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Innovative Detection System for Rapid 3D Radiation Dose Mapping with Printed Plastic Scintillators

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According to the World Health Organization (WHO), cancer is a leading cause of death worldwide. Often, radiotherapy is the primary or sole therapeutic procedure employed in the treatment process. Ensuring that each patient receives a fast, efficient, and safe treatment is essential. To address this need, our team has developed a scalable detection system using plastic scintillators as the active element for evaluating dose distributions in 3D reconfigurable detectors (phantoms) during the preparation of treatment plans in photon radiotherapy. A unique feature of the system is its capability to monitor dose deposition simultaneously in 3D and in real time.

At the conference, we will present the design details of a complete prototype system, which consists of dedicated hardware, software, and configurable phantoms made from tissue-equivalent, 3D-printed plastic scintillator cubes. We will also discuss the performance characteristics of the system, including its optical components and active elements, in detail.

Key design features, such as system modularity, scalability, and potential applications, will be highlighted. Furthermore, we will demonstrate the customization possibilities of the phantom to nearly any arbitrary 3D arrangement and share results from test-beam campaigns conducted using a clinical accelerator at a cancer treatment facility —specifically, the real-time 3D dose distribution captured during a treatment procedure.

Primary experiment

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