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GPU parallel Grad-Shafranov solver for real-time equilibrium reconstruction

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To achieve real-time control of tokamak plasmas, the equilibrium reconstruction have to be completed rapidly enough. For EAST experiment case, real-time equilibrium reconstruction is generally required to provide results within 1ms. A GPU parallel Grad-Shafranov solver is developed in P-EFIT code[1], which is built with the CUDA™ architecture to takes advantage of massively parallel Graphical Processing Unit(GPU) cores and significantly accelerate the computation. GPU parallel numerical algorithms for block tri-diagonal linear system are implemented based on eigenvalue decomposition and optimized with latest Pascal TITAN X GPU. The solver can complete calculation within 28us with 65×65 grid size and 72us with 129×129 grid size in double floating precision. It supports that P-EFIT can complete one whole equilibrium reconstruction iteration in about 167us with 65×65 grid size and 319us with 129×129 grid size and fulfill the time feasibility for real-time plasma control with both grid sizes. P-EFIT provides a routine real-time plasma equilibrium reconstruction method which has high spatial resolution[2], customized modules and internal current profile calculation for plasma control in EAST.

References
[1] Yue, X. N., et al. "Fast equilibrium reconstruction for tokamak discharge control based on GPU." Plasma Physics and Controlled Fusion 55.8 (2013): 085016.
[2] Huang, Yao, et al. "Implementation of GPU parallel equilibrium reconstruction for plasma control in EAST." Fusion Engineering & Design 112(2016):1019-1024.

Eligible for student paper award?

No

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