

Tartu Observatory Development Plan 2008-2013

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Introduction

Tartu Observatory is a research and development institution, administered by the Ministry of Education and Research, that operates on the basis of the Research and Development Organisation Act, other laws and international treaties. The principal activity of Tartu Observatory is research and development. The objective of Tartu Observatory is to promote Estonian research in astrophysics and atmosphere physics and provide services based on the research in these areas.

Tartu Observatory conducts basic and applied research in the areas related to its objective, participates in teaching astronomy, cosmology, atmosphere physics and other sciences in universities, provides consultations and professional expertise, advises institutions and companies, introduces science in general and the role of Estonia in world science to the public through astronomy and atmosphere sciences. Tartu Observatory carries on the long traditions of Estonian science and continues to be an internationally recognized centre of excellence in space science and atmospheric research.

The drafting of the Tartu Observatory development plan for 2008-2013 began in January 2008 when the analysis of the results of the last development plan, a SWOT analysis and the mapping of the interest groups affecting the activities of Tartu Observatory were carried out. During the discussions six breakthrough areas were determined through which the development of Tartu Observatory is realised. These are management and cooperation between research groups, the cultivation of excellence at international level, securing the next generation of top scientists, modernisation of infrastructure, output to enterprises and popularisation of science.

1. Background Information

Tartu Observatory is the continuer of the work of the University of Tartu Old Observatory, founded in 1808, and the University of Tartu Meteorological Observatory, founded in 1865. Tartu Observatory is the legal successor of the Institute of Astrophysics and Atmospheric Physics, founded in 1973 on the basis of the Estonian SSR Council of Ministers regulation no. 374. Tartu Observatory is located in the small town of Tõravere in Nõo rural municipality in Tartu county.

Research topics and funding

In 2007 the total budget of Tartu Observatory was ca 18.1 MEEK (~1.15 MEUR).

In 2008-2013 there are three target financed research topics in Tartu Observatory which cover the traditional research areas of cosmology, stellar physics and remote sensing and atmospheric research. In 2008 the total amount of targeted financing is ca 10 MEEK.

Since 2005 basic funding has been added to the budget (2008 - 1.7 MEEK). In 2008 the Estonian Science Foundation finances 12 grants and the co-investigation of a grant project with the total amount of 2.3 MEEK.

During the last years the amount of research carried out based on contracts with Estonian and foreign organisations has increased nearly fourfold, from 800 000 to 1 000 000 EEK. In 2008 the infrastructure is financed from the state budget by 4.7 MEEK with an additional 980 000 EEK for investments.

In 2008 the three year EU 7th Framework Program project EstSpace will begin with a total budget of 17.2 MEEK (1.1 MEUR). Together with the amount budgeted for 2008 in this project the total budget of Tartu Observatory for 2008 may exceed 30 MEEK.

Personnel and the Research Evaluation Results.

Tartu Observatory is composed of three research departments and an administrative department. There are 16 scientists and engineers working in the cosmology department, 21 in astrophysics department, 21 in the atmospheric physics field and 14 people in total in management and the administrative department. On 01.03.2008 there were 72 full-time employees, including 20 senior researchers, 24 researchers, 1 postdoc and 8 research engineers. Most University of Tartu PhD students supervised by Tartu Observatory scientists are employed as part-time researchers or engineers.

In 2008 the age distribution of the research employees and research engineers is as follows:

Age	Number of employees
< 30	13
31-40	10
41-50	4
51-60	10
61-70	12
> 70	4
Total	53

The average age of scientists and research engineers is 46.3 years, the average age of senior researchers and researchers separately is 49.5 years. By the end of 2010 16 of them will be over 65 years old.

All Tartu Observatory research groups underwent an international evaluation in 2000 and 2001 as prescribed by the law. Two assessment teams visited Tartu Observatory: one from ecology and the other from astronomy and atmospheric physics disciplines. According to the Estonian research evaluation summary ¹the average grade, 4.7, of astronomy and atmospheric physics was the highest in exact sciences and matched the highest grade in biosciences. In 2001-2007 the Department of Atmospheric Physics of the Tartu Observatory participated in the University of Tartu fundamental and applied ecology centre of excellence.

