CENTRO
CONSERVAZIONE
RESTAURO
LA VENARIA REALE

DETECTORS FOR CULTURAL HERITAGE

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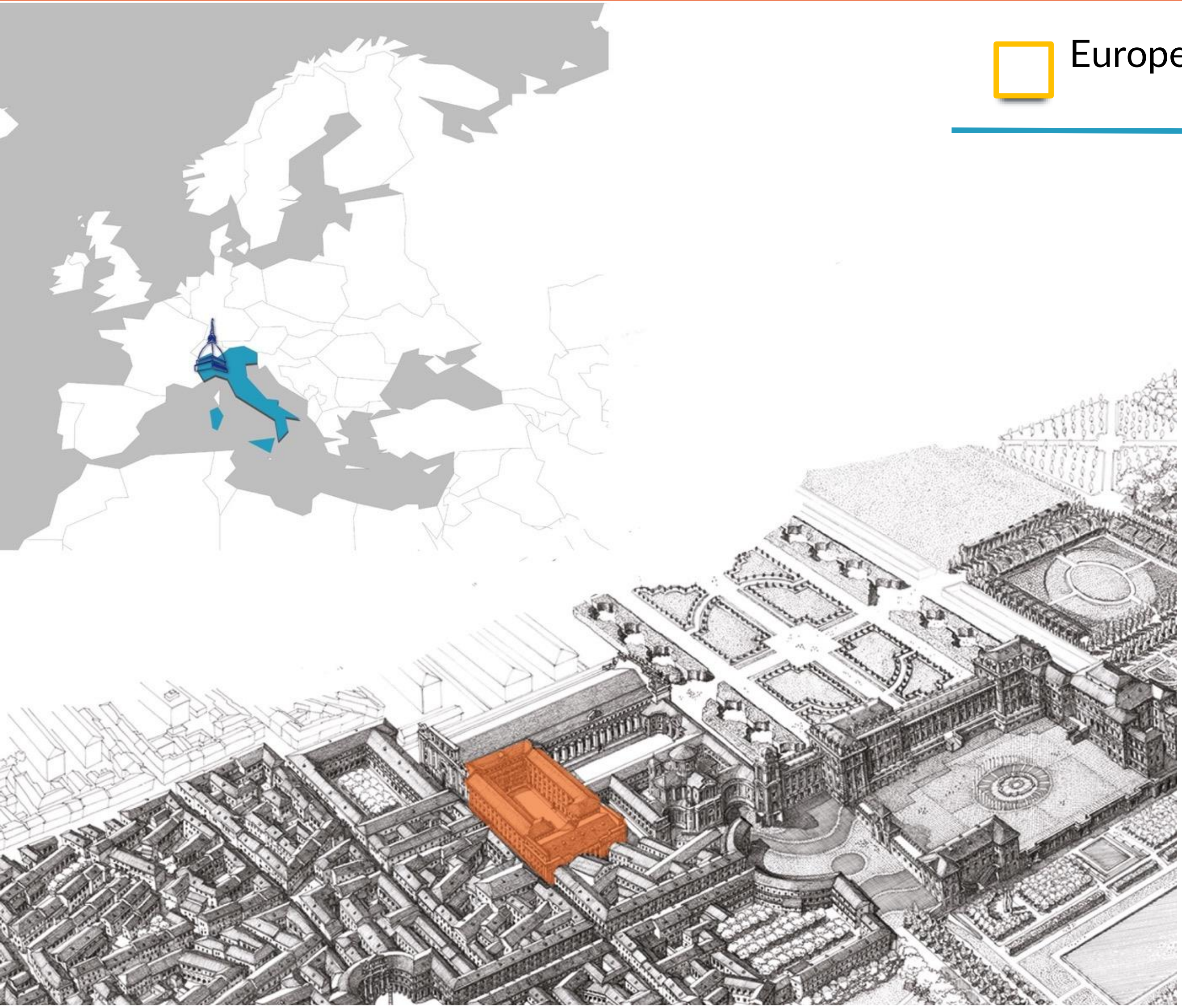
Fondazione Centro per la Conservazione ed il Restauro dei Beni Culturali “La Venaria Reale”

XXX Giornate di studio sui rivelatori – Cogne, 14 giugno 2022

Europe Italy Piedmont Venaria Reale



The Centro Conservazione e Restauro ”La Venaria Reale” is a strategic hub for the preservation of cultural heritage, higher education and research on the conservation field located near Turin, Piedmont, North-West Italy.

It’s a no-profit Foundation established in 2005 as part of the redevelopment project of the Reggia di Venaria, a natural and architectural masterpiece, UNESCO World Heritage Site reopened to the public after completing the EU’s largest cultural restoration intervention to date.

Founded by public and private institutions, but acting as a private company, the CCR La Venaria Reale covers the complete project cycle of preservation:

- TRAINING
- MONITORING
- PREVENTION
- MAINTENANCE
- CONSERVATION
- MANAGEMENT
- SHARING
- DISSEMINATION

The CCR La Venaria Reale hosts nine CONSERVATION LABORATORIES

Canvas

Wooden panels

Wooden sculptures

Fornitures

Stone materials, stucco, wall paintings and architectural surfaces

Texitiles, tapesteries, leather, ethnographic materials and carpets

Metals, ceramics, archeological finds and glass

Contemporary materials art, synthetic and assembled multi-material works of art

Papers and parchment items, photographic materials

The CCR "La Venaria Reale" hosts fully equipped **scientific laboratories** that operate on various field, from the scientific analysis of objects of archaeological, historical, and artistic significance to applied research through grant-based national and international projects.

SCIENTIFIC ANALYSIS

relies on a wide range of instrumental techniques, such as multispectral imaging, tridimensional imaging, digital radiography, computed tomography, optical microscopy, colorimetry, FORS, XRF, SEM/EDS, FTIR, Raman, and biological investigations.

PREVENTIVE CONSERVATION

entails a series of integrated activities of risk management, particularly in the projects dedicated to the study and preservation of historical residences.

SAF
Scuola Alta Formazione/ Higher Education School

course organization

management of practical conservation activities in laboratories and the outdoor restoration sites

partnerships with research organizations, professionals, institutions

educational tools and training at different levels.

Master's Degree course in Cultural Heritage Conservation

The advanced training in the Conservation and Preservation field, along with the materials and methodologies research is the CCR La Venaria main goal.
The agreement signed with the University of Turin led to the establishment of the **Master's Degree course in Cultural Heritage Conservation**.

