Evaluation report
Amsterdam University Physics
2010-2016

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Content

1 Foreword

In this report the results of the scientific assessment of the physics research carried out at the Vrije Universiteit Amsterdam (VU) and the Universiteit van Amsterdam (UvA) are presented. The purpose of this report is to present a reliable picture of the research quality, relevance to society and viability of Amsterdam University Physics, to reflect on the PhD programmes, research integrity and diversity, and to advise on the strategy, governance and leadership of the institutions in which the various research teams are embedded.

Information on the method used by the Committee in this research assessment can be found in Chapter 2 of this report. Despite the fact that the utmost was asked from the logistical skills of the organisation due to the – otherwise well predicted – extreme weather conditions during the site visit, all interviews and related activities were carried out successfully, albeit in a different order. The site visit was very pleasant and informative. We heard interesting presentations and had stimulating discussions, both with the staff member of the various teams involved in Amsterdam University Physics as well as within the Committee itself. For this I would like to thank the organising committee of both universities and their support staff, as well as the Committee members, who all were prepared to go to great lengths to make this evaluation possible.

This evaluation comes at a point in time that – despite great efforts from both the UvA Institute of Physics and the VU Department of Physics and Astronomy – it was decided not to merge these institutions into one single entity. This decision came as a disappointment to many physicists involved, as the process that led to this decision took the better part of the 7 year review period, and seemed to be very promising. A point of view shared by the Committee. As this decision was taken relatively recently, the full impact of this development has not been translated in a revised strategy. Hence, the Committee found it necessary to devote part of this report to address this issue.

It is clear that the Amsterdam University Physics stands at a crossroad, and that the actions taken within this year will be decisive for the coming decade(s). We hope that this evaluation, besides reporting about the excellent quality and relevance to society of Amsterdam University Physics, may be of help in shaping this future.

On behalf of the entire assessment Committee,

Prof.dr. Gerard van der Steenhoven
Chairman of the Evaluation Committee

2 Preamble

2.1 Scope and context of the review

This evaluation concerns the research carried out at the physics departments of the Universiteit van Amsterdam (UvA) and the Vrije Universiteit Amsterdam (VU) in the period 2010-2016. Every six years Dutch universities are required to evaluate their research activities in accordance with a Standard Evaluation Protocol (SEP) that has been developed by the Royal Academy of Sciences (KNAW), the National Science Funding Agency (NWO) and the Association of Dutch Universities (VSNU). Over the previous evaluation period (2001-2009) this was done in a nationally coordinated effort over all Dutch university physics research groups. In the current evaluation period the universities decided for a more local approach, with a joint evaluation of the two Amsterdam universities.

The assessment was carried out in accordance with the SEP 2015-2021. The primary aim of this protocol is to ensure a transparent, unified and fair assessment of a) the quality and b) relevance for society of publicly funded research, and c) the viability of the research unit towards the future. The Evaluation Committee assigned a ranking or category (1 to 4) for each of these three criteria, in accordance with definitions in the SEP. For a description of the three assessment criteria and an explanation of the categories utilised, see paragraph 2.5 and Appendix 4.

The physics research at the two Amsterdam universities is jointly organized in four research units – all part of the Institute of Physics (UvA) or Department of Physics and Astronomy (VU). The units were all individually assessed and assigned a category on the criteria of research quality, societal relevance, and viability. The four research units are:

- LaserLaB (representing five of the experimental physics groups of the VU physics department)
- Van der Waals-Zeeman Institute (WZI, representing all experimental physics activities – except particle physics – of the UvA Institute of Physics)
- Institute for High-Energy Physics (IHEF, joint unit of UvA and VU groups, which together form an integral part of Nikhef, the national institute for subatomic physics)
- Institute for Theoretical Physics Amsterdam (ITFA, the theoretical physics division of the UvA Institute of Physics)

In addition, the Committee was asked to provide a qualitative assessment of the Institute of Physics (UvA) and the Department of Physics and Astronomy (VU) as a whole in relation to their strategic targets and to the governance and leadership skills of its management, and to reflect on the PhD programmes, research integrity and diversity.

2.2 The Evaluation Committee

The Evaluation Committee was appointed by the Executive Boards of UvA and VU and consisted of:

- professor Gerard van der Steenhoven (chair), Royal Netherlands Meteorological Institute (KNMI) and University of Twente
- professor Peter Littlewood, Argonne National Laboratory
- professor Jun Ye, University of Colorado Boulder
- professor Monika Ritsch-Marte, Medical University of Innsbruck
- professor Albert de Roeck, University of Antwerp and CERN
- professor Roberto Emparan, University of Barcelona
- professor Villy Sundström, Lund University

A short curriculum vitae of each member is included in Appendix 1. The Committee was supported by Dr. Mark Boneschanscher (NWO).

Before the site visit all members of the Committee signed a statement of impartiality and confidentiality conform the SEP. Hereby they declared to have no personal, professional or hierarchical relationship with members of staff, management or board of a nature that leads to bias in the assessment process.

2.3 Data provided to the Committee

When invited, the Committee members were provided with the site visit programme, the Terms of Reference, and the SEP 2015-2021. One month prior to the site visit the Committee was supplied with the combined self-evaluation reports of the four research units, including a department-level description of the governance and education, and all other information required by the SEP.

2.4 Procedures followed by the Committee

Prior to the site visit, all Committee members independently studied all the written information supplied by the two universities. The chair prepared a division of tasks, according to which the Committee members were assigned particular evaluation criteria and/or particular research units. Although (at least) two Committee members were assigned to give particular attention to one research unit, all members studied the material of each unit and were actively involved in questioning the group members and in the discussion leading to the conclusions of this assessment. As homework, the Committee members drafted their first questions and initial conclusions on the assigned topics.

At the beginning of the site visit the Committee discussed the SEP criteria and categories to ensure that a common framework would be used during the actual interviews and assessments. Thereafter the Committee visited the four research units, and interviewed external stakeholders, PhD students, tenure trackers, and scientific as well as managerial staff members from both universities. The weather conditions prior to and during the visit made it impossible for some Committee members to be present during the *entire* site visit. However, the schedule was rearranged in such a way to accommodate the presence of the primary responsible Committee members for each research unit during the discussions with that unit. Moreover, in the end all but three Committee members participated in the full site visit, one Committee member participated through a telephone connection and two Committee members missed only one (but not the same) day of the site visit. For the final programme of the site visit see Appendix 2.

After the interviews the Committee discussed its findings in a closed session, and adjusted the preliminary assessments accordingly. These closed sessions were done with the entire Committee (the Committee member that could not be present was connected by phone). Once the Committee agreed on the integral draft of the evaluation report, it presented its findings orally to representatives of the university boards and the university staff.

This draft was elaborated to a full report, based on both the documentation provided by the universities and the information gathered during the site visit. The final version of the report was obtained after various iterations within the Committee via email. This report was supplied to the universities on 2 February 2018 for a factual check, and subsequently submitted to the university boards.

2.5 Assessment criteria and categories

In accordance with the SEP 2015-2021, and taking into account international trends and developments in science and society, the Committee assessed the following three criteria of the research units:

- *Research quality*: the Committee assessed the quality of the unit's research and the contribution that the unit makes to the body of scientific knowledge. The Committee also assessed the scale of the unit's research results (scientific publications, instruments and infrastructure developed by the unit, and other contributions to science).
- *Relevance to society*: the Committee assessed the quality, scale and relevance of contributions targeting specific economic, social or cultural target groups, of advisory reports for policy, of contributions to

public debates, and so on, based on contributions in areas that the research unit itself had designated as target areas.

- *Viability*: the Committee assessed the strategy that the research unit intends to pursue in the years ahead and the extent to which it is capable of meeting its targets in research and society during this period. It also considered the governance and leadership skills of the research unit's management.

The three evaluation criteria were rated according to the four-category scale as specified in the SEP (1. World leading/excellent; 2. Very good; 3. Good; 4. Unsatisfactory – see Appendix 4 for a more elaborate description). The verdict was given in qualitative form – in terms of a narrative, with the addition of a quantitative figure. Furthermore a qualitative assessment is given of the strategy, governance, and leadership of the Institute of Physics (UvA) and the Department of Physics and Astronomy (VU), specifically taking into account the PhD programmes, research integrity, and diversity.

