EDGE2D-EIRENE calculations of JET ILW plasmas near radiative collapse

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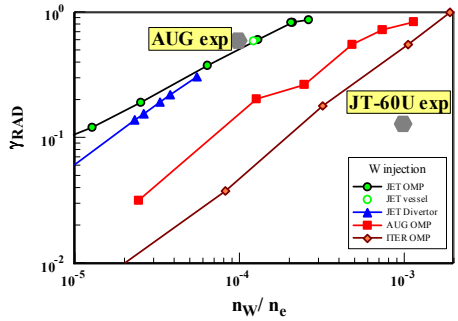
** See Appendix of F. Romanelli, et al, Fusion Energy 2010 (Proc 23rd Int. Conf. Daejon, Korea) IAEA, (2010)*

Overview

Tungsten radiative collapse effects on the SOL, pedestal, and divertor of hypothetical JET and ASDEX-Upgrade H-Mode plasmas, and an ITER L-Mode plasma are calculated by EDGE2D. The tungsten was introduced by injection (not sputtering) and the amount was increased until W radiation was significant in the energy balance. The primary effect is the reduction in separatrix power flow. The radiative collapse reduced the plasma temperatures in front of the targets, at the pedestal edge as well as the core. These temperatures control the W sputtering by ion bombardment of the targets as well as neutral bombardment of the main chamber walls. Consequently, when the tungsten radiation becomes large the W sputtering and radiation are reduced. Thus the W sputtering has a self-regulating nature.

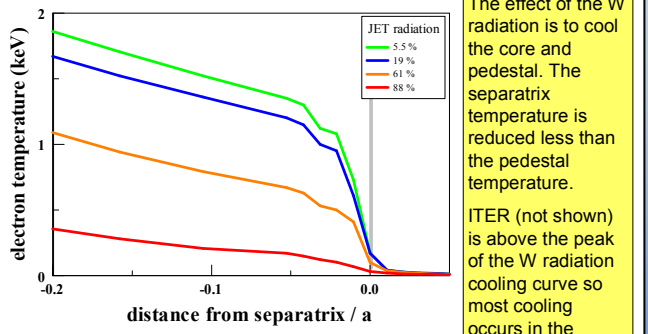
W injection caused the radiation collapse



The AUG and JT-60U data are for illustration, and no attempt was made to model those plasmas

W radiated fraction is 90% for W particle content of 2 10^{-4}, 10^{-3}, and 2 10^{-3} for JET, AUG, and ITER hypothetical plasmas heated by 10, 8, and 150 MW respectively but with similar transport coefficients.

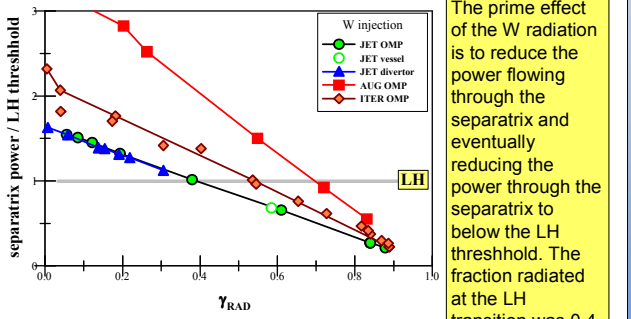
Core temperature collapse



The effect of the W radiation is to cool the core and pedestal. The separatrix temperature is reduced less than the pedestal temperature.

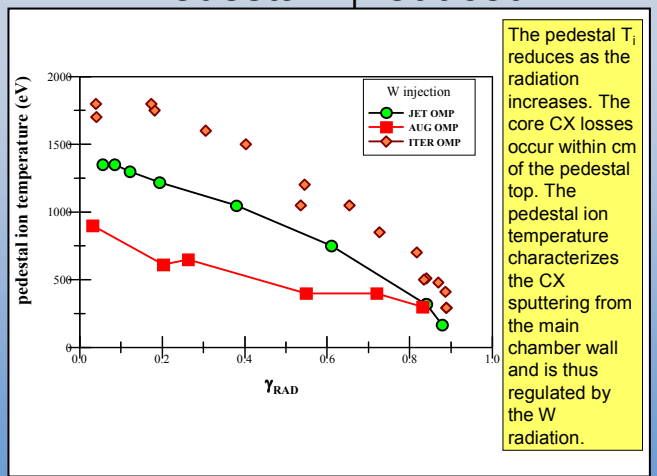
ITER (not shown) is above the peak of the W radiation cooling curve so most cooling occurs in the pedestal region.

Separatrix power reduced



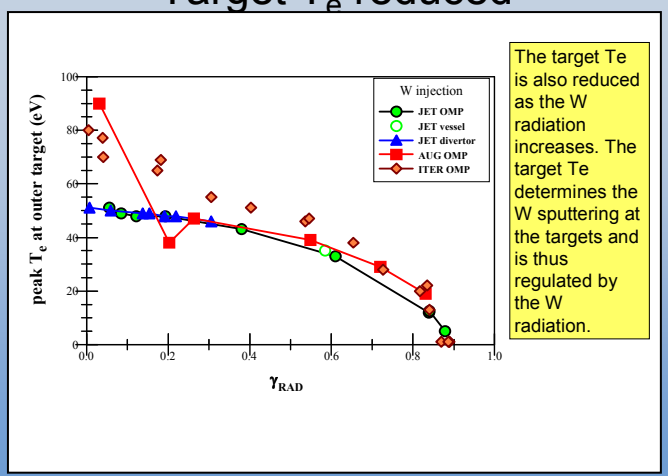
The prime effect of the W radiation is to reduce the power flowing through the separatrix and eventually reducing the power through the separatrix to below the LH threshhold. The fraction radiated at the LH transition was 0.4 to 0.7 for the 3 machines

Pedestal T_i reduced



The pedestal T_i reduces as the radiation increases. The core CX losses occur within cm of the pedestal top. The pedestal ion temperature characterizes the CX sputtering from the main chamber wall and is thus regulated by the W radiation.

Target T_e reduced



The target Te is also reduced as the W radiation increases. The target Te determines the W sputtering at the targets and is thus regulated by the W radiation.

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