

The Shroud

A Critical Summary of Observations, Data and Hypotheses



"If the truth were a mere mathematical formula, in some sense it would impose itself by its own power. But if Truth is Love, it calls for faith, for the 'yes' of our hearts."

Pope Benedict XVI

Version 1.3

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Preface

The only purpose of TSC's **Critical Summary** is to provide a synthesis of the TSC team's thinking and understanding about the Shroud and to make that synthesis available to the serious inquirer. Our evaluation of scientific, medical forensic and historical hypotheses presented here is based on TSC's internal research, STURP data, studies by other groups or persons as appropriate, and published literature.

The evaluations made herein are not intended, and should not be construed, as representing or presenting a unified global consensus or final word on Shroud research. There are, in fact, many contrasting opinions that can be found on the Shroud in various books, papers, and websites. We hope, however, that our analysis will provide a meaningful focus to understanding the Shroud from the perspective of our particular organization. Even our synthesis at TSC that we present here is at best an approximation because our team members sometimes hold different opinions on issues, but we strive to resolve differences, not by debate of varying opinions, but by designing ways to test hypotheses based on the Scientific Method and then evaluating results to form our synthesis from a team internal review process.

Only new hypotheses that have first been published elsewhere are included herein. The rating given to each item is based on TSC's judgment of whether the item is "Established", "Plausible" or "Disputed", even though there might still be contrary opinions elsewhere. In coming to this judgment we have done our best to reflect an honest and thorough review of all the pertinent published research results and then integrating these results with our own work. We intend to evaluate our ratings over time as new published research results emerge.

We welcome comments and input, but we can only consider those that are substantive and which are emailed directly to our website (via the Shroud Data tab).

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Introduction

The purpose of this document is to make available to the serious inquirer a comprehensive and up-to-date source on the various hypotheses and data related to the Shroud of Turin. One thing is certain.....the Shroud is an artifact that plainly exists. It is of interest because it is claimed by many to be the actual burial cloth of Jesus of Nazareth. This is a remarkable claim. Can it be true? This is a question that interests Christians and non-Christians alike. Only by an examination of the evidence can the inquirer make a judgment regarding the answer to that question. The authors of this paper have made an attempt to summarize that evidence in this document. We are grateful for the review of our work by many who have reviewed the document. In particular, we are grateful to Dr. John P. Jackson and Dr. Keith Propp for their patient review and helpful comments. John Jackson is a PhD in physics and is one of the founders and serves as the president of the Turin Shroud Center of Colorado (TSC). Keith Propp is also a PhD in physics. He serves as a leading member of the TSC research team. The authors themselves have served for a number of years at TSC as research associates.

In 1978 Dr. Jackson led a large team of scientists, under the auspices of the Shroud of Turin Research Project (STURP), to study the Shroud in Turin, Italy. The STURP team was given unprecedented access to the Shroud. For 120 continuous hours the Shroud was examined and data was collected. Such direct and free access to the Shroud had not been given prior to this, nor has it been given since. One of the primary goals of the STURP team of scientists was to test the hypothesis that the Shroud's image was painted and to gather data that would assist in the evaluation of other possible image formation hypotheses. The team consisted of outstanding scientists and researchers chosen solely for their scientific skills and expertise. The team used advanced scientific instruments available at that time for their five days and nights of examining the Shroud. Among the methods used to gather data were direct microscopy, infrared spectrometry, X-ray fluorescence spectrometry, X-ray radiography, thermography, and ultraviolet fluorescence spectrometry. In addition, a broad spectrum of photographic data was collected. Ultraviolet fluorescence photographs, raking-light photographs, normal front lit photographs and back lit photographs of the entire Shroud were taken. To support continued study and analysis once the on-site work was concluded, sticky tape samples from the surface of the Shroud cloth along with thread samples were collected and retained by the researchers. Subsequent studies of these samples were conducted using microscopy, pyrolysis-mass-spectrometry, laser-microbe Raman analysis and microchemical testing. The results of the STURP research were published in 24 peer-reviewed scientific journal articles over the four years following the conclusion of the work in Turin. This document includes many pieces of data that trace their source back to the research conducted by the STURP team as well as data from the broad spectrum of studies conducted by other scientists, forensic and historical researchers in the years following STURP.

The analyses contained herein is presented in five (5) tables as follows:

1. Image Characteristic Evidence

In order to build upon the work of other Shroud research colleagues not associated with TSC, we have included, as an initial benchmark, the image characteristics that are most often mentioned in the corpus of

empirical studies on the Shroud and also enumerated in an important paper by Giulio Fanti published in the ***Journal of Imaging Science and Technology***. (See reference 1.) The cardinal numbered items in this table correspond to the characteristics listed in Fanti's paper. The descriptions for these items generally conform literally with Fanti's descriptions. Where changes to Fanti's descriptions have been made, for what we think adds better clarity or precision, the changes are documented in the **Revision Log**. There are additional items included in the table that augment Fanti's list. These items are supported by multiple sources including the research team of TSC. These additionally listed image characteristics, like the benchmark characteristics, place restrictions on proposed image formation hypotheses. The additional items are inserted into the table at what we believe are the proper logical points and are identified with a decimal fraction number.

2. Image Formation Hypotheses

This table presents the most important image formation hypotheses that have been proposed down through the years.

3. Evaluation of Image Formation Hypotheses

This table presents a matrix lining up Image Characteristics with proposed Image Formation Hypotheses. The table thus presents a critical evaluation of the proposed image formation hypotheses.

4. Linen Cloth Data

This table presents the most important data related to the linen cloth of the Shroud, including information concerning carbon dating of the cloth.

5. Medical Forensics Data

This table presents the major findings from medical forensic research on the Shroud image and related stains and materials on the cloth.

6. Historical Data

This table is under construction.

The items in Table 1, 4, 5 and 6 are presented in a table grid, an example of which is illustrated below:

Established
 | **Plausible**
 | | **Disputed**
 | | |

ID	Data or Observation	E	P	D	Comment
I1.0	The front and back images of the body show almost the same color intensity (yellow-brown), i.e., at first sight, we cannot appreciate, which image is the more evident, front or back.	X			To the naked eye it is difficult to distinguish between the intensity of the frontal and dorsal body images. We believe this observation demonstrates that neither cloth-body contact nor the weight of the body on the cloth significantly affected the image formation process.

The first column gives the identification number (**ID**) for the hypothesis or data item presented. This column is also used for the reference to the endnotes. The second column gives what we believe is the best description of the observation, hypotheses or data. The next three columns indicate the status of the item. (**E**) stands for **Established**. This designation indicates that the item is either forensically or empirically soundly established. To be rated with an (**E**) the item must have multiple corroborating research sources or be supported as being true by a broad consensus of researchers. (**P**) stands for **Plausible**. This designation indicates that the item is broadly supported as being true but that additional research confirmation is needed or desirable before the item can receive the firm status of being established. (**D**) stands for **Disputed**. This designation is used to classify items as not currently supported by multiple published research findings or that the item is seriously disputed by different researchers. The **comment** column is used for our clarification and, where appropriate, our opinion on the item including what conclusions we believe can be reached concerning the item.

About Versions

The document itself is designed to be maintained and evolve over time as new scientific analyses and data emerge. Thus, this document can be characterized, uniquely, as a “living” summary of Shroud research. To facilitate tracking all changes over time, each scientific hypotheses and item of data in all the tables have been given a unique identification number and the end notes are also tied to this identification number. As changes are made to the document a revision log will be updated to aid in tracking the changes. We believe this design will materially assist the reader to learn and keep up with scientific analyses and the publishing of new data regarding the Shroud.

Each new release of this document will be given a new version number. **Major** revisions will be given a new cardinal number designation, for example 1.0, 2.0, 3.0, etc. **Major** revisions will

be issued when there are significant new research findings related to the Shroud or the publication of very significant papers or books on the Shroud. All other revisions will be classified as **Minor** revisions and they will be given a decimal fraction designation, for example 1.1, 1.2, 1.3, etc.

