Particle-in-cell simulations with charge-conserving current deposition on graphic processing units

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Recently using CUDA, we have developed an electromagnetic Particle-in-Cell (PIC) code with charge-conserving current deposition for Nvidia graphic processing units (GPU's) (Kong et al., Journal of Computational Physics **230**, 1676 (2011). On a Tesla M2050 (Fermi) card, the GPU PIC code can achieve a one-particle-step process time of 1.2 – 3.2 ns in 2D and 2.3 - 7.2 ns in 3D, depending on plasma temperatures. In this talk we will discuss novel algorithms for GPU-PIC including charge-conserving current deposition scheme with few branching and parallel particle sorting. These algorithms have made efficient use of the GPU shared memory. We will also discuss how to replace the computation kernels of existing parallel CPU codes while keeping their parallel structures. This work was supported by U.S. Department of Energy under Grant Nos. DE-FG02–06ER54879 and DE-FC02–04ER54789 and by NSF under Grant Nos. PHY-0903797 and CCF-0747324.