The Role of Edge Plasma Parameters in H-mode Density Limit on the JET-ILW

H. J. Sun¹, RJ. Goldston², A. Huber³, XQ. Xu⁴, J. Flanagan⁵, DC. McDonald⁶, E. de la Luna⁷, M. Maslov⁸, J.R. Harrison⁹, F. Militello¹, J. Fessey¹, S. Cramp³ and JET Contributors*

EUROfusion Consortium, JET, Culham Science Centre, Abingdon, OX14 3DB, UK

ABSTRACT

• JET-ILW plasmas stay in dithering phase after reaching MHD limit, associated with a higher (=20%) HDL than JET-C equivalents.
• A new, reliable estimator for JET Er has been derived by combining HRTS measures of pedestal and SOL regions
• JET-ILW radial Er ETB wells are in the range -15 to -60 kV/m in H-modes. A higher positive ExB shear plays a role in sustaining a marginal phase.
• SOL broadens at high collisionality and a hypothesis for the dithering H-mode phase is proposed.

EXPERIMENTAL METHODS AND ESTIMATION OF $E_r$ min

Assuming $T_i \approx T_e$ and $n_i \approx n_e$ for high density JET pulses, $E_r$ can be estimated by $E_r \approx \nabla p_i / n_i \approx \nabla p_e / n_e$, where all the parameters are measured on JET-ILW.

Discussion and summary

This two-parameter phase space [3-5] can explain the edge plasma behaviour on JET-ILW.
• For low collisionality, the drift wave turbulence can be suppressed by $E \times B$ shear ($E_r$ min threshold). Pressure gradient increases until the MHD stability limit.
• As collisionality increases, the perpendicular transport is enhanced by resistive modes and the confinement degrades even when $\alpha_{HDL}$ is well below MHD limit.
• The enhanced transport reduces the pressure gradient and cools down the plasma, corresponding to a decrease of $E_r$ min.

CORRELATION WITH BALLOONING STABILITY AT THE SEPARATRIX

The ballooning parameter for the separatrix position, $\alpha_{HDL,sep}$, can be expressed as:

$$\alpha_{HDL,sep} = \frac{R a_0^2 \nabla p_{sep} R a_0^2}{B_i^2 / 2 \rho_0 - B_i^2 / 2 \rho_0}$$

$\alpha_{HDL,sep}$ increases almost linearly as $n_{sep}$ increases until the $\alpha_{HDL,sep}$ is $\approx 2.5$, when $n_{sep} / n_{dH} \approx 0.35$. The very large range of $n_{sep}$ with $n_{sep} > 0.35$ implies that the HDL is NOT directly set by ballooning stability at the separatrix.

REFERENCES

1. A. Huber, S. Wiesen, M. Bernetti and e. al, Nucl. Fusion, vol. 57, p. 086007, 2017

The figures below for #1676, support that a higher positive Er shear plays a role in sustaining a marginal phase.