MAGIC

Science of the Cosmos

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Numerical simulation of high energy particle physics problems.

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Particle-in-cell (PIC) numerical simulations are widely used for the numerical modeling of plasma physics problems. These simulations are used primarily, but not exclusively, to study the kinetic behavior of the particles. For example, we used this method for numerical simulations of physics in linear particle accelerators [1,2,3].
The main idea of the method is to describe the plasma as a set of electrons and ions, which are modeled as discrete entities that move in continuous fields that are calculated on a computational mesh. The calculation of the motion of each particle is defined by electromagnetic fields.
The main difference between different PIC codes is in the coupling of the
particles and the field. Another PIC method classification is based on Maxwell's equation solver. There are different types of discretization techniques, such as second-order finite-difference time-domain (FDTD) algorithm, non-standard finite-differences as well as pseudospectral analytical time-domain (PSATD), pseudospectral time-domain (PSTD) algorithms. In our simulations, we use our modification of the FDTD method.
In this talk, we will show our new 3D solver for the numerical simulation of an open magnetic trap, which is also helpful for cosmic rays and random magnetic trap simulation. Our new code is optimized for high-performance supercomputers based on CPUs with advanced vector instructions (AVX2, AVX512). We will show the mathematical problem, numerical method, code structure, technical details of vectorization, and code performance with some simulation results of the open magnetic system for plasma confinement.
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