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Latvia: Research Assessment Exercise

Panel Report: Natural Sciences and Mathematics

technopolis |group|, December 2013

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Introduction

Background

On 26 April 2011, the Cabinet of Ministers of the Republic of Latvia adopted a decision (Protocol No 27, §29) regarding the need to conduct an external assessment of the implementation of the science and innovation policy in Latvia in 2011/2012, in order to perform the necessary measures for the implementation of structural reforms in science and to ensure well-founded strategic planning of the future cohesion policy of the European Union.

The overall objective of the assessment of the research performance of Latvian scientific institutions/structural units is

To provide the Latvian public, policy-makers and decision-makers and the academic community with the most objective picture possible of the excellence and competitiveness of Latvian science in comparison with the global practice in the respective area of science.

The assessment will produce analytical material that will describe the research excellence and competitiveness of Latvian research, its socioeconomic impact and the capacity of its research institutions. This material will

- Provide evidence for research policy making at different of levels
- Enable the research institutions involved in the process to gain a significant impetus for improving their operations

The research assessment is directed at institutions included in the Register of Scientific Institutions, that is:

- Higher education institutions and their constituent departments/ faculties/ research groups
- Scientific institutes established by higher education institutes
- State scientific institutes
- Other scientific institutes/ organisations, including private scientific bodies

Altogether six panels were appointed to perform the evaluation. This document is the report of Panel M: Natural Sciences and Mathematics

Scope of Panel M: Natural Sciences and Mathematics

Panel M was asked to evaluate 28 institutions. The scientific disciplines of these institutions include mathematics, astronomy, physics, chemistry, geography and earth sciences. It is to note that computer science was *not* among the disciplines to be evaluated by Panel M. This is surprising, because computer science, like mathematics, provides methods and models to attack scientific problems. Together mathematics and computer science form a methodological basis for most of modern science. In one case the allocation of mathematics and computer science to different panels was particularly unfortunate: The strength of the Institute of Mathematics and Computer Science is its combination of the two disciplines, but Panel M was only asked to evaluate the mathematics part of the Institute.

The panel felt that one of the institutions it was asked to evaluate is not a scientific research institution and therefore refrained from evaluating it. Thus the total number of institutions assessed was 27.

Material on which the assessment was made

Each institution participating in the evaluation provided the panel with a self-assessment report for the years 2006 - 2012. The self-assessment report contained a short description of the institutions' research profile and statistics on funding, personnel, scientific output in terms of published papers, patents, and doctoral training. Researcher mobility, national and international collaboration, and other scientific and societal activities were also reported. The self-assessment also included a SWOT-analysis and a list of best publications by the personnel (maximum seven papers per person). Copies of the institution's five best papers were sent to the panelists. The panel also had access to a bibliometric analysis including information on citations and international co-authors.

Institutional visits

Panel M spent the week September 2-6, 2013 in Latvia and during this period it made site-visits to 12 of the 27 institutions it evaluated. At least two panel members were present at each visit.

During the site-visits the panel used, whenever possible, part of the allocated time to discussions with the PhD-students without the presence of senior staff. These discussions were very informative and complemented the picture formed through the self-assessment and the discussions with academic personnel.

Assessment of the Research Institutions

1. M_01_Institute of Physical Energetics

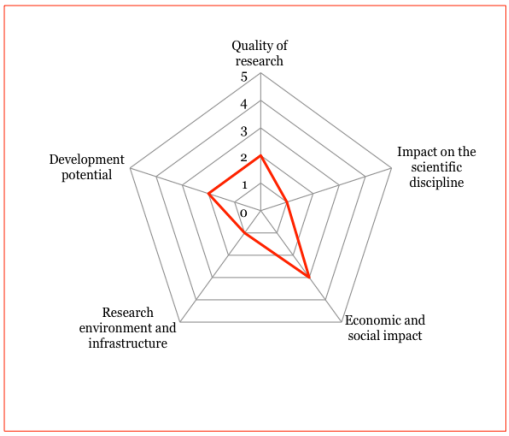
Name of the institution	Institute of Physical Energetics
Name of university	Institute of Physical Energetics
Type of institution	State Scientific Institute

The Institute of Physical Energetics (IPE) was established in 1946. It is a mid-size State Scientific Institute with about 125 scientists and non-academic staff (self-assessment report 2012). The Institute is organised in 12 research laboratories and groups addressing as the following main research topics:

- Regional energy sector analysis and optimisation
- Energy saving management
- Energy - environmental policy studies
- Renewable energy resources
- Energy efficiency
- Electrical networks and electricity supply systems
- Clean fossil energy technologies
- Electrical devices and machines and
- Research into advanced materials and solid state physics problems connected with energy technologies.

Figure 1 Assessment of the Research Quality of the Research Quality of the Institute of Physical Energetics

Criteria	Scores
Quality of research	2
Impact on the scientific discipline	1
Economic and social impact	3
Research environment and infrastructure	1
Development potential	2
OVERALL SCORE	**2**



Overall Score

The Institute defines itself as the leading institute in Latvia in the field of energy research - a perception not necessarily confirmed by the self-report and the on-site visit. The main focus of the Institute's activities have to be defined as consultancy for mainly Latvian public entities at the national or regional level. Original research at an internationally recognised level is rare with some exceptions (e.g. modelling of smart grids and material and components for photovoltaic elements and modules).

Those activities of the Institute that are neither central for its consultancy role nor are visible with respect to international journals (beyond the in house-edited journal) should be carefully reconsidered with respect to their continuation. In its current form the Institute shows a clear imbalance between budget and scientific product.

Quality of Research

The Institute defines itself as the leading institute in Latvia in the field of energy research. It addresses a vital topic of industrialised nations nowadays, i.e., energy. The focus on renewables represents one of the major topics of this field. The Institute significantly contributes to the Latvian discussion by both technically and economically oriented projects and publications for a wider range of aspects of the field including the development of the electrical grid with an increasing amount of electricity generation from renewables. In the field of material science some contributions are made for the PV sectors. During the period 2006-2011, the scientists of IPE have been involved in many national and international cooperation projects, through various framework and infrastructure programmes.

Overall the research made and the results delivered are at a solid national level but do lack a wider international visibility. The academic staff structure of the institute includes about 30 persons being designated as being in leading positions (self-assessment report 2012, Section 1.2). Compared with the overall staff number this is kind of top-heavy.

Impact on the scientific discipline

The laboratory had on average of slightly above 30 publications in journals in the years 2006 to 2012 each. For the size of the staff this is not overly impressive. Many papers are published in conference proceedings having a low impact because the readers are mostly the people attending the conference. Among the 15 best publications of the Institute listed in Section 2.4 of the self-assessment report for the period 2006-2011 eight did appear in the Latvian Journal of Physics and Technical Sciences, a journal started in 2008 by the Institute itself with a very limited international visibility, four have been in international journals with a moderate impact factor, and three in conference proceedings.

The positive part is that during the period 2006-2011, the laboratory has taken 58 patents including 5 international one.

Consequently, while the Institute does influence the national development of science and engineering in Latvia it has to significantly develop further with respect to its international impact. The number of dissertations completed has to be increased given the high number of leading scientists.

The exchange of scientist with international partners is also very limited. The Institute has been involved in a number of EU projects of various natures forming a good basis for the future development of its visibility at least in the European context. The Institute should try to obtain European grants to send young researchers and postdocs abroad and try to bring some foreign researchers at IPE for short periods.

Economic and social impact

The Institute is strongly involved in a number of consulting processes with respect to key developments in Latvia concerning its energy future. This includes the generation of heat and electricity from renewables but also the further development of Latvia's electrical grid.

With energy aspects being at the heart of an industrialised nation these activities potentially constitute a significant contribution to Latvia's future economic development.

The Institute has supported industry and creation of SMEs by creating the Latvian Technological Center (LTC). Researchers of the Institute cooperate with LTC to assist SMEs to find scientifically sound solutions. Many companies that are based on high added-value products have started at the premises of LTC with the assistance of Institute.

The Institute researchers in collaboration with “GroGlass” developed a new product-rectified solar panel glass, which would increase the solar panel efficiency and the amount of electricity produced, protecting in the same time the panels from the UV and IR radiation, extending the lifetime of the solar panel. The Institute has started a collaboration with the Latvia University of Agriculture on energy-saving bio-ethanol congruentional dehydrated technology development. The results will be used for product commercialisation. The Institute’s investigation of methanol sensor adaptation for fuel cells and other control and measurement systems contributed the ELMI Ltd. technologies up growth. The Institute’s investigations of biomass use contributed to the "Ludzas Bio-energy" Ltd. conversion of Ludza boiler house on domestic fuel (biomass - wood chips) use. Scientifically a prominent role can be seen in the modelling efforts of the national and regional electrical grid development.

The small number of graduating PhD students limits the direct influence of the Institute by transferring those after graduation to industry or the public sector. The large share scientist designated as leading should result in a higher output of well-trained PhDs making their way into the field.

Research environment and infrastructure

The Institute owns and operates a variety of scientific equipment and instruments focussed on elements of the electrical grid, photovoltaic materials of various kinds and on testing of PV systems. The equipment mentioned is far from cutting edge. Based on the Institute's description in the self-assessment report and the on-site visit it can be said that most of these pieces of equipment are relatively old and the more modern pieces have been acquired around 2008 with the help of national and EU grants (EU Structural Funds “Improvement of scientific infrastructure at the Institute of Physical Energetics of the Latvian Academy of Sciences” and “Complex for nanostructure synthesis and analysis”). Other equipment is not mentioned (e.g., any reasonable powerful computing facility), and must be deemed outdated or dysfunctional. There are extensive investment plans for the years until 2016 depending completely on EU support and some industrial contracts, while national support is not mentioned. Such finance structure is not really healthy in the long run.

Development potential

The current 2012 funding situation (15 % state national base funding, 25 % state national and 60 % external project funding) represents a very unhealthy situation. When the Institute is expected to contribute significantly to Latvia's future development in energy-related questions, a reliable state national funding of the overall budget needs to be assured. Otherwise there is significant risk, that the Institute will only be capable to deal with short- and mid-term project questions but will loose its ability to provide sound technical and economical policy advice. Whether the size of the Institute should be maintained at the current level needs some additional discussions and insight. Possibly a stronger focussing of the activities will be helpful to counteract at least some of the budgetary restraints.

Conclusions and recommendations

Energy research is very important for Latvia as for all industrialised nations. Currently the Institute focuses on consulting projects for various government bodies. Original research at an internationally recognised level is rare but the work on PV material and

the modelling activities on the future development of the electrical grid represent exceptions both nationally and regionally.

Those activities of the Institute that are neither central for its consultancy role nor are visible with respect to international journals (beyond the in house-edited journal) should be carefully considered for abandoning. In its current form there is a clear imbalance between budget and product.

2. M_02_Latvian Institute of Wood Chemistry

Name of the institution	Latvian State Institute of Wood Chemistry
Name of university	Latvian State Institute of Wood Chemistry
Type of institution	State Scientific Institute

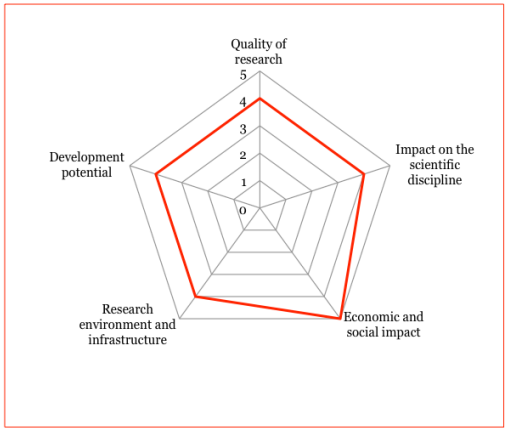
The Latvian State Institute of Wood Chemistry (IWC), representing the centre of wood science in Latvia, was founded in 1946. It is an independent state non-profit organisation under the supervision of the Ministry of Education and Science of the Republic of Latvia.

The mission of IWC is the development of science-based technologies for obtaining economically competitive materials and products from wood and wood biomass. The Institute is organised in nine research laboratories and departments as follows:

- Laboratory of Biocomposites
- Laboratory of Bioengineering
- Laboratory of Biomass Eco-Efficient Conversion
- Laboratory of Cellulose
- Laboratory of Lignin Chemistry
- Laboratory of Polymers
- Laboratory of Polysaccharides
- Laboratory of Wood Biodegradation and Protection and
- Department of Technological Research.

Figure 2 Assessment of the Research Quality of the Latvian Institute of Wood Chemistry

Criteria	Scores
Quality of research	4
Impact on the scientific discipline	4
Economic and social impact	5
Research environment and infrastructure	4
Development potential	4
OVERALL SCORE	4



Overall Score

The Institute has successfully undertaken serious efforts to achieve the status of a strong international leader with a very good potential for further positive development. This is especially remarkable because the results have been accomplished with limited resources requiring the Institute to work at least to some extent much harder than other international players. The research quality is among the best one can achieve in Latvia,

and it is internationally competitive. There are only very few other places addressing these research issues in a similarly comprehensive and holistic manner.

Quality of research

The use of raw materials from forests represents an important factor of Latvia's economy. The area of research is well focused and relevant resulting in innovations for competitive high added-value products. Main priorities of the multidisciplinary scientific activities are wood, its waste, recyclable materials and other types of biomass further to wood and wood materials with upgraded properties for construction. The quality of research generally is very good but somewhat inconsistent across the Institute's branches.

The extended list of national and international cooperation underlines the Institute's visibility to and acceptance by its peer institutions. Very good scientific outputs in terms of scientific publications and active participation in various activities (COST, EU FP projects, technology platform, etc) place the Institute among the most recognisable not only in Latvia but also in Europe.

Impact on the scientific discipline

The list of publications and the number of citations demonstrate a very good visibility of the Institute and its scientific outputs. The publications appear in reasonably good international journals and they involve a large proportion of researchers listed. In addition to the scientific publications, numerous presentations at national and international level, events organised by the Institute prove that they are very active internationally. This places the Institute as a strong international player and a partner in international networking and research projects.

There are many young scientists at the Institute being very active and enthusiastic. The current number of doctoral students project that the number of granted PhD degrees will significantly increase from about two per year in the foreseeable future.

Economic and social impact

Data provided in the self-assessment report clearly demonstrate the high importance of the research and classify the Institute as a highly sought-after partner in non-academic sectors. The scientists of the Institute are members of various bodies directly related to knowledge transfer to the users, including both public and industry sectors. An active role in thematic COST networks also demonstrates high-level economic and societal impact. Furthermore the Institute contributes to agricultural as well as technological value creation for Latvia and its European partners.

Research environment and infrastructure

Laboratories and equipment are available to conduct high-level research. The Institute has made good use of its extensive research cooperation within the European research programmes. Its equipment is reasonably modern which allows it to be competitive on an international level. The Institute has initiated a number of steps as outlined in the self-assessment report, to improve the efficiency of its operation. These provisions affect the infrastructure of the Institute but they also put a major emphasis on developing its intellectual capabilities and portfolio. The plans described in the report are realistic with a very good chance to realise them successfully.

Development potential

It is expected that the Institute will continue or even expand its role as an important scientific and technological player in the field of applied research on wood and its usage both at national as well as international levels. With the realistic development vision presented it is highly possible that the institute will become an attractive site for international research and education.

Although the funding schemes at the national level are not very high the Institute has been able to become integrated in the competitive environment that is characterises the activities at a wider EU level. This national funding situation has to be regarded as

critical and potentially harmfully low. This core funding has varied between 15- 20% of the overall budget in the past forcing the Institute to heavily rely on project funding including international funds for supporting the building of research infrastructure in the Eastern-European states. However, this funding will not remain around the same level in the future.

Conclusions and recommendations

The Institute is not a strong international leader currently, but it has undertaken some serious efforts to achieve such status. The results have been accomplished with limited resources requiring the Institute to work at least to some extent much harder than other international players. The research quality is among the best one can achieve in Latvia, and it is internationally competitive. There are only very few other places addressing these research issues in a similarly comprehensive and holistic manner.

Bioeconomy is one of the Horizon 2020 Societal Challenges representing a field where the Institute is already well established and integrated in European research initiatives. Given the importance of forests to the Latvian economy and the unique role of this Institute, a stronger base funding by the national government is highly recommended.

3. M_03_Department of Chemistry and Geography

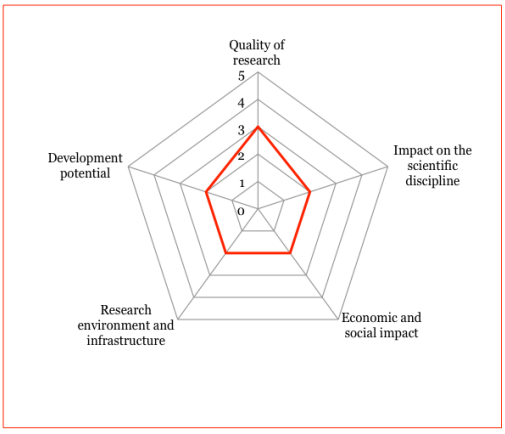
Name of the institution	**Department of Chemistry and Geography**
Name of university	Daugavpils University
Type of institution	University

The activities of the two groups

- The Institute of Ecology
- and (ii) the Department of Geography and Chemistry fall within the area of interdisciplinary environmental sciences of high relevance at the national and international level. Collaboration between the two groups is well recognised in the development and application of smart monitoring systems, particularly for water bodies.

Figure 3 Assessment of the Research Quality of the Department of Chemistry and Geography

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	2
Economic and social impact	2
Research environment and infrastructure	2
Development potential	2
OVERALL SCORE	2



Overall Score

Overall, good quality of research with average science and socio-economic impacts. The groups have the capacity to develop into a strong player at national and international level. The research outcomes are largely dependent on the stability of the funding available. The funding situation also influences the number of employees, especially those with a capacity to become leaders in some aspects of the research activities. In the absence of stable funding the groups should streamline their research portfolio, focus on selected topics, and develop them further to become competitive at national and international level.

Quality of research

The groups address a broad range of research topics with a focus on the development of fluorescence markers for various applications in life sciences and work related to aquatic ecosystems of rivers and lakes. The high relevance of the research at the national level is insufficiently complemented with novel developments visible at the international level. Additional research aspects within the Institute have the potential to be further developed offering expertise both at national and international level. First steps have already been undertaken through ongoing and planned research activities.

Impact on the scientific discipline

The groups' publishing activities are unevenly distributed between the researchers and disciplines. Some are more focussed on national (partially in Latvian) or conference publications while others are clearly more visible in well-recognised international journals (e.g., analytical and Bioanalytical Chemistry, J. Fluorescence, J. Bioluminiscence). The latter ones cover a rather narrow range of the groups' research topics in chemistry and in particular analytical chemistry, e.g., the fluorescence-marker research and part of the river/lake research activities. There is room for improvements in publishing topics in other key disciplines within ecology. The number of citations is modest with more than half being self-citations.

A significant increase with respect to relevant publications was noticed in 2012, probably as a response to research-capacity building through ESF and other projects that started in 2009. The groups ramp up their doctoral programme, which led to a slow increase in the number of dissertations in recent years.

Economic and social impact

The research implemented is of relevance to various sectors, in particular to environmental policy as well as to interactions with business sector for the development of novel observational systems. Interactions with national and regional policy makers are mentioned in the self-assessment report and a few staff members are involved in activities of societal and economic importance, in particular the Institute of Ecology.

There is a need for significant improvement regarding the Institute's active participation in planning and execution of practical case studies at national and international level. This is largely due to the insufficient visibility of the Institute's research potential, which can be explained by the relatively moderate publication record and need for more active role of the staff in various national and international applied type of environment.

The number of PhDs is relatively low, although Master theses are numerous. While this can be regarded as an important societal contribution, still these activities need to be further increased. It is unclear how the themes for the theses are defined and how the work contributes to the prospects of the groups and the candidate.

Research environment and infrastructure

Based on the self-assessment report the Institute can be scored as an important national player. Equipment listed covers the needs for field and laboratory research and observations. The software necessary is also available. Investments into modern equipment would help increase the quality, innovation-potential and originality of the Institute's work and most importantly bring them to the level of effective international cooperation. The groups are largely dependent on international project funds, a source that is unpredictable in its availability. Strong funding dependence on success indicators is evidenced by the improved performance associated with increased funding starting in 2009.

Development potential

The Institution has a potential to become more active player at national and international scene. In addition to unpredictable funding, the key issue mentioned in self-evaluation report is the lack of good and skilled personnel for the implementation of projects outside the narrow educational and research frame that is currently implemented. However, statements on how to improve the current situation are very general without clear and well-defined goals and means of how to achieve them. The mid- and long-term planning seems to be ambitious when compared with the current situation. The Institute fails to make a convincing point that the goals set can realistically be achieved.

