RUSSIAN SPACE MISSIONS FOR SOLAR-TERRESTRIAL SCIENCE

update 2014

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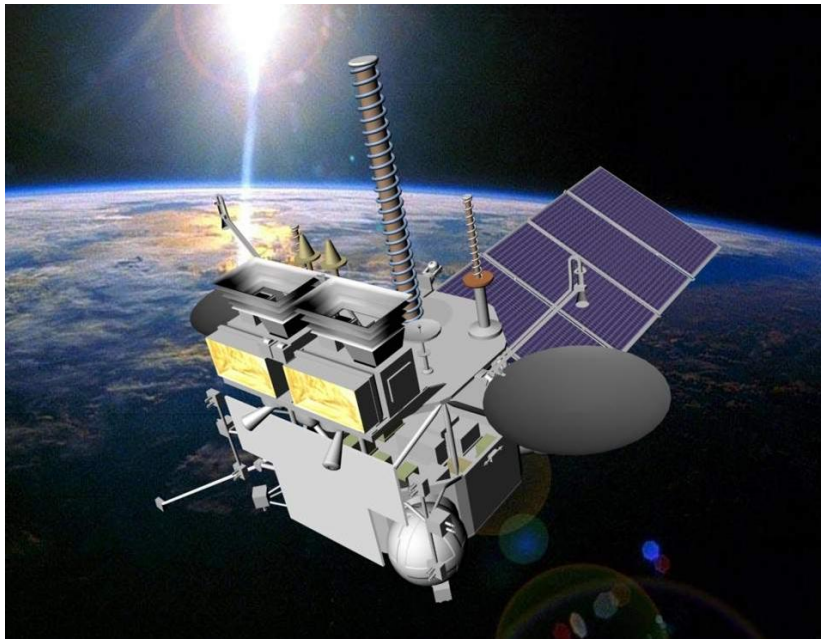
IZMIRAN

Meteo spacecraft ELECTRO-L, Meteor-M1, Meteor-M2

- **Launched in February 2011, July 2014**



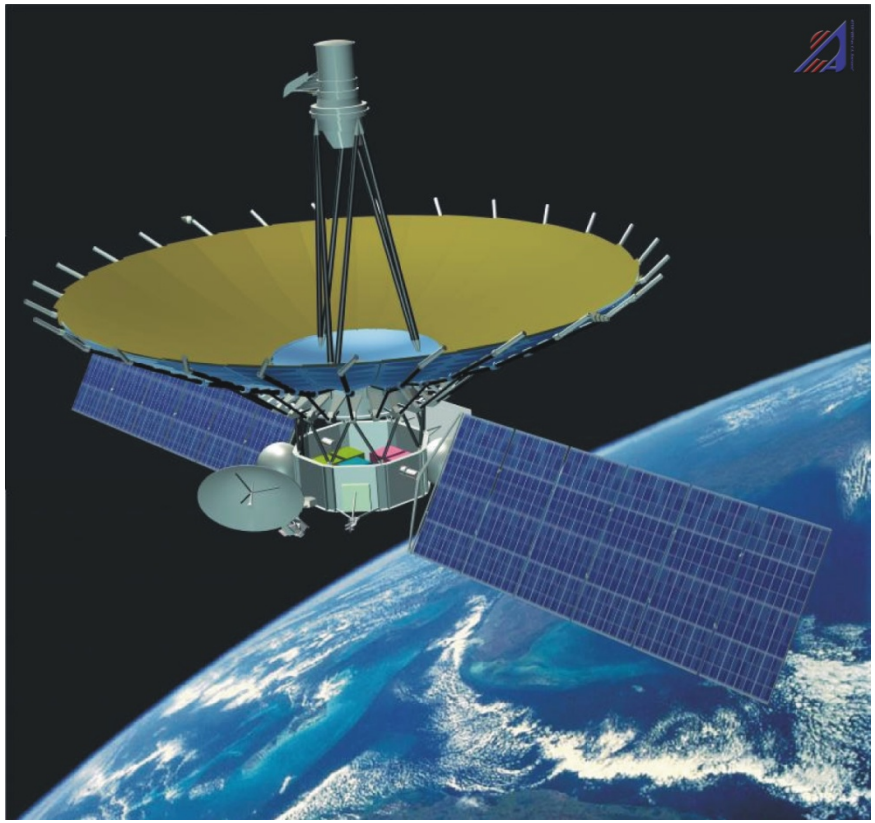
Solar and magnetospheric payload:

