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Runaway electron generation and mitigation on the European medium sized tokamaks ASDEX Upgrade and TCV

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Disruptions in tokamaks can lead to the generation of a relativistic runaway electron (RE) beam that may cause serious damage to the first wall. The uncontrolled loss of such a high energy electron beam is intolerable and therefore the issue of how to avoid or mitigate the beam generation is of prime importance for ITER. The European medium sized tokamaks ASDEX Upgrade (AUG) and TCV have recently joined the international effort of better understanding runaway electron generation and dissipation, aiding the development of the future ITER disruption & runaway electron mitigation system.

The AUG RE scenario is a 2.5 T, circular, low density, limiter discharge with 2.5 MW of Electron Cyclotron Resonance Heating. The injection of 0.05-0.2 bar*l (1.2-5e21 particles) of argon produces a well reproducible disruption and leads to the generation of 100-400 kA of runaway electron beam that can last up to 400 ms. The main goal on AUG was to study the interaction of REs with partially ionized high-Z materials. Suppression of REs was achieved with 0.17 bar*l of argon or 0.7 bar*l of neon using the in-vessel piezo valves. Injection from ex-vessel valves requires ˜10x more gas to achieve suppression. We identified a (1,1) mode surviving the disruption for several ms, indicating a partial survival of the plasma core, which was also indicated by the survival of ECRH-introduced seed particles. A resonant magnetic perturbation configuration was developed that leads to up to a factor of 2 decrease in the RE current by changing the disruption dynamics.

The main goal of experiments carried out on TCV is to utilize TCV's flexible plasma shape and position control to determine the direct and indirect effects of plasma shaping on RE generation and dissipation. The base scenario is a 1.4 T, low density, circular, limiter discharge. Using multi-chord HXR spectrometers we have determined the effective critical field for RE generation and detection. The value found is higher than the Dreicer value by approx. an order of magnitude, in agreement with previous experimental findings. These quasisteady discharges also provide a dataset for validating time-dependent Fokker-Planck simulations. Further discharges, including post-disruptive studies are ongoing, and the results of these experiments are also going to be presented in this contribution.

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Primary author: Dr PAPP, Gergely (Max Planck Institute for Plasma Physics)

Co-authors: Dr MLYNEK, Alexander (Max Planck Institute for Plasma Physics); Dr DUVAL, Basil (Ecole Polytechnique Fédérale de Lausanne –Centre des Recherches en Physique des Plasmas(CRPP), Association Euratom-Confédération Suisse(EPFL) CH-1015 Lausanne, Switzerland); Mr SIEGLIN, Bernhard (Max Planck Institute for Plasma Physics); Ms ERDOS, Boglarka (Budapest University of Technology); Dr REUX, Cedric (CEA, IRFM, F-13108 Saint Paul-lez-Durance, France.); Dr FUCHS, Christoph (Max Planck Insitute for Plasma Physics); Mr SOMMARIVA, Cristian (CEA IRFM); Ms CHOI, Dahye (SPC EPFL); PAUTASSO, Gabriella (IPP, Garching, Germany); Dr TARDINI, Giovanni (Max Planck Institute for Plasma Physics); Ms ANJA, Gude (Max Planck Institute for Plasma Physics); Dr GERGO, I. Pokol (Budapest University of Technology); Dr DECKER, Joan (SPC EPFL); Prof. LACKNER, Karl (Max Planck Institute for Plasma Physics); Dr MARELLI, Lionello (Consorzio RFX); Dr GIANNONE, Louis (Max Planck Institute for Plasma Physics); Dr MARASCHEK, Marc (Max Planck Institute for Plasma Physics); Dr GOBBIN, Marco (Consorzio RFX); Dr VALISA, Marco (Consorzo RFX); Dr NOCENTE, Massimo (Dipartimento di Fisica, Università di Milano-Bicocca); Mr FICKER, Ondrej (Institute of Plasma Physics AS CR); PIOVESAN, Paolo (Consorzio RFX); Dr MCCARTHY, Patrick J. (Department of Physics, University College Cork); Mr POLOSKEI, Peter Zsolt (Budapest University of Technology); Dr DUX, Ralph (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Dr CODA, Stefano (CRPP-EPFL); Dr POTZEL, Steffen (Max Planck Institute for Plasma Physics); Dr PLYUSNIN, Vladislav V (Instituto de Plasmas e Fusão Nuclear, Associação EURATOM-IST, Instituto Superior Tecnico); Dr SUTTROP, Wolfgang (Max-Planck-Institut für Plasmaphysik); Dr TREUTTERER, Wolfgang (Max Planck Institute for Plasma Physics)

Presenter: Dr PAPP, Gergely (Max Planck Institute for Plasma Physics)

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