Nuns at a convent in Turin, Italy, unroll a cherished copy of the shroud made in 1644. Unlike this painted version, the original shroud shows no evidence of artificial pigments.

PHOTOGRAPH BY MARCO ANSALONI

IN FOCUS

Why Shroud of Turin's Secrets Continue to Elude Science

As the venerated relic goes on public exhibition, its origin remains a mystery wrapped in an enigma.

By Frank Viviano

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NATIONAL GEOGRAPHIC

The 53-square-foot rectangle of linen known as the Shroud of Turin is one of the most sacred religious icons on Earth, venerated by millions of Christians as the actual burial garment of Jesus Christ.

It is also among the most fiercely debated subjects in contemporary science, an extraordinary mystery that has defied every effort at solution.

Over the 117 years since a photographic negative of the linen unexpectedly revealed the image of a tortured body, ranks of physicists and chemists have weighed in on the fabric's age and the image's composition. Forensic pathologists, microbiologists, and botanists have analyzed its bloodstains, along with specks of dirt and pollen on its surface. Statisticians have combed through mountains of data.

The sum result is a standoff, with researchers unable to dismiss the shroud entirely as a forgery, or prove that it is authentic. "It is unlikely science will provide a full solution to the many riddles posed by the shroud," Italian physicist **Paolo Di Lazzaro**, a leading expert on the phenomenon, told National Geographic. "A leap of faith over questions without clear answers is necessary—either the 'faith' of skeptics, or the faith of believers."

On April 19, the shroud goes on public display at Turin's cathedral for seven weeks, its longest **exhibition** in modern history.

To readers of the New Testament gospels, the mysterious man of the shroud evokes the slain Christ, complete wit...

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The Scientific Record

Scientific inquiry into the shroud began in 1898, with the startling image captured by Italian amateur photographer Secondo Pia. Under normal conditions, only the vague sepia blur of a human body appears on the fabric. But when Pia examined the reverse negative of his photographic plate in the darkroom, he discovered the detailed likeness of a bearded man with visible wounds on his body.

For seven decades, indirect analyses of the image were conducted by researchers, most aimed at determining whether it had been painted onto the linen or produced through contact with a human corpse. It wasn't until 1969 that scientists were allowed to examine the fabric directly, with the task of advising on preservation techniques and future testing. This set the scene for the establishment of the U.S.-led **Shroud of Turin Research Project (STURP)**, which was granted an unprecedented five days of continuous access to the shroud itself in 1978.

The project's 33 members ran the gamut of scientific disciplines, and their credentials included high-level posts at 20 major research institutions. They arrived in Turin with seven tons of equipment and worked in shifts 24 hours a day. An associate team of European scientists acted as expert observers.

