Effect of Profiles and Shape on Ideal Stability of Advanced Tokamak Equilibria*

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The pressure profile and shape, through elongation (κ), triangularity (δ), and squareness, strongly influence stability. In this study, ideal stability of single null and symmetric double null advanced tokamak (AT) configurations is examined. All the various shapes are bounded by a common envelope and can be realized in the DIII-D tokamak. The calculated AT equilibria are characterized by $P_0/\langle P\rangle \sim 2$–3, weak negative central shear, high bootstrap fraction, an H-mode pedestal, and varying shape parameters. The pressure is modeled by various polynomials together with a hyperbolic tangent pedestal, consistent with experimental observations. Stability is calculated with the DCON code and the resulting stability boundary is corroborated by GATO runs.

The study undertaken here represents the first systematic exploration of the global stability properties of AT equilibria including the effects of the pedestal. Results show that decreasing the pressure peaking significantly increases the β-limit as measured by β_N, from ~3 for $P_0/\langle P\rangle \sim 3$ to ~7 for $P_0/\langle P\rangle \sim 2$. The shape dependence of the stability limit is much weaker at higher peaking than at lower peaking. For the range of shapes examined, the pedestal pressure has a stabilizing influence on low n modes by effectively broadening the profile. Together, the results indicate that strongly shaped AT equilibria with broad pressure profiles offer superior stability properties over more conventional shapes with typically highly peaked profiles.

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