- theoretical-practical activities in labs
- teachers-restorers
- teacher/student ratio of 1:5.
- 5 training courses
- 5 years

degree title of the professional qualification of restorer, according to the Italian Cultural Heritage and Landscape Code.

The interdisciplinary training course:

- humanistic
- scientific and technical subjects
- artistic techniques
- materials and methods for conservation and prevention

Talk about **detectors for Cultural Heritage** is not completely correct
More correct is to talk about detectors that are **adapted** to the use in the field of Cultural Heritage

Most detectors are developed for the industrial and medical sector, it is rare that they are designed specifically for Cultural Heritage

Most of these can be immediately used in the field of cultural heritage (e.g., a scanning electron microscope)

If the instruments are based on a **comparative reference database** (e.g., spectrophotometer) it is essential to build thematic databases but to do this you need a great job of preparing **mockups representative of the materials used in the artistic techniques → collaboration with restorers is important**

The restoration\conservation process

1. The preliminary researches
2. The restoration activities \ The conservation activities (actions on the work of art)
3. Final check: test of materials and their behavior over time, test of methods

The term “research" has a broad meaning:
- direct observation of the work
- documentary investigations (historical-artistic research)
- scientific studies

All these steps may require a diagnostic support

The preliminary researches – Questions

What is the technique used by the artist?

- what pigments did he use?
- how did he mix them together?

What is the state of preservation of the work of art?

- what is causing the degradation that I observe on the artefact?
- is the cause still present?

What is the history of conservation of the work of art?

- does the artefact appear today as it was conceived by the artist?
- has the artefact undergone a restoration in the past?

To answer these questions, the most suitable diagnostic techniques and methodologies are chosen → diagnostic protocol

The restoration activities – Questions

Was the material I see placed by the artist or by a restorer in the past? If it was added later, how does it behave compared to the original material? Is it harmful?

How can I remove a material from the work of art that is harmful? What solvent do I use? Do I risk damaging the original material with my actions? Are there any other methods?

How do I make the restoration recognizable?

To answer these questions, the most suitable diagnostic techniques and methodologies are chosen → diagnostic protocol

Final check – Questions

Did I slow down the degradation processes after the restoration? Did I activate any other processes?

The restoration products I am using, how do they behave over time? Can they become harmful? In 20 or 30 years, will it be possible to remove these products from the artefact?

I have restored the work of art and put it back in its place (museum, church, etc.), but is the environment in which the artefact is located suitable for the preservation of the artefact itself?

To answer these questions, the most suitable diagnostic techniques and methodologies are chosen → diagnostic protocol

Purposes of diagnostics on Cultural Heritage

- to characterize the **original materials** → because we don't always have documentation, or the existing documentation is incomplete
- to characterize the materials **added** in later periods (e.g., **repainting**) → because we don't always have documentation, or the existing documentation is incomplete
- to characterize **previous restoration interventions** → because we don't always have documentation, or the existing documentation is incomplete
- to characterize the **alteration processes** → to know the causes
- to characterize the **environment** in which the work of art is preserved → because some of the causes of alteration are found in the environment

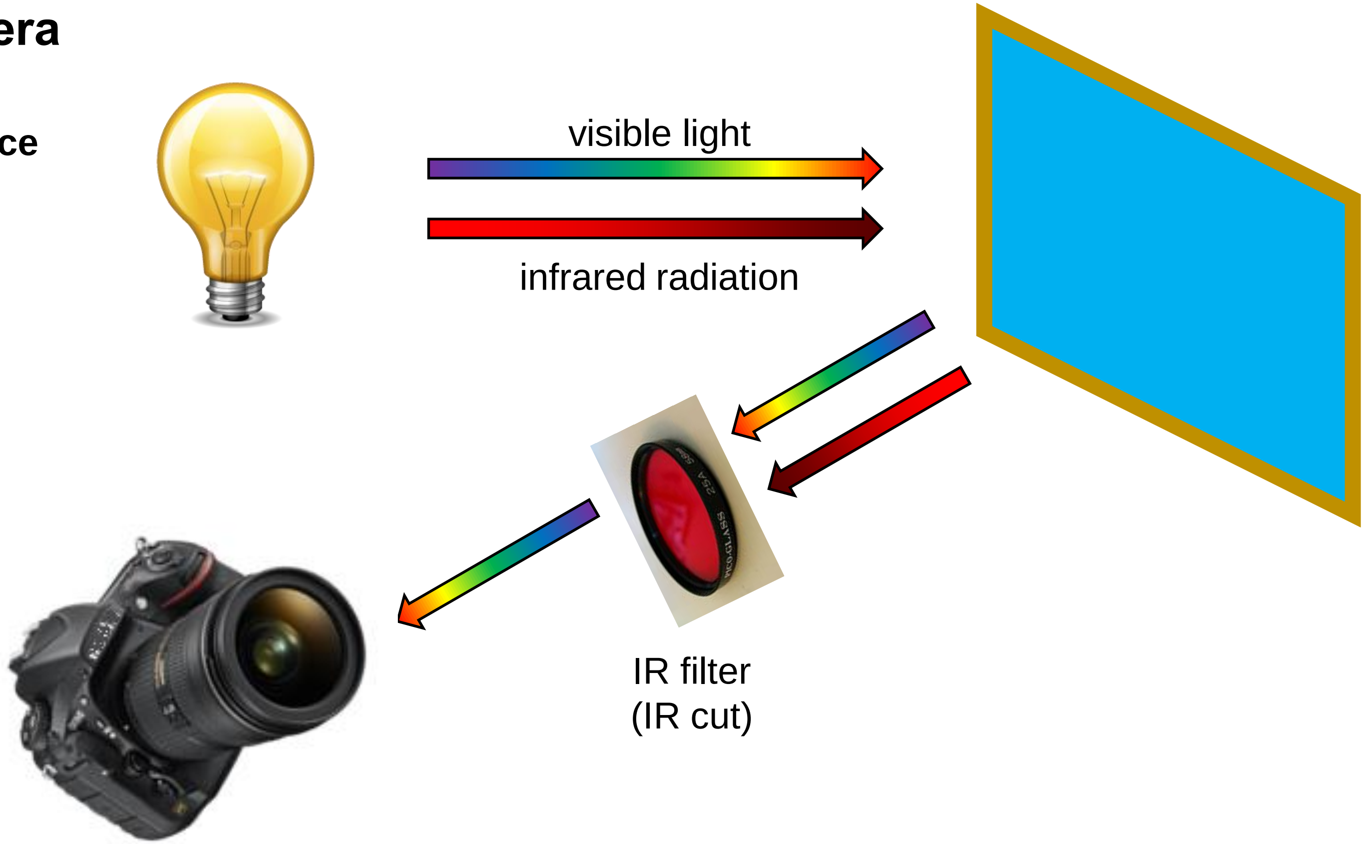
The documentation of the restoration activities is essential
(restoration files, materials used, technical reports, etc.)

