Proporsals of “Electrical machines” department of NTU “KhPI”
for the cooperation

Head of “Electrical machines” department

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# Research fields:

- Development of multilevel mathematical models of electric machines for general and special purpose asynchronous frequency controlled motors, generators for wind power and diesel-generator of autonomous power installations;
- development, production and research of high torque low speed motors for gearless electric drive (motor with rolling rotor);
- Impact study of linear motors and special electric machines with permanent magnets;
- The creation of scientific-technical and educational software for the development of electric machines design system based on numerical-field methods;
- The development of the theory of scientific and methodological foundations for the development and modernization of turbogenerators that meet the modern requirements of power system;
- Development, manufacturing and introduction of instruments and electrical machinery diagnostics.

# Results

• the creation of scientific-technical and educational software for the development of electric machines design system based on numerical-field methods;
• the development of the theory of scientific and methodological foundations for the development and modernization of turbogenerators that meet the modern requirements of power system.
Project Manager: **Milykh V.I.**, Doctor of Technical Sciences, Full Professor.
More than 8 patents, 250 articles.

• Impact study of linear motors and special electric machines with permanent magnets.
Project Manager: **Bolyuh VF**, prof. Ph.D. , professor of general electrical SEC "KPI“; h-index 2, 31 documents,22 citations, Author ID: 6602384476, https://www.scopus.com/authid/detail.uri?authorId=6602384476 in the database Scopus.
Performer: Ph.D. **Shchukin IS**, Associate Professor; h-index 2, Document 2, 8 citations, Author ID: 38562144800 https://www.scopus.com/authid/detail.uri?authorId=38562144800 in the database Scopus.
More than 16 patents, 1 monograph, 3 articles in Scopus with SNIP ≥ 0,727

• Development, production and research of high torque low speed motors for gearless electric drive (motor with rolling rotor). Project Manager: **Masliennikov A. M.** , Ph.D., Associate Professor.
More than 5 patents, 30 articles isn’t in the database Scopus.