Conclusions and recommendations

These groups are located at the University of Daugavpils and represent very important regional centre in Latvia that deals with environmental topics of specific regional

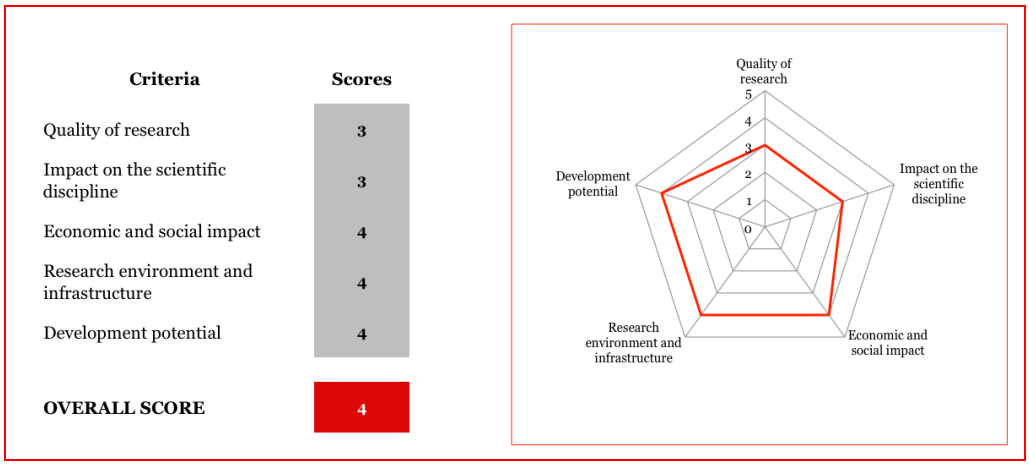
character and needs. As such, it is of a strategic importance to build regional expertise that can be of significance for Latvia and to a wider European region. The research topics should be optimised with other research institutions/infrastructure in Latvia dealing with environmental research, so that the focus of research at the University of Daugavpils can be better defined and focused. The capacity held by the researchers is very high and should be maintained and further exploited.

4. M_04_G.Liberts Innovative Microscopy Centre, Department of Physics, Mathematical Research Center

Name of the institution	**G.Liberts Innovative Microscopy Centre, Department of Physics, Mathematical Research Center**
Name of university	Daugavpils University
Type of institution	University

This is a small institute with academic personnel of only nine people. Most of them work in the field of functional materials for nanotechnology and holography. The Institution is the national centre for microscopy (*not* electron microscopy).

Figure 4 Assessment of the Research Quality of the G.Liberts Innovative Microscopy Centre, Department of Physics, Mathematical Research Center



Overall Score

The G. Liberts Innovative Microscopy Centre localized within the Department of Physics of Daugavpils University is a small unit working in the field of holographic recording and nanotechnology. The unit involves an excellent infrastructure for this type of materials research. The centre has been able to attract a considerable amount of external, especially European, funding during the last years and there is a good potential to attract more research funds in the future which will be essential for this Institution. In order to materialize the vision of the unit as a "European level research centre in nanotechnology and materials science" more visibility in terms of publications and other exploitation and dissemination activities is needed. Nevertheless, the unit has the potential for a development towards a strong international leader.

Quality of research

The Institution conducts good solid research, but the results are not published in the best international journals. Moreover, the overall number of scientific papers is moderate. At the same time, four new PhDs in the period of 2006-2012 is a quite good result for a department of only nine people.

Impact on the scientific discipline

Too much of the Institution's papers are published in conference proceedings and Latvian journals. These are not particularly visible internationally and thus the impact of the Institution's research on the scientific discipline has suffered. The papers are not particularly well cited.

Economic and social impact

There is a relatively high amount of external funding, especially in 2011/2012, and especially from ERDF and ESF (Structural Funds) infrastructure projects. This indicates some significant social impact. The research fields of the Institution are such that one would expect collaboration with industry. However, there is very little interaction with companies, it exists only in the field of holographic recording where some positive developments can be discerned. The Institution is well connected to the rest of Latvia, although it is located in a disconnected area. The Institution is very active in outreach.

Research environment and infrastructure

There is some excellent infrastructure especially in the field of holographic recording/nanotechnology, mainly obtained from EU Structural Funds. The good infrastructure/environment may open ways to collaborate with international and national companies as well as to take part in future collaborative projects. The facilities are really good; furthermore they are building new facilities to replace some that are outdated. In the long run renewal and maintenance of necessary equipment can be difficult because of shortage of funding. There are many young people around, and the management is good. Its enthusiastic PhD students are one of the greatest resources of the Institution. They could really benefit from mobility programmes if they had access to them. The Institution is well connected to the neighbouring countries, but more international orientation is needed.

Development potential

The Institution has a strategy for its development in the coming years. It has the vision to become a "European level research centre in nanotechnology and materials science". Some of the goals may be difficult to achieve for an Institution of only nine people. Only a small fraction of the funding is core funding from the state. The rest is project based funding (research councils and other funding). There is a good potential to attract research funds also in the future which is essential for the Institution. If for some reasons the project based funding decreases, it will have a large negative effect on the functioning of the Institution. The Institution should have the potential to act as a recognised partner in EU-funded collaborative projects in its fields of research.

Conclusions and recommendations

This is a small, but well-functioning Institution. Panel Members were impressed by the site visit, which gave a much more positive picture of the Institution than the one formed based on the self-assessment report. People are dedicated, active and would like to build, develop the area. The structure of the Institution is really good, with a few senior scientists and enthusiastic PhD students. In order to reach the goals set forth in the strategy the Institution should:

- Publish in highly regarded international journals
- Enhance their international collaboration
- Apply for European funds allowing mobility of their PhD students
- Apply for EU Framework Programme Projects.

5. M_05_Faculty of Chemistry

Name of the institution	**Faculty of Chemistry**
Name of university	University of Latvia
Type of institution	University

The Faculty of Chemistry of the University of Latvia is organized in four chairs and three centres. The chairs include:

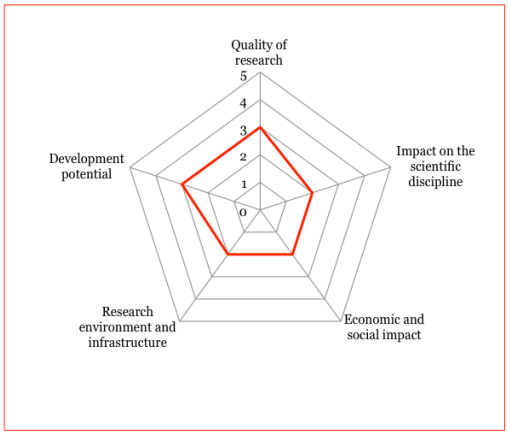
- Analytical chemistry
- Inorganic chemistry
- Organic chemistry and
- Physical chemistry.

The three centres are:

- Environmental studies
- Food chemistry and
- Chemistry didactics.

Figure 5 Assessment of the Research Quality of the Faculty of Chemistry

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	2
Economic and social impact	2
Research environment and infrastructure	2
Development potential	3
OVERALL SCORE	2



Overall Score

The national as well as the international impact of the Faculty's current research is limited with the exception of very few individuals. Based on the current competences organic chemistry should be a primary research focus of the Faculty. With chemical industry only present at a very limited level in Latvia industrial contacts need to be developed on a regional or European level. This would be also important in gaining resources to keep the key players with the Faculty and to offer them a reasonable funded research and teaching environment. It can be hoped that starting from this positive nucleus a quality surge for other members of the Faculty may result.

Quality of Research

The Faculty's research portfolio covers a number of topics in the field of chemistry necessary for the education of chemists with different degrees of success and visibility. The quality of the research is very inhomogeneous. Results on functional materials and nanotechnology, ergonomics, food science and pharmaceutical chemistry are recognised at an international level as a result of well executed development plans during the last 5-10 years. Some researchers show a good or very good track record: e.g., Silvija Abele (photochemistry, photopolymerization), Liana Orala (Crystallography) and Edgars Suna (Organic Chemistry, excellent performance).

Impact on the scientific discipline

The overall output is only moderate. The majority of the published papers were not cited by others. There are a few very good researchers in this Faculty: Edgars Suna publishes in journals with very high reputation. The national as well as the international impact of the Faculty's research is however somewhat limited. Within the above mentioned research foci a smaller number of long-term co-operations - e.g., with German and South African universities in the fields of chemical education and functional materials - exist resulting in common publications, but not necessary in the involvement of the faculty members in various European projects. Beyond these research foci a wider impact of the research is not really documented in the Faculty's self-assessment report. The number of enrolled PhD students (ca. 5 degrees/year) is reasonable but should be increased.

Economic and social impact

The amount of external funding is rather low. There were only a three FP projects documented in the self-assessment report, including one FP7 project with a topic in chemical education and two finished FP6 projects in the field of nanotechnology. Additionally, some contract research with a small budget is mentioned. The Faculty plays an important role in the education/graduation of chemists in Latvia. There are not many contacts to industry documented, which might be partially due to the fact that there is not much chemistry-related industry in Latvia. This also limits the job options for the Master's and PhD graduates.

Research environment and infrastructure

The research equipment available forms an acceptable basis for the active research fields. In some subareas a relatively good environment exists (X-ray methods, chromatography, trace element analysis, ICP-MS) but overall, the equipment does not seem to be fully appropriate. Te self-assessment report did not provide any information with respect to the equipments' age and functionality. Besides some European infrastructure-support projects and funds all funding comes from state-governmental sources essentially. There was no direct industry funding listed in the Faculty's report. This is a very unhealthy situation for a chemistry faculty. The further development of the Faculty will be crucially dependent on infrastructure improvements.

Development potential

The development plans for the upcoming five years for the above-mentioned research foci were described in the self-assessment report only in a bullet-point style and without any indication of the resources needed to achieve these goals. Although it is mentioned in the report that the state-government support has decreased significantly, the Faculty's planning does not reflect this situation, and fails to identify alternative sources. A continued stream of European funding cannot be taken for granted.

The development of the Faculty will be strongly coupled (i) to the attraction of internationally recognised, promising young faculty members who are familiar with international research standards, and (ii) to infrastructure improvements. The Faculty plans to focus the research on areas of materials science, organic chemistry, analytical chemistry, and chemical education.

Conclusions and recommendations

Based on the current competences organic chemistry should be a primary research focus. The excellent people currently present must be taken care of in the future to avoid loosing them. Some strategic decisions are urgently needed to attract external (international) funding to help attract active scientist from the outside. With chemical industry only present at a very limited level in Latvia industrial contacts need to be developed on a regional or European level.

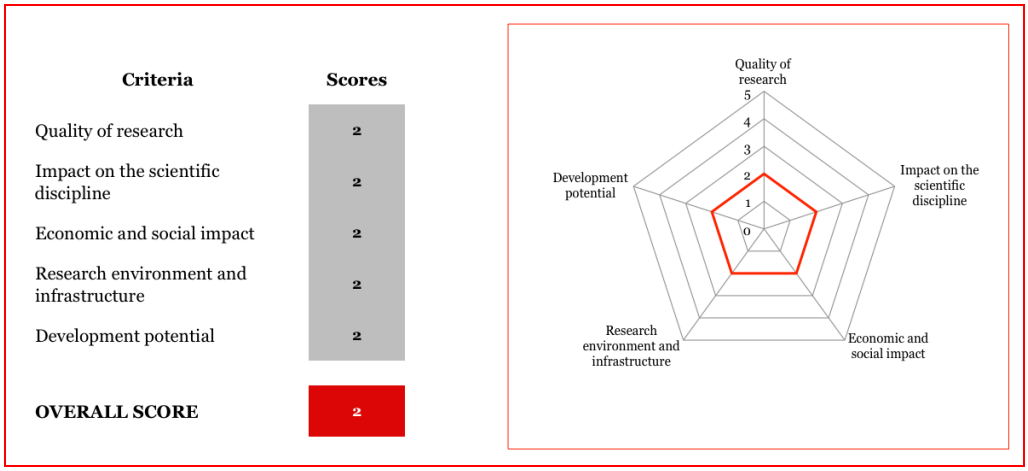
6. M_06_Department of Mathematics

Name of the institution	Department of Mathematics
Name of university	University of Latvia
Type of institution	University

The Department carries out research in a variety of mathematical fields. Applications to physics play a prominent role. Industrial problems and numerical methods to solve specific applied problems are also in the focus. Discrete and continuous dynamical systems are also worth mentioning. Multi-valued mathematical structures in topology, algebra and analysis, approximation under inexact information, cryptography, probability theory and statistics, didactics of high school mathematics are other fields of interest at the department.

Many of the academic personnel are also affiliated with the Institute of Mathematics and Computer Science at the University of Latvia.

Figure 6 Assessment of the Research Quality of the Department of Mathematics



Overall Score

The low score given to this Institution is due to the little international recognition and the little impact on the development of the scientific discipline: this is corroborated by the lack of international collaborations. Although the research fields are very much application oriented, there are neither contact with industry nor collaborative activities. The publications of the Institution are mainly in conference proceedings and low impact journals. The number of publications per year is low and they are poorly cited. The number of trained students is also low.

Quality of research

Many of the research fields, for example numerical analysis, mathematical physics, dynamical systems, cryptography, probability are internationally highly competitive fields of research and the team does not appear to belong to the international forefront, although the Department does solid work in these fields. The work on fuzzy sets and multi-valued structures is sound research in pure mathematics, but seems to be a little bit away from mainstream mathematics. Most of the results are published in conference proceedings and obscure journals. It is clear that the research is at the national level, with weak international visibility.

Impact on the scientific discipline

The impact is quite low. The main reason is that the Institution publishes mainly in conference proceedings and obscure journals. The number of publications per year is rather low and they are poorly cited. The number of trained students is also low. There are almost no research visits abroad and very few presentations at international conferences. The only research collaborators are from the neighbouring countries, Lithuania and Estonia, but published papers do not seem to have followed these collaborative activities. It is therefore fair to say that although the Department occupies a stable position in the national scientific community it has received little international recognition and has had little impact on the development of the scientific discipline.

Economic and social impact

Mathematics is a fundamental methodological science that is applied not only in the natural sciences but nowadays also in social sciences and the humanities as well as in all parts of society. It is of fundamental importance for the development of the Latvian society and economy to have high-level education and research in Latvia.

Much of the research of the Department deals with physical applications and as such may have economic and social impact. Although the research fields are very much application oriented, there are neither connections to industry nor industrial collaborative activities.

Taking into account the small size of the Department, the laboratory has done quite well in educating new PhDs with an average of two new doctoral graduates a year. All of them are employed, also outside academia.

Research environment and infrastructure

There is almost no information about the equipment of the laboratory in the self-assessment report. Neither is there any information on the availability of support services, research infrastructures and databases. There is no administrative personnel. On the one hand, one might argue that it is better to hire research and teaching staff. However, this also means that the researchers and teachers have to be their own secretaries, which is not an optimal solution. On the other hand, there is an ample resource of administrative and technical support at the Institute of Mathematics and Computer Science at the University of Latvia, which this Department should be allowed to use as well. Merging these two Institutions would benefit both.

The main deficiency in the research environment is the almost complete lack of international collaboration. In the six-year period under evaluation there was not a single visiting professor, researcher or student visiting the Department for at least one month.

Development potential

The present trend in the development of the personnel seems very worrying. The age structure is unhealthily skewed. The professors are old. In the period 2006 - 2011 the academic personnel has almost halved and the number of professors has dropped to about one third. In the same time period there has been a slight increase in "Academic Research Personnel", but this is no compensation. People previously listed as Full Professors reappear later as "Leading Researcher". The main challenge for the Department is to recruit new young professors who could take a leading role in the development of the research at the department. Only by doing so can the Department remain a visible local player in its research area and could possibly reach an international level. However, this needs a substantial effort, in particular it needs financial commitment.

Conclusions and recommendations

The Department does solid work in pure and applied mathematics at a national level. The present state of the Department and the trend for the future seem very worrying. The low amount of funding, the recent drastic drop in academic personnel, and the skewed age-distribution of the employees are real threats to the future development of the Institute. To maintain the Department's role as a local player and make it internationally more visible, it is necessary to immediately:

- Start recruiting new young professors
- Improve the management of the Department
- Consider merging the department with the Institute of Mathematics and Computer Science
- Increase international collaboration
- Apply for EU Framework Programme Projects and
- Obtain postdoctoral positions from European grants.

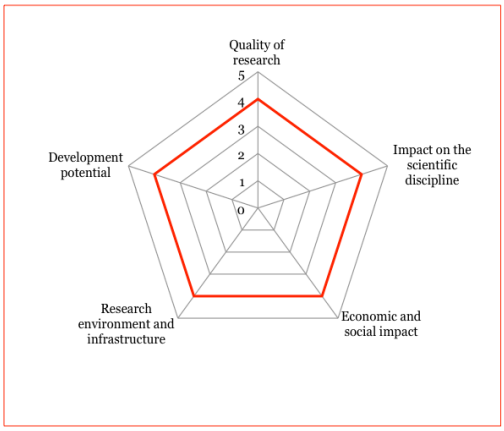
7. M_07_Department of Physics and Department of Optometry and Optical Science

Name of the institution	**Department of Physics and Department of Optometry and Optical Science**
Name of university	University of Latvia Faculty of Physics and Mathematics
Type of institution	University

The Institution is part of the Faculty of Physics at the University of Latvia, and it consists of two departments: the Department of Physics and the Department of Optometry and Optical Sciences and the Laser Center of the University of Latvia. The Laser Centre is the largest laser resource in Latvia and a leading national centre of laser based research involving atomic, molecular and chemical physics, astrophysics (studies of chemical composition of stellar atmosphere) and various applications of laser techniques. Its modern infrastructure allows performing high-resolution spectroscopy, and is further developed for laser manipulation of atomic and molecular quantum states, and to obtain Bose-Einstein condensate. The Department of Physics performs high-level research in area of theory of single electron current sources, magnetic colloids, modelling of crystal growth processes and modelling of environmental and technological processes. The main task of the Department of Optometry and Optical Sciences is to provide optometrists with the up-to-date knowledge in optical materials and related optics, as well as visual perception.

Figure 7 Assessment of the Research Quality of the Department of Physics and Department of Optometry and Optical Science

Criteria	Scores
Quality of research	4
Impact on the scientific discipline	4
Economic and social impact	4
Research environment and infrastructure	4
Development potential	4
OVERALL SCORE	4



Overall Score

The Department of Physics, Department of Optometry and Optical Science, and the Laser Center of the University of Latvia show a very good level of scientific research. The units are visible internationally and their strong side is up-to-date research topics, modernised infrastructure and high involvement of PhD students in research.

Quality of the research

The scientific research in the two departments and the Laser Center is organised according to the long-term strategic plans of the University of Latvia, with the main goal to be a leading education and research facility in the Baltic region and highly ranked among European universities. The two departments and the Laser Center provide

generally good level of research, and the realised research topics are up-to-date. The Institute involves groups leaded by internationally recognised scientists, e.g., A. Cebers, V. Kashcheyevs, E. Ferber, M. Auzinsh, A. Muiznieks, publishing in high-impact international journals. On the other hand, there are scientists involved in interesting research, but with low visibility in the scientific community, and outputs mainly in conference proceedings, or low-impact Latvian journals. The evaluated institution has good number of citations per publication and a high total number of citations. Experimental equipment has been strongly modernised in the recent years, mainly due to European funds, giving possibility for high-level research. A record number of 45 of PhD degrees was reached during the time period covered by this evaluation. Most of MSc and PhD students are involved in research projects.

Impact on the scientific discipline

The Laser Centre is a leading centre in Latvia, bringing together different laser based research. Also, the two departments have good scientific achievements. The units perform very good level of research in the area of magnetic colloids (A. Cebers - internationally recognized, world pioneer in this currently very important subject in many areas including biology and medicine), atomic and molecular physics (M. Auzinsh, R. Ferbers - specialists in light-atom interactions, magneto-optical resonances in atoms and atomic potentials), theory of quantum nanoelectronics (V. Kashcheyevs – one of the world leaders in theory of single electron current sources based on quantum dots) and modelling of crystal growth processes (A. Muiznieks). However, not all scientific groups are performing at this level. The total number of invited talks and especially total number of invited speakers are small. The groups were the main organisers of a few international conferences, inviting world specialists. They have broad international collaboration and they participated in several projects including FP7, ESF, ERDF, NSF, NATO research projects, Fulbright programme, market oriented and contract research projects, also with foreign partners. A long list of joint publications with international collaborators is provided in the institution's self-assessment report. The Physics Department has "cotutelle thesis" in collaboration with France. The number of publications in journals both in 2010 and 2011 was rather low; however in 2012, it has moved substantially up.

