High WET resolution proton radiography using dedicated image processing methods and a commercial plug'n'play detector

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Abstract

Proton transmission imaging uses protons with high enough energy to fully traverse the phantom/patient and to be captured in a suitable detector placed behind it. The measured residual energy or residual range provide a direct estimate of the water equivalent thickness (WET) of the image volume. Requirements for proton imaging to be exploitable in clinical practice include: (a) sufficient WET accuracy and (b) integrability into the treatment room and the clinical workflow. In this work, we report on experiments performed at the Institut Curie - Proton therapy center in Orsay (IC-CPO), France, using a commercial range telescope commonly employed for quality assurance measurements. The purpose was to keep the experimental aspects as simple as possible and to achieve nonetheless high WET resolution radiographies by developing and applying dedicated image processing methods. We explain these methods in detail and discuss their performance. We assess theWET accuracy based on two different reference phantoms: a CIRS electron density phantom with tissue equivalent inserts and a homogeneous step phantom. We nd an agreement between the measured and the ground truth WET values of better than 0.5mm and 0.2mm, respectively. Our work suggests that proton radiographies with good WET accuracy can be obtained with a reasonable experimental effort that would facilitate integration into clinical routine.

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