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Cosmic rays used for Arctic GPS

Muons made by cosmic rays can be used for navigation at latitudes where GPS works poorly

David Hambling

NAVIGATION via cosmic ray muons could supplement GPS in high latitudes, as well as working underwater and underground.

The US Office of Naval Research (ONR) has awarded a contract to UK company Geoptic Infrastructure Investigations to demonstrate navigation in the Arctic where GPS coverage is poor due to positioning of GPS satellites run by the US military, which are mostly at lower latitudes.

The firm's Muometric Positioning System (muPS) uses muons made by cosmic rays instead of the radio signals from satellites used by GPS. When a high-energy cosmic ray strikes the upper atmosphere, a shower of muons rains down. These pass through solid matter, but can be detected by scintillation counters. On average, "one muon will pass through your thumbnail every minute", says Chris Steer at Geoptic.

MuPS has a set of reference counters that pick up muon showers in a pre-defined locale. Aided by precise atomic clocks, they triangulate the source and time of each shower. This allows

a mobile counter to locate itself by comparing the time difference for the same shower.

The method requires multiple muon showers to get a fix on the location, but lab tests have shown how accurate it can be. Just 10 muon events are enough to locate a point with an accuracy of 60 millimetres, says Lee Thompson at Geoptic. Further measurements increase

An artist's representation of high-energy cosmic rays colliding with Earth



SCIENCE PHOTO LIBRARY/ALAMY

that to 10 millimetres or less.

The proof-of-principle experiment will use detectors that are 1 square metre in size, plus atomic clocks accurate to within a 10 billionth of a second. These cost tens of thousands of dollars, but are quickly becoming cheaper.

The real challenge is that the ONR wants a demonstration beneath the surface of a frozen lake in Finland to take place before August 2022. "The average temperature is around -20°C, so we'll be using [snowmobiles] for transport and cutting holes in the

ice with chainsaws to deploy the system," says Steer.

The aim is to show that muPS works in difficult field conditions. Once the receiver has been calibrated with the reference counters, it can continue to locate itself while underwater even if it only communicates with the counters intermittently.

MuPS could provide underwater navigation for uncrewed vehicles and submarines. Precise submarine navigation is a major issue: in October, the nuclear submarine USS Connecticut was damaged by a collision with an underwater mountain.

The developers say that because muons can also travel through rock, they have had interest from the US Army in a portable version for navigating tunnels.

"This is the first time I've heard of [cosmic rays] being used for navigation, but there are a lot of new applications ranging from mineral prospecting to inspecting industrial infrastructure and detecting nuclear material," says David Mahon at the University of Glasgow in the UK. ■

Cybercrime

Covid-19 vaccine passports for sale on the dark web

DIGITAL covid-19 vaccination certificates for use in the US and the European Union are available to buy on the dark web. Most appear to be fake, but others may be valid entries in national databases that have been leaked, say researchers.

Covid-19 restrictions in many countries require proof of vaccination against the coronavirus to access certain places, such as restaurants. Vaccine passports

most commonly take the form of a digital record in a smartphone app, presented as a scannable QR code.

Emmanouil Vasilomanolakis at Aalborg University in Denmark and his colleagues found 17 marketplaces and 10 shops on the dark web – a collection of websites that can be accessed privately via special browsers – that claim to offer falsified digital vaccine passports for sale. The researchers analysed listings using search engines that crawl the dark web.

The listings claimed to sell vaccine passports and certificates for a number of European countries

and the US in exchange for payment in cryptocurrencies. But many of the certificates aren't real, says Vasilomanolakis. "Our opinion, at least from our findings, suggests that the vast majority of everything is a scam," he says.

However, Vasilomanolakis and his colleagues believe there were a number of legitimate vaccination certificates offered for sale. Some of the QR codes shown as evidence

"Some of the QR codes to entice customers to buy appear to be valid entries in national databases"

to entice customers to buy appear to be valid entries in national databases. One seller displayed a video showing part of the back end of a European vaccine records system, indicating they had access to it (arxiv.org/abs/2111.12472).

The possibility that insiders might have leaked some certificates is concerning, says Matthew Shillito at the University of Liverpool, UK, who studies the dark web. "It appears some could be people within health service providers selling or providing access to legitimate certificates," he says. ■
Chris Stokel-Walker