Testing MASS-DIMM units 16 to 20

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1 Testing the DIMM channel

On January 29-30, all 5 new MD units were tested with the star simulator and an ST-5 detector. The detector was oriented with its cable looking towards telescope (180° with respect to standard orientation). Thus, the "left" spot formed by the DIMM-L mirror is rightmost spot in the images.

First, the DIMM mirrors were aligned to center the image of the field stop. It turns out that all images were initially de-centered, despite good pre-alignment. It means that the CCD is likely offset with respect to the camera mechanical center.

Typical images of the uniformly illuminated field are shown in Fig. 1. The edge of the field stop is quite sharp (due to the mechanical adjustment at assembly that compensated for the deviation of the DIMM mirror's focal length from its nominal value). The fuzzy details in both images come from the dust in the camera.

Next, focused images of the spots were taken. The focusing was done by reaching the maximum intensity in the image. Given that this maximum depends also on the spot position (which, itself, changes with focusing), it was impossible to reach best focus. Moreover, tests of MD16 and MD18 were done with 2x2 binning. Figure 2 shows the 1-dimensional scans obtained by compressing the spots in the vertical direction (IDL program `plotstar.pro`). The difference between the intensities of the spots is caused by the non-uniformity of the simulator's illumination (it could be changed by adjusting the simulator).

The FWHM of the scans is about 2 pixels. The diameter of the apertures in the DIMM mask is 5.5mm, the distance to the CCD is 152mm, the wavelength is 0.65mum. The expected FWHM size of diffraction

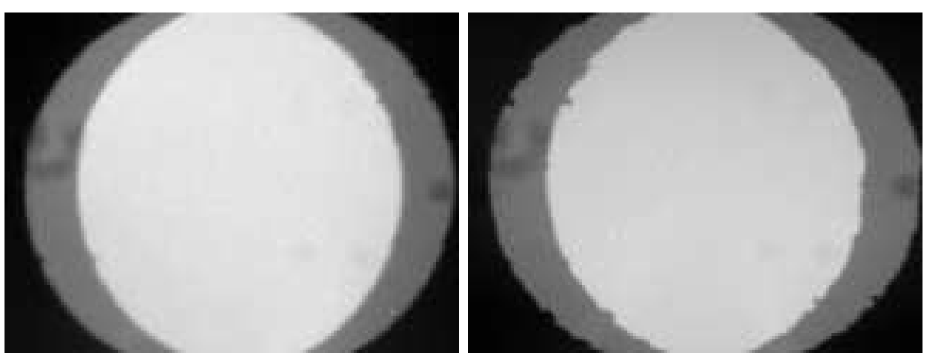

Figure 1: Images of the field in MD16 and MD17.

