



**SMALL SATELLITES DEVELOPED BY
YUZHNOYE SDO FOR SCIENTIFIC RESEARCHES**

Since 1954 Yuzhnoye SDO has developed and provided:

4 generations of strategic missile systems

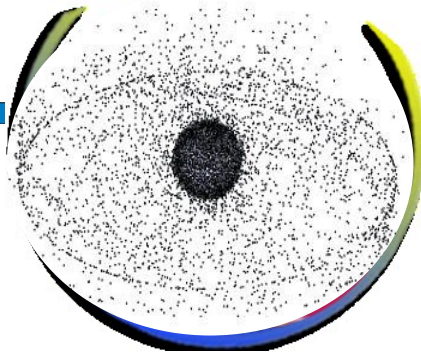
7 types of space launch systems

more than 400 spacecraft of 78 types

about 50 types of rocket engines and propulsion systems

876 launches





Global projects



Launch vehicles



DIRECTIONS OF ACTIVITY

Ground complexes



Components



Engines



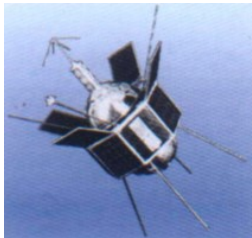
YUZHNOYE SMALL SCIENTIFIC SPACECRAFT (FIRST GENERATION)

Small spacecraft developed on the basis of DS-U unified platform were the world's first spacecraft family for scientific experiments according to the statement of works set by the USSR Academy of Science.



Small spacecraft for short-term studies

A non-oriented modification of the DS-U1 platform with the chemical current sources (batteries) was used for short-term studies (up to 1 month)



Small spacecraft for long-term studies

A non-oriented modification of the DS-U2 platform with a solar array was used for studies requiring a long-term cycle of measurements of space parameters (from 3 months to 1 year)

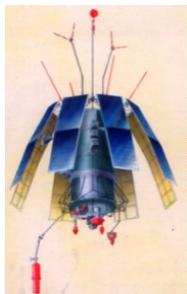


Small spacecraft for researches of the Sun

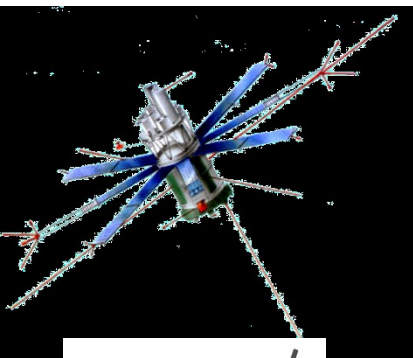
Modification of the DS-U3 platform with an orientable solar array was used for the research purposes requiring small spacecraft orientation to the Sun

49 small spacecraft were developed, manufactured and launched into the orbit for the period from 1963 to 1976.

In 1977-2004 scientific spacecraft were developed on the basis of heavy-class platforms.



Under the program of international cooperation there were developed the spacecraft for comprehensive study of space environment, physical nature of solar activity, geophysical phenomena in the near-Earth space and connection of these phenomena with solar activity. The AUOS-Z platform (with orientation to the Earth) was used for this purpose. 11 spacecraft were designed, manufactured, and launched on the basis of the AUOS-Z unified platform.



Under the Coronas-I and Coronas-F projects there were developed the spacecraft for comprehensive solar studies in the interests of science. The main scientific goals of these projects were connected with the research of physical processes occurring while energy release and transfer in various areas of the active Sun, as well as with development of a diagnostic hardware system for prediction of solar activity on a permanent basis. The AUOS-SM platform (with orientation to the Sun) was used for this purpose.

Z spacecraft were designed, manufactured, and launched on the basis of the AUOS-SM unified platform.

