Accumulated Experiences From Implementations of the DIII-D Plasma Control System Worldwide*

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The complex task of controlling the many aspects of a DIII-D plasma discharge has resided for the last 15 years with the real-time digital DIII-D Plasma Control System (PCS). The current PCS has evolved through several iterations into a robust platform that has been adopted at several fusion devices around the world. Each installation, as well as each new upgrade at DIII-D, has presented new challenges. Each of these challenges has provided an additional opportunity to expand our understanding of the requirements, alternative operational methods, and differing real-time implementations for tokamak plasma control.

Although not always the case, all installations derived from the DIII-D PCS are now centered around off-the-shelf computing, I/O, and real time networking hardware. This fact, along with an open source software design has facilitated the expanded use of the DIII-D PCS. Common hardware and software principles allow for a low cost solution where control system developers can focus the bulk of their efforts upon the unique aspects of their particular device. In turn, each new implementation of the PCS expands the global "community" of PCS users. This expanding community benefits control development at each individual device, because it allows shared development and troubleshooting with increased control system reliability. Collaborative or remote operation of each device is also facilitated because of common architecture, concepts, and user interface

This paper presents a brief historical overview of PCS hardware evolutions and describes some of the design, structure, and techniques that have allowed the PCS to be a productive component at many fusion facilities. It will also discuss some of the major differences between the individual PCS installations and bring to light some of the major challenges that were overcome during integration. The lessons learned from these experiences provide general solutions and can inform control system designs for other next-generation devices. We also describe some limitations of the PCS relative to identified present and future needs at DIII-D and other devices, and discuss planned upgrades to the PCS to address these needs.

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