ECFA
European Committee for Future Accelerators

13th ECFA Newsletter

Following the 114th Plenary ECFA meeting
4-5 July 2024
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Summer 2024

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Introduction

The major news of the first half of 2024 has certainly been the launch of the new process for the update of the European Strategy for Particle Physics (ESPP) by the CERN Council in March 2024. With this, the community was granted a year to submit contributions to the Strategy by 31 March 2025, while the Open Symposium, i.e. the corresponding "Granada meeting", will be held in June 2025 and the Briefing Book will be submitted in late September 2025. A more detailed presentation of the ESPP update appears in the article by ESPP Secretary Karl Jakobs in this newsletter. For this introduction, suffice to say that the launch of the new ESPP has brought forth a new focus for ECFA.

The first half of 2024 has also witnessed significant progress in all the ECFA panels:

(a) The ECFA Detector Panel (EDP) has been following up the DRD collaborations that formed in 2023 in response to the implementation of the ECFA Detector R&D Roadmap. The key development here has been the establishment of the DRD Collaborations Managers Forum, which consists of two representatives per DRD collaboration and is intended to provide a forum for discussions among the DRD projects and the EDP. More details on the status of the DRDs and the work of the EDP in the two dedicated articles in this newsletter.

(b) The ECFA panel on the Study towards a Higgs/Electroweak/top (HET) factory has accelerated its work, with a view to completing the study by March 2025 in time for submission to the new ESPP update process. The three working groups on (i) physics potential, (ii) physics analysis methods and (iii) detector R&D have been meeting throughout the past months and are preparing for the third and last Study Workshop, which will be held in Paris from 9 to 11 October 2024. This will be the last major get-together of the ECFA HET community prior to the submission of a report to the ESPP in March 2025. We encourage all members of the community to make an effort to attend this last workshop in the ECFA HET series. A more detailed presentation of the current work and workshop organisation appears in another dedicated article in the current newsletter.

(c) The ECFA Early-Career Researchers (ECR) Panel has been particularly active, with the completion of a large survey among ECRs, the organisation of national ECR meetings to inform the community about future colliders, and preparations for engaging ECRs in the ESPP. A dedicated article in the current newsletter presents more details of recent and ongoing ECR activities.

Looking further out to our cousin fields of astroparticle and nuclear physics, we continue to seek and promote synergies between them and particle physics through Joint ECFA–NuPECC–APPEC Activities (JENAA). So far, seven Expressions of Interest (EoI) have been endorsed by at least two of the three communities, and all of them have held at least one organisational meeting. The first part of 2024 saw a major event of the "Gravitational Waves for fundamental physics" initiative in Rome (12–16 February) as well as the kick-off meeting of the "European Coalition for Artificial Intelligence (AI) in Fundamental Physics" initiative in Amsterdam (30 April–3 May). All EoIs are proceeding, and we expect to hear status reports and plans at the next major get-together of the three communities, i.e. the JENA Seminar (JENAS). JENAS 2025 will take place from 8 to 11 April 2025 and will be hosted by RAL (UK).

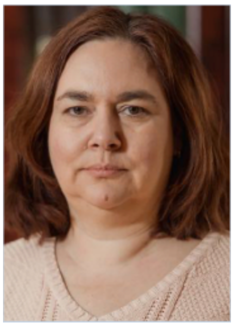
The last major element of JENA is the Computing Initiative, which was launched in response to recommendations made by the funding agencies at the second JENAS, in 2022. That meeting identified, among other elements, the need for discussions on the strategy and implementation of European federated computing at future large-scale research facilities. The Computing Initiative was launched to identify areas of potential synergies among the computing requirements and plans of the three communities. The five working groups, on high-performance computing, software, data, AI and training, are working towards a report by the end of the year.

The Restricted ECFA tradition and key mission of visiting a few countries every year is continuing at a steady pace. So far in 2024 we visited Switzerland (8–9 March at PSI) and Sweden (16–17 May in Lund). Two more country visits are scheduled for the remainder of the year: to the UK (13–14 September in London) and to Serbia (29–30 November in Belgrade). Plenary meetings of ECFA have also resumed their normal frequency and location: two meetings are held per year, with the November meeting always held at CERN and the summer meeting at the EPS-HEP conference on odd years and at a major European laboratory on even years. This year, the PECFA meeting was graciously hosted by the Laboratori Nazionali di Frascati. We are indebted to our Italian colleagues for an impeccably organised event, a very interesting visit of several facilities in the laboratory and their warm hospitality, which included some distinctly Italian touches, like handmade ice cream during the coffee break.

The first half of 2024 has brought several changes to ECFA too. We have had a change of guard in the EDP: after many years of immeasurable service and astounding contributions, we bid farewell to Phil Allport, who has stepped down as EDP Co-Chair, and to Doris Eckstein, who stepped down as EDP Scientific Secretary after more than a decade of service. The new EDP Co-Chair, joining Didier Contardo, is Felix Sefkow. Also new to the EDP are Susanne Kuhn and Jens Dopke, who has also taken up the role of EDP Scientific Secretary. We most warmly thank Phil and Doris for carrying the torch so successfully for an extended period.

Lastly, we picked up the baton from the previous Chair, Karl Jakobs, who has left a distinctive imprint on ECFA through his indefatigable leadership and several achievements, including the development and the Council’s approval of the Detector R&D Roadmap, which led to the creation of the DRD collaborations. We are also indebted to Patricia Conde-Muino, who graciously agreed to extend her term as Scientific Secretary until July 2024 in order to ensure ample overlap with the new Scientific Secretary. We would like to extend to both Karl and Patricia our sincere thanks for their excellent work and for successfully steering all ECFA activities, handing over a well-oiled operation.

Paris Sphicas,
ECFA Chair



Lidija Zivkovic,
ECFA Scientific Secretary

A word from the organisers

HEP landscape in Italy

by S. Malvezzi (Milano)

The 114th Plenary ECFA meeting was held in Frascati on 4 and 5 July 2024. The INFN, as the hosting institute, was invited to give the opening talk on the "HEP landscape in Italy"; a brief summary of which is reported here.

The National Institute for Nuclear Physics (INFN) is the Italian research agency dedicated to the study of the fundamental constituents of matter and the laws that govern them, under the supervision of the Ministry of Universities and Research (MUR).

The INFN performs both theoretical and experimental research in the field of fundamental physics. In particular, there are five main research areas: subnuclear physics, astroparticle physics, nuclear physics, theoretical physics and technological and interdisciplinary research.

A distinctive feature of the INFN is its widespread presence over the territory: it is organised into linked units and groups, which are hosted by the physics departments of all major Italian universities. The INFN has its own infrastructures across the country: namely, four national laboratories (LNL, LNF, LNGS and LNS), three national centres (CNAF, TIPFA and GGI) and one consortium (EGO).

The INFN's research activities are undertaken within a framework of international competition, in close collaboration with Italian universities on the basis of solid academic partnerships. In order to conduct experiments, the INFN designs and produces cutting-edge technologies in its own laboratories and in collaboration with industry.

The INFN's HEP research areas cover many diverse topics, including hadron colliders, flavour physics, neutrinos with accelerators and R&D for future accelerators and detectors.

The INFN is heavily involved in the four LHC accelerator experiments, participating in a wide range of activities in ATLAS, CMS, LHCb and ALICE.

Some INFN groups contribute to the field of flavour in the Belle2 experiment in Japan.

In the area of neutrino physics at accelerators, the two biggest projects, both of which see Italian participation, are DUNE (US) and Hyper-K (Japan).

The INFN is also preparing for the longer-term future. In recent years, the INFN has aligned itself with the research recommendations identified by the latest update of the European Strategy for Particle Physics for the post-LHC future, which involve developing innovative machines and technologies. Our community is currently involved, on the front line, in both studying the FCC-ee and researching and developing the new magnets required for the FCC-hh. The interests of the community are also devoted to the ambitious muon collider R&D and plasma acceleration technology.

Analogously, in the detector area, R&D activities have been undertaken and supported by dedicated INFN funds and EU grants; some of which might also flow into the DRD efforts.

Future Facilities

FCC Feasibility Study after the Mid-Term Review

by M. Benedikt, F. Zimmermann (CERN)

The ongoing Future Circular Collider (FCC) Feasibility Study has been described in previous ECFA Newsletters (#7, #8, #9, #10, #11 and #12). Figure 1 presents the overall FCC timeline. The schedule shown can be considered "realistic", as it takes into account past experiences building colliders at CERN, the approval timeline, which is dependent on the update of the European Strategy for Particle Physics and subsequent Council decision, and the intention to run the HL-LHC until 2041. Nevertheless, the schedule could be accelerated if more resources become available.

Figure 1: Realistic schedule for the integrated FCC programme.

The Mid-Term Review of the FCC Feasibility Study was successfully conducted from October 2023 to February 2024. The documents provided were the 700-page Mid-Term Report (covering all deliverables except for cost and funding), the Executive Summary, an updated cost assessment and a funding model. The review bodies were the FCC Scientific Advisory Committee, the Cost Review Panel, the CERN Scientific Policy Committee, the CERN Finance Committee and the CERN Council. The review concluded that all requested deliverables had been supplied and no technical showstoppers had been found. The feedback received from the different committees was combined into 70–80 key recommendations.

The main goal until the end of 2024 or early 2025 is to complete the technical work for the Feasibility Study by implementing and addressing most of the recommendations from the Mid-Term Review, focusing on "feasibility items" and on items with a significant impact on cost or performance. A risk register will be developed and the cost estimate will be updated. The funding model will be further elaborated by the CERN Management in close coordination with the CERN Council. In parallel, work will continue with the Host States to define the project, the responsibilities of each party, the authorisation procedures, the strategy for the management of excavated material and the regional implementation scenario. The Feasibility Study will be concluded in March 2025, and its results will be available as input for the next update of the European Strategy for Particle Physics.

Work with municipalities and Host States will continue in order to identify land plots for the surface sites, to understand site-specific design aspects, to identify opportunities to exploit synergies with regional developments (e.g. reuse of waste heat) and to reserve land plots until a possible project decision. These activities will be complemented by public information and engagement meetings in France and Switzerland and at the CERN Science Gateway.

Significant progress has already been made in addressing most of the mid-term recommendations on FCC accelerators, notably in the definition of the baseline optics; the optimisation of the FCC-ee injector to reduce its energy consumption; the injector implementation study performed at the CERN Prévessin site; the further development of beam-based tuning, alignment and survey techniques; the identification of residual risks to achieving the design luminosity, with lessons learned from other facilities; the identification of R&D activities on the critical path; the adaptation of the FCC-hh to the optimised layout; and the confirmation of the inner tunnel diameter. Major progress has also been made in the development of a simplified RF design with lower cost, faster installation and greater flexibility to switch between running modes, achieved by using two-cell 400 MHz cavities for all beam energies and by counter-phasing different sets of cavities to lower the effective total voltage. This will result in a reduced cost, shorter installation time and greater flexibility to switch between collision energies. Significant advances have also been made in the development of monochromatization optics, with non-zero collision-point dispersion in both transverse planes, for direct Higgs production at 125 GeV and the measurement of the so-far elusive electron Yukawa coupling.