2. Mission

The mission of Tartu Observatory is to realise the high competency and traditions of the world class space science located in Estonia through securing the new generations of scientists, international cooperation, the synergy of research groups resulting from the joint solving of scientific problems and the development of the infrastructure necessary for the growth of top scientists. The mission of Tartu Observatory can be carried out only in cooperation with domestic and foreign partners.

3. Vision

Tartu Observatory is an internationally recognised centre of excellence in the space and atmospheric research and remote sensing areas, the maintainer of the continuity of Estonian science and a centre of high-tech innovation. The following activities will be conducted in Tartu Observatory: research of the structure and evolution of the Universe, internationally important research of atmosphere and substratum, the applications of which will be used both in Estonia and elsewhere, training of top scientists and popularising of science.

4. Research and Development Strategy

The research and development strategy specifies the actions needed to achieve the vision stated in the development plan, taking into account the internal strengths and weaknesses of Tartu Observatory and the opportunities and threats arising from the external environment. The development indicators show the desired level of achievement in 2013.

The general objectives of the Tartu Observatory research and development activities are as follows:

1. Based on the results of the R&D activities, Tartu Observatory will be among the leading European research institutions in its research areas.
2. Tartu Observatory is a leading national centre of excellence and competency for space

¹ Evaluation of the funding system for science and R&D activities. The seminar materials of Estonian Academy of Sciences. Tallinn 2004

research, astronomy, atmospheric research and remote sensing.

Development Indicators for 2013

1. By 2013 the financing of the Tartu Observatory R&D activities per one scientist is at least 75% of the similar EU average.
2. The number of scientists has increased to 70.
3. The number of publications in internationally peer-reviewed scientific journals has increased to at least 70 per year.
4. The number of supervised students at any given time has increased to 50 and PhD students to 20.

Breakthrough Areas

To ensure the sustainable development of Tartu Observatory in 2008-2013 attention must be paid to the following strategically important breakthrough areas:

1. Cooperation and management of research groups
2. Internationally high level of scientific excellence
3. Modern working environment
4. The next generations of scientists
5. Innovation and research output to enterprises
6. Science popularisation

The next sections contain the descriptions of the vision, strategic objectives and main activities to achieve them for each of the areas.

4.1. Cooperation and Management of Research Groups

Vision of the Area

While planning its activities Tartu Observatory takes into account the requirements and policies of Estonia and the EU. There is an international board in place that gathers once a year and advises the observatory regarding its scientific courses of action. There are a lot of young scientists in action in Tartu Observatory, both supervising and being supervised, on all academical levels of study (bachelor's, master's and doctorate).

The organisation has a clear structure and appointed people responsible for the activities conducted in all breakthrough areas (scientific cooperation and securing of resources, development of working environment, bringing up and training the next generations of scientists, partnership with companies and popularisation of science)

There is a regular information exchange taking place between the cosmology, astrophysics and remote sensing research groups that creates a synergy for solving common scientific problems through using similar themes or methods. The Tartu Observatory research groups develop together with other research groups in their field from the University of Tartu and other

research institutions.

The employees of Tartu Observatory feel that they are all part of one family. The initiatives of the employees are encouraged and supported.

The main objectives of the area

- Strengthening cooperation between research groups.
- Increasing financial resources for research, development and learning, including remuneration of student supervisors.
- Broadening and deepening of cooperation with partner organisations in Estonia and abroad.

Activities

- An international board will be put to work to direct the research and development activities of Tartu Observatory. The Council shall meet at least once a year.
- Atmospheric Physicists will develop cooperation with the University of Tartu, Estonian Agricultural University, Estonian Meteorological and Hydrological Institute and other partners.
- Astronomers will develop cooperation with the University of Tartu and the Institute of Chemical and Biological Physics in the field of integrating cosmology and high energy physics.
- International cooperation will be fostered both on personal and institutional level via exchanging of scientists, participating in conferences and seminars and organising events on the initiative of Tartu Observatory.
- Maximum use will be made of the EU 7th Framework Program and other cooperation opportunities (OPTICON, ASTRONET, RadioNET, COST, etc) by submitting project applications to fulfil the objectives stated in the development plan.
- Cooperation will be developed with the European Space Agency (ESA).
- Cooperation will be developed with the European Southern Observatory (ESO).
- Particular attention will be paid to enhancing the administrative capabilities of the observatory in the project work area.

