Alignment of the first two magnet system modules of Wendelstein 7-X

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The stellarator fusion experiment Wendelstein 7-X (W7-X) is presently under construction at the Max-Planck-Institut für Plasmaphysik in Greifswald (Germany). With placing the first and second module on the machine base a new assembly phase started, the transition from preassembly to final assembly. W7-X consists of 5 nearly identical modules. At the beginning of final assembly the main components of each module are the magnet system, the outer vessel and the vacuum vessel. The installation of ports and plasma facing components is following immediately after the modules are placed on the machine base.

At the end of preassembly a final geometry check of the coil positions of a completely assembled module takes place. This paper presents a comparison of the actual and nominal position of the coils of the first modules. Based on these data, the resulting magnetic field and its perturbations are calculated. In an additional calculation process new optimized co-ordinates for the final module adjustment are determined. Shift and rotation parameters for the first module are presented.

The positioning of modules ($m \approx 135$ t, $V \approx 5$ x 5 x 7 m³) on the machine base is a key process during W7-X assembly. The alignment takes place in the torus hall co-ordinate system. The paper describes the internal accuracy of the hall reference point net of ≈ 0.1 mm. For module alignment a final deviation of $r \leq 1.5$ mm for each reference point of the magnet system is required. To meet this value in a limited period of 2 days, a well prepared and tested alignment procedure is necessary. We present this alignment procedure and discuss especially the line of sight condition during the alignment and the calculation of virtual point co-ordinates used to determine the directions and displacements at setting elements. Due to these calculations of the displacements the number of iterations to achieve the final module position can be kept low. Tests and experience of the first module alignment show that no more than 2 to 4 iterations are necessary to reach the final position.

The deviations of the aligned modules from there nominal position are presented and it is demonstrated that the required alignment accuracy of $r \leq 1.5$ mm can be achieved.