Contribution ID: **129** Type: **Oral presentation**

Measurements of secondary particle production induced by particle therapy ion beams impinging on a PMMA phantom

Tuesday, 23 June 2015 15:45 (20 minutes)

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Particle therapy is a technique that uses accelerated charged ions for cancer treatment. The high irradiation precision and conformity achievable with heavy ions enhance the Radio Biological Effectiveness (RBE) of such therapy while helping sparing the surrounding healthy tissues and Organs At Risk (OAR). To fully profit from the improved therapy spatial selectiveness, a novel monitoring technique, capable of providing a high precision "in-treatment"feedback on the dose release position, is required. Since the primary beam is fully stopped inside the patient body, it is necessary to exploit the knowledge on the secondary fragments, that are capable of exiting the body, in order to reconstruct "online"the dose release spot.

In this contribution we will review the results from a campaign of measurements at different beam facilities (LNS - Catania, GSI - Darmstadt, HIT - Heidelberg), aiming for a precise measurement of the fluxes and energy spectra for secondary particles produced by 4He, 12C and 16O ion beams of therapeutic energies impinging on thick PMMA phantoms.
The precise knowledge of the secondary particles production is a key ingredient for both Treatment Planning Software (TPS) development, allowing to improve the MC description of the ion beams interaction with the patient body, and for dose monitoring research and development. In this presentation we present the production of charged and neutral secondary particles, as well as the production of photons that are the result of a beta+ annihilation, for the different energies and experimental setup explored. The fluxes, energy spectra and correlation with the Bragg Peak (BP) position will be shown, together with the expected resolution on the BP position for a typical treatment scenario.

The measurements performed in the different facilities, provided a solid evidence that the rate of produced protons and prompt photons is large enough to supply the particle sample needed for a fast online monitor operating during a typical treatment that will be capable to provide the (millimetric) spatial resolution required by clinical standards.

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Session Classification: Nuclear Energy and Applications of Nuclear Science and Technologies

Track Classification: Nuclear Energy and Applications of Nuclear Science and Technologies