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Monitoring, Modeling, and Protecting Against Insulation Failures in the NSTX-U TF Outer Legs

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The purpose of the effort described here is to model, and monitor the insulation shear bonds between the 3 conductors of the TF outer legs. Mechanical failure of the insulation could be a precursor to an electrical failure that could damage the more difficult to repair TF inner leg central column. The shear stress in these bonded layers is proportional to the TF outer-leg out-of-plane (OOP) bending.

Bending of the outer leg due to out-of-plane loads and is supported partly by shear in the bond between the three conductors that are bonded together to form the outer leg. Bending stress in the outer conductors will provide an indication of the integrity of the shear bond. If the three conductors act together, as a beam , the metal bending stress in the outer conductors is as analyzed in the global qualification calculations. If the bond fails, then the bending stress will increase. This can cause a failure due to fretting motion in the insulation or overstress in the copper conductors, or failures in the water cooling tubes.

As a part of the orderly planned increase in operational parameters to .8 T (as of Feb 2016 it was at .61T), . Ten new FISO gauges were purchased and installed in March 2016. They yielded useful data prior to the forced shut-down due to the failure of PF1aUpper. The analytic process used to split out the thermal, in-plane and out-of-plane bending strains is described and compared with measured results. Measured results provide reasonable benchmarks for the analysis. Ultimately, the main purpose of the instrumentation is to compare coil to coil behavior, to watch for consistency. If a coil starts to deviate from the others we can inspect for possible de-bonding between the three conductors that make up the outer leg. To properly monitor the full TF system, more channels are needed than the FISO system can provide. The planned Fiber-Bragg Grating (FBG) system is introduced in the paper.

Monitoring and evaluation of the TF outer leg strains also is related to computed quantities monitored and protected by the Digital Coil Protection System. Currently the bending strain is expected to be adequately represented by upper-outer leg global moment sums. This relationship will be discussed in the paper.

Eligible for student paper award?

No

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