Calculation of the poloidal magnetic system of the MEPHIST-0 tokamak [[1]](#footnote-1)\*)

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MEPHIST-0 [1] is an educational and demonstration small spherical tokamak created at the Department of Plasma Physics of MEPhI in 2019. The tokamak's poloidal system consists of two independent parts. The first is an inductor that includes a central solenoid CS and compensation coils CC connected to it in series, designed to ensure plasma breakdown by creating a region with minimum of the vertical component of the magnetic field. The second part of the poloidal system consists of 6 independent control coils PF, to which a current of a pre-programmed shape can be supplied. These coils are responsible for controlling the shape and position of the plasma cord. In the work [2], a model of a poloidal system was described, and an algorithm for calculating the optimal in terms of minimizing the vertical component of the inductor's magnetic field in the breakdown zone was given.

To the previously obtained model of the poloidal system, it was added to take into account the effect of the "screw configuration" of toroidal coils, associated with their arrangement in the form of an element "winding" around the toroidal chamber. In this regard, the inclination of the coils by π/12 occurs, and they affect the vertical component of the magnetic field.

The effect on the vertical component of the magnetic field is taken into account by adding 17 TS poloidal conductors. For this, a configuration was selected so that the calculated distributions of currents would be as close as possible to the experimental ones, which made it possible to improve the results obtained by more than 20%.

Based on the obtained configuration of the poloidal system using the DINA code [3], plasma evolution was calculated for various ways of connecting control coils. The main task in this case was to check the possibility of reducing the requirements for the number of independent power supplies and the requirements for the maximum current values generated by these sources. Based on the results of the calculations, a configuration of 4 sources was chosen: 1 source with a voltage of 1.2 kV and 3 sources of 700 V to power the pairwise symmetrically arranged control coils. The main parameters of the scenarios are shown in Table 1.

Table 1. Basic discharge parameters

|  |  |
| --- | --- |
| $$τ$$ | 20 ms |
| $$I\_{pl max}$$ | 10 kA |
| $$B\_{tor}$$ | 0.4 T |
| $$a$$ | 13 cm |
| $$R$$ | 24 cm |
| $$Z\_{eff}$$ | 2.5 |
| $$Density , [10^{13}cm^{-3}]$$ | 1.3 |

In addition, the possibility of obtaining an elongated plasma configuration was investigated. So far, it is noted that with an elongation value of *κ ≤* 1.2, the plasma remains in the equilibrium position without feedback during the entire discharge time. At the same time, in the case of adding passive stabilization coils, it was possible to increase the parameter *κ* up to 1.6.

References

1. V.A. Kurnaev, G.M. Vorobyov et al., Phys. At. Nucl. 82, 1329–1331 (2019)
2. D.L. Ulasevich, R.R. Khayrutdinov et al., Problems of atomic science and tech. series, Thermonuclear fusion 45, 98-107 (2022)
3. Khayrutdinov R.R., Lukash V.E.. — J. Comput. Physics, vol. 109, 193-201 (1993)
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/AQ-Ulasevich.docx) [↑](#footnote-ref-1)