Concerning Arguments and Judgments

Full disclosure requires that we acknowledge that we, along with Drs. Jackson and Propp, have come to believe that the totality of data supports the judgment that the Shroud of Turin once wrapped the body of Jesus of Nazareth. Nevertheless, we have consciously tried to avoid making an explicit argument in this document. Our goal is to objectively present a sound summary of the data associated with the Shroud. We respect the autonomy of each person to formulate his or her own judgment concerning what conclusions the data leads him or her to. Unfortunately, many people make a snap judgment concerning the Shroud based on one or two pieces of data or the fact that there are conflicting hypotheses. A good example is the data relating to **CARBON DATING**. In 1988 a sample cut from the Shroud was radiocarbon dated to indicate a cloth source date ranging between 1260 and 1390. Many Shroud researchers today believe the sample tested was not representative of the entire Shroud and that historical data now reliably places the Shroud in Constantinople in 1204, well before the date indicated by carbon dating. Yet many people who hear the Shroud was radiocarbon tested simply take the results at face value and look no further. This is a mistake. (In this document we address the **CARBON DATING** evidence in the Linen Table under Item L13.0).

There is a large corpus of scientific, forensic and historical data related to the Shroud and that data in its totality is complicated and interconnected. Consequently some level of effort to grapple with the totality of data must precede a judgment, if the judgment is to have any justifying weight. Our goal here is to help individuals to do that...to be exposed to the best summary of the totality of data that we can present and to have sound references to aid further individual research and inquiry. As an organization TSC has studied the Shroud for literally 10's of thousands of hours. We believe an individual must spend at least a number of hours in studying the extensive evidence in order to begin to form his or her own judgments and arguments concerning this fascinating object that many consider the most important artifact in existence.

Important Note on Photographs, Shroud Orientation and Terminology

The Shroud is a cloth approximately 14' 6" long by 3'9" wide, as shown in the photograph below.



← **Dorsal Image** (back of the body)

← **Frontal Image** (front of the body)

The body was placed on the end of the cloth corresponding to the dorsal image and the other end of the cloth was then folded over the head and then the top of the body. The image presented on the cloth is thus a mirror image of the actual body.



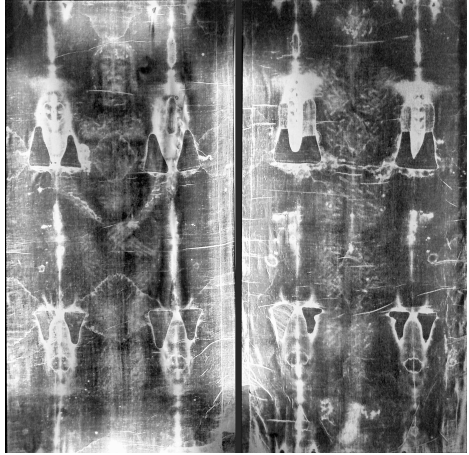
There are a number of Shroud photographs included in the various sections of this document. Keep in mind that the actual Shroud presents a mirror image of the body. In many cases the photographs have been reversed so that the image is not shown as a mirror image but rather as if the body itself is being viewed directly. Both orientations are used in this document as well as in other Shroud documents and resources where photographs are displayed. In most cases other Shroud resources do not alert the reader to which view is being presented. In order to avoid confusion we have labeled appropriate Shroud photographs to indicate whether the mirror image or body image view is being presented. We use the simple labels: mirror image or body image. In general, it may help the reader to remember that there are three important benchmarks that can always be used to help to establish the orientation being used for the frontal view, as follows:


- 1.** The actual body that was wrapped in the Shroud has the left hand crossing over the right hand.
- 2.** The prominent blood flow on the forehead of the actual body is in the shape of the number "3".
- 3.** The side wound is on the physical right side of the actual man of the Shroud. The large blood flow from the side wound, like the crossed hands, can help establish the orientation being viewed.

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Table I: Image Characteristic Evidence

Established
 | Plausible
 | | Disputed
 | | |

ID	Evidence	E	P	D	Comment
I1.0	<p>The front and back images of the body show almost the same color intensity (yellow-brown), i.e., at first sight, we cannot appreciate, which image is the more evident, front or back.</p>	X			<p>To the naked eye it is difficult to distinguish between the intensity of the frontal and dorsal body images. We believe this observation demonstrates that neither cloth-body contact nor the weight of the body on the cloth significantly affected the image formation process.</p>
I2.0	<p>The body image has the normal tones of light and dark reversed, so the body parts nearer the cloth are darker. This fact leads us to state that the body image appears as a photographic negative.</p> <p>See the contrasting naked eye and photographic negative images of the face below.</p> <div data-bbox="224 1146 786 1612" style="display: flex; justify-content: space-around;">   </div> <p style="display: flex; justify-content: space-around;"> Naked Eye View Photo Negative </p> <p>Photos of actual Shroud: (Mirror Image)</p>	X			<p>Italian photographer Secondo Pia took the first official photographs of the Shroud in 1898. He had been invited to photograph the Shroud while it was being exhibited to the public in the Turin Cathedral. As he developed the film he was shocked to see what was revealed. His negatives showed incredibly detailed images of an anatomically correct, naked and crucified man, which could simply not be seen when viewing the Shroud with the naked eye. When released to the public, Pia's photographic negative images acted to spontaneously launch modern scientific forensic and historical inquiry into the Shroud. As a result the Shroud has arguably become the single most studied artifact in history.</p> <div data-bbox="980 1325 1445 1776" style="display: flex; justify-content: space-around;">  </div> <p style="display: flex; justify-content: space-around;"> Frontal Dorsal </p> <p style="text-align: center;">(Body Image)</p>

I3.0	The image density distribution of both front and back images can be correlated to the clearances between the three-dimensional surface of the body and a covering cloth. This is why many state that the Shroud is a 3D image.	X		<p>The variation in the image density has been analyzed mathematically to render a high-resolution 3-dimensional body image.</p>  <p>While a photograph can be either a positive or a negative, there is no correlation in a photograph between the density of the imprint and the distance to the object. Uniquely, the image on the Shroud appears denser in the areas where the vertical distance to the body from the cloth surface would logically be shorter. This allows the use of a simple mathematical function to recover the 3-dimensional information about the body.</p> <p>The 3-D characteristics present on the Shroud cannot be recovered with any normal reflected light photograph or painting.</p>
I4.0	A body image is visible in areas of noncontact zones between body and Shroud, for example, the nose and cheek areas.	X		This characteristic is inconsistent with the image being formed by a contact mechanism.
I5.0	The front image, at least in correspondence of the face, is doubly superficial. This means that the 0.34-mm thick fabric presents a superficial image on one side (about 0.03 mm thick), no image in the middle, and another superficial image on the other side.	X		This double superficial image of the face was discovered when the Shroud backing cloth was removed during the 2002 preservation project. This double superficiality is highly significant in relation to the viability of competing image formation hypotheses.
I5.1	Compared to the frontal image, there is no double superficiality of the dorsal or back image.	X		An image formation hypothesis that is able to account for a frontal double superficiality of the face must also be consistent with there being no dorsal double superficiality.
I5.2	There is no image of the top of the head or of the sides of the body.	X		If there were side images then the body image, especially the face, would be grotesque. Instead the image shows a largely undistorted front and back of a naked human body. These results suggest a vertical mapping of the frontal image with respect to a body laid out