Economic and social impact

The groups are national leaders in higher education in their respective fields of activity at all three levels: bachelor, master and doctoral education. They enrolled a record number of PhD students and a record number of PhD degrees were granted, with respect to other institutes assessed by the Natural Sciences and Mathematics Panel. It is worth mentioning the education of optometrists. Research performed in the groups of the institution is important for society. There are several market-oriented projects conducted, tackling both needs of Latvian partners and of German industrial partners. The most notable examples are: the project contracted with the Latvia National Armed Forces Joint Headquarters, which enabled the Latvian Navy to develop an operational oceanography model for waters of Latvia's jurisdiction and added a meteorological service linked with real-time meteorological observations. Furthermore mathematical modelling developed at the Department of Physics helped to improve substantially industrial Si growth methods used by German crystal producer Siltronics AG. Research at the institution has produced two spin-offs. The institution is also very active in school education and in popularisation of science by contributing to activities such as summer camp "Alfa" for gifted high-school students, national physics Olympiads, and research project conference of high-school students.

Research environment and infrastructure

The institution has developed a research strategy for the years 2010-2020. The strategic paper outlines important future directions and goals of the planned research activities. Funding is constantly increasing. There is substantial increase in funding coming from European sources. The infrastructure of the institution is quite decent, especially the experimental equipment for magnetic soft materials and laser based studies. There are

also high efficiency computer clusters, software, journal and databases available, although the access to research journals and data bases is reported as insufficient. In the recent years modern equipment has been purchased through European funds. Infrastructure is available for internal and external users. The number of technical and administration staff seems to be sufficient.

Development potential

The groups within the institutes have really good potential in terms of academic knowledge, existing experimental base and research expertise gained. Core funding, state budget funding, grants of the Latvian Council of Science and State Research Programmes have established stable reputation of the groups of the institution as serious research centers in Latvia. These grants also supported the very basic needs of the research activities, but the funding was not at all sufficient to enable serious development of research in physics at international level. The institution was however very active in attracting international funding - mostly European – which has allowed maintaining high level, internationally recognised research in physics. The groups of the institution have realistically assessed their SWOT. They have concerns about the future especially regarding the financing possibilities of PhD students, young researchers, exchange visits or necessary further development of the infrastructure. These concerns are reinforced by the insufficient national research funding - with sharp decrease during the last two-three years - and by the expected end of a substantial part of the European support. However, they have a clear vision of further development. Assuming that they will be able to attract enough funding in the future, there is a good chance that they establish themselves as a recognised and respected player in the international scientific community within some research subjects, especially those which are already recognised internationally.

Conclusions and recommendations

The achievements of the institution as described in the self-assessment report and the impressions from the site-visit underline that the institution provides an internationally comparable high level of education and research, especially in solid state physics, modern material science (including nanoscience), magnetic hydrodynamics, atomic and molecular laser spectroscopy, astro-spectroscopy and medical physics (optometry). The units have also proved the potential that lays in close collaboration with external partners, showing that the results of applied physics can lead to “real” products with high added value both at national and international level. The institution should be treated as high priority by the government and supported decently. Especially important are to have clear policies regarding funds for PhD students, post-docs, exchange visits, maintenance and further development of infrastructure.

8. M_08_Faculty of Geography and Earth Sciences

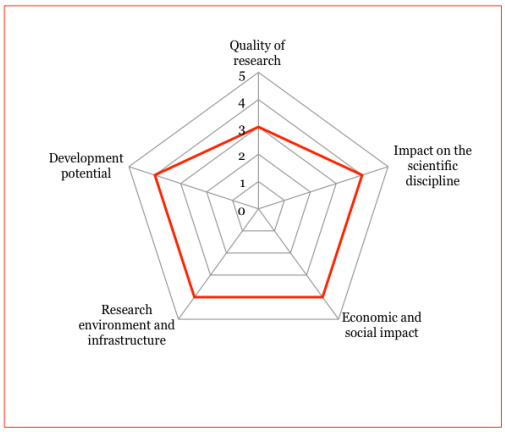
Name of the institution	Faculty of Geography and Earth Sciences
Name of university	University of Latvia Faculty of Geography and Earth Sciences
Type of institution	University

The Faculty of Geography and Earth Sciences of the University of Latvia is one of the leading institutions in Latvia dealing with geology, geography and environmental sciences. It is a unique merge of disciplines needed for implementation of interdisciplinary environmental research. The Faculty is integrated into a wider research arena as demonstrated by collaboration with academic and non-academic sectors.

The research at the Faculty is currently well organised with national and international visibility and high level of developmental potential.

Figure 8 Assessment of the Research Quality of the Faculty of Geography and Earth Sciences

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	4
Economic and social impact	4
Research environment and infrastructure	4
Development potential	4
OVERALL SCORE	4



Overall Score

The research at the institution is currently well organised with national and internationally visibility and high level of developmental potential.

Quality of the research

The Faculty performs high standard research in many fields of environmental sciences. The thematic groups, each covering particular fields, are balanced and well suited to cover wide range of interdisciplinary research related to environment at large. International cooperation is also well represented. The research implemented is publishable in the best journals dealing with environmental issues. During the period under evaluation the Faculty has been involved in international collaboration, which has led to one paper in Nature and one in Science. The Faculty has also published in other well-known international journals. The number of original articles cited in SCOPUS, WOS etc. is very good, but modest compared to the number of articles published in national scientific journals and proceedings at conferences.

Impact on the scientific discipline

The scientific outputs are very good, well recognised at national and international level. Relevance and excellence of the published work is also demonstrated by high citation

index, as on average each paper is cited 9 times which is among the best scores in Latvia. Very good production of new PhDs represent an important impact on the scientific discipline. In addition to the extensive list of journal articles, the number of presentations - including invited presentation - is also high. A considerable proportion of the publications are still in Latvian series. Although, in general, outstanding outputs are recorded, this seems to be concentrated around some key researchers.

Economic and social impact

Collaboration with non-academic partners is intensive, although mostly with governmental and societal sectors. Direct interactions with industry are mentioned in the Faculty's self-assessment report, and these are primarily due to the nature of the work carried out. Such interactions are also reflected in a few patents. The work has already direct impact on better environmental management practises in society. In this respect the merger of the disciplines is very practical. The representatives of the Faculty are members of important national bodies addressing environmental issues. The Faculty is also very active in the organisation of international meetings and events.

Research environment and infrastructure

The Department is sufficiently large to provide a good research environment. International collaboration is also prevalent with guest professors and team members spending extended periods abroad. The budget of the Department is well balanced consisting of national funding (state and industry) as well as international such as FP7, networks etc. funding sources. The age structure of the academic staff is also well balanced, covering all age groups. The proportion of support staff seem to be large - over 30% - which in the long run will be difficult to sustain, especially due to the decrease in financial resources for research in general. Some members of the academic staff seem to be less productive and remedial actions to improve the situation are not discussed in the self-assessment report.

The research goal orientation to improve the infrastructure is in place and well planned. The description of premises for implementation of the research is however lacking in the Faculty's self-assessment.

Development potential

The researchers proved to be successful in international competition as a result of healthy research strategies and plans put in place. Improved national research funding and policies may also help the situation. The research themes are compliant with national and international priorities. The SWOT analysis is well presented, recognising weaknesses and threats supported by exact and clear information. The development plans regarding visits and students from and to abroad have positive results, although there is still some room for improvement.

Conclusions and recommendations

This institution needs to be recognised as a strong national player with high international potential. Funding at the national level needs to be provided in a more sustainable/stable manner so that the research plans are not highly dependant on international funding. This Faculty demonstrates all qualities necessary to become one the leading environmental research institutes in Latvia. Their role as coordinators of these activities at the national level should be considered.

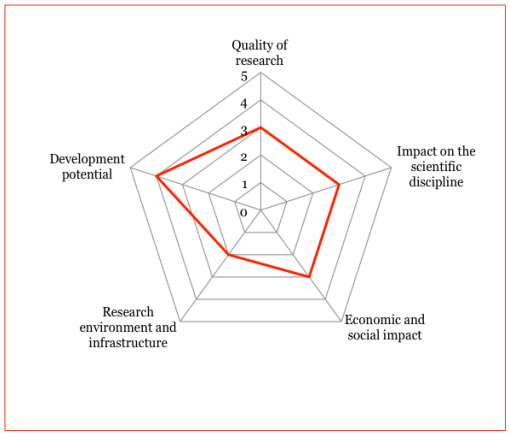
9. M_09_Institute of Astronomy

Name of the institution	Institute of Astronomy
Name of university	University of Latvia
Type of institution	University

The Institute of Astronomy performs research on stars and interstellar medium, microwave sources at Sun and asteroids in the Solar System. It updates and maintains General Catalogue of Galactic Carbon Stars. The Institute runs a satellite laser ranging system (SLR, which has been in substantial part designed on the site) and a permanent GPS station. SLR and GPS stations, working with high accuracy, are involved in international service, define the origin of the Latvian national geodetic coordinate system and tie it to international reference frames. The Institute provides design of small optical systems, and software support and construction of laser ranging equipment for its own use, and also for international collaborators.

Figure 9 Assessment of the Research Quality of the Institute of Astronomy

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	3
Research environment and infrastructure	2
Development potential	4
OVERALL SCORE	3



Overall Score

The Institute of Astronomy shows a good level of scientific research, especially in the field of navigation which is an area important both for Latvia and the international community. It should increase its internal visibility by stronger use of its potential (good infrastructure and skilled scientists) for extending research portfolio to more up-to-date research topics. Current international exchange and activity in attracting national funds are not satisfactory. The REGPOT 'Fotonika-LV' project and Latvia's accession to the European Space Agency create perspectives for further development of the Institute.

Quality of the research

The Institute is actually a small laboratory with around 20 researchers, and only one PhD degree was completed during the evaluation period. The research topics are interesting but outside the main stream of current astronomy exploratory studies. This influences the scientific output. Average number of citations per publication is low and the number of research outputs in Scopus for the time period under evaluation is small. Most papers are published in journals with low impact factor, or in conference proceedings. No invited talks at international conferences are listed in the Institute's self-assessment report. Four publications in high impact journals should be however acknowledged. The Panel also wants to point out that the number of publications,

although rather low during the past few years, has significantly increased in 2012. Archived and constantly updated General Catalogue of Galactic Carbon Stars (late-type stars) with about 40,000 monthly requests has proven to be very useful for the international community. Applied research, especially in the field of navigation and design of small optical systems, constitutes an important part of the Institute's research, which is performed very professionally building on long traditions and substantial expertise gained.

Impact on the scientific discipline

The low number of publications and their citations project that the results of the Institute's basic research are not much visible in the scientific world. The Institute has not organised any international conferences. There were only two visits (1-2 months) abroad, and no visits longer than 1 month from foreign collaborators during the evaluated period. However, the Institute has a lot of national and international collaboration. The abrupt change in the international visibility of the Institute's research can be expected in the near future, since the Institute - together with the Institute of Atomic Physics and Spectroscopy and the Institute of Geodesy and Geoinformatics, University of Latvia - took the initiative to create a multidisciplinary association called "Fotonika-LV" and submitted a project proposal to the FP7 REGPOT call for proposals. Although it was a highly competitive call, the project was accepted and awarded. The REGPOT project involves strategic partnership with leading European institutions including the Max Planck Institute of Quantum Optics, GFZ-Potsdam, the Finnish Geodesic Institute and the Lund Laser Centre. This clearly shows recognition of the quality of the laboratory, and opens possibilities to employ leading international experts in the planned research, organise international conferences, and improve student and researcher mobility. As already mentioned above, a very strong side of the Institute is its experimental base and especially skills in calculation and design of equipment for laser ranging systems, spectrographs and optical components for telescopes. In the past high precision instruments designed and constructed by scientists from the Institute were used for observatories in many countries. These traditional skills have been used recently in construction of scientific equipment for Germany, Japan and Finland.

Economic and social impact

The research of the Institute and especially applied research is important for local and international society. The Institute works in the area of Global Navigation Satellite System service as part of world-wide activities. Observations of the Sun and small objects in Solar System performed at the Institute serve for weather forecast and help to keep safety on Earth. The Institute contributes to popularisation of astronomy by publishing a popular science journal. It also serves world scientific communities by maintaining the General Catalogue of Galactic Carbon Stars. The Institute has collaboration with SMEs in field of optomechanical equipment, design of small telescopes, and observation system for Ministry of Defence. Upon a request of the GeoforschZentrum Potsdam the Institute has also improved a satellite laser ranging system.

Research environment and infrastructure

The Institute has defined the main research directions for the coming years, which encompass generally the continuation of the present research portfolio, i.e., late evolution stars, interstellar medium, asteroids, maintaining catalogue of carbon stars, digitalization of the Schmidt telescope photographic archive, satellite laser ranging. The experimental infrastructure is decent: astrophysical observatory at Baldone and satellite laser ranging station at Riga have valuable scientific equipment, which with moderate investment can be upgraded to the world-class state of art systems. Such infrastructure opens a wide range of possibilities for modern astronomical observations, experiments in physics and theoretical research. Financial resource planning is difficult for the Institute, because of the substantial decrease of core funding starting from 2008, and not big activity in raising Latvian funding that is awarded competitively. The Institute had no grants from the Latvian Council of Science in 2011 and 2012. All plans are based

practically on funding coming from the FP7-REGPOT project "Fotonica-LV" which allows planning of an upgrade of the equipment and temporary employment of good scientists from abroad. This should substantially strengthen scientific activity at the Institute. However, the Institute should try to find alternative sources of funding as well.

Development potential

The Institute has untapped potential in terms of its ability to participate in international research competition. It has quite a good infrastructure and skilled scientists, especially in experimental observatory astrophysics and navigation systems. It is very important for such a small institute to have close collaboration with other centres with common projects. The amount of attracted funds by the Institute has been very small with some recent improvement. The above-mentioned above FP7-REGPOT "Fotonica-LV" project (to be implemented during 2011-2015) involves strategic partnership with leading European institutions. The Institute plans to upgrade the infrastructure, and to recruit good scientists from abroad for 12-36 months. The problem of the Institute with the aging staff can also be at least partially and temporarily solved with use of the REGPOT money. The other possibility to further develop the Institute is due to Latvia's accession to the European Space Agency (European Cooperating State Agreement signed in 2013), which should provide the opportunity for the Institute to expand its local and international collaboration.

Conclusions and recommendations

The Institute plays an important role for society in applied research connected with satellite laser ranging system and permanent GPS station. This activity is vital for Latvia and for the international community, but it needs state support. Regarding basic research, the Institute has showed its ability to raise European funds by obtaining FP7-REGPOT "Fotonica-LV", and obtaining additional competitively awarded funding is absolutely necessary. The Institute still needs an upgrade of its infrastructure and funds available for PhD students and post-docs, especially to address the ageing problem. Funds for such activities should be available first of all in national competitions. A separate problem is to reach a critical mass – this is a very small Institute, therefore it should have close connections with other research institutes of similar or complementary expertise. Probably, collaboration with the Institute of Atomic Physics and Spectroscopy and the Institute of Geodesy and Geoinformatics within "Fotonica-LV" project will create deeper links among those Institutes of the University of Latvia.

10. M_10_Institute of Atomic Physics and Spectroscopy

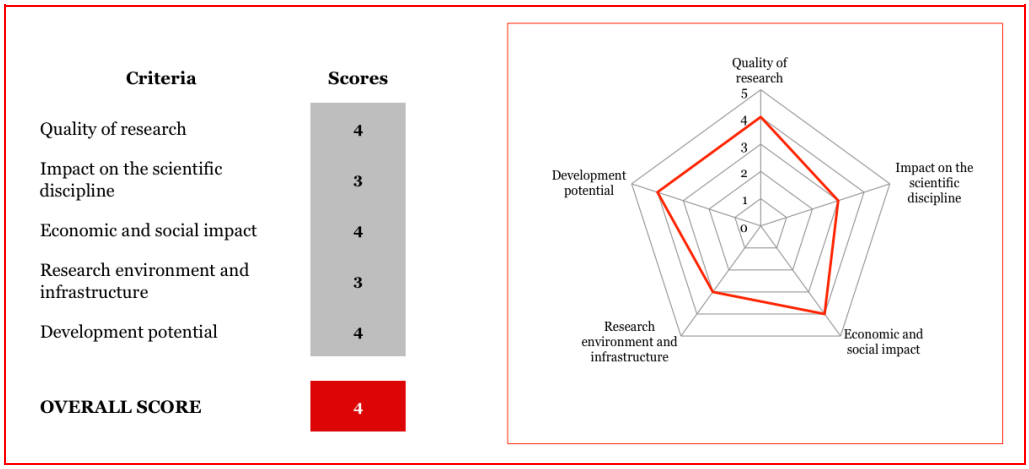
Name of the institution	Institute of Atomic Physics and Spectroscopy
Name of university	University of Latvia
Type of institution	University

The main research topics of the Institute include:

- Plasma research and diagnostics for applications such as light source technology, environment pollution control, and surface treatment
- Biophotonics methods and systems for medical diagnostics, monitoring and imaging
- Sustainability: physics and photochemistry of the polluted atmosphere, environmental engineering
- Theoretical Physics: theory of interaction of atoms with strong laser fields.

The Institute has no academic personnel, only researchers, about 21 in 2012, with a good technical support (10) as described in the self-assessment report.

Figure 10 Assessment of the Research Quality of the Institute of Atomic Physics and Spectroscopy



Overall Score

The overall score of this laboratory (4) is justified by a very good level of basic and applied research, the initiative to federate three Laboratories in the association FOTONIKA-LV with the goal of a sustainable development of photonics in Latvia and the submission of an ambitious project to the FP7 call of proposals REGPOT and obtaining 3.8million LVL. In addition the institution has good links with the emerging industry, a large development potential and a dynamic management.

Quality of research

The basic research is well integrated into various applied research fields of multidisciplinary nature. The research in photonics is highly relevant at national and international level. The importance of the work span from national research areas including the development of devices for pollution control (Hg), and development of optical fibers; regional cooperation in EU funded projects as well as wider international level in areas spanning from theoretical background studies in laser pulse interactions

with atoms, interaction of plasma with materials, bio-photonics and UV spectroscopy in space technology and atmospheric studies.

The researchers are active at national and international level as demonstrated by invited lectures at conferences, membership in editorial boards and participation in internationally funded projects. The list of publications of key researchers demonstrates high quality of basic and applied research results in many of the fields addressed. The number of publications until 2011 was low (9 per year) compared with the number of researchers. Additionally it is surprising to see that some researchers have only two or three publications over a five-year period. Moreover many publications were made in conference proceedings. However, the Panel noticed a substantial increase in 2012 with 17 publications. The number of citations of the research results is acceptable, however lower than expected (number of citations vs. number of papers published). The specificity of selected research topics might be the reason for this. The large amount of money received recently from The REGPOT project may also help to quickly in-crease the number of publications.

Impact on the scientific discipline

Productive interaction with academic and non-academic sectors at national and international level is very good as demonstrated in the list of collaborating institutions. Joint development of technologies in medical field has been put in practice already. Continuous education and mentorship are very strong components of the research group.

The excellence in applied research has been recognised. The list of patents - 8 during the period 2006-2012 - is good. Due to the nature of the work the IPR issues and patenting should be high on the lists.

As for other institutions, many publications are in fact conference proceedings. There are some very good publications but still too many in low profile journals. The number of students and the number of PhD/year need to be increased.

Economic and social impact

In April 2011, the Institute and two other research institutes established the association FOTONIKA–LV with the aim to take responsibility for sustainable advancement of the sector of photonics in Latvia. The association submitted an ambitious FP7 project of basic and applied research in traditional and innovative fields of photonics to the 2011 REGPOT call for proposals and they managed to win winning LVL3.8million. The project started in February 2012.

Since April 2007, the Institute has been a member of the network BALTICNET-PlasmaTEC, a borderless network, standing for a technology and market-oriented cooperation of science, research, and economics in the field of plasma technology. In 2011 the Institute also became a member of the Baltic Photonics Cluster fostering development of photonics industry and applications in the Baltic countries.

The Institute has direct links with the emerging industry around photonics products in Latvia, including fibre-optic cables and assemblies (Z-Light, Ltd), optical crystals and components (ISP Latvia, Ltd.), holographic products (Holograma, Ltd., Difraks, Ltd., Dard-edze Holografija, Ltd.), and others. It should be mentioned that the laboratory has also obtained many contracts from the Seventh Framework Programme and the Institute intends to continue submitting applications. The Institute's efforts should be acknowledged for these initiatives.

Research environment and infrastructure

The different disciplines are well organised in thematic groups with appropriate leadership. Staff members are active participants in various boards making decisions at higher national and EU level, which is a bonus when designing long-term plans for their research agenda. The Institute is mainly composed of research personnel supported by technical staff, who represent more than 40 % of the manpower. The nature of the work

might require such balance, however financially sustaining this ratio among the current financial settings might cause some problems.

