TOF MLEM for Total-Body J-PET with Analytical System Response and Resolution Modelling

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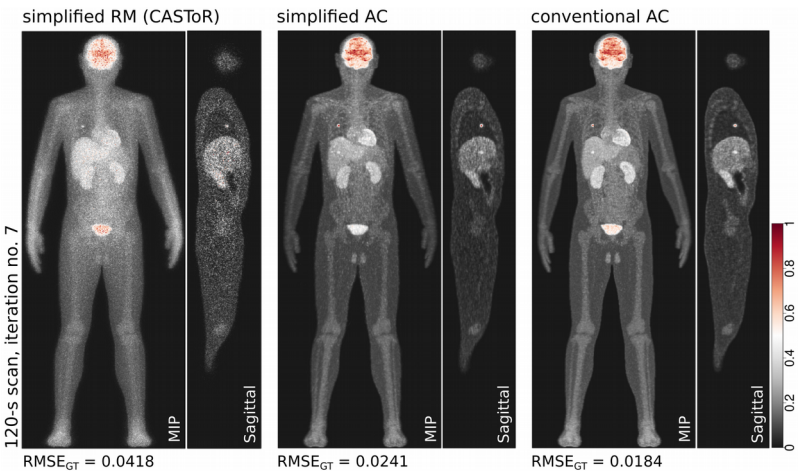
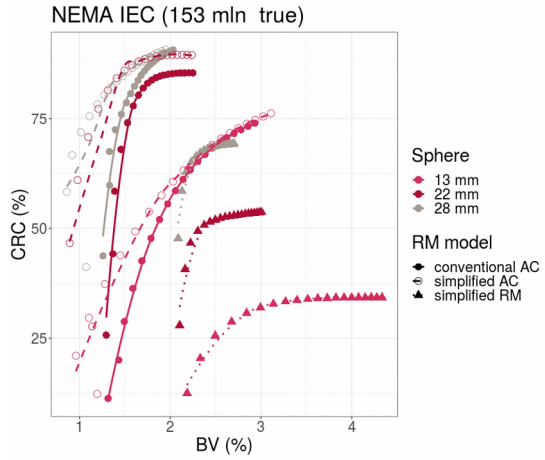
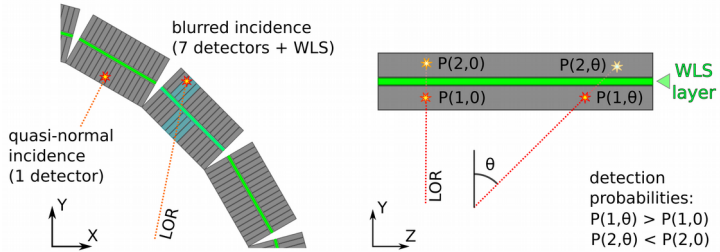
A **time-of-flight maximum likelihood expectation maximisation (TOF MLEM)** image reconstruction algorithm implemented for the total-body **Jagiellonian PET** with system response matrix (**SRM**), using two attenuation corrections (AC):

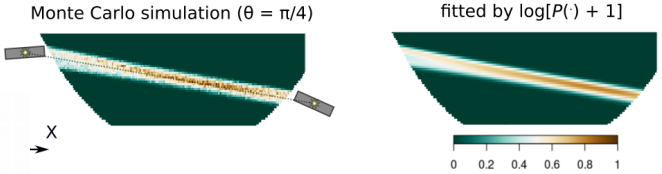
$$\lambda_j^{(k+1)} = \frac{\lambda_j^{(k)}}{\sum_{i\in I} a_i n_i \chi_{ij}} \sum_{\epsilon\in E} \frac{\chi_{(it)_\epsilon, j}}{\sum_{j'\in J} \chi_{(it)_\epsilon, j'} \lambda_{j'}^{(k)}} \qquad \lambda_j^{(k+1)} = \frac{\lambda_j^{(k)}}{\sum_{i\in I} n_i \chi_{ij}} \sum_{\epsilon\in E} \frac{a_{i_\epsilon}^{-1} \chi_{(it)_\epsilon, j}}{\sum_{j'\in J} \chi_{(it)_\epsilon, j'} \lambda_{j'}^{(k)}}$$

GATE simulations: 24-module J-PET, 2 layers + wavelength shifters (WLS), L = 140/200 cm, PSF_{XYZ} ~ 5 mm, CRT = 191/237 ps [Moskal et al. PMB 2021].









Shift-variant SRM $\chi_{i_\epsilon}(x_j, y_j, z_j, \Delta t_\epsilon, \theta)$: 2D Monte Carlo – emissions on transverse planes for various obliqueness $\theta \rightarrow$ express SRM as *log-polynomial fitting functions, + kernels for TOF, parallax correction and Z.*

Tested on simulated NEMA IEC and XCAT, appear to be superior to the reference (geometric resolution modeling only) from CASToR [Merlin et al. PMB. 2018].

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