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MARTe based Plasma Position Reflectometry System Integration at COMPASS Tokamak

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Plasma Position Reflectometry (PPR) presents an alternative to the employment of magnetic based diagnostics in the determination of the plasma separatrix position. For future controlled nuclear fusion devices, where harsh radiation environment may induce drifts and even damage magnetic probes, PPR can play a major role as a diagnostic for plasma position control during machine operation.

PPR has been demonstrated at ASDEX-Upgrade, where the Discharge Control System (DCS) framework is used, making it relevant to assess an implementation on a different device and real-time control framework. The COMPASS Tokamak presents suitable conditions for such demonstration and further regular operation, by using the O-Mode reflectometer and the Real-Time Control System (RTCS) based on the Multi-Threaded Application Real-Time executor (MARTe) framework. MARTe is currently under upgrade to a Quality Assurance version, MARTe-QA.

Herein we present the integration of the reflectometer diagnostic on the RTCS, both at hardware and software levels. The MARTe-PPR node runs at a rate matching the COMPASS slow control cycle of 500us at the main control node. Sweep data is acquired during discharges using a 200Msps FPGA based acquisition board. The FPGA firmware was modified to enable RT DMA packet streaming at configurable rates. Streamed data via optical PCIe links is now used to reconstruct density profiles, and to estimate the separatrix position, to be delivered to the main node through UDP. This bidirectional UDP link enables synchronization between the MARTe-PPR and main nodes. Acquisition system, sweep trigger generator and reflectometer are all synchronized using a 10MHz time base clock.

Tests conducted so far have shown that the system performs within the required specifications, enabling the trial of closed loop operation using PPR estimated radial positions during discharges. A migration to MARTe-QA is also discussed.

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