What is the most used detector for the study of Cultural Heritage?

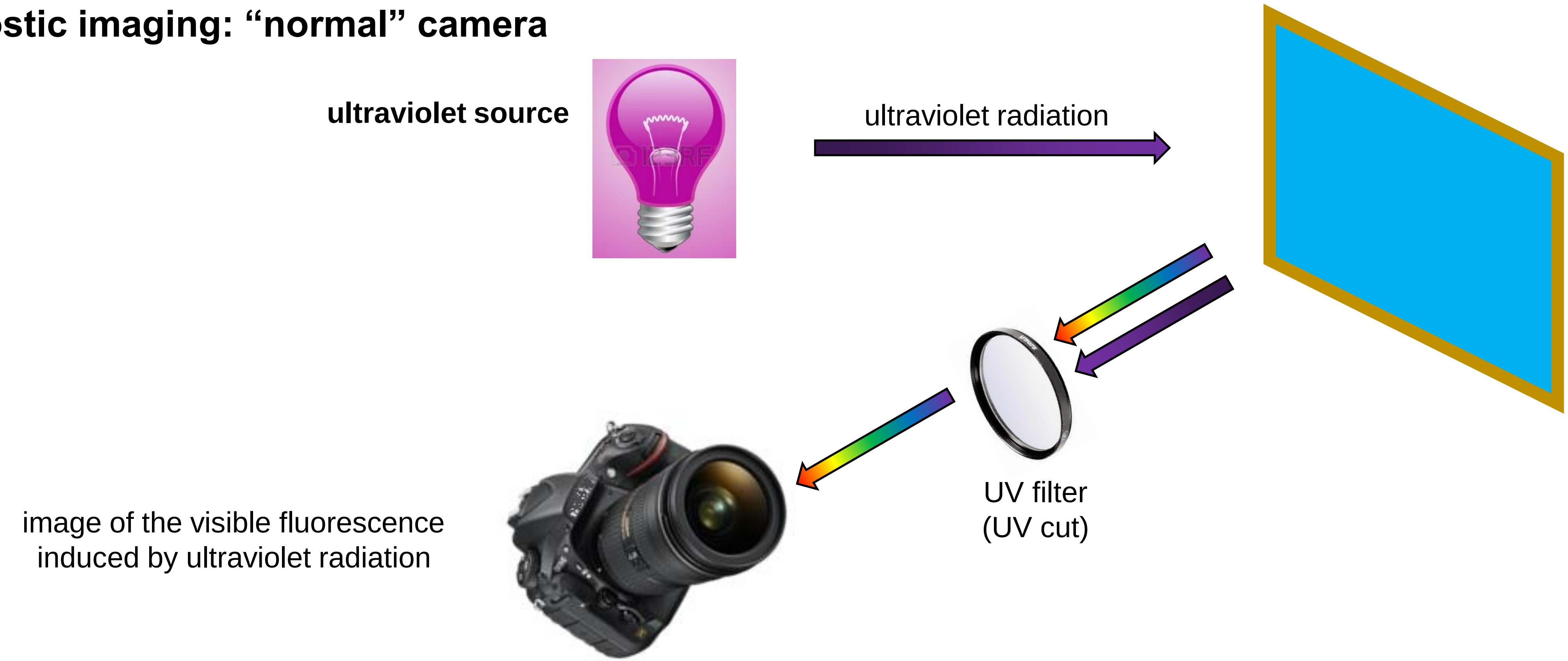
the camera (CMOS)

When we study the works of art, we must think of the camera as a **scientific instrument**

