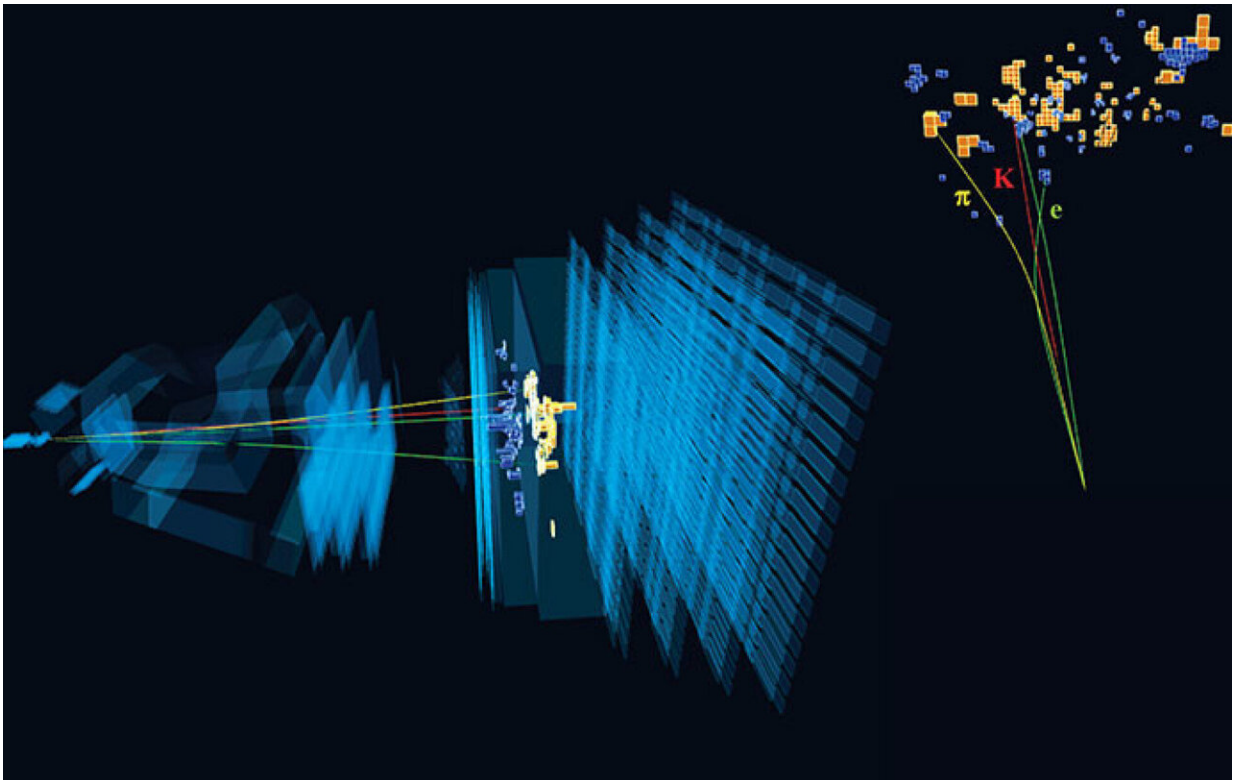


New result from the LHCb experiment challenges leading theory in physics

March 23 2021, by Hayley Dunning



Very rare decay of a beauty meson involving an electron and positron observed at LHCb. Credit: Imperial College London

The LHCb Collaboration at CERN has found particles not behaving in the way they should according to the guiding theory of particle physics—the Standard Model.

The Standard Model of particle physics predicts that [particles](#) called beauty quarks, which are measured in the LHCb experiment, should decay into either muons or electrons in equal measure. However, the new result suggests that this may not be happening, which could point to the existence of new particles or interactions not explained by the Standard Model.

Physicists from Imperial College London and the Universities of Bristol and Cambridge led the analysis of the data to produce this result, with funding from the Science and Technology Facilities Council. The result was announced today at the [Moriond Electroweak Physics conference](#) and [published as a preprint](#).

Beyond the Standard Model

The Standard Model is the current best theory of particle physics, describing all the known [fundamental particles](#) that make up our Universe and the forces that they interact with.

