AKBP 11: Accelerators for Medical Applications (joint session ST/AKBP)

Time: Thursday 9:30–11:00 Location: PC 203

AKBP 11.1 Thu 9:30 PC 203

Investigation of the track structure of therapeutic carbon ion radiation at HIT using the PTB ion counting nanodosimeter. — •Miriam Schwarze, Hans Rabus, and Gerhard Hilgers — Physikalisch-Technische Bundesanstalt, Germany

Nanodosimetry characterizes charged particle track structure and its biological effectiveness by the frequency distribution of ionizations in a given target, the ionization cluster size distribution (ICSD). First measurements of ICSDs were performed with the PTB Ion Counter nanodosimeter with therapeutic 12C ions at HIT.

The nanodosimeter was operated behind a PMMA collimator and PMMA absorbers of different thickness. Ionizations in the target were recorded in coincidence with the signals from two silicon strip detectors to determine the dependence of ICSDs on the impact parameter of the ions to the target.

Measurements with different absorber thickness and beam energy, combined such as to give an energy of 1 GeV in the target, produced mean ICSD values (M1) varying by almost 50 % over the investigated beam energy range for all impact parameters. Experiments with fixed beam energy and varying absorber thickness showed significantly higher M1 values than expected from previously measured data at lower energies [1].

A simulation of the measurement setup by the simulation software Geant4 was used to determine whether these deviations are caused by secondary particles.

[1] G. Hilgers et al., Phys. Med. Biol. 62 (2017) 7569-97

AKBP 11.2 Thu 9:45 PC 203

Dosimetry at low and ultra-high dose rates at FLASHlab@PITZ — •Felix Riemer, Namra Aftab, Zohrab Amirkhanyan, Prach Boonpornprasert, Dmytro Dmytriiev, Anna Grebinyk, Matthias Gross, Andreas Hoffmann, Mikhail Krasilnikov, Xiangkun Li, Frieder Mueller, Anne Oppelt, Chris Richard, Frank Stephan, Grygorii Vashchenko, Daniel Villani, and Steven Worm — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

A new R&D facility for radiation therapy studies, called FLASHlab@PITZ, is being setup at the Photo Injector Test facility at DESY in Zeuthen (PITZ). It can provide worldwide unique beam parameters regarding delivered dose and dose rate. With an average dose rate within one RF pulse of up to 10^9 Gy/s and peak dose rates up to 4×10^{13} Gy/s, PITZ is fully capable of ultra-high dose rate experiments, for example the investigation of the FLASH effect. Nevertheless, dosimetry is a major challenge. Traditional detectors suffer from saturation and cannot provide reliable measurements up to such high dose rates. The goal is to test and benchmark detectors (also from external users) that cover the whole range of dose rates available at PITZ. Results of experiments using Gafchromic films in air and water will be presented. Dose depth profiles for four completely different beam configurations were measured with films and compared to Monte-Carlo simulations using FLUKA. The commercially available ionization chamber PPC05 (IBA Dosimetry) was benchmarked and comparisons with film measurements will be shown.

AKBP 11.3 Thu 10:00 PC 203

Dosimetry based on Cherenkov radiation: a method proposed to be studied for a wide range of dose rates at FLASHlab@PITZ — •Daniel Villani, Namra Aftab, Zohrab Amirkhanyan, Prach Boonpornprasert, Dmytro Dmytriiev, Anna Grebinyk, Matthias Gross, Andreas Hoffmann, Mikhail Krasilnikov, Xiangkun Li, Frieder Mueller, Anne Oppelt, Chris Richard, Felix Riemer, Frank Stephan, Grygorii Vashchenko, and Steven Worm — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) is preparing an R&D platform for electron FLASH radiation therapy and radiation biology (FLASHlab@PITZ). This platform is based on the unique beam parameters available at PITZ: ps scale electron bunches of up to 22 MeV with up to 5 nC bunch charge at 4.5 MHz bunch repetition rate in bunch trains of up to 1 ms in length repeating at 1 to 10 Hz. These parameters can result average dose rates within one RF pulse of up to 10^9 Gy/s and peak dose rates up to 4×10^{13} Gy/s. At such beam conditions, dosimetry is a challenge. Studies have established that light emitted by the Cherenkov effect may be used for several radiation therapy dosimetry applications, since there is a correlation between the light captured using a UV-sensitive CCD camera and expected absorbed dose under certain conditions. This work aims to present a proposal for using Cherenkov light as a dosimetry method to be used at both low and high dose rates available at FLASHlab@PITZ.

