Addendum to the input from the Netherlands to ESPP 2026

November 2025

1 Introduction

This document is the final input from the Netherlands to the update of the 2025 European Strategy for Particle Physics. It serves as an addendum and extension to our initial input submitted in March 2025. The considerations and recommendations from the initial document remain fully valid. This addendum builds on those foundations and reflects the outcomes of further national discussions, using the information that became available during the past months, and focusing on preferred and alternative future collider scenarios and on a small number of key elements of which we would like to emphasise their importance.

2 The Dutch strategy process

The Dutch process for shaping input to the ESPP has been broad, iterative, and community-driven, coordinated by Nikhef with participation from across the particle and astroparticle physics community.
Following the initial consultation phase in 2024–2025 (as described in our March 2025 document), three additional large open meetings were held after summer.
These meetings gathered the Dutch particle and astroparticle physics community to discuss the information that became available at the Open Symposium, the physics briefing book and the report on large-scale accelerator projects. The discussions covered collider scenarios, and strategic priorities for this final input.
The resulting document represents a consolidated national view, reflecting a broad and inclusive discussion among Dutch researchers.

3 Important elements to future colliders

In our initial input document, we reflected on important elements for a future collider. In this section, we highlight the elements from our input document that the Dutch community deems essential for the future of the field.

Sustainability

Long-term sustainability must be a guiding principle for all future collider projects.

CERN should take a proactive role and invest up front in making large-scale research infrastructures more sustainable, with investments in developing more sustainable technologies for accelerators, detectors and computing, and making use of life-cycle analyses for future projects and sustainable procurement.

Clear and open communication on sustainability efforts for future collider projects is crucial for societal support, including transparent reporting of environmental impact and mitigation strategies.

Scientific diversity

A diverse experimental portfolio beyond colliders for both CERN and Europe is vital to the field. This is also supported by the physics briefing book.

The future collider programme must preserve Europe's investment in scientific diversity, maintaining current levels of support for non-collider (astro)particle physics at the very least.

Technology and innovation

A coordinated and forward-looking technology strategy is essential to maintain Europe's global leadership in particle physics. CERN should play a central role in this effort by investing in transformative technologies identified in strategic R&D roadmaps.

Continued R&D in accelerator technology, particularly in high-field magnets, remains crucial across all future collider scenarios.

Beyond supporting the critical technologies that underpin current experiments, CERN should also establish a comprehensive roadmap for the development of transformative technologies in computing and AI that will enable future experiments.

Engagement and society

We encourage the adoption of a coordinated European vision for education, communication and public engagement, and the implementation of joint initiatives.

The Dutch community values the contribution from Early Career Researchers (ECRs) to the ESPP and underlines the importance of fostering and attaining talent.

4 Scenarios for future colliders

The ESPP has requested statements on a preferred collider option and an alternative option in case the preferred one proves not feasible or not competitive.

The Dutch community emphasises the importance of a broad and forward-looking strategy that ensures Europe's long-term leadership in high-energy physics, rather than focusing on single options.

We propose to think in terms of scenarios, i.e. integrated programmes, that include both a lower-energy and a higher-energy collider. This aligns with the long-term goal of reaching the 10 TeV parton-energy scale as set out in the 2020 ESPP.

This broader perspective:

- Allows flexibility to integrate new discoveries and technological innovations;
- Allows for long-term planning and advancements in the field of high-energy particle physics. At the same time, this helps to foster talent by keeping the field viable and attractive;
- Facilitates risk management, since scenarios can adapt to global developments or financial realities.

Therefore, we have explored and compared complete collider scenarios rather than isolated machine options, with physics motivation as the primary guiding principle, feasibility as an essential consideration and taking into account the important elements we mentioned above.

5 The Dutch preferred collider scenario

Completing the full exploitation of the HL-LHC programme must remain CERN's top priority, including considerations to further diversify and extend its physics scope.

We support the ambition expressed in the 2020 ESPP update for the community to ultimately reach 10 TeV parton-energy collisions in a future collider scenario, with a Higgs factory as a first stage.

Achieving this ultimate goal requires a coherent, multi-step strategy.

The integrated FCC scenario, with FCC-ee followed by FCC-hh, offers a broad and exciting physics programme. The feasibility study of the FCC-ee demonstrated that this collider is within reach. **We strongly support the implementation of the integrated FCC programme as our preferred scenario**.

Fundamental properties and interactions of matter are also studied in experiments outside of the collider physics domain. The (astro)particle physics experiments studying these topics provide complementary information to the insights obtained at colliders. It is important to maintain at least today's level of resources for these types of experiments.

The development of alternative future collider scenarios must be supported by CERN up to a well-defined go/no-go point, to be reached around the end of the decade, at which the risks of the FCC integrated scenario will be reviewed to determine whether they are sufficiently mitigated to proceed.

6 The Dutch preferred alternative collider scenario

While our preferred path is the integrated FCC programme, CERN must be ready to follow an alternative route to high energies should key risks of the FCC scenario materialise.

Alternative collider scenarios should therefore be further developed and supported in parallel for as long as significant risks for the preferred collider scenario persist.

Different risks may lead to different alternative programmes. The main risks considered are:

- The possible inclusion of the CEPC or SPPC in China's five-year plan in 2030;
- Implementation challenges, such as budgetary constraints, preventing timely execution of the FCC-ee;
- New discoveries in particle or astroparticle physics that shift experimental priorities.

Taking these potential risks into account, we recommend to further develop an alternative collider scenario that commences with the LHeC and/or LEP3 as a fall-back solution. This would then be followed at the high-energy scale with the FCC-hh or a muon collider. This combination has flexibility and continuity towards achieving 10 TeV parton-energy collisions, but would result in a reduced physics programme in the next decades.

The LHeC is an attractive alternative option providing timely, cost effective and valuable physics and it would allow an earlier start of the high-energy collider. In addition, it would be a complementary collider at CERN if the CEPC is built. LEP3 would be a pragmatic alternative Higgs factory if the FCC-ee proves out of reach due to implementation challenges.

Both LEP3 and LHeC would not require an early construction decision. Investments in the implementation feasibility and technology readiness of both are essential such that they become ready-to-implement colliders by the early 2030s, in case the preferred scenario cannot proceed. The longer-term pathway could lead either to FCC-hh or a muon collider, depending on how the landscape evolves.

The muon collider at CERN is particularly attractive if China proceeds with the SPPC, as it would allow Europe to maintain leadership at the energy frontier with complementary physics coverage. A dedicated muon collider demonstrator remains a prerequisite, and we encourage continued support for its realisation, including collaboration with the US.

For the FCC-hh, we strongly support the further development of HTS magnets, such that they can be a viable alternative to Nb3Sn magnets.

Further studies by the theoretical and experimental communities to clarify the physics potential of these alternative collider scenarios are essential. In particular, it is important to explore the physics potential of combining HL-LHC with LHeC and/or LEP3, as well as either the FCC-hh or the muon collider.