PACS numbers: **01.65.** + **g**, **28.70.** + **y**, 89.20.Dd
DOI: 10.3367/UFNe.0183.201305g.0518

Scientists' contribution to the Great Victory in WWII on the example of the Leningrad (now A F Ioffe) Physical Technical Institute

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1. Introduction

For us, The Great Patriotic War is seen as heroic pages in the history of the USSR and of the USSR Academy of Sciences, the history of the Leningrad Physical Technical Institute (LFTI, known as FizTekh in *Russ. abbr*.), and the fate of its scientists, engineers, technicians, and workers. This article includes a description of the events that informed the activities of LFTI during this period, as well as those documents important for understanding the past. The greatest importance is placed on analyzing the achievements of the scientists of the Leningrad Physical Technical Institute and their relevance to the war on the fronts, to the defense of Leningrad, and to victory.

2. LFTI on the eve of war

LFTI was created on 23 September 1918 and rapidly joined the ranks of the leading research centers around the world. The credit for this belongs to one of its founders — Abram Fedorovich Ioffe — who led the institute until 1951 (Fig. 1).

LFTI, which previously belonged to the People's Commissariat of Heavy Industry [renamed later the Ministry of Medium Machine Building (MinSredMash in *Russ. abbr*.)], was transferred to the USSR Academy of Sciences (AS) in 1939.

By the summer of 1941, LFTI was, by the criteria of the time, a large institute: 18 laboratories and more than 300 staff members, among them 23 DSc researchers and 56 senior and junior researchers [1].

By June 1941, groups of LFTI scientists had converted some laboratories and affiliates into 10 research institutes of physical and technical profiles in Leningrad and in some other towns in the USSR.

Saturday night, 21 June 1941... Scientists' House in Lesnoe, not far from LFTI. A group of colleagues, including a large group from FizTekh, were toasting Academician N N Semenov in connection with the Stalin Prize that he had received for outstanding achievements in the field of chemical physics [2], including the discovery of chain reactions made while he was still at LFTI. Fifteen years later, N N Semenov (Fig. 2) won the Nobel Prize in Chemistry 1956 for this discovery.

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Uspekhi Fizicheskikh Nauk **183** (5) 518 – 528 (2013)
DOI: 10.3367/UFNr.0183.201305g.0518
Translated by V I Kisin; edited by A Radzig

Figure 1. Academician A F Ioffe.

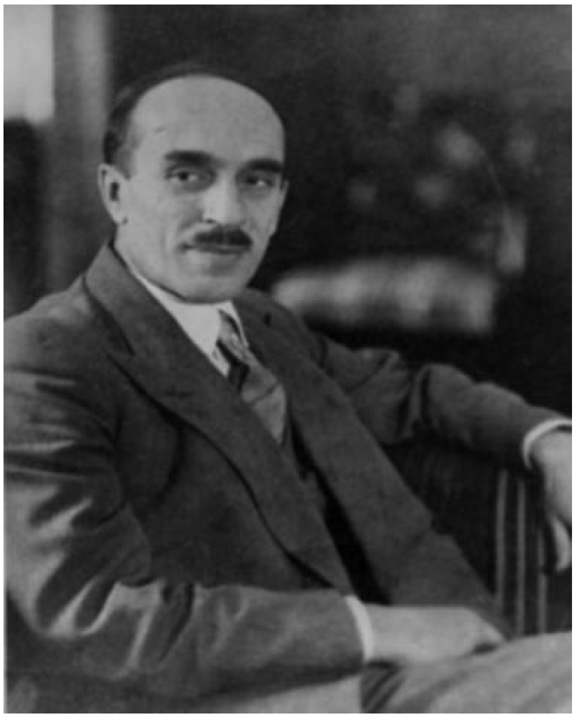

Figure 2. Academician N N Semenov.

They had another reason to celebrate that day, though the country learned about it on the next day. The newspaper *Pravda* (*Truth* in English) presented in its issue of 22 June 1941 the news of a huge achievement by LFTI scientists, who had completed the construction of the largest cyclotron in Europe (Fig. 3). The equipment was partly manufactured and partly purchased and delivered to LFTI.

The war abruptly changed the scientists' plans... .

ПРАВД

Орган Центрального Комитета и МК ВКП

Воскресенье, 22 июня 1941 г.

22 июня 1941 г., № 171 (8579)

СОВЕТСКИЙ ЦИКЛОТРОН

ЛЕНИНГРАД, 21 июня. (Корр. «Правды»). В Лесном, на территории Физико-технического института Академии наук СССР недавно построено двухэтажное здание, похожее на планетарий. Продолгова-

Figure 3. Snippet from the article announcing the completion of construction of the LFTI cyclotron (published by *Pravda* on 22 June 1941).

3. LFTI and restructuring of science in the first weeks of the war

When the war started, the staff of LFTI included 197 people liable for military service, while 43 were exempt.

