

The background is a textured, light-colored surface, possibly a map or a historical document, featuring several architectural drawings and Arabic text. The drawings include a domed building, a rectangular structure with a red roof, and various smaller structures. The Arabic text is written in a cursive style, with some words appearing to be 'مدرسة' (school) and 'مكتبة' (library).

Technical Photography (TP)

Cultural
Heritage
Science
Sopen
Source

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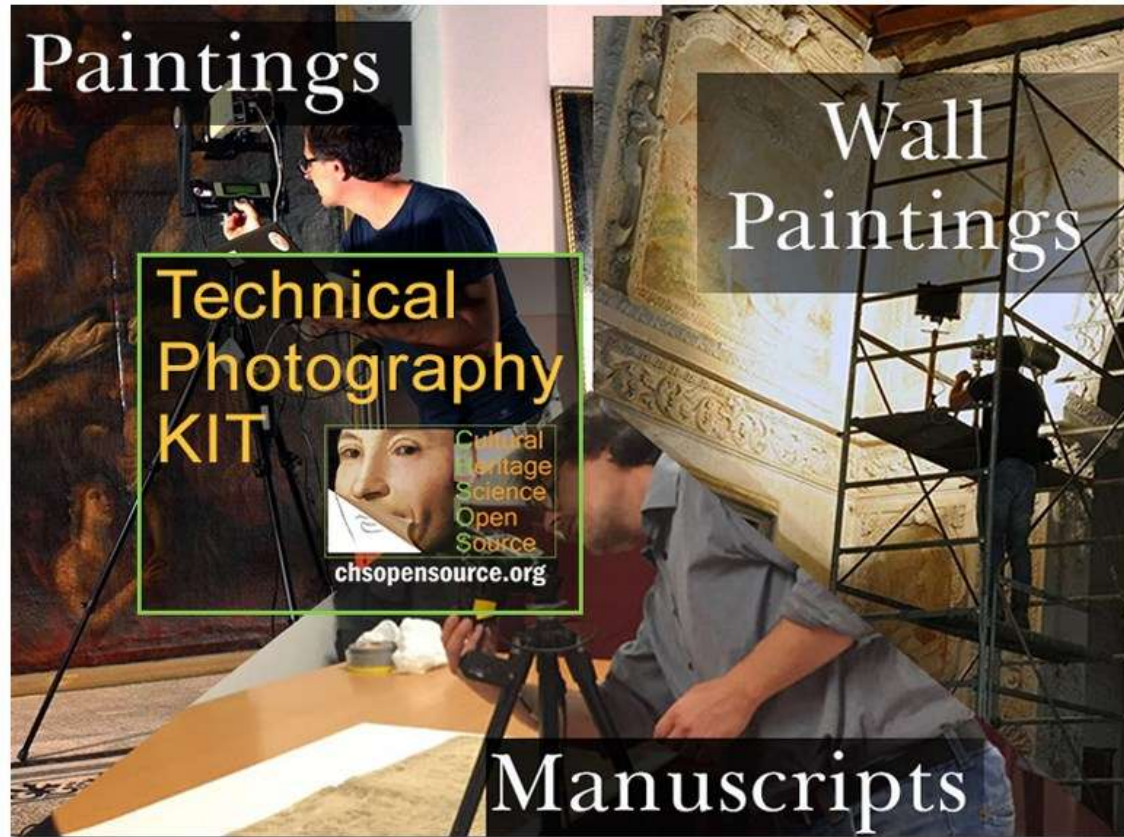
- setup
- applications

IRFC:

- setup
- applications

IRF:

- setup
- applications



This course will illustrate Technical Photography for art and archaeology documentation and examination. We will use the **CHSOS Technical Photography Kit**. This is a complete set of equipment to autonomously perform this method. This kit is designed to be lightweight, affordable, modular and versatile. We had in mind the professional that need to apply this examination method on different scenarios: such as wall paintings, manuscripts, and easel paintings.

The CHSOS Technical Photography KIT: intro

COMPONENTS

The TP Kit contains all you need to perform technical photography on art and archaeology objects.

- Digital camera modified for UV-VIS-IR Nikon D800.
- Extra accessories for the camera: 50 mm lens, power adapter, remote shutter.
- Laptop.
- TP filters set (72 mm).
- 2 x UV lamp – Fabrizio.
- 2 x IRF lamp – Alice.
- 2 x Halogen lamps – Elio.
- 4 x tripods for the UV and Halogen lamps – Lorenzo.
- Pigments Checker with TP–MSI calibration card.
- Polarizer filters set – Pitty.
- Technical Photography Online training course.

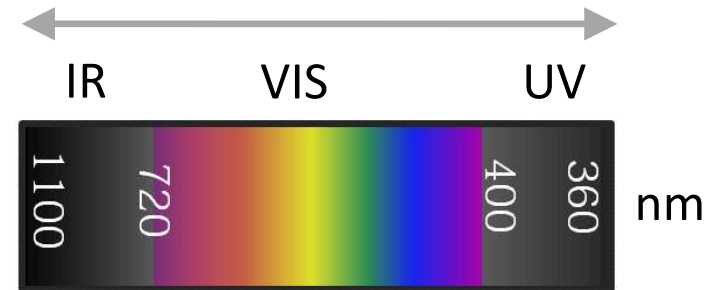
PORTABLE. The TP Kit was designed for the traveling Art Expert. It is a set of lightweight and compact tools to perform technical photography with very lightweight equipment. We ship worldwide.

ADAPTABLE. Our TP kit is meant to be the best solution for those art professionals that need to work on different kind of objects. It can be used for paintings, wall paintings, works of art on paper, and anything that can be photographed.

READY. You will receive a laptop containing all the software already installed and set up. Every piece of software you need to shoot and edit the images is already installed and set. It is easy to shoot with our Technical Photography kit. Connect the camera to the laptop and use the shooting software already installed and set.

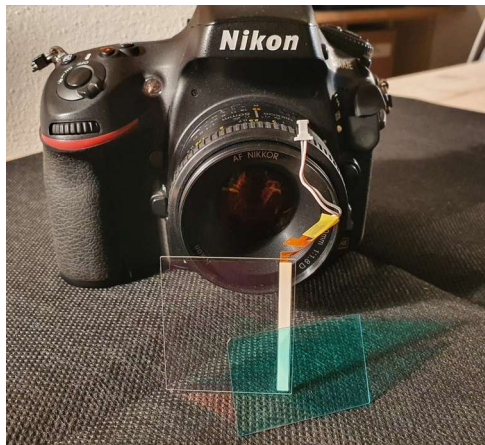
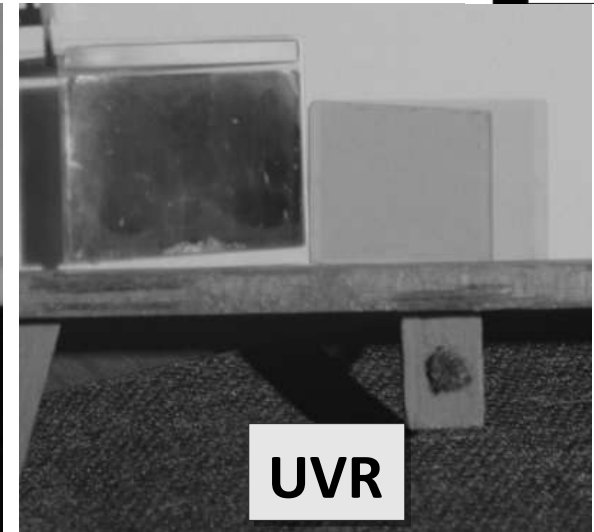
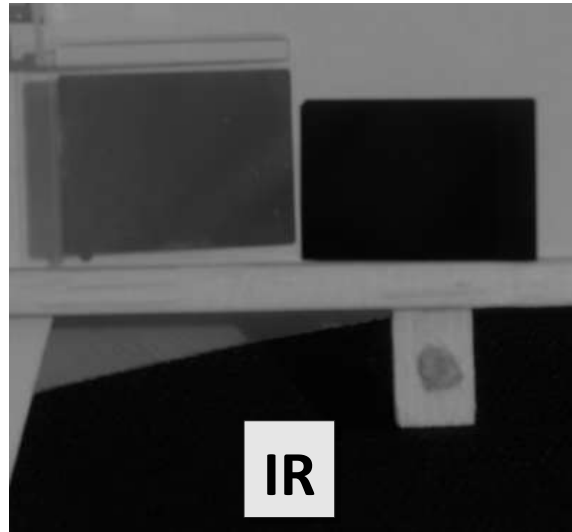
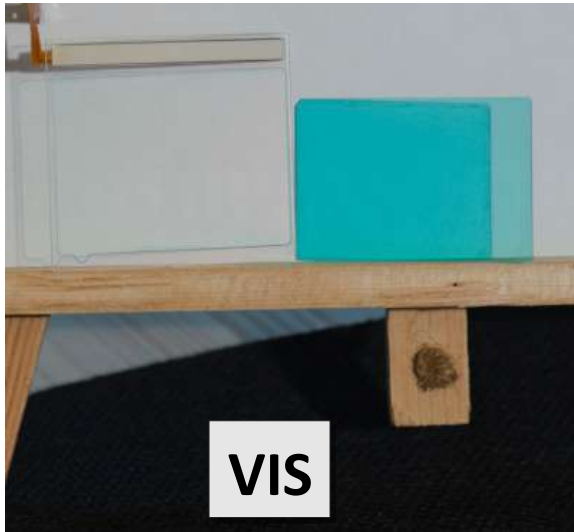
The CHSOS Technical Photography KIT : camera

TP camera: (modified for Technical Photography)



The main component of the kit is the **modified digital camera**. A standard camera can see just the Visible range. The Technical Photography modified camera can explore the spectral range between 1100 nm and 360 nm. We distinguish 3 main regions: Infrared is between 1100 and 720 nm. The Visible region is between 720 and 400 nm. The Ultraviolet region is between 400 and 360 nm.