3 Evaluation and assessment

3.1 Institute of Physics (UvA) and Department of Physics and Astronomy (VU)

Amsterdam University Physics represents a very strong focus point of high level physics research in the Netherlands. With 350 active physics researchers more or less equally spread over four research units, it compares favourably to the most prestigious physics research centres in a university environment worldwide. Together with other top-level research institutes such as Nikhef, AMOLF and ARCNL, a true centre of excellence in physics research has been formed in Amsterdam.

Both the quality and volume of research in the various teams have grown substantially in most research units. Dedicated decisions by the Dutch government, in the form of the so-called sector plans, have certainly contributed to this growth. But the impressive increase in the number of prestigious grants awarded to physicists in almost every team has been equally important. Each of the four research units has been able to recruit top level researchers in the past decade, resulting in a truly exciting and vibrant research community. This was illustrated by the meeting with external stakeholders having backgrounds ranging from start-ups and SME's to large companies, and from educational services to national television.

In view of these developments the impossibility to form a joint Institute of Physics on one location at the Science Park Amsterdam is extremely frustrating, especially as this decision was taken outside the realm of influence of the leadership of the physics departments involved. Given the attractive prospects of forming a large centre of high quality physics research amidst a series of top level research institutes in the Amsterdam Science Park, given the fact that the educational programs have already been successfully merged at the Science Park location, given the anticipated synergies between individual VU and UvA research teams, and – most importantly – given the fact that the new entity would have the prospect of being one of the world's leading physics institutes in Europe, the Committee urges all stakeholders involved to reconsider the present situation and explore whether any possibility exists to form such a joint VU-UvA physics institute in one location after all. Other joint projects between the two universities such as the Amsterdam University College and ARCNL exist as well in the Science Park and may serve as an example. Cross-fertilization in such an environment is the ideal foundation for unexpected breakthroughs and surprising innovations.

However, if the use of two locations is a hard boundary condition for the future of Amsterdam University Physics, the Committee advises to form – on short notice – a concrete plan on how to best make use of these two locations, allowing for individual research teams to move either to the VU campus or the Science Park depending on the best prospects for the given activities. As an example of what the Committee has in mind: the LaserLaB activities on energy and materials might profit from a move to WZI, whereas the business incubator activities of the UvA groups might profit from a move to the Demonstrator Lab at the VU campus. It is not the task of this Committee to fully explore these options, but given the time scales and deadlines involved, the formulation of such a common strategy should be initiated very soon.

To conclude this part of our report, the Committee has noted that a considerable amount of energy is at stake when discussing the issue of the failed merger with individual leading physicists in Amsterdam. In order to prevent a further drifting apart of the two communities, the deans and governing boards of the two universities are asked to take action soon. Otherwise a unique opportunity will have passed, which might be regretted in years to come.

3.1.1 Strategy, governance, and leadership

The management of the UvA Institute of Physics and the VU Department of Physics and Astronomy has shown extraordinary leadership during the review period by defining a common strategy that should have led to the formation of the joint Amsterdam Institute of Physics. Although the envisioned institute has not materialized, the common strategy has led to substantially increased funding, the recruitment of excellent staff, and growth in output for both universities. It will be a challenge to regain the common spirit in the period to come, and still profit from the good ideas that were formulated. However, this Committee would like to encourage the management to continue on the course set out during the previous period, to promote further collaboration as much as they can, and – as soon as possible – develop a new common strategy for the coming decade.

The governance of the two organizations is somewhat different, but in both cases it involves little hierarchy as is fitting for organizations consisting of independently operating physicists. As a result the various teams have a considerable amount of freedom when developing their future plans. However, in line with the remarks made above, it is desirable to construct more commonality between the various groups, by at least sharing a common mission and vision for the (near) future.

The management of the four research units comprising Amsterdam University Physics has shown considerable vision during the review period by choosing to represent themselves as a future single entity. It is unfortunate that this goal did not materialize, but this cannot be attributed to a lack of leadership at this level. As for the individual research units, proper leadership resulted in a range of successes in each research programme, where the well-chosen participation in gravitational wave research with the subsequent seminal discovery of gravitational waves can serve as an example. Moreover, the impressive number of grants approved in each of the four units is further evidence of considerable leadership and a well-defined strategy. The Committee now urges the management of the four research units to make an inventory of the combined research portfolio, and – given the outcome on a joint or a bilocation – to define a strategy on how to maximize collaboration and synergy.

3.1.2 PhD programmes

UvA and VU have joined forces in the physics bachelor and master programmes. The master programme offers courses directly linked to the research topics of the different research groups. This is an excellent way to get well-trained and motivated PhD students. The nominal length of the PhD studies is four years, independent of the origin of funding. Bursary students are treated equally as far as possible. Broad advertisement of PhD vacancies and participation of several staff members in the selection process ensures many and diverse applicants, and admission of the best students from a scientific and social perspective. A promotor and additional supervisors assure quantity and quality in supervision. In addition, all units have a third independent supervisor from another group, or a similar function (department-wide PhD monitor at VU), to act as a confidentiality advisor in case of conflicts between supervisor and student.

A training and supervision plan is set up right after admission, defining the project and courses to be taken, and discussed during the annual progress meeting. This guarantees that steady progress is maintained. Preparations for finding a job after the PhD years are part of these discussions. Approval of the theses by promotor, supervisors and reading committee assures high international standard of PhD Theses. Participation of up to 10% in teaching is an effective mechanism to broaden the physics knowledge of PhD students and provides pedagogic skills useful later in their careers.

The above was confirmed in a meeting of the Committee with a group of excellent and well-motivated PhD students. When asked the PhD students were happy and enthusiastic about their position and secondary circumstances. Moreover, the PhD students stated their appreciation of the corresponding educational programme and their willingness to participate therein. At the same time the Committee noted that, despite active measures being taken on this subject, the time to completion of their theses is for most Amsterdam physics PhD students beyond the nominal 4 years. This is in particular the case for VU and LaserLaB. Several reasons were given for this, but nevertheless this is a situation that must be attended to and improved. The Committee suggests developing an independent monitoring tool or instating a supervisory committee in order to create an improved attitude and awareness with respect to the duration of individual PhD programs.

After PhD graduation unemployment is virtually unknown. Approximately 40% of the students take up postdoc positions in the same or another field (somewhat higher for ITFA, ~60%), 30-40% finds a job in industry or governmental research, and the remaining 20-30% finds a job outside academia (consultancy, finance, teaching, policy making, etc.).

3.1.3 *Research integrity*

No major or minor issues providing evidence of a breach of scientific integrity have been brought to the attention of the Committee. Moreover, the Committee learned that all PhD students are requested to participate in a course on scientific integrity. Nevertheless, the Committee observed that not all staff members are fully aware of the procedures that need to be followed once they are confronted with a case involving a possible breach of scientific integrity. The Committee recommends to prepare a plan for bringing the existing policy under the attention of all ranks of staff, and to further stimulate the open environment and discussions on this topic, e.g., by addressing this on meetings that are attended by all scientists.

Finally, the Committee observed with pleasure that in response to increasingly stringent boundary conditions for data storage set by funding agencies and publishers, the universities have developed tools to help researchers to meet these requirements, and to enable safe storage and sharing of research data.

3.1.4 *Diversity*

Considerable progress has been obtained at both universities regarding the gender balance of the staff. In particular several new female professors have been hired, which is important as they serve as role models for students. Moreover, a large cultural diversity is observed at each research unit based on the fact that many nationalities are represented in the scientific staff.

At the same time the Committee has several concerns regarding the development of diversity. Although the right policies seem to be in place, the Committee noticed that there was still clearly an unconscious bias with respect to gender differences. In that respect the awareness thereof and of the diversity policy in general was perceived to be more mature at the VU physics as compared to the UvA physics research units. This was underlined by the discontinuation of the faculty-wide support for the UvA MacGillavry fellowship programme, conveying the wrong signal towards prospective female junior scientists.

Therefore, the Committee recommends that when discussing diversity more attention should be given to the concept of inclusion rather than the numerical progress obtained. As a more specific recommendation the Committee suggests to pay more attention to the so-called two-body problem of young physicists, i.e., the challenge of combining the career opportunities of young couples, when they apply, and in their first months after the start of their contract.

3.2 LaserLaB

This successful research unit works actively on the frontiers of light-matter interactions ranging from atoms and molecules to living cells and tissues, as well as on sustainable energy. It has 30 PI’s and a total of approximately 120 researchers. The lab is internationally visible and well-connected with joint research activities across Europe, for example being part of *European LaserLaB* which provides networking opportunities and transnational access.

