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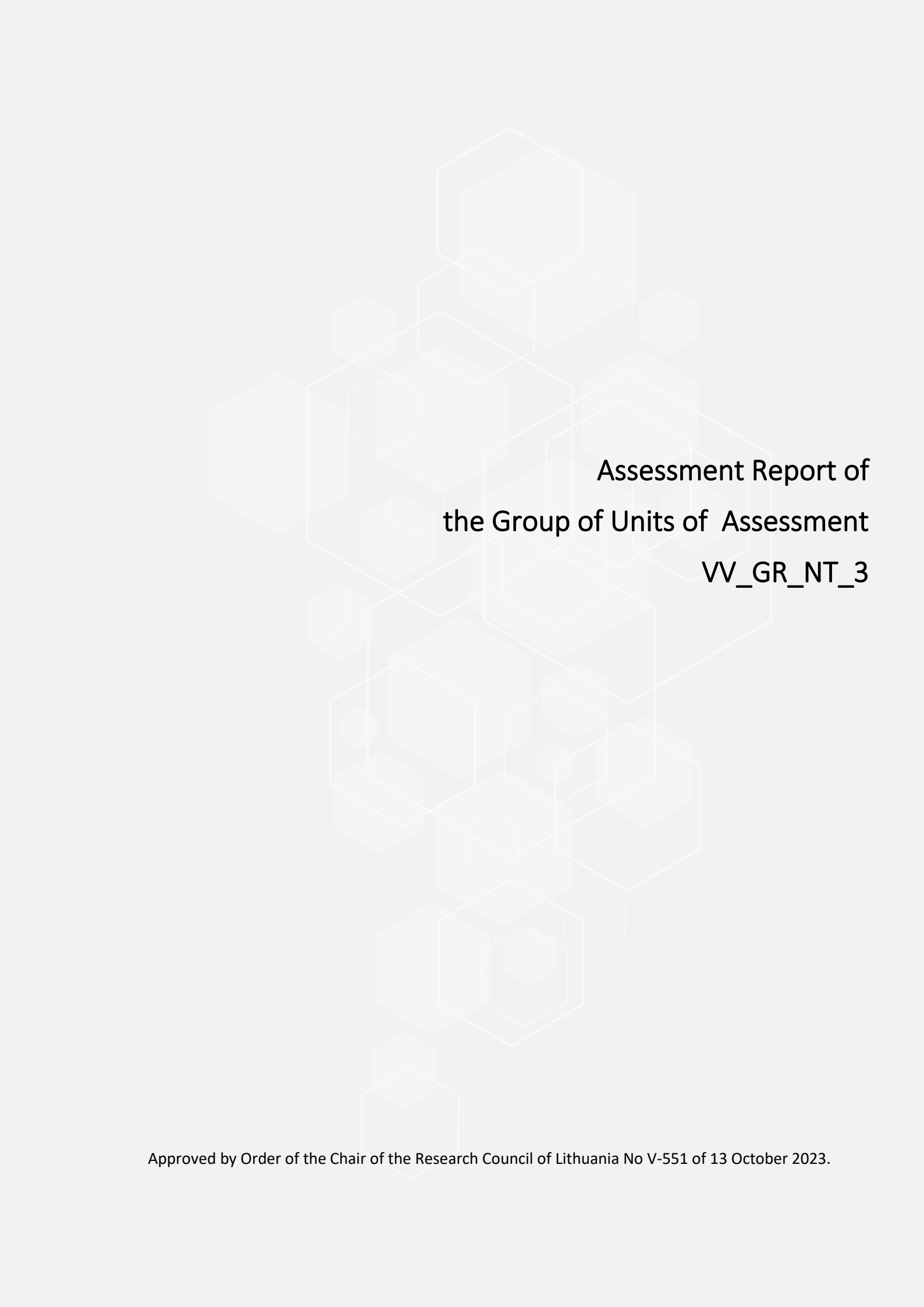
**Assessment Report of  
Comparative Expert  
Assessment of Research  
and Development Activities  
Carried out by Universities  
and Research Institutes for  
the Group of Units of  
Assessment VV\_GR\_NT\_3**

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**Assessment Report of  
the Group of Units of Assessment  
VV\_GR\_NT\_3**

Approved by Order of the Chair of the Research Council of Lithuania No V-551 of 13 October 2023.

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## Terms & Abbreviations

**CEA** – Comparative Expert Assessment of research and development activities carried out by Lithuanian universities and research institutes

**FTE** – Full-Time Equivalent

**Institutions** – Lithuanian universities and research institutes

**RCL** – Research Council of Lithuania

**R&D** – Research and Development

**UoA; Unit(s)** – Unit(s) of Assessment

**FTE<sup>1</sup>** – the number of working hours worked during the year by a certain group of employees divided by a number of working hours in the 12 months of that year, as set by the Minister of Social Security and Labour (with a 5-working-day week). <..> The FTE unit – a person per year.

**FTE(SD)<sup>1</sup>** – the sum of the FTE of teaching staff members with a science degree divided by 3, and the FTE of research workers and other researchers with a scientific degree.

### Research areas:

**N** – Natural sciences; **T** – Technology

### Universities:

**KTU** – Kaunas University of Technology

**VU** – Vilnius University

### Research Institutes:

**FTMC** – Center for Physical Sciences and Technology

**PTTTI** – Applied Research Institute for Prospective Technologies

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<sup>1</sup> Description of the Comparative Expert Assessment of Research and Development Activities by Universities and Research Institutes approved by Order No V-1593 of the Minister of Education, Science and Sport of 2 September 2021

# 1. INTRODUCTION

## 1.1. Purpose, Scope, Goals of the Comparative Expert Assessment

The Comparative Expert Assessment of research and development activities carried out by universities and research institutes of Lithuania (hereinafter – CEA) was carried out in 2023 by Research Council of Lithuania (hereinafter – RCL) in accordance with the *Description of the Comparative Expert Assessment of Research and Development Activities by Universities and Research Institutes* approved by Order No V-1593 of the Minister of Education, Science and Sport of 2 September 2021 (hereinafter – the Description), the *Regulation on Procedures for the Comparative Expert Evaluation of Research and Development Activities Carried out by Universities and Research Institutes* approved by Order No V-486 of the Chair of the RCL of 8 August 2022 (hereinafter – the Regulation), and other related legislation.

The purpose of CEA is to provide a picture of research and development (hereinafter – R&D) performance, socio-economic impact, and the development potential of Lithuanian universities and research institutes (hereinafter – Institutions) based on their R&D activities during the period of 2018–2022.

The scope of CEA encompasses both state and non-state Institutions operating in Lithuania. All state universities (in total eleven) and all state research institutes (in total eleven as well), four non-state universities and two non-state research institutes were participating in the CEA in 2023. The Institutions or parts thereof were assessed as the units of assessment (hereinafter – UoA or Units). The CEA facilitates the comparison of R&D performance of the UoA against international standards and within the national context. It provides valuable evidence to R&D policymakers at different levels, as well as offers the Institutions involved in the assessment a significant incentive to enhance their performance.

Since 2018, the CEA has been an integral part of assessment of R&D activities of Lithuanian institutions. The annual assessment of R&D activities carried out by the Institutions together with CEA conducted every five years constitutes the Lithuanian assessment system of R&D activities. The results of the two-step assessment are used to allocate state funding for R&D activities for Institutions. The results of the CEA implemented in 2023 will determine 70% of state budget funding for R&D activities of Institutions for the subsequent five years.

The assessment results will also determine the continuity of doctoral studies as well as the new rights to carry out doctoral studies at Institutions in accordance with the *Regulations on Doctoral Studies* approved by Decision No. V-739 of the Minister of Education, Science and Sport of 18 May 2020. Moreover, the findings from the CEA might serve as a trusted source of evidence on R&D performance of the Institutions for assessments concerning other funding instruments or higher education studies.

## 1.2. Comparative Expert Assessment Organization and Assessment Criteria

The CEA relies on international peer review panels to evaluate Lithuanian Institutions' R&D activities. Using panels rather than individual peers creates a possibility for discussion and debate within the peer group and enabling comparison within the group.

The assessment is carried out on the UoA level, which is the organisationally defined structure – ranging from a whole Institution to a division of an Institution corresponding to the faculty or other formal structures of the Institution. In accordance with the Description the rules for the formation of the UoA are as follows:

- the UoA should be interrelated by common R&D activities and might operate in one or two research areas;
- the minimum size of the UoA should be no less than 5 full-time researchers with scientific degree (FTE(SD)) and the maximum size of UoA should not exceed 75 FTE(SD).

The exceptions could be made for better reflection of R&D activities in the Institution. If an Institution had a UoA with a higher number of FTE(SD) or/and UoA operated in three research areas, it should have submitted arguments and obtained RCL approval for participating with not typical composition.

Following the instructions, Institutions have formed eighty-five UoA. All these UoA were split into thirteen groups resulting from four to nine UoA per Panel. The interval of the UoA size ranged from slightly above 5 FTE(SD) to UoA of more than 150 FTE(SD). The number of research areas and research fields one UoA was operating in also varied, i. e., while most UoA operated in one or two research fields, there were outliers where Units were involved in up to five research fields. The variations in size, composition, and research areas among the UoA within each group posed challenges for comparison and required careful consideration by the Expert Panel.

The assessment of the Units is based on three criteria:

- The quality of R&D activities (weight 0.65) of UoA in the research field(s) (group of research fields);
- The economic and social impact of R&D activities (weight 0.2) of UoA;
- The development potential of R&D activities (weight 0.15) of UoA.

The quality of R&D activities is assessed either in each research field or the group of research fields within the research area while economic and social impact as well as development potential are assessed on the UoA level. Each assessment criterion is scored on a five-point scale, namely, ranging from excellent [5] to poor [1] or no R&D [0]. The description of the values of the scores for each criterion are provided in the Description. Half point scores were allowed, and that provided a possibility for more nuanced assessment when necessary.

The quality of R&D activities of the Unit is assessed following these rules: if UoA has at least 10 FTE(SD) in the research field or has between 2 and 10 FTE(SD) and has the right to provide doctoral studies (or intends to seek such right in the next 5 years) in the research field, then the research quality is assessed in the research field; if UoA does not meet these criteria, then the research quality is assessed in the group of research fields within the research area. In the latter case, the assessment considers the collective quality across the research fields within the group.

The assessment was based on the material provided by the UoA to the RCL information system “Vieversys” and covered the period 2018–2022, as well as summarized results of the annual assessment of R&D activities of Institutions (for 2018–2021) provided by RCL, alongside the information obtained during the visits of the Panels to the Institutions and meetings with the representatives of the UoA. Following the Description and the *Procedure for the Submission of Data on Results of Research and Development Activities Carried out by Universities and Research Institutes for the Comparative Expert Assessment* approved by Order No V-1593 of the Minister of Education, Science and Sport of 2 September 2021 (hereinafter – the Procedure for Submission of Data) relevant data was examined when assessing the UoA against each of the CEA criteria. In most cases the number of provided outputs for the assessment depended on the size of the UoA varying from a minimum of five to maximum of eighty-two outputs.

