Comparative study between MHD simulation codes for nonlinear dynamics of the ELMs in KSTAR H-mode plasma

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KSTAR ECEI systems have provided high-quality 2-D images of the ELMs ideal for study of the ELM dynamics such as the entire evolution of the ELM [1], interaction between excited multiple modes [2] and rapid change of dominant mode numbers during the inter-ELM-crash period [3]. A validation of the observed 2-D ELM dynamics with the MHD simulation has elevated the understanding of the ELM physics. To further enhance understanding of the underlying common physics of the ELM dynamics, results from three well-established nonlinear MHD simulation codes, BOUT++, M3D-C1 and JOREK, are cross-checked for the same target ELM data with the same equilibrium of the KSTAR H-mode plasma. Each code partially reproduced the observed ELM dynamics, perhaps, due to different initial conditions used in each code which is optimized in different operating window. In BOUT++, the initial dominant mode number \( n = 8 \) is changed to lower \( n \)-number \( n = 4 \): lower mode number becomes dominant just before the ELM-crash [1]. Before lower-\( n \) mode is excited, broadband spectrum appears probably related to the transient disappearance of coherent mode [1]. In JOREK, changes of dominant mode number \( n = 5–8 \) are observed during the pedestal build-up [3] and evolution of poloidal plasma rotation during ELM cycle is investigated: poloidal velocity is decreased and its profile is strongly sheared prior to the ELM-crash. In M3D-C1 and JOREK, the perturbations are clearly expelled outside separatrix during the pedestal relaxation. In M3D-C1, perturbation structure outside separatrix is clearer and more stretched in radial compared to others. This work is supported by NRF of Korea under contract no. NRF-2014M1A7A1A03029865. [1] G. S. Yun, et al., Physics of Plasmas, 19 (2012) 056114 [2] M. Kim, et al., Nuclear Fusion, 55 (2015) 073001 [3] J. E. Lee, et al., Nuclear Fusion, 55 (2015) 113035