one month instead of a few days or hours, says Zhou. That makes it possible for researchers to conduct longer experiments on the same sample, he explains.

Another magnet system is enabling other types of superconductivity research. Gang Li, a condensed-matter physicist at the IOP, heads a station that combines blisteringly cold temperatures with a 30-T superconducting magnet and a 20-T one to detect quantum oscillations — physical phenomena that are used to map the electronic 'fingerprint' of materials. Last July, Alexander Eaton, a condensed-matter physicist at the University of Cambridge, UK, and his colleagues spent two weeks using the station to unpick the electronic properties of an unusual superconductor called uranium ditelluride[3]. "It was the only place we could do the experiment we wanted to do," says Eaton.

Mix and match

Other superconductivity researchers are using multiple tools at SECUF. Guanghan Cao, a condensed-matter physicist at Zhejiang University in Hangzhou, China, used the cubic anvil cell and NMR to probe an intriguing chromium-based material he had discovered by accident. Cao and his colleagues spotted hints of superconductivity when they subjected it to high pressures using the cubic anvil cell[4]. Over at the NMR station, the researchers were also able to catch a glimpse of the compound's magnetic properties. The ability to measure the material in multiple ways in one location enabled the researchers to conduct a more in-depth study in less time. "That's really convenient for us," Cao says.

Superconductivity isn't the only phenomenon researchers are pursuing at SECUF. Some researchers are using ultrafast lasers to study the properties of semiconductors, whereas others are using a range of instruments to hunt down elusive quantum states of matter. The facility is open to domestic and international users alike, and all proposals are considered equally, says Cheng. But the process will be more selective for all researchers this year, to give successful applicants more time at each station, he adds.

Although researchers from all over the world are using the facility, Ali Bangura, a condensed-matter physicist at the NHMFL, says that SECUF could give China an edge over other countries in the quest to achieve room-temperature superconductivity. By expanding the scope of measurements on offer in one location, SECUF "substantially increases the likelihood of groundbreaking discoveries", says Bangura.

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REMKO DE WAAL/AFP VIA GETTY

A physician tends to a person who is recovering from COVID-19.

SCIENTISTS TRIED TO GIVE PEOPLE COVID — AND FAILED

Participants' high levels of immunity in 'challenge' trials complicate efforts to test vaccines and drugs.

By Ewen Callaway

When Paul Zimmer-Harwood volunteered to be intentionally infected with SARS-CoV-2, he wasn't sure what to expect. He was ready for a repeat of his first brush with COVID-19, through a naturally acquired infection that gave him influenza-like symptoms. But he hoped his immunity would help him to feel well enough to use the indoor bicycle trainer that he had brought into quarantine.

It turned out that Zimmer-Harwood, a PhD student at the University of Oxford, UK, had nothing to worry about. Neither he nor any of the 35 other people who participated in the 'challenge' trial actually got COVID-19.

The study's results, published on 1 May in *Lancet Microbe*, raise questions about the usefulness of COVID-19 challenge trials for testing vaccines, drugs and other therapeutics (S. Jackson *et al. Lancet Microbe* https://doi.org/mtqs; 2024). "If you can't get people infected, then you can't test those things," says Tom Peacock, a virologist at Imperial College London. Viral strains used in challenge trials take many months to produce, making it impossible to match emerging circulating variants that can overcome high levels of existing immunity in populations.

Researchers use challenge trials to understand infections and quickly test vaccines and therapies. In March 2021, after months of ethical debate, UK researchers launched the world's first COVID-19 challenge trial (B. Killingley *et al. Nature Med.* **28**, 1031–1041; 2022). The study identified a minuscule dose of the SARS-CoV-2 strain that circulated in the early days of the pandemic that could infect about half of the participants, who had not previously been infected with the virus (at that time, vaccines weren't yet widely available).

In parallel, a team led by Helen McShane, an infectious-disease researcher at Oxford, launched a second SARS-CoV-2 challenge study in people — including Zimmer-Harwood — who had recovered from naturally acquired SARS-CoV-2 infections, caused by a range of variants. The trial later enrolled participants who had also been vaccinated.

Evolving strains

The first participants in McShane's trial got the same tiny dose of the 'ancestral' SARS-CoV-2 strain as did those in the 2021 trial. None of the participants developed a sustained infection, so the researchers increased the dose by more and more in subsequent groups of

participants, until they reached a level 10,000 times the initial dose. A few volunteers developed short-lived infections, but these quickly vanished.

