The past decades have witnessed the success of the Standard Model (SM) in describing particle phenomena: other than the discovery of the Higgs boson, numerous predictions and relations between observables have strengthened the SM description of strong and electroweak interactions, and its intrinsic mechanism of spontaneous symmetry breaking. Nevertheless, new physics (NP) beyond the SM is clearly needed, to address neutrino mass generation, explain the observed baryon asymmetry of the Universe, and account for a dark matter (DM) candidate, as well as several theoretical shortcomings including the origin of the electroweak (EW) symmetry breaking or the hierarchy problem. Other than punctual tensions between observation and expectation, no NP has so far been discovered. The path ahead is two-fold: discovery of new states, or tests of the SM (through precision and consistency).

Currently, several Higgs-boson couplings have been determined to 5-10% precision, while its mass is known to the permille level. Determining the Higgs boson self-coupling (and hence the shape of the SM scalar potential) will constitute the ultimate test of the SM's mechanism of EW symmetry breaking, further shedding light on the stability of the vacuum, and to the possible presence of NP. Precise determinations of scalar couplings to other fields (and relations between self-couplings) are also sensitive probes to extended scalar sectors, which are a feature of many well-motivated NP models (multi-Higgs doublet models, CP violation, compositeness, supersymmetry...). The full exploitation of the HL-LHC data should allow for a determination of g_{HHH} with an accuracy better than 50%. Any indirect sensitivity to g_{HHH} is not only limited by the statistical and systematic experimental uncertainties on the observables, but also by the available precision on other SM EW and strong parameters, and finally by theoretical uncertainties. Historically, EW precision tests have played an instrumental role in constructing and testing the SM. The HL-LHC is expected to improve upon many EW precision measurements (and carry out new ones). Other than indirectly suggesting the presence of NP (and possibly its scale), precision measurements at the Z-pole and at the WW-threshold are critical to our capacity to precisely determine Higgs and EW couplings. In view of its uniquely large couplings to the Higgs, precise determinations of the top quark mass, couplings and production cross sections constitute additional tests of the EWSB mechanism, with the potential to reveal new deviations.

The HL-LHC will be the last high-energy hadron collider for several decades, and the only means of searching for heavy NP states in the near future. Exploiting its full physics potential, through the realisation of the planned detector upgrades – Higgs-boson properties, top-quark physics, QCD and EW studies, BSM searches (including DM and long-lived particles) – is of the utmost importance. The full exploitation of the (HL-)LHC legacy requires ensuring that the data (and results) are preserved, and can be (re)used and (re)interpreted by the whole community. Effort should be put in enforcing systematic guidelines allowing to do so, and in ensuring that publicly released material should follow the FAIR principles (Findable, Accessible, Interoperable, and Reusable data and data products).

The GT1 has focused most of its attention on the need for precise measurements of the Higgs boson properties and couplings as recommended by the 2020 iteration of the European strategy. In addition, the community acknowledges the importance of the studies of the top quark (especially its mass). With this in mind, the following facilities have been considered based on their R&D and design maturity: the FCC-ee project which is a 91 km-long e+e- collider, an e+e- linear collider facility (LCF) à la CLIC or ILC, both of which could be hosted at CERN. With such machines, the precision on the Higgs boson couplings can be typically improved by a factor 10 compared to the ones which will be obtained at the HL-LHC. The FCC-ee provides larger statistics compared to a LCF (typically a factor 5-10) thanks to a higher luminosity and multiple interaction points which can operate at the same time. The energy in the center of mass ranges from 90 GeV to 365 GeV, *i.e.* from the Z-pole to the ttbar threshold which allows for a theoretically clean measurement of the top quark mass. With data collected at $\sqrt{s}$ = 125 GeV, it could probe the electron Yukawa coupling. In addition, on a longer term, such a tunnel could host a high energy proton-proton collider (at 100 TeV). An LCF presents the advantage of being able to probe energies up to 500-1000 GeV (with an upgraded version) which allows to directly produce HH and hence measure the Higgs-boson trilinear coupling. The possibility of doing high precision Higgs boson measurements (especially probing the trilinear coupling) with a high energy proton-proton collider has also been evoked even with a relatively low energy machine (27 TeV) with a precision comparable to an LCF. The community also acknowledges the importance of an e-p collider program to ensure the success of a potential high energy proton-proton program. The importance of building the next machine at CERN in a timely fashion was stressed, in order to maintain the expertise and attractiveness of the field for future physicists.

In addition to the short-term need for a Higgs factory, the community agrees upon the necessity to engage on longer term developments. It has been stressed that a muon collider able to reach a center-of-mass energy of several TeVs is one of the most promising projects with a physics scope ranging from the Higgs boson precision measurements to probing the longitudinal vector boson scattering and the potential to explore new energy scales and the possibility of BSM discoveries. All the limitations for such a project are technical, one of the dominant ones being muon cooling. Its community is now organised within the international muon collider collaboration, with a growing participation from French groups. Other interesting R&D on collider projects have been mentioned like plasma acceleration (*e.g.* AWAKE), which would offer small sized accelerators with impact from particle physics to societal applications.