It should be noted that since the previous round of CEA in 2018, several organisational improvements of assessment have been made, therefore caution should be exercised when comparing the results of these two assessments. Some of them are worth mentioning:

- 85 UoA were formed and grouped into 13 Expert Panels in 2023, while the first CEA resulted in 117 UoA formed and grouped into 6 Expert Panels. The cause is mainly due to the change of rules for setting up a UoA. During the 2018 CEA, forming a UoA was allowed in only one respective research area, i. e., if the UoA operated in two research areas, it had to be split into two Units for the assessment purposes. In 2023 this restriction was eliminated, and Unit could easily operate in two (and in some cases in three) research areas. As well UoA formation was influenced by changing landscape of Institutions during the assessment period as mergers of several institutions took place: Aleksandras Stulginskis University and the Lithuanian University of Educational Sciences merged with Vytautas Magnus University since 1<sup>st</sup> January 2019; Šiauliai University was merged with Vilnius University, as well as the Institute of Law, the Lithuanian Institute of Agrarian Economics and the Lithuanian Social Research Center were merged into Lithuanian Centre for Social Sciences since 1<sup>st</sup> January 2021.
- The CEA scoring system has also undergone some changes. While five-point scales were used in both assessments, in 2023 half points were allowed, while in 2018 only whole numbers were used.
- There were some changes in the requirements for documentary input. In 2023 one list of Unit's R&D outputs for a five-year period was required while in 2018 a list of R&D outputs for each assessment year (from 2013 to 2017) and an additional list for the entire assessment period were required, resulting in a large volume of data.

### 1.3. Expert Panel for the VV\_GR\_NT\_3 Group of Units of Assessment

The Expert Panel for the VV\_GR\_NT\_3 group had to assess five UoA from four Institutions:

- **Applied Research Institute for Prospective Technologies** – 1 UoA:  
*Public institution APPLIED RESEARCH INSTITUTE FOR PROSPECTIVE TECHNOLOGIES (abbr. PROTECH);*
- **Center for Physical Sciences and Technology** – 1 UoA:  
*Photonics and Applied Physics (abbr. FTMC\_FTF);*
- **Kaunas University of Technology** – 1 UoA:  
*Materials Engineering and Physics (abbr. KTU\_Medž-fizik);*
- **Vilnius University** – 2 UoA:  
*Physics + Astronomy (abbr. VU\_02P+08P),  
Electrical and Electronic Engineering, Material Engineering (abbr. VU\_eeimi).*

The Units were operating in the Physics, Astronomy, Materials Engineering, Electrical and Electronic Engineering, and Chemical Engineering research fields, and considering these research fields RCL has appointed the Expert Panel members with the main responsibility to assess UoA against three criteria and provide recommendations for UoA future development. The Panel consisted of eight members affiliated with institutions abroad:

- Olaf Scholten (Panel Chair), University of Groningen, the Netherlands
- Vittorio Bellani, University of Pavia, Italy
- Miroslav Cieslar, Charles University, Czech Republic
- Piotr Deuar, Institute of Physics of the Polish Academy of Sciences, Poland
- Majid Ebrahim-Zadeh, The Institute of Photonic Sciences, Spain
- Sven Frøkjær, University of Copenhagen, Denmark
- Greg Hughes, Dublin City University, Ireland

- Igor Jex, Czech Technical University in Prague, Czech Republic.

#### 1.4. Assessment Organization for the VV\_GR\_NT\_3 Group of Units of Assessment

Timeline of the assessment organization for the VV\_GR\_NT\_3 Group of UoA:

**Submission of data** – Institutions participating in the VV\_GR\_NT\_3 Group submitted data for the assessment by the 9th of March 2023.

**Individual assessment** – Prior to the visit to Lithuania, the data submitted for the assessment of each UoA was evaluated individually by a minimum of three experts from the Panel. The number of experts assigned to assess each UoA would increase based on the number of research fields within that particular UoA. The individual assessment of the Units within the VV\_GR\_NT\_3 Group was conducted till the 10th of April 2023.

**Visit to Lithuania** – The Panel members for the VV\_GR\_NT\_3 Group visited Lithuania from the 17th to the 21st of April 2023. The main objectives of the visit included discussing the results of the individual assessment within the Expert Panel, ensuring a uniform and consistent understanding of the assessment criteria among the Panel members; visiting and familiarizing with the academic and administrative staff, PhD students, and research infrastructure of the UoA (at least three experts from the Panel had to visit one UoA); and collectively agreeing on all scores for the Units within the group in the joint session.

**Final report** – After the visit to Lithuania, the preparation of the Panel report took place. The coordination of the preparation was done by the Panel chair. Before the submission of the final report, the institutions were given an opportunity to provide feedback and comments on factual errors in the written justification of the scores. After the revision of the comments, the final report with the consent of all Panel members was submitted to RCL.

**Submission of data.** Institutions participating in the VV\_GR\_NT\_3 Group submitted data on R&D activities of their UoA to the information system “Vieversys” by the 9th of March 2023 following the Procedure for Submission of Data.

**Individual assessment.** Prior to the visit to Lithuania, the data of each UoA submitted for the assessment was individually evaluated by at least three experts from the Panel. The number of experts assigned to assess each UoA would increase based on the number of research fields within the UoA. The individual assessment of the Units within the VV\_GR\_NT\_3 Group was conducted till the 10th of April 2023.

**Visit to Lithuania.** The Panel members for the VV\_GR\_NT\_3 Group visited Lithuania from 17th to 21st of April 2023. The main objectives of the visit included discussing the results of the individual assessment within the Expert Panel, ensuring a uniform and consistent application of the assessment criteria among the Panel members; visiting and familiarizing with the academic and administrative staff, PhD students, and research infrastructure of the UoA (at least three experts from the Panel had to visit one UoA); and collectively agreeing on all scores for the Units within the group in the joint session.

**Final report.** After the visit to Lithuania, the preparation of the Panel report took place. The coordination of the preparation was done by the Panel chair. Before the submission of the Panel’s report, the institutions were given an opportunity to provide comments on the factual errors if any observed in the written justification of the scores for UoA. Taking into consideration the comments, the Panel's report has been adjusted where necessary. In addition, the Panel prepared a reply to the commenting authorities. The report was submitted to the RCL with the agreement of all Panel members.



**Appeals.** Upon receiving the final results on each Unit, the Institutions had the right to submit a substantiated appeal to the RCL if they believed there were factual errors in the justification of the UoA assessment and/or if they suspected a breach of the assessment procedures that may have affected the assessment outcome.

RCL has established an external Board of Appeal, comprised of seven members selected from the candidates nominated by the Lithuanian Research Academy, the Conference of Rectors of Lithuanian Universities, the Conference of Directors of the Lithuanian National Research Institutes, and the Ministry of Education, Science, and Sports. The Board of Appeal was responsible for determining whether the appeals adhered to the specified provisions and in case of favourable decision to examine the appeal thoroughly.

The Panel VV\_GR\_NT\_3 has received one appeal. The Board of Appeal dismissed the appeal due to non-compliance with the established appeal provisions.

**Approval of the report.** The final report of the VV\_GR\_NT\_3 group is approved by the Order of the Chair of the RCL in accordance with the Regulation.

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## 2. ASSESSMENT REPORTS

### 2.1. KTU\_Medž-fizik Unit of Assessment

Name of the institution	<b>Kaunas University of Technology</b>
Official abbreviation of the name of the institution	<b>KTU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Materials Engineering and Physics</b>
Abbreviation of the UoA name	<b>KTU_Medž-fizik</b>
The scope of the UoA (FTE(SD))	<b>36,84</b>
Research area(s)	<b>T 000 - Technology, N 000 - Natural sciences</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Technology

Research field	Scope (FTE(SD))	Score (points)
<b>T 008 - Materials Engineering</b>	<b>24,20</b>	<b>3,5</b>

#### Reasoned justification of the score

The data relating to PhD students show a remarkable capacity to attract young scientists to this research area at KTU. The number of PhD students throughout the assessment period has remained very strong for a research unit of this size. The composition displays an increasing number of students from abroad (the total number is almost constant over the years, close to or above 40, with a well-balanced fraction of international students, 11 in 2018 and 19 in 2022). Ideally, the number of graduating PhD students should reflect the average number. It should be approximately one-quarter of the total enrolled student number - on average, 10 per year, which has only been achieved once in the period under review. This fact may indicate an issue in the success rate of PhD accomplishments.

The research outputs from the Materials Engineering group presented in the submitted report cover various research topics, from nanomaterials, synthesis of materials, and the optoelectronic properties of these materials to textile fibres research activities, etc. The research performed by the group has a strong application potential, also reflected in the top research outputs. The output shows a good mixture of research publications and the granting of patents related to research outcomes. Six presented patents, however, represent just three unique patents with securing patents in different geographical locations included in the data. While applying for patents in different geographic regions is a real commitment by the UoA to the potential value of this idea, it is still the same scientific concept. The scientific publications are in good subject-specific journals. The Impact Factors of the journals mentioned reflect the ambition to publish in reputable international journals. The number of publications in the top 10% of subject-oriented journals is relatively low when the number of highly qualified researchers (or FTE (SD)) and the assessed period are

accounted for, thus indicating the national high quality of the research; however, with limited marks of excellence on the international level.

There is a solid geographical spread across Europe and Asia in the physical locations where research outputs were presented at international conferences, with some having the invited speaker status. However, there is a shortage of conferences with the same status in the US and, more generally, also in Western Europe. Additionally, the number of listed invited talks is comparatively small compared to the size of the group.

While most Awards focus primarily on national achievements, they nevertheless reflect a positive dynamic towards the diversity of how research achievements are recognized and their importance at all career stages, from students to more established researchers. In the Funding section, there is evidence of extensive use of European Social Funds, and ERDF funds focused primarily on building capacity and strengthening the indigenous R&I environment, expecting this to assist competitiveness in future funding calls. A plan should therefore be put in place to build upon these EU investments to secure funding support in future open Horizon Europe funding calls.

## Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 002 - Physics</b>	<b>12,64</b>	<b>2,5</b>

### Reasoned justification of the score

The Physics unit works in a fast-developing area of research with a high application potential. The many contacts with commercial Lithuanian companies are greatly appreciated and reflect positively on the group.

The best research outputs representing diverse research areas include publications in good subject-specific journals. However, the representation of publications in the first decile (10%) is deficient concerning the number of researchers and the duration of the assessment period. It confirms a satisfactory research quality and very limited visibility at the international level. The small number of invited or plenary speaker invitations at international conferences in the US and Western Europe partially illustrates the limited international recognition. These numbers are all well below what should be expected of a group of this size over five years with some international standing.

The Physics unit has presented four examples on the list of main national and international awards received for R&D. Three of the awards are national, e.g., as winners of scholarships. The only international award is given as "Best Presentation Award". Again, this reflects a national focus and recognition of the R&D activities but shows a lack of international recognition.

The KTU-Physics doctoral program has a small number of PhD students but a very good balance between national and international students which is acknowledged. The doctoral program was established relatively recently (around 2017), which might partly explain why only one doctoral thesis has been defended successfully from 2018 to 2022, however, several students left the program without having defended a thesis. During the site visit, the Panel got the impression that the two doctoral programs at KTU, i.e., KTU-Materials Engineering and KTU-Physics, were partly integrated. Thus, it might be worthwhile to consider merging the two doctoral programs to secure critical mass for the physics program.

