8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

Tungsten and Tungsten-equivalent radiative studies in the DIII-D ITER Baseline Scenario

A.C.C. Sips[1], F. Turco[2], C.M Greenfield[3], T. Odstrčil[1], A. Hyatt[1], T. Luce[4], T. Osborne[1], A. McLean[5], and I. Bykov[1]

[1] General Atomics, San Diego, USA
[2] Columbia University, New York, USA
[3] Oak-Ridge National Lab, Oak Ridge, USA
[4] ITER Organization, Saint Paul lez Durance, France
[5] Lawrence Livermore National Laboratory, Livermore, USA
e-mail (speaker): sips@fusion.gat.com

DIII-D obtained sustainable stationary (>4t_R) ITER Baseline Scenario (IBS) plasmas with Kr and Xe impurities, which have the same radiative loss rate L_z as Tungsten in the hotter ITER core plasmas, spanning the range of ITER expected impurity concentration C_W~$1x10^{-5}$ and W radiated fraction f_{rad}~30%, and compared the results to intrinsic metal impurities such as W, Mo and Fe. The database with intrinsic metals shows lower confinement enhancement factor H_{98} than the equivalent Kr and Xe discharges, indicating that the behaviour of present W-wall machines with lower core temperatures than ITER provides an overly pessimistic assessment of the impact of W in the core of ITER and future reactors. The use of the radiators that mimic the behaviour of W in ITER also shows that the operational space at low P_{in}/P_{LH}<1.5 can be opened, while no Baseline conditions were sustainable in W environment in those conditions. Simulations show that for core temperatures expected for ITER, the plasmas would not have a radiative collapse at C_W=$1x10^{-5}$, while a fusion gain of Q=8-10 would still be achieved for C_W up to $3x10^{-5}$ (relevant for the new ITER wall program). Comparing the results with previous ITPA database studies of the IBS confirms that, with higher radiation fraction due to Kr and Xe injection, a drop in H_{98} of >10% is observed, compared to much larger confinement degradation in W environments, confirming the relevance of carbon-wall machines when W-equivalent radiators are used.

Acknowledgement: Work supported by US DOE under: DE-FC02-04ER54698, DE-FG02-04ER54761 and DE-AC52-07NA27344