3.2.1 *Research quality*

The Committee considers the scientific work of LaserLaB to be excellent. There are a number of examples, ranging from the area of fundamental physics to biophysics, that are world-leading in research quality. The strategy to staff the research unit with excellent researchers, give them intellectual freedom, and encourage them to work together in teams of 3-5 PI’s is obviously very effective.

Lasers are the foundational technology for this research unit. This common technical base connects various scientific efforts at LaserLaB in a fruitful manner, for example, coherent diffractive imaging, or comb-assisted transfer of stable light. The unit thus has a number of shared technicians as well as shared technical infrastructure. Experimental collaboration is a highlight in LaserLaB, with several common projects being carried out between different groups.

The quality of the research in the past few years is reflected in the truly impressive track record in high-level funding, including several ERC grants (3 advanced, 2 consolidator, 1 starting, 3 proof of concept) besides several highly competitive national grants.

Quantitative assessment research quality: 1

3.2.2 Relevance to society

The societal relevance of LaserLaB is amazingly strong. The work on technology transfer being carried out at LaserLaB is creative, unique, and sets an example for other such groups elsewhere in Europe. The high-tech start-ups emerging from this group are having significant social and economic impact, as illustrated by the recently awarded NWO valorisation prize.

The Committee commends the establishment of the Demonstrator Lab, which is a very effective means for tech transfer. Before the Demonstrator Lab was established, LaserLaB was already involved in getting technology out of the research labs. For example, they had invented fiber-top technology by placing a cantilever directly at the output surface of the fiber. This grew out of a Casimir force measurement, and it now turns into several sensor applications.

This strategy has been institutionalized through the establishment of the Demonstrator Lab, a very creative setup allowing physicists to bring their ideas to market. The Lab helps with a first analysis of ideas, an evaluation of the business case, provides support for space, equipment, network, strategy, seed funding, and moreover implements regular checkpoints. In the first year, 15 ideas were proposed to the market groups, and 8 became registered start-ups. The Demonstrator Lab provides an incubator place for people to explore ideas, but once a company is formed, people move out of the Demonstrator lab. The key to success of the Demonstrator Lab formula is the lowering of the threshold for scientists interested in technology transfer. The Lab also teaches master students a course on entrepreneurship for physicists. The concept of the Demonstrator Lab created by experimental physicists of the LaserLaB may well serve as a best-practice-example that reaches out beyond the Netherlands.

Quantitative assessment relevance to society: 1

3.2.3 Viability

LaserLaB has been very successful in the past, but the Committee has identified several critical issues which require immediate attention to avoid potential harm for the research unit.

Most importantly the viability of LaserLaB is unfortunately affected in a negative way by the failed merger. The fact that the educational curricula of UvA and VU were combined while the planned joint location of the research units could not be realized in the end, may turn out to be a threat for LaserLaB. If they do not enforce active measures to recruit research students, they might become too decoupled from the ‘student flux’.

The PI’s from LaserLaB are still very eager on a closer collaboration with groups from UvA, which would be greatly facilitated by shorter distances between collaborating groups. If the most preferred option of a single location on the Amsterdam Science Park is out of reach, alternatives should be sought without any delay. In such a scenario the planning of the new building that the VU is developing for the LaserLaB researchers (since their current building will be demolished in a few years) should be made as soon as possible. Since this new building probably offers a unique time-window to implement good spatial boundary conditions for closer collaboration, the planning should not be restricted to technical requirements, but should include detailed plans on how to accommodate specific VU - and UvA! - groups who would like to interact more in close vicinity, e.g., by allowing for a flexible mixing of groups across departments in the new building.

The Evaluation Committee sees various possibilities in this respect, for example between the optical tweezers group from LaserLaB and the soft matter group at UvA working on colloidal systems. Or, as another possible example, energy and materials research is being carried out by a single research group at LaserLaB, which raises the question on how a single group can compete with a very active worldwide effort. A new initiative between the two universities and AMOLF is underway, which may help with this issue. Naturally, in some cases special infrastructural requirements (as in the Quantum Gases lab) will prevent a migration of the lab. Here the already discussed fiber link between the two campuses will be a better solution.

It is recommended to set up a committee in the near future that will address possible ways of collaborating more closely with selected UvA teams, as well as the consequences for LaserLaB of having educational programs at a remote campus. Methods need to be developed to encourage students to move from one location to another for enhanced research and learning experiences. Also for this reason the Committee recommends to establish a quick and direct line of public transport that students and staff can use to commute between the two locations. This is a prerequisite for joint events (such as seminars or colloquia) to be successful.

Moreover, the long-term sustainability of Demonstrator Lab is not clear. A worrisome issue is the prospect that the University technology transfer office may limit the number of shares an inventor can have to < 5% shares. The Committee strongly recommends that the university provides support to - instead of placing limits on - this wonderful initiative.

And finally, a strategic effort at the VU Department of Physics level will be needed to find outstanding candidates to replace the prominent PI's of LaserLaB who will retire in coming years. Possibly the 'tiling' that has already been adopted in recent hirings, providing an overlap between two successive generations, can again be realized here, for the maximum benefit of the lab.

Quantitative assessment viability: 2

3.3 Van der Waals-Zeeman Institute

This research unit has developed around three interacting pillars of experimental physics research: hard condensed matter, quantum gases, and soft condensed matter. Within these notably distinct topics the unifying theme is the study of emergent properties of complex matter, both quantum and classical, which provides an intellectual unity. The WZI has laid out a set of grand challenges for their research strategy which are at the forefront of the fields.

3.3.1 Research quality

Over the recent review period, the WZI has been strongly rebuilt with a number of new hires in all three areas. The overall impression of the Committee is that it has developed into a vibrant, interactive, and ambitious research community. It has seen a growth of about 70%, is financially stable, and has been making reinvestments in the group, for example by supporting the new hires and using base funding for infrastructure and equipment.

The Committee acknowledges the high quality of the research performed in the hard condensed matter groups. The strategy to grow high quality single crystals in house, but to rely on (inter)national collaborations for specialized thin films is commendable, as this fits well with the size and positioning of the groups.

The establishment of new cold atom and trapped ion labs is applauded by the Committee. The new labs have developed unique physical systems to work with that are very attractive. This has reinvigorated the activities of WZI on quantum gases, showing great potential for the future.

Also the soft matter groups perform high quality research, exploiting their broad research network in the greater Amsterdam region, especially with AMOLF. The Committee supports the strategy to further strengthen these connections, and the plan to unify the circa 90 soft matter researchers in the area into one large collaborative research effort on soft matter.

Furthermore, the Committee has seen notable evidence of good collaboration with theorists from ITFA, positively impacting science and productivity in both directions.

The Committee is of the opinion that WZI has grown uniformly – no weaker groups being present – into a research unit with ambitious PI's that conduct very good, internationally recognised research. Therefore, the Committee holds little doubt that, as these programs mature, they show promise of developing into world-leading activities.

Quantitative assessment research quality: 2

3.3.2 *Relevance to society*

The grand challenges of WZI span from interesting fundamental and theoretical problems to important practical problems of great potential impact to society and industry. Examples of the former are work on understanding the glass transition in condensed matter physics, or the exploration of new types of interactions in quantum gases. Studies of new materials for photovoltaics, like organometal halide perovskites, and understanding friction at the microscopic level could have great impact on how energy is produced and used. Research output consequently covers a broad spectrum from fundamental to directly applicable science, such as material science, chemistry and engineering.

WZI is very active in outreach through a number of different activities aimed at the general public. There is also a lot of valorisation of scientific results through partnerships with multinationals, SME's, and non-profit organisations, as well as by the founding of start-up companies. Apart from generating income, these collaborations contribute to anchoring WZI research in society. This is also visible in the active participation of WZI in the combined UvA-VU Amsterdam Physics Research and Innovation Lab (APRIL), that hosts amongst others the Demonstrator Lab described earlier.

It is the view of the Evaluation Committee that the WZI makes an outstanding contribution to society through its multifaceted outreach activities and valorisation of scientific results.

