Input to the update of the European Strategy on Particle Physics provided by the Spanish Scientific Particle Physics community

Submitted to the ESPP Physics Preparatory Group - December 2018

Abstract

This document summarizes the views of the Spanish community concerning the update of the European Strategy for Particle Physics, which was launched by the CERN Council in its September 2018 session. The priorities, recommendations, and commitments of the community regarding the mid- and long-term plans in the different areas of activity of Particle Physics are discussed. We address the following aspects: the energy frontier (the LHC/HL-LHC program and beyond), beyond colliders' physics (astroparticles, neutrinos, multi-messengers and cosmological surveys), nuclear physics and our contributions to theoretical physics. An Addendum containing more detailed information on the activity and resources of the Spanish community complements this main document.

Editorial Board:
Caterina Biscari, Martine Bosman, Antonio Bueno, Luis M. Fraile, Juan Fuster, María José García-Borge, Inés Gil, Luis Ibáñez, Mario Martínez, Sergio Pastor, Antonio Pich, Teresa Rodrigo

Contact persons:
Antonio Pich (pich@ific.uv.es) and Teresa Rodrigo (rodrigo@ifca.unican.es)

Introduction

It is the purpose of this document to summarize the general views of the Spanish community concerning the update of the European Strategy for Particle Physics, which has been launched by the European Strategy Session at the CERN Council in its September 2018 session.

A summary of the status and the priorities in the field of Particle Physics of the Spanish community is presented. The input provided here is the result of the work of the various national thematic networks, as well as the output of extended discussions of the whole community during two town meetings that took place in September and October 2018.

It is considered that Spain still needs critical mass in key areas, more coordination and networking among the different Institutes, increased sharing of technical and industrial support, and a stable and reliable framework of funding, as well as a more structured community. The creation of a National Institute is still a pending organizational goal. CPAN (Centro Nacional de Física de Partículas, Astropartículas y Nuclear) a national network created at the beginning of 2008, integrating the bulk of the community, is acting as a hub of several national thematic networks, each covering a different research area.

The contribution is organized in two documents. In this main document an Executive Summary collects the priorities of the community in the areas of (a) Energy Frontier (accelerator physics), (b) Neutrinos in accelerator experiments, (c) Beyond Colliders physics, (d) Nuclear Physics, and (e) Theoretical physics. Following the Executive Summary, three main topics of the European Strategy for Particle Physics are briefly addressed in separate sections. A second document, the addendum, complements the information providing more detailed information on the activity and resources of the Spanish community. The addendum (Addendum-ESPP2020-ES) contains information on the Spanish contribution to the high-energy frontier physics program, neutrino physics, the activity and contributions to astroparticle physics, multi-messengers and cosmological surveys, the synergies with nuclear physics and the status and contribution to Particle Physics of medium- and large-size scientific Spanish infrastructures.

Executive Summary

A Energy Frontier: The LHC program and beyond

A.1 The LHC program

- The LHC program and its upgrade HL-LHC benefits from the highest investment of the Spanish resources. Therefore, we believe that the full LHC/HL-LHC operation and the exploitation of its physics program should be the first priority of Europe for the next years.

- Many important open questions in the SM are related with Flavour Physics. B-physics should represent an important ingredient of the LHC and HL-LHC physics program. The Spanish scientific community involved in Flavour physics prioritizes the participation in the LHCb experiment over other existing options.

A.2 Beyond the LHC physics program

- The present LC proposals, conceived as a Higgs factory at 250 GeV centre-of-mass energy with potential upgrades to higher energies, are positively seen by the community. The scientific program is sound and the project technically feasible. In general, the community prioritize an e^+e^- collider extendable in energy. At this level both e^+e^- lineal collider proposals, ILC and CLIC, are supported with a preference for the ILC due to its a more mature technology and for its faster implementation.