- Cosmic ray
- Energetic plasma
- Magnetic field
- Solar radiation

smdc.sinp.msu.ru
space-weather.ru

Radioastronomy mission SPECTR-R

- **three years in orbit**



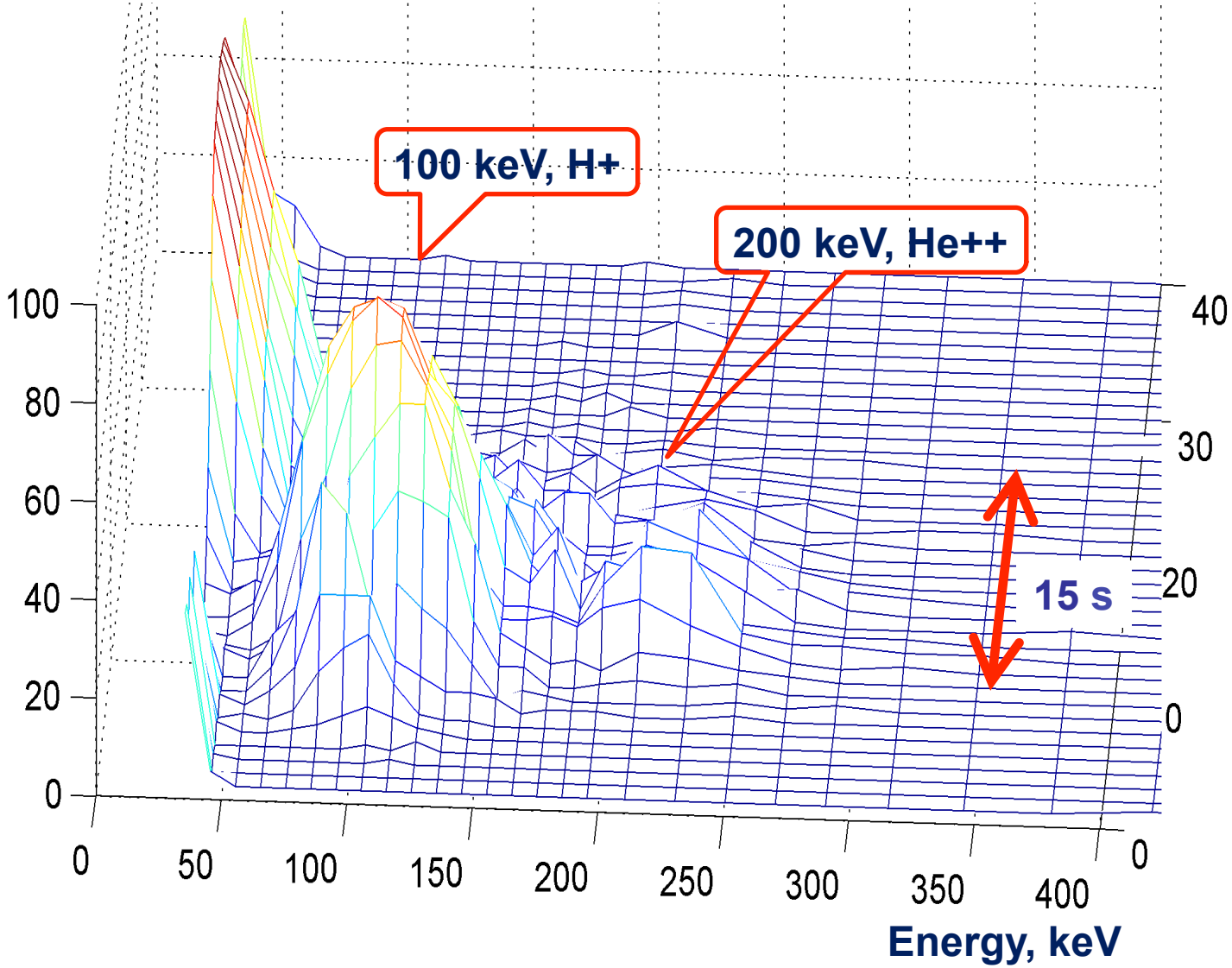
- ✓ space VLBI
- ✓ 10-meter radio telescope
- ✓ orbit with apogee 350 000 km

PLASMA-F : payload of opportunity to study solar wind with high time high resolution

solar wind flow, IMF, cosmic rays
up to 32 samples/sec

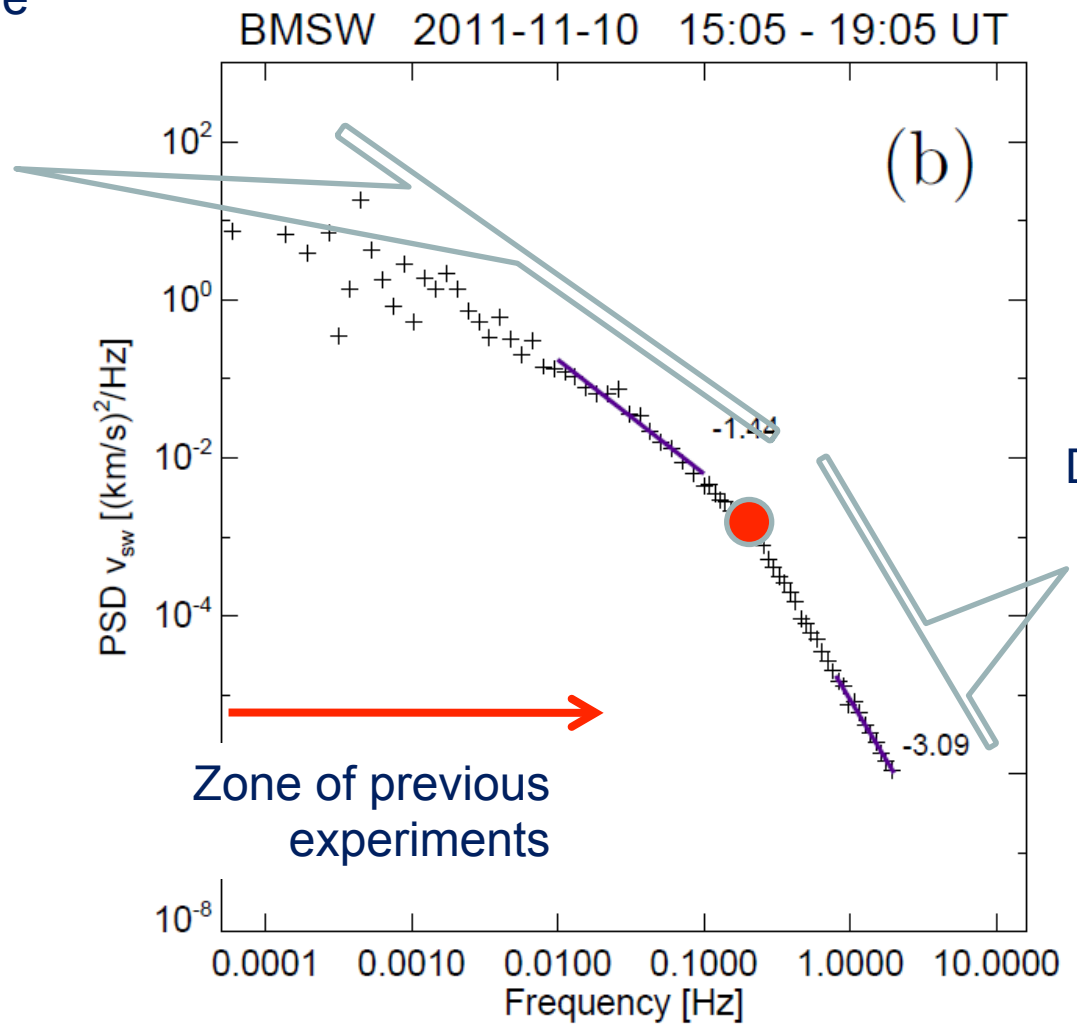
http://www.plasma-f.cosmos.ru

Plasma-F: impulses of accelerated ions in the forshock



Solar wind fluctuation spectrum first measured up 10 Hz
With a kink between inertial and dissipation range