Diagnostic imaging: “normal” camera



Diagnostic imaging: “normal” camera

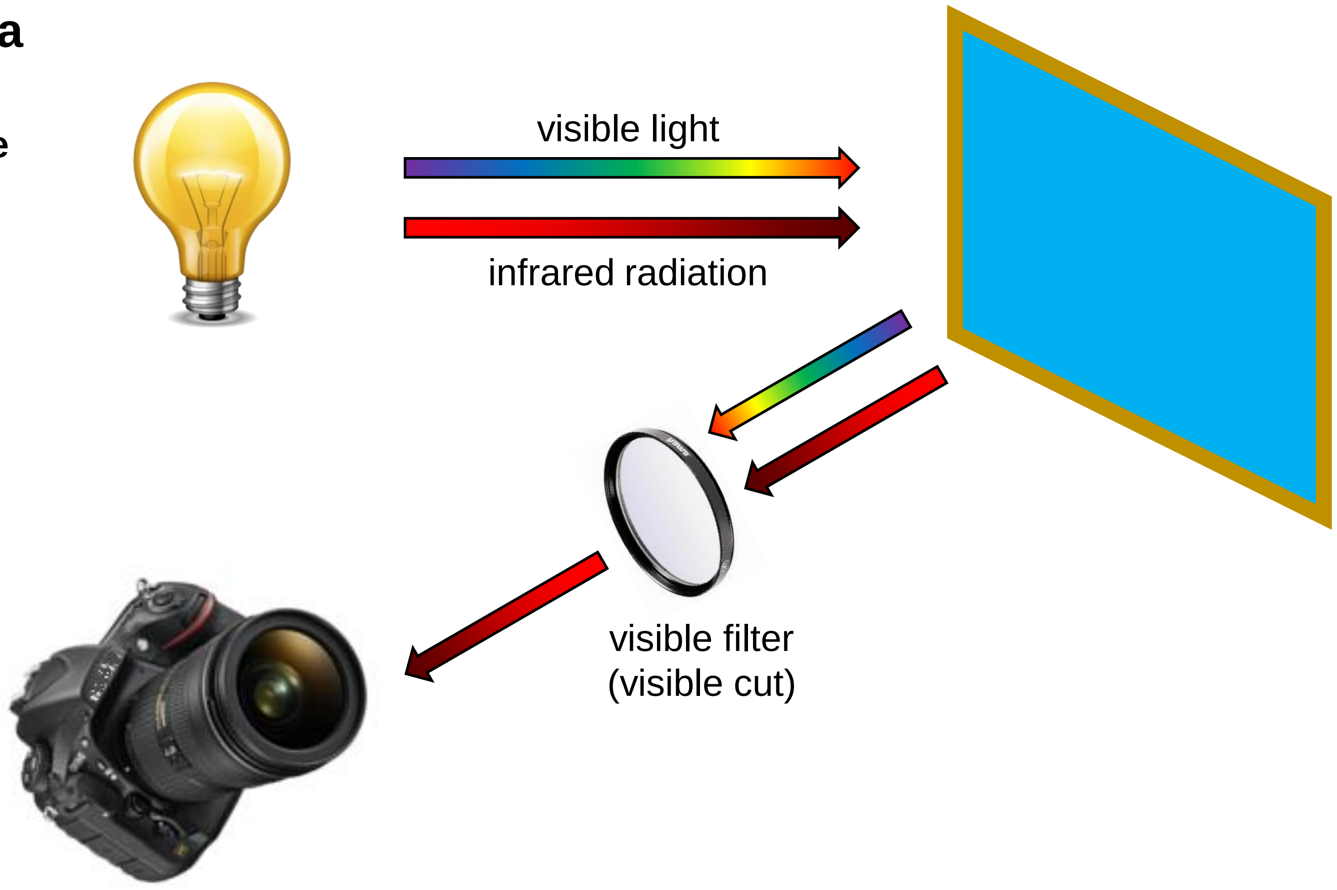


what can we see:
varnish (ancient, recent)
identification of some pigments
repainting

Diagnostic imaging: “normal” camera

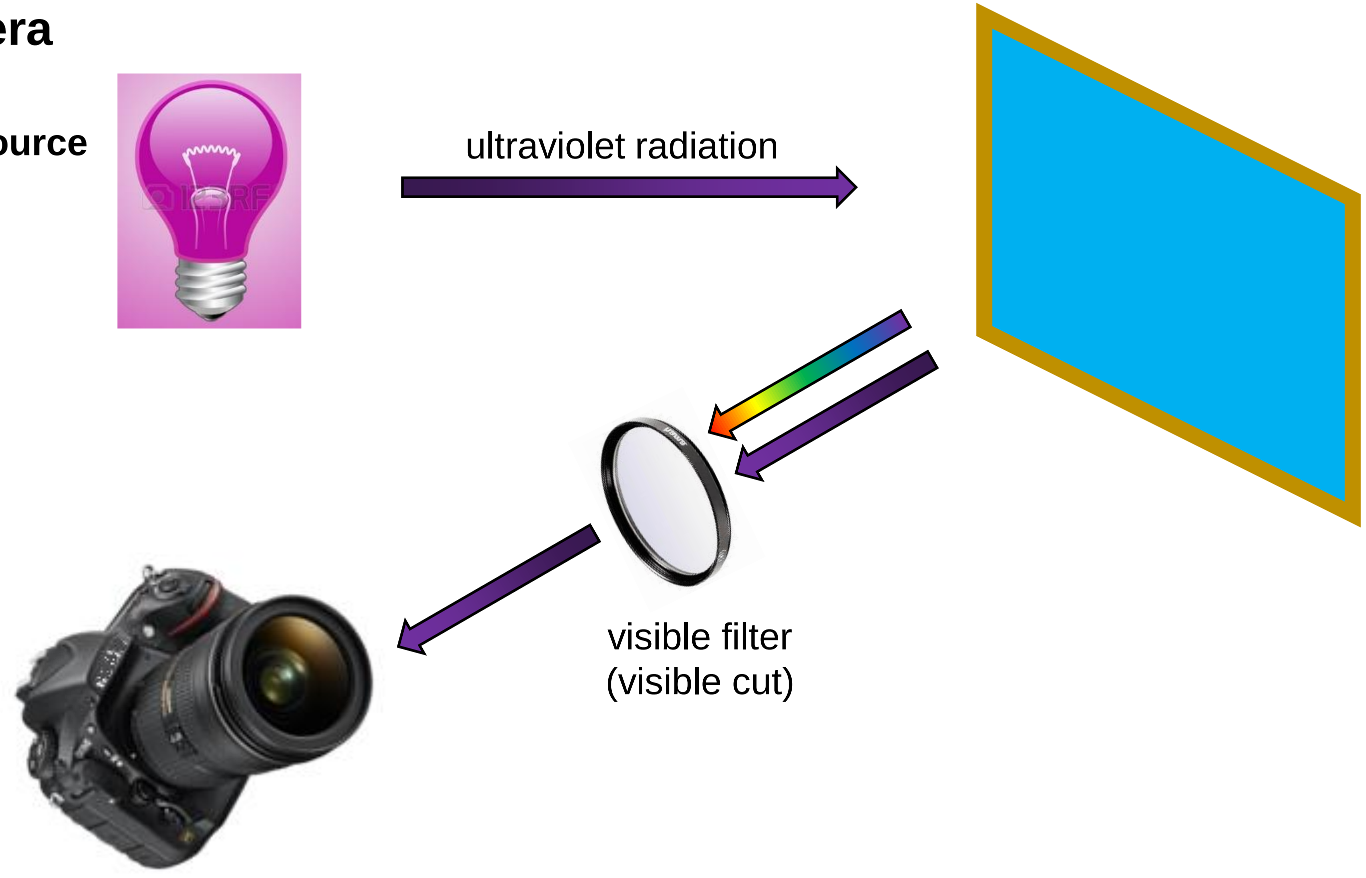
photogrammetry
3D model (surface)

Diagnostic imaging: modified camera
without the IR filter



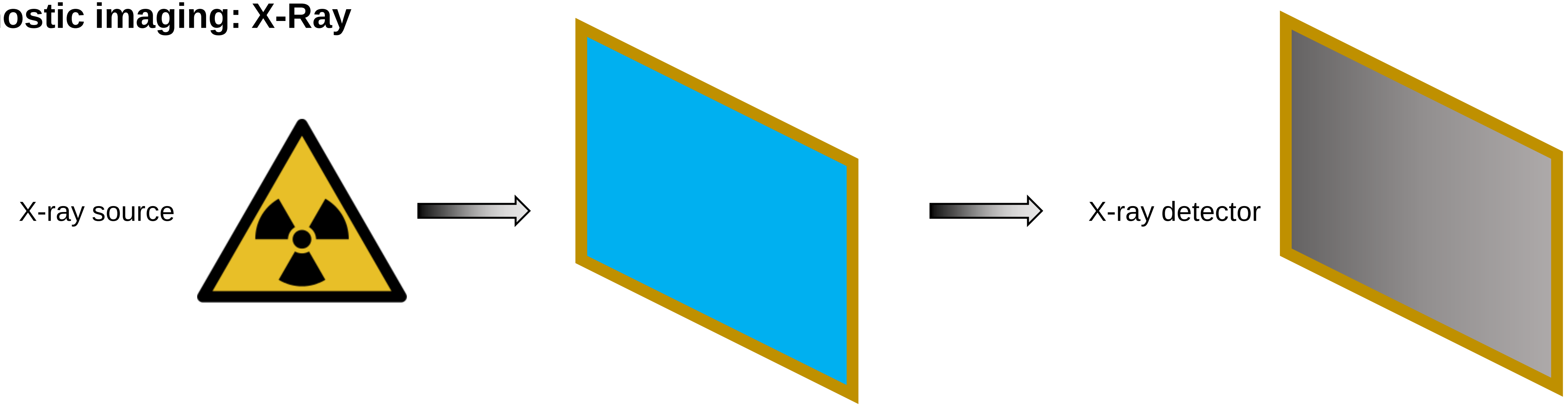
what can we see:
pictorial layers (IR can penetrate the layers)
identification of some pigments
underdrawing

