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Design optimization for a flat-panel PET scanner with DoI capability

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Cancer is a disease characterized by the uncontrolled proliferation of mutated cells that spread to other tissues and organs. Proton beams are effective in treating deep, radioresistant tumors close to sensitive organs. Positron Emission Tomography (PET) makes it possible to locate beta+ emitters produced in nuclear reactions between the proton and the nuclei of the patient's atoms, making it possible to monitor treatment in real-time. The main goal of this project is to fine-tune, through Monte Carlo simulations, the design of a flat panel PET scanner in terms of spatial resolution and image distortions. The scanner is being developed at Austin Technical University (UT Austin) in collaboration with the Laboratory for Instrumentation and Experimental Particle Physics (LIP), which is the external institution in this project.
The first objective of the study is to create a simulation model of the scanner (geometry and materials) in the ANTS3 toolkit, an in-house software package for Geant4. The second objective is to establish the scanner's depth-of-interaction (DoI) determination capabilities by testing various sizes of the scintillation crystal and applying different approaches to encapsulating the crystal. The final objective is to carry out a study characterizing the resolution and image distortion of the optimized scanner over the entire field of view.

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