The CHSOS Technical Photography KIT : camera



How is the camera modified for Technical Photography?

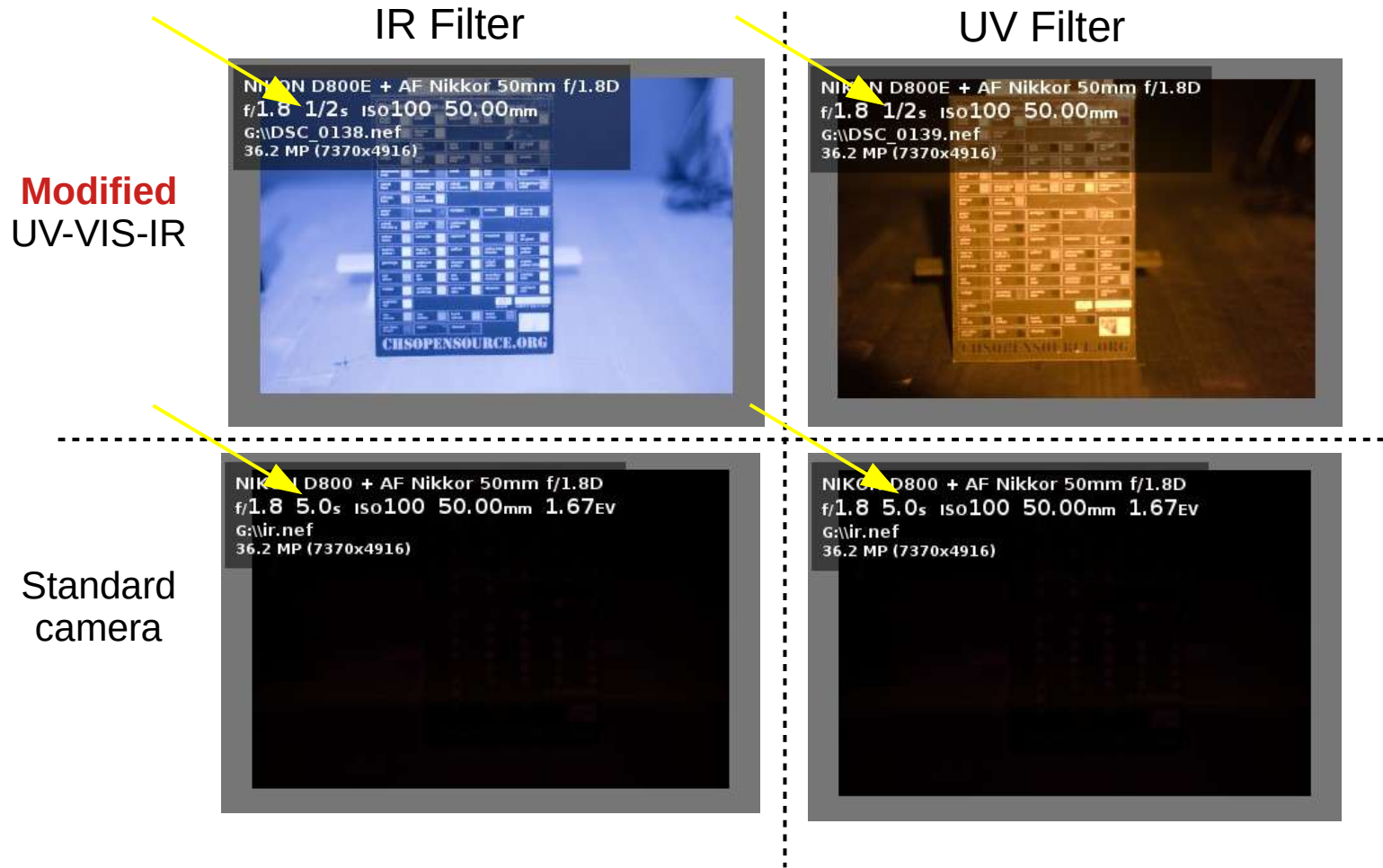
These 2 filters are removed from the camera. The blue filter is the “hot mirror” that blocks IR.

The clear filter is the Dust Reduction Filter which is shaken with ultrasonic waves to get rid of dust particles.

This filter has also an IR-reflective coating and blocks UV.

In conclusion: both the 2 filters must be removed to open the camera to the UV and IR.

The CHSOS Technical Photography KIT : camera



This is a test to compare our modified camera with the same standard (non modified) model (a Nikon D800). The UV-IR blocking filters in the camera are very effective at blocking all the IR and UV. They really must be removed in order to make Technical photos.

The CHSOS Technical Photography **KIT** : filters set **Robertina**

CHSOS Filters Set
Just 3 Filters

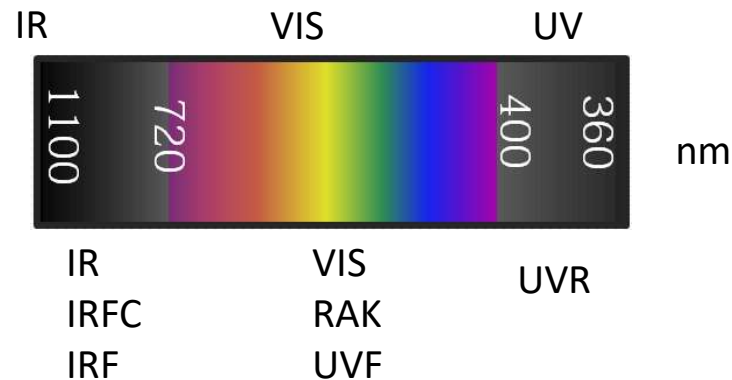


UV-VIS-IR modified
camera

Spectral band acronyms

Spectral band ranges

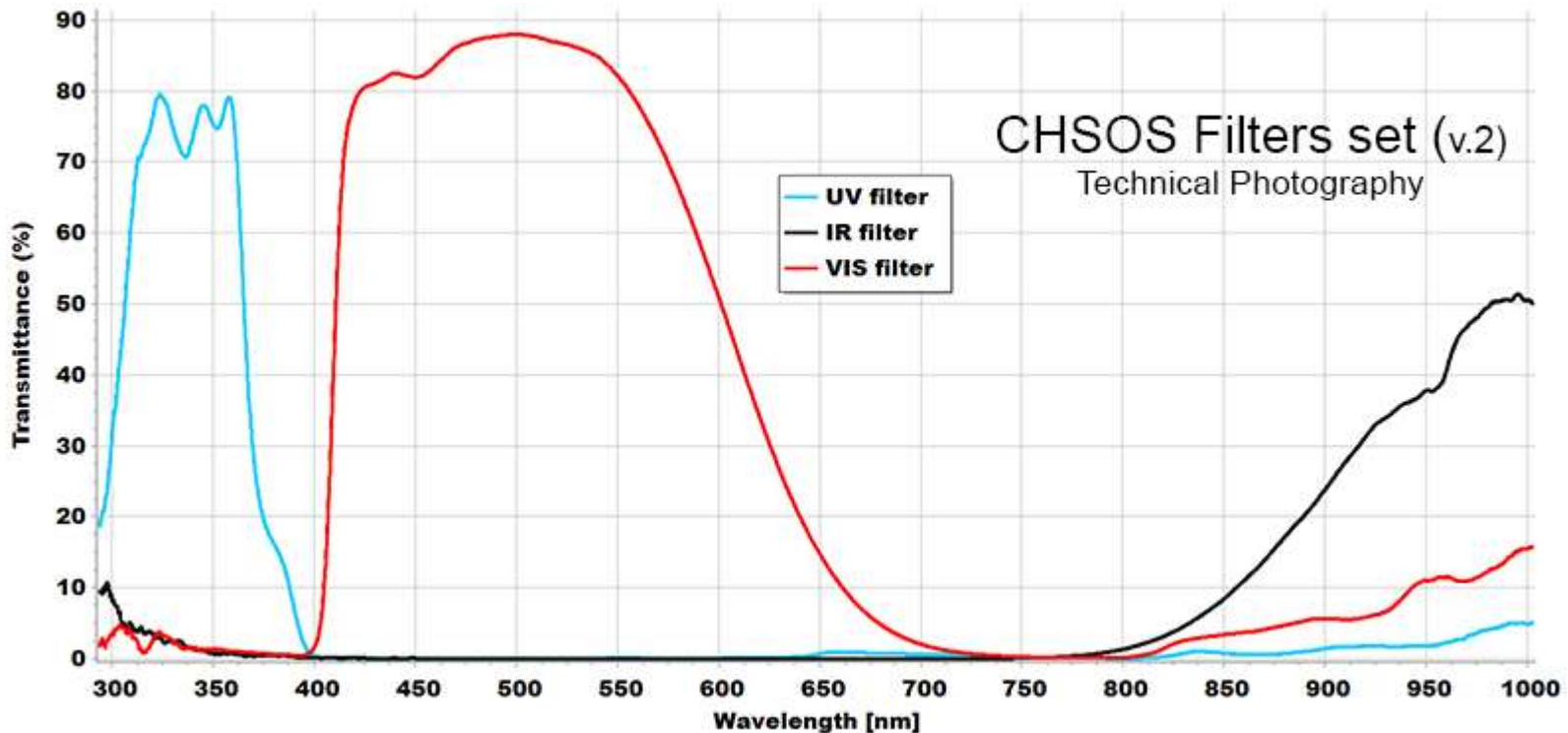
TP methods acronyms



The Filters set **Robertina** contains 3 filters, named IR, VIS and UV. These names indicate the respective spectral band that the filter allows.

