with politicians. "We want evidence-based arguments to show that bottom-up, curiosity-driven research is valuable to society," he says. The council will have to lobby to keep its generous funding in the next Framework programme, due to begin in 2021.

The pilot evaluation rated projects that were among the first to be funded by the council, mostly in 2007 and 2008. It assigned eight projects each to 25 three-person expert groups.

The ERC gave the experts a bibliometric analysis of the publications from each project, but asked them to use their professional judgement to form an overall view of each one.

They found that 43 had led to a scientific breakthrough, 99 had generated a major advance — and only 7 had had no appreciable scientific output. That indicates an appropriate level of risk and ambition, says Bourguignon.

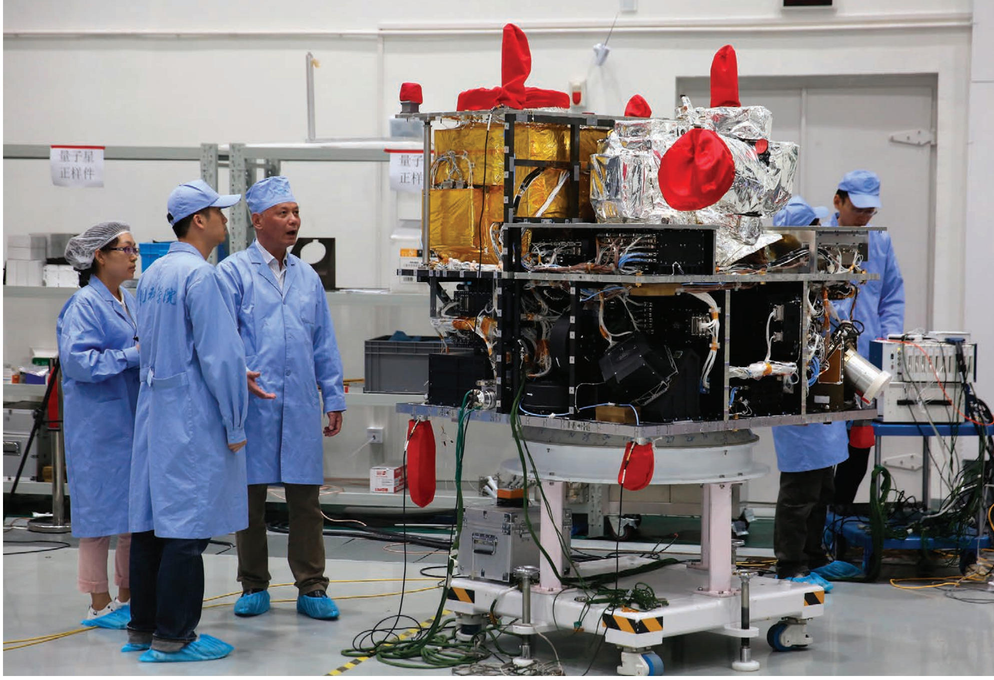
The evaluators also judged that almost 10% of projects had already had a large impact on the economy, policymaking or other aspects of society, and that around one-quarter were likely to do so in the future.

"It's a delight to see a qualitative approach," says science-policy specialist Ben Martin at the University of Sussex in Brighton. "Bibliometrics are misleading in isolation — but too often used this way." Bourguignon says that many of the evaluators, who remain anonymous, struggled with the unfamiliar task of subjectively declaring research a "scientific advance".

The study has limitations. Two experts in each group had served on ERC grant-awarding panels. None of the projects that they judged was included in the analysis, but the process could seem unobjective, says Arnold. Martin says the terms used to categorize the projects may be interpreted differently across disciplines. "As a social scientist, I can tell you that we don't describe our work in terms of 'breakthroughs'."

Bourguignon agrees that the small study was not optimally designed. But the ERC has since solicited independent comments on the methodology, and an ongoing evaluation of a further 250 projects has been fine-tuned to let evaluators across disciplines report consistently.

In the pilot review, evaluators also stressed the ERC's impact on an individual's career, something that Hanganu-Opatz experienced at first hand. Her university gave her tenure on 18 July, and three other universities made her offers. "The visibility you get when you win an ERC grant is embarrassing," she says. ■ SEE EDITORIAL P.465



CAI YANG/XINHUA VIA ZUMA WIRE

China's 600-kilogram quantum satellite contains a crystal that produces entangled photons.

