Assessment Committee Report on Research in Applied Physics, 2010-2015 at the Faculty of Applied Sciences, Delft University of Technology

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Colophon

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Assessment Committee Report on Research in Applied Physics, 2010-2015 at the Faculty of Applied Sciences, Delft University of Technology

Editors
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PREFACE

The Assessment Committee was assigned the task of evaluating the research carried out by four departments in the Faculty of Applied Sciences at Delft University of Technology over the period 2010-2015. The committee, composed of Sara Bals, Matthias Rief, Heike E. Riel, Benjamin M.W. Tsui, and myself covered a broad range of expertise that matched well with the topics of the review.

The committee held in-depth deliberations on all aspects of the evaluation, addressing fundamental aspects related to scientific and engineering excellence, societal impact and viability, management, and as well as strategic planning. The final conclusions in this report that result from our discussions are unanimously supported by all committee members.

I wish to thank the committee members for their hard work and the collaborative spirit in these two intense days, and our secretary Sven Laudy for excellent preparations and support. We thank the Faculty for the very welcoming atmosphere and the informative and open interaction that we experienced during our site visit in Delft.

Prof. Dr. Albert Polman
Chairman of the Committee

1. Assessment Committee and Assessment Procedures

1.1 Assessment Scope

The Assessment Committee was asked to assess the research of the four physics Departments of the Faculty of Applied Sciences at Delft University of Technology. This assessment covers research in the period 2010-2015. In accordance with the Standard Evaluation Protocol 2015-2021 for Research Assessments in the Netherlands (SEP), the Committee's tasks were to assess the quality, relevance to society, and viability of the research programmes on the basis of the information provided by the Faculty and interviews with Faculty management and research Departments. Following this, the Committee was to make recommendations for the future.

1.2 Committee Composition

The members of the Committee were:

Prof. Dr. Albert Polman, Committee Chair, Professor of Nanophotonics at FOM Institute AMOLF, Amsterdam, The Netherlands.
Prof. Dr. Sara Bals, Professor of Electron Microscopy for Materials Science at University of Antwerp, Belgium.
Prof. Dr. Matthias Rief, Professor of Molecular Biophysics at Technical University Munich**,** Germany.
Dr. Heike E. Riel, Researcher of Materials Integration & Nanoscale devices at IBM Research Laboratory, Rüschlikon, Switzerland.
Prof. Dr. Benjamin M.W. Tsui, Professor of Radiology, Electrical and Computer Engineering, Biomedical Engineering, and Environmental Health Sciences at Johns Hopkins University, Baltimore, MD, USA.

A short curriculum vitae of each committee member is included in Appendix A.

Ir. Sven Laudy of Quicken Management Consultants was appointed secretary to the Committee.

1.3 IMPARTIALITY

All Committee members signed a statement of impartiality and confidentiality to ensure that they would assess the quality of the research programmes in an impartial and independent way. Committee members reported any existing personal or working relationships between Committee members and members of the programmes under review before the interviews took place. The Committee discussed these relationships at the first Committee meeting. The Committee concluded that there exist no unacceptable relations or dependencies that could lead to bias in the assessment.

1.4 DATA PROVIDED TO THE COMMITTEE

The Committee received the following detailed documentation:

- Self-evaluation report of the unit under review, including all the information required by the Standard Evaluation Protocol (SEP), with appendices,
- Previous assessment report 2004-2009,
- The full publication lists of the physics Departments of the Faculty of Applied Sciences,
- Long term strategic plan Faculty of Applied Sciences 2016 – 2020,
- Additional benchmarking information of the Departments of Imaging Physics, Quantum Nanoscience, Bionanoscience and Radiation Science and Technology.

In addition, Department heads provided hand-outs for each presentation. The Self-evaluation report together with the interviews were the committee’s key bases for the assessment.

1.5 Committee Procedures

The Committee followed the Standard Evaluation Protocol, 2015-2021 (SEP). Prior to the Committee meeting, two assessors were asked to evaluate each programme. These assessors independently formed a preliminary assessment for each programme. Final assessments are based on documentation provided by the Faculty, preliminary assessments and interviews. The Committee spoke with the Rector Magnificus of the TUD and the acting dean of the Faculty of Applied Sciences and interviewed the four department heads in the Faculty management team, research staff of the four departments, and representatives of the Casimir, Kavli and QuTech institutes. Interviews took place on November 24 and 25, 2016 at the Faculty of Applied Sciences in Delft. The interview schedule appears in Appendix B.

Before the interviews, the secretary of the Committee briefed the Committee on the Standard Evaluation Protocol for research assessments. This briefing also covered the rating system (Appendix C). On the same day, the Committee discussed the preliminary assessments. For each programme interview, the Committee prepared a number of comments and questions. All committee members were actively involved in the interviews. After each interview, the Committee discussed scores and comments. The committee also discussed a separate request for advice to the Executive Board of the TUD regarding future research directions and infrastructure of the Faculty of Applied Sciences. The Committee chair presented preliminary general impressions to the Faculty on the last day of the visit.

Following the on-site visit, the Committee finalised the report through email. Following approval by all Committee members, the Faculty received a copy of the first version with the invitation to correct factual errors. In response, the Committee discussed these comments, made several modifications to the text and then presented the final report to the Board of the University. This was printed after formal acceptance.

2. ASSESSMENT OF APPLIED PHYSICS WITHIN THE FACULTY OF APPLIED SCIENCES

2.1 THE FACULTY OF APPLIED SCIENCES

Research and education in applied physics at Delft University of Technology (TUD) is carried out within in four research Departments of the Faculty of Applied Sciences: the Departments of Bionanoscience (BN), Imaging Physics (ImPhys), Quantum Nanoscience (QN), and Radiation Science & Technology (RST). The Faculty is also home to the research Departments of Biotechnology and Chemical Engineering.

As written in its Self-evaluation Report, the Faculty of Applied Sciences' main ambition is to contribute solutions for the major societal challenges of our time through its teaching and research. These challenges include a sustainable and efficient energy supply, high-quality affordable healthcare, safety and security, and technical innovations. The Faculty is committed to excellence. In terms of research it aims to be among the best in the world.

The four Departments that were reviewed have a broad portfolio of research areas that address key scientific challenges and technological developments. During the review period (2010-2015), the Faculty has actively adjusted its research focus in response to external developments. It has started a new Department on BioNanoscience, which was built up in a period of 5 years and has already become a highly internationally visible activity. The Quantum Nanoscience programme has led to the establishment of a strategic alliance with TNO (QuTech), that is presently being shaped, and a new research institute on quantum computing of Microsoft that will be started at the TUD campus. The RST programme started the Oyster reactor upgrade and has led to the establishment of the Holland Particle Therapy Center for medical diagnosis and treatment.