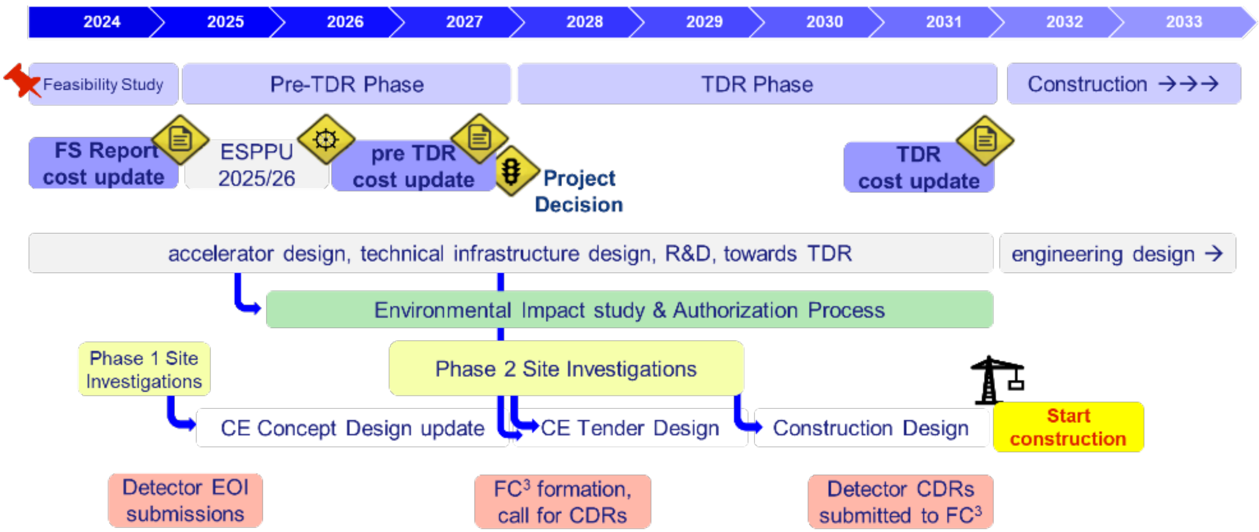


Figure 2: FCC timeline until the start of construction.

In order to ensure the success of the project, it is vital to increasing international collaboration. In this spirit, the FCC Week 2024 was held in San Francisco. It was organised together with relevant US national laboratories, in particular, SLAC and LBNL, and supported by several local universities in California. About 450 experts attended the event, approximately half of them from the United States.

A month earlier, at the end of April, the United States and CERN had issued a Joint Statement of Intent (SoI), signed by the White House Office of Science and Technology Policy Principal Deputy, U.S. Chief Technology Officer Deirdre Mulligan, for the United States, and by Director-General Fabiola Gianotti for CERN. Among other topics, it states that "Should the CERN Member States determine that the FCC-ee is likely to be CERN’s next world-leading research facility following the High-Luminosity Large Hadron Collider, the United States intends to collaborate on its construction and physics exploitation, subject to appropriate domestic approvals." The strong collaboration with the United States and other international partners will be a cornerstone of the future FCC project.

The main FCC goals for the coming years are clear. By March 2025, the FCC Feasibility Study will be completed. By 2027–28, the Council is expected to issue a final decision on whether to proceed with the FCC project, enabling the start of the civil engineering design contract. All specifications needed for the civil engineering tender design must therefore be ready by 2028, together with refined input for the environmental evaluation and project authorisation process, and an overall integration study and designs based on a technical pre-design of the accelerators, the technical infrastructure and the detectors. By 2031–32, civil engineering construction could start with the civil engineering groundbreaking, while the completion of a Technical Design Report in 2031 will enable prototyping and industrialisation towards component production.

Update on the US programme in the post-P5 era

By C. Touramanis, (Liverpool & CERN)

A 30-member Particle Physics Project Prioritisation Panel (P5) was formed by HEPAP in 2023, tasked by the two US funding agencies, the Department of Energy (DOE) and the National Science Foundation (NSF), "to develop an updated strategic plan for U.S. high-energy physics that can be executed over a 10-year timeframe in the context of a 20-year, globally aware strategy for the field".

Starting with the reports of the latest "Snowmass" community study, the Panel took further input from the community in four in-person and two virtual town hall meetings across the USA, and then went into closed sessions. Their report was presented, and accepted, at a public HEPAP meeting in December 2023. The report, entitled "Exploring the Quantum Universe, Pathways to Innovation and Discovery in Particle Physics", is available at https://www.usparticlephysics.org/2023-p5-report/. It describes particle physics in three science themes and six science drivers, and recommends a programme that represents the most promising avenues of investigation for the next 10 to 20 years. The report has been well received by the community and funding agencies, and has already generated important follow-up actions.

Two funding scenarios were provided by the DOE, with ongoing construction projects saturating both in the next five years and the community proposals, excluding an on-shore Higgs factory, adding up to around twice the default (higher) scenario. The P5 formed a Cost, Risk and Schedule sub-panel which advised on all proposals above 50 M USD in an attempt to mitigate the "factor π" cost overruns observed currently.

The report sets as the highest priority the completion and operation of ongoing projects "to enable maximum science", notably the HL-LHC and DUNE Phase I as well as PIP-II in the areas of ECFA scope. This was strongly endorsed by both the DOE and NSF and is in line with current European priorities.

The relevant highest-ranked future projects are DUNE Phase II and "an off-shore Higgs factory, realized in collaboration with international partners, in order to reveal the secrets of the Higgs boson". According to the report, the current FCC-ee and ILC designs meet the US scientific requirements. It recommends that "once a specific project is deemed feasible and well-defined, the

US should aim for a contribution at funding levels commensurate to that of the US involvement in the LHC and HL-LHC, while maintaining a healthy US on-shore program in particle physics", and a special panel at the appropriate time to evaluate that project and recommend "the level and nature of the US contribution".

In April 2024 the USA and CERN signed a "joint statement concerning future planning for large research infrastructures, advanced scientific computing and open science" which contains the statement: "Should the CERN Member States determine the FCC-ee is likely to be CERN's next world-leading research facility following the high-luminosity Large Hadron Collider, the United States intends to collaborate on its construction and physics exploitation, subject to appropriate domestic approvals."

Both the DOE and NSF made strong statements of support for the future Higgs factory at HEPAP and other meetings. They jointly formed the US Higgs Factory Coordination Consortium (HFCC) for developing the physics, experiments and detectors (PED) programme, with strong leadership already in place. The corresponding committee for accelerators is being set up, and its leadership will be announced imminently. The DOE announced that, together with the NSF, national laboratories and the community will work to convene a dedicated panel as recommended. For completeness we note that in 2023 KEK had requested US support for the ILC through the ITN, and the DOE responded that they would continue R&D under the existing cooperation scheme but not join the ITN.

In terms of the next energy-frontier collider, the P5 recommended that it should have 10 TeV parton centre-of-momentum (pCM), and as part of this vision to "support vigorous R&D toward a cost-effective 10 TeV pCM collider based on proton, muon, or possible wakefield technologies, including an evaluation of options for US siting of such a machine, with a goal of being ready to build major test facilities and demonstrator facilities within the next 10 years". The muon collider community is organising an Inaugural US Muon Collider Meeting in August 2024. A dedicated panel, as per the P5 recommendation, will be convened later in the decade to decide on options for demonstrators towards the 10 TeV pCM collider.

Status of the Circular Electron Positron Collider

By X. Lou (Chinese Academy of Sciences (CN)

The Circular Electron Positron Collider (CEPC) is envisioned to be a Higgs factory located in China, with the possibility to be upgraded to a Super Proton Proton Collider (SPPC), which would be housed in the same tunnel. The CEPC Study Group recently published the Technical Design Report (TDR) [1] of the CEPC accelerator system, following the completion of the conceptual design of the accelerator and the detectors [2, 3] in 2018.

Status and progress: The CEPC accelerator TDR [1] was finalised in December 2023, following comprehensive reviews of the technical systems and of the cost by two separate groups of leading international experts. The civil engineering aspects were presented to a review committee made up of domestic experts; its findings were reported to an international panel which in turn briefed the International Cost Review Committee and the CEPC International Advisory Committee (IAC). The TDR has been approved by all the review committees and endorsed by the IAC.

The CEPC accelerator complex comprises four accelerators: a 30 GeV linac, a 1.1 GeV damping ring, a booster capable of achieving energies of up to 180 GeV and a collider operating at varying energy modes (Z, W, H and top pair). The linac and the damping ring are situated on the surface, while the booster and the collider are housed in an underground tunnel with a 100-km circumference. In its baseline design with the synchrotron radiation power of 30 MW per beam, it will be able to achieve a luminosity of $5\times10^{34}cm^{-2}s^{-1}$ per interaction point (IP), producing an integrated luminosity of 13 ab^{-1} for two IPs over a decade, corresponding to 2.6 million Higgs boson events. If the single beam power is increased to 50 MW, the CEPC's capability will expand to produce 4.3 million Higgs events, facilitating measurements of Higgs couplings at sub-percent levels and exceeding the precision expected from the HL-LHC by an order of magnitude for many final states of the Higgs. The TDR details the machine's layout, performance metrics, physical design and analysis, technical systems design, R&D and prototyping efforts and associated civil engineering aspects. The cost estimates (5 B EUR) and a preliminary construction timeline are also included.

Figure 3.

In the last decade, the CEPC R&D programme has covered the designs, critical technologies and components in accelerators and instrumentation, software and physics performance study. Progress has been helped by the construction of a 4th-generation high-performance light source by IHEP at its Huairou campus, as well as by the various detector upgrade projects in which CEPC collaborators have participated. The CEPC is expected to be ready for construction by 2027–28.

The CEPC group is working on a reference technical design [1] of a detector system for the CEPC experiments. The TDR_ref is mainly intended for project review and approval in China. It is expected to be completed by mid-2025 and will be included in the CEPC proposal in China's 15th Five-Year Plan (FYP, 2026–30). Once the project is approved, calls for letters of intent will be issued to form international collaborations and the formal TDR of the detectors will be developed by the detector collaborations.

Development for 15th FYP: The Chinese Academy of Sciences has organised high-level studies to prepare for the 15th FYP. New particle and nuclear physics projects were evaluated and reviewed and the CEPC project was ranked first by each of the three review committees (the International Advisory Committee, the domestic senior scientist group and the HEP association).

The SPPC: The SPPC presented in the TDR consists of two IPs with the centre-of-mass energy reaching 125 TeV in pp collision and a luminosity target of $10^{35}cm^{-2}s^{-1}$. The main progress with the SPPC is in the development of high-field magnets, particularly in the areas of HTS materials and dipole magnets, and the consistency of the design of the CEPC Higgs factory with the future requirements of the SPPC, especially in the tunnel layout in the accelerator TDR. For the former, the group and its collaborators achieved a highest quenched field of 14T at 4.2K with the model dipole magnet with the Nb_3Sn+HTS combination in 2023. A 16 T (4.2K) model dipole is under development.

The CEPC Engineering Design Report: The CEPC Engineering Design Report (EDR, 2024–27) process has begun and the scope and the working plan have been defined. International committees will evaluate and guide the activities. The development of technologies to automate the production of high-volume components, such as magnets and NEG-coated vacuum chambers, is one of the most important EDR tasks.

Summary: The CEPC project is beginning to take shape. The CEPC team has received a great deal of help from international scientists and labs and is committed to maximising international collaboration. The CEPC Study Group is making a strong effort to complete a proposal to submit to the Chinese Government for approval. If successful, the CEPC will offer the worldwide community an early Higgs factory.

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European Strategy for Particle Physics

Update of the European Strategy for Particle Physics

By K. Jakobs (Freiburg), Strategy Secretary

The European Strategy for Particle Physics is the cornerstone of Europe's decision-making process for the long-term future of the field. (Mandated - original) Overseen by the CERN Council, the Strategy takes into account the worldwide particle physics landscape and developments in related fields with the aim of maximising scientific returns.

In March 2024, the CERN Council launched the process for the third update of the Strategy. Since the last update, excellent progress has been made at CERN and beyond in preparation for future colliders. A Feasibility Study for the realisation of the Future Circular Collider (FCC) was launched by the CERN Council following the adoption of the 2020 Strategy update and a mid-term report was presented in February 2024. A final report is expected to be available in 2025. In addition, the international landscape for future colliders has also become clearer: in December 2023 the P5 prioritisation process concluded in the USA and a Technical Design Report for the CEPC project in China was released. The ILC project has established an International Technology Network. Given the long timescales involved in realising new large-scale projects and the importance of long-term community engagement, the next update of the European Strategy process is timely.

