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Welcome to the 2007 Finnish Space Directory.

Finland entered space activities in the mid 1980’s. Finland joined the ESA in 1987. Finnish industry and science have played an important role in many European satellite missions, e.g. SOHO, Rosetta, MetOp and Envisat. Recent bilateral space programmes include NASA’s EOS-Aura, Sweden’s Odin and Canada’s Radarsat applications. Current bilateral programmes include instrument development for ESA’s Planck and BebiColombo missions. In 2002, Finland joined the ESA’s AlphaSat and European Galileo satellite and Global Monitoring of Environment and Security programmes. In 2005 Finland joined ESA’s ARTES 11 Small GEO programme.

Finland’s science and research policy states that Finland is developing its knowledge based society by investing in R&D more than 3 percent of GDP which is one of the highest in the OECD countries. Space activities are one of the tools we use to implement our R&D policy. Space programmes have provided us with important data for forest and environmental management applications, ice breaker operations and hydroelectric generation. Space technologies support technology development in various companies and institutions.

This fifth edition of the Finnish Space Directory gives an overview of all Finnish space activities. It describes the space programmes in which Finland is involved, public sector resources for space activities and the space industry. We hope that this directory will facilitate new contacts and cooperation with Finnish industry and research groups.

Kari Tilli
Head of the Finnish delegation to the European Space Agency
Tekes, the Finnish Funding Agency for Technology and Innovation
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</table>
Overview of Finnish space activities

The purpose of this directory is to inform the reader, with respect to questions such as:

■ What ESA programmes does Finland participate in?
■ Which company specializes in what?
■ Who does one contact?

The entries are short but instructive. If more details are needed, please contact the listed persons. The information is valid as of November 2006, budgets and percentage distributions reflect the state of affairs at the end of 2005. Updated information is available at www.tekes.fi/space.

Planck will perform cosmological studies. Its Low Frequency Instrument has Finnish 70 GHz receivers. It is the most sensitive in the world.

If you are unable to find your answer in the directory, please contact Tekes, the Finnish Funding Agency for Technology and Innovation – contact information on page 69.

SMOS-satellite studies the salinity of the oceans and soil moisture – its 1.4 GHz Noise Injection Radiometer contains Finnish technology.
In 1987 Finland became an Associate Member of the European Space Agency. Significantly for Finland, the space industry started to diversify into the supply of hardware and software for spacecraft platforms and associated ground support equipment. Spin-ins from non-space fields, such as the defence, naval and aviation industries, are not uncommon.

In 1995 Finland became a Member State of ESA, and Finnish capability was space-certified as ESA’s SOHO, Cluster, XMM-Newton and NASA’s Cassini/Huygens were launched in the latter part of the 1990s.

**Background**

**Finnish space** activity commenced in the mid-1980s through bilateral cooperation with Sweden and the former Soviet Union. The Finnish Meteorological Institute developed instrument modules for the Phobos spacecraft that left for Mars in the summer of 1988. This cooperation also involved Finnish universities, research institutes and the developing space industry.

The Swedish telecommunications satellite Tele-X was an important part of Finnish space policy in the mid-1980s. The Tele-X satellite programme brought more ground stations and DBS antenna experience to the industries involved. This led to the manufacturing of spacecraft electrical ground support equipment and, in one case, back to terrestrial telecommunications.

**International cooperation**

Finland is a member of the following international space organizations:

<table>
<thead>
<tr>
<th>Organization</th>
<th>Responsible body</th>
</tr>
</thead>
<tbody>
<tr>
<td>COSPAR</td>
<td>Finnish COSPAR Committee</td>
</tr>
<tr>
<td>ESA</td>
<td>Tekes</td>
</tr>
<tr>
<td>ESO</td>
<td>Academy of Finland</td>
</tr>
<tr>
<td>EUMETSAT</td>
<td>Finnish Meteorological Institute</td>
</tr>
<tr>
<td>EUTELSAT</td>
<td>Telia-Sonera Corporation</td>
</tr>
<tr>
<td>INMARSAT</td>
<td>Telia-Sonera Corporation</td>
</tr>
<tr>
<td>EARSeL</td>
<td>Helsinki University of Technology</td>
</tr>
<tr>
<td>COSPAS-SARSAT</td>
<td>Finnish Border Guard</td>
</tr>
</tbody>
</table>
Finnish participation in ESA programmes

Finnland is active in the Science, Technology, Earth Observation, Navigation and Telecommunications Programmes of ESA. Finland does not currently finance launchers, micro-gravity or manned space activities.

Figure & Table 1. Payments to ESA Programmes 1995–2006 by Tekes and the Ministry of Trade and Industry (MTI); in million euros.
GOCE will study Earth’s gravitation and oceans’ circulation. Its flight will be guided by onboard software that was made in Finland.

Technology

Finland supports the ESA General Support and Technology Programme (GSTP) by 1–2 million euros per annum.

ESA’s technology demonstrator satellite was developed in GSTP and launched in October 2001. It included a Finnish space debris and micrometeoroid instrument.

Science

Finland contributes to the ESA Science Programme EUR 5,5 million per year. Finnish industry is involved in spacecraft bus equipment, software and structures, and in the development of science payload units. The latter are usually funded from national sources.

Venus Express has Finnish contribution in its power subsystem that has heritage from Rosetta and Mars Express. It also carries science instrumentation with Finnish contribution.

Finland has been involved in the following ESA Science Programme spacecraft:

- **SOHO**, launched in 1995, still carries ERNE and SWAN instruments funded by the Finnish government.
- **Cluster**, launched in 2000, carries an EFW instrument that has a Finnish deployment mechanism and plasma instrument. Part of the EGSE for the RAPID instrument is Finnish made, as are parts of the power supply system.
- **Huygens**, launched in 1997, has a radar altimeter and pressure measurement probe which were made in Finland.
- **XMM-Newton**, launched in 1999, carries one of the largest carbon fibre reinforced structures in space – the conical tube structure housing the X-ray mirrors. This was designed and manufactured in Finland.
- **INTEGRAL** was launched in October 2002. Its JEM-X instrument was developed by Denmark and Finland.
- **Rosetta** was launched in February 2004. Its primary structure and power conditioning electronics are designed and manufactured in Finland. In addition, there are Finnish science and technology contributions to the spacecraft’s payload and lander.
- **Mars Express** was launched in June 2003. Its power conditioning electronics are made in Finland. Finland is also contributing the ASPERA instrument on board the orbiter.
- **SMART-1** was launched in September 2003 carrying two Finnish PI Instruments: XSM and SPEDE.
- **Venus Express** was launched in October 2005. Its power conditioning electronics are made in Finland. Finland is also contributing the ASPERA instrument on board the orbiter.
Table 2. Finnish AO and industrial participation in ESA space science missions.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Finnish participation</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOHO</td>
<td>SWAN and ERNE AO instruments</td>
<td>Launched 1995</td>
</tr>
</tbody>
</table>
| Cluster / Cluster-2| EFW AO instruments, satellite electronics                                               | Launch failure 1996,
|                    |                                                                                        | new launch 2000    |
| Huygens            | HASI AO instrument, lander radar altimeter                                               | Launched 1997      |
| XMM-Newton         | Telescope structure and satellite electronics                                           | Launched 1999      |
| INTEGRAL           | JEM-X AO instrument                                                                     | Launch 2002        |
| Rosetta            | COSIMA, PP, MIP AO instruments and lander CDMS, satellite structure and power electronics| Launch 2003        |
| Mars Express       | ASPERA-3 AO instrument, participation in Beagle-2 lander, satellite power electronics   | Launch 2003        |
| SMART-1            | XSM and SPEDE AO instruments                                                             | Launch 2002        |
| Herschel / Planck  | LFI AO instrument and satellite control electronics on board Planck; mirror for Herschel| Launch 2007        |
| Venus Express      | Satellite Power electronics                                                             | Launch 2005        |

Table 3. Finnish participation in ESA telecommunications programmes.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Finnish participation</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRS</td>
<td>Artemis satellite ground station developed in Finland.</td>
<td>1991-2001</td>
</tr>
<tr>
<td>ARTES Element 1</td>
<td>Basic specifications of the systems. An extension programme of PSDE-1. Involvement in R&amp;D.</td>
<td>1993-</td>
</tr>
<tr>
<td>ARTES Element 5 (ASTE)</td>
<td>Telecommunications systems and equipment programme. Extension of ASTP. Involvement in R&amp;D.</td>
<td>1994-</td>
</tr>
<tr>
<td>ARTES 8 Large Platform</td>
<td>New activities starting in 2002.</td>
<td>2002-</td>
</tr>
<tr>
<td>ARTES Element 9 and Galileosat Definition</td>
<td>Industry activities related to Galileo satellite navigation system definition.</td>
<td>1998-</td>
</tr>
<tr>
<td>ARTES 11</td>
<td>Small geostationary satellite</td>
<td>2005-</td>
</tr>
</tbody>
</table>

Telecommunications

Finnish activities have been focused on the ground segment, particularly mobile telecommunications. In mid-2002 Finland joined the ARTES 8 programme which is developing a large telecommunications satellite for Europe. In 2005 Finland joined the ARTES 11 programme developing a small geosynchronous telecommunications satellite.

Finland is involved in MMIC, signal processing and RF technologies, and is the home of MilliLab, ESA’s microwave testing laboratory (an ESA external laboratory).

Alphabus, the largest European telecommunications satellite platform, has Finnish power regulation unit. Finland has participated earlier in telecommunications satellites in ESA’s Artemis and in the Nordic Tele-X.
Navigation

Finland participates in the joint ESA-EU Galileo programme. Navigation and location based services are expected to play a key role in the third generation mobile telecom network services.

As terminal technologies and navigation applications are not specifically space oriented, they are included in the telecommunications programmes of Tekes.

Earth Observation

The launch of Envisat in February 2002 put the GOMOS ozone instrument in to orbit. The French-Finnish instrument is financed by ESA. MSG-1 and MSG-2 were launched in 2002 and in 2005. MetOp-A was launched in October 2006 CryoSat launch failed in 2005 but will be replaced. SMOS, GOCE and ADM Aeolus are under development. All of these include equipment developed by Finnish space industry.

Sea ice and its effect on maritime transportation, and Finland’s forest industry are other major reasons for Finland’s interest in Earth Observation. Industry and research institutes have acquired considerable expertise in the building of remote sensing instruments and in processing and interpreting SAR and radiometric data for sea ice, snow cover, forest and land use mapping.

Finland participates in Global Monitoring of Environment and Security (GMES) both through EU and ESA. Finland receives Meteosat and NOAA satellite data, and data from NASA’s EOS Aura.

Table 4. ESA remote sensing programmes involving Finland.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Finnish participation</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthnet</td>
<td>Pre-processing, archiving, and distribution of image data.</td>
<td>1979-</td>
</tr>
<tr>
<td>EOPP</td>
<td>Remote sensing technology programme. Involvement in R&amp;D.</td>
<td>1986-</td>
</tr>
<tr>
<td>ERS-1 &amp; -2, Phase E</td>
<td>Involvement in several data AO activities.</td>
<td>1984-2000</td>
</tr>
<tr>
<td>MSG</td>
<td>Software for satellite platform, hardware for SEVIRI observation instrument.</td>
<td>1994-2002</td>
</tr>
<tr>
<td>Envisat-1</td>
<td>Software and hardware for GOMOS observation instrument.</td>
<td>1992-2002</td>
</tr>
<tr>
<td>MetOp-1 PP</td>
<td>MetOp satellite series, GOME-2 instrument electronics and satellite bus software development.</td>
<td>1993-</td>
</tr>
<tr>
<td>MetOp-1 C/D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EOEP</td>
<td>Earth Observation Envelope Programme (industrial involvement in CryoSat, GOCE, SMOS and ADM satellites)</td>
<td>1998-</td>
</tr>
<tr>
<td>Earth Watch</td>
<td>Global Monitoring of Environment and Security (GMES) and Infoterra/TerraSAR.</td>
<td>2001-</td>
</tr>
</tbody>
</table>
National and bilateral programmes

National and bilateral space programmes have served their purpose well. Current examples include the JEM-X X-ray instrument for ESA’s INTEGRAL, and smaller efforts for the Stardust, Contour and numerous other spacecraft.

Bilateral Earth Observation programmes include the OMI ozone instrument developed in partnership with the Netherlands for NASA’s EOS-Aura spacecraft. Similar arrangements were made with Sweden for developing instrumentation for the Swedish Odin satellite.

The X-ray solar monitor (XSM) and spacecraft potential electron and dust experiment (SPEDE) used in SMART-1 satellite are examples of nationally developed instruments.

Within the national ANTARES space research programme a Finnish team is contributing to Denmark’s Roemer and ESA’s XEUS missions.

In the field of RadarSat data applications Finland has signed a bilateral agreement with Canadian Space Agency on R&D co-operation.

ADM-Aeolus will study the winds of the world. Its PDCU is of Finnish origin.

Under development are the following missions with Finnish participation (mission by ESA unless marked otherwise):

