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Overview of KSTAR Experiments and Future Plans

Won-Ha Ko[1*], S.W. Yoon[1], W.C. Kim[1], J.G. Kwak[1], K. L. Park[1], Y. U. Nam[1], S.J. Wang[1], J. Chung[1], B.H. Park[1], G.Y. Park[1], H.H. Lee[1], H.S. Han[1], M.J. Choi[1], Y.S. Na[2], G.S. Yun[3], Y. In[4], W.H. Choe[5], J.M. Kwon[1], J.P. Lee[6], Y.M. Jeon[1], B.K. Na[1], J.S. Ko[1], J.H. Lee[1], G.W. Shin[1], K. D. Lee[1], J. Kim[1], J. Lee[1], S.H. Hahn[1], J.W. Lee[1], H.S. Kim[1], M. Kim[1], J. G. Bak[1], S. G. Lee[1], J.S. Kang[1], Y.H. Lee[1], J.H. Jeong[1], M.H. Woo[1], J.H. Kim[1], J.W. Juhn[1], J.W. Yoo[1], G. Kim[1], Y. Chu[1], K. P. Kim[1], H.S. Kim[1], J.S. Kim[1], M. Joung[1], S.H. Park[1], H.J. Kim[1], H.M. Wi[1], J.S. Hong[1], D.C. Seo[1], S.H. Seo[1], Y.S. Lee[1], Y.S. Kim[1], J.H. Jang[1], K.C. Lee[1], K. Kim[1], H.G. Jhang[1], J.K. Lee[1], S.H. Ko[1], W. Lee[1], T. Rhee[1], J.H. Yeom[1], J.W. Kim[1], J. Seol[1], M.W. Lee[1], L. Jung[1], S.I. Lee[1], Y.J. Lee[1], H.T. Park[1], W. Cho[1], D.J. Choi[1], S.G. Kim[1], H.H. Wi[1], J.W. Han[1], I.H. Rhee[1], K.H. Jang[1], H.Y. Lee[1], H.J. Lee[1], L. Qi[1], J.H. Seo[1], E.N. Bang[1], H.J. Ahn[1], I.S. Woo[1], Y.O. Kim[1], T.G. Lee[1], S.W. Yun[1], S.J. Lee[1], K.S. Lee[1], G.I. Kwon[1], J.D. Kong[1], S.T. Kim[1], S.W. Kwag[1], J.K. Jin[1], C.H. Kim[1], H.S. Ahn[1], D.S. Park[1], J.H. Choi[1], C. Sung[5], J.H. Yoon[5], M.S. Park[5], B.S. Kim[2], J.H. Hwang[5], H.W. Shin[5], J.M. Park[7], S.K. Kim[2,8], J. K. Park[8], N.C. Logan[8], S.M. Yang[8], Q. Hu[8], E. Kolemen[8], R. Shousha[8], J. Barr[9], C. Paz-Soldan[10], W. Wehner[9], Y. S. Park[10], S. A. Sabbagh[10],K. Ida[11], K. Ogawa[11], S. Kim[12], A. Loarte[12], E. Schuster[13], M. Hole[14], R. Nazikian[8], E. Gilson[8], D. Eldon[9], O. Schmitz[15], T. Nakano[16], T. Tala[17], A.O. Nelson[8], M. Okabayashi[8], H. Park[4], and the KSTAR Team[1]

[1]Korea Institute of Fusion Energy, [2]Seoul National University, [3]Pohang University of Science and Technology, [4]Ulsan National Institute of Science and Technology, [5]Korea Advanced Institute of Science and Technology, [6]Hanyang University, [7]Oak Ridge National Laboratory, [8]Princeton Plasma Physics Lab., [9]General Atomics, [10]Columbia University, [11]National Institute of Fusion Science, [12]ITER Organization, [13]Lehigh University, [14]Australian National University, [15]University of Wisconsin-Madison, [16]National Institutes for Quantum and Radiological Science and Technology, [17]VTT Technical Research Center, Finland

*e-mail: whko@kfe.re.kr

Korean Superconducting Tokamak Advanced Research (KSTAR) has been focused on exploring the key physics and engineering issues of the high-performance steady-state operation for ITER and future fusion reactors utilizing unique capabilities of KSTAR with low intrinsic error field, toroidal field ripple, etc. [1, 2].

First of all, a new advanced scenario was developed targeting steady-state operation based on the early diverting and heating during the ramp-up phase of plasma current [3] and significant progress has been made in shape and heating control to address the MA level of plasma current, stationary high ion temperature, and high li scenario with beta_N ~3 and newly observed I-mode-like regime.

Symmetric multiple Shattered Pellet Injections (SPIs) for ITER disruption mitigation was installed and uniquely demonstrated on its performance in KSTAR. It was shown successfully the current quench rate changes proportionally as the time difference varies from several percent to several tens of percent of the thermal quench duration (1~2 ms) and it was demonstrated that peak density was increased twice with dual SPIs compared with a single SPI.

Recent KSTAR 3D magnetic field experiments have observed q95 window dependence on RMP-driven ELM suppression which is consistent with prediction confirmed the importance of edge toroidal rotation and associated turbulence motion and validated poloidal asymmetry in RMP plasma coupling in RMP ELM suppression[4, 5].

RMP ELM optimization and automatic control techniques such as adapted ELM controller and Machin Learning algorithm in order to suppress ELM were successfully implemented in KSTAR PCS [6]. Adapted ELM controller enhanced plasma performance about 60% during ELM suppression [7]. Machin Learning algorithm successfully suppressed the first ELMs and almost full ELM-crash with high performance in RMP ELM suppression experiments

The coming KSTAR research plan will be focused on the machine upgrades such as extensive heating & current drive capabilities including off-axis NBI with 6MW and Helicon current drive with 4MW, the installation of new tungsten divertors with active cooling for the development of the DEMO/ITER relevant operational scenario.

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