

CZECH SPACE ACTIVITIES

Explore the Czech Republic from space perspective



CZECH SPACE TIMELINE

1969



1969 - 1995
Several dozens of instruments on Earth orbit satellites, Russian Salyut and Mir stations and missions to Venus, Halley comet, Mars and Phobos



1978
Vladimir Remek on the Russian orbital station Salyut-6



1984 - 1999
Programmable space crystallizers on Salyut and MIR stations



2003
Czech Space Office established



2008
Czech Republic became 18th member state of ESA



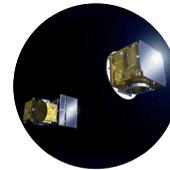
2011
BMSW instrument for fast measurement of the Solar wind on board Russian Spektr-R



2015
Two transponders on board student CubeSats PSat-A and BRICSat-P



2017
European Laser Timing within Atomic Clock Ensemble in Space on ISS station



2018
ASPIICS coronagraph on board ESA Proba-3



1992 - 2013
Microaccelerometers on board Russian Resurs F1 satellite, NASA STS-79 Atlantis, Czech MIMOSA satellite, Russian Tatiana 2 satellite and ESA Swarm satellites



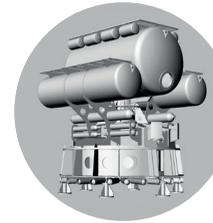
2007 - 2011
DOBIES and DOSIS-3D experiments for radiation doses determination on ISS



2010
61st International Astronautical Congress in Prague



2013
Czech Space Office an Authorized Payload Integrator of XCOR's Lynx®



2016
Testing of Hydronaut underwater research laboratory and training station



2022
Radio Plasma Wave Instrument on board ESA JUICE spacecraft



1978 - 1996
Five Magion satellites designed to research parameters of magnetic field, ionosphere and plasma around Earth.



1999
Photon counting LIDAR for NASA Mars Polar Lander 98



2003
MIMOSA satellite



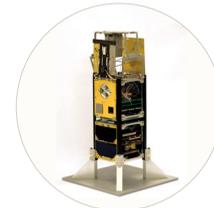
2009
Thermal Plasma Measurement Unit and Dual Segmented Langmuir Probe on board ESA Proba-2



2012 - 2016
Timepix radiation detectors on ISS, ESA Proba-V, NASA Orion spacecraft and Japanese RISESAT



2015
Humans in Space Symposium 2015 in Prague



2016
VZLUSAT-1 CubeSat

For the Czech Republic, space research and technology development are becoming more indispensable means to increase the level of knowledge and economic competitiveness and to inspire the young generation. Those are stepping stones for securing decent level of scientific and industrial maturity, high economic strength and well established political and strategic position in the international community.



CZECH SPACE OFFICE

Mission

The Czech Space Office (CSO) was founded in 2003 with aim to create a dedicated infrastructure required for working relations with ESA and to support government decision makers and Czech research and development organizations with qualified recommendations and advice. In form of non-governmental non-profit organization the CSO has been supporting the Ministry of Education, Youth and Sports since 2003 to coordinate and develop national science and engineering capabilities through several CR-ESA agreements, leading to ESA membership in November 2008. CSO makes its best effort to increase Czech participation in national and international space projects.



Services

To fulfill its mission, CSO follows national capabilities in various space related fields and analyzes the opportunities for Czech academia and industry in international programmes. CSO offers consultancy and assistance with preparation and management of space project and if suitable also an establishment of strategic partnerships. It provides informational support to everyone interested in space projects.



*Above: CSO staff presents Czech space activities on International Astronautical Congress. Source: CSO
Below: Schoolchildren from Toronto learn about Czech space instruments. Source: CSO*

International Activities

CSO maintains the relations with space organizations and partners worldwide. The CSO staff carries out functions of national delegates to ESA programme. CSO has been actively involved in actions of the UN Office of Outer Space Affairs, like coordinating Czech activities during the World Space Week and participating on Human Space Technology Initiative. Being a longstanding member of the IAF and IAA, the CSO organized in 2010 the 61st International Astronautical Congress in Prague and in 2015 the 20th Humans in Space Symposium in Prague. CSO is also active in several ministry advisory bodies.

