The ITER Neutral Beam Test Facility for the development of the ITER heating neutral beam injector prototype

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An important feature of the ITER project is represented by a mix of heating systems with the aim of supplying ITER with additional power in order to fulfil ITER mission that is the experimental demonstration of the sustainability of the fusion reactions with a Q factor ranging from 5 to 10 in a stationary condition.
One of the heating systems is represented by the injection of neutral beams obtained from accelerated negative ions. Two neutral beam injectors (NBIs) are planned, delivering to ITER a total of 33 MW in a stationary condition up to one hour. Each injector is required to accelerate at 1 MV a deuterium ion current of 40 A at the exit of the last accelerating grid.
These requirements have never been achieved simultaneously and therefore, in order to minimize the risks and the time to provide ITER with reliable NBIs, the experimental demonstration and optimisation of critical components and systems has been strongly endorsed by the ITER Organization and the ITER parties involved in the development of the NBIs, namely EU, Japan and India.
Such a huge effort is carried out in a dedicated test facility being built at Consorzio RFX in the CNR research area of Padua. The facility site and the overall activities on the experimental devices have been assigned the name of PRIMA (Padova Research on ITER Megavolt Accelerator). New buildings will be constructed, covering a surface of 2 hectares, and the existing 400 kV power substation will be adapted. The PRIMA facility will host two experimental test stands.
The first experimental device hosted into the facility is SPIDER (Source for the Production of Ions of Deuterium Extracted from Rf plasma), a full size negative ion source aiming to demonstrate the capability to create and extract a negative ion current up to approximately 50/60 A on a wide surface (more than 1 m^2) with a uniformity within the 10%.
MITICA (Megavolt ITer Injector and Concept Advancement) represents the second test stand, which will be the prototype of the ITER injector and will test all solutions, including the capability of 1 MV voltage holding at low pressure.
The experimental effort is supplemented by numerical simulation activities devoted to the optimisation of the accelerator optics, taking into account various operational scenarios, and to the computation of the particle trajectories, allowing the estimation of heat loads and currents on the various surfaces.
All the experimental plants and components of SPIDER are ready for the procurement phase.
Most of the design for the procurement of the plant and many of the components for MITICA are well developed and close to being ready for starting of procurement. The design of the remaining components and systems will be ready within the next two years.
Other European laboratories are cooperating to the success of this enterprise: CCFE- Culham IPP-Garching, KIT- Karlsruhe, and other European research institutions.
In this contribution the main requirements of the test stands will be discussed as well as the design solutions of the main components and systems will be described. Finally the planning of the overall facility will be presented.
This work was set up in collaboration and financial support of F4E.