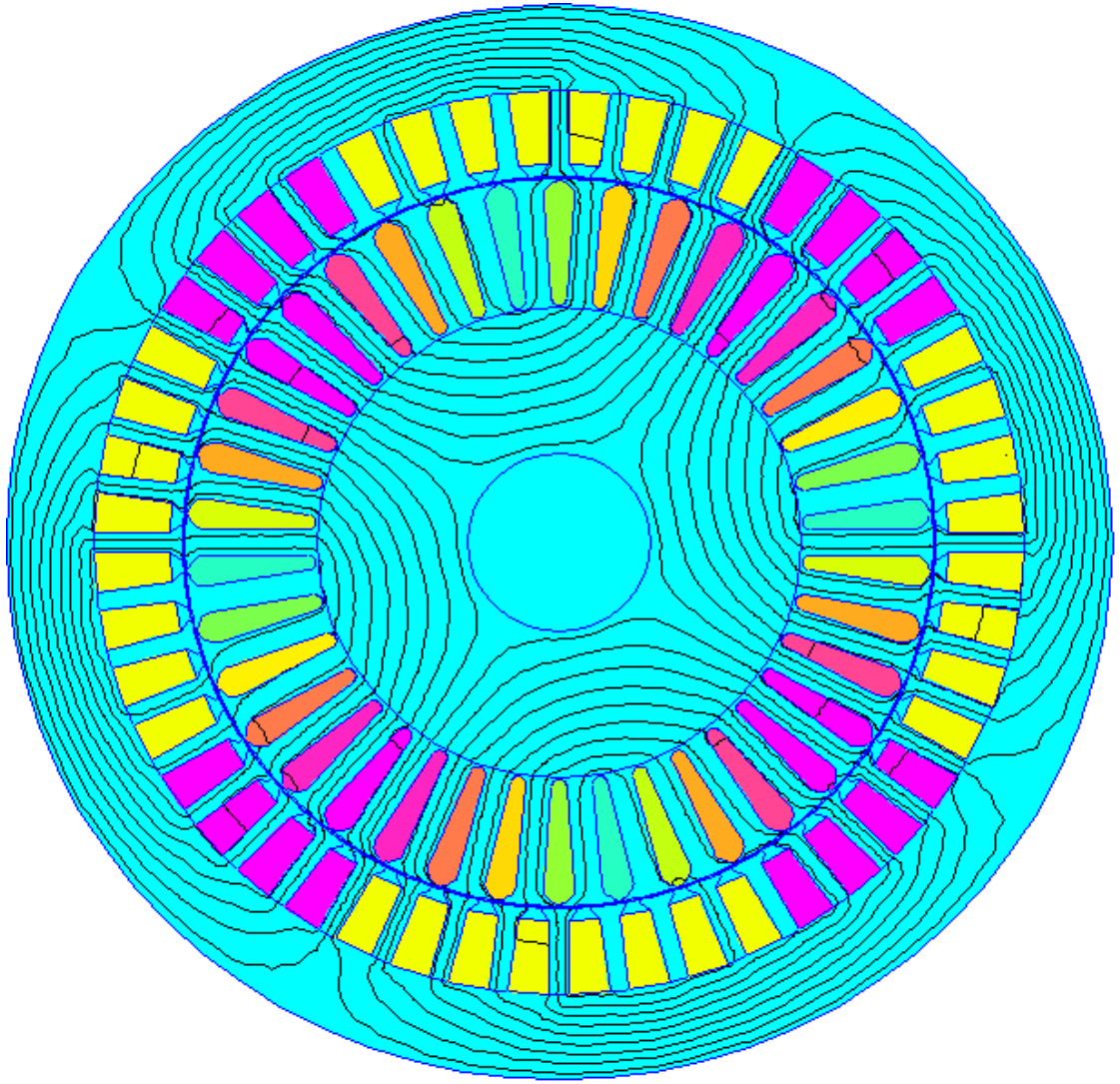
# Results_1

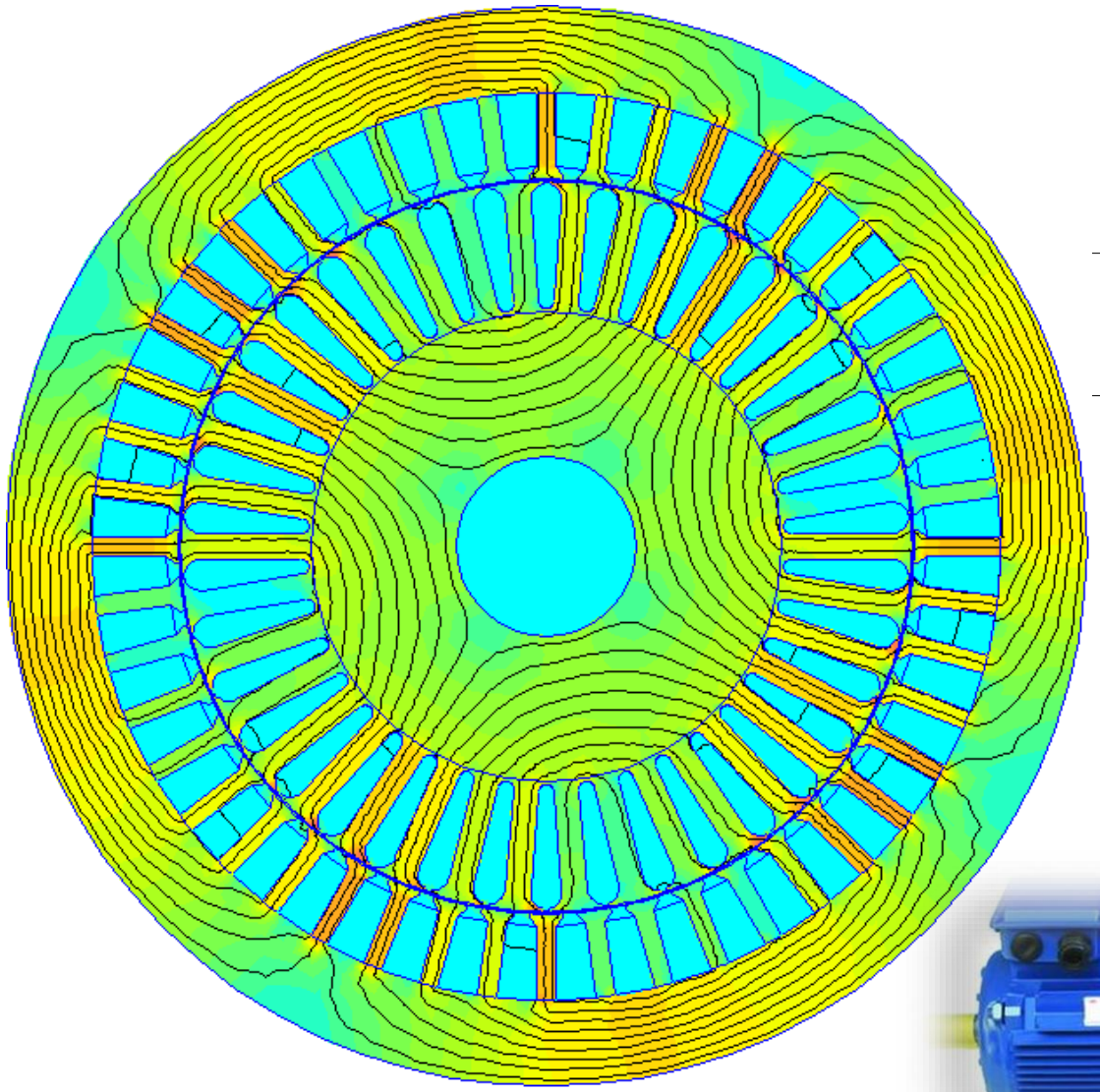
The department established the program complex automated numerical-calculation of electromagnetic field and power parameters and processes of electric machines such as synchronous, such as turbine generators, induction, such as three-phase asynchronous motors, linear motors percussion, DC machines and others. The program creates a calculation model the study of the electrical machine. It consists of a geometrical model displaying the design of the machine, and the physical model defining winding currents, time shifts between them, the material properties.

