A BRIEF HISTORY OF INTERCOSMOS ACTIVITIES AND DEVELOPMENT OF SCIENTIFIC INSTRUMENTS FOR IONOSPHERIC AND MAGNETOSPHERIC RESEARCH AT THE INSTITUTE OF ATMOSPHERIC PHYSICS, PRAGUE

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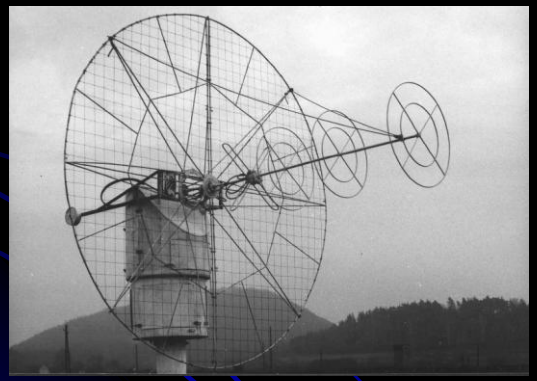
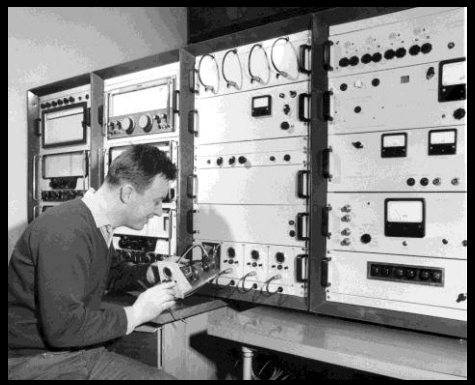
Klepr textu

THE FIFTIES AND SIXTIES

- Estabilishment of the Ionospheric department at Geophysical Institute(*), ground ionospheric measurements, new young scientists and engineers are coming
- Activity during the International Geophysical Year, experiments with Sputnik 1 reception
- Building of the Panska Ves Observatory in 1964, building of the equipment for satellite reception
- Receiving of scientific data from SOLRAD satellites
- Establishment of the INTERCOSMOS organisation (1967)
- A new dimension and challenge for space activities – possibility to build and send to the space own instruments



The first directed back-fire antenna for satellite reception installed at the Panska Ves Observatory (round 1965)



Jaroslav Vojta operates the instrument for measuring of satellite signal polarisation (round 1964)

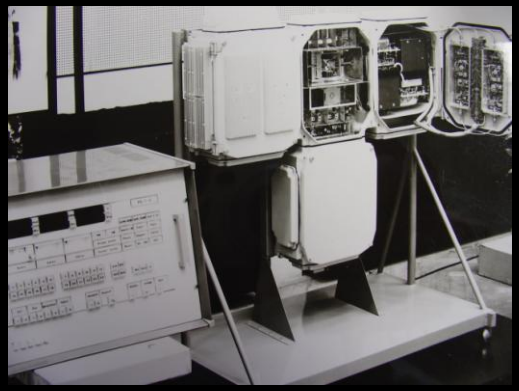
The first device designed to work on board the satellite was the telemetry transmitter for the satellite INTERCOSMOS 3 (1970)

(*) Since 1994 part of the Institute of Atmospheric Physics

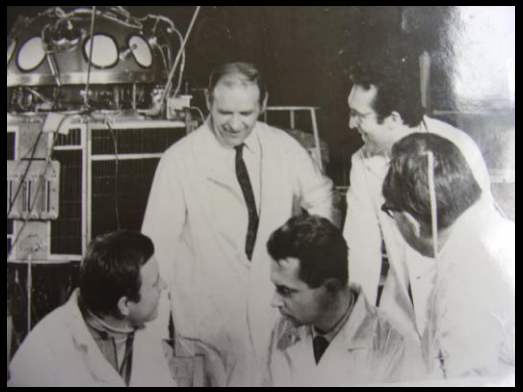
THE SEVENTIES

- Dr. Pavel Triska create an experienced team of scientists and engineers, cooperation with the Institute of Space Research in Moscow (IKI) and other international contacts
- The boom of instrumentation, ability to actively participate in several project per year
- Many of unique instrument are developed, cooperation with the Research Institute for Electronics (VUST) and others
- Building of the satellite telemetry and command station at Observatory Panska Ves
- Activity culminate by construction of own satellite MAGION 1