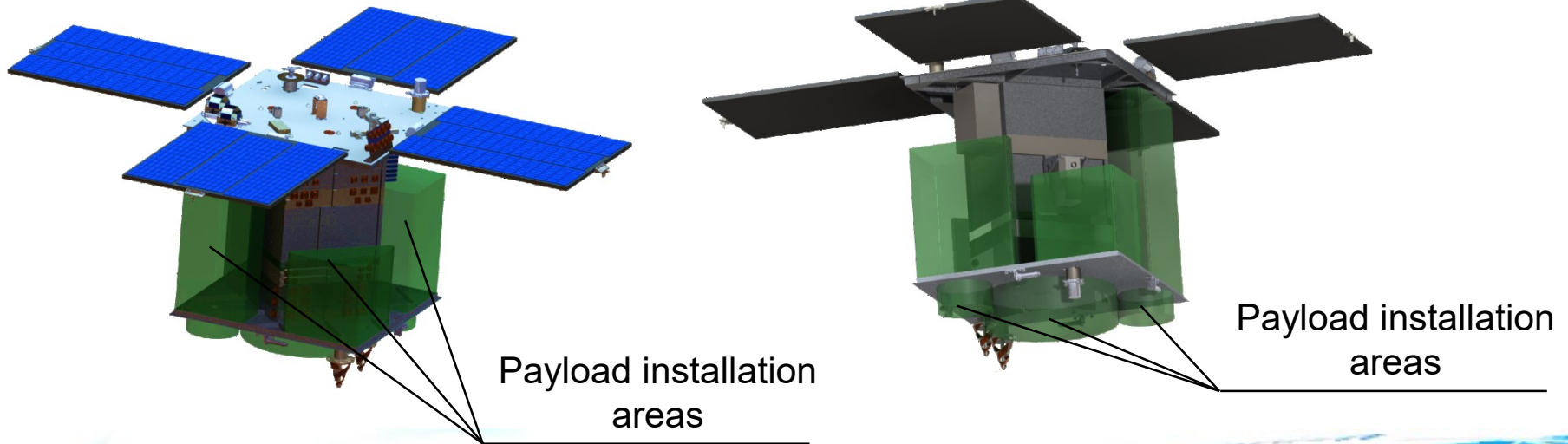
Earth remote sensing satellite for studying the fine structure of the electric currents of low-frequency electric and magnetic fields in the Earth's ionosphere plasma was developed under the international space project (the Variant scientific equipment was installed).

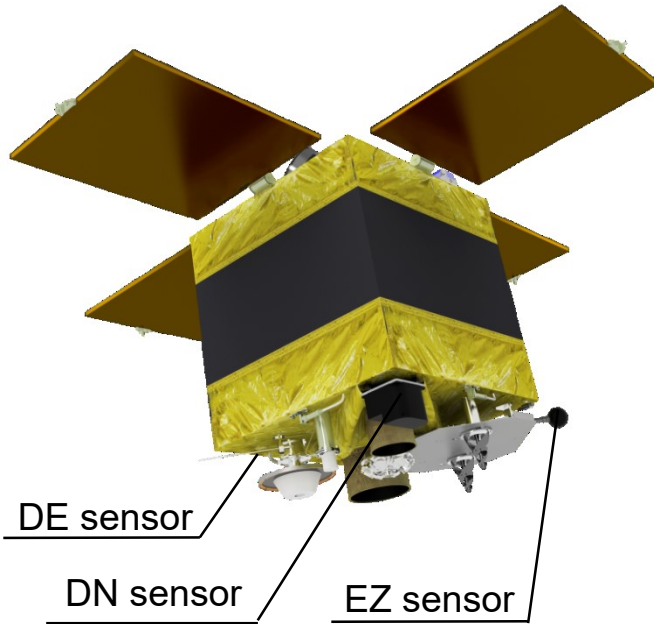
For this purpose Sich-1M spacecraft was launched in 2004.



In the early 2000s Yuzhnoye SDO developed the unpressurized MS-2 platform for development on its basis of small spacecraft for applied and scientific purposes.

Sich-2 spacecraft was developed on the basis of this platform; and currently Microsat-M spacecraft is under development.





