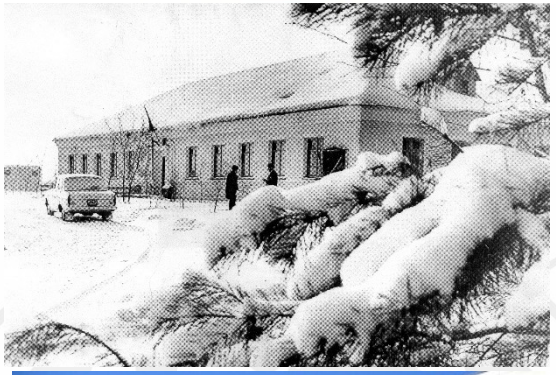
ИНСТИТУТ СОЛНЕЧНО-ЗЕМНОЙ ФИЗИКИ
СИБИРСКОГО ОТДЕЛЕНИЯ РОССИЙСКОЙ АКАДЕМИИ НАУК

The Radiophysical Complex for Ionospheric and Atmospheric Research

Irkutsk, September 11, 2024

Brief History of the Institute

- 1886 – East-Siberian magnetic observatory was opened.
- 1948 – Irkutsk Ionospheric Station was founded.
- 1952 – Start of recording cosmic ray data.
- 1956 – Irkutsk Complex Magnetic-Ionospheric Station (CMIS) was organized to study Earth magnetism, ionosphere, cosmic rays, optical and radio solar emission.



- 1960 – Siberian Institute for Earth Magnetism, Ionosphere and Radiowaves Propagation (SibIZMIR) SB AS USSR was opened on the basis of Irkutsk CMIS.
- 1992 – SibIZMIR was renamed as ISTP SB RAS.

ISTP created eight astrophysical and geophysical observatories with a broad spectrum of research instruments. The Institute is a leader in ground-based experimental research in the field of solar-terrestrial physics in Russia.

Objectives of the “National Heliogeophysical Complex of RAS” project:

- Get to a new level of development of experimental (ground-based) research in the field of solar-terrestrial physics;
- Solve urgent fundamental and applied problems in the interest of development of new space technologies.

Basic research

- Studying solar activity (magnetic fields, flares, plasma ejections, and other) and its effect on space weather;
- Studying the magnetosphere–ionosphere–atmosphere system and effects imposed on it by solar factors and meteorological and lithospheric processes.

Applied research

- Effects of space factors on operation of spacecraft and various engineering systems – radio communications, radar, GPS-GLONASS and other;
- Monitoring of near-Earth space, spacecraft and space debris;
- Developing methods for solar activity and near-Earth space monitoring and prediction to the benefit of different consumers.

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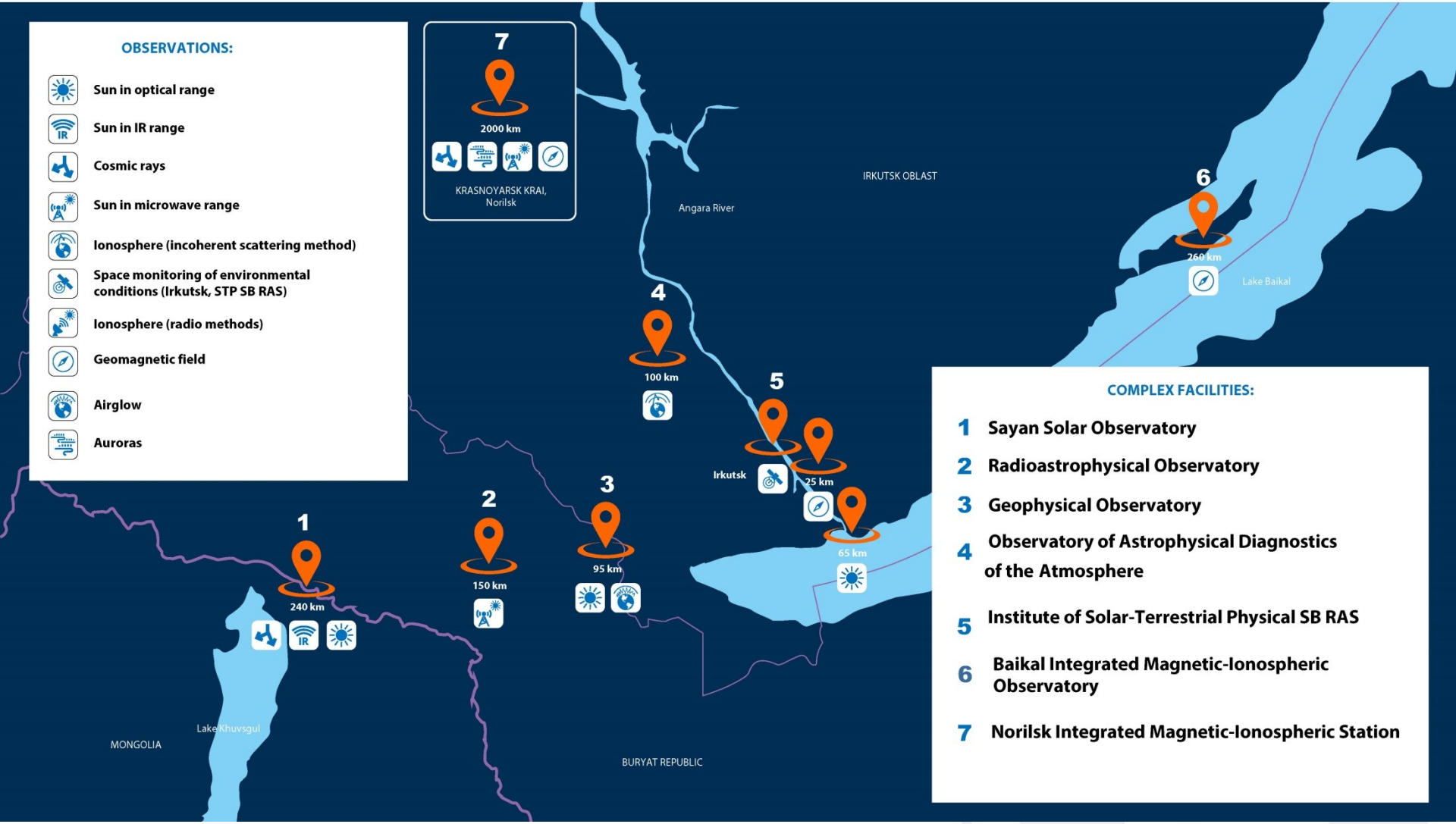
Observatories of ISTP SB RAS



