Evaluation 2011-2016

Nikhef

Dutch National Institute for Subatomic Physics

Amsterdam, 19 September 2017

NWO Netherlands Organisation for Scientific Research

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Content

1 Introduction

1.1 Scope and context of this review

This evaluation concerns the research carried out at the Dutch National Institute for Subatomic Physics (Nikhef) since 2011. The evaluation was commissioned and organised by the Netherlands Organisation for Scientific Research (NWO) and supported by Dialogic Innovation & Interaction and Birch Consultants. The external evaluation follows the Standard Evaluation Protocol 2015-2021 (SEP, amended version September 2016). It is the protocol for research assessments in the Netherlands as agreed upon by NWO, the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Association of Universities in the Netherlands (VSNU). The primary aim of the assessment procedure is to reveal and confirm the research quality, relevance to society and viability and to provide recommendations to improve these aspects. In addition, the procedure includes considerations with regard to PhD programmes, the research integrity and diversity of the (scientific) staff.

An international Evaluation Committee was established and asked to produce a reasoned evaluation of the institute and its research programmes, in accordance with the SEP. Prior to the external evaluation, Nikhef submitted a self-assessment document covering the period 2011-2016 including a strategic forward look. This report was approved by the NWO Executive Board on July 5th 2017. The self-assessment report and addendum included a SWOT analysis and a full set of statistics at institute and programme level concerning input (finances, funding and staff) and output (refereed articles, books, PhD theses, conference papers, publications aimed at the general public, and other output) for the six years prior to the evaluation. A number of tables were included about research staff, main categories of research output, funding, and PhD candidates (see SEP appendix D, D3). The self-assessment report therefore offered a concise picture of the institute and research groups' work, ambitions, output and resources in accordance with the guidelines provided by the SEP. A site visit formed an important part of the evaluation and included interviews with the management of the institute, the programme leaders, other levels of staff, and a tour of the laboratories and facilities.

1.2 The Evaluation Committee

The Evaluation Committee was installed on September 17th by Prof. dr. Stan Gielen, president of the NWO Governing Board. Its members were:

- Prof. dr. Tejinder (Jim) Singh Virdee (chair), Imperial College, London, United Kingdom.
- Prof. dr. Paula Eerola, University of Helsinki, Finland.
- Prof. dr. Teresa Montaruli, University of Geneva, Switzerland.
- Prof. dr. Fernando Ferroni, INFN, Rome, Italy.
- Prof. dr. Reynald Pain, IN2P3, Paris, France.
- Prof. dr. Thomas Gehrmann, University of Zürich, Switzerland.
- Prof. dr. Marco Beijersbergen, Cosine, Leiden, the Netherlands.

A short curriculum vitae of each of the members is included in Annex 1. The Committee was supported by NWO (drs. Jacqueline Mout) and Dialogic Innovation & Interaction (dr. Frank Bongers).

Before the site visit all members of the Committee signed the NWO Code of Conduct, by means of which they declared that their assessment would be free of bias and without regard

to personal interest, and that they had no personal, professional or managerial involvement with the institute or its research programmes. It was concluded that the Committee had no conflicts of interest.

1.3 Data supplied to the Committee

Five weeks prior to the site visit the Evaluation Committee received the self-assessment report of Nikhef together with the site visit programme and an accompanying letter. The documentation supplied to the Committee included all the information required by the SEP as well as by the additional questions raised by NWO.

At the start of the site visit the Committee was informed about the Dutch science policy and the organisation of scientific research in the Netherlands, about (the transition of) NWO and the governance structure of the NWO research institutes.

1.4 Procedures followed by the Committee

The Committee proceeded in accordance with the Standard Evaluation Protocol 2015-2021. The assessment was based on the Nikhef self-assessment report and the other documentation provided by NWO, the institute, and the interviews.

The interviews took place during the site visit made from 17-19 September 2017. The programme of the visit is included in Annex 2.

The Committee met on the afternoon and evening preceding the site visit to discuss and plan the interviews with all programme leaders.

The Committee agreed on procedural matters and aspects of the assessment as described in the following paragraphs.

The interviews with the Nikhef Management Team, Governing Board, Scientific Advisory Committee, senior research staff, PhD students, postdocs and support staff took place during the site visit on 17-19 September 2017. All interviews were conducted by the entire Committee.

After completing the interviews the Committee discussed the scores and comments on the institute and its research programmes and determined the final assessment.

At the end of the site visit, a meeting was held with the Nikhef director and the Evaluation Committee and a member of the Nikhef Governing Board to report on the Committee's main findings.

On October 31st a draft version of this report was sent to the Nikhef director for factual correction and comments. The report was subsequently submitted to the NWO Executive Board.

1.5 Aspects and assessment scale

The Standard Evaluation Protocol 2015-2021 required the Evaluation Committee to assess three main aspects of the institute and its research. These are (as described in the SEP):

1. *Research quality.* The Committee assesses the quality of the institute's research and the contribution that research makes to the body of scientific knowledge. The Committee also assesses the scale of the institute's research results (scientific publications, instruments and infrastructure developed by the institute, and other contributions to science).

2. *Relevance to society.* The Committee assesses 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 institute has itself designated as target areas.
3. *Viability.* The Committee assesses the strategy that the institute 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 institute's management.

These three main evaluation criteria were rated according to a four-category scale, as specified in the SEP. The verdict was given in qualitative form, though a quantitative figure should be added. The scale is as follows: 1. World leading/excellent; 2. Very good; 3. Good; 4. Unsatisfactory (see Annex 5).

The Evaluation Committee considered three additional topics. These are:

1. *PhD programmes.* The Evaluation Committee considered the supervision and instruction of PhD candidates.
2. *Research integrity.* The Evaluation Committee considered the institute's policy on research integrity and the way in which violations of such integrity are prevented.
3. *Diversity*. The Evaluation Committee considered the diversity of the institute. It is precisely the presence of mutual differences that can act as a powerful incentive for creativity and talent development in a diverse institute.

These topics were considered in qualitative terms (instead of using the four-category scale).

In addition to the topics above NWO formulated three questions for all NWO institutes:

1. What is the institute's added value in the national context and its international position?
2. How does the institute stimulate and facilitate knowledge utilization and open access?
3. How does the institute's structure, size and financial policy contribute to its mission?

2 Institutional framework of Nikhef

Nikhef is the Dutch National Institute for Subatomic Physics. It performs research into the elementary building blocks of the universe, their mutual forces and the structure of space and time.

2.1 Mission

The mission of Nikhef is: "to study the interactions and structure of all elementary particles and fields at the smallest distance scale and the highest attainable energy".

Nikhef coordinates and leads the Dutch experimental activities in the following fields:

- *Accelerator-based particle physics* - interactions in particle collision processes at particle accelerators are studied, in particular at CERN.
- *Astroparticle physics* – interactions of particles and radiation emanating from the universe are studied.

The research at Nikhef relies on the development of innovative technologies. Transfer of knowledge and technology to third parties (industry, civil society, general public) is an integral part of its mission.

2.2 Research

Research activities at Nikhef are organised in the following programmes:

Table 1. Research programmes

Particle physics
ATLAS (LHC): To find and study the Higgs particle(s) responsible for the generation of mass. To search for physics beyond the Standard Model, such as supersymmetry, large extra space-time dimensions, or unexpected phenomena.
LHCb (LHC): To search for particles and interactions that affect the observed matter-antimatter asymmetry in nature, by making precision measurements of B-meson decays.
ALICE (LHC): To study the physics of strongly interacting matter at extreme energy densities, where the formation of a new phase of matter, the quark-gluon plasma, is expected.
eEDM (since 2016): Measuring the electron electric dipole moment.
Astroparticle physics
Gravitational waves (Virgo/LIGO/ET): To detect gravitational waves, or ripples in the fabric of space-time, that are produced by violent events throughout nature.
Neutrino telescopes (Antares/KM3NeT): To discover neutrino sources in nature. The observation of cosmic neutrinos will provide information about the origin of cosmic rays, the mechanism of particle acceleration and transient astrophysical phenomena.
Dark matter (XENON1T): To identify and study the particles responsible for dark matter in nature.
Cosmic rays (Pierre Auger Observatory): To study the origin and composition of ultra-high-energy cosmic rays (UHECRs), their interpretation and consequences for the understanding of astrophysical objects, and the interaction of these ultra-high-energy particles with the Earth's atmosphere.
Theory
Theory: To describe and explain the properties and interactions of subatomic particles. To study theoretical models, such as the Standard Model, for predicting and describing new and existing experimental or observational results, mostly in the framework of quantum field theory. To develop analytical and computational tools for these studies.
Instrumentation and Computing
Detector R&D: To develop state-of-the-art detector technologies to advance future particle and astroparticle experiments. To take a leading role in implementing these technologies in next generation

experiments via (inter)national partnerships. Collaborations with industrial partners are actively pursued.
Physics Data Processing: Operation of state-of-the-art computing resources for Nikhef physicists, participation in national and international distributed computing infrastructures, and R&D on large scale scientific computing.

2.3 Organisational structure

Nikhef is a partnership between the Netherlands Organisation for Scientific Research (NWO)[1] and five universities: Radboud University (RU), University of Amsterdam (UvA), University of Groningen (RUG), Utrecht University (UU) and VU Amsterdam (VU). The partnership is governed by the Nikhef Board and a director. The Scientific Advisory Committee is the external advisory body for the Nikhef Board.

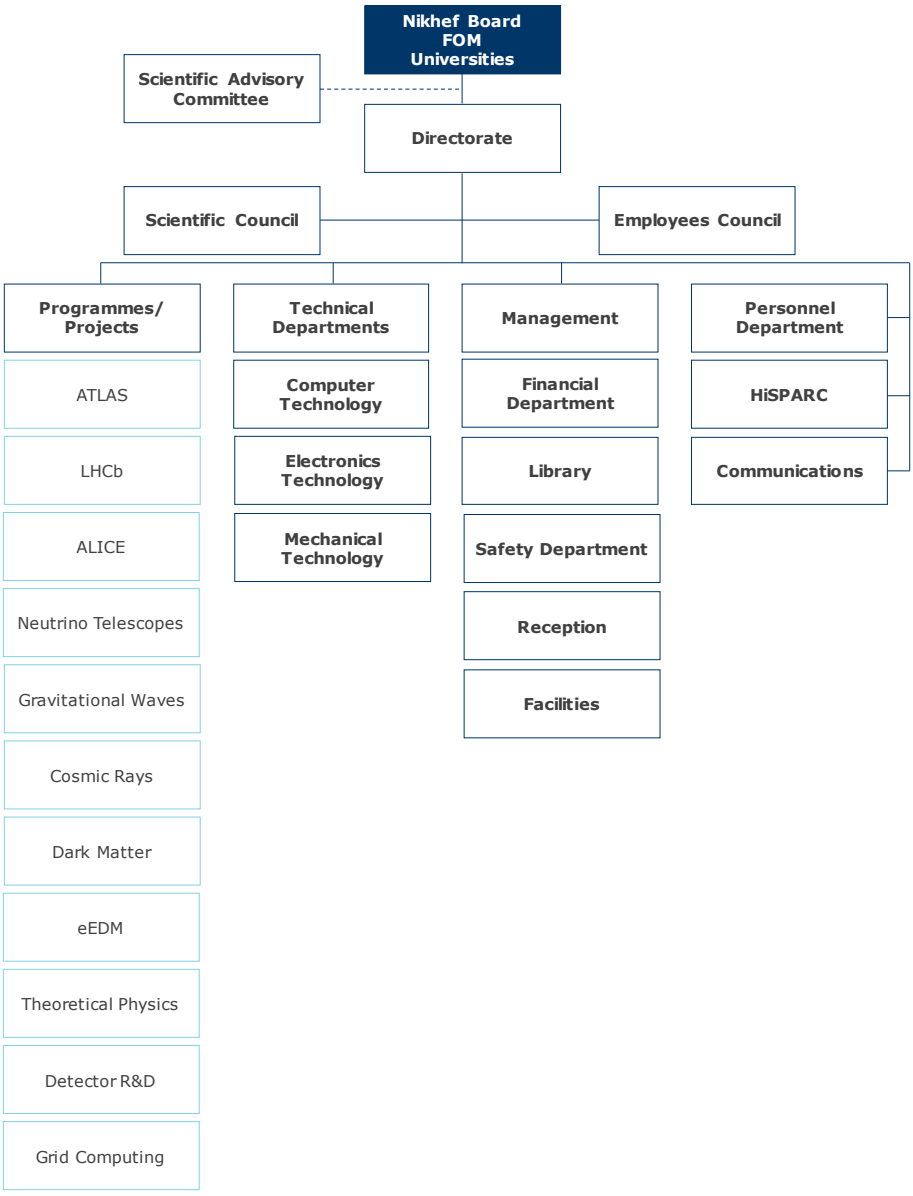

Figure 1. Nikhef 2016 Organigram

[1] During the evaluation period foundation FOM was the responsible governing body of Nikhef. FOM was absorbed into NWO in January 2017.

2.4 Financial matters

The Nikhef income has increased over the course of 2011 to 2016 from 26 M€ to 34,5 M€ (see Figure 2). More than half of the increase is attributable to university groups and staff joining recently. These university groups now form about 20% of the total effort. The additional funding also almost doubled.

