Real-time Beamforming for the Focal-plane L-band Array feed on the Green Bank Telescope (FLAG)

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A phased array feed (PAF) provides a contiguous, electronically synthesized wide field of view for large-dish astronomical observatories. Significant progress has been made in recent years in improving the sensitivity of PAF receivers though optimizing the design of the antenna array, cryogenic cooling of the front end, and implementation of real-time correlation and beamforming in digital signal processing. We report on commissioning tests in summer 2017 of the L-band FLAG PAF receiver developed by the National Radio Astronomy Observatory, Green Bank Observatory, West Virginia University, and Brigham Young University for the Green Bank Telescope (GBT).

FLAG is a 19 element, dual-polarization, cryogenic phased array with direct digitization of RF signals at the front end, digital signal transport over fiber, and a real time signal processing back end with up to 150 MHz bandwidth. The digital back end includes multiple processing modes, including real-time beamforming, real-time correlation, and a separate real-time beamformer for commensal radio transient searches. Following a polyphase filterbank operation performed in FPGAs, beamforming, correlation, and integration are implemented on graphical processing units (GPUs) that perform parallelized operations. Parallelization greatly increases processing speed and allows for real-time signal processing.

During a recent test/commissioning of FLAG, Tsys/efficiency of approximately 28 K was measured across the PAF field of view and operating bandwidth, corresponding to a system temperature below 20 K. To demonstrate the astronomical capability of the receiver, a pulsar (PSR B1937+21) was detected with the real-time beamformer.

The presentation will give an overview of the FLAG system, back end signal processing implementation and data pipeline, measured performance figures of merit, and experimental results from commissioning tests.

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