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Conception of a Cryogenic Target Factory for IFE

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A central feature of an inertial fusion energy (IFE) power plant is a target that must be delivered to the target chamber center at a rate of about 1–15 Hz.

A high rep-rate target supply system, which operates with moving free-standing targets (FST) is the culmination of a 25-year science-&-technology effort of the Lebedev Physical Institute (LPI) in collaboration with other Russian Institutes.

This report provides an overview of our research activities towards realization of the FST target supply system for IFE including high rep-rate cryogenic target production, transport and tracking:

1. Cryogenic target mass production: the FST layering method has been developed for rapid fuel layering via heat conductivity in moving free-standing targets. A batch mode is applied, and high cooling rates ($q = 1-50$ K/s) are maintained to form isotropic ultra-fine solid layers inside free-rolling targets. The total layering time is typically less than 15 seconds, which has a side benefit in the view of tritium inventory minimization. A spherically symmetric layer with a uniform thickness and acceptable surface quality have such a structure, which supports the fuel layer survivability under target injection and transport through the reaction chamber.

2. Cryogenic target transport:

-Gravitational target transport was demonstrated at cryogenic temperatures, including the assembly of a couple "target -and- sabot". A design of the corresponding devise was developed.

-Electromagnetic target transport in the couple of "target -and- sabot" was demonstrated at cryogenic temperatures. A devise for injecting the fusion cryogenic targets at the laser focus of a reaction chamber was developed.

-Magnetic levitation transport. Our recent results (successfully made at $T = 6\text{-to-}80$ K) have shown that maglev transport systems based on using high-temperature superconductors (HTSC) is an excellent springboard for the development of IFE cryogenic target positioning and transport systems, including a new type of cryogenic target accelerators – a magnetic levitation accelerator.

3. Injected target tracking: the Fourier holography was proposed and examined in the computer experiments for on-line characterization and tracking of a flying target.

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Primary author: Ms KORESHEVA, Elena (Russian Federation)

Co-authors: Dr NIKITENKO, Andrei (P.N.Lebedev Physical Institute of Russian Academy of Sciences); Prof. KUTEEV, Boris (National Research Center «Kurchatov Institute»); Mr KOSHELEV, Evgeniy (P.N.Lebedev Physical Institute of Russian Academy of Sciences); Dr OSIPOV, Igor (Power Efficiency Center INTER RAO UES); Dr

ALEKSANDROVA, Irina (P.N.Lebedev Physical Institute of Russian Academy of Sciences); Dr NIKOLAEV, Vladimir (Power Efficiency Center INTER RAO UES)

Presenter: Ms KORESHEVA, Elena (Russian Federation)

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