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Evaluation 2000-2005

FOM Institute for Atomic and Molecular Physics

The Hague/Utrecht, 2006

Netherlands Organisation for Scientific Research

and

Foundation for Fundamental Research on Matter

CONTENTS

1 Introduction

1.1 Scope and context of this evaluation

The Netherlands Organisation for Scientific Research (NWO) and the Foundation for Fundamental Research on Matter regularly evaluates the scientific performance of its research institutes. As part of this evaluation scheme, the FOM-institute for Atomic and Molecular Physics (AMOLF) has been evaluated by an international committee. The aims of the assessment system are:

- Improvement of the quality of research through an assessment carried out according to international standards of quality and relevance.
- Improvement of research management and leadership.
- Accountability to higher levels of research organizations and funding agencies, government, and society at large.

The committee is asked to produce a reasoned judgement on the mission, strategy and performance of the institute. The evaluation contains retrospective and prospective elements. The assessment is based on the Standard Evaluation Protocol 2003-2009 (Standard Evaluation Protocol) (ISBN 90-5588278x/FOM-03.0536), which calls for an evaluation both of the research institute itself and of the research programmes it conducts. The research institute submits details of the results that have been achieved in each research programme over the previous six years (including quantitative data about staff input, key publications and a list of publications), a short outline of the mission statement of each programme, and details of developments anticipated in the context of the research profile of the institute. Important elements of each review are a site visit, which includes interviews with the management and the programme directors, and a tour of the facilities. AMOLF has chosen to use the opportunity the evaluation presents and reorganise its research in two new directions, where before there were four research programmes. The report therefore has two main parts: one assessing the past performance, one the future plans.

1.2 The evaluation committee

The evaluation committee was appointed by the Governing Board of NWO following consultation with FOM. Its members are:

- Prof.dr. Sir John Pendry (chair) Imperial College, London;
- Prof.dr.T. Elsaesser, Max Born Institute Berlin;
- Prof.dr. U. Gösele, Max-Planck-Institute of Microstructure Physics, Halle;
- Prof.dr. M.L. Klein, University of Pennsylvania, Philadelphia;
- Prof.dr. J. Prost, ESPCI, Paris.

A short curriculum vitae of each of the members is included in Appendix 6.1. The committee was supported by FOM programme officer Dr.ir. C.L.A. Hooijer.
All members of the committee declared that their assessment had been free of bias, personal preference or personal interest, and that it had been reached without undue influence from the institute, the programme directors or other stakeholders. Any existing professional relationships between committee members and programmes under review were brought to the attention of the committee. The committee concluded that there were no conflicts of interest.

1.3 Data supplied to the committee

The documentation included all the information required by the Standard Evaluation Protocol, as well as answers to the additional questions addressed to AMOLF by NWO and FOM.
It included:

- The self-evaluation report 2000-2005 by AMOLF;
- The strategic plan AMOLF 2006-2011;
- A selection of full text papers for each group;
- A bibliometric study of AMOLF by the Center for Science and Technology Studies (CWTS).

During the site visit, handouts of all the presentations were made available:

1.3.1 Jargon

AMOLF uses some terms that are different from those used by the Standard Evaluation Protocol. In this report we will use the AMOLF terminology. The expression 'management team' refers to the director, the department heads, and the controller. The term 'groupleader' refers to a tenured permanent staff member. A 'projectleader' is a non-tenured staff member that leads a group and has the qualifications to apply for funding.

For convenience, the following abbreviations are used:
PhD = graduate student (oio, promovendus).
PD = postdoctoral researcher.
FTE = full-time equivalent (labour contract of 38 hours/week).

1.4 Procedures followed by the committee

The committee proceeded in accordance with the Standard Evaluation Protocol 2003-2009 (see Appendices 6.2 and 6.5). The assessment was based on the documentation provided by the institute, the selected key publications, and the interviews conducted during the site visit on 21-23 May 2006. The programme of the site visit is included in Appendices 6.3 and 6.4.

The self-evaluation report, the selected papers and an explanatory letter were sent to the committee one month before the site visit. The chair and the secretary of the committee established a timetable for the site visit (see Appendix 6.3) and the committee members divided up the task of reading the full text papers to ensure total coverage.

The committee was installed on the first day by the vice chairman of NWO Prof.dr. C.H.C.M. Buys and the director of FOM, Dr. K.H. Chang. Prof.dr. A. Polman, director of AMOLF, gave a short introduction to his institute. Afterwards the panel met in closed session to finalize the division of tasks and finalize the agenda for the site visit on day two and three.

On day 2 (Monday 22 May 2006), the panel discussed with all programme leaders the progress of the five programmes, and privately met all group- and projectleaders who are foreseen to be at AMOLF for at least another 3 years. During lunch 6 PhD students were informally interviewed in the absence of director or supervisors. The panel wrote their reports on the meetings of that day the same evening. On day 3 (Tuesday 23 May 2006) the director and the department heads presented the future plans, gave a labtour and elaborated on the request for an increased mission budget. Also, the panel met Prof.dr. W. van Saarloos, chairman of the Scientific Advisory Committee of AMOLF. The afternoon of day 2 was spent writing the main part of the report and formulating the conclusions of the panel together. The conclusions of the

panel were presented to the director of FOM and the permanent scientific staff of AMOLF by Prof.dr. J.B. Pendry over dinner. After the visit, the panel chair and secretary prepared a proposal for the final version of the panel report. This report was approved by the panel on 16 June 2006, and sent to the director of AMOLF for a reaction on 5 July 2006. The report was completed on DATE.

1.5 Assessment scale

The committee used the scale provided in the Standard Evaluation Protocol.

2. AMOLF

2.1 Mission

The FOM Institute for Atomic and Molecular Physics (AMOLF), located in the Science Park Amsterdam, is one of the research laboratories of the Foundation for Fundamental Research on Matter (FOM), the physics division of the Dutch National Science Foundation (NWO).
For the coming period AMOLF has defined it's mission as follows:
To perform leading fundamental research on strategically important complex atomic and molecular systems with key potential for technological innovations, and to transfer knowledge to industry and society.

