PROPOSAL FOR THE CONSTRUCTION OF A CALIBRATED MULTIRESOLUTION ATLAS OF THE TURIN SHROUD

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INTRODUCTION

Last scientific researches on the Turin Shroud have been made by STURP (*Shroud of Turin Research Project*) in 1978 when the group showed that the body image is not a painting and the red stains are blood[1, 2, 3]. After these interesting results, in 1984 STURP proposed a series of new tests but the radiocarbon result of 1988[4] stopped drastically the experimental research on the Shroud.
Many scientists continued their work basing themselves of the data acquired by STURP or photographs also done by Enrie in 1931 with an orthocromatic plate.
The data that presently exist are insufficient to adequately insure the Shroud's on-going well-being and, perhaps of equally serious import, the relative scarcity of reliable and objective data has given rise to an enormous variety of sometimes fantastic hypotheses regarding the Shroud's origins and the nature of the body image it contains. This problem has lead to the treatment of the Shroud in the general media as a matter of "occult mystery" or as an object surrounded by intrigue, suspicion and doubt.
It would now appear timely to support the suggestion that the Pope and the Turin Custodian of the Shroud should now authorize an organized and multi-disciplined series of non-destructive measurements to be taken on the Shroud using the most up-to-date scientific equipment and expertise and the creation of a digital atlas/database of this data which could be readily accessed by researchers now and in the future.
The absence of new data slacks the research with the consequence that nowadays the Shroud is an object not completely known jet (also according to the late Alan Adler). In particular it is not scientifically explainable yet how the body image was formed.
As a consequence, without a better knowledge of it, it is both impossible to make accurate radiocarbon measurements and to make some hypotheses for its conservation.
It is therefore necessary to try to reduce the actual ignorance level about the object in exam.
For example, as it is not known how the body image was formed (only some hypotheses can be done, but the actual science can not experimentally verify them) we can not know what kind of ambient factors interacted with the sheet. Therefore we can not measure the age of the linen basing the measurement process on the percent of ^{14}C that may be influenced by external factors (also drastically in the hypothesis, not yet rejected, of a neutron radiation).
It is so preferable to increase the knowledge about the linen sheet *before* proceeding in the two important streams: radiocarbon dating and conservation.
To do this, among the other possible researches, the construction of a Big Shroud Atlas, useful as a very detailed data base for future researches, is very important[5, 6]. This data base must obviously be accessible by any scientist interested in the researches on the Turin Shroud.
The Big Shroud Atlas proposed would contain all the information detectable by the most sophisticated instruments now available and will be presented in different forms.
-a) A *book* containing a great variety of photos, from the whole image to microscopic details up to 2000 x magnification. This book will be useful as a database for each scientist interested in the Shroud researches.
-b) A *digital atlas* codified in few CD/R form containing some important images acquired during the tests. These CD/R will be useful for each person interested in the computer analysis and data processing about the Shroud.
-c) A *digital atlas put into Internet* containing the most important photos of the Shroud, details included. This will be useful for each person interested in the Shroud.
-d) A *complete digital database* codified in different digital forms (CD/R, DWD) containing all the calibrated high resolution images acquired. These data will be used by researchers that will deepen some particular aspects regarding the Shroud.

Obviously, all data will be placed at the scientific community disposal for future studies and any money made will go to a charity or as financial support for further researches.

PROJECT MOTIVATION

This project has as its primarily scope that of achieving as many calibrated images and information on the Turin Shroud as possible.
In this way every interested scientist can employ them to elaborate new hypotheses to be scientifically verified about many question related to the sheet; for example:

- How the image was formed?
- May the Shroud body image be correlated to a radiant energy connected to the wrapped body surface or to its volume?
- How old is the Shroud?
- Are there any subtle discoloration features that may be connected to historical display configurations?

During the tests and image acquisition some questions[7] may be answered as:

- Can more details in many region of interest both of the body image and outside it be observed?
- What are the visible fluorescent characteristics of the Shroud?
- What does the characteristics of the Shroud in the infrared while being illuminated in visible light?
- What is the fluorescence pattern of the cloth weave?

In particular this project is devoted to the improvement of the knowledge of both the body image formation mechanism and conservation.
To reach this goal it is necessary to acquire and archive Shroud images certified by means of previous instrument calibration. Many mappings at very low resolution (complete Shroud image) and at very high resolution (microphotos 200-2000x), all having quantitative information on the image, are necessary to have a complete data base of the Shroud.
It is also necessary the construction of a *double reference grid* for an objective location of images acquired at lower or higher resolution. It is foreseen the definition of both a big grid (22x6 squares 20x20 cm) and a little grid (20x20 squares 1x1 cm); each position will be so defined by two couples of coordinates (XY-xy).

PROJECT PHASES

The project of constructing a “Calibrated Multiresolution Atlas of the Turin Shroud” is subdivided in the following 5 phases.
Phase A: in this preliminary phase, here presented, the scopes of the research are defined and the first studies about the instrumentation design are done. The feasibility study is then defined in a preliminary way. The whole project is subdivided in many sub-proposals that are submitted to the approval of the Pope and the Turin Custodian of the Shroud.
Phase B: after the approval of each sub-proposal, Phase B begins with a detailed description of the scopes of the project and a detailed design of the instrumentation is done according to the specifications established. The sponsors define their effective participation in the project.
Phase C: consists in the development and in the construction of the experimental apparatus defined in each sub-proposal. In this phase all the calibration procedures are verified with experimental tests and the whole instrumental apparatus is prepared for the project. Reference samples are also defined and tested and the traceability of each instrument or sample is verified. Since the Shroud is composed of an aged and irregular weave of linen fibers care must be taken when designing a measurement protocol.

Phase D or Operative: consists in the execution of the project. Images and data are acquired controlling that the relative uncertainty is within the specifications. This is the only phase that requires the presence of the Turin Shroud. Some preliminary data analysis are requested in this phase also basing on the detailed experience of the participants to the project on the Shroud.
Phase E: consists in the acquired data processing and the construction of the Atlas in its different forms as described in the introduction.
Detail of the digital atlas at multi-resolution up to 2000x will be processed.
In particular, the following points may be outlined:

1. Statistical distribution of the image fibrils in the nose, fingers and feet areas.
2. Blood areas.
3. Pollens and material, such as travertine, aragonite, etc.
4. Bugs and microbial items.
5. Waterstains.
6. Possible copper traces from coins in the eyes area.
7. Debris from Chambéry fire (silver traces).
8. Debris from the fires in the ancient burns.
9. Paint pigment traces.
10. Linen waves characteristics to better identify its origins.
11. Possible iron oxide traces from thumb tack.

At the end of this phase the hypotheses evaluation, based on the data acquired, are done to try to answer some of the questions previously defined.

SUB-PROPOSALS

The project is composed of the following 14 sub-proposals. Each one is necessary if a complete comparison of data coming from different systems is done during Phase E.

1. **Design and construction of 2-axes manipulators**
2. **Hardware and data acquisition**
3. **Visible, IR, UV lighting, shaving light included**
4. **Calibration procedures and uncertainty analysis**
5. **High resolution digital photography**
6. **High resolution analog photography**
7. **CCD colorimetry**
8. **Microphotography of body image in situ**
9. **Mid -IR, Near-IR, VIS and Near-UV spectroscopic measurements**
10. **Microscopic FT-IR examination**
11. **Mapping with a scanner also in UV light**
12. **Drawing some fibrils**
13. **Partial mapping of the back of the Shroud also with endoscopy in visible light, UV and IR light**
14. **Collection of dusts and fine materials**

ABOUT THE GROUP

The group proposing the construction of a Calibrated Multiresolution Digital Atlas of the Turin Shroud was formed during the Orvieto Worldwide Congress "Sindone 2000" and it is composed of 14 scientists interested in studies about the Turin Shroud. 71% of them has one or more degrees in scientific disciplines and 21% are professors teaching in Italian Universities. 57% of them wrote books on the Shroud. One of them is member of the "Centro Internazionale di Sindonologia" and two of them are expert photographers that have experience of the Turin Shroud.

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READING KEYS

Attached to this document are the following integrating parts:
- description of each sub-proposal (the description will evolve in parallel with the subsequent phases);
- curriculum with some publications of the participants to the project.

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1) TITLE OF SUB-PROPOSAL n°1:

Design and construction of 2-axes manipulators

2) OBJECTIVES

Two different 2 axes manipulators are employed to displace the acquisition instruments along the Shroud.
A small manipulator, with accuracy of the order of 1 µm, and a range of about 300x300 mm, can support instruments such as a microscope or a spectrophotometer, and they are used to acquire relatively small zones of the Shroud.
A big manipulator, with accuracy of about 1 mm and a range of about 1100x5500 mm, can support cameras, or a scanner, and they are used to acquire images of the whole Shroud.

3) PARTECIPANTS NAMES

Roberto Basso, Kevin Moran.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The manipulator will be designed in order to support properly all the instrumentation. In particular some interfaces are assigned to stiffly connect each instrument with the manipulator.
A particular study will also be done in order to connect the small manipulator to the bigger to have the possibility to control large and small displacement at same time.
The instant position of the instrument will be simultaneously recorded, via PC, with the images.
The manipulators must be designed in order to minimize the instrument vibrations during signals acquisition.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

Small 2-axes manipulator: resolution of 1 µm, accuracy of 2-5 µm, range of about 300x300 mm.
First natural frequency of the acquisition system coupled with the manipulator higher than 300 Hz.
Big 2-axes manipulator: resolution of 1 mm, accuracy of 2-3 mm, range of about 1100x5500 mm.
First natural frequency of the acquisition system coupled with the manipulator higher than 70 Hz.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

Each acquisition system will be mounted on the manipulator, and will be driven and controlled by a PC in order to automatically acquire the relative position of the acquisition system with respect to the Shroud.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

To be defined after the instrumentation will be chosen.
Design of the manipulators and interfaces construction costs may be supported be the Dipartimento di Ingegneria Meccanica of Padua University.

8) SPONSORS (IF EXISTING)

None at this time, but the total cost may be supported by sponsors.
Many manipulator manufacturers or Kodak may collaborate to this research.

9) INSTRUMENTATION CONSTRUCTION TIME

About 6 months are required for the design and the construction of the instrumentation.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

The effective metrological characteristics of the manipulator will be tested before and after the experiments.

About 1-2 hours will be necessary to control the manipulator behavior during the data acquisition.

