Magnetic Flux Pumping at JET

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In hybrid tokamak scenarios, a flat elevated central q-profile around unity stabilizes sawteeth, can enhance the performance and avoid other harmful instabilities. This q-profile can be achieved and sustained in high-β plasmas through the influence of MHD modes on the current profile. This anomalous redistribution of magnetic flux is known as "magnetic flux pumping". After robust flux pumping scenarios were successfully established at ASDEX Upgrade and other machines ([1] and references therein), dedicated experiments were conducted at JET to investigate the existence of flux pumping in a large machine.

A scenario featuring a continuous 1/1 mode was developed by adapting the timing of the heating phase in the JET hybrid scenario. Fuelling and heating power were scanned to reach optimal β values, I_p and B_t were varied from 1.4 MA to 2.0 MA, and 1.7 T to 2.3 T, respectively. A narrow parameter space was discovered at $q_{95} \sim 4$ without 3/2 NTMs at high β, in which the quasi-absence of sawteeth was observed. Although classical sawteeth were absent, the pulses exhibited an off-axis sawtooth-like reconnection event. We hypothesize that the operating scenario lies in the marginal region of flux pumping. Attempts to reach higher beta in order to fully suppress q=1 reconnection events resulted in undesirable effects, including density peaking, followed by impurity accumulation, and hollow temperature profiles. Nevertheless, the scenario characterized by the absence of distinct sawteeth and the presence of only off-axis events proved to be highly reproducible.

As the absence of sawteeth alone does not conclusively confirm the presence of flux pumping, to ascertain the potential existence of flux pumping, the "natural" evolution of the q-profile is modelled using TRANSP and comparison with experimental data is discussed.

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