Edit Proposal: Milestone-Proposal: Zenit three-coordinate parabolic reflector L-band pulsed radar, 1938

Docket ID: (admins only) 2014-02

Thank you for proposing a technical achievement for possible recognition as an IEEE Milestone in Electrical Engineering and Computing. Your efforts help preserve the heritage of technology. Detailed information on the Milestone application process may be found at: Milestones:Milestone Guidelines and How to Propose a Milestone.

Is the achievement you are proposing more than 25 years old? ◉ Yes ○ No

Is the achievement you are proposing within IEEE's fields of interest? (e.g. "the theory and practice of electrical, electronics, communications and computer engineering, as well as computer science, the allied branches of engineering and the related arts and sciences" – from the IEEE Constitution) ◉ Yes ○ No

Did the achievement provide a meaningful benefit for humanity? ◉ Yes ○ No

Was it of at least regional importance? ◉ Yes ○ No

Has an IEEE Organizational Unit agreed to pay for the milestone plaque(s)? ◉ Yes ○ No

Has an IEEE Organizational Unit agreed to arrange the dedication ceremony? ◉ Yes ○ No

Has the IEEE Section in which the milestone is located agreed to take responsibility for the plaque after it is dedicated? ◉ Yes ○ No

Has the owner of the site given permission to place an IEEE plaque? ◉ Yes ○ No

Contact us at ieee-history@ieee.org if you are unable to answer "yes" to all of the above and would still like to proceed.

Year or range of years in which the achievement occurred: 1938

Title of the proposed milestone. (Include date or date range in title. Example: "Alternating Current Electrification, 1886")

"Zenit parabolic reflector L-band pulsed radar, 1938"

Please provide a plaque citation in English summarizing the achievement and its significance. *Text absolutely limited by plaque dimensions to 70 words; 60 is preferable for aesthetic reasons. NOTE: The IEEE History Committee shall have final determination on the wording of the citation.* For more information and suggestions about writing milestone citations, please visit Milestones:Helpful Hints on Citations, Plaque Locations.

"A major advance in the national development of radar occurred at the Laboratory of Electromagnetic Oscillations of the Ukrainian Institute of Physics and Technology in 1938, when radar Zenit was tested. Designed by Abram Slutskin, Alexander Usikov and Semion Braude, microwave scientists and magnetron pioneers, it established the practicality of the combination of pulsed method and a shorter wave band in the precise determination of all three coordinates of airborne targets".

In what IEEE section(s) will the milestone plaque(s) reside? IEEE Ukraine Section

Please specify the IEEE Organizational Unit(s) which have agreed to sponsor the Milestone, and supply name and contact information for the senior officer from those OU(s). *Sponsorship has three aspects: 1) Payment for the cost of the plaque(s), 2) Arranging the dedication ceremony, and 3) agreeing to monitor the plaque and to let IEEE History Center staff know in case the plaque needs to be moved, is no longer secure, etc. Number 3 must be done by the IEEE Section(s) in which the plaque(s) is located, but aspects 1 and 2 can be done by any IEEE Organizational Unit, and they need not be the same one.* **Please note:** your email address and contact information will be masked on the website for privacy reasons. Only IEEE History Center Staff will be able to view the email address.

IEEE Organizational Unit(s) paying for milestone plaque(s)

Unit: IEEE East Ukraine Joint Chapter

Senior Officer Name: Nataliya Sakhnenko

E-mail: n_sakhnenko@yahoo.com

Unit: IEEE Ukraine Section

Senior Officer Name: Valerii Zhuikov

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IEEE Organizational Unit(s) arranging the dedication ceremony

Unit: IEEE East Ukraine Joint Chapter

Senior Officer Name: Nataliya Sakhnenko

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Unit: IEEE Ukraine Section

Senior Officer Name: Valerii Zhuikov

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IEEE section(s) monitoring the plaque

IEEE Section: IEEE Ukraine Section

IEEE Section Chair name: Valerii Zhuikov

IEEE Section Chair e-mail: valery.zhuikov@gmail.com

Milestone proposer(s)

Proposer name: Alexander Nosich

Proposer email: anosich@yahoo.com

Proposer name: Nataliya Sakhnenko

Proposer email: n_sakhnenko@yahoo.com

Street address(es) and GPS coordinates of the intended milestone plaque site(s).

