Radiation and Medical Physics Division
Fachverband Strahlen- und Medizinphysik (ST)

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Overview of Invited Talks and Sessions

(Lecture hall PC 203; Poster A)

Invited Talks

ST 1.1	Tue	9:30–10:00	PC 203	**25 years of intra ocular proton therapy at HZB** — •Jens Heufelder, Dino Cordini, Roland Stark, Andreas Weber, Johannes Gollrad, Georgios Kourkafas, Oliver Zeitz, Andrea Denker, Daniel Zips, Antonia Joussen
ST 7.1	Wed	16:30–17:00	PC 203	**Elekta Unity-Beschleuniger; Neue Wege in der Strahlentherapie Technische Lösung * Klinischer Workflow * Projektumsetzung** — •Michael Rossi
ST 7.2	Wed	17:00–17:30	PC 203	**About Mountaineers and Explorers: Frontiers of Ultrahigh Field Magnetic Resonance** — •Thoralf Niendorf
ST 7.3	Wed	17:30–18:00	PC 203	**Halbach Magnets for Applications in Medical Physics** — •Peter Blümler

Sessions

ST 1.1–1.1	Tue	9:30–10:00	PC 203	**Keynote: Intra Ocular Proton Therapy at HZB**
ST 2.1–2.3	Tue	10:00–10:45	PC 203	**Radiation Therapy I**
ST 3.1–3.4	Tue	11:00–12:00	PC 203	**Radiation Therapy II**
ST 4.1–4.4	Wed	9:30–10:30	PC 203	**AI in Medicine**
ST 5.1–5.7	Wed	11:00–12:30	Poster A	**Poster Session**
ST 6.1–6.5	Wed	15:00–16:15	PC 203	**Medical Imaging Technologies**
ST 7.1–7.3	Wed	16:30–18:00	PC 203	**DPG meets DGMP**
ST 8.1–8.6	Thu	9:30–11:00	PC 203	**Accelerators for Medical Applications (joint session ST/AKBP)**
ST 9.1–9.5	Thu	15:00–16:15	PC 203	**Radiation Monitoring and Dosimetry**
ST 10.1–10.1	Thu	16:30–17:00	PC 203	**Prize Talk: Georg-Simon-Ohm-Prize**
ST 11	Thu	17:00–17:30	PC 203	**Prize Ceremony and Closing Session**
ST 12	Thu	18:00–19:00	PC 203	**Members' Assembly**

Members' Assembly of the Radiation and Medical Physics Division

Thursday 18:00–19:00 PC 203

ST 1: Keynote: Intra Ocular Proton Therapy at HZB

Time: Tuesday 9:30–10:00 Location: PC 203

Invited Talk ST 1.1 Tue 9:30 PC 203

25 years of intra ocular proton therapy at HZB — •Jens Heufelder[1,2], Dino Cordini[1,2], Roland Stark[1,2], Andreas Weber[1,2], Johannes Gollrad[3], Georgios Kourkafas[4], Oliver Zeitz[2], Andrea Denker[4], Daniel Zips[3], and Antonia Joussen[2] — [1]Charité - Universitätsmedizin Berlin, BerlinProtonen am HZB, Berlin, Deutschland — [2]Charité - Universitätsmedizin Berlin,Klinik für Augenheilkunde CBF, Berlin, Deutschland — [3]Charité - Universitätsmedizin Berlin, Klinik für Strahlentherapie und Radioonkologie CBF, Berlin, Deutschland — [4]Helmholtz-Zentrum Berlin für Materialien und Energie, Protonentherapie, Berlin, Deutschland

For 25 years, the Department of Ophthalmology of the Charité - Universitätsmedizin Berlin has been successfully irradiating intra-ocular tumors at the Helmholtz-Zentrum Berlin für Materialien und Energie in close cooperation with the Charité's Department of Radiation Oncology and Radiotherapy. During this period, over 4600 patients, mainly from Germany, were treated. The primary indication is uveal melanoma (90%). Other indications are iris melanoma and intra-ocular hemangiomas. For choroidal melanomas, the tumor control rate is over 96% and the eye preservation rate 94%. These successes are based on excellent interdisciplinary cooperation between all departments involved and the continuous further development of the procedures and methods used.

This article provides an insight into the technical and clinical developments of the last 25 years in areas such as radiation planning, dosimetry, application and research (flash therapy).

ST 2: Radiation Therapy I

Time: Tuesday 10:00–10:45 Location: PC 203

ST 2.1 Tue 10:00 PC 203

Concept for the implementation of Ru-106 eye plaque characteristics in treatment planning — •Michelle Stroth[1], Henning Manke[1], Dirk Flühs[2], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]Department of Radiotherapy, Essen University Hospital, Germany

Brachytherapy with Ruthenium-106 eye plaques is an effective method for successfully treating ocular tumours.
To minimize side effects due to irradiation of radiosensitive structures, such as the fovea and optic nerve head, a standardized treatment planning software is needed which considers every relevant therapy parameter. This includes the geometry of the treated eye, the plaque size and position, as well as the inhomogeneous surface dose rate distribution of an individual plaque.
Implementing a patient-specific eye model within Geant4-based Monte Carlo simulations allows for the generation of dose-volume histograms and, thus, for comparing different therapeutic approaches with various plaque types and positions. The general software concept for the investigation and implementation of the characteristics of Ru-106 eye plaques in treatment planning is presented.

ST 2.2 Tue 10:15 PC 203

Simulation of inhomogeneous surface dose rate distributions of Ru-106 eye plaques — •Johannes Wintz[1], Michelle Stroth[1], Johannes Albrecht[1], and Dirk Flühs[2] — [1]TU Dortmund University, Dortmund, Germany — [2]Department of Radio- therapy, Essen University Hospital, Essen

Brachytherapy with Ruthenium-106 plaques is a successful method for treating ocular tumours.

However, the surface dose distribution of the Ru-106 eye plaques is not homogeneous. There are so-called hot and cold spots where the dose can deviate from the dose at the centre of the plaque. To achieve the goal of complying with the tumour control rate, it is essential to consider these inhomogeneities in treatment planning.

