

16TH

INTERNATIONAL SYMPOSIUM

ON NONDESTRUCTIVE
CHARACTERIZATION
OF MATERIALS

10-12 August 2021

Royal Sonesta Harbor Court
Baltimore, MD

ASNT | **EVENTS.**



Nondestructive Testing of the Shroud of Turin

Robert A. Rucker

August 12, 2021

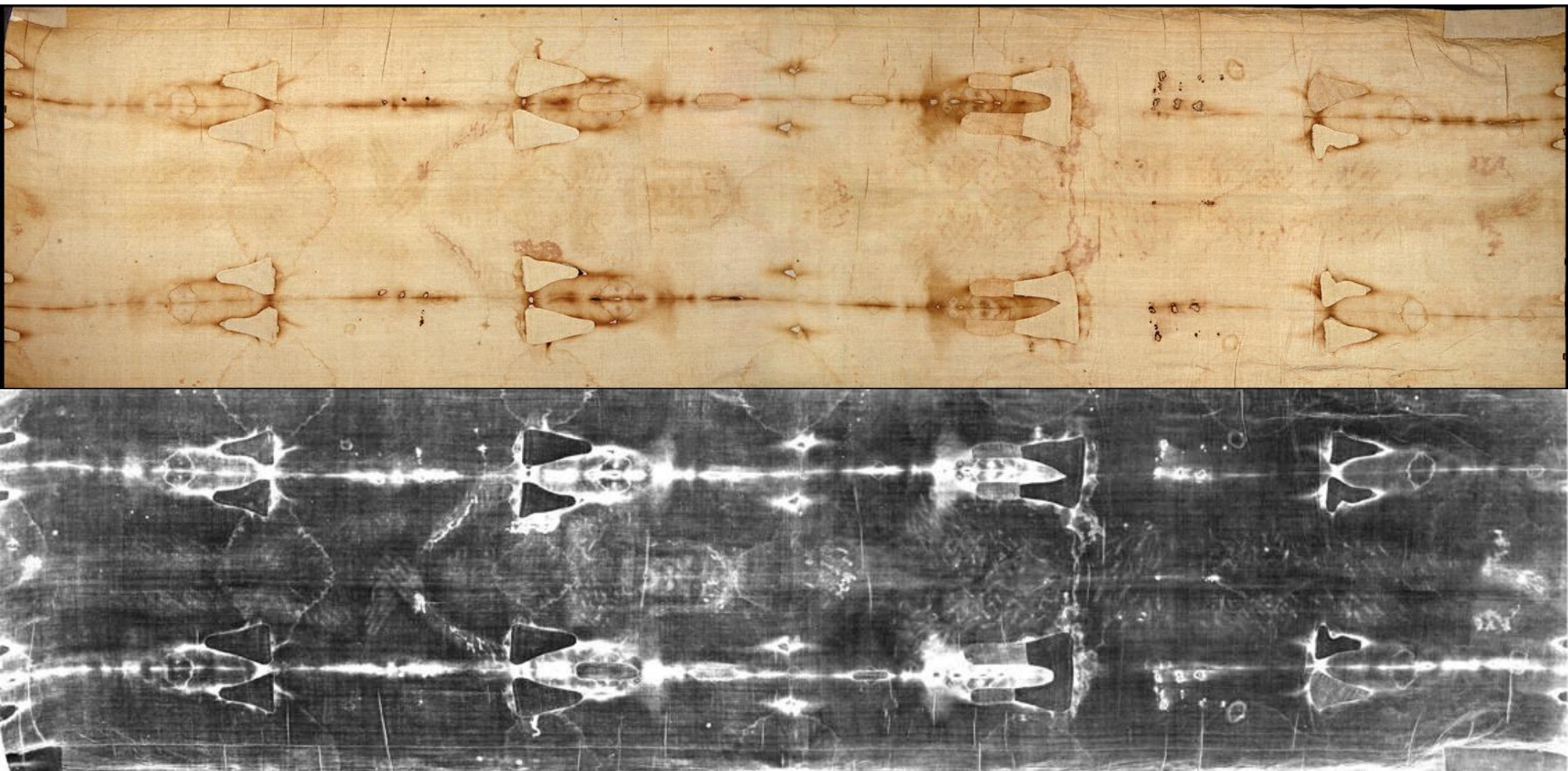
www.shroudresearch.net

American Society for Nondestructive Testing

Bob Rucker

- MS in Nuclear, U. of Michigan
- 38 years in the nuclear industry
 - Nuclear reactor design
 - NDT for fissile material in containers
 - Criticality safety for nuclear fuel production
- 8 years in Shroud research
 - 30 papers on www.shroudresearch.net
 - Organized Shroud conference in 2017
 - Goal: Explain the mysteries of the Shroud

Images on the Shroud of Turin



Photos ©1978 Barrie M. Schwartz Collection, STERA, INC.