Until the end of July, 42 people joined the regular army and the militia voluntarily or by conscription. A month later, the number had reached 130 [3]. In the first weeks of the war, the Leningrad people's volunteer corps proved useless for front duty because of the catastrophic shortage of weapons and poor training. Some time later, it was disbanded and the volunteers were transferred to regular troops.

On 23 June 1941, a meeting of the Presidium of the USSR AS discussed restructuring the activities of the Academy of Sciences in accordance with wartime requirements. The meeting was chaired by O Yu Schmidt, Vice President of the USSR AS. Briefly, the following decisions were made.

(1) Re-orient research projects to 'strengthening military capabilities'.

(2) Provide defense-oriented research work with staff and equipment.

(3) Pay particular attention to research projects nearing completion.

(4) Empower the Presidium of AS to carry out the operational management of functioning of the institutions comprising the Academy of Sciences.

(5) Comply with the strictest wartime discipline.

The degree to which the work of scientists was to be intensified is seen in the text of Order No. 85 of the director of LFTI, A F Ioffe, on 7 July 1941 on extending the workday length to eleven hours [1].

Leningrad was becoming a frontline city. The life of the scientific establishment changed drastically.

In July 1941, the Leningrad Communist Party (VKP(b)) Committee set up a commission, headed by Academician N N Semenov, for considering and implementing defense recommendations. The commission included A F Ioffe, Ya B Zeldovich, Yu B Khariton, and other scientists and experts from amongst the townspeople. During the first two months of the war, the commission considered 847 proposals [3], and many of those were realized. Thus, wooden lofts typical of urban homes were treated with a specially designed solution that prevented ignition. This greatly reduced the effectiveness of using incendiary bombs by the enemy. A F Ioffe wrote: "I have never — and nowhere — witnessed such a rapid pace of transition from research ideas to practice as in Leningrad in the early months of the war " [4].

4. Organization of the work of the Kazan subdivision of FTI and of the Leningrad branch of FTI

In late July, Vice Chairman of the USSR Council of People's Commissars A N Kosygin (plenipotentiary of the State Defense Committee (GKO) for Leningrad) took a decision to evacuate LFTI as one of the leading institutes of the Academy of Sciences for defense work.

Two special trains evacuated 8 of 18 laboratories (about 70 people headed by A F Ioffe) to Kazan on 2 and 23 August 1941 [3]. The labs were integrated with scientists of other institutes of the Academy of Sciences on the territory of Kazan State University.[1] All provisions were completed by October and the work of the Kazan subdivision of FTI was in full swing.

The laboratories of the Kazan subdivision of FTI were reorganized into thematic groups. To quote from Order No. 12 issued by A F Ioffe on 20 October 1941 for the Kazan groups of FTI [1]: "For urgent execution of the tasks in the thematic plan of the institute, a group will be organized for each theme which will temporarily include employees from different laboratories... ." Ten groups were set up,[2] headed by Yu P Maslakovets, A A Kharkevich, V L Kuprienko, L A Artsimovich, Yu B Kobzarev, S E Bresler, B M Gokhberg, S N Zhurkov, E M Shevandin, and A P Aleksandrov.

I cannot help quoting yet another document — the Resolution of the Bureau of the Division of Physical and Mathematical Sciences of the USSR AS of 15 August 1941 [5]: "It is considered desirable for the researchers of LFTI, FIAN, IFP, and RIAN conducting work for a number of themes to do it in close cooperation[3]... . Some FIAN theorists will be assigned to LFTI... ." Section 4 describes one example of such cooperation.

The staff of the Leningrad branch of FTI who stayed behind comprised 103 people, headed by professor Pavel Pavlovich Kobeko (Fig. 4). In the meantime, events in Leningrad evolved quite dramatically. The loss of Schliesselburg on 8 September 1941 started the siege of the city that was to last for 900 days. Embrasures appeared on the ground floor of the main building of LFTI, a military unit occupied the first floor, and a local anti-aircraft defense battery was placed on the roof of the cyclotron (Fig. 5).

The work of the Leningrad branch of FTI was radically changed to satisfy the needs of the city's defense. To quote Order No. 29-a for the Leningrad branch dated 27 November 1941: "Due to the circumstances and needs of war time, the work of the Leningrad branch of FTI is switching from research projects to output orders meeting the needs of Leningrad's defense..." [1].

In this way, the following workshops were organized since 1 December 1941:[4]

[1] The memory of this is carefully preserved in the museum of Kazan State University.

[2] Each became later known as a laboratory.

[3] FIAN — P N Lebedev Physical Institute of the USSR AS, IFP — Institute for Physical Problems of the USSR AS, and RIAN — Radium Institute of the USSR AS. (*Editor's note.*)

[4] People working at LFTI workshops were supplied through worker's ration cards.