Diagnostic imaging: modified camera
without the UV filter



what can we see:
identification of some pigments

Diagnostic imaging: X-Ray



what can we see:
difference between pigments
metal inserts
state of preservation (pictorial layers, ground layer)

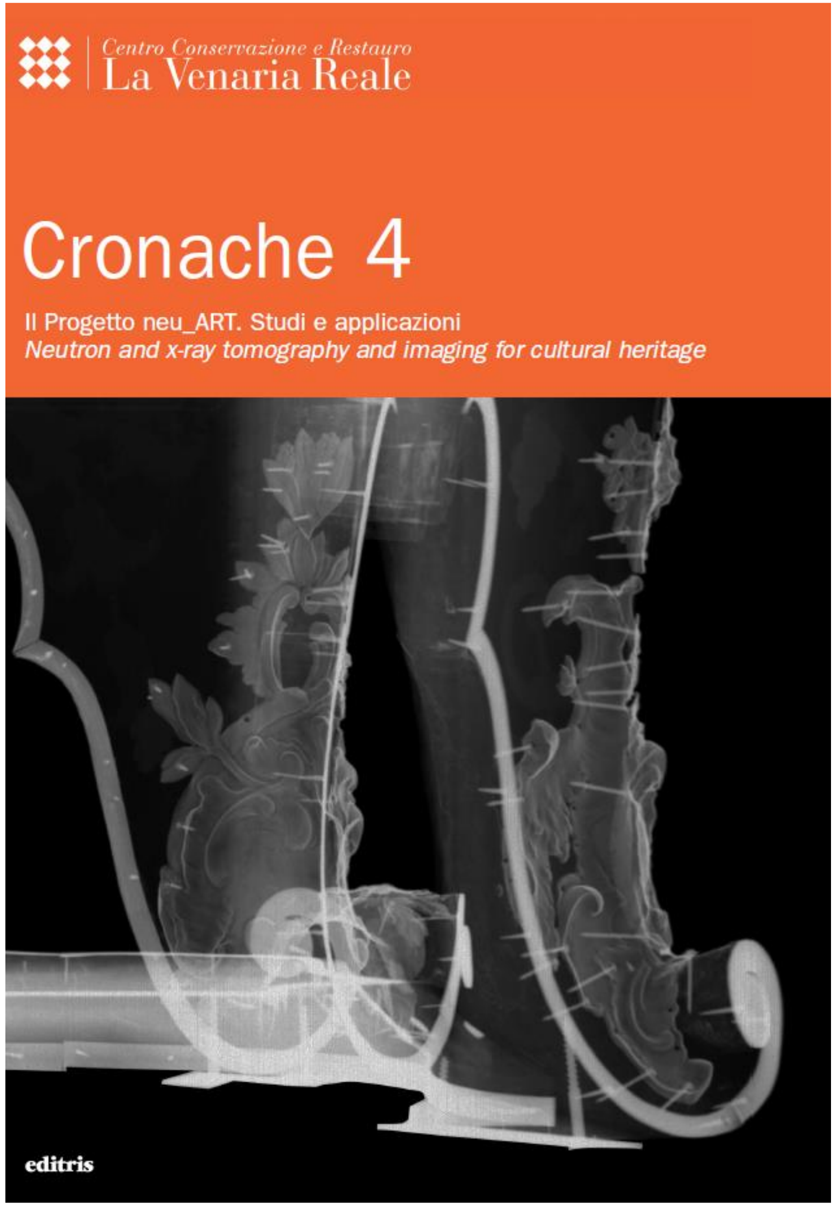
neu_ART project (2009 – 2013)

Centro Conservazione e Restauro Foundation

National Institute of Nuclear Physics – Torino section

University of Torino – Physics Department

co-founded by Regione Piemonte



Radio-tomographic apparatus installed in the Scientific Laboratories of CCR "La Venaria Reale"

- High precision horizontal and vertical motorized axes for the detector movement
- Vertical axis for the X-Rays source movement
- Rotating table (for CT scan)

X-rays source
200 kV @ 4.5 mA (for CT scan)
60-90 kV @ 10 mA (for radiography)

n. of pixel: 2560
pixel size: 200 µm x 200 µm
grey levels: 4096 (12 bit)

