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A substantial step forward in the realization of the ITER HNB system: The ITER NBI Test Facility

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HIGHLIGHTS

- The ITER Neutral Beam Test Facility in Padova, Italy: substantial progress achieved.
- The realization of SPIDER, the ITER full-size negative ion source, is well advanced.
- Integrated tests of Power Supply and preparation of SPIDER operation starting now.
- Big progress on the realization of MITICA full-scale prototype of ITER HNB injector.
- MITICA operation planned to start in 2021, depending on the BS and BLC delivery.

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ABSTRACT

Substantial progresses have been achieved in the realization of the ITER Neutral Beam Test Facility (NBTF) hosted in Padova, Italy; the buildings, completed by the end of 2015, are being progressively filled with new systems and components. The realization of SPIDER, the ITER full-size negative ion source, is well advanced and important progress is also recorded for MITICA, the full-scale prototype of the ITER HNB injector. The paper gives an overview of the achieved results, highlighting the main challenges faced.

1. Introduction

The realization of the ITER Neutral Beam Test Facility (NBTF) and the start of its experimental phase are important tasks of the fusion roadmap, since the target requirements of injecting to the plasma a beam of deuterium atoms with a power up to 16.5 MW, at 1 MeV of energy and with a pulse length up to 3600 s have never been reached together before [1]

The ITER NBTF, called PRIMA (Padova Research on ITER Megavolt Accelerator), is hosted in Padova, Italy. It includes two experiments: MITICA, the full-scale prototype of the ITER HNB injector, reproducing the whole geometry, and SPIDER, the full-size Radio Frequency (RF) negative-ions source [2,3]; the main parameters are summarized in Tables 1 and 2 respectively.

The realization promoted by the ITER organization is carried out with the contribution of the European Union, channeled through the Joint Undertaking for ITER (F4E), of the Consorzio RFX which also hosts the Test Facility, the Japanese and the Indian ITER Domestic Agencies (JADA and INDA) and several European laboratories, such as IPP-Garching, KIT-Karlsruhe, CCFE-Culham, CEA-Cadarache.

The earliest start of SPIDER and MITICA experiments is pursued to maximize the fallout in terms of design optimization of the ITER HNB components and of preparation and then support to the ITER HNB use, planned during the Third Plasma stage, in 2031. SPIDER operation is expected to start in Q1 2018, thus several years of exploitation are planned toward the achievement of the target parameters of the RF ion source and improvements of its reliability and availability. Similar considerations apply also to MITICA, mainly devoted to optimize accelerator and Beam Line Components (BLC), which will enter in operation in 2021. Both experiments should provide key indications before the design of the different components of the ITER HNB is frozen.

Fig. 1 shows a 3D CAD view of the PRIMA facility.

Substantial progress has been achieved along all the work lines of the ITER NBTF realization. The paper highlights the main challenges encountered and gives an overview of the achieved results.

Table 1
SPIDER requirements.

	Unit	H	D
Beam energy	keV	100	100
Max beam source pressure	Pa	0.3	0.3
Max deviation from uniformity	%	±10	±10
Extracted current density	A/m^2	>355	>285
Beam on time	s	3600	3600
Co-extracted electron fraction (e^-/H^-) and (e^-/D^-)		<0.5	<1

Table 2
MITICA requirements.

	Unit	H	D
Beam energy	keV	870	1000
Ion beam current	A	49	40
Max beam source pressure	Pa	0.3	0.3
Beamlet divergence	mrad	≤7	≤7
Beam on time	s	3600	3600
Co-extracted electron fraction (e^-/H^-) and (e^-/D^-)		<0.5	<1

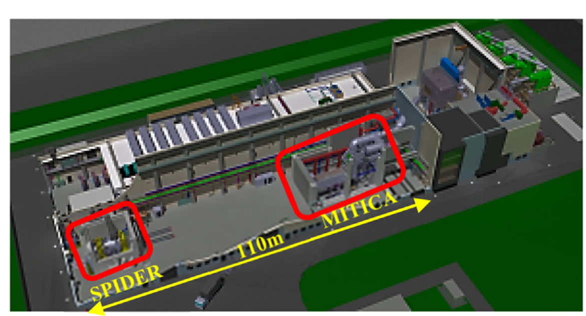

Fig. 1. 3D CAD view of the PRIMA facility.

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