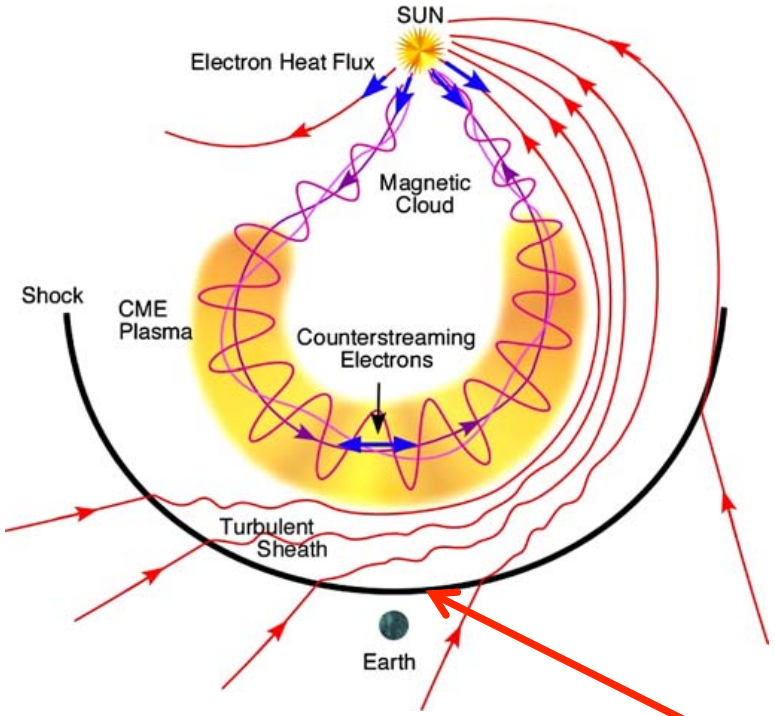
Inertial range



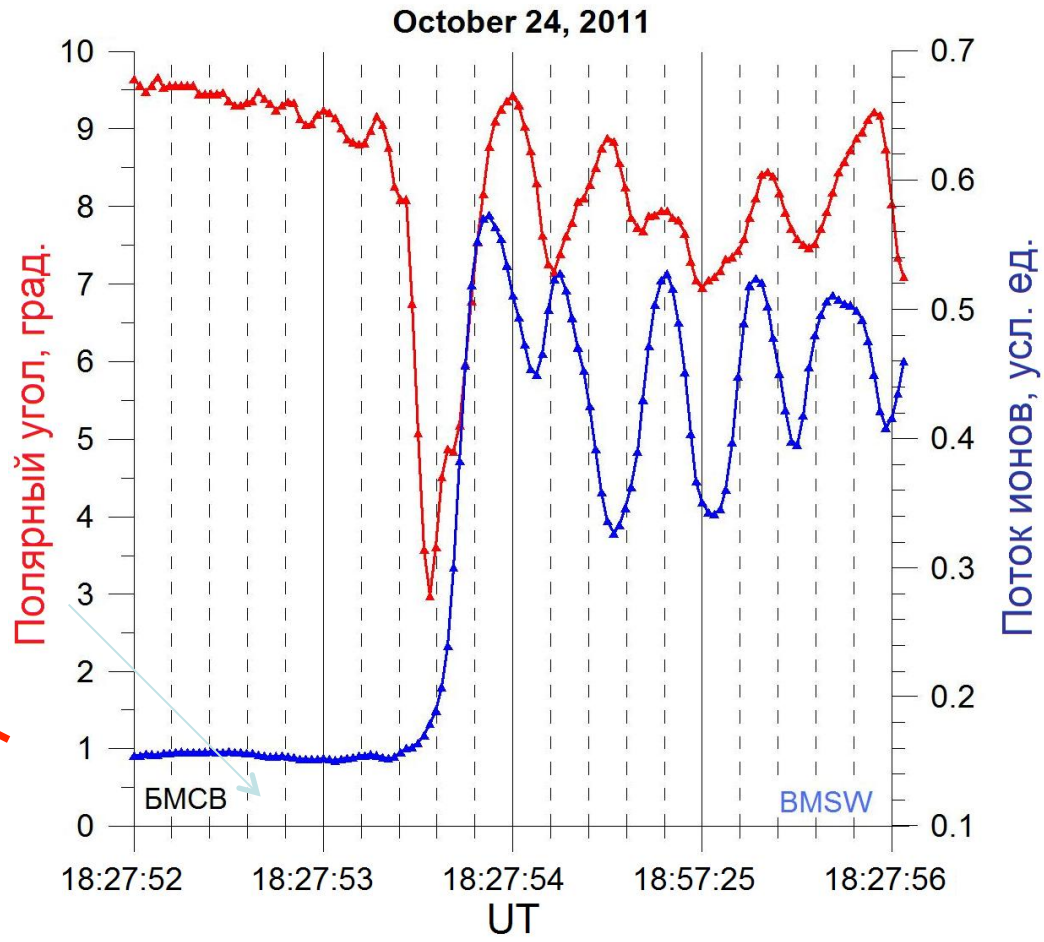
Dissipation range

Zone of previous experiments

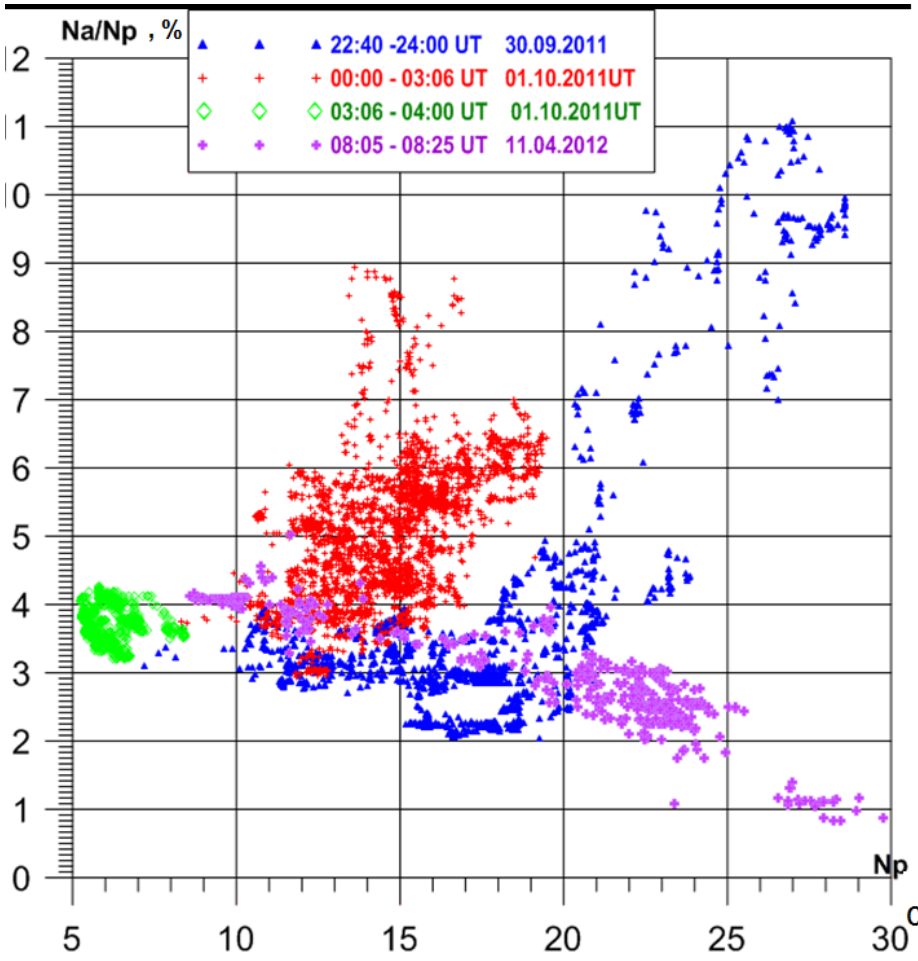
Interplanetary shock width is measured

