

Swedish Institute of Space Physics—Research Strategies

The Swedish Institute of Space Physics (IRF) is a national research institute under the auspices of the Swedish Ministry of Education and Research. Research at IRF is currently carried out within five research programmes. IRF also carries out observatory activities in the fields of space and atmospheric physics within its observatory programme. The objectives, success factors and long-term goals of IRF as a whole and of each programme are summarized in this document.

Objectives

IRF's objectives are to:

- Conduct research in the fields of space- and atmospheric physics and development in space technology.
- Contribute to research education in these fields.
- Focus on experimental research in these fields.
- Continue as a node in the global network of geophysical observatories.
- Promote opportunities for, and the intellectual development of, its employees.

Success factors

Successful scientific research and continued support from decision makers in our society require that IRF:

- Conducts research of the highest international standard.
- Acts as a national and international network organisation.
- Has a strong connection with universities, other research organisations, industry and society.
- Stands for good leadership, exciting work opportunities, a creative atmosphere and intellectual challenges.
- Takes advantage of Sweden's geophysical location.
- Remains a flexible and efficient research organisation.

Goals

The long-term goals for IRF (5-10 years) are to:

- Be recognised as one of the top experimental space and atmospheric physics organisations in Europe.
- Remain one of the most successful European competitors to be chosen as Principal Investigator (PI) on major missions.
- Strengthen its role as an innovation partner within the Swedish and European space industries.
- Establish itself as a natural research link for students at Swedish and European universities.
- Play a major role in the graduation of 3-5 PhD students per year.
- Become a significant partner in emerging sensor network projects in its field.
- Retain five research programmes with individual profiles in successful operation with an overall average of 50% external funding.

Atmospheric Physics Research Programme

The programme conducts research into processes affecting the atmosphere, with main emphasis on the free troposphere, stratosphere and mesosphere at polar latitudes. Research is primarily based on the use of IRF's ground-based remote sensing instruments—radar, lidar and mm-wave radiometers—and the international radar facility EISCAT. Atmospheric models and further complementary observations are included through collaboration with external research groups.

Objectives

The objectives of the programme are to:

- Improve understanding of the physical and chemical processes affecting the Arctic and Antarctic free troposphere, stratosphere and mesosphere.
- Contribute to global change research through long-term monitoring and research in the field of stratospheric trace gas chemistry related to depletion of the ozone layer.
- Contribute to global change research through studies into the ways in which processes in the stratosphere and above contribute to conditions at the Earth's surface.

Success factors

The programme is known and respected for:

- Research on the full height scale of the high-latitude atmosphere including both neutral and plasma states—from the Earth's surface to the aurora.
- Complementing Swedish and international observations (from sounding rockets, aircraft, balloons and remote-sensing satellites) with observations by ground-based remote sensing in the Arctic and Antarctic.
- Contributing our observations to international networks aiming for pan-European and global monitoring of the atmosphere.

Goals

The long-term goals of the programme (10 years) are to:

- Establish long-term measurements of key atmospheric parameters related to climate change.
- Develop state-of-the-art analytical tools for scientific interpretation of measurements.
- Be recognized nationally and internationally as an important scientific contributor to atmospheric research.
- Establish a new professorship in atmospheric physics.

The short-term goals of the programme (3 years) are to:

- Extend existing measurement time series by a further 3 years and implement upper troposphere-lower stratosphere (UTLS) ozone measurements by lidar and mesospheric ozone and stratospheric water vapour measurements by mm-wave.
- Operate our atmospheric radar MARA in Antarctica and record high-quality measurements covering at least 4 months.
- Increase the rate of first-author refereed publications from the group to at least five per year.
- Have at least one publication in print from each of our existing collaborations with groups in Sweden, Germany, Russia and within the NLC network.
- Establish new scientific collaborations nationally and with research institutes in India and Japan.

Solar Terrestrial Physics Research Programme

The programme conducts research into aspects of the sun, the solar corona and the space environment, including the solar wind's interaction with satellites, the Earth and its magnetosphere.

Objectives

The objectives of the programme are to:

- Improve our understanding of basic space plasma physics phenomena in the solar-terrestrial environment, with focus on problems related with the variable Sun and its influence on the Earth: its atmosphere, ionosphere and magnetosphere.
- Improve our understanding of the long-term solar variability and how that affects the Earth, human society, technological systems and the climate.
- Communicate our knowledge about solar-terrestrial relations to Swedish society.