The surface dose distribution is characterized by the manufacturer for each eye plaque using 33 defined measuring points. To simulate these dose profiles accurately, the measured dose values must be extrapolated and expanded, forming a mapping of the entire applicator surface. This approach allows the visualization of the surface as a two-dimensional array. The inhomogeneities of the dose profile are then simulated using Geant4-based Monte Carlo simulations. The processes, from the mapping of the dose distributions to the results of the simulation, are presented.

ST 2.3 Tue 10:30 PC 203

Total Reaction Cross Section Measurements for Proposed Technique in Proton Therapy Range-Verification — •Laila Weisel, Devin Hymers, Markus Schiffer, and Dennis Mücher — Institut für Kernphysik, Universität zu Köln, Köln, Germany

The use of proton beams in cancer treatment offers significant advantages compared to photon therapy due to their depth-dose distribution which is characterized by a small entrance dose and a sharp maximum at the Bragg peak. To ensure the prescribed dose is properly delivered, precise knowledge of beam range in the patient is required. A proposed technique for in vivo range verification by Kasanda et al. [1] uses an implanted hadron tumor marker (HTM) which emits characteristic γ-rays when activated by the treatment beam, with intensities which are maximized for energies near the Bragg peak. Previous investigations, which used an HTM consisting of two materials, have demonstrated a sub-milimeter precision in range verification. The ratio of the γ-ray yield from two reactions of interest ^{89}Y(p,n)^{89}Zr and ^{92}Mo(p,n)^{92}Tc has been measured for different initial proton beam energies. In previous experiments the γ-ray ratios were related to a beam energy at the marker position by using calculated reaction cross sections. In order to obtain a more precise calibration of the correspondence between γ-ray ratios and energy, an experimental setup is currently being finalized at the Cologne 10 MV tandem accelerator, to measure the total cross sections in small energy steps. The status of these measurements and preliminary results will be presented.

[1] E Kasanda *et al* 2023 *Phys. Med. Biol.* 68 185005

ST 3: Radiation Therapy II

Time: Tuesday 11:00–12:00 Location: PC 203

ST 3.1 Tue 11:00 PC 203

A High-Performance Particle Tracker Based on CBM Silicon Strip Detectors for Range Verification in Heavy-Ion Therapy — •Devin Hymers[1], Sebastian Schroeder[1], Olga Bertini[2], Johann Heuser[2], Joerg Lehnert[2], Christian Joachim Schmidt[2], and Dennis Mucher[1] — [1]Institut für Kernphysik, Universität zu Köln, Köln, Germany — [2]GSI GmbH, Darmstadt, Germany

The growing societal burden of cancer necessitates improvement in safety and efficacy of radiation therapy. Scanned heavy-ion therapy provides precise and highly conformal dose delivery, but inherent uncertainties make it difficult to ensure accuracy. Filtered Interaction Vertex Imaging (fIVI) has been demonstrated to have potential as a relative range verification method with sub-millimeter accuracy, to ensure full and consistent tumour coverage in treatment [1]. A high-performance system, based on modern strip-segmented silicon detectors originally developed for the Compressed Baryonic Matter (CBM) experiment at GSI, is being adapted for use in fIVI. These sensors have a segment pitch of 58 microns, cover a large sensitive area of up to 72 cm^2, and are capable of count rates up to 250 kHz on each segment, in line with the expected requirements for fIVI under clinical conditions. These detectors are coupled to a parallel, pipeline-based analysis system, for high-efficiency data processing. Results of initial tests on detector and analysis software performance will be presented, along with the expected precision of the setup.

[1] Hymers *et al* 2021 Phys. Med. Biol. **66** 245022

ST 3.2 Tue 11:15 PC 203

Geant4 Simulation of the CBM Silicon Strip Detector for Interaction Vertex Imaging — •Sebastian Schroeder, Devin Hymers, and Dennis Mücher — Institut für Kernphysik, Universität zu Köln, Germany

Interaction vertex imaging (IVI) is a method which can be used to determine relative range differences in Bragg peaks in heavy-ion therapy. Current treatment plans must account for uncertainties in Bragg peak position on the order of millimeters. The sub-millimeter precision of IVI reduces the overall treatment uncertainty and allows further reduction of dose to healthy tissue. Previous studies suggest that to achieve IVI under clinical conditions, large sensitive detectors will be required to operate at high event rates of order MHz [1]. One possible detection system uses the double sided silicon strip detectors and fast readout electronics developed for the Compressed Baryonic Matter (CBM) experiment at GSI (Gesellschaft für Schwerionenforschung). To evaluate the suitability of this system, an IVI setup was simulated using the Geant4 Monte Carlo toolkit. The resultant event rates and cluster sizes, when compared to the capability of various readout configurations, are an order of magnitude lower than the limit of the CBM detection system. When energy cuts relevant for IVI are applied, the simulation shows that 98% of detected events correspond to particle species of interest, further demonstrating the suitability of this system for range monitoring in heavy-ion therapy under clinical conditions.

[1] Hymers *et al* 2021 Phys. Med. Biol. **66** 245022

ST 3.3 Tue 11:30 PC 203

A coded mask setup for on-line beam range monitoring in proton therapy — •Monika Kercz[1,2,3], Alexander Fenger[3], Ronja Hetzel[3], Jonas Kasper[3], Magdalena Kołodziej[1,2], Linn Mielke[3], Magdalena Rafecas[4], Katarzyna Rusiecka[1], Achim Stahl[3], Ming Liang Wong[1], and Aleksandra Wrońska[1] — [1]M. Smoluchowski Institute of Physics, Jagiellonian University, Kraków, Poland — [2]Doctoral School of Exact and Natural Sciences, Jagiellonian University, Kraków, Poland — [3]III. Physikalisches Institut B, RWTH Aachen University — [4]Institute of Medical Engineering, University of Lübeck

The full potential of proton therapy cannot be reached without an on-line method for beam range verification. One technique for dose monitoring involves the analysis of spatial distribution of prompt gamma radiation emitted during the treatment and its translation to the distribution of deposited dose.

