Low Noise Tile Development for Radio Astronomy Application

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Aperture array technology is one of the possible technologies for the mid frequency range of the SKA, from 500 to 1500 MHz. Showing 50 K system noise temperature in the 1-1.5 GHz frequency range, aperture arrays have proven to be a feasible option for the SKA, but further lowering of the array noise temperature down to 40 K is essential to achieve the SKA sensitivity requirement at affordable cost. The aim of our LNT (Low Noise Tile) project is to improve the array sensitivity using commercially available devices and to extend the frequency range down to 500 MHz.

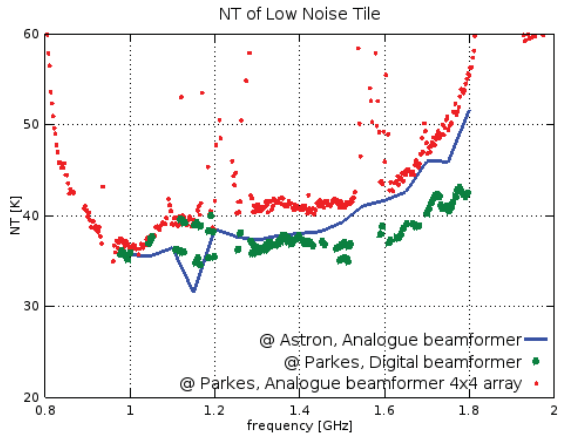

Fig. 1 Comparison of measurement results at Parkes and Dwingeloo

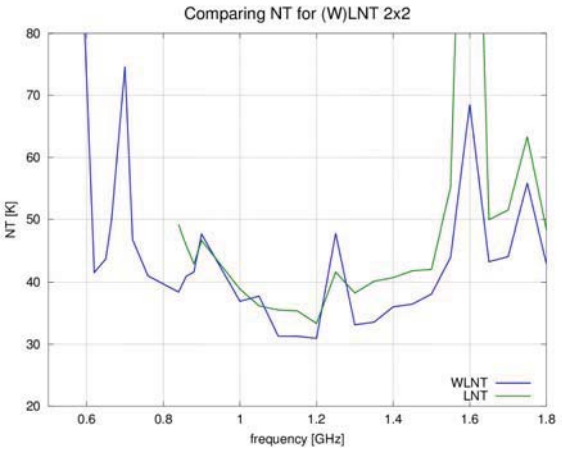

Fig. 2 Comparison of LNT and WLNT results

Initial results: The LNT elements have been tested extensively in our outdoor test facility THACO (see results presented at ICEAA 2014), using analog beam forming. The Medium Sized Tile, a dual polarized 5x6 element Vivaldi array, was then shipped to Parkes (AU) to take part in the PAF Comparison Campaign of the SKA Dish consortium. The array was measured using the Australian digital backend and beam former. We also measured the array with our analog beam former using 4x4 elements. Fig. 1 shows the results measured in THACO, compared to the Parkes results. The latter confirmed the previous measurement in Dwingeloo, showing array noise temperatures below 40K over the 1-1.5 GHz frequency band, with a minimum value of 35 K.

Bandwidth extension: The original LNT elements were redesigned to meet the 500-1500 MHz bandwidth specification for the SKA Mid Frequency Aperture Array. Four prototypes of these wideband (W)LNT elements have been measured in THACO in a 2x2 array and the results were compared to the LNT results. The most important difference between the two designs is the high pass filter in the LNT that removes the RFI signals below 1 GHz. Due to the amount of RFI it is only possible to do noise measurements at a limited number of frequencies below 1 GHz. Fig. 2 shows that the WLNT has lower noise than the LNT, extending at frequencies below 1 GHz, giving noise temperatures down to 45 K at 600 MHz. For better performance at even lower frequencies, the next step in the development will be the design of a new antenna element, optimized for better sensitivity and noise match at frequencies down to 500 MHz.