Understanding and controlling the ITER baseline plasma response

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DIII-D experiments with low-torque ITER baseline demonstration discharges show that the plasma's magnetic response to applied low-frequency, non-axisymmetric field perturbations is correlated with the onset of plasma disruptions.

Measurements of the low-frequency plasma response have previously been linked to proximity to the resistive wall mode (RWM) stability boundary [1]. However, understanding the response in plasma regimes, such as the ITER baseline, that are well below the RWM pressure limit and subject to resistive tearing instabilities remains an active area of research. The growth rate γ of the driven, stable RWM is calculated from $n = 1$ response measurements using a single mode model [1], normalized to the wall eddy current decay timescale $\tau_w = 2.5$ ms, and compared with the linearized, ideal MHD, resistive wall dispersion relation [2]. Figure 1 shows that the dependencies of $\gamma\tau_w$ on the plasma normalized internal inductance ℓ_i and normalized beta β_N are consistent with ideal MHD predictions. The β_N dependence was exploited to demonstrate closed-loop control of the response via feedback modulation of the neutral beam injected power in the low-torque baseline regime. Using heating power to directly control a plasma stability-related parameter, such as the response, may help facilitate the optimization of fusion output while simultaneously avoiding stability limits.

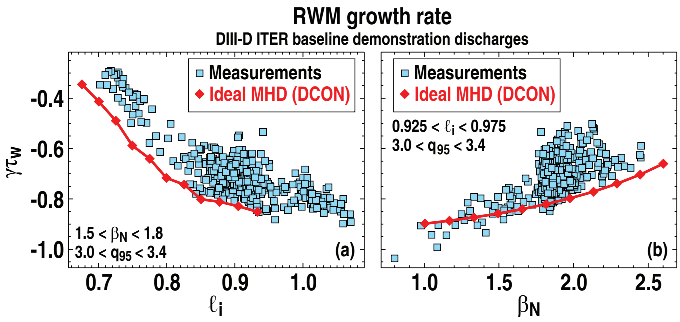

Figure 1: *Comparisons of the (a) ℓ_i and (b) β_N dependencies of the normalized RWM growth rate $\gamma\tau_w$ inferred from plasma response measurements (squares) with predictions of the linearized, ideal MHD, resistive wall dispersion relation (diamonds).*

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References

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