Quantitative assessment relevance to society: 1

3.3.3 *Viability*

The WZI strategy to achieve research excellence across a varied programme from fundamental physics to physics with long-term applications has been successful during the evaluation period, judging by the very good, significantly increasing funding over the evaluation period (it almost doubled), and high quality and impact of published work (RI = 2-4, with an increasing trend). The Evaluation Committee considers the strategy to be good, especially given the combination with the very good experimental facilities. The group has also been successful in rejuvenating the age structure among PIs, and the new PIs have already proven to be successful in establishing their own external funding and developing new experimental facilities. This, together with the very active outreach activities and various collaborations with industry, forms as a strong basis for future success. The Committee applauds the fact that the research unit reserved money for strategic reinvestments. The newly initiated collaboration between soft condensed matter physicists in the Amsterdam area is also recognized by the Committee as an important step to make physics research in Amsterdam stronger and more visible.

A potential risk is the large fraction of temporary funding with respect to the base funding. This risk is however partially mitigated by the base funded PhD positions provided by the IoP, significantly increasing the agility of the WZI to set up new research directions. Two ERCs grants have been obtained during the evaluation period, one starting and one consolidator grant, indicating competitiveness also in the near future.

As for its strategic plan, the WZI has a clear vision to be seen as one of the top 10 of comparable institutions in Europe and competitive globally. With the recent hires, strong partnerships with neighbouring institutions on the Science Park and VU, and a solid funding position, it is in a good position to ascend to that rank.

Quantitative assessment viability: 1

3.4 Institute for High-Energy Physics

The IHEF combines the (astro)particle physics sections of both the UvA and VU groups. IHEF is an integral part of Nikhef, the Dutch national institute for subatomic physics. Both experimentalists and theoretical particle physicists from the universities of Amsterdam, Groningen, Nijmegen and Utrecht are part of the Nikhef collaboration and make use of the institutes facilities. For, e.g., the development of instrumentation, there are also connections with the technical universities of Delft, Eindhoven, and Twente.

De facto this means that the VU and UvA particle physics communities have merged via Nikhef. Therefore, the failed departmental level merger is considered a missed opportunity, but has no strong impact on the daily working of the IHEF research unit. IHEF is engaged in a large number of experiments, such as ATLAS and LHCb at the Large Hadron Collider, Antares/KM3NeT, XENON1T, and the VIRGO gravitational wave experiment.

3.4.1 Research quality

During 2010-2016 IHEF was an active player in research that led to two mayor discoveries, namely the discovery of a Higgs particle at the LHC, and the direct discovery of gravitational waves with the LIGO-VIRGO collaboration. These discoveries have led to two Nobel Prizes in Physics based on the work of a community to which the IHEF group belongs. Together with the other projects, the research unit has made smart strategic choices on experiments and projects that they joined in recent years.

The research unit has a very strong involvement in several world leading experimental physics projects, and has made several key contributions to these projects. This is evidenced by the fact that researchers from IHEF have leadership roles in these projects, as exemplified most recently by the prestigious role as elected spokesperson of the VIRGO collaboration.

The connection between experimentalists and theorists is very fluid and easy, and generates good synergy for both parties involved. This collaboration covers most of the areas of high energy physics in IHEF, but the Committee noticed a lack of expertise in gravitational wave theory. The research unit has a plan to remedy this with the planned hire of a gravitational wave astrophysicist through GRAPPA.

Quantitative assessment research quality: 1

3.4.2 Relevance to society

IHEF has done a very good job of taking advantage of the recent breakthroughs in fundamental physics – the discovery of the Higgs, and the first direct detection of gravitational waves – in order to create substantial public impact. The research unit has given a large number of public talks and organized several outreach activities. The work in this direction has been very good – however, given the very favourable current environment, a larger effort in innovating outreach activities might have been possible.

In terms of applications of the research output of IHEF, the instrumentation and software development has been useful to the wider HEP community. There is also involvement in R&D for detectors, and software for medical applications (something that, on the other hand, is relatively common in HEP groups). There appears to be some room for a stronger effort in this direction.

Quantitative assessment relevance to society: 2

3.4.3 Viability

IHEF has grown during the last years through strategic new group member hirings, and also thanks to the GRAPPA initiative. There is a plan for the expansion and later continuation of gravitational wave research. The Committee fully endorses this plan, as well as that to expand in theoretical research efforts on this subject.

A very positive aspect is that the funding for most core projects of IHEF seems secured into the future for the next 10 years. However, some of the projects (e.g., on dark matter, cosmic rays, and neutrinos) – while having sufficient bridging funds – are dependent on the outcome of calls from the national funding agency NWO. In that sense the present ongoing restructuring of the NWO funding system might be perceived as a potential threat.

There are enough plans and ambitions within IHEF for the coming period. Furthermore, via Nikhef they have impressive workshops available and are involved in various activities in several on-going experiments, making them highly wanted as a collaborator in new high-energy or astroparticle physics projects. Hence, the research unit has more than enough possibilities to participate in future projects. The European-wide review in high-energy physics starting in 2018 and the world-wide evolution in, e.g., colliders will form an excellent framework for future decisions on new projects in which Dutch particle physicists – and hence IHEF – may participate. IHEF is via the Nikhef collaboration exceptionally well positioned to make the right choices in this context.

Quantitative assessment viability: 1

3.5 Institute for Theoretical Physics Amsterdam

The Institute of Theoretical Physics Amsterdam (ITFA) has a longstanding history as a leading centre of theoretical physics in the Netherlands and as being among the topmost institutions in its field in Europe and in the world. It is particularly strong in the areas of string theory and cosmology, but additionally, one aspect that makes it rather unique is its blend of high energy theory and condensed matter theory. ITFA also has a large public visibility and has engaged successfully in public outreach by taking a very proactive stance, including the appointment of a part-time outreach officer.

ITFA is currently planning to launch an international high-quality MSc program that would be a focus of attraction of young talent worldwide. The Committee encourages ITFA to pursue this goal – the institute definitely has the potential to carry it out, given the excellence of its personnel both in research and in teaching. However, a main obstacle is how to secure stable funds for providing scholarships. ITFA is well aware of this, and the Committee is convinced that the right steps are taken to overcome this problem.

3.5.1 Research quality

The quality of the research done at ITFA is excellent, of worldwide top level. The Committee regards some of its members as exceptional researchers of the kind who make a strong qualitative difference. Indicators of quantity and quality of the research output show a clear upward trend in the period of evaluation. However, although the string theory and cosmology groups are consistently very strong and essentially show no significant weaknesses, the group in soft condensed matter is somewhat hampered by its currently limited size.

Quantitative assessment research quality: 1

3.5.2 Relevance to society

ITFA makes a strong effort to generate a return to society in different forms. In fact, the Committee is under the impression that the unit actually undersells what it achieves in this direction. The example of an application to MRI made by a former student of the group is an excellent example of relevance to society which, surprisingly, was not included in the SEP report. The Committee recommends making, e.g., the strong transformative potential of the QuSOFT project, or the very interesting and promising SciPost initiative, much more visible as part of the efforts that ITFA undertakes in this direction.

Quantitative assessment relevance to society: 2

3.5.3 Viability

With its recent hirings ITFA has achieved a very good age set-up, and has been successful in attracting very substantial research funds. However, during the site visit the impression was created that it might be difficult to continue this hiring strategy in the coming years. At present ITFA lacks expertise on Beyond the Standard Model (BSM) physics and Gravitational Wave (GW) physics. It is clear that GW physics is going to remain important for many years. To remedy the current gap, it is planned to hire a gravitational wave astrophysicist through GRAPPA. The future prospects of BSM physics may be less clear, but if there is a sudden development in this field, it is not quite clear how ITFA will be able to quickly adapt to it. The Committee recommends considering the benefits to ITFA of filling this gap and of acting in this direction, and to further strengthen the efforts on quantum information.

For soft condensed matter theory, its future prospects are less convincing as they acknowledged themselves to be subcritical in size. Additionally, the lack of large groups on experimental research on hard condensed matter nearby seems to be a factor preventing a stronger connection of the condensed matter theory group's work to actual experiments. The Committee recommends taking steps to remedy this situation, and to try to reach out to groups that perform relevant table top experiments in the Netherlands. This may possibly anticipate the formation of a larger soft condensed matter group in the Amsterdam region.

Finally, the Committee recommends setting up a strategic hiring plan, in which the above considerations are taken into account.