On this basis, the control program organizes numerical calculations of electromagnetic fields, the subsequent calculation of a complex electromagnetic and power parameters, as well as their timing functions.

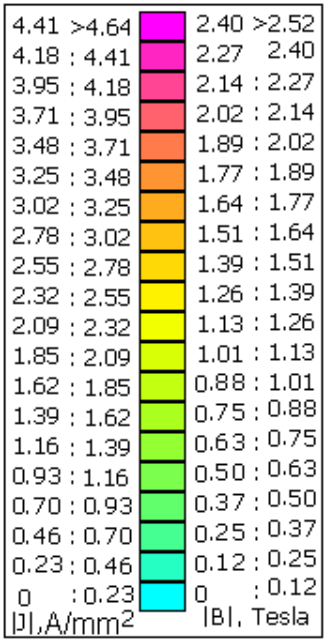
Additionally performed harmonic analysis of periodic variables. One illustration of the dynamics of the processes carried out by the study is the rotating magnetic field. It is presented by the example of the turbine generator and three-phase induction motor.

# Dynamic processes in the TAD

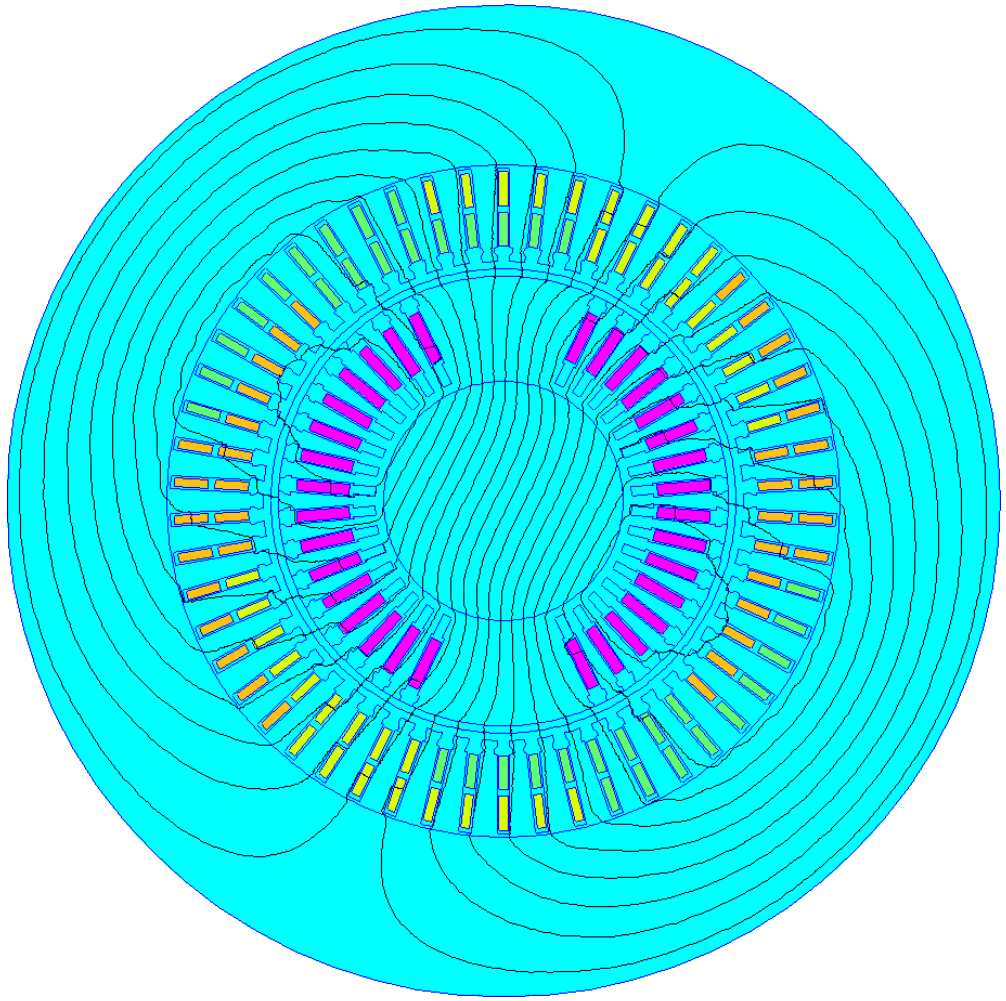




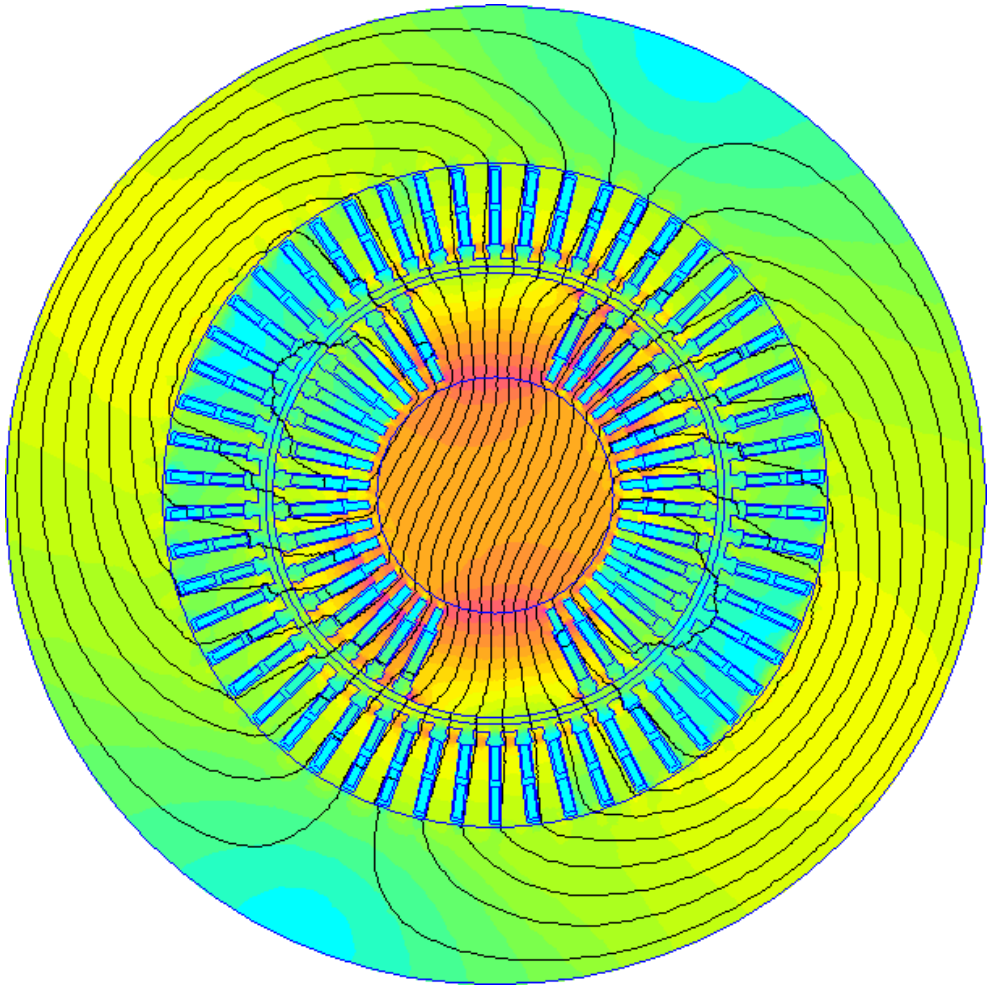
# The rotating magnetic field TG TA 35 at asymmetrical loading