About 20 minutes are necessary to mount and dismount the instruments.

11) PRODUCT DESCRIPTION

The small manipulator, with a range of about 300x300 mm, will be used to acquire microphotos and data concerning small areas of the Shroud.

The big manipulator, with range of about 1100x5500 mm, will be used to acquire images concerning large areas of the Shroud.

12) SHROUD IMPACT DESCRIPTION

No impact is foreseen for the Shroud.

A possible problem to be considered consists in the natural frequencies of the manipulator with instruments. If these frequencies are close to those of the Shroud support system, the relative motion between the instrument and the Shroud may distort the acquisition of the signals. In this case, stiffening masses for the manipulator might be necessary.

1) TITLE OF SUB-PROPOSAL n°2

Hardware and data acquisition

2) OBJECTIVES

Systematic filing of real-time data as soon as they are obtained by the various plans or sub-proposals.

3) PARTECIPANTS NAMES

Maurizio Marinelli, Emanuela Marinelli.

4) EXPERIMENTAL APPARATUS DESCRIPTION

Portable computer Pentium III 600 MHz with filing system software already set up. Scanner and digital camera for local images and colour printer for possible data printing. Internet connection for possible consultation of remote data.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

- Portable computer Pentium III 600 MHz with TFT screen 14"
- Portable colour Printer
- Scanner
- External CD burner
- Digital camera
- Internet connection

6) EXPERIMENTAL PROCEDURE DESCRIPTION

Installation of the computer post in the place to file data as soon as they are taken in order to verify the systematic nature and the homogeneity of the real-time acquisitions.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

Portable computer, Printer, Scanner, External CD burner, Digital camera, Internet connection.
Total 4.5 kEuro

8) SPONSORS (IF EXISTING)

Compaq – Toshiba – Acer – Canon – Epson – Kodak (to be contacted)

9) INSTRUMENTATION CONSTRUCTION TIME

Two hours on the site.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

Dependent on the operating time of the other plans as this is the filing system of the latter.

11) PRODUCT DESCRIPTION

Final carrying out of one or more CD-ROMs with the acquired data to be used by the team; these CD-ROMs will lead to the carrying out of one or more CD-ROMs to be placed at the scientific community disposal for future studies.

12) SHROUD IMPACT DESCRIPTION

None.

1) TITLE OF SUB-PROPOSAL n°3

Visible, IR, UV lighting, shaving light included

2) OBJECTIVES

It is well known that a photograph is strongly influenced by the employed lighting. If we want to obtain the best results it the acquisition of the images for the Calibrated Shroud Atlas, it is necessary to optimise all light sources during each acquisition.

In most cases the uniform illumination is preferred, but in some cases other objectives have to be reached: for example a non uniform light distribution is necessary in shaving light to evidence the linen weft or the possible presence of ancient folds on the Shroud.

The following acquisitions are foreseen:

- Uniform (the most possible) back light to acquire normal images in reflected light during both digital and analog mapping of the Shroud;
- Shaving light;
- Uniform (the most possible) front light to acquire images in transmitted light during both digital and analog mapping of the Shroud at relatively low resolution;
- Multi-lateral light (almost 4 positions) to acquire 3-D images of the linen threads.

Different kinds of light sources are to be employed; among them the following:

- Visible light for normal acquisitions;
- Ultraviolet light also to evidence the fluorescence of serum halos;
- IR light;
- Narrow band light to evidence more clearly the body image; for example G. Enrie, employing orthocromatic films obtained a good contrast between the body image and the back. A better result may be obtained by using a narrow band source that enhance this contrast.
- Polarised and cross-polarised light to evidence particular characteristics of the linen fibrils in microphotos.
- Particular light sources such as illuminates D-65 or alogen lamps may be necessary for colour measurements.

3) PARTECIPANTS NAMES

B. Schwortz, A. Guerreschi, Giulio Fanti.

4) EXPERIMENTAL APPARATUS DESCRIPTION

Something is considered in the single sub-proposals, but a complete description of the experimental apparatus will follow the definition of the detailed procedure to be followed in each sub-proposal.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

To be defined after the approval of the other sub-proposals.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

To be defined after the approval of the other sub-proposals.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

To be defined after the approval of the other sub-proposals, but in first analysis a cost variable from 10 to 50 kEuro may be considered.

8) SPONSORS (IF EXISTING)
To be defined after the approval of the other sub-proposals.

9) INSTRUMENTATION CONSTRUCTION TIME
About 2 months are necessary to prepare the instrumentation.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE
As particular care must be taken for optimal light sources and the stability of the source is reached many minutes after their turning on, about 1-2 hours may be necessary before the beginning of each kind of acquisition.

11) PRODUCT DESCRIPTION
Optimal photos also employable for future measurement.

12) SHROUD IMPACT DESCRIPTION
As light can interfere with the linen characteristics, the minimum power must be employed to obtain photographs. For this reason, in any case laser sources are not allowed.

1) TITLE OF SUB-PROPOSAL n°4

Calibration procedures and uncertainty analysis

2) OBJECTIVES

First scope of the sub-proposal is to define the procedure to be strictly followed during the data acquisition in order to have reproducible data.

Second scope is to develop the uncertainty analysis in parallel with the measurement process in order to assign a proper uncertainty value to the measured parameter according to ISO-GUM (Guide to the expression of uncertainty in measurement).

The metrological features of each measuring instrument or reference sample are examined and their traceability is considered so no any break in the traceability path should be evidenced.

3) PARTECIPANTS NAMES

Giulio Fanti.

4) EXPERIMENTAL APPARATUS DESCRIPTION

All the experimental apparatus (instrument and samples) are subjected to the uncertainty analysis.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

Technical specification of each instrument and sample must agree with the effective characteristics also considering the particular ambient factors in which the experiment is done.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

Each procedure must be properly chosen in order to minimize the uncertainty in the measurement of each parameter.

For example in some cases the repetition of 5 – 100 times the same acquisition may be necessary in order to reduce the repeatability uncertainty (as happens at pixel level when an image is acquired with not-cooled systems).

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

5 kEuro may be necessary if some instrument or sample are not calibrated and Padua University has not the possibility to do it.

8) SPONSORS (IF EXISTING)

None for the moment.

9) INSTRUMENTATION CONSTRUCTION TIME

Calibration of each instrument is necessary before, during and after the acquisition time. The following increment in time may be considered for calibration: +30% before the acquisition; +10% during the acquisition and about 10% of the total acquisition time before all the operations.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

See §9.

11) PRODUCT DESCRIPTION

All the measurements and acquisitions will be associated to the correspondent uncertainty values; for example each image will have the luminance uncertainty relative to each pixel.

12) SHROUD IMPACT DESCRIPTION
It depends of the proposed instrumentation.

1) TITLE OF SUB-PROPOSAL n° 5

High resolution digital photography

2) OBJECTIVES

The objective of this sub-proposal is to provide the best possible solution for the acquisition and archiving of the highest resolution digital photography of the Shroud of Turin possible with today's technology. This includes conventional visible light as well as ultraviolet and infrared digital photography from low to high resolutions. This is in support of and integrated with the overall goal of constructing a calibrated, multi-resolution image Atlas of the Turin Shroud.

The results of this proposal will include high resolution visible light, ultraviolet and infrared digital photographs covering the entire Shroud, including separate ventral and dorsal images, medium close ups of prominent image features (face, hands, feet, etc.), close ups of blood, water, burns, scorches and other stains and finally, extreme macro images of predetermined areas. Another possibility is the construction of a mosaic of images that covers the entire cloth. A final detailed list of imaging areas will be compiled after consultation with the entire group and should be based specifically on the needs of all other sub-proposals to ensure we meet the goals of the overall Atlas.

This Digital Photography sub-proposal will be integrated with the Analog Photography sub-proposal n°6, with input from the rest of the group, should satisfy all the photographic requirements of the overall proposal.

3) PARTECIPANTS NAMES

Barrie M. Schwortz, Aldo Guerreschi.

With the collaboration of Joseph Tarsia - Photographic Engineering/Technical Support; Equipment Technician - To be determined - There will be at least one other team member that in all likelihood will be provided by the equipment manufacturer, Phase One United States, Inc. (Carsten Steenberg - Chief Executive Officer, Phase One United States, Inc.) or Phase One Denmark A/S. He or she will be a certified expert on the instrumentation and camera systems used and will be qualified to provide full technical support on site. The manufacturer of the primary digital hardware is headquartered in Denmark and has indicated that additional technical support for the systems can easily and quickly be provided "locally" in Europe.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The basic apparatus will consist of a camera support system, a 4" x 5' long bellows view camera with a compliment of appropriate lenses, a high resolution digital scanning back, a laptop computer with appropriate software for image control and acquisition and a specially designed quartz lighting system that emits no infrared or ultraviolet light. All equipment is designed to operate on available local power (110 to 220V 50-60Hz).

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

Introduction: The best examples of the state-of-the-art equipment used today in professional digital photography are the high resolution digital scanning backs designed for use on large-format view cameras. Of those currently in the market, two stand out as the finest available. Interestingly, they both use the same CCD array but handle image and signal processing somewhat differently. Each uses its own proprietary software which is provided with the system. Both companies have offered their

tentative support for this project and have made information and literature available to B. Schwortz for the purposes of this proposal.
After careful evaluation, Schwortz has selected the Phase One Power Phase FX digital imaging system as the primary hardware for this proposal. The company has been developing and manufacturing this technology since the early 1990's, giving them considerable experience in the field. The Phase One system's major advantages include well-developed software that allows for ease of operation, excellent image resolution with no interpolation, relatively short exposure times of between 2 to 5 minutes, special features to compensate for variations in lighting and intensity and a removable infrared filter which can be replaced with a Wratten 87C filter. This last feature will allow us to produce concurrent digital infrared images of the Shroud with a sensitivity of 1000 nanometers in the infrared spectrum at the same high resolution as the white light imaging.
Phase One is one of the oldest manufacturers in this field and there are many thousands of Phase One digital scanning backs being used regularly by professional photographers and other important organizations worldwide.