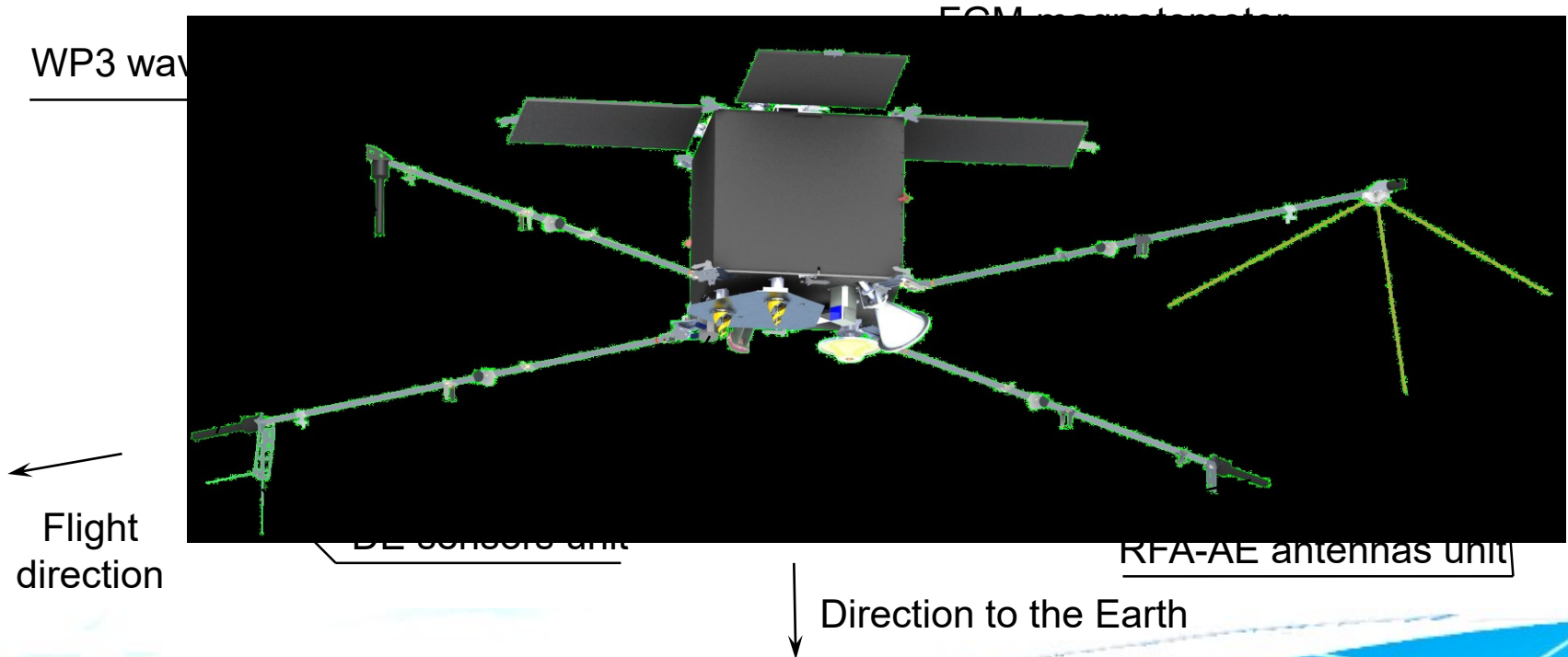
Sich-2 spacecraft (MS-2-8) is designed for the Earth observation in the optical band.

In addition to the Earth remote sensing instruments, Sich-2 spacecraft was equipped with the Potential scientific equipment developed by the Institute of Technical Mechanics of the National Academy of Science and State Space Agency of Ukraine in cooperation with Lviv Center of the Space Research Institute of the National Academy of Sciences and State Space Agency of Ukraine. The purpose of the experiment was to test the methods of space weather monitoring and search of geophysical effects in the ionosphere.

Sich-2 spacecraft was launched on August 17, 2011 by Dnepr LV.

