Prototype Platform for Array Feed Development

James R. Nagel*, Micah A. Lillrose, Karl F. Warnick, and Brian D. Jeffs
ECE Dept., Brigham Young University, Provo, UT 84602 USA

Radio frequency interference (RFI) is a fast-growing problem for the radio astronomy community. Protected research bands and radio quiet zones are steadily encroached upon by cellular phones, radar systems, and orbiting satellites. Existing methods for mitigating RFI include time and frequency domain blanking and adaptive cancellation. In previous work, our research group has demonstrated through numerical simulations that arrays of electrically small elements allow for RFI suppression via spatial nulling when used as a feed for a large reflector antenna. Array feeds may also offer other advantages over traditional feeds, including improved sensitivity and aperture efficiency, as well as electronic beam steering for rapid sky surveys.

The goal of our current research is to demonstrate the array feed approach to interference mitigation in hardware. Initial characterization of a seven element L-band prototype array feed was done at the outdoor antenna range of the National Radio Astronomy Observatory facility in Green Bank, WV. Beamforming and calibration studies have been performed using this data in post-processing. More recently, we have built a development platform consisting of an expandable eight-channel low noise microwave receiver with a two-stage mix down, baseband subsampling data acquisition, and simultaneous data streaming to disk storage for all channels.

With a bare array and no reflector, beamformer weights can be chosen to attenuate an interfering signal by over 34 dB at a cost of 0.3 dB loss in signal gain. We are investigating the use of more sophisticated signal processing algorithms to improve system performance and practicality. We are also studying array pattern and system gain calibration methods, and performing on-reflector interference mitigation experiments.