- If the Japanese government proposes to construct and to host the ILC250, the Spanish community will be in favour of a participation in this new endeavour. A possible future contribution from

Spain to ILC250 should be negotiated in close collaboration with the rest of interested European countries, including a possible CERN participation in technology, science and logistics.

- FCC is the next ambitious CERN proposal. It is scientifically sound, and although technologically challenging it could be credible in a reasonable time scale after HL-LHC, provided a long-term schedule, including technical and financial constraints, is available as soon as reasonably possible. A strong R&D programme to develop the needed technologies for the future CERN projects is mandatory. This includes detector and accelerator R&D. The Spanish community fully supports this programme; the development of high-field superconducting magnets for either HE-LHC or FCC-hh is today our main line of activity in the area of accelerator physics and magnet development.

- The various FCC phases (e-e, h-h, e-h) currently in the program could be adjusted to the evolving technological developments and international scientific panorama. Moreover, the similar China proposal of a circular collider could have a relevant impact. Effort should be made to integrate all existing proposals in a global HEP strategy.

- For the HE-LHC and FCC-hh proposals the Spanish community understands that at this stage both projects need to develop a common technology mainly for high-field magnets. For the period of the next 4-5 years no urgent need to prioritize is felt. The results from HL-LHC may also help finding the best balance between physics potential and available resources.

- R&D in novel acceleration techniques is considered a must for the future of the field. The AWAKE program should be completed and complemented with other initiatives (plasma wakefield acceleration, muon collider, etc.). A coordinated R&D program between CERN and the individual national initiatives should be consolidated in a timely manner.

B Neutrinos in accelerators

- A solid neutrino oscillation physics program is being established at Fermilab for the construction and operation of the DUNE long-baseline neutrino experiment with a strong involvement of the European neutrino physics community, in which CERN plays a central role. The neutrino national community considers of high priority for the next years to support and enhance the Spanish participation in this program.

C Beyond Colliders: Astroparticle physics, Multi-messengers, Cosmological Surveys

- The Spanish community is aligned with the update on long-term strategies put forward by the Astroparticle Physics European Consortium (APPEC) at the beginning of 2018. We endorse the societal, organizational and scientific recommendations issued for the period 2018-2026.

- In the multi-messenger era, the study of the Universe through gamma rays, neutrinos, cosmic-rays and gravitational waves is taking a paramount role in its understanding. We support a larger involvement of CERN in future Astroparticle Physics endeavors through a sharing of the technological know-how, infrastructures and human resources. We encourage the development of coordinated actions in areas of common interest like theory, R&D for new detector technologies, open data, education and outreach.

- At the national level, we stress the importance of coordinating the efforts of the Spanish groups, and the interest to guarantee a continuous and adequate support to the big infrastructures installed in our country (i.e., Canfranc Underground Laboratory, Observatory of El Roque de los Muchachos) and their contribution to the European particle physics program.
  To secure the contribution of the Spanish community, we recommend to set a coherent program of funding such that our community can contribute to the construction of future large-scale experiments; as well as to foster the rich program of measurements and detector R&D to study dark matter, axions and the nature of neutrinos and their masses, as well as the participation in the current and forthcoming cosmological surveys.

In particular, the Spanish contribution to axion physics is highly visible and the community is committed to the intensive research program planned to be hosted at DESY.

D Nuclear Physics

- The Spanish Nuclear Physics community plays an important role in advanced research at the European and World scales. The main goals are in line with those defined by the recent Long Range Plan drawn up in 2017 by NuPECC.

- We endorse the strong recommendation by NUPECC to complete and exploit the ESFRI flagship facility FAIR, including the science pillar devoted to Nuclear Structure, Astrophysics and Reactions (NUSTAR), where the Spanish experimental nuclear physics community is strongly involved.

- We encourage the Spanish research groups to keep their prominent role in the CERN nuclear physics facilities, ISOLDE and n_TOF, and recommend upgrading these infrastructures to take full advantage of the CERN LHC injector upgrades.