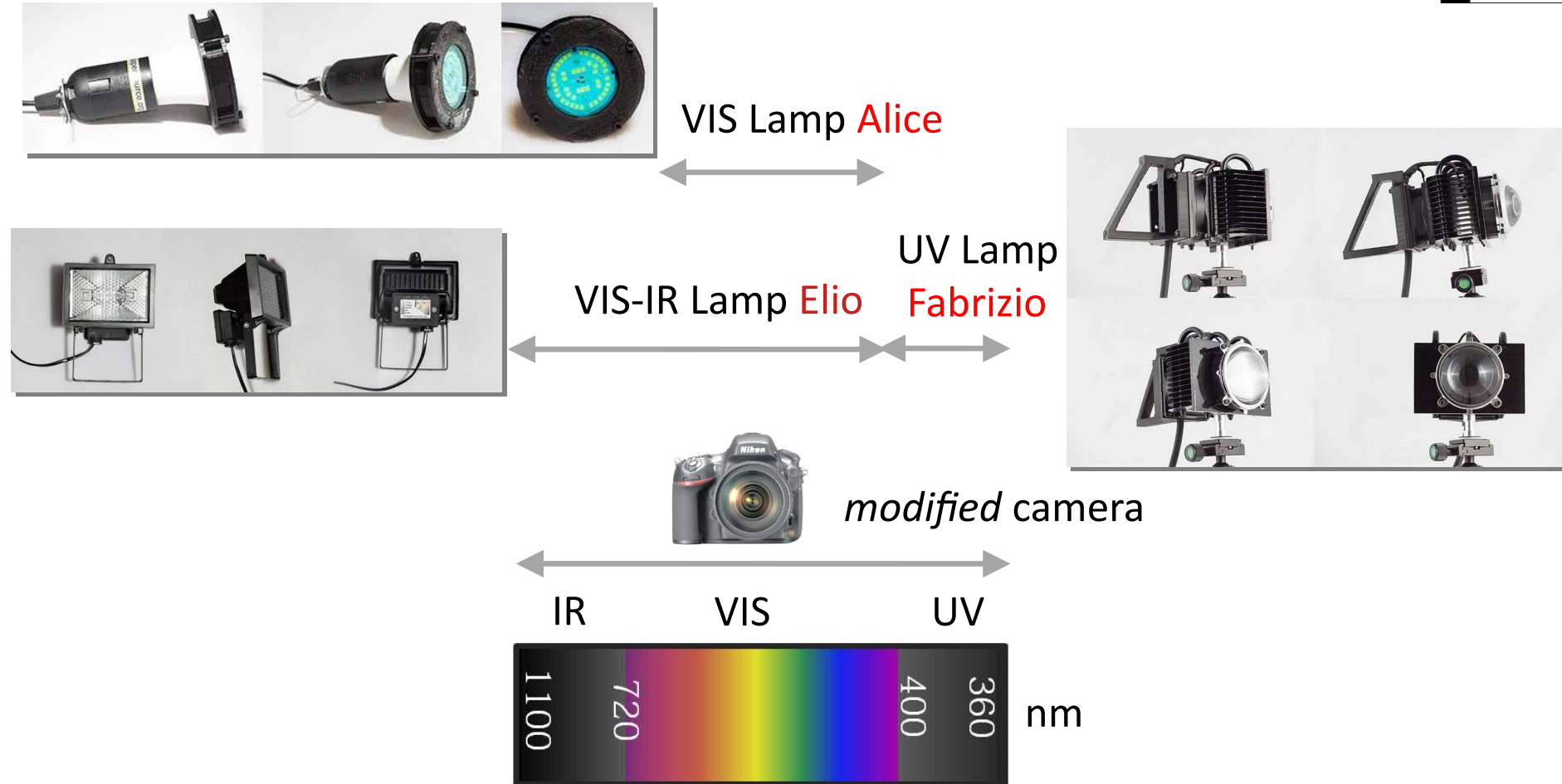
Look at the “TP methods acronyms”. This shows that using the IR filter you can do these photo methods: IR, IRFC and IRF. If you use the VIS filter, you can do VIS, RAK and UVF. If you use the UV filter, you can do the UVR photo.

The CHSOS Technical Photography KIT : filters set **Robertina**



The Filters set **Robertina** contains 3 filters, named IR, VIS and UV. These names indicate the respective spectral band that the filter allows. These are the Transmittance spectra of the 3 filters. Each filter allows just the spectral band as its name indicates.

The CHSOS Technical Photography KIT : lamps (Fabrizio, Elio, Alice)



The TP kit uses 3 kind of lamps. VIS lamp **Alice** produces a beam of pure VIS light. UV lamp **Fabrizio** provides a beam of pure UV and the VIS-IR lamp **Elio** emits VIS and IR together.

The CHSOS Technical Photography KIT : FREE software

We will use just FREE software!

- You can install and test this software on any computer, any time, no license, no cost
- This Free software has all the features that we need for our task
- This software is installed and set up in the **TP laptop** included in the **KIT**

We shoot **RAW** images with **DigicamControl**

- Can tether a large number of cameras, Nikon, Canon, Sony

We edit **RAW** images with **RawTherapee**

- Can be used to edit RAW images from any camera (Nikon, Canon,..)

We prepare the **TP documentation** using **GIMP**

- GIMP is the FREE alternative to Photoshop
- We can share a GIMP file with anybody, just need to install the FREE software!

The CHSOS Technical Photography **KIT** : pigments checker

CLICK HERE
Pigments checker
webpage

Collection of the most
important Pigments in
art history and
archaeology



It's a very useful tool to practice Technical Photography and it is included in the Technical Photography KIT. **Pigments Checker** is a collection of the most important pigments in art history. Among all the pigments and their varieties ever used in art, this collection selects the most used from antiquity to early 1950'. Pigments Checker is a standard tool designed for Art professionals, scientists, students and conservators to evaluate and practice non-invasive techniques for pigments identification.

Pigments Checker Timeline provides a simplified representation of the use of the pigments across ages.

Pigments' history is actually quite complex and depends on a number of factors;

The kind of artifacts. A pigment can be used on wall paintings while becoming obsolete in easel paintings.

Geography. As an example, natural cinnabar is found in Almaden (Spain) and Murillo used it since it was close to him, rather than the artificial form, vermillion, much more diffused elsewhere.

CLICK HERE
Pigments checker
webpage

Pigments Checker timeline



The CHSOS Technical Photography KIT : pigments checker

BLACKS	BROWNS	GREENS	BLUES	REDS	YELLOWS	WHITES
ivory black	burnt sienna	chrome oxide green	azurite	naphthol red	cadmium yellow	lead white
vine black	burnt umber	cobalt titanate green	blue bice	cadmium red	cobalt yellow	zinc white
bone black	van dyke brown	green earth	cobalt cerulean blue	red lead	lead tin yellow I	lithopone
lamp black	raw sienna	malachite	egyptian blue	red ochre	lead tin yellow II	titanium white
iron gall ink	raw umber	phthalo green	indigo	vermilion (natural)	massicot	gypsum
	bitumen	verdigris	maya blue	madder lake	naples yellow	chalk
	sepia	viridian	prussian blue	lac dye	orpiment	
		cadmium green	smalt	carmine lake	curcuma	
			ultramarine (natural)	realgar	yellow ochre	
			phthalo blue	vermilion (artificial)	yellow lake Reseda	
			cobalt violet	alizarin	gamboge	
			cobalt blue		chrome yellow	
			cobalt chromite blue		arylide yellow 5GX	
			manganese violet		stil de grain	
			vivianite		saffron	
			han blue			
			ultramarine (artificial)			

On the pigments checker webpage, you can find chemical and various information on each pigment. You can also download and view their Reflectance, Raman and XRF spectra.

[CLICK HERE
Pigments checker
webpage](#)

The CHSOS Technical Photography KIT : pigments checker

Pigments Checker

egyptian blue

The first synthetic pigment used from the early dynasties in Egypt until the end of the Roman period in Europe.

