# NEWS IN FOCUS

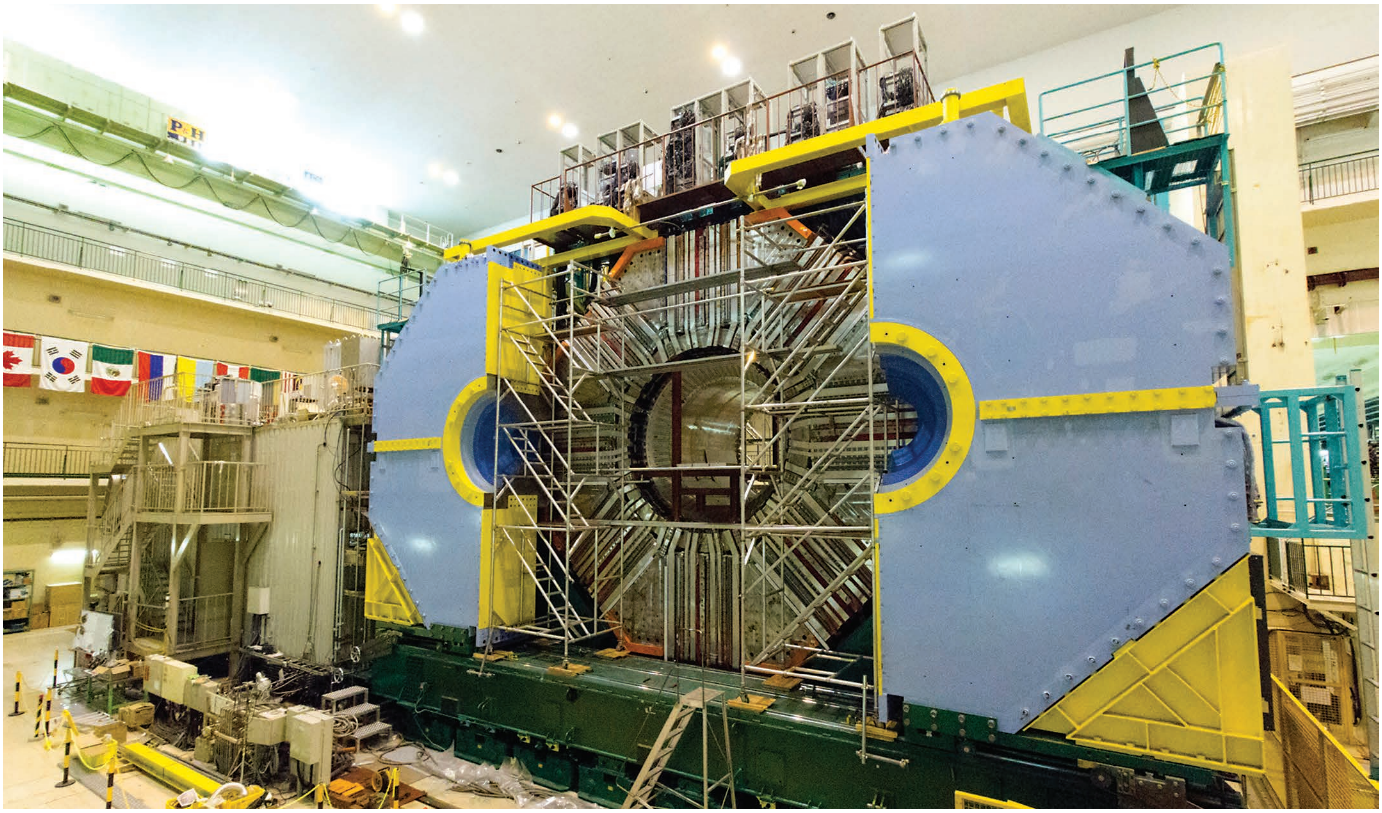
**GENETICS** Edited genes could keep modified organisms from spreading **p.259**

**COMPUTING** Labour shortage may limit China's push in artificial intelligence **p.260**

**SPACE** Experiment tests pulsars as interstellar navigation aid **p.261**

**ECOLOGY** The new fight over the light that steals the night **p.268**

KEK/BELLE II





**The Belle II experiment at the High Energy Accelerator Research Organization (KEK) in Tsukuba, Japan.**

PARTICLE PHYSICS

# Collider seeks cracks in physics framework

*The Belle II experiment in Japan will search for missing pieces in the standard model.*

**BY ELIZABETH GIBNEY**

The quest to explore the frontiers of physics will heat up in Japan next month, when beams of high-energy electrons are set to start smashing into their antimatter counterparts at one of the world's premier accelerator laboratories. The experiment, called Belle II, aims to chase down rare, promising hints of new phenomena that would extend the standard model — a remarkably successful, but incomplete, physics theory that describes matter and forces.

In February, an accelerator at Japan's High Energy Accelerator Research Organization (KEK) in Tsukuba will begin an initial six-month run of collisions. The eventual goal is to chart in high precision the decays of B-mesons, which contain a fundamental building block of nature known as a the b quark ('b' stands for 'beauty' or 'bottom').

The work builds on B-meson observations made by experiments including those at the Large Hadron Collider (LHC) at CERN, Europe's particle-physics laboratory near Geneva, Switzerland. Both efforts are looking for the subtle influence of any new particles or processes on the ways in which known particles decay into others.

