Leveraging AI for Resilient Fusion Plasma monitoring and Control: Mitigating Failures and Enhancing Diagnostics

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Artificial intelligence is transforming the monitoring and control of fusion plasmas by enhancing diagnostic capabilities and compensating for system limitations. This talk will explore the use of AI in reconstructing synthetic diagnostics to mitigate failures in fusion devices, thereby improving resilience in fusion plasma operations. We will discuss the application of machine learning models, including the Diag2Diag methodology, which leverages correlations between high-frequency diagnostics to generate synthetic high-resolution Thomson Scattering. These advancements not only enhance temporal resolution for monitoring critical instabilities, such as Edge Localized Modes (ELMs), but also provide a robust framework for maintaining control when faced with diagnostic failures. By using AI-based models for real-time applications, we demonstrate how fusion plasma control can achieve increased accuracy, reliability, and resilience—key factors in advancing towards commercially viable fusion energy.