

VACUUM SYSTEM OPTIMIZATION FOR NEGATIVE ION SOURCE

NIO1

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A fundamental component of the ITER Neutral Beam Injectors (NBI) is the plasma radio frequency (RF) driven negative ion source. In the perspective of developing the NBIs for the DEMO (DEMONstration power plant) reactor, it is essential to optimize the efficiency of the negative ion generation in the source, in addition to the extraction and acceleration of the beam. A fundamental aspect is to guarantee the longest possible duration of the beam production, while maintaining acceptable conditions of extracted current density and fraction of co-extracted electrons. In the European research framework EUROfusion for DEMO NBI, Consorzio RFX and INFN-LNL designed, built and have operated a small source called NIO1 (negative ion optimization experiment) capable of continuous plasma generation and beam extraction.

The conditions of extraction of the ion beam strongly depend on the vacuum quality in the source and in the entire vacuum chamber. During the 2020 NIO1 experimental campaign, several issues on the vacuum system and on the cryogenic plant required to completely replace and upgrade the vacuum pumping system. It now includes two Turbomolecular pumps with magnetic bearings and a drag stage to allow better pumping into the source during the experimental process, where the pressure is higher. The primary pump has been replaced with a new generation SCROLL dry pump. The gas inlet system has been implemented with an electro-polished stainless steel line to ensure greater purity of the injected gas, while the safety of the operators is guaranteed by new detectors. A new cryogenic system, consisting of 2 cryo-pumps and a SCROLL dry pump to improve hydrogen pumping, was completed at the end of 2021, ensuring an ultra-high vacuum regime that enhances the control of the plasma in the source and better qualifies the beam performances.