Scientists reveal hidden corridor in Great Pyramid of Giza

Description

The corridor is 30 feet long and likely slopes upward. Where it leads is still a mystery.

In 2016, scientists using muon imaging picked up signals indicating a hidden corridor behind the famous chevron blocks on the north face of the Great Pyramid of Giza in Egypt. The following year, the same team detected a mysterious void in another area of the pyramid, believing it could be a hidden chamber. Two independent teams of researchers, using two different muon imaging methods, have now successfully mapped out the corridor for the first time, according to a new paper published in the journal Nature Communications. Zahi Hawass, Egypt's former antiquities minister, called it "the most important discovery of the 21st century."

As we've reported previously, there is a long history of using muons to image archaeological structures, a process made easier because cosmic rays provide a steady supply of these particles. An engineer named E.P. George used them to make measurements of an Australian tunnel in the 1950s. But Nobel-prize-winning physicist Luis Alvarez really put muon imaging on the map when he teamed up with Egyptian archaeologists to use the technique to search for hidden chambers in the Pyramid of Khafre at Giza. Although it worked in principle, they didn't find any hidden chambers.

There are many variations of muon imaging, but they all typically involve gas-filled chambers. As muons zip through the gas, they collide with the gas particles and emit a telltale flash of light, which is recorded by the detector, allowing scientists to calculate the particle's energy and trajectory. It's similar to X-ray imaging or ground-penetrating radar, except with naturally occurring high-energy muons rather than X-rays or radio waves. That higher energy makes it possible to image thick, dense substances like the stones used to build pyramids. The denser the imaged object, the more muons are blocked, casting a telltale shadow. Hidden chambers in a pyramid would show up in the final image because they blocked fewer particles.

Muons are being used to hunt for illegally transported nuclear materials at border crossings and to monitor active volcanoes in hopes of detecting when they might erupt. In 2008, scientists at the University of Texas, Austin, tried to follow in Alvarez's footsteps, repurposing old muon detectors to search for possible hidden Mayan ruins in Belize. And physicists at Los Alamos National Laboratory

have been developing portable versions of muon imaging systems to unlock the construction secrets of the soaring dome (Il Duomo) atop the Cathedral of St. Mary of the Flower in Florence, Italy, designed by Filippo Brunelleschi in the early 15th century. The dome has been plagued by cracks for centuries, and muon imaging could help preservationists figure out how to fix it.

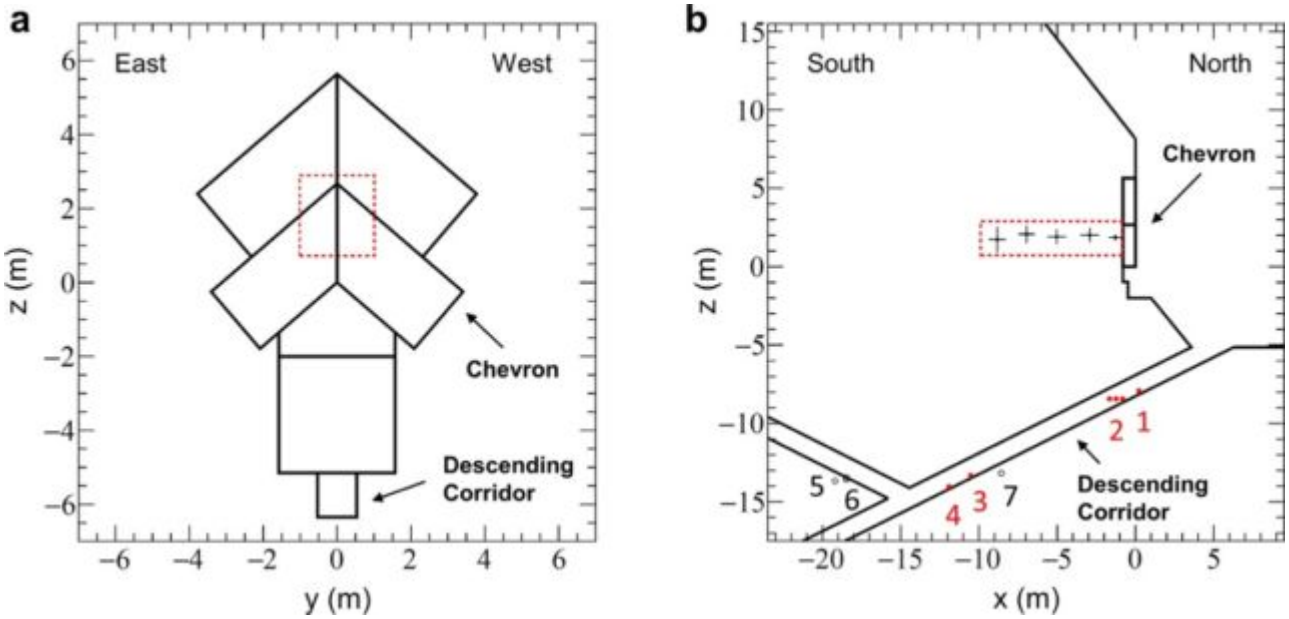
Enlarge / The Great Pyramid of Giza.
Nina Aldin Thune/CC-BY-2.5