The SiFi-CC project focuses on developing a setup operating in two imaging modes: a Compton camera and a coded mask camera. A Compton camera comprises two detector modules: a scatterer and an absorber, while a coded mask camera uses a single detection module combined with a structured passive collimator. In our approach, both modules are made of elongated LYSO:Ce crystals coupled to SiPMs.

After the prototyping phase, the first full-scale module has been constructed. First measurements in the coded mask setup were performed at HIT using a proton beam and a PMMA phantom. Preliminary results will be presented.

ST 3.4 Tue 11:45 PC 203

Progress of a Geant4 Simulation for the SiFi-CC Compton camera project in proton therapy — •Linn Mielke[1], Achim Stahl[1], Ronja Hetzel[1], Alexander Fenger[1], Jonas Kasper[1], Monika Kercz[1,2], Magdalena Kołodziej[2], Magdalena Rafecas[3], Katarzyna Rusiecka[2], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland — [3]Institute of Medical Engineering, University of Lübeck

Proton therapy is a clinically established cancer treatment characterized by its precise dose deposition. However, a prerequisite to this advantage is that there are no discrepancies between what is foreseen by the treatment plan and the actual deposition. One approach to monitor such shifts is to detect the prompt gamma radiation from the proton interactions inside a patient. The SiPM and scintillating Fiber-based Compton Camera (SiFi-CC) project is an example of this approach. The full camera consists of a scatterer and an absorber, both of which are constructed by layering LYSO fibers read out in SiPMs. Ideally, the origin of each detected prompt gamma lies somewhere on the surface of its associated Compton cone. With enough cones, the position of the Bragg peak can be inferred. The concept is tested in a multi-step Geant4 simulation, where a beam shift can be artificially generated and retrieved. This talk will focus on the simulation side of the project, its structure and results as well as recent developments.

ST 4: AI in Medicine

Time: Wednesday 9:30–10:30 Location: PC 203

ST 4.1 Wed 9:30 PC 203

Enhancing Brain Tumor Characterization through Machine Learning on Raw MRI K-Space Data — •Marco Schlimbach[1], Jens Kleesiek[2], Kevin Kröninger[1], Moritz Rempe[2], and Jens Weingarten[1] — [1]TU Dortmund University — [2]Institute for AI in Medicine (IKIM)

Differentiating brain tumor types is a diagnostic challenge, influencing subsequent therapeutic decisions. Clinics employ various methods to examine tumors, including biopsies and Magnetic Resonance Imaging (MRI). One goal of research is the improvement of MRI-based tumor characterization to avoid invasive biopsies. Numerous Machine Learning (ML) approaches have been developed to enhance tumor classification in MRI scans. However, most of these methods use the final images created by MRI scanners through a complex reconstruction pipeline, involving filtering operations. This process, aimed at producing human-interpretable images, loses phase information of the complex-valued raw MRI data, which potentially has diagnostic value.

In an ongoing data acquisition process from our medical partners, raw data, known as k-space data, is extracted from clinical MRI scans to create a new unique dataset. The k-space is hypothesized to reveal new features for the characterization of tumors. This work introduces the innovative approach of applying ML techniques directly to this MRI k-space data. It aims to utilize the complete information of the raw MRI data by using different complex-valued neural network architectures. A generative neural network approach is introduced with the objective to produce synthetic k-space data.

ST 4.2 Wed 9:45 PC 203

Fast Dose Prediction in Microbeam Radiation Therapy (MRT) Across Varied Field Angles. — •Tobias Cremer[1], Cornelius Grunwald[1], Kevin Alexander Kröninger[1], Jens Weingarten[1], Marco Schlimbach[1], and Florian Mentzel[2] — [1]TU Dortmund, Germany — [2]formally TU Dortmund, Germany

Microbeam radiation therapy stands as a promising preclinical approach to treating tumors, offering enhanced post-treatment outcomes. It uses a multi-slit collimator to create dosis peaks with high doserates and valleys in between with lower doserates. This spacial segmentation of the beam and high doserates over small amounts of time (FLASH-Therapy) leads to a higher survivability rate of the healthy tissue. For clinical implementation

This project builds upon prior research which demonstrated the suitability of Machine Learning for dose prediction. This work involves training a neural network capable of predicting doses for diverse field angles. Initially, training data are simulated for basic volumes as a proof of concept. Using this training data, a 3D U-Net will be trained to predict the corresponding dose deposition. Subsequently, the developed prediction model for basic volumes will be adapted to function with CT data imported into the Geant4 Simulations.

The presentation will showcase recent outcomes from the mentioned project, featuring initial results from the basic simulation and insights into the corresponding neural network utilized for dose prediction.

ST 4.3 Wed 10:00 PC 203

Entwicklung und Überprüfung eines Ensemble Learning basierten Entscheidungsunterstützungssystems. — •Jonathan Berthold, Carlos Brandl, Anna Nitschke, Jannis Demel und Matthias Weidemüller — Physikalisches Institut, Universität Heidelberg, Heidelberg, Deutschland

Die Durchführung vermeidbarer invasiver Eingriffe, wie beispielsweise einer Biopsie, stellt eine unnötige Belastung sowohl für Kliniken als auch für Patienten dar. Eine auf Machine Learning basierende Entscheidungsunterstützung bietet einen vielversprechenden Ansatz zur präziseren Diagnosestellung und zur Reduzierung unnötiger Eingriffe. Für die spezifische Entscheidung zur Durchführung einer Biopsie bei einem Verdacht auf ein malignes Prostatakarzinom haben wir ein Entscheidungsunterstützungssystem entwickelt. Es basiert auf Ensemble-Learning und bietet Ärzten Interpretationsmöglichkeiten für die Vorhersagen. In diesem Vortrag wird eine Untersuchung vorgestellt, die den Einfluss des Systems auf ärztliche Entscheidungen überprüft. Diese Untersuchung wurde unter Mitwirkung von zwei Urologen des Universitätsklinikums Heidelberg durchgeführt.