Four of the six successfully funded projects were nationally awarded through the Lithuanian Research Council. The other two were funded by the European Regional Development Fund, which reflects a national rather than an international profile for the research. The projects are characterized by relatively lower funding for the individual project. Although the KTU-Physics unit is smaller than the Materials Engineering

unit, the total amount of funding achieved during the evaluation period is significantly less than the funding achieved by the Material Engineering unit, i.e., approximately EUR 700 thous. versus EUR 6000 thous. The low funding rate and a partial dependence on regional development funding, which has a finite lifetime, is considered a challenge for the future R&D activities at KTU- Physics.

This leads the Panel to conclude that the research at KTU is satisfactory at the national level, however with a very limited international recognition.

## Economic and social impact of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

The majority of the submitted projects described in this section are applied research projects, many with company partners, which are still very much focused on the processes of the development of solutions to the stated problem. Engagements with companies, mainly indigenous, high-tech entities, are critical to modern economic development. However, the capacity building of expertise to address these technological challenges in the future is suffering. The Panel feels that the group should put a higher priority on more basic science that is not directly related to the priorities of commercial partners. In this respect, it might be beneficial to give the research effort a stronger focus on a selected number of subjects.

The external participation of UoA researchers in national and international development organizations, be it trade organizations or national science entities, is to be commended, reflecting their willingness to contribute to the overall development of the R&D ecosystem in the country, which is essential to improving international competitiveness. Service given to the Research Council of Lithuania and the Lithuanian Academy of Sciences is significant in quality assuring the R&D outputs of the participating research-performing organizations in the country. The international visibility is, however, limited.

A diverse range of external consultancy engagements is presented, which clearly shows the effective utilization of the research knowledge and expertise of the academic researchers in providing advice on manufacturing innovations, from work on advanced fabrics and clothing materials to instrumentation and high-technology materials. These interactions clearly improve industrial competitiveness and are perfect examples of university- based researchers' broader impact on addressing more comprehensive societal needs. They also reflect the equally important willingness and responsiveness of researchers to address manufacturing innovation requirements, which tend to be locally focused and are a key element in exploiting R&D expertise for economic advancement in the region. Quite important is the thriving of the UoA patenting, which will bring (in the future) potentially significant economic stimuli as it can help introduce new industry trends.

The range of research conferences hosted by the UoA, some of which are locally focused on the Baltic Region, are a good blend of Research and Research Education activities that help develop broader communities of researchers with common interests. Representation of UoA researchers on scientific journal editorial boards in relevant research disciplines again displays researchers' broader commitment to the national and international scientific community, thereby contributing to the integration of Lithuanian research activities on this platform. Equally, the list of UoA researchers servicing a diverse range of international working groups of high standing, reflects the broader ambition of this UoA in KTU to take the opportunities to contribute beyond national boundaries.

The broader outreach of researchers to popularize scientific research and innovation to address real-world challenges is well captured in the list of external engagements. These activities are an increasingly important element in attracting capable students to study STEM disciplines and contribute to modern economic development, which is centrally related to exploiting new knowledge.

## The development potential of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

The UoA has access to a variety of infrastructure that is available to others in an open access strategy. This is very important and appreciated. The Panel feels, however, that the infrastructure is aging and there are too few initiatives to obtain funding to extend the instrumentation. In this respect, it is regarded as a definite plus that the researchers at the UoA are actively participating in the activities of CERN, the European EuroNanoLab network, and a broad range of other European organizations and associations.

The focus at KTU of committing to fostering a good working environment and career development for researchers by implementing the European Charter for Researchers and the Code of Conduct for Recruitment of Researchers is to be commended as it was awarded the Human Resource Strategy for Researchers (HRS4R) award in 2020. In addition, adopting the EURAXESS researcher recruitment strategy of focusing on implementing the "Principles of Open, Transparent and Merit-Based Recruitment" is to be welcomed. An academic staff evaluation system involving a five-year performance evaluation and an annual evaluation review is essential to encourage continuous performance improvements.

The Panel appreciated the fact that several applications for ERC fellowships have been submitted, even though these were not successful. This is seen as a good step to improve the international visibility of the staff. The Panel feels that to support this international visibility the HR department should more actively encourage the international mobility of the staff.

The distribution of human resources is well balanced from the point of view of gender and age composition. The further development strategy is based on a further increase in employee qualification, forming strong research groups led by outstanding scientists, and the motivation of young researchers and students to develop their careers and plan their future research works. International collaboration and participation in international projects will support young researchers' mobility and further qualification and this should be encouraged more strongly. The plan to increase the competitiveness of the research teams on the international scale based on one publication in Q1 and Q2 journals per FTE per year is not showing sufficient ambition, instead one should focus on the top 10% of journals. Likewise, the invited talks at international conferences should be valued highly as a sign of international recognition.

The SWOT analysis provides a basis for longer-term planning to build on strengths and identify limiting factors that can be addressed systematically. The Unit points to some critical areas for improvement, e.g., uncompetitive salaries, poor staff mobility, and a low number of foreign researchers. Some of these could have been addressed more prominently in the strategy document.

In summary the Panel concludes that the Unit definitely has a very good potential but there are some points that needs to be addressed more thoroughly.

## Recommendations for continuity and/or improvement of the activities of the UoA

The research program of the UoA is focused on materials preparation, testing, and characterization. However, the available instrumentation is considered to be insufficient to stay the state-of-the art in the future. There should be strategies developed to meet these goals in national and international perspective. One possibility would be to make more use of available European infrastructure. To be able to develop this it is important to encourage the international mobility of the tenured researchers as well as the PhD students.

On the other hand, the department does possess a range of top-level equipment (MBE, microscopy) around which high impact research could be built, but currently there does not yet seem to be a research plan for it with ambitions to match.

To follow up on these observations of the Panel will require a major adjustment and reformulation of the strategy but will be important to increase the national and international standing of the Unit. The Panel finds that the potential is present.

Collaboration with commercial parties is important and the Panel was happy to see that this is also recognized by the staff. However, care should be taken that one does not only perform service tasks for industry but go to the utmost to take a leading position in developing innovative ideas that are of commercial use and lead to patents. The potential is present, but this needs stronger emphasis.

It is seen by the Panel that the performance of the Physics group is not at the level one would like to see. Having a separate PhD program for this group may even hurt their visibility and it is recommended that they integrate with the material science group to have a single, strong, PhD program. This in particular so because in the usual operation of the Unit there is apparently no strong division between different groups. The two PhD programs do not have features that clearly distinguishes the two.

## 2.2. PROTECH Unit of Assessment

Name of the institution	<b>Applied Research Institute for Prospective Technologies</b>
Official abbreviation of the name of the institution	<b>PTTTI</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Public institution APPLIED RESEARCH INSTITUTE FOR PROSPECTIVE TECHNOLOGIES</b>
Abbreviation of the UoA name	<b>PROTECH</b>
The scope of the UoA (FTE(SD))	<b>4,50</b>
Research area(s)	<b>T 000 - Technology, N 000 - Natural sciences</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Technology

Group of research fields within the research area	Scope (FTE(SD))	Score (points)
<b>T 008 - Materials Engineering</b>	<b>3,00</b>	<b>2,5</b>
<b>T 005 - Chemical Engineering</b>		

#### Reasoned justification of the score

The Technology group of the Unit of the PTTTI consists of two research fields groups, Materials Engineering and Chemical Engineering. The two groups consist of a total of four personnel who hold a scientific degree and conduct R&D activities. The scientific research activities of the Unit are focused mainly on the technological development and industrial advancement of photovoltaic materials and devices, which is an area of considerable interest and intense research activity and competition at the global level. The group conducts R&D activities, with no teaching, and does not train any PhD students. However, it provides support for doctoral students through industrial internships at the Unit in collaboration with academic institutions and universities in Lithuania as well as at international collaborative academic and industrial partner laboratories. In addition to R&D activities, it also provides support to industrial and commercial enterprises inside and outside Lithuania through test, measurement, and validation services, given the state-of-the-art facilities and infrastructure available at the Unit.

The group has a low critical mass in terms of the number of scientific personnel. However, given that the activities of the group are focused mainly on research with no teaching, the overall scientific quality of R&D activities of the group can be evaluated as satisfactory to good, but as yet not at the level of very good to excellent with significant recognition outside Lithuania. The quality of scientific output over the past five years is moderate with the best research results published mainly in journals of lower prominence and the scientific share of the Unit in these collaborative publications range from 9% to 42%. One or two invited talks at international conferences for a group of 3FTE over the course of five years and the absence of awards are also indicative of the hitherto limited scientific recognition of the group at the highest international level. At the same time, the notable success of the group in securing significant research funding through five competitive EU projects over five years is recognised and commendable, supporting the fact that the group is involved in a timely and relevant research field and the R&D activities carried out by the group have the

potential to make useful contributions to the field at national and transnational level. On the other hand, the quality of the scientific output requires further improvement in order to match the good level of funding secured by the group relative to its small size. Overall, the quality of R&D activities of the Technology group can be evaluated as satisfactory to good at the national level with limited recognition on the international scale.

## Natural sciences

Group of research fields within the research area	Scope (FTE(SD))	Score (points)
<b>N 002 - Physics</b>	1,50	2,5

### Reasoned justification of the score

The Physics group of the Unit of the PTTTI is small. It consists of three researchers who hold a scientific degree and is focused on R&D activities in photovoltaics science and technology. The main thrust of the scientific research of the Physics group is the search for new materials and the study and investigation of platforms and structures to advance the performance of photovoltaic devices towards higher efficiency and lower cost on the commercial and industrial scale. As with the Technology group, the Physics group also does not conduct any teaching activities or doctoral training, but provides support to PhD students from academic institutions and universities in Lithuania through industrial internship at the Unit as well as in international collaborative academic and industrial partner laboratories.

Notwithstanding the small critical mass of scientific personnel, the R&D outputs of the Physics group are very limited, considering the focus of the group on scientific research in the absence of any teaching. The group lists a total of 3 journal publications (with a share of 30-40% for the group) and reports 2 conference contributions (share of 75% and 25% for the group) over the period of five years, which is somewhat low for the number of active researchers. The publications are also not in the most recognized journals of highest standing, and there are no invited conference presentations or awards at national or international level. These indicate that the scope and quality of scientific output of the group are not at the highest level commensurate with the size of the group and that there is limited recognition on the international scale. On the other hand, it is recognised that the group has been effective in attracting significant research funding through three EU collaborative projects with broad international participation over the past five years, albeit two of the listed projects are shared with the Technology group. The success of the Unit in securing competitive research funding from the EU confirms the timeliness and importance of the topics of R&D activity conducted at the Unit. However, the quality of scientific output in terms of publications, conference presentations, invited talks, awards and recognitions also does not, so far, match the level of funding secured and available to the group over the past 5 years. Overall, the R&D activities of the Physics group can be evaluated satisfactory to good at the national level, but with limited recognition on the international scale.

