IAEA FEC 2014

Contribution ID: **502** Type: **Poster**

Turbulent Electromagnetic Filaments in Toroidal Plasma Edge

Tuesday 14 October 2014 08:30 (4 hours)

Filament or blob structures have been observed in all magnetic configurations with very similar features despite the difference in the magnetic geometry: theory and experiments suggest they exhibit a radial convective motion across the SOL, and the interest in blob dynamics is further motivated by their interaction with first wall and divertor.
Despite their different generation mechanism, turbulent structures and Edge Localized Mode (ELM) filaments share some common physical features, as the localization in the cross-field plane and the associated parallel current, with a convective radial velocity component somehow related to their dimension.
The electromagnetic effects on filament structures deserve particular interest, among the others for the implication they could have for ELM, related for instance to their dynamics in the transition region between closed and open field lines or to the possibility, at high beta regimes, of causing line bending which could enhance the interaction of blobs with the first wall.
Electromagnetic features of turbulent filaments, emerging from turbulent background, will be shown in four different magnetic configurations: the stellarator TJ-II, the Reversed Field Pinch RFX-mod, a device that can be operated also as a ohmic tokamak, and the Simple Magnetized Torus TORPEX. In all cases, direct measurements of both field-aligned current density and vorticity were performed inside the filament. Despite the great specific differences, the inter-machine comparison revealed a clear dependence of the filament vorticity upon the local time-averaged ExB flow shear. Furthermore the wide range of local beta that was explored through the four mentioned configurations allows concluding that this parameter plays a fundamental role in the appearance of the electromagnetic features of filaments, suggesting an underlying common physics.
The RFX-mod experiment versatility is exploited also from the point of view of the active control of the edge magnetic topology focusing on the filament interaction with local magnetic island. High frequency fluctuations, characterizing electrostatic and magnetic filament features, have been observed to be affected by the island proximity. This observation hints at the challenging possibility of active control of filaments and their related transport by modulating the local magnetic topology.

Paper Number

EX/P1-40

Country or International Organisation

Italy

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Session Classification: Poster 1