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

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Overview of Invited Talks and Sessions

(Lecture hall ZEU/0146)

Plenary Talk of ST

See PV for details.

PV VII	Thu	9:00– 9:45	HSZ/AUDI	**The role of artificial intelligence in modern radiation therapy** — •Guillaume Landry

Invited Talks

ST 4.1	Wed	14:00–14:20	ZEU/0146	**Innovationen in die Praxis bringen – die EXIST Gründungsförderung** — •Antje Dewitz
ST 4.2	Wed	14:20–14:40	ZEU/0146	**Development and Certification of an IGRT system** — •Claus Promberger
ST 4.3	Wed	14:40–15:00	ZEU/0146	**Klinische Anwendung von Protonen-/Partikeltherapie** — •Esther Troost
ST 10.1	Thu	17:30–18:00	ZEU/0146	**Online-adaptive particle therapy: Current status and vision for the future** — •Christian Richter

Sessions

ST 1.1–1.6	Tue	11:00–12:30	GER/038	**Accelerators for Radiation Therapy (joint session ST/AKBP)**
ST 2.1–2.6	Tue	17:00–18:30	ZEU/0146	**Medical Imaging Concepts**
ST 3.1–3.3	Wed	11:00–12:30	ZEU/0146	**Poster Session**
ST 4.1–4.3	Wed	14:00–15:30	ZEU/0146	**DPG meets DGMP: Von der Idee bis zur klinischen Anwendung**
ST 5.1–5.6	Wed	15:50–17:20	ZEU/0146	**Physics and Technology for Radiation Detection**
ST 6	Wed	17:45–18:45	ZEU/0146	**Members' Assembly**
ST 7.1–7.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
ST 8.1–8.6	Thu	14:00–15:30	ZEU/0146	**AI Topical Day – AI in Medicine (joint session ST/AKPIK)**
ST 9.1–9.6	Thu	15:50–17:20	ZEU/0146	**Radiation Therapy**
ST 10.1–10.1	Thu	17:30–18:00	ZEU/0146	**Keynote: Online-Adaptive Particle Therapy**
ST 11	Thu	18:00–18:15	ZEU/0146	**Prize Ceremony and Closing Session**

Members' Assembly of the Radiation and Medical Physics Division

Wednesday 17:45–18:45 Location: ZEU/0146

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.

ST 2: Medical Imaging Concepts

Time: Tuesday 17:00–18:30 Location: ZEU/0146

ST 2.1 Tue 17:00 ZEU/0146

Investigation of the prospects of BaF2 as a fast scintillator for TOF-PET — •Katrin Herweg, Vanessa Nadig, Volkmar Schulz, and Stefan Gundacker — Department of Physics of Molecular Imaging Systems, RWTH Aachen University, Aachen, Germany

Future time-of-flight positron emission tomography (TOF-PET) will be in need of ultra-fast scintillation, with potential seen in cross-luminescencent materials like BaF2, which shows a sub-100ps decay time with 300 photons produced per MeV. However, it poses challenges such as medium radiation length, low photofraction, moderate light yield and VUV emission around 200nm. A slow emission at 310nm presents an additional challenge, which has been addressed before by doping BaF2 with yttrium. Recent developments in UV-sensitive SiPMs (here manufactured by Hamamatsu) have the potential to establish cross-luminescence for ultrafast TOF in PET. In this work, we aim to study BaF2, read out by these new VUV SiPMs, as a viable alternative to LYSO:Ce:Ca. Comparing the coincidence time resolution (CTR) of air-coupled 2 x 2 x 20mm3 undoped and yttrium-doped BaF2 crystals to LYSO:Ce:Ca crystals of the same size, with high-frequency readout electronics, we reached 233ps with undoped BaF2 and 213ps with BaF2:Y. The performance of LYSO:Ce:Ca was 181ps with Hamamatsu SiPMs optimized for LYSO. Conducting measurements at different depth of interaction positions shows a pronounced impact on the CTR. Furthermore, we investigated the performance for systems of BaF2 with TOFPET2c ASIC measurements and Geant4 simulations for effective sensitivity comparisons to LYSO:Ce:Ca.

ST 2.2 Tue 17:15 ZEU/0146

Advancements in Energy Resolution for Positron Emission Tomography with light sharing Scintillation Crystals — •Matthias Bovelett[1], Florian Müller[1], Yannik Kuhl[1], Stephan Naunheim[1], David Schug[1,2], and Volkmar Schulz[1,2] — [1]Department of Physics of Molecular Imaging Systems, RWTH Aachen University — [2]Hyperion Hybrid Imaging Systems GmbH

Positron Emission Tomography (PET) is widely used in clinical and pre-clinical applications. Commercially available PET-detectors use arrays of segmented scintillators coupled to a SiPM matrix. Of current scientific interest are detectors using light sharing scintillators. In these, the scintillator covers multiple SiPM channels and, therefore, one gamma interaction shares the light among the optically coupled SiPM channels. Key parameters of the gamma interaction, i.e., interaction position, timing, and energy information, need to be reconstructed from the measured light distribution. To acquire a good energy resolution in PET it is necessary to filter out specimen scattered events, thereby reducing background, and improving the signal to noise ratio. This work presents a framework, in which a light sharing scintillator is divided in virtual voxels. For each voxel a dedicated energy calibration is performed. Different summation pattern of involved SiPM channels and their impact on the energy resolution are discussed, including events for which not all SiPM channels were read-out. For these "incomplete" light distributions ($\sim$ 15% of all) imputation strategies are presented. Overall, the presented strategies result in an improvement from 14% to below 12% for energy resolution of all events.

