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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 conducted within three research programmes. IRF also has an observatory programme and carries out observatory activities in the fields of space and atmospheric physics. This document summarizes the objectives, success factors and goals of IRF as a whole and of the individual programmes.

Objectives

IRF's objectives are to:

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

Success factors

Successful scientific research and continued support from decision makers 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 and the Arctic environment.
- 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 by being chosen as Principal Investigator (PI) on major missions.
- Strengthen its role as a partner in EU projects and with 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 an average of two to three PhD students per year.
- Be recognised as a provider of reliable scientific data.
- Maintain successful research programmes with individual profiles and an overall average of 50% external funding.

Swedish Institute of Space Physics—Research Strategies
Solar Terrestrial and Atmospheric Research Programme

The programme conducts research into processes affecting the polar atmosphere and the near-Earth environment in space, including space weather and meteor research.

Objectives

The objectives of the programme are to:

- Improve the understanding of basic space plasma processes in the solar terrestrial environment by studying the whole chain of events from the Sun's activity and the solar wind to effects in the Earth's magnetosphere, ionosphere, and atmosphere.
- Improve the understanding of the physical and chemical processes affecting the polar troposphere, stratosphere, and mesosphere.
- Communicate our knowledge to Swedish society by participating in educational programs and public outreach activities

Success factors

- Research on the full height range of the high-latitude atmosphere, including both neutral and plasma states, the latter from the ground to the Sun.
- Takes advantage of Sweden's geophysical location and the Arctic environment.
- Excellence in radar-, optical-, satellite conjugate observations and research.
- Excellence in developing new data analysis- and space weather forecasting methods.
- National and international collaboration, contributing unique observations by ground-based remote sensing in the Arctic and satellite observations.

Goals

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

- Be recognized as an important scientific contributor to research on the polar atmosphere and the near-Earth environment in space, including space weather and meteor research.
- Be recognized as an EISCAT_3D expert user group and appreciated collaborator.
- Maintain excellence in assuring KAGO scientific data quality.
- Develop advanced analysis tools applied to ground- and space-based scientific data.
- Provide calibrated measurements of key atmospheric parameters, which can be used in future detection and attribution of atmospheric changes in the polar regions.

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

- Study events that make use of the broad competence within the programme.
- Participate in and provide ground-based support to relevant Swedish and international space-based, balloon and sounding rocket missions.
- Further develop Regional Warning Center Sweden and IRF:s role concerning space weather in Sweden.
- Support the establishment of EISCAT_3D and ALIS_4D.
- Prepare for and participate in satellite missions SMILES and FACTORS.
- Increase the dissemination of scientific results in scientific publications and publish an average of one first-author paper per scientist each year.
- Increase the involvement of students in the programme's research.

Swedish Institute of Space Physics—Research Strategies Solar System Physics and Space Technology Research Programme

The programme conducts research on the interaction of planets, moons, asteroids, comets, and exoplanets with space environment.

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 of particles in support of space science and solar system 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

- Leading European group in the field of experimental space plasma physics with focus on particle measurements
- Excellence in managing experiments for national, international, and bilateral space missions. Wide international contact net.
- Excellence in designing and manufacturing world-class instrumentation for in-situ measurements of ions, electrons and energetic atoms in space.
- Excellence in analysing and interpreting data.
- Excellence in numerical modelling of space plasmas.
- 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.
- Availability of unique calibration and manufacturing facilities.

Goals

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

- Remain the European leader in the field of solar system space physics
- Continue a "grand tour" of the inner planets and comets and moons for comparative magnetospheric studies and to achieve a deep understanding of solar wind interaction physics including plasma-surface interactions.
- Advance research in the field of space environments of the giant planets, and ice giants
- Continue development of compact ion mass analysers and reach a mass resolution of a few tens (CNO group separation) and angular resolution around 5° x 5°.
- Remain the European leader in ENA imaging technique. Reach angular resolution of ENA imagers for a few tens of eV to a few keV range down to 5° and develop techniques for ultra-high angular resolution down to 0.1° and ultra-low energies down to a few eV
- Establish a world-class calibration and test facility for space particle instrument development (SpaceLab).

