Rotation Acceleration and Braking due to RMP in MAST-U Experiment

T. Tala[1], E. Tomasina[2,6], A. Salmi[1], C. Albert[3], J. Ball[4], C. Beckley[5], S. Blackmore[5], T. Bolzonella[6], D. Dunai[7], L. Frassinetti[8], G.S. Graßler[3], A. Kirjasuo[1], C. Michael[5], A. Niemelä[1], B. Patel[5], L. Pigatto[2], M. Poradinski[9], D. Ryan[5], H. Sun[4], and Tokamak Exploitation Team*

*[1]VTT, Espoo, Finland, [2]Università degli Studi di Padova, Padova, Italy, [3]TU Graz, Graz, Austria, [4]SPC, Lausanne, Switzerland, [5]UKAEA, Culham Campus, Abingdon, UK, [6]Consorzio RFX, Padova, Italy, [7]HUN+REN, Budapest, Hungary, [8]KTH, Stockholm, Sweden, [9]IPP-LM, Warsaw, Poland, *See the author list of E. Joffrin et al 2024 Nucl. Fusion **64** 112019*

Plasma toroidal rotation is less well-known transport channel than heat or particle transport [1], including both momentum transport and in particular rotation sources. In this work, we have studied rotation changes or torque sources induced by Resonant Magnetic Perturbations on MAST-U tokamak. Relatively repeatable pulses in L-mode plasmas in both n=2 and n=4 RMP coil configurations were performed on MAST-U by introducing RMP coil modulation waveforms at various amplitudes and frequencies. In the n=4 RMP coil configuration, quite surprisingly an edge rotation acceleration was measured due to the RMP coil current, resulting in an increase of relative edge rotation by 20% (~5km/s [2]) at ρ_{tor}≈0.97 at maximum RMP coil current of 1.9kA. This increase in rotation is limited to the region of $\rho_{tor} > 0.9$.

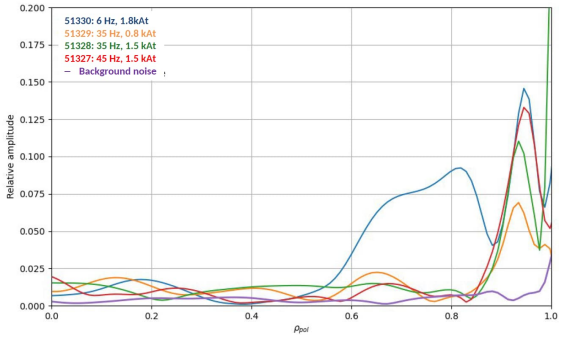

Figure 1. Relative rotation amplitude for different RMP coil current magnitudes.

In the n=2 RMP coil configuration, we performed an RMP coil current scan shown in figure 1. Similar edge rotation acceleration was observed as with n=4 configuration, the acceleration being higher with increasing RMP coil current. At the highest RMP coil current, significant rotation braking was also seen at ρ_{pol}≈0.55-0.85 as shown in figure 1.

To interpret and quantify the mechanisms responsible for this edge rotation acceleration and core braking, modelling with the MARS-F/K [3] code is being carried out. Modelling the n=4 case with MARS-K is suggesting the observed co-torque in the edge region while the modelling results in n=2 configuration are in disagreement with experiments. Investigation of other possible sources of RMP-driven torque, such as the stochastic torque, is on-going [4].

[1] M. Yoshida *et al.*, Nucl. Fusion **65**, 033001 (2025); [2] N.J. Conway *et al.*, RSI **77**, 10F131 (2006); [3] Y.Q. Liu *et al.*, Physics of Plasmas **7**, 3681 (2000); [4] E. Tomasina *et al.*, EPS conference 2025, Lithuania, July 2025.