AbstractID: 3737 Title: PET/CT imaging for 3D in-vivo treatment verification in proton therapy - a feasibility study

Purpose: to investigate the clinical feasibility of off-line PET/CT for in-vivo treatment verification of proton therapy.

Method and Materials: Two PMMA blocks and one inhomogeneous phantom consisting of PMMA and muscle and bone equivalent slabs were irradiated with one or two orthogonal SOBP proton fields (8×8 cm^2 aperture, 10 cm modulation and 15 or 16 cm range in water). The targets were imaged using a PET/CT (CPS/Siemens Biograph Sensation 16) scanner within 20 min after irradiation. At first, a high dose of 8 Gy was delivered and 1 h listmode acquisition was performed to investigate image quality based on counting statistics in variable time framesets. In the other studies a maximum dose of 2 Gy was applied and acquisition was limited to 20 min to mimic realistic therapeutic cases. The amount and spatial distribution of measured activity was compared to calculations based on the FLUKA Monte Carlo code and experimental cross-sections. Proton range was extracted from the analysis up to the second derivative of the activity distal edge. Isotopes were identified from decay time analysis.

Results: The shape of the irradiated field and the range-correlated activity distal edge could be imaged with sufficient accuracy after therapeutic doses, despite the delay between irradiation and scan. In PMMA, maximum ^{11}C activation (0.9±0.1 kBq/Gy/ml after 1.0–1.6 Gy/min irradiation) and distal edge position agree within 2% and 1% with calculations, respectively. Besides ^{11}C, minor amounts of ^{15}O and ^{13}N were identified at the beginning of acquisition.

Conclusion: This feasibility study indicates the potential of off-line PET/CT for range and field position verification in proton therapy. In addition to PET alone, PET/CT provides information on possible anatomical changes during fractionated radiotherapy. Clinical patient studies addressing the accuracy and possible limitations due to perfusion are planned. If available, preliminary clinical results will be presented.