

## HISTORY OF EARLY MAGNETRONS AND PULSE RADAR IN UKRAINE

**Objective.** Kharkov is the second largest city of Ukraine and one of the major centers of science and technology in FSU. Between 1919 and 1934 it was the capital city of then Soviet Ukraine. The subject of the proposed study is closely tied to the history of the Kharkov State University (KhSU, since 1805), the Ukrainian Institute of Physics and Technology (UIPT, since 1929), and the Institute of Radio-Physics and Electronics of the National Academy of Sciences of Ukraine (IRE NASU, branched off UIPT in 1955). The following topics related to the pioneering R&D into microwaves are supposed to be studied, clarified and published: L-band magnetrons (1920-1940s) and 3-coordinate L-band pulse radar (1930-1940s).

**Background.** Prof. Abram Slutskin started magnetron studies in KhSU in the early-1920s. By the end of decade, he reached the world highest level in terms of output power and frequency. This was materialized in the expression “to bring the output power in watts to the value of the wavelength in centimeters”. The shortest wavelength obtained in 1925 was reported as 7 cm. This work was continued and greatly extended when UIPT was established in 1929 in Kharkov, then the capital city of Ukraine. Slutskin obtained there his second job as a head of the Laboratory of Electromagnetic Oscillations (LEMO) and dwelled on the development of both continuous-mode and pulsed magnetrons with the wavelength around 60 cm (*L*-band). UIPT was brand-new research center aimed mainly at the fundamental studies of nuclear, magnetic and low-temperature phenomena. It was staffed with young and ambitious graduates of the older Russian science hubs, such as the Leningrad Institute of Physics and Technology. In contrast, the field of R&D in LEMO was more on the engineering side of science with emphasis on defense applications; the staff was mainly from Kharkov. In the beginning years UIPT became famous for its very open and free style of scientific exchange and interaction, very unusual for the spy-mania and political purges of USSR. Many world celebrities in physics willingly visited it and used to stay and give lectures and seminars. Several dozens of foreign researchers, mainly Germans and Austrians who escaped from the Nazis, were given posts at UIPT. The institute published its proceedings in German to facilitate a global dissemination of results. It was in this journal that LEMO researchers published their papers on early magnetrons.

No surprise that LEMO success attracted the attention of the military. Based on the successful magnetron development, Slutskin started, in 1937, the works on developing 3-coordinate *L*-band pulse radar. Then it was far from clear that this band and the pulse method would be more promising. It should be emphasized that Orwellian environment of the FSU forced engineers and scientists to use the defense R&D as a shield from political purges frequent in the late 30's. In addition, the team of Slutskin got under strong pressure inside UIPT from the “pure physicists” led by the future Nobel Prize winner, 28-year-old L. Landau. As a result, the work of LEMO was almost paralyzed. Nevertheless, several two-antenna radar prototypes were successfully designed, fabricated and tested in 1938 to 1940. Radar *Zenit* was the first device able to locate an airborne target in all three coordinates (other contemporary devices determined only two coordinates such as distance and azimuth). This work was intensified in 1940. First antennas were solid parabolic reflectors fed by in-focus half-wave dipoles, with the source and receiver units placed on the back side of each reflector. It was planned to develop more sophisticated single-antenna radar with improved characteristics and shorter dead-zone. However the war disrupted all the plans, and no radar was put into serial production. Indeed, the catastrophe on the front led to the loss of Kharkov after less than four months of fighting. LEMO was evacuated very far away, into the desert of Central Asia. There, in Bukhara, the team did their best to improve the radar. They succeeded in solving many technical problems by using innovations that were well ahead of the existing level of radar engineering. Finally, *Rubin* single-antenna radar using a wire-grid reflector was assembled and tested in the Arctic in 1944. It had shown champion performance in detection of all kinds of naval targets and low-flying aircraft. Although as early as in 1942 the USSR government decided to start back-engineering of radars supplied by the Western powers, the experience of LEMO played very important role in the further development of the microwave community in Kharkov and Ukraine.