Secondary Radiation Measurements for Charged Particle Therapy Monitoring: Fragmentation of Therapeutic He, C and O Ion Beams Impinging On a PMMA Target

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Purpose:

In Charged Particle Therapy (CPT), besides protons, there has been recently a growing interest in ^{4}He, ^{12}C and ^{16}O beams. The secondary radiation produced in the interaction of those beams with a patient could be potentially used for on−line monitoring of range uncertainties in order to fully exploit the advantages of those light ions resulting from increased Radio Biological Effectiveness, reduced multiple scattering and Oxygen Enhancement Ratio. The study and precise characterization of secondary radiation (beta+, prompt gamma, charged fragments) is the cornerstone of any R&D activity aiming for online monitoring development and purpose of the analysis presented here.

Methods:

We present the measurements of the secondary radiation generated by He, C and O beams impinging on a beam stopping PMMA target. The data has been collected at the Heidelberg Ionbeam Therapy center (HIT), where several millions of collisions were recorded at different energies, relevant for therapeutical applications.

Results:

The experimental setup, as well as the analysis strategies will be reviewed. The detected particle fluxes as a function of the primary beam energy and the emission angle with respect to the beam direction will be presented and compared to the results of other available measurements. In addition, the energy spectra and emission shapes of charged secondary particles will be shown and discussed in the context of the primary beam range monitoring technique that is being developed by the ARPG collaboration, within the INSIDE project funded by the Italian research ministry. The implications for dose monitoring applications will be discussed, in the context of the current (or planned) state−of− the−art detector solutions.

Conclusion:

The characterization of the radiation produced by ^{4}He, ^{12}C and ^{16}O beams fully supports the feasibility of on−line range monitoring in the clinical practice of CPT by means of secondary particles detection.