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Developing JET Gas Controllers with Uncertainty Quantified Deep Learning Models for Plasma Control

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JET pulses are regularly disrupted by the iterative process of tuning the gas controllers. Current gas calibration methods cannot accommodate the time-varying parameters of the gas system, which leads to poor repeatability of experiments. Therefore, there is a need for improved gas control algorithms. Developing these algorithms requires a significant amount of testing to evaluate performance. This testing must be done during a pulse and the controller will need re-tuning after any major change to the plant's operation. As such, creating and maintaining these gas controllers costs huge amounts of machine pulsing time and, as a result, money. It is also particularly challenging to compete for operational time during DT campaigns, so a project was undertaken to produce a model of the plant that would enable offline testing of control algorithms to save resources.

This paper outlines the framework chosen to create this model, the process of refining the input data, the approach to training, and the statistical methods for testing. It describes the use of deep artificial neural networks to perform predictive analysis on historic JET data, as well as how uncertainty quantification was applied to the model to validate the output. It also highlights how similar techniques could be used to produce models of other plant systems to build up a digital twin.

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