## Economic and social impact of R&D activities of the UoA

Score (points)
<b>3</b>

### Reasoned justification of the score

The main economic and social impact of R&D activities at this UoA derives almost exclusively from its industrial focus on photovoltaics (PV), which is an important and timely research topic with major



implications for the future of renewable energy, climate change, and green planet. The UoA has close interaction with industrial partners and at the same time is active in national and international collaborations with universities, small research centres, and enterprises in the field of renewable energy sources. It thus provides a useful link between academia and industry, helping accelerate progress in PV technology by narrowing the gap between fundamental research and commercial market. The primary mission of the UoA is to deliver results to industry at the technology readiness levels 7- 9, to enable the development of more efficient and cost-effective products. In this context, the UoA clearly provides an added value to the R&D ecosystem by providing an efficient route for transfer of PV research to industry. This can potentially have significant economic and social benefit in the long term in Lithuania and beyond.

The R&D activities of the UoA have also led to the creation of a new spin-off company in Lithuania in the PV sector and continue to support training and employment of a number of young researchers in this important topic, hence providing socio-economic benefit to Lithuania in the immediate term.

There are several schools listed where PTTTI participated as one of the co-organisers, but for the information it is not clear what the role was of PTTTI in organizing this series.

The supplied information did not show that researchers from this UoA were members of editorial boards. Also, no consultations to public and economic entities are listed, however from the membership of researchers from this UoA in working groups it is clear that some consultations were provided. For its size this UoA has been very active in various national and international advisory committees, expert panels, industrial forums, government bodies, and working groups.

The participation of this UoA in a public event at the Lithuanian Parliament is very much applauded by the Panel, however, the total impact of all popularization events organized by this UoA appear to be limited.

It is important to recognise that the while the UoA provides an effective vehicle for the industrial development of PV technology with significant social and economic benefits, the scientific impact of R&D activities is not at a high international level. Given the success of the UoA in attracting significant EU funding and the extensive network of national and international collaborators, there should be a stronger focus on R&D activities in order for scientific impact to match the industrial progress achieved so far.

In summary, the research carried out is particularly important to industry with significant socio-economic benefit in the short-term and potentially high impact on human society in the future. The relationship with business, industry, and decision-makers provides added value to the society, particularly in Lithuania. The quality of R&D activities, however, needs to be elevated for a stronger impact at the global level.

## The development potential of R&D activities of the UoA

Score (points)

3

Reasoned justification of the score

The UoA has the potential to make further contributions to Photovoltaic technology in the near future and aid industry in the development of new products of higher efficiency and lower cost, particularly at the national level. The activities of the UoA are focussed on an important topic at national and global level, that has major implications for the future of green energy generation and development of energy harvesting and storage technologies. The UoA, therefore, plays a valuable role and will continue to be major player in a key technological area in Lithuania. It is a useful conduit between research and industry, providing accredited

services to academic and industrial partners, as well as potentially aiding the creation of new start-up companies and new employment opportunities at the national level.

The Panel has observed several threads that may hamper future growth that should have been addressed in more detail and where some are named in the following.

While the infrastructure concerning durability test is very good, the infrastructure in other areas where the Unit has expressed ambitions, such as coating to name one, is at a much lower level. In order to keep a good standing, substantial investments need to be made, or priorities need to be re-focussed. The diverse focus, while important to spread economic risks, will hamper the international, and even national, visibility of the Unit.

It was also observed by the Panel that the leading staff, the directorate, while performing excellently in guiding the institute, is growing in age and natural successors seem not to be present. While on the short term this is not an issue, it will become important for planning for the long-term future of the institute.

While the Unit is performing an important task in the link between basic research and commercial applications in Lithuania, it is seen that the ambition to work on an international level is limited. This is, by no means, an easy feat, but will be important for developing a long-term sustainable future.

## **Recommendations for continuity and/or improvement of the activities of the UoA**

The UoA been successful in attracting significant R&D funding and establishing several collaborative projects with international partners in Europe and beyond, which is commendable. However, the focus on industrial and commercial development, while valuable, needs to be better balanced by a further strengthening of the scientific quality of R&D activities if the UoA is to ensure long-term continuity and growth in the future, and higher recognition at the international level. The key element to achieve this important goal is the recruitment of high-quality researchers and highly motivated young scientists to elevate the scientific output to a more competitive level in the global scale. Another important strategy will be to provide a better balance between activities related to test, measurement, validation and services to industry, and scientific research, which is currently far more strongly in favour of commercial enterprise.

However, at the current level of R&D activities, the development potential of the UoA at the scientific will remain limited at the international level. The field of Photovoltaics is an intensely competitive research topic with many players at the international level. While the UoA has to date shown to be capable of making useful contributions to the field at the industrial level, especially in Lithuania, it will only be able to remain a significant player in the topic globally if it can enhance the scientific quality of its R&D activities in the future. In order to strengthen the long-term development potential of the UoA at the international level, it will be imperative that in addition to the focus on technological and industrial development, there will be a major concerted effort to enhance the scientific quality of R&D activities in terms of publications, international conference presentations, invited talks, membership of editorial boards of journals, as well as overall scientific recognition at the world stage.

An effective strategy to bring about a major shift in the scientific quality of the UoA will be to put a stronger emphasis on R&D activities relative to technological development. Other activities of the UoA in terms of provision of test, measurement, and validation services to commercial and industrial entities, must in the future be balanced by the need for stronger focus and emphasis on scientific R&D activities. Another critical factor in reaching higher R&D standards will be the recruitment of new high-quality established scientists as well as excellent early-career doctoral graduates. This will greatly help to strengthen the scientific activities

of the UoA in addition to ensuring its sustainability and progress at the cutting edge of photovoltaics research at the international level in the future.

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### 2.3. VU\_02P+08P Unit of Assessment

Name of the institution	<b>Vilnius University</b>
Official abbreviation of the name of the institution	<b>VU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Physics + Astronomy</b>
Abbreviation of the UoA name	<b>VU_02P+08P</b>
The scope of the UoA (FTE(SD))	<b>115,06</b>
Research area(s)	<b>N 000 - Natural sciences</b>

## Quality of the R&D activities by research fields (groups of research fields) of the UoA

### Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 002 - Physics</b>	<b>97,87</b>	<b>4</b>

#### Reasoned justification of the score

The UoA is strong at the international level, its R&D is of high level and is internationally recognised. The Faculty of Physics at Vilnius University has carried out significant R&D activities of high quality over the past 5 years in the field of Physics. Its scientific output in this field is very respectable, with a number of researchers and publications having strong international recognition. There are many strengths of this Unit listed, and correctly so. Extensive international collaboration with top centres is also evidenced. In terms of international rankings, Vilnius University is, for example, ranked in the top 400 universities worldwide in the subject area of Physics and Astronomy according to the QS ranking list for 2023. On the other hand, while there are many good researchers in this large Unit, a weakness is that the overall number of top-level outputs reported is rather low compared to the total research effort evidenced by FTE(SD) and the number of available slots for outputs. The weakness is in comparison to the top European standard, which would expect the majority of researchers to take part in high-performing outputs on an international scale at some time over a five-year period.

The data provided for assessment provides an impressive publication record that includes about half a dozen works published in the top physics journal *Physical Review Letters*, other top widely respected journals such as *Nature Physics*, *JACS*, *Angewandte*, *Nature Communications* (over a dozen in the above list) and over a dozen other high impact publications in titles with an impact factor over 10. The above corresponds approximately to so-called TOP10 journals, i.e., the top 10% in terms of impact in their field. There are also several review articles, and the remaining publications are almost without exception in solid, well-regarded journals. This is overall a very good effort and shows that clearly some researchers are working at the top of their fields. However, for top international centres in Europe, one would expect the top-level very highly regarded publications as listed above to be a part of most researchers' portfolios over a five year span, which is well above the displayed level given the large FTE(SD)-count of the UoA. Given that there is only about one publication slot in the assessment data for two FTE over five years, top-level European centres would fill

practically all slots with such very top-ranked publications. Also, the UoA employees are a minority in the author list for most of the top-ranked publications they are part of, whereas the top-level centres would usually be the lead group in such research and dominate the author list. Overall, then, in terms of publications the Unit is judged to be strong at the international level but not yet among the top international players.

Conference presentations paint a similar picture to publications. Almost all of the provided contributions are talks at highly regarded conferences overseas, which indicates very high quality research by the groups in question. However, comparing the number of invited presentations reported to the total number of chief and senior researchers or the number of slots (FTE(SD)/2), the number is far below what would be expected of top-performing institutions (all slots would be expected to be filled by invited talks, with many to spare).

The competitive research projects won by the Unit indicate vibrant activity in procuring research funding at the level of many individual groups. Researchers from the Unit have been able to attract a substantial amount of funding from non-Lithuanian resources and take part in about half a dozen European and NATO grants for multi- institution collaborations, and very many small and medium-sized grants using primarily European structural funds and financing offered by the Research Council of Lithuania. The Unit is making the most of the conditions of the local funding ecosystem. Of particular note is the participation of researchers in the LASERLAB-EUROPE projects, and being a founding member of the ELI consortium. The main thing lacking in this regard to the top level is to lead European or other international grants.

Moving to awards and prizes, some of the awards given to group members are very distinguished. Of particular note are the Humboldt fellowships, particularly the experienced award, which are indications of international recognition of research excellence. Also, the three Lithuanian Science Prizes which are the top local prizes, and very distinguished. It is also good to see that the young generation continues to gather many scientific awards. Clearly, the UoA is a great leader in the country for natural sciences research.

Overall, in the Lithuanian milieu, the Unit is a top performer, arguably the best in the country and strong at the international level, which can be seen from the presence of a sizeable body of top-level publications and invitations to conferences. However, there remains a large gap to the top international players. This gap is most clearly seen from the ratio of the number of top-level publications and presentations to the FTE(SD) effort, which is typically several times higher in top international centres.

Research field	Scope (FTE(SD))	Score (points)
<b>N 008 - Astronomy</b>	17,19	4

Reasoned justification of the score

The Astronomy Unit is the largest Astronomy group in Lithuania and acts as a coordinator for various activities in Lithuania. This relatively large astronomy group is very active in several different fields. Most of the scientific staff members are working at almost a hundred percent of their time on research, which is a sign of a strongly committed group. There are some top-performing clusters in this group but also a fair number who lack international visibility. This can be concluded from inspecting the number of high visibility publications as listed in the 'best research outputs'. The number of such publications is sizable, but not as large as should be expected from a group this size over a period of five years. The same holds for the conference contributions, where a sizable number is listed, but falling short of what should be expected for an excellent group of this size over a five-year time span.

The group is very active in general education and outreach activities and these efforts were generally very much appreciated by external bodies, as shown by the awards given to the members of the group for

excellent teaching and outreach activities. However, there were hardly any awards listed related to outstanding science.

The Panel is not aware of any ERC applications written by this group for personal excellence grants such as the ERC-starting or ERC-advanced grant, as should be expected for a group of good international standing. It is very much appreciated that the group participates in many international collaborations such as GAIA, LOFAR, among many others and is a member of many international networks. These have certainly contributed much to the success of this group.

The Panel noted that due to the absence of a PhD program, the group lacks visibility and identity at the student level, however, it was noted that this is by choice, as the group prefers to have a common program with Physics. Indeed, there is a considerable overlap in the disciplines. The number of PhD-thesis with a clear astronomy basis, 3 over the evaluation period, is however very small for a group this size. It is strongly recommended the group tries to find funding from national (very difficult) or international (European) sources to be able to increase the number of PhD students.

