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Experimental characterization of current sheets associated to spontaneous magnetic reconnection in a reversed field pinch plasma

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An experimental investigation of the fast dynamics of the discrete relaxation events in the RFX-mod reversed field pinch device is presented. The analysis is performed by means of a large system of probes internal to the vacuum vessel, measuring the fluctuation of the toroidal magnetic field, and of an insertable edge probe. The latter is equipped with matrices of electrostatic (Langmuir) and three-axial magnetic probes. It is shown that the relaxation events, which are due to a global rearrangement of the magnetic topology through reconnection of magnetic field lines, are associated to the formation of a toroidally localised poloidal current sheet. The current structure occurs in the toroidal position where the phase locking of the dynamo tearing modes has its maximum, with an extension of some tens of degree. Soon after its formation, the perturbation is observed to move toroidally, strongly perturbing the electric field along with the plasma density and temperature at the edge.

A characterization of the current density flowing in the poloidal sheet is performed by means of the insertable probe, and a local balance between the pressure gradient associated to the current structure and the Lorentz force, due to the interaction of the current structure with its own magnetic field, is found.

An estimate of about 400 μs is given of the resistive time decay of the perturbation in its motion along the torus, by which a radial width of the current sheet of few centimeters, comparable to the ion skin depth, can be deduced.

A flattening of the E × B shear flow at the edge plasma, during the transit of the current perturbation, is also measured, whose effect on the plasma confinement at the edge might be significant.