2.2 Research

2.2.1 Past

In the period 2000-2005, research at AMOLF was organized within FOM programs: scientific research units with clearly defined research goals and a budget provided by FOM. In the past period, the following FOM programmes were carried out:

- Quantum dynamics of atomic- and molecular systems (QDAMS, 1999-2002); followed by Ultrafast molecular dynamics (UMD, 2003-2009)
- Structure, function, and flow of soft materials (SFFSM, 1999-2006)
- Mass spectrometry of macromolecular systems (MSMS, 1999-2003); followed by Mass spectrometric imaging and structural analysis of biomacromolecules systems (BIOMSL, 2002-2008)
- Nanostructured opto-electronic materials (NOEM, 1999-2007)

In addition, a Transition/Exploratory research programme was carried out.

2.2.2 Future

AMOLF's research programme for the period 2006-2011 focuses on two main themes:

1. Physics of Biomolecular Systems, focusing on the study of collective and active mechanisms in the spatial and temporal organisation of the 'hardware' (biomolecular structures) and 'software' (biochemical networks) of cells. Fundamental research on the physical basis of these mechanisms will inspire the design of new functional materials, and will contribute to the 'systems-level' understanding of biological systems needed for future breakthroughs in medicine and healthcare. This research programme explores existing strengths in soft matter- and biophysics, femtophysics, mass spectrometry and computational physics. It will be organised in three coherent themes, each benefiting from the concerted effort of four- to six research groups with complementary experimental and theoretical expertise:

- Biomolecular dynamics and interactions,
- Supramolecular structures and active biomaterials,
- Spatio-temporal design of biomolecular networks.

The total research staff of this programme is 70 FTE. The Physics of Biomolecular Systems Programme will be carried out in collaboration with biologists, mathematicians and computer scientists within the BioCentrum Amsterdam.

2. Nanophotonics, focusing on the manipulation of light in artificially engineered nano-structures, with the aim of controlling and understanding emission and propagation of light. Fundamental research on the generation, manipulation, confinement, scattering and amplification of light at length scales smaller than the wavelength of light may lead to novel functional devices that are applied in communication, information and medical technology. The programme will be organised around 3 coherent themes that will each benefit from the concerted effort of 4-6 research groups with complementary experimental and theoretical expertise:
   - Photonic and plasmonic light sources,
   - Dispersion control and nanoscale confinement of light,
   - Photonic integrated circuits.

The total research staff of this programme is 45 FTE.
In addition to the two main programmes, AMOLF will carry out a small Exploratory Research Programme to initiate new scientific directions. AMOLF has stated to seek new industrial partnerships in systems biology, nanomedicine and/or biomolecular aspects of the processing of food, and in nanophotonics.

2.3 Organizational structure

AMOLF is an organisation with a low level of hierarchy. Research is organized within research groups lead by a group leader or project leader. Research groups are relatively small (5-10 pp), and the group/project leader bears full responsibility for running the group and attracting sufficient external funds to carry out research projects. Research groups are organized within departments. In 2005, AMOLF was organised in five research departments:

- Femto-physics
- Life-science inspired Physics: experiment
- Life-science inspired Physics: theory
- Nanophysics
- Exploratory programme

The department heads coordinate activities, collaboration, and initiatives for grant applications within the department; they report directly to the director. Engineering and administrative support is also organized within groups. The heads of the three central technical support groups (Design department, Mechanical workshop, and Electronics and Informatics Group), organized within the Engineering Department, report to the Head of engineering support. Similarly, administration support groups (organized within the Administration Department) report to the Head of administration support. Presently, the same person carries out the task of Head of engineering and Head of administration; this person reports directly to the director.

2.3.1 Location

AMOLF is located in Amsterdam in the science park, adjacent buildings of the university of Amsterdam Science faculty, including those of biology, the NWO institute for Informatics and Computer Sciences (CWI), the National Institute for High Energy Physics (NIKHEF) and SARA, the national super computer centre which also serves as a European node on the GRID. Shortly AMOLF will move to new purpose build laboratories on a neighbouring site.

2.3.2 Financial matters

AMOLF received in the period 1999-2005 on average M€ 6,2 through FOM institutional programmes, and M€ 9,6 on average in total. The budget of the institute has grown over the period 1999-2005 from M€ 8,1 to M€ 12,1, largely due to extra project funding. The institute's personnel increased from 170 FTE in 1999 to 181 FTE in 2005.

2.3.3 Current staff

AMOLF employs a scientific staff of about 115 FTE. Each of the 20 research groups is composed of PhD students, post docs, undergraduate students, guests, and one leading staff member (typically 5-10 group members). The scientific groups are led by 14 group leaders with a permanent position, and 6 project leaders who are appointed at AMOLF to initiate and carry out a 5-year project, with the possibility of tenure afterwards. Group technicians are linked to the experimental research groups to develop and support equipment that is specific for the group. The total research-related scientific and support staff is 129 FTE. Central technical support at AMOLF is provided by some 27 FTE in three engineering groups: Design Office, Mechanical Workshop, and Electronics & Informatics. Administrative support and general facility management is provided by another 24 FTE.

3 Assessment of the Institute

3.1 Answers to the Standard Evaluation Protocol

Evaluation of the institute with respect to Score

1. Leadership	4
2. Mission and goals	5
3. Strategy and policy	
4. Adequacy of the resources (€)	not graded
5. Funding policies	
6. Facilities	5
7. Academic reputation of the institute	5
8. Societal impact of the institute	4
9. Balance of the strengths and weaknesses of the institute	not graded
10. Overall assessment of the institute	5

Overall assessment of the institute	**5**

AMOLF is recognised internationally as a major centre for research in the physical sciences. Although of a relatively small size, the quality of the staff is high as evidenced by the citations rate for its publications and the awards and honours received by several of the staff. This quality is vital to the mission of AMOLF: not only does it ensure work of the highest quality but also it empowers management with great flexibility. High quality staff contribute positively to the management process and tend to be flexible in their response to change.