As Annalee Newitz wrote for Ars in 2017, the Pharaoh Khufu (2509-2483 BCE) ordered the Great Pyramid to be built at Giza roughly 4,500 years ago. The structure remained sealed until 820 CE, when the Caliph al-Ma'mun broke open one of its walls and discovered three chambers inside, arranged vertically: the King's Chamber, the Queen's Chamber, and an abandoned subterranean chamber, connected by the "Grand Gallery," a large corridor. There is also a descending corridor, an ascending corridor, and a passage dug in the Middle Ages that now serves as a tourist's entrance.

Many tried to find additional rooms and failed. Part of the problem is that there are no remaining plans for the pyramid's design, so it's impossible to know where to look. Plus, today's archaeologists can't explore the pyramid using invasive techniques that might damage the structure. That's why Heritage Innovation Preservation Institute's (HIP) Mendhi Tayoubi organized a team of engineers and physicists several years ago who would use cosmic radiation to map the pyramid's interior to look for empty spaces: the Scan Pyramid Project.

In 2016, the team used muography to detect a void space shaped like a corridor behind the chevron-shaped structure on the pyramid's northern wall. The following year, they identified a large empty space or void above the Grand Gallery. It appeared to be about the size of the Grand Gallery, roughly

30 meters long, and was located about 15 to 17 meters above the ground's surface. Tayoubi wondered at the time whether the corridor-like void they'd found might be connected to the chamber-like void. Once again, there was no non-invasive way to reach the big void to explore further. But the void on the northern wall was sufficiently close to the structure's surface that the team was hopeful of finding a good solution to explore that area, at least.



Enlarge / The location and shape of the hidden corridor shown in cross-sectional views of the analysis area including chevron from the north (a) and east (b) sides.
Procureur et al., 2023

For this latest work, one team used muon radiography to map the shape and location of the secret corridor, placing detectors at various points around the pyramid. Specifically, they used nuclear emulsion films (supplied by colleagues at Nagoya University in Japan), which can detect particles without an electric power supply. Those multi-point observations enabled them to determine the location, inclination, and vertical layout of the corridor.

A second team deployed three gaseous detectors, or muon telescopes, outside the pyramid, supplied by the Centre for Extragalactic Astronomy (CEA) at Durham University in the UK. These are less compact than the emulsion films and require a power source, but the detectors produce results much faster. The telescopes gathered about 140 days' worth of solid data, collecting over 116 million muons.

The results of the two independent analyses confirmed the presence of a corridor-like void. The corridor is about 9 meters long (29.5 feet), with a transverse section of 2×2 meters (6.5×6.5 feet), and most likely slopes upward, although where it leads remains a mystery.

The Scan Pyramid project's scientists even used a tiny camera to perform the archaeological equivalent of an endoscopy of the interior. "We knew the cavity was there, but of course it's totally different when you see it," co-author Sebastien Procureur, of the University of Paris-Saclay in France, told New Scientist. "We felt strange when we saw this. It's a controversial opinion, but I'm relieved the cavity was empty. I wouldn't have liked to participate in opening a tomb."

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Date Created
03/09/2023