Wendelstein 7-AS results relevant for Wendelstein-7X

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During his operational phase, on the partially optimized low-shear stellarator W7-AS, important findings were obtained relevant for the successor device W7-X. Central issues of W7-X physics are (1) MHD equilibria and MHD stability, (2) fast-particle confinement, (3) drift optimization and neoclassical transport barriers, (4) turbulence and anomalous transport, (5) island divertor operation, (6) advanced operational scenarios. With regard to these points, W7-AS already gave a flavour of the favourable features of the "fully" optimized stellarator W7-X. In particular, no beta-limit was observed on W7-AS up to volume-averaged $\langle\beta\rangle \leq 3.4\%$, limited by the available neutral beam heating power $P_{NBI} \leq 4$MW only. Three-dimensional code calculations suggest a stabilizing effect of the pressure-induced deepening of the magnetic well along with increasing magnetic shear. Fast-particle confinement in W7-AS is relatively poor, but the benchmarking between experimental findings and code calculations strengthen the confidence in W7-X drift optimization. Internal transport barriers have been shown to be triggered by neoclassical electric fields, rather than turbulent transport effects. However, turbulence is likely to be the most important transport effect in the drift-optimized W7-X. The first island divertor was very successfully operated in W7-AS. Partial detachment happens without entering a high-recycling regime, owing to the long magnetic connection length $L_{||} \sim 100$m, which makes cross-field transport and particle drifts being the far dominant effects. The new island divertor improved the impurity transport behaviour sigificantly, and above a certain density threshold, a new advanced operational regime could be established, the high-density high-confinement (HDH) mode. The HDH is characterized by quiescent high-density ($\langle n\rangle \leq 4 \cdot 10^{20} m^{-3}$) discharges with flat density profiles, good energy confinement, much reduced impurity confinement time and edge-localized radiation. It is not yet clear, if the HDH mode can be established as well in W7-X, where the central temperatures are one order of magnitude higher. The paper concludes with an outlook on future W7-X operational scenarios.