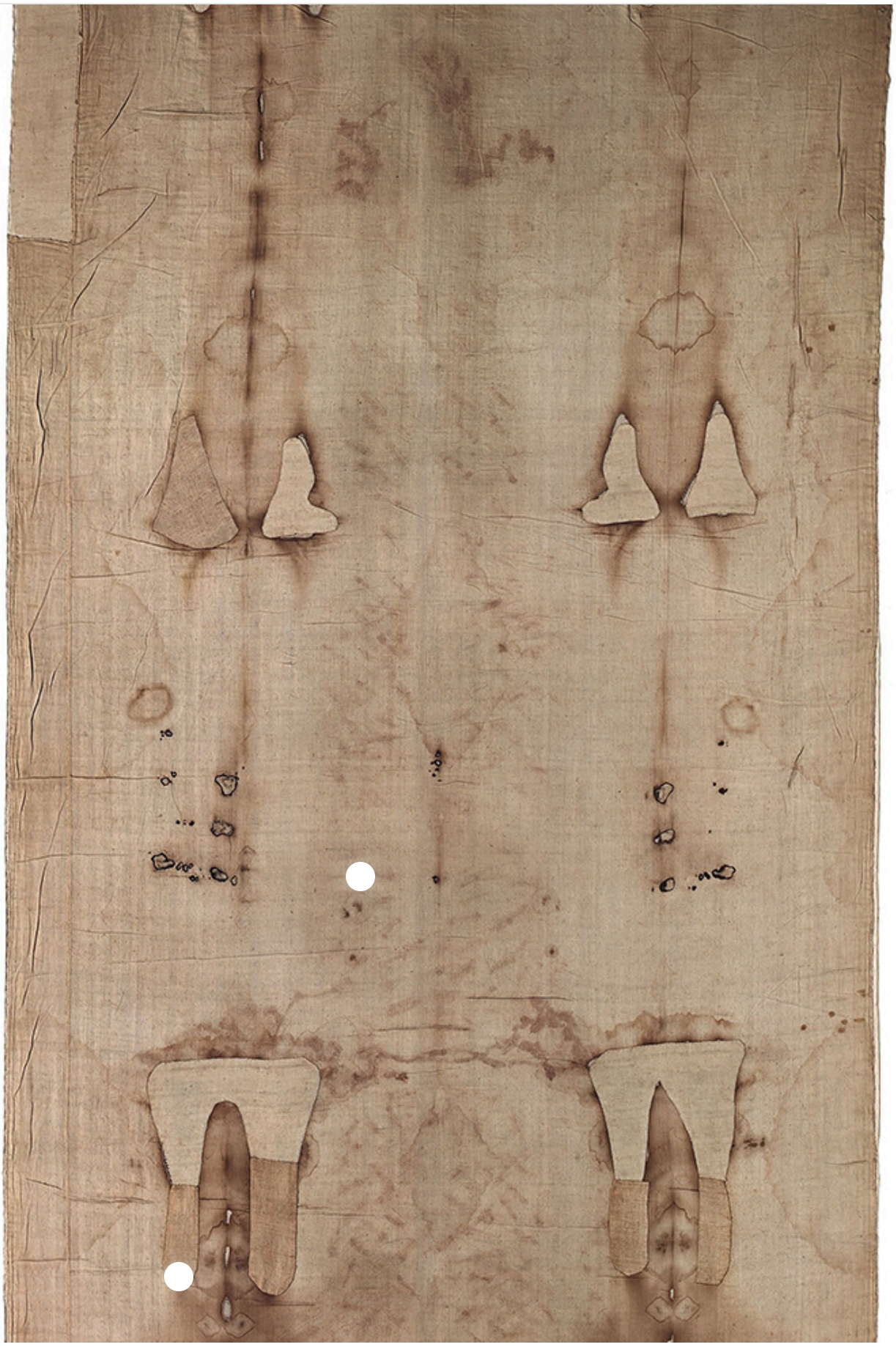
of an artist," the project's **1981 report** declared. "The blood stains are composed of hemoglobin and also give a positive test for serum albumin." But the report also conceded that no combination of "physical, chemical, biological or medical circumstances" could adequately account for the image.

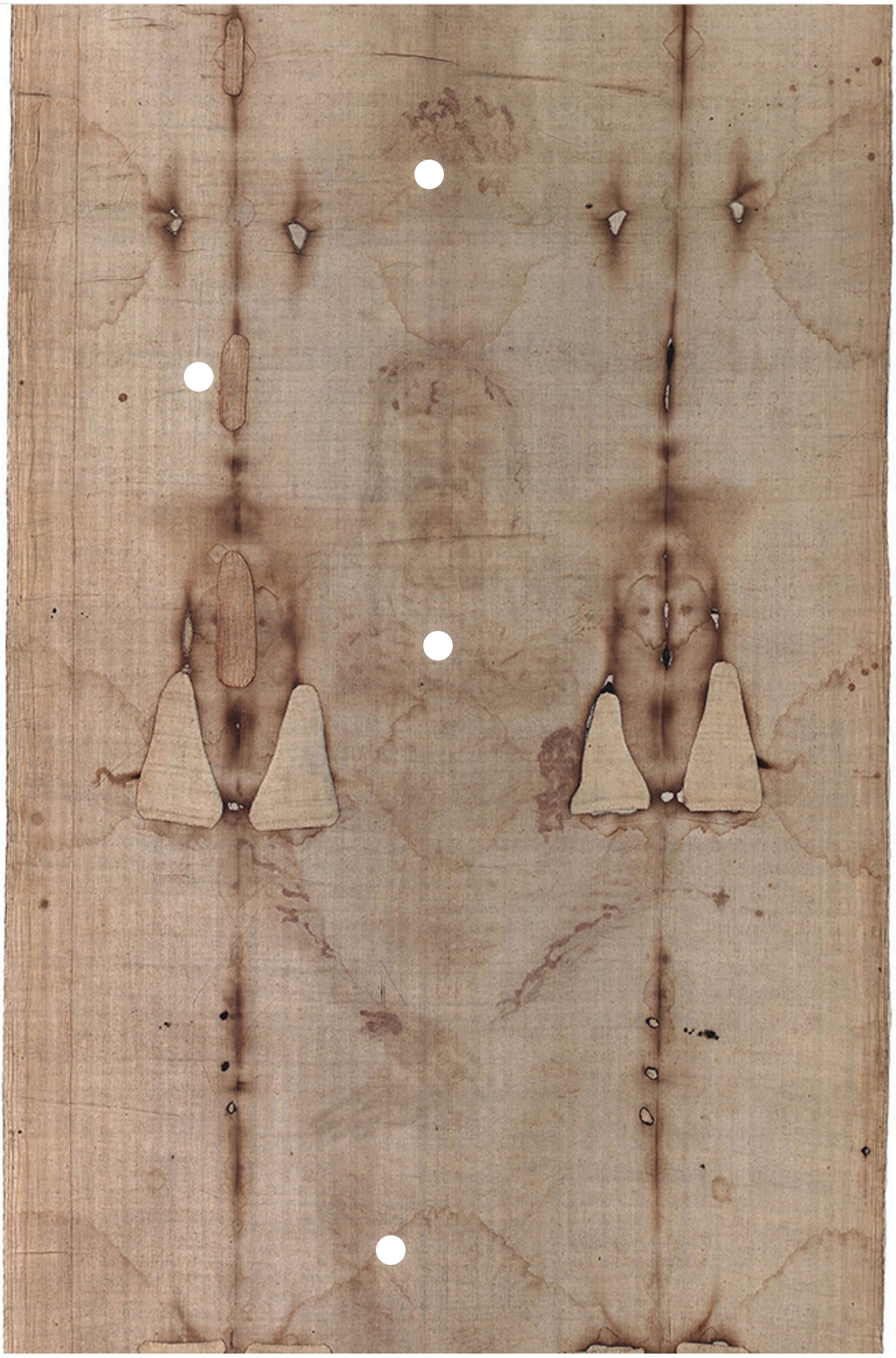
The Shroud of Turin, the STURP team concluded, "remains now, as it has in the past, a mystery."

