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High time resolution reconstruction of electron temperature profiles with a neural network in C-2U GABRIEL PLAYER, RICHARD MAGEE, ERIK TRASK, SERGEY KOREPANOV, RYAN CLARY, AND THE TRI ALPHA ENERGY TEAM, Tri Alpha Energy, Inc. — One of the most important parameters governing fast ion dynamics in a plasma is the electron temperature, as the fast ion-electron collision rate goes as $\nu_{ei} \sim T_e^{3/2}$. Unfortunately, the electron temperature is difficult to directly measure—methods relying on high-powered laser pulses or fragile probes lead to limited time resolution or measurements restricted to the edge. In order to rectify the lack of time resolution on the Thomson scattering data in the core, a type of learning algorithm, specifically a neural network, was implemented. This network uses 3 hidden layers to correlate information from nearly 250 signals, including magnetics, interferometers, and several arrays of bolometers, with Thomson scattering data over the entire C-2U database, totalling nearly 20,000 samples. The network uses the Levenberg-Marquardt algorithm with Bayesian regularization to learn from the large number of samples and inputs how to accurately reconstruct the entire electron temperature time history at a resolution of 500 kHz, a huge improvement over the 2 time points per shot provided by Thomson scattering. These results can be used in many different types of analysis and plasma characterization—in this work, we use the network to quantify electron heating.

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