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Gaseous Detectors for Preclinical Proton Beam Monitoring, Characterization and Imaging

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At LMU Munich a proton irradiation platform for preclinical research with tumor bearing mouse models has been developed and commissioned. It converts injected clinical proton beams to low energies of 20 to 50MeV and small diameters of O(1mm) to enable precise, image-guided irradiation of mice. The profile of the produced beam has been in depth characterized with an optically read out bulk Micromegas detector with ITO glass anode, coupled to a pixel Electron Multiplying CCD. The device has been operated at particle rates from single to 107Hz and proton energies between 20 to 70MeV in multiple testbeams. Clinical and preclinical beam are monitored with identical ionization chambers. They feature two perpendicular 40nm thick aluminum strip readout planes and an unsegmented plane for beam current measurement. Latter is read out with an in-house developed, FPGA controlled gated integrator, also enabling control of the clinical accelerator. A proton computed tomography system (pCT) will enable object imaging, by combining particle position information with a residual energy measurement of the transmitted particles. We have developed ultra-thin floating strip Micromegas detectors with two-dimensional strip readout structures, consisting of 9µm thick aluminum electrodes on a 32µm Kapton substrate. For determining the residual energy with high precision, we have built a Time Projection Chamber (TPC) with a discharge insensitive floating pad Micromegas readout structure. Transmitted particles are successively slowed down and then stopped by 65 0.6mm thick, field-shaping Mylar absorbers inside the TPC drift region, alternating with 8mm gas layers. The pCT detectors are read out with the VMM3a SRS. All detectors were developed and built at LMU. The sub-systems were successfully tested individually and recently all together in a beam test at DCPT. We present and discuss construction methods and performance in several test beam campaigns for all detector systems in comparison to reference data.

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