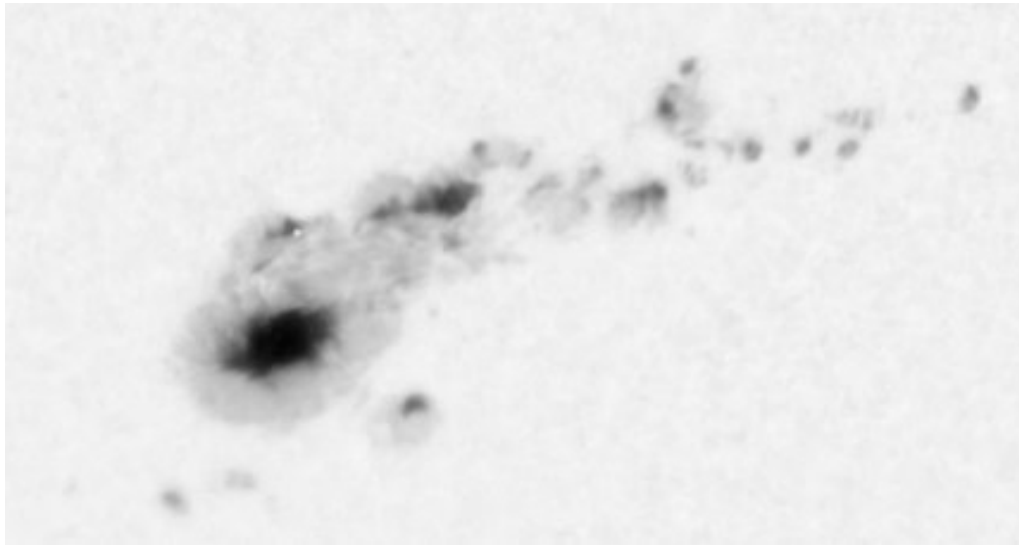# ESA PECS project No. C98081 (2009-2012)

Production and cross-calibration of space-borne sunspot data

The present project is the continuation of a previous ESA-PECS project (SOHO/VIRGO,MDI - DPD catalogue studies - No. C98017).   The aim of the present proposal is to extend the time-coverage of the SOHO/MDI space-borne sunspot database for the post-SOHO era by continuing the work on the HMI images of the Solar Dynamics Observatory (SDO) and by ensuring homogeneity between the two materials and also with ground-based datasets. The unified SOHO/MDI and SDO/HMI catalogue will be the longest high-time resolution sunspot catalogue available at all.
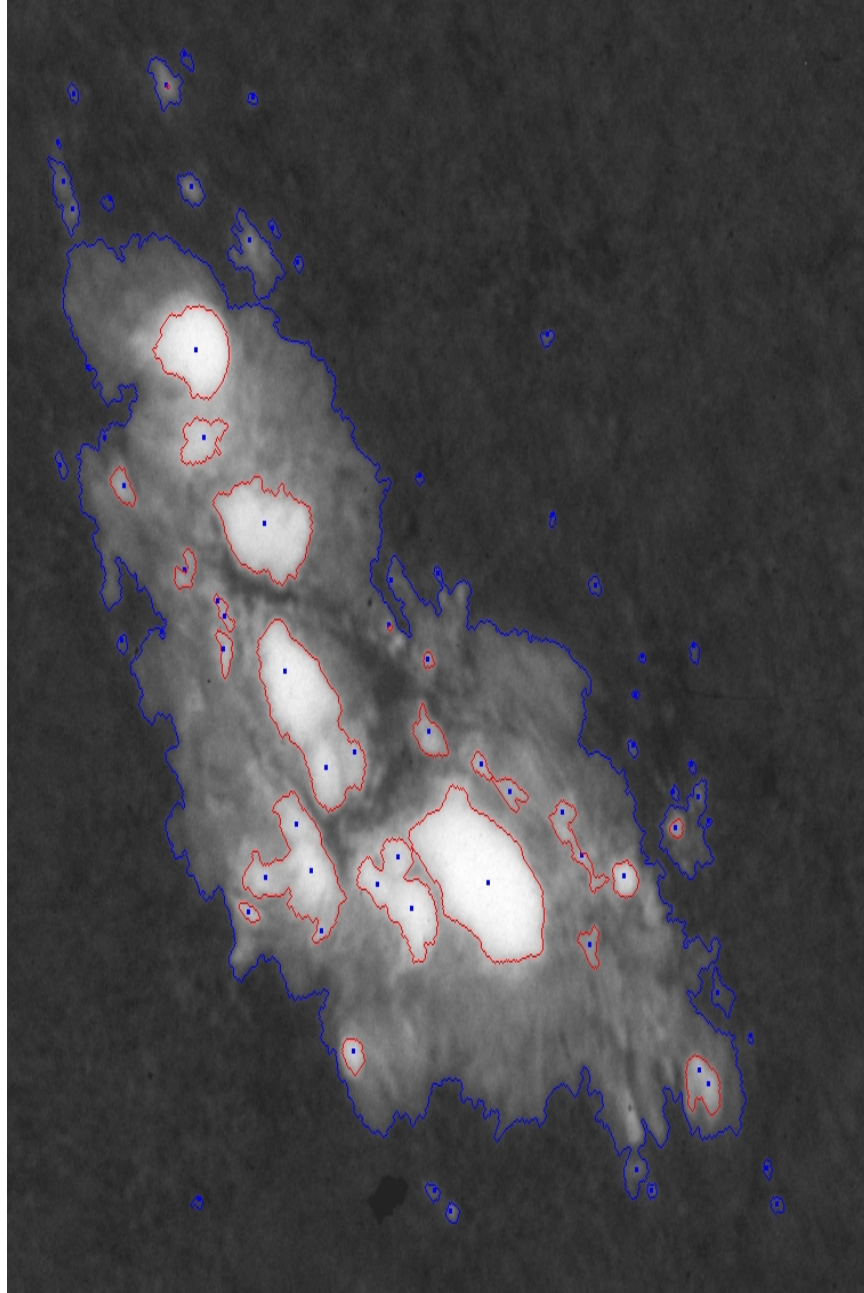
The software called "Sunspot Automatic Measurement" (SAM) automatically determines the borders of the sunspots (Gyŏri 1998, 2003) after correction for limb darkening and flat field. From the image, an iso-intensity contour set is produced. The penumbra border of a sunspot is the first (counted from the photosphere) contour having a local maximum in averaged gradient along contour (AGAC) and the umbra border is the contour having the global maximum in AGAC. The area is the number of the pixels inside the border and the position is the centre of gravity of pixels inside the border weighted by their intensities. The SAM can be applied to any full disk digitized solar image if the orientation of the image is known or can be derived from the image itself.