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

- Continue modelling the solar wind/magnetosphere interactions with the moon, Mars, Venus, Mercury, and Galilean moons.
- Use Rosetta, Mars and Venus Express data to continue the studies of the solar wind interaction with non-magnetized bodies and understand the role of the magnetic field for atmospheric evolution.

- Develop and deliver the instrument for the ESA JUICE mission
- Complete Chang'4 to understand physics of the solar wind interaction with the lunar regolith.
- Participate actively in proposing and planning of international and national missions.
- Secure the program's participation in a mission with a launch date in 2024 – 2028 meeting the SSPT science objectives.
- Complete phase A of the SpaceLab project.

Swedish Institute of Space Physics—Research Strategies
Space Plasma Physics Research Programme

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

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, including dusty 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 universities with respect to space technology.
- Participate in teaching at Uppsala University.
- Contribute to public outreach.

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

- Use the multi-spacecraft missions MMS and Cluster to investigate micro-plasma physics.
- Use the multi-spacecraft mission Swarm to investigate the ionosphere.
- Use data from Cassini, Rosetta, MAVEN and MEX, to investigate Saturn and its moons and the surroundings of comet 67P and Mars, and to compare these objects.
- Develop and deliver instruments for the ESA JUICE mission to Jupiter.
- Participate actively in the improvement of space weather models.
- Participate actively in new missions, including BepiColombo and Solar Orbiter.
- Participate actively in national and international planning of future missions.
- Take major responsibility for courses at Uppsala University.
- Publish on average one first-author paper per scientist each year.

Swedish Institute of Space Physics—Research Strategies
Kiruna Atmospheric and Geophysical Observatory (KAGO)

The Swedish Institute of Space Physics (IRF) has a national responsibility from the Swedish government (SFS 2007:1163 1§) to perform long-term monitoring (collect and archive observatory data) in the fields of atmospheric- and space plasma geophysics. This responsibility has existed since IRF was founded in 1957 and is carried out within the organisational unit Kiruna Atmospheric and Geophysical Observatory (KAGO). The time-scale for the long-time monitoring is very long, more than 100 years.

Objectives

The primary objective of KAGO *is to provide future scientists with long, continuous archived time series of data of highest possible scientific quality from:*

- Magnetometers
- Optical observations of aurora and related phenomena
- Ionosondes
- Riometers
- Infrasound stations
- Trace-gas measurements in the upper atmosphere

In order to reach this objective KAGO *is required to make the archived and near real-time data easily available to contemporary scientists, the space-weather community and to the general public.* This is essential for data quality assurance (validation) as well as to preserve instrument competence over time.

It should be noted that *the long-term scientific interest in long continuous time-series of data are judged as more important than the present day interest in data from a particular instrument.* For example, time-series of 100 years or more are required to study variations in the geomagnetic field and its relation to solar activity, where the period of several cycles are believed to be century-long, or even longer.

Strategies

KAGO focuses on the following strategies:

- Long-term aspects (stability, durability over 100 years or more).
- Highest possible scientific quality of the collected data including calibration and data quality assurance.
- Develop and maintain competence to design, develop operate and preserve the required instrumentation and infra- structure over extended time periods.
- Data retrieval and long-time archiving.
- Participation in national and international networks for long time monitoring.
- A close scientific collaboration with data users, in particular with the STAR research programme regarding quality assurance, analysis, interpretation and publication of data.

Goals

Long-term goals:

The long-term goals of KAGO are to continuously:

- Ensure that a continuous time series of long-term monitoring data of the highest possible scientific quality is securely archived and made available via the IRF web server.
- Improve and upgrade the instrumentation and infrastructures without compromising the long-time objectives.
- Strengthen the connection between KAGO and related scientific research at IRF, in particular with: the STAR research programme at IRF, and EISCAT 3D, as well as elsewhere.
- Promote KAGO data usage in for example: satellite conjugate studies, EISCAT 3D campaigns, etc.

- Work on improving the quality of the observations and initiate external evaluations of the observatory activities.
- Ensure that all archived data will eventually be digitised and readily available via the IRF web server.
- Evaluate new candidate instruments and time series to be included in the observatory's long-term monitoring activities.

The KAGO project plan (updated in November each year) is more detailed and includes short-time goals, etc.