Impact of EC location and timing on the stability and performance of the zero torque ITER Baseline Scenario in DIII-D

FRANCESCA TURCO, Columbia University, TIMOTHY LUCE, ITER Organization, CRAIG PETTY, General Atomics, JEREMY HANSON, GERALD NAVRATIL, Columbia University, AL HYATT, General Atomics, JOHN FERRON, General Atomics (retired) — Scans of EC deposition at zero input torque in recent ITER Baseline Scenario (IBS) Demonstration discharges show that power deposition in the region of the q=2 surface is prone to causing (not suppressing) 2/1 modes, due to its impact on the local $T_{e\text{ped}}$. The maximum stable $T_{e\text{ped}}$ is inversely proportional to $l_i$, which points to a first order dependence of the stability on the global current profile ($J$) shape. The local minimum in $J$ near q=2 is higher later in the shot, when $l_i$ is lower, and the equilibrium can sustain a higher $T_{e\text{ped}}$ without crossing the stability boundary. Local $T_e$ impacts both the bootstrap current and the resistivity, therefore both the outer and inner layer physics, affecting the $\Delta'$ and the $\Delta'$ critical for instability. An in-shot dynamic scan of EC deposition from core to edge decreases $H_{98y2}$ by 17% and $\tau_E$ by 30%, due to loss of heating efficiency. This calls into question the compatibility of direct EC stabilization with achieving ITER’s performance goals. 0-D simulations show that the zero torque IBS shots with core ECH project to the ITER goals ($Q=10$, $P_{\text{fus}} = 550$ MW, with heating power $P_{\text{heat}} = 70$ MW, compatible with the ITER hardware), and indicate the trade-offs between density, field, pressure and gain.

Francesca Turco
Columbia University

Date submitted: 27 Jun 2019
Electronic form version 1.4