				horizontally on its back.
I6.0	The body image has a resolution of 4.9 ± 0.5 mm but no well-defined contours. This means that that human details such as the nose, lips, and beard are clearly defined, but that the body image seems to disappear if someone looks at it from a distance closer than about 1m.	X		The combination of the low contrast between the image and the background and the lack of defined borders makes the image essentially disappear when viewed from a range closer than 1.5 meters. An artist attempting to paint the image would need an assistant to indicate where to paint or an exceedingly long handle on the brush or applicator, scenarios inconsistent with the image's high resolution.
I7.0	The convex "hills" of the face (e.g., the eyeballs and tip of the nose) are more clearly represented than the concave hollows; the tip of the nose is one of the most evident.	X		This observation is consistent with the image being correlated with the cloth-to-body distance.
I8.0	The body image does not fluoresce when viewed under ultraviolet radiation		X	This observation tends to rule out scorching as an image formation mechanism since scorched linen clearly fluoresces when excited by ultraviolet light. This item is listed as Plausible because some researchers, including the TSC research team, believe some minor fluorescence can be seen in the image area. This item should be retested on the actual Shroud with more sensitive equipment and photographic techniques than those used in 1978 STURP research upon which this observation is based.
I9.0	The Shroud enveloped a dead human body.	X		There are bloodstains that are "off" of the body image, most prominently at the left elbow and to the side of the face in the hair. The off-body bloodstains support the conclusion that a body was indeed wrapped in the Shroud. There is a very complex coordination between body image and bloodstains that has not been explained forensically other than by an actual human corpse being wrapped in the Shroud..(see item I22.0). The wound in the side is also consistent with a post mortem wound (See Item M13.0).
I10.0	Image distortions of the hands, calves and torso correspond to those that would be obtained if a body was wrapped in the Shroud.	X		This two-dimensional distortion characteristic appears to be inconsistent with any proposed artistic image formation hypotheses.
I11.0	The pronounced rigor mortis of the body is evident, especially on the back image near the buttocks.		X	This forensic attribute is most evident on the dorsal image in the area of the buttocks where there is no observed flattening due to weight. The forensics of the Shroud image also show

				that the head and upper torso are slightly elevated from the horizontal and the knees are flexed. The item is placed in the (P) column because, although the image appears to be fully consistent with a state of rigor mortis, the fact that the body was in a state of rigor mortis when the image was formed cannot be empirically tested. Unlike the image itself, there simply is no body to be so tested.
I12.0	The image shows no signs of putrefaction.	X		There is no sign of putrefaction on the Shroud, even around the nose and mouth where any sign of putrefaction would first be evident.
I13.0	The hair is soft, not matted, as would be expected if it had been soaked with aromatic substances and blood.		X	This is an unusual result. It would be expected that the hair would be soaked with perspiration, blood and likely with aromatic substances and would be matted close to the head. It could be argued that this observation is subjective in nature. TSC has therefore placed the item in the (P) column even though it could be significant in supporting the presence of an electrostatic charge as a factor in image formation.
I14.0	The linen fibers of the image lie only on the uppermost portions of the threads, leaving the inner fibers uncolored.  Dark image at bridge of nose on the Shroud © 1978 Mark Evans	X		The extreme superficiality of the Shroud body image is incompatible with an artificial thermal mechanism such as heating a metal or ceramic statue and impressing it on the cloth. This method has been tried numerous times without success. It is known as the " <i>bas-relief</i> " technique. This method can produce an image but is not consistent with the extreme superficiality observed for the entire frontal and dorsal images on the Shroud. The image to the left shows a highly magnified close up of the threads and image bearing fibers at the bridge of the nose. This is one of the most intensely colored areas on the Shroud and you can see how little discoloration there actually is. This is a good "macro" demonstration of the extreme superficiality of the body image. It should be noted in the photograph that spectral reflectance acts to mask the color observed in the fibrils.
I15.0	The coloration does not appear under the threads where they cross in the weave of the cloth.	X		The photograph in the item above helps clarify the meaning of this image characteristic. Many proposed image formation hypotheses are

				inconsistent with this observation.
I16.0	The fibers of the image are adjacent to unyellowed fibers: striations are evident		X	This observation we believe may be influenced by spectral reflectance as mentioned in Item I14.0. This image characteristic needs to be confirmed by further research in which lighting variables are strictly ruled out in order to be placed in the (E) column.
I17.0	Color is concentrated in the crevices where two or more threads cross each other.		X	We believe this observation is correct. However, to be placed in the (E) column this item should be confirmed with further research in which lighting variables are strictly ruled out.
I18.0	Color lies on the 0.2-mm thick layer interpreted as the primary cell wall of the fibers; the cellulose of the medulla (interior of the fibers) is colorless.		X	This characteristic is very restrictive. Most proposed image formation hypotheses are not consistent with this observation of the Shroud image. TSC confirms that the depth of discoloration is extremely small but would like to see additional published work that confirms the cell wall depth on the order of 200 nanometers.
I19.0	The fibers are uniformly colored round their cylindrical surface, whereas variations in color intensity can be detected along the fibers.		X	This observation is well documented in Shroud photographs. However, some researchers have suggested that the lighting under which the photographs or observations were made is a factor. This observation is thus placed in the (P) column and it is believed additional direct microscopic observation of the Shroud under rigorously controlled lighting is required before this image characteristic can be confirmed and placed in the (E) column.
I20.0	In contrast to the bloodstains area, there is no cementation between fibers or sign of capillary flow in the image area.		X	By contrast, the bloodstains on the Shroud show evidence of cementation between fibers and capillary flow, as would be expected with viscous human blood or fluids associated with putrefaction or decay of the body.
I21.0	Many tests including X-ray fluorescence, reflectance spectrometry, and low-energy / high-resolution X-ray transmission have shown that the body image is not compatible with a painted image. The fibers are colored only due to chemical reactions of the polysaccharides composing the linen fibers: oxidation, dehydration and conjugation.		X	During medieval times artists made copies of the Shroud and many copies were subsequently laid on top of the Shroud to "authenticate" them as true copies. This practice is assumed to have left small traces of pigment from the copies on the Shroud. Also, iron oxide, a common compound found in medieval paint mediums, has been found on the Shroud. However, the iron oxide is evenly distributed over the entire cloth in both image and non-image areas, except in the bloodstains where it

				is highly concentrated, as would be expected. It is likely that the iron oxide came from soaking the hanks of threads in water soon after weaving, a common process known as retting . Microscopist Walter McCrone incorrectly concluded in the 1980's (a conclusion, often cited by Shroud skeptics) that the presence of iron oxide on image fibers showed the image was painted.
I22.0	The red stains are those of human blood, frequently surrounded by serum haloes.	X		<p>1978: The STURP team collects sticky tape samples during the on-site Turin study of the Shroud, including samples from alleged blood areas. These samples are retained for further study by STURP when they leave Turin.</p> <ol style="list-style-type: none"> 1. 1980: STURP team members, biophysicist John Heller and chemist Alan Adler, collaborate in publishing a report on chemical testing they conducted on Shroud sticky tape samples. Their research confirms that the alleged blood on the Shroud is real blood. The tests are not able to classify the blood as human since chemical tests alone cannot distinguish blood from different animal species. 2. 1981: Heller and Adler extend their research of Shroud blood samples to include serological techniques, which involve the diagnostic identification of two major blood serum proteins: albumin and immunoglobulin (antibody). This research is able to further classify the blood on the Shroud as primate blood, which is most likely of human origin. 3. 1985: Italian Professor Baima Bollone, a pathologist, using serological techniques confirms Heller and Adler's identification of immunoglobulin in Shroud blood. He also evaluates the expression of additional blood components, specifically the antigens identified as M, N and S. The research shows that the blood on the Shroud is M, N and S positive. Unlike M and N antigens, which are shared between certain primates and humans, the S antigen is exclusive to humans only. The S positive result indicates human blood. 4. 2013: In a paper published by K.P. Kearse, Ph.D., and a researcher with a background in immunology and