ST 2.3 Tue 17:30 ZEU/0146

Metamaterials for Magnetic Resonance Imaging — •Dennis Philipp — Fraunhofer Institute for Digital Medicine MEVIS, 28359 Bremen, Germany

Electromagnetic metamaterials (MTMs) offer manifold degrees of freedom in MRI applications. Most prominently, field homogeneity improvement and signal-to-noise ratio (SNR) enhancement are typical use cases. However, passive MTMs also have some drawbacks such as transmit field (Tx) deformations. Here, we pave the way towards dynamic and active MTMs, which overcome some of the open problems. Bluetooth-controlled, reconfigurable MTMs for signal-to-noise ratio (SNR) enhancement in MRI are presented. These metasurfaces allow to be wirelessly interfaced and tuned during an MRI scan by means of a digital capacitor (DCAP), which is connected to a low-power microcontroller with BLE capabilities. Two prototypes are manufactured, one of which is a metasurface with adjustable resonance frequency, and the second one is dynamically tunable at the meta-atom (unit cell) scale. It includes multiple DCAPS and, thus, is the first wirelessly reconfigurable MTM for MRI that offers field shaping capabilities, adjustable FoV, focal regions, sequence sync., and active Tx detuning. A MTM arrangement that encloses a volume "metaBox" is shown to yield a significant and volume-homogeneous SNR enhancement in 3T MRI. Due to the integration of non-linear components, the structure self-detunes in Tx whilst being resonant in Rx. Fine-tuning capabilities are included in two different prototypes via (i) a manually trimmable capacitor and (ii) a BLE controlled DCAP.

ST 2.4 Tue 17:45 ZEU/0146

Proton Radiography: An Overview and Outlook — Jana Hohmann, Kevin Kröninger, Isabelle Schilling, •Hendrik Speiser, and Jens Weingarten — TU Dortmund, department of physics

For years, proton therapy has been increasingly 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. This allows to reduce the safety margin around the target volume and protecting the surrounding healthy tissue.

One such enhanced imaging technique is proton radiography. It allows to take images whose properties are directly dependent on the proton interactions with the structures in the patient. Therefore, by measuring the residual energy of protons after passing through the patient, conclusions on the stopping power distribution in the patient can be drawn. Extending a proton radiogram to a CT allows to reduce the proton range uncertainty from the conversion of Hounsfield units into stopping power. However, even a single proton radiogram taken on the treatment day can be used to verify the predefined therapy plan and the correct patient positioning.

This talk will include an introduction into the topic of proton radiography followed by an overview of several proton radiography approaches. Subsequently, two new methods developed and investigated at the TU Dortmund University are presented and discussed.

ST 2.5 Tue 18:00 ZEU/0146

A Two-plane Spectral Proton Radiography System using Silicon Pixel Detectors — •Jana Hohmann, Kevin Kröninger, Isabelle Schilling, Hendrik Speiser, Jens Weingarten, and Jolina Zillner — TU Dortmund University, Germany

To take advantage of the locally high dose in proton therapy the irradiation must be planned precisely. X-Ray CT images are used for this purpose. However, when Hounsfield units are converted to the stopping power of the material, this entails a range uncertainty in the treatment plan, which can lead to unintentional radiation damage in healthy tissue or to missing dose in the tumor.

To avoid this, the stopping power of the protons can be determined via imaging techniques with protons themselves. This could be used to verify and adjust the existing irradiation plan.

One attempt is a two-plane system that is designed to measure the water equivalent thickness (WET) directly, from which the stopping power can be calculated. Two pixelated silicon detectors with an absorber in between track the deposited energies of individual protons. With a reference measurement and the initial proton energy, the WET of a phantom can thus be determined.

The detector design is simulated and optimized in GEANT4. This is then used to determine the 2D WET distribution of a known phantom. The talk summarizes the simulation results and provides a comparison to the single plane method.

ST 2.6 Tue 18:15 ZEU/0146

Experimental characterization and comparison of two Si-based compact setups for proton radiography and tomography of small animals for image-guided proton irradiation — •Angelica Noto[1], Guyue Hu[1], Katrin Schnürle[1], Matthias Würl[1], Franz Englbrecht[1], Johannes Gebhard[1], Julie Lascaud[1], Marco Pinto[1], Ze Huang[1], Jonathan Bortfeldt[1], Mateusz Sitarz[2], Per Poulsen[2], and Katia Parodi[1] — [1]Medical Physics Department, LMU, Munich, Germany — [2]Danish Center for Particle Therapy, Aarhus University Hospital, Aarhus, Denmark

In the project SIRMIO we develop advanced imaging for positioning and treatment planning to aid precise proton irradiation of small animals.In contrast to the widely adopted X-ray cone beam CT, the project integrates 3 solutions of proton imaging. Here, we compare 2 approaches that provide spatially resolved detection of individual or integral proton energy deposition relying on the commercial Timepix3 or Lassena Si-based pixelated detectors. Proton radiographs were acquired at the Danish Center for Particle Therapy for a calibration phantom housing inserts of well characterized relative stopping power values. We will compare the achievable spatial resolution and accuracy of water equivalent thickness retrieval in radiographic mode for different systems and imaging doses. Moreover, ongoing acquisitions of tomography with the Timepix3 will be presented for the calibration phantom and a dedicated mouse-like phantom. The work is supported by EU through the grant agreements 725539, 730983 and 101008548. The authors would like to thank Nordson and Advacam.