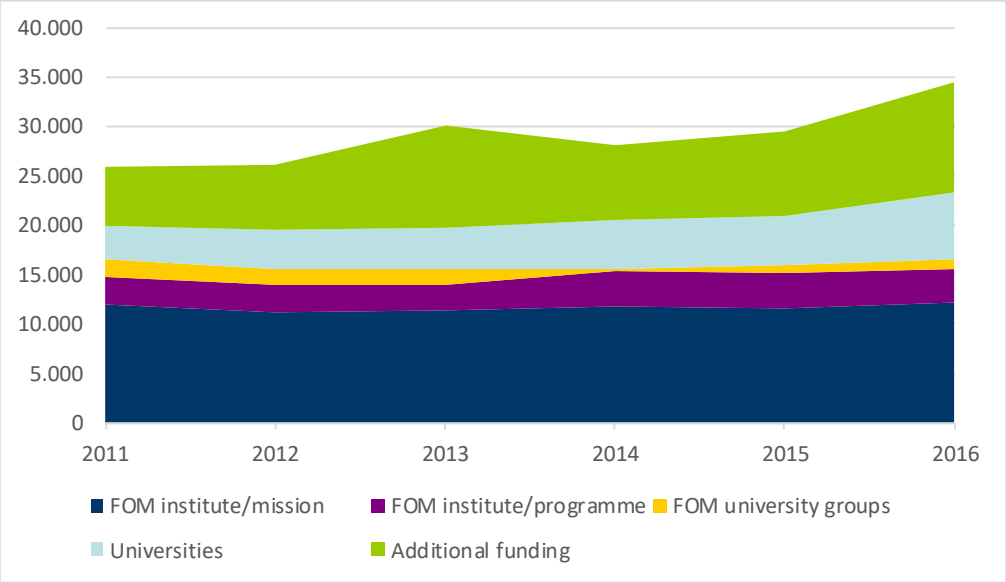

Figure 2. Funding of the running budget (M€)

2.5 Staff

The number of personnel (fte) at Nikhef increased in the period 2011-2016 from 281 to 296 fte. The number of permanent scientific staff is now at a level of 71 fte, an increase with more than 10 fte since 2011. This is mainly due to the admittance of University of Groningen to the Nikhef partnership in 2016. Nikhef typically hosts around 30 postdocs and 80-100 PhD-students (depending on the availability of funding and university groups joining).

Most of Nikhef staff members are employed by NWO-I (formerly FOM foundation), but from the permanent scientific staff 55% is employed by the university partners. Almost half of the permanent scientific staff holds a professorship.

3 Assessment of Nikhef

3.1 Strategy and targets Nikhef

Nikhef is a world-leading laboratory in accelerator and astroparticle physics, with an outstanding record in the extraction of physics from frontier experiments in several domains supported by strong technical and theory groups. The work is enabled by internationally recognized contributions to the construction of technologically advanced instruments, to detector and electronics design and advanced computing techniques.

Nikhef is a "partnership" between the NWO-I institute and five Dutch universities. And is henceforth labelled Nikhef.

The Committee appreciated the way the strategy and targets were defined in terms of three pillars: proven approaches, new opportunities and beyond scientific goals (reproduced in App. 1), and endorses them. These translate to the consolidation and full (physics) exploitation of the established frontier experiments, to be alive to new openings in fundamental research in the area of Nikhef's mission, and to seek connections with industry and society at large and attract and train the next generations of scientists and engineers.

The current evaluation period (2011-2016) has seen Nikhef and its scientists centrally involved in two of the most important scientific discoveries of this new century, namely of the Higgs boson (ATLAS) and of gravitational waves (LIGO/VIRGO).

The future prospects in all of the Nikhef experiments look bright, whether they be ongoing experiments, harvesting physics and building upgrades, or in the new initiatives under consideration.

At the last strategy update of European HEP in 2013 the exploitation of the full potential of the LHC, including the high-luminosity upgrade of its detectors (and accelerators) was classed as the highest priority. The Committee is pleased to see that this is also seen as the highest priority target for Nikhef. The recent discovery of gravitational waves places Virgo in a position of priority. The enviable position attained by Nikhef scientists and the technical staff in these and other experiments should be maintained, better still strengthened, requiring careful prioritization and nimble deployment of resources (human and financial) by Management.

The way the Nikhef laboratory is organized is enviable, underpinning its past and undoubtedly its future success. The organization has demonstrated the ability to efficiently deploy the talent and resources available in the universities, as well as at the Institute, to make impactful and visible contributions in the several international frontier experiments that would not be possible by any one of the individual groups comprising the Nikhef partnership.

Nikhef has a strong and innovative "connection to society" programme enabling the general public to be scientifically better informed in areas of its work, especially recently in the context of the two ground-breaking discoveries, increased knowledge and technology transfer activities, and in communicating the central role of fundamental science in driving technological innovation and in promoting scientific education and scientific literacy. Many of these activities are attracting envious international attention. It is commendable that a fulltime Coordinator for stimulating industrial cooperation has been established.

In summary Nikhef has an outstanding international reputation in the field of its work. Sufficient funding and sufficient human resources (students, scientists, engineers and

technicians) should be made available for Nikhef scientists to maintain and improve their current standing, nationally and internationally, and for the facilities and infrastructure, including buildings, to be kept at a sufficiently high level that normally constitutes a "well-found laboratory".

3.2 Research quality

Overall score research quality	1

Nikhef is a world leading laboratory in particle physics, with outstanding achievements in detector and electronics design, construction and commissioning, physics analysis and advanced computing techniques, supported by a strong theory group. Nikhef's mission is to study the interactions and structure of elementary particles and fields. The mission is clear and captures most of the main issues in today's particle and astroparticle physics. Nikhef members are also visible in the different international Committees and boards of the field, and appointed to scientific advisory boards at other national laboratories outside the Netherlands.

Nikhef research is at the very frontier of the field. All experiments are amongst the best in their domains: energy frontier – ATLAS, b-physics – LHCb, heavy ion physics – ALICE, gravitational physics – Virgo, cosmic rays – AUGER, neutrino telescopes – KM3Net, and dark matter search – XENON, and the related theoretical effort. The Committee cannot see any domain where a stronger approach could have been taken given the infrastructure, human resources and funding. In each programme the Committee sees clear, efficient, leading and original Nikhef contributions.

The addition of eEDM experiment signals the attention for searches that still address the quest for New Physics Beyond the Standard Model by tools complementary to the more standard ones.

It is noted that Nikhef does not participate in some fields, such as gamma ray astroparticle physics, studies of the cosmic microwave radiation and accelerator/reactor-based neutrino physics. The Committee, however, understands that at the resources available a selection has to be made and strongly supports the choices made by Nikhef.

The contribution to most of the experiments has been outstanding so far and the program for the future is clear and well detailed, though there are challenges ahead. The size of the effort and the responsibilities in KM3Net, having produced the technological solution chosen for the final configuration, will have an impact on the laboratory. The radio-wave (AERA) antennas for AUGER might be considered for equipping of the entire array. Does the XENON group have the right size to ensure good visibility in the future phases of the experiment? The new, challenging, eEDM programme will have to be properly supported and that may require extra resources in case of unforeseen difficulties.

There are very good connections between Nikhef's experiment and theory groups. Intensifying these could further strengthen physics analyses and inject new ideas.

The overall score of the research quality is mainly based on a (qualitative) assessment of the individual research programs that Nikhef develops or where Nikhef substantially participates. Together these programs form Nikhef's research agenda. These programs - which differ in goals, size and duration - will be addressed separately in the next sections.

3.2.1 Particle physics

a. ATLAS

The Nikhef ATLAS group, exploring physics at the TeV scale, is world leading. ATLAS is a flagship experiment of Nikhef.

With the discovery of the Higgs boson, the ATLAS research programme has become a national beacon of science, contributing strongly to the positive public perception of natural sciences and fundamental research in general, and attracting students to physics.

Within the large ATLAS collaboration Nikhef is very visible, with an excellent reputation in all aspects of the experiment: physics analysis, data processing and reconstruction, and the design, construction and the operation of detector components. Nikhef scientists have occupied, and continue to occupy, a large number of positions of responsibility within the collaboration.

During the last evaluation period the Nikhef ATLAS group made major contributions to the discovery of the Higgs boson and is now involved in the measurements of its properties and couplings. It had a strong role in the development of statistical analysis methods (the RooFit/RooStat packages), which have become crucial in LHC data analyses.

Looking ahead, for the Phase-2 upgrade of ATLAS the Dutch contribution is focused on the new fully silicon Inner tracker. Nikhef will build the carbon fibre support structure for both end caps by 2019, and assemble a full end-cap of the tracker starting in 2020. The group is also developing a new data acquisition system called FELIX for event data, timing and trigger control. They are positioning themselves well to use the higher statistics to make more precise measurement of the properties and couplings of the Higgs boson.

The hardware contributions are well aligned with the focus of Nikhef's detector development in the coming years. It will be important to keep the good synergy with the Nikhef R&D activities going forward, for example through joint positions. The same encouragement applies to cooperation with the Physics Data Processing programme.

b. LHCB

Nikhef's LHCb group has a world-leading role in the LHCb experiment whose goal is to make precision measurements of the B-meson sector in order to search for new phenomena that could help to explain the matter-antimatter asymmetry in nature. It has a leading role both in hardware and software. It's staff also have played a leading role in the design and implementation of the high-level trigger (HLT), a critical component for LHCb physics. In view of the relevance of the HLT performance the ongoing coordination with the activities of the computing centre is a key component for the success of LHCb's triggering model, essential in its future phases.

The Nikhef group focus in selected areas of physics has paid off handsomely, and led to several important results. Measurements of the mixing phase in B_s decays, the gamma angle of the CKM matrix and the decay of B_s and B_d into muon pairs have seen the Nikhef group at the forefront. It is commendable that the strong connection between the Nikhef's LHCb scientists and the Nikhef theory group has resulted in new strategies for analysis and several joint physics publications.

The Nikhef group is making key contributions to LHCb upgrade projects for the higher luminosity operation, also at HL-LHC. The readout for all LHCb sub-detectors needs to be upgraded in order to operate at 40 MHz. Nikhef will construct half of the new VELO detector modules, a fifth of the scintillating fiber tracker modules, and upgrade the HLT to take full

benefit of the increased instantaneous luminosity. The upgrades will open up new physics possibilities for LHCb.

Nikhef's LHCb group has demonstrated its prowess in management and contributes to LHCb through a variety of coordination functions both in construction tasks, software responsibilities, running duties and key physics analyses. Special attention is paid to the evolution of HLT, a Nikhef-LHCb speciality.

c. ALICE

The Nikhef ALICE group is an outstanding and world-leading group in the field of heavy-ion physics. The ALICE experiment investigates hot and dense matter in extreme conditions through heavy-ion collisions at high energy at the LHC. Nikhef was already a strong contributor to the STAR experiment at RHIC (Brookhaven), and the ALICE involvement is a natural continuation in this research field. Physicists from the Nikhef-ALICE team have had several important management and coordinator positions.

The physics analyses at Nikhef concentrate on selected key topics, which are aimed at measuring the properties of the quark gluon fluid: elliptical flow and hard probes (jets and heavy flavours). Dutch physicists have played a decisive role in many of these analyses. The Nikhef group is also very successful in collaborating with theory colleagues in the Netherlands. On the national level the Nikhef-ALICE group has recently been particularly successful in obtaining several grants, which is reflected in the rapid increase in the number of PhD students in the group.

The main Nikhef hardware contribution to ALICE was in the silicon Inner Tracker System (ITS), leading the construction of the outer two layers and assembling half of the ITS. Nikhef is heavily involved in the operation of this detector. The Nikhef-ALICE upgrade efforts are well on track. It is contributing to the upgrade of ITS, through the integration of the readout electronics and assembly of a part of the staves. The start of production is imminent. The detector should be ready for installation during the LHC long shutdown 2 (2019-2020). There is also ongoing R&D work for a high-granularity calorimeter FoCAL (Forward Calorimeter); a possible timeframe for installation is long-shutdown 3 (2025-26).

Nikhef-ALICE group has a well-rounded experimental programme with good theory contacts. It is very visible in the ALICE collaboration. Due to the recent rapid increase of number of PhD students the student to staff ratio is high, so special attention should be paid to continued good student supervision. The high number of students should be balanced with an adequate number of post-docs.

d. eEDM

Measurement of EDM is a very daunting task but it is one the few ways that would challenge the Standard Model and give birth to a new era in physics. Indeed, a measurably large EDM requires a new mechanism for T violation, equivalent to CP violation given the CPT theorem. Nearly all the extensions of the Standard Model introduce a CP violating phase. It is an extremely delicate measurement that pushes technology and researchers' skill beyond the state of the art. The actual limit, slightly higher than 10^{-28} e.cm, although far higher than the value predicted by SM, already bites into the region where supersymmetric models would call for an effect. In the context of such models the current limit constrains CP violation up to energy scales comparable with those explored at the LHC. This is an active field of research with a few experiments, ongoing or planned. In order to be competitive the proposed program must remain on schedule and achieve the planned goals. One order of magnitude improvement as a first step, with a technique different from the ones so far adopted, is a real challenge. The University of Groningen group has much experience in the molecular

beam technology that will be employed, though the experiment still poses formidable challenges. However, this program will be in the spotlight and will attract a lot of attention worldwide. Enough resources therefore should be committed together with regular monitoring of the project. The integration of the project within Nikhef, given its experience in managing large projects, should help in keeping the project on track.