- The strong synergies between nuclear and particle physics should be exploited, both inside and outside CERN. They are mainly related to accelerator facilities and advanced instrumentation, neutrino physics, astrophysics and applications.

- The research topics addressed by Spanish groups include experimental research, theoretical activities and applications. Concerted efforts with other countries are co-ordinated within European-wide integrating activities. It is of the utmost importance to guarantee an adequate support to allow Spain maintaining its relevant position in the field.

E Theoretical Physics

- Spain has a large HEP community, which is strongly involved in providing theoretical predictions for current LHC precision measurements and searches. This concerns higher-order corrections for SM processes (e.g. Higgs and top) as well as for BSM physics (Higgs, SUSY, new gauge bosons, vector-like fermions, etc.), flavour phenomenology of quark and leptons, magnetic monopoles, and heavy ion physics (PbPb and pPb). Furthermore, the Spanish theory community takes a vital role in the planning and the evaluation of the physics potential of future facilities, in particular the ILC/CLIC/FCC-ee and HL/HE-LHC. High experimental precision anticipated for future e^+e^- machines can only be fully exploited if it is matched with theory predictions at the same level of accuracy (or better).

- The theoretical community is also searching for new hints on the physics BSM coming from astrophysical observations that at present provide compelling evidence of new physics such as dark matter. The activity on this field is closely related with that of the astroparticle and cosmology communities.

- There is also a strong effort in trying to understand what is the fundamental theory underlying the SM and its unification with gravity. These efforts may also give us hints on what physics BSM to search for at future colliders. The strategy for the future is to continue supporting all these combined efforts that will ensure that the Spanish theory community, also in the future, will hold its strong involvement in the discovery of BSM physics.

1 The Energy Frontier: collider-based physics

This section addresses the LHC program, flavour physics, and future facilities. The above prioritization and recommendations are explained in the context of the Spanish contributions to this endeavour.

The main goal of particle physics is to identify the fundamental laws and basic constituents of nature and to use this knowledge for studying the intricate connections between the physics at the smallest scales and the development and characteristics of our universe. The collider-based experiments represent nowadays the main experimental tool to study the smallest accessible scales in the range of 10^{-18} m and below.

With the discovery of the Higgs boson in 2012, Particle Physics has entered a new era. The Higgs boson could be the closing piece of the Standard Model (SM), but more likely it opens up the door to physics beyond the Standard Model (BSM), that is known to exist. Consequently, it is of utmost importance to learn as much as possible about the Higgs boson, its interaction to SM particles and to (so far undiscovered) particles beyond the SM.

Spanish HEP groups have made substantial contributions to the LHC experiments since their conceptual phase, participating in the R&D activities for the development of the experimental techniques, to the design studies and taking important responsibilities in the construction, installation, commissioning and operation of the detectors, as well as in the data preparation and data analysis, in many physics areas. The participation in the LHC project is also well aligned with the Spanish membership of CERN and will help to maximize the scientific, technological and industrial returns.

The extension of the physics program beyond the LHC will require the construction of a new generation of colliders and the development of new cutting edge detectors, using much improved detector technologies than those existing at present. In Spain, starting in the mid 2000's, a continuous effort has been made in this direction by the Spanish Network for Future Colliders, including experimental groups, technological centres and departments, accelerator groups and theoretical groups.

On Accelerator Technology**,** during the past 20 years there has been a significant activity in Spain for developing and constructing accelerator components as contributions to major International Projects and Facilities like LHC, HL-LHC, CLIC and its test facility CTF3 at CERN, ILC and its test facility ATF2 in KEK, XFEL at DESY, FAIR at GSI, IFIMIF and others; and even for a complete accelerator complex as the Spanish Synchrotron Radiation Source, ALBA-CELLS in Barcelona.