Physics studies and detector design form a virtuous circle: while the studies assessing the physics potential of future experiments inform the optimization of the detector design, detailed detector simulations help in getting more realistic expected performances. The French community is involved in many studies for the FCC-ee, spanning from precise determinations of the Higgs-boson properties to the searches for axion-like particles or light composite scalars (hinting at Higgs compositeness), also addressing ways of measuring the strong coupling constant with the Lund jet plane, or how to more precisely determine some of the top quark properties. Extensive preparatory work has also gone into new detector concepts, starting with those for an ILC, such as the ILD, to which the French community significantly contributed, notably through R&D work on the calorimetry, vertex detector or tracking with a TPC. The expertise of the community in calorimetry, tracking and vertexing detectors, and associated high-flux electronics is employed in R&D for the FCC-ee: for example calorimeters based on LAr, SiW, or a novel crystal-grain structure, ToF tracking layers to extend PID at low momenta, or a demonstrator for CMOS pixel sensors connected in a snail shape which would allow to reduce the material budget.

The volume of data is continually increasing, already reaching the exascale. The increased detector granularity and timing precision, and the larger samples of real and simulated data will only push this more. This is reflected in terms of the storage size needed to host the data to be made accessible, and in terms of increased computing needs with an increased reliance on heterogeneous resources. It not only poses the problem of component costs, which need constant renewal, but also of their energy use. Software optimization, also needed to make the best use of new processor technologies and increased parallelization, is a key component, already shown to be effective at the LHC. The use of ML/AI also increased significantly in the last years, becoming a high-impact field boosting the performances in data acquisition, object reconstruction, data processing, detector simulation, and final analysis which can use supervised or unsupervised approaches. The necessary computational resources, person power (with recognised career paths) and a comprehensive training offer in software and computing would benefit from a multidisciplinary approach and should be fully supported as these are crucial to the success of the physics programme.

The environmental footprint of any future high-energy collider must be addressed in both feasibility studies and decision-making processes. The HEP community should strive to lead by example, assessing the impact of current and future projects, and putting a clear effort into the reduction of their environmental impact. This starts with the infrastructure itself: proper use of excavated material must be ensured, and developments in industry should be fostered to render available lower-carbon concrete (ultimately the negative impact "carbicrete"), which would also translate into a positive impact for society. The construction of surface buildings can also rely on ecological materials and the experimental sites could be planned to include a biodiversity preservation aspect. Concerning accelerators and detectors, the problems of cryogeny and cooling can be mitigated: acceleration-wise, via the inclusion of energy recovery linac and the replacement of conventional superconducting RF technology (operating at 2K) by a new one operating at 4K; reduction of power consumption of detectors, and replacement of (currently) used gases HFCs, PFCs and SF6, further envisaging entirely banning the usage of high GWP gases for cooling or particle detection/identification in future facilities. The expected amounts of data also will lead to GPU/CPU cooling issues. In general, life cycle assessments must be carried out, and collaboration's activities should be optimised to reduce their environmental and computational impact. The development of more compact, sustainable future accelerators (as mentioned above) should be strongly encouraged, with intensive R&D efforts starting as soon as possible.

Dark matter searches looking for either WIMPs (with experiments such as DarkSide or XENON) or axions such as MADMAX should also continue to be vigorously pursued, as they offer unique opportunities to address open questions about the nature of matter. With the growing size of these experiments, it could become interesting to create a new European network to foster the collaboration of the involved institutions on technical, scientific, organisational and funding aspects. The effort towards precision measurements can be complemented by non-collider approaches such as the measurements of $\sin^2\theta_W$ at different energy scales, or (new) experimental setups to achieve relative uncertainty on αQED at the level of 10^{-11}. Among these, PAX opens a new avenue for strong-field QED tests with exotic atoms, and for high-precision QED theory tests using accurate spectroscopy of highly-charged ions. Societal applications such as biomedical imaging should also continue to be supported.

Executive summary

Given the peculiar nature of the Higgs boson and its role in the SM, this particle deserves a thorough study of its couplings and properties. The FCC-ee, thanks to its high integrated luminosity delivered in a short amount of time, appears to be the ideal machine to achieve this goal. It provides in addition a large amount of data at the Z pole ($O(10^{12})$ bosons) allowing for a large variety of stringent electroweak tests of the SM, possibly paving the way to a future hadron collider. If such an ambitious project is not deemed feasible, a LCF at CERN (operating up to at least 500 GeV) is a noteworthy alternative approach, its high energy program (directly addressing the Higgs boson trilinear coupling) making it a complementary machine to any other potential circular collider project with a center of mass energy below 365 GeV. The community also stresses the importance of a sustained R&D on both colliders and detectors, recognising the broad and promising physics case of a muon collider, covering both precision and Higgs-boson physics, and its potential for the discovery of high energy resonances.