**A comprehensive spectroscopic diagnostic suite for the C-2W field-reversed configuration device**

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In TAE Technologies’ current experimental device, C-2W (also called “Norman”) [1], record breaking, advanced beam-driven field-reversed configuration (FRC) plasmas are produced and sustained in steady state utilizing variable energy neutral beams (15 – 40 keV, total power up to 20 MW), advanced divertors, end-biasing electrodes, and an active plasma control system. An extensive suite of advanced spectroscopic diagnostic systems has been developed and deployed on C-2W enabling shot-to-shot as well as ensemble measurements of key plasma parameters from emitted radiation. The suite consists of 20+ individual systems including PMT-based Bremsstrahlung and Balmer-alpha arrays for Z-effective and neutral density measurements, VUV/VIS survey spectrometers, active charge-exchange recombination spectroscopy for main/impurity ion temperature and velocity profiles, high-resolution Doppler spectroscopy for impurity dynamics studies and isotope fraction monitoring, laser-based Doppler-free saturation spectroscopy for internal magnetic field vector measurements, multiple filtered fast-imaging cameras for plasma visualization, X-ray energy spectrometer, etc. [2-5] These diagnostic systems work together to provide a comprehensive picture of the FRC and allow TAE to advance physics understanding of its fusion concept and improve prediction models required for designing future machines. Here, we shall provide an overview of the spectroscopic diagnostic suite in C-2W and present key results inferred by these systems.

[1] H. Gota et al., Nucl. Fusion 61, 106039 (2021)

[2] E. M. Granstedt et al., Rev. Sci. Instrum. 92, 043515 (2021)

[3] M. Nations et al., Rev. Sci. Instrum. 92, 053512 (2021)

[4] M. Nations et al., Rev. Sci. Instrum.93, 113522 (2022)

[5] T. Roche, Rev. Sci. Instrum. 92, 033548 (2021)