ST 4.4 Wed 10:15 PC 203

Prediction of Chronic Disease for improved screening on large scale population Data — •Carlos Brandl, Anna Nitschke, Jonathan Berthold, Jannis Demel, Carola Behr, and Matthias Weidemüller — Physikalisches Institut, Universität Heidelberg, Deutschland

Chronic Diseases threaten a lot of individuals worldwide and are a major cause of mortality. Early detection by Screening is effective in reducing severity and improving the quality of life. However, early screening is often not accepted or even available to the individual, the latter being a big problem in developing countries. To overcome this, we are developing a prediction system using Machine Learning and Network-based approaches on different granularities of large-scale population data in India. The first results have been obtained based on a large publicly available dataset ranging from socio-economical data to behavioural to biological factors. Ultimately our goal is to allow public health professionals to identify population groups at risk and improve their access to screening capacities.

ST 5: Poster Session

Time: Wednesday 11:00–12:30 Location: Poster A

ST 5.1 Wed 11:00 Poster A

Angle-dependent light scattering in the case of thin bone layers for the application of optical cochlear implants — •Tom Witke[1], Fabian Teichert[2,3,4], and Angela Thränhardt[1] — [1]Institute of Physics, Chemnitz University of Technology, Chemnitz, Germany — [2]Fraunhofer Institute for Electronic Nano Systems (ENAS), Chemnitz, Germany — [3]Center for Microtechnologies, Chemnitz University of Technology, Chemnitz, Germany — [4]Center for Materials, Architectures and Integration of Nanomembranes (MAIN), Chemnitz University of Technology, Chemnitz, Germany

Understanding light scattering in human tissue is essential for the further development of optical cochlear implants. We investigate this using Monte-Carlo simulations and an analytical approach. The focus in simulation and analytics is on the investigation of phase functions that can model the properties of tissue best. Here we will present a phase function that has the same precision as a calculated distribution and yet has all the advantages of an analytical function, and show how multiple scattering and corresponding transmissions can be calculated analytically and compared with Monte-Carlo simulations.

ST 5.2 Wed 11:00 Poster A

Advanced nano-CT with laboratory X-ray radiation: optimization of geometry and anode material — •Claas Warnecke, Paul Meyer, Jordi Carstens, and Tim Salditt — Institute for X-ray physics, University of Göttingen, Germany

Phase-contrast tomography of biological tissue with laboratory X-ray sources is a quickly advancing imaging modality which opens up new possibilities for three-dimensional virtual histology and clinical pathohistology, to be performed in hospitals rather than at synchrotron sources.

In this work, a 3D virtual histology setup is realized using a nanofocus X-ray tube with a cone-beam geometry, as well as scintillation and direct photon-counting detectors. The focus of this work is the optimization of the experimental parameters of the setup including focal spot size and photon flux, magnification and phase contrast. The X-ray tube also allows for an easy exchange of anodes that makes a quantitative comparison between different anode materials possible, including tungsten, copper and molybdenum. The results are compared to data from a synchrotron source.

ST 5.3 Wed 11:00 Poster A

Unravel patterns of chronic diseases in India using Graph Networks — •Carola Behr, Anna Nitschke, Jannis Demel, Jonathan Berthold, Carlos Brandl, and Matthias Weidemüller — Physikalisches Institut, Universität Heidelberg, Deutschland

To uncover insights from complex and diverse medical datasets, Network Science and Graph based approaches can play an important role. Based on the DHS 2019-2021 dataset from India, we apply different methods to gain a deeper understanding of the prevalence of chronic diseases. In this poster we present the application of techniques such as Community Detection, which aims to identify inherent structures within the dataset, and Graph Convolutional Networks, designed to exploit the rich relational information embedded in the data. Our goal is first to uncover the nuanced connections of socio-economical parameters and biological parameters within that dataset using advanced network-centric methodologies and second improve the disease management for individuals and the health care system.

ST 5.4 Wed 11:00 Poster A

Development of a Monte Carlo computational software and its application in Medical physics — •Milena Živković and Dragana Krstić — University of Kragujevac, Kragujevac, Serbia

The FOTELP-VOX code (author R. Ilić), with its advanced Monte Carlo techniques and precise dose distribution analysis, serves as a versatile tool applicable not only to particle transport simulations but also to the field of radiotherapy, including the specific application of the gamma knife. The software*s adaptability allows for its integration into radiotherapeutic practices, contributing to optimizing radiation treatments with a high degree of precision. The capability to model radiation interactions within the human body, coupled with the flexibility to customize parameters such as beam type, shape, and energy levels, positions FOTELP-VOX as a valuable asset in the planning and refining of radiotherapeutic interventions. For post-simulation analysis, the deposited energies, measured in either MeV/kg or Gy, are recorded in the REDOSE.TXT and SLIKA.DAT output files. These files, in conjunction with CT anatomy data, serve as the foundation for visualizing slices of the anatomy and the corresponding deposited doses in the individual voxels. In summary, FOTELP-VOX*s versatility makes it a powerful tool not only for general radiotherapeutic applications but also for addressing the unique challenges and requirements of gamma knife procedures, ultimately aiding in improving patient outcomes.

ST 5.5 Wed 11:00 Poster A

Cell Irradiation Experiments and Film Dosimetry with Low Energy Electrons from a Compact Ultrafast Electron Source — •Julian Freier[1], Bastian Löhrl[1], Leon Brückner[1], Christoph Bert[2], Luitpold Distel[3], and Peter Hommelhoff[1] — [1]Department Physik, FAU Erlangen-Nürnberg — [2]Department Medizinische Strahlenphysik, Universitätsklinikum Erlangen, FAU — [3]Department Strahlenbiologie, Universitätsklinikum Erlangen, FAU

Millimeter-sized accelerators could provide new opportunities for radiotherapy [1]. Such a chip-based (electron) accelerator using nanophotonic structures driven by femtosecond laser pulses could be built into an endoscopic system and be used for highly localized cancer treatment, for example. Motivated by this goal, we present the successful implementation of a cell irradiation experiment using pulsed 40 keV electrons, which coincides with the latest electron energy achieved in an accelerator on a chip [2]. The femtosecond laser-triggered compact electron source can provide currents of few fA on the sample position. Irradiation-induced DNA double strand break damages are detected and visualized in different types of cells through gH2AX immunofluorescence staining. Furthermore, the first signs of high radiation severity have been shown with colony formation assay and damage after long repair times. For dosimetry, unlaminated EBT3 GafChromic films are investigated on their response and efficiency to low energy electron radiation and are compared with X-Ray radiation. [1]*England, et al. "Dielectric laser accelerators." RMP 86, 1337 [2]*Chlouba, et al. Nature 622, 476 (2023).

