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Physics and Engineering Design of the 500 keV Beam Source for the BEST Neutral Beam Injector

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Burning plasma Experimental Superconducting Tokamak (BEST) will be a new magnetic confinement fusion device (major radius ~3.6 m, minor radius ~1.1 m, plasma current <7 MA, toroidal field <6.1 T) located at Hefei, China. BEST aims to research and develop the physics and technology of the fusion power to generate electricity. Neutral beam injection is one of the auxiliary heating and current drive systems for the BEST to ignite and sustain the D-T burning plasma. The BEST NBI system is now under final design, which has one injector with one beam source. The BEST beam source is required to generate a 500 keV and 20 A beam of deuterium negative ions for the first phase (800 keV and 31.25 A for the second phase). This paper presents the important details of the physics and engineering design of the 500 keV BEST beam source, which mainly consists of a four-driver RF plasma source and a three-stage electrostatic accelerator. The concepts, structures and parameters of the design are determined and supported via a series of numerical analyses, experimental activities, and also the R&D experience of the negative ion beam source worldwide.

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