3.2.2 Astroparticle physics

a. Gravitational waves (VIRGO and ET)

The Committee judged Nikhef's participation in VIRGO/ET to be world-leading. The recent discovery of gravitational waves by the LIGO-Virgo Science collaboration is the result of a 25 years international effort in which Nikhef has made key contributions. The direct observation of gravitational waves is of enormous importance for fundamental physics and cosmology and detectors capable of observing binary black hole and neutron star mergers will have an enormous impact in several key scientific and technical areas. Enhancing detection performance of the existing antennas and planning for future ground based detectors, such as Einstein Telescope (ET) in which the Netherlands and Nikhef could play a major role, as well as space based projects, such as the European led LISA project, is of utmost importance for the future. Such new detectors will make it possible to continuously observe and better understand the distant dark Universe.

The Nikhef group has played an important role in the analyses of the first gravitational waves detections, with one of its members coordinating the Virgo Data analysis with the delicate task of organizing, together with his LIGO counterpart, the joint LIGO-Virgo analysis activities. One noticeable contribution came from a VU PhD student who used the data to put a bound on the mass of the hypothetical graviton, which led to the strongest limit on the graviton mass yet obtained. The paper in which this result was reported was the most cited research publication of the LIGO-Virgo Collaboration for 2016, second only to the two detection papers.

The group has recently been reinforced with 3 new staff members and is developing an ambitious research program, covering all aspects of this new field of research. They intend, in particular, to fully participate in upgrading the advanced Virgo antenna with the goal of increasing its sensitivity by a factor 5 to 10 and testing new technologies in preparation for the construction of the next generation ground based detector.

The Committee fully supports Nikhef's participation in the Virgo experiment. The technical support given to Virgo is excellent and further support should boost Nikhef's participation in the upgrade program of the Virgo antenna beyond the current advanced Virgo phase.

The Committee recommends that Nikhef becomes a full member of the EGO/Virgo consortium and develops, and possibly leads, a European R&D effort to design, construct and operate key components towards the construction of a third-generation project. This could be synergistic with developments towards further improvements of Virgo's sensitivity.

The Committee recommends that the group works with European partners to prepare for, and design, the next generation ground-based interferometer – the Einstein Telescope, aiming to start taking data around 2030. It encourages Nikhef to continue exploring the possibility of hosting the Telescope in the Netherlands with the aim of presenting a bid around 2020.

b. KM3NET

Given that Nikhef has defined the construction technology for KM3NeT, and its strong role in the coordination of the experiment, it can be classified as a world-leading institute in the

field of neutrino astronomy. Nikhef staff members constitute half of the management of the experiment and its role has been crucial, also during the past stretching as far back as ANTARES. Some of the staff recently moved into the project, indicating a commendable mobility between groups in Nikhef.

The Mediterranean KM3NeT is currently under construction. The long-term goal is to complete KM3NET 2.0, which comprises: one block of a dense DOM array of strings, labelled ORCA, off-shore Toulon, dedicated to neutrino oscillations; two blocks of strings making up ARCA off-shore Capo Passero. The institute led the effort of putting KM3NeT onto the ESFRI Roadmap in 2016. The current challenge is the establishment of an ERIC legal entity and work has started in the frame of H2020.

The multi-DOM (digital optical module) is a Nikhef development to improve angular uniformity, time and energy resolution of the system. The Nikhef group, owing to very strong technical support from the institute, has played a pivotal role in the definition of the hardware of KM3NeT, the multi-PMT digital optical module and the deployment system of strings developed in collaboration with Dutch industry and navy. Cables also are produced in industry. A major achievement is the deployment of the first ARCA string with multi-PMT DOMs at the Italian site. Nikhef significantly contributed to the software development of both experiments, including the reconstruction of cascades, mostly focusing on cosmic neutrino searches. One member leads the largest analysis working-group of ANTARES.

The research program of ANTARES/KM3NeT is strongly motivated by the recent discovery of astrophysical neutrinos by IceCube and by the possibility of determining the neutrino mass hierarchy on a relatively short time scale compared with accelerator based experiments. This implies that the ORCA schedule is time critical if results are to be obtained before the PINGU, DUNE and Hyper-Kamiokande experiments. The Committee understands that in this initial construction phase, Nikhef has assigned priority to ORCA. Hence, the Committee is pleased to hear that the number of PhD students will soon increase, which should be even further reinforced by personal grants obtained by 7 senior staff. This should reinforce the neutrino oscillation studies in Nikhef. ORCA could be a player in the neutrino oscillations appearance of tau neutrinos, which would exploit the cascade reconstruction developed by Nikhef. This theme can then be followed up also in Phase 2 by studies of neutrino oscillations from cosmic sources. Together with gravitational waves, cosmic neutrinos constitute the frontier of astrophysics and offers new means to unravel the mysteries of the universe. Target of opportunity programs are already running between GWs and the highest neutrino energy events in IceCube. The triangulation between LIGO and Virgo offers a new option to identify sources of GW events, not only in various photon bands, but also with neutrinos. This guarantees a vibrant multi-messenger astronomy during the next years.

The Committee notes the wish of the KM3NeT group to host the headquarters of the experiment. We recall the previous recommendation: "Nikhef should continue with the ambition to host the KM3NeT headquarters in the Netherlands". Headquarters requires a strong financial commitment to the experiment and a long-term financial commitment to its operation. This requires a strategy of timely deployment, in agreement with the collaboration, of the 3 blocks, collecting all the needed funding that maximises impact of physics from the experiment. Hence it is important that the KM3NeT decides which blocks should have priority and adapt the spending accordingly.

c. XENON

The Committee judged Nikhef's contribution to the Xenon experiment as excellent. Joining the XENON experiment was a good strategic move on Nikhef's part. Nikhef group is now playing a central role in the experiment. The XENONnT upgrade, which will provide a 5 to 10

times increase in sensitivity, is an opportunity for the Nikhef group to strengthen its position in this highly visible project. The group is small and if Nikhef wishes to be more visible in the Collaboration reinforcement of the group will be needed.

The group aims at directly detecting dark matter particles through their interactions with Xenon nuclei. The XENON international experiment is located at the INFN's Laboratori Nazionali del Gran Sasso (LNGS) underground laboratory in Italy. The technique requires a large volume of liquid xenon, instrumented with ultra-sensitive instrumentation, in a low-background environment. The group is also pursuing R&D work in Nikhef in order to study and design a next generation experiment.

The Nikhef group has made key contributions to the construction of the XENON1T detector, which in 2016 started scientific exploitation. XENON1T is already the most sensitive direct detection dark matter experiment and will remain so until circa 2020. The experiment is two orders of magnitude more sensitive than its predecessor XENON100 that the group helped operate and exploit. The group is now participating in the design, and the eventual construction, of the improved XENONnT experiment, which should also be able to search for neutrinoless double beta decay events. It is also contributing to the design of the next-generation liquid xenon experiment called DARWIN.

This program addresses an important issue in particle physics, and is a very good fit to the technical competence available at Nikhef. The group is small but dynamic and very active in all aspects of the experiment. The XENON1T detector is performing very well and data analysis is progressing well. Science runs will take place in the coming years, with detector improvements planned for the XENONnT, to be completed in 2024.

Dark Matter is a research theme that crosses several Nikhef research programmes, including indirect searches in ATLAS and LHCb using protons colliders, the XENON direct detection experiment, as well as KM3NeT. This should be taken as an opportunity to enhance collaboration between the various Nikhef groups, particularly as far as young researchers and Ph.D. students are concerned.

d. Pierre AUGER

The Nikhef cosmic ray group is very active in AUGER, especially in the radio-detection of cosmic ray showers in which they are world-leaders (this has recently been added to the Pierre Auger' programme).

In AugerPrime Nikhef is committed to the construction of 135 modules of the scintillation surface detector and mounting frames. This constitutes a modest investment that could have a large scientific return. These modules are being added to better tag the muon component in the showers. This is a critical aspect: models do not agree with current measurements of muon content and this disagreement influences the main measurement which is required to solve the puzzles concerning UHECRs, principally their composition at high energy. This is an analysis topic on which the Nikhef groups actively work, including the use of sampling and fluorescence techniques.

The Nikhef group has invested a substantial amount of R&D on radio detection of cosmic ray showers and has established for itself a leading role in the Auger radio detector AERA. Remarkable work, also done by many PhD students, has been carried out on data analysis to build up and benchmark models to attain a better understanding of the power of radio detection concerning the measurement of energy and composition of cosmic rays. This study requires the comparison of the Fluorescence Detector and Surface Detector measurements so as to achieve a good calibration at differing energies of this relatively novel method. The presence of several Ph.D. students is an indication of the vibrancy of this area offering the

possibilities of theoretical studies, data analysis and technical work. The Committee noted with interest that recently the Pierre Auger collaboration has lent full support to radio-detection becoming part of its experimental programme, complementing the surface detector programme. This opens the way to extend the radio array to enhance sensitivity to horizontal air showers on a 1000 km scale.

The field of radio-detection in the Netherlands is mostly supported by the ASTRON institute for ground-based radio astronomy, which supports LOFAR. Radio-detection applied to cosmic rays, or to astronomy, shares similar data analysis techniques. The Committee encourages the Nikhef group to keep strong synergy between the two programmes.

3.2.3 Base programmes

a. Theory

The Nikhef theory group produces highly recognised research results of an excellent standing. Some of its activities are clearly at a world-leading level. The group covers a broad range of research activities on formal and phenomenological aspects of particle physics, astroparticle physics and cosmology. It benefits from the integration of groups from VU, RU and more recently of the Van Swinderen Institute of RUG. Close contacts exist also with the Grappa astroparticle initiative at UvA, which complements the research portfolio of the group. Researchers from the different groups regularly collaborate on research projects, optimally exploiting synergies. It attracts excellent young talent (as doctoral students or postdoctoral researchers). Compared with similar international groups, Nikhef's theory group is exceptionally successful in attracting external funding in the form of individual and collaborative research grants.

A strong asset of the theory group is its close interaction with experimental and observational activities at Nikhef, resulting frequently in joint publications, proposing new measurements or interpreting recent data. The Committee is pleased to note that this will be further reinforced in the future with the planned theory-experiment collaborative projects.

Since over 30 years, the Nikhef theory group supports a unique effort for the maintenance and development of the computer algebra language, FORM, driven by Prof. Vermaseren. This language is the backbone of most calculations in theoretical particle physics. It has enabled enormous progress (by many groups using FORM world-wide) in making precise predictions for diverse particle physics processes. The Nikhef group is itself a world-leading player in these precision calculations. In view of the upcoming retirement of Prof. Vermaseren, the future of the FORM project is of concern. First steps have been taken in porting the project to open source. Also, collaborative transfer-of-knowledge efforts are envisaged. In the discussion, Nikhef expressed a strong commitment to a future hiring in the field of computer algebra developments for particle physics, should a suitable candidate be found.

The Committee recognises the excellent quality of the theory research program, and encourages the further development of collaborative projects within the local experimental and observational groups, as outlined in the research strategy. The commitment to the unique research program on computer algebra for particle physics is strongly endorsed.

b. Physics Data Processing

The quality of the "Physics Data Processing" programme is excellent. When evaluating this activity, it has to be recalled that the programme comprises activities of a very different nature: including stably operating the e-Infrastructure, developing new technologies, and carrying out academic research/academic degrees. The goals of the activities are different,

and therefore the assessment has to be necessarily in the context of each activity. The Committee encourages Nikhef to further develop "measures of success" for the Physics Data Processing group for future strategic planning and the purposes of monitoring progress.

The Nikhef computing team has been instrumental in developing the distributed computing paradigm. Nikhef was a major player in practically all the European grid development projects during the past 15 years (European Datagrid, EGEE, EGI.eu, EMI, etc.). The NL/Tier1, which is part of the Worldwide LHC Computing Grid, is operated by SURFSara in partnership with Nikhef, and investments in the NL/Tier1 have been included in the granted LHC detector upgrade funding till 2019. The Nikhef team has strongly contributed to the development of the national strategy for sustainable distributed computing in support of scientific research.

The Nikhef Physics Data Processing (PDP) programme serves as the provider of the compute and storage infrastructure for the local analysis facility Stoomboot and the associated storage, the Nikhef Data Processing Facility (a node in the Dutch National eInfrastructure), and the NL/Tier1 together with SURFSara. The main goal of this activity is to provide stable operations with adequate resources. This goal has been continually achieved, as is shown for example by the Worldwide LHC Computing Grid monitoring reports of the NL/Tier1.

The PDP programme also pursues research initiatives on advanced computing technologies, software applications (activity Applied Advanced Computing), and general aspects such as security (activity Infrastructure for Collaboration). The Committee appreciates the chosen initiatives dealing with timely and topical subjects involving future storage architectures, security, software-defined networking, and virtualized platforms. There is excellent collaboration with vendors, which makes it possible to get access to experimental hardware still in the testing phase. The publications in this area consist primarily of conference reports.

Adequate compute and storage infrastructure is a fundamental enabler of the whole of Nikhef's scientific programme. Nikhef is aware that a long-term strategic plan for e-infrastructure is needed, with a sustainable solution for ownership, responsibilities, partnership and funding.

c. Detector R&D

The Detector R&D group is performing excellent in research and development into new detector technologies with high potential for future high-energy physics experiments, and collaborates with the experiment groups on the development of detector technology for their experiments. The group has developed several important technologies for Nikhef experiments, such as the Timepix ASICs, and the silicon telescope for sensor characterization. The work is published in high-level international journals either by the group itself or by co-authoring papers from the experiment groups.

Even though the work is often done in collaboration with external parties, there is enough room to start research on new topics in an informal way that allows evaluation of ideas before significant investments (human and financial) are made. This allows development of key technologies that have the potential to lead to key roles in future projects. This also is the case for the technologies that are currently under development.