The Institute has modern laboratory equipment for optical measurements. The most valuable instruments and equipment were acquired through ERDF (Structural Funds) funding dedicated to the improvement of equipment (2005-2008). The Institute offers the following modern and excellent scientific equipment to collaborative partners:

- Portable Hg analyzer for Hg control in air (DL 1-2 ng/m3)
- High-resolution monochromator 1000 MP with CCD detector for spectral measurements of emission in UV and VIS.
- High resolution Fabry Perrot interferometer
- Spectrometer AVASPEC 2048-2 available for measurement of the absorption and fluorescence spectra within UV, VIS and near IR spectral region
- Blue emission LED arranged with optical fibers at the exit, for connection to a 40 mW power emitter of 405 nm
- Hyperspectral imaging camera NUANCE
- Tunable Ti:Sa laser system equipped for frequency doubling (from IR to UV).

The lab is currently in the process of installing a mobile negative-ion beam apparatus and equipment for optical coating in the basement, with a small clean room.

Development potential

By winning the REGPOT project the Institute has gained an advantage to develop and improve regional potential in research in the near future. A crucial component is of course building a strong group of motivated researchers who will be able to enter into the competitive environment. The nature of their work has very high potential in future national, regional and EU research area. The recent hiring of an excellent young scientist, Janis Alnis, who has spent five years in the T. W. Hänsch laboratory in Garching, Germany, points into that direction.

Interactions with industry are likely to be enhanced, however for this the system needs to provide appropriate conditions, as one institute alone can not make significant advancements in innovation. The potential is very high for innovative sensor technologies field. The laboratory has a young new director and it is on a very positive slope. Due the decrease of the state funding in the last few years, the Institute has been forced to change fundraising strategy by including a stronger emphasis on applied and on research with commercial potential and direct useful benefits for the society in terms of availability of new products.

Conclusions and recommendations

1. It is important to increase the number of PhD students and postdocs, if possible
2. The laboratory has to make an effort to publish more in good international journals and less in conference proceedings
3. The management of IPR and advertisement of research results need to be improved at the institute.

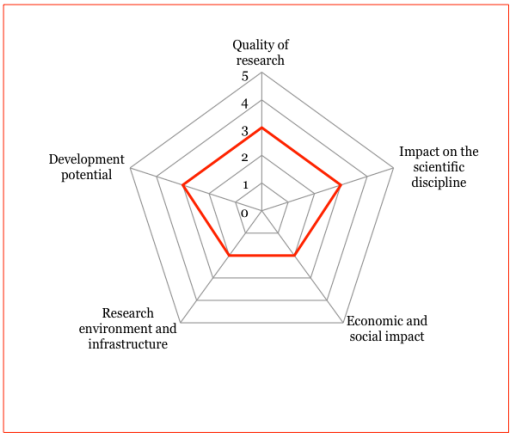
11. M_11_Institute of Chemical Physics

Name of the institution	Institute of Chemical Physics
Name of university	University of Latvia
Type of institution	University

The Institute of Chemical Physics of the University of Latvia includes nanotechnology and radiation chemistry laboratories. In 2012 the *Salaspils* nuclear reactor complex (a Cyclotrone Centre) was included into this Institute. Researchers of the Institute perform science on an internationally well-recognised level. Especially the work of D. Erts and co-workers fulfills highest international standards. Another part of research falls in the field of nuclear research.

Figure 11 Assessment of the Research Quality of the Institute of Chemical Physics

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	2
Research environment and infrastructure	2
Development potential	3
OVERALL SCORE	3



Overall Score

The Institute of Chemical Physics shows a good performance level of scientific research on a well-recognised level, especially in the fields of nanotechnology and nuclear research. Planned investments in new infrastructure and the perspective to move into a new institute's building - planned for 2014 – may give a push for further development.

Quality of the research

The institute is a strong national player with some international recognition. Original and important work was published in the field of nanoscience. Worth mentioning is the engagement of the Institute in European collaboration in the field of fusion energy. Undoubtedly outstanding is the group around D. Erts, with publications in very prestigious journals (Nano Letters, Advanced Materials). The overall number of outputs per researcher seems appropriate but their quality should be increased. The number of Masters and PhD students is relatively low.

Impact on the scientific discipline

The institution occupies a stable position in the international scientific community. First, the institution is important in the field of nuclear research for the Baltic area. Second, research into nanotechnology by D. Erts and co-workers - semiconductor nanowires, nano-devices, carbon nanotubes, carbon and silicon fibers etc. - is a real highlight in the science landscape in Latvia and it represents a very important factor for

the development of nanotechnology. Undoubtedly the institute today continues its long-standing tradition in the development of nano-scale research, e.g., scanning probe microscopes, tools for manipulation of individual nanoscale objects inside TEM and SEM. The Institute has many national and international collaborators in the field of nanotechnology, e.g., with KIT Karlsruhe (DE), Chalmers University (SE), INU Cork (IE).

Economic and social impact

The research topics of the Institute are important for society, e.g., for future micro- or nano-electronics and nuclear fusion research. The level of interaction with business and other non-academic units seems only moderate. No market-oriented or contract projects have been mentioned in the self-report. The institute lists collaborations with some companies in the field of applied research, but not in the frame of existing research projects. D. Erts and his team are active in outreach activities. It should be acknowledged that the Institute provides training courses in radiation safety for about 200 persons per year.

Research environment and infrastructure

Adequate, but relatively aged equipment for high-level research is available in scanning and transmission microscopy (SEM, AFM, TEM) and in the field of nuclear chemistry (scintillation spectrometer, tritium monitors, linear electron accelerator). The room situation is reported as inadequate and flood threatened. The currently available equipment mirrors the main research directions. A new CVD system inside a new clean room environment planned for 2012 will give a push for additional research activities into the nanotechnology field, especially towards generation of graphene layers. The funding situation is not satisfying, with some improvement in external funding (ESF, ERAF) during the last two years, especially in the field of nuclear chemistry and nanotechnology. The research staff evidently lacks scientists from the younger generation.

Development potential

The Institute seems capable of being a visible local player in its area of research and with valuable input to the international community in nanoscience and nuclear fusion research. The planned new research activities into the graphene field may help to attract an increasing number of European research funds. This nanotechnology part possesses a high development potential. New activities in the field of nuclear chemistry are also planned within the ES Euratom programmes 2020+2 and 2050.

Conclusions and recommendations

The age structure of the research personnel is not appropriate. Recommended actions include the establishment of additional full-time research positions and the increase of the number of young experienced scientists.

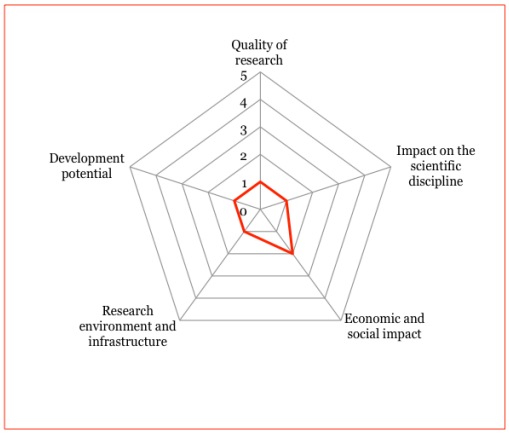
12. M_12_Institution of Geodesy and Geoinformatics

Name of the institution	Institution of Geodesy and Geoinformatics
Name of university	University of Latvia
Type of institution	University

The Institute was founded in 1924 as the Institute of Geodesy but was not operational during the end of the Soviet time. It was re-established in 1994 at the University of Latvia as the Institute of Geodesy and Geoinformatics. Its main task is to provide services in the form of development and applications of technology (GIS, positioning, navigation, remote sensing) for Latvian customers.

Figure 12 Assessment of the Research Quality of the Institution of Geodesy and Geoinformatics

Criteria	Scores
Quality of research	1
Impact on the scientific discipline	1
Economic and social impact	2
Research environment and infrastructure	1
Development potential	1
OVERALL SCORE	1



Overall Score

Both the quantity and the quality of the research, measured in term of the publication output, are insufficient, resulting in limited impact on the scientific discipline. The activities are largely focused on market oriented research projects and short-term contracts. The innovation potential is not clearly evidenced and the future research prospective is insufficiently discussed in the report.

Quality of research

The numbers of research staff and funds allocated are insufficient to perform research of interest to the international research community. The research largely focuses on the implementation of small-scale projects of national priority. Some elements have a potential to be further explored, such as for example imaging methodologies for large-scale observation systems. Both the quantity and the quality of the research, measured in term of the publication output, are insufficient. The list of "Copies of the Institution's/Unit's best publications" contains 14 items, none of which is published in an international journal. Only three papers are attached to the self evaluation. The first one does not appear on the list. It is published in Geodesy and Cartography, a journal not recognized by ISI Thomson Reuters Web of Knowledge. Two new PhDs in the period under evaluation is quite good taking into account that only four researchers at the Institute hold a doctoral degree.

Impact on the scientific discipline

Although a group is small, it has experience that can be exploited by numerous research groups within the national and international research communities. Complementary knowledge available for earth observation studies as well as environmental studies in general should further be exploited. The involvement of the research group in networks has proven to be effective and useful (for example EUPOS). But because of the meagre publication record and obscure publication fora, the Institute has not had any impact on the scientific discipline.

Economic and social impact

Activities reported to have societal impact include various themes from developing new scientific instruments, lecturing, development of DTM models, and close cooperation with the state agency dealing with electronics and computer sciences. Expertise in precise geodesy and cartography is also provided. It is unclear whether this is offered as routine services or as novel research results. The IPR issues and innovation potential are also not clearly presented and discussed. According to the self-assessment report, the activities are largely focused on market oriented research projects and short-term contracts with the users.

Research environment and infrastructure

This is a very small unit. It has only four researchers with a PhD (3.8 FTE). On cannot perform high standard science with such a small personnel. There is basic infrastructure making the research reported in the self-assessment possible but much of the office equipment is outdated. Any further advances in the area of observational science would require considerable investments in research infrastructure.

Development potential

The Institute could develop into an important national player only if considerable investments into infrastructure and personnel are made. At the present level of funding the Institute cannot survive on its own. As the needed increase in funding seems unlikely in the near future one should seriously consider merging the Institute with another unit, e.g., the Faculty of Geography and Earth Sciences at the same university.

Conclusions and recommendations

The group possesses experience in geodesy, astrometry, geoinformatics, cartography, electronics and programming. It could be very important in various types of environmental research as it may offer complimentary experience needed. The Institute lacks critical mass. To survive, it must therefore be merged with another unit, e.g., the Faculty of Geography and Earth Sciences at the same university. This requires a well-thought-out research strategy as otherwise important experience might get lost.

13. M_13_Institute of Applied Chemistry

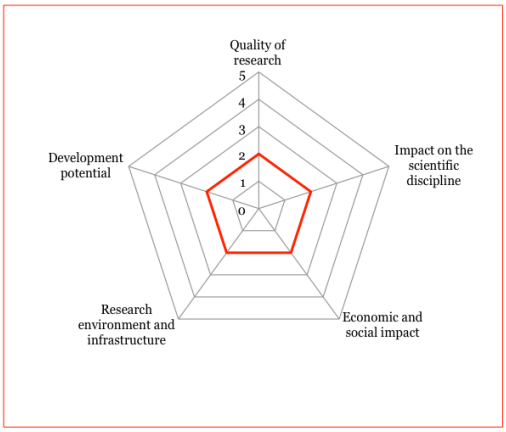
Name of the institution	Institute of Applied Chemistry
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

The Institute of Applied Chemistry is part of the Faculty of Material Science and Applied Chemistry of the Riga Technical University. It is organised in five laboratories:

- Synthesis
- Spectroscopy
- Chromatography
- Fuel Analysis, and
- Food Analysis.

Figure 13 Assessment of the Research Quality of the Institute of Applied Chemistry

Criteria	Scores
Quality of research	2
Impact on the scientific discipline	2
Economic and social impact	2
Research environment and infrastructure	2
Development potential	2
OVERALL SCORE	2



Overall Score

Overall the present research portfolio of the Institute has limited spatial - focussed on Latvia and its immediate neighbours - and temporal - no research activities are to be implemented for longer than the next 5+ years – influence on its field. The Institute needs to reconsider its current research portfolio and to develop international visibility at least in some of its research fields. Development of stronger ties to industry at national, regional, and international levels is absolutely necessary to foster a positive development of the Institute

Quality of research

The different main topics of the research described for this Institute - renewable fuels; organic material for photonics and optoelectronics; recycling of raw materials; synthesis of benzoquinone derivatives - are well established, but in relation to the relatively high number of researchers the output is very limited. The different research topics are not well connected, as there is not much or actually hardly any collaboration between the research tasks. With regards research in the field of bio-fuels, the panel is not convinced whether this is the right research direction for Latvia. Publications and research in the field of optoelectronics represent a traditional research field in the Baltic States.

Impact on the scientific discipline

Main research activities are in the areas of renewable and mixed fuels, further to organic materials for photonics and optoelectronics. In the first area, industrial collaboration is much prevalent, a couple of patents have been filed, and a limited number of international, but mainly national or university publications are listed. The second area is hardly visible on an international level. The publication list focuses on a subset of the professors of the Institute. The number of papers in high-impact journals is low, the average number of citations is approx. 1.2, and the majority of the papers are not cited at all. Some international collaboration exists, but the self-evaluation report did not give detailed information on them. The number of finished PhD dissertations seems moderate.

Economic and social impact

One of the most important 'products' of university institutes are young scientists with a PhD leaving the university to join other academic institutions or industry. With an overall number of professors and docents of 14 an average number of approx. 2 PhDs per year is not overly impressive, which is closely related to a rather small number of doctoral students. The latter however shows a slow increase between 2006 and 2011. Beyond this aspect the Institute has a multitude of links to national and international academic institutions, and it is also well connected to Latvian enterprises of various sizes. There is some economic (and social) impact in the field of bio-fuels. The external funding has been increasing since 2008, however, the amount of these funds is still not at a satisfying level at all. The self-assessment report does not contain much detailed information with regards this point. The Institute also has some contract research.

Research environment and infrastructure

The Institute's equipment is at an acceptable level, and it includes 250 m² of synthesis labs, a laboratory for fuel quality control, a spectroscopy lab (UV-Vis, PL, FTIR, X-ray fluorescence, TG, DTA, DSC), and a chromatography lab specially for fuel analysis. However, there was no information provided regarding the age, availability and usability of the equipment in the Institute's self-assessment report. Neither contained the self-assessment report comments on the state of the Institute's building. The Institute recognises and addresses the lack of younger but experienced scientists in its current structure. This situation - at least partially caused by the unfortunate salary level in Latvia - has a serious potential to endanger currently successful directions of research in the mid- and long-term. The overall funding structure compared with other research institution's budgetary profile seems relatively sound. Private industrial funding is not mentioned, and the from the self-assessment report it is not clear whether at least part of the contract work is funded by industry. The Institute is highly dependent on funding generated from European infrastructure projects.

Development potential

The development plan for the upcoming five years for the above-mentioned research foci are given only in a bullet-point style. No indication is given with respect to the resources needed to achieve these goals. It is mentioned in the report that the state-government support has been decreased significantly, but the planning does not reflect this situation. Furthermore it fails to identify alternative sources, although a continued stream of European funding cannot be taken for granted.

Conclusion and recommendations

Research into fuels / bio-fuels will be of importance 5 to 10 years but not necessary beyond. The Institute must develop international visibility in some research. It also needs to reconsider its current research portfolio and the research behind it. Therefore a development plan beyond the current ideas will be essential.

Given the current and foreseeable situation of Latvia's research budget, the Institute's expectation regarding increased national has to be discarded as unrealistic.

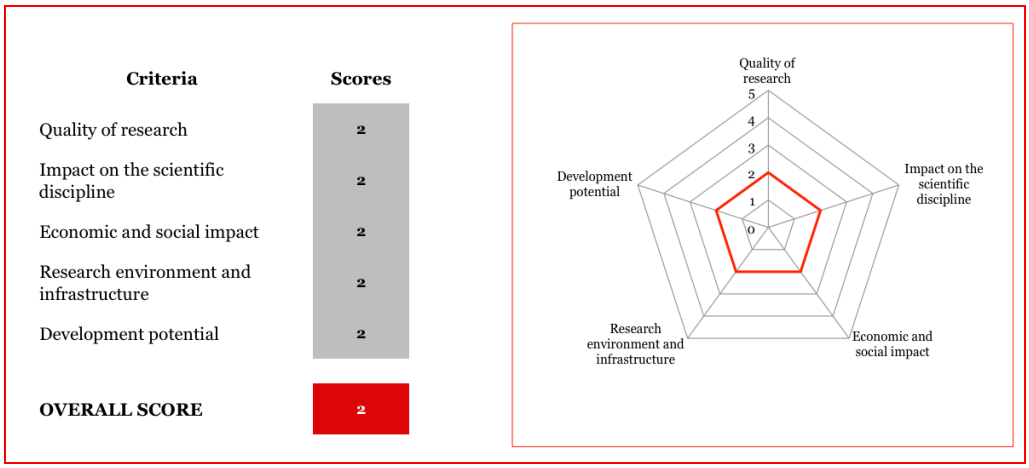
Development of stronger ties to industry at national, regional, and international levels is absolutely necessary to foster a positive development of the Institute.

14. M_14_Institute of Polymer Materials

Name of the institution	Institute of Polymer Materials
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

The Institute of Polymer Materials of RTU carries out research into various fields of fundamental and applied polymer science. Polymers and products based on them represent an important factor of value generation in industrialised nations. This creates a strong demand for new polymer-based materials for an increasing range of applications.

Figure 14 Assessment of the Research Quality of the Institute of Polymer Materials



Overall Score

The Institute of Polymer Materials shows an average performance level of scientific research. There is a strong need for increasing the international visibility of the Institute. Significant investments towards an improved infrastructure of the institute seem necessary for further development.

Quality of the research

The institution seems to be a satisfactory national player. The self-assessment report lists research into synthesis and characterisation of new polymers and polymer-based composites, also for a variety of potential applications including polymer-based composites, fillers for polymers, research into plastics recycling, and polymers for medical applications. The research should be of importance at national level.

Impact on the scientific discipline

The Institute published at a reasonable rate, but failed to be present in high-impact polymer science journals during the last years. Consequently the impact to the polymer community is quite limited. The number of Master and PhD students is increasing, especially the number of the Master students. The Institute is connected to various national and some international research institutes. However, the international impact of this Institution is too low.

Economic and social impact

Training and education in polymer science represents a cornerstone and crucial sub-discipline of chemistry education, since over 1/3rd of chemistry jobs and chemical products are connected to polymers. This point may be very important on a national level. Members of the Institute participate in international conferences, workshops, and faculty exchanges. The close interaction with a number of partners in EU-funded projects may help in bringing the Institute closer in contact with prospective international academic and industrial partners.

Research environment and infrastructure

The amount of external funding is relatively low, but increasing, and includes some contract research and ESF/ERAF funding, especially in the field of bio-based polymer composites. The research equipment especially allows research into polymer processing and characterisation. The equipment seems quite appropriate for the research work that have been carried out during the last years. New microscopy equipment (TEM/SEM + FIB) will be purchased within an ERDF infrastructure project. New infrastructure activities at the European level are planned.

Development potential

The priority area in polymer research as specified in the self-assessment report of the institute is "Materials Science". Two new research sub-directions are planned, but not specified in detail. There is of course some reasonable development potential of the Institution. However, the Institute will be much dependent on attracting new EU grants.

Conclusions and recommendations

With respect to scientific publications the Institute should focus on high impact polymer journals to increase its international visibility and relevance. The current status of the Institute's building seems inadequate and significant investments are necessary to improve the situation. One of the prerequisites for further development will be the attraction of new faculty members willing to do research on an internationally competitive level. Creating a reasonable age structure of the scientific personnel is another must. The attraction of young experienced researchers could help to increase the research potential of the unit.

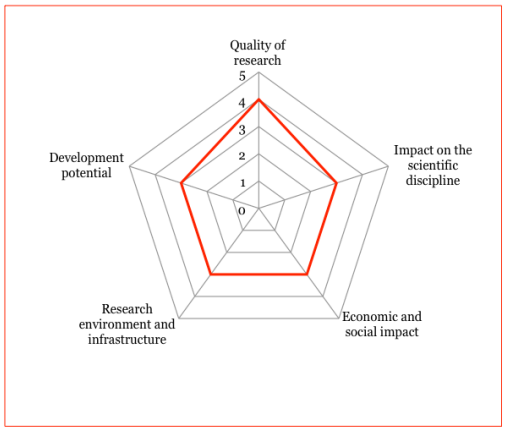
15. M_15_Institute of Technology of Organic Chemistry

Name of the institution	Institute of Technology of Organic Chemistry
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

The Institute belongs to the Faculty of Material Sciences and Applied Chemistry of the Riga Technical University. The Institute is particularly strong in the field of organic synthesis in a number of fields including pharmaceutically relevant substance classes and oil processing plants.