The Equipment:
Phase One PowerPhase FX Digital Scanning Back: 10,500 x 12,600 pixels; Files Size: 760MB (48 bit RGB);1GB (64bit CMYK); Capture Area: 8.4cm x 10cm; Scan Times: Over 240MB/minute; ISO Rating: 1600 ISO; Connection 200' IEEE 1394 Cable Removable TG1 IR Filter replaceable with Wratten 87C for IR imaging; Active Power Stabilizing technology that enables on-the-fly light intensity compensation; Integrated ColorSync based on Color Management; 48 bit internal data path with 14 bit A/D converter: larger dynamic range than film; "Local" European Technical Support.
Suitable 4" x 5" Professional Long Bellows View Camera with appropriate lens array
Suitable Camera Support System
Suitable Laptop Computer with extra large or multiple Hard Disc Drives: A PCMCIA powered CD-R Recorder for additional archiving if needed
Specialized Lighting Equipment

TTI Reflective Lighting manufactured by Tarsia Technical Industries, Inc.
3200° Kelvin Color Temperature
Internal fans and special filters/reflectors eliminate IR and Ultraviolet output
Non-destructive lighting system used by museums, galleries and the Vatican for both photography and display illumination of art treasures.

Lighting Considerations:
Careful illumination of the Shroud of Turin will be critical throughout both the analog and digital photographic processes. The best possible lighting should provide the necessary level of illumination for each stage of photography without subjecting the cloth to elevated and potentially harmful levels of infrared and ultraviolet exposure. The TTI Reflective Lighting fixtures manufactured by Tarsia Technical Industries, Inc., were highly recommended by both digital scanning back manufacturers. The company has offered their tentative support for this project, including direct involvement by their president, and has made information and literature available to me for the purposes of this proposal. More information about the company and their lighting products will be found in the addendum.

6) EXPERIMENTAL PROCEDURE DESCRIPTION
The procedure for the digital photography will be somewhat dependent on the scale of the photographs being taken at any given time, since the size of the area being lit and photographed will necessarily dictate the lighting and camera positions. In all cases the camera will remain at a distance greater than

several millimeters from the cloth and the lighting at a distance greater than some meters. The lighting will generally be placed on both sides of the camera at 45° angles, although varying lighting patterns will be tested in advance to determine the optimum placement for the best imaging contrast on linen cloth.

The procedure, other than camera and lighting placement, is relatively simple and consistent. The lights and camera are positioned and focused, the computer and software are initialized and the image is viewed and adjusted on the computer monitor. When the image is correct, the scan is initiated and the data goes directly from the digital scanning back to the hard disk drive of the computer, where it is stored. Then the Phase One TG1 infrared filter is removed and replaced with an 87C filter which passes only the infrared portion of the spectrum while blocking all visible light. The image is refocused on the computer monitor and again the scan is initiated, sending the high resolution infrared digital image to the hard disk drive for storage.

This process will be repeated for each image in visible light, ultraviolet and infrared modes.

A preliminary cataloging system will be predesigned to provide appropriate filenames and identification for each image.

These will later be imported into an image database program like ImageAXS Pro that allows for cataloging by up to 20 fields of textual data. Large file sizes will require the creation of lower resolution (thumbnail) versions of each image for inclusion in general distribution catalog disc(s) to aid researchers in finding what they are looking for. However, this is just a preliminary solution as the media format for the Atlas itself has yet to be determined and could influence the image database methodology.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

No formal financial commitments have been made by any of the involved parties. However, Phase One and Tarsia Technical Industries, Inc., have indicated a tentative willingness to provide all hardware and software systems necessary to produce the described digital photography. In exchange, they would certainly expect an opportunity to mention the use of their equipment for this purpose in their marketing materials. I explained it would be impossible for them to use a photograph of the Shroud itself in any of their marketing materials, but a photograph of their equipment in use during the photographic sessions might not be out of the question. This is similar to the arrangement made by STURP with several manufacturers who provided them with equipment during the 1978 scientific examination (Wilde Photomacroskop, etc.). Of course, there is still the cost of travel and accommodations which would also have to be considered.

At this stage, B. Schwortz would be willing to volunteer his time during the actual photography, but there will probably need to be some consideration for the preliminary testing and calibration of the hardware and software prior to departure. Both companies have expressed a tentative willingness to make their systems available in advance so appropriate testing and calibration could be performed.

Consequently, detailed cost factors are difficult to estimate at this point, but with the willing participation of all parties, the costs would certainly be kept minimized. The cost to purchase the equivalent systems outlined in this proposal would be about 100 kEuro, depending on lenses, computer system, etc. If the proposal is accepted, formal agreements will need to be drafted amongst all participants that will ultimately dictate final costs. At that point, a more detailed budget would be developed.

8) SPONSORS (IF EXISTING)

There are currently no formal sponsors for this proposal. However, if we go to the next step and the proposal is accepted, Phase One, along with Tarsia Technical Industries, Inc. and Barrie Schwortz Productions would certainly be considered the primary sponsors of the proposal.

9) INSTRUMENTATION CONSTRUCTION TIME

In the event that this proposal is accepted, a minimum of 3 months would be required for adequate testing and calibration of the hardware and software in preparation of the testing, along with the design and fabrication of an appropriate camera support system. This is only a tentative estimate and more time might be necessary. However, since all of the hardware and instrumentation (aside from the camera support system) is readily available in the commercial market, a minimum of customization or fabrication should be necessary. That should allow for efficient system integration in a relatively short time period.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

Since a final list of necessary images has yet to be completed, it is difficult to estimate the accurate time necessary to perform the digital photography. However, a 24 hour period would probably be adequate for the requirements of this sub-proposal. If possible, it should be divided into two twelve-hour or three eight-hour sessions to allow for archiving the images off of the hard disk drive and giving the photographers an opportunity to rest.

11) PRODUCT DESCRIPTION

See attached addendum for detailed information on all primary products planned for use in this proposal.

12) SHROUD IMPACT DESCRIPTION

Great care and consideration has been taken in the development of this proposal to assure there would be minimum impact on the Shroud itself. There will never be any need for any photographer to come in physical contact with the cloth although it must be photographed without any glass covering. The lighting equipment, described above and in the attached addendum, has been selected as among the best available for such a delicate purpose and is designed to eliminate output of infrared and ultraviolet radiation. There should be little if any impact on the Shroud during the performance of the digital photography.

1) TITLE OF SUB-PROPOSAL n° 6

High resolution analog photography

2) OBJECTIVES

The objective of this sub-proposal is to provide the best possible solution for the acquisition and archiving of the highest resolution analog photography of the Shroud of Turin possible with today's technology. This includes conventional visible light as well as ultraviolet and infrared digital photography from low to high resolutions. This is in support of and integrated with the overall goal of constructing a calibrated, multi-resolution image Atlas of the Turin Shroud.

The results of this proposal will include high resolution visible light, ultraviolet and infrared analog photographs covering the entire Shroud, including separate ventral and dorsal images, medium close ups of prominent image features (face, hands, feet, etc.), close ups of blood, water, burns, scorches and other stains and finally, extreme macro images of predetermined areas. Another possibility is the construction of a mosaic of images that covers the entire cloth. A final detailed list of imaging areas will be compiled after consultation with the entire group and should be based specifically on the needs of all other sub-proposals to ensure we meet the goals of the overall Atlas.

This Analog Photography sub-proposal will be integrated with the Digital Photography sub-proposal n°5, with input from the rest of the group, should satisfy all the photographic requirements of the overall proposal.

3) PARTECIPANTS NAMES

Aldo Guerreschi, Barrie M. Schwortz.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The basic apparatus will consist of a camera with relative optics that mounts color slides with maximum dimensions of 20x25 cm.

The camera will be mounted on a 2-axes manipulator (see sub-proposal n°1) and will acquire the analog photos from a maximum distance of 8 m from the Shroud laying vertically in a panel.

The lighting system consist of al least 6 lamps.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

All the analog photos will be color slides with dimensions of 20x25 cm; this corresponds to a resolution of about 16000x20000 pixels.

Sinar 20x25 instrumentation will be employed coupled with positive and negative slides and cold light sources.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

Many acquisitions at different resolution level are foreseen. A more detailed plan will be furnished after a deeper discussion with all the participants to the Atlas proposal.

For the moment the following acquisitions are foreseen:

-1) 1 slide of the whole Shroud with resolution of about 0,25 mm;

-2) 2 slides of the Shroud with resolution of about 0,12 mm;

-3) 4 slides of the Shroud plus another slide corresponding to the frontal and dorsal head of the Man.

These slides have a scale about 1:6 and resolution of about 0,06 mm.

-4) 3 x 9 slides of the Shroud. These slides have a scale about 1:3 and resolution of about 0,03 mm.
-5) many slides of some details.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

No formal financial commitments have been. The cost to purchase the systems would be about 50 kEuro, depending on lenses, etc.

8) SPONSORS (IF EXISTING)

Sinar may sponsor the experimental equipment.

9) INSTRUMENTATION CONSTRUCTION TIME

In the event that this proposal is accepted, a minimum of 1-2 months would be required.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

Since a final list of necessary images has yet to be completed, it is difficult to estimate the accurate time necessary to perform the digital photography. However, a 12 hour period would probably be adequate for the requirements of this sub-proposal.

11) PRODUCT DESCRIPTION

To be completed.

12) SHROUD IMPACT DESCRIPTION

Great care and consideration has been taken in the development of this proposal to assure there would be minimum impact on the Shroud itself. There will never be any need for any photographer to come in physical contact with the cloth although it must be photographed without any glass covering. The lighting equipment, described above and in the attached addendum, has been selected as among the best available. There should be little if any impact on the Shroud during the performance of the analog photography.

1) TITLE OF SUB-PROPOSAL n°7

CCD colorimetry

2) OBJECTIVES

Here is proposed a quick method for colour measurements of the Shroud by means of a 3-CCD camera obtaining colorimetric values at pixel level. The method is based on acquiring together and comparing the object of interest and a proper set of calibrated colours. The measurement uncertainty is less than 2 % level as regard the CIELAB co-ordinates a* and b* and less than 0,5 % as regard L*.
This is may be a useful accurate database for future controls of colour variations in each point of the whole sheet.

