A model of the L-H transition in tokamaks

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A first principles model of the L-H transition in tokamaks has been developed, based on the criterion that the transition occurs when plasma turbulence and shear Alfven waves compete in the vicinity of the last closed flux surface. The model is used to predict the scaling of the H-mode access power, $P_{L\text{-}H}$, with magnetic and plasma variables. The predictions are found to be in good agreement with the experimental scaling of $P_{L\text{-}H}$ with plasma size and shape, magnetic field and edge safety factor (plasma current), plasma density, ion mass and charge, see Figure below. They are also consistent with measurements of $P_{L\text{-}H}$ in limiter vs divertor plasmas, single vs double null configurations and divertor leg length (on JET and MAST), and H-L vs L-H hysterisis. Finally, the model explains the appearance of the minimum in $P_{L\text{-}H}$ with plasma density, and correctly predicts the scaling of the density at minimum $P_{L\text{-}H}$ with magnetic field. In this contribution, the model is described and compared against experimental data, and used to predict $P_{L\text{-}H}$ in ITER and DEMO. The implications of the model to edge transport barrier evolution following the L to H transition are also discussed, including the presence of the 'sand-pile' property.

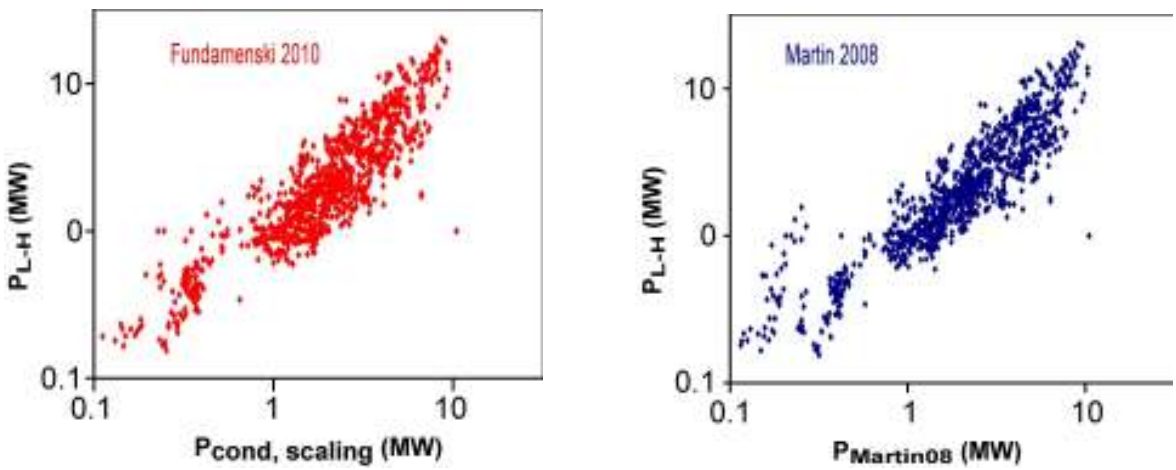

Figure: Multi-machine empirical data plotted vs the predictions of the new L-H transition model (left) and vs a best-fit expression (right) recommended in [1]. The new model is found to reproduce the best fit scaling, and to improve the level of agreement with spherical tokamak (low power branch in right figure).

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