

The WIYN One-Degree Imager and its Precursor QUOTA

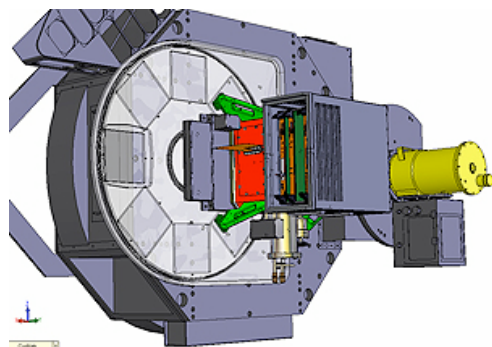
Daniel Harbeck & George Jacoby (WIYN Observatory)

The WIYN 3.5-meter telescope delivers excellent images that are usually limited by atmospheric conditions. However, no instrument to date has exploited WIYN's superb image quality and its large field of view at the same time.

The current imager at WIYN, MiniMo, provides a field of view only 10 arcmin across and it has an inefficient CCD readout time of 3.5 minutes. The fibers of the one-degree field spectrograph, on the other hand, are two arcsecs and three arcsecs wide, and its observations do not benefit from WIYN's sharp delivered seeing. Thus there is a clear demand for improved imaging capabilities to utilize WIYN's full potential.

The One-Degree Imager (ODI) will provide wide-field, high-resolution imaging to the WIYN community in 2009. ODI will feature a one billion-pixel camera having a one-square-degree field of view. To fully exploit the image quality of WIYN, ODI will actively stabilize the images through tip/tilt image correction, and will sample the focal plane with 0.11-arcsec pixels. Tip/tilt correction has been shown to enhance the seeing by 0.1 to 0.2 arcsecs under good seeing conditions.

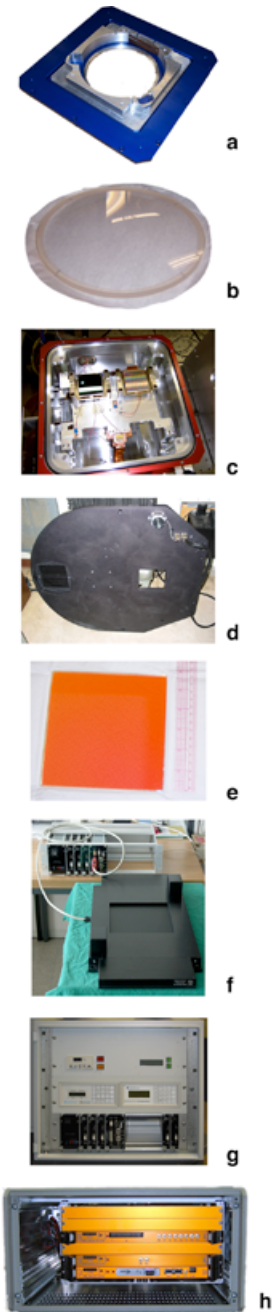
Image stabilization will be achieved by locally moving the charge image directly within the CCD to follow the optical image as it moves due to atmospheric turbulence, telescope shake, and guiding errors. The prototype camera OPTIC, on loan from the University of Hawaii's John Tonry, currently uses this "orthogonal transfer" CCD technique. Each of ODI's CCD chips will be divided into an 8 x 8 array of 480 x 494 pixel cells that can operate independently (in either integrating mode or in video mode) to measure and track the local image motion using bright guide stars. These specialized Orthogonal Transfer Array (OTA) detectors are being developed in a collaboration between WIYN and the PanSTARRS project.



For near-term use, we are currently building a pathfinder camera called QUOTA (QUad OTA) see figure 1. QUOTA is a downscaled version of ODI that will use the same type of detectors and controllers. While ODI's focal plane will consist of 8 x 8 array of OTA CCDs, QUOTA's focal plane will have only a 2 x 2 array, with a total of 8K x 8K pixels.

Figure 1. Rendering of QUOTA at WIYN's imaging port, with WTTM to the right.

The purpose of QUOTA is to teach us how to control and operate these new detectors. For example, the configuration of guide stars for ODI will require sophisticated software support: roughly 200 guide stars will have to be assigned for each fully corrected tip/tilt exposure. Such observations would benefit greatly from advance planning by the observer using designated software tools.



All the mechanical components for QUOTA are in the WIYN lab in Tucson, including the shutter, the filter wheel, the dewar, and the corrector optics (figure 2). Special attention has been given to the QUOTA filters: it is currently impossible to buy uniform colored-glass filters of ODI's size (40 x 40 centimeters), so these filters will have to be custom-designed interference filters.

Although the filter size for QUOTA is more modest, given that it is fully compatible with the KPNO Mosaic filters, we are using QUOTA to prototype the interference broadband filter construction techniques. An SDSS r' band filter has been delivered that demonstrates the excellent homogeneity of the transmission curve that will be required for ODI. We have tested the filter successfully at the KPNO 4-meter telescope using the Mosaic camera (figure 3). The demonstration of the most recent OTA detectors is still pending, as is the interplay between the OTA CCDs and the Monsoon CCD controller.

Figure 2. Hardware components of QUOTA received in the Tucson WIYN lab: Lens mount (a) for the two corrector lenses (only one lens shown). One lens (b) will serve as the front element of the dewar (c). The filter wheel (d) will carry up to eight filters. Some QUOTA filters will be broadband interference filters to serve as prototypes for large-format ODI filters (e). The Bonn shutter (f) allows very short exposures with homogeneous illumination of the focal plane. The instrument control box (g) will deliver telemetry, control the focal plane temperature, and the filter wheel interface. A small eight-channel version of the Monsoon CCD controller (h) is capable of reading out a single OTA chip; a larger 40-channel version for use with QUOTA is currently being assembled.

QUOTA is scheduled for commissioning as a static imager this fall. Active image stabilization will be added over the subsequent six months. We expect to offer QUOTA, in shared risk mode, beginning in semester 2007A. It will replace MiniMo as the standard WIYN imager in semester 2007B.

By the time ODI arrives at the telescope, QUOTA will have taught us how to deal with the peculiarities of an OTA-based camera, and we will “only” face the problems of scaling up QUOTA by a factor of sixteen!



figure 3: http://www.noao.edu/image_gallery/html/im1013.html