Discharge improvement through control of neoclassical tearing modes by localized ECCD in DIII–D

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Abstract. Neoclassical tearing modes (NTMs) are MHD modes which can limit the performance of high beta discharges in tokamaks, in some cases leading to a major disruption. The destabilizing effect which results in NTM growth is a helical decrease in the bootstrap current caused by a local reduction of the plasma pressure gradient by "seed" magnetic islands. The NTM is particularly well suited to control since the mode is linearly stable although nonlinearly unstable, so if the island amplitude can be decreased below a threshold size the mode will decay and vanish. One means of shrinking the island is the replacement of the "missing" bootstrap current by a localized current generated by electron cyclotron current drive (ECCD). This method has been applied to the m=3/n=2 neoclassical tearing mode in DIII-D, in H-mode plasmas with ongoing ELMs and sawteeth, both of which generate seed islands periodically. In the case of the 3/2 mode, full suppression was obtained robustly by applying about 1.5 MW of ECCD very near the rational surface of the mode. When the mode first appears in the plasma the stored energy decreases by 20%, but after the mode is stabilized by the ECCD the beta may be raised above the initial threshold pressure by 20% by additional neutral beam heating, thereby

generating an improvement in the limiting beta of nearly a factor 2. An innovative automated search algorithm was implemented to find and retain the optimum location for the ECCD in the presence of the mode.