Quantitative assessment viability: 2

4 General conclusions and recommendations

During the past six years physics research at the Amsterdam universities has succeeded in presenting itself increasingly as a single entity with a common strategy and a clear division of tasks. The strong leadership and common strategy have resulted in a significant growth in quality and volume of research, and a rejuvenation of the staff with highly competitive new researchers. Given the success of this collaboration and cooperation the Committee recommends to continue on this course of convergence, and to redefine a common strategy taking into account recent developments. The Committee still envisages a shared location on the Science Park in Amsterdam, in which most of the VU and UvA physics research units are jointly based, as the most desirable outcome of this new strategy. However, if the use of two locations is a boundary condition for the future of Amsterdam University Physics, the Committee advises to form – on short notice – a concrete plan on how to best make use of these two locations, allowing for individual research teams to move either to the VU campus or the Science Park depending on the best prospects for the given activities.

Having assessed the four research units, the Committee ranks the overall scientific quality as excellent, with some groups internationally recognized to be very good and others to be world leading, but no significantly weaker groups being present. Room for improvement may be found in strengthening the synergy between some of the smaller groups in the different research units, or in creating a stronger connection between theoretical and experimental groups. The relevance to society is ranked as very good to excellent, with outstanding contributions represented by the collaborative VU-UvA efforts in the APRIL programme and the Demonstrator Lab. The efforts on outreach are very good, but may leave room for some innovation. Also the viability is ranked as very good to excellent, with each research unit on itself being very well to excellently equipped for the future. However, as a whole the viability of the vibrant physics community in Amsterdam is severely hampered by the failed merger of the two departments. In this respect the Committee can only reiterate what was stated in the paragraph above.

The Committee regarded the PhD programme of both UvA and VU to be well organised, although the time to completion of the PhD thesis is a point of attention, especially at the LaserLaB. With regards to both research integrity and diversity, the universities seem to have made a considerable effort by means of developing and implementing the right policies. However, on both topics there is room for an increase in awareness of these policies, in particular at the UvA for the diversity policy.

Below we summarize the most important recommendations for the four individual research units that were reviewed during the research assessment.

LaserLaB

1. Set up a committee in the near future that will address possible ways of collaborating more closely with selected UvA teams, as well as the consequences for LaserLaB if the educational programs have to be given at a remote campus.
2. In the case of separated educational and research activities, take active measures to recruit research students, for example by establishing a quick and direct line of public transport that students and staff can use to commute between the two locations.
3. Prepare a detailed planning on how to accommodate specific VU and UvA groups that would like to collaborate in close vicinity in the new VU building, in case the most preferred option of a single location on the Amsterdam Science Park turns out to be out of reach.
4. Initiate the setting up of a strategy at the VU Department of Physics for the replacement of prominent PI's of LaserLaB who will retire in coming years.

Van der Waals-Zeeman Institute

1. Stick to the current strategy of reserving money for strategic reinvestments, hiring promising young PI's and seeking strong partnerships with neighbouring institutions on Science Park and VU.
2. One of the strengths of WZI is in the balance between the three topical groups (hard condensed matter, soft condensed matter and quantum gasses). Make sure that in the further development of WZI this balance is preserved, and prevent that one of the topical groups becomes subcritical in size.

3. Stimulate the further development of the recently started PI's which have the potential of becoming world leading.
4. Strengthen the ties with the condensed matter theorists at ITFA and other relevant theory groups, especially anticipating the larger collaborative effort on soft condensed matter.
5. Provide full support for and set up a shared strategy with LaserLaB to come to further exchange and collaboration, either (ideally) in one location, or by means of exchange of (sub)groups and the construction of a direct fiber link.

Institute for High-Energy Physics

1. Expand and continue the work on gravitational wave research by reinforcing the theoretical research efforts on this subject.
2. Prepare a solid personnel strategy, anticipating upcoming retirements.
3. Try to innovate in outreach activities, making use of the current favourable environment.

Institute for Theoretical Physics Amsterdam

1. Prepare a strategic hiring plan, accounting for the current lack in expertise on *Gravitational Wave* physics and possibly also in *Beyond the Standard Model* physics and the subcritical size of the soft condensed matter theory group.
2. Strengthen the collaboration of the condensed matter theory groups with relevant table top experiments in the Netherlands, also anticipating the possible formation of a larger soft condensed matter group in the Amsterdam region.
3. Give more visibility to the very good efforts that the research unit undertakes that are relevant to society, for example by showcasing the work on the QuSOFT project and the SciPost initiative.

Appendix 1. Curricula Vitae of Evaluation Committee Members

Gerard van der Steenhoven was appointed as Director General of the Royal Netherlands' Meteorological Institute (KNMI) in 2014. Previously, he served as dean of the Department of Science and Technology of the University of Twente (2008 – 2013), one of the three technical universities in the Netherlands. During this period he founded (in 2009) and led the Twente Graduate School, a university-wide organization aimed at streamlining and modernizing graduate education. In 2015 he was re-appointed as extraordinary professor in the domain of meteorology and climatology. Van der Steenhoven was educated in physics at the Vrije Universiteit in Amsterdam, where he defended his PhD thesis in 1987. Thereafter, he obtained a postdoc position at MIT (Cambridge, Massachusetts) at the Laboratory for Nuclear Science. Subsequently, he was employed by the National Institute for Subatomic Physics (Nikhef) in Amsterdam, where he has been involved in – and led – various large international scientific projects in Lund (Sweden), Hamburg (Germany) and Marseille (France). In the year 2000 he was appointed as part-time professor of physics at the University of Groningen. Over the years, Van der Steenhoven has served in numerous boards and advisory committees. A few examples. In 2004 he founded the Committee for Astroparticle Physics in the Netherlands. Later he served as president of the Netherlands' Physical Society (2007 – 2013) and chairman of the board of the Research School for Process Engineering (2008 – 2013). Moreover, he has been chairing the international Scientific Advisory Committee of the Dutch institute for energy research (DIFFER) from 2009 to 2016. Other examples include various boards and committees that were initiated by the Department of Economic Affairs in the framework of the so-called top sector policy (2011 – 2013). More recently, he was appointed in the fellowship committee of the "Prins Bernhard Cultuurfonds" and various (international) review committees.

Roberto Emparan obtained his PhD in 1995 from the University of the Basque Country, and afterwards held postdoctoral positions at University of California in Santa Barbara, at Durham University, and at CERN. Since 2003 he is ICREA Research Professor at University of Barcelona. His field of research is classical and quantum gravity, string theory, and black hole physics, subjects on which he has authored more than one hundred articles (with >11.000 citations and h-index=52 in Google Scholar). He has given about 200 invited and plenary talks at international conferences, workshops, and seminars. Among other institutional responsibilities, he is a Committee Member of the International Society on General Relativity and Gravitation, panel member for ERC Starting Grants, and editor of JHEP. In 2014 he held an Invited Visiting Professorship at Yukawa Institute of Theoretical Physics, Kyoto. In 2016 his project on "A New Strategy for Gravity and Black Holes" was awarded an ERC Advanced Grant.

Peter B. Littlewood is professor of Physics at the University of Chicago. He gained a first-class degree in Natural Sciences at the University of Cambridge (UK) in 1976 and was then awarded a Kennedy Scholarship to work at the Massachusetts Institute of Technology for two years. He returned to Cambridge (UK) in 1977 to complete his PhD. Beginning in 1980, he worked at Bell Labs, finishing his time there as head of theoretical physics research after assuming the position in 1992. In 1997, he became a professor at the Cavendish Laboratory in Cambridge (UK), was head of the Theory of Condensed Matter group, and served as Matthias Scholar at Los Alamos National Laboratory during a sabbatical in 2003-04. In 2005, he returned to Cambridge (UK) to become head of the Cavendish Laboratory. In 2011 he was named the Associate Laboratory Director for Physical Sciences and Engineering at the Argonne National Laboratory in the US, of which he became full director in 2014. In January 2017, he retired as director to resume his research at the University of Chicago. Littlewood holds 8 patents, has published more than 250 articles with >21.000 citations and h-index=70 in Google Scholar. His research has variously included studying the phenomenology and microscopic theory of high-temperature superconductors, transition metal oxides and other correlated electronic systems, and the optical properties of highly excited semiconductors. He has applied his methods to engineering, including holographic storage, optical fibers and devices, and new materials for particle detectors.

Monika Ritsch-Marte received her M.Sc. in Physics from the University of Innsbruck in 1984 and her PhD in Quantum Optics from the Waikato University in New Zealand (under the supervision of D.F. Walls) in 1988. After several Postdoc projects (Boulder/Colorado, Milano, Helsinki), and after completing her Habilitation at the Institute of Theoretical Physics in Innsbruck, she accepted the Chair of Biomedical Physics at the Medical University in Innsbruck in 1998 where she founded a Biomedical Optics group. Her current research interests include holographic optical tweezers, digital holographic microscopy and linear and non-linear Raman microscopy. She has received numerous research grants and awards, including an ERC Advanced Grant and the Boltzmann Award of the Austrian Physical Society. She is a member of the Austrian Academy of Science and a Fellow of the Optical Society of America.

