AAPPS-DPP 2018 Plenary speaker Name: Dr. Yong Kyoon In
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Rationale: Dr. In will present the latest outstanding progress in 3-D Physics research activities in KSTAR. He has been leading the RMP-driven, ELM-control physics research, 3-D transport and NTV physics, along with plasma response quantification and 3-D structure. His talk will not only address each noticeable achievement in stability, transport and turbulence, but also discuss the key physics values and implications to ITER and beyond. In particular, since ITER RMP is planned to be configured similarly to what has been installed in KSTAR, the discussion of 3-row RMP results would be quite unique, in that no other device can emulate the outcome elsewhere.

Talk Title: Critically resolved non-axisymmetric field physics in KSTAR

Short abstract: The presence of non-axisymmetric magnetic fields ($\delta\mathbf{B}$) in tokamaks poses both challenges and opportunities on magnetically confined plasmas. Since such non-axisymmetry of magnetic fields greatly affects plasma stability, transport and turbulence, we are often attempting to minimize any detrimental effects, while maximizing potential benefits. In that view, KSTAR, whose intrinsic error field and toroidal field ripple are an order of magnitude lower than in other devices respectively [1, 2], appears ideal to address a variety of critical physics premises that could be highly subject to the characteristics and levels of nonaxisymmetric fields. In particular, since the 3-row in-vessel control coils (IVCC) in KSTAR is uniquely versatile to rigorously control dominantly resonant and exclusively non-resonant components, we may be in a good position to resolve the associated critical transitions that had not been well understood. Indeed, recent KSTAR experiments have demonstrated several meritorious benefits of low-level of intrinsic nonaxisymmetric field on both stability and transport, as well as on turbulence. First of all, we have established robust full ELM-crash-suppression using low-n RMPs, while discovering the importance of shape effects (e.g. triangularity of δ) and electron perpendicular flow of $\omega_{e,\perp} \sim 0$ on pedestal top [3, 4], along with the safety factor of q_{95}, and collisionality of ν^*. Taking advantage of highly reproducible robust low-n RMP-driven, ELM-crash-suppression, a set of intentionally misaligned RMP configurations, similarly configured to the planned ITER RMPs, has been explored to address the 3-D field impact on divertor heat flux profiles [5]. As a result, we have confirmed a broadened divertor heat flux profiles with 3-row RMPs for the first time, while no similar broadening is expected with 2-row RMPs [6]. Unlike resonant components that have affected the power threshold of L-H transition (P_{th}), dominantly non-resonant components were not influencing P_{th} at all [7], which suggests there is no need of non-resonant error field correction in ITER or future reactors. Also, in the vicinity of magnetic islands, strong TEM-turbulence has been observed near O-points in hot core plasma side, while weak ITG-associated turbulence appears peaked in the outer X-points. Recent XGC simulation has confirmed such experimental observation, while predicting the enhanced transport inside O-point [8,9]. This paper will elaborate such 3-D physics activities in KSTAR associated with stability, transport and turbulence.

List of related published papers

[1] Y. In *et al*, Nucl. Fusion **55,** 043004 (2015)
[2] H.H. Lee *et al*, Phys. Plasmas **23**, 082510 (2016)
[3] Y.M. Jeon *et al*, APS-DPP (2017)
[4] J.H. Lee *et al*, APS-DPP (2017)
[5] Y. In *et al*, Nucl. Fusion **57**, 116054 (2017); APS-DPP (2017)
[6] A. Loarte, Y. In *et al*, to be published (2018)
[7] W.H. Ko *et al*, APS-DPP (2017)
[8] M.J. Choi *et al*, Nucl. Fusion **57**, 126058 (2017)
[9] J.M. Kwon *et al*, private communication (2018)