The European Strategy Group (ESG) and the Strategy Secretariat for this update were established by the CERN Council in June 2024 to organise the full process. Chaired by Karl Jakobs, former Chair of the European Committee for Future Accelerators (ECFA), the Secretariat includes Hugh Montgomery (Chair of CERN's Scientific Policy Committee), Paris Sphicas (ECFA Chair) and Dave Newbold (Chair of the European Laboratory Directors Group – LDG). The Strategy update process is expected to converge by January 2026, when a draft Strategy document will be submitted to the Council. The community at large will be involved throughout the process and asked to provide input at several stages.

According to the remit defined by the Council, the Strategy should aim to develop a visionary and concrete plan that greatly advances knowledge in fundamental physics through the realisation of the next flagship project at CERN. This plan should attract and value international collaboration and allow Europe to continue to play a leading role in the field. Regarding a future collider project, the Strategy update should include the preferred option for the next collider at CERN and prioritised alternative options to be pursued if the preferred plan turns out not to be feasible or competitive.

The ESG is mandated to take into consideration:

- the input of the particle physics community;
- the implementation of the 2020 Strategy update;
- the accomplishments in recent years, including results from the LHC and other facilities / experiments worldwide, progress in the construction of the High-Luminosity LHC, the FCC Feasibility Study, and recent technological developments in accelerator, detectors and computing;

• the international landscape.

In line with the recommendations of the CERN Council, the Strategy Secretariat calls upon the particle physics community across universities, laboratories and national institutes to provide input to the process in various forms and at various stages:

• To inform the process, the community is asked to submit input by 31 March 2025. A major component of the community input is the "national inputs", which are expected to be collected individually by each country (and in some cases by regions). The information collected from the different countries/regions will be most useful if it is as coherent and as uniform as possible when addressing the key issues. To assist with this, the ECFA has put together a set of guidelines for the collection of the national inputs.

• An Open Symposium, at which the community will be invited to debate scientific input to the Strategy update, will take place on 23–27 June 2025 at a venue to be determined by the Council in September 2024.

• A "Briefing Book" based on the input and discussions will then be prepared by the Physics Preparatory Group (PPG, to be established by the Council in September 2024). The Briefing Book will be submitted to the ESG for consideration during a five-day drafting session which is scheduled to take place from 1 to 5 December 2025.

• To allow the community to take into account and to react to the submissions collected by March 2025 and to the content of the Briefing Book, the national communities will be offered further opportunities for input: (i) ahead of the Open Symposium, with a deadline of 26 May 2025, and (ii) ahead of the drafting session, with a deadline of 14 November 2025.

The overall timeline is displayed in the graphic below. More details on the full process are available on the Strategy update webpage.

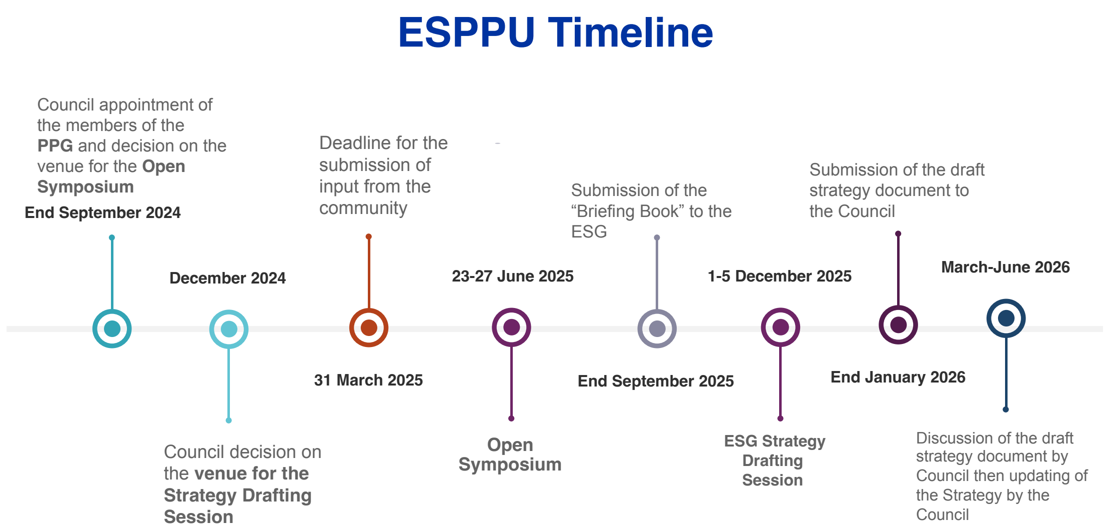

Figure 4. Timeline of the 2025–2026 update of the European Strategy for Particle Physics (to be updated in order to add further input stages for national input).

In this Strategy process the community must converge on a preferred option for the next collider at CERN and identify a prioritised list of alternative options. The outcome of the process will provide the basis for the decision by the Council in 2027/28 on the construction of the next large collider at CERN after the High-Luminosity LHC. In addition, areas of priority for exploration complementary to colliders and for other experiments to be considered at CERN and at other laboratories in Europe, as well as for participation in projects outside Europe, will be identified. Given the importance of this process and its outcome, we encourage a strong community involvement throughout the full process to reach a consensus for the future of our field.

Report from the DRD Committee

by T. Bergauer (HEPHY Vienna), Chair of the DRDC

This article provides an update on the detector R&D (DRD) collaborations, which are now being established in line with the ECFA Detector Roadmap document, released in 2021. After the CERN Council and SPC decided that the DRD collaborations would be hosted at CERN, the DRD Committee (DRDC) was formed in the summer of last year. It began its work immediately by reviewing the first DRD proposals. This enabled the CERN Research Board to approve four DRD collaborations in December 2023 for an initial period of three years. These collaborations cover gaseous detectors (**DRD1**), liquid detectors for rare event searches and neutrino experiments (**DRD2**), photon detectors and particle identification (**DRD4**) and calorimetry (**DRD6**). A collaboration on semiconductor detectors (**DRD3**) was given only conditional approval due to the very late submission of its proposal and several pending issues that were not addressed in time.

After this initial round of approvals, two further collaborations were approved in a second round in June 2024 by the CERN Research Board, following reviews and iterations with the DRDC. These collaborations, discussed in more detail below, cover quantum sensors and emerging technologies (**DRD5**), as well as electronics and on-detector processing (**DRD7**). Moreover, full approval for three years was granted to **DRD3** after the pending points had been adequately addressed. Their proposals (and the ones of the previously approved DRD collaborations) have been published in CDS. Moreover, all DRD collaborations and working meetings have been consolidated under the Indico section "Experiments → R&D".

DRD5: Quantum sensors and emerging technologies

The unprecedented sensitivity and precision of quantum systems enable the investigation of fundamental questions in particle physics. Quantum technologies are also rapidly emerging in various domains nowadays. The DRD5 collaboration follows these advancements and aims to identify key technologies and topics that will benefit our community the most. Three domains are being followed: a) exploring fundamental physics questions, such as demonstrating fundamental symmetries through particle, atomic or molecular EDMs, spectroscopy, and the search for dark matter and new couplings, b) enhancing quantum measurements by addressing foundational questions and testing the violation of fundamental symmetries and interactions, and c) developing applied technologies for novel types of detectors using new materials and extreme sensitivity through phase transitions.

Since no large collaboration has worked on these topics before, another important goal of DRD5 is to identify groups that are willing to participate in a global collaborative effort and establish trust and mutual interest to determine benefits across these groups. For this, community building is a very important aspect. Thus, no membership fee or common fund is planned, and joining the collaboration will be a lightweight process involving a simple request to the collaboration board. The proposal, developed last year in an effort coordinated by Michael Doser (CERN) and Marcel Demarteau (Oak Ridge), was submitted to the DRDC at the end of February 2024 and sent to interested institutions in parallel. Based all the responses, 94 groups with 338 individuals expressed interest in signing the proposal for its approval, while the actual FTE number is assumed to be only a fraction of that number.

Based on the detector R&D themes (DRDTs) and topics covered in the ECFA Detector Roadmap, the DRD5 collaboration has identified six work packages: **Work Package (WP) 1** covers exotic systems in traps and beams and atom interferometry, as well as networks, signals and clock distribution. **WP2** is about building blocks for complex nanoscale low-dimensional "quantum materials". It includes application-specific research, such as investigating quantum dots and monolayers with extended functionality, and its inclusion in simulation packages, such as Geant4. **WP3** deals with cryogenic materials, devices, electronics and systems, and its aim, among others, is to investigate the role of high-T_c superconductors in HEP instrumentation. **WP4** covers large spin-polarised ensembles, molecules with radioisotopes for EDM searches, hybrid devices like quantum wells in semiconductors and quantum cascade lasers coupled to silicon sensors, as well as opto-mechanical sensors for DM, neutrinos, and gravitational wave searches by using low-loss solids, levitated particles or sensors based on superfluidity. **WP5** deals with opto-mechanical resonators and atom interferometers for GW detection and beyond, as well as investigation of the use of quantum entanglement in HEP. In **WP6**, education and exchange platforms, as well as infrastructures, are covered.

The milestones and deliverables in each WP are mostly reports and documents and fewer physical objects, as this proposal covers much lower technology readiness levels (TRLs) than the other DRD collaborations. Thus, it is accepted for the time being that resource planning has not been done for the deliverables and institute responsibilities have not been defined yet. At its meeting in June, the DRDC suggested selecting the more mature projects and starting such resource planning, as well as establishing contact with the other DRDs on possible areas of overlap.

DRD7: Electronics and on-detector processing

High-performance electronic systems are an essential aspect of all HEP experiments. The complexity and costs of the necessary developments are high and will continue to increase in the future.

The objective of the DRD7 collaboration is to carry out strategic R&D in electronics, fulfilling the DRDTs from the ECFA Roadmap. TF7 (now DRD7) was listed there, together with integration/ mechanics (TF8) and education/training (TF9), as an orthogonal task force, since these topics are essential for all DRD collaborations. However, the DRD7 collaboration has been set up to perform R&D **on** electronics, covering low TRLs 1–5 and targeting disruptive, transformative and mid-to-long-term goals. It does not act as a "service provider" for other DRDs, where higher TRL components are needed on shorter time scales.

However, DRD7 will also provide access to expertise, tools and industry vendors, supporting the entire DRD programme and facilitating future standards and approaches. It will support both specific technical goals in the area of electronics and the general strategic recommendations of the Roadmap. Thus, interfaces with other DRDs are being defined, and liaison persons have been nominated.

The proto-DRD7 collaboration held an open workshop in March 2023, where WP convenors were nominated and proto projects were defined, which were then reviewed and refined in a second workshop held in September 2023, when a Letter of Intent was also submitted to the DRDC.

The full proposal of the DRD7 collaboration was submitted to the DRDC in February 2024. After being reviewed and iterated with the proponents, it was presented at the open session of the DRDC meeting and approved by the CERN Research Board in June. A first full collaboration meeting will be held on 9 and 10 September 2024 at CERN. In parallel, a collaboration board (CB), comprising representatives of each of the 68 member institutes from 19 countries, is being formed and a chair elected. The first proto-CB meeting was held on 26 June.

DRD7 has chosen a different management approach to the other collaborations, comprising a steering committee rather than a single spokesperson as a central executive body. The steering committee members, who will be replaced on a rolling basis, currently comprise Francois Vasey (CERN), Frank Simon (KIT), Jerome Baudot (IPHC Strasbourg), Marcus French (RAL), Ruud Kluit (Nikhef) and Angelo Rivetti (INFN Torino). The first two act as co-chairs and represent the collaboration vis-à-vis the outside.

Based on the five DRDTs from the Roadmap, DRD7 has defined six genuine research WPs and one cross-cutting WP on tools and technologies (WP7) based on proposed projects in a bottom-up approach. However, certain DRDT topics have not been covered so far, in particular intelligent power management, data-reduction techniques based on AI, novel on-chip architectures, and reliability and fault tolerance.