These major developments testify to an excellent strategic ingenuity of the TUD in (re-)defining its research portfolio. The new developments are complemented by large streams of students that subscribe to new programmes in the newly started research areas. Very large financial investments in Applied Physics at the

TUD campus are made in nuclear science and technology and these will be discussed further in this report.

A key strength of TUD is the strong combination of scientific and engineering research, which are both carried out at a very high level. The engineering programmes support the creation of an ecosystem of start-up companies and high-tech equipment manufacturing industry in the Netherlands. They also provide key technical input that helps create new business at major companies in the Netherlands and abroad. The Faculty trains the technical specialists that are needed for the Netherlands to maintain and expand its knowledge-based economy.

A detailed report with a motivation for the quality rankings for the four Departments is provided further on.

2.2 PhD programmes, Graduate School, Casimir Research School and Kavli Institute

It is the ambition of the University Graduate School (UGS) to prepare and train doctoral candidates to become highly qualified, autonomous and leading researchers and skilled professionals. At TUD, a Doctoral Programme consists of Research and Doctoral Education (DE). The research is embedded in one of the research Departments. The DE Programme is an integral part of the preparation for the doctorate and the graduate's further career. It ensures and enhances the development of scientific quality along with the needed proficiency for interpersonal skills. The Casimir Research School is Leiden University's and Delft University of Technology's joint research school in interdisciplinary physics.

Remarks and recommendations

The Faculty of Applied Sciences Research School provides and extensive programme for the training of PhD students. The Casimir research school provides additional opportunities for BN and QN PhD students, as does the Kavli institute. All these activities are excellently planned and provide a highly valuable contribution the Faculty's graduate education. A major point of concern is that the average time to acquire a PhD degree at the Faculty of Applied Sciences is (very) far beyond the formal period of four years. In the self-evaluation report none of the departments has proposed a realistic strategy to solve this problem.

GENDER BALANCE

All departments suffer from a strong gender imbalance, with the exception of the BN department that has a 30/70 female/male ratio in its staff and students. The departments are well aware of the imbalance, and should be supported in their ongoing efforts to resolve this issue, which is a common problem in applied physics departments, as much as possible.

2.3 RESEARCH INTEGRITY

TU Delft strives to be articulate and explicit with respect to its ideals, values, principles and responsibilities and the means it utilises to implement its vision in day-to-day practices, procedures and operations. TUD's integrity policy entails the 'Code of Ethics', several regulations to support students and staff. TUD offers training modules for new PhD students on the topic of scientific integrity and has instated a Scientific and Academic Integrity Committee. This committee handles complaints arising from suspected breaches of academic or scientific integrity that may occur within the organisation. Overall, TUD has a professional Research Integrity policy that is organised very well.

2.4 FACULTY'S EXTRA QUESTIONS

QUESTION 1: "THE VIABILITY OF OPENING UP MORE FIELDS OF RESEARCH THAT PROVIDE A CROSSOVER BETWEEN DISCIPLINES"

The four Applied Physic Departments have a broad portfolio of research areas that address key scientific challenges and technological developments. A research area that is enjoying increased interest worldwide is the materials science of complex functional (quantum) materials. Some topics in this field are covered by the new hires within the QN Department. Further expansions in this area would be interesting to explore.

Furthermore, a Faculty-wide strategic vision regarding the future of the electron microscopy infrastructure can create many new modes of interaction between departments, in particular BN, ImPhys and QN, as they all require electron microscopy at a very high level.

QUESTION 2: "THE PHYSICS INFRASTRUCTURE IN DELFT IN RELATION TO THE EUROPEAN CONTEXT"

a) Cleanroom facilities. The present facilities in the Kavli NanoLab are state-of-the art and competitive on an international scale. To keep the cleanroom facilities up to date, continuous major equipment investments will be required. These are foreseen through a NanoLab application for the NWO Big programme in 2017. The university should be prepared for a financial backup plan in case this application turns out unsuccessful.

b) Biochemical laboratory. The BioNanoscience Department has set up state-of-the-art biochemical laboratories that are internationally competitive. In the coming years these facilities will need continuous upgrades. It appears that this can be mostly financed through existing departmental budgets and regular research grants.

c) Electron microscopy. TUD used to maintain the (very successful) National Facility for High-Resolution Electron Microscopy, led by prof. Zandbergen. He has retired but is still largely active within the department. Recent investments include an ultrasensitive detector and there are plans to apply for a double aberration corrected microscope. The BN department has installed its own (second-hand) cryo electron microscope and plans to use the NeCEN facility in Leiden for its state of the art analysis. A task force could be formed with representatives from QN, BN, and ImPhys, led by the QN department head, to ensure that the electron microscopy research infrastructure and investment plans of QN, BN and ImPhys are (better) coordinated and to determine if the operation as a national user facility will be discontinued or not.

d) Laboratory building infrastructure. The building that houses Imaging Science and Quantum Nanoscience needs to be urgently replaced by a modern new building to provide stat-of-the-art laboratory infrastructure for QN and ImPhys. A new building can also provide new opportunities for collaboration within and between these departments.

e) Nuclear reactor facilities. The entanglement of RST and the Reactor Institute Delft (RID) makes strategic discussions on their future complex, as each depends on the other, while they are managed and evaluated separately. Part (but not all) of the scientific program of RST is strongly linked to the presence of the nuclear reactor and the Oyster program that runs until 2022. The importance of future investments (after 2022) in nuclear technology (reactor, beamlines and detectors) will depend on the outcome of strategic decisions at TUD regarding the nuclear science and technology programme, as discussed in detail below in the evaluation of the RST department.

3. ASSESSMENTS OF INDIVIDUAL RESEARCH DEPARTMENTS

The Committee assessed the four physics research Departments of the Faculty of Applied Sciences of Delft University of Technology. These are the Department level assessments:

Research Department	***Research quality***	***Relevance to society***	***Viability***
Bionanoscience	1	1	1
Imaging Physics	1	1	1-2
Quantum Nanoscience	1	1	1
Radiation Science and Technology	2	2	3

The detailed assessment of each Department follows.

