Effect of 'baseline' and 'hybrid' operational parameters on plasma confinement and stability in JET with a Be/W ITER-Like Wall

J. Mailloux\textsuperscript{1}, M. Beurskens\textsuperscript{1}, I. Chapman\textsuperscript{1}, I. Nunes\textsuperscript{2}, B. Alper\textsuperscript{1}, M. Baruzzo\textsuperscript{3}, P. S. A. Belo\textsuperscript{1}, E. Belonohy\textsuperscript{4}, J. Bernardos\textsuperscript{2}, P. Buratti\textsuperscript{1}, C. D. Challis\textsuperscript{5}, E. de la Luna\textsuperscript{6}, L. Frassineti\textsuperscript{1}, J. Garcia\textsuperscript{1}, C. Girolu\textsuperscript{1}, N. Hawkes\textsuperscript{1}, J. Hobirk\textsuperscript{4}, E. Joffrin\textsuperscript{4}, D. Keeling\textsuperscript{1}, M. Lennholm\textsuperscript{1}, T. Luce\textsuperscript{7}, P. Mantica\textsuperscript{10}, C. Marchetto\textsuperscript{10}, M. Maslov\textsuperscript{1}, G. Pucella\textsuperscript{1}, S. Saarelma\textsuperscript{1}, S. Sharapov\textsuperscript{1}, E. R. Solano\textsuperscript{6}, C. Sozzi\textsuperscript{19}, M. Tsalas\textsuperscript{11} and JET EFDA contributors*

\textsuperscript{*}F. Romanelli et al, Fusion Energy 2012 (24th IAEA International Conference, San Diego, 2012)

Database studies\cite{1} on JET with the Carbon wall (JET-C) and JET-ILW suggest that the transition in confinement properties between the so-called ‘baseline’ ($q_{95}$\approx3, $H_{98(y,2)}$\approx1, $\beta_N$\approx1.8, fully diffused current profile) and ‘hybrid’ ($q_{95}$\approx4, $H_{98(y,2)}$\approx1.2, $\beta_N$\approx3, tailored q-profile) scenarios is of a continuous nature. The comparison gains relevance as in the first JET-ILW campaigns, ‘baseline’ plasmas showed a reduced confinement by \approx20-30\% ($\beta_N$\approx1.4, $H_{98(y,2)}$\approx0.7-0.8) compared to similar plasmas in JET-C\cite{1,2} with possible impact on ITER’s predicted performance of $Q$=10 with $H_{98(y,2)}$=1 assumed. In contrast, the ‘hybrid’ scenario performed equally well with $\beta_N$\approx3, $H_{98(y,2)}$=1.2 in both JET-C and JET-ILW. In order to understand whether the difference between scenarios is due to the different operational space, pedestal physics and/or turbulent transport in the core plasma, an experiment was conducted where the input power (hence $\beta_N$) and $q_{95}$ were varied in ranges overlapping those typical of hybrid and baseline plasmas.

‘Baseline-like’ and ‘hybrid-like’ plasmas have been compared at the same value of $q_{95}$ and $\beta_N$, but with their usual, different q-profile tailoring techniques. It was found that the confinement was similar when $q_{95}$ and $\beta_N$ were matched (i.e. at $q_{95}$\approx3 with $\beta_N$ of \approx1.4 or \approx2.5, and at $q_{95}$\approx4 at $\beta_N$\approx1.4 or \approx2.5). In this study, only low triangularity plasmas were used, and no $N_2$ seeding. The analysis shows that by increasing $\beta_N$ from 1.4 to 2.5, $H_{98(y,2)}$ rises from 0.85 to 1.2, leading to an increase of both the pedestal pressure and the core gradients. This can be understood in terms of a weaker power degradation of confinement than that expected from the IPB98(y,2) scaling, as seen in dedicated power scans. The different q-profile shape at fixed $\beta_N$ does not seem to affect the global confinement at either $q_{95}$. However, small differences in core transport are visible in the ion heat channel. Analysis based on MSE data and MHD mode locations in these plasmas confirm that the q-profiles are different.

Transport analysis will be presented, including the effects of fast ion pressure, which increases with $\beta_N$ and when $I_p$ (and $n_e$) decreases. The pedestal stability at low and high $\beta_N$ will be compared. MHD stability in hybrid and baseline plasmas will be reported on, and consequences for ITER operational scenarios discussed.

\textsuperscript{[1]} M. Beurskens \textit{et al.}, IAEA 2012 and accepted for publication in NF
\textsuperscript{[2]} E. Joffrin \textit{et al.}, 2014 Nucl. Fusion 54 013011

\textit{This work was part-funded by the RCUK Energy Programme and by EURATOM and carried out within the framework of the EFDA. The views and opinions expressed herein do not necessarily reflect those of the European Commission.}