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Time-of-Flight Requirements to Mitigate Blurring Induced by Annihilation Photon Acollinearity

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One of the limiting factors of spatial resolution in positron emission tomography (PET) imaging is the acollinearity of the annihilation photons (APA). For a whole-body PET scanner, APA induces a blurring of about 2 mm FWHM. We have previously shown that perfect TOF resolution can reduce the blurring induced by APA, i.e., overcome the conventional theoretical limit of spatial resolution. However, the requirements to achieve an observable gain in this regard have yet to be explored. We propose a preliminary study of these requirements for whole-body and total-body scanners, in terms of TOF resolution and coincidence event statistics. Using a fictive 81-cm diameter scanner with 2-mm wide detectors, we show that ultrahigh TOF resolution—13 ps FWHM—enables an observable gain in spatial resolution for a range of coincidence event statistics. In addition, we show that lower TOF resolutions (i.e., 26 or 65 ps) can be sufficient to mitigate APA for the oblique tubes of response of large 3D systems subjected to larger APA blurring. This last observation is of particular interest since it suggests that the non-stationary nature of spatial resolution in PET imaging can be further mitigated with high and ultrahigh TOF precision.

Field

Software and quantification

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