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Characterisation of the secondary fast and ultrafast neutrons emitted in Particle Therapy with the MONDO experiment

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Content

The Particle Therapy is a modern technique of non-invasive radiotherapy mainly devoted to the treatment of tumours untreatable with surgery or conventional radiotherapy, because localised closely to organ at risk. The beam interactions with the patient produce a large component of secondary particles: the largest fraction of the dose is released to the tumour volume, but a non-negligible amount is deposed in other body regions, mainly due to the scattering and nuclear interactions of the neutrons within the patient body. The risk of developing a radiogenic second malignant neoplasm, years or decades after undergoing a PT treatment is one of the main concerns in PT administration and planning. Since neutrons can release a significant dose far away from the tumour region, precise measurements of their flux, production energy and angular distributions is eagerly needed in order to improve the analytical models and the MonteCarlo simulation underlying the Treatment Planning Systems codes, so to predict the normal tissue toxicity in the target region and the risk of late complications in the whole body. The MONDO (MOnitor for Neutron Dose in hadrOntherapy) project is devoted to the construction of a secondary fast and ultrafast neutron tracker and to the characterisation of that secondary neutron component in the range of [10-400] MeV. The detector, based on the tracking of the recoil protons produced in two consecutive (n,p) elastic scattering interactions, is a matrix of thin scintillating fibres, arranged in layer x-y oriented ($10 \times 10 \times 20$ cm^3, with fibers of square cross sections 250 μm thick). The detector is under development the construction is expected to be completed by the end of the year so to start the experimental tests in Proton and Carbon Ion Therapy Centres. A prototype of the tracker will measure (May 2017) the proton track at Proton Therapy Center of Trento. A tailored readout sensor, based on SPAD array developed in CMOS technology, has been developed with Fondazione Bruno Kessler (FBK). A sensor prototype will be tested ad well. Experimental results with m.i.p and proton beam will be presented. A Monte Carlo FLUKA code has been developed to study the detection efficiency with double scattering events and to study the possible background due to inelastic scattering. One of the most important goal to be achieved in the simulation study is the estimation of the achievable energy resolution of the incoming neutrons. Simulation details and the results obtained in the design study will be presented.