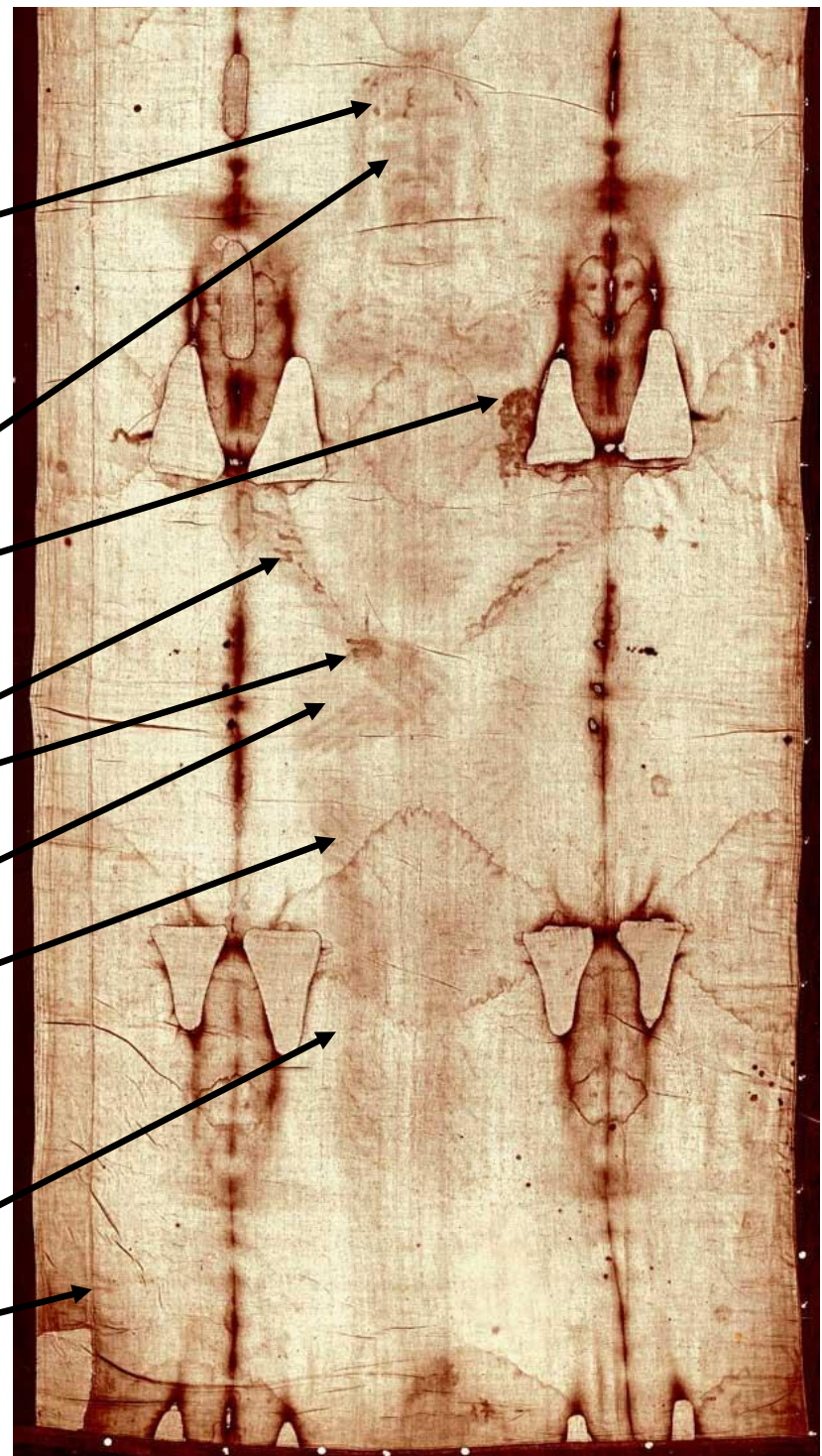
Descent from the Cross with the Shroud of Turin by Giulio Clovio, 1498-1578



Photo ©1978 Barrie M.
Schwartz Collection,
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Frontal Image

- Puncture wounds
- Swollen cheek and nose
- 2" wide elliptical wound
- Blood running down arm
- Nail through wrist
- Thumbs not visible
- Scourge marks
- Nose & knee abrasions
- Side strip sown on



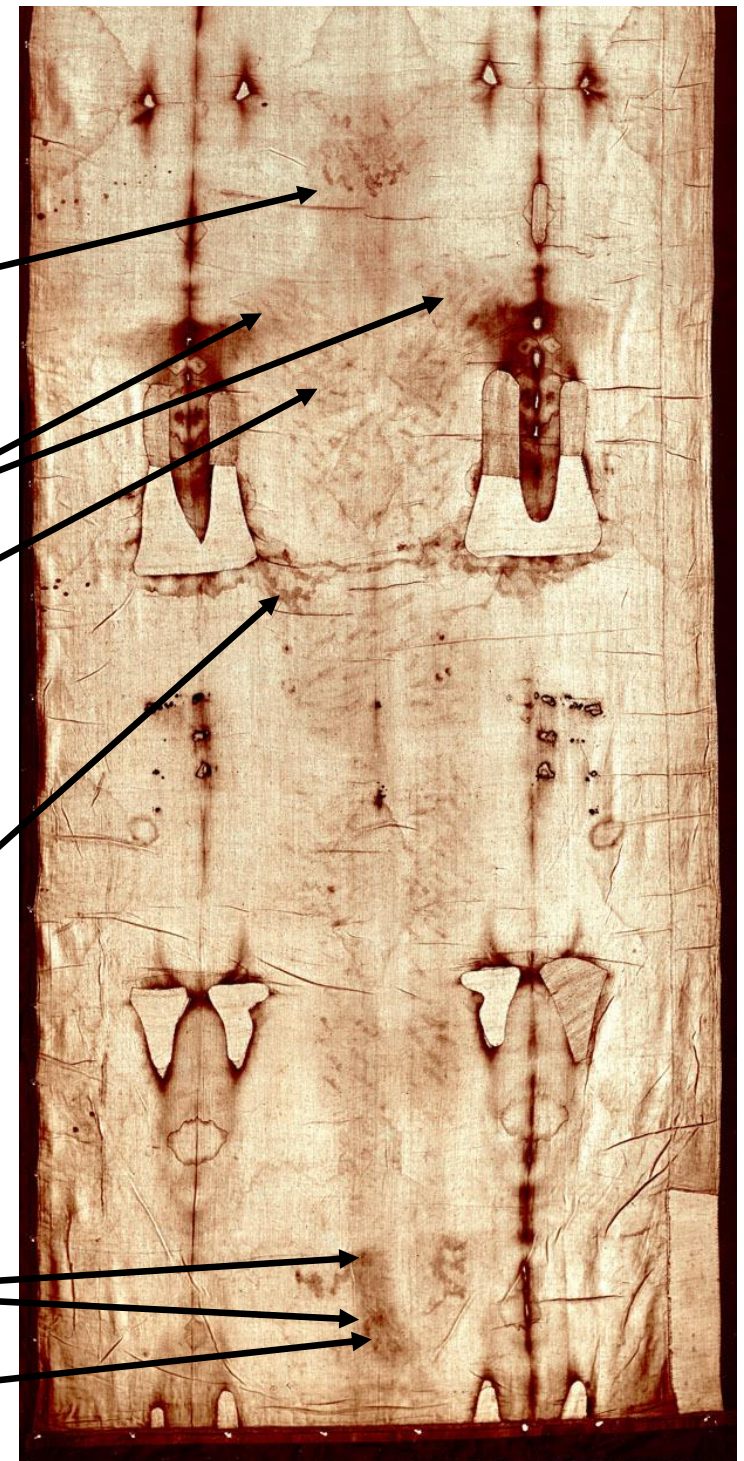
Photographic Negative of the Face

Photo ©1978 Barrie M. Schwartz Collection, STERA, INC.