Figure 4. P P Kobeko, LFTI Director during the years of siege.

Figure 5. Embrasure of a pill-box in the main building of FTI.

Figure 6. Exhibit from the Museum of the Defense and Blockade of Leningrad.

(1) purifying of oil and petrol (production of edible oils by drying oil and paint as an important additive to very scant siege rations [5] (Fig. 6) and pure aviation fuel from waste gasoline);

(2) fabrication of selenium rectifiers;

(3) production of dielectrics (the Eskapon high-frequency cable was developed by P P Kobeko; its production line was built at the Sevkabel factory in Leningrad. It was used as a replacement for the worn-out British-made polystyrene in systems of automatic aiming anti-aircraft guns on the Leningrad front and other fronts);

(4) execution of special tasks (degaussing of ships of the Baltic and Northern Navies);

(5) production of hydrophobic land (to prevent the erosion of earthworks by rains).

5. Work on degaussing warships

In 1936, A F Ioffe received the Commander of the Baltic Fleet, Admiral I S Isakov. The admiral informed Ioffe of the governmental decision to start building very large ships for the Soviet Navy, up to battleship class. The weapon of great danger for these ships was magnetic mines. The detonator in these mines acted as the needle of a magnetic compass, responding to a change in the magnetic field near the mine caused by the ship's magnetized hull. The magnetization of the hull begins on the building berths of the dockyard during the construction process. As the ship puts to sea, Earth's

[5] The purification technology developed by P P Kobeko saved many from starvation not only among FizTekh staff but many other survivors of the Leningrad siege.

Figure 7. A P Aleksandrov with the staff of his laboratory at LFTI.

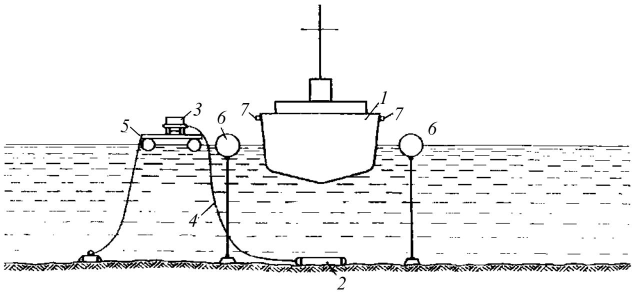

Figure 8. Diagram of the test bench for debugging the 'LFTI system': *1* — ship, *2* — disarmed mine, *3* — mine control circuit, *4* — cable, *5* — raft, *6* — gate buoys, and *7* — cable of the degaussing device.

magnetic field adds the so-called inductive component, which has a strongly pronounced vertical component — the one to which the detonator of the magnetic mine responds. These mines sink to the bottom, are difficult to trawl, and destroy the most vulnerable part of the hull — its bottom. The objective was to find a countermeasure against this formidable weapon.

At LFTI, A P Aleksandrov and his laboratory decided to take on this challenge. The team was strengthened by adding a first-class engineer, B A Gaev, from the Mines and Torpedoes Design Institute (Fig. 7). None of them had any experience of studying magnetic phenomena. They began from scratch, designing the simplest magnetometers around razor blades.

In the subsequent three years, a system of ship degaussing — termed as the 'LFTI system' — was developed and tested. It compensated for the magnetic field of the ship (which roughly resembled the field of a single current-carrying coil) with the residual field smaller by at least an order of magnitude, to values not exceeding approximately 10 mOe. This was achieved by laying on the upper deck of the ship the sections of a current-carrying cable forming a special pattern (Fig. 8).

On 31 December 1940, the Supreme Military Council of the Soviet Navy (VMF) decided to have all navy ships equipped with the LFTI systems [6]. Among battleships, however, only *Marat* was protected in this way by the time the war started.

In the first days of the war, the German Air Force peppered the Gulf of Finland and the bays of Sevastopol from the air with magnetic mines in order to lock our fleets in their bases. The baptism of fire for the LFTI system was the transfer of the entire squadron from Tallinn to Kronstadt on 28–29 August 1941. The squadron lost 53 ships, many of them due to mine explosions. In fact, those ships which had been luckily equipped with LFTI systems by a FizTekh team virtually on the eve of the transfer[6] reached Kronstadt with no losses inflicted by magnetic mines [6].

On submarines and small support ships, the LFTI system was not employed for technical and economic reasons, respectively. Already in the first months of the war, a 'coilless' degaussing method was applied on them, based on multiple hull magnetization reversal by a magnetic field of strong electric current at specially equipped stations for coilless degaussing. The procedure was repeated every several months. (In Leningrad, for example, such stations were built at the Grenadier bridge, where the cruiser *Avrora* is anchored now, and also at the Foundry Bridge and in Kronstadt.)