Panska Ves Observatory in 1975



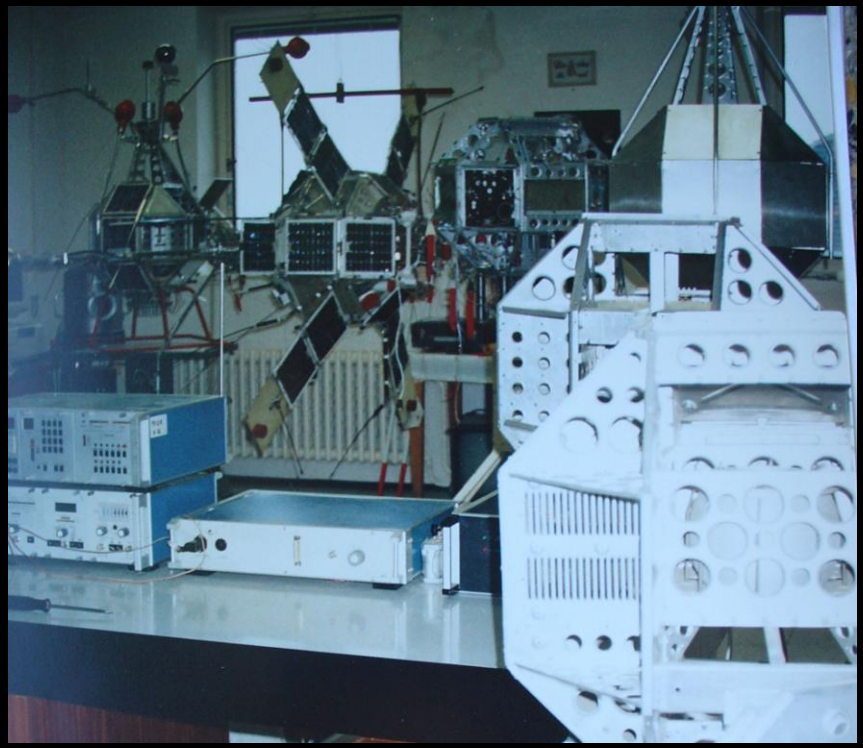
Terrestrial full solid-state command transmitter with an output power of 200W made by TESLA VUST



Pre-flight test of satellite INTERCOSMOS 5 (1971). In the middle foreground Dr. Pavel Triska

THE EIGHTIES AND NINETIES

- Increasingly challenging and complex INTERCOSMOS projects were planned, such as the VEGA probe to the Halley comet, or the launch of several satellites with one launcher
- After the success of satellite MAGION 1 the construction of satellites weighting 50 kg started
- The political changes after 1989 brought a gradual decline of the INTERCOSMOS programme and switched it to bilateral agreements
- Difficulties with financing, translation to the Institute of Atmospheric Physics, team is keeping together
- MAGION projects continue with the new series of satellites
- Start of large-scale international project INTERBALL



View of the laboratory of the Ionospheric Department in 1994, left engineering model of the satellite MAGION 2, hanging flight model of the MAGION 4, half-finished MAGION 5 and a number of frames for mechanical, thermal and high-frequency tests