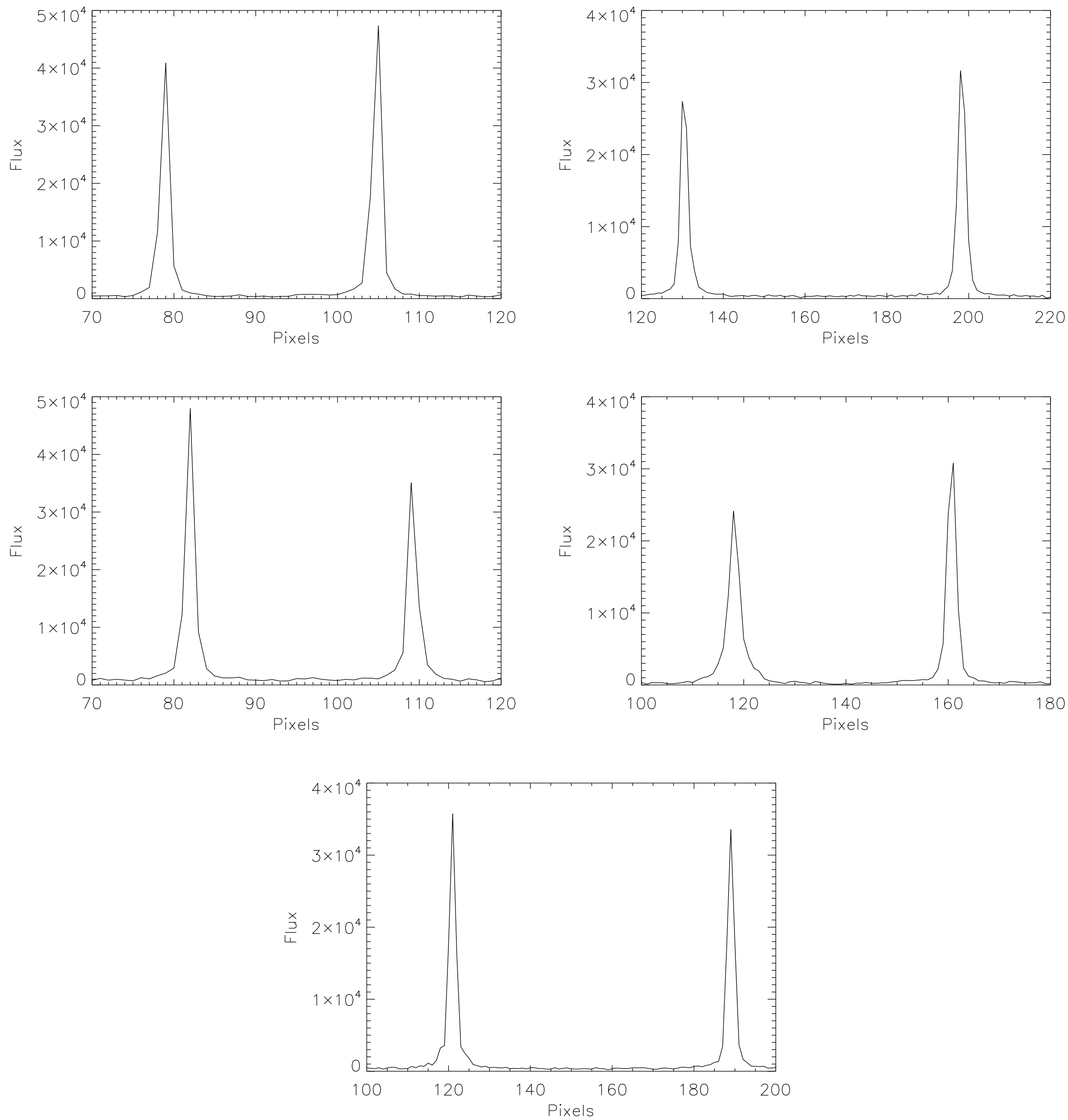

Figure 2: X-scans of the spots in MD16, MD17 (top row), MD18, MD19 (middle row), and MD20 (bottom). For MD16 and MD18, the pixels are binned 2 times.

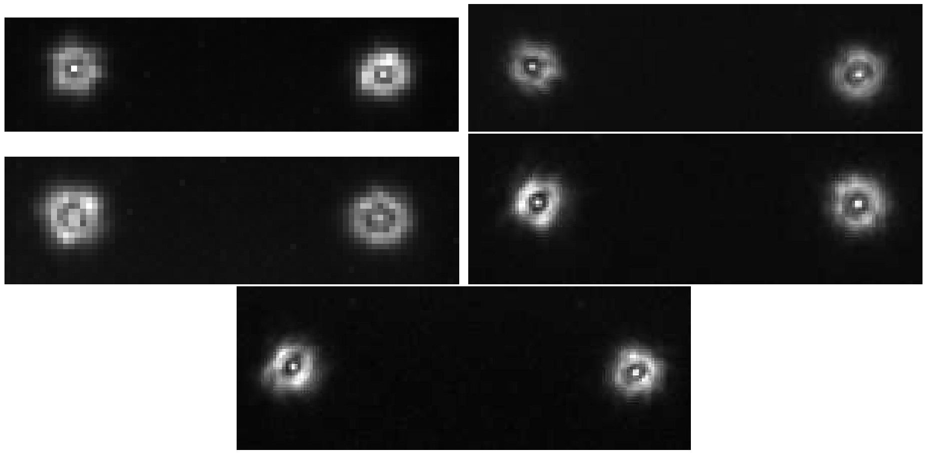

Figure 3: Images of intra-focal spots in MD16, MD17 (top row), MD18, MD19 (middle row), and MD 20 (bottom).

spots is $F\lambda/D = 18.0\mu$m, or 1.82 unbinned pixels (pixel size 10μm). Hence the spots are essentially diffraction-limited. Formal calculation of the Strehl ratios gave values around 0.5 for well-focused images (a careful focusing has been done on MD17), or lower for other, not-so-well focused or binned images. The table below shows the Strehls and the distance between the spots. The asterisks mark binned images.

Unit	SR(left)	SR(right)	dx
MD16	0.30	0.21 *	52
MD17	0.51	0.44	70
MD18	0.30	0.21 *	54
MD19	0.37	0.47	43
MD20	0.55	0.53	68

Finally, intra-focal images of the spots (increased separation) were recorded (Fig. 3). They demonstrate that there is no visible astigmatism (or any other low-order aberration) and that the defocusing in both spots is identical. The spottedness of these images comes from the dust in the simulator.

