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# H-Mode Confinement in Tokamaks with Fully Metallic Walls: New Energy Confinement Scaling and Implications of the Reduced Size Dependence

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Global energy confinement studies based on empirical scaling expressions represent an important instrument for benchmarking experiments in tokamaks and stellarators, for specification of boundary conditions in modeling activities, for guiding the development of theoretical models of heat transport and for extrapolating plasma performance to new machines, such as ITER.

In this contribution, we report on a new H-mode confinement scaling with important implications regarding the dependence of confinement on plasma and machine parameters, including a remarkably weaker dependence on machine size. Referred to as ITPA20 and with a corresponding confinement enhancement factor H20, the new scaling has been derived from the recently updated International Tokamak Physics Activity (ITPA) global H-mode confinement database [1]. Compared to earlier versions of the database, new data have been added closer to ITER conditions, along with data from JET [2] and ASDEX Upgrade [3] with fully metallic walls. In addition, the range of several important parameters has been extended.

We first focus on the parameter estimates and predictions of the new scaling, obtained with innovative techniques grounded in Bayesian probability and information theory. This has revealed uncertainties that are significantly larger than those estimated with simple least squares, greatly influencing the significance of the various predictor variables in the scaling. These results are also relevant for other scaling laws derived from multi-machine databases that are routinely used within the fusion community.

We then touch upon the issue of the considerably weaker scaling with machine size (major radius) observed in the new scaling. In order to trace the origin of this reduced dependence, an optimization together with a clustering technique has been carried out to identify the subset of the database contributing to the reduction of the size scaling [4]. The clustering is interpreted in dimensionless space and shown to partly relate to the degree of multicollinearity between the predictor variables. Finally, the implications for ITER are discussed.

References:
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