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Facing the challenge of power exhaust on the way to a future power plant with experiments in the JET and ASDEX Upgrade tokamaks

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Future fusion devices such as ITER and DEMO face a major challenge when limiting the thermal power load reaching the plasma-facing components, PFCs, to values below the engineering specifications. In the case of DEMO the combination of power load and erosion limitations require plasma operation at a high fraction of power dissipation, estimated to be well beyond 90%, while maintianing a sufficient energy confinement time to achieve an economically competitive gain in power. In the case of an ITER-like divertor geometry this leads to a radiative power fraction, f_rad, in the order of 70% in the region of closed flux surfaces.

In the all-metal devices ASDEX Upgrade (AUG) and JET high radiation is achieved by seeding impurities by gas injection. While AUG and JET have both operated with N, Ne and Ar, only AUG extended its operation to include Kr, which is expected to be included in the ongoing experimental campaign at JET. Nitrogen has been established in both devices for achieving stable highly radiative regimes with strong X-point radiation and complete detachment along the target plates. For both devices at the highest seeding levels the dominant radiation originates from the confined region. Higher Z impurities increase the radiation in this region already at lower divertor radiative power fraction. A deterioration of the confinement is only observed when enhanced radiation is obtained for a rho_pol smaller than the position of the pedestal top. Albeit this upper limit at JET for all demonstrated seeding species the highest f_rad obtained were consistently linked to complete detachment over the tested range of P/R. For both devices enhanced perpendicular transport is observed in the SOL that correlates with the establishment of a highly collisional divertor regime.

For both devices numerical efforts for interpretative studies using complex transport codes such as SOLPS and EMC3-EIRENE are ongoing. With increasing confidence additional physics such as the role of drift terms are being studied, allowing for consistently better agreement with experimental observations. Cases exist for which it has been possible to numerically recover many of the experimentally observed features of the high recycling and the completely detached H-mode regimes for AUG.

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Primary author: Dr WISCHMEIER, Marco (IPP Garching)

Co-authors: Dr SIPS, Adrianus (JET Exploitation Unit); Dr HUBER, Alexander (Forschungszentrum Jülich); Dr MEIGS, Andy (CCFE); Dr KALLENBACH, Arne (Max-Planck-Institut f. Plasmaphysik); Prof. LIPSCHULTZ, Bruce (University of York); Dr VIOLA, Bruno (ENEA); Dr LOWRY, Christopher (European Commission); Dr

MAGGI, Costanza (CCFE); Dr HARTING, Derek (CCFE); BRIDA, Dominik (IPP Garching); Dr REIMOLD, Felix (Forschungszentrum Jülich); Dr SERGIENKO, Gennady (Forschungszentrum Jülich GmbH,); Dr CALABRO, Giuseppe (ENEA); Dr CHRISTOPHE, Guillemaut (Instituto de Plasmas e Fuso Nuclear); Dr AHO-MANTILA, Leena (VTT Technical Research Centre of Finland); Dr TILMANN, Lunt (IPP Garching); Dr NAVE, Maria Filomena (Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico); Dr GROTH, Mathias (Aalto University); Dr REINKE, Matthew (ORNL); Dr BERNERT, Matthias (IPP Garching); Dr STAMP, Mike (CCFE); Dr DREWELOW, Peter (IPP Greifswald); Dr DUX, Ralph (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Dr BREZINSEK, Sebastijan (Forschungszentrum Jülich); Dr POTZEL, Steffen (IPP Garching); GLÖGGLER, Stephan (IPP Garching); Dr WIESEN, Sven (Forschungszentrum Jülich)

Presenter: Dr WISCHMEIER, Marco (IPP Garching)

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