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Experimental studies of pressure and plasma current profiles for equilibria calculations during AC transition in the ISTTOK tokamak

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In general, the operation of AC discharges in small tokamaks requires the control of a few external parameters such as vertical and horizontal fields, external heating (where available), chamber conditioning and gas puff. The dynamics and type of control used are mostly based on experimental empirical learning, with different combinations of actuators depending on the tokamak device. Experimental studies performed during the AC operation in the ISTTOK tokamak have addressed the influence of several control parameters in the success of the AC transition. Although the link between the different external actuators and plasma discharge evolution could be verified, successful AC transitions above 4 kA plasma current could not be achieved. In order to build a more predictive control of the AC transition it would be useful to develop a first principles model which interprets the experimental observations. Such model would need to combine experimental data and calculations on the equilibria and stability in several time stamps of the transition, current profile evolution, ramp-up and runaway generation, drift electrons, and the electro-technical properties of the tokamak during AC operation. The output of such model would inform the discharge controller how to balance evolution of the external actuators during the AC transition.
The present paper presents an initial step towards the development of a deeper understanding of the equilibria and current profile during the AC transition in ISTTOK. The goal of the present study is to identify the topology of flux surfaces based on experimental pressure-like measurements and matched current profiles, the existence (or not) of antiparallel plasma currents during transition and the existence of drifting electrons and their role during current ramp-up. There is also experimental evidence on the presence of fast electrons (possibly a significant run-away fraction) playing an important role during the initial stages of the discharge immediately after the transition. This will be further investigated using colisonless numerical simulations to determine the maximum lifetime of the drift electrons and their response to H-V fields. It is important to use this electron population in combination with gas puff to produce a more efficient Townsend avalanche during the current ramp-up.

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