



HartRAO Spectrometer Upgrade: Expanding possibilities

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1 Extended Abstract

The South African Radio Astronomy Observatory's (SARAO) facilitates multiple radio telescopes including the Hartebeesthoek site, HartRAO, which operates two single antenna radio telescope instruments (26m and 15m diameter) for astronomy and geodesy purposes. The 26m antenna's analog front-end is equipped with Right-hand Circular Polarised (RCP) and Left-hand Circular Polarised (LCP) feeds, combined with 7 receivers spanning L to K bands, with mixer and filter operations providing band selection and down-conversion prior to sampling and channelisation.

A new digital back-end has been in development to provide improved wideband channel resolution as well as introduce narrowband processing. The legacy digital back-end hardware consists of an iBOB FPGA board with an 8-bit 125MSPS ADC and is capable of processing RCP and LCP data products at a resolution of 1024 channels with accumulated data products at a precision of 32-bits. The new digital back-end is an FPGA-based SKARAB board with co-located ADC sampling at 2.8GSPS providing wideband channelised data (reduced to 350MHz bandwidth to match existing analog front-end limit) over 8192 channels with auto and cross correlated RCP and LCP data products (accumulated precision 64-bits); with four configurable narrowband windows offering 0.5MHz, 1MHz, 2MHz, 4MHz, 8MHz and 16MHz bandwidths; as well as raw voltage data. The four narrowband processing streams are shared by off-board host processing at 8192 channels per stream. Raw ADC voltages with options up to full analog wideband bandwidth for each polarisation will be streamed for storage and further processing as required. A system block diagram is illustrated in Figure 1.

Narrowband and radiometer features are co-processed with the host machine. This is intentional to enable more resources to be available to processing stages such as the polyphase filter bank. Narrowband and radiometer processing is performed in software post-transmission of the respective data products. The FPGA accommodates four independently controlled streams which can select out contiguous set(s) of channels based on the bandwidth requirements. Each stream is egress on the same physical Ethernet interface but separate virtual ports. The narrowband stream is different from the wideband stream in that no accumulation takes place on the four sub-streams. Each stream is processed and further channelised into 8192 channels for the selected bandwidth of interest.

This presentation will overview the data acquisition and signal processing pipeline, including wideband channelisation with a polyphase filter bank, and will highlight additional features including narrowband and radiometer design considerations and host co-processing. Current results and future plans will also be discussed.

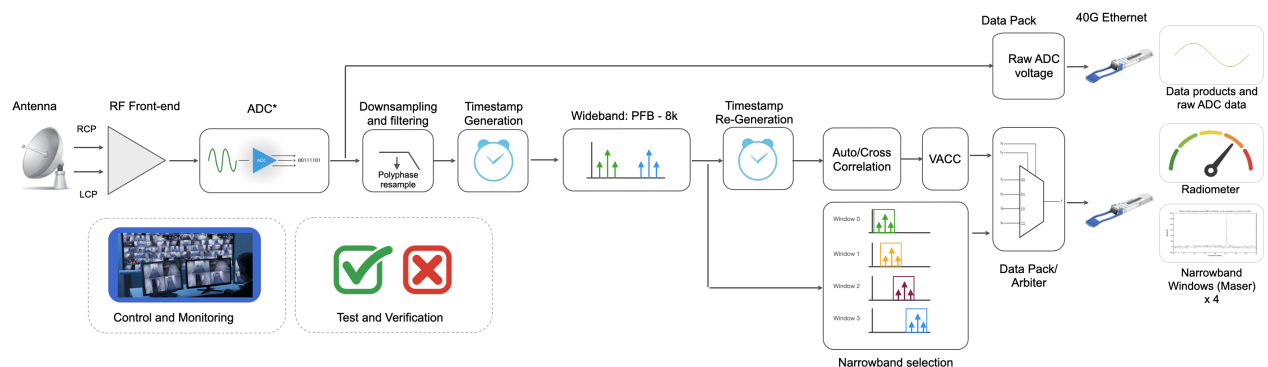


Figure 1. HartRAO spectrometer digital back-end. A single feed is represented however in practice both RCP and LCP are processed independently.