As the war started, each fleet created a degaussing service headed by A P Aleksandrov. Without their permission, no warship was allowed to put to sea. Sailors joked: "Before putting out to sea, visit LFTI." The backbone of the degaussing service consisted of 24 staffers of LFTI who worked in 1941–1942 in all fleets and all flotillas, training fleet officers in elementary degaussing in frontline conditions. Among them were I V Kurchatov, V M Tuchkevich, L M Nemenov, G Ya Shchepkin, B S Dzhelepov, and P G Stepanov. I E Tamm, assigned to the Kazan branch of FTI, took part in the computation of magnetic fields, and G N Flerov took part in improving magnetometers.

Incidentally, military engineers of the Reich kept making attempts until 1943 to respond in some way to the LFTI system and similar developments by the allies, mostly by improving the detonator. But then these attempts were stopped.

Once fleet degaussing services were created in 1942–1943, the FizTekh experts involved switched to other defense assignments. Not a single warship equipped with a LFTI system was blown up by a magnetic mine. A 'public demonstration' of the effectiveness of the system happened after the war ended, in Tallinn's port [6]. On a Sunday, the entire crew of one of the gunboats was allowed ashore on leave, and someone turned off the generator that powered the LFTI system. A German magnetic mine that had been sleeping on the bottom under the stern sprang into action. The explosion was immediate: the stern of the ship was virtually torn off. Fortunately, no one was killed.

In 1942, six LFTI scientists were awarded the Stalin Prize Class I for developing the LFTI system: A P Aleksandrov, I V Kurchatov, B A Gaev, V M Tuchkevich, V R Regel, and P G Stepanov (Fig. 9). In 1979, a monument, exceptional in its expressiveness and simplicity, was built in Sevastopol to the memory of FizTekh people for degaussing the ships of the Black Sea Fleet during WWII (Fig. 10).

[6] These were hastily installed 'jerry-rigged circuits' for the battleship *October Revolution* and for other ships, which were replaced in Kronstadt with permanent systems. The FizTekh experts also left Tallinn aboard the *October Revolution*.

Figure 9. A P Aleksandrov, I V Kurchatov, B A Gaev, V M Tuchkevich, V R Regel, and P G Stepanov.

Figure 10. A monument in Sevastopol commemorating the degaussing of the ships of the Black Sea Fleet during WWII.

6. Creation of pulsed radar network

On 16 January 1934, a meeting was called at LFTI on the problem of developing a system of aircraft detection by radars.[7] It was chaired by A F Ioffe, and A A Chernyshov and S I Vavilov were among the participants. On the suggestion of the Office of Anti-Aircraft Defense (UPVO) of the Workers' and Peasants' Red Army (RKKA), this work began at LFTI under the guidance of D A Rozhanskii, and after his death in 1936, under Yu B Kobzarev [3].

LFTI specialists developed the IG-7 pulse generator valve ($\lambda = 4$ m, $P = 50$ kW), the pulse modulator, the receiver, and indicator devices for the first pulse radar station (RLS), Redut, with a detection range of up to 150 km. Before the war started, a ship-borne version, Redut-K, was created; then LFTI employees modernized the Redut RLS and developed the first system for target identification.

Pulsed long-range RLSs (for a long time the enemy had no idea they existed in the USSR) played a huge role in the war years, especially in the defense of Moscow and Leningrad. They allowed the anti-aircraft forces about half an hour to get combat-ready. Television, which was invented right before the war, was for the first time utilized in Leningrad to speed up data transfer from RLS operators to anti-aircraft defense headquarters. Loss of life in the huge city due to bombs was under 10 thousand; due to artillery shelling was under 40 thousand, and due to hunger was up to a million.

In 1941, the FizTekh scientists Yu B Kobzarev, P A Pogorelko, and N Ya Chernetsov (Fig. 11) were awarded the Stalin Prize Class I for "the creation of the first radar system in the country for the detection of aircraft and ships." Having been introduced to the Redut RLS system at the end of the war, British experts were amazed by its simplicity, reliability, and the fact that it required only one antenna.

Figure 11. N Ya Chernetsov, P A Pogorelko, Yu B Kobzarev (right to left) on the testing site.

7. Strengthening of tank armor and design of night vision devices

On 17 May 1943, the Deputy Commander of the Armored Troops of the Red Army, N I Biryukov, received from Stalin the strictest guidelines concerning preparations for the Kursk Bulge battle [7]:

"Check the results of the investigation into *night driving devices*. You were not allowed to send them without permission... . Mine trawls and *night driving devices* are classified, not to be sent to anyone without permission... .[8]

[7] The principle applied at the time was acoustic location, but its usefulness began to decrease as the speed of aircraft steadily grew.

[8] Here is what happened. One of the tanks on which these devices were being tested was captured by the Germans. (*Note by A.G.Z.*)

Figure 12. L A Artsimovich.

Check where the regiment with *shielded tanks* is now, and report for the purpose of obtaining permission for its application."

Both classified products shown in italics were connected with LFTI [3].

