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Development of a 120 kV high power ion source prototype for neutral beam injector

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Neutral beam injection (NBI) is one of the most effective tools for the plasma heating and current driver. The high power ion source is the key part of NBI system. In order to increase the performance of high power source on the Experimental Advanced Superconducting Tokamak (EAST), a new ion source with 120 keV was proposed.
The accelerator of ion source is the key parts. The accelerator gird was designed with hole type. The beam optics was simulated with tetrode and triode type, respectively. The results shown that, the tetrode accelerator can extract the deuterium beam with the lowest divergeance angle of 0.65 degree and optimum extracted ion current density of 0.17 A/cm2. When change to the triode type, the accelerator can get the lowest divergeance angle of 0.7 degree with optimum extracted ion current density of 0.22 A/cm2. The transparency of grid was designed as 0.5, which can extract more ions to form high current ion beam. The cooling channels inside the grids was analyzed with Cu and Mo materials, respectively. The results shown that, the grids with Mo can got good performance with active cooling during long pulse operation.
An ion source prototype was developed and tested on the testbed. High energy of 120 keV was achieved with beam current of 15 A. Long pulse of 100 s was tested with lower energy of 80-95 keV due to the limitation of testbed. The hydrogen beam with 80 keV and 12.7A was extracted with 102 s. The beam divergence angle was measured with calorimeter around 1 degree, which larger than the simulation value of 0.7. The results are good for the R&D of a high power ion source with 120 keV.

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