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Dual Ring Feed 130-260 MHz for the upgraded GMRT

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Abstract : This paper describes the ongoing development of next generation wideband feed for the upgraded GMRT. The new broadband feed covered in this paper is dual ring feed for 130-260 MHz. Design techniques and performance results for these are described.

1. Introduction

The Giant Metrewave Radio Telescope (GMRT) is an international facility for Radio Astronomy, operational since 2002. Located near Pune in western India, the GMRT consists of 30 fully steerable parabolic dishes, each of 45 m diameter, spread over an area with an effective radius of about 15 km. It operates in 5 distinct bands covering frequencies in the range of 50 MHz to 1420 MHz. Though meant primarily as an aperture synthesis instrument, antenna arrays can be formed out of the 30 dishes, where separate sub-arrays can work on different frequency bands concurrently.

The GMRT has prime-focus feeds at four faces of a rotating turret, covering frequency bands at 150, 233, 327, 610 & 1420 MHz (one turret face houses a dual frequency feed operating at 233 & 610 MHz), with relatively modest bandwidths of a few tens of MHz, except for the 1420 feed that covers 1000 to 1450 MHz. Currently, the GMRT is going through an upgrade to provide seamless frequency coverage from 50 to 1500 MHz, with a maximum instantaneous bandwidth of 400 MHz for increased sensitivity. For this, new broadband feeds are being designed with octave bandwidths.

2. Dual Ring Feed 130-260MHz for the upgraded GMRT

The existing feeds in use at the GMRT for (i) 150MHz band, consists of a pair of thick folded dipoles over a ground plane. It gives good VSWR over the frequency band 130-230 MHz, with an edge taper of -9dB, and a cross-polar of -17 dB. However, good match of E & H plane patterns and acceptable beamshape are obtained only over a narrower range of 130-150 MHz. (ii) 233MHz band, 610/233MHz dual co-axial feed. It has very narrow VSWR over the frequency band 225-245 MHz, with an edge taper of -9.8 dB and a cross-polar of -22.8 dB.

As part of the ongoing upgrade of the GMRT, the plan is to provide seamless frequency coverage from 50 MHz to 1500MHz. To cover this range efficiently, the following wideband feeds (octave or more bandwidth) are being designed (using the WiPLD software): 130-260 MHz, 250-500 MHz and 500-1000 MHz.

For 130-260 MHz coverage, the basic design of the Kildal Feed (dipole-disk feed) is being adopted, with the following design changes: (i) triple sleeved cross dipoles for larger BW (ii) provision of 2 beam-forming rings for better polarization features over a larger BW and (iii) an optimized reflector design. The prototype version of this feed covers 138-279 MHz, and is quite promising. , the prototype feed that has been designed and tested and the test results indicate a BW ratio of 1:1.8 for a return-loss of -10 dB or less (figure 2), with good pattern symmetry and fairly good match of E and H plane patterns (on the primary lobe, especially within the angular spread of -62.5 to + 62.5 deg., being the edge-angle of the GMRT's parabolic dish) over 130 to 260 MHz (figure 3).

