ST 1: Accelerators for Radiation Therapy (joint session ST/AKBP)

Time: Tuesday 11:00–12:30 Location: GER/038

ST 1.1 Tue 11:00 GER/038

Real-time analysis for a scintillating fiber-based ion beam profile monitor — •Liqing Qin, Qian Yang, and Blake Leverington — Physikalisches Institut, Heidelberg, Germany

For raster scanning of a pencil beam during ion beam therapy, it is necessary to monitor the beam in real-time for safety and quality reasons.

A scintillating fiber-based beam profile monitor developed from LHCb fiber winding techniques will offer real-time information of the pencil beam parameters, including position, width, and intensity, with a readout rate of up to 10 kHz.

The preliminary reconstruction algorithm for a Gaussian-like beam is being implemented on an FPGA. Preliminary results of the reconstruction algorithm performance on the FPGA will be presented.

ST 1.2 Tue 11:15 GER/038

Application of HV-CMOS sensor in a position monitoring system for therapeutic ion beams — •Bogdan Topko[1], Matthias Balzer[2], Alexander Dierlamm[1,2], Felix Ehrler[2], Ulrich Husemann[1], Roland Koppenhöfer[1], Ivan Perić[2], Martin Pittermann[1], and Alena Weber[2,3] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Institute for Data Processing and Electronics (IPE), KIT — [3]now with Bosch AG

Cancer treatment with ion beams provides critical advantages compared to the photon irradiation approach. The Bragg peak of the ion energy deposition near the end of the particle range allows to deposit the maximum of energy to the tumor and minimize the damage of healthy tissue. The beam position and size can be precisely controlled by the beam delivery system. In order to provide effective and safe dose delivery to the tumor, a fast and reliable beam monitoring system is required. The studies presented in this talk are focused on the application of HV-CMOS sensors for such a beam monitoring system. This system should provide information about beam position, shape and fluence in real time. It should work under beam intensities up to 10^{10} s^{-1} and deliver fluence information every 1-2 μs. In order to fulfill the timing requirements, the HitPix chip family with counting electronics and frame based readout has been developed at the ASIC and Detector Lab (IPE, KIT). Recent measurements with ion beams and a multi-chip matrix as well as future developments are discussed.

ST 1.3 Tue 11:30 GER/038

Medical irradiation simulations for IBPT accelerators — •Katharina Mayer[1], Erik Bründermann[1], Alfredo Ferrari[3], Michael J. Nasse[1], Markus Schwarz[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe — [3]IAP, KIT, Karlsruhe

An important cancer treatment method used in oncology is radiation therapy, in which the tumor is irradiated with ionizing radiation. In recent years, the study of the beneficial effects of short intense radiation pulses (FLASH effect) or spatially fractionated radiation (Microbeam) have become an important research field. Systematic studies of this type often require non-medical accelerators capable of producing the requested short intense pulses. At KIT, the Ferninfrarot Linac- und Testexperiment (FLUTE) can produce ultra-short electron bunches and the KIT storage ring KARA (Karlsruher Research Accelerator) is a source of pulsed X-rays. Both can be used as pulsed high-energy radiation sources and compared to conventional X-ray tubes. In this contribution, first dose simulations for FLUTE using the Monte Carlo simulation program FLUKA are presented.

ST 1.4 Tue 11:45 GER/038

Dose Simulation of Ultra-High Energy Electron Beams for Novel FLASH Radiation Therapy Applications — •Kelly Grunwald, Klaus Desch, Daniel Elsner, Dennis Proft, and Leonardo Thome — Physikalisches Institut der Universität Bonn

The electron stretcher facility ELSA delivers up to 3.2 GeV electrons to external experimental stations. In a new setup the irradiation of tumor cells inside a water volume with doses of up to 50 Gy by ultra-high energy electrons (UHEE) in time windows of microseconds up to milliseconds (FLASH) is currently investigated. This technique may enable highly efficient treatment of deep-seated tumors alongside optimal sparing and protection of healthy tissue. Along the effort to measure the dose with a suitable detector, our approach is to determine the optimal dose distribution by simulations. Therefore, the electromagnetic shower process is simulated in Geant4, taking the extracted electron pulse properties into account. A virtual water volume is constructed of voxels of different sizes for precise investigation in the volume of interest. Various properties such as particle types, deposited energy and the energy spectra of the particle shower can be extracted and correlated to relative and absolute dose measurements at the real water phantom. The method and first results will be presented.

ST 1.5 Tue 12:00 GER/038

Evaluation of Measuring Techniques to Determine the Applied Dose of Ultra-High Energy Electorn Beams in Cell Samples for FLASH Therapy — •Leonardo Thome, Klaus Desch, Daniel Elsner, Dennis Proft, and Kelly Grunwald — Physikalisches Institut der Universität Bonn

The electron accelerator facility ELSA delivers up to 3.2 GeV electrons. Ultra-high energy electrons (UHEE) in short pulses of microseconds up to milliseconds (FLASH) are used to investigate the effect of UHEE on tumor cells. This may enable highly efficient treatment of deep-seated tumors due to the FLASH effect. Currently, in a preliminary setting the Booster-Synchrotron is used to deliver electrons of 1.2 GeV energy, to irradiate cell samples placed in a water phantom. A precise dose determination is necessary to monitor the efficacy of the biological effect. Therefore, the usability of different detector types for a precise dose determination is evaluated.

ST 1.6 Tue 12:15 GER/038

Dosimetry tests for FLASH RT at PITZ — •Felix Riemer, Zakaria Aboulbanine, Gowri Adhikari, Zohrab Amirkhanyan, Namra Aftab, Prach Boonpornprasert, Georg Georgiev, Anna Grebinyk, Andreas Hoffmann, Mikhail Krasilnikov, Xiangkun Li, Anusorn Lueangaramwong, Raffael Niemczyk, Houjun Qian, Chris Richard, Frank Stephan, Grygorii Vashchenko, Tobias Weilbach, and Steven Worm — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) can provide unique beam parameters regarding delivered dose and dose rate. With an average dose rate of up to 10^7 Gy/s and peak dose rates of up to $4 \cdot 10^{13}$ Gy/s, PITZ is fully capable of FLASH radiation therapy. Nevertheless, dosimetry is a major challenge. Traditional detectors cannot provide reliable measurements and linearity up to such high dose rates. A new setup is being built to create a test infrastructure for all kinds of detectors. This includes a completely new beamline exclusively for FLASH RT and biology experiments. The goal is to develop and test detectors (also from external users) which cover the whole range of dose rates available at PITZ. First dosimetry experiments using Gafchromic films were done in air and water. Dose rate linearity and a limit test of the films were done. Beam parameters like beam profile, dose depth profile in water, homogeneity and dark current were measured. First detector tests will be done using silicon sensors utilized in high energy physics experiments.