An FPGA-Based Back End for Real Time, Multi-Beam Transient Searches Over a Wide Dispersion Measure Range

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Isolated, short pulses of radio emission of unknown origin have been reported and there is strong interest in wide and sensitive searches for such events. To achieve high sensitivity, large collecting area is needed and dispersion due to the interstellar medium should be removed. To survey a large part of the sky in reasonable time, a telescope that forms multiple simultaneous beams is desirable. We have developed an FPGA-based transient search engine that is suitable for these circumstances. It accepts short-integration-time spectral power measurements from each beam of the telescope, performs incoherent de-dispersion simultaneously for each of a wide range of dispersion measure (DM) values, and automatically searches the de-dispersed time series for pulse-like events. If the telescope provides buffering of the raw voltage samples of each beam, then our system can provide trigger signals to allow data in those buffers to be saved when a tentative detection occurs; this can be done with a latency of tens of ms, and only the buffers for beams with detections need be saved.

In one version of our implementation, intended for the Australian SKA Pathfinder array of 36 antennas (currently under construction in Western Australia), 36 beams are simultaneously de-dispersed for ~400 different DMs with an integration time of 1.0 ms. In the absence of such a multi-beam telescope, we have built a second version that handles up to 6 beams at 0.1 ms integration time and 512 DMs. We have deployed and tested this at a 34 m antenna of the Deep Space Network in Goldstone, California.

Our implementation allows nearly any DM to be included in the list of ~400 to 500 values to be searched. In fact, an arbitrary frequency-time profile can be used for one or more "DMs" in place of the usual quadratic plasma dispersion, $\tau = D/f^2$ where τ is the excess path delay at frequency f and D is the dispersion coefficient.

The Goldstone telescope provides two beams, one in a 2.2 to 2.3 GHz band and the other in an 8.1 to 8.6 GHz band. These are processed simultaneously. The system is not yet in routine operation, but the results of test observations will be presented.