Erosion and Screening of Tungsten during inter/intra-ELM Periods in the JET-ILW Divertor

A. Huber1, S. Brezinsek1, V. Huber2, I. Borodkina3, M. Baruzzo4, A. Kirschner1, M. Sertoli5, G. Sergienko1, D. Borodin1, J. Mailloux5, S. Aleiferis5, K. Lawson5, Ch. Linsmeier1, A. Meigs5, S. Menmuir5, Ph. Mertens1, E. Pawelec5 and JET contributors

1Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich, Germany
2Forschungszentrum Jülich GmbH, Supercomputing Centre, 52425 Jülich, Germany
3Institute of Plasma Physics of the CAS, Prague, Czech Republic
4Consorzio RFX, corso Stati Uniti 4, 35127 Padova, Italy,
5CCFE, Culham Science Centre, Abingdon, OX14 3DB, UK
6Institute of Physics, University of Opole, Opole, Poland

A.Huber@fz-juelich.de

Tungsten (W) is intended as the main plasma-facing material (PFM) in fusion devices such as ITER, because of its high threshold energy for sputtering, a high melting point and a low tritium inventory. The net erosion of W can significantly limit the lifetime of the respective wall components while the influx of W into the confined region can result in dilution of the fusion plasma and energy losses due to radiation. In fact, the interplay of the W source strength, the screening of W by the divertor geometry/plasma and the transport of W in the plasma determines the W content in the plasma core, hence affects the plasma performance [1]. Therefore, it is very essential to get a complete understanding of the interplay between the gross erosion source of W and its screening to find the recipe to control the net W source and minimize the impact of eroded W on the confined plasma.

It was shown in JET-ILW that the dominant W erosion mechanism in the divertor is the intra-ELM sputtering induced by impurities as well as hydrogenic ions with energies determined by the pedestal temperature. The amount of the sputtered W atoms for individual ELMs demonstrates a dependence on the ELM frequency. It decreases when the pedestal temperature is lower and, correspondingly, the ELM frequency is higher. However, when we talk about the entire cross erosion W source (the number of eroded W atoms per second), an increased ELM frequency results in an increased W source. The in/out asymmetry of the intra-ELM W sources during ELMs is a critical issue and is investigated in this contribution. Because the recombination emission could strongly affect the measurements the tungsten emission in the area of the inner divertor, a new algorithm for the subtraction of continuum radiation has been used to evaluate the W erosion in the inner divertor region. At a lower ELM frequency of about 25Hz the outer divertor cross W source is larger by a factor of 1.5. However the in/out asymmetry of the W erosion decreases strongly with ELM frequency demonstrating the nearly symmetric W source in both divertor legs at frequencies above 80 Hz. The dependence on the tungsten source of its content in the core plasma has been investigated. The W content increases with the source at low ELM frequencies. However, beyond 40 Hz there is a tendency for saturation or even descent, which is probably due to flushing of W from the confined area by ELMs [2].

In this contribution, an analysis of cross erosion and screening of tungsten during inter/intra-ELM periods in the JET-ILW divertor will be presented and discussed for different magnetic field shapes: closed and open divertor configuration. It focuses in particular on missed results in previous work [1] for corner and outer vertical target configurations. Please note, that corner configuration is foreseen as reference shape for scenarios of the deuterium-tritium experiments on JET scheduled for 2020. Additionally, this study includes a comparison of ERO modelling with experimental results.


*See the author list of E. Joffrin et al. accepted for publication in Nuclear Fusion Special issue 2019, https://doi.org/10.1088/1741-4326/ab2276
** See author list in the paper. E. Joffrin et al. 2019 Nucl. Fusion 59 112021