4.2. Internationally High Level of Scientific Excellence

Vision of the Area

Tartu Observatory is an internationally recognised and known centre of excellence in the fields of space research, atmospheric physics and remote sensing, that in 2013 employs at least 50 researchers with a PhD.

The main objectives of the area

- Help create an internationally competitive centre of excellence in the field of space and atmospheric research.
- *Ensure the favoured development of the environment (facilities, equipment) necessary for the operation of the centre of excellence.*
- Increase the interdisciplinarity of the research work by strengthening the cooperation between the research groups.
- Stimulate the participation of Tartu Observatory scientists and research groups in research and development programs through co-financing.

Activities

- An internationally competitive centre of excellence will be created in the field of space and atmospheric research based on the research groups of Tartu Observatory and the University of Tartu.
- Research will be continued in the three traditional research directions of the observatory - cosmology, stellar physics, atmospheric and surface studies - while remaining open for new research topics.
- The cosmology and stellar physics research groups will cooperate more to investigate the evolution of the Universe.
- More fundamental knowledge based application possibilities will be created for the Estonian and European economies in atmospheric physics.
- Research topics will be linked with closer international cooperation by participating in local and European collaborative projects as Nordic Optical Telescope, ESO and others, the amount of network-based research will be increased and international exchange of researchers will be promoted.
- The number of scientific articles published in internationally peer-reviewed journals will be increased to at least 70 per year.

4.3 Modern Working Environment

Vision of the Area

Tartu Observatory is a research centre with a modern working environment and equipment that has motivating working conditions for both cultivating international level excellence and developing scientific cooperation and popularising science. There is a sufficient amount of highly qualified supporting personnel to assist the researchers.

The main building of Tartu Observatory has been renovated and has a new extension with new laboratory spaces and seminar rooms. A modern communication network has been created that facilitates remote working and cooperation between research groups using info- and communication technologies. In cooperation with the University of Tartu new science labs have been created in Tõravere and Tartu for the joint usage of both institutions. There is a

good bus service running between Tartu and Tõravere.

The main objectives of the area

- *Upgrade the infrastructure (facilities, equipment) and the working environment of the researchers to the level necessary for the successful operation of the centre of excellence.*
- Develop a modern science and technology base on the territory of Tartu Observatory in Nõo rural municipality.
- Develop an information and communication system corresponding to the requirements of Tartu Observatory (remote administration, software solutions allowing remote working and group communication).
- Support the creation of disciplinary and multidisciplinary shared laboratories and centres and their outfitting with equipment.

Activities

- Renovation of the main building and improving of the working environment of the scientists (ventilation and cooling system, electrical system and the roof will be renovated, modern furnishing and required office equipment will be acquired).
- New lab spaces for space research and radiometry, seminar rooms for developing cooperation and popularising science and common rooms for scientists will be created with the new extension.
- The control and guidance system of the 1.5 meter telescope will be modernised and a new modern universal observation tool (combining the functions of a spectrograph, photometer and polarimeter) will be purchased
- Computer lines will be upgraded (transition from radio relay line to optical cable) and modern communication network will be ensured. Participation in global grid computing systems.
- A set of field spectrometers covering the whole required spectre from UV to IR and the equipment for their, and other sensors, regular calibration will be purchased for atmosphere physicists.

4.4. The Next Generations of Scientists

Vision of the Area

Tartu Observatory continuously focuses on bringing up the next generation of scientists by teaching and supervising students in all academic stages. By 2013 there will be 50 students and 20 PhD students supervised in Tartu Observatory at all times and a possibility to obtain professional work experience in the research areas of the observatory will be created.

Tartu Observatory will create an attractive and modern working environment for young scientists and promote the internships in Tõravere of young scientists from other research institutions. Tartu Observatory will help universities design the astronomy, atmospheric

physics and remote sensing degree pathways related to the research areas of the observatory. The observatory will provide the prerequisites and assistance in the preparation of modern learning materials paying great attention to the use of e-learning opportunities. Tartu Observatory contribute to the professional training of physics and science teachers.

