Lithuania:
Comparative Expert Assessment of R&D Activities | 2018

Panel P:
Physical Sciences
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INTRODUCTION

BACKGROUND

The overall objectives of Comparative expert assessment (CEA) of research and development in Lithuania were:

To provide the Lithuanian public, policy-makers and decision-makers and the academic community with the expert-based evaluation of the status and competitiveness of Lithuanian research in comparison to the national and international practice.

Comparative assessment of research and development is an integral part of R&D evaluation system. In 2017 a renewed two-stage evaluation system was introduced, where the first stage (quantitative assessment) is implemented by the Research Council of Lithuania (LMT) and the second stage (qualitative assessment) is organised by the Research and Higher Education Monitoring and Analysis Centre (MOSTA). The aim of assessment is to evaluate all participating Units of Assessment (UoA) using three criteria: research quality, economic and social impact and development potential. The results of CEA will enable the Ministry of Education and Science to allocate 60% of basic funding for R&D. CEA will be organized every 5 years starting from 2018.

The assessment shall produce evidence based analytical material that carefully and in detail analyses the research excellence and competitiveness of Lithuanian research, whilst also considering its socioeconomic impact and the development prospects of research activities. This material provides evidence for research policy-making at different levels as well as enabling the research institutions involved in the process to gain a significant impetus for improving their operations. The Higher education institutions or State research institutes and their constituent faculties/departments/research groups were evaluated. The institutions, involved in the assessment process, formed their Units of Assessment (UoA) engaged in one area of research (agricultural sciences, humanities, biomedical sciences, physical sciences, social sciences or technological sciences). One Institution could have more than one UoA.

Altogether six expert panels (61 experts in total) were appointed to perform the evaluation. This document is the report of Panel P: Physical Sciences.

SCOPE OF PHYSICAL SCIENCES PANEL & INSTITUTIONS INVOLVED

The Panel was asked to evaluate the research using the following criteria: the quality of R&D activities, economic and social impact of R&D activities and development potential of R&D activities and to score each Unit on a five-point scale*, namely, ranging from excellent [5] to poor [1] or no R&D [0]. The evaluation period was 2013–2017.

The quality of R&D activities was evaluated in one of two levels – either in a research area (broad field) or a research field (narrow field) depending on the size of the research field considering researcher’s FTE and the study fields in which the UoA operates or holds a PhD right. Economic and social impact as well as development potential were evaluated only in research area.

Panel P was asked to assess 17 UoAs in 9 institutions. The scientific disciplines (research fields) of these institutions include Astronomy, Biochemistry, Chemistry, Geography (physical), Geology, Informatics, Mathematics, Physics. The institutions were as follows:

Universities:

1. Kaunas University of Technology
2. Klaipeda University
3. Lithuanian University of Educational Sciences

* The scale of each criterion can be found in the regulation of CEA methodology approved by the Minister of Education and Science in Lithuanian at: https://www.e.tar.lt/portal/lt/legalAct/6de23010a2c011e78a4c904b1afa0332/OLQDQXSWpB
4. Šiauliai University
5. Vytautas Magnus University
6. Vilnius Gediminas technical university
7. Vilnius University

Research institutes:
1. Center for Physical Sciences and Technology
2. The State Scientific Research Institute Nature Research Centre

MATERIAL ON WHICH ASSESSMENT WAS MADE

The evaluation by the Panel was based on the material prepared by the UoA, R&D activities evaluation results provided by the Research Council of Lithuania (RCL) for the years 2013-2016, publicly available information via the websites of the research institutions and other official sources as well as site visits and meetings with the representatives of the UoA. The Panel and the organisers of the CEA do not take any responsibility for the quality and accuracy of the information submitted by the individual UoA.

ASSESSMENT PROCEDURE

Experts from Panel P visited Lithuania on September 24 – 28, 2018 and during this period they made site visits to all UoAs. The final Panel P assessments were based on data provided for the experts with contextual information about Lithuanian higher education and research system, as well as information and documents necessary for the evaluation of the UoA and evidence gathered during site visits. At least three Panel members were present at each visit. All provided materials by UoA were read in detail by at least three Panel members and then discussed by the whole Panel on at least two occasions, namely, before and after the Panel visits to the Units.

Expert assessment is carried out following the principles of transparency, equality, mutual recognition, diversity, clarity, reliability, consistency, proportionality and non-discrimination.
ASSESSMENT OF THE UNIT
Sustainable Chemistry, Center for Physical Sciences and Technology

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The economic and social impact of R&D activities

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Development potential of UoA

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The quality of R&D activities:

Chemistry (03P)

The UoA (Sustainable Chemistry) is composed of five departments: Chemical Technologies, Electrochemical Materials Science, Catalysis, Characterization of Materials Structure, Organic Chemistry. During the reporting period between 65 and 100 articles have been published each year of which an increasing proportion are in Q1 or Q2 ranked journals (63% in 2017). Despite conducting research at a high level and publishing in international journals, the UoA receives limited international recognition: the median citation rate of the 16 articles reported in 2013 was only 9. In addition, there is a high proportion of articles where most of the authors are from this institution resulting in reduced level of internationalization. However, the degree of internationalization, as documented by published papers, is improving from 24% in 2013 to 36% in 2017. One highlight is a recent (2017) paper in Nature Communications which 2 researchers from the UoA are co-authors together with colleagues from Lithuania and Sweden. The quality of research is recognised at a national level as evidenced by the prizes awarded to members of the institution, for example the Lithuanian National Science Prize in 2015. Researchers are attending a wide range of international conferences, often multiple conferences in one year, and some of the oral presentations have been invited. In terms of PhD students, the UoA officially has 15, however due to close collaboration with Vilnius University the actual number of PhD students being (co-)supervised by researchers in the UoA is considerably higher. In the reporting period 16 dissertations were defended. Only half of the PhD students defended with 2 or more first-author publications and two students had no first-author publications. As is common throughout Lithuania, no PhD students are international. Given the number of FTE research staff, the number of PhD students should be increased. The UoA is successful at attracting industry funding as well as funding from National research programmes and European projects. The UoA reported two FP7 and one Horizon2020 project; the Horizon2020 project in particular is one of the largest in the country in terms of budget. In addition, one researcher, who obtained their PhD abroad, successfully obtained a Marie Curie Fellowship to return to Lithuania. In summary, the UoA is strong in R&D at national level but a UoA of this size should be publishing a greater number of high impact papers with a wider range of international collaborators and be involved in (leading or partner) a greater number of national and international research projects.
The economic and social impact of R&D activities

The UoA has actively engaged in a large number of projects with business partners to develop relevant solutions/products. In the reporting period around 10 major R&D contracts are listed. Some of these are research projects involving industry, for example the Horizon 2020 COSMOS project which is a consortia of 8 SMEs, 9 research organisations and one industry partner, whilst others are direct projects with industry partners, for example LAM Research Corporation Company, USA. The UoA’s research has led to a number of patent applications (including US) and also a spin-off company Alanodas; demonstrating the societal impact. In addition the UoA's researchers are regularly consulted by (mainly) national companies for their expertise and have a number of business cooperation agreements with a wide range of international partners. Other activities have a smaller financial impact but show a strong connection of the UoA with Lithuanian companies and its economic relevance. The close ties with industry the UoA secures a steady funding stream, which it reinvests in its infrastructure and personnel. Employees of the UoA are represented in a number of high level national committees related to research funding and research policy, for example government working groups. A few employees are represented on journal editorial boards though this representation is mainly low-impact journals and is dominated by the Lithuanian journal Chemija (impact factor 0.4). Relatively few employees are involved in international expert panels/working groups. During the reporting period the UoA organised 14 conferences though these were predominantly national in scope. Public outreach is mainly restricted to press releases/interviews i.e. not much direct public engagement through open days (with the exception of one career day for students in 2017). In summary, the UoA carries out very important research and is a very important partner in R&D outside the scientific community.

Development potential of UoA

The majority of the UoA moved into a new building halfway during the reporting period and the concentration of FTMC Chemistry, FTMC Physics and VU in the same building has created a vibrant atmosphere and closer cooperation between the previously separate entities. The impact of these new collaborations will no doubt be apparent in the coming years. In addition, the UoA has identified four promising areas for new research directions: novel materials for energy, materials for nanomedicine, surface finishing and recycling and sustainable management. The facilities are very impressive and reflect considerable investment. Further funding has already been approved for an additional 3.5 M€ equipment upgrade (INNOCHEM). With this concentration of state-of-the-art equipment, the UoA has clear potential to produce internationally-leading research and expand its range of international partners and industry collaborations. The equipment usage is well-balanced between internal and external users and the UoA needs to capitalise on these already existing collaborations and ensure that high-impact publications arise. Nevertheless, for this potential to be realised, the UoA needs to have a clearer strategy with regard to attracting and retaining international talent. The average age of staff was 51 in 2017 and it will not be sufficient to only focus on attracting researchers from within Lithuania. The PhD students are motivated by the applied nature of their research and the majority see their future either wholly or partly within industry. The panel was particularly impressed by the UoAs presentation of concrete measures it had taken to act on the results from the last research exercise and we note that these measures have by-and-large been successful. This demonstrates strong strategic leadership of the UoA that bodes well for future development. In summary, the UoA has great potential to achieve excellent ratings.

Recommendations on the activities of UoA continuity and (or) improvement

The UoA has an enviable suite of laboratories and facilities and it needs to develop a strategy to market itself at an international level in order to showcase itself to the international community and thereby increase the number of international collaborators using the facilities. Raising the profile of the institute could also help attract international talent to work and study at the institute. For example, during the last reporting period the 10 visits by international researchers reported, were often for short periods. There is clearly potential to increase this number significantly. The use of internal seed money for new projects is good, but needs to be followed through with action to encourage researchers to follow up these pilot studies with funding applications for national and EU funding (both Horizon2020 and ERC), and at a later stage, concerted assistance to commercialise products.

There has been considerable investment in instrumentation, many of which are relatively new and for which the full potential has not yet been realised. The UoA should ensure that it has enough personnel to both maintain the instruments, contribute to technique development, and encourage exchanges with other
institutes in order to keep up to date with best-practice procedures and ensure that these instruments are used for cutting-edge research and development activities.

The UoA has been hampered by the unpredictable nature of national research funding and both the consolidation of national funding agencies and support for post-doctoral positions could help the UoA in this regard. Despite a government focus on publications in high impact journals, the UoA should continue to invest in its highly successful applied activities which are resulting in patents. Outreach activities (e.g. school visits) could be more strongly supported and encouraged.
Fundamental Physics, Center for Physical Sciences and Technology

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The quality of R&D activities:

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The economic and social impact of R&D activities

| Score | 3 |

Development potential of UoA

| Score | 5 |

The quality of R&D activities:

Physics (02P)

This mostly theoretical Unit performs research in popular areas of modern physics as nonlinear dynamics, chaos, fluctuations, neural networks, "big data", or collective phenomena in large stochastic and complex systems. These fundamental concepts are applied to human brain modelling, star formation, galaxy evolution, image recognition, etc. In addition, electronic structure of semiconductors and fast processes are investigated at ab initio level. Fluctuations in semiconductors are also studied experimentally.

The bibliometric score of the Unit is high. The list of publications per year is split between various research groups. Almost all papers appear in several strong established journals (Q1), only a few papers presented in the reports are published in slightly less impacted journals. The papers are highly cited; the Tutorial on defects in semiconductors in the J. Appl. Phys. (2017 IF=2.176) published in 2016 has collected so far (October 2018) 50 citations. Other 5 papers (2013–2016) received 10 or more citations. Overall the Unit publishes very good internationally recognized results; nevertheless, high-impact "leading" papers are missing.

The conference selection is appropriate and the activity at conferences is high, mostly with oral contributions and a few invited talks at important events; more invited speakers presented their results at local destinations.

Two defended dissertations in five years are below average for the Unit size. The dissertations are based on 4–5 papers, which is a good average. Nevertheless, the number of PhD students increased recently from 2 to 7.

The list of awards is not particularly extended, but it includes an important recognition of the activities of A. Alkauskas who was awarded the Marshak lectureship at the APS meeting. Very good are the results of the unit in terms of funded projects. There are five major projects listed, with funding ranging from 100 to 300 thousands €; they cover different areas, from complex networks to semiconductors to galaxy evolution. Three of these projects are funded from international agencies. Overall, the Unit has excellent international connections, reasonable number of research visits and collaborations with foreign scientists, and its activities are highly recognized worldwide. There are no international students, though.

To summarize, the Unit is strong at international level.
The economic and social impact of R&D activities

The Unit performs mostly fundamental research; therefore, economic impact is indirect and difficult to quantify. Particularly, cooperation with business is not expected (nor reported except preliminary contacts with Osram). The application of the chaos control theory to understand better processes in human brain may serve as an example of fundamental research with potentially high impact. The project includes extensive observations taken in a hospital and may lead to better treatment of Parkinson's disease and similar neurological disorders.

The work of Vladas Vansevičius in the Research Council of Lithuania is prestigious and important, but this is the only reported case of engagement in commissions. No information on consultations has been provided. One international conference has been organized, but this Unit would certainly have capacity for more events. Similarly, the membership of K. Pyragas in the editorial board of the International Journal of Bifurcation and Chaos (2017 IF=1.501) can be appreciated. On the contrary, it is not impressive to be an editor of a not-impacted journal.

The Unit is good in popularisation of science, for instance various activities at schools, EU Contest for Young Scientists (EUCYS) including a written guide (Handbook for Young Scientists), a blog, commentaries in media, interviews, popular articles and talks, etc.

To summarize, the UoA carries out important scientific research and is an important partner in R&D outside the academic community.

Development potential of UoA

There are plans to add new computing facilities which serve as the main research tool for theoreticians. The experimental infrastructure for fluctuation measurements is of a good standard. This small Unit is of average age with a few new employees (some of them with experience from abroad). Apparently, it is not easy for the Unit to plan the future development of the personnel. As it is noticed in the report, "The Unit is a small part of the Center and does not control the human resources management issues". This can be a critical issue for the development of the UoA.

There are clear and elaborated plans for future R&D activities towards two main lines of development of methods in the fields of: (i) complex system analysis with applications in neurology and astronomy and (ii) analysis of semiconductors based on the measurement of fluctuations and \textit{ab initio} modelling. Both topics are timely and relevant. The strategy discusses mainly how the fundamental research will progress but does not detail enough of its societal impact, although examples of such an impact were presented in the discussions during the experts' visit.