Old campus of the National Science Center “Kharkiv Institute of Physics and Technology” (NSC KIPT) of the National Academy of Sciences of Ukraine, vul. Chaykovskoho 2, Kharkiv 61002, Ukraine

What is the intended site(s) of the milestone plaque(s) relation to the achievement? The intended site(s) must have a direct connection with the achievement (e.g. where developed, invented, tested, demonstrated, installed, or operated, etc.). A museum where a device or example of the technology is displayed, or the university where the inventor studied, are not, in themselves, sufficient connection for a milestone plaque.

Also, please Describe briefly the intended site(s) of the milestone plaque(s). (e.g. Is it corporate buildings? Historic Site? Residential? Are there other historical markers already at the site?)

Entrance to the old campus of the National Science Center “Kharkiv Institute of Physics and Technology” (NSC KIPT) of the National Academy of Sciences of Ukraine. Radar Zenit was conceived in 1935, developed since 1937, and demonstrated at that site in 1938. This is a corporate building. There are no historical markers at the site.

Are the original buildings extant? Yes

Please provide the details of the mounting, i.e. on the outside of the building, in the ground floor entrance hall, on a plinth on the grounds, etc.

On the outer wall of the ground floor entrance hall.

How is the intended plaque site protected/secured, and in what ways is it accessible to the public? If visitors to the plaque site will need to go through security, or make an appointment, please give details as well as the contact information visitors will need in order to arrange to visit the plaque.

As the plaque is supposed to be placed on the outer wall, the plaque will be accessible for all visitors and public.

Who is the present owner of the site(s)? National Science Center “Kharkiv Institute of Physics and Technology” (NSC KIPT) of the National Academy of Sciences of Ukraine

Please attach a letter in English, or with English translation, from the site owner(s) giving permission to place IEEE milestone plaque on the property.

Zenit-site-owner-permission2014.pdf

Please attach a letter or email from the appropriate Section Chair supporting the Milestone application.

MZenit-supportSectionUA.pdf

In the space below, please describe in detail:

- the historic significance of the achievement,
- its importance to the evolution of electrical and computer engineering and science,
- its importance to regional/national/international development,
- its benefits to humanity,
- the ways the achievement was a significant advance rather than an incremental improvement of existing technology.

The material submitted here will constitute the main descriptive article on the GHN website for readers to learn about the milestone. Space is unlimited, and detail is encouraged. Most milestones require 1000 to 1500 words of support, however there is no word limit. The article should be readable by a wide audience that includes practicing engineers, scholars of history, and the general public. Some examples of the text of good milestone articles are Milestones:First Radio Astronomical Observations Using Very Long Baseline Interferometry and Milestones:International Standardization of G3 Facsimile (Do not worry about the formatting of the page, IEEE History Center Staff will do that afterwards.)

What is the historical significance of the work (its technological, scientific, or social importance)?

As to the regional and national Ukrainian development, one can state that Zenit work performed in Kharkiv in the 1930’s served as a cradle for the whole microwave, antenna, and radar community in Ukraine [1-7]. The group of talented microwave and radar scientists was headed by Prof. A. Slutskin, who was inventor of a very successful L-band split magnetron first reported by him as early as 1926, and the initiator and leader of the Zenit project. His staff members and former students A. Usikov and S. Braude discovered the pulsed operation of magnetron, and were responsible for the transmitter and receiver units of Zenit, respectively. Later Usikov and Braude were the founders of the Institute of Radio-Physics and Electronics of the National Academy of Sciences of Ukraine (IRE NASU, 1955) and the Institute of Radio Astronomy (IRA NASU, 1985) in Kharkiv.

