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OV/5-2Rb: Overview of the RFX Fusion Science Program

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With a program well-balanced among the goal of exploring the fusion potential of the reversed field pinch (RFP) and that of contributing to the solution of key science and technology problems in the roadmap to ITER, the European RFX-mod device has produced a set of high-quality results since the last 2010 Fusion Energy Conference. RFX-mod is a 2 MA RFP, which can also be operated as a tokamak and where advanced confinement states have 3D features studied with stellarator tools. Self-organized equilibria with a single helical axis and improved confinement (SHAx) have been deeply investigated and a more profound understanding of their physics has been achieved. First wall conditioning with Lithium provides a tool to operate RFX at higher density than before, and application of helical magnetic boundary conditions favour stationary SHAx states. The correlation between the quality of helical states and the reduction of magnetic field errors acting as seed of magnetic chaos has been robustly proven. Helical states provide a unique test-bed for numerical codes conceived to deal with 3D effects in all magnetic configurations. In particular the stellarator equilibrium codes VMEC and V3FIT have been successfully adapted to reconstruct RFX-mod equilibria with diagnostic input. The border of knowledge has been significantly expanded also in the area of feedback control of MHD stability. Non-linear dynamics of tearing modes and their control has been modelled, allowing for optimization of feedback models. An integrated dynamic model of the RWM control system has been developed integrating the plasma response to multiple RWMs with active and passive conducting structures (CarMa model) and with a complete representation of the control system. RFX has been operated as a tokamak with safety factor kept below 2, with complete active stabilization of the (2,1) Resistive Wall Mode (RWM). This opens the exploration of a broad and interesting operational range otherwise excluded to standard tokamaks. Control experiments and modelling led to the design of a significant upgrade of the RFX-mod feedback control system to dramatically enhance computing power and reduce system latency. The possibility of producing D-shaped plasmas is being explored.

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