The Strehl ratios measured with MD16 at the telescope reached 0.6. They could be higher, being limited by the small residual astigmatism in the fore-optics that coupled MASS-DIMM to the telescope.

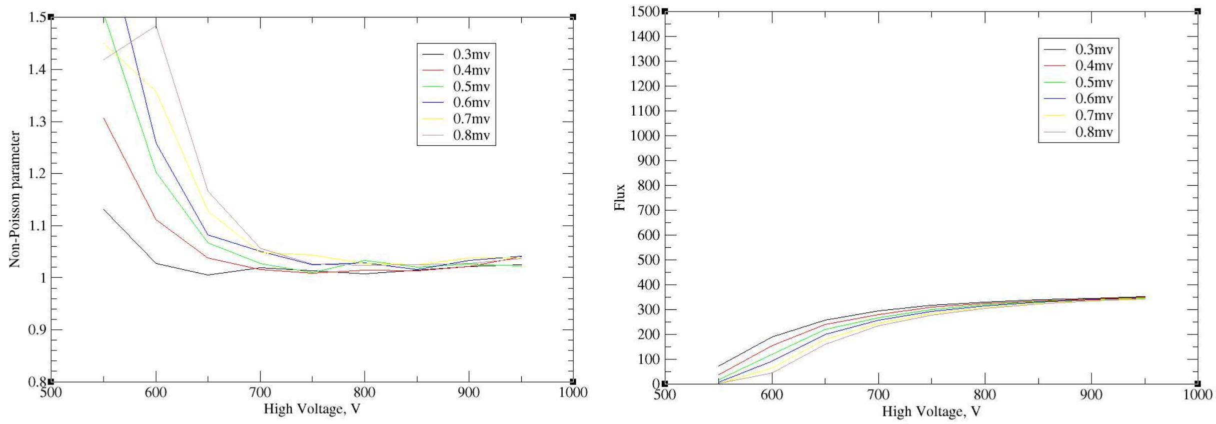

Figure 4: Counting characteristics of the A-channel in the MD16 unit.

2 Testing the MASS channel

J.Sequel has measured the counting characteristics of all new electronic units (except MD17, still not fully functional). An example is given in Fig. 4. Clearly, these characteristics are excellent: the non-Poisson parameter is close to 1 for a wide range of discrimination thresholds and high voltages. Based on these tests, optimal values of thresholds and high voltage for each unit has been determined and written in the corresponding `device.cfg` files

Additional tests have been done on the fully assembled devices MD16 and MD18, using their own cables and LPT adaptors. The results of 30-s detector test are reported below. The light level was set at 0.04, the temperature was around +25°C.

	A	B	C	D
MD16 Flux	328	333	217	142
MD16 p	1.02	1.01	1.01	1.02
MD18 Flux	367	359	310	207
MD18 p	1.02	1.01	1.01	1.04

The statistic test (scintillating internal source, amplitude 0.2) gave the expected results. The non-Poisson parameters were all set at 1.00. Nevertheless, the differential indices were all zero to within 0.0001, and the measured indices matched their expected values to this same accuracy.

Figure 5 shows the residuals to scintillation indices obtained during brief tests of MD16 unit with the RCX400 telescope (Cerro Tololo, January 11, 2006). We see that the residuals are small and do not deviate from zero in a systematic way. In fact, average residuals (23 measurements) are all within 0.04. The free-atmosphere seeing was around 0.5 arcsec.

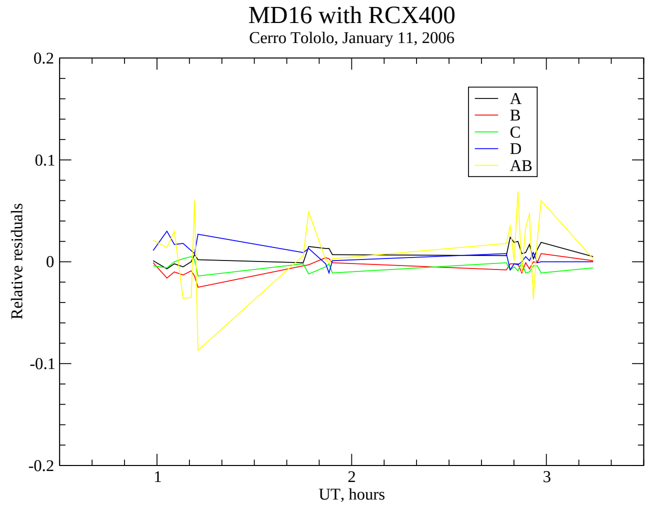

Figure 5: Residuals of scintillation indices obtained during first tests of MD16 with the Meade RCX400 telescope.

3 Conclusion

The 5 new MASS-DIMM instruments passed quality checks.