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Divertor impurity seeding experiments at the COMPASS tokamak

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Partial detachment is the desired regime for the baseline burning plasma scenario in ITER and next–step devices, as it allows to convert the majority of the energy carried by charged particles through the scrape-off-layer (SOL) into isotropic radiation and thus avoids localized heat flux deposition in the divertor region. In order to maintain relevance to ITER and DEMO, a concentrated effort has been initiated at the COMPASS tokamak to achieve detached operation by means of impurity seeding.

Series of experiments with impurity injection in the range of 2-9x1020 molecules per second at different locations in the divertor were performed with the aim to cool the plasma and influence the particle and heat transport in the divertor region and provoke partial detachment. Previously reported results [1] were largely extended by injection of nitrogen at the outer divertor target and also by attempts to seed the plasma with neon. The effects on SOL and divertor plasma conditions were monitored by means of horizontal reciprocating probe manipulator located at the outer midplane and by arrays of divertor Langmuir and Ball-pen probes. The radiation in the edge plasma was observed by AXUV bolometers and fast visible cameras.

Experiments in L-mode discharges with nitrogen injected at the outer divertor target have shown that the presence of radiating impurity leads to drop of pressure in the divertor. Depending on the magnitude of the seeding, the upstream pressure can be also affected, suggesting possible penetration of nitrogen into the confined plasma region. The target pressure, however drops at faster rate than upstream, which allows to reach the regime of partial detachment. Similar results were obtained by the HFS nitrogen injection, however the change in divertor pressure was more generally more abrupt and was less sensitive to the amount of injected nitrogen.

References:

[1] M. Komm et al., proceedings of the 44th EPS conference, Belfast (2017) P1.118

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Author: Dr KOMM, Michael (Institute of Plasma Physics of the Czech Academy of Sciences)

Co-authors: Mr DEVITRE, Alexis (Universidad de Costa Rica, San Jose, Costa Rica); Mr KHODUNOV, Igor (Department of Applied Physics, Gent University, Gent, Belgium); Dr SEIDL, Jakub (Institute of Plasma Physics of the CAS); Mr KRBEC, Jaroslav (Institute of Plasma Physics of the CAS); Dr ADAMEK, Jiri (Institute of Plasma Physics of the CAS); Dr CAVALIER, Jordan (Institute of Plasma Physics of the CAS); Dr HAVLICEK, Josef (Institute of Plasma Physics of the CAS); Ms TOMOVA, Kristina (Department of Applied Physics, Gent University, Gent, Belgium); EUROFUSION TEAM, MST1 (See the author list of Meyer H. et al 2017 Nucl. Fusion 57 102014); Mr IMRISEK, Martin (Institute of Plasma Physics of the CAS); Mr PETERKA, Matej (Institute of Plasma Physics of the CAS); Mr TOMES, Matej (Institute of Plasma Physics of the CAS); Dr FAITSCH, Michael (Max-Planck-Institut für Plasmaphysik, 85748 Garching b. München, Germany); Dr DIMITROVA, Miglena (Institute of Plasma Physics of the CAS); Mr SAMOYLOV, Oleg (Department of Applied Physics, Gent University, Gent, Belgium); Mr HACEK, Pavel (Institute of Plasma Physics of the CAS); Dr BOHM, Petr (Institute of Plasma Physics of the CAS); Mr VONDRACEK, Petr (Institute of Plasma Physics of the CAS); Dr BILKOVA, Petra (Institute of Plasma Physics of the CAS); Dr PANEK, Radomir (Institute of Plasma Physics of the CAS); Dr ELMORE, Sarah (Culham Sci Ctr, CCFE, Abingdon OX14 3DB, Oxon, England); Prof. POPOV, Tsviatko (Sofia Univ St Kliment Ohridski, Fac Phys, 5 J Bourchier Blvd, Sofia 1164, Bulgaria); Dr WEINZETTL, Vladimir (Institute of Plasma Physics of the CAS)

Presenter: Dr KOMM, Michael (Institute of Plasma Physics of the Czech Academy of Sciences)
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