The main objectives of the area

- Assist with educational work in universities on all academic levels and supervise the research work of bachelor's, master's and PhD students.
- Encourage capable young scientists and researchers to join Tartu Observatory through international competitions and targeted searches.
- Increase the number of specialists being trained based on the continuity requirements of Estonian research excellence.
- Promote the development of scientific language and terminology to preserve national scientific research.

Activities

- The scientists of Tartu Observatory together with the Faculty of Science and Technology of the University of Tartu help to carry out educational work in astrophysics and environmental physics on all academic levels. There will be cooperation in these areas with other universities as well.
- Every year the scientists of Tartu Observatory supervise the research work of the students of the University of Tartu on all academic levels, suggesting research topics and looking for young capable researchers to start a professional career. Tartu Observatory will take into account the contribution of its employees in supervising the students when calculating performance related pay and bonuses.
- Tartu Observatory offers both internships and jobs to students and pays scholarships to the more successful students who have the potential to continue a professional research career in Tartu Observatory.
- Tartu Observatory supports the training of young scientists abroad.
- Job opportunities will be created in Tartu Observatory for foreign degree students and post docs.
- The training of the next generation of engineers will be supported in cooperation with the Tallinn University of Technology.
- Tartu Observatory actively creates other additional opportunities to create an attractive working environment for young scientists to influence the youth to take up a research career and start working in Tartu Observatory.

4.5. Innovation and Research Output to Enterprises

Vision of the Area

Tartu Observatory has developed a number of applications required by the small- and medium-sized companies in Estonia and Europe. The applicability of the results is continuously monitored while planning research and offers to cooperate with companies are always welcomed.

Tartu Observatory employs well-known and recognised experts who advise both companies and state agencies regarding environmental problems and in other areas of competence of the observatory.

The main objectives of the area

- Increase the administrative capability of Tartu Observatory to launch and manage projects and to implement research results.
- Create an environment in the observatory that supports the creation of new knowledge and the implementation of innovative solutions in business, public and nonprofit sectors.
- Find application possibilities in Estonian economy for its research results.

Activities

- Creating the space laboratory and providing space related services.
- Developing remote sensing methodologies and technologies.
- Involving the scientists of the observatory in solving Estonian IT problems.
- Releasing calendar data to calendar manufacturers.

4.6. Science Popularisation

Vision of the Area

The public has continuing interest in the space sector and the International Year of Planet Earth 2008 and the International Year of Astronomy 2009 declared by the UN will considerably increase the youth's interest in space and astronomy. The scientists of Tartu Observatory are valued guests at public events and experts at several public discussions and assessments. The "Tähetorni Kalender" and "Tähistaeva Kalender" will be issued every year.

Tartu Observatory continues its long traditions as a research centre and science populariser being, in its widest meaning, a centre of culture that is equally interesting for pupils, students and science teachers. New seminar rooms provide an opportunity to organise different events, seminars and conferences to popularise science.

The main objectives of the area

- To continuously inform the Estonian public about the results of the research and development work done in Tartu Observatory and the development of these areas in the world, including through popular science publications.
- To regularly introduce the research activities of Tartu Observatory in international publications.

Activities

- "Living science" will be shown in Tartu Observatory.
- Popularisation activities will be counted as significant factors in research staff competitions.
- The "Tähetorni Kalender" and "Tähistaeva Kalender" will be issued in colour print every year.
- New ideas and interdisciplinarity will always be welcomed.

5. Financing

Carrying out of this development plan will be mainly finance from the Estonian state budget funds.

Additional funds will be sought from public project competitions organised both in Estonia and within the EU framework programs to carry out different activities.

The resources for a number of activities will be acquired together with partners from research and development institutions, universities and companies.

6. Development Plan Review Procedure

This development plan will be reviewed by the Tartu Observatory Scientific Council at least once a year, more frequently if necessary. International Advisory Board will submit its opinion also annually.

This development plan has been approved by the Tartu Observatory Scientific Council on 03. March 2008.