				<p>glycobiology, it is pointed out that of all the serological analyses of blood components on the Shroud, the study of Ballone remains the single result that directly confirms the human origin of the blood. Kearse added in his paper that major advances in serology have taken place since the mid 1980's when the last published test results on Shroud blood samples were issued. For example, until 2010 there was no simple, rapid confirmatory test for distinguishing human versus animal blood. However, since 2010 such analysis is now possible using only a few micro liters of blood and the technique is developed for the study of dried bloodstains. Kearse believes that confirmatory testing of Shroud blood samples, if they could be made available, should be conducted using these new and evolved techniques. We concur with Kease's recommendation provided this and other research proposals for the Shroud are all subjected to a well-designed peer review process prior to implementation.</p> <p>Besides serological testing results there are forensic reasons to judge that the blood on the Shroud is human blood. See item I23.0 and I24.0 below.</p> <p>It is also very important to consider the significance of the serum halos surrounding the Shroud bloodstains. These rings are invisible to the naked eye. They are only revealed when they are irradiated by ultraviolet light under which they fluoresce brightly. Ultraviolet fluorescence was a phenomena not understood until well into the 19th century.</p>
I23.0	Bloodstains appear on and outside the body image, indicating that some blood drained from the corpse to the fabric.	X		<p>Most of the bloodstains are consistent with body contact. Other bloodstains, prominently those off the left elbow and below the back, are consistent with "flow" away from the body.</p>
I24.0	No image can be found under the bloodstains.	X		<p>There is a fine-tuned coordination of the entire structure of the body image, both frontal and dorsal, with the bloodstains. The body image is not found below either the bloodstains or the invisible (to the naked eye) serum retraction rings which evidence indicates the blood was deposited onto the cloth before the formation of the body image. We do not believe that any</p>

				artistic method is consistent with the extreme complexity of this coordination. In fact, no modern effort to reproduce the Shroud image has even attempted to duplicate the totality of this complex coordination.
I24.1	There are images of teeth and bone structures associated with the face, as well as indications of finger bones all the way to the wrist. There is also a shadow image of a hidden thumb.	X		John Jackson and his team of research associates have observed these features and they are mutually confirmed by Whanger and other researchers.

Table II: Image Formation Hypotheses

Modern scientific inquiry into the nature of the Shroud began in 1898 shortly after Secondo Pia's negative photographic images became public. In the early years numerous image formation hypotheses were proposed. Then, with the publication of the STURP findings on the Shroud, beginning in the early 1980's, the true in-depth scientific nature of the image characteristics began to be understood. This understanding of the image characteristics allowed for a critical evaluation of all existing image formation hypotheses and encouraged yet new hypotheses. In this table we provide a brief description of what we believe are the nine (9) most important hypotheses that have been proposed, tested or thoroughly documented down through the years. One very important fact that should be kept in mind is that the first documented exposition of the Shroud in Europe occurred in 1355. The year 1355 thus represents a cut off for any human artifact or "Artistic" rendering of the Shroud image. This means that any "Artistic" hypothesis must be consistent with the artist performing the work prior to 1355, as well as meeting all of the established image characteristics. Other hypotheses evaluated are not date constrained.

ID	Hypothesis	Description
F1.0	Natural: Contact	Paul Vignon was a French scholar who studied the Shroud in the era shortly after the Pia photographs were made public. Like most early researchers he assumed the image on the Shroud was either simply caused by contact with a dead body or was the creative work of an artist. Another suggestion was that the image was a contact image like that often obtained by placing a flower in a closed book, an image known as a Volkringer image. In-depth scientific study of the image shows that a contact mechanism is simply not consistent with many of the observed image characteristics, first and foremost the fact that the body image appears where there could not have been any bodily contact.
F2.0	Natural: Gaseous Diffusion	Paul Vignon, in addition to his body "contact" hypothesis, proposed that the image might be caused by ammonia vapors produced by a dead body wrapped in the Shroud. Chemist Ray Rogers, who was a member of the STURP scientific team, made several key refinements and extensions of the Vignon "vapor" theory by examining a Maillard chemical reaction between amines generated by a decomposing body and an assumed starch layer on Shroud fibers. He proposed that the starch was left on a very thin evaporation surface of the Shroud as a by-product of the manufacturing process. Rogers demonstrated that a Maillard reaction could lead to coloration of linen fibers that closely match the microscopic characteristics of the Shroud fibers. However, other STURP chemical analysis ruled out there being any starch on the Shroud and there are major difficulties with any gas diffusion mechanism being consistent with the totality of the Shroud image characteristics, particularly the high resolution of the image.
F3.0	Artistic: McCrone	Walter McCrone was a scientist who specialized in microscopy. He received actual Shroud samples for analysis from Ray Rogers and he did his research on these samples in the late 1970's and early 1980's. He reported that he found iron oxide on the samples and simply concluded that the iron oxide was evidence pointing to

		tempera paint and that therefore the Shroud image had to have been painted. McCrone was correct in that minute amounts of iron oxide are found on the Shroud, but it is found evenly distributed over the entire cloth not just in the image areas, except for the high level of iron found in the bloodstains. The original retting process used at the time of the manufacture of the cloth is well known to deposit small amounts of iron on the linen threads used to manufacture ancient cloth. In fact, McCrone's was the last of a long list of "painting" hypotheses that have all been discredited because all painting hypotheses are found to be inconsistent with multiple, now known, image characteristics.
F4.0	Artistic: Craig	Emily A. Craig and Randall R. Bresee obtained one of the best results, from a macroscopic point of view, of producing a face image with many of the characteristics of the Shroud image. Their result was produced by a modified carbon dust drawing technique. After "dusting" the image they heated their cloth in an oven to induce artificial aging of the fabric. The hypothesis is inconsistent with many Shroud image characteristics.
F5.0	Artistic: Delfino	Vignon hypothesized that the image was the result of the Shroud cloth being draped over a living body that had been smeared with chalk. In his experiments he only tested the face. His results were inconsistent with most image characteristics but they spurred a number of other failed efforts to produce the image by coating bodies, statues and bas-relief ceramics with powder, acidic liquids, alkaline liquids or other reactive agents. One variation on the bas-relief method that is arguably the best was proposed and tested by Pesce Delfino. Delfino used a metal bas-relief and heated it before impressing it on cloth. This hypothesis is also inconsistent with many Shroud image characteristics. By itself the superficiality of the image would appear to rule out any bas-relief method.
F6.0	Artistic: Garlaschelli	The Garlaschelli hypothesis was tested and announced to great media fanfare in 2009. His method was a modified bas-relief method. He prepared a mixture of dust and sulfuric acid to produce the body image and a bas-relief to obtain the face image. His results are interesting but ultimately inconsistent with the detail characteristics of the Shroud image.
F7.0	Artistic: Photograph	There are two variations of interest. The first is the camera-obscura method. In this method a cloth is impregnated with chemicals that react to light. The cloth is then suspended in a darkened room where a small opening admits light. An object suspended outside the room in the light is projected onto the cloth and an image results. Nathan Wilson tested a different variation of the proto-photographic idea in 2005. He painted an image on a piece of glass. He then placed the glass over a piece of linen fabric and exposed the glass and fabric to sunlight for several days. The paint and glass acted as a filter, while the rest of the fabric was exposed forming an image. Photographic methods appear to totally lack historical support considering the 1355 cut off date. They are also inconsistent with multiple image characteristics.
F8.0	Radiation: Jackson	John Jackson and his research team have proposed a hypothesis for image formation that appears to be consistent with all of the established Shroud image characteristics. The hypothesis is known as the " Radiation / Fall-Through

		<p>Hypothesis". It was first proposed in 1989 and has been worked on and refined ever since. The unique and unusual 3-D characteristic of the Shroud image inspired this hypothesis. In the original work of Dr. Jackson and his colleagues describing the 3-dimensional character of the Shroud image it was established that a very close correlation could be established between the intensity of the image and the vertical distance to a hypothetical body wrapped in the Shroud. Jackson and his team did experiments with human volunteers and further established that there was no correspondence in image if the distances to a draping cloth were measured in a perpendicular direction from the body but only in a vertical direction corresponding to the earth's gravitational field. (See Items I3.0 and I5.2) This led Jackson to conclude that indeed gravity was a deciding factor in determining several of the Shroud image characteristics. The detailed and complex "Radiation / Fall-Through Hypothesis" followed. The hypothesis, in brief, states that the body wrapped in the Shroud appears from the data of the image to have become (without explanation) radiant and simultaneously mechanically transparent. That is, the data of the image suggests the body instantaneously offered no mechanical resistance to the cloth. This allowed the Shroud cloth to collapse and fall through the radiant body space under the influence of gravity. The remaining irradiated cloth then, over some indeterminate period of time, aged and the image developed.</p> <p>This hypothesis posits a singular event that has been modeled theoretically but it cannot be physically replicated. Nevertheless, the hypothesis does make predictions concerning image characteristics that can be evaluated and ultimately tested by the Scientific Method.</p>
F9.0	Corona Discharge: Fanti	<p>In 2008 Giulio Fanti published a paper in which he hypothesized that a corona discharge phenomenon might be responsible for the formation of the Shroud image. This hypothesis, like the Jackson hypothesis, posits a singular event. Nevertheless, this hypothesis also makes predictions concerning the image characteristics that can be tested by the scientific method.</p> <p>Note: In 2012 a team of scientists at the ENEA Research Centre in Frascati, Italy led by P. Di Lazzaro, in collaboration with Dr. D. Murra and Dr. A. Santoni published an important paper in <i>Applied Optics</i> entitled "Superficial and Shroud-like coloration of linen by short laser pulses in the vacuum ultraviolet". This paper offers important findings that may have relevance in relation to Jackson's Radiation hypothesis, G. Fanti's Corona Discharge hypothesis and possibly to any other radiation related hypothesis that might be published in the future.</p>