To summarize, the UoA has a great potential to achieve or maintain very good and excellent ratings.

Recommendations on the activities of UoA continuity and (or) improvement

The Unit works in several popular fields. New results can be achieved with moderate effort, but at the same time there is a danger that after some time such fields will be exhausted. New areas will have to be found.

The Unit does not feel sufficiently appreciated ("The ignorance of the importance of fundamental research in the science policy of Lithuania" is mentioned in SWOT threats). The Unit should work on improving the acceptance of fundamental research at all possible levels, from PR to popularization of the results.

Memberships in editorial boards of low-end journals do not bring prestige and should be avoided.
Photonics and Applied Physics, Center for Physical Sciences and Technology

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Development potential of UoA

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The quality of R&D activities:

Physics (02P)

The Unit of Photonics and Applied Physics within the Center for Physical Sciences and Technology is among the largest units of its kind in Lithuania. The Unit appears very strong, internationally competitive as well as internationally linked and with a very clear and strong mission concerning the research strategy. A number of international R&D projects, international publications, as well as some useful interactions with commercial companies are evident. There is a good cooperation between national and international centres and laboratories. A steady track record in obtaining R&D funding is noticeable. The development of high-tech laser based technologies was convincingly demonstrated during the site visit. The connection to other disciplines is given, in particular good synergies exist with life sciences. The Unit has a strong publication records, very often in cooperation with partners outside Lithuania and is therefore internationally well recognized. The Unit plays a vital role in educating young people on PhD level which helps to minimise the brain-drain. They currently have a significant number of PhD students – most, if not all, Lithuanian. They run different PhD studies and graduate a few students per year on a doctoral level, with good level of the defended dissertations. They demonstrate that they are able to attract young PhD holders from abroad, although there are only Lithuanian nationals at the moment. The Unit is among the leaders at an international level, the quality of R&D activities in terms of publications, presentations delivered at the conferences abroad, awards received by UoAs researchers, defended dissertations of PhD students, and R&D projects is ranked as excellent.

The economic and social impact of R&D activities

Cooperation with university technology transfer center results in spin-off companies. The Unit’s economic impact lies in the capitalisation of scientific knowledge in several fields including systems for environmental investigation by the development of multifunctional cost-effective diagnostic and analytical tools. The Unit is an extremely important partner in R&D outside the academic community, with particular reference to the private sector.
Intensive conference participation is evident as well and demonstrates a dynamic attitude. A good number of conferences have been organised by researchers of the Unit, with good impact.

There are some memberships of editorial boards of international journals which is good, however a significant number of contributions is to national local journals, with less impact.

The UoA carries out scientific research of exceptional importance and is an extremely important partner in R&D outside the academic community.

**Development potential of UoA**

The human resources can be characterised as an appropriate balance of experienced and young researchers. The staff is only partly involved in teaching, which means that most of the time can be dedicated to research – although paperwork related to bureaucracy was explicitly mentioned as a negative and time consuming aspect of work routines. MSc-students are involved in research.

The Unit has experimental and computational equipment of good international quality, being absolutely competitive at international level. The equipment includes advanced spectroscopic techniques (e.g., Coherent anti-Stokes Raman), isotope dating and also modelling software. Furthermore, the Unit has clean room facilities, device manufacturing and characterization equipment. The Open Access Centre for Prototype Fabrication and Integration serves FTMC and VU for (opto)electronics and sensoric development.

The atmosphere in the Unit was very friendly and welcoming during our visit. The staff left the impression to be curiosity driven and open for new ideas.

A clear development potential which would results in a wider international recognition of the Unit is associated to the possibility to increase the participation in advisory or editorial boards of international journals.

The Unit has a huge developing potential in terms of research and development as well as capitalisation, given the increasing global demand for new technologies and products.

Attracting researchers from abroad is still difficult as salaries are not (yet) competitive but a development potential with this regards is clearly visible. The Unit has a great potential to achieve or maintain very good and excellent ratings.

**Recommendations on the activities of UoA continuity and (or) improvement**

Try to attract researchers from abroad by implementing appropriate programs, in particular in the educational sector, including PhD studies.
Condensed Matter Physics, Center for Physical Sciences and Technology

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The economic and social impact of R&D activities

Score 4

Development potential of UoA

Score 5

The quality of R&D activities:

Physics (02P)

The UoA is working on condensed matter physics with a broad spectrum of activities which cover areas of physics, chemistry, materials science, nanotechnology, biophysics, electronics. It is doing a range of research from fundamental science to applied research in materials and technology and so there is plenty of scope for R&D impact in all its forms. There is significant synergy between the researchers within the group and also with local collaborators. The site visit made such interactions clear and demonstrated the benefit of such working practices. There is a very strong potential for additional/expanded interactions with business which the Unit is benefiting from.

A lot of the research outputs are focused on papers and development of science that will be published. This is fine and given applied nature of work it is a natural progression on to industrial collaboration and societal impact. The scientific output in terms of the best published papers can be considered good, with some publications in international journals of good reputation. There is some room for improvement here where some of the work should be aimed at the higher end of the Q1 journals. Low quality journal publications should be avoided.

The results in terms of R&D projects approved is reasonable with successful attempts in obtaining funds, but the Unit should attempt to gain more from both national and international sources of funding. There is a good level of international interaction, however procedures to try to strengthen close collaboration with international collaborators can be tightened up.

The work allows for very good links and crossover between academia and industry; this is highlighted in the PhD students where such ties are strong.

In general, the outputs in terms of presentations delivered at conferences abroad, awards received by UoAs researchers, defended dissertations of PhD students, and R&D projects can be considered good. One R&D project is a Horizon 2020 Marie–Curie, GRAMAS; the others are projects funded by Research Council and national agencies. In this respect the research carried out is well recognized at national level. In short, the UoA is strong with limited international recognition.
The economic and social impact of R&D activities

As the Unit is doing both fundamental science with quite a few materials applications there is plenty of scope for societal R&D impact. The Unit has a very strong potential for interactions with business; this is being exploited well but the institution needs to support this further to be developed to its full potential. The Unit has good procedures to try to strengthen close collaboration with international collaborators, both industry and academia, and hence performing well. However, they can certainly develop this more, particularly with increased support from senior management of the institution.

The list of research outputs mostly contains the description of basic research papers, but examples of economic and societal impact include the radiometric testing of the Maišiagala radioactive waste storage facility and by the development of a multi-channel measuring system of pulsed magnetic field, which is interesting for industrial applications. Also, some members of the UoA have been involved in some individual consulting activities which should also be encouraged and exploited.

On the site visit it became clear that quite a few well-placed interactions that could lead to further impact. A lot are stated as a "possibility" of future work, therefore robust plans should be in place to fully exploit the opportunities made. Similarly, companies have been "consulted", but outcomes need to be fully worked upon. The UoA has a good track record in this and therefore is fully placed to develop and grow such links between fundamental and applied science leading to economic impact.

There are a few reasonable memberships of boards of scientific journals but also quite a few of lower quality. It is best to avoid these lower quality ones as little is gained and it will free time for more research.

A few nice popular science articles have been published, and also there have been some interviews and press releases. Popularisation of science has been evaluated as being at a good level.

The UoA has been involved in the organization of the 15th International Symposium "Ultrafast Phenomena in Semiconductors", in a Nano School on "Application of Nanolaminates for Biosensors Design", in the 10th Nano-conference "Current Trends in Electrochemistry and Material Science" and the 9th Nano-conference "Advances in Bio-electrochemistry and Nanomaterials". Overall a rich and diversified activity that demonstrates that the UoA carries out very important scientific research and is a very important partner in R&D outside the academic community.

Development potential of UoA

The Unit is well-equipped, including metrology standards with broader use. These standards are also intensively used by other subjects, state and private. Several interesting projects in diverse areas (condensed matter, biology, radionuclide metrology, etc.) are planned. The Unit has an excellent set of R&D infrastructure (equipment). The site visit was extremely useful where descriptions of its future potential were provided including details of how, why and funding costs and what funding and research opportunities that will bring.

The Unit is involved with the open sharing of equipment and procedures are in place to exploit this well. It was not fully clear how successful this has been so far, but the Unit is positioned to exploit their own and other national resources.

The strategic plan is to develop activities towards emerging material technologies related to electronics, sensors, information processing and data storage, energy storage and conversion, environmental issues, transport, food, biotechnologies and medicine. The spread of activities appears a bit too large for a Unit of this size to it might be possible to focus the efforts on a few topics which could result in better performances and results.

Although some of the aspects are clear and demonstrate great potential for the Unit, there is room to expand on links between local, national and international researchers both within academia and in industry. Overall, the UoA has a great potential to achieve or maintain very good and excellent ratings.

Recommendations on the activities of UoA continuity and (or) improvement

Recommendations for the Unit are to aim for the higher quality journals (Q2 is not high enough) as they have the equipment and ability to do this. They need support from the institution to allow them to do this, including increasing the amount of time and wages available for research. The Unit is well-placed to exploit its work for economic impact; it is currently doing well here but the institution needs to ensure support for this to allow the researchers to fully achieve this.
NRC_3, Nature Research Centre

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The quality of R&D activities:

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The economic and social impact of R&D activities

Score 3

Development potential of UoA

Score 2

The quality of R&D activities:

The Unit of Assessment consists of the Geology and the Geography Institute within the Nature Research Centre, which also includes an Institute in Botany and another one in Ecology. The Physical Sciences Panel assessed the Unit’s research activities in the research fields of Geology and Geography. The Unit is assessed satisfactory at a national level. The Geology and Geography fields are well integrated, and most of what can be said about one also applies to the other. The Centre has recently experienced a complicated sequence of mergers and un-mergers. The administration is concerned about further such steps, and it has a clearly articulated vision how to meet the challenges it is likely to face in the near future.

Geology (05P)

The Geology division encompasses three of the five laboratories into which the Unit is divided. The UoA publishes articles with modest impact and nearly all articles are co-authored with researchers from other institutions (national and international). Researchers attend a range of international conferences including high impact events such as EGU and Goldschmidt. Thus, the researchers publish but not sufficiently often in internationally recognized top journals. The same can be said about dissemination of results at conferences. One of the reasons comes with the territory, since geological studies are most often necessarily local and therefore of national but not necessarily international interest. This does not subtract from the importance of such studies, which is surely needed for the long-term prosperity of the country. There are measures to improve the publications already in place, such as financial incentives to publish in highly ranked international venues.

Data on completed PhD dissertations show that students tend to publish in national journals, hindering wider readership and career mobility. The UoA is involved in two Horizon 2020 projects (but as a minor partner) and a partnership with the University of Bern. There is exchange of researchers between the institution and other institutions. In general, the activity is satisfactory at national level.

Geography (06P)

The Geography division encompasses two of the five laboratories into which the Unit is divided. See below for comments about infrastructure, personnel, and other topics. Furthermore, presentations delivered at the
conferences abroad, awards received by UoAs researchers, defended dissertations of PhD students, and R&D projects can be considered satisfactory at national level.

The economic and social impact of R&D activities

The social impact of the Unit is considerable, and indeed indispensable for the country in the future. Naturally, they are inseparable from the general research efforts of the Unit and include monitoring radiation effects from the decommissioned nuclear power plant, the maintenance of an extensive mineral collection, an Open Access Centre for their equipment, and others. The Unit members participate in expert groups on atomic energy & environment. High activity in popularization helps geology and geography recruit new generation of scientists. The Unit also organized several conferences. Overall, the UoA carries out important scientific research and is an important partner in R&D outside the academic community.

Development potential of UoA

There are important challenges to the country that provide opportunities for the Unit, such as nuclear investigations necessary during the time-consuming decommission of the nuclear power plant, and environmental issues on the Baltic Sea. Indeed, there are contamination hazards dating back to the Soviet time that will need the study of geological researchers and the attention of State officials. The Unit is well positioned to play a key role in the formulation of adaptation strategies with respect to global climate change related challenges.

The Unit possesses infrastructure and other conditions to perform research, although it feels underfinanced. Unfortunately, while interviewing the researchers, the Panel members were confronted with a rather conservative attitude to solving these problems. On the other hand, we were pleasantly surprised by the motivation and enthusiasm displayed by the PhD students.

The infrastructure of the Unit is adequate while in need of modernization. This includes a national core storage facility, a unique paleontological collection, an extensive mineral collection, and an Open Access Centre made available also outside the Nature Research Centre.

There are synergistic connections to the other institutes in the Centre. Specifically, researchers in the Unit regularly use facilities available in the Botany and the Ecology divisions, and they make their facilities available to members of these division.

A general challenge is the decline of student numbers and the difficulties to attract talent to rejuvenate the personnel within the Unit. It is likely that this will require future financial investment in the Unit, but this is money well spent. Overall, the UoA has the potential to maintain satisfactory or better ratings.

Recommendations on the activities of UoA continuity and (or) improvement

Strengthen the collaboration and communication with other groups working on overlapping topics, in particular with the Faculty of Natural Sciences at Vilnius University.

Improve the communication with government offices that are responsible for environmental issues in the country. This includes pro-active probes into the environmental health of the country and the active communication to the appropriate government bodies.

The Unit needs an influx of younger people taking initiatives and responsibility to find new directions and continue the important work contributing to the environmental health of the country.
Chemistry, Kaunas University of Technology

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The economic and social impact of R&D activities

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Development potential of UoA

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The quality of R&D activities:

Chemistry (03P)

The main field of activity of the UoA, chemistry, has been divided into Chemical and Chemical Engineering sub-units, although the definition has more an administrative motivation and does not reflect a particular separation of the research activities.

The self-assessment report lists six major research outputs, five are publications in good scientific journals, one is a patent. In particular, two papers (one in 2015 and one in 2016) have garnered widespread international recognition (with more than 80 citations). The quality of the 30 best research outputs demonstrates a strong involvement in publishing the most relevant results in the field of chemistry in quite good impact journals. Overall, the scientific production over the five years appears of very good level. The UoA has also clear strategies to stimulate publications in good journals.

The members of the UoA have regularly reported their results in international conferences, both oral and poster presentations, not only in European symposia but also in Singapore, Australia, Turkey, USA, China, Korea, Japan, etc.

The received awards for the past five years are from Lithuanian agencies and in particular from KTU or Lithuanian Academy of Sciences. A notable exception is the Westinghouse Prize awarded to three of the Unit’s members (and one external researcher).

Research funding come from the Research Council of Lithuania, but the UoA did participate in various competitive R&D projects, covering hybrid solar cells, organic colorants, molecular switches, functionalized surfaces, organic synthesis, etc. In this respect, the UoA has shown a very good capability to attract funding.

