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Overview of the RFX-mod fusion science activity

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Thanks to its flexibility and unique control capability, the RFX-mod device has been operated in the last two years to investigate a wide range of experimental conditions. Reversed-Field Pinch (RFP), Tokamak and the full range of magnetic configurations in between the two, the ultra-low q, have been produced to contribute to physics common topics highlighting similarities and/or peculiarities. The experiments have been inspired and complemented by an intense theoretical modeling activity, based on 3D nonlinear visco-resistive MHD, advanced non-local transport simulation, Hamiltonian guiding center and non-linear gyrokinetic codes. The RFX-mod scientific program thus provides contribution to magnetically confined plasma physics on various fundamental aspects: 3D effects, transport barriers and MHD control.

The effect of spontaneous or externally induced 3D (helical) equilibria on high current RFP plasmas has been deeply investigated, with particular emphasis on the role of the isotopic effect. An enhancement of confinement in deuterium plasmas has been observed and reproduced by simulations. The role of 3D effects on transport and small scale turbulence in the presence of magnetic islands has been studied, as well as the role of a helical boundary in the formation of 3D core equilibria, relevant for the dynamo effect in hybrid regimes in Tokamaks.

Physics issues associated to the density limit phenomenon have been addressed in all magnetic configurations. The analysis of the locking-unlocking threshold for the spontaneous rotation of the tearing in the RFP has shown the absence of hysteresis in the presence of feedback control. The results are well reproduced by a code, reliable for Tokamak plasmas as well in the investigation of the feedback control of the (2,1) mode, successfully experimented in RFX-mod.

The application of 3D perturbations has demonstrated to be effective in deconfining runaway electrons in Tokamak plasmas.

Long lasting H-modes have been attained in both circular and shaped (single null) plasmas thanks to the exploitation of an edge polarized electrode. Indications of the first L-H transitions in q(a)<2 circular plasmas have been obtained.

In order to enhance the confinement properties in RFP and to extend the operational scenarios both in RFP and Tokamak, a series of modifications for the RFX-mod device has been proposed.

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