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Learning-based Control for Non-equilibrium Plasmas

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Learning-based control is a form of adaptive control, whereby controller and/or process model parameters are modified based on system measurements. Learning-based control can create unprecedented opportunities for process control of non-equilibrium plasmas (NEPs), which are increasingly used for treatment of heat and pressure sensitive (bio)materials in surface etching/functionalization, environmental, and biomedical applications. Some of the main challenges in process control of NEP applications arise from their inherent complexity and variability. Firstly, the dynamics of NEPs are highly nonlinear and spatio-temporally distributed, which are both expensive and also difficult to model due to their mechanistic complexity. Secondly, the NEP effects on complex surfaces are generally poorly understood. And thirdly, NEPs exhibit run-to-run variations and time-varying dynamics, whereby the same experiment may be carried out under similar conditions, but yield different results. In this talk, we will demonstrate the usefulness of learning-based predictive control approaches for NEP treatment of complex surfaces. We will discuss how machine learning approaches such as Gaussian process regression and Bayesian neural networks can be leveraged to learn the complex plasma and surface dynamics in real-time, toward safe and high-performance NEP treatment of complex surfaces.