Contribution ID: **253** Type: **Poster**

A reconfigurable detector for measuring the spatial distribution of radiation dose for applications in the preparation of individual patient treatment plans

Tuesday, 24 May 2022 15:40 (1 minute)

Currently, cancer is one of the most frequent death causes in the world and radiation therapy is used in approximately 50% of patients diagnosed with cancer. This implies the need of the treatment to be as efficient and safe as possible. In this work, 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 device is comprising a customizable detector head, a scalable data acquisition system (including hardware, firmware and low-level software) and a state of the art high-level software.

The detector head is being designed as a set of 3D-printed scintillator pieces, whose shape and arrangement can be changed to accommodate patient's needs. A feasibility study was done to assure the quality of the detector manufactured using the aforementioned method. The results show, that the light output of 3D-printed scintillators provides sufficient signal to noise ratio for the project.

The data acquisition system (DAQ) is designed to accommodate the changing geometry by varying the number of slices, each capable of aggregating 64 detection channels into 1 Gbps Ethernet link. The low-level software can interact with virtually any number of DAQ units. Prototype devices have been tested successfully with the whole detection chain in place.

The high-level software is being designed to automatically convert medical data (CT scans) into accurate 3D models of the tumor and neighbouring cells using machine learning. Obtained geometry will be used to create dedicated detector head for the patient, as well as an environment for dose simulation in GEANT.

In conclusion, the research undertaken until now confirm the possibility to build a device to greatly personalise and improve radiotherapy planning and effectiveness.

Collaboration

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Session Classification: Application to life sciences and other societal challenges - Poster session