Success factors

The programme has the following current strengths:

- A world-class reputation in space plasma physics research using experimental-, simulation- and forecasting techniques.
- Excellence in designing, testing and operating space science instrumentation.
- Excellence in developing new data analysis- and advanced forecasting methods.
- An advantageous geographical location combined with long-term observations of solar-terrestrial phenomena (aurora, magnetic disturbances etc).

Goals

The long-term goals of the programme (5-10 years) are to:

- Be recognized and respected in the worldwide science community as a research programme providing major contributions in:
 - Solar physics and space weather.
 - Auroral acceleration and magnetosphere dynamics.
 - Optical aurora and the upper atmosphere.

Achievement of these goals requires a broad international collaboration, a creative research environment and advanced data analysis tools applied to ground-based and space-based scientific data. It also requires active involvement in developing new experimental techniques for space-based and ground-based instruments, plus participation in future space plasma missions.

- Maintain three complementary disciplines, each with its own professor, in solar-, magnetospheric-, and auroral physics within the science of solar-terrestrial relations.

The short-term goals of the programme (2-3 years) are to:

- Establish a new data-mining centre (DMC) to increase accessibility to solar-terrestrial physics data and improve our scientific productivity.
- Establish new interdisciplinary contacts/centers of excellences, in Kiruna with a focus on optical aurora and other upper atmospheric phenomena, in Lund with focus on the solar activity and the long-term and short term global climate (together with Lund University and the Danish Space Science Center)
- Publish high-quality scientific papers at a continued high rate (about 20 per year) based on satellite- and ground-based data.

Solar System Physics and Space Technology Research Programme

The programme conducts research into the interaction of the solar wind with the environment of planets, moons, asteroids, comets and exoplanets. It also conducts meteor research.

Objectives

The objectives of the programme are to:

- Study the environment (plasma and neutral gas) and the solar wind interaction as well as the evolution and dynamics of solar system objects—planets, moons, asteroids, comets and dust.
- Develop scientific instrumentation for satellite-based measurements in support of space science and exploration.
- Develop new numerical models and data analysis methods in the field of space science.
- Participate in space-related educational programs and public outreach activities.

Success factors

The programme is respected for or as:

- A leading European group in the field of experimental space plasma physics with a focus on particle measurements and competence in analyzing and interpreting data.
- A wide international contact network and excellence in managing experiments for national, international and bilateral space missions.
- Excellence in designing and manufacturing world-class instrumentation for in-situ measurements of ions, electrons and atoms in space.
- Excellence in radar meteor research.
- Flexibility in research planning and the ability to develop expertise in new areas of research related to the programme topics.
- Highly professional and experienced engineering and scientific staff.

Goals

Long-term goals of the programme (5-10 years) are to:

- Remain the European leader in the field of solar system space physics.
- Complete a “grand tour” of the inner planets for comparative magnetospheric studies.
- Develop techniques for high mass-resolution imaging spectrometers.
- Establish research in the field of space environments of the giant planets and exoplanets.
- Establish the High Power Large Aperture (HPLA) radar application as a method for studying astronomical dust and meteor impact on the near-Earth space environment.

Short-term goals of the programme (2-3 years) are to:

- Complete development of a hybrid simulation code to study the solar wind interactions with Mars, Venus, Moon, Mercury and comets.
- Complete investigations of the solar wind-Moon interaction.
- Develop a MEMS-based mass spectrometer.
- Continue studies of the solar wind interaction with non-magnetized bodies.
- Participate successfully in ground-based meteor radar studies.
- Develop and deliver instruments for the ESA BepiColombo mission.
- Participate actively in the planning of international and national missions.

Space Plasma Physics Research Programme

The programme conducts research into magnetospheres and dynamic processes in space plasma.

Objectives

The objectives of the programme are to:

- Explore the plasma universe by means of in-situ and ground-based observations.
- Understand and model plasma phenomena in the universe.
- Promote space technology and space science.
- Participate in teaching, in particular of space physics and space technology.
- Contribute to public outreach activities.

Success factors

The programme is known and respected for or as:

- A world-class space plasma physics team.
- In-situ observations by spacecraft of DC and wave E-fields as well as of plasma density and temperature (including multi-probe, multi-spacecraft techniques).
- Experience of planning, engineering, management and operations on several Swedish and international missions.
- Experience of detailed data analysis, validation and comparison with theory.
- Software for data analysis and distribution.