Based on these results, the scientific productivity and the participation to competitive projects looks good. Overall, the UoA is strong, with limited international recognition.

The economic and social impact of R&D activities

The UoA has a strong capability to translate research into business and to produce patents. A number of materials/technologies have been developed which have been classified as having high TRL numbers (Technology Readiness Level). Research has fed into the work of several start-up companies in Europe (e.g. Denmark, Germany) and has led to creation of jobs. Close ties with business results in internship...
opportunities for students. The research focuses on societally relevant issues and the Unit regularly provides consultations for national businesses and government organisations.

The outputs in terms of R&D are quite impressive. Here is just a selection of successful cases. One project is dealing with functional materials for the development of the Yocto Reactor Technology Design for the synthesis of amino acids and their DNA linkers; the work is in collaboration with Vipergen ApS (Denmark) and has led to substantial external funding. The UoA has been part of a consortium of leading European scientists in the field of organic and hybrid photovoltaics together with industrial partners working on solar cell development, from fundamental understanding, to large scale prototype construction (Meso-superstructured Hybrid Solar Cells project). Based on the research results, patent applications were submitted. A project on hybrid solar cells has been developed in collaboration with Tokyo Chemical Industry who has acquired the license for the KTU patent. Another successful project is dealing with dye sensitized solar cells in collaboration with the spinoff company TrinamiX GmbH (Germany); the activity has produced various patent applications. A project aimed to develop methods for separation of active ingredients from raw plant materials to be used for functional foods, nutraceuticals, cosmetics and pharmaceuticals was exploited by Vincenty Enterprise LLC (USA). The developed materials have been patented and are commercialized. A project aimed to produce novel multifunctional phytochemical ingredients funded by the Research Council of Lithuania enabled increasing the effectiveness of processing of various botanicals resources into ingredients to increase food quality and safety. In collaboration with Endobiotech, the Smartinvest LT proposal was selected for funding by Lithuanian Business Support Agency. The company is building its own facility for production of functional ingredients from various botanicals. In another project new heterocyclic systems have been patented due to a high potential for application and use of the new chemicals.

The members of the UoA have significantly contributed to committees, consulting agencies, etc. There are some researchers representing Lithuania in some European bodies such as COST. Editorial membership is restricted to journals with modest impact factors. Among the events organized are the Baltic Polymer Symposium, the 4th North and East European Congress on Food, the Baltic Conference on Food Science and Technology, etc. Memberships and participation in editorial boards is good. The Unit holds an annual conference 'Chemistry at school' to help chemistry teachers pass on current research to the school pupils and regularly visits schools and engages with the public. There is an intense outreach activity in schools and media.

Overall, the economic and social impact of the R&D activity is very good, and has contributed to create job opportunities.

**Development potential of UoA**

The UoA has at disposal a superb infrastructure aimed at the synthesis and characterization of organic, inorganic and bio-based materials for industrial applications in chemical, pharmaceutical, food, energy, and environmental sectors. This instrumentation forms the basis of the Open Access Centre of Kaunas University of Technology.

Most of the researcher employees (21 out of 30) are in the age 25-44, 9 are in the age 45-64. In the past 5 years 21 researchers were hired with a scientific degree, and 12 had employments that were terminated and 1 retired. In average, the age distribution of the UoA members is very good, with several young scientists. KTU is committed to foster good working environment and career development for researchers by complying with the European Charter for Researchers and the Code of Conduct for Recruitment of Researchers. The UoA is also engaged in attracting and favouring the incorporation of new talents in the research environment and has clear plans to favour the development of their careers.

There are two PhD studies, one in Chemistry and one in Chemical Engineering. The number of PhD students is good but it could be increased. Most, if not all, are coming from inside the country, most of them from the city of Kaunas. It would be good to facilitate the mobility of PhD students among other Lithuanian and European Universities. PhD students are producing a good number of first author publications, but not always their publications are in journals of good reputation. In general, about 20% PhD students want to go to industry, about 30% plans to look for positions abroad, while the remaining 50% wants to stay in academia, and in particular in the same institution where they will get the PhD.

The strategic aims for the future include 1) strengthening of the impact to local and international business and society; 2) increasing involvement of society and business in the development and funding of R&D, 3)
attracting talented and leading researchers, 4) maintaining high quality of R&D; 5) development the necessary R&D infrastructure.

KTU’s R&D strategy sets the following thematic priority areas: 1. Diagnostic and measurement technology; 2. Smart environments and information technology; 3. New materials for high technology; 4. Technology for sustainable development and energy; 5. Sustainable growth and socio-cultural development. Some of these topics appear a bit generic, but overall a clear and well formulated plan.

Among the key indicators, KTU aims at reaching contribution of R&D to the university budget above 25%. The amount of high quality publications should reach 1.25 per researcher. A clear strategy is proposed to reduced number of research groups (20 in 2015, 15 in 2020), to increase the number of publications in WoS journals (95 in 2015, 100 in 2017; 120 in 2020), the number of total R&D projects (18 in 2015, 25 in 2017, 35 in 2020), the average annual revenue from projects by a research group (20 kEur in 2015, 30 kEur in 2017, 35 kEur in 2020), the number of established spin-off companies (1 in 2015, 2 in 2017, 4 in 2020), the number of postdoctoral researchers at the Faculty (2 in 2015, 4 in 2017, 6 in 2020), the number of foreign researchers at the Faculty (0 in 2015, 1 in 2017, 2 in 2020).

Overall, the UoA has a great potential to achieve or maintain very good and excellent ratings. The trend towards a clear and constant growth, both qualitative and quantitative of the activities is already there. The excellent infrastructure available can be extremely important to attract good researchers in the future.

**Recommendations on the activities of UoA continuity and (or) improvement**

Overall the Unit is well organized, and delivers good quality research, with particular success in translation to business. The instrumentation available is of high quality, and there is a good number of motivated PhD students. The relationship with the private sector is already very good, and it can be further improved.

The main weakness at the moment is represented by the low level of internationalization of the PhD studies. It would be desirable to increase the international level either by establishing some joint programmes or double degrees, by encouraging participation in international actions (COST, Marie Curie Networks), and by favouring the students to spend part of their PhD abroad, in other institutions. To this end, either the UoA or the University could dedicate some funds to support stays abroad of at least 6 months during the PhD period.

The potential evolution of the research environment is good, in particular considering the average age of the staff members. Although several collaborations are already active, it will be good to see that the excellent infrastructure present can be used to foster new collaboration with other institutions in the country.
Physical Sciences, Kaunas University of Technology

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The economic and social impact of R&D activities

Score 3

Development potential of UoA

Score 3

The quality of R&D activities:

Mathematics (01P)

Although smaller in size than the other groups, the sub-UoA in Mathematics is quite consistent, with a sufficiently large spectrum of interests. Some publications have appeared in internationally leading journals, which is a certain indication about the potential. Also, some awards for both researchers and PhDs show a recognition for the work being done. From the point of view of journals, it is satisfactory to focus on journals indexed in Clarivate and Scopus, but aim high in Q1. Journals form particular publishing houses should be avoided (e.g. Hindawi, MDPI). The same applies for some conferences (e.g. ICNAAM). Moreover, particular attention should be given to submit works to journals indexed in MathSciNet, which indexes the core journals in Mathematics. In any case, the level of activities could be improved, both from the point of view of publications (in terms of quantity and quality) as well as with respect to the number of international collaborations. A significant part of the research activities is oriented towards applications; this approach can be continued and possibly be reinforced in the future. However, at the same time fundamental mathematics should not be neglected, as it is necessary for the training of new generations of Mathematicians of a high quality. The number of young scientists in the Unit is good; on the other hand, several participants to the research Unit show a level of activity still low, in terms of number of publications, citations, and participation to important international projects. It is finally noticed that the UoA has no PhD studies in Mathematics.

Overall, the research carried out is of high-level and recognized at national level.

Physics (02P)

This sub-UoA has the largest number of FTE researchers in comparison to the other two groups and is characterized by a good level of activity, with several ongoing projects, some of which at an international level. There is a certain publishing activity in journals with impact factor (IF) in the range 2 to 5 and published by international prestigious publishing houses, which is a good sign proving a progress that occurred during recent years. However, despite of their high IF, these journals are not characterized as the leading ones. Therefore, there is a need to focus on high impact papers in the leading journals. The topics tackled belong mainly to applied Physics, with a minor impact in theoretical Physics. The particular number
of staff of the group would allow to have a larger spectrum of interests, and to include more theoretical aspects of Physics. The training of young students would also benefit from this widening of interests. In addition, there is a fair number of conference presentations, which are oral; hence, they may have some impact greater than posters. The group has received some awards, mainly local. It appears that there is a lack of PhD students for a couple of years; however, some students started recently. In any case, a reasonable number of PhDs were awarded given size of the Unit. In addition, PhD graduates can demonstrate a satisfactory list of published results.

Also in this case the research carried out is of high-level and recognized at national level.

Informatics (09P)

The sub-UoA in Informatics is rather oriented to teaching than to research as can be deduced from the numbers of the respective personnel. Due to this fact, several major areas of Informatics are not covered from the research point of view (e.g. Algorithms and Complexity, Databases and Information Retrieval, Software Engineering, Networks, etc). The focus is mostly in Artificial Intelligence topics, such as evolution/genetic algorithms, fuzzy classification, and forecasting. Also, papers in image processing, cryptography have been contributed. These research lines are up to date in the core of Informatics. With respect to the quality of the outlets, it is remarked that some articles have appeared in prestigious journals, published by international well-known publishing houses (e.g. Neurocomputing and Information Sciences). On the other hand, it is remarked that some articles are not always placed correctly, either because the journal is not well-received internationally (not included in any classical system, such as WoS or Scopus), or because the main focus of the journal does not fully agree with the research topics of the papers (e.g. journals about Astrophysics, Optics, Operations Research). This way, although the research performed maybe of decent/high value, it does not reach the community of interest. In the same respect, some commercial journals must be avoided, as they are not just low quality but detract from the status of the UoA. Such publications are “burned” even if they are of high quality content. Finally, some articles fit better in the area of Mathematics than in Informatics (e.g. the ones in Automatica, Operations Research, Applied Mathematics, Composite structures, Biophysics, Chaos etc) since they could very hardly be considered to touch peripheral Informatics topics. With respect to the conferences where articles have been presented, it is noticed that some of them are internationally recognized (with IEEE or Springer proceedings), whereas some other could be avoided as being commercial and non-competitive (e.g. IARIA, WMSCI, ICNAAM, CEMA).

The UoA is assessed satisfactorily at national level.

The economic and social impact of R&D activities

There are several actions which signify a certain impact of the UoA to society and business. Several members of the UoA participate in key national bodies, such as the Lithuanian Academy of Sciences and the Lithuanian Research Council. Apparently, these memberships are honouring but a wider diversity would be good, in particular at an international level. In addition, several members of UoA have contributed in external consulting, plus they are involved in innovation and business centres. Notably, a number of national conferences have been organized (e.g. a yearly meeting/workshop on Mathematical Modelling is organized together with business partners for 1 week with ~25 persons). Again, at this point, a further effort for internationalization is necessary (e.g. to attract international conferences to take place in Lithuania), which in turn will improve the visibility and impact at national level. A few members of the UoA serve as editors of a few specialised journals, nevertheless it is worth spending more time on international impact than on low quality journal editorship. It is noted also, that the offered degrees span a wide spectrum of disciplines, which means that diverse educational opportunities exist locally for the young generation (5 Bsc programs and 5 Msc programs in Informatics, Mathematics, and Physics as well 27 PhD students in Physics and Informatics).

The UoA carries out important scientific research and is an important partner in R&D outside the academic community.

Development potential of UoA

The UoA is of a quite consistent size and has shown its capability to obtain some contracts from industry and to attract PhD students and young scientists. The research part oriented to the applications is now solid enough, whereas the part more oriented to fundamental sciences still suffers with an insufficient international
visibility, which could attract more students and turn the Unit to become a large spectrum research center. A significant number of retirements have occurred during the last 5 years, but at the same time the same quantity of new blood has been hired. The chances that replacing retirements may lead to further development are high. The hiring strategy of the next years will then be crucial; the Unit should carefully target to hire young and very active, talented scientists, who can contribute to reinforce the international collaborations. For further development, it is important to apply a paradigm shift and focus to mainstream and prestigious publishing outlets; a goal which is achievable. The available facilities seem of a sufficiently good level, which should be further exploited. The UoA has the potential to improve its ratings in the future.

**Recommendations on the activities of UoA continuity and (or) improvement**

It is evident that there has been a great progress during the last 5-10 years in terms of internationalization. Several PhD students have graduated in Physics or Informatics. The recent decision of the government to increase the salaries of PhD students can help significantly to attract young scientists during the next years and perform research of even better quality. At this point it is noted that the quality of a particular article is not directly related by the Q1/Q2 journal categories; the real quality/impact of an article is measured by the number of received citations. Therefore, special attention should be paid to this end. Necessary actions in this respect would be to create profiles in Google Scholar, obtain ORCID identities and so on. In addition, efforts should be directed to publishing in top international specialized conferences, where a researcher can meet his own community. This way, the researchers and the performed research will have better international visibility. The present policy of selecting conferences mainly if journal special issues with selected conference papers will then be published, probably serves the current goal (rewarding for Q1/Q2 publications) but in the long-term does improve the recognition of the international community.
Physical Science, Klaipėda University

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The economic and social impact of R&D activities

Score

3

Development potential of UoA

Score

3

The quality of R&D activities:

Geography (06P)

The group is relatively small (less than 6 FTE staff with PhD degree). There were four PhD students during the year 2017, which is an important factor for the future development as they are expected to help producing good quality research. The group shows a steady approach towards publishing in journals run by well-known international publishing houses (IEEE, Elsevier, Springer, Wiley), although with some exceptions. These articles have reasonable impact, plus they are co-authored by researchers from abroad. Nevertheless, the publishing activity, as judged by the number of citations, could be higher. In addition, the group has attracted some international staff which is a very positive sign as this opens the possibility to strengthen international collaborations. Also, the researchers attend international conferences; however, with the exception of EGU these are mostly regional in focus. The researchers are engaged in international research projects with a focus on the Baltic Sea Region. Notably, in all these projects the UoA is a project partner. There does not seem to have been any successful applications for individual research projects either from the Lithuanian Research Council or the EU.

