Examining Transport and Integrated Modeling Predictive Capabilities for Negative-Triangularity Scenarios

J. McClenaghan[1], A. Marinoni[2], L.L. Lao[1], G.M. Staebler[1], S.P. Smith[1], O.M. Meneghini[1], B.C. Lyons[1], P.B. Snyder[3], and M. Austin[4]

[1]*General Atomics, PO Box 85608, San Diego, CA 92186–5608, USA*

[2]*Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*

[3]*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*

[4]*The University of Texas at Austin, Austin, Texas 78712, USA*

Accurately predicting the confinement in negative triangularity is critical to assessing the scenarios prospects as a viable fusion reactor such as a Fusion Pilot Plant (FPP). Simulations of negative triangularity ($\delta < 0$) plasmas predict relatively good confinement with only a small H-mode edge pedestal, consistent with DIII-D experimental observations. Transport simulations using the TGYRO transport manager predicting the core kinetic profiles show good agreement with experimental profiles for both negative and positive-δ L-mode plasmas. Additionally, TGLF predicts more electron temperature gradient (ETG) mode transport for positive-δ and that increasing electron temperature gradient reduces the particle transport in negative-δ. Predictions of the pedestal show that the negative-δ pressure is significantly reduced compared to positive-δ. Self-consistent core-pedestal modeling using the STEP (Stability, Transport, Equilibrium, Pedestal) workflow finds that confinement increases as δ is reduced below zero, and may be due to a reduction of ETG transport with an increase of electron temperature gradients reducing the particle transport. The confinement improvement at negative-δ is predicted to be stronger at high power densities with strong electron heating sources suggesting that negative-δ may be well suited for a compact FPP.

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