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Table III: Evaluation of Image Formation Hypotheses

This table presents a matrix lining up **Image Characteristics** with proposed **Image Formation Hypotheses**. Note that only established (E) Image Characteristics are included.

Consistent: The image characteristic can be produced by the hypothesized method.

Inconsistent: The image characteristic cannot be produced by the hypothesized method. A single inconsistent rating effectively rules out the method.

Dubious / Unsubstantiated: It may be possible but has not been demonstrated that the hypothesized method can produce the image characteristic.

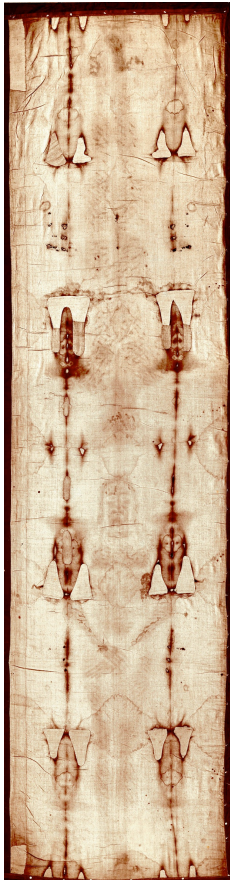
Key: ● = Consistent; "blank" = Inconsistent; ? = Dubious / Unsubstantiated



ID	Image Characteristic	F1.0 Natural Contact	F2.0 Natural Gas	F3.0 Artistic Painting McCrone	F4.0 Artist Craig	F5.0 Artist Delfino	F6.0 Artist Garlaschelli	F7.0 Artistic Photo	F8.0 Radiation Jackson	F9.0 Corona Discharge Fanti
I1.0	Front/back intensity		●	●	●	●	●	●	●	?
I2.0	Reverse negative image	●	●	?	●	●	●	●	●	●
I3.0	3-Dimensional				●	?	?		●	●
I4.0	Noncontact image		●	●	●	●		●	●	●
I5.0	Frontal double superficiality		?	?	?	?	?	?	●	●
I5.1	No dorsal double superficiality	●	●	●	●	●	●	●	●	?
I5.2	No side images			●	●	●	●	●	●	●
I6.0	High resolution	●		●	●	●	●	●	●	●
I7.0	Convex "hills"	●	?	●	●	●	●	●	●	●
I9.0	Dead human body	●	●						●	●
I10.0	Wrapping distortion	●	●	?			?		●	●
I12.0	No decomposition	?		●	●	●	●	●	●	●
I14.0	Superficiality		●				?		●	●
I15.0	Crossing threads		●	●	●		●	●	●	●
I20.0	No cementation / capillary flow	?	●		●	●	●	●	●	●
I21.0	Image Chemistry/ no paint	●	●			●		●	●	●
I22.0	Human blood and serum	●	●	?	?	?		?	●	●
I23.0	Blood outside body image	●	●	?	?	?	?	?	●	●
I24.0	Image-blood coordination	●	●						●	●
I24.1	Bone structure								●	?
Number of items that are inconsistent		8	5	7	6	6	6	6	0	0
Number of items that are dubious		2	2	5	3	4	5	3	0	3

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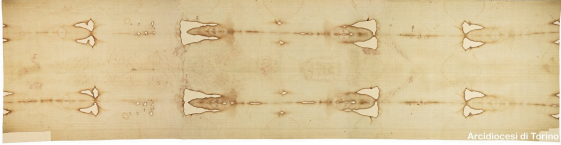

Table IV: Linen Cloth Evidence


Established
 | Plausible
 | | Disputed
 | | |

ID	Evidence	E	P	D	Comment
L1.0	<p>The Shroud conservation project of 2002 stabilized the layout of the Shroud by stretching it out for flat storage. The reported post-preservation dimensions are approximately 14' 6" by 3' 9".</p>  <p>(Mirror Image)</p>	X			<p>The Shroud was not woven to these particular specifications. Instead these English dimensions are only approximate measurements given to the nearest inch for an ancient cloth that has been handled, stretched and manipulated for centuries. Consequently the more accurate specified dimensions of the Shroud, that is the dimensions used by those who crafted the Shroud, is more likely in cubits. A weaving specification of the Shroud of 8 cubits long by 2 cubits wide would conform closely with the ancient Assyrian cubit of approximately 21.7 inches which was used in the area of Palestine in the first century.</p>
L2.0	<p>The linen Shroud cloth is nominally 0.34 mm (.013 inches) thick, woven of threads of a mean diameter of 0.25 mm (.010 inches) each of which is composed of 70-120 linen fibers each between 10 and 15 micrometers (.0004 inches.) in diameter.</p>	X			<p>Jackson measured the cloth thickness at the time of the STURP expedition, using a micrometer, to be variable from 318 to 391 micrometers. Due to the fact that the threads and the cloth are handmade, both the number of fibers per thread and their diameter vary up to 50%.</p>

<p>L3.0</p>	<p>The cloth is woven in a three-to-one herringbone twill.</p>  <p>Shroud: Vertical Warp and Horizontal Weft Threads</p>  <p>Above: Example of a modern cloth with a Herringbone Weave similar to Shroud.</p>	<p>X</p>	<p>Warp: These are the threads that are strung onto the loom before weaving begins, usually in a vertical direction. They run the length of the cloth corresponding to its long fourteen-foot plus dimension.</p> <p>Weft: These are the threads that run across the loom, being passed over and under to create the cloth. For the Shroud the weft or cross thread passes over three warp threads, under one, over three in a repeat pattern across the full width of the warp threads on the loom. Each succeeding weft thread is offset one warp thread either to the right or left.</p> <p>Herringbone: This simply means the offset or twilling is periodically reversed. The appearance is likened to a herring fish bone. The diameter of the Shroud warp and weft threads is slightly different. This effects the angle of the weave.</p>
<p>L4.0</p>	<p>The weave and certain stitching are very distinctive and rare.</p>	<p>X</p>	<p>Nothing comparable to the Shroud has been found that originated in medieval Europe. When the carbon dating of the Shroud was done in 1988 the effort was conducted under the direction of the British Museum. Michael Tite, who was the lead manager on the project for the British Museum, conducted a thorough search for a control sample that would reasonably match the Shroud. He could find nothing. On the other hand, archaeologists have discovered ancient wool artifacts with a herringbone weave similar to the Shroud. The artifacts were found in the ruins of a Roman fort in Egypt that dated from the 1st century. In addition, Mechthild Flury-Lemberg, the textile expert who was in charge of the 2002 Shroud preservation project in Turin, found a</p>

