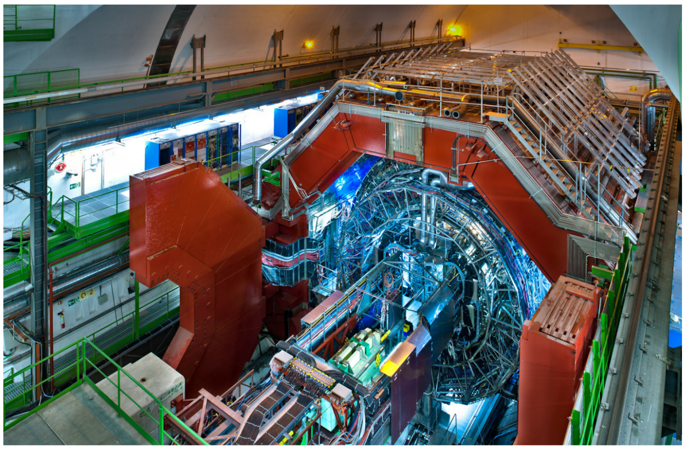
LHC Season 2: Major work at the experiments for Run 2



ALICE: A LARGE ION COLLIDER EXPERIMENT

WHAT IS ALICE?

The heavy-ion detector ALICE studies the quark-gluon plasma, a phase of matter that formed just after the Big Bang and that gave rise to the particles that make up the matter in the universe today. A droplet of this primordial matter is produced when very high-energy lead nuclei collide at the LHC.

ALICE IN FIGURES

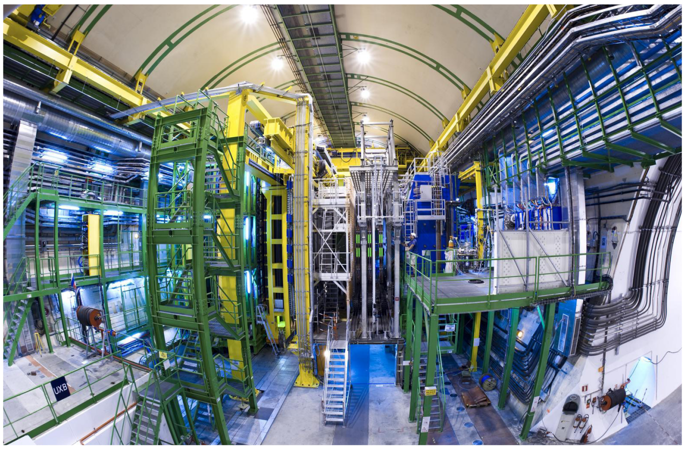
- The detector: 10,000 tonnes, 26 metres long, 16 metres high, 16 metres wide
- The collaboration: 1500 members from 154 institutes in 37 countries

LONG SHUTDOWN 1

Many hundreds of members of the ALICE collaboration worked together to improve the detector. Among the consolidation and improvements to its 19 subdetectors, they installed a new calorimeter (DCAL) extending the range covered by the electromagnetic calorimeter (EMCAL). The EMCAL now covers a wider angle, allowing the measurement of the energy of the photons and electrons over a larger area. The TRD (Transition Radiation Detector) that detects particle tracks and identifies electrons has also been completed with the addition of 5 more modules.

PHYSICS AT 13 TEV

During Run 2, the ALICE collaboration will further explore the properties of quark-gluon plasma. The higher collision energy will lead to more high-energy particles interacting with this hot medium. With more collisions, ALICE will see an increase in statistics that will allow more detailed measurements.



LHCB: LARGE HADRON COLLIDER BEAUTY

WHAT IS LHCB?

The LHCb experiment investigates the slight differences between properties of matter and antimatter by studying a type of particle containing the “beauty quark” (or “b quark”). Analysing rare beauty particle decays allows LHCb to investigate a possible manifestation of new physics effects.

LHCB IN FIGURES

- The detector: 5600 tonnes, 21 metres long, 11 metres high, 13 metres wide
- The collaboration: 1128 members from 68 institutes in 16 countries

LONG SHUTDOWN 1

To make the most of the high-energy collisions, the LHCb collaboration improved its detector and facilities. They installed the new HeRSCheL detector to distinguish rare processes in which particles are observed in the detector but not along the beampipe. One section of the beryllium beam pipe was replaced. In addition the new beam pipe support structure is now much lighter.