Overall, the UoA is assessed satisfactorily at national level.

Informatics (09P)

Although this group offers degrees in Informatics with a full curriculum in IT, the members of the group do not publish in journals and conferences tightly related to core Informatics in a systematic manner. For instance, with respect to journals papers, most of them cannot be considered as publications in Informatics but rather articles about applications using some Informatics elements. Such examples are the following journals: Non-linear Analysis, Journal of Agronomy, Plant Biosystems, Environmental Engineering, Ocean Science. Overall, the publication activity, especially in journals with higher impact, is weak with respect to the Unit size (FTE). On the other hand, there do exist conference articles published in core outlets with respect to Informatics (for example, conferences BIS, ICPRAM, Baltic DB&IS, ERCIM). Despite the basic characteristic of the opportunity for inter-disciplinary research, efforts have to be made so that the particular sub-UoA is internationally recognized in core Informatics.

Also, in this case the UoA is assessed satisfactorily at national level.
The economic and social impact of R&D activities

R&D contracts have mainly been from state organisations (e.g. Klaipeda State Seaport authority) rather than businesses. The UoA has built up expertise within sediment contamination and regularly provides consultations on this topic to the local state entities. This is a positive fact even if for confidentiality reasons we do not have access to their results. Representation of the UoA in working groups and committees is dominated by membership of academic/state groups (Lithuanian Academy of Sciences, Valleys), with only a few links to business entities. Only 2 examples of research–business cooperation agreements are provided. More persistent activation is necessary to penetrate the private sector. It is a good practice to organise conferences as this helps in building the visibility of the UoA and the cross-fertilization with the community. Certainly, there have been successful conference organizations; however, again of local/region character and limited visibility. Members of the UoA serve as editors of a few specialised journals of some prestige. It is preferable to try to re-position at the international arena and gain further reputation and international impact. The exceptions are researchers for whom their primary affiliation is not Klaipeda University. The Unit regularly publishes articles in the newspaper and is involved in a number of projects to help inspire school children into science careers. During the conversations it emerged that the researchers like teaching and they even feel that they could teach more.

The UoA carries out significant scientific research and is an important partner in R&D outside the academic community

Development potential of UoA

The UoA combines two rather diverse research fields, geography and informatics, and clearly it is not easy to find common targets and objectives for the future development of the whole UoA. Furthermore, the national classification of research areas and fields in Lithuania does not reflect the situation of research dedicated to the Marine sciences, which is seen as a weakness, leading to difficulties in applying for funding, assign scientific output to a proper area or field of research. The concept of the Marine Valley is admirable, but the benefits of these wider industry collaborations have yet to materialise. The future plan 'to establish recognized Laboratory methods and to accredit them in two years' is vague. For instance, it is not clear which methods will be targeted. Funding is precarious with all R&D funding derived from EU projects in 2017. Total funding has decreased substantially since 2013. Some fresh doctoral graduates have appeared whereas some more are in the line. The UoA is small in size in terms of FTE but can attract serious funding. This shows dynamicity and may give rise to a future development. The potential is significant because of the unique status as a Unit focusing on marine science. The new infrastructure needs to be fully exploited. The combination of Geography and Informatics has a potentiality that should be developed as much as possible but at the same time is challenging due to the diversity of the topics. The UoA has the potential to improve its ratings.

Recommendations on the activities of UoA continuity and (or) improvement

The UoA has to invest and develop its true and unique strengths nation-wide, which is the focus in Marine Science (as opposed to the classical Geography). The Marine Research Institute could serve as a lighthouse at an international level, a unique contact point for the Baltic sea and beyond. The current sciences classification by the state authorities does not help in this respect. The UoA should demand its reclassification, even if it is the only such Unit in Lithuania.

It is important for the UoA to attract talented young students in PhD studies and fresh researchers. The recent decision of the government to increase the salaries of PhD students can help significantly to this end. At this point, it is noted that the quality of a particular article is not directly related by the Q1/Q2 journal categories; the real quality/impact of an article is measured by the number of received citations. Therefore, special attention should be paid to this end. Necessary actions in this respect would be to create profiles in Google Scholar, obtain ORCID identities and so on. In addition, efforts should be directed to publishing in top international specialized conferences, where researchers can meet their own community. This way, the researchers and the performed research will have better international visibility.
Physical Science, Lithuanian University of Educational Sciences

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The economic and social impact of R&D activities

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Development potential of UoA

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The quality of R&D activities:

**Physics (02P)**

The Physics part of the UoA is recognised for piezo systems in mechatronic and ultrasonic applications, ferroelectric crystals, and nanosystems. The bibliographic scores are weak, even if the small Unit size (and the number of results the Unit is allowed to present) is taken into account. Most papers appear in specialized journals with low or average impact factors, and they are not cited very often. One notable exception is a paper in Chem. Mat. (2017 IF=9.89); this recent (2017) article has already (October 2018) collected 20 citations, but the contribution of the authors from the Unit is not dominant. Furthermore, another paper has 16 citations, two papers 7. The activity at conferences is fine but it seems that only poster presentations are delivered. Some papers are published in conference proceedings, but these are less able to create impact than regular papers. Two defended dissertations within five years correspond to the Unit size, their quality is high (they are based on 13 and 8 papers, respectively). The funding of research is from local sources only and again is proportional to the Unit size. Three larger projects are from the field of piezo-based mechatronics.

To summarize, the Unit is assessed satisfactory at national level.

**Informatics, Mathematics, Chemistry, Geography (09P, 01P, 03P, 06P)**

The group of research fields in which the UoA works are diverse, two most populated topics being statistics and linguistics. The bibliographic score is weaker than for Physics; however, this Unit is even smaller and if we consider teaching duties, formally only 1.1 FTE is left for research. Whereas the number of papers is in proportion to the Unit size, most of them appear in journals with no or low impact factor. Only a few results can be considered as internationally recognised work with some impact – the maximum number of citations per paper is 4. There are several works in the field of Lithuanian linguistics with local importance and some citations. The activity at conferences is low, few of them are global-impact events and only posters are delivered. No PhD students are trained. Speech recognition project LIEPA (2013–2015) of local importance focused on helping school learners, adults and disabled individuals to use computers, devices or tools that understand and speak Lithuanian.

To summarize, the Unit is assessed satisfactory at national level.
The economic and social impact of R&D activities

The work on mechatronic actuators for flying micro robots has a potential economic impact, although so far the research is conducted only at academic level; the same is true for other projects: piezoelectric systems for precision technologies, sensors and actuators for mechatronic systems, and ultrasonic oil extraction from algae. It is unclear whether the Lithuanian speech recognition project LIEPA (see above) and the older project for dendrimer-Gd(III)-nanodiamond as contrast agent in MRI had a real economic and societal impact. The UoA organized one international workshop and three local meetings. The Unit members are active in several editorial boards; however, of low-impact journals (although the Lith. J. Phys. is certainly locally important). Two consultations (for German and Chinese entities) in the field of piezoelectric motors are provided on a regular basis. The list of popularization activities is rich and reflects the main mission of the University of Educational Sciences. It includes lectures, articles, practical classes for pupils, National Science festival "Spaceship Earth", participation in the "Researchers' Night", and preparation and evaluation of solutions of students' Olympiads in several fields.

To summarize, the Unit is assessed satisfactory at national level.

Development potential of UoA

This UoA is already in the process of integration with the Vytautas Magnus and Aleksandras Stulginskis Universities; also, many employees have left. The remaining staff is older than average. It is therefore difficult to speak about a development potential of the Unit as a whole; a potential can be found in individuals and groups possessing unique know how in a number of fields: piezoelectronic mechatronics, ultrasonic technology, nanodiamonds, differential geometry, statistics, data mining, neural networks, and linguistics. The infrastructure is very diverse and corresponds to research topics and particular projects of the groups. It includes a single point laser Doppler vibrometer, an ultrasonic device, a Fourier spectrometr, and a computer cluster; the resources are available on the "open access" basis. In addition, a telescope is used in teaching and popularisation. The future directions to be developed are dealing with ferroelectric semiconductors, nano/micro technologies, and model forms of biological diversity. The particular research plans are soundly based, but the topics appear as very diverse, fragmented, and disconnected. The strategic plan has aims ("foster", "enhance", "increase"), but it does not seem to give a mechanism by which the aims will be achieved. Therefore, the idea of dissolving the research infrastructure and human resources in a different institution appears logical; the administration and researchers seem to accept this merger and are looking forward to new possibilities connected with the larger institution.

To summarize, the UoA has the potential to maintain satisfactory or better ratings.

Recommendations on the activities of UoA continuity and (or) improvement

Because of the planned merger with the Vytautas Magnus university, no recommendations can be given for this UoA as a whole. Individuals and groups should continue to make use of their skills, publish in internationally recognized journals (perhaps except for works in Lithuanian linguistics), and also avoid memberships in editorial boards of low-end journals. Oral presentations in conferences have higher impact than posters and should be preferred; the aim should be to get prestigious invited talks. Invited talks both evidence impact of work and also research status of the presenter. Writing PhD (and other) theses in English and stays of students abroad (Erasmus+) will enhance language skills of young researches and make recognition by international community easier. International contacts of any kind should be fostered.
Physical Sciences, Šiauliai University

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**Development potential of UoA**

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**The quality of R&D activities:**

**Mathematics (01P)**

In the section of mathematics, the research Unit is rather small in terms of the number of involved researchers; most of research is made in number theory, with a minor part on partial differential equations, fluid dynamics, and probability. The Unit has a couple of scientists of a high level, and some of the members of the section have a good level of activity, in terms of papers in international journals, participation in several important conferences abroad, and international collaborations. On the contrary, in average the scientific output of the section shows a much lower level of activity. This is surely a point that has to be taken into account in the future. Also, from a training point of view, concentrating almost all the research in a single subject (analytic number theory) could represent an obstacle for the future young researchers, that may have serious gaps in their cultural spectrum, finding difficulties in a possible future academic career.

The section publishes a mathematical journal with title "Šiauliai Mathematical Seminar", which is devoted to print original research papers and surveys on various fields of mathematics and its applications. The journal is abstracted in Zentralblatt MATH and in Mathematical Reviews/MathSciNet.

The research carried out is of high-level and recognized at national level.

**Physics (02P)**

The section of Physics in the Unit is rather small and with a rather low level of activity, in terms of collaborations and involvements in important projects. The link with industrial sectors is very limited and should be improved: it could represent a source of funding to complement the basic resources provided by the university. The number of publications is also low and reflects the small number of students attracted by the section; at the moment no PhD students appear to be enrolled in the section. Teaching seems to be the primary focus of this section rather than research.

The members of the Panel that visited the Unit want to stress that the data above have been deduced by the documents provided, because during the visit no member of the section was present.
Research in Physics is crucial for the university and the issue of improving the section of the Unit has to be seriously considered; the next positions that will be available by turnover reasons have to be very carefully discussed, trying to hire some very active young scientists able to improve the visibility of the section.

The UoA is assessed poorly at national level.

Informatics (09P)

The Informatics section of the research Unit does not seem very active. Several publications appear in Clarivate and Scopus digital libraries; however, the publications of good level are not numerous and the presentations in international conferences of a high reputation are rather limited, while most of research outputs are at a regional scale and with limited visibility. As a consequence, the participation to important international projects is also limited. The resources provided by the university, in terms of positions and of financial support, are probably not sufficient, but an effort has to be done to compensate this lack of funds by means of applications to several national and European programs. New fields in Informatics are rapidly developing worldwide, and the Unit could try to invest part of its scientific skills in these directions.

The members of the Panel that visited the Unit met two already graduated students that intend to continue the academic career and are mostly connected with Vilnius university.

The UoA is assessed satisfactorily at national level.

The economic and social impact of R&D activities

The Unit shows a non-uniform societal impact with respect to the different sections of mathematics, physics and informatics. The section of mathematics has a good level of activity from this point of view: a grant to organize the important science event "International Conference on Number Theory" was obtained in 2013 in the framework of the programme “Support for Scientific events” of Research Council of Lithuania; other meetings were organized in the framework of Latvia-Lithuania Cross Border Cooperation and aimed to identify the needs of the labour market for socio-economic development and integration of professional competences of mathematics in border regions. The section of mathematics publishes a journal of medium/low impact but indexed by the main mathematical databases as Zentralblatt MATH and Mathematical Reviews/MathSciNet. In addition, the organization of Mathematical Olympiads and other events help increase science awareness in the society and recruit future students. The informatics section has some few R&D contracts with the private sector, and is involved in e-Learning, m-Learning and t-Learning Technologies. No impact of economic nor societal type appears to arise from the physics section.

The UoA carries out important scientific research and is an important partner in R&D outside the academic community.

Development potential of UoA

The research Unit has some very good researchers in number theory and this level of excellence should be maintained in the future. Concerning the sub-UoA in Informatics, it seems that there is a distance of future plans with respect to mainstream Informatics. On the other hand, the Unit, even if small in size, should allow some young researchers to invest their energies in new and more applied fields. Not only this would widen the research horizon of the Unit, but it could represent a way to attract new students and to apply to research funds that are often allocated for applied fields. The first issue is to obtain recognition inside the Šiauliai University which should provide the basic needs in terms of computer network, other facilities, and some basic funds for travels and invitations of some senior experts. The additional resources have to be found by the members of the Unit, through the applications to national and international research programs.

The human resources need some younger new entries but no clear strategies to overcome this problem are reported. Targeting to the hiring of some young excellent scientists who want to produce good results not only in a rather isolated way, but through collaborations and interactions with other research centers of high reputation, could be one of the crucial issues in the next few years. Similarly, the maintenance and development of network hubs and communication lines linking them (LITNET services) are crucial for the next future and the Unit has to invest in this direction.

During the visit the Panel learned about the merging of the Šiauliai University (hence this Unit) with Vilnius University: this could represent a good occasion to widen the scientific interests of the Unit. Indeed, the small size of the teams is a negative factor with respect to potential, and the merging with Vilnius University
is definitively positive in this respect, because it will allow to reach a critical mass, necessary to obtain a good scientific visibility.

To summarize, the UoA has the potential to maintain satisfactory or better ratings.

**Recommendations on the activities of UoA continuity and (or) improvement**

The panel appreciated the good quality research of some few members of SU_FM and the energy they put in trying to increase the visibility of the Unit. However, other more applied fields, in mathematics and in other sciences, should be developed as well. The possibility to work with PhD students from other universities would help increasing the quality of the UoA and could also contribute to reinforce the international collaborations. The research fields have to be widened by inviting foreign scientists and through visits of young SU_FM researchers abroad. Even if theoretical research does not need a lot of funds, applications to national and international grants could provide the financial support necessary for having a sufficiently good computer network, to invite some senior experts from other universities, and to allow young researchers to visit high quality research centers abroad.

