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Exascaling strategies for the EPOCH Community PIC Code

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Since its public release in 2015, the EPOCH particle-in-cell community code has accumulated a large base of over 1100 registered users, becoming an indispensable workhorse tool for many groups worldwide whose research specialisation ranges from high-power laser-plasma interactions and QED-plasmas, to kinetic instabilities in tokamaks, space physics and particle accelerator design. EPOCH solves the Maxwell equations for the electromagnetic field with fully relativistic charge dynamics, providing a choice of several numerical implementations of the field solver and particle integration schemes respectively. EPOCH runs on computers ranging from standard laptops for one- and two-dimensional simulations, to national Tier-1 supercomputers with up to 10,000's of cores for more substantial three-dimensional problems.

Despite its wide acceptance and usability, the code still exhibits performance deficits in the parallel implementation of its communication scheme, including load balancing and data I/O. The PICeX project in the framework of the PRACE 6IP plans to carry out optimisation refactoring of EPOCH's core algorithmic kernels, considering parallelism, vectorization, and I/O libraries while maintaining the integrity of code's physics packages. One priority is to enable the code for contemporary Tier-0 PRACE supercomputers as well as to explore more innovative schemes for future Exascale machine architectures. In this talk we will outline these strategies in the light of recent hardware developments at the Juelich Supercomputer Centre and within EuroHPC.

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