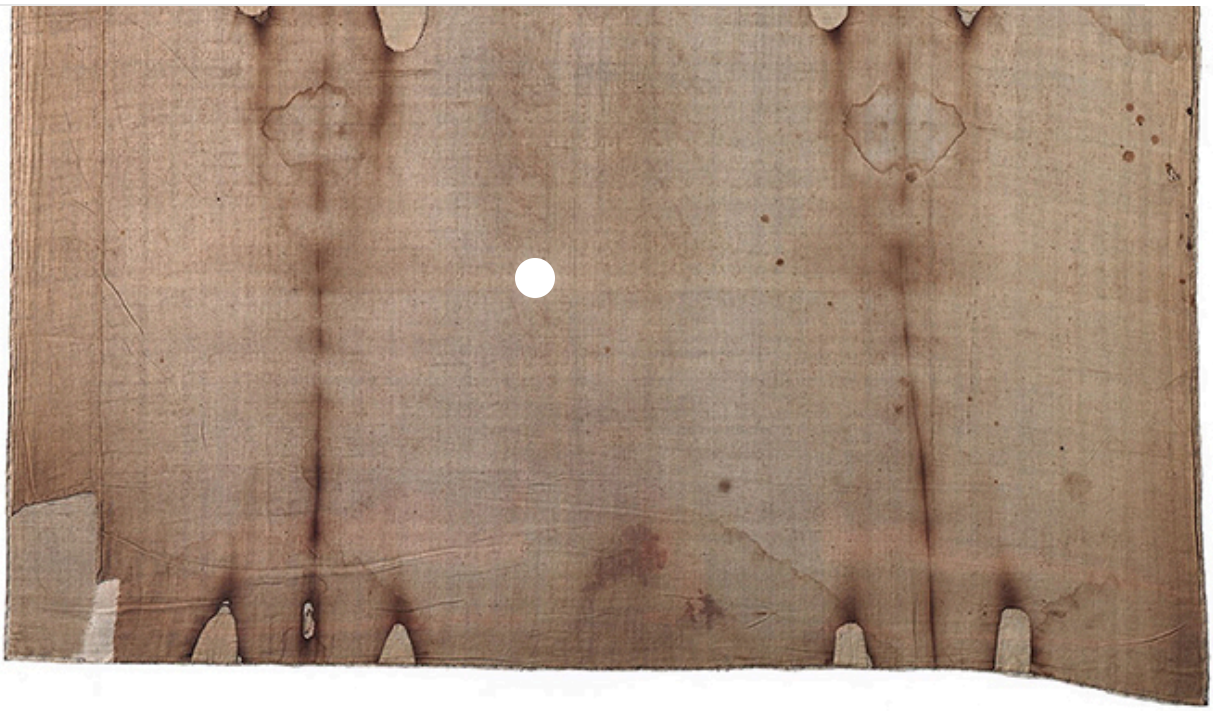
The Carbon-14 Bombshell

In 1988, the Vatican authorized carbon-14 dating of the shroud. Small samples from a corner of its fabric were sent to labs at the **University of Oxford's Radiocarbon Accelerator Unit (RAU)**, the University of Arizona, and the Swiss Federal Institute of Technology. All three found that the shroud material dated to the years between 1260 and 1390, more than a millennium after the life and death of the historical Jesus.