<table>
<thead>
<tr>
<th>Mission</th>
<th>Launch Year</th>
<th>Institution</th>
<th>Contribution/Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADM-Aeolus</td>
<td>2008</td>
<td>Patria</td>
<td>PDCU and Aladin instrument DEU</td>
</tr>
<tr>
<td>AlphaSat</td>
<td>2009</td>
<td>Patria</td>
<td>Power shunt regulator unit</td>
</tr>
<tr>
<td>BepiColombo MPO</td>
<td>2013</td>
<td>University of Helsinki, Space Systems Finland, ASRO, Patria</td>
<td>SX5S instrument, DPU, SX5S and MIXS software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Finnish Meteorological Institute</td>
<td>Participation in Serena instrument</td>
</tr>
<tr>
<td>BepiColombo MMO</td>
<td>2013</td>
<td>Finnish Meteorological Institute</td>
<td>Participation in Mefisto instrument</td>
</tr>
<tr>
<td>Chandrayan-1 (ISRO, ESA)</td>
<td>2008</td>
<td>University of Helsinki and Oxford Instruments Analytical</td>
<td>XSM instrument</td>
</tr>
<tr>
<td>Cryosat-2</td>
<td>2009</td>
<td>Patria</td>
<td>Power distribution unit</td>
</tr>
<tr>
<td>Galileo (ESA, EU)</td>
<td>Launches in 2010</td>
<td>Space Systems Finland</td>
<td>Several software projects in the Mission Segment and in the Ground Segment</td>
</tr>
<tr>
<td>GOCOE</td>
<td>2008</td>
<td>Space Systems Finland</td>
<td>Platform Application Software and DFACS (ADCS) software</td>
</tr>
<tr>
<td>Herschel</td>
<td>2008</td>
<td>Opteon</td>
<td>Mirror polishing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patria</td>
<td>Cryostat control unit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space Systems Finland</td>
<td>CDMU Application Software</td>
</tr>
<tr>
<td>ISS (JAXA)</td>
<td>Launch in 2010</td>
<td>Oxford Instruments Analytical</td>
<td>MAXI X-ray detector</td>
</tr>
<tr>
<td>ISS (NASA)</td>
<td>Launch in 2009</td>
<td>University of Turku</td>
<td>AMS-02 instrument Tracker and tracker cooling system</td>
</tr>
<tr>
<td>ISS (ESA)</td>
<td>Launch in 2007</td>
<td>Patria, Oxford Instruments Analytical, Space Systems Finland</td>
<td>Debie-2 instrument</td>
</tr>
<tr>
<td>Mars Science Laboratory (NASA)</td>
<td>Launch in 2009</td>
<td>Finnish Meteorological Institute</td>
<td>Meteorological instrumentation</td>
</tr>
<tr>
<td>MetOp-1 ja -3 (EUMETSAT)</td>
<td>Launches 2010 and 2015</td>
<td>Patria</td>
<td>GOME-2 instrument power distribution unit</td>
</tr>
<tr>
<td>MetNet (KI)</td>
<td>Ballistic test launch in 2007</td>
<td>Finnish Meteorological Institute</td>
<td>Mission lead</td>
</tr>
<tr>
<td>Phoenix (NASA)</td>
<td>Launch in 2007</td>
<td>Finnish Meteorological Institute</td>
<td>Meteorological instrumentation</td>
</tr>
<tr>
<td>Planck</td>
<td>Launch in 2008</td>
<td>Ylenen Electronics, VTT, Milliab, Helsinki University of Technology</td>
<td>LFI instrument 70 GHz receivers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space Systems Finland</td>
<td>CDMU Application Software</td>
</tr>
<tr>
<td>Pleiades (CNES)</td>
<td>Launches in 2008 and 2009</td>
<td>Patria</td>
<td>Solar array structures</td>
</tr>
<tr>
<td>SMOS (ESA, CNES, CDTI)</td>
<td>Launch in 2007</td>
<td>Ylenen Electronics</td>
<td>Noise injection radiometer subsystem and calibration subsystem</td>
</tr>
<tr>
<td>SWARM</td>
<td>Launch in 2010</td>
<td>Patria</td>
<td>Power distribution unit</td>
</tr>
<tr>
<td>TanDEM-X (DLR)</td>
<td>Launch in 2009</td>
<td>Ylenen Electronics</td>
<td>Leaf amplifier assembly</td>
</tr>
<tr>
<td>TerraSAR-X (DLR)</td>
<td>Launch in 2007</td>
<td>Ylenen Electronics</td>
<td>Leaf amplifier assembly</td>
</tr>
<tr>
<td>TWINS (NASA)</td>
<td>Launches TBD</td>
<td>VTT</td>
<td>Instrument scanning mechanisms</td>
</tr>
</tbody>
</table>
Most of the Finnish space budget is invested in ESA through the Ministry of Trade and Industry, which pays Finland’s membership fee, and Tekes, responsible for programme payments.

Administration of space activities in Finland.
Figure & Table 5. Finnish space funding 1996–2006; in million euros.

<table>
<thead>
<tr>
<th>Year</th>
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<th>Ministry of Trade and Industry</th>
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Aboa Space Research Oy (ASRO) designs and manufactures instruments and software for space environment measurements, develops the related technologies and environment models, and carries out consultation and research. ASRO is particularly active in the domains of high-energy particle radiation and space debris. ASRO provides solutions for measurements and observations of space environment conditions, as well as tools and methods for exploiting the data in space systems design, mission planning, and operative purposes.

Turnover in 2005: 300,000 €
Personnel: 6

Space expertise
- on-board electronics
- on-board software
- radiation detectors
- ground support systems
- data analysis software
- particle observations in space
- plasma simulations and space radiation modelling
- optical space debris observations
- near real-time control systems.

Main space contracts
- Charged Particle Telescope Phase-A Study (ESTEC)
- ESA space debris telescope observations and system upgrade management (ESOC)
- Space-based optical observation of space debris (ESOC)
- BepiColombo SIXS particle detector.

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The ESA Optical Ground Station (OGS) at Tenerife, Spain. The OGS was built for in-orbit test of laser communication terminals and for space debris search. The station is equipped with a 1-meter optical telescope.
Aerial Oy

With 30 years’ experience in the design, production and testing of antennas, Aerial Oy’s expertise is a link to a dependable antenna solution. Companies in a wide range of industries throughout the world rely on Aerial’s solutions. Aerial’s service concept includes antennas and antenna products, consultation, design and measurement.

Aerial supplies antennas and related passive components for the 3 MHz to 40 GHz frequency range. The delivery programme includes antennas, power dividers, filters, waveguide and coaxial components and masts. Aerial has its own production facilities for HF antennas, FM/TV transmitter antenna systems, radio link antennas, radar antennas and base station antennas for cellular networks including GSM 900, GSM 1800, TETRA and UMTS. The company is an experienced supplier of special antennas made to customers’ individual specifications. Aerial Oy is specialized in small series antenna production and/or products that require high knowledge and craftsmanship. For instance we can make reflector antennas up to 5.4 m as single piece construction with very high accuracy (RMS value typically in single piece construction 0.5 mm). Aerial Oy is also especially skilled in doing antenna solutions to hard environments. Please kindly explore our website www.aerial.fi for a better understanding of our profile.

Turnover: 6 million €
Personnel: 30

Space expertise
Antenna technologies for the 3 MHz to 40 GHz frequency range.

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www.aerial.fi

Two 4.2 meter reflector antennas manufactured by Aerial Oy.
AL Safety Design Ltd

AL Safety Design Ltd is an independent consulting firm, founded in 1991, with main office in Helsinki, Finland. The company is privately owned by its employees. Our international customers include major companies in the electronics, aerospace, heavy machinery, energy technology and chemical industries.

Turnover in 2005: 342,000 €
Personnel: 4

Space expertise

- Product assurance of space technology design and development projects
- Risk analysis
- Reliability engineering, reliability analysis
- Quality systems

Main space contracts

Planck /Herschel
LFI instrument PA/QA management / VTT MilliLab, Elektrobit Ltd., Laben (Italy)

Rosetta-Lander
PA/QA management of CEU, Mass Memory and PP instrument / Finnish Meteorological Institute (FMI), Deutsches Zentrum fur Luft- und Raum Fahrt, Max Planck Institute Berlin, KFKI Budapest

SMART-1 Satellite/
SPEDE instrument
Instrument PA/QA management / FMI, Swedish Space Corporation, ESA

Cassini HUYGENS
Radar Altimeter Unit reliability / Ylinen Electronics, Aerospatiale (France), Laben

MARS NetLander, phase A
PA/QA management of NetLander weather stations / FMI, CNES (France), ESA, NASA

METEGG
Small Weather Stations for Mars, CEU reliability / FMI, IKI (Russia)

ERNE
PA Management of ERNE instrument / ESA, VTT, University of Turku

SPACE 2000
PA/QA survey of Finnish space technology industries

Civil Aviation Authority (FIN)
Reliability of Air Traffic Control System, Procurement Project

Contact details

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contact@alsafety.com
www.alsafety.com

AL Safety Design is responsible for the PA management of the Planck LFI 70 Ghz radiometric receivers.
Apollo Materials Oy opened in Finland in 1993. It belongs to the international Apollo Metals group. Apollo Metals is known worldwide as a metals service provider with supply chain management activities. Apollo is approved by several aerospace customers, such as Bae Systems, EADS, Boeing etc.

Apollo Materials Finland focuses on supporting customers’ core business through supply chain management. We have a large network to suit each customer’s business. We focus on customers who mainly produce lightweight structures, such as aerospace, space structures, trains and ships. We have different materials for these applications available from stock. With the help of our network, we can process these materials from first-stage processes (such as cutting, profiling, waterjet cutting) to finished components or structures.

Our main target is to find suitable supply chains to meet our customers' needs. It might be a matter of just keeping the material in stock and available at all times, or it might be fully machined and finished components, ready for assembly.

We are selling solutions to your needs.

**Space expertise**
- material management (metals, paints, composites, honeycombs)
- ISO9001:2000/ EN9100 approved supply chain management
- machined components
- GSE turnkey supplies
- project management

**Space contracts**
- material supplies to XMM and Rosetta satellites
- Herschel GSE and Brackets

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www.apollometals.com
Arbonaut Ltd

Arbonaut is a Finnish technology company that develops information-management and GIS solutions for assessing and managing forests.

All kinds of forestry operations need to be tied to a definite geographical unit. Management operations aiming at both ecological and financial goals require a “mooring” to which the operations are to be applied. Forests need to be delineated in relatively homogeneous units of varying size, most often called ‘forest stands’.

Arbonaut’s ArboGIS platform features advanced semiautomatic forest stand delineation functionality.

The process of carrying out forest inventories is currently becoming airborne. The efficiency of forest assessment is, quite literally, being taken to new heights with the latest technology. State-of-the-art inventory methods based on remote sensing imagery, such as digital aerial photos, satellite imagery and laser scanning data create an entirely new perspective for forest resource management. As an innovation-driven company, Arbonaut has been at the forefront of remote sensing technology development since 1996.

One of the best examples of the innovative thinking and development work of Arbonaut’s professionals is the first forest inventory tool in the world that is based on detecting individual trees from optical aerial and satellite imagery. It has been used for forest inventories in Finland and in the USA since 2000.

Arbonaut’s ArboGIS platform now uses aerial images, laser scanning and optical and SAR satellite images for forest assessment and analysis. The accuracy obtained with ArboGIS is frequently 90 per cent in timber volume on stand level, which far surpasses the accuracy of ground-based surveys.

Arbonaut’s Web-based GIS solutions and hosted services bring this accuracy to the desktop. They make it easy for forest management organizations to communicate to their forest customers the value of their forestlands, as well as their plans on when to harvest each stand, together with the associated costs and revenues.

*Turnover: 0.6 million €
*Personnel: 10

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www.arbonaut.com
CCC Group is a Finnish software house specialised in software production and software products. CCC Group employs over 400 software professionals and also has a presence in Asia, Europe and USA.

CCC Group’s software production is specialised in delivering customer-specific solutions to various sectors i.e. to industry, electronics, public authorities, health care (wellness), data transfer, media, space, and telecommunications (wireless).

CCC Group’s software products consist of software designed to meet the high requirements of the mobile smart communication equipment, wireless technology, Internet, multimedia, teledicine, virtual templating in Ebusiness and CAD-planning.

In 1992, CCC Group received the ISO 9001 Certificate for all its functions as the first Finnish software company ever. Another recognition that CCC Group has received is the AQAP 110 Quality Certificate given by the Finnish Defensive Forces in 1997, the same one that also NATO uses in their quality evaluations.

CCC Group is one of the largest private-owned software house in Finland. The turnover in 2004 was 40 EURm.

Space Technology

We focus on serving the cooperation partners in space and aviation industry. The strong software know-how of concise CCC and the expertise of the Space Unit on mobile positioning solutions are applied to all projects.

Our projects are very international the partners in cooperation being e.g. the Esrin office of the European Space Agency (ESA) and the Meteorological Institute.

We have been the finnish member of the Odin/OSIRIS project, which was carried out in co-operation between scientists and space agencies in Sweden, Canada, France and Finland. CCC was responsible and main task was Level-2 data processing.

In the future, Europe will invest strongly in the development of a European navigation system (Galileo) to function alongside the United States controlled GPS system. The construction and development of such systems together with the mobile data transfer and the Internet create new needs for system solutions in an ever-growing space. This swift development offers CCC challenging opportunities to develop services of additional value.

Turnover in 2004 (CCC Group):
40 million €
Personnel: over 400

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www.ccc.fi
We produce high quality company and product presentations and 3D animations for the needs of technology and science. Our visualisation services are used in organisations like Finnish Meteorological Institute, ESA, VTT, Tamro, Lemminkäinen and Eltel Networks.

**Turnover 2005:** 250.000 €, 2006: 350.000 € (estimated)

**Personnel:** 6

### Space related expertise
- Visualisation services for space related programmes and technologies.

### Space related contracts
- Bepi Colombo 3D animation (ESA).
- OMI/ EOS CHEM, Odin, SMART / SPEDE, Aurora Borealis, GOMOS, Change (FMI).
- LFI/Planck (VTT).
- Several company and technology presentations (Tamro, Eltel Networks, University of Oulu).

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Fax +358-9-68133101
www.cdqsolutions.com
www.presentor.fi
www.3dvoima.com

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BepiColombo 3D animation (ESA).
CLS-Engineering Oy

CLS-Engineering Oy is a company focusing on automation, electrification and all-inclusive new or modernization projects for (industrial) automatic systems, i.e. power plants and marine installations. Our main customers are: Wärtsilä Corporation, Valmet Automotive, Rolls-Royce, Ahlström Paper Group, Outokumpu, UPM-Kymmene, CAA Finland, Nokia Mobile Phones Oy.


Turnover in 2005: 4.4 million €
Personnel: 44

Space expertise

Automation and control systems (projects)
- New installations, modernization and modification
- Turnkey projects
- Overall process control designing
- Digital automation systems
- Remote (SCADA) and On-line controls
- Sensor fusion
- Measurement filtering
- Real time and historical database systems
- Safety-related systems
- Cabling
- Commissioning and SAT
- Customer training.

Aerospace
- Instrumentation
- Space technology
- Flight mission planning, including ground support (GPS).

Remote sensing
- Instrumentation
- Data processing.

Geographic Information Systems (GIS)
- GIS Software.

Imaging techniques and technology
- Optics
- Optoelectronics
- 3-D imaging
- Digital / still / video
- Laser imaging
- Scanning.

Technical writing
- CAD / CAE.

Electrical engineering
- Low and high voltage
- Electrical supplies.

Digital electronics
- Components.

Telecommunications
- Fibre optics
- Wired and wireless
- Industrial networks (Ethernet, Profibus, Modbus+ , Modbus).

Networks
- Internet
- Intranet
- LAN
- Servers, switches, bridges, hubs etc.

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Managing Director
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Mr Tomi Nikkanen,
Deputy Managing Director
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Componeering Inc.

Componeering Inc. is a SME specializing in the analysis and design of high-performance composite structures. The development and distribution of ESAComp software together with related services form the core business of the company. Componeering also provides technical consulting for customer projects.

ESAComp is software for the analysis and design of composite laminates and laminated structural elements. The European Space Agency (ESA/ESTEC) initiated the development of ESAComp in the early 1990s. The goal was to create a standard tool to replace the various in-house codes used by the aerospace industry for the analysis and design of composite structures. The development work was first conducted at Helsinki University of Technology’s Laboratory of Lightweight Structures. In 2000 Componeering was established, the development was transferred to the company, and commercialization of the product was started. Today ESAComp is used in 27 countries around the world by various industries utilizing high-performance composite structures. The aerospace industry remains the biggest user group. Customers include various EADS establishments and Airbus. ESAComp is also widely used for research and education.

Expertise relevant to space

- Composite structures analysis and design
- ESAComp software
- Customized CAE software solutions for composites design

Space contracts

- Composite Structures Analysis and Design (ESA)
- Advanced Equipment Design (ESA)

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www.componeering.com

Componeering was responsible for the mechanical and thermal analyses of a composite electronics housing in the ESA project Advanced Equipment Design. In this feasibility study, a carbon-fibre-reinforced replacement was developed for an aluminium electronics housing of the Proba 2 microsatellite.

Source: Contraves Space AG
Detection Technology Inc.

High-Performance Silicon Photodiodes and Radiation Detectors

Detection Technology designs, manufactures, and markets unique, high performance silicon photodiodes, radiation detectors and related electronics, and detector modules. The measurement instrument “eyes” provides excellent accuracy and reliability while offering the benefits of modern solid-state technology.

