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# Features of energetic particle transport in the after-glow phase of the JET plasma discharges

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After the last Deuterium-Tritium (DT) tokamak experiments on TFTR and JET in the 1990's, the next DT campaign on JET in 2021 (DTE2) will inform the physics community on important aspects of fusion plasma properties that will be essential for planning future ITER experiments. Investigating alpha particle transport and alpha-driven instabilities is one of the physics goals of the JET DTE2 campaign. Reliable projections from existing JET DD plasma discharges are required to develop a scenario allowing to observe alpha-particle driven modes and the resulting transport of energetic particles in DT plasmas [1].

Favorable conditions to observe Alfvén Eigenmodes (AE) driven by alpha-particles include reducing mode damping by beam ions and maintaining minimum q at high values to destabilize modes. Since in DD plasmas alpha particles are absent, scenario development in the presented research is focused on optimization of the JET NBI heating scheme to ensure fast slowing down of beam ions along with elevated q-profile. We analyse the after-glow phase of JET DD high performance plasma discharges, in which NBI power is switched off abruptly, as well as the low-power phase, as shown in Fig. 1a) for the JET discharge #96851. Optimization performed with the low-power phase provides essential diagnostic information, like the q-profile measurements constrained by MSE or ion temperature profiles, reliant on NBI injection that is not present during the full after-glow when all NBI power is removed. Such optimization can then inform analysis of the full afterglow discharges with sparser temporal diagnostic coverage.

Evolution of plasma profiles for various NBI heating schemes is predicted by the TRANSP code [2]. Time-dependent predictive modelling of a transient phase like after-glow, with rapid simultaneous changes in multiple plasma parameters and missing data from diagnostics based on charge-exchange recombination spectroscopy (e.g. $T_i$, rotation, q-profile), requires validated models of heat and particle transport. As shown in Fig. 1b), the neutron yield is significantly decreased with the NBI power drop, and its main trends have to be reproduced during model validation. Simulation results are sensitive to assumptions on particle transport, as well as magnetic equilibrium and kinetic profiles. For instance, uncertainties in the electron temperature measurements contribute more than 10% on the computed neutron yield. Uncertainties in plasma rotation and ion temperature contribute to uncertainties in the decay rate of the neutron emissivity, which may reveal differences in simulated and measured fast ion transport. In mixed plasmas, modeling assumptions on thermal ion transport results in significant variation in plasma composition and can cause deviations in the neutron rate up to 30%. Improvement of thermal ion transport models will be crucial for DT plasma modelling.

We have assessed uncertainties in plasma performance parameters depending on modeling assumptions and availability of diagnostic data, like plasma rotation profiles and measurements of ion temperature. Through comparison between simulation results and experimental measurements we validate existing models of energetic particle transport to identify their range of applicability and limitations. Our modelling of fast ion transport is improved by including orbital dependence of transport coefficients computed by the reduced "kick" model [3] into TRANSP. Projections from DD to DT plasmas will need to include AE mode stability analysis for optimized NBI scenarios. TRANSP simulation results are the starting point for numerical investigation of AE destabilization in the planned JET DTE2 discharges and their stability linear analysis with the NOVA-K code [4].

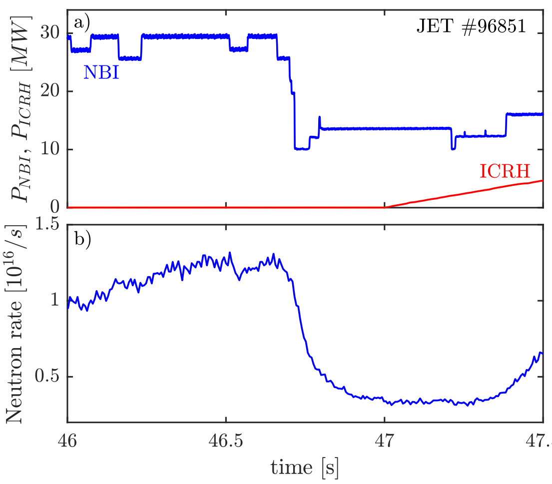


Fig. 1. JET #96851 time traces of a) input NBI and ICRH power; b) the neutron rate.

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