The group has a clear strategy for the future, in the development of ultra-fast photon detectors and technology for gravitational wave detection. This requires collaborations outside the traditional field of high-energy detectors, including scientific groups and high-tech companies, and these collaborations are being successfully set up.

There is considerable overlap in detector developments pursued by this group and what is being developed for other applications such as high-energy astrophysics, nuclear energy, nuclear science and medical science. This provides good opportunities for utilization. A strong

collaboration with other scientific groups as well as high-tech companies, both in the Netherlands and outside, is therefore beneficial. There are already several of these collaborations in place, for example with the technical universities and many high-tech companies. These collaborations are set up early in the development, which is important for successful collaboration and utilization.

The institute should ensure that even if a project is started with an informal approach, timely and proper arrangements are made to prevent problems relating to intellectual property and commercial rights. For this it is recommended to improve the education and awareness of its staff on intellectual property and commercialization.

The group has significantly increased in size in the period 2001-2010. Since then the group has remained stable for a few years but in 2015 and 2016 the budget and the number of people, in particular engineers and technicians, has decreased considerably. The SAC has identified that the detector technology development by Nikhef has proven to be very important and has recommended it strengthen the group again. The group has replaced retired staff since then and two new tenure track positions have been offered. This will help ensure viability of the group. Further strengthening can occur by acquiring funding for new projects.

3.3 Relevance to society

Overall score relevance to society	1

Nikhef makes an outstanding contribution to the society. Its research is relevant to society in many different ways: scientific results of interest to the general public, breeder of talent, outreach and education, applied research, and economic impact.

Educating talented people, who then move to other jobs in the private or public sector, is common to almost all of the Nikhef research lines. Young scientists and engineers learn problem solving and analytical skills in an international, project-based and competitive environment. Their ability to use, and further develop, modern research tools make those trained within the Nikhef research programmes valuable experts sought by high-tech industry, the ICT sector (specially data science), publishing, higher education, to name a few areas. Data from the period 2014-2015 show that more than half of the Ph.D. students who graduated during that period are now working outside academia, which is a commendably high fraction compared with many other European countries.

Investigation of basic building blocks of matter and interactions generates a lot of positive public interest. This observation is supported, for example, by the large number of suggestions and questions received when collecting input for determining the topics for the National Research Agenda. The public proposed many questions in the area of Nikhef's mission. These could be collated in two routes which deal with curiosity-driven fundamental science: Route 4 'Origin of life on Earth and in the Universe', and Route 5 'Building blocks of matter and Fundaments of Space and Time'. Route 5, organised by Stan Bentvelsen, fits the science portfolio of Nikhef very well and brings together particle physics, astronomy, astroparticle physics, theoretical physics, cosmology, mathematics, chemistry, philosophy along with industry.

The past evaluation period (2011-16) was particularly spectacular with two major discoveries: of the Higgs boson and gravitational waves. Nikhef was very effective in capitalizing on these events for the benefit of raising public awareness. The discovery of Higgs boson and gravitational waves attracted a lot of attention in national and international media, and even led to appearance of Nikhef scientists in a popular talkshow on Dutch television. Nikhef staff

is very active in organizing special events and programmes to stimulate scientific literacy among the general public and especially among young children (e.g. annual science weekends). The latter activities involve both primary and secondary level pupils and their teachers.

Applied research and joint work with the private sector and commercialization is yet another way of making an (economic) impact on society. Nikhef is doing an exemplary job in developing detector applications. Detectors developed for particle physics experiments or sensors needed for gravitational wave experiments find application areas such as medical imaging, security, seismology, and geosciences. Similar transfer of knowledge occurs in areas of software, data processing tools and methods, and computing hardware. There are several spin-offs, such as Innoseis stemming from the gravitational waves research programme, where former Nikhef employees commercialize technologies developed in Nikhef research programmes. In particular the Nikhef detector instrumentation activities fit very well in the Topsector 'High Tech Systems and Materials - Roadmap Advanced Instrumentation'. This has opened up explicit opportunities for cooperation with industry (public private partnerships). Nikhef has moderately benefitted from the Topsector grants available. The increase within Nikhef of collaborative projects with industry in the 2011-2016 timeframe is partially due to this policy.

In summary, Nikhef's relevance to and interactions with society are at a high level. Nikhef serves as a successful model for similar institutes worldwide.

3.4 Viability

Overall score viability	2

Nikhef has a wide range of laboratory facilities and seems to be well equipped for the experiments/projects in hand. Nikhef's 2017-2022 strategic plan is well balanced with LHC experiments (ATLAS, LHCb, ALICE) and their upgrades, the new eEDM experiment in Particle physics, and a rich Astroparticle physics program ranging from the recent detection of gravitational waves with VIRGO, that opens a new window on the physics of the Universe, the search for Dark Matter with the XENON detector, the quest for the highest energy cosmic rays and neutrinos with Auger and KM3NeT, with the promise of interesting results in neutrino physics.

Over the past decade Nikhef has made excellent strategic choices, some of which, like participating in the advanced Virgo project, are already producing spectacular results. Nikhef is in an enviable situation that even more major discoveries may take place in the next few years when it comes to e.g. Dark Matter search for example or in studying neutrino oscillations.

This ambitious scientific program of Nikhef together with the recent change of organization and funding scheme is introducing uncertainties in predicting how individual research programs will perform. In addition, the difficulty in securing long-term funding, both for investment and running costs, of research programs that take decades such as for the LHC (ATLAS, LHCb, ALICE), but also for projects such as KM3NeT and EGO/Virgo, is affecting the viability of participation in large international projects.

The Committee also noted that the current level of the mission budget is making it very difficult for Nikhef to fund the research programs at the required level. We recommend that the mission budget be increased. The Committee notes that long-term projects, a norm at Nikhef, require allocation of long-term funding. NWO is encouraged to adapt its funding

schemes to recognise this nature of Nikhef's work and also to include funding related to the recurring operating costs of experiments.

Nikhef management deploys skilfully the technical staff, moving from experiment to experiment, as the needs arise and is aware of the future needs of the LHC upgrades. Nikhef should be mindful of the age profile of the technical staff (loaded towards the high range); the three new hires represent steps in the right direction.

Buildings maintenance and improvement of working spaces are needed to fulfil the full scientific potential from the commitments made by Nikhef. The Committee endorses the proposed plan to renovate parts of the Nikhef buildings.

3.5 Considerations regarding organisation, management policies and staffing

3.5.1 PhD programmes

In 2016, 102 doctoral students were studying at Nikhef (see also the table about the composition of Nikhef's staff in Annex 4). They all are enrolled in a graduate school program (subatomic physics: OSAF, or theoretical physics: DRSTP), which organises tutoring and supervision. The majority of students are employed by NWO-I. The doctoral training program encompasses specialised lectures and summer schools on subatomic physics. Besides this, NWO also provides courses on extracurricular competences (project management, presentation skills, etc.), thereby providing the students with important skills for a future career anywhere. In the past, FOM also supported a business training course for doctoral students in their final year. A business training course adds excellent value to doctoral training and NWO should continue supporting it. Overall, the doctoral training is clearly very well thought-through, and of excellent quality.

The doctoral students have a supervisor, responsible for running the thesis project, and a doctoral advisor, who is a professor from the degree-awarding university. Almost all scientific staff at Nikhef act as doctoral supervisors, resulting in a very favourable student-to-staff ratio. A detailed project plan and timetable is outlined at the start of the thesis project, and progress is monitored in regular meetings with the supervisor and the advisor, as well as in four interviews with the education Committee of the graduate school. This framework appears to be sufficiently strong to ensure high quality of training and supervision, without overly interfering in the detailed running of the thesis project. In individual discussions, the students expressed a very high level of satisfaction with their working conditions, and praised the open and collaborative culture at Nikhef. The dropout rate of doctoral students is very low (see also the table about PhD candidates in Annex 4). The Committee noticed that the median duration of a Ph.D. thesis (55 months) is comparably long. It, however, recognises that this is in part due to the inclusion in this number of the delay between the submission of the thesis and the examination. It encourages Nikhef to consider further measures that would help ensure the completion of doctoral projects in the nominal period of four years. Nikhef's graduating Ph.D. students succeed well in getting good positions, both inside and outside academia, which further illustrates the excellent quality of the doctoral programs.

3.5.2 Research integrity policy

Research integrity is a concept that deals with good research ethics and practice, including proper management of research data. In this evaluation, the Committee is asked to assess how the research unit itself describes its internal research culture, what is the research unit's policy on research integrity and how violations are prevented?

Nikhef complies with the overall NWO policy on research integrity. In addition, students are provided a course on scientific writing, including how to avoid plagiarism, and that includes guidelines for good practice for writing scientific papers. In the self-evaluation Nikhef referred to internal peer-review practices within the experimental collaborations, and plagiarism checks of theses. The Committee finds that, at the moment, research integrity is still being perceived in a somewhat narrow way, and that there is room for improvement to better accommodate research integrity as a natural part of the research process. It recommends that awareness of research integrity be further raised, at all levels in Nikhef. Scientific integrity could be made an integral part of educational programmes. It should define an approach on how best to prevent possible research integrity violations, and what procedures to follow in case of violations.

3.5.3 Diversity

The Nikhef environment is very diverse and hosting an increasing fraction of non-Dutch scientists, technical staff and students. In the period 2011-2016 this fraction has passed 50% for Ph.D. students, while that for the scientific staff has increased from 21% in 2011 to 27% in 2016. There is a noticeable increase in the average age, particularly of postdocs, going up from 58% (3%) to 77% (13%) in the age-interval 30-39 (40-49), respectively.

A diverse environment requires understanding of cultural differences, which the Institute seems to be doing well owing to a very friendly working environment. The Institute still has a lower than ideal fraction of women scientists at all career levels, but most noticeably at the higher levels. The Institute has in place a number of measures, for instance the existence of designated persons to address specific issues; Nikhef participates in WISE, an NWO programme dedicated on hiring women on tenure track positions; NWO participates in the GENERA EC project which provides a toolkit of actions for implementation of Gender Equality Plans - Nikhef should profit from this project.

The evaluation 2011-2016 reports noticeable improvement in the fraction of female staff. The commitment of Nikhef in recruiting women is indicated by the increase of 7% in the number of scientific staff employees from 2011 to 2016. Nonetheless the achieved 13% is still low, and this fraction may be even lower at full professorial level. Despite the large effort made by Nikhef in hiring female staff, several challenges were faced: a few female candidates could not accept the offered tenure track positions due to dual career issues. Nikhef is already tackling this issue by actively searching for jobs for partners, if requested, also outside academia. The Committee encourages Nikhef to keep exploring opportunities to address such issues and to make them known more widely. A variation on the theme of the issue of dual-career was raised by some doctoral students in the Institute who considered that the established tradition of having to leave the country after the PhD, before being able to re-enter academia in the Netherlands, is a drawback. Mobility between different Institutes in the Netherlands itself could be explored as a possible option. The Committee encourages NWO to extend the current WISE program to hiring at higher career level as well.

Initiatives such as training courses on good practice, awareness of issues relating to harassment, unconscious bias, diversity and gender awareness should be further encouraged. The Committee recommends the Institute (and NWO) define a Gender Equality Plan, containing strategic actions concerning gender and cultural equality.

3.6 Supplementary questions by the NWO Executive Board

3.6.1 Generic questions

Question 1: What is the institute's added value in the national context and its international position?

The primary raison d'être for Nikhef is to carry out research in fundamental particle and astroparticle physics.

At the national level, the Nikhef "partnership" (henceforth labelled Nikhef in this section) consisting of the NWO-I institute and 5 Dutch universities) provides a central and crucial "platform" for promoting very effective and productive scientific collaboration amongst its constituent members. Nikhef provides an exemplary and enviable platform that promotes scientific, technical and managerial collaboration and allows all its members to flourish.

At an international level it is clear that Nikhef enables and facilitates contributions with tremendous impact in international 'Big Science' experiments. Nikhef serves as a conduit between international facilities (e.g. CERN experiments), international consortia (e.g. LIGO/Virgo) and those at Dutch institutions. Amongst the scientific collaborations (small and large) Nikhef has an excellent reputation as a crucial, dependable, and sought-after partner. It can be relied-upon to deliver (often challenging) on commitments it undertakes with full confidence of the experiment managements. This would be almost impossible for individual constituent members.

Nikhef as an institute can host advanced infrastructure (technical and engineering of differing flavours) in a central place that allows the partnership to contribute competitively at the highest level in international frontier experiments. The concentrated competence in differing areas such as instrumentation, software, computing and analysis tools enables efficient and rapid "problem-solving' in case of need, as has been demonstrated. In fact, the international collaborations often rely on Nikhef's competence in solving problems that invariably arise in advanced and complex scientific projects.

Nikhef as a hub also allows efficient use of resources available in the partnership to fulfil the important role of "connection with industry and society", part of the third pillar in its strategy.

The Committee noted that it is only through Nikhef that a future ambitious programme, namely the Einstein Telescope, can even be contemplated in the Netherlands. Nikhef can serve as the bridge between all the relevant national and international parties and optimize the Dutch bid, scientifically, technologically and managerially.

Question 2: How does the institute stimulate and facilitate knowledge utilization and open access?

The institute has a very good policy in knowledge utilization that benefits from several methods, and is very successful in its realization. An example of this is the filing of 7 patents and founding of three start-up companies during the reporting period 2011-2016. There are several successful collaborations with small and large companies. The fact that a coordinator is assigned for stimulating industrial relationships, including procurement as well as joint and contract research, is a strong commitment to this end.