Detection Technology has offices, R&D Center, ASIC Design Center, inhouse factories, and assembly lines in Ii, Helsinki, Cleveland (USA), Hong Kong and Beijing (China). DT’s state-of-the-art production facilities are equipped with the latest technology, and are capable of manufacturing both small prototype series and high-volume products. Modern clean rooms are designed especially for Detection Technology’s unique ultra-clean manufacturing process. Quality and Environmental Management System of Detection Technology is ISO 9001 and ISO 14001 certified by Lloyd’s Register Quality Assurance.

Detection Technology’s expertise originates from its participation in international physics research in the late 1980s. The company has maintained close cooperation with leading research centers around the world, which provides an excellent channel for development of state-of-the-art technology.

In the early 1990s, Detection Technology began applying its technological ingenuity to the needs of industrial customers. A solid background in scientific research, combined with a strong customer orientation and knowledge of applications, lets Detection Technology offer complete solutions to customers in medical imaging and safety and security imaging markets. Close cooperation with customers ensures the most effective utilization of superior technology.

Today, Detection Technology serves an extensive and demanding customer base worldwide.

Turnover in 2005: 17.0 million $  
Personnel: 162

Our customers say...
“You seem to be the only manufacturer who understands these kinds of measurements”

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The detectors are manufactured on silicon wafers using Detection Technology’s proprietary processes optimized for different light and radiation detection needs. This picture shows some samples of our wafers and detector components at different stages of the manufacturing process.
Elcon Power Oy

"POWERING YOUR APPLICATION"

Elcon Power Oy is a power electronics company specializing in customized power supplies, adjustable rectifiers and complete power supply solutions.

The company was founded in 1997. So with 9 years' of experience Elcon Power has designed and produced products and services for customers in telecommunication, industrial automation as well as for military and public authority.

Most often the development of a project means close and long-lasting cooperation with the customer.

In addition to company’s own development and manufacturing Elcon Power also is cooperating with some of the leading international power supply manufacturers offering standard products to the customers.

**Turnover est.: 1 M€**

**Personnel: 10**

**Product groups**
- Customized solutions
- Adjustable power supplies
- DC/DC converters
- Open / enclosed power supplies
- External power supplies
- Other standard power supplies

**Space expertise**
- Special power supply equipment for satellite simulator.

**Space related contracts**
- VTT Information Technology, Finland.

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Company

Environics Oy is a high-technology company founded in 1987 specializing in the development and supply of gas detection instruments for both military and civil applications. Main products include M90 and ChemPro 100 chemical warfare agent detectors and Enviscreen software for prediction of the dispersion of hazardous chemicals.

Environics Oy’s annual turnover has grown rapidly in recent years. Export sales generally account for more than half the turnover.

The majority of its shares are owned by the shelter equipment manufacturer TEMET OY and a group of private investors.

Technology, research and development

The main products of Environics are based on ion mobility spectrometry (IMS), a special technology applicable to detection of various gases and aerosols. The company maintains continuous and extensive R&D in various applications of IMS. Environics owns domestic and international patents in this technology.

All software needed for operation of detectors as well as for the detection method itself are developed, maintained and continuously updated by the company’s own specialists.

Marketing and sales

Environics has a subsidiary in the USA, Environics USA Inc. A large network of agents and representatives covers other parts of the world: Scandinavia, central Europe and the Middle East, as well as Canada and the Far East. Today, Environics Oy operates in over 40 countries.

Environics’ main customer groups include civil defence authorities and defence force NBC protection units, shelter manufacturers, and detection and warning systems suppliers. The fastest-growing customer group are authorities responsible for antiterrorist activities.

Space expertise

- Design of low power mixed signal electronics for space applications
- PCB (Printed Circuit Board) design for space applications
- Manual soldering and soldering processes for space applications

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Chempro 100 (right) and M90-D1-C (above) are high performance CWA detectors manufactured by Environics Oy.
Fastrax Ltd

Fastrax Ltd is a high-technology company specializing in the development of industry-leading iSuite embedded GNSS receiver software and iTrax OEM GNSS receivers. The iSuite Software Development Kit and firmware are utilized by GNSS IC vendors and location-aware product developers. iTrax receivers are used by companies developing tracking, recreational and navigation products. Fastrax’s annual revenue has grown rapidly in recent years. In 2006 more than 85% of the revenue came from export markets. Fastrax was founded in 1999 and it employs 28 people. Key shareholders include private equity investors CapMan and Eqvitec Partners as well as the sports instrument manufacturer Suunto.

Software technology, research and development

The iSuite Software Development Kit (SDK) for embedded GNSS applications enables the utilization of the spare Central Processing Unit (CPU) and memory capacity in OEM GNSS receivers. This eliminates the need for a separate control unit or application processor leading to smaller, lower power and lower cost-location-aware product design. The iSuite SDK can also be used to tailor the performance of the receiver for a specific use profile very easily. The unique open programming architecture and access to GNSS signal carrier phase measurements enables development of low-cost centimetre-accurate solutions.

Hardware technology, research and development

Fastrax focuses on transforming new GNSS technologies into easily usable solutions with open interfaces and ultra-low power, and miniature hardware design. With their industry-leading performance, Fastrax programmable iTrax130 and iTrax03 OEM GNSS receivers and NMEA (National Marine Electronics Association) compatible iTrax300, iTrax100 and uPatch OEM GNSS receivers navigate continuously – even in extreme conditions. Receivers are ideally suited for tracking applications and high-volume consumer products such as personal navigation devices and sports accessories. Hardware manufacturing is outsourced to cost-effective, high-quality EMS partners in South Korea and Hungary.

Fastrax products are widely used in asset-, person- and animal-tracking devices, recreational products and personal navigation devices. Fastrax Ltd. currently employs 28 people at its Helsinki-Vantaa headquarters in Finland.

Space expertise

- Software development environment for embedded GNSS applications
- GNSS signal search, tracking and position calculation algorithms
- GNSS receiver firmware
- State-of-the-art GNSS receiver reference designs

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FM-International Oy FINNMAP

FM-International Oy FINNMAP is an independent, privately-owned consulting company with major activities in remote sensing, aerial photography, mapping, surveying, cadastre and GIS. The major shareholders of the company are the Pasco Corporation in Japan and the acting directors. Our company provides services in remote sensing, and various photo and satellite image interpretation features.

FINNMAP was established in 1951 as a mapping and planning company that has since been the leading mapping and surveying company in Finland. Over the last 30 years the company has carried out assignments covering all areas of work within mapping, surveying and aerial photography.

FINNMAP has carried out projects worldwide in over 25 different countries. During the last decade FINNMAP’s overseas assignments have focused on South-East Asia, Asia, Northern Africa, Eastern Europe and Latin America, and a number of other countries on a single mapping assignment basis. Our main clients consist of bilateral development cooperation agencies, the United Nations, the Commission of the European Union, Development banks and other international organizations.

FINNMAP has its head office in Helsinki, Finland and currently has overseas offices in Lao PDR, Thailand, Cambodia, Nepal, Egypt and Turkey. Over the years of our international operations, the main policy has been the sustainable transfer of technology through training and local production without any race or gender discrimination. Our overseas production offices are currently occupied by dozens of locally-trained staff. At the moment, the overseas operations employ 29 highly-qualified Finnish professionals whose experience covers the full spectrum of the surveying profession and procedures.

Turnover 2005: EUR 4.3 million
Personnel 2006: 29

Space expertise
- Remote Sensing Applications
- Main space contracts
- Land-use maps and other spatial data for telecommunication planning
- Satellite image capability analysis for monitoring vegetation.

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Experience
- Zanzibar (Tanzania) 2003–06
- Egypt 1987–1999
- Libya 1979–1986
- Saudi Arabia 1980–86 and 2004–
- Palestine 2005–
- Nepal 1992–2004
- Bangladesh 1986–2000
- Mongolia 2005
- South-East Asia (Thailand, Lao PDR, Cambodia, Myanmar, Vietnam) 1988–
- Kosovo 2004–05
- Bosnia & Herzegovina 2003
- Romania 1999–
- Turkey 1998–2000, 2005v
- Azerbaijan 2000
- Uzbekistan 2000–2002
- Georgia 2005
- Tajikistan 2006–
- Latin America (El Salvador, Guatemala, Honduras, Nicaragua, Belize) 1999–
Finnsat Oy

Finnsat Oy is one of the leading system integrator for digital television contribution and distribution systems in Finland and Baltic countries.

Finnsat has more than 14 year’s experience building professional satellite earth stations for the radio and television broadcasting industry. Skilled personnel and a global network of associated business partners guarantee customer satisfaction.

Finnsat uses only the up-to-date technology, both in software and hardware. The company supplies complete DSNG’s (Digital Satellite News Gathering systems) and Fly-Away’s in various configurations for outside broadcasting vans, IP-casting, or emergency circuit restoration.

Turnover in 2006: 23 million €
Personnel: 21

Space expertise
- system integration, earth stations
- system integration, digital television uplink systems
- mobile tv-uplink vehicles (Digital Satellite News Gathering)

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Toikka Oy specializes in ground truth equipment manufacturing, ice, snow, dielectric properties and ground measuring services, and the industrial applications of microwaves. Other services include the design, development and manufacturing of microwave devices according to the specific requirements of the customers.

Toikka Oy has participated in developing the MIRAS for the European Space Agency (ESA) Earth Explorer Mission. MIRAS (Microwave Imaging Radiometer with Aperture Synthesis intended for Earth Observation) is the core instrument of the second Earth Explorer Opportunity Mission (SMOS), dedicated to the observation of soil moisture and ocean salinity. Also Toikka Oy has participated as a subcontractor in designing 70 GHz ultra low noise receiver for ESA Planck mission. Both satellites, SMOS and Planck, are expected to be launched in 2007.

The short pulse radar ImRa is designed for various environmental and construction measurements. It can be used in severe environmental conditions including low temperatures. The standard ImRa model is equipped with a 1 GHz frequency antenna, optimized for measuring distances up to 3 m with an accuracy of 1–15 cm depending on the measured material. The ImRa will indicate e.g. rot or decay in trees. It also tells the thickness of snow and ice. Furthermore ImRa indicates the location of moisture faults, joists, cables etc. in concrete, wooden or other structures.

Snow Fork, a portable instrument for measuring the properties of snow, is designed explicitly for field use; it is light, quick and easy to use, and operates in extreme conditions ranging from rain to temperatures as low as minus 40 °C. The sensor is a steel fork microwave resonator. Measuring results are used to accurately calculate the complex dielectric constant of snow. In addition, the liquid water content and density of snow are calculated using semi-empirical equations. All data can be stored for future use. With the same principle, but in much higher moisture range operates the Peat Probe. It is designed for measuring the properties of peat-lands and is suitable also for measuring other wet materials.

**Turnover in 2005:** about 200,000 €
**Personnel:** 4

**Space expertise**
- Measuring ground truth data for satellite imagery applications
- Development and manufacturing of microwave systems and radiometers.
- Main space contracts
  - ESA EMAC, 1995
  - MIRAS Demonstrator Pilot Project-2, Validation of L-band Imaging Radiometry
- Planck, 70 GHz ultra low noise receiver.

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Metso Powdermet Oy

Metso Powdermet Oy, a member of Metso Corporation, specializes in materials technology and components produced by powder metallurgical methods. Using powder metallurgy, materials and components having properties superior to conventionally produced materials can be created. Powder metallurgy also produces excellent wear, corrosion and mechanical properties. In addition, the manufacture of new multimaterial structures, coatings and components with internal channels or cavities is possible.

The main application areas for Metso Powdermet’s products are pulp and paper, minerals, offshore technologies, power generation and the chemical and petrochemical industries. Typical products include different wear parts, key components for process machinery, as well as wear and corrosion protection surfaces produced by hot isostatic pressing or weld cladding.

Main R&D involves metal matrix composites, other wear-resistant materials and multimaterial manufacturing technology.

Core competencies
- Materials technology
- Powder metallurgy
- Hot isostatic pressing
- Joining technologies
- Coating technologies (laser and plasma welding).

End covers for CERN’s new particle accelerator.

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Modulight, Inc.

Modulight brings light to space missions

Modulight is a privately-held Finnish semiconductor company focusing on laser diodes. The Company designs, manufactures and markets laser diodes for communication, industrial, medical, automotive, space and defence applications. The Company has its ISO9001:2000 and ISO14001:2004 certified production facilities and headquarters in Tampere, Finland with a sales office in San Jose in the US.

The Company offers value-added solutions on optical applications. Products include various types of laser diodes from visible to infrared (IR) with power levels from milliwatts to tens of watts. Laser diodes are multilayer semiconductor structures that convert an electrical current into a coherent light. The manufacture of the products involves more than 100 steps and only a few companies in the world have been able to master it in commercially interesting volumes. The company already has several hundreds of existing off-the-shelf laser products that are sold to customers worldwide.

The company’s products are categorized into 3 product lines, i.e. high-power lasers, transmitter lasers and custom products and services. The company has a complete optoelectronics manufacturing process from epitaxy to component life-testing in-house. The company’s engineering skills and capabilities in laser products are recognized and widely used by several industry leaders, including the European Space Agency (ESA). The company utilizes state-of-the-art IT technology with 100% traceability of products in semiconductor business and has well-established business processes for exceptional customer support and to ramp up production. The company is one of the leading European-based laser diode manufacturers and has existing accounts for the strategic supply of lasers to the European market.

Turnover: 3M€

Space related expertise

- ESA MOHA-SMOS: supply of fiber pigtailed communication laser diodes
- Design, development, manufacturing, and qualification of laser diodes and other optoelectronic components for space application
- Design and development of laser diodes for compact Cs-beam atomic clocks for space application (GSTP)
- Design and development of sealed laser diode pump modules for space application (GSTP)
- Design and development of laser diodes for hybrid integrated optical processing application (GSTP)
- Design and development high-power laser diodes for pumping applications in space
- GaAs-based X-ray detector manufacturing for space application (in cooperation with Oxford Instruments Analytical)

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Nokia

Nokia is the world’s largest manufacturer of mobile devices; a leader in equipment, services and solutions for network operators; and a driving force in bringing mobility to businesses. Nokia is about enhancing communication and exploring new ways to exchange information. In short, Nokia is about connecting people.

In 2005, Nokia’s net sales totaled EUR 34.2 billion. The company has 15 manufacturing facilities in nine countries and research and development centers in 11 countries. At the end of 2005, Nokia employed approximately 58,900 people. Nokia is a broadly held company with listings on the Helsinki, Stockholm, Frankfurt and New York stock exchanges.

Nokia comprises four business groups: Mobile Phones, Multimedia, Enterprise Solutions and Networks. Mobile Phones connects people by providing expanding mobile voice and data capabilities across a wide range of mobile devices. We seek to put consumers first in our product-creation process and primarily target high-volume category sales.

Multimedia brings connected mobile multimedia experiences to consumers in the form of advanced mobile devices and applications. Our products give people the ability to create, access and consume multimedia, as well as share their experiences with others through a range of radio technologies. Enterprise Solutions offers businesses and institutions a broad range of products and solutions, including enterprise-grade mobile devices, underlying security infrastructure, software and services. We also collaborate with other companies to provide fixed IP network security, mobilize corporate email, and extend corporate telephone systems to Nokia’s mobile devices.

Networks provides network infrastructure, communications and networks service platforms, as well as professional services to operators and service providers. Networks focuses on the GSM family of radio technologies and aims at leadership in three areas: GSM, EDGE and 3G/WCDMA networks; core networks with increasing IP and multiaccess capabilities; and services.