ST 3: Poster Session

Time: Wednesday 11:00–12:30 Location: ZEU/0146

ST 3.1 Wed 11:00 ZEU/0146

Large-area-diode based micro-dosimeter concept for a femto-satellite — Roman Bergert, •Nico Krug, Hans-Georg Zaunick, and Kai-Thomas Brinkmann — II. Physics Institute Justus-Liebig-University Giessen

A low-budget micro-dosimeter concept based on a large area diode (5×5 mm^2 sensitive area) and commercial of-the-shelf (COTS) components is designed and integrated to operate on an open-community femto-satellite platform provided by *AmbaSat Ltd.* The satellite platform is limited to a dimension of (3.5×3.5 cm^2) with a space of about 2×2 cm^2 for the dosimeter concept. Besides this challenge of space for the integration of the electronics on the platform, the challenge to operate in free harsh-space environment (radiation, vacuum, temperature) has to be overcome in the concept design. To target these challenges, several stress tests were performed, which will be presented with a performance mapping of the different components for their physical and electrical properties together with a discussion of the device performance.

ST 3.2 Wed 11:00 ZEU/0146

Systematic study of a large data set of CT scans with regard to diagnostic reference levels — •Hanna Eick[1], Lydia Bock[1], Jans Böing[1], Lennart Henkenherm[2], Norbert Lang[2], Christina Westphälinger[2], and Alfons Khoukaz[1] — [1]Institute for Nuclear Physics, Westfälische Wilhelms-Universität Münster — [2]Gesellschaft für Medizinische Physik und Strahlenschutz mbH, Münster

Diagnostic reference levels (DRL) for examinations on humans with ionizing radiation or radioactive sources are reviewed or updated if necessary every three years. These DRLs are determined and published by the Federal Office for Radiation Protection and are based on the data provided by the medical authorities. Each operator of a device with the mentioned types of radiation must provide review values to the medical authorities every two years. The collaboration of our working group from the WWU Münster with the 'Gesellschaft für Medizinische Physik und Strahlenschutz mbH' makes it possible, on the one hand, to analyze a large data set of CT examinations from different devices in various facilities and to shed more light on the DRLs and on the other hand, to develop an analysis program, which enables a fast and uncomplicated evaluation of the recorded data for every CT scanner. The results will be considered in particular in the context of the update of the DRLs published in November 2022 and to the reference levels valid until then. The analyses also make it possible to establish new DRLs for examinations that have not yet been considered.

ST 3.3 Wed 11:00 ZEU/0146

Cell irradiation experiments using a compact ultrafast electron source — •Bastian Löhrl[1], Leon Brückner[1], Julian Freier[1], Luitpold Distel[2], and Peter Hommelhoff[1] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]Department Strahlenbiologie, Universitätsklinikum Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91054 Erlangen

Dielectric laser acceleration (DLA) could provide new opportunities for radiotherapy [1]. The goal is to build a chip-based (electron) accelerator using nanophotonic structures driven by femtosecond laser pulses. Built into an endoscopic system, such a novel mini-accelerator could 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 electrons. The setup provides a custom-made, compact electron source with adjustable beam energies up to 30 keV. An integrated electrostatic lens enables focusing of the emitted electron beam. The source can provide several thousand electrons per laser pulse. Irradiation-induced DNA double-strand breaks are detected and visualized in different types of cells through γH2AX immunofluorescence staining. We report on the current status of the experiment and the results of the first measurements.

[1] England, R. Joel, et al. "Dielectric laser accelerators." Reviews of Modern Physics 86.4 (2014): 1337.

ST 4: DPG meets DGMP: Von der Idee bis zur klinischen Anwendung

Time: Wednesday 14:00–15:30 Location: ZEU/0146

Invited Talk ST 4.1 Wed 14:00 ZEU/0146

Innovationen in die Praxis bringen – die EXIST Gründungsförderung — •Antje Dewitz — Projektträger Jülich, Berlin, Germany