Composition of Potential scientific equipment

Device	Application	Developer
DN and DE sensors	Measurement of kinetic parameters of plasma	Institute of Technical Mechanics of the National Academy of Science and State Space Agency of Ukraine
EZ electrical probe	Determination of the electric field potential	Lviv Centre of the Space Research Institute of the National Academy of Sciences of Ukraine and State Space Agency of Ukraine
LEMI-016M fluxgate magnetometer	Measurement of magnetic field induction	L'viv Centre of the Space Research Institute of the National Academy of Sciences of Ukraine and State Space Agency of Ukraine

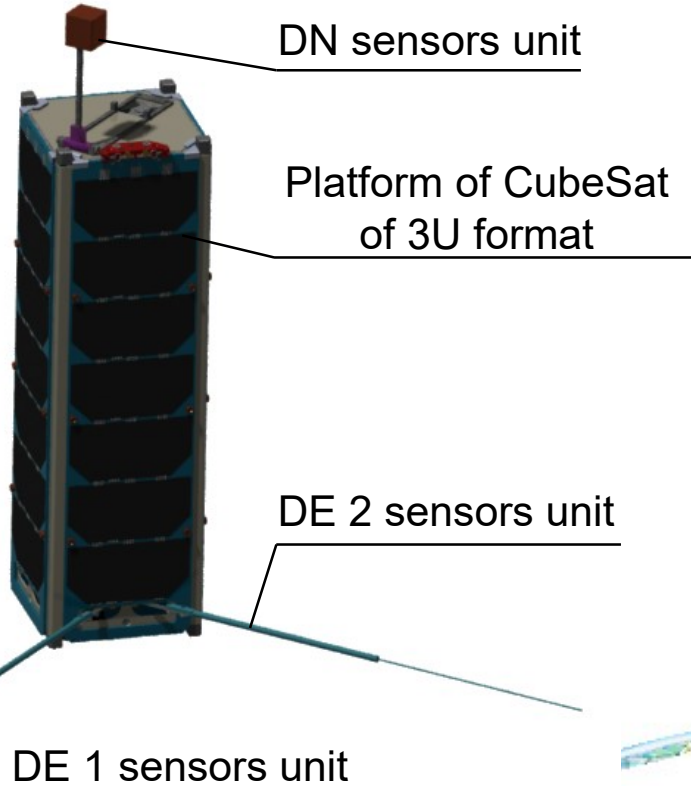


Microsat-M spacecraft is designed for monitoring of dynamic processes in the Earth ionosphere. Microsat-M spacecraft is equipped with the Ionosat-Micro scientific equipment for ionospheric measurements.

As of now, a full-scale dynamic mockup of Microsat-M spacecraft has been manufactured and its strength tests have been carried out.

Composition of Ionosat-Micro scientific equipment

Device	Measurable value	Developer
1. MWC magnetic wave complex:		Lviv Centre of the Space Research Institute of the National Academy of Sciences of Ukraine and State Space Agency of Ukraine
<ul style="list-style-type: none"> • WP wave probes (3 pcs.) 	Current density in plasma; Induction vector of the variable magnetic field; Potential of the variable electric field	
<ul style="list-style-type: none"> • EP electrical probe 	Potential of the variable electric field	
<ul style="list-style-type: none"> • FGM magnetometer 	Induction vector of the quasi-constant magnetic field	
2. DN-DE particles density analyzer	Pressure of neutral component; Concentration of neutral particles; Concentration of charged particles; Temperature of electrons.	Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and State Space Agency of Ukraine
3. RFA analyzer of the electric field spectrum	Frequency spectrum of electric field.	Space Research Center of the Polish Academy of Sciences
4. IDM ionic drift-measuring device	Parameters of the plasma ionic component	Space Research Institute of the Bulgarian Academy of Sciences