3) PARTECIPANTS NAMES

Giulio Fanti.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The experimental apparatus consists of a 3-CCD camera supported by a 2 axes manipulator (see sub-proposal n°1) connected with an integration sphere. It acquires images both of the Shroud and a reference mask that contains precalibrated colors. The integration sphere is necessary to avoid shade effects in the linen threads. Acquired images are also compared with the data of a spectrophotometer.
For more details, see ref. 1, 3, 8 in the personal bibliography.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

A 1024x1024 3-CCD camera is sufficient for the acquisition if it is pre-calibrated at pixel level.
Almost 2 integration spheres are necessary: a little sphere having a work area of about 50x50 mm is necessary for high resolution photos of some details and a big one having a work area of at least 300x300 mm is necessary for the acquisition of the whole Shroud (as an integration sphere having a working area of 5000x5000 is not proposable, many acquisitions of the Shroud are necessary).
Illuminant D-65 may be used for this purpose.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

The Shroud lies in a vertical plane; the acquisition system moves parallel to the Shroud at a proper distance; the calibration mask is at a distance of about 3 mm from the Shroud but it does not touch the sheet (see fig. 1).
Before and after the image acquisition, some reference panel calibrate the response of the measurement system.
To reduce the electro-optical noise, about 100 images of the same subject are acquired and the relative averaged image is stored.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

Costs of about 80 kEuro (sub-proposal N°1 not considered) may be partially covered by sponsors, partially covered by the Dipartimento di Ingegneria Meccanica (DIM) of Padua University that may design the reference mask and the support systems. DIM can also furnish the little integration sphere and the 3-CCD camera.

8) SPONSORS (IF EXISTING)

Gasparoli - OLYMPUS-EUROPA and Maurizio Abbate - IMMAGINI & COMPUTER, Bareggio (Mi).

9) INSTRUMENTATION CONSTRUCTION TIME
About 5-7 months are necessary to construct and pre-calibrate the instrumentation.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE
After the definition of a more detailed procedure it will be possible to define the execution times.
In any case it is foreseen a time varying from 5 to 50 hours pre and post calibration excluded.

11) PRODUCT DESCRIPTION
A number to define (variable from 20 to 500) of calibrated images of the Shroud taken at different resolution level. Each image will contain color information at pixel level characterized by an uncertainty level less than 2% also useful to future comparison for the conservation of the Shroud.

12) SHROUD IMPACT DESCRIPTION
No impact on the Shroud is foreseen because the acquisition system is not in contact with the sheet. Only the illuminant D-65 light is to be considered.

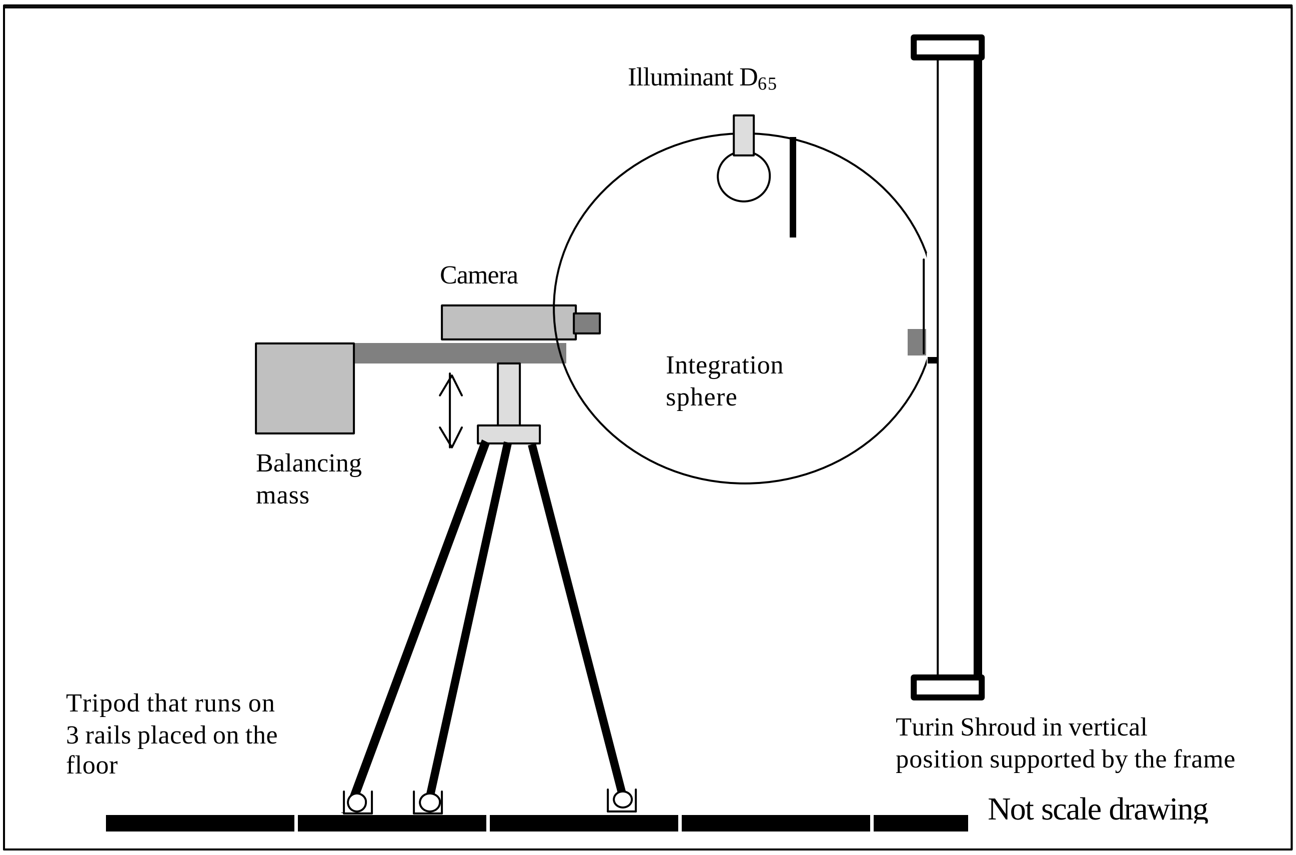

Fig. 1: Scheme of the acquisition systems; it is showed the system foreseen for the mapping with integration sphere.

1) TITLE OF SUB-PROPOSAL n°8

Microphotography of body image in situ

2) OBJECTIVES

Record the body image picture elements on the Turin Shroud, at 200x or higher, in the fibers that make up the threads over high gradient areas such as the nose and fingers to establish the physical nature of the random pattern of the darkened sections of the fibers that make up the visible image.

3) PARTECIPANTS NAMES

Kevin Moran.

4) EXPERIMENTAL APPARATUS DESCRIPTION

A high resolution digital camera with a 20x microscope objective dedicated lens barrel equipped with fiber optic lighting, supplied from a separate adjustable wavelength source, will capture the image and supply it to computer and mass memory work station. The camera will be mounted on a small X-Y servo pad (see sub-proposal n°1) that rests on the cloth. Image processing software will be used to filter and record the location of each marked fiber.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

Microscope camera: 1 megapixel; monochrome; 12 bit; SMD 1M30p (Dalsa) or DC250 Leica., or equal

Power Supply, Cables; Capture Card; PCI.

PC Computer system: Hewlett Packard, Dell or equal; P-3 500 Mhz or better, 19” monitor, B/W laser printer and color Inkjet printer. Mass memory storage; JAZ dive, CD-R, or 40 Gig hard drive.

Objective lens Assembly*: 20x, 0.5NA objective; 50x,100x optional; Relay barrel, folding prisms, C or F mount as required to fit camera; Z axis Focus servo; X-Y stage; Kollmorgen NEAT OFS 4040; Cables; Servo Card; PCI.*

Software: *Camera control; Image preparation; Image stacking ; X-Y stage drive; Mosaic mapping; Binary Large object mapping; Histogram and spatial filters.*

Illumination*: Stocker/Yale Mille Luce 150w 220v w/ iris and 5 wave length filters; Optional: Zenon/monochrometer and band stop filters as required; Fiber optics cables; 0.25” quartz 1 meter long and 0.375” glass 1.2 meters 0.66NA; Adapters and counterbalance for all cables to minimize weight on cloth.*

Special fabrications: *Assembly brackets for base pad; Counter balance arm to minimize cable weight; Light weight adaptation to servo stage to keep cloth footprint to be below 1 kPa; Dust shields; Anodizing and coating to protect from contamination.*

Accessories: *Media for recording data; Shipping containers; Manuals; Power conditioning Supply and cables 220/120 interfaces as needed.*

System software vendor will be either “Image-Pro Plus” by MediaCybernetics or “Image Manager” by Leica Microsystems.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

With Shroud cloth flat in the horizontal position the areas to be scanned will be selected based on density gradient falling from maximum to the non-imaged background in less than 10 millimeters. Such a region is found in the nose and finger areas.

The micro-camera instrument will be in its "home" position with respect to the small X-Y servo base pad. The location of the instrument can be manually measured from the cloth edges or from a well known mark on the Shroud.
The computer cable and fiber optic to the light source will be the only connections to the instrument. The computer workstation and variable wavelength illuminator will be some distance from the microscope camera unit. Weight on the cloth will be minimized by counter balancer supporting the cables.
The scan will consist of 20 micro steps over the 10 millimeter travel in the X direction and then repeated in 20 lines in the Y direction. This will yield a 400 element mosaic with better than a one micron resolution. Each thread is about 300 µm so that at least 200 threads can be used for the statistical analysis. The fibers in each thread are 10 to 15 µm in diameter. The target field of view will be 1 millimeter.
Multiple focus will be used to build an image stack over the mosaic area that will display a map of the best focused fibers. Thresh holding and spatial filtering will be used to classify the types of objects in the scan field.
A binary large object (BLOB) filter will be used to present the map of the imaged areas in their base form. The distribution of these elements over the scan distance can be correlated to the observed visual gamma to verify that these are the source of the color density seen by the human eye, and camera.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)
Camera system 15 kEuro; PC computer system 3,5 kEuro; Optical & X-Y stage 11 kEuro; Software 10 kEuro; Illumination 2 kEuro; Special fabrications 12 kEuro; Accessories 1 kEuro; Spectrophotometer 7 kEuro; Shipping, travel, on-site costs 4 kEuro.
Current Estimated Total 65,5 kEuro.

8) SPONSORS (IF EXISTING)
Holy Shroud Guild of Esopus, NY; Dr. Gina Glick and family; and possibly the instrument supplier.

9) INSTRUMENTATION CONSTRUCTION TIME
Build and test system will take 2 months.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE
Best Effort. Time is needed to setup equipment, calibrate and scan at least two areas, preferably scanning over five areas. 24 hours is the shortest time to do this and could be spaced over 3 days of 8 hours each.