Thanks to successful development of L-band magnetrons and Zenit in the 1930’s and mm-wave magnetrons in the late 1940’s, other important establishments were opened in Kharkiv after WW II. To mention only a few, these were the USSR Military Academy of Radio Engineering (1947), the School of Radio Physics at the Kharkiv National University (1952), the Kharkiv National University of Radio Electronics (1963), and the Hartron Space Control Systems Industry (1960).

All these establishments and their offspring are at the core of today science and technology in the electromagnetic waves and their applications in the independent Ukraine [6]. Since then, Kharkiv has become and remains the major Ukrainian center of research into microwaves, millimeter waves, and sub-millimeter waves.

Still the work on Zenit should be evaluated separately in relation to the USSR technological developments as Ukraine had been a part of that country until 1992. In the scope of the USSR, Zenit technology clearly demonstrated the strength and merits of combined use of shorter-than-usual for the late 1930's waves and the pulsed method, in the determination of all three coordinates of the flying aircraft. A crucial evidence of the role played by Zenit is found in the capital Soviet source on the history of national radar – the book of Gen. M. Lobanov [8] who was supervising all gun-laying radar works before and during WW II.

Here, it must be noted that an earlier journal article of M. Lobanov was extensively cited in the famous work of J. Erickson [1] and his later book chapter [2], where the development of Zenit was also mentioned, together with its test in October 1938. That article, published in 1962, was a precursor to Lobanov's much more comprehensive book [8] published in 1973.

It must be also emphasized that the negative evaluation of Zenit given in the generally well documented and in all other aspects accurate book of Louis Brown [10] with a reference to the book of Lobanov is erroneous. Lobanov had devoted three full pages to Zenit, described this achievement with strong sympathy and concluded with very high evaluation. It is apparent that, unlike Erickson's thorough study of preceding Lobanov's article, L. Brown never read the book of Lobanov and used apparently only a poor quality translation of selected pages.

This overlook has been corrected and important role of Zenit has been fully acknowledged in the later published encyclopedia of radar history worldwide of Raymond Watson [11] – see pp. 292-296.

For the international technological development, Zenit remained largely unknown and had little or no impact. Still there exists a certain mystery. There is an article in the Ukrainian newspaper "Evening Kharkiv" dated 2000 [9] stating that the German intelligence, apparently political service SD, was aware of that work in Kharkiv and put some efforts to obtain information about it. The journalist claimed that in the 1970's he was told by the pre-war and wartime Soviet minister of communications, Signal Corpse Marshal I. Peresypkin that the latter had a copy of the German intelligence report bearing the handwritten note of Hitler ordering to send the best spies to Kharkiv for radar intelligence. This interest could be connected to the work in Germany on a similar system later known as Wurtzburg radar (wavelength 53 cm, 3-m parabolic dish antenna).

Today one can also state that besides of above-mentioned points, the success of Zenit demonstrated one other principle of deep social meaning. The highly innovative R&D, even in defense-related area, has better chances for a rapid progress at a civil laboratory rather than at a military one. This was never admitted in the highly militarized and infested with spy-mania USSR, however was well known circumstance in the UK and USA, where famous civil organizations such as the Telecommunications Research Establishment and the Radiation Laboratory at the Massachusetts Institute of Technology, respectively, had played crucial role in the acceleration of radar developments during the WW II [see, e.g., IEE Proc. A, Special Issue on Historical Radar, vol. 132, no 6, 1985; R. Buderi, The Invention that Changed the World, NY: Touchstone, 1997].

What obstacles (technical, political, geographic) needed to be overcome?

In the mid-1930's, it was still far from obvious that the pulse radar technique had advantages before the continuous-wave radar. In similar manner, the use of waves shorter than a few meters in length was not yet considered as a mainstream of radar development. Before Zenit, the USSR engineers and scientists were arguing that the continuous-wave Doppler principle was more promising and that the meter waves were better suited for the early warning and gun-aiming applications [1-5]. This was true for radar-related research both in the USSR and globally, where the UK-based Home Chain radar network can be a good illustration. Therefore pursuing such a challenging direction in the conditions of Kharkiv was a matter of great courage and real insight into the problem.