Dorsal Image

- Puncture wounds on the back of the head
- Abrasions on shoulders
- ~ 120 scourge marks from 2 Roman flagrum with dumbbells on ends
- Flow of blood and clear blood serum from the side wound
- Two nails through feet
- Rigor mortis in feet



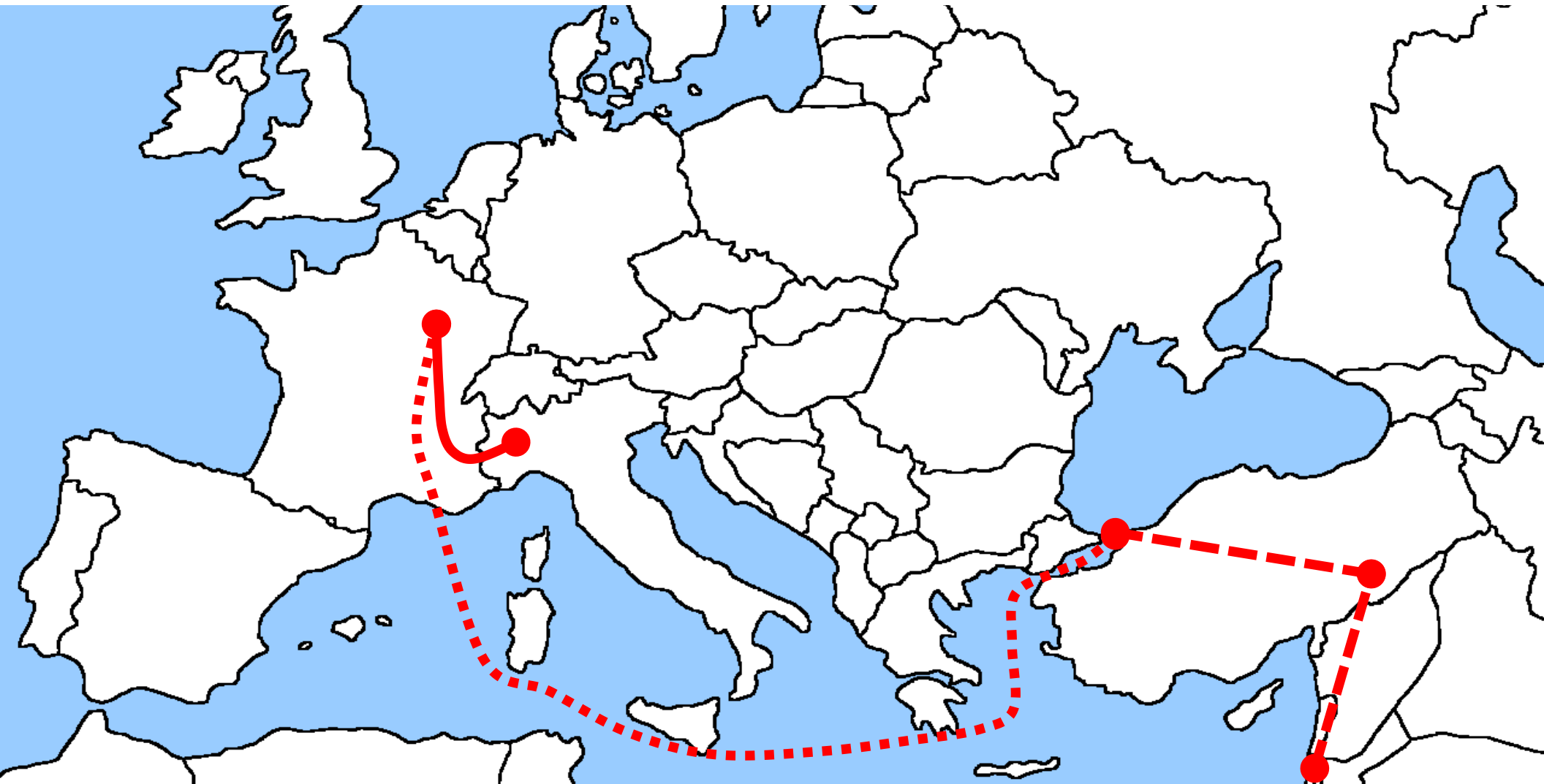
Cathedral in Turin (Torino), Italy

Photo ©1978 Barrie M. Schwartz Collection, STERA, INC.



History of the Shroud (paper 19)

Jerusalem → Antioch (?) → Gal. 3:1 (?) → Edessa (Urfa), Turkey → Constantinople (Istanbul), Turkey → Athens (?) → Lirey, France → Turin, Italy



