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Development progress of negative beam source for the CRAFT NNBI

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Neutral beam injection (NBI) is one of the most effective ways for the plasma heating and current driver. The negative based NBI was proposed for the fusion device, especially for the fusion reactor. In order to support the development of fusion energy, a large scientific device, the Comprehensive Research Facility for Fusion Technology (CRAFT) was under-development in China. 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 sub-system. The radio frequency (RF) based negative beam source was employed for the CRAFT NNBI system. There have several different sizes of negative beam sources, such as single driver, double drivers and four drivers.

The double drivers negative beam source was half size of the CRAFT NNBI source. It contains two RF drivers, an expansion chamber and a negative ion accelerator with three electrodes, which is plasma grid (PG), extraction grid (EG) and ground grid (GG). The extracted beam size around 320 mm × 800 mm. A complete negative beam test facility was developed at the same time. The half-size beam source was tested and achieved the long pulse of 50s with beam energy of 200 keV. The RF power is 75 kW with two drivers, the extracted voltage is 7 kV and the extracted negative hydrogen current is 10.5 A. The ratio of electrons to negative ions is around 0.5 and the extracted ion current density is 178 A/m2. The temperature of accelerator almost got the equilibrium state, which shows long pulse operation ability. During higher power and long pulse is still under conditioning and exploration. The results and lessons lays good foundation for the R&D of full size negative ion source for CRAFT NNBI system.

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