Marks on the Shroud of Turin







The labs assessed the reliability of their estimate at 95 percent. To make the case even more convincing, the dates closely coincided with the first documented appearance of the Shroud of Turin in 1353.

Since their release 27 years ago, the carbon-14 dating results have become the focal point of the shroud controversy, with a stream of critics taking aim at its methodology and conclusions.

Among the most innovative critiques were those published in 2010 by statisticians **Marco Riani**, of the University of Parma in Italy, and **Anthony Atkinson**, of the London School of Economics. In a recent interview with National Geographic, they noted that the laboratories conducting the carbon-14 tests were in full agreement on the ages of control fabrics from an ancient Egyptian mummy, a medieval Nubian tomb, and a medieval French ecclesiastical vestment. Yet raw data from the same tests on the shroud yielded results that differed by more than 150 years.

HISTORY & CULTURE

Why the idea that the Maya civilization 'collapsed' is wrong

The published carbon-14 findings were the mean results drawn from the combined data of the three labs. It was assumed that the data were "homogeneous"—near-identical age estimates based on repeated measurements of the samples, each of which had been divided into four segments for testing.

But when computers crunched through all 387,072 ways to cut the samples, they identified a marked pattern of variations. "The dating which comes from a piece at the top edge [of an uncut sample] is very different from the date which comes from a piece taken from the bottom edge," Riani explains.

"Our research does not prove that the shroud is authentic, nor that it is 2,000 years old," he cautions. But it does call into question the carbon-14 report's assertion of "conclusive evidence that the linen of the Shroud of Turin is medieval."

NATIONAL GEOGRAPHIC

The Question of Questions

Looming above all other issues is what physicist Paolo Di Lazzaro calls “the question of questions”: how the image was produced, regardless of its age. Every scientific attempt to replicate it in a lab has failed. Its precise hue is highly unusual, and the color’s penetration into the fabric is extremely thin, less than 0.7 micrometers (0.000028 inches), one-thirtieth the diameter of an individual fiber in a single 200-fiber linen thread.

Di Lazzaro and his colleagues at Italy’s **National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)** conducted five years of experiments, using state-of-the-art excimer lasers to train short bursts of ultraviolet light on raw linen, in an effort to simulate the image’s coloration. The ENEA team, which **published its findings in 2011**, came tantalizingly close to approximating the image’s distinctive hue on a few square centimeters of fabric. But they were unable to match all the physical and chemical characteristics of the shroud image. Nor could they reproduce a whole human figure.

Visitors to Jerusalem's Church of the Holy Sepulchre gather around the Stone of Anointing, held by church tradition to be the spot where Christ's body was prepared for burial.

PHOTOGRAPH BY MARCO ANSALONI

The ultraviolet light necessary to do so "exceeds the maximum power released by all ultraviolet light sources available today," says Di Lazzaro. It would require "pulses having durations shorter than one forty-billionth of a second, and intensities on the order of several billion watts."

If the most advanced technologies available in the 21st century could not produce a facsimile of the shroud image, he reasons, how could it have been executed by a medieval forger?

For believers, the radiation thesis suggests that a "divine light" in the tomb might have seared the crucified form of Jesus Christ onto the shroud. "One could look at hypotheses outside the realm of science, a sort of miracle," says Di Lazzaro. "But a miracle cannot be investigated by the scientific method."

A life-size reproduction of the shroud at a Turin museum has been photographically enhanced. The actual image appears as faint as an apparition.

PHOTOGRAPH BY MARCO ANSALONI

Historical Backdrop

References to various “divine images” of Christ, some explicitly described as burial sheets, reach back 15 centuries. Whether or not any was the linen known today as the Shroud of Turin is uncertain. The history is clearer after 1353, when a French knight, **Geoffroi de Charny**, acquired the shroud and deposited it at a monastery in Lirey, France, 130 miles east of Paris. By the early 16th century, it had been moved to the city of Chambéry, where it was damaged by a fire in 1532, leaving scorch marks and water stains that are still visible on the fabric. Its owner by then was the aristocratic **House of Savoy**.

In 1578, the Savoys moved the shroud to their capital, Turin. It has been there ever since, housed in the royal chapel of the Cathedral of Saint John the

The Vatican takes no official position on the shroud's authenticity, although it encourages the faithful to venerate it as a symbol of Christ's suffering. As Pope John Paul II put it in 1998, "The Church entrusts to scientists the task of continuing to investigate."

ARCHAEOLOGY BIBLE ANCIENT HISTORY