HTSC-Maglev circular system for noncontact acceleration of IFE targets: results of theoretical and experimental modeling [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2022.49.1.078

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In the frame of the inertial fusion energy (IFE) program, in previous works [1, 2] our researches were aimed at development of a linear HTSC-MAGLEV accelerator for realizing a noncontact delivery of fuel cryogenic targets at the laser focus. In this report, studies were carried out on the possibility of noncontact acceleration of an HTSC-sabot (i.e. target carrier) using a circular HTSC-MAGLEV system. Among them are:

1. Measurements of the magnetic moment M of high-temperature superconductors (HTSC) of a SuperOx type with a superconducting transition temperature ТС = 92 K. They were carried out on a multifunctional automated measuring complex PPMS-9 in the zero-field cooled (ZFC) mode. The HTSC sample was cooled from temperatures above ТС to 10 K, after which the studied magnetic field was switched on, and the HTSC-sample temperature began to increase. Measurements were carried out in the constant magnetic fields of 0.01; 0.5; 1.0; 2.0; 4.0; and 8.0 T. It was shown that the modulus M increases by 1−2 orders of magnitude depending on the value of the magnetic field as the sample temperature decreases from 85 K to 10 K. In particular, at B = 1 T and T = 83 K the value |М| = 0.0077 emu; and at T = 10 K the value of |М| = 1.14 emu, which is 148 times more.

2. Construction the HTSC-MAGLEV system. It is based on a circular neodymium magnet (size is (100x50x5) mm3, magnetic field is B = 0.13 T), which is placed in a ferromagnetic insert with a size of (105x44x3) mm3. The HTSC-sabot was made of the SuperOx tape in the form of a closed parallelepiped with a size of (30x4x4) mm3. At 80-85 К, it was placed above the magnet and set in motion under gravity. Studies have shown that the HTSC carrier is in a state of a stable noncontact movement over the magnet until a certain velocity is reached (Vout − velocity of stalling from the trajectory), the value of which is determined by the parameters of the HTSC-MAGLEV system, namely, the value of K = B × dB/dx and the magnetic moment modulus |М| of HTSC material, and the more |М|, the smaller K are required to maintain a given velocity. At K = 3000 mT2/mm, the experimentally measured stalling velocity was Vout = 1.2 m/s (Т = 85 К).

3. Calculations of the Vout at T = 80-85 К have been carried out, and they are in good agreement with experiment. It is shown that for K = 3000 mT2/mm Vout > 1.2 m/s (Т = 85 К). Taking into account a significant growth in the magnetic moment modulus |М| with temperature decreasing, the stalling velocity can reach the values of Vout ~ 100 m/s at T ~ 18 K.

The results obtained are unique and make it possible to move from mock up experiments to the creation of a prototype of circular accelerator, which will allow reducing significantly the dimensions of the system for noncontact delivery of the cryogenic fuel targets to the ICF chamber. Schematic of such accelerator is discussed in the report as well.

References

1. Aleksandrova I.V., et al. 2018, J. Russian Laser Research, 39 (2), 140-155.
2. Aleksandrova I.V., et al. Method for the delivery of a cryogenic fuel target for inertial confinement fusion, system and carrier. Patent RF № 2727925 from 27.07.2020 (in Russian).
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/It/ru/DN-Koresheva.docx) [↑](#footnote-ref-1)