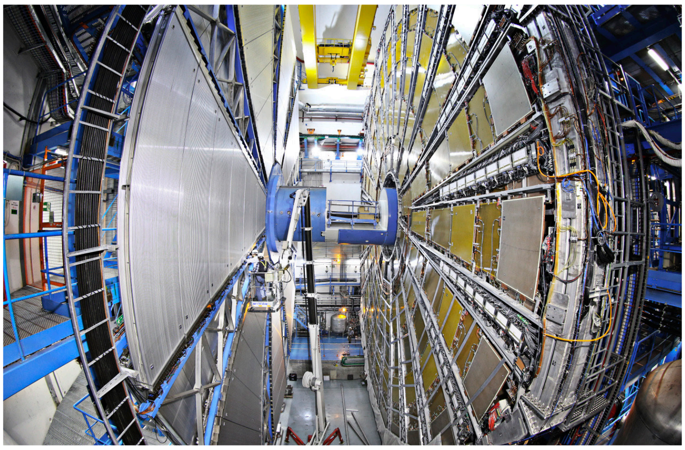
PHYSICS AT 13TEV

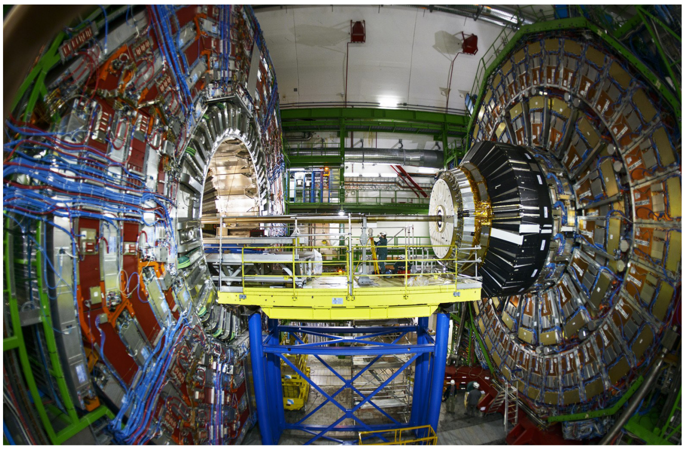
LHCb published many results based on data collected during the Large Hadron Collider’s first three-year run. But this was only a beginning. Collisions at 13 TeV will double the production rates of beauty hadrons enabling LHCb to get even more precise, interesting and hopefully surprising results.

ATLAS: A TOROIDAL LHC APPARATUS / CMS: COMPACT MUON SOLENOID

WHAT IS ATLAS? WHAT IS CMS?

The ATLAS and CMS detectors have a broad physics programme including investigating the recently discovered Higgs Boson, searching for extra dimensions and particles that could make up dark matter, as well as continuing systematic studies of the Standard Model.





ATLAS IN FIGURES

- The detector: 7000 tonnes, 46 metres long, 25 metres high, 25 metres wide
- The collaboration: 3000 members from 174 institutes in 38 countries

LONG SHUTDOWN 1

In Run 2 the number of collisions per beam crossing will increase. The ATLAS pixel detector was improved with the insertion of a fourth and innermost layer that will provide the experiment with better vertex identification, essential to distinguish interesting collisions. The collaboration also used the shutdown to improve the general ATLAS infrastructure, including electrical power, cryogenic and cooling systems. The gas system of the TRT, which contributes to the identification of electrons as well as track reconstruction, was modified significantly to minimise losses. New chambers were added in the muon spectrometer and the calorimeter readout consolidated. The forward detectors were upgraded to provide a better measurement of the LHC luminosity, and a new aluminium beam pipe was installed to reduce the background. Another challenge is the increased collision rate. The whole detector readout system was improved to be able to run at 100 KHz and all data acquisition software and monitoring applications were re-engineered. The trigger system was redesigned, going from 3 levels to 2 while implementing smarter and faster selection algorithms. The time needed to reconstruct ATLAS events also needed to be reduced, even with more activity in the detector. A very ambitious upgrade of simulation, reconstruction and analysis software was completed, and a new generation of data management tools on the GRID was implemented.

CMS IN FIGURES

- The detector: 14000 tonnes, 21 metres long, 15 metres high, 15 metres wide
- The collaboration: Over 3000 scientists engineers and students from 185 institutes in 42 countries

LONG SHUTDOWN 1

The biggest priority was to mitigate the effects of radiation on the performance of the Tracker, by equipping it to operate at low temperatures (down to -20°C). This required changes to the cooling plant, and extensive work on the environment control of detector and cooling distribution to prevent condensation or icing. The central beam-pipe was replaced by a narrower one in preparation for the installation in 2016-‘17 of a new Pixel Tracker that will better measure the momenta and points of origin of charged particles. A fourth measuring station was added to each muon endcap, in order to maintain discrimination between low-momentum muons and background as the LHC beam intensities increase. Complementary to this was the installation at each end of the detector of a 125-tonne composite shielding wall to reduce neutron backgrounds. A luminosity-measuring device, the Pixel Luminosity Telescope, was installed on either side of the collision point around the beam-pipe. Other major activities included replacing photo-detectors in the hadron calorimeter with better-performing designs, moving the muon readout to more accessible locations for maintenance, installation of the first stage of a new hardware triggering system and consolidation of the solenoid’s magnet cryogenic system and of the power distribution. The software and computing systems underwent a significant overhaul during the shutdown to reduce the time needed to produce analysis datasets.

ATLAS & CMS: PHYSICS AT 13TEV

The second run of the LHC will allow ATLAS and CMS physicists to extend the search for physics beyond the Standard Model. The increase in energy opens up unexplored regions for the production of high-mass new particles. Standard Model physics studies, in particular in the Higgs sector, will largely profit from the increased rate of collisions that will allow the physicists to improve the precision of the measurements.