ISTTOK real-time control of AC discharges

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ISTTOK is one of the few tokamaks that have a regular alternate current (AC) discharges scientific program. In AC discharges, the current reversal should be as short as possible to optimize the plasma performance. However, plasma position becomes very difficult to control during this short period as a result of the low plasma current. In the current reversal the magnetic diagnostics are unreliable due to their low signal and other diagnostics such as the visible tomography have to be used for real-time control.

In order to produce systematic alternate discharges a real-time control system was developed at IST based on the Advanced Telecommunications Computing Architecture (ATCA) standard. Furthermore, the ISTTOK tokamak actuators (vertical field power supply, horizontal field power supply, primary field power supply and gas puffing) were upgraded to be able to communicate with the ATCA control system.

Several diagnostics were connected to ATCA digitizers to provide real-time information for the control system including: tomography, Mirnov coils, interferometer, electric probes, current in the primary power supply, loop voltage and plasma current.

The system has a control cycle of 100 μs and can operate in four different modes; (i) automatic mode, (ii) hybrid mode, (iii) single pulse discharge mode and (iv) preprogrammed manual mode.

The usual mode of operation is the automatic mode (i), where the system controls all the plasma parameters in order to obtain the desired plasma current, monitoring the flux saturation of the iron core and inverting the current whenever this flux becomes saturated, the maximum runtime of the discharge is selected by the operator. In the other modes, the operator can preprogram a part (ii) (iii) or the entire (iv) discharge procedures, with the system always monitoring the safety limits.

This paper presents the upgrade of the diagnostics and actuators for real-time usage and also illustrates the novel control system for ISTTOK operation.