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Identification and confinement scaling of hybrid scenarios across multiple devices (LPP-ERM-KMS-01)

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Motivation

- ITER research plan in H-mode: inductive (baseline), hybrid, non-inductive
- Definition of 'hybrid' varies across devices
- Energy confinement scaling scenario-dependent (\leftrightarrow IPB98 and ITPA20)



Objectives

1. Multi-machine database (JET, AUG, DIII-D, JT-60U)

- Largely based on existing databases

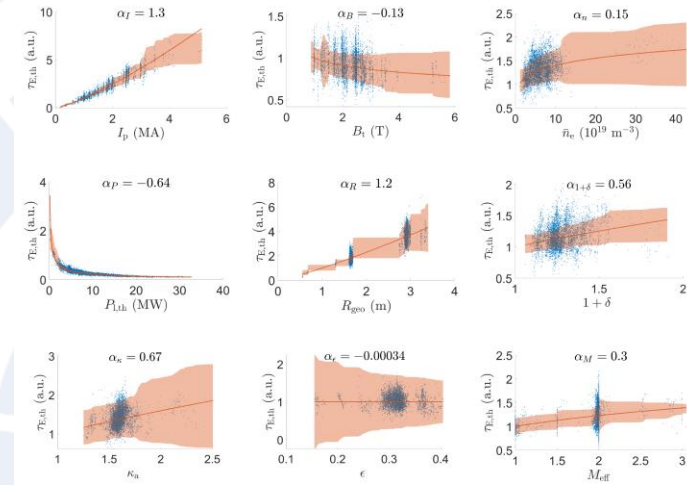
2. Classification/clustering → standardized selection criterion

3. Profile quantities and MHD spectra

- Enhance classification results
- Characterization of hybrid plasmas in terms of underlying physical mechanisms
- Separate classification for core and pedestal

4. Global energy confinement time scaling specific to hybrid plasmas

- Optimal set of engineering and dimensionless variables
- Particular regard to multicollinearity issues



ITPA20
[Verdoolaege21]



Methods

- Data:
 - ITPA Global H-mode Confinement Database [Verdoolaege21]
 - International Multi-tokamak Confinement Profile Database [Roach08]
 - EUROfusion databases [Maslov20, Frassinetti21]
 - JET hybrid plasmas [Hobirk24]
- Classification/clustering features
 - Greenwald fraction
 - q_0, q_{95}
 - β_p, β_t
 - T_{0i}/T_{0e}
 - n_e, T_e profiles (density peaking, stiffness, pedestal height)
 - Current profiles, q profiles
 - ECE spectrograms (NTMs)
 - ...
- Strategies for missing data
- Power law scaling
 - Regularize multicollinearity: hierarchical Bayesian model with Dirichlet priors [McKay11]
 - Statistically significant differences baseline vs. hybrid



Deliverables

Year	Description
2024	Criteria, based on a number of accessible features, for discriminating baseline from hybrid plasmas, applicable to multiple devices, including ITER
2025	Scalings, with realistic uncertainty estimates, for the energy confinement in the baseline and hybrid scenario, and extrapolation to ITER

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