				<p>very remarkable example of stitching on the Shroud. She judged that the stitching pattern along a seam on the Shroud was the work of a professional and that the stitching pattern was similar to the hem of a cloth found in the tombs of the Jewish fortress of Masada. That Masada cloth has been convincingly dated to between 40 B.C. and 73 A.D. Flury-Lemberg also commented about the weave of the Shroud, that "this kind of weave was special in antiquity because it denoted an extraordinary quality".</p>
L5.0	<p>Backlit photographs of the Shroud linen shows intensity banding in both the vertical and horizontal direction corresponding to the warp and weft threads. There is more intensity of the banding in the horizontal corresponding to the weft threads.</p>	X		<p>The banding is difficult to see in normal light. Some banding can be seen in the positive photographs and more can be seen in the negative images. However, when contrast is computer enhanced, the vertical and horizontal banding is easily discerned particularly in backlit photographs. Banding can result when individual collections of flax used to manufacture linen thread are retted and bleached separately. Retting is the process of soaking the flax in water to separate the linen fibers from the main stalk of the flax plant. Separate batches of flax are then woven into hanks of thread and mildly bleached. This observation of bands of color conform to Pliny the Elders (23AD – 79 AD) documented methods of producing ancient linen. Medieval linen was manufactured differently and surviving high quality medieval linens (none found with a herringbone weave) typically do not show banding like the Shroud.</p>
L6.0	<p>Raking or grazing light photographs of the Shroud show old fold marks in the linen cloth.</p>	X		<p>One of the tasks undertaken by the STURP team was to take raking light photos of the Shroud. Linen has poor elasticity, explaining why it wrinkles so easily. Linen cloth thus has sort of a memory that can reveal how the cloth was folded during its history.</p>
L7.0	<p>There is a seam that runs the full 14-foot length of the Shroud approximately 3" from one edge.</p>	X		<p>The purpose of the seam is debated. Jackson and his team of Shroud researchers believe the seam was used to reconnect a strip that was originally removed from the Shroud and used to wrap the dead body that was once enshrouded in the cloth.</p>
L8.0	<p>Dirt and Travertine Aragonite (limestone) has been found on the linen cloth of the Shroud.</p>	X		<p>The dirt and aragonite is found in coordination with the body image, most prominently at the bottom of the feet. The chemical make up of the Travertine Aragonite is consistent with a rare type of limestone found in Jerusalem and</p>

				only a small number of other places on earth.
L9.0	<p>There are large burn holes on the Shroud and coordinated water stains associated with the 1532 fire in Chambrey, France. The eight (8) major blemishes on the Shroud illustrated below shows this damage.</p> 	X		<p>The large burn holes and water stains are associated with a well-documented fire in 1532 in which the Shroud was damaged. There are other water stains on the Shroud that are known to be much older because they appear on artistic drawings of the Shroud made before the 1532 fire.</p>
L10.0	<p>There are four (4) matched repetitions of "L" shaped holes on the linen cloth that predate the 1532 fire.</p>  <p>The photo shows just one of the four sets of burn holes.</p>	X		<p>The four matched sets of holes show progressive levels of burn penetration. This pattern has been used forensically to determine that the cloth was folded in half lengthwise and then widthwise when the burns occurred.</p>
L11.0	<p>Pollen from the environs of Jerusalem has been found on the cloth.</p>		X	<p>Max Frei, a Swiss criminologist and botanist, reported finding pollen on sticky tapes used to collect surface contaminants from the Shroud in the early 1970's and again during the STURP testing in 1978. He reported that the bulk of the pollens he found were of middle east provenance from the area around Jerusalem. Additional samples must be collected and tested to corroborate Frei's results before this evidence can move beyond the disputed category</p>
L12.0	<p>Images of coins, flowers and symbols have been found on the Shroud.</p>		X	<p>Some researchers have claimed that seeing these objects on the Shroud is dependent on subjective judgment while others claim rigorous and objective testing show these images to be present. Further testing and collaboration by additional researchers using rigorous analytic</p>

			tools is required to validate these claims.
L13.0	<p>Radiocarbon dating performed in 1988 shows the Shroud was manufactured sometime between 1260 and 1390.</p> <p>The pictures below are related to comment 2.</p>  <p style="text-align: center;">Hungarian Pray Manuscript</p> <p>Note the crossed hands and invisible thumbs in the top image which shows Jesus being placed in the tomb. The bottom image shows the empty tomb and the burial cloths that remained.</p>		<p>X The radiocarbon date is disputed because there is counterfactual evidence that is compelling. There are four (4) major evidentiary conflicts:</p> <ol style="list-style-type: none"> 1. The location from which the radiocarbon samples were taken has been judged as the "worst possible" location. Many scientists, after microscopic and chemical investigation, have concluded the area contains materials not representative of the rest of the Shroud and that it is contaminated. The area from which the carbon dating sample was cut is considered by many other Shroud researchers to be a rewoven or patched area. 2. The Pray Codex, also known as The Hungarian Pray Manuscript, is a collection of medieval manuscripts. They date from 1192-1195. The bottom illustrations in the codex shows a herringbone weave pattern, identical to the weaving pattern of the Shroud and four (4) circles, which appear to form the letter "L" that matches the "L" shaped burn holes found on the Shroud. The textile authority Mechthild Flury-Lemberg stated, "The painter of this picture must have seen the Shroud of Turin, otherwise it's not possible because it (contains) exactly the signs which we find on the Shroud..." 3. Research based on eye-witness testimony from the fourth crusade and forensic analysis conducted by Jackson and his team of historical fold marks on the Shroud give compelling evidence that the Shroud was in Constantinople at the time of the Fourth Crusade in 1204. And if the Shroud was in Constantinople in 1204 it was certainly in Constantinople in 966 (see history table). 4. Vanillin is an aromatic natural chemical compound that occurs in plants, including flax. In flax fibers the vanillin is a by-product of the decomposition of the lignin in the fibers. Over a long period of time, measured in centuries, the vanillin naturally