Manufacturer / product code: Kremer / 10060
Chemical description: artificial copper calcium silicate. Kremer PDF
Color: blue
Color Index: PB31
More info: Pigments Through The Ages

Raman spectroscopy

DOWNLOAD Free Raman Database

DOWNLOAD paper: "Pigments Checker version 3.0, a handy set for conservation"

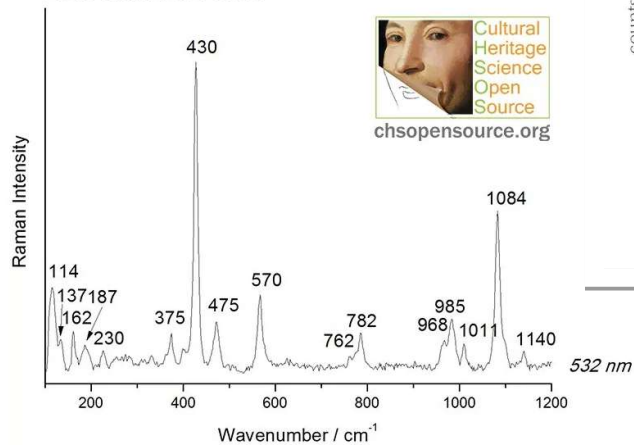
EGYPTIAN BLUE 10060

Raman spectroscopy

DOWNLOAD Free Raman Database

DOWNLOAD paper: "Pigments Checker version 3.0, a handy set for conservation scientists: A free online Raman"

EGYPTIAN BLUE 10060

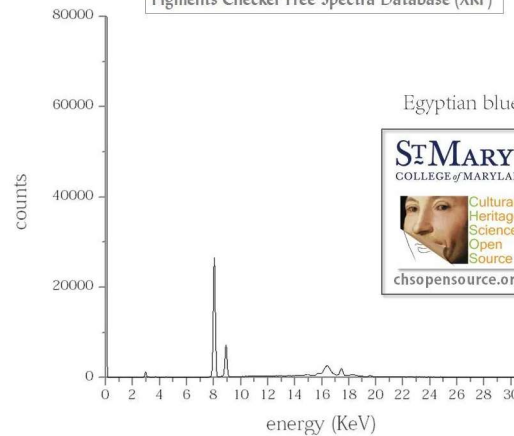


XRF spectroscopy

DOWNLOAD Free Online Database

DOWNLOAD paper: R. Larsen, N. Coluzzi, A. Cosentino "Free XRF Spectroscopy database of Pigments Checker" Intl Journal of Conservation Science.

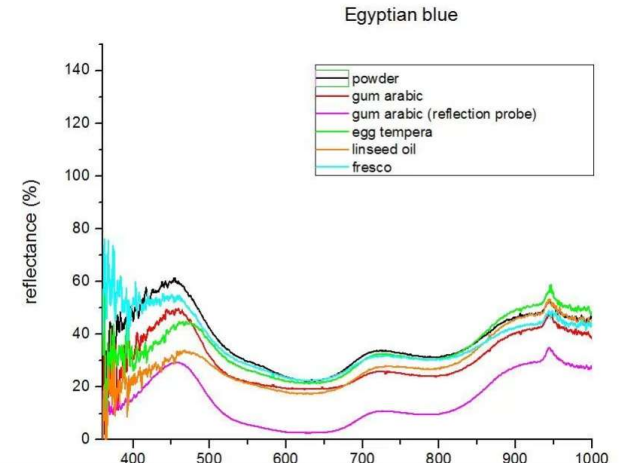
Pigments Checker Free Spectra Database (XRF)



Reflectance spectroscopy

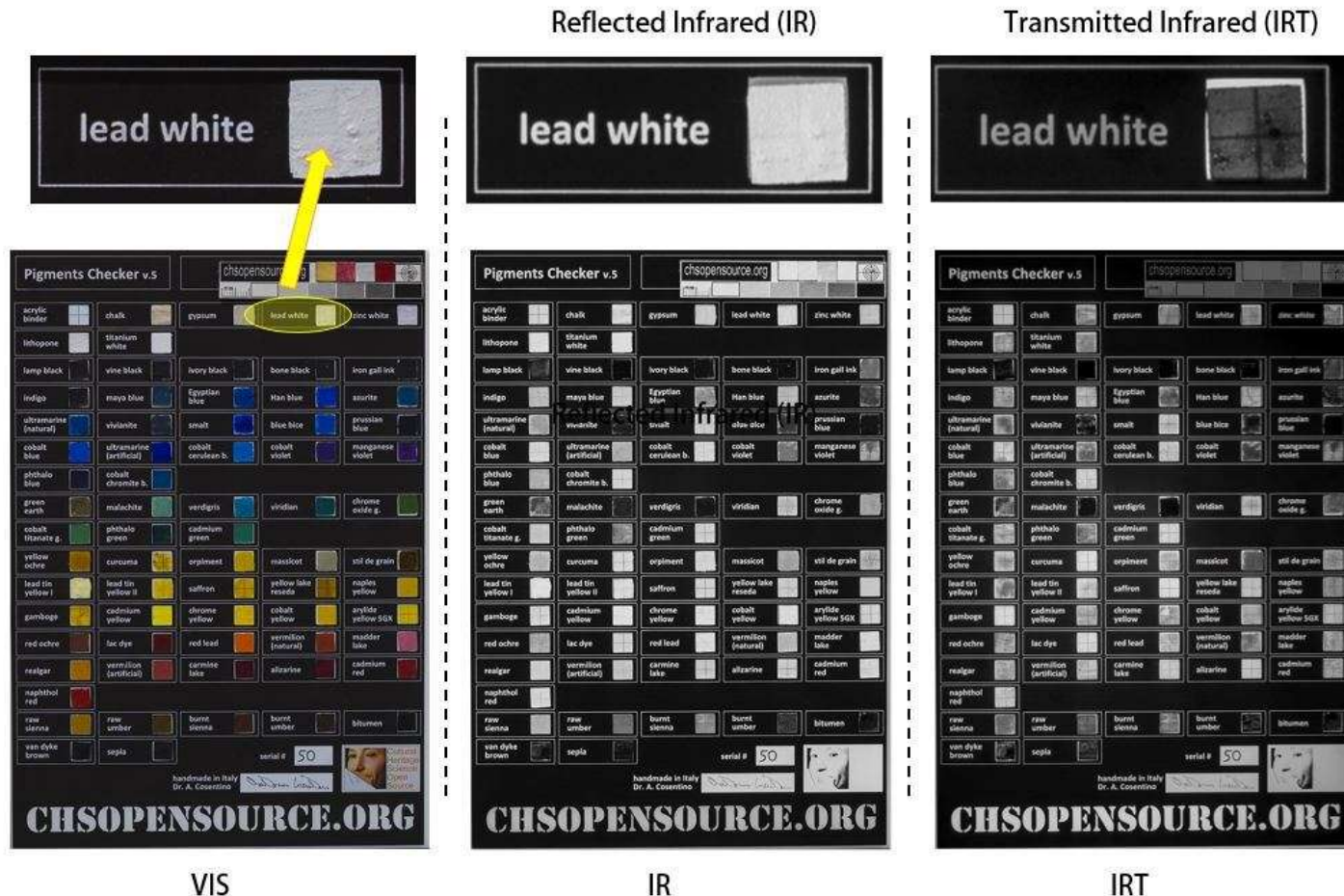
DOWNLOAD Free Reflectance Database

DOWNLOAD paper: "FORS spectral database of historical pigments in different binders"



Pigments thoroughly characterized by Reflectance, Raman and XRF spectroscopy

The CHSOS Technical Photography KIT : pigments checker



We often examine a painting with transmitted visible light and infrared radiation. In particular, Transmitted Infrared photography (IRT) is part of the Technical Photography documentation and allows to detect underdrawing and pentimenti. It is a very effective imaging method since pigments become even more transparent than in the usual IR photography method.

Pigments Checker has a translucent support, such that of a canvas painting, so you can use Pigments Checker to practice also those useful and effective imaging methods implying transmitted radiation.

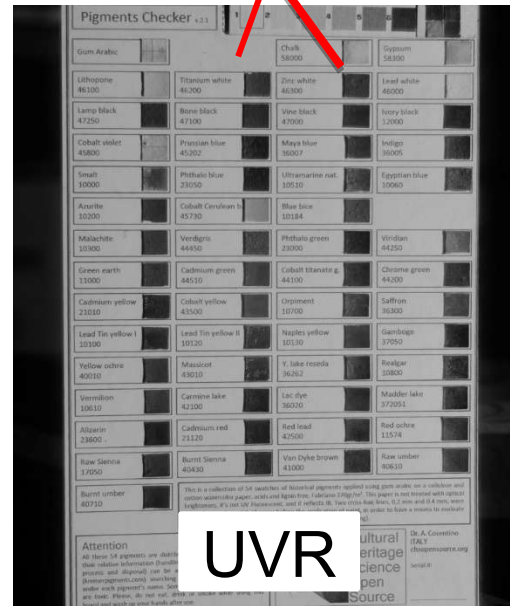
The CHSOS Technical Photography KIT : pigments checker

Spectral Range Test for your modified camera

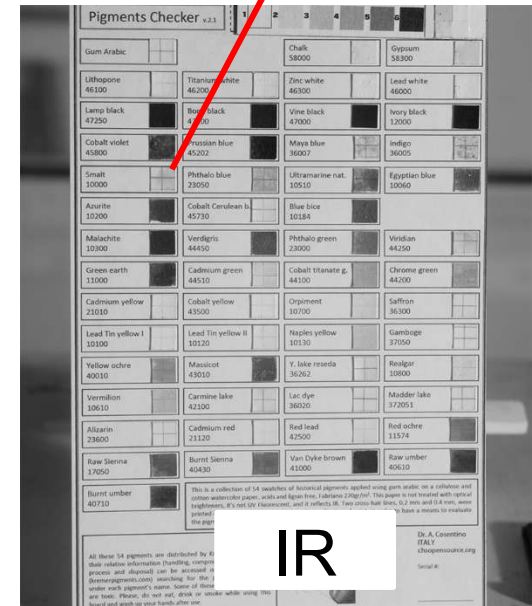
Color calibration with our VIS filter is successful