WP1 covers data density and power efficiency topics, targeting e.g. silicon photonics transceivers, power systems and wireless transmissions. **WP2** deals with radiation-tolerant RISC-V System-on-Chip ASICs to increase the intelligence in the detector. **WP3** aims to develop high-performance TDC and ADC blocks for ASICs with ultra-low power and high-precision timing distribution. **WP4** is on extreme environments, covering the development of CMOS PDKs at cryogenic temperatures and research on radiation-resistant CMOS nodes, as well as cooling (which partly overlaps with future DRD8 topics). **WP5** is on DAQ platforms and simplified backend systems and investigates commercial off-the-shelf electronics. **WP6** deals with imaging ASICs for MAPS sensors and technologies, providing common access to selected CMOS nodes like TPSCo 65 nm, Tower 180 nm and LFoundry 110 nm. **WP7**, as mentioned above, proposes a hub-based structure to support ASIC developments by the HEP community in general and the other DRD collaborations in particular, establishing and maintaining access to process nodes at large foundries and EDA software tools and facilitating collaborative work like for IP-block sharing. This WP relies heavily on collaboration and coordination with experienced regional centres (hubs) and on structures set up in the European context, such as Europractice IC and Software services. Internationalising these efforts will be challenging due to licensing and legal issues.

The manpower committed in all the WPs is around 110 FTEs, with an additional 67 FTEs needed to achieve the planned work programme. This might sound less than for the other DRD collaborations. However, DRD7 has categorised its membership into "contributors," who commit resources to dedicated tasks, and "observers," who follow the activities only in the WPs. In the other DRD collaborations, this distinction has not been made so strict, a factor that must be considered when comparisons are made.

Outlook

Apart from Task Force 9, which became the ECFA Training Panel, all the other topics listed in the ECFA Roadmap are now being actively followed in DRD collaborations, except for **TF8 (Integration)**. As the initial TF8 convenors did not continue as a proposal preparation team, new convenors had to be searched for, and were found around the group organising the "Forum on Tracker Mechanics" workshop. A survey was conducted and revealed that the community was interested in moving forward. Subsequently, an open meeting was held in December 2023 at CERN, and the DRDC received a Letter of Intent setting out the aim to submit a full DRD8 proposal by the end of this year, which is being coordinated by a steering group comprising A. Jung (Purdue), A. Mussgiller (DESY), C. Gargiulo, P. Petagna, B. Schmidt (all CERN) and G. Viehhauser (Oxford). However, the Letter of Intent does not cover all the TF8 DRDTs, as they are quite diverse and focus on vertex detector mechanics and cooling only, with interest currently from 22 institutes in seven countries, while magnet development as well as beam, radiation and environment monitoring are not covered.

The next DRDC meeting will take place in November. Its open session will have presentations from all the DRD collaborations approved in the first round (DRD1, DRD2, DRD4 and DRD6), presenting the progress from their first year. A similar session is planned for spring 2025 with presentations from the collaborations (fully) approved recently, i.e. DRD3, DRD5 and DRD7.

ECFA–LDG Detector R&D Infrastructure Panel: Labs Resources Supply Survey

by S. Bentvelsen (Nikhef), M. Mikuž (University of Ljubljana and Jozef Stefan Institute), Panel Co-Chairs

The joint ECFA–LDG Detector R&D Infrastructure Panel was established to assess the infrastructure needs of the emerging detector R&D (DRD) collaborations that are not met within the DRDs themselves. Such infrastructure might, however, be available either in large national laboratories (LDG) or institutes/universities throughout Europe (ECFA).

As a first step, the Panel decided to conduct two surveys. The first was to identify the needs of the DRD communities, and the second to map out the availability of relevant resources in Europe.

Results from the DRD Resources Request Survey were reported at the 113th PECFA meeting at CERN in November 2023, together with preliminary findings from the Labs Resources Supply

Survey. A short write-up also appeared in the ECFA Newsletter. Here we provide a brief analysis of the completed resources supply survey and suggest how to proceed based on the information gathered.

The survey was structured around the following infrastructure types:

- test-beam and irradiation facilities
  - existing facilities
  - plans and ambitions
- characterisation and test-bench measurement facilities
- local expertise
  - electronics expertise
  - mechanical expertise
  - software support

targeting the implementation of the following General Strategic Recommendations (GSR) of the ECFA Detector R&D Roadmap:

- GSR 1 – Supporting R&D facilities
- GSR 2 – Engineering support for detector R&D
- GSR 3 – Specific software for instrumentation
- GSR 5 – Distributed R&D activities with centralised facilities

The final response, presented at the 114th PECFA meeting in Frascati in July 2024, includes replies from 73 national labs, institutes and universities in 19 countries. This represents a significant improvement with respect to the turnout in November 2023 (47 labs / 12 countries) and can be regarded as providing decent regional coverage of ECFA's 28 countries.

The survey responses were fed into an Excel sheet with a mixed structure of multiple choice, numerical data and comments in cells. While it is difficult to make a consistent analysis, the data represents a valuable collection of information on the resources available throughout Europe. A quick and superficial analysis shown below, based on the list of infrastructure types, is just a starting point; interested users should consult the complete data and preferably get in touch with the relevant lab to see if it would fit their need(s).

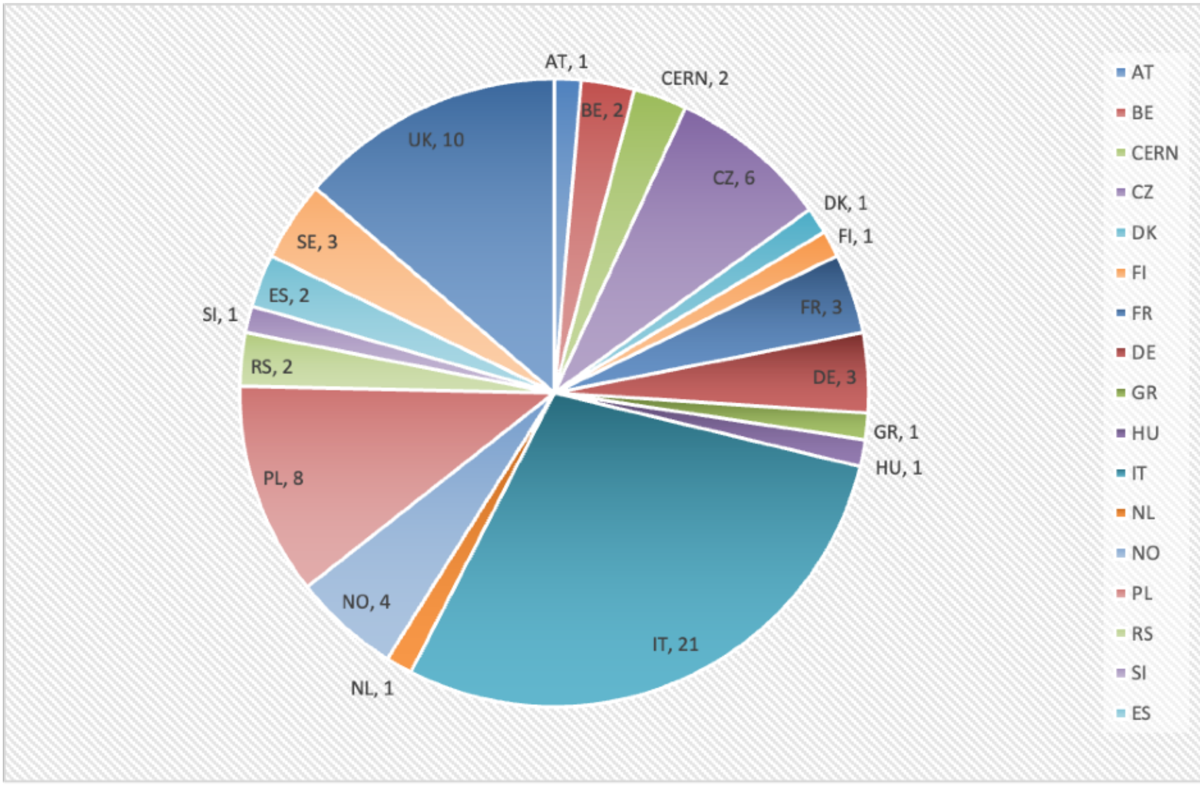

Figure 5: Lab survey coverage showing participating labs per country.

Test-beam and irradiation facilities

These are the resources most requested by the DRD collaborations. Various kinds of test beams are present in 12 labs and planned in 8, while irradiation facilities of very different flavours exist in 21 and are planned in a further 15 labs.

Characterisation and test-bench measurement facilities

Almost all labs claim to have several of the 13 varieties of these infrastructures. The top three listed are the very generic labels of detector characterisation, and mechanical and electronic workshops.

Electronics expertise

The expertise was structured into IC design, FPGA design, PCB design and fibre optics, with sizeable, little and none as choices. To complement, an overall FTE count of technical manpower in electronics was required. Other activities and comments were also requested.

The results show that one half of the labs support IC design, roughly half of them in a sizeable way. One third can tackle FPGAs, but only five claim mastery in the field. Surprisingly, just two labs claim proficiency in PCB design, while a third is involved. About two thirds deal with fibre optics.

Mechanical expertise

The poll was structured into availability of CAD design engineers, technicians and applied physicists. Again, an overall FTE count of technical manpower in mechanics was required, together with other activities and comments.

The results show that about 40% of labs employ applied physicists, 35% CAD engineers and 30% technicians with mechanical expertise. A high level of expertise in mechanics is claimed in about 10% of the labs.

Detector software support

General software, FPGA expertise and real-time computing were the three categories offered. In addition, head count, other activities and comments were requested. About one third of the labs offer general and FPGA software support; while two thirds offer real-time computing support. Sizeable support in all categories, however, is claimed by about 10% of the labs.

The responses to the survey provide a rather exhaustive snapshot of the resources that could be made available to facilitate detector R&D in Europe. The sheer existence of the data is already a valuable asset to be exploited.

The next, very basic, mechanism is to make the data available on the Panel webpage, which requires the consent of the 70+ parties involved. At the same time, the DRDs must be made aware of the data and where to access it. This bottom-up approach could help establish direct contact between the users and the resources they need.

Beyond this, pruning the data and making recommendations to funding agencies concerning support for a limited slate of labs to maximise impact on detector R&D would require serious engagement, probably best based on actual use of resources by the DRDs in an iterative way. A valuable complement can be found in EU-sponsored Transnational Access funding. Currently, 11 research infrastructures receive funding dedicated to HEP detector R&D as part of the EURO-LABS project.

Resources:
Talk at the 113th PECFA meeting
12th ECFA Newsletter
Talk at the 114th PECFA meeting
DRD survey summary
EURO-LABS project

Towards an EDP contribution to the 2025 ESPP update process

by D. Contardo (IP2I Lyon) and F. Sefkow (DESY)

As in previous updates, the ECFA Detector Panel (EDP) plans to contribute to the upcoming update of the European Strategy for Particle Physics (ESPP), providing its perspective on how the goals outlined in the ECFA Detector R&D Roadmap can be achieved by the recently formed DRD collaborations (CERN/SPC/1190 CERN/3679). The status of the DRD collaborations is presented in this newsletter in the contribution by Thomas Bergauer.

By the end of the current year, the Memoranda of Understanding (MoUs) specifying the resources from all the funding agencies are expected to be up for agreement. This new step will form the basis for the EDP input to the ESPP update, as the MoUs will provide, with respect to the corresponding proposals, an updated and consolidated view of the DRD scientific programmes, the division of responsibilities between the contributing institutes and the availability of resources to achieve the initial goals laid out in the ECFA Detector R&D Roadmap[1].

The EDP input will first consider the status of the DRD programmes and the expected progression of work over the current DRD timescales of three to four years. It will then compare these expectations with current ideas and concepts for next-generation detectors and experiments – including those at a potential future flagship project at CERN – and with the overall goals set out in the Detector R&D Roadmap. Depending on the status of the DRD programmes and the new Strategy, the ESPP submission could trigger an incremental update of the Detector R&D Roadmap. This update process would be launched after the publication of the ESPP and would hopefully address new concepts with low technology readiness levels[2], as well as novel commercial technologies that are not currently available to HEP but could enter the DRD programmes on a longer timescale.

