DPP12-2012-000272

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

Heating and current drive requirements for ideal MHD stability and ITB sustainment in ITER steady state scenarios[1]

FRANCESCA POLI, Princeton Plasma Physics Laboratory, Princeton, NJ, 08543, USA

Steady state scenarios envisaged for ITER aim at optimizing the bootstrap current, while maintaining sufficient confinement and stability to provide the necessary fusion yield. Non-inductive scenarios will need to operate with Internal Transport Barriers (ITBs) in order to reach adequate fusion gain at typical currents of 9 MA. However, the large pressure gradients associated with ITBs in regions of weak or negative magnetic shear can be conducive to ideal MHD instabilities in a wide range of β_N, reducing the no-wall limit. Scenarios are established as relaxed flattop states with time-dependent transport simulations with TSC [1]. Fully non-inductive configurations with current in the range of 7-10 MA and various heating mixes (NB, EC, IC and LH) have been studied against variations of the pressure profile peaking and of the Greenwald fraction. It is found that stable equilibria have $q_{min} > 2$ and moderate ITBs at 2/3 of the minor radius [2]. The $\mathbf{E} \times \mathbf{B}$ flow shear from toroidal plasma rotation is expected to be low in ITER, with a major role in the ITB dynamics being played by magnetic geometry. Combinations of H&CD sources that maintain reverse or weak magnetic shear profiles throughout the discharge and $\rho(q_{min}) \geq 0.5$ are the focus of this work. The ITER EC upper launcher, designed for NTM control, can provide enough current drive off-axis to sustain moderate ITBs at mid-radius and maintain a non-inductive current of 8-9MA and $H_{98} \geq 1.5$ with the day one heating mix. LH heating and current drive is effective in modifying the current profile off-axis, facilitating the formation of stronger ITBs in the rampup phase, their sustainment at larger radii and larger bootstrap fraction. The implications for steady state operation and fusion performance are discussed.

[1] Jardin S.C. *et al*, J. Comput. Phys. **66** (1986) 481
[2] Poli F.M. *et al*, Nucl. Fusion **52** (2012) 063027.

---

[1] Work supported by the US Department of Energy under DE-AC02-CH0911466.