The academic personnel of SU_FM, through the ongoing merging with the University of Vilnius, should widen their horizons in terms of the research topics they focus on. In addition, they should widen the international outlook by augmenting their research output in prestigious journals. Systematically submitting and presenting papers in highly recognized conference would increase the desired internationalization.
VMU Physical sciences, Vytautas Magnus University

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Development potential of UoA

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The quality of R&D activities:

**Biochemistry (04P)**

Biochemistry is attracting students interested in interdisciplinary projects and the R&D activity in this field, despite the medium size of the group, is good. This is demonstrated by the good level of publications in journals of prestigious publishing houses (e.g. Springer, Elsevier, Wiley), as well as by the presentations delivered at quite prestigious international symposia (11 oral communications and 9 posters in Europe, Russia, Japan, USA). However, the number of PhD students is quite limited. In particular, only 1/2 PhD students/year are recruited, one was recruited from abroad in 2016, two PhD students defended in 2014 and in 2017. It is clear that the number of PhD students should increase, but this is a quite general problem in Lithuania. Some good funded projects from Lithuanian agencies have been continued, such as on the development and updating of infrastructure for biotechnology and biopharmaceutical specialist training and R&D (2010-2014), or on estimation of an impact of climate change on biological diversity in the southwest Lithuania and development of measures.

The UoA is strong with limited international recognition.

**Informatics (09P)**

This medium size team shows a good quality of its R&D activities. The group presents publications in specialised journals, as well as 18 oral communications and 2 posters at international symposia in Europe, Singapore, Hong Kong, Indonesia, Japan. Some prizes from Lithuania were awarded. They have a rate of 2 PhD students/year of which one was recruited from abroad in 2014. Two PhD defended in 2013, 3 in 2014 and 1 in 2016. The Informatics group had a reasonable set of R&D projects granted from competitive calls such as on Learning and Execution of Action Categories (2013-2016) and European Structural Support Funds (2013-2015).

The UoA is strong with limited international recognition.
The group is rather small in terms of number of involved researchers and the quality of its R&D activity is satisfactory. They present a number of publications in specialised journals commensurate with the number of research staff, a good number of oral communications in Europe, Japan, Taiwan, South Africa. The number and quality of published papers improved with respect to the previous evaluation; however, a further increase in productivity aimed to publish in higher impact leading journals would be advantageous. Two prizes from Lithuania were awarded (2016 and 2017), and the group participated in various research projects, but only one project was funded for the period 2012-2014, with Mathematics as a leading party, by the National Research Programme "Future Energy". The group has no PhD students, even if some students from VMU_Mathematics entered the Vilnius University Doctoral School continuing to collaborate with the group.

The UoA assessment is satisfactorily at national level. Some members of the group have good international activities (participation in international organizations, publications in international journals, organization of international conferences, etc.) but in average the internationalization of the group needs to be improved.

**Physics (02P)**

The group in Physics demonstrates a satisfactory R&D activity. However, considering the relatively small number of FTE members the group is possibly involved in too many research activities, e.g., in applied physics, including plasma physics, and applications to renewable energies, climate changes, biology and medicine, etc. An adequate number of publications is presented, but only few ones appear on international journals of high reputation. No prizes have been awarded. At the beginning of the assessment period the number of PhD students was rather small and now the UoA does not conduct doctoral studies in the field of Physics. It is clear that this is a critical issue and a strategy for PhD recruitment has to be envisaged if the group intends to maintain the variety of interests as at present, also trying to attract good students not only from Lithuania but also internationally. Participation to international research projects has also to be increased, not only because new funds could support the section to update the necessary instruments, but also for the visibility that the group could gain internationally.

The UoA assessment is satisfactorily at national level.

**The economic and social impact of R&D activities**

The UoA carries out important scientific research for society and has appropriate relationship with society and business environment with an economic and social impact. The most relevant R&D actions are in the field of investigation of Lithuanian energy security and assessment of energy security level funded by Research Council of Lithuania for the National Research Program “Energy for the Future” to evaluate Lithuanian energy security and to perform its analysis. This interdisciplinary study involves modelling of energy systems, analysis of technical, economic, environmental, socio-political and other risks and their consequences. The international EU FP7 project ”Learning and Execution of Action Categories” (ACAT), involving partners from Germany, Denmark, and Slovenia had the goal to provide robots with tacit information to generate internal knowledge about individual task creating and storing all required action information. The project on integrated impact of climate and environment changes to the productivity has an impact on biodiversity and sustainability of agro-systems. INOVEKS project aims to support preparation of high-quality investment proposals, meeting the requirements of the following stages of support for young entrepreneurs. Six new technological prototypes were created by newly established small business enterprises. More than thousand hours of consultations for newly established companies were provided by the UoA’s members. Some researchers are involved in consulting activities to companies on R&D activity planning, evaluation, and documentation. Some international conferences have been organised in Lithuania and some researchers are part of international editorial boards, but also of committees as EU panel experts.

The UoA carries out important scientific research and is an important partner on R&D matters outside the academic community.

**Development potential of UoA**

The UoA is small and an important investment has to be done in hiring some active young scientists. Up-to-date, researcher employees with a scientific degree in 2017 are limited to 10 units. Six are in the age 25-44 and four are in the age 45-54. In the past 5 years 13 researchers were hired with a scientific degree and 2
had employments that were terminated and 2 retired. On the other hand the CLARIN-LT that is a Common Language Resources and Technology Infrastructure for Lithuanian language, is a gateway also to resources and technology in the whole European CLARIN network. It is maintained via interdisciplinary activities of professionals and researchers both in information technology and humanities. It is a research infrastructure of paramount importance for Lithuanian language resources and technologies closely related to ESFRI ERIC source CLARIN and based on a national consortium. CLARIN-LT activities in the context of CLARIN-ERIC, have been precisely planned for 2018–2022. VMU Physical Science Unit covers 4 directions in physical sciences in Faculty of Informatics and Faculty of Natural Sciences: Informatics, Mathematics, Physics, and Biochemistry, as an integral part of VMU and its Artes Liberales culture. VMU Physical Sciences strategic, long-term research plans are in agreement with the University Strategy 2012–2020 and EU Smart specialization innovation policy: the Implementation Program of Priority R&D and Innovation Development Directions and Priorities approved by LR Government in 2014. In conclusion, considering the above-mentioned strategic plan, the UoA has the potential to maintain satisfactory, but hopefully increasing ratings within the next 5–10 years.

The UoA has the potential to sustain its satisfactory or better assessments.

**Recommendations on the activities of UoA continuity and (or) improvement**

The UoA should be much more involved in enrolment of strongly motivated PhD students, but also young researchers and providing reasonable opportunities for their future academic careers. That is an emerging problem considering the strong demand of talented researchers in the UoA research fields from the private sector. The natural turnover of the next years will generate an ideal situation to start a process of recruitment of the new scientists’ generation. Moreover, new funding opportunities as European programs applications should complement the basic funds provided by the national agencies. This could help also in increasing the international visibility of the UoA, improving its research productivity, i.e., increasing the number of publications in higher impact journals (Q1/Q2) and presenting research results in more prestigious conferences, decreasing the number of publications in journals with limited international recognition. Moreover, this could be beneficial in keeping gifted young researchers in the academic career, competing with the private sector that is able to attract them offering higher salaries. The possibility to use the Erasmus+ programme opportunities also to supervise Master and PhD thesis from other EU countries is encouraged. These actions have been so far, not enough exploited.
Fundamental Sciences, Vilnius Gediminas technical university

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The economic and social impact of R&D activities

Score 2

Development potential of UoA

Score 2

The quality of R&D activities:

Informatics (09P)

The Informatics section in the research Unit is mainly involved in applications to construction mechanics, to optimization problems, to analysis of information systems, and to the design and development of databases. The research funds at present are mostly provided by the university and cover the basic needs, so an additional effort has to be done to obtain extra funds through participation to national and international projects.

The number of PhD students is rather low, probably due to the fact that most of the Master students prefer to start a career in private companies, where the salary is considerably higher than in academia.

The section of Informatics, like the other ones in the research Unit, provides the basic courses for all of VGTU; this implies a very heavy teaching load for most of the members of the section, leaving little time for research. This is probably one of the reasons why the scientific production does not correspond to the large number of researchers.

Nevertheless, the section is able to have research activities of a sufficient level, with a good balance between international (IEEE, Elsevier, Taylor&Francis etc.) and regional journals. Efforts have to be made to increase the percentage of the former over the latter. The same phenomenon, even if to a smaller degree, occurs with respect to conference papers, that are related to minor meetings and not to the very important ones as ISD, ICEIS, BIR etc. Due to their involvement in applications, some of the publications are not categorized in Informatics.

The UoA is assessed satisfactorily at national scale.

Mathematics (01P)

In the section of mathematics, one of the largest teams to be assessed in this exercise, the research Unit is composed of several professors, associate professors, and lecturers. On average, the section has a sufficient level of research activity, even if, given the number of scientists in the group, they could easily have a much
larger scientific production. In particular, the largest part of the research activity is due to a small number of researchers, and is mainly concerned with the fields of numerical analysis, probability and statistics, and number theory.

The number of publications is, on average, low, and several of the members of the section have not published any papers in recent years. As for the other sections in the Unit, the very heavy teaching load the members have to carry out is probably one of the main reasons the section has low scientific production. The mix of publications is balanced: some of them are in journals of a very good level by well-known publishing houses whereas some others are in journals of local horizon, which cannot be found in the commonly used databases.

The spectrum of scientific interests is quite large and this is a good point, also from the training side. On the other hand, the scientific collaboration appears mainly developed on a national level; an effort has to be made to broaden the network of collaborations, at least at an European level. The absence of a PhD study in the field of Mathematics is an issue that the research Unit has to seriously consider and try to improve, since the success of a research team strongly depends on the young generations the team has been able to train. The panel also remarked that the youngest researchers seem to not yet have a sufficient level of scientific independence.

The UoA is assessed satisfactorily at national scale.

Physics, Biochemistry (02P, 04P)

The Physics and Biochemistry section is the smallest one in the research Unit and may have good development opportunities if it can attract talented PhD students, giving them good career opportunities, not only in the academic sector but also in the private sector. This does not yet seem the case and the number of PhD students was very limited in the period 2013–2017. This is related to the fact that there are no PhD studies associated to both research fields of this UoA. The research funds for an applied section such as Physics and Biochemistry should not simply come from the hosting university, which provides the basic needs in terms of equipment and academic positions, but have to be found through participation in international projects, for which the section seems to have the necessary skills.

In spite of the small size of the section, the number and quality of the publications are good, with some papers in important international journals (IEEE Transactions, Springer, Elsevier etc.). The conferences attended by the members of the section are also of an international level and not only regional.

The UoA is assessed satisfactorily at national scale.

The economic and social impact of R&D activities

The research Unit is involved in several research areas, with particular attention to the societal applications. On the one hand this represents an excellent opportunity to obtain industrial contracts and to develop synergies with academic and industrial partners, but on the other hand, this type of research needs greater financial resources that, at the moment, do not seem fully available. Nevertheless, at the moment the Unit has little interaction with private companies and in general with the society.

A number of members of the Unit are present in national bodies and agencies, some of which are of a high national level. Also, some efforts to popularize science have been made.

The UoA carries out important scientific research but has limited interactions with the private sector, with decision makes and the society.

Development potential of UoA

The research Unit has sufficient potential to maintain its level of scientific activity. This has to increase and improve, in order for the Unit to be attractive for the best national young researchers and also for scientists from abroad. At the moment the Unit does not seem to be in a position to successfully compete with the best Units in this evaluation procedure. The high teaching load prevents most of the members of the Unit from doing basic research, which means they can’t attract PhD students and they have little motivation and energy to apply for external funding. Teaching seems to be the primary focus of this UoA rather than research.

The infrastructure is of a good level as well as the library, which provides the necessary material for the research and teaching; it is reasonable to expect that this level of infrastructures will remain sufficient in the
next few years. The computer facilities, also accessible to students, are good at least for the immediate future; for a unit doing applied research it will be crucial to regularly update the computer resources together with a good accessibility to fast networks.

The UoA has the potential to sustain its satisfactory assessments, or to slightly improve them.

**Recommendations on the activities of UoA continuity and (or) improvement**

The visiting members of the Panel gave some suggestions about how to proceed in order to improve the visibility of the Unit: increase the quality of publications, attract more PhD students and young researchers, improve the links with industries and submit projects to national and international programs. The various research teams participating in the Unit should find multidisciplinary research topics to develop internal collaborations; this may be facilitated by the fact that the participating departments mainly carry out applied research.
Physics + Astronomy, Vilnius University

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The economic and social impact of R&D activities

Score

Development potential of UoA

Score

The quality of R&D activities:

Physics (02P)

This is the largest Physics centre in Lithuania with an excellent track record in both fundamental and applied research. This includes activities in Chemical Physics, Lasers, Theoretical Physics, Photonics, Nanotechnology and Applied Electrodynamics and Telecommunications. It has a wide range of international collaborators and a large number of students attending courses. Some specific activities in the Unit of Assessment include work on ultrafast laser technologies, optical characterisation, solid state lighting and a wide range of condensed matter activities.

The infrastructure is impressive. Located in a purpose built, new building the department hosts a significant set of advanced scientific equipment covering the needs of the researchers. There are also capabilities in computing.

Physics has a high research output with papers published in a wide range of journals, from specialised subject specific ones to leading, high impact journals. The quality of the work is mainly high, and low impact work seems to be mainly avoided, therefore there is a higher than average impact from papers. There is an aim to push for publications in Q1 and Q2 journals, however the Unit of Assessment should aim higher and avoid Q2 journals as much as possible; Q2 are already getting into the low impact scoring.

Further impact is gained with a high number of conference presentations in Physics. The presentations are almost all oral presentations rather than poster with is preferable as it gains a larger audience and wider impact. The conferences attended are often the main international ones. There appears to be an availability of funds for international conferences as well as for visiting and hosting international researchers.