Appendix 1. Analysis of Interest Groups

As a state research and development institution the activities of Tartu Observatory are guided by the interests of the Estonian state and economy and are directed towards achieving and maintaining an internationally renowned level in scientific excellence as well as guaranteeing the next generation of top-level Estonian scientists.

Based on the objectives stated above, the Estonian organisations interested in the activities of Tartu Observatory can be divided into four large groups: ministries and state authorities, companies, educational institutions and the public. In international cooperation networks of scientists and researchers will be added to the research institutions, companies and educational institutions.

1. Interest groups in Estonia related to the activities of Tartu Observatory.

Ministries, state authorities

- whose interest and need is to represent Estonia in European and worldwide professional working groups as well as using expert assessments to develop scientifically justified opinions and policies.
- Tartu Observatory offers both state and international level competency by having experts in different fields and can provide assistance in developing opinions and policies.

Agencies dealing with environmental problems (Ministry of Environment, ARIB, EMHI, etc.)

- who have the interest and need to monitor changes in Estonian environment, conduct analyses, evaluate environmental resources, audit the allocation of the European Union agricultural subsidies and so on.
- Tartu Observatory offers research, development and consultancy services in different aspects of forestry, agriculture, radiometry, climatology and other fields.

Companies

- who have the interest and the need to implement innovative developments, introduce new instrumentation and relevant software, recruit specialists with modern training.
- Tartu Observatory is a centre of competency in developing remote sensing hardware and software as well as a research centre that motivates companies to make improvements in radiation measurement and radiometry, offers environmental consultancy and provides valued assistance for preparing guides, encyclopedias and calendars.
- Tartu Observatory takes care of the next generation of scientists and trains master's and PhD students to become an international level competent work force for companies and authorities.

Researchers in the same field from other research institutions

- who are interested in participating in joint projects, giving a cutting-edge contribution to the development of Estonian and international science and exchanging professional information.
- Tartu Observatory can assist in data sharing, has competency in comparing and using measurement data and software development, is interested in the close cooperation of the research groups of different research institutions that creates synergy for solving research- and economic problems in the common areas of different fields.

Universities

- who are interested in conducting international level teaching on all academic levels as well as in research cooperation between different research groups.
- Tartu Observatory has strong competency for and interest in supervising PhD, masters and bachelor's theses as well as carrying out teaching on all academic levels in universities and research cooperation with other research and development institutions that train versatile specialists and scientists for Estonian companies and institutions.

Educational institutions, schools

- who are interested in learning and teaching astronomy, observing the stars and training their teachers.
- Tartu Observatory offers schools the possibility to visit the observatory in groups, observe stars and in cooperation with universities and community organisations conduct the training of science teachers.

Press

- that is interested in commenting on the news about astronomy, natural phenomena and environment.
- Tartu Observatory offers competent professional knowledge in the fields of space research, astronomy, cosmology, atmospheric physics and remote sensing and sees the need for cooperation with journalists to popularise the science through topics interesting to the public.

Community, the public

- who are interested in astronomy, space research, sky observation and physical phenomena related to the natural phenomena and the environment.
- Tartu Observatory helps to maintain the interest in science in its widest meaning, develop engineering though and improve the understanding of global changes among the Estonian youth by its professional competency, issuing calendars, organising tours, publishing articles in the press and other means.

2. Interest groups in the world related to the activities of Tartu Observatory.

European Union

- whose interest is to develop and implement the policies of the different sectors of the European Union.
- Tartu Observatory contributes to the implementation of the EU policies (space policy, GMES - Global Monitoring for European Security), using its scientists as experts provides assistance in evaluating the EU framework programs' and other international projects and helps to shape the policies of the respective areas in Estonia.

Universities and research and development institutions

- who are interested in starting and carrying out joint projects in the EU, in contributing to the development of international scientific excellence in the whole world and in the exchanging of professional information.
- who are interested in creating opportunities for training its students at the international level and for finding supervisors and reviewers for research projects.
- Tartu Observatory is a strong partner in joint projects both as the initiator and the implementer, is interested in the international exchange of young scientists and educating young Estonians in foreign universities while having competency for supervising foreign students and reviewing research projects.
- Tartu Observatory is a strong partner in data sharing, has competency in comparing and using measurement data and software development, is interested in the close cooperation of the research groups from different research institutions that creates synergy for solving research- and economic problems in the common areas of different fields.

