Multi-Mode Tearing Suppression on DIII-D

E. Kolemen (PPPL) and A. Welander and R. La Haye (General Atomics)

High performance fusion plasmas can sometimes exhibit plasma instabilities known as tearing modes, which can lead to disruption of the plasma. Hence, avoiding or recovering from tearing mode instabilities is a key issue for sustainment of high performance plasmas. In support of an m/n=2/1 tearing mode recovery experiment, a new real-time multi-mode electron cyclotron current drive (ECCD) launch mirror steering tearing mode suppression capability at DIII-D was successfully used for the first time. Mirror steering is now faster and more accurate, and a real-time Thomson density analysis was implemented in the code TORBEAM to improve the accuracy of the ECCD deposition location. The system (Figure 1) first aligned the ECCD to the q=3/2 surface to preempt the 3/2 mode from occurring; eventually the more deleterious 2/1 mode appeared and was detected in real-time. The ECCD was then commanded to re-steer to the q=2/1 surface and used to completely remove this mode and demonstrate the recovery of the high confinement H-mode (Figure 2). The results show that the six sets of gyrotron systems can be aligned with multiple modes within a shot, track them as the q-profile evolves during the discharge and successfully preempt and/or suppress them. This is the third experiment where the real-time tearing control system was a critical component in the 2014 campaign at DIII-D (the other two were for resistive wall mode kink stability physics studies and for avoiding n=1 tearing in the high internal inductance scenario experiment). This shows the utility and capability that the system has provided to DIII-D plasma physics studies. Further development is underway to both test algorithms and improve the operational robustness of the system.

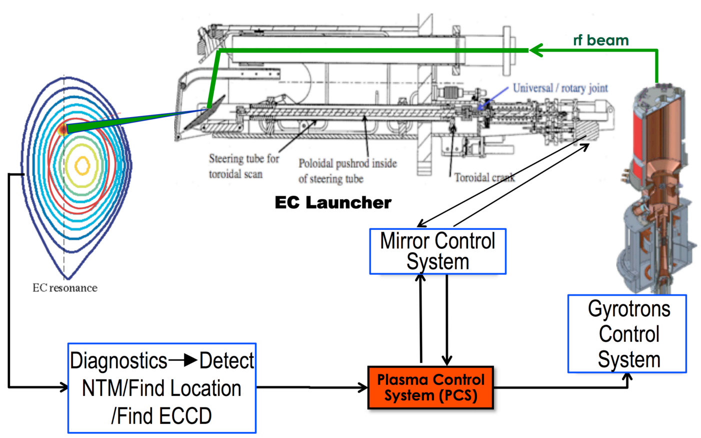

Figure 1. DIII-D tearing mode control system (here m/n=3/2 island shown); real-time tearing mode detection and amplitude, location of q-surfaces by “EFIT”, and location of current drive location are managed by the Plasma Control System to move the launching mirrors for alignment and to turn on or off the gyrotrons.

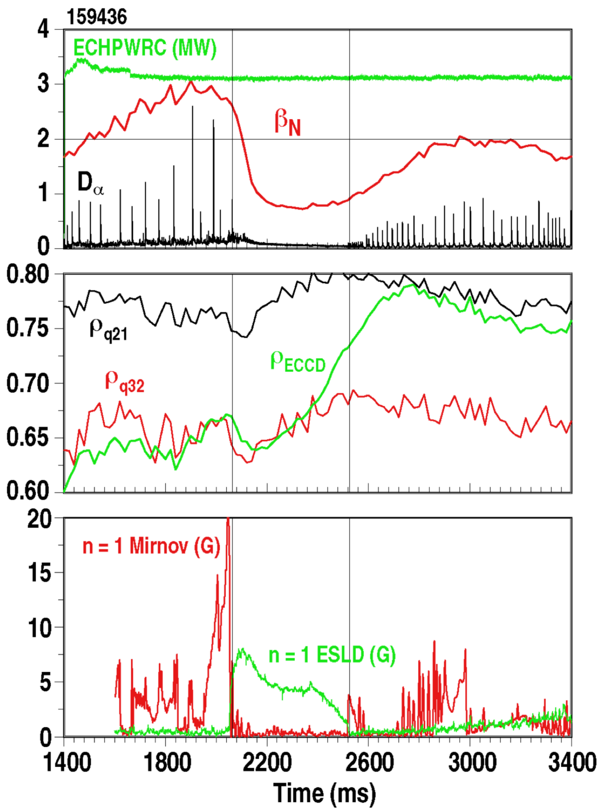

Figure 2. ECCD initially aligned with q=3/2 for 3/2 mode preemption (avoidance successful thus not shown) until redirected to q=2 upon real-time detection of a m/n=2/1 "locked mode" (which is then stabilized by the ECCD); mirrors set at conservative slow speed here can actually move about 3X faster.