Lavochkin Association: Past, Present, Future.

On the 85th anniversary of the enterprise

On June 1st, 2022 Lavochkin Association celebrated the 85th anniversary. Throughout its activity, the company has implemented responsible government orders in the field of creating aircraft structures, rocket technology, spacecraft for scientific research of deep space. The ideas and projects of the designers were embodied in unique products: a complex symbiosis of devices and aggregates.

The history of Lavochkin Science and Production Association starts from April, 1937. It was the time when the Counsel of Work and Defense of the USSR decided to hand over the Furniture Factory, located in Khimki, to the People's Commissariat of Defense Industry to launch the aeronautic manufacture on its base. **The order №121** of the recreated aviation manufacture, dated by June 1, 1937, was assigned a number 301.

In September 1939 the **Design Bureau** was created, headed by the three chief engineers: **S.A. Lavochkin, V.P. Gorbunov and M.I. Gudkov**. At the end of 1940 it was decided to mass-produce the **LaGG-3 fighter**. This aircraft was the first and the last joint work of Lavochkin, Gorbunov and Gudkov designers. Then their paths diverged, each headed his own Design Bureau.

By development of **the first LA fighters Semeon A. Lavochkin** showed his inherent innovation: he proposed delta wood as the main structural material, which had not previously been ever used for that.

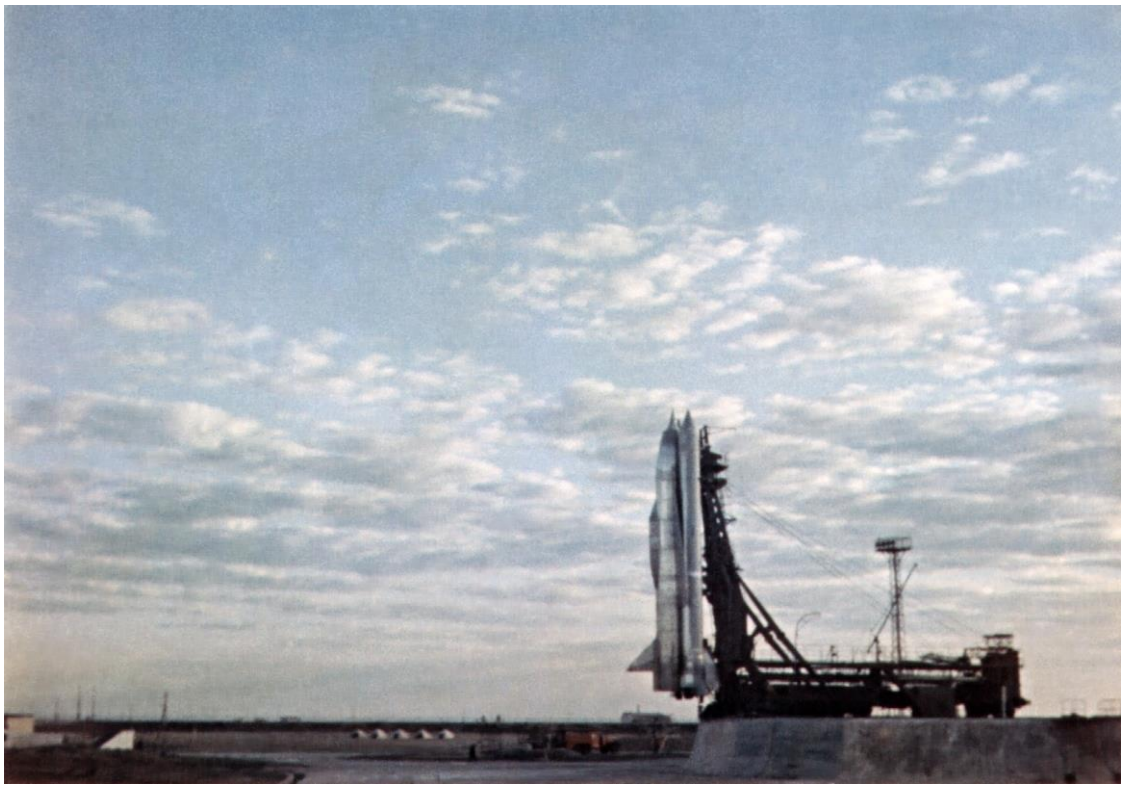
During the World War II more than **22 thousand LA fighters** were handed over to Russian Air Forces. It was almost the third part of all military fighters of the country. The Lavochkin Association Design Bureau was honored by the highest government award – **the Order of Lenin (1944)** for the two types of fighters (LA-5 and LA-7) during the World War II.

