

# High density and high performance operation with pellet injection in W7-X

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In this contribution we present details of recent W7-X pellet injection experiments and discuss properties of the achieved plasmas. Hydrogen pellet injections allowed to raise the electron density above  $1.2 \cdot 10^{20} \text{ m}^{-3}$  and to establish: (i) operation above the cut-off for the X2 polarization of the 140 GHz electron cyclotron resonance heating (ECRH); (ii) stable divertor heat flux detachment; (iii) plasmas with the diamagnetic energy above 1 MJ. In the latter case, a series of pellets raised the electron density to almost  $10^{20} \text{ m}^{-3}$  in a hydrogen discharge heated by X2 ECRH with the total power stepped from 2.7 MW to 5 MW. These electron densities are sufficiently high for electron and ion temperatures to equilibrate and to cause a change in the radial electric field. In the reheat phase after the pellet injection, ion temperatures above 3.5 keV could be reached with the ECRH only and a significant plasma pressure is achieved. The volume averaged  $\langle \beta \rangle$  is about 1%, whereas the peak value  $\beta_0$  is about 3.5%. The diamagnetic energy of about 1.1 MJ corresponds to confinement times above 0.2 s. In the middle of the high energy phase, a sudden crash by about 150 kJ is observed by a number of diagnostics, with an inversion radius present in the ECE and soft X-ray signals. These  $\beta$  values allow for the first time the analysis of the MHD stability and the validation of the Shafranov shift optimization. High central  $\beta$  values are also required for the improved confinement of fast ions.

A further improvement of the plasma performance can be achieved by a further increase of the electron density, which requires ECRH heating in the O2 polarization, as the electron densities are already close to the X2 cut-off. To use the full available ECRH power of 7 MW in the O2 polarization a scenario with a switch of the polarization during the discharge has to be implemented. Such a scenario was successfully tested with initially helium target plasma, because of an easier density control. The hydrogen pellet injection was used to raise the density above the X2 cut-off and to maintain it at this high level for more than half a second. In the second half of the campaign such a scenario will be attempted for hydrogen target plasmas.

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