MAGION SATELLITES

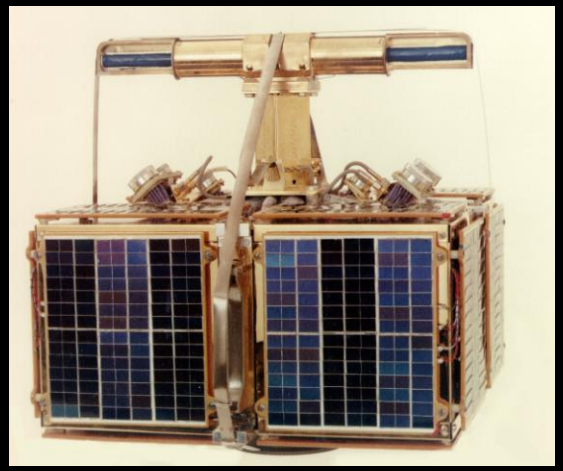
- The name MAGION was derived from the words MAGnetosphere and IONosphere and expressed the area of scientific research to which it was devoted
- The MAGIONs were always launched together with a bigger parent satellite and after separating in orbit carried on board scientific equipment similar to that on the parent satellite. The main purpose was to obtain the data measured by the same method from two points and allow the studied phenomena to be resolved in time and space
- All MAGION satellites were completely built and tested at the Geophysical Institute and later at the Institute of Atmospheric Physics
- The only station for the control and acquisition of data was the Panska Ves Observatory, interactive operation of scientific payload
- Experiments on the main satellite, pre-launch tests, and launch were organized by the Institute of Space Research in Moscow

Satellite	Mass [kg]	Perigee [km]	Apogee [km]	Launch date	End of mission
MAGION 1	14,5	406	768	24/10/78	10/09/81
MAGION 2	52	500	2492	28/09/89	21/11/90
MAGION 3	52	438	3070	18/12/91	20/08/92
MAGION 4	58,7	870	192000	03/08/95	23/09/97
MAGION 5	68,5	775	19210	29/08/96	02/07/02

MAGION 1

- Shape of a block, dimensions 300x300x150mm and weight 14.5 kg
- On board carried telemetry equipment, an apparatus for research into the electric and magnetic components of electromagnetic waves at very low frequencies (100Hz - 15kHz) and a Geiger counter for energies greater than 30keV
- Launched as a piggy-back with the parent satellite INTERCOSMOS 18 from Plesetsk Cosmodrome on 24th October 1978 to orbit with a perigee of 406 km and apogee of 768 km
- Verified the possibility of building a small, cheap, non-hermetic satellite in modest conditions and proved that its performance and reliability was comparable with large satellites, verified the possibility of multi-point measurements in orbit.