11) PRODUCT DESCRIPTION
Data sheets can be seen on the internet;
http://www.smd.com/products/1m30.asp http://www.leica-microsystems.com
http://www.mediacy.com http://www.olympus.com http://www.neat.com http://www.equitechintl.com

12) SHROUD IMPACT DESCRIPTION
The resting pressure of the instrument on the cloth will only be 1 kPa or less. This is about the same as a salt shaker resting on the diner table cloth.
There will be not be any material removed from the Shroud at this time.

1) TITLE OF SUB-PROPOSAL n° 9

Mid -IR, Near-IR, VIS and Near-UV spectroscopic measurements

2) OBJECTIVES

To create a molecular map of the entire Turin Shroud and, at higher resolution, for specific areas of interest using portable spectroscopic measurement equipment.

3) PARTICIPANTS NAMES

Bryan Walsh (Shroud of Turin Center in Richmond).

Possible collaboration with the Turin Shroud Center of Colorado.

A variety of manufacturers make excellent portable spectroscopy equipment with which to conduct the measurement plan. These include Analytical Spectral Device's *Lab Spec* and *Field Spec* series, ABB Bomem's *MD* series, Nicolet's *Antaris* series, Midac's *I* series, PerkinElmer's *Spectrum* series, Ocean Optics *S2000* series and StellarNet's *EPP2000* series.

For the near-IR thru near-UV portion of the spectrum, the Ocean Optics S2000 instrument provides an excellent mix of flexibility (uses a flexible fiber optic probe), range (200 - 1100nm) and resolution (2048-element linear CCD fiber optics) to make it a suitable instrument for this portion of the spectrum when combined with fiber optic probes.

For the *mid-IR portion* of the spectrum, the *PerkinElmer Spectrum One* is a widely used portable spectroscopy device which could be readily adapted for use on the Shroud and which would produce superior spectral resolution for subsequent analysis. It has a working range of approximately 1,300nm to 29,000nm.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The devices employed use non-destructive illumination technology with which to extract their data. Each device is readily connected through either an A/D card or with on-board capability to a personal computer to facilitate data analysis and data compilation.

Windows-based software is included with each system and can be supplemented with other software as the need arises. This digital capability will enable other researchers to have ready access to the data in digital form and would also permit the data collected to be readily incorporated into an integrated digital atlas of the Shroud.

Prior to taking measurements on the Shroud, all instruments would be benchmarked against known standards to insure instrument reliability. This procedure would be employed at the beginning of every measurement run and periodically during the measurement taking process to insure instrument stability.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

UV-VIS-Near-IR: Ocean Optics S2000 fiber optic spectrometer with CCD detector response from 200-1100nm.with a 250:1 signal-to-noise ratio. System is fed by SAD500 microprocessor controlled A/D card which is PCMCIA compatible with portable PC with either an AMD K2 or Pentium II 250MHZ capability under Windows 95/98 operating system and at least 3GB HD to accommodate file creation and retention and the OOIBase32 FFT analysis software which accompanies the S2000. A 2 meter-long Ocean Optics R200-mixed reflection probe for reflection measurements will be utilized. The Ocean Optics LS-450 will be utilized as a 470nm (blue) light source for fluorescence measurements.

Mid-IR: PerkinElmer Spectrum One spectrometer with an operating range of 1.3 to 29 microns and a short period (10 sec) signal-to-noise ratio >30,000:1. The device is connected to a portable PC with either an AMD K2 or Pentium II 250MHZ (or greater) capability under Windows 95/98 operating system and at least 3GB HD. The measurement-taking device will be a diamond-tipped Attenuated Total Reflectance probe that will require firm and direct contact with the Shroud's surface. This equipment, or equipment with similar characteristics, is currently owned and operated by the Turin Shroud Center of Colorado.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

An electromechanical device will need to be constructed *(see sub-proposal n°1)* which will enable the equipment to be precisely placed to permit measurements characterized by relatively low uncertainty on the Shroud while actually touching the Shroud only with the probe necessary to transmit and measure the mid-IR thru near-UV spectra. Further, the spectroscopic equipment will also need to be employed flexibly to take measurements in specific areas of interest such as the area surrounding the radiocarbon sample site, various blood stain areas, water stain and image areas, etc. Thus, the device constructed should have a capability to be moved anywhere on the Shroud cloth from which spectral data is required.

The measurements taken will be correlated to a grid with a 2 cm vertical and horizontal resolution that would be placed around the Shroud for reference purposes. This grid could be constructed of black poly thread, similar to fishing line, which will be constructed in a 2 cm grid and suspended over the Shroud to assist positioning and calibration. The grid coordinates would be used as a frame of reference for all optical, spectral and physical information derived from the Shroud.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

In exploring other alternatives, I have evaluated the equipment and computer costs, the time to acquire, test and integrate the necessary equipment, as well as the staffing (minimum of 3 people) and training time necessary to create an integrated research team. It would incur a direct cost in excess of 95 kEuro most of which can be avoided if the Turin Shroud Center of Colorado is utilized to take the measurements.

8) SPONSORS (IF EXISTING)

None at this time - but the total cost may be supported by sponsors and research centers.

9) INSTRUMENTATION CONSTRUCTION TIME

It would take between 4 to 6 months from the time a proposal was approved to gather equipment and develop a research team.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

While individual measurements do not take a long time (<2 min. ea.), the large number of measurements to be taken (~10,000), the need to verify instrument calibration from time to time, and the level of human fatigue continuous measurements will likely create will require a time period of at least 7 days of uninterrupted access if such a detailed molecular map is to be created.

This time could be reduced if the data-gathering gradient was enlarged or if the actual measurement time was substantially less than expected.

11) PRODUCT DESCRIPTION

The proposed evaluation of the Shroud's physical and chemical state, the nature of its image as well as the impact environmental exposure has had on the cloth involves three distinct activities:

- *a) Data Acquisition* using a variety of modern measurement instruments to create an in-depth digital compendium of data taken from the Shroud. Two principal types of measurements are involved: *Physical Characteristics* (Imaging) color, stains, debris; and *Electromagnetic radiation* (Spectroscopy) absorption, emission, scattering.
- *b) Data Analysis* using the detailed knowledge derived from the new measurements to determine physical characteristics, chemical composition, pollutant analysis and a wide variety of site-specific analyses.
-*c) Hypothesis Evaluation* based on the data derived and the analysis of principal regions of the Shroud including the body image, scorch marks, water stains, blood stains, burn marks and other areas of interest.

12) SHROUD IMPACT DESCRIPTION

The Shroud will be exposed to low-level illumination in wavelengths between the mid-IR and the near-UV. Non-invasive and non-destructive equipment probes and cloth contacts will be used to deliver the illumination and gather appropriate data from the cloth through contact with the cloth.

13) SOME SPECIFIC AREAS TO BE MEASURED

Entire surface of Shroud: a grid of mid-IR thru near-UV spectra taken in 4cm by 4cm increments and recorded digitally on computer hard drive. All data collected in this manner will be accessible thru Windows-compatible software and will also be archived on both hard drive and CD-ROM media.

Radiocarbon dating site: a series of mid-IR thru near-UV spectra taken in 1 cm increments around the sample area and recorded digitally. In addition a series of similar measurements spaced at 2 cm intervals should be taken that extends from the middle of the radiocarbon sample area and extends both horizontally and vertically to the middle of the Shroud cloth. The horizontal and vertical measurements should be taken at 2 cm intervals from the edge of the cloth to the end of the sample area yielding 5 separate horizontal sets of measurements and 3 separate vertical sets of measurements. In addition, the remnant portion of the radiocarbon sample site retained by Pietro Vercelli should also be examined in 1 cm horizontal and vertical increments using the same equipment and conducted at the same time the Shroud is being measured.

Eye image site: a series of mid-IR thru near-UV spectra should be taken in 1 cm increments around the eye image area extending 2 cm beyond the edge of the eye sockets and covering the area from one edge of the eye socket to the other both vertically and horizontally. Further, very high-resolution photomicrographs and magnified images of both eye areas.

Blood sites: a series of mid-IR thru near-UV spectra should be taken in 1 cm increments from an area extending 4 cm beyond the edge of the blood stain on all sides. This would result in a data set of 25 measurements recorded for each portion of the spectrum from each discrete stain area evaluated. The measurements of the non-blood areas would be noted separately from the blood areas so that researchers could differentiate visually non-blood from blood spectra and use that information in their analysis.

"Food stain" sites: a series of mid-IR thru near-UV spectra should be taken in 1 cm increments on and around the purported stain areas as well as a series of very high resolution photomicrographs and magnified images of each of the purported "stains".

"Tack-mark" sites: a series of mid-IR thru near-UV spectra taken in 1 cm increments on and around the purported tackmark areas as well as a series of very high resolution photomicrographs and magnified images of each of the purported "tackmarks".

Waterstain border sites: a series of mid-IR thru near-UV spectra taken in 1 cm increments on and surrounding the waterstain sites as well as a series of very high resolution photomicrographs and magnified images of each of these areas.

Image sites: a series of near-IR thru near-UV spectra taken at 2 cm intervals on portions of the head, thorax, apparent image rolloff in the groin area, knees, thighs and feet. These spectra should be taken from both the ventral and dorsal areas.

Scorch sites: a series of near-IR thru near-UV spectra taken at 2 cm intervals on and surrounding the scorch sites as well as a series of very high resolution photomicrographs and magnified images of each of these areas.

1) TITLE OF SUB-PROPOSAL n° 10

Microscopic FT-IR examination

2) OBJECTIVES

To examine, for specific areas of interest, the FTIR spectrum of fibers taken from the Shroud of Turin using no-portable spectroscopic measurement equipment.

3) PARTICIPANTS NAMES

Maurizio Bettinelli, Francesco Barbesino, Mario Moroni.
Possible collaboration with the two instrument manufacturers as Perkin Elmer or Nicolet (in Italy).
Both the manufacturers make excellent FTIR equipments with which to conduct the measurements. These include “FTIR Nicolet Continuμm” and PerkinElmer’s Auto IMAGE System.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The devices that could be employed use non-destructive illumination technology and can operate in transmission or in reflection mode but also in ATR (Attenuated Total Reflectance). Each device is connected to a personal computer to facilitate data analysis and data compilation.
Windows-based software is included with each system and can be supplemented with other software as the need arises. This digital capability will enable other researchers to have ready access to the data in digital form and would also permit the data collected to be readily incorporated into an integrated digital atlas of the Shroud. (see figure 1 as example).

