

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

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

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Community consultation process

In light of the European Strategy Group's call for national contributions to update the European Strategy for Particle Physics, the Portuguese community of particle physicists collaborated with its national representatives at the CERN Council and ECFA to organise the process for preparing the Portuguese input. It was decided to hold a national workshop to discuss this input, and an organising committee was formed, consisting of João Paulo Silva (CFTP and IST-Lisboa), Nuno Castro (LIP and University of Minho), Orlando Oliveira (University of Coimbra), Patricia Conde Muíño (LIP and IST-Lisboa), and Rute Pedro (LIP).

In December 2024, the organising committee issued a call for individual or collective contributions from the Portuguese HEP community and announced the date and venue of the workshop (<https://indico.lip.pt/event/1924>). All contributions received are listed on the workshop webpage (<https://indico.lip.pt/event/1924/sessions/998/#20250120>), and their authors were invited to present them in the workshop's first session. Additionally, dedicated sessions on accelerator physics, physics beyond colliders, and technologies and applications were held at the workshop, which concluded with a discussion on preparing the Portuguese input. It was agreed to prepare a survey aimed at the national HEP community, which was prepared with consideration for the ECFA guidelines for inputs from national HEP communities to the European Strategy for Particle Physics.

The present input was prepared from the collected survey answers and circulated in the community for comments before submission.

Future colliders at CERN and worldwide

The Portuguese HEP community advocates for establishing a future “flagship collider” at CERN, ensuring the immediate continuity of the High-Luminosity Large Hadron Collider (HL-LHC). It highlights the significance of having an ambitious baseline physics programme

from the outset, which should be open to worldwide collaboration. The Portuguese HEP community also views it as pertinent that such a programme should drive technology R&D and innovation, and ensure stable support for small and medium scale projects in experimental and theoretical topics.

The Portuguese HEP community showed overwhelming support for FCC and measurable support for a linear e^+e^- collider (e.g. CLIC). The most crucial element mentioned as rational for such choices was its physics potential, with the long-term prospects also being pointed out as an important aspect.

In addition to the efforts towards the next major/flagship project for CERN, it is also considered that other R&D topics should be pursued in parallel, most notably alternative colliders, such as a demonstrator for a muon collider. It is particularly important to pursue the development of high-field magnets and alternative accelerator technologies, including plasma wake-field accelerators in projects such as AWAKE.

If China approves the project of a Circular Electron-Positron Collider (CEPC) and could deliver first collisions in 2035-2040, the community supports a complementary project at CERN: a linear e^+e^- or FCC-hh collider with smaller but measurable support for still pursuing FCC-ee before FCC-hh. In the scenario of the approval of an International Linear Collider (ILC) in Japan, the Portuguese HEP community is overwhelming in its support for building an FCC at CERN. There is also a clear indication of support for the option of having FCC-ee followed by FCC-hh.

Similar to the rationale indicated for the CERN alternatives, the most critical elements mentioned in the community's preferred next major/flagship collider project at CERN was overwhelmingly the physics potential, with a second important element regarding the long-term perspective.

The Portuguese HEP community advocates for the importance of approving future collider projects in Europe, particularly at CERN, whilst is also interested, to a lesser extent, in an involvement in projects outside Europe.

Beyond colliders

Among the community members who responded to the survey, the main areas preferred to be pursued beyond colliders are Neutrino Physics (such as DUNE and SND@LHC), Nuclear and Hadron Physics (such as AMBER) and Hidden Sector searches (SHiP); with Astroparticle

Physics, Direct Dark Matter detection, Neutron Star Physics, and Applications in Medical Physics as other pertinent options.

Once again, the most significant element highlighted in individuals' preferred Beyond-Collider projects was the physics potential, followed closely by the long-term perspective, careers, and training.

In case CERN does not have a collider project after the HL-LHC (e.g. within 20 years), which would be highly undesirable, CERN should increase accelerator R&D beyond the state of the art, Beyond-Collider projects, Astroparticle Physics, and Neutrino Physics.

Final considerations

As CERN embarks on realising a long-term vision (which could culminate with the FCC starting, at best, in the mid-2040s), the Portuguese HEP community acknowledges that continued effort must be made to attract the best students to this field and maintain its momentum.

We believe that providing consistent support for groups with a strong track record in attracting and training talented students is vital for the future of the field. Creating opportunities for early-career researchers, such as grants for introductory research projects, MSc, and PhD programmes, will maintain the momentum of talent development across Europe. ECFA and the international community in this domain should leverage their influence with the granting agencies of member states to ensure dedicated funds for these initiatives in regular application calls.

We also recognise the importance of sustained efforts in public awareness and public engagement in the process of creating a thriving particle physics community. This is the only way to attract top students and secure public support for a long term endeavour that will be expensive and require sustainable funding over several decades.

The discussions held in the preparatory workshop, the contributions received, and the answers to the survey demonstrate that the Portuguese HEP community considers it of utmost importance that CERN continues to lead worldwide efforts in colliders physics and beyond. Therefore, we support: i) that the HL-LHC begins operations around 2030 and that its full physics potential, including a robust heavy-ions programme extending into Run5, is explored; ii) that the Neutrino Platform continue operation at CERN; iii) that FCC-ee be operated as a first stage into the FCC-hh.

The Portuguese HEP community looks forward to the future of HEP in Europe and worldwide and is strongly committed to CERN's success. Seventy years after its creation, CERN still provides a precious and unique environment for advancing knowledge and promoting peaceful and constructive scientific collaboration on a global scale.