

Preliminary Application of Hardware-in-the-loop Simulation Technology in EAST PCS Control Simulation

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Abstract EAST PCS, a linux cluster configured with real-time data acquisition and data transmission hardware devices, executes a series of algorithms for plasma parameters control in real time. The control performance and reliability of PCS determines the operation safety of the device and the achievements of physics experiment objectives. In order to test the performance of whole control system under real working conditions, the hardware-in-the-loop (HIL) simulation technology is applied for EAST PCS control simulation, which has been widely used in the aerospace, automotive industry and new energy fields. The essence of HIL simulation is to connect EAST PCS with the digital tokamak models through the configured data input/output devices, which simulates the real operation mode for the control system. This research uses the time synchronization method of aligning the hardware time with the real physical time to build the simulation framework. The HIL simulation framework is mainly divided into two parts. One is the upper computer that deploys real-time tasks, the other is the lower computer that executes real-time tasks. The work of the upper computer is mainly divided into three parts, using Matlab to develop a fixed-step physical model, using Labview to develop real-time drive services for the lower computer, and using VeriStand to compile, deploy and monitor real-time tasks. The main job of the lower computer is to run real-time tasks and exchange real-time data with EAST PCS through the reflective memory card. In order to verify the framework, two models, simple coil current model and rigid plasma model, were built for the EAST application. The fixed-step model running in the lower computer and the DMA transmission performance of the reflective memory card were tested. Both the transmission performance of the reflective memory card and the solution performance of the model met the requirements of the control cycle, less than 100us. The coil current, plasma current and position control had the consistent results with that in experiment or Matlab/Simulink model in loop test. The HIL simulation provides a powerful validation tool for the development of control functions in EAST PCS.

Keywords:Hardware-in-the-loop simulation, Control simulation, VeriStand, PCS

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