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A Range Verification Method for Proton Therapy using a Photon Counting Detector

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A range verification method plays an important role in the quality assurance of the proton therapy offering the high conformity and reduction in radiation dose. To localize the distal falloff of the dose distribution, secondary particles (C-11, O-15, N-13) produced by the proton interaction within the patient body can be used as a measure of the beam range. We proposed a multi-modality imaging system for X-ray and gamma-ray coincidence imaging using a single CdZnTe detector to measure proton range verification. The detector system consists of two parallel planes of detectors and an X-ray generator. An X-ray image is acquired using one detector for the verification of 2-dimensional anatomical structure of the patient, and the paired gamma rays from the annihilation are imaged with two modules to determine the maximum range of proton penetration. Image registration is intrinsic because the X-ray and gamma ray images are acquired in the same geometry. 110 MeV proton beam, a cylindrical tissue phantom, and two rectangular CdZnTe detectors were modeled, and the imaging performance of this system was evaluated using GATE simulation. The results showed the potential benefits of a X-ray/gamma-ray imaging with a single detector for range verification in proton therapy.

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