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Traveling-wave electron accelerators –leveraging exascale computing towards scalable laser-plasma accelerators

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Traveling-wave electron acceleration (TWEAC) is an advanced laser-plasma accelerator scheme, which is neither limited by dephasing, nor by pump depletion or diffraction. Such accelerators are scalable to energies beyond 10 GeV without the need for staging and are candidates for future compact electron-positron colliders based on existing CPA lasers.

Requiring to model a large plasma volume in 3D at high-resolution over an extended acceleration distance for high-fidelity results, TWEAC simulations need exascale compute resources – even “small” test simulations need hundreds of GPUs.

We present recent progress in TWEAC simulations and various technical advances in the 3D3V particle-in-cell code PIconGPU that enable running on the upcoming Frontier cluster (#1 in TOP500), most notably support of the HIP computational backend allowing to run on AMD GPUs, as well as openPMD, PICMI and algorithmic developments. These advances are mainly driven by our participation in OLCF’s Frontier Center for Accelerated Application Readiness providing access to the hardware platform of the Frontier exascale supercomputer. We show performance data and present recent applications of PIconGPU profiting from these developments.

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