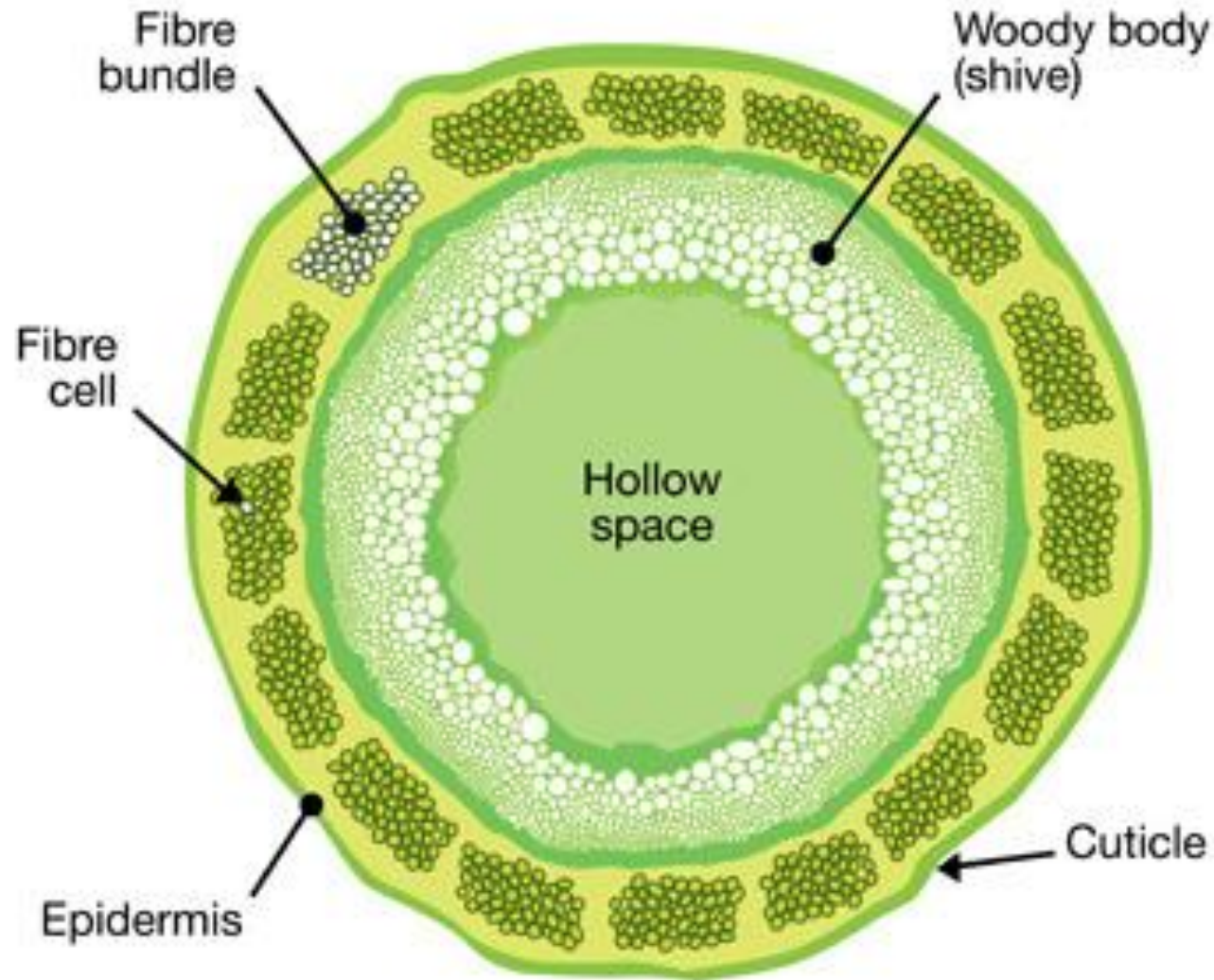
Opportunity for NDT of the Shroud

- Last tested in 1978 after an exhibition
- Rumors of an exhibition in 2025
- Vatican could allow testing in 2025
- Need NDT program to promote a decision to allow testing
- Improvements in NDT since 1978

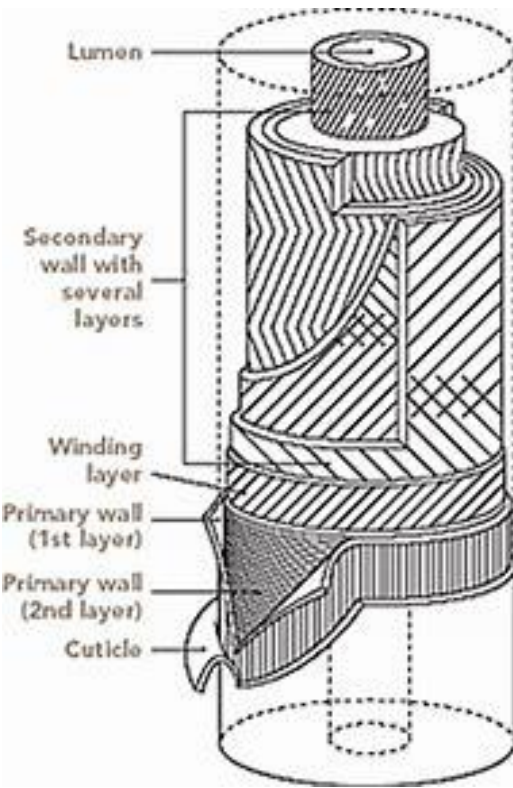
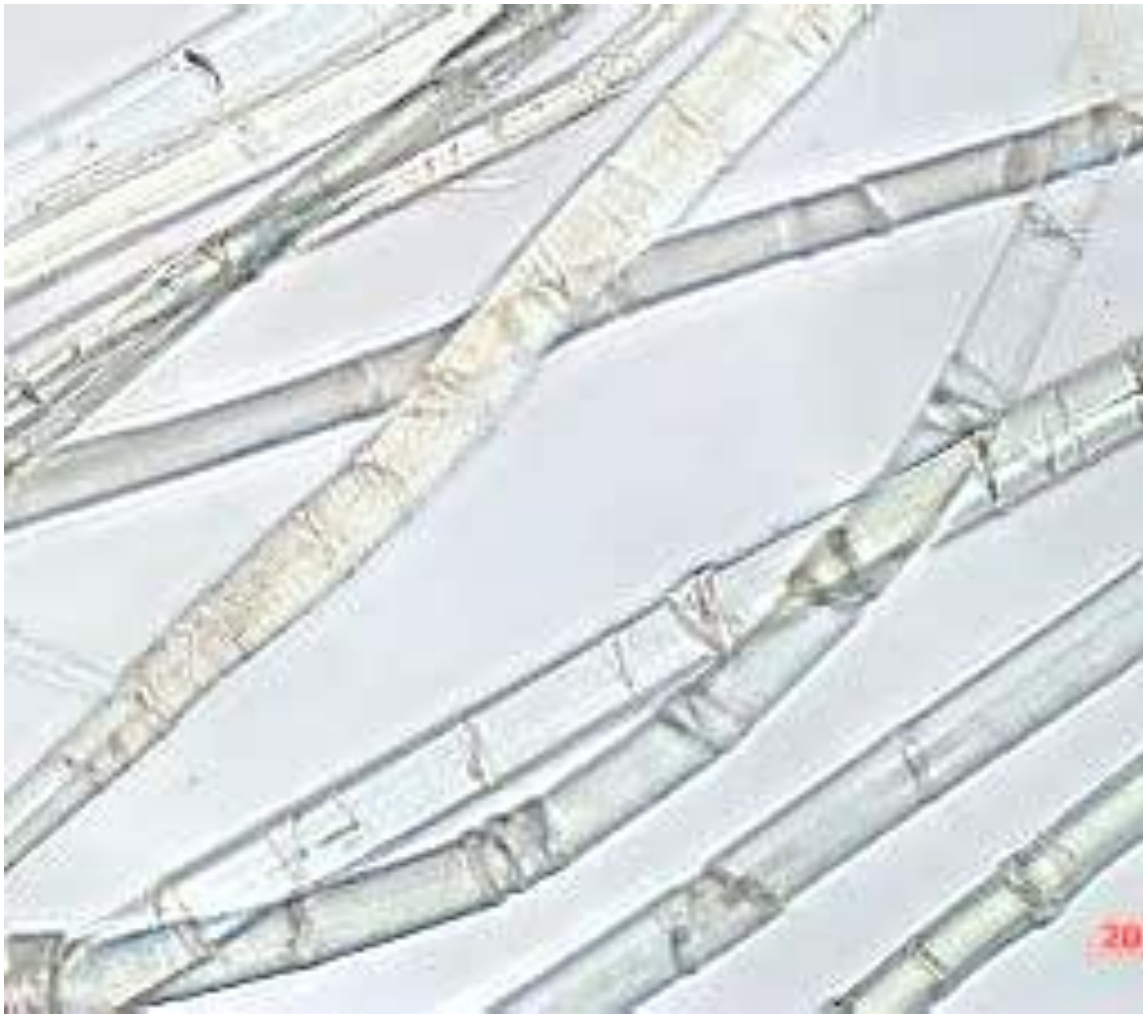
Linen is Made from the Flax Plant



