MODERNIZATION of the DIAGNOSTIC neutral beam INJECTOR for TOKAMAK ST-40 [[1]](#footnote-1)\*)

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In 2020, the RuDI neutral beam injector for plasma diagnostics [1], designed at the Budker Institute of nuclear physics, was upgraded and physically launched on tokamak ST-40 (Tokamak Energy Ltd., Abingdon, UK). The injector allows you to measure the ion temperature, the plasma rotation velocity, the magnetic field, and other parameters of the tokamak plasma.

The original version of the injector was used for plasma diagnostics on the tokamak TEXTOR. The main parameters of the injector are: 50 keV particle energy, the extracted ion current up to 3 A, the duration up to 8 sec, 4-electrode ion-optical system (IOS) with a focal length of 4 m, a plasma source with a hot LaB6 cathode.

The following changes were made during the deep modernization:

- The plasma source of the injector was replaced by the arc-discharge plasma generator with a cold cathode [2], which is more reliable and much easier to operate (although it loses in terms of the pulse duration).

- Instead of the traditional resistive divider, a circuit with a branch of an electrical circuit from the regulated cell of a partitioned high-voltage power supply system is used to power the focusing electrode of the IOS. This power supply scheme dramatically increased the stability of the potential of the focusing grid and practically eliminated the danger of the shorting of the first gap, which is typical danger for the 4-electrode IOS in modes, reaches the lowest beam divergence. In addition, in this scheme, the current losses for the divider are eliminated, and, accordingly, the beam current increases.

- The arc discharge power supply system for a cold-cathode plasma generator was modified for stable arc initiation by means of low-current overvoltage scheme. A scheme with stabilization of the lower and upper levels of the discharge current is applied, which increases the stability of the mode with beam modulation.

- All power systems are redesigned to work from capacitive storage devices on modern supercapacitors, with a power consumption sufficient for a 2-second working pulse of the injector. This eliminates powerful pulse loads on the local power grid.

- The cryogenic system with helium filling has been replaced with an easier-to-operate system with cryocooler heads.

- A new injector control system has been developed using a hardware platform consisting of an industrial computer with National Instruments modules. The software is executed in the LabVIEW environment.

Referens

1. A. Listopad, et al. Use of the focusing multi-slit ion optical system at RUssian Diagnostic Injector (RUDI). Rev. Sci. Instrum. 83, 02B707 (2012); DOI: 10.1063/1.3669794.
2. Stupishin N.V., Deichuli P.P., Ivanov A.A. et al. Multi-Second Neutral Beam Injector (60kV, 6A) for Plasma Diagnostics in the Upgraded T-15 Device. AIP Conference Proceedings vol. 1771, 50012, 2016.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Mu/ru/BP-Deichuli.docx) [↑](#footnote-ref-1)