Source impact on density peaking in JET experiments

A. Kirjasuo[1], A. Salmi[1], T. Tala[1], E. Fable[2] and JET Contributors [*]

[1] *VTT, Espoo, Finland,* [2] *Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany,*

[*] *See the author list of 'Overview of JET results for optimising ITER operation' by J. Mailloux et al. to be published in Nuclear Fusion Special issue: Overview and Summary Papers from the 28th Fusion Energy Conference (Nice, France, 10-15 May 2021)*

Despite a vast body of knowledge that has already been accumulated on particle transport at both theoretical and experimental level, a simple method for estimating the source impact on density peaking has been lacking. In [1] a parameter for calculating the source strength (S_{str}, the S parameter), was presented:

$$S_{str} = C \frac{P}{EnV} \frac{a^2}{\chi} \tag{1}$$

where P is the NBI power, E is the beam ions injection energy, n is the plasma density, V is the plasma volume, a is the plasma minor radius and χ is the effective core heat transport diffusivity. The coefficient C is a possibly machine-dependent parameter, with value 2000 fitted on TGLF run for an ASDEX Upgrade experiment, incl. approximations $Ln/A \sim a^2/V$ and $D \sim \chi$.

The formula was applied to a database of 165 H- and L-mode pulses, mostly with NBI heating, in JET. The results appear reasonable considering the approximations in the formula. In addition to the S parameter values, also normalised density gradient dependence on NBI heating power and collisionality were investigated, to compare the results with those obtained at ASDEX Upgrade in [1]. Detailed studies of 6 gas puff modulation shots [2, 3, 4] at JET are used as reference. In [2] the source contribution for the H-mode shots was 50-60% and L-mode shots 10-20%. This is further validated in [3] and the H-mode shots are compared to DIII-D in [4]. Observed differences are attributed to different dominant turbulent environments.

The average calculated level of S parameter values suggest mostly non-negligible source contribution to density peaking, and the values differ for H- and L-mode plasmas (Fig. 1), in line with [2, 3, 4]. However, the results imply that the coefficient C is not constant across the database; the relationship will be investigated with simulations.

References

[1] E. Fable, et al. Nuclear Fusion, 59(7):076042, Jun 2019.

[2] T. Tala, et al. Nuclear Fusion, 59(12):126030, Oct 2019.

[3] F Eriksson, et al. Plasma Physics and Controlled Fusion, 61 (11):115004, Sep 2019.

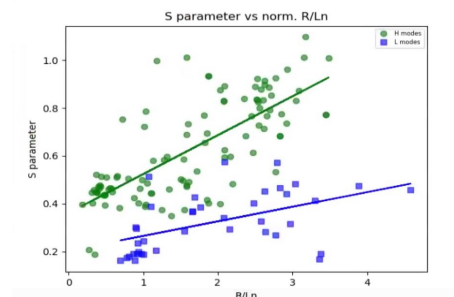[4] E. Fransson, et al. Nuclear Fusion, 61(1):016015, Nov 2020.

Figure 1: *S parameter vs R/L_n*