AbstractID: 7414 Title: Quantitative assessment of the accuracy of proton beam range verification with PET/CT

Purpose: At present the most promising method for an in vivo and non-invasive monitoring of radiation treatments with proton beams is positron emission tomography (PET). This study investigates the sensitivity and accuracy of the PET/CT treatment verification method in the presence of highly inhomogeneous tissue regions as well as in the presence of metallic implants.

Method and Materials: A circular SOBP proton field has been delivered to a sophisticated in house designed phantom consisting of poly-methyl methacrylate (PMMA), lung and bone equivalent slabs. The bone material contained authentic dental gold implants as well as tin lead alloy implants in different shapes. PET data were acquired in listmode starting within 15 min after irradiation at a commercial PET/CT scanner. The measured PET distributions were compared to full-blown simulations of the PET signal based on Geant4 and FLUKA Monte Carlo (MC) codes.

Results: Activation profiles were analyzed behind air-lung, air-bone and lung-bone interfaces parallel to the beam as well as downstream interfaces angled at 6°. In general, a good agreement between measured and simulated PET distributions was found. Measured PET images reflected even small characteristic changes in the dose distribution. This showed the potential of PET/CT treatment verification in the presence of highly inhomogeneous tissue regions. CT artifacts due to metal implants can trick all dose calculation algorithms and lead to the prediction of a proton range overshoot behind metal implants, whereas in reality a range undershoot occurs. The PET/CT treatment verification method can detect such dose calculation errors.

Conclusion: This preliminary study indicates the feasibility of PET/CT treatment verification to detect the full characteristic of the delivered dose distribution even in the presence of complex tissue inhomogeneities and metal implants.