Sixth IAEA Technical Meeting on Fusion Data Processing, Validation and Analysis

Contribution ID: **17** Type: **Oral (Short)**

# Prediction of NTM seed magnetic island trigger threshold in EAST based on supervised learning

*Wednesday 10 September 2025 13:30 (15 minutes)*

The stability control of neoclassical tearing modes (NTMs) is critical for achieving high-performance steady-state operation in future magnetic confinement fusion devices. Active suppression of seed magnetic island formation represents a key early intervention strategy to minimize the cost of NTM control. This study addresses the critical threshold problem of NTM seed magnetic island triggering in the EAST tokamak, proposing a supervised learning-based temporal prediction framework to identify key
triggering parameters and quantify their abrupt transition characteristics. By integrating diagnostic signals (e.g., Mirnov probes, soft X-rays, electron cyclotron emission ECE) and inversion parameters (βp, q profile), a multimodal temporal database (time resolution ≤1 ms) containing magnetic island width evolution is constructed, focusing on capturing trigger event labels where the magnetic island width exceeds 2
cm. Using a hybrid deep network (HDL) and LightGBM algorithm with physics-informed feature engineering, the following objectives are achieved: 1) Establishing a correlation model between magnetic
island trigger thresholds and βp/ne, validating experimentally observed critical conditions; 2) Revealing the dominant roles of 1/1 internal kink mode coupling strength and error field harmonic components through SHAP value analysis and feature importance ranking for 2/1 NTMs; 3) Developing cross-device adaptation strategies to generalize the model to other tokamak data, verifying universal threshold patterns of normalized parameters (e.g., βN/q95). Experimental validation demonstrates high-precision prediction (AUC >0.91 with ≥20 ms warning window) on EAST historical data, showing consistency between key parameters (magnetic island growth rate, soft X-ray fluctuation amplitude) and theoretical/simulation results. This research provides a data-driven theoretical tool for analyzing NTM triggering mechanisms and active avoidance strategies in ITER and future fusion reactors.

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**Session Classification:** Physics-Based Machine Learning

**Track Classification:** Physics-Based Machine Learning