



The Swedish Space Sector

– a diverse eco-system in Northern Europe

Sweden is an important space cluster and Luleå University of Technology, Kiruna Space Campus, plays a key role within research and education, not least through our international network. Our research develops space technology, which also is useful on earth. One example is the development of nanosatellites which can be used for studies of the world's oceans and lakes. Our researchers also study ice particles, which deepens our understanding of the atmosphere.

Norrbotten – the centre for space activities

Kiruna is located North of the Arctic Circle, a geographical position that creates excellent conditions for launching, operating, monitoring and downloading data from satellites, low light pollution for space observation, access to the only land-based satellite launch site in Continental Europe, Norrbotten's position is unique for European space activities. The excellent infrastructure and eco-system, the political stability, and low population density adds even more value. The space eco-system covers the whole value chain, from developing satellites at the Nano Satellite Lab at Luleå University of Technology, to testing rockets, launching and receiving space data at Swedish Space Corporation's Esrange Space Centre. Esrange Space Centre will be the new European launch site for small satellites, with full launch capabilities for polar and near-polar orbits in 2023.

Seen from a strategic perspective

The Swedish strategy for space activities¹ provides the platform for Sweden's long-term objectives, positioning Sweden as a strong space nation. The space industry is an important player in Norrbotten's S3 strategy². It aims to tackle some of the most critical challenges today, such as fighting climate change, helping to stimulate sustainable technological innovation, and providing socio-economic benefits to citizens. Space technologies, e.g., data transmission from satellites, play an important role when it comes to finding solutions. S3P Space, the collaboration platform for space activities between European regions, with Norrbotten being one of the leading regions, aims to strengthen the collaborations and networks between actors within academia, industry, and the public sector

Extensive Regional Space Ecosystem

In Norrbotten, Sweden's and Europe's space centre, this becomes visible through a rapidly growing space industry and the emergence of a diverse eco-system for space – in constant dialogue with many leading actors at a global level. Luleå University of Technology has been the initiator and driver for the deliberately and strategic development of the extensive space ecosystem in the region in close cooperation with several world leading organisations e.g. Institute for Space Physics (IRF), Swedish Space Corporation (SSC), two German locally-established rocket manufacturers, EISCAT (multi national association for near-space observations), and many more.



The Space University of Sweden

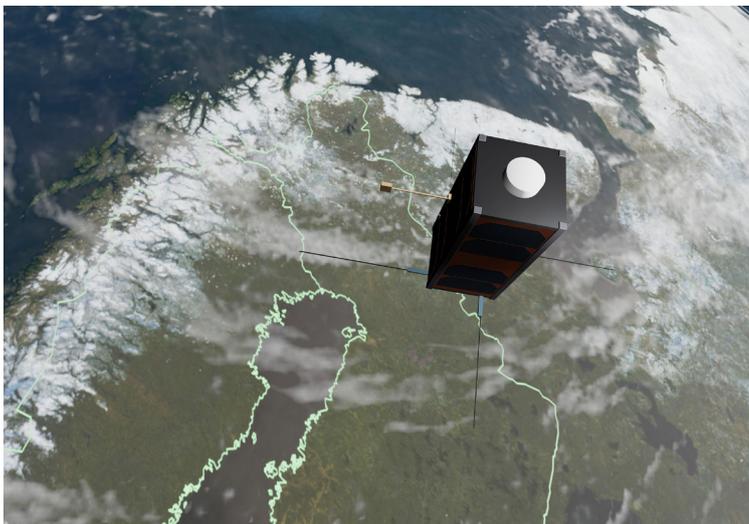
Luleå University of Technology contributes with world-leading expertise within several research domains, many of them connected to the green and digital transformation, among them the space industry. The Division of Space Technology consists of two research groups, Atmospheric Science and Space Systems, both in Kiruna. Together they perform research in various areas: asteroid engineering, atmospheric physics, nano satellites, planetary ices, space education, space propulsion and spacecraft avionics. The research is carried out in close collaboration with other universities and research institutes, leading industry partners and innovation hubs, on local, regional, national, and international level.

Luleå University of Technology research develops space technologies, that are also useful on Earth. One example is the development of nano satellites which can be used for studies of the world's oceans and lakes. Our researchers also study ice particles, which deepen our understanding of the polar atmosphere. Kiruna's concentration on space activities together with a diversified eco-system forms a strong research environment for space that delivers critical competences. The Swedish Space Data Lab is a national knowledge and data hub for Swedish and international stakeholders working with Earth observation data. In Luleå we develop AI-applications to help making informed, sustainable and timely decisions regarding the Earth's surface, weather predictions and biodiversity both globally and locally.

Our programs

Our programs give students extensive theoretical knowledge and broad practical skills in astronautics, space physics, spacecraft engineering, and atmospheric science. All programs work closely with several of Sweden's foremost actors in the aerospace industry such as the Institute of Space Physics, EISCAT Scientific Association, and Swedish Space Corporation, providing deep insights into Swedish and international space research with hands-on opportunities to participate in satellite, rocket, and stratospheric balloon projects.

