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Proton CT application in X-CT calibration for treatment planning in proton therapy

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Treatment planning systems for proton therapy require accurate information about stopping power ratio (SPR), relative to water, of the biological tissues the patients are made of. This information, in the present clinical practice, are extracted from X-rays computed tomography (X-CT) images. In this context the inaccuracy introduced in the conversion between Hounsfield Units (HU) and SPR maps is one of the main sources of uncertainty on the estimated proton range limiting the accuracy of treatment planning. In the recent past, in the framework of INFN funded research projects, a 5x20 cm2 field of view proton CT (pCT) system, composed of a microstrip silicon tracker and a YAG:Ce calorimeter, has been built with the aim to directly measure SPR maps. Proton tomographies of test phantoms acquired with this apparatus at Trento Proton Therapy Centre showed an accuracy on SPR measurement of about 1% (2020, Phys. Med. Biol. 65 225012). Recently a novel X-CT calibration technique, that makes use of the INFN pCT apparatus, has been proposed to improve X-CT calibration accuracy (2021, Med. Phys. 48 (3) 1349-1355). The aim of this project (XpCalib) is to prepare a set of biological phantoms and to acquire both pCT and X-CT scans on each of them by the pCT and X-CT systems to eventually extract a SPR-HU calibration function. The use of biological phantoms is proposed instead of synthetic tissue equivalent materials, which fail in accurately mimicking the real biological tissues' properties. Another aspect that will be investigated is the possibilities to stabilize those phantoms, in order to be able to extend the calibration procedure to other proton therapy centers, even to those not equipped with a pCT scanner. In this contribution the proposed calibration method will be presented together with the main results of the pCT system.

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