Input to the European Strategy for Particle Physics - 2026 update

Report of Contributions

https://indico.cern.ch/e/1439855

Contribution ID: **2** Type: **not specified**

Light Ion Collisions at the LHC

In the week of 11-15 November 2024, more than 150 theorists, experimentalists and accelerator physicists met at CERN to discuss newly emerging opportunities with light ion beams, cern.ch/lightions. This workshop responded to the growing realisation that light ion collisions open qualitatively novel possibilities for the study of QCD at extreme temperature or parton densities. In particular, it has been demonstrated that even short special runs (such as the "pilot"runs with p-Pb in 2012 and Xe-Xe in 2017) can address central open questions resulting from recent discoveries of the LHC heavy ion programme, and that such short runs are also of interest for neighbouring physics communities including nuclear structure and cosmic rays. With this consensus report, the workshop participants summarise the main motivations for future light ion collisions at the LHC.

Authors: GIACALONE, Giuliano; NIJS, Govert Hugo (CERN); SONG, Huichao; WANG, Jing (CERN); HU, Qipeng (University of Science and Technology of China (CN)); ALEMANY FERNANDEZ, Reyes (CERN); MARIANI, Saverio (CERN); WIEDEMANN, Urs (CERN); Dr VAN DER SCHEE, Wilke (CERN); ZHOU, You (Niels Bohr Institute (DK))

Contribution ID: **4** Type: **not specified**

Contribution about Neutrino Physics to the European Strategy for Particle Physics

On behalf of the French community
structured by the Neutrino International Research Network

Authors: TONAZZO, Alessandra; MEREGAGLIA, Anselmo (Centre National de la Recherche Scientifique (FR)); GIGANTI, Claudio (LPNHE Paris (IN2P3/CNRS)); BAUSSAN, Eric; BOLOGNESI, Sara (Université Paris-Saclay (FR)); LAVIGNAC, Stephane (IPhT Saclay)

Contribution ID: **5** Type: **not specified**

Prospective report of the French QCD community to the ESPPU 2025 with respect to the program of the LHC Run 5 and beyond and future colliders at CERN

This document summarizes the prospective physics plans of the French QCD and Heavy-Ion community, including the experimental programs at the LHC Run 5 and beyond and future colliders at CERN, within the context of the French contribution to the update of the European Strategy in Particle Physics (ESPPU 2025), as discussed in the workshop on European Strategy for Particle Physics Update 2025 organised by the QCD GdR in Oct. 2024.

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Contribution ID: **6** Type: **not specified**

Input for the EUROPEAN STRATEGY FOR PARTICLE PHYSICS UPDATE 2026 compiled by THE ISOLDE COLLABORATION COMMITTEE

The scientific opportunities using the ISOLDE Facility are presented as a series of themes that are expected to form the scientific programme for the facility in future running periods. The facility status, operations and competitiveness are discussed. The facility developments planned for the LS3 period and for future shutdowns are outlined. Ideas for the longer term are discussed within the context of the future of unique nuclear physics programmes at CERN that benefit from the proton injectors.

Author: FREEMAN, Sean John (CERN)

Contribution ID: **7** Type: **not specified**

Conclusions of the Town Meeting: Heavy Ion and QGP Physics at CERN

On Monday, February 17, 2025, a town meeting was held at CERN to gather input on heavy ion and quark gluon plasma (QGP) physics for the European Strategy for Particle Physics 2026. The meeting included brief presentations on current and upcoming heavy ion experiments at CERN's LHC and SPS, along with future projects at the FAIR facility in Darmstadt and Brookhaven RHIC. It also highlighted CERN's injector and accelerator complex capabilities for providing ion beams to the HL-LHC (with a view to FCC-hh) and future fixed-target experiments. Additionally, the meeting offered a platform for scientists and groups to share comments and statements, including a panel on theory.

The meeting had 279 registered participants representing all experimental and theoretical activities in the field. It concluded with an open discussion on the priorities within the field. The following text, while not officially endorsed by any of the mentioned experimental collaborations or facilities, summarizes the consensus of the scientific community on the field's priorities, as expressed by the town meeting participants. It is submitted to the Open Symposium of the European Strategy Group in Venice by the convenors of the meeting.

Authors: MILOV, Alexander (Weizmann Institute of Science (IL)); WINN, Michael (Université Paris-Saclay (FR)); SNELLINGS, Raimond (Nikhef National institute for subatomic physics (NL)); ARNALDI, Roberta (Universita e INFN Torino (IT)); WIEDEMANN, Urs (CERN); LEE, Yen-Jie (Massachusetts Inst. of Technology (US))

Contribution ID: **9** Type: **not specified**

The Worldwide LHC Computing Grid input to the ESPP24-26

The Worldwide LHC Computing Grid (WLCG) is the global infrastructure, developed and operated over the last two decades, that provides the computing infrastructure for the processing and analysis of data from the LHC experiments. The WLCG Collaboration comprises the sites being part of the infrastructure and the LHC experiments, with a thin management layer. The notable achievement of WLCG has been to successfully meet the needs of the LHC experiments by the integration of globally distributed Exascale-level resources, with services and software within a trust framework that transcends site and national boundaries. The success of WLCG has relied on innovation, leadership, collaboration, agility, and the confidence of the community and funding agencies to commit to the endeavour as an essential step towards the success of the physics initiatives. Today, WLCG has evolved from the initial Grid of uniform systems to a much more diverse infrastructure, able to support the experiments via owned centers, public and private clouds, and HPC systems. WLCG is still a rather unique facility in science, but as the needs of other communities grow beyond what can be provided by individual facilities, they too have started to tackle similar issues. The future brings new challenges in terms of scale, technology, funding, sustainability, and the integration and coexistence with related communities. This note is the WLCG input to the ESPP 2024-2026 process and elaborates on the WLCG 2024-2027 Strategy Document approved by the WLCG Overview Board in June 2024. While the ESPP process looks at a much larger timespan, in the context of computing the most significant challenge of the next two decades is the HL-LHC, starting in 2030. The next few years will be vital for the commissioning of the software and the computing infrastructure for HL-LHC, which is why we focus on this shorter time span.

Author: CAMPANA, Simone (CERN)

Co-authors: BRITTON, David (University of Glasgow (GB)); Dr BOCCALI, Tommaso (INFN Sezione di Pisa)

Contribution ID: **10** Type: **not specified**

European Strategy for Particle Physics 2024-26 Israeli Input

This report constitutes Israel's national contribution to the European Strategy for Particle Physics for 2024–2026. It provides an overview of the ongoing research activities and outlines future plans of the Israeli High Energy Physics community, covering experimental, theoretical (phenomenological), and formal theory research. The report also discusses key considerations and offers recommendations for future projects.

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Co-authors: AHARONY, Ofer; BARAK, Liron (Tel Aviv University); CITRON, Zvi (Ben-Gurion University of the Negev (IL)); GELLER, Michael (Tel Aviv University); KAJOMOVITZ MUST, Enrique (Technion, Israel Institute of Technology); KATS, Yevgeny (Ben-Gurion University); TAL HOD, Noam (Weizmann Institute of Science (IL)); TELEM, Ofri (The Hebrew University of Jerusalem)

Contribution ID: **11** Type: **not specified**

Fermilab Interest in a Higgs Factory at CERN

The 2023 Particle Physics Project Prioritization Panel (P5) in the US, in putting forth a strategic plan for the US in the context of a 20 year vision for global particle physics, has recommended the construction of an off-shore Higgs Factory and that the US engage in the feasibility studies and contribute and collaborate if the project is approved for construction.

Fermilab teams have made major contributions to collider physics, from simulation and algorithm development to a broad array of physics measurements. Through R&D, construction and operations of collider detectors for past and on-going experiments (CDF, D0, CMS), Fermilab has developed unique world class facilities and in-house technical expertise (Appendix) that enable a variety of cutting-edge detector and computing R&D for future projects.

Apart from the availability of a broad spectrum of world class facilities, capabilities and competencies, their co-location and synergy is what makes Fermilab a leader in the field. As host laboratory for the USCMS, Fermilab is a national hub for US contributions to CMS.

Fermilab's aspiration is to make leading physics, detector, and computing contributions to the electron-positron Future Circular Collider (FCC-ee), if this is Europe's choice, or to the Higgs Factory program that emerges from the European Strategy process. Fermilab also aims to become the US host laboratory for one of the FCC-ee experiments.

Authors: CANEPA, Anadi (Fermi National Accelerator Lab. (US)); APRESYAN, Artur (Fermi National Accelerator Lab. (US)); PEÑA, Cristián (Fermi National Accelerator Lab. (US)); CUMMINGS, Grace (Fermi National Accelerator Lab. (US)); DUTTA, Irene (Fermi National Accelerator Lab. (US)); FREEMAN, Jim (Fermi National Accelerator Lab. (US)); HIRSCHAUER, Jim (Fermi National Accelerator Lab. (US)); GRAY, Lindsey (Fermi National Accelerator Lab. (US)); BAUERDICK, Lothar A T (Fermi National Accelerator Lab. (US)); SAFDARI, Murtaza (Fermi National Accelerator Lab. (US)); BACCHETTA, Nicola (Universita e INFN, Padova (IT), FERMILAB (US)); HOECHE, Stefan (Fermilab); ELVIRA, Victor Daniel (Fermi National Accelerator Lab. (US))

Contribution ID: **12** Type: **not specified**

Strategy for HPC Integration in WLCG/HEP

High-Energy Physics (HEP), and particularly the sector supported by the WLCG Collaboration at the LHC experiments, is entering a new era of data-intensive research. This shift is driven by the High-Luminosity LHC (HL-LHC) that will generate exabyte-scale datasets each year. Fully realizing the physics potential of this massive volume of data will require a significant increase of resources. High Performance Computing (HPC) centers are crucial partners in this effort, offering either pledged resources or for providing additional opportunistic resources that enhance the physics output. Integrating HPC systems into HEP workflows offers transformative benefits, like expanding computational power, accelerating simulations, and enabling more sophisticated AI/ML algorithms. However, realizing these benefits demands a concerted effort to address technical, organizational, and policy-related barriers.

Author: Dr GIRONE, Maria (CERN)

Contribution ID: **13** Type: **not specified**

Laboratori Nazionali di Frascati of INFN

This document presents the status and plans of the INFN Frascati Laboratory, the largest Italian infrastructure in particle physics. Established in 1957 for the development of particle accelerators, it is the oldest national laboratory of the INFN and is renowned world-wide for its contributions to both theoretical and experimental physics.
At present, it offers infrastructure for accelerator physics, particle detectors, interdisciplinary physics studies, and technology transfer. The laboratory hosts small-scale particle and nuclear physics experiments, including searches for low-mass dark matter candidates. Researchers' training during post-graduate and doctoral studies, as well as outreach initiatives to support science education and increase public awareness of science, are actively pursued.
The laboratory is expected to maintain a fundamental role in shaping the future of particle physics, capitalizing on its extensive expertise, and its
state-of-the-art infrastructure

Author: FRASCATI NATIONAL LABORATORY OF INFN

Contribution ID: **14** Type: **not specified**

Input to the European Strategy for Particle Physics 2024-2026 from the Hungarian high-energy physics community

The document summarizes the Hungarian national input to the European Strategy for Particle Physics 2024-2026, representing the high-energy physics community.

Authors: VARGA, Dezso (HUN-REN Wigner Research Centre for Physics (HU)); SIKLÉR, Ferenc (Wigner RCP, Budapest (HU))

Contribution ID: **15** Type: **not specified**

French HEP community input to the European Strategy for Particle Physics

In view of the European Strategy for Particle Physics process, the French HEP community has organized a national process of collecting written contributions and has pursued a series of workshops culminating with a national symposium held in Paris on January 20-21, 2025 that involved over 280 scientists. The present document summarises the main conclusions of this bottom-up approach centred on the physics and technology motivations.

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Co-authors: TEIXEIRA, Ana Margarida; MEREGAGLIA, Anselmo (Centre National de la Recherche Scientifique (FR)); MUNOZ CAMACHO, Carlos; SMITH, Christopher (LPSC Grenoble); MARQUET, Cyrille (CPHT - Ecole Polytechnique); CONTARDO, Didier Claude (Centre National de la Recherche Scientifique (FR)); AUGE, Etienne (Institut National de Physique Nucleaire… (IN3P3)); COUDERC, Fabrice (CEA-Saclay/Irfu/DPhP (FR)); FERRI, Federico (Université Paris-Saclay (FR)); DUJANY, Giulio (IPHC - CNRS); Dr LEVEQUE, Jessica (CNRS LAPP (Annecy-Le-Vieux)); D'ERAMO, Louis (LPCA - CNRS/IN2P3 (FR)); PORTALES, Louis (CEA Paris-Saclay, IRFU); BOONEKAMP, Maarten (CEA/Saclay); GENEST, Marie-Helene (LPSC - Grenoble, CNRS/UGA); WINN, Michael (Université Paris-Saclay (FR)); SCHWEMLING, Philippe (CEA/IRFU,Centre d'etude de Saclay Gif-sur-Yvette (FR)); CRÉPÉ-RENAUDIN, Sabine (LPSC-Grenoble, CNRS/IN2P3); CALVET, Samuel (LPC Clermont-Ferrand, IN2P3 / UCA (FR)); BOLOGNESI, Sara (Université Paris-Saclay (FR)); LAVIGNAC, Stephane (IPhT Saclay); MONTEIL, Stephane (Université Clermont Auvergne (FR)); AMHIS, Yasmine Sara (IJCLab/CERN); CHAPON, Émilien (Université Paris-Saclay (FR))

Contribution ID: **16** Type: **not specified**

Polish national input to the 2026 update of the European Strategy for Particle Physics

The Polish high energy physics (HEP) community fully recognizes the urgent need to host at CERN a flagship project implementing a broad, long-term, and comprehensive vision of particle physics research and pursuing technological advances. Thus, we give preference and declare willingness to actively engage and participate in every aspect of the FCC project (both FCC-ee and FCC-hh), particularly accelerator development, detector construction, theoretical calculations, and physics analyses. As the e^+e^- Higgs Factory is the top priority for our field, the proposal to build a linear collider facility at CERN, opening up complementary physics prospects, should be considered as the second option.

Polish teams declare strong support and are fully committed to contribute to the full exploitation of all aspects of the physics potential of the LHC and the HL-LHC programmes. To ensure the long-term development of particle physics, we also support the continuation of the high-field magnet research programme, as well as investigating other scenarios including, in particular, linear acceleration techniques and new acceleration technologies such as plasma acceleration, the muon collider and Gamma Factory. In addition, CERN should continue to provide support to fixed-target programmes at SPS as well as other non-collider and non-accelerator experiments at CERN. Participation in major projects conducted in and outside Europe should also be fostered.

Education, communication, and outreach of particle physics are of paramount importance for the future of our field. An increased effort coordinated at the European level and resources allocated in all Member States are essential to effectively support future large-scale particle physics projects.

Authors: LAGODA, Justyna (National Centre for Nuclear Research (PL)); LESIAK, Tadeusz (Polish Academy of Sciences (PL)); ZARNECKI, Aleksander (University of Warsaw (PL))

Contribution ID: **17** Type: **not specified**

Enabling future detector technology within ePIC at the EIC

The ePIC experiment at the EIC incorporates a wide variety of detector technologies. The different technological approaches are imposed by the broad EIC physics scope and by the nature of the collider, which is asymmetric in energy and beam particles, and by the wide variety of ion species that will collide with electrons. Major parts of the experiment use novel technologies, developed for application in ePIC and with applications at major coming experiments and facilities, worldwide. The ePIC detector is, therefore, both a stimulus toward innovative detector approaches and a testbench for the implementation of novel
technologies in collider experiments.
This document is to underline the value of the ePIC detector in terms of technological developments and the options for collaborative efforts that can be beneficial to fundamental studies at high energies.

Authors: MUNOZ CAMACHO, Carlos; ELIA, Domenico (INFN Bari); LAJOIE, John (Oak Ridge National Laboratory); JONES, Peter.G (School of Physics and Astronomy); DALLA TORRE, Silvia (Universita e INFN Trieste (IT))

Contribution ID: **18** Type: **not specified**

CERN openlab: A Flagship Model for Industry-Science Computing R&D

CERN openlab is a unique public-private partnership initiative at CERN (European Organization for Nuclear Research), dedicated to addressing the ICT-related challenges of hosting the world's most advanced particle accelerator. Through strategic collaborations with leading technology companies, CERN openlab co-develops, tests, and integrates advanced computing solutions, ensuring timely access and training for the scientific community. Structured in three-year cycles, CERN openlab's Phase VIII, which runs from 2024 to 2026 inclusive, emphasises heterogeneous computing infrastructures, advanced storage solutions, low-latency interconnect technologies, artificial intelligence (AI) applications. Additionally, it supports diverse services both inside and outside CERN, enabling unique use cases and innovative solutions. It also explores emerging technologies like digital twins and new materials for long-term digital storage. The initiative's impact extends beyond high-energy physics (HEP), benefiting healthcare and climate modelling. CERN openlab further supports workforce development through training programs, summer student initiatives, and technical workshops, ensuring scientists and engineers gain essential computational expertise. CERN openlab fosters academia-industry collaboration, helping to maintain the European particle physics community's global innovation leadership and serving as a model for future partnerships.

Authors: Dr GIRONE, Maria (CERN); JAMES, Thomas Owen (CERN)

Co-authors: NAPPI, Antonio (CERN); WULFF, Eric (CERN); VERDER, Killian; ATZORI, Luca (CERN); MASCETTI, Luca (CERN); VELHO, Mariana (Universidade Nova de Lisboa (PT))

Contribution ID: **19** Type: **not specified**

The Forward Physics Facility at the Large Hadron Collider

The Forward Physics Facility (FPF) is a proposal developed to exploit the unique scientific potential made possible by the intense hadron beams produced in the far-forward direction at the high luminosity LHC (HL-LHC). Housed in a well-shielded cavern 627 m from the LHC interactions, the facility will enable a broad and deep scientific programme which will greatly extend the physics capability of the HL-LHC. Instrumented with a suite of four complementary detectors –FLArE, FASERν2, FASER2 and FORMOSA –the FPF has unique potential to shed light on neutrino physics, QCD, astroparticle physics, and to search for dark matter and other new particles. This contribution describes some of the key scientific drivers for the facility, the engineering and technical studies that have been made in preparation for it, the design of its four complementary experiments, and the status of the project's partnerships and planning.

Authors: BARR, Alan (University of Oxford (GB)); DE ROECK, Albert (CERN); KLING, Felix (DESY); BOYD, Jamie (CERN); MCFAYDEN, Josh (University of Sussex); ROJO CHACON, Juan (Nikhef National institute for subatomic physics (NL))

Contribution ID: **20** Type: **not specified**

Future of CERN

Focal point: It is too early to decide the future of CERN from now all the way until the end of this century.

Author: PIOTRZKOWSKI, Krzysztof (AGH University (Kraków, PL))

Contribution ID: **21** Type: **not specified**

Search for the electric dipole moment of the neutron with the n2EDM experiment

This is the contribution of the nEDM collaboration for the European Strategy for Particle Physics - 2026. We point out the high relevance of the search for a permanent neutron electric dipole moment (nEDM). We sketch the theoretical challenges and worldwide experimental efforts, with the nEDM collaboration currently commissioning the n2EDM apparatus at the ultracold neutron source of the Paul Scherrer Institute as the most advanced effort in the field.

Authors: LAUSS, Bernhard; Prof. STOFFER, Peter (Paul Scherrer Institut)

Contribution ID: **22** Type: **not specified**

Statement by the German Particle Physics Community as Input to the Update of the European Strategy for Particle Physics

This is the national statement by the German particle physics community, which is based on the results of four open community workshops.

The German community agrees that Europe's leading role in particle physics is to be secured by a flagship collider project at CERN after the LHC, which is essential to search for answers to the fundamental questions in particle physics. A Higgs factory remains the highest priority of the German community. The German community supports the FCC-ee as the next flagship project at CERN with highest priority. Its realization requires the timely development of a solid and affordable financial plan by CERN. Recommendations are made for scenarios in which the FCC-ee is considered not financially feasible or in which international competition calls for a complementary and more competitive collider at higher energies at CERN and related accelerator R&D efforts.

The German community considers a diverse experimental landscape of non-collider experiments essential. Furthermore, strategic considerations are presented on CERN, DESY, and the German research landscape, on theory, on sustainability, on enabling technologies and detector development, on computing, software, algorithms, and data science, on early-career researchers, on diversity, equity and inclusion, as well as on outreach.

Author: Prof. FELD, Lutz (RWTH Aachen University)

Contribution ID: **23** Type: **not specified**

Prospects and Opportunities with an upgraded FASER Neutrino Detector during the HL-LHC era: Input to the EPPSU

The FASER experiment at CERN has opened a new window in collider neutrino physics by detecting TeV-energy neutrinos produced in the forward direction at the LHC. Building on this success, this document outlines the scientific case and design considerations for an upgraded FASER neutrino detector to operate during LHC Run 4 and beyond. The proposed detector will significantly enhance the neutrino physics program by increasing event statistics, improving flavor identification, and enabling precision measurements of neutrino interactions at the highest manmade energies. Key objectives include measuring neutrino cross sections, probing proton structure and forward QCD dynamics, testing lepton flavor universality, and searching for beyond-the-Standard Model physics. Several detector configurations are under study, including high-granularity scintillator-based tracking calorimeters, high-precision silicon tracking layers, and advanced emulsion-based detectors for exclusive event reconstruction. These upgrades will maximize the physics potential of the HL-LHC, contribute to astroparticle physics and QCD studies, and serve as a stepping stone toward future neutrino programs at the Forward Physics Facility.

Authors: Prof. RUBBIA, Andre (ETH Zurich (CH)); KLING, Felix (DESY); BOYD, Jamie (CERN); FENG, Jonathan Lee (University of California Irvine (US))

Contribution ID: **25** Type: **not specified**

Countering the biodiversity loss using particle physics research sites

Together with the climate changes and the finite amounts of resources, the loss of bio- diversity is one of the major global socio-ecological problems to tackle. Land use, degradation and destruction was identified as the major cause of biodiversity loss. The fact that all areas, even small or urban, are suitable places to work on countering this loss justifies that actions are conducted on the sites used for high energy physics. But such sites also have specific characteristics –such as a long-term, stable and non-profit governance, or the presence of technical zones –which are important advantages for biodiversity. This makes the new particle physics sites foreseen in the future projects key places that can play a significant role in increasing the local biodiversity, also because, as academic sites, they can host original projects on environment and sustainability sciences. In the last two decades, numerous studies and projects have addressed biodiversity at the scale of a building, a district, or a town: reliable knowledge and tools are therefore available to organize such new sites. However, these works also show that to obtain the best results, biodiversity must be included from the beginning of the project in the reflections about the design and organization of a site.

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Contribution ID: **26** Type: **not specified**

HFLAV input to the 2026 update of the European Strategy for Particle Physics

Heavy-flavour physics is an essential component of the particle-physics programme, offering critical tests of the Standard Model and far-reaching sensitivity to physics beyond it. Experiments such as LHCb, Belle II, and BESIII drive progress in the field, along with contributions from ATLAS and CMS. The LHCb Upgrade II and upgraded Belle II experiments will provide unique and highly sensitive measurements for decades, playing a key role in the searches for new physics. Future facilities with significant heavy-flavour capabilities will further expand these opportunities. We advocate for a European Strategy that fully supports Upgrade II of LHCb and an upgrade of Belle II, along with their subsequent exploitation. Additionally, we support a long-term plan that fully integrates flavour physics in a positron-electron collider to run as a Z factory.

Authors: DORIGO, Mirco (INFN Trieste); EGEDE, Ulrik (Monash University (AU))

Contribution ID: **27** Type: **not specified**

Exploring the Dark Universe: A European Strategy for Axions and other WISPs Discovery

Axions and other very weakly interacting slim (with $m < 1$ GeV) particles (WISPs) are a common feature of several extensions of the Standard Model of Particle Physics. The search of WISPs was already recommended in the last update of the European strategy on particle physics (ESPP). After that, the physics case for WISPs has gained additional momentum. Indeed, WISPs may provide a new paradigm to explain the nature of dark matter and puzzling astrophysical and particle physics observations. This document briefly summarizes current searches for WISPs and the perspectives in this research field for the next decade, ranging from their theoretical underpinning, over their indirect observational consequences in astrophysics, to their search in laboratory experiments. It is stressed that in Europe a rich, diverse, and low-cost experimental program is already underway with the potential for one or more game-changing discoveries. In this context, it is also reported the role of the EU funded COST Action "Cosmic WISPers in the Dark Universe: Theory, astrophysics, and experiments" (CA21106, https://www.cost.eu/actions/CA21106) in coordinating and supporting WISPs searches in Europe, shaping a roadmap to track the strategy to guarantee a European leadership in this field of research.

Authors: DE GIORGI, ARTURO; LELLA, Alessandro; MIRIZZI, Alessandro; DREW, Amelia; GATTI, Claudio (INFN e Laboratori Nazionali di Frascati (IT)); AYBAS, Deniz (Department of Physics, Boston University); VITAGLIANO, Edoardo; TODARELLO, Elisa Maria; CALORE, Francesca (Unite Reseaux du CNRS (FR)); LUCENTE, Giuseppe (Bari University & INFN Bari); GORGHETTO, Marco (DESY); KARUZA, Marin (Universita e INFN Trieste (IT)); REIG LOPEZ, Mario (University of Oxford); BENITO CASTAÑO, María; KALTSCHMIDT, Mathieu (Universidad de Zaragoza); GIANNOTTI, Maurizio (Universidad de Zaragoza (ES)); CICOLI, Michele; RIGHI, Nicole; RUIMI, Ophir; GASPAROTTO, Silvia

Contribution ID: **28** Type: **not specified**

The PTOLEMY project

The PTOLEMY project aims at taking a snapshot of the first second of the Universe, when the Cosmic Neutrino Background (CvB) decoupled, which has been for a long time a dream in the field
of Cosmology. The PTOLEMY detection principle relies on CvB capture on a target of beta-unstable elements, since in this process mono-energetic electrons are emitted just above the beta-decay endpoint. The extremely low cross section imposes a large target mass resulting in a prohibitive rate of background events. For this reason a novel concept dynamic electromagnetic-filter, capable of selecting electrons in the region of interest has been developed. The usage of beta-unstable element, as target, imposes an extreme energy resolution to disentangle electrons from beta-decays from those emitted in the case
of neutrino capture. This makes a possible detector of relic neutrinos a perfect instrument to measure neutrino mass. This neutrino mass measurement has the advantage that can be achieved with much less target mass while the technology for relic neutrino detection is being validated. This pushed the collaboration to concentrate on a project to measure the neutrino mass while the final goal of designing a CvB detector is achieved.

Authors: Prof. RUOCCO, Alessandro (University of Roma3); Dr COCCO, Alfredo Giuseppe (LNGS-INFN); Prof. COLJN, AukePetr (Nikhef and University of Amsterdam); Dr DE LOS HEROS, Carlos Perez (University of Uppsala); Prof. TULLY, Christopher (Princeton University); Prof. GATTI, Flavio (University of Genova); Prof. CAVOTO, Gianluca (University Sapienza); MESSINA, Marcello (LNGS-INFN); BORGHESI, Matteo; Dr RAJTERI, Mauro (INRIM); Dr TOZZINI, Valentina (CNR-Pisa, Nano)

Contribution ID: **29** Type: **not specified**

Strategy for the Future of Lattice QCD

This submission highlights the sustained importance and requirements, over the coming decades, of the Lattice Quantum Chromodynamics community. We provide predictions for an increasing set of Standard Model observables and parameters with nonperturbative-physics contributions, such as matrix elements for hadron-transitions, hadron structure, the QCD phase diagram, and even properties of non-Standard-Model scenarios. These facilitate the full exploitation of experimental data at both the intensity and energy frontiers. In this document we argue that for sustained progress the community requires continued access to computing as well as storage resources at large Tier-0/1 high-performance-computing centres, as well as research staff and research-software-engineers.

Authors: JUTTNER, Andreas (CERN); FINKENRATH, Jacob Friedrich (CERN)

Contribution ID: **30** Type: **not specified**

European training in instrumentation and particle accelerators

Training researchers in instrumentation and accelerator physics is crucial for the timely realization of the European Strategy for Particle Physics (ESPP). To achieve this, a coordinated and well-supported effort at the European level is necessary.
This document highlights the urgent need for a strategic plan to attract, train, and retain young talent in particle accelerator and detector physics. A sustained, Europe-wide initiative, anchored at CERN, is essential for providing researchers across all CERN member and associate member states with world-class training opportunities and for building the expertise required for the next European Initiatives, including the next collider flagship project.
The ECFA Training Panel proposes a structured approach to training and requests formal recognition within the ESPPU document. The goals are :
● To establish a coordinated training strategy;
● To seek endorsement from the ESPP to facilitate the implementation of this program;
● To leverage this endorsement to seek support from CERN and other European institutions to realize the proposed initiatives;
● To get more recognition of instrumentation R&D as a scientific discipline in particle physics.
Given that accelerator physics training is more developed than instrumentation training, this document devotes more attention to the latter. However, this should not prevent the community from continuing—and even strengthening—its support for accelerator training. The structure of accelerator training could very well serve as a valuable model for the development of instrumentation training.

Authors: ILG, Armin (University of Zurich); CURCEANU, Catalina (LNF-INFN); GWENLAN, Claire (University of Oxford (GB)); METRAL, Elias (CERN); GARUTTI, Erika (Hamburg University (DE)); TECKER, Frank (CERN); COLLOT, Johann (university Grenoble Alpes (FR)); VAN BAKEL, Niels (Nikhef National institute for subatomic physics (NL)); MARTINENGO, Paolo (CERN); MERKEL, Petra (Fermi National Accelerator Lab. (US)); BURROWS, Philip Nicholas (University of Oxford (GB)); BRENNER, Richard (Uppsala University (SE)); Dr APPLEBY, Robert Barrie (University of Manchester (GB))

Contribution ID: **31** Type: **not specified**

Slovak Particle Physics Community Input to Update of the European Strategy for Particle Physics

This document contains the input collected in Slovak HEP community.

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Contribution ID: **32** Type: **not specified**

Performance study of the MUSIC detector in $\sqrt{s} = 10$ TeV muon collisions

This study investigates the performance of the MUSIC (MUon System for Interesting Collisions) detector concept in the context of sqrt{s} = 10 TeV muon-antimuon collisions. The detector is designed to mitigate machine-induced background effects while maintaining high efficiency and accuracy in reconstructing physics events, particularly in the Higgs boson sector and searches for new physics. The MUSIC detector features an advanced tracking system, electromagnetic and hadronic calorimeters, and a superconducting solenoid providing a 5T magnetic field. Simulation studies demonstrate promising tracking efficiency, photon and electron reconstruction capabilities, and jet identification performance, confirming the detector's potential for high-energy muon collider experiments.

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Contribution ID: **33** Type: **not specified**

Computer Algebra for Precision Calculations in Particle Physics: the FORM project

Precision calculations in particle physics rely on computer algebra tools to manipulate and process the large-scale algebraic expressions that result from applying perturbation theory in the Standard Model. Commercial computer algebra packages are often insufficient to handle state-of-the-art problems. The FORM computer algebra system is a community-based effort overcoming these restrictions, which has been developed continuously and has enabled the vast majority of precision calculations up to now. This document discusses the current status and future objectives of computer algebra for particle physics, and outlines the needs required to accomplish them.

Authors: VON MANTEUFFEL, Andreas (University of Regensburg); GLOVER, EDWARD,WILLIAM,NIGEL; LAENEN, Eric (Nikhef National institute for subatomic physics (NL)); HERZOG, Franz (CERN); HEINRICH, Gudrun (KIT); VERMASEREN, Jos; DAVIES, Joshua (University of Liverpool); TANCREDI, Lorenzo (Technische Universitat Munchen (DE)); STEINHAUSER, Matthias; MOCH, Sven-Olaf (Hamburg University (DE)); Dr UEDA, Takahiro (Juntendo University); GEHRMANN, Thomas Kurt (University of Zurich (CH))

Contribution ID: **34** Type: **not specified**

Some thoughts on the future of particle physics.

I present some considerations on the possible future of particle physics,
taking into account the challenge from climate change.
For a more thorough theoretical background some references are given.

Author: VAN DER BIJ, Jochum Johan

Contribution ID: **35** Type: **not specified**

Cusp Spectroscopy, Hyperon-Nucleon Scattering, and Femtoscopy: Pioneering Tools for Next-Generation Hadron Interaction Studies

Cusp spectroscopy, hyperon-nucleon (YN) scattering, and femtoscopy are indispensable tools for unraveling the complexities of hadron interactions and hypernuclear physics. Cusp spectroscopy enables precise determination of scattering lengths and interaction strengths by analyzing threshold cusp structures. YN scattering experiments provide valuable information on hyperon-nucleon interactions, which are key to understanding the baryon-baryon interaction in the strangeness sector. These experiments, including hypernuclear spectroscopy, are actively conducted at J-PARC in Japan, where a strong focus is placed on studying hypernuclei.

At CERN, Femtoscopy is performed in the ALICE experiment to probe the space-time structure of particle emission by measuring two-particle correlations at small relative momenta. This technique, sensitive to final-state interactions, provides critical insights into hadronic interactions in high-energy heavy-ion collisions.

The synergy between these techniques provides a comprehensive understanding of hadron interactions and hypernuclear properties. Hypernuclear studies at J-PARC deepen our understanding of multi-strange systems and contribute to refining theoretical models of baryon-baryon interactions. %Simultaneously, femtoscopy measurements at CERN offer complementary information on short-range hadronic forces, enhancing the predictive power of theoretical models.
By integrating the results from J-PARC and CERN, a more profound understanding of hadron interactions, hypernuclear structures, and multi-baryon systems can be achieved, driving future discoveries in hadron physics.

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Contribution ID: **36** Type: **not specified**

The JUNO Experiment

The Jiangmen Underground Neutrino Observatory (JUNO) is new-generation 20-kton multipurpose underground Liquid Scintillator detector designed to address fundamental questions in neutrino and astroparticle physics. Its primary scientific goal is to determine the neutrino mass hierarchy (MH) with a significance of 3-4 σ within approximately six years of data collection. JUNO's exceptional energy resolution (<3% at 1 MeV) and the large fiducial volume will enable precise measurements of three neutrino oscillation parameters: sin2θ12, Δm212, and |Δm231|, with an accuracy better than 1%. These measurements will play a pivotal role in testing the unitarity of the PMNS matrix and predicting neutrinoless double-beta decays.
JUNO will detect antineutrinos from nearby nuclear power plants, providing a robust dataset for MH determination and oscillation parameter measurements. Beyond reactor antineutrinos, JUNO is designed to observe a wide range of neutrino sources, including geoneutrinos, atmospheric neutrinos, solar neutrinos, supernova burst neutrinos and diffuse supernova neutrino backgrounds. A core-collapse supernova at 10 kpc would yield approximately 5000 inverse beta-decay events, 2000 neutrino–proton elastic scattering events and 300 neutrino–electron elastic scattering events in JUNO. These observations will enhance our understanding of supernova mechanisms, collective neutrino oscillations and cosmic star-formation rate. Additionally, JUNO will detect geoneutrinos from uranium and thorium decays at a rate of approximately 400 events per year, significantly improving the statistics.
The experiment will also explore Beyond-Standard-Model physics, including searches for proton decay via the p → K+ν decay channel, dark-matter annihilation neutrinos, Lorentz invariance violation and non-standard neutrino interactions. JUNO's design allows for future upgrades, such as loading the scintillator with Xe or Te, to enable neutrinoless double-beta decay searches.
JUNO's detector construction began in 2014 and is currently in the commissioning phase, with liquid scintillator filling underway. The experiment is on track to commence data collection by summer 2025.

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Contribution ID: **37** Type: **not specified**

Long-Baseline Atom Interferometry

Long-baseline atom interferometry is a promising technique for probing various aspects of fundamental physics, astrophysics and cosmology, including searches for ultralight dark matter (ULDM) and for gravitational waves (GWs) in the frequency range around 1˜Hz that is not covered by present and planned detectors using laser interferometry. The MAGIS detector is under construction at Fermilab, as is the MIGA detector in France. The PX46 access shaft to the LHC has been identified as a very suitable site for an atom interferometer of height $\sim$ 100m, sites at the Boulby mine in the UK and the Canfranc Laboratory are also under investigation, and possible sites for km-class detectors have been suggested. The Terrestrial Very-Long-Baseline Atom Interferometry (TVLBAI) Proto-Collaboration proposes a coordinated programme of interferometers of increasing baselines.

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Contribution ID: **38** Type: **not specified**

Neutrino Theory in the Precision Era

This document summarises discussions on future directions in theoretical neutrino physics, which are the outcome of a neutrino theory workshop held at CERN in February 2025. The starting point is the realisation that neutrino physics offers unique opportunities to address some of the most fundamental questions in physics. This motivates a vigorous experimental programme which the theory community fully supports. A strong effort in theoretical neutrino physics is paramount to optimally take advantage of upcoming neutrino experiments and to explore the synergies with other areas of particle, astroparticle, and nuclear physics, as well as cosmology. Progress on the theory side has the potential to significantly boost the physics reach of experiments, as well as go well beyond their original scope. Strong collaboration between theory and experiment is essential in the precision era. To foster such collaboration, we propose to establish a CERN Neutrino Physics Centre. Taking inspiration from the highly successful LHC Physics Center at Fermilab, the CERN Neutrino Physics Centre would be the European hub of the neutrino community, covering experimental and theoretical activities.

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Contribution ID: **39**   Type: **not specified**

Clarifications for the Israeli Input for ESG

This document contains clarifications for the Israeli input for ESG. It is a summary of answers to specific questions, following the ECFA guides document.

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Contribution ID: **40** Type: **not specified**

The Linear Collider Facility (LCF) at CERN

In this paper we outline a proposal for a Linear Collider Facility as the next flagship project for CERN.
This proposal offers the opportunity for a timely, cost-effective and staged construction of a new collider that will be able to comprehensively map the Higgs boson's properties, including the Higgs field potential, thanks to a large span in centre-of-mass energies and polarised beams.
A comprehensive programme to study the Higgs boson and its closest relatives with high precision requires data at centre-of-mass energies from the Z pole to at least 1 TeV. It should include measurements of the Higgs boson in both major production mechanisms, ee -> ZH (Higgs-strahlung) and ee -> vvHH (WW fusion), precision measurements of gauge boson interactions as well as of the W boson, Higgs boson and top-quark masses, measurement of the top-quark Yukawa coupling through ee -> ttH, measurement of the Higgs boson self-coupling through HH production, and precision measurements of the electroweak couplings of the top quark. In addition, ee collisions offer discovery potential for new particles complementary to HL-LHC.
The facility we propose robustly satisfies these scientific goals.
With a total length of 33.5 km, two interaction regions as well as additional R&D and fixed-target experiments, it offers significant flexibility to take into account scientific and strategic developments.
From today's perspective, we propose to equip the Linear Collider Facility in a first stage with superconducting RF cavities for polarised ee collisions at a centre-of-mass energy of 250 GeV with a luminosity of 2.7×10^{34} cm^{-2}s^{-1}, which requires an investment of about 8.3 BCHF.
With a preparatory phase of six years, followed by ten years of construction, this first stage could start data-taking by 2042.
First upgrades comprise doubling of the luminosity for 0.8 BCHF and an increase of energy up to at least 550 GeV, which can be achieved with the same accelerator technology for about 5.5 BCHF.
Later stages will involve further increase of luminosity and energy as well as other new capabilities that will further enhance the Higgs programme and extend the discovery potential for new physics.
These upgrades will primarily be accomplished by accelerator technology innovations rather than by additional civil construction.

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Contribution ID: **41** Type: **not specified**

Input to the European Strategy for Particle Physics - 2026 update by the Czech particle physics community

This document presents the strategic priorities of the Czech particle physics community in response to the European Strategy Group's key questions. It outlines the near-term commitment to the High-Luminosity Large Hadron Collider (HL-LHC) upgrade, evaluates the preferred path for the next-generation collider, and discusses broader research directions beyond the main collider program.

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Contribution ID: **42** Type: **not specified**

Early Career Researcher Input to the European Strategy for Particle Physics Update —Fifty-five recommendations for the future of our field

This document, written by early career researchers (ECRs) in particle physics, aims to represent the perspectives of the European ECR community and serves as input for the 2025–2026 update of the European Strategy for Particle Physics. With input from a community-wide survey, it highlights key challenges faced by ECRs —career stability, funding access and long-term research opportunities —while proposing policy recommendations and targeted initiatives. It underscores the importance of practices fostering diverse, equitable, inclusive and healthy workplaces, as well as of stronger ECR communities, and highlights how effective communication and interdisciplinary collaborations reinforce the societal relevance of particle physics and promote continued support for large-scale and long-term projects. Finally, the future of both collider and beyond-collider experiments is addressed, emphasising the critical role of ECRs in shaping future projects.
The ECR contribution is formed of two parts: this ten-page executive summary submitted as input to the European Strategy for Particle Physics Update and, as backup document, an extended white paper providing additional context.

