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Medipix/Timepix for characterization of ion beam passing irradiated sample via tracking of induced secondary radiation –J. Jakubek, S. Pospisil (CTU, Prague, Czech Republic), M. Campbell, S.P. George, F. Murtas, C. Severino, M. Silari (CERN)

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Semiconductor pixel detector Timepix can be used to measure the geometrical characteristics of the beam, such as the lateral penumbra, the beam flatness and the beam broadening while passing through different samples.
1. Investigations of Secondary Ion Distributions in Carbon Ion Therapy Using the Timepix Detector
The purpose is to investigate the potential for beam monitoring by detecting the prompt secondary ions emerging from a phantom during an irradiation. Using the energy calibration of all 65535 pixels, the detector provides measurements of the energy loss of ions in silicon. The Timepix can act as a digital nuclear emulsion giving a detailed track structure of incident particles. These characteristic tracks are dependent on the particle type, energy and direction. Detailed pattern recognition enables to differentiate between the primary carbon ions and secondary particles such as protons, alphas and heavier fragments. We should also be able to measure the particle fluences, energies and plot their spatial distributions. This capability is of direct relevance to beam monitoring as the range of secondary light ions can be much larger than that of the primary carbon ions and they may leave the patient. Due to the small size of the single detector, the Timepix is suitable for measurements directly within phantoms.
In addition we plan to use a multi-layered array of detectors (a voxel detector) to take similar measurements. The voxel detector allows the 3D reconstruction of fragmentation distribution along the beam path. It can be used with a neutron converter layer to form an anticoincidence detector for neutrons as well.
We also want to investigate the energy deposition characteristics of primary ions and fragments in the Timepix detector. This will allow us to test the inherent resolution of backtracking particle fragments from the Timepix data and also the capability to discriminate between different charged particle fragments based on the measured track profiles.

1. Monte Carlo simulation We plan to undertake a series of Monte Carlo studies to support the proposed experimental plan. The most important priority is to determine the predicted particle fluences and spectra around the room. This will allow us to optimize the exposure time for the Timepix detectors as well as the detection geometry. We plan to make use of MCNP and FLUKA to model the fragmentation of the beam in different materials along its path (air, PMMA and water) and fluencies of secondary particles around the room. The SRIM tool will be used to determine accurate ionization curves for the passage of different nuclear fragments through silicon in combination with GEANT4 and own C++ code for detector response modeling.

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