3.1 Research Department Bionanoscience

Head of Department	Prof. dr. M. Dogterom	
Research staff 2015	98.1 FTE	
Assessments	Quality	1
	Relevance to society	1
	Viability	1

As written in its Self-evaluation Report, the Department of Bionanoscience (BN) focuses on the fundamental understanding of biological processes, from the level of single molecules to the full complexity of living cells. The mission of BN is to conduct pioneering, fundamental research at the interface between nanophysics and biology, with the aim to understand how the properties of living systems emerge from molecular processes at the nanoscale. BN aims to operate at the forefront of the international fields in which it is active, and contribute methods and insights that represent major scientific and technological advances. Since the start of the Department in 2010 the research focus has broadened and now includes the following three research areas:

(I) Single-molecule biophysics
(II) Synthetic biology
(III) Quantitative cell biology

The research staff is composed of 15.3 FTE scientific staff, 28.0 FTE post-docs and 54.9 FTE PhD-candidates (2015).

Table 1 shows the demonstrable research output of the Department of Bionanoscience.

	2010	2011	2012	2013	2014	2015
Refereed articles	24	24	28	26	29	57
Non-refereed articles	1	0	1	1	1	2
Books	0	0	0	0	0	0
Book chapters	0	1	2	1	0	0
PhD theses	1	1	3	0	2	4
Conference papers	4	1	1	0	0	0
TOTAL	**30**	**27**	**35**	**28**	**32**	**63**

Table 1: Total output of the Department of Bionanoscience

The composition of the research staff at level of BN is found in Table 2.

(FTE)	2010	2011	2012	2013	2014	2015
Scientific staff	5.9	9.8	10.2	11.3	14.1	15.3
Post-docs	14.2	17.2	17.5	21.4	25.3	28.0
PhD candidates	13.1	20.2	27.7	34.9	48.9	54.9
Total research staff	**33.2**	**47.2**	**55.4**	**67.7**	**88.3**	**98.1**
Support staff	4.9	6.8	9.9	13.9	15.5	17.4
TOTAL STAFF	**38.1**	**54.0**	**65.3**	**81.6**	**103.8**	**115.5**

Table 2: Staff embedded in the Department of Bionanoscience.

The total funding of BN is found in Table 3.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	553	15	651	9	2216	33	2108	23	2152	18	2168	23
Research funding[2]	1748	46	892	12	243	4	1865	20	925	8	2014	21
Contract research[3]	1238	33	628	9	706	11	1718	19	4556	39	2111	22
Other[4]	221	6	5016	70	3532	53	3408	37	4062	35	3163	33
Total funding	**3760**		**7187**		**6697**		**9099**		**11695**		**9456**	

Table 3: Total funding at level of the Department of Bionanoscience. All amounts in k€.

1 Direct funding by the University, obtained directly from the University, and the financial compensation for educational efforts.
2 Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, ESF).
3 Research contracts for specific research projects obtained from external organisations, such as industry, governmental ministries, European Commission, charity organisations, and ERC.
4 Funds that do not fit the other categories.

QUALITY

The BN department, with professors C. Dekker and N. Dekker as its early pioneers, has attracted prof. M. Dogterom as a high-profile senior Principal Investigator. Together, these three have managed to attract a number of very promising assistant professors that came from the best labs worldwide. BN has an exceptional strength in biophysics and nanotechnology and is in this mixture second to none worldwide. Current attempts to bring in cell biologists will strengthen the profile of this Department even further. Relevant benchmark parameters are excellent: 50 % of the papers are published in high-impact journals (IF>7) and the citation impact factor MNCS of 2.61 is excellent. While much of the publication output naturally has so far come from the senior PI's, many of the young faculty are becoming productive, demonstrating the successful hiring strategy. The success of this Department is further demonstrated by 6 ERC as well as 3 VIDI and 1 VICI grants to the PI's.

RELEVANCE TO SOCIETY

The overarching goal of the research programme is understanding how properties of living systems emerge from molecular processes at the nanoscale. This research programme has a potentially very high impact on society. Obviously, many aspects have immediate relevance to biotechnology, medical diagnostic or treatment like the DNA and protein sequencing technologies or the search for new antibiotics, to name a few. Links with industry are established and industrial applications are explored. Since biotechnology is a very hot field for new start-ups in the US and Europe, it will be important to grasp such opportunities in the future and we feel the management is well aware of this. The Department is in close contact with the valorisation center at TUD. Also, the Department employs a part time programme manager that is responsible for strategic support. Beyond mere application aspects, however, the question „What is life?“ goes deeper and is no less important to mankind as the question for the origin and expansion of the universe.

Viability

Viability for this Department appears excellent. Both the successful hiring of young faculty as well as the excellent funding acquired, both internally and externally, provide almost ideal conditions for the future. This success is owed in no small part to the very large strategic investment by TUD into this research area. The foundation of BN was a shift from engineering to fundamental science for applied physics within the Faculty of Applied Sciences and is already paying off, also because this new research direction is attractive among students, with 135 students enrolling in the new nanobiology Bachelor’s programme.

Future success of this Department will crucially depend on its leadership, which is exemplary: BN has implemented as the first Department in Applied Sciences a modern, flat hierarchy with truly independent assistant and associate professors, which will allow them also in the future to hire the best people on the market with competitive start-up packages and a clear tenure perspective. The strong collaborative spirit among the research groups of this Department is impressive to see, making it much more than the sum of its parts.

Recommendations

All actions needed for a prosperous future of BN are well described in its strategic plan and their full adoption is highly recommended.

3.2 RESEARCH DEPARTMENT IMAGING PHYSICS

Head of Department	Prof. dr. ir. L.J. van Vliet	
Research staff 2015	83.4 FTE	
Assessments	Quality	1
	Relevance to society	1
	Viability	1-2

As written in its Self-evaluation Report, the Department of Imaging Physics (ImPhys) focuses on developing novel, sometimes revolutionary, instruments and imaging technologies. These research products demonstrate their insight in imaging since they extend existing boundaries in terms of spatial resolution, temporal resolution, and information/data throughput. The four disciplinary-based research groups jointly work on three key research themes in imaging physics with a clear societal impact: Life sciences (instrumentation and computational imaging), Healthcare (ultrasonic imaging devices and quantitative biomarker extraction), and Industry (electron-based instrumentation, optical techniques, seismic imaging). Also, each group contributes knowledge to the shared fundamental layer comprising numerical and analytical image formation modelling, image/data processing, solving inverse problems, and reconstruction.

The research staff is composed of 17.2 FTE scientific staff, 6.0 FTE post-docs and 60.1 FTE PhD-candidates (2015).

Table 4 shows the demonstrable research output of the Department of Imaging Physics.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Refereed articles	75	86	74	86	107	102
Non-refereed articles	0	0	0	1	1	0
Books	3	2	2	1	1	0
Book chapters	27	35	32	41	32	30
PhD theses	12	7	3	10	13	5
Conference papers	64	39	44	31	38	70
TOTAL	**181**	**169**	**155**	**170**	**192**	**207**

Table 4: Total output of the Department of Imaging Physics

The composition of the research staff of ImPhys is found in Table 5.

