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Scalable particle-in-cell simulations on many-core hardware with the free and open source code PIConGPU

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Exploring new regimes, optimizing experimental setups, or quantifying sensitivity of final beam parameters on experimental parameters, represent current challenges for simulations of laser plasma accelerators. Time-to-solution and scalability are key parameters for codes to minimize turnaround times in order to scan e.g. tens of parameters such as the laser leading edge, resolve solid density target physics and run full-scale start-to-end simulations. PIConGPU reaches unprecedented performance by accelerating 100% of its computations on many-core architectures and leveraging next-generation scalable I/O. High-resolution, full-geometry studies on top-ten listed supercomputers decisively enhance predictive capabilities. PIConGPU's design allows for utilizing various compute architectures, including modern X86 and ARM CPUs and GPUs with a single, adaptable code base. Users can now run PIConGPU on almost any machine, either by easy recompiling or using predefined Docker images, and everybody can download, use and contribute to the code without extensive knowledge in compute architectures. We highlight latest additions to PIConGPU such as scalable file I/O via a new openPMD-API including ADIOS2 support for on the fly loosely coupled data analysis, live visualization with particle and field rendering, non-standard Gaussian laser pulses via Laguerre modes, in-situ X-ray scattering image generation, and an pythonic simulation setup interface.

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