Devices for night-time driving (*vision*) were developed under the direction of L A Artsimovich (Fig. 12) in specialized group (laboratory) No. 4 of the Kazan subdivision of FTI. By the coming of the winter of 1942–1943, an image converter with an antimony–cesium cathode, an image converter with image demagnification, and multistage light amplifiers were ready.

The Armor Laboratory of LFTI was set up in 1938 by the order of the People's Commissar of Machine Building; the lab was based on the world-renowned school of 'materials strengthening experts' of LFTI headed by UkrSSR Academician N N Davidenkov. Until 1942, the work of the Armor Laboratory [9] was led by V L Kuprienko, from February 1942 until August 1943 by I V Kurchatov, and after August 1943 by F F Vitman (Fig. 13).

In August 1941, the task set for the laboratory was to *find the main elements in the design of fuel tanks of aircraft* that proved to be the most vulnerable. The laboratory proposed a multisegment design of steel tanks coated on the inside by sponge rubber for leak 'healing'. The rubber was developed at LFTI under the guidance of A P Aleksandrov.

The use of HEAT projectiles (panzerfausts) by the German army in late 1942 posed an acute problem of the need for better armor-plating of Soviet tanks. The Armor Laboratory developed an efficient method of shielding the tank armor by a separated outer bar.

8. Thermoelectric power sources

The team led by Yu P Maslakovets (Fig. 14) of the Kazan subdivision of FTI [10] was solving problems concerning the development and production of thermoelectric power sources for guerrilla and sabotage units.

They used a zinc antimonide–constantan thermocouple [3]. The outside junction was heated by the flame of a bonfire, and the inner junction was at water temperature inside this 'guerilla kettle'. At temperature difference between the junctions, $\Delta T \approx 300\,^{\circ}\mathrm{C}$, and efficiency $\approx 2.0\%$, this source provided power supply to filament and anode circuits of portable radio transmitter–receivers. The production line started operations in March 1943 at Research Institute No. 627 affiliated with Experimental Plant No.1 [11](subsequently reorganized to form the All-Union Research Institute of Electromechanics).

[9] It was given No. 3 in the Kazan subdivision of LFTI.
[10] Theme group (laboratory) No. 1.
[11] Later on, the plant produced several tens of thousands of improved thermoelectric generators for nonelectrified areas of the USSR.

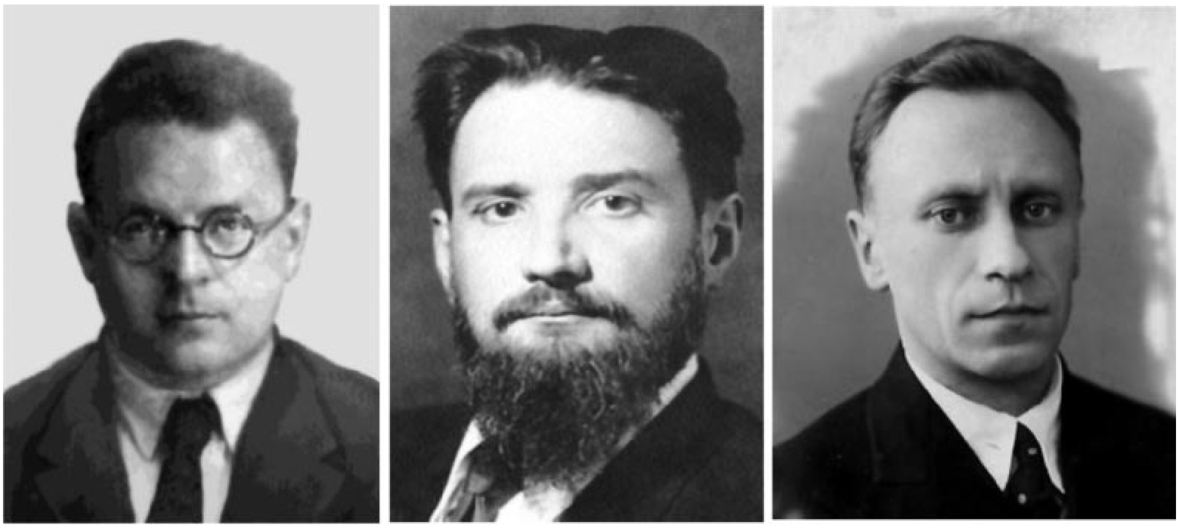

Figure 13. V L Kuprienko, I V Kurchatov, F F Vitman.

Figure 14. Yu P Maslakovets.

Figure 15. Testing the sagging-meter on the ice of Lake Suzdal. The man in the sheepskin coat near the instrument is P P Kobeko.

