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Ultra High Resolution Particle-In-Cell Simulations of Transition to Turbulence using GPU acceleration KAI GERMASCHEWSKI, WILLIAM FOX, University of New Hampshire, HOMA KARIMABADI, VADIM ROYTERSHTEYN, UCSD / Sciberquest, Inc., WILLIAM DAUGHTON, Los Alamos National Laboratory — Advances in computing power have enabled kinetic particle-in-cell simulations of plasma transition to turbulence at unprecedent resolutions. Nonlinear Kelvin-Helmholtz and tearing instabilities, driven by an initial shear flow, lead to fully developed turbulence, spanning scales from MHD down to electron kinetic scales. Currently, advances in computational capabilities for some of the largest computers in the world, like DOE's upcoming Titan machine, are driven by the use of graphics processing units (GPUs) to accelerate computationally intensive tasks. We present new modules in the electromagnetic particle-in-cell code PSC that enable effective use of the computational capabilities of massively parallel GPU based computers for kinetic plasma simulations. In particular, we will address (1) efficient algorithms for implementing particle advance, current deposition and sorting, (2) a load balancing scheme based on decomposition into small patches and space-filling curves, and (3) challenges of using both CPU and GPUs simultaneously in order to exploit all available computational resources optimally.

Kai Germaschewski
University of New Hampshire

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