

## High-performance software-defined radio spectrometer: A GPU implementation for multi-GHz radio astronomical signal processing

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This paper presents a GPU-accelerated polyphase filterbank (PFB) spectrometer enhanced with spectral kurtosis (SK) capability for real-time operation in radio astronomical signal processing. Modern wideband radio telescopes employ analog-to-digital converters (ADCs) that sample signals at multi-GHz rates, generating tens of gigabits per second (Gbps) of data per antenna that demand high-speed processing while operating in radio frequency interference (RFI)-contaminated environments. Existing solutions often separate FPGA- or GPU-based spectrometer backends and RFI detection systems, but this work unifies both within a single GPU pipeline. Using NVIDIA's PyCUDA framework on a Tesla T4 GPU, the system employs a four-tap Hamming-windowed PFB for channelisation, an averager and a higher-order spectral moment estimator based on the SK algorithm for automated RFI detection in the measured spectrum. The implementation achieved 8.88 GSamples/s throughput with high spectral fidelity. Tests using radio telescope data confirmed accurate detection of stationary and transient interference while maintaining false-alarm rates only 1.3% above theoretical expectation. This research demonstrates that modern GPUs can enable efficient and flexible high-throughput spectrometer architectures for advanced digital signal processing (DSP) in radio astronomy.