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MONDO: a neutron tracker for particle therapy secondary emission fluxes measurements

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Particle therapy (PT) is a novel technique that uses accelerated charged particles for cancer treatment.
The PT high irradiation precision and conformity allows the tumor destruction while sparing the surrounding healthy tissues. Monitoring methods using photons and charged particles have already been proposed, but no attempt has yet been made to use the abundant fast neutron component. The large penetrating power of neutrons produces nearly energy threshold free escape, providing a secondary particle sample that is higher in number with respect to photons and charged particles. Therefore, neutrons allow for a backtracking of the emission point that is not affected by multiple scattering. Since neutrons can release a significant dose far away from the tumor region, a precise measurement of their flux, production energy and angle distributions is eagerly needed in order to improve the Treatment Planning Systems (TPS) software, so to predict not only the normal tissue toxicity in the target region, but also the risk of late complications in the whole body. Up to now, neutrons secondary emission has been very poorly investigated for monitoring purpose. This underline the importance for an experimental effort devoted to the precise measurement of the neutron production, induced by the beam interaction with body tissues. The technical challenges posed by a neutron detector aiming for high detection efficiency and good backtracking precision will be addressed within the MONDO (MOnitor for Neutron Dose in hadrOntherapy) project. The MONDO main goal is to develop a tracking detector capable of a full reconstruction and backtracking of secondary neutrons produced by the primary beam interaction with the patient body. The full reconstruction of protons, produced in elastic interactions, will be used to measure the kinematic of the impinging neutron in the (20-300) MeV kinetic energy range. The neutron tracker will measure the neutron production yields, as a function of production angle and energy, using different therapeutic beams at CNAO in Pavia (protons, 12C ions and possibly 4He and 16O ions). A device will reduce significantly the large uncertainties currently related to the neutrons flux estimate produced in typical PT treatments, as well as in other medical therapies involving the neutrons production.

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