ST 5.6 Wed 11:00 Poster A

Comparison of the proton therapy doses obtained with the Geant4 and matRAD — •Mariam Abuladze[2], Achim Stahl[1], Ronja Hetzel[1], and Revaz Shanidze[2,3] — [1]RWTH Aachen University, Aachen, Germany — [2]Kutaisi International University, Kutaisi, Georgia — [3]Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia

Proton therapy is a high-quality radiation therapy that uses a proton beam to irradiate cancer tissue. The advantage of this type of treatment is a highly conformal dose deposition due to the presence of the Bragg peak. The treatment planning systems (TPS) which are used for calculation of delivered doses in radiation therapy are usually based on semi-analytical methods and hence are less precise than Monte-Carlo technique. GEANT4 is the most well-developed software platform for the simulation of the passage of particles through matter using Monte Carlo methods. It can calculate delivered doses with high accuracy, by considering all the possible particle matter interactions which can occur during proton passage into tissue. MatRad is well-known opensource TPS software for intensity-modulated photon, proton, and carbon ion therapy, which is actively used for educational and research purposes. In this work we compared dose distributions in matRad and Geant4 by executing matRad with the help of Octave platform which makes it possible to extract beam parameters generated by matRad optimization algorithms and then simulating it in Geant4 monte-carlo simulation for the same patient phantom and see how DVH obtained from both simulations differ.

ST 5.7 Wed 11:00 Poster A

From a single to a multi-channel array Prompt Gamma detection system based on PETsys Electronics — •Olga Novgorodova and Arno Straessner — IKTP TU Dresden, Dresden, Germany

Prompt Gammas (PG) in proton therapy are one of the developing techniques for non-invasive measurement of the in-vivo proton range. For the prompt gamma timing (PGT) application, we have successfully characterized a single channel system of a $CeBr_3$ crystal read out by a SiPM based on PETsys Electronics. Both time and spectral characteristics achieved the required resolution. Measurements at the OncoRay TU Dresden facility with energies between 100 and 162 MeV protons suffered from very low statistics for a single channel. We investigated several multi-channel arrays that were read out by Hamamatsu SiPMs with 3x3 mm^2 dimensions and 50 μm microcells, as well as by Sensl SiPMs with 6x6 mm^2 dimensions and 35 μm microcells, and Hamamatsu SiPMs with 6x6 mm2 dimensions and 25 and 50 μm microcells. We present our investigation of system characteristics, including crosstalk and homogeneity, as well as energy and time spectra using multi-channel $CeBr_3$ crystal array.

ST 6: Medical Imaging Technologies

Time: Wednesday 15:00–16:15 Location: PC 203

ST 6.1 Wed 15:00 PC 203

Piezo-Optic Power Calibration of Nonlinear and Shocked Ultrasound in Real Time — •Milan Fritsche, Johannes Köppl, Luis Guillermo, and Florian Steinmeyer — Technische Hochschule Nürnberg Georg Simon Ohm, Deutschland

Calibration of ultrasound transducers - used in medical diagnostics and therapies like lithotripsy or thermal ablation - is cumbersome: Standard is a radiation-force-balance calibration with time resolution of 1s-2s, where a target is irradiated off-focus to avoid damage. Hydrophones measure acoustic pressure over hours. They are easily destroyed by cavitation, suffer from reflections and exhibit resonances in the frequency response.

The piezo-optic effect is the change of the refractive index under pressure. A Schlieren imaging system consists of a LED with a collimator illuminating the acoustic wavefield in water, a focussing "Schlieren lens", a knife-edge at the lens focus (blocking parts of the Fourier plane) and a camera. Light is refracted proportional to pressure gradients integrated along the light path. The camera records the wavefield in a real image. It is very sensitive to the precise knife edge position, thus not useful for calibration.

In our procedure a CMOS sensor replacing the knife edge records intensity over the full Fourier plane. The intensity variance displays a linear dependence on acoustic power - so far over more than two orders of magnitude (0,5W-150W). This allows for robust calibration of acoustic power even of shock waves with real time resolution of sub-milliseconds.

ST 6.2 Wed 15:15 PC 203

Seeing Sound: Real-Time Schlieren Imaging of Ultrasound Wavefields — Milan Fritsche, Adrian Dittmaier, Maximilian Jahrsdörfer, and •Florian Steinmeyer — Technische Hochschule Nürnberg Georg Simon Ohm

In 1864 August Toepler visualised acoustic waves by Schlieren imaging. Modern components as aspherical lenses, LEDs, CMOS-sensors expand the method to short timescales and a broad range of amplitudes. We demonstrate a number of novel applications.

The piezo-optic effect is the sensitivity of the refractive index to pressure. Our in-line Schlieren setup consists of a LED illuminating the acoustic wavefield of a transducer in water through a collimating lens. Light is refracted proportional to the pressure gradient integrated along the light path. Downstream, a "Schlieren lens" condenses light onto a knife-edge at the lens focus (blocking unrefracted light, yielding a dark field image of the waves). Eventually, a digital camera reconstructs a real image.

By illuminating stroboscopically (frequency 0.5-8 MHz, acoustic power 50mW-150W) a propagating wave appears frozen, images are very sharp. It is shown that the projection of a radially-symmetric ultrasound field is converted into a tomogram of a central symmetry plane. While wave intensity is hard to quantify, field geometry can be evaluated, e.g. wavelength, phase, focal position, distortion by shocks, propagating or standing waves, reflection, cavitation. As a means of quality assurance beam steering in array transducers and/or manufacturing errors can be detected - down to sub-millisecond shutter speed.