Titanium white and zinc white must be black

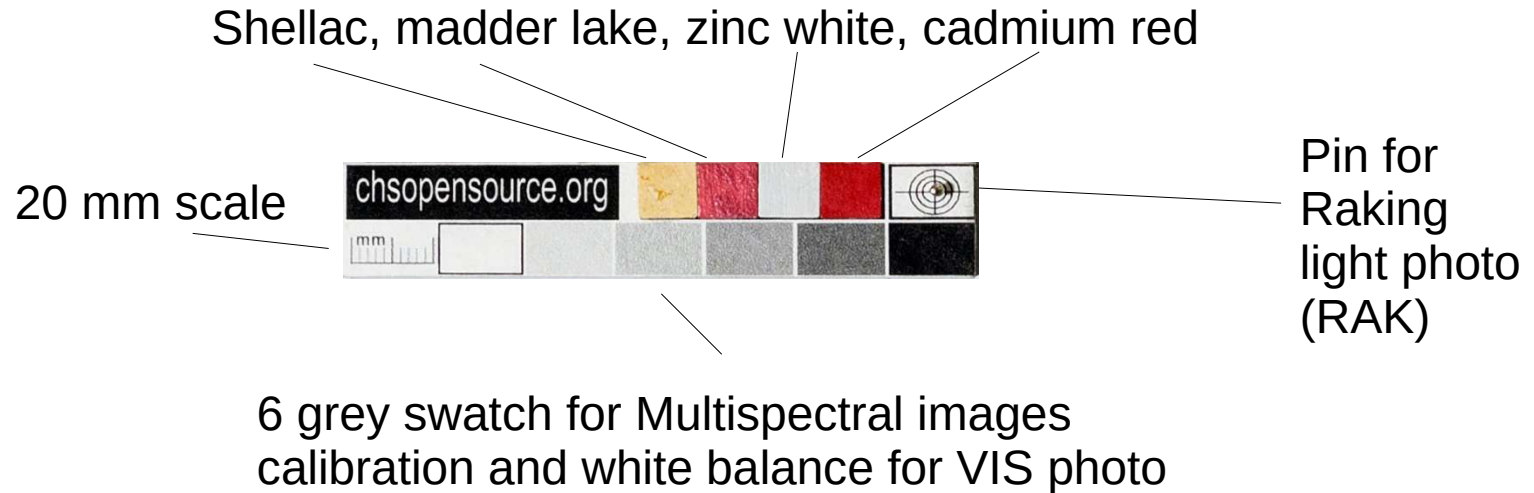


Smalt becomes transparent



Use pigments checker to check if your camera can see into the IR and UV. Put the IR filter on the camera and turn on the Elio lamp. Point at the pigment "smalt". If your camera can see into the infrared you will see smalt has become transparent and you can see the cross hairs. Then test the UV range, mount the UV filter and turn on the Fabrizio UV lamp. You will see that "lead white" pigment is bright, while "titanium white" is black. If both these experiments are positive you have a modified UV-VIS-IR camera!

The CHSOS Technical Photography KIT : TP-MSI calibration card



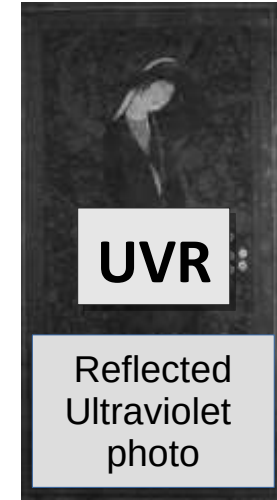
The TP-MSI calibration card comes with the Pigments checker box. This card must be included in ALL your technical photos.

The four swatches on the top are used to calibrate the technical photo.

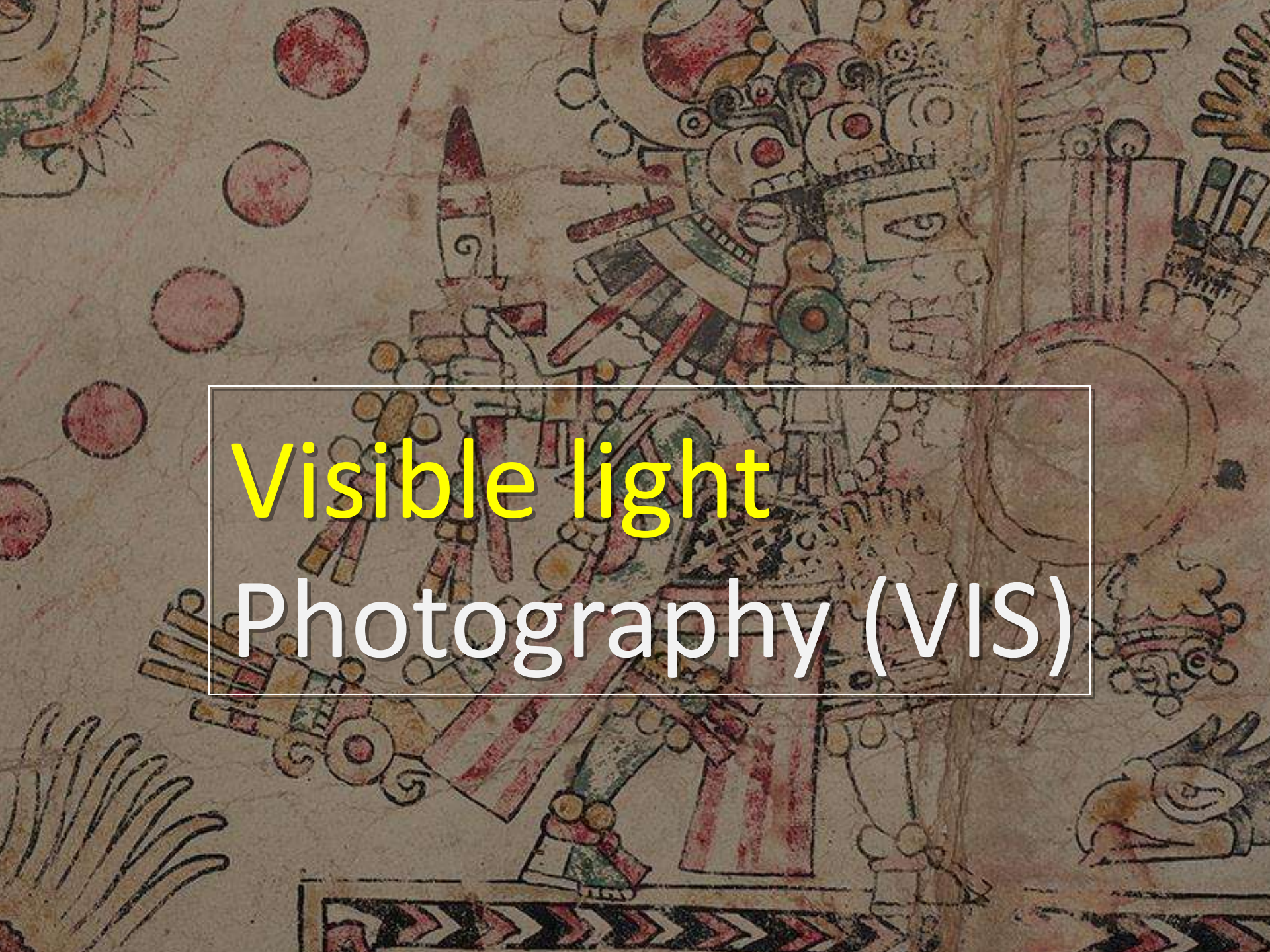
On the far right, the pin is used for documenting the position of the lamp for Raking light Photography.

The 6 grey swatches on the bottom are used for calibration of the multispectral images and for white balance of the VIS image.