Seit 1998 fördert das EXIST-Programm des Bundesministeriums für Wirtschaft und Klimaschutz Existenzgründerinnen und -gründer aus der Wissenschaft, kofinanziert durch den Europäischen Sozialfonds. Durch Start-ups aus Universitäten und Forschungseinrichtungen gelangen Innovationen besonders schnell in die industrielle Praxis und die Gesellschaft. Außerdem entstehen so neue qualifizierte Arbeitsplätze. Wissenschaftlerinnen und Wissenschaftler können im eigenen Start-up auf Grundlage ihrer Forschungsergebnisse innovative Produkte oder Dienstleistungen entwickeln und in die Praxis bringen. Die finanzielle Unterstützung des EXIST-Programms mindert dabei das individuelle Risiko der Gründenden in der Anfangszeit. Außerdem stehen Sachmittel zur Verfügung, um die technische Machbarkeit zu belegen oder einen Prototypen zu bauen. Und durch betriebswirtschaftliche Beratungsangebote und individuelles Coaching wird unternehmerisches Handwerkszeug vermittelt. EXIST ist themenoffen und fördert wissenschaftlich basierte Gründungen von Agrarwissenschaft bis Zivilschutz. Fördervoraussetzung ist eine technische Innovation oder eine neuartige innovative Dienstleistung. Zudem muss erkennbar sein, dass die Idee vom Gründungsteam wirtschaftlich erfolgreich umgesetzt werden kann und grundsätzlich ein Markt vorhanden ist. Ein besonders anspruchsvolles Technologiefeld für Unternehmensgründungen stellt die Medizintechnik dar. Mehr Informationen zu EXIST: www.exist.de

Invited Talk ST 4.2 Wed 14:20 ZEU/0146

Development and Certification of an IGRT system — •Claus Promberger — Brainlab AG, München

As a mid-size company we decided several years ago to redesign a successful IGRT product line to follow current and upcoming regulations and standards in development, verification, validation and certification processes. The journey will be presented which ends again in a successful product and even in a nomination for the "Deutsche Zukunftspreis". The focus will be on the necessary tasks and timeline to bring a fully MDR certified product consisting of software and hardware components to the market in the EU and to keep it there.

Invited Talk ST 4.3 Wed 14:40 ZEU/0146

Klinische Anwendung von Protonen-/Partikeltherapie —

•Esther Troost — OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

Partikeltherapie, insbesondere Protonentherapie, wird aktuell an zahlreichen Zentren in Deutschland und Europa als Alternative zur herkömmlichen Photonentherapie angeboten. In diesem Vortrag werden die Unterschiede in der Dosisverteilung zwischen Photonen- und Protonentherapie, die Indikationen für eine Protonentherapie sowie der bisher bewiesene Mehrwert von Partikeltherapie dargestellt.

Round Table Discussion (30 min)

ST 5: Physics and Technology for Radiation Detection

Time: Wednesday 15:50–17:20 Location: ZEU/0146

ST 5.1 Wed 15:50 ZEU/0146

Measuring the beam energy at a proton therapy facility using ATLAS IBL pixel detectors — •Isabelle Schilling[1], Claus Maximilian Bäcker[1,2,3,4], Christian Bäumer[1,2,3,4], Carina Behrends[1,2,3,4], Marius Hötting[1], Jana Hohmann[1], Kevin Kröninger[1], Beate Timmermann[2,3,4,5], and Jens Weingarten[1] — [1]TU Dortmund University, Department of Physics, D-44221 Dortmund — [2]West German Proton Therapy Centre Essen, D-45122 Essen — [3]West German Cancer Center, D-45122 Essen — [4]University Hospital Essen, D-45122 Essen — [5]Clinic for Particle Therapy, University Hospital Essen, D-45122 Essen

The accurate measurement of beam range for quality assurance (QA) in proton therapy is important for optimal patient treatment. Conventionally used detectors mostly calculate the energy by detecting the depth dose distribution of the protons. In contrast to this, the ATLAS pixelated silicon detector measures the deposited energy in the sensor for individual protons, allowing the determination of the Linear Energy Transfer (LET). The restriction on the dynamic energy range of the measurement is given by the readout chip. Hence, there are different ways to use the detector whose applicability is being examined. An absorber with different thicknesses is used to investigate the variation of the charge production in the sensor and perform an energy calibration relative to the NIST PSTAR database. In comparison, this talk also presents measurements of the LET per pixel along the trajectory of individual proton, all performed at the West German Proton Therapy Centre Essen.

ST 5.2 Wed 16:05 ZEU/0146

Development of a Compton Camera with detection of electrons' interaction point and energy in the scattering layer using Cherenkov photons — •Kaveh Kooshk[1], Reimund Bayerlein[2], Ivor Fleck[1], Ulrich Werthenbach[1], and Michael Ziolkowski[1] — [1]Universität Siegen, NRW, DE — [2]University of California Davis, CA, US

A Compton Camera can be a great real-time imaging asset for Proton Beam Therapy cancer treatment and radio-immunotherapy. The main goal is imaging of gammas above 0.5 MeV, which cannot otherwise be resolved by conventional detectors such as SPECT with good efficiency. To that end, we designed an experimental setup which reconstructs Compton electron's energy and direction using coincident detection of Cherenkov photons. In order to calibrate the energy estimation, we built a device which separates electrons with energies up to 2.28 MeV from a 90Sr/90Y source to a very small spectrum using a magnetic field. The electrons subsequently undergo Cherenkov effect in a PMMA radiator, in contact with a 8x8 SiPM array with $3x3mm^2$ sized read-out channels. A separation resolution of 10 to 20% has been achieved for 7 different energy beams from 0.8 MeV to 2 MeV. The number of Cherenkov photons, detected in coincidence from SiPm's time-over-threshold signal within a time-window of 10 ns, is used to estimate the electron energy. The results are compared with a mean value available from theory.

