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GEMPix detector as beam monitor at CNAO Hadrontherapy Center: Geant4 simulation and measurements

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Purpose
The aim of this work consists in the full simulation and measurements of a GEMPix (Gas Electron Multiplier) detector for a possible application as monitor for beam verification at CNAO Center (National Center for Oncological Hadrontherapy).
A triple GEMPix detector read by 4 Timepix chips could provide a beam monitoring, dose verification and quality checks with good resolution and optimal radiation background control with respect to the existing devices.
The Monte Carlo Geant4 10.01 patch 03 toolkit was used to simulate the complete CNAO extraction beamline (beam delivered with active scanning modality). The simulation allowed the characterization of the GEM detector response carbon ions with respect to reference detectors (EBT3 radiochromic films).

Methods
The GEMPix detector is fully simulated: an homogeneous electric field was implemented to take into account the drift of secondary particle in gas gap. An ArCO2CF4 gas mixture was simulated to reproduce the GEMPix response. The complete measurement setup was simulated with the GEMPix placed in a water phantom and irradiated with carbon ions at different energies.
Important beam parameters such as the transverse FWHM were compared with experimental measurements at CNAO Center.
A triple GEM detector prototype, with a 55 μm pitch pixelated ASIC for the readout, was tested at CNAO in Pavia for a detailed characterization and measurements of energy deposition inside the water phantom. The energy deposition was measured at different positions in depth allowing a 3D reconstruction of the beam inside the phantom.

Results
The simulation results are very encouraging since they reproduce in a few percent the experimental data set. All the measurements are carried out in a stable setup at CNAO Center and are acquired in several experimental sessions with different parameters settings. Experimental measurements are still ongoing.

Conclusions
Even further validations must be done, the good results so far obtained by this work point out and confirm that GEMPix detector is suitable to be used as beam monitor in hadrontherapy.

Secondary Keyword (Optional)

Analysis tools and techniques

Primary Keyword (Mandatory)

Simulation

Tertiary Keyword (Optional)

Authors: RIMOLDI, Adele (Universita e INFN, Pavia (IT)); Mr DE MAGGI, Adriano (University of Pavia & INFN Section of Pavia); Dr TAMBORINI, Aurora (INFN Section of Pavia); MURTAS, Fabrizio (CERN & INFN); LEIDNER, Johannes (Rheinisch-Westfaelische Tech. Hoch. (DE)); SILARI, Marco (CERN)

Co-authors: Dr MIRANDOLA, Alfredo (National Centre for Oncological Treatment (Italy)); Dr CIOCCA, Mario (National Centre for Oncological Treatment (Italy))

Presenter: Dr TAMBORINI, Aurora (INFN Section of Pavia)

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