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Automation and Control of a plasma experiment using EPICS

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The IST-BPlasma device is a compact setup used for the execution of plasma physics experimental protocols. It creates a low temperature plasma resultant from the interaction of an electron beam with noble gases gas at low pressure and is equipped with Radio-Frequency (RF) based diagnostics, namely (i) resonant cavity and (ii) electrostatic probes. These allow to measure the plasma density and study the propagation of electrostatic waves. However, its control system did not enable to maintain stable operating parameters, such as gas pressure or accurate probe positioning throughout the experiments and the output from the diagnostics was not recorded into digital data files due to fully analog acquisition system.

As a result, a set of two dsPICnode V3.0 boards, fitted with Microchip dsPIC30F microcontrollers, were selected and their firmwares and expansion cards developed according to the specific purpose. The board used for hardware control was connected to actuators and sensors installed on the setup including valves, pressure gauges via RS-485, vacuum pumps and position encoder among others. The firmware also includes a gas injection PID algorithm. On the other hand, the second board was used to acquire the output signals of the RF diagnostics crystal detectors. Both boards were connected via RS-232 to a local-host computer running EPICS I/O Controller (IOC). The interface was achieved using StreamDevice generic device support for EPICS, along with a communication protocol to send configuration commands and receive operation and diagnostics data. Finally, a Graphical User Interface (GUI) was developed using Control System Studio (CS-Studio) enabling the operator to have supervisory control and live access to operation parameters, as well as, to the diagnostics data. The client application ran on a separate computer and was connected to the the local-host IOC using EPICS ChannelAccess. This approach presented operation flexibility since it allowed both local and remote access.

Operation trials conducted showed that by using the presented solution it was possible to control the fundamental parameters of the apparatus and correctly retrieve experimental data. Moreover, this configuration created the possibility of introducing additional features in future modifications. The designed control and acquisition solution improved reliability, reproducibility of experimental conditions and user experience. Given the successful implementation of this solution, it is foreseeable that it can be easily ported and implemented in other similar devices.

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