HIGH-PERFORMANCE VERSION OF the RPB CODE FOR DETERMINATION OF THE PLASMA boundary IN TOKAMAks BASED ON GRAPHIC PROCESSORS

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The operation of modern tokamak devices is impossible without an effective plasma boundary control system during the discharge. The problem of determining the plasma boundary on the basis of discrete magnetic measurements has been the subject of a considerable number of papers (see, for example, [1–4]). From a mathematical point of view, the problem reduces to the Cauchy problem for the two-dimensional homogeneous elliptic equation for the plasma MHD-equilibrium (the homogeneous Grad-Shafranov equation). Different computational approaches are used to solve a poorly-conditioned (ill-posed) mathematical problem — the method of harmonic expansion in special functions (EFIT code), the point filament method, the distributed filament method, the integral equation method (RPB code - Reconstruction of Plasma Boundary). Each of these methods has its advantages and disadvantages.

In this paper, we consider a method for determining the plasma boundary using integral equations. A high-speed parallel boundary reconstruction code using GPUs has been developed. Various methods of parallelization of the algorithm have been studied. We have shown the possibility of processing magnetic measurements in the real-time experiment.

The results of simulation modeling of electromagnetic diagnostics on various GPUs for the tokamak T-15M device (currently under construction) are presented, and single-processor and multi-processor versions are compared (as long as single and double precision versions). The simulation was carried out on high-end NVidia video cards (Tesla C2075, Tesla K20c, Tesla K40c) installed in the supercomputer complex of the MSU CMC faculty, and on conventional serial devices (GeForce GTX 730M, GTX 970M, GTX 1050Ti). It is shown how the technical parameters of a video device (such as number of cores, data bus width and the video memory size) affect the code efficiency.

As we have discovered, the efficiency of the parallel code allows us to choose the regularization parameter by the quasioptimality criterion at each time step, while being able to solve the problem with a frequency close to the frequency of measurements.

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References

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