Analysis of Wendelstein 7-X divertor load symmetrization

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The achievement of long pulses in the first divertor campaign (OP1.2a) on Wendelstein 7-X (W7-X) required the development of trim coil scenarios which ensured heat load symmetry among the ten divertor modules. Application of magnetic fields from these five copper coils located outside the cryostat, allowed actuation of the $n = 1$ components of the error fields. A series of compass scans were performed where the amplitude of the applied $n = 1$ field and phase (relative to the device) were varied [1]. The corresponding change in divertor heat loads were measured using thermocouples located in the carbon divertor tiles and through a set of infrared camera measurements. These scans were used to develop a map of the divertor asymmetry allowing prediction of trim coil currents which best symmetrize the divertor heat loads. This method was employed to characterize the correcting field for many of the magnetic configurations produced by the superconducting coil set. Correction was found to require around 10% the rated trim coil capacity, confirming previous limiter results that error fields were small [2, 3, 4, 5]. Comparison with flux surface measurements suggests that error fields comprise the majority of the symmetry breaking phenomena. From this we infer that the divertor structures themselves are well aligned and that any misalignment is small and easily correctible by application of trim coil currents. Assessments of the ten in-vessel control coils capability to correct both $n = 1$ and $n = 2$ fields are presented.

References

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