Albert De Roeck is a senior research scientist and staff member of CERN, professor at the University of Antwerp (Belgium) and a visiting professor at the University of California Davis, the British University in Cairo (Egypt) and NTU in Singapore. He obtained his PhD in 1988 at the University of Antwerp on the NA22 experiment at CERN, studying the multi-particle dynamics in hadron-hadron interactions, by colliding meson beams on protons and nuclear targets. From 1989 until 1999 he was permanent research scientist at DESY, where he and his team made very precise measurements of the quark and gluon structure of the proton, performed precise tests of the strong force, 4 years of this time he was the physics coordinator of the H1 experiment. From 1999 onwards he was based at CERN as a senior research scientist, with major science focus on searches for the Higgs and new physics at future particle colliders, in particular Supersymmetry and Extra Dimensions. He first joined the OPAL experiment at the large electron-positron collider LEP, studying the strong force and searching for signals of new physics. In 2000 he joined the preparation the Compact Muon Solenoid (CMS) at the LHC. De Roeck was the organizer of the Physics TDR of the experiment in 2005-2007, was also the deputy spokesperson of the CMS experiment in 2010 and 2011, and the convener of the Higgs search physics group in 2011-2013, and had a leading role in the discovery of that particle in July 2012. He now leads an exotica search group in CMS. Since 2016 he became also the leader of the newly reinstated neutrino physics group at CERN and is now also an active member in the DUNE experiment. Currently he is involved in the MoEDAL (CERN), MilliQan (CERN) and SoLiD (Mol, Belgium) experiments. He has over 1400 publications and h-index of 161 (SPIRES).

Villy Sundström received his PhD at Umeå University, Sweden, in 1977 after studies at Bell Laboratories under the guidance of Professor Peter Rentzepis. At Umeå University he later built the first picosecond laboratory in Scandinavia. In 1994 he moved to Lund University where the Chemical Physics Division was created, which today houses approx. 50 scientists and students working on ultrafast and single molecule spectroscopy. Sundström received an ERC Advanced Investigator Award 2008, is an Editor of Chemical Physics Letters and Member of the Royal Swedish Academy of Science. He has authored 367 papers (with >18000 citations and h-index=73 in Web of Science). His research interests include the study of excited state and charge carrier dynamics in nanostructured materials for solar energy conversion, chemical reaction dynamics, ultrafast structural dynamics in chemical and biological systems studied with time resolved X-ray spectroscopy, photophysics and photochemistry of melanin and other natural pigments and their building blocks, femtobiology (ultrafast spectroscopy applied to various biological systems), and photosynthetic light-harvesting (energy flow pathways and energy transfer mechanisms).

Jun Ye is a Fellow of JILA, a joint institute of NIST and University of Colorado. He is a member of the National Academy of Sciences, a Fellow of NIST, a Fellow of the American Physical Society, and a Fellow of the Optical Society of America. His research focuses on the frontiers of light-matter interactions and includes precision measurement, quantum physics and ultracold matter, optical frequency metrology, and ultrafast science. He has co-authored over 300 scientific papers and has delivered 500 invited talks. Awards and honours include US Presidential Rank (Distinguished) Award, three Gold Medals from the U.S. Commerce Department, Foreign Member of the Chinese Academy of Sciences, Frew Fellow of the Australian Academy of Science, I. I. Rabi Prize of the American Physical Society, European Frequency and Time Forum Award, Carl Zeiss Research Award, William F. Meggers Award and Adolph Lomb Medal from the Optical Society of America, Arthur S. Flemming Award, Presidential Early Career Award for Scientists and Engineers, Friedrich Wilhem Bessel Award of the Alexander von Humboldt Foundation, and Samuel Wesley Stratton Award and Jacob Rabinow Award from NIST.

Appendix 2. Site visit programme

Sunday, 10 December	
18:00	Welcome
18:30	Installation of Committee on behalf of University Boards
19:30	Dinner

Monday, 11 December	
09:30	Closed briefing: discussion on procedures, division of tasks
11:00	Discussion with staff on human resource policies (tenure track, diversity)
13:00	Lunch meeting with stakeholders of UvA and VU Physics
14:30	Assessment research unit ITFA
14:30	Presentation and discussion
15:45	Pitch sessions
16:20	Topical presentation: Cosmology
16:35	Discussion with Committee
17:00	Closed session: recap ITFA and day 1
19:00	Working dinner for Committee

Tuesday, 12 December	
09:00	Assessment research unit LaserLaB
09:00	Presentation and discussion
10:15	Discussion with deans
10:30	Lab tour
11:15	Second presentation and discussion
11:45	Closed session: recap LaserLaB
12:15	Transport to Science Park
13:00	Lunch meeting: poster session and discussion with PhD students and postdocs
14:30	Assessment research unit WZI
14:30	Presentation and discussion
15:45	Lab tour
16:30	Second presentation and discussion
17:00	Closed session: recap WZI and day 2
19:00	Working dinner for Committee

Wednesday, 13 December	
08:30	Assessment research unit IHEF
08:30	Presentation and discussion
09:45	Lab tour
10:30	Second presentation and discussion
11:00	Closed session: recap IHEF, work on report (including lunch)
14:00	Presentation by Committee of first impressions
15:00	Adjourn

Appendix 3. Quantitative data on composition and financing

To ensure that the evaluation report can be read as a standalone document, the SEP 2015 – 2021 requires the addition of quantitative data on composition and financing of the evaluated research units. However, the here presented information is only an excerpt of the full self-evaluation report of the Amsterdam University Physics presented to the Committee, which can be found here http://iop.uva.nl/evaluation/.

A3.1 VU Department of Physics and Astronomy

The VU Department of Physics and Astronomy is led by a head of department (currently Gijs Wuite). Together with the department manager (currently P.M. Erne), the director of education (currently Marloes Groot) and a fourth member (currently Gerhard Raven), the head of department forms the department management team. The department decides on appointments and all matters related to finances and laboratory & office space. Final decisions on the budget are taken after consultation of the Faculty Board and the Dean of the Faculty of Science (currently Guus Schreiber). Major strategic decisions are discussed within the physics “staff convent” consisting of all tenured staff in the department, or, for some specific issues (major appointments; cum laude PhD awards), with all full professors at the department. Over the last years, major decisions have been made in consultation with the management team of UvA.

Over the past 10 years, the department has grown significantly thanks to very successful grant acquisition and ‘Sectorplan’ funds from the Dutch government (see Figure A3.1). With Sectorplan funding and as a result of the focus-area policy of the VU (‘speerpuntenbeleid’), the research programme of the department has been consolidated along three main profiles: Physics of Life, Physics of Energy and Fundaments of Physics. Each profile consists of research groups with several PIs and independent research lines. The research activities combine theoretical and experimental research. Within the Fundaments of Physics profile, the department’s subatomic physics activities are embedded within the Nikhef collaboration, which brings together the expertise of five universities in the National Institute of Subatomic Physics, located in Amsterdam. These subatomic physics research activities are evaluated as part of the research unit IHEF. The rest of the department’s research activities are evaluated as the research unit LaserLaB.

Despite severe cuts in the budget allocations to universities on the national level, multiplied by equally severe budget cuts towards the science departments within VU, the Department of Physics and Astronomy has managed to grow based on external funding.

In Figure A3.2 the financial developments within the VU Department of Physics and Astronomy 2010-2016 are presented. The research-specific part of the direct funding could not be presented in a meaningful way: income from research and education are typically lumped and the rules for awarding direct funding have changed several times during the evaluation period.

In the new financial arrangement of VU, the research within the department (i.e., PhD students, postdocs, equipment and running budget) is mostly financed by outside sources (FOM, NWO, EU, etc.) while the department itself provides the salaries of the scientific and support staff, the running budget for all academic staff and ‘hours’ for support in the electronic and mechanical machine shops. The running budget and machine shop hours are provided to the research sections according to the group size. In addition, the department has defined a “solidarity model” in which recipients of personal grants (NWO-Vidi/Vici, ERC) pay their salary or part of it from their grant. This financing model critically relies on the academic staff members obtaining external research funding.