Since 1945 the Lavochkin Design Bureau has been working on the design and development of fighters with jet engines. By 1947 the **LA-160 fighter was created, the first domestic swept wing aircraft**. Under the leadership of S.A. Lavochkin, the work continued by development of **the first domestic aircraft with a large sweep wing LA-176 fighter.** In December 1948 that fighter achieved acoustic velocity for the first time in the USSR.

Then in **1949 the all-weather fighter-interceptor LA–200** was developed and **in 1956 LA–250 (Anaconda)** a fighter that was not inferior to the most advanced machines of that time and equipped with air-to-air missiles with homing heads, which were also developed by the Lavochkin Design Bureau.

In 1950 S.A. Lavochkin got the special government assignment to create the surface-to-air guided missiles for the newest air defense (AD), aimed at the defense of the major industrial center and Moscow foremost. And in 1955 protective Moscow rings of the **S-25 (Berkut)** air defense system with anti-aircraft guided missiles **(ZUR) 205** appeared around the capital. For almost 30 years various modifications of these missiles have been on combat duty, guarding the sky over Moscow. For this work the R&D Bureau and Plant team was awarded the **Order of Red Banner of Labor.**

In mid 50s the world's first Burya intercontinental supersonic cruise missile was developed and successfully tested. Ideas, design solutions, technologies, the latest materials embedded in the Burya missile design were decades ahead of time. The rocket had a fully titanium body and was equipped with an astrogation system.



During next two decades the Design Engineering Bureau lead by S.A. Lavochkin, expanded from a small group of constructors to the greatest air-missile engineering bureau of the country. Over the years, **more than 30 types of aircraft** have been developed and built, of which 10 were mass-produced, and **more than 20 types of missiles** and unmanned aerial vehicles. Many of them were of **priority importance** for the defense of our country.

On June 9, 1960 Semyon Alekseevich Lavochkin died suddenly of a heart attack at the southern Sary-Shagan polygon during the Dal' air defense missile system testing.

By the Government decision after the death of the General Designer, the enterprise became known as the Lavochkin Engineering Plant.

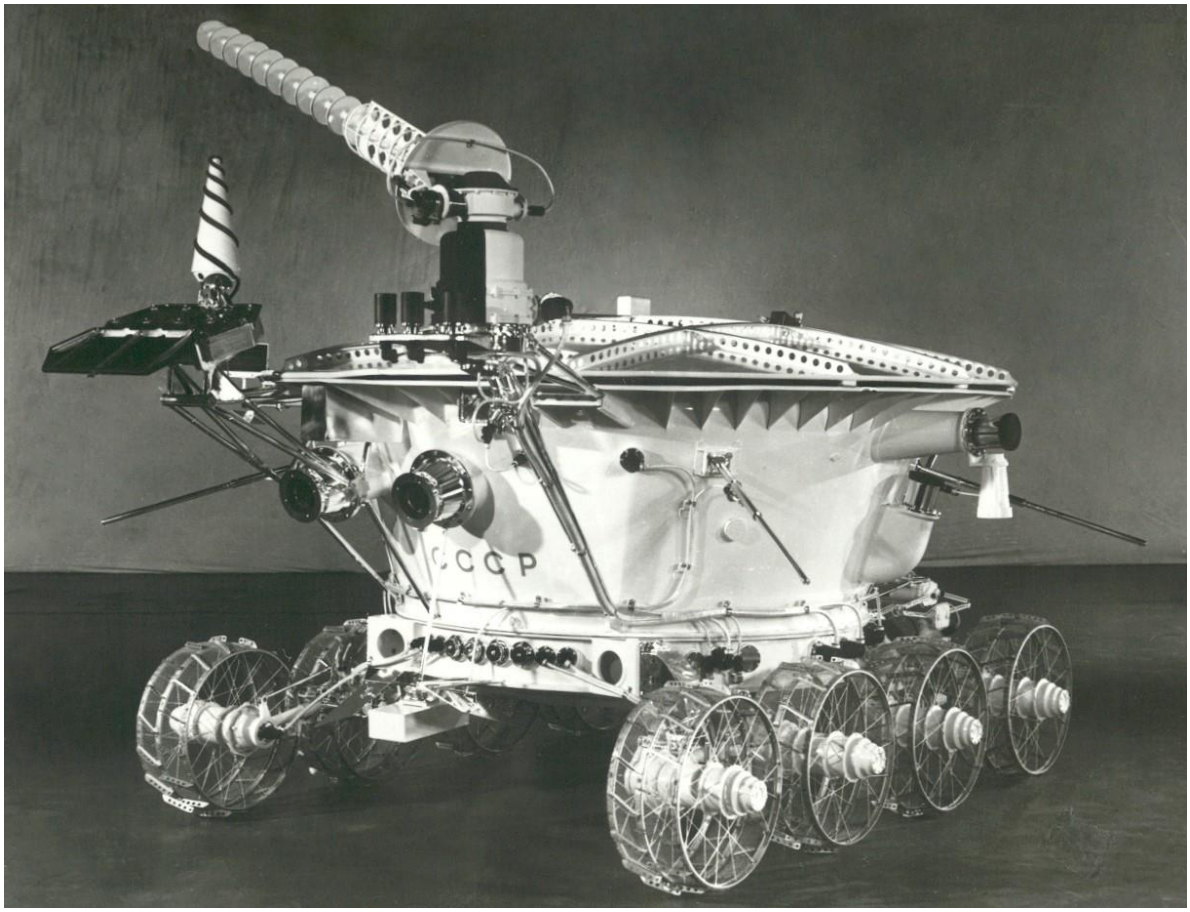
Between 1962 and 1964 the plant was the OKB-52 branch, the design bureau headed by V.N. Chelomey. They were involved in creation of missiles for the Navy (anti-ship missiles, missiles of the Amethyst system).