The group has been relatively successful in acquiring national and international grants. Since some research clusters in this group are performing at the top international level it is recommended that members are encouraged even more to apply for European excellence grants as these give a strong increase in visibility to the group and, additionally, allow for many more PhD students.

## Economic and social impact of R&D activities of the UoA

Score (points)

4,5

Reasoned justification of the score

The research performed by this UoA is closely related not only with the academic community, but is a highly valued partner in R&D matters with business, decision makers, and society. Employees of the institution are regarded as experts in public and private sectors.

Firstly, in terms of economic impact, the listed contribution to public and economic entities includes excellent examples of R&D contracts with the VU LRC and the Light Conversion company in Lithuania, which is recognised as one of the world's leading manufacturers of femtosecond lasers. With respect to the many laser technology companies, having this expertise within the country is particularly important both from the perspective of a focused research base that can be oriented to meet specific company demands in a timely fashion as well as a source of highly educated graduates who can be employed in this high tech sector in their home country, thereby addressing some of the brain-drain concerns. The focus on optics and laser technology correlates very well with the growth of laser industry in Lithuania, including the manufacturing of femtosecond lasers.

A good example of the wider impact of R&D activity within the UoA is the invention of optical parametric chirped pulse amplification in 1992 by the group of LRC scientists led by Prof. A. Piskarskas which ultimately led to the development of a unique table-top OPCPA system. This scientific achievement led to the production of the very first commercial OPCPA system by Lithuanian laser companies, which led to Lithuanian science entering into the ELI collaboration as a valued founding and equal partner, and also allowed a Lithuanian company to build commercial OPCPA systems for ELI. This is a considerable achievement. As a result, the Unit and company have a presence internationally. It has been also a contributing factor to the

growth of this industry locally. The possible transfer of technologies from CERN and ELI are of particular value as they represent the high end of technology available.

Several other valuable and forward-looking industry cooperations have been listed. In terms of numbers, there are however relatively few spinoff companies and cooperations with the laser and optics industry compared with some competing units in Lithuania, though some of the past research of the Unit has had a very large impact over the last three decades.

The staff is very well represented in primarily Lithuanian working groups and committees, including several leading positions, e.g., the acting President of the Lithuanian Academy of Sciences, President of the Lithuanian Laser Association, and acting President of the Lithuanian Physical Society. In fact, it can be said that the board of the Lithuanian Physical Society and Laser Associations are dominated by members of the Unit. There are also many employees present in boards of public associations. Staff members were also active in several international working groups and committees. A member in the CERN council is also a very distinguished post. Of particular note also is having a member of the International Scientific and Technical Advisory Committee (ISTAC) of (ELI) ERIC.

The level of conference organisation activity and public outreach is neither significantly above nor below expectations for the five years for a major university department. The Open Readings and ECAMP meetings deserve particular mention as being known internationally. The outreach activities and public engagement in TV and radio contribute to public understanding of science in an increasingly complex connected society and play an important part in attracting the next generation of bright minds towards scientific career paths which is to be commended.

The self-assessment report also includes several examples documenting frequent consultancy activity to public bodies in Lithuania. Along with the presence on industry boards, this demonstrates a commitment of the researchers forming the Unit to contributing to the economic development in partnership with these stakeholders and to make a wider contribution to the development of the national scientific ecosystem which is an important part of developing a research system which stands up to international scrutiny.

While the impact in terms of on professional and public bodies is excellent and seems to be leading in the field in Lithuania, the current impact on the burgeoning laser and optics, or other industry and economic activity in Lithuania could be somewhat higher for such a large research and development Unit, especially in light of the number of spin-off companies and industry connections of some other units in Lithuania that appear significantly stronger.

## The development potential of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

Based on the track record over the past 5 years, the staff and PhD student structure, and the strategic plan and its long-term objectives, the development potential of R&D activities at this Unit appears solid and point to further advancement of science and training of graduate students, especially in the faculty of Physics. There is also reasonable potential for future expansion in the field of applications. The submitted material is well presented and gives a picture of a very good academic unit with a highly qualified research staff, which is internationally recognized and well-positioned in various national and international academic organizations.

Nevertheless, there is a significant risk that the Unit's very high position locally in Lithuania may be eroded in upcoming years to some degree, compared to other units. This is because the strategic goals, and also statistically the individual goals of the research groups, are set primarily on the continuation of the good work done so far but are rather timid in terms of developing new disruptive research directions, or tackling the impending funding crisis that is likely to eventuate due to the drying up of European structural funds, or attracting new highly qualified researchers from outside the Lithuanian community.

Moving to the different aspects in more detail, the staff structure is quite robust in terms of age distribution, which bodes well for the future. The faculty has sufficient workforce to cover a rich spectrum of research directions, and should be able to continue its high level of research in the near to medium future. Two shortcomings are the gender balance that is biased to the male side more than it could be, and the very small number of faculty of foreign origin.

The human resources policy that is formulated is clear and active in promoting the employment and retention of high-quality staff and stands out in a positive way compared to the standard across evaluated units. Good evidence is provided that active and successful recruitment of new researchers who can lead new research topics is being conducted. In fact, it is at a level that appears to be capable of a successful replacement of the faculty on career timescales. The number of postdocs is not very high on the European scale for a large faculty such as this, but is a very good effort given the local financing ecosystem.

There are certain weaknesses and threats, some of which are noted in the SWOT analysis – for instance brain drain, understaffing in administration, or an inability to compete on regional and global levels to attract the most qualified foreign researchers due to limited state funding and low salaries. However, one whose seriousness appears to not be noticed in the development plan is the low overall FTE per person in the Physics field, which reaches only around 60% even when taking into account that persons employed in education (part-time) are overwhelmingly the same ones employed (part-time) in research. This is significantly below the level usually expected in a well-functioning research lab, which is more like the approximately 80% seen in the Astronomy field. A low FTE lowers the intensity and depth at which research is conducted by the groups in question since management and maintenance tasks do not usually reduce proportionally.

At the young end of the staff spectrum, PhD student numbers are healthy and good graduation rates indicate a vibrant research community. While the number of doctoral students to total staff appears significantly lower than it could be for such a Unit, this ratio is understood to be somewhat lowered compared to overseas units because of the strong policy of promoting young researchers to the highest staff bracket possible. The number of PhD students from abroad is low, also compared to some other Lithuanian Units in the field, but the trend has been a rising one in recent years, and the overseas PhD student proportion is tending to a reasonable level. The significant increase in overall PhD intake in 2022 with a good proportion being from overseas is an important indication of a strong future performance on this front. The PhD studies are well organised and active in promoting the PhD students welfare, including strong incentives for stints at foreign institutions and the expectation of regular attendance of scientific meetings every year which is usually met. Activity by the students is highly encouraged. The practice of employing many promising students in part-time positions is a good approach that goes a long way towards bringing up the new generation of Unit employees, and goes some way towards alleviating brain drain to industry or overseas.

On the infrastructure, a number of nationally very significant research infrastructures are run or participated in by the Unit. The recent upgrade of the faculty's infrastructure funded by the EU structural funds with an investment of around EUR 25 mil. is the type of investment required to raise the standard of R&D activities. It has contributed to a broader international participation, as have other international cooperation programmes. Examples of major infrastructure that will benefit the Unit for many years to come include the Moletai Astronomical Observatory (MAO), full partner status in the Extreme Light Infrastructure (ELI), CERN



participation, and MAX IV. The Unit has also shared access to various important infrastructures provided by Vilnius University. The joint agreement between the Centre of Semiconductor Technology (PTC) and the Centre for Physical Sciences and Technology in the field of semiconductor science and technology is another good example of effective use of high-end equipment.

The research development plan is well formulated in several aspects and the envisioned goals in the strategic plan appear largely attainable, increasing confidence in the very good development potential of R&D activities of the UoA over the next 5 years. The mission of the institute is formulated well, and the SWOT analysis is well-presented and quite candid about problems that are present, which is to be commended. The strategic directions are also formulated well, including the plan to put significant effort into collaborating with large international infrastructures. However, they could be more courageous in suggesting disruptive high-risk concepts, and it is not always clear what concrete measures will be taken to move towards the stated goals. There is no sufficiently detailed timeline for the implementation of the generally desirable directions and concepts put forward.

The plan is also more timid than it should be in some other aspects. A more pro-active and explicit strategy for improving the research quality across the board and more explicit tactics for bringing in foreign nationals at the staff level would have also been advantageous. For example, the difficult issue of what should be done with relatively poorly performing groups and topics (remedial strategies, phasing out, etc.) should be explicitly tackled in order to raise the ratings of the Unit further in future. Judging by the research output, only part of the researchers working on a top international level. This is hard to improve without an explicit revitalisation plan that goes beyond merely perturbative corrections.

Overall, the Unit is working actively on many planes of research and interfacing with society and industry. The very positive points above and the provided development plans look to be sufficient to maintain the current very high R&D quality of the Unit. However, stronger and qualitatively more courageous action is needed if the level of R&D is to be raised further. This will also help avoid the risk of being overtaken by other local units in the mid-term future.

## **Recommendations for continuity and/or improvement of the activities of the UoA**

Although the future potential of the Unit is very promising, there are underlying weaknesses and threats that could compromise this opportunity.

The Panel recommends that the Unit's researchers and administration should take a more pro-active stance to further develop the Unit's R&D power, in order to not let complacency over their current high position nationally to set in and avoid being overtaken by other units which appear to be taking a more active stance. In particular:

- Researchers and the subsidiary institutes in the faculty should be encouraged to formulate disruptive and ambitious research plans which may be high risk but high gain. The scientific potential and infrastructure are there to facilitate this proposal.
- The Unit should endeavour to focus the excellent scientific infrastructure installed in recent years more towards groundbreaking research on an international scale than service to industry. While the latter is valuable, the Unit's greatest forte compared to other Physics units in the country lies in basic research. The Panel had the impression during lab visits that the focus on service to industry was dominating use of the facilities and possibly somewhat hampering groundbreaking basic research that could be done on the same equipment.

- The submitted research outputs when compared to the number of research and teaching employees suggest that a part of the research groups, perhaps a third or somewhat more, are working on a high international level, and the rest probably not quite. A plan should be prepared regarding the way forward with relatively poorly performing groups - remedial strategies, phasing out, etc. - in order to raise the ratings of the Unit further in the future. It is likely that this should go in hand with making the funding to the constituent institutes and groups more strongly dependent on scientific results. The Panel's understanding after meetings on-site is that currently funding appears to consist mostly of a set or algorithmically determined amount per institute, which can lead to complacency.
- Persons the Panel talked with on-site, mentioned a shortcoming of the general body of employees regarding a certain shyness and modesty in advertising one's results, submission to top journals, application to top grants. This meshes with a similar impression that the Panel obtained from analysis of the reported research outputs and reports. It would be advantageous for the administration to encourage researchers to take advantage of more opportunities and play with the best whenever the chance appears. It is time to be more bold and ambitious. Otherwise, the UoA will not be able to rise in ranks and international recognition.
- Measures should be introduced to encourage and support employees in applying as leaders for ERC funding and other international grants, not necessarily just partners in a network.
- The Panel judges the intent to put significant effort into collaboration with CERN and other large national and international scientific infrastructures to be a good path to take.
- The manner in which research outputs and best reports were provided for the Panel was not optimal. There are indications that in fact a significant number of top-level publications and invited presentations of the unit from the years 2018-2022 were left out of the list in favour of much lower-profile items. As a result, the output appears less impressive than it could have been. Moreover, it was never made clear how many approximately independent research groups there are in the Unit. The administration should realise that panels will compare the number of top-level papers and invited talks to the number of groups or employees.
- It would be good to take measures to increase the share of the Unit's employees in author lists in high-profile publications.
- It would also be helpful for improved research intensity to take measures to increase the mean FTE per employee in physics to about 80% from the current level near 60%.
- A sizeable increase of the number of foreign-origin faculty and researchers with doctoral degrees employed at the Unit would be beneficial for scientific output and increasing the scientific network of the Unit.
- The Unit should make an emphasis on hiring more women to improve the gender balance, and especially on increased retention of female staff in higher faculty positions.

