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PD/1-1: State-of-the-art Neoclassical Tearing Mode Control in DIII-D Using Real-Time Steerable Electron Cyclotron Current Drive Launchers

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Real time steerable electron cyclotron current drive (ECCD) has been demonstrated to reduce the power requirements and time needed to remove $3/2$ and $2/1$ neoclassical tearing modes (NTM) in the DIII-D tokamak. In a world first demonstration of the techniques required in ITER, the island formation onset is detected automatically, gyrotrons are turned on, and the real-time steerable ECCD launcher mirrors are moved promptly to drive current at the location of the islands; the modes are shrunk and suppressed well before saturation with the use of real-time motional Stark effect (MSE) constrained equilibria reconstruction with advanced feedback and search algorithms. For ITER, this method will reduce the ECCD energy requirement and so raises Q by keeping the EC system off when the NTM is not present. Further, in the experiments with accurate tracking of pre-emptive ECCD to resonant surfaces, both $3/2$ and $2/1$ modes are prevented from appearing with up to 5 times less ECCD power.

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