Stem of a Flax Plant



Flax Fiber



Dorsal Image, Small of the Back (32x)



Tip of the Nose (64x)

Photo ©1978 Barrie M. Schwartz Collection, STERA, INC.



Shroud is the Most Researched Artifact in Human Possession

- Dr. Yves Delage, Prof. of Comparative Anatomy, Paris 1900-1902
- Dr. Paul Vignon, Professor of Biology, Paris 1900-1943
- Dr. Pierre Barbet, Prof. of Anatomy, Paris 1932-1961
- Dr. Robert Bucklin, M.D, Forensic Examiner, LA 1941-1993
- Dr. Frederick Zugibe, Chief Medical Examiner, NY 1953-2002
- Dr. Alan D. Adler, Prof. of Chemistry, Conn. State U. 1978-2000
- Dr. John Heller, Prof. of Medical Physics, Yale 1978-1995
- Dr. John Jackson, Prof. of Physics, Air Force Aca. 1978-
- Dr. Baima-Bollone, Chief of Forensic Medicine, Turin 1978-

STURP Scientific Investigation, 1978

- **STURP** = **S**hroud of **T**urin **R**esearch **P**roject
- 26 American scientists to Turin, Italy
- Equipment worth 2.5 million dollars
- Allowed to do any non-destructive experiment
- 5 days, 24 hours a day
- Worked in three shifts
- Led by Dr. John Jackson

Shroud of Turin Research Project (STURP)

Photo ©1978 Barrie M. Schwartz Collection, STERA, INC.



Testing by STURP in 1978

- Light (1000x) and electron microscopy
- Photography, various wavelengths, front & back
- UV spectrophotometry of fluorescence
- X-ray fluorescence and absorption radiography
- Thermal photography
- Mass spectrography
- Laser-microprobe Raman spectroscopy
- Attempts to alter color on fibers using acids, bases, oxidants, reductants, organic chemicals

Testing by STURP in 1978

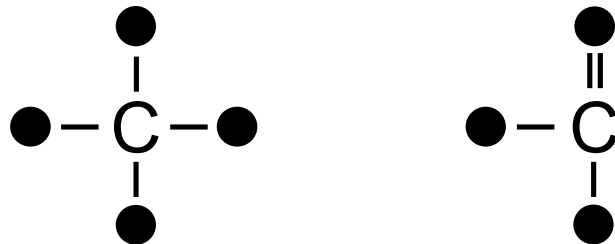
- Testing image for the presence of protein using:
 - Ultraviolet fluorescence test
 - Biuret-Lowry test
 - Proteolytic enzymes
 - Fluorescamine test
- Blood tested for protein, high Fe content, hemochromagen, human albumin, porphyrin fluorescence, cyanmethemoglobin, bile pigments, protease, bilirubin, immunoglobulin, serum clot rings, and blood reflectance spectra

STURP's Conclusions

- Image not due to paint, dye, or stain
 - No pigment, no binder, no brush strokes
 - No clumping of fibers or threads
 - No stiffening of the cloth
 - No cracking of image along fold lines
- Image not due to any liquid: no capillarity
- Not a scorch from hot object: no fluorescence
- Not a photograph: 3D information in the image

