Low-noise receivers for Mid Frequency Aperture Arrays and their developments

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Extended Abstract

This paper presents the progress in the development of low-noise receivers for radio astronomy Mid-Frequency Aperture Arrays (MFAA). To continue discoveries in astronomy, continual introduction of new technology is required, since just refining or scaling up existing technology soon plateaus out. MFAA is the technology of choice at frequencies below 1.5 GHz. An MFAA based radio telescope is based on the concept of phased arrays, which are being used widely in radar, communication and positioning systems. An MFAA telescope consists of many small stationary antenna elements. Each antenna element is receiving signals from the entire visible sky. By electronically combining the responses of the individual elements, beams can be formed. The multi-beaming, wide field of view and fast pointing capabilities of aperture arrays provide a very flexible system with many new capabilities and modes of operation compared to existing dish-based instruments [1].

MFAA technology development has been steadily progressing over the last decade. Key technology challenges for MFAA are the reduction of receiver noise, power consumption, capital and operational costs. In all these areas, major progress has been recorded. For example, the capital costs and power consumption of antenna tiles have been reduced 2 – 4 times over the last 5 years, while at the same time the system temperature was reduced.

MFAA technology has been demonstrated up to a sub-station level, i.e. arrays of about 100 m^2. A consortium of universities, institutes and industry has strong aspirations towards realizing MFAA science demonstrator [2] of ~2000 m^2 at the Square Kilometer Array (SKA) site in South Africa, co-located with MeerKAT and SKA1-Mid. It will be a first MFAA station on the SKA site and the effort can be gradually expanded as a major component of SKA Phase 2.

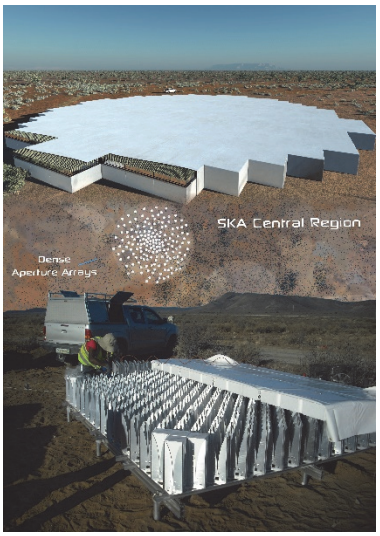

Figure 1. Artist impression of an MFAA based radio telescope (top) and a tile of MFAA antenne elements (bottom).

4. References

1. S.A. Torchinsky, J.W. Broderick, A. Gunst, A.J. Faulkner, W. van Cappellen, "SKA Aperture Array Mid Frequency Science Requirements", arXiv:1610.00683 [astro-ph.IM].

2. W.A. van Cappellen, et al., "MANTIS: The Mid-Frequency Aperture Array Transient and Intensity-Mapping System", arXiv:1612.07917 [astro-ph.IM].