Whilst maintaining a high profile programme of research the Institute is in the process of a major change in its research emphasis towards more interdisciplinary research. This aligns the institute's work with the NWO and FOM strategy. It follows the international trend and although it has meant discontinuing some projects of undoubted excellence, the focus and renewal achieved are vital to its continuing excellence and relevance.

3.1.1 Leadership **4**

AMOLF operates a policy of a flat management structure which is appropriate to a group of creative individuals. The past few years have seen great change at AMOLF as the research programme has turned from one concentrating heavily on the physical sciences to a more interdisciplinary approach. Activities in biophysical sciences are being built up partly by existing staff turning their attention to new problems and partly by recruitment of new staff who bring the required expertise in biosciences. Nanophotonics is the second programme chosen and has been largely implemented in a short space of time.

This policy has been agreed by consensus within AMOLF and carried forward with energy despite several changes of Director. The present director has seized the initiative and is driving with vigour in the new directions.

3.1.2 Mission and goals and 3.1.3 Strategy and policy **5**

The mission of AMOLF is reported as:

"To perform leading fundamental research on strategically important complex atomic and molecular systems with key potential for technological innovations, and to transfer knowledge to industry and society."

This statement has been broadly interpreted in the new strategic plan with two new major programs: one in the physics of biomolecular systems and the other in nanophotonics. Both are fields replete with opportunities and the panel strongly supports the new directions. The second part of the mission, "..... to transfer knowledge to industry and society" is less securely established and requires something of a culture change at some levels. AMOLF has much to contribute in this respect and we should like to see it achieve its potential.

We note that the 'exploratory research programme' is vital to nurture new and developing areas, as well as excellent research beyond the two main programs.

3.1.4 Adequacy of resources (€) and 3.1.5 Funding policies **not graded**

The funding arrangements by FOM for AMOLF have changed. The programmes are ending leading to a gradual cut in the direct contribution from FOM and in 4 years time there will remain a mission budget of M€ 5.2. This leaves a potential gap of M€ 2.2.

Some of this cut can be made good by seeking funding from the variety of other sources available. However it is in the nature of project specific grants that they provide little or no contribution to infrastructure at least under current funding models operated in Europe.

Therefore the mission budget ultimately limits the size of the institute, and a cut must mean that ultimately the size will shrink.

It is not for this panel to recommend an ideal size for AMOLF. Nevertheless we do believe that AMOLF represents money well spent and that further investment would be rewarded with excellent science. The Institute is small by international standards and though the planned cut in budget would not reduce the institute below any critical mass one should bear in mind that further cuts to the mission budget would bring matters dangerously close to that situation.

We strongly recommend to FOM and NWO further investment of M€ 4.5 - M€ 5.0 in the mission budget over the period 2007-2011, which would enable full implementation of the new strategy by:

- Retaining the flexibility, earning capacity, and matching funds that are required to attract the presently raised sum of M€ 4.8 rising to a projected M€ 5.8 by 2010 per annum in externally acquired projects and programmes.
- Creating the desired focus and mass and to achieve its national and international ambitions;
- Starting a new group in systems biology thereby strengthening the Physics of Biomolecular Systems programme and its relation with the BioCentrum Amsterdam,;
- Starting a new group in bio-photonics thereby creating additional synergy between the Nanophotonics and the Physics of Biomolecular Systems programme;
- Explore the possibilities for biomimetics research.

3.1.6 Facilities	5

It was repeated to the panel many times in the course of our interviews that one key advantage of AMOLF is the excellence of the technical support. This is clearly something not easily achieved as it requires stability, good management, and adequate resources. The nature of the support required is changing with the mission and it is vital for the quality of the Institute that the excellence of support is maintained as the new strategy is implemented. We particularly commend the excellent choices made for investment in instrumentation. Also the natural sharing of resources was a particularly positive feature.

3.1.7 Academic reputation of the institute	5

3.1.8 Societal impact of the institute	4

As is appropriate to an international institute, AMOLF's research is disseminated at conferences and through publications in journals. We have remarked above on the high impact factors and citations achieved by these publications.

One feature of the Institute we commented on is the small number of tenured staff. Each of these attracts a substantial complement of students, post docs , and visitors. This intellectual current not only feeds the Institute's research programme but also provides a stream of highly trained people into society.

Given the quality of work and particularly the excellence of the facilities it came as a surprise to us how little experience there is in patents and intellectual property. Of the nine patents listed in the reporting period, most were concentrated in one small part of the Institute's activities. We are not suggesting a heavy emphasis on applications that would distort the mission of the Institute but applications will naturally arise in the course of first class work and there should be greater awareness of the potential for applications with intellectual property rights. In fact FOM itself could well show more interest in the whole area of intellectual property and start up companies. We encourage the Director in his efforts to increase this kind of activity.

3.1.9 Balance of the strengths and weaknesses of the institute not graded

We confirm the accuracy of the SWOT analysis presented in the strategic plan.

3.2 Answers to the questions addressed to the committee by NWO

Two questions were put by NWO and FOM in addition to the Standard Evaluation Protocol.

- How does AMOLF position itself in the national research landscape? To what added value does this lead?

- What is the role of the institute in the European research landscape?

We start from our assessment of the scientific strengths of the institute, its position of international eminence, its helping shape the national research agenda in nanophotonics and biophysics, and the technical excellence of the facilities. These could have been created in other ways, possibly in attachment to a major university. However they exist as the AMOLF institute and the real question is whether more would be achieved by dispersing this excellence through the dissolution of the Institute and recreating it elsewhere. This is the Cromwellian approach to administration which we do not support. If FOM decides to support excellence in the new areas of research, continuation of AMOLF with its traditions of excellence and even more its continued ability to renew, represents an efficient way forward. We note elsewhere in this document that it would not be inappropriate to consider further investment in this excellent but modest sized and world wide visible institution.

