Measurement and modeling of [neoclassical] tearing modes at TCV

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In fusion plasmas, magnetic reconnection is typically observed in the formation of [neoclassical] tearing modes ([N]TMs), mostly rotating magnetic islands that break the typically nested magnetic field line topology. Once developed, the mode amplitude is reinforced by the local perturbation of the pressure gradient-driven bootstrap current. The latter is caused by the enhanced heat transport across the island region, leading to a local flatting of the pressure profile. Since a fully developed magnetic island can considerably reduce overall confinement and, hence, the fusion gain, it has motivated the development of various [N]TM control strategies, mainly based on the application of localized electron cyclotron (EC) waves.

This contribution focuses on [N]TMs in experiments at the *tokamak à configuration variable* (TCV), a medium-sized tokamak experiment based in Lausanne, Switzerland. We will present various diagnostic techniques to measure and characterize the magnetic island width and rotation frequency at TCV. The generation of magnetic islands, either *triggerless* by the application of EC waves or through the formation of a seed island, as well as the preemption and stabilization of [N]TMs will be discussed.

The primary model to compare with experimental results is the Modified-Rutherford equation (MRE) [1]. It is implemented in the comprehensive MRE solver *co-MRE* for modeling the island width [2] and frequency [3,4], which comprises a model considering the non-linear evolution of the classical Δ' from zero to finite island widths. We will discuss possible use cases for MRE modeling, e.g., for interpretative analysis of TCV discharges, perspectives for its application in real-time control, as well as implications for reactor-grade experiments.

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[3] E. Lazzaro et al., *Plasma Physics and Controlled Fusion* 60, 014044 (2018)
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