ПРАВИТЕЛЬСТВО РОССИЙСКОЙ ФЕДЕРАЦИИ

ПОСТАНОВЛЕНИЕ

от 26 декабря 2014 г. № 1504

МОСКВА

Об осуществлении бюджетных инвестиций в проектирование и строительство объектов капитального строительства "Укрупненный инвестиционный проект "Национальный гелиогеофизический комплекс Российской академии наук", 1 этап"

Правительство Российской Федерации **п о с т а н о в л я е т :**

1. Осуществить в 2014 - 2017 годах бюджетные инвестиции за счет бюджетных ассигнований федерального бюджета в проектирование и строительство объектов капитального строительства "Укрупненный инвестиционный проект "Национальный гелиогеофизический комплекс Российской академии наук", 1 этап" согласно приложению.

2. Установить, что государственным заказчиком в отношении указанных в пункте 1 настоящего постановления объектов является Федеральное агентство научных организаций, застройщиком (заказчиком) - федеральное государственное бюджетное учреждение науки Институт солнечно-земной физики Сибирского отделения Российской академии наук.

3. Федеральному агентству научных организаций - главному распорядителю средств федерального бюджета, Министерству образования и науки Российской Федерации, Министерству экономического развития Российской Федерации и Министерству финансов Российской Федерации обеспечить в 2014 - 2017 годах финансирование за счет бюджетных ассигнований федерального бюджета работ по проектированию и строительству объектов, указанных в пункте 1 настоящего постановления, с распределением в соответствии с приложением к настоящему постановлению.

Председатель Правительства
Российской Федерации Д.Медведев

Scientific Advisor of the Project Academician Gely A. Zherebtsov

The project «National Heliogeophysical Complex of RAS» includes interrelated sub-projects (instruments):

In the field of solar physics:

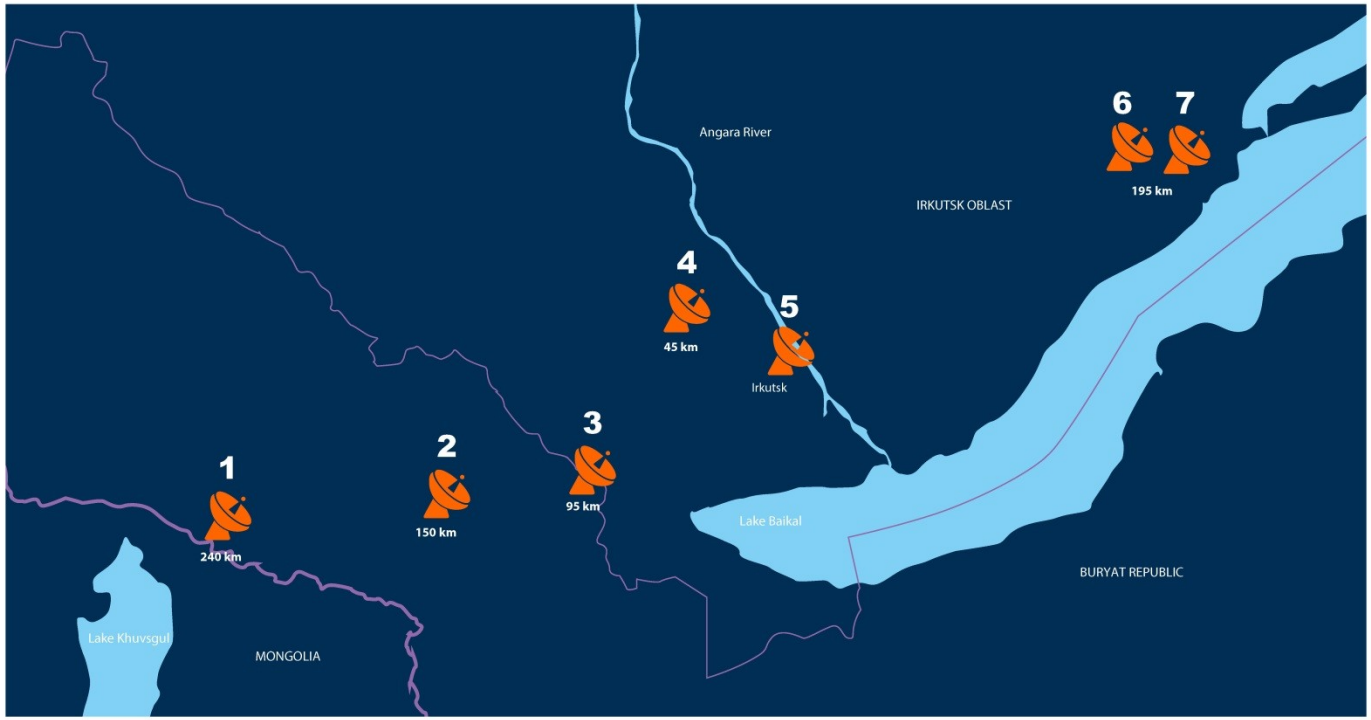
Large Solar Telescope-Coronagraph;
Multi-wave Radioheliograph;