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Contribution ID: **43** Type: **not specified**

REDTOP: Rare Eta Decays TO Explore New Physics

REDTOP will undertake an unprecedented experimental effort to search for Beyond Standard Model (BSM) physics by studying rare decays of the η and η' mesons. Strong theoretical motivations exist to explore New Physics in the MeV to GeV range.
The η and η' mesons are unique particles as they carry no standard model charges, a property shared only by the Higgs boson and the vacuum. The mesons also possess the same quantum numbers as he Higgs (except for parity). Since New Physics is also expected to be neutral under Standard Model charges, an η/η' factory is an excellent
laboratory for studying rare processes and BSM physics at low energy.

The REDTOP experiment is designed to explore violations of fundamental symmetries and search for new particles and fields in the MeV to GeV energy range.
The experiment focuses of producing an η and η' sample that is five orders of magnitude larger than the existing world sample, using high-intensity proton or pion beams with energies of a few GeV.
REDTOP aims to improve the sensitivity of key physics conservation laws by several orders of magnitude beyond previous experiments by exploring η and η' processes with branching ratios as low as $\sim 10^{-12}$.

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Contribution ID: **44** Type: **not specified**

Proposal for a shared transverse LLP detector for FCC-ee and FCC-hh and a forward LLP detector for FCC-hh

As the particle physics community has explored most of the conventional avenues for new physics, the more elusive areas are becoming increasingly appealing. One such potential region, where new physics might be hiding, involves light and weakly interacting long-lived particles (LLPs). To probe deeper into this region, where the possibility of highly displaced scenarios weakens the role of general-purpose collider detectors, dedicated LLP detectors are our best option. However, their potential can only be fully realized if we optimize their position and dimensions to suit our physics goals. This is possible at the upcoming Future Circular Collider (FCC) facility, where the feasibility and design studies are still ongoing and can accommodate new proposals focused specifically on LLP searches. We propose optimized dedicated detectors in both the transverse and forward directions, significantly enhancing the sensitivity to previously unchartered regions of the new physics parameter space. Our proposed DELIGHT detector can additionally serve as a shared transverse detector during both the FCC-ee and FCC-hh runs. The concept of a shared transverse detector is novel and sustainable, utilizing the proximity of the interaction points of the lepton and hadron colliders at the FCC. This minimizes costs and boosts the LLP physics case at FCC. Furthermore, we emphasize the impact of our proposed forward detector, FOREHUNT, along the FCC-hh beam pipe, in probing LLPs from meson decays.

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Contribution ID: **45** Type: **not specified**

Portuguese HEP community input to the update of the European Strategy for Particle Physics

Following the European Strategy Group's call for national contributions to update the European Strategy for Particle Physics, the Portuguese community of particle physicists collaborated with its national representatives at the CERN Council and ECFA to organise the process for preparing the Portuguese input. This document was prepared in a collaborative way and reflects the position of the Portuguese High Energy Physics community.

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Contribution ID: **46** Type: **not specified**

Search for feebly interacting particles with the Lohengrin experiment at the ELSA accelerator

An interesting family of extensions to the Standard Model features new, light particles that interact only feebly with the SM sector. A prominent example are models that aim to explain dark matter with the existence of a dark sector. A feeble coupling between the dark sector and the SM is established by introducing a kinetic mixing term between the SM photon and a new massive vector portal, the dark photon, in the Lagrangian. In these models, dark photons can be produced in a process that is similar to SM bremsstrahlung by shooting a beam of electrons at a fixed target. The radiation of a dark photon would cause the incoming electron to lose a significant fraction of its energy in the process. The dark photon could escape the experiment undetected, provided that its mass is high enough to enable its decay into two dark matter particles. The Lohengrin experiment is an experiment that is to be set up at the ELSA accelerator in Bonn, exploiting the unique ability of the accelerator to produce extremely clean events at an exceedingly high rate. Lohengrin is projected to provide sensitivity to a dark sector with the mixing term as small as necessary to explain the relic amount of dark matter in the universe for scalar, Majorana and Pseudo-Dirac dark matter particles and dark photon masses of a few MeV and above, so far uncovered by existing experiments. The realization of the experiment requires the finalization of short-term silicon detector R&D to enable data taking at the necessary event rate. An AI-engine driven track trigger, in combination with a high rate-capable tracking detector and a reasonably sized set of fast calorimeters will enable the full physics potential of the experiment. This extends beyond light dark matter models to any models with one or more particles that couple feebly to the electron.

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Contribution ID: **47** Type: **not specified**

Input of Ukraine to the 3rd Update of the European Strategy for Particle Physics

The discovery of the Higgs boson at the LHC confirmed the validity of the Standard Model (SM) across a broad range of energies. However, the SM remains incomplete as it does not incorporate gravity, explain neutrino masses, or address dark matter, highlighting the need for a more comprehensive theory that ongoing and future accelerator-based research aims to uncover. In this regard, a new European Strategy for Particle Physics (ESPP) should be developed. This document represents the input to ESPP-2026 from researchers at institutes of the National Academy of Sciences and National Universities of Ukraine as well as members of Ukrainian scientific diaspora. The research groups in Ukraine are making innovative contributions across various areas, including the development of new detector systems and beam collimation techniques, experimental studies, the advancement of theoretical models for interpreting experimental results, and the modernization of computing and software for data analysis. They also place great emphasis on training young talented researchers, leading to the creation of various educational programs. Ukrainian researchers actively participate in LHC experiments (ALICE, LHCb, CMS), non-LHC projects (SHIP, ISOLDE), CERN R&D programs (CLIC), and international collaborations such as SuperNEMO, DUNE, Belle-II, DESY, and FAIR. In this context, the Future Circular Collider (FCC) project offers a broad energy range for exploring physics beyond the SM, ensures long-term research continuity, fosters technical innovation, and presents significant collaboration opportunities. Given this background, there is strong confidence that Ukrainian scientists will make valuable contributions to future precision measurements and searches for signatures of New Phenomena.

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Contribution ID: **48** Type: **not specified**

Particle Data Group Input to European Strategy for Particle Physics Update

The Particle Data Group's (PDG) Review of Particle Physics is used pervasively throughout particle physics. This document summarizes the organization and funding of the international PDG collaboration with an emphasis on European contributions, provides usage statistics, and discusses the input received from the user community in a comprehensive survey carried out in 2022. In order to ensure continued availability of the Review of Particle Physics, it is important that European contributions to the PDG are maintained.

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Contribution ID: **49** Type: **not specified**

High Performance and Cost Effective Superconducting Accelerator Magnet R&D at IHEP

High-field superconducting accelerator magnets are pivotal components for next-generation high-energy accelerators such as the Super Proton-Proton Collider (SPPC) and the Future Circular Collider (FCC-hh). Enhancements in field strength are directly correlated with increases in center-of-mass energy, as well as reductions in size and cost of the accelerators. Initiated in 2014, the Institute of High Energy Physics (IHEP) has focused its research and development (R&D) endeavors on high-field superconducting magnet technology, addressing critical scientific and technical challenges. The goal is to achieve a dipole field exceeding 20 T (Tesla) by the 2030s, while maintaining a field quality of 10-4 and feasible costs for mass production. The R&D activities span three primary dimensions: 1. Advancement of high-performance, cost-effective High-Temperature Superconductors (HTS): The research is directed towards novel fabrication techniques and mechanisms that yield advanced HTS materials with superior overall performance suitable for high-field applications, particularly increasing the current-carrying capacity (Je) and mechanical properties of both Iron-Based Superconductors (IBS) and REBCO (Rare Earth Barium Copper Oxide) wires. 2. Development of compact, high-current HTS cables: Exploration of innovative structures and manufacturing processes for HTS superconducting cables suitable for using in accelerator magnets. 3. Exploration of novel technologies for high-field superconducting magnets: advanced coil structures, stress management strategies, and quench protection methods, particularly for the progression of HTS and high-field model magnets characterized by incremental improvements in field strength, field quality, and operational stability.

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Contribution ID: **50** Type: **not specified**

Searching for Light Dark Matter and Dark Sectors with the NA64 experiment at the CERN SPS

Since its approval in 2016, NA64 has pioneered LDM searches with electron 1, positron [2], muon [3], and hadron [4] beams. The experiment has successfully met its primary objectives, as outlined in the EPPS input (2018), and even exceed them producing results that demonstrate its ability to operate in a near-background-free environment. The Physics Beyond Collider (PBC) initiative at CERN recognize NA64's contributions as complementary and worthy of continued exploration. Its key advantage over beam-dump approaches is that the signal rate scales as $(\text{coupling})^2$ rather than $(\text{coupling})^4$, reducing the required beam particles for the same sensitivity.

To fully exploit the NA64 physics potential, an upgrade during LS3 will enable NA64 to run in background-free mode at higher SPS beam rates. Planned upgrades include (a) improved detector hermeticity with a new veto hadron calorimeter, (b) enhanced particle identification with a synchrotron radiation detector, and (c) increased beam rates via upgraded electronics.

With the recently strengthened NA64 collaboration, stable operations and timely data analysis are planned for LHC Run 4. The expected $\sim 10^{13}$ electrons, $\sim 10^{11}$ positrons (40 and 60 GeV), and $\sim 2 \times 10^{13}$ muons on target will allow NA64 to explore new light dark matter regions, with the potential for discovery or conclusive exclusion of many well-motivated LDM models.

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Contribution ID: **51** Type: **not specified**

Ultra-relativistic Heavy-Ion Collisions: Inputs of the Italian community for the ESPP 2026

This document has been prepared by the community that is active in Italy, within INFN (Istituto Nazionale di Fisica Nucleare), in the field of ultra-relativistic heavy-ion collisions. The experimental study of the phase diagram of strongly-interacting matter and of the Quark–Gluon Plasma (QGP) deconfined state will proceed, in the next 15–20 years, along two directions: the high-energy regime at the HL-LHC, and the low-energy regime at FAIR, NICA and SPS. The Italian community is strongly involved in the present and future programme of the ALICE experiment. A number of fundamental questions will remain open after the LHC Run 4: in order to address these questions and fully exploit the unique LHC potential for this physics the new detector ALICE 3 will enable, in the late 2030s, novel studies of the QGP using, among others, multi-differential measurements of heavy-flavour hadron and thermal dileptons. In addition, there is a growing interest in a possible future experiment at the SPS, which would primarily target the search for the onset of deconfinement using dimuon measurements. The strong expertise of the community in detector development and construction, in particular in the sector of low-material silicon trackers and particle identification constitutes a common basis for these new projects at the LHC and SPS. On a longer timescale, the community expresses interest for a heavy-ion programme at the Future Circular Collider.

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Contribution ID: **52** Type: **not specified**

The Astro-particle Physics Commission 2

This document contains some initial input from INFN Commission 2 on Astro-particle Physics (CSN2) for the update of the European Strategy for Particle Physics. It is not intended to provide a comprehensive overview of CSN2 activities or to cover all possible relevant aspects of the Strategy: this will be defined with other stakeholders during the update process in February 2024. The goal is to emphasize CSN2 activities that are or could be related soon to particle physics programs and CERN activities, one way or the other. CERN is already giving important contributions to the neutrino (neutrino platform), gravitational waves (ET) and cosmic ray physics (beam tests and ground segments of space missions). On the other hand, CERN could also benefit from opening to astro-particle physics issues by enlarging its scope and taking advantage of the synergies between astro-particle ad particle physics searches. We conclude with a short section devoted to some proposals for active CERN involvement in astroparticle physics programs.

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Contribution ID: **53** Type: **not specified**

P-ONE: The Pacific Ocean Neutrino Experiment A Next-Generation Deep-Sea Neutrino Detector for Fundamental Physics

The Pacific Ocean Neutrino Experiment (P-ONE) is a next-generation neutrino observatory planned for deployment in the deep Pacific Ocean off the coast of Canada. By detecting high-energy (up to the PeV scale) and ultra-high-energy (above the PeV scale) cosmic neutrinos with unprecedented sensitivity and resolution, P-ONE will probe extreme cosmic environments—such as those powered by black holes—where particle physics and gravity converge. P-ONE capitalizes on Ocean Networks Canada's (ONC) world-class infrastructure to establish a stable, long-term, deep-sea platform for neutrino detection. Its innovative architecture, in which each detection line functions as a fully integrated unit, enables precise event reconstruction, continuous calibration, and seamless multi-messenger synergy with observatories such as IceCube, KM3NeT, Baikal-GVD, and gravitational-wave detectors. In addition to advancing fundamental physics, P-ONE integrates oceanographic instrumentation to monitor environmental parameters over long time baselines, supporting marine and climate sciences. With strong international collaboration, European and Canadian institutional leadership, and a phased deployment strategy, P-ONE is poised to become a key pillar in the future of high-energy neutrino astro-particle physics. Its inclusion in the European Particle Physics Strategy Update would consolidate Europe's leadership in neutrino and cosmic messengers research, ensure P-ONE's pivotal role in addressing fundamental questions about our Universe, and enhance the resilience of neutrino studies against present and future geopolitical challenges.

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Contribution ID: **54** Type: **not specified**

Grenoble Axion Haloscopes: From BabyGrAHal to GrAHal for axion dark matter search in the 1-150 micro-eV mass range

Particle physics is not only confined to the high energy frontier. There are unexplored territories at ultra-low energies, i.e. sub-eV, which are also promising for major discoveries. The emblematic particle for this physics is the axion, a pseudo-scalar particle predicted to solve the fundamental problem of the apparent non-violation of the CP symmetry by the strong interaction. This constitutes one of the remaining sand grains in the gear of the standard model of particle physics. Standard axion at the electroweak scale has been excluded after extensive searches, leaving fully open the case of almost invisible axion, i.e. with mass and coupling extremely weak. This particle could also be the main dark matter component of our universe and is one of the rare non-supersymmetric leading candidates. A collaboration between three main laboratories of CNRS, Université Grenoble-Alpes and CAPP in South Korea (now DMAG/IBS) is bringing together key expertises to build and operate several haloscopes for Axion searches with unprecedented sensitivity. Based on existing infrastructures at Grenoble like the 43T/9T modular hybrid magnet of LNCMI recently put in operation at 42 T as a first step, the technological know-hows of Institut Néel to develop novel quantum detectors and amplifiers together with ultralow temperature cryogenics (< 50 mK) and of CAPP for RF cavities, GrAHal will reach beyond state-of-the art sensitivities focusing first to uncharted regions in the 1-150 micro-eV axion mass range. A collaboration with CERN regarding RF cavity technologies is also currently being explored.

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Contribution ID: **55** Type: **not specified**

Kaon Physics: A Cornerstone for Future Discoveries

The kaon physics programme, long heralded as a cutting-edge frontier by the European Strategy for Particle Physics, continues to stand at the intersection of discovery and innovation in high-energy physics (HEP). With its unparalleled capacity to explore new physics at the multi-TeV scale, kaon research is poised to unveil phenomena that could reshape our understanding of the Universe.
This document highlights the compelling physics case, with emphasis on exciting new opportunities for advancing kaon physics not only in Europe but also on a global stage. As an important player in the future of HEP, the kaon programme promises to drive transformative breakthroughs, inviting exploration at the forefront of scientific discovery.

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Contribution ID: **56** Type: **not specified**

PERLE : an ERL facility for future sustainable colliders (LHeC, FCC)

Energy recovery linacs (ERLs) have been emphasized by the 2020 update of the European Strategy for Particle Physics as one of the most promising technologies for the accelerator base of future high-energy physics. Their unique combination of bright, linac-like beam quality with high average current and extremely flexible time structure, excellent operating efficiency, and compact footprint opens the door to previously unattainable performance regimes.
The present contribution advertises the PERLE project, in construction at Orsay, as a critical milestone in the development of ERLs. It is specifically designed to validate choices for a 50 GeV ERL envisioned in the design of the Large Hadron Electron Collider (LHeC) and, potentially, for the Future Circular Collider (FCC-eh).
In addition, PERLE will provide a high-energy (~ 150 keV) X-ray source through the inverse Compton scattering process thanks to a high-finesse Fabry-Perot optical cavity. Moreover, PERLE could host unique experiments in nuclear physics by studying electron-nucleus interactions with radioactive nuclei.
The implementation will operate in a first phase (~ 2029) in a single-turn mode reaching an energy of 89 MeV followed by a second phase (~ 2031) with three turns to achieve a 5 MW beam power at 250 MeV.
After the 3-turn demonstration phase, PERLE could become a Test Facility for Future Accelerator and System aimed at improving their energy efficiency and in particular for validating and testing the 800-MHz cryomodules for FCC.
The installation of a second cryomodule to reach 500 MeV energy and 10 MW beam power is considered further in time, as an option requiring an important upgrade of the facility.

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Contribution ID: **57** Type: **not specified**

HALHF: a hybrid, asymmetric, linear Higgs factory using plasma- and RF-based acceleration

HALHF is a hybrid linear collider that uses electron-driven plasma-wakefield acceleration to accelerate electrons to high energy while using radio-frequency cavity technology to accelerate positrons. The most cost-effective solution collides low-energy positrons with high-energy electrons, producing a boost to the final state in the electron direction with $\gamma = 1.67$. The current HALHF baseline design produces a luminosity comparable to that of the baseline ILC but with a greatly reduced construction and carbon footprint and hence much lower cost than the mature linear-collider designs ILC and CLIC. Costs for HALHF are evaluated, together with that for the approximate 15-year R\&D programme necessary to realise HALHF. Time scales and cost for the R\&D are estimated. Upgrade paths for HALHF technology from a 250˜GeV Higgs factory, through 380 and 550˜GeV, up to 10˜TeV are sketched.

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Contribution ID: **58** Type: **not specified**

Spanish astroparticle community input to the European Strategy Group

This document summarises the view of the Spanish astroparticle community for the 2026 update of the European Strategy for Particle Physics (ESPP).
The contribution was prepared by representatives of three national astroparticle networks: RENATA (National Network on Astroparticles), MultiDark (Multimessenger Approach for Dark Matter Detection), and RedONGRA (Spanish Network on Gravitational Waves).
These networks together represent the Spanish astroparticle physics community, composed of both experimental and theoretical groups from 27 institutions across Spain. The entire community contributed to the ideas presented in this document during a meeting held on October 8–9, 2024. A draft of the document was then prepared and circulated among the participating institutions, and it was further discussed at the CPAN (Centro Nacional de Física de Partículas, Astropartículas y Nuclear) annual workshop, held on November 19–21, 2024.

Authors: SOPUERTA, Carlos (ICE-CSIC); PALOMARES, Carmen (CIEMAT); MARTINEZ PEREZ, Maria (Universidad de Zaragoza (ES)); SOREL, Michel (IFIC); SANCHEZ-CONDE, Miguel Angel (IFT-UAM)

Contribution ID: **59** Type: **not specified**

Croatian national input to European Strategy for Particle Physics 2026 update

The Croatian high-energy physics community convened at the Faculty of Science of the University of Zagreb on February 18, 2025, to discuss its contributions to the third update of the European Strategy for Particle Physics. The meeting marked a critical step in shaping Croatia's input to the update process, which is summarized in this document.

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Contribution ID: **60** Type: **not specified**

The Critical Role of Particle Physics Education and Outreach

This document provides input concerning Education and Outreach for the open call for the European Strategy for Particle Physics Update (ESPPU) 2026. It addresses new and increasing challenges since ESPPU 2020, and emphasises the need to expand and diversify global Outreach programmes. This necessity is driven not only by our community's desire to develop critical new long-term, large-scale infrastructure projects but also by the desire to counteract growing worldwide efforts to undermine public trust in scientific research.

The content has been written and assembled by active members of the International Particle Physics Outreach Group (IPPOG), an international collaboration comprising 42 signing members (countries, laboratories, experiments).

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Contribution ID: **61** Type: **not specified**

MATHUSLA: An External Long-Lived Particle Detector to Maximize the Discovery Potential of the HL-LHC

We present the current status of the MATHUSLA (MAssive Timing Hodoscope for Ultra-Stable neutraL pArticles) long-lived particle (LLP) detector at the HL-LHC, covering the design, fabrication and installation at CERN Point 5. MATHUSLA40 is a 40 m-scale detector with an air-filled decay volume that is instrumented with scintillator tracking detectors, to be located near CMS. Its large size, close proximity to the CMS interaction point and about 100 m of rock shielding from LHC backgrounds allows it to detect LLP production rates and lifetimes that are one to two orders of magnitude beyond the ultimate reach of the LHC main detectors. This provides unique sensitivity to many LLP signals that are highly theoretically motivated, due to their connection to the hierarchy problem, the nature of dark matter, and baryogenesis. Data taking is projected to commence with the start of HL-LHC operations. We summarize the new 40m design for the detector that was recently presented in the MATHUSLA Conceptual Design Report, alongside new realistic background and signal simulations that demonstrate high efficiency for the main target LLP signals in a background-free HL-LHC search. We argue that MATHUSLA's uniquely robust expansion of the HL-LHC physics reach is a crucial ingredient in CERN's mission to search for new physics and characterize the Higgs boson with precision.

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Contribution ID: **62** Type: **not specified**

INFN National Committee for Particle Physics (CSN1): Input to the European Strategy for Particle Physics Update

This document represents the input of INFN CSN1 to the European Strategy for Particle Physics Update. CSN1 (Commissione Scientifica Nazionale 1) is the INFN scientific committee in charge of reviewing, monitoring, and supporting particle physics experiments and projects at accelerators. The projects supported on the mid-term, in construction or approved, are briefly described, followed by future colliders projects. The CSN1 vision for the next strategy is presented.

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Contribution ID: **63** Type: **not specified**

Input from the SND@LHC collaboration to the 2026 Update to the European Strategy for Particle Physics

By observing collider neutrino interactions of different flavours, the SND@LHC and Faserν experiments have shown that the LHC can make interesting contributions to neutrino physics. This document summarizes why the SND@LHC Collaboration intends to continue taking data at the High Luminosity LHC (HL-LHC).

The upgraded detector will instrument the regions of both the neutrino vertex and the magnetized calorimeter with silicon microstrips. The use of this technology will allow us to continue the physics program of the current SND@LHC detector with higher statistics. It will also offer new possibilities. For instance, the magnetization of the hadron calorimeter will enable the separation between neutrinos and antineutrinos. This could lead to the first direct observation of tau antineutrinos.

The use of ultrafast timing layers will enable triggers to be sent to ATLAS, potentially allowing the identification of the charm quark pair that produced the neutrino interacting in the detector. Such tagging of the neutrino source would fulfill Pontecorvo's original proposal of a tagged neutrino beam. The experiment will perform unique measurements with high energy neutrinos and will also provide a means to measure gluon parton distribution functions in a previously unexplored domain (Bjorken-$x < 10^{-5}$).

Furthermore, the technological advancements of the upgrade and the experience that will be gained in the areas of operation and data analysis will play a crucial role in the design of the neutrino detector for the SHiP experiment.

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Contribution ID: **64** Type: **not specified**

Swiss inputs to the 2026 update of the European Strategy for Particle Physics (ESPP)

This document summarizes the Swiss inputs to the 2026 update of the European Strategy for Particle Physics (ESPP), compiled by CHIPP, the Swiss Institute for Particle Physics. Building on the "CHIPP Community Roadmap 2024,"which outlined national research infrastructure needs, a series of workshops were held to develop consensus on the strategy. The resulting responses were finalized and approved by the CHIPP board in March 2025.

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Contribution ID: **65** Type: **not specified**

Accelerator R&D proposals by INFN

The study of the next accelerator at CERN is fundamental to the future of European particle physics, as highlighted in the INFN National Input document. Within the current ESPP, INFN has already provided substantial support to the particle accelerator R&D program through various initiatives relating to the general design of the Future Circular Collider (FCC) and the muon collider, as well as to advanced and less specific technologies. This document summarizes these ongoing activities and new ones, all of which INFN considers to be of crucial importance for the next ESPP, and which it intends to develop in collaboration with CERN and other European partners. These include improvement of superconducting radiofrequency cavities (both bulk-Nb and thin-film coated), higher-field superconducting magnets for colliders and detectors, machine–detector interface studies for FCC-ee and the muon collider, design of the FCC-ee-injector damping ring, FCC collective effects studies and beam pipe material testing. High-efficiency novel positron sources based on oriented crystals, enhanced RF coupling window designs and AI support in accelerator setup and operation are also planned, being not less important for several schemes of future colliders and for FCC. Finally, emphasis is put on developments for plasma-based colliders, a theme strongly connected to the EuPRAXIA project which is being exploited in Frascati.

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Contribution ID: **66** Type: **not specified**

Empowering particle physics beyond discoveries: a unified European communication strategy for the next generation research infrastructures

Our society is experiencing a delicate historical moment, marked by critical issues and global challenges that are often interdependent. At the same time, the European particle physics community is facing decisive choices that will shape the future of research in the field and must ensure Europe's long-standing leadership in one of the most cutting-edge scientific sectors. In this complex context, science communication—particularly particle physics communication—plays a crucial role, both for society and for the advancement of research.
To meet this responsibility, CERN and the European National Institutes must make a shared and coordinated commitment to ensuring that science and science communication are as effective as possible.
Building on these premises, INFN Communication Office would like to propose a set of strategic recommendations for communicating European particle physics: strengthening a European common vision and strategy for science communication, supported by a strong coordination, to more effectively implement joint initiatives; shifting the narrative in science and physics communication, expanding the focus beyond groundbreaking discoveries to include the scientific method, research processes, personal stories, and the daily work of scientists; enhancing the role of research infrastructures as valuable assets not only for science but also for society and communication – promoting both large international facilities like CERN and national laboratories that contribute to CERN's mission; recognizing institutionally and funding adequately science communication, ensuring the necessary human and financial resources to implement these strategic recommendations successfully.
The ultimate goal of these recommendations is to create in Europe a critical mass of research institutions to promote knowledge and science effectively; to increase the engagement of all the stakeholders in scientific research, in its activities, and in its outcomes; to strengthen society's ability to counter misinformation and disinformation; and to raise national awareness of each country' s contributions to the advancement of global science and technology

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Contribution ID: **67** Type: **not specified**

The Critical Importance of Software for HEP

Particle physics has an ambitious and broad global experimental programme for the coming decades. Large investments in building new facilities are already underway or under consideration. Scaling the present processing power and data storage needs by the foreseen increase in data rates in the next decade for HL-LHC is not sustainable within the current budgets. As a result, a more efficient usage of computing resources is required in order to realise the physics potential of future experiments. Software and computing are an integral part of experimental design, trigger and data acquisition, simulation, reconstruction, and analysis, as well as related theoretical predictions. A significant investment in computing and software is therefore critical.

Advances in software and computing, including artificial intelligence (AI) and machine learning (ML), will be key for solving these challenges. Making better use of new processing hardware such as graphical processing units (GPUs) or ARM chips is a growing trend. This forms part of a computing solution that makes efficient use of facilities and contributes to the reduction of the environmental footprint of HEP computing. The HEP community already provided a roadmap for software and computing for the last EPPSU, and this paper updates that, with a focus on the most resource critical parts of our data processing chain.

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Contribution ID: **68** Type: **not specified**

Input from the ALICE Collaboration

The ALICE Collaboration is planning to build a new experimental apparatus, ALICE3, to be installed during Long Shutdown 4, that will ensure the full exploitation, before the end of the HL-LHCoperations, of the unique environment for the study of the quark-gluon plasma (QGP) offered by nuclear collisions at the multi-TeV scale. The very high QGP temperatures, the abundant production of heavy flavours and the very large single-event multiplicities available at the LHC have already provided major inroads in the understanding of the emergent properties of the QGP and opened an era of systematic quantitative measurements of its physical parameters that is well under way for Run 3 and Run 4. The HL-LHC still allows access to a number of new, powerful, but as yet unexplored, experimental observables to understand the approach to thermal equilibrium, measure the temperature of the QGP and its evolution, provide access to fundamental aspects of the phase transition, and to use LHC as a laboratory for hadron physics. In order to make progress in these areas, excellent pointing resolution is required to identify heavy flavour hadrons, including beauty at low pT, multi-charm baryons, and to enable angular and momentum correlation measurements of charm hadrons. Furthermore, lepton and hadron identification are required to obtain clean access to thermal dielectron emission and signatures of chiral symmetry restoration. Large acceptance and high rate capabilities are needed to ensure sufficient coverage for correlation measurements, to map the rapidity dependence of key processes and to ensure sufficient precision for rare probes. Starting from today's state-of-the-art technology, such requirements can be satisfied with a compact experimental apparatus based on silicon sensors, as optimised in the ALICE3 design. Besides ensuring the accomplishment of the HL-LHC QGP physics campaign, the unique features of ALICE3 also offer opportunities for the study of exotic hadrons and searches for BSM particles, such as dark photons and axion-like particles.

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Contribution ID: **69** Type: **not specified**

Future Opportunities with Lepton-Hadron Collisions

Deep Inelastic lepton-hadron Scattering (DIS) is a cornerstone of particle physics discovery and the precision measurement of the structure of matter. This document surveys the international DIS landscape, exploring current and future opportunities to continue this rich heritage, leading to new understandings and enabling discoveries. Of immediate relevance to the future of the field in Europe, the Large Hadron electron Collider (LHeC) offers an impactful bridge between the end of the HL-LHC and the beginning of the next CERN flagship project, both in terms of technology development and new scientific exploration from Higgs physics to the partonic structure of the proton.

More generally, the facilities described here cover centre-of-mass energies from a few GeV to multiple TeV and address a wide range of physics topics, with unique sensitivity to Quantum Chromodynamics and hadron structure at their core. In addition to their stand-alone importance, these topics enhance the precision measurement and new physics search programmes at hadron-hadron colliders.

The very high luminosity fixed-target CEBAF programme that is in progress at Jefferson Laboratory probes nucleon and light ion structure at large x in novel ways, while high energy neutrino DIS is being enabled at the FASER and SND@LHC experiments by the intense LHC beams; both have exciting potential upgrade programmes. The Electron Ion Collider (EIC) is on course for deployment at Brookhaven in the early 2030s, and will provide lepton-nucleus and double-polarised lepton-proton/light-ion collisions for the first time. Its science includes a 3-dimensional mapping of the internal structure and dynamics of hadrons, leading to a thorough understanding of the mechanisms that generate proton mass and spin, whilst establishing accelerator and detector technologies of direct relevance to next-generation facilities. Adding the LHeC provides a Europe-based lepton-hadron frontier. The LHeC extends DIS capabilities to include a complementary Higgs, top and electroweak programme to the HL-LHC, together with precise determinations of proton and nuclear structure in a kinematic range that improves HL-LHC sensitivities. In the longer term, plasma wakefield acceleration and the Future Circular Collider offer different possible pathways for major steps forward in centre-of-mass energy, extending into a low parton momentum-fraction domain where our present understanding fails and new strong interaction discoveries are guaranteed.

This review emerges from the 'DIS and Related Subjects'conference series, which provides an annual focus for the diverse community of scientists involved in Deep Inelastic Scattering, currently estimated to consist of around 3000 experimental and theoretical particle, nuclear and accelerator physicists worldwide.

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Contribution ID: **70** Type: **not specified**

Frontier sensor R&D for the ALICE 3 apparatus

The ALICE Collaboration plans to build a new experimental setup, ALICE3, which will be installed during Long Shutdown 4. This apparatus will maximize the potential of the HL-LHC as a heavy-ion collider by giving access to new and unexplored experimental observables, thereby enabling the investigation of open fundamental questions regarding the quark-gluon plasma and other aspects of the strong interaction. The hallmarks of the ALICE3 physics programme are discussed in a dedicated ESPP input document. They require unprecedented pointing resolution (e.g.about 10 μm at pT = 250 MeV/c), large acceptance (|η| < 4 and pT > 50 MeV/c) and extensive identification capabilities for electrons, hadrons and muons. Thesetup consists of a compact silicon pixel tracker within a new superconducting magnet (2 T), silicon time-of-flight layers, a ring-imaging Cherenkov detector, a muon identification system, an electromagnetic calorimeter, a forward photon conversion tracker, and two forward counting detectors. An intense R&D programme on frontier sensors is well underway. The primary focus of the R&D on Monolithic Active Pixel Sensors for the trackers is on high spatial precision, low material budget, low power consumption, and large-area sensors. A pioneering concept is being pursued for a retractable barrel vertex detector that closes to a minimum radius of 5 mm from the interaction point. For particle identification, R&D is in progress towards ultra-fast timing with silicon sensors for time-of-flight measurement, and towards improving the radiation hardness of silicon photo-multipliers. The target specifications of the ALICE3 silicon sensors are similar to those of detectors at future colliders. The advancements in sensor technologies targeted by the ALICE3 R&D programme constitute a significant milestone in the ECFA strategic roadmap for detector R&D.

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Contribution ID: **71** Type: **not specified**

CERN AD/ELENA Antimatter Program

The CERN AD/ELENA Antimatter program studies the fundamental charge, parity, time (CPT) reversal invariance through high-precision studies of antiprotons, antihydrogen, and antiprotonic atoms. Utilizing the world-unique Antiproton Decelerator (AD) and the Extra Low Energy Antiproton (ELENA) decelerator, the program supports multiple groundbreaking experiments aimed at testing fundamental symmetries, probing gravity with antimatter, and investigating potential asymmetric antimatter/dark matter interactions. Some experiments focus on precision spectroscopy of antihydrogen, while others conduct the most precise tests of CPT invariance in the baryon sector by comparing proton and antiproton properties. Other efforts are dedicated to measure the ballistic properties of antihydrogen under gravity and performing antiproton-based studies of neutron skins in exotic nuclei. These efforts have led to major breakthroughs, including the first trapped antihydrogen, antihydrogen's first gravitational acceleration measurement, and record-breaking precision CPT-tests in the baryon sector.

With continuous advancements in antimatter cooling, trapping, and transport, CERN's program is opening new frontiers in fundamental physics. Future goals, described in this document and reaching to timelines beyond 2040, include further improving the precision of antimatter studies, developing transportable antimatter traps, and advancing our understanding of quantum field theory, gravity, and dark matter interactions. Furthermore, new areas of hadron physics with antiprotons will be explored through studies of the Pontecorvo reaction, antineutron annihilation dynamics and hypernuclei decays. The CERN AD/ELENA Antimatter program remains at the forefront of experimental physics, pushing the limits of precision measurements to unravel the mysteries of the universe.

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Contribution ID: **72** Type: **not specified**

DESY’s role in Europe: A Contribution to the European Particle Physics Strategy Update Process

The Deutsches Elektronen-Synchrotron DESY is Germany’s largest accelerator laboratory, with programmes in particle physics, astroparticle physics and photon science, and with R&D activities in the areas of accelerators, detectors and computing. In particle physics, DESY is a key contributor to experiments at the LHC and at the SuperKEKB collider. The laboratory hosts the ALPS II experiment and plans to use the DESY infrastructure for hosting further axion and strong-field QED experiments. DESY is home to a broad and world-class theory group. The laboratory commands important system competences and infrastructures, including a test beam facility that is used by hundreds of users per year for particle physics experiments. DESY plays the important role of a national hub and facilitator for large-scale German contributions to international particle physics endeavours. The laboratory is also very visibly contributing to efforts for defining the next big collider project in the field. This paper describes DESY’s current scientific programme as a whole, and it elaborates on the strategy for the future development of particle physics at DESY.

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Contribution ID: **73** Type: **not specified**

INFN Input on the update of the European Strategy for Particle Physics: Computing

Computing plays a crucial role in High-Energy Physics experiments and, to deal with the large amount of data that will be collected in the HL-LHC era and beyond, substantial changes are needed both in the software and computing models of the experiments and in the computing infrastructure. The HEP community can't rely only on the current High-Throughput Computing infrastructure and has to take advantage of the large computing power offered by the High-Performance Computing centres that are playing a strategic role in the scientific and industrial innovation in Europe and around the world. These centres, together with the existing Tier-1 and Tier-2 WLCG centres, which are to continue to host data from the experiments, will form the combined computing infrastructure for High-Energy Physics of the future.
In addition, Artificial Intelligence and Quantum Computing are taking on an increasingly important role for High-Energy Physics. Artificial Intelligence tools are required to analyse and fully exploit the physical potential of data and High-Performance Computing centres are ideal structures to handle the workloads massive computational demands. Quantum Computing is still at the level of research and development but is an emergent field of cutting-edge computer science that promises to revolutionize the High-Energy Physics computing horizon. This document presents some input from the INFN National Computing Coordination Steering Committee (C3SN) to the update of the European Strategy for Particle Physics.

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Contribution ID: **74** Type: **not specified**

Charged Lepton Flavour Violations searches with muons: present and future

Charged-lepton flavor violation (cLFV) is one of the most powerful probes for New Physics (NP). Since lepton flavor conservation is an accidental symmetry in the Standard Model (SM), it is naturally violated in many NP models, with contributions at the level of the current experimental sensitivities. Moreover, the negligible SM contributions would make the observation of cLFV unambiguous evidence of NP. It makes these searches extremely sensitive and, at the same time, extremely pure.
Thanks to the intense muon beams currently available, their intriguing upgrade programs, and the progress in the detection techniques, cLFV muon processes are the golden channels in this field. Experimental programs to search for $\mu^+ \to e^+\gamma$, $\mu^+ \to e^+e^+e^-$ and the $\mu \to e$ conversion in the nuclear field are currently ongoing. We review the current status and the strategic plans for future searches.
This document is an update of the prior cLFV submission to the 2018 European Strategy for Particle Physics (ESPP); the earlier submission should be consulted for more experimental details.

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Contribution ID: **75** Type: **not specified**

Future perspectives for $\mu \to e\gamma$ searches

Searches for charged lepton flavor violation in the muon sector stand out among the most sensitive and clean probes for physics beyond the Standard Model. Currently, $\mu^+ \to e^+\gamma$ experiments provide the best constraints in this field and, in the coming years, new experiments investigating the processes of $\mu^+ \to e^+e^+e^-$ and $\mu \to e$ conversion in the nuclear field are anticipated to surpass them. However, it is essential to maintain comparable sensitivities across all these processes to fully leverage their potential and differentiate between various new physics models if a discovery occurs. In this document, we present ongoing efforts to develop a future experimental program aimed at improving the sensitivity of $\mu^+ \to e^+\gamma$ searches by one order of magnitude within the next decade.

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Contribution ID: **76** Type: **not specified**

Input on the update of the European Strategy for Particle Physics by the INFN Nuclear and Hadron Phyiscs Community

This document contains input from the INFN Nuclear and Hadron Physics Commission 3 (CSN3) to the ongoing development of INFN contributions to the update of the European Strategy for Particle Physics. The medium-term strategy for Nuclear and Hadron Physics at the Italian National Laboratories has been the subject of an extensive review in 2022, involving the whole Italian CSN3 scientific community https://web.infn.it/nucphys-plan-italy/. The conclusions have been structured in a set of comprehensive papers published in
EPJPlus https://epjplus.epj.org/component/toc/?task=topic&id=1894. Moreover, the strategic vision of the European Hadron and Nuclear Physics community has recently undergone an extensive reflection process, in the framework of the development of the NUPECC Long Range Plan (LRP). The NUPECC 2024 LPR is the result of a process of more than a year, which has involved the whole European Scientific community in Nuclear and Hadron Physics and their applications, and it has been publicly presented in Brussels on Nov 19th, 2024. The INFN scientists of CSN3 have very actively participated in the organization, writing and discussing of the NUPECC LRP, which therefore embeds the vision for the future of our community. More information can be found in https://www.nupecc.org/?display=lrp2024/main
Here, we will report a few points which are important for the Italian Nuclear and Hadron Physics Scientific community.

Author: THE INFN NATIONAL SCIENTIFIC COMMITTEE FOR NUCLEAR AND HADRON PHYSICS

Contribution ID: **77** Type: **not specified**

A Silicon-Tungsten ECAL for Higgs Factory Detectors

A highly granular electromagnetic calorimeter, based on silicon sensors associated with tungsten absorbers (SiW-ECAL), is proposed for the Higgs-Factory detectors, based on Particle Flow approach such as the ILD, the SiD, CEPC baseline, or the CLD. The concept has been developed considering all the technical, instrumental, and construction constraints for linear colliders, backed-up on tested small prototypes.
Work has started on the adaptation to circular collider operations, on the evaluation of adding a timing dimension or dedicated layers, and on reaching ultra-granularity using MAPS as sensors.

