Status of the high performance and long pulse operation in KSTAR and exploring the issues in ITER and K-DEMO

Yeong-Kook Oh\textsuperscript{a}, S. W. Yoon\textsuperscript{a}, J. G. Kwak\textsuperscript{a}, K. R. Park\textsuperscript{a}, Y. Chu\textsuperscript{a}, H. Park\textsuperscript{ab}, and KSTAR team

\textsuperscript{a} National Fusion Research Institute, Daejeon, Korea
\textsuperscript{b} Ulsan National Institute of Science and Technology, Ulsan, Korea

Email: ykoh@nfri.re.kr

Korea Superconducting Tokamak Advanced Research (KSTAR) program has mission to explore the scientific and technical issues in steady-state high performance plasma achievement that are essential to ITER and Korea demonstration reactor, K-DEMO. In this regards, KSTAR has made a remarkable progress in developing long pulse and high performance operation. The outstanding engineering features of KSTAR, such as extremely low intrinsic error field, low toroidal field ripple, flexible in-vessel control coil, and advanced 2D/3D imaging diagnostics systems, enable the exploration of the plasma confinement and instability under extremely advanced operation window.

According to improvement in the plasma control, KSTAR could achieve an extremely long pulse H-mode discharge up to 70s in 2016. In addition to long pulse H-mode operation, various operation modes have been explored such as sustaining the internal transport barrier formation in electron and ion profile up to 7s, sustaining the high normalized beta scenario ($\beta_N >3$) up to 3s, achieving large fusion gain ($G \sim 0.38$) in hybrid mode, and achieving very low edge safety factor ($q_{95} <2.3$) in H-mode. As a high priory research topic in ITER baseline operation, KSTAR has investigated a very robust and reproducible edge localized mode (ELM) crash suppression window in $n=1$ by adopting appropriate plasma model.

In 2017, KSTAR will be operated with increased PFC temperature up to 150 degree of Celsius, liquid helium circulation in in-vessel cryopump, and operation of a pellet injector for the improved particle control. And in-depth exploration of advanced operation scenarios and long pulse operation will be conducted by the improved diagnostics and analysis.

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