Note four (4) poker holes

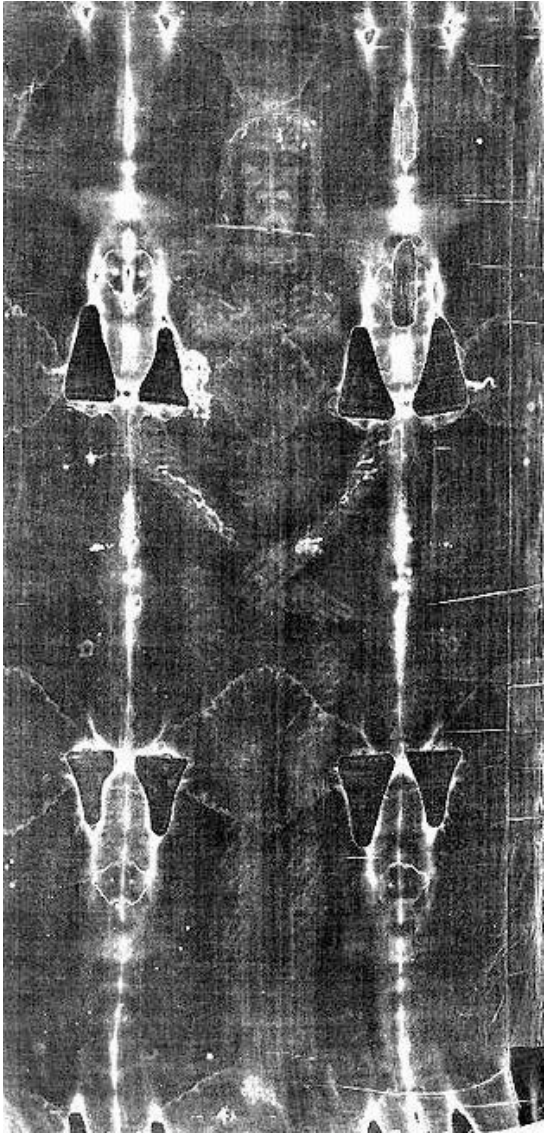



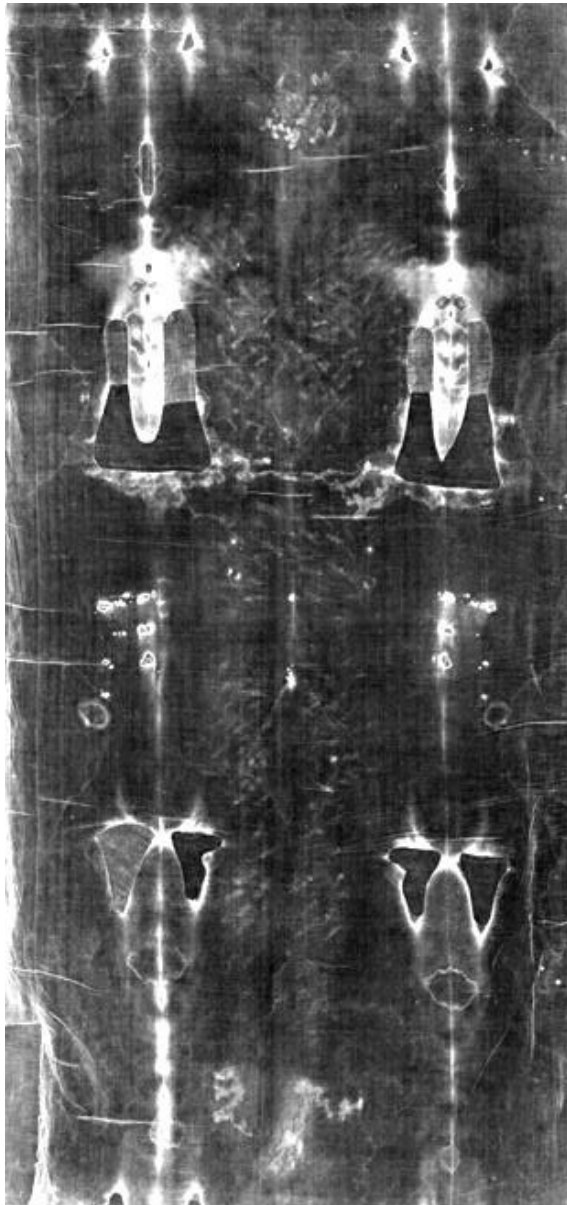
disappears from the flax cloth. Typical medieval linen tests positive for vanillin. By contrast the linen wrappings of the Dead Sea Scrolls dating to the 1st century do not test positive for vanillin. The only part of the Shroud that tests positive for vanillin is the corner area from which the radiocarbon test sample was cut. The rate at which vanillin dissipates in a typical sample of cloth is related to the temperature at which the cloth is stored. One factor that might have affected the vanillin content in the main body of the Shroud is the heat from the fire involving the Shroud in the year 1532. Yet even if the 1532 fire affected the vanillin in the main part of the Shroud there nevertheless remains the anomaly of why the carbon dating sample area continues to test positively for vanillin.

Clearly, historical and chemical facts related to the Shroud indicate that the carbon dating results of 1988 are anomalous. The question of exactly why they are anomalous requires additional research and clarification.

Table V: Medical Forensics Evidence

Established
 | **Plausible**
 | | **Disputed**
 | | |

ID	Evidence	E	P	D	Comment
M1.0	<p>The photographic negatives below show the frontal and dorsal images of the body on the Shroud.</p>  <p style="text-align: center;">Frontal Image (Body Image)</p>	X			<p>Medical doctors and forensic scientists have studied the body images on the Shroud for more than 100 years. Intense forensic evaluation of the Shroud began as soon as the photographic negatives of Secondo Pia first were released to the public in 1898. The negative images show the wounds and blood flows in great detail.</p> <p>On the photographic negatives the darker blood stains on the Shroud show up as nearly white. For example, in the close up of the face shown below, the image that looks like the letter "3" is a flow of blood.</p>  <p style="text-align: center;">(Body Image)</p> <p>On the frontal image to the left note all the white blood flows beginning at the top of the head and continuing down to a large blood flow at the top of the feet.</p>



Dorsal Image

← Note blood on back of head.

← Note abrasions across shoulders.

← Note crossing pattern of wounds on back.

← Note naked buttocks and continuation of blood flows.

← Note wounds continuing down backs of legs and calves.


← Note extensive blood flows around area of the feet.

M2.0


The image on the Shroud shows a naked and scourged man. Forensic calculations indicate the man had a height of approximately 5 feet 11 inches and a weight of approximately 175 pounds. The body is anatomically well developed and normal.

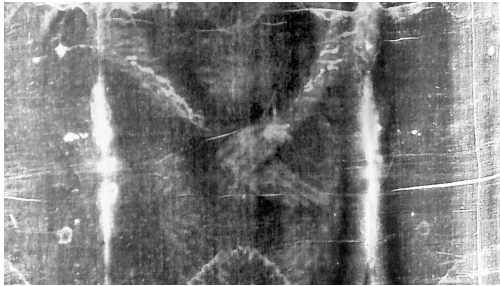
X

The body is considered tall for a first century Judean Jew. However, findings from a first century cemetery excavation near the wall of the Temple in Jerusalem include remains of individuals approaching six feet.

M3.0	<p>There are a series of traumatic injuries on both the front and back of the body. The injuries shown on the dorsal image start at the shoulders, continue down across the buttocks and down the backs of the legs.</p> <p>Forensic evidence shows that the beating was very severe and unrestrained. It was, however, stopped before the victim died from the beating. At a minimum it would have led to shock from the loss of blood and bodily fluids.</p>	X	<p>The wounds are consistent with those that would be inflicted by whipping with a Roman scourge (Latin: flagrum; English: flagellum). Study of the Shroud image has allowed some researchers to estimate that the flagrum that were used consisted of three separate thongs, each ending in a set of two lead balls. The impact of the balls on the flesh show distinct "dumbbell" impressions. The roughly shaped balls added weight to the beating, but would also tear the flesh of the victim.</p> <p>Study of historical artifacts of the Roman Empire from the first century reveal that a typical flagrum consisted of a wooden handle measuring approximately 8" long, while the thongs, typically of leather, were of varying lengths (11", 12", 13"). The varying lengths of the thongs were well designed to prevent the balls from striking each other and inadvertently shedding energy before striking the victim.</p> <p>The imputed angle at which the blows causing the wounds on the back of the body on the Shroud were delivered, leaving their crosshatched pattern, has been used forensically to suggest that two individuals, one taller than the other, stood behind and to the side of the victim to administer the beating.</p> <p>The severity of the beating could have easily caused a partial or complete collapse of a lung. Just breathing after the beating would have been excruciatingly painful.</p> <div style="text-align: center;">  </div>
M4.0	<p>There are multiple puncture wounds encircling the entire skull area.</p>	X	<p>This finding is consistent with a "crown of thorns". There is a distinct pattern of blood flows associated with the wounds, especially visible on the forehead.</p>
M5.0	<p>There are abrasions on both the right and left shoulder and across the nape of the neck. These abrasions are consistent with injuries that would have been inflicted by carrying the</p>	X	<p>Research shows the patibulum would weigh approximately 70 pounds. Typically the condemned would have the patibulum in back of the head across the shoulders with the arms</p>

	crosspiece, or patibulum , of the cross.			<p>outstretched and secured to the patibulum with a rope.</p> <p>Backlit photographs also clearly show that the blood from the scourging across the back of the shoulders is smeared or smudged due to the action of some abrading object.</p>
M6.0	The nose is distorted. Dislocation of individual nose cartilage pieces, most prominently the septal cartilage, is indicated.	X		<p>If the condemned man was carrying the patibulum across his shoulders with his outstretched arms secured there would be no way to protect the face when falling. A remarkable detail is that the blood on the back of the shoulders is smeared which is consistent with the carrying of the patibulum.</p>
M7.0	The right cheek is distinctly swollen.	X		<p>This injury is consistent with the same blunt force trauma that caused the dislocation injury to the nose.</p>
M8.0	There is abrading and denuding of the right knee.	X		<p>This injury is again consistent with a fall. There is swelling associated with the contusion of the knee and some forensic doctors have suggested the swelling is consistent with a fracture of the kneecap bone.</p>
M9.0	The act of crucifixion began by nailing the hands of the condemned as he lay on the ground with his arms outstretched on the patibulum . The patibulum with the attached man was then lifted into position onto the vertical member of the cross. The medical forensics shows that the victim of crucifixion shown on the Shroud had puncture wounds through the back of the wrists .	X		<p>The word excruciate means to torment or torture. Excruciating means extreme pain or anguish. Both words come from the same Latin root as does the word crucifixion.</p> <p>The nailing shown on the Shroud is consistent with the established Roman method of crucifixion. The entry wounds may have been in the palm close to the wrist or in the wrist area itself. The exact entry point is conjecture because only the back of the right hand is visible on the Shroud. The exit wound is clearly in the wrist. It is known from tests with cadavers that nailing through the palms alone would not be sufficient to support the weight of a human body. The hand would simply tear free from the nail due to the weight and the additional stresses imposed by any repetitive or violent movement of the crucified body. To guarantee fixing the body to the cross necessitated penetrating the bone structure in the wrist area with the nail.</p> <p>The typical Roman nail used in crucifixion was made of iron, with a gradually tapering square shaft. Nails were approximately seven inches long with a round head about an inch in diameter.</p>