Pair of MAGION 1 satellites during tests

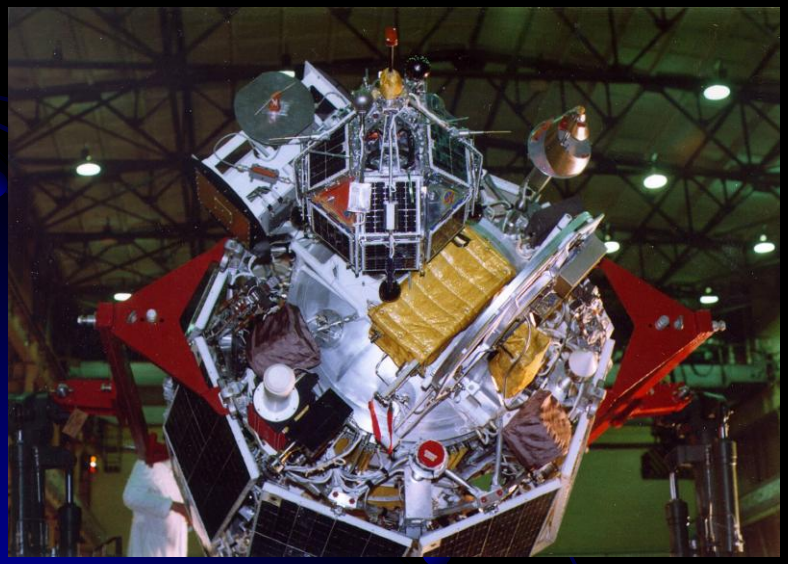


Satellite MAGION 1 with folded antennas ready for transport

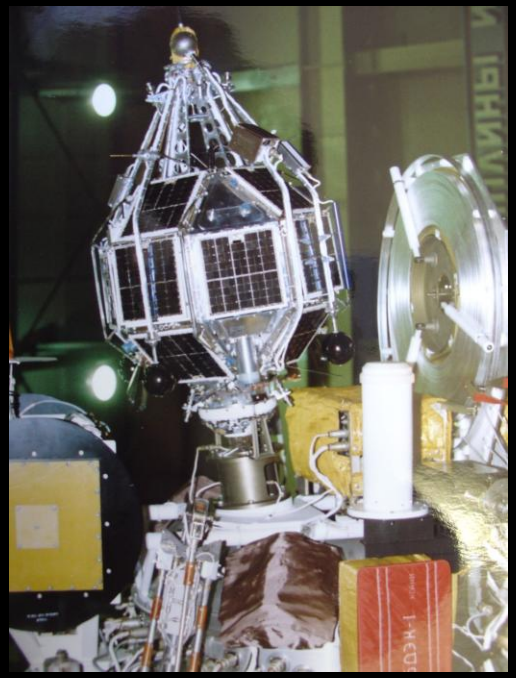
Miroslav Jiskra operating the satellite at the Panska Ves TM/TC station

MAGION 2

- The first satellite of a new mechanical design in the shape of a polyhedron with four additional deployable solar panels and booms
- Prepared as part of the AKTIVNIJ project devoted to study experimentally the changes in the characteristics of the ionosphere activated by a high power transmitter.
- MAGION 2 carried a low frequency and high frequency analyzer for receiving the excited electromagnetic waves. Other equipment included a magnetometer, equipment for measuring the temperature and density of cold plasma, a Langmuir probe, a device for particle measurements and a photometer. In the housekeeping section newly developed board transmitters, receivers and command decoders were used.
- The satellite weighed 52 kg and was magnetically stabilised by a series of permanent magnets located at the bottom. Newly a system of compressed air nozzles was used to control orientation.
- MAGION 2 was launched into orbit on 28th September 1989 with a perigee of 500km and apogee of 2492km .

