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Runaway electron beam stability and decay in COMPASS

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Runaway electrons (REs) as one of the yet unsolved threats for ITER and future tokamaks are a topic of intensive research at most of the tokamaks. The experiments performed on COMPASS are complementary to the experiments at JET and MST (Medium-Size Tokamaks), building on the flexibility of the diagnostics set-up and low safety constraints at this smaller (R0=0.56 m, a=0.23 m) device. During the past couple of years two different scenarios with the RE beam generation triggered by gas injection have been developed and investigated. The first one is based on Ar or Ne massive gas injection (MGI) into the current ramp-up phase leading to a disruption accompanied by runaway plateau generation, while the second uses smaller amounts of gas in order to get runaway current dominated plasmas.
The successful generation of the beam in the first scenario depends on various parameters, including the toroidal magnetic field. The generated beam is often radially unstable, and the stability seems to be a function of various parameters, including the value of current lost during the CQ. Surprisingly, the current decay rate of the stable beams is rather similar in most discharges. The second scenario is much more quiescent, with no observable fast current quench. This allows to better diagnose the beam phase and also to apply secondary injections or resonant magnetic perturbations (RMP) to assist the decay of the beam. In this regard, interesting results have been achieved using secondary deuterium injection into a runaway electron beam triggered by Ar or Ne injection and also using n=1 error field generated by top and bottom RMP coils. While D dilution is clearly able to almost stop the beam decay, RMPs help to accelerate the beam decay. The effect of RMPs seems to be very different when acting on Ar and Ne background plasmas.
Very interesting effects have been observed also by the high-speed cameras, including filamentation during the application of the RMPs and a slow local variation of the light intensity similar to turbulence during the beam decay.

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