Figure 15 Assessment of the Research Quality of the Institute of Technology of Organic Chemistry

Criteria	Scores
Quality of research	4
Impact on the scientific discipline	3
Economic and social impact	3
Research environment and infrastructure	3
Development potential	3
OVERALL SCORE	3



Overall Score

Overall, the Institute has a high quality of research and a status of well-recognised and respected player in its research fields both at national and international levels. Participation in international competition is strong and ambitious. Organisational structure also allows for identification of priority fields of research in the future. Although contribution of non-academic funds is significant, it can be short-lived and this has been addressed as a problem in the self-assessment report.

Quality of research

The Institute is a strong national and international player. The Institute's research represents a successful mix of basic and applied research. For example the development of new synthesis strategies feeds into pharmaceutical applications. Close interaction between the Institute's researchers and pharmaceutical companies allow for short implementation time of new concepts; moreover these interactions establish fruitful innovation cycle from newly generated knowledge and inventions to implementation in relevant pharmaceutical innovations. Such cooperation also generates additional funds for research. Besides this applied aspect, the Institute's work also broadens the scientific understanding for a number of substance classes, e.g., compounds from various plants and their respective reactions. Participation in EU and other international research funding programmes is significant as well as a strong involvement in projects with the industrial sector.

Impact on the scientific discipline

The research activities resulted in visible contribution well documented by publications in mid- to high-impact factor international journals. The relevance of the research is also demonstrated by very good citation record. In addition to the very good publication record, papers have also been presented at conferences at a very high level. Furthermore, the Institute is very productive in generating patents. Although the Institute's capacity to engage PhDs is evidenced by the staff qualifications, the current number is relatively low.

Economic and social impact

High relevance of the Institute's activities to society is evidenced by a large number of projects funded by the industrial sector and European funds. The strong series of patents generated annually form a solid basis for turning the scientific results into economic value for the industrial partners and thereby for Latvia's economy. In particular, the Institute's strong role and technological contribution to pharmaceutical industry and oil processing plant need to be emphasized. The staff is also active in other non-academic societies and educational activities. Outreach and similar engagement activities were not described sufficiently in the self-assessment report.

Research environment and infrastructure

The Institute is a young establishment within the RTU – it has been operating since 2010 – hence it was created as a result of a recent reorganization. The links with other groups and universities are well established and facilitated. Four thematic groups were established, which can use the laboratories and other infrastructure available at RTU. From the self-assessment report it is not clear how old and reliable the current equipment is. The state base funding is quite limited, and this makes it difficult to renew or even extend the existing equipment. As a consequence, the Institute has to rely on mainly short-term projects and funding obtained from industrial partners to acquire modern new equipment to replace the old ones and to extend the Institute's technical capabilities. No detailed information was provided in the self-assessment report on the state of the Institute's building(s). Problems related to the national economic crisis are recognised as well as the lack of administrative support and the limited possibilities to attract good young researchers. The latter will result in an age structure that may be a problem on a long-term basis.

Development potential

The information presented on the foreseen and planned future development of the Institute is limited. Most of the current activities with a balanced approach between state-funded basic research and applied research based on European and industry-funded projects are to be continued. For both sectors the field of research will remain focused mainly on the current research topics, with some potential extension, hence these constitute the main fields of competence of the Institute. Overall the Institute will be able it maintain its current strong national and visible international role in its research fields. To become a stronger international player a significant improvement in the financial situation would be necessary and advisable.

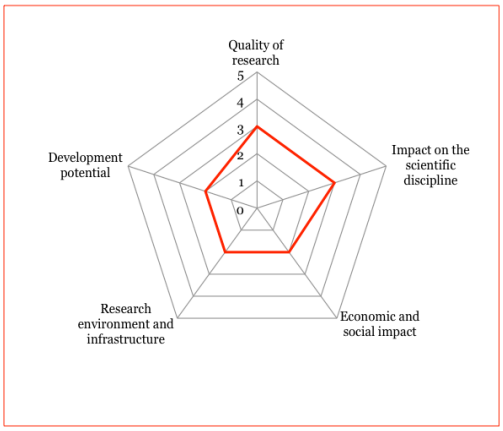
16. M_16_Institute of Technical Physics

Name of the institution	Institute of Technical Physics
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

Institute of Technical Physics is an integrated research and education institute at the Faculty of Materials Science and Applied Chemistry at Riga Technical University. The Institute conducts fundamental and applied research in technical physics and material science. The main research topics are related to new materials for information technology (like sensor materials), for holographic recording of information and for energy applications. The scientific activities are integrated with Bachelor, Master and doctoral study programmes in material science.

Figure 16 Assessment of the Research Quality of the Institute of Technical Physics

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	2
Research environment and infrastructure	2
Development potential	2
OVERALL SCORE	2



Overall Score

The Institute of Technical Physics shows an average level of scientific research. There is a strong need to increase its international visibility and become much more active in attracting funds. Increase of funding can help in solving important problems of the Institute with aging personnel, old equipment and low level of collaborative activities on national and international levels.

Quality of the research

The Institute presents good level of basic and applied research in technical physics and material science. The main stream of the Institute's research is to elaborate new materials for sensors and holographic recording of information. The studied topics are up to date, and involve modification of semiconductor surfaces by laser radiation, holographic spectroscopy, mechano-electrical properties and resistivity changes of polymer composites induced by volatile organic compounds, and design of human motion energy harvester for wearable electronic systems. All scientific groups publish their results in international journals, however mostly in journals of moderate impact factor. Citation frequency of these publications is mid-range and such are the Hirsch indices of the scientific group leaders (M. Knite, A. Ozols, A. Medvis, J. Blums). The research performance can be rated as solid but could still be significantly improved. There is a very low involvement of PhD students in research.

Impact on the scientific discipline

The Institute is a member of 7th National Research Centre in Material Science, and with its research subject fields - which mirror the needs of modern experimental material science - is of considerable importance for the development of physical sciences in Latvia. A good network with other institutes in Latvia and beyond, with the Baltic area exists. However, generally the international visibility of the Institute is low. It has some international recognition, in the fields of holographic spectroscopy of inorganic and organic materials (A. Ozols), polymer-based composites for mechanical and chemical sensors (M. Knite), nanostructure formation on semiconductor surfaces induced by laser radiation (A. Medvids), however with moderate numbers of citations of the respective publications. A new attractive research direction, connected to human motion energy harvesting for wearable electronic systems, has been started by J. Blum, but it is too early for visible international impact. Only two names appear on the lists of invited talks at international conferences, mostly held in Lithuania and Ukraine. There were no visits to and from abroad. There is only a small involvement of the Institute in the organisation of international conferences on the studied topics, and this involvement is limited to participation in the Programme Committees only, they are not as main organisers. Only two papers are listed as the outcome of the collaborative contacts. The Institute has been a partner in three EU Framework Programme and two other international projects, but the amount of the funding attracted is very small.

Economic and social impact

The Institute is involved in research and education activities at Riga Technical University, and most of the personnel with doctoral degree hold both academic and research positions. Although the Institute claims to play a leading role in the education of doctoral studies in materials science, the output is not very impressive as there have been only two PhD theses completed during the time period covered by the evaluation. The Institute has collaboration with several national universities and public research institutes with whom it implements the National Programme in Materials Science. The research of the Institute covers quite important research topics, which touch upon societal needs, such as solar energy conversion, sensor devices, actuators. The Institute has cooperation agreements with four Latvian industrial partners and claims to perform joint research, however there are no official common projects listed in the Institute's self-assessment report. There is also a lack of activities with regard to popularisation of science. The self-assessment report does not give account of any spin-offs, consultations outside the academic research field or the use of the Institute's patents.

Research environment and infrastructure

The strategy formulated by the Institute is very generic and it lacks specificities. There is no elaboration how the Institute intends to realise the strategic goals set. Most of the goals simply need funding. The Institute is not very efficient in attracting funding; even at the Latvian scale, it is at the very end of the list of institutes in terms of state and non-state funding per researcher. Since 2010 the Institute has had no grants from the Latvian Council of Science, and obtained only a little from the State Research Programme. The Institute did not provide information on its strategy how to gain more funding.

Some of the key scientists at the Institute are senior researchers. A lack of post-doc and researcher positions is described in SWOT analysis, which indicates the Institute's difficult situation with regards human resource development. For the research activities, mostly continuation of existing projects is listed. However, it should be acknowledged, that future research into innovative materials for renewable energy conversion is planned.

There is only little support available from administrative and technical personnel. Research infrastructure is decent for realisation of the current research. It encompasses a mixture of modern setups and old equipment, which need modernisation. There were no comments about a strategy how to develop the existing apparatus. Also, no information about computer resources was given.

Development potential

As for today, the Institute has a long way to go to become internationally recognised. Its research is at a good level and in the proposed, up-to-date topics it can be visible on the international scientific arena. However, to achieve this goal it must be much more active in competitive fund-raising. Only extra funding can lead to increased mobility of students and researchers; can help provide necessary positions for young researchers and cover their salary plus support for the development of research techniques; can ensure that the infrastructure is upgraded and new positions for administrative and technical personnel are established. The Institute must also strengthen its international collaborative activities, which should be possible to achieve through the existing EU Framework Programmes. The Institute must also attract more young people through PhD studies; support post doc researchers; and encourage young scientists to write proposals. The Institute quite realistically assesses its situation in the SWOT analysis, but the overview lacks criticism regarding the Institute's ability to raise fund, although the problem is crucial and very visible.

Conclusions and recommendations

The selection of research topics of the Institute is in line with current research directions in materials science. However, the results of the Institute's work are not much visible in the international scientific community. Improvement of the situation should be based on increasing student numbers; attraction of motivated, high quality young faculty members; modernisation of the infrastructure; and increase of international exchange and project-oriented collaborative activities with national industrial partners. Additional competitive funding – both from national and international sources - attracted by the Institute is a prerequisite of a successfully implementation of these tasks. A separate problem is reaching critical mass, as this is a very small Institute. The expected collaboration within the 7th National Research Center in Material Science, including the use of common infrastructure, should create more opportunities for the development of the Institute.

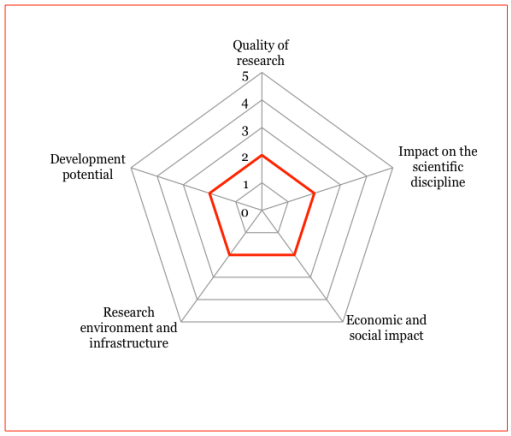
17. M_17_Institute of Silicate Materials

Name of the institution	Institute of Silicate Materials
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

The Institute of Silicate Materials of RTU is mainly active in the area of inorganic solid-state materials, silicate technology and stone restoration. Most of these areas seem of reasonable societal importance. The Institute has a long-standing tradition in the science landscape of Latvia.

Figure 17 Assessment of the Research Quality of the Institute of Silicate Materials

Criteria	Scores
Quality of research	2
Impact on the scientific discipline	2
Economic and social impact	2
Research environment and infrastructure	2
Development potential	2
OVERALL SCORE	2



Overall Score

The Institute of Silicate Materials shows an average performance level of scientific research with mainly national visibility. There is a strong need for increasing the international visibility and for attracting new academic and industrial collaborators, especially as project partners.

Quality of the research

The Institute seems to be a satisfactory national player. The Institute covers a number of relevant topics around silicate chemistry. Visible contributions have been made in the field of nano-structured materials for various applications. A number of additional research activities exist, e.g., into high-temperature ceramics and materials for application in civil engineering, including stone restoration. The research performance seems somewhat inhomogeneous. The description of the Institute's activities in the self-assessment report fails to make clear connections between the different fields of activities or to point out existing or possible future collaboration.

Impact on the scientific discipline

The research of the Institute touches quite important sub-disciplines of materials science. However, the visibility of the Institute in the international community is quite underdeveloped. This is reflected in the list of best publications, most of them in international, but low impact journals. However, there is a very solid performance in terms of filed patents (e.g., by V. Svinka, L. Bidermanis, A. Cimmers). Moreover, producing publications may not be the main purpose in some research directions, e.g., in

stone restoration technology. The number of Master- and PhD students is moderate, but on a constant level. The relatively low number of PhD students limits the national impact of the institute. The institute has a reasonable good visibility in Latvia via collaboration with scientific and industrial partners. However, the amount of international contacts seems rather low.

Economic and social impact

The research directions of the Institute cover fields of high societal relevance, e.g., silicate technology, stone restoration. Several collaborative relations with foreign institutions exist, including Germany, Hungary, Israel, and Poland. The high-temperature ceramics unit of the Institute has been especially involved in collaboration with industrial partners in Germany in the past, but this activity seems to have come to an end during the recent years. Currently no activities with international industrial partners are reported.

Research environment and infrastructure

The Institute's equipment and infrastructure is at a reasonable, but not fully appropriate level. Since 2010 the Institute has obtained increasingly external funding (see 2010-2012 numbers from the self-assessment report) through ESF and ERDF programmes in the field of ceramic materials, e.g., optical fibers technology, porous ceramics, materials for solar heating technology. These grants will help to improve the research infrastructure. Newly installed setup of the last years includes AFM, X-ray diffractometer, particle analyser, porosimeter, rheometer, and IR spectrometer. The infrastructure and research environment should and must be improved during the next years, e.g., with the help of EU Structural Funds. However, the Institute could not acquire significant EU Structural Funds support during the last years. The amount of contract research is surprisingly low for an application-oriented institute.

Development potential

The long-standing experience in the field provides a distinct development potential for the Institute. To improve the research performance, the Institution should try to increase participation in international projects, the amount of external funding secured. Furthermore it should attract motivated, high quality new faculty members and commercialise the research results, outcomes. The development plan of the self-assessment report does not go beyond a generic statement reflecting the overall strategy of RTU, as the development plan provided only cites the faculty's plan. There were no institute-specific goals and milestones provided or any detailed plans to further mid- and long-term development of the Institute.

Conclusions and recommendations

The Institute has long traditions in the fields of its activities. During the reporting period, the Institute could attract some external funding with a current focus on shorter, third-party funded projects. This seems to be an insufficient base for further development into a research institution that is visible both to the academic community and potential industrial partners. A number of scientific collaboration exists, mainly on the international level.

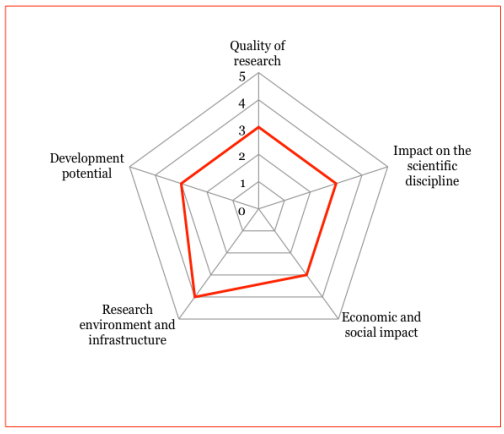
18. M_18_Institute of General Chemical Engineering

Name of the institution	Institute of General Chemical Engineering
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

The Institute of General Chemical Engineering of RTU has a long-standing tradition in the Latvian science landscape. The Institute has been restructured during the last years. The impressively renovated building of the Institute provides a very nice frame for further development.

Figure 18 Assessment of the Research Quality of the Institute of General Chemical Engineering

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	3
Research environment and infrastructure	4
Development potential	3
OVERALL SCORE	3



Overall Score

The Institute of General Chemical Engineering of RTU shows a good performance level of scientific research. The Institution has recently focussed and strengthened its research potential as documented by significant improvements of common research indicators and an expansion into novel and promising research fields of innovative biomaterials for medical applications.

Quality of the research

The Institute is a strong national player with some international recognition. "Innovative biomaterials" - implants, coatings, ferromagnetic materials for cancer treatment, and intelligent drug delivery materials - have been defined as main research task of the Institution. However, the research performance in terms of original articles in highly ranked international journals is not satisfying until now, but has been significantly increased in 2012. The current research of the group reflects rather high quality standards and high innovation potential.

Impact on the scientific discipline

The Institute is still in expansion, the number of employees has been significantly increased during the last years. The Institute is very active in international research projects and networks. The Institute has attracted an increasing number of Master and PhD students, especially since 2010. Active collaborations with National and foreign institutions exist, e.g., with several Latvian research institutions and companies, and

with research institutions in Germany. The impact of the Institute on the development of the science landscape in Latvia seems high.

Economic and social impact

The research topics of the Institute are important for society. However, the self-assessment report of the Institute did not list specific points to the social and economic impact of the research. Since 2009, the external funding by ESF-ERDF schemes has been rapidly increasing in fields of biomaterials for bone regeneration, nanostructured ceramics. Strong collaboration with industry, especially in Latvia, is noticed.

Research environment and infrastructure

The research environment, equipment and infrastructure - including the new, renovated building - of the Biomaterial Innovation and Development Center allow to conduct scientific research on innovative biomaterials at an internationally fully competitive level, covering topics from materials synthesis to processing (spray dryer), and detailed characterization (X-ray diffractometer, optical and electron microscopes, etc.). The Convent of Advisors of the Institute facilitates collaboration with external partners. The age structure of the Institute shows a remarkably high number of young experienced researchers.

Development potential

As demonstrated during the last 2-3 years the Institution shows a considerable high development potential, what is reflected in the very good scientific infrastructure, the research focus on innovative biomaterials, and in the significantly increasing international visibility. The further development will depend on the attraction of more high quality new faculty members, active participation in the National Research Centers and establishment of sustainable international collaborations.

Conclusions and recommendations

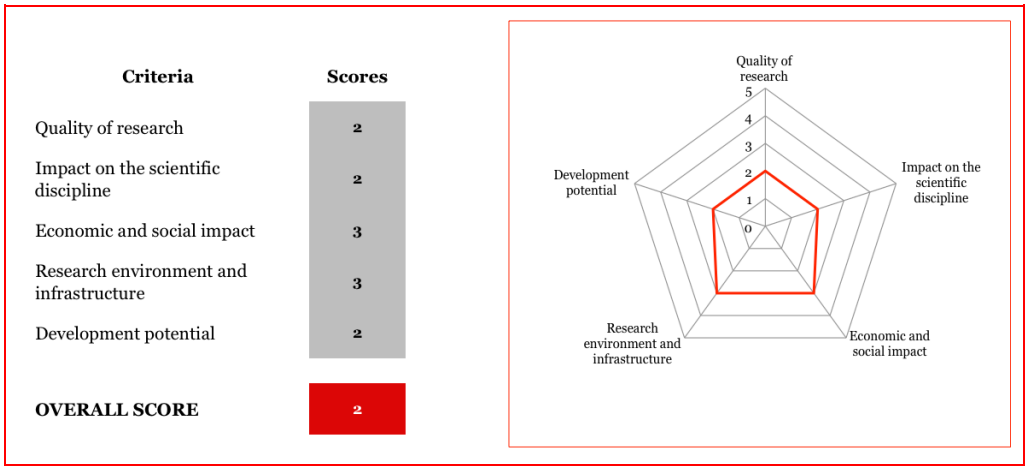
The institute seems to be on a good way towards a sustainable research concept in a mid- and long-term time frame. However, more high quality, young faculty members should be attracted. The level of international collaboration with academia and industry must be increased. The Institute should work on developing a close interaction with the Institute of Biomaterials and Biomechanics, RTU, Faculty of Material Science and Applied Chemistry.

19. M_19_Institute of Textile Materials Technologies and Design

Name of the institution	Institute of Textile Materials Technologies and Design
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

This is a large interdisciplinary Institute within the Riga Technical University. It covers two major research areas related to i) textile and clothing technologies and ii) wooden materials and technologies. This is an Institution with strong national position and strong international cooperation.

Figure 19 Assessment of the Research Quality of the Institute of Textile Materials Technologies and Design



Overall Score

Overall, the quality of research is good in some areas only resulting in an average impact in the scientific discipline as a whole. Research topics, human capacity and infrastructure of the Institute represent important strengths for the development of strategic objectives and research activities. This needs to be accompanied by a realistic research plan that can put the Institute into a stronger position at national and international level.

Quality of research

The research activities are well described in the self-assessment report and well connected to the users' community. The scientific outputs are good, published in well-recognised journals in the field. However, the number of good papers is not proportionate to the large number of researchers employed by the institute. Furthermore, not all areas of research are equally represented in the research outputs. Due to the nature of research one would expect more patents instead of outstanding publications, but the information on filed patents provided in the self-assessment report is insufficient.

Impact on the scientific discipline

Collaborations with international partners are limited mostly to bilateral cooperation on selected scientific questions. The number of PhDs is modest, especially considering the number of research staff employed with capacity to mentor them, as demonstrated by the high number of granted Masters degrees. The list of prizes and honorary positions

indicate strong national recognition and relevance of the research carried out. In summary the Institute has a significant national role with some international importance, which is still evolving.