Besides of that, one should be reminded that in 1932-1933, a genocide-scale famine devastated Ukraine when the Communist Party government decided to eliminate the grain market. Then the Soviet secret police, GPU was ordered to confiscate, if the grain tax could not be paid off, all other foods from the farmers. As, besides of Ukraine, such killing measures were introduced only in the North Caucasus and a part of Volga region inhabited by the ethnic Germans, this artificial famine is believed to be the political action of Russian communists, with a smell of ethnic cleansing. Today the most conservative estimations place the number of victims in Ukraine close to 4 million. The end of this cruel campaign saw independent farmers eliminated and the USSR being the largest grain seller in the world market. The obtained funds enabled the government to buy sophisticated machinery, tools, and equipment in the West, shaken by the global economic crisis, build factories and power stations, and feed the military. In a way the UIPT scientists were also fed and their labs equipped at the expense of the starved to death peasants whose bodies were collected in hundreds every morning along the Kharkov rim by the police patrols. Although very few people knew about the real scale of famine as any reference to it in the news was strictly prohibited, the scientists of LEMO felt great concern of the situation [7].

Despite these tremendous technical and political obstacles, by the end of 1936 LEMO-UIPT had carried out a wide-range fundamental research on the magnetron generation method and had a complete set of the 60-cm (L-band) devices both for CW and pulse operation. This was a solid background for launching a complex work on developing pulsed "radio-searchlight", as it was called by Slutskin when he conceived the idea in 1935. By that moment, several laboratories in the USSR were fiercely competing for the design of radar. However, only LEMO happened to possess the both of two crucial ingredients – high-power source of short enough waves and experience with pulse method. The key point was the pulsed mode of operation of their decimeter-wave magnetrons – this seems to be the exclusive know-how of LEMO by 1936, without any close competitors in the USSR or elsewhere before 1938.

In fact, Zenit had good chances to serve, after final improvements planned for 1941, as a principal USSR fighter-guidance and gun-aiming radar system. This is proved by the protocols of the official government commission that tested Zenit in September 1940, found in Usikov's private archive [4,5]. However such radar was not developed by the start of the Hitler's offensive on the USSR. The failure of the project was not a result of bad engineering but rather of the Orwellian circumstances of the Soviet life in the late 1930's. Starting from 1935, UIPT was swept by a wave after wave of spy-mania investigations of the Soviet secret police, NKVD. As explained in [4,5,7], their main target was Lev Landau and foreign scientists who had been arrested, jailed, and interrogated; however by 1939 the work of LEMO was irreparably spoiled as well.

What features set this work apart from similar achievements?

The work on Zenit was on the mind of A. Slutskin since 1935, officially started in March 1937, and lasted, with breaks, till the end of 1940. The date of October 14, 1938 should be paid a special attention as that day, according to S. Y. Braude, the first successful field-test of Zenit was performed in Kharkiv demonstrating the ability to accurately determine all three coordinates of a flying airplane [1,2,5]. Importance of that event was tremendous as apparently all radars in service and in development that existed at that moment (i.e., British Chain Home, German Freya and Seetakt, Soviet Burya, Rapid and Redut, and Doppler radar prototypes developed at the Tohoku University, Japan and in the laboratory of Marconi in Italy) were able to determine the azimuth of the target and either its range or elevation, while the third coordinate remained essentially undetermined. Zenit was able to overcome this drawback thanks to the lucky combination of two principal innovations: it used pulsed method and worked with shorter than common waves of the 60-65 cm wavelength.

Pulsed method itself was not absolutely new as it was first tested in Germany (Lorenz Co.) in 1936 and in the UK, USA (L. Young and R. Page), and USSR (M. D. Gurevich, Jr. [8, p.52]) even earlier, in 1934. However by 1938 it had gained no significant attention of the military and civilian customers both in the USSR and abroad. Important exception was apparently the UK Chain Home early-warning network using the pulsed method from the start; however its ability to determine the target range and bearing was greatly degraded by the small resolution because of the 26-m (1936) to 10-m (1939) wavelength. The USSR experts then commonly viewed the continuous-wave principle of radar as more promising [1,4,8]. Initiative of Zenit development came from a civilian R&D laboratory, which was eager to explore the opportunities given by a freshly discovered pulsed mode of their original L-band split-anode magnetron operation. In this aspect Zenit was a champion – it was apparently the first ever radar with a pulsed magnetron source although the German Wurtzburg engineers had tried magnetrons at approximately the same period.