Technical Photography Documentation



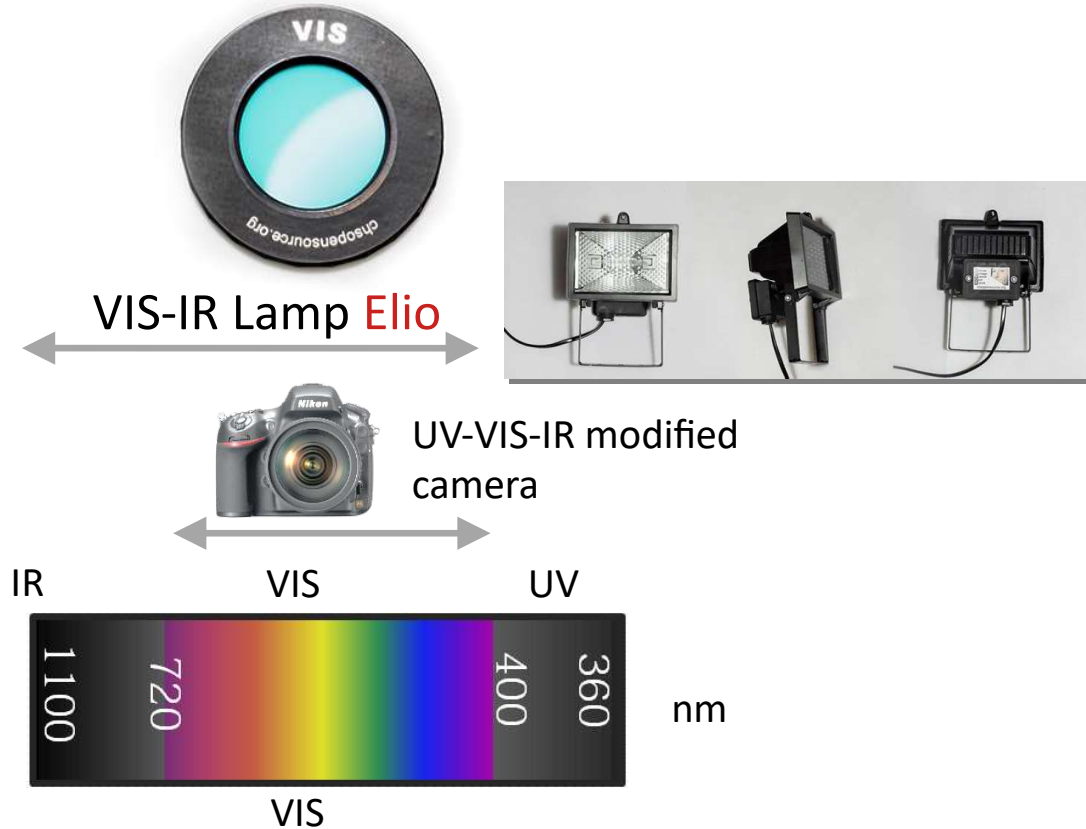
Using the CHSOS Technical Photography kit you can make a “Technical Photography (TP) documentation” of your art object. This means a collections of photos realized using the **same** modified camera **but** a specific combination of filters and lamps for each photographic method. Each photographic method will bring a bit more information on your object. All these images together, a complete TP documentation, will deliver plenty of info!

The background is a dense, hand-drawn illustration. It features a central figure with multiple eyes and a complex, multi-colored body. To the left, there are several red circular shapes, possibly representing planets or suns. The drawing uses a variety of colors including red, green, yellow, and black, with a textured, sketchy appearance. The overall style is reminiscent of ancient or indigenous art.

Visible light
Photography (VIS)

VIS: setup

----- Shooting ----->>>>>----- Raw image editing --



See the Raw Therapie manual.pdf for detailed info on editing VIS raw images.



2nd grey ~N8 = 200 (white balance)

Taking a good standard visible range photo is the first step in our TP documentation. The VIS photo will be the reference image on which to register the other technical images. We use the VIS filter and the Elio lamps. Be sure the TP-MSI calibration card is in the scene. See the **video course lesson VIS** for more practical advices for this shooting.

VIS: Elio lamp



The TP KIT includes 2 Elio lamps. These are halogen lamps and they provide a continuous source of VIS and IR radiation. There are plenty of alternatives, but Elio lamps are a good starting point to master the technique.



VIS: camera profile

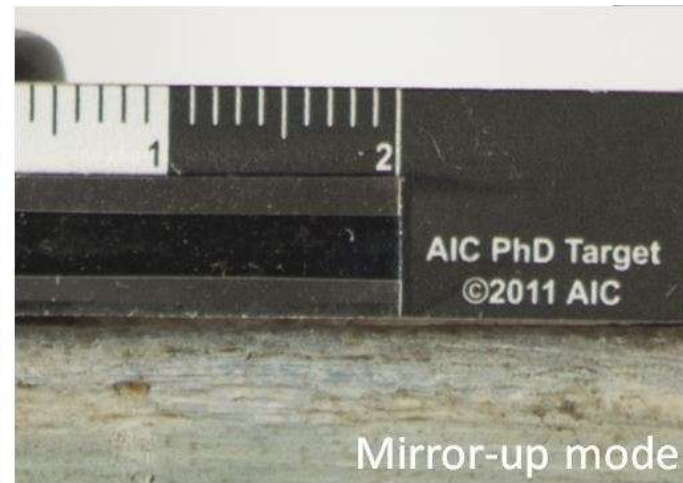


Color accuracy is of the most importance in art documentation.

Due to differences in technologies and variables in manufacturing processes every camera captures colors a bit differently. To get the best out of your camera, your camera has been profiled by us in our lab. A profile has been created and added to the raw file editor software Raw Therapee.

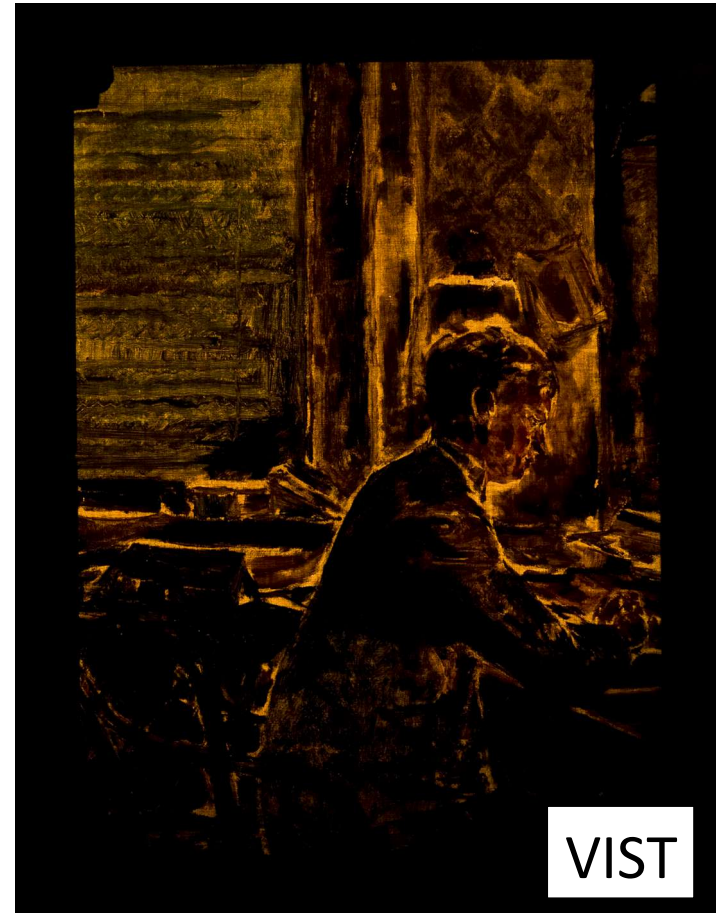
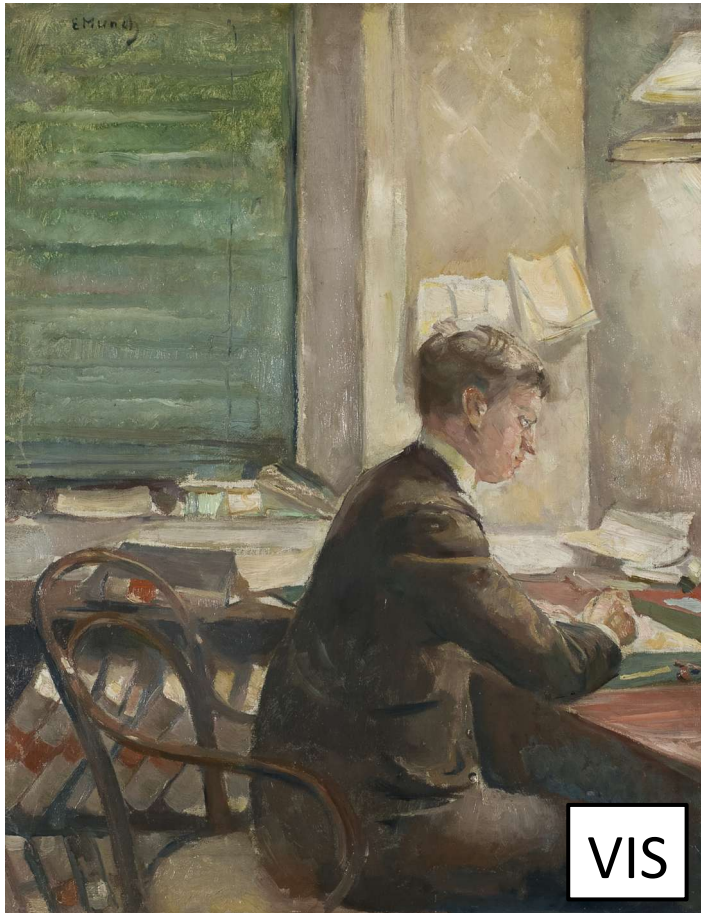
We use X-rite ColorChecker Passport to profile your camera and free Adobe DNG converter to convert raw images into the DNG format used by X-Rite.

VIS: mirror-up mode



In DSLR camera, the reflex mirror goes up, the shutter blade opens to expose the sensor and finally shutter blades close and mirror returns down. This process shakes the camera. We recommend you use the “Mup” mode. You can select it from the mode selector ring in your camera. With the mirror-up mode you will have to shoot 2 times, first the mirror goes up and then, wait a couple of second to shoot again, to take the actual image. This mode will give more stable images.

VIS: VIST - Transmitted Visible Photo



The letter T, at the end of the acronyms of the photo methods, stands for “Transmitted”. This means that the painting stands between the lamp and the camera. Of course, this examination is possible just for those supports that allows some radiation (visible or infrared) to pass through. VIST can be done for most paintings on canvas, while it is not possible for panel paintings and thick cardboards, VIST allows to get information on the build up of the painting and reveal hidden changes.

