INTEGRATED APPROACH IN MODELING AND OPTIMIZATION OF ACCELERATOR ELEMENTS

Perepelkin E., Kovalenko A., Tarelkin A., Polyakova R., Inozemtseva N., Sadovnikova M.

Joint Institute for Nuclear Research (JINR), Dubna, Moscow region, 141980 Russia

The design of modern accelerator facilities requires the use of an integrated approach in modeling and optimization of the system parameters [1]. This approach implies a high degree of detail (realism) of the mathematical model with the possibility of a quick numerical optimization process that is impossible without the use of modern hybrid computing architectures, which include massively parallel computing on graphic processors (GPUs) [2]. Magnetic systems, RF accelerator systems, various types of particle detectors are integral elements of accelerator complexes. The design of these elements is a nonlinear self-consistent task requiring a multiple process of optimization of the accelerator system parameters. For example, in order to obtain a given distribution of the magnetic field in a particle detector, it is necessary to select the geometric configuration of the magnetic system, optimize the currents in the windings, and perform strength calculations. If the current winding operates in superconductivity, then at least an assessment of thermal deformations will be required. Even the "given" distribution of the magnetic field in the particle detector is not always predetermined, since it itself requires a choice from many different configurations due to physical processes that are planned to be studied at the facility. In such cases, it is necessary to consider related problems, for example, the electromagnetic design of the setup and modeling of the beam dynamics or the problem of particle tracks recognizing. Since 2008 the staff of LIT, VBLHEP (JINR) and Lomonosov Moscow State University has been jointly developing the described integrated approach in modeling and optimization of elements of accelerator facilities. A software engine was created on the massively parallel architecture of graphic processors (GPUs) for modeling beam dynamics in a cyclotron and numerical solving of the nonlinear magnetostatics problem [1-4]; these algorithms accelerated the calculation from one to two orders of magnitude per GPU.

References

1. Inozemtseva N.G., Perepelkin E.E., Sadovnikov B.I. Optimization of algorithms for mathematical physics problems for graphic processors, Faculty of Physics, Lomonosov Moscow State University, Moscow, 2012, 256 pp.

2. Perepelkin E.E., Sadovnikov B.I., Inozemtseva N.G. Computations on graphic processors in problems of theoretical and mathematical physics, Series "Classical textbook of Moscow State University", URSS, Moscow, 2019, 240 pp.

3. Perepelkin E.E., Kovalenko A. D., Tarelkin A. A., Polyakova R.V., Sadovnikov B. I., Inozemtseva N. G., Sysoev P. N., Sadovnikova M. B. Modeling of Magnetic Systems in an Area with an Angle // Phys. Part. Nucl., 3rd edition, Volume 50, 2019.

4. Perepelkin E.E., Kovalenko A.D., Tarelkin A.A., Polyakova R.V., Inozemtseva N.G., Sysoev P.N., Sadovnikova M.B. 3D calculations of the options for the magnetic system of the detector SPIC of the NICA complex // Phys. Part. Nucl., Lett., 2nd edition, Volume 16, pp. 140-152, 2019.