Our business groups are supported by various horizontal entities:

- Customer and Market Operations is responsible for marketing, sales, sourcing, manufacturing and logistics for mobile devices from Mobile Phones, Multimedia and Enterprise Solutions.
- Technology Platforms is responsible for the competitiveness of Nokia’s technology assets. The group supports Nokia’s overall technology management and development by delivering leading technologies and well-defined platforms both to Nokia’s business groups and to external customers.
- Nokia-wide horizontal units drive and manage specific Nokia assets. They include brand and design, developer support, research and venturing, and business infrastructure.
- Corporate Functions support Nokia’s businesses with company-wide strategies and services.

Nokia Research Center

Interacting closely with all Nokia business groups and Technology Platforms, Nokia Research Center is responsible for the strategic and long-term research in Nokia. Looking beyond current product development, the Research Center challenges current strategies and drives Nokia’s renewal through long-term technology exploration. Nokia Research Center participates in the standardization work and various international R&D projects in cooperation with universities and research institutes. Nokia Research Center employs about 1,100 people and has activities in Finland, USA, Germany, Hungary, China and Japan.

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Opteon Oy specializes in manufacturing precision optics for telescopes and instruments. Opteon currently uses the optical laboratory facilities of Tuorla Observatory at the University of Turku, thus benefiting from nearly 80 years’ experience in precision optics manufacturing.

Opteon uses computer-controlled polishing methods developed in-house. The polishing machines based on these methods enable fast optical figuring to high surface accuracy. An example of the large mirrors manufactured is the 2.56 m mirror of the Nordic Optical Telescope. Opteon has also polished the 3.5 m silicon carbide mirror of ESA’s Herschel space telescope and the 1.5 m silicon carbide mirror of the Aladin telescope on the Aeolus satellite.

The available optical laboratory facilities include a vertical 25-m-high testing tower and a horizontal 70-m-long testing tunnel. These have been built into the bedrock, which guarantees extremely stable conditions for optical testing.

The company has developed a wavefront sensing system, including hardware and software design, used in active optics applications of astronomical telescopes. The system’s very high wavefront measuring accuracy is well suited for space applications.

**Turnover in 2006:** 1,600,000 €

**Personnel:** 4

**Space expertise**
- Computer-controlled polishing of aspheric optics
- Polishing of lightweight silicon carbide mirrors
- Wavefront sensor system for active optics
- Optical testing facilities.

**Main space contracts**
- Polishing the 3.5 m silicon carbide mirror of the ESA Herschel space telescope.

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Oulun Hienomekaniikka Oy

Oulun Hienomekaniikka Oy, established in 1982, is a strategic partner for manufacturing of versatile, demanding and precise part families, components and modules. The company is ISO 9001 certified.

Oulun Hienomekaniikka focuses on machining demanding, precise components from a wide selection of materials. It manufactures single components, prototype series and production series. Company’s assembly service optionally also includes maintenance and spare component services. Finished products are packed into customer packages.

Company’s operation is based on long term and intensive quality system development which is the backbone to achieve the customer satisfaction. According to company’s policy the newest CNC machines are in use. Modern way of operating covers the development and industrialisation of a product and the use of fit to purpose technologies in cooperation with a customer.

Description of the offered technology

Oulun Hienomekaniikka Oy offers contract manufacturing for part families, components and modules. Based on long term experience and intensive quality system development combined with the newest and versatile equipment in the field the company is able to offer high quality services even for the most demanding applications.

Company is specialized in high precision machining of small and mid-sized components. Range of machined pieces is from a few grams to around 20 kg, and normal turn of components vary between 2–250 mm but even rod diameter of 0.9 mm can be machined. Selection of materials is wide; stainless steel, acid-proof steel, titanium, hastelloy, plastics, brass, aluminium, copper etc. Machined products may be single components, prototype series or production series, depending on customers’ specific needs.

In addition to machining services company offers assembly services. They can be partial or complete assemblies with electrical and/or optical work, electronics, pneumatics and hydraulics. Full documentation as well as test and measurement reports are included in the service. Finished assemblies and products are packed in customer packages if needed.

The assembly service optionally includes also maintenance and spare component service.

Application areas

- healthcare; instruments and analysators
- industrial; analysators and measurement devices
- military
- aviation

Type of partners sought

- Customers for application areas

Task to be performed

- Strategic partnership for contract manufacturing of demanding precise part families, special components and modules.

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Oxford Instruments Analytical Oy (OIA) supplies detector technology and spectral analysis systems for the demanding environment of space. OIA is a leading supplier of advanced equipment for elemental analysis and rapid chemical identification. We also work directly with other companies, supplying them with OEM equipment.

Space technology is a special area in which we offer extensive and often unique expertise in x-ray and gamma-ray detector technology and spectral analysis for space environments. We design, develop and produce customized instruments and components, including position-sensitive proportional counters, solid-state spectrometers and detector arrays, gas handling systems and ultra-thin X-ray windows and filters.

Several of our instruments are already launched and operational (9 spacecrafts), others are waiting to be launched on board ESA, NASA, JAXA and national satellites and space probes. This technology is readily adaptable for terrestrial use in physics research and in harsh industrial and natural environments.

**Personnel:** 70

**Space expertise**
- Solid-state detectors
- Proportional counters
- Bolometers
- Read-out electronics
- X-ray windows & filters.

**Examples of Oxford Instruments Space Products**

**X-ray Solar Monitor - XSM - SMART-1**

The XSM is a mobile-phone-sized instrument, weighing just 200 grams and was built for measuring the X-ray spectrum emitted by the Sun.

The design and fabrication of a low noise sensor and electronics by Oxford Instruments Analytical Oy enables the measurement of very low energy (< 1 keV) X-rays. In space, the sensor will be bombarded by high energy particles, which is why a miniature movable radiation shield had to be developed. The scientific planning and utilization is carried out by the University of Helsinki Observatory.

The XSM was launched on the European Space Agency’s (ESA) SMART-1 probe on September 28, 2003. SMART-1 reached moon orbit in 2005 and successfully completed its mission on September 3, 2006.

**X-Ray Spectrometer - XRS - MESSENGER**

As part of NASA’s Discovery Programme, the Applied Physics Laboratory at the Johns Hopkins University developed the Mercury Surface, space environment, geochemistry and ranging (MESSENGER) spacecraft to orbit the planet Mercury. It was launched on August 3, 2004. The spacecraft will fly past the Earth once, Venus twice and Mercury three times starting a year-long orbital study of the innermost planet in March 2011.

The X-ray spectrometer (XRS) aboard the spacecraft uses three gas proportional counter detectors to measure the surface elemental composition of the planet Mercury, using X-ray fluorescence excited by the Sun’s radiation. The x-ray radiation from the Sun is measured by a silicon PIN-diode-based x-ray monitor.

Oxford Instruments Analytical Oy delivered the XRS proportional counters and silicon pin diodes for the mission. Each XRS proportional counter consists of two concentric detectors. These detectors are surrounded by a graphite walled inner cylindrical detector and have a number of interconnected veto wires. This cage of veto anodes makes an anticoincidence shield around the centre detector. The shield is required to reduce the spectral background induced by the intense charged particle radiation prevalent in Mercury’s orbit.

“The total lifetime of our products in space exceeds 100 years – without any failures”

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Patria Systems Oy

Patria operates on both the institutional and commercial space markets. The focus areas include design and manufacturing of on-board space electronics and light-weight composite structures.

*Turnover in 2005 (Patria group):* 317 million €
*Personnel:* 1781

**Space expertise**

On-board electronics for spacecraft:
- Power control & distribution units
- Signal processing electronics for payloads.

Spacecraft structures:
- Advanced low weight panels.

**Main space contracts**

- Galileo: Remote Terminal Unit
- Herschel: Cryostat Control Unit
- ADM Aeolus: Power Conditioning and Distribution Unit
- Aladin instrument: Detection Electronics Unit
- Venus Express: Power Distribution Unit
- CryoSat-1&-2: Power Distribution Unit
- Mars Express: Platform and payload power distribution units
- Rosetta: Entire platform structure and sub-system, and payload power distribution units
- XMM: Main load-carrying structure (telescope tube) and mirror thermal control unit
- EOS-AURA: Interfacing and data pre-processing electronics unit for the OMI-ozone monitoring instrument

Patria is the leading Finnish company in the field of space technology.

- Envisat-1: Science data electronics unit for the GOMOS global ozone monitoring instrument
- Cluster I and II: Parts for power control
- MARS-96: Central processing electronics unit
- SOHO: Digital and power electronics for three different instruments
- Freja, Interball: Power electronics.

**Patria**

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Patria is a Finnish industrial group whose business areas include products and services for the aerospace and defence sectors.
PIEneering Oy

PIEneering Oy, founded in 2003, specializes in customized software and system development in the field of geomatics and parallel computing. The focus is on state-of-the-art technology in photogrammetry, remote sensing, computer vision, and other areas using digital image processing and pattern recognition.

PIEneering also aims at maintaining and promoting industry awareness of the evolving parallel computing technology and at providing innovative solutions to the industry.

The core competence includes areas such as:
- Photogrammetry
- Remote sensing
- Computer vision
- Image processing
- Parallel computing
- Cluster computing
- Sensor modelling
- 3D reconstruction

The quality and advantages of PIEneering's solutions have been recognized in:
- Excellent accuracy and reliability
- High speed, possibly through parallel computing
- Sophisticated algorithms
- High degree of automation
- Ease of use
- Wide field of use
- Low pricing

PIEneering is currently involved in developing state-of-the-art software and hardware systems for different applications. PIEneering has been a co-partner of Stora Enso since September 2004 developing and maintaining EnsoMOSAIC software. This software system consists of all the necessary tools for flight management, data collection and image processing that are required in creating orthoimage mosaics out of airborne non-metric digital camera data, or scanned aerial photographs.

Space expertise
Development of algorithms and software for satellite image processing:
- Rigid sensor modeling
- Orbit modeling
- Raw satellite image handling
- Sensor fusion
- Geometric corrections
- Radiometric corrections
- Orthorectification
- DTM generation
- Mosaic creation
- Classification
- Statistical optimization & analysis

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Protoshop Oy specializes in manufacturing precision mechanical components and assemblies. Our customers include companies from very different fields of industry and research. We manufacture single parts and small batches according to customer specification as well as complete machines. Our company delivers testing systems and other machinery tailored to meet customer requirements.

We have experience of working with many different materials, such as titanium, machinable ceramics, high temperature alloys etc. Our machinery includes both CNC and conventional machines for turning, milling, drilling, boring and other operations. We have both vertical and horizontal machining centres and CNC machines with rotary axes which enable us to manufacture many parts which are otherwise difficult to produce.

For our design work we use 3D CAD systems. MasterCam software is used to produce the programs for CNC machine tools. Our long-standing network of partner companies carries out operations such as laser and water-jet cutting, anodising, polishing and painting.

Our company, founded in 2000, has its roots in VTT Space Technology. We have delivered components and assemblies for several space technology projects.

**Turnover in 2005:** 1.1 million €

**Personnel:** 17

**Space expertise**
- high quality machined parts

**Space contracts**
- parts for Cassini CAPS and LEMMS instruments
- manufacturing of TWINS rotators
- parts for SWAN and ERNE instruments

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Pöyry Environment Oy

REMOTE SENSING SERVICES

Within Pöyry Environment Oy’s GIS and mapping unit works a team of remote sensing experts. The team utilizes remote sensing in projects worldwide and supplies tailored expert services based on satellite imagery.

The team offers image-processing services, products and applications using satellite data, and distributes commercial satellite imagery.

Team members

- M.Sc. Miranda Saarentaus, team leader for remote sensing
- Anne Leskinen, sales manager for imagery and contracts
- M.Sc. Arto Vuorela, senior remote sensing specialist,
- multispectral and radar imagery
- M.Sc. Vesa Roivas, remote sensing specialist, VHR and photogrammetry
- M.Sc. (For.) Antti Kaartinen, GIS specialist, land use and forest classification
- M.Sc. Kari Mikkonen, GIS Consultant, ESRI certified trainer

Services

- Regional planning
- Land use
  - classification
  - field monitoring
- Forest
  - volumes
  - species
  - height of trees
- Elevation
  - radar DEM
  - VHR stereomodels

Image processing

- ortho rectification
- mosaicing
- image fusion
- change detection

Satellite images

- extensive commercial image distributor agreements
- world wide
- optical images: Ikonos, IRS, SPOT, Landsat, QuickBird
- radar images: Envisat, ERS, RADARSAT

Security

- nuclear power plants
- forest fires
- disaster areas

Environmental changes

- pollution
- water and wetlands
- forest cuttings
- agriculture
- nature conservation
- infrastructure (roads and buildings)

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Rejlers Oy is a multi-disciplinary engineering consultancy specializing in the development and design of different equipment and systems, and in providing professional, design and management services for investment projects. We are committed to providing technical plans and expert services aimed at improving the competitive standing of our client.

Rejlers Oy operates in eight locations in Finland. Our offices are located in Anjalankoski, Hyvinkää, Hämeenlinna, Kotka, Kurikka, Mikkeli, Porvoo and Savonlinna.

Our operations are constantly expanding and we currently employ 180 people. Our annual net sales are 10 million euros. Rejlers Oy is part of the Skandinavian Rejlers group.

Our quality system is structured around ISO 9001 and complies with ESA Product Assurance standards.

Turnover in 2005: 10 million €
Personnel: 180

Space contracts

ESA
- Herschel: Design of MGSE and tools for the AIT (Dutch Space)
- LSSM: Study and preliminary design on Low-Shock Separation Mechanism (VTT Technical Research Centre of Finland)
- Rosetta: Design of tools and jigs for the manufacture and assembly of satellite bus (Patria)
- XMM: Design of jigs and tools for the manufacture and assembly of XMM/TT (Patria)

NASA
- Cassini: Design and manufacture supervision of launch latches for the CAPS and LEMMS instruments (VTT Technical Research Centre of Finland)

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Selmic Oy

Selmic is one of the leading suppliers of customised ceramic electronics modules in Europe offering micromodules manufacturing and R&D services as well as conceptual products for telecommunications, defence, aerospace, automotive and medical electronics industries.

In micromodules we utilize advanced packaging technologies like LTCC with integrated passives, COB, flip-chip technology and BGA interconnection. Selmic products include micromodules such as MCM-C, MCP and thick-film hybrid circuits utilizing a wide range of substrate materials (e.g. LTCC, HTCC, Alumina, BT resin high TG laminates and flex based substrates).

Selmic adds customers’ competitiveness through advanced technologies and cost-efficiency. Selmic offers a complete range of services from large turn-key projects to a single manufacturing phase. Micromodule technology is most suitable in applications, where compact size together with high reliability and high performance is needed.

Turnover: 20 million €
Personnel: 200

Space expertise
Selmic has been working with several space application projects together with CERN (AMS, CMS) and Finnish Meteorological Institute.

Finnish Meteorological Institute built a pressure sensor unit for NASA Phoenix 2007 Mars lander. Selmic packaged Vaisala silicon pressure sensors for this application. Sensor packages and the sensor unit have passed all the demanding environmental tests. The lander will be launched in August 2007 and will land on Mars northern polar region in May 2008. The pressure sensors will also be used in the Mars Science Laboratory 2009 Rover’s pressure measurement instrument.

