The bootstrap current and neutral beam current drive in DIII-D

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Abstract. Noninductive current drive is an essential part of the implementation of the DIII-D Advanced Tokamak (AT) program. For an efficient steady-state tokamak reactor, the plasma must provide close to 100% bootstrap fraction (f_{bs}). For noninductive operation of DIII-D current drive by injection of energetic neutral beams (NBCD) is also important. DIII-D experiments have reached ~80% bootstrap current in stationary discharges without inductive current drive. The remaining current is ~20% NBCD. This is achieved at $\beta_N \approx \beta_p > 3$, but at relatively high q_{95} (~10). In lower q_{95} AT plasmas, $f_{bs} \sim 0.6$ has been reached in essentially noninductive plasmas. The phenomenology of high β_p and β_N plasmas without current control is being studied. These plasmas display a relaxation oscillation involving repetitive formation and collapse of an internal transport barrier. The frequency and severity of these events increase with increasing β, limiting the achievable average β and causing modulation of the total current as well as the pressure. Modeling of both bootstrap and NBCD currents is based on neoclassical theory. Measurements of the total bootstrap and NBCD current agree with calculations. A recent experiment based on the evolution of the transient voltage profile after an L-H transition shows that the more recent bootstrap current models accurately describe the

plasma behavior. The profiles and the parametric dependences of the local neutral beam driven current density have not yet been compared with theory.