Latest performance prediction of the single pixel feeds for the SKA1-mid array

Isak P. Theron^{* (1)}, Robert Lehmensiek⁽¹⁾ (1) EMSS Antennas, 18 Techno Ave, Stellenbosch, South Africa, iptheron@emss.co.za

The SKA1-mid array will consist of 133 offset Gregorian dishes with 15 m effective diameter build in the Karoo region of South Africa. These will work in conjunction with the 64 MeerKAT antennas. Phase 1 will use five frequency bands: a 3:1 wideband feed from 350 MHz to 1050 MHz, three 60% bandwidth feeds from 950 MHz to 1760 MHz, 1.65 GHz to 3.05 GHz and 2.8 GHz to 5.18 GHz respectively, and another 3:1 feed from 4.6 GHz to 13.8 GHz.

The most important performance parameter is the receiving sensitivity which is proportional to the effective aperture area and inversely proportional to the system noise temperature. The dual offset optics is shaped for maximum sensitivity rather than to keep sidelobes down. An extension at the bottom of the sub-reflector allows achieving a high aperture efficiency without compromising the spill-over noise when tipping the feed towards the ground, i.e. when pointing the beam to lower elevation. This allows better sensitivity for a given cost in the lower frequency bands than when the feed is moved upwards to point the beam at low elevation. In addition, special emphasis is placed on minimizing the system noise temperature. This requires controlling the loss and using Gifford-McMahon cryogenic cooling to temperatures below 20 K.

Using a wider frequency band in Band 1, reduces the total feed volume. It does, however, compromise performance as the size implies that it is not possible to cool the entire feed and the wideband structure (a quad-ridge feed horn) does not lend itself to having a thermal break inside the feed. Hence only the low noise amplifiers (LNAs) are cooled.

For Bands 2, 3 and 4 both the LNAs and the ortho-mode transducers (OMTs) are cooled. This lead to optimum sensitivity in these bands.