V127b Initial study of 15–29 GHz optics and receiver system for SKA Band 6

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SKA project is constructing 50–350 MHz SKA Low in Australia and 0.35–15.4 GHz SKA Mid in South Africa under international cooperation, and the first phase construction (SKA1 project) started in July 2021. The band 6 receiver is an additional higher frequency receiver for the next phase, and its RF coverage is currently 15–24 GHz, but expected to be up to 30 GHz or higher on a best-effort basis.

SKA Mid antenna is a kind of offset Gregorian, and the subtended angle from the feed horn to the sub-reflector is 58 degrees. A feed horn is required to radiate beams with constant beam widths, phase center positions, and low cross-polarization levels without frequency dependence to achieve high aperture efficiencies over the whole band. We adopted an axial corrugated horn because of its simple structure, superior beam characteristics and easy fabrication. By optimizing the horn parameters, we achieved above 70 % of aperture efficiencies between 15–29 GHz.

We have designed a dual-polarization receiver system based on a commercially available cryogenic LNA (CLNA) and a turnstile OMT. The simulation study shows that the design with the greater than 20 dB in return loss is feasible (Chinen et al. 2022, ASJ, spring). The receiver noise temperature of less than 14 K with the OMT and a CLNA in the expected environment in the cryostat ($\sim$ 10 K) can be achievable.