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Contribution ID: **78** Type: **not specified**

The Compact Linear e^+e^- Collider (CLIC)

The Compact Linear Collider (CLIC) is a TeV-scale high-luminosity linear e^+e^- collider studied by the international CLIC and CLICdp collaborations hosted by CERN. CLIC uses a two-beam acceleration scheme, in which normal-conducting high-gradient 12 GHz accelerating structures are powered via a high-current drive beam. For an optimal exploitation of its physics potential, CLIC is foreseen to be built and operated in stages. The initial stage will have a centre-of-mass energy of 380 GeV, with a site length of 11 km. The 380 GeV stage optimally combines the exploration of Higgs and top-quark physics, including a top threshold scan near 350 GeV. A higher-energy stage, still using the initial single drive-beam complex, can be optimised for any energy up to 2 TeV. Parameters are presented in detail for a 1.5 TeV stage, with a site length of 29 km. Since the 2018 ESPPU reporting, significant effort was invested in CLIC accelerator optimisation, technology developments and system tests, including collaboration with and gaining experience from new-generation light sources and free-electron lasers. CLIC implementation aspects at CERN have covered detailed studies of civil engineering, electrical networks, cooling and ventilation, scheduling, and costing. The CLIC baseline at 380 GeV is now 100 Hz operation, with a luminosity of 4.5×10^{34} $cm^{-2}s^{-1}$ and a power consumption of 166 MW. Compared to the 2018 design, this gives three times higher luminosity-per-power. The new baseline has two beam-delivery systems, allowing for two detectors operating in parallel, sharing the luminosity.The cost estimate of the 380\,GeV baseline is approximately 7.17 billion CHF. The construction of the first CLIC energy stage could start as early as 2033 and first beams would be available by 2041, marking the beginning of a physics programme spanning 20-30 years and providingexcellent sensitivity to Beyond Standard Model physics, through direct searches and via a broad set of precision measurements of Standard Model processes, particularly in the Higgs and top-quark sectors. This report summarises the CLIC project, its implementation and running scenarios, with emphasis on new developments and recent progress. It concludes with an update on the CLIC detector studies and on the physics potential in light of the improved accelerator performance. The physics potential includes results from the 3 TeV energy stage, which was studied in detail for the CLIC CDR in 2012 and the CLIC Project Implementation Plan of 2018.

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Contribution ID: **79** Type: **not specified**

Ensuring continued operation of INSPIRE as a cornerstone of the HEP information infrastructure

The INSPIRE platform —the most widely-used discovery service specifically tailored to the needs of researchers in High Energy Physics (HEP) —has become a central component of the information infrastructure for the discipline. Despite this, INSPIRE's continued sustainability is frequently endangered by resource constraints, recently made more acute by the loss of support from historical funders changing their research priorities. If the European particle physics community wishes to ensure INSPIRE's long-term sustainability, the community should secure international support and ensure appropriate funding.

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Contribution ID: **80** Type: **not specified**

INFN - Gran Sasso National Laboratory - Input for the European Particles Physics Strategy

In the panorama of Astroparticles Physics, Deep Underground Laboratories (DULs) play a key role in characterizing astronomical particles sources, elementary particles properties and stellar nuclear reactions. The main mission of DULs in particle physics is to enable world-class science that requires low-background environment. In that sense LNGS is considered as the leading laboratory in the world for Particle and Astroparticle Physics and it also supports and coordinate activities with many other DULs in Europe. In the document the strategic plan of LNGS for future experiments in particles physics is reported with some emphasis for the connections between research activities in astroparticles physics, in DULs, and in experiments at colliders.

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Contribution ID: **81** Type: **not specified**

Discovery potential of LHCb Upgrade II

A second major upgrade of the LHCb detector is necessary to allow full exploitation of the HL-LHC for flavour physics. The new detector will be installed during long shutdown 4 (LS4), and will operate at instantaneous luminosity up to $1.5 \times 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$. By upgrading all subsystems and adding new detection capability it will be possible to accumulate a sample corresponding to an integrated luminosity of at least $300\,\mathrm{fb}^{-1}$ of high energy pp collision data, giving unprecedented and unique scientific opportunities in flavour physics, in electroweak physics, in searches for new feebly interacting particles and in hadron spectroscopy. In this document, the potential of the LHCb Upgrade II detector to enable major discoveries through increased sensitivity to a range of as-yet unknown phenomena is summarised.

Authors: PUNZI, Giovanni (Pisa University and INFN); GERSHON, Timothy (University of Warwick (GB)); VAGNONI, Vincenzo (INFN Bologna (IT))

Contribution ID: **82**   Type: **not specified**

Heavy ion physics with LHCb Upgrade I

A second major LHCb detector upgrade will be installed during long shutdown 4 (LS4) of the CERN Large Hadron Collider. The new detector will provide excellent performance for studies of Quantum Chromodynamics at high temperature and density, as achieved in collisions of heavy nuclei. The high granularity of the tracking system will allow lead-lead collisions to be reconstructed across the full range of centrality at far forward rapidity for the first time. Moreover, the forward acceptance of the detector, covering the pseudorapidity region close to the beamline, and the capability to reconstruct a wide range of hadrons containing strange, charm, and beauty quarks result in unique potential to probe the medium produced in the collisions. In this document, the heavy ion physics programme that will be pursued in LHCb Upgrade II is summarised, including precision studies of the partonic structure of nuclei, probes of the conditions allowing deconfinement, and measurements of plasma properties.

Authors: PUNZI, Giovanni (Pisa University and INFN); GERSHON, Timothy (University of Warwick (GB)); VAGNONI, Vincenzo (INFN Bologna (IT))

Contribution ID: **83** Type: **not specified**

Lithuanian Particle Physics Community Input to the 2026 Update of European Strategy for Particle Physics

Current engagements of the Lithuanian particle physics community are outlined together with the opinion on the focus of near-term European strategy for particle physics.

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Contribution ID: **84** Type: **not specified**

The CERN Festival Programme

The CERN Festival Programme offers a novel approach to science communication by embedding cutting-edge research and technology into mainstream cultural events across Europe. Since its inception in 2016, the programme has successfully engaged diverse and typically underserved audiences, effectively addressing contemporary societal challenges such as science skepticism, sustainability, and the educational impacts of artificial intelligence. By transforming passive observers into active participants through interdisciplinary activities and authentic scientific materials, the programme has fostered deeper public understanding and appreciation of fundamental research.
To sustain and amplify its impact, the programme recommends explicitly expanding geographical reach across Europe, cultivating new collaborations to engage broader audiences; further integrating interdisciplinary collaborations between science, art, and emerging technologies to create compelling and accessible educational experiences; and enhancing volunteer and early-career researcher engagement to provide valuable professional development for future science communicators. These strategic recommendations ensure the programme continues to bridge the gap between scientific research and public engagement, promoting long-term sustainability, and reinforcing CERN's role as a leader in science communication.

Authors: POTTER, Connie (CERN); Dr SIEBERT, Kaj

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Contribution ID: **85** Type: **not specified**

Higgs Criticality and the Metastability Bound: a target for future colliders

New physics at the TeV scale or lower may destabilise the electroweak vacuum. How low could the vacuum instability scale be? This fundamental question may be tied to a deeper understanding of the Higgs potential and its associated hierarchy problem. The scale of vacuum instability can be viewed as an upper bound on the Higgs mass-the so-called vacuum metastability bound-and criticality of the Higgs potential through some underlying mechanism then places our universe at this metastable point. In this report, we summarise recent work developing this eminently testable hypothesis. If the vacuum metastability bound plays a role in determining the properties of the Higgs boson, the new physics responsible will likely be discovered or excluded in the entire natural region of parameter space at future facilities. This makes it a tantalising and attractive target for future colliders.

Authors: GAVELA LEGAZPI, Belen (Universidad Autonoma de Madrid (ES)); DETERING, Maximilian; YOU, Tevong (King's College London); STEINGASSER, Thomas; ENGUITA VILETA, Victor

Contribution ID: **87** Type: **not specified**

The NEXT Search for Neutrinoless Double Beta Decay in Xe-136

The Neutrino Experiment with a Xenon TPC (NEXT) is an experimental program searching for neutrinoless double-beta decay (bbonu) in Xe-137 using high-pressure xenon time projection chambers (HPXe) with electroluminescent (EL) amplification of the ionization signal. This technology offers several advantages:
(a) Low intrinsic background—signals occur in the gas volume, away from surfaces where radioactive contaminants accumulate.
(b) Excellent energy resolution—in the range of 0.5–1.0 % FWHM at 2.5 MeV.
(c) Powerful topological signature—the ability to reconstruct the event topology as a double-electron track.
(d) Scalability—as the detector size increases, the signal-to-noise ratio improves linearly.
(e) Ba2+ tagging potential—the ability to identify the Ba2+ cation produced in \bbonu\ decay, which could enable a background-free experiment.
The NEXT-100 detector, designed to operate with up to 100 kg of xenon at 15 bar, is currently running at the Laboratorio Subterráneo de Canfranc (LSC), Spain. The collaboration is now preparing for the construction of a ton-scale HPXe detector, NEXT-HD, which could serve as the first module of a multi-ton, potentially multi-site program. This program has an asymptotic projected sensitivity to the bbonu decay half-life of T ˜5 10ˆ{27} y. Simultaneously, an intense R&D effort is underway to develop NEXT-BOLD, an HPXe detector equipped with sensors capable of detecting single Ba2+ ions with high efficiency. A future multi-module, multi-site NEXT-BOLD program could ultimately reach a sensitivity of T ˜ 10ˆ{28}$˜y.

Author: GOMEZ CADENAS, Juan Jose (Donostia International Physics Center (DIPC) (ES))

Contribution ID: **88** Type: **not specified**

A Survey of the Latin American High Energy Physics community on the future flagship project at CERN for the ESPP Update

This document collects input from Latin America as a contribution to the Update of the European Strategy for Particle Physics. It emerges from a survey of members of the Latin American Association for High Energy, Cosmology and Astroparticle Physics (LAA-HECAP) that collected data in February and a subsequent town-hall meeting, inspired by the ECFA guidelines for national communities. This contribution first reviews the Latin American participation at CERN, provides background on LAA-HECAP, and then presents the survey methodology and its results. Some conclusions are drawn based on the results of the survey.

Authors: SANDOVAL USME, Carlos (Universidad Nacional de Colombia); Dr MONTICELLI, Fernando (National University of La Plata (AR)); Prof. TEJEDA-YEOMANS, Maria Elena (Universidad de Colima); MULDERS, Martijn (CERN); CRUZ TORRES, Melissa Maria (CBPF - Brazilian Center for Physics Research (BR)); CAMACHO TORO, Reina Coromoto (LPNHE-Paris CNRS/IN2P3); ROSENFELD, Rogério; MELE, Salvatore (CERN)

Contribution ID: **89** Type: **not specified**

Precision cross-sections for advancing cosmic-ray physics

The latest generation of cosmic-ray direct detection experiments is providing a wealth of high-precision data, stimulating a very rich and active debate in the community on the related strong discovery and constraining potentials on many topics, namely dark matter nature, and the sources, acceleration, and transport of Galactic cosmic rays. However, interpretation of these data is strongly limited by the uncertainties on nuclear and hadronic cross-sections. This contribution is one of the outcomes of the Cross-Section for Cosmic Rays at CERN workshop series, that built synergies between experimentalists and theoreticians from the astroparticle, particle physics, and nuclear physics communities. A few successful and illustrative examples of CERN experiments'efforts to provide missing measurements on cross-sections are presented. In the context of growing cross-section needs from ongoing, but also planned, cosmic-ray experiments, a road map for the future is highlighted, including overlapping or complementary cross-section needs from applied topics (e.g., space radiation protection and hadrontherapy).

Authors: OLIVA, Alberto (Universita e INFN, Bologna (IT)); TYKHONOV, Andrii (Universite de Geneve (CH)); EVOLI, Carmelo (SISSA/ISAS); LUCARELLI, Chiara (Universita e INFN, Firenze (IT)); MAURIN, David Alain (Centre National de la Recherche Scientifique (FR)); GIORDANO, Davide (INFN Torino); GOMEZ CORAL, Diego Mauricio (Universidad Nacional Autonoma (MX)); BERTI, Eugenio (Universita e INFN, Firenze (IT)); DONATO, Fiorenza; GRAZIANI, Giacomo (INFN, Sezione di Firenze (IT)); LEYA, Ingo (University of Bern, Space Sciences and Planetology, CH-3012, Bern, Switzerland); NORBURY, John (NASA); OCAMPO PELETEIRO, Jose (Universita e INFN, Bologna (IT)); ŠERKŠNYTĖ, Laura (CERN); AUDOUIN, Laurent (Université Paris-Saclay (FR)); MOREJON, Leonel (CERN); ORUSA, Luca (Princeton University); VANSTALLE, Marie (GSI); LOSEKAMM, Martin Jan (Technische Universitaet Muenchen (DE)); DI MAURO, Mattia; MAHLEIN, Maximilian (Technische Universitaet Muenchen (DE)); ZHAO, Mengjie; Dr PANICCIA, Mercedes (Universite de Geneve (CH)); UNGER, Michael (Karlsruhe Institute for Technology); CHIOSSO, Michela (University of Torino and INFN); Prof. MAESTRO, Paolo (Universita degli studi di Siena (IT)); SERPICO, Pasquale (LAPTh - CNRS & Univ. Savoie (FR)); COPPIN, Paul (Universite de Geneve (CH)); VON DOETINCHEM, Philip (University of Hawaii at Manoa); GHOSH, Priyarshini (NASA Goddard Space Flight Center); MARIANI, Saverio (CERN); Dr PIEROG, Tanguy; Dr POSCHL, Thomas (CERN); GENOLINI, Yoann; BONCIOLI, denise

Contribution ID: **90** Type: **not specified**

Strategic Imperative: Investing in Accelerator R&D and Technologies for the Future of Particle Physics and Societal Impact –Comments in the framework of the European Strategy for Particle Physics (ESPP) update by the German Committee of Accelerator Physics (KfB)

Abstract: This document outlines recommendation for accelerator R&D in the context of the European Strategy for Particle Physics (ESPP) update and highlights the strategic importance of accelerator research and development (R&D). The German Committee of Accelerator Physics (KfB) emphasizes the importance of accelerator technology for both scientific research and industrial applications, highlighting key areas of development, including magnets, RF structures, plasma/laser acceleration, energy recovery linacs, and muon beams.
Key themes include the need to maintain Germany's and Europe's leadership in accelerator technology, address a looming skills gap due to retirements and reduced funding leading to fewer support of young talents, integrate sustainability into future accelerator designs, and capitalize on the broader applications of accelerator technology in areas ranging from semiconductor manufacturing to cancer treatment.
The document emphasizes the importance of large-scale accelerator projects in attracting and training the next generation of experts. The wider demand for accelerators and their performance will certainly keep growing, which requires strategic investment in accelerator R&D and education of a skilled workforce. CERN, Europe's leading laboratory for particle accelerators, must strengthen in any case R&D efforts in accelerator-related technologies.

Authors: Dr BRÜNDERMANN, Erik; HUG, Florian (Johannes Gutenberg-Universität Mainz); TECKER, Frank (CERN); WENSKAT, Marc

Contribution ID: **91** Type: **not specified**

United States Early Career Researchers in Collider Physics input to the European Strategy for Particle Physics Update

This document represents a contribution of the United States early career collider physics community to the 2025-2026 update to the European Strategy for Particle Physics. Preferences with regard to different future collider options and R&D priorities were assessed via a survey. The early career community was defined as anyone who is a graduate student, postdoctoral researcher, untenured faculty member, or research scientist under 40 years of age. In total, 105 participants responded to the survey between February and March 10th, 2025. Questions were formulated primarily to gauge the enthusiasm and preferences for different collider options in line with the recommendations of the United States' P5 report, relevant to the European Strategy Update.

Authors: CUMMINGS, Grace (Fermi National Accelerator Lab. (US)); AMRAM, Oz (Fermi National Accelerator Lab. (US))

Contribution ID: **92** Type: **not specified**

The LUXE Experiment

This document presents an overview of LUXE (Laser Und XFEL Experiment), an experiment that will combine the high-quality and high-energy electron beam of the European XFEL with a high-intensity laser, to explore the uncharted terrain of strong-field quantum electrodynamics. The scientific case, facility, and detector setup are presented together with an overview of the foreseen timeline and expected capital costs.

Authors: MELONI, Federico (Deutsches Elektronen-Synchrotron (DE)); WING, Matthew (University College London); JACOBS, Ruth Magdalena (Deutsches Elektronen-Synchrotron (DE))

Contribution ID: **93** Type: **not specified**

Strengthening the Instrumentation Programme

Instrumentation Community Input to the European Strategy for Particle Physics 2026 Update

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Contribution ID: **94** Type: **not specified**

The SiD Detector concept Input to the European Strategy Process Update 2026

The SiD Detector is one of two detector designs validated in 2012 for the International Linear Collider (ILC). SiD features a compact, cost-constrained design for precision Higgs and other measurements, with sensitivity to a wide range of possible new phenomena. A robust silicon vertex and tracking system, combined with a five Tesla central solenoidal field, provides excellent momentum resolution. The highly granular calorimeter system is optimized for Particle Flow application to achieve very good jet energy resolution over a wide range of energies. Given the advances in detector technology and the current set of three linear collider concepts under consideration, the SiD team is reviewing its earlier design and technology decisions and updating the design and choices with recent technological advances. For each area of SiD development R&D topics and opportunities for participation will be discussed.

Authors: Prof. WHITE, Andrew (U. Texas at Arlington); Dr VERNERI, Caterina (SLAC); Prof. YAMAMOTO, Hitoshi (Tohoku University); Prof. BRAU, James (U. Oregon); Dr STRUBE, Jan (U. Oregon); Dr STANITZKI, Marcel (DESY); Dr BREIDENBACH, Martin (SLAC); Prof. BURROWS, Philip (Oxford University); Dr MARKIEWICZ, Thomas (SLAC)

Contribution ID: **95** Type: **not specified**

Expressions of Interest for the Development of Detector Concepts and Sub-detector Systems for the Future Circular Collider FCC

Contact persons: M. Dam, M.-A. Pleier, F. Sefkow

This document accompanies a compilation of submissions of Expressions of Interest (EoIs) for the development of detector concepts and sub-detector systems for the Future Circular Collider (FCC). The actual EoIs can be found in a back-up document submitted in parallel; they are also collected in an indico repository and individually linked in a table in this document for quick access. This summary gives background information about the process leading to these EoIs, presents an overview and general observations, and proposes further steps.

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Contribution ID: **97** Type: **not specified**

ESPPU INPUT: C3 within the ”Linear Collider Vision”

The Linear Collider Vision calls for a Linear Collider Facility with a physics reach from a Higgs Factory to the TeV-scale with e^+e^- collisions. One of the technologies under consideration for the accelerator is a cold-copper distributed-coupling linac capable of achieving high gradient. This technology is being pursued by the C^3 collaboration to understand its applicability to future colliders and broader scientific applications. In this input we share the baseline parameters for a C^3 Higgs-factory and the energy reach of up to 3 TeV in the 33 km tunnel foreseen under the Linear Collider Vision. Recent results, near-term plans and future R&D needs are highlighted.

Authors: VERNIERI, Caterina (SLAC National Accelerator Laboratory (US)); NANNI, Emilio

Contribution ID: **98** Type: **not specified**

Design Initiative for a 10 TeV pCM Wakefield Collider

The community-driven Design Study for a 10 TeV pCM Wakefield Accelerator Collider introduced by this document is motivated by the 2020 ESPP Report emphasizing the need for advanced accelerator R&D for future colliders, and the 2023 P5 Report calling for the "delivery of an end-to-end design concept, including cost scales, with self-consistent parameters throughout" targeting the energy frontier. This Design Study leverages recent experimental and theoretical progress from a global R&D program with the goal of delivering a unified, 10 TeV Wakefield Collider concept. Wakefield accelerators provide ultra-high accelerating gradients which enables an upgrade path to extend the physics reach of a Higgs factory linear collider beyond the electroweak scale. Here, we describe the organization of the Design Study including timeline and deliverables, and detail requirements and challenges on the path to a 10 TeV Wakefield Collider.

Authors: OSTERHOFF, Jens (Berkeley Lab); GESSNER, Spencer

Contribution ID: **99** Type: **not specified**

Japan's Updated Strategy for High Energy Physics for the ESPP Update 2026

The Japanese High Energy physics community, JAHEP (Japan Association of High Energy Physicists) provides Japan's Updated Strategy for High Energy Physics for the ESPP Update 2026. High energy physics research in Japan encompasses a variety of groundbreaking experiments conducted at major facilities. These include the SuperKEKB accelerator and the Belle II experiment, which focus on search for new physics in heavy flavor decays; the high power proton accelerator complex J-PARC, where experiments are conducted using the high intensity neutrino, kaon, muon and neutrons beams; and collaborative efforts in CERN's Large Hadron Collider (LHC and HL-LHC) experiments. For neutrino research, the construction of the Hyper-Kamiokande experiment started and is currently underway. We emphasize the importance of maintaining timely progress in these ongoing experiments and construction of experimental facilities. We acknowledge significant contributions by European collaborators to the Japan-based experiments, and wish to see more participation. We also acknowledge essential support of CERN to the experiments as a key hub for the European activities.

Looking into the future, the early realization of a Higgs factory through international collaboration is crucial for our field. We take into account the evolving situation of Higgs factory proposals: CEPC, FCC-ee, ILC, and LC@CERN. To ensure the realization of a Higgs factory, we pursue the following key directions:
- We prioritize efforts to realize the ILC as Global Project, taking a leading role in advancing ongoing initiatives. We will engage with international partners to discuss governance, responsibilities, and site selection. We intend to develop and expand our scientific and promotional activities to host the ILC as Global Project in Japan.
- We also extend our activities in other Higgs factory proposals as a collective approach to maximize the chances of timely realizing a Higgs factory.

In addition, the ILC Technology Network (ITN), international R\&D framework for the ILC accelerator initiated by KEK and ILC International Development Team (IDT), has started. The collaboration with CERN is essential for ITN. The detector R&D with test beams are essential for future experiments, and we would promote international collaborations in detector developments, such as ECFA-Detector R&D. Beyond a Higgs Factory, developing high-field magnets using state-of-the-art superconductors is critical to realize a future hadron collider.

By advancing current and future projects, we aim to continue contributing to fundamental discoveries and to foster international collaboration. We will actively participate in international discussions on shaping the global strategy for high-energy physics.

Authors: (JAHEP), Japan Association of High Energy Physics (Japan); Dr NAKAYA, Tsuyoshi (Kyoto University)

Contribution ID: **100** Type: **not specified**

Probing and Knocking with Muons

We propose here a set of new methods involving probing and knocking with muons (PKMu). There is a wealth of rich physics to explore with GeV muon beams. Examples include but not limited to: muon scattering can occur at large angles, providing evidence of potential muon-philic dark matter or dark mediator candidates; muon-electron scattering can be used to detect new types of bosons associated with charged lepton flavor violation; precise measurements of GeV-scale muon-electron scattering can be employed to probe quantum correlations

Authors: ZHOU, Chen (Peking University (CN)); GAO, Leyun (PKU); LI, Qiang (Peking University (CN)); Dr LI, Qite (Peking University)

Contribution ID: **101** Type: **not specified**

SBN@CERN: A short-baseline neutrino beam at CERN for high-precision cross-section measurements

A new generation of neutrino cross-section experiments at the GeV scale is crucial in the precision era of oscillation physics and lepton flavor studies. In this document, we present a novel neutrino beam design that leverages the experience and R&D achievements of the NP06/ENUBET and NuTag Collaborations and explore its potential implementation at CERN. This beam enables flux monitoring at the percent level and provides a neutrino energy measurement independent of final state particle reconstruction at the neutrino detector. As a result, it eliminates the two primary sources of systematic uncertainty in cross-section measurements: flux normalization and energy bias caused by nuclear effects. We provide a detailed description of the beam technology and instrumentation, along with an overview of its physics potential, with particular emphasis on cross-sections relevant to DUNE and Hyper-Kamiokande.

Authors: TERRANOVA, Francesco (Universita & INFN, Milano-Bicocca (IT)); PERRIN-TERRIN, Mathieu (Centre National de la Recherche Scientifique (FR)); CHARITONIDIS, Nikolaos (CERN)

Contribution ID: **102** Type: **not specified**

The ILD Detector: A Versatile Detector for an Electron-Positron Collider at Energies up to 1˜TeV

The International Large Detector, ILD, is a detector concept for an experiment at a future high energy lepton collider. The detector has been optimised for precision physics in a range of energies from 90˜GeV to about 1˜TeV. ILD features a high precision, large volume combined silicon and gaseous tracking system, together with a high granularity calorimeter, all inside a central solenoidal magnetic field. The paradigm of particle flow has been the guiding principle of the design of ILD. ILD is based mostly on technologies which have been demonstrated by extensive research and test programs. The ILD concept is proposed both for linear and circular lepton collider, be it at CERN or elsewhere. The concept has been developed by a group of nearly 60 institutes from around the world, and offers a well developed and powerful environment for science and technology studies at lepton colliders. In this document, the required performance of the detector, the proposed implementation and the readiness of the different technologies needed for the implementation are discussed.

Author: BEHNKE, Ties

Contribution ID: **103** Type: **not specified**

Nuclear Physics and the European Particle Physics Strategy Update 2026

This document provides input to the update of the European Strategy for Particle Physics in fields that are related to Nuclear Physics as described in the NuPECC Long Range Plan 2024 https://arxiv.org/abs/2503.15575.

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Contribution ID: **104** Type: **not specified**

HTS Potential and Needs for Future Accelerator Magnets

HTS has the potential of a game changer for many applications of superconductivity, not last in the field of particle accelerators and detectors. This paper explores the potential of HTS, with a focus on REBCO-coated conductors, in relation to the evolving demands of superconducting magnets for accelerators. HTS already have a spectacular current carrying ability at high field, demonstrated and available on relevant lengths. Recent advances in non-conventional winding techniques for solenoids, in particular non-insulated windings, have shown that it is possible to reach engineering current densities in the coil exceeding by far those of LTS . This approach seems to offer an extended field reach, as well as solutions to the challenges associated with magnet mechanics, quench management and cost. Most important, beyond the ability to reach a field range higher than what is possible with LTS, HTS offers an extended range of operating temperature, with large margin. This can be exploited to obtain higher availability and better cryogenic efficiency, a must for the future of sustainable large scale research infrastructures such as particle accelerators.

Authors: BORDINI, Bernardo (CERN); BOTTURA, Luca (CERN)

Contribution ID: **105** Type: **not specified**

Magnet R&D for the Muon Collider

The Muon Collider, proposed under the International Muon Collider Collaboration (IMCC), represents a groundbreaking advancement in circular collider technology. By using muons instead of protons or electrons, this collider has the potential of unprecedented discovery reach, luminosity, and compact design, significantly increasing energy efficiency, reducing environmental impact and improving sustainability. However, achieving this vision necessitates overcoming unique and extreme challenges in superconducting magnet technology. This document summarizes the state of the art, challenges, and the proposed R&D roadmap for developing the next generation of superconducting magnet systems crucial for the Muon Collider over the next ten years. The goal is to advance accelerator magnet technology beyond current limits, with a special focus on High-Temperature Superconductors (HTS) materials for high-field and high-temperature applications. This note is a concise summary of the extensive proposal [BOT-2025] which we refer to for detailed referencing and as supporting material. We focus here on the technology gap to be filled by the proposed R&D, the structure and objectives of the proposed R&D, and provide the resource estimate for the next ten years.

Authors: CAIFFI, Barbara (INFN e Universita Genova (IT)); BORDINI, Bernardo (CERN); AUCHMANN, Bernhard (PSI); BOATTINI, Fulvio (CERN); COOLEY, Lance; BOTTURA, Luca (CERN); Dr STATERA, Marco (INFN Milano - LASA); MARIOTTO, Samuele; FABBRI, Siara Sandra (CERN); PRESTEMON, Soren; Dr GOURLAY, Stephen (FNAL); NAKAMOTO, Tatsushi (KEK)

Contribution ID: **106** Type: **not specified**

Country input - Serbia

The Serbian research community strongly supports the Future Circular Collider (FCC) as CERN's next major project, with FCC-hh as the preferred option due to its unparalleled energy reach and broad physics potential. While there is some backing for a Linear Collider (LC) and a Muon Collider, they are seen as secondary alternatives. Key considerations include physics potential, long-term perspectives, and financial and human resources. If Japan proceeds with the ILC, Serbian researchers would shift support to FCC and a Muon Collider. If China builds CEPC, FCC-hh remains the priority. Beyond colliders, Serbian researchers emphasize R&D in muon collider technology, superconducting materials, and laser wakefield acceleration while also considering related fields like dark matter, neutrinos, and medical and material sciences. Detailed discussion is below.

Author: ZIVKOVIC, Lidija (Institute of physics Belgrade (RS))

Contribution ID: **107** Type: **not specified**

CMS Offline Software and Computing input to the European Strategy for Particle Physics - 2026 update

This document outlines the CMS Offline Software and Computing strategy in preparation for the High-Luminosity LHC (HL-LHC) era and serves as input to the 2026 update of the European Strategy for Particle Physics. As CMS faces a significant increase in data volume, event complexity, and computing demands in Phase-2, this report details the necessary evolution of software, computing models, infrastructure, and sustainability practices. Key developments include optimizing the CMSSW framework for heterogeneous architectures, expanding the use of AI/ML in simulation and reconstruction, adopting container-based analysis environments, and improving storage efficiency through hybrid models. The document emphasizes collaborative development across the HEP community, the need for sustainable computing aligned with environmental goals, and securing long-term resource commitments, especially from HPC centers, to ensure the success of CMS scientific program and its broader impact on future experiments.

Authors: LANGE, David (Princeton University (US)); SEXTON-KENNEDY, Elizabeth (Fermi National Accelerator Lab. (US)); PEDRO, Kevin (Fermi National Accelerator Lab. (US)); KORTELAINEN, Matti (Fermi National Accelerator Lab. (US)); SRIMANOBHAS, Phat (Chulalongkorn University (TH))

Contribution ID: **108** Type: **not specified**

DRD 6 Calorimetry - Input to European Strategy of Particle Physics Update (ESPPU)

This contribution outlines the status of plans of the DRD-on-Calorimetry (DRD 6).

Authors: GAUDIO, Gabriella (Dipartimento di Fisica Nucleare e Teorica); POESCHL, Roman (Université Paris-Saclay (FR))

Contribution ID: **109** Type: **not specified**

Searching for millicharged particles with the FORMOSA experiment at the CERN LHC

In this contribution, we evaluate the sensitivity for particles with charges much smaller than the electron charge with a dedicated scintillator-based detector in the far forward region at the CERN LHC, FORMOSA. This contribution will outline the scientific case for this detector, its design and potential locations, and the sensitivity that can be achieved. The ongoing efforts to prove the feasibility of the detector with the FORMOSA demonstrator will be discussed. Finally, possible upgrades to the detector through the use of high-performance scintillator will be discussed.

Author: CITRON, Matthew Daniel (University of California Davis (US))

Contribution ID: **110** Type: **not specified**

National Input from the Swedish Community to the Update of the European Strategy for Particle Physics

This document presents Sweden's national input to the 2026 update of the European Strategy for Particle Physics (ESPP). The status and current involvements of the Swedish community working on both experiments and theory are first described in order to provide some context, however a more comprehensive overview of particle physics activities in Sweden was provided in the previous ESPP update in 2020. Hence, our recommendations follow here the guidelines set by the European Committee for Future Accelerators (ECFA). We support a broad and complementary particle physics program from the high-energy frontier to the high-intensity frontier.

Author: FERRARI, Arnaud (Uppsala University (SE))

Contribution ID: **111** Type: **not specified**

The Role of Particle Physics in Revolutionising Imaging Technologies: From Quantum Entanglement to Clinical Applications

Positron emission tomography (PET) has become an indispensable tool in clinical medicine over the past three decades, enabling high-resolution imaging with spatial resolution of 1–3 mm and temporal resolution on the order of seconds. However, a significant portion of signal information is currently discarded due to photon scattering. Harnessing this lost data—for instance, by exploiting the quantum entanglement of annihilation photons 1—could substantially improve scan sensitivity. For example, measuring the scattering angle of one photon could inform the reconstruction of its entangled counterpart. Yet, current PET technology faces limitations, including an energy resolution of only 8–10% for 511 keV photons, which must be improved without compromising timing resolution. Additionally, recent studies suggest that positronium half-life measurements may correlate with hypoxic cells [2], but existing detectors lack the sensitivity for low-energy photons and triple-gamma annihilations. These challenges underscore the urgent need for advancements in particle physics technologies with impact in medical applications. Integrating next-generation PET imaging into the European Strategy for Particle Physics would amplify its scientific, societal, and industrial impact, further demonstrating the field's broader relevance.

1 Watts et al (2021) Photon quantum entanglement in the MeV regime and its application in PET imaging. Nature Communications: 12:2646, https://doi.org/10.1038/s41467-021-22907-5.

[2] Moskal et al (2024) Positronium image of the human brain in vivo. Science Advances 10(37): eadp2840, https://doi.org/10.1126/sciadv.adp2840.

Author: Prof. TSOUMPAS, Charalampos (University Medical Center Groningen)

Contribution ID: **112** Type: **not specified**

Enhancing European Cooperation in the Search for Dark Matter

The search for dark matter is an exciting topic that is pursued in different communities over a wide range of masses and using a variety of experimental approaches.
The result is a strongly correlated matrix of activities across Europe and beyond, both on the experimental and the theoretical side.
We suggest to encourage and foster the collaboration of the involved institutions on technical, scientific and organisational level, in order to realise the synergies that are required to increase the impact of dark matter research and to cope with the increasing experiment sizes.
The suggested network — loosely titled "DMInfraNet" — could be realised as a new initiative of the European strategy or be based on existing structures like iDMEu or DRD. The network can also serve as a nucleus for future joint funding proposals.

Authors: ZERWAS, Dirk (Université Paris-Saclay (FR)); REINDL, Florian (Vienna University of Technology (AT)); SCHIECK, Jochen (Austrian Academy of Sciences (AT)); SCHORNER, Thomas (Deutsches Elektronen-Synchrotron (DE))

Contribution ID: **113** Type: **not specified**

Quantum Information meets High-Energy Physics: Input to the update of the European Strategy for Particle Physics

Some of the most astonishing and prominent properties of Quantum Mechanics, such as entanglement and Bell nonlocality, have only been studied extensively in dedicated low-energy laboratory setups. The feasibility of these studies in the high-energy regime explored by particle colliders was only recently shown, and has gathered the attention of the scientific community. For the range of particles and fundamental interactions involved, particle colliders provide a novel environment where quantum information theory can be probed, with energies exceeding, by about 12 orders of magnitude, the laboratory setups typically used in the field. Furthermore, collider detectors have inherent advantages in performing certain quantum information measurements, and allow for the reconstruction the state of the system under consideration via quantum state tomography. Here, we elaborate on the potential, challenges, and goals of this innovative and rapidly evolving line of research, and discuss its expected impact on both quantum information theory and high-energy physics.

Authors: FABBRI, Federica (Universita e INFN, Bologna (IT)); MARZOLA, Luca (University Of Tartu); LOW, Matthew (University of Pittsburgh); AFIK, Yoav (University of Chicago (US))

Contribution ID: **114** Type: **not specified**

Synergies between a U.S.-based Electron-Ion Collider and European Research in Particle Physics

This document is submitted as input to the European Strategy for Particle Physics Update (ESPPU). The U.S.-based Electron-Ion Collider (EIC) aims at understanding how the complex dynamics of confined quarks and gluons makes up nucleons, nuclei and all visible matter, and determines their macroscopic properties. In April 2024, the EIC project received approval for critical-decision 3A (CD-3A) allowing for Long-Lead Procurement, bringing its realization another step closer. The ePIC Collaboration was established in July 2022 around the realization of a general purpose detector at the EIC. The EIC is based in U.S.A. but is characterized as a genuine international project. In fact, a large group of European scientists is already involved in the EIC community: currently, about a quarter of the EIC User Group (consisting of over 1500 scientists) and 29% of the ePIC Collaboration (consisting of $\sim$1000 members) is based in Europe. This European involvement is not only an important driver of the EIC, but can also be beneficial to a number of related ongoing and planned particle physics experiments at CERN. In this document, the connections between the scientific questions addressed at CERN and at the EIC are outlined. The aim is to highlight how the many synergies between the CERN Particle Physics research and the EIC project will foster progress at the forefront of collider physics.

Author: RADICI, Marco

Co-authors: GAL, Ciprian; MAMMEI, Juliette; EVDOKIMOV, Olga (University of Illinois Chicago (US)); SEIDL, Ralf; DUPRÉ, Raphaël (IJCLab, Univ. Paris-Saclay); MA, Rongrong (BNL); REED, Rosi (Lehigh University); FAZIO, Salvatore (Universita della Calabria e INFN Cosenza); Dr DIEHL, Stefan (Justus Liebig University Giessen and University of Connecticut); MAPLE, Stephen; KUTZ, Tyler; Dr TU, Zhoudunming (BNL)

Contribution ID: **115** Type: **not specified**

PIONEER: a next generation rare pion decay experiment

PIONEER: A next-generation rare pion decay experiment

PIONEER is a rapidly developing effort aimed to perform a pristine test of lepton flavour universality (LFU) and of the unitarity of the first row of the CKM matrix by significantly improving the measurements of rare decays of the charged pion. The experiment is approved at the Paul Scherrer Institute (PSI). In Phase I, PIONEER aims to measure the charged-pion branching ratio to electrons vs. muons $R_{e/\mu}$ to 1 part in 10^4, improving the current experimental result $R_{e/\mu}$ (exp) $= 1.2327(23) \times 10^{-4}$ by a factor of 15. This precision on $R_{e/\mu}$ will match the theoretical accuracy of the SM prediction allowing for a test of LFU at an unprecedented level, probing non-SM explanations of LFU violation through sensitivity to quantum effects of new particles up to the PeV mass scale.

Phase II and III will aim to improve the experimental precision of the branching ratio of pion beta decay, $\pi^+ \to \pi^0 e^+ \nu(\gamma)$, currently at $1.036(6) \times 10^{-8}$, by a factor
of three and six, respectively. The improved measurements will be used to extract V_{ud} in a theoretically pristine manner. The ultimate precision of V_{ud} is expected to reach the 0.05\,\% level, allowing for a stringent test of CKM unitarity.

The PIONEER experiment will also improve the experimental limits
by an order of magnitude or more on a host of exotic decays that probe the effects of heavy neutrinos and dark sector physics.

The conceptual design of PIONEER includes a 3π-sr 19 radiation length calorimeter, a segmented low-gain avalanche diode (LGAD) stopping target, a positron tracker, and ultra-fast electronics. Compared to the previous generation of rare pion decay experiments, the 5-D (position, time, and energy) tracking capability of the LGAD-based active target allows for excellent separation of $\pi \to e\nu$ signal from vast amount of $\pi \to \mu \to e$ background ($\pi \to \mu\nu$ followed by $\mu \to e\nu\overline{\nu}$).

The PIONEER collaboration consists of participants from both the nuclear and particle physics communities including PIENU, PEN/PiBeta, and MEG/MEGII collaborations, as well as experts in rare kaon decays,
low-energy stopped muon experiments, the Muon $g-2$ experimental campaign, high energy collider physics, neutrino physics, and other areas. The collaboration is engaged in R\&D in several critical areas including i) beam studies, ii) LGAD-based active target (sensor and readout electronics), iii) calorimetry (Noble gas and crystals), iv) DAQ, and v) trigger. A detailed simulation framework is used to estimate sensitivity and systematics. The collaboration is still developing and welcomes new members.

This input to the 2026 update of the European Strategy for Particle Physics Strategy describes the physics motivation and the conceptual design of the PIONEER experiment, and is prepared based on the PIONEER proposal submitted to and approved with high priority by the PSI program advisory committee (PAC). Using intense pion beams, and state-of-the-art instrumentation and computational resources, the PIONEER experiment is aiming to begin data taking by the end of this decade

Author: HERTZOG, David (University of Washington)

Contribution ID: **116** Type: **not specified**

T2K Experiment: future plans and capabilities

The Tokai-to-Kamioka (T2K) experiment uses an intense (anti)neutrino source produced at J-PARC, which is sampled by detectors close to production (280m) and far from it (295km). T2K's physics program includes precision measurements of oscillation physics, neutrino interactions, and searches for exotic phenomena. T2K has made important contributions to the evolving landscape of oscillation physics, including the discovery of charged current ν_e appearance and significant constraints on CP violation (CPV) in the lepton sector, assuming three-flavour PMNS neutrino oscillations. T2K will take data with its recently-installed near detector upgrades until the start of Hyper-Kamiokande, aiming to collect data corresponding to a total of 10×10^{21} protons-on-target (POT), for a continued, vibrant physics program which will pursue 3σ observation of CPV and will lay the ground work to performing analyses with the next generation of neutrino experiments. Approximately 60% of the T2K collaboration comes from European institutions, making Europe a strong contributor in T2K. Europe has provided infrastructure, detector R&D and operational expertise which have been essential to T2K's successful science program. European groups have significant leadership and initiatives within T2K. Europe has also been essential to important input measurements to T2K. CERN has been a successful hub for T2K's neutrino oscillation program. We provide examples for consideration to ensure a successful European strategy in the domain of neutrino oscillation experiments based on the T2K model.