(FTE)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Scientific staff	16.8	16.8	17.5	17.1	17.8	17.2
Post-docs	7.3	5.6	3.3	5.1	4.7	6.0
PhD candidates	42.0	44.8	55.1	58.9	58.8	60.1
Total research staff	**66.0**	**67.2**	**75.9**	**81.1**	**81.3**	**83.4**
Support staff	16.7	15.0	13.4	14.0	14.2	13.5
TOTAL STAFF	**82.7**	**82.1**	**89.3**	**95.2**	**95.5**	**96.9**

Table 5: Staff embedded in the Department of Imaging Physics.

The total funding of ImPhys is found in Table 6.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2666	52	2538	48	3004	51	3219	46	3251	51	3086	48
Research funding[2]	1139	22	1160	22	1016	17	1455	21	689	11	476	7
Contract research[3]	1158	22	1620	31	1732	29	2296	33	2465	39	2987	46
Other[4]	197	4	-31	-1	195	3	-26	0	-43	-1	-77	-1
Total funding	**5160**		**5287**		**5947**		**6944**		**6362**		**6472**	

Table 6: Total funding at level of the Department of Imaging Physics, excluding FOM contracts and contract PhD's. All amounts in k€.

1 Direct funding by the University, obtained directly from the University, and the financial compensation for educational efforts.
2 Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, ESF).
3 Research contracts for specific research projects obtained from external organisations, such as industry, governmental ministries, European Commission, charity organisations, and ERC.
4 Funds that do not fit the other categories

QUALITY

The selected performance indicators of ImPhys are: instrumentation, software methods, technologies and experimental findings. In other words, the use of instrumentation and methods by peers and societal/industrial partners is equally important as publications and citations. The number of publications has increased over the evaluation period and the impact of the journal publications is high. The citations are measured through the MNCS, which equals 1,41 and is equal to the target put forward by the Faculty. The committee was very impressed by the examples presented during the interview and during the lab tour and feels the research projects and results are highly innovative. For example, the research on the theory behind the resolution of optical nanoscopy is highly appreciated and was awarded by an ERC grant. The Department presents a great balance between science and engineering. The value of such an engineering Department in a technical university cannot be ranked highly enough. The committee understood that it is the vision of the Department to develop novel instrumentation, which can be used by researchers at the university and beyond. At the same time, the goal is to valorise these developments through industrial contracts and commercialization. The success of this approach was demonstrated by different examples, including the combination of fluorescence and SEM as well as the multi-beam scanning electron microscope. From the report, a weakness appears to be the limited number of personal grants (1 VIDI and 1 ERC), nevertheless the committee feels that the intrinsic quality within the Department is sufficiently high for successful application of such grants in the future.

Relevance to Society

The research of ImPhys has an excellent and direct focus on valorisation, which is reflected by the research themes Healthcare imaging, Lifescience imaging and Industrial Imaging. Research contracts exist with many companies, such as FEI and Applied Materials and a very high number of patents is licensed or transferred to industry. Many research products (hardware, software) have found their way to external users, for example in the biomedical world. The research within the Department furthermore led to several spin-offs and start-up companies. This obviously has direct impact on the local economy.

Viability

The very high quality of engineering and the strong links with several companies makes the "Industry" part of the research programme very strong, ranking very high in viability. It is a successful example of how academic engineering can lead to relevant industrial developments. During the interview, it became clear that the Department is not afraid of discontinuing specific research lines which they feel are not sufficiently viable. This guarantees a very dynamic structure and the innovative character of the Department. The committee agrees with the remark made during the interview concerning the need to engage end users at an earlier stage of the research. In this manner, one may further increase the valorisation potential of the research. The structure of the Department is in the middle of a transition from a hierarchical structure to a more flat structure. The committee encourages this process in order to enhance the visibility of the assistant and associate professors and the acceleration of their career growth. So far, the Department has been very successful in attracting new PI's related to promising research themes, but a more clear future strategy that focuses on what the

Department describes as “better planning the purpose of the technologies” will be helpful.

RECOMMENDATIONS

All actions needed for a prosperous future of ImPhys are described in its strategic plan and their full adoption is highly recommended. To further advertise the transition to a tenure-track system with independent research groups an ImPhys website with separate divisions for each assistant/associate/full professor’s research group could be created, using the website of QN as an example. Furthermore, when hiring new group leaders, a focus on both depth in scientific investigations and high-quality engineering, in combination with plans to engage end users at an early stage, must be key selection criteria. We also encourage the department to try to increase the number of personal grants.

3.3 RESEARCH DEPARTMENT QUANTUM NANOSCIENCE

Head of Department	Prof. dr. ir. H.S.J. van der Zant	
Research staff 2015	144.7 FTE	
Assessments	Quality	1
	Relevance to society	1
	Viability	1

As written in its Self-evaluation report, the Department of Quantum Nanoscience (QN) comprises an internationally oriented research and teaching environment focused on studies of physical processes at the nanoscale using a large variety of electronic and optical device structures. QN seeks to advance the understanding of physical processes at the nanoscale, with a focus on research for fundamental scientific and technological breakthroughs. The approach is based on developing novel quantum materials, innovative fabrication and measurement techniques, and advanced theoretical models. Research involves a wide variety of materials and device concepts including those which are based on atomically thin layers such as graphene or oxide interfaces. Next to revealing new quantum physics, the Department aims at initiating novel applications of quantum effects of which building quantum computer components and ultra-sensitive detectors for single photons are examples.

The research is supported by facilities such as the cleanroom facility in the Kavli Nanolab, which is run by the staff of QN. Together with the Department of Bionanoscience (BN), QN forms the Kavli Institute of Nanoscience at Delft established by the US-based Kavli foundation; both departments are also affiliated with the Casimir Research School. In a recent development, QuTech, an advanced research centre for quantum computing and quantum information processing, was founded; it is a separate organisational unit with contributions from the Faculty of Applied Sciences, the Faculty of Electrical Engineering, and TNO, a non-profit organisation for applied scientific research in the Netherlands. QuTech addresses scientific challenges as well as engineering issues jointly with industrial partners. Most recently, it was announced that Microsoft will start a research laboratory at the TUD campus.

The research staff is composed of 24.7 FTE scientific staff, 45.9 FTE post-docs and 74.1 FTE PhD-candidates (2015).

