high-POWER neutral beam iNJECTORS NB15-40 WITH TUNABLE BEAM ENERGY

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High-energy neutral beams are widely used for plasma heating in machines with magnetic confinement. The Budker Institute has been developing ion sources for neutral beams since 1959 [1]. This report describes powerful neutral beam system with particles energy tunable during a pulse at a constant extracted current for C-2W machine [2]. The development of a tunable neutral beam with a constant beam current requires more complicate IOS and the use of a complex high-voltage power supply system.

At the beginning of the pulse, the ion beam energy is 15 keV, the current in the extracted ions is 130 A, then the IOS is tuned to 40 keV energy at a constant current. The power of the neutral beam increases from 1.6 MW to 3.5 MW. The total pulse duration of a hydrogen or deuterium beam is 30 ms.

Two possible tunable IOS configurations were studied: “acceleration-deceleration” scheme in the IOS triode configuration and “pre-acceleration – acceleration” scheme in the tetrode IOS.

After a series of tests, a more promising tetrode scheme was chosen.

Parameters of custom energy injector:

- Beam energy is 15–40 keV;

- The power of the neutral beam is 1.6–3.5 MW;

- Ion beam current is 130 A;

- Pulse duration is 30 ms;

- Focal length is 3.5 m;

- Pumping speed is 400000 l/s.

A total of 4 atomic tunable neutral beams were produced that operate on a C-2W machine (TAE, USA).

References

1. Yu.I. Belchenko, V.I. Davydenko,. P.P. Deichuli, et al. Studies of ion and neutral beam physics and technology at the Budker Institute of Nuclear Physics, SB RAS. PHYSICS-USPEKHI, v. 61, No. 6, p. 531–581, 2018.
2. M. W. Binderbauer et al. A high performance field-reversed configuration. Physics of Plasmas 22, 056110 (2015)