Author: Prof. MAHN, Kendall (Michigan State University)

Contribution ID: **117** Type: **not specified**

The INFN National Scientific Committee for Theoretical Physics

This document summarizes the discussions within the INFN national scientific commission for theoretical physics (CSN4) on the future challenges in theoretical physics of interest for INFN, triggered by the national meeting on the INFN input for the update of the European Strategy for Particle Physics. Present and future challenges in theoretical physics are presented, with the vision of CSN4 on the next ESPPU.

Authors: PICCININI, Fulvio (INFN Pavia (IT)); DEGRASSI, Giuseppe (Roma Tre University and INFN (IT))

Contribution ID: **118** Type: **not specified**

The DUNE Science Program

The international collaboration designing and constructing the Deep Underground Neutrino Experiment (DUNE) at the Long-Baseline Neutrino Facility (LBNF) has developed a two-phase strategy for the implementation of this leading-edge, large-scale science project. The 2023 report of the US Particle Physics Project Prioritization Panel (P5) reaffirmed this vision and strongly endorsed DUNE Phase I and Phase II, as did the previous European Strategy for Particle Physics. The construction of DUNE Phase I is well underway. DUNE Phase II consists of a third and fourth far detector module, an upgraded near detector complex, and an enhanced > 2 MW beam. The fourth FD module is conceived as a 'Module of Opportunity', aimed at supporting the core DUNE science program while also expanding the physics opportunities with more advanced technologies.
The DUNE collaboration is submitting four main contributions to the 2026 Update of the European Strategy for Particle Physics process. This submission to the 'Neutrinos and cosmic messengers', 'BSM physics' and 'Dark matter and dark sector' streams focuses on the physics program of DUNE. Additional inputs related to DUNE detector technologies and R&D, DUNE software and computing, and European contributions to Fermilab accelerator upgrades and facilities for the DUNE experiment, are also being submitted to other streams.

Authors: SOREL, Michel (IFIC); BERTOLUCCI, Sergio (Universita e INFN, Bologna (IT)); GOLLAPINNI, Sowjanya (Los Alamos National Laboratory (US))

Contribution ID: **119** Type: **not specified**

The DUNE Phase II Detectors

The international collaboration designing and constructing the Deep Underground Neutrino Experiment (DUNE) at the Long-Baseline Neutrino Facility (LBNF) has developed a two-phase strategy for the implementation of this leading-edge, large-scale science project. The 2023 report of the US Particle Physics Project Prioritization Panel (P5) reaffirmed this vision and strongly endorsed DUNE Phase I and Phase II, as did the previous European Strategy for Particle Physics. The construction of DUNE Phase I is well underway. DUNE Phase II consists of a third and fourth far detector module, an upgraded near detector complex, and an enhanced > 2 MW beam. The fourth FD module is conceived as a 'Module of Opportunity', aimed at supporting the core DUNE science program while also expanding the physics opportunities with more advanced technologies.
The DUNE collaboration is submitting four main contributions to the 2026 Update of the European Strategy for Particle Physics process. This submission to the 'Detector instrumentation' stream focuses on technologies and R&D for the DUNE Phase II detectors. Additional inputs related to the DUNE science program, DUNE software and computing, and European contributions to Fermilab accelerator upgrades and facilities for the DUNE experiment, are also being submitted to other streams.

Authors: SOREL, Michel (IFIC); BERTOLUCCI, Sergio (Universita e INFN, Bologna (IT)); GOLLAPINNI, Sowjanya (Los Alamos National Laboratory (US))

Contribution ID: **120** Type: **not specified**

European Contributions to Fermilab Accelerator Upgrades and Facilities for the DUNE Experiment

The Proton Improvement Plan (PIP-II) to the FNAL accelerator chain and the Long-Baseline Neutrino Facility (LBNF) will provide the world's most intense neutrino beam to the Deep Underground Neutrino Experiment (DUNE) enabling a wide-ranging physics program. This document outlines the significant contributions made by European national laboratories and institutes towards realizing the first phase of the project with a 1.2 MW neutrino beam. Construction of this first phase is well underway. For DUNE Phase II, this will be closely followed by an upgrade of the beam power to > 2 MW, for which the European groups again have a key role and which will require the continued support of the European community for machine aspects of neutrino physics.
Beyond the neutrino beam aspects, LBNF is also responsible for providing unique infrastructure to install and operate the DUNE neutrino detectors at FNAL and at the Sanford Underground Research Facility (SURF). The cryostats for the first two Liquid Argon Time Projection Chamber detector modules at SURF, a contribution of CERN to LBNF, are central to the success of the ongoing execution of DUNE Phase I. Likewise, successful and timely procurement of cryostats for two additional detector modules at SURF will be critical to the success of DUNE Phase II and the overall physics program.
The DUNE Collaboration is submitting four main contributions to the 2026 Update of the European Strategy for Particle Physics process. This paper is being submitted to the 'Accelerator technologies' and 'Projects and Large Experiments' streams. Additional inputs related to the DUNE science program, DUNE detector technologies and R&D, and DUNE software and computing, are also being submitted to other streams.

Authors: SOREL, Michel (IFIC); BERTOLUCCI, Sergio (Universita e INFN, Bologna (IT)); GOLLAPINNI, Sowjanya (Los Alamos National Laboratory (US))

Contribution ID: **121** Type: **not specified**

DUNE Software and Computing Research and Development

The international collaboration designing and constructing the Deep Underground Neutrino Experiment (DUNE) at the Long-Baseline Neutrino Facility (LBNF) has developed a two-phase strategy toward the implementation of this leading-edge, large-scale science project. The ambitious physics program of Phase I and Phase II of DUNE is dependent upon deployment and utilization of significant computing resources, and successful research and development of software (both infrastructure and algorithmic) in order to achieve these scientific goals. This submission discusses the computing resources projections, infrastructure support, and software development needed for DUNE during the coming decades as an input to the European Strategy for Particle Physics Update for 2026.
The DUNE collaboration is submitting four main contributions to the 2026 Update of the European Strategy for Particle Physics process. This submission to the 'Computing' stream focuses on DUNE software and computing. Additional inputs related to the DUNE science program, DUNE detector technologies and R&D, and European contributions to Fermilab accelerator upgrades and facilities for the DUNE experiment, are also being submitted to other streams.

Authors: SOREL, Michel (IFIC); BERTOLUCCI, Sergio (Universita e INFN, Bologna (IT)); GOLLAPINNI, Sowjanya (Los Alamos National Laboratory (US))

Contribution ID: **122** Type: **not specified**

LVK contribution on Gravitational Waves Physics

The first detection of GW in 2015 and the successful data recording campaigns of those last ten years have opened a new avenue for observing the Universe, studying general relativity and the fundamental interactions that govern it. GW detection constitutes a pillar of multimessenger astronomy in place today and for the 2030s.
The improved sensitivity of the LIGO-Virgo-KAGRA interferometers will increase the number of observed compact binary coalescence events and will give access to a deeper investigation of the merger and post-merger signals. It will also improve the source-localization ability, which is crucial for many of the scientific goals of gravitational-wave astronomy, such as electromagnetic follow-up and cosmology. Besides the detection of other events, new phenomena have still to be observed, such as stellar collapses, continuous signals from pulsars, and the gravitational-wave background of astrophysical origin.
If properly and timely upgraded, second generation GW detectors have the potential to significantly contribute to the achievement of high-priority scientific goals, at least till 2040s, when the third generation of instrument is supposed to start observations.
In this context, this document highlights the existing synergies between high-energy, nuclear and gravitational wave physics, as well as the importance of strengthening it in the coming years to meet these scientific challenges.

Authors: GEMME, Gianluca; VERDIER, Patrice (Centre National de la Recherche Scientifique (FR))

Contribution ID: **123** Type: **not specified**

IUPAP Commission 11 (Particles and Fields) Support Letter on behalf of the High Energy Physics (HEP) Information Infrastructure

High Energy Physics (HEP) is a data-intensive and highly collaborative scientific field that produces, analyses, and distributes large amounts of information around the globe, including experimental results, theoretical models, and computational simulations. Efficient curation, analysis, and dissemination of the information produced by international experimental collaborations and theoretical physicists are essential for advancing our understanding of fundamental physics and enabling global collaboration. The International Union of Pure and Applied Physics (IUPAP) Commission 11 (C11), dedicated to the field of Particles and Fields, strongly recommends robust support for HEP information infrastructure which provides free access to research papers and promotes the unrestricted exchange of scientific information ensuring that advancements in particle physics are accessible to the global research community.

Author: GAMEIRO MUNHOZ, Marcelo (Universidade de Sao Paulo (USP) (BR))

Contribution ID: **124** Type: **not specified**

JENA White Paper on European Federated Computing

The Joint ECFA-NuPECC-APPEC (JENA) Activities launched an initiative (JENA Computing) in 2023 to promote the increasing need for discussions on the strategy and implementation of European federated computing at future large-scale research facilities. In workshops and dedicated working groups on specific topics, expert groups from all relevant research areas were formed to compile an overview of existing strategies in the individual countries and communities. Here we present a summary of the resulting Working Group Reports, including the most important recommendations from these areas of computing. Furthermore, an additional chapter on sustainability in the field of computing is included. This version of the JENA White Paper on European Federated Computing serves as input to the European Strategy for Particle Physics 2026 update (ESPPU).

Authors: HAUNGS, Andreas; FOR THE JENA COMPUTING INITIATIVE

Contribution ID: **125** Type: **not specified**

The SNO+ Science Programme: Input to the European Strategy for Particle Physics - 2026 Update

The search for neutrinoless double beta decay ($0\nu\beta\beta$) is considered by the community as one of the most important topics in neutrino physics and as a priority by successive updates of the European Strategy for Particle Physics. An understanding of the nature of neutrino mass is connected to the charge conjugation nature – Dirac or Majorana – of neutrinos. An observation of $0\nu\beta\beta$ would prove that neutrinos are Majorana particles, demonstrate lepton number violation, and have profound implications on cosmology and physics at higher energy scales. The SNO+ experiment has pioneered the techniques to purify and load large quantities of natural tellurium into liquid scintillator and is getting ready to start a high sensitivity search for the $0\nu\beta\beta$ of ^{130}Te. Reusing the Sudbury Neutrino Observatory detector, SNO+ has been operating with 780 tonnes of liquid scintillator since 2022, characterizing all the detector and scintillator-related backgrounds. Using Tellurium that has "cooled" underground for several years, the initial loading is planned to start in 2026 and is expected to reach a world-leading $0\nu\beta\beta$ sensitivity for ^{130}Te. The collaboration is actively seeking funding for an additional 7.8 tonnes of tellurium and upgrades to the underground plants in order to pursue a 1.5\% loading phase, expected to reach the bottom of the inverted mass hierarchy for some nuclear matrix elements and potentially leading sensitivity for any isotope. The exceptional location of SNOLAB and low backgrounds of the detector will continue to be exploited for solar, reactor and geo-neutrinos. SNO+ is a CERN recognized experiment and European groups have been founding members of the collaboration and have a significant impact on SNO+, making central contributions to the development of the tellurium purification and loading techniques, to data analysis and calibration.

Authors: MANEIRA, Jose (LIP Lisboa); KLEIN, Joshua R (University of Pennsylvania (US)); Prof. CHEN, Mark (Queen's University); BILLER, Steven Douglas (University of Oxford (GB))

Contribution ID: **126** Type: **not specified**

Input to ESPPU by the German Astroparticle Community

This document summarises, from a German perspective, the close relation of astroparticle physics and particle physics. It specifically identifies CERN activities complementing and supporting astroparticle physics, and concludes with recommendations on cooperation between both fields, on the projects mentioned, and on suggested astroparticle-related activities at CERN.

Authors: VALERIUS, Kathrin; KATZ, Ulrich (U Erlangen-Nürnberg)

Contribution ID: **127** Type: **not specified**

Computing and software for LHCb Upgrade II

A second major upgrade of the LHCb experiment is necessary to allow full exploitation of the High Luminosity LHC for flavour physics. The new experiment will operate in Run 5 of the LHC at a maximum luminosity of $1.5 \times 10^{34} cm^{-2} s^{-1}$. The experiment will therefore experience extremely high particle fluences and data rates, posing a high challenge not only for the detector but also for the software and computing resources needed to readout, reconstruct, select and analyse the data. This document presents these challenges and the ongoing and future R&D programme necessary to address them. This programme will benefit not only the LHCb Upgrade II experiment, but the whole particle physics community as similar challenges will be faced by the next generation of experiments.

Authors: COUTURIER, Ben (CERN); MARIN BENITO, Carla (University of Barcelona (ES)); ROBBE, Patrick (Université Paris-Saclay (FR)); VAGNONI, Vincenzo (INFN Bologna (IT))

Contribution ID: **129** Type: **not specified**

The CERN n_TOF neutron-time-of-flight facility: present and future

The CERN n_TOF neutron-time-of-flight facility: present and future

Alberto Mengoni (*) on behalf of the n_TOF Collaboration

The neutron time-of-flight facility, n_TOF at CERN, will approach the 25th year of operation in 2026. Its long successful history can be ascribed to the unique features of the neutron beams available, that combine a wide energy range, excellent neutron energy resolution and high instantaneous flux. Neutron-induced reaction experiments can be performed at n_TOF, providing new fundamental data of significance for nuclear astrophysics, advanced nuclear technologies and basic nuclear science. Currently, three distinct experimental areas are operational: two dedicated to time-of-flight measurements placed at 186 and 20 meters (EAR1, EAR2), and one for neutron irradiations and activation studies located at 5 meters (NEAR) from the target assembly. This variety of working areas effectively meets the demands for energy resolution and neutron beam intensity, required in in a wide assortment of neutron-induced nuclear reaction experiments.
n_TOF research activities on neutron-induced reactions provide key insights for astrophysics in understanding the origin of the chemical elements in the universe, notably for the slow neutron capture nucleosynthesis (s-process). Nuclear data with unprecedented accuracy, in broad energy domains, are routinely produced at n_TOF, instrumental for innovation of advanced nuclear technologies, in several areas of nuclear sciences. Upcoming upgrades will enhance the capabilities of the facility, enabling new research areas such as space technology and fusion science. These improvements include a new transmission station, a moderator for the NEAR station, high-pressure gas cells for gaseous targets, and advanced detectors to widen the range of nuclear reaction channels that can be exploited.
The n_TOF Collaboration is investigating the opportunities provided by the incoming CERN SPS Beam Dump Facility (BDF), to expand its capabilities for activation measurements, thus enhancing the core activities of neutron induced reactions. The recently endorsed facility will produce ultra-high neutron fluxes over a wide energy range. The neutron beam, opportunely filtered and complemented by the installation of a pneumatic rabbit system, can be used for measurements of neutron induced activation cross sections on radioactive nuclear species with short half-lives. This represents a particularly interesting development, for its potential synergy with the radioactive ion beam facility ISOLDE, aiming at the study of nuclear structure properties and neutron interaction with unstable nuclei.
A community grown to include over 150 scientists has formed around the n_TOF facility at CERN. The n_TOF Collaboration is a well-established and thriving research community, deeply integrated within the nuclear physics landscape, both in Europe and worldwide.

Authors: MENGONI, Alberto (CERN & INFN, Bologna); THE N_TOF COLLABORATION

Contribution ID: **130** Type: **not specified**

Simplified Models Expose the Interplay of Direct and Indirect Searches

We propose to use Simplified Models as a tool to investigate the new physics potential of both direct and indirect searches at the LHC and future colliders. This approach leads to more transparent interpretation and reframes questions of theoretical validity in terms of concrete models. A number of examples are given to illustrate the utility of this approach. By way of three characteristic examples, we argue that the region where indirect searches that rely on SMEFT interpretations are the most powerful probes often correspond to a strong coupling limit of the associated Simplified Models. This approach allows for a robust comparison among different future collider options, where the model assumptions can be made very precise.

Authors: KAPLAN, David (Johns Hopkins University); FORSLUND, Matthew; MEADE, Patrick; STANGL, Peter (CERN); COHEN, Tim (CERN)

Contribution ID: **131** Type: **not specified**

European Strategy for Particle Physics 2026: the NA60+/DiCE experiment at the SPS

The exploration of the phase diagram of Quantum ChromoDynamics (QCD) is carried out by studying ultrarelativistic heavy-ion collisions. The energy range covered by the CERN SPS ($\sqrt{s_{\mathrm{NN}}} \sim 6-17$ GeV) is ideal for the investigation of the region of the phase diagram corresponding to finite baryochemical potential (μ_{B}), and has been little explored up to now. We propose in this document a new experiment, NA60+/DiCE (Dilepton and Charm Experiment), that will address several observables which are fundamental for the understanding of the phase transition from hadronic matter towards a Quark-Gluon Plasma (QGP) at finite μ_B. In particular, we propose to study, in Pb-Pb collisions, as a function of the collision energy, the production of thermal dimuons from the created system, from which one can obtain a caloric curve of the QCD phase diagram that may be sensitive to the order of the phase transition. In addition, the measurement of a $\rho - \mathrm{a}_1$ mixing contribution will provide conclusive insights into the restoration of the chiral symmetry of QCD. Studies of open charm and charmonium production will also be carried out, addressing the measurement of transport properties of the QGP and the investigation of the onset of the deconfinement transition. Reference measurements with proton-nucleus collisions are an essential part of this program.
The experimental set-up couples a vertex telescope based on state-of-the-art monolithic active pixel sensors (MAPS) to a muon spectrometer with tracking detectors (MWPC). Two existing CERN dipole magnets, MEP48 and MNP33, the first being stored and the second currently in use by NA62, will be used for the vertex and muon spectrometers, respectively. The continuing availability of Pb-ion beams in the CERN SPS is a crucial requirement for the experimental program.
After the submission of a LoI , the experiment proposal is currently in preparation and is due by mid 2025. The start of the data taking is foreseen by 2029/2030, and should last about 7 years.

Author: THE NA60+/DICE COLLABORATION

Contribution ID: **132** Type: **not specified**

Input to the European Strategy for Particle Physics – KATRIN collaboration

Direct kinematic neutrino-mass measurement is essential for determining the absolute neutrino mass scale, a key unknown in particle physics with deep implications for cosmology and for theories beyond the Standard Model. Unlike neutrino oscillation experiments, which probe mass differences, kinematic methods directly measure absolute neutrino masses. Precision spectroscopy of weak decays, such as beta decay and electron capture, complements cosmological and neutrinoless double beta decay constraints while providing the only model-independent approach.
Tritium beta decay leads these efforts, with KATRIN currently setting the most stringent upper limit and aiming for sub-300 meV sensitivity with its final dataset. Future advancements, including atomic
tritium and improved detection techniques, target sub-50 meV sensitivity to ultimately probe the full mass range presently allowed by oscillation bounds.
Beyond neutrino mass, high-precision beta-decay spectroscopy enables searches for exotic weak interactions, sterile neutrinos across various mass scales, and tests of fundamental symmetries, offering a powerful probe of physics beyond the Standard Model.

Authors: VALERIUS, Kathrin; Prof. MERTENS, Susanne (Technical University Munich)

Contribution ID: **133** Type: **not specified**

A High-Precision, Fast, Robust, and Cost-Effective Muon Detector Concept for the FCC-ee

We propose a high-precision, fast, robust and cost-effective muon detector concept for an FCC-ee experiment. This design combines precision drift tubes with fast plastic scintillator strips to enable both spatial and timing measurements. The drift tubes deliver two-dimensional position measurements perpendicular to the tubes with a resolution around 100˜μm. Meanwhile, the scintillator strips, read out with the wavelength-shifting fibers and silicon photomultipliers, provide fast timing information with a precision of 200˜ps or better and measure the third coordinate along the tubes with a resolution of about 1˜mm.

Authors: BROSS, Alan; TAFFARD, Anyes (University of California Irvine (US)); ZHOU, Bing (University of Michigan (US)); SUSLU, Can (University of Michigan (US)); BINI, Cesare (Universita di Roma I "La Sapienza"); YOUNG, Charlie (SLAC National Accelerator Laboratory (US)); LI, Chihao (University of Michigan (US)); HERWIG, Christian (University of Michigan (US)); FERRETTI, Claudio (University of Michigan (US)); LUCI, Claudio (Sapienza Universita e INFN, Roma I (IT)); WEAVERDYCK, Curtis (University of Michigan); LEVIN, Dan (University of Michigan (US)); DENISOV, Dmitri (Brookhaven National Laboratiry); DUKES, E. Craig (University of Virginia); SALZER, Emmett Wyse (University of Michigan (US)); ANULLI, Fabio (Sapienza Universita e INFN, Roma I (IT)); LUBATTI, Henry (University of Washington (US)); LIN, Hui-Chi (University of Michigan (US)); GE, Jiajin (University of Michigan (US)); QIAN, Jianming (University of Michigan (US)); FREEMAN, Jim (Fermi National Accelerator Lab. (US)); HUTH, John (Harvard University (US)); ZHU, Junjie (University of Michigan (US)); NELSON, Kevin Michael (University of Michigan (US)); GUAN, Liang (University of Michigan); CORRADI, Massimo (Sapienza Universita e INFN, Roma I (IT)); Prof. FRANKLIN, Melissa (Harvard University (US)); FLEISCHMANN, Philipp (University of Michigan (US)); BEAUCHEMIN, Pierre-Hugues (Tufts University (US)); SCHWIENHORST, Reinhard (Michigan State University (US)); VARI, Riccardo (Sapienza Universita e INFN, Roma I (IT)); HSU, Shih-Chieh (University of Washington Seattle (US)); ROSATI, Stefano (Istituto Nazionale di Fisica Nucleare Sezione di Roma 1); VENEZIANO, Stefano (INFN e Università Roma Sapienza); WILLOCQ, Stephane (University of Massachusetts (US)); SCHWARZ, Thomas Andrew (University of Michigan (US)); DAI, Tiesheng (University of Michigan (US)); MARTINEZ OUTSCHOORN, Verena Ingrid (University of Massachusetts (US)); TENG, Yao (University of Michigan (US)); GUO, Yuxiang

Contribution ID: **134** Type: **not specified**

PSI European Strategy Input

We emphasize the unique and peculiar opportunities that PSI provides in the field of particle physics. PSI is home
to a number of accelerator-based, low-energy precision experiments with unique reach, complementing particle physics
at the collider frontier. The document outlines both mid- and long-term projects, connected to international collabo-
rations. It highlights how particle physics contributes to advancements in other scientific fields, while also showcasing
how innovations from other sectors enrich the particle physics program. By sharing resources, such as facilities for
material science applications, the scope of research is greatly expanded. Moreover, spin-offs from developments in
detector technology and electronics benefit a wide range of industries. Radiochemistry enables unique experimental
possibilities, and shared accelerator infrastructure, along with advances in accelerator and magnet technologies, unlocks
diverse application opportunities.

Authors: PAPA, Angela; KIRCH, Klaus

Co-authors: SIGNER, Adrian; ANTOGNINI, Aldo (Paul Scherrer Institute); KNECHT, Andreas; AUCHMANN, Bernhard (PSI); LAUSS, Bernhard; CAMINADA, Lea Michaela (Paul Scherrer Institute (CH)); RIVKIN, Lenny (Paul Scherrer Institute (CH)); Dr HILDEBRANDT, Malte; JANOSCHEK, Marc; CALVI, Marco; SPIRA, Michael (Paul Scherrer Institute (CH)); SEIDEL, Mike; VAN DER MEULEN, Nicholas Philip; CRAIEVICH, Paolo; STOFFER, Peter (Paul Scherrer Institut); Dr SCHMIDT-WELLENBURG, Philipp; EICHLER, Robert (Paul Scherrer Institute); SCHIBLI, Roger; RITT, Stefan (Paul Scherrer Institut (Switzerland)); SANFILIPPO, Stephane; PROKSCHA, Thomas; HAJDAS, Wojciech

Contribution ID: **135** Type: **not specified**

Neutrino Scattering: Connections Across Theory and Experiment

In this document drafted by the Neutrino Scattering Theory Experiment Collaboration (NuSTEC), we provide input on the synergies between theoretical and experimental efforts that can provide critical input to the prediction accuracy needed for the forthcoming high-precision neutrino measurements. These efforts involve a wide range of energies and
interaction processes, as well as target nuclei and interaction probes. The challenges discussed will be overcome only through the active support of integrated collaboration across strong and electroweak physics from both the nuclear and high energy physics communities.

Authors: ASHKENAZI, Adi; PAPADOPOULOU, Afroditi; SOBCZYK, Joanna; ROCCO, Noemi

Contribution ID: **136** Type: **not specified**

Input to the European Strategy for Particle Physics - 2026 update from the Greek Community

This report presents the views of the Greek particle physics community regarding the future of high-energy physics in Europe, particularly in relation to the European Strategy for Particle Physics (ESPP) update. The survey outlines the community's academic and research profile, current challenges, and preferences for future projects. The dominant preference is for the Future Circular Collider (FCC) at CERN, with a phased approach starting with FCC-ee followed by FCC-hh. Key areas of concern include career development, sustainability, and the retention of technological expertise. The report also highlights the community's interest in advancing research in other areas, such as neutrino physics and dark matter, alongside collider projects.

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Contribution ID: **138** Type: **not specified**

Data Preservation in High Energy Physics

Data preservation significantly increases the scientific output of high-energy physics experiments during and after data acquisition. For new and ongoing experiments, the careful consideration of long-term data preservation in the experimental design contributes to improving computational efficiency and strengthening the scientific activity in HEP through Open Science methodologies. This contribution is based on 15 years of experience of the DPHEP collaboration in the field of data preservation and focuses on aspects relevant for the strategic programming of particle physics in Europe: the preparation of future programs using data sets preserved from previous similar experiments (e.g. HERA for EIC), and the use of LHC data long after the end of the data taking. The lessons learned from past collider experiments and recent developments open the way to a number of recommendations for the full exploitation of the investments made in large HEP experiments.

Authors: DIACONU, Cristinel (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); Dr SCHWICK-ERATH, Ulrich (CERN)

Co-authors: GEISER, Achim (Deutsches Elektronen-Synchrotron (DE)); IRIBARREN, Alex (CERN); ARBEY, Alexandre (Lyon U. & CERN TH); VERBYTSKYI, Andrii; Dr WIEBALCK, Arne (CERN); FUKS, Benjamin; MARIOTTI, Chiara (INFN Torino (IT)); LANGE, Clemens (Paul Scherrer Institute (CH)); CARTARO, Concetta (SLAC); BRITZGER, Daniel (Max-Planck-Institut für Physik München); SOUTH, David (Deutsches Elektronen-Synchrotron (DE)); LIKO, Dietrich (Austrian Academy of Sciences (AT)); FITZGERALD, Dillon (University of Michigan (US)); DUELLMANN, Dirk (CERN); DENISOV, Dmitri (Brookhaven National Laboratiry); ELSEN, Eckhard (Deutsches Elektronen-Synchrotron (DE)); LANCON, Eric (Brookhaven National Laboratory (US)); LE DIBERDER, Francois Rene; DAVID, Gabor; MYATT, Gerald (Nuclear Physics Laboratory); GANIS, Gerardo (CERN); Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US)); SCHELLMAN, Heidi Marie (Oregon State University (US)); KLEST, Henry (Argonne National Laboratory); FANINI, Jacopo (CERN); BOYD, Jamie (CERN); TIMMERMANS, Jan (Nikhef National institute for subatomic physics (NL)); LE MEUR, Jean-Yves (CERN); GONZALEZ LOPEZ, Jose Benito (CERN); HOGAN, Julie (Bethel University (US)); LASSILA-PERINI, Kati (Helsinki Institute of Physics (FI)); HEINRICH, Lukas Alexander (Technische Universitat Munchen (DE)); EBERT, Marcus (University of Victoria (CA)); SCHROEDER, Matthias (CERN); POTEKHIN, Maxim (Brookhaven National Laboratory (US)); RONEY, Michael; HILDRETH, Mike (University of Notre Dame (US)); SAIZ, Pablo (CERN); KRAML, Sabine (LPSC Grenoble); LEVONIAN, Sergey; HARA, Takanori (KEK/IPNS); MCCAULEY, Thomas (University of Notre Dame (US)); SIMKO, Tibor (CERN); SMITH, Tim (CERN); MARSHALL, Zach (Lawrence Berkeley National Lab. (US)); ZHANG, Zhiqing Philippe (IJCLab, Orsay (FR))

Contribution ID: **139** Type: **not specified**

Neutrinos@CERN: A Community-Driven Contribution to the Update of the European Strategy for Particle Physics

The Neutrinos@CERN workshop was held on January 23-24, 2025, at CERN. Organized by the CERN Neutrino Platform and Physics Beyond Colliders, this two-day event aimed to explore opportunities for neutrino physics experiments at CERN, leveraging existing, planned, and proposed facilities. The workshop brought together a significant portion of the neutrino physics community to discuss these possibilities and provide input to the European Strategy for Particle Physics Update (ESPPU). This document summarizes these inputs and the corresponding community statements.

Authors: RESNATI, Filippo (CERN); TERRANOVA, Francesco (Universita & INFN, Milano-Bicocca (IT)); SCHNELL, Gunar

Contribution ID: **140** Type: **not specified**

A Linear Collider Vision for the Future of Particle Physics

In this paper we review the physics opportunities at linear ee colliders with a special focus on high centre-of-mass energies and beam polarisation, take a fresh look at the various accelerator technologies available or under development and, for the first time, discuss how a facility first equipped with a technology that is mature today could be upgraded with technologies of tomorrow to reach much higher energies and/or luminosities. In addition, we discuss detectors, alternative collider modes, as well as opportunities for beyond-collider experiments and R&D facilities as part of a linear collider facility (LCF). The material of this paper supports all plans for ee linear colliders and additional opportunities they offer, independently of technology choice or proposed site, as well as R&D for advanced accelerator technologies.
This joint perspective on the physics goals, early technologies and upgrade strategies has been developed by the LCVision team based on an initial discussion at LCWS2024 in Tokyo and a follow-up at the LCVision Community Event at CERN in January 2025. It heavily builds on decades of achievements of the global linear collider community, in particular in the context of CLIC and ILC.

Authors: LIST, Jenny (Deutsches Elektronen-Synchrotron (DE)); POESCHL, Roman (Université Paris-Saclay (FR))

Contribution ID: **141** Type: **not specified**

The ECFA Higgs/Electroweak/Top Factory Study

This is the executive summary of the ECFA Higgs/Electroweak/Top Factory Study report being submitted as input to the 2025 European Strategy for Particle Physics Update. A very brief overview of the Study's activities is given here, taking the Focus Topics developed in the course of the Study as a structure to highlight aspects that were explored. A broad effort across the experimental and theoretical community has advanced the joint development of tools and analysis techniques, fostered new considerations of detector design and optimisation, and led to a new set of studies resulting in improved projected sensitivities across a wide physics programme. The report demonstrates the significant expansion in the state-of-the-art understanding of the physics potential of future \epem Higgs/Electroweak/Top factories.

Authors: ROBSON, Aidan (University of Glasgow (GB)); LEONIDOPOULOS, Christos (The University of Edinburgh (GB))

Contribution ID: **142** Type: **not specified**

A Straw Tracker for an FCC-ee experiment

We propose a straw tracker concept for an FCC-ee experiment. Combining excellent track reconstruction accuracy with a minimal material budget, the straw tracker enables precise momentum measurements with a resolution in the range of 0.1%. In addition, it provides excellent charged particle identification capabilities over a wide momentum range through dE/dX or dN/dX measurements.

Authors: VERBYTSKYI, Andrii (Max Planck Society (DE)); TAFFARD, Anyes (University of California Irvine (US)); KOTWAL, Ashutosh (Duke University (US)); ZHOU, Bing (University of Michigan (US)); SUSLU, Can (University of Michigan (US)); YOUNG, Charlie (SLAC National Accelerator Laboratory (US)); LI, Chihao (University of Michigan (US)); HERWIG, Christian (University of Michigan (US)); WEAVERDYCK, Curtis John (University of Michigan (US)); CIERI, Davide (Max Planck Society (DE)); VOEVODINA, Elena (Max Planck Society (DE)); LIPELES, Elliot (University of Pennsylvania (US)); SALZER, Emmett Wyse (University of Michigan (US)); Dr FALLAVOLLITA, Francesco (Max Planck Society (DE)); IAKOVIDIS, George (Brookhaven National Laboratory (US)); PROTO, Giorgia (Max Planck Society (DE)); KROHA, Hubert (Max Planck Society (DE)); GE, Jiajin (University of Michigan (US)); QIAN, Jianming (University of Michigan (US)); HUTH, John (Harvard University (US)); ZIMMERMANN, Jorg (Max Planck Society (DE)); OKFEN, Julia Isabel (Max Planck Society (DE)); ZHU, Junjie (University of Michigan (US)); KUZNETSOVA, Katerina (University of Florida (US)); NELSON, Kevin Michael (University of Michigan (US)); GUAN, Liang (University of Michigan); ZHANG, Linnuo (University of Science and Technology of China (CN)); ARIAS, Marcos (University of Michigan (US)); Prof. FRANKLIN, Melissa (Harvard University (US)); NEWCOMER, Mitchell Franck (University of Pennsylvania (US)); RISTOW, Nicholas (University of Michigan); KORTNER, Oliver (Max Planck Society (DE)); ONYISI, Peter (University of Texas at Austin (US)); BEAUCHEMIN, Pierre-Hugues (Tufts University (US)); SCHWIENHORST, Reinhard (Michigan State University (US)); RICHTER, Robert (Max Planck Society (DE)); KORTNER, Sandra (Max Planck Society (DE)); Prof. OH, Seog (Duke University); WILLOCQ, Stephane (University of Massachusetts (US)); ENIK, Temur (Joint Institute for Nuclear Research (RU)); SCHWARZ, Thomas Andrew (University of Michigan (US)); DAI, Tiesheng (University of Michigan (US)); MARTINEZ OUTSCHOORN, Verena Ingrid (University of Massachusetts (US)); LI, Yicheng (University of Michigan (US)); GUO, Yuxiang

Contribution ID: **144** Type: **not specified**

Communicating for the future of particle physics

The European Particle Physics Communication Network (EPPCN) has its origins in the inaugural European Strategy for Particle Physics exercise in 2006. The need for greater coordination in communicating CERN's large-scale scientific projects was a key recommendation and EPPCN was established at the request of the CERN Council.

EPPCN provides strategic communication guidance to CERN and its Member and Associate Member States, ensuring coordinated and effective public engagement in particle physics. As the field faces critical decisions regarding its next major research infrastructure, proactive communication is essential to secure public and political support.

This paper outlines the need for a strengthened European strategy for communicating particle physics, emphasising the importance of transparency, inclusivity, and outreach. It highlights four key recommendations:

1. establishing a central office to coordinate a common European vision and strategy and joint initiatives for communications,
2. encouraging all members of the community to engage in outreach activities,
3. transparently addressing environmental sustainability in particle physics communications, and
4. ensuring adequate funding for education, communication and outreach initiatives.

By implementing these recommendations, the particle physics community can foster greater public trust, demonstrate its societal value, and build a broad coalition of support for future scientific endeavours. Effective communication will be instrumental in inspiring the next generation of scientists, reinforcing international collaboration, and securing the resources necessary for the continued advancement of fundamental research.

Author: Mrs MEXNER, Vanessa (Nikhef / EPPCN)

Co-authors: MARSOLLIER, Arnaud (CERN); Mr BUBNJEVIC, Slobodan (IPB / EPPCN co-chair elect)

Contribution ID: **145** Type: **not specified**

SHiP experiment at the SPS Beam Dump Facility

In 2024, the SHiP experiment, together with the associated Beam Dump Facility (BDF) under the auspices of the High Intensity ECN3 (HI-ECN3) project, was selected for the future physics exploitation of the ECN3 experimental facility at the SPS. The SHiP experiment is a general-purpose intensity-frontier setup designed to search for physics beyond the Standard Model in the domain of Feebly Interacting Particles at the GeV-scale. It comprises a multisystem apparatus that provides discovery sensitivity to both decay and scattering signatures of models with feebly interacting particles, such as dark-sector mediators, both elastic and inelastic light dark matter, as well as millicharged particles. The experiment will also be able to perform both Standard Model measurements and Beyond Standard Model searches with neutrino interactions. In particular, it will have access to unprecedented statistics of tau and anti-tau neutrinos. The construction plan foresees commissioning of the facility and detector, and start of operation in advance of Long Shutdown 4, with a programme of exploration for 15 years of data taking. By exploring unique regions of parameter space for feebly interacting particles in the GeV/c2 mass range, the SHiP experiment will complement ongoing searches at the LHC and searches at future colliders.

Author: SHIP COLLABORATION

Co-author: CERN HI-ECN3 PROJECT TEAM

Contribution ID: **146** Type: **not specified**

The International Axion Observatory (IAXO): case, status and plans.

The International Axion Observatory (IAXO) is a next-generation axion helioscope designed to search for solar axions with unprecedented sensitivity. IAXO holds a unique position in the global landscape of axion searches, as it will probe a region of the axion parameter space inaccessible to any other experiment. In particular, it will explore QCD axion models in the mass range from meV to eV, covering scenarios motivated by astrophysical observations and potentially extending to axion dark matter models. Several studies in recent years have demonstrated that IAXO has the potential to probe a wide range of new physics beyond solar axions, including dark photons, chameleons, gravitational waves, and axions from nearby supernovae. IAXO will build upon the two-decade experience gained with CAST, the detailed studies for BabyIAXO, which is currently under construction, as well as new technologies. If, in contrast to expectations, solar axion searches with IAXO "only"result in limits on new physics in presently uncharted parameter territory, these exclusions would be very robust and provide significant constraints on models, as they would not depend on untestable cosmological assumptions.

Authors: LINDNER, Axel (Deutsches Elektronen-Synchrotron (DE)); GARCIA IRASTORZA, Igor (Universidad de Zaragoza (ES)); GIANNOTTI, Maurizio (Universidad de Zaragoza (ES))

Contribution ID: **147** Type: **not specified**

Spanish national input to the European Strategy for Particle Physics

The LHC will continue to be the world's leading project in particle physics for the next two decades. Therefore, completing its high-luminosity upgrade and fully exploiting its physics programme must remain the top medium-term priority. The FCC project, including the initial electron-positron and subsequent hadron-hadron phases, has broad support across the Spanish community as the preferred next flagship facility at CERN. The community is committed to participating at all levels. This ambitious project, with its large overall physics potential, would strengthen Europe's leadership in the field, with CERN as the global reference laboratory. Should the FCC be unfeasible, the preferred alternative would be a linear electron-positron collider at CERN, starting with a Higgs factory stage and further upgrading it to reach the TeV scale.
Ensuring a diverse and comprehensive physics programme is crucial for addressing fundamental physics questions, including fixed-target, neutrino, flavour, astroparticle and nuclear physics experiments. CERN should continue supporting leading-edge projects through the Recognized Experiment status and international collaboration agreements.
A strong investment in accelerator R&D, along with the necessary advancements in detectors and computing, is essential for the success of future endeavours. Full implementation of the corresponding ECFA R&D roadmaps, prioritizing the required FCC developments and including environmental sustainability considerations, must be achieved. Additionally, continued theoretical advancements, particularly in high-order perturbative computations, non-perturbative studies and model-building, are crucial for future discoveries, with CERN remaining a key hub for collaboration and support.
An early decision on CERN's next flagship project is critical for our young researchers, and their involvement in the early stages would be highly beneficial. Effective communication and outreach will be essential for such an unprecedented endeavour as the FCC.