In the short term, LHC will continue operation in Run 3 in 2021, with already twice the design instantaneous luminosity and possibly an increase in the energy of the collisions to 14 TeV. In the medium term, the already approved high-luminosity phase (HL-LHC), which is expected to start by 2026-2027, will bring a major increase in the luminosity, aiming to collect 3000-4000 fb^{-1} of data at 14 TeV by ATLAS and CMS, and 50 fb^{-1} by LHCb. The physics program includes more precise measurements of the Higgs boson properties, SM parameters, physics of the flavour sector of the SM, as well as direct searches for new phenomena. The expected improvements at the LHC and the HL-LHC in both, precision measurements and searches for BSM physics are significant and will improve our knowledge of nature substantially.

Recently, several observables in the flavour sector of the SM have shown anomalies concerning heavy quarks, which can be pointing to BSM physics. The LHCb experiment, which will be upgraded in the coming years to be operative during Run 3, and the Belle-II experiment at SuperKEKB, which is at present starting to take data, are of high interest to confirm or refute those possible hints of new physics. The Spanish groups are strongly committed to the LHCb upgrade detector (tracking system and calorimeter) and to the data physics exploitation.

Progress in the field of high-energy physics has come in the past from the combination of experiments at hadron colliders, as powerful discovery machines, and high precision measurements in high-luminosity e^+e^- colliders. For the latter, several proposals are currently discussed: the linear colliders ILC (with the most mature design, starting with a center-of-mass energy of 250 GeV) and CLIC (starting at 380 GeV), as

well as circular machines with about 100 km circumference, the FCC-ee (going up to 365 GeV) and the CepC (going up to 240 GeV), which can operate at a very high luminosity.

The International Linear Collider (ILC) with center-of-mass energies between 250 GeV and 1000 GeV has a mature technical design that is ready for construction. The Compact Linear Collider (CLIC) project may open the possibility of multi-TeV e^+e^- collisions. While the CLIC design is somewhat less mature than that of the ILC, the low-energy stage forms a realistic and affordable option for the period following the LHC. Both ILC and CLIC would be a Higgs boson factory where the clean operating environment, low backgrounds, adjustable beam energies and polarizations will allow model-independent measurements of the Higgs-boson absolute couplings to SM fermions and gauge bosons, most of them to better than 1% precision. They could be also precision top-quark factories. The adjustable beam energy and clean operating environment will allow determining the top quark mass to a precision of 50 MeV or better. Also they will be able to produce new BSM particles up to half its centre-of-mass energy, and sensitive to new force particles Z' with masses ranging up to 7-12 TeV.

The ILC250 with its high luminosity and the possibility to polarize both beams offers the opportunity to measure with high precision the couplings of the Higgs and gauge bosons. This will allow discriminating between the SM and many different BSM models, e.g. through exotic/invisible Higgs decays. Going to lower energies, high-precision measurements of SM processes can be performed (GigaZ, WW threshold), offering a high potential for the indirect discovery of BSM physics. Extended to higher energies the ILC will give access to the top-quark properties and in particular to the Higgs self-coupling.

Going beyond HL-LHC, the way to higher energies in pp colliders has to be paved. We support on-going R&D efforts that would allow the construction of very high-energy pp colliders, such as the HE (High Energy)-LHC (foreseen to reach 27 TeV using the current LHC tunnel, which can be seen as an intermediate step in the road towards higher energies) or the FCC (Future Circular Collider)-hh (foreseen to reach 100 TeV center-of-mass energy in a 100 km circular collider).

