The IBIS Mosaic
G. Cauzzi 1, K. P. Reardon 1,2
(1) INAF - Osservatorio Astrofisico di Arcetri, Italy; (2) Queen’s University, Belfast, UK

Motivation:
Structures on the Sun occur on a variety of spatial scales, from active regions spanning 100,000’s of km, to features at the limit of our current resolving power. AO and image reconstruction techniques make it possible to achieve diffraction-limited images at ground-based solar telescopes, but the resulting field of view is quite limited, often to much less than 100”. This is very inconvenient for studies of the solar chromosphere: proper assessment of the magnetic connectivity among structures requires large fields of view, but small scale dynamics still plays an important role producing those features (Figs. 1, 2).

This motivated us to attempt high resolution observations of an AR’s chromosphere using a mosaic technique, combining both diffraction-limited resolution with full imaging spectral scans of photospheric and chromospheric lines. Current solar telescopes are not well equipped for this observation mode, but mosaic observations are supposed to become an important part of operation for future large facilities.

Methods:
We utilized the IBIS imaging spectrometer installed at the Dunn Solar Telescope (NSO) to obtain spectrally resolved images of AR 11092 in the photospheric Fe I 543.4 nm line, and in the chromospheric Ca II 854.2 nm, He I 303.4 and Hα. Each line was sampled in more than 20 spectral points to retrieve full spectral profiles for each spatial position in the FOV. The spatial scale was 0.1”/pixel.

The telescope was manually positioned over 9 separate targets, representing the tiles of a 3 x 3 mosaic covering the whole AR. The normal circular field-stop (95” diameter) was removed to give a 100” x 100” FOV, overlapping about 20” between adjacent tiles (Fig. 1). The raster order was performed so to minimize delay between bordering tiles. Data was acquired on Aug. 3, 2010 under very good seeing conditions, so we extended the usual line samples of 1 image/pass, with bursts of 50 images at selected wavelengths, to be used later for speckle reconstruction. Each set of spectral data (4 lines, scanned twice for each single FOV) was acquired in about 4 minutes. The whole dataset was obtained in less than 40 minutes. This could be reduced to 15 minutes or less with a more selective choice of spectral samples.

The white light images were speckled, and then aligned with respect to the HMI continuum images. This allows the images to be mapped onto a proper solar coordinate grid, which would otherwise be difficult using only ground-based data. The different wavelength were then aligned with an iterative process based on the speckled WL. The final datacube (x,y, lambda) is thus fully internally consistent, and precisely coaligned with the HMI and AIA images, with an accuracy much better than one HMI pixel.

The mosaic:
Fig. 2 below shows some of the results of the mosaic process. The final FOV is over 4’ x 4’ (2500 x 2500 pixels) with an actual spatial resolution close to 0.2”. The FOV encompasses the whole extension of AR 11092, including the leading spot, the trailing polarity, and a host of quieter structures. AR 11092 is displayed in various wavelengths and parameters obtained from the spectral scans, probing the atmosphere from the deep photosphere (continuum) to the upper chromosphere (Hα core). Three SDO images provide further context: the HMI line-of-sight magnetic flux map; the intensity in the He II 30.4 nm line (upper photosphere/lower transition region); the intensity in the Fe IX/X complex at 17.1 nm (lower chromosphere). The circles represent FOVs of 30”, 60”, 90” diameter, respectively. A FOV between 30” and 60” is typical of imaging spectrometers at current large telescopes (i.e. the GREGOR). The IBIS’ FOV is 95” diameter in spectral mode, and 60”x60”” in polychromatic mode.

Such wealth of information is suited to a variety of statistical studies of both active and quieter Sun, including chromospheric fibrillar structures and their relationship with the corona; heating in and around magnetic areas; magnetic topology over the AR size (see e.g. Reardon et al. 2011 ApJ 742, 119; Jing et al. 2011 ApJ 739, 67).

The spectral data is available to the community as a set of FITS files (write to: kreardon@arcetri.astro.it; gcauzzi@arcetri.astro.it).