Author: COSTA, Maria Jose (IFIC (CSIC-UV) Valencia (ES))

Contribution ID: **148** Type: **not specified**

Technology developments for LHCb Upgrade II

A major LHCb detector upgrade will be installed during Long Shutdown 4 (LS4) of the CERN Large Hadron Collider.The experiment will operate at a maximum luminosity of $1.5 \times 10^{34}\text{cm}^{-2}\,\text{sec}^{-1}$, with acceptance covering a pseudorapidity range close to the beamline. The detector will therefore experience extremely high particle fluences. In order to carry out the LHCb physics programme, technologies are being developed that can withstand the high rates and associated radiation damage while also providing excellent resolution in both space and time. The amount of data to be processed in the online computing and trigger system is also unprecedented. In this document, the technology developments that are necessary to realise this programme are summarised.

Authors: PUNZI, Giovanni (Universita & INFN Pisa (IT)); GERSHON, Timothy (University of Warwick (GB)); UNKNOWN, Vincenzo Vagnoni (Bologna)

Contribution ID: **149** Type: **not specified**

MINERvA neutrino interaction experiment input to the ESPP

The MINERvA neutrino interaction experiment operated at Fermilab from 2009 to 2019. We achieved a set of measurements on nuclei from helium to lead that support current and future neutrino experiments. Among neutrino experiments, we have a world-leading number of scientific publications with about twenty more in the pipeline. In our experience, new measurements on elementary nucleons (hydrogen and deuterium) would be especially valuable. Support for the Phase 2 DUNE near detector with gas argon technology is also complementary to our program. MINERvA will be releasing a public data preservation product toward the end of 2025. Deeper use of the MINERvA data in addition to our publications will be complementary to new dedicated and oscillation near detector measurements. We also want to see the strong neutrino interaction theory and phenomenology community in Europe grow to maximize use of recent data.

Authors: WALDRON, Abbey (Oxford/T2K); WALDRON, Abigail (Imperial College (GB)); GRAN, Rik (University of Minnesota Duluth)

Contribution ID: **150** Type: **not specified**

Reinterpretation and preservation of data and analyses in HEP

Data from particle physics experiments are unique and are often the result of a very large investment of resources. Given the potential scientific impact of these data, which goes far beyond the immediate priorities of the experimental collaborations that obtain them, it is imperative that the collaborations and the wider particle physics community publish and preserve sufficient information to ensure that this impact can be realised, now and into the future. The information to be published and preserved includes the algorithms, statistical information, simulations and the recorded data. This publication and preservation requires significant resources, and should be a strategic priority with commensurate planning and resource allocation from the earliest stages of future facilities and experiments.

Authors: PROSPER, Harrison; BUTTERWORTH, Jonathan (UCL); KRAML, Sabine (LPSC Grenoble)

Co-authors: Prof. LESSA, Andre (CCNH - Univ. Federal do ABC); BUCKLEY, Andy (University of Glasgow (GB)); LANGE, Clemens (Paul Scherrer Institute (CH)); DIACONU, Cristinel (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); Dr STARK, Giordon Holtsberg (University of California,Santa Cruz (US)); WATT, Graeme; REYES GONZALEZ, Humberto; WURZINGER, Jonas (Technische Universitat Munchen (DE)); MAMUZIC, Judita (IFAE - Barcelona); LASSILA-PERINI, Kati (Helsinki Institute of Physics (FI)); ROLBIECKI, Krzysztof (Warsaw University); Dr CORPE, Louie Dartmoor (Laboratoire de Physique Clermont Auvergne (LPCA)); GOODSELL, Mark Dayvon (Centre National de la Recherche Scientifique (FR)); HABEDANK, Martin (University of Glasgow); GRAS, Philippe (Université Paris-Saclay (FR)); MAHBUBANI, Rakhi (Rudjer Boskovic Institute (HR)); SEKMEN, Sezen (Kyungpook National University (KR)); MCCAULEY, Thomas (University of Notre Dame (US)); MARSHALL, Zach (Lawrence Berkeley National Lab. (US))

Contribution ID: **151** Type: **not specified**

ESSnuSB (European Spallation Source neutrino Super Beam)

ESSnuSB (the European Spallation Source neutrino Super Beam) is a design study for a Long Baseline (LBL) neutrino experiment to precisely measure the CP violation in the lepton sector, at the second neutrino oscillation maximum, using a beam driven by the uniquely powerful ESS proton linear accelerator in Lund, Sweden, a near detector suite and two large underground water Cherenkov detectors of a total fiducial volume 540,000 m3, located 360 Km north of Lund. The ESSnuSB Conceptual Design Report showed that after 10 years of running, about 72% of the possible CP-violating phase, δCP, range will be covered with 5σ C.L. to reject the no-CP-violation hypothesis. The expected precision for δCP is better than 8° for all δCP values, making it the most precise proposed experiment in the field. The ESSnuSB collaboration is currently working on the extension project, the ESSnuSB+, which aims in designing two new facilities, a Low Energy nuSTORM and a Low Energy Monitored Neutrino Beam to be used to precisely measure the neutrino-nucleus cross-section in the energy range of 0.2–0.6 GeV. A new water Cherenkov detector will also be designed to measure cross sections and also serve to explore the sterile neutrino case in a Short Baseline (SBL) experiment. An overall status of the project is presented together with the ESSnuSB+ additions.

Authors: FANOURAKIS, Georgios (Nat. Cent. for Sci. Res. Demokritos (GR)); Dr DRACOS, Marcos (Centre National de la Recherche Scientifique (FR)); EKELOF, Tord (Uppsala University (SE))

Contribution ID: **152** Type: **not specified**

United States Muon Collider Community White Paper for the European Strategy for Particle Physics Update

This document is being submitted to the 2024-2026 European Strategy for Particle Physics Update (ESPPU) process on behalf of the US Muon Collider community, with its preparation coordinated by the interim US Muon Collider Coordination Group. The US Muon Collider Community comprises a few hundred American scientists. The purpose of the document is to inform ESPPU about the US plans for Muon Collider research and development (R&D), explain how these efforts align with the broader international R&D initiatives, and present the US community vision for the future realization of this transformative project.

Authors: STRATAKIS, Diktys; DI PETRILLO, Karri Folan (University of Chicago); Dr BEGEL, Michael (Brookhaven National Laboratory (US)); CRAIG, Nathaniel; MEADE, Patrick; BHAT, Pushpa (Fermi National Accelerator Lab. (US)); JINDARIANI, Sergo (Fermi National Accelerator Lab. (US)); PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US)); DASU, Sridhara (University of Wisconsin Madison (US)); GOURLAY, Stephen (FNAL); HOLMES, Tova Ray (University of Tennessee (US)); Dr PALMER, mark (BNL)

Contribution ID: **153** Type: **not specified**

The Circular Electron Positron Collider (CEPC)

The Higgs boson, discovered in 2012 by the ATLAS and CMS Collaborations at the Large Hadron Collider (LHC), plays a central role in the Standard Model. The arrival of the Higgs boson brings along great scientific opportunities for the human being. Measuring the Higgs properties precisely will advance our understandings of some of the most important questions in particle physics, such as the naturalness of the electroweak scale and the nature of the electroweak phase transition. The Higgs boson could also be a window for exploring new physics, such as dark matter and its associated dark sector, heavy sterile neutrino, and more. The Circular Electron Positron Collider (CEPC), proposed by the Chinese High Energy community in 2012, is designed to run at a center-of-mass energy of 240 GeV as a Higgs factory. The CEPC can also be operated at lower energies to deliver unprecedented amount of Z and W bosons, and further be upgraded to run at higher energy to the top pair threshold. The estimated construction cost is approximately 4.6B CHF. The luminosities of the CEPC are mainly limited by the synchrotron radiation (SR) power. The CEPC baseline SR is set for 30 MW per beam, and is upgradable to 50 MW. A tentative "10-2-1-5" operation plan is devised to run the CEPC firstly as a Higgs factory for 10 years to produce about 2.6 million Higgs bosons with the baseline configuration, followed by 2 years of operation as a Super Z factory to produce 2.5 trillion Z bosons, and then 1 year as a W factory to produce approximately 130 million WW bosons. Finally, an energy upgrade will enable the CEPC to operate at the $t\bar{t}$ energy to produce 0.4 million $t\bar{t}$ pairs.

The CEPC Conceptual Design Report (CDR) was formally released in November 2018, while the Technical Design Report (TDR) for the CEPC accelerator was published on December 25, 2023. The TDR for the CEPC detector and an Engineering Design Report (EDR) are currently under development, and are expected to be released in June 2025 and December 2027, respectively. A CEPC proposal (including the accelerator, the detector, an EDR site feasibility study and the civil engineering design) will be submitted to the central Chinese government in 2025 to apply for the approval of the CEPC project. The planned schedule aims at starting the construction during the "15th five-year plan (2026-2030)"(for example, around 2027) and completing it around 2035. This document provides a brief summary of the development, the design and the plan of the CEPC accelerator and the detector, the associated physics potential, drawing from both published and forthcoming TDRs and EDRs, and the work being conducted to prepare CEPC for delivery. Effective international collaboration will be crucial at this stage. This submission for consideration by the ESPP reflects our commitment to seeking international cooperation and leveraging global synergies for a Higgs factory.

Authors: Dr WANG, Dou (IHEP); WANG, Jianchun (Chinese Academy of Sciences (CN)); GAO, Jie; HE, Miao

Contribution ID: **154** Type: **not specified**

Midterm Review of the European Accelerator R&D Roadmap

The European Accelerator R&D Roadmap with five topical R&D panels was implemented in 2022, following a recommendation of the 2020 update of the European Strategy for Particle Physics Update (ESPPU) to intensify the accelerator R&D. This first phase of the accelerator roadmap is planned till 2026. In February 2025 a mid-term review of the roadmap activities has been conducted on behalf of LDG, by an independent panel of experts. The review assesses the status of the R&D activities, the readiness of the involved technologies and the future plans. In this submission to the ESPPU we motivate this review of the European Accelerator Roadmap and publish the report of the review committee.

Author: SEIDEL, Mike

Contribution ID: **155** Type: **not specified**

Experimental Study of Rare Kaon Decays at J-PARC with KOTO and KOTO II

The rare kaon decay $K_L \to \pi^0 \nu \bar{\nu}$ is extremely sensitive to new physics, because the contribution to this decay in the Standard Model (SM) is highly suppressed and known very accurately; the branching ratio is 3×10^{-11} in the SM with a theoretical uncertainty of just 2\%. The measurement of this branching ratio could provide essential new information about the flavor structure of the quark sector
from the $s \to d$ transition.
The decay is being searched for in the KOTO experiment at J-PARC, which has obtained the current best upper limit on the branching ratio of 2.2×10^{-9}; a sensitivity to branching ratios below 10^{-10} is achievable by the end of the decade.
A next-generation experiment at J-PARC, KOTO˜II, was proposed in 2024 with 82 members worldwide, including significant contributions from European members. The goal of KOTO˜II is to measure the $K_L \to \pi^0 \nu \bar{\nu}$ branching ratio with sensitivity below 10^{-12} in the 2030s. Discovery of the decay with 5σ significance is achievable at the SM value of the branching ratio. An indication of new physics with a significance of 90\% is possible if the observed branching ratio differs by 40\% from the SM value. Another important goal of KOTO˜II is to measure the branching ratio of the unobserved $K_L \to \pi^0 e^+ e^-$ decay, which can give an input to flavor structures of new physics. Other rare K_L decays and hidden-sector particles are also in the scope of the study.
After 2026, KOTO will be the only dedicated rare kaon decay experiment in the world, and KOTO˜II is the only future rare kaon decay project currently proposed. We would like to lead a global initiative for the experimental study of rare kaon decays, with significant contributions and support from the European community.

Authors: LAZZERONI, Cristina (University of Birmingham (GB)); NANJO, Hajime (Osaka University (JP)); MOULSON, Matthew (INFN e Laboratori Nazionali di Frascati (IT)); NOMURA, Tadashi; WAH, Yau

Contribution ID: **157** Type: **not specified**

Towards instrumentation for future HEP experiments

This input provides a perspective on progress of the formation of Detector Research and Development collaborations and where they stand on their way to execute the scientific program outlined in the ECFA Detector Development Roadmap.

Authors: CONTARDO, Didier Claude (Centre National de la Recherche Scientifique (FR)); SEFKOW, Felix (Deutsches Elektronen-Synchrotron (DE))

Contribution ID: **158** Type: **not specified**

Community input to the European Strategy on particle physics: Searches for Permanent Electric Dipole Moments

Searches for electric dipole moments (EDMs) in fundamental particles and quantum systems with spin are pivotal experiments at the intersection of low-energy and high-precision particle physics. These investigations offer a complementary pathway to uncovering new physics beyond the Standard Model, parallel to high-energy collider searches. EDM experiments are among the most sensitive probes for detecting non-standard time-reversal (T) symmetry violations and, via the CPT theorem, CP-violation (CPV). Current EDM measurements test new physics at mass scales in or above the $10-100$TeV range.
This community input to the European Particle Physics Strategy Update highlights the status of the field, and describes challenges and opportunities in Europe.

Authors: KESHAVARZI, Alex (University of Manchester); BORSCHEVSKY, Anastasia; PAPA, Angela; LAUSS, Bernhard; RIES, Dieter Achim; MARTINEZ-VIDAL, Fernando (IFIC, Universitat de Valencia-CSIC); PIEGSA, Florian Michael; Prof. ONDERWATER, Gerco (University of Maastricht); NEYENS, Gerda (KU Leuven (BE)); DOBACZEWSKI, Jacek; DE VRIES, Jordy; FLANAGAN, Kieran (University of Manchester); DI LUZIO, Luca; NIES, Lukas (CERN); KORTELAINEN, Markus; AU, Mia (CERN); Dr JENTSCHEL, Michael (Institute Laue-Langevin); TARBUTT, Michael; ATHANASAKIS-KAKLAMANAKIS, Michail (CERN); NERI, Nicola (Università degli Studi e INFN Milano (IT)); VIVES GARCIA, Oscar Manuel (Univ. of Valencia and CSIC (ES)); Prof. FIERLINGER, Peter (Technical University Munich); STOFFER, Peter (Paul Scherrer Institut); Dr SCHMIDT-WELLENBURG, Philipp; Prof. BERGER, Roland (U. Marburg); Prof. STELLMER, Simon (University Bonn); DEGENKOLB, Skyler; HOEKSTRA, Steven (University of Groningen, and Nikhef); HOEKSTRA, Steven (University of Groningen, and Nikhef); FLEIG, Timo (University of Toulouse); VAN KOLCK, Ubirajara; SCHMIDT, Ulrich; Prof. SANZ GONZALEZ, Veronica (Universities of Valencia and Sussex); CIRIGLIANO, Vincenzo; Dr GRIFFITH, W. Clark (University of Sussex); Prof. SEMERTIZIDIS, Yannis (KAIST); FILIPPONE, brad (caltech); CARUGNO, giovanni (INFN)

Contribution ID: **159** Type: **not specified**

Contribution of ALEGRO to the Update of the European Strategy on Particle Physics

Advanced and novel accelerators (ANAs), driven a by laser pulse or a relativistic particle bunch, have made remarkable progress over the last decades. They accelerated electrons by 10 GeV in 30 cm (laser driven) and by 42 GeV in 85 cm (particle bunch driven). Rapid progress continues with lasers, plasma sources, computational methods, and more. In this document we highlight the main contributions made by the various major collaborations, facilities, and experiments that develop ANAs for applications to particle and high-energy physics. These include: ALiVE, ANL-AWA, AWAKE, BNL-ATF, CEPC Injector, DESY-KALDERA, ELI ERIC, EuPRAXIA, HALHF, LBNL-BELLA, LBNL-kBELLA, LCvison, PETRA IV Injector, 10 TeV Collider design, SLAC-FACET II, as well as the development of structures, lasers and plasma sources, and sustainability, and demonstrate the intense activities in the field.
ANAs can have, and already have, applications to particle and high-energy physics as subsystems, the so-called intermediate applications: injectors, lower energy experiments, beam dump experiments, test beds for detectors, etc. Additionally, an ANA could be an upgrade for any Higgs factory based on a linear accelerator, as proposed in the LCvison project. ANAs have advantages over other concepts for reaching multi-TeV energies: lower geographical and environmental footprints, higher luminosity to power ratio, and are thus more sustainable than other accelerators.
However, ANAs must still meet a number of challenges before they can produce bunches with parameters and the luminosity required for a linear collider at the energy frontier. It is therefore extremely important to strongly support vigorous R&D of ANAs, because they are, at this time, *the most sustainable acceleration scheme to reach very high energies with a linear accelerator.*
They also have numerous lower energy applications as light and particle sources for research, industrial, medical, and security applications.

Authors: CROS, Brigitte (LPGP CNRS UPSaclay); MUGGLI, Patric (Max Planck Institute for Physics)

Contribution ID: **160** Type: **not specified**

Beam monitoring through beamstrahlung

Beam monitoring is crucial for particle accelerators to achieve high luminosity. We describe our work to develop a reliable beam monitoring device utilizing observation of the beamstrahlung, radiation emitted by a beam of charged particles when it accelerates in the electromagnetic field of another beam of charged particles.

Authors: Dr LIVENTSEV, Dmitri (Wayne State University); BONVICINI, giovanni (Wayne State University)

Contribution ID: **161** Type: **not specified**

Call for a new approach to detector developments involving microelectronics

Microelectronics technologies form the basis of many innovative developments for HEP detectors and will continue to do so. However, the cost of access (both in terms of monetary resources and design manpower) has exploded over recent years. Even the largest experiments (ALTAS and CMS) have been obliged to pool design resources for their latest pixel detector upgrades. The Medipix Collaborations have demonstrated that it is possible to develop ASICs which can bring meaningful breakthroughs in different scientific fields. The pooling of resources has permitted to gain access to leading edge packaging technologies which would otherwise be unobtainable. The Timepix ASICs, in particular, have been used in many HEP experiments both large and small. The critical mass of resources available in the collaborations has enabled the development of knowhow which led directly back to designs for HEP (LHCb VELOpix ASIC). However, such activities have been considered as low priority or even a distraction by some in the HEP community. As the need for resource pooling grows with time, the HEP community needs to find ways to open up to collaborating with others. The HEP community is a model of international collaboration. If it wants to benefit from the fantastic opportunities available using near leading-edge CMOS processes it needs to extend this model to include colleagues from other fields of science.

Author: CAMPBELL, Michael (CERN)

Contribution ID: **162** Type: **not specified**

Sustainability Assessment of Future Accelerators

The Large Particle Physics Laboratory Directors Group (LDG) established the Working Group on the Sustainability Assessment of Future Accelerators in 2024 with the mandate to develop guidelines and a list of key parameters for the assessment of the sustainability of future accelerators in particle physics.
While focused on accelerator projects, much of the work will also be relevant to other current and future Research Infrastructures. The development and continuous update of such a framework aim to enable a coherent communication amongst scientists and adequately convey the information to a broader set of stakeholders.
This document outlines the major findings and recommendations from the LDG Sustainability WG report - a summary of current best practices
recommended to be adopted by new Research Infrastructures. The full report will be available in June 2025 at:
https://ldg.web.cern.ch/working-groups/sustainability-assessment-of-accelerators.
Not all of sustainability topics are addressed at the same level. The assessment process is complex, largely under development and a homogeneous evaluation of all the aspects deserves a strategy to be pursued over time.

Authors: BLOISE, Caterina (INFN e Laboratori Nazionali di Frascati (IT)); Dr TITOV, Maksym (IRFU, CEA Saclay, Université Paris-Saclay (FR))

Contribution ID: **163** Type: **not specified**

Science4Peace: A Plea for Continued Peaceful International Scientific Cooperation

The European Strategy for Particle Physics (ESPP) - 2026 update is taking place in a turbulent international climate. Many of the norms that have governed relations between states for decades are being broken or challenged. The future progress of science in general, and particle physics in particular, will depend on our ability to maintain peaceful international scientific collaboration in the face of political pressures. We plead that the ESPP 2026 update acknowledge explicitly the importance of peaceful international scientific collaboration, not only for the progress of science, but also as a precious bridge between geopolitical blocs.

Scientific thought is the common heritage of mankind - Abdus Salam

Authors: ALI, Ahmed (Deutsches Elektronen-Synchrotron (DE)); BARONE, Michele (Nat. Cent. for Sci. Res. Demokritos (GR)); BRITZGER, Daniel (Max-Planck-Institut für Physik München); COOPER-SARKAR, Amanda; Prof. ELLIS, John (Kings College London); FRANCHOO, Serge (Université Paris-Saclay (FR)); GIAMMANCO, Andrea (Universite Catholique de Louvain (UCL) (BE)); GLAZOV, Alexander (Deutsches Elektronen-Synchrotron (DE)); JUNG, Hannes (Deutsches Elektronen-Synchrotron (DE)); KAEFER, Daniela; LIST, Jenny (Deutsches Elektronen-Synchrotron (DE)); LÖNNBLAD, Leif (Lund University (SE)); MANGANO, Michelangelo (CERN); RAICEVIC, Natasa (University of Montenegro (ME)); ROSTOVTSEV, Andrei (ITEP Institute for Theoretical and Experimental Physics (RU)); SCHMELLING, Michael (Max Planck Society (DE)); SCHUCKER, Thomas (CPT, Marseille); TANASIJCZUK, Andres Jorge (Universite Catholique de Louvain (UCL) (BE)); VAN MECHELEN, Pierre (University of Antwerp (BE))

Contribution ID: **164** Type: **not specified**

Science of the LISA mission: A Summary for the European Strategy for Particle Physics

The LISA mission is an international collaboration between ESA, its member states, and NASA, for the detection of gravitational waves from space. It was adopted in January 2024 and is scheduled for launch in the mid-2030's. It will be a constellation of three identical spacecraft forming a near-equilateral triangle in an heliocentric orbit, transferring laser beams over 2.5 million km long arms. Laser interferometry is used to track separations between test masses, thus measuring spacetime strain variations as a function of time. LISA Science Objectives tackle many open questions in astrophysics, fundamental physics and cosmology, including ESA's Cosmic Vision questions "What are the fundamental laws of the universe?" and "How did the universe
originate and of what is it made?". In this contribution, based on the LISA Red Book, we present a summary of the LISA Science Objectives relevant for the European Strategy for Particle Physics.

Authors: HEFFERNAN, Anna; CAPRINI, Chiara (CERN); STEER, Daniele Ann (Ecole Normale Superieure (FR)); Mrs FRANCIOLINI, Gabriele; NARDINI, Germano (University of Stavanger); LISA SCIENCE TEAM; TAMANINI, Nicola (L2IT / CNRS); BRITO, Richard

Contribution ID: **165** Type: **not specified**

A Possible Future Use of the LHC Tunnel

The FCC program at CERN provides an attractive all-in-one solution to address many of the key questions in particle physics. While we fully support the efforts towards this ambitious path, we believe that it is important to prepare a mitigation strategy in case the program faces unexpected obstacles for geopolitical or other reasons. This approach could be based on two components: I) a circular electron-positron collider in the LHC tunnel that operates at the Z-pole energy of 45.6 GeV and II) a high-energy electron-positron linear collider which acts as a Higgs, top quark and W-boson factory, and that can further be extended to TeV energies. The former could reach a high luminosity that is not accessible at a linear collider, the latter could probe the high energy regime with higher sensitivity and discovery potential than LEP3. The program should be flanked by dedicated intensity frontier searches at lower energies. These accelerators can be used in a feasible, timely and cost-efficient way to search for new physics and make precise determination of the parameters of the Standard Model.

Authors: SHAPOSHNIKOVA, Elena; DREWES, Marco (Universite Catholique de Louvain (UCL) (BE)); Prof. SHAPOSHNIKOV, Mikhail (EPFL - Ecole Polytechnique Federale Lausanne (CH))

Contribution ID: **167** Type: **not specified**

AI-RDs: A EuCAIF proposal to structure AI research in Particle Physics

Accelerating the development and application of state-of-the-art artificial intelligence (AI) solutions for high-energy physics calls for a structured effort. The European Coalition for AI in Fundamental Physics (EuCAIF) provides a framework for coordinating AI research in fundamental physics. We propose AI Research and Development Groups (AI-RDs) to enable a long-term, fundamental AI research program. AI-RDs will support the development and maintenance of leading AI tools for experimental and theoretical physics, facilitate knowledge transfer, and provide a structure for the systematic evaluation of AI methods. Additionally, they will create new training and career development opportunities for researchers working at the interface of AI and physics.

Authors: WENIGER, Christoph; PIERINI, Maurizio (CERN); CARON, Sascha (Nikhef National institute for subatomic physics (NL)); PLEHN, Tilman

Contribution ID: **168** Type: **not specified**

Addressing Scientific Computing for HEP needs beyond Experimental Particle Physics

We propose the establishment of a specialized group at CERN focused on Advanced Scientific Computing. This group would address the increasing complexity of computing applications beyond experimental particle physics, such as Lattice QCD and event generator libraries for experiments at colliders. Building on advancements in heterogeneous computing, large-scale computation, and AI applications—both within and beyond the LHC experimental collaborations—this group would serve as a central hub, fostering a community that supports scientific progress through advanced computing expertise.

Authors: JUTTNER, Andreas (CERN); FINKENRATH, Jacob Friedrich (CERN); PIERINI, Maurizio (CERN); MANGANO, Michelangelo (CERN)

Contribution ID: **169** Type: **not specified**

Pakistan Input to the European Strategy for Particle Physics 2026

1. Introduction
2. Pakistan's Contributions to the European Strategy for Particle Physics
3. Proposed Areas for Collaboration
4. Answers to ECFA questions
5. Executive Summary

Author: YASIN, Zafar (Pakistan Inst. Nucl. Sci. Tech., Physics Division)

Contribution ID: **170** Type: **not specified**

Highlights of the HL-LHC physics projections by ATLAS and CMS

The ATLAS and CMS experiments are unique drivers of our fundamental understanding of nature at the energy frontier. In this contribution to the update of the European Strategy for Particle Physics, we update the physics reach of these experiments at the High-Luminosity LHC (HL-LHC) in a few key areas where they will dominate the state-of-the-art for decades to come. With a collected luminosity of 3ab^{-1} of physics quality data per experiment, ATLAS and CMS can achieve:

-The observation of the $H \to \mu^+\mu^-$ and $H \to Z\gamma$ rare processes and the determination of the corresponding couplings with a precision of 3 and 7%, respectively;
-The measurement of the other main Higgs boson couplings to fermions and vector bosons (including loop-induced and Standard Model (SM) suppressed couplings to the photon and the gluons) with a precision between 1.6 and 3.6%, assuming only known Higgs boson interactions;
-A sensitivity to the charm Yukawa coupling of 1.5 times the SM value at 95% Confidence Level (CL);
-The observation of the SM di-Higgs-boson production with a significance exceeding 7σ;
-The measurement of the Higgs boson trilinear self-coupling λ_3 with a precision better than 30%;
-Sensitivity to fully exclude at 95% CL generic, high-scale new physics models enabling a strong first-order electroweak phase transition in the early universe;
-The observation of the longitudinally polarised vector boson scattering W_LW_L process, which constitutes an independent check of the spontaneous electroweak symmetry breaking mechanism, and the measurement of its cross section with better than 20% precision;
-The measurement of extremely rare processes, such as simultaneous four-top-quark production, with a precision of 6%;
-Constraints on anomalous interactions between the top quark and the Z boson, probing new physics at energy scales up to 2 TeV.

Several results are limited by theoretical uncertainties, highlighting the need for further progress in high-precision theoretical calculations aligned with the demands of the HL-LHC.

We interpret these HL-LHC projections in the following contexts:

-A generic BSM model for baryogenesis featuring an additional heavy neutral scalar;
-The constraints on various BSM scalar potentials, highlighting the power of future HL-LHC measurements in establishing the shape of the electroweak vacuum;
-Our capability to use the top quark and Higgs boson mass constraints in unveiling the nature of the electroweak vacuum and the stability of the universe.

This document serves two purposes:

-Updating the physics goals of HL-LHC, in line with the phenomenological studies made in the last five years on the impact of future collider proposals;
-Providing a more realistic assessment of the HL-LHC physics reach, as input to the discussion on the choice of a future collider at CERN.

Authors: PIERINI, Maurizio (CERN); FERRARI, Pamela (Nikhef National institute for subatomic physics (NL)); LOWETTE, Steven (Vrije Universiteit Brussel (BE))

Contribution ID: **171** Type: **not specified**

Proposal from the NA61/SHINE Collaboration for the update of the European Strategy for Particle Physics

Building on the current program's success and driven by new physics challenges, the NA61/SHINE Collaboration proposes to continue measuring hadron production properties in reactions induced by hadron and ion beams after CERN Long Shutdown 3. These measurements are of significant interest to the heavy-ion, cosmic-ray, and neutrino physics communities and will focus on:

(i) Investigating hadron production in the light-ion systems to explore the diagram of high-energy nuclear collisions, and to obtain new insight into the unexpected violation of isospin (flavour) symmetry recently
observed by the experiment.
(ii) Measuring charm–anti-charm correlations to gain unique insights into the production locality of charm and anti-charm quark pairs.
(iii) Examining strangeness and multistrangeness production to improve our understanding of the early Universe's evolution and neutron star formation.
(iv) Measuring cross-sections relevant for cosmic-ray measurements, significantly boosting searches for new physics in our Galaxy.
(v) Conducting hadron production measurements with proton, pion, and kaon beams for neutrino physics, enhancing the precision of hadron production data needed for initial neutrino flux predictions in neutrino oscillation experiments.
(vi) Measuring hadron production processes relevant for understanding the flux of atmospheric neutrinos as well as neutrinos and muons from spallation sources.

To achieve these objectives, a detector upgrade and a beam upgrade are required, with data-taking planned for the period 2029–2032 and beyond.

Authors: RYBICKI, Andrzej Krzysztof (Polish Academy of Sciences (PL)); ZIMMERMAN, Eric Daniel (University of Colorado Boulder (US)); STEPANIAK, Joanna Maria (National Centre for Nuclear Research (PL)); STEPANIAK, Joanna (NCBJ, Warsaw); GREBIESZKOW, Katarzyna (Warsaw University of Technology (PL)); GREBIESZKOW, Katarzyna (Warsaw University of Technology (PL)); TURKO, Ludwik (University Wroclaw); TURKO, Ludwik (University of Wroclaw (PL)); MACKOWIAK-PAWLOWSKA, Maja (Warsaw University of Technology (PL)); GAZDZICKI, Marek (Jan Kochanowski University (PL)); UNGER, Michael; UNGER, Michael (Karlsruhe Institute for Technology); VON DOETINCHEM, Philip (University of Hawaii at Manoa); ADRICH, Przemyslaw (National Centre for Nuclear Research (PL)); ADRICH, Przemysław (National Centre for Nuclear Research); KOWALSKI, Seweryn (University of Silesia (PL)); PULAWSKI, Szymon (University of Silesia (PL)); PULAWSKI, Szymon (University of Silesia); NAGAI, Yoshikazu (Eötvös Loránd University (HU))

Contribution ID: **172** Type: **not specified**

AWAKE - Input to the European Strategy for Particle Physics Update on behalf of the AWAKE Collaboration

The Advanced Wakefield Experiment, AWAKE, is a well-established international collaboration and aims to develop the proton-driven plasma wakefield acceleration of electron bunches to energies and qualities suitable for first particle physics applications, such as strong-field QED and fixed target experiments (~50–200 GeV). Numerical simulations show that these energies can be reached with an average accelerating gradient of ~ 1 GeV/m in a single proton-driven plasma wakefield stage. This is enabled by the high energy per particle and per bunch of the CERN SPS (~19 kJ, 400 GeV) and LHC (~120 kJ, 7 TeV) proton bunches. Bunches produced by synchrotrons are long, and AWAKE takes advantage of the self-modulation process to drive wakefields with GV/m amplitude.
By the end of 2025, all physics concepts related to self-modulation will have been experimentally established as part of the AWAKE ongoing program that started in 2016. Key achievements include: direct observation of self-modulation, stabilization and control by two seeding methods, acceleration of externally injected electrons from 19 MeV to more than 2 GeV, and sustained high wakefield amplitudes beyond self-modulation saturation using a plasma density step.
In addition to a brief summary of achievements reached so far, this document outlines the AWAKE roadmap as a demonstrator facility for producing beams with quality sufficient for first applications. The plan includes:
–Accelerating a quality-controlled electron bunch to multi-GeV energies
in a 10 m plasma by 2031;
–Demonstrating scalability to even higher energies by LS4.
Synergies of the R&D performed in AWAKE that are relevant for advancing plasma wakefield acceleration in general are highlighted.
We argue that AWAKE and similar advanced accelerator R&D be strongly supported by the European Strategy for Particle Physics Update.

Authors: GSCHWENDTNER, Edda (CERN); MUGGLI, Patric (Max Planck Institute for Physics); TURNER, Marlene (CERN)

Contribution ID: **173** Type: **not specified**

Input from the Netherlands to ESPP 2026

The process of shaping the input from the Netherlands for the European Strategy Update has been led by the Dutch National Institute for Subatomic Physics Nikhef. It has been a structured, open and iterative effort, starting early-2024 by broadly informing our community, followed by multiple days of in-depth presentations and discussions. We concluded the process with an open session to refine the statements that were formulated during the process, and that now form the basis of this document. As the detailed ESPP inputs for the future collider options will become available after the March deadline, this document focusses on which considerations are viewed as most important in deciding on the next flagship collider.

We are convinced that a new flagship collider is essential and that it should be located at CERN, but it should not affect the completion of the high-luminosity phase of the LHC (HL-LHC). We see physics as the primary motivation for a future collider, with the study of the Higgs boson and the search for physics beyond the Standard Model as main targets. While physics is the primary driver, other considerations were also viewed as important in deciding on the next collider: it should offer an attractive and innovative R&D programme and the time gap between the HL-LHC and the next flagship collider has to be small or there should be an attractive physics programme in the gap.

Flexibility is important to adapt to new physics results and new technologies, and environmental impact must be addressed. Furthermore, sufficient career opportunities are essential to continue to attract and foster physicists and technologists, and a strong communication strategy is imperative for the viability of our field.

Finally, there was a strong sentiment that non-collider (astro)particle physics should be included in the ESPP, and that the next collider project should not come at the expense of a diverse scientific programme in Europe in terms of resources.

Author: D'HONDT, Jorgen (Nikhef)

Contribution ID: **174** Type: **not specified**

Phase-One LHeC

In *White Paper* on the Large Hadron electron Collider (LHeC), submitted to the ESPP Update, its commissioning is proposed several years after the completion of the HL-LHC programme in 2041. Here an alternative staged approach is considered in which a phase-one LHeC is using a 20 GeV single-pass Energy Recovery Linac (ERL), to be commissioned at P2 after LS4 allowing for unique studies of the electron-hadron interactions already during Run5. In this case, the project financial stress will be distributed over more years, and the experience acquired during the first phase of the LHeC will allow for a more robust design of the final stand-alone LHeC and possibly also allow its earlier startup. Moreover, such a phase-one LHeC is expected to provide important and timely scientific feedback to the hadron-hadron experiments at the HL-LHC already two years after commissioning, especially in the domain of the parton distribution functions. Conceptual studies indicate high luminosity performance, and this in turn guarantees excellent original scientific output, including, for example, unique research in the physics of the Higgs boson, top quark and $\gamma\gamma$ interactions at the electron-proton centre-of-mass energy of 0.75 TeV, as well as interesting comparative studies of *eA* and *AA* interactions, since the proposed design of the interaction region allows for both types of collisions at IP2. Last but not least, the new detector at the P2 site can be designed by extension of the ALICE 3 proposal, which offers strong synergies and benefits in several areas.

Author: PIOTRZKOWSKI, Krzysztof (AGH University (Kraków, PL))

Contribution ID: **175** Type: **not specified**

XLZD: The low-background observatory for astroparticle physics

The XLZD underground rare event observatory based on liquid xenon technology will address some of the most important open questions in fundamental physics and cosmology: the nature of dark matter, which drives the formation of structures in the universe such as galaxies and clusters, and the fundamental nature of neutrinos, which is closely tied to the puzzling matter-antimatter asymmetry in the universe. XLZD will
conduct highly sensitive measurements with its quiet, massive detector, offering an unrivaled low energy threshold and background level required to tackle these mysteries. Additionally, XLZD will perform precision measurements of solar neutrinos, search for solar axions, and watch for neutrinos from supernovae in our cosmic neighborhood. With its rich scientific program, XLZD will thus be a true multi-purpose observatory
in astroparticle physics, poised to make a global impact.

In its nominal design, XLZD is an observatory with a target mass of 60 tonnes of cryogenic liquid xenon in its central detector, as xenon is an ideal medium for detecting ultra-rare particle interactions. It will operate as a dual-phase time projection chamber, a technology which revolutionized the field of direct dark matter searches about 20 years ago with its highly scalable detection principle, which has since led the field. XLZD is being pushed forward by the leading teams in this area: XENON and LZ, which currently operate the largest liquid xenon detectors, with target masses of 5.9 tonnes and 7.0 tonnes, respectively, and DARWIN conducting R&D towards a multi-ton liquid xenon detector.

Authors: AKERIB, Daniel; Prof. SCHUMANN, Marc (University of Freiburg (DE))

Contribution ID: **176** Type: **not specified**

National input from the United Kingdom to the 2026 Update to the European Strategy for Particle Physics

This document has been prepared on behalf of the UK particle physics community to provide input to the 2026 Update to the European Strategy for Particle Physics (ESPPU). The UK process began with an initial workshop hosted by the IPPP in Durham in September 2024, aiming to bring together the experimental and theoretical communities to discuss the physics and technological opportunities and challenges associated with the future of particle physics. This was followed by two community drafting days in November 2024 and January 2025. These drafting days focussed on the questions provided by the European Strategy Group (ESG) on both collider and non-collider physics along with additional topics outside the direct scope of the questions but relevant to the future roadmap. These include detector RD; software and computing; attracting and maintaining talent and expertise; industrial return, and public engagement and outreach. The drafting was facilitated by a drafting team which had representation from both plenary and Early Career Researcher (ECR) UK ECFA delegates and the STFC Particle Physics Advisory Panel (PPAP). For the first submission (31st March 2025) answers to most questions are provided (including q3a –the next high-priority collider at CERN) but prioritisation of alternative options if this is not feasible under various scenarios, and prioritisation of non-collider and complementary areas of exploration, is not provided. These will be discussed further in the next community drafting meeting on 28th April (when further information will be available following community submissions) and updated ahead of the Open Symposium. We anticipate one final community meeting following the release of the briefing book in September 2025 to discuss possible revisions/updates to the draft but we expect these to be minor.

Authors: SAAKYAN, Ruben (University of London (GB)); WILLIAMS, Sarah Louise (University of Cambridge (GB))

Contribution ID: **177** Type: **not specified**

Norwegian Input to the European Strategy for Particle Physics

Norwegian experimental and theoretical particle physics, heavy-ion physics, nuclear physics, astroparticle physics, and cosmology, present their research programme for the next period of the European Strategy for Particle Strategy Update. The Norwegian response to the ECFA questionnaire concerning the future of particle physics in Europe is detailed, including our preferred flagship project(s) for CERN to ensure sustainability of the laboratory and a rich physics programme post High Luminosity LHC.

Author: Prof. OULD-SAADA, Farid (University of Oslo (NO))

Contribution ID: **179** Type: **not specified**

The HIBEAM/NNBAR program

The European Spallation Source will open a new intensity frontier in particle physics. The two-stage HIBEAM/NNBAR program can exploit the potential of the ESS with a series of high-precision searches and measurements. A key part of the program is the first search for over thirty years for free neutrons converting to antineutrons, thereby testing baryon number conservation. A discovery sensitivity, compared with earlier work, of three orders of magnitude is possible. In addition to neutron-antineutron conversions, the HIBEAM/NNBAR program has a broad potential, including, for example, high-sensitivity searches for ultralight axion-like particles (ALPs) and sterile neutrons. Modifications to a beamline of HIBEAM design allow highly sensitive measurements of neutron decay and a search for a non-zero neutron electric dipole moment.

Authors: Prof. MILSTEAD, David (Stockholm University, Physics Department); Dr SANTORO, Valentina (Lund University, Physics Department)

Contribution ID: **180** Type: **not specified**

SPECTRUM Project: Input to the European Particle Physics Strategy Update 2026

The amount of data gathered, shared and processed in frontier research is set to increase steeply in the coming decade, leading to unprecedented data processing, simulation and analysis needs. In particular, High Energy Physics (HEP) and Radio Astronomy (RA) are gearing up for groundbreaking instruments, necessitating digital infrastructures many times larger than the current capabilities. In this context, the EU-funded SPECTRUM project brings together leading European science organisations and e-Infrastructure providers to formulate a Strategic Research, Innovation, and Deployment Agenda (SRIDA) along with a Technical Blueprint for a European computer and data continuum. This collaborative effort is set to create an Exabyte-scale research data federation and compute continuum, fostering data-intensive scientific collaborations across Europe.