COMMUNICATIONS

One giant step for quantum internet

Chinese satellite is first in a wave of planned craft that could form network secured by quantum cryptography.

BY ELIZABETH GIBNEY

China is poised to launch the world's first satellite designed to do quantum experiments. A fleet of quantum-enabled craft is likely to follow.

First up could be more Chinese satellites, which will together create a super-secure communications network, potentially linking people anywhere in the world. But groups from Canada, Japan, Italy and Singapore also have plans for quantum space experiments.

"Definitely, I think there will be a race," says Chaoyang Lu, a physicist at the University of Science and Technology of China in Hefei, who works with the team behind the Chinese satellite. The 600-kilogram craft, the latest in a string of Chinese space-science satellites, will launch from Jiuquan Satellite Launch Center in August. The Chinese Academy of Sciences and the Austrian Academy of Sciences are collaborators on the US$100-million mission.

Quantum communications are secure because any tinkering with them is detectable. Two parties can communicate secretly — by sharing a encryption key encoded in the polarization of a string of photons, say — safe in the knowledge that any eavesdropping would leave its mark.

So far, scientists have managed to demonstrate quantum communication up to about 300 kilometres. Photons travelling through optical fibres and the air get scattered or absorbed, and amplifying a signal while preserving a photon's fragile quantum state is

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extremely difficult. The Chinese researchers hope that transmitting photons through space, where they travel more smoothly, will allow them to communicate over greater distances.

At the heart of their satellite is a crystal that produces pairs of entangled photons, whose properties remain entwined however far apart they are separated. The craft's first task will be to fire the partners in these pairs to ground stations in Beijing and Vienna, and use them to generate a secret key.

During the two-year mission, the team also plans to perform a statistical measurement known as a Bell test to prove that entanglement can exist between particles separated by a distance of 1,200 kilometres. Although quantum theory predicts that entanglement persists at any distance, a Bell test would prove it.

The team will also attempt to 'teleport' quantum states, using an entangled pair of photons alongside information transmitted by more conventional means to reconstruct the quantum state of a photon in a new location.

"If the first satellite goes well, China will definitely launch more," says Lu. About 20 satellites would be required to enable secure communications throughout the world, he adds.

The teams from outside China are taking a different tack. A collaboration between the National University of Singapore (NUS) and the University of Strathclyde, UK, is using cheap 5-kilogram satellites known as cubesats to do quantum experiments. Last year, the team launched a cubesat that created and measured pairs of 'correlated' photons in orbit; next year, it hopes to launch a device that produces fully entangled pairs.

Costing just $100,000 each, cubesats make space-based quantum communications accessible, says NUS physicist Alexander Ling, who is leading the project.

A Canadian team proposes to generate pairs of entangled photons on the ground, and then fire some of them to a microsatellite that weighs less than 30 kilograms. This would be cheaper than generating the photons in space, says Brendon Higgins, a physicist at the University of Waterloo, who is part of the Canadian Quantum Encryption and Science Satellite (QEYSSat) team. But delivering the photons to the moving satellite would be a challenge. The team plans to test the system using a photon receiver on an aeroplane first.

An even simpler approach to quantum space science, pioneered by a team at the University of Padua in Italy led by Paolo Villoresi, involves adding reflectors and other simple equipment to regular satellites. Last year, the team showed that photons bounced back to Earth off an existing satellite maintained their quantum states and were received with low enough error rates for quantum cryptography (G. Vallone *et al. Phys. Rev. Lett.* **115,** 040502; 2015).

Researchers have also proposed a quantum experiment aboard the International Space Station (ISS) that would simultaneously entangle the states of two separate properties of a photon to make teleportation more reliable and efficient.

As well as making communications much more secure, these satellite systems would mark a major step towards a 'quantum internet' made up of quantum computers around the world, or a quantum computing cloud, says Paul Kwiat, a physicist at the University of Illinois at Urbana–Champaign who is working with NASA on the ISS project.

Eventually, quantum teleportation in space could even allow researchers to combine photons from satellites to make a distributed telescope with an effective aperture the size of Earth — and enormous resolution. "You could not just see planets," says Kwiat, "but in principle read licence plates on Jupiter's moons." ■

CORRECTION

The News story 'Canada builds quake warning system' (*Nature* **534,** 446–447; 2016) incorrectly stated that the warning system being developed by Ocean Networks Canada would be the first in Canada.