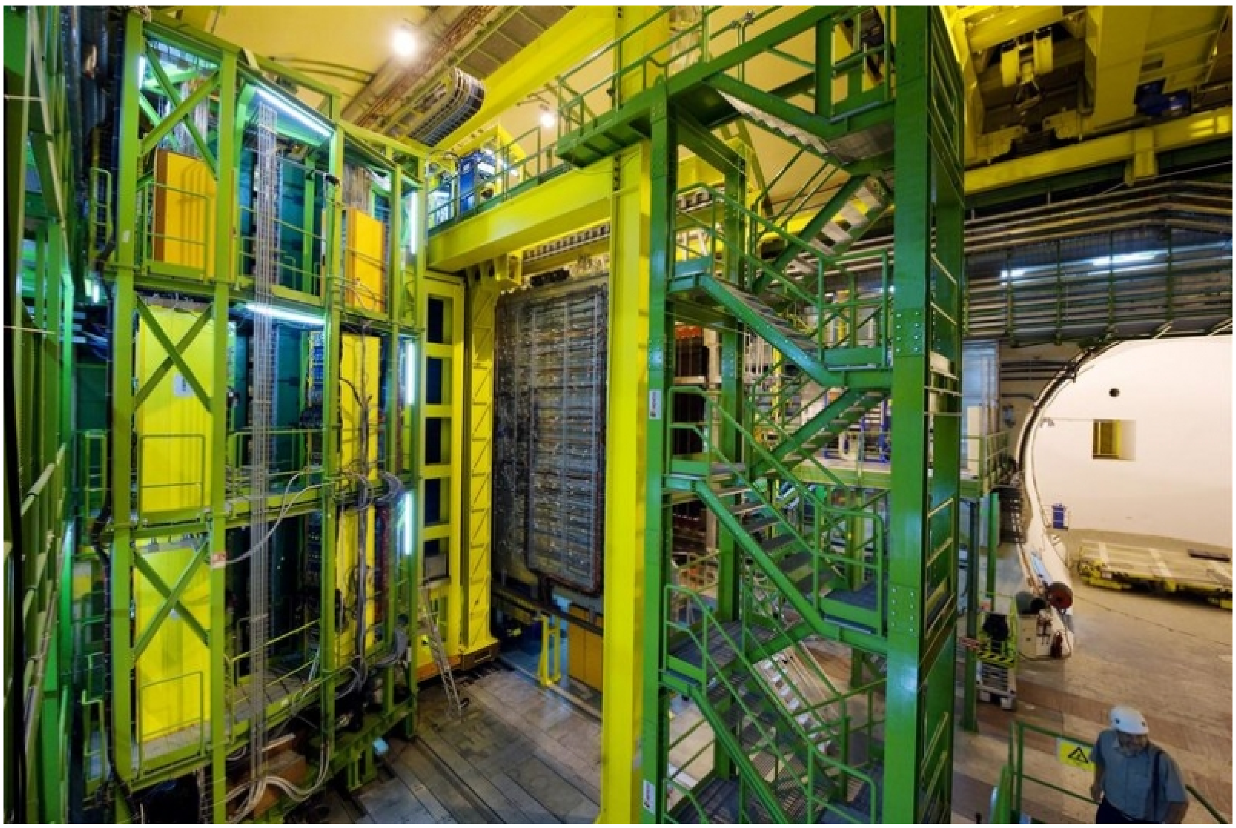
LHCb unveils new particles

July 5 2016

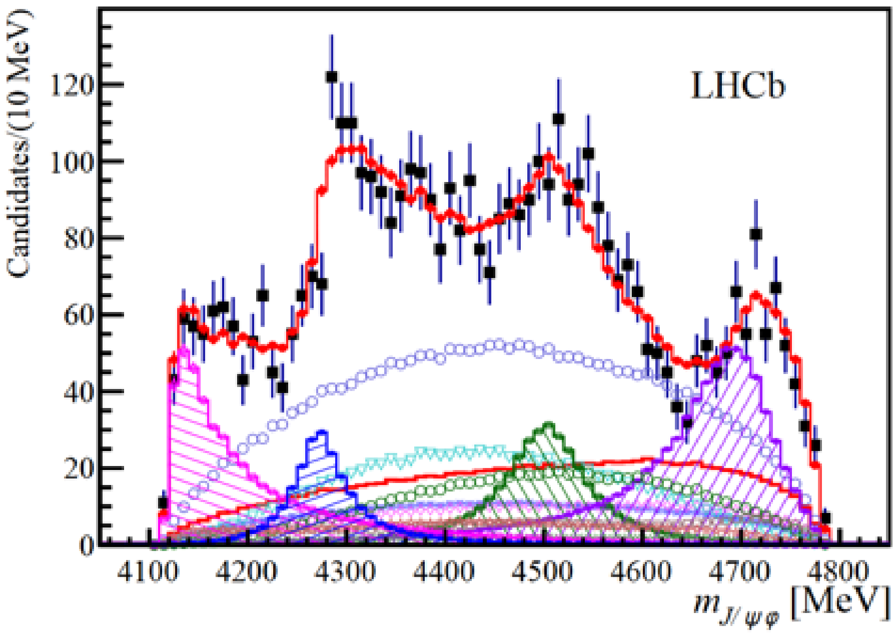


A view of the LHCb experimental cavern. Credit: Claudia Marcelloni/CERN

On 28 June, the LHCb collaboration reported the observation of three new "exotic" particles and the confirmation of the existence of a fourth one in data from the Large Hadron Collider (LHC). These particles seem to be formed by four quarks (the fundamental constituent of the matter inside all the atoms of the universe): two quarks and two antiquarks (that is, a tetraquark). Due to their non-standard quark content, the newly observed particles have been included in the broad category of so-called exotic particles, although their exact theoretical interpretation is still under study.

The quark model, proposed in 1964 by Murray Gell-Mann and George Zweig, is the most valid classification scheme of hadrons (all the composite particles) that has been found so far and it is part of the Standard Model of particle physics. In this model, hadrons are classified according to their quark content. However, it has been for a long-held mystery that all observed hadrons were formed either by a pair of quark-antiquark (mesons) or by three quarks (baryons) only. But, in the last decade several collaborations have found evidence of the existence of particles formed by more than three quarks. For example, in 2009 the CDF collaboration found one of these, called X(4140) – where the number in parentheses is its reconstructed mass in megaelectronvolts. This result was then confirmed later by a new CDF analysis, and by the CMS and D0 (link is external) collaborations.

Nevertheless, until now, the X(4140) quantum numbers – characteristic numbers with which the properties of a specific particle are identified – were not fully determined, and this ambiguity exposed the theoretical explanation to uncertainty. The LHCb collaboration could determine the X(4140) quantum numbers with high precision. This result has a large impact on the possible theoretical interpretations, and indeed it excludes some of the previously proposed theories on its nature.