Table 7 shows the demonstrable research output of the Department of Quantum Nanoscience.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Refereed articles	142	127	135	116	98	142
Non-refereed articles	0	0	1	1	0	0
Books	0	0	0	0	0	0
Book chapters	1	2	4	3	0	2
PhD theses	16	4	11	11	11	11
Conference papers	18	12	12	2	12	11
TOTAL	**177**	**145**	**163**	**133**	**121**	**166**

Table 7: Total output of the Department of Quantum Nanoscience

The composition of the research staff of QN is found in Table 8.

(FTE)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Scientific staff	19.4	19.4	18.5	18.3	22.4	24.7
Post-docs	24.9	26.8	26.0	36.7	45.5	45.9
PhD candidates	61.4	65.4	69.6	60.5	63.0	74.1
Total research staff	**105.7**	**111.6**	**114.1**	**115.5**	**130.8**	**144.7**
Support staff	16.0	17.4	17.4	17.0	19.0	18.1
TOTAL STAFF	**121.8**	**129.0**	**131.5**	**132.5**	**149.8**	**162.8**

Table 8: Staff embedded in the Department of Quantum Nanoscience

Note 1: Including 2 FTE of the clean room

Note 2: Mostly FOM PhD's (95%)

Note 3: Including the staff (9.8 FTE in 2015) of the clean room

The total funding of QN is found in Table 9.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2676	25	2816	24	4785	37	3485	19	3478	18	3422	20
Research funding[2]	4580	42	5392	46	6060	46	2795	15	3369	18	3356	19
Contract research[3]	3501	32	3472	30	2125	16	1095 3	60	7404	39	8570	49
Other[4]	81	1	33	0	73	1	948	6	4864	25	1998	12
Total funding	**10838**		**11713**		**13043**		**18181**		**19115**		**17346**	

Table 9: Total funding at level of the Department of Quantum Nanoscience. All amounts in k€.

1 Direct funding by the University, obtained directly from the University, and the financial compensation for educational efforts.
2 Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, ESF).
3 Research contracts for specific research projects obtained from external organisations, such as industry, governmental ministries, European Commission, charity organisations, and ERC.
4 Funds that do not fit the other categories.

QUALITY

The quality of research of QN is excellent. QN comprises long-standing efforts in quantum transport that are considered world leading. Over the recent years complementary research topics have been added which are on a good path to also become world class.

The department was able to significantly increase its impact within the last 5 years. This is manifested by several indicators such as the growing number of publications in high impact journals combined with excellent citations (MNCS=2.68), and the very high number of ERC grants for senior as well as for mid-career and early career PI's .

Due to the scientific and technical excellence and leadership, the amount of funding was increased by 60% during the past 5 years. In particular, the efforts towards quantum computing were able to attract significant research funds from governments and international corporations. This allowed QN to grow and to push the research efforts on a national and international level by attracting outstanding talents from around the globe.

Prestigious awards were received by the QN Faculty, postdocs and PhD students during the review period with potential for more in the future, considering their outstanding research and track records.

RELEVANCE TO SOCIETY

The overall mission of QN is to advance the understanding of physical processes at the nanoscale and to develop novel quantum materials and devices, innovative fabrication and measurement techniques, and advanced theoretical models. These research areas are fundamentals with great potential to bring QN out of the laboratory to significantly impact society as a whole through applications in electronic and optoelectronic devices, sensing, quantum technologies and, especially quantum computing. The latter in particular would allow problems to be solved which are intractable today. Examples include quantum simulations too complex to tackle using even the most powerful classical computer.

The relevance to society is also nicely demonstrated by the spin-off companies established based on research initiated at QN. DENSsolutions and Single Quantum are excellent examples of launching innovative QN products into the commercial market and demonstrating their impacts to the society. Furthermore, strong links with mainly US-based industry were created over the last 5 years in the area of quantum computing, indicating industrial applications may soon come. Since quantum technology is a very dynamic and hot field of science and technology, there is great potential for more opportunities for industrial collaborations and commercial start-ups.

VIABILITY

The viability of QN seems excellent. All the PI's are very capable and agile and are committed to contribute to the health and viability of the Department. It was able to successfully implement a transition to a flat organisational structure which created a dynamic and collaborative environment which is inspiring to all its members. This forms a strong basis for further success in the next years. QN was also able to attract an influx of excellent young researchers to their tenure track Faculty to provide a fruitful environment for success growth. The newly recruited

PI's have broadened the research scope of the department in a healthy way, and they are now in a good position to create a synergy of collaborative research. They have manifested their excellence in research and leadership in their impressive success of securing a large number of external research grants and contracts, especially from the ERC, and high-quality publications in high-impact journals.

Although the currently available infrastructure of QN is excellent, it needs continuous maintenance and upgrade to stay as a world leader. We appreciate the unsuccessful efforts in finding a new senior PI in the field of electron microscopy during the past few years. We encourage QN to reach out to the ImPhys and BN departments for a stronger collaborative effort and joint planning strategy to maintain and further enhance the electron microscopy facilities.

With the creation of QuTech, complementary capabilities of TUD and TNO have been brought together. The synergy provided by this collaboration presents a competitive advantage over other universities in the area of quantum computing. Furthermore, the strategy of partnering with hardware and software companies will ensure the viability of the efforts and QN.

Recommendations

All actions needed for a prosperous future of QN are described in its strategic plan and their full adoption is highly recommended.

With the establishment of QuTech, a new mode of management must be designed so that the different responsibilities of the QN department head and the QuTech management (which both supervise the same four/five research groups) are clearly defined. Similarly, with the establishment of a Microsoft institute in a TUD building, clear and fair arrangements must be made regarding intellectual property, the use of TUD's facilities, and the exploitation of TUD's intellectual capital.

3.4 RESEARCH DEPARTMENT RADIATION SCIENCE AND TECHNOLOGY

Head of Department	Prof. dr. H.Th. Wolterbeek	
Research staff 2015	86.3 FTE	
Assessments	Quality	2
	Relevance to society	2
	Viability	3

As written in its Self-evaluation Report, the mission of the Department of Radiation Science and Technology (RST) is to make a significant contribution towards a sustainable society of the twenty-first century by improving our understanding of (nuclear) radiation phenomena, disseminating this knowledge thereby engineering and applying these insights to societal relevant research. The research programme is focused on (a) conducting ground-breaking scientific research and development in the domains Energy and Health, (b) training scientists and engineers and (c) disseminating the accumulated knowledge to the society. Research topics at Radiation Science and Technology (RST) are tied together by the concept of radiation. The focus of the research is on health and energy, as well as the development of relevant nuclear probe instruments for materials science and nuclear medicine. The research in the area of health comprises integrated medical/nuclear imaging systems (SPECT and PET), the use of radiation and radionuclides for microscopic structural studies, diagnostics and therapy, as well as innovative production routes of medically relevant radionuclides. The research in the area of energy spans from nuclear reactor systems of the fourth generation and beyond to the development of tailored materials for efficient energy production, conversion, storage, and use.

