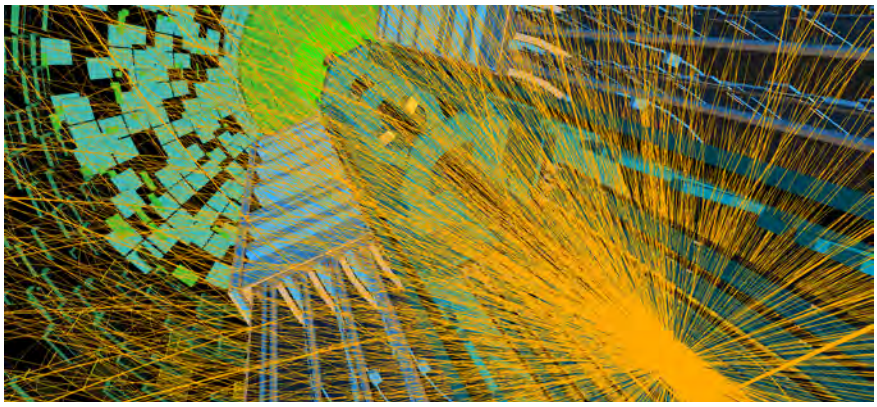
HL-LHC
High-Luminosity Large Hadron Collider

An upgrade of the highest-energy particle collider in the world for exploring new physics



Description
The Large Hadron Collider (LHC) at CERN is the highest-energy particle collider in the world. The ATLAS and CMS experiments at the LHC have provided the breakthrough discovery of the so-called Higgs boson. This discovery is the start of a major programme to measure this particle's properties with the highest possible precision for testing the validity of the Standard Model and to search for further new physics at the energy frontier. To extend its discovery potential, the LHC will be upgraded to High-Luminosity LHC (HL-LHC).

The HL-LHC will be implemented over the next decade in order to increase the data sample for ATLAS and CMS by an order of magnitude compared to the integral collected by the end of 2022. For the full development of the physics programme also the experiment's detectors require upgrade as well as the computing infrastructure that will need to handle the substantially increased data rates. The full exploitation of the LHC, including the HL-LHC, was identified as the highest priority for European particle physics, in the update of the European Strategy for Particle Physics approved by CERN Council in May 2013. This recognition has also been adapted in the National Roadmaps of countries all over the world including the USA.

Activity
The accelerator and experimental systems for the HL-LHC project will take a decade to complete. The HL-LHC accelerator relies on a number of innovative technologies including a combination of cutting-edge superconducting magnets, ultraprecise superconducting RF cavities for beam rotation, as well as high-power superconducting links with zero energy dissipation. In addition, the higher luminosity sets novel constraints on vacuum, cryogenics and machine protection, and will require new concepts for beam collimation and diagnostics to maximize the physics output of the collisions. The success of experiments at the HL-LHC relies on innovative instrumentation (radiation-hard detectors, high-granularity calorimeters, and large-area silicon trackers), state-of-the-art infrastructures and large-scale data-intensive computing.
The main physics goals are clear. The first goal is to push further the validation of the Standard Model at the energy frontier, in particular by measuring the properties of the newly discovered Higgs particle and of the longitudinal components of the massive vector bosons with the highest possible precision, and with the aim of establishing whether there are any deviations from the Standard Model predictions. The second goal is to check whether the Higgs particle is accompanied by other new particles at the TeV energy scale, which could play a role in the global picture of electroweak symmetry-breaking or in the solution of the dark matter puzzle.

Impact
The LHC is a unique international infrastructure to study the fundamental constituents of matter and their interactions. The HL-LHC is an upgrade to this already existing facility which will allow the full exploitation of its scientific potential. It defines a long-term programme for at least the next two decades until 2035. The scientific community at CERN consists of over 11.500 users from around the world, the significant majority of whom work on the LHC.
The HL-LHC and its surrounding facilities will require a constant stream of supplies and services. These include civil engineering work and the systems and equipment needed to build and operate the accelerator and the experiments. The HL-LHC will collaborate with many types of industries and businesses to pursue its goals. Knowledge and technology to be developed during the HL-LHC project will make a lasting impact on society. Many young physicists and engineers trained during the project will transfer their expertise to society and industry. The HL-LHC is for all the three aspects – accelerator, detector and computing – a major upgrade of LHC of CERN and will impact the corresponding technologies that are of quite general relevance for other research infrastructures and for the big data and computing paradigm.

TYPE: single-sited
COORDINATING ENTITY: CERN
MEMBER COUNTRIES: AT, BE, BG, CH, CZ, DE, DK, EL, ES, FI, FR, HU, IL, IT, NL, NO, PK, PL, PT, RO, RS, SE, SK, TR, UK

PARTICIPANTS: See
ACCELERATOR COLLABORATION
ATLAS COLLABORATION
CMS COLLABORATION

TIMELINE
- **ESFRI Roadmap entry:** 2016
- **Preparation phase:** 2014-2017
- **Construction phase:** 2017-2025
- **Operation start:** 2026

ESTIMATED COSTS
- **Capital value:** 1.370 M€
- **Operation:** 100 M€/year

HEADQUARTERS
CERN
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Switzerland

WEBSITE
http://home.cern/

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