Decimeter (L-band) waves were also actively studied at that moment in many countries. Anyway at the time of its first test Zenit apparently had the most powerful decimeter-wave source of 3 kW in the world, and by 1940 it used the source of 17 kW. Indeed, the cavity magnetron at the 9.8-cm wavelength was invented in the UK in the beginning of 1940, improved for 10-kW power by the end of 1940, and used in radars since 1941.

Before that, in the UK the Chain Home network operated with 26 m to 10 m wavelengths, and AMES-2 radar working with 1.5 m waves, for the Chain Home Low, appeared only in the end of 1939; in the USA experimental 50-cm gun-aiming radar was developed by the Bell Laboratories only in 1940; in Germany the prototypes of the early-warning radar Freya and naval radar Seetakt used 2.4 m and 80 cm wavelengths, respectively, while radar Wurtzburg working with a shorter, 53 cm, wavelength had not appeared before 1939 or 1940; and in Japan the waves shorter than 10 m and pulse method was apparently not applied in radar studies at all until 1941 - see [11] and also IEE Proc. A, Special Issue on Historical Radar, vol. 132, no 6, 1985; R. Buderi, The Invention that Changed the World, NY: Touchstone, 1997.

Significant references to establish the dates, location, and importance of the achievement. Minimum of five (5), but as many as needed to support the milestone, such as patents, contemporary newspaper articles, journal articles, or citations to pages in scholarly books. At least one of the references must be from a scholarly book or journal article.

1. J. Erickson, "Radio-location and the air defence problem: The design and development of Soviet radar 1934-40," Science Studies, vol. 2, pp. 241-268, 1972.

2. J. Erickson, Chapter 16 in Radar Development to 1945, ed. by R. Burns, Peter Peregrinus/IEE Publ., 1988.

3. S.S. Swords, Technical history of the beginnings of Radar, Peter Peregrinus/IEE Publ., 1986, section 4.7.

4. A.A. Kostenko, A.I. Nosich, I.A. Tishchenko, “Development of the first Soviet 3-coordinate L-band pulsed radar in Kharkov before WWII”, IEEE Antennas Propagat. Magazine, vol. 44, no. 3, pp. 28-49, 2001. [attached]

5. A.A. Kostenko, A.I. Nosich, I.A. Tishchenko, “Radar prehistory, Soviet side: development of the first 3-coordinate L-band pulse radar in Ukraine in the late 1930’s”, IEEE Antennas Propagat. Symp. Digest, Boston, vol. 4, pp.44-47, 2001.

6. A.I. Nosich, Y.M. Poplavko, D.M. Vavriv, F.J. Yanovsky, “Microwaves in Ukraine”, IEEE Microwave Magazine, vol. 2, no 4, pp. 82-90, 2002. [attached]

7. A.I. Nosich, A.A. Kostenko, "In the labor people's name: development of 60-kW magnetrons in the artificial famine plagued Ukraine in the early 1930s," Proc. Int. Conf. Origins and Evolution of the Cavity Magnetron (CAVMAG-2010), Bournemouth, pp. 82-88, 2010. [attached]

8. M. Lobanov, The Beginning of Soviet Radar, Moscow, Sov. Radio Publ., 1973 (in Russian).

9. V. Artemenko, "Watched by Muller," Newspaper “Vecherny Kharkov” (Evening Kharkov), no 128 (8189), page 4, 16.11.2000 (in Russian with translation). [attached]

10. L. Brown, A Radar History of World War II: Technical and Military Imperatives, Taylor and Francis Publ., 1999.

11. R. C. Watson, Jr., Radar Origins Worldwide: History of Its Evolution in 13 Nations through World War II, Victoria, Trafford Publ., 2009.

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