

Liner experiment

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The experiment with a high energy liner, HEL-1 (August 1996), was performed using a five-module disk explosive magnetic generator (DEMG) with a diameter of 1000 mm. The goal was to use this device to let 100 MA of current pass through an aluminum liner. The liner must accelerate up to 8.4 km/s, as a result of which its kinetic energy must exceed 20 MJ. According to I. Lindemuth, these liner current and energy values were the highest achieved in tests in which US scientists took part. In addition, we wanted to see the capabilities of the HEL-1 system and understand how we can use it. One of the examples of how to use the system with a kinetic energy of higher than 20 MJ is to heat fuel, aiming to ignite plasma in a MAGO facility. Energy values achieved in the HEL-1 system exceed by more than 100 times the kinetic energy which will be available for heating fuel of a non-magnetized target on NIF (The US National Ignition Facility).

To illustrate my words, I provide a fragment from the article “Liner experiment” that I wrote for “*Gorodskoy Kurier*”, our local newspaper, in May 1996.

“Events preceding this experiment developed very fast. In early January, VNIIEF signed a subcontract with the University of California in the amount of over \$500 000. One of the items of this contract which cost about \$ 400 000 was the performance of an experiment on acceleration of a high energy liner (an aluminum cylindrical shell 4 mm thick) at a VNIIEF firing point in June. The experiment was called HEL, an abbreviation from English: High Energy Liner. The suggested Liner speed and energy were 10 km/s and 20 MJ, respectively, which was unachievable for facilities available at that time in the USA. The only instrument that allowed the acceleration of such a liner was a disk explosive magnetic generator of 1 m diameter. This unique energy source was developed at VNIIEF several years ago. “Perestrojka” in Russia stopped experiments with DEMG.

The contract had very narrow terms of performance for the experiment. The reason for this was simple. The Americans wanted to have results showing prospects for the collaboration with Russians in the field of development of high power sources of electromagnetic energy three months before the end of their fiscal year. (The American fiscal year starts on October 1). At the time, it appeared that because of the VNIIEF 50 year celebrations, the LANL delegation could come only after June 26. We faced a choice to perform the test either on May 31, which was impossible for us for technical reasons, or on June 30, which was not good for the Americans because of little time for installation of their diagnostics.

After hot discussions, the decision was made to perform the liner test on August 21 and invite three people from LANL to participate in a smaller test with an explosive magnetic generator with a diameter of 1 meter. It was projected to obtain current of 150 MA or higher.

The preparations for the test went very quickly and reminded us of work at VNIIEF at its best time. Suffice it to say that the experimental assembly was constructed in a record time of 10 days. The team worked in a concerted and perfectly organized way. They started at 8 in the morning and finished at 9 at night without days off and with one only a break for lunch.

Assembly components were fitted in situ. Continuous transport communication was established between the assembly shop and the production department. If fabrication of some component required additional working hours, people stayed after their working hours without any hesitation. And people worked not only for the sake of money, but mainly for the sake of VNIIEF prestige. One of the most important results of the work was recognition of the fact that we can still do real things in spite of everything. We felt how our self-respect and self-confidence were growing, and it was exactly what many of us needed at that difficult time.

More than 300 people took part in that work. I could name many of them, but being afraid of missing someone, I would like to take a chance and to thank everyone: physicists, experimentalists, theorists, designers, mathematicians, technicians, especially those from department #1 of the VNIIEF plant and other VNIIEF employees who contributed so much to that experiment.

On May 30 at half past one p.m., window glasses jingled in many houses of our city. At a firing point 10 km from the city, 250 kg of HE was exploded. From the very beginning, it became clear that the experiment was successful. The current value was about 170 MA according to preliminary estimates. Our American colleagues congratulated us. And in half an hour a heavy rain began and washed away the experiment traces.

The main experiment also took place at the set date and was successful. The contract supported the prestige of Russian science and became the basis for continuation of the joint VNIIEF-LANL work in the field of electro-physics.