Goals

The long-term goals of the programme (5-10 years) are to:

- Remain a top space plasma physics team for instrumentation, observations and modelling.
- Achieve understanding of micro-plasma physics of importance for large-scale physics (turbulence, transport and particle acceleration associated with boundaries) obtained by comparing different space plasmas.
- Develop new and improved scientific instruments to achieve these scientific goals, and fly these on Swedish and international missions.
- Be an important partner for the space industry and Uppsala University with respect to space technology.
- Participate in teaching at Uppsala University.
- Contribute to public outreach.

Short-term goals of the programme (2-3 years and on-going missions) are to:

- Use Cluster and EISCAT to explore the dynamics and structure of the electric fields in boundaries.
- Use Cassini to explore the dynamics of the ionosphere of Titan, and the rings of Saturn and their similarities to astrophysical discs.
- Bring on-going satellite missions to completion: Cluster, Cassini and Rosetta.
- Bring on-going scientific hardware projects to completion: Swarm, BepiColombo and MMS.
- Complete one technical test hardware project.
- Participate actively in national and international planning of future missions.
- Participate in planning EISCAT operations.
- Collaborate on engineering and development with Uppsala University, KTH and ÅAC.
- Take major responsibility for four courses at Uppsala University.
- Publish an average of one first-author paper per scientist each year.

Physics in Space Research Programme

The programme studies the principles and mechanisms which control Earth's interaction with its space habitat by using the near-space environment of the Earth as a large plasma laboratory for research into fundamental physical processes in space. The programme researches distributed processes and systems concerning electrodynamics and investigates physical phenomena such as the relationship between large- and small-scale processes in their context.

Objectives

The objectives of the programme are to:

- Study dynamical processes and structure formation associated with natural and anthropogenic perturbations of geospace, including electromagnetic radiation phenomena.
- Study electrostatic and electromagnetic turbulence and the turbulent generation of large-scale flows both in situ and remotely.
- Develop and utilise computer codes for the efficient modelling of the dynamics of structures in space.
- Develop new methods and sensor networks for radiometric studies of geospace.

Success factors

The programme will:

- Benefit from synergies between the members of the programme, their combined expertise and competence, and the interdisciplinary networks they represent.
- Utilise its position as a leader in the development of novel space physics instrumentation and methodology.
- Use the holistic view and the physics competence furnished by programme members and collaborators to put space research on a firm physical basis.
- Benefit from excellent contacts with media, science centres and museums to enhance public outreach activities.

Goals

The long-term goals of the programme (5-10 years) are to:

- Reach a deep understanding of the fundamental physics of geospace, in particular non-linear dynamics, self-organisation and turbulence.
- Establish ourselves as key players in science and technology within large transnational projects such as LOFAR and LOIS.
- Become a world leader in instrumentation for wide-area time-coherent sensor networks for space studies from ground and space.
- Earn an international reputation as a first-class educator in space sciences and technologies.

The short-term goals of the programme (2-3 years) are to:

- Finalise the theory of SEE and associated phenomena so that this technique can be used at its full diagnostic power.
- Develop and utilise new radio methods for space physics and exploration.
- Obtain a thorough understanding of the physics governing processes at transition layers in geospace.
- Complete the multi-dimensional simulation and visualisation tool-set as a routine tool for space physics phenomenology and modelling.

Observatory Programme

The Swedish Institute of Space Physics has a national responsibility to collect observatory data in the field of atmospheric and space plasma physics; this is done within the Observatory Programme. The main data series, which have been collected since the 1950s (and some even earlier) are provided by magnetometers (Kiruna and Lycksele), riometers (Kiruna and Lycksele), all-sky-camera (Kiruna) and ionosondes (Lycksele and Uppsala).

Objectives

The objective of the Observatory Programme is to:

- Provide society with as much information as possible about what is happening in the upper atmosphere and ionosphere over Sweden (within the constraints of the available resources).

Success factors

The programme will focus on the following success factors:

- International visibility (easily accessible web site).
- High technical quality of the observations.
- Long-term stability of the observations.

Goals

The long-term goals of the programme (50 years) are to:

- Demonstrate whether or not there have been long-term changes in the atmospheric/ionospheric properties monitored.

The short-term goals of the programme (2-3 years) are to:

- Maintain an online service showing in real-time the state of auroral and other solar-induced activity (for scientists and the public).
- Increase use of the data to complement space-based or other instruments in scientific studies.