## 2.4. VU\_eeimi Unit of Assessment

Name of the institution	<b>Vilnius University</b>
Official abbreviation of the name of the institution	<b>VU</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Electrical and Electronic Engineering, Material Engineering</b>
Abbreviation of the UoA name	<b>VU_eeimi</b>
The scope of the UoA (FTE(SD))	<b>36,51</b>
Research area(s)	<b>T 000 - Technology</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Technology

Research field	Scope (FTE(SD))	Score (points)
<b>T 008 - Materials Engineering</b>	<b>28,07</b>	<b>4</b>

#### Reasoned justification of the score

The group of Materials Engineering is performing leading-end research in some areas. In the staffing levels, there is an overly large number of senior researchers, but this is related to the fact that this serves to keep the top level people at the institute, which is welcomed by the Panel. The group has many ties with commercial partners which is very important for the standing of the group. The Panel has noted that these contacts are also valued by the PhD students as this allows them to begin to build contacts early in their career. The implications of this focus is that much of the work in the group is very strongly oriented at instrumentation and utilizing the available instruments to help the commercial partners at the expense of performing fundamental science that does not directly promise commercial benefits.

The group as a whole has some clusters that are competitive on an international scale and are really world class, however, the Panel feels that a sizable fraction of the group is not operating at a competitive international level. This is reflected in the list of best publications where some have appeared in highly cited the top journals. However, the number of these outstanding publications, as listed in the best research outputs of the group, is quite a bit less than one should expect for an outstanding group of this size.

The same conclusion can be deduced from the number of presentations at highly regarded international conferences, which is large, however, the number of key-note and invited presentations is lower than one should expect for a group of this size. The members of the group that have received multiple awards and recognitions at national and international level, is of an excellent level.

The group has received a large number of grants and funding awards for several projects with commercial partners which is an important achievement.

The number of PhD students is too small for a group this size. The Panel realizes that this is in part due to the system in Lithuania, however, there appear to be very few initiatives undertaken by the group to acquire

international funding (in particular from European sources) and national (non-governmental) resources. The group could also have been more active in pursuing ERC personal-excellence funding opportunities.

In general, the Panel feels that -for its size- the group is too strongly focused on ultra-fast lasers and that it would be a good strategy to diversify and open some new research areas.

Research field	Scope (FTE(SD))	Score (points)
<b>T 001 - Electrical and Electronic Engineering</b>	8,44	3,5

#### Reasoned justification of the score

The group of Electrical and Electronic Engineering is a relatively small group within this UoA. According to the information received, the scientific staff of this group consist of well over 30 persons that are contributing less than 9 FTE (SD). This is only a very small percentage and may reflect that the group is missing some strong scientific leaders that are pushing the research performance to new levels which necessarily implies that they spend a large fraction of time on research. By having distributed these FTEs over such a large group of people, suggests that most probably the members of the group also have commitments to other groups, therefore, the identity of this group will suffer. This will hamper the development of new directions within this specialisation.

This sentiment is not only based on the fractional FTEs, but is also evident in the scientific and technological outputs. The provided list of best research outputs shows several publications in international journals, however the number of publications in top ranked journals (in the first quartile) is considerably less than one should expect from an internationally recognized group of this size. Over a five year period one should expect that a group of this size would have published a number of papers even in the top 10% journals. The list of best outputs shows a few invited talks at international conferences. This is regarded as a sign of excellence, however, the total number is well below the level one should expect over a five year period for a group of this size. The group members have received several awards that show excellence. It is noted that for these awards there are two or three names that occur in all nominations. This suggests that the basis for excellence is relatively small.

The absence of a separate PhD programme for this group does not contribute to the visibility of this group. The Panel is of the opinion that this is limiting the viability of the Electrical engineering group at both national and international levels. The main signature of an active and thriving group is that it has enough innovation power to be able to create and maintain a lively environment for PhD students. This aspect is, most unfortunately, missing. Not having a strong community of PhD students, the future staff, will hurt the sustainability of Electrical engineering as a separate group in this UoA.

It is noted that the group has been able to attract considerable funding, especially when taking the small size of the group in FTEs into account. This is seen as a very positive achievement of the group.

In summary, the group is performing reasonably well with some, but limited, international visibility.

## Economic and social impact of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

The UoA has many close links with commercial partners which is very important to anchor it within society. This is appreciated very much by the Panel and is highly valued. This means that the UoA has a significant influence on several activities with economic or social impact. As a result, the research of the Unit is often based on a collaboration with national and international industrial partners. To a certain extent the interests of the commercial partners and the institute run parallel, however, usually the interests of industry are more short term, while academic research should be seen as an investment in the future. In this respect, the Panel feels that due to this strong emphasis on commercial interests, the research on fundamental and basic science is under too much pressure.

The range of external consultancies in laser expertise to the relevant companies, and contributions in advancing 3D nanolithography, pulsed precision micromachining and street lighting consultation display strong evidence of an excellent applied research focus within the UoA.

Some staff members of the Unit have outstanding positions on editorial boards of national journals, but many fewer on international journals.

The staff of the UoA has been the main organizer of only a few major international conferences.

The Unit is active in international collaborations such as CERN, ELI, HiLase Facility, and Laserlab-Europe which is very important in developing a recognised international profile for Lithuanian research. These memberships also result in having research staff members on the boards of the governing bodies of these international organizations which is to be commended.

The staff of the UoA has been active in several activities connected with the popularization of research work among the broader public which has been disseminated through public lectures and presentations, popular science articles, TV and video presentations and periodic reviews about laser technology. At a higher level, the links between researchers and commercial partners reflect a commitment to translating new scientific knowledge which has the potential to improve industrial processes to the relevant stakeholders external to the University, something that is important in embedding the University in the society of the region. Unfortunately, these activities have not resulted in a sizable increase in the number of students at the UoA at VU.

The Panel also feels that the group is putting too much emphasis on instrumentation and service to the industry at the expense of more basic and fundamental science topics. It is recommended to see service to commercial partners as a source of income that should help to finance basic and fundamental science, thus emphasizing indirect and possible long-term benefits.

## The development potential of R&D activities of the UoA

Score (points)

3,5

Reasoned justification of the score

The UoA is housed in excellent and spacious buildings that give access to up to date small-scale infrastructure in addition to the main equipment installed in recent years. The UoA's commitment to upgrading the R&D infrastructure in line with the Smart Specialization Priorities "New Production Processes, Materials and Technologies" is noted. The selected topics "Laser Technologies and Photonics" and "Advanced Materials and Structures" fit very well with the international state-of-the-art R&D activities. The fact that R&D infrastructure of the UoA operates through several open access centers (OACs) again ensures the necessary access to expensive instrumentation and contributes to strengthening the competitiveness of the UoA teams to participate in international research programs. The partnership with FTMC also contributes in a good manner to enhancing the research experience of Master and PhD students participating in these research programs. In the international context, access to the European Laser Infrastructure projects-LASERLABEUROPE, central participation in the ELI RI and associate membership of CERN again allows researchers to contribute at the international stage beyond what ever could be achieved utilizing national resources.

However, the strategic plan does not clearly specify the way the Unit wants to guarantee sufficient funds for further development and sustainability of these very ambitious research plans. Covering the full breadth of fields in an international setting requires a very ambitious and collaborating, outgoing staff. The Panel has concerns in this respect. This is in part because the mobility of the staff and PhD students appears to be limited and in part because of the limited total number of PhD students, who should drive new developments and become the staff members of the future.

The PhD studies as a whole at the faculty look well organized and active in promoting the PhD student's welfare. The practice of employing many promising students in part-time positions is a good approach that goes a long way towards bringing up the next generation of Unit employees, however this should not be at the expense of working on topics that are of more fundamental nature and thus not of immediate interest to commercial partners.

The policy for the management of the human resources at VU, to which the UoA belongs, is good; the recruitment is well organized, with the valuable contribution of external international experts to poor gender balance with the number of female researchers strongly under-represented.

As noted before, some of the researchers in the UoA operate at an international competitive level while there is a large number that do not. The plans laid out in the strategic plan for the next 5 years do not appear to be tackling this problem and it is thus not likely that this situation will improve much unless this is specifically addressed in the plan.

## Recommendations for continuity and/or improvement of the activities of the UoA

The UoA has received large grants from the European Regional Development and European Social Funds programs in the past. Since in future the funding from these two programs will very probably reduce, the UoA should be more pro-active in preparing and submitting to EU project calls under other programs that allow capacity building and innovation, such as ERC, Horizon Europe, and European Innovation Council grants.

The UoA should implement pro-active strategies for improving gender balance. Human resources management declares quality-based recruitment, however, the current gender distribution with a dominant male representation should be addressed proactively to aim for more even gender balance.

The UoA should foster the mobility of its staff abroad towards improving their international dimension. It should foster their mobility in Europe to use and exploit the instrumentation available at the EU facilities (ESRF, EMFL, European XFEL, ILL, INL-AEMIS etc.) to increase the scientific level and the international visibility of the research.

It appears that the scientific staff is very fragmented over different research groups. While this is good for the mobility of people among different research groups, this will make it very hard to build concentrated groups with a clear focus on a particular research topic. For making research breakthroughs it is very important to have these clearly-focussed groups of people that closely work together and thus make a clear impact at the international level.

Additionally, performing service tasks for commercial parties is very important for the visibility of researchers to the local parties, but it will be very important not to correctly value this activity and continuously to keep in mind that the emphasis should be put on developing intellectual property. Service should rather be regarded as lubricant in contacts with industry to develop innovations, not as a main goal.

The UoA is in a very good position at present with an excellent building and infra structure. However, performing front-end research requires continuing investments. It will be most important to detail this in the future strategy since otherwise the present leading position will be lost, certainly in the international setting.

