Chequerboard Phased Array Feed Testing for ASKAP

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ABSTRACT

We will present recent test results of a prototype chequerboard array and describe how the knowledge gained is being applied to the development of phased array feeds for the Australian Square Kilometre Array Pathfinder (ASKAP) with a target system–temperature–on–efficiency $T/\eta$ of 50 K.

ASKAP will deliver high survey speed by processing up to 37 simultaneous beams from 94 port × 2 polarisation phased array feeds on 36 parabolic reflectors of 12 m diameter. Surveys of unprecedented sensitivity made by ASKAP, and its northern hemisphere counterpart Apertif, will improve understanding of galaxy formation and evolution. Building ASKAP will generate cost and performance information necessary to wisely design the Square Kilometre Array.

We have tested a prototype 5 × 4 port × 2 polarisation chequerboard array at the primary focus of a 12 m diameter dish. It currently achieves $T/\eta$ of 134 K at 1260 MHz and operates from 700 MHz to 1,800 MHz. Hot/cold load (Y–factor) measurements of the 5 × 4 × 2 array, operating as an aperture tile, suggest that $T/\eta$ of 80 K should be achieved for this prototype by improving integration of the array with its supporting electronics and the parabolic antenna. The highest Y–factor, measured for a beam formed on the hot absorber indicates a system temperature $T$ of approximately 60 K at 1,100 MHz.

Investigation continues to identify issues that may be addressed to improve performance. Electromagnetic simulations show that blockage and reflection, from the array and its support structure, can account for some of the performance discrepancy between operation as a phased array feed and as an aperture tile. Comparing measured and simulated noise covariance matrices for the array identified a stray additive contribution that is coherent across all ports. This has been causing an unwanted correlation of order 7% between ports. The downconversion system will be modified to remove this unwanted correlation.