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Examples of PIC code limit and potential for the simulation of wakefield acceleration and accelerator applications

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Beam- and laser-driven wakefield acceleration is now routinely simulated with Particle-In-Cell (PIC) codes. Due to their increasingly wide use in our community, these tools tend to be considered as highly trustworthy under any circumstances. However, some numerical errors can significantly affect the acceleration process and alter the simulated beam properties. One example is the Numerical Cherenkov Radiation (NCR) and Instability (NCI) that may degrade the beam divergence and emittance among other spurious effects. Solving the NCR/NCI issue in a PIC code is still challenging, but different recent numerical schemes able to remove or reduce NCR and NCI will be presented.

PIC codes can also be unique tools to simulate diverse applications of electron accelerators. We will show how the development of new modules in PIC code can allow us to study various radiation sources with a broad range of photon energies, ultrarelativistic beam-plasma instabilities that are relevant to beam propagation in plasma and to astrophysical scenarios, or the nearly unexplored strong-field QED regime.

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