Theory and simulation basis for magnetohydrodynamic stability in DIII-D

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Abstract. Theory and simulation have provided one of the critical foundations for many of the significant achievements in magnetohydrodynamic (MHD) stability in DIII-D over the past two decades. Early signature achievements included the validation of tokamak MHD stability limits, β and performance optimization through cross section shaping and profiles, and the development of new operational regimes. More recent accomplishments encompass the realization and sustainment of wall stabilization using plasma rotation and active feedback, a new understanding of edge stability and its relation to edge localized modes (ELMs), and recent successes in predicting resistive tearing and interchange instabilities. The key to success has been the synergistic tie between the theory effort and the experiment made possible by the detailed equilibrium reconstruction data available in DIII-D and the corresponding attention to the measured details in the modeling. This interaction fosters an emphasis on the important phenomena and leads to testable theoretical predictions. Also important is the application of a range of analytic and simulation techniques, coupled with a program of numerical tool development. The result is a comprehensive integrated approach to fusion science and improving the tokamak approach to burning plasmas.