Plasma Startup Design of Fully Superconducting Tokamaks EAST and KSTAR with Implications for ITER

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Abstract. Recent commissioning of two major fully superconducting shaped tokamaks, EAST [Y. Wan, et al., Proc. 21st IAEA Fusion Energy Conf., Chengdu, China, 2006] and KSTAR [Y. K. Oh, et al., Proc. 25th Symp. on Fusion Technology, Rostock, Germany, 2008, O8-3], represents a significant advance in magnetic fusion research. Key to commissioning success in these complex and unique tokamaks was (1) use of a robust, flexible plasma control system (PCS) based on the validated DIII-D design [B. G. Penaflor, et al., Proc. 6th IAEA Tech. Mtg. on Control, Data Acquisition and Remote Participation for Fusion Research, Inuyama, Japan, 2007]; (2) use of the TokSys design and modeling environment, which is tightly coupled with the DIII-D PCS architecture [J. A. Leuer, et al., Fusion Eng. Design, vol. 74, p. 645, 2005], for first plasma scenario development and plasma diagnosis; and (3) collaborations with experienced, internationally recognized teams of tokamak operations and control experts. We provide an overview of the generic modeling environment and plasma control tools developed and validated within the DIII-D experimental program and applied through an international collaborative program to successfully address the unique constraints associated with startup of these next generation tokamaks. The unique characteristics of each tokamak and the machine constraints that must be included in device modeling and simulation, such as superconducting coil current slew rate limits and the presence of nonlinear magnetic materials, are discussed, along with commissioning and initial operational results. Lessons learned from the startup experience in these devices are summarized with special emphasis on ramifications for ITER.

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