Analysis of the DEMO-FNS magnetic field passive reduction and neutral beam injectors shielding methods [[1]](#footnote-1)\*)

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Steady-state operation mode of a fusion neutron source (FNS) will require plasma heating and maintaining the current in it by fast atoms beam injecting. The DEMO-FNS project [1] assumes the use of six injectors providing additional heating power up to 30 MW at an atomic energy of 500 keV. As a prototype for the DEMO-FNS injector, an injector developed in detail for the ITER project can be used, with the injector layout retained, but changes in individual components, which is caused by the difference in beam energy and power [2]. Inside these components, there are very strict restrictions on the magnetic field magnitude (the flux density should be below a certain value along the path of ion movement and even lower in the neutralization region) [3]. To achieve these characteristics in an environment with a high scattered field due to the magnetic system of the facility, which includes the coils of the poloidal and toroidal fields, the central solenoid and the plasma itself, additional shielding of the injectors is provided. At this stage, we expect that the proposed design will allow obtaining the required magnetic field values only by passive injector(s) shielding due to a case made of a ferromagnetic material with a high magnetic permeability.

An electromagnetic analysis of the effectiveness of such a screen was performed using 3D modeling using the ANSYS code. For this, a computational finite-element model DEMO-FNS was created, which includes a vacuum volume in which the entire electromagnetic system is located, including the current in the plasma, and one of 6 heating injectors. The magnetic field components values on the injection axis were calculated without shielding the injector region. It was shown that the vertical field component *Bz* in the injector region is maximum and is in the range of *300 G* at the input (from the side of the torus) to *150 G* at the other end of the unshielded case. Variants of single-layer shielding using various materials, and multilayer ones: two-, three- and four-layer with different layer thicknesses and vacuum gaps between them were considered. By choosing the optimal thicknesses of layers and vacuum gaps between them, the magnitude of the projection of the magnetic induction vector on the plane perpendicular to the beam direction was suppressed to permissible values in the region of the injector components. These results will be used later in the injector case and the duct engineering design.

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References

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