

The effects of magnetic topology on the SOL island structure and turbulence transport in the first divertor plasma operation of W7-X

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Wendelstein 7-X (W7-X) was operated successfully with the first divertor plasma in the operation phase 1.2a (OP1.2a). A new combined probe head, which consists of Langmuir probe pins, Mach probe, ion sensitive probe (ISP), differential coil and a tri-axial pick-up coil, is able to measure the edge plasma profiles (T_e, n_e, ϕ_f, M), magnetic field, poloidal and radial turbulence structures. The plasma parameters in three magnetic configurations (KJM, EJM, FTM) are measured by the new combined probe head, which are in good agreement with the island structure calculated by field line tracer. In configuration of EJM, the floating potential has a negative value around the radial region from 6.065 m to 6.071 m, where the island center is located at $R = 6.068$ m and $R_{LCFS} = 6.035$ m along the path of probe. Within this region, the electron pressure reveals a platform, the parallel Mach number exhibits a symmetric profile, and the radial particle flux driven by turbulence reduces to a relatively low level. However, outside this region the particle flux is extremely high on both sides. The high particle flux is dominated by the broadband turbulence between 80 to 120 kHz, while the inner radial region with low particle flux is driven by the turbulence below 25 kHz. It should be noticed that the high turbulent particle flux is located in the region with large gradient of electron density, indicating that the transport could be driven by the instability caused by density gradient. Additionally, a large positive floating potential is observed in all the three configurations, which has strong dependence on line integrated density. The mechanism of this positive floating potential has been studied with a simple model, suggesting a large gradient of parallel electron density between upstream and divertor region. In this work, the turbulence modes and their propagations are compared for these three magnetic configurations.

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