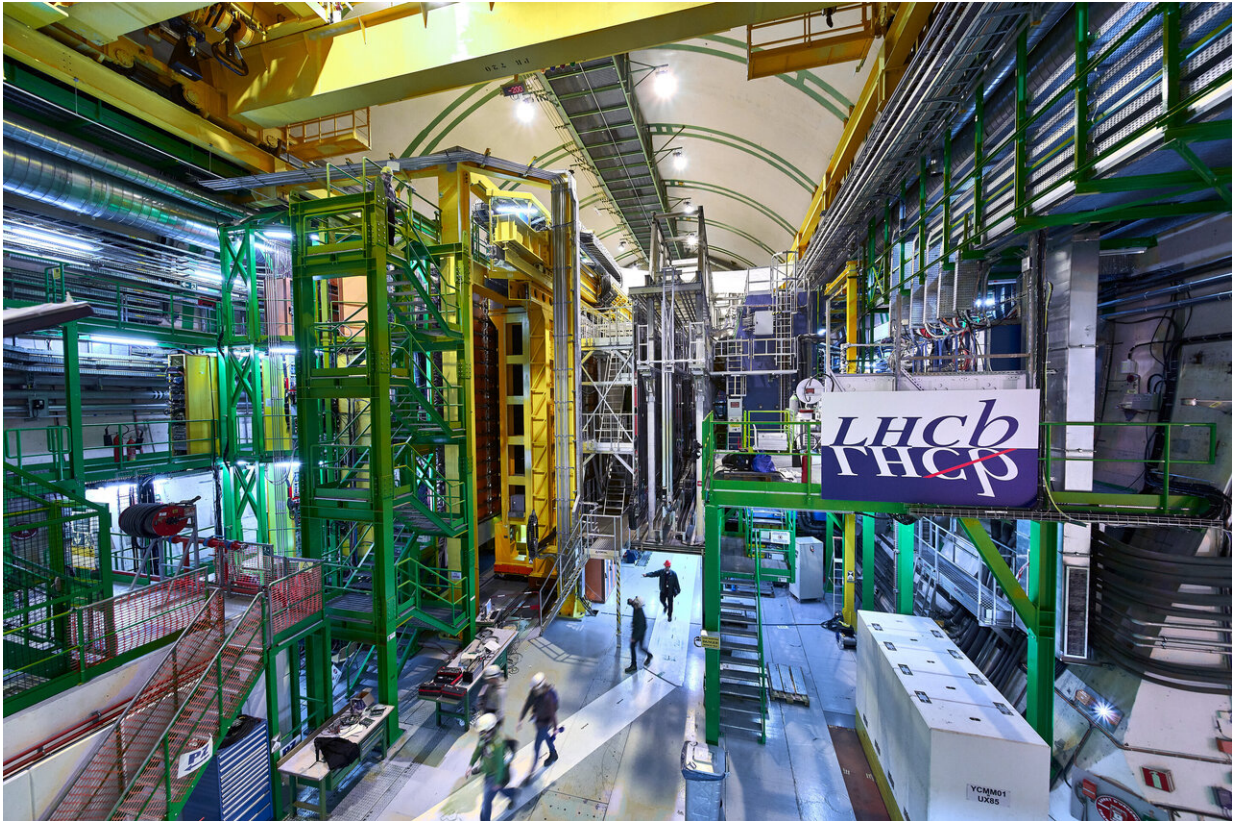
However, the Standard Model cannot explain some of the deepest mysteries in modern physics, including what [dark matter](#) is made of and the imbalance of matter and antimatter in the Universe.

Researchers have therefore been searching for particles behaving in different ways than would be expected in the Standard Model, to help explain some of these mysteries.

Dr. Mitesh Patel, from the Department of Physics at Imperial and one of the leading physicists behind the measurement, said: "We were actually shaking when we first looked at the results, we were that excited. Our hearts did beat a bit faster.

"It's too early to say if this genuinely is a deviation from the Standard

Model but the potential implications are such that these results are the most exciting thing I've done in 20 years in the field. It has been a long journey to get here."



The LHCb experiment is one of the four large experiments at the Large Hadron Collider at CERN, situated underground on the Franco-Swiss border near Geneva. Credit: CERN

Building blocks of nature

Today's results were produced by the LHCb experiment, one of four huge particle detectors at CERN's Large Hadron Collider (LHC).

The LHC is the world's largest and most powerful particle collider—it accelerates subatomic particles to almost the speed of light, before smashing them into each other. These collisions produce a burst of new particles, which physicists then record and study in order to better understand the basic building blocks of nature.

The updated measurement questions the laws of nature that treat electrons and their heavier cousins, muons, identically, except for small differences due to their different masses.

According to the Standard Model, muons and electrons interact with all forces in the same way, so beauty quarks created at LHCb should decay into muons just as often as they do to electrons.

But these new measurements suggest the decays could be happening at different rates, which could suggest never-before-seen particles tipping the scales away from muons.



Opening of the LHCb detector to install an upgrade. Credit: CERN

Imperial Ph.D. student Daniel Moise, who made the first announcement of the results at the Moriond Electroweak Physics conference, said: "The result offers an intriguing hint of a new fundamental particle or force that interacts in a way that the particles currently known to science do not.

"If this is confirmed by further measurements, it will have a profound impact on our understanding of nature at the most fundamental level."

Not a foregone conclusion

In particle [physics](#), the gold standard for discovery is five standard deviations—which means there is a 1 in 3.5 million chance of the result being a fluke. This result is three deviations—meaning there is still a 1 in 1000 chance that the measurement is a statistical coincidence. It is therefore too soon to make any firm conclusions.

Dr. Michael McCann, who also played a leading role in the Imperial team, said: "We know there must be new particles out there to discover because our current understanding of the Universe falls short in so many ways—we do not know what 95% of the Universe is made of, or why there is such a large imbalance between matter and anti-matter, nor do we understand the patterns in the properties of the particles that we do know about.

"While we have to wait for confirmation of these results, I hope that we might one day look back on in this as a turning point, where we started to answer to some of these fundamental questions."

It is now for the LHCb collaboration to further verify their results by collating and analysing more data, to see if the evidence for some new phenomena remains. The LHCb experiment is expected to start collecting new data next year, following an upgrade to the detector.

More information: Test of lepton universality in beauty-quark decays, arXiv:2103.11769 [hep-ex] arxiv.org/abs/2103.11769

Provided by Imperial College London

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