In 1965 the enterprise opened its new "chapter" by transfer under supervision of the USSR General Mechanical Engineering Ministry. Since then Lavochkin Engineering Plant has been engaged in development and manufacturing of **automated space stations for the Moon, Venus, Mars exploration**, artificial Earth satellites and applications spacecraft. In addition, it started development, manufacturing and operation of upper stages intended for spacecraft inserting into target orbits.

In 1965 **Georgy N. Babakin** was appointed Chief Designer of the Design Bureau. The brightest page in the history of space exploration by automated stations is associated with the name of G.N. Babakin.

In 1965-1976 the development of automated lunar stations was one of the mainstreams of the enterprise activities. During these years, a number of unique spacecraft was created that made a huge contribution to the study of the Earth's natural satellite (4 priorities of global importance).

For the first time the spacecraft, produced by our plant, demonstrated the capability to perform a controlled landing on the Moon surface (**Luna-9 SC**). The **Luna-10 space station** became the first artificial Moon satellite. The next generation stations **Luna-16, Luna-20, Luna-24** automatically collected the samples from the various Moon areas and depths of drilling, then delivered them to the Earth. It was the first time when the **Lunakhod-1** rover being controlled from the Earth, demonstrated a long-lasting multi-kilometer travel on the Moon surface.



In December 1971 for the brilliant implementation of the Moon Exploration Program Lavochkin Design Bureau and Plant team was awarded **the second Order of Red Banner of Labor.**

