Progress on the KSTAR beam emission spectra research

Jinseok Ko[1,2], Jekil Lee[1,2], Youngho Lee[1,3], Juyoung Ko[1,2]

[1]Korea Institute of Fusion Energy, Daejeon, Korea, [2]University of Science and Technology, Daejeon, Korea, [3]Seoul National University, Seoul, Korea

Several progresses have been made for both polarimetric and spectral motional Stark effect (MSE) diagnostic systems in KSTAR. We have developed a new and effective beam-into-gas calibration technique applicable to superconducting tokamaks to calibrate out major systematic uncertainties such as Faraday rotation and secondary neutral beam effects [1, 2]. A systematic methodology has been devised to evaluate the effect of multi-ion-source neutral beam injection on polarimetric MSE measurements, which in turn, can be used to benchmark the spectral MSE method under the same situations [3]. The spectral MSE approach under development has been tested with a wide range of plasma densities and its sensitivity has been compared with that of the polarimetric MSE. The study of the beam emission spectra has been extended to the thermal Balmer alpha region to detect the ion thermal temperature, utilizing the main ion charge exchange with the neutral atoms. Finally, the KSTAR version of the beam penetration code (originally, ALCBEAM) has been developed (KSTARBEAM) and used to evaluate impurity carbon (C^{6+}) density profiles associated with the effective charge exchange emission rates from ADAS.

[1] J. Ko, 'A very simple and accurate way to measure the transmission axis of a linear polarizer', *Meas. Sci. Technol.* **31**, 017004 (2020).

[2] J. Ko, S. Scott, F. Levinton, M. Galante, S. Sabbagh, S. Hahn, and Y. M. Jeon, 'Application of motional Stark effect in situ background correction to a superconducting tokamak', *Rev. Sci. Instrum.* **92**, 033513 (2021).

[3] Y. Lee, J. Ko, Y. S. Na, 'Systematic evaluation of the effect of multi-ion-source neutral beam injection on motional Stark effect diagnostic in KSTAR', *Fusion Eng. Des.* **173**, 112870 (2021).