Examples for the borders in a negative image of a sunspot group: blue - penumbra; red - umbra; blue dot - centre of spot

SAM has been modified in order to measure the MDI 1024x1024 pixels full disk intensity images (Gy ri et al. 2006). The evaluation of the Ic images with the new type of magnetograms is in progress, and the new data will be published for the whole SOHO era within the EU FP7 "SOTERIA" (2008-2011) project (http://soteria-space.eu/). The time cadence of *SOHO/MDI-Debrecen Sunspot Data (SDD)* is ~ one observ./hour when Hourly Data Sets allow it. The set of images contains the Ic images with the nearest magnetograms selected after using quality-filters and time sequence criteria. The Ic images are enlarged (3x) so that the precision of fit of contours can be increased.

Gyula 1997.11.03 13:31:53

SOHO/MDI 1997.11.03 13:27:34

**Examples for ground-based Debrecen and space-borne MDI observations**
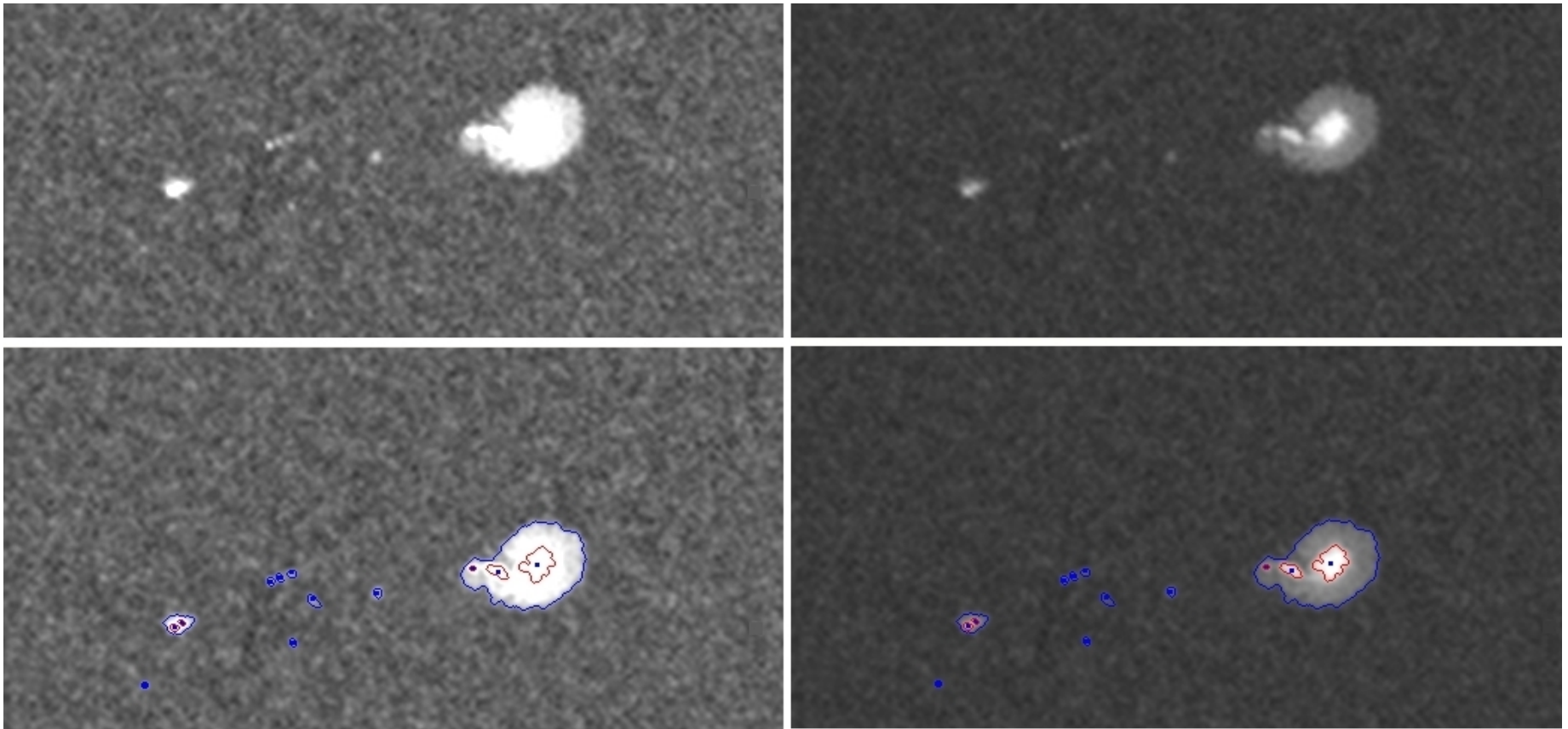
Examples for the contours of a group in a negative MDI Ic image with two
different brightness settings :

