Research Assessment 2022

Physical and Chemical Sciences
Utrecht University

Debye Institute for Nanomaterials Science

Institute for Marine and Atmospheric Research Utrecht

Institute for Theoretical Physics

Institute for Gravitational and Subatomic Physics

Final version – 31 January 2023

Contents

1. Introduction

1.1 Background

This report presents the assessment of the research conducted at four research institutes at the Faculty of Science of Utrecht University (UU) in the Netherlands in the period 2016-2021:

- Debye Institute for Nanomaterials Science (Debye Institute),
- Institute for Gravitational and Subatomic Physics (GRASP),
- Institute for Marine and Atmospheric Research Utrecht (IMAU),
- Institute for Theoretical Physics (ITP).

These institutes are responsible for all research at the Department of Physics and roughly half of the research at the Department of Chemistry of the UU Faculty of Science. The assessment was performed by an external review committee using the Strategy Evaluation Protocol 2021-2027 (SEP).[1] The primary aim of SEP assessments is to evaluate the research quality, societal relevance, and viability of a research unit considering its own aims and strategy, and to suggest improvements where necessary.

Target groups that are served by this assessment include:

- the researchers and management of the institutes, who need to know how the quality of the research, its societal relevance, and its strategy are perceived by independent experts and how these elements can be improved, with explicit attention to the aspects of Open Science, PhD Policy and Training, Academic Culture, and Human Resources Policy,
- the Boards of UU and the Faculty of Science who wish to track the impact of their research policy,
- the Dutch government that evaluates the outcomes of assessments in connection with the institution's accountability for expenditure and its own efforts to support an outstanding research system,
- society and the private sector that seek to solve a variety of problems using the knowledge that the research of the institutes delivers.

1.2 Members of the assessment committee

The Board of UU has appointed as members of the assessment committee:

- Professor Daan Frenkel, *chair* (University of Cambridge, United Kingdom),
- Professor Ulrike Diebold (TU Wien, Austria),
- Professor Dieter Vollhardt (University of Augsburg, Germany),
- Professor Elias Kiritsis (Université de Paris Cite, France and University of Crete, Greece),
- Professor Astrid Kiendler-Scharr (Research Center Jülich and University Cologne, Germany),

[1] The SEP was drawn up and adopted by the Association of Universities in the Netherlands (VSNU), Royal Netherlands Academy of Arts and Sciences (KNAW), and the Netherlands Organisation for Scientific Research (NWO). All research conducted at the various Dutch universities, University Medical Centres, and NWO or KNAW institutes is assessed once every six years in accordance with the SEP.

- Professor Barbara Erazmus (CNRS/IN2P3 Subatech, France),
- Dr Jessica Steinlechner (Maastricht University, the Netherlands),
- Kevin Venrooij (Radboud University, the Netherlands).

Dr Linda van den Berg (Washoe Life Science Communications, the Netherlands) served as the secretary to the assessment committee. The committee members have declared to have no conflicts of interest. The evaluation and recommendations in this report constitute the committee's consensus. 'Currently' refers to the time of the site visit; 'we' refers to the committee members.

1.3 Procedure

The committee evaluated the research conducted at the institutes based on

- the institutes' self-evaluation report, which described the mission and strategy of the institutes during the evaluation period; reflected on the quality and relevance of the research, the PhD policy and training, the working environment, and personnel policies; and presented SWOT analyses and strategies for 2022-2027,
- a series of interviews during a site visit in November 2022 with the dean, department heads, institute directors, director of the graduate school, and representatives of principal investigators (PIs), early career staff, PhD candidates, and technicians, as well as tours of the facilities. The discussions were transparent and constructive. The site visit programme is listed in Appendix 1.

Personal circumstances prevented one committee member from physically visiting the institutes, but the others were present at UU during the site visit and received a guided tour of several facilities. In addition, the committee met virtually twice prior to the site visit, ensuring that there was sufficient time to prepare for the interviews. We are confident that the hybrid nature of the site visit (i.e., partially online and partially in-person) did not prevent us from receiving a clear view of the research conducted at the institutes and carrying out a solid and careful review.

Assessment criteria

The assessment committee evaluated the research based on three assessment criteria, all considering the institutes' own strategy and aims:

- **Research quality**, i.e., the quality and scientific relevance of the research in an international and national context, including contributions to the body of scientific knowledge and the academic reputation and leadership within the field,
- **Relevance to society**, i.e., impact, public engagement, and uptake of the research in economic, social, cultural, educational, or other terms, including the teaching- research nexus,
- **Viability**, i.e., the extent to which the goals for the coming six-year period remain scientifically and societally relevant; whether the aims, strategy, the foresight of its leadership, and the overall management are optimal to attain these goals; and whether the plans and resources are adequate to implement this strategy; including a reflection on the viability of the institute in relation to the expected developments in the field and society as well as on the wider institutional context of the institute.

The committee was also asked to reflect on a new institute (Institute for Sustainable and Circular Chemistry, ISCC) at UU. This ISCC will have tight collaboration with the Debye Institute because of the

existing connections between the groups of the two institutes. However, the faculty aspires to further integrate ISCC into the physics and chemistry institutes and the faculty as much as feasible. Therefore, they asked the committee to identify any additional synergies with the physics and chemistry institutes or other (for example life sciences) institutes in the Faculty of Science beyond the synergies that were presented in the self-assessment report.

Aspects

In line with the SEP and in relation to the aims and strategy of the institutes, the assessment committee incorporated four specific aspects in the assessment, because these help to shape the quality of the research unit:

- **Open science**
  - involving stakeholders in the preparation and execution of the aims and strategy,
  - opening the work to other researchers and societal stakeholders,
  - way of handling research data, methods, and materials, including reusing data and applying the FAIR Principles,
  - making publications available through open access.
- **PhD policy and training**
  - institutional context of the PhD programme, including position of PhD candidates and PhD training in the research,
  - selection and admission procedures for PhD candidates,
  - program content and structure,
  - supervision of PhD candidates and functioning of the quality assurance system, effectiveness of the Training and Supervision Plans,
  - duration, success rate, exit numbers,
  - guidance of PhD candidates to the job market and career prospects.
- **Academic culture**
  - **openness, (social) safety and inclusivity** of the research environment, reflecting on the culture in terms of appreciating the multiplicity of perspectives and identities in the workplace; measures that are taken to ensure openness, safety, and inclusivity; how responsibility is taken by leaders to contribute to such an academic culture,
  - the policy on **research integrity** and the way the institute facilitates the relevant actions and requirements, reflecting on data integrity; the extent to which an independent and critical pursuit of science is made possible; the degree of attention given to integrity and ethics; the prevailing research culture and mode of interaction; relevant dilemmas (e.g., authorship, ethical considerations regarding privacy or collaborations with stakeholders) that have arisen and how the institute has dealt with them.
- **Human resources (HR) policy**
  - extent to which **diversity** (gender, age, ethnic & cultural background, disciplines) is a concern at present, reflecting on how the institute guarantees diversity-promoting HR practices such as inclusive selection and appraisal procedures and its actions and future plans,
  - policies on **talent** selection and development, i.e., the recruitment policies; opportunities for training and development; coaching and mentoring; career perspectives for researchers and research support staff; selection, training, promotion, and retention policy; the way that the institute offers opportunities for diverse career paths and ensures that researchers are properly evaluated, rewarded, and incentivised.

These aspects are mainly discussed in Chapter 2. We have not written separate paragraphs about Open Science, academic culture, and HR policy in the chapters about the individual institutes because most of the committee's comments on these aspects pertained to all four institutes.

1.4 Research unit under assessment

The assessment concerns four collaborating research institutes at the Faculty of Science of UU:

- the **Debye Institute for Nanomaterials Science** facilitates and promotes fundamental and more applied research in the wide field of nanomaterials science, with a special emphasis on the research lines catalysis, colloids, and nanophotonics,
- the **Institute for Marine and Atmospheric Research Utrecht** (IMAU) performs high quality fundamental climate research and teaching to contribute to solving grand societal challenges related to the global climate crisis, including the training of a new generation of climate scientists with a physics background,
- the **Institute for Theoretical Physics** (ITP) unites theoretical physicists with a research focus that ranges from the vast scale of the cosmos all the way down to the smallest sub-atomic scales of elementary particles, with quantum materials, soft matter, and biophysics all found in between,
- the **Institute for Gravitational and Subatomic Physics** (GRASP) has research lines in the experimental study of high-density strongly interacting matter at CERN and in the study of gravitational waves, aiming to gain understanding of the basic constituents of matter, their interactions and the fundamental properties of space and time.

Each of these institutes is led by a scientific director who is responsible for the research quality assurance and the academic strategy of the institute. The heads of the relevant departments are responsible for personnel, finances, and the coherence between research and education. On average, the permanent staff of the institutes spend 40-50% of their time on research, 30-40% on teaching, and 20% on managerial tasks and committees. Postdocs and PhD students spend approximately 90-100% of their time on research and 0-10% on teaching. The Faculty of Science has an undergraduate School for BSc education and two graduate schools for MSc and PhD education (one in the natural sciences and one in the life sciences).

The institutes are embedded in several campus-wide initiatives, such as the Centre for Complex System Studies (CCSS), the Molecular and Biophysical Life Sciences Bachelor's programme, the Center for Extreme Matter and Emergent Phenomena, and the Science for Sustainability (S4S) platform. The latter was initiated to better connect the fundamental natural sciences within the faculties of Science and Geosciences and the UU Strategic theme 'Pathways to Sustainability'. S4S facilitates transdisciplinary interactions between researchers, lectures, and students from natural sciences who are interested in new technologies, materials, processes, and methods for a more sustainable society. The institutes are also involved in the strategic alliance between UU, Utrecht University Medical Center (UMCU), Wageningen University and Research (WUR), and Technical University Eindhoven (TU/e), which addresses urgent societal challenges related to climate change, health, food, energy, and sustainability.

2. Assessment of the research unit as a whole

2.1 Strategy and aims

During the review period, the following strategic developments took place at the level of the university and the faculty:

- In 2018, the Sector Plan 2.0 was initiated by the Ministry of Education, Culture, and Science, with the aim to strengthen fundamental research and education in the fields of natural and technical sciences by expanding research capacity, attracting, and retaining new research talent, and improving the gender balance. The Departments of Chemistry and Physics received funding from this Sector Plan, enabling them to strategically create six new positions each.
- In line with UU's Strategic Theme 'Pathways to Sustainability' and with trends in science and society, UU has decided to establish a new institute focused on sustainable and circular chemistry with an associated new MSc programme in Sustainable and Circular Chemistry. This Institute for Sustainable and Circular Chemistry (ISCC) will host the Debye research groups focusing on inorganic and organic chemistry and catalysis (see section 3.4).

Each institute has its own strategy and aims, which will be summarized in Chapters 3-6. The committee has one general remark about the strategy and aims of the institutes: it is our impression that the institutes do not seek external (international) advice on important strategic decisions at present, for instance:

- the institutes do not seek international advice in the decision to give tenure to scientists, whereas this is common practice in many countries,
- to our knowledge, no input was sought from any external advisory committee on the decision to split off a part of the Debye Institute research portfolio to form the ISCC,
- external advisers from other institutes are not routinely involved in the annual progress monitoring of the PhD candidates at the institutes.

