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RFX-MOD: A Multi-Configuration Fusion Facility for 3D Physics Studies

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RFX-mod exploits its 192 active coils in both RFP and tokamak configurations with varying degree of 3D shaping, providing also a test bed for validating stellarator codes. This makes RFX a unique and flexible facility for comparative studies on 3D shaping and control, key tools for advanced fusion scenarios. The talk discusses how 3D fields allow access to RFP and tokamak advanced regimes. 3D fields are used to feedback control Single Helicity (SH) RFP equilibria with 1/7 helicity up to ∼2MA. This ensures record persistence of SH magnetic equilibrium, nearly 100% of flat-top, avoiding back-transitions typical of spontaneous SH. It also allows accessing SH regimes with higher density (Greenwald fraction up to 0.5) presently inaccessible in spontaneous SH. 3D shaping opens for RFPs the path to helical divertor concepts similar to stellarator, through the control of the region of maximum PWI. Preliminary thoughts will be presented. Feedback on the 2/1 RWM in RFX tokamak allows for safe operation at q95<2, a almost unexplored promising regime. Forcing the 2/1 mode at finite small level, we produce a helical tokamak equilibrium with significant n=1 modulation and we find a new way to control sawteeth: their amplitude and period are inversely proportional to the 2/1 amplitude. This is reproduced with non-linear MHD code PIXIE3D. This new sawtooth control tool might be applied in larger tokamaks. The effects of different levels of 3D shaping on momentum transport are discussed. The strong 3D shaping in the SH RFP makes the flow follow a helical pattern. This flow and its shear increase with the level of 3D shaping, providing a way to control rotation. In tokamak the applied 2/1 non-resonant field – though much smaller than in RFP - strongly affects toroidal flow: when is increased the plasma first decelerates and then accelerates in the opposite direction. This is compared with NTV theory.