Contribution ID: **509** Type: **Oral**

Technologies for realization of Large size RF sources for –ve neutral beam systems for ITER -Challenges, experience and path ahead & Progress in the ITER Neutral Beam Test Facility & Demonstration of 1 MV vacuum insulation for the vacuum insulated beam source in the ITER NB system

Monday, 22 October 2018 17:20 (10 minutes)

A. Technologies for manufacturing of small and medium size Ion source (upto four RF driver) for positive and negative neutral beam systems have been evolved over last many decades and such ion sources are being successfully operated at various experimental facilities across the world. However, as the need arises for the larger size ion sources (eight driver) for ITER diagnostics and heating neutral beam systems, several existing manufacturing technologies and considerations have to upgraded and re-evaluated to qualify them for (1) highest vacuum quality class (2) nuclear environment.
Diagnostic Neutral Beam (DNB) source is the first candidate in a family of such big size ion sources, being manufactured according to the ITER specification with 're-evaluated' manufacturing technologies and it throws light on many unforeseen challenges as manufacturing progresses. The nature of challenges are mainly related to usage of the material with radioprotection requirement (i.e restricted contents of Co wt%0.05, Nb wt %0.01 and Ta wt %0.01), special requirements on weld joint configuration to enable full penetration with 100% volumetric inspectability, dissimilar material welding technologies, machining process development to meet stringent dimensional accuracies (in the range of 10-50 microns) of individual 'angled' grid segment to achieve overall alignment of +/-0.2mm, electro-deposition of copper with thickness>3mm over the angled surfaces with control over distortion, vacuum brazing, restricted usage of Silver for brazing and plating purpose, development of electrical isolators with customized electrostatic shield, threaded connection between metal and alumina load carrying capacity of 10kN with electrical isolation of 140kV in vacuum.
The paper shall present experience gathered in development of above mentioned manufacturing technologies, the methodology adopted for mitigating the practical limitations, prototyping to establish and qualify the manufacturing procedure, evaluating the non-conformities, assessment of deviation proposals, in compliance with ITER specifications. In summary, the experience generated during the manufacturing of DNB Beam source, presented here, is aimed to help in generating the recipe manufacturing and providing the 're-evaluated' technical specifications for upcoming ITER neutral beam sources.

B. The ITER Heating Neutral Beam (HNB) injectors, one of the tools necessary both to achieve burning conditions and to control plasma instabilities, are characterized by such demanding parameters as to require the construction of a test facility dedicated to their development and optimization. This facility, called NBTF, is in an advanced state of realization in Padua (Italy), with the direct contribution of the Italian government, through the Consorzio RFX as the host entity, IO, the in kind contributions of three DA's (F4E, JADA, INDA) and the technical and scientific support of various European laboratories and universities. The NBTF hosts two experiments: SPIDER and MITICA. The former is devoted to the optimization of the HNB and DNB ion sources and to the achievement of the required source performances. It is based on the RF negative Ion Source concept developed at IPP (Garching). MITICA is the full size prototype of the ITER HNB, with an ion source identical to the one used in SPIDER. The construction and installation of SPIDER plant systems was successfully completed with their integration into the facility, followed by integrated commissioning with control (CODAS), protection and safety systems. The mechanical components of the ion source have been installed inside the vessel and connected to the plants. Finally, the integrated commissioning of the whole system ended positively and the first experimental phase began. Also the realization of the MITICA project is well advanced, although the completion of the system and its entry into operation is expected in 2022 due to the long procurement times of the in-vessel mechanical components. In particular, the power supply designed to operate at 1MV are in an advanced phase of realization, all the high voltage components have been installed and the complex insulation test phase has begun in 2018. Furthermore, all the other auxiliary plant systems are being installed and / or undergoing testing. This paper gives an overview of the progress of the NBTF realization with particular emphasis on issues discovered during this phase of activities and to the adopted solutions in order to minimize the impact on the schedule while maintaining the goals of the facilities. Finally, the first results obtained with SPIDER experimentation and with the 1MV insulation tests on the MITICA HV components will be presented.

C. For the ITER neutral beam (NB) system, a measure to achieve the 1 MV vacuum insulation of the beam source have been developed. For this purpose, design basis for 1 MV vacuum insulation has been developed by integrating previous empirical scaling for plane and coaxial electrodes and new scaling for area with locally-concentrated electric field. Consequently, as the measure, the beam source is surrounded by more than three intermediate electrostatic shields instead of single gap to sustain 1 MV. Effectiveness of the shields designed by the design basis was experimentally verified by using a part of the beam source. The voltage holding capability has been significantly improved from 0.7 MV to 1 MV. This result ensures the 1 MV vacuum insulated beam source in the ITER NB system.

Country or International Organization

India

Paper Number

FIP/1-3Ra

Primary author: Mr JOSHI, Jaydeepkumar (ITER-India (Institute for Plasma Research))

Co-authors: CHAKRABORTY, Arun Kumar (ITER-India, Institute for Plasma Research); Mr PATEL, Hitesh (ITER-India, Institute for Plasma Research, Bhat, Gandhinagar-382 428, Gujarat); Dr MAINAK BANDYOPADHYAY, MAINAK (ITER-INDIA, INSTITUTE FOR PLASMA RESEARCH); Dr SINGH, Mahendrajit (ITER-India, Institute for Plasma Research, Bhat, Gandhinagar-382 428, Gujarat)

Presenter: Mr JOSHI, Jaydeepkumar (ITER-India (Institute for Plasma Research))

Session Classification: FIP/1 ITER Technology

Track Classification: FIP - Fusion Engineering, Integration and Power Plant Design