

Multi purpose Ultra fast Monte Carlo PET simulator

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Accurate Monte Carlo simulations play a major role in PET corrections and scanner design. We present the Ultra-fast Monte Carlo PET simulator (UMC-PET) developed for multiple purposes, an accurate, fast and flexible PET simulator. The UMC-PET includes all the relevant physics related to the emission, transport and detection of the radiation in a PET acquisition, such as positron range, scatter and attenuation inside the patient, photon interaction with the scanner, and detector response (energy resolution, time of flight, etc.). The simulator accuracy has been extensively tested against other MC PET simulators such as PeneloPET, obtaining similar results, while being more than 3000 times faster. The code can handle arbitrary scanner geometries with simple and intuitive input files. These features allow applying UMC-PET beyond standard MC uses. UMC-PET has been tested to accurately predict scatter and attenuation corrections during reconstruction, or to compute system response matrix (SRM) for adapting scanner geometries. Furthermore, the speed of UMC-PET allows for a 3D iterative reconstruction for complex scanners, with a projection step based on, on the fly, raw, MC calculations with UMC-PET and thus avoiding explicit storage of the SRM or physics simplifications. On a single common (500 USD) GPU these fully MC reconstructions require a few hours for a scanner with > 1 billion lines of response. This provides not only a useful and flexible gold standard method, but may become a practical reconstruction approach if it is combined with variance reduction methods and/or high performance multi-GPU systems.

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