In order to face the experimental challenges that HL-LHC (and future colliders) will impose on the detectors, a major upgrade (and R&D) of their equipment is required. The aim is to cope with the extremely high HL-LHC instantaneous and integrated luminosity, along with the associated radiation levels. There will be major upgrades in tracking detectors, electronics of the calorimeter and muon systems, as well as improved triggers and data acquisition systems. The experiments and their physics potential will benefit of extensions to larger pseudorapidity, particularly in tracking and muon systems. Depending on the upgrade schedule of the individual experiments, some of these activities already took place during the first Long Shutdown period (2013-2014) of the LHC or during the end-of-year maintenance periods. In any case, the bulk of the work is still to be done during the Long Shutdown periods LS2 (2019-2020) and LS3 (2023-2024). The Spanish LHC groups are participating in detector upgrade activities in ATLAS, CMS and LHCb experiments since day one. The community is strongly committed to the project and a substantial fraction of their human and financial resources is already dedicated to it.

Our contribution to LHC and HL-LHC detectors has been based on an extensive R&D program. On detectors for future colliders, the central R&D activity of the Spanish groups is related to two aspects. On one side in the tracking systems, pixel and strip semi-conductor detectors, with excellent space-point resolution in systems of extremely low mass and low power consumption. The activity focuses on the sensor performance and quality tests, module assembly, connectivity, powering, system engineering, alignment and data extraction. On the other, in highly segmented calorimetry inside the CALICE Collaboration, the mechanics of the semidigital hadron calorimeter and its final detector interface readout electronics are the challenges.

Computing activities for HEP are crucial in the next years to cope with the HL-LHC data processing requirements. Spanish ATLAS, CMS and LHCb Tier-1 and Tier-2 infrastructures will need 20 times more resources for HL-LHC with respect to current ones, being storage the main challenge to address. The Spanish LHC computing community is establishing the main guidelines for the next years, moving towards common implementations: Integrated High Performance Computing, Grid resources and increasing network bandwidth. The investment in computing resources is a strategic point towards the successful exploitation of the LHC and future colliders' data.

From the theory side, the Spanish HEP community is strongly involved in providing theory predictions for current precision measurements and searches of the LHC experiments. This concerns higher-order corrections for SM processes (e.g. Higgs and top) as well as for BSM physics (Higgs, SUSY, new gauge bosons, vector-like fermions, etc.), flavour phenomenology concerning quark and leptons, magnetic monopoles, and heavy ion physics (PbPb and pPb). Furthermore, the Spanish theory community takes a vital role in the planning and the evaluation of the physics potential of future facilities, in particular the ILC/CLIC/FCC-ee and HL/HE-LHC. High experimental precision anticipated for future e^+e^- machines can only be fully exploited if it is matched with theory predictions at the same level of accuracy (or better). There is also a strong effort in the Spanish HEP theory community in trying to understand what is the fundamental theory underlying the SM and its unification with gravity. These efforts may also give us hints on what physics BSM to search for at future colliders. All these combined efforts will ensure that the Spanish theory community, also in the future, will continue its strong involvement in the on-going efforts to discover BSM physics.

The ranking of priorities established by the community are as follows:

- The full LHC/HL-LHC operation and the exploitation of its physics programme are fully supported. Further steps of the community towards a future new collider need to be compatible with the planned LHC activities.

- Given the latest LHC physics results and those of the field, it is generally agreed the need of an e^+e^- collider extendable in energy to access the top-quark properties and in particular the Higgs self-couplings.

- Between the two present Linear Collider projects, ILC and CLIC, the ILC is the most mature and affordable project worldwide. Having more labs in addition to CERN distributed in other regions and having central roles in the development of collider high energy physics is noticed as a positive feature to strength our field. The present ILC proposal, conceived as a Higgs factory at 250 GeV centre-of-mass energy with potential upgrades to higher energies, is the preferred option (ILC250). If the Japanese government proposes to construct and to host the ILC250, the Spanish community will be in favour of a participation in this new endeavour. A possible future contribution from Spain to ILC250 should be negotiated in close collaboration with the rest of interested European countries, including a possible CERN participation in technology, science and logistics.

