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Real-time MHD Analysis Computer System Design, Architecture, and Integration with PCS

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PPPL and Columbia University are together building a solution for analyzing rotating magnetohydrodynamic (MHD) mode measurements in real-time on KSTAR for use in new KSTAR Plasma Control System (PCS) algorithms supporting disruption prediction and avoidance research on KSTAR. The KSTAR PCS is based on the General Atomics (GA) PCS and uses the same software infrastructure with a Reflective Memory (RFM) interconnect between the existing real-time computer and the acquisition devices. A new real-time computer currently being configured in-house will complement this design, providing a second system with additional capability connected via RFM to the existing real-time computer in a passive way so as not to disturb ongoing operations. The system has localized data acquisition that can acquire 16 signals at 300 kHz and 16-bit resolution using differential inputs. These channels will connect to an existing toroidal array of Mirnov coils via a buffer chassis and operate both autonomously as well as synchronously with the existing PCS. There are algorithms that will run on the real-time computer hardware PCIe-based FPGA alongside companion algorithms running on the CPU as part of a new PCS category specific to real-time MHD system operation. The computer will provide 16 cores at 3.5 GHz each, and communication within the computer, and between the computer and the hardware FPGA will utilize shared memory for fast, efficient, and low latency data propagation.

Primary authors: ERICKSON, Keith (Princeton Plasma Physics Laboratory); SABBAGH, Steven (Columbia University); RIQUEZES, J. (Columbia University, USA); PARK, Young-Seok (Columbia University); QUE, W. (PPPL)

Presenter: ERICKSON, Keith (Princeton Plasma Physics Laboratory)

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