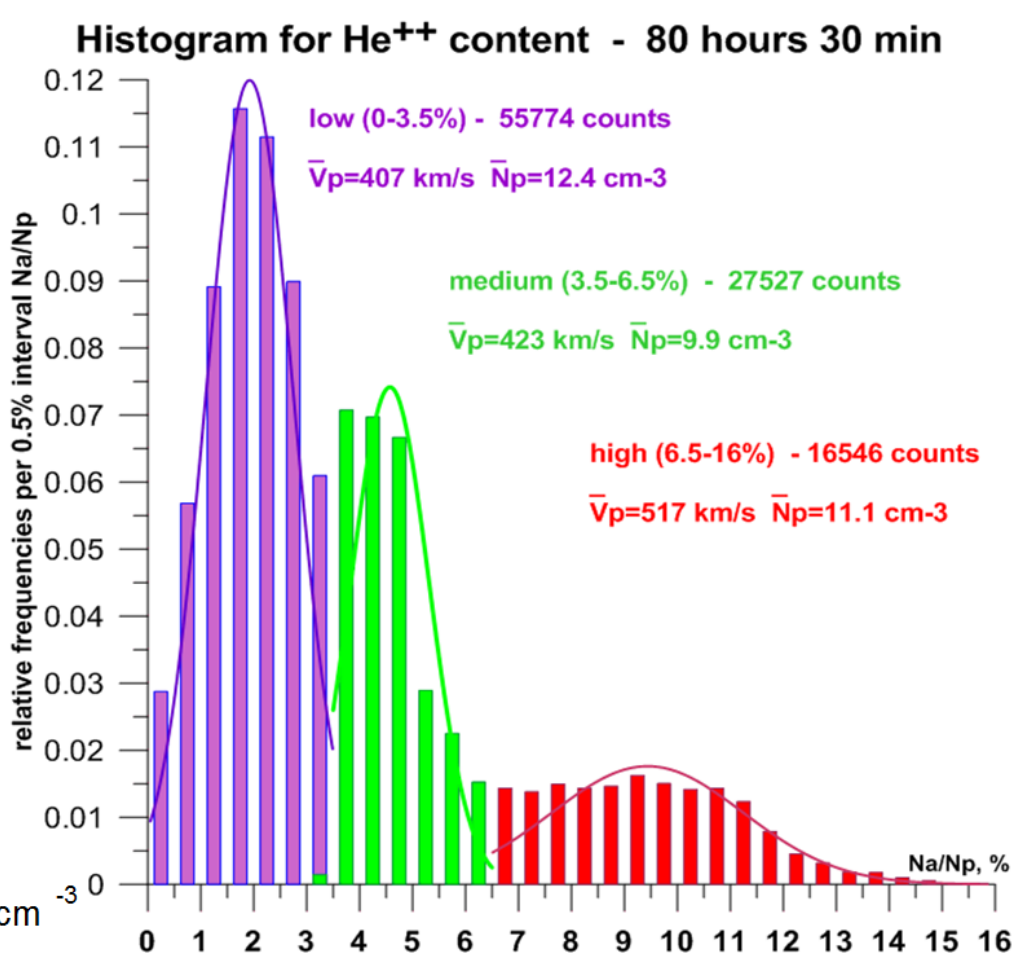


1 sec, ~ 400 km



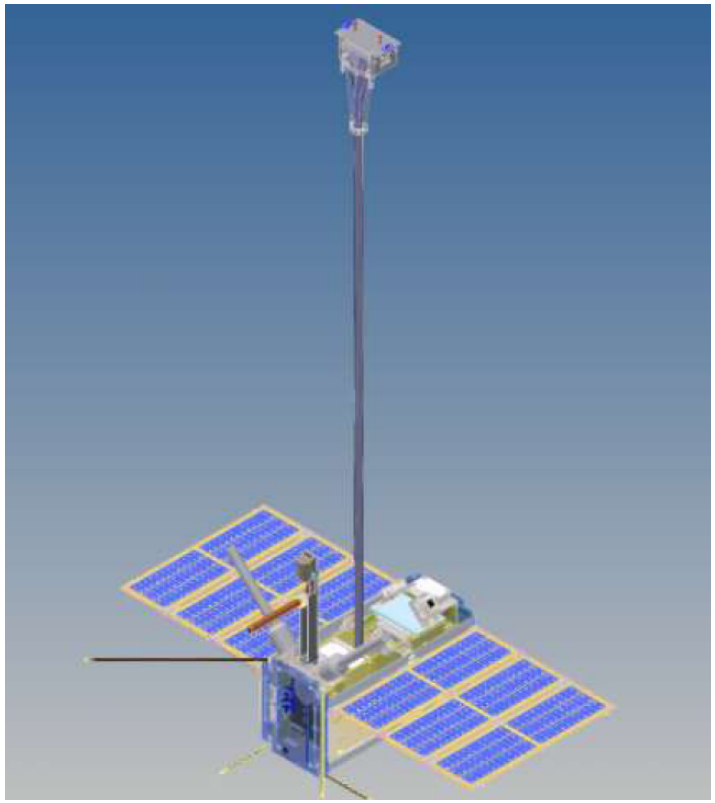
Variety of He++/H+ ratio





Ionospheric micro satellite CHIBIS - M

- **three years in operation**

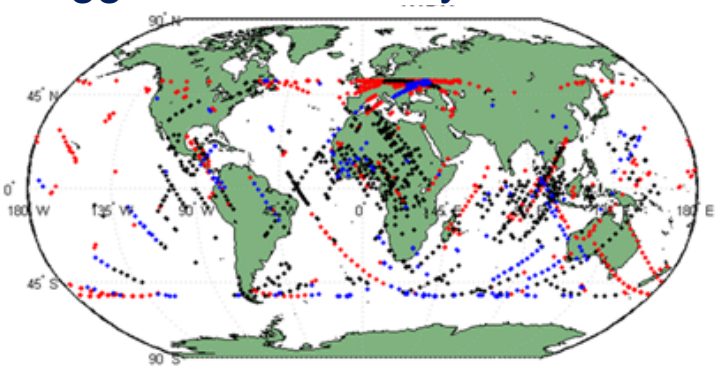


Microsat to study atmospheric electricity and TGFs

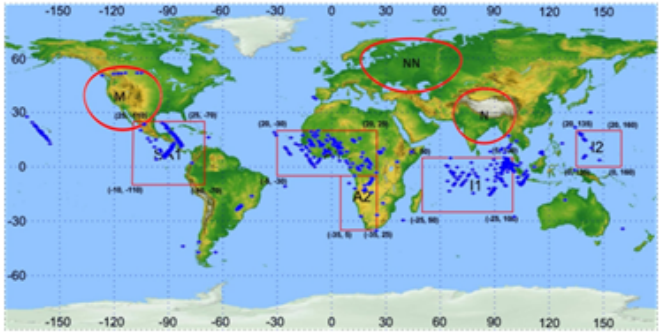
- X-ray / gamma detector
- UV sensor
- Radiowave analyzer
- Magnetic and electric sensors
- Photocamera
- Data analysis system