4 Past performance: research programme assessments

4.1 Research programmes QDAMS (1999-2002) and UMD (2003-2009)

Current research programme leader:	Prof.dr. H.J. Bakker
Groupleaders:	Prof.dr. M.J.J. Vrakking, Prof.dr. M. Bonn
Projectleaders:	Dr. J. Herek, Dr. S. Woutersen
Other personnel (end 2005):	6 postdocs, 10 PhD-students, 5 technical staff
Publications (2000-2005):	183 journal papers, 2 other journal papers, 29 book chapters, 14 PhD-theses, 4 other publications, 96 invited talks.

Quality	5
Productivity	4
Impact	5
Vitality	4
Overall	**5**

Research in this area has moved from quantum dynamics of atomic and molecular systems (QDAMS) which were - to large extent - studied in the gas phase to ultrafast molecular dynamics (UMD) mainly in the condensed phase. Such change of direction was part of AMOLF's re-direction towards life-science inspired physics. The present programme aims at analyzing and controlling microscopic processes and elementary functional steps in biological, biologically relevant and small model systems using nonlinear and/or ultrafast spectroscopy with a time resolution down to the attosecond range. Such topics generate additional links to the SFFSM and NOEM programmes.

The UMD research strategy combines a clever choice of the systems to be investigated with state-of-the art methods of nonlinear ultrafast spectroscopy, addressing both electronic and nuclear dynamics. Basic issues of understanding biological function at a molecular level are addressed by studying model and bio-systems in a step-wise approach. A broad range of ultrafast spectroscopies in the near- to far-infrared range have been implemented successfully to measure molecular couplings, monitor structural dynamics induced by optical excitation, and study carrier dynamics and charge transport in organic systems. There is a good balance of method-oriented work and spectroscopic applications.

The work on water has provided new insight into the dynamics of solvation shells around ions, of water in nanodroplets and of proton transfer processes in the bulk liquid. First experiments on the interaction of biomolecules with water are promising and have the potential to characterize local structure-determining interactions and structural fluctuations. The well-established cooperation with theory groups performing molecular dynamics simulations will allow for an in-depth analysis of such elementary processes. Hydrogen bond research at AMOLF is at the international forefront and its excellent quality is widely recognized.

In a related effort, nonlinear biosurface spectroscopy has been applied very successfully to unravel intermolecular couplings and structural dynamics in biological (model) membranes and biomolecules on surfaces. Structural changes in model membranes have been characterized on a local scale by measuring changes of the vibrational spectrum with very high sensitivity. Recently, the feasibility of mapping such changes on a 100 fs time scale has been demonstrated. Such impressive progress will play a key role for future work on membranes and biomolecules embedded in membranes.

Control of biomolecular dynamics has been demonstrated in the LH2 light-harvesting antenna and in metalloporphyrins. Based on standard coherent control techniques and self-learning algorithms, the results are of high quality and have been well received by the control community. With the ongoing experiments on light localization in nanostructures, close links are being established to the photonics programme of AMOLF.

The work on extreme-ultraviolet physics of atoms and small molecules has led to a sequence of spectacular results on attosecond electron dynamics, electron wavepacket interferometry, electron velocity mapping and electron localization in elementary dissociation processes. The strategy in this rapidly progressing field is chosen very carefully and well embedded in international research cooperations which in part are coordinated by AMOLF. The complexity of the experiments requires a research environment like AMOLF with state-of-the art high-power lasers and a combination of expertise from laser and atomic physics. Overall, this outstanding activity makes a major contribution to the international visibility and recognition of AMOLF.

The productivity in the UMD programme is very good with a large number of papers, many of them published in high-class journals, and a strong impact documented by the high level of citations. AMOLF has been successful in hiring excellent young scientists for this programme who became productive within a short period of time.

Recommendations
The UMD programme is mainly carried out in separate projects of the individual groups although there are certainly links with respect to laser technology and spectroscopic methods. It is recommended to intensify collaboration between the different groups. In addition, cooperation with theory groups outside AMOLF should be extended to warrant an appropriate level of theoretical analysis and simulation.

4.2 Research programme SFFSM (1999-2006)

Programme leader:	Prof.dr. D. Frenkel
Groupleaders:	Prof.dr. A.M. Dogterom, Prof.dr. B.M. Mulder, Prof.dr. W.H. de Jeu
Projectleaders:	Dr. P.R. ten Wolde, Dr.ir. S.J. Tans
Other personnel (end 2005):	15 postdocs, 17 PhD students, 3.3 technicians
Publications (2000-2005):	220 journal papers, 11 book chapters, 15 PhD-theses, 14 other publications, 154 invited talks

Programme assessment

Quality	5
Productivity	5
Impact	5
Vitality	5
Overall	**5**

The hiring programme proved to be very successful. In particular the bio-assembly and organization has blossomed into a fully mature scientific project at the best international level. It is probing and answering in a quantitative way biologically relevant questions with in vitro reconstituted systems such as force generation by microtubule polymerization, or phospholipidic nanotube formation by molecular motors. The goal of deciphering the feedback circuitry implementing cell symmetry is excellent. The theory of biomolecular matter has

found a nice niche in addressing the question of cell plant growth. The demonstration that entropy could drive plasmid separation during prokaryotic cell division is appealing. The biochemical network project has been developing new methodology for sampling rare events in the study of biochemical networks in both space and time. This in turn has allowed for showing that gene proximity could stabilize correlated or anticorrelated of pairs of gene expression. This opens the way for understanding the robustness of spatial patterns of gene expression. By addressing key issues on evolution of gene networks and DNA recombination including at a single cell level Biophysics looks promising. Computational Physics which has always been at the highest international level, has now moved to fully relevant biological problems. The example of the work on the GroEs-GroEs chaperonin is particularly pleasing: statistical physicists have ignored the role of chaperonin for several decades: we have here the first example of a theoretical fundamental contribution to protein folding in cellular environment.

The presentation made it clear that there is active exchange of idea and knowledge within the program. The general quality and productivity is competitive on the world scale. The problems being tackled are of direct biological interest and the connections to the biological community are real at the local, national and international level. Such outstanding results could not be achieved without inspired leadership and nurturing environment.

Recommendations
We expect that the impressive collaboration will be carried over to the centre for physics of biomolecular systems.