Economic and social impacts

The Institute has strong cooperation with manufacturers, industry associations and clusters. Its research is of high importance for the society. Project development outside the academic environment is well presented and seems significant. Staff members of the Institution are in high demand as experts in various societies and users groups. In summary, the Institute carries out important research for the society at the expected level of a recognised academic institution.

Research environment and infrastructure

Many textile and fiber characterisation tools are available. Through an ESF project - "Modernisation of the study process in textile and clothing technologies" - the available equipment was significantly improved and seems appropriate. Supporting information technology tools including software packages, computer-aided design systems etc. were also significantly improved. The laboratories of the Institution are widespread geographically. This is not effective, in particular for the educational activities. Overall, the Institution is able to provide a research environment that is comparable with globally recognised academic institutions in its discipline.

Development potential

The self-assessment report mentions new research directions, more effective collaboration within national and international settings, new education and capacity building opportunities as well as intensified collaboration with industrial and other non-academic partners. This is integrated into the framework of national strategic plans. However, insufficient information is provided on details of the development plan and concrete actions within the near future. The innovation potential should have been better identified as well, especially for the strategic plans with regards the upcoming EU HORIZON2020 framework programme.

Conclusions and recommendations

The Institute plans new activities in the field of renewable raw materials for textile fibers, textile-based nanomaterials and smart textiles. Although a clear strategy for the implementation of these goals is missing in the self-assessment report, the advice is to implement these plans with high attention. The research area of the Institution can in the long run be of great importance nationally as well as internationally since textile industry is in an era of revival.

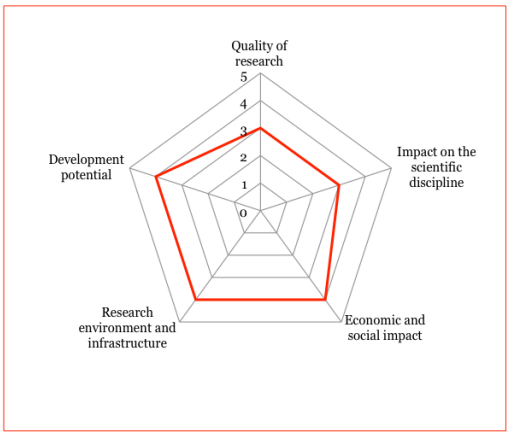
20. M_20_Ventspils International Radio Astronomy Centre (VIRAC)

Name of the institution	Ventspils International Radio Astronomy Centre
Name of university	Ventspils University College
Type of institution	University

VIRAC operates two large radio antennae at Irbene (32m and 16m) that were built by the Soviet Army. In 1994, when the Army left, parts of the equipment were torn down with no drawings left behind to help reinstallation. It took about 15 years to restore the facility and to start to take data. The priority of the activities in astrophysics is to exploit the capabilities of these radio telescopes. The principal scientific directions are the observations and theoretical modelling of the solar chromosphere and corona; studies of the interstellar medium; as well as studies of distant galaxies and quasars. The latter task will be carried out primarily through participation in European VLBI (Very-long-baseline interferometry) Network. The results of solar research are at Latvian scale but the rest of astrophysics has many applications in broader - EU, NATO, ESA (European Space Agency) - context where Latvia is a member country.

Figure 20 Assessment of the Research Quality of the Ventspils International Radio Astronomy Centre

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	4
Research environment and infrastructure	4
Development potential	4
OVERALL SCORE	4



Overall Score

The overall score of this laboratory (4) is justified by the real 'tour de force' to re-establish the operation of the two large radio antennae of 32 and 16m built by the Soviet Army. In 1994, when the Army left, parts of the equipment were torn down with no drawings left for the reinstallation. The institution has an enthusiastic management. And their efforts to find resources for the refurbishment of the two telescopes, combined with the strong support of the Ventspils University and City Hall created promising results. The Centre has a large development potential which can be exploited through various European projects after 2015 when the refurbishment will be finished. There is also a necessity to have good laboratories outside of Riga.

Quality of research

The Institute has four divisions. The priorities for 2012 for the different divisions were as follows:

- For the Applied Space Division: research in processing of Earth remote sensing data
- For the Engineering Electronics Division: continuation of the project" Software designed radio (SDR) satellite communication model design"
- For the Astronomy and Astrophysics Division inclusion of the Irbene 32m radio telescope into the European Very Large Base Interferometry (VLBI) network (EVN). The Institution participates in 2 FP7 projects.
- For the High Performance Engineering Computing Division, the long term goal of the research is to develop reliable real-time data processing framework for on-going radar-VLBI session data processing up to orbital element reconstruction (asteroids, cosmic debris, satellites) to avoid unprocessed data. Models are developed to exploit the data in a more efficient way as well as to prepare the upcoming reconstruction of RT-16 and RT-32.

As pointed out above, the first goal was to rebuild the facility and that explains why the number of publications was low up to 2010 (7 publications) and 2011 (12 publications) with a sudden increase in 2012 with 34 publications.

Many of these papers were published in Latvian or in international journals with moderate impact factor. However this trend has also changed recently, as three papers have been published in the best astrophysics and astronomy journal.

Impact on the scientific discipline

Until 2011, the laboratory had 26.3 researchers (FTE) for a total of 45 personnel, including technical and administrative staff. Since 2009, there were about 10 students starting post-graduated studies. In 2012, 8 professors, associated professors and docents were added and the number of students was increased to 15. This is a very positive move. The laboratory has a lot of national and international collaboration. The management of the laboratory has been able to obtain funds to refurbish the two telescopes - some of the motors and gears are more than 40 years old - and this work is currently ongoing and will be finished at the end of 2015. The inclusion of the 32m telescope in the European VLBI network will open completely new possibilities.

Economic and social impact

VIRAC has a lot of cooperation with companies like Arbo, Dendrolight, Autonams, VEF, Hansa Electronics, Ventspils Reiss, etc. It has contributed to about 30 new products, helped to construct prototypes, supplemented companies, solved technological developments and have been able to provide essential research advices. About 60 companies were supported to develop export plans, business ideas and to facilitate process and organisational innovation. VIRAC economic research group professionals have made a significant contribution to the development of the local innovation system and to the commercialisation of technologies. The laboratory has deposited 16 patents. VIRAC specialists carry out a large amount of work in all study programmes of the IT Faculty of Ventspils University College. Twice a year VIRAC organises events for the first and second year students of the University College, to inform them about VIRAC's performance and possible career opportunities.

Research environment and infrastructure

As already pointed out, the laboratory has two radio-telescopes with diameters of 32 and 16 meters. Due to important funding obtained from European sources and from the Latvian State the radio-telescopes have been recently modernised, and the refurbishment will continue until the end of 2015. In 2010, the Engineering Research Center (ERC) and VIRAC were merged, which reinforced the Centre's potential to carry out applied science projects. There are basic infrastructures - research laboratories, facilities and equipment - available to carry out applied research in space technology and to perform engineering calculations, mechanical studies and mathematical modelling. During the period 2006-2011, the laboratory provided consultations or sold services to about 90 industrial partners. The annual number of students is very good but for the

moment, VIRAC has no doctoral study programme and this should be changed in the future.

Development potential

During the site visit, Panel Members were impressed by the dynamism of the management and their capacity to introduce changes in the laboratory such as merging with ERC, integration of eight faculty members in the laboratory, building very good relationship with the City of Ventspils (attracting local financial contribution) and recruitment of very good young scientist.

At the end of 2015, Latvia should be competitive at the international level in that area.

Recommendations

- To keep the same sprit
- To implement a doctoral study program
- To make an effort to publish in good international journals

21. M_21_Liepaja University, Natural Sciences and Mathematics

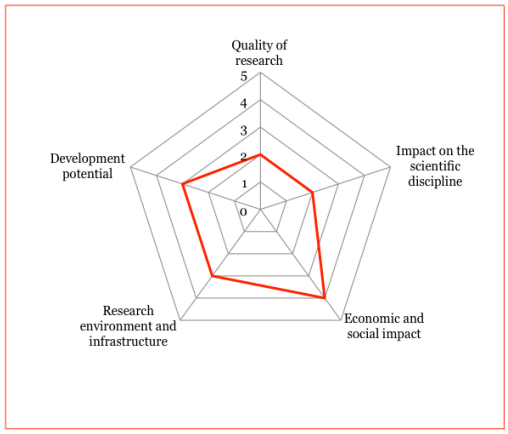
Name of the institution	Natural Sciences and Mathematics
Name of university	Liepaja University
Type of institution	University

At Liepaja University research in mathematics and natural sciences is carried out at the Institute of Mathematical Sciences and Information Technologies and at the Natural and Social Science Faculty. Scientific fields include mathematics, physics, environmental science, information technology and computer science.

The institution is by Latvian standards quite large and conducts research in a variety of important topics including mathematical modelling and computation problems related to materials science, environment and economics.

Figure 21 Assessment of the Research Quality of Liepaja University, Natural Sciences and Mathematics

Criteria	Scores
Quality of research	2
Impact on the scientific discipline	2
Economic and social impact	4
Research environment and infrastructure	3
Development potential	3
OVERALL SCORE	3



Overall Score

The overall level of scientific research performed in the Institute is good, although the quality of the research is not uniform, with some groups substantially better than other. There is insufficient number of publications in internationally recognized journals. No clear strategy with respect to the big problem of aging academic and research staff has been developed. There is also too low activity in attracting funds, in particular state and local. Wide involvement in activity important for society should be acknowledged

Quality of Research

Research is performed in a variety of important topics. The quality is varying with very good results for the group around Kaupuzs and Rimsans, but the results of other groups are of less importance. The total research output is low taking the size of the Institution into account.

Impact on the scientific discipline

Some of the scientists publish in highly regarded international journals, but too much is still published in conference proceedings and Latvian series. As a consequence, the visibility and hence the impact is still rather low, but there are trends of improvement. The production of new PhDs is low.

Economic and social impact

The research topics are of intrinsic importance to the society at large and also for the local community. This is recognised by the Institution and there is a clear strategy for societal outreach. There is engagement of the researchers in problems concerning Latvia and the Baltic region. The Institution is involved in education of Master and doctoral students. It participates in the following initiatives of Liepaja University: Kurzeme Business Incubator Ltd which was established to support the creation of spin-off companies, available also for students; Cluster of Green Energy and Environmental Technology to help Latvian entrepreneurs; and several other initiatives for education of schoolchildren, popularisation of science and lifelong education of the inhabitants of the region. The Institution has a joint ERDF project with Company Liepajas RAS Ltd. – a municipal solid waste management company - to decrease biogas production costs. Researchers also work as advisors in Liepaja City Council.

Research environment and infrastructure

The years 2006-2012 were a period of expansion, which is usually good for the research environment. International exchanges also took place with two researchers spending time abroad and an Australian guest lecturer visiting the Institution for five months.

The research infrastructure is improving; the computer facilities have been renewed and extended. The Institution has gained access to European computation facilities through the DEISA Extreme Computing Initiative. Computer cluster supplemented by high performance computations and access to European supercomputer resources are available. There is also new equipment for environmental quality estimation and work in renewable energy resources. The Institution's state budget funding is extremely low, while other funding sources, such as EU Structural Funds, represent 20 times higher funding. The situation is unhealthy because the EU support will come to an end and this will probably stop further modernisation of the infrastructure.

The group has a clear research strategy in mathematics, mathematical didactics and with regards environmental and renewable energy resource problems (sea wave energy accumulation technologies). While the Institution is active in the education of young children, who might represent potential human resources for the group later on; there is no strategy in place to attract PhD students and young generation of researchers to the Institution.

Development potential

The total active academic and research personnel has more than doubled during the 2006-2012 period. At the same time the administrative and technical support staff has increased to a much smaller extent, which is regarded as a good development. The quality is also increasing. There are a few scientists with good international visibility and one might hope that they will inspire the others to follow their example.

Conclusions and recommendations

The group has a potential to become an international player. First, it can build on its human potential with skilled researches who have ambition to execute state-of-the-art projects with topics of high importance responding to the needs of a modern society and the local community. Second, the Institution has a modernised infrastructure. Third, it is highly active in international projects and benefits from its international relations through joint publications and access to sophisticated equipment available in Europe. Collaboration with local authorities, who clearly support the development of Liepaja University, is also very important.

However, there is a problem with the low total funding, which includes a very dominant contribution from the EU Structural Funds, a funding source that comes to an end soon. The Institution needs higher state and local financial support to foster its development and achieve good position in the international scientific community. It must be more active in funding raising both from national and European competitive funding sources.

The state budget funding depends on scientific activity and this has increased during the last years, therefore there is a possibility that the Institution's funding might be also increased in the future. The group realistically defines its SWOT, but the plan how to deal with the problems stops by pointing out the difficulties of fund raising, the uncertainties due to the country's economic situation and the policy attitude towards research activities. The Institution needs to face the problem of aging academic and research personnel, and it has no clear idea how to attract young scientists, PhD students to the group.

The Panel recommends that the Institution:

- Concentrates on publishing in highly regarded international journals
- Quickly make realistic plans for how to compensate for the stop of funding from the EU Structural Funds
- Apply for EU Framework Programme projects
- Obtain postdoctoral positions from European grants

22. M_22_Institute of Mathematics and Computer Science

Name of the institution	Institute of Mathematics and Computer Science
Name of university	University of Latvia
Type of institution	Institute established by HEI

The Institute of Mathematics and Computer Science is by Latvian standards a very large institute with more than 200 employees (about 150 FTE). A large proportion of the employees are also affiliated with university faculties, not only at the University of Latvia, but also at, e.g., Liepaja University and Daugavpils University. The panel has been asked to evaluate only the mathematics part of the Institute, which is a pity because one of the strengths of the institute is in Theoretical Computer Science, which lies on the border of Mathematics and Computer Science.

The mathematics part of the Institute is much smaller than the Computer Science part. Its mission is to be the scientific centre of mathematics in Latvia, merging all mathematical research under one national institution and solving the current issues in the scientific field in Latvia, as well as presenting Latvia's competence internationally.

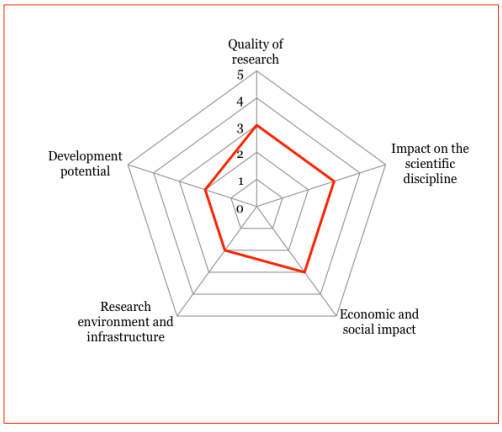
The main fields of research are:

- Boundary value problems for ordinary differential equations
- Theory of discrete dynamical systems and mathematical modelling
- Theory of fuzzy sets and multi-valued structures
- Theoretical basics of quantum computing
- High Performance Computing

There is also an active group concentrating on research in mathematical education and coaching of Latvia's team in the International Mathematical Olympiad.

Figure 22 Assessment of the Research Quality of the Institute of Mathematics and Computer Science

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	3
Research environment and infrastructure	2
Development potential	2
OVERALL SCORE	3



Overall Score

The Institute of Mathematics and Computer Science is a very large Institute with more than 200 employees. A large fraction of the publications are in conference proceedings, Latvian series and less well-known international journals. The quality of the research is

not homogeneous: it varies from outstanding to satisfactory. The management of the Institute needs improvement. There is an urgent need to secure funding from European funds and to initiate collaboration with industrial partners. The management should make a big effort to achieve this. The system inherited from Soviet times with faculty departments responsible for teaching and institutes responsible for research seems particularly obsolete in the case of mathematics.

Quality of research

The quality of the mathematical research at the Institute varies from outstanding to satisfactory. Quantum Computing and Quantum Algorithms have been studied intensely in many research centers around the world for some decades. The Institute's work in this area is internationally renowned and of a very high quality. The High Performance Computing Group has achieved good results in computational physics that have received some international recognition. The qualitative theory of ordinary differential equations and discrete dynamical systems are internationally very important topics, but here the Institute has merely reached a good national level. The work on fuzzy sets and multi-valued structures is sound research in pure mathematics but seems to be a little bit away from mainstream mathematics.

Impact on the scientific discipline

The Quantum Computation and High Performance Computation groups have decent records of international publications. The leader of the Quantum Computing Group is regarded to have a real impact on several aspects of theoretical computer science. Still, as a whole, the Institute publishes too much in conference proceedings, Latvian series and less well-known international journals. However, it needs to be emphasised that the laboratory had 10 invited presentations at international conferences in 2012. It has also been active in organising important international conferences and has a number of national and international collaboration.

Economic and social impact

Mathematics is a fundamental methodological science that is applied not only in the natural sciences but nowadays also in social sciences and the humanities as well as in all parts of society. It is of fundamental importance for the development of the Latvian society and economy to have a high-level education and research in Latvia.

The Institute has a very good record in producing PhDs in mathematics. Recently it has been very successful in recruiting new graduate students. These activities might lead to an increase in the number of scientists in Latvia in the near future. The laboratory does not have too many contacts with enterprises which is quite normal in the field of pure mathematics. However, part of the activities deal with mathematical modelling and physical applications. In these fields some improvements with regard to industrial collaboration is needed. The work with pupils and mathematical education is an example of successful outreach.

Research environment and infrastructure

As mentioned above this review is concerned only with the mathematics part of the Institute. The computer equipment has been modernised with the aid of European and Latvian funding, and the mathematical research at the Institute benefits from this.

During the period 2006 - 2102 the academic personnel of the Institute has dropped drastically. The main reduction in academic staff has been on the mathematical side. At the same time the non-academic staff has decreased only very little. As a consequence, there is now much more non-academic support personnel than researchers present. This is a very bad development which could have disastrous consequences unless corrected immediately.

As it is the case for the Department of Mathematics (see the institutional evaluation above), the main deficiency in the research environment is the almost complete lack of international collaboration. In the six-year period under evaluation there was not a single visiting professor, researcher or student visiting the department for at least one

month. Only one member of the Institute made visits abroad. There is only little international research collaboration, and this collaboration does not seem to have led to many published papers.

The management of the Institute needs improvement. There is an urgent need to secure funding from European funds and to initiate collaboration with industrial partners. The management should make a big effort to achieve this.

The system inherited from Soviet times with faculty departments responsible for teaching and institutes responsible for research seems particularly obsolete in the case of mathematics. The whole idea of higher education is that it should be based on research. Every researcher should teach and every teacher should conduct research. In practice, this is already so as many of the employees of the Institute are also affiliated with a university department. However, a complete integration of the Institute into a university department - for instance, Department of Mathematics and Computer Science - would not only be scientifically motivated but could and should save resources.

Development potential

The age-distribution of the academic personnel is skewed. The Institute is very top heavy, which represents a major threat and requires thorough succession planning to preserve knowledge accumulated by educating a new upcoming generation. The problem has not been acknowledged by the Institute in the self-assessment report. However, these issues need addressing urgently and the Institute should start recruiting new young personnel, leading scientists who are involved both in teaching and research activities.

Conclusions and recommendations

The Institute conducts sound and important research in several areas of mathematics with a particularly successful group in Theoretical Computer Science, especially in Quantum Computation. The low amount of funding, the recent drastic drop in academic personnel, and the skewed age-distribution of the employees present real threats to the future development of the Institute. To remedy this, it is necessary to:

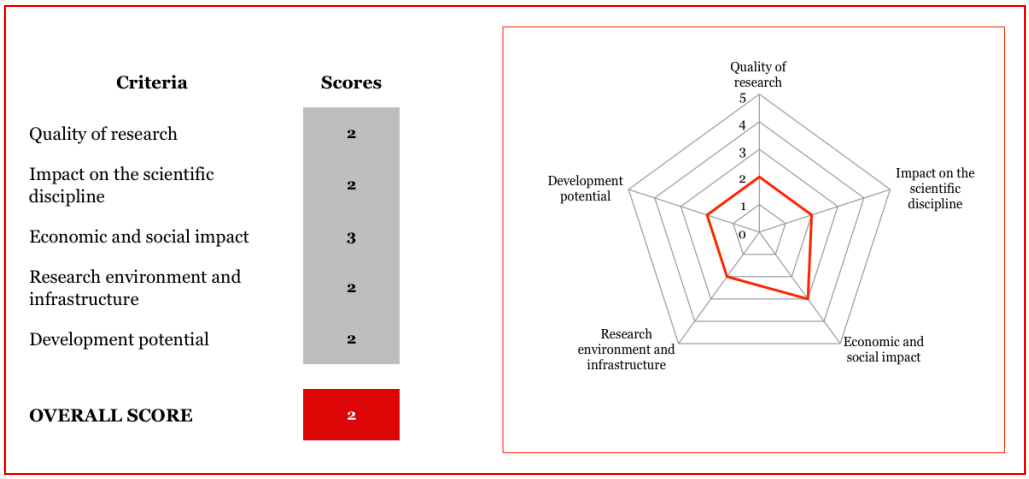
- Improve the management of the Institute
- Consider merging the Institute with the Department of Mathematics
- Strengthen the research on mathematical modelling, using the Institute's e-infrastructure (HPC), which will allow some contracts from enterprises
- Apply for EU Framework Programme projects;
- Obtain postdoctoral positions from European grants.

