Input from the Netherlands for the European Strategy for Particle Physics – Update 2020

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On behalf of Nikhef

Particle- and Astroparticle Physics in the Netherlands

The programme for Particle Physics in the Netherlands is co-ordinated by Nikhef, the National Institute for Particle Physics (www.nikhef.nl). Nikhef presently comprises groups from the NWO (Dutch national funding agency) Institute for Subatomic Physics and five universities: Free University of Amsterdam, Radboud University, University of Amsterdam, University of Groningen and Utrecht University. The historical aim of Nikhef was to be the Dutch home base for Particle Physics experiments at CERN. While this aim is still being honoured, Nikhef is now the home base for experiments at a larger variety of labs all around the world.

The current Nikhef strategy is described in the Nikhef Strategy 2017-2020 and Beyond. The strategy is divided in three pillars: Proven Approaches, New Opportunities and Beyond Scientific goals. For the Proven Approaches Nikhef takes part in the particle physics experiments ATLAS, LHCb and ALICE. The Astroparticle Physics portfolio comprises of Advanced Virgo on gravitational waves, KM3NeT (and a small effort in protoDUNE) for the neutrino program, Pierre Auger Observatory for Ultra High Energetic Cosmic Rays and Xenon for the direct search of Dark matter. Further, Nikhef is building a precision atomic physics programme to determine the electric dipole moment of the electron.

Next to these programs, Nikhef has a vivid theory department, a dedicated R&D group and a Physics Data Processing group. Together with SARA Nikhef houses a Tier-1 computing centre.

In the Nikhef strategic plan the importance of a healthy theory community is underlined as essential for progress in Particle and Astroparticle Physics. The Nikhef strategy depends crucially on international co-operation and therefore a proper embedding in the European Strategy for Particle Physics is essential for the Dutch Particle Physics community to flourish. The Netherlands as founding Member of CERN and through its participation in CERN experiments has traditionally strived to play a strong role in the European Particle Physics community and will continue to do so.

Continued Support for CERN as the European centre for Particle Physics Research

We fully embrace the mission of CERN, the research content having developed from the original goals mentioned in the 1954 Convention to frontier fundamental particle physics research today. CERN should remain the most important laboratory for seeking and finding answers to fundamental questions about the Universe and it should continue to push back the frontiers of technology. In particular CERN should continue to be the world leading laboratory of bold projects that challenges the imagination, that pushes the boundaries of knowledge of fundamental physics. CERN has the responsibility to maintain the concentrated eco-system between theory, phenomenology, instrumentation, computing, R&D, innovation, talent; attention to all these aspects should remain as high as ever.

We also fully embrace CERN as the organizer and sponsor of international co-operation in research, promoting contacts between scientists and interaction with other laboratories and institutes. CERN should continue its important role in training the scientists of tomorrow.

CERN must continue to be the highly successful world-leading laboratory of fundamental particle physics research it has been until now. The future success of CERN depends on the strategic choices for the post-LHC period. With the discovery of the Higgs particle and the fabulous LHC machine running for many more years, the challenges of particle physics are to cross yet another level of understanding of the building blocks of matter, their forces and the structure of space and time.

In the view of the Dutch Particle Physics community, CERN as the top research centre for this type of fundamental research should play an even stronger role in our field. CERN should not only develop a strong collider physics program on-site, but also enlarge its diversity by embracing aspects of the Astroparticle Physics program that are relevant for Particle Physics.

Improvements for the CERN Organization and Laboratory

We formulate a number of recommendations that Nikhef views relevant for the CERN laboratory

1. The link with industry can be further intensified, notably also for the Dutch industry. A better balance of the industrial returns between the member States can be achieved by making the procurement rules more flexible. In this respect we would also encourage further steps to facilitate the recruitment of Dutch technical students, fellows and staff members.

2. CERN is encouraged to investigate and implement a better balance between the CERN membership contribution and M&O contributions of the collaborations for member- and non-member countries.

3. Open science can be brought to the next level at CERN by stimulating open data as put forward by the European Open Science Cloud and by encouraging open membership of collaborations, such that authors can access data of multiple collaborations. Cross-experiment and cross-collaboration projects should be stimulated.

4. Physics Collaborations in Europe should give more opportunities for individuals to present their views in conferences and publications, for example in the form of shortened author-list notes or publications that should be publicly accessible.

5. The computing and data analysis challenges ahead of us are enormous. CERN should develop a strategy to further support data science as a separate research item, both at the CERN lab and in co-ordinating the European community effort. This will require to make data science jobs attractive in the strong competition with industry.

6. CERN should continue to strengthen its role as a centre for theoretical particle phenomenology, to perform state-of-the-art calculations relevant to high energy and high precision collider physics as well as Astroparticle physics topics. The Netherlands support the proposal as is put forward by CERN and APPEC to establish a network of

European institutions active in theoretical Astroparticle physics, with a central position taken by CERN.

Future Particle Physics Developments

The program of CERN should maximize the exploitation of its physics potential. Keywords here are 'high precision', 'high energy' and 'diversification'. The Netherlands support both a flagship program with high physics potential, as well as a diversification program to maximize the potential to find BSM physics.

7. The successful realization of the High Luminosity LHC is the highest priority, including the upgraded general-purpose experiments Atlas and CMS, as well as flavour physics with LHCb and heavy-ion physics with Alice.

8. The Netherlands strongly support the construction of an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision, and whose energy can be upgraded.

9. We look forward to the imminent statement from Japan on hosting the ILC, including guidance about the resources foreseen. In the scenario that the ILC (phase-1) project in Japan is approved, CERN should take a visible and vivid role in its design, construction and exploitation and utilize the full potential of CERN's capabilities. CERN's CLIC technology is seen as an ideal opportunity for an energy upgrade in the ILC infrastructure in Japan.

10. For the Netherlands, taking part in large new international infrastructural projects such as the ILC can only be done via the CERN Membership. The Dutch particle physics community expects CERN to be the leading and co-ordinating European partner in such projects.

11. If Japan does not propose to host the ILC, CERN should optimize the costs to construct a high luminosity e^+e^- machine of 250 GeV to become online in the mid-2030-ies.

12. The FCC-ee and FCC-pp programs are strongly linked and highly ambitious: the construction of the FCC-ee facility is an excellent opportunity with the vision to construct the FCC-pp in the future as well. CERN should therefore strengthen the combined physics case and scrutinize these two projects together.

13. In the meantime, CERN should prepare vigorously for a future accelerator on-site by pushing the R&D efforts for high-gradient acceleration, e.g. wakefield- and high field magnet technology. In addition, the feasibility of building a muon collider should be pursued.

CERN involvement to Astroparticle Physics

Given that the fields and communities of Astroparticle Physics and Gravitational Wave physics are internationally growing, CERN should widen its physics palette and welcome the hosting and support of the Astroparticle program part that is relevant for fundamental Particle Physics.

14. CERN should take measures to optimize diversity within its physics program. We support the “Physics Beyond Colliders” initiative at CERN to optimally use its existing accelerator infrastructure. The neutrino platform with, e.g. ProtoDUNE, is an excellent new initiative and we encourage CERN to continue this fruitful collaboration with other particle physics laboratories, such as Fermilab.

15. CERN should initiate a ‘Dark Matter’ platform to advance technological and experimental challenges in this field of research, similar to the neutrino platform.

16. CERN’s mission and governance is well suited and profitable to be involved and play an active role in the construction of the Einstein Telescope third generation Gravitational Wave interferometer. CERN should take a visible and vivid role in the design, construction and exploitation of the Einstein Telescope.