

O3.104 Energy confinement in the pellet-enforced high-density regime at ASDEX Upgrade

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See the full abstract here <http://ocs.ciemat.es/EPS2019ABS/pdf/O3.104.pdf>

Operation in a future fusion reactor will aim to establish a high plasma core density n_0 in order to harvest a maximum output power. Hence, for example the near term EU-DEMO1 concept foresees operation at n_0 values at or even beyond 1.2 the Greenwald density n_{Gw} . Like for most envisaged reactor scenarios this approach assumes as well a confinement that can be achieved as predicted by the $H_{98}(y,2)$ scaling. This scaling predicts that the energy confinement time E increases with the line averaged electron density as 0.41. However, the data set employed for deriving this scaling contains very little input from the high density regime. This is due to the fact that a significant loss of confinement sets in when gas puff fuelling is applied, encountering the H-mode density limit at about $0.8 - 0.85 \times n_{Gw}$. Reliable access to the high density regime while sustaining good confinement is typically allocated to the injection of fuelling pellets, mm sized bodies formed of solid hydrogen. Accordingly, fuelling experiments proved H-mode operation at trans-Greenwald density, the achievable confinement however never showed the favourable ~ 0.41 correlation. In order to provide a better understanding of the confinement behaviour in this pellet generated high-density regime, a data base was created covering a wide range of experiments performed at the all-metal-wall tokamak ASDEX Upgrade. They include plasma scenarios run with and without ELM mitigation, with and without impurity seeding, the ITER base line configurations but also straightforward technical discharges for actuator tests. In total, the data base contains 598 time slices from 47 different discharges; ranging from $0.5 - 1.85 \times n_{Gw}$. As expected, data above $0.8 \times n_{Gw}$ shows a rather poor correlation with the $H_{98}(y,2)$ predictions, which are significantly overestimating observed values. Much better agreement is found with the more sophisticated scaling H_{06} which predicts a roll-over to ~ 0 when approaching high densities. Efforts taken for performance enhancement by e.g. shaping or seeding result in a clear positive impact below $0.8 \times n_{Gw}$; however these improvements are quickly fading away with increasing until beyond $1.2 \times n_{Gw}$ no visible improvements remain. In the pellet-enforced high-density regime, the achievable plasma confinement becomes virtually insensitive to measures usually found effective for low and moderate densities. Major excursions from this behaviour are only observed for cases when deterioration is caused by adversities like e.g. excessive edge fuelling, core impurity accumulation or strong mode activity.

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Presenter: LANG, P.T. (EPS 2019)

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