Selmic has also provided FMI a LTCC module for prototype humidity sensor head & transducer unit. This humidity sensor head is intended for low temperature humidity observations on future Mars missions like proposed Metnet mission.

Space contracts
- CERN – AMS and CMS projects
- FMI – Pressure sensors for NASA Phoenix 2007 Mars Lander and Mars Science Laboratory 2009 Rover
- FMI – Humidity sensor for Mars Metnet mission.

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This LTCC based technology is applicable also for terrestrial low temperature humidity sensing applications.
Space Systems Finland Ltd

Space Systems Finland is one of Europe’s leading space applications software providers – and has provided high-reliability software solutions for many of Europe’s most ambitious space missions. The company focuses on mission-critical solutions in areas such as spacecraft onboard software (OBSW), autonomy, data processing control environments, and pseudolite navigation systems.

Besides developing software itself, SSF also provides independent 3rd party verification and validation services for critical software systems.

Controlling the flight …
Spacecraft onboard software is responsible for all the functions critical to the success of a mission: managing spacecraft operations, thermal control, telecommunications, and attitude and orbit control.

OBSW must be able to operate reliably and efficiently with computer hardware that has limited capability, and cope with problems caused by the extreme conditions of the space environment. The design, implementation, and testing of OBSW is a major challenge, therefore, as any system failure can have major repercussions and prove very expensive.

… from pinpointed locations …
Space Systems Finland’s innovative NAVIndoor solution is a versatile system that extends the usage of satellite-based positioning into environments where satellite navigation signal is not available. These environments include urban and indoor areas where consumers spend 95% of their time, as well as large industrial facilities.

NAVIndoor technology enables navigation and location detection solutions to locations that have been ‘out of bounds’ for navigation systems so far.

NAVIndoor consists of several synchronised pseudolites (pseudo-satellites) that transmit a GPS-like navigation signal, and a control station to monitor and synchronise the pseudolites.

There are no technological limitations on the number of receivers utilising the generated signal. Nor are there any limitations on the number of applications using the location information generated.

… reliably, consistently, and everywhere
Reliability is a key issue for Space Systems Finland when developing its applications, whether they are onboard packages for satellite systems, earth observation data processing systems, or pseudolite navigation systems.

Although rooted in space applications, SSF’s technology is utilised in ground-based applications as well, including software solutions for critical industrial systems such as telecommunications.

Turnover in 2006: 3.0 million €
Personnel: 37

Main space contracts

Onboard software
- Envisat/GOMOS ASW
- MetOp TM/TC SW
- GOCE OBSW
- PROBA/DEBIE OBSW
- Herschel/Planck ASW
- Galileo ASW

Data processing and ground segment software
- Envisat/GOMOS processing facility
- EOS-Aura/OMI level 2 data processing SW
- Fin-CoPAC GOMOS processing control system
- OMI Very-Fast-Delivery processing control system

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SPECIM is a leading supplier of state-of-the-art hyperspectral imaging instruments for industrial processes and quality control and life science applications, and for airborne remote sensing systems. SPECIM’s personnel have extensive experience in developing spectrometric optics, instruments and applications in UV, VIS and shortwave infrared spectral regions.

SPECIM’s products are based on its unique, transmissive imaging spectrograph technology, which offers superior image quality in rugged, compact industrial construction. The technology provides high throughput that is practically independent of light polarization. This technology is currently available in the 200-2500 nm spectral range, and is also being expanded to thermal infrared.

**SPECIM’s product line consists of**

1. Industrial spectral imaging products include:
   - ImSpector imaging spectrographs
   - Spectral cameras
   - Spectral imaging systems for laboratory and terrestrial applications.

2. AISA Hyperspectral Sensors for airborne remote sensing SPECIM’s industrial spectral imaging products are sold in over 30 countries, and are used in diverse applications such as precise colour inspection, fruit sorting, tablet quality control in pharmaceutical manufacture, moisture profiling in paper machines, biomedical research, and various security applications.

The AISA Airborne Hyperspectral Sensor family includes systems for the VNIR (400–1000 nm) and SWIR (1000–2400 nm) spectral ranges. AISA systems combine high performance, flexible use, and low cost and they are also compact enough to be used in the smallest aircraft. AISA systems are turnkey solutions for hyperspectral data production in research and operational use. The systems are used by remote sensing service companies, and research and defence organizations in precision farming, vegetation mapping, water and coral reef monitoring, forest and geological applications, and target identification. As a result of its innovative and intensive product development, SPECIM has attained market leadership in the production of small, low-cost airborne hyperspectral systems.

*Turnover in 2006: 3 milj. €
Personnel: 20*

**Expertise**

- Spectral imaging instruments
- Airborne hyperspectral sensors
- Imaging spectrographs.

**Contact details**

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Stora Enso Oyj – Wood Supply

EnsoMOSAIC, a digital imaging system developed by Stora Enso, enables collecting of aerial imagery below clouds. The system produces high-resolution, geo-referenced, true or false colour ortho-mosaics. The entire EnsoMOSAIC process is fully digital, from image capturing to the creation of ortho-images and ortho-mosaics. Imaging is controlled by PC software that triggers the camera and labels the images with GPS coordinates. The EnsoMOSAIC image processing software automatically rectifies thousands of images at a time, applying bundle block adjustment, and unites them in a large geo-referenced mosaic. In addition to the image mosaics, the system also creates a digital surface model of the target area. All image processing is performed by a standard PC equipped with a high-capacity hard disk for data storage. The digital data facilitate flexible printing of mosaic maps on any scale and importing of data into a GIS for further processing.

In addition to carrying out imaging missions Stora Enso provides EnsoMOSAIC for global clientele as:

- a complete aerial survey system with hardware, software and training
- advanced, fully automated image processing software for aerial triangulation and ortho-mosaicking.

Stora Enso Wood Supply can also assist in collecting ground truth data by high-resolution aerial surveys and through the corporation’s four-continent forest database.

In forestry-related development and research projects Stora Enso can provide the industrial end-user’s viewpoint.

Space expertise

- Ground truthing
- Airborne digital imaging systems
- Earth observation
- Satellite imagery in forest inventories
- Development of image rectification software.

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Stora Enso Oyj is the largest forest products corporation in Europe, and it has forest holdings and pulp and paper production plants in four continents. The Group's annual net sales total more than USD 10 billion.

Stora Enso’s Wood Supply unit is responsible for the use and development of space and airborne instruments and data for wood supply planning. It has acquired broad expertise in remote sensing from tropical to boreal zones. Satellite data are used in for large-area surveys, and for smaller areas (up to a million hectares) Stora Enso uses its EnsoMOSAIC digital aerial imaging system.

Stora Enso Wood Supply has developed algorithms for continental and national surveys in cooperation with leading research organizations. As result, advanced calibration and classification tools are available for large-area natural resource surveys. The production of wood procurement maps by remote sensing, for example, is a key area of wood supply operations.
Suomen Optomekaniikka Oy

Precision mechanics – from drawing board to serial production

We concentrate on products based on precision mechanical engineering, which often include electronics and optics. Our expertise comprises precision kinematics and environmental tolerances. Our services begin with product development. After designing a product together with the customer, we construct a prototype, make any necessary improvements on the basis of testing, and then offer contract manufacturing to the customer. We also manufacture products designed elsewhere and product components. We use up-to-date CAD technology in design. Our company was established in 1989.

We have references from the following sectors:
- paper-making technology
- medical equipment technology
- space technology
- defence equipment technology
- other test equipment and tools

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Mechanical structure for SPEDE instrument electronics in ESA’s SMART-1 satellite.
Suunto Oy

Founded in 1936 and celebrating its 70th anniversary this year, Suunto is a leading designer and manufacturer of sports instruments for diving, mountaineering, training, hiking, skiing, sailing and golf.

The company is the world’s leading manufacturer of dive computers and outdoor wristop computers. True to its roots, Suunto remains the world’s largest compass manufacturer.

Prized for their design, accuracy and dependability, Suunto sports instruments combine the aesthetics and functionality of watches with sport-specific computers that help athletes at all levels analyze and improve their performance.

The success of the company is based on its high quality products and increasing investments in R&D.

Suunto’s headquarters is located in Vantaa, Finland, where the company manufactures dive computers and instruments, wristop computers, field and marine compasses and precision instruments under its brand name, Suunto. The company employs more than 500 people worldwide and distributes its products to nearly 60 countries.

Suunto is part of the Amer Sports corporation, the world’s leading sports equipment company, that today has five major brand: Wilson, Atomic, Suunto, Precor and Salomon. Amer Sports offers technically advanced equipment and products that improve the performance of active sports participants.

Expertise in LBS

Sports instruments utilizing GPS technology and microsensor systems.

The Suunto X9i is the world’s smallest and lightest wrist-mounted GPS unit and is compatible with several digital mapping services and with the Google Earth™ mapping service.

The Suunto GPS POD tracks speed and distance across a wide variety of outdoor activities including hiking, cycling, cross-country skiing, inline skating and kayaking. It adds a new dimension to all POD- (peripheral observation devices) compatible Suunto heart rate monitors.

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Tumo Oy's machine shop was founded in 1942. Today Tumo Oy specializes in demanding machining and material processing. The machining and processing of aluminium, magnesium and titanium are important business areas for the company.

Tumo Oy also has a well equipped tooling department specialized in precision grinding and sharpening of metal cutting tools and the manufacturing of special tooling. In addition to a wide array of quality manual machine tools Tumo Oy uses modern CNC machine tools; five machining centers (two high speed) and three lathes. Programming is performed with EZ-CAM14® software.

We conduct non-destructive testing (NDT) for various metal alloys. Surface treatment includes chemical conversion coating of aluminium alloys and magnesium, Type I (chromic acid anodizing), Type II (sulfuric acid anodizing) and Type III (hard anodizing).

Salt spray testing is an important part of the Quality Assurance process, and is also marketed as a separate service.

The company follows the ISO 9001, AS 9100, AQAP 2110 Quality Management standards and is a bronze level preferred supplier for The Boeing Company, McDonnell Aircraft and Missile Systems since December 1996.

Company is Nadcap accredited by PRI for Aerospace Quality System, Chemical Processing and Non Destructive Testing.

Turnover in 2005: 2.7 million €
Personnel: 34

Space expertise
- Precision machined parts
- NDT, electrochemical and chemical coatings.

Main space contracts

**ESA**
- Precision-machined parts for the high energy detector and low energy detector of the ERNE instrument onboard ESA’s SOHO spacecraft.

**Patria**
- Rosetta, component for fuel cells, aluminium and titanium.

Rosetta fuel cells connected to platform.

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Tuotantoyhtiö Kupla Productions Oy

Science and technology specialized information services from popular science articles for general public press to promotional video presentations for a specific audience.

Turnover: 95,000 euros
Personnel: 1 full time + 5 regular freelancers

Expertise in spaceflight, astronomy and astronautics (from science popularisation and public relations angle)

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<th>Clients and references</th>
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<tr>
<td><strong>Full-time</strong></td>
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<td>■ Finnish Broadcasting Company (radio, TV and web), from 1991</td>
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<tr>
<td>■ European Space Agency (Finnish Country Desk and PR services), from 2001</td>
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<tr>
<td>■ Tekniikan Maailma (general public technology magazine), from 1987</td>
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<td>■ Tähdet ja Avaruus (general public space magazine), from 1990</td>
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<td>■ Tekes, from 2001</td>
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<td>■ Academy of Finland, from 2002</td>
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<td>■ Astronomical association Ursa, from 1986</td>
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<td>■ Finnish supercomputer centre CSC, from 2000</td>
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Contact details

www.kupla.com
YLINEN Electronics

Microwave and millimetre-wave instruments, subsystems and components

YLINEN Electronics specializes in the design, development, manufacture and testing of microwave and millimetre-wave systems, subsystems and components, at a frequency range of 1GHz to 150GHz. YLINEN provides microwave solutions for terrestrial and space applications, and since 1989, it has developed hardware for space programmes in telecommunication, earth observation and science. With its highly-qualified staff, YLINEN offers comprehensive design, development and manufacturing services that comply with ECSS and other space standards, if required. YLINEN has an extensive range of in-house facilities and processes (e.g., thin-film process, space-qualified electronics assembly, MMIC bonding). This enables the company to respond to unusual and challenging customer demands and provide a rapid prototype service and final manufacturing to commercial, military or space flight specifications.

Turnover in 2006: 1 million
Personnel: 10

- Space expertise
- Management of demanding space projects
- Product Assurance according to ECSS standards
- Mechanical and electrical manufacturing
- Microwave and millimetre wave design, development and test
- Systems design
- MMIC specification, chip development management, packaging and test.

Main space contracts

- Cassini/HUYGENS: 15 GHz Radar Altimeter
- TerraSAR-X: 9.65 GHz Leaf Amplifier Assembly, hybrid filter and power divider
- Planck: ultra low noise receivers at 70GHz (25K Noise temperature over 14GHz)
- SMOS: 1.4 GHz Noise Injection Radiometer (NIR) subsystem and Calibration Subsystem (CAS)
- Odin: 119 GHz radiometer receiver
- Radioastron: 22 GHz radiometer receiver
- Artemis: 23 GHz microwave system for in-orbit test ground station

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The Finnish Environment Institute (SYKE) is the Finnish national centre for environmental research, development and monitoring. SYKE monitors and assesses the state of the environment, pollution loading, land use changes and water resources. Other responsibilities include research on environmental changes and their causes along with possible ways to solve these problems and restore the environment. SYKE employs about 600 people, more than 370 of whom are scientists.

A total of 30 persons work in the Geoinformatics and Land Use Division, of whom 9 are engaged in developing and implementing remote sensing applications and providing related services. The group’s aim is to make environmental monitoring more effective using remote sensing techniques.

Currently the main operational near-real-time applications concentrate on monitoring of snow cover, sea surface temperature and water quality. NOAA AVHRR, EOS MODIS and Envisat MERIS instruments are used. High resolution instruments (mainly Landsat 7 ETM) are utilized for land cover mapping projects (e.g. CORINE 2000).

SAR imagery is used for snow covered area monitoring and oil spill detection in the Baltic Sea.

Active research and development continues in algorithm development and validation. Assimilation of remote sensing data with environmental models is an important aspect of remote sensing research and implementation.

SYKE takes actively part in national and international cooperation, for example in GMES (Global monitoring for environment and security).

**Personnel:** 598

**Space expertise**

Employment of remote sensing techniques for environmental monitoring of:

- snow
- sea surface temperature
- water quality (lakes and the Baltic Sea)
- oil spill monitoring
- land cover.

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**Time series of snow melt during spring 2006 from Terra MODIS satellite imagery** (satellite data by NASA, received by FMI, processed by SYKE)

**Weekly composite of maximal surface water chlorophyll concentration in the Gulf of Finland during week 19/2006 (8th to 14th May, 2006; processed from Envisat MERIS data provided by ESA as GMES MarCoast product in SYKE)**
The Finnish Forest Research Institute (Metla) was established in 1917. Metla is a governmental, sectoral research institute which is subordinate to the Ministry of Agriculture and Forestry. Metla’s duties are defined by the law and statute to promote, through research, the economical, ecological, and socially sustainable management and use of forests.