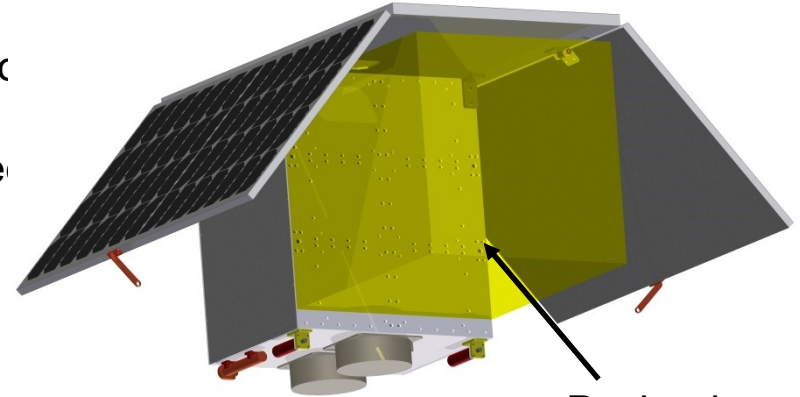
Following the global trends, in 2015 Yuzhnoye SDO initiated design studies of the CubeSat-class platform with the purpose of nano-satellites development on its basis.

There was considered a possibility of installation of the DN-DE sensors unit on CubeSat platform of 3U format. The DN-DE sensors unit was developed by the Institute of Technical Mechanics of the National Academy of Science and State Space Agency of Ukraine; it was adapted for the platform of this format.

Platform is designed for creation of the Earth observation microsatellites (up to 50 kg) for scientific and technological purposes.

Depending on a type of the installed payload selected orbit parameters, required type accuracy of attitude, the platform can be updated in terms of:

- increasing the data transmission rate;
- improvement of the attitude accuracy;
- increasing the performance capabilities.



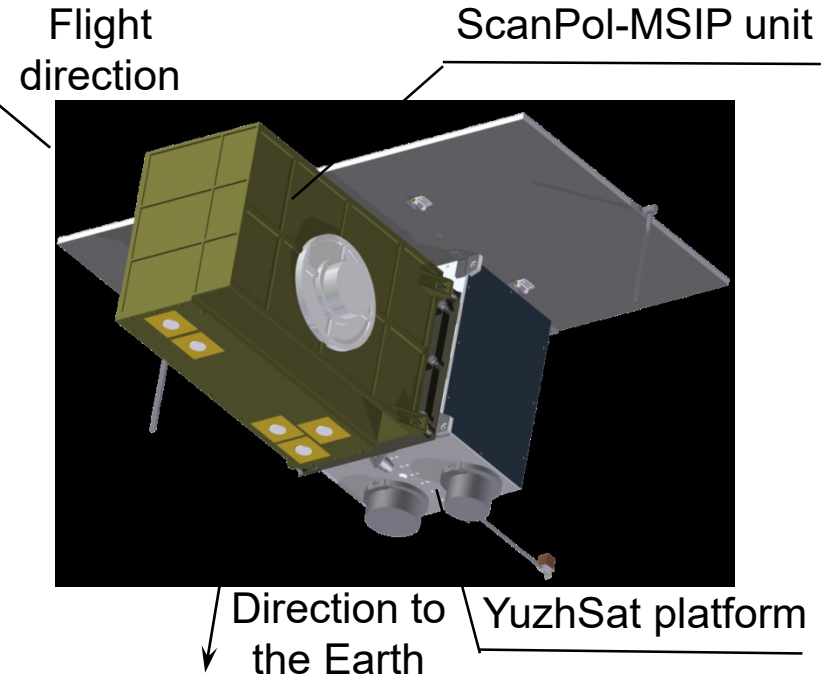
Payload area
~ 35-50 dm³

Main characteristics	Configuration-1	Configuration-2	Configuration-3
Platform mass, kg	15	20	30
Payload mass, kg	up to 10	up to 15	up to 20
Payload power supply, W:			
- Maximum	20	40	80
- Daily average	5	10	20
Payload data transmission rate, Mb/s	0.5 (S-band)	32 (X-band)	50 (X-band)
Roll and pitch rotation range, deg	-	±35	±35
Attitude accuracy, deg	<5	<0,2	<0,2
Stabilization accuracy, deg/s	<0.01	<0.01	<0.01
Accuracy of attitude determination, deg	<3	<0.1	<0.1
Operating lifetime, years	>2	>2	>2

The first Aerosol-UA microsatellite based on YuzhSat platform is designed to perform space experiments aimed at studying the atmospheric aerosols.