Figure 1: photo of feed

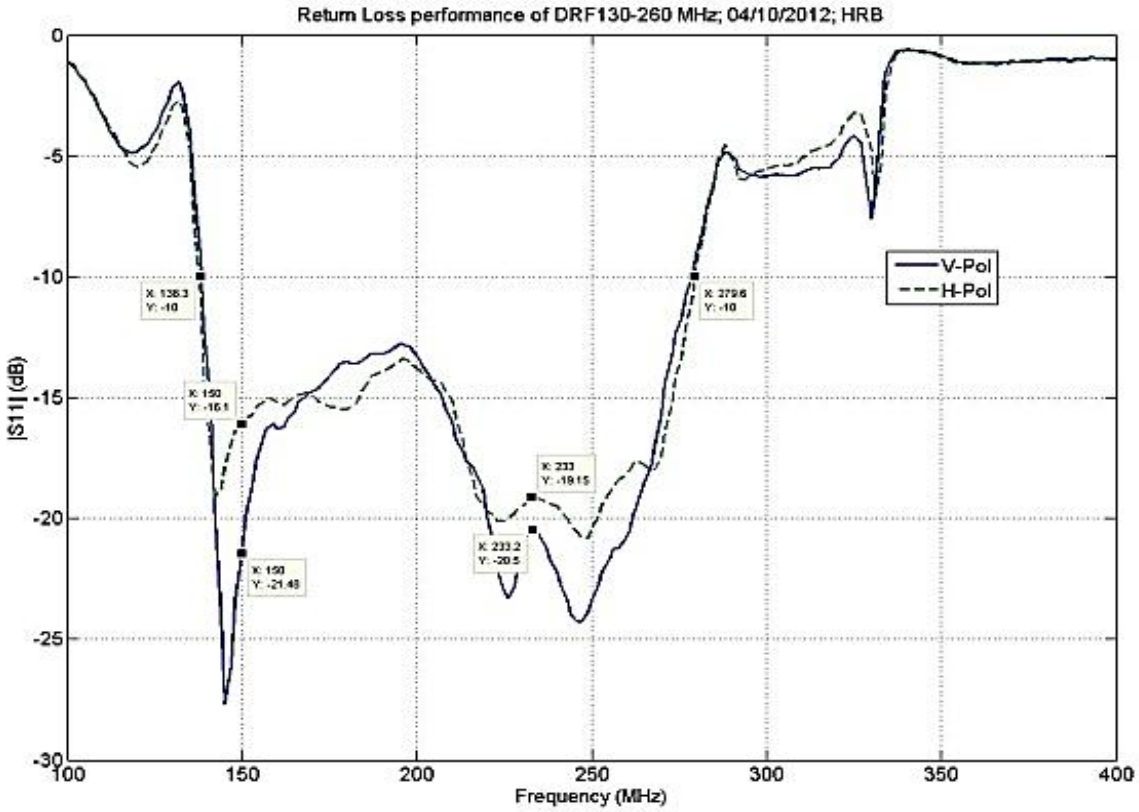

Figure 2: measured Return Loss response

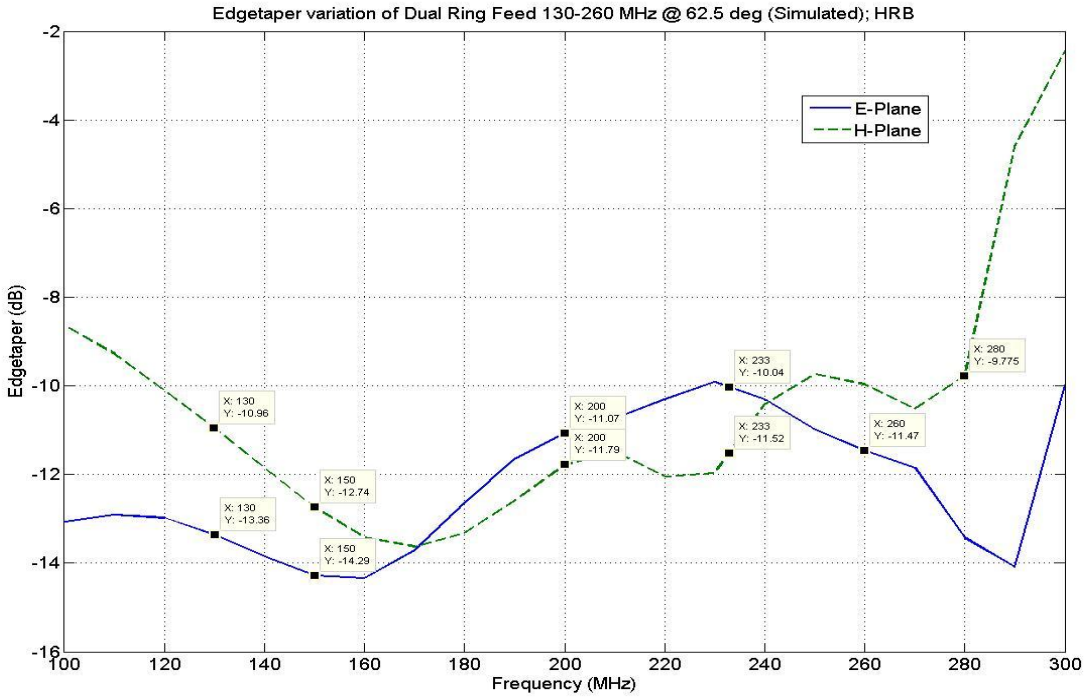

Figure 3: Edgetaper response (Simulated; Wipl-D software)