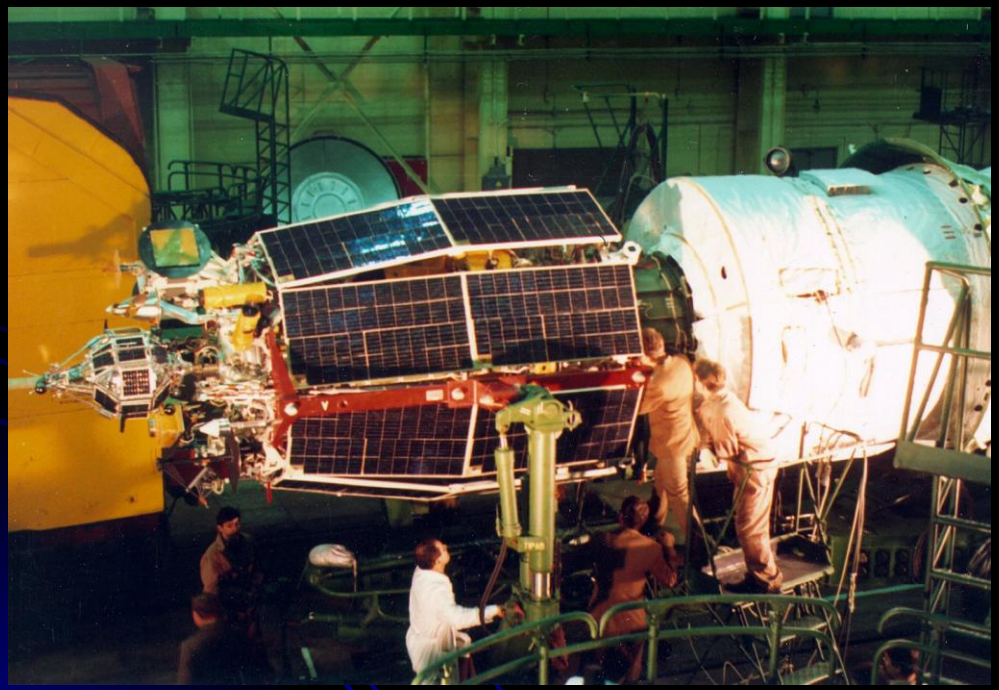


Integration of MAGION 2 on the parent satellite, Plesetsk 1989

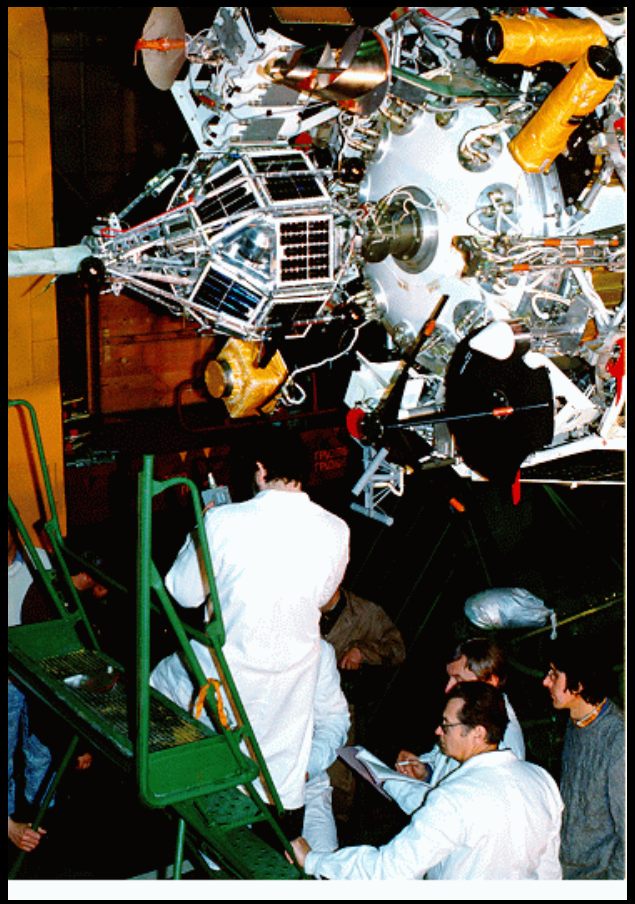


MAGION 3

- Launched in December 1991 as part of the APEX (Active Plasma Experiments) project together with the parent spacecraft INTERCOSMOS 25, orbit 438/3070km
- The main objectives of the APEX project were the study of the near-Earth plasma environment, aurora dynamics and electromagnetic waves in the magnetosphere and ionosphere
- The weight, housekeeping system and scientific payload of MAGION 3 were similar to those of MAGION 2.

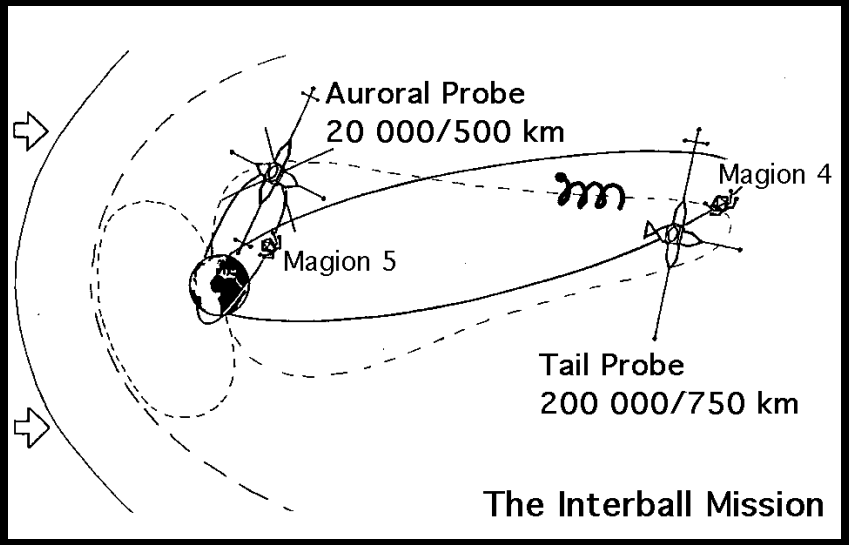


Integration of satellite MAGION 3 and the parent satellite INTERCOSMOS 25 on the launcher, launch site Plesetsk in December 1991