4.3 Research programme NOEM (1999-2007)

Programme leader:	Prof.dr. A. Polman
Tenured staff:	Prof.dr. A. Lagendijk, Prof.dr. L. Kuipers, Prof.dr. W. Vos, Dr. J. Verhoeven
Staff on tenure track:	Dr. J. Goméz Rivas
Other personnel (end 2005):	3 postdocs, 12 PhD students, 3.5 technicians
Publications:	93 journal papers, 3 other papers, 18 book chapters, 8 PhD theses, 19 other publications, 71 invited talks.

Programme assessment NOEM

Quality	5
Productivity	4
Impact	5
Vitality	5
Overall	5

The programme Nanostructured Opto-Electronic Materials (NOEM) has been strongly increased in size in the last couple of years in accordance with AMOLF's Strategic Plan for 2006-2011 in which "Nanophotonics" will be one of the two main focus areas (the other one being 'Physics of Biolmolecular Systems') beside a smaller future research programme dealing with "Exploratory Research". Therefore, the accomplishments over the past 6 year should be seen in the context of the plans for this area and should be assessed especially critically since it does not only concern the past performance but does also gives an indication concerning future directions and the probability of being successful in the future.

The manipulation of light (or in scientific language of 'photons') on a submicrometer or nanometre scale by purposely micro- or nanostructuring solid materials is a major research subject worldwide. This kind of research concerns emission, wave guiding, and manipulation of light as well as detection of light. It is reasonable to expect that the outcome of research in the area of micro- and nanophotonics will have technological impact provided the required nanostructures can be designed properly based on a deep understanding of the interaction of light with the nanostructures and also be fabricated reliably and priced competitively. The two types of nanostructures of special importance are i) periodic arrangement of dielectric objects ('photonic crystals'), typically fabricated based on common semiconductors such as silicon, gallium arsenide or gallium phosphide and ii) single or one- or two-dimensional arrangements of metallic nanostructures interacting with light in terms of surface plasmon polaritons (SPP).

The NOEM programme was started in AMOLF already in 1999 as a relatively small research activity. Van Blaaderen who specialised on colloidal materials left AMOLF 2002 for a professorship at Utrecht University. Initially the nanophotonic research concentrated on erbium-based optical amplifiers in the technologically important near infrared range, especially also on the use of implantation for the localized positioning of erbium as well as the transfer of light energy from silicon nanocrystals to erbium. Resonators based on microdisks containing erbium were successfully fabricated jointly with a group at CALTECH. Later on the subjects of photonic crystals and of plasmonic nanostructures were added.

Starting in 2003 three new groups were installed at AMOLF in the area of nanophotonics complementing the already existing know-how. Finally, in April 2005 a research group was started jointly with and physically located at Philips Research. This junior research group deals in nanowire photonics. This is a highly positive development in terms of marketing research results. The chosen research area of nanowire photonics looks promising. However, because of the short time since inception of this group, scientifically it can not yet been judged whether this effort will lead to world-class research results.

The nanophotonics research performed requires the high quality fabrication of the designed nanostructures to be investigated. For this purpose in 2003 the Amsterdam nanoCenter was formed and opened in 2003 at AMOLF. Partly, the nanooptics research was also performed involving nanostructured samples fabricated as part of national or international collaborations.

The research subjects dealt with by the already established and the new groups are at the forefront of international nanostructure research. The publication record overall is excellent, including the previous record of the senior group leaders before joining AMOLF. The publications include an unusually high number of publications in Physical Review Letters with overall an impressive citation record.

The past and present performance and the addition of new senior group leaders with excellent track records and the strengthening of the ties with industry are showing the hallmarks of an excellent international research programme clearly exceeding the critical mass on a national level as expected from a successful AMOLF programme. There is a very healthy balance between experimental and theoretical projects and capabilities.

Recommendations
The expansion of the research staff with high quality people is considered very positive. The management might consider to add research elements on light detection as this might allow to go for the area of fully integrated nanophotonics. The collaboration with Philips research should be further developed if possible. The existing positive intellectual property efforts should be further strengthened in this area.

4.4 Research programme MSMS (1999-2003) /BIOMSL (2002-2008)

Programme leader:	Prof.dr. J.J. Boon
Groupleaders:	Prof.dr. R.M.A. Heeren
Projectleader:	Dr. S. Piersma
Other personnel:	5 Postdocs, 8 PhD-students, 3 technicians
Publications:	83 journal papers, 55 book chapters, 11 PhD theses, 1 other publication, 54 invited talks

Research programme assessment

Quality	5
Productivity	5
Impact	4
Vitality	4
Overall	**5**

Using mass spectrometry and chemical imaging, the molecular painting research has provided a convincing molecular level understanding of the aging mechanisms of paintings. In particular it has highlighted metal soap aggregates. The role of this invaluable contribution has open the way to intelligent restoration of master pieces. The conversion to biologically guided mineralization in animals has opened the way to using the acquired expertise in chemical and electron microscopy and mass spectroscopy imaging.

Macromolecular ion physics has achieved forefront positions in rapid resolution imaging of bio-molecules in cells and tissues. For example this technique allowed for new neuro-peptide discovery together with their localisation in the rat brain. Furthermore the study of the molecular chaperon complex «GroEl-GroEs» is a real tour de force, made possible efficient data handling and analysis of truly massive amount of data. The quality of this work is outstanding and able to address fundamental biological and medical questions and the productivity is high. The project has already impacted in a very positive fashion other researches in AMOLF, and more is to come in the future.

Recommendations
Although we understand that the molecular painting project no longer fits in the AMOLF (FOM) strategic mission it certainly deserves FOM and NWO help transitioning to a more appropriate location, including the possibility of a start-up company.

4.5 Exploratory/Transition programme

The people who where in the transition programme in the evaluation period 2000-2005 have all left.
Publications (2000-2005): 95 journal papers, 4 book chapters, 10 PhD theses and 7 other publications

Research programme assessment
Quality –
Productivity –
Impact –
Vitality –
Overall –

Recommendations
The exploratory/transition programme has been an important vehicle for change and innovation within the institute and should remain so.

