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Investigation of the prompt gamma ray emission for online monitoring in ion therapy

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This talk deals with the investigation of the characteristics of prompt gamma ray emission in radiotherapy with carbon ions. The aim of this investigation was to study the principle of using the prompt gamma rays, created by nuclear reactions of the incident therapy beam with the irradiated tissue, to determine the position of the Bragg peak during the medical treatment. Developing a system for online monitoring in ion therapy with the required accuracy is an important step for the utilization of modern acceleration facilities for medical purpose.

The studies were carried out by Monte Carlo simulations in the framework of the simulation environment GATE(GEANT4 Application for Tomographic Emission) realized on the computer cluster of the Vienna General Hospital. In the course of these investigations some production parameters of prompt gamma rays like the emission rate, energy and direction were determined as a function of the primary carbon ion energy and the penetration depth in a water target. A possible connection between these parameters and the position of the Bragg peak and the dose delivery was checked. An energy range for produced gamma-rays can be detected in which the production rate of the photons shows a significant drop right after the Bragg peak. Additional the detection of prompt photons outside of the irradiated material was simulated. Using the results of the photon production and the virtual geometry a response function of the virtual detector was acquired which allows linking the photon detection with the photon production and the depth of the Bragg peak. New simulation results show that the accuracy of the recalculation can be raised by distinguishing between photons created directly in the beam line and photons created outside by fraction products.

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