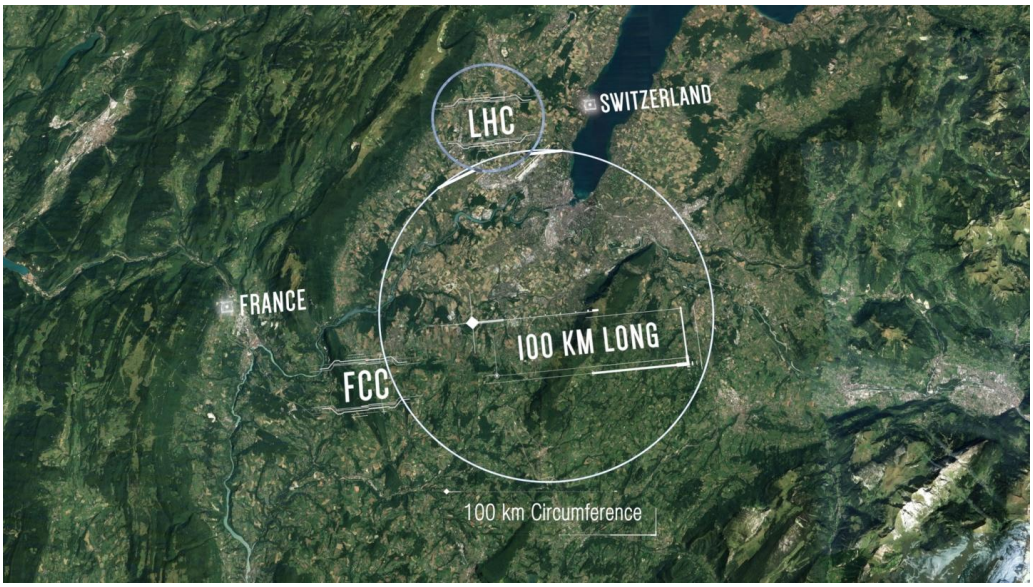
# FCC publishes concept design for a post-LHC future circular collider at CERN

FCC publie la conception d'un futur collisionneur circulaire post-LHC au CERN 15/01/2019

Today, the Future Circular Collider (FCC) collaboration submitted its Conceptual Design Report (CDR) for publication, a four-volume document that presents the different options for a large circular collider of the future. It showcases the great physics opportunities offered by machines of unprecedented energy and intensity and describes the technical challenges, cost and schedule for realization.

Over the next two years, the particle physics community will be updating the European Strategy for Particle Physics, outlining the future of the discipline beyond the horizon of the Large Hadron Collider (LHC). The roadmap for the future should, in particular, lead to crucial choices for research and developments in the coming years, ultimately with a view to building the particle accelerator that will succeed the LHC and will be able to significantly expand our knowledge of matter and the universe. The new CDR contributes to the European Strategy. The possibility of a future circular collider will be examined during the strategy process, together with the other post-LHC collider option at CERN, the CLIC linear collider.

The FCC study started in 2014 and stems directly from the previous update of the European Strategy, approved in May 2013, which recommended that design and feasibility studies be conducted in order for Europe "to be in a position to propose an ambitious post-LHC accelerator project at CERN by the time of the next Strategy update". The FCC would provide electron-positron, proton-proton and ion-ion collisions at unprecedented energies and intensities, with the possibility of electron-proton and electron-ion collisions.




*"The FCC conceptual design report is a remarkable accomplishment. It shows the tremendous potential of the FCC to improve our knowledge of fundamental physics and to advance many technologies with a broad impact on society",* said CERN Director-General Fabiola Gianotti. *"While presenting new, daunting challenges, the FCC would greatly benefit from CERN's expertise, accelerator complex and infrastructures, which have been developed over more than half a century."*

The discovery of the Higgs boson at the LHC opened a new path for research, as the Higgs boson could be a door into new physics. Detailed studies of its properties are therefore a priority for any future high-energy physics accelerator. The different options explored by the FCC study offer unique opportunities to study the nature of the Higgs boson. In addition, experimental evidence requires physics beyond the Standard Model to account for observations such as dark matter and the domination of matter over antimatter. The search for new physics, for which a future circular collider would have a vast discovery potential, is therefore of paramount importance to making significant progress in our understanding of the universe.

The FCC design study was a huge effort, possible only thanks to a large international collaboration. Over five years and with the strong support of the European Commission through the Horizon 2020 programme, the FCC collaboration involved more than 1300 contributors from 150 universities, research institutes and industrial partners who actively participated in the design effort and the R&D of new technologies to prepare for the sustainable deployment and efficient operation of a possible future circular collider.

*"The FCC's ultimate goal is to provide a 100-km superconducting proton accelerator ring, with an energy of up to 100 TeV, meaning an order of magnitude more powerful than the LHC",* said CERN Director for Accelerators and Technology, Frédérick Bordry. "The FCC timeline *foresees starting with an electron-positron machine, just as LEP preceded the LHC. This would enable a rich programme to benefit the particle physics community throughout the twenty-first century."*

Using new-generation high-field superconducting magnets, the FCC proton collider would offer a wide range of new physics opportunities. Reaching energies of 100 TeV and beyond would allow precise studies of how a Higgs particle interacts with another Higgs particle, and thorough exploration of the role of the electroweak symmetry breaking in the history of our universe. It would also allow us to access unprecedented energy scales, looking for new massive particles, with multiple opportunities for great discoveries. In addition, it would also collide heavy ions, sustaining a rich heavy-ion physics programme to study the state of matter in the early universe.

*"Proton colliders have been the tool-of-choice for generations to venture new physics at the smallest scale. A large proton collider would present a leap forward in this exploration and decisively extend the physics programme beyond results provided by the LHC and a possible electron-positron collider."* said CERN Director for Research and Computing, Eckhard Elsen.

A 90 to 365 GeV electron-positron machine with high luminosity could be a first step. Such a collider would be a very powerful "Higgs factory", making it possible to detect new, rare processes and measure the known particles with precisions never achieved before. These precise measurements would provide great sensitivity to possible tiny deviations from the Standard Model expectations, which would be a sign of new physics.

The cost of a large circular electron-positron collider would be in the 9-billion-euro range, including 5 billion euros for the civil engineering work for a 100-kilometre tunnel. This collider would serve the worldwide physics community for 15 to 20 years. The physics programme could start by 2040 at the end of the High-Luminosity LHC. The cost estimate for a superconducting proton machine that would afterwards use the same tunnel is around 15 billion euros. This machine could start operation in the late 2050s.

The complex instruments required for particle physics inspire new concepts, innovation and groundbreaking technologies, which benefit other research disciplines and eventually find their way into many applications that have a significant impact on the knowledge economy and society. A future circular collider would offer extraordinary opportunities for industry, helping to push the limits of technology further. It would also provide exceptional training for a new generation of researchers and engineers.