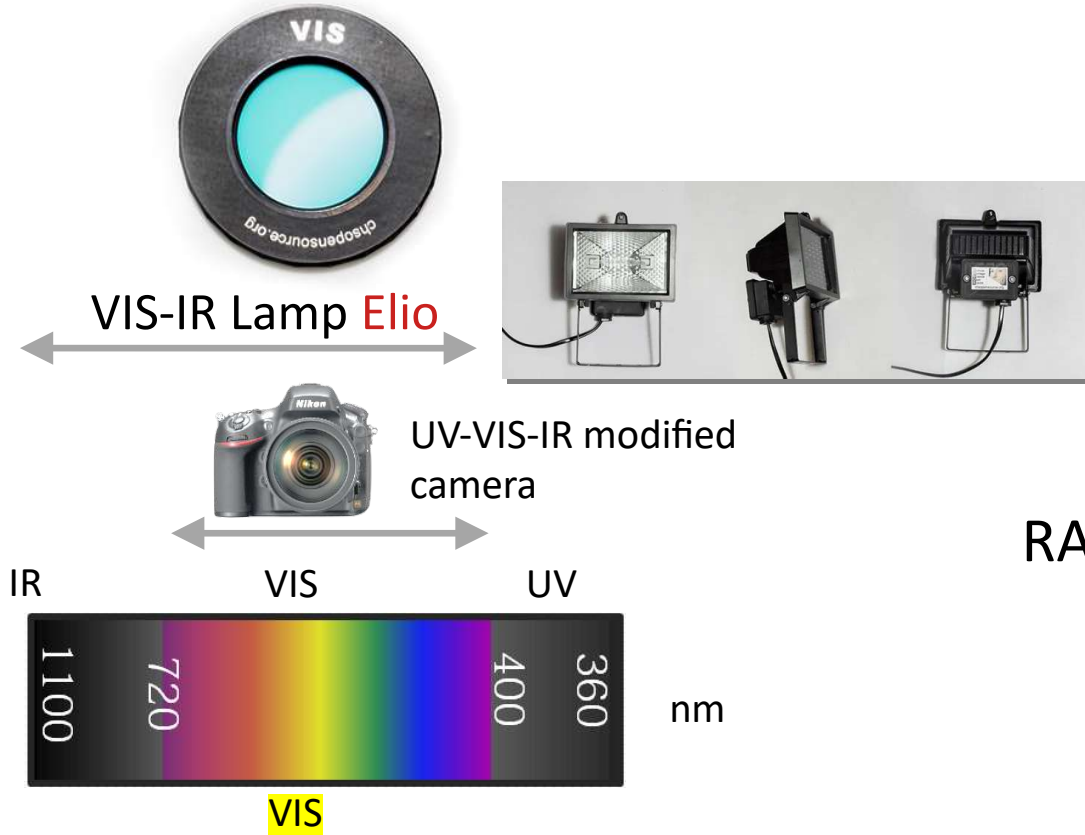


Raking light

Photography (RAK)

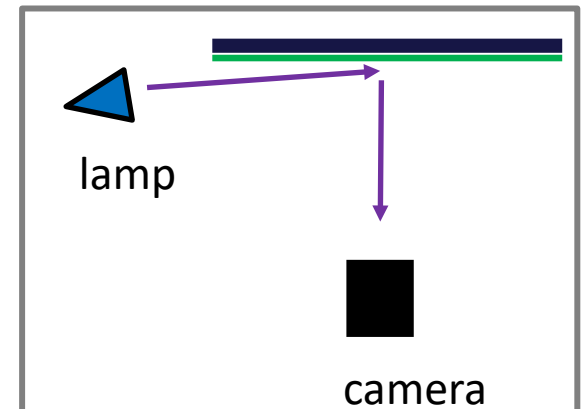
RAK: setup

----- Shooting ----->>>>>----- Raw image editing -----



See the Raw Therapie manual.pdf for detailed info on editing UVF RAW images.

RAK



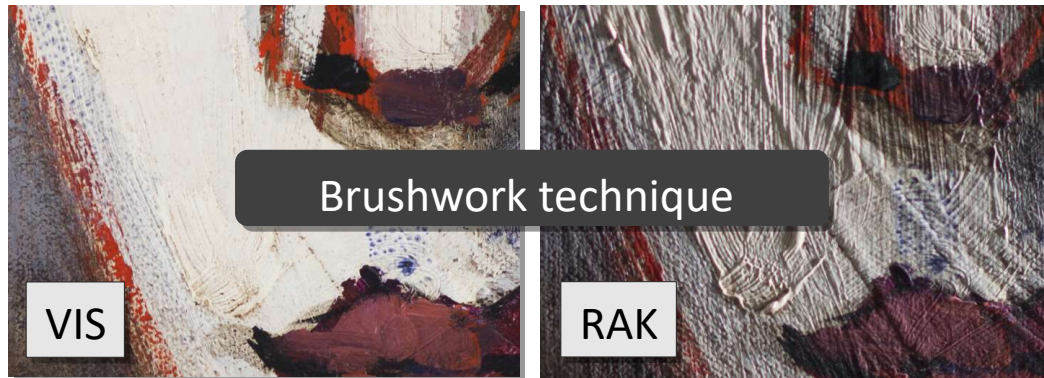
RAK setup is the same as for the VIS photo, the only difference is that the light must come from just one direction and should be raking to the surface. The direction could be any, left, right, top, bottom. The pin in the TP-MSI calibration card will document with its shadow the relative position of the lamp.

See the **video course lesson RAK** for more practical advices for this shooting.

RAK: applications



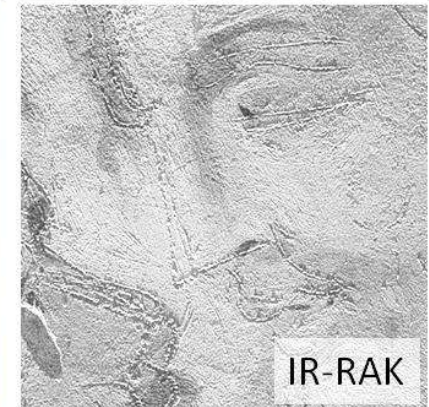
Raking light photography (RAK) is a very simple method to realize. Nevertheless, it allows to reveal and to document numerous information. A standard VIS photo is intended to reproduce the look of the artwork as seen in museum lighting, with soft and diffused light. A RAK photo clearly shows how the paint was laid (brushwork), texture and building up of figures and details, warping and condition of the support and paint layer, incisions.

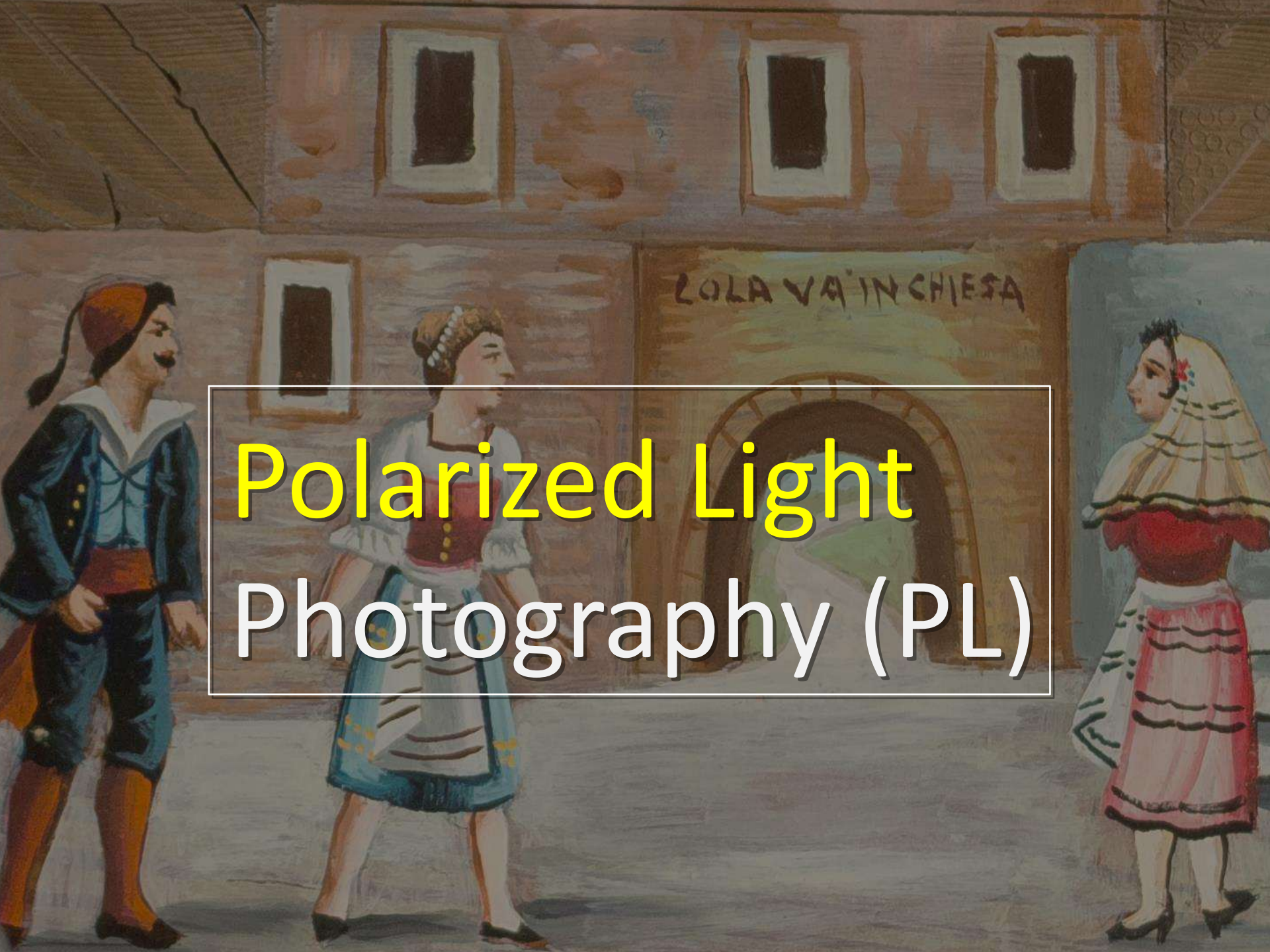


RAK: using infrared and ultraviolet

Raking light with **visible** or **infrared** radiation

Raking light photography (RAK) is usually done with the VIS filter. Though, you can experiment with the IR and UV filters, and using Elio lamp or Fabrizio UV lamp. Depending on your application, it could make sense to do your RAK photo in the VIS, IR or UV range. This image shows a comparison of RAK images taken in the VIS and in the IR ranges. The advantage of the IR method is that the pigments become transparent and therefore the incisions could become more apparent, since there is no more distracting color.





