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Proton radiography as a tool to improve proton stopping powers in proton therapy treatment

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The quality of the cancer treatment with protons critically depends on accurate predictions of proton stopping powers of traversed tissues. Today, proton treatment planning is based on stopping power information derived from X-ray Computed Tomography (CT) images. The conversion of the CT image to proton stopping powers has systematic uncertainties in the calculated proton range in a patient of approximately 3-4% and even up to 10% in regions containing bone. The inaccuracies may lead to no dose at all in parts of the tumor or a very high dose in organs at risks and other normal tissues. A direct measurement of the proton stopping power by transmission radiography of high-energy protons will make it possible to significantly reduce these uncertainties and thereby improve the quality of dose delivery. This is expected to have a positive impact on treatment outcome. Our studies benefit from the novel gas-filled time projection chambers based on GridPix technology, being developed at the National Institute for Subatomic Physics (Nikhef), The Netherlands, to track a single proton entering and exiting the phantom. A BaF2 calorimeter has been used to measure the proton's residual energy. Different phantom geometries and materials have been irradiated with a scattered proton beam of 150 MeV. The experiment was simulated using the Geant4 toolkit. First results show a good agreement between simulated and experimental energy radiographs. The multiple Coulomb scattering that affects the position resolution of the proton traversing different materials is being analyzed. Both energy and scattering angle radiographs will be discussed.

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