Interference Cancellation and Sensitivity Optimization using an L-Band Focal Plane Array on the Green Bank 20m Telescope

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A fully-sampled, electrically small focal plane array (FPA) was installed on the 20 meter telescope at the Green Bank NRAO facility during the summer of 2007 to demonstrate adaptive beamforming for sensitivity optimization and interference mitigation in Radio Astronomy. As seen in Figure 1, the array consists of 19 single-polarization linear dipoles, 0.25λ above a ground plane, spaced 0.6λ from each other in a hexagonal grid, and tuned to 1600 MHz. A separate 3.6m antenna is used as a reference antenna to collect a high-gain copy of interference needed in some modes of interference cancellation. The 3.6m signal is transmitted via optical fiber to the receiver backend in the 20m pedestal, where it and the 19 FPA channels are synchronously sampled and streamed to disk, preserving phase information for digital beamforming in post-processing. Off-the-shelf room-temperature LNA's are used throughout.

Preliminary characterization of the FPA beampattern was done on the Green Bank antenna test range. H and E-plane response cuts were collected for all elements in both open-circuit and terminated configurations. Figure 2 presents center element power vs. normalized angle and shows that mutual coupling changes the individual element patterns from the typical isolated dipole half-cosine response to a more complex structure. Measured E-plane response matches the major structural features of our detailed numerical model. Measured responses will be used in accurate mathematical modeling of the combined FPA /reflector telescope for detailed studies of gain, spillover, and aperture efficiency.

Operational experiments will be performed in November 2007 on the 20m telescope to demonstrate several benefits of active array processing in radio astronomy. Adaptive cancellation of signals from GPS and GLONASS satellites and other local interference will be performed while observing deep space objects. The negative effects of pattern rumble introduced by adaptive beamforming will be quantified, and our recently developed algorithms to stabilize these pattern variations will be evaluated. Adaptive array processing methods will also be studied for gain and sensitivity optimization to exploit the changing spillover noise scene as the dish moves in elevation.

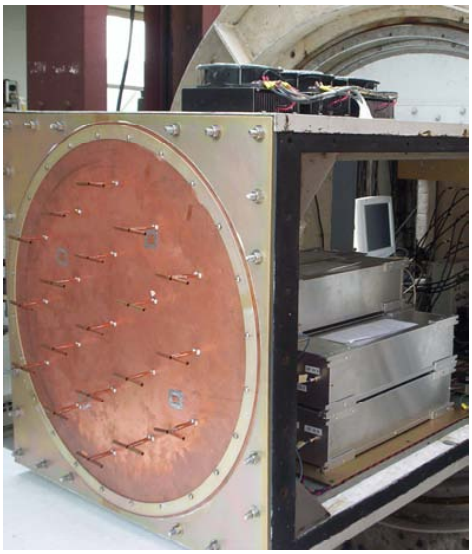

Figure 1. The 19 element array in the 20m front-end box prior to mounting.

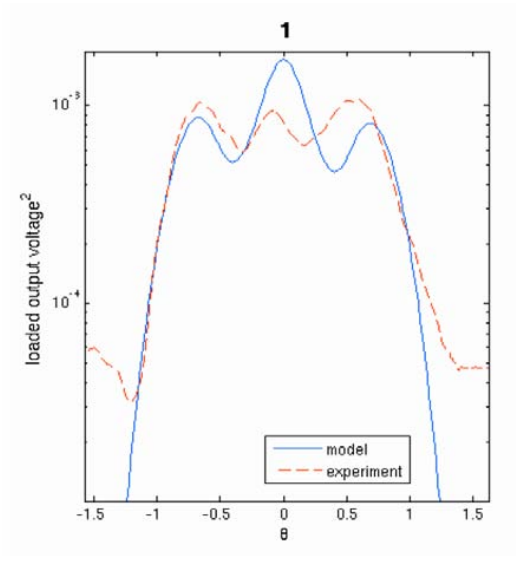

Figure 2. Measured and simulated coupled array response vs. angle for the center element.