The National Forest Inventory of Finland (NFI) is one of the official duties of Metla. The NFI has produced large area forest resource information since 1921 with unique datasets and time series for national and regional decision-making. It also produces information on forest health conditions, biodiversity and carbon balance. Since the late 1980s, the NFI has applied the multi-source forest inventory method (MS-NFI), which combines information from field measurements, satellite images and other numerical data sources.

The MS-NFI team is firmly established in the field of forest remote sensing. The MS-NFI method has also been successfully applied outside Finland, and further development work continues in cooperation with institutions in several other countries. Consequently, the MS-NFI can serve as a prototype for a globally applicable forest inventory system using remote sensing techniques.

Current research activities of the MS-NFI team include:

- Planning of inventory design by means of satellite image-based theme maps
- Improving the accuracy of the estimates of multi-source inventory
- Updating of NFI information by means of remote sensing data
- Utilization of laser scanner data in forest inventories
- The dynamics of biodiversity and methods for biodiversity assessment
- Estimation of forest carbon pools and carbon pool changes.

Space-related expertise

- remote sensing methods
- analysis of multi-source data for forestry and environment applications
- forest inventory theory and applications
- producing of forest resource information based on multi-source data
- spatial statistics
- physical imaging models and devices
- remote sensing software.

Turnover 2005: 52,2 million euros
Personnel: about 930
Remote sensing personnel: 15, of which 10 with NFI
Finnish Meteorological Institute FMI

The Finnish Meteorological Institute (FMI) is a governmental research and service institute with a staff of about 500 people. Research constitutes close to 40% of the Institute’s activities, including research on the weather, climate, air quality and space physics. About 50% of the research and development work is covered by external funds and contracts.

About 100 members of the FMI staff are involved in space research and applications. Space research is conducted by the Earth Observation and Space Research Units as well as by the Sodankylä Arctic Research Centre. From January 1, 2006, the FMI has been jointly operating a new collaborative unit called Kumpula Space Centre with the Department of Physical Sciences of the University of Helsinki.

In middle atmosphere research, the FMI specializes in the retrieval to visible wavelengths of ozone and other constituents of the atmosphere from instruments that use UV. These instruments currently include GOMOS on ESA’s Envisat, OSIRIS on the Swedish-Canadian Odin and OMI on NASA’s EOS-Aura. The FMI also organizes stratospheric-measuring campaigns during periods of ozone loss. Other Earth observation projects involve studies of biologically active UV surface irradiation and changes in surface characteristics, especially in polar regions.

**Key operational functions** include the Earth observation data receiving and processing facility in Sodankylä which is working on the development of satellite data processing, archiving and dissemination (EUMETSAT O3M SAF).

The physics of Sun-Earth interactions is central in space research. The institute operates a unique ground-based network (MIRACLE), which carries out research on aurora and other space weather effects, and consists of magnetometers and digital all-sky cameras and covers the area reaching from Estonia to Spitzbergen. The results are best used in combination with measurements from magnetospheric satellites and modelling. The FMI has one of the world’s leading computational models for the behaviour of the magnetosphere. The goal is to develop methods for predicting space weather events; the strongest events are known to be harmful to satellites, power transmission systems, satellite communications and global positioning systems.

The FMI is also active in comparative studies of planetary atmospheres and the influence on them by solar wind and irradiation. The FMI has been particularly active in developing small meteorological stations for Mars exploration, and it is now working on a next generation lander in a joint Finnish-Russian project.

In all fields of space research and applications the FMI carries out strong cooperation with industry from small entrepreneurs to the main Finnish actors in space research.

**Relevant expertise**
- the physics of space weather
- comparative meteorology of solar system bodies
- small meteorological stations
- stratospheric-measuring campaigns
- biologically active UV surface irradiation
- changes in surface characteristics.

**Space contracts**
- EUMETSAT Ozone and Atmospheric Chemistry Monitoring SAF (coordination)
- EUMETSAT Climate monitoring SAF
- Envisat Finnish GOMOS Processing Centre ESA Operations (FIN-CoPAC).

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FMI hosts a satellite data receiving and processing centre at its Arctic Research Centre in Sodankylä (67.368 °N in Finnish Lapland).
Sodankylä Geophysical Observatory

Sodankylä Geophysical Observatory, located more than 100 km north of the Arctic Circle, was founded in 1913 primarily for conducting continuous measurements of the Earth’s magnetic field. This remains an important function today – a Finnish contribution to the worldwide network of geomagnetic observatories. Magnetic field measuring was later complemented by measuring of the ionosphere, auroras, cosmic rays and seismicity. One of the EISCAT radar stations is located at Sodankylä, several substantial records of geophysical quantities are available for research and applications.

The facility excels in observatory measurements and data processing, radar experiment design and applications, as well as tomography methods. A new ionospheric sounder designed and constructed in SGO was taken in use in November 2005.

The observatory became a part of the University of Oulu in 1997, as a national research institute. It employs 26 permanent and close to 20 temporary staff. The observatory’s basic yearly budget is approximately EUR 2 million. In addition, external funding for projects is EUR 0.5 million per year.

Space expertise
- Observatory activity, continuous measurement of space phenomena
- Ionospheric and auroral research
- Cosmic rays
- Radar experiment design
- Inversion methods
- EISCAT radar site
- VLF-measurements.

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The Aurora Borealis as seen in Northern Finland.
The group of companies that makes up the Turku Science Park is responsible for its management and development. This is done in close cooperation with the universities, polytechnics, companies and public actors. The main focus areas are biotechnology and information technology, and other important areas are space technology and materials research.

The parent company, Turku Science Park Ltd, is responsible for the strategic management of the Turku Science Park area and for activities including marketing and business development services. Its subsidiaries ICT Turku Ltd and Turku Bio Valley Ltd are responsible for developing the bio and ICT industries in southwest Finland.

The business development services provided by Turku Science Park speed up the launch of new technology businesses and considerably increase their potential to succeed. The Science Park offers high-tech companies as well as research and educational units with an interactive, innovative and attractive operational environment and it also functions as a flagship for trade and industry in the whole of southwest Finland.

Turku Science Park Ltd. has a balance sheet of 42.9 million euros and turnover of 11.2 million euros. The main owner of the company is the City of Turku, and the number of employees is 55.

Institutes and Research Centres

Turku Science Park Ltd is a connecting link between industry and university research.

Space expertise

- Space Technology Transfer Finland project (STTF) since 2001. STTF project operates as part of IRC Finland and it is a link between ESA Technology Transfer activities and Innovation Relay Centre (IRC) network. The contractor for STTF project is Turku Science Park Ltd.
- Updated Space Directory of Finland and Mobile Location Directory of Finland in 2006.

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VTT Technical Research Centre of Finland provides high-end technology solutions and innovation services. From its wide knowledge base, VTT can combine different technologies, create new innovations and a substantial range of world class technologies and applied research services thus improving its clients’ competitiveness and competence. Through its international scientific and technology network, VTT can produce information, upgrade technology knowledge, create business intelligence and value added to its stakeholders.

In space related science and technology VTT conducts comprehensive research and development work. VTT develops instruments for Earth observation platforms as well as for space science missions, and carries out studies using Earth observation data.

Turnover & personnel
Total turnover in 2005 was 225 million EURO and a number of personnel 2700. The turnover of the space related activities in 2005 was 3.5 million EURO and a number of personnel 30.

Space related expertise
- Space electronics and optomechanics
- Sensor technology (optical, MEMS)
- X-ray and THz radiation detectors
- Device modelling and characterisation at millimetre wave frequencies
- Telecommunication systems and networks
- Antennas and electromagnetics
- Digital transmitter and receiver technologies
- Mechanical and climatic testing
- Remote sensing of forestry, environment and security.

Space related contracts
Space instrumentation technologies
- Imaging Spectral Signature Instrument for VIS and NIR
- Detector and readout development for the X-ray mission XEUS of ESA
- High resolution aerial sensor system GeoPIE
- Calibration of Global Ozone Monitoring spectrometer onboard Envisat satellite of ESA
- Miniaturized infrared spectrometer to measure ethene concentration on the International Space Station.

Millimetre wave technologies, MilliLab
- 70 GHz receivers for the Planck Mission.
- Comparative on-wafer measurements of European Schottky diodes.
- 94 GHz Low Noise Amplifiers for Cloud Profiling Radar.
- Submillimetre wave antenna testing using a hologram CATR (Compact Antenna Test Range).
- Millimetre and submillimetre wave open structure integrated receiver front-end technology development.
- Submillimetre integrated SIS (Solid-state Imaging Spectrometer) imaging receiver technologies (SISIRT).
- 119 GHz receiver for the Swedish Odin-satellite.

Telecommunications
- ESA project for the assessment of the satellite-DAB (Digital Audio Broadcasting) signal availability within buildings.
- Generic Si waveguide platform developed for optical telecommunication and sensing.

Remote sensing
- GMES Service Element: GSE Forest Monitoring funded by ESA.
- Prediction of natural disasters, such as landslides using SAR interferometry (co-operative work with a Japanese research institute).
- Environmental monitoring system ENVIMON.
- SAR image mosaic of Europe and Northern Asia.
- Route planning tool for icebreakers.

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At left a color composite of three ERS SAR based features from French Guiana in 1992/1993. At right the same area in 2004 as an Envisat ASAR composite. The images are processed by VTT in the GMES Service Element Project Forest Monitoring. The purpose of the project is to help implementation of the Kyoto Protocol of the UNFCCC.

Forest cover and change map 1992–2004 using ERS and ASAR SAR data from French Guiana. Changes are indicated as light blue, red and bright green. Yellow and green indicate areas without change. The image is processed by VTT in GMES Forestry Project for monitoring of the Kyoto Climate Convention Protocol.

User display of the season monitoring system that was developed in VTT project Envimon. The system uses optical satellite data from the Modis instrument and ground data (from the Finnish Forest Research Institute).

The front-end and back-end modules of the 70 GHz mm-wave receiver of the radiometer for the ESA’s Planck Surveyor mission 2007. VTT has led the development work of the extremely sensitive receiver.

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VTT holds versatile mechanical and climatic testing equipment to perform tests for environmental and mechanical endurance.

Product testing in simulated environmental conditions

General Description

The influences of environmental conditions must be known for the entire life cycle of a product. Environmental conditions affect a product during its manufacture, transportation, storage and service. Temperature and humidity are the most important climatic parameters; air pressure, rain, solar radiation and air pollutants are other significant parameters. Mechanical tests, on the other hand, are needed to verify the capability of a device or product to withstand its dynamic environment.

Our testing facilities offer a wide range of repeatable conditions and a quick and affordable way of determining protection against environmental harm and product quality.

Mechanical Testing

The influences of dynamic conditions in the use and during transportation are verified in the product’s development phase. Mechanical tests are a useful way of verifying the capability of a product to withstand its dynamic environment.

Testing Services

- Vibration and shock tests according to EN, IEC and MIL standards
- Temperature and change of temperature tests
- Damp heat tests
- Dust and water tests
- Corrosion tests and analysis
- Low pressure tests
- Test program planning.

Climatic Testing

The influences of climatic conditions must be known for the entire life cycle of a product.

Testing Services

- Climatic tests according to EN, IEC and MIL standards
- Temperature and change of temperature tests
- Damp heat tests
- Dust and water tests
- Corrosion tests and analysis
- Low pressure tests
- Test program planning.

Additional Information

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The Millimetre Wave Laboratory of Finland, MilliLab, is a joint laboratory shared by the VTT Technical Research Center of Finland and Helsinki University of Technology. MilliLab is also a European Space Agency External Laboratory for Millimetre Wave Technology (Centre of competence). MilliLab provides measurement, design and modelling services in the millimetre and submillimetre wave range of 30 to 1000 GHz. These include on-wafer characterization of circuits or components, and antenna measurements. One of MilliLab’s unique capabilities is on-wafer measurement of transistor noise parameters in the 50 to 100 GHz range. The measurement facility plays a crucial role in the design of devices such as monolithic microwave integrated circuits (MMIC) for low-noise applications. On-wafer scattering parameter measurements up to 110 GHz can also be carried out in cryogenic temperatures as low as 20 K. Antenna testing is done using outdoor test range, anechoic chamber, compact test range and near-field scanning up to 500 GHz.

**Space expertise**
- On-wafer component and circuit testing up to 220 GHz
- Cryogenic on-wafer testing
- Component modelling
- MMIC design
- Antenna testing
- RF MEMS design, manufacture and testing
- Imaging millimetre-wave and THz sensors and systems

**Space contracts**
- 70 GHz receiver development for ESA Planck Low Frequency Instrument
- 94 GHz MMIC development for ESA Cloud Profiling Radar
- 119 GHz receiver for Sweden’s Odin satellite
- Odin satellite 1.1 m antenna tests at 119 GHz using a hologram compact test range
- MEMS impedance tuners for on-wafer measurements

**MilliLab**

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The Helsinki University of Technology, TKK (formerly HUT), is the largest and oldest technical university in Finland, with approximately 12,000 undergraduate and 2,500 postgraduate students and a staff of close to 3,300. The university teaches science and engineering only, while the University of Helsinki caters to Arts and Social Sciences.

TKK is comprised at several faculties, which are in turn divided into laboratories. Space research and expertise is to be found in four of these laboratories: the Laboratory of Space Technology, the Laboratory of Lightweight Structures, the Radio Laboratory and the Institute of Photogrammetry and Remote Sensing.

**Institute of Photogrammetry and Remote Sensing**

Photogrammetry and remote sensing are technologies of measurement, observation and control within the science of surveying and mapping. Basically all activity is based on images used for both acquiring and managing geoinformation. The applications include environmental monitoring with satellite imagery, large-scale urban mapping with aerial imagery, 3D virtual modelling of buildings, industrial plants, building quality and traffic modelling. The number of researchers on the pay-roll is around 20.

Research topics include image analysis and pattern recognition, photogrammetric mapping, digital photogrammetry, interpretation and classification methods, automated measuring procedures, and system development for photogrammetric online control and 3D digitizing. The institute has a strong national reputation as a research unit. It is also internationally recognized for work in application of laser scanning of rural and urban environment, three-dimensional digitizing using video imagery, the use of projective transformations for analytical photogrammetry, networking of parallel processes for geometrical image analysis, and the use of neural networks in the classification of image information.

External funding for basic research comes mainly from the Academy of Finland and private foundations, while applied research is funded by the European Commission, Tekes and the Ministry of Agriculture and Forestry. A growing amount of application-oriented research has recently been funded by industry as part of postgraduation.

Examples of basic research and application development projects:
- Digital image processing in remote sensing
- Forest inventory and change detection measurement techniques based on digital imagery and laser scanning
- Quality and applications of laser scanning for civil engineering
- ICT Applications in building quality
- FJHP99 Finnish Jabal Haroun Project – Historical virtual reality and 3D archaeological documentation
- Transportation data acquisition by means of ICT-derived 3D modeling
- 3D georeferences for imagery
- Photogrammetric applications of spherical imaging
- Geodetic applications of SAR interferometry
- Map updating with remote sensing data
- Historical reproduction of ancient maps.

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Laboratory of Lightweight Structures, KRT

Helsinki University of Technology, Laboratory of Lightweight Structures

TKK’s Laboratory of Lightweight Structures (KRT) belongs to the professorship of aeronautical engineering. Fibre reinforced polymer composites and their use in lightweight structures have been studied in the laboratory since 1969. The main areas of interest are:

- design and analysis of composite structures including software development
- manufacturing techniques of composites
- structural repair with composites
- mechanical testing of composites.