AKBP 11.4 Thu 10:15 PC 203

Investigation of Measurement Techniques to Determine the Applied Dose of Ultra-High Energy Electron Beams in Cell Samples for FLASH Therapy at ELSA — •Leonardo Thome[1], Manuela Denz[2], Klaus Desch[1], Stephan Garbe[2], Frank Giordano[3], Kelly Grunwald[1], Carsten Herskind[3], Miriam Lösgen[1], Dennis Proft[1], and Susanne Spaeth[2] — [1]Physikalisches Institut der Universität Bonn — [2]Klinik für Strahlenthearpie und Radioonkologie der Universitätsklinik Bonn — [3]Klinik für Strahlentherapie und Radioonkologie der Universitätsklinik Mannheim

Ultra-high energy electrons (UHEE) are used to investigate their effect on tumor cells and healthy tissue in short pulses of microseconds at the electron accelerator facility ELSA. This may enable highly efficient treatment of deep-seated tumors due to the FLASH effect. 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. Irradiation occurs with dose rates of up to 10 MGy/s due to the short pulse lengths of 250 ns. A precise dose determination is necessary to monitor the efficacy of the biological effect. Measurement techniques based on the usage of different detector types, such as radiochromic films, luminous screens, ionisation chambers and a diamond based detector, are evaluated.

AKBP 11.5 Thu 10:30 PC 203

Medical irradiation studies at IBPT accelerators — •Katharina Mayer, Markus Schwarz, Alfredo Ferrari, Michael J. Nasse, Martin Börner, Angelica Cecilia, Erik Bründermann, and Anke-Susanne Müller — KIT, Karlsruhe

Radiation therapy is an important oncological treatment method 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/MiniBeam) have become an important research field. Systematic studies of this type often require non-medical accelerators that are capable of generating the desired short intense pulses and, in general, possess a large and flexible parameter space for investigating a wide variety of irradiation methods.

At KIT, the accelerators of IBPT (Institute for Beam Physics and Technology) give access to complementary high-energy and time-resolved radiation sources. While the linear electron accelerator FLUTE (Ferninfrarot Linac- und Testexperiment) can generate ultrashort electron bunches, the electron storage ring KARA (Karlsruhe Research Accelerator) provides a source of pulsed X-rays.

In this contribution, first dose measurements and simulations for FLUTE and KARA using the Monte Carlo simulation program FLUKA are presented.

AKBP 11.6 Thu 10:45 PC 203

Hochleistungs-Röntgenquelle für die Krebstherapie mit Mikrostrahlen — •Stefan Bartzsch[1], Anton Dimroth[2], Johanna Winter[1], Christian Petrich[1], Thomas Beiser[3], Ghaleb Natour[2] und Kurt Aulenbacher[3] — [1]ZEA-1, Forschungszentrum Jülich — [2]Klinikum rechts der Isar, TU München — [3]Institut für Kernphysik, Universität Mainz

Zahlreiche präklinische Studien konnten zeigen, dass die Mikrostrahltherapie mit nicht homogenen Strahlenfeldern erhebliche Vorteile bringt: Bereiche niedriger Dosis ermöglichen die rasche Regeneration gesunden Gewebes, hohe Dosen in den mikrometerbreiten Peaks schädigen das Tumorgefäßsystem und lösen Immunreaktionen aus.

Um Strahlen mit 50 um Breite zu erzeugen, bedarf es einer Röntgenquelle im Orthovoltbereich, die hohe Dosisraten von einem mikrometerbreiten Brennfleck liefert. Wir entwickeln eine Linienfokusröntgenröhre, die 100 Gy/s, 600 kVp Röntgenstrahlung liefert und demnächst für erste Patientenbehandlungen eingesetzt werden soll.

Um derart hohe Dosisraten zu erzeugen, entwickeln wir einen Elektronenbeschleuniger mit über 1 A Strahlstrom. Die Elektronen werden auf einen Brennfleck von 50 um Breite und 20 mm Länge fokussiert. Durch die hohe Rotationsgeschwindigkeit des Röntgentargets wird das Wärmekapazitätslimit erreicht und damit die Temperatur im Brennfleck unterhalb des Schmelzpunktes von Wolfram gehalten. Die großen Herausforderungen bei der Beschleunigerentwicklung betreffen eine niedrige Emittanz, trotz hohem Strahlstrom und erheblicher Raumladungseffekte.