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A Prototype Antenna Feed for Observations at Decimeter and Meter Wavelengths

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The objective of this work is to develop a prototype broadband antenna that can be used for observing the solar corona and other astronomical sources in the 200–600 MHz band. In the case of the solar corona, this frequency range corresponds to a heliocentric height range of ~1.01-1.30 solar radii. Observations of the solar corona above the limb in the above distance range is one of the primary goals of the ADITYA-L1, the first Indian space solar mission. This height range is of interest since the transient energy and mass releases such as the flares, coronal mass ejections and the associated radio bursts originate there. Observations of the solar corona above the solar limb as well as the solar disk are possible in radio observations since there is no occulting disk as in white light coronagraph observations. In the case of non-solar targets, the above frequency is well suited for observations of the Fast Radio Bursts (FRBs) and other transients. The Log Periodic Dipole Antenna (LPDA) is chosen as the feed because it has broadband, directional and uniform characteristics over its operating bandwidth compared as to other broadband antennas [1]. Additionally, the antenna is fitted with a rotor system with minimal radio frequency interference (< -100 dBm) in order to track the Sun in both hour angle and declination. The tracking increases the observing duration to ~9 hours. It also helps to achieve uniform antenna gain as a function of frequency throughout the observing time period as compared to a stationary zenith pointing system where the observed signal amplitude would vary as a function of the direction. Further, the tracking system helps to compare the solar emission at different frequencies within the operating bandwidth, and at different times within the observation period. To facilitate tracking with good mechanical stability, the dimensions of the LPDA were optimized to have minimum weight without compromising the antenna gain; the structure was fabricated using aluminium; the maximum dimension of the LPDA is ≤1 meter and its weight is ≈1 kg. Following the studies carried out at the Gauribidanur Radio Observatory, uniform dipole length to diameter ratio (~80) was maintained and the spacing between the transmission lines of the LPDA were varied from ~2mm at its apex to ~31mm at its lower end. Although a dish antenna with feed horn has a larger collecting area and better sensitivity, the gain varies over the operating bandwidth and the return loss is also higher [1]. The performance of this new system (in the stand-alone receiving element mode at present) is better than a dish antenna feed in terms of uniform gain and return loss over the designed operating bandwidth of 200 - 600 MHz. Figure 1 shows the antenna gain variations of our system with the antenna system reported in [1]. Figure 2 shows similar plot for the return loss. The LPDA designed & fabricated in-house has uniform gain (~7.5dBi), nearly-constant impedance (50Ω), constant radiation pattern (64°×115°), effective aperture ($0.6\lambda^2$) etc., throughout the operating bandwidth. Commercial DiSEqC Stab HH-100 rotor and controllers (one for hour angle and other for declination) are presently used to track the Sun. Considering the possibility to mount our new LPDA as a feed element for a dish antenna too, observations of non-solar sources are also feasible.

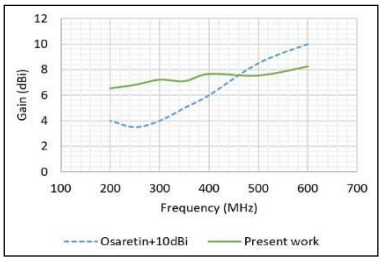

Figure 1. Antenna gain vs Frequency for the feed horn (Osaretin) mentioned in Ref. [1] & our LPDA

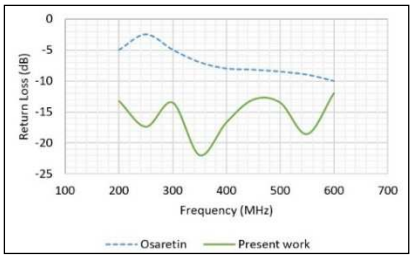

Figure 2. Return loss vs Frequency for the feed horn (Osaretin) mentioned in Ref. [1] & our LPD

1. I. A. Osaretin, A. Torres and C. Chen, "A Novel Compact Dual-Linear Polarized UWB Antenna for VHF/UHF Applications," in *IEEE Antennas and Wireless Propagation Letters*, January 2009, vol. 8, pp. 145-148, doi: 10.1109/LAWP.2009.2012881.