Abstract for 13th INTERNATIONAL STELLARATOR WORKSHOP

Density limit studies with a divertor in the W7-AS Stellarator.

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Impurity transport and density limit studies at W7-AS [1,2] in a plasma with 0.5 MW NBI heating without divertor showed that the radiation collapse in discharges of pulse length 2 s at central densities above $1x10^{20}$ m^{-3} could be understood in terms of a peaked impurity density profile. Such impurity density profiles result from a low diffusion coefficient and an inward drift term for the impurity transport coefficients.

In a divertor plasma similar phenomena have been observed in 1 MW NBI plasmas with a maximum density such that a peaked radiation profile steadily increases until a radiation collapse occurs. For discharges less than this maximum density the radiated power remains lower than the deposited power. In contrast, for 2 MW NBI discharges there exists a density threshold above which the plasma detachs. A plasma radiating up to 80% of the deposited energy can be maintained for up to 0.5 s. The radiation power profiles in this case are broad up to the minor radius of the plasma. Further raising the density can provoke a radiation collapse. Below the density threshold for detachment the radiated power profiles are hollow.

Preliminary investigations suggest that impurity transport again plays an important role in understanding these observations. In the 1 MW NBI discharges the impurity particle confinement time is 200-400 ms and increases with density. This was also found in earlier plasmas without a divertor. In the 2 MW NBI discharges the impurity particle confinement time is 340 ms and decreases with increasing density. The change in density dependence of the impurity particle confinement time and the achievement of steady state radiated power occur then at the higher NBI power.

Radiated power measurements in the divertor chamber with the recently installed bolometer cameras comprising of 44 channels show that at detachment the radiating volume moves away from the divertor plate. In addition the bolometer camera viewing the main chamber shows regions of strongly localised power density of radiation. These regions can also be moved in the vacuum chamber by adding OXB heating.

First attempts to compare the maximum achieved $\bar{n}_e$ with predictions by the scaling law for W7-AS [2] were made. Assuming 0.75 MW of deposited power and a minor radius of 12 cm then the scaling law predicts $\bar{n}_e = 2.7x10^{20}$ m^{-3} in comparison to the $\bar{n}_e = 1.9x10^{20}$ m^{-3} achieved. Further studies will be presented in an attempt to clarify whether this discrepancy is consistent with theoretical considerations that predict a lower value of maximum achievable density on the basis of a less strong scaling with plasma volume [3,4].

[1] R.Burhenn, M.Anton, J.Baldzuhn et al., J. Plasma Fusion Res. SERIES, Vol. 1, 255, 1998

[2] L. Giannone, K. Itoh, and S.I. Itoh, Plasma Physics and Controlled Fusion, **42**, 603, 2000

[3] K.Itoh S.-I. Itoh and L.Giannone,"Modelling of Density Limit Phenomena in Toroidal Helical Plasmas", NIFS-627, Technical Report, 2000

[4] C.D.Beidler, U.Stroth and H.Wobig, "Empirical Scaling Laws and Extrapolation to Helias Reactors", IPP 2/338}, Technical Report, 1998

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