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Development of a utility negative ion test equipment with RF source at ASIPP

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The negative ion source is a key component of the neutral beam injector for the reactor-scale fusion devices, such as ITER, CFETR, and DEMO. Considered the lack of research on the negative ion source for NBI application in China, a utility negative ion test equipment with RF source is being developed at Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP). The original task of the test equipment is to train the design and operation of negative ion source at ASIPP. The further mission is to promote the research and development activities related to RF plasma discharge, magnetic field configuration, Cs dynamics, beam extraction, and beam optics.

The RF-driven negative ion source is being assembled, which is able to extract 120 H⁻ beamlets up to 60 kV for 10 s. The extracted current density is expected to 350A/m² with Cs-seeded. The test equipment has been completed, including the power supply system, the vacuum chamber, and the auxiliary system (e.g., cooling, pumping, gas). An alternative accelerator is also designed, where the electrode grids and insulators are immersed in the vacuum condition. Besides, a new electrical circuit topology is also applied for the alternative accelerator, where the plasma grid is at the ground potential, the last grid and beam dump are at the high potential.

Several diagnostic techniques are equipped to estimate and optimize the performance of negative ion source. In the source, the generation of negative ions is investigated with a set of electrostatic probes for plasma character, with optical emission spectroscopy for Cs and impurity density, and with cavity ring-down spectroscopy for negative ion density. The beam profile uniformity and divergence will be studied with beam emission spectroscopy, graphite tiles calorimeter, and beam dump with thermocouples array.

Eligible for student paper award?

No

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