ST 5.3 Wed 16:20 ZEU/0146

Neutron Detection With Coated Semiconductors — Kevin Alexander Kröninger, •Alina Johanna Landmann, Ruben Trimpop, 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 detection methods. Coated semiconductors represent a promising alternative in high flux particle fields. Typical environments with high particle fluxes are found at (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. A first prototype with a single converter layer on top of a silicon sensor was built to investigate the detection principle. Further studies concerning the thin film coating process for the different converting materials have been performed and will be presented.

ST 5.4 Wed 16:35 ZEU/0146

Neutron dosimetry with diamont sensors — •Jennifer Schlüss, Kevin Kröninger, Jens Weingarten und Alina Landmann — Technische Universität Dortmund, Dortmund, Germany

Neutron dosimetry is becoming increasingly relevant in proton therapy. From to the neutrons released, conclusions can be drawn about the deposited energy in the body. However, neutron dosimetry is complicated because neutrons are electrically neutral particles and cannot ionize directly. Neutrons must therefore be converted to charged particles before they can be detected. One way to convert neutrons is with the help of diamond sensors. The natural carbon isotope ^{12}C captures fast neutrons ($E_{kin} > 5MeV$). This produces alpha particles which can be detected in the diamond detector itself. To make the detector more sensitive to thermal neutrons, an attempt is made to coat the detector with a converter material such as ^{6}LiF. The simulation tool Geant4 will be used to test carbon capture reactions as a tool for further detector development. A multi-spectrum will then be used to perform neutron dosimetry with the goal of implementing a multi-spectrum detector for neutron dosimetry. To characterize the detection of fast neutrons, the diamond sensor will be tested in a later step with a simple readout in a neutron field.

ST 5.5 Wed 16:50 ZEU/0146

Fast neutron detection in proton beam therapy using SciFi detectors — •Martin Lau, Justus Beckmann, Kevin Kröninger, Alina Johanna Landmann, Jennifer Schlüss, and Jens Weingarten — TU Dortmund University, Department of Physics, Germany

Proton beam therapy is a rapidly growing field, due to the precise dose distribution within the patient. There are however many uncertainties regarding the range of proton beams. A simulation study showed, that the proton beam depth in a water phantom could be reconstructed by tracking the fast neutron trajectories emitted along the beam during irradiation. Fast neutrons undergo less scattering in material. This leads to a more precise reconstruction of their trajectories. Due to the difficulty of fast neutron detection, the potential use of SciFi detectors from the LHCb upgrade are investigated to track fast neutrons in a clinical environment due to their high spatial resolution. To determine the applicability of scintillating fibres for fast neutron detection in a clinical setting, the neutron detection capabilities and the resulting light yields of these fibres are investigated through GEANT4 simulations. Parallel, we will be testing the actual SciFi detector matt for practical uses during irradiation.

This talk will present the first results of the simulations, necessary for the reconstruction of the beam. Additionally, first studies of the actual SciFi detector system were performed, which will also be presented.

ST 5.6 Wed 17:05 ZEU/0146

A novel silicon photomultiplier in 350 nm CMOS technology with virtual guard rings and improved geometric efficiency — •Jonathan Preitnacher[1], Wolfgang Schmailzl[1], Sergei Ageev[2], and Walter Hansch[1] — [1]Bundeswehr University Munich, Neubiberg, Germany — [2]The Moscow Engineering Physics Institute-Kashira Hwy, 31, Moscow, Russland, 115409

Silicon photomultipliers (SiPM) are solid-state detectors that can resolve single photons and that are used in various applications like high energy physics or the fields of medical imaging. The implementation of virtual guards is an established technique in full costume SiPM designs to increase the geometric efficiency and therefore the photon detection efficiency (PDE). We present a novel approach applying virtual guard rings in a standard CMOS 350 nm process, improving the geometric efficiency by up to 45% compared to a guard ring design of the same process. We compare both approaches, presenting PDE measurements and additional characteristics of the devices like the breakdown voltage or the dark count rate. In a third design, we coupled the SiPM on the same chip to a costume low-power integrated amplifier to improve the pulse height and the slew rate. Measurements are presented to compare the photon time resolution of the SiPM designs with and without the amplifier.

ST 6: Members' Assembly

Time: Wednesday 17:45–18:45 Location: ZEU/0146

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

ST 7: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk ST 7.1 Thu 11:00 HSZ/AUDI

AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany

Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk ST 7.2 Thu 11:30 HSZ/AUDI

Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk ST 7.3 Thu 12:00 HSZ/AUDI

Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg

Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

ST 8: AI Topical Day – AI in Medicine (joint session ST/AKPIK)

Time: Thursday 14:00–15:30 Location: ZEU/0146

ST 8.1 Thu 14:00 ZEU/0146

Multimodal image registration with deep learning — •Alexander Ratke[1], Christian Bäumer[2], Kevin Kröninger[1], and Bernhard Spaan[1] — [1]TU Dortmund University, Dortmund, Germany — [2]West German Proton Therapy Centre Essen, Essen, Germany

In radiation therapy, precise localisation of tumour and risk structures is important for treatment planning. Medical imaging methods, such as computed tomography (CT) and magnetic resonance imaging (MRI), allow a differentiation between these structures. Planning systems typically align CT and MRI scans rigidly to compensate inaccurate immobilisation of the patient, but distortions in MRI or movement of organs still remain.

