

# Magnetic Flux Conversion and the Importance of Benign Tearing Modes in the DIII-D Advanced Inductive Scenario

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In DIII-D advanced inductive (AI) scenario discharges, the rate of poloidal magnetic energy consumption is more than the rate of energy flow from the poloidal field coils. This is evidence that there is a conversion of toroidal flux to poloidal flux, which may account for a process known as flux pumping that leads to anomalous broadening of the current profile. The broader current profile aids discharge sustainment by raising the minimum safety factor above unity thereby avoiding sawtooth-triggered 2/1 tearing modes (TM). Flux states  $\Psi_{coil}$  and  $\Psi_{kin}$  are scalar energies, normalized by the plasma current, that have been primarily applied to determine the optimal flux usage in current and future devices [1]. The flux states are defined by  $\Psi_c I_p = W_c$  and  $\Psi_{kin} I_p = W_{kin}$ , where  $W_c$  is the amount of energy coupled between the poloidal field coils and the plasma and  $W_{kin}$  is the amount magnetic energy converted to kinetic energy by the electric field within the plasma.

During stationary intervals with constant stored magnetic energy, a difference in the rate of change of the flux states ( $d\Psi_{kin}/dt - d\Psi_{coil}/dt > 10$  mV) was observed. This inequality implies that the conversion of poloidal flux to kinetic energy is measurably larger than the rate at which energy is provided by the poloidal field coils. Figure 1 shows the results from 25 stationary AI intervals where ECCD was applied to the  $q=3/2$  surface to destabilize or suppress the 3/2 TM. In cases of suppression a smaller 4/3 TM appeared. The anomalous consumption of poloidal flux only occurred in discharges with  $\beta_N > 2.25$  and when a 3/2 TM was present. A conversion of toroidal flux to poloidal flux could explain the observed inequality and this suggests that the TM plays a critical role in the flux conversion. This work is supported by the US DOE under DE-FC02-04ER54698 and DE-AC05-06OR23100.

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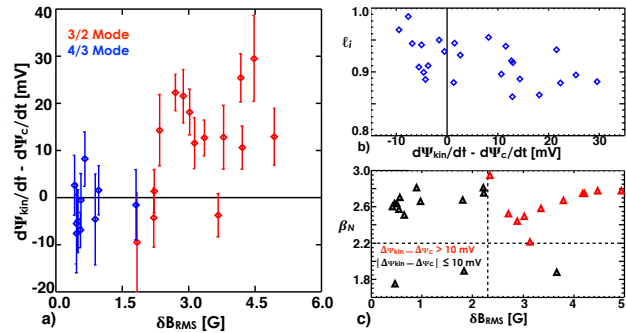


Figure 1: a) The inequality in the evolution of flux states in stationary AI intervals vs TM amplitude. b)  $\ell_i$  is lower (broader current) in intervals with a large flux state inequality. c) Flux state inequality observed with large TM amplitude and  $\beta_N$