abroad have been injected with one of the four Chinese vaccines under policies known as emergency-use authorization. The vaccines include those developed by Sinopharm, plus a jab developed by Beijing-based vaccine maker Sinovac and another by CanSino Biologics in Tianjin.

Scientists say the country's drug regulator, which is part of the Ministry of Health, needs to wait for robust trial data that show the vaccines are safe and effective before it grants vaccines full approval.

In an e-mail to *Nature*, Wu said that the health ministry will await trial results before approving the vaccines for sale. "Until then, there are still uncertainties," she says.

Outside China, expectations are high that a successful Chinese vaccine will soon be available. Sinopharm started large-scale trials in Argentina last month, and these have received widespread media coverage, says Eduardo Spitzer, the scientific director of Laboratorio Elea Phoenix in Buenos Aires, which is organizing them. "We are working as fast as possible, but without losing quality in the data obtained from the trials."

Chinese President Xi Jinping told the World Health Assembly in May that its vaccines would be a "global public good", and said that the list of countries with which China has promised to share its vaccines continues to grow. But scientists are not sure that vaccine makers will have enough doses to fulfil those commitments.

In the past few months, Chinese leaders, including Xi and Premier Li Keqiang, have publicly pledged to make the country's vaccines accessible to the Philippines, Cambodia, Myanmar, Thailand, Vietnam and Laos, as well as to countries in Africa and Latin America.

Chinese vaccine makers also have agreements with the countries where vaccines are being tested. Sinovac, which has a vaccine in phase III trial and says results should be out by the end of November, has a deal to deliver 60 million doses to hard-hit São Paolo, Brazil, and has promised 40 million doses to Indonesia by March. Spitzer says that details of the deal that Sinopharm made to provide vaccines to Argentina are confidential.

Zheng Zhongwei, the head of the Chinese government's COVID-19 vaccine task force, said last month that China will have the capacity to produce 600 million doses by the end of the year, and one billion next year. But, given that the country has a population of 1.4 billion people, most of whom have not been vaccinated, that would not leave many doses for export.

The numbers don't add up, says Klaus Stöhr, who led the epidemic response unit at the WHO for 15 years and is now retired. "The number of doses available in China will by far be too little to permit export unless a political decision is taken to ship vaccines to overseas despite still-existing vaccine needs in China," he says.

China might also use its deals with individual countries to gain future political or economic leverage, says Jerome Kim, director-general of the International Vaccine Institute in Seoul. "That would be regrettable," he says.

But Kim commended China's decision to join COVAX. "When Xi said he would make vaccines a 'global public good', he said the right words. Joining COVAX turns those words into action," he says.

If China commits doses of vaccines, they will need to be approved by the WHO and CEPI. Currently, none of the four leading Chinese candidates is on the list of vaccines funded by CEPI. If China provides vaccines, it will also have to increase its capacity. "Lots of questions remain," says Kim.

Safety first

Before Chinese vaccines are given to more people, their safety and effectiveness need to be firmly established, says Marie-Paule Kieny, a vaccine researcher at INSERM, France's national biomedical-research agency in Paris.

She and other scientists have also criticized Sinopharm for claiming that widespread use of its two vaccines under emergency-use provisions show that the jabs are safe and effective. The company says there have been no infections among the tens of thousands of people that it vaccinated before they went abroad to countries affected by the coronavirus, even though no data supporting this claim have been made available.

"I would give personally no credit [to] the results," says Kieny.

It is hard to draw conclusions from such observations because there's a strong risk of bias, says Paul Offit, a vaccine researcher at the Children's Hospital of Philadelphia in Pennsylvania. People who were vaccinated might assume that any influenza-like symptoms they have could not have arisen from a SARS-CoV-2 infection, and might therefore not report them.

Sinopharm did not respond to *Nature*'s requests for comment about its vaccines.

In response to *Nature*'s questions about whether vaccines might be approved on the basis of those preliminary data, Wu said such data would be only a "small part" of the evidence that China's regulator uses to evaluate vaccines. "It is also necessary to obtain the valid data of phase III clinical trials to fully assess the safety and effectiveness of the vaccines," she says.

Wu says that the emergency-use programme has expanded gradually since July. People who have been vaccinated are being monitored for adverse reactions, and told to avoid exposure to the virus, she says.

But publicly available information about the leading vaccine trials has been limited, says Stöhr, which has cast doubts on those efforts. "That is a pity, as I know many colleagues in China who have been working at the highest scientific and medical standards," he says.

PHYSICISTS LAUNCH HUNT FOR ELUSIVE DARK-MATTER CANDIDATE

Decades-long search for 'WIMPs' continues with plans to build a final generation of supersensitive detectors.

By Elizabeth Gibney

Physicists are hatching a plan to give a popular but elusive dark-matter candidate a last chance to reveal itself. For decades, physicists have hypothesized that weakly interacting massive particles (WIMPs) are the strongest candidate for dark matter — the mysterious substance that makes up 85% of the Universe's mass. But several experiments have failed to find evidence for WIMPs, meaning that, if they exist, their properties are unlike those originally predicted. Now, researchers are pushing to build a final generation of supersensitive detectors that will leave the particles no place to hide.

"The WIMP hypothesis will face its real reckoning after these next-generation detectors run," says Mariangela Lisanti, a physicist at Princeton University in New Jersey.