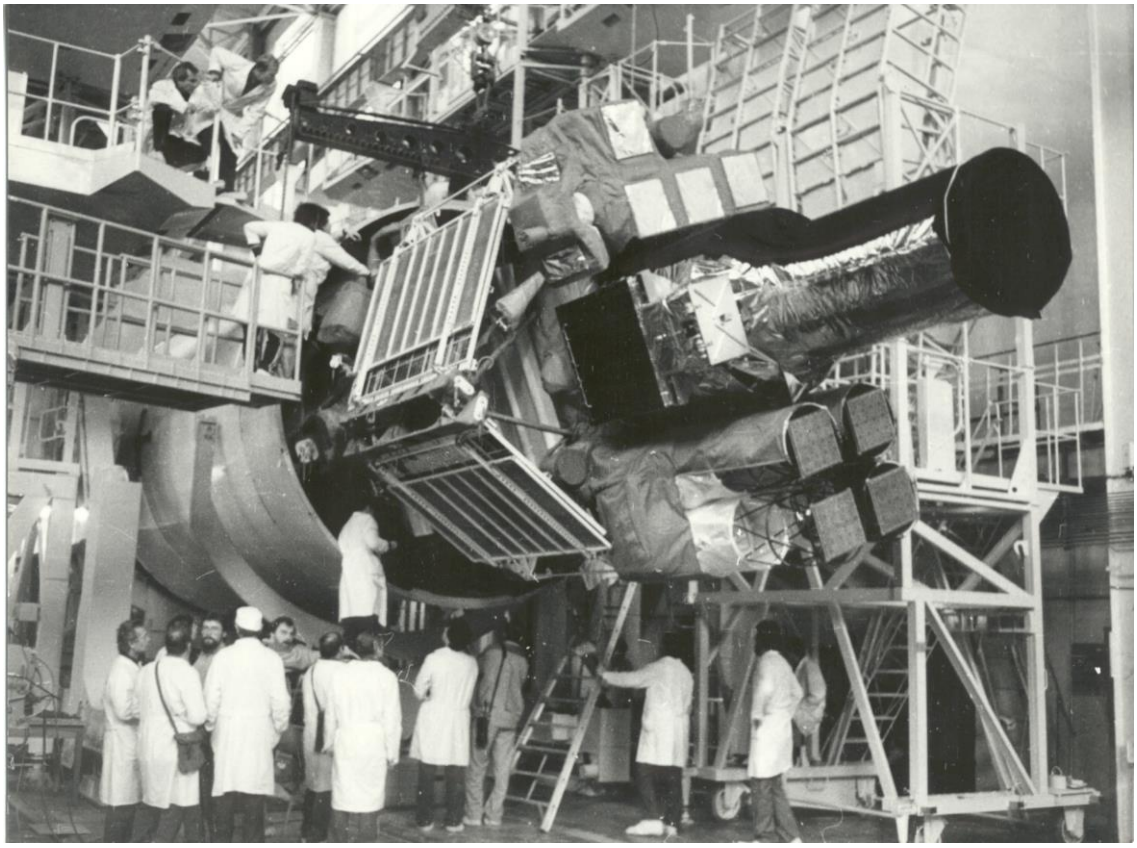
Since 1967 the interplanetary stations Venera-4, Venera-5, Venera-6 and Venera-7, developed under G.N. Babakin’s leadership have been sent to Venus. It was the landing vehicle of **Venera-7 station (1970) which was the first** to succeed in reaching the surface of the planet and transferring the data on the landing place temperature, pressure and atmosphere gas composition. Since 1975 the next generation stations have become the world's first artificial satellites of Venus, transmitted black-and-white and color panoramic images of the surrounding area, took

soil samples and conducted their chemical analysis on board the descent vehicle. These studies were of great scientific importance for understanding the processes occurring on Venus.

In 1970s the enterprise was renamed as Lavochkin Science and Production Association and started development and testing automated interplanetary stations Mars-2 to Mars-7. **The Mars-3 spacecraft** became the first to perform a controlled landing on the Mars surface. The enterprise has built many generations of interplanetary stations that performed a significant scope of studies of Mars and its moon Phobos.

In 1986 for the first time in the world, the **Vega-1 and Vega-2** stations transmitted unique images of the Halley's comet core. For the first time in the domestic space navigation practice the mission profile included a sequential flight towards two celestial bodies: Venus and Halley's comet aimed at their studying.