ST 6.3 Wed 15:30 PC 203

NeuroMap: Human magnetic particle imaging scanner for brain perfusion — •Liana Mirzojan[1,2], Jan-Philipp Scheel[1,2], Florian Sevecke[1,2], Eric Aderhold[1], Egor Kretov[1], Pascal Stagge[1], Mandy Ahlborg[1], and Matthias Graeser[1,2] — [1]Fraunhofer Research Institution for Individualized and Cell-Based Medical Engineering IMTE, Lübeck — [2]Institute of Medical Engineering, University of Lübeck, Lübeck

In the ever-evolving landscape of medical imaging Magnetic Particle Imaging (MPI) emerges as a new imaging modality that harnesses the unique properties of superparamagnetic nanoparticles, offering high contrast and high sensitivity, with an absence of ionizing radiation. Despite its advantages the development of robust human applications has proven to be a challenge, therefore MPI is still mostly pre-clinical. There are several challenges in scaling a pre-clinical scanner to human size, especially in the most crucial parts, which are the drive and the selection field generators. Main reason for this challenge is the rising power dissipation when scaling to human size. Currently there is a lack of bedside imaging equipment in intensive care units for stroke patients. The aim of the NeuroMap project is to close this gap with a low-field magnetic particle imaging bed-side system. In this work a novel human MPI scanner for stroke monitoring will be demonstrated. Both the drive field and selection field have been optimized with a focus on a clinical application with high patient safety and a performance-efficient design.

ST 6.4 Wed 15:45 PC 203

Imaging local diffusion in microstructures using NV-based pulsed field gradient NMR — Fleming Bruckmaier[1], •Robin D. Allert[1], Nick R. Neuling[1], Philipp Amrein[2], Sebastian Lettin[2], Karl D. Briegel[1], Maxim Zaitsev[2], and Dominik Bucher[1] — [1]Department of Chemistry, Technical University of Munich, 85748 Garching, Germany — [2]Division of Medical Physics, University of Freiburg, Freiburg, Germany

Investigating diffusion phenomena within microstructures holds significant importance across scientific domains such as neuroscience, cancer research, and energy research. While magnetic resonance methods are widely employed for quantitative diffusion measurements, their sensitivity in resolving and measuring molecular diffusion within individual microstructures remains limited. This research introduces an innovative tool for exploring diffusion at a microscopic scale by utilizing nitrogen-vacancy (NV) center-based nuclear magnetic resonance imaging (MRI). Our experimental framework integrates pulsed gradient spin echo (PGSE) with optically detected NV-NMR spectroscopy, enabling precise quantification of molecular diffusion and flow within nano-to-picoliter sample volumes. Through correlated optical imaging with spatially resolved PGSE NV-NMR experiments, we showcase the potential of this methodology to investigate local anisotropic water diffusion within a representative microstructure. This approach expands current capabilities in exploring diffusion processes to the microscopic scale, thereby facilitating investigations into single cells, tissue microstructures, and ion mobility in thin film materials.

ST 6.5 Wed 16:00 PC 203

Bildgebung statt Biopsie — •Mona Pistel — Universitätsklinikum Erlangen, Radiologisches Institut

Um auffällige Läsionen im Brustkrebs-Screening weiter klassifizieren zu können, führen Ärzte häufig eine Brustbiopsie durch. Biopsien bringen sowohl eine körperliche wie auch psychische Belastung für die betroffenen Frauen mit. In bis zu 50 % aller Biopsien erweist sich die untersuchte Läsion als gutartig. Dies verdeutlicht den großen Bedarf an einem präziseren und bestenfalls nicht invasiven Tool in der Brustkrebsdiagnose. Die diffusionsgewichtete MRT (DWI) ist ein solches Verfahren, mit dem nicht-invasiv und zudem ohne Verwendung von Kontrastmittel zwischen gutartigen und bösartigen Brustläsionen differenziert werden kann. DWI misst die durch thermische Energie zustande kommende Brownsche Molekularbewegung im Körper. Da bösartige Läsionen eine höhere Zelldichte haben als gutartige, ist die Diffusion der Moleküle in bösartigen Läsionen eingeschränkter als in gutartigen. Neben der Klassifizierung der Läsionen wurde die DWI in dieser Studie auch für die Untersuchung molekularer Eigenschaften von Brustkrebs genutzt. Diese molekularen Eigenschaften können wichtige Hinweise auf den Verlauf der Erkrankung sowie die Wahl der richten Therapie geben. Standardmäßig werden die molekularen Eigenschaften durch eine Biopsie gewonnen. Durch die Heterogenität der Läsionen kommt es jedoch in bis zu 20% der Fälle zu Unterschieden zwischen den Ergebnissen der Biopsieprobe und der postoperativen Probe. Durch die holistische Betrachtung kann DWI hier einen Mehrwert liefern.

ST 7: DPG meets DGMP

Time: Wednesday 16:30–18:00 Location: PC 203

Invited Talk ST 7.1 Wed 16:30 PC 203

Elekta Unity-Beschleuniger; Neue Wege in der Strahlentherapie Technische Lösung * Klinischer Workflow * Projektumsetzung — •Michael Rossi — Elekta GmbH Borsteler Chaussee 49, 22453 Hamburg

Elekta Unity * MR-Beschleuniger Neue Wege in der Strahlentherapie Technische Lösung * Klinischer Workflow * Projektumsetzung

Präsentiert wird die technische Umsetzung von der ersten Entwicklung in UMC Utrecht bis zur klinischen Realisierung durch Elekta. Fokussiert wird dabei auf den klinischen Workflow, den klinischen Nutzen und Gating-Verfahren (CMM). Im Weiteren wird auf die projektseitige Umsetzung intensiv eingegangen. Dies umfasst das Projekt selbst, die örtlichen Grundvoraussetzung für die Installation, das Schulungsprogramm für den Anwender und die physikalischen Aspekte des Trainings.

Elekta Unity - MR accelerator New ways in radiotherapy Technical solution - clinical workflow - project realisation

The technical implementation from the first development in UMC Utrecht to the clinical realisation by Elekta will be presented. The focus is on the clinical workflow, the clinical benefits and the gating procedure (CMM). Furthermore, the project-side realisation is discussed in detail. This includes the project itself, the basic local requirements for the installation, the training programme for the user, and the physical aspects of the training.