The success of the DRD collaborations relies on cross-DRD activities and synergies with other R&D programmes, as well as on the external partnerships needed in the execution of the different activities. The EDP input will consider how to effectively synchronise these cross-cutting activities (including by exploiting synergies with ApPEC and NuPECC), how to strengthen industrial partnerships and how to ensure that the instrumentation developed is of benefit to society. The availability of infrastructure for characterisation and the role of large laboratories in providing this infrastructure will also be discussed, based on the outcome of the Laboratory Directors Group (LDG) investigations (see contribution of Marko Mikuz in this newsletter).

The process to prepare the EDP input to the ESPP update will involve several consultations in the period up to the end of October[3]. A first draft will be compiled before the end of 2024, for discussion with the main actors. Following subsequent discussions and iterations, the final EDP document will be submitted on 31 March. In order to obtain a wide range of views from the community, the EDP will consult the DRD collaborations, the leaders of the detector concept groups of the strategic projects, the ApPEC and NuPPEC communities through their EDP representatives, the LDG, the DRD ECFA national contacts and the ECR Panel, and it will also consider direct contributions sent by individuals.

[1] The MoUs will cover a period of about three years, with flexibility to be updated every year depending on technical progress, evolution of collaborations membership and funding agency budget cycles.

[2] Low-TRL developments are often referred to as “Blue Sky” R&D.

[3] Benefiting from the Higgs, Electroweak & Top Factories ECFA workshop in Paris, 9–11 October.

Planning national inputs to the European Strategy for Particle Physics (ESPP)

by P. Sphicas (CERN and NKUA)

The remit (charge) of the European Strategy Group (ESG) specifies that it should take into consideration various aspects of the high-energy physics (HEP) landscape, including, very importantly, “the input of the particle physics community”. A major component of this overall community input will be the “national inputs”, collected individually by the national community in each country (or, in some cases, countries grouped into regions). Clearly, engaging the maximum number of colleagues, especially ECRs, in the field of particle physics is of the utmost importance for the process.

To be of greatest use in informing the ESPP, the information collected must be as coherent and as uniform as possible, especially when addressing the key issues. To assist with this, ECFA has drawn up a set of guidelines for the collection of national inputs. They are intended as suggestions aimed at streamlining the process across the different countries/regions, on the clear understanding that each country/region is at liberty to define its own process, schedule and questions to consider in order to form its own national view(s) as input(s) for the Strategy.

National inputs to the ESPP update can be sent at different points in time: prior to the deadline of 31 March 2025 for the submission of input to the ESPP; after the March 2025 deadline and by 26 May at the latest in order to be analysed by the ESG in time for the Open Symposium; and after the Briefing Book has been released, in time for the Strategy Drafting Session from 1 to 5 December 2025. The final deadline for input to be considered by the ESG at its Drafting Session is 14 November 2025.

The guidelines suggest that two national (“town-hall” or similar) meetings be organised (clearly, each country/region is free to decide on the number):

a) one meeting between the end of March 2025 and the Open Symposium at the end of June, with a deadline for comments of 26 May 2025, and

b) a second meeting after the release of the Briefing Book around the end of September 2025, with a deadline for comments of 14 November 2025.

The meeting(s) could/should be co-organised by the country’s Restricted ECFA delegate and its representative on the ESG (for some countries this is the same person) and should be guided by a set of “standard questions” to be considered.

Clearly, a central element of the next ESPP is the choice of the next collider at CERN. This is reflected in the ESG's remit, which explicitly states that “[t]he Strategy update should include the preferred option for the next collider at CERN and prioritised alternative options to be pursued if the chosen preferred plan turns out not to be feasible or competitive”. It is, therefore, imperative that the European HEP community provide explicit feedback on both the preferred and alternative options for this “next collider at CERN”, which will be the Laboratory's next flagship project, and an explanation of any specific prioritisation.

Lastly, the remit to the ESG also specifies that “the Strategy update should also indicate areas of priority for exploration complementary to colliders and for other experiments to be considered at

CERN and at other laboratories in Europe, as well as for participation in projects outside Europe". It would thus be most useful if the national inputs explicitly included the preferred prioritisation for non-collider projects.

The full set of guidelines is available on the ECFA website.

ECFA Higgs Factory Study

by A. Robson (Glasgow)

The ECFA Study towards an e^+e^- Higgs/Electroweak/top factory continues to be very active, with an extensive series of working meetings having already taken place during 2024. Much of the current activity is centred around 14 'Focus Topics', and this initiative reached an important milestone in January with the arXiv publication of their descriptions: https://arxiv.org/abs/2401.07564. This document, of 50 pages plus references, represents a large effort by 108 authors. The topics span the physics landscape and energy stages of a future e^+e^- machine and are intended to bring people together across different projects, to work cooperatively for the benefit of all projects. Work on the topics is under way and, while the Study faces a challenge from the significant reduction of available working time owing to the acceleration of the European Strategy update, there should be some valuable new results ready in time for the Strategy.

Ongoing activities beyond the Focus Topics include development of common tools such as flavour tagging, and a project to provide technical benchmarking for Monte Carlo event generators. Work has now started towards a final report, and the third and final ECFA Workshop, taking place from 9 to 11 October 2024 in Paris, will be an important step towards this. Registration for the workshop is open, with an early registration deadline of the end of July, and strong participation is encouraged across the particle physics community!

ECFA Reports from Laboratories

Report of the Laboratory Directors Group

By D. Newbold (RAL / STFC), Chair of LDG

The LDG and the national laboratories

The LDG (formally, the Large Particle Physics Laboratory Directors Group) brings together the senior leadership of the large national laboratories in Europe, in order to address topics and initiatives of common interest. As we approach the next update of the European Strategy for Particle Physics, particular aspects of the LDG remit come into focus:

- The provision of direct input into the European Strategy process, representing the viewpoint and interests of the major laboratories;

- The maximisation of the regional and national benefits of investment in fundamental research and in CERN, noting that the scale of the next major projects at CERN will require the active contributions of laboratories across Europe;

- Coordination of activities and exchange of information with partner laboratories outside Europe, reflecting the nature of modern particle physics as a fully worldwide endeavour.

The laboratories play a unique role within their own national communities and collectively. The provision of practical support for large-scale HEP projects includes: engineering capabilities; access to large computer systems and skilled software engineers; and an increasing level of project and financial management for projects, often on behalf of the national funding agency. In many cases, the laboratories operate accelerators or contribute to their construction; in other cases, emphasis is on specialised facilities above or below ground, or on R&D in detectors. Collectively, the laboratories support the careers of both physicists and specialists in the previously mentioned areas, complementary to the career path provided by universities.

Most major laboratories are involved in multiple research fields, in many cases drawing upon skills, facilities and capabilities originally developed for particle physics. The research facilities available across LDG laboratories include X-ray and UV light sources, reactor and beam-driven neutron sources, telescopes, high-power lasers, and specialised supercomputers and data storage systems. The laboratories provide a route for exchange of expertise and people between fields, and between academia and industry. Use of particle physics technologies and approaches across other scientific areas is a major generator of societal and economic impact and forms a clear secondary justification for continued funding of the field.

In recent years, the mission of the major laboratories has become increasingly diverse, challenging and expensive. The costs of operating and maintaining major research infrastructures have risen sharply, requiring new approaches and efficiencies. Laboratories across the world share similar challenges and increasingly work together to learn from each other and to find common solutions.

Accelerator R&D programme

The LDG is charged by the CERN Council to oversee the accelerator technology R&D programme mandated by the 2020 update of the European Strategy. This programme commenced with the definition of an R&D roadmap representing the consensus position of the accelerator R&D community. Following the publication of the roadmap (arXiv:2201.07895; CERN-2022-001), coordination panels were established in order to guide R&D in each of the five topical areas highlighted in the Strategy. In each of these areas, significant progress has been made against the R&D goals, both on topics directly relevant to the next generation of machines and towards longer-term goals with the potential to radically improve the performance, cost and sustainability of following generations of accelerators.

Recent progress highlighted at the ECFA meeting included the following items:

- The High-Field Magnets collaboration has undertaken replanning of its work programme, with the goal of speeding up progress and reducing the number of parallel developments. Paper designs for test and prototype structures drawn up in previous years are now increasingly becoming real objects in laboratories across Europe. The goal of HFM remains the parallel development of a 14 T Nb_3Sn dipole and a 20 T HTS dipole, corresponding to collision energies of 80 TeV and 120 TeV respectively for the proposed 91 km FCC-hh machine.

- The RF group continues to progress six work packages covering all aspects of high-gradient normally-conducting and superconducting RF structures. The group brings together efforts from multiple national and transnational projects involving technology development and its application for practical purposes in accelerators.

- The plasma group is now focusing on the HALHF concept, which aims to exploit both conventional and beam-driven-plasma acceleration techniques to provide highly asymmetric electron–positron collisions in a Higgs / electroweak factory. This concept has several advantages but also presents major long-term challenges in technology development. The group also reported on recent progress in the CERN AWAKE experiment, particularly around the successful testing of new and more stable plasma sources at 10 m scale.

- The International Muon Collaboration reported on the outcome of the recent P5 review in the USA, which expressed support for an increased American contribution to the efforts towards a muon collider, and the ambition to host such a future machine. The scope of the interim technical report of the collaboration – a key goal of the R&D roadmap – was presented publicly for the first time.

- The Energy Recovery Linac group reported on progress in the newly funded iSAS project funded via Horizon Europe, including ambitious plans for new cryomodule developments to be used at the PERLE test ring at IJCLab in Paris.

Sustainability working group

In light of the growing attention being paid to the environmental sustainability credentials of future major science infrastructures, the LDG has inaugurated a working group on “Objective sustainability assessment of accelerators”. The charge to this group is to identify metrics and criteria that permit comparison of a range of proposals for new machines, allowing environmental impact to be properly used as one of the comparison points between proposals along with cost, physics potential, technical feasibility and other factors.

The group brings together accelerator experts, physicists with deep knowledge of a range of future proposals and experts on environmental sustainability from several European laboratories. It is specifically tasked to coordinate with the ICFA panel on sustainability, though to take a technical rather than political / organisational approach. The key goal is to make tools and methodologies available to allow sustainability assessment as part of the Strategy update process during 2025.

The group has held several meetings and workshops and has defined the scope of a comprehensive report to be delivered as input to the Strategy update before the deadline of March 2025. This will cover topics including assessment methodologies, key impact factors for lifetime carbon emissions, mitigation measures, and background information on legislation and standards. Following the report publication, the group then plans to continue its work in parallel with the Strategy update

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LDG composition

The term of the current LDG Chair will come to an end in December 2024. At its meeting in June 2024, the LDG unanimously elected Professor Mike Seidel (PSI Zurich) as its Chair for the period 2025–2026. Professor Seidel will take over the duties of the LDG Chair, including participation in the Secretariat of the European Strategy update process, from January 2025.

The representatives of several LDG laboratories (Nikhef, Frascati, DESY, RAL) will change during 2024 or early 2025 due to changes of management. We thank the outgoing representatives for their strong contribution to the work of the LDG during the past years and welcome the new laboratory representatives, who will of course play a key role in the Strategy update during 2025.

Report from CERN

By J. Mnich (CERN)

In 2024 the LHC started very successfully, delivering by early July already about 37 fb^{-1} of pp luminosity to both ATLAS and CMS, with a maximum of 1.3 fb^{-1} within 24 hours. The accelerator and the experiments are well on track to reach the goal of 110 fb^{-1} by the end of the 2024 pp running. It is worth noting that the original luminosity goal of the LHC, before switching to the HL-LHC, of 300 fb^{-1} has already been achieved.

