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Multi-frequency observations of the Sun using Upgraded Gauribidanur Radio Interferometric Polarimeter (U-GRIP)

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Direct estimates of the magnetic field strength (MF) in the solar atmosphere are currently limited to the inner corona, i.e., to a heliocentric radial distance, $r \leq 1.2\ R_{\odot}$ ($R_{\odot}$ = Photospheric radius). In the outer corona, i.e., $r \geq 3\ R_{\odot}$, Faraday rotation observations of microwave signals emitted by transmitters onboard artificial satellites and/or distant background cosmic sources that pass through the solar corona are used to derive the magnetic field strength. Compared to this, polarization measurements in the $1.2\ R_{\odot} \leq r \leq 3\ R_{\odot}$ (i.e., middle corona) are rare due to a lack of observational facilities. As the Photosphere, Chromosphere, and Corona are coupled by the solar MF, it is generally obtained by mathematical extrapolation of the observed line-of-sight component of the Photospheric magnetic field, assuming a Potential or Force-free model. Most low-frequency solar radio bursts originate in the middle corona, and their emission mechanism is due to plasma processes. Plasma emission in the presence of a MF is split into ordinary (O) and extraordinary (X) modes. As a result of the differential absorption of these two modes in the medium, a net degree of circular polarization (DCP) is observed. The latter is related to the strength of the MF in the source, which enables estimating the coronal MF using observations of polarized radio bursts [1]. Note that due to the decrease in the coronal electron density and hence the associated plasma frequency with increasing height in the solar atmosphere, the lower the observation frequency, the larger the corresponding radial distance. This makes observations with a broadband radio interferometric polarimeter useful because the MF can be obtained over a range of ‘r’ for the same observation in a near-simultaneous manner. The Indian Institute of Astrophysics (IIA) has commissioned the Gauribidanur Radio Interferometric Polarimeter (GRIP) for dedicated observations of the solar corona in the frequency range 30–130 MHz at the Gauribidanur Observatory [2]. Radio emission in this frequency range typically originates at $1.2\ R_{\odot} \leq r \leq 3\ R_{\odot}$ in the solar atmosphere. Until last year, the GRIP array carried out regular observations at two spot frequencies in the above-mentioned frequency range. We recently upgraded its analog front-end and digital backend systems to enhance its ability to observe and address various scientific problems. This has increased its time, frequency resolution, and sensitivity. The new digital backend is a ROACH FPGA board, which can help vary the data acquisition parameters depending on the science case. The presentation will describe the upgrade in the observational setup, calibration scheme, and first results.

1. G. A. Dulk, D.J. McLean, “Coronal magnetic fields”, *Sol Phys*, 57, 279–295, 1978, doi:10.1007/BF00160102.

2. R. Ramesh, C. Kathiravan, M. S. SundaraRajan, I. V. Barve, and C. V. Sastry, “A Low-Frequency (30 - 110 MHz) Antenna System for Observations of Polarized Radio Emission from the Solar Corona”, *Solar Physics*, vol. 253, no. 1–2, pp. 319–327, 2008. doi:10.1007/s11207-008-9272-y.