PIConGPU: First Experiences on Minsky

G. Juckeland, R. Widera, A. Huebl
Electron Acceleration with Lasers
- Compact X-Ray sources

Ion Acceleration with Lasers
- Tumor Therapy

Plasma Instabilities
- Astrophysics
Domain Decomposition — Field and Particle Domain

- Moving Particles create Fields
- Fields act back on Particles
- Particles change Cells
Creating Vectorized Data Structures for Particles and Fields

Field Domain

- chunked in supercells
- line wise aligned

Particle Domain

- fixed size frames
- struct of aligned arrays
Algorithm Driven Cache Strategy

Global Memory

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Shared Memory

Cell 1

Cell 2

Cell 3

Cell 4
High Utilization of Threads
Task-Parallel Execution of Kernels + Asynchronous Communication

Diagram showing the process of computing fields, moving protons and electrons, and communicating fields and electrons in a parallel computational model.
PIConGPU — Scales up to 18,432 GPUs

strong scaling

weak scaling efficiency

Efficiency >95%

6.9 PFlop/s (SP)
First P100 Measurements

200M particles, single precision, KHI benchmark, one GPU

- not yet at 100% utilization as we usually see with *nvidia-smi*

  → tracing on P100 next

- 0.4s (P100), 1.6s (K80 1 GPU), … s (K20X)
Open Source Software Stack

PIConGPU
(hardware-independent, physics algorithms)

PMacc
(hierarchical domain decomposition, data flow management)

alpaka
(kernel acceleration)

mallocMC
(memory manager)

MPI

CUDA, OpenMP, ...

Plugins

https://github.com/ComputationalRadiationPhysics