All the LHC experiments continue to produce many excellent physics results, mostly based on the full Run 2 data sets. Recent examples are a new ATLAS analysis on di-Higgs production from which constraints on Higgs coupling modifiers can be derived: $-1.2 < \kappa_\lambda < 7.2$ and $0.57 < \kappa_{2V} < 1.48$[4]. Although these limits are not yet very stringent, they demonstrate the significant progress made in improving analysis techniques and provide good prospects for the HL-LHC phase, in which di-Higgs production will be a key scientific goal. Another example is the first observation of quantum entanglement in top–antitop events at high di-top masses by CMS[5]. The measurement shows quantum entanglement well above the critical entanglement criterion defined by the exchange of information at the speed of light between the top and antitop quarks.

The current LHC schedule has the ongoing Run 3 continuing until the end of 2025 before entering a three-year shutdown (LS3) to upgrade the LHC and the ATLAS and CMS detectors. The HL-LHC is scheduled to start in 2029 and continue until 2041, with the goal of delivering 3000 fb^{-1} of pp luminosity. A lot of progress has been made with the HL-LHC accelerator upgrade. The civil

[4] See ATLAS-CONF-2024-006 for details.

[5] See TOP-23-007 for details.

engineering work is completed and the magnet production is progressing well. The Nb_3Sn technology and the high-temperature superconducting links have been validated. In 2024 a complete inner triplet string will be installed in the magnet test facility to be operated at cold temperature in 2025. Although a lot of work remains to be completed, the HL-LHC project is on track for installation in LS3 starting in 2026.

In addition, ATLAS and CMS continue to make very good progress and are entering (pre-)production for many items. However, technical problems resulted in additional delays, which have eliminated the contingency on some critical subsystems. Examples include the ATLAS inner tracker (ITk) strip sensors, which exhibited cracking when thermally cycled on their support structures, and the HGCROC ASIC for the CMS High-Granularity Calorimeter (HGCAL), where design issues delayed the start of production. Additional, significant risks remain, and severe concerns about the schedule have been expressed by the relevant CERN scientific committees. Therefore, CERN is preparing for an LS3 Schedule Review in autumn 2024.

Among several scientifically excellent proposals, the CERN Management selected the SHiP (Search for Hidden Particles) project for operation at the new high-intensity ECN3 beamline in the North Area. SHiP is a beam dump with the main scientific goal of searching for feebly interacting GeV-scale particles (0.5–5 GeV)[6]. The experiment is currently expected to start around 2031 and take data for 15 years.

The Swiss Collaboration for Accelerator Research and Technology enters a new four-year phase

By L. Rivkin and M. Seidel (PSI/EPFL)

CHART, the Swiss Collaboration for Accelerator Research and Technology, was founded to support the future-oriented accelerator project, the Future Circular Collider (FCC), at CERN and the development of advanced accelerator concepts in Switzerland beyond the existing technology. The proposed CHART programme has a strategic character not only for CERN but also for Switzerland. Today, CERN has to dedicate much of its resources to the next project, the High-Luminosity LHC (HL-LHC). CHART's mission is to support CERN for the phase beyond the HL-LHC: the realisation of the FCC. CHART was founded in 2016. Since then, two funding periods have covered the period until the end of 2024, and another period will cover the years 2025–2028. During CHART Phase 2, more than 20 projects financed by CHART funds presented excellent and important results.

Past and future CHART activities cover a wide range of topics, from beam dynamics projects for the FCC to geodesy and geology studies for its underground tunnel, to the development of superconducting high-field magnets (HFM). The injector complex for the FCC-ee is relevant to the collider's luminosity performance, and its design will be covered by a prominent CHART project in the next four years. The project is a collaboration between IJCLab, INFN Frascati, CERN and PSI, with the latter in a coordinating role. For the linear accelerator sections, all operated at room temperature, the plan is to use technology developed for the electron linac driving SwissFEL.

[6] See SHiP Reports for details.

Another key component in addition to the damping rings is a positron source. A new type of source is being developed, delivering a high yield of positrons per electron of the drive beam. A conceptual test of the source is planned at PSI (Fig.1). The development of a superconducting capture solenoid presents a synergy with the HFM programme in CHART.

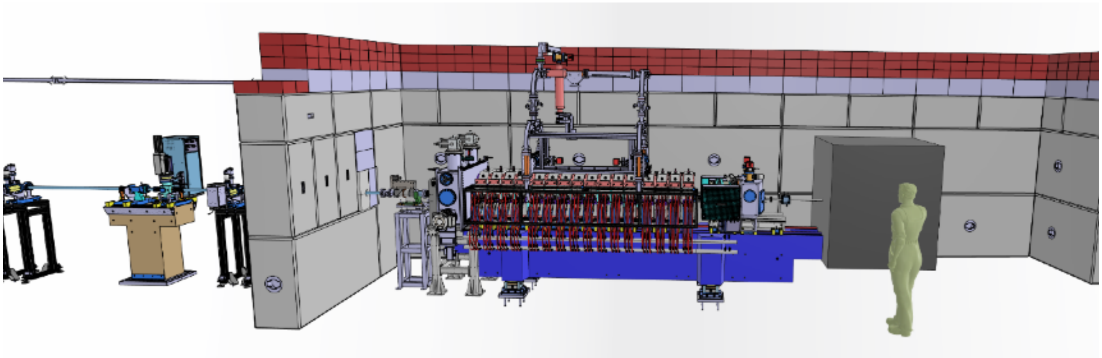

Figure 6. The planned P3 experiment at PSI uses the 5.8 GeV electron beam of SwissFEL to demonstrate high-yield positron production, albeit at low intensity. It uses a 12 T solenoid based on a non-insulated high-temperature superconductor, to maximise positron capture.

For a future hadron collider, the attainable field strength is of the utmost importance to maximise the physics potential, and the development of a new generation of magnets requires a dedicated and long-term R&D effort. Research on innovative HFM concepts represents a key CHART activity for the coming years. Several magnet concepts are being considered, based on the well-known Nb_3Sn conductor material as well as using high-temperature superconductors (HTS). A particular aim of the CHART activity is to speed up the traditionally long prototyping cycles of superconducting magnets, for example by testing subscale sections of magnets. While the comparably new HTS tape conductors exhibit promising advantages in terms of field strength and better cryogenic efficiency, significant R&D work must still be done before HTS magnets can be used to build a particle collider. For example, large losses during the ramping of HTS magnets pose a serious problem. However, for applications such as static solenoid fields, HTS magnets already offer a valid solution (Fig.2).

The HFM magnet research has strong synergies with PSI projects, as superconducting magnets are of great interest for the production of bright hard X-rays (SLS 2.0, compact sources for lithography, security and personalised medicine applications) and for future proton-therapy gantry designs as they should make it possible to have lighter and cheaper gantries. The development of cost-efficient fusion reactors may also benefit from the CHART HFM programme in a synergetic way.

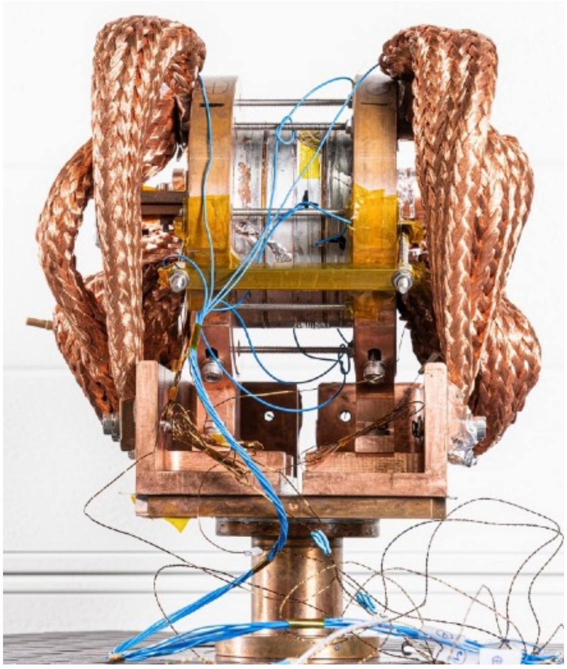

Figure 7. This solenoid test magnet is equipped with HTS coils and achieved a high field of 18 T at a temperature of 12 K in a 5 cm bore.

For more information on the CHART programme, please visit CHART Reports and CHART News.

News from Gran Sasso National Laboratory – INFN

By Roberta Antolini (Gran Sasso)

Several new steps for our underground facilities.

On 18 October 2023, the Bellotti Ion Beam Facility (Bellotti IBF) at Gran Sasso National Laboratory (LNGS) was officially inaugurated, with the first call for proposals for experiments at the facility closing on 30 October. Bellotti IBF will provide the scientific community with unique research opportunities in an environment characterised by very low cosmic radiation. LNGS aims to include the facility in the ChETEC-INFRA network for transnational access to research infrastructures. The second call for proposals was published on 30 June 2024 with a deadline of 18 August 2024.

COSINUS (Cryogenic Observatory for SIgnatures seen in Next-generation Underground Searches) was inaugurated on 18 April. This international experiment aims to reveal one of the greatest unsolved mysteries of the Universe: dark matter. Based on a collaboration between research institutions from Germany, Austria, Finland and Italy, COSINUS' main purpose is to clarify controversial findings in the search for dark matter and to reconcile apparently contradictory experimental results.

Figure 8. Maintenance on the 3.5 MV accelerator installed in the underground laboratories.

At the 2024 International Conference on Neutrino Physics, held in Milan from 16 to 22 June, the LEGEND collaboration presented the first physics results from the first year of data collection of the LEGEND-200 experiment. Born from the expertise and experience of the GERDA and MAJORANA DEMONSTRATOR experiments, it aims to significantly improve sensitivity in the search for neutrinoless double-beta decay of Ge-76. The background level was found to be comparable to that of its predecessor GERDA, an excellent starting point for the project. With the accumulated statistics of approximately 48 kg x yr, and combining the results of its predecessors, it has set a limit on the half-life of this hypothetical decay at T1/2 > 1.9 x 10^26 yr, one of the most competitive limits in this research field. This is a great success and a launch pad for the future ton-scale phase of the project, LEGEND-1000.

Figure 9. The Inauguration of the Cosinus Experiment

Report from Frascati

By F. Bossi (Frascati)

Since its foundation, in 1957, the INFN Laboratori Nazionali di Frascati (LNF) has been dedicated mainly to the construction and operation of particle accelerators and to the development of particle and radiation detectors.

At present, the Laboratory runs two accelerator facilities, the DAΦNE e^+e^- collider complex and the SPARC_LAB linear accelerator facility.

For over twenty years, DAΦNE has provided electron–positron collisions at the centre-of-mass energy of 1.02 GeV, at record luminosities exceeding 10^{34} $cm^{-2}s^{-1}$. At this energy, corresponding to the peak of the φ meson resonance, a copious production of low-energy kaons is obtained, allowing a large number of nuclear and particle physics studies to be performed. In June 2024, the SIDDHARTA-2 experiment successfully completed data taking: an integrated luminosity exceeding 800 pb^{-1} was accumulated, with the purpose of observing, for the first time, the production and decay of kaonic deuterium. SIDDHARTA-2 is a key experiment to better understand low-energy kaon–nucleon interactions and to perform studies of QCD in the non-perturbative regime. Preliminary results, obtained with a small portion of the acquired data, have already ruled out a few theoretical models to describe these transitions. The final, highly anticipated result is expected in a few months.

DAΦNE is the only electron–positron collider still operating in the western hemisphere. There is therefore a lot of interest in its exploitation to perform dedicated accelerator science studies in the future, in view of the construction of the next big accelerator at CERN. However, a well-defined plan in this respect has yet to be put forward by the interested community.

Particles extracted from the DAΦNE LINAC are also delivered to users in the two lines of the Beam Test Facility (BTF) to perform detector characterisation tests, irradiation of materials and, in some cases, small physics experiments. The facility provides beams for more than 200 days per year to users from many universities, laboratories and private companies all over Europe.