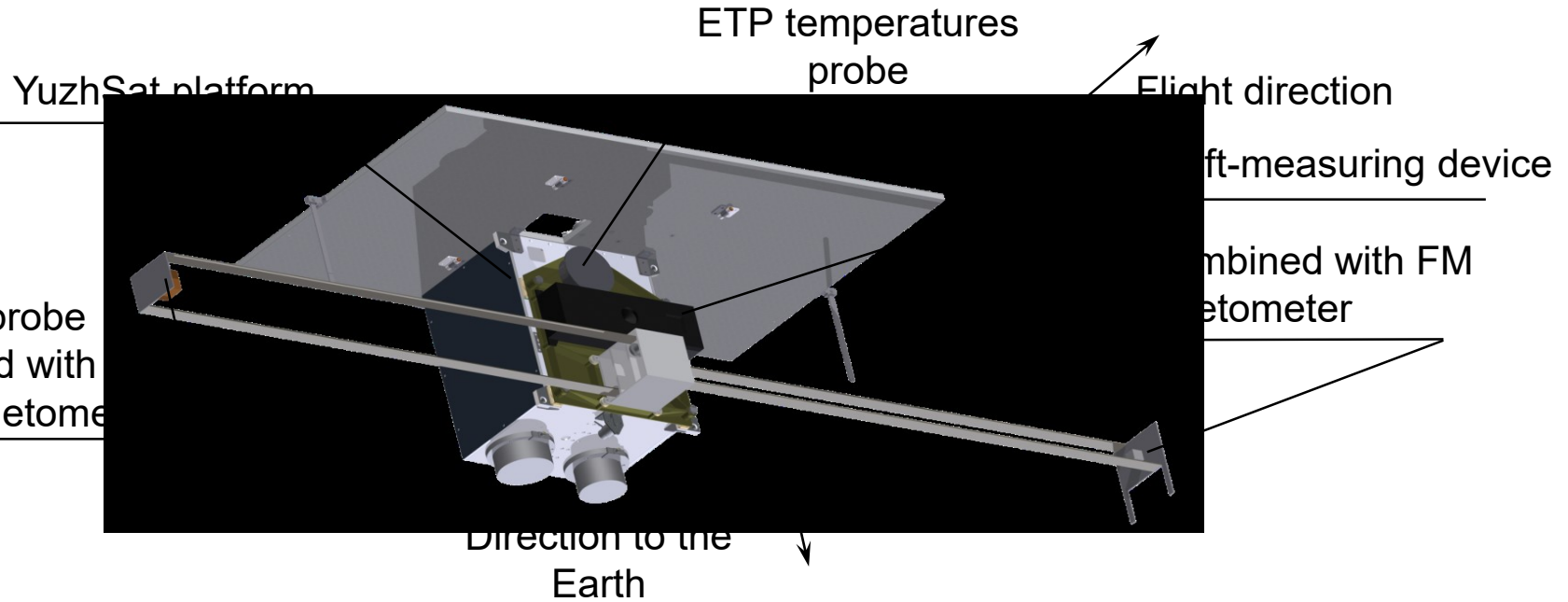
ScanPol-MSIP unit is used as a payload, it consists of the following devices: scanning polarimeter (ScanPol) and multispectral imager-polarimeter (MSIP).

As of today, the design documentation has been issued, a full-scale dynamic mockup of the Aerosol-UA spacecraft has been manufactured, its strength tests have been carried out.



