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The negative beam source with single driver for CRAFT NNBI: design and conditioning results

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The Comprehensive Research Facility for Fusion Technology (CRAFT) is a large scientific device that is preferentially deployed for the construction of major national science and technology infrastructures. A negative beam source based neutral beam injector (NNBI) with beam energy of 200-400 keV, beam power of 2 MW and beam duration of 100 s is one of the device. A giant radio frequency (RF) based negative beam source was designed for the CRAFT NNBI system. In order to understand the physics and pre-study the engineering problems for RF negative beam source, several beam sources with different scale will be design and tested. According to the R&D schedule, a negative beam source with single driver was designed, developed and tested firstly. The single driver beam source is a quarter of the size of full size negative beam source. It contains a RF driver, an expansion chamber and a negative ion accelerator with three electrodes, which is plasma grid (PG), extraction grid (EG) and ground grid (GG). In order to enhance the negative ion production, Cs is injected into the plasma chamber and a magnetic filter field is produced by current flow through the PG to decrease the electron temperature. The negative beam source was tested on the test facility after assemble, including RF plasma generation, negative ion production, extraction and acceleration. The characteristic of plasma discharge, beam extraction and acceleration was studied without and with Cs injection. The long pulse of 105 seconds negative ion beam was achieved successfully. The extracted ion current is 160 A/m² and the ratio of electron and negative ion is around 0.8. It lays good foundation for the R&D of negative ion source with multi-driver for CRAFT NNBI system. The details of design and experimental results of beam source was shown in this paper.

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