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

Can be easily obtained by manufactures because both the instruments are commercial equipment.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

The spectroscopic equipment should be used to take measurements in specific areas of interest such as the area surrounding the radiocarbon sample site, various bloodstain areas, water stain and image areas, etc. Obviously the linen samples should be removed from the Shroud and send to laboratory.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

The instruments have no cost for us because they should be arranged from the manufactures. M. Bettinelli has evaluated the time to acquire the spectrum, to elaborate the data, as well as the training time necessary to create a research team (1-2 people). It would incur a direct cost of about 2.5-5 kEuro for a working time of about one – two months.

8) SPONSORS (IF EXISTING)

None at this time.

9) INSTRUMENTATION CONSTRUCTION TIME

The instruments are commercial therefore available at any time.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

The instrument calibration should be done in accordance to calibration procedures set up by UNICHIM (Italian Standardization Body for analytical instruments).

11) PRODUCT DESCRIPTION

The results of the proposed evaluation should regard a detailed knowledge of chemical composition, pollutant analysis and a wide variety of site-specific analyses.

Based on the data derived and the analysis of principal areas of interest of the Shroud some hypotheses on the formation mechanism of the image but more simply the actual "chemistry" of the linen should be obtained.

12) SHROUD IMPACT DESCRIPTION

The linen samples (few µm- mm) should be taken from the Shroud to be analyzed by MC-FT-IR in laboratory.

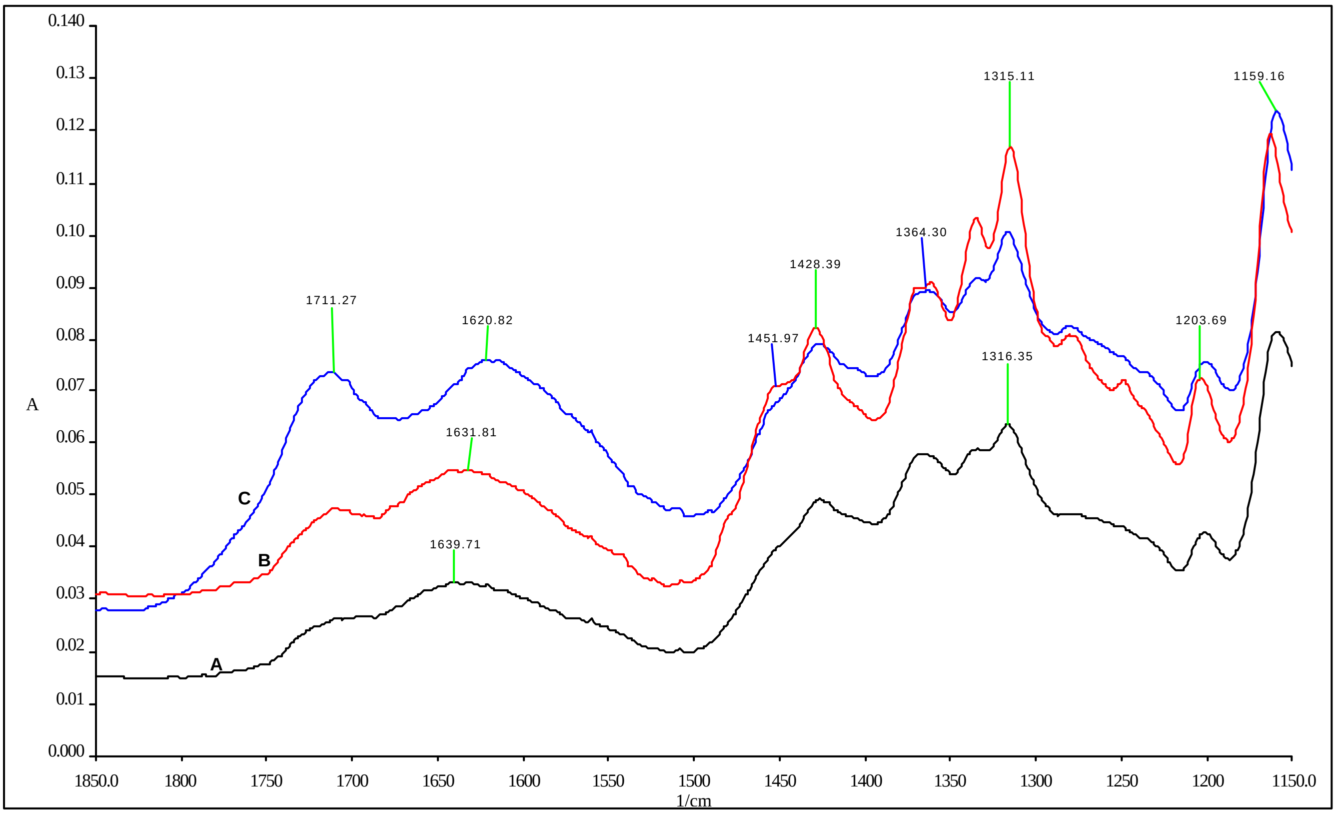

Figure 1: example.

1) TITLE OF SUB-PROPOSAL n° 11

Mapping with a scanner also in UV light

2) OBJECTIVES

This sub-proposal is done to have a more accurate source of information with respect to both analog and digital photography.

With a scanner, that is based on a linear CCD sensor, many problems due to the optical distortion and the spatial variation of luminance related to the optics, are overcame.

The resulting images will then be used for quantitative analysis on the Shroud if the scanner is properly calibrated.

As in the scanner the field of view is different from that relative to the analog or digital camera, the comparison of the results obtained with the different system may be useful for increasing the knowledge of the Shroud.

The same image is acquired 4 times according to perpendicular direction of motion of the linear CCD sensor in order to have 3-D information of the cloth.

Using a modified scanner, the acquisition may be done not only in visible light, but also in UV, IR and narrow-band light. For example, using the scanner in visible, UV excited, light, the serum stains are evidenced.

3) PARTECIPANTS NAMES

Giulio Fanti, Aldo Guerreschi.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The experimental apparatus consists of a modified scanner mounted on a 2-axes manipulator described in sub-proposal n°1.

The scanner has an interchangeable source of light and the CCD linear sensor acquires images at a distance of about 3-8 mm from the Shroud without touching it.

An A4 format scanner may be employed in the acquisition of 4 x 22 high resolution images in files of 100 megabytes.

For more details, see fig.1 and ref. 12.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

A commercial A4 1200 dpi (dot per inch) scanner can be modified in order to have the possibility to change the linear visible light source with others UV included.

The external structure of the commercial scanner is to be lightened, the glass plane can be taken away and be interfaced with the 2 axes manipulator.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

The Shroud lies in a horizontal plane and the scanner, mounted on the 2 axes manipulator, acquires images parallel to the Shroud from a distance of about 3-8 mm.

The scanner is positioned in each of the 88 position along the Shroud by the 2 axes manipulator and acquires images.

At the end the acquisition is repeated for 4 time turning the scanner of 90°.

A total of 352 acquisitions in visible light, each of about 100 megabytes are foreseen. About 10-20 calibration acquisitions, using reference plates in Spectralon, are also to be considered during the image acquisition.

An additional group of 88 images in UV light are foreseen changing the illumination system of the scanner.
Other possible light sources may be considered.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)
Costs of about 10 kEuro (sub-proposal N°1 not considered) may be partially covered by sponsors partially covered by the Dipartimento di Ingegneria Meccanica of Padua University that may design and modify the scanner structure.

8) SPONSORS (IF EXISTING)
To be defined.

9) INSTRUMENTATION CONSTRUCTION TIME
About 5-7 months are necessary to construct and pre-calibrate the instrumentation.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE
If all the 352 acquisitions in visible are done at very high resolution, about 30-40 hours will be necessary.
If 88 acquisitions in UV light are done at the same resolution, about 10-15 hours are foreseen.
For each group of 88 acquisition at narrow band, IR or other kind of light are foreseen, about 10-15 hours must be considered.

11) PRODUCT DESCRIPTION
352 calibrated images, having a resolution of 1200 dpi, corresponding to four independent acquisition of the whole Shroud, seen from 4 mutually orthogonal points of view are foreseen. Details of 0.02 mm are therefore resolved.
These images may be jointed in a unique digital image of the Shroud having a very high resolution, minimal distortions, negligible uncertainties in luminance and a 3-D aspect of the linen threads.
88 calibrated images of the Shroud in UV light are also foreseen.

12) SHROUD IMPACT DESCRIPTION
No impact is foreseen for the scanner that does not touch the Shroud.
Any light source will be chosen in order to minimize the impact on the Shroud.

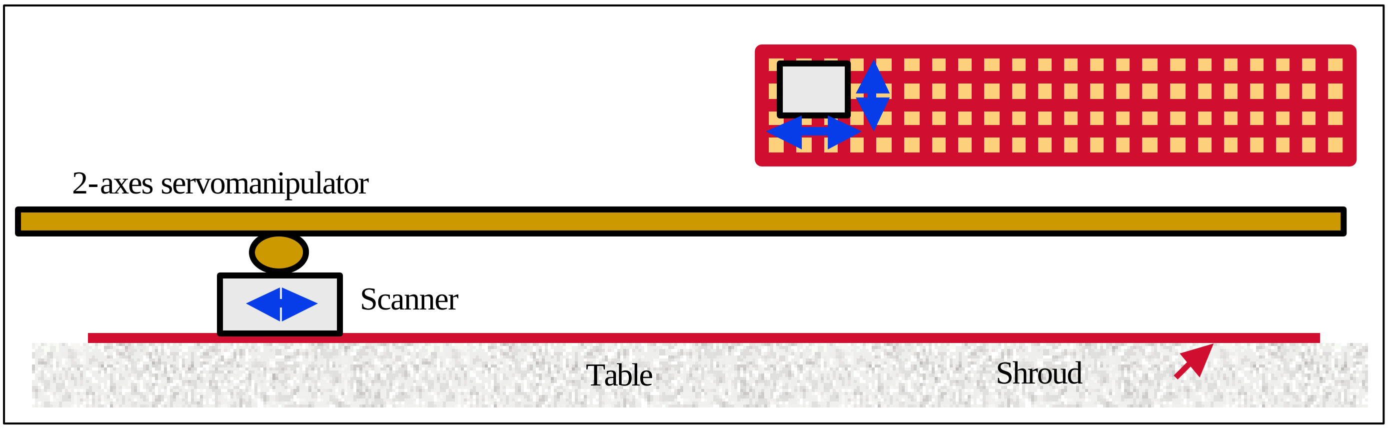

Fig. 1: Scanner mounted on a 2-axes servomanipulator

1) TITLE OF SUB-PROPOSAL n°12

Drawing some fibrils

2) OBJECTIVES

Taking documentation by videocamera here is proposed the drawing of:

- a ten of body-image fibrils from the feet area;
- some tens of non-image fibrils near the zone of the body-image;
- a ten of non-image fibrils near the zone of the 1988/C-14 drawing;
- a ten of scorched fibrils near the 1532 burn marks;
- a some fibrils in correspondence of the charred area of pre 1532 fire.
- a ten of non-image fibrils in the zone of the side strip.

