ALPACA BEAMFORMER DIGITAL BACK END DEVELOPMENT

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Brigham Young University (BYU), in collaboration with Cornell University, is developing the Advanced Cryogenic L-Band Phased Array Camera for Arecibo (ALPACA) as a user provided facility instrument on the Arecibo 305 m radio telescope. The instrument will be comprised of a fully cryogenic 138 element phased array feed (PAF) and real-time digital beamformer back end capable of producing 40 simultaneous dual-polarized beams with approx. 308 MHz of instantaneous bandwidth. The digital beamformer design is a heterogenous architecture using 18 Xilinx RF System on Chip (RFSoC) ZCU111 evaluation boards for direct antenna voltage sampling and frequency channelization (F-engine) followed by 25 GPU servers (two GPUs each) for beamforming and correlation (XB-engine). The baseline XB-engine implementation will include separate coarse and fine channel spectrometer modes and an array calibration mode for beamformer weight calculations. This presentation will introduce a high-level overview of the system design architecture and introduce the ZCU111 platform and report on the current status of hardware implementations and system integration. For example, with the XB-engine providing a second-stage 'zoom' fine channel spectrometer mode, the first stage polyphase filter bank (PFB) in the F-engine cannot be a conventional critically sampled design without introducing spectral aliasing and amplitude scalloping in the second stage fine spectra. ALPACA will use an oversampled PFB fist stage spectrometer to avoid these issues. We also plan to present the status of porting the ZCU111 as a CASPER compatible board based on progress from the 2019 CASPER board porting workshop in South Africa.