Atmospheric electricity in radiowaves and UV

Joint trigger detections by UV and EM waves

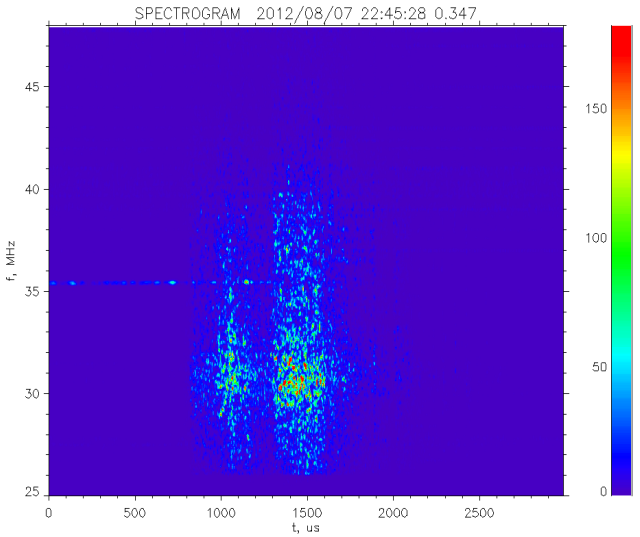


МВК
0.001-40кГц
E, Uo
Bx, By, Bz
Jx, Jy



ДУФ

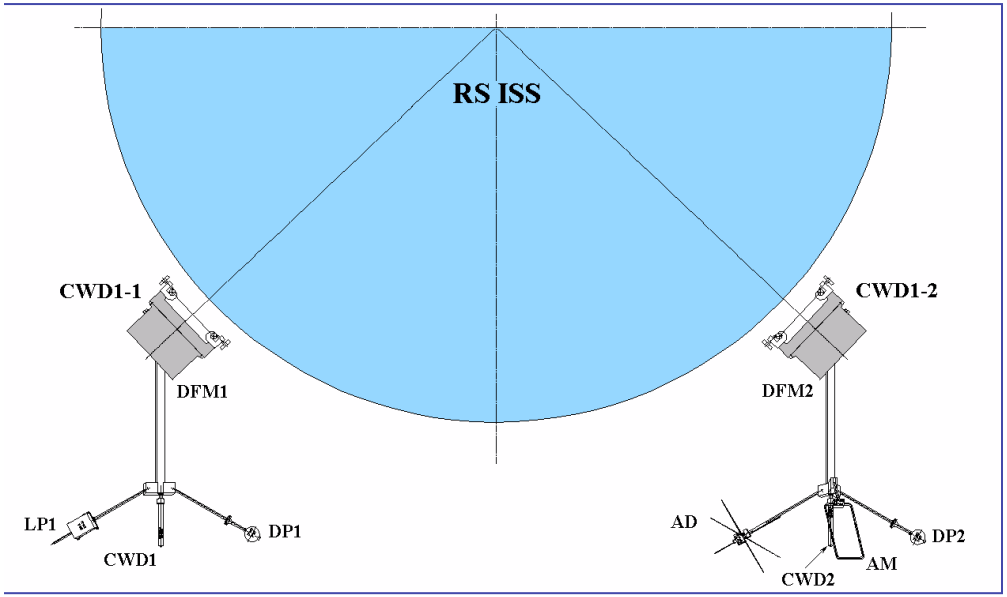
РЧА
26-48 МГц

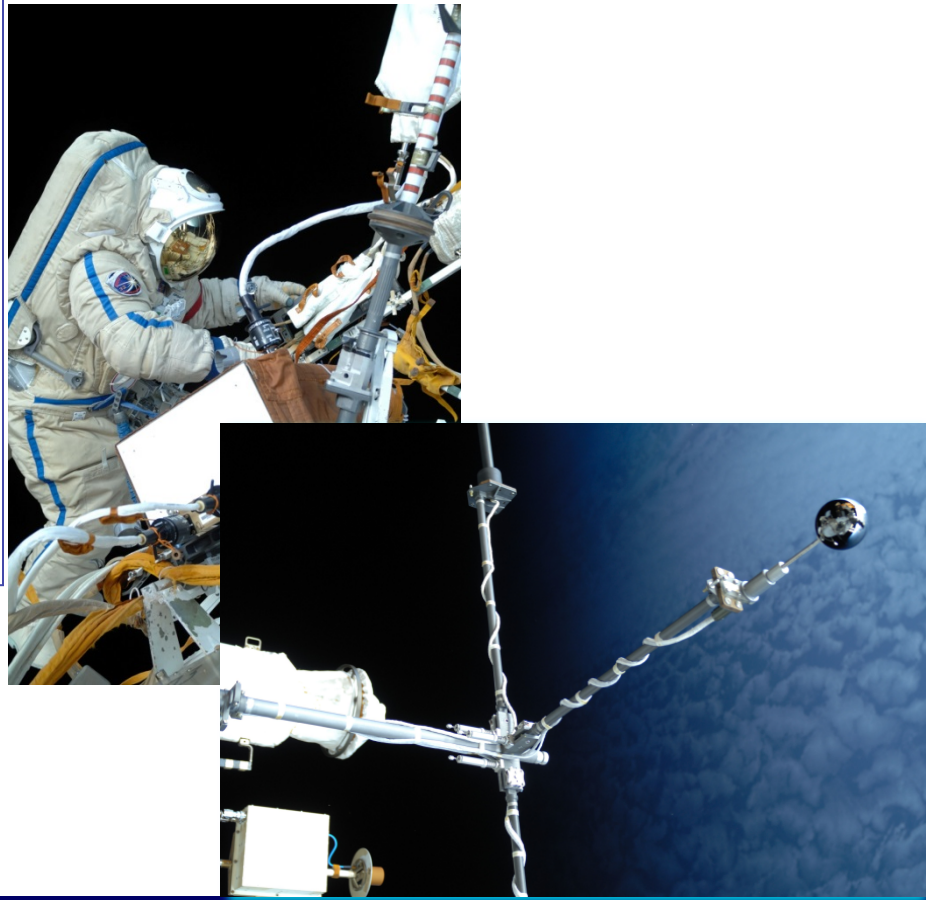


International Space Station experiment “Obstanovka”

- **launched in 2013**

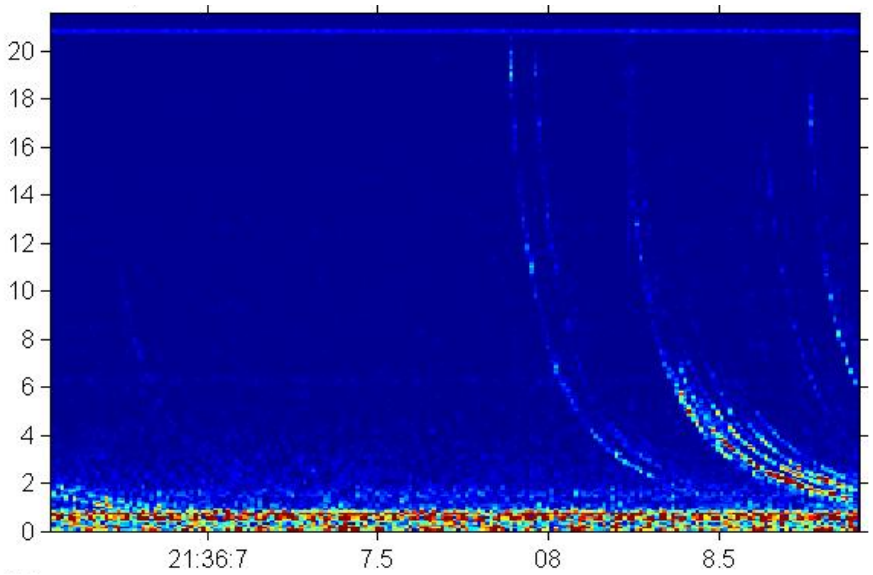
Multipoint multi-component wave and field experiment to study electro-magnetic environment of ISS

