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The ITER Neutral Beam Test Facility: status and perspectives

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Efficient and reliable operation of the Heating Neutral Beam Injectors (HNB) is required to achieve thermonuclear-relevant plasma parameters in ITER, a fundamental step on the path towards unlimited sources of clean fusion energy. ITER will be provided with two HNBs, expandable to three, each one expected to inject into the plasma a beam composed of deuterium atoms accelerated up to 1 MeV energy, delivering a power of up to 16.5 MW for a beam pulse length up to 3600s.

These operating conditions have never been simultaneously reached before, and require the realization of a complex system far beyond the performance and technologies adopted in the existing neutral beam injectors. Many issues need to be addressed, eg production of a high negative ion beam current (40A of D⁻, 46A of H⁻), using a caesiated source and a large number of beamlets (1280); reliable operation of the source, fully immersed in a low-pressure gas; holding of the 1MV voltage in vacuum; reliable operation of the 1MVdc power supply components, etc.

All these aspects led to recognizing that a dedicated Neutral Beam Test Facility (NBTF) is needed to carry out an international R&D programme aimed at constructing, testing and optimizing the full-scale prototype of the HNBs and at assisting ITER during its operation.

A fast track strategic plan was developed which is based on the implementation of two experiments operating simultaneously: MITICA, the full-scale prototype of the ITER HNB injector, and SPIDER, the full-size radio frequency (RF) negative-ion source.

SPIDER aims at testing and fine-tuning the ion source, in terms of ion current density, uniformity, co-extracted electron current and beam stability over time.

MITICA, using the ion source optimised in SPIDER, has the purpose of verifying the full performance of the accelerator and of the beam line components for the production of the focused neutral beam with the same characteristics as the HNB.

The present contribution gives a description of SPIDER, which went into operation in mid-2018. It operated for about 3.5 years and is now in a long shut down phase for the implementation of important changes, identified on the basis of previous experience, necessary to achieve full performance.

MITICA is still under construction and commissioning. During the integrated tests of 1 MV power supplies, issues occurred which resulted in failures and a delay in the overall plan. The problems encountered are now understood and are being addressed.

It will be shown that the experience acquired so far has fully confirmed the soundness of the choice of developing the ITER neutral beam test facility, with both its experiments, so that the HNBs will be realized on the basis of a reliable project, guaranteeing the performances required by the ITER operation.

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