The quality of training of PhD students is high with all recent dissertations achieving good publications. The Unit stated that there are an appropriate number of PhD scholarships available but finding the best students is difficult because they often leave after completion of Batchelors or Masters degrees for higher paid jobs in industry. There is a low number of international students and also a tendency for PhD students to remain in the institution. It is possible that the increase in student scholarship value will help attract and maintain the best students.
The researchers seem reasonably successful in participating in competitive R&D projects obtaining a good amount of funding at a national level. There are collaborations with other international institutions some of which forms the basis for EU grant possibilities. Some encouragement to lead such international projects would be beneficial.

There are some issues that are out of the hands of the researchers which need to be addressed. It appears that major issues include the low wages of researchers which discourages the best future scientists from remaining in research. Significantly higher wages are found in industry and abroad. Additionally, there are bureaucratic issues in grants that take the time of researchers; procedures can be simplified allowing more time for research.

The research is performed at the highest international level.

**Astronomy (08P)**

The generalities are similar to above with Physics. The astronomers are members of large collaborative groups for access to telescopes, e.g. whole Earth telescope consortium. Participation in active astronomy field will attract young researchers. The Unit has a good output of papers; however, they publish in much more specialised journals compared to Physics, but a few are in higher impact journals.

There are some reasonable awards obtained for R&D activities. The level of output reflects the level of work, which is fairly high in the most part.

The research carried out is of high-level and internationally recognized.

**The economic and social impact of R&D activities**

This large Unit has provided a thorough description of their research infrastructure, which includes high quality equipment (laser technology, SPECTROVERSUM package, computer centre, astronomy observatory, semiconductor technology tools), as well as the know-how. The infrastructure is provided to other users on the basis of transparent applications. There is a large amount of good quality science being produced, both applied and fundamental. There should be excellent opportunities for impact both societal and economic. With the growth of the tech industry in the country this large department should be placing itself at the forefront of academia-industry collaboration, working with industry, obtaining patents and spin-offs. This will enhance the attractiveness from outside Lithuania and lead to more international collaborations, etc. Societal impact should easily follow.

The strategy for research has a set of excellent aims and objectives. We have been presented details on how this will enhance societal and economic R&D activities which were useful. There are a number of current very good collaborations and membership of leading international projects.

The quality of the R&D contracts with private sector entities is high. Both Physics and Astronomy are performing well here.

The Unit is very active in popularizing science. In addition to usual activities (lectures, events at the observatory), there were four popular books published and one translated.

There are a lot of researchers who are interacting with the main entities in Lithuania to promote, fund and teach science, hence the influence and impact will be high. Although the membership of local authorities is excellent there is room to expand into more international committees, such as the major EU funding bodies.

The UoA carries out very important scientific research and is a very important partner in R&D outside the academic community.

**Development potential of UoA**

There is a reasonable list of international researchers coming to visit. This is good but given the size of the department one would have thought that they would be able to have a larger number. Although international collaboration is very good in this department, the Panel thinks not having higher numbers of long-stay international visitors illustrates a minor weakness.

There is a good set of R&D infrastructures used by both local and international researchers. Both astronomy and physics have available infrastructure. The proposed future use is good, indicating high potential development of further R&D activities. Users of R&D infrastructure, operating with the open access principle...
is listed and seems to operate adequately. Given the size of department the list seems fairly short, so there is potential for this to grow.

The plans for future are ambitious and described in detail. Taking into account high research quality, the excellent impact of their results and the relatively young employees (and also high turnover of employees), this Unit has a high potential for development.

The UoA has a great potential to achieve or maintain very good and excellent ratings.

**Recommendations on the activities of UoA continuity and (or) improvement**

This is a very good Unit with great potential. The Unit could aim to increase its internationality by developing long-term visits of its PhD students at international laboratories and institutions, increasing its use of, for example, the Erasmus scheme. It should encourage long term visits to the UoA by high quality international workers to further develop its research standing.
Biochemistry, Vilnius University

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The economic and social impact of R&D activities

Score 5

Development potential of UoA

Score 5

The quality of R&D activities:

Biochemistry (04P)

The UoA of Biochemistry together with the Institute of Biosciences and of Biotechnology are subunits of the Life Sciences Centre (LSC) that entered in 2017 as a newly established unit of Vilnius University. Therefore, LSC became the first academic unit in Lithuania having fully implemented a management reorganisation process.

The outstanding scientific productivity of the UoA proves the excellent quality of the R&D activities performed in the context of the UoA. In fact a relevant number of contributions are published in high impact journals, such as in journals of the Nature group, Science, PNAS, JACS, Angewandte Chemie, etc. Relevant projects were granted by competitive international R&D calls. The most relevant one is the first ERC ADG in Lithuania, the ERC-2016-ADG EpiTrack (2017-2022). Other important funded projects are the H2020-EU.3.5. - SOCIETAL CHALLENGES - Climate action, Environment, Resource project INMARE (2015-2019) and EU.3.5.3 SOLSA (2016-2019). Dissemination of scientific achievements at the international level is demonstrated by a very good number of oral presentations not only at European symposia but also in USA. A significant number of prestigious awards demonstrates the strength and dynamism of researchers associated at this UoA, e.g., the Lithuanian Science Prize, the Kavli Prize (in 2018), the L’Óreal Women in Science Prize, the victory of the VU iGEM team in the Synthetic Biology context in Boston, the Lithuanian-American Innovation Award, etc.

A rate of 14 PhD students/year, essentially from Lithuania, are recruited that is for the standard quite a large number. Even if their productivity appears in a quite relevant number of very good publications, the possibility to increase students’ competences and visibility in different, international, scientific environments during their PhD programme is advisable. Particularly for those who are envisaging to pursue an academic career, that appears up to now to be a minority.

The UoA is a leader at international level.

The economic and social impact of R&D activities

The R&D activities of the UoA are already proving an excellent social and economic impact. In fact the UoA has been actively involved in a large number of projects such as CRISPR-Cas initiated in the Department of Protein-DNA interactions. The research boosted by the EUROPEAN SOCIAL FUND grant "The Structure..."
and molecular mechanisms of bacterial antivirus defense systems” (2011–2015), resulted into 10 high quality publications in top journals (PNAS, EMBO J), cited >1500 times, and the corresponding patent application was licensed by DuPont Pioneer in 2014. A Marie Curie grant (awarded twice) enabled to perform research at Harvard University and bringing back to Lithuania the technological know-how of droplet microfluidics. The results published in Nature Protocols supported the new startup HabSel Inc. (Boston, MA, USA) developing the microfluidics technology for antibody discovery. The development of the high-resolution economical technique Tethered Oligonucleotide-Primed sequencing, TOP-seq, that attracted the first ERC ADG in Lithuania, aims to specific diagnostic implementation and extension to the single-cell level. An incubator including a relevant number of small companies is present with a clear economic impact in terms of licensing agreements of the quite relevant number of patents filed and young researchers’ employment. Researchers have been involved in national working groups and commissions, scientific conferences and events organisation, such as the 9th International Conference “Neurodiversity: from theory to clinics”, the COST Action TD0905 conference "Epigenetics Bench to Bedside", etc. Moreover, some researchers are members of international editorial boards, but also of committees as representatives of Lithuania, such as of the Research Infrastructures network, ESFRI, EMBO, ESAB. Outstanding lectures by prominent scientists, including Nobel laureates Robert Huber and Robert J. Shiller, were organised at the LSC. This is a clear sign of an intellectually vibrant scientific environment that is making Life Sciences one of the major new and attractive topics in Lithuania.

In summary, the UoA carries out scientific research of exceptional importance and is an extremely important partner in R&D outside the academic community.

**Development potential of UoA**

Most of the researcher employees (55 out of 133) are in the age 35–44, 26 are in the age 45–54, 23 are in the age 55–64, 17 are in the age 25–34. In the past 5 years 49 researchers were hired with a scientific degree and 20 had employments that were terminated and 2 retired. R&D strategy of the UoA is aimed at excellence and themes are planned by its prominent scientists, with the idea of stimulating the scientific environment of all teams. The research infrastructure is organised in five areas: biotechnology, structure and interactions of biomolecules, bioinformatics, genomics and proteomics, cell, plant and animal facilities. The impressive equipment available to researchers, companies, and different institutions and the strategic plans for the future activities in genomics, epigenomics and post-genomics, recombinant proteins, pharmaceutical applications, immunology, biomarkers, cell technologies and biosensors, drug delivery systems, and microfluidics could contribute to the development potential of the Centre as a worldwide recognised centre of excellence in Life Sciences. An appropriate balance between academic freedom and fundamental challenges of the society is envisaged. The R&D themes of the UoA are already steered by collaborations with industrial partners (such as Teva, Thermo Fisher, etc.) and this approach could be beneficial to increase R&D performance of the UoA. Anyway, development potential of UoA could be strongly dependent on young researcher recruitments particularly after an international experience to bring new technological capabilities, knowledge, cooperative projects. Certainly, implementation of the microfluidics platform developed at Harvard could be beneficial not only to the Lithuanian research environment but also to the Baltic region. Active integration with EMBL and INSTRUCT infrastructures could improve visibility for participation to research programs at an international level that is compulsory for the future of the UoA. A strong recruitment strategy of young international PhDs and postdocs, not only from Lithuania, but also at international level will be instrumental to strengthen this aspect.

The UoA has huge potential to achieve and sustain good and excellent assessments.

**Recommendations on the activities of UoA continuity and (or) improvement**

The outstanding researchers’ activities and the state-of-the-art equipment available is leading the new Life Sciences Centre to compete at the international level. In the next years a strong strategy to attract talented students, particularly PhDs and Postdocs, but also Master students, as well as visiting scientists from all over the world, will have to be implemented to increase the international visibility of the Life Sciences Centre. The possibility to use the Erasmus+ Programme is also encouraged. These actions have been so far, not enough exploited. However, in the strategic plan presented, the possibility to organise twin laboratories to promote international knowledge is clearly mentioned.
Chemistry, Vilnius University

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The economic and social impact of R&D activities

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Development potential of UoA

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The quality of R&D activities:

Chemistry (03P)

The UoA is composed of 18 researchers and 44 teachers with 52 PhD students (50% are female) and is entirely dedicated to chemistry. Research and teaching activities are more or less equally distributed. The UoA is hosted partly in an old building where some laboratories have been renovated, and partly in a new building in a separate area. The wish is to be able to merge in a single new building in the future, since the present situation presents some logistic problems. There are six Departments (Analytical, Physical, Inorganic, Organic, Polymer, Applied chemistry) plus one Centre for nanotechnology and materials science, but the research is conducted interdisciplinary across the six departments who are in charge of the maintenance of the equipment assigned. The main scientific directions are the synthesis, characterization, and use of new organic, polymeric, hybrid and bio-materials.

The scientific productivity is very good, with several publications in journals of good impact, and a few publications in high impact journals. Most relevant, the publications reported in Web of Science are growing over the years; from about 40 papers published in 2013 the Institute has published over 90 papers in 2017, doubling the productivity. A similar positive increase has occurred in the capability to attract external funding.

Some relevant grants were obtained from European programmes in competitive R&D projects: TUMOCS (2015-2018), SELECTA (2015-2018), SMARTELECTRODES (2018-2021). Other projects were funded by National Programme: "Healthy Ageing" 3D SEM (2016-2018), “Towards future technologies” Electrochromic/electrochemical gas sensor (2016-2018), etc. Some of these projects are dedicated to oxide materials with ferroic and multiferroic properties, electrodeposited alloys for protective coating, and new metallic and semiconductor electrodes.

The results have been reported in international conferences as oral presentations. The members of the UoA have received some national awards. Seven important awards were received in the past five years from Lithuanian agencies, and one International Honor Professor at National Taipei University of Technology was awarded for implementation of joint scientific projects between Lithuania and Taipei.

Overall, the scientific outcome in terms of publications, projects, presentations at conferences can be considered as very good.

The research carried out is of high-level and internationally recognized.
The economic and social impact of R&D activities

The UoA is quite active in transferring knowledge to the territory and transforming it into economical activities. In the area of contracts with private sector and social and economic impact, one can mention a programme on the improvement of a gene transfection agent with Thermo Fisher Scientific Baltics (this has produced a patent). In 2016 a Lithuanian Swiss cooperation programme on “Broadband impedance study of memristor oxide film led to the contractual Research between Tailorlux GmbH (Germany), Leibniz Institute of Photonic Technology (IPHT), Jena, Germany, and the National Cancer Institute, Vilnius, Lithuania. The economic impact of these activities is moderate, but shows a great attention of the UoA towards these topics.

The PhD students are coming mostly, but not exclusively, from Lithuania, and some of them show a positive attitude to pursue a career in the private sector or in an international context. A good fraction (not the majority) aims at staying in academia in Lithuania.

The UoA has organized a few meetings, among them the International Conference "EcoBalt", the International Conference "There is no Future without the Past. Science on the Interface of XIX–XXI Centuries", the International Conference "Oxygenalia", and the International Conference "Current Trends in Cancer Theranostics". The dissemination to general public is restricted to a few lectures, interviews, and participation to events.

Some researchers are involved in national advisory committees, scientific councils, etc. Some national and international conferences have been organised in Lithuania. Some researchers are part of international editorial boards and act as experts evaluators also in EU panels (ERA-NET, Marie Curie Action, FET-OPEN) but also for different EU countries agencies (Hungary, Poland, Estonia, etc).

There is an activity dedicated to popularize science by delivering popular science lectures or participating to TV events. This aspect of the activity is not particularly strong and should be improved in the future.

The UoA carries out important scientific research and is an important partner on R&D matters outside the academic community.

Development potential of UoA

The Unit has provided only a very brief description of the research infrastructure, but during the visit it has been possible to see part of this instrumentation. The main analytical tools, NMR, high resolution SEM, XRD, AFM, etc. are operated by the institution, providing unrestricted access. The maintaining costs of equipment are covered by the Institute. EU funded INOCHEM project will facilitate international and local collaborations, because in this project there are plans to acquire sophisticated state of the art research equipment. Overall, the instrumentation can be considered as very good, and provides the infrastructure which is needed to expand the activities in the next years.

The age distribution of the researchers is fine, with about 50% being < 44, and one fourth being older than 55. The activities on which the UoA plans to work in the future are those traditionally belonging to the institute: OLED materials, luminescence materials for LEDs, graphene oxide materials for sensors and semipermeable membranes, functional polymeric materials, supramolecular compounds for cell assembled materials, shaped-selective catalysis, etc. There are also other smaller areas where the researchers are active. Probably, the identification of some priority areas would help to develop the UoA and make a better use of the resources.

Better plans for international recruitments and R&D strategies involving industrial partners would be useful.