The image shows the data (black dots) of the mass distribution resulting from the association of the J/ψ and φ mesons, where the contribution of the four exotic particles is put into evidence by the four peaking structures at the bottom. Credit: CERN

While the X(4140) had already been seen, the observation of the three new exotic particles with higher masses, called X(4274), X(4500) and X(4700), has been announced for the first time. Even though the four particles all contain the same quark composition, they each have a unique internal structure, mass and their own sets of quantum numbers.

These results are based on a detailed analysis of the decay of a B+ meson into mesons called J/ψ, φ and K+, where the new particles appear as intermediate ones decaying to a pair of J/ψ and φ mesons. To perform this research, the LHCb physicists used the full set of data collected during the first LHC run, from 2010 to 2012. The large signal yield efficiently collected with the LHCb detector has allowed LHCb scientists to discover those three new particles that were (literally, see the picture) peaking out from the data.

This news comes in addition to the discovery of the first two pentaquark particles by the LHCb collaboration last year.

More information: For more information, see lhcb-public.web.cern.ch/lhcb-p … .html#JpsiPhiExotics

Observation of J/ψφ structures consistent with exotic states from amplitude analysis of B+→J/ψφK+ decays. arxiv.org/abs/1606.07895

Amplitude analysis of B+→J/ψφK+ decays. arxiv.org/abs/1606.07898

Provided by CERN

Citation: LHCb unveils new particles (2016, July 5) retrieved 25 April 2024 from https://phys.org/news/2016-07-lhcb-unveils-particles.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.