We recommend seeking international or at least external advice on important strategic decisions.

2.2 Research quality

Overall, the committee is highly impressed by the outstanding quality of the research conducted by the four institutes. The institutes are all strong in their own fields, as evidenced by the examples given in Chapters 3-6. The high number of prizes and competitive research grants acquired during the review period are a mark of esteem. In addition, the scientists of these institutes play leading roles in large international scientific endeavours. They are highly visible, for instance at CERN, the Intergovernmental Panel on Climate Change, Innovative Training Networks, and the Horizon2020 funding programme of the European Commission.

2.3 Societal relevance

During the evaluation period, the strategy of the institutes promoted fundamental research. Such basic research is highly important because modern society and its future survival are built on it. In the long term, the fundamental insights produced by the institutes will be crucial to address the

challenges that society is currently facing and will shape the future development of our society. In addition, the research of the four institutes has resulted in shorter-term societal benefits. Each institute contributes to society in its own way, in line with its strategic aims. For instance, the high-quality PhD graduates that the institutes deliver find jobs in academic institutions, companies, governmental organizations, and non-governmental organizations, disseminating the knowledge and expertise that they acquired during their PhD training in Utrecht. The institutes have also successfully participated in outreach activities during the review period. The general public has a keen interest in basic research that addresses key societal questions, and equally in research that helps to understand the universe - from the very small to the very large. This became clear when Dutch citizens could ask their 'questions to science' as part of the Dutch National Science Agenda endeavour in 2015.

2.4 Viability

The committee is highly optimistic about the viability of the institutes. The mechanisms are in place to safeguard their research quality in the future. Their research foci will continue to be of high scientific and societal relevance in the next six years. In addition, the institutes have a robust scientific and societal strategy for the future. The financial position of the institutes is relatively advantageous because of the recent implementation of the Sector Plan 2.0 and rolling grants, as well as their success in competitive funding schemes such as the Gravitation programme and collaborations with industry. However, we note that major investments tend to have longer-term financial implications in terms of personnel and consumables. Such costs should be made clear up front.

To ensure that the institutes will indeed continue to thrive, we recommend safeguarding support by the grant office, technical support staff, and administrative staff in the future.

- We would like to stress the importance of the support that the institutes receive from the grant office at the Faculty of Science. It is our understanding that the current highly qualified grant officer will retire in the years to come, so we recommend ensuring the timely succession of this person, to guarantee that the key expertise is transferred to the successor.
- The institutes appear to value their technical support staff and to ensure that these persons receive proper recognition. This is highly important because excellent technical support staff is crucial to the research quality, societal impact, and viability of the institutes. (Societal impact because these staff members train students and scientists that disseminate expertise and knowledge to societal stakeholders when they continue their careers outside the institutes.) We recommend continuing the investments in technical support staff in the future.
- The Faculty of Science has plans to provide additional support with project administration; the committee supports this because administrative support is insufficient in some of the institutes.

The committee learned that the demands associated with teaching appear to increase over the years. For instance, staff is required to follow education courses and create plans for their teaching activities. While we agree that teaching is a core task of universities, the increase in the number of mandatory qualifications for different levels of teaching staff appears to be out of proportion with what is required at top universities outside the Netherlands, and we observed no hard evidence

supporting the need for this policy. We recommend critically monitoring the demands associated with teaching.

2.5 Open Science

In line with a long tradition in the sciences, the institutes promote the uptake of their research results by peers and stakeholders by pushing the principles of Open Science. At the level of the university and the faculty, several initiatives have been developed to encourage Open Science practices. The executive board of UU has launched an Open Science programme to motivate and enable UU scientists to implement Open Science into their daily practice. The Open Science Community Utrecht has an active branch in the Faculty of Science and organizes activities such as an annual Open Science symposium and courses for reproducible data practices. In addition, the Faculty of Science has installed an Open Science Team that helps to develop a UU-wide Open Science platform and promotes applying for the UU Open Science grants. The Faculty of Science intends to employ a dedicated support officer to address submission and administration of Open Access publications.

At the level of the institutes, Open Science has also received considerable attention during the review period. For instance, a new course about Open Science practices, open hardware, and reproducibility has been developed in the Experimental Physics MSc programme. In addition, a new course on Open Science entitled 'Talking of future vision' is currently being developed for all three MSc programmes in physics at UU. The 2019 Debye Spring School featured a workshop about Open Science. In 2021, the percentage of open access publications was 84% for the Debye Institute, 90% for IMAU, 95% for the ITP, and 98% for GRASP. Stakeholders are involved in the preparation and execution of the aims and strategies of the institutes when appropriate, e.g., in joint projects with industry at the Debye Institute and in citizen science project with the general public at IMAU. For research data management, there is a UU-wide system called 'Yoda', which enables researchers from UU and their partners to securely deposit, share, publish, and preserve large amounts of research data during all stages of a research project.

2.6 PhD policy and training

The PhD programmes of the four research institutes are embedded in the UU Graduate School of Natural Sciences (GSNS). In addition, many PhD candidates are affiliated with national research schools that provide topical training. PhD candidates typically receive supervision from a PhD supervisor ('promotor') and a daily supervisor ('co-promotor'). The minimum required supervision hours are one hour and four hours per month respectively. The committee noted that the actual supervision time was well above this minimum in most research groups.

Supervisors and PhD candidates create a Teaching & Supervision Agreement at the beginning of the PhD track, describing the scientific content of the project as well as the plan for training, teaching, and self-actualization. Training may consist of courses, seminars, workshops, PhD retreats, summer schools, and conferences. These can be chosen from a range of training possibilities offered by the institutes, the GSNS, UU, or national graduate schools. PhD candidates and supervisors jointly monitor and document the progress in an annual assessment & development interview. The

department of human resources reminds supervisors and PhD candidates of deadlines for these meetings, checks whether the meetings have taken place, and administers the required forms. PhD candidates are offered courses in academic and general skills (minimum of 20 ECTS). The committee learned that soft skill courses for PhD candidates have limited capacity, so we recommend increasing the capacity and frequency of these courses if possible.

The PhD candidates are obliged to engage in teaching for a maximum of 600 hours, usually concentrated within the first three years of the PhD track, under supervision of a staff member, who formally is the examiner or course coordinator. This teaching consists of mixture of activities such as supervising lab courses, seminars, or working groups; (exceptionally) giving a lecture; outreach activities (e.g., open days); and supervising undergraduate projects within the BSc and MSc curriculum. The results of MSc projects may be used by the PhD candidates for their own PhD theses. PhD candidates and postdocs with an interest in teaching are offered the opportunity to apply for a position as 'Super Teaching Assistant', who coordinates, leads, and further develops the tutorials of two courses for the BSc and MSc Physics programmes.

In general, the committee appreciates the Dutch system of training and supervision of PhD candidates. Monitoring the progress of PhD candidates has improved since the last evaluation in 2017. We recommend that the annual progress monitoring of the PhD candidates, and in particular the crucial go-no go decision at the end of the first year, should involve at least one independent advisor. This independent advisor could be attracted from another group at the same institute, another institute, or possibly (but this is more complicated) from another university. In any case, there should not be a relation between the main supervisor and the independent advisor that would result in a conflict of interests. We also stress the importance of using the annual assessment & development interviews to set and monitor a clear time path for the completion of the PhD project. Such a procedure should help minimize the (already small) number of cases where the PhD project takes more than five years. The minimal requirements for admission to the PhD defence should be communicated early and clearly by the supervisors. Within-institute compatibility of the requirements is recommended. Requirements in terms of the necessary number of publications should not be made overly rigid, as the success of ambitious research projects should be primarily reflected in the quality, rather than quantity of the output. These requirements should be clearly communicated to all staff and PhD candidates, to prevent any confusion.

2.7 Academic culture

In general, we observed an open and supportive atmosphere during the site visit. We learnt that office space is limited at some of the institutes and that working from home part-time is seen as a potential solution to this problem. We strongly advise against this because working from home hampers the emergence of novel collaborative research.

In 2019, the Dutch universities have drawn up a statement on social safety, committing to providing a safe environment of collegiality, integrity, equality, respect, openness, and attention to each other. Specific regulations have been established in various codes of conduct. UU has developed guidelines how to act upon encountering inappropriate behaviour. The Faculty of Science recently developed a

mandatory course on research integrity issues for PhD candidates. Three types of confidential advisors are available to the employees and students of the four institutes:

- a 'UU confidential advisor for inappropriate behaviour' available for all students, PhD candidates, and employees,
- a 'UU confidential advisor research integrity' who can be contacted by students, PhD candidates, and employees with questions or complaints about research integrity, including suspicion or observation of an injustice (violation of integrity) and scientific misconduct,
- a dedicated 'PhD confidential advisor', who can be contacted by PhD candidates at the Faculty of Science in case they encounter issues with their development or supervisor (since 2021).

The institutes are highly aware of the importance of physical safety (in particular in laboratory spaces), social safety, and research integrity. There is a 'red button system' including a mailbox where anonymous complaints can be reported. We are impressed that UU is actively trying to create a safe environment, for instance through posters with contact info in toilets at the Debye Institute. We support wider implementation of this policy, provided that the posters target all potentially vulnerable groups. Prior to the site visit, the committee has requested to receive an anonymized briefing by one of the confidential advisors, focusing exclusively on statistical information.
As this request was not granted, we cannot judge whether the red button system is working in practice. We urge the university to reflect on the optimal balance between confidentiality and transparency, the more so as serious issues in other universities were not identified by review panels such as ours. The ongoing trend towards a flatter organization structure may also help to prevent potential issues with inappropriate behaviour. We recommend engaging PhD candidates and support staff (i.e., different stakeholders) in formulating questions for the anonymised surveys about social safety.

2.8 Human resources Policy

Diversity
The Faculty of Science has tried to improve the gender diversity of its scientific staff during the review period. For instance, at least half of the positions created by the recent Sector Plan 2.0 had to be filled by female scientists. In addition, the faculty has installed an equality, diversity, and inclusion committee, which has implemented programmes such as the tenure track Westerdijk fellowship for talented female researchers. Members of recruitment committees can follow a training on unconscious (gender) bias and at least one of the members of these committees is female. The committee likes the 'returning carers' opportunities at the Faculty of Science. For instance, women may take a 'research sabbatical' after a pregnancy leave. They may use this to receive a temporary exemption from their teaching duties, or to hire a postdoc to catch up with scientific work. We are reluctant to propose specific policies but advise the Faculty of Science to reflect on additional measures to consolidate the family-friendliness of the workplace and to keep in mind that family-friendliness concerns both mothers *and fathers*.

The institutes are sufficiently aware of the importance of gender balance and have actively tried to increase the percentage of female staff members during the review period. The gender balance at the institutes is excellent compared to similar institutes in other countries. The committee agrees

that it is important to compensate for the historical gender imbalance. However, there are many other underrepresented groups. The committee acknowledges that the institutes are aware of the importance of these aspects of diversity. We encourage both the faculty and the individual institutes to continue striving for a balanced representation of minorities among their staff, while keeping in mind that a firm commitment to redress existing balances is more important than the imposition of mandatory quota, at least when these are unrealistic in view of the composition of the 'recruitment pool'. We also recommend liaising with the university to develop plans for dedicated housing for foreign PhD candidates and postdocs if possible because it has been brought to our attention that young foreign scientists have difficulties in finding housing in the area.