detector below the Lead shield

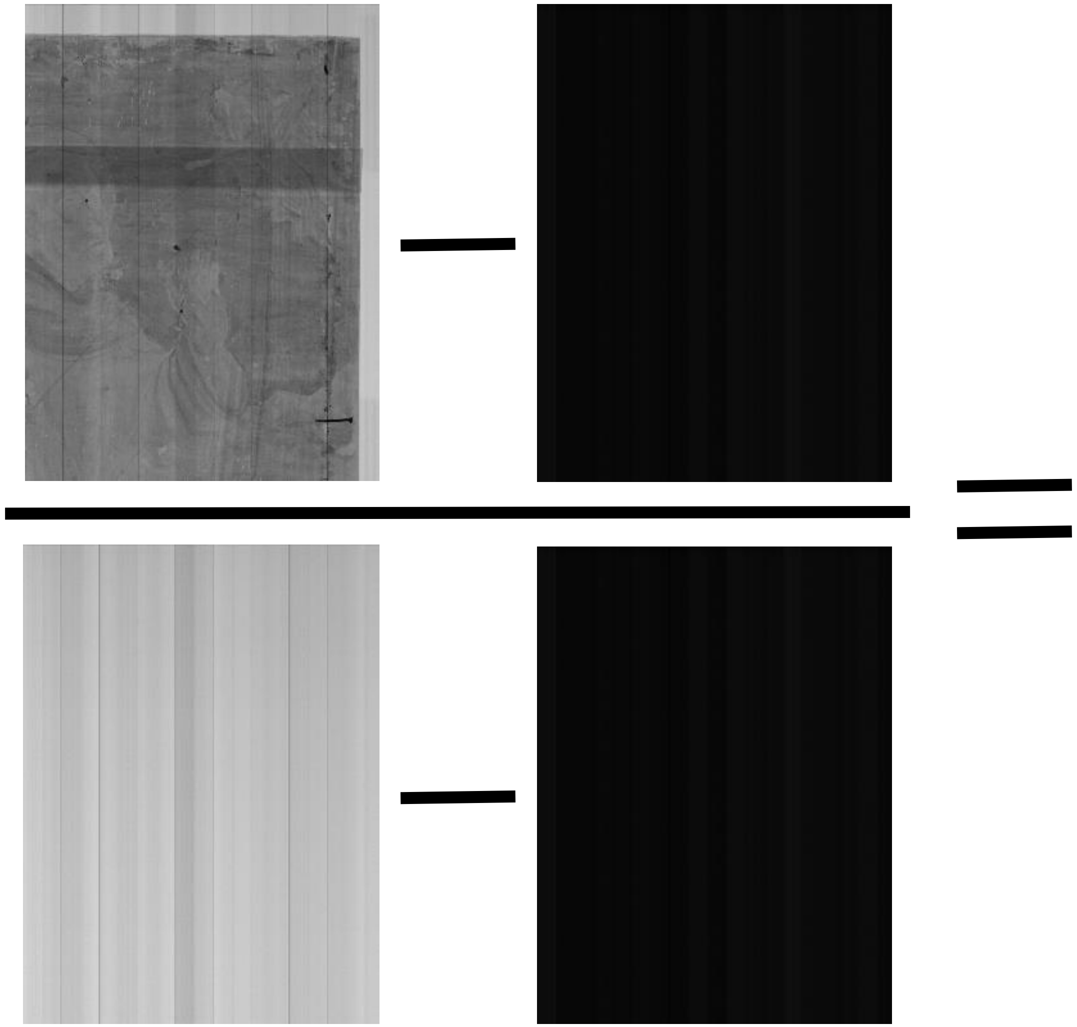
50 cm

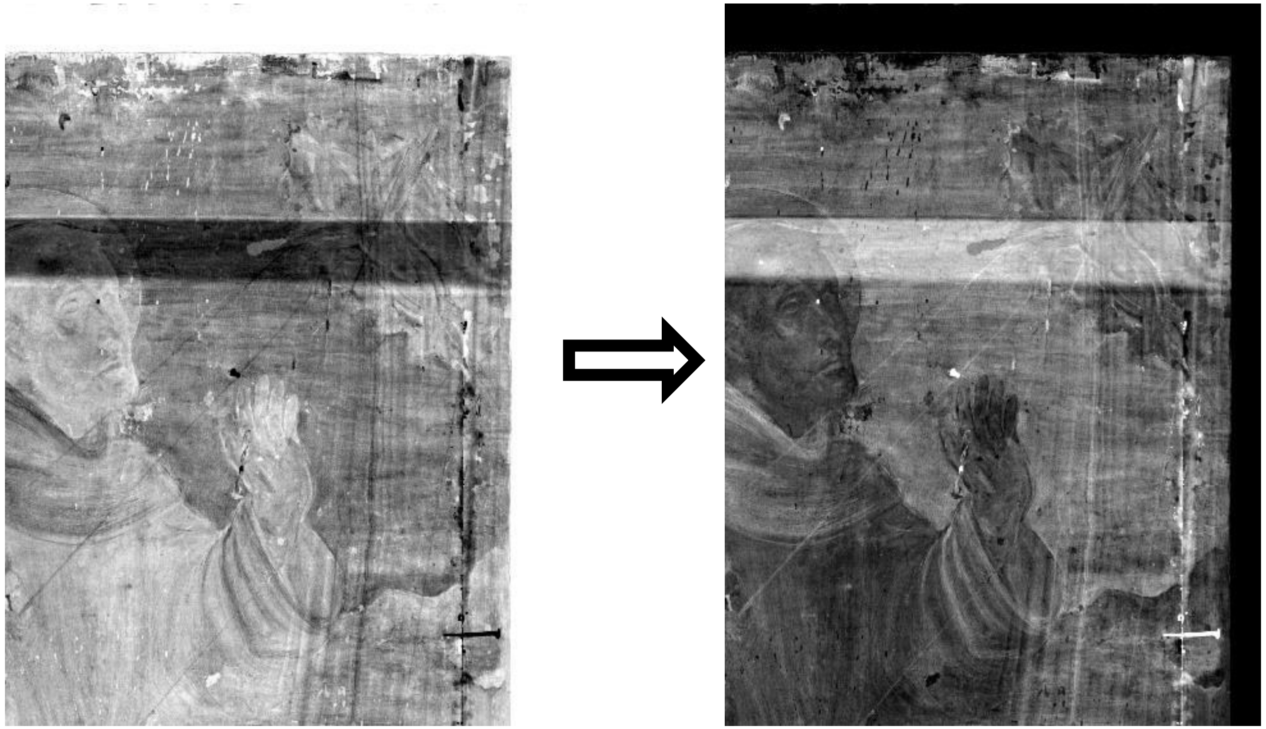
scintillator: GOS (gadolinium-based)

control room

shielded room

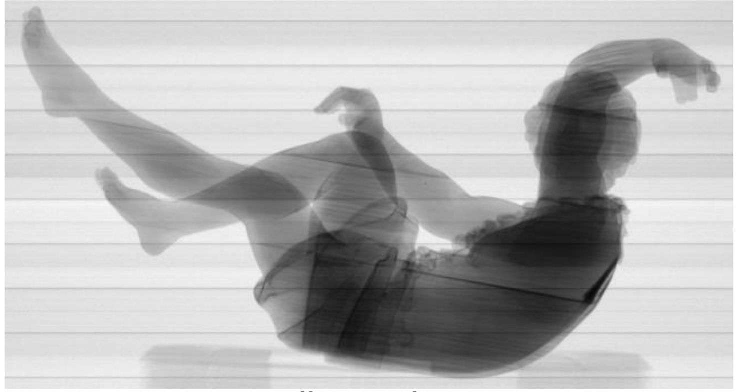
Digital radiography: image processing



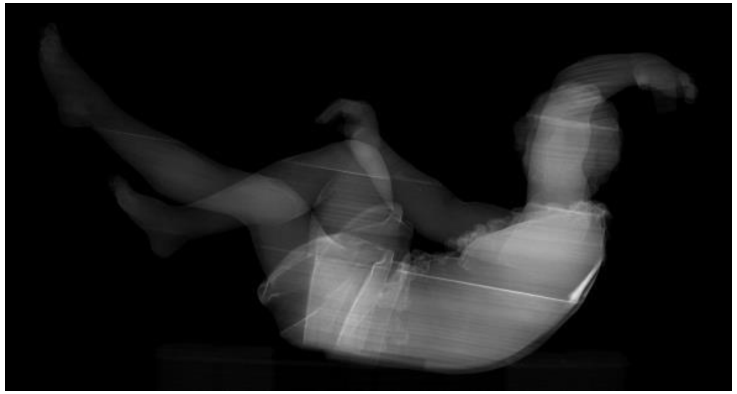


raw: signal as acquired by the detector
dark: radiography acquired with source off
white: radiography acquired with source on, without the object