5 Conclusions and recommendations

AMOLF is recognised internationally as a major centre for research in the physical sciences. Although of a relatively small size, the quality of the staff is high as evidenced by the citations rate for its publications and the awards and honours received by several of the staff. This quality is vital to the mission of AMOLF: not only does it ensure work of the highest quality but also it empowers management with great flexibility. High quality staff contribute positively to the management process and tend to be flexible in their response to change.

Whilst maintaining a high profile programme of research the Institute is in the process of a major change in its research emphasis towards more interdisciplinary research. This aligns the institute's work with the NWO and FOM strategy. It follows the international trend and although it has meant discontinuing some projects of undoubted excellence, the focus and renewal achieved are vital to its continuing excellence and relevance.

Given the quality of work and particularly the excellence of the facilities it came as a surprise to us how little experience there is in patents and intellectual property. We encourage the Director in his efforts to increase this kind of activity.

It is not for this panel to recommend an ideal size for AMOLF. Nevertheless we do believe that AMOLF represents money well spent and that further investment would be rewarded with excellent science. The Institute is small by international standards and though the planned cut in budget would not reduce the institute below any critical mass one should bear in mind that further cuts to the mission budget would bring matters dangerously close to that situation.

We strongly recommend to FOM and NWO further investment of M€4.5 - M€5.0 in the mission budget over the period 2007-2011, which would enable full implementation of the new strategy.

6. Appendices

6.1 Curricula vitae of the committee members

J.B. PENDRY - CURRICULUM VITAE
at 16 December 2005

Address:	Department of Physics, Imperial College London, Prince Consort Road, London SW7 2AZ, UK
telephone:	020-7594-7606
email:	j.pendry@imperial.ac.uk
Date of Birth:	4th July, 1943

Degrees:	1965 BA, Cantab (Physics) 1969 MA, PhD,Cantab (Solid State Theory)
1962-65	Scholar of Downing College, Cambridge
1965-66	Part III Mathematics - postgraduate course
1966-69	Research student, Cavendish Laboratory, Cambridge
1969-73	Research Fellowship in Physics, Downing College, Cambridge
1969-71	ICI post-doctoral Fellow
1972-73	Member of Technical Staff in the Theoretical Physics Department, Bell Laboratories, Murray Hill, USA
1973-75	Senior Assistant in Research, Cavendish Laboratory, Cambridge
1973-75	Fellow in Physics and Praelector, Downing College
1975-81	Senior Principal Scientific Officer: Head of Theory Group, SERC Daresbury Laboratory
1981-	Professor of Theoretical Solid State Physics, Imperial College of Science and Technology, and Head of the Condensed Matter Theory Group
1983-85	Head of Experimental Solid State Physics Group
1984	FRS
1984	F. Inst. P.
1984-92	Associate Head of Physics Department
1992-93	Member, SERC Science Board, SERC Nuclear Physics Board
1992-94	Member of Council, Royal Society.
1993-96	Dean, Royal College of Science
1996-2002	Editor, Proceedings A of the Royal Society
1996-97	Leverhulme Trust Senior Research Fellowship
1997-1998	EPSRC Senior Research 5-Year Fellowship (resigned April 1998)
1998-2001	Head of Physics Department, Imperial College London
1998-2002	Member of Particle Physics and Astronomy Research Council
1998-2000	Commonwealth Scholarships Commissioner
2001-2002	Principal, Faculty of Physical Sciences, Imperial College London
2003-	EPSRC Senior Research 5-Year Fellowship
2004	Knight Bachelor
2005-	Chairman Physics sub panel of RAE 2008
2005	Fellow Optical Society of America
2005	Decartes prize for 'Extending Electromagnetism through Novel Artificial Materials'

Prof. Dr. Thomas Elsaesser
Max-Born-Institut für Nichtlineare Optik
und Kurzzeitspektroskopie
& Institut für Physik der Humboldt-Universitaet
Max-Born-Str. 2 A
12489 Berlin

Thomas Elsaesser was born in Tübingen, Germany. After studying physics at the University of Heidelberg and the Technical University of Munich, he received a Dr. rer. nat. degree from the Technical University of Munich in 1986. His PhD work in the group of Prof. Wolfgang Kaiser was devoted to picosecond infrared spectroscopy. After spending a postdoc period at AT&T Bell Laboratories in the US, he finished his habilitation at the TU Munich in 1991. Since 1993, Thomas Elsaesser is a director of the Max-Born-Institute for Nonlinear Optics and Short-Pulse Spectroscopy, holding a joint appointment with the Institute of Physics of Humboldt University. He turned down several calls from other universities.

Optical studies of ultrafast processes in condensed matter represent the main area of his scientific work. Major topics are transient structures of (bio)molecules and solids as well as the investigation of basic microscopic interactions in solids and liquids. His work includes the application of results in optoelectronics. Such work has resulted in approximately 300 publications in refereed journals and books, several patents and more than 100 invited talks at international conferences. Thomas Elsaesser received the Rudolf Kaiser Prize 1991 and the Otto Klung Award in Physics in 1995. In 2004, he worked at the Ecole Normale Superieure in Paris as a Professeur invité.

ULRICH M. GÖSELE
Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle, Germany
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EDUCATION

"Habilitation" - degree in solid state physics, University of Stuttgart, 1983
Ph.D., Max-Planck-Institute for Metallurgy, University of Stuttgart, 1975
Diploma-Physics, University of Stuttgart, W. Germany, 1973

RESEARCH INTERESTS

Defects and diffusion processes in silicon and other semiconductors; defect formation during crystal growth or during device processing and implications on the electronic quality of the materials; science and technology of semiconductor wafer bonding; quantum effects in porous silicon; self-limited fabrication of nanostructures; semiconductor nanowires; quantum dots; ferroelectric thin films; photonic crystals and silicon photonics; nanoporous materials.

