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Confinement in Wendelstein 7-X Limiter Plasmas

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Wendelstein 7-X (W7-X) is built to assess the concept of optimized stellarators at reactor-relevant values of both collisionality and the plasma beta.

In its first operation phase (started in the end of 2015 for 10 weeks of plasma experiments), the device is equipped with five uncooled, inboard carbon limiters. This phase of the project is dedicated to integrated operation, commissioning and tests of components, diagnostics and device control performed under plasma conditions. In addition a physics program has been conducted as far as the machine conditions allowed.

The experimental program started with the optimization of the ECH induced plasma break-down. Sequences of ECH pulses have been performed for wall conditioning as well as helium glow discharge conditioning (in periods without magnetic field). The device is operated with helium and hydrogen gas puffs but yet without feedback density control. Pulses are limited by technical margins and machine capabilities. For example the discharge length is restricted by the maximum allowed energy for a single discharge which has been set to 4 MJ per pulse to avoid uncontrolled overheating of unprotected in-vessel components.

At the time this abstract is being prepared, stationary discharges over 6s have been achieved, however, due to the decribed energy limit with reduced heating power. High performance discharges with 4 MW heating power and an overall duration of around a second reach stationary electron temperature profiles with about 8 keV in the core surrounded by steep temperature gradients at around half minor radius. The density ramped up in successive gas pulses reaches ˜2.5 1019 m-3; beyond that the discharges degrade and are terminated by radiation. The central ion temperature increases continuously unto the discharge end due to the increasing electron ion coupling and reached up to 2 keV in the best cases.

The paper gives an overview of the energy and particle confinement in the first phase of W7-X in line with findings on transport.

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