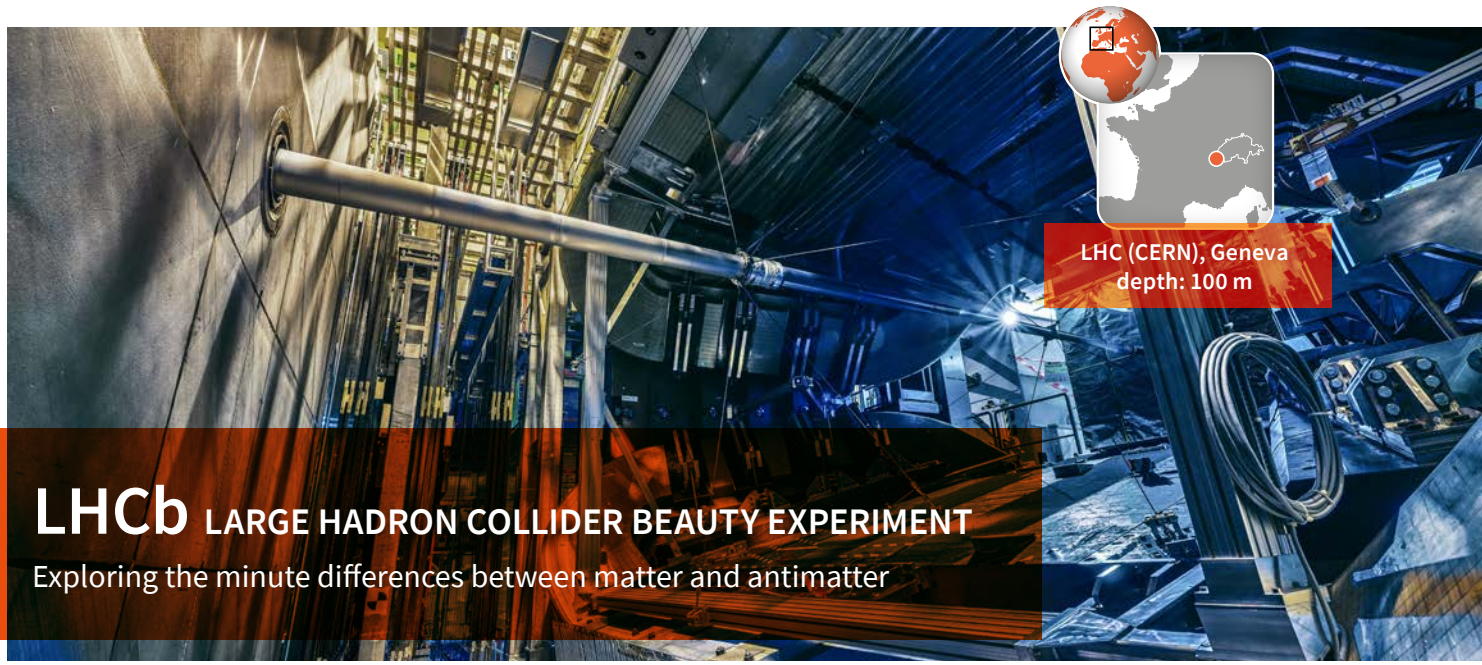
National Institute of Nuclear and Particle Physics

CP mixing and violation in the quark sector



LHCb LARGE HADRON COLLIDER BEAUTY EXPERIMENT

Exploring the minute differences between matter and antimatter

- **Scientific leader:** Renaud Le Gac (CPPM) *
- **Laboratories involved:** CC-IN2P3 (Lyon), CPPM (Marseille), IJCLab (Orsay), LAPP (Annecy), LLR (Palaiseau), LPC (Clermont-Ferrand), LPNHE (Paris)
- **Nature:** research infrastructure
- **Status:** international project in operation based in Ferney-Voltaire (France) on the CERN site. France and Switzerland are the host countries of the LHC.
- **Websites:** http://lhcb.web.cern.ch/ and http://lhc-france.fr

SCIENTIFIC OBJECTIVES

Some questions resist the very solid theoretical framework of the standard model of particle physics. These include the disappearance of antimatter in the course of the evolution of the universe, dark matter, or the hierarchy of masses and couplings of quarks. To find answers, LHCb studies with great precision the beauty and charmed hadrons through spectroscopy, their very rare decays, and their particle-antiparticle asymmetries. Since 2013, the LHCb collaboration has expanded its field of investigation by studying p-Pb and Pb-Pb forward collisions. Following a major upgrade in 2019-2021, over the next ten years the statistics will increase fivefold. An extension of the project beyond 2030 is under consideration, to gain a further factor of six.

RESOURCES DEPLOYED

The detector, installed at one of the four collision points of the LHC at CERN, is 20 m long, 10 m high, 12 m wide and weighs 5 600 tonnes. It brings together a set of detection systems deployed in front of the collision point, to optimise the detection of beauty hadrons. The trajectography system is located next to the collision point to reconstruct the trajectories of the charged particles, and the particle identification system is composed of a succession of three types of detectors.

89 laboratories

15 years of design

18 participating countries

30 years of operation

1 461 scientists

123 million euros (total cost)

IN2P3 CONTRIBUTIONS

- Front-end and mechanical electronics for the calorimeters and for the stack detector.
- A first-level triggering system that reduces the number of collisions from 40 to 1 million per second and searches for large transverse momentum electrons, muons and photons in less than a microsecond for each collision.
- In the second data collection, which starts in 2022, the detectors is equipped for: reconstruction and filtering of all collisions in real time at 40 Tb/s, the development of very high-speed acquisition cards, information processing on heterogeneous computing architectures (CPU + GPU); the PLUME luminometer.
- DIRAC software package for distributing collision reconstruction and simulation on the WLCG computing grid.

1998 Approval of the LHCb project

2010 First data collection

2015 The LHC ramps up to 13 TeV

2019 Discovery of a new pentaquark

2019-2021 Major detector upgrades

2021-2030 2nd data capture (luminosity x5)

* Since 2013

April 2022