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Effect of fuel isotope mass on q-profile formation in JET hybrid plasmas

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The initial current ramp phase of JET hybrid plasmas is used to optimise the q-profile to allow access to high β and avoid MHD instabilities. Mixed protium-deuterium experiments have shown that the q-profile evolution during this phase varies systematically with average main ion isotope mass (M_{eff}), as seen in Fig.1, indicating the need for re-optimisation for future T and D-T experiments. $\langle T_e \rangle$ increased with M_{eff} , consistent with improved Ohmic confinement and/or reduced electron-ion coupling^a. But the effect on plasma resistivity was compensated by an increase in Z_{eff} with M_{eff} due to increased metallic impurity contamination, consistent with increased sputtering by higher mass isotopes^{b,c}. Current diffusion modelling shows that the key factor for the change in q-profile evolution was a reduction in T_e peaking as M_{eff} was increased, which was due to increased radiation. Reduced T_e peaking can lead to magnetic shear reversal, 2/1 double tearing modes and disruptions, suggesting an increased likelihood of disruptions in T and D-T. To mitigate this risk T_e

peaking measurements are being included in the real-time control system to allow disruptions to be avoided by central heating, gas puffing or early pulse termination. These results and the experience being gained at JET will help to guide the safe transition to D and D-T in ITER.

^aE. Delabie *et al* 2017 *Proc 44th EPS Conference on Plasma Physics (Belfast, Northern Ireland, UK)* P4.159

^bD. Borodin *et al* 2018 *Proc 27th IAEA Fusion Energy Conference (Ahmedabad, India)* EX/P1-14

^cS. Brezinsek *et al* 2018 *Proc 27th IAEA Fusion Energy Conference (Ahmedabad, India)* EX/9-4

*See the author list of "Overview of the JET preparation for Deuterium-Tritium Operation" by E. Joffrin *et al.* to be published in Nuclear Fusion Special issue: overview and summary reports from the 27th Fusion Energy Conference (Ahmedabad, India, 22-27 October 2018)

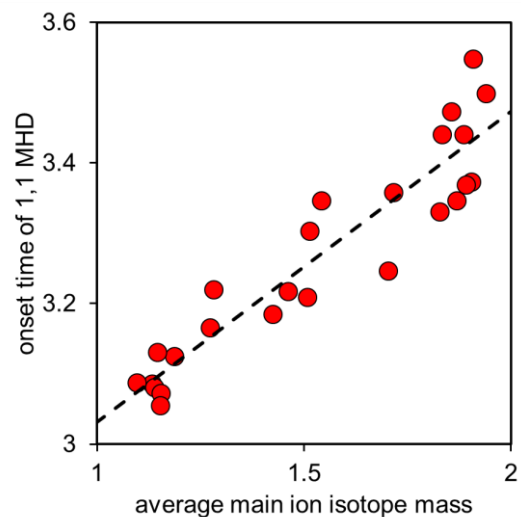


Fig.1 Delay in arrival time of $q=1$ surface as plasma main ion isotope mass is increased