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Software for Low-Energy Beam Simulation by Particle-in-Cell Algorithm

Understanding of low-energy beam dynamics is crucial in construction of electron guns, ion sources and several other types of devices employed in nuclear physics. Apart from external guiding and focusing systems, a prominent role in evolution of non-relativistic high-density beams is played by particle-particle interaction. Numerical simulations taking into account all of these effects are typically accomplished by a well-known particle-in-cell method [1]. While many programs implementing this method exist, not all of them are suited to model low-energy beam devices. Overview of the programs is given and requirements for an "ideal"one for this purpose are formulated. Particular attention is paid to effective utilization of CPU and GPU clusters, since it is essential to perform computationally demanding high quality simulations. To address the formulated requirements, development of a new open source code has been started [2]. It's current features and main functionality are discussed. Comparison with several analytical models demonstrates good agreement between the numerical results and the theory. Performance benchmarks are presented. Further development plans, including GPU-parallelization and implementation of rectilinear grids to increase computation speed are discussed.

References:
[1] Hockney, Roger W.; James W. Eastwood (1988). Computer Simulation Using Particles. CRC Press. ISBN 0-85274-392-0.
[2] https://github.com/epicf/ef

Primary authors: Mr BOYTSOV, Alexey (JINR LHEP); Dr BULYCHEV, Andrey (')

Presenter: Mr BOYTSOV, Alexey (JINR LHEP)

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