The present document reports on a specific work stream from the SPECTRUM project, conducted during the first 15 months within Work Package 3: the learning from establishing and working with a Community of Practice (a.k.a. SPECTRUMCoP) with more than 80 participants. It reports on discussions and findings, including a Community Survey which was active during the second part of 2024.

Author: ANDREOZZI, Sergio

Contribution ID: **181** Type: **not specified**

HOLMES+ Project

HOLMES+ is the natural evolution of the HOLMES project toward an ambitious experiment capable of directly measuring a neutrino mass lower than 100 meV. Since HOLMES, together with the competing ECHo experiment, has demonstrated both the feasibility of electron-capture calorimetry with ^{163}Ho as a method for investigating neutrino mass and the availability of all the necessary technologies, it is possible to formulate a realistic and evidence-based plan for a future experiment with sub-eV sensitivity.\\
With HOLMES+, we propose to start by bridging the gap toward a large-scale final experiment by setting two main goals. First, we propose to scale up the HOLMES experiment from the current 64 to 256 detectors, while improving the quality of the ion implantation to achieve a uniform activity of about 1 Bq in all detectors. The aim is to perform a high-statistics measurement to study the problems associated with combining data sets taken with many detectors. Secondly, in parallel with the previous effort, we propose to optimize the working temperature of the detectors and the efficiency of the ion source for implantation to realize a first small prototype of the high-activity detectors needed for the large-scale experiment. We plan to realize an array of about ten implanted detectors with an activity of at least 30 Bq of ^{163}Ho, which represents an improvement over the current HOLMES' detector activity by a factor of $\sim$100.
Both the low and the high activity arrays will be hosted in the HOLMES dilution refrigerator, and both will also allow us to test new readout and DAQ systems with improved performance and a reduced cost per channel.\\
High-statistics data taken with both arrays will improve the limit on the neutrino mass to the few eV level, and we will have the opportunity to better understand potential statistical sensitivity of the ^{163}Ho experiments, possibly confirming the recent findings of HOLMES and ECHo. In fact, their data suggest that the achievable sensitivity is up to two times better than predicted by the first-order theoretical calorimetric EC decay spectrum.

Author: NUCCIOTTI, Angelo Enrico Lodovico

Contribution ID: **182** Type: **not specified**

CONUS100: Precision neutrino physics with coherent elastic scattering of reactor neutrinos

Abstract:
Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) was predicted in 1974, but it took until 2017 before it was first observed in the COHERENT experiment in pion decays at rest. Recently first indications were presented that solar neutrinos are detected in the direct dark matter experiments XENONnT and PandaX via CEνNS. Last but not least the reactor anti-neutrino experiment CONUS+ has recently observed the process already in its first data taking run which immediately leads (alone and in combination with other experiments) to interesting and very competitive sensitivity to physics beyond the Standard Model of particle physics. The ongoing operation of the upgraded CONUS+ detector will produce significantly better results already within a year. The main point of this proposal is to highlight that the underlying detector technology is mature and allows an upscaling to a CONUS100 experiment with O(100kg) detector mass. This can be achieved by a small collaboration with comparably moderate costs and within a few years. Simulations show that O(500.000) signal events could be detected within 5 years of data taking. This implies that the long lasting route towards an observation of CEvNS will foreseeably turn in the next few years into an exciting new area of precision neutrino physics with CEvNS. Each detection channel will by itself lead to very important results, but combinations will have a significantly bigger physics potential.

Author: Prof. LINDNER, Manfred (Max-Planck-Institut fuer Kernphysik, Heidelberg, Germany)

Contribution ID: **183** Type: **not specified**

Input of the German Nuclear and Hadron Physics Community to the ESPPU 2026 Regarding the Programs at CERN, at FAIR, and Related Activities

This document summarizes the contributions of the German nuclear and hadron physics community, represented by the elected KHuK committee, to the ESPPU 2026 and complements the input from the German particle physics community submitted by KET\footnote{https://www.ketweb.de/stellungnahmen/}.
Our statements and recommendations are based on both our established priorities and those outlined in the European community's NuPECC Long-Range Plan (LRP) 2024\footnote{https://nupecc.org/lrp2024/Documents/
We focus primarily on areas of overlap with the particle physics community, including fixed-target experiments at the SPS at CERN, QCD studies in hadron and heavy-ion physics at the FAIR facility, comprising key activities within the CBM and PANDA collaborations. We also address complementary dark matter searches, precision measurements at low energies to explore beyond-standard-model physics at various facilities, and low-energy antiproton experiments at the CERN AD.
We emphasize the importance of maintaining a diverse and compelling scientific program at CERN, extending beyond the development of future colliders. Such a program offers attractive opportunities for early-career scientists to engage in cutting-edge research, while fostering related technological and methodological advancements. Furthermore, projects that deliver high-impact results in shorter time frames, while retaining flexibility to adapt to emerging developments, remain essential.

Author: BLOCK, Michael

Contribution ID: **184** Type: **not specified**

Sensitivity study on $H \to b\bar{b}$, $H \to WW^*$ and $HH \to b\bar{b}b\bar{b}$ cross sections and trilinear Higgs self-coupling with the MUSIC detector in $\sqrt{s} = 10$ TeV muon collisions

This study investigates the physics reach in the Higgs sector of muon-antimuon collisions at a center-of-mass energy of 10 TeV. The statistical sensitivity of the production cross sections for $H \to b\bar{b}$, $H \to WW^*$, and $HH \to b\bar{b}b\bar{b}$, as well as the measurement of the Higgs boson trilinear self-coupling, is evaluated using a detailed detector simulation that includes the dominant contributions of the machine-induced background. The studies utilize MUSIC, a detector concept specifically designed and optimized for the muon collision environment at 10 TeV, and assume a dataset of 10 ab^{-1} collected over a five-years period by a single experiment. The results highlight the exceptional potential of a high-energy muon collider for exploring the Higgs sector, in particular for determining the Higgs potential. A multi-TeV muon collider offers a level of precision that cannot be achieved by any other proposed future collider within a comparable time frame.

Authors: GIANELLE, Alessio (Universita e INFN, Padova (IT)); ZULIANI, Davide (Universita e INFN, Padova (IT)); LUCCHESI, Donatella (Universita e INFN, Padova (IT)); PALOMBINI, Leonardo; SESTINI, Lorenzo (Universita e INFN, Firenze (IT)); CASARSA, Massimo (INFN, Trieste (IT)); ANDREETTO, Paolo (Universita e INFN, Padova (IT))

Contribution ID: **185** Type: **not specified**

EuCAIF Recommendations for Scaling AI Capabilities in Particle Physics

Artificial intelligence (AI) is transforming scientific research, with deep learning methods playing a central role in data analysis, simulations, and signal detection across particle, nuclear, and astroparticle physics. Within the JENA communities—ECFA, NuPECC, and APPEC—and as part of the EuCAIF initiative, AI integration is advancing steadily. However, broader adoption remains constrained by challenges such as limited computational resources, a lack of expertise, and difficulties in transitioning from research and development (R\&D) to production.

This contribution to the European Strategy in Particle Physics presents recommendations detailed in a strategic roadmap. This roadmap was submitted as a contribution to the JENA White Paper on Federated Computing and is available (in its complete form) on arXiv at \url{https://arxiv.org/abs/2503.14192}. The JENA document on federated computing will be submitted as input to the European Strategy for Particle Physics. As the recommendations in the JENA document summarize those presented here, we are presenting them in this document in their original form.

The recommendations are the result of a community survey aimed at addressing identified barriers. It outlines critical infrastructure requirements, prioritizes training initiatives, and proposes funding strategies to scale AI capabilities across fundamental physics over the next five years.

Authors: IPP, Andreas; CARON, Sascha (Nikhef National institute for subatomic physics (NL))

Contribution ID: **186** Type: **not specified**

CERN-MEDICIS: A unique facility for the production of innovative biomedical research radionuclides

This document provides an input on behalf of the CERN-MEDICIS collaboration to the call for the European Strategy for Particle Physics Update (ESPPU) 2026 . While MEDICIS has been developping its programme for the past few years on the development of the production and supply of innovative medical radionuclides for translational research, 2025 acts as a corner stone for its translationnal biomedical research programme. We highlight in this document the history and challenges ahead of the facility and collaboration.

Authors: STORA, Thierry (CERN); Prof. COCOLIOS, Thomas Elias (KU Leuven - IKS)

Contribution ID: **187** Type: **not specified**

ATLAS Software and Computing for the Future

To achieve its physics program, the ATLAS collaboration operates large, internationally- distributed computing systems and maintains millions of lines of code. These systems and software are growing in complexity in preparation for the High Luminosity upgrade of the LHC. The planned development of the experiment software has been shaped by the integration, validation, and adoption of new hardware for computing, deployment of work on High-Performance Computing systems and commercial clouds, stringent demands on physics precision, and drive for common solutions. As input to the European Particle Physics Strategy Update, the opportunities and challenges in ATLAS software and computing impact the future direction of the field in the following ways:
• The challenges that ATLAS takes on overlap significantly with the challenges that face future colliders, and the solutions that have been, are being, and will be developed form an excellent starting point for any future collider.
• Investment in the people supporting the existing software and infrastructure while working to solve these challenges in the coming years is therefore not just critical for the experiment, but for the future of the field as a whole.

Authors: ATLAS COLLABORATION; Dr HOWARTH, James William (University of Glasgow (GB)); KRETZSCHMAR, Jan (University of Liverpool (GB)); GENEST, Marie-Helene (LPSC - Grenoble, CNRS/UGA)

Contribution ID: **188** Type: **not specified**

LEP3: A High-Luminosity e+e– Higgs & Electroweak Factory in the LHC Tunnel

As stated in the 2019 European Strategy for Particle Physics (ESPP), it is of the utmost importance that the HL-LHC upgrade of the accelerator and the experiments be successfully completed in a timely manner. All necessary efforts should be devoted to achieving this goal.
We also recall two of the principal recommendations of the 2019 ESPP for future accelerator initiatives, namely that
• An electron-positron Higgs factory is the highest priority for the next collider (Recom-mendation c).
• Europe, together with its international partners, should investigate the technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage (Recommendation e).

A major objective in particle physics is always to operate an accelerator that allows a leap of an order of magnitude in the constituent centre-of-mass (CoM) energy with respect to the previous one.
We support FCC-ee and FCC-hh as the preferred option for CERN's future,
as it addresses both of the above recommendations.
The guidance for the 2025 ESPP requests, in addition to the preferred option, the inclusion of "prioritised alternatives to be pursued if the chosen preferred option turns out not to be feasible or competitive". Proposed alternatives to the preferred FCC option include linear,muon colliders and LHeC accelerators. In response to this request **we propose reusing the existing LHC tunnel** for an electron-positron collider, called LEP3, as a back-up alternative if the FCC cannot proceed. **LEP3 leverages much of the R&D conducted for FCC-ee, offers high-precision studies of Z, W, and Higgs bosons below the t-¯t threshold**, and offers **potential physics performance comparable or superior to other fallback options at a lower cost while supporting** continued R&D towards a next-generation energy frontier machine.
LEP3 is not intended to compete with the FCC-ee

Author: Prof. VIRDEE, Jim (Imperial College (GB))

Co-author: FOR FULL LIST OF AUTHORS, see attached document

Contribution ID: **189** Type: **not specified**

The ATLAS Upgrade for the HL-LHC

The HL-LHC projects a leveled instantaneous proton–proton luminosity of up to 7×10−34 cm−2s with 200 simultaneous collisions within a bunch crossing (pileup) and an integrated luminosity of 3000 fb−1. These conditions require unprecedented detector technologies in terms of radiation hardness, high detection granularity and resolution, precision track timing, and powerful triggers.
To meet these challenges, ATLAS pursues an ambitious upgrade programme
featuring:
• an all-silicon inner tracker with today's largest five billion channel counting silicon-pixel detector and a silicon strip detector providing forward acceptance until a pseudorapidity of 4,
• a forward high-granularity timing detector featuring better than 50 ps timing resolution per hit,
• a new RPC trigger chambers in the barrel to improve the muon trigger selection,
• a new trigger and data acquisition system with 1 MHz first-level global event selection using programmable hardware and a 10 kHz second-level software selection, and
• an upgraded detector front-end and back-end electronics in the calorimeters and muon systems.
The construction of this upgrade involves thousands of ATLAS members worldwide and represents the number one priority for the collaboration.

Authors: ATLAS COLLABORATION; Dr HOWARTH, James William (University of Glasgow (GB)); KRETZSCHMAR, Jan (University of Liverpool (GB)); GENEST, Marie-Helene (LPSC - Grenoble, CNRS/UGA)

Contribution ID: **190** Type: **not specified**

Particle Physics at the European Spallation Source

In this paper we outline the opportunities for fundamental nuclear and particle physics at the European Spallation Source, which will eventually be the world's most powerful pulsed neutron source and simultaneously the worlds brightest pulsed neutrino source. The ESS provides unprecedented and unique opportunities to address outstanding questions in the Standard Model of particle physics, which we know is incomplete. Using as many probes as possible is a most fitting approach to discover the missing elements in our understanding of the fundamental forces and building blocks of matter. This note as input to the European Strategy Update briefly summarizes the complementary contributions neutron sources can provide to addressing the biggest fundamental challenges to modern physics.

Authors: DEMARTEAU, Marcel (Oak Ridge National Laboratory); EKELÖF, Tord (Uppsala University); SANTORO, Valentina (Lund University)

Contribution ID: **191** Type: **not specified**

Input to the European Strategy for Particle Physics: Strong-Field Quantum Electrodynamics

The attached document sets out the intention of the strong-field QED community to carry out, both experimentally and numerically, high-statistics parametric studies of quantum electrodynamics in the non-perturbative regime, at fields approaching and exceeding the critical or 'Schwinger'field of QED. In this regime, several exotic and fascinating phenomena are predicted to occur that have never been directly observed in the laboratory. These include Breit-Wheeler pair production, vacuum birefringence, and quantum radiation reaction. This experimental program will also serve as a stepping stone towards studies of elusive phenomena such as elastic scattering of real photons and the conjectured perturbative breakdown of QED at extreme fields. State-of-the-art high-power laser facilities in Europe and beyond are starting to offer unique opportunities to study this uncharted regime at the intensity frontier, which is highly relevant also for the design of future multi-TeV lepton colliders. However, a transition from qualitative observational experiments to quantitative and high-statistics measurements can only be performed with large-scale collaborations and with systematic experimental programs devoted to the optimisation of several aspects of these complex experiments, including detector developments, stability and tolerances studies, and laser technology.

Authors: THOMAS, Alexander; ILDERTON, Anton; DI PIAZZA, Antonino; Dr KING, Benjamin; KEITEL, Christoph; RIDGERS, Christopher; SEIPT, Daniel; KARBSTEIN, Felix; MATHIEU, Francois; SARRI, Gianluca (Queen's University Belfast); KRAJEWSKA, Katarzyna; JI, Liangliang; VRANIC, Marjia; WING, Matthew; MIRZAIE, Mohammad; MCKENNA, Paul; MEUREN, Sebastian; BULANOV, Sergey; BULANOV, Stepan; BOOGERT, Stewart; MANGLES, Stuart; BLACKBURN, Tom; UGGERHOJ, Ulrik; MALKA, Victor

Contribution ID: **192** Type: **not specified**

National Input to the European Strategy for Particle Physics 2026 - Slovenia

The document summarizes the Slovenian input to the ESPP 2026 update process.

Author: KERSEVAN, Borut Paul (Jozef Stefan Institute (SI))

Contribution ID: **193** Type: **not specified**

ESPP - 2026 update: input from the Romanian experimental particle physics community

RO-ESPP-2026-Update.pdf
RO-ESPP-2026-Update - Back-up document.pdf

Authors: ALEXA, Calin (IFIN-HH (RO)); STOICEA, Gabriel (IFIN-HH (RO))

Contribution ID: **194** Type: **not specified**

Brazilian input to the European Strategy for Particle Physics Update

TheBrazilianHigh-EnergyPhysics(HEP) community has expanded remarkably since its first involvement at CERN and Fermilab in the 1980s. Its recent organization under the Brazilian Network for High-Energy Physics (RENAFAE), since 2008, has further strengthened its scientific and technological goals, particularly in detector instrumentation, computing, and industry partnerships. In 2024, Brazil became an Associate Member State of CERN, opening new opportunities for deeper engagement in accelerator and detector R&D. This input to the 2026 update of the European Strategy for Particle Physics highlights Brazil's current participation in LHC experiments as well as ongoing developments in detector and accelerator technology, and details the community's view towards future colliders. The potential for expanded scientific and industrial collaborations between Brazil and CERN is also discussed.

Authors: LESSA, Andre (UFABC - Universidade Federal do ABC); VILELA PEREIRA, Antonio (UERJ - Universidade do Estado do Rio de Janeiro); JAHNKE, Cristiane (UNICAMP - Universidade Estadual de Campinas); PURCINO DE SOUZA, Edmar Egidio (UFBA - Universidade Federal da Bahia); GIL DA SILVEIRA, Gustavo (UFRGS - Universidade Federal do Rio Grande do Sul); MALBOUISSON, Helena (UERJ - Universidade do Estado do Rio de Janeiro); CITADINI, James (CNPEM - Centro Nacional de Pesquisa em Energia e Materiais); DE PAULA, Leandro (UFRJ - Universidade Federal do Rio de Janeiro); BRITO, Marisa (CNPEM - Centro Nacional de Pesquisa em Energia e Materiais); RANGEL, Murilo (UFRJ - Universidade Federal do Rio de Janeiro); FERNADEZ PEREZ TOMEI, Thiago Rafael (UNESP - Universidade Estadual Paulista); DE FREITAS CARNEIRO DA GRAÇA, Ulisses (CBPF - Centro Brasileiro de Pesquisas Físicas)

Contribution ID: **195** Type: **not specified**

Estonian national input to the ESPP

The Estonian high-energy physics community, represented by the Estonian CERN Science Consortium, discussed potential candidates for CERN's next flagship experiment and reached the following conclusions.
Our first choice is the Future Circular Collider (FCC). The FCC offers the most compelling physics potential, with electron-electron (ee), electron-proton (ep), and proton-proton (pp) collision options, enabling comprehensive tests of the Standard Model and exploration of new physics beyond it. The FCC stands out as the only collider with mature underlying technology. Additionally, the required detector technologies are already under development through the ECFA DRD programs. Its timeline is the shortest among the proposed alternatives, and its cost is well-defined with high certainty. The FCC is particularly favored by young researchers, as it provides a clear and promising career path.
Our second choice is a linear collider. While its technology is not as mature as that of the FCC, it holds significant potential for advancing high-energy physics on the international stage. If the problems with muon cooling will be solved, any collider with a muon-muon collision option would advance our science to unprobed territories. If any collider, dark matter detector, or other experiment discovers a new, unexpected particle, CERN's high-energy physics program must be adapted accordingly to align with these new scientific realities.

Author: RAIDAL, Martti (National Institute of Chemical Physics and Biophysics (EE))

Contribution ID: **196** Type: **not specified**

Prospects in flavour physics at the FCC

The sample of 6×10^{12} Z decays that will be produced by FCC-ee offers immense opportunities for flavour physics. The low background environment, and high acceptance and reconstruction efficiencies of the detectors will allow this dataset to be fully exploited for a wide range of studies in the beauty, charm and tau sectors. In many cases, it is expected that these measurements will be world-leading in precision, and thereby be powerful in probing for the effects of New Physics. Interesting possibilities also exist for the measurement of the magnitude of CKM elements from W-boson and top decays. Discussion and numerical estimates are provided for the prospects of FCC-ee in a set of benchmark measurements, as requested by the Physics Preparatory Group of the European Strategy for Particle Physics Update 2025-26. Additional discussion is included on some other studies of interest. Finally, brief consideration is given to the prospects for flavour-physics studies at FCC-hh.

Authors: LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa); WILKINSON, Guy (University of Oxford (GB)); F. KAMENIK, Jernej; MONTEIL, Stephane (Université Clermont Auvergne (FR))

Contribution ID: **197** Type: **not specified**

AMoRE Experiment

AMoRE searches for the signature of neutrinoless double beta decay
from the ^{100}Mo with an experiment on the scale of 100 kg of the isotope ^{100}Mo.
We developed scintillating molybdate crystals to run at millikelvin temperatures coupled with a metallic magnetic calorimeter and a SQUID sensor.
To demonstrate the full-scale AMoRE, we ran pre-experiments at the Yangyang Underground Laboratory. The AMoRE-II experiment is under construction and will start data-taking at Yemilab in 2027. The first stage of the experiment with 90 lithium molybdate crystals will begin in 2025. The 5-year run of AMoRE-II has a sensitivity of 4.5×10^{26} years with an expected background rate of $\sim 1 \times 10^{-4}$ counts/keV/kg/year.

Author: AMORE COLLABORATION

Contribution ID: **198** Type: **not specified**

Einstein Telescope - The future European Gravitational Wave Observatory

The Einstein Telescope (ET) is a groundbreaking scientific initiative aiming to build a third-generation gravitational wave observatory with the ambitious goal of revolutionizing our understanding of the Universe.
ET will greatly exceed the sensitivity and range of current detectors, unlocking new horizons by detecting gravitational waves—spacetime ripples produced by events such as merging black holes and neutron stars. This observatory will be a true game changer, a tool that promises breakthroughs in our understanding of fundamental physics, astrophysics, and cosmology, ranging from the role of the gravitation in the description of the Dark Universe, the QCD of Neutron Stars and the mechanisms of the expansion of the Universe. Methods, scientific targets and technical challenges are synergic and complementary to the HEP targets at CERN.
ET's research infrastructure requires cutting-edge technology to surpass the sensitivity and detection capabilities of current observatories like LIGO, Virgo and KAGRA. Technological developments across multiple fields, including quantum computing and artificial intelligence, life and environmental science, electronics and high-precision optics, mechanics and vacuum, and many other are needed to face the scientific challenges. Currently, ET is one of the largest projects in the ESFRI roadmap

Author: Dr PUNTURO, Michele

Co-authors: FREISE, Andreas; FERRONI, Fernando; LUECK, Harald

Contribution ID: **199** Type: **not specified**

CODEX-b: Opening New Windows to the Long-Lived Particle Frontier at the LHC

This document is written as a contribution to the European Strategy of Particle Physics (ESPP) update. We offer a detailed overview of current developments and future directions for the CODEX-b detector, which aims to detect long-lived particles beyond the Standard Model. We summarize the scientific motivation for this detector, advances in our suite of simulation and detector optimization frameworks, and examine expected challenges, costs, and timelines in realizing the full detector. Additionally, we describe the technical specifications for the smaller-scale demonstrator detector (CODEX-β) we have installed in the LHCb experimental cavern.

Author: CID VIDAL, Xabier (Instituto Galego de Física de Altas Enerxías)

Contribution ID: **200** Type: **not specified**

Neutrinos from Stored Muons (nuSTORM)

The Neutrinos from Stored Muons, nuSTORM, facility has been designed to deliver a definitive neutrino-nucleus scattering programme using beams of ν_e and ν_μ from the decay of muons confined within a storage ring. The facility is unique, it will be capable of storing $\mu^\pm$ beams with a central momentum of between 1\,GeV/c and 6\,GeV/c and a momentum spread of 16\%. This specification will allow neutrino-scattering measurements to be made over the kinematic range of interest to the DUNE and Hyper-K collaborations. At nuSTORM, the flavour composition of the beam and the neutrino-energy spectrum are both precisely known. The storage-ring instrumentation will allow the neutrino flux to be determined to a precision of 1\% or better. By exploiting sophisticated neutrino-detector techniques such as those being developed for the near detectors of DUNE and Hyper-K, the nuSTORM facility will:
* Serve the future long- and short-baseline neutrino-oscillation programmes by providing definitive measurements of $\nu_e A$ and $\nu_\mu A$ scattering cross-sections with percent-level precision;
* Provide a probe that is 100\% polarised and sensitive to isospin to allow incisive studies of nuclear dynamics and collective effects in nuclei;
* Deliver the capability to extend the search for light sterile neutrinos beyond the sensitivities that will be provided by the FNAL Short Baseline Neutrino (SBN) programme; and
* Through the delivery of a unique neutrino-physics programme, create an essential test facility for the development of muon accelerators to serve as the basis of a multi-TeV lepton-antilepton collider.

To maximise its impact, nuSTORM should be implemented such that data-taking coincides with the accumulation of substantial data samples by the the DUNE and Hyper-K collaborations. This will allow measurements at nuSTORM to be used to resolve the correlation between flux and cross-section uncertainties that naturally arise in the analysis of near-detector data and so allow oscillation probabilities to be determined with percent-level precision.

With its existing proton-beam infrastructure, CERN is uniquely well-placed to implement nuSTORM. The feasibility of implementing nuSTORM at CERN has been studied by a CERN Physics Beyond Colliders study group. The muon storage ring has been optimised for the neutrino-scattering programme to store muon beams with momenta in the range 1\,GeV/c to 6\,GeV/c. The implementation of nuSTORM exploits the existing fast-extraction from the SPS that delivers beam to the LHC and to HiRadMat. A summary of the proposed implementation of nuSTORM at CERN is presented below. An indicative cost estimate and a preliminary discussion of a possible time-line for the implementation of nuSTORM are presented in the PBC study report.

Authors: PASARI, DHRUV (Durham University); TURNER, JESSICA; FRANKLIN, Jack; LONG, Kenneth Richard (Imperial College (GB)); ALVAREZ-RUSO, Luis; Mx VOGIATZI, Maria (Imperial); KYBERD, Paul (Brunel University (GB)); JURJ, Paul-Bogdan; Prof. HOBSON, Peter; KAMATH, Rohan (Imperial College London); Mr CHANG, Wongjong (Warwick); Dr LU, Xianguo (University of Warwick); RICCIARDI, stefania (CCLRC RAL)

Contribution ID: **201** Type: **not specified**

Statement of the Pierre Auger Collaboration as input for the 2026 European Particle Physics Strategy

This document describes, on behalf of the Pierre Auger Collaboration, the close relation between the research interests of the particle and astroparticle physics communities. We underline the main areas in which synergies between the CERN and the astroparticle physics fields of reasearch can be developed, providing input to the 2026 European Particle Physics Strategy Update. We conclude with recommendations on cooperation in topics of mutual interest, and on suggested astroparticle-related activities at CERN.

Author: CASTELLINA, Antonella (Universita e INFN Torino (IT))

Contribution ID: **202** Type: **not specified**

U.S.Higgs Factory Consortium input to ESG on CERN's future collider options.

This white paper responds to the request by the European Strategy Group (ESG) to submit national inputs as part of the European Strategy for Particle Physics Update (ESPPU). It focuses on CERN's future collider options and provides strong support for FCC-ee as its preferred next major flagship project. The paper follows the ECFA guidelines, responding explicitly to item 3, and is supported by recent developments following the 2023 P5 Report. It also outlines the U.S. scientific and engineering expertise including potential technical contributions to a future Higgs Factory.

Authors: RAJAGOPALAN, Srini (Brookhaven National Laboratory (US)); RAUBENHEIMER, Tor (SLAC National Accelerator Laboratory - On Leave (US))

Contribution ID: **203** Type: **not specified**

Austrian input to the European Strategy of Particle Physics Update 2026

We present the current activities, future objectives and strategic needs of the Austrian particle physics research community. The present document will also outline our main recommendations and approach to future experiments and facilities at CERN and beyond. This document summarizes, among other consultation processes, three round table meetings which the Austrian community held in the last year.

Authors: Prof. MAAS, Axel Torsten (University of Graz); SCHWANDA, Christoph (Austrian Academy of Sciences (AT)); DOBRIGKEIT CHINELLATO, David (Austrian Academy of Sciences (AT)); WIDMANN, Eberhard (Austrian Academy of Sciences (AT)); HECHENBERGER, Florian (Stony Brook University); INGUGLIA, Gianluca (Austrian Academy of Sciences (AT)); SCHOEFBECK, Robert (Austrian Academy of Sciences (AT)); PLÄTZER, Simon (University of Graz (AT)); BERGAUER, Thomas (Austrian Academy of Sciences (AT)); ADAM, Wolfgang (HEPHY-Vienna)

Contribution ID: **204** Type: **not specified**

R&D on quantum sensors for particle physics: the DRD5 collaboration

The detector R&D roadmap initiated by ECFA in 2020 highlighted the large number of particle physics opportunities that can be enabled by targeted and collaborative R&D in the field of quantum sensors and related technologies. Task Force 5 (TF5) of that roadmap exercise, together with the involved communities, established a list of the most promising areas for investment, and defined the R&D that would be needed to bring quantum sensors to a level that they can be incorporated into experiments. The vision outlined in the ECFA report led to the formation of DRD5 (Detector R&D 5), a global collaboration dedicated to addressing the challenges that must be overcome to realise the potential of quantum sensing for the community.

DRD5 focuses on five families of Quantum Sensors with particular suitability to particle physics, and where coordinated developments can bring about major advances in terms of sensitivity, ease of access, standardization, cost or physics reach. These are: 1) Atomic, Nuclear & Molecular Systems in Traps and Beams; 2) Quantum Materials (0-, 1- and 2-dimensional); 3) Quantum Superconducting Devices; 4) Scaled-up large ensembles of spin-oriented, hybrid or opto-mechanical elements; 5) Quantum Techniques for Sensing. These five technological domains are complemented by an overarching activity dealing with Capacity Expansion and Exchange. This document lays out the resulting high-level opportunities and common challenges that are part of pursuing the required R&D on quantum sensor technologies on a global scale.

Authors: DEMARTEAU, Marcel (Oak Ridge National Laboratory); DOSER, Michael (CERN); WORM, Steven (Deutsches Elektronen-Synchrotron (DE))

Contribution ID: **205** Type: **not specified**

The Belle II Experiment at SuperKEKB

Belle II is an intensity-frontier experiment at the SuperKEKB collider in Tsukuba, Japan. Over the coming decades, it will record the decays of billions of bottom mesons, charm hadrons, and tau leptons produced in 10 GeV electron-positron collisions. The experiment's low-background environment and precisely known kinematics enable high-precision measurements of hundreds of Standard Model (SM) parameters while probing for new particles at mass scales far beyond the direct reach of high-energy colliders. We project Belle II's sensitivity for key measurements - where it will be uniquely positioned or world-leading - over datasets ranging from 1 to 50 ab^{-1}. By exploring previously uncharted regions of non-SM parameter space with high precision, Belle II will either reveal new physics or set stringent constraints, guiding future experimental and theoretical efforts. Additionally, we outline near-term upgrades to the Belle II detector and SuperKEKB accelerator, which will enhance sensitivity in searches for new physics beyond the SM across flavor, tau, electroweak, and dark sector physics. These improvements will ensure that Belle II remains both complementary to and competitive with the LHC and other experiments.

Authors: GAZ, Alessandro; MARINAS PARDO, Carlos (Univ. of Valencia and CSIC (ES)); BERNLOCHNER, Florian Urs (University of Bonn (DE)); LIBBY, James; TRABELSI, Karim (TYL - KEK); RONEY, Michael; MASUZAWA, Mika (KEK); LEWIS, Peter (University of Hawaii); BROWDER, Thomas; KUHR, Thomas (Ludwig Maximilians Universitat (DE)); BERTACCHI, Valerio

Contribution ID: **206** Type: **not specified**

ESPPU contribution of Finland-2025

In the report current plans and some ideas for the future are reported for particle physics and related fields in Finland.

Authors: KIRSCHENMANN, Henning; HUITU, Katri; LUUKKA, Panja

Contribution ID: **207** Type: **not specified**

The Muon Collider

Muons offer a unique opportunity to build a compact high-energy electroweak collider at the 10 TeV scale. A Muon Collider enables direct access to the underlying simplicity of the Standard Model and unparalleled reach beyond it.
It will be a paradigm-shifting tool for particle physics representing the first collider to combine the high-energy reach of a proton collider and the high precision of an electron-positron collider, yielding a physics potential significantly greater than the sum of its individual parts. A high-energy muon collider is the natural next step in the exploration of fundamental physics after the HL-LHC and a natural complement to a future low-energy Higgs factory.
Such a facility would significantly broaden the scope of particle colliders, engaging the many frontiers of the high energy community.

The last European Strategy for Particle Physics Update and later the Particle Physics Project Prioritisation Panel in the US requested a study of the muon collider, which is being carried on by the International Muon Collider Collaboration. In this comprehensive document we present the physics case, the state of the work on accelerator design and technology, and propose an R&D project that can make the muon collider a reality.

Authors: ROGERS, Chris; SCHULTE, Daniel (CERN); MELONI, Federico (Deutsches Elektronen-Synchrotron (DE))

Contribution ID: **208** Type: **not specified**

Initial INFN Input on the Update of the European Strategy for Particle Physics

Advancing particle physics through the development of a new accelerator at CERN represents a primary step in exploring the frontiers of fundamental science. Such an endeavour is crucial to addressing key unanswered questions in physics, including the nature of the electroweak symmetry breaking, the hierarchical pattern of fermion masses, the nature of dark matter, the unification of the fundamental forces, and the origins of the matter-antimatter asymmetry in the universe. The next-generation accelerator will not only drive ground-breaking advancements and possibly new discoveries but also consolidate CERN's and Europe's global leadership in fundamental physics, strengthening the collaborative efforts of research institutions such as the INFN. An international laboratory like CERN, with a frontier accelerator facility, at the forefront of global basic research, will enhance the role of European physics laboratories, and, in particular, of the INFN in cutting-edge research, enabling European scientists and engineers to contribute to technological innovation, deepen scientific knowledge and inspire future generations of scientists.
This document provides initial input from the INFN to the Update of the European Strategy for Particle Physics. It reflects the content and extensive discussions held during the National INFN 'Town Meeting', which took place in Rome on 6–7 May 2024 and in Milan on 4 February 2025. More detailed and independent input is being submitted by several of the National INFN Scientific Committees and Laboratories. Further input might be provided throughout the update process, in preparation of the Open Symposium planned on 23–27 June 2025 in Lido di Venezia and of the Strategy Drafting Session.

Authors: ZOCCOLI, Antonio (Bologna); MALVEZZI, Sandra (Universita & INFN, Milano-Bicocca (IT))

Contribution ID: **209** Type: **not specified**

FCC: QCD physics

he Future Circular Collider (FCC) will deliver unprecedented precision in the measurement of the properties and parameters of the Standard Model (SM), directly and indirectly probing new physics up to the 100-TeV scale. Its broad and diverse programme, including very high-luminosity e^+e^- collisions (FCC-ee) and hadronic collisions at the energy frontier (FCC-hh), will offer exceptional opportunities to advance knowledge of the strong interaction through high-precision measurements across a wide range of energy scales and scattering processes. Key measurements at the FCC-ee and FCC-hh are reviewed that will provide a deeper understanding of quantum chromodynamics (QCD) in the perturbative, nonperturbative and high-density regimes, and advance its theoretical description to a level of precision far beyond that of current collider experiments. The critical role played by QCD in determining key Standard Model quantities at FCC-ee is also discussed, highlighting how improved theoretical calculations and simulations are needed to match the foreseen FCC-ee experimental uncertainties.

Authors: D'ENTERRIA, David (CERN); MONNI, Pier Francesco (CERN)

Contribution ID: **210** Type: **not specified**

Proton-Driven Plasma Wakefield Acceleration for Future HEP Colliders

We discuss the main elements of a collider facility based on proton-driven plasma wakefield acceleration. We show that very competitive luminosities could be reached for high energy e+e- colliders. A first set of parameters was developed for a Higgs Factory indicating that such a scheme is indeed potentially feasible. There are clearly many challenges to the development of this scheme, including novel RF acceleration modules and strong, high-precision magnets for the proton driver. Challenges in the plasma acceleration stage include the ability to accelerate positrons while maintaining necessary emittance and the energy transfer efficiency from the driver to the witness. Since many exciting applications would become available from our approach, its development should be pursued.

Authors: PUKHOV, Alexander; CALDWELL, Allen (Max-Planck-Institut fur Physik (DE)); WILLEKE, Ferdinand; FARMER, John Patrick (MPP / CERN); LOPES, Nelson (Universidade de Lisboa (PT)); Dr WILSON, Thomas Cunningham (HHU Duesseldorf)

Contribution ID: **211** Type: **not specified**

Expression of Interest for the ALLEGRO Full-Detector Concept for FCC-ee

The following document proposes ALLEGRO as a high-performance general-purpose detector concept for FCC-ee, that is being designed to fulfil all the requirements of its ambitious physics program. While the concept is centered around a noble-liquid based electromagnetic calorimeter, the technology choices concerning all other sub-detectors are open at this stage. We document interests and ideas for these sub-detectors, but the presented selection does not preclude any decision on the future composition of ALLEGRO.

Authors: ALEKSA, Martin (CERN); MORANGE, Nicolas (Université Paris-Saclay (FR)); PLEIER, Marc-Andre

Contribution ID: **213** Type: **not specified**

LHCspin: a Polarized Gas Target for LHC

The goal of the LHCspin project is to develop innovative solutions for measuring the 3D structure of nucleons in high-energy polarized fixed-target collisions, exploring new processes and new probes in a unique, poorly explored kinematic regime at LHC beam energies.
This ambitious task is being based on the recent experience with the successful installation and exploitation of the SMOG2 unpolarized gas target in front of the LHCb spectrometer. SMOG2 provides an ideal benchmark for studying beam-target dynamics at the LHC and demonstrates the feasibility of simultaneous operation with beam-beam collisions.
With the installation of the proposed polarized target system, LHCb will become the first experiment to simultaneously collect data from unpolarized beam-beam collisions at $\sqrt{s}$=14 TeV and polarized and unpolarized beam-target collisions at $\sqrt{s_{NN}}$ ∼100 GeV. LHCspin has the potential to open new frontiers in physics by exploiting the capabilities of the world's most powerful collider and one of the most advanced spectrometers.

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Contribution ID: **214** Type: **not specified**

The Large Hadron electron Collider (LHeC) as a bridge project for CERN

The LHeC program elaborated in the CDR of 2021 included a first phase with concurrent operation of electron-hadron and hadron-hadron collisions at the HL-LHC, followed by a second phase of standalone electron-hadron collisions. In view of the current HL-LHC schedule, we propose an LHeC program extending the regular HL-LHC program with only a standalone electron-hadron operation phase. In this way, the LHeC becomes an impactful bridge project between major colliders at CERN. It is considered the last phase of the LHC and the first phase of a new flagship collider. The high-energy high-luminosity electron-proton collisions enable a multi-purpose experiment leveraging the HL-LHC proton beams. The data from the LHeC unlocks precision physics in the Higgs, Electroweak, QCD and top-quark sectors and specific searches for BSM physics. It further empowers the physics analyses at the HL-LHC by retrofitting measurements and searches with significantly more precise knowledge on the proton structure and the strong coupling. The accelerator technology deployed in the Energy Recovery Linac for the LHeC is a major stepping-stone for the performance, cost reduction and training for future colliders. The capital investments in the LHeC electron accelerator can be reused in a cost-efficient way as the injector for the FCC-ee. In addition, the data from the LHeC is an essential enabler for the physics potential of any new high-energy hadron collider. The operational plan of 6 years easily fits in the period between two major colliders at CERN. Similar to the LHeC empowering the HL-LHC physics program, the FCC-eh would be an impactful addition to the FCC physics program.

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Contribution ID: **215** Type: **not specified**

A roadmap for astroparticle theory in Europe

Important and challenging questions remain unanswered about the fundamental constituents of Nature, their interactions, and the evolution of the Universe and its extreme environments. Astroparticle physics, lying at the interface between particle physics, astrophysics and cosmology, aims to provide vital clues to answer them. A vibrant effort in theoretical astroparticle physics is needed to support, fully exploit and guide the ambitious experimental and observational programme in Europe and worldwide. We stress the importance of a balanced programme of theoretical, experimental and observational activities, in synergy with and complementary to the collider programme at CERN, to answer these challenging questions, exploring a broad range of physics scales and phenomena. - This contribution has been prepared by the EuCAPT Strategy Task Force, based on the input from the European astroparticle theory community and with the endorsement by 430 astroparticle theorists.