In this project, a data set of CT and MRI scans of the head and neck areas is used to study unsupervised deformable image registration with deep learning. First, the scans are pre-processed, which includes rigid registrations and the equalisation of the image formats. Then, deep learning is employed to filter structures of an image through multiple layers and to match them to a second image. The registration model strongly depends on the choice of its parameters. Therefore, variations of these parameters are investigated on the data set. The results are presented as well as the overall workflow including the pre-processing.

ST 8.2 Thu 14:15 ZEU/0146

Position reconstruction in proton therapy with proton radiography and machine learning — •Jolina Zillner, Carsten Burgard, Jana Hohmann, Kevin Kröninger, Florian Mentzel, Olaf Nackenhorst, Isabelle Schilling, Hendrik Speiser, and Jens Weingarten — TU Dortmund University, Department of Physics, Germany

In proton therapy precise patient positioning is essential for treatment quality. Current research in proton radiography (pRad) enables imaging of the patient immediately prior to irradiation. The idea is to use such pRad images to verify the patients position.

Therefore a 3D Convolutional Neural Network will be developed in order to predict pRad images depending on the CT image of an object and different translations and orientations. A minimization algorithm can then find the translation and rotation vector for which the predicted image has the smallest difference to a measured pRad image of the object, which can be used to correct the objects position. To predict pRad images, the CNN needs to be trained with pRad images and their related object translation and rotation and the CT-image.

This talk introduces the simulation used to generate these pRad training data. Simulations and reference measurements are performed with a primitive elbow phantom: a 3D-printed 3x3x3 cm^3 cube with a T-cavity for gypsum-inlays representing a stretched or bent elbow. The target is implemented in GEANT4 based on CT-data.

ST 8.3 Thu 14:30 ZEU/0146

Event identification in the SiFi-CC Compton camera for imaging prompt gamma rays in proton therapy via deep neural networks — •Alexander Fenger[1], Ronja Hetzel[1], Jonas Kasper[1], George Farah[1], Achim Stahl[1], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland

One of the biggest challenges in proton therapy is ensuring that the dose is delivered to the right position. A promising approach for online monitoring of the beam range is the detection of prompt gamma rays using a Compton camera, as it provides the possibility to reconstruct the 3D distribution of the deposited dose.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) project is a joint collaboration of the RWTH Aachen University, the Jagiellonian University in Kraków and the University of Lübeck. The two modules of the SiFi-CC, the scatterer and the absorber, both consist of stacked LYSO fibres and are read out by SiPMs. Deep neural networks are employed to separate valid Compton events from background and reconstruct the direction and energy of prompt gamma rays. First implementations of neural networks show promising results in classification of Compton events as well as full reconstruction of the event topology and kinematics. The next step is to further optimize the current neural network implementation to gain sensitivity towards a detectable range shift in the source position. Different neural network designs as well as an evaluation of their performance are presented.

ST 8.4 Thu 14:45 ZEU/0146

Selection of Compton events in the SiFi-CC camera using convolutional neural networks — •George Farah[1], Ronja Hetzel[1], Jonas Kasper[1], Alexander Fenger[1], Achim Stahl[1], and Aleksandra Wrońska[2] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]M. Smoluchowski Institute of Physics, Jagiellonian University Kraków, Poland

Proton therapy is a promising form of cancer treatment that uses charged protons to target and kill cancer cells. One of the main challenges in proton therapy is accurately determining the depth at which the protons will deposit their energy in the tumor.

The SiFi-CC (SiPM and scintillating Fiber-based Compton Camera) aims to enable range detection in proton therapy. It consists of multiple scintillating LYSO fibers generating signals that get read by SiPMs attached to both ends of the fibers. The camera utilizes the Compton effect and photoelectric effect to detect the prompt gamma rays produced in nuclear interactions of the protons with the nuclei in the tumor. This allows restricting the origin of the prompt gamma to a cone surface and by reconstructing many of such cones it is possible to reconstruct the source distribution of the prompt gammas.

The most recent SiFi-CC geometry has four fibers coupled to one SiPM in a shifted manner, so signals from multiple fibers get read by a single SiPM. In this talk, we present how three-dimensional neural networks can be advantageous by taking into consideration this new geometry. Hence improving the detection of Compton events, which improves the accuracy of range detection in proton therapy.

ST 8.5 Thu 15:00 ZEU/0146

Fast dose predictions for conformal synchrotron microbeam irradiations — •Marco Schlimbach[1], Micah Barnes[2], Kevin Kröninger[1], Florian Mentzel[1], Olaf Nackenhorst[1], and Jens Weingarten[1] — [1]TU Dortmund, Germany — [2]University of Wollongong, Australia

An important optimization goal of radiation therapy is to apply the prescribed dose to the tumor while minimizing the dose deposition to surrounding healthy tissue. The new preclinical irradiation method, called Microbeam Radiation Therapy (MRT), enables higher control for certain tumors by spatial fractionation of photon beams compared to conventional irradiation methods. At the same time, the exposure of normal tissue remains the same.