In November 2013, CSO became an authorized payload integrator of XCOR's rocket-powered suborbital spacecraft Lynx[®], currently being built at XCOR's headquarters in Mojave, California. CSO is part of the global network of authorized partners preparing experiments for XCOR and provides services including both technical and administrative support.



Public Relations

CSO promotes education and training in space science and technology, supports enthusiastic kids and promising student projects. It also communicates benefits of space research and technology to general public through TV, radio and other media channels.



Above: Artist's impression of Lynx[®] spacecraft that is being built by XCOR in Mojave Desert. Source: XCOR

Below: Guests of the Czech Space Office during press conference at the Humans in Space Symposium 2015 in Prague. Source: CSO



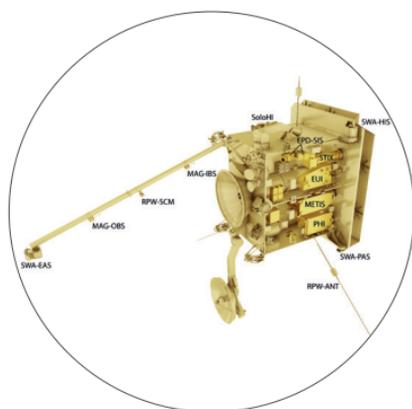
SPACE SCIENCE & EXPLORATION

Space science is a broad discipline exploring objects and processes in our Solar System and everything beyond its formal boundaries, including far deep space. The Czech Republic has a long tradition in studying Sun and Sun-Earth interactions and interplanetary matter, as well as other planets. Several dozens of scientific instruments were launched into space on board the satellites and probes.

The most valuable contribution to the Sun research from outer space is the forthcoming ESA Solar Orbiter mission. The academic institutes together with their partners from the industry participate in the development of four scientific instruments for this technologically very demanding probe: Spectrometer/Telescope for Imaging X-rays, Radio and Plasma Wave Instrument, Multi Element Telescope for Imaging and Spectroscopy and Solar Wind Plasma Analyzer. Another interesting project is the development of coronagraph for Proba-3 tandem flight experiment, where the participation is on the side of the optical system development.

Speaking about the space weather and research of the planetary magnetosphere, scientists also cooperate on the development of the electron analyzer for BepiColombo probe that will visit Mercury and the JUICE spacecraft, ESA's first large-class mission to investigate planet Jupiter and its icy moons. It will carry two instruments developed in cooperation with Czech scientists: the magnetometer to characterise the Jovian magnetic field and its interaction with the internal magnetic field of Ganymede and secondly the radio plasma wave instrument to describe the radio emission and plasma environment of Jupiter and its moons.

Czech scientists participate not only in ESA missions, but they also collaborate with the other national space agencies. For example, they have developed the long-wavelength electromagnetic radiation analyzer for the Russian Luna-Glob mission, which is to perform a complex planetary research of Moon from its orbit. Research teams intensely exploit data from several ESA, NASA, JAXA, Roscosmos and other space agencies missions. Main research fields are solar and stellar physics, interplanetary matter, formation and evolution of galaxies, dynamics of planetary systems, astrophysics, ionosphere and magnetosphere of the Earth and other planets.



Czech research teams have participated on four of the scientific payload elements of Solar Orbiter. Source: ESA



SPACE SITUATIONAL AWARENESS

Space situational awareness (SSA) is the ESA programme federating group of services providing real-time overview of the threats coming from the interplanetary space. SSA threats include harsh space weather, associated with solar energetic particle storms, near earth asteroids and artificial satellites for both of which trajectories are tracked to predict possible collision courses. The predictions are based on modelling of all the relevant processes for which a scientific understanding is required.