23. M_23_Institute of Polymer Mechanics

Name of the institution	Institute of Polymer Mechanics
Name of university	University of Latvia
Type of institution	Institute established by a HEI

The Institute of Polymer Mechanics of UL has long-standing tradition in the testing of polymers/polymer-based composite materials and research into composites for applications as construction materials. The Institute provides capacities for custom-tailored materials testing.

Figure 23 Assessment of the Research Quality of the Institute of Polymer Mechanics



Overall Score

The Institute of Polymer Mechanics shows an average performance level of scientific research but seems important as a national facility for materials testing and standardisation, especially for external customers. These activities accompanied by improved research activities may define some development potential of the Institution.

Quality of the research

The Institute seems to be a satisfactory national player. The performance numbers of the research institute are quite weak. Most of the scientific papers are published in moderate or low impact research journals. Among the scientist of the Institute, J. Andersons and his team showed a significantly better research output if compared to the average of the Institute.

Impact on the scientific discipline

Polymer mechanics is a central point in the development of polymers and polymer-based composite materials for several applications, especially as construction materials. Therefore the Institute covers an important field of materials research. The number of enrolled Master and PhD students is low, but increasing, especially in 2012. The self-assessment report lists many national and international research collaborations, some of them coupled with the participation in international research projects. The Institute organizes the biannual International Conference on Mechanics of Composite Materials.

Economic and social impact

The institute runs the Laboratory of Mechanical Testing of Structural Materials that offers testing facilities as a service to customers from Latvia and from other European countries. The funding situation has been improved since 2009, due to several ERDF projects, e.g., investigation of polymer composites, organic fibers, biofoams, thermal insulation materials from renewable raw materials, infrastructure development in nano-science. Moreover, the Institute is active in a couple of small-sized industry-funded projects and in establishing spin-off companies. Researchers from the Institute work as consultants for a couple of national institutions in Latvia.

Research environment and infrastructure

The Institute is mainly equipped with machines for mechanical and thermal materials testing, for example mechanical and thermo-physical properties of polymers, polymer blends, composites. Most of the equipment is out of date. During 2012-2015 a project funded by the European Regional Development Fond (ERDF) should allow new investments, e.g., for testing at low and high temperatures. The self-assessment report mentions problems with the Institute's building and with access to scientific literature.

Development potential

Main development potential of the Institution is in the field of polymer testing and external services for customers. Unfortunately, the amount of money that has been generated in service activities is not listed in the self-assessment report. The purely scientific potential seems comparably low, but may be improved through collaborative European projects during the next 5 years.

Conclusions and recommendations

The Institute seems quite important as a national facility for materials testing and standardisation. However, these activities must be accompanied by visible research activities if the Institute will further operate as a research institution. Alternatively, the Institute may be re-structured into a "pure" testing facility without additional research activities. Actually, the Institute includes a quite large number of scientists with limited research output. For improving the situation, young experienced scientists should be attracted. Additionally, young experienced scientists should be attracted. Modernisation of the Institute's buildings seems also necessary.

24. M_24_Institute of Solid State Physics

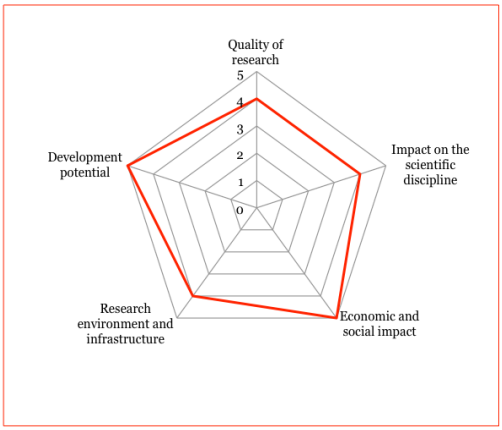
Name of the institution	Institute of Solid State Physics
Name of university	University of Latvia
Type of institution	Institute established by HEI

The Institute of Solid State Physics is one of the largest institutes in Latvia. The main field of its research is material science, with emphasis on nanoscience and nanotechnology of new advanced functional materials, with a special focus on materials applicable for sustainable energetics. The Institute is modern and well-run. A major concern of its management and staff is regarding further development, which is understood as the realisation of important and up-to date research topics, ongoing collaboration with other national and international centres and continuous involvement of the young generation in the performed work. The Institute is a national coordinator and leader in several projects. It has an active International Supervisory Board consisting of internationally recognised experts. The Board plays an important advisory role.

The mission of the Institute is to carry out high-level scientific activity, and to use its knowledge in the fields of education and innovation. The Society of Students and Young Scientists founded at the Institute helps students in their studies and professional development; and it also organises popularisation activities.

Figure 24 Assessment of the Research Quality of the Institute of Solid State Physics

Criteria	Scores
Quality of research	4
Impact on the scientific discipline	4
Economic and social impact	5
Research environment and infrastructure	4
Development potential	5
OVERALL SCORE	4



Overall Score

The Institute of Solid State Physics is a leading Latvian centre in modern technology and materials research, combined with high-level education. It is visible internationally and carries out respectable activities. The Institute can provide an internationally comparable excellent research environment in materials science, educate students in modern technology and material studies, and provide innovative solutions for industrial applications. It constitutes a link for Latvia to world cutting-edge technology and science.

Quality of the research

Research performed at the Institute is of high level, and it involves topics which are generally considered as important and up-to date in materials science and in the related

interdisciplinary areas. The Institute is following research priorities set by the European Commission and the Latvian Ministry. The publication output is good; the Institute produces papers mostly in international journals and with high impact factor. It had several invited papers at very good international conferences. Projects of applied character are also implemented. The Institute is a non-questionable national leader in its field of research – the total number of research outputs and total number of citations for Scopus outputs are by far the highest among all Latvian institutions assessed by the Panel - and it is a coordinator and leader in important nation-wide projects such as in the National Research Programme in Materials Science, the National Research Centre of functional and construction materials and their technologies, including the development of the Latvian Nanostructured Material Centre LATNANO-C.and also Latvian leader in big EU programmes, like EURATOM and Fusion for Energy. There is high involvement of PhD students in the research performed.

A criticism regarding the self-assessment report is that it does not show the research topics which were born in the Institute and are a local specialty. The main directions of the research are not described in detail, they are only listed. The full description is provided in the information booklet edited by the Institute in 2013, which was given to the Panel Members during the institutional visit.

Impact on the scientific discipline

The international competence of the Institute was confirmed already in 2001 by the status of "Excellence Centre of Advanced Materials Research and Technology" awarded by the European Commission. The international level of the institution is also corroborated by the large number of international collaborations, which has produced many joint publications with European and world scientists working in materials research. The Institute offers to its international partners a high-level human potential – e.g. in computer modelling and characterization of advanced materials – further to its technological and characterisation infrastructure. The infrastructure has been substantially modernised in the recent years and is still under development - due to the European funds and also to Latvian contribution - which has allowed the Institute to be competitive at the international level. The Institute has also strong collaboration with European large-scale materials research centres. It participates in quite a large number of EU projects. The world-scale impact of the laboratory's scientific results can be seen from the high number of invited talks at prestigious international conferences. Researchers from the Institute are taking part in edition of several international journals, and the Institute is very active in organisation of international scientific meetings.

Economic and social impact

The Institute is a leading research centre in material science at Latvian scale, and plays an important role in education in the areas of modern technology and material research. Topics of research performed at the Institute are very important for modern society, for example the innovative materials and technologies, also applied for energy and environment issues. The Institute is a national leader in several big projects in materials science. It tries to use its high level of scientific activity for education and innovation. Some of the staff members are responsible for teaching of fundamental physics and solid state physics at all study levels at the University of Latvia and Riga Technical University, and several MSc and PhD theses are performed in the Institute. Worth mentioning is the Institute's care about PhD students and young scientists, which goes beyond pure science. The Institute tries to help the students in problems associated with their studies and also in their professional development; it is done partially through the Society of Students and Young Scientists founded at the Institute. A number of spin-off companies have been established as a result of technological and scientific research. There are many common projects realised at the Institute with these and other industrial partners, regarding different applied research. The Institute participates also in other national and international (EUREKA) support programmes for market oriented research projects. It takes an active role in popularisation of science in press, radio and TV and also by organising events for school children.

Research environment and infrastructure

The Institute is able to provide an internationally comparable excellent research environment to high-level international researchers in materials science - it offers skilled personnel, interesting research topics and good infrastructure. It has already taken its chance in attracting European funds, and has substantially modernised the infrastructure, which is available to all of the Institute's scientific staff, as well as Latvian and international partners working on joint national and international projects. Upon successful competition for funding, the infrastructure of the Institute will be further developed. For example they have already started on an experimental basis the construction of "cleanrooms", which are essential for the development of nanotechnology and extension will be added if more funds will be obtained. The Institute has a clear strategy to become an excellent institute in novel materials science on a world scale, which is presented in the very well written self-assessment report and in the Institute's modern forward-looking strategy. The research goals of the Institute were developed to align with the European and national priorities identified in materials science. Current availability of support personnel is quite good. The Institute understands the need for continued employment of young and active researchers, and strongly supports these intentions. There is no doubt about the present and future status of the Institute as a very good research centre, as long as the national funding is on satisfactory level.

Development potential

The Institute has potential to become a really strong international player and even a global leader. It is already on a good track to achieve this goal. It has high-level researchers with internationally recognised scientific outputs (L. Skuja, J. Purans, A. Truhins, I. Tale, V. Kuzovkov) and modern infrastructure. It is active in fundraising from competitive sources. It has clearly defined its research goals, which involve important, up to date topics. It has made a competitive and realistic SWOT-analysis, and a carefully considered plan to manage weaknesses, threats and opportunities. It has world-wide collaboration in material research, also involving PhD student exchange. The Institute takes special care of young scientist generation and knows well that its future depends on them - their interest to continue research career in the most efficient way. The Institute has critical mass, and can be or will soon be attractive for PhD students and scientists from abroad. It should continue its role as a leading centre of Latvian research in material science.

Conclusions and recommendations

This institution is one of the best - arguably *the* best institution evaluated by Panel M. It has all the qualities to continue its role as the leading centre of Latvian research in material science. Securing funding for the Institute should be of highest priority for the Latvian Government and Latvian research funding agencies.

25. M_25_Institute of Physics of University of Latvia

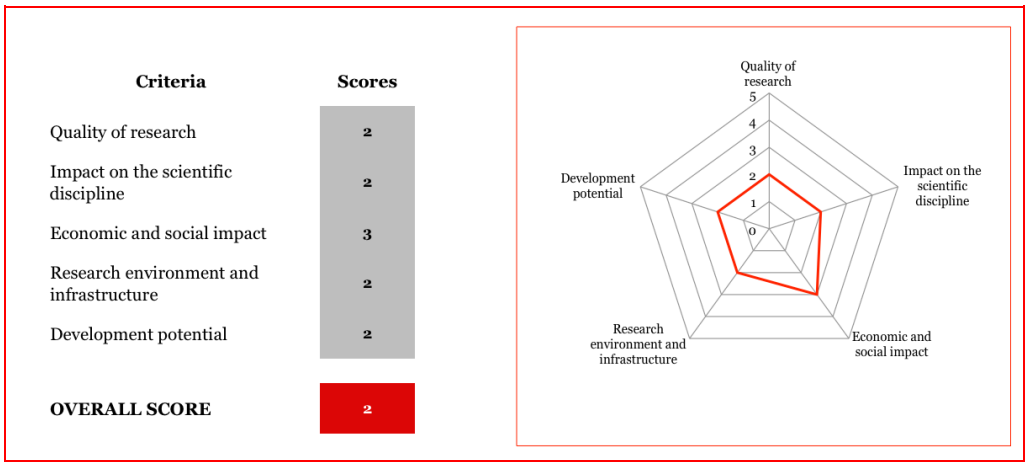
Name of the institution	Institute of Physics of University of Latvia
Name of university	University of Latvia
Type of institution	Institute established by HEI

The Institute consists of three research groups:

- The first (and largest) one deals with fundamental and applied liquid metal magnetohydrodynamics
- The second one is involved with the study of magnetic nanocolloids: physical properties, transport, thermomagnetic properties and biomedical applications.
- The last one is studying the heat and mass transfer of different types of local renewable biomass fuels.

The Institute has about 80 employees including 39 scientists - leading researchers, researchers and assistant - but very few students.

Figure 25 Assessment of the Research Quality of the Institute of Physics of University of Latvia



Overall Score

The low grade given to this Institute (2) concerns the Magnetohydrodynamics laboratory doing basic and applied research on liquid metals like mercury or sodium. This area is very important for nuclear science, fusion and spallation sources. The Institute is internationally recognised but it gives the impression to live on its past. The lack of young scientists and students is a very serious problem. Contrary to other laboratories visited, the management gives the impression of waiting for a miracle which will result in budget increase, without making the effort to fight for funding. The capacity of the Institute is not fully exploited. If nothing is done quickly, by changing the management, and reorganizing the laboratory, the Latvian competence in magnetohydrodynamics of liquid metals will disappear in the next few years.

Quality of research

Research performed at the Institute is on an average level, and it is concentrated on magnetohydrodynamics, liquid metal technologies, magnetic nanocolloids, heat and mass transfer. The Institute has a long tradition in the fundamental and applied studies

of transfer processes - electrodynamical, hydrodynamical, heat, mass - in liquid conducting media.

Professors Agris Galitis and Elmars Blums are worldwide known researchers in this area of science. The Institute obtained EU support as a Magnetohydrodynamic (MHD) Excellence Center between 2002-2005. However, most of the researchers have publications only in conference proceedings and in the journal "Magnetohydrodynamics" edited by the University of Latvia. The average number of citations is low. It should be acknowledged that this journal has been indexed in Science Citation Index Expanded since 2007, but it has a low impact factor (0.55 in 2012) due to lack of selection. Until 2011, the typical number of publications of the Institute per annum was around 20, while the number increased to 30 in 2012. Although this is a positive trend, the Institute's publication pattern limits its potential to achieve international impact. There were only two doctoral dissertations in the last six years. This is compromising the future of the laboratory. During the six years covered by the evaluation the Institute was involved in a large number of projects. However, some of these projects consist only of selling electromagnetic pumps. The Institute holds 16 patents. In the area of MHD the Institute is an international player with good standard of research but it does not exploit its capacity. The Magnetic Nanocolloids group is small but dynamic.

Impact on the scientific discipline

The Institute is internationally recognised, judging from its participation in rather high number of European research projects. For the MHD group, there is a list of several national and international collaborations with universities, research institutes and enterprises. However, there was no single joint publication presented. Neither contained the self-assessment report any description of the most important outcomes achieved with collaborative partners. The Magnetic Nanocolloids group has collaborations with an American company Ferrotec-USA and three Universities: Pierre et Marie Curie in Paris, France and two technical universities in Germany, one in Bremen and the other one Dresden. The list of invited talks (12) at international events is low and contains five different researchers. There were visits abroad (6) only to France and visits to the Institute (8) only from India. Two international conferences on Fundamental and Applied Magnetohydrodynamics and one training school on magnetoscience were organised by the Institute. At the international level this is not sufficient.

Economic and social impact

Most of the developments of the Institute of Physics of University of Latvia in the MHD field are for industry. For several years the lab has been carrying out investigations, design, verification and construction of liquid metal electromagnetic pumps on permanent magnets for a wide range of applications, predominantly to cool systems of high-density thermal power (like nuclear reactors). The Institute has unique experience at European scale in design of these pumps. It has also developed Lead-Lithium eutectic industrial production methodology, which was transferred to SIA "Hidrovats" and successfully introduced in Pb with 15.7 atom% Li production process of an Italian company. The Institute also developed a new technique to stabilise the electromagnetically levitated molten drop of metal to produce highly intense flux of metal vapour, which is deposited on a steel sheet as an anticorrosion coating for Tata Steel Europe. The stabilisation problem was solved successfully and Tata Steel Europe is patenting the process. In addition, the Institute developed a new method of very precise dosing of the liquid metal into the levitated droplet, controllable starting from a fraction of cm3/second. This technique will also be patented by Tata Steel Europe. Large-scale metallurgical applications need contactless liquid metal breaks. The Institute has long-term collaboration with the laboratory SIMAP-EPM of CNRS, the French National Centre for Scientific Research. They developed a new technical solution for the company Siemens-VAI, where the electromagnetic break is used in the setup of continuous anticorrosion coating of steel sheet by liquid zinc alloy. However, one has the impression that the Institute has a wider potential which is not exploited enough.

Research environment and infrastructure

A description of the management of the research at the Institute was not provided in the self-assessment report. It is however evident that the Institute lacks young researchers, there are 18 leading researchers and only 4 researchers. There seems to be enough technical and administrative personnel. The goal orientation of the research work is described shortly with no description of means to achieve the key research objectives. There is no long-term financial resource planning in the self-assessment report besides listing a threat 'unpredictable financial support for projects and further research'. Furthermore there is no human resource development strategy either. The experimental complex of Institute was recently renovated. It contains specially equipped rooms for work with alkaline metals Na (5 tons), K and Li, high temperature metals (PbBi and PbLi) used for nuclear applications and low melting point metals (Ga, GaSn and InGaSn). A recently acquired magnet (5 T in a D = 30 cm and L = 100 cm bore) should also be mentioned. Equipped with a 450 0C PbLi loop it allows to investigate MHD phenomena typical in the blankets of fusion facilities. There is also a mercury (13 tons) laboratory. The laboratories are purpose-built to host experiments of exceptional size and complexity. It is the base for participation in large collaborative programs like the ESS, the European Fusion Development Agreement or the Sustainable Nuclear Energy Technology Platform platform. In addition, the laboratory has various pieces of equipment for the characterization of these liquid metals. It should be noted that there are very few laboratories of this kind in Europe. No specific safety measures or dedicated personnel to be expected when dealing with these large amounts of especially mercury could be identified.

The magnetic nanocolloids laboratory includes a small chemical laboratory for colloid preparation, optical and heat transfer laboratories equipped with steady-field and high frequency electromagnets, vibration sample magnetometer, nanoparticle size analysers, viscosimeters, lasers for magnetooptics studies and holographic facilities for mass transfer measurements.

Development potential

The Institute already contributes to the activities of the international community. It has accumulated knowledge and skills focussed in a rather old core group of scientists as well as a specific infrastructure. Its experience in magnetohydrodynamics is important for the world scientific community, especially when it comes to fusion and spallation sources. The Institute has some international collaboration and participates in large European projects, such as EURATOM or the European Spallation Source (ESS). Especially in the latter case the self-understanding and goal of the Institute's role as a paying participant for Latvia should be critically revisited and evaluated. There are however substantial weaknesses, like aging personnel, old equipment, and rather inefficient commercialisation of the Institute's prototypes. The SWOT analysis presented in the self-assessment report is not profound. Not all weaknesses, opportunities, threat and strengths are shown in the analysis. The Institute did not consider carefully the options how to manage factors listed in the SWOT. It seems that the Institute had problems writing the self-assessment report and providing the information requested, as they did not provide answer to all questions raised.

The Institute is far from being a leader in attracting funds but it is able to raise some funding that is awarded competitively. In order to help the situation the Institute needs better organisation, including support for public relations, plan for attracting young people, and better organisation of commercialisation of the Institute's research results.

Conclusions and recommendations

1. MHD group - There are very few laboratories in Europe with the competence of this group. If nothing is done about the average age of the personnel quickly, this competence regretfully will disappear in the next few years.
2. The small magnetic nanocolloids group is in a much better situation due to the young scientists.

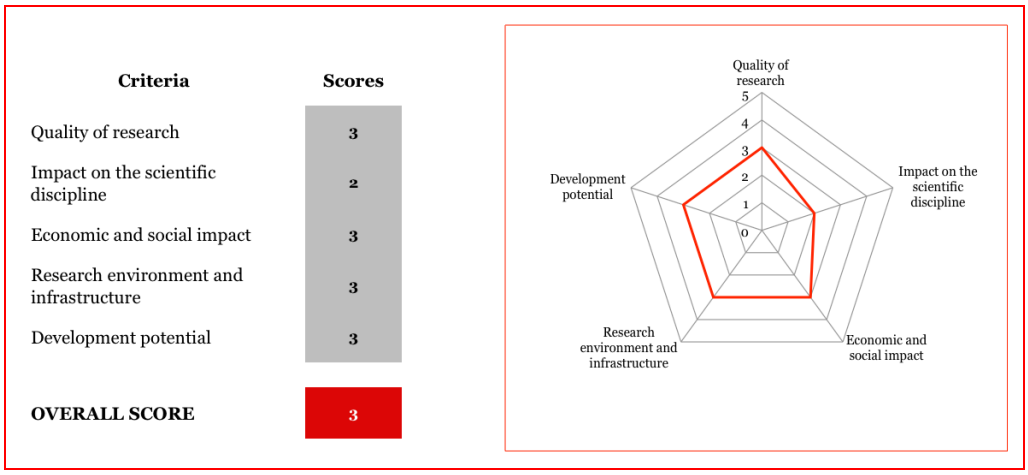
3. The group on heat and mass transfer for local renewable biomass fuels has no obvious interaction with the two others. This group should rather move to the Latvian State Institute of Wood Chemistry.
4. It is necessary to have a new management to reorganise the laboratory, attracting young people and trying to obtain funds from partners in Europe or worldwide.

