ST 4: Radiation monitoring and dosimetry I

Time: Tuesday 14:00–15:40 Location: ST-H4

Invited Talk ST 4.1 Tue 14:00 ST-H4

Present status and future challenges of magnetic resonance-guided radiotherapy — •Christian P. Karger — German Cancer Research Center (DKFZ), Heidelberg, Germany

As a special realization of image-guided radiotherapy (IgRT), magnetic resonance (MR)-guided radiotherapy (MRgRT) has been implemented clinically by integrating linear accelerators (Linacs) into MR imaging devices. These so-called MR-Linacs allow for fast imaging with superior soft-tissue contrast without extra dose prior or even during radiation treatment. The acquired images may be used to adapt the treatment plan to the actual anatomical situation and to compensate for motion by beam gating or tracking. Besides technical challenges of integrating and shielding of the two devices, dose distributions and the detector responses are changed by the magnetic field requiring modified dose calculation techniques and dosimetry protocols. Clinically, the development and validation of new workflows is challenging as adaptive treatment planning while the patient is lying on the table (online adaptive radiotherapy) requires fast and robust planning techniques as well as new methods for validating the adapted treatment plan. In addition special end-to-end tests have to be developed to quantify the overall dosimetric and geometric accuracy. The presentation gives an overview on the present status and future developments in MR-guided radiotherapy.

ST 4.2 Tue 14:40 ST-H4

The performance of scintillating fibre based beam profile monitor for ion therapy in magnetic field — •Qian Yang, Liqing Qin, and Blake Leverington — Physikalisches Institut Universitaet Heidelberg

In the Heidelberg Ion-beam Therapy Center (HIT), proton, helium, carbon and oxygen ions are used for cancer therapy. The existing scanning technique, it is called Raster scanning. The beam is not switched off between spots but adjusted by the 2 dimensions fast deflection magnet. A tracking system is used to monitor the beam and feedback to adjust the scanning magnet currents online. The commercial MWPC (multiwire proportional chamber) currently used has several drawbacks. An MR magnetic is currently installed at the HIT facility for studying treatment with prompt MR imaging. The BMBF funded ARTEMIS project is focused on the establishment of a unique MR-guided ion-beam therapy prototype for clinical application. A scintillating fibre based detector is now studied as a possible monitor replacement for this system. The detector performance in the environment of MR magnetic fields is also be studied, to complement the ARTEMIS project at HIT. Recently, the performance of the detector was tested under the condition inside the Helmoltz coil by changing the magnetic field (from 0.1 mT ~ 99.9 mT) and it will also be tested inside the prompt MR imaging in the following days.

ST 4.3 Tue 14:55 ST-H4

First study on energy resolution in proton radiography — •Marius Hötting, Kevin Kröninger, Isabelle Schilling, Jacqueline Schlingmann, Hendrik Speiser, and Jens Weingarten — TU Dortmund, department of physics

Proton radiography offers the possibility of real-time patient positioning before or during the treatment. Typically, pixelated silicon sensors are used in the implementation, which makes it possible to contour various structures of phantoms or patients from the pure evaluation of the proton hit position.

With the additional information of the deposited charge of each particle per pixel, the initial proton energy, the residual range and finally the water equivalent thickness (WET) can be calculated. This allows conclusions about the material traversed without an additional external energy detector and gives the opportunity for cross-check with the treatment plan.

The challenge is to determine the proton energy with the limited resolution in deposited charge and a low number of detected protons per pixel. The measurement of the WET of a phantom is therefore done in two steps, one without and one with an additional homogeneous absorber of known width. The energy difference in both images allows minimization of the systematic uncertainties. Finally, the conversion to the WET is done with a simulated calibration curve.

In this talk, we describe the currently investigated method for WET calculation with pixel sensors and first simulations with Allpix^2 to determine depth-dependent uncertainties.

ST 4.4 Tue 15:10 ST-H4

New Optimisation Method for Proton Radiography Images — Marius Hötting, Kevin Kröninger, Florian Mentzel, •Hendrik Speiser, and Jens Weingarten — TU Dortmund, department of physics

For years, proton therapy for cancer treatment has been experiencing an increasing application, as it has known advantages such as the high dose conformity of protons. However, using this precision requires enhanced imaging techniques to ensure the accurate patient alignment. This results in a reduction of the safety margin around the target volume and in the protection of the surrounding healthy tissue.

As part of a master thesis, a new method is being developed to improve the quality of proton radiography images and thereby achieve greater therapeutic success as mentioned above. At present, the image quality and the resolution of structures in the patient are degraded by proton scattering. The goal of the project is to combine the projections of the widened proton trajectories onto the image plane with conventional proton hit maps to increase the resolution of object edges in radiography images.

This talk will include a brief description of the developed method and the evaluation of the image quality using Monte Carlo simulations. Subsequently, the application of the new approach will be compared with results of previous imaging methods.

ST 4.5 Tue 15:25 ST-H4

Monte Carlo feasibility study for neutron radiography in proton therapy — •Hannah Rotgeri, Marius Hötting, Kevin Kröninger, Alina Landmann, and Jens Weingarten — TU Dortmund University, Department of Physics

Due to their depth dose dose distribution, proton beams used in cancer treatment can reduce damage to healthy tissue when compared to irradiation with photons. Neutrons, and other secondary particles, are produced during proton therapy, causing dose deposition outside the treatment field. Being unavoidable, the feasibility for using these neutrons for imaging during the treatment is studied in the context of a master thesis.

The study is performed in the Monte Carlo framework Geant4. It is investigated whether different energy ranges of neutrons are suitable for radiography, due to the different ways they can be detected. This talk will present the recent results of this study. This includes the investigation of different angles of the detector with respect to the proton beam. Finally it will be shown whether the different materials found in a human body can be distinguished.