Figure 10: Part of the extraction line for BTF

SPARC_LAB was initially conceived of as a test facility for advanced accelerator developments, focused on free-electron lasers (FELs) and in general on the production of new radiation sources. More recently, research has been concentrated on achieving very high acceleration gradients with the plasma wakefield technique. In the last couple of years, many experiments have demonstrated, for the first time, that electron beams accelerated using this technique can drive coherent radiation production, an extraordinary scientific achievement and a key result that proves the feasibility of the next machine to be built at the laboratory: EUPRAXIA@SPARC_LAB.

This machine is intended to be the first FEL user facility driven by a plasma accelerator. The project has received more than 100 M EUR in funding from the Italian Government and has been inserted, within the context of a pan-European effort, in the ESFRI Roadmap. The design phase is well advanced, and the machine is expected to begin operating towards the end of the present decade.

Figure 11: Part of the SPARC_LAB complex

LNF also contributes to many international projects based in all of the major physics laboratories in the world, including CERN, FERMILAB, KEK and LNGS. Among these projects, it is worth mentioning the construction of the ATLAS inner detector for the HL-LHC and the re-use of the KLOE calorimeter and magnet, formerly running at DAΦNE, as part of the near detector of the DUNE neutrino experiment.

Last but not least, LNF is also involved in many outreach activities, through the organisation of visits to the facilities, seminars, courses and other events aimed at both students at all levels and the general public. In 2023, more than 20 000 people visited the Laboratory.

Report from IJCLab – 2024

By A. Stocchi (IJCLab)

This report presents significant novelties in 2023 for which IJCLab is the major accelerator project lead or in which it participates.

Following a first commissioning phase, **ThomX** has undertaken a major upgrade: adjusting the ring length to have a better laser/electrons synchronisation and changing the accelerator cavity to achieve a beam energy of 70 MeV. ThomX will start to take data again at the end of the summer after RF conditioning of the accelerator section.

The 14 **ESS** Spoke Cryomodules were delivered to and qualified in Uppsala, then installed in the tunnel in Lund and connected to their valve boxes, and the cryogenics were successfully installed and chilled. Figure 1 shows the inauguration of ESS in March in the presence of the King of Sweden and the French President, who are standing in front of the IJCLab cryomodules.

For the **PIP-II** project, we have validated four prototype cavities following vertical cryostat tests and optimisation of the HPR process (mitigation of the strong field emission observed during the first tests). IJCLab is currently in the preparation phase for testing the SSR2 series cavities (33 cavities).

For the **PERLE** project, the complete optimisation of the 250 MeV machine design and critical equipment is complete. The site has been chosen and the infrastructure work is under way. Work on the injection line is starting, with the installation of the electron source (DC gun and integrated photocathode frame). It is important to note that the European iSAS project (March 2024) has started, which will make it possible to fund the PERLE cryomodule with the imminent procurement of SRF cavities. Figure 2 shows the PERLE site (Igloo building in Orsay) and the work under way for the installation of the DC gun.

Fig. 12: The inauguration of ESS by the French President and the King of Sweden (March 2024).

Figure 13: The installation of the PERLE DC gun in the chosen site (Igloo, Orsay).

We have recently inaugurated a new platform for **surface analysis and ultrahigh vacuum studies of materials** in accelerators. It is hosted in a new building with several pieces of equipment .

IJCLab continues to be strongly involved in three LHC experiments – ATLAS, LHCb and ALICE – conducting data analysis and hardware work for detectors for the HL-LHC phase. We recall here in particular the increasing involvement in ATLAS, the ITk tracker and the HGTD calorimeter as well as significant involvement in the newly formed DRD6, with three projects: SiW-ECal, Allegro and GRAiNITA.

Finally, IJCLab is increasingly involved in DUNE, namely the cathode and participation in the vertical drift Module-0, now fully installed at CERN.

Report from Daresbury Laboratory

By J. Clarke (STFC)

Daresbury Laboratory is a national laboratory operated by the Science and Technology Facilities Council, situated mid-way between Manchester and Liverpool. The main activities at Daresbury are centred around particle accelerator research and development, scientific computing and high-performance computing. Daresbury Laboratory sits at the heart of the Sci-Tech Daresbury Campus, which hosts over 150 companies and approximately 2000 workers, of which around 700 work at Daresbury Laboratory.

The particle accelerator activities at Daresbury Laboratory are focused primarily on developing the CLARA accelerator user facility, delivering in-kind contributions to the international infrastructures in which the UK has chosen to invest and designing the next generation of accelerator-based facilities for the UK.

CLARA is an open access user facility that supports users from the UK and Europe. Access is provided on a competitive basis, with the highest-ranked proposals being offered beamtime. European users are able to make use of transnational access supported by the EURO-LABS project. Experiments that require access to bright, high-energy electron bunches are also supported, with the majority of users being accelerator experts testing new technologies or developing novel techniques for accelerating particles, often in combination with a very high peak power laser. A significant community of users is also active in very high-energy electron therapy research. CLARA has previously operated for users at up to 50 MeV; now a major upgrade is being installed and commissioned, which will increase its capabilities significantly. Operations for users will resume in 2025. The upgraded performance of CLARA will establish this facility as Europe’s premier open access accelerator test facility. The electron beam energy will increase to 250 MeV and the bunch repetition rate from 10 to 100 Hz. The 10-TW high-power laser for novel acceleration experiments is being replaced with a 120-TW system and the electron bunch length is being reduced from around 1 ps to less than 50 fs.

Currently, staff at Daresbury are responsible for the delivery of key accelerator sub-systems to three major international projects, with a fourth – the Electron–Ion Collider – due to start soon. Activities for the European Spallation Source (ESS) in Sweden are now almost complete, with proton beam transport units and the RF waveguide systems already delivered. The only components yet to be completed are the high-beta superconducting RF cavities. More than 90% of these cavities have been shipped out of Daresbury, and the remaining few will be delivered this year.

Daresbury is responsible for the delivery of three superconducting RF accelerator cryomodules for the Deep Underground Neutrino Experiment (DUNE) in the United States. As the ESS project has tailed off, this activity has ramped up and the superconducting RF infrastructure at Daresbury is now being reconfigured to match the needs of this project. In addition, Daresbury is responsible for the delivery of 137 anode plane assemblies for DUNE and a new detector factory has been established for this purpose.

The final in-kind contribution for which work at Daresbury is ongoing is for the HL-LHC upgrade. For this project, Daresbury has already delivered a pre-series superconducting RF crab cavity cryomodule for testing on the SPS. Four more production superconducting RF crab cavity cryomodules are now being developed and will subsequently be delivered to CERN.

A number of new accelerator-based facilities are under active consideration by the UK. The first of these is the Relativistic Ultrafast Electron Diffraction and Imaging (RUEDI) facility, which will enable MeV electron diffraction and microscopy. The design for this new multidisciplinary research facility has been developed jointly by the University of Liverpool, the Rosalind Franklin Institute and Daresbury Laboratory. Excitingly, approval for this project has recently been secured and it will be hosted at Daresbury Laboratory. The science case covers a wide range of research topics, such as the dynamics of chemical change, quantum materials and processes, biosciences, matter in extreme conditions and energy generation and storage. Construction is due to start in 2026.

Another project under development at Daresbury is the conceptual design of an X-ray free-electron laser (XFEL). This is in response to a science case drafted by the UK research community, published in 2020, which called for access to next generation XFEL capability. The project is also assessing other options, such as how overseas facilities might be upgraded to be able to offer next-generation capability. The current conceptual layout of the XFEL consists of a superconducting RF linac capable of accelerating electron bunches at a repetition rate of 1 MHz up to 8 GeV. These bunches would be shared equally between ten independent FEL lines, with each operating at 100 kHz. Such a facility would offer a massive step change in both research capacity and capability compared to existing FELs elsewhere.

Finally, many of the accelerator research and development activities at Daresbury are focused on making accelerators more sustainable, especially in terms of RF and magnets, which are often the highest energy consumers in an accelerator facility. The STFC has ambitious plans for a Centre of Excellence in Sustainable Accelerators (CESA) to rapidly increase the scale and pace of this R&D and to significantly increase the technology readiness levels of these technologies in collaboration with industry, the UK accelerator community and CERN; indeed, the STFC recently signed an agreement with CERN to work together on this activity.

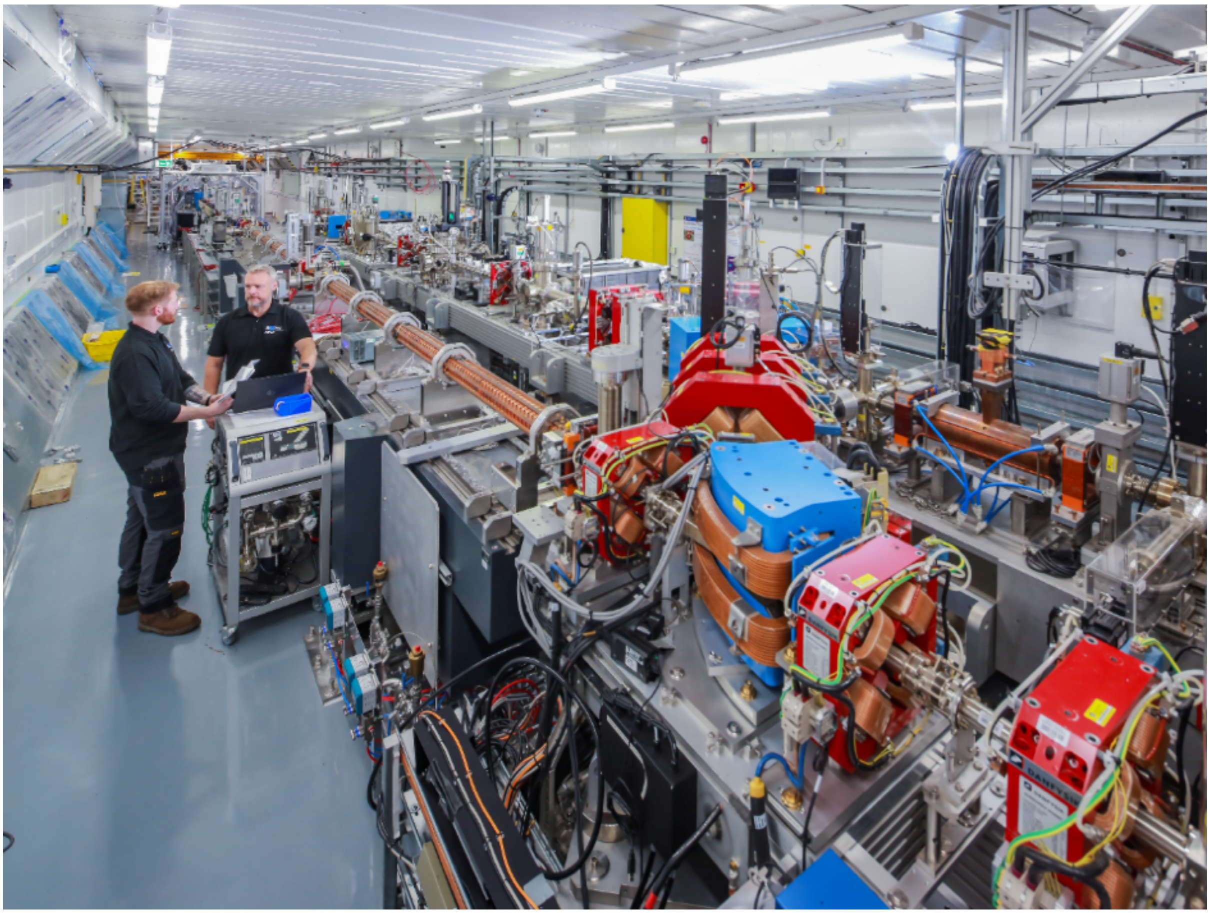

Figure 14. The CLARA upgrade to 250 MeV is now being commissioned at Daresbury Laboratory.