26. M_26_Institute of Inorganic Chemistry

Name of the institution	Institute of Inorganic Chemistry
Name of university	Riga Technical University
Type of institution	Institute established by HEI

The Institute acts as an Agency formed within the Riga Technical University with priority research areas including material science and nanotechnology, physical chemistry of inorganic materials, electrochemistry, solid state chemistry and crystallography.

Figure 26 Assessment of the Research Quality of the Institute of Inorganic Chemistry



Overall Score

Overall, the Institute is a strong national player with clearly visible international collaboration and the potential to develop into a strong international player. The research directions of the Institute define numerous possibilities for future collaborations with the industrial, non-academic sector.

Quality of the research

The Institute is very active at a national and international level. The performance in terms of research publications is very good; with some researchers publishing in journals with high impact factor. The Institution is internationally recognised and involved in numerous international activities including EU FP projects as well as COST and ESF networks. Although one of the missions is to educate PhD students, the total number of PhD students is rather modest.

Impact of the scientific discipline

The number of papers in journals with high impact factor in the field is rapidly improving, mainly during the last few years. Consequently, number of citations/paper is still modest with almost 60% of papers without citation. The number of patents also increased during the last couple of years. Although inorganic chemistry represents an important component in the educational curricula at post graduate level, the number of completed Master's thesis is modest as well the number of enrolled PhD students.

International collaborations exists with strong players in the field, e.g., Fraunhofer IKTS (DE), CNRS Institut de Chimie des Surfaces et Interfaces (FR), CNRS Institut de Physique et de Chimie (FR) which has already resulted in joined publications.

Economic and social impacts

The group demonstrates strong applied nature of their research work. A considerable number of patents (national and international) have been filed. Two SMEs have been founded in order to strengthen the research potential for users. It seems that there is a strong interest from industry in the applied research of the Institution particularly in inorganic nanoparticles, solid state electrolytes, biomaterials, and corrosion inhibitors. The group also organises open events for interested public. Funding obtained from non-public sources is considerable.

Research environment and infrastructure

The Institution is strongly tied to the administrative structure of the RTU as an agency. This may cause high administrative burden including a lot of reporting obligations. Due to the institutional arrangements with RTU much time is devoted to administrative tasks. The large percentage of technical staff requires stable funding. The reduced funding of the last years may result in certain insecurities. The ratio between young and old researchers within the Institute is not favourable. The small number of enrolled PhD students seems also problematic. Although external funds were obtained for improving the technical infrastructure, the present infrastructure seems rather aged. In 2012 a major renovation of the Institute was done with the help of ERDF funds.

Development potential

The researchers have proved to be capable of obtaining international funding, although in most cases only as partners. In the self-assessment report insecurities to guarantee successful research environment are mentioned as a results of economic crises: low salaries, reduced funding at the national level. The Institute shows high potential to continue research activities at the international level. The improved infrastructure through ERDF funds may create an improved base for international cooperation and higher visibility.

Conclusions and recommendations

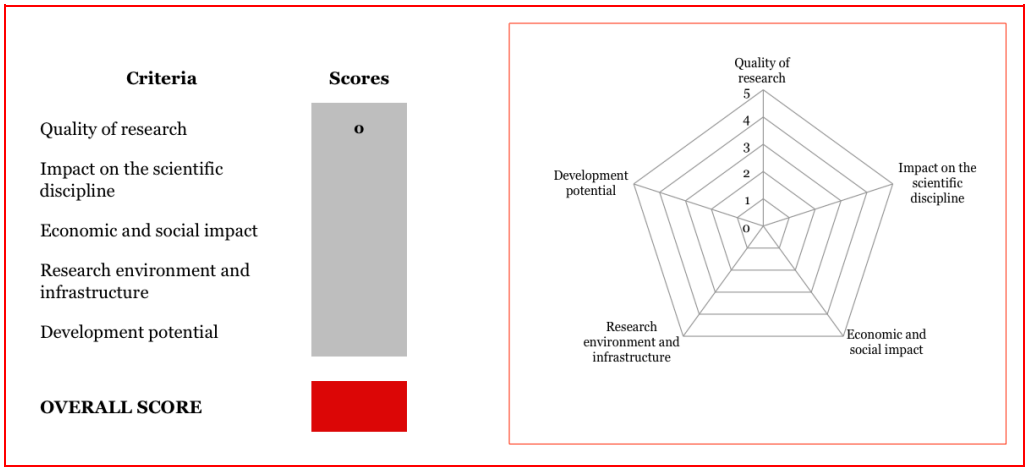
The strategic directions are in line with national and international trends, but are not well supported in the self-assessment by detailed descriptions of how to achieve them. The large proportion of technical and administrative workload may limit the future performance of the Institution. The main focus for the Institute must be to guarantee a stable funding situation. This point is crucial for the future of the research Institute and is not sufficiently considered in the self-assessment report.

27. M_27_Institute for Environmental Solutions

Name of the institution	**Institute for Environmental Solutions**
Name of university	Institute for Environmental Solutions
Type of institution	Institute established by HEI

The Panel felt that this Institute is not a scientific research institute but rather a private enterprise or company. Therefore the Panel refrained from evaluating it. Furthermore, the company was established recently and had only one employee in 2011 so even if it would have been within the realm of the Panel's remit, it would have been all too early to evaluate.

Figure 27 Assessment of the Research Quality of the Institute for Environmental Solutions



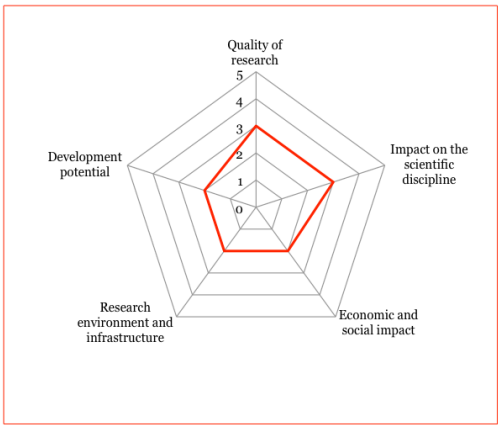
28. M_28_Institute of Biomaterials and Biomechanics

Name of the institution	Institute of Biomaterials and Biomechanics
Name of university	Riga Technical University, Faculty of Material Science and Applied Chemistry
Type of institution	University

The Institute is currently a small organisational unit at the Faculty of Material Sciences and Applied Chemistry of Riga Technical University. The research area represents a long tradition at RTU, but it has undergone considerable structural changes during the past years, which are also reflected in the significant changes in the number of personnel as well as in the available infrastructure for research. The Institute was very active till 2009, however since there has been a noticeable decrease in its activities. Recently, the biomechanics went through another restructuring and while some parts remained at the Institute, others left. Overall, the self-assessment report lacks clarity on some key aspects, resulting in a low score for some criteria.

Figure 28 Assessment of the Research Quality of the Institute of Biomaterials and Biomechanics

Criteria	Scores
Quality of research	3
Impact on the scientific discipline	3
Economic and social impact	2
Research environment and infrastructure	2
Development potential	2
OVERALL SCORE	2



Overall Score

While the Institute's work can be viewed as a solid contribution to the field, the overall performance with respect to the international competition is insufficiently elaborated in the self-assessment report. The strategy to deal with the lack of available national industry in the field is also not well elaborated. Overall, the self-assessment report lacks clarity on some key aspects, resulting in a low score for some criteria.

Quality of Research

Work on artificial-bone material is a subject of research in numerous laboratories and companies worldwide. Work done at the Institute is recognised by the international community evidenced by a fairly good citation rate, especially of papers in recognised journals. The self-assessment report does not explain sufficiently where the Institute really is leading the international development of its field of work.

Impact on the scientific discipline

The Institute is respected in the scientific domain at the national level and in the Baltic region. The complementarity of expertise allows implementation of research in

interdisciplinary teams. Potential for effective collaboration in international project is high but it seems not sufficiently exploited.

Economic and social impact

Transfer of knowledge into practice is not effective due to the lack of the corresponding industry in Latvia. This should have been further exploited at the international level. No word is mentioned on IPR issues and patenting. The national and international cooperation of the Institute is of limited nature, centred around a few foreign partners with no counter visits recorded. Interaction with national or international industrial partners is not evidenced. The EU TEMPUS programme is focussed only the further development of curricula and not so much on research.

Research environment and infrastructure

Basic equipment is provided, however the Institute's units are scattered over various buildings and the laboratories are not optimised for biomaterial research. Duplication of equipment that is not easy to access results in serious problems for effective use of infrastructure. Although high-tech equipment exists it is not easy to use it due to unavailable training and personnel to help. The RTU as a whole seem to experience structural difficulties, duplication of infrastructure and research topics within the single university.

Development potential

The Institute has its position in the research community. The Institute correctly addresses realistic planning based on improved internationalisation, interdisciplinarity, modernised education system, optimised administration and excellence in research and transfer of knowledge to industry. However, this strategic planning is vaguely addressed and not well supported by concrete description and means on how to achieve far-reaching goals.

Conclusions and recommendations

The self-assessment report lacks clear description making the evaluation of this institute difficult. In the report for the period 2006 to 2011 the text describing the developmental potential has been copied from a strategy document created for the faculty without any adaptation for the institute's need and how to implement and achieve specific goals. The 2012 self-assessment report - which the reviewers did not receive initially with the other documentation - does offer some ideas with respect to the further development but does not describe how the difficult financial situation could be overcome.

In the faculty a number of activities are underway with respects to biomaterials. Possible interactions between this institute's and those other research activities should be critically evaluated and explored. It is recommended to consider a closer integration with the other groups within the RTU requiring and utilising similar infrastructure. In particular, one should seriously consider merging the Institute with the Institute of General Chemical Engineering (M_18).

29. Overview of the research performance across the Panel coverage

Latvian science is in a deplorable state. The whole scientific system is dysfunctional because of underfunding which is the result of unfortunate political decisions in the recent past. In real terms, Latvian science funding in 2013 is less than half of what it was in 2008. It is now only 0.65% of GDP, a number that should be compared with 3.3% for Sweden and 3.1% for Finland in 2011. Most Latvian scientific institutions have survived the period since 2008 only because of support from the European Social Fund (ESF). Now when the ESF-projects have come to an end, there is a significant risk of a complete collapse of Latvian science unless measures to correct the situation are taken immediately.

Latvian science also suffers from isolation and non-optimal institutional and administrative structures, some of which are inherited from the Soviet Union. The lack of proper evaluation and independent international peer review as a basis for recruiting professors and making funding decisions is another factor harming the development of science in Latvia.

In 1992 the Danish Research Councils organised an evaluation of the research system in Latvia on the request of the Latvian Council of Science. The published report "Latvian Research - An International Evaluation" (Copenhagen 1992, ISBN 87-984408-0-2) contained a number of relevant recommendations. It is disappointing to notice that only a few of these recommendations have been implemented. Most of them could, and should, be repeated *verbatim* 20 years after the publication of the 1992 evaluation.

The general level of quality of research in Latvia in the fields covered by Panel M

The average level of research in Mathematics and Natural Sciences in Latvia is in an international perspective moderate, even low, and not satisfying. Of the 28 institutions evaluated by Panel M none could be considered as a global leader, one fourth were characterised as strong international players, one fourth as strong national players with some international recognition, and the rest (50%) as satisfactory or poor national players. Some institutions host single faculty members with high international reputation, working on an internationally fully competitive level. These researchers are of outstanding importance for the development of the scientific institutions and of Latvian science as a whole. The number of such faculty members must increase.

Administrative scientific structures

Latvia still has, as a heritage from the Soviet Union, a parallel structure of research institutions. On the one hand there are University Faculties and Departments responsible for the higher education and on the other hand, there are Research Institutes focussing solely on research. Since the 1990s the Institutes have been, at least partly, integrated into the Universities. But the Institutes are still independent institutions of the Universities with no obligations to teach. This is a non-optimal solution. The whole idea of higher education is that it is based on scientific research and ideally every teacher should conduct research and every researcher should teach. In practice the situation is actually better, because a large fraction of scientists are affiliated both with a University Department and an Institute. In many cases one could save a lot of resources by merging the Institutes with suitable University Departments without negatively affecting the every-day life of the scientists (they are already affiliated with both). During the site-visits the Panel heard arguments both in favour of keeping the parallel structure of Departments and Institutes an in favour of merging the Institutes with the Departments. The main argument in favour of the present system was that University Departments have a much heavier bureaucracy than Institutes and that it therefore is easier to recruit new personnel, implement reforms, etc. in Institutes than in Departments. But this is not a valid argument. One should instead remove the red tape from the Universities. In case of collaboration between institutions of different

Universities sharing the same infrastructure and having common human resources, a joint Institute might be justified. But there are no scientific grounds for having Institutes operating in one University only.

Structure of the personnel

In the material handed out to the Panel the scientific personnel was divided into two main categories: Academic personnel and research personnel. The academic personnel (Professors, Associated Professors, Docents, Lecturers, Assistants) are responsible for teaching. This distinction derives from the corresponding difference between University Departments and Institutes and is unhealthy. The most striking fact is the lack of post docs. Recently graduated PhDs could of course be hired as researchers, but such positions appear to be permanent. The system of typically three-year post doc positions, which has been successful in many countries, does not exist in Latvia. This is a severe drawback as the post docs are the pillars of every laboratory. It is absolutely necessary for Latvia to implement a nation-wide programme granting post doc positions on a competitive basis.

Another severe problem is the age-structure of the personnel. At most institutions the age-distribution is bimodal and heavily skewed towards scientists well above the normal retirement age in most European countries with a lower peak in the age range 30 - 40 years. The older scientists are presumably comparably well-paid and form a bottle-neck hindering the much needed recruitment of young brilliant scientists. On the other hand, the bimodality of the age-distribution might be an opportunity for the young generation when their hour finally comes. However, small funding opportunities for young researchers and absence of funding for post-doc positions can lead to a generation vacancy in science; the threat is increased even more because of demographic decline and high emigration. In any case, all institutions must make careful personnel and recruitment plans taking into account the inevitable exit of a large fraction of scientists in the near future.

A very important personnel category of every scientific institution is formed by the doctoral students. Despite the present difficult situation most PhD students that were interviewed during the site-visits were enthusiastic about their work. However, they pointed out the enormous differences in salaries for PhD students. The income (salary, grant) depends on the source of funding and as a consequence the students are treated unequally. Some students got, for the same work a ten-fold salary compared with the least fortunate. This is not only unfair, but could eventually destroy one of the most important resources of Latvian science: the good and enthusiastic doctoral students.

Finally the management of Faculties, Departments and Institutes is important for the success of a scientific institution. The Panel noted that at some institutions the directors stayed at their posts for a very long time (perhaps they were permanently employed as directors). It is much better if Deans, Heads of Departments and Directors of Institutes are appointed for a fixed, possibly renewable, period of a few years. The Panel noted that the best institutions had young, dynamic directors that actively worked on renewing and raising funds for their laboratories.

Consolidation of research institutions in order to reach critical mass in particular research fields

The development/consolidation will strongly depend on (i) the hiring of new, high quality faculty members, (ii) organisational reforms, and (iii) a stable funding situation, including a sufficient research infrastructure. A strong focus on European collaborative projects seems crucial. The core (state budget) funding is too low for most of the institutions.

Most of Latvian institutions are small with an average total number of researchers about 20. It would be important to consolidate some of the research groups by creating research centres with modern instruments to share. However, it should be taken into consideration to employ technical staff in such centres, especially if they are equipped with sophisticated, specialised equipment.

In April 2011, three institutions of the University of Latvia (Atomic Physics and Spectroscopy, Astronomy and Geodesy and Geoinformatics) established the association FOTONIKA –LV with the aim to take responsibility for sustainable advancement of the sector of photonics in Latvia. The association submitted an ambitious FP7 project of basic and applied research in traditional and innovative fields of photonics: REGPOT–2011-1 which was eventually granted €3.8million. Other laboratories should follow this example.

Much research in Latvia is focussed on nanotechnology and other "main-stream" areas. However, within such areas the scientific competition is globally very high. Therefore, such a research focus needs a clear strategy. Not all institutions could present or provide clear and detailed strategies. In particular in nanotechnology research more collaboration between the institutions would be beneficial and one might also consider merging some of the institutions in this field.

Only one of the institutions evaluated had a Scientific Advisory Board. For a laboratory having the critical mass, it is very important to have one. It is therefore recommended that all larger institutions consider establishing an international Scientific Advisory Board.

Infrastructure

Although the best laboratories had adequate infrastructure, many institutions still had to manage with old equipment from the Soviet times. A particularly serious deficiency is that many institutions do not have access to important bibliographic and bibliometric databases such as Thomson Reuters Web of Knowledge and Science Direct. Classical libraries are often not up-to-date and the scientists do not have full online access to journal articles. This makes it next to impossible for the researchers to follow the developments in their fields. Also, with only a restricted access to international journals, young scientists may have difficulties learning how to publish in high impact journals.

Publishing practice

At the best institutions there are a few scientists who publish in highly regarded international journals. But still too much is published in conference proceedings, Latvian journals and other obscure publications. Papers in conference proceedings are typically not peer reviewed and they are at best read by some of the participants of the conference. With the advent of Internet, conference proceedings have become obsolete. Even if some journals edited and published in Latvia have an international profile and are indexed in the main international bibliographic databases, they still have a low impact. There does not seem to have been an enticement for Latvian scientists to publish internationally. To increase the impact of Latvian research it is necessary to find means, possibly in the form of both carrot and stick, to get scientists to publish in high impact international journals.

Internationality

Latvia is still to a large extent scientifically isolated. Many of the institutions evaluated by the Panel had no international collaboration in the form of foreign scientists visiting the institution or staff spending time abroad for collaborative research. Of course, the best institutions had normal international relations attracting foreign scientists to Latvia. It is of utmost importance for the development of Latvian research to increase international collaboration.

The best thing would be to start with the young generation and the PhD students. Most of them speak excellent English and are very eager to spend time abroad during their thesis work. It would considerably enhance the PhD education and, as a consequence, improve the future quality of science in Latvia, if it were made possible for every PhD student to spend, say, a semester at a university abroad. At the best Latvian institutions this has already been implemented and even made mandatory.

There is also a lack of funding for shorter research visits abroad for senior scientists.

Evaluation and peer review

New university professors are typically recruited internally without proper independent peer review. Funding decisions concerning research grants by the Latvian Research Council have until very recently been made without proper evaluation and peer review. This has led to scientific inbreeding, which has harmed the development of science in Latvia. Latvia is a small country, were all key actors know each other. It is therefore imperative that all important science policy decisions such as recruitment and promotion of professors, funding of research proposals, etc. are based on independent international review. It is also important to increase competition as this is the only way to increase quality. Research grants should be competitive and professors should be recruited after an open call.

Recommendations

Based on the analysis above, the Panel makes the following recommendations:

1. The governmental science funding should without delay be lifted back to the 2008 level and even beyond.
2. The current two-tier system makes an unnecessary distinction between professors that are responsible for teaching and researchers that only do research; University Departments and Research Institutes working in parallel should be abandoned. The Institutes should be fully integrated into the Departments and a career ladder with four steps (i) Professors, (ii) Associate Professors and Lecturers, (iii) post docs, and (iv) PhD students implemented.
3. A national post doc programme should be inaugurated.
4. PhD students should get the same salary for the same work independently of where their funding comes from.
5. One should seriously consider merging institutions performing similar kinds of research in order to get rid of overlaps and to preserve resources.
6. Institutions should consider establishing Scientific Advisory Boards.
7. Money should be allocated for subscriptions to the most important bibliographic and bibliometric databases and online journals.
8. Latvian scientists must be encouraged to publish in high impact international journals.
9. Funds should be made available for international collaboration in the form of shorter research visits for senior scientists (Latvian scientists travelling abroad and foreign scientists visiting Latvia).
10. An independent and international peer review system must be implemented at all levels of scientific decision making. In particular, professors should be recruited and research funding granted only after competition and a careful objective review process.
11. Dedicated starter research grants should be developed and allocated to young scientists (e.g. under 35 years) with different criteria applied during the selection procedure compared to the grants for senior researchers

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