STURP's Conclusions

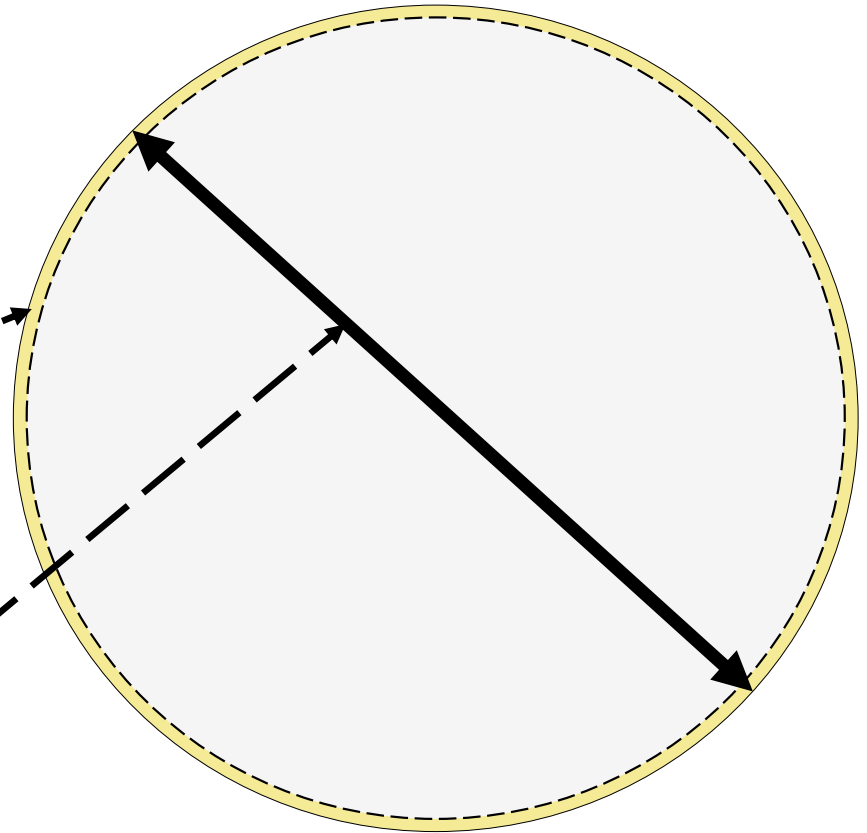
- Only top 1 or 2 layers of fibers discolored
- Discoloration $\leq 0.2 \mu\text{m}$ deep around $20 \mu\text{m}$ fiber
- Discoloration caused by a change in the atomic structure of the atoms in the cellulose
- Carbon atoms changed from all single electron bonds to some double electron bonds:



- Not due to any substance added to the cloth

Discolored Fiber

The discolored layer is a sepia or light straw-yellow color with a thickness of ≤ 0.2 micrometers around the fiber's circumference. The diameter of a linen fibers is about 20 micrometers = 0.020 mm = about 1/5 the diameter of a human hair.



Mystery #1: Image Formation

- We can see the image on the Shroud because the information that defines the form of a crucified man has been encoded into the pattern of discolored fibers on the cloth. (Paper 26)
- Information was carried from body to cloth by vertically collimated radiation.
- Caused an electrical discharge from top fibers → heat & ozone → discoloration