In the field of near-Earth space physics:

IS-MST radar;
Arctic network of coherent HF radars;
Lidar-Optical Complex;
HF Ionospheric heating facility.

Data from the created instruments of the Complex will be integrated with the infrastructure of the Shared Equipment Center in the Control and Data Processing Center.

Heliogeophysical Complex facilities



1
SOLAR TELESCOPE-CORONAGRAPH
Sayan Solar Observatory

2
MULTI-WAVE Radioheliograph
Radioastrophysical Observatory

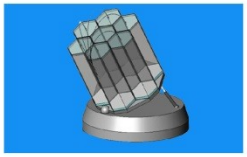
3
COMPLEX OF OPTICAL INSTRUMENTS
Geophysical Observatory

4
HEATING STAND
Observatory of Nolinear Radiophysics

5
CONTROL CENTER
Institute of Solar-Terrestrial Physics of Siberian Branch of Russian Academy of Sciences

6
RADAR NETWORK
Baikal Integrated Magnetic-Ionospheric Observatory

7
LIDAR
Baikal Integrated Magnetic-Ionospheric Observatory



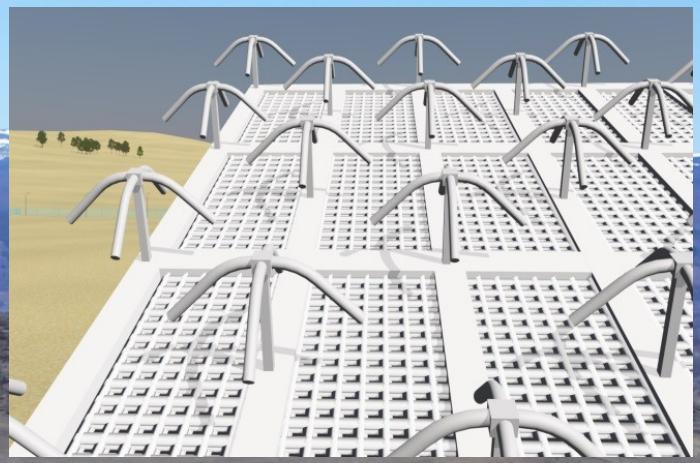
Radar System

Irkutsk region, in-service date 2027

All-Atmosphere Radar (IS-MST)

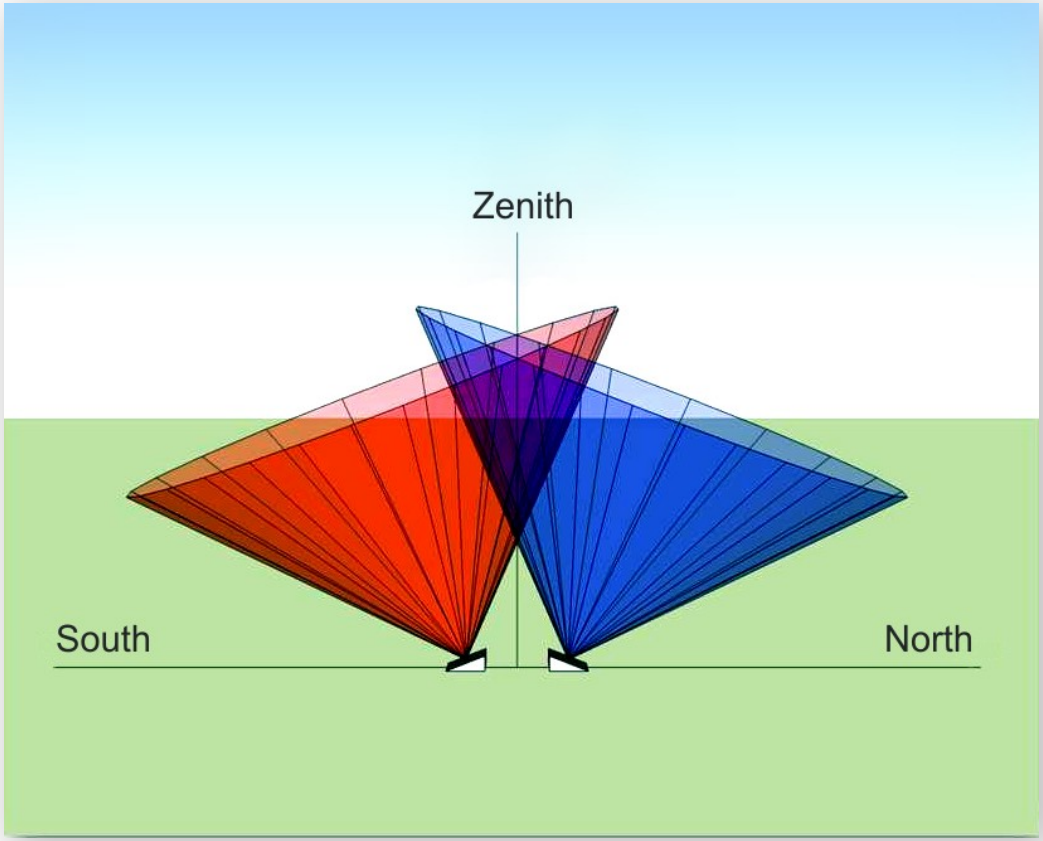
Mesosphere-Stratosphere-Troposphere radar + Incoherent Scatter Radar