Invited Talk ST 7.2 Wed 17:00 PC 203

About Mountaineers and Explorers: Frontiers of Ultrahigh Field Magnetic Resonance — •Thoralf Niendorf — Max Delbrück Center for Molecular Medicine in the Helmholtz Association, Berlin, Germany — Charite - University Medicine, Berlin, Germany

Progress in the understanding of ultrahigh field magnetic resonance (UHF-MR) physics provides meaningful technologies for the advancement of biomedical and diagnostic MRI. The argument for moving 7 T MRI into clinical applications is more compelling than ever. Images from these instruments have revealed new aspects of anatomy, function and physio-metabolic characteristics of the neurovascular and cardiovascular systems, as well as other organs with unparalleled detail. With 7 T human MRI now present in the clinic, there is increasing interest in exploring ever higher magnetic field strengths. That makes this a perfect moment to review the current state of UHF-MR. The presentation surveys the development of novel methodology and technology, frontier human studies, breakthrough clinical applications and future directions of UHF-MR. At the moment some of these new concepts and clinical applications are merely of proof-of-principle nature and vision, but they are compelling enough to drive the field forward. The speaker hopes to engage the interest of physicists, basic researchers and applied scientists, and particularly to attract young scientists and new entrants into the field. The presentation will convey the seeds of this vision and inspire you - as it has the speaker and his team - to become pioneers in these amazingly promising new areas of MR physics and biomedical research.

Invited Talk ST 7.3 Wed 17:30 PC 203

Halbach Magnets for Applications in Medical Physics — •Peter Blümler — University of Mainz, Institute of Physics, Mainz, Germany

In recent years permanent magnets with the design that was originally proposed by Klaus Halbach [1] have found an increasing number of uses in various fields of medical physics. Their first application was in accelerator designs, then in magnetic resonance [2], magnetic particle imaging [3] and magnetic guiding [4] of nanoparticles and larger objects (e.g. endoscopes). Many of these applications are still exploratory, mainly because the Halbach design is often considered to be very elegant and optimized but also very complicated.

This talk will introduce the concept, briefly explain the construction and then focus on certain features which are unique for this magnet design, e.g. creation of homogeneous magnetic fields or gradients of variable strengths, or magnets that can be opened or closed without force. To conclude on examples of applications in medical physics and potential uses in the future.

[1] K. Halbach, Nucl. Inst. Methods 169 (1980) 1-10 doi: 10.1016/0029-554X(80)90094-4

[2] P. Blümler and H. Soltner, (2023) Appl. Magn. Reason. 54 (2023) 1701-1739.doi: 10.1007/s00723-023-01602-2

[3] A. C. Bakenecker et al., Phys. Med. & Biol. 65 (2020) 195014 doi: 10.1088/1361-6560/ab7e7e

[4] P. Blümler, Cells 10 (2021) 2708 doi: 10.3390/cells10102708

ST 8: Accelerators for Medical Applications (joint session ST/AKBP)

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

ST 8.1 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

ST 8.2 Thu 9:45 PC 203

Dosimetry at low and ultra-high dose rates at FLASH-lab@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 FLASH-lab@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.

ST 8.3 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.

ST 8.4 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.

ST 8.5 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 ultra-short 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.

ST 8.6 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.

ST 9: Radiation Monitoring and Dosimetry

Time: Thursday 15:00–16:15 Location: PC 203

ST 9.1 Thu 15:00 PC 203

Neutron Dosimetry with Diamond Sensors — Claus Maximilian Bäcker[2], Christian Bäumer[2], Kevin Kröninger[1], Alina Landmann[1], •Jennifer Schlüss[1], Holger Stevens[1], and Jens Weingarten[1] — [1]TU Dortmund University — [2]West German Proton Therapy Center Essen

Neutron dosimetry is becoming increasingly relevant in proton therapy. From the neutrons released, conclusions can be drawn about the deposited energy in the body. However, the dosimetry is complicated because of their physical characteristics. One way to convert neutrons is using diamond sensors. The natural carbon isotope ^{12}C captures fast neutrons ($E_{kin} > 5$ MeV). ^{12}C produces alpha particles which can be detected in the diamond detector itself. The detection spectrum of diamond sensors is limited to fast neutrons. The goal is to make the detector sensitive to fast and thermal neutrons. To make the detector sensitive to thermal neutrons, an attempt is made to coat the detector with a converter material such as ^{6}LiF. ^{6}LiF has a large neutron absorption cross-section for thermal neutrons. The simulation platform Geant4 is used to test carbon capture reactions as a tool for further detector development. The results of the Geant4 simulation show that a diamond sensor coated with ^{6}LiF is suitable for measuring thermal and fast neutrons. A first prototype of a diamond sensor is ready to measure energy spectrums in proton therapy. To characterize the detection of the whole spectrum, the diamond sensor will be tested in a later step with a converter.

ST 9.2 Thu 15:15 PC 203

Neutron Detection With Coated Semiconductors — Kevin Alexander Kröninger, •Alina Johanna Landmann, and Jens Weingarten — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4a, 44227 Dortmund

3He is a popular element in neutron detection. However, the world is suffering from an extreme 3He shortage which increases the need for alternative neutron detection methods. Coated semiconductors represent a promising alternative for 3He gas-filled detectors in high flux particle fields. Typical environments with high particle fluxes are represented by (research) reactors. To make use of semiconductor detectors in lower particle flux environments, the detection efficiency has to be increased significantly. In Geant4 simulations, we investigated various neutron-converting materials and possible detector layouts capable of increasing the detection efficiency of neutron-detecting silicon detectors. Based on the simulation results, a first prototype with a single converter layer on top of a silicon sensor was built to investigate the detection principle. This prototype additionally allows the investigation of more complex detector layouts which will be presented in this talk.

