ST 6: Detectors and Applications I

Time: Wednesday 11:00–12:15 Location: ST-H4

ST 6.1 Wed 11:00 ST-H4

Upgraded Proton Irradiation Site at Bonn University — •Pascal Wolf[1], Dennis Sauerland[2], Jochen Dingfelder[1], David-Leon Pohl[1], and Norbert Wermes[1] — [1]Physikalisches Institut, Universität Bonn — [2]Helmholtz Institut für Strahlen- und Kernphysik, Universität Bonn

The Bonn Isochronous cyclotron delivers 14 MeV (≈ 12.5 MeV on-device) protons with typical beam currents of 1 μA and beam diameters of a few millimeters to the irradiation site. Enhanced beam diagnostics as well as R/O electronics allow for online monitoring across several orders of magnitude of beam currents with a relative uncertainty of ≈ 1%. Devices are irradiated by being scanned through the beam in a row-wise pattern while housed in a thermally-insulated cooling box kept at ≈ -20 °C to minimize annealing. Online monitoring of the beam current at extraction facilitates a measurement of the fluence per scanned row with an accuracy of a few %, ensuring homogeneous irradiation. The setup allows one to power and read out DUTs during irradiation as well as pause irradiations for in-between measurements. Latest irradiations of thin CMOS pixel test structures yield a proton hardness factor with reduced uncertainty, compatible with previous measurements and simulation, facilitating irradiations up to 10^{16} neq / cm^2 within a few hours. The setup, its reworked components, the irradiation procedure as well as the latest proton hardness factor measurements are presented in this talk.

ST 6.2 Wed 11:15 ST-H4

Comparison of different methods measuring the beam energy in proton therapy using pixelated silicon detectors — •Isabelle Schilling[1], Claus Maximilian Bäcker[1,2,3], Christian Bäumer[1,2,3], Carina Behrends[1,2,3], Marius Hötting[1], Kevin Kröninger[1], Beate Timmermann[2,3,4,5], and Jens Weingarten[1] — [1]TU Dortmund University, Department of Physics, 44221 Dortmund — [2]West German Proton Therapy Centre Essen, 45122 Essen — [3]West German Cancer Center, University Hospital Essen, 45122 Essen — [4]University Hospital Essen, Clinic for Particle Therapy, 45122 Essen — [5]Faculty of Medicine, University of Duisburg-Essen, 45147 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 single protons, allowing the determination of the stopping power. 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. For range consistency checks during the QA, an absorber with different thicknesses is used to investigate the variation of the charge production in the sensor. In comparison, this talk also presents results of energy calculations by measuring the stopping power in the silicon sensor directly, all performed at the West German Proton Therapy Centre Essen.

ST 6.3 Wed 11:30 ST-H4

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

A lighter, faster and more precise real-time beam profile monitor (BPM) is desired by the Heidelberg Ion-beam Therapy Center (HIT) to upgrade their original Multiwire chambers. A Scintillating Fibre based BPM will offer real-time information of the beam conditions, including position and width, with a readout rate of 10 kHz using photodiode arrays with a channel size of 0.8mm. Currently the data from the BPM is saved offline for processing and analysis, but the goal is to reconstruct the beam profile in real-time on board the device. A reconstruction algorithm has been designed and the goal is to implement this within the FPGA of the readout electrons. The calibration of the detector as well as the beam reconstruction steps will be presented, describing how radiation damage effects to the fibres will be managed.

ST 6.4 Wed 11:45 ST-H4

Evaluation of HV-CMOS Sensors in a Beam Monitoring System for Ion Therapy — •Martin Pittermann[1], Alexander Dierlamm[1], Ulrich Husemann[1], Stefan Maier[1], Hans Jürgen Simonis[1], Pia Steck[1], Matthias Balzer[2], Felix Ehrler[2], Ivan Perić[2], Rudolf Schimmasek[2], and Alena Weber[2] — [1]Institute of Experimental Particle Physics (ETP), Karlsruher Institute of Technology (KIT) — [2]Institute for Data Processing and Electronics (IPE), KIT

Ion therapy is an advanced tool for the treatment of cancer by means of irradiation. The characteristic Bragg peak of ionizing radiation creates a highly localized energy deposit. Additionally, very narrow beams (pencil beam) and raster scan techniques are used. This allows the dose distribution to conform to the tumor while minimizing damage to surrounding tissue. Fast and precise feedback of the beam parameters is required for closed-loop control of the beam optics.

We investigate the feasibility of using HV-CMOS pixels sensors to monitor the position, size and shape of such a medical ion beam in real-time. The high intensities encountered in a primary particle beam prohibit the use of traditional single-hit-readout sensors used in high energy particle physics. Instead, a dedicated counting pixel sensor is being developed at the IPE. The radiation hardness and high-rate capabilities of this sensor are tested at the therapeutic ion beam line. Further development steps towards a beam monitoring system replacing the current wire chambers are also discussed.

ST 6.5 Wed 12:00 ST-H4

Coincident Detection of Cherenkov Photons from Electrons for Medical Applications — •Kaveh Kooshk, Ivor Fleck, and Daniel Berker — Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen

The need for medical imaging devices capable of detecting high energy photons prompts research into new detection methods such as Compton camera in nuclear medicine. A new detection method for Compton electrons using Cherenkov radiation is proposed in this work as a proof of principle. Electrons from beta minus decay of Strontium 90/Yttrium 90 with energies up to 2.28 MeV are used. They are directed through a vacuum channel within which an EM field from an electromagnet allows only a specific energy to reach a collimator at the end of the path. After the collimator, the energy spread of the electrons is less than 6% around the nominal energy which can vary between 0.5 and 2.28 MeV. The electrons subsequently reach a radiator material (PMMA) and produce Cherenkov photons, which are detected via a 8x8 Silicon-Photomultiplier array with 64 readout channels. For each electron, the Cherenkov photons are collected within a time-window of 100 ns. The spatial distribution of the Cherenkov photons and their total number are recorded and will be investigated as a function of electron energy, and the results will be compared with theoretical data.