Working frequency ~ 160 MHz
Peak radiation power – 4 MW
Radiation cycle covering – 33 %
Receiving bandwidth – up to 5 MHz
Pulse length – 10–5000 μs.
Recurrence frequency – 75–2000 Hz



IS-MST radar near Lake Baikal

Basic characteristics of IS-MST radar



Antenna configuration of IS-MST radar, scanning sectors

Basic specifications:

1. Working frequency ~ 160 MHz
2. Peak radiation power – 4 MW
3. Radiation cycle covering – 33 %
4. Receiving bandwidth – up to 5 MHz
5. Pulse length – 10–5000 μs
6. Recurrence frequency – 75–2000 Hz
7. Arbitrary pulse modulation
8. Circular polarization – right and left
9. Antenna type – phased array

Configuration of antenna system

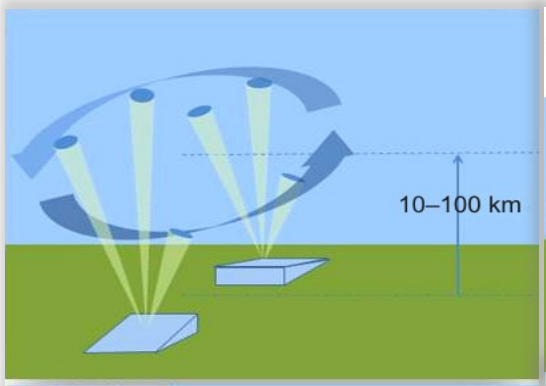
provides maximum spatial coverage of the region to be sounded and creates conditions for interferometric measurements. For the purpose, the antenna system of IS-MST radar is splitted into two areas in the magnetic meridian direction, sized ~ 40x40 m, distance between them is about 100 m.

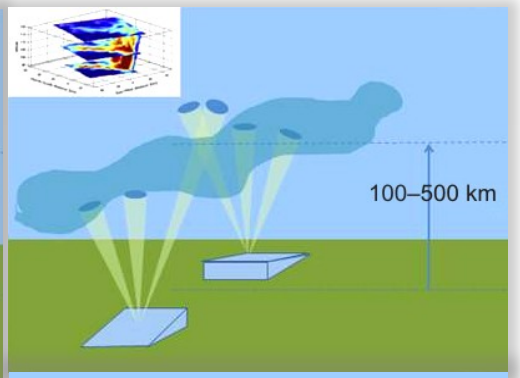
Main working modes of IS-MST radar

Diagnostics of dynamics in the lower and middle atmosphere using the MST method.

Lake Baikal ecology.

Altitudes 10–100 km.





Studying interactions in the atmosphere–ionosphere system using the IS method.

Multi-parameter diagnostics of the ionospheric plasma.

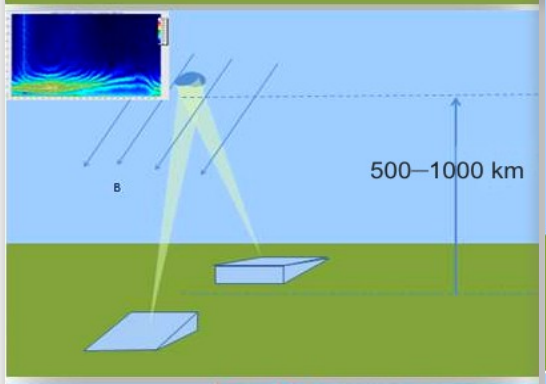
Interferometry.

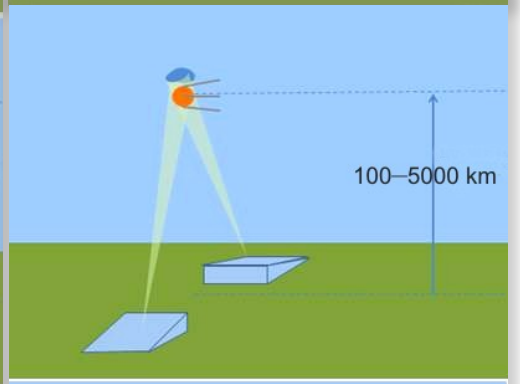
Altitudes 100–500 km.

