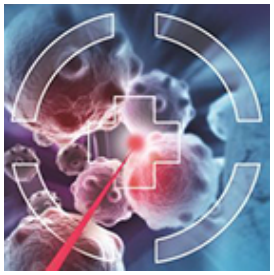

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PET Imaging and Dose correlation from Proton Activation.

Wednesday 4 September 2019 12:00 (20 minutes)

Range verification techniques for protontherapy include positron-emission tomography (PET) and prompt-gamma (PG) imaging. The main challenges preventing their clinical implementation are, in case of PET, the relatively long half-lives of the isotopes of interest and the large energy needed to activate PET-decaying nuclei [1].
We have investigated the use of certain isotopes as contrast agents for PET, increasing their activation rates and shifting the activity peaks towards the Bragg peak. For this purpose we have developed an activation calculation tool in different software packages such as TOPAS and PenH, and we have compared both. The experiental and theoretical results show an increased PET activation at the distal end of a 150 MeV proton beam, within 1 mm from the Bragg peak (BP), using Water-18O (H2O18) as a contrast agent.
The activation maps of 18F (T1/2≈110 min) and 15O (T1/2≈122 s) obtained from TOPAS and the SuperArgus 4R preclinical PET scanner [2] have been simulated with PeneloPET [3], in order to obtain 5-minute-long acquisitions right after irradiation and 15 minutes later. Results show the dominance of the 15O signal in a delocalized region far from BP in the first 5 minutes, but the BP distal end is perfectly identified for the 15 minutes delayed acquisition due to the 18F signal arising from the proton activation of 18O. The H2O18 is perfect for validation and verification with phantoms, and in vivo patients, provided if it could be biologically fixed in area of maximum dose deposition.
[1] S. España, et al., "The reliability of proton-nuclear interaction cross-section data to predict proton-induced PET images in proton therapy", Phys. Med. Biol., 56(9) 2687–2698, 2011.
[2] S. España, et al., "PeneloPET, a Monte Carlo PET simulation tool based on PENELOPE: features and validation,"Phys. Med. Biol., 54 (6) 1723–1742, 2009.
[3] J. M. Udías, et al., "Performance evaluation of the PET subsystem of the extended FOV SuperArgus 6R preclinical scanner,"IEEE NSS MIC, 2018.

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