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3D BEAM-BEAM EFFECTS SIMULATION ALGORITHM

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ABSTRACT

A new method for full three-dimensional simulation of beam-beam effects is proposed. The beam-beam interaction research in newest Super-B Factory and International Linear Collider projects can be significant application of the method.

Great value of relativistic factor γ is the main problem of high-energy beams simulations. In these cases electromagnetic fields of charged particle stretch out γ times as much in transversal plane and converge longitudinally γ^2 times less. This leads to necessity of extension domain length in transversal directions and reducing spatial step in longitudinal direction, thus it yields huge computing times. We present a new algorithm [1] based on solving Vlasov's kinetic equation and a set of Maxwell equations with special boundary conditions, that permits to make calculations with high relativistic factors (up to $\gamma \sim 10^6$).

3D time-dependent problem of moving charged particles in self-consistent electromagnetic fields considered. To get the solution we used particle-in-cell method with leap-frog scheme - function values of interest is defined in nodes of grids shifted by time and space, what yields the second order of approximation. Initial and boundary conditions for the electromagnetic fields are set with the help of special kind of potential. Currents are calculated in such a way when finite-differential analogue of continuity law is fulfilled identically, what greatly reduces approximation errors and makes the algorithm more stable.

Computer simulation results of focusing beam dynamics problem are presented. Result dependencies on physical (beam charge, energy) and technical (grid size, particle number) program parameters are investigated. Calculation results evidence chosen model appropriateness.

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