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Overview of the NSTX-U Recovery Project Physics and Engineering Design

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The NSTX-U device began operation in 2016, producing 10 weeks of commissioning and scientific operations. However, a number of technical issues, including the failure of a key diverter coil, resulted in the suspension of operations. A comprehensive extent of condition review was initiated at the request of the Department of Energy; this paper will summarize the result of that process, focusing on the design and implementation improvements that are in progress in order to resume operation and increase reliability. Many elements of the physics design have been revisited as part of the Recovery, although most key NSTX-U mission goals remain. New requirements for the divetor heat fluxes have been defined, based on recent SOL heat flux width models. New halo currents loads have been determined based on combining data from NSTX, NSTX-U, MAST, and conventional aspect ratio devices. New error field analysis has been conducted, with the goal of optimizing both the global MHD stability and minimizing PFC heat flux asymmetries for scenarios with large poloidal flux expansion. New divertor coil current requirements have been defined, based on the tolerable heat fluxes and current drive for the various potential equilibria. Numerous design improvements are being included as part of the Recovery effort, with a primary goal of supporting flexible operations at BT=1 T, IP=2 MA, Pinj=10 MW, and tpulse=5 seconds. New designs of graphite plasma facing components utilize castellations to reduce the mechanical stresses, allowing tiles to reach surface temperature limits, ~1600 degC, driven by sublimation. Improved divertor coil designs simplify fabrication and facilitate turn-to-turn testing. Modifications to the NSTX-U vacuum chamber will eliminate one the ceramic insulators necessary for coaxial helicity injection (CHI), increasing system reliability at the expense of the CHI research capability. The physics and engineering R&D activities that support Recovery will be summarized, along with highlights of the new design. This work was supported by U.S. DOE Contract D-AC02-09CH11466 and DE-AC05-00OR22725

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Author: Dr GERHARDT, Stefan (Princeton Plasma Physics Laboratory)

Co-authors: Mr BASILE, Alan (Princeton Plasma Physics Laboratory); Mr KHODAK, Andrei (Princeton Plasma Physics Laboratory); Mr GAO, Andy (Princeton Plasma Physics Laboratory); Mrs JARIWALA, Ankita (Princeton Plasma Physics Laboratory); Mr BROOKS, Arthur (Princeton Plasma Physics Laboratory); Mr BRERETON, Atiba (Princeton Plasma Physics Laboratory); Dr STRATTON, Brent (Princeton Plasma Physics Laboratory); Mr LINN, Brian (Princeton Plasma Physics Laboratory); Mrs CIUMMO, Carmella (Princeton Plasma Physics Laboratory); Mr NEUMEYER, Charles (Princeton Plasma Physics Laboratory); Mr FREEMAN, Christopher (Princeton Plasma Physics Laboratory); Mr CAI, Dang (Princeton Plasma Physics Laboratory); Mr DOWNING, Doug (Princeton Plasma Physics Laboratory); Mr LOESSER, Doug (Princeton Plasma Physics Laboratory); Dr CAI, Feng (Princeton Plasma Physics Laboratory); Dr HOFFMANN, Frank (Princeton Plasma Physics Laboratory); Mr JONES, Frank (Princeton Plasma Physics Laboratory); Mr TCHILINGUIRIAN, Gregory (Princeton Plasma Physics Laboratory); Mrs ZIMMER, Gretchen (Princeton Plasma Physics Laboratory); Mrs ZHANG, Han (Princeton Plasma Physics Laboratory); Mr SCHNEIDER, Hans (Princeton Plasma Physics Laboratory); Mr ZATZ, Irving (Princeton Plasma Physics Laboratory); Mrs GUTTENFELDER, Jessica (Princeton Plasma Physics Laboratory); Mr DELLAS, John (Princeton Plasma Physics Laboratory); Mr KLABACHA, Jonathan (Princeton Plasma Physics Laboratory); Dr MENARD, Jonathan (Princeton Plasma Physics Laboratory); Dr PARK, Jong-Kyu (Princeton Plasma Physics Laboratory); Mr PETRELLA, Joseph (Princeton Plasma Physics Laboratory); Mr ERICKSON, Keith (Princeton Plasma

Physics Laboratory); Mr DUDEK, Lawrence (Princeton Plasma Physics Laboratory); Mr KUMAR, Manish (Princeton Plasma Physics Laboratory); Mr CROPPER, Mark (Princeton Plasma Physics Laboratory); Mr SIBILIA, Mark (Princeton Plasma Physics Laboratory); Mr SMITH, Mark (Princeton Plasma Physics Laboratory); Dr REINKE, Matthew (ORNL); Mr D'AGOSTINO, Michael (Princeton Plasma Physics Laboratory); Dr JAWORSKI, Michael (Princeton Plasma Physics Laboratory); Mr KALISH, Michael (Princeton Plasma Physics Laboratory); Mr MARDENFELD, Michael (Princeton Plasma Physics Laboratory); Mr VIOLA, Michael (Princeton Plasma Physics Laboratory); Mr AWAD, Mounir (Princeton Plasma Physics Laboratory); Mr DEAN, Nathanial (Princeton Plasma Physics Laboratory); FERRARO, Nathaniel (Princeton Plasma Physics Laboratory); Mr GREENOUGH, Nevell (Princeton Plasma Physics Laboratory); Mr ATNAFU, Neway (Princeton Plasma Physics Laboratory); Mrs ALLEN, Nicole (Princeton Plasma Physics Laboratory); Mr TITUS, Peter (Princeton Plasma Physics Laboratory); Mr BURKE, Richard (Princeton Plasma Physics Laboratory); Mr ELLIS, Robert (Princeton Plasma Physics Laboratory); Mr FEDER, Russell (Princeton Plasma Physics Laboratory); Mr RAFTOPOULOS, Steven (Princeton Plasma Physics Laboratory); Mr STEVENSON, Tim (Princeton Plasma Physics Laboratory); Dr GRAY, Travis (Oak Ridge National Laboratory); Dr QUE, Weiguo (Princeton Plasma Physics Laboratory); Mrs WANG, Wenping (Princeton Plasma Physics Laboratory); Mr BLANCHARD, William (Princeton Plasma Physics Laboratory); Mr ZHAI, Yuhu (Princeton Plasma Physics Laboratory)

Presenter: Dr GERHARDT, Stefan (Princeton Plasma Physics Laboratory)

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