INDUSTRIAL AND ACADEMIC EXPERIENCE

(June 1993-) Director, Max-Planck-Institute of Microstructure Physics, Halle, Germany
(July 1998-) Adjunct Professor of Materials Science, Duke University, Durham, NC, USA
(Oct. 1985-June 1998) Professor of Materials Science (since 1993 J. B. Duke Professor of Materials Science and leave of absence), Duke University, Durham, NC, USA
(1984-Sept. 1985) Research Engineer, Siemens Corporation, Munich, Germany
(1977-1983) Tenured research scientist, MPI for Metallurgy, Stuttgart, Germany
(1975-1976) Max-Planck-Institute, Post Doctoral Research Associate

PROFESSIONAL ACTIVITIES

Visiting Appointments-Honors

- Member of Leopoldina Academy (Germany) (2002)
- Fellow of the Institute of Physics (UK) (2001)
- Fellow of the American Physical Society (2000)
- Electronics Division Award of the Electrochemical Society (USA) (1999)
- Visiting Scientist , Harvard University, Cambridge, USA (Sept.-Dec. 2003)
- Visiting Professor, NTT LSI Laboratories, Atsugi, Japan (Sept.-Dec. 1991)
- Visiting Scientist, Department of Materials Science, M.I.T., Massachusetts (June 1988)
- Visiting Scientist, Department of Materials Science, Cornell University, N.Y. (1983)
- Visiting Scientist, IBM Thomas J. Watson Research Center, N.Y. (1980-81)
- Senior Scientist, Atomic Energy Board, Pretoria, South Africa (1976-77)
- Otto-Hahn Medal - for young scientists of the Max-Planck-Society (1978)

Membership in Professional Societies

American Physical Society; Institute of Physics; Scientific Member, Max Planck Society; LEOPOLDINA; Boehmische Physical Society, Electrochemical Society; German Physical Society; Materials Research Society (Director of the MRS Board, 2003-2005)

Service

- Appointment, Promotion and Tenure Committee, Duke University for three years, including chairman for one year
- Co-editor, editorial board member or advisory board member over various time periods for: Appl. Phys. Lett., J. Appl. Phys., Appl. Phys. A., Information Sciences, J. Mater. Research, Adv. Materials, Physikalische Blaetter, Zeitschrift fuer Metallkunde, Mat. Chem. Physics, Inf. Sciences
- Co-organization or in Advisory Board of numerous National and International Symposia, amongst others for Electrochem. Society and Materials Research Society
- Many invited lectures at universities, industrial laboratories, and international conferences

CURRICULUM VITAE:

MICHAEL L. KLEIN
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Honors & Awards

Honorary Fellow – Indian Academy of Sciences (Bangalore), 2005
Honorary Fellow – Academy of the Developing World (TWAS), 2004
Fellow – American Academy of Arts & Sciences, 2003
Fellow – Royal Society of London, 2003
Fellow – Institute of Physics UK, 2003
Fellow – American Physical Society, 1991
Fellow – Royal Society of Canada, 1984
Fellow – Chemical Institute of Canada, 1979

Ciba-Geigy Research Fellow, Genova, Italy 1964-65; ICI Fellow, Bristol, UK 1965-67;
IBM World Trade Fellow, 1970; Professeur Associé, Université Paris, 1975;1982;1985;1994
Visiting Fellow, Australia National University 1980; SERC Visiting Fellow, Cambridge, UK 1981;
JSPS Visiting Fellow, Kyoto, Japan 1982; Visiting Professor, University of Amsterdam, 1985;
Fellow Commoner, Trinity College Cambridge, UK, 1985;
Néel Visiting Professor, École Normale Supérieure, Lyon 1988
Guggenheim Fellow, 1989-90; Visiting Professor, Università di Firenze, 1993
William Smith Professor of Chemistry, University of Pennsylvania 1991-93
Coulson Professor Elect, University Of Oxford, UK 1993
Hepburn Professor of Physical Science, University of Pennsylvania 1993
Alexander Von Humboldt Fellowship, Max-Planck-Institute, Stuttgart 1996
Miller Research Professorship, University of California, Berkeley 1997
Linnett Professorship, University of Cambridge, UK 1998
American Chemical Society, Philadelphia Section Award 1998
American Physical Society, Aneesur Rahman Computational Physics Prize 1999
INFM Visiting Professor, Università di Roma, La Sapienza 2001
Schlumberger Visiting Professor, University of Cambridge & University of Oxford 2003
Bernie J. Alder CECAM Prize for Computational Physics, Genoa Italy 2004

Professional Experience

CIBA-GEIGY Fellow, Instituto di Fisica, Università di Genova, 1964-65
ICI Fellow, Department of Theoretical Chemistry, Bristol, UK, 1965-67
Research Associate, Physics Department, Rutgers University, New Jersey, 1967-68
Research Officer, Chemistry Division, NRCC, Ottawa, Canada 1968-87
Professor of Chemistry, University of Pennsylvania, 1987-present
Director, Penn Laboratory for Research on the Structure of Matter, 1993-present
Director, Penn Center for Molecular Modeling, 1995-present

CURRICULUM VITAE

Jacques PROST

Born 1946 (France)
Address 10 rue Vauquelin, ESPCI, 75231 PARIS, cedex 05, France

1995-1996 leader« Groupe de Physico-Chimie Théorique » ESPCI, URA 1382

1996 → 2003 Director « Physico-chimie Curie »

2003 General Director ESPCI, PARIS

Honors

1981 Louis Ancel Award (French Physiscal Society)
1984 CNRS silver medal
1987 « Grand Prix » best interaction University -Entreprise in Aquitaine
1995 « Jean Ricard » Price « Grand Prix, French Physical Society »
1998 Member European Academy of Sciences

Fields of interest

Soft condensed Matter, Statistical Physics, Biophysics

6.2 Standard Evaluation Protocol 2003-2009

The present evaluation has been prepared in accordance with the Standard Evaluation Protocol. The institute wrote a self-evaluation report, which was accepted by the Governing Board of NWO and then sent to the members of the evaluation committee.
The committee met for a three-day site visit, starting at 5 p.m. on 21 May 2006 and ending at 7 p.m. on 23 May 2006. The evaluation report was written during and after the site visit. Around 7 p.m. on Tuesday, a preliminary draft of the evaluation document was presented. The chair together with the secretary then edited this further and a week later sent a second draft to the committee members with a request to provide comments within a week. Based on this input, a third draft was prepared by the chair and this was sent on DATE to the director of AMOLF to be checked for factual errors. His remarks were received on DATE and a final draft was then prepared. The report was sent to the Governing Board of NWO on DATE.
The Governing Board accepted the report on DATE.