Studying interactions within the ionosphere – plasmasphere system.

Measuring variations in the ion composition and tracks of plasma fluxes.

Altitudes 500–2000 km.





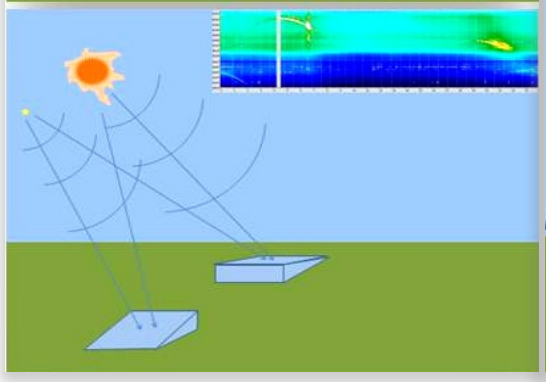
Monitoring of spacecraft and **"space debris".**

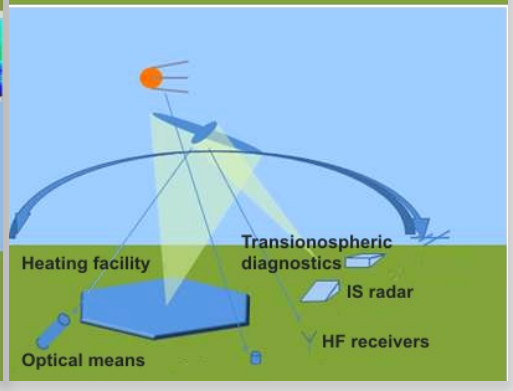
Development of methods to enhance accuracy and data rate of space monitoring.

Altitudes 100–5000 km.

Radio astronomy observations of radiation of the Sun and space radio sources.

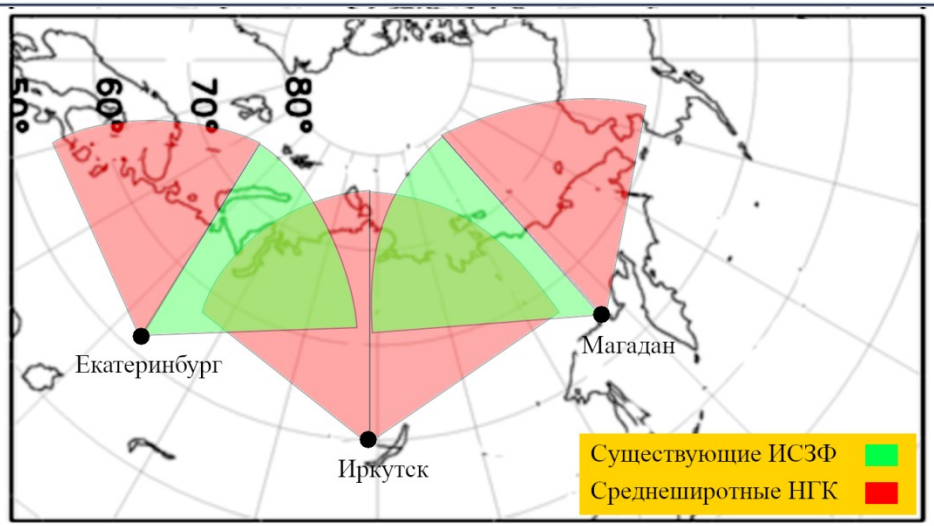
Studying radio storms and radio signal scintillations.