International cooperation networks

- that are interested in the joint solving of common science problems, sharing professional information both in smaller and larger science fields and creating a joint community of scientists.
- Tartu Observatory is a significant partner in a number of professional science organisations and cooperation networks (ESA, JRC - Joint Research Centre, Aeronet, Nordic Network Physense, VALERI, RAMI, EARSeL, Nordic Optical Telescope, OPTICON and others).

Scientific Journals

- that are interested in finding reviewers and members for the editorial boards and in publishing high level scientific articles.
- Tartu Observatory has professional competency for reviewing and editing the articles of different scientific journals.

Small Businesses

- that require professional assessments, analyses, motivation and a test bed to implement innovative ideas for their successful operation and from which the observatory would like to purchase equipment or services.
- Tartu Observatory is interested in cooperation with small- and medium-sized businesses, can perform international level assessments and analyses and can be a strong partner in its research areas.

Appendix 2. Analysis of the Internal and External Environment (SWOT)

1. Analysis of the Internal Environment

1.1. Strengths

*The main **strengths** of Tartu Observatory and the prerequisites for the development of the organisation resulting from the internal environment are as follows.*

History and Traditions

Tartu Observatory is one of the oldest research institutions in Estonia, whose history and traditions reach back to the works of the internationally renowned top astronomers Struve and Öpik. International reputation and recognition, long-term experience, traditions and schools have created the prerequisites for sensing the scientific frontier and for participating in it. The observatory continues to bear the continuity of Estonian science.

Organisational culture

Tartu Observatory has a strong collective and extensive teamwork experience. The organisation is compact and has integrated management. Optimal sizing of the research groups ensures the high level of research.

Cooperation in Estonia and on the International Level

One of the strengths of Tartu Observatory among Estonian research institutions is the readiness to assist Estonian universities with conduction bachelor's master's and PhD teaching within its research areas. Scientists will be supervising students' research work. All this creates the conditions to ensure the next generation of scientists.

The research groups of Tartu Observatory have strong connections with other Estonian research institutions that are active in research fields similar to those in the observatory.

Tartu Observatory is a valued partner both in Estonia and internationally. The observatory has developed an international communications network and a lot of different contacts with other research centres all over the world. There is a close cooperation with several observatories.

Human resources and potential

Tartu Observatory employs internationally recognised highly qualified scientists who have

both nationally and internationally renowned scientific competency. There are both elderly and experienced scientists and talented young players working under the same roof.

Infrastructure - Working Environment and Equipment

Tartu Observatory is located sufficiently close to Tartu and the University of Tartu while there are no interfering urban surroundings. The institution has a compact and working infrastructure and a good working environment - working spaces, work and communications equipment, workshop.

Output to the Economy - A Topical Research Theme

Tartu Observatory is the leading consultant and implementer in Estonia regarding the atmospheric research related to environmental issues and the scientific approach to solar UV radiation. It also participates in these fields in the respective European structures.

Tartu Observatory has professional competency in the field of radiation measurement, can offer solutions to problems related to the environmental protection in Estonia and provide necessary services to companies in these areas. The research theme of the observatory is multidisciplinary. Astronomy and atmospheric physics create synergy in the research work.

Output to the Society

Tartu Observatory has been successful in popularising science, has created a bond with the public and has kept the public interested in space related topics. The scientists of the observatory have published many high-level scientific articles, thereby making a strong contribution to the sustainable development of Estonian science.

1.2. Weaknesses

*The following **weaknesses** resulting from the internal environment of Tartu Observatory can be pointed out as factors hindering the development.*

Infrastructure - Working Environment and Equipment

On the one hand Tartu Observatory has a very pleasant working environment that is complemented by the proximity to nature and the distance of urban areas. On the other hand the distance from Tartu may become an obstacle for the youth coming to Tartu Observatory. The problem can be solved by creating a compensation mechanism or by other appropriate measures.