- A strong R&D programme to develop the needed technologies for the future CERN projects following LHC is mandatory and fully supported by the Spanish community. This includes detector and accelerator R&D. In the case of Spain accelerator R&D, the development of high-field superconducting magnets for either HE-LHC or FCC-hh is our main line of activity in the area of accelerator physics and magnet development.

- On the physics front, a priori the FCC-hh collider, if affordable, is more attractive than the HE-LHC. However, to better understand the time scale, physics goals and technical issues further studies must be envisaged.

2 Neutrino Physics in Accelerators

Neutrino oscillation experiments led to the historical discovery of neutrino mass through flavour oscillations, but they will continue to provide answers to key questions in particle physics (CP violation in the lepton sector, mass hierarchy, sterile neutrinos, violation of unitarity of the neutrino mixing matrix, etc.). In addition, deep underground detectors offer powerful physics synergies with e.g. proton decay searches, detection of geophysical, solar, atmospheric and supernova neutrinos.

The Spanish community, both experimental and theorerical, is actively working in accelerator and reactor-based neutrino oscillation physics for more than 20 years, providing very relevant results to improve our

understanding of neutrino properties. In the experimental side, currently, the neutrino comunity is involved in the T2K long-baseline experiment in Japan and is participating in the Double Chooz reactor neutrino experiment in France.

The CERN Neutrino Platform was created following the recommendations by the 2013 European Strategy for Particle Physics. This is CERN undertaking to foster and contribute to fundamental research in neutrino physics at particle accelerators worldwide. It includes the provision of a facility at CERN to allow the global community of experts to develop and prototype the next generation of neutrino detectors and, therefore, is CERN's main contribution to a globally coordinated programme of neutrino research. The Spanish groups supported this initiative, participated since the beginning and have leading roles in the R&D program. They are nowadays heavily involved in the R&D program at the CERN Neutrino Platform, developing liquid argon TPC detectors and new near detector concepts for the upcoming long-baseline neutrino experiments. In particular, they participate in the protoDUNE liquid argon TPC prototypes (NP02 and NP04 CERN experiments) for the Deep Underground Neutrino Experiment (DUNE) and in the near detector developments for T2K-II. The work done for protoDUNE, will be directly applied to the design and construction of the DUNE far detectors. With the aim of maximizing its scientific impact, the Spanish community is developing a common strategy for a coherent and coordinated participation in DUNE.

DUNE is considered the most advanced project to serve as future flagship experiment that will answer the questions of the CP violation and mass hierarchy within one decade of data taking. The US Department of Energy (DOE) formally approved in 2016 plans for construction of the first two (out of four) large underground caverns at the Sanford Underground Research Facility for DUNE and excavation started in July 2017. DOE also approved in July 2018 Fermi National Accelerator Laboratory to proceed with its design of PIP-II, an accelerator upgrade project that will provide increased beam power to generate an unprecedented stream of neutrinos. CERN is currently working on the first of four cryostats for the DUNE detectors based on new technology and plays a central role in the development of the DUNE cryogenic facility and infrastructure. Several European countries (UK, France, Switzerland and Italy) have signed Cooperative Research and Development Agreements with Fermilab and/or DOE for their contribution to the Neutrino Program.

A solid neutrino oscillation physics program is being established at Fermilab for the construction and operation of the DUNE long-baseline neutrino experiment with a strong involvement of the European neutrino physics community, in which CERN plays a central role. This programme also represents the highest priority of the Spanish neutrino community for the next years.

3 Astroparticle physics, Multi-messengers, and Cosmological Surveys

The act of observing the phenomena occurring in the Universe, in a coordinated way with "messengers" of different nature, has brought Astroparticle Physics to a new era. Thanks to the combination of state-of-the-art detection techniques, innovative analysis and calibration tools, Astroparticle Physics has experienced a rapid development that is shedding new light on the way we understand the most violent phenomena of the Universe, its dark side, the Physics of the Big Bang and their connection to the Micro-Cosmos, represented by the study of the fundamental particles and their interactions.

