# The Role of the m/n=3/2 Tearing Mode in the Hybrid Scenario and Extension of the Hybrid Operating Regime*

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The hybrid scenario has been proposed as a robust operating scenario for high performance operation of ITER. It is intermediate between the standard, high current scenario and the steady-state Advanced Tokamak scenario, and it provides high gain (Q) for long pulses. Understanding the physical mechanisms underlying the improvement in the beta limits in the hybrid regime will allow more confident implementation of this scenario in ITER. In hybrid scenario tokamak plasmas, the central current density is lower and the central safety factor is higher than is expected for comparable conventional scenario plasmas. A key feature of the hybrid scenario in DIII-D is the presence of an $m$=3, $n$=2 neoclassical tearing mode. This essentially stationary island structure is associated with the reduction (at $q_{95} \leq 4$) or elimination (at $q_{95} \geq 4$) of sawteeth. The decreasing sawtooth amplitude reduces or eliminates a trigger for the deleterious $m$=2, $n$=1 neoclassical tearing mode. The 2/1 mode limits the achievable beta in the conventional H-mode scenario. The effect of the 3/2 mode on the sawtooth amplitude has been demonstrated using localized ECCD (≤50 kA) to enhance or suppress the mode amplitude. With co-ECCD the mode is suppressed and sawteeth appear. With counter-ECCD the 3/2 amplitude increases and small pre-existing sawteeth are suppressed. The sawteeth do not recur after the end of the counter-ECCD pulse. A variety of physical mechanisms may be involved in the regulation of q(0) and the sawteeth by the 3/2 mode. There is significant time-asymmetric modulation of the mode amplitude by ELMs, as well as a small noisy amplitude modulation which also shows evidence of time-asymmetry. Initial modeling indicates that such time-asymmetries can move poloidal flux from the region between the magnetic axis and the 3/2 mode to the exterior region. There may also be a true dynamo present, with conversion of mechanical to magnetic energy. Because the stationary state always has q(0) close to one, even in the absence of sawteeth, it is likely that the observed 2/2 component of the 3/2 mode is playing a role.

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