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GPU-MPI Parallelization for QuickPIC, an Algorithm for Simulating Plasma Wake Field Acceleration

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Plasma wake field acceleration (PWFA) is a new method for particle acceleration. It is potentially capable of reaching an accelerating gradient 1000 times the gradient of conventional accelerators. QuickPIC is a program for simulating PWFA. It can offer helpful insight on the construction and usage of plasma wake field accelerators, as well as some other plasma-related phenomena.

Considering that more and more supercomputers are equipped with GPUs, we need to make full use of these computing resources. This project attempts to develop a version of QuickPIC with GPU-MPI parallelization, based on the UPIC framework. We rewrite the subroutines in the classes part2d, fft2d, fpois2d, ufield2d and fdist2d, in the 2d loop of the program. In the end, this project realizes the running of QuickPIC on supercomputers with GPU clusters, and compares the efficiency and accuracy of the program running on CPUs and different numbers of GPUs. The results show the advantage of using GPUs over CPUs in PWFA simulation.

Primary authors: Ms TIAN, Yueran (Beijing Normal University); Mr WANG, Yueluo (Peking University); Mr DALICHAOUCH, Thamine (University of California Los Angeles); Dr DECYK, Viktor (University of California Los Angeles); Prof. MORI, Warren (University of California Los Angeles); Prof. AN, Weiming (Beijing Normal University)

Presenter: Ms TIAN, Yueran (Beijing Normal University)

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