Currently, the dose for MRT is mostly calculated with time-consuming Monte-Carlo simulations. However, for transfer to clinical application, a fast dose calculation is essential, so that therapies can be planned in a sufficiently short time. Recent studies show that MRT doses can be predicted accurately within milliseconds using neural networks. These studies, however, are limited to predicting the dose from a fixed MRT field size.

This work presents a method to extend the developed machine learning model to predict the doses from MRT irradiation fields of variable size and shape. Since there is no data from the clinic for MRT compared to conventional irradiation methods, the models are trained using a Geant4 Monte-Carlo simulation of a rodent head irradiation at the Imaging and Medical beamline at the Australian Synchrotron.

ST 8.6 Thu 15:15 ZEU/0146

Thermoluminescence glow curve generation using generative adversarial networks (GANs) — •Evelin Derugin[1], Olaf Nackenhorst[1], Florian Mentzel[1], Jens Weingarten[1], Kevin Kröninger[1], and Jörg Walbersloh[2] — [1]Department of Physics, TU Dortmund University — [2]Materialprüfungsamt NRW

Personal dose monitoring is essential for a successful radiation protection program for occupationally exposed persons. The Materialprüfungsamt NRW (MPA NRW) provides thermoluminescence (TL) dosimeters based on LiF:Mg,Ti. Proof-of-concept studies to predict the day of irradiation have been successfully performed on measured TL glow curves using artificial neural networks (ANN). However, large data sets are required to train an ANN to predict the parameters of new measurements. Therefore the Department of Physics at TU Dortmund is developing multivariate methods for generating TL glow curves using generative adversarial networks (GANs). These generated glow curves will be used as training data for the irradiation day prediction model. This study trains GANs to generate glow curves using a measured data set of 4100 glow curves with 28 irradiation dates. In this talk, we present the comparison of the simulated glow curves with the measured ones and provide information about the performance and optimization of the GAN.

ST 9: Radiation Therapy

Time: Thursday 15:50–17:20 Location: ZEU/0146

ST 9.1 Thu 15:50 ZEU/0146

Simulations of a combination of brachytherapy and X-ray irradiation for the treatment of intraocular tumors — •Michelle Stroth[1], Henning Manke[1], Dirk Flühs[2], Bernhard Spaan[1], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]Department of Radiotherapy, Essen University Hospital, Germany

Brachytherapy with Ruthenium-106 Eye Applicators is an effective method for successfully treating ocular tumours. However, this treatment is contraindicated for intraocular tumours with an apex height above 7 mm due to insufficient irradiation of the tumor apex. To reduce side effects that can occur with alternative forms of therapy, an integrated concept consisting of brachytherapy with external X-ray irradiation is investigated for treating intraocular tumours.

For this purpose, the combined therapy modality is simulated using real patient data. The radiation sources' weights are adjusted by optimization through differential evolution, minimizing the dose to the organs at risk. Comparison of the dose-volume histograms of the combined form of therapy with the dose-volume histograms of brachytherapy only, confirms the advantages of integrating external X-ray irradiation using the ruthenium-106 applicator in terms of protection of the structures at risk and homogeneity of the dose profile in the tumour. This presentation shows the results of the Monte Carlo simulations of the combined concept.

ST 9.2 Thu 16:05 ZEU/0146

A novel therapy concept for intraocular tumors — •Henning Manke[1], Michelle Stroth[1], Dirk Flühs[2], Bernhard Spaan[1], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]Department of Radiotherapy, Essen University Hospital, Germany

To investigate the suitability of a new therapy concept for intraocular tumors consisting of both brachy- and radiotherapy a new phantom was developed and tested. Tumors with a height up to 7 mm are mostly treated with Ruthenium-106 plaques. Due to the steep dose gradient, tumors with a higher apex are irradiated insufficiently. A therapy modality for tumors that big is to use Iodine-125 plaques, but due to their isotropic gamma radiation healthy tissue is partly irradiated and damaged. The new concept consists of simultaneous therapy with Ruthenium-106 plaques and X-ray. Both the tumor base and apex can be irradiated sufficiently while sparing healthy tissue. The plaque may serve as an absorber for the X-rays.

A new phantom was constructed from the material Plastic Water Low Range to measure dose profiles of X-rays in front and behind a Ruthenium-106 plaque. Three different detectors can be used in the phantom to measure dose profiles: a soft X-ray chamber, radiochromic films and self-made scintillation detectors. Measurements have been performed with a X-ray therapy unit type T-105 distributed by BEBIG Medical GmbH.

This talk presents the first results which show an appropriate application of the combined therapy.

ST 9.3 Thu 16:20 ZEU/0146

Proton Therapy Dose Calculations with the Monte-Carlo Simulation — •Mariam Abuladze[2], Ronja Hetzel[1], Jonas Kasper[1], Revaz Shanidze[2], and Achim Stahl[1] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Kutaisi International University, Kutaisi, 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 results of the Geant4 simulation (version 10.6.3.) are presented. The dose distribution was studied in the phantom materials with proton beams of different geometry and intensity. Different geometric shapes are used for phantoms, which are filled with water and carbon. 3D phantom models are divided into voxels of different sizes. Obtained simulated data was used for calculations of dose-volume histograms for different proton beam parameters and different phantom models.

