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On-the-fly reconstruction of activation by proton beams using in-beam PET

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Introduction: In-beam PET is attractive in terms of feedback-time of treatment quality in protontherapy. However, it is challenged by the high rates produced during the beam-on period. In this work, we report the first results using a novel in-beam portable PET system that can detect and process on-the-fly the β^+ activity produced during and after irradiation.
Methods: The specific PET setup consisted of 6 phoswich detector blocks with 338 pixels each, with of 1.55×1.55×LYSO (7mm)+GSO (8mm) . The system was coupled to a fast data acquisition system able to sustain rates up to 10 Msingles/sec. Two different PMMA targets were irradiated with mono-energetic clinical proton beams at the Quirónsalud proton therapy center.
Results: The radionuclide-specific contribution (^{11}C, ^{15}O, ^{10}C) was obtained from the time-activity curves corresponding to the irradiated region. 3D maps of the activity were reconstructed on-the-fly every 0.5 seconds and with a 0.5 mm spatial resolution (Figure 2). We also assessed the system response to changes in the position and direction of the beam during irradiation.
Conclusion: This validates the experimental setup to be used for in-beam on-the-fly reconstruction of the 3D activity when irradiating with proton beams and provides a gold standard to obtain the deposited dose distribution when combined with a fast dose reconstruction method.

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