Test of the Eich model for ELM energy densities in DIII-D

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A non-dimensional collisionality scan conducted on DIII-D confirms the model for ELM energy densities recently put forward by Eich [1], but also reveals key effects that may explain the large scatter typically observed about the scaling. The values of the peak parallel ELM energy density $\varepsilon_{\|}$ are found to be within 0.5 - 2 x the prediction of the Eich model, where $\varepsilon_{\|}$ is the maximum of the time-integrated heat flux during ELMs mapped onto the divertor. The experiment did not reveal an explicit pedestal-pressure dependence of $\varepsilon_{\|}$ as proposed in the model. The ratio of heating power to the power required to overcome the L-H-threshold is identified as a parameter determining the accuracy of the model, with discharges marginally above the threshold exceeding the prediction by up to a factor of two and showing the largest scatter in the database. Operation close to the L-H-threshold comes with low ELM frequency and large ELM heat loads. In general, the divertor peak heat flux is found to be slightly higher on the inner than on the outer divertor target. Using linear stability calculations, ELM energy densities are shown to be inversely proportional to the most unstable linear mode number n_{max} before the ELM crash (figure 1). Low n peeling-ballooning modes come with large ELM sizes, especially if close to the L-H-threshold, the ITER operational space. Hence, our studies encourage further machine comparisons regarding low heating scenarios and influence of mode numbers on ELM energy densities.

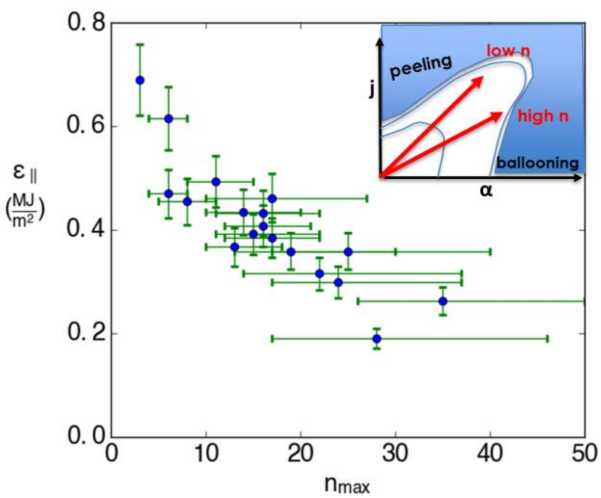

Figure 1 Inverse proportionality between linear mode number with the highest growth rate and peak parallel ELM energy density for type-I ELMy plasmas

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[1] T. Eich et al., Nuclear Materials and Energy 12 (2017) 84–90