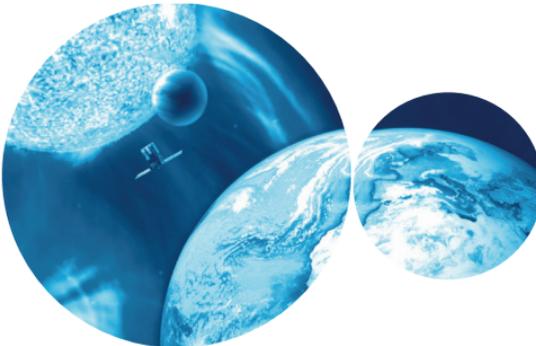
The Czech Republic has a long tradition in studying both the minor planetary bodies and Sun-Earth interaction including mainly geomagnetic, magnetospheric and ionospheric effects, therefore this expertise allows significant contribution to its prediction and monitoring both of Space Weather and Near Earth Objects.

The valuable contribution of the Czech Republic are studies and monitoring of small meteoritic bodies and their interactions with the Earth's atmosphere. The Czech Republic is a founder of the European Fireball Network, which includes specialized antenna for monitoring day-time meteors and a number of stations located in the Czech Republic and Australia, where the meteoritic body can be easily recovered. Many Czech teams are focused on finding, tracking and reconstructing the surface characteristics of Near-Earth asteroids and comets.

Several scientific instruments are monitoring the space weather conditions, both directly and remotely. Most relevant instrument developments in the past include space radiation and high energetic particle monitors, thermal plasma probes, plasma waves and plasma particle instruments. Many of them are still functional and currently in-orbit monitoring relevant space weather parameters.

Multi-point continuous Doppler sounding portable systems of ionospheric state were deployed at number of locations throughout the Czech Republic and based on its success also in Argentina, South Africa and Taiwan. The models and space weather predictions based on these data and Lowell digisonde ionospheric sounding from nearby Prague are provided in the scope of the International Space Environment Service through the Regional Warning Center Prague.

Czech Republic is typical by many teams providing simulation runs and real-time modelling of the different regions of the geospace influenced by the Space Weather.



Space weather effects on geospace and satellites. Source: ESA



LAUNCHERS

The independent access to space via operational launch pad and affordable and reliable family of launchers is strategic and crucial for space endeavour and as such it is of high importance for every country. The Czech Republic is fully aware of its importance and several of our companies, universities and research institutions are already involved in development of specific components of European launchers and maintenance of space port Kourou in French Guiana.

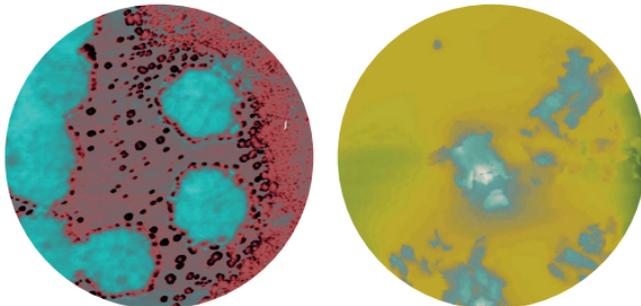
Czech companies excel in development of new advanced materials, for example leak resistant polymer liner for cryogenic propellant tank, epoxy core systems with syntactic foam structure, tailored adhesive bonding for thermoplastic composites or dedicated resin for foam to foam gluing compatible with cryogenic conditions. Many of these materials are unique in Europe and there is no other company able to produce them.

The evaluation, modelling and testing is another domain where our space industry is involved. These projects are focused on using reliability methods to evaluate and increase the inherent reliability of a nozzle design, reliability analysis and life prediction of combustion chamber with probabilistic methods and based on survival analysis, computational methodology and experimental testing of scaled model of the upper stage thermal insulation panel to assess its flutter response or developed sensors instrumentation for diagnostic of the propellant electric pump.

Other experiences of Czech companies were gained by projects focused on design and development of complex flight hardware or software. We can mention preliminary design of the semi-active damping system for payload vibration isolation or development of the fully automated on-board software for the capsule designed to observe upper stage deorbitation behaviour.

Also studies and assessments are part of Czech projects. Our companies worked on suitability study evaluating potential of the ultra-wideband communication system for reliable onboard communication of satellites or launchers and assessment of existing plastic optical fibres and associated connectors for launcher application.

Last but not least, Czech industry was manufacturing and installing the telecommunication and security systems for the launch pads of Vega and Soyuz in Kourou and on a commercial basis, a few companies supply the manufacturing process of Ariane 5 launcher with mechanical parts and assemblies.