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Contribution ID: **216** Type: **not specified**

Advancing Global Collaboration through the Electron-Ion Collider (EIC)

The Electron-Ion Collider (EIC) at Brookhaven National Laboratory represents a groundbreaking opportunity to explore the fundamental structure of matter by colliding polarized electron beams with polarized hadron beams. This facility is designed to address critical questions in Quantum Chromodynamics (QCD), particularly the role of gluons in binding quarks within nucleons and nuclei. With the potential to achieve luminosities up to ~10^{34} $cm^{-2}s^{-1}$, the EIC will rely on cutting-edge technologies such as hadron beam cooling, spin-transparent optics, crab cavities, and advanced superconducting magnets. In addition to advancing scientific knowledge, the EIC project offers a unique opportunity for international collaboration, particularly for European institutions. By contributing to the EIC, European researchers will play a pivotal role in enhancing accelerator technology and advancing QCD research. Furthermore, this collaboration will foster innovation in accelerator technologies such as superconducting RF cavities and polarized beams dynamics, benefiting future accelerator projects worldwide. The proposed EIC Accelerator initiative aims to provide a platform for collaboration and discussion, focusing on facilitating opportunities for US and European institutions to contribute to the EIC's construction and future upgrades. This initiative will also serve as a vital communication channel between the accelerator R&D community and EIC stakeholders, guiding the long-term development of the facility and exploring opportunities for future accelerator technologies. By taking a forward-thinking approach, the initiative will help ensure that the EIC remains at the forefront of accelerator innovation and contributes to the success of future particle colliders, serving as a testbed for new accelerator physics concepts and technologies.

Authors: SERYI, Andrei (Jefferson Lab); Dr PIELONI, Tatiana (EPFL)

Contribution ID: **217** Type: **not specified**

Prospects in Electroweak, Higgs and Top physics at FCC

The FCC integrated programme offers a unique opportunity to comprehensively explore the Higgs, electroweak and top sectors. The FCC-ee clean experimental conditions and well-defined initial state enable the exploitation of all produced Higgs, W, Z bosons and top quarks and allow, in a record time, for a precise characterisation of the Standard Model properties with unrivalled precision. The model-independent determination of Higgs and Top couplings at FCC-ee provides an absolute normalisation for FCC-hh measurements. With the large production rates at FCC-hh, complementary precision measurements of rare Higgs decay modes and an unparalleled characterisation of the Higgs self-interaction become possible. The extended kinematic range provides indirect probes of new physics via precision measurements in the multi-TeV regime. Together, the FCC-ee and the FCC-hh comprehensively explore potential new physics through precision measurements in complementary energy regimes.

Authors: SELVAGGI, Michele (CERN); BLONDEL, Alain (Universite de Geneve (CH)); EYSERMANS, Jan (Massachusetts Inst. of Technology (US))

Contribution ID: **218** Type: **not specified**

COMET —An Experiment to Search for Muon-to-Electron Conversion in Nuclear Field at J-PARC—

COMET is an experiment aiming to search for the muon to electron conversion in a nuclear field (μ-e conversion) with a sensitivity at a level of 10^{-17}. The μ-e conversion is one of charged-Lepton Flavor Violation (cLFV) processes and not only strictly forbidden in the Standard Model of Particle Physics (SM), but also undetectable in a SM minimally extended via massive Dirac neutrinos. Many New Physics (NP) models beyond the SM predict sizable occurrences of the μ-e conversion. The μ-e conversion is one of the most sensitive searches for NP and, combined with other cLFV observables, has the potential to reveal its nature.
COMET utilizes state-of-the-art muon beam technology with a pion-capture solenoid to produce about 2×10^{11}/s negative muons, later stopped on a muon-stopping target to create muonic atoms. It takes a staged approach to maintain a steady and robust development of this new experimental technique. In Phase-I, a short muon beam line with a 90◦ bend is constructed and beam quality will be measured. Physics data will also be collected to search for μ-e conversion with an aluminum target at a sensitivity level of 10^{-15}, which is two orders of magnitude improvement over the current upper limit given by SINDRUM-II. Phase-II will be constructed based on an experience and knowledge we accumulate in Phase-I to reach the sensitivity at a level of 10^{-17} or better.
The construction of the Phase-I experiment setup is in progress at J-PARC. All superconducting magnets have been delivered to J-PARC to be installed and tested in 2025–2026. The development and construction of the detectors for physics data-taking and beam measurement are going well. Installation of the detector for the physics data will be carried out in the middle of 2026, followed by COMET Phase-I data acquisition using muon beam in late 2026.

Author: AOKI, Masaharu

Contribution ID: **219** Type: **not specified**

RF developments for future colliders

A Coordination Panel of European RF experts is following up the implementation of the Accelerator R&D roadmap prepared for the European Large National Laboratory Directors Group (LDG) of CERN in Jan 2022, on the topic of high-gradient RF structures and systems.
This paper is intended to summarise the main results achieved in 2022-25, those still expected during the current ESPP period (until 2026) and to provide prioritised directions for future R&D to be conducted during the exploitation of the next ESPP update (2027-33), to best fulfil the needs of the principal collider schemes.

Authors: BISOFFI, Giovanni (INFN); MCINTOSH, Peter (STFC)

Contribution ID: **220** Type: **not specified**

Advanced Accelerator and HEP Developments through Networking between the Large Particle Physics Laboratories and CERN

Together, the large particle physics laboratories of the CERN Member States and Associate Member States own significant resources. Their infrastructure and technical capabilities are necessary for the implementation of most large-scale projects in the field. The LDG provides a forum to synchronize the laboratories'respective strategies, projects and priorities, with the aim of maximising cooperation in the planning, preparation and execution of future projects. We describe the specific and unique opportunities that the LDG laboratories offer for particle physics. The input outlines competences, and planned activities at the laboratories. We highlight opportunities to strengthen the collaborations with CERN and between the laboratories. The LDG oversees the European accelerator road map activities, aimed at developing technologies and concepts for future particle collider infrastructures. This input summarizes the plans for the five individual themes that are covered by the road map and by the panel for sustainability.

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Contribution ID: **221** Type: **not specified**

The DArk Messenger Searches at an Accelerator Experiment, A Case of a Table-Top Scale Experiment at a Beam Dump

DAMSA (**DA**rk **M**essenger **S**earches at an **A**ccelerator) is a table-top scale, extremely-short-baseline experiment designed to probe dark-sector particles (DSPs) that serve as portals between the visible sector and the hidden dark-matter sector. These particles, such as axion-like particles (ALPs), can decay into two photons or e^+e^- pairs. DAMSA is specifically optimized to explore regions of parameter space that are inaccessible to past and current experiments, by operating at ultra-short baselines and employing high-resolution calorimetry, precision timing, and precision tracking in a magnetic field with suppression of beam-related neutron backgrounds.
The experiment can be integrated into facilities such as CERN's Beam-Dump Facility (BDF), operating concurrently with the SHiP experiment, and provides complementary sensitivity in the MeV to GeV mass range. DAMSA represents a cost-effective and timely opportunity to expand CERN's discovery potential in dark-sector physics. It exemplifies how innovative, small-scale experiments can effectively complement large-scale experiments, taking advantage of existing and future infrastructure.

Authors: KIM, Doojin; Prof. YU, Jaehoon (University of Texas at Arlington (US)); ESTRADA VIGIL, Juan Cruz; ESTRADA, Juan; YANG, Un Ki (Seoul National University (KR))

Contribution ID: **222** Type: **not specified**

To build or not to build: FCC

This is my individual contribution to the discussions ongoing on the update of the European Strategy for Particle Physics. After participating in many discussions and contributing to a number of documents being prepared for the ESPP submission, I came to the conclusion that these "official" documents do not give the whole picture. I wanted to express my concerns about the strategy update process and the possible choice of FCC as the next flagship project at CERN. I do hope my short contribution is found relevant by those interested in the strategy update process.

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Contribution ID: **223** Type: **not specified**

Projections for Key Measurements in Heavy Flavour Physics

Precision studies of flavour-changing processes involving quarks and leptons provide a number of ways to improve knowledge of the Standard Model and search for physics beyond it. There are excellent short- and mid-term prospects for significantly improved measurements in heavy flavour physics (involving b and c hadrons and τ leptons), with upgrades in progress or planned for the ATLAS, CMS and LHCb experiments exploiting proton-proton collisions at CERN's Large Hadron Collider, and for the Belle II experiment operating with electron-positron collisions from the SuperKEKB accelerator in KEK. The expected sensitivities that can be achieved from these experiments for a number of key observables are presented, highlighting the complementarity of the different experiments and showing how the precision will improve with time. This international programme in heavy flavour physics will result in unprecedented capability to probe this sector of the Standard Model and, potentially, observe imprints of physics at higher energy scales than can be accessed directly.

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Contribution ID: **224** Type: **not specified**

Community Support for Physics with high-luminosity proton-nucleus collisions at the LHC

This document promotes the physics case for the operation of high-luminosity proton-nucleus pA collisions during Run 3 and 4 at the LHC. The collection of $\mathcal{O}(1\text{–}10\ \text{pb}^{-1})$ of proton-lead (pPb) collisions at the LHC will provide broad and unique physics reach on multiple fronts including proton and nuclear Parton Distribution Functions (PDFs and nPDFs), Generalised Parton Distributions (GPDs), Transverse Momentum Dependent PDFs (TMDs), low-x QCD and parton saturation, hadron spectroscopy, baseline studies for quark-gluon plasma and parton collectivity, double and triple parton scatterings (DPS/TPS), photon-photon collisions, and physics beyond the Standard Model (BSM); which are not otherwise as clearly accessible by exploiting data from any other colliding system at the LHC. This report summarises the accelerator aspects of high-luminosity pA operation at the LHC, as well as each of the physics topics outlined above, including the relevant experimental measurements that motivate -much- larger pA datasets.

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Contribution ID: **225** Type: **not specified**

The Project 8 Neutrino Mass Experiment

Measurements of the β^- spectrum of tritium give the most precise direct limits on neutrino mass. Project 8 will investigate neutrino mass using Cyclotron Radiation Emission Spectroscopy (CRES) with an atomic tritium source. CRES is a new experimental technique that has the potential to surmount the systematic and statistical limitations of current-generation direct measurement methods. Atomic tritium avoids an irreducible uncertainty associated with the final states populated by the decay of molecular tritium. Project 8 will proceed in a phased approach toward a goal of 40 meV/c^2 neutrino-mass sensitivity.

Authors: FORMAGGIO, Joseph; BÖSER, Sebastian (Universität Mainz); FERTL, Martin (Johannes Gutenberg-Universität Mainz); REIMANN, René; STACHURSKA, Juliana; THÜMMLER, Thomas

Contribution ID: **226** Type: **not specified**

ICARUS contribution to the European Strategy Process 2026

We present the scientific and technical progress from the ICARUS experimental project at Fermilab. The ICARUS detector represents a major investment in accelerator neutrino science and liquid argon technology from Europe and particularly from INFN/Italy. This report is a summary from the ICARUS collaboration for the European Strategy for Particle Physics Update 2025-26. We will describe the status of the detector systems, the quality of the data obtained so far, expected scientific impact and future goals.

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Contribution ID: **227** Type: **not specified**

Prospects for physics at FCC-hh

This submission reviews and updates the extensive work done over the years to explore and quantify the physics potential of FCC-hh, the hadron collider component of the integrated Future Circular Collider facility. The document introduces the context of these studies, as it has developed over the years, and offers an update of key targets of FCC-hh such as the precision Higgs studies and the discovery reach at the highest mass scales. New analyses added or improved with respect to the CDR, are introduced. A general assessment is also given of the impact of the new energy/luminosity baseline for the accelerator, and of alternative configurations, on the physics results.

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Contribution ID: **228** Type: **not specified**

Quantum Technologies in High Energy Physics. The CERN Quantum Technology Initiative input to the European Strategy for Particle Physics

Quantum technology has the potential to revolutionize High Energy Physics (HEP), thanks to its disruptive nature. Quantum hardware could be employed to conceive novel detector technologies. Quantum software could speed up computing-demanding tasks in the next or next-to-next generation of particle physics experiments. Several national initiatives, across CERN Member States and beyond, are investigating various directions on R&D, coordinated through initiatives such as QC4HEP and DRD5.
The CERN Quantum Technology Initiative (QTI) has played a crucial role in consolidating quantum-related activities, serving as a European hub as well as carrying out its own R&D projects. Launched in 2020, QTI focuses on three main areas: hybrid quantum computing, quantum sensing, and quantum communication. These efforts aim to enhance the practical applicability of quantum technologies in HEP, fostering innovation and cross-disciplinary collaboration.
This document reviews the achievements of CERN QTI, highlighting its role in developing quantum algorithms, exploring novel detector technologies and fostering international collaborations. It provides a series of concrete recommendation to the European Strategy for Particle Physics group, advocating for a long-term investment in quantum technologies.
The recommendations are grounded in the lessons learned from QTI's initial phases, emphasizing the importance of realistic expectations, interdisciplinary collaboration, and the integration of quantum technologies in existing research frameworks. By aligning with the priorities of the HEP community and leveraging CERN's unique position, QTI is ideally situated to drive the next generation advancements of quantum technologies for HEP.

Authors: MACPHERSON, Alick (CERN); DIEZ FERNANDEZ, Amanda (CERN); TEEPE, Annick; FRISCH, Benjamin (CERN); MURGUI GALVEZ, Clara (CERN); MARTELLI, Edoardo (CERN); SERRANO, Javier (CERN); KOPP, Joachim (CERN); PIERINI, Maurizio (CERN); DOSER, Michael (Massachusetts Inst. of Technology (US)); Dr GROSSI, Michele (CERN); CALATRONI, Sergio (CERN); Dr VALLECORSA, Sofia (CERN)

Contribution ID: **229** Type: **not specified**

Development of Gaseous Detector Technologies: CERN-DRD1 Collaboration Model

This report summarizes CERN-DRD1 collaboration model and its main pillars

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Contribution ID: **230** Type: **not specified**

US National Input to the European Strategy Update for Particle Physics

In this document we summarize the output of the US community planning exercises for particle physics that were performed between 2020 and 2023 and comment upon progress made since then towards our common scientific goals. This document leans heavily on the formal report of the Particle Physics Project Prioritization Panel and other recent US planning documents, often quoting them verbatim to retain the community consensus.

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Contribution ID: **231** Type: **not specified**

Super Tau Charm Facility

The Super Tau Charm Facility (STCF) is a third-generation high-luminosity electron-positron collider designed to operate at a center-of-mass energy ($\sqrt{s}$) ranging from 2 to 7 GeV, achieving a peak luminosity exceeding $5 \times 10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ at $\sqrt{s} = 4\ \mathrm{GeV}$. Compared to other experiments, STCF represents a substantial advancement for electron-positron colliders in the Tau-Charm energy region, both in terms of energy coverage and luminosity. A two-order-of-magnitude increase in luminosity and expanded energy range present complex challenges in the accelerator's design and construction. A series new methodologies and cutting-edge technologies in accelerator and particle detector will be implemented.

STCF will offer a unique and comprehensive physics program covering Quantum Chromodynamics (QCD), hadronic physics, flavor physics, Charge-Parity (CP) violation, rare and forbidden decays, and exploration of new physics phenomena, complementing the research carried out at SuperKEKB, LHC, and future high-energy colliders over the next two decades. Key highlights include the potential observation of CP violation in strange-baryon decays, leading-edge tests of CPT symmetry in kaon decay, and ultra-precise measurements of strong-phase parameters in charm meson decays. STCF will provide exceptional opportunities for investigating exotic hadron spectroscopy. Furthermore STCF will offers the opportunities to precisely measure the key physics variables including R-value, τ lepton mass, CKM elements, and strong coupling constant α_s.

The STCF project was first proposed over a decade ago and has since been extensively discussed within China's high-energy physics community. The conceptual design was completed in 2021. A detailed report on physics and detector was released in 2023, and an updated accelerator report is forthcoming. A key technology research and development (R&D) project, jointly supported by Anhui Province and Hefei City with a budget of 364 million RMB, began in 2023. It focuses on designing accelerator and spectrometer systems and overcoming key technological challenges, and is on track for completion by the end of 2025.Efforts to establish STCF as one of China's National Major Science and Technology Infrastructure Projects under the 15th Five-Year Plan are progressing steadily.

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Contribution ID: **232** Type: **not specified**

The Short-Baseline Near Detector at Fermilab

The Short-Baseline Near Detector (SBND) is a 112-ton liquid argon time projection chamber (LArTPC) neutrino detector located 110 meters from the Booster Neutrino Beam (BNB) target at Fermilab. Its main goals include searches for eV-scale sterile neutrinos as part of the Short-Baseline Neutrino (SBN) program, other searches for physics beyond the Standard Model, and precision studies of neutrino-argon interactions. In addition, SBND is providing a platform for LArTPC neutrino detector technology development and is an excellent training ground for the international group of scientists and engineers working towards the upcoming flagship Deep Underground Neutrino Experiment (DUNE).

SBND began operation in July 2024, and started collecting stable neutrino beam data in December 2024 with an unprecedented rate of $\sim 7,000$ neutrino events per day. During its currently approved operation plans ($2024 - 2027$), SBND is expected to accumulate an exposure of around 10×10^{20} protons on target, recording nearly 10 million neutrino interactions. The near detector dataset will be instrumental in testing the sterile neutrino hypothesis with unprecedented sensitivity in SBN and in probing signals of beyond the Standard Model physics. It will also be used to significantly advance our understanding of the physics of neutrino-argon interactions ahead of DUNE. After the planned accelerator restart at Fermilab (2029+), opportunities are being explored to operate SBND in antineutrino mode in order to address the scarcity of antineutrino–argon scattering data, or in a dedicated beam-dump mode to significantly enhance sensitivity to searches for new physics.

SBND is an international effort, with approximately 40% of institutions from Europe, contributing to detector construction, commissioning, software development, and data analysis. Continued European involvement and leadership are essential during SBND's operations and analysis phase for both the success of SBND/SBN and its role leading up to DUNE.

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Contribution ID: **233** Type: **not specified**

FCC Integrated Programme Stage 1: The FCC-ee

The Future Circular Collider (FCC) 'integrated programme'consists of an initial electron-positron collider FCC-ee, which is followed by a proton-proton collider, FCC-hh. This integrated programme is well matched to the current scientific landscape after 15 years of LHC operation. The proposed staging takes into account: (1) the physics priorities as developed and stated by EPPSU 2013 and 2020; and (2) the relative technology readiness and costs of FCC-ee and FCC-hh.

Both FCC-ee and FCC-hh would be installed in the same 91 km circumference tunnel close to CERN, reusing all the FCC-ee civil engineering and much of the technical infrastructure for the subsequent FCC-hh, thereby maximising the return on investment and ensuring guaranteed physics deliverables along with the broadest and most versatile exploration potential of the intensity and energy frontiers. Taking advantage of a perfect four-fold superperiodicity, FCC-ee and FCC-hh each accommodate
four detectors. The two stages, FCC-ee and FCC-hh, are optimised so as to enable the widest possible physics programme, with ample complementarity and synergies between stage 1 and stage 2.

Key design ingredients of FCC-ee, such as a double-ring layout, top-up injection with a full-energy booster, crab-waist collision scheme, minimum vertical beta function, high-current operation, required positron production rate, and precise energy calibration were all demonstrated in routine use at several previous or presently operating colliders, including LEP, SLC, KEKB, PEP-II, DAΦNE, and SuperKEKB. The FCC-ee, thus, is technically ready for construction, and it can deliver 4 to 5 orders of magnitude higher luminosity per unit electrical power than the previous LEP collider. The ongoing technology R&D aims at further increasing its energy and operational efficiency, and at cost minimisation. A project implementation scenario has been developed and an analysis of the present territorial and environmental conditions indicate favorable prospects for construction. A socio-economic impact assessment integrating environmental aspects has revealed a positive net present value and a positive benefit-cost ratio, under conservative assumptions and implementation conditions. The project can therefore be considered sustainable from a socio-economic perspective. Dialogue with the public and host state authorities have started. All those activities presented are necessary prerequisites for the authorisation processes with the host states. Their anticipation facilitate convergence towards a credible implementation schedule and provides better planning security.

The FCC-ee collider with its injector also offers unique opportunities for numerous other branches of physics and science, ranging from the proposed production of true muonium to generate spatially coherent photon beams down to 0.1 Å wavelengths at several orders of magnitudes higher average and peak brightness than any existing or planned light source.

The three volumes of FCC Feasibility Study Report are available for download along with complimentary material.

Authors: BENEDIKT, Michael (CERN); ZIMMERMANN, Frank (CERN); AUCHMANN, Bernhard (PSI/CERN); BARTMANN, Wolfgang (CERN); BURNET, Jean-Paul (CERN); CARLI, Christian (CERN); CHANCE, Antoine (CEA Irfu); CRAIEVICH, Paolo; GIOVANNOZZI, Massimo (CERN); GROJEAN, Christophe (DESY (Hamburg) and Humboldt University (Berlin)); GUTLEBER, Johannes (CERN); HANKE, Klaus (CERN); HENRIQUES, Andre (CERN); JANOT, Patrick (CERN); LOURENCO, Carlos (CERN); MANGANO, Michelangelo (CERN); OTTO, Thomas (CERN); POOLE, John Howard; RAJAGOPALAN, Srini (Brookhaven National Laboratory (US)); RAUBENHEIMER, Tor (SLAC National Accelerator Laboratory - On Leave

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Contribution ID: **234** Type: **not specified**

Enhancing New Physics Searches with a Future Beam Dump Configuration at SBND

Accelerator-based neutrino experiments, especially those with high-intensity beams and highly capable detectors, offer a powerful and complementary method for probing new physics scenarios. The MiniBooNE experiment at Fermilab pioneered a special Booster Neutrino Beam (BNB) beam dump run and set new limits on sub-GeV dark matter. This white paper explores the physics opportunities enabled by operating the Short-Baseline Near Detector (SBND) at Fermilab in a future BNB beam dump configuration. Redirecting the proton beam away from the default target suppresses neutrino backgrounds, enabling SBND to significantly enhance sensitivity to many new physics scenarios. We evaluate two operational scenarios –off-target mode and a new dedicated beam dump mode –and demonstrate that both approaches can open new avenues in the search for physics beyond the Standard Model. We present two example cases, scalar dark matter and heavy neutral leptons via axion-like particle.

Authors: Prof. DUTTA, Bhaskar; VAN DE WATER, Richard (Los Alamos National Laboratory); Dr PANDEY, Vishvas; TABRIZI, Zahra (University of Pittsburgh (US)); KARTHIKEYAN, Aparajitha (Department of Physics and Astronomy, Texas A&M University); GOSWAMI, Debopam (Department of Physics & Astronomy, Texas A&M University)

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Summary Report of the Physics Beyond Colliders Study at CERN

The Physics Beyond Collider Study Group was initially mandated by the CERN Management to prepare the previous European Particle Physics Strategy Update for CERN projects other than the high-energy frontier colliders. The main findings were summarized in a report. Following the Update process, the Physics Beyond Collider Study Group was confirmed on a permanent basis with an updated mandate taking into account the strategy recommendations. The Study Group is now in charge of supporting the proponents of new ideas to address the technical issues and physics motivation of the projects ahead of their review by the CERN Scientific Committees and decision by the Management. The present document updates the previous PBC summary report to inform the new ongoing European Particle Physics Strategy Update process, taking into account the evolution of the CERN and worldwide landscapes and the new projects under consideration within the Study Group.

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Contribution ID: **236** Type: **not specified**

Expanding the neutrino facility at the South Pole: IceCube-Upgrade and IceCube-Gen2

Since its completion in 2011, the IceCube Neutrino Observatory has opened a new window to the extreme Universe. Building on its success in multi-messenger astronomy and particle physics, the collaboration is pursuing two major extensions: the IceCube Upgrade, a low-energy addition under construction to enhance studies of neutrino properties and dark matter; and IceCube-Gen2, which is optimized for high energies and which will advance neutrino astronomy from discovery to precision science. European institutions play a key role in both international projects.

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Contribution ID: **237** Type: **not specified**

The Elastic Analysis Facility's (EAF's) Contribution to the Future of Analysis at Multi-Experiment Institutions and Future Colliders

The Elastic Analysis Facility (EAF) hosted at Fermi National Accelerator Laboratory (Fermilab) is a platform being developed with the goal of providing a fast and efficient facility for physics analysis. As high-energy physics moves towards collecting larger datasets, such as those from the High-Luminosity LHC, the EAF strives to provide a powerful and adaptable framework for future colliders and multi-experiment institutions. Currently, the EAF supports several experiments including CMS, NOvA, and DUNE as well as serving accelerator physicists and beam line operations through integrated software and secure connections to Fermilab's computing resources. In addition, the EAF was designed with a user-friendly interface, intended to be more intuitive for emerging generations of physicists, that is still accessible for established styles of analysis. The EAF can also achieve better analysis efficiency due to the modernization of software and tools that can better utilize Fermilab's computing power. Furthermore, its design incorporates industry standards whenever possible, enhancing its sustainability and making it a possible template for other national or international laboratories and research facilities. Overall, the EAF is a forward-looking solution that will meet the evolving needs of particle physics, ensuring readiness for future colliders and multi-experiment research institutions.

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Contribution ID: **238** Type: **not specified**

The Hyper-Kamiokande experiment: input to the update of the European Strategy for Particle Physics

This document summarises the input of the Hyper-Kamiokande collaboration to the 2026 Update to the European Strategy for Particle Physics, ESPPU.

Hyper-Kamiokande is a large infrastructure for particle and astroparticle physics being built in Japan and aiming to start operations by the end of 2027 whose objective is to address the most important questions in science today, for instance how the universe began and evolved. It aims to measure with the highest
precision the leptonic Charge-Parity violation parameter that could explain the baryon asymmetry in the Universe and study / challenge the standard three-flavour neutrino framework using both a Mega-Watt intense neutrino beam and high-statistics atmospheric neutrino samples. The combination of these samples will break the degeneracies between the effects of the Mass Ordering and Charge-Parity violation, allowing for their measurement without relying on external information.

Hyper-Kamiokande is also a neutrino observatory for astrophysical events that will collect the highest statistics due to its size. It will also be able to precisely measure solar neutrino oscillations and other astrophysics events as supernova bursts, relic supernova neutrinos, neutrinos in correspondence with gravitational waves, etc. It can also detect neutrinos from sources such as dark-matter annihilation, gamma-ray burst jets, and pulsar winds, further increasing our understanding of some of the most spectacular, and least understood, phenomena in the Universe.

Furthermore, due to its size and particle identification capability, the experiment has an excellent potential to search for proton decay, providing a
significant improvement in discovery sensitivity over current searches for the proton lifetime and nucleon decays.

Hyper-Kamiokande is expected to run at least 20 years from the start of operations and is supported by 10 countries in Europe that are contributing to its construction, future operation and data analysis. Prototyping and assembly are also being carried out at CERN.
The reduction of the flux systematic uncertainties would benefit from new hadron production measurements at the NA61/SHINE experiment at CERN, also with a low-energy beam.
A final upgrade of the magnetised off-axis near detector (ND280++) for the high-statistics phase in the 2030s aim to be sought and would benefit from CERN support.

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Contribution ID: **239** Type: **not specified**

Physics Prospects for a near-term Proton-Proton Collider

Hadron colliders at the energy frontier offer significant discovery potential through precise measurements of Standard Model processes and direct searches for new particles and interactions. A future hadron collider would enhance the exploration of particle physics at the electroweak scale and beyond, potentially uniting the community around a common project. The LHC has already demonstrated precision measurement and new physics search capabilities well beyond its original design goals and the HL-LHC will continue to usher in new advancements.

This document highlights the physics potential of an FCC-hh machine to directly follow the HL-LHC. In order to reduce the timeline and costs, the physics impact of lower collider energies, down to $\sim$ 50˜TeV, is evaluated. Lower centre-of-mass energy could leverage advanced magnet technology to reduce both the cost and time to the next hadron collider.

Such a machine offers a breadth of physics potential and would make key advancements in Higgs measurements, direct particle production searches, and high-energy tests of Standard Model processes. Most projected results from such a hadron-hadron collider are superior to or competitive with other proposed accelerator projects and this option offers unparalleled physics breadth. The FCC program should lay out a decision-making process that evaluates in detail options for proceeding directly to a hadron collider, including the possibility of reducing energy targets and staging the magnet installation to spread out the cost profile.

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Contribution ID: **240**   Type: **not specified**

Key4hep: A Software Framework for Future Colliders

The Key4hep project provides a collaborative software ecosystem for the development and study of future collider detector concepts. Initiated in 2019 by multiple international particle physics communities, it offers a comprehensive software infrastructure for simulation, reconstruction, and analysis. By developing its own event data model, EDM4hep, and integrating it with established tools like DD4hep and Gaudi, Key4hep has become the standard framework for detector studies at future colliders. However, it faces funding challenges that could impact its long-term sustainability.

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Contribution ID: **241** Type: **not specified**

The FCC integrated programme: a physics manifesto

The FCC integrated programme comprises an $\mathrm{e}^+\mathrm{e}^-$ high-luminosity circular collider that will produce very large samples of data in an energy range $88 \leq \sqrt{s} \leq 365$\,GeV, followed by a high-energy pp machine that, with the current baseline plan, will operate at a collision energy of around 85\,TeV and deliver datasets an order of magnitude larger than those of the HL-LHC. This visionary project will allow for transformative measurements across a very broad range of topics, which in almost all cases will exceed in sensitivity the projections of any other proposed facility, and simultaneously provide the best possible opportunity for discovering physics beyond the Standard Model. The highlights of the physics programme are presented, together with discussion on the key attributes of the integrated project that enable the physics reach. It is noted that the baseline programme of FCC-ee, in particular, is both flexible and extendable, and also that the synergy and complementarity of the electron and proton machines, and the sharing of a common infrastructure, provides a remarkably efficient, timely and cost-effective approach to addressing the most pressing open questions in elementary particle physics.

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Contribution ID: **242** Type: **not specified**

Prospects in BSM physics at FCC

The exceptional opportunities offered by the FCC programme in the search for physics beyond the Standard Model are reviewed. Uniquely to FCC, all frontiers on which the search for new physics must continue are significantly pushed back: Flavour, Intensity, Higgs, Dark, Electroweak and High Energy.

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Contribution ID: **243** Type: **not specified**

High Field Magnet Programme –European Strategy Input

In this submission, we describe research goals, implementation, and timelines of the High Field Magnet Programme, hosted by CERN. The programme pursues accelerator-magnet R&D with low-temperature- and high-temperature superconductor technology with a main focus on the FCC-hh. Following a long tradition of magnet R&D for high-energy particle colliders, HFM R&D fosters important societal impact through synergies with other fields.

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Contribution ID: **244** Type: **not specified**

The Importance of Test Beams for Particle Physics worldwide

The test beams provided by the major laboratories worldwide are a key infrastructure for developing detectors for high-energy physics, nuclear physics, and adjacent fields. They are also an ideal training ground for the next generation of instrumentation experts. Close to a thousand users make use of the worldwide test beam facilities, with CERN, DESY and Fermilab being the most heavily used ones. Over the last decades all laboratories have worked hard to coordinate the shutdowns of their accelerator complexes as much as possible to prevent a global dark time for test beam users. For the next generation of experiments in particle physics and also for nuclear physics – in particular for the proposed future flagship project of high-energy physics at CERN – the availability for test beams is essential.

Authors: HOLZER, Eva Barbara (CERN); NINER, Evan (Fermilab); BERNHARD, Johannes (CERN); DESCH, Klaus (University of Bonn (DE)); ROMINSKY, Mandy (Fermilab); STANITZKI, Marcel (Deutsches Elektronen-Synchrotron (DE)); JAEKEL, Martin R. (CERN); PASTIKA, Nathaniel Joseph (Fermi National Accelerator Lab. (US)); MEYNERS, Norbert (Deutsches Elektronen-Synchrotron (DE)); DIENER, Ralf; Dr SCHMELING, Sascha (CERN); ACKERMANN, Sven (DESY)

Contribution ID: **245** Type: **not specified**

MUonE Contribution to the European Strategy: status of the project

The MUonE experiment aims at an independent and very precise determination of the leading hadronic contribution to the muon magnetic moment, based on an alternative method, complementary to the existing ones. This can be achieved by measuring with unprecedented precision the shape of the differential cross section of μe elastic scattering, using the intense muon beam available at CERN, with energy of 160 GeV, off atomic electrons of a light target. The status of the project is presented, with recent results in preparation for the test run scheduled in 2025 with a reduced detector.

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Contribution ID: **246** Type: **not specified**

U.S. interest in high-energy nuclear physics at the LHC

The authors are experimental heavy-ion physicists from universities and a national laboratory across the U.S. We are writing to stress interest and support in a continued heavy-ion physics program at the LHC. The arguments in this document are intended to be synergistic with those organized by the broader U.S. community for the U.S. 2023 Long Plan for Nuclear Science, and international communities as input to the 2026 European Strategy for Particle Physics Update.

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Contribution ID: **247** Type: **not specified**

FCC Integrated Programme Stage 2: The FCC-hh

The Future Circular Collider (FCC) 'integrated programme' consists of an initial electron-positron collider FCC-ee, which is later followed by a proton-proton collider, FCC-hh. This comprehensive programme is well matched to the current scientific landscape after 15 years of LHC operation. The proposed staging takes into account: (1) the physics priorities as developed and stated by EPPSU 2013 and 2020; and (2) the relative technology readiness and costs of FCC-ee and FCC-hh.

Both FCC-ee and FCC-hh are installed in the same 91 km circumference tunnel close to CERN, which allows reuse of all FCC-ee civil engineering and much of the technical infrastructure for the subsequent FCC-hh, thus maximising the return on investment and ensuring sustainable long-term use of the infrastructure. Taking advantage of a perfect four-fold superperiodicity, FCC-ee and FCC-hh each accommodate four experimental detectors. The two FCC stages, FCC-ee and FCC-hh, are optimised so as to enable the widest possible physics programme, with ample complementarity and synergies between Stage 1 and Stage 2.

The hadron collider, FCC-hh, operates at a centre-of-mass energy of about 85 TeV, extending the energy frontier by almost an order of magnitude compared with the LHC, and providing integrated luminosity 5–10 times higher than that of the upcoming High-Luminosity LHC. The mass reach for direct discovery at FCC-hh amounts to several tens of TeV and allows, for example, the direct production of new particles, whose existence could already be indirectly exposed by precision measurements at FCC-ee. The FCC-hh hadron collider can also accommodate ion-ion, ion-hadron, and lepton-hadron collision options, allowing for complementary physics explorations.

A project implementation scenario has been developed, and an analysis of the current environmental status has not revealed any showstoppers. Dialogue with the public has begun. The project implementation scenario, the analysis of the environment, and engagement with the public, representing about seven years of past activities, are necessary prerequisites for the authorisation processes with the host states and facilitate convergence towards a credible implementation schedule and planning security. For the FCC-ee, a wider socio-economic impact assessment has revealed a positive net present value under conservative assumptions and implementation conditions. An equivalent assessment remains to be done for FCC-hh.

The three volumes of the FCC Feasibility Study Report are available for download.

Authors: BENEDIKT, Michael (CERN); ZIMMERMANN, Frank (CERN); AUCHMANN, Bernhard (PSI/CERN); BARTMANN, Wolfgang (CERN); BURNET, Jean-Paul (CERN); CARLI, Christian (CERN); CHANCE, Antoine (CEA Irfu); CRAIEVICH, Paolo; GIOVANNOZZI, Massimo (CERN); GROJEAN, Christophe (DESY (Hamburg) and Humboldt University (Berlin)); GUTLEBER, Johannes (CERN); HANKE, Klaus (CERN); HENRIQUES, Andre (CERN); JANOT, Patrick (CERN); LOURENCO, Carlos (CERN); MANGANO, Michelangelo (CERN); OTTO, Thomas (CERN); POOLE, John Howard; RAJAGOPALAN, Srini (Brookhaven National Laboratory (US)); RAUBENHEIMER, Tor (SLAC National Accelerator Laboratory - On Leave (US)); Dr TODESCO, Ezio (CERN); ULRICI, Luisa (CERN); WATSON, Timothy Paul (CERN); WILKINSON, Guy (University of Oxford (GB))

Contribution ID: **248** Type: **not specified**

Canadian pre-submission to the ESPP

This is the preliminary Canadian input to the ESPP. A full submission is anticipated for the May deadline.

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Contribution ID: **249** Type: **not specified**

KM3NeT contribution to the European Strategy for Particle Physics

The two KM3NeT neutrino detectors, currently under construction in the Mediterranean Sea, have been optimised to cover a broad neutrino energy range, spanning from a few GeV to tens of PeV. This document aims to highlight the expected key physics results. In particular the ORCA detector, designed to study neutrino oscillations in the atmospheric neutrino flux, will be able to determine the neutrino mass ordering (achieving more than 4σ significance after three years of operation) and precisely measure the values of the oscillation parameters Δm^2_{31} and $\sin^2\theta_{23}$. Furthermore, it is expected to yield valuable constraints on the limits on sterile neutrinos and non-standard interactions. The ARCA detector, thanks to its geographic position in the Northern Hemisphere, will enable rapid investigations on the diffuse flux and on neutrinos originating from the Galactic Centre and the Galactic plane (achieving 5σ significance after three years of operation). Discoveries or stringent upper limits are also expected for neutrino searches in the Southern Sky. The innovative design of the KM3NeT optical module also allows for the search and for the characterization of a galactic Core-Collapse supernova O(10 MeV) neutrino signal. The importance of the KM3NeT multi-site infrastructure to the European Research Area is recognized by the European Strategy Forum for Research Infrastructures (ESFRI) with KM3NeT featuring on the ESFRI roadmap since 2006. KM3NeT is currently the only facility located in Europe capable of studying fundamental neutrino oscillation physics and to detect high energy cosmic neutrinos. In particular, KM3NeT ORCA offers the opportunity for a first measurement of the neutrino mass ordering in advance of competing experiments.

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Contribution ID: **250** Type: **not specified**

Rich dark sectors

The Standard Model (SM) of particle physics provides a very successful description of fundamental particles and their interactions but it is incomplete, as neutrino masses, dark matter and the baryon asymmetry of the Universe indicate. In addition, the origin of masses and of the approximate fundamental symmetries call out for deeper explanations. The hunt for a New SM Theory, that extends the SM to a more general theory, is ongoing. For decades the main focus has been on the TeV scale, but despite an impressive theoretical and experimental effort, no hints of new physics at such scale has been found in experiments.
Dark sectors provide an interesting alternative to TeV scale extensions of the Standard Model to explain the open questions in particle and astroparticle physics. Going beyond minimal models, rich dark sectors extend the SM to a complex theory with multiple particles and interactions, in analogy to the Standard Model. They have a wealth of theoretical and astrophysical/cosmological consequences. They can lead to phenomenological signatures that can be markedly different to that of minimal ones: typically fast decays (instead of long lived particles) and semi-visible signature (instead of purely visible or invisible decays). Given the experimental configurations and analysis strategies, current DS search might miss such signatures.
We advocate a dedicated programme of searches for rich dark sectors that overcomes the assumptions on minimality and on the long lifetime of particles and encompasses a broader range of possibilities. A combined effort between theorists and experimentalists is needed to explore these possibilities and fully exploit the wealth of experimental opportunities available in the Physics Beyond Collider Study at CERN and other experiments sensitive to rich dark sectors.

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Contribution ID: **251** Type: **not specified**

Physics opportunities with high-brightness, high-intensity muon beams at CERN: a staged approach

This report presents new physics opportunities at CERN made possible by muon and neutrino beams of unprecedented intensity, achieved through a staged approach in the realization of the Muon Collider as proposed by the International Muon Collider Collaboration (IMCC).

Unlike other facilities, in a multi-TeV Muon Collider every advancement in energy and intensity opens new windows of opportunity for physics, creating a dual benefit: enabling excellent scientific output while simultaneously developing cutting-edge technologies for the host laboratory.

From this perspective, the recent project aimed at establishing a muon cooling channel facility at CERN, based on ionization cooling, can be envisaged as the first step in this direction. This technology offers numerous advantages among which, first and foremost, the production of high-intensity, collimated muon beams of both polarities.

This approach opens up the possibility, for the first time, of producing both muon (anti)neutrinos and electron (anti)neutrinos by exploiting the decay of μ^- (μ^+), which is much cleaner in composition compared to the conventional method based on meson decay. The exploitation of the infrastructure for neutrino physics can start as soon as the first high-precision tertiary muon beams are available. At the same time, several opportunities are offered by directly exploiting the muon beams, from the low energies straight from the cooling channel (for Charged Lepton Flavor Violating processes), to additional physics with gradually increasing beam energies (g-2, EDM, dark matter searches), in experimental conditions not available elsewhere.

In this report, we emphasize the physics opportunities that accompany the staged implementation of the Muon Collider high intensity muon source. We focus both on the physics opportunities at relatively low energies (from tens of MeV to tens of GeV) enabled by the first stage of the Muon Collider and on the unique perspective of equipping CERN with high-brightness, high-intensity muon beams at even higher energies.

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Contribution ID: **252** Type: **not specified**

Cosmic Microwave Background (CMB) as a window to particle physics.