Striving for equal representation of both genders in committees and other commissions of trust may lead to work overload of female staff members. Therefore, the Department of Chemistry has developed a strategy to ensure 'meaningful representation' of female staff members. In consultation with the female staff members, they have selected the most important committees where female representation is crucial (i.e., the hiring committee and the departmental promotion committee). The committee thinks that this is exemplary. The Department of Physics does not have a similar strategy, so we recommend developing something similar in consultation with female staff members. This is important in fields where women are underrepresented.

Talent management

UU and the Faculty of Science offer a variety of trainings to staff members, including for instance a two-day training in management for future leaders. Staff members and their superiors engage in annual assessment and development interviews to monitor progress. The committee was surprised to discover that the institutes do not seek international advice about the decision to give tenure to scientists. It is common practice to do this in many countries, for instance by asking for letters from independent peers. Expert opinions are highly suitable to evaluate the performance of tenure trackers, especially given the recent developments in science that encourage science evaluations based on qualitative rather than only quantitative measures. Therefore, we recommend involving external international advice in the decision on tenure.

In September 2022, UU implemented the TRIPLE model (Team Spirit, Research, Impact, Leadership, Professional practice, and Education) to evaluate the performance of staff members. This model is the local implementation of the Dutch Recognition and rewards programme.[2] TRIPLE and Recognition and Rewards are in line with the DORA principles and support – amongst other things- moving from using quantitative parameters (e.g., H-indices) to more qualitative indicators to evaluate the performance of researchers. According to senior staff members that the committee interviewed, TRIPLE formalizes developments that were already ongoing. Some senior staff members feel that TRIPLE is in line with modern developments (i.e., 'it removes an outdated system'). For instance, ERC applicants are asked to mention their top 10 papers along with an explanation why these papers

[2] The Recognition and rewards programme (R&R) advocates a modernisation of the system of recognition and rewards at Dutch universities. This should improve the quality of the key areas education, research, impact, leadership, and (for UMCs) patient care. The programme has been developed in cooperation with all universities, UMCs, reputable research institutes, and research funders. TRIPLE (Team Spirit, Research, Impact, Professional practice, Leadership, and Education) is the local implementation of R&R. Rather than expecting excellence in all domains, the TRIPLE model stimulates diversity in profiles and career paths. The implementation of TRIPLE for assistant and associate professors started in September 2022.

stand out rather than providing quantitative measures of success. However, mixed feelings were expressed in the interview session with early career staff. These young scientists may feel confused and uncertain what is expected from them and how they will be assessed. We recommend clearly communicating what will be expected from junior staff and how they will be evaluated. In general, the committee subscribes to the idea that the evaluation of academic achievements should be based on both qualitative and quantitative measures. However, it is highly important that the evaluation must be based on familiarity with the field. Therefore, we repeat the importance of involving international experts in important decisions, as was already mentioned above. In fact, the committee noticed that the TRIPLE documents mention peer evaluation as an example of evidence on past performance, which supports this committee recommendation.

As a last remark about junior staff, we were told by the representatives of one of the institutes that the junior staff had received variable start-up packages, ranging from nothing to a PhD student or a postdoc. A more egalitarian start-up package may be appropriate, although we acknowledge that start-up packages depend on the funding source for the position of the new staff member.

Nurturing postdocs is as important for the reputation of a modern institute as the training PhD students. We recommend devoting attention to training, supervision, and career perspectives of postdocs at the four institutes, for instance by

- ensuring that postdocs are sufficiently prepared for the next steps in their careers, e.g., by providing training in grant writing,
- clearly indicating the teaching opportunities for postdocs that are interested in this,
- liaising with the university to develop plans for dedicated housing for foreign PhD candidates and postdocs if possible.

2.9 Synergies with ISCC

The Faculty of Science aspires to integrate the new ISCC into its institutes as much as feasible. Therefore, the committee was asked to identify any additional synergies with the institutes at the Faculty of Science beyond the synergies that were presented in the self-assessment report. IMAU naturally has a strong link to the ISCC. For instance, the research on micro-plastics in the atmosphere and the research on plastic removal in the Galapagos Islands (case study #2 in self-assessment) have clear implications for the Circular Chemistry research. We encourage further strengthening of the link between IMAU and the ISCC, as the development and system-wide implementation of new technologies should be accompanied by assessment of environmental and climate implications. For example, the (unintended) emission of short-lived climate forcers and implications for atmospheric composition are examples of study areas that link IMAU to the ISCC. The case for a stronger IMAU-ISCC link is also summarised in specific recommendations in sections 4.4 and 7.2.

The UU Centre for Complex System Studies is an obvious partner as well. This centre stimulates and facilitates interdisciplinary complexity research and organizes education in this field. At present, researchers of the Debye Institute, IMAU, and the ITP are already actively involved in the CCSS. The ISCC could also reach out to other faculties at UU. For instance, the UU School of Economics at the Faculty of Law, Economics and Governance may be an interesting partner. Exploring synergies with the KNAW-NWO Dutch Climate Research Initiative could also be worthwhile.

3. Assessment Debye Institute for Nanomaterials Science

Debye Institute for Nanomaterials Science

Scientific director: Professor Marjolein Dijkstra (2015-2017), Professor Daniel Vanmaekelbergh (2018-2021), Professor Allard Mosk (2021-present)

Mission: to facilitate and promote fundamental and more applied research in the wide field of nanomaterials science, with a special emphasis on the research lines Catalysis, Colloids, and Nanophotonics ('Nanomaterials for Sustainability')

Department: Chemistry and Physics

Research groups:
1. Inorganic Chemistry and Catalysis,
2. Organic Chemistry and Catalysis,
3. Materials Chemistry and Catalysis,
4. Condensed Matter and Interfaces,
5. Physical and Colloid Chemistry,
6. Nanophotonics,
7. Soft Condensed Matter and Biophysics.

Research staff in 2021: 40 scientific staff; 172 postdocs & PhD candidates (Table 1 in Appendix 2)

Total funding in 2021: 17.7 M € (Table 2 in Appendix 2)

3.1 Summary of Debye strategy & aims

Strategy in 2016-2021
According to the self-assessment report, the strategy of the Debye Institute to achieve its mission encompassed three aspects during the review period:

- attracting and fostering research talent for carrying out research at the highest level in the field of nanomaterials science, and applying the knowledge generated for achieving a more sustainable society,
- providing a stimulating environment that enables synergy between the research lines as well as collaborations between disciplines, in particular chemistry and physics, to optimise research, education, dissemination, societal value, and outreach,
- providing an optimal and state-of-the-art research infrastructure to achieve the scientific objectives.

The Debye Institute has strategically hired new staff during the review period and several strategic reorganizations took place. In 2021, the Inorganic Chemistry and Catalysis (ICC) group was split into two new groups to gain more focus in research and efficiency in management. In addition, UU has decided to establish a new institute focused on sustainable and circular chemistry, the ISCC (see Chapter 2). This new institute will initially consist of the present research groups Inorganic Chemistry

and Catalysis (ICC) and Organic Chemistry and Catalysis (OCC). The ISCC plans to put a broad range of expertise in the field of chemistry at the service of a more sustainable, circular society. Several staff members will be affiliated with both institutes and the management of the institutes will be in close contact.

Future strategy for the Debye Institute
In the next six years, the Debye institute intends to maximise the opportunities for high-quality research by providing a stimulating, open and healthy work and learning environment, as well as state-of-the-art infrastructure. The Debye research results will add to the fundamental understanding of the materials that enable the energy transition, thus contributing to the societal relevance and viability of the research activities of the institute itself and its collaborators.

3.2 Debye research quality

The committee rates the research quality of the Debye Institute as outstanding. It is a world-class institute with impressive output and highly recognized scientists. With only 40 scientific staff members, they managed to acquire 20 competitive research grants during the review period, including ERC grants and prestigious grants of the Dutch Research Council. In collaboration with the ITP, they acquired a 21.5 M€ Gravitation programme grant for a national programme on quantum materials for energy efficient IT. In addition, many prizes and leadership/board positions were awarded to the scientists of the institute.

The institute successfully covers a very broad range of research topics, and it performs well on all. Debye scientists have published 1073 refereed articles during the review period. Many of these papers are well-cited, with 4% of the publications in the top 1% of most-cited articles in the field and 27% in the top 10%. To support its contribution to the body of scientific knowledge in the field of nanomaterials science, the institute strives to publish its scientific papers with open access (84% in 2021). The institute also strives to open up its research data, although there may be IP issues in some projects.

The Debye Institute pursues a welcoming research environment through organizing institute-wide activities, enhancing collaborations, and supporting new staff. For instance, the institute has recently created the ‘Young Debye network’ for its assistant professors. In addition, a buddy system has been implemented where more senior members help new staff members to get to know the organization. The committee appreciates this initiative. Debye research is highly interdisciplinary, bridging chemistry, physics, and materials science. The institute’s ‘make - measure - model’ approach (i.e., synthesis, study of structure/performance/ properties, and modelling of nanomaterials and nanoscale processes) requires synthetic chemists, physical chemists, and theoreticians to join forces. The scientists are very collaborative and optimally take advantage of the opportunities for interdisciplinary research that the institute offers. Importantly, this collaborative spirit is also internalized by the PhD candidates and postdocs. For instance, the committee was told that PhD candidates and postdocs can easily find a peer in another group who knows equipment if they need characterization. As a result, the Debye Institute occupies a very special spot in the scientific world where the interplay between disciplines works out very well.

3.3 Debye societal relevance

In line with the institute's strategy to perform both applied and fundamental research, Debye scientists have conducted research with immediate as well as long-term impact during the review period. The Debye Institute is one of the leading institutes in Europe working on catalysis towards energy conversion, which is important for the energy transition. The institute is also leading in the field of colloid and particle nanoscience, and quantum materials, through which it will have societal impact in the longer term. A significant fraction of Debye research is dedicated to make society more sustainable and most research topics fit into the sustainability theme, e.g., short-term energy storage, more efficient catalysts for energy conversion). However, we fully support the view of the institute that not all research groups need to fit into the UU Strategic Theme Pathways to Sustainability. Exploratory research is also essential for the viability of the institute.

The Debye Institute considers the training of experts in nanomaterials science as its most important contribution to society. On average, 30 PhD candidates and 50 MSc students that were trained at the Debye Institute graduate each year. The training that they receive at the institute prepares them for positions in companies, academic institutions, governmental organizations, and national laboratories. The institute's relationships with industrial partners facilitates career paths in this direction for the students.

The Debye Institute has initiated great outreach activities during the review period, such as science murals in the city of Utrecht and the award-winning 'Klimaat Helpdesk'. Debye research is regularly featured in national newspapers, magazines and journals aimed at interested professionals and members of the public, as well as national television and radio. The institute also has a very direct impact on economic growth through close collaboration with companies in consortia. The institute is involved in joint projects with chemical industry, thereby focusing on the forward-looking branch that focuses on sustainable solutions that will drive the energy transition. These projects thus contribute to the societal impact of the institute and are to be applauded. We noticed that the institute is keenly aware that public-private collaborations should focus on sustainable solutions. To avoid reputational damage, this focus should be clearly communicated.