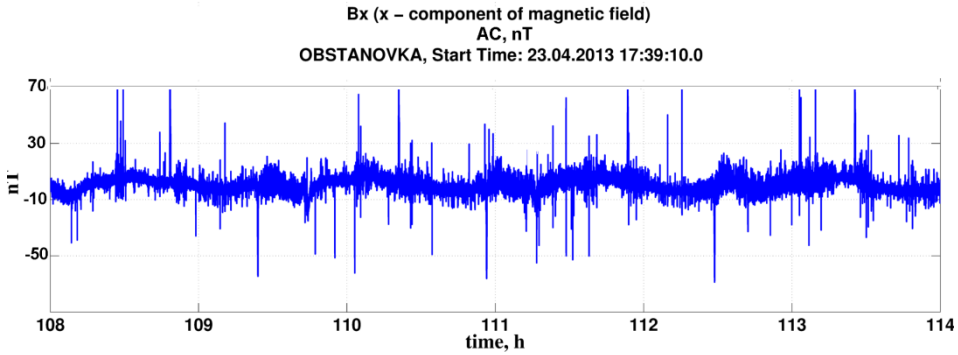


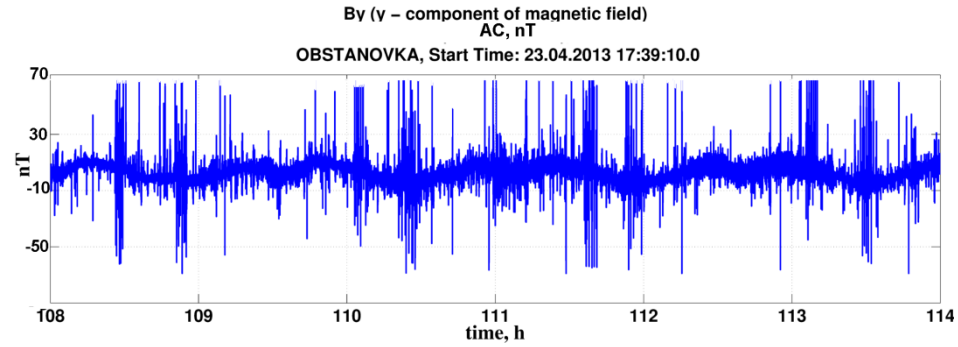


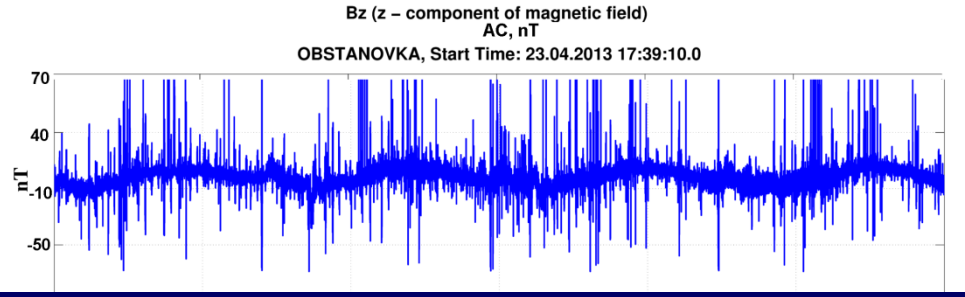
First data

Whistlers can be detected even in ISS environment









MKA KARAT RELEC

- **launched July 2014**

Spacecraft producer: NPO Lavochkin
100 kg platform class

Orbit sun-syncrhonous 800 km

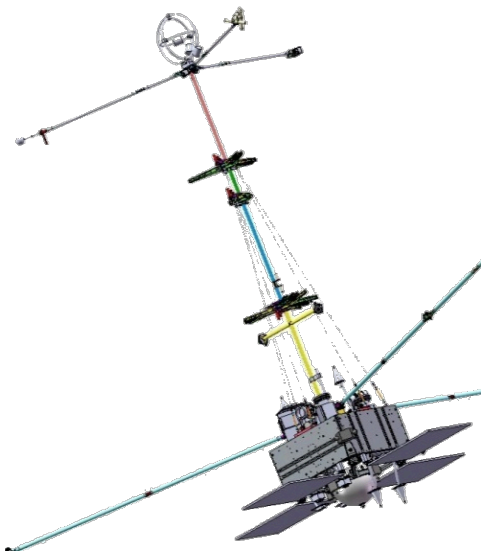
Science:
- Energetic particle precipitation,
- Atmospheric electricity and transients

Instruments:
- Energetic particle detectors
- Radio and plasma wave experiment
- Visible, UV & X-ray detectors

Science lead: SINP MSU

Resonance

Inner magnetospheric mission



- **Space weather**
  Ring current, outer radiation belt,plasmasphere
- **Magnetospheric cyclotron maser**
  Interaction of electrons and waves
- **Auroral region acceleration**
  Small-scale active zones, precipitation

- **Two pairs of spacecraft**
- **Magneto-synchronous orbit**

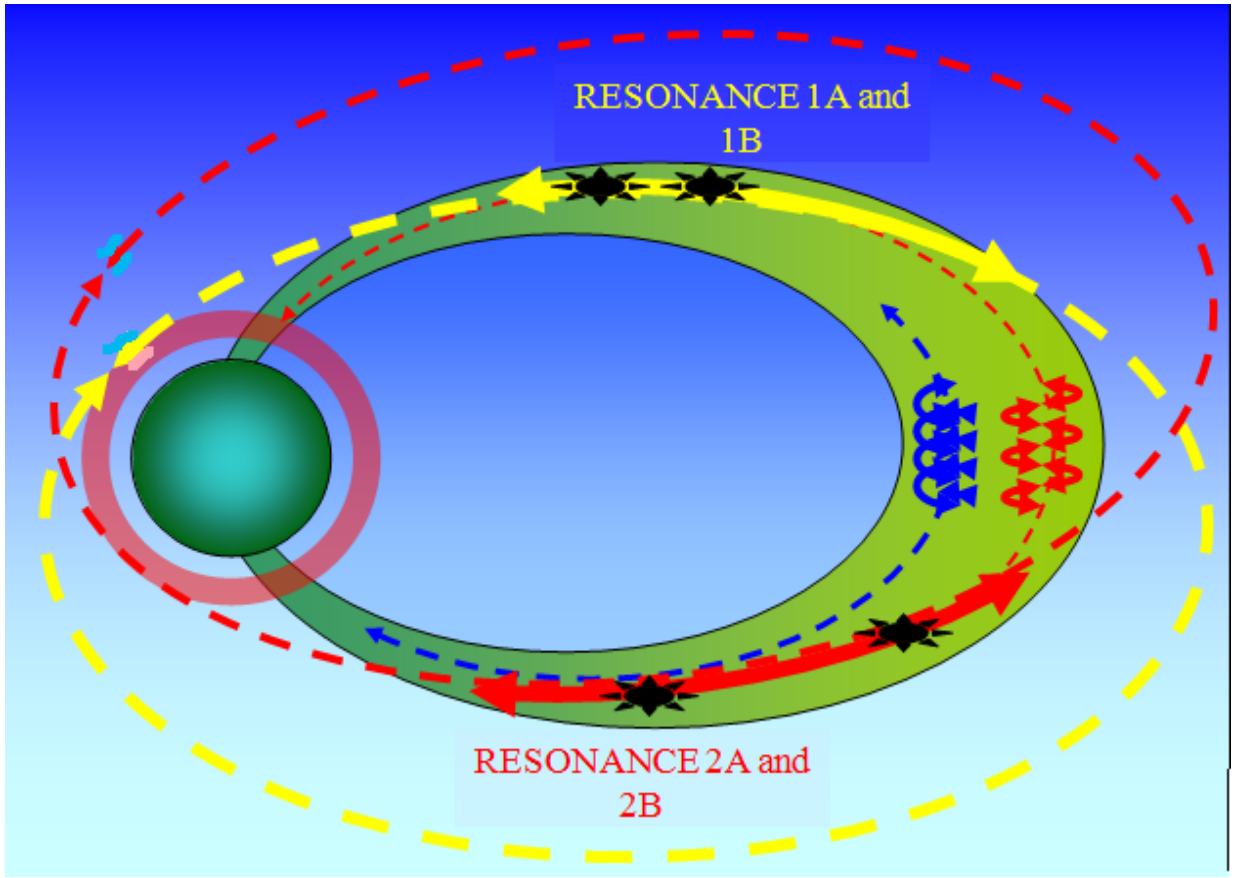
Electric and magnetic sensors
Wave analyzer and interferometer
DC – 10 MHz

Cold plasma sensors
Suprathermal plasma analyzer
Energetic particles and
Relativistic electron spectrometer

