Plasma preparation for α-particle excitation of TAEs in JET DT plasmas

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JET DT experiments will provide a rare opportunity to investigate α-particle (α) physics, thereby improving confidence in predictions of their impact in ITER. Of particular interest are α driven toroidal Alfvén eigenmodes (TAEs), as they could cause significant fast particle redistribution, thus reducing core heating, and also fast particle losses to the first wall3. α driven TAEs were seen in TFTR DT plasmas with high minimum values of the safety factor q_{minite}. TAEs observed in the first full DT campaign in JET (DTE1) could not be attributed clearly to α--particles because ICRH fast ions dominated the fast particle beta gradient (β_{fast}).

Recent JET experiments were devoted to preparing plasmas for observing α driven TAEs in the next DT experiments (DTE2). The requirements for high TAE drive and low NBI damping required the development of new operational space in JET with the ITER-like wall: low electron density (n_e) plasmas with elevated q_{min} (1.5 - 2.5), and fusion power enhanced by internal transport barriers (ITBs), with ion temperature up to 13 KeV, and T_e ≈ 1.4 x T_i. Due in part to type III ELMs, high power NBI-only plasmas with relatively low impurity content were achieved, but fast core impurity accumulation due to gradients associated with ITBs limited their useful duration. I_p was varied from 2.0 to 3.0MA to find the best compromise between low n_e, for slower fast particle thermalisation, and reduced fast particle losses.

Ions accelerated to MeV energies by ICRH (H minority heating) were used to diagnose TAE stability and fast particle losses. Using an upgraded TAE antenna system4, TAE damping rates were measured. The impact of β_{fast} and q_{min} on TAE stability was studied experimentally. Fast particle modelling taking into account NBI and ICRH fast ion synergy and fuel dilution due to impurities agrees well with measured neutron rates. TAE stability calculations will be compared to the experimental results, and extrapolations for DT plasmas will be presented.