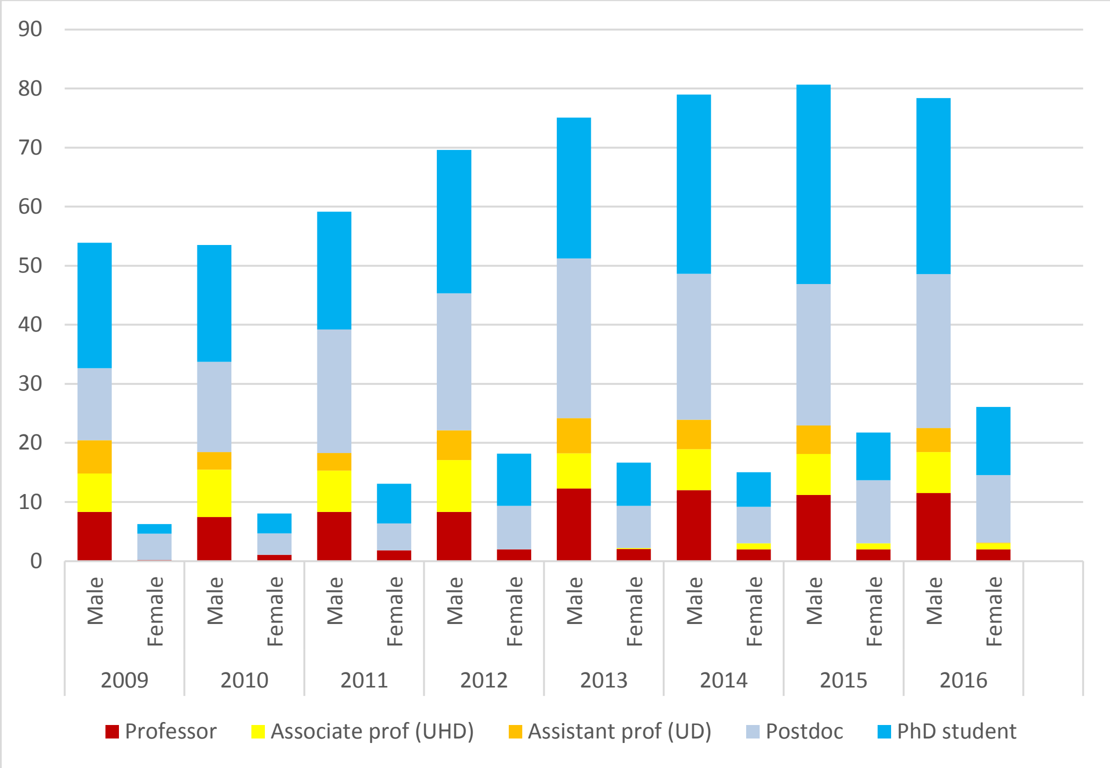

Figure A3.1. Development of staff positions at the VU Department of Physics and Astronomy 2010 – 2016.

	2010	2011	2012	2013	2014	2015	2016
Funding	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**
Direct funding	28.7 (42%)	27.6 (31%)	27.2 (32%)	29.0 (40%)	35.2 (34%)	39.0 (50%)	41.2 (47%)
Research grants	27.2 (36%)	31.3 (40%)	38.0 (44%)	38.0 (37%)	39.4 (40%)	36.3 (28%)	33.9 (24%)
Contract research	13.8 (22%)	22.9 (29%)	31.9 (24%)	31.9 (23%)	27.2 (26%)	36.1 (22%)	37.3 (29%)
Total funding	**69.6**	**81.69**	**97.13**	**96.76**	**101.78**	**111.46**	**112.3**
Expenditure							
Personnel costs	M€ 4.91	M€ 5.57	M€ 6.92	M€ 7.66	M€ 7.99	M€ 8.52	M€ 8.65
Other costs	M€ 1.98	M€ 4.87	M€ 3.89	M€ 2.47	M€ 3.71	M€ 2.63	M€ 5.52
Total expenditure	**M€ 6.89**	**M€ 10.43**	**M€ 10.81**	**M€ 10.14**	**M€ 11.7**	**M€ 11.14**	**M€ 14.17**

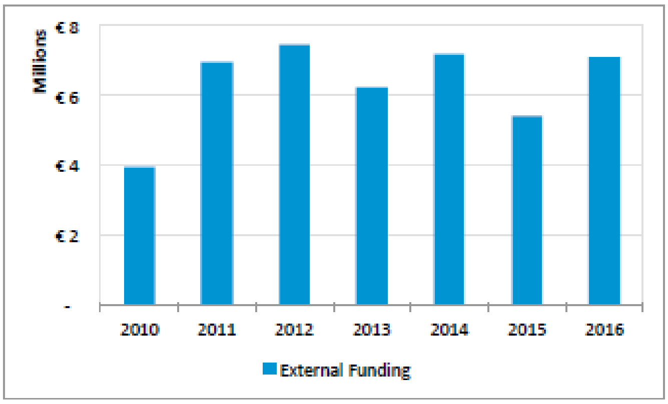

Figure A3.2. Financial development of the VU Department of Physics and Astronomy 2010 – 2016. Bottom graph showing external funding only. Fluctuations are due to large investments, but an overall increase in turnover can be observed.

A3.2 UvA Institute of Physics

The UvA Institute of Physics (IoP) was founded in 2011 and consists of three smaller physics institutes: the Van der Waals-Zeeman Institute for Experimental Physics (WZI), the Institute for Theoretical Physics Amsterdam (ITFA) and the Institute for High-Energy Physics (IHEF). The IHEF is embedded within the Nikhef collaboration, together with fellow institutes of VU and three other universities.

Over the evaluation period, the Institute of Physics has tremendously grown, from 98 fte in 2010 to 171 fte in 2016 (see Figure A3.3). This growth is primarily caused by successful grant acquisition, Sector Plan funds from the Dutch government and a successful use of the Research Priority Area within the UvA.

The divisions of IoP are all of roughly equal size in terms of (permanent) scientific staff. The IoP is led by a directorate / management team consisting of the heads of the three divisions (currently Paul de Jong for IHEF, Daniel Bonn for WZI, and Jan de Boer for ITFA), one of which acts as the IoP director (currently Paul de Jong), and the institute manager (currently Joost van Mameren). The IoP directorate operates in an informal and collegial manner, in which much of the divisions' strategic and operational matters are effectively delegated to the division heads. The divisions each have a separate tradition of (informal) management, such as via regular staff lunches, where matters concerning research and teaching are discussed on an informal basis.

The IoP support office provides administrative and secretarial support for matters related to HR, ICT, outreach and PR, finance, event organization, website, etc. Specialized services are offered by faculty-level teams for project administration, finance and control, HR and legal advice, communications and outreach. To make sure research and outreach stay closely connected, a dedicated position was created in 2016, currently filled by M. Vonk, who spends 40% of his time on research and teaching and 60% on outreach. Also a few members of the technical support staff are directly appointed at the IoP. In addition, the Faculty of Science comprises a Technology Centre (TC) providing mechanical and electronic workshop services to all experimental research institutes. IoP alone (through its WZI division) takes up well over 50% of the capacity of TC, indicating the important role of such services in an experimental physics context.

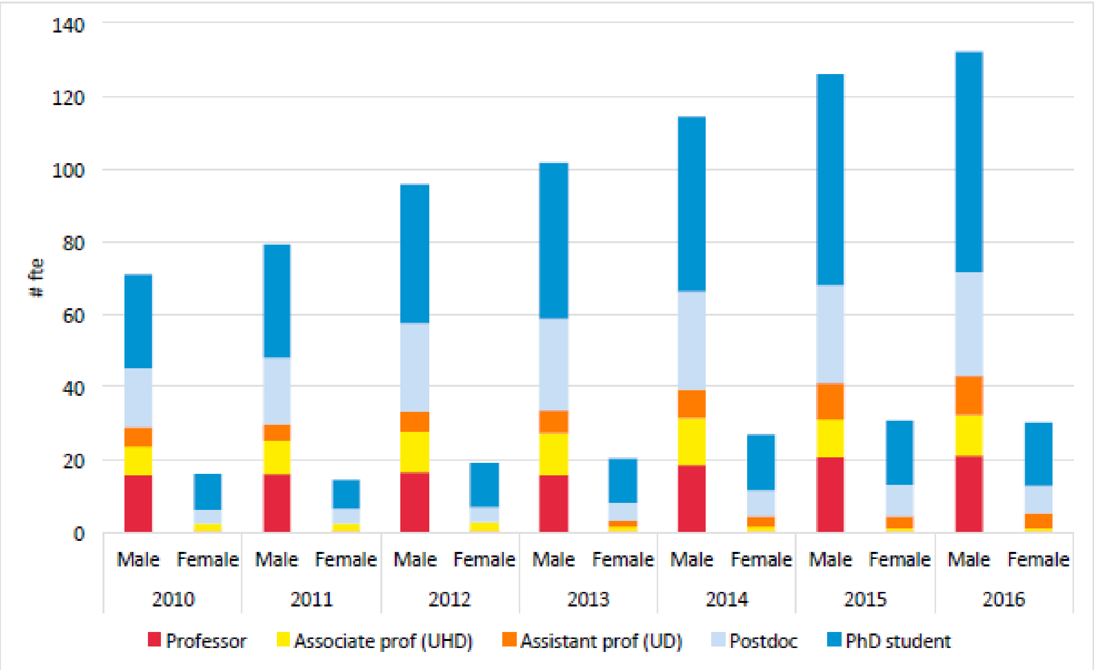

Figure A3.3. Development of staff positions at the UvA Institute of Physics 2010 – 2016.