The institute carries out in-house manufacturing and assembly on a large scale. The Institute acknowledges that outsourcing to and manufacturing in high-tech companies contributes to its mission and is pursued wherever possible However, it is perceived as risky, expensive and limited by the availability of companies with the required skills. This could be improved

by setting up partnership with suppliers at an earlier stage, at the level of subsystems, including development and engineering. Make-or-buy decisions should take into account the total cost and benefit.

The institute reports that, in general, it satisfies the recent NWO Institute Data Management Policy Framework (2016). This is supported by the fact that it promotes open access to publications by placing them on archiv.org ("green route"), and that for example the source code of the FORM software, used by many parties in the field, has been made publicly available. Data that are produced in collaborations are stored long-term and made available within the collaborations, including the raw data, but not all projects make all data publicly available. The institute should ensure that all new projects are set up with open data access and negotiate open data access for existing collaborations. Attention should be paid to ensure open data access for projects that are run in-house.

The concepts and results from the development of technology and instrumentation are made available publicly through scientific publications. Technical designs, source code, performance models and other technical details are part of the efforts for knowledge utilization through start-up companies and company collaborations. Where this is not the case, open access should be provided to these as well.

Question 3: How does the institute's structure, size and financial policy contribute to its mission?

The organisational structure has a small senior management team led by the director.

Each of the programmes and technical departments has a programme or technical group leader, reporting to the director. Each project or programme has its own internal structure and a project plan, agreed with the director. The projects are structured across the collaborating institutes of Nikhef in an integrated way. This structure fits well for the execution of the tasks to fulfil Nikhef's mission.

The size of the institute has remained almost constant over the last few years, with the notable addition of the University of Groningen staff that fits well the scientific mission of the institute. The success of Nikhef in the fields of gravitational waves searches and underwater neutrino telescopes, however, poses a challenge for the future. In order to maintain high visibility and leadership additional staff might be required.

So far the financial resources have seen an increase in the last few years and the policy set by the management of the laboratory has been effective in providing the experiments and the services with efficient allocation of resources.

Nikhef should be mindful of adding new programmes unless commensurate resources (financial and human) can be found to fully support them.

4 Conclusions and recommendations

4.1 Conclusions

The Committee assesses the Nikhef partnership to be outstanding, and one that operates at the very highest level in the competitive world of particle and astroparticle physics. It performs at a much higher level than would be expected for a grouping of its size and resources.

The Committee endorses and commends the strategic selection of the experiments in its portfolio, sitting at the edge of current knowledge. It is pleased to see Nikhef producing new insights into particle and astroparticle physics through the intimate involvement of its scientists in physics analyses in the experiments e.g. in two of the most important scientific discoveries of this new century. The extraction of physics is aided by the strong liaison between the theorists and the experimentalists, putting the latter at an advantage within the experiments, and computing scientists.

Nikhef is making outstanding and unique contributions to the development of new hardware (instrumentation, electronics, etc.) and advanced computing techniques for the upgrades of the experiments.

The Committee is very supportive of Nikhef in its endeavour to host the Einstein Telescope, the third generation of gravitational wave detectors.

The Management shows visionary leadership engaging well with all levels of staff. Many of the staff have won prizes and competitive grants that constitute markers of high national and international esteem.

The Committee very much appreciated the quality of the information which was provided to it prior to the review, the presentations and the open and constructive dialogue with all during the review.

4.2 Recommendations

Specific recommendations for the near future, bearing in mind the governance and leadership skills of the research unit.

Research quality

The Committee is pleased to see that improvements foreseen for increasing the sensitivity of VIRGO could also serve for benchmarking of components for the third generation gravitational wave detectors such as the Einstein Telescope (ET). The Committee encourages Nikhef to put in place mechanisms that enable vigorous pursuit of hosting ET in the Netherlands, a revolutionary endeavour that should include collaboration with other international partners. It would be beneficial for Nikhef to join EGO/VIRGO as full members in view of hosting the ET in the Netherlands.

Relevance to society

The Committee was pleased to see considerable and successful effort in this direction and encourages Nikhef to continue and further strengthen such efforts.

Viability

The Committee notes that long-term projects, a norm at Nikhef, require allocation of long-term funding. NWO is encouraged to adapt its funding schemes to recognise this nature of Nikhef's work and also to include funding related to the recurring operating costs of experiments.

The Committee endorses Nikhef's plans for the renovation of its buildings to provide more space for performing high quality scientific research, well adapted for developing advanced instrumentation, efficient workspaces and an attractive working environment.

PhD programmes

The Committee urges Nikhef to continue its efforts to reduce the duration of the PH.D. research project to the nominal 4 years. A business training course adds excellent value to doctoral training and NWO should continue supporting it.

Research integrity

Nikhef should raise more awareness, and further define procedures to follow, in case issues arise concerning research integrity.

Diversity

The Committee encourages Nikhef to look at possibilities of mobility post Ph.D., including within Netherlands itself.

The Committee was pleased to see an improvement of gender balance since the last assessment, and encourages efforts towards the continuation of this trend, also at more senior levels.

Nikhef is encouraged to write a "Gender Equality Plan" and to use the relevant available tools, and targeted funding plans such as WISE, also at higher levels.

Annex 1. Summary Strategy Nikhef

Strategy 2017-2022

The Nikhef strategy for the coming years 2017-2022 contains the pillars "proven approaches", "new opportunities" and "beyond scientific goals" as detailed in this chapter.

Pillar I. Proven approaches:

Construct the upgrades and exploit the physics of the LHC experiments ATLAS, LHCb and ALICE Build KM3NeT phase 2.0 and exploit neutrino (astro)physics Exploit the astroparticle experiments Advanced Virgo, XENON1T/nT and the Pierre Auger Observatory Fully utilise the theory, detector R&D and computing activities at Nikhef

Pillar II. New opportunities:

- Determine the electron electric dipole moment with world-class precision
- Prepare for a new era of high-energy accelerators
- Strengthen and exploit the thematic connections between individual scientific programmes
- Prepare a bid to host the Einstein Telescope in the Netherlands

Pillar III. Beyond scientific goals:

- Establish further links with industry in terms of transfer of knowledge generated at Nikhef
- Attract and train a new generation of scientists and engineers
- Modernise the Nikhef branding and building
- Inspire and nurture scientifically aware general audiences

Annex 2. Curricula Vitae of Evaluation Committee Members

Prof. dr. Tejinder Singh Virdee

Email: Tejinder.virdee@cern.ch Link: en.wikipedia.org/wiki/Tejinder_Virdee

Education

University:	1971-1974	Queen Mary College, London (B.Sc.)
	1974-1977	Imperial College, London (Ph.D.)

Academic Positions Held

1996-present	Professor of Physics, Imperial College
2015-2017	Scientific Associate, CERN
2002-2010	Scientific Associate, CERN
1996-2002	Staff Member, CERN
1991-1996	Reader, Imperial College
1983-1991	Lecturer, Imperial College
1982-1983	Research Associate, Imperial College
1979-1982	Research Fellow, CERN
1977-1979	Research Associate, Imperial College

HEP Experiments

1974-1979	SLAC BC60, Hybrid Bubble Chamber, SLAC, U.S.A.
1979-1984	CERN-NA14 Experiment (photoproduction)
1985-1990	CERN-UA1 Experiment (p-pbar)
1991-present	CMS Experiment; 1993-1996 Deputy Spokesperson, 1997-1999 Spokesperson

Honours

2014	Knight Bachelor, The Queen's Birthday Honours, U.K.

Awards

2017	W.K.H. Panofsky Prize in Experimental Particle Physics, American Physical Society, U.S.A.
2015	The Glazebrook Medal and Prize, of the U.K. Institute of Physics
2013	The European Physical Society High Energy and Particle Physics Prize
2012	The Fundamental Physics Prize, Milner Foundation, U. S. A.
2009	The Chadwick Medal and Prize of the U.K. Institute of Physics

Membership of Learned Societies

2012	Elected Fellow of the Royal Society, UK.
2012	Elected Fellow of the Institute of Physics, UK.

Commissions of Trust

2016	Member of Scientific Advisory Committee, Max Planck Institute of Physics, Munich, Germany
2014	Member of Scientific Committee of Institut de Fisica d'Ates Energies, Barcelona, Spain.

2013 Chairperson, Committee for Review of NIKHEF LHC Proposal, FOM, Amsterdam, Holland.
2009-2012 Member, Advisory Committee, Helmholtz Alliance, "Physics at Terascale", Germany.
2010 Member, Committee of Visitors, Review of High Energy Physics, Dept. of Energy, U.S.A.
2005 Member *Comité d'évaluation* of *Labratoire de Accelerateur Lineare*, Orsay, Paris, France.
2000-2004 Member, Scientific Programme Advisory Committee, Fermilab, U.S.A.
1999-2001 Member, Scientific Programme Advisory Committee, Dubna, Russia.
1999-2000 Chairman, Particle Physics Long Term Science Review Panel, PPARC, U.K.
1999-2001 Member, Science Committee, PPARC, U.K.

Notable HEP Talks

2016 Particle Physics since 1945 and the Emergence of the Standard Model, Oxford, U.K.
2016 The Long Journey to the Higgs boson and Beyond, Salam Memorial Meeting, Singapore.
2014 Highlights and Prospects in Hadron Collider Physics, Opening talk at LHCP conference, New York, U.S.A.
2014 The Discovery of the Higgs boson and Measurements, Royal Society, London, U.K.
2013 Highlights from LHC Physics, European School of Physics, Parafurdo, Hungary.
2012 Construction of Large-scale Projects, Technical Capabilities and Infrastructure, European Strategy for Particle Physics, Krakow, Poland.
2011 The Experimental Summary, Hadron Collider Physics, Intl. conference, Paris, France.
2011 The LHC Project and Superconductivity, Superconductivity Centennial Conf, Den Haag, Holland.
2011 The Experimental Summary, Physics at LHC Intl. conference, Perugia, Italy.
2009 The LHC Project: Accelerator and Experiments, Opening Talk at the 1st Conference on Technology and Instrumentation in Particle Physics, Tsukuba, Japan.
2007 The LHC Project, Opening Talk, IEEE-Nuclear Science Symposium, Hawaii, U.S.A.
2001 Developments in Particle Detection, Plenary Talk, Intl. Europhysics Conference on High Energy Physics, Budapest, Hungary.
1998 The Large Hadron Collider Project at CERN, Keynote Speaker, IEEE-Nuclear Science Symposium, Toronto, Canada.
1994 Prospects in Hadron Collider Physics, Plenary Talk, Intl. Europhysics Conference on High Energy Physics, Marseille, France.

Science Communication

Virdee is regularly invited to give public talks on particle physics and the LHC project. The diverse venues range from schools (e.g. ESIC, Den Haag 2001), science fairs (e.g. Barcelona, 2008; ISEF, Reno 2009; Cheltenham, 2012), named lectures, symposia and conferences (e.g. London 2007 and 2012; Philadelphia 2008 and 2011, Victoria, Canada 2016, Bangalore, 2016), and cities (e.g. Split 2009, Providence 2010, Barcelona 2013).

Virdee is a campaigner for science, and education[2]. He has featured, and appeared, in numerous international press articles, radio and TV programmes. Some examples are given below:

2014 Interview on Sikh Spectrum, UK. https://www.youtube.com/watch?v=p5D0gthxBXI

[2] http://www.iop.org/about/international/grants/page_66833.html

2013 BBC Festival of Science Africa[3], broadcast from Makerere University, Kampala, Uganda.
2012 BBC Radio programme, "Life Scientific"[4], 20 March 2012.
2009 Dialogue on the LHC project and CMS with philosopher Prof. A. C. Grayling, Exchanges at the Frontier"[5], BBC World Service.

Prof. dr. Teresa Montaruli

PERSONAL INFORMATION

Montaruli Teresa,
ORCID ID: 0000-0001-5014-2152;
Italian, Born on 4/10/1968;
Web site: https://unige.ch/sciences/astroparticle/
Career break: 2-6/2013 Twenty weeks of break for maternity leave (two twins).

EDUCATION

6/1998 PhD in Physics, Dipartimento di Fisica, Università di Bari, Italia
1995 Specialization Diploma in Physics, Dip. di Fisica e Astronomia, Univ. di Bologna, Italia
12/1994 Master Diploma, Dipartimento di Fisica, Università di Bari, Italie.

CURRENT AND PREVIOUS POSITIONS

10/2011– Prof. Ordinaire, Département de Physique Nucléaire et Corpusculaire (DPNC), Faculté des Sciences, Université de Genève (UniGE), Switzerland;
2006–11 Full Prof. (4-8/2011); Associate Prof. with tenure (9/2007-3/2011); Assistant Prof. (1/2006-8/2007) at Dep. of Physics, Univ. of Wisconsin-Madison (UW-Madison), USA;
2001–9 Ricerc. Universitario (tenured in 2004), Dipartimento di Fisica, Università di Bari, Italia;
2000 Assegno di Ricerca, Università di Bari.

FELLOWSHIPS AND AWARDS

2011– Honorary Fellow of UW- Madison
2009– American Physical Society Fellow;
8/2001 Duggal Award (http://archive.iupap.org/commissions/c4/cosnews/cos-news46.html);
1998 B.Rossi scholarship at "36 Course: from the Planck Length to the Hubble Radius", Erice;
1996 Euroconference Grant to attend VIIIth Rencontres de Blois, France;
1995 & 1998 INFN undergraduate student and Postdoctoral Fellowships (2 years each);
1995–98 PhD Fellowship, Università di Bari.

