FCC

74 institutes

100 TeV

50 YEARS

75%

26

8 T

20 T

FCC

2035

COUNTRIES

100 km

74 institutes

90-100km tunnel

EXPERIMENTS

PHYSICS

ACCELERATORS

COLLABORATION

TECHNOLOGIES

FCC
IN NUMBERS

26 COUNTRIES

74 institutes

12 TO 15 FEBRUARY 2014

100 TeV

600 CAVITIES

100 km

COST/VALUE

74 institutes

16 T

26 COUNTRIES

600 CAVITIES

3 Different Collider Options

20 T

8 T

300 PARTICIPANTS

100 TeV

fcc.web.cern.ch

CERN

FCC hh ee he

The aim of the Future Circular Collider study (FCC) is to develop a conceptual design for a post-LHC particle accelerator infrastructure.

The Large Hadron Collider (LHC) and its High Luminosity upgrade (HL-LHC) is the world's primary machine for exploring the energy frontier up to **2035**.

Around 2025, the **LHC** will be upgraded to reach much increased luminosity. The **HL-LHC** upgrade aims at achieving higher integrated luminosities at the same energies, allowing for higher precision measurements.

Expanding our understanding of the fundamental laws of nature requires the energy and luminosity frontiers to be pushed back further. Reaching this goal within the 21st century in an economically sustainable and energy efficient way calls for a large circular collider.

In the last 50 years, circular colliders have been the primary tool for pushing the energy frontier on three continents. These colliders and their performance have been spectacularly successful, as they have allowed for a number of important discoveries about the fundamental laws that describe our Universe.

Following the discovery of the Higgs boson at the LHC, the story is just beginning to get interesting. Only 5% of the Universe is explained by the Standard Model of particle physics. What about the other 95%?

To answer these questions we need to understand in depth the structure of present theories, as well as extend the energy reach to search for possible new physics beyond the Standard Model of particle physics.

The significant lead time of approximately **30 years** for the design and construction of a large- scale accelerator calls for a coordinated effort. **The main goal** is to ensure the seamless continuation of the world's particle physics programme.

The **FCC study** takes into account 3 main different collider scenarios:

A hadron-hadron (like the LHC) **and a lepton-lepton** (like LEP) collider form the **core of the study**. A hadron (proton-proton) collider at **100 TeV** in a **100 km** long tunnel defines the overall infrastructure for the FCC study. A high-luminosity, high-precision electron-positron circular collider with centre-of-mass energies from **90 to 350 GeV** is also foreseen as a potential intermediate step, resembling in a sense the step from LEP to the LHC. The hadron and lepton machines could act complimentarily in our search for answers to the open fundamental questions and provide a robust physics programme for the next decades.

Finally, a hadron- lepton **inter-action scenario** that would revamp the long tradition of deep-inelastic scattering is examined.

The conceptual design study also includes physics studies to define the parameters that could probe new phenomena and interactions at the new energy and intensity regime, as well as the design of related detector concepts, taking into account the machine parameters.

PUSH TECHNOLOGIES!

To realize these colliders, an extensive R&D programme is ongoing in a number of different areas: *magnet design, superconductivity, cooling techniques, radiofrequency accelerator system, global computing, novel materials and processes, along with studies on reliability, construction and cost optimization.*

Reaching higher energies — an order of magnitude higher than those of the LHC — in a 90-100 km tunnel, new superconducting magnets, capable of achieving a magnetic field of **16 Tesla**, are needed. This is two times higher compared to the 8T magnets of the LHC. The study also aims to demonstrate the feasibility of building 20T magnets. The design of the magnets should meet the operation requirements.

They will be based on the use of new superconducting materials like **Nb_3Sn.**

More powerful Superconducting Radio Frequency cavities are also developed, An efficient **100 MW** radio frequency acceleration system is planned for the lepton collider, where about **600 cavities** are foreseen. The associated power conversion systems aim for conversion efficiency up to 75% from electrical plug to beam.

A highly efficient large-scale cryogenics infrastructure and the accompanying refrigeration systems, as well as new concepts for the vacuum system are considered under the study. **A future circular collider** requires large-scale distribution, recovery and storage of cryogenic fluids that would ensure its reliability and sustainable operation. This calls for the study of more efficient refrigeration cycles but also for new cryogens.

Development of novel materials and manufacturing. The unprecedented energie and intensities foreseen- put a number of challenges on accelerating, handling and monitoring the beams.

Finally, **reliability and availability** are key to the successful design of a future circular collider. They open the door to improved physics performance, as well as to the cost optimization of the operation of such an infrastructure.

The FCC is an international collaboration consisting today of more than

74 institutes from 26 countries.

The conceptual design report and an active R&D portfolio of new technologies developed in collaboration with leading research institutes and industries **will lay the foundations for the implementation of a future collider.**

By the end of 2018, the FCC study will deliver a conceptual design report, together with preliminary cost estimates and feasibility assessments.

The FCC Kickoff meeting in 2014 brought together more than 300 participants. This year's FCC Week in Rome brings together 400 participants from different fields: **scientists, engineers, industrial partners**.

The numbers reflect the growing interest in the ongoing R&D efforts and the importance of thinking about the next step in our exploration of the World.

Strategic Goals:

- **Provide a robust case for a future circular collider** that will ensure the seamless continuation of the world's scientific programme in high-energy and particle physics.

- Strengthen capacity and effectiveness in high-tech domains.

- **Establish long-term relations between research institutes, universities and industrial partners**.