

Mid-Frequency Aperture Array for the Square Kilometre Array

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The Square Kilometre Array, SKA, is the next generation low frequency radio telescope to be constructed in Australia and South Africa. It will be deployed in two phases. SKA phase 1 has a large low frequency sparse aperture array, LFAA, operating over 50-650MHz using log periodic antennas. The implementation of the full SKA will include aperture arrays operating from 50MHz up to 1.45GHz. The development of the mid-frequency aperture array system, MFAA, is for deployment in the full SKA, which will commence in the mid 2020s. The MFAA will operate from 300MHz to above the rest emission line of neutral hydrogen at 1.421GHz and is likely to also use a log periodic antenna. To achieve the necessary sensitivity for SKA requires approximately 8 million antennas. Much of the work in LFAA for calibration, signal processing techniques and control can be applied to MFAA.

Signal transport using multi-wavelength analogue optical fibre brings a signal from each polarization over many kilometres from all the antennas into a processing facility. The processing architecture of MFAA enables the whole array to be treated as a software defined aperture, dynamically specifying station size for beamforming; extent of apodisation for well formed beams; capability of forming beams of a constant size as a function of frequency etc. Processing can be conducted as simple beamforming of groups of antennas combined as stations or by more advanced processing structures.

The SKA was originally conceived to observe neutral hydrogen throughout the known universe at high sensitivity and field of view enabling very high survey speeds. This can be achieved by achieved with a phased arrays using MFAA in combination with LFAA.