Visualization of nanoparticles using Atomic Force Microscopy. Source: Toseda



HUMAN SPACEFLIGHT & MICROGRAVITY

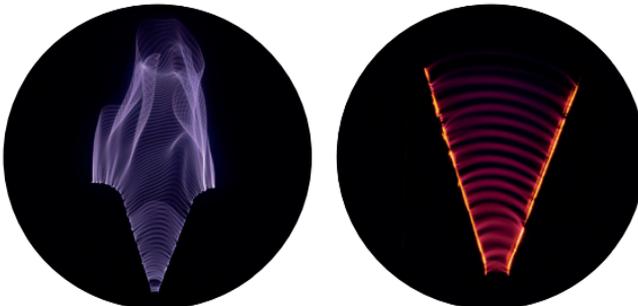
Research in the microgravity conditions and human spaceflight related research in the Czech Republic have been reborn recent years. More than 30 experiments have been accomplished from mid seventies, with the significant decrement in the nineties. Czech scientists are experienced in research of the human factors and physiology, astrobiology, radiation dosimetry, fundamental physics and crystallization.

The biggest Czech contribution to microgravity research is the dedicated optical link for synchronization of a pair of extremely precise atomic clock on board the International Space Station with stations on the ground. This experiment called European Laser Timing (ELT) is part of the Atomic Clock Ensemble in Space (ACES) instrument setup, which will be launched and attached to the Columbus laboratory in early 2017. Instruments will allow clock comparisons, time transfer and ranging experiments in the optical domain. Czech engineers and scientists provide the onboard hardware development as well as ground stations calibration campaign.

Several dosimetry experiments were done during past years on ISS. The latest one, which included a three-dimensional survey of the radiation environment in all segments of the station, started in 2012. Czech experts prepared sets of passive dosimeters attached to the side walls of Columbus laboratory module. The Mars-500 mission simulation conducted by Russia, ESA and China, includes three Czech research experiments that are to explore the dynamics of relationships in a small group of people, changes in perception and memory related to long-term isolation and to examine the source of human endurance in critical situations.

Team of doctoral students investigated the behaviour of gliding arc discharge in conditions of hypergravity. Research team studied the effects of gravity in the range 1 – 18 g on the shape, intensity, colour and emission spectra of the discharge.

A group of space enthusiasts, engineers and scientists developed underwater Hydronaut station, which can be used as a realistic simulator of conditions on board manned spacecraft, orbital, Lunar and Mars stations. Hydronaut will allow the implementation of a broad range of human factor and physiology experiments in simulated conditions. Other experiments in microgravity conditions using ISS, small satellites and ground based facilities are being prepared.



Photographs of gliding arc in krypton under normal gravity and under hypergravity conditions.

Source: Faculty of Science, Masaryk University



SATELLITE NAVIGATION & TELECOMMUNICATION

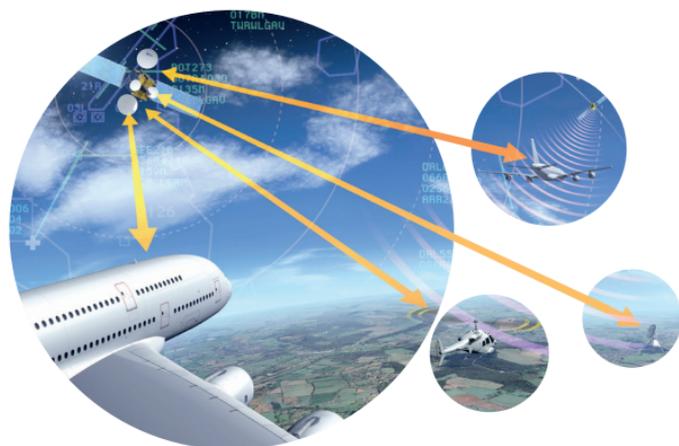
The Czech Republic already benefits from applications offered by satellite telecommunications and navigation and actively supports development of new technologies to exploit potentials of both space domains. Czech institutions and companies have taken part on the European Satellite Navigation competition for over a decade and the capital city of Prague hosts administrative and certification centre of European GNSS Agency (GSA). The Czech Republic participates in ESA telecommunication and navigation programmes and develops technologies associated with future generations of EGNOS and Galileo systems.

