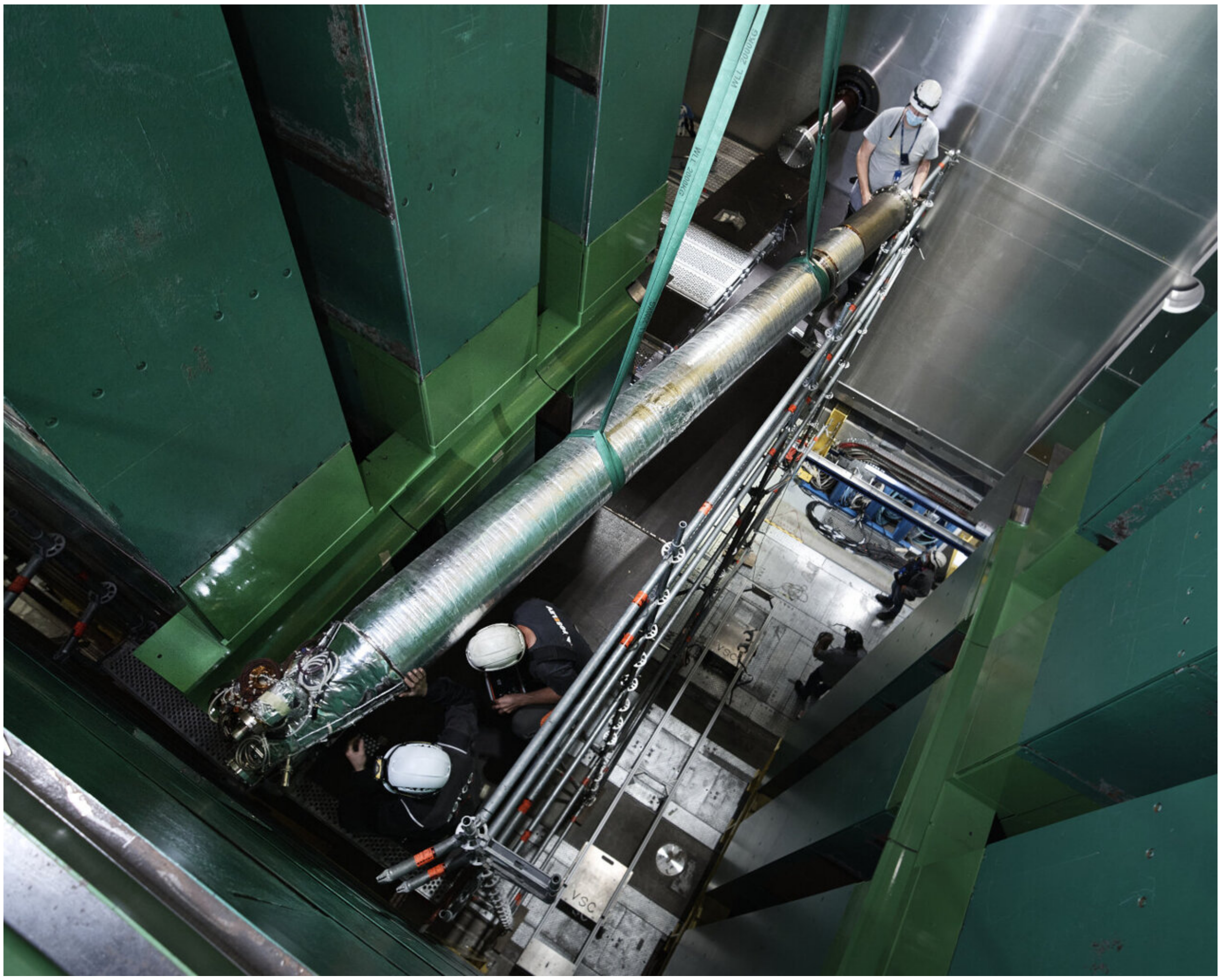
Successful beam pipe installation at LHCb

October 18 2021, by Cristina Agrigoroae



The stainless-steel section of the LHCb beam pipe is lifted up to the beamline with a crane and put in place between the filters of the muon system. Credit: CERN

The LHC experiments are nearing the completion of maintenance and upgrade works carried out in the framework of the second long shutdown of CERN's accelerator complex. Of all the experiments, LHCb is undergoing the most significant metamorphosis during these two years, namely the installation of a faster Vertex Locator (VELO), a new scintillating-fiber particle-tracking detector (SciFi), and upgraded ring-imaging Cherenkov detectors, RICH1 and RICH2. While the installation of LHCb's subdetectors and infrastructure in preparation for commissioning is still under way, its beampipe was successfully reinstalled over the summer, marking a milestone in the detector's preparation for Run 3 of the LHC.

The LHCb beam pipe has a conical shape through the whole of the LHCb detector, which makes it different from that of the other experiments. Along its total length of 19 m, its diameter ranges from 50 mm close to the LHCb interaction point to 380 mm in the experiment's muon system. The beam pipe is composed of four sections, all of different lengths. Three of these sections are made of beryllium and measure 11.6 m, giving LHCb the longest beryllium beam pipe of all the LHC experiments. The last and biggest section is made of stainless steel. Both the shape and material of the beam pipe were chosen to optimize its transparency to particles emerging from the collisions that take place at the LHC.

The beam pipe has a spider-web-like support structure in the aperture of the LHCb magnet, with beryllium collars and carbon-fiber ropes and rods ensuring that the amount of material is kept to a minimum. Installed during the first long shutdown, it was the first such structure ever used in an experiment and remains unique in the world today. The support structure may seem fragile, but is able to keep the beam pipe in place under the huge force that it exerts on itself when under vacuum.

The smallest of the beryllium sections is slid inside its spider-web-like support. Credit: CERN

The installation of the LHCb beam pipe, which involved engineers and technicians across multiple departments, started in April. The first smaller section was inserted through the RICH1 subdetector and connected to the VELO vacuum tank surrounding the interaction point. The installation and careful alignment of the spider-web-like structure followed in mid-July. The remaining sections were installed afterwards in a well-defined order: first, the longest (7 m) beryllium section was slid through the inner cylindrical sheath of the RICH2 subdetector. Then, the stainless-steel cone, the heaviest (160 kg) and biggest section, was lifted up to the beamline with a crane and then slid into place in the center of the muon system. Finally, the lightest beryllium section (about 4 kg) was carefully installed by hand, sliding it into place on its spider-web support in the magnet.

Once the sections had been connected with bellows and checks had been carried out to make sure that there were no leaks in the connections, the bake-out procedure to improve the quality of the vacuum started in mid-August. For this step, the beam pipe was wrapped in heating blankets, allowing it to be heated up to 250 °C. The VELO vacuum tank and the very thin radio-frequency foil that separates the LHCb detector vacuum from the LHC beam vacuum were also heated at the same time as the beam pipe. After final checks of the vacuum quality, the heating blankets were removed and the beam pipe was filled with neon gas at atmospheric pressure to keep it ready for beams to circulate in October.

Provided by CERN

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