"We were quite surprised," says Susan Jackson, a study clinician at Oxford and co-author of the latest study. "Moving forward, if you want a COVID challenge study, you're going to have to find a dose that infects people."

An ongoing COVID-19 challenge trial at Imperial College London, in which participants have been exposed to the Delta SARS-CoV-2 variant, has also encountered problems with infecting participants reliably, says Christopher Chiu, an immunologist and infectious-disease physician at Imperial who is leading the trial and was involved in the others. Some participants have experienced infections, but probably not enough for a study testing whether a vaccine works, adds Chiu.

"We need a challenge strain that's more representative of what's circulating in the community," says Anna Durbin, a vaccine scientist at Johns Hopkins University School of Medicine in Baltimore, Maryland, who was a member of the board that oversaw the safety of the McShane's trial.

Viral strains used in challenge trials are produced under stringent conditions, a process that can take six months or longer, say scientists, making it impossible to match circulating variants perfectly. McShane and Chiu are readying a challenge trial using the BA.5 Omicron subvariant that emerged in 2022.

Raising doses

Researchers are looking at other ways to give people COVID-19. Jackson says that an even higher SARS-CoV-2 dose might be needed — one similar to doses used in influenza challenge trials, in which participants have substantial immunity. Another method could be giving participants multiple doses. Chiu says that his team is exploring the possibility of screening potential participants to identify those with low levels of immune protection against the BA.5 variant and any future challenge strains.

Chiu is leading a consortium that in March was awarded US$57 million by the European Union and CEPI, the Coalition for Epidemic Preparedness Innovations in Oslo, to use challenge trials to test inhaled and intranasal COVID-19 vaccines that might also block transmission. He's hopeful that such changes to trial protocols will do the trick. "What you really want is a model that replicates a genuine infection and ideally one that causes some symptoms," he adds.

Zimmer-Harwood, who works for a nonprofit organization that advocates for challenge trials and their participants, says he would welcome changes that make COVID-19 challenge studies more useful to researchers — even if it means less time on the bicycle trainer.

TANDEM STILLS + MOTION/GETTY

Select fires in the Yukon Flats National Wildlife Refuge in Alaska will be allowed to burn.

EPIC BLAZES THREATEN PERMAFROST. CAN FIREFIGHTERS SAVE IT?

Some scientists want a rethink of the policy of letting blazes burn themselves out in northern wildernesses.

By Jeff Tollefson

Fire season is approaching in the massive Yukon Flats National Wildlife Refuge in east Alaska, where fires have long been allowed to burn unchecked unless they threaten human life and property. But as climate change increases the frequency of these fires, the land's overseers are changing course. Working with scientists, refuge managers have designed a pilot programme to parachute elite firefighting teams into remote areas to quash infernos — to protect not people, but permafrost.

The forests and tundra of the Denmark-sized refuge cloak a deep layer of permafrost, frozen ground that holds enormous quantities of carbon across the Northern Hemisphere. After fires remove vegetation and soils, however, that frozen ground often begins to thaw, releasing its stores of greenhouse gases into the atmosphere. New research[1] suggests that the resulting emissions could be on a par with those of a major global economy over the course of this century. This could effectively reduce by up to 20% the amount of carbon dioxide that humanity can emit and still meet its goal of limiting global warming to 1.5 °C above preindustrial levels. The research has not yet been peer reviewed.

These numbers suggest that a rethink of long-standing fire policies in high-latitude boreal forests might be needed, says Brendan Rogers, an Earth-systems scientist with the Woodwell Climate Research Center in Falmouth, Massachusetts. The pilot programme at Yukon Flats will test that idea in an area where permafrost is particularly vulnerable.

"What we're talking about is aggressive attacks on fires when they ignite in these areas," Rogers says. Once such fires get going, he adds, it's often too late. "That carbon is lost."

Earth ablaze

The proposal to suppress boreal fires to help fight climate change follows years of increasingly intense conflagrations across northern forests and Arctic peatlands. By some estimates, the wildfires in Canada's boreal forests last year released more than three times as much carbon dioxide as the entire country emitted from burning fossil fuels. Officials at Yukon Flats say that the frequency of major fires on the refuge has quadrupled since 1988.

A rise in fire frequency can have cascading effects on the ecosystem, and thus carbon, says Xanthe Walker, an ecologist at Northern Arizona University in Flagstaff, who has studied the effect of fires on permafrost.