SUPERVISION OF GRADUATE, MASTER STUDENTS AND POSTDOCS

2011– DPNC-UniGE: Postdocs 9(7M/2F); PhD advisor: 6(4M/2F), Summer & master students: 2(M); Supervised full time Engineers: 2(M);
2006–11 UW-Madison: Postdocs: 5(3M/2F); co-advisor: 3(1M/2F); visiting graduates: 2(M); PhD advisor: 5(4M/1F); co-advisor of 4 (M); Master & Summer students: 6(3M/3F);

[3] http://www.bbc.co.uk/programmes/p016l3y6/episodes/guide
[4] http://www.bbc.co.uk/programmes/b01dhrmb
[5] http://www.bbc.co.uk/programmes/p005fbrf

2001−5 Università di Bari: Master students: 5 (3M/2F).

TEACHING ACTIVITIES

2001−17 UniGE: Physique Generale B (3 semesters, ca. 180 pharm/biology bachelor students); Particules dans l'universe (4 semesters, 10-20 physics bachelor, master, PhD students); Detecteurs et accélérateurs (3 semesters, about 10 physics bachelor and master students);

2007−11 UW-Madison: Instrumentation and Methods in Astroparticle Physics (2 semesters, ca. 10 PhD students); PHYS208 General Physics (3 semesters, about 200 biology and pharmacy bachelor students) PHYS248 – A Modern Introduction to Physics (2 semesters, ca. 70 physics students); PHYS103 - General Physics (500 students, 1 semester);

2003−17 Int. PhD schools: blocks of lectures at INFN, SLAC, NWO, Niels Bohr Int. Academy, Benasque, Les Houches, CERN Summer student lectures, https://cds.cern.ch/record/2275230); Public Lectures: Rencontres et Culture, Genève; Univ. 3eme age, Geneva; Osservatorio Brera e Bari; INFN LNF (https://www.youtube.com/watch?v=kKtz9WbmxEs) Outreach: La Nuit de Metiers, Florimont School; "Messagers de l'Univers", Geneva TecDay

2017; La Nuit de la Science, Genève, 2016 and 2014.

INVITED TALKS AT CONFERENCES, SEMINARS and COLLOQUIA

1996−2017 38 invited seminars and colloquia; 42 invited talks at Int. Conferences and Workshops.

ORGANISATION OF SCIENTIFIC MEETINGS

Chair of LOC (Conf. title/year/place, participants, web): Gender in Physics Day, 2017, Geneva, 82, https://indico.cern.ch/event/525539/;TeVPA2006, Madison, WI, 145,http://icecube.wisc.edu/tev/; founder of yearly meetings MANTS (Mediterranean Antarctic Neutrino Telescope Symposium), chair of 2009 and 2014 editions; IceCube Spring 2014 Plenary meeting, CERN, 220; 2nd SiPM Adv. Workshop, Cartigny, Switzerland, 70, http://dpnc.unige.ch/SiPM_Workshop; Strategy Workshop in AstroParticle Physics in Switzerland, 2014, Cartigny, 72, https://indico.cern.ch/event/301955/;

Member of LOC or SOC (Conf. title/year/place/participants): LHC Days, 2016 and 2014, Split, 90; TeVPA 2016, CERN, 292 participants; Neutrino Telescopes, 2017, 2015 and 2013, Venice, around 120; 28th Texas Symposium on Relativistic Astrophysics, 2015, Geneva, 460; SUGAR2015 Geneva and 2018, Brussels, about 50.

Chair of sessions: Astroparticle at EPS-HEP 2017, Venice, Italy (965 participants); IEEE NSS Topic Convener: Astrophysics and space instrumentation, Strasbourg, France (29/10/2016).

INSTITUTIONAL RESPONSIBILITIES

2011– UniGE: Member of the Collège de Professeur de la Faculté de Science, College de la Section de Physique et Comité de gèstion, DPNC; Commission de Planification de la Section de Physique;
2006– UW-Madison Faculty Member.

COMMISSIONS OF TRUST

2012– Swiss Delegate in the General Assembly of the Astroparticle Physics European Consortium (ApPEC), vice-chair since 21/6/2017; Member of the Round Table Swiss

Representation in Int. Organisations and Research Infrastructures; Member of the Scientific Advisory Committee of the Laboratori Nazionali del Gran Sasso;

2017– Reviewer of the Nat. Inst. of Subatomic Physics (Nikhef), NOW, The Netherlands; Concorso Prof. Univ. Prima Fascia Fis/01 (Fisica Sperimentale) of the Gran Sasso Science Institute, Italy; Concorso INFN per Dirigente di Ricerca, Italy;

2016 Reviewer of the Projected Collaborative Research Centre 1258 "Neutrinos and Dark Matter in Astro- and Particle Physics" of DFG, Germany.

2012–16 Observer in LA FLARE (Funding LArge international REsearch projects program of SNF);

2015 Commission for the evaluation on the law on Innosuisse - Swiss agency for innovation;

2010 Science Frontier Panel on Particle Astrophysics and Gravitation, Decadal Survey of Astronomy and Astrophysics 2010;

2006– Professor hiring and PhD Thesis defence commissions at UW-Madison and UniGE.

2000 – Referee of Astrop. Physics, JCAP, Physics Rev. J., Astron. J., Rev. Modern Phys., New J. Physics, editor of Cogent Physics.

MEMBERSHIPS OF SCIENTIFIC SOCIETIES

1994–2005 Società Italiana di Fisica

2006– American Physical Society

2011– Swiss Physical Society and CHIPP (past member of Executive Board).

RESPONSIBILITIES IN EXPERIMENTS

1994–2004 MACRO: dark matter, atmospheric and astrophysical neutrino analyses;

1998–1999 The Airwatch-RD (precursor of Jem-EUSO): Simulation and feasibility study;

1999–2006 NEMO-RD/KM3NeT: Simulation and feasibility study;

2000–2012 ANTARES: Coordinator of Astrophysics and Exotics Working group (2000-8); author and responsible of the neutrino Monte Carlo physics generator, Publication committee member;

2006– IceCube: Coordinator of IceCube-Pierre Auger-Telescope Array working group; member of Collaboration Board, Publication Committee, Trigger Filtering Transmission board; Analyses on dark matter, neutrino cosmic sources, atmospheric neutrino flux, coordinate transformations.

2008–2011 HAWC: responsible of the FPGA trigger system, set up the electronic testing lab at UW-Madison; defended the science case at DOE review for starting construction grant;

2012– CTA: Project leader of the small-size telescope project SST-1M for contributing the construction of 70 telescopes (2012-), member of Project Committee and of Consortium Board, Chair of committee for Spokesperson Election (5/2017);

2012– LHAASO: responsible of camera light guides, sensor performance tests; As sociate member of FACT First G-APD Cherenkov Telescope, responsible of shutter.

Paula Anna-Maria Eerola

1. Full name and address

- Paula Anna-Maria Eerola.
- Work address. P.O.Box 64, FI-00014 University of Helsinki, Finland. Tel: +358-(0)29-41 50 520. Email: paula.eerola [at] helsinki.fi.
- Home address. Koroistentie 6 B 10, FI-00280 Helsinki, Finland. Tel. +358-44-217 4526.

2. Date and place of birth, citizenship, languages
- Born January 10, 1962 in Joensuu, Finland.
- Finnish and Swedish citizen.
- Mother tongue Finnish. Fluent in Swedish and English (oral, written). A fair knowledge of French and German.

3. Current position
- Director of Helsinki Institute of Physics, from 2016.
- Professor of Experimental Elementary Particle Physics at the University of Helsinki from 2008.

4. Education and training
- Docent of experimental particle physics in University of Helsinki, Finland, 1994.
- Doctor of Philosophy (PhD) in experimental particle physics, University of Helsinki, Finland,1990.
- Master of Science in physics, University of Helsinki, Finland, 1985.

5. Previous professional appointments
- 2001 - 2008 Professor of Particle Physics, Lund University, Sweden.
- 1998 - 2004 Special Researcher (Swedish Research Council), Lund University, Sweden.
- 1997 Associate professor locum, Physics Department, University of Helsinki, Finland.
- 1996 - 2001 Assistant professor in experimental particle physics, Physics Department, University of Helsinki, Finland. On leave of absence 1996 - 1997, 1998 - 2001.
- 1993 - 1997 CERN Staff Research Physicist, Particle Physics Experiments Division, CERN, Geneva, Switzerland.
- 1994 - 1998 Research Assistant in the Research Institute for High Energy Physics, University of Helsinki, Finland. On leave of absence 1994 - 1998.
- 1991 - 1993 CERN Research Fellow, Particle Physics Experiments Division, CERN, Geneva, Switzerland.
- 1991 - 1991 Junior Research Associate locum, Academy of Finland, Finland.
- 1988 - 1992 Research Assistant in the Research Institute for High Energy Physics, University of Helsinki, Finland. On leave of absence 1988 - 1990, 1991- 1992.
- 1987 - 1990 Research Assistant, Academy of Finland, Finland.
- 1984 - 1986 Research Assistant locum in the Research Institute for High Energy Physics, University of Helsinki, Finland.

6. Research leadership and coordination Research leadership, funding and policies
- Delegate of Finland at the CERN Council 2016-
- Delegate of Finland at the FAIR Council 2016-
- Chair, Research Council for Natural Sciences and Engineering, Academy of Finland 2013-2018.
- Chair, Research Infrastructure Sub-Committee (Tutkimusinfrastruktuurijaosto), Academy of Finland 20132014; Member, Research Infrastructure Committee (Tutkimusinfrastruktuurikomitea), Academy of Finland, 2014-2018.
- Member of the Board, Academy of Finland 2013-2014.
- Chair, Physics and Astronomy Panel, Publication Forum, Federation of Finnish Learned Societies 20102017.
- Member of the NordForsk High Level Group for Research Infrastructure 2013-2017.
- Member of NOS-N, representing the Research Council for Natural Sciences and Engineering, Academy of Finland, 2013-2018.
- Member of the Tenure Track Steering Group, University of Helsinki, 2010-2012.

- Member of the Faculty Board, Science Faculty, University of Helsinki, 2010-2013, 2014-2017
- Representative of Finland in Restricted ECFA - European Committee for Future Accelerators 1997-1998 and 2012-2017.
- Director of the Doctoral School in Natural Sciences, University of Helsinki, 2014-2015.
- Director of studies (Oppiainevastaava) for physics, Dept. of Physics, University of Helsinki 2010-2013.
- Division Head, Experimental High Energy Physics, Lund University, Sweden, 2005-2008.
- Member of the Board of the Physics Institution of Lund University 2005-2008.
- Member of the Staff Appointments Committee, Science Faculty, Lund University, 2006-2008.
- Member of the Equal Opportunities Committee, Science Faculty, Lund University, 2004-2008.
- Member of the Board of Directors of SNIC, Swedish National Infrastructure for Computing 2002-2012.

Coordination responsibilities related to own research field
- Member of the Particle Data Group 2014-
- Member of the CMS B physics publication committee 2012-2015, B/top physics public. committee 2016-
- Member of the CMS Management Board 2012-2016.
- Programme director of the CMS Programme of Helsinki Institute of Physics 2010-2015.
- Project leader of the HIP CMS Tracker project 2009, HIP CMS Experiment Project 2010.
- Member of the CMS Chair Advisory Group 2011-2012.
- Convener, CMS B Physics Analysis Group, and member of the CMS Physics Coordination 2009-2010.
- Member of the CMS Tracker Institute Board and Tracker Upgrade Management Board 2010-2016.
- Main coordinator of a NordForsk Joint Nordic Infrastructure Project `LHC and Beyond´ 2008-2012.
- Main coordinator of a NorFA-NordForsk Research and Training Network `Discovery Physics at LHC´ 2001-2007.
- Nordic Member of the Project Overview Board of the LHC Computing Grid project 2003-2012.
- Nordic Member of the LHC Computing Grid Memorandum-of-Understanding taskforce 2004-2005.
- Member of the NorduGRID Steering Group 2000-2008, 2010-
- Member of the SWEGRID committee of the Swedish Natural Science Research Council 2000-2002.
- Member of the CERN-committee of the Swedish Natural Science Research Council 1999-2005.
- Member of the Board of the Swedish LHC-consortium 1998-2008.
- Member of the ATLAS TRT Steering Committee 1998-2005, and TRT Institute Board 2006-2008.
- Convener of the B-physics working group of ATLAS 1993-2005.

Research evaluation
- Millenium Technology Prize, member of the preselection management group 2017-
- Member of the selection board for CERN limited duration physics research staff 2013-
- Evaluations of applications for the Knut and Alice Wallenberg foundation, 2013, 2015-2017.
- Member of the MAT-PHY Panel, H2020, EC, Innovative training networks 2016.

- Member of the Physics Panel, EC Consultation on Integrating Activities for H2020, EC, 2013.
- Member of the Physics Panel, Capacities Programme, FP7, EC. Research Infrastructures 2008.
- Member of the Physics Panel, People Programme, FP7, EC. Marie Curie fellows 2007-2011. Also acting as a vice-chair. Initial training networks 2011, Innovative training networks 2014.
- Member of the Physics Panel, Human Potential Programme, FP6, EC. Research and Training Networks in 2003, Marie Curie fellows 2004-2006.
- Member of the Physics Panel, Human Potential Programme, FP5, EC. Research Networks in 1999.
- Member of the KFI/RFI (Research Infrastructure Committee) Evaluation group 1 of the Swedish Science Research Council 2005-2012.
- Member of the Evaluation group NT-M of the Swedish Science Research Council. Evaluation of applications to VR in 2001-2004.
- Member of the Evaluation group 1 under the Physics Committee of the Swedish Natural Science Research Council. Evaluation of applications to NFR and FRN in 1999-2000.