Winding currents (Jz current density)



The magnetic induction B



# Directions of development the domestic turbogenerators that provide their competitiveness

**Competitiveness of the turbogenerators (TG) is determined by the requirements of their technical excellence and their corresponding characteristics of a special regime of power systems**.

Development directions the designs of the TG designs taking into account ways to power development:

1) The increase the power of TG in the per unit execution (up to 1500-2000 MW);
2) modernization of the new TG on the basis of traditional designs (replacement of hydrogen cooling at the air cooling, power increase without changing the dimensions, reduction of specific weight and dimension);
3) execution maintenance and reconstruction of worn-out electrical equipment, which is installed in thermal power plants, application of new systems of diagnostics, the use of new insulation materials, electrical steel and technology;
4) The increase of the operating range changes loads of turbogenerators and the use of new types of equipment in power plants; prospects for the use of asynchronized turbogenerators for regulating the balance of power in the power networks.

Employees of faculty "Electric machines" developed a complex of works and activities that will improve the reliability and preserve the competitiveness of domestic TG. Three government agreements made on this topic ((№№ state registration0111U002269, 0113U000433, 0115U000528)

# Results_2

Improved technical systems and devices through the linear pulse electromechanical transducers

The project is expected to develop models multiphysics linear pulse electromechanical transducers, which describes the interconnected electromagnetic, mechanical, thermal and hydrodynamic processes and methods of optimization converters using advanced algorithms that take into account all their basic geometry and dimensions and weight parameters, electrical parameters of power and modes work. Will advanced technology of magnetic pulse compaction of powders of ceramics and protection for unauthorized access.

The main hypothesis for improving the efficiency of electromechanical transducers is to align a transition between electric, magnetic, mechanical and thermal processes occurring at different speeds. It is assumed the use of complex electromagnetic repulsive forces and electromagnetic forces of attraction between the active elements of the ferromagnetic core and special screens and cooling systems, including cryogenic, electronic control systems.

The aim is to improve technical systems and devices, scientific and industrial by pulsed electromechanical transducers. The project goal is to increase efficiency, improve weight and size parameters and reduction of magnetic stray fields.

