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A proton Computed Tomography scanner for biological phantoms imaging

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To study the 'proton Computed Tomography' (pCT) technique the INFN-Prima collaboration has built and successfully tested a 20x5cm2 field of view system based on a silicon microstrip tracker and a YAG:Ce scintillating calorimeter. This apparatus has demonstrated the feasibility of the pCT for objects with size suitable for pre-clinical studies [1]. Recently a possible clinical application of the proton tomography apparatus (INFN XpCalib project), has been proposed to explore the possibility of a new method for x-ray computed tomography (CT) calibration using pCT data. This methodology aims at a more accurate conversion of CT Hounsfield Units into proton stopping power ratio relative to water (SPR) to be used in proton-therapy treatment planning to eventually reduce the uncertainties in proton range evaluation [2]. In this respect the use of biological phantom, is of particular importance due to the fact that plastic tissue substitutes, that are presently used in clinical practice, are not always accurate in mimicking biological samples. To accomplish this goal a set of formalin stabilized phantoms has been prepared and tested under a 200 MeV proton beam at the experimental area of the Trento proton therapy center. An example of tomographic image of a bovine stabilized phantom is shown in Figure 1.
In this contribution a detailed description of the apparatus, together with the data analysis procedure, will be presented with a particular focus on the calorimeter energy calibration. This last aspect is of paramount importance in the accuracy of the SPR measurements and consequently on the precision of the proton treatment plans. Moreover, the XpCalib project will be introduced and the tomographic images of biological phantoms will be shown.

[1] C. Civinini et al., 'Relative stopping power measurements and prosthesis artifacts reduction in proton CT' Phys. Med. Biol. 65 (2020) 225012;
[2] P. Farace et al., 'Technical Note: CT calibration for proton treatment planning by cross-calibration with proton CT'Med. Phys. 48 (3), (2021), 1349-1355;

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