7. Academic and professional activities

- Experiments
    - Member of the CMS experiment since 2008. Research: All aspects of B physics at LHC-CMS. Physics beyond the Standard Model at LHC-CMS. Application of GRID-technologies to LHC data processing. CMS Tracker. CMS upgrade.
    - Member of the ATLAS experiment 1992-2008. Research: All aspects of B physics at LHC-ATLAS, and new physics searches – feasibility studies and detector performance optimization. Design and construction of the ATLAS Transition Radiation Tracker. B-physics triggers, track trigger using the ATLAS Transition Radiation Tracker.
    - Member of the DELPHI experiment, as a PhD student and post-doc 1985-1994. Research: Soft gluon structure in hadronic final states. Heavy flavours in Z0 Decays. Neural Networks. Search for nonminimal Higgs bosons. DELPHI microvertex detector: Mechanics of the detector upgrade. Muon trigger and event tagging in the DELPHI Hadron Calorimeter.
    - UA1 experiment, diploma work 1984-1985. Analysis of UA1 data: Measurement of the strong coupling constant from jet rates.
    - UA2 experiment, summer student 1984. Development of an on-line filter for top-quark searches.
- Other research projects
    - Application of particle physics detectors to radiation detection
    - Grid development (2001-present): NorduGrid-ARC, KnowARC, and other projects.
    - Linear colliders (1991-1992): Simulation of charged Higgs boson production.
- Publications. Over 700 peer-reviewed publications. See http://www.helsinki.fi/~paeer-ola/PE.html
- Student supervision
    - Main supervisor of 6 PhD theses, currently supervising 2 PhD students.
    - Main supervisor of 11 MSc theses.
- Teaching experience
    - Director of Doctoral School in Natural Sciences, University of Helsinki, 2014-2015.
    - Director of studies (Oppiainevastaava) for physics, Dept. of Physics, University of Helsinki 2010-2013.
    - Courses at University of Helsinki since 1997. Helsinki University of Technology 1991.
- Outreach
    - Popular lectures: e.g. Studia Generalia, Helsinki Insight seminars (U. Helsinki), Lund Philosophy Circle, lectures to physics teachers, etc.
    - TV-, radio- and newspaper interviews.

- Coordination of particle physics outreach activities at the Helsinki Institute of Physics and Univ. of Helsinki.

8. Membership in scientific societies

- Member of the Finnish Academy of Engineering Sciences since 2016.
- Member of the Finnish Academy of Science and Letters since 2012.
- Member of the Finnish Society of Sciences and Letters since 2010. Deputy Board member since 2017.
- Member of the Royal Swedish Academy of Sciences since 2010.
- Member of the Board, High Energy Particle Physics division of the European Physical Society 2008-2015.
- Member of Kungliga Fysiografiska Sällskapet since 2007.
- Vice-chair of the Swedish Physical Society 2007-2009, member of the Board 2004-2009.
- Member of the Swedish National Committee for Pure and Applied Physics, The Royal Swedish Academy of Sciences, 2004-2009.

9. Prizes, acknowledgements

- E.J. Nyström prize awarded by the Finnish Society of Sciences and Letters 2016
- Honorary doctor in technology, Lappeenranta University of Technology, Finland 2017

Fernando Ferroni

Biographic Details, Qualifications, Current position

- Fernando Ferroni, born 12th January 1952 in Roma , Italy
- Laurea in Physics (1975) Sapienza University in Roma
- Professor of Physics at Sapienza University
- President of National Institute for Nuclear Physics (INFN)

Appointments

1975-1981 Research Associate at INFN Roma
1982-1987 Assistant Professor of Physics at Sapienza University in Roma
1988-1991 Associate Professor of Physics at Politecnico delle Marche in Ancona
1991-1992 Visiting scientist at CERN
1992-2000 Associate Professor of Physics at Sapienza University in Roma
1998-1999 Visiting scientist at SLAC
2000- Professor of Physics at Sapienza University in Roma

Research Interests

1. Search for single photon production at ISR (1974-1979)
2. Neutrino physics at CHARM (1979-1988)
3. Parton densities determination and parameterization (1986)
4. LEP physics at L3 (1986-1997)
5. Beam extraction by bent silicon crystals (1991-1993)
6. CP violation in B-Physics at BaBar at SLAC (1994-2008)
7. Neutrinoless double beta decay in CUORE at LNGS and (2005-)
8. ERC Advanced Grant for Lucifer (a zero background demonstrator for neutrinoless double beta decay) (2011-2016)

Committees

2000-2005	Member of Scientific Committee of Laboratori Nazionali del Gran Sasso- INFN
2001-2004	Member of Large Hadron Collider Committee (LHCC) at CERN
2005-2008	Member of Modane-Frejus Laboratory Scientific Commiteee
2004-2010	Chair of Commissione Scientifica Nazionale I of INFN
2008-2011	Member of the Joint Standing Committee for the China CAS – Italy INFN Virtual Laboratory
2009	Member of the Scientific Coordination Committee of INFN
2010- 2014	Member of Scientific Council of IN2P3-CNRS
2011- present	Italian Scientific Delegate to CERN Council
2015-present	Member of Governing Board of Science Europe

Reynald Pain

Director Institut National de Physique Nucléaire et de Physique des Particules (IN2P3)

DEGREES AND AWARDS

1982	Master degree in Theoretical Physics, Université Pierre et Marie Curie, Paris, France
1984	Thèse de 3ème Cycle (Master Thesis) de l'Université Pierre et Marie Curie, Paris, France
1987	Thèse d'Etat (PhD Thesis), Université Pierre et Marie Curie, Paris, France
1999	Joliot Curie Award of the French Physical Society
2007	Cosmology Prize of the Gruber Foundation
2011	Physics Nobel Prize awarded to S. Perlmutter, B. Schmidt and A. Riess for the discovery of the acceleration of the expansion of the universe (Perlmutter's team member)
2015	Breakthrough Prize in Fundamental Physics

MAIN COLLECTIVE AND OFFICIAL RESPONSABILITIES

1991-1993	Project Leader, DELPHI Outer Detector, DELPHI Collaboration, CERN
1996-2000	Convenor, Search for Supersymetric Particles working group, DELPHI Collaboration, CERN
1997-2007	Member Executive Committee, Supernova Cosmology Project (SCP)
1998-2014	National Coordinator, IN2P3 Supernova Cosmology projects
2001-2015	French Principal Investigator, Nearby Supernova Factory (SNF) project
2002-2006	Coordinator, French node of the EU FP6 Research Training Network "The physics of Type Ia supernovae"
2003-2015	Principal Investigator, Supernova Legacy Survey (SNLS) project
2007-2009	National Coordinator, IN2P3 LSST project
2009-2014	Director, Laboratoire de Physique Nucléaire et des Hautes Energies (LPNHE), Université Pierre et Marie Curie (UPMC), Université Paris-Diderot, CNRS IN2P3
2014-2015	Scientific Director, Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), in charge of Astroparticles and Neutrinos.
2015-present	Director, Institut National de Physique Nucléaire et de Physique des Particules (IN2P3)

POSITIONS

Short-term	Affiliate, Lawrence Berkeley National Laboratory, Berkeley, USA
1984-1986	CERN fellow scientist, Geneva, Switzerland
1985-2000	CNRS permanent scientist, Paris, France
1993-1995	Visiting scientist, University of California Berkeley, USA

2000-present CNRS senior scientist, Paris, France
2004 Visiting scientist, Lawrence Berkeley National Laboratory, Berkeley, USA

RESEARCH ACTIVITIES

Electroweak Physics (CELLO experiment at DESY and DELPHI experiment at CERN)
Neutrino Physics (CHARM experiment at CERN)
Dark Matter and Dark Energy (Supernova Cosmology Project, Nearby Supernova Factory, Supernova Legacy Survey, Large Synoptic Survey Telescope)

SELECTED RECENT PUBLICATIONS

- Improved cosmological constraints from a joint analysis of the SDSS-II and SNLS supernova samples, SNLS Collaboration, M. Betoule et al., A&A 568 (2014) A22
- Constraints on Dark Energy Combining the Supernovae legacy Survey 3-year Data with Other Probes, SNLS Collaboration, M. Sullivan et al., ApJ 737 (2011) 102
- Improved Cosmological Constraints from New, Old, and Combined Supernova Data Sets, SCP Collaboration, M. Kowaslki et al., ApJ 686 (2008) 749
- The SuperNova Legacy Survey: Measurement of ΩM, ΩΛ and w from the first year data set, SNLS Collaboration, P. Astier et al., A&A 447 (2006) 37
- The Distant Type Ia Supernova Rate, SCP Collaboration, R. Pain et al., ApJ 577 (2002) 120
- Measurement of Ω and Λ from 42 High-redshift Supernovae, SCP Collaboration, S. Perlmutter et al., ApJ 517 (1999) 565

Prof. Dr. Thomas Gehrmann

PERSONAL INFORMATION

Prof. Dr. Thomas Gehrmann, Department of Physics, Universität Zürich, Switzerland
Researcher unique identifiers: ORCID: 0000-0001-7009-432X, ResearcherID: J-4940-2016
Date of birth: 10. Jan. 1971 (Waltrop, Germany)
Nationality: German
Email: thomas.gehrmann@uzh.ch
URL: http://www.physik.uzh.ch/en/groups/gehrmann

EDUCATION

1990 – 1993 Undergraduate Studies in Physics, Universität Dortmund, Germany
1993 – 1996 Doctoral Studies in Theoretical Physics, Department of Physics, Durham University, UK
09/1996 PhD in Theoretical Physics, Durham University, UK

CURRENT POSITION

2003 – 2009 Associate Professor of Theoretical Physics, Universität Zürich, Switzerland
2009 – Full Professor of Theoretical Physics, Universität Zürich, Switzerland

PREVIOUS POSITIONS

1996 – 1998 Postdoctoral researcher, DESY Theory Group, Hamburg, Germany
1998 – 2000 Postdoctoral researcher, Universität Karlsruhe, Germany
2000 – 2002 Fellow, CERN Theory Division, Geneva, Switzerland
2002 – 2003 Research associate, RWTH Aachen, Germany

INSTITUTIONAL RESPONSIBILITIES

2003 – Faculty member, Faculty of Science, Universität Zürich, Switzerland
2007 – 2014 Organization of the Zürich Physics Colloquium

2009 – 2016 Pauli Center Executive Board (joint theoretical physics conference and visitor programme of Universität Zürich and ETH Zürich)
2009 – 2013 Faculty Executive Board (representative of mathematics and physics), Faculty of Science, Universität Zürich, Switzerland
2011 – 2013 Head of the Institute for Theoretical Physics, Universität Zürich, Switzerland

COMMISSIONS OF TRUST AND SERVICES TO THE COMMUNITY

2003 – Referee for all major journals in particle physics
2005 – Referee for project applications in Switzerland (SNSF), Germany (DFG, Humboldt Foundation), Austria (FWF), Netherlands (NWO), Italy (MIUR), Great Britain (STFC, Royal Society), United States (NSF), European Commission (ERC)
2008 – Reviewer for High School Examinations, Kantonsschule Scha_hausen, Switzerland
2010 – 2012 European Committee for Future Accelerators (ECFA), representative for Switzerland
2011 – 2012 KCETA Advisory Board, KIT Karlsruhe, Germany
2014 – High Energy Physics Board of the European Physical Society (EPS-HEPP), panel member for EPS High Energy and Particle Physics and EPS Young Experimental Physicist prizes
2014 – Member of the Research Council of the Swiss National Science Foundation (SNSF), in SNSF panels: Div.II (project funding natural sciences), SNSF professorships (assistant professor career funding), Ambizione (senior postdoctoral career funding), FLARE (funding of large research infrastruc tures in particle physics and astrophysics), REquip (funding of large research equipment)
2014 – Editorial Board, Journal of High Energy Physics (JHEP), Springer Publishing

Marco Beijersbergen

Prof. Dr Marco Beijersbergen
cosine measurement systems
Oosteinde 36
2361 HE Warmond
the Netherlands
m.beijersbergen@cosine.nl

Prof. Dr Marco Beijersbergen is founder and managing director of cosine. Now a well established group of companies, including subsidiaries 3D-One and condi food, cosine currently employs around 40 highly educated staff. His goal is to use his experience and entrepreneurship to solve measurement challenges using a combination of science and technology.