Report from DESY

By B. Heinemann (DESY)

The main highlights from last year at DESY were:

1. DESY is constructing two tracker endcaps, one for ATLAS and one for CMS, together with national and international partners in the large Detector Assembly Facility that was built for this purpose. For ATLAS, one highlight was the preparation of system test with an 8th of an endcap. The final production of the end-of-substructure cards for the entire ATLAS tracker has been launched and is progressing well. For CMS, a major effort was undertaken to improve the tooling and workflows to ensure that construction is as quick and as robust as possible. DESY is also contributing to the outer part of the CMS HGCAL and has finished the design of the active read-out modules for the scintillator SiPM part.

2. DESY had a very successful test beam operation in 2023 (396 users) and 2024 (344 users so far). Most users come from the LHC experiments but many other particle and nuclear physics experiments also benefit from the test beam, e.g. Mu3e, Belle II and CBM. A significant fraction of test beam is also devoted to generic R&D.

3. Plasma wakefield acceleration is a major R&D focus at DESY. In the past year, the KALDERA project, which aims at using lasers to accelerate electrons to an energy of about 0.5–1 GeV with a high level of beam quality and a high reproducibility, has advanced significantly. First beam is expected this autumn. In addition, federal funding has been secured to develop an injector for the PETRA III synchrotron based on this technology.

Plenary ECFA Meeting Reports

NuPECC Long Range Plan 2024 for Nuclear Physics in Europe

By M. Lewitowicz (GANIL), Chair of NuPECC

The Nuclear Physics European Collaboration Committee (NuPECC) regularly consults the physics community ahead of the publication of the Long Range Plan (LRP) for Nuclear Physics in Europe. The LRP is a unique document that covers the whole European nuclear physics landscape, identifying opportunities and priorities for nuclear science in Europe and providing the national funding agencies, the ESFRI and the European Commission with a framework for coordinated advances in nuclear science. It also serves as a reference document outlining the strategic plans for nuclear physics in European countries.

NuPECC decided to launch the process of creating a new Long Range Plan for European nuclear physics in May 2022, aiming to publish the document at the end of 2024. The drafting process was supervised by a steering committee composed of recognised experts in different sub-fields of nuclear science and of representatives of major nuclear physics facilities, including the chairs of the Astroparticle Physics European Consortium (APPEC) and the European Committee for Future Accelerators (ECFA). The Committee also invited two observers, one from the Nuclear Science Advisory Committee (NSAC), in the United States, and one from the Asian Nuclear Physics Association (ANPhA). The NSAC US Long Range Plan for Nuclear Science was issued at the end of 2023 and a strategic plan for nuclear physics in Asia is currently being developed by ANPhA.

This bottom-up approach, which has always been central to the LRPs, was strengthened by the launch, in 2022, of an open call for contributions to the 2024 LRP. 159 contributions were received from more than 400 individual scientists, collaborations, research infrastructures and institutions in Europe, forming a solid basis for further analysis by the 11 thematic working groups (TWGs). The TWGs covered a wide range of topics relevant to the development of nuclear physics, namely, hadron physics; properties of strongly interacting matter at extreme conditions of temperature and baryon number density; nuclear structure and reaction dynamics; nuclear astrophysics; symmetries and fundamental interactions; applications and societal benefits; research infrastructures; nuclear physics tools – detectors and experimental techniques; nuclear physics tools – machine learning, artificial intelligence and quantum computing; open science and data; and nuclear science – people and society. This version of the LRP saw the inclusion of new TWGs on detectors, tools and topics of current interest.

After a year-long preparation, the 300-page LRP2024 document was approved by NuPECC at its meeting in June 2024 in Lund, Sweden.

Please note the following information:

The main findings and recommendations from LRP2024 are summarised in the Executive Summary, which can be found on the NuPECC website. These findings were briefly presented at the Plenary ECFA meeting in Frascati in July 2024, with a focus on topics related to particle physics. The major recommendations on research infrastructures concern nuclear physics infrastructures included within the ESFRI Roadmap, namely FAIR, SPIRAL2, HL-LHC and ELI-NP. In particular, the recommendation regarding nuclear physics infrastructures at CERN states:

"Nuclear physics opportunities at **CERN** constitute a world-leading research programme. The construction of **ALICE 3** as part of the **HL-LHC** plans is strongly recommended. Continued support for exploitation and new developments are recommended to maximise the scientific output of **ISOLDE**, **n_TOF**, **SPS fixed-target program** and **AD/ELENA**. As the roadmap for the post-LHC future of CERN is developed, a strategy should be prepared to secure future opportunities for continuing world-leading nuclear-physics programmes that are unique to CERN."

The full LRP2024 document is expected to be published in the second half of 2024, and it will be officially presented to representatives of all institutions dealing with nuclear physics research in Europe at the University Foundation in Brussels on 19 November 2024.

Report from APPEC

By A. Ianni (Gran Sasso), Chair of APECC

APPEC (Astroparticle Physics European Consortium) is an international coordinating structure founded in 2001. It is based on a memorandum of understanding signed by the partners. APPEC currently comprises 18 member countries with 22 funding agencies. Denmark and Norway are currently member candidates of the Consortium. The APPEC management structure consists of a General Assembly (GA), a Joint Secretariat (JS) and a Scientific Advisory Committee (SAC). The GA is the funding agencies' representative body and takes strategic decisions. The SAC is an advisory body and has the responsibility of elaborating the scientific roadmap to be approved and published by the GA. The JS is the executive body of APPEC.

APPEC carries out its work of coordinating between the European astroparticle physics community in Europe and funding agencies by organising meetings, workshops and schools; supporting R&D programmes and links with industry; engaging with society through outreach and dissemination; and reinforcing links with the EU. APPEC has so far developed three roadmaps, in 2001, 2008 and 2017. In 2023, a roadmap midterm upgrade was presented to the astroparticle physics community, covering relevant developments since 2017 . Examples include multi-messenger observations, high-energy neutrino observations between TeV and PeV, new direct neutrino mass limits and improved neutrino oscillation parameters as well as increased sensitivities in the direct dark matter search.

The updated roadmap also takes into account changes in resource planning, maintenance and operation of existing facilities and new research infrastructures. Major changes since 2022 are related to the Cherenkov Telescope Array (CTA) and the Einstein Telescope (ET) as shown in Figure 1 (see APPEC website for more details).

The current activity in APPEC is focused on developing the new decadal roadmap (2027–2036). The plan is to launch a community survey in autumn 2024. This survey will be the basis for a kick-off meeting, planned for June 2025, to engage with the scientific community and national and international plans. A town meeting to conclude the work of the SAC in agreement with the GA is expected to take place in June 2026. The timeline proposed for the new APPEC roadmap is reported in Table 1.

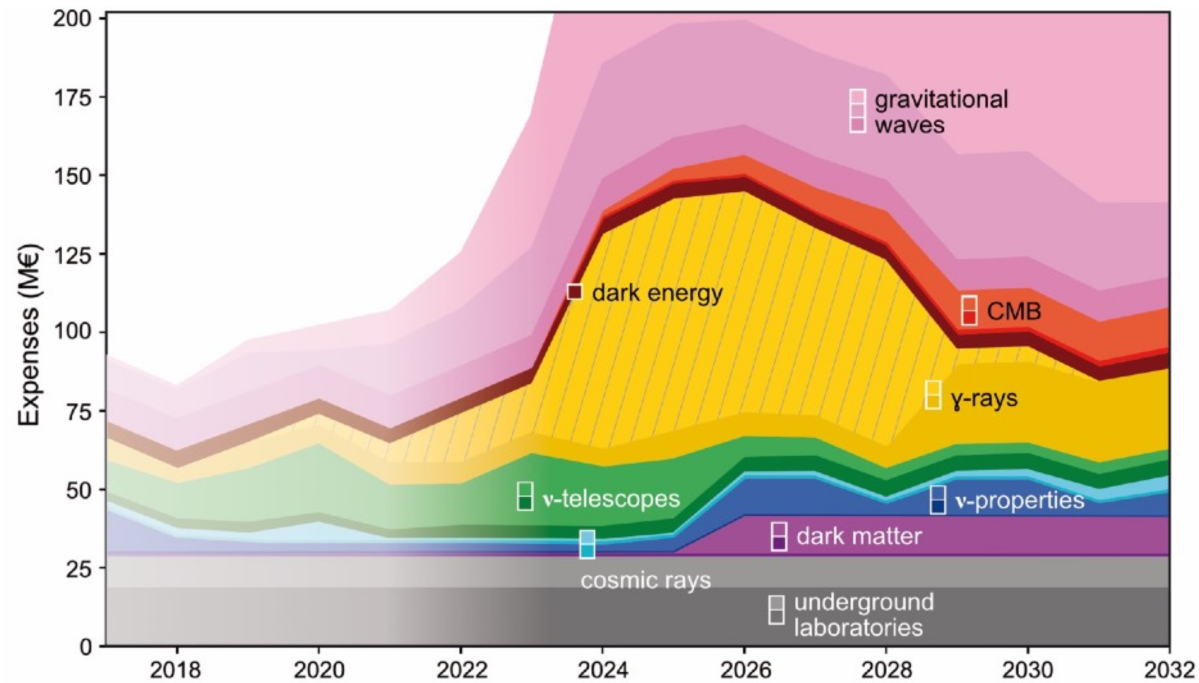

Figure 15. Roadmap update 2023: projected annual capital investment. The darker colour for each topic relates to M&O; the brighter to instrument investments. The colour code for ET corresponds to operation, instrument and infrastructure. The peak for ET (not shown) in 2028 is about 400 MEUR and is related to the construction of the infrastructure.

Table1. Timeline for the new APPEC roadmap.

	2024						2025												2026											
	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
SAC activity	SM		QO SM		QC	SM																								
					KFM preparation								Roadmap preparation												Roadmap finalisation					
EU community												KFM												TM						

SM = SAC meeting

QO = questionnaire out

QC = questionnaire closing

KFM = kick-off meeting

TM = town meeting

The ECFA Early-Career Researchers Panel

By P. Dougan (University of Manchester)

A report summarising the activities of the ECFA Early-Career Researchers (ECR) panel in 2023 is due to be published soon. In the first half of 2024, the panel has been active across all our working groups.

The Working Group on Software and Machine Learning Applications for Instrumentation is currently conducting a new survey to gather information from ECRs on existing schools on instrumentation and how ECRs would like to see future schools be designed. With a comprehensive set of questions across data acquisition/control systems, detector electronics, simulation and machine learning, the results will help highlight gaps in the training available to ECRs and shape the training offered by instrumentation schools in the future.

The Working Group on Career Prospects and the Working Group on Diversity in Physics Programmes recently published a full analysis of their joint survey, in which 760 ECRs participated. The results are extensive and present a broad view of the experience of ECRs, covering their work lives, career prospects and job priorities. In addition to the complete set of results, extensive correlation analysis is included to highlight trends across topics and survey population subgroups. It would be reductive to highlight any specific results here, so we encourage those interested to read the complete report, particularly the concluding points, which outline the most noteworthy findings. ECR Panel members are already using the results to better inform the activities of the Panel, for example, by organising national events to address the specific issues raised, such as the recent HEP jobs event held in the UK.

After the successful "Future Colliders for Early-Career Researchers" event last year, the Working Group on Future Colliders produced a report summarising the full range of topics discussed, including an assessment of the consequences of the future collider prospects for ECRs and a list of key messages and conclusions to be taken into account. The report also featured the open letter to the CERN Council highlighting ECR concerns with the timeline of the European Strategy for Particle Physics (ESPP), which the Council cited in its acceleration of the ESPP schedule. Following the success of the CERN-based event, ECFA ECR panelists have been organising national future collider workshops across Europe to help engage the ECR community in work on future collider prospects, with recent events for Nordic countries and Italy and upcoming events for Belgium and the Netherlands and the Czech Republic and Slovakia .

Overall, the ECFA ECR panel continues to push the envelope on the issues that matter to ECRs, highlighting our concerns to senior colleagues, providing opportunities for ECRs to get involved in work on prospective future colliders and broadening access to skills training.

Figure 16. First ECFA-INFN Early-Career Researchers meeting @LNF-INFN, Frascati, with 70 participants from all INFN sites.