To be launched in 2016+ changing electronic components

Two pairs of spacecraft

Distance in pairs: varies from 1-10 km to 100-1000 km



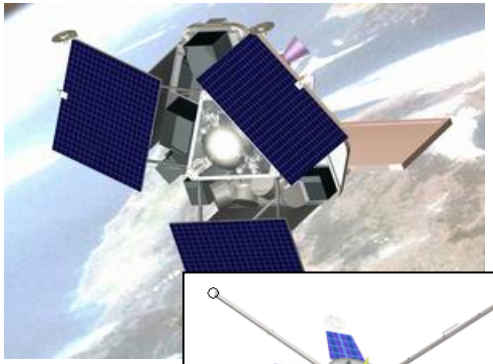
Period: 8 hours
Apogee: ~27000 km
Inclination: 63.4°
Co-rotation with magnetic line at L~4-5 (foot-point HAARP)

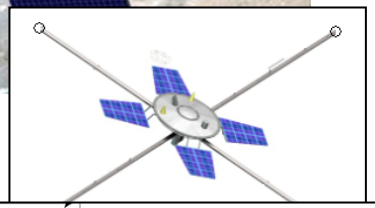
Orbit needs to be reconsidered HAARP closing

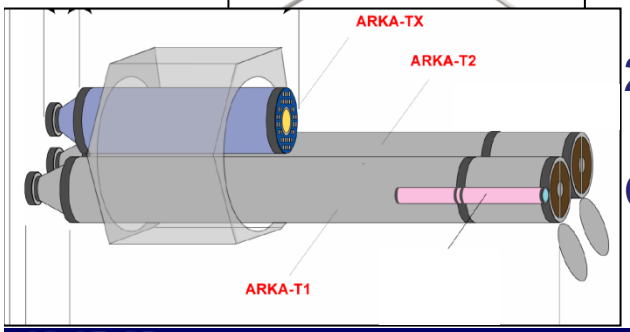
Small satellite platform MKA KARAT for scientific projects

5 spacecraft are contracted for 2010-2015
up to 60 kg of payload

First launch in 2011







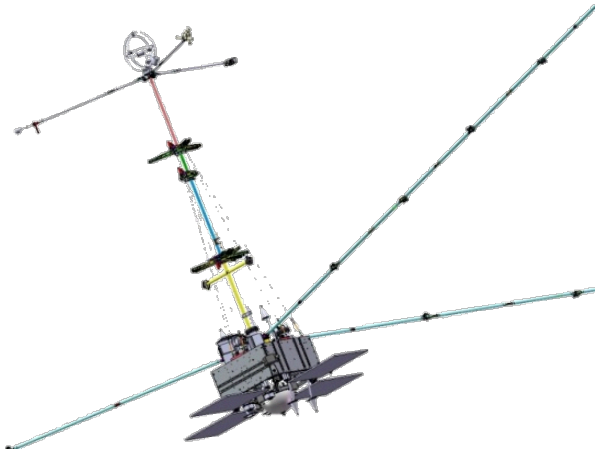
2011 MKA-1: Zond-PP (microwave remote sensing)
2014 MKA-2: RELEC (particle precipitation and atmospheric electricity

…

2015-2016 MKA-4: Strannik (magnetospheric)

2015-2016 MKA-5: ARKA (high resolution solar corona)

Cancelled to future decision



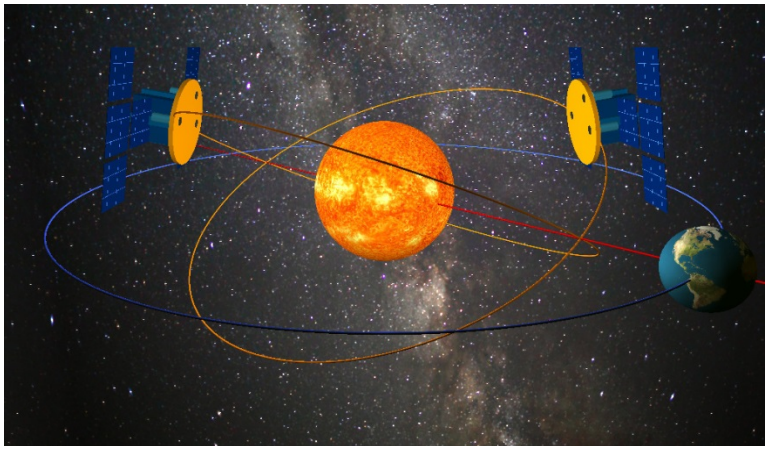
MKA-4 Strannik ("Pilgrim")

- Plasma turbulence up to electron scales
- Thin boundaries and transient processes

- 3D electric and magnetic field measurements, fast particle measurements
- Single spacecraft
- Outer magnetosphere orbit (apogee 25-30 Re)

Fast-track cheap mission relying on heritage of previous projects
Combination of PLASMA-F and Resonance instruments

Interhelioprobe



Solar observations from inner heliosphere

- High-resolution observations of the solar atmosphere
- In-situ measurements near Sun (60 R_s)
- Out-of-ecliptic observations (up to 30°)
- Observations of Sun invisible side

Scientific goals

- Solar dynamo and solar cycle
- Thin structure and dynamics of the solar atmosphere
- Corona heating and acceleration of the solar wind
- Solar flares, coronal mass ejections, solar-terrestrial relations and space weather
- Solar energetic particles

A special ILWS working group on solar project collaboration
(Solar orbiter, Solar probe+, Interhelioprobe, SPORT

Interhelioprobe project details

Idea: IZMIRAN, IKI and Lindau team — 1995
Leading scientific organization: IKI since April 2013 (IZMIRAN before)
Principal Investigators: L.M. Zelenyi (IKI) & V.D. Kuznetsov (IZMIRAN)

Spacecraft design: The Lavochkin Association (NPO Lavochkin)

Scientific instrumentation design: IKI, IZMIRAN, NIRPhI, LPI, SINP MSU, MEPhI, IPTI +
+ International collaboration
Scientific payload: 160 kg: 11 instruments for remote + 9 instruments for in-situ

Launch date: 2022 or 2023 by “Soyuz-2/1b” rocket with the “Fregat” rocket stage
Current stage: Phase C (development of the instrumentations and spacecraft)

Two spacecraft under investigation. If separated by a quarter of a period always at least one is out of the ecliptic plane