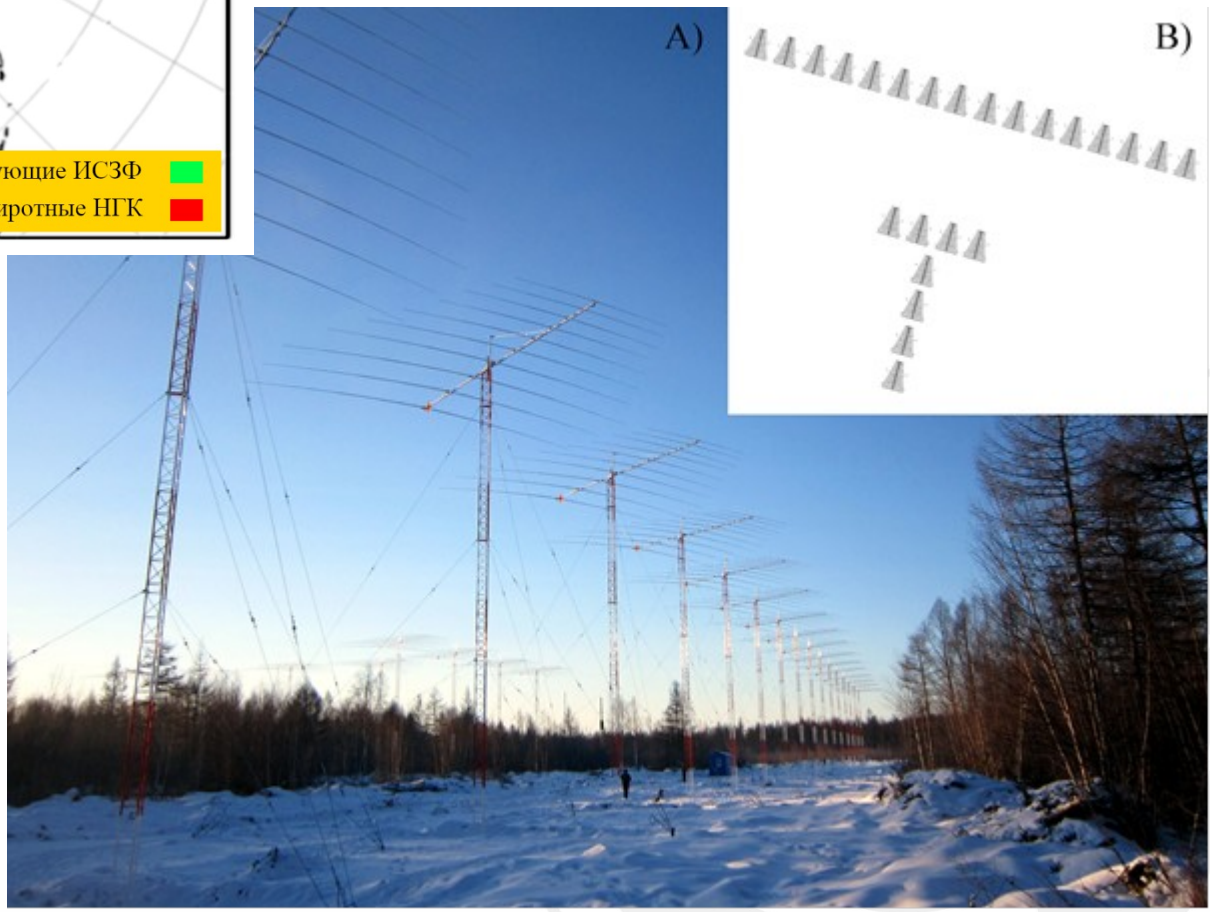
Comprehensive diagnostics of phenomena occurring upon powerful high-frequency impact on the ionosphere.