6.2.1 Additional questions put by NWO and FOM

- How does AMOLF position itself in the national research landscape? To what added value does this lead?
- What is the role of the institute in the European research landscape?

6.3 Programme of the site visit

Members of the Evaluation Committee
Prof.dr. Sir J.B. Pendry (chair) Imperial College, London
Prof.dr. H.T. Elsässer, Max Born Institut Berlin
Prof.dr. U. Gösele, Max-Planck-Institute of Microstructure Physics, Halle
Prof.dr. M.L. Klein, University of Pennsylvania, Philadelphia
Prof.dr. J. Prost, ESPCI, Paris

PROGRAMME
Sunday, 21 May 2006
Location: NH Hotel Barbizon Palace

All day			Arrival of Panel
17:30	-	18:30	Installation of the panel by Prof.dr.C.H.C.M. Buys, the vice chairman of NWO and Dr. K.H. Chang, the director of FOM General introduction to AMOLF by the director of AMOLF, Prof.dr. A. Polman
18:30	-	19:30	Internal discussion
20:00			Working dinner with Prof.dr. C.H.C.M. Buys at D'Vijf Vlieghen

Monday, 22 May 2006

08:30	-	09:00	Taxi from NH hotel Barbizon Palace to AMOLF
09:00	-	09:15	Reception with coffee
			QDAMS/UMD
09:15	-	09:30	Introduction from panel discussion leader
09:30	-	09:45	Programme leader – Prof.dr. H.J. Bakker
09:45	-	10:00	Prof.dr. H.J. Bakker
10:00	-	10:15	Prof. dr M. Bonn
10:15	-	10:30	Dr. J. Herek
10:30	-	10:45	Prof.dr.ir. M.J.J. Vrakking
10:45	-	11:00	Panel discussion
11:00	-	11:15	Coffee break
			SFFSM
11:15	-	11:30	Introduction from panel discussion leader
11:30	-	11:45	Programme leader – Prof.dr. D. Frenkel
11:45	-	12:00	Prof.dr. D. Frenkel
12:00	-	12:15	Prof.dr. M. Dogterom
12:15	-	12:30	Prof.dr. B.M. Mulder
12:30	-	12:45	Dr. P.R. ten Wolde
12:45	-	13:00	Dr.ir. S. Tans
13:00	-	13:15	Panel discussion
13:15	-	14:15	Lunch with PhD students

			NOEM
14:15	-	14:30	Introduction from panel discussion leader
14:30	-	14:45	Programme leader Prof.dr. A. Polman
14:45	-	15:00	Prof.dr. A. Polman
15:00	-	15:15	Prof.dr. L. Kuipers
15:15	-	15:30	Prof.dr. A. Lagendijk
15:30	-	15:45	Prof.dr. W.L. Vos
15:45	-	16:00	Dr. J. Gómez Rivas
16:00	-	16:15	Panel discussion
16:15	-	16:30	Break
			MSMS/BIOMSL
16:30	-	16:45	Introduction from panel discussion leader
16:45	-	17:00	Programme leader Prof.dr. J.J. Boon
17:00	-	17:15	Prof.dr. J.J. Boon
17:15	-	17:30	Prof.dr. R.M.A. Heeren
17:30	-	17:45	Panel discussion
17:45	-	18:30	Taxi from AMOLF to restaurant
18:30			Working Dinner in hotel restaurant Vermeer, and report writing at NH Hotel Barbizon Palace

Tuesday, 23 May 2006

08:30	-	09:00	Taxi from NH hotel Barbizon Palace to AMOLF
09:00	-	09:15	Coffee
			Strategic Plan AMOLF
09:15	-	10:00	Prof.dr. A. Polman – introduction; Prof.dr. A.M. Dogterom – Center for Physics of Biomolecular Systems; Prof.dr. L. Kuipers – Center for Nanophotonics. (Prof.dr. D. Frenkel, Prof.dr. H. Bakker present)
10:00	-	10.45	Lab tour: Center for Physics of Biomolecular Systems – Prof.dr. M. Dogterom
10.45	-	11:00	Coffee
11.00	-	11.45	Lab tour: Center for Nanophotonics – Prof.dr. L. Kuipers.
11:45	-	12:15	Prof.dr.ir. W. van Saarloos chairman scientific advisory board of AMOLF
12:15	-	13:00	Discussion with Prof.dr. M. Dogterom, Prof.dr. D. Frenkel, Prof.dr. H. Bakker, Prof.dr. L. Kuipers, Prof.dr. A. Polman
13:00	-	13:15	Panel discussion

13:15	-	14:15	Lunch with non-tenured group leaders
14:15	-	14:45	Possible meeting with Prof.dr. A. Polman, director of AMOLF
14:45	-	19:00	Internal Discussion and report writing
19:00	-	19:30	Taxi from AMOLF to restaurant 'de Kas'
19:30	-	21:30	Dinner at restaurant 'de Kas' with presentation of main conclusions

6.4 List of PhDs and projectleaders interviewed

On Monday, the panel had an informal lunch with the following PhD-students (in the absence of their advisors and AMOLF management):
Ms. A. van Loon, Molecular painting research
Ms. C. Valeriani, Computational Physics
Mr. E. Verhagen, Photonic Materials
Mr. F. Poelwijk, Biophysics
Ms. M. Sovago, Biosurface spectroscopy
Mr. S. Tindemans, Theory of biomolecular matter

On Tuesday the panel lunched with the following projectleaders:
Dr. J. Goméz Rivas
Dr. J. Herek
Dr.ir. S.J. Tans
Dr. S. Woutersen
Dr. P.R. ten Wolde