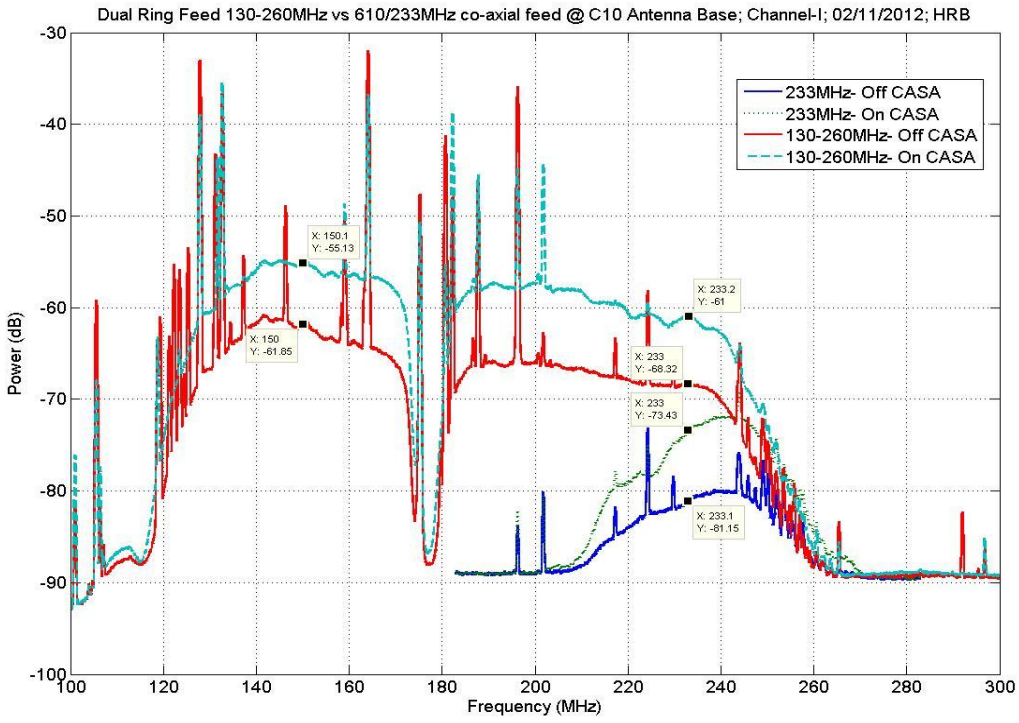

Figure 4: Deflection tests on calibrator (Cas-A) RF Channel-I; the narrower curves are for the existing narrow band 235 MHz feed @ C10 Antenna Base.