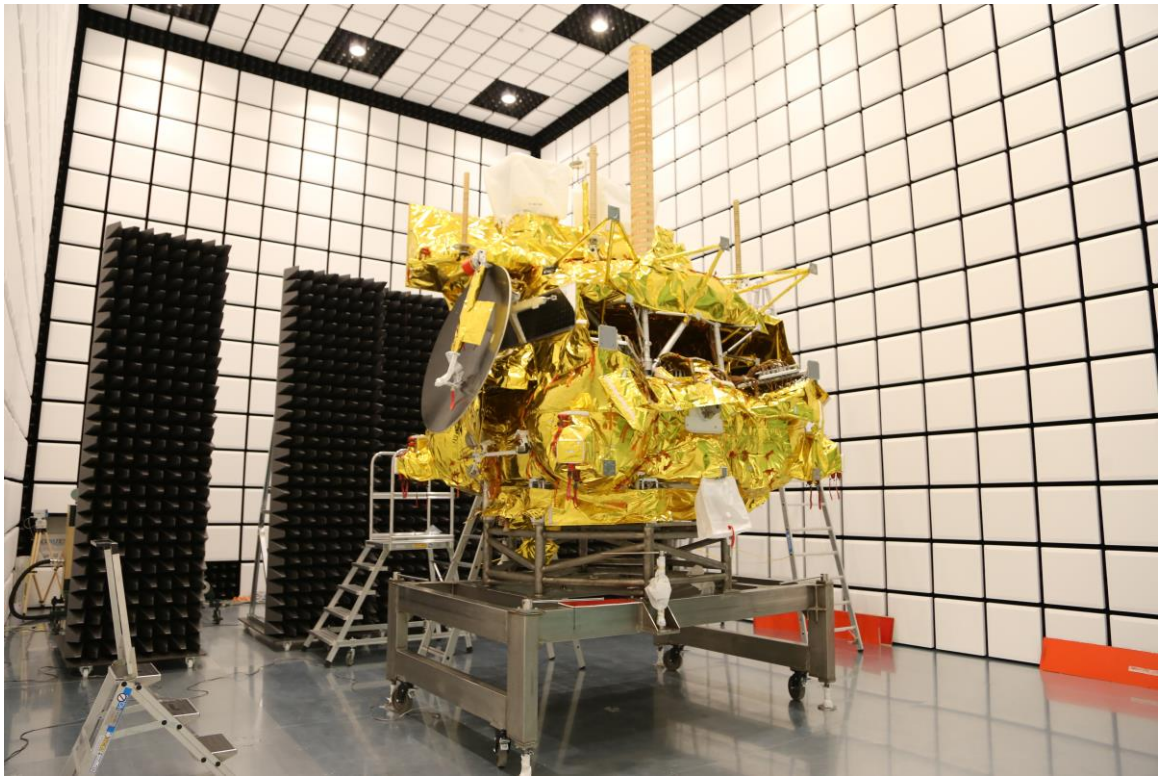
In close cooperation with astrophysicists Lavochkin Association was a success as the Prime contractor for development of extra-atmospheric astrophysical observatories. **Astron Space Observatory** operated in outer space for more than six years (launch in 1983), and **Granat Observatory** (launch in 1989) for more than nine years; scientific results obtained by these spacecraft have entered the history of world astrophysics and lay in basis of many scientific reports. From 1972 to 1996 a family of **Prognoz spacecraft** was built. These are special Earth satellites capable of continuous real time transmission of astrophysical data, solar activity data and the natural solar-terrestrial communications mechanism data.



In the mid-90s enterprise initiated development of a multipurpose **Fregat upper stage** with a multiple-launch propulsion system. On February 9, 2000 Fregat upper

stage made its first qualification flight. This launch lay foundation for successful operation of our upper stage. Fregat upper stage is used for spacecraft launches under the Federal Space Program of the Russian Federation. Satellites of the Russian GLONASS navigation system are also being put into orbit by Fregat upper stage. Over 20 years, more than 100 launches of Fregat upper stage of various modifications have been provided, more than 700 spacecraft both Russian and foreign have been launched into target orbits.

On January 20, 2011 **the first spacecraft of the Electro-L family** was launched, on December 11, 2015 – the second one, on December 24, 2019 – the third one, on February 5, 2023 – the fourth one. These spacecraft contribute the Electro geostationary hydrometeorological space system and are designed to provide real-time hydrometeorological data to the environmental monitoring services. Currently two spacecraft of the Electro hydrometeorological geostationary space system are operated in orbit: Electro-L# 2 SC at the 14.5°WL standing point and Electro-L#3 SC at the 76°EL standing point. The peculiarity of these SC is the data transmission every 30 minutes (Electro–L#3 SC transmits every 15 min.)



On February 28, 2021, the world's first meteorological spacecraft of a new Arktika family **Arktika-M #1** was launched in the highly elliptical orbit. The system is designed to monitor the Arctic region of our planet from a highly elliptical orbit. Sharing of data obtained from both geostationary and highly elliptical spacecraft will enable quasi-continuous receipt of meteorological data and provision of the Northern Sea Route with communication and navigation. On March 22, 2021 during flight testing Arktika-M spacecraft received the first images of the Arctic region and transmitted it to Earth. Arktika-M spacecraft is located in a highly elliptical Molnya-type orbit with an apogee height of 37400-39800 km, a perigee of 600-3000 km, respectively, and an inclination of

63.30 degrees. All spacecraft systems operate nominally. On September 3, 2021 the State Commission reviewed the flight tests results of the highly elliptical hydrometeorological Arktika-M space system consisting of Arktika-M#1 SC and decided to finalize the flight tests. It was recommended to put the highly elliptical hydrometeorological Arktika-M space system consisting of Arktika-M#1 SC into operation. Today at Lavochkin Association Arktika-M#2 SC is passing through assembly and testing phase.