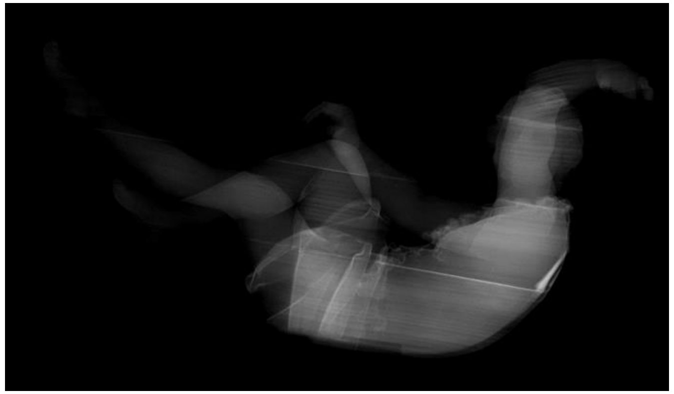
CT workflow



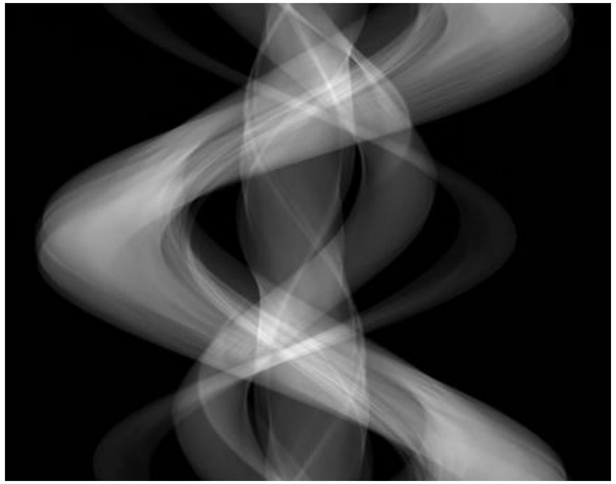
raw radiography



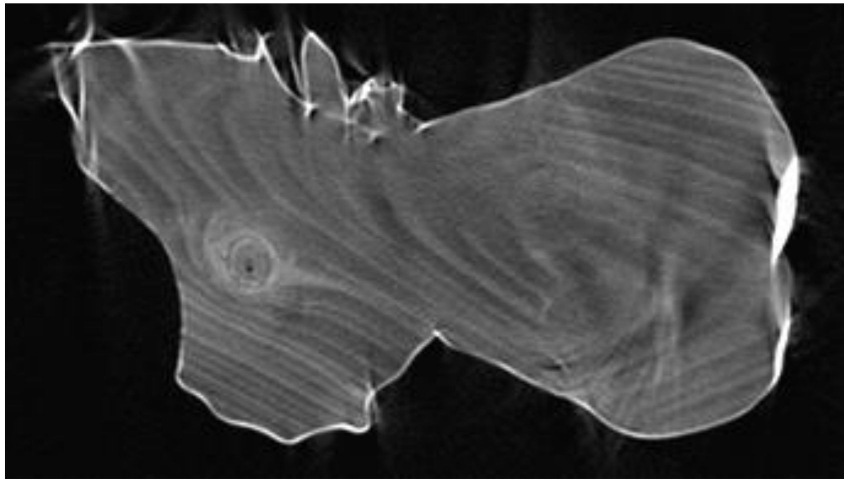
radiography (1 for each angular position)



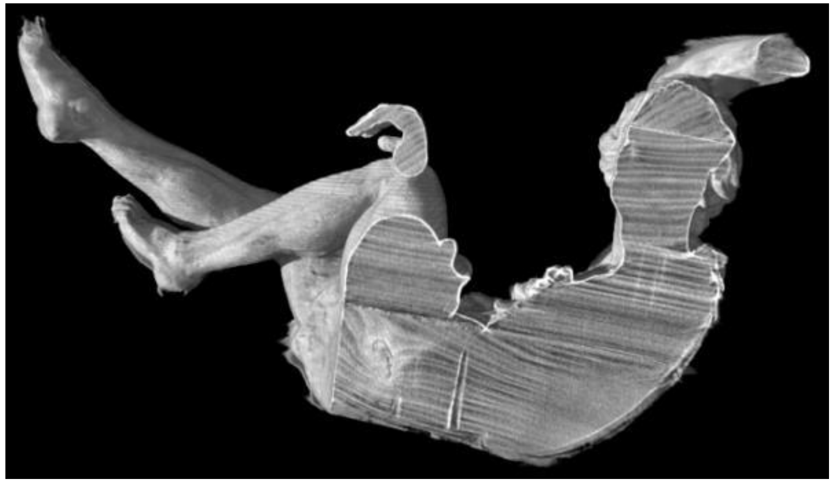
sequence of radiographies



sinogram



horizontal reconstructed section (*slice*)



rendering 3D and virtual cut

The diagnostic protocol

Imaging techniques (non-invasive techniques) → information on the entire work of art

Punctual non-invasive techniques → information on a small area of the work of art

Punctual invasive techniques → information on a small sample taken from the work of art