The research staff is composed of 21.5 FTE scientific staff, 15.0 FTE post-docs and 49.9 FTE PhD-candidates (2015).

Table 10 shows the demonstrable research output of the Department of Radiation Science and Technology.

	2010	2011	2012	2013	2014	2015
Refereed articles	109	125	96	104	116	87
Books/ Book chapters	5	0	0	2	1	3
PhD theses	7	3	7	12	9	8
Conference papers	25	26	17	13	3	4
TOTAL	**146**	**154**	**120**	**131**	**129**	**102**

Table 10: Total output of the Department of Radiation Science and Technology

The composition of the research staff of RST is found in Table 11.

(FTE)	2010	2011	2012	2013	2014	2015
Scientific staff	22.6	21.6	20.4	22.2	19.8	21.5
Post-docs	17.8	13.4	12.0	16.3	15.0	15.0
PhD candidates	45.4	45.2	51.0	50.5	53.5	49.9
Total research staff	**85.8**	**80.1**	**83.4**	**89.1**	**88.3**	**86.3**
Support staff	13.2	11.0	11.6	11.1	12.0	12.2
TOTAL STAFF	**99.1**	**91.1**	**94.9**	**100.2**	**100.2**	**98.5**

Table 11: Staff embedded in the Department of Radiation Science and Technology

The total funding at level of RST is found in Table 12.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2400	40	2400	41	3400	49	3000	42	2900	39	3100	41
Research funding[2]	1600	27	1400	24	1900	28	1900	26	2000	27	1900	25
Contract research[3]	1700	28	1400	24	1600	23	1500	21	1700	23	1600	21
Other[4]	300	5	600	10	0	0	700	10	700	9	1000	13
Total funding	**6000**		**5800**		**6900**		**7200**		**7400**		**7500**	

Table 12: Total funding at level of the Department of Radiation Science and Technology, without the OYSTER investment programme, which is administratively embedded within RID. All amounts in k€.

1 Direct funding by the University, obtained directly from the University, and the financial compensation for educational efforts.
2 Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW,, ESF)
3 Research contracts for specific research projects obtained from external organisations, such as industry, governmental ministries, European Commission, charity organisations, and ERC.
4 Funds that do not fit the other categories

QUALITY

The quality of the Department is evaluated based on the indicators proposed by the Department: research articles and citations, awards and grants, invited talks at international conferences, and membership of prominent scientific committees and editorial boards. The number of publications by the Department is high and highlighted papers presented in the Self-evaluation Report are published in high-impact journals. The number of publications has decreased during the evaluation period; the necessary efforts to set up the OYSTER project partially explain the decrease. The citation impact, normalised to the field, is 50% above the world average. The Department holds some prestigious awards and grants, including two FOM Valorisation awards as well as a Vidi and an ERC grant. On average, about 20 invited talks at international conferences are presented every year for the entire department. A long list of memberships is provided.

During the lab tour, the enthusiasm of the PhD students and the assistant professors was very much appreciated; such a driven spirit could have been reflected better in the Self-evaluation Report. The committee highly values the work on battery and magnetocaloric materials and the state-of-the-art small animal SPECT imaging system development.

Overall, taking all activities into account, the quality of RST is ranked very good.

RELEVANCE TO SOCIETY

The Department has a strong focus on energy and health, which are important to society. The work on battery and magnetocaloric materials, medical isotope production, and preclinical and clinical SPECT system development for biomedical applications is of excellent relevance, the latter also because of the start of a collaborative research project with the new Holland Particle Therapy Center.

However, the use and application of the enhanced nuclear reactor through the Oyster project, a very large investment (41 M€), is impeded by a lack of funding support for additional staff and lack of a management plan to run it as a user facility, as explicitly mentioned by RST throughout the interviews. This strongly affects the relevance of this part of the RST programme. Furthermore, the societal impact of the nuclear reactor science and engineering programme of RST depends on many factors, including the effect of public opinion on the future of nuclear energy, and external political and economic factors.

A strong collaboration with industry resulted in 12 patents in the theme Energy, 11 in the theme Health, and 5 in the theme of Nuclear Probe Instruments. The RST Department is also acting as a facility to educate laymen and experts working in business, public bodies and universities to keep up with recent developments in the nuclear energy field, in academic and non-academic continuing education programmes, workshops or seminars as well as publications in popular scientific magazines. The above activities engaged by the RST are important to keep their research and education missions visible and to stay relevant to the society.

On average, the societal relevance is ranked very good. This average reflects the high relevance of the medical theme on the one hand, and the lack of a clear and strong user/scientific exploitation plan of RST for Oyster on the other hand.

VIABILITY

The OYSTER programme to enhance the capabilities of the nuclear reactor is an important opportunity for the Department. However, the delay in the full implementation of the project and the lack of funding for additional staff to run it has negatively affected the scientific investigations and application of the enhanced reactor. Although a goal of the enhanced reactor is to make it a user facility, practical management and user recruitment plans have not been established. It is unclear who will be the potential users, and how the enhanced reactor will benefit their research projects and society.

Nevertheless the committee acknowledges the potential of the reactor for medical applications as demonstrated by the lab tour, such as the Mo/Tc generator as well as research related to the generation of new radioisotopes and radiopharmaceuticals for medical imaging. At the interviews the committee was told by RST that the Department is lacking staff to carry out all of the projects that are currently ongoing or planned for the future. The committee feels the large number of proposed new projects and collaborations is too ambitious. RST must define a clear focus for the future. For example, the proton therapy project has excellent potential for success by taking advantage of existing expertise within the Department for the project. It is not clear if RST should play a national coordinating role for use of neutron facilities abroad (e.g., ISIS, possible new future spallation source), as it is not carrying out a major research programme itself at these facilities.

The committee understood that the RST Department is trying to re-organise in order to improve the scientific freedom and the personal development of the scientific staff. Although the committee encourages such reorganisation, it remained unclear during the visit how this will be done in practice. Currently, OYSTER and other large research programmes seem to have limiting personal research themes. A suggestion might be to adapt the more flat structure as is already installed in other Departments of the Faculty, especially for the researchers working in the field of Health and Energy. However, from the Self-evaluation Report and the site visit the committee did not obtain sufficient insight into the research and tasks of all Faculty in RST to advise on this further.

RECOMMENDATIONS

As the Faculty strives for excellence in all of its research, a further improvement in quality of the research programme at RST is desired. This will require reevaluation of the many different research activities that RST is carrying out. The RST department must focus more on topics that have high societal relevance and viability on the one hand, and that match with areas where the scientific staff has high-level scientific and engineering expertise on the other hand.

