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.