The environment at the Kiruna Space Campus is highly international, with students and researchers from all continents.



PROGRAMMES

The department offers engineering programs and several international masters programs.

Master Program in **Space Engineering** - Sweden's only engineering master program in space technology with a strong focus on developing new technologies, e.g., satellites, study of the Earth's climate or exploration of the solar system.

Master Program in **Space Science and Technology** (SpaceMaster) – an interdisciplinary research-oriented education with hands-on experience in space science, technology, and engineering. Based on the Erasmus Mundus Joint Master Degree Program it is provided in close cooperation with leading European universities, space research institutions and industrial organisations.

Master Program in **Spacecraft Design**, focused on the design of satellites and other vehicles, including integration of complex technical systems that must work in the extremely harsh space environment.

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Swedish Space Corporation

WE HELP EARTH BENEFIT FROM SPACE

Swedish Space Corporation, SSC, helps space organizations, companies, other commercial actors and research institutes to get access to Space. Among our strongest assets is Esrange Space Center in northern Sweden, set to become European mainland's first launch facility for small satellites, with full launch capabilities for standardized polar orbits in 2023.

Through our local presence on all continents and more than 650 committed employees, we offer specialist expertise in satellite communications, spacecraft operations, rocket and balloon systems, launch services, flight test services and data analytics. SSC's products and services enable successful space projects within Earth observation, telecommunications, security, meteorology, navigation and positioning, scientific research and other applications.

At Esrange, SSC provides a state-of-the-art testbed for reusable, sustainable and cost-effective rocket technology. The facility is also used by the international scientific community for launching sounding rockets for microgravity and atmospheric research as well as high altitude balloons for astronomy, atmospheric research and drop tests of space and aerial vehicles.

Esrange also accommodates one of the world's largest civilian satellite ground stations, offering satellite communications services from this unmatched location for polar orbiting satellites. The station acts as a hub in our satellite station network, one of the largest commercial ground station networks in the world.

Via our subsidiary GlobalTrust, we also leverage satellite data and analytics applications to help companies, organizations and governments to develop and deliver sustainability strategies.

More information at www.sscspace.com

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Images: <https://sscspace.canto.global/v/Press/>

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Esrange Space Center

Europe's premier gateway to Space

Swedish Space Corporation, SSC, helps space organizations, companies, other commercial actors and research institutes to get access to Space. Among our strongest assets is Esrange Space Center in northern Sweden, set to become European mainland's first launch facility for small satellites, with full launch capabilities for standardized polar orbits in 2023. Esrange sits above the Arctic Circle, around 40 km outside Kiruna, and is already one of the world's largest and most versatile space centers. The facility has been operational since 1966 and is presently used to conduct experiments that involve launching sounding rockets and balloons, collecting and uploading data from satellites as well as rocket tests.

Rapid pace of development

Around 10,000 new satellites are set to be launched over the next few years, and by 2040 the total number of satellites is expected to 100,000 compared with the 5,000 operational satellites in orbit today. Most of these are small, about the size of a shoebox. They contain advanced technology which makes them more advanced and cheaper to produce and launch than ever before. This has created significant demand for new capacity in the space field, urging Sweden and Esrange to play a key role in future developments.

One of Europe's largest test areas

Esrange offers one of the largest test areas in Europe: a vast, unpopulated impact area of 5,200 km² with restricted airspace of 6,600 km² and unlimited altitude potential. The area is perfectly fitted for launching and recovering rockets, as well as for testing vehicles and sensors on the ground.

Esrange Satellite Station

The satellite station is a vital part of Esrange's operation and an important node in SSC's global ground network, one of the world's largest commercial ground station networks. It is one of the world's largest civilian satellite stations and certainly the busiest. Esrange has daily contact with about 140 satellites in different orbits.

It is also an ideal location for gathering data from polar orbiting satellites, estimated to 40-50 percent more efficient down- and uplink than other orbits, as well as an unmatched geopolitical location for in the European polar region. Esrange collects, analyzes and processes satellite data in real time.

Facilities on the ground include remote sensing systems, multi-frequency antenna systems and a control center where data is received and processed by SSC.

Sounding rockets

SSC supports a wide spectrum of tests and launches of sounding rockets at Esrange – providing researchers, scientists and commercial actors with easy access to Space. Apart from launching customers' rockets, the station also offers "flight tickets" for space research onboard SSC's own rockets. SSC has built more than 60 sounding rockets since the 1970's and provided services – mechanics, electronics, power design, software and systems engineering – to scientists and space organizations through more than 600 rocket launches.

Stratospheric balloons

Esrange also offers a variety of stratospheric balloon services, including payload design and manufacturing, balloon systems, launch services and recovery. The balloons themselves range from small sounding balloons with a payload of less than a kilo, to larger models with a diameter of 100 meters with the capability of lifting four tons to an altitude of 40 km.

Launches take place regularly from Esrange. In the summer season, we perform long-duration transatlantic flights westwards from Sweden to North America, as well as circumpolar flights. Eastward flights are performed during the winter season, while in spring and autumn there are local flights of one or two days.

