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Flexible Data Acquisition Software for Imaging of Radiation Dose Spatial Distribution for Radiotherapy Treatment Planning

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It is well known that cancer is one of the deadliest diseases worldwide, accounting for nearly ten million deaths in 2020 [1]. There are various treatment methods proposed and one of the most frequently used is radiation therapy. This method requires precise knowledge of radiation dose distribution to limit damage to the surrounding healthy tissues. To address this complex problem, we present the state-of-the-art reconfigurable Dose-3D detector concept based on the active voxels approach to improve radiotherapy treatment planning. Three of its key components are radiation imaging scintillation detectors controlled by the data acquisition system (DAQ) and the high-level data analysis software.

The DAQ consists of hardware, firmware and low-level software (Figure 1.). A single hardware unit, called a slice (with multianode photomultiplier, Application Specific Integrated Circuit (ASIC) and an FPGA), gives access to 64 detection channels of the read-out ASIC while the low-level software (Server Application) handles operation with any number of slices simultaneously. The modular architecture of this software follows concepts of the recently published DAQ [2] with further modifications. Communication with each slice is handled using 1 Gbit/s UDP/IP protocol. The software maps registers and data sources from each slice independently and broadcasts such data to any consumer application giving high-level access to the underlying hardware. This way there might be any number of consumer applications in the network monitoring in real-time specific aspects of the hardware operation.

The main advantage of the proposed DAQ design is its scalability and portability to other FPGA-based DAQ systems. It might be a solid foundation for future designs which would only require a redefinition of registers binding and data sources while the protocol of data management by the Server Application will remain virtually the same. The development of consumer applications is also simpler and less labour demanding since they are separate processes possibly running on a different machine than the one running the Server Application. All in all, we believe that the proposed DAQ design will greatly contribute to deepening the understanding of radiation dose distribution in the human body.

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