In 2006, the UvA adopted a full-cost accounting system. In this system, practically all costs of the university's supporting infrastructure (housing, financial, personnel, IT services, library, etc.) are attributed to the institutes. The institutes are compensated for these higher costs in the form of additional direct funding. This not only influences the apparent difference in the ratio of internal to external research funding between experimental and theoretical institutes (as the former need to meet a much higher non-personnel cost base), but also impacts comparisons between such figures for different universities. The development of personnel numbers and other expenditures can be found in Figure A3.4. The direct government funding budget allocated to the IoP is characterized by three components:

1. A fixed base amount;
2. A parametrized component that is primarily determined by performance indicators such as the numbers of PhD degrees and undergraduate diplomas conferred, the teaching effort by IoP staff and the annual turnover of externally funded projects;
3. Fixed (often temporary) budgets earmarked for specific strategic goals, such as investments in research priority areas.

Besides direct funding, project funding is obtained from national research funding organization like NWO, FOM and STW, from international sources such as the EU, or from industrial / private partners.

Figure A3.4 shows the budget development of both the direct and external budgets over the past years. Note that the full-cost accounting system used at UvA makes for the fact that acquired project grants do not cover the full overhead costs of a project, which thus has to be covered by the direct funding. Also note that externally funded projects in which IHEF staff is involved are completely administrated through Nikhef and are thus not included in the graph. From the graph it is clear that both the direct funding and the external funding have increased significantly, despite national trends of budget cuts in the type of (fundamental) research carried out at IoP. A large fraction of the external funding consists of personal grants (ERC Starting/Consolidator grants, NWO Vidi/Vici grants) awarded to early to mid-career staff members. This is to a large extent attributed to the coherent support programme offered to staff members who apply for grants offering (a) the help of a freelance text editor, (b) structurally organising proofreading sessions by colleagues, and (c) support by a freelance interview trainer to prepare for committee interviews.

	2010	2011	2012	2013	2014	2015	2016
Funding	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**	**# fte (%)**
WZI							
Direct funding	21.1 (46%)	18.7 (37%)	20.0 (35%)	24.4 (40%)	31.6 (47%)	33.1 (45%)	33.9 (43%)
Research grants	24.2 (52%)	30.8 (61%)	34.7 (62%)	33.2 (54%)	30.0 (44%)	31.7 (43%)	32.3 (40%)
Contract research	1.0 (2%)	1.3 (3%)	1.7 (3%)	3.5 (6%)	6.2 (9%)	8.6 (12%)	13.5 (17%)
Total funding	**46.3**	**50.9**	**56.5**	**61.1**	**67.8**	**73.4**	**79.8**
IHEF (IoP)							
Direct funding	11.4 (82%)	10.0 (76%)	10.1 (74%)	12.1 (100%)	12.1 (92%)	12.2 (86%)	12.8 (73%)
Research grants	2.5 (18%)	2.5 (19%)	3.6 (26%)	0.0 (0%)	1.0 (8%)	2.0 (14%)	4.7 (27%)
Contract research	0.0 (0%)	0.6 (5%)	0.0 (0%)	0.0 (0%)	0.0 (0%)	0.0 (0%)	0.0 (0%)
Total funding	**13.9**	**13.2**	**13.7**	**12.1**	**13.1**	**14.2**	**17.5**
ITFA							
Direct funding	14.4 (38%)	15.7 (40%)	19.6 (37%)	15.1 (29%)	18.6 (31%)	20.3 (29%)	20.8 (28%)
Research grants	11.0 (29%)	20.3 (52%)	25.1 (48%)	27.8 (53%)	28.7 (48%)	36.1 (51%)	41.7 (57%)
Contract research	12.3 (33%)	3.1 (8%)	7.6 (14%)	9.8 (19%)	12.7 (21%)	14.7 (21%)	11.1 (15%)
Total funding	**37.7**	**39.1**	**52.2**	**52.7**	**60.0**	**71.0**	**73.6**
Institute of Physics							
Direct funding	46.9 (48%)	44.5 (43%)	49.7 (41%)	51.6 (41%)	62.3 (44%)	65.6 (41%)	67.5 (40%)
Research grants	37.7 (38%)	53.7 (52%)	63.5 (52%)	61.0 (48%)	59.6 (42%)	69.8 (44%)	78.7 (46%)

	2010	2011	2012	2013	2014	2015	2016
Contract research	13.3 (14%)	5.0 (5%)	9.3 (8%)	13.3 (11%)	18.8 (13%)	23.2 (15%)	24.7 (14%)
Total funding	**97.9**	**103.2**	**122.4**	**125.9**	**140.8**	**158.7**	**170.9**
Expenditure (Institute of Physics)							
Personnel costs	M€ 4.65	M€ 4.2	M€ 4.98	M€ 5.39	M€ 6.8	M€ 7.83	M€ 8.44
Other costs	M€ 4.35	M€ 4.19	M€ 5.69	M€ 5.75	M€ 7.32	M€ 7.45	M€ 8.08
Total expenditure	**M€ 9.01**	**M€ 8.38**	**M€ 10.67**	**M€ 11.15**	**M€ 14.12**	**M€ 15.27**	**M€ 16.52**

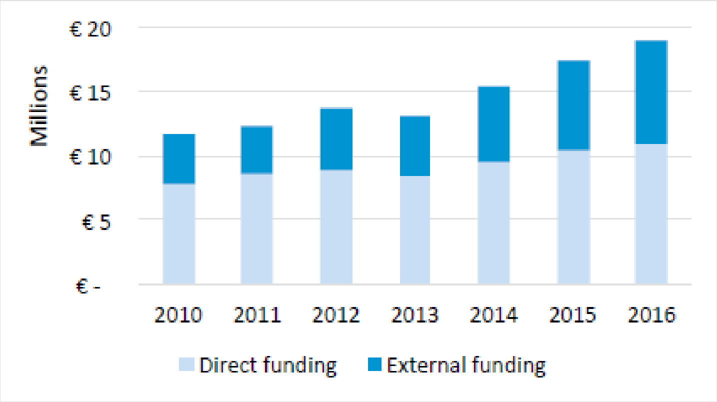

Figure A3.4. Financial development of the UvA Institute of Physics 2010 – 2016. Externally funded projects in which IHEF staff is involved are not included in this graph. The ratio of direct and external funding is influenced by the full-cost accounting scheme currently in place at the UvA, in which overhead costs have to be covered from the direct funding budget.

Appendix 4. Explanation of the categories utilised

Table 1, definition of categories according to SEP 2015 – 2021.

Category	Meaning	Research quality	Relevance to society	Viability
1	World leading/ excellent	The research unit has been shown to be one of the few most influential research groups in the world in its particular field.	The research unit makes an outstanding contribution to society.	The research unit is excellently equipped for the future.
2	Very good	The research unit conducts very good, internationally recognised research.	The research unit makes a very good contribution to society.	The research unit is very well equipped for the future.
3	Good	The research unit conducts good research.	The research unit makes a good contribution to society.	The research unit makes responsible strategic decisions and is therefore well equipped for the future.
4	Unsatisfactory	The research unit does not achieve satisfactory results in its field.	The research unit does not make a satisfactory contribution to society.	The research unit is not adequately equipped for the future.