3.4 Debye viability

With its state-of-the-art research infrastructure, its highly collaborative atmosphere, and its ability to attract a large amount of research funding, the Debye Institute appears well-equipped to attain its goals for the future. Moreover, the Debye scientists operate in a research area with ample future funding opportunities. The new Electron Microscopy Centre is world-class, harbouring an impressive range of high-quality equipment. Establishing this centre was a substantial investment, but the committee is convinced that this will bring ample scientific fruit in the future. Several topics will require attention to ensure that the institute will indeed be able to thrive in the future: (i) the housing situation of the research groups, (ii) the group structure, (iii) the human resources policy, and (iv) the split-off of the ISCC.

Housing situation

There is a general shortage of floor space at the Debye Institute. As a result, there is pressure on office space, and it is difficult for the scientists to find places to meet. The committee learnt that working from home (part-time) is seen as a potential solution to the shortage of floor space. We strongly advise against this because working from home hampers the emergence of novel collaborative research. In addition, there are plans to create open office spaces. We advise against creating too many open office spaces because quiet space is crucial in a world where video meetings have become common.

The research groups of the Debye Institute are currently distributed over several buildings. This is disadvantageous because collaboration constitutes the core of the institute's approach. We acknowledge that the institute has managed to collaborate despite its distributed housing situation, but we strongly advocate for housing in one building to optimally facilitate collaboration. The institute 'lives' the collaborative atmosphere between different, yet well-defined research groups. This is essential for its success.

Some of the buildings are severely outdated and will soon require renovation. The university board has decided to restructure the Kruyt building, which is now planned to house the entire Debye Institute, as well as the fine-mechanical instrumentation facility, GRASP, and the Department of Biology. The exact housing plans (e.g., quantity and quality of lab and office space) appear to be in a state of flux, creating uncertainty among the personnel of the institute. Rehousing will take a considerable amount of time and will be associated with many challenges. Moving groups multiple times should be minimized because this is detrimental to the research, especially for the experimental groups. We recommend ensuring that the research groups will only need to move once, with a clear timetable. The scientists need certainty. Ideally, the whole institute should be housed in one building, and office spaces should be fit for purpose, in the sense that they should allow for frequent in-person interactions and video calls, without disturbing others.

Group structure

Some research groups within the Debye Institute are very large. This may be beneficial if the research is very method/instrumentation intensive. Many different methods are typically required to fabricate, characterize, or test nanomaterials. This can only be achieved by a large group that harbours a range of methodological expertise. However, large group sizes also come with challenges. For instance, it is difficult for group leaders to stay in frequent contact with the PhD candidates in large groups. The supervision of PhD candidates is then often delegated to early career scientists, who thus perform extra work, perhaps without receiving proper credits. In addition, it may be more difficult for early career scientists to be visible in large groups. We were pleased to learn that the Debye Institute aims to foster the scientific independence of junior staff, because such independence is a requirement for example when applying for European research funding. Yet, some large research groups at the Debye Institute have a rather hierarchical structure. We acknowledge that the large size of these research groups reflects their success in attracting funding. Clearly, this success should be celebrated, but it puts a special responsibility on these groups to ensure that younger staff members are also given the kind of responsibilities that they will later need as independent group leaders.

Human resources

During the review period, the Debye Institute recruited 12 new scientific staff members. This has rejuvenated the staff, broadened the knowledge base, and improved the staff diversity. We applaud that the number of staff recruited externally is increasing because this is evidence of the institute's excellent international reputation. The institute is clearly aware of the importance of diversity and the percentage of women is increasing among new recruits and young scientists. The institute also recognizes that it needs female leaders. The committee acknowledges that it takes time to change the gender balance. The targets for the female-to-male ratio should be ambitious yet realistic, reflecting at least the composition of the available pool of students. As discussed in section 2.8, the Department of Chemistry has a good strategy to protect female staff members from work overload ('meaningful representation'). Skilled technical support staff is also highly important for the Debye Institute. We recommend ensuring that there are career opportunities for high-level technicians in the institute and we recommend providing the necessary training.

Split-off of the ISCC

Establishing the ISCC is a strategic move that makes this work visible enough to attract funding and students. The committee was surprised that the decision to split off a part of the Debye Institute research portfolio was made shortly before this assessment and that no input on this decision was sought from this committee or (to our knowledge) any other advisory committee. This supports the committee's impression that the institutes tend to be hesitant to seek international advice on important strategic decisions, as was discussed in section 2.1. Initially, the committee was concerned that the split-off of the ISCC might affect the viability of the remainder of the Debye Institute. However, during the interviews, no major concerns of this nature were expressed. We recommend ensuring that the synergy between the ISCC and the rest of the Debye Institute will be retained.

3.5 Debye PhD policy and training

The Debye PhD candidates are enrolled in the GSNS. In addition, they regularly participate in activities organized by the Dutch Institute for Research on Catalysis, which is a national graduate school. The Debye Institute organizes a variety of training activities for its PhD candidates, e.g., an annual three-day PhD workshop, biannual Spring School, biannual DO! Days, and regular Debye Colloquia and Lunch Lectures. A PhD Committee with representation from each group advocates the interests of the PhD candidates and postdocs at the Debye Institute. The PhD committee contributes to the collaborative atmosphere at the institute by promoting interaction between PhD candidates at different research groups. Indeed, the committee met enthusiastic PhD candidates and postdocs that confirmed the collaborative spirit at the institute. The members of the PhD committee regularly meet with Debye board members to discuss issues that concern the Debye PhD candidates, formally or informally. We recommend facilitating a direct representation of the PhD candidates in the board of the institute.

The strength of the Debye PhD training programme is reflected in the high number of MSc students who seek a PhD position within the institute and the large number of applicants who respond if a new PhD position is advertised. In addition, most PhD graduates of the Debye Institute rapidly find a next position, often already before their PhD contract ends. The Debye Institute does not appear to experience problems with PhD duration and success rates. The committee learned that Debye PhD

candidates are expected to publish or submit three to four first-author papers during their PhD track. Such a criterion, when applied rigidly, may clash with the overall move towards recognition and reward based on a broader range of indicators of scientific excellence. We recommend broadening the range of criteria that are used to quantify the progress and success of PhD projects. The general remarks about supervision of PhD candidates that were discussed in section 2.6 apply particularly to the Debye Institute because there are several large research groups at this institute.

4. Assessment Institute for Marine and Atmospheric Research Utrecht

Institute for Marine and Atmospheric Research Utrecht (IMAU)

Scientific director: Professor Michiel van den Broeke (2016-present)

Mission: to perform high quality fundamental climate research and teaching to contribute to solving grand societal challenges related to the global climate crisis, including the training of a new generation of climate scientists with a physics background.

Research themes:
1. Atmospheric Dynamics,
2. Atmospheric Physics and Chemistry,
3. Coastal and Shelf Sea Dynamics,
4. Oceans and Climate,
5. Ice and Climate.

Methodological topics:
1. In situ observations,
2. Satellite remote sensing,
3. Earth system models,
4. Complex systems science.

Department: Department of Physics of Faculty of Science (= focus of this assessment), Department of Physical Geography of Faculty of Geosciences

Research staff in 2021: 19 scientific staff; 53 postdocs & PhD candidates (Table 3 in Appendix 2)

Total funding in 2021: 6 M € (Table 4 in Appendix 2)

4.1 IMAU strategy & aims

In the self-assessment report, IMAU formulated the following main strategic research aims for the review period:

- to cover an important part of the breadth of the climate system,
- yet maintain sufficient focus to excel in the selected research areas,
- by delivering high-quality, high impact scientific results,
- that are relevant to society through public engagement and policymaking,
- including the training of a new generation of climate scientists with a physics background.

To achieve these aims, IMAU has organized its research into the five thematic and four methodological topics that are listed in the box above, and has worked on its embedding in local, national, and international networks.

Future strategy for IMAU

During the site visit, IMAU presented the following strategic aims for the period 2022-2027:

- Scientific impact: developing processes for projections and increasing the staff size (i.e., the scientific and societal impact of IMAU's research is likely to grow; staff size may become a limiting factor, so the institute aims to address this),
- Societal relevance: co-creating with stakeholders,
- Open Science: Data management plan, thesis projects, course,
- Working environment: improving diversity and PhD success rate; implementing TRIPLE.

4.2 IMAU research quality

The committee is impressed by the excellent achievements of IMAU. The strength of the institute builds on its basic research expertise, as well as the strong and unique emphasis on interfaces of climate compartments in its research focus. Being an inter-faculty institute, the reviewed part has strong collaborations with the Faculty of Geosciences. There are several advantages of the set-up in two faculties. Collaboration is organized along methods, with strong interactions (e.g., mutual supervision of students).

International recognition of the scientific excellence at IMAU is evident. For instance, IMAU researchers have leading roles in project steering committees, research programmes, networks (e.g., IPCC, SCOR, WCRP, EGU Cryosphere division president), model intercomparison projects (MIPs), and Marie Curie Training Networks (ITN). The research output of IMAU is impressive, as for instance evidenced by the large number of high impact publications (6% of peer reviewed papers in journals like Nature, Science, PNAS). The high citation numbers of IMAU publications puts IMAU research in the world leading category, with 8% of the publications in the top 1% of most cited articles in the field and 35% in the top 10%. In addition, IMAU researchers are very successful in acquiring personal grants and are recognized through awards, for instance for their role in the Kigali Amendment to the Montreal Protocol, or for their public engagement activities.

To support the outstanding research quality, there is a good atmosphere at IMAU, as evidenced by happy PhD candidates and a very high overall job satisfaction. Its open-door policy is effective. The institute dealt remarkably well with the COVID-19 pandemic. For instance, there was a 'plan B' for expeditions. To increase its impact on the fields of marine and atmospheric research, IMAU has a strong culture of FAIR and Open Science. Publications are open access where possible: 90% of IMAU publications were open access in 2021. Software is made freely accessible, and tools provided are widely used in the scientific community (e.g., Oceanparcel.org code led to >60 peer-reviewed publications). It is common practice to create research data management plans at the start of IMAU research projects. Limited data storage capacity can be a bottleneck in opening up IMAU data because the institute works with very large volumes of data. We recommend ensuring sufficient storage and data science expertise & support to build and maintain the large datasets that are generated in earth system models.

4.3 IMAU societal relevance

IMAU has a strong focus on societal impact, complemented with highly relevant basic research. Climate research obviously is of the highest societal and policy relevance at present. Therefore, knowledge transfer of climate research results is one of the key impacts achieved by IMAU. The

research has provided concerted input into assessment reports such as the 2019 IPCC Special Report on Oceans and the Cryosphere in a Changing Climate, and the Working Groups I and II of Assessment Report 6 with lead and contributing authorship of IMAU researchers. One example of IMAU research with very high societal relevance are the studies of methane leaks in cities. These studies are extremely timely and provide input for decision makers to reduce methane emissions as part of the European Green Deal. A second example is IMAU's work on optimizing plastic removal on the Galapagos Islands to help mitigate the growing problem of plastic pollution in the oceans of the world. This work has resulted in predictive technology for decision makers to focus clean-up efforts. These examples build on the high scientific expertise of IMAU, for instance to develop instrumentation and methods to quantify nano- and microplastics in environmental samples or isotopic composition of methane facilitating source attribution.