9. Maintenance of ice roads

In November 1941, during the first two weeks after the trucks on the 'Road of Life' started delivering goods from the Mainland to the sieged Leningrad using the puny road on the ice of the Lake Ladoga, nearly a hundred trucks were lost, not necessarily the heaviest (!). Consultation of Professor P P Kobeko at the Leningrad branch of the FTI was sought. Under his supervision, his colleagues rapidly designed an instrument for automatically recording vibrations of the ice sheet — a self-styled 'sagging-meter' (Fig. 15). Applying miraculous inventiveness, with an almost complete absence of materials,[12] they manufactured more than 50 such meters. The cause of destruction of the ice sheet was found to be the resonant amplification of oscillations when the speed of the truck became equal to the velocity of the waves under the sheet (about 35 km h^{-1}). Waves reflected from the shore and waves produced by other trucks also contributed to ice

Figure 16. Column of trucks on the Road of Life.

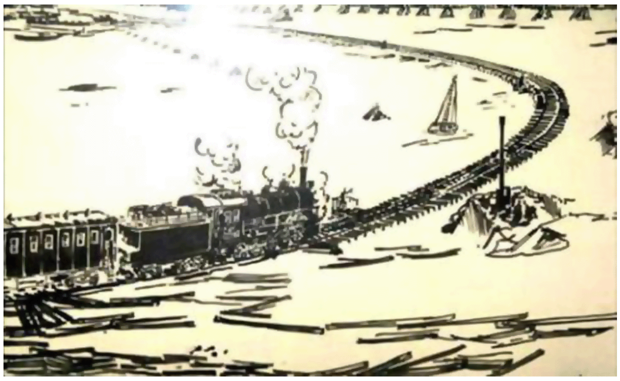

Figure 17. Shallow-water piles-and-ice bridge across the Neva River. Drawing by S P Svetlitskii (1943).

cracking. Strict traffic rules were worked out for each segment of the Road: they regulated truck speed and the intervals between trucks and truck columns (Fig. 16). The road functioned until 24 April 1942, when the ice sheet thickness had reduced to a mere 10 cm (!) [3].

In the course of preparing military operations of partly lifting the siege in January 1943, scientists of the Leningrad Branch of FTI with their sagging-meters took part in laying the piles-and-ice railway on the ice of Lake Ladoga (Fig. 17). Moreover, heavy KV tanks[13] were motoring on the Ladoga ice directly to the frontline, ignoring cracks! In January 1944, as part of preparations to completely crush the siege of Leningrad, a railroad was laid on the site of the current dam between Gorskaya and Kronstadt, where the shock troops were concentrated [3].

10. Creating an antibacterial 'preparation P'

In 1944, Winston Churchill sent Stalin a certain amount of penicillin. A part of the consignment went to Leningrad. However, there was already a locally created antibiotic known as 'preparation P'. It was developed at LFTI.

S E Bresler of the Kazan subdivision of FTI wrote a letter to his subordinate M V Glikina in the Leningrad branch of FTI (Fig. 18). Referring to the experience of WWI, he remarked that in the conditions of a steady-state frontline (as it was then outside Leningrad) the development of gas

[12] For their first device, the scientists made use of a segment of a cast-iron fence around the park of the Polytechnic Institute, which they dug out from under deep snow and dragged on a sledge to FTI.

[13] Tank gun turrets were dismantled (a simple procedure) and towed behind the tanks on skids.

Figure 18. S E Bresler and M V Glikina.

gangrene in the wounded is greatly speeded up, and he believed it necessary to try to develop an efficient antibacterial drug. S E Bresler suggested using for this purpose the method developed by Hugerheid (USA), who worked with some sort of soil bacteria. M V Glikina was lucky to hunt up the necessary soil bacteria in one of the institutes of blockaded Leningrad and to grow the desired culture. These results were included in the report of the FTI Leningrad branch for 1941; in early 1942, 'preparation P' was recommended for use and for further improvement in evacuation hospital No. 1170 located in the Aleksandro-Nevskaya Lavra [1]. Compared to penicillin, preparation P was found to be more efficient. Its taking reduced the mortality rate due to anaerobic infections by half.

11. LFTI and the Atomic Project

Wide-range research programs on the physics of atomic nuclei were launched at LFTI in the early 1930s. The corresponding structural unit of the institute — its 'nuclear group' — was established by the order of the LFTI director on 16 December 1932, which, among other things, reads:

"§ 1. A special group will be set up for nuclear research composed of Acad. A F Ioffe — head of group, I V Kurchatov — deputy head of group, M A Eremeev, D V Skobeltsyn, P A Bogdaevich, S A Bobkovskii, I P Pustovoitenko, L P Selinov, M P Bronshtein, and D D Ivanenko.

§ 2. G A Gamow and L V Mysovskii will be appointed consultants of the group."

A year later, it was decided that LFTI was capable of organizing and conducting a major international conference on the atomic nucleus in Leningrad. Only a few years later, A F Ioffe characterized the work on nuclear physics as the second most important field of research at the institute.

