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Multi-slit Triode Ion Optical System with Ballistic Beam Focusing

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High power focused neutral beams with small divergence are necessary for heating of localized regions inside plasma. Particularly they are useful in the devices with narrow access ports through which only small size, high power density beams can be transported. In the neutral beams developed in the Budker Institute, the ballistic beam focusing is provided by spherically shaped multi-aperture electrodes of ion optical system. Use of slit apertures in the ion optical system additionally reduces a width of the focused beam in the direction along the slits due to smaller divergence in this direction, which is determined only by the ion temperature of plasma emitter. For application in powerful heating neutral beam injectors focusing triode ion optical systems with slit apertures are developed. Formation of high perveance beam in slit geometry of the grid was optimized by making use of three dimensional KOBRA-INP code. Results of the simulations are in agreement with experimental data on ion beam formation from single slit aperture.

At present, two versions of focusing multi-slit triode ion optical system are developed. The first ion optical system forms the proton beam with 15 keV energy, 140 A current, and 30 ms duration. The second ion optical system is intended for heating neutral beam injector of TCV tokamak. The injector produces focused deuterium neutral beam with 35 keV energy, 1 MW power, and 2 s duration. In the later case the angular beam divergence of the neutral beam is 20-22 mrad in the direction across the slits of the ion optical system and 9 mrad in the direction along the slits.