IMAU collaborates closely with (semi) governmental stakeholders as well as companies to ensure that its research results are taken up by relevant stakeholders. IMAU researchers are very active in public outreach activities through public lectures, media contacts, and professional products for public outreach. Examples include the TippingPointAhead.nl website for high school students, the Weather Challenge movie series, the Weather Man podcast series, and the award-winning KlimaatHelpdesk.org portal.

4.4 IMAU viability

Climate research with an emphasis on fundamental studies of the climate system as such is indispensable for the development of actionable knowledge. IMAU is performing great research in this field and the institute's strategy for 2022-2027 puts it in a great position for the future as well. The combination of (in situ) observation (e.g., Ruisdael Observatory), inverse and Earth system modelling, and satellite remote sensing are a particular stronghold for climate system research. Climate research will remain high on the international research and policy agendas in the years to come and there will likely be a wide range of funding opportunities for IMAU research. Taken together, the committee is convinced that IMAU is well-equipped to meet its scientific and societal goals in the years to come.

A long-term national strategy to fund basic climate research is long overdue. The fundamental research conducted at IMAU could complement and strengthen the activities of the KNAW-NWO Dutch Climate Research Initiative (KIN). Basic data is crucial for such an institute. For instance, the source of methane is unclear yet crucial for understanding climate change. The ability to measure for instance the isotopic composition of gases in the atmosphere and derive process level understanding is vital in basic climate research. IMAU is well-positioned to deliver such basic data, ensuring that the opportunities and benefits of the new KNAW-NWO Dutch Climate Research Initiative are fully shaped and the entire climate research community can act in concert.

IMAU is an active partner in the CCSS. This UU-wide centre stimulates and facilitates interdisciplinary complexity research and organizes education in this field. The CCSS offers a great opportunity to further strengthen IMAU's basic research. It reaches out to other domains to provide methods and complex systems expertise. In addition, the CCSS is a good basis for enhancing and applying machine-learning developments within IMAU.

We have several recommendations that may help to ensure that IMAU will continue to thrive in the future:

- Continue and sustain funding for equipment and (technical) personnel as well as data specialists and data storage to ensure long term perspective.
- Explore further opportunities to collaborate with local institutes such as the Debye Institute and the new ISCC (see section 2.9).
- For obvious reasons, IMAU's research attracts much societal attention, and this implies that IMAU contributes much to university-wide initiatives in outreach and knowledge transfer. It is important that the IMAU researchers retain enough time and resources for basic research.

4.5 IMAU PhD policy and training

The IMAU PhD programme is embedded in the GSNS. Training and supervision of the PhD candidates is carried out at the levels of the research group (for research), institute (for training), and department (for teaching). IMAU PhD candidates are typically also enrolled the Buys Ballot Research School for Fundamental Processes in the Climate System, which is coordinated by IMAU.

IMAU has a relatively high PhD dropout rate compared to the other institutes under review. This was already the case during the previous (2017) evaluation. The institute has tried to address this problem with several measures, for instance a go/no go decision after the first year. Despite these efforts, still too many IMAU PhD candidates discontinue their PhD track. Although the drop-out rate is below the national average, the institute takes this problem seriously and recognizes the need to strengthen the PhD programme and ensure a further reduction of the PhD dropout rate. We have several recommendations to help achieve this objective:

- Complement the recently implemented measures with a detailed plan for the final year to ensure that PhD theses are finished.
- Organize a mandatory annual meeting with an external supervisor (i.e., affiliated with another institute).

5. Assessment Institute for Theoretical Physics

Institute for Theoretical Physics (ITP)

Scientific director: Professor Stefan Vandoren (2012-2018), Professor René van Roij (2018-present)

Mission: to make major contributions to the understanding of the physical world around us by making use of a large variety of concepts and methods in mathematical language and models.

Research themes:

1. String theory, cosmology, and elementary particles, and (since 2019) gravitational waves,
2. Quantum matter, soft matter, and biophysics.

Department: Physics

Research staff in 2021: 15 scientific staff; 39 postdocs & PhD candidates (Table 5 in Appendix 2)

Total funding in 2021: 3.6 M € (Table 6 in Appendix 2)

5.1 ITP strategy & aims

Strategy in 2016-2021

In the self-assessment report, the ITP presented the following strategic aims for the review period:

- being a well-funded top research institute that coherently covers a broad spectrum of outstanding research within an extremely competitive international environment,
- training young researchers with a broad range of skills that are pertinent for life and profession inside and out of academia,
- educating excellent students within the MSc programme Theoretical Physics with good prospects on the job market inside and out of academia,
- reaching out and transferring knowledge to society where possible.

Future strategy

The strategic aims of the ITP will largely remain unchanged in the period 2022-2027. The actions to improve staff diversity will be continued. The institute has already taken measures to address the workload associated with the large increase of students in the MSc programme Theoretical Physics. At the site visit, the institute presented the following aims for the future:

- restoring the informal atmosphere and social cohesion that was naturally present before the COVID-19 pandemic, by organizing a variety of social activities such as a monthly welcome event for new ITP-arrivals and a festive event to mark and celebrate all ‘corona-PhD’s’,
- enabling new staff to blossom and equilibrate,
- increasing the number of PhD positions.

5.2 ITP research quality

The ITP continues to be an excellent, internationally visible institute, where the two broad directions of fundamental research (string theory, cosmology, and particle physics on the one hand, and quantum matter, soft matter, and biophysics on the other) thrive and collaborate in an exemplary way. The institute has strategically invested in the sub-fields of gravitational waves and biophysics, which was enabled by funding by the Sector Plan 2.0. The strength of the ITP is clearly demonstrated by an impressive number of personal grants and the involvement and leadership in FOM/NWO programmes, as well as by a substantial increase (almost by 100%) of the number of students in the Theoretical Physics MSc programme during the evaluation period. They also acquired a 21.5 M€ Gravitation programme grant for a ten-year national programme on quantum materials for energy efficient IT, jointly coordinated by the Debye Institute and the ITP. The ITP scientists have published 600 refereed articles during the review period. Around 6% of their publications are in the top 1% of most-cited articles in the field and 25% in the top 10%.

To promote excellent science, the ITP has actively strived to foster a diverse and inclusive environment that cherishes and fosters talents regardless their gender, cultural background, age, sexual orientation, race, etcetera, such that all feel safe to engage in open discussions and pose critical questions. The ITP has actively increased the percentage of non-male scientists within the institute, as well as among invited colloquium speakers. It has installed an internal equality-diversity-inclusiveness council in 2019 to improve its overall diversity. The institute is keenly aware of the importance of social safety, as evidenced for instance by the presence of virtual and physical mailboxes where ideas for improvements, complaints, and problems can be posted anonymously by anybody within the ITP. The atmosphere in the institute has benefited from the return of face-to-face contacts: the ‘buzz’ is back. The institute has also embraced the newly developed UU Open Science agenda, many aspects of which have long been common practice at the ITP. In 2021, the percentage of open access publications was 95% for the ITP.

5.3 ITP societal relevance

The ITP is a fierce advocate of fundamental research, arguing that such research

- produces skilled professionals that are highly demanded by society,
- addresses age-old questions about the cosmos and matter which attract young students to the natural sciences,
- leads to potentially game-changing applications, albeit often in the longer run.

The committee supports this message. As discussed in 2.3, modern society and its future survival are built on fundamental research, e.g., blue energy which provides a strategy for extracting sustainable energy from the difference in salt concentration of see and river water.

A major contribution of the ITP to society is the training of professionals that can disseminate their knowledge and expertise to a variety of stakeholders. On average, 10 PhD candidates and 50 MSc students were trained by the ITP graduate each year. The ITP is answering core questions that the public is asking, as became clear when Dutch citizens could ask their ‘questions to science’ as part of the Dutch National Science Agenda (NWA) endeavour in 2015. The ITP actively reaches out to the public with activities such as public lectures, visits to primary and secondary schools, masterclasses, open days on campus, and interviews at national television and radio. Appealing examples include a

children's book that was written by an ITP PhD candidate and the NWA-funded Dutch Black Hole Consortium'. The ITP has also strived to increase its visibility in the UU Strategic Themes during the review period, to create more opportunities to participate in calls that involve industrial or other societal partners.

5.4 ITP viability

The committee is highly positive about the viability of the ITP. The combination of particle and condensed matter physics is exceptional, in the sense that these two communities are separate and do not attend each other's seminars in many other theoretical physics institutes. The institute is well-embedded at Utrecht Science Park, for instance through common projects and joint publications with GRASP. The ITP also plays a key role in the CCSS. Strong interactions with several research groups in the Debye Institute exist, and the number of interactions is likely to expand in view of the biophysics initiatives in both institutes. The ITP scientists are continuously keeping an open eye for new scientific, societal, and political developments. Their financial resources appear to be adequate to implement their future strategy and aims, and they have a clear strategy to ensure sufficient human resources as well. For instance, a new position at the interface of theoretical physics and computer science landed in the ITP recently, shared 50-50 with the Department of Information and Computing Sciences.

Several topics will require attention to ensure that the institute will be able to thrive in the future:

- There is a constraint on **housing** and floor space, hampering optimal interaction between the institutes at the Department of Physics. Recently, a plan was developed for the ITP to move closer to the Debye Institute and GRASP in a renovated building in the new physics/chemistry area of Utrecht Science Park. This plan is broadly supported by the ITP, and we support this initiative, because both the Debye Institute and GRASP are natural partners for the ITP.
- The ITP is well-aware that the number of **MSc students** in the Theoretical Physics programme creates challenges. The institute has implemented several measures to reduce the workload of the ITP staff, at least to some extent. We urge the ITP staff to explore strategies to keep the supervision of MSc students manageable. Existing collaborations with the Debye Institute and in particular GRASP might facilitate such a strategy.
- During the site visit, the committee discussed the **TRIPLE** model with representatives of the ITP. TRIPLE incorporates many best practises of the ITP and gives additional possibilities for career development. The ITP staff feels confident that the TRIPLE model will be implemented sensibly at the level of the Department of Physics. However, as in the other institutes, TRIPLE appears to create uncertainty among junior staff, so we recommend clearly communicating what will be expected from them and how they will be evaluated (see also section 2.8).
- We recommend keeping the administrative support of the ITP at its current level after a period of being understaffed.

5.5 ITP PhD policy and training

All PhD candidates at the ITP are enrolled in the GSNS and the Dutch Research School of Theoretical Physics (DRSTP). The latter is a national cooperation for which the ITP provides the scientific director and the managerial and secretarial support. In general, the GSNS organizes training in soft skills (e.g.,

courses in presentation and writing skills) and the DRSTP offers advanced theoretical-physics courses and a network of theoretical physicists in the Netherlands. PhD candidates at the ITP form a particularly international group. The average duration of PhD tracks at the ITP is very close to the nominal 48 months. We have no specific recommendations for the training and supervision of PhD candidates at the ITP. Our general suggestions to safeguard the quality of PhD training at all four institutes are discussed in section 2.6.