Upper panel: spots without contours - Lower panel: spots with contours

Left panel: the brightness is optimized to see the small spots and penumbra borders -
blue lines

Right panel: the brightness is optimized to see the umbra borders – red lines

Delta group from SDD and its magnetogram.
(http://fenyi.solarobs.unideb.hu)
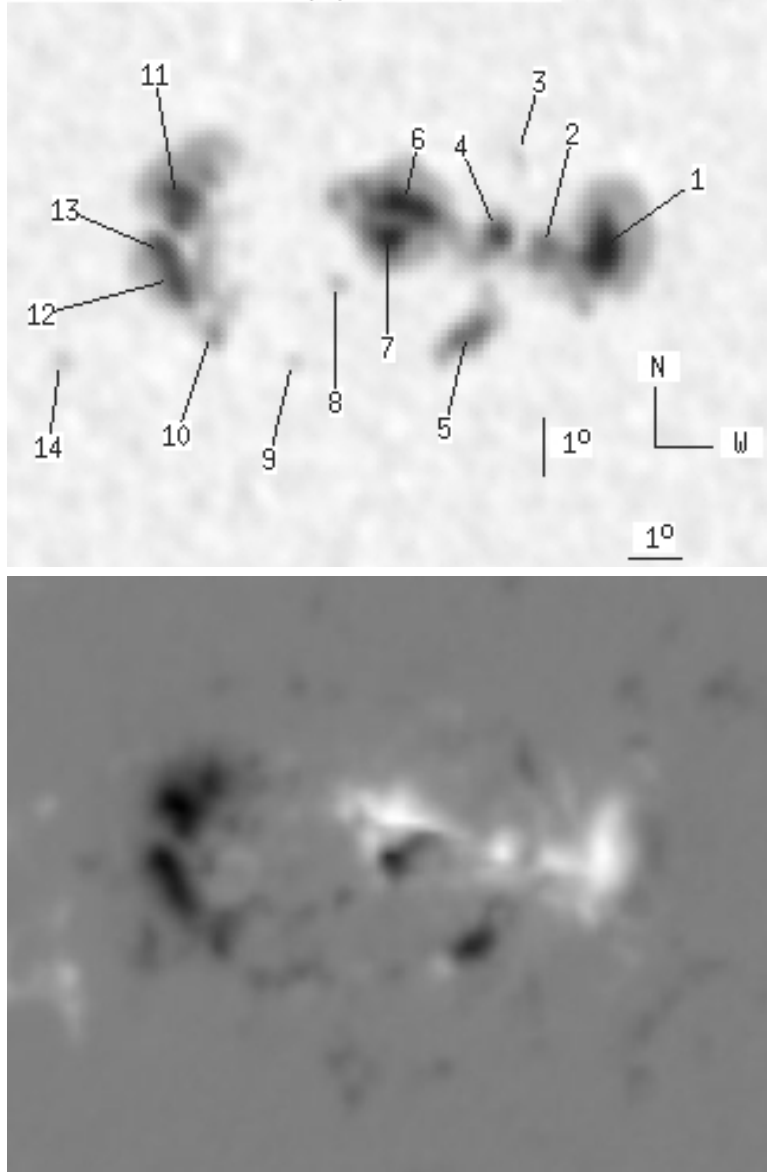
The **SDD** catalogue will contain the position and (umbral and whole) area data for each spot ordered into groups. The magnetograms enable us to add information about the magnetic field of sunspot umbrae and penumbrae which are averaged within the umbral and penumbral contours. Mean values of the line-of-sight magnetic field are published if intensity images and magnetograms are available within 50 min. The images of sunspot groups with the numbers of spots will be also published.

The same method will be used for the HMI images, and the same data products will be published in the frame of the present ESA-PECS project