Since the 1970s the Italian CMB community has played a leading role in several groundbreaking CMB experiments, including the very successful BOOMERanG and Planck projects, that have contributed significantly to the present-day era of precision cosmology, where models and theories can be tested and cross-checked with data from other fields, in particular high-energy physics. During the last ten years, this community has organized itself in the COSMOS network, supporting current and future observations of CMB polarization anisotropy and spectral distortions.
The present document summarizes the deep connection between CMB observables and fundamental physics. In Section 2, we recall in particular how the evolution of our Universe, from the very early stages (Inflation) up to the late stages (Dark Energy take-over) is driven by the nature of the particles and fields that fill it in the different eras, and how cosmic evolution leaves distinct imprints both on CMB anisotropies (polarized and unpolarized) and its frequency spectrum. In the same Section, we recall that CMB can be seen as a backlight that travels through the Large Scale Structure, thus opening the possibility of a rich cross-correlation science with Euclid and other experiments targeting different LSS tracers. Section 3 provides a ladscape of ongoing and future experiments planned worldwide, with an emphasis on the Italian contribution. This broad scientific return is enabled by a substantial technological development, mostly related to cryogenic ultra-low noise detection and microwave/millimeter wave techniques, which is described in Section 4.
Overall, the present document represents a summary of the connections between CMB and collider physics with a view on current and future projects, highlighting the areas of common interest and possible synergistic developments.

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Contribution ID: **253** Type: **not specified**

Input to the European Strategy for Particle Physics - 2026 update: The COHERENT Experiment

The COHERENT experiment measures neutrino-induced recoils from coherent elastic neutrino-nucleus scattering (CEvNS) with multiple nuclear targets at the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory (ORNL), USA.
Three successful CEvNs measurements have been achieved in the recent years with tens-of-kg detector masses, with a CsI scintillating crystal; a liquid argon single-phase detector; and high-purity germanium spectrometers. For the next phase, COHERENT aims at high-statistics detection of CEvNS events for precision tests of the standard model of particle physics, and to probe new physics beyond the standard model.
Percent-level precision can be achieved by lowering thresholds, reducing backgrounds, and by scaling up the detector masses. Further detectors will measure CEvNS in additional nuclei, including lighter target nuclei such as sodium and neon, in order to continue to test the expected neutron-number-squared dependence of the cross section.
COHERENT can furthermore study charged-current and neutral-current inelastic neutrino-nucleus cross sections on various nuclei at neutrino energies below 50 MeV. Many of these cross sections have never been measured before, but are critical input for the interpretation of core-collapse supernova detection in multi-kton-scale experiments such as DUNE, Super-K and Hyper-K.

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Contribution ID: **254** Type: **not specified**

ESPP Contribution - Gravitational Field of Proton Bunches

The Newtonian law describing the gravitational interaction of non-relativistic (slowly moving) gravitating matter, has been tested in many laboratory experiments with very high precision. In contrast, the post Minkowskian predictions for the gravitational field of ultra-relativistic matter, dominated by momentum instead of rest mass, have not been tested directly yet. The intense ultra-relativistic proton beam in the LHC storage ring offers the potential to test general relativity and alternative gravitational theories in this parameter regime for the first time in controlled lab-scale experiments. If successful, this would open the road to a novel use case of the LHC, where non-trivial gravitational physics could be studied likely in a parasitic mode, without the necessity of dedicated filling patterns. While the technical challenges are formidable, they should also lead to the development of ultra-high-sensitive acceleration sensors with abundant applications in other parts of science and technology. The present document summarizes the status of the theoretical studies in this direction, points out the challenges, and possible ways of addressing them.

Authors: Dr PFEIFER, Christian (ZARM University Bremen); Prof. BRAUN, Daniel (University Tübingen); Dr RÄTZEL, Dennis (ZARM University Bremen); Dr MARCHESE, Marta Maria; HERMES, Pascal Dominik (CERN); CAI, Rongrong (CERN); Prof. NIMMRICHTER, Stefan (University Siegen); Dr REDAELLI, Stefano (CERN); Prof. ULBRICHT, Hendrik (University of Southampton)

Contribution ID: **255** Type: **not specified**

A Flexible Strategy for the Future of Particle Physics at CERN

This document outlines a strategy to ensure CERN remains at the forefront of particle physics by addressing the most pressing questions of our field in a timely and effective manner. The strategy balances ambition with feasibility—financially, logistically, and environmentally—while ensuring a robust path to exploring fundamental interactions at energies far beyond those of the LHC.

This approach prioritizes rapid progress toward the 10 TeV frontier and beyond, while maintaining a seamless continuity in frontier-physics experiments to maximize scientific output and preserve expertise in experimental operation. The plan also recognizes the need for a next-generation collider with a rich physics program that engages the young scientists currently involved in the LHC era.

This requires a strategic compromise: an optimized near-term solution that is cost-effective yet scientifically compelling, leaving room for future accelerator innovations. The vision leverages decades of breakthroughs in accelerator technology, combining proven methods with new creative advancements to overcome the challenges ahead. By pursuing a flexible and forward-looking program, we aim to meet both the immediate and long-term needs of the global particle physics community in its search for a deeper understanding of nature.

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Contribution ID: **256** Type: **not specified**

Superconductivity Global Alliance (ScGA) European Strategy Input

This document presents a rationale for CERN, and the broader High Energy Physics (HEP) community, to engage strategically with the Superconductivity Global Alliance (ScGA). Building on HEP's historical leadership in superconducting technologies and aligned with future needs, we outline three primary motivations for engagement:

1. Research and development efforts enhance collaboration with the broader applied superconductivity community, whose goals align with those of HEP.
2. Enhance the societal impact of superconductivity R&D in HEP, leveraging the ScGA's network of partners.
3. Attract additional institutional and private funding to accelerate development for both HEP and broader applications.

In association with the ScGA, the HEP community can more effectively advocate for more significant investment and collaboration in the development of superconducting technologies, benefiting both HEP's future experiments and contributing to key societal impact areas, towards increased European Competitiveness. This proposal outlines an advocacy plan, including events and strategic documents, to achieve the aligned goals of the ScGA and HEP.

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Co-authors: HATZIANGELI, Eugenia (CERN); BOTTURA, Luca (CERN); Dr MELHEM, Ziad (Oxford Quantum Solutions)

Contribution ID: **257** Type: **not specified**

National input from Belgium to the 2026 Update to the European Strategy for Particle Physics

This document summarises the input of the Belgian scientists to the European Strategy Group (ESG) in the context of the upcoming European Strategy Update for Particle Physics (ESPP) research. The Belgian HEP community, together with related community representatives, met on several occasions to exchange views on future collider and non-collider based high energy physics experiments. Our feedback to the ESG consists of a short overview of the Belgian HEP landscape and current involvements in experimental HEP, followed by our opinions on priorities on future large-scale HEP projects, following the ECFA guidelines (questionnaire) provided. The last section summarises additional considerations.

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Contribution ID: **258** Type: **not specified**

The Electron Capture in Ho-163 experiment –ECHo

The Electron Capture in Ho-163 Experiment has been conceived to determine the effective electron neutrino mass by the analysis of the end-point region of the calorimetrically measured Ho-163 electron capture spectrum. The key technology is based on metallic magnetic calorimeters (MMC) enclosing Ho-163 which are operated at millikelvin temperature and readout via microwave SQUID multiplexing. First R&D phases have been completed demonstrating the high yield fabrication of large MMC array, the multiplexed readout and the stability of data analysis. Background studies have been performed and indicated that the contribution of natural radioactivity can be kept below the intrinsic background level given by unresolved pile-up events, defined by the activity in each pixel and the time resolution. An independent measurement of the energy available to the decay with sub-eV precision via Penning Trap Mass Spectrometry and a theoretical model based on ab-initio calculations of the electron capture process have been obtained to guide the analysis of the endpoint region. A preliminary analysis of the data acquired during the first ECHo phase, ECHo-1k, corresponding to a Ho-163 spectrum with 126 million events lead to the achievement of the upper limit for the effective electron neutrino mass of 19 eV at 90% confidence level. Presently the ECHo Collaboration is working towards the construction of a large experiment where 20000 pixels enclosing 10 Bq Ho-163 each will be operated with the goal to reach sub-eV sensitivity on the effective electron neutrino mass with two years of data taking.

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Contribution ID: **259** Type: **not specified**

Equity, Diversity and Inclusion: Strategic Elements of the European Particle Physics Programme

This document provides input concerning HEP programmes and activities in Equity, Diversity and Inclusion (EDI) for the open call for the European Strategy for Particle Physics Update (ESPPU) 2026. It briefly describes important development and growth of activity in EDI since ESPPU 2020, outlines current challenges, and provides specific recommendations for the High-Energy Physics (HEP) community in order to support its scientific goals in the coming years. We believe the recommendations put forth in this document will serve as a re-affirmation of our commitment to support all members of our community, to create a healthy and safe working environment, and to continue our positive path forward, as an example to humanity.

The challenges and recommendations presented here have been written and assembled by active members of LHC EDI offices, CERN LGBTQ+, CERN Women in Technology, Supporting Neurodiversity At CERN, and others from the CERN User Community. They do not necessarily reflect the official positions of CERN or those entities.

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Contribution ID: **260** Type: **not specified**

Quantum Sensing for Dark Matter and Gravitational Waves

Searches for wave-like dark matter can benefit from efforts to develop experimental sensitivity beyond the Standard Quantum Limit. In particular, RF cavity experiments and spin magnetometers are promising technologies in this endeavour. In recent years, it has been shown that experiments of this kind can also be sensitive to high-frequency gravitational waves. As part of the community input to the European Strategy for Particle Physics 2026 update, we report on the activities and plans of some experimental and theoretical groups aiming to search for dark matter (and gravitational wave) signals beyond the Standard Quantum limit. Our report is not exhaustive in cataloging the efforts of experimental or theoretical groups in Europe, but presents the current status and plans of the CASPEr, GNOME, GravNet, MAGO, RADES and SRF Heterodyne collaborations.

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Contribution ID: **262** Type: **not specified**

Expression of Interest Toward MCMOS Time of Flight Tracking Layers for a detector at FCC-ee

We express interest to prepare a Time of Flight system to enhance the physics reach of the FCC-ee detectors. The physics motivations are well established and we mostly present here technical options considered and their possible implementations as ToF layers in the overall foreseen detector concepts. The performance target is to achieve a 30 ps MIP ToF precision with Monolithic CMOS sensor implementing at the same time the position precision required to be part of a tracking systems. Such layers could also be considered in a high granularity Si/W pre-shower calorimeter both to enhance the calorimetry performance and the PID. The sensor R&D interests are outlined for two main technologies, with the prospect to simulate the performance of system configurations and to design the layer mechanical structures and services in a tracking configuration.

Authors: CONTARDO, Didier Claude (Centre National de la Recherche Scientifique (FR)); GUILLOUX, Fabrice (Université Paris-Saclay (FR)); BOUDOUL, Gaelle (Centre National de la Recherche Scientifique (FR)); MEYER, Jean-Pierre (IRFU-CEA - Centre d'Etudes de Saclay (CEA)); Prof. SCHWEMLING, Philippe (Université Paris-Saclay (FR)); ALEKSAN, Roy (Université Paris-Saclay (FR)); DEGERLI, Yavuz (CEA Saclay)

Contribution ID: **263** Type: **not specified**

Theia: technology and summary of physics program

White paper submission to the European Strategy for Particle Physics on behalf of the Theia detector concept

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Contribution ID: **264** Type: **not specified**

Coherent Neutrino-Nucleus Scattering Experiment (CONNIE)

Abstract

The Coherent Neutrino-Nucleus Interaction Experiment (CONNIE) employs low-noise, fully depleted charge-coupled devices (CCDs) to detect low-energy recoils from coherent elastic neutrino-nucleus scattering (CEνNS) of reactor antineutrinos in silicon, providing a window into physics beyond the Standard Model. The experiment operates approximately 30 meters from the core of the 3.8 GW Angra-2 nuclear reactor in Rio de Janeiro, Brazil. From 2016 to 2020, CONNIE conducted two data-taking runs with 8 scientific CCDs, setting limits on CEνNS and placing competitive constraints on nonstandard neutrino interactions with low-mass vector and scalar mediators. In 2021, the experiment was upgraded with two Skipper-CCD sensors, which utilize multiple non-destructive readouts to achieve sub-electron noise, enabling the detection of individual electrons. This breakthrough lowered the experiment's energy threshold to an unprecedented 15 eV, making CONNIE the first to use Skipper-CCDs for reactor neutrino detection. Results from this run set new limits on CEνNS and neutrino interactions with light vector mediators and introduced a novel dark matter (DM) search via diurnal modulation, leading to constraints on DM-electron scattering. Additionally, a search for relativistic millicharged particles produced in reactors established world-leading limits, building on the exceptional low-threshold capabilities of Skipper-CCDs. These recent achievements highlight the sensitivity and potential of Skipper-CCDs, reinforcing the need for increased detector mass. As a first step, in 2024, the detector was upgraded with a Multi-Chip-Module containing 16 Skipper-CCDs. This work also outlines future plans to further expand the detector mass and enhance its physics reach.

Scientific Context

The process of Coherent Elastic Neutrino-Nucleus Scattering (CEνNS) was first predicted within the Standard Model (SM) over four decades ago [1, 2], following the discovery of neutral-current neutrino interactions. This process benefits from a coherent enhancement of the elastic scattering cross-section when the incident neutrino energy is low enough, allowing the interaction amplitudes of all nucleons in the nucleus to add constructively 1. The energy threshold for coherence depends on the target nucleus, and for silicon, it is satisfied for Eν < 60 MeV. The CEνNS cross-section for ˜1 MeV neutrinos on silicon is approximately 10^{-42} cm^2 [3]. However, its detection remained challenging until recent years due to the extremely low energy deposition in nuclear recoils, typically below 15 keV for most materials. The first experimental observation of CEνNS was achieved in 2017 by the COHERENT collaboration [4], enabled by advances in detector technology and the intense neutrino flux available at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory.

CEνNS opens a new avenue for studying low-energy neutrino interactions, making it a powerful tool for probing physics beyond the SM [5, 6]. It has also been recognized as an important background for future dark matter (DM) searches, as CEνNS interactions from solar, atmospheric, and diffuse supernova neutrinos will become increasingly relevant with the next generation of ultra-sensitive detectors [7]. Recent results from the XENONnT and PandaX collaborations [8] provided the first evidence of low-energy nuclear recoils from solar neutrinos, highlighting the need for direct CEνNS measurements in controlled neutrino experiments to properly model and mitigate this background in DM searches. Additionally, anomalies observed in reactor and short-baseline neutrino experiments have led to speculation about the existence of sterile neutrinos [9], prompting several ongoing experimental efforts to investigate these anomalies [10, 11]. Since CEνNS cross-sections are independent of neutrino flavor and accessible at low energies, they provide an ideal framework for studying potential sterile neutrino oscillations at extremely short baselines [12–15]. Beyond sterile neutrinos, CEνNS offers a unique way to explore non-standard neutrino interactions and properties predicted in various SM extensions, including neutrino millicharge [16–18]. Some models propose that neutrino-nucleus scattering is mediated by a new light boson, leading to an enhanced cross-section at low energies. In scenarios where neutrinos possess an anomalous magnetic moment, the event rate could increase by several orders of magnitude [19]. The implications of CEνNS extend beyond particle physics. In astrophysics, understanding neutrino interactions at MeV energies is crucial for modeling energy transport in supernovae, where current uncertainties remain a limiting factor in the development of new theoretical models [20]. Furthermore, interest in using neutrinos for nuclear reactor monitoring has grown in recent years, with CEνNS offering a potential method for this application [21–23].

Objectives
The Coherent Neutrino-Nucleus Interaction Experiment (CONNIE) aims to detect the coherent elastic scattering of reactor neutrinos off silicon nuclei using charge-coupled devices (CCDs) and to explore physics beyond the Standard Model (BSM). The first step toward this goal is to upgrade the experiment by significantly increasing the Skipper-CCD mass—by approximately a factor of 30 —through the implementation of Multi-Chip-Module (MCM) technology developed by the Oscura experiment, which integrates an array of 16 Skipper-CCDs. This enhanced detector is being tested and commissioned using low-energy neutrinos from the Angra 2 reactor in Brazil. In the medium to long term, the objective is to establish a large-scale reactor neutrino experiment by deploying up to 1–10 kg of Skipper-CCDs in a new laboratory near a nuclear reactor, which could be Angra 2 or another suitable facility worldwide.

Methodology
Nuclear reactors are an intense source of low-energy neutrinos from fission, with a flux of approximately 1020 ν cm-2 s-1 MeV-1 for reactors with a thermal power of about 109 W. Commercial power reactors provide a nearly constant flux, modulated by their fuel cycle, typically with one month of shutdown per year. These neutrinos have an energy spectrum peaking at ˜1 MeV, producing silicon nuclear recoils below the keV scale, significantly lower than neutrinos from spallation sources, making detection more challenging. Searching for CEνNS in reactor experiments extends the reach of BSM physics into the low-energy neutrino sector, with sensitivity to models that are only accessible at these energies.
CONNIE [24, 25] uses low-noise, fully depleted charge-coupled devices (CCDs) [26, 27] to detect low-energy recoils from CEνNS interactions between reactor antineutrinos and silicon nuclei [3]. The experiment operates in a portable laboratory (NuLab) located 30 m from the Angra 2 nuclear reactor core, a 3.8 GW pressurized water reactor that has been in commercial operation since 2000. This facility also hosts a water-based neutrino detector, the Neutrinos Angra experiment [23]. The reactor produces a total neutrino flux of 1.21 × 1020 ν s-1 [3], with a flux density of 7.8 × 1012 ν cm-2 s-1 at the detector site. The experiment is remotely operated, with continuous monitoring and logging of operational parameters. CONNIE's engineering run in 2014–2015 [28] was followed by the installation of 14 scientific CCDs in 2016.
The standard CCDs used by CONNIE from 2016 to 2020 were developed in collaboration with LBNL Micro Systems Labs [29]. Each sensor consists of a square array of 16 million pixels, each measuring 15 × 15 μm. These detectors are an evolution of fully depleted thick CCDs originally designed for astronomical instruments like DECam [30] and DESI [26], with increased thickness (675 μm) to enhance sensitivity. Full depletion is achieved using high-resistivity (10 kΩ-cm) silicon wafers. To minimize thermally generated dark current, sensors are cooled to 100 K and operate under vacuum (10−7 torr). The detectors are housed in a copper box inside a vacuum vessel, with passive shielding comprising a 15 cm lead layer sandwiched between two 30 cm polyethylene layers for photon and neutron shielding.
For CEνNS detection, the key parameter is the silicon recoil energy. However, the measured energy corresponds to the ionization signal, which is only a fraction of the total recoil energy. The conversion is determined by the quenching factor, which represents the ionization efficiency of nuclear recoils. The latest Skipper-CCD data analysis employed a recent silicon quenching factor model [31], based on Lindhard theory [32] and the latest measurements [34], covering the low-energy range relevant to CONNIE. Future experiments using larger Skipper-CCD masses will require new quenching factor measurements at these energies.
CEνNS signals are searched by applying neutrino event selection criteria to data from reactor-on and off periods, then subtracting their spectra. A statistically significant excess would allow a cross-section measurement, while the absence of a signal leads to a 95% confidence level (CL)

upper limit on the CEνNS event rate, which can be translated into BSM physics constraints, particularly on nonstandard neutrino interactions.
The analysis of CONNIE's 2016–2018 data [24] considered 8 CCDs (47.6 g active mass) with a total exposure of 3.7 kg-days. Subtracting reactor-on and off event rates yielded no significant excess. The results [24] established a 95% CL upper limit at a factor of 40 above the SM prediction for deposited energies of 0.1 keVee, or recoil energies of 1 keV. This was the first CEνNS search at a nuclear reactor reaching such low recoil energies, achieving a detection threshold an order of magnitude lower than the 20 keV threshold used in the first CEνNS detection by the COHERENT experiment [4].
The achieved low threshold enabled constraints on nonstandard interaction models, which at the time were competitive with COHERENT's bounds. For instance, models with a light mediator [19], which predict a significant event rate increase at low energies, were strongly constrained by CONNIE data. The 2016–2018 results [24] placed world-leading constraints [34] on simplified BSM extensions with light mediators, setting limits on vector mediator masses $M_{Z'} < 10$ MeV and scalar mediator masses $M_\phi < 30$ MeV. These results demonstrated the power of combining a high flux of low-energy reactor antineutrinos with a low-threshold detector to explore new physics via CEνNS. In the 2019–2020 run, an improved readout scheme using hardware binning reduced the detection threshold to 50 eV. The analysis of 2.2 kg-days of data with enhanced techniques set expected (observed) CEνNS limits at 34 (66) times the SM expectation [25].
In 2021, CONNIE upgraded its detector with two Skipper-CCDs, a novel sensor technology enabling multiple nondestructive readouts of pixel charges, reducing noise to sub-electron levels and allowing single-electron counting. This upgrade was part of a broader R&D effort, led by CONNIE members at Fermilab, to develop Skipper-CCDs for next-generation experiments. So far, Skipper-CCDs have been used in dark matter experiments such as SENSEI and DAMIC-M, which face different backgrounds and analysis challenges. During the 2021–2023 Skipper-CCD run, a new analysis chain was developed, significantly reducing background levels by leveraging the sub-electron noise (0.15 e−) to identify defective pixels and artificial events.
Readiness and expected challenges
The CONNIE-Skipper 2021-2023 run marked a major milestone in the experiment, achieving the lowest energy threshold among all CEνNS searches. The implementation of Skipper-CCDs allowed for a significant reduction in readout noise and an improved detection threshold, reaching a record low of 15 eV. Over this period, a total exposure of 18.4 g-days was collected, enabling the first detailed analysis of low-energy events using these sensors in a reactor neutrino experiment.
The analysis of this dataset revealed reactor-on and reactor-off event rates compatible with zero, as expected due to the small detector mass. Nevertheless, the data extended CEνNS sensitivity to lower energies, where higher event rates are predicted. The obtained 95% confidence level (CL) limit stands at 76 times the Standard Model expectation, comparable to the previous result achieved with three orders of magnitude larger exposure. Additionally, the data refined constraints on new light vector mediators, improved limits on dark matter-electron scattering by three orders of magnitude compared to previous surface-level experiments, and enabled the first study of diurnal modulation at CONNIE.
Furthermore, CONNIE carried out a search for relativistic millicharged particles, which could be produced in reactors and interact electromagnetically in the detector. The interaction probability in silicon is enhanced at ionization energies of 10–25 eV due to plasmon excitation. A statistical analysis, conducted in collaboration with the Atucha-II experiment [41], resulted in individual and combined exclusion limits on the mass and charge fraction of millicharged particles. The combined analysis provided a more robust constraint, mitigating systematic uncertainties from each experiment separately, and extended exclusion limits down to $\varepsilon = 1.4 \times 10^{-6}$ for masses as low as 1 eV.
Building upon the success of this run, the continued operation of Skipper-CCDs from 2021 to 2023 allowed for further improvements in energy sensitivity and background suppression. The refined analysis of this extended dataset confirmed that CONNIE had achieved the lowest energy threshold among all CEνNS experiments, while also improving efficiency in the low-energy range. Using an updated quenching factor by Sarkis [31], the expected event rate in the lowest-energy bin (15 to 215 eV) was calculated to be 29.3 events keV-1 kg-1 day-1. Simultaneously, the background event rate was reduced to approximately 4000 events keV-1 kg-1 day-1, consistent with previous measurements by the experiment. With these parameters, a 1 kg detector would allow

for a CEνNS measurement at 90% CL with approximately 200 days of reactor-on exposure and 50 days of reactor-off exposure.
These prospects can be further improved by increasing the neutrino flux at the detector by moving the experiment closer to the core of the Angra 2 reactor. Relocating to a position 15 m from the reactor core would quadruple the neutrino flux, significantly reducing the exposure time required to measure CEνNS. Under these conditions, a 1 kg detector could reach a 90% CL measurement in just 13 days of reactor-on exposure. Additionally, as demonstrated by the CONUS experiment [36], positioning the detector under the reactor dome could further suppress cosmic backgrounds, further optimizing the experimental sensitivity.
Currently, the experiment has a new detector with 16 Skipper-CCDs, totaling 8 g of active mass, installed in May 2024. These state-of-the-art sensors are mounted in a compact arrangement on a single board, the Multi Chip Module (MCM), designed for the Oscura experiment [36,37], which will operate with 10 kg of Skipper-CCDs. An Oscura array with 16 MCMs, called a SuperModule, will have approximately 130 g of active mass, enhancing the potential for detecting neutrinos and dark matter in the ultra-low-energy range. With just one SuperModule of Skipper-CCDs, installed at 15 m from the nuclear reactor under the same operating conditions as 2021-2023, a CEνNS measurement would be achieved in 100 days.
Negotiations with Eletronuclear are underway to explore the feasibility of relocating CONNIE to a position under the reactor dome. Such a move would require the development and implementation of new laboratory infrastructure to support the detectors and other necessary instrumentation, as well as obtaining authorization from the nuclear power plant for the installation of a larger experimental setup.
One of the key experimental challenges ahead is obtaining a reliable quenching factor measurement for low energies, which will be accessible for the first time using Skipper-CCDs. The CONNIE collaboration is actively working to reduce the uncertainty on the quenching factor, in collaboration with other teams using silicon targets for nuclear recoil detection [33, 38–40]. In parallel, theoretical efforts are also underway to refine the modeling of the quenching factor, incorporating updated theoretical frameworks based on Lindhard theory [30, 31].
Another crucial challenge is the precise measurement of background contamination levels in the laboratory, including contributions from neutrons, natural radioactivity of detector components, and cosmic muons. To address this, a detailed characterization of the cosmic muon background is being conducted by monitoring the evolution of the cosmic rate and its angular distribution. This effort is complemented by a collaboration with the Neutrinos Angra experiment [23], which continuously tracks the cosmic rate inside the laboratory. Additionally, plans are in place to perform neutron background measurements at NuLab using dedicated neutron detectors from the Instituto de Radioproteção e Dosimetria (IRD) of the Brazilian National Commission for Nuclear Energy (CNEN).
Beyond CONNIE, there is a broader initiative in Latin America to develop the next-generation reactor neutrino experiment using Skipper-CCDs. The technology demonstrated in current CCD and Skipper-CCD experiments, including CONNIE, DAMIC [26], and SENSEI [34, 39, 40], scales efficiently to 100 g. However, reaching larger detector masses will require integrating thousands of Skipper-CCD sensors, necessitating significant engineering developments. Key challenges include designing compact, low-noise readout electronics and developing robust packaging solutions to ensure high yield and thermal stability.
Members of the CONNIE collaboration are currently leading the Oscura DOE program to develop a 10 kg Skipper-CCD experiment for dark matter detection. The technological advances made for Oscura will directly benefit future neutrino experiments with Skipper-CCDs. In fact, CONNIE has already taken a major step in this direction by installing an MCM, becoming the first experiment to implement this recently developed technology for Oscura. This milestone once again highlights the strong synergy between different collaborations and the various research groups working on the advancement and application of Skipper-CCD technology.

Timeline
The planned operation of the current CONNIE detector, with a Multi-Chip-Module (MCM) of 16 Skipper-CCDs and 8 g mass, will continue at least until the next reactor shutdown in Janeiro 2026 and ideally beyond. This run is essential to test the detector's performance, measure background levels, and refine data analysis techniques.

Starting in 2026, we plan to increase the detector mass to ˜100 g by adding more MCMs and upgrading the cryogenic system at CONNIE NuLab. In parallel, we aim to explore relocating the detector under the reactor dome, improving both neutrino flux and shielding. The feasibility of installing a larger detector in a dedicated lab inside the dome will depend on further developments.
By 2027/8, we expect to reach Standard Model (SM) sensitivity for CEvNS. Between 2027 and 2029, the goal is to scale up to 1-10 kg of Skipper-CCDs, significantly enhancing sensitivity. By the 2030s, a multi-kilogram detector at an optimized location could achieve a reach of 0.01 times the SM prediction, enabling precision measurements and new physics searches.
The experiment's reach is expressed as the ratio of the predicted upper 95% limit to the expected SM CEvNS rate. The current limit is 40 times the SM expectation, with a projected sensitivity reaching the SM prediction by 2027/8.

Final remarks
CEvNS is a powerful probe for both Standard Model physics and potential new physics, offering insights into neutrino properties, nuclear structure, and beyond. Its precise measurement can test fundamental interactions, constrain new physics scenarios, and contribute to astrophysical studies such as supernova dynamics. Skipper-CCD technology has demonstrated the lowest energy thresholds achieved so far for reactor neutrino detection, opening new experimental possibilities. The CONNIE experiment has successfully used this technology, setting a precedent for future advancements. Developing an experiment with a few kilograms of Skipper-CCD detectors will be a crucial step toward precisely measuring the CEvNS cross-section in silicon and exploring signals of physics beyond the Standard Model, further expanding our understanding of neutrino interactions and weak force detection.
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Input to European Strategy Update for Particle Physics: Sustainability

Human activity continues to have an enormous negative impact on the ability of the planet to sustain human and other forms of life. Six out of the nine planetary boundaries have been crossed, a seventh is close to threshold. Prominent manifestations of this development are climate change caused by greenhouse gas emissions, as well as loss of biodiversity. In recognition of the urgency of these problems, several international agreements have been ratified to achieve net-zero emissions and to halt and reverse biodiversity loss. Significant reductions in emissions are required by 2030 to meet international climate targets. The field of particle physics has an obligation and an opportunity to contribute to such mitigation efforts and to avoid causing further harm. This document urges the European Strategy Update in Particle Physics to set a clear and bold mandate for embedding environmental sustainability throughout the future scientific programme, and advocates for a series of actions that will enable this.

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Novel 3D-Projection Pixelated Detector for Next-Generation High-Energy Physics Experiments

We are proposing a single, homogeneous, and cost-effective calorimetry system capable of seamlessly achieving particle identification, tracking, and energy measurement. While 3D-projection readout, opaque liquid scintillators, and metal doping have each been investigated separately, this project for the first time combines all three into a fully homogeneous and active detector with unprecedented control over energy resolution and shower development. The integration of liquid scintillator with ultra-short scattering lengths ensures that optical photons are highly localized without the need for optical segmentation,
while heavy-metal loading offers tunable electromagnetic (EM) shower containment, allowing precise control over the detector response. This combination is a major departure from traditional sampling calorimeters and provides a novel approach to optimizing detector performance across different experimental applications. This project is built upon a solid foundation of established expertise and successful studies of its individual components. We present a rare opportunity to blend multidisciplinary expertise at the forefront of innovation in particle and nuclear physics, non-proliferation and medical imaging research.

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Constraining the real scalar singlet extension of the SM

The real scalar singlet extension of the Standard Model (SM) represents one of the simplest and most theoretically motivated scenarios beyond the SM, with potential implications for electroweak baryogenesis and vacuum stability. In this work, we present an up-to-date study of the model parameter space under current and projected constraints. We systematically combine indirect probes (precision Higgs measurements, trilinear coupling deviations), direct searches for heavy scalar resonances, and theoretical requirements including a strong first-order EWPT and ultraviolet vacuum stability. Our findings demonstrate that, while current data already constrain substantial regions of parameter space, future facilities, notably the High-Luminosity LHC (HL-LHC) will significantly enhance sensitivity, testing the majority of the viable parameter space. This benchmark model thus provides a valuable reference for probing electroweak symmetry breaking and early universe dynamics.

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Dark Matter Searches with Low-Radioactivity Argon

We present the case for the DarkSide-Argo program for direct dark matter searches
with low-radioactivity argon from underground sources.

The immediate objective is the DarkSide-20k two-phase liquid argon detector, currently under construction at the Gran Sasso laboratory (LNGS). DarkSide-20k will have ultra-low backgrounds, with the ability to measure its backgrounds in situ, and sensitivity to WIMP-nucleon cross sections of 5.1 × 10−48 cmˆ2 (4.8 ×
10−47 cmˆ2) for WIMPs of $1\ \mathrm{TeV/c^2}$ ($10\ \mathrm{TeV/c^2}$) mass, to be achieved during a 10 yr run with exposure of 460 t y. This projected sensitivity is a factor of > 40 better than currently-published results above $1\ \mathrm{TeV/c^2}$. DarkSide-20k is foreseen to start taking data in 2028 and will either detect WIMP dark matter or exclude a large fraction of the parameter space complementary to LHC experiments.

An important element for this program will be the searches for low-mass WIMP candidates and dark matter candidates beyond the WIMP using the ionization-only technique. Based on demonstrated ultra-low threshold and world-leading sensitivity achieved with DarkSide-50, DarkSide-20k will improve existing constraints at $1\ \mathrm{GeV/c^2}$ dark matter mass by two orders of magnitude. The same technique can also deliver valuable insight in case of a galactic core-collapse supernovae detection using the flavor blind CEνNS reaction.
In parallel, a dedicated experiment specifically optimized for the observation of the electroluminescence signal, coupled to ^{39}Ar reduction by the large cryogenic distillation plant (Aria) meant to purify the DarkSide-20k target, will be able to reach through the so-called "neutrino floor" in the low-mass search region.

The final objective will be the construction of the ultimate Argo detector with a 300 t fiducial mass to push the sensitivity to the region where neutrino background will be a limitation in detectors without directional capability.
The WIMP detection sensitivity will only be limited by systematic uncertainties in nuclear recoil background from Coherent Neutrino Scattering of Atmospheric neutrinos. The strong electron recoil rejection will eliminate background from solar neutrinos and some
residual internal backgrounds such as radon. This unique property of argon extends the sensitivity with respect to technologies with more limited electron recoils discrimination, enabling a broad physics program which includes the observation of ultra-rare solar neutrino
sources (CNO, hep).

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LEP Data@EDM4HEP: Mitigating Data Loss Risks and Strengthening FCC-ee Potential Studies

The LEP data represent the most precise sample of e+e- collision data collected to date. Numerous scientific articles have been published since the conclusion of the experiments, underscoring the ongoing relevance of this dataset. In the context of FCC-ee, these data could play a crucial new role, which would be significantly enhanced by making them available in a standardized event data format such as EDM4HEP, currently developed in the context of the common HEP software ecosystem Key4HEP.
Migrating to EDM4HEP would not only facilitate future studies but also greatly mitigate the risk of data loss, facilitating long-term accessibility and preservation.

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LEGEND-1000

The observation of neutrinoless double-beta decay (0νββ) would show that lepton number is violated, reveal that neutrinos are Majorana particles, and provide information on the neutrino mass. The LEGEND collaboration, founded in 2016, is developing a phased, ^{76}Ge based double-beta decay experimental program located at the Italian Underground Laboratori Nazionali del Gran Sasso (LNGS). The international LEGEND collaboration consists of approximately 300 scientists from 56 institutions from North America and Europe. In its first phase, LEGEND-200, up to 200 kg of high-purity germanium detectors enriched in the isotope ^{76}Ge are operated in liquid argon, which serves as both a coolant and an instrumented shield. LEGEND-200 started data taking in 2023 and strives for a discovery potential at a half-life beyond 10^{27} years. In its second phase, LEGEND-1000, a new research infrastructure will be built in Hall C at LNGS, and one ton of high-purity germanium detectors enriched in the isotope ^{76}Ge with typical masses around 3˜kg are operated in underground sourced liquid argon serving depleted in the isotope ^{42}Ar. With a five-fold increased target mass with respect to LEGEND-200 and a background index reduced by one order of magnitude to $\leq 10^{-5}$˜cts/$(\mathrm{keV} \cdot \mathrm{kg} \cdot \mathrm{yr})$, LEGEND-1000 will achieve a discovery potential at a half-life beyond 10^{28} years. It builds on the successful LEGEND-200 experiment and its European GERDA and U.S. Majorana Demonstrator precursor experiments.

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A Spin-Based Pathway to Testing the Quantum Nature of Gravity

A key open problem in physics is the correct way to combine gravity (described by general relativity) with everything else (described by quantum mechanics). This problem suggests that one or both of these cherished theories may need fundamental corrections. Most
physicists expect that gravity should be quantum in character, but gravity is fundamentally different to the other forces because it alone is described by spacetime geometry. Experiments are needed to test whether gravity, and hence space-time, is quantum or classical. We propose an experiment to test the quantum nature of gravity by checking whether gravity can entangle two micron-sized crystals. A pathway to this is to create macroscopic quantum superpositions of each crystal first using embedded spins and Stern-Gerlach forces. These crystals could be nanodiamonds containing nitrogen-vacancy (NV) centres. The spins can subsequently be measured to witness the gravitationally generated entanglement. This is based on extensive theoretical feasibility studies and experimental progress in quantum technology. The eventual experiment will require a medium-sized consortium with excellent suppression of decoherence including vibrations and gravitational noise. In this white paper, we review the progress and plans towards realizing this. While implementing these plans, we will further explore the most macroscopic superpositions that are possible, which will test theories that predict a limit to this.

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Neutrino Astronomy in the Peruvian Andes with TAMBO

The detection of high-energy astrophysical neutrinos by IceCube has opened a new window on our Universe. While IceCube has measured the flux of these neutrinos at energies up to several PeV, much remains to be discovered regarding their origin and nature. Currently, measurements are limited by the small number of astrophysical neutrino sources discovered and by the difficulty of discriminating between electron and tau neutrinos. TAMBO is a next-generation neutrino observatory specifically designed to detect tau neutrinos in the 1-100 PeV energy range, enabling tests of neutrino physics at high energies and the characterization of astrophysical neutrino sources. The observatory's tau neutrino specificity will provide a high-purity sample of astrophysical neutrinos whose locations on the sky can then be used to improve the sensitivities of all-flavor neutrino observatories. TAMBO will comprise an array of water Cherenkov or plastic scintillator detectors deployed on the face of a deep valley, such as the Colca Valley in the Peruvian Andes. This unique geometry will facilitate a high-purity measurement of astrophysical tau neutrino properties and allow us to begin the era of high-energy tau neutrino astronomy.

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2026 EPPSU input from the ANUBIS Collaboration

It is imperative for us as a particle physics community to fully exploit the physics potential of the High-Luminosity LHC.
This calls for us not to leave any stone unturned in the search for Beyond the Standard Model (BSM) physics.
Many BSM models that address fundamental questions of physics like the particulate nature of dark matter, the matter-antimatter asymmetry in the Universe, small but non-zero neutrino masses \etc, predict Long-Lived Particles (LLPs) with macroscopic lifetimes of $\tau > 10^{-10}$ s.
The challenge in searching for BSM models with LLP signatures at the HL-LHC is that it requires the complementary interplay of general purpose detectors like ATLAS, CMS, and LHCb; dedicated detectors situated close to the beamline including the proposed Forward Physics Facility (FPF); and dedicated detectors covering a large decay volume at a reasonable solid angle transverse to the beamline, i.e., a Transverse Physics Facility (TPF).
Hence, it is of vital importance to realise a TPF in order to expand dramatically the physics coverage within long-lived particle searches to harvest the physics at the HL-LHC fully.
A TPF may be composed of several experiments based at the HL-LHC.
In this document, we propose that the community realise the ANUBIS experiment as part of a TPF.

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Dark Matter Complementarity: from the Snowmass process to the EPPSU

This submission consists of:

1. a main document (main.pdf), where we describe the dark matter complementarity whitepapers developed for the Snowmass process and the highlights that we would like to submit to the ESG
2. the extended version of the Snowmass dark matter complementarity whitepaper (dark_matter_complementarity_exte
3. the summarised version of the same document (dark_matter_complementarity_summary.pdf)

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Status of the International Linear Collider

This paper is not a proposal for a CERN future project but provides information on the International Linear Collider (ILC) considered for Japan to facilitate the European Strategy discussion in a global context. It describes progress to date, ongoing engineering studies, updated cost estimate for the machine at $\sqrt{s}$ = 250 GeV and the situation in Japan. The physics of the ILC is not presented here, but jointly for all Linear Collider projects in the separate document "A Linear Collider Vision for the Future of Particle Physics", submitted for the forthcoming European Strategy deliberations.

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Input by the AstroParticle Physics European Consortium

This statement as input to ESPP 2026 summarises some recommendations on how the common goals of answering fundamental physics questions can be achieved synergistically by astroparticle physics and particle physics on a European basis in an efficient and sustainable way. The recommendations are then followed by the core statements of the European Strategy for Astroparticle Physics (Update 2023), from which the recommendations emerged.

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Initial input from the Danish CERN Community to the European Strategy for Particle Physics update

This document presents the interests and priorities of the Danish high energy and nuclear physics community based on the town hall meeting held by the National Center for CERN research (NICE) in January 2025 in Nyborg, Denmark, and other dedicated meetings and consultations.

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