Architectural project



Russian Arctic network of coherent HF radars

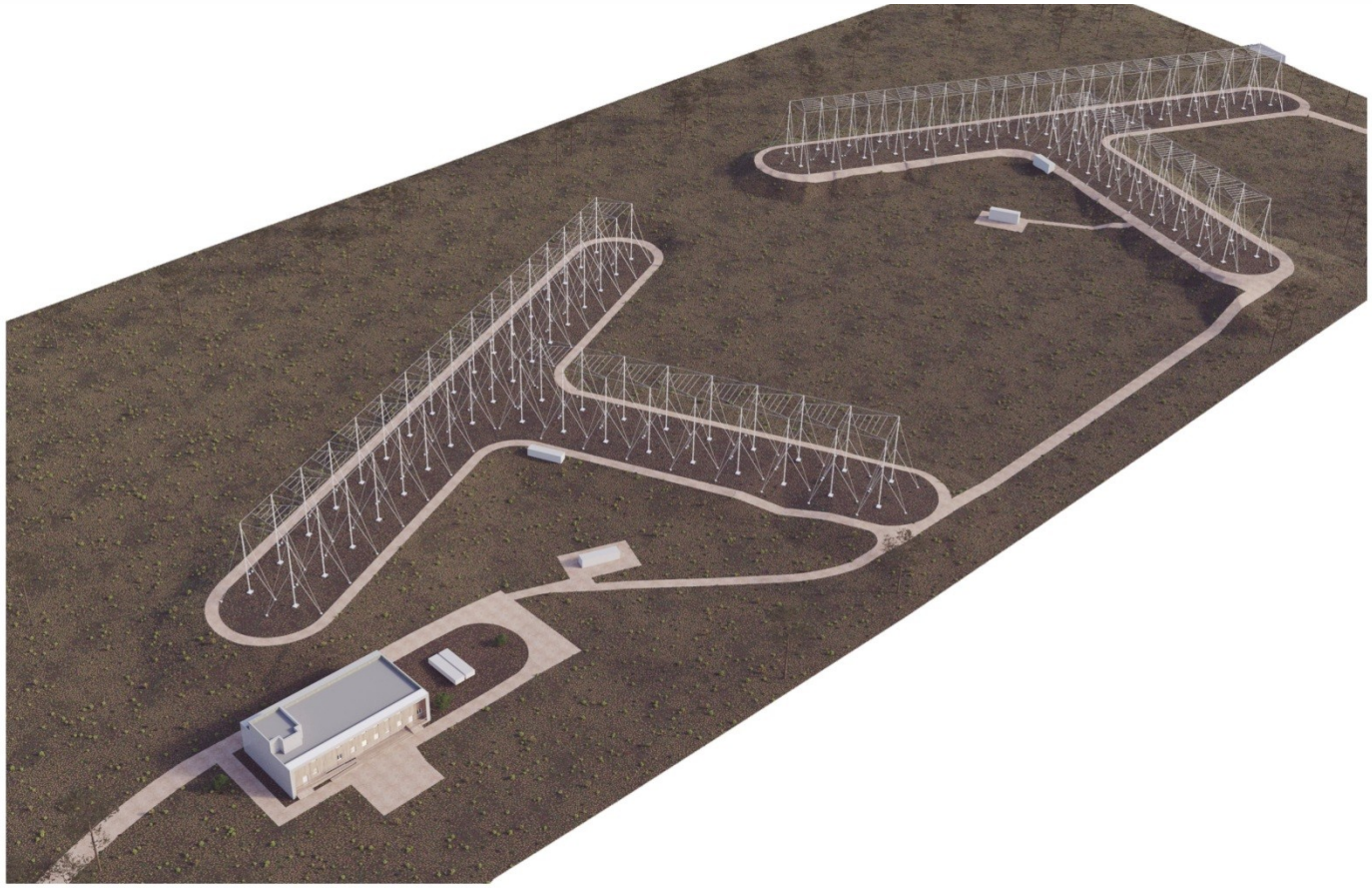
in-service date 2027



Fundamental tasks:

- ***Interaction of the solar wind with the magnetosphere and ionosphere;***
- ***Atmospheric gravity waves;***
- ***Natural and artificial plasma inhomogeneities.***

Architectural project



HEATING FACILITY

Irkutsk region, in-service date 2027

Operating frequency range 2.6-5.6 MHz

Antenna field ~500×500 m2, 200 radiating elements

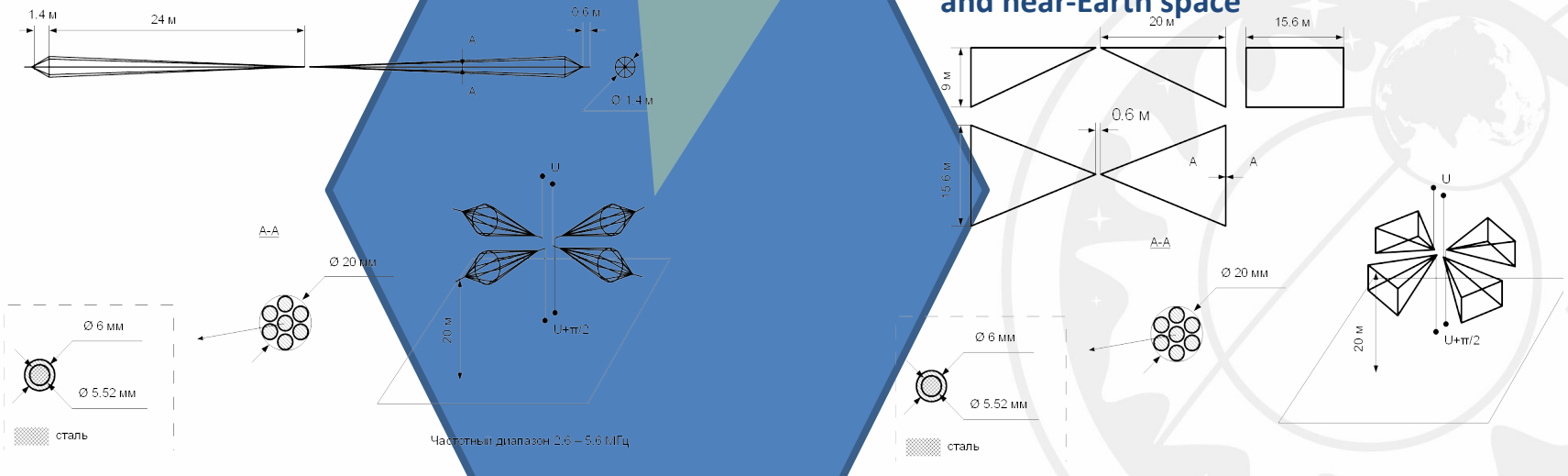
The effective radiated power is ~500 MW.

Fundamental tasks:

Studies of the charged component of the atmosphere – ionosphere – by the method of resonant absorption of HF radio waves.
The study of energy transfer processes in the ionosphere, atmosphere and magnetosphere of the Earth.

Applied tasks:

Study of the effects of controlled exposure by means of powerful HF radio waves on the parameters of the Earth's upper atmosphere and near-Earth space