Given the very large investments made in Oyster, the very high running costs of a nuclear facility, and the fact that so many stakeholders at different levels of society are involved, the committee advises that a strategic discussion on the future of the nuclear research of RST and its relation to the reactor facility will be held at the level of the Board of the University.

APPENDIX A CURRICULA VITAE OF THE COMMITTEE MEMBERS

Professor Albert Polman (chairman of the committee) is scientific group leader at the FOM Institute AMOLF in Amsterdam, the Netherlands and professor of photonic materials for photovoltaics at the University of Amsterdam. Polman obtained his PhD from the University of Utrecht, was post-doctoral researcher at AT&T Bell Laboratories and then became scientific group leader at AMOLF. From 2006-2013 he also served as director of AMOLF.

Polman's research focuses on the realisation of optical metamaterials with tailored properties that do not exist in natural materials. He uses these designs to realize novel photovoltaic architectures with enhanced power conversion efficiency. Polman's group is the inventor of angle-resolved cathodoluminescence microscopy, a novel technique that creates optical images with 10 nanometer spatial resolution.

Polman is an elected member of the Royal Netherlands Academy of Arts and Sciences (KNAW), Fellow of the Materials Research Society (MRS) and the Optical Society of America (OSA), and recipient of two ERC Advanced Investigator Grants (2011, 2016), the EPS QEOD Research into the Science of Light Prize, the Physica Prize of the Dutch Physical Society, the Julius Springer Award for Applied Physics, the ENI Renewable Energy Prize, and the MRS Materials Innovation and Characterization Award.

Professor Sara Bals is group leader of the electron microscopy group (EMAT) at the University of Antwerp and a professor in the Physics Department. Bals obtained her PhD (2003) from the University of Antwerp and was a post-doctoral researcher at the National Center for Electron Microscopy, which is part of the Lawrence Berkeley National Laboratory.

Bals' research consists of the application and further development of electron tomography for functional nanostructured materials. By combining state-of-the-art electron microscopy with advanced reconstruction algorithms, Bals and her co-workers are able to measure the positions and chemical nature of individual atoms in a broad variety of nanomaterials. In 2013, she received an ERC Starting Grant concerning 3D characterization of nanostructures by electron tomography (Colouratom). In 2016, the Royal Flemish Academy of Belgium awarded her with the title of "Laureate of the Academy for Natural Sciences".

Professor Matthias Rief obtained his PhD in Physics in 1997 at Ludwig-Maximilians-Universität Munich, Germany, working in the field of dynamic force spectroscopy of biomolecules. He continued his studies as a postdoctoral fellow at Stanford University focusing on the function of molecular motors. Since 2003, Matthias Rief has been a full professor of Biophysics at Technische Universität München.

Matthias Rief's research field is single molecule biophysics with a special focus on optical trapping and AFM. He has made contributions to the understanding of the mechanics of molecular motors, protein folding and cellular mechano-sensing.

Prof. Rief is an elected member of the German National Academy of Sciences, Leopoldina as well as the Bavarian Academy of Sciences and a Fellow of the Biophysical Society. He has been awarded the Heinz Maier-Leibnitz Prize from the DFG, and the Nanowissenschaftspreis.

Dr. Heike Riel is the Manager of the Materials Integration & Nanoscale Devices (MIND) group at IBM Research – Zurich and is responsible for projects in the area of semiconducting nanowires for various applications and molecular electronics. Her research focuses on new materials and novel device concepts for future nanoelectronics in particular steep slope devices for energy efficient computation. In 2013, Riel was named IBM Fellow, the company's highest technical distinction. Riel studied physics at the University of Erlangen-Nuremberg (Germany) and received a PhD from the University of Bayreuth (Germany) in 2003 for her work on the optimization of multilayer organic light-emitting devices. After an internship at the Hewlett-Packard Research Laboratory in Palo Alto, she joined the IBM Zurich Research Lab in 1998 as a PhD student, and became a Research Staff Member in 2003. Since 2008, she has been leading the Nanoscale Electronics Group. In 2011, she graduated with an MBA from Henley Business School.

Riel has made major contributions to the development of the (at that time) world's largest ever (20") full-color amorphous-silicon active-matrix display based on organic light-emitting diodes, which was presented in May 2003. For her outstanding scientific contributions, Riel was elected by Technology Review, MIT's Magazine of Innovation, to the TR100, the annual list of the world's 100 Top Young Innovators in September 2003 and she received the 2005 Applied Physics Award of the Swiss Physical Society. In June 2012, Heike Riel received an award in the category "Technical or Scientific Innovation" from the Swiss Association of Women in Engineering (SVIN) on the occasion of their 20th anniversary.

Professor Benjamin M.W. Tsui is currently a Professor of Radiology with joint appointments in Electrical and Computer Engineering, Biomedical Engineering and Environment Health Sciences and the Director, Division of Medical Imaging Physics, Department of Radiology at the Johns Hopkins University. He has a B.S. and A.M. degrees in Physics from the Chinese University of Hong Kong, Hong Kong and Dartmouth College, USA, respectively, and a Ph.D. degree in Medical Physics from the University of Chicago. He was an Assistant Professor of Radiology at the University of Chicago and an Associate Professor and Professor of Biomedical Engineering and Radiology at the University of North Carolina at Chapel Hill before joining the Johns Hopkins University in 2002.

Tsui’s research interests include medical imaging physics of SPECT, PET and CT, computer generated phantoms, computer simulation techniques, quantitative analytical and statistical 3D and 4D image reconstruction methods from projections, image quality evaluation using model and human observers, cardiac and respiratory motion compensation, multi-modality SPECT/CT, PET/CT, SPECT/MR and PET/MR imaging, and preclinical small animal imaging instrumentation and techniques.

Tsui is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), The Institute of Physics (IOP) and the American Institute of Medical and Biological Engineering (AIMBE), and the recipient of the IEEE Edward J. Hoffman Medical Imaging Scientist Award in 2009 and the SNMMI Edward J. Hoffman Memorial Award in 2015.

APPENDIX B SITE VISIT PROGRAMME

Between each interview, time is reserved for a *wrap up* by the Committee. To improve the readability, this activity is omitted from the table.

