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Normalization and scatter corrections for the J-PET scanner

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Abstract

The Jagiellonian PET scanner is a cost-effective large axial FOV Positron Emission Tomography technology that enables multiphoton imaging and is currently under development at the Jagiellonian University. The current 50 cm prototype, named “Modular J-PET”, is being investigated for various applications. It is well known that PET data can be affected by several effects during acquisition, such as scattered gamma photons or variations in detection efficiency. Consequently, achieving the reconstruction of images of satisfactory quality requires a set of corrections to be applied to each line-of-response. This summary discusses the implementation and performance of scatter and normalization corrections for the Modular J-PET, and their extension prior to the assembly of a total-body Jagiellonian PET scanner. Normalization correction is achieved using component-based normalization, a method particularly suitable for large scanners with a high number of lines-of-response. Scatter correction is achieved using an extension of the single scatter simulation technique that incorporates time-of-flight information. Reconstruction of reference phantoms based on Monte Carlo simulations highlight improvements in image quality. The application of normalization reduces the non-uniformity in the reconstructed image by a factor of 10 in the axial direction and 2 in the radial direction.

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References

[1] S. Nied´zwiecki et al., “J-PET: a new technology for the whole-body PET imaging,” arXiv preprint arXiv:1710.11369, 2017.

[2] P. Moskal et al., “Simulating NEMA characteristics of the modular total-body J-PET scanneran economic total-body PET from plastic scintillators,” Physics in Medicine & Biology, vol. 66, no. 17, p. 175015, Sep. 2021.

[3] L. Raczy´nski et al., “Novel method for hit-position reconstruction using voltage signals in plastic scintillators and its application to positron emission tomography,” Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, vol. 764, pp.

186–192, 2014.
[4] P. Moskal et al., “Positronium imaging with the novel multiphoton PET scanner,” Science Advances, vol. 7, no. 42, p. eabh4394, 2021.
[5] P. Moskal, “First in-vivo positronium imaging of humans with a portable j-pet scanner - on the way to total-body positronium imaging,” Invited talk at Total-body PET 2022 Conference, 2022.