Magnetic reconnection events in RFX-mod high current plasmas

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Magnetic reconnection is a basic process involving a topological rearrangement of the magnetic topology observed in almost all magnetized plasmas, including those relevant for controlled nuclear fusion experiments. The magnetic energy released during reconnection events can be converted into thermal or kinetic energy. The goal of this contribution is to investigate magnetic reconnection phenomenology associated to the partial or complete transition from a helical to an axisymmetric magnetic topology in high plasma current (I_p up to 2MA) reversed field pinch (RFP) configuration [1]. In particular the analyses here reported concern the RFX-mod experiment [2], which is at present the largest RFP experiment in operation, focusing in particular on: 1) the MHD activity and magnetic energy evolution, 2) the electron temperature dynamics and the energy released during these phenomena and 3) the corresponding ion heating.

By a power balance technique in axisymmetric approximation [3] it has been possible to compute, for several hydrogen discharges, the energy released during reconnection events which is generally in the range 5 – 180kJ at I_p = 1.2 - 2 MA. Experimental measurements from Neutral Particle Analyzer diagnostic have been used to estimate the corresponding changes in the ion temperature profile (T_i) which shows an increase of about 250eV in the core region (at I_p=1.3MA). The associated thermal energy variation computed from the whole T_i radial profile, of the order of 0.5-1kJ, is lower than the released magnetic energy, thus suggesting that suprathermal ion heating and electron acceleration might be dominant.

The analyses described above have been recently extended to deuterium plasmas too and preliminary results on magnetic activity, electron thermal energy variation and DD neutrons generation during reconnection events are here reported. Given the great relevance of ion heating during reconnection events in a reactorial perspective these issues will be further investigated with dedicated experiments and new diagnostics in RFX-mod2 [4], an upgrade of the present device currently under implementation.

[1] Lorenzini R. *et al* 2009 *Nat. Phys.* **5** 570
[2] Sonato P. *et al* 2003 *Fusion Eng. Des.* **66–68** 161
[3] Gobbin M. *et al* 2022 *Nucl. Fusion* **62** 026030
[4] Marrelli L. *et al* 2019 *Nucl. Fusion* **59** 076027