AVALON

the field, is rumoured to be planning a quantum-research centre in Hefei worth billions of US dollars.

The European Union initiative is the commission's third flagship scheme, after the Human Brain and Graphene flagships started in 2013. It was announced in 2016 in response to a 'Quantum Manifesto' written by a group of experts. The two previous flagships have been criticized, in part about how they awarded the grants. The organizers of the Quantum Flagship have been mindful of those controversies, says Tommaso Calarco, who was an author of the original Quantum Manifesto and is a theoretical physicist at the Helmholtz Centre in Jülich, Germany. "Grants are decided with open calls, evaluated by external collaborators," he says.

Other grants announced this week included those for a range of projects. Some of the proposed technologies are relatively close to having market applications, including ultra-precise, portable, atomic clocks, and chip-sized devices that produce random numbers for use in secure networks. For most labs involved, the flagship funds will not make a substantial difference to buying machinery or hiring researchers: the money is distributed over ten years and dozens of laboratories. (The EU provides half of the €1 billion; member countries must provide the remaining half.)

Lieven Vandersypen, a physicist at the Delft University of Technology in the Netherlands, says that the flagship is a missed opportunity to provide a 'Moonshot' on a single focused goal, such as building a large quantum computer. Instead, "only €20 million goes to computing" in this round of funding, says Vandersypen, who is leading an effort to build a quantum computer on a silicon chip, in collaboration with US semiconductor giant Intel. "I don't see the Moon."

But others say that the main advantage of the flagship is that it has forced groups to pool their efforts and knowledge — in particular, those in academia and industry. "It is a strong incentive to make sure that we collaborate on a European scale," says Thomas Monz, a physicist at the University of Innsbruck in Austria.

Major public funding will be necessary merely to keep a pipeline of experts, says Rodney Van Meter, an engineer at Keio University in Tokyo. "You need to build quantum programmes inside universities simply to train the people that Google and Intel are going to need." Public funders worldwide, from Canada to Japan, and major corporations are betting that quantum technologies will grow into multi-billion-dollar markets. The "decisive stimulus" for the European Commission to select quantum physics as its third flagship project, says Calarco, was a dramatic increase in investment in the field from US technology giants such as Google and IBM. ■

A project to protect bananas from disease is among those affected by a European court decision.

RESEARCH

EU gene-editing rule squeezes science

Researchers protest about impacts of stricter legislation.

BY ANDREW J. WIGHT

Three months after the European Union's top court gave gene-edited crops the same stringent legal status as genetically modified (GM) organisms, researchers across the world are starting to feel the pinch. And some are becoming increasingly vocal in their opposition to the ruling.

The ruling by the European Court of Justice (ECJ) imposes extensive risk evaluations before gene-edited organisms can be planted or sold as crops.

Much basic research on gene editing in plants isn't affected because these evaluations apply only to organisms released into the environment, and so pose hurdles at the field-trial or commercialization stage. But some applied-research projects are feeling the strain.

"A maize field trial we've been conducting in Belgium for over a year and a half was suddenly considered a GM field," says Dirk Inzé, science director at the VIB–UGent Center for Plant Systems Biology in Ghent, Belgium.

As a result of the ruling, he says, local authorities have insisted on extra precautionary measures, such as placing a fence around the researchers' plot and completing extensive documentation.

Meanwhile, a Belgian start-up that planned to use CRISPR technology to help Africa's banana industry says it lost its financing. And a company in Brazil says it has put millions of dollars' worth of gene-editing projects focused on soya beans on hold because its major market is in Europe.

A 2001 EU Directive required GM organisms to be identified, tracked and monitored for their effects on the environment and consumers. The new ruling imposes those restrictions on gene-edited crops, even though gene editing mostly involves small, precise changes to DNA — and not inserting foreign genes, as in the case of GM organisms.

"We see a chilling effect on plans for performing research with CRISPR-edited plants in the field," says René Custers, manager of regulatory and responsible research at the VIB life-sciences research institute in ▶

Belgium. "The climate for precision breeding in general and CRISPR in particular has worsened after the ECJ ruling."

SCIENTISTS GET VOCAL

Scientists are also making public demands for exemptions from the ruling, which they say is not in line with scientific evidence. On 24 October, 170 European scientists from 75 research centres in more than a dozen countries released a position paper urging that the law should change so that crops with small DNA adaptations made through gene editing would follow the regulations for varieties produced through conventional methods such as selective breeding, not for GM organisms.

In August, the organizers of the International Plant Molecular Biology congress in Montpellier, France, started an online petition calling for a review of the ruling. The petition has now attracted more than 5,200 signatures, including Inzé's. It declares that there is "no scientific rationale" for the ruling and that the EU should regulate crop genetic techniques on the basis of science.