				
M10.0	There are puncture wounds through both feet. The left foot was placed over the right foot before the nailing.		X	Sometimes the feet of crucifixion victims were placed against the vertical crucifixion post (<i>Stipes</i>), one foot on top of the other. Then a single nail was driven directly through the top of each foot. Archaeological finds in Jerusalem have shown that sometimes the feet were turned to the side and nailed through the heels with a long single nail. In either case, it was excruciatingly painful. The blood flows on the Shroud appear to be consistent with either method of nailing the feet.
M11.0	The Shroud shows that gravity affected the blood flows associated with the wrist wounds. The alignment of the blood flows show the arms were raised at an angle of approximately 65 degrees from the horizontal while the man was suspended on the cross.		X	Hanging in this position would lead to extreme pain in the shoulders and arms. Also the chest would be stretched and thus compressed. Just breathing would be difficult. The remedy would be to push up on the impaled feet in order to gain some relief. One agony would be joined to another. Movement to gain any respite would cause exhaustion and profuse sweating, but no middle ground where the agony would subside would be possible.
M12.0	The exact cause of death of the Man of the Shroud has been determined.		X	This is disputed. The exact cause of death cannot be definitively stated. There is an image on the Shroud showing the wounds of the condemned in great detail that can be studied forensically, but there is no body available for an autopsy. Nevertheless, the weight of the forensic work tends to favor a judgment that death resulted from a combination of hypovolemic and traumatic shock. That is, death resulted from loss of body fluid from hemorrhage of blood and severe sweating due to the trauma of the brutal scourging and crucifixion prior to the lance thrust to the side.

M13.0	There is a wound to the right chest area, penetrating into the thoracic cavity, produced by a sharp puncturing instrument.	X	<p>The image of the back of the body (Shroud dorsal image) shows a large volume of blood and body fluid from this wound pooling under the back of the body as it lay in the Shroud.</p> <p>A post mortem thrust of the lance would appear to be consistent with the release of a massive pleural effusion of fluid around the lungs. This fluid would have accumulated because of the trauma of the brutal scourging and the hanging agony of the crucifixion. The lance thrust penetrating the chest and heart would release the "water" and "blood". If death did not come prior to the lance thrust then the lance thrust would have been the coup de grace.</p>
M14.0	The Shroud shows no evidence that the legs of the crucifixion victim were broken.	X	<p>Typically, the legs of a crucifixion victim were broken to cause rapid death. The breaking of the legs would remove the ability of the victim to distribute weight on the impaled feet to help with breathing and the fracturing blows would cause severe traumatic, hemorrhagic shock. Death would come quickly. This wasn't done to the Shroud victim.</p>
M15.0	<p>The image on the Shroud shows only four fingers. The Thumbs are folded under the palm.</p> 	X	<p>Some forensic scientists believe that the traumatic puncture wounds of the crucifixion nails through the wrists would have damaged nerves causing the thumbs to rotate in toward the palm. Other forensic doctors believe the thumbs would naturally fold inward in death if the arms were crossed as shown on the Shroud.</p>
M16.0	The blood on the Shroud has been shown to be human blood.	X	See Item I22.0 comment.
M17.0	The body is in rigor mortis.	X	<p>Forensic scientists who have studied the Shroud image concur that the body appears to be in a state of rigor mortis. One sign of rigor mortis is readily visible in the dorsal image above (see item M1.0). The thighs, buttocks, and torso are not flat, but instead are stiff and rigid. If rigor mortis had declined and the muscles had relaxed, these parts of the body would appear flatter and wider. There are other signs of rigor mortis associated with an in depth analysis of the body's three- dimensional posture as it lay</p>

					in the Shroud as discussed in the references. (Also see item I11.0)
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Revision Log

Version	Date	ID	<u>A</u> <u>C</u> <u>D</u> Change Delete	Comment
1.3	06/04/2013	Intro	C	Added sentence in Table 1 (Image Characteristic Evidence) to indicate any changes to Item Descriptions will be documented in the Revisions Log.
		I3.0	C	In the Item Description inserted the words " image density " to replace the word "luminance". The term "luminance" should be avoided because it has a technical definition, which may be confusing to some readers. It is the image density variation that has been analyzed mathematically to render a high-resolution 3-dimensional body image.
		I22.0	C	Modified Fanti's description to remove the statement "This was due to transposition of blood clots by fibrinolysis". Changed Comment to include more complete notes in support of human blood being found on the Shroud.
		I24.0	C	Modified Fanti's description "...because they formed before the body image" and moved this conclusion to the comment column. Also changed Comment by adding additional clarifications.
		Table III I5.0/F2.0	C	Changed to "Dubious/ Unsubstantiated" from "Inconsistent".
		M16.0	C	Changed Comment to refer to I22.0 comment.
1.2	02/10/2013	Preface	A	Preface added.
		F9.0	C	Inserted reference to important new paper published in <i>Applied Optics</i> by Di Lazzaro, et al, and adjusted End Note references accordingly. In V1.1 the research described in the <i>Applied Optics</i> paper was attributed incorrectly.
		L11.0	C	Changed word "collaborate" to "corroborate"

		End Notes	C	Corrections to various errors published in V1.0
1.1	01/25/2013	M1.0	C	Correction of typographical errors only.
1.0	01/24/2013	All	A	Initial publication of Version 1.0.

End Notes

Introduction

- 1 G. Fanti, "Hypotheses Regarding the Formation of the Body Image on the Turin Shroud. A Critical Compendium," *Journal of Imaging Science and Technology* 55(6) 060507 (Nov.-Dec. 2011): 1-14.

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(Note: We have relied in the Image Characteristics End Notes on Fanti's paper referenced above to lead the reader to further research sources. Additional references are included where deemed necessary.)

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- I2.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
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- I4.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I5.0 Giulio Fanti and Robert Maggiolo, "The Double Superficiality of the Frontal Image of the Turin Shroud," *Journal of Optics* Vol 6 No. 6 (2004) 491.
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- I5.2 Giulio Fanti, Barrie Schwartz, August Accetta, Jose Botella, et al, "Evidences for Testing Hypotheses about the Body Image Formation of the Turin Shroud," *The Third International Conference on the Shroud of Turin* (Dallas, Texas September 2005): 9.
- I6.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I7.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I8.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.

- Discussion with senior members of the TSC research team including John Jackson and Keith Propp.
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- I9.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I10.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I11.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
Frederick T. Zugibe, *The Crucifixion of Jesus: A Forensic Inquiry* (New York, NY: M. Evans and Company, Inc., 2005), 189-198
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- I12.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I13.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
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- I14.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I15.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I16.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
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- I17.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
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- I18.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
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- I20.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I21.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
- I22.0 G. Fanti, "Hypotheses Regarding The Formation of the Body Image," 3.
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I24.1 Giles F. Carter, "Formation of the Image on the Shroud of Turin by x-rays: a New Hypotheses," in *Archaeological Chemistry, The American Chemical Society* 0065-2393/84/0205-0425806-50.0 (1984): 431-33.

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