The visibility and size of the Spanish community has been steadily increasing since the last update of the European Strategy for Particle Physics. Therefore, it has notably contributed to the major past and current experiments on gravitational waves, gamma rays, atmospheric and cosmic neutrinos, charged cosmic rays, dark matter, dark-energy surveys, axions and neutrinoless double beta decay. The impact of theoretical research has been outstanding too.

The Spanish community is aligned with the update on long-term strategies put forward by the Astroparticle Physics European Consortium (APPEC) at the beginning of 2018. We endorse the societal, organizational and scientific recommendations issued for the period 2018-2026. The recommendations discussed in this document follow the approach issued in the APPEC roadmap to go beyond the current framework set by the Standard Models of Particle Physics and Cosmology. We therefore group our set of recommendations on two lines of action:

- Large-scale infrastructures that provide vital inside into the Universe through the exploitation of the information provided by confirmed messengers (gravitational waves, high-energy neutrinos, gamma rays and charged cosmic rays). We support and look forward the operation of the running experiments is secured to fully exploit the scientific potential of their data. We also recommend setting a coherent program of funding such that our community can contribute to the exploitation and construction of future large-scale experiments.

- Medium-scale infrastructures to study dark matter, axions and the nature of neutrinos and their masses. We support the continuation of a rich program of measurements and detector R&D that allows the community to pursue the search to the level of discovery. We expect that, within the constraints imposed by the current funding framework, funds will be allocated to guarantee an adequate involvement of the Spanish groups on current projects and the next generation of experiments.

As reflected in the APPEC roadmap and to further strengthen the synergies with satellite missions and ground-based, we endorse projects aiming at getting new insights on our understanding of the cosmological parameters, in particular the nature of dark energy. In this regard, we support the active participation of Spanish groups in the international collaborations in charge of current and forthcoming cosmological surveys (both satellite-based and ground-based), which will provide crucial information on the dark universe and other relevant issues for particle physics, such as the absolute scale of neutrino masses.

In the era of the multi-messenger approach to the understanding of the Universe, we stress the importance of coordinating the efforts worldwide and, in particular, of the Spanish groups through networks or projects that integrate different multi-disciplinary lines of research, such that a further connected community of experimentalists and theoreticians can develop, in an efficient way, a coherent program of activities. From the technology point of view, it is important to strength the links between research institutions and the industry, now that large-scale infrastructures are being upgraded or begin their design and construction phases.

It is also key to guarantee a continuous support to the big infrastructures installed in our country (i.e., Canfranc Underground Laboratory, Observatory of El Roque de los Muchachos). The goal is to extract the maximum scientific and technological profit of the variety of experiments that are either taking data already or have been approved to run at those research infrastructures (see Addendum, for a description of existing infrastructures).

Axions are strongly motivated by theory, and are very appealing candidates for dark matter. They are recently emerging as promising portals to search for physics beyond the SM. The fact that relevant axion parameters are at reach of current and near-future technologies is increasing the interest of experimental searches. The physics case of axions has been considerably refined in recent years, and the experimental landscape has rapidly grown in size and diversity. The Spanish community enjoys a high visibility and reputation in both axion theory and experimentation, and it is actively committed to the plans of building the next generation axion helioscope, conceived to take place within the axion research program of DESY.

The most compelling clues hinting to the existence of new phenomena, not contemplated in the Standard Model for Particle Physics, come from measurements and observations done with astroparticle messengers. This has created tight and fruitful connections between the disciplines of Particle and Astroparticle Physics. This link is conspicuously displayed in the rewarding relations the astroparticle community has with CERN. In this context we strongly support a larger involvement of CERN in future Astroparticle Physics endeavors, as a complementary program of the laboratory, through a sharing of the technological know-how, infrastructures and human resources. We also encourage the development of coordinated actions in areas of common interest like theory, R&D for new detector technologies, open data, education and outreach.