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## 2.5. FTMC\_FTF Unit of Assessment

Name of the institution	<b>Center for Physical Sciences and Technology</b>
Official abbreviation of the name of the institution	<b>FTMC</b>
Name of the Institution's unit of assessment (hereinafter – UoA)	<b>Photonics and Applied Physics</b>
Abbreviation of the UoA name	<b>FTMC_FTF</b>
The scope of the UoA (FTE(SD))	<b>159,59</b>
Research area(s)	<b>N 000 - Natural sciences, T 000 - Technology</b>

### Quality of the R&D activities by research fields (groups of research fields) of the UoA

#### Natural sciences

Research field	Scope (FTE(SD))	Score (points)
<b>N 002 - Physics</b>	<b>126,00</b>	<b>3,5</b>

#### Reasoned justification of the score

The Physics group of the FTMC is very large with a well-balanced composition in terms of the number of chief researchers, senior researchers and researchers. In terms of evaluating the research excellence through research publications documented over the last 5-years, there is evidence of a small number of outputs in discipline-relevant high-ranked journals. These include 1 publication in PRL and 3 other publications in the very top Physics/Chemistry journals (Nature Comms, JACS, MNRAS) that are widely regarded to have top reputations. In addition, 15 papers in other very high-impact factor journals (10+) are listed. Many of the other remaining publications listed in various journals, while highly regarded, cannot be considered to be of a top international standard. Given that this selected list of best research outputs is from a large group of researchers (126 FTE) over a 5-year period, it is clear that pockets of research excellence exist as exemplified by this small number of high-impact publications with other groups, while contributing to scientific advancement quite strongly, are not currently performing at a top international standard at this time with some research groups having only weak representation in this high-quality group of journals.

In terms of the data on doctoral studies, both the overall numbers of Phd students, which has been increasing over the 5-year period and in particular, the increasing number of students from abroad which has increased from ~4% in 2018 to almost 40% in 2022, is to be highly commended and represents an extremely encouraging trend. The graduate rates also seem to be appropriate given the overall student numbers, however, given the large researcher FTE in FTMC, the total number of students is still relatively small by international standards.

In relation to the data presented in the list of best reports at conferences abroad for Physics, 1 Plenary and 11 invited talks are listed along with 3 oral presentations and 47 other international presentations with no information on whether they were contributed, oral presentations or posters, mostly in highly regarded conferences. However, considering the FTE researchers to be 126, the total number of invited presentations



(12) reported over a 5-year period is relatively low for a leading Lithuanian institute and while all of these conference presentations reflect representation at international level, again, the number of researchers with high levels of recognition at the international level is comparatively small which directly impacts on the international reputation of FTMC.

From the list of national and international awards, while there is a predominance of national award success, there are examples of outstanding achievement including a prestigious state award (Order of the Lithuanian Grand Duke Gediminas), the Lithuanian Science Prize from the Lithuanian Academy of Sciences and yearly research scholarships from the Lithuanian Academy of Sciences which is a very competitive award as well as 12 best presentation/poster awards for young scientists. While it is very encouraging to see so many good results for PhD students and young scientists – they dominate the list, by consisting of over 80% of all awards listed. However, the number of senior awards is rather low given the large FTE numbers which reflects limited international recognition.

Significant success in projects funded directly by European agencies is presented with FTMC being the coordinator of a QuantERA project which is an excellent achievement and one prestigious MSCA is listed as an Individual Fellowship carried out at the Centre. In addition, the utilisation of ERDF and European Social Funding to build research capacity at a national level to enable participation in future international projects which assist in addressing the brain drain trends and make economic development more homogeneous across Europe is to be commended. Overall, the funded projects listed indicate very vibrant activity in procuring research funding by many individual groups. Very positively, the large numbers of European networks, consortia, and programmes in which the Unit participates indicate that it is internationally recognised as a valued research and organisational partner in many activities.

In summary, the grants won by the Centre look excellent putting it on a very high level of cooperation internationally and very successful in winning grant money from national sources. On the other hand, publications, presentations, and prizes, while containing some great achievements, reflect pockets of strong international recognition, but limited to specific areas which is particularly evident given the FTE number for Physics.

## Technology

Research field	Scope (FTE(SD))	Score (points)
<b>T 008 - Materials Engineering</b>	<b>33,09</b>	<b>3,5</b>

### Reasoned justification of the score

For Materials Engineering FTE (33), all publications reported are in very good to top-level mainstream journals with authors from the Unit having either 100% or dominant contributions in almost all of these publications indicating that certain individual researchers in the Unit perform at a very high research level. Given that there are 10 chief researchers in this section of the UoA, although the calculated FTE is a rather low number at just over 4, it appears that most of them have publications in very good journals over the 5-year period. The Materials Engineering group has demonstrated a good track record in the training of doctoral students, producing a total of 18 completed PhD graduates over the past 5 years and increasing numbers from 15 to 27 ongoing doctoral students as of 2022, including 3 students from abroad, however, this number of international students is static and has not increased over the last 3 years. For international conference activities, the majority of presentations (10/17) are invited with two of them described as keynote lectures. However, when consideration is given to the fact that there are 10 chief and 27 senior researchers

participating in the Unit, and that this selected list reflects a 5-year time window, by international standards this is a rather limited level of international recognition.

The researchers in this Unit have been awarded a Lithuanian Science Prize from the Lithuanian Academy of Sciences and a young scientist yearly research scholarship from the Lithuanian Academy of Sciences which are significant achievements. The other prizes listed concern primarily young scientists at the national level, but these are important in terms of career development.

On funding awards, 4 European Horizon 2020 projects are listed in which the UoA participated as one of the partners, although the funding total received is rather modest. Nevertheless, for a unit of this size it is a significant achievement for highly competitive H2020 calls and also indicates that on this aspect, these researchers in the Unit are highly valued international collaborators. Moreover, researchers have participated in 2 ESA projects carried out at the centre in addition to a research collaboration funded by the NATO SPS grant funding scheme. They also successfully participate in ERDF and European Social Development funding which represents EU structural funds channelled through the state government SMART programme and these awards are the largest funding grants listed by a considerable amount. This success in funding compares very favourably with the number of chief researchers, and even the FTE of chief + senior researchers.

In summary, the grants won by the Centre in this field suggest that it is strong with a limited international recognition which is constantly improving and provides a firm basis to further develop high levels of international cooperation which will continue to enhance the reputation of the UoA. On the other hand, in terms of assessment of the past 5 year results, the publication and presentation record and the degree of internationalisation, considering the FTE, would indicate that it should not be concluded that the group is strong on the international level.

Group of research fields within the research area	Scope (FTE(SD))	Score (points)
<b>T 001 - Electrical and Electronic Engineering</b>	0,50	2,5

Reasoned justification of the score

The Electrical and Electronic Engineering group at FTMC has conducted R&D activities at a relatively low to moderate level over the past 5 years, given the small number of personnel at the Unit. With just one senior researcher working half-time and two technical workers, it is not clear why this is being assessed separately.

The data shown for 6 PhD students indicates low numbers, however, of greater concern is that the overall trend in the 5-year period is downward with only one international student reported. There are no journals with a particularly high reputation on the list of publications. Nevertheless, the sensor and materials-based publications listed in this section are all in journals with good international standing. In terms of the presentations, for the first three listed, it is difficult to evaluate the significance of these in that no measures of esteem are mentioned, like in the case of the final two presentations. The awards listed are predominately at the national level which is an important part of career development for young researchers, but do not reflect a strong international performance. The R&D listed projects range from modest international funding awards to National Science Programme and European Union funds investment actions.

Of the 5 conference presentations that are listed in a variety of international conferences, it appears that none of them were invited talks, and their nature is not explained (oral or poster). Listed research awards include 3 sizeable grants funded by the Research Council of Lithuania for technology development and 2 grants for Ukraine- Lithuania cooperation, which represent good regional level activity.

In summary, the publication and presentation data presented do not indicate a strong level of R&D activity at the international level with limited international recognition and the decreasing number of PhD students makes the viability of this separate activity area increasingly difficult to justify.

As it stands at present, the Electrical and Electronic Engineering group is not sustainable and this will reflect negatively on the whole UoA. The Panel advises strongly to merge this group with some of the others and stop this separate degree program. On the other hand, it would potentially help the UoA to have a group on the topic of electric and electronic engineering since, in principle, such a group would greatly complement the scientific pallet of R&I activities offered by the FTMC. In the strategy part of the documents there was little information found on this topic, however action is required.

## Economic and social impact of R&D activities of the UoA

Score (points)

4,5

Reasoned justification of the score

The vast majority of the sample projects in this section are applied research in nature and have potential economic impact, however, this has not been realised in most cases as yet in that translating research outcomes, even in highly applied research projects, can take many years to be able to demonstrate economic impact which, for example, can take the form of new product development, international patents resulting from new intellectual property generating income or working with commercialisation experts in the university's or research centre's technology transfer office (TTO). This requires greater engagement with TTO staff to evaluate commercial potential of scientific innovations. What is reported is the important and necessary steps to bring scientific discovery towards a pathway for potential commercial exploitation, but in many instances, the examples given are still on this pathway but are too immature in the technology readiness level context at this stage of development to show demonstrable economic or societal impact which can take 10-15 years beyond discovery. If the state of development is still referring to a research publication as the primary output, it is safe to conclude that the journey to successful commercialisation is a long way off.

Nevertheless, developing translational research expertise in diverse areas such as Adaptive Camouflage, Smart textiles, Stability of perovskite solar cells, Environmental monitoring is an important element in moving towards this pathway. Being instrumental in fostering a Pan-European infrastructure to empower SME's digital competences in laser-based processing is also a measure of international ambition. The EUREKA project aimed at developing the eco-design of casual garments from biodegradable and natural fibres based on the principles of the circular economy has obvious economic potential, as has the air monitoring technologies being developed and the development of an automatic cervical cancer detection system. Obtaining a global patent on a method for generating ultra-short light pulses for a wide range of technological applications is also a commitment to develop income streams from this research excellence.

A wide range of researcher representation on boards is provided, the vast majority of which are at a national level. Nevertheless, this reflects a strong commitment to make a wider contribution to the development of the national scientific ecosystem which is an important part of developing a fit for purpose research system which stands up to international scrutiny.

The listed contribution to public and economic entities, which is essentially a summary of consultation services with both public bodies and industry clients indicates a strong commitment of the researcher

community to contributing to the economic development in partnership with these external stakeholders. Having this expertise within the country is particularly important for SMEs as frequently they don't have the international contact network to source solutions from the university sector in other countries. This became of particular importance around public health concerns during the COVID epidemic where countries had to rely on their own experts for reassurance and guidance around the implemented policies and practices.

The hosting of important international scientific conferences is below what would be expected for a leading research institute of this size, particularly when considering the national prominence of FTMC. In many instances, the listed activities refer to FTMC members on conference organising committees rather than being the conference host. Some entries in the list provided refer to internal Seminars within FTMC and reference is also made to organising a Chess tournament. This probably reflects the continuing evolution of FTMC's international profile which definitely takes time to establish but is an area which could be considered for more proactive engagement as the international reputation of this flagship institute develops.

The contribution of UoA researchers to editorial boards of scientific journals is an indication of the international standing of these individuals and again assists in building an international research community to which Lithuanian researchers can contribute and learn from. Likewise, in relation to representing the UoA in international working groups and associations, where in many instances, the FTMC represented Lithuania's participation in these international bodies. This reflects very positively on the responsibilities assumed by these representatives on the international stage.