The microphotos (200-2000x) subsequently obtained in visible, IR, UV lights also cross-polarized, will be included in the atlas.
For more details see ref. 13.

3) PARTECIPANTS NAMES

Giulio Fanti, Kevin Moran.

4) EXPERIMENTAL APPARATUS DESCRIPTION

The experimental apparatus consist on a stereo-microscope 10-30x connected to a computer vision system. It allows the experimenter to choose the proper fibril to be drawn by means of thin watch-tweezers. The microscope is mounted on the 2 axes manipulator that furnish the x-y coordinates of the drawing.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

A zoom stereomicroscope with camera connection and amplification 10-30 x is preferred.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

A particular procedure was previously tested on a linen sheet similar to the Shroud.
The Shroud lies in a horizontal plane and the operator is seated on one side.
The operator choose roughly the drawing position from a distance of about 1 m and put over the Shroud a particular reference card. Then, using the microscope, he catches the fibril to draw.
Particular care must be taken when fragile body-image fibrils are pulled out.
The fibril is then put on a slide and catalogued with the relative x-y position.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

Costs of about 15 kEuro (sub-proposal N°1 not considered) may be partially covered by sponsors, partially covered by the Dipartimento di Ingegneria Meccanica (DIM) of Padua University.

8) SPONSORS (IF EXISTING)

To be defined the collaboration with Olympus.

9) INSTRUMENTATION CONSTRUCTION TIME

About 10 days are necessary to prepare the instrumentation.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

Due to the particular care necessary for the drawings, about 5-10 hours are necessary for a good work.

11) PRODUCT DESCRIPTION

About 60-100 slides each one containing a linen fibril (image, non-image, scorching, and C-14 test zone).

These slides may be then accurately analyzed in different light sources with magnification 200-2000x and employed for a chemical analysis described in sub-proposal n°10.

12) SHROUD IMPACT DESCRIPTION

Some tens of fibril are drawn from the Shroud. The diameter of about 10 μm causes no danger for the visible aspect of the Shroud if particular care is taken when drawing.

1) TITLE OF SUB-PROPOSAL n°13

Partial mapping of the back of the Shroud also with endoscopy in visible light, UV and IR light

2) OBJECTIVES

This sub-proposal has multiple scopes because the back of the Shroud is not well known because it is sewed on an Holland cloth.

For this reason the objectives are the following.

-a) If possible, high resolution mapping by means of cameras, of a part of the Shroud back near the feet area if some seams can be cut. The Atlas should then be enriched of information about the back of the Shroud in correspondence of the image and the non-image zones.

-b) Mapping of some image and non-image zones the Shroud back by means of a gastro-endoscope (having a diameter of about 4 mm) in order to reach smaller areas inside the two cloth sewn. It will then possible to evidence the back of the linen in correspondence of blood, serum, water stain etc.

-c) Mapping of some details of the Shroud as the possible writings around the face and the possible coins traces by means of a micro-endoscope (having a diameter of 0.6 mm). Some information about the back of the possible writings, possible coins traces, etc. will be added.

An important question is about the hypothesis that the body image of the Turin Shroud Man could be obtained by means of a singeing of a linen sheet leaned on a heated bas-relief. Even if not much credible, the hypothesis is not yet excluded. To exclude this hypothesis, recognition of the not visible Shroud face in Ultra-Violet lighting is therefore proposed.

Experimental tests evidenced that a singeing of a linen sheet at low temperature (about 50 °C) generate an image, in visible light excited by UV, that is evident both on the face in contact with the bas-relief and on the opposite one. At higher temperatures (about 120 °C) an oxidation and dehidratation of the linen fibers cancel the image. Other experimental tests showed that the singed image passes from a side to the other in the sheet if it was not previously wetted with a aloe and myrrh solution; in this case the image is superficial, but the opposite face shows the image only in UV light.

The body image of the Turin Shroud, caused by an oxidation and dehidratation, is extremely superficial. Then, if an endoscope, easily to insert among the Shroud sewing, is capable to show the absence of an image in the visible spectrum excited by UV light, the singeing hypothesis should be rejected.

3) PARTECIPANTS NAMES

Giannandrea Bianchini, Giulio Fanti, Mario Moroni

4) EXPERIMENTAL APPARATUS DESCRIPTION

The experimental apparatus consists of:

- a 2-axes servomanipulator ranging in a 300x300 mm area (described in Sub-proposal n°1) which mounts cameras and spectrophotometer;
- a spreader properly designed (dimensions of about 500x100 mm) to distance out the Shroud from the Holland cloth;
- an UV, IR, visible multi-lightening system capable to illuminate the cloth with a uniform intensity (within about +/- 20%);
- a gastro-endoscope having a diameter of about 4 mm connected to a PC capable to acquire images in real time;

- a micro-endoscope (Olympus type) having a diameter of 0.6 mm connected to a PC capable to acquire images in real time, that may be inserted among the Shroud linen threads;
- a video camera managed by an operator that acquire all the operation done during the acquisition: this is both useful to document the delicate operations and to recall particular positions of the instruments with respect to the Shroud.

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

The gastro-endoscope is a multi optical fibers sensor that acquires color images via a CCD sensor connected to a frame grabber and a PC. Its diameter is about 4 mm.

The micro-endoscope (Olympus type) is a single optical fiber with a diameter of 0.6 mm connected to a vision system.

The spreader will be designed with the following specifications: it must have no impact on the Shroud, but it must distance as far as possible the Shroud from the Holland cloth.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

After a first recognition on the Shroud to define which zone may be acquired, the best procedure will be decided.

It will be chosen the sequence of the acquisitions (camera, gastro-endoscope and micro-endoscope) and the different lightening systems.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

Costs of about 100 kEuro may be partially covered by sponsors (Olympus, Immagini&Computer), partially covered by other persons involved in other sub-proposals and partially covered by the Dipartimento di Ingegneria Meccanica of Padua University that may design and build the spreader and lend some instruments.

8) SPONSORS (IF EXISTING)

Olympus, Immagini&Computer and possibly others.

9) INSTRUMENTATION CONSTRUCTION TIME

About 5 months are necessary to construct and pre-calibrate the instrumentation.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

It depends on the number of allowed acquisitions that will be decided after a first sight of the Shroud.

The minimums time foreseen for having few information about the back of possible writings, possible coins, etc. and to acquire few images in UV light of the back of the Shroud are 3 hours, but it is preferable to have about 30 hours to make a complete analysis.

11) PRODUCT DESCRIPTION

Three types of products are foreseen to enrich the Shroud Atlas:

-a) high resolution map of a part of the Shroud back near the feet area if some seams can be cut.

-b) high resolution map of details in the Shroud back in correspondence of blood, serum, water stain etc.

-c) acquisition of details in the Shroud back not easy to reach with traditional instruments as the writings around the face and the coins.

12) SHROUD IMPACT DESCRIPTION

Great care and consideration has must be taken in the definition of the final procedure in order to minimize the impact on the Shroud.

The micro-endoscope (diameter of 0.6 mm) has a minimum impact passing through the linen threads and the gastro-endoscope has a little impact passing through the sewing.

UV, visible and IR light will be chosen in order to minimize the impact on the Shroud.

1) TITLE OF SUB-PROPOSAL n° 14

Collection of dusts and fine materials

2) OBJECTIVES

Here is proposed the collection of dusts and fine materials in some way free resident in the cloth, using a "controlled" micro-vacuum system to be applied systematically on the complete area of the Shroud.

It will so possible to prepare a map to distribute in "statistical terms" the presence of different materials, i.e. :

- inorganic particles
- organic particles :
  - of vegetal origin
  - micro-organisms
  - others.

This research connected with the existing data should be used also to understand if in the system there is a presence of possible qualities of the materials dangerous for the life or the preservation of the cloth in relation to some possible chemical interference with the images.

The collection of dusts and fine materials are done from the whole Shroud area and in some zones between the Shroud and the Holland cloth. This will be done using a proper retractor.

3) PARTECIPANTS NAMES

Giovanni Novelli, Paul C. Maloney.

4) EXPERIMENTAL APPARATUS DESCRIPTION

a) *Self retaining retractor*. A special equipment useful to maintain raised the Shroud cloth from the sewed Holland cloth in order to permit the collection of the dusts in the surface areas included between the Holland cloth and the back side of the Shroud.

This, when open, is a parallelepiped trap that consent to move the leg with the filter at the head to collect the dust using a control system outside the area occupied by the cloth.

b) *For the general exploration a vision equipment based on optical fibers is used*. For details see sub-proposal n° 13.

a) *For the aspiration of the dust, the equipment is based on the following parts*:

- A *sampler* characterized as the Universal basic 44 EX/44 XR. This unit is able to produce a vacuum at a regulating flux to produce the necessary aspiration.
- A *box filter* (diameter 37 mm) in transparent polyethylene connected with the aspirator and including a round leg to be inserted in the area between the Holland cloth and the back part of the Shroud after the raising and the inclusion of the equipment.
- A *membrane filter* to be included in the above box based on mixed cellulose esters with a porosity of 0,45 nm.
- *Petri Analyslide* (Petri microconteiners on microsupport transparent on polystirene and able to collect membrane filter samples till 47 mm).

5) TECHNICAL SPECIFICATIONS OF THE INSTRUMENTATION

For the moment, see §4; the definition of the technical specification will be done during Phase B, after a more detailed definition of the sub-proposal.

6) EXPERIMENTAL PROCEDURE DESCRIPTION

The collection of dusts and micro-materials will be done on the visible side of the Shroud in the areas not interested by blood stains. A minimum pressure of the micro-vacuum instrument will be chosen in correspondence of the body image.

