A View on the European Strategy for Particle Physics

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Abstract Worldwide, the particle physics and accelerator community is very actively working towards the next major facility. Based on the designs and performance of linear and circular e^+e^- colliders in the 90 (Z) to 365 (above top-antitop) GeV centre-of-mass energy range, we consider a circular collider at CERN to be the most attractive option. It is also an investment in the future for a possible later stage as a 100 TeV hadron collider.

A View on the European Strategy for Particle Physics

The community of particle physicists is preparing the next European Strategy. It will consider recent advances, such as the impressive success of the Standard Model and the Higgs boson discovery, but also address fundamental questions that remain open.

Exploring the "uniqueness" of the Higgs boson and placing the emerging understanding in a larger context (and new physics?) will be one key item on our to-do list. While the ongoing and planned LHC exploitation will provide considerable progress, it is generally agreed that a new facility, sometimes dubbed a "Higgs Factory", will be required for the ambitious programme of precision measurements. Currently, this is obviously the domain of an e^+e^- collider.

Linear or Circular: that is the question.

The **Linear Collider** offers the possibility to extend, in principle, the available collision energy as physics indicates, and electric power and funding allows. Longitudinal beam polarization can be exploited. It has a disadvantage: only one experiment will take data at a given time.

The circumference of a **Circular Collider** has to be chosen with some vision. Its maximum energy can be reached with a staged installation of RF-power, a significant cost driver of the machine itself. Its several interaction regions offer stimulating competition in experimental approach and physics exploitation, as well as the essential possibility to independently confirm observations.

The e^+e^- circular collider does not require the same level of extreme nanotechnology in terms of beam size and stability of beam elements as a linear collider. It can be operated as a very high luminosity vector boson (Z, W pairs) factory with well-defined beam energy, and optimized as a 240 to 365 GeV Higgs factory, with a luminosity about ten times higher than that at a linear collider (CLIC or ILC), a substantial advantage if precision is the name of the game. It also covers top physics up to 365 GeV centre-of-mass energy.

A circular collider offers a unique advantage: just as it was for LEP/LHC, it is an investment in the future. Discovery is possible in the e^+e^- mode, but

even without, conversion into a hadron collider is the next logical option – once the physics case is clarified and appropriate R&D has brought the relevant technologies to maturity. At the energy frontier of 100 TeV, more than seven times LHC and far above the electro-weak scale, discoveries can be expected. Moreover, the huge production rate of interesting objects, such as Higgs bosons and Higgs boson pairs, will open the way to key measurements, e.g. a conclusive determination of the Higgs boson self-coupling.

Non-Collider programmes are complementary in addressing some of these open questions. Worldwide, very diverse, stimulating and experimentally challenging activities are under way.

Now we address the European Strategy. The vision of the Founding Fathers of CERN, scientists and politicians, has led to more than 60 years of fruitful work at the science frontier, a marvel of European accomplishment. The accumulated expertise and the vast infrastructure are unique assets. While ensuring the success of the LHC upgrade work over the coming years, we also need to think of preparing the next 30 to 40 years. When mapping the strategy, we need to both leverage this enormous European investment and offer an exciting long-term future to the next generations.

With this in mind, we arrive at the following main conclusions:

1. Provide a plan for the timely availability of the next major facility in Europe. We have sketched the arguments as to why the most promising and rational step would be a large circular e^+e^- collider, to be followed by a proton-proton, ion-ion, e-p collider in the same tunnel, as proposed in the FCC (Future Circular Collider) study.
2. Address explicitly and forcefully the research environment of very large international collaborations extending over decades, as for the LHC. One could consider working in parallel on an energy frontier detector and on another research project. The next generation of students and young researchers deserve a stimulating and diverse education and research environment.

Plans for similarly large machines, in newly created laboratories, are also being developed in other regions, a sign of the health and attractiveness of the field. It will require wise leadership and a collaborative attitude to host such a “World Facility” at the most suitable place. CERN is uniquely positioned to be that place.

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