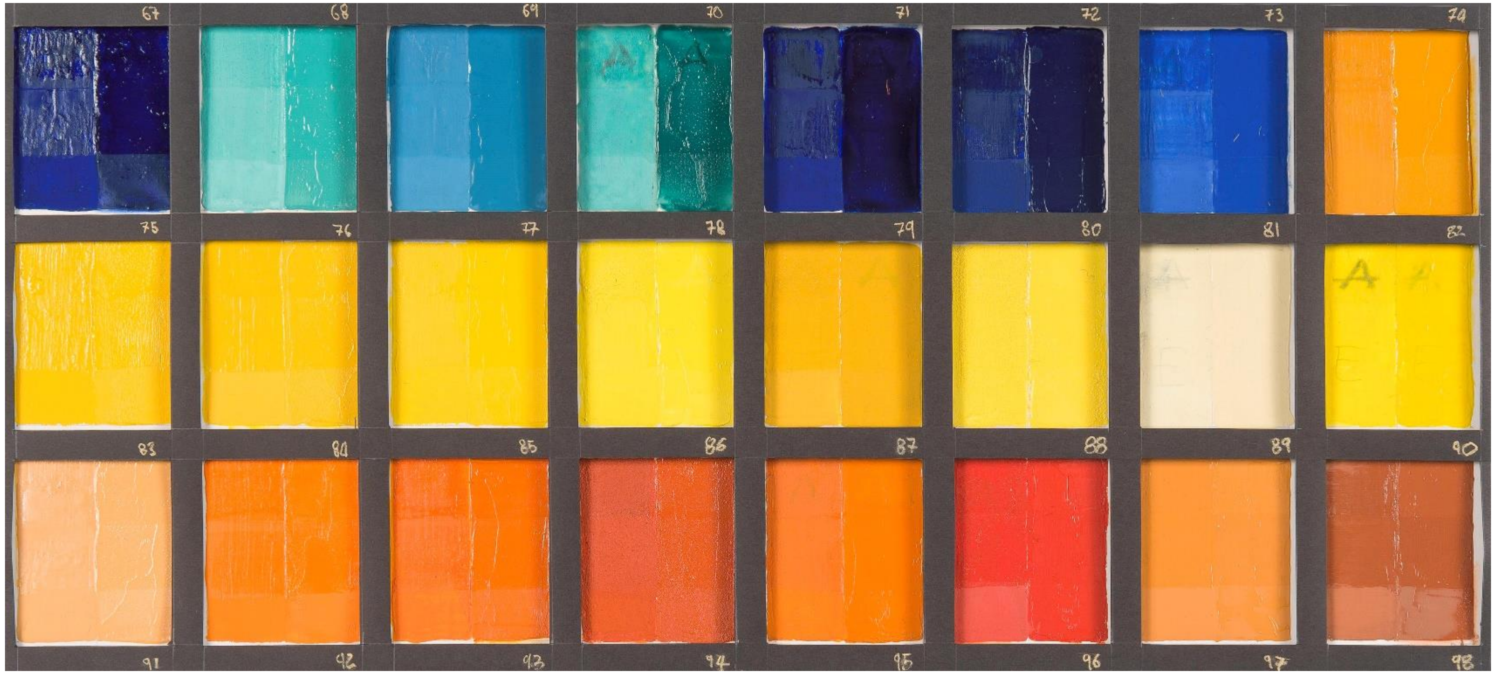
The diagnostic protocol is not a standard!

For each work of art, using the information already available and considering what we have to do on the work of art and considering the requests of the superintendence, it is necessary to design a specific diagnostic protocol

Punctual non-invasive techniques

- identification of chemical elements (e.g., X-Rays Fluorescence)
- identification of chemical compounds (e.g., nonivasive Fourier Transform Infrared Spectroscopy)
- surface documentation (e.g., videomicroscopy)
- identification by comparison with database (e.g., spectrophotometry)

Identification by comparison with database



database of diagnostic analyses carried out on about **1200 combinations of pictorial materials**

4 panels of pictorial mockups were designed to simulate the main artistic techniques **from Antiquity to Contemporary art.**
Panels were previously treated with a glue-based solution and prepared with *stucco.*
Mockups were prepared with **139 inorganic pigments, 34 natural and synthetic dyes, 4 binders, 2 varnishes and 4 different underdrawing materials**. Each pigment or dye is presented in 6 different combinations: in 2 binders with 2 resins, in 2 binders without resin.

Punctual invasive techniques

The sample must be **representative** and **relevant**

The analyses on the sample must in fact lead to conclusions that can be **extended** to (the whole of) the work of art

Wrong sampling can lead to wrong conclusions:

if in a 16th century painting, I analyze (without knowing it) a 20th century repainting area, I can consider the painting a fake!

How many techniques are used?

from the INFN-CHNet site:

In situ analysis
Digital Radiography (RX)
X-Ray Tomography and Microtomography (TC)
X-Ray Fluorescence (XRF)
X-Ray Diffraction (XRD)
alpha-PIXE
Raman Spectroscopy
Multispectral Imaging
Reflectance and colorimetry
Termography

Dating
Radiocarbon Dating with Accelerator Mass Spectrometry (AMS)
Thermoluminescence and Optically Stimulated Luminescence

Laboratory analysis
Ion Beam Analysis (PIXE, PIGE, BS, IBIL, DPAA)
Digital Radiography (RX)
K-edge Radiography
X-ray Tomography and Microtomography (TC)
X-ray Fluorescence (XRF)
X-ray Diffraction (XRD)
Fourier Transform Infrared Spectroscopy (FTIR)
ToF-SIMS Spectrometry
Profilometry
Scanning Electron Microscopy (SEM)
Catodoluminescence
Time-resolved Laser Induced Fluorescence (TR-LIF)
Mass spectrometry (HR-ICP-MS)
Thermal Ionization Mass Spectrometry (TIMS)

Last but not least…

There are two other important detectors for cultural heritage, which are widely used:

air temperature meter (thermometers)
air relative humidity meter (hygrometer)

Some of the alterations we observe on works of art are caused by the environment in which the works of art are placed

Unsuitable values of temperature and relative humidity of the air can cause deterioration of the works of art: damage to the painting layers, cracks on wooden panels

Unsuitable values of temperature and relative humidity of the air can also be a concurrent cause for other problems: proliferation of biodeteriogens (e.g., mould)

Museum

- few constraints in the installation of an environmental monitoring system, often already provided as a part of the air treatment system (HVAC systems)
- possibility of feedback with respect to the values of the monitored parameters
- availability of electricity and WiFi networks

Museum residence (i.e., a museum inside a historic building)

- constraints in the installation of an environmental monitoring system (decorated surfaces, wall fabrics, ...)
- no or limited presence of air treatment systems
- no or limited possibility of feedback with respect to the values of the monitored parameters
- availability of electricity network, difficulties in setting up WiFi networks (due to the very thick walls)

Widespread heritage

- constraints in the installation of an environmental monitoring system (decorated surfaces, ...)
- no air treatment systems
- no possibility of feedback with respect to the values of the monitored parameters
- possible non-availability of electricity, difficulty in setting up WiFi networks
- accessibility in the absence of staff people

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