Referring to space telecommunication, a development of airborne user terminal prototype was carried out in the ANTARES programme. The project included the development of standard tool allowing the deployment of compatible systems for safety critical air/ground data and voice communication worldwide, enabling the Air Traffic Management.

Other Czech activities were related to the ESPRIT project that had been focused on preliminary design of satellite communication link for Unmanned Aerial Systems, which encompasses payload data as well as Command & Control flows. A key driver is the ability to ensure safe and secure communication between the Remote Pilot Station and controlled aircraft.

Project SATCOM (Building Penetration Measurement and Modeling for Satellite Communication at L, S and C-Band) addressed satellite-to-indoor propagation for future satellite services. Extensive measurement campaign, including the use of remote-controlled airship, was provided by the Czech laboratory.

The Czech Republic has been also successfully involved in projects addressing satellite navigation. Project SISNeT (Signal in Space through Internet) was oriented on the development of a software tool for dissemination of the EGNOS accurate navigation data online. The EGNOS EduTools project that followed is an example of educational project supporting better understanding of functionalities of EGNOS system.



Iris programme for air traffic management. A Czech company was responsible for the development of the first laboratory prototype of the airborne User Terminal (UT). Source: ESA



EARTH OBSERVATION

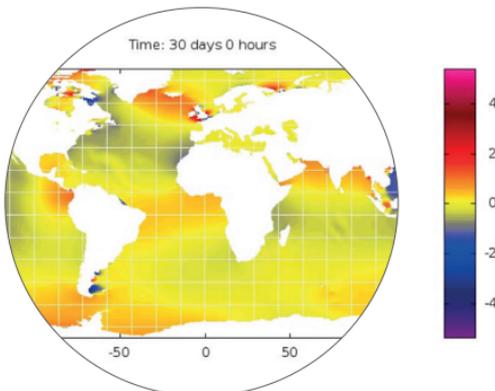
Earth Observation is a global initiative and the Czech Republic provides support through a participation in GEO, ESA and EUMETSAT. Czech public administration already benefits from EO applications and value added services in areas like urban planning, agricultural monitoring, forestry, environmental monitoring or flood risk mapping. There is a growing basis of young scientists and GIS professionals that receive university education in remote sensing, who may also help to foster the use of EO data in various human activities in the future.

Because of widespread cloud cover, radar satellite data are often used to monitor areas at risk of landslides and floods, the key environmental issues in Czech country. The value adding industry also contributes to a number of international projects in fields of urban planning, land monitoring and disaster management, mostly connected to the EU Copernicus programme or fulfilling the needs of EEA and international financial institutions.

In the area of Earth sciences, the data from ESA Earth Explorers satellites are very useful. The gravity mission GOCE has provided measurements utilized by geodetic research performed by a Czech scientific institute that also participated in the fine-tuning of the mission's orbit before launch. Specific group of scientists focus on LiDAR scanning and hyperspectral spectroscopy of the forests, dump sites and other areas and they are involved in the scientific part of the preparation of ESA FLEX mission. Interest in the Earth's magnetic field has drawn a group of university researchers into the scientific utilization of Swarm mission data.

The Swarm mission also carries on board three supporting instruments – precise microaccelerometers developed by a consortium of Czech companies. Another promising development concerns an innovative acousto-optic tunable filter suitable for hyperspectral imaging. Based on a single calomel crystal and having no moving parts, it has a good potential to be deployed on future remote sensing missions. Another example of calomel based optical component under development is an infrared polarizing element for IR remote sensing telescopes.

Czech industry also participates in the development and manufacturing of the European operational satellites like Meteosat Third Generation and Copernicus/Sentinel missions. The contribution is on both software and hardware side.



