CONTACTLESS HTSC SABOT ACCELERATION BY MUTUALLY NORMAL MAGNETIC FIELDS GENERATED IN PMG SYSTEM WITH A MAGNETIC TRAVELLING WAVE

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Creation of a delivery system based on contactless positioning and transport of the cryogenic fuel target (CFT) represents one of the major tasks in the general program of the inertial confinement fusion (ICF). The purpose of developments is to maintain quality of a fuel layer during acceleration and injection of CFT at the focus of the powerful laser facility or ICF reactor.

The researches carried out at the Physical Lebedev Institute (LPI) include two main directions on creation of hybrid accelerators for contactless CTF delivery: (a) gravitational injector + permanent magnetic guideway (PMG) systems, (b) electromagnetic (EM) injector (INJ) + PMG systems. They are based on a quantum levitation effect of high-temperature superconductors (HTSC) in magnetic field.

Currently, concept development of the hybrid accelerator «EM-INJ + PMG systems» is complete and proof-of-principle experiments are made. In this scheme, the HTSC sabot is accelerated in the “EM-INJ + PMG” system with a magnetic traveling wave. The concept differs from the known systems of acceleration in application of the following elements:

1. Superconducting sabot which comprises not only the accelerated HTSC-round (or rounds) with current, but also the HTSC-plates providing a stable levitation of the sabot.
2. Levitation (contactless) system of acceleration which comprises not only an accelerating system of the short solenoids for generation of a magnetic traveling wave, but also a magnetic rail (as a PMG system component) for providing both levitation and stabilization of the HTSC-sabot trajectory due to a pinning-effect in the HTSC materials.

A number of researches have been performed in confirmation of the concept operability, including:

- Modeling: (a) calculation of key parameters of the hybrid electromagnetic accelerator with the PMG system of type «Magnetic Rail» for different superconducting materials; (b) firstly, it is shown that when using an HTSC-round from MgB2 (Ic = 500 A) as the accelerated element, a reactor CFT can reach the speed of 200 m/s at the following conditions: external accelerating field - 0.25 T, acceleration - 400 g, acceleration length - 5.0 m, levitation force - 0.01254 N, which for the HTSC-sabot from Gd123 corresponds to a 3-mm levitation height, and from Y123 - 5 mm.

- POP experiments: (a) using various driving pulses (mechanical, electromagnetic and gravitational) in different PMG systems; (b) demonstration of simultaneous acceleration and levitation of the HTSC-sabot made from Gd123 tape at 3-mm levitation height in the contactless system «Short Solenoid + Magnetic Rail» with mutually normal magnetic fields.

Thus, the obtained results, both theoretical and experimental, have shown that the HTSC materials can be successfully used when developing the hybrid accelerators for contactless CTF delivery with the purpose to minimize risks of a fuel layer roughening at the acceleration stage, and also to provide a required correction of the CTF trajectory due to pinning effect in the HTSC materials.

This work was supported by the International Atomic Energy Agency under Research Contract No. №20344, the Russian Academy of Sciences Program of Basic Researches and by the Russian Government (in the frame of the State Task Program).