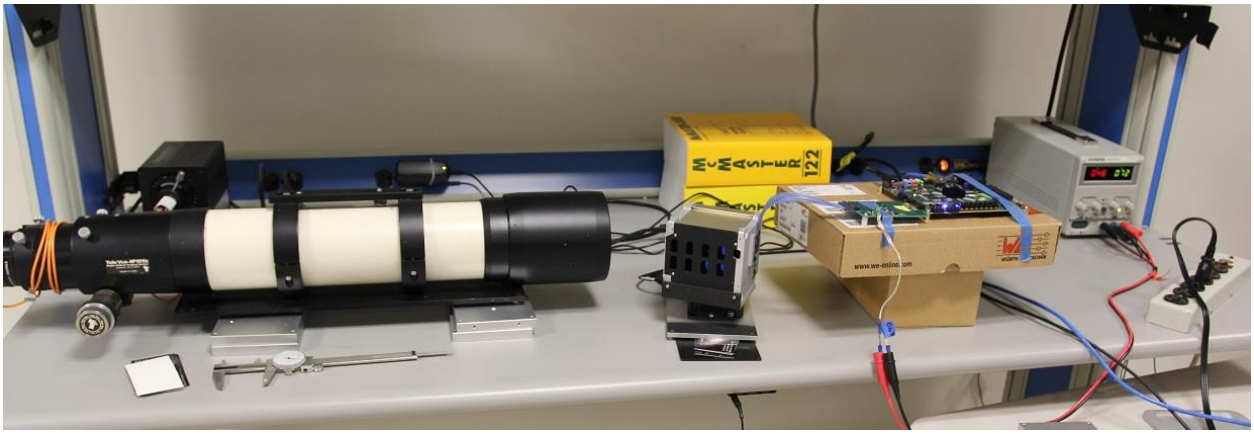
The spot size for each band was measured during calibration. To capture this data, a star-like source was projected into the instrument and scanned. The setup is shown below in Figure One. A fiber optic tip was placed at the focus of a Televue NP101 F/5.4 refractor and projected into the instrument. The projected geometric fiber tip image size would have been 0.5 pixel. This refractor has an aperture large enough to illuminate all bands at once. I trusted the chromatic aberration of this refractor to not be a limitation in the measurement since I have used it extensively for unfiltered astronomical imaging and the image quality is excellent. I realize this is a qualitative assessment but I knew if our images were as good we would have a quality instrument. The field tests are an independent check of this.

Figure One: Televue Refractor illuminating Instrument on Rotary Stage



The instrument was mounted to a rotary stage that rotated the instrument across the projected image. The full width half maximum for each band's image is tabulated in Table One. Note that, in general, Unit Two is a little better than Unit One – we basically improved our focusing technique with practice. Another general trend is apparent, and that is that the Y-direction (along track) is slightly better than the X-direction (along the array). This is a bit odd since both our 4:1 oversampling technique and the polarization scrambler prism should have created some smear in the Y-direction. It could be due to a limitation of the CCD. The subtle differences between bands are not particularly significant, except that Unit One bands 2 and 4 clearly have some blur, which can also be detected in field test image data. All other bands are sharp enough that the finite sampling of the CCD effect dominates the image resolution.

The data used for this table was the Unit One data of 6/19/2017, "Alan3\TelescopeStrayLight-U1", and the Unit Two data of 6/23/2017, "Alan3\Unit2\TelescopeStrayLight-PostRework".

Table One: Measured Spot Sizes

Full Width Half Maximum in Pixels for each Band				
Band	Unit One		Unit Two	
	X	**Y**	**X**	**Y**
1	2.2	2.1	2.1	1.4
2	2.6	2.5	2.0	2.0
3	2.1	1.7	2.0	1.3
4	3.0	2.2	2.1	2.2
5	2.3	2.4	2.1	1.9
6	2.3	2.2	2.1	1.3
7	2.2	2.2	2.2	2.0
8	2.4	2.0	2.4	1.7

Figures Two-A, Two-B, and Two-C provide evidence from the second field test of Unit One that there is not some chromatic error lurking in the instrument image quality. I show a cropped 578x237 pixel portion of a scene where all 8 bands were captured at once. Note that the sharpness of the palm trees and the glints off the cars in the parking lot are comparable in sharpness, even though the wavelength ranges from 412 to 865 nm.

For reference, the focus was sent visually for every band using another Televue refractor to view the CCD through the Hawkeye lenses. The filter and scrambler were left off for this step. At the end of the visual setting each lens was incremented by the calculated focus difference between the green Band 5 (555 nm) and the band under examination. The instrument was then moved to the scan table, with the filters and scramblers in place, and multiple scans acquired while the fiber tip was moved through focus. The focus was tweaked for bands that measured off, and then all bands were locked down with setscrews. The unit was then moved back to the visual station, without the filters, and all bands were aligned to each other visually. The X-direction alignment was refined using software adjustments in a later step. The whole process took about two hours.

Figure Two: A, B and C – Band 1 (412nm), Band 5 (555 nm), and Band 8 (865 nm) are Shown