Taking into account (i) the high research quality, (ii) the impact of the research, and (iii) the good number of relatively young staff members (both researchers and teachers), the conclusion is that the UoA has the potential to achieve and sustain excellent assessments.

Recommendations on the activities of UoA continuity and (or) improvement

Overall, the Unit is well organized and delivers high quality research. The instrumentation available is of high quality, and there is a good number of motivated PhD students. The relationship with the private sector is good but it can be improved, in particular considering the main lines of the research performed that are of key importance in many sectors of materials science. It would be desirable to increase the international level of the PhD programme, either by establishing some joint programmes or degrees, or by favouring the students to spend part of their PhD abroad, in other institutions. To this end, either the UoA or the University
could dedicate some funds to support stays abroad of at least 6 months during the PhD period. Some researchers have also suggested that it would be useful to establish a programme to help researchers bridge the gap between the end of the PhD and the starting of an academic career, by creating post-doc positions with some starting funding.

In order to maximize the output from the good instrumentation available, it would be also highly desirable to be able to merge all the activities in a single renovated building. Incentives to produce good publications are already present, the recommendation is to strengthen the quality more than the quantity of the scientific output.

As a general requirement from the researchers, it would be good to reduce the level of bureaucracy and paperwork required to access funding.

In conclusion, the potential evolution of the research environment is good, in particular considering the average age of the staff members. Although several collaborations are already active, it will be good to see that the very good infrastructure available can be used to foster new collaboration with other institutions in the country and to attract young researchers from abroad.
The quality of R&D activities:

**Geology (05P)**

The UoA is part of the faculty of Geosciences and Chemistry of Vilnius University and comprises 5 departments, namely: Geography and Land Management; Hydrogeology and Engineering Geology; Hydrology and Climatology; Geology and Mineralogy; Cartography. The joining with the Chemistry Institute was a top-down decision by the university management that started in November 2016 and was completed in May 2017. The reorganisation slightly hindered the staff in their research activities. The Unit offers 4 BSc,2 MSc as well as 2 PhD programs.

The Unit covers a wide range of traditional research fields. Future research fields are identified as earth observation, climate change impact and paleo environmental research. These topics are modern and it is realistic that the Unit can conduct research in this field.

Collaboration on an international level is visible in ongoing projects and was convincingly expressed by all groups during our meeting. Collaboration on a national level is not evident which is surprising as the geo-unit within the National Research Centre conducts similar research.

The group publishes articles in a wide range of journals but has only achieved modest impact as judged by number of citations. A positive trend in quality and quantity of the research is noticeable. Teaching seems to be a major task. Researchers attend a variety of conferences. These tend to be small scale mostly.

Two R&D projects are highlighted, both of which concluded in 2014.

PhD students are publishing their research and some are targeting higher profile journals such as PLoS One. The PhD-students expressed a very positive attitude towards their projects as well as the working environment within the Unit. They are encouraged to visit international conferences and have access to financial resources to cover the expenses. Thesis are planned to be written in English.

Overall, the UoA is assessed satisfactorily at national scale.
**Geography (06P)**

Difficult to differentiate the 2 subunits during the expert group’s meeting. Most of above statements hold true for the geography sub-unit as well.

The group publishes articles in a wide range of journals but has only achieved modest impact as judged by their reputation and by the number of citations received. Researchers attend a variety of conferences all over the world and these tend to be workshop style conferences with a specific theme. National recognition for research. PhD students are publishing first-author papers but mainly in local journals with limited international readership. Research projects for mapping services, one grant from Lithuanian research council and one international project with Switzerland.

The level of research carried out in physical geography is satisfactory at national scale.

**The economic and social impact of R&D activities**

The question which economic and social impact the Unit has in terms of R&D activities was answered with general statements about earth science education in schools. The social relevance of geoscientific research could have been addressed more specifically. The Panel judged the performance as satisfactory, however, the interaction of the UoA with business, decision-makers, and society is weak.

In general, the research conducted by the Unit has broad social and economic impact in that it addresses future impacts to living conditions from environmental change and in developing mapping tools. The Unit is represented in academic bodies at a national level. Three listed consultations in the last 5 years. The Unit primarily organised small scale workshops and conferences but also has experience with large international events such as the International Gemmological Conference. Editorial positions are restricted to journals published in Lithuania with a few exceptions. Members of the Unit are represented in international associations and working groups. A number of these positions are as representatives of Lithuania. Active engagement with the public through the department museum and also through books, interviews and newspaper articles. Limited interaction with business. Geology provides some analytical services whereas Geography primarily offers mapping services to the state.

The Unit carries out important research activities but has limited interaction with the private sector, decision-makers, and the society.

**Development potential of UoA**

The management of the Unit presented a clear vision of future research tasks. They also recognise that increasing the visibility of the Unit will be key to participation in international projects. The largest development potential is seen in the increase of business partnerships (contracts and consultations). There is the potential to develop by internationalisation, which needs to be fostered further. As mentioned above, future research fields where to concentrate efforts are earth observation, climate change impact and paleo environmental research, all timely and relevant. It is to be expected that the Unit can significantly contribute to these fields.

There is a good number of PhD students, relative to the number of staff members. However, to the surprise of the expert group, internationalisation in form of longer (> 6 months) stays abroad was not seen as relevant. On the contrary, in the long term this can substantially help to raise the international level of the entire UoA.

The Unit’s infrastructure – building and research equipment – is not state-of-the-art and needs urgent attention. The UoA has the potential to sustain its satisfactory or better assessments.

**Recommendations on the activities of UoA continuity and (or) improvement**

A stronger collaboration with national institution conducting similar research (Nature Research Center) is encouraged.

It would be desirable to increase the international level, in particular of the PhD programme, either by establishing some joint programmes or double degrees, or by encouraging the students to spend part of their PhD abroad, in other institutions. To this end, either the UoA or the University could dedicate some funds to support stays abroad of at least 6 months during the PhD period. Also measures to favour incoming PhD students or visitors from other countries are encouraged.
Mathematics and Informatics, Vilnius University

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<thead>
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The quality of R&D activities:

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The economic and social impact of R&D activities

Score 4

Development potential of UoA

Score 5

The quality of R&D activities:

The Unit of Mathematics and Informatics within the Vilnius University is the largest and most developed such unit within Lithuania. It is strong at international level and consists of four divisions: Mathematics, Applied Mathematics, Informatics, and Data Science. We discuss the latter two first and the former two second. We mention that combining Informatics and Mathematics under one roof is internationally not common and an interesting academic experiment. There are administrative difficulties because of the different requirements and conditions in the two divisions, and this is to be expected. However, it can be hoped that the advantages resulting from the synergy between the two disciplines outweigh the difficulties.

Informatics (09P)

The Informatics division covers a broad range of topics in Computer Science, which is the more recognizable term because it is broader and internationally more common than Informatics. The human resources are appropriate for the status quo, but could be expanded since the program is attractive and could educate a larger number of students in this economically important field. The division has a strong publication record, which can be improved; see recommendation below.

The division has strong computing facilities, in particular a large cluster of compute cores, and it has the technical competence to make the best use of it.

There are a number of ongoing projects at a national and international level, which brings some extra research funds; though this is a positive issue, the size of the section would allow a much stronger participation, for instance in important EU programs. While the total amount of publications is of good level, several members in the section are not active in the recent years.

The conference venues are spread internationally (and not regionally). There is a significant number of national awards and PhD students and PhD graduates.

The open source computing facilities are made available broadly within the Unit but also outside the Unit within the University. There are connections to other disciplines within the University, in particular Physics. The UoA is strong at international level.
Mathematics (01P)

The Mathematics division covers a number of important topics within mathematics, which provides excellent balance between breadth and concentrated strength. The mathematical section of the research Unit is rather large, divided into several more thematic departments. The Unit covers all the main fields in mathematics. The division publishes well, including in the very top journals of the field. A recent article in the Annals of Mathematics solving the 80 years old Leray Problem in differential equations deserves to be mentioned. It contributes greatly to the international visibility of Lithuanian mathematics. On the other hand, this high level of publications and of international collaborations is not uniform, and the Unit has still several people that show a quite lower level of activity, often limited at a national level. The researchers in the division also write textbooks and monographs in a number of fields, which contributes to the wide international visibility of the Unit. The human resources are appropriate and the researchers showed enthusiasm in teaching and in top quality research.

The facilities are adequate, with several large lecture halls equipped with plenty of blackboard space. Local computer labs are available to all staff and students, and a local library supports the research as needed.

The UoA is strong at international level.

The economic and social impact of R&D activities

Both divisions in the Unit are involved in a number of outreach activities that contribute to the economy and the social structure within Lithuania. For example, cyber security projects enhance the sophistication on a national level and solve practical problems in a research environment, and methodology to solve Navier-Stokes equations is employed in a local hospital to shed light on blood flow questions.

Members of the UoA participate in prestigious executive national committees (e.g. Lithuanian Academy of Sciences, Lithuanian Mathematical Society, Lithuanian Operational Research Society etc.). Many scientific conferences of national and international interest have been organized (e.g. IFIP, ACM ITCSE, Baltic Olympiads in Informatics). Memberships in editorial boards of several international (e.g. published by Springer), regional and national journals are reported. The UoA is involved in the organization of several international and national events (e.g. contests in Mathematics).

A number of researchers spend time and effort in science popularization projects within Lithuania, which is an important contribution to the society, which too often grows critical of science because of ignorance.

To summarize, the UoA carries out very important scientific research and is a very important partner on R&D matters outside the academic community.

Development potential of UoA

The Computer Science division of the Unit has significant development potential. There are more students interested in studying the topic than can currently be accepted. Many of the students leave academia and opt for careers in industry, thus contributing significantly to the economic strength of the country.

In order to keep a high scientific level and to attract the best students toward an academic career a sufficient quantity of financial resources is necessary, both for theoretical and experimental sectors, and in particular for these last ones, where a good equipment is needed. This does not seem to be the case at present; in addition, the various research teams are in difficulty of facing the turnover, replacing the old staff with new young collaborators. This insufficient level of funding does not allow the participation of scientists to the main conferences and international activities and may explain why the publication record of the scientists in the Unit shows a large variation, with several scientifically inactive people. In spite of this fact, and mainly due to some very active scientists, the average level of publications is good both in number and in quality. Most of the financial support for research activities comes from national sources. There is potential to tab more aggressively into European research opportunities, but this requires an investment into administrative support for grant writing activities; see below.

The UoA has huge potential to achieve and sustain excellent assessments.

Recommendations on the activities of UoA continuity and (or) improvement

A current hindrance for the Computer Science division to flourish internationally is that publications in conference proceedings are not counted on par with journal articles. To gain international recognition within
Computer Science it is absolutely necessary to be present at the top conferences in the field, and this includes the publication in very competitive proceedings. To not embrace such contributions leaves the Computer Science researchers with a dilemma, since they have to choose between internal and external recognition.

An obstacle to success that is often mentioned is the considerable level of bureaucracy demanded for grant applications, annual reviews of students, and other activities. We recommend that the general level of bureaucratic requirements is lowered and that more resources are invested in the managerial support of the faculty in writing grant applications.

Currently the two divisions, Mathematics and Computer Science, are located in different buildings on campus, about three kilometres apart. The separation causes inconveniences and is an obstacle to the better integration of the two divisions. The Panel feels that that this situation should be resolved before it is too late.
PANEL REPORT SUMMARY
The Panel has examined the reports of the assessment period and visited the 17 Units of Assessment (UoA), having interesting and useful conversations and discussions with administrators, researchers, teachers, and PhD students. The overall impression is good in a significant number of areas in terms of achievements and performances, in particular considering the continuous growth both in terms of quality and quantity of the research performed. This assessment has considered the outcomes of basic, curiosity-driven research, as well as of activities that are more oriented towards a practical application with a direct benefit in economic and social terms. In both areas the Panel has recognized significant improvements compared to the previous MOSTA evaluation exercise in 2015, which is promising for the future.

Three UoA have been classified as leaders in their field for the quality of the R&D activities and received the highest grade (grade 5): Photonics and Applied Physics at the Center for Physical Sciences and Technology; the field of Physics at Vilnius University UoA “Physics + Astronomy”; the Biochemistry Unit of Vilnius University. This shows that in some specific areas the research performed in Lithuania is competitive at international level. Considering that no Unit received grade 5 in the previous assessment, this is a significant achievement. Five UoAs have received grade 4 (the Unit of Fundamental Physics at the Center for Physical Sciences and Technology; the field of Astronomy at Vilnius University UoA “Physics + Astronomy”; the Chemistry Unit at Vilnius University; the fields of Mathematics and Informatics at Vilnius University UoA “Mathematics and Informatics”), which indicates research carried out at a high, internationally recognized level. Overall, one fourth of the Units have been classified as Excellent (grade 5) or Very good (grade 4). Most of the other Units have shown good levels of activities, with a clear potential to increase the number of publications of high quality. These were classified grade 3 level, indicating a strong national player with some international recognition. In several cases, weaknesses emerged in the research performed. For all Units, the Panel have made specific recommendations in the individual Unit of Assessment reports.

Taking into account that some of the research groups visited just underwent a merging process with other research groups, and considering the overall positive outcome of the evaluation, the Panel does not recommend at the moment to further concentrate the activities by reducing the number of Units. Rather, it is desirable to see reinforced collaboration and cooperation of activities at a national level. In this context it is desirable that Universities and the Nature Research Center develop common policies to increase their cooperation.

In general, the research environment and infrastructure in Lithuania is in excellent condition wherever the system has benefited from European funding and the Government initiative to create the Valleys. However, there are cases where the facilities do not represent state-of-the-art and need a similar substantial funding to be renovated. An additional challenge for the future is to maintain and operate the rather excellent and up-to-date infrastructure at a very high level. To this end, the Panel feels that specialized and well-trained technical staff are absolutely necessary. The Universities and Research Centres should establish clear plans to hire qualified personnel to run the equipment. Other issues that are not always clearly addressed are the maintenance and running costs. At the moment, the infrastructure is rather new and covered by service contracts, but in the future a credible plan to guarantee the proper functioning of the equipment should be put in place.

The Panel noticed that the Units do not always have clear plans to shape future directions and to improve the quality of the output of the research. In specific situations the research management could be improved, and the future strategic lines of development and objectives should be better defined. This may also imply the identification of research areas that have to be reinforced, or areas that are no longer productive. In this respect, it is particularly important that early career development policies and promotion criteria are clearly established and put to work.