6. Assessment Institute for Gravitational and Subatomic Physics

Institute for Gravitational and Subatomic Physics (GRASP)

Scientific director: Professor Thomas Peitzmann (2002-2019), Professor Raimond Snellings (2019-present)

Mission: to gain understanding of the basic constituents of matter, their interactions and the fundamental properties of space and time.

Research lines:
1. High-density strongly-interacting matter,
2. Gravitational waves.

Department: Physics

Research staff in 2021: 6 scientific staff; 8 postdocs & PhD candidates (Table 7 in Appendix 2)

Total funding in 2021: 2.6 M € (Table 8 in Appendix 2)

6.1 GRASP strategy & aims

Strategy in 2016-2021
According to the self-assessment report, GRASP research is curiosity-driven, striving to discover what the universe is made of and how it works. The institute focuses on high-density strongly-interacting matter physics (quark-gluon plasma, QGP) with the ALICE detector at the Large Hadron Collider (LHC) at CERN. A new research line focusing on gravitational-waves (GW) data analysis with the Virgo detector at Cascina (Italy) started in 2019 with the implementation of the Sector Plan 2.0. The QGP and GW research programmes overlap in the study of nuclear matter under extreme conditions.

During the evaluation period, GRASP's strategic aims were:
- to make a major contribution to the understanding of the fundamental properties of space and time and of the basic constituents of matter and their interactions,
- to motivate and educate young people for this fundamental research via Master's and Bachelor's courses and a PhD programme,
- to contribute to society at large.

Future strategy
GRASP aims to remain on the forefront of gravitational waves and quark-gluon plasma research. These two research lines have approved ambitious programmes nationally and internationally well into the 2040s. GRASP will contribute to the ALICE experiment at CERN by performing high-profile analyses, staying involved in the construction and running of subdetectors, and holding leading positions within the collaboration. Planned upgrades of the detectors will facilitate higher resolution measurements and the ability to probe a larger region of phase space. In a collaboration within

Nikhef, the ALICE group will develop fast tracking devices that operate in four dimensions, enabling ALICE to distinguish between quasi-simultaneous collisions and improving particle identifications at low momentum. GRASP is actively involved in the development of the new ALICE vertex tracker (ITS3) targeting 2026 and in the planning and development of the future ALICE3 detector targeting 2032.

The gravitational waves group aims to address several challenges that the field will face in the near future. First, the number of detections per year is expected to increase substantially, putting stress on computational resources. In the longer term, the new Einstein Telescope, will become available, with specific scientific challenges. The scientists plan to explore various routes to tackle these challenges, many of which will be based on machine learning. In addition, they will investigate the applicability of various machine learning and quantum computing algorithms to gravitational waves data analysis in anticipation of a scaling-up of quantum computer capabilities over a longer timeframe.

6.2 GRASP research quality

The research quality of GRASP is excellent. The institute is highly internationally recognized and very productive. The GRASP scientists have published 329 research articles during the review period. Many of these papers are extremely well-cited, with an impressive 11% of the publications in the top 1% of most-cited articles in the field and 42% in the top 10%. GRASP scientists are highly visible in large national and international collaborations. Nationally, GRASP is a partner in the National Institute for Subatomic Physics (Nikhef), which is a partnership between the Institutes Organization of NWO and six Dutch universities. Nikhef is situated in Amsterdam and coordinates and leads the Dutch experimental activities on accelerator-based particle physics and astroparticle physics. GRASP's active involvement in Nikhef is of great added value to UU. Internationally, GRASP is highly active and has leading positions in the ALICE experiment at LHC, Virgo, and the new Einstein telescope project. Importantly, GRASP scientists contribute to data analysis and the development of high-level technologies for future experiments, such as trackers for ALICE3 and the Einstein Telescope.

To support its contribution to the body of scientific knowledge, GRASP is committed to Open Science. The GRASP scientists were drivers in open access publications. In 2021, 98% of their publications were open access. GRASP has contributed to the research IT programme, in which the UU-wide system called 'Yoda' has been established, which enables researchers to securely deposit, share, publish, and preserve large amounts of research data. CERN and Virgo have their own policies to release data after a certain amount of time. These research data thus become available, but of course, sophisticated tools are required to analyse the data.

6.3 GRASP societal relevance

GRASP research answers fundamental questions that intrigue the public. The research is well-aligned with one of the routes of the Dutch National Science Agenda, which focuses on the building blocks of matter and the foundations of space and time. Developing top level high-end technologies also is a

major contribution to society because it fosters innovation in the Dutch high-tech industries that are involved in developing the necessary equipment.

Research and education are well-integrated at GRASP. The MSc and PhD students at GRASP are offered opportunities to participate in exciting international research & education activities such as the CERN Summer School. GRASP also participates in the HiSPARC project, which sets up a detector network of secondary schools and research institutes to jointly measure ultra-high-energy cosmic rays. The high-quality PhD graduates of GRASP obtain positions in academic institutions, non-university research institutes (including CERN), industries such as banking and high-tech businesses, or governmental organizations, disseminating the knowledge and expertise that they acquired during their PhD training at the institutes.

The institute actively engages in outreach activities and performs excellent science communication. Examples are popular talks at astronomy clubs, science cafés, and student associations, as well as interviews for popular science magazines, newspapers, radio, and television.

6.4 GRASP viability

With its outstanding local, national, and international embedding (the ITP, Nikhef, ALICE, Virgo, Einstein Telescope) and its excellent staff, GRASP is well-equipped for the future. The institute has very good talent management and offers great career perspectives, also due to its involvement in international collaborations. Several topics will require attention to ensure that the institute will be able to thrive in the future:

- It is challenging to ensure **long-term funding** for GRASP research because it is planned 20-30 years ahead. Other countries involved in CERN experiments have dedicated grants for this type of long-term projects. It is important that the Dutch scientific community (through NWO) is actively involved in all decisions concerning the Dutch role in international collaborations that require very long-term policies. National research funding should be aligned with the selected long-term priorities.
- GRASP needs help with developing the hardware expertise among the scientific staff at the institute to optimize the interactions with Nikhef where many of the technical developments are carried out. High-level technical staff within GRASP is important (so, not only in Nikhef).
- We recommend organizing support in finding housing so that foreign staff members can land; this is particularly important for this institute.

6.5 GRASP PhD policy and training

The PhD programme of GRASP is embedded in the GSNS and in the national research school for subatomic physics which coordinates the research and training programme for MSc and PhD candidates in particle and astroparticle physics. The supervision of the GRASP PhD candidates is of high quality, with two supervisors per candidate. The collaborations with Nikhef and the ITP add to the quality of PhD training as well.

GRASP has no problems in recruiting international PhD candidates, but it appears to be difficult for the institute to compete with industry to attract PhD candidates from its own MSc programme. The

committee acknowledges that GRASP is trying to attract talented PhD candidates and encourages the institute to ensure that it is visible to this group. Gravitational waves is an attractive field that is now taught in a MSc course, so this probably already tackles the problem to a certain extent. A closer collaboration with the ITP in the MSc programme is also likely to be beneficial. In addition, we recommend arranging dedicated housing for foreign PhD candidates and postdocs if possible, at the level of the university, as was already mentioned in section 2.8 and 6.4.

7. Summary of conclusions and recommendations

7.1 Summary of observations and conclusions

Overall, the committee is highly impressed by the outstanding quality of the research conducted by the four institutes. They are all strong in their own fields, as evidenced by the examples given in this report. The high number of prizes and competitive research grants acquired during the review period are a mark of esteem. In addition, the scientists of these institutes play leading roles in large international scientific endeavours. In line with a long tradition in the sciences, the institutes promote the uptake of their research results by peers and stakeholders by pushing the principles of Open Science.

In the long term, the fundamental insights produced by the institutes will be crucial to address the challenges that society is currently facing. Each institute also yields shorter-term societal benefits in its own way. For instance, high-quality PhD graduates that the institutes deliver find jobs in academic institutions, companies, governmental organizations, and non-governmental organizations, disseminating the knowledge and expertise that they acquired during their PhD training in Utrecht. In addition, the institutes have successfully participated in outreach activities during the review period.

The PhD candidates at the institutes are enrolled in the UU Graduate School of Natural Sciences, which organizes training and support. In general, the committee appreciates the Dutch system of training and supervision of PhD candidates. Monitoring the progress of PhD candidates has improved since the previous peer review. To continue this positive development, we recommend (i) involving at least one independent advisor from another institute in the annual progress monitoring of the PhD candidates, (ii) planning how to finish the project in time, (iii) clearly communicating requirements for PhD graduation, and (iv) ensuring within-institute comparability of the requirements.

To promote high-quality research with substantial societal impact, the institutes have undertaken actions to improve the diversity of their staff, and to safeguard social safety and research integrity. The current gender balance at the institutes is excellent compared to similar institutes in other countries. The committee agrees that it is important to compensate for the historical gender imbalance. However, there are many other underrepresented groups. A firm commitment to redress these balances is more important than the imposition of mandatory quota, at least when these are unrealistic in view of the composition of the ‘recruitment pool’.

The committee noticed that the recent implementation of the novel TRIPLE model to evaluate the performance of staff members has created uncertainty among younger scientists. They may feel unsure what is expected from them and how they will be assessed. We recommend clearly communicating what will be expected from them and how they will be evaluated. The committee subscribes to the idea that the evaluation of academic achievements should be based on both qualitative and quantitative measures. However, we stress that the evaluation must be based on familiarity with the field. Therefore, we recommend seeking external (international) advice on important strategic decisions such as giving tenure to scientists.

Taken together, mechanisms are in place to safeguard the research quality and societal impact of the institutes in the future. Their research foci will continue to be of high scientific and societal relevance in the next six years and they have a robust scientific and societal strategy for the future. The financial position of the institutes is relatively advantageous. To ensure that the institutes will continue to thrive in the future, we recommend safeguarding support by the grant office, technical support staff, and administrative staff.

7.2 Complete list of recommendations and suggestions mentioned in the report

(Note that the recommendations and suggestions are addressed at the institutes, unless indicated otherwise.)

Recommendations and suggestions for the research unit as a whole

- Seek international (or at least external) advice on important strategic decisions such as giving tenure to scientists (p. 8 & 13 & 14).
- Make a succession plan well in advance of the retirement of the grant officer at the Faculty of Science, to ensure that no expertise is lost in the succession of this highly qualified person (p. 9).
- Continue the investments in technical support staff and ensure that these persons receive proper recognition (p. 9).
- Ensure adequate administrative support, including support with project administration (p. 9).
- Critically monitor the demands on scientists involved in teaching, such as following education courses and creating plans for teaching activities (p. 10).
- Increase the capacity and frequency of soft skill courses for PhD candidates if possible because this capacity appears to be insufficient (p. 11).
- Ensure that the annual progress monitoring of the PhD candidates, and in particular the crucial go-no go decision at the end of the first year, involves at least one independent advisor from another group, institute, or university (p. 11).
- Use the annual assessment & development interviews to set and monitor a clear time path for the completion of PhD projects (p. 11).
- Ensure that the minimal requirements for admission to the PhD defence are communicated early and clearly by supervisors, without overly formalizing things or making them inflexible. Within-institute comparability of the requirements is recommended, and the success of ambitious PhD projects should be primarily reflected in the quality rather than quantity of the output (p. 11).
- Discourage working from home because it hampers the emergence of novel collaborative research (p. 11).
- Reflect on the optimal balance between confidentiality and transparency because serious social safety issues in other universities were not identified by review panels such as ours (recommendation to the university, p. 12).
- Engage PhD candidates and support staff (i.e., different stakeholders) in formulating questions for the anonymised surveys about social safety (p. 12).
- Reflect on additional measures to consolidate the family-friendliness of the workplace and keep in mind that family-friendliness concerns both mothers *and fathers* (recommendation to the Faculty of Science, p. 12).

