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Modular Data Acquisition System of a Reconfigurable Detector for Measuring the Spatial Distribution of Therapeutic Radiation Dose

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Radiation dose reconstruction is crucial for the success and safety of radiation therapy in cancer patients. In this paper, a modular data acquisition system (DAQ) for a novel reconfigurable Dose-3D detector intended for a full spatial therapeutic dose reconstruction to improve radiotherapy treatment planning by providing a breakthrough detector with active voxels is presented. The reconfigurability of the active volume of the detector implies that the DAQ hardware and firmware need to be as flexible as possible.
The data acquisition hardware is divided into single slices, each comprising a 64-channel multianode photomultiplier tube (PMT) assembly, a front-end readout ASIC and an FPGA (see Figure 1). The system is designed in such a way that the number of slices can be easily adjusted to accommodate different detector geometries without sacrificing performance.
The modular FPGA firmware is based on an open-source platform to share a UDP/IP over an Ethernet link between many functional modules [1]. Intermediate modules were created to interface between the UDP layer of the platform and control registers and data streams. These, in turn, control independent units orchestrating the communication with the ASIC (see Figure 2). The communication between the FPGA and a DAQ PC is realised using a custom software package based on one of our previous designs [2].
Both the hardware and the firmware have reached the maturity level needed for the operation of the fully reconfigurable detector. The system has undergone an extensive set of calibration tests with promising results.

[1] A. Forencich. Extensible FPGA Control Platform
[2] P. Jurgielewicz et al., Modular data acquisition system for recording activity and electrical stimulation of brain tissue using dedicated electronics. Sensors, 21(13), 2021

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