The laboratory has well established knowledge on the mechanical behaviour and manufacturing technologies of composite materials. The knowledge achieved in basic research has been utilised in several product development projects. Recent non-space projects include:

- modelling of composite laminate fatigue, 2003–
- adaptive composite structures, 2003–
- aircraft structural fatigue, several projects, 1993–
- repair of military aircraft structures, several projects, 1989–
- VARI (Vacuum Assisted Resin Infusion) Technology transfer to Finnish SME’s, 2000–2002
- development of VARI manufacturing method, several projects, 1993–2000

Satellite CFRP electronics housing with good thermal conductivity and particle radiation protection.

Expertise relevant to space

- Design and analysis of composite structures
- Manufacture of composite structures
- Mechanical testing of materials and structural elements.

Space contracts

ESA
- Radiation Protection for Advanced Equipment Design – together with Helsinki Institute of Physics (HIP)
- Study on Carbon Fibre Tube Inserts – together with DLR and Patria Finavicomp
- Advanced Equipment Design – Lightweight Housings for Equipment Units – a multinational miniproject
- Rosetta – testing of structural elements of the spacecraft bus for Patria Finavicomp
- XMM – design of the telescope tube for Patria Finavicomp

- ESAComp – software for the analysis and design of composite material systems.

Expertise

- Design and Analysis of Polymer Composite Structures
- Manufacture and Mechanical Testing of Composite Structures.

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Laboratory of Space Technology

The main research area of HUT’s Laboratory of Space Technology is spaceborne and airborne microwave remote sensing, including instrumentation, experimental research and the development of geophysical inversion algorithms. The laboratory is also responsible for teaching all topics of space technology to students at the university. The total number of personnel is about 30.

Space expertise
- Microwave radiometers, imaging microwave radiometry
- Scatterometers
- Passive and active microwave polarimetry and interferometry
- Inversion algorithms
- Development of new spaceborne remote sensing technology and applications.

International projects
- ESA SMOS – Development of calibration system CAS and noise injection radiometer NIR for the SMOS interferometric radiometer
- ESA SEPS – SMOS End-to-end Performance Simulator & Level 1 Processor Prototype analysis and evaluation support
- EUMETSAT – H-SAF (Satellite Applications facility on Support to Operational Hydrology & Water Management)
- ESA – PolarView
- EU NorSEN – Nordkalotten Satellite Evaluation co-operation Network
- ESA Marcoast – Marine and Coastal Services
- FIN-CAN POL-ICE – Multi-polarization SAR for operational sea ice monitoring
- FIN-CAN CryoSat – Verification of the sea ice thickness distribution determined from CryoSat data
- ESA Ku-band SAR – Ku-band SAR measurements for snow applications: modelling and sensitivity
- EU EnviSnow – Remote sensing of snow using SAR and optical data
- EU FloodMan – Development of remote sensing methods for detection and monitoring of floods
- ESA Announcement of Opportunity projects.

National projects
- Development of airborne HUT-2D interferometric radiometer
- LIME – L-Band Interference Measurements in Urban and Suburban Environment
- NewSAR – Utilization techniques for polarimetric-generation satellites
- BALTIC – Development of methods to apply Earth Observation data in the monitoring of water quality in the Baltic Sea and lakes
- Envisat – Development of methods for retrieval of boreal forest and surface characteristics from Envisat multisensor data
- Oili – Development of remote sensing methods for oil spill detection and monitoring

Field campaigns
- Airborne campaigns in cooperation with foreign institutes
- Radiometry, scatterometry and optical spectrometry
- Ground-based ozone monitoring radiometry.

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Radio Laboratory

The TKK Radio Laboratory is active in research and education in the fields of RF, microwave and millimetre wave techniques and their applications. The research areas include millimetre wave receiver and antenna techniques for communications and space technology, RF and microwave frequency antennas and propagation modelling for mobile communications, modelling and measurement technologies as well as novel materials (including metamaterials) in radio engineering, and design of radio equipment and systems for various radio applications.

The Radio Laboratory participates in the research conducted at the Millimetre Wave Laboratory of Finland (MilliLab). The Radio Laboratory takes part also in ACE (Antenna Centre of Excellence) which is EU’s Network of Excellence.

The Smart and Novel Radios Research Unit SMARAD, formed by groups from the Radio Laboratory and the Signal Processing Laboratory, is serving as a national centre of excellence in research for 2002–2007. Its successor, the Centre of Excellence in Smart Radios and Wireless Research (including now besides the Radio Laboratory also one research group in Signal Processing and one group in Electronic Circuit Design) has been nominated as a CoE for years 2008–2013.

The Radio Laboratory has 3 professors and the total number of personnel is over 50. Annually, about 5 doctoral degrees and some 15 diploma (M.Sc.) degrees are awarded, and over 100 papers are published in refereed international journals and conferences.

Space expertise

- Anechoic chamber test facility
- Hologram-based compact antenna test range for mm wavelengths
- Near-field scanning facility
- Microwave and millimetre wave components, systems, and measurement techniques
- RF technology and EMC.

Main space contracts

- ADMIRALS RTO testing at 322 GHz using a hologram CATR
- Antenna testing at 650 GHz using a hologram CATR
- mm and sub-mm wave open structure integrated receiver front-end technology development
- 119 GHz receiver for the Swedish Odin satellite
- Odin satellite 1.1 m antenna tests at 119 GHz using a hologram compact test range
- 22 GHz receiver for the Russian Radioastron VLBI satellite
- Participation in MilliLab’s contracts (see: MilliLab – Millimetre Wave Laboratory of Finland).

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Hologram-based CATR at 322 GHz for ADMIRALS RTO tests.
Metsähovi Radio Observatory

The Metsähovi Radio Observatory is a research institute that is separate from Helsinki University of Technology. It operates a 14-metre radio telescope in Metsähovi, 35 km west of the main campus. The observatory has been in operation since 1974. Metsähovi staff consists of approximately fifteen people.

Research activity focuses on microwaves and millimetre waves at 2–150 GHz. The Metsähovi group is active in the following research fields: radio astronomical research and space research, development of instruments and methods for radio astronomy, and (radio) astronomical education.

Metsähovi carries out radio astronomical observations of active galactic nuclei and solar millimetre wave radiation. The observatory also actively participates in very long baseline interferometry in European and worldwide networks.

Space co-operation

- Planck Surveyor: Coordination of the Finnish science participation in the Planck project; consortium member of the Low Frequency Instrument; active contribution to the foreground science.
- AMS-02, development of high data rate electronics.
- Scientific co-operation includes the use of several astronomical satellites (e.g., XMM, RXTE, INTEGRAL).

Metsähovi radio telescopes. In background is the 20 m radome and inside of it is the 14 m telescope. In foreground is e.g. a 1.8 m solar survey telescope which is used for solar flare monitoring and space weather prediction.
The accelerator laboratory at JYFL (Department of Physics at the University of Jyväskylä) is a national facility with an extensive international programme in education and research. The laboratory operates under the Infrastructure Initiative for Nuclear Structure Physics (EURONS) of the 6th EU framework, is one of ESA’s external European Component Irradiation Facilities (ECIF) and owns the status of Finnish Centre of Excellence (CoE) in Nuclear and Accelerator Based Physics program of the Academy of Finland.

The accelerator system consists of a cyclotron type particle accelerator equipped with two external electron-cyclotron-resonance (ECR) ion sources and a multicusp light-ion source. This combination can deliver a large variety of heavy- and light-ion beams up to the energy of 1.2 GeV for xenon. In conjunction with the ECR, the cyclotron can run “ion cocktails”, which are mixtures of ions with near-identical charge-to-mass ratios. Swapping between the ion species happens very quickly, which is especially useful in the single event effect (SEE) testing of space electronics. The so-called high penetration cocktail has an energy of 9.3 A MeV and the penetration depths in silicon can range from 100 up to 200 µm. The ion selection provides linear energy transfer (LET) values in silicon up to 60 MeV/(mg/cm²) in normal incidence.

A dedicated radiation effects facility (RADEF) has been installed in the laboratory. ESA has assessed that the station is also able to fulfil the requirements for the SEE tests (ESA/SCC Basic Specification No. 25100). The vacuum chamber and heavy ion beam line include the equipment needed for proper beam dosimetry. The component boards can be attached to a standard 250mm 250mm plate of the linear tilt movement apparatus. The user interface is based on a LabVIEW application. From that the user can follow all the test parameters on-line during the irradiation. Proton irradiations are performed in the air and the component board can be fixed in the similar standard plate as in the heavy ion tests. The maximum proton energy is 60 MeV. A set of degraders ensures that the change of energy is a fast procedure. The maximum proton flux is about 3 108 protons/cm². Photomultiplier tubes are used for the calibration before the test and proton intensity is monitored with an ionization chamber during the irradiation.

**Personnel:** 160
**Annual funding:** 10.1 M

**Space expertise**
- Simulation of space radiation effects.
- Radiation testing of electronic components and semiconductor detectors.

**Space cooperation**
- Alenia ALCATEL Space Ltd., Toulouse, France
- Centre National d’Etudes Spatiales, CNES, Toulouse, France
- EADS Astrium Space Ltd., France
- EADS Space Transportation GmbH, Bremen, Germany
- European Space Agency, ESA/ESTEC, Noordwijk, The Netherlands
- HIРЕX Engineering Ltd., Toulouse, France
- Institut für Datentechnik und Kommunikationsnetze – IDA, Braunschweig, Germany
- Instituto Nacional de Tecnica Aeroespacial – INTA, Madrid, Spain
- Patria New Technologies Ltd, Tampere, Finland
- Saab-Ericsson Space Ab, Sweden
- Swedish Space Corporation AB, Sweden
- Technical University of Braunschweig, Germany
- The French Aeronautics and Space Research Center, ONERA, Toulouse, France
- Ørsted DTU, Technical University of Denmark

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The University of Helsinki is the oldest and largest university in Finland. It was founded in 1640 in Turku, the former capital of Finland. In 1827 the university moved to Helsinki where it remained the only university in Finland until 1919.

The University of Helsinki Observatory is the largest department of astronomy in Finland's universities. It plays a leading role in space activity at the university, including astronomical research, education, and space science projects. Department staff totals approximately 40 persons. Total budget for 2005, including project funding, was 1.6 million euros.

The observatory's research includes:

- high energy astrophysics, especially in connection with with X-ray and gamma-ray observations of binary stars, AGN and clusters of galaxies
- interstellar medium and star formation in connection with radio, submillimetre and infrared observations
- solar system research related to photometry of solar system bodies, studies of light scattering by small particles, X-ray fluorescence and scattering by planetary regoliths, celestial mechanics of the few-body problem, and inverse problems of near-Earth-object and transneptunian-object polarimetry, photometry, and astrometry.
- stellar surface imaging using photometric and spectroscopic observations.

In connection with the beginning of Finland's membership in the European Southern Observatory (ESO) in 2004, an extensive data analysis SW development project for ESO was started in Finland where the University of Helsinki Observatory plays a major role, with four full time SW specialists at the Observatory until the end of 2007. The project is coordinated in Finland by CSC-Scientific Computing. The project will develop new SW expertise at the Observatory, which will help improve the already active use of ESO observatories and future scientific collaboration within ESO, and also gives possibilities for new technology development activities with ESO.

Ground-based observations are obtained from domestic telescopes and from facilities abroad, including the La Palma Observatory in the Canary Islands (Nordic Optical Telescope) and the European Southern Observatory in Chile. The Observatory is a key member in the largest observing program ever running at ESO entitled “Trans-Neptunian objects: characterization of their surface properties”, and also works with the European Southern Observatory in Chile. The Observatory is also participating in the Active Archival Phase of the ISO satellite project.
Research groups at the Observatory are actively participating in science planning and hardware development for a number of international space projects in collaboration with foreign institutes, international space organizations, and the Finnish space industry. Among the near future missions, several researchers at the Observatory are participating in preparatory studies and the coordination of science projects for the Planck Surveyor mission. The most significant future project is ESA’s cornerstone BepiColombo (BC), where the Observatory has leading role in two instruments, PI for SIXS and Co-PI for MIXS. The instrument development project for BC will continue until 2013, and science activity beyond 2020.

Altogether, more than 20 persons at the Observatory are involved in work related to space science instruments, and long term average funding related to development of space science instruments has been over 1 million euros per year.

**Space projects**

**ESA**
- PI for SIXS/BepiColombo
- Co-PI for MIXS/BepiColombo
- Co-I for ISOPHOT/ISO
- Associate in Planck Surveyor Mission
- PI for XSM/SMART-1
- Co-I for D-CIXS and AMIE/SMART-1
- Management of Gaia Dynamical Modeling of Solar system Work Package
- Co-I for JEM-X/INTEGRAL
- Co-I of ICAPS/ISS
- Co-I for Lobster
- Co-I for HRSC/Mars Express
- Power PC processor development for XEUS instruments

**Other international**
- Co-I for Odin
- Co-PI of CIXS for ISRO’s Chandrayaan-1
- Data analysis SW development for ESO (Sampo)
- Part of EU-funded Gaia/ELSA network of 14 nodes across Europe
- Co-I of NESS/NEOSSat (Canadian Space Agency)
Space activities at the University of Turku are located at the Space Research Laboratory (SRL) and Tuorla Observatory, which together form a common research organization, the Väisälä Institute for Space Physics and Astronomy (VISPA). With a staff of 50, VISPA is a major space research unit in Finland. The research covers cosmology and dark matter, active galactic nuclei, solar and stellar physics, the few-body problem, Earth’s radiation environment and space weather, and instrumentation in these fields. VISPA operates in close collaboration with two private companies: Aboa Space Research Oy and Opteon Oy.

Since 1986 SRL has been the principal investigator for the Energetic and Relativistic Nuclei and Electron (ERNE) experiment on board the ESA/NASA SOHO spacecraft, launched in 1995. The successful SOHO mission is expected to be continued at least until the end of 2009.

SRL has the lead-coinvestigator status in the multinational Alpha Magnetic Spectrometer (AMS) project, targeted at finding antimatter and dark matter in space. AMS will be mounted on the International Space Station. The laboratory is responsible for the on-ground communication front-end and is contributing to the particle detector and superconducting magnet systems of the instrument. An expected major future challenge is participation in ESA’s Solar Orbiter mission.

Tuorla Observatory participates in the science programmes of several space missions. The most important of these are the INTEGRAL and AGILE gamma-ray satellites (launch 2002 and 2003), the space VLBI satellites HALCA and planned follow-ups VSOP-2 and ARISE, the cosmic microwave background mission Planck (2007), and the astrometry mission Gaia (2012). The optical filter systems for the Gaia mission are being defined at Tuorla.

Tuorla Observatory’s long-standing tradition of precision optical manufacturing is continued at Opteon Oy. Opteon specializes in the manufacture of various optical components, including new technology products such as thin, ultralight silicon carbide mirrors. Opteon has polished the 3.5m SiC mirror for the Herschel infrared satellite (launch 2007).

**Space expertise**

- space electronics
- on-board software
- radiation detectors
- precision optics for space applications
- ground support systems
- data analysis and data analysis software
- plasma and particle simulations and modelling
- instrument calibrations
- spacecraft and science instrument integration
- space instrument operation.

**Main space projects**

- ESA: SOHO, INTEGRAL, Planck, Herschel, Gaia
- Bilateral: AGILE, HALCA, VSOP-2
- Multinational: AMS, ARISE.

