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Energetic particle studies on TCV

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Recent upgrades of the heating systems and new diagnostic capabilities have expanded the capabilities of the Tokamak à Configuration Variable (TCV) to address energetic particle (EP) physics. A second Neutral Beam (NB) injecting at V_{inj}~53kV complements the first system with maximum V_{inj}~28kV [1], with a total NB power of 2.8MW now available to study EP dynamic and the interaction with EP-driven instabilities such as Alfvénic modes (AEs) [2][3] and EP-driven Geodesic Acoustic Modes [4]. The flexibility in the achievable plasma configurations that characterizes TCV makes it possible to tailor the fast ion distribution from NBI from on-axis to off-axis, with inter-discharge scans of both plasma configuration (e.g. positive vs negative triangularity) and NB parameters (on/off-axis injection, injection energy). Together with the TCV Electron Cyclotron (EC) system, the mix of NBI and EC heating expands the range of electron and ion temperatures achievable in TCV, which can be controlled e.g. to study the relative contribution of different damping mechanisms to AE stability.

A new fast ion loss detector (FILD [5]) allows simultaneous measurements of co- and counter-going NB ions. Its rotatable head can be adjusted on a shot-to-shot basis to optimize the alignment with the magnetic field, thus allowing systematic scans of I_p and B_t while maintaining optimum acceptance for the diagnostic. FILD complements a set of four Fast Ion D-Alpha (FIDA) systems [6] with a total of ~40 lines of sight to sample the fast ion distribution in different regions of real and velocity space. Neutron detectors are routinely used for an overall assessment of core fast ion confinement. A new set of high-frequency coils gives access to magnetic fluctuations at harmonics of the ion cyclotron frequency, as required to study Ion Cyclotron Emission (ICE).

The combination of machine flexibility and expanding set of fast ion diagnostics has resulted in contributions to different EP studies, e.g. on AE stabilization via ECH/ECCD, fast ion transport by AEs and other instabilities such as ELMs, and a first characterization of ICE on TCV. Recent results on those topics will be summarized and plans for EP studies in the coming TCV experimental campaigns will be discussed.

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