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Development of Local-Imaging and High-Speed Visible Diagnostics for Real-Time Plasma Boundary Reconstruction of EAST

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Fast plasma boundary reconstruction is usually used for real-time control of tokamak plasma. In EAST experiment, the time consuming for boundary reconstruction should be within 1ms to meet the need of real-time control. Fast evolution of cameras in recent years has made them promising tools for diagnostics of Tokamak. The solution presented in this paper consists of a prototype of high-speed visible image acquisition and processing system (HVIAPs) dedicated for EAST shape and position control. The optical system can be applied in high-speed camera diagnostics, due to its large relative aperture (1:1.5). Three visible cameras, which are mounted outside the EAST at a distance of 3.4 m, are all controlled via optical fibers over QSFP+ (40 Gbit/s data rates) interfaces. As each new frame comes in from the camera, it is stored in main memory of the server by direct memory access (DMA). In order to meet the needs of real-time storage, the acquired image data is cached in main memory and written to Solid state drive (SSD) after one shot discharged. 16 frames per second are chosen from the cached data and sent to another server for displaying by using website. GPUs and FPGAs are typically used as accelerators and co-processors in addition to a CPUs. Such a heterogeneous computing system can combine the advantages of its individual components. The offline image process results are compared to offline EFIT, with an average error of 1.5 cm. The total processing time for one frame is less than 0.2 ms.

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