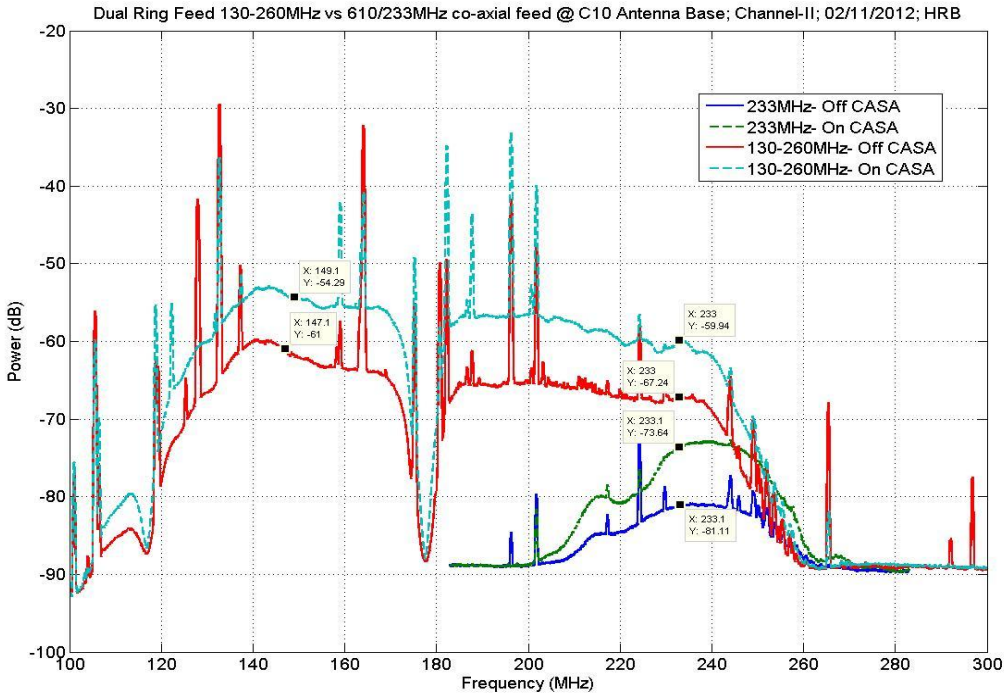

Figure 5: Deflection tests on calibrator (Cas-A) RF Channel-II; the narrower curves are for the existing narrow band 235 MHz feed @ C10 Antenna Base.

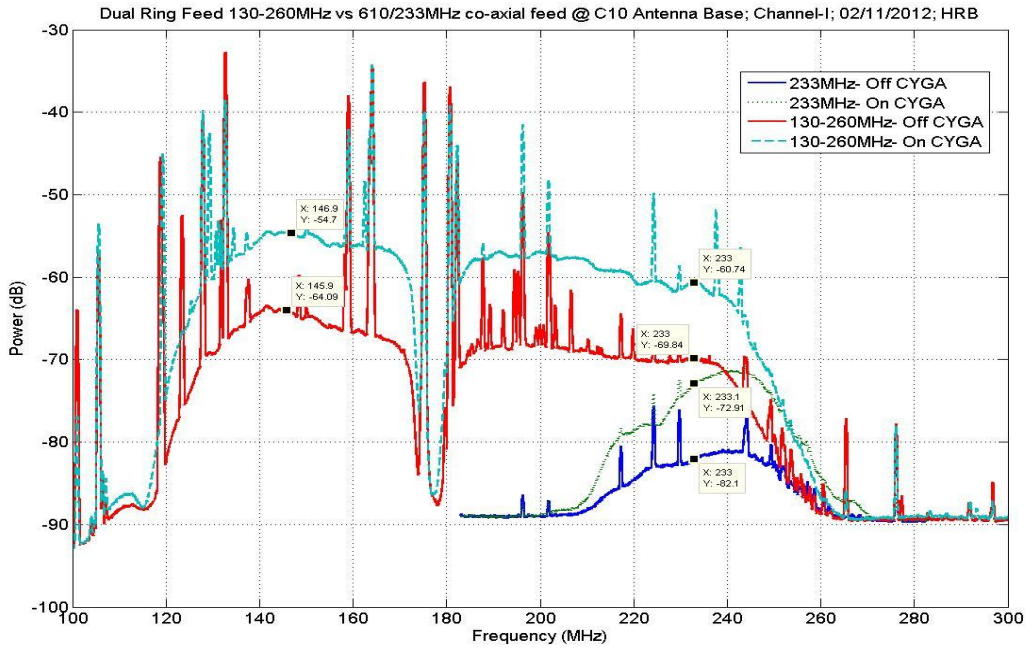

Figure 6: Deflection tests on calibrator (Cyg-A) RF Channel-I; the narrower curves are for the existing narrow band 235 MHz feed @ C10 Antenna Base.

