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MPEXS: A CUDA MonteCarlo of the simulaiton of electromagnetic interactions

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As more detailed and complex simulations are required in different application domains, there is much interest in adapting the code for parallel and multi-core architectures. Parallelism can be achieved by tracking many particles at the same time. This work presents MPEXS, a CUDA implementation of the core Geant4 algorithm used for the simulation of electro-magnetic interactions (electron, positron and gamma primaries) in voxelised geometris.
A detailed analysis of the code has been performed to maximise the performances on GPU hardware, we have reduced thread divergence, perform coalesced memory reads and writes and introduced atomic reduction of dose calculation. The voxelised geometry allows for a simplified navigation navitation that further reduces thread divergence.
These optimizations allows for very encouraging results and experiments with simulations in MPEXS demonstrate speedups of more than 200 times over Geant4.
A rigorous physics validation has shown that the calculations obtained with MPEXS are equivalent to the Geant4 predictions.
The primary interest of MPEXS code is to simulate benchmarks for radiation-therapy calculations, however the general lessons learn from this code can be applied to more general applications. As an example we have extended MPEXS to treat the simulation of production and transport of radicals (the so called Geant4-DNA extension). We are currently studying its extension to other particles species (neutrons and low-energy hadrons) that could be of interest of domains outside the radiation therapy one.

Tertiary Keyword (Optional)

Parallelization

Secondary Keyword (Optional)

Simulation

Primary Keyword (Mandatory)

High performance computing

Authors: KIMURA, Akinori; DOTTI, Andrea (SLAC National Accelerator Laboratory (US)); MURAKAMI, Koichi; ASAI, Makoto (SLAC National Accelerator Laboratory (US)); GERRITSEN, Margot (Institute for Computational & Mathematical Engineering, Stanford University); HENDERSON, Nick (Institute for Computational & Mathematical Engineering, Stanford University); OKADA, Shogo (KEK); SASAKI, Takashi (High Energy Accelerator Research Organization (JP))

Presenter: DOTTI, Andrea (SLAC National Accelerator Laboratory (US))

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