Mystery #2: Carbon Dating

Location of Samples for C¹⁴ Dating

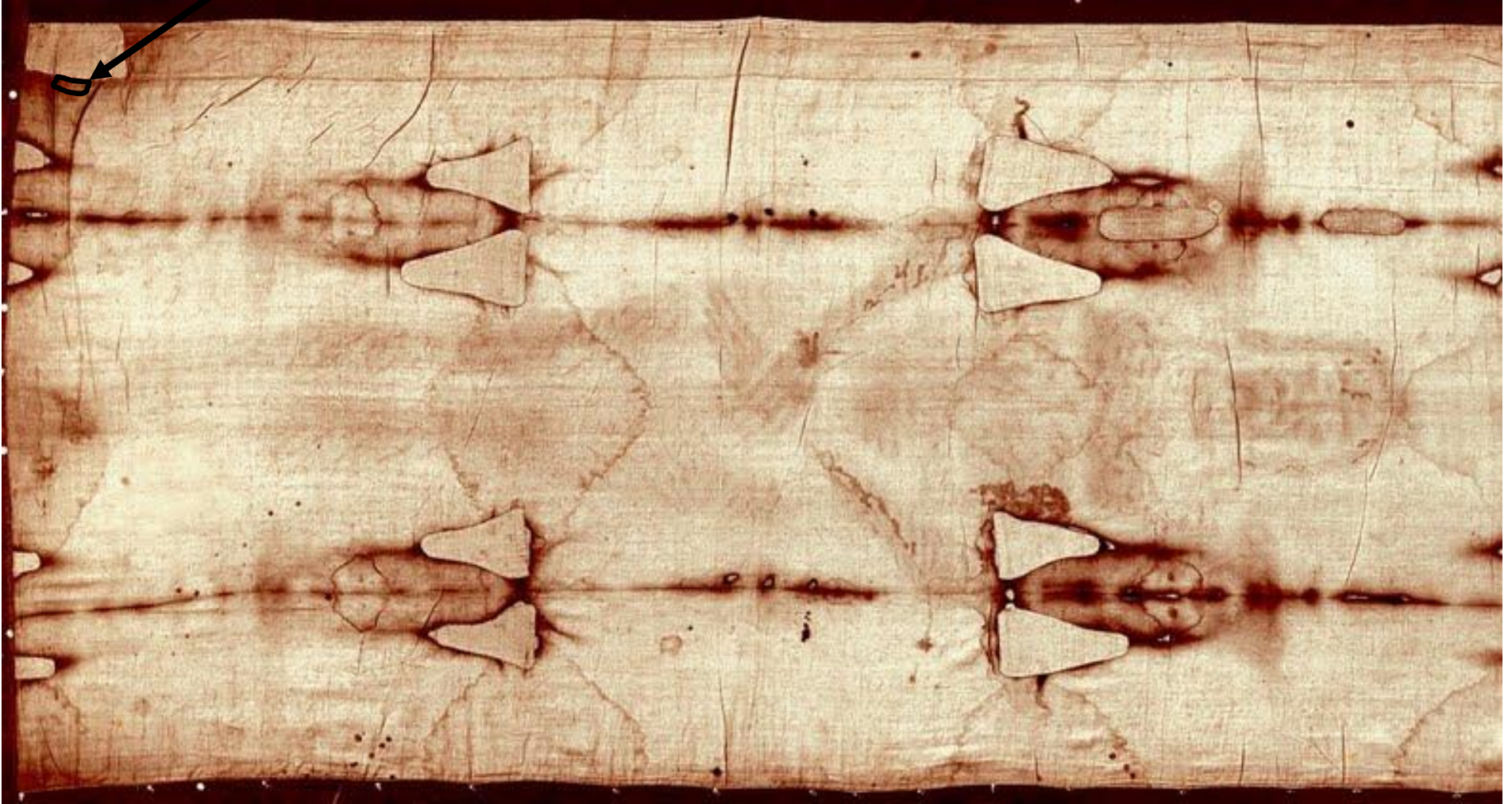
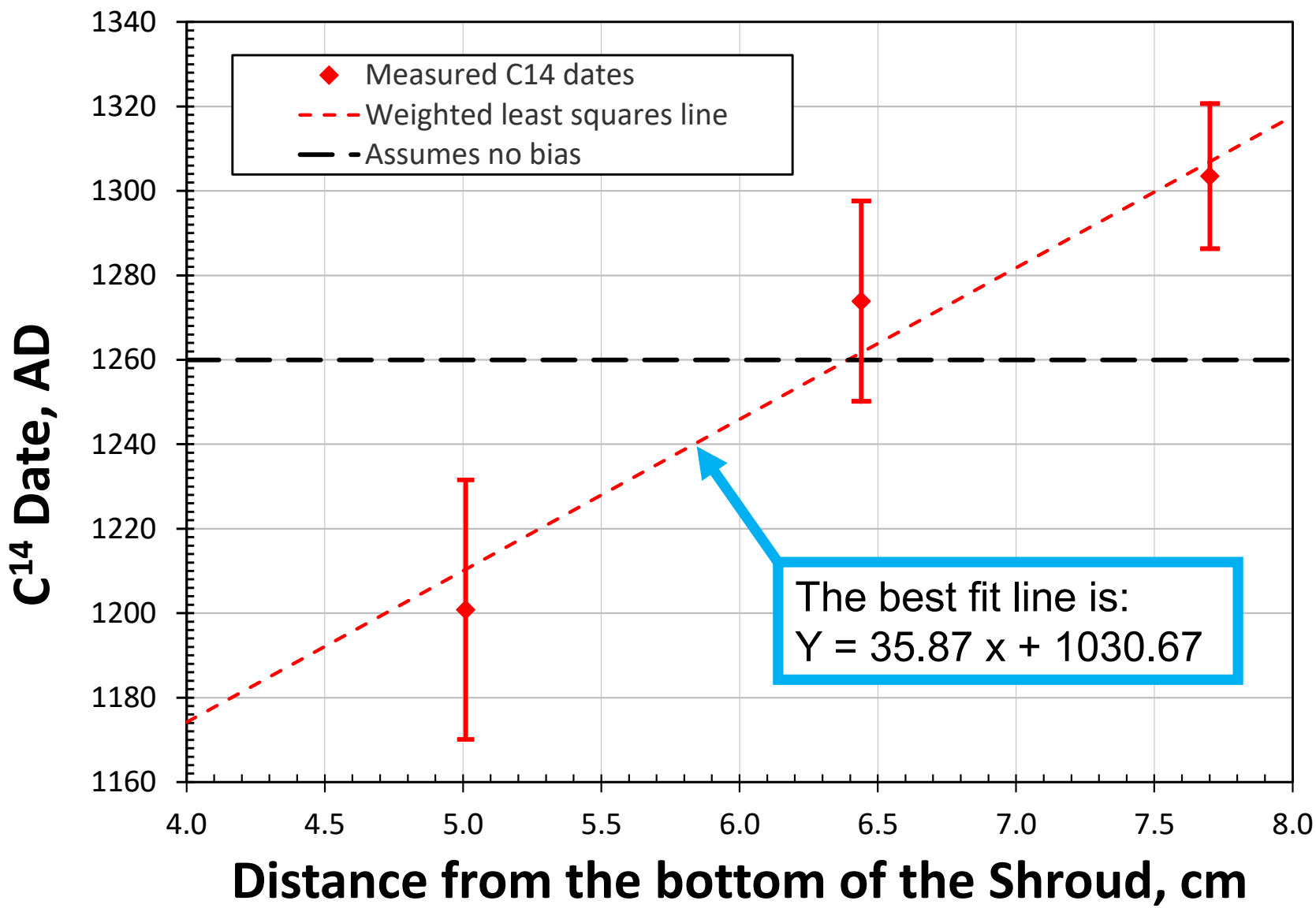


Photo ©1978 Barrie M. Schwartz Collection, STERA, INC.

1260-1390 AD Should be Rejected

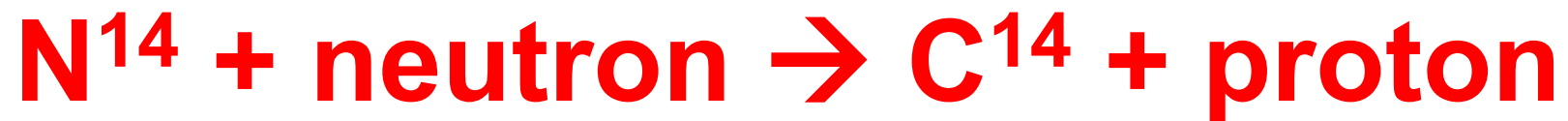
- The technology did not exist to make the image in 1260-1390
 - 13 date indicators contradict 1260-1390
 - Statistical analysis of measurement data
 - Dates depend on distance from end of cloth
 - Two labs different by 104 ± 35 (3.0 sigma)
 - Probability different dates are consistent with the random errors is only 1.4%
- (Papers 9, 10, 11, 12, 23, 25, 28, and 30)