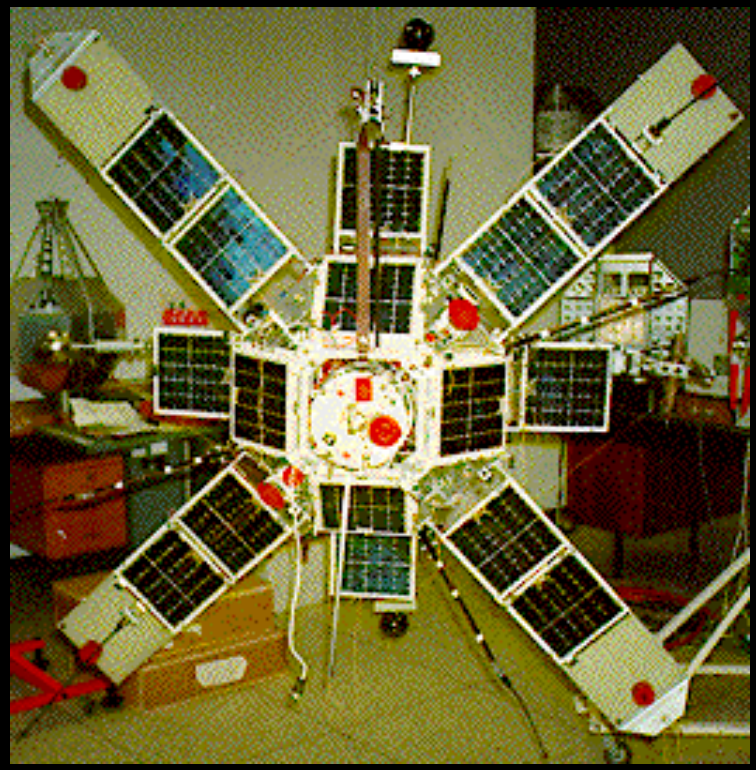
INTERBALL PROJECT

- The INTERBALL project was part of the international Solar Terrestrial Energy Programme (STEP), devoted to the study of the transfer of energy from the Sun to planet Earth and the effects of solar activity on the processes in the Earth's neighbourhood and on its surface
- For this purpose it was proposed to launch a series of satellites exploring Sun-Earth relations and the impact of the Sun's activity on the Earth's environment
- Scientists from 14 countries took part in the INTERBALL project itself
- The project planned a four-satellite system with one pair of satellites moving in a high apogee orbit and measuring in the magnetosphere's tail, and the second pair measuring in the inner magnetosphere, in the radiation belts
- The pairs were formed by the parent satellite and small MAGION satellites. All four were to have been launched and operated together. However, the delay in the project caused a one year delay in the launch of the second pair of satellites.



MAGION 4

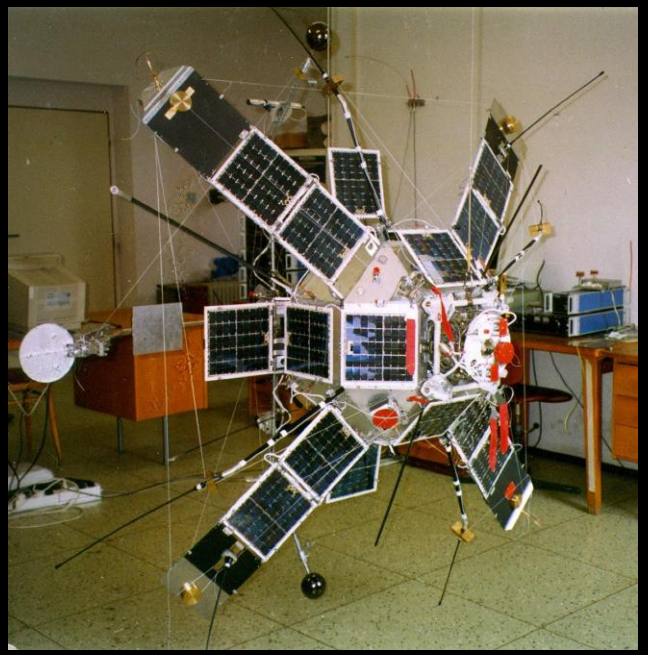
- MAGION 4 was equipped with additional deployable solar panels and stabilised by rotation with respect to the Sun, cold gas thrusters used to keep orientation
- Complex scientific payload for wave, plasma and particles measurement
- Launched on 3rd August 1995 with the INTERBALL 1 parent satellite of the PROGNOZ type to very high orbit with apogee 200 000km
- New ground equipment with two 10m dishes built at Panska Ves Observatory



