Plasma Startup Design and Experience in Fully Superconducting Tokamaks

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Recent commissioning of two major fully superconducting shaped tokamaks, EAST [1] and KSTAR [2], 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 [3], 2) use of the TokSys design and modeling environment, which is tightly coupled with the DIII-D PCS [4], for first plasma scenario development and plasma diagnosis, and 3) collaborations with experienced, internationally-recognized teams of tokamak operations and control experts. We provide a general 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 slew rate limits and non-linear magnetic material characterization, will be discussed, along with commissioning and initial operational results. Application of this same modeling environment to design of startup scenarios and other major control needs for ITER will also be discussed.

This work was supported by the US Department of Energy under DE-FC02-04ER54698.

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