ST 9.3 Thu 15:30 PC 203

Dose gradients for calibration of planar dosimeters in modern radiotherapy — •Stevan Pecic[1], Strahinja Stojadinovic[2], Ivan Belca[1], Ljubomir Kurij[3], Borko Nidzovic[4], and Slobodan Devic[5] — [1]Faculty of Physics, University of Belgrade, Belgrade, Serbia — [2]Department of Radiation Oncology, University of Texas Southwestern Medical Center, Dallas TX, USA — [3]University Clinical Center, Belgrade, Serbia — [4]Institute of Oncology and Radiology of Serbia, Belgrade, Serbia — [5]Medical Physics Unit, McGill University, Montreal, Canada

This investigation explores the importance of dose gradients in achieving accurate calibration for modern planar dosimeters. The focus was on the advantages of using dose gradients while identifying novel methodologies for gradient-based calibration. Radiochromic films were subjected to both conventional and cutting-edge gradient-based calibration techniques, including an in-depth examination of physical wedge calibration. The study investigated the problem of achieving the desired calibration dose range by identifying optimal gradient placement and the required number of exposures. The insights gained from physical wedge calibration demonstrated promising outcomes in terms of reliability and useability. Optimization studies on wedge gradient positioning indicated the potential for achieving uniformity with just a few exposures. Additionally, valuable insights were obtained regarding the measurement resolution. In summary, the presented method proves the synergistic interplay of using gradients and optimization, holding promise for broader application in contemporary medical physics.

ST 9.4 Thu 15:45 PC 203

A Two Plane Proton Imaging System Using ATLAS IBL Pixel Detectors — •Hendrik Speiser[1], Claus Maximilian Bäcker[2], Christian Bäumer[2], Jana Hohmann[3], Kevin Kröninger[1], Isabelle Schilling[3], Helen Thews[1], and Jens Weingarten[1] — [1]TU Dortmund — [2]West German Proton Therapy Center Essen — [3]Formerly TU Dortmund

For years, proton therapy is increasingly being used to treat cancer because of its well-known advantages, such as the high dose precision of protons. However, exploiting this precision requires improved imaging techniques to ensure accurate patient positioning and dose delivery. One such technique is proton radiography, where the residual energy distribution of protons after going through the patient is measured.

Former studies showed the feasibility of proton radiography using a single radiation hard ATLAS IBL pixel detector. In order to improve the energy resolution of the resulting images, a second pixel detector of the same kind and a water equivalent absorber between both detectors are used. Proof-of-concept simulation studies of a so-called Two-Plane-System showed promising results. Thus, the aim of the project is to realize such a system and investigate the yielded energy resolution. To this purpose, first measurements were conducted at the West German Proton Therapy Centre in Essen.

This talk will briefly introduce the Two-Plane-System. Subsequently, first results concerning its realization with the ATLAS IBL pixel detector and future steps of the project are presented.

ST 9.5 Thu 16:00 PC 203

Optimizing the Energy Resolution of the ATLAS IBL Pixel Detector for Proton Imaging — Dennis Hermelyn, Kevin Kröninger, Hendrik Speiser, •Helen Thews, and Jens Weingarten — TU Dortmund, department of physics

In radiotherapy for cancer treatment, proton therapy is an important method because of the steep dose gradient which allows a conformale dose distribution in the tumour while protecting the healthy tissue. However, patient misalignment and the uncertainties of the calculated stopping power using the conversion of Houndsfield units lead to larger safety margins around the tumour.

One opportunity to decrease the uncertainties is the usage of proton radiography imaging. Investigations in the past showed the feasibility of proton range measurement with ATLAS IBL pixel detectors despite their limitations in energy resolution.

As part of a master thesis, the concept of superpixel tuning is studied to improve the energy resolution of the detector. A superpixel includes multiple pixel that have different fine tunings to measure adjacent small energy ranges. With that, besides the higher energy resolution a broader range of deposited energy in the detector can be measured. In addition a spatial resolution is maintained to obtain two dimensional images.

This talk will introduce the concept of superpixel tuning and discuss its technical realization. Subsequently, first results of the study about arising challenges in data post-processing are discussed. Finally, the achieved change of the energy resolution is shown.

ST 10: Prize Talk: Georg-Simon-Ohm-Prize

Time: Thursday 16:30–17:00 Location: PC 203

Prize Talk ST 10.1 Thu 16:30 PC 203

Ultrasonic Interferometric Procedure for Quantifying Prosthesis Loosening — •Jan Lützelberger — Institute of Sensor and Actuator Technology, Coburg University of Applied Sciences and Arts, Am Hofbräuhaus 1b, 96450 Coburg — Laureate of the Georg-Simon-Ohm-Prize 2024

Loosening of an artificial hip joint is a frequent complication in orthopedics and trauma surgery. Due to a lack of accuracy, conventional diagnostic methods such as projection radiography cannot reliably diagnose loosening in its early stages or detect whether it is associated with the formation of a biofilm in the bone-implant interface.

In this work, we developed an ultrasonic measurement procedure for quantifying the thickness of the layer between bone and prosthesis as a correlate to loosening. In principle, it also allows for the material characterization of the interface. An analytical model for the reflection of sound waves in a three-layer system was combined with a new data processing method to face the challenges of the specific medical application. By non-linear fitting the theoretical prediction of the model to the actual shape of the reflected sound waves in frequency domain, the thickness of the interlayer can be determined and predictions about its physical properties are possible. The presented approach was successfully applied to idealized test systems and a bone-implant system for thickness determination in the range of approx. $200\,\mu$m to $2\,$mm [1].

The talk will focus on the physical background and the key concepts of the procedure as well as on representative experiments, but also highlight its future potential in medical application.

[1] J. Lützelberger et al., Sensors 23, 5942 (2023)

ST 11: Prize Ceremony and Closing Session

In this last session we would like to take the opportunity to thank all participants for their attendance and contributions. We will announce the winner of this years award for the *Best contribution in the radiation and medical physics division at the DPG Spring Meeting 2024*. We welcome everyone to celebrate all prize winners and a successful conference with us, to provide some final feedback and to take the chance to meet again the other participants of this meeting.

Time: Thursday 17:00–17:30 Location: PC 203

Prize Ceremony and Closing Session

ST 12: Members' Assembly

Time: Thursday 18:00–19:00 Location: PC 203

All members of the Radiation and Medical Physics Division are invited to participate.