Dates are a Function of Sample Location



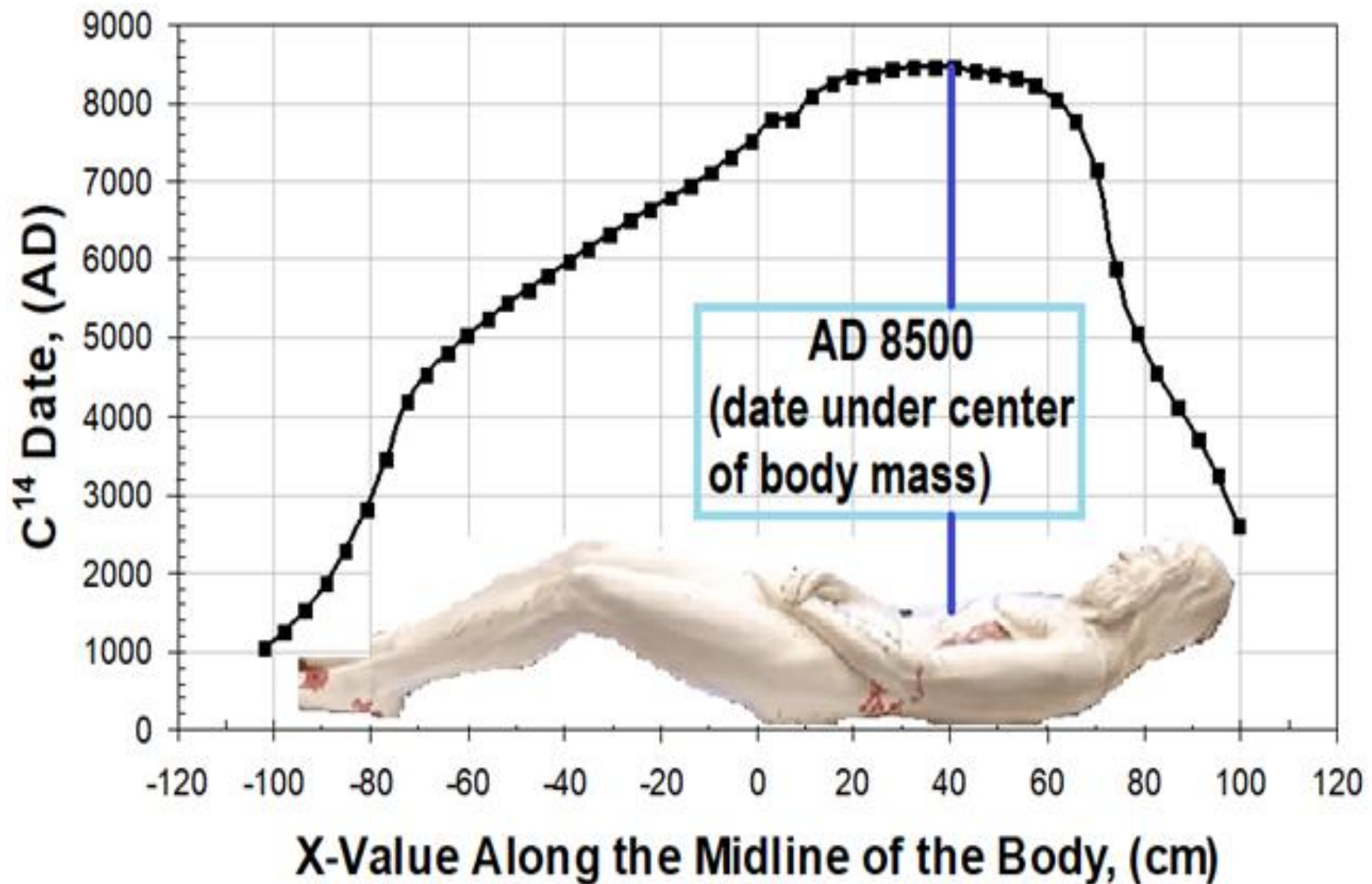
Neutron Absorption Hypothesis

If neutrons were included in the burst of radiation that caused the image, then a small fraction of them would have been absorbed in N^{14} in the Shroud to produce new C^{14} atoms:



This would cause the Shroud to be C^{14} dated younger than its true age.

C¹⁴ Date in Shroud Below the Body



Mystery #3: Blood

- It is blood, consistent with human blood.
- Blood could drain onto the cloth from wounds in the scalp, wrists, side, & feet
- But dried blood is not absorbed by cloth
 - Blood from wrists that ran down the arms
 - Blood from scourging
- Burst of radiation could have thrust dried blood off the body onto the cloth by radiation pressure.

Questions for Future Testing

- Image Formation
 - Nature & location of discoloration?
 - Evidence of bones, backside image, coins?
 - Cause of banding and mottling?
 - Evidence of radiation / neutron absorption?
- Dating
 - Carbon dates for other locations?
 - Evidence of an invisible reweave?
 - Other dating methods?

Questions for Future Testing

- Blood
 - Location, shape, composition, serum rings?
 - Is blood human, male, type AB?
 - DNA genome? What race?
 - Why is it reddish? Has it been painted?
- History
 - Pollen?
 - Limestone chips, dust, debris?
 - Side piece and stitch?

NDT Methods for Testing the Shroud

- Light and electron microscopy
- Multispectral & Hyperspectral imaging
- X-ray fluorescence
- Fourier Transform Infrared Spec.
- Raman and Energy Dispersive Spec.
- Atom probe tomography
- Nuclear Activation Analysis
- Radiation detection methods

Further Information

- Websites
 - shroud.com, Barrie Schwartz
 - shroudresearch.net, Bob Rucker
 - testtheshroud.org, Mark Antonacci
- Books
 - “Report on the Shroud of Turin”, Heller 1983
 - “The Blood and the Shroud”, Wilson 1998
 - “Resurrection of the Shroud”, Antonacci 2000
 - “Test the Shroud”, Antonacci 2015
 - “The Shroud of Turin”, Fanti & Malfi, 2015

Thank You

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