Lavochkin Association continues development of unique astrophysical orbital observatories.

Spektr-R spacecraft, developed by the enterprise's designers was launched on July 18, 2011. The **Spektr-R Orbital Observatory** contributes the largest international RadioAstron Program. Jointly with terrestrial radio telescopes (more than 50) located in various places on Earth, the spacecraft constituted a radio interferometer with an ultra-large base (350,000 km), capable of obtaining scientific data with a record angular resolution (8 microseconds of arc). The spacecraft operated in orbit for more than 2.5 times of guaranteed active life (7.5 years instead of 3). In May 2019 the State Commission decided to stop operation of the observatory, due to the end of the spacecraft remaining life. The spacecraft was equipped with a 10 meters diameter radio telescope, which consisted of 27 petals opening into a parabolic antenna, and a central 3 meters diameter mirror. It is the world's largest space telescope, which was noted in the Guinness Book of Records. Over the years, more than 4,000 observation sessions have been conducted, more than 250 objects in the Universe have been studied, 240 scientists from 23 countries of the world took part in the research. The amount of accumulated data is more than 4 petabytes.

A unique **Spektr-RG astrophysical observatory** aimed at the Universe X–ray studying was developed under the Russian program involving Germany. The spacecraft similarly to the Spektr-R spacecraft was built on the unified Navigator platform developed by Lavochkin Association/ The spacecraft was equipped with two unique X–ray telescopes - ART-XC developed by IKI RAS (Russia) and eROSITA developed by Institute of Max Planck (Germany). The spacecraft was launched on July 13, 2019. The spacecraft operates in the vicinity of the L2 libration point of the Sun-Earth system, located at a distance of 1.5 million km from Earth, in order to study dark matter, dark energy and the evolution of the Universe. Since December 19, 2021, the Russian Spektr–RG X-ray observatory has been conducting the fifth of eight planned surveys of the entire sky which was completed in early summer 2022. On February 26, 2022, one of the two onboard telescopes German eROSITA was put into standby mode and the survey suspended. Russian telescope ART-XC named after M.N. Pavlinsky continued its operation but within the framework of a new program of scientific observations, compiled considering the results already obtained. In 2021, the Spektr-RG observatory was awarded the Marcel Grossman Prize.

Currently a unique **Spektr-UV space observatory** is under development. It will explore the objects of the Universe in the ultraviolet range of the electromagnetic spectrum. The spacecraft will be equipped with a telescope of the company's own design with a 170 cm diameter mirror.

Lavochkin Association has developed the strategy of Moon exploration by automated space complexes. It is included in the Federal Space Program of Russia for 2016-2025. Under the Russian Lunar Program four SC launches are scheduled in total: 3 landers and 1 orbiter. The aim is to study the Moon South Pole and deliver cryogenic samples of lunar regolith with intact structure obtained from a depth of up to 2 meters. The first **Luna 25 lander** will explore the Moon South Pole in 2023.

Later in 2024 the **Luna-Resource Orbiter (Luna-26)** will start to the Earth's natural satellite. The spacecraft is aimed at data collecting from Lander and transmitting it to the Earth. It will also perform scientific experiments by the onboard scientific equipment complex.

In 2025 the second SC **Luna-Resource Lander (Luna-27)** is planned to be launched towards the Moon South Pole, carrying a cryogenic deep drilling rig. The objective of the **Luna-Grunt spacecraft (Luna-28)** which launch is scheduled after 2025 is processing test and validation of takeoff and cargo delivery approach from the Moon polar area.

Furthermore, Lavochkin Association has a wealth of experience in development

of unmanned interplanetary stations for Mars exploration. Currently, automated spacecraft is under development for the exploration of Mars and its moon Phobos.

Today Lavochkin Association, JSC is a well–coordinated, highly organized, well-reconfigurable structure with high creative and executive potential, involved in challenging scientific and technical issues aimed at strengthening the Russian Federation international authority and its strategic development. Possessing a wealth of practical experience and its implementation capabilities using modern technologies and unique human resource enables Lavochkin Association to undertake ambitious space missions for the Academy of Sciences and other customers.