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# Initial design and analysis of 15–29 GHz feed system for SKA Band 6

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The Square Kilometre Array (SKA) is an ambitious international project aiming at building two telescopes for the next generation radio astronomy: the SKA-Mid in South Africa operating at 0.35–15.4 GHz and the SKA Low Telescope in Australia operating at 50–350 MHz. The first phase of SKA-Mid (called SKA1-Mid) includes an array of 197 dish antennas incorporating the recently completed MeerKAT dishes to cover the frequency range of 350 MHz to 15.4 GHz. SKA-Mid has six receivers with different radio frequency (RF) bands, and each receiver has been developed. The SKA1-MiD construction commenced in July 2021. The total observational bandwidth is segmented into six bands (Band 1, 2, 3, 4, 5a and 5b). The Band 6 receiver is an additional higher-frequency receiver for the next phase. Its RF coverage is currently 15–24 GHz and is expected to be up to 30 GHz or higher.

We have made an initial study of a 15–29 GHz feed system for SKA Band 6. The SKA-Mid antenna is a 15 m shaped Gregorian offset reflector antenna and the subtended angle from the feed is 58 degrees (Figure 1). A feed horn is required to radiate beams with constant beam widths, phase center positions, and low cross-polarization levels without frequency dependence to contribute to achieve high aperture efficiencies over the whole band. We adopted an axially-corrugated horn with eight grooves and a turnstile orthomode transducer (OMT) as a dual-polarization feed system. For the horn, we have optimized the basic structure and the grooves to achieve the high return loss and the high aperture efficiency by electromagnetic simulations. We also have optimized the OMT in terms of the impedance matching with the horn. The simulation of the combination of them showed above 19 dB of return loss and 72 % of aperture efficiencies between 15.4–29 GHz can be achieved. Furthermore, we investigated the beam squint of the system composed of the optics, horn and OMT. At frequencies lower than $\sim$25 GHz, the squint was less than 0.5% of the beam size, while from $\sim$25 GHz the squint increased and the squint of 1.5% was observed at 29 GHz. As reported in [1], the higher-order modes in the circular waveguide caused by the OMT may account for this phenomenon. Finally, we have estimated the sensitivity, $A_{eff}/T_{sys}$, to be $\sim$3–6 $m^2/K$.

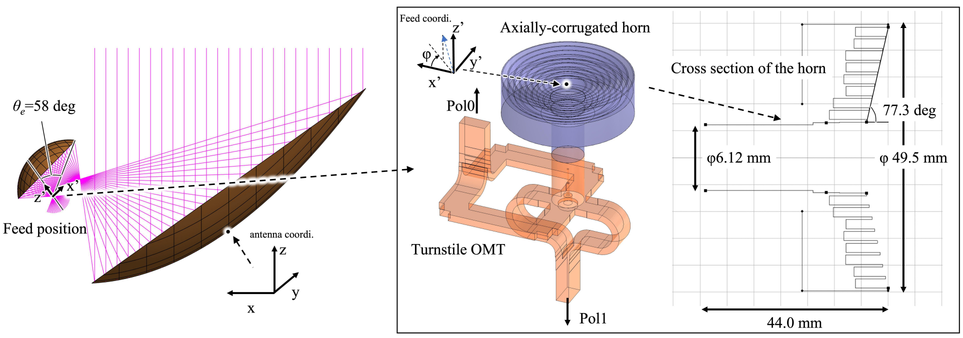


**Figure 1.** CAD drawing of the optics (left), the corrugated horn, and the orthomode transducer (right).

## References

[1] M. S. de Villiers, M. Venter and A. Peens-Hough, "The Effect of the OMT in Electromagnetic Simulations of MeerKAT Primary Beams," in IEEE Trans. Antennas Propag., vol. 69, no. 10, pp. 6333-6339, Oct. 2021