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The Finnish Space Committee (established in 1985) is the coordinating body for Finnish space activities. The Committee makes propositions and proposals and gives statements on matters related to space research and education and industrial development, exploitation of knowledge deriving from space activities and cooperation of Finnish partners involved in these activities.

The Committee is nominated on MTI’s proposal by the Government for a period of three years. It is chaired by MTI and has members from relevant ministries and main actors. Currently, the following instances are represented in the Committee: the Ministries of Trade and Industry, Foreign Affairs, Education, Transport and Communications, Environment, and Defence as well as industry, applied research and other government sector users of space activities. The Committee meets on average six times per year.

Finnish Space Committee
1.4.2004–31.3.2007

Chairman
Mr Antti Joensuu,
Ministry of Trade and Industry

Vice chairman
Ms Mirja Arajärvi,
Ministry of Education

Members
Mr Jaakko Halttunen,
Ministry for Foreign Affairs
Prof. Jarkko Koskinen,
Finnish Meteorological Institute
Dr Susan Linko,
Academy of Finland
Mr Kimmo Myllyoja,
Patria Systems Ltd
Prof. Petteri Taalas,
Finnish Meteorological Institute
Dr Kari Tilli, Tekes

Advisors
Mr Jukka Juusti,
The Finnish Defence Forces
Prof. Hannu Koskinen,
University of Helsinki
Prof. Tuomas Häme,
VTT Technical Research Centre of Finland
Prof. Risto Kuittinen,
Finnish Geodetic Institute
Mr Janne Lahtinen,
SF-Design Oy
Mrs Irja Vesalan-Nikitin,
Ministry of Transport and Communications
Mr Esa Panula-Ontto,
Tekes
Mr Yrjö Sucksdorff,
Finnish Environment Institute
Mr Juha Vuorimies,
Ministry of the Environment

Secretaries
Mr Pauli Stigell,
Tekes
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Academy of Finland

The Academy of Finland is an expert organisation for research funding within the administrative sector of the Ministry of Education. The Academy has a board and four research councils, as well as an Administrative Office. The research councils are the Research Council for Biosciences and Environment, the Research Council for Culture and Society, the Research Council for Natural Sciences and Engineering, and the Research Council for Health.

The Academy’s function is to improve the quality and prestige of Finnish basic research through selective, long-term funding based on competition, systematic evaluation, and relevant science policy. The Academy’s development initiatives focus on developing professional researcher careers and promoting creative research environments. The various forms of support for research, such as research posts, research projects, and research grants, provide opportunities for versatile funding of research in different disciplines.

The research funding of the Academy of Finland amounted to EUR 175.6 million in 2005, of which about EUR 3.5 million was spent on space research. Examples of international cooperation funded by the Academy include scientific research at EU, CERN, UNESCO, and Finnish scientists participating in ESA science programmes. The Academy also funds the membership fee to European Incoherent Scatter Radar Facility (EISCAT), Nordic Optical Telescope (NOT), the European Southern Observatory (ESO), the European Science Foundation (ESF), the European Synchrotron Radiation Facility (ESRF), and the European Molecular Biology Laboratory (EMBL).

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The four Cluster satellites measuring the energy flow from solar wind to Earth’s magnetosphere. Finnish groups participate in analysis of particles and fields data and provide a large-scale context to point measurements through ground-based instrument networks.
Tekes, the Finnish Funding Agency for Technology and Innovation

Tekes, the Finnish Funding Agency for Technology and Innovation (established in 1983) is the main financing organisation for applied and industrial R&D in Finland. The funds for financing are awarded from state budget. Tekes offers channels for cooperation with Finnish companies, universities and research institutes.

Tekes primary objective is to promote the competitiveness of Finnish industry and the service sector by technological means. Activities aim to diversify production structures, increase production and exports, and create a foundation for employment and societal well-being.

Tekes coordinates and offers financial support for participation in international technology initiatives, including EU research programmes, EUREKA, research activities of OECD’s energy organisation IEA (International Energy Agency), European Cooperation in Scientific and Technical research (COST), European Space Agency (ESA) and Nordic cooperation. Tekes has a network of experienced technology experts that serves both Finnish and overseas companies and research organisations, particularly in catalysing R&D cooperation within Tekes technology programmes.

Tekes overseas offices are located in Beijing, Brussels, San Jose California, Shanghai, Tokyo and Washington.

Technology programmes aim at gaining new technology expertise and product development options in the important business areas of the future. Technology programmes are used to promote development in specific sectors of technology or industry, and to pass on results of the research work to business in an efficient way.

Programmes have proved to be an effective form of cooperation and networking for companies and the research sector. The programmes also offer good frameworks for international R&D cooperation. During 2006, 19 national technology programmes were under way. In 2005 Tekes total financing of national and international R&D programmes was 430 million euros. From this figure, 19 million euros was provided for space activities (ESA, national and bilateral).

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<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ADM</td>
<td>Aeolus Satellite Atmospheric Dynamics Mission</td>
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<td>AGILE</td>
<td>Gamma-ray mission (ASI)</td>
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<td>AGN</td>
<td>Active Galactic Nuclei</td>
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<tr>
<td>AMS</td>
<td>Alpha Magnetic Spectrometer</td>
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<tr>
<td>ANTARES</td>
<td>Academy of Finland and National Technology Agency space RESEARCH programme (2001-2004)</td>
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<td>AO</td>
<td>Announcement of Opportunity</td>
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<tr>
<td>ARISE</td>
<td>Advanced Radio Inferometry between Space and Earth (NASA)</td>
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<td>ASI</td>
<td>Italian Space Agency</td>
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<td>ASIC</td>
<td>Application Specific Integrated Circuit</td>
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<td>ASTP</td>
<td>Advanced Systems &amp; Technology Programme</td>
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<tr>
<td>AVHRR</td>
<td>Advanced Very High Resolution Radiometer (on Landsat)</td>
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<td>AVALI</td>
<td>Space technology business programme 2002-2005 (Tekes)</td>
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<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
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<tr>
<td>CAE</td>
<td>Computer Aided Engineering</td>
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<td>CATR</td>
<td>Compact Antenna Test Range</td>
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<td>CCD</td>
<td>Charged Coupled Device</td>
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<tr>
<td>CERN</td>
<td>Centre Européenne de Recherche Nucleaire</td>
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<tr>
<td>CEU</td>
<td>Central Electronics Unit</td>
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<tr>
<td>Cluster</td>
<td>ESA scientific mission (4 satellites)</td>
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<td>CNC</td>
<td>Computer Numerical Control of metalworking machines</td>
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<tr>
<td>CNES</td>
<td>Centre National d’Etudes Spatiales</td>
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<td>Co-I</td>
<td>Co-Investigator</td>
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<td>CORINE</td>
<td>Coordination of Information on the Environment (EU)</td>
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<td>COSPAR</td>
<td>Committee on Space Research</td>
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<td>COSPAS</td>
<td>Name for Soviet Cosmos satellites for Search &amp; Rescue</td>
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<tr>
<td>CryoSat</td>
<td>ESA’s Earth Explorer Opportunity Mission</td>
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<tr>
<td>DBS</td>
<td>Direct Broadcast Satellite</td>
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<td>DEBIE</td>
<td>DEBris In orbit Evaluator</td>
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<td>DEM</td>
<td>Digital Elevation Model</td>
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<td>DTM</td>
<td>Digital Terrain Modelling</td>
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<tr>
<td>EADS</td>
<td>European Aeronautic, Defence and Space Company</td>
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<tr>
<td>EARSeL</td>
<td>European Association of Remote Sensing Laboratories</td>
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<td>e.g.</td>
<td>For Example (Latin)</td>
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<tr>
<td>EBU</td>
<td>European Broadcasting Union</td>
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<tr>
<td>ECSS</td>
<td>European Cooperation for Space Standardization</td>
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<tr>
<td>EDGE</td>
<td>Enhanced Data rates for Global Evolution</td>
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<tr>
<td>EFW</td>
<td>Electric Fields &amp; Waves Instrument (on Cluster)</td>
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<tr>
<td>EGSE</td>
<td>Electrical Ground Support Equipment</td>
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<tr>
<td>EISCAT</td>
<td>European Incoherent Scatter Radar Facility</td>
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<td>EMAC</td>
<td>European Multi-sensor Airborne Campaign</td>
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<td>EMC</td>
<td>Electromagnetic Compatibility</td>
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<tr>
<td>Envisat</td>
<td>Environmental satellite (ESA)</td>
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<td>EOS</td>
<td>Earth Observation System (NASA)</td>
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<tr>
<td>ERNE</td>
<td>Energetic Relativistic Nuclei Experiment (onboard SOHO)</td>
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<tr>
<td>ERS</td>
<td>Earth Resources Satellite (ESA)</td>
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<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>ESO</td>
<td>European Southern Observatory</td>
</tr>
<tr>
<td>ESOC</td>
<td>European Space Operations Centre (Darmstadt, D)</td>
</tr>
<tr>
<td>ESTEC</td>
<td>European Space Research &amp; Technology Centre (Noordwijk, NL)</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EUMETSAT</td>
<td>European Meteorological Satellite Organisation</td>
</tr>
<tr>
<td>EUR</td>
<td>euro</td>
</tr>
<tr>
<td>EUREKA</td>
<td>European Research Coordination Agency</td>
</tr>
<tr>
<td>EUTELSAT</td>
<td>European Telecommunications Satellite Organisation</td>
</tr>
<tr>
<td>Freja</td>
<td>Magnetospheric research satellite (Sweden)</td>
</tr>
<tr>
<td>Galileo</td>
<td>European satellite navigation system</td>
</tr>
<tr>
<td>GEO Programme Group on Earth Observations</td>
<td></td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
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</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>GMES</td>
<td>Global monitoring for environment and security</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
</tr>
<tr>
<td>GOCE</td>
<td>Gravity Field and Steady-State Ocean Circulation Mission (ESA)</td>
</tr>
<tr>
<td>GOMOS</td>
<td>Global Ozone Monitoring by Occultation of Stars (on Envisat-1)</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System (US Military Navigation / Positioning)</td>
</tr>
<tr>
<td>GSTP</td>
<td>General Support and Technology Programme (ESA)</td>
</tr>
<tr>
<td>HASI</td>
<td>Huygens Atmosphere Structure Instrument</td>
</tr>
<tr>
<td>Ikonos</td>
<td>Commercial imaging satellite (USA)</td>
</tr>
<tr>
<td>INMARSAT</td>
<td>International Maritime Satellite Organisation</td>
</tr>
<tr>
<td>Interball</td>
<td>Solar-terrestrial programme (Russia)</td>
</tr>
<tr>
<td>IRS</td>
<td>Indian Remote Sensing Satellite</td>
</tr>
<tr>
<td>ISO</td>
<td>Infra-Red Space Observatory</td>
</tr>
<tr>
<td>ISO 9001</td>
<td>International Organization for Standardization standard</td>
</tr>
<tr>
<td>JAXA</td>
<td>Japan Aerospace Exploration Agency</td>
</tr>
<tr>
<td>LEMMS</td>
<td>Low Energy Magnetospheric Measurement System</td>
</tr>
<tr>
<td>LFI</td>
<td>Low Frequency Instrument</td>
</tr>
<tr>
<td>MEMS</td>
<td>Micro-Electro-Mechanical Systems</td>
</tr>
<tr>
<td>MGSE</td>
<td>Mechanical Ground Support Equipment</td>
</tr>
<tr>
<td>mm</td>
<td>millimetre</td>
</tr>
<tr>
<td>MMIC</td>
<td>Monolithic Microwave Integrated Circuit</td>
</tr>
<tr>
<td>MTI</td>
<td>Ministry of Trade and Industry</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NASDA</td>
<td>National Space Development Agency of Japan</td>
</tr>
<tr>
<td>NDT</td>
<td>Non Destructive Testing</td>
</tr>
<tr>
<td>NMEA</td>
<td>National Marine Electronics Association (industrial standard)</td>
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<tr>
<td>Odin</td>
<td>Scientific Satellite (Sweden)</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>OMI</td>
<td>Ozone Monitoring Instrument (on EOS Aura mission)</td>
</tr>
<tr>
<td>OSIRIS</td>
<td>Optical, Spectroscopic and Infrared Remote Imaging System</td>
</tr>
<tr>
<td>PA</td>
<td>Product assurance</td>
</tr>
<tr>
<td>PI</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>PROBA</td>
<td>Project for On-Board Autonomy-satellite (ESA)</td>
</tr>
<tr>
<td>QA</td>
<td>Quality assurance</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>Radioastron</td>
<td>Russian VLBI mission</td>
</tr>
<tr>
<td>RAPID</td>
<td>Research with Adaptive Particle Imaging Detectors (on Cluster)</td>
</tr>
<tr>
<td>Roemer</td>
<td>Danish microsatellite</td>
</tr>
<tr>
<td>RXTE</td>
<td>Rossi X-ray Timing Explorer</td>
</tr>
<tr>
<td>SAF</td>
<td>Satellite Application Facility</td>
</tr>
<tr>
<td>SAR</td>
<td>Synthetic Aperture Radar</td>
</tr>
<tr>
<td>SARSAT</td>
<td>Search and Rescue Satellite</td>
</tr>
<tr>
<td>SMART-1</td>
<td>Small Mission for Advanced Research and Technology (ESA)</td>
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<tr>
<td>SMOS</td>
<td>Soil Moisture and Ocean Salinity</td>
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<tr>
<td>SOHO</td>
<td>Solar and Heliospheric Observatory (ESA)</td>
</tr>
<tr>
<td>SPACE 2000</td>
<td>Space equipment technology 1995-2000 (Tekes)</td>
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<tr>
<td>SPEDE</td>
<td>Spacecraft potential electron and dust experiment</td>
</tr>
<tr>
<td>SPOT</td>
<td>Satellite Pour l’Observation de la Terre</td>
</tr>
<tr>
<td>SWAN</td>
<td>Solar Wind Anisotropy (Experiment onboard SOHO)</td>
</tr>
<tr>
<td>SWIR</td>
<td>Short Wave Infrared</td>
</tr>
<tr>
<td>Tekes</td>
<td>The Finnish Funding Agency for Technology and Innovation</td>
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<tr>
<td>TERRA MODIS</td>
<td>Moderate Resolution Imaging Spectroradiometer (EOS)</td>
</tr>
<tr>
<td>TETRA</td>
<td>Terrestrial Trunked Radio</td>
</tr>
<tr>
<td>TWINS</td>
<td>Two Wide-Angle Imaging Neutral-atom Spectrometers</td>
</tr>
<tr>
<td>UMTS</td>
<td>Universal Mobile Telecommunications System</td>
</tr>
<tr>
<td>VLBI</td>
<td>Very Long Baseline Incerferometry</td>
</tr>
<tr>
<td>VNIR</td>
<td>Visible and Near Infrared</td>
</tr>
<tr>
<td>VSOP</td>
<td>VLBI Space Observatory Programme (Japan)</td>
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<tr>
<td>VTT</td>
<td>Technical Research Centre of Finland</td>
</tr>
<tr>
<td>WDCMA</td>
<td>Wideband Code Division Multiple Access</td>
</tr>
<tr>
<td>XMM</td>
<td>X-Ray Multi-Mirror (ESA Science Mission)</td>
</tr>
<tr>
<td>XSM</td>
<td>X-ray Solar Monitor</td>
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