SKA Low Frequency Aperture Array

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Abstract

The Square Kilometre Array, SKA is the next generation low frequency radio telescope and is described on its website [1]. The work performed in the European funded FP6 programme, SKA Design Studies, SKADS, [2] showed that an implementation of the SKA using phased aperture arrays, AAs, operating from 50MHz up to 1.4GHz with a dish based array covering ~1.2GHz to 10GHz represents the most capable design for the agreed SKA Phase 2 science case [3].

The deployment of the SKA starts with a ~10% instrument, Phase 1, commencing construction in 2018. This includes a low frequency sparse AA covering 50MHz to at least 350MHz. The development of the more technically challenging mid-frequency AA system will continue in parallel, preparing for deployment in SKA Phase 2 commencing in the mid 2020's. This schedule enables SKA Phase 1 to benefit from the experience gained with current low frequency AAs, LOFAR [4] and MWA [5] systems, followed by the more difficult higher frequency AA in Phase 2.

A very large phased array, the Low Frequency AA, LFAA, will be deployed in only a few years time. The LFAA, illustrated in Figure 1, covers the lowest frequency band for the SKA, from 50MHz up to 350MHz as described in the SKA Baseline Design or, as proposed up to ~650MHz. This is an aperture array consisting of ~131,000 (2^{17}) wide bandwidth antennas. The configuration will be very close packed with 95% of the antennas within a 3km radius core and the remaining collecting area situated on three spiral arms, extending out to a radius of 45km to enable higher spatial resolution observations. The overall system is organized as logical stations constituting correlatable entities. The signal processing design is to support 512 stations of ~35m diameter.

The large bandwidths and low noise temperature levels required are a challenging requirement for a receiving antenna [6] with a 13:1 frequency range, well matched to a very low noise amplifier, ability to deploy quickly and cheaply, minimal self-induced radio frequency interference and able to withstand the harsh conditions of the Western Australia desert for decades.

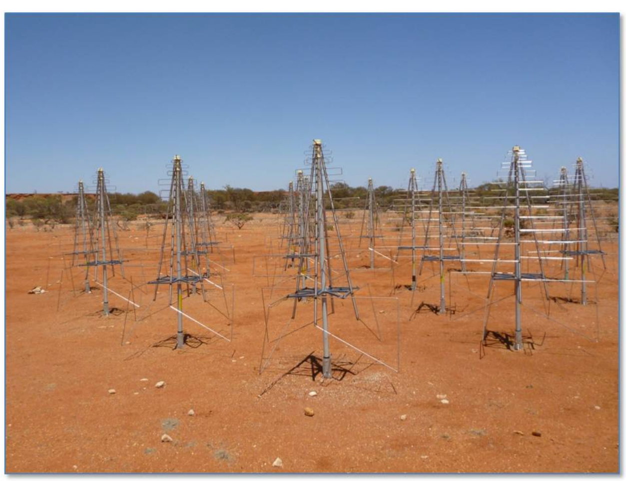

Figure 1: SKA-low test array on the SKA site

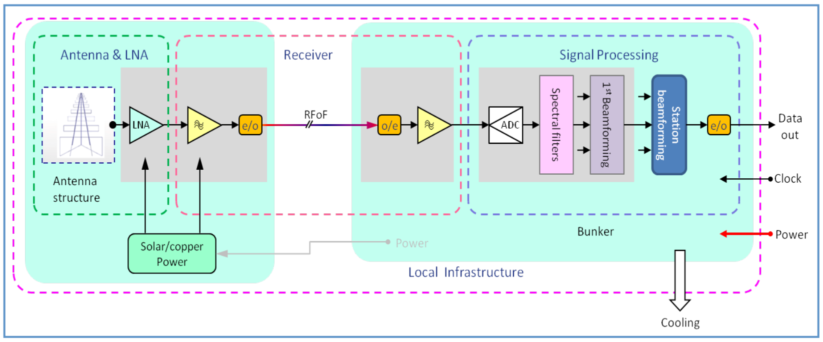

Figure 2: Signal flow for LFAA

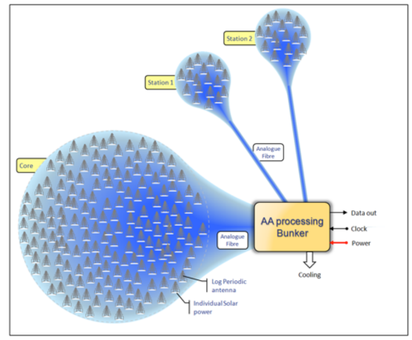

Figure 3: LFAA overall topology

1. *"The SKA telescope project"*, www.skatelescope.org.

2. *"Square Kilometre Array Design Studies, SKADS"*, www.skads-eu.org

3. A. J. Faulkner et al., *"SKA Memo 122: Aperture Arrays for the SKA - the SKADS White Paper"*, 2010

4. M. de Vos, A. W. Gunst, R. Nijboer, "The LOFAR Telescope: System Architecture and Signal Processing", *Proceedings of the IEEE, Vol. 97*, No. 8, August 2009

5. C. J. Lonsdale et.al., "The Murchison Widefield Array: Design Overview", *Proceedings of the IEEE*, Vol. 97, No. 8, August 2009

6. E. de Lera Acedo, N. Razavi-Ghods, N. Troop, N. Drought and A. J. Faulkner, "SKALA, a log-periodic array antenna for the SKA-low instrument: design, simulations, tests and system considerations," Experimental Astronomy 07/2015. DOI: 10.1007/s10686-015-9439-0