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# Plasma dynamics and transport studies in Wendelstein 7-X

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A primary goal of Wendelstein 7-X (W7-X) operation is to demonstrate stationary, long pulse discharges at fusion-relevant plasma densities and temperatures. Studies on the behavior and the control of impurity ions originating from plasma-wall-interaction with the divertor and other plasma facing components is a crucial issue potentially leading to a thermal collapse and dilution of the fuel. W7-X had been equipped with a bolometer diagnostic, the VUV/EUV survey spectrometer system HEXOS, a soft X-ray camera array and a pulse height analysis system as well as two imaging Johann X-ray spectrometers. To distinguish between diffusive and convective impurity transport, a laser blow-off system as transient impurity source was installed at W7-X. In order to characterize the transport properties, the experimental results are compared to the transport code STRAHL. Since W7-X is optimized with respect to neoclassical transport, it is expected that turbulence transport plays a significant role in the regulation of radial particle and heat transport in the core and edge plasma. Fully-nonlinear gyrokinetic simulations in the three-dimensional W7-X magnetic field geometry indicate that turbulence is dominated by ion temperature gradient driven modes with an amplitude pattern which forms relatively narrow poloidal stripes on the W7-X flux surface. Key diagnostics are a phase-contrast imaging diagnostic (PCI) measuring core plasma density fluctuations, radial and poloidal correlation ECE systems for the diagnostics of electron temperature fluctuations, and a set of correlation and Doppler reflectometry systems, which provide edge poloidal flows and density fluctuations. The experimental program has focused on the comparison to gyrokinetic GENE simulations. Closely related to the plasma profiles is the question of the stability of the plasma state. In magnetic configurations with co-ECCD (i.e., the bootstrap current and the driven current are co-aligned), sudden drops in core temperature (measured by the ECE diagnostic), diamagnetic energy, Mirnov diagnostic and X-ray cameras have been observed. The ECCD-induced crashes repeat on a time scale of several ms to seconds, depending on the amplitude of the driven current. Combined data analysis supported by modeling activity has been started to improve the understanding of the mechanism(s) behind these events.

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