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Measuring the flatness of focal plane for very large mosaic CCD camera

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(Submitted on 28 Oct 2010)

Large mosaic multiCCD camera is the key instrument for modern digital sky survey. DECam is an extremely red sensitive 520 Megapixel camera designed for the incoming Dark Energy Survey (DES). It is consist of sixty two 4k$\times$2k and twelve 2k x 2k 250-micron thick fully-depleted CCDs, with a focal plane of 44 cm in diameter and a field of view of 2.2 square degree. It will be attached to the Blanco 4-meter telescope at CTIO. The DES will cover 5000 square-degrees of the southern galactic cap in 5 color bands (g, r, i, z, Y) in 5 years starting from 2011.

To achieve the science goal of constraining the Dark Energy evolution, stringent requirements are laid down for the design of DECam. Among them, the flatness of the focal plane needs to be controlled within a 60-micron envelope in order to achieve the specified PSF variation limit. It is very challenging to measure the flatness of the focal plane to such precision when it is placed in a high vacuum dewar at 173 K. We developed two image based techniques to measure the flatness of the focal plane. By imaging a regular grid of dots on the focal plane, the CCD offset along the optical axis is converted to the variation the grid spacings at different positions on the focal plane. After extracting the patterns and comparing the change in spacings, we can measure the flatness to high precision. In method 1, the regular dots are kept in high sub micron precision and cover the whole focal plane. In method 2, no high precision for the grid is required. Instead, we use a precise XY stage moves the pattern across the whole focal plane and comparing the variations of the spacing when it is imaged by different CCDs. Simulation and real measurements show that the two methods work very well for our purpose, and are in good agreement with the direct optical measurements.

Comments: Presented at SPIE Conference,Ground-based and Airborne Instrumentation for Astronomy III, San Diego, 2010

Subjects: **Instrumentation and Methods for Astrophysics (astro-ph.IM)**

Journal reference: Proc.SPIE Int.Soc.Opt.Eng.7735:77353U,2010
Report number: FERMILAB-CONF-10-191-A
Cite as: **arXiv:1010.6072v1 [astro-ph.IM]**

Submission history

From: Jiangang Hao [view email]
[v1] Thu, 28 Oct 2010 20:00:12 GMT (1734kb,D)

Which authors of this paper are endorsers?