BOLTED COIL SUPPORT AT THE W7-X MODULE INTERFACE

A. Dudek[1], A. Benndorf[1], V. Bykov[1], P. v. Eeten[1], J. Fellinger[1], D. Hathiramani[1], D. Kuse[1], F. Meisel[1], S. Padelt[2], D. Pilopp[1], F. Schauer[1], L. Sonnerup[1]

[1]*Max-Planck-Institut für Plasmaphysik, EURATOM Association, Teilinstitut Greifswald, Wendelsteinstraße 1, D-17491 Greifswald, Germany*
[2] *Fa. Padelt 3D- Systeme GmbH, D-15344 Strausberg*

Corresponding author: Andrzej.Dudek@ipp.mpg.de

The connection between two modules of the W7-X magnet system includes two bolted joints called "Lateral Support Elements D06" (LSE D06). The LSE D06 connect the neighbouring non-planar coils type 5 (NPC5) at the top and the bottom of the module interface. Due to individual positioning and alignment of the magnet system modules and the tolerance chains it is expected that each of these connections require individual adaptations to fit at these interfaces. The design challenge is to satisfy simultaneously the requirements to minimise coil deflections, transmit significant forces and moments, comply with the heavily restricted installation space, limit possible coil deformations during assembly, be adaptable within a wide range to the as-built interfaces and be mountable with reasonable effort.
After numerous iterations the LSE D06 design finally consists of an individually manufactured steel monoblock bridge which is bolted by super bolts onto coil blocks. The latter have been welded onto the NPC5 coils before.
The design allows the accommodation of expected misalignments of the modules up to ±23 mm and ±1º, measured at the coil block positions. It is capable to cope with forces up to 1.3 MN and moments up to 0.2 MN·m between the modules. The loads are transmitted by a combination of form lock provided by tapered coil block shoulders, and by friction between the bridge and coil block bottom surfaces. In order to ensure a sufficient friction factor >0.5, a special foil with protruding hard particles [1] is inserted between the bridge and bottom coil block surfaces. Smooth insertion of the tightly fitting monoblock is ensured by strict manufacturing tolerances and by a low friction coating on the tapered sides.
Nonlinear finite element (FE) analyses based on elastic-plastic material models show that local plastification and even slippage in spite of the high friction are unavoidable but stay within an acceptable level. In parallel, machining and assembly tests were carried out with the goal to check and simplify the design further, and to develop the manufacturing strategy. Separate test series have also been performed to investigate and qualify the friction-enhancing foil [1].
The paper gives an overview of the functional requirements, design evolution, FE analysis, tests, the proposed machining technology, and the assembly strategy for these critical connections.

[1] M. Schülke et al., Friction increase by micro-formlock for W7-X structure connections, this conference