Composition of ScanPol-MSIP Unit

Device	Application	Developer
1. ScanPol	Measurement of the detailed physical characteristics of natural and anthropogenic aerosols, assessment of their chemical composition.	Main Astronomical Observatory of the National Academy of Sciences of Ukraine
2. MSIP	ScanPol device data reference and determination of aerosol optical and physical characteristics	



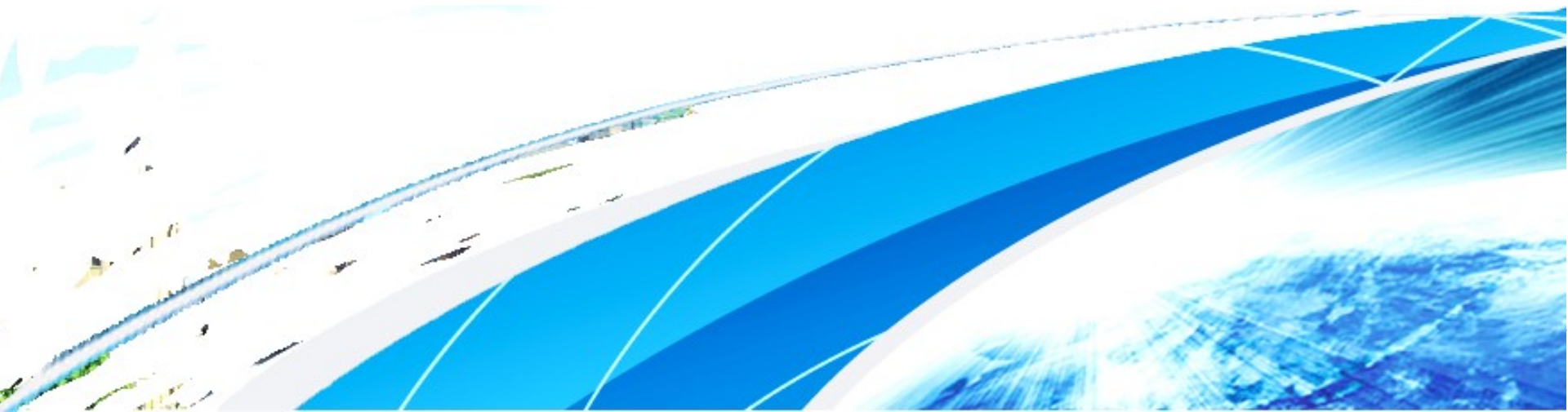
The Clusterion is a perspective project that will provide new quality of study of the dynamic links in the “atmosphere-ionosphere-magnetosphere” system by carrying out the multi-point synchronous measurements of the ionosphere plasma parameters using a cluster of 2 ... 4 microsattellites based on the YuzhSat - magnetically clean platform. It is planned to install the Clusterion scientific equipment on the spacecraft.

Preliminary composition of Clusterion scientific equipment

Device	Measurable values	Developer
ID ionic drift-measuring device	Concentration, temperatures and three components of the drifting velocity of the plasma ionic component	Space Research Institute of the Bulgarian Academy of Sciences
ETP electronic temperature probe	Temperature of the electronic component of plasma	National Cheng Kung University, Taiwan
FM fluxgate magnetometer	Three components of the magnetic field 0-10 Hz	Lviv Centre of the Space Research Institute of the National Academy of Sciences of Ukraine and State Space Agency of Ukraine
IM induction magnetometer	Three components of the magnetic field 10 Hz - 20 kHz	
EP electrical probe (2 pcs.)	Y-component of the electric field 10 Hz - 20 kHz	

In order to install the payload on the platforms developed by Yuzhnoye SDO (MS-2, YuzhSat etc.), a developer of the payload device should provide:

- At the phase of preliminary design – input data, including dimensional drawing of the device;
- At the development and tests phase – full-scale dynamic mockup of the device, or dimensional drawing of the full-scale dynamic mockup of the device for its manufacturing;
- At the phase of electrical tests – flight model of the device or electrical equivalent of the device for testing the electrical interfaces with the platform.





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