- Continue striving for a more balanced representation of minorities among the staff, but keep in mind that the targets for e.g., the female-to-male ratio should be realistic, e.g., the percentage of women in the staff should at least reflect the percentage in the available pool of students (p. 13).
- Liaise with the university to develop plans for dedicated housing for foreign PhD candidates and postdocs (p. 13 & 14).
- Develop a strategy for 'meaningful representation' of female staff members at the Department of Physics, following the example of the Department of Chemistry. This should be done in consultation with the female staff members (p. 13).
- Clearly communicate what will be expected from junior staff and how they will be evaluated because TRIPLE appears to create uncertainty among these young scientists (p. 14 & 27).
- Consider if it is possible to provide more egalitarian start-up packages to junior staff members (p. 14).
- Devote more attention to training, supervision, and career perspectives of postdocs, for instance by ensuring that postdocs are sufficiently prepared for the next steps in their careers, and by clearly indicating teaching opportunities (p. 14).
- To better integrate the new ISCC into the Faculty of Science and UU, strengthen the natural links with IMAU and the CCSS, and explore the possibilities to collaborate with other faculties such as the UU School of Economics at the Faculty of Law, Economics and Governance. Exploring synergies with the KNAW-NWO Dutch Climate Research Initiative (KIN) could also be worthwhile (p. 14).

Recommendations and suggestions specific for the Debye Institute

- Clearly communicate that the institute's public-private collaborations focus on sustainable solutions (p. 17).
- When planning a new building, ensure that experimental research groups will only need to move once, with a clear timetable. Ideally, the whole institute should be housed in one building, and office spaces should be fit for purpose (p. 18).
- Ensure that younger staff members are given the kind of responsibilities that they will later need as independent group leaders, in particular in large research groups (p. 18).
- Ensure that there are career opportunities for high-level technicians in the institute, including possibilities for training (p. 19).
- Ensure that the synergy between the ISCC and the rest of the Debye Institute will be retained (p. 19).
- Facilitate a direct representation of the PhD students in the board of the institute (p. 19).
- Refrain from using a one-size-fits-all policy when setting the expectations for PhD projects (i.e., three to four first-author papers may be appropriate in some case, but not in all, p. 20).

Recommendations and suggestions specific for IMAU

- Ensure sufficient funding for equipment and specialized (technical) personnel, in particular in the area of data storage and data-base management (p. 24).
- Explore further opportunities to collaborate with local institutes such as the Debye Institute and the new ISCC, while ensuring that the efforts on outreach, knowledge transfer, and university-wide initiatives are balanced with the effort spent on research (p. 24).

- Complement the recently implemented measures for PhD quality assurance with a detailed plan for the final year to ensure that PhD theses are finished (p. 24).
- Organize a mandatory annual meeting with an external supervisor that is affiliated with another institute as part of the PhD supervision system (p. 24).

Recommendations and suggestions specific for the ITP

- Explore strategies to keep the supervision of the MSc programme in Theoretical Physics manageable (p. 27).
- Keep the administrative support of the ITP at its current level (p. 27).

Recommendations and suggestions specific for GRASP

- Try to ensure that the Dutch scientific community (through NWO) is involved in long-term policy decisions to ensure that adequate funds can be allocated to the chosen priorities (p. 31).
- Ensure that high-level technical staff is employed at GRASP, to profit optimally from the interaction with Nikhef (p. 31).
- Ensure that the institute is visible to talented MSc students at the UU. A closer collaboration with the ITP in the MSc programme may be beneficial to this end (p. 31).
- Try to arrange dedicated housing for foreign PhD candidates and postdocs at the level of the university (especially important for GRASP, p. 32).

Appendix 1. Site visit programme

Monday, November 21					
			Program	**Participants**	**Location**
11:30	11:35		Welcome by Isabel Arends	**Review committee**, Isabel Arends	BBG 7.47
11:35	**12:30**		**Welcome lunch**	**Review committee**	**BBG 7.47**
12:30	13:45		Meeting Faculty management board and Institute management of all 4 institutes	Review committee Dean & Heads of departments (Physics and Chemistry) Directors	BBG 7.12
13:45	**14:00**		**Brief evaluation**	**Review committee**	**BBG 7.47**
14:00	15:00		GRASP 5' presentation by director 55'questions by panel (with director / board)	Review committee Board / director & staff	BBG 7.12
15:00	**15:15**		**Brief evaluation**	**Review committee**	**BBG 7.47**
15:15	**15:30**		**Coffee break**	**Review committee**	**BBG 7.47**
15:30	17:00		Debye 10' presentation by directors 40' questions by panel (with director / board) 40' questions by the panel (without director / board)	Review committee Board / director & staff	BBG 7.12
17:00	18:15		Lab tours – location DDW 10' Taxi / walk to DDW	Review committee	DDW
18:15	**18:30**		**Brief evaluation**	**Review committee**	**DDW 4.04**
19:15	**21:15**		**Dinner**	**Review committee**	**NH hotel**

Tuesday, November 22					Location
8:45	**9:00**		**Committee meeting**	**Review committee**	**BBG 7.47**
9:00	10:45		IMAU 20' lab tour 15' presentation by director & director complex systems 35' questions by the panel (with director / board) 35' questions by the panel (without director / board)	Review committee Board / director & staff	BBG 7.12
10:45	**11:00**		**Brief evaluation**	**Review committee**	**BBG 7.47**
11:00	11:45		Meeting with early career staff (assistant professor and tenure tracker) of all 4 institutes	Review committee Early career researchers (tenure-track and assistant professor)	BBG 7.12
11:45	12:30		Buffet lunch with early career staff (assistant professor and tenure tracker) of all 4 institutes	Review committee Early career researchers (tenure-track and assistant professor)	BBG 7.12
12:30	**12:45**		**Brief evaluation**	**Review committee**	**BBG 7.47**
12:45	14:15		ITP 10' presentation by director 40' questions by panel (with director / board) 40' questions by the panel (without director / board)	Review committee Board / director & staff	BBG 7.12
14:15	**16:30**		**Private interim meeting (including break)** - Brief evaluation of ITP session - Coffee break - Wrapping-up findings so far - Identifying further questions - Writing prelim conclusions	**Review committee**	**BBG 7.47**
16:30	17:00		If necessary: Q&A session to additional questions / office hour	Review committee Stand by: directors	BBG 7.12
17:00	17:30		Poster pitches PhDs / postdocs	Review committee PhDs & PDs	BBG 7th floor hall
17:30	18:30		Poster session with drinks and bites PhDs / postdocs	Review committee PhDs & PDs	BBG 7th floor hall
19:15	21:15		Dinner	Review committee Heads of departments (Physics and Chemistry) Directors & Frank Bestuurssecretarissen & coordinator support	Huize Molenaar

Wednesday, November 23					Location
8:30	**8:45**		**Committee meeting**	**Review committee**	**DDW 1.01**
8:45	9:05		Meeting with education responsible	Review committee Education representatives	**DDW 1.01**
9:05	9:45		Meeting with PhDs and postdocs of all 4 institutes	Review committee PhDs & PDs	**DDW 1.01**
9:45	10:15		Final interview with management / feedback session	Review committee Dean & Heads of departments (Physics and Chemistry)	**DDW 1.01**
10:15	**12:45**		**Final private meeting including break** **Deliberation, writing and finalizing assessment**	**Review committee**	**DDW 1.01**
12:45	13:00		Brief oral report	Review committee Public Faculty	**DDW 2.01**
13:00	14:00		Buffet lunch	Review committee Public Faculty	**DDW 2.01**

BBG = Buys Ballot Gebouw: Princetonplein 5, 3584 CC Utrecht

DDW = David de Wied Gebouw: Universiteitsweg 99, 3584 CG Utrecht

NH Hotel: Janskerkhof 10, 3512 BL Utrecht

Huize Molenaar: Korte Nieuwstraat 6, 3512 NM Utrecht

Appendix 2. Quantitative data on composition and funding of the institutes

The tables in this appendix were copied from the institutes' self-assessment report.

Explanation of staff tables
The number of FTE (full-time equivalents) in the staff tables refers to the total employment of the research staff. A researcher with a full-time position thus counts for 1 FTE, even though this person will typically spend a significant amount of time on non-research activities such as teaching. At the four institutes, typical percentages of time spent on research are 40-50% for professors, associate professors, and assistant professors; and 90-100% for postdocs and PhD candidates. Each year, 31 December was used as date for the headcount and FTE counting.

Explanation of funding tables
'Direct funding' is funding by the university ('basisfinanciering'); 'Research grants' are grants obtained in national and international scientific competition through open calls, such as grants from NWO, KNAW, and ERC. (Note that this deviates from SEP, where ERC grants are listed under 3); 'Contract research' is funding for specific research projects obtained from external organizations, such as industry, governmental ministries, the European Commission, and charity organizations. Funding is given in €m, not in FTE, thus deviating from the suggestion in the SEP. For GRASP (Table 8), figures include FOM projects (material + personnel) which are not in the UU administration (e.g., projects from the FOM institutes, including Nikhef).

Table 1: Debye Institute research staff (headcount / FTE of internal staff)

	2016	2017	2018	2019	2020	2021
Full professor	14 / 14 FTE	14 / 14 FTE	15 / 15 FTE	15 / 15 FTE	16 / 15.7 FTE	14 / 13.7 FTE
Associate professor	6 / 5.7 FTE	7 / 6.7 FTE	7 / 6.7 FTE	6 / 6 FTE	9 / 9 FTE	10 / 10 FTE
Assistant professor	12 / 12 FTE	13 / 13 FTE	11 / 11 FTE	12 / 12 FTE	11 / 11 FTE	16 / 15.2 FTE
Total scientific staff	**32 / 31.7 FTE**	**34 / 33.7 FTE**	**33 / 32.7 FTE**	**33 / 33 FTE**	**36 / 35.7 FTE**	**40 / 38.9 FTE**
Postdocs	35 / 33.2 FTE	36 / 34.2 FTE	38 / 35.2 FTE	34 / 33.2 FTE	36 / 34.8 FTE	29 / 27.5 FTE
PhD candidates	126 / 126 FTE	130 / 129.6 FTE	119 / 118.6 FTE	129 / 128.6 FTE	122 / 121.6 FTE	143 / 142.6 FTE
Total PD + PhD	**161 / 159.2 FTE**	**166 / 163.8 FTE**	**157 / 153.8 FTE**	**163 / 161.8 FTE**	**158 / 156.4 FTE**	**172 / 170.1 FTE**

