URAT - year 3

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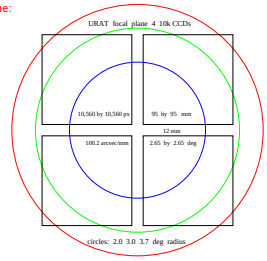
Abstract:

The USNO Robotic Astrometric Telescope (URAT) is now in the third year of observing. Survey observing began in April 2012 at the Naval Observatory Flagstaff Station (NOFS). URAT has taken over 55,000 exposures of the northern sky with multiple overlaps, 28 sq. degrees with a single exposure at 0.9"/pixel resolution. Raw data processing, quality control, and scheduling are performed automatically. In normal survey mode URAT covers stars in the R = 10.5 to 18.0 magnitude range. Utilizing an objective grating and the clocked anti blooming (CAB) feature of the 4 CCD chips results in a bright limit of 3rd magnitude. Exposures taken on the east and west side of the pier enable the calibration of potentially significant systematic errors. URAT mean positions are predicted to be on the 5 to 20 mas level depending on stellar brightness and sky coverage. URAT will also provide proper motions for most stars and parallaxes for nearby stars, independent of any selection criteria. We are currently working on the reduction pipeline and a first astrometric catalog is expected to be released in 2014.

URAT Focal Plane:

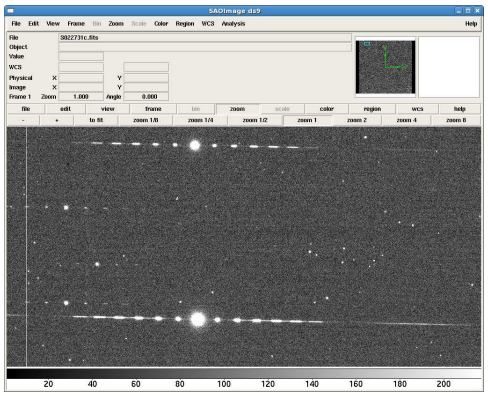


The "redlens" of the USNO astrograph was built by the Optical Science Center, University of Arizona in Tucson, following design goals and guidelines provided by the late Christian de Vegt who worked as a consultant for USNO. The design field-of-view is 4.8 degree radius at 100 "/mm (203 mm aperture, f/10) giving a field diameter of 346 mm in the focal plane. For URAT the largest distance of a CCD pixel from the optical axis is 3.95 degree at 142 mm. The layout of the 4 big 10k CCDs is shown in the figure above. There is a 12 mm gap between each of the 95 by 95 mm detectors.

Project:

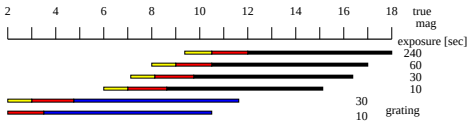
telescope	USNO astrograph		
	aperture	203	mm
	focal length	2060	mm
	bandpass	680-750	nm
camera	4 CCDs, each	10.5k x 10.5k	pixels
	scale	0.905	arcsec/pixel
	field of view	28	square degrees
guiding camera	3 CCDs, each	2k x 2k	pixels
	scale	0.8	arcsec/pixel
regular survey	2 exposures/field	60 & 240	sec
grating survey	2 exposures/field	10 & 30	sec

Grating Images:



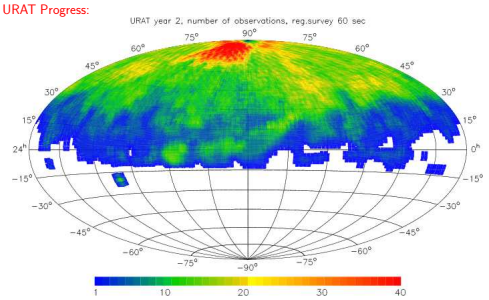
The above picture shows a screen shot of a small area of CCD C of a 30 sec exposure taken with the grating on. The vertical line at the left is a column defect. Faint stars display only the central image, as if observed without the grating. The diffraction images of these stars are too faint to show up. By design the grating produces diffraction images about 5 magnitudes fainter than the central image. This allows to still obtain positions of bright stars from unsaturated grating images even when the central image is (vastly) overexposed, thus extending the dynamic range for astrometry considerably. For example the central image of the brightest star in the picture above is about 2.9 magnitudes beyond saturation, while the next brightest star is about 1.4 magnitudes beyond saturation. For both stars the 1st order diffraction images are unsaturated and low error position centers can be obtained from these. The star on the left still showing sufficiently well exposed grating images is about 1.8 magnitudes below saturation and thus its central image will give an even smaller error position fit than the much lower S/N grating images.

URAT Magnitude Range:



Coverage of magnitude ranges by various types of exposures are shown in the figure above. The red bars indicate the 1.5 mag beyond saturation which are well covered by the CAB of our CCDs. The yellow bars indicate the extended CAB regime, where fit positions are possible but calibration will be more difficult.

URAT Progress:



The sky plot above shows year 2 sky coverage (April 2013 - April 2014) for all acceptable 60 sec exposures. For each regular survey field URAT took a 60 sec and a 240 sec pair. The color bar goes from blue to red indicating 1 to 40 observations per area.

URAT Telescope:

URAT inside the dome in Flagstaff. This picture shows the telescope setup to take calibration frames on the West side of the pier. The arm sticking out to the left has a counterweight that tracks the rate of LN2 evaporation throughout the observing night. The dewar seen at the very bottom of the picture holds about 30 kilograms of LN2. At the top of the picture is the lenscover which was constructed to keep the redlens protected and free from debris which can be opened and closed by computer control.

Acknowledgments:

We like to thank the entire STA team for continued support during URAT operations.