Ground-based Solar Observations in the Space Instrumentation Era
ASP Conference Series, Vol. 504
Ivan Dorotovič, Catherine E. Fischer, and Manuela Temmer, eds.

Fast Solar Polarimeter: Prototype Characterization and First Results

F. A. Iglesias,[1] A. Feller,[1] N. Krishnappa,[1,2] and S. K. Solanki[1,3]

[1]*Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany;* iglesias@mps.mpg.de ; feller@mps.mpg.de solanki@mps.mpg.de

[2]*Indian Institute of Astrophysics, Koramangala Second Block, Bengaluru 560034, India;* nagarajuk@iiap.res.in

[3]*School of Space Research, Kyung Hee University, Yougin, Gyeonggi 446-701, Korea*

Abstract. Due to the differential and non-simultaneous nature of polarization measurements, seeing induced crosstalk (SIC) and seeing limited spatial resolution can easily counterbalance the benefits of solar imaging polarimetry from the ground. The development of instrumental techniques to treat these issues is necessary to fully exploit the next generation of large-aperture solar facilities, and maintain ground-based data at a competitive level with respect to its space-based counterpart. In particular, considering that many open questions in modern solar physics demand data with challenging specifications of resolution and polarimetric sensitivity that can only be achieved with large telescope apertures (Stenflo 1999).

Even if state-of-the-art adaptive optics systems greatly improve image quality, their limited correction —due to finite bandwidth, mode number and seeing anisoplanatism— produces large residual values of SIC (Krishnappa & Feller 2012). Dual beam polarimeters are commonly used to reduce SIC between the intensity and polarization signals, however, they cannot compensate for the SIC introduced between circular and linear polarization, which can be relevant for high-precision polarimetry.

It is known that fast modulation effectively reduces SIC, but the demodulation of the corresponding intensity signals imposes hard requirements on the frame rate of the associated cameras. One way to avoid a fast sensor, is to decouple the camera readout from the intensity demodulation step. This concept is the cornerstone of the very successful Zurich Imaging Polarimeter (ZIMPOL). Even though the ZIMPOL solution allows the detection of very faint signals ($\sim 10^{-5}$), its design is not suitable for high-spatial-resolution applications.

We are developing a polarimeter that focuses on both spatial resolution (<0.5 arcsec) and polarimetric sensitivity (10^{-4}). The prototype of this Fast Solar Polarimeter (FSP, see Feller et al. 2014), employs a high frame-rate (400 fps), low-noise (<4 e- RMS), pnCCD camera (Hartmann et al. 2006) that is read in synchronization with a polarization modulator based on ferroelectric liquid crystals. The modulator package is similar to the SOLIS (Keller et al. 2003) design and optimized to have an achromatic total polarimetric efficiency above 80 % in the 400-700 nm wavelength range. The fast modulation frequency of FSP, yielding up to 100 full-Stokes measurements per second, and high duty cycle (>95%), have the double benefit of reducing seeing induced artifacts and improving the final spatial resolution by providing an optimal regime for the application of post-facto image reconstruction techniques.

In this poster we describe the FSP prototype, including the characterization results, a technique to correct image smearing due to the sensor frame transfer (Iglesias

et al. 2015) and some of the first measurements obtained with the 68-cm Vacuum Tower Telescope located at the Observatorio del Teide, Spain.

References

Feller, A., Iglesias, F. A., Nagaraju, K., Solanki, S. K., & Ihle, S. 2014, in ASP Conference Series, vol. 498, 271

Hartmann, R., Buttler, W., Gorke, H., Herrmann, S., Holl, P., Meidinger, N., Soltau, H., & Strüder, L. 2006, Nuclear Instruments and Methods in Physics Research A, 568, 118

Iglesias, F. A., Feller, A., & Nagaraju, K. 2015, Appl.Optics, 54, 5970

Keller, C. U., Harvey, J. W., & the SOLIS Team 2003, in Solar polarization 3, vol. 307 of ASP Conference Series, 13

Krishnappa, N., & Feller, A. 2012, Appl.Optics, 51, 7953

Stenflo, J. 1999, in Polarization, edited by K. N. Nagendra, & J. O. Stenflo, vol. 243 of Astrophysics and Space Science Library, 1

Helena Desidério (ABREU-PCO) *and Dário Passos*