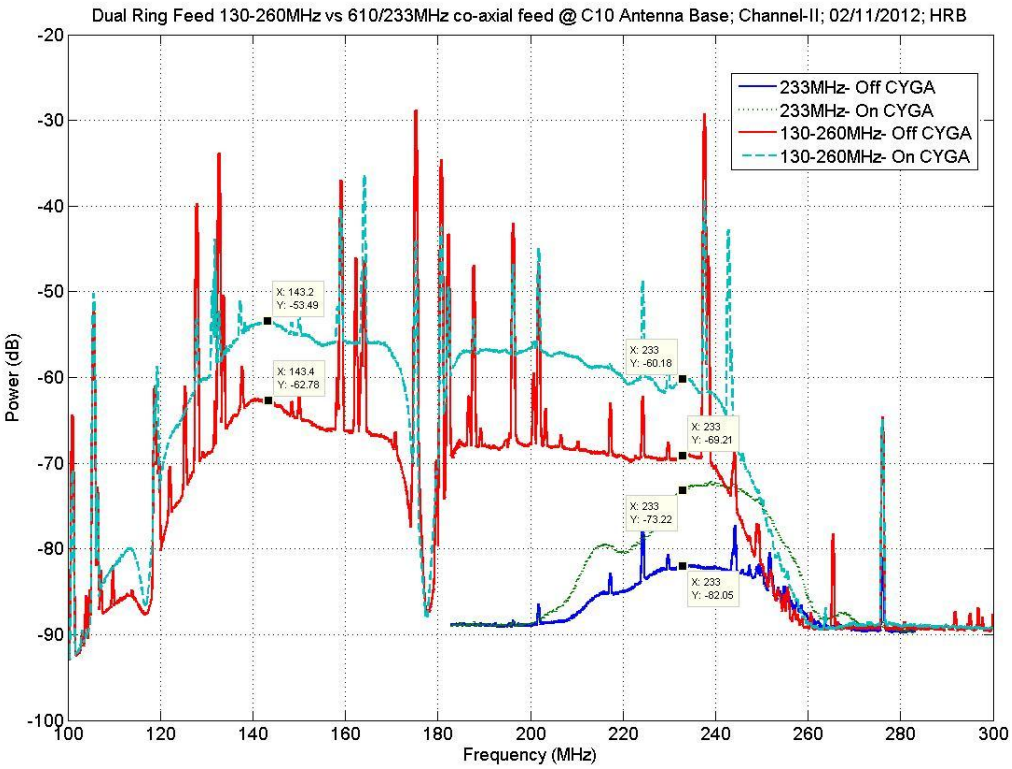

Figure 7: Deflection tests on calibrator (Cyg-A) RF Channel-II; the narrower curves are for the existing narrow band 235 MHz feed @ C10 Antenna Base.

3. Conclusion and future work:

Dual Ring Feed 130-260MHz covers both the astronomical bands (150MHz & 233MHz) based on the return loss and sensitivity performances. Sensitivity at astronomical band (i) 150MHz is more when compared with existing 150MHz feed since it eliminates the additional cable losses and the insertion loss of power combiner (used to combine the power from a pair of folded dipole in the existing system) and (ii) 233MHz is exactly the same as the existing 233 MHz feed. Additional mechanical strength is needed for the dipole 130-260MHz which is being employed in the 2nd prototype. After extensive tests of prototypes on GMRT antennas (Figure 4, 5, 6 & 7), this feed may accept for mass production.

4. Acknowledgements

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