Ground instruments

In addition to airborne services, Esrange has excellent facilities for companies to test ground instruments at the station. SSC has access to advanced ground-based instruments, such as a radar monitoring the atmosphere, a photometer measuring light intensity, a riometer for measuring electrons in the ionosphere, night sky cameras and a meteor radar. SSC also offers meteorological soundings with possibilities for ozone measurement.

Testbed Esrange

Through its state-of-the-art testbed facility, Esrange gives European and global space companies access to the infrastructure that has long been needed for testing new rocket technologies. Currently, two German partners are testing future multi-stage rockets and more sustainable fuels at their respective sites at Esrange. And in 2023, the European program for reusable rocketry, called THEMIS, will begin tests at the site.

Orbital launches from 2023

The market for small satellites is growing at a rapid pace and the need for satellite-based services is constantly increasing. In 2023, SSC will inaugurate European mainland's first orbital launch site, filling the need for satellite launching capabilities that Europe lacks today. Spaceport Esrange will offer an independent European gateway to Space.

These satellites will pave the way for advanced climate research, disaster relief, more evolved agricultural methods, more efficient logistics and spatial planning – just to mention a few. They will also support several of the UN's Sustainable Development Goals and improve crisis management globally and regionally.

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Swedish Institute of Space Physics – 65 years of space research

Who we are and what we do

The Swedish Institute of Space Physics (IRF) is a world-renowned governmental research institute under the Ministry of Education and Research. IRF conducts research and postgraduate education in space physics, space technology, and atmospheric physics.

IRF has more than 60 years of experience developing instruments for space research projects and participates in several major international collaborative projects using satellites and ground-based equipment. Measurements are made in the earth's atmosphere, ionosphere, magnetosphere, and around other planets. IRF was established (as Kiruna Geophysical Observatory) in 1957 and its first satellite instrument was launched in 1968. The head office is in Kiruna. IRF also has offices in Umeå, Uppsala, and Lund.

What do we have in space today?

IRF has instruments on board spacecraft in orbit around Earth and Mars. In addition, we have instruments on the way to Mercury and the Sun, as well as an instrument on the far side of the Moon.

Current active missions

IRF on ESA four Cluster satellite: www.irf.se/en/irf-in-space/cluster/

IRF on ESA three Swarm satellites: www.irf.se/en/irf-in-space/swarm/

IRF on NASA four Magnetospheric Multi Scale – MMS-satellites:
www.irf.se/en/irf-in-space/magnetospheric-multiscale-mms/

IRF on ESA Mars Express satellite: www.irf.se/en/irf-in-space/mars-express/

IRF on ESA/JAXA BepiColombo satellite: www.irf.se/en/irf-in-space/bepicolombo/

IRF on CNSA Chang'e 4 Moon rover: www.irf.se/en/irf-in-space/change-4/

IRF on ESA Solar Orbiter satellite: www.irf.se/en/irf-in-space/solar-orbiter/



What will happen at IRF in the coming years?

The largest project ever for IRF is part of the European Space Agency mission JUICE, Jupiter ICy Moons Explorer. Two out of the ten experiment packages on JUICE are led by IRF.

In 2023 JUICE will be sent to Jupiter and its icy moons Europe, Callisto, and Ganymedes.

JUICE will reach Jupiter in 2030 and start doing measurements. It will do close fly-bys of three of Jupiter's icy moons, and orbit (and finally crash on) the largest of Jupiter's moons, Ganymede.

The information collected by the instruments on board will be analyzed and will contribute to scientific discoveries until at least year 2050.

The European Space Agency (ESA) is responsible for the JUICE project and IRF has received funding from the Swedish National Space Agency to develop its two experiments. More than 15 European countries, as well as the United States and Japan, participate in the work with the experiments.

Jupiter with its icy moons forms a kind of solar system in miniature, which JUICE will investigate using ten experiments. The researchers hope to get some answers on how a solar system forms and ESA's overall goal with JUICE is to be able to answer if there are conditions for life under the frozen oceans found on the icy moons.

IRF in Kiruna is responsible for the Particle Environment Package instrument (PEP), while IRF in Uppsala is leading the Radio and Plasma Wave Investigation (RPWI).

PEP, the Particle Environment Package, will study the interaction between space and Jupiter's icy moons. The instrument with its various sensors will investigate how neutral and charged particles, such as ions, electrons, and atoms, behave in the magnetosphere and the electrical fields contained in the Jupiter system.

RPWI, the Radio and Plasma Wave Investigation, will measure magnetic and electric fields on Jupiter's moons to draw further conclusions about how the magnetosphere works and how magnetic fields can give rise to new phenomena. It is hoped that RPWI will help map out any ocean currents under the icy crusts of the moons.

IRF on JUICE: www.irf.se/en/irf-in-space/juice/

High Resolution pictures from IRF:

<https://cloud.irf.se/s/ET9tG4Xky5cd5rx>

Free to use and crop. Image credit IRF.

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