Also a collection of dusts and micro-materials will be done on the back side of the Shroud using a proper retractor.

Details will be defined during Phase B after a more detailed definition of the sub-proposal.

7) ECONOMIC ASPECTS (COSTS FOR EMPLOYMENT AND USE OF THE INSTRUMENTATION)

The equipment cost for dust collection is estimated in the value of about 2.5 kEuro.

About the retractor, it will be designed and constructed at the Dipartimento di Ingegneria Meccanica of Padua University probably at no-cost.

About the analysis of the dust, we can use the facilities and the support of Assist Group in U.S. and possible help of the American Company Perkin Elmer. Probably all this will be obtained at no-cost.

8) SPONSORS (IF EXISTING)

Sponsor: Assist Group in U.S.; Perkin Elmer in U.S. (to be confirmed). Other possible sponsors are to be defined.

9) INSTRUMENTATION CONSTRUCTION TIME

About 3 months from the moment of the clear start up.

10) TESTS EXECUTION TIME INCLUDING THE POSSIBLE CALIBRATION IN SITE

If we consider 3 min. flux for each sampling plus the time for insertion, deplacement, substitution, clearing etc. (about additional 3 min.) and a collection of about 200 samples, the total estimation of the dust sampling should be about 20 hours. For the different analyses of acquired samples the time is much more longer but these operations does not involve the Shroud.

11) PRODUCT DESCRIPTION

According to the new definition of both a big grid (22x6 squares 20x20 cm) and little grid (20x20 squares 1x1 cm), as discussed in Project Phase A – Motivations, a statistical analysis about the distribution of different materials will be done for each big square and for some interesting little squares.

It will so possible to have a systematic study of the distribution of both inorganic and organic (of vegetal origin and micro-organisms) particles.

Also a microscopic FT.IR analysis on single grains will be done according to sub-proposal n° 10.

The different particles will be then photographed and inserted in the Atlas showing the correspondent pick-up zone and the relative concentration.

12) SHROUD IMPACT DESCRIPTION

The Shroud is “touched” by the micro-vacuum system and some micro-particles are picked-up. The contact pressure is chosen in order to make no minimal danger to the linen threads; the effective impact on the Shroud must be lower than that caused by Frei tapes.

Francesco Barbesino

Francesco Barbesino got the degree in Industrial Engineering (sub section Chemical) at Milan Politecnico, worked for over 30 years as responsible of the *Laboratorio Prove Materiali*, then as “senior scientist” at *Centro Informazioni Studi ed Esperienze* of Milan participating to a number of multidisciplinary researches programs as materials, tests on materials, metallic and polymeric materials ageing expert.
He deepened themes regarding fracture mechanics, radiated materials, aging of polymeric materials and solid state diffusion.

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Roberto Basso

Roberto Basso is associate professor of Mechanical Vibrations at the Faculty of Engineering of the Padua University. His scientific activity concerns mainly automation fluid, monitoring and diagnostics of machine, and dynamics of motor vehicles suspension.
The researches in the sector of the fluid automation concerns theoretical and experimental analysis of the control of motion in pneumatic actuators driven by proportional systems. The principal objective of such researches regards the performance optimization of pneumatic actuators used in manipulators and industrial manipulator in which the control of the force and of the motion is generally difficult because the compressible fluid used in these systems.
In the field of monitoring and diagnostics of machines, the researches have the aim of developing reliable methodology to forestall irreversible damages in the machine members. The methods are based on the analysis of the vibrations in one or more points of the machine, and relating them with the efficiency of the machine mechanical components. At the present a research concerning the diagnostics of the gears is in progress; developing such research a new monitoring technique for the monitoring of the shafts and a new spectral analysis technique (the power spectre of the power cepstrum) of the vibration data have been carried out.
The research activity concerning motor vehicles suspensions is focused on three aspects: the improvement of the experimental test machines for the characterization of the damping force produced

by shock absorbers; the optimization of models for shock absorbers and their experimental validation; the modelling and simulation of the dynamic behavior of motor vehicles suspension.
The research activity is documented by more than 50 papers published in various journals, or presented in national and international conferences.

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Maurizio Bettinelli

Maurizio Bettinelli is Group Leader of Analytical Chemistry Group at ENEL Central Laboratory of Piacenza.
In his position of Head of Analytical Chemistry Group he coordinates the activity of internal specialists in several multidisciplinary fields: environment, fuels, materials, industrial hygiene, fluids. The main activities are devoted to analysis of the inorganic and organic trace contaminants, fuel oil and lubricants characterization, morphological and physical studies of environmental matrices, Insulating materials characterization.
His deep knowledge of analytical techniques and the experience gained in 20 years of chemical analysis makes it possible to participate at national and international committees for the validation of analytical methods.
Since 1985 he coordinates the activity of ENEL Round Robin Test (Interlaboratory Comparison Test) among laboratories performing environmental analysis and he his member of UNICHIM Commitee coordinating the Italian Round Robin Test on potable, discharge waters and sludges.

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Giulio Fanti

Giulio Fanti is associate Professor of Mechanical and Thermic Measurements at Padua University since 1996; he was ass. Prof. at Parma University, Italy since 1992 until 1996. He teaches Mechanical and Thermic Measurements and Testing.

Secretary of the Italian group of official professors of Mechanical and Thermic Measurements and founding member of the Center of Studies and Activities for Space CISAS "G. Colombo", he has been member of technical teams of international Space Missions: the Giotto Mission to the Halley Comet, the TSS-1 Mission, the Mission Mars '94 for the study of "Fourier Realtime Michelson Spectrometer", the Cassini Mission for Huygens probe for HASI and member of a group for studies on the Turin Shroud.

His past research activity was devoted to the study of physical models of space structures, finite elements modeling, thermo-mechanical optimization of space instruments and sound, pressure, vibration, damping, color and tension measurements.

His present research activity is devoted to measurements by means of vision systems, uncertainty analysis, diagnostic of structures and testing of space systems.

He is the Author of more than 90 papers also published in Italian and international journals.

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12. Fanti G., *Proposta di mappatura colorimetrica della Sindone con scanner*, Congresso Mondiale "Sindone 2000", Orvieto, 27-29 Agosto 2000.
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Aldo Guerreschi

Aldo Guerreschi is expert photographer from 45 years; he was apprentice and successor of R. Scoffone, the Savoys's photographer; he officially photographed the Shroud. He continued in printing Enrie's plates of the Shroud done in 1931, which holds in his laboratory.
He collaborates in the research with many sindonologists.

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Maurizio Marinelli

Maurizio Marinelli got the Diploma of Technical Director Engineer at "Max Planck" State Technical School for Different Sectors of Industry in Rome. At present he is the Director of the Technical Office of the "E. Fermi" State Technical School for Different Sectors of Industry in Rome and he has been enrolled in the Register of Technical Engineers in Rome and its province.
He has been interested in the Shroud since 1977. He is author of a book, a cd-rom and articles on the Shroud. He has been among the promoters of the periodical *Collegamento pro Sindone* in Rome since its foundation (1985) and is the webmaster of its Internet website http://www.shroud.it

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Emanuela Marinelli got a degree in Natural Sciences and a degree in Geological Sciences at "La Sapienza" University in Rome. At present she teaches at "Giulio Verne" State Vocational Training School for Business and Tourist Services in Rome.
She has been interested in the Shroud since 1977 and has been among the promoters of the periodical *Collegamento pro Sindone* in Rome since its foundation (1985). She is author of five books, a cd-rom and articles on the Shroud.
She was the Coordinator of the Organizing Committee of the Worldwide Congress "Sindone 2000", held in Orvieto in 2000.

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Kevin Moran

As owner and director of Cambiano Engineering Co., Mr. Moran provides consulting in optical instrumentation and process design for the electronics and textile industry.

At the Estek Division of Eastman Kodak, Moran designed laser scanning equipment for textile, film and semiconductor industries. He also designed and built an optical disk inspection system for the disks used to master CD roms. Mr. Moran has developed accelerometers for aircraft and missile guidance systems at Schaevitz Engineering and he was director of engineering at Edmund Scientific Co., where he developed their new line of astronomical telescopes including the 2001 Astroscan that has become the world's best selling diffraction limited Newtonian telescope. Some of Kevin Moran's more recent US patents are:

4630276	Compact Laser Scanning System	12/86
4875780	Method and Apparatus for Inspecting Reticles on Both Sides	10/89
5127726	Low-Angle/High-Resolution Laser Surface Inspection System	7/92
5448364	Particle detection system with reflective line-to-spot collector	9/95
6052983	Fluid-Jet twist-inserting apparatus and method (Foreign patents also)	4/00

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Mario Moroni

Industrial expert (electrical technology), Mario Moroni has committed twenty years in studies and experiments concerning the Holy Shroud.

Member of the *Centro Internazionale di Sindonologia* (International Shroud Center) of Turin and of the British Society for the Turin Shroud.

Author of many papers presented at National and International Conferences.

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Giovanni L. Novelli

Giovanni Novelli got the degree in Chemistry at Rome University and is dust suction expert.

Managing Director of Chemical-Mining Societies, from 1981 to 1997 he was Managing Director of *Gruppo Laviosa* at Livorno. From 1997 is President of S.S.B., firm of Multinational "Sud Chemie".
From 1986 is Project Director in a cooperation between China and Italy program promoted by I.C.S.C. World Laboratory, Switzerland. He is also member of a number of Scientific National and International Associations.
He is author of many scientific publications also written on international journals and he wrote some publications about the Turin Shroud, one of them also translated in Russian language (1999).

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Barrie Schwortz

Barrie Schwortz was Official Documenting Photographer for the Shroud of Turin Research Project (STURP) and a direct participant in the 1978 scientific examination of the cloth. Editor and Publisher of the Shroud of Turin Website (www.shroud.com).

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Bryan Walsh

Bryan Walsh worked for the USAF in the fields of statistical quality control and physics of atmosphere. He is Executive Director of the Shroud of Turin Center in Richmond Virginia, an organization he founded in 1997. The Shroud of Turin Center is devoted to research and education on the Shroud of Turin. The Center provides presentations and seminars on various aspects of the Turin Shroud's history, the scientific evaluations performed on it, and the reasonable hypotheses currently being evaluated as to the nature of its Image.
The Center conducts original research on the early history of the Image of Jesus and the mathematical analysis of various scientific hypotheses on the Shroud's age, composition and Image-creation processes.

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