Physicists at the LHC have seen some intriguing signs of potential departures from the standard model, most recently in 2017 (The LHCb collaboration *et al. J. High Energ. Phys.* **2017**, ▶

▶ 55; 2017). Buzz around these results has piqued theorists' interest in Belle II, and has prompted new groups to join the international collaboration, says Tom Browder, a physicist at the University of Hawaii at Manoa and spokesperson for the Japan-based experiment.

## CLEANER PHYSICS

The collisions at the Belle II experiment will be cleaner and more precise than those at the LHC experiment, called LHCb. That is because the LHCb experiment smashes together protons, which are each composed of three quarks and so make for messy collisions. But Belle II will crash electrons and positrons into each other, both of which are fundamental and so cannot break down any further.

Belle II will be able to study decays involving elusive neutrinos and photons that are harder to investigate with LHCb. This could help it to spot evidence for hypothetical particles, such as charged versions of the Higgs boson — a particle discovered at the LHC in 2012 — and particles such as the axion, a form of dark matter thought to interact with matter only very weakly, says Browder. "There's definitely competition between the two, but also complementarity."

The collider feeding the Belle II experiment will squeeze particles into a tight beam just 50 nanometres across, an advance that will lead to a collision rate 40 times that achieved by its KEK predecessor. This will help it to explore reams of recently discovered exotic particles made up of four or five quarks — tetraquarks and pentaquarks, respectively — and allow it to scour rare b-quark decays for any as-yet unknown preference towards the production of matter over antimatter. It will enable physicists to explore intriguing signs of physics beyond the standard model, a theory that has been verified repeatedly by experiments since the 1970s, but which fails to account for gravity or a host of other mysteries.

Collider experiments produce sprays of many particles that can live for tiny fractions of a second before decaying into other particles. In a handful of decays — involving the transformation of certain B-mesons into electrons and their heavier cousins, called muons and taus — LHCb has seen particles produced at unexpected rates.

***It will enable physicists to explore intriguing signs of physics beyond the standard model.***

Although each individual finding could easily be a statistical fluctuation, together they have gained attention, says Giovanni Passaleva, a physicist at the National Institute for Nuclear Physics in Florence, Italy, and spokesperson for the LHCb experiment. They broadly point in the same direction and build on similar findings from two previous experiments: the BaBar Collaboration at the SLAC National Accelerator Laboratory in Menlo Park, California; and Belle II's predecessor at KEK, he says. "So it looks like there is some correlation in these deviations, which make them more interesting than others."

## SCHEDULED CATCH-UP

However, Belle II will need to catch up with LHCb, whose accelerator produces more B-mesons and has been running since 2009. Once the full physics programme gets under way at the start of 2019, Belle II will take around a year to gather enough data to compete with LHCb. Meanwhile, LHCb will collect data from May until it shuts down for upgrades in November. By then, it should have seen enough decays to either dispel the potential signal or push it into discovery territory. "Our hope is that we get the machine and the detector working fast enough so we can start to catch up with them," says Browder.

The race to claim discovery will come down to which decays prove the most revealing, says Browder. But even if LHCb gets there first, confirmation of new physics from Belle II will be "absolutely essential", says Passaleva. Differences between the two experiments mean that Belle II could help physicists to work out what is behind any new interaction, and definitively rule out experimental error. "Then we'd be sure it's really new physics," he says, "because it will be seen by a completely different experiment in a completely different environment." ■

---

IMMIGRATION

# Uncertainty grows for US 'Dreamer' scientists

*Court temporarily revives protections against deportation as Congress mulls policy reform.*

BY CHRIS WOOLSTON

Like other young researchers in graduate school, Evelyn Valdez-Ward has a lot on her plate. An ecology student at the University of California, Irvine, she has been running field experiments and scrounging for research funding. But, above all, she is worried about whether she can stay in the United States. "My first year has been a real whirlwind," she says. "On top of how difficult grad school is, Trump got elected."

Her future depends on a US government programme that the president, Donald Trump, has attempted to shut down. Known as Deferred Action for Childhood Arrivals (DACA), it shields nearly 800,000 people from deportation, all of whom were brought to the United States illegally as children. Last September, Trump moved to end the programme, prompting a flurry of lawsuits. On 9 January, a federal judge in San Francisco, California, ordered the government to continue DACA while one of the court cases proceeds.

That is little comfort to Valdez-Ward. "If DACA expires, there's no way I can finish my PhD. I would lose everything."

Former president Barack Obama established the DACA programme in 2012 to give young, undocumented immigrants access to legal employment and more forms of financial aid for university studies. To enrol, immigrants must prove that they came to the United States before their sixteenth birthday and have a high-school diploma or are studying for one, among other requirements. Those who are granted DACA status — known as Dreamers —must apply to renew it every two years. Without such protections, they risk being sent back to countries they might not remember, and whose language they might not speak.

Trump's move last year to end DACA prompted lawsuits from 19 states and Washington DC, among other challengers. The case that ultimately led federal judge William Alsup to order DACA's reinstatement was filed by the University of California system — which estimates that some 4,000 of its students are in the country illegally, and that many are probably eligible for DACA status.

"DACA empowered people to start making