Quantifying uncertainties for a coherent Thomson scattering system with Bayesian sensitivity analyses on the synthetic data of X-pinch plasmas

Yong Sung You[1], Jae-seok Lee[1], Jung-Hwa Kim[2], Sungbin Park[2], Seunggi Ham[3], Y. S. Hwang[2], Young-chul Ghim[1]

[1]*Department of Nuclear and Quantum Engineering, KAIST, Daejeon, 34141, S. Korea*
[2]*Department of Nuclear Engineering, Seoul National University, Seoul, 08826, S. Korea*
[3]*Agency of Defense Development, Daejeon, 34186, S. Korea*

An X-pinch device has been developed to investigate dynamics of the high energy density plasmas during an X-pinch discharge [1]. Coherent Thomson scattering (CTS) systems have provided plasma properties such as electron density, ion and electron temperature as well as jet velocity in other similar devices [2, 3]. We perform sensitivity analyses on the density, temperature and velocity of the X-pinch plasma jet to determine uncertainty levels associated with the expected measurements from the to-be-built CTS system. By utilizing a forward model within the Bayesian analysis framework, synthetic data are generated to perform the sensitivity analyses. We further investigate effects of the instrumental broadening and the electrical noise on the uncertainty of the inferred parameters. With the sensitivity analyses on the model parameters, it is possible to identify required improvements for the CTS system such that the parameters can be reliably measured. [4]

References

[1] Jonghyeon Ryu, Seunggi Ham, Juhyeong Lee, JongYoon Park, Sungbin Park, YeongHwan Choi, H. J. Woo, Kern Lee, Y.-C Ghim, Y. S. Hwang, and Kyoung-Jae Chung, *Rev. Sci. Instrum*, **92**, 053533 (2021).
[2] M. Zorondo, C. Pavez and V. Muñoz, Results in Physics, **40**, 105831 (2022).
[3] L.G. Suttle, J.D. Hare, J.W. D. Halliday, S. Merlini, D.R. Russell, E. R. Tubman, V. Valenzuela-Villaseca, W. Rozmus, C. Bruulsema and S. V. Lebedev, Rev. Sci. Instrum., **92**, 033542 (2021).
[4] R Fischer, C Wendland, A Dinglage, S Gori, V Dose and the W7-AS team, Plasma Phys. Control. Fusion, **44**, 1501, (2002).

*Presenting author: utility@kaist.ac.kr