# Practical implementation of linear impulse electromechanical of inverters in industrial applications

*a*

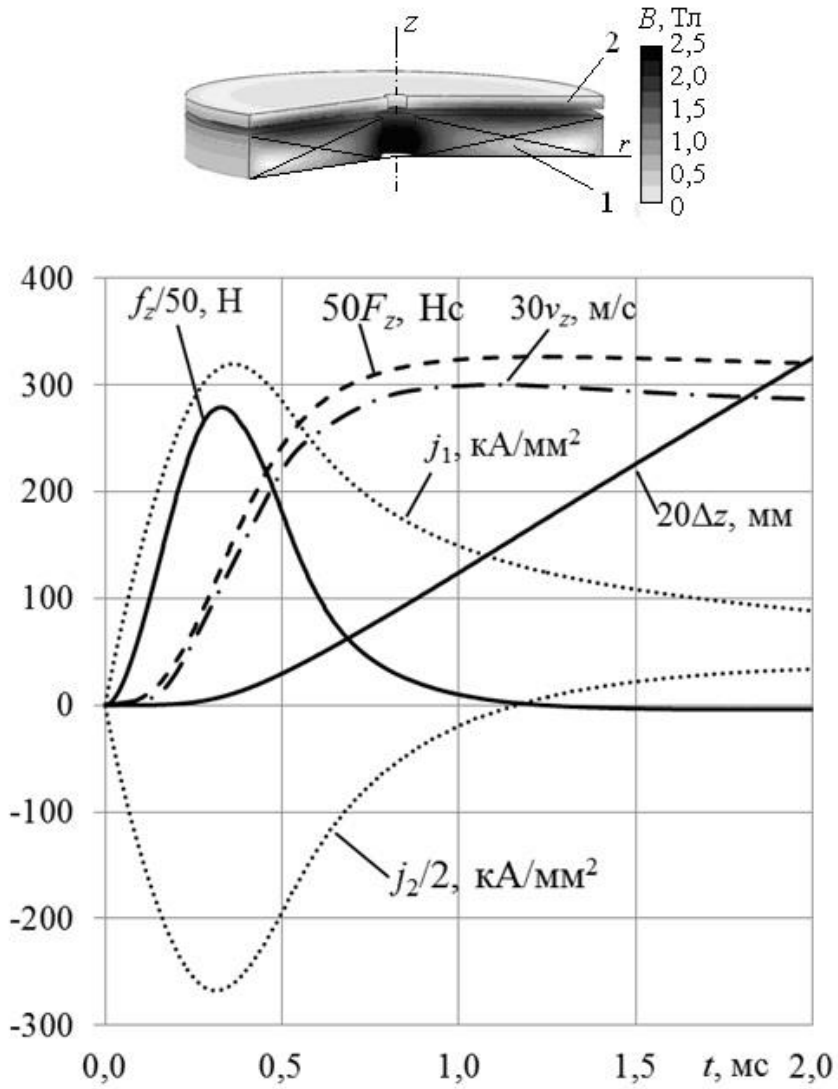
*b*

Type dry cement bunker with (*a*) and after (*b*) work device shock treatment

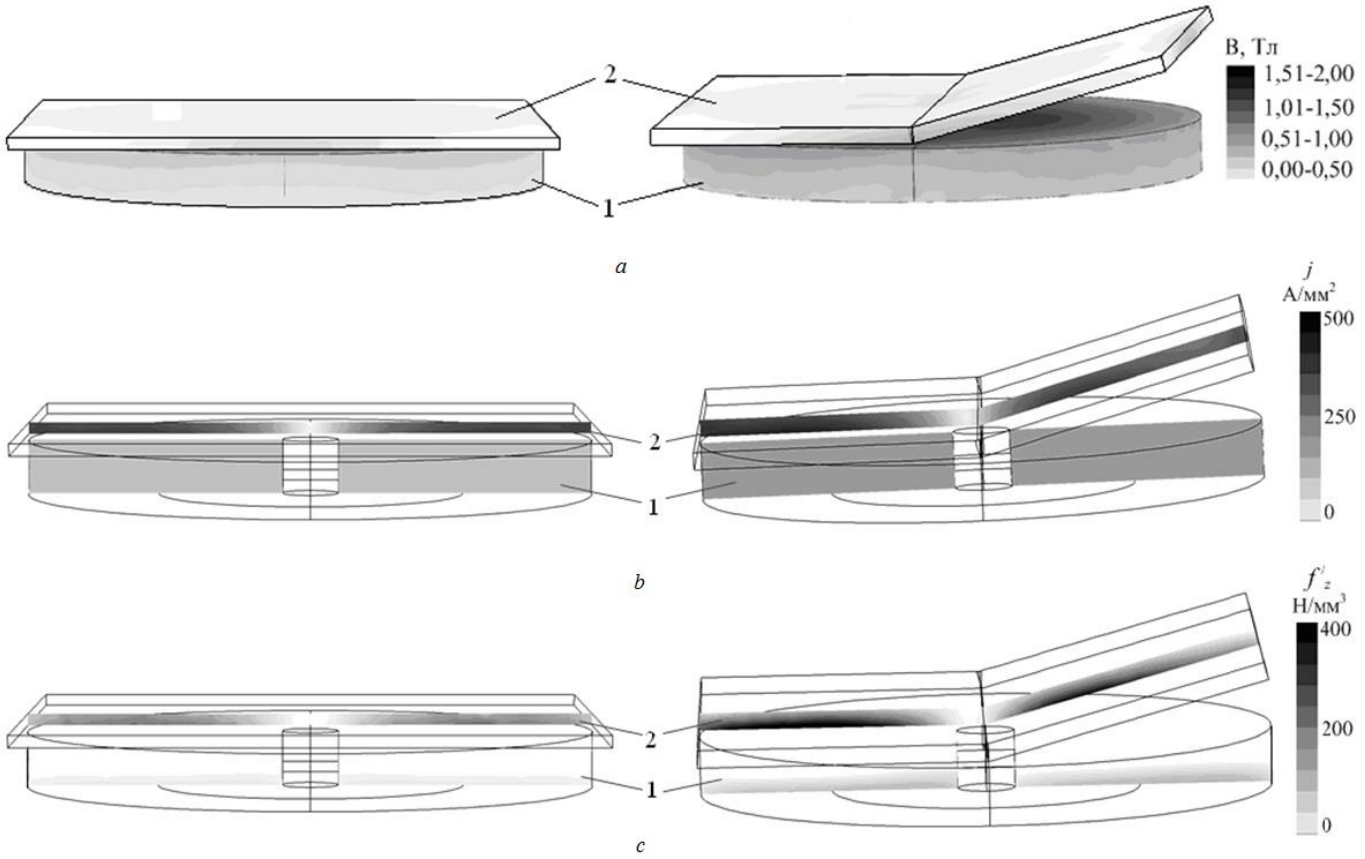
*a*

*b*

Wire transmission line (*a*) before and after (*b*) operating shock treatment device




Electromechanical characteristics and distribution of the magnetic field at the time of action of the maximum electrodynamic forces




The distribution of the magnetic field *(a)*, current density *(b)* and the specific axial electrodynamic forces on the center line of the actuator backup (left) and alternate (right) at the time of the relay maximum electrodynamic forces *(c)*

# Results_3

- Replacement of low-speed and high-torque electric drive, which combines a high-speed motor with a mechanical gearbox, on the low-speed, high-torque electric motor will improve the weight and size of electric drive performance and obviate the need for costly multi-step production of gear. Two groups of low-speed engines are the most promising solutions to this problem. The first group includes various types of stepper motors and inductor. The second group consists of motors with a rolling rotor. Obtaining of high torque motors in the first group is associated with the number of stator teeth and the rotor, which increases the size of the machine and the reduction ratio. It shows the reduction rate difference between rotor speed and the stator field, and an increasing the torque on the motor shaft. Rational limit maximum reduction ratio for the first group of motors is in a range from 50 to 100. The reduction ratio of motors with a rolling rotor depends on the difference of diameters of the stator and rotor and allows to achieve reduction coefficient values from 100 to 5000 at a constant amount or number of pole pairs of the stator teeth for any scale. Stepper and inductor motors can not implement the following initial parameters without exceeding its rational boundaries of geometric dimensions. Thus, the existing scientific and technical development of a low-speed and high-torque electric drive with a multistage gearbox of replacement to the gearless motor with a rolling rotor is an actual scientific and technical problem.
- At 05.16.16 motors with a rolling rotor, which was produced in an amount of 6 units. Three motors of these (240-600 watts) is made with funding from "Ukrtehnologiyaservis" in order to introduce in Zmiev TPP as evidenced by the the meeting protocol of the STC at 12.06.12. The development has a high state of readiness for deployment. The implementation period will be adjusted time-consuming for certification and manufacturing of motor - 1 year.

# Example motors with a rolling rotor