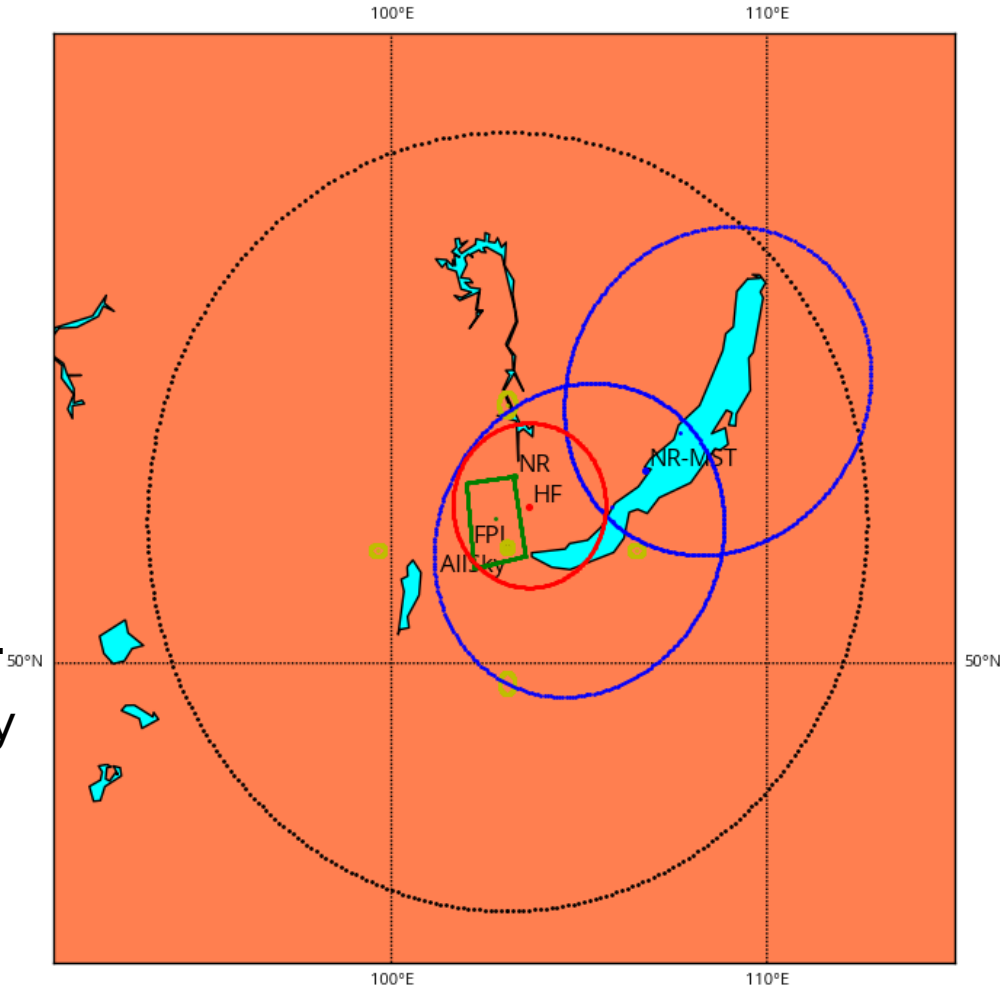
ovision of the Heating Facility with basic diagnostic to

Red is the effective scanning area of the Heating Facility.

Blue is the field of view of the IS–MST all-atmospheric radar.

Green is the scanning area of the existing Irkutsk IS-radar.

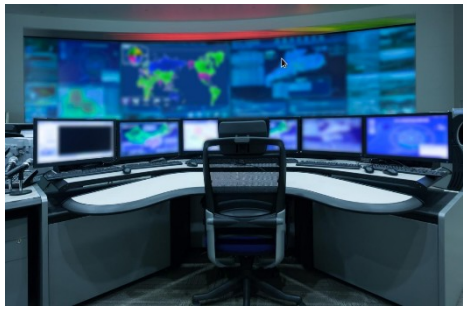
Black is the area controlled by the complex of optical instruments.



Architectural project

Control and Data Processing Center

Irkutsk, in-service date 2024



Main goals

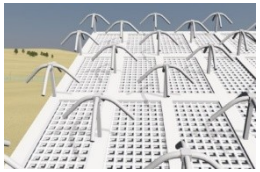
- **Shared Equipment Center: carrying out experiments to the benefits of scientific organizations;**
- **Preparing data products for end users (customers);**
- **Space weather conditions: warnings and alarms for consumers;**

- **Online control of working modes of the instruments of the National Heliogeophysical Complex;**
- **Collecting data from NHC instruments;**
- **Data processing;**
- **Data storage.**

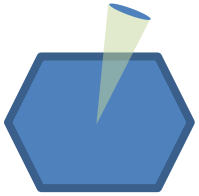
Radioheliograph

Large Solar Telescope-Coronagraph

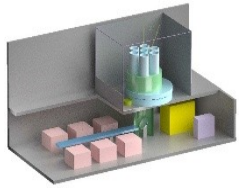
Radar system



Heating Facility



MS Lidar



Optical Instruments

Architectural project

More details

Zherebtsov G.A. Complex of heliogeophysical instruments of new generation. *Solar-Terrestrial Physics*. 2020. Vol. 6. Iss. 2. P. 3–13. DOI: 10.12737/stp-62202001

Medvedev A.V., Potekhin A.P., Setov A.G., Kushnarev D.S., Potekhin A.P., Lebedev V.P. All-atmosphere IS-MST Radar. *Solar-Terr. Phys*. 2020, vol. 6, no. 2, pp. 41–48. DOI: 10.12737/stp-62202004.

Vasilyev R.V., Setov A.G., Frolov V.L., Ratovsky K.G., Beletsky A.B., Oinats A.V., et al. Modern heating facility for research into the mid-latitude ionosphere. *Solar-Terr. Phys*. 2020a, vol. 6, no. 2, pp. 49–62. DOI: 10.12737/stp-62202005.

Berngardt O.I., Kurkin V.I., Kushnarev D.S., Grkovich K.V., Fedorov R.R., Orlov A.I., et al. ISTP SB RAS decameter radars. *Solar-Terr. Phys*. 2020, vol. 6, no. 2, pp. 63–73. DOI: 10.12737/stp-62202006.

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Thank you for your attention!