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Application of Finite Element Techniques in Simulation of Mechanical Design and Performance Assessment of Different Components of a Neutral Beam Systems

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Accelerators, Ion dumps and beam transport system for Neutral Beam application are designed to manage high heat loads in the range of 2-10MW/m2. The performance of these components under various damage criteria are assessed for their thermo-mechanical stability under various operating and faulty conditions. Due to the pulse nature (3s ON/ 20s OFF with 5 Hz modulation) of beam operation, components often exposed to cyclic thermal loads. Further, the above system is incorporated with large number of flexible elements (e.g. bellows, etc.) to absorb the thermal movements. For systems like accelerator and electrostatic residual ion dumps, there is an additional need of non-metallic components, like ceramics, which functions as electrical isolation as well act as structural elements. To assess diverse nature of such systems with complex loading requirements, Finite Element Analysis tools (e.g. ANSYS, CFX, SYSWELD, etc.) have been employed as part of design evolution and results are verified according to codes and standards (ASME / RCC-MR / EJMA). The experimental validation of effectiveness of these assessment have been also performed by prototype testing and performing the tests on the real manufactured products. It is also important to note that, the tools are also useful to address the in-process manufacturing modification those may arise due to feasibility constraints.
The paper shall present some of the important simulations results on 10MW/m2 capability of Heat Transfer elements, functional tests on 100 kV post insulators, bellows assessment in water lines, CFD simulations for beam source components, etc.

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Author: Mr MUVVALA, VENKATA NAGARAJU (ITER-India, Institute for Plasma Research)

Co-authors: CHAKRABORTY, Arun Kumar (ITER-India, Institute for Plasma Research); Mr YADAV, Ashish (ITER-India, Institute for Plasma Research); Mr SINGH, Dhananjay (ITER-India, Institute for Plasma Research); Mr SHARMA, Dheeraj (Institute for Plasma Research); Mr PATEL, Hitesh (ITER-India, Institute for Plasma Research); Mr JOSHI, Jaydeepkumar (ITER-India, Institute for Plasma Research); Dr MAINAK BANDYOPADHYAY, MAINAK (ITER-INDIA, INSTITUTE FOR PLASMA RESEARCH); Dr SINGH, Mahendrajit (ITER-India, Institute for Plasma Research); Dr SHAH, Sejal (ITER-India, Institute for Plasma Research); Mr PILLAI, Suraj (ITER-India, Institute for Plasma Research)

Presenter: Mr MUVVALA, VENKATA NAGARAJU (ITER-India, Institute for Plasma Research)

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