The Panel has particularly enjoyed the discussions with the PhD students, and appreciated their enthusiasm and commitment. However, a few aspects emerged that could be addressed in order to produce an even better outcome of the PhD studies.

- Most of the students have not spent, or do not plan to spend, a part of their PhD (6–12 months) abroad, in other laboratories;
- Most of the students are coming from Lithuania, and often from the same city where they obtained the Bachelor and the Master;
- The number of incoming PhD students from other countries for secondments or short stays is rather low, and often close to zero.

For all these reasons, the level of internationalization of the PhD studies is not particularly strong and should be improved. Participation to international networks (COST, Marie-Sklodowska Curie, Erasmus+, etc.) is strongly encouraged. Furthermore, the Units could dedicate a specific budget to help students to spend part of their PhD abroad. In the long term, this will have beneficial effects on the internationalization of the entire system.

The Panel also noticed that regular seminar programs that students must attend are not always in place. Exposure of the PhD students to foreign lecturers, also outside their own field of activity, would facilitate international exchanges and interdisciplinarity.

The Units need to make the PhD studies more attractive and the Government has addressed this by increasing the salaries, but further actions have to be implemented to make a progression in academic career viable by offering competitive salaries compared to the private sector.

Several researchers have pointed out the importance to expand funding programs at Postdoctoral level, in order to favour mobility to Lithuania and from Lithuania.

From the conversations, it emerged that there are multiple funding schemes in Lithuania, each one with its own objectives, rules, and strategic plans. The Panel feels that it would be highly desirable to have a common procedure to submit and evaluate proposals, also to reduce the bureaucratic load to apply, manage and report on the funded projects.

Overall the panel is rather positive about the development potential of the Units. Nine Units are expected to achieve or maintain very good or excellent assessments for research quality and impact. Two Units have potential to improve the results of research. Six units are expected to maintain or better their satisfactory ratings.

In summary:
- the level of research in Lithuania has improved from the previous assessment, but nevertheless there is potential for further development;
- where investment has recently happened, the level of the equipment and infrastructure is very good and this will facilitate cooperation with foreign researchers, but it needs to be maintained and operated by specialized technical staff;
- the level of internationalization of the PhD studies should be improved;
- a program for post-docs should be established;
- the number of funding schemes should be rationalized and the level of bureaucracy should be reduced;
- researchers’ salary needs to be competitive with the private sector in order to retain the best talent.

The panel noticed that some of the UoA were unfairly disadvantaged by having had to artificially divide the research outputs between several Units of Assessment, not always reflecting the actual situation.

AN OVERVIEW OF THE RESEARCH PERFORMANCE ACROSS THE PANEL COVERAGE

Mathematics

The various research Units in the present evaluation procedure cover a large part of the main areas of mathematics, as number theory, algebra, partial differential equations, discrete mathematics, probability, statistics, and optimization. In few cases the research is only devoted to theoretical topics, while in most of
the Units the applications represent an important point of view, that has to be maintained in the future, and possibly improved. In some cases the international collaborations are of a good level, as for instance in number theory and in fluid dynamics models, but in general the research teams work on a local basis, with a rather limited horizon.

The number of international projects in mathematics is small for the Units under evaluation; this is one of the main points that has to be improved in the future. Even if most of the research in mathematics does not require heavy investments in terms of funds, the participation in international projects could allow the number of PhD students to increase, as for some Units the number of PhD students is rather limited.

The very heavy teaching load of a large part of the scientists working in mathematics is probably one of the reasons for the lack of time for other scientific activities. Several courses in mathematics are needed in all universities for almost all disciplines, from the first year until the Master level; hence mathematicians are often required to provide a large number of teaching hours. This fact should be taken into account in the future planning and distribution of human resources.

Another point which requires particular attention is the competition between academia and private companies to attract the best students. Since mathematical skills are needed in many fields of society, as for instance economy, finance, industrial applications, insurance products, many private companies offer to students in mathematics a level of salary that universities cannot afford. This implies the loss of the best students and possibly the loss of competitiveness in advanced research for several Units in the medium-long term. We learned that in Lithuania, due to a recent decision of the Ministry of Education, the salaries of PhD students will increase considerably; this is a very good sign that may contribute to make the competition between academia and private sector more balanced in the future.

Informatics

The panellists have visited seven UoA with specialization in Informatics: Kaunas University of Technology (KTU), Klaipėda University (KU), Lithuanian University of Educational Sciences (LEU), Šiauliai University (SU), Vytautas Magnus University (VMU), Vilnius Gediminas Technical University (VGTU) and Vilnius University (VU). The sizes of these Units differ quite significantly, with the largest at KTU with 38 FTE staff for research and teaching and at VU with 49 FTE. Since all other Units have less than 12 FTE staff for research and teaching, we will categorize these seven Units in two classes according to their size.

Regardless of the Unit size, significant progress has been recorded during the last five to ten years. More or less all Units orientate themselves towards the internationally competitive and fast-changing world of Informatics. The financial provision to encourage publishing in high quality journals has mobilized the academic staff at a personal level, and thus at a collective level. Despite the aforementioned great progress, there are issues that need attention so that the momentum is kept.

A first remark is that small departments are handicapped. Critical masses are important to develop the concept of a Research University and play a significant role at both the national and the international level. If there are no developments and national policies to hire new researchers at the small Units, they will mainly serve as educational centres with limited international visibility.

Although practically the high quality publication incentive was successful during the last period and embedded a competitive philosophy to aim high, it needs adjustments for the future. For example, there is an international debate about Q2 journals that fall short in comparison to Q1 journals. This suggests that financial incentives should be limited to Q1 journals. In addition, a neglected aspect is the number of citations received per article authored by a researcher. From the citation curve, the h-index is derived. The number of citations and h-index are the best proxies to measure a researcher’s impact. It is a mistake to measure a researcher’s performance using journal impact factors.

The field of Informatics has a substantial difference in comparison to other physical sciences. Mainly the novel and innovative ideas appear first in conferences, where full papers are submitted and reviewed by 2–3 or even 5 peers. Conferences in Informatics are first class outlets; in particular, some conferences are competitive in prestige with top journals. It is through conferences that researchers communicate and are recognized in the respective communities. If researchers are not motivated to participate in landmark conferences, then it will be nearly impossible to penetrate international communities.

Finally, a general remark about all the Units under evaluation concerns their involvement in the field of Informatics (or equivalently Computer Science). Clearly, all B.Sc. programs on Informatics are based on standard curricula that include all core courses, from programming and theory to systems and applications.
However, it is remarked that the most of publications do not appear in core journals and conferences and do not deal with core subjects of Informatics. The content of the papers are mainly applications and, for this very reason, have limited contribution to advancing the state-of-the-art of Informatics. This hinders the better integration of the national research scene into international communities.

Physics and astronomy

For the purposes of this summary, physics and astronomy have been combined. The Units in the current assessment cover a range of topics in Physics including a wide range of research in condensed matter physics, applied physics, particle physics, interfaces to life sciences and biophysics and also technological applications. In particular, the areas covered include, but are not limited to, optical characterization, solid state physics, laser technologies, organic technologies, ferroelectrics, nonlinear dynamics, thin films, materials growth. There are Units with very modern, high quality equipment both experimental and computing, some of which have benefited from recent large investments in buildings and infrastructure. There is a single Unit presenting for astronomy, which presents high quality work benefiting from good international collaborations.

There is a significant imbalance in funding in the Units of Assessment across the country. Physics and Astronomy research benefit from regular, appropriate funding which is required to perform work at the forefront of science. The lack of funding and hence hindrance to high-quality research is evident in a number of Units of Assessment.

There are a number of good, well-structured international collaborations, but this is not uniform across the Units of Assessment. The Physics and Astronomy research will benefit from increasing the number of international partnerships, which is currently lower than expected. An increase in long term visits to and from leading international research institutions will be beneficial, particularly by PhD students (e.g. Erasmus and other similar schemes).

A number of Units show excellent societal and economic impact. Much of the work is in applied areas of science and therefore should be in an excellent position to exploit work via industry, both National and International. This should be encouraged and expanded, but not to the detriment of fundamental research which is underfunded.

There is an imbalance in wages between industry and academia, with academic wages being significantly too low. This is detrimental to attracting and maintaining the best researchers. Many leave for better pay in industry or go abroad; Lithuania appears to have a significant “brain drain”. An attempt to attract PhD students has happened recently with an increase in the PhD scholarship. This is fine for PhD students, but on completion of PhD studies there is little financial incentive to remain in academic research.

The research staff work-load is very heavy, where significant teaching and administrative duties often have to take priority leaving not enough time for research activities. Multiple contracts are sought by researchers to supplement income. A mechanism for a well-paid, balanced workload is required. There are also schemes in place in some Units of Assessment where a financial bonus is obtained for publishing high quality research papers; while this is one mechanism, it is not sufficient. Adequate time for research, suitable training and support from senior management of the Units is also required.

Chemistry

All major fields of applied and fundamental chemistry are present in a well-balanced mixture. Several important topics receive special attention: sustainable chemistry (and physics, as various aspects of solar cells, electrochemistry, and sustainable energy applications), biochemistry, pharmaceutical chemistry, materials science, etc. Research in chemistry is generally of good level and internationally recognized in all three major institutions (VU, FTMC, KTU), with smaller contribution of other groups. A number of results are published in good established journals; a few top results appear in high-impact journals. On average, research papers in chemistry have a lower share of co-authors from abroad than in other fields. This may be interpreted both positively (no need of help from others) and negatively (reduced international impact). In general, a higher level of internationalization in the research performed is desirable. The dissemination of results at conferences is good, although the number of invited talks could be higher. The employee turnover maintains favourable age distribution. A number of PhD dissertations have been defended; most of them are based on several papers. There is a clear tendency to write the dissertations in English.
The research infrastructure is excellent, with superb facilities available both for synthesis and characterization of new compounds. This should be taken as an opportunity to attract young scientists and visitors from abroad, and start new collaborations at international level. Funding to maintain the infrastructure is sufficient at the moment, but clear plans should be established to guarantee to be able to run the infrastructure also in the future. Interaction with business, patents, consultations etc. are at a reasonable level. Teaching facilities are good. In some cases, teaching duties are so high that little time is left for research. Plans for R&D themes to be developed contain mostly timely topics reflecting societal and industrial needs (e.g., solar cell research) as well as a reasonable ratio of classical fields representing the necessary knowledge base (e.g., heterocyclic chemistry). The level of international cooperation is good but it can be improved; many (but not all) young researchers make use of the exchange possibilities available to visit laboratories abroad.

**Biochemistry**

Biochemistry in the Lithuanian Universities, with a particular focus to chemical biology, is clearly emerging as one of the strongest research field in Lithuania as demonstrated by the significant applied research outputs. The effort in boosting aggregation of technologies and competences present in the Institutes of biochemistry, biosciences and biotechnology creating the interdisciplinary Life Sciences Centre that entered in 2017 as a newly established unit of Vilnius University, is a paradigmatic example of a positive process of implementation of a management reorganization. This fostered quality of the R&D activities leading already to excellent scientific, internationally recognized productivity. The clear strategy aimed to attract young talented Lithuanian scientists from abroad who were able to obtain prestigious European funds and awards, as well as the important collaborations with leading industrial partners that decided to operate in the region, is providing PhD students an ideal scientific environment within which to develop their potential. The possibility of recruiting technicians able to maintain the infrastructure at the top level is a challenge of the next years. Moreover, a stronger investment in the synthesis of biomolecules, also by the most updated strategies of synthetic biology, could be instrumental to have all the competences available in the centre in order to compete internationally in translational research. Collaborations with other UoAs expert in these fields could be also a possibility to explore.

In this centre of excellence, the smallest UoAs involved in biochemistry research could implement the most ground-breaking ideas contributing to increase the critical mass in the biochemistry field, strengthening translational research thanks to the superb infrastructure organized. Innovative teaching methods need to be developed to train and motivate students and staff members to exploit at the best this translational potential. In conclusion, the biochemistry field can really lead Lithuania to organize a European centre for interdisciplinary research attracting international students and scientists. However, there is already a clear sign of an intellectually vibrant scientific environment that is making life sciences evolving thanks to the UoAs involved in biochemistry, one of the major new and attractive research topics in Lithuania.

**Geology and Geography (Geosciences)**

For the purposes of this summary, geology and physical geography have been combined as their research activities significantly overlap, illustrating the inter-disciplinary approach within the Units. The Panel reviewed three institutions containing these disciplines: Nature Research Centre, Klaipeda University and Vilnius University. The geoscience research conducted at these institutions was assessed as being satisfactory at a national level making it one of the weaker areas of physical science in Lithuania. In contrast to other areas such as chemistry and physics, geoscience has not received significant funding in order to upgrade its facilities making it very difficult to compete at an international level. However, these Units should take advantage of the modern open access equipment located in the new building housing FTMC and some Vilnius University departments, for example ICP-OES, (LA)-ICP-MS, materials characterization facilities (XRD, XRF, SEM...). The formation of the Marine Research Institute in Klaipeda is a welcome development and there is potential for innovative inter-disciplinary science to be conducted focused on the marine and coastal environment. Nevertheless, researchers at this Institution highlighted that the inter-disciplinary nature of their research made it difficult to apply for research funding in the current system. The Units are small, with less than 35 FTE, and there are low numbers of PhD students. The ability to attract and retain young researchers from Lithuania, let alone from abroad, is concerning for the future of this research field.

Geoscience research is societally relevant for Lithuania, for example addressing topics of coastal erosion, behaviour of radionuclides and environmental responses to climate change. Within the reporting period, research has tended to be inward looking: researching specific problems to Lithuania and publishing these results in Lithuanian journals, often in Lithuanian. This is starting to change, especially with the formation
of international research consortia focused on the Baltic Region. However, a concerted effort should be made to further increase international collaboration and dissemination. A good start has been made in Klaipeda where two staff members are primarily based at foreign institutes (Finland and Italy), but hold part-time positions, conducting both research and teaching activities in the Unit. Research on local problems can easily be made relevant to an international audience by highlighting similarities or differences with other regions of the world. The Units are engaged in consultation activities, however these are limited and have potential to be expanded.

The financial situation in general for geosciences is concerning, with few new research proposals funded during the reporting period and two of the three Units experiencing a marked decrease in funding between 2013 and 2017. Therefore, it is recommended that these three Units increase collaboration (but not merge) and develop an overarching strategic plan for Lithuanian Geoscience research in order to maximise both human and equipment resources.