Contribution ID: **528** Type: **Poster**

First experimental results of runaway beam control in TCV

Friday, 21 October 2016 14:00 (4h 45m)

Runaway mitigation is one of the main concerns for safe ITER operation. The disruption mitigation system, still under development for ITER, will be designed to inject the correct amount of high-Z impurities in order to dissipate thermal and magnetic energy by radiation within the mechanical limits of the structure. During the ITER disruption phase and specifically during the Current Quench (CQ), significant production of high-energy runaway electrons (RE) is foreseen due to primary and secondary generation mechanisms. Present strategies to limit post-disruption runaway formation and suppression are based on massive gas injection (MGI) and shattered pellet injection. A different approach, more likely to be used simultaneously to MGI, exploits the ohmic coils to obtain a RE beam current ramp-down while its position is stabilized. This paper presents the first results of attempting RE beam suppression at TCV. In order to obtain a disruption-generated RE beam, small injections of high-Z impurities (Ar and Ne) have been performed in low-density inner limiter discharges with circular plasmas, B_t = 1.43 T and I_p=200 kA. The gas injection is performed by means of the disruption mitigation valve system. A dedicated controller for RE suppression has been implemented in the digital plasma control system of TCV. The CQ and the RE plateau onset are detected by feeding I_p through an approximate derivative linear filter with specific logic. Once the RE plateau onset is detected at t_CQ, a new I_p reference is smoothly (via an exponential decay) substituted to the standard one. The new I_p reference, starting from the value at t_CQ, is ramped-down towards zero with a pre-selectable rate. To improve the ramp-down tracking performance, a further logic block, implementing a novel double integrator scheme, is paired with the standard plasma current controller to select the appropriate voltage for the amplifiers powering the ohmic coils. During the RE plateau, the beam has a slow outward (radially) and upward shift of the order of 0.15 m but the standard position control system is able to avoid RE interactions with the vessel before the final loss.

Paper Number

EX/P8-27

Country or International Organization

Italy

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Session Classification: Poster 8

Track Classification: EXC - Magnetic Confinement Experiments: Confinement