Table 2: Debye Institute funding and expenditure

	2016	2017	2018	2019	2020	2021
Funding:						
Direct funding (1)	€4.6m / 27%	€4m / 22%	€4.5m / 26%	€4.7m / 27%	€5.3m / 25%	€6.2m / 37%
Research grants (2)	€10.6m / 61%	€12m / 67%	€10m /57%	€9.4m / 55%	€12.2m / 58%	€7m / 42%
National	€6.4m / 37%	€6.7m / 37%	€6.3m /36%	€6m / 35 %	€8.9m / 42%	€4.9m / 29%
International	€4.2m / 24%	€5.3m / 30%	€3.8m / 21%	€3.4m / 20%	€3.3m / 16%	€2.1m / 13%
Contract research (3)	€2.1m / 12%	€1.8m / 10%	€2.9m / 16%	€2.8m / 17%	€3.3m / 16%	€3.4m / 20%
Other	€0m / 0%	€0.1m / 1%	€0.2m / 1%	€0.2m / 1%	€0.2m / 1%	€0.1m / 1%
Total funding	**€17.3m / 100%**	**€17.9m / 100%**	**€17.6m / 100%**	**€17m / 100%**	**€21m / 100%**	**€17.7m / 100%**
Expenditure:						
Personnel costs	€10.4m / 72%	€10.8m / 73%	€10.7m / 74%	€10.6m / 75%	€10.7m / 59%	€11.1m / 78%
Other costs	€4m/ 28%	€3.9m / 27%	€3.8m / 26%	€3.4m / 25%	€7.3m / 41%	€3.1m / 22%
Total expenditure	**€14.4m / 100%**	**€14.7m / 100%**	**€14.5m / 100%**	**€14m / 100%**	**€18m / 100%**	**€14.2m / 100%**

Table 3: IMAU research staff (headcount / FTE of internal staff and professor by special appointment)

	2016	2017	2018	2019	2020	2021
Full professor	5 / 4.6 FTE	5 / 4.5 FTE	6 / 4.6 FTE	6 / 5.0 FTE	6 / 5.0 FTE	7 / 6.0 FTE
Associate professor	5 / 4.2 FTE	6 / 5.2 FTE	6 / 5.2 FTE	5 / 4.2 FTE	6 / 5.2 FTE	5 / 4.2 FTE
Assistant professor	3 / 3.0 FTE	3 / 3.0 FTE	4 / 4.0 FTE	6 / 5.5 FTE	6 / 5.5 FTE	5 / 4.5 FTE
Professor by special appointment	1 / 0.2 FTE	1 / 0.2 FTE	1 / 0.2 FTE	1 / 0.2 FTE	1 / 0.2 FTE	1 / 0.2 FTE
Researcher						1 / 0.6 FTE
Total permanent scientific staff	**14/ 12.0 FTE**	**15/ 12.9 FTE**	**17/ 14.0 FTE**	**18/ 14.9 FTE**	**19/ 15.9 FTE**	**19 / 15.5 FTE**
Postdocs	24 / 21.9 FTE	23 / 22.2 FTE	17 / 14.9 FTE	10 / 8.4 FTE	17 / 15.9 FTE	22 / 21.4 FTE
PhD candidates	19 / 18.8 FTE	21 / 20.8 FTE	23 / 22.8 FTE	26 / 25.8 FTE	27 / 26.5 FTE	31 / 31.0 FTE
Total PD + PhD	**43 / 40.7 FTE**	**44 / 43.0 FTE**	**40/ 37.7 FTE**	**36 / 34.2 FTE**	**44/ 42.4 FTE**	**53 / 52.4 FTE**
Total scientific staff (research FTE)	**4.8 FTE**	**5.2 FTE**	**5.6 FTE**	**6.0 FTE**	**6.4 FTE**	**6.2 FTE**
Total PD + PhD (research FTE)	**36.6 FTE**	**38.7 FTE**	**33.9 FTE**	**30.8 FTE**	**38.2 FTE**	**47.2 FTE**
Total all research staff (research FTE)	**41.4 FTE**	**43.9 FTE**	**39.5 FTE**	**36.8 FTE**	**44.6 FTE**	**53.4 FTE**

Table 4: IMAU funding and expenditure

	2016	2017	2018	2019	2020	2021
Funding:						
Direct funding (1)	€1.6m / 32%	€1.4m / 33%	€1.6m / 37%	€1.7m / 32%	€1.7m / 30%	€1.9m / 23%
Research grants (2)	€3.3m / 68%	€2.8m / 65%	€2.7m / 61%	€3.4m / 64%	€3.5m / 63%	€3.7m / 62%
National	€3.1m / 64%	€2.3m / 53%	€2m / 45%	€2.6m / 50%	€2.6m / 46%	€2.4m / 41%
International	€0.2m / 4%	€0.5m / 12%	€0.7m / 16%	€0.7m / 14%	€0.9m / 16%	€1.3m / 21%
Contract research (3)	€0 / 0%	€0.81m / 1%	€0.1m / 1%	€0.2m / 3%	€0.4m / 7%	€0.3m / 5%
Other	€0 / 0%	€0 / 0 %	€0 / 1%	€0.1 / 1%	€0 / 0%	€0 / 0%
Total funding	**€4.8m / 100%**	**€4.3m / 100%**	**€4.5m / 100%**	**€5.3m / 100%**	**€5.6m / 100%**	**€6m / 100%**
Expenditure:						
Personnel costs	€3.2m / 67%	€3.5m / 81%	€3.7m / 82%	€3.6m / 68%	€4.2m / 74%	€4.7m / 79%
Other costs	€1.6m / 33%	€0.8m / 19%	€0.8m / 18%	€1.7m / 32%	€1.5m / 26%	€1.2m / 21%
Total expenditure	**€4.8m / 100%**	**€4.3m / 100%**	**€4.5m / 100%**	**€5.3m / 100%**	**€5.6m / 100%**	**€6m / 100%**

Table 5: ITP research staff (headcount / FTE of internal staff and professor by special appointment)

	2016	2017	2018	2019	2020	2021
Full professor	4 / 4.0 FTE	4 / 4.0 FTE	4 / 4.0 FTE	5 / 5.0 FTE	5 / 5.0 FTE	6 / 6.0 FTE
Associate professor	3 / 3.0 FTE	3 / 3.0 FTE	4 / 4.0 FTE	4 / 4.0 FTE	4 / 4.0 FTE	4 / 4.0 FTE
Assistant professor	4 / 4.0 FTE	4 / 4.0 FTE	4 / 4.0 FTE	4 / 4.0 FTE	5 / 5.0 FTE	5 / 5.0 FTE
Total scientific staff	**11 / 11.0 FTE**	**11 / 11.0 FTE**	**12 / 12.0 FTE**	**13 / 13.0 FTE**	**14 / 14.0 FTE**	**15 / 15.0 FTE**
Postdocs	10 / 10.0 FTE	6 / 6.0 FTE	11 / 10.8 FTE	8 / 7.8 FTE	12 / 11.3 FTE	13 / 13.0 FTE
PhD candidates	27 / 26.9 FTE	23 / 22.9 FTE	27 / 26.8 FTE	26 / 25.8 FTE	23 / 22.9 FTE	26 / 25.9 FTE
Total PD + PhD	**37 / 36.9 FTE**	**29 / 28.9 FTE**	**38 / 37.6 FTE**	**34 / 33.6 FTE**	**35 / 34.2 FTE**	**39 / 38.9 FTE**

Table 6: ITP funding and expenditure

	2016	2017	2018	2019	2020	2021
Funding:						
Direct funding (1)	€1.4m / 35%	€1.5m / 32%	€1.6m / 35%	€1.6m / 39%	€1.6m / 44%	€1.7m / 48%
Research grants (2)	€1.7m / 44%	€2.3m / 50%	€2.3m / 52%	€1.9m / 48%	€1.6m / 44%	€1.4m / 38%
Contract research (3)	€0.8 / 21%	€0.8m / 18%	€0.6m / 13%	€0.5m / 13%	€0.4m / 12%	€0.5m / 14%
Other	€0 / 0%	€0 / 0 %	€0 / 0%	€0 / 0%	€0 / 0%	€0 / 0%
Total funding	**€4m / 100%**	**€4.7m / 100%**	**€4.4m / 100%**	**€4m / 100%**	**€3.7m / 100%**	**€3.6m / 100%**
Expenditure:						
Personnel costs	€3.5m / 88%	€4.1m / 88%	€4m / 90%	€3.6m / 88%	€3.5m / 96%	€3.5m / 97%
Other costs	€0.5m / 12%	€0.6m / 12%	€0.4m / 10%	€0.5m / 12%	€0.1m / 4%	€0.1m / 3%
Total expenditure	**€4m / 100%**	**€4.7m / 100%**	**€4.4m / 100%**	**€4m / 100%**	**€3.7m / 100%**	**€3.6m / 100%**

Table 7: GRASP research staff (headcount / FTE of internal staff)

	2016	2017	2018	2019	2020	2021
Full professor	2 / 2 FTE	2 / 2 FTE	2 / 2 FTE	3 / 3 FTE	3 / 3 FTE	3 / 3 FTE
Associate professor	1 / 1 FTE	1 / 1 FTE	0 / 0 FTE	0 / 0 FTE	0 / 0 FTE	0 / 0 FTE
Assistant professor	1 / 1 FTE	1 / 1 FTE	1 / 1 FTE	2 / 2 FTE	3 / 2.8 FTE	3 / 2.8 FTE
Total scientific staff	**4 / 4 FTE**	**4 / 4 FTE**	**3 / 3 FTE**	**5 / 5 FTE**	**6 / 5.8 FTE**	**6 / 5.8 FTE**
Postdocs	3 / 3 FTE	3 / 3 FTE	3 / 3 FTE	1 / 1 FTE	1 / 1 FTE	1 / 1 FTE
PhD candidates	4 / 4 FTE	6 / 6 FTE	4 / 4 FTE	4 / 4 FTE	7 / 7 FTE	7 / 7 FTE
Total PD + PhD	**7 / 7 FTE**	**9 / 9 FTE**	**7 / 7 FTE**	**5 / 5 FTE**	**8 / 8 FTE**	**8 / 8 FTE**

Table 8: GRASP funding and expenditure

	2016	2017	2018	2019	2020	2021
Funding:						
Direct funding	€0.4m / 23%	€0.4m / 20%	€0.5m / 22%	€0.5m / 21%	€0.7m / 29%	€0.9m / 34%
Research grants (only national)	€1.3m / 77%	€1.6m / 74%	€1.8m / 75%	€1.8m / 78%	€1.7m / 71%	€1.7m / 66%
Contract research	€0m / 0%	€0.1m / 5%	€0.1m / 3%	€0m / 1%	€0m / 0%	€0m / 0%
Total funding	**€1.7m / 100%**	**€2.2m / 100%**	**€2.4m / 100%**	**€2.3m / 100%**	**€2.4m / 100%**	**€2.6m / 100%**
Expenditure						
Personnel costs	€1.4m / 82%	€1.8m / 83%	€1.9m / 79%	€2m / 86%	€2.2m / 92%	€2.4m / 91%
Other costs	€0.3m / 18%	€0.4m / 17%	€0.5m / 21%	€0.3m / 14%	€0.2m / 8%	€0.2m / 9%
Total expenditure	**€1.7m / 100%**	**€2.2m / 100%**	**€2.4m / 100%**	**€2.3m / 100%**	**€2.4m / 100%**	**€2.6m / 100%**