Contribution ID: **139** Type: **Contributed**

# Validation of state-of-the-art runaway electron generation models in simulations of ASDEX Upgrade disruptions

The importance of considering kinetic effects for the generation of relativistic runaway electrons (RE) in the presence of non-fully ionized impurities [1,2] is demonstrated in first-time integrated simulations of massive material injection (MMI), background plasma response, and RE generation in artificially induced disruptions in ASDEX Upgrade (AUG). Understanding the processes governing RE generation during MMI is crucial for the design of an effective disruption mitigation system in ITER, where RE currents of several MA can severely damage plasma facing components. To complement experimental studies at e.g. AUG [3], a computational toolkit based on the 1.5D transport code ASTRA-STRAHL [4,5] has been developed [6].

Applying state-of-the-art models for RE generation [1,2], the evolution of key plasma parameters (plasma current decay, line integrated electron density, etc.) is calculated well in agreement with experimental observations of AUG. Considering instead commonly used formulae which neglect the impact of partially ionized species on runaway [7,8], simulations cannot capture experimental trends, thus demonstrating the importance of these kinetic effects on RE generation.

The propagation of material into the plasma center is well described by a 1D approach, despite the complexity and 3D nature of MMI. Transport is governed by both neoclassical phenomena and MHD effects; the latter triggered as the material reaches the q = 2 surface. A 0D model of exponentially decaying transport coefficients was found suitable to simulate the impact of MHD phenomena on impurity transport. Further studies using a non-linear MHD framework will have to assess the applicability of the chosen transport coefficients.

Given the suitability of the toolkit for the study of RE generation in MMI scenarios, the impact of varying impurity composition and injection quantities on RE generation is to be further explored and compared to experimental observations (see e.g. [9]).

**References**

[1] L Hesslow, O Embréus, O. Vallhagen and T. Fülöp. *Nucl. Fusion* **59**, 084004 (2019)

[2] L. Hesslow, L. Unnerfelt, O. Vallhagen, O. Embréus, M. Hoppe *et al. J. Plasma Phys.* **85**, 475850601 (2019)

[3] G. Pautasso, M. Dibon, M. Dunne, R. Dux, E. Fable *et al.* Submitted to *Nucl. Fusion* (2020)

[4] E. Fable, G. Pautasso, M. Lehnen, R. Dux, M. Bernert *et al. Nucl. Fusion* **56**, 026012 (2016)

[5] R. Dux, A.G. Peeters, A. Gude, A. Kallenbach, R. Neu *et al. Nucl. Fusion* **39**, 1509 (1999)

[6] O. Linder, E. Fable, F. Jenko, G. Papp, G. Pautasso *et al. Submitted to Nucl. Fusion*, pre-print available on arXiv.org (2020)

[7] J.W. Connor and R.J. Hastie. *Nucl. Fusion* **16**, 415 (1975)

[8] M.N. Rosenbluth and S.V. Putvinski. *Nucl. Fusion* **37**, 1355 (1997)

[9] G. Papp, the ASDEX Upgrade Team, the TCV Team, the EUROfusion MST1 Team. *Paper presented at the 46th EPS Conf. on Plasma Physics, Milan, Italy, 08.-12.07.2019*, I4.105 (2019)

## Member State or International Organization

Germany

## Affiliation

Max-Planck-Institut für Plasmaphysik

**Primary author:** LINDER, Oliver (Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany)

**Co-authors:** FABLE, Emiliano (Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany); JENKO, Frank (Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany); PAPP, Gergely (Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany); PAUTASSO, Gabriella (Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany)

**Presenter:** LINDER, Oliver (Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany)

**Track Classification:** Consequences