Currently there are no suitable facilities in the main building of the observatory for improving the information exchange within the organization. The present working environment is not very attractive to young scientists. They want more options to communicate with colleagues and a physical and IT environment offering better information exchange with other research groups. There is also no modern infrastructure for welcoming guests, organising conferences and popularising science.

The equipment infrastructure is not up to date either, the equipment park is weak and the

astronomical observation equipment has not been modernised. At the same time there is no access to large telescopes located in good astroclimate either.

Financial Sustainability

The main risk regarding financial sustainability is the low experience of the employees of the observatory in the world of project based financing and market economy and in participating in the EU framework program projects.

The second risk related to financing is the lower salary of the scientists of the observatory compared to the business sector or universities.

Research Excellence

The possible risks related to research are the low number of published articles and modest participation in international cooperation and monitoring programs. There are specific activities planned in the development plan to prevent these risks. Scientists see the small proportion of applied sciences and lack of experimental space research as possible risks as well.

People - Resources and Potential

The biggest possible threat to the continuity of Tartu Observatory is the age structure of the scientists. The proportion of young scientists is currently low and more undergraduate and graduate students must be involved in the research work.

Communication with Companies, Universities and Other Institutions

At the moment Tartu Observatory doesn't have strong contacts with the business sector. Therefore the output to the economy is small.

Tartu Observatory has shown low activity in voicing their opinions in designing Estonian research policies and participating in the respective committees.

There are not enough young people in Tartu Observatory and therefore more attention must be paid to strengthening the connections with universities.

So far external communication has been one-sided. More foreign scientists should be invited to work at the observatory and an attractive working environment and financial possibilities should be created to support this.

2. Analysis of the External Environment

2.1. Opportunities

*Considering the general developments taking place in EU and Estonian society and the nature of Tartu Observatory, the following can be shown as **opportunities** for the development of the institution resulting from the external environment.*

Standing for Estonia's National Interests

The activities of Tartu Observatory are directly related to the strategic goals of Estonia and the EU in developing the space sector. Tartu Observatory is the main centre for space science, technology and remote sensing in Estonia whose scientists can significantly contribute as experts to the development and implementation of the Estonian space program.

Cooperation in Estonia and on the International Level

An excellent base for cooperation in space sector within Estonia and on the international level will be created by process of Estonia joining the European Space Agency (ESA). Initiating the work of the international advisory committee gives Tartu Observatory the opportunity to better organise its research and development activities.

Astronomy, atmospheric physics and remote sensing are characterised by the ever increasing international cooperation between different research institutions, the joint development of large infrastructure projects by several countries and international organisations, high mobility of scientists and graduate students and the rapid deployment of new technologies. These external factors create an opportunity for the Tartu Observatory scientists and research groups to actively participate in international research projects, to offer Estonian scientists internships in outstanding foreign research centres and to strengthen local personnel by bringing foreign scientists to Estonia and creating an attractive working environment for them.

Only a few large devices, both on Earth and in space, give novel results that are on the forefront of the science. Most of them are open for program applications from all over the world. This creates opportunities for the Tartu Observatory scientists to perform observations using large telescopes in good astroclimate. The competition for observation time between the applicants is very strong, but the results are made available to all interested parties relatively quickly after the observations. This in turn gives the Tartu Observatory scientists a chance to participate in the processing and interpreting of the data gathered with the large devices and in the modelling and theory development using virtual observatories and databases.

The main task of smaller telescopes and other devices will be to train young scientists and long-term monitoring programs. The satellite remote sensing support area at Järvselja and the international reputation of the research team adds possibilities to participate in international projects. Earth observations from space and global climate research are becoming increasingly more important. But the atmospheric and surface phenomena specific to Estonia can be studied only on the site. This gives the observatory a chance to widen the cooperation within Estonia with the Ministry of Environment, the Environmental Investment Centre, the Ministry of Defence and other agencies. Regarding radiation measurements Tartu Observatory is the leading information and technology centre of the field in Estonia.