Satellite MAGION 4 during tests in the laboratory of the Institute of Atmospheric Physics ASCR

MAGION 5

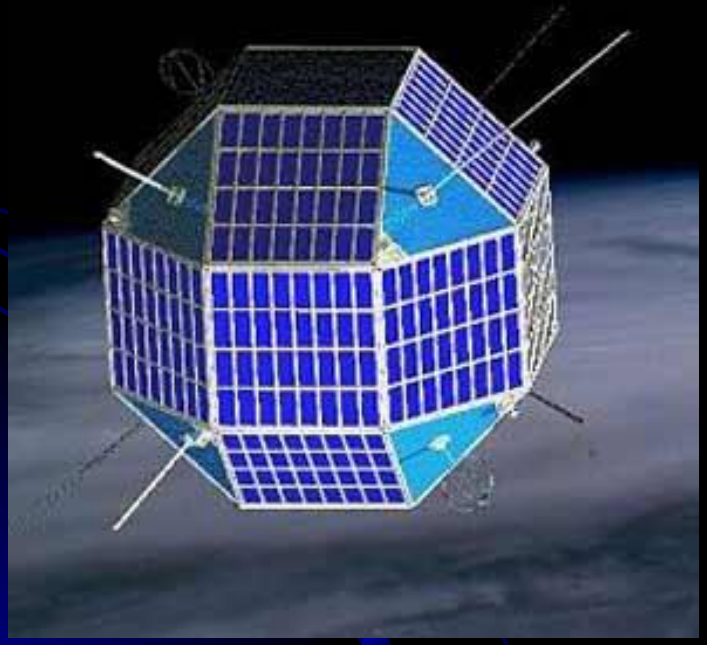
- The construction and payload of MAGION 5 was the culmination of the MAGION series. Due to its frequent passage through the radiation belts, it was equipped with thick cover plates. A part of the payload were also two cameras
- Shortly after separation from the parent satellite, a serious failure occurred, the solar battery failed to supply any power and communications with MAGION 5 ceased on 30th August 1996
- The analysis of the failure showed that there is a theoretical possibility that it could disappear. A series of telemetry commands for re-activating the satellite then was periodically transmitted.
- These attempts were not successful, nevertheless, the observatory staff did not give up and periodically, at least once a month, repeated the experiment. After twenty months of attempts they managed to re-activate MAGION 5 successfully
- The condition of the housekeeping systems and payload was very good and satellite worked another 4 years till the gas for orientation was exhausted



Pictures: MAGION 5 at ESENTIA exhibition early 1996 and during testing in the laboratory of the Institute of Atmospheric Physics

FURTHER DEVELOPMENT

- More satellite projects were planed, but were not realised
- The last Czech satellite was MIMOSA (launched 30.6.2003) derived from MAGION satellite and built by private company for Astronomical Institute
- We continue in developing of scientific instruments and housekeeping systems
- Rest models of MAGION 1 and MAGION 2 satellites are exhibited and presented for students and public
- National Technical Museum in Prague is preparing a new exhibition of Czech space activities with our contribution



MIMOSA satellite

Engineering model of the satellite MAGION 2 exhibited during Open door days at Institute of Atmospheric Physics

CONCLUSION

- The instruments and satellites developed and produced at the Geophysical Institute and later at the Institute of Atmospheric Physics AS CR document the history of space exploration, technological development and enthusiasm of the late 20th century.
- They were evidence of the skill and ingenuity of scientists and engineers who, in humble conditions, could create devices meeting the exacting demands of space technology.
- At the end of the seventies, Czechoslovakia had not only the first cosmonaut from a country other than the USSR and the U.S.A., but also its own satellite and telemetry station, and at that time was also instrumentally on the top of space activities.
- This history and tradition are a good basis for the development and continuation of space activities in the present and future.

Cosmodrome Plesetsk 1978, people participating on launch of MAGION 1 and INTERCOSMOS 18 satellites

THANK YOU