Abstract Submitted
for the DPP16 Meeting of
The American Physical Society

Advanced Plasma Diagnostic Analysis using Neural Networks[1]

KEVIN TRITZ, Johns Hopkins University, MATT REINKE, ORNL — Machine learning techniques, specifically neural networks (NN), are used with sufficient internal complexity to develop an empirically weighted relationship between a set of filtered X-ray emission measurements and the electron temperature (T_e) profile for a specific class of discharges on NSTX. The NN response matrix is used to calculate the T_e profile directly from the filtered X-ray diode measurements which extends the electron temperature time response from the 60Hz Thomson Scattering profile measurements to fast timescales (>10kHz) and greatly expands the applicability of T_e profile information to fast plasma phenomena, such as ELM dynamics. This process can be improved by providing additional information which helps the neural network refine the relationship between T_e and the corresponding X-ray emission. NN supplement limited measurements of a particular quantity using related measurements with higher time or spatial resolution. For example, the radiated power (P_{rad}) determined using resistive foil bolometers is related to similar measurements using AXUV diode arrays through a complex and slowly time-evolving quantum efficiency curve in the VUV spectral region. Results from a NN trained using Alcator C-Mod resistive foil bolometry and AXUV diodes are presented, working towards hybrid P_{rad} measurements with the quantitative accuracy of resistive foil bolometers and with the enhanced temporal and spatial resolution of the unfiltered AXUV diode arrays.

[1]Work supported by Department of Energy grant : DE-FG02-09ER55012

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Date submitted: 14 Jul 2016 Electronic form version 1.4