Stabilization of Neoclassical Tearing Modes by Active Control of Electron Cyclotron Current Drive Alignment in DIII–D*

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Neoclassical tearing modes (NTMs) are completely suppressed and/or avoided and stable beta increased in DIII–D by use of well-aligned radially localized electron cyclotron current drive (ECCD). Real-time alignment of the ECCD on the mode (algorithms are "search and suppress" and "target lock") or on the rational surface without a mode ("active tracking" by either an adaptive network predictor or real-time equilibrium reconstruction) is done by the DIII–D plasma control system.

An example of the various alignment techniques for the m/n = 3/2 NTM is shown in Fig. 1. Upon initiation of the 110 GHz rf power, the search and suppress adjusts the plasma major radius R_{surf} to sufficiently align the island on the ECCD to achieve complete suppression. As the alignment by this method is good enough but not necessarily optimum, a further advancement is developed, "target lock," which applies a jitter to the position (or B_T) to judge where the optimum is. After suppression, the search and suppress hands over alignment to active tracking, an adaptive network predictor. This adjusts changes in the alignment, without a mode, particularly as the rising beta and increased Shafranov shift would otherwise cause the q = 3/2 flux surface to shift outward. Thus, the well-aligned ECCD maintains stability, even as beta rises above the initial onset value.

ECCD alignment has also been successfully applied to the more dangerous m/n = 2/1 NTM (which tends to lock), in order to raise the stable beta close to the n=1 no-wall ideal kink limit.

The latest NTM suppression results will be presented with a focus on the success of the development and use of DIII–D NTM control algorithms.

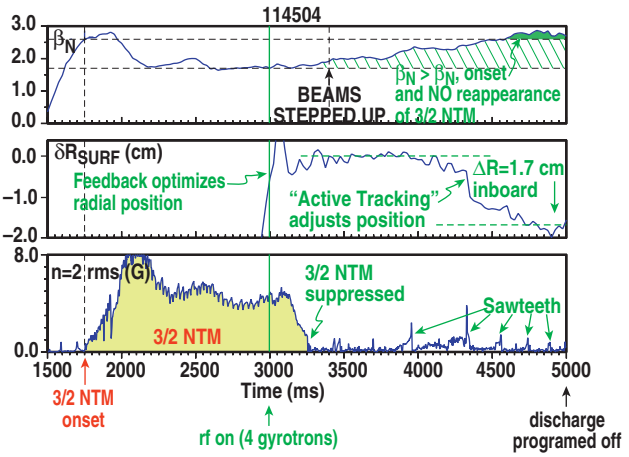

Fig. 1. Alignment of the ECCD on the q = 3/2 rational surface is done by the "search and suppress" in the presence of the mode and by an adaptive network predictor without the mode. (a) β_N, (b) change in plasma major radius R_{surf}, (c) n=2 Mirnov amplitude.

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