And on 13 September, researchers from 33 UK science, farming and agricultural–technology organizations sent an open letter to the UK government to encourage recognition of gene editing as a non-GM method.

Outside Europe, Alexandre Garcia, who heads soya-bean research and development at the Brazilian plant-breeding company Tropical Melhoramento & Genética, says that the company had been expanding partnerships and investing in several research initiatives in soya-bean gene editing, but now needs to factor in the extra compliance work needed to meet the EU rules.

"For at least the past six years, the European Union has been the second biggest market for Brazilian soya beans, and Brazil is the main provider to the EU — so if any farmer plans to plant soya beans on Brazilian land, they need to worry about EU rules," he says.

Garcia says that the decision was a "cold water bath" on the company's research activities, and that research partnerships and investments that it valued at millions of dollars are now on hold while their viability is evaluated. The company might permanently cull research projects involving gene-editing unless they are expected to recoup the higher regulatory costs, he says.

The Belgian start-up faces similar challenges. It had wanted to use CRISPR technology to develop an edible banana that is resistant to Panama disease and black Sigatoka, two fungal pests that put 80,000 African growers at risk of losing their entire crops.

Biotech entrepreneur Roel Sterken, who leads the business side of the project, says that the company had secured venture capital financing of more than €1 million (US$1.14 million), and a distribution partner. Then, within days of the July ruling, Sterken says, the finance "blew up" and the partner backed out. He attributes this to fears that consumers would conflate the new product with the bad press that GM organisms receive.

Legal experts say that there is no mechanism for appealing the European court's ruling. "We have reached the end of the road as regards the ruling," says Julian Hitchcock, a partner at the London-based law firm Marriott Harrison. The only way to reverse the decision would be for the European Commission to revise the legislation and get it passed in parliament, he says. But he adds that the commission has been sluggish in responding to rapidly changing gene-editing technologies. ■

ORGANIC CHEMISTRY

Atomic structures solved in minutes

Cross-disciplinarity led to method's use on small molecules.

BY MATTHEW WARREN

Organic chemists, make sure you're sitting comfortably. The structure of small organic molecules, such as those used in drugs, can be deduced in minutes rather than weeks, thanks to a technique that uses beams of electrons.

Three-dimensional electron diffraction has been used by some inorganic chemists and materials scientists since the mid-2000s. But organic chemists, for whom the implications could be transformative, have not adopted it widely. In mid-October, two papers[1,2] appeared online describing a way to use the technique for drugs, making it much faster and easier to work out the structures of these small organic molecules than has been possible with previous techniques.

"I think there are a lot of people smacking their heads, saying, 'Why didn't we think to do this earlier?'" says John Rubinstein, a structural biologist at the University of Toronto in Canada who uses related techniques to study large molecules. Existing methods for determining the structure of small molecules require scientists to grow crystals for analysis, a laborious process that can take weeks or months. "Something that was a real barrier to their research is now basically removed," says Rubinstein.

Knowing how atoms are arranged in a molecule is necessary for understanding that substance's function. Chemists working to develop new drugs, for example, depend on this structure to understand how a compound acts in the body — and how it could be tweaked to bind more strongly to its therapeutic target or to reduce side effects.

"I think there are a lot of people smacking their heads, saying, 'Why didn't we think to do this earlier?'"

X-ray crystallography has been used for decades to deduce this arrangement. But it can take weeks of work — and is not always successful. First, scientists need to coax the molecules to crystallize. Then they blast the crystal with an X-ray beam. The crystal's lattice structure causes the X-rays to diffract, and a detector records the resulting pattern. Scientists then use software to analyse the pattern and work out the structure of the molecule.

The challenges arise because X-ray diffraction works only with large crystals, and these can take months to form. And some molecules are so hard to crystallize that it might not even be possible to analyse them in this way.

One alternative is to replace X-rays with electron beams, which can produce diffraction patterns for much smaller crystals. In 2007 and 2008, respectively, crystallographers at the Johannes Gutenberg University in Mainz, Germany, and at Stockholm University developed the first methods for detecting the 3D structures of molecules automatically using electron diffraction[3,4]. Previously, scientists had to laboriously merge multiple 2D diffraction patterns to get this 3D structure.

Initially, the technique was used mainly with inorganic structures, which are less affected by radiation than are organic molecules. Then, in 2013, Tamir Gonen, a structural biologist at the University of California, Los Angeles, developed a version of electron diffraction called MicroED, which could be used on large biomolecules such as proteins[5].

Now, Gonen's team and another group, based in Switzerland, have shown that electron diffraction can also be used to work out the structure of smaller organic molecules. It's an important demonstration of just how fast and easy this kind of analysis can be, says Xiaodong Zou, a structural chemist at Stockholm University.

A team led by crystallographer Tim Grüne at the Paul Scherrer Institute in Switzerland