Wednesday 23 November 2016

Time	Activity	Participants
17.30	Welcome of committee	Committee + • Prof.dr.ir. Lucas van Vliet • Prof.dr. Bert Wolterbeek • Prof.dr. Marileen Dogterom • Prof.dr. Kobus Kuipers • Prof. Karel Luyben
18.30 – 21.30	Working dinner: kick-off and preparation of interviews	Committee
21.30	Closure	

Thursday 24 November 2016

Time	Activity	Participants
9.00 – 9.45	Management interview	Committee + • Prof.dr.ir. Lucas van Vliet • Prof.dr. Bert Wolterbeek • Prof.dr. Marileen Dogterom • Prof.dr. Kobus Kuipers
10.00 – 10.30	Context site visit	Committee + • Rector Prof. Karel Luyben • Prof.dr.ir. Lucas van Vliet
10.45 – 11.45	Interview Radiation Science & Technology	Committee + • Prof.dr. Bert Wolterbeek • Dr.ir. Marnix Wagemaker
12.00 – 13.15	Lab Tour and poster presentation Radiation Science & Technology	Committee + PhD students: • Yuan Chen • Ir. Robin de Kruijff Tenure track professors • Dr. Pablo Serra Crespo • Dr. Elisabeth Oehlke • Dr. Anna Smith

13.15 – 14.15	Lunch meeting	Committee + Department of Imaging Physics : • Prof.dr.ir. Lucas van Vliet • Dr. Bernd Rieger • Prof.dr.ir. Nico de Jong • Aditi Srinivasa Raja, MSc • Sander Konijnenberg, MSc Department of Radiation Science & Technology : • Prof.dr. Bert Wolterbeek • Prof.dr.ir. Jan Leen Kloosterman • Ir. Jasper Kouwenberg • Ir. Lars Bannenberg • Dr. Lambert van Eijck
14.30 – 15.30	Interview Department of Bionanoscience	Committee + • Prof.dr. Marileen Dogterom • Prof.dr. Cees Dekker • Prof.dr. Nynke Dekker • Dr. Stan Brouns • Dr. Chirlmin Joo
15.45 – 16.55	Lab Tour	Committee + • Dr.Greg Bokinsky • Dr. Hyun Youk • Laura Restrepo MSc (MR lab) • Victor Marin Lizarraga MSc (HR lab) • Dr. Timon Idema
17.00 – 17.30	Presentation Graduate School, Pitch Casimir (QN/BN) Research School + Interview	Committee + • Prof.dr. Laurens Siebbeles (Graduate School Applied Sciences) Casimir School (representatives Dept. BN en QN): • Prof.dr. Herre van der Zant • Marije Boonstra MSc.
17.30 – 18.30	Discussing and writing preliminary judgements	Committee
19.30 – 21.30	Working dinner	Committee

Friday 25 November, 2016

Time	Activity	Participants
8.30 – 9.30	Interview Department of Quantum Nanoscience	Committee + • Prof.dr. Kobus Kuipers • Dr. Sander Otte • Prof.dr. Herre van der Zant • Dr. Miriam Blaauboer • Prof.dr. Ronald Hanson
9.45 – 11.00	Lab Tour Department of Quantum Nanoscience	Committee + • Dr. Sonia ConesaBoj • Dr. Simon Gröblacher(lab E-05) + PhD: Andreas Wallucks • Dr. Leo DiCarlo + PhD: Adriaan Rol
11.15 – 12.15	Interview Department of Imaging Physics	Committee + • Prof.dr.ir. Lucas Van Vliet • Prof.dr.ir. Pieter Kruit • Prof.dr. Paul Urbach • Prof.dr.ir. Nico de Jong • Dr. Jacob Hoogenboom • Dr. Sjoerd Stallinga
12.30 – 13.30	Lunch meeting with the following topics: Kavli Institute of Nanoscience Delft; Kavli Nanolab and QuTech	Committee + • Prof.dr. Cees Dekker • Prof.dr.ir. Lieven Vandersypen • Prof.dr. Marileen Dogterom • Prof.dr. Kobus Kuipers
13.40 – 15.00	Lab Tour Imaging Physics	• Dr. Jeroen Kalkman + Jelle van der Horst, MSc. • Prof.dr.ir. Pieter Kruit + Wilco Zuidema, MSc. • Dr. N. Bhattacharya + Dr. Aurele Adam
15.00 – 15.45	Summarizing findings and first conclusions	Committee
15.45 – 16.00	Concluding meeting with management	Committee • Prof.dr.ir. Lucas van Vliet, • Prof.dr. Bert Wolterbeek • Prof.dr. Marileen Dogterom, • Prof.dr. Kobus Kuipers
16.00 – 17.00	Discussing and writing preliminary judgements	Committee
17.00 – 17.30	Presentation on first impression by committee	Committee, Dean, MT, delegate from Board, all staff of Departments
17.30 – 18.00	Drinks and closure	

APPENDIX C EXPLANATION OF THE SEP SCORES

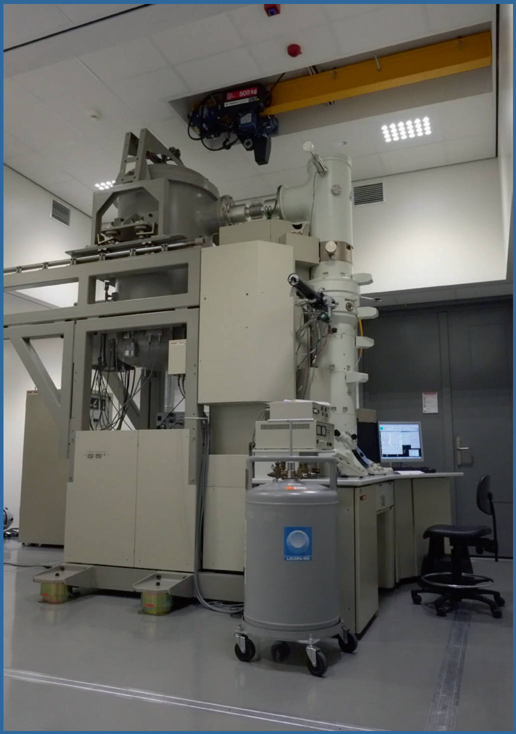
	Meaning	***Research quality***	***Relevance to Society***	***Viability***
1	*World leading/ excellent*	*The research unit has been shown to be one of the few most influential research groups in the world in its particular field.*	*The research unit makes an outstanding contribution to society.*	*The 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.*

Quality is seen as the contribution that research makes to the body of scientific knowledge. The scale of the unit's research results (scientific publications, instruments and infrastructure developed by the unit, and other contributions to science) are also assessed.

Relevance to society is seen as 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. The point is to assess contributions in areas that the research unit has itself designated as target areas.

Viability is seen as 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 considers the governance and leadership skills of the research unit's management.

The categories in this SEP and the descriptions differ from the scores in prior SEPs and are therefore not comparable.



Quicken ORGANISATIE ADVISEURS

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