The soul of the 'nuclear' community at LFTI, and later the head of the Department of Nuclear Physics, was Igor' Vasil'evich Kurchatov. Colleagues respectfully called him the General because he would invariably and very soon become the leader of any undertaking that would be to his taste.

The development of experimental nuclear physics at LFTI needed support from the government. An example of the manner in which the General would organize this support is a letter from the LFTI staff to the Chairman of the USSR Council of People's Commissars, V M Molotov, concerning the basis of experimental nuclear research of 5 March 1938 [7]. Here is its brief summary. To make nuclear research at the LFTI fruitful, the institute needs 2 g of *radium* and a *cyclotron* (1,000,000 rubles on the whole — a fairly large sum at the time). The request was signed by A Ioffe, I Kurchatov, A Alikhanov, D Skobeltsyn, L Artsimovich, A Alikhan'yan, L Nemenov, L Rusinov, B Dzhelepov, G Shchepkin, V Kuprienko, V Dukelskii, Ya Frenkel, and some others (23 signatures in all). This was that very cyclotron: the newspaper *Pravda* reported the completion of its construction on 22 June 1941. Only three years passed between the submission of the request and the end of the construction work!

The cyclotron was the brainchild of I V Kurchatov, who guided both its design program and the building phase. In 1940, his postgraduate students G N Flerov and K A Petrzhak discovered the phenomenon of spontaneous fission in uranium nuclei. Kurchatov proposed the *experimentum crucis* testing: the effect was confirmed, but Igor' Vasil'evich refused to sign as co-author, assuming that his students conducted a largely independent research effort.

At the beginning of the war, Kurchatov's request to have him sent to the Army in the Field [3] was refused. He left nuclear research behind and joined A P Aleksandrov's command, which was doing degaussing of warships in the frontline zone. After A P Aleksandrov left Sevastopol, Kurchatov became head of the team of FizTekh experts at the Black Sea Fleet, which had done the huge job of lifting the siege of ships trapped in the bays by magnetic mines. I V Kurchatov returned to the Kazan team of FTI in December 1941 with severe pneumonia, and grew a beard (he would say: "until victory"; in fact — forever).

By the beginning of the war, LFTI was at the forefront of the atomic nucleus research. A number of scientists were aware of the fundamental possibility of utilizing the energy released in the fission of uranium nuclei for fabricating weapons of unprecedented destructive power. The terrible danger facing the country moved them towards initiation of the work on nuclear weapons and to address the Soviet Government on this matter;[14] this stimulated the beginning of the Soviet Atomic Project. S V Kaftanov, who was the State Defense Committee's representative on science, recalled [9] that along with intelligence sources, the Academy of Sciences, A F Ioffe and G N Flerov personally contributed to the governmental decision to launch the Atomic Project.

[14] For example, the letters written by N N Semenov, G N Flerov, and A F Ioffe are well known.

Figure 19. Triple-laureates of the distinction of Hero of Socialist Labor among the Soviet Atomic Project team who at some time worked at LFTI (left to right): I V Kurchatov, A P Aleksandrov, Yu B Khariton, Ya B Zeldovich, and K I Shchelkin.

To quote from GKO Order No. 2352ss, "On organizing the work on uranium", of 28 September 1942, which resulted from the letters written by A F Ioffe and S V Kaftanov to the GKO [10]: "Oblige the USSR AS (Academician Ioffe) to resume work on the feasibility of projects of utilization of atomic energy released by the fission of uranium nuclei and by 1 April 1943 to submit to GKO a report on the feasibility of creating a uranium bomb or uranium fuel.

For this purpose:

1. The Presidium of the USSR Academy of Sciences is empowered to:

A. Organize at the Academy of Sciences a special laboratory of atomic nucleus research...

7. Ensure the delivery to Kazan by 5 October 1942 from Leningrad by air cargo of 20 kg of uranium and 200 kg of equipment for physical research that belong to USSR AS FTI."

To manage the project, A F Ioffe recommended I V Kurchatov, who at that moment was heading the Armor Laboratory (Laboratory No. 3) at the Kazan subdivision of FTI. It was Kurchatov who prepared the analytical memo based on the Soviet intelligence materials, and then the above-mentioned report to GKO.

In March and April 1943, decisions of the USSR AS Presidium on the appointment of I V Kurchatov as head of the Nuclear Laboratory and on the organization of the laboratory itself appeared. The corresponding Order No. 86 for the Kazan subdivision of LFTI on setting up Laboratory No. 2,[15] on relieving I V Kurchatov of his responsibilities for Laboratory No. 3, and on transferring him and ten more FizTekh staff crucial for Laboratory No. 2 to Moscow was signed by A F Ioffe [1] on 14 August 1943. On 30 December 1943, the AS Presidium gave I V Kurchatov the power of attorney "for supervising the entire administrative, executive, and financial activities of Laboratory No. 2". On 27 January 1944, I V Kurchatov was "removed from the staff and remuneration list of LFTI in view of being transferred to the individual position of staff member" [11].

