Analysis of the scheme and parameters of the neutral beam injector for the FNS-ST tokamak [[1]](#footnote-1)\*)

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The work is devoted to the choice of the scheme and parameters of the fast deuterium atom injector for the neutral injection system of the FNS-ST tokamak [1]. The energy of fast atoms is an important parameter that determines the efficiency of current generation in the tokamak plasma and the neutron yield. As shown in [2], in the range of 100–200 keV with increasing energy, the fraction of neutrons produced by the D-T reaction in the thermal component of the plasma decreases, but the total neutron yield increases, which is provided by an increase in the intensity of the D-T reaction during the beam-plasma interaction. With increasing beam energy, a noticeable increase in the efficiency of current generation is also observed.

The given energy range is transitional for choosing an injector scheme based on either positive ion (PI) or negative ion (OI) sources, since the efficiency of neutralization of PI in this energy region rapidly decreases with increasing energy, while for OI it remains at about 60%. In favor of the OI scheme, the fact that the average angular divergence of a beam with OI is about half as small as in PI sources also works. On the other hand, the emission current density of ions in PI sources is almost an order of magnitude higher than the current density in OI sources, injectors with PI are more compact and their technology has been tested on many installations. In this paper, the analysis of injector schemes for FNS-ST is performed and a variant using PI sources with deuterium ion energies up to 140 keV is selected. Specific energy values will be determined by the operating modes and parameters of the tokamak plasma.

A variant of the injection module with the power of a deuterium atom beam injected into the plasma up to 3.5 MW is considered. The geometry and parameters of an ion source (II) with a deuterium ion beam current of up to 80 A and the geometry of the beam path components from the II grounded electrode to the entrance window to the tokamak chamber are determined. The power loads from the beam onto the components and their cooling conditions are calculated. The gas flow conditions in the injector are determined and the losses of the neutral beam due to the re-ionization of atoms on the background gas are estimated.

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References

1. Kuteev BV et al, 2011 Steady state operation in compact tokamaks with copper coils Nucl. Fusion 51 073013
2. A.Yu. Dnestrovskij, A.A. Golikov, B.V. Kuteev et al. Investigation of the stationary operation of a tokamak-based neutron source. VANT, Ser. thermonuclear fusion 2010, issue 4
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/Mu/ru/AL-Anan%27ev.docx) [↑](#footnote-ref-1)