Contribution ID: **83** Type: **Contributed Oral**

Prediction and validation of disruption-induced eddy currents and forces within engineering design cycles using ThinCurr and TokaMaker

Friday 6 September 2024 10:05 (25 minutes)

In tokamaks, eddy currents and associated forces, driven by rapid current quenches during disruptions are important drivers for structural engineering requirements. Additionally, recent interest in disruption-driven 3D currents, such as the Runaway Electron Mitigation Coil (REMC) concept, further motivates the need to capture currents in passive conducting structures early in and throughout the design process. To support this the ThinCurr [1] and TokaMaker [2] tools, part of the broader open source Open FUSION Toolkit [3], are being developed, validated, and applied to provide analysis of such currents and their effects as part of the engineering design cycle for future devices (eg. SPARC, ARC, NT, etc.). TokaMaker is a time-dependent Grad-Shafranov tool that can be used to model current quenches, Vertical Displacement Events (VDE) and other relevant events with accurate (2D) vessel geometry, including thick-wall effects, and the effect of control systems, realistic power supplies, and other relevant features. Currents, forces and other impacts can be directly evaluated in TokaMaker or used as input to ThinCurr, a fully 3D thin-wall electromagnetic modeling code, for more accurate simulations and assessment of 3D effects from asymmetries in the vessel and plasma. The use of Hierarchical Off-Diagonal Low-Rank (HODLR) approximation within ThinCurr enables scalability to large models that can capture complete devices, including both large (eg. VV) and small (eg. first wall tiles) features in a single model. Both tools utilize unstructured mesh approaches, common in commercial analysis software, that enable tight coupling to design and engineering workflows (eg. directly from CAD). This talk will present application of ThinCurr and TokaMaker to the prediction of eddy currents and forces in present and future devices as well as plans for, and results from, validation using a newly-installed REMC coil on the HBT-EP tokamak [4] at Columbia University.

[1] A. Battey et al., Nucl. Fusion 64 016010 (2024)
[2] C. Hansen et al., Comput. Phys. Commun. 298 109111 (2017)
[3] https://github.com/hansec/OpenFUSIONToolkit
[4] D. Maurer et al., Plasma Phys. Control. Fusion 53 074016 (2011)

Work supported by US DOE awards DE-SC0019239, DE-SC0021325, DE-FG02-86ER53222, and DE-SC0022270, Commonwealth Fusion Systems, and Next Step Fusion

Speaker's title

Mr

Speaker's email address

cjh2199@columbia.edu

Speaker's Affiliation

Columbia University, New York, NY

Member State or IGO

United States of America

Primary author: HANSEN, Chris (Columbia University)

Co-authors: BATTEY, Alexander (Columbia University); Mr BRAUN, Anson (Columbia University); Ms GUIZZO, Sophia (Columbia University); LEVESQUE, Jeffrey (Columbia University); Mr MILLER, Sander (Columbia

University); Prof. PAZ-SOLDAN, Carlos (Columbia University); SWEENEY, Ryan (Commonwealth Fusion Systems, Devens, MA, USA); LAGIESKI, Michael (Commonwealth Fusion Systems); SUBBOTIN, Georgy (Next Step Fusion); NURGALIEV, Maxim (Next Step Fusion)

Presenter: HANSEN, Chris (Columbia University)

Session Classification: Consequences

Track Classification: Consequences