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Stability analysis of Laser-Plasma accelerators using quasi-cylindrical PIC simulations

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Particle-in-Cell (PIC) codes have proven to be a vital tool for studying the physics of plasma based accelerators. However, the enormous cost of a single full 3D simulation limits their applicability for extensive stability or parameter studies. Further, numerical errors from commonly used finite difference solvers can cause unphysical results. The quasi-cylindrical, pseudo-spectral code FBPIC overcomes these limitations and allows insights beyond that of the few simulations often affordable with standard 3D codes. We will show that the resolution required for accurate results of typical LWFA problems can be much higher than what is commonly used and how the consideration of temperature effects in the plasma can improve the accuracy as well as the performance of the simulation.
As an example on how FBPIC allows insight into a new kind of problem, we will present a tolerance study of a laser plasma accelerator against laser driver fluctuations based on hundreds of accurate PIC simulations.

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