Positions

1996-2000 ESA/ESTEC, scientist, teamleader, consultant re XMM-Newton, XEUS
2000-present cosine measurement systems, founder and managing director
2005-present Leiden University Institute of Physics, Honorary Professor

Education

1981-1987 Gymnasium, Fioretticollege, Lisse, the Netherlands
1987-1988 Propaedeuse, Technical Physics, Technical University of Delft, the Netherlands
1988-1991 Msc, Experimental Physics, Leiden University, the Netherlands

1991-1996	PhD, Quantum Optics, Leiden University, the Netherlands

Committees

2007-2013	SpaceNed, association of space companies in the Netherlands: member of the board
2008-present	Netherlands Space Office Stakeholderscouncil, representing all stakeholders of space in the Netherlands: member
2012-present	Holland Instrumentation, association of companies and institutes which develop instruments: founder and member of the board/advisory board
2013-present	Roadmapteam Advanced Instrumentation, of Topsector High-Tech Systems and Materials: chairman, representing around 400 companies which develop instruments in the Roadmap Council, of Topsector High-Tech Systems and Materials
2013- present	Roadmap Council, of Topsector High-Tech Systems and Materials: member
2014-2016	*Stichting voor Fundamenteel Onderzoek der Materie (FOM)*, now: Netherlands Organisation for Scientific Research: member of the board of governors
2015-present	*Stichting voor Fundamenteel Onderzoek der Materie (FOM)*, now: Netherlands Organisation for Scientific Research: member of the selection committee for the NWO Domain Science grant program *Valorisatieprijs 2015-2017*
2016-2017	NanoNextNL, aimed at research into micro and nanotechnology: member of the supervisory board
2016-present	Dutch National Research Agenda * *Nationale Wetenschapsagenda (NWA)*: delegate of Route Measurement and Detection * *Boegbeeld van NWA Route Meten & Detecteren*
2016-present	Holland Instrumentation: member of entrepreneurspool, platform for experienced entrepreneurs to share their expertise
2016-present	*KIEM-LIFT* review committee, grant program to promote public-private cooperation, for applications relevant for Topsector High-Tech Systems and Materials: member

Selected publications

L. Allen, M.W. Beijersbergen, R.C.J. Spreeuw & J.P. Woerdman (1992). Orbital angular momentum of light and the transformation of Laguerre-Gaussian laser modes. *Phys. Rev. A 45, 8185*

G.C.G. Berkhout & M.W. Beijersbergen (2008). Method for Probing the Orbital Angular Momentum of Optical Vortices in Electromagnetic Waves from Astronomical Objects. *Phys. Rev. Lett. 101, 100801*

G.C.G. Berkhout, M.P.J. Lavery, J. Courtial, M.W. Beijersbergen & M.J. Padgett (2010). Efficient Sorting of Orbital Angular Momentum States of Light. *Phys. Rev. Lett. 105, 153601*

Knowledge sharing

Marco enjoys sharing his knowledge by lecturing at universities, supervising PhD students, giving workshops, reviewing scientific publications, as well as speaking at conferences and events. He is the author of a variety of scientific publications. He is currently involved in teaching the Master course Advanced Optics at Leiden University.

Annex 3. Programme of the Site Visit 17-19 September 2017

Sunday, 17 September 2017

Location: The Manor hotel

16.00 – 16.10	Welcome, introduction and installation by Stan Gielen (chairman of NWO Governing Board)
16.10 – 16.40	Introduction of NWO in Dutch context by Stan Gielen (chairman of NWO Governing Board) and discussion
16.40 – 17.00	Presentation on the Dutch Science Landscape by the secretaries
17.00 – 17.30	General introduction to Nikhef (past and future) by Stan Bentvelsen
17.30 – 18.30	Internal discussion of panel, division of tasks (closed session)
19.00	Dinner at Boven C (closed session)

Monday, 18 September 2017

08.30 – 09.00	Transport from the hotel to the institute
09.00 – 09.10	Welcome at the institute, coffee/tea, checking internet connections
	BASE PROGRAMMES
09.10 – 09.20	Introduction by panel discussion leader(s): Gehrmann, Eerola and Beijersbergen (closed) Presentations 10 *min + 15 min discussion (panel and presenter) + 5 min internal panel discussion*
09.20 – 09.50	Eric Laenen – Theory
09.50 – 10.20	Jeff Templon – Grid Computing
10.20 – 10.50	Niels Van Bakel – Detector R&D
10.50 – 11.05	*Coffee break*
	PARTICLE PHYSICS
11.05 – 11.10	Introduction by panel discussion leader: Ferroni (closed)
11.10 – 11.40	Steven Hoekstra - eEDM
11.40 – 11.50	Introduction by panel discussion leader(s): Eerola and Ferroni (closed) Presentations 10 *min + 15 min discussion (panel and presenter) + 5 min internal panel discussion*
11.50 – 12.20	Wouter Verkerke – ATLAS
12.20 – 12.50	Meeting (by telephone) with the chairman of the SAC-Nikhef (panel and chair SAC)
12.50 – 13.50	*Lunch* (including programme leaders)
13.50 – 14.20	Marcel Merk - LHCb
14.20 – 14.50	Raimond Snellings - ALICE

ASTROPARTICLE PHYSICS

14.50 – 15.00 Introduction by panel discussion leader: Montaruli and Pain (closed)
Presentations 10 *min + 15 min discussion (panel and presenter) + 5 min internal panel discussion*

15.00 – 15.30 Sijbrand de Jong - AUGER

15.30 – 16.00 *Tea break with PhD students and young postdocs*

16.00 – 16.40 Tour of the premises

16.40 – 17.10 Auke Pieter Colijn - XENON
17.10 – 17.40 Paul de Jong – KM3NET
17.40 – 18.20 Chris van den Broeck and Frank Linde – Gravitational waves (VIRGO and ET)

18.30 - 18.45 Transport from institute to restaurant Enoteca (at the hotel)
19.00 Working dinner (closed session) at the hotel

Tuesday, 19 September 2017

07.30 - 08.30 Closed breakfast session with Committee
08.30- 08.50 Transport from the hotel to the institute

NIKHEF ORGANISATION AND LONGER TERM FUTURE

08.50 – 09.40 Presentation by the Management Team (Stan Bentvelsen, Arjen van Rijn and Pieter van Braam van Vloten) on the long term future plans (new initiatives, etc.), technical skills, infrastructure, education and outreach, PhD programs, knowledge transfer, finances, diversity

09.40 – 10.30 Discussion

10.30 – 11.00 *Coffee break*
11.00 – 12.30 Internal Committee discussion and report writing

12.30 – 13.30 *Lunch* (committee, but MT stand-by for additional questions)

13.30 – 16.00 Closed session Committee <writing report>

16.00 – 18.00 Report consolidation

18.00 - 18.30 Closure with director (and a representative of GB of NWO), presentation of draft assessment

18.30 - 18.45 Transport to restaurant
19.00 Dinner at Neva (with Nikhef staff members) followed by transport to the hotel

Annex 4. Quantitative data composition and financing

Funding

Table 2 Funding Nikhef

Funding (M€)	2011	2012	2013	2014	2015	2016
FOM institute/mission	11.989	11.274	11.390	11.844	11.526	12.289
FOM institute/programme	2.767	2.647	2.656	3.519	3.668	3.360
FOM university groups	1.806	1.678	1.551	299	741	926
Universities	3.453	3.913	4.202	4.828	5.033	6.882
Additional funding	5.942	6.740	10.266	7.675	8.490	11.047
Total	**25.957**	**26.252**	**30.065**	**28.164**	**29.458**	**34.504**

Staff

Table 3 Staff Nikhef

Nikhef Total	**Year 5/2011**		**Current year/2016**	
	#	**FTE 2011**	**#**	**FTE 2016**
Scientific staff	64	60,6	73	71,3
Postdocs	27	26,8	29	28,8
PhD students	82	81,1	102	100,4
Total research staff	173	168,5	204	200,5
Technical staff	84	83,8	72	69,8
Support staff	32	29,3	29	25,4
Total staff	**289**	**281,6**	**305**	**295,7**

Research output

Table 4 Research output Nikhef

		2011	2012	2013	2014	2015	2016	Total
Publications		351	433	446	356	380	436	2402
Theses		17	22	18	15	20	38	130
ATLAS	Pub	118	173	109	108	135	144	787
	Thes	6	8	2	5	7	7	35
LHCb	Pub	55	92	124	83	80	63	497
	Thes	2	2	2	1	4	4	15
ALICE	Pub	41	38	32	24	29	47	211
	Thes	1	3	3	2	2	8	19
Neutrino Telescopes	Pub	14	10	18	4	6	20	72
	Thes	2	1	1	1	1	1	7
Gravitational Waves	Pub	14	33	12	23	14	27	123
	Thes	2		2		1	2	7
Dark Matter	Pub		3	4	3	3	5	18
	Thes					1		1
Cosmic Rays	Pub	8	16	8	11	8	12	63
	Thes	2	1	1			2	6
Detector R&D	Pub	16	8	13	5	9	8	59
	Thes		2		1	2		5
Theoretical Physics	Pub	55	25	75	68	67	77	367
	Thes	1	4	6	4	1	5	21
Physics Data Proc.	Pub	4	2	4	1	2	1	14
	Thes						1	1
Astroparticle Physics	Pub		12	28	13	12	9	74
	Thes	1			1			2
Miscellaneous	Pub	26	21	19	13	15	23	117
	Thes		1	1		1	9	12

PhD candidates

Table 5 PhD candidates Nikhef

Enrolment				**Success Rates**											
Starting year	**Enrolment (male/female)**			**Graduated in year 4 or earlier**		**Graduated in year 5 or earlier**		**Graduated in year 6 or earlier**		**Graduated in year 7 or earlier**		**Not yet finished**		**Discontinued**	
	M	**F**	**Total**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
T-8 (2008)	14	5	19	2	11%	10	53%	2	11%	2	11%	0	0%	3	16%
T-7 (2009)	12	6	18	2	11%	11	61%	3	17%	1	6%	1	6%	0	0%
T-6 (2010)	14	4	18	4	22%	5	28%	7	39%	2	11%	0	0%	0	0%
T-5 (2011)	16	2	18	2	11%	14	78%	2	11%	0	0%	0	0%	0	0%
T-4 (2012)	16	3	19	6	32%	5	26%	0	0%	0	0%	8	42%	0	0%
Mean					**17%**		**49%**		**15%**		**5%**		**10%**		**3%**

Annex 5. Explanation of the categories

The Committee assesses the institute on the three assessment criteria: research quality, relevance to society and viability. These criteria are assessed both in qualitative terms (with arguments) and quantitative terms (in one of the four categories, see the table below).

Table 6. Meaning of categories in SEP 2015-2021

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

In addition to the three criteria, every assessment also considers at least three further aspects: PhD programmes, research integrity, and diversity. These aspects are only assessed in qualitative terms.

Annex 6. Terms of Reference

The board of The Netherlands Organisation for Scientific Research (NWO) hereby issues the following Terms of Reference to the assessment committee of Nikhef, chaired by Prof. dr. Tejinder (Jim) Singh Virdee.

Topic	**Description**
Title	External evaluation of Nikhef of the period 2011 – 2016
Why	NWO organizes periodic evaluations of each research institute within the organisation every six years. This is part of the standing agreement with the Ministry of Education, Culture and Science. Together with Royal Netherlands Academy of Arts and Sciences (KNAW) and the Association of Universities in the Netherlands (VSNU), NWO has stated to conduct these evaluations according to the Standard Evaluation Protocol (SEP). The goal of the periodic assessments is primarily to identify the quality of the research and the societal relevance and secondly to - partly on the basis of the assessment results - determine the mission and the basic funding for the next six years (2018-2023).
What	The assessment committee evaluates quality and relevance to society of the research conducted by the institute as well as its strategic targets and the extent to which it is equipped to achieve them. The committee does this by judging the institute's performance on the three SEP assessment criteria, taking into account current international trends and developments in science and society in the analysis. Each criterion should receive a ranking in one of the four categories in accordance with the SEP guidelines. The committee also ensures that the qualitative assessment (text) and the quantitative assessment correspond. Furthermore, the committee should give recommendations for improvement. The three SEP assessment criteria are: - Research quality - Relevance to society - Viability The assessment committee also gives a qualitative evaluation on three additional aspects: - PhD programmes - Research Integrity - Diversity Further information about the criteria and additional aspects can be found in chapter 2 of the Standard Evaluation Protocol (SEP). In addition to the topics above NWO has formulated three questions: 1. What is the institute's added value in the national context and its international position? 2. How does the institute stimulate and facilitate knowledge utilization and open access? 3. How does the institute's structure, size and financial policy contribute to its mission?
For whom	- The researchers themselves in order to establish where they stand, how they can improve and what the research should aim for. - The management of the institute who wishes to track the impact of their policy. - The board of NWO who decides on the accountability of the institute and the support for the institute.

	- Other stakeholders from, for example, the society and private sector. - The Ministry of Education, Culture and Science has requested a portfolio analysis of all the research institutes of NWO and the Royal Netherlands Academy of Arts and Sciences in 2018. The results of the SEP-evaluations will act as input for this portfolio analysis.
Who	The independent assessment committee consists of 4-7 renowned international experts within the realm of the institute. Each committee member signs a statement of impartiality and confidentiality.
How	The assessment committee will be supported by a liaison officer from NWO and an independent secretary. The necessary documentation to conduct the assessment will be made available to the committee one or two months before the site visit. This documentation includes at least a self-evaluation by the institute, a strategy document of the institute and the conclusions and recommendations from the previous assessment. If feasible the institute may provide a bibliometric analysis or a different study of its own choice to support the self-evaluation. The assessment committee will be invited to the institute for a site visit of two days during which the institute will present itself in short lectures and interviews by the committee. The assessment committee will deliver a draft evaluation report to the NWO board no later than eight weeks after the site visit and a final version no later than 12 weeks after the site visit. Finally, the NWO board will publish the assessment report on the website accompanied by a public statement.
When	The site visit will take place in September or October 2017. NWO distributes the necessary information and documents to the committee 1 or 2 months in advance of the site visit. For further information on the general time schedule please refer to the attached Standard Evaluation Protocol.
Contact	Dr. Frank Bongers (Dialogic) and Dr. Jacqueline Mout (NWO)

Necessary documents that will be made available to the assessment committee:

- Self-evaluation 2011-2016
- Strategy document
- Further description of what the committee needs to know about the scope/context, assessment questions, method, time schedule, final report
- Programme of the site visit
- Standard Evaluation Protocol (SEP)
- Conclusions and recommendations from previous evaluation
- Response NWO to the previous evaluation report