Design of a Multibeam Spectrometer for the Green Bank Telescope

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A new multi-beam spectrometer for the Green Bank Telescope (GBT) is being designed and built by a partnership between the National Radio Astronomy Observatory (NRAO) and the University of California at Berkeley, and partially funded by a National Science Foundation Advanced Technology Instrumentation grant. The spectrometer is a heterogeneous computing device based on a Field Programmable Gate Array (FPGA) front-end and a heterogeneous compute server backend, comprised of Graphical Processing Units (GPUs) and x86 CPUs. Working together, the hardware in this system provides processing power to analyse up to 8 dual-polarization or 16 single-polarization inputs, at bandwidths of up to 1.25 GHz per input. An aggregate of up to 10 GHz of bandwidth, dual polarization, may be processed with the spectrometer.

Each input feeds an 8-bit, 5 GS/s analog-to-digital converter which digitizes the signal and transfers it to the FPGA, where it is first processed. In the wideband modes ($bw > 400$ MHz/pol), the FPGA uses a polyphase filter bank to channelize the data, calculate cross products where needed, and accumulate samples. Accumulations are then dumped to the GPU computers, where they are further accumulated, processed, and stored on disk. In the narrow-band modes, time-domain data is sent to the GPU computers where it is processed into spectra, accumulated, and written to disk.

The architecture of this heterogeneous system will be explored, including implemented and planned modes of operation. System software that interfaces the spectrometer to the observing systems at the GBT will be explained. The low-level system architecture, including the system interconnections, GPU software, hardware, and FPGA firmware will be described. Data collected to date during testing and commissioning will be presented.