Tokamak startup modeling and design for EAST first plasma campaign*

J.A. Leuer, B.J. Xiao, D.A. Humphreys, M.L. Walker, A.W. Hyatt, G.L. Jackson, D. Mueller, B.G. Penaflor, D.A. Piglowski, R.D. Johnson, A.S. Welander, Q.P. Yuan, H.Z. Wang, J.R. Luo, and the EAST Team

Abstract. The Experimental Advanced Superconducting Tokamak (EAST) was the first shaped tokamak of Mega-Ampere scale to achieve plasma utilizing a fully superconducting poloidal field coil system and is addressing ITER relevant superconducting constraints associated with breakdown, plasma formation, and initial plasma current ramp. Electric field production for plasma startup is severely limited in fully superconducting machines as a consequence of constraints associated with coil and lead voltages and eddy current heating in the superconducting coils. Such constraints motivate the use of electromagnetic modeling codes to design startup scenarios for these devices. The successful first plasma campaign of the EAST superconducting tokamak was greatly facilitated by extensive and careful planning, development of appropriate modeling, simulation and diagnostic tools, a highly flexible plasma control system, and a highly experienced international collaboration team. We describe the design and modeling tools used to develop the first plasma scenario along with results of their application in the startup campaign. Control design tools and plasma control algorithms utilized during the first campaign are discussed. Key physics, engineering, and operations results of the first plasma campaign are presented, including observations relevant to future devices such as ITER.

*This work was supported in part by the US Department of Energy under DE-FC02-04ER54698 and DE-AC02-76CH03073.