Visualisation of magnetic signatures of barotropic and baroclinic flows in data from ESA Swarm satellite constellation.
Source: Faculty of Mathematics and Physics, Charles University in Prague



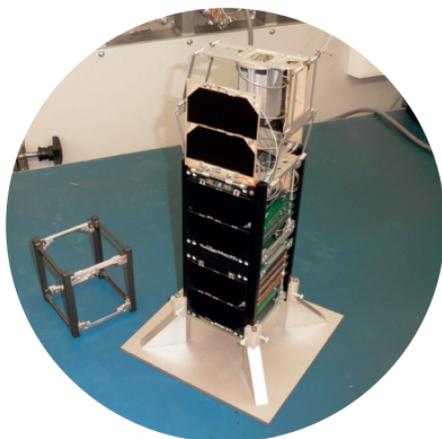
SPACE TECHNOLOGY

The wide area of space technologies is one of the new emerging sectors in the Czech country. Several manufacturing companies have already been supplying mechanical or electronic parts and sensors for satellites. Apart from these, which already proved their capability to deliver for space, there are many companies with a potential to transfer and upgrade their technological skills into the space sector.

The main hardware competencies of Czech industry are as follows: high-precision mechanical alloy structures and assemblies; composites and polymers – sandwich structures, carbon fiber materials and other nanomaterials, epoxy resins and adhesives; thermal, structural, and mechanical modelling; environmental testing; PCBs assembling; tantalum capacitors, power supplies, time and frequency electronics, electrical and mechanical ground support equipment; high-quality optics and X-ray optics; microaccelerometers, electronics for sensors, single photon detectors, cosmic radiation detectors and scintillation crystals.

In the field of software development, the major skills include: vehicles health monitoring systems, ground segment software, on board software for operational instruments, safety-critical systems, real-time systems, digital image processing and signal processing. As the scope of technologies covers a broad spectrum of activities, they have been developed through a number of national and European technological programmes, for example EU H2020 and ESA TRP/GSTP programmes.

Practical examples of results include: power supplies of scientific instruments for Solar Orbiter mission, objective for Proba-3 coronagraph, compact radiation detector for Proba-V satellite, calibration system for the transportable laser communication terminal, hermetically sealed low ESR tantalum capacitor, thermo-mechanical evaluation of Lunar Lander thruster platform, control and tracking system for ground station antennae, solar array deployment mechanisms, on-board software reference architecture for payloads, real-time performance monitoring tool for EO data processing by GRID system and other.



Qualification model of Czech CubeSat VZLUSAT-1. Source: VZLU



EDUCATION & OUTREACH

Beginning with little kids and reaching up to university students and young professionals, the Czech young generation has nowadays a number of opportunities to engage in the wide spectra of space projects and endeavors. Most of the information support including some funding comes from the Czech Space Office, which is the national partner of international events such as World Space Week and European Researchers' Night, workshops and student conferences on modern science and technology.

CSO provides outreach through a number of lectures for kids and students. It teams up with nursery, primary and secondary schools, universities, NGOs, museums, libraries and other organizations interested in space education. It supports Czech students at multitude of international events like congresses and workshops, the International Astronautical Congress or the Alpach Summer School being the major examples. Participation of teachers in international workshops and space camps is also available and CSO supports the applicants not only with information, but also funding opportunities.

CSO is co-organizing international student scientific contests Expedition Mars and Odysseus aiming at outreach of space research and astronautics. Students are also supported while applying to the international space-related studies. The most important one is the Spacemaster Erasmus Mundus programme, but there are many other master programmes throughout Europe, which offer training towards the degrees of space engineering or space management. The broadest scope related to space offers the International Space University.

Thanks to the educational programmes of the European Space Agency, students can gain practical skills by building their own experiments for balloon or rocket launches or by using ESA's ground infrastructure, such as experimental centrifuge or drop tower. After their experience with high school projects, such as building a microsatellite in a can (CanSat), students develop CubeSats which can be launched to operate in real space environment.

In the Czech Republic, there is a new branch of the European Space Education Resource Office now being prepared under the ESA's guidance. Czech GNSS Center of Excellence is also supporting young students, mainly interested in application areas of satellite telecommunications, navigation and Earth observation.



Young finalists of the international educational competition Expedition Mars in the cockpit of the shuttle simulator during the training in the Euro Space Centre in Transinne, Belgium. Source: Expedition Mars

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