Stable Completely Detached Plasma Operation in the First Island Divertor Experimental Campaign of Wendelstein 7-X

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A central aim of the superconducting stellarator Wendelstein 7-X (W7-X) is to demonstrate the suitability of the island divertor concept to meet the requirements of power and particle exhaust during continuous operation. Without boronisation, stable completely detached plasma operation (peak heat loads reduced by factors of 10 to 15) was successfully demonstrated with 3 MW ECRH heating power at line integrated densities of 3 10^{19}m^{-2} for 3s, and little loss in diamagnetic energy (<10%). Low sub-divertor neutral particle pressures (~5 10^{-5} mbar) would have been sufficient, had the cryo-pumps been available, to pump all fuelled particles. However, high oxygen concentrations resulted in high Z_{eff} values of 3.5-4 in stable discharges. Boronisation and the related oxygen gettering, in combination with a reduced carbon content, higher reliable heating power and O2-mode ECRH produced stable detached plasmas at densities of 1.1 10^{20} m^{-2} for up to 28 s with 5.5 MW ECRH and constant Z_{eff} of ~1.5. Sub-divertor neutral pressures of up to 8 10^{-4} mbar allowed efficient particle exhaust and will improve during the next campaign when the cryo-pumps will be available. First indications of increased divertor recycling conditions were observed and are expected to increase with the availability of higher reliable heating power in the next campaign (up to ~8 MW). The status of the detailed understanding of the detachment physics with and without boronisation, partly supported by first EMC3/EIRENE simulations, will be presented.