

# Operation and Remote Collaboration Tools in view of the ITER Neutral Beam Test Facility Experimental Campaigns

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The ITER Neutral Beam Test Facility (NBTF) serves as a crucial testing ground for the development and validation of neutral beam injection systems essential for ITER's fusion power plant. Two experimental campaigns, SPIDER and MITICA, are conducted within the NBTF. SPIDER (Source for Production of Ion of Deuterium Extracted from Rf Plasma) focuses on the development and optimization of the ion source, which is responsible for producing and accelerating the deuterium ions. It serves as a prototype for the ion source planned for use in ITER. MITICA (Megavolt ITER Injector and Concept Advancement) adds to the ion source technology by integrating high-energy beam acceleration. MITICA aims to demonstrate the full-scale neutral beam injection system that will be utilized in ITER for plasma heating, diagnostic and control. The SPIDER experimental campaign starting in April 2024 is a relevant step towards ensuring the successful operation of neutral beam injection systems in the future ITER fusion reactor, contributing to the advancement of fusion energy research.

Operation tools based on EPICS (Experimental Physics and Industrial Control System) and MDSplus play a crucial role in facilitating the operation and management of complex scientific facilities, particularly in fusion energy research. EPICS provides a robust framework for real-time monitoring and control of experimental parameters, ensuring precise and reliable operation of experimental devices. MDSplus, on the other hand, offers a comprehensive data management system, enabling efficient storage, retrieval, and analysis of experimental data.

Collaborative efforts at the NBTF, involving scientists from different institutions across Europe, India and Japan, emphasize the importance of data sharing and advanced computing infrastructures. Common computing platforms facilitate analysis of big datasets, aiding informed decision-making. Remote collaboration tools play a crucial role in fostering communication among global experts. With involvement from EUROfusion and ITER experts, strict collaboration accelerates ITER's neutral beam heating and diagnostic systems development. Moreover, remote participation, data visualization, and efficient operation tools are essential for enhancing accessibility and collaboration in scientific research. These tools enable researchers to remotely access and control experimental facilities, visualize data in real-time, and collaborate with colleagues worldwide, fostering interdisciplinary collaboration and accelerating the necessary scientific developments.

In this contribution we will present the architecture design and implementation of the operation tools based on EPICS and MDSplus, developed using Grafana, Python and nodeJS, to accomplish the remote participation, data visualization, efficient operation and collaboration tools, which are indispensable components of modern scientific research infrastructure, empowering scientists to conduct advanced fusion experiments

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