The list of most important results of science popularisation activities involves a broad multimedia based approach utilising communication strategies which include public lectures (some in schools), TV, web, radio, and popular science books as methods to inform a wider audience of the importance of scientific research and provide evidence based information for addressing major societal challenges including climate change, security and the importance of scientific innovation in contributing to a modern economy and society. Varied topics including Smart Textiles, the importance of lasers, personalised medicine, biosensors, opening Chinese markets, distinguished women interviews, corona virus masks, the green economy, "What happens in FTMC?", "Why nuclear weapons?" and novel approaches such as - Chemistry in verses and addressing topics like "If no one would do science, we would be stuck with all the problems?" are to be commended.

The list of cooperation agreements between research and economic entities essentially details company engagements on addressing various technical challenges and difficulties and are captured in JOINT ACTIVITY (PARTNERSHIP) AGREEMENTS with the interested parties addressing industrial and environmental issues. Almost all nationally based companies are referred to, but as mentioned above, this is very important in driving innovation in the local economy. However, given the infrastructural resources available to FTMC, and the stated ambition of being a regional leader, a greater focus on international engagements should be initiated both in terms of researcher exchanges with innovation leading institutions and attracting international talent to move to the next level.

## The development potential of R&D activities of the UoA

Score (points)

4

Reasoned justification of the score

The establishment of FTMC in 2010 by merging four research institutes has the potential to maximise the impact of the institute and critical to this success is working to transform the individual research institutes

into an internationally recognised RTO. An indication of the success of this approach was FTMC being among the first organisations from Central and Eastern Europe to be accepted as a full individual member of EARTO. Central to this is the pooling of shared infrastructure to empower young researchers and administrative staff and developing new management structures such as TTO and intellectual property rights offices which assist supporting SMEs' technology uptake.

A comprehensive list of scientific infrastructure is provided for the different Departments that constitute the UoA which greatly assists the researcher base to operate in an increasingly competitive international scientific context. The Strategic Plan 2023-2025 which is well focused on building the research strengths within FTMC appears to be very much about maintaining current levels of activity rather than any planned expansion. The age profile of the FTMC staff had a high proportion below 44 years which is desirable, but had 3 times more men than women, so any plans to address the gender imbalance could be a topic for inclusion in future strategic plans.

Having the ambition to become one of the leading scientific institutions in Northern Europe through concrete measures such as making the research career path more attractive, nurturing the best talent in the field from the region, driving scientific innovation towards economic development with industry, developing new technologies and capture related IP, and acting as a catalyst for entrepreneurship in commercializing scientific advances in deep-tech and start-ups is a strong statement of intent which can directly impact on national economic development.

Alignment of FTMC R&D themes in the international context around the headline EU policies regarding the Sustainable Development Goals, the Green Deal and Circular Economy, the Materials Manifesto 2030, EU Quantum Manifesto, and the Chip Act for Europe again heightens the prospect of international research collaborations and raising the R&D standard nationally enabling the development of the knowledge economy.

Sustainability themes such as circularity of materials, zero pollution targets and climate change challenges are also in line with international research objectives. Responding to the recently passed Chips Act for Europe which is aligned with three long-term programmes at FTMC, the institute has the potential to maximize the prospects of participating in this major funding initiative. Finally, FTMC's success in attracting funding from private patronage, is also important in developing the overall research profile and diversity of income streams.

Policies for the training of the new generation of researchers and the recruitment of new researchers are well thought out, extensive, and follows best practice in this regard, especially for institutes that are not directly part of a university department. Policies related to doctoral students – in particular the policy for them to take part in at least one mission per year – are good and should be effective in giving them a well-rounded entrance into the practicalities of scientific research. A return programme for young researchers is mentioned but no concrete details are given which undermines its potential impact. This is a big problem, since an effective generational replacement strategy is key for longer-term development and is probably the only really potential way to increase the vitality and efficiency of scientific research in the Unit in a long-term sustainable way.

The SWOT analysis identifies some critical threats to the ambitions of the institute to continue to develop and these include, a decrease of EC investments in the country after the completion of financing via Structural Funds, decrease in number of undergraduate and PhD students in Physics and Chemistry, an increasingly competitive international environment for talented researchers and an external threat articulated as a lack of skills and competence in the Ministry of Economy and Innovations. In addition the weaknesses articulated include relatively weak cooperation with local industry, weakly expressed priorities in scientific topics and technological development, limited internal resources to sustain and improve technological infrastructure,

limited internal resources to co-finance international projects, lack of incubator for start-ups and spin-offs, monitoring of intellectual property rights, difficulty in attracting new personnel to the FTMC which has a major non-competitive salary component and difficulty in attracting foreign talent to science and deep-tech start-ups. Many of these are common challenges faced by small economies in Europe, so international discussion about addressing some of these issues can be beneficial and should be considered in a European context.

In general ideas on addressing these challenges are lacking in the Strategic Plan, as are any efforts to address the large gender imbalance. Addressing the international aspect of development in terms of ambition is not clearly articulated in the plan nor is addressing the inevitable drop off in EU Structural Funds which will happen within the next few years and poses a threat to the continued development of the UoA. These challenges need to be addressed to realise the development potential of the FTMC.

### **Recommendations for continuity and/or improvement of the activities of the UoA**

FTMC is a flagship institute of the Lithuanian research system and has both the staffing levels and research infrastructure facilities to enable it to contribute strongly at the international level with similar research centres across Europe. Effective use of Structural Funds has given it the capacity to move to this next stage of development on the international stage. In this regard, the Horizon Europe WIDERA funding calls could be a mechanism to build on these EU investments towards greater international collaborations and competitiveness. In the meeting with the UoA Administration team during the site visit the Director, Prof. Gintaras Valušis, gave a clearly presented overview of the FTMC research activities and articulated the ambition to become the leading scientific institutions in this Northern Europe geographic region which is definitely within the capabilities of the UoA. In order to achieve this potential, a more ambitious Strategic Plan is required which articulates activities enabling development beyond existing levels of activity, particularly on international research collaborations thereby enabling Lithuanian based researchers to contribute to the major research challenges that society faces for continued sustainable development. Some of the leading researchers the Panel met during the laboratory site visits were undertaking translational research activities of the highest standard and clearly demonstrate the wider potential of FTMC in future economic development of the country.

In general ideas on addressing the challenges pointed out in the Unit's SWOT analysis are mostly lacking in the Strategic Plan, as are any efforts to address the large gender imbalance. Addressing the international aspect of development in terms of ambition is not clearly articulated in the plan nor is addressing the inevitable drop off in EU Structural Funds which will happen within the next few years and poses a threat to the continued development of the UoA. These challenges need to be addressed to realise the development potential of the FTMC.

The Panel also advises to merge the Electrical and Electronic Engineering group with some of the others and stop this separate degree program or to put in a major effort to revive this group.

### 3. FINDINGS

#### Overall quality of research

In general, the quality of research in the research fields of panel NT3 is of a good level. The Panel has seen several groups engaged in top-level research of excellent international standing. Equally important, researchers were enthusiastic and proud of their work. The PhD students we spoke with felt very much engaged with their research.

There are, however, also some more critical notes to make. Although some groups perform at a leading international level, there are a great many others who lag behind, where their research lacks international (and even maybe national) recognition. In the perception of the Panel many individuals limited their research work to more service tasks for commercial partners, not taking the opportunity of the important contacts that they have developed with commercial partners to develop true (technological) innovations. Maybe related to this, it was observed that much of the research is more inward-focused, with limited interest (by some groups) to connect to the international scene. Many researchers, including several PhD students, expressed some hesitation to go abroad for periods of several months and longer to build more intense contacts with leading international research groups. This lack of international visibility is reflected in the limited number (per FTE) of publications in top-level international journals, of invited talks at international conferences, and of European excellence grants such as ERC Awards (none reported, but there were a few, be it unsuccessful, applications, which were valued by the Panel). It was very much appreciated by the Panel that some researchers did receive distinguished Humbolt grants and visiting professor positions at foreign universities.

#### Knowledge transfer

The Panel noted that there are rather intense contacts between all Units we evaluated and commercial parties. These will certainly result in strengthening the economic activity in Lithuania, which the Panel considers very important. It was noted that, due to these contacts, the commercial partners have given several scholarships to promising PhD students, which is an excellent motivation. Unfortunately, the drawback of this policy is that after completing their PhD they - most probably - leave academia. While strengthening the industry is important, the research institutes also need a constant inflow of top-level people to be able to support front-end research.

Despite these already strong contacts, the panel felt that these could be intensified further by developing a stronger focus on projects that will result in intellectual property (patents) and creating spin-off companies. It was not clear to what extent these kinds of activities are encouraged by the management.

Another important aspect is outreach to the broader public. There are several groups that are very successful in doing so with appearances on national TV and radio. The Panel learned, however, that the interest of young kids to engage in STEM subjects is decreasing since this is perceived to be hard work and difficult. In the long run, this will be a threat to the sustained economic development of Lithuania and thus an issue that needs attention. This problem is not confined to Lithuania but this does not lessen its importance. In this light, it thus would be good to intensify programs directed towards schools, already at the primary and middle level, to convey the fun of doing science.

#### Infrastructure & management

The Panel was generally very impressed with the excellent infrastructure. There is a large number of state-of-the-art laser facilities and other equipment available, many as shared facilities, thus open for use to all of Lithuanian science, which is important. Most of the buildings are new and well-maintained. The concern felt

by the panel is that such high-level equipment will need a constant flow of investment money for maintenance and upgrades, where the management was sometimes unspecific regarding the sources for this financing.

It was seen by the Panel that the research was not organized along rigid hierarchical lines, which is regarded as a strong stimulus to develop one's own individual creativity, which is extremely important for performing front-end research. While this is true for the more innovative researchers, there will be others who benefit from more guidance through, for example, a mentorship program. It was not clear to the Panel how these different interests are managed in the system in order to increase the efficiency of research groups. Clarifying this in the organizational structure will be helpful.

It was noted by the Panel that most (if not all) Units calculate the remuneration of the researchers taking into account their output. Although such a system may be perceived as harsh by some, it will be able to boost the research output, provided the system involves the right factors. Without knowing the details of the implemented system, the Panel recommends placing special emphasis on lead authors of publications in high-level journals, invited talks at important international conferences, patents, spin-off companies, and personal grants.

#### Recommendations

At the national level, it is important to increase the total number of PhD students. At present, their number (as a fraction of FTE of researchers) falls well (a factor 2 or 3) below international standards. Increasing the number of PhD students is important, in part to keep and improve the level of the national research institutes and universities, and in part to be able to educate enough high-level scientists to sustain and improve the international competitiveness of the industry.

At the same time, it will be important to have remuneration of researchers at a level that makes it attractive to work in Lithuania. In the long run, it will prove impossible to keep top-level technologically oriented commercial activity without having universities and research institutes being able to educate researchers at the same top level.

The Panel got the feeling that the management generally seems focused on keeping the status quo rather than improving research performance. Often, in the self-evaluations risks and threats were correctly identified, however, in the strategy for the future these were addressed at an insufficient level. Some of these may be due to policies set at the national level, but measures may be taken at a lower level to ameliorate some of this.

Any large unit will have some strong and some weaker performing groups. It can be a policy to keep the weaker performing groups to diversify research directions, in which case one probably should implement policies to strengthen these. It may also be a good policy to actively re-direct weaker performing groups to more promising or more suitable areas of research. The panel was missing a clear analysis at this level by the management.