ST 9.4 Thu 16:35 ZEU/0146

Prompt gamma-ray timing for online proton range verification - status quo — •Krystsina Makarevich[1,2], Katja E. Römer[3], Sonja M. Schellhammer[1,2], Joseph A. B. Turko[3], Andreas Wagner[3], and Toni Kögler[1,2] — [1]Helmholtz - Zentrum Dresden - Rossendorf, Institute of Radiooncology - OncoRay, Dresden, Germany — [2]OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz - Zentrum Dresden - Rossendorf, Dresden, Germany — [3]Helmholtz - Zentrum Dresden - Rossendorf, Institute of Radiation Physics, Dresden, Germany

The prompt gamma-ray timing (PGT) technique is a promising candidate for proton therapy range verification as it is light-weighted, can be integrated into existing therapy systems, and introduces no additional dose to patients. This work explains the physical basics of the PGT method and gives an overview of a setup developed for future integration into clinical practice. Currently, the PGT technique undergoes extensive testing under close-to-clinical conditions so to prepare for the first in-human application. The latest measurements with an anthropomorphic head phantom irradiated with clinical treatment plans are delineated. The work sets out the main outcomes of this experiment such as the choice of the detector crystal size, the relationship between the detector load and the processed count rate, the influence of the range shifter on the PGT distributions, etc. An overview of the directions for future investigations is presented.

ST 9.5 Thu 16:50 ZEU/0146

First Results for Prompt Gamma Spectra measured by PETsys Electronics with 100-162 MeV Proton Beam at OncoRay TU Dresden — •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 measurements of in-vivo proton range. For the prompt gamma timing (PGT) application both time and spectral characteristics are important. Time and coincidence time resolution (CTR) studies showed already results below 100 ns. We concentrate now on the spectral properties of the system measuring PG in the range up to 8 MeV at OncoRay TU Dresden facility with proton energies between 100 to 162 MeV. A big challenge for PGT application is the data load due to the large number of photons hitting the crystal. By decreasing the size of the crystals and increasing the number of channels in the detector matrix the load to each channel can be reduced and more PGs can be detected. We are investigating $CeBr_3$ crystals of 5x5x20 mm^3 and 10x10x30 mm^3 size coupled with Sensl SiPM of 6x6 mm^2 with 35 μm microcells and Hamamatsu SiPM of 6x6 mm^2 with 25 and 50 μm microcells. The size of existing SiPMs is a limiting factor. For the readout electronics we optimized the PETsys electronics towards higher PG energies. It offers high photon detection efficiency, good time resolution, low bias voltage and can operate in magnetic fields. In the presentation we present first measurements of energy spectra with two different targets performed at OncoRay TU Dresden.

ST 9.6 Thu 17:05 ZEU/0146

Sub-Millimeter Relative Range Verification in Heavy-Ion Therapy using Filtered Interaction Vertex Imaging — •Devin Hymers[1,2], Eva Kasanda[2], Vinzenz Bildstein[2], Joelle Easter[2], Andrea Richard[3,4], Artemis Spyrou[3], Cornelia Hoehr[5], and Dennis Muecher[1,2,5] — [1]Institut für Kernphysik, Universität zu Köln, Köln, Germany — [2]Department of Phyiscs, University of Guelph, Guelph, ON, Canada — [3]National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI, USA — [4]Lawrence Livermore National Laboratory, Livermore, CA, USA — [5]TRIUMF, Vancouver, BC, Canada

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. Relative range verification via filtered Interaction Vertex Imaging could allow monitoring of beam depth spacing, to ensure full and consistent tumour coverage. To validate this method, twelve ^{16}O beams of differing energy irradiated a 40 mm poly-(methyl methacrylate) phantom, and external secondary particle yields were monitored with position-sensitive silicon detectors. These data were used to reconstruct sites of secondary particle origin. Comparison of logistic fits to the distal edges of these distributions via χ^2 minimization computed the range shift between any two beam depths with sub-millimeter precision, to a standard deviation of the mean of 220(10) μm. This result validates filtered Interaction Vertex Imaging as a candidate for high-performance clinical range verification.

ST 10: Keynote: Online-Adaptive Particle Therapy

Time: Thursday 17:30–18:00 Location: ZEU/0146

Invited Talk ST 10.1 Thu 17:30 ZEU/0146

Online-adaptive particle therapy: Current status and vision for the future — •Christian Richter — OncoRay - National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — Department of Radiotherapy and Radiation Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany — Helmholtz-Zentrum Dresden - Rossendorf, Institute of Radiooncology - OncoRay, Dresden, Germany

In this overview talk the following questions will be addressed: - What is the status concerning fast adaptations in particle therapy also in relation to photon therapy?

- Why we need online-adaptive particle therapy (OAPT)?

- What are different approaches also in relation to different adaption speed?

- What are the different imaging approaches for OAPT?

- How can we verify the treatment delivery when no pre-treatment phantom QA is performed?

- What is the role of AI-based decision support?

- What initiatives exist on national and international level? Where do we stand?

ST 11: Prize Ceremony and Closing Session

Time: Thursday 18:00–18:15 Location: ZEU/0146

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 Devision at the DPG Spring Meeting 2023. We welcome everyone to celebrate a successful conference with us, to provide some final feedback and to take the chance to meet other participants one last time at this meeting.