Wendelstein 7-X magnetic configuration properties with as-built coil geometries

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Wendelstein 7-X (W7-X) is a modular advanced stellarator, which successfully went into operation in December 2015 at the Max-Planck-Institut für Plasmaphysik in Greifswald, Germany. The term modular stellarator refers to a generalized stellarator configuration with nested magnetic surfaces created by a system of toroidally discrete coils, providing both toroidal and poloidal field components. The as-designed coil shapes were modeled based on the optimized equilibrium properties. This optimization included the high quality of vacuum magnetic surfaces, good finite beta equilibrium and MHD-stability properties as well as a substantial reduction of the neoclassical transport and bootstrap current. The mission of the W7-X project is to demonstrate the reactor potential of the optimized stellarator line.

The W7-X modular coil system, consisting of 70 superconducting coils, can realize a large variety of stellarator configurations, with a set of islands at the edge of the plasma forming a magnetic divertor. Coil filament geometries are the basic input for the analysis of the magnetic field. The as-built coil shapes and positions can considerably deviate from their as-designed values due to manufacturing and assembly tolerances as well as due to the deformations under the mechanical and electromagnetic loads. The evaluation process of the filament deviations included measurements of the winding pack geometry during the coil fabrication process, the tracking of coil positions during main assembly steps as well as finite element calculations to predict different kinds of coil deformations. This presentation discusses the influence of the evaluated as-built coil geometry on W7-X magnetic configuration properties, in particular, on the mirror term in different magnetic configurations.

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