Physicists have long predicted that an invisible substance, which has mass but doesn't interact with light, permeates the Universe. The gravitational effects of dark matter would explain why rotating galaxies don't tear themselves apart, and provide a reason for the uneven pattern seen in the microwave 'afterglow' of the early Universe. WIMPs became a favourite candidate for dark matter in the 1980s. They are typically predicted to have between one and 1,000 times the mass of a proton and to interact with matter only feebly — through the weak nuclear force, which is responsible for radioactive decay, or something even weaker.

Over the coming months, operations will

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XENON1T, an experiment that hunts for dark matter, is being upgraded this year.

begin at three existing underground detectors – in the United States, Italy and China – that search for dark-matter particles by looking for interactions in supercooled vats of xenon. Using a method honed over more than a decade, these detectors will watch for telltale flashes of light when the nuclei recoil from their interaction with dark-matter particles.

Physicists hope that these experiments – or rival WIMP detectors that use materials such as germanium and argon – will make the first direct detection of dark matter. But if this doesn't happen, xenon researchers are already designing their ultimate WIMP detectors. These experiments would probably be the last generation of their kind because they would be so sensitive that they would reach the 'neutrino floor' – a natural limit beyond which dark matter would interact so little with xenon nuclei that its detection would be clouded by neutrinos, which barely interact with matter but rain down on Earth in their trillions every second. "It would be sort of crazy not to cover this gap," says Laura Baudis, a physicist at the University of Zurich in Switzerland. "Future generations may ask us, why didn't you do this?"

The most advanced of these efforts is a planned experiment called DARWIN. The detector, estimated to cost between €100 million (US$116 million) and €150 million, is being developed by the international XENON collaboration, which runs one of the 3 experiments starting up this year – a 6-tonne detector called XENONnT at the Gran Sasso National Laboratory near Rome, an upgrade of the existing XENON1T. DARWIN would contain almost ten times this amount of xenon. Members of the collaboration have grants from several funding agencies to develop detector technology, including precise techniques that will work over DARWIN's much larger scales, says Baudis, a leading member of XENON and co-spokesperson for DARWIN.

Global experiment

The project is also on Switzerland's national road map for future scientific infrastructure, and Germany's research ministry has issued funding calls specifically for DARWIN-related research; these steps suggest that the nations are likely to contribute further cash in the future. And although DARWIN does not yet formally have a home, it could end up at Gran Sasso. In April, the laboratory formally invited the collaboration to submit a conceptual design report by the end of 2021. "It tells us very clearly that the lab is very interested in hosting such an experiment," says co-spokesperson Marc Schumann, a physicist at the University of Freiburg in Germany. The team hopes to be taking data by 2026.

"The goal is, of course, to have one large, global xenon-based dark-matter experiment."

Although DARWIN is currently led by the XENON collaboration, Baudis is hopeful that Chinese colleagues, who this year are starting up an experiment called PandaX-4t, or the team involved in the US-based xenon experiment called Lux-Zeppelin, might join them in building a single 'ultimate' detector. These teams have also considered building experiments that would take them to the neutrino floor, but "the goal is, of course, to have one large, global xenon-based dark-matter experiment", says Baudis.

Physicists might have no choice but to club together, because of the sheer quantity of xenon needed. The noble gas is difficult to obtain in large amounts owing to the energy-intensive process needed to extract it from the air and because of competing demand from the electronics, lighting and space industries. One kilogram can cost more than US$2,500. DARWIN's 50 tonnes would be close to the world's annual production of around 70 tonnes, meaning that – even if all 3 existing detectors combine their 25 tonnes – a future experiment would need to buy the rest in batches over several years. "We have to plan very carefully for it already now," says Baudis.

Researchers behind similar experiments that use argon to look for dark matter also hope to build a detector to reach the neutrino floor. A 300-tonne experiment known as ARGO is likely to begin operations around 2029 and could confirm any signal seen by DARWIN.

Why WIMPs?

WIMPS have been the focus of dozens of experiments because there is a strong theoretical case for their existence. Not only do they explain why galaxies seem to move as they do, but their existence also fits with theories in particle physics. A group of theories known as supersymmetry, devised in the 1970s to fill holes in physicists' standard model of fundamental particles and their interactions, predict a WIMP-like particle. And when particle physicists model the early Universe, they find that particles with WIMP-like properties would survive the hot soup of interactions in just enough numbers to match the dark-matter abundance observed today.

But null results – from direct dark-matter detectors and from particle accelerators such as the Large Hadron Collider – mean that, if WIMPs exist, they must be at the lowest end of initial predictions for either mass or how likely they are to interact with other particles. The failure to detect WIMPs has caused the physics community to "pause and reflect" on their status, says Tien-Tien Yu, a physicist at the University of Oregon in Eugene. Many in the physics community, including Yu, are now searching for other dark-matter candidates; some are using smaller, cheaper experiments.

Still, WIMPs remain theoretically attractive enough to continue the decades-long hunt, says Yu. And the DARWIN team emphasizes that its supersensitive detector would have myriad uses – including addressing pressing questions in neutrino physics, says Baudis.

Whether a single experiment or many, "I would bet quite some money that a DARWIN-like detector gets built", says Schumann.