Thus ended the LFTI period of preparing and launching the Soviet Atomic Project. The main results obtained during this period and the contribution of LFTI to the project are the following.

(1). Creation of the world-famous domestic school of nuclear physics specialists — the core of the staff for the Atomic Project. All five outstanding scientists who took part in the Soviet Atomic Project and were awarded the distinction of Hero of Socialist Labor three times worked at LFTI during some of the years discussed here (Fig. 19).

(2) Initiation in the USSR of nuclear physics research and of the Atomic Project itself, proof of their importance and feasibility at the State level.

(3) Construction of the largest cyclotron in Europe. In 1943, its equipment was moved to Moscow. It started working at LFTI in 1946 and kept producing weapons-grade plutonium for the Atomic Project.

(4) Elaboration of technology for the separation of uranium isotopes for the Atomic Project.

(5) Development of neutron counters for tests of the atomic bomb.

The parity in weapons of deterrence created as a result of completion of the Soviet Atomic Project had an important influence on the life of humankind and still continues to make an impact in our time.

12. Science at LFTI in the war years

Even though defense-oriented projects were the main jobs for most scientists at LFTI, they nevertheless continued to do research and submit their theses.

In 1941–1945, 38 theses were submitted and defended by viva voce at LFTI: ten DSc's, and 28 PhD's [3]. According to the staff list of the institute, every other researcher received a PhD or DSc degree among those who could, in principle, do it. Thus, B P Konstantinov (Fig. 20), who headed the Physical Technical Institute in 1957–1967, was awarded with the PhD and the DSc degrees during the war (in 1942 and 1943).

In addition to the two Stalin Prizes of the war years (for radar and degaussing of ships), the following prizes were also awarded: A F Ioffe — for semiconductor research; N N Davidenkov — for strength of materials achievements; E F Gross — for light scattering results; G N Flerov — for the discovery of the spontaneous fission of uranium, and Ya I Frenkel — for studies in the theory of the liquid state.

Among the staff of the Academy of Sciences who received Stalin Prizes during the war years, and those we find in the Decree of the Presidium of the Supreme Soviet of 10 June 1945, which awarded orders and medals (for the war effort), the fraction of LFTI researchers comes to several percent. This is a measure of the enormous contribution to the Great Victory made by the Academy of Sciences of the USSR on the whole.

[15] By that time, the former Laboratory No. 2 of the Kazan subdivision of LFTI was no more, and thus nominated a mere vacancy.

Figure 20. B P Konstantinov.

13. Conclusion

The activities of LFTI are a clear example that the Great Patriotic War was not won on battlefields and in the rear only, but also in laboratories and design bureaus. Notice that the developments of Soviet scientists were qualitatively at least as good as those accomplished by the allies, and in many cases better. What LFTI did for victory and increasing the military might of the country in the post-war years was a part of the enormous contribution to the creation of principally new defense systems and types of weapons that the institutes of the Academy of Sciences and their scientists made. [16]

It is difficult to find the right words that would describe the unprecedented activities of the Leningrad Branch of FTI in the city under siege and its role in the heroic defense of the city, in which mere survival was already an exploit.

The mission of LFTI was to serve as a forgery of specialists capable of implementing large-scale projects, be it radar, the degaussing of warships, or the Atomic Project. Working in wartime conditions, and in some cases even at the frontline, trained a unique generation of scientists with an acute sense of social duty, capable of assuming responsibility in critical situations. It was no accident that participation in these projects became an important stage of personal maturation for a huge constellation of brilliant scientists — prominent organizers of Soviet science.

[16] This titanic work was carried out under the conditions of evacuation of the scientific and industrial complex of the country, which had no precedent in world history in terms of the shortness of time available and the scale of the undertaking.

Acknowledgments
I wish to express my gratitude to scientists of Ioffe FTI R F Vitman, B B Dyakov, and Yu I Koptev, whose work on the history of the institute greatly enriched my understanding of the work of LFTI during the war years.

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PACS numbers: **01.65. + g**, **28.52. – s**, **28.70. + y**
DOI: 10.3367/UFNe.0183.201305h.0528

Major stages of the Atomic Project

R I Ilkaev

1. Introduction

The implementation of the Soviet Atomic Project was an issue of the greatest State priority. Its solution was based on mobilizing the best personnel and cadres in the country, including specialists of the highest qualification, scientists in academic research institutes and industrial institutions, and organizers of the defense industry in the USSR, who identified candidatures and trained research and managerial leaders at every level of the Atomic Project.

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Uspekhi Fizicheskikh Nauk **183** (5) 528 – 534 (2013)
DOI: 10.3367/UFNr.0183.201305h.0528
Translated by V I Kisin; edited by A Radzig