Educational Needs of Estonia

On the Estonian job market there is a need for young people trained in sciences to develop the engineering thought. Improving the connections with universities by supervising students' research work, developing joint research projects and carrying out educational activities, affects students and young scientists and helps to ensure there is a sufficient amount of scientists and specialists in the next generation. In addition to the previous Tartu Observatory has a strong potential in the form of its scientists to offer professional training to secondary

and high school science and physics teachers to maintain a high level of Estonian science education.

Economic Needs of Estonia

Tartu Observatory has the potential to provide Estonian economy with significant applied research. The research topics of the observatory are still relevant due to the need to investigate the various aspects of the condition of the environment. At the same time Estonian companies have a growing interest in finding their niche in space industry and this gives the observatory the opportunity to pay more attention to the implementation of the research results in the economy.

Infrastructure - Working Environment and Equipment

The remote location of Tartu Observatory in a place of natural beauty allows a people-friendly working environment to be designed. The development of the IT and communications technology has created the prerequisites for creating an attractive and modern work arrangement, that allows home offices to be integrated with the modern communications equipment at the renovated centre in Tõravere. The increase of the national financing funds from the European Structural Funds creates favourable conditions for developing infrastructure. Thanks to its location and the complex of buildings and devices the observatory has a chance to become an important centre in the Southern Estonia that popularises science amongst the youth.

Financing

Tartu Observatory has the opportunity to use both national and international funding to carry out the activities of the development plan, send young people to study and train abroad, welcome distinguished foreign scientists in the observatory and actively participate in astronomical observation programs.

Science popularisation

The growing interest of Estonian and European public in space topics, astronomy and meteorology creates excellent opportunities for Tartu Observatory to popularise science. The International Year of Planet Earth 2008 and the International Year of Astronomy 2009 declared by the UN provide an additional chance to introduce the area more widely.

2.2. Threats

*Considering the circumstances, issues with differing significance can be pointed out from the following areas as **threats** resulting from the external environment.*

Estonia in EU

Changes in Estonian and EU strategies that lead to the reduction of the importance of the

space sector are the main possible threats from the external environment that can endanger the development of Tartu Observatory. During the last years the process of Estonia joining the ESA has given a huge boost to the development of Tartu Observatory. In case this process slows down, stops or fails, Tartu Observatory won't continue developing fast enough to take advantage of all the opportunities arising from the external environment. The scientists of the observatory see the development scenario where only strategic key technologies will be developed in Estonia as a second threat as in that case the fundamental science will perish. The third possible threat is the retreat of education and scientific terminology in Estonian language in front of the education in English.

The next generations of scientists

The issues reducing the size of the next generation of scientists are the reducing number of students and the low interest in exact sciences among the youth. Another great threat is also the fact that the old top scientists may disappear before the young ones are trained. The reduction in the number of people leads to the possible danger that the sizes of the research groups fall below the critical limit.

Research Excellence and Financing

Financing threats are related to the possible general decline of the economic climate, the significant reduction of the EU financing programs to Estonia from 2013 onwards, the lack of national targeted financing in the space sector and the public authority status that means that the funds from the budget year become available with a few months delay and usually these cannot be transferred to the next budget year.

Bureaucracy will increase due to the participation in international projects and project based financing. The need to keep the applications and subsequent reports clear calls for a greater number of technical personnel skilled in project work. Some project can't be carried out due to the public authority status.

Project based funding is not suitable for astronomy where the observations to get decent results may take years and thus may lead to the extinction of such working groups. Therefore there is a possible indirect danger that Estonia will lose competency in space science.

A possible threat to Estonian science as a whole is also the fact that the evaluation criteria of the research results are not clear to the scientists. Basing the evaluations excessively on articles rules out practical output into applications that the Estonian economy needs. Therefore there is a conflict between the requirements put on the teams and the evaluation principles. In addition there is a possible danger that applied research may perish due to unclear ordering.

Infrastructure - Working Environment and Equipment

There is a potential danger that if the existing infrastructure is not renovated then the working environment won't be attractive to young scientists and the scientific level of the observatory will decrease. Reductions in the financing of the infrastructure may lead to a situation where the conditions of the working environment are not able to keep up with the requirements. There is a potential risk when purchasing new equipment that it won't be put to effective use. The latter can be reduced by training young engineers and scientists to use these devices.

