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Evaluation of different image regularization techniques on simulated phantoms with the TRIMAGE brain PET scanner

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This work presents the study of the performance of the TRIMAGE brain PET scanner obtained through experimental detectors characterization, simulated phantom acquisitions and image reconstruction optimization. The TRIMAGE scanner uses dual-layer staggered LYSO:Ce crystal matrices coupled to silicon photomultipliers (SiPM). The dual layer architecture provides depth of interaction (DOI) capabilities and a finer sampling of the lines of response. Using Monte Carlo simulations, a standard-like phantom for brain imaging has been simulated. The used phantom is a smaller version of the standard image quality phantom used in whole body PET imaging, as it has been done already in similar works available in literature. Image noise and image resolution have been evaluated in terms of uniformity, recovery coefficient (RC) and spill-over ratio (SOR). In order to improve image quality, the reconstruction software has been enhanced by introducing image regularization. Different regularization algorithms have been used, including Gaussian filtering, patch-based regularization and a novel gradient-enhancer algorithm. The latter is the only iterative procedure used so far that combines a denoising filter with a feature restoration one. Image quality analysis have been performed for all the configurations mentioned above, showing that the proposed gradient minimization algorithm is very stable and performs well in terms of uniformity versus recovery coefficients, although the asymptotic values of RC and SOR are lower than in patch-based regularization.

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