Edge localized modes in DIII-D high performance discharges

A. D. Turnbull, L. L. Lao, T. H. Osborne, O. Sauter,[1] E. J. Strait, T. S. Taylor, M. S. Chu, J. R. Ferron, C. M. Greenfield, A. W. Leonard, R. L. Miller, P. B. Snyder, H. R. Wilson,[2] H. Zohm[3]

[1]*CRPP – EPF Lausanne*

[2]*Euratom/UKAEA Fusion Association, Culham Science Centre, Abington, U.K.*

[3]*Max Planck Institute, Garching, Germany*

Abstract. A new understanding of edge localized modes (ELMs) in tokamak discharges is emerging [P.B. Snyder, *et al*., Phys. Plasmas, **9**, 2037 (2002)], in which the ELM is an essentially ideal magnetohydrodynamic (MHD) instability and the ELM severity is determined by the radial width of the linearly unstable MHD kink modes. A detailed, comparative study of the penetration into the core of the respective linear instabilities in a standard DIII-D ELMing, high confinement mode (H-mode) discharge, with that for two relatively high performance discharges shows that these are also encompassed within the framework of the new model. These instabilities represent the key, limiting factor in extending the high performance of these discharges. In the standard ELMing H-mode, the MHD instabilities are highly localized in the outer few percent flux surfaces and the ELM is benign, causing only a small temporary drop in the energy confinement. In contrast, for both a very high confinement mode (VH-mode) and an H-mode with a broad internal transport barrier (ITB) extending over the entire core and coalesced with the edge transport barrier, the linearly unstable modes penetrate well into the mid radius and the corresponding

consequences for global confinement are significantly more severe. The ELM accordingly results in an irreversible loss of the high performance.