Polarized Light Photography (PL)

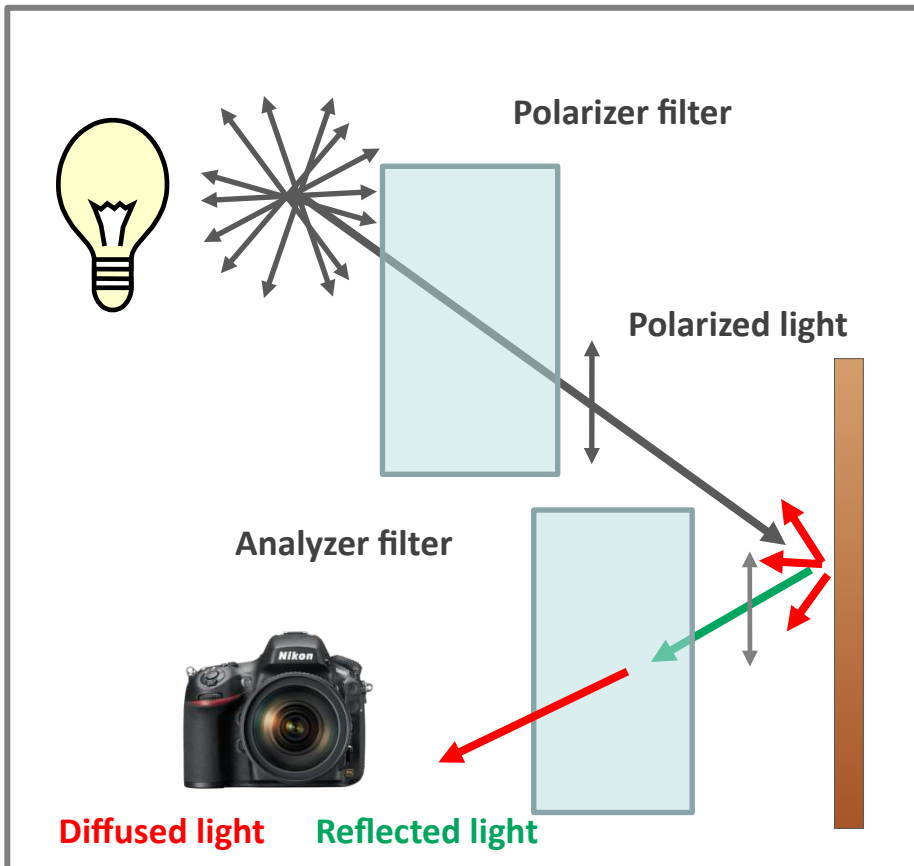
PL: setup



PL photo setup is like VIS. We just need to add the polarizing filters in the ELIO lamps and to add the polarizer filter on the camera's lens. Note: the polarizer filter must be between the lens and the Robertina filter holder.

See the **video course lesson PL photography** for more practical advices for this shooting.

NOTE: standard PL filters work with VIS only. They stop UV and are transparent to the IR. So, you cannot do PL photo with UV or IR.



Polarized light photography (PL) is used to remove glare and ugly reflections from photos of varnished paintings. Also can be used to remove the reflection of metal parts, like the coin in this example. The colors of the painting are not affected but the metal reflection is removed.



Ultraviolet Fluorescence Photography (UVF)

UVF: setup

----- Shooting ----->>>>>----- Raw image editing -----



UV Lamp
Fabrizio



UV-VIS-IR modified
camera



UVF setup uses the VIS filter and the Fabrizio UV lamp. We are interested in documenting the visible fluorescence excited by the invisible UV radiation from the Fabrizio lamp.

See the **video course lesson UVF** for more practical advices for this shooting.

See the Raw Therapie manual.pdf for detailed info on editing the UVF RAW images.

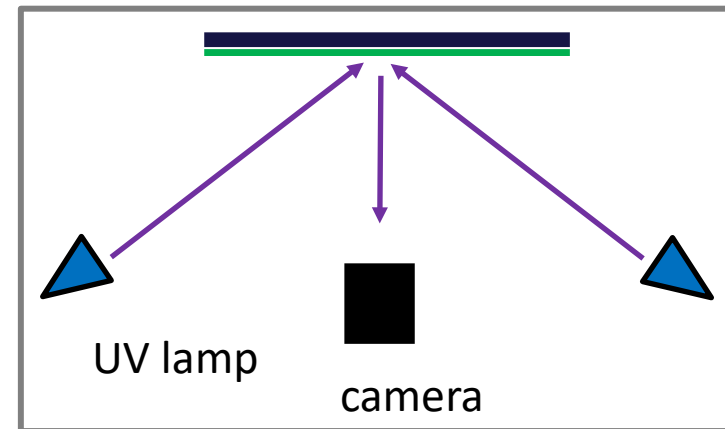
VIS



UVF



blue channel = 150

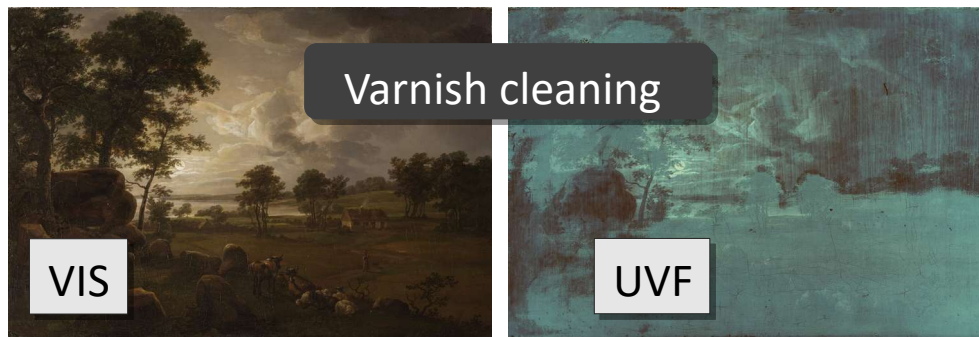


UVF: applications

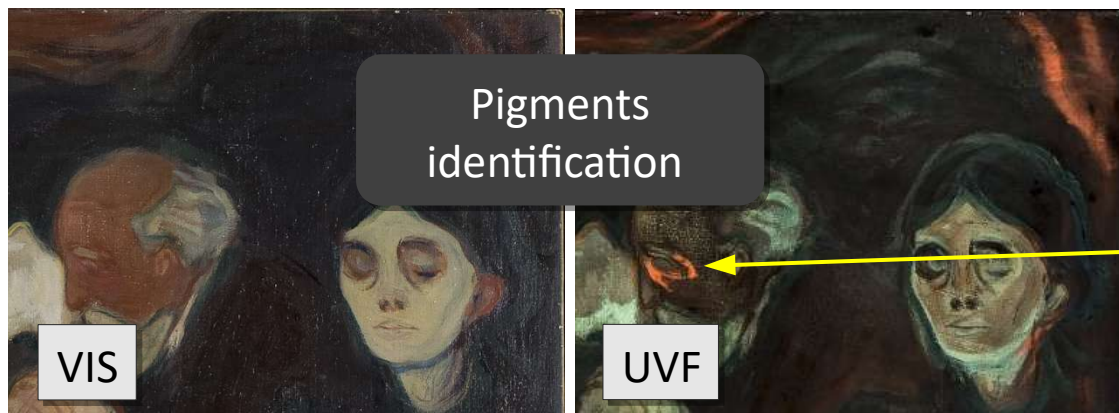


Ultraviolet Fluorescence photography (UVF) is probably the most diffused technical method for art examination since it can be successfully applied on practically every art or archaeology object category.

In a painting, UVF photo reveals retouchings as **dark spots** while the aged original materials exhibit light emission with different colors.



UVF photo can provide information on the varnish layers. In this case, we can see a partially cleaned painting with its original varnish still lasting in the bottom right region.



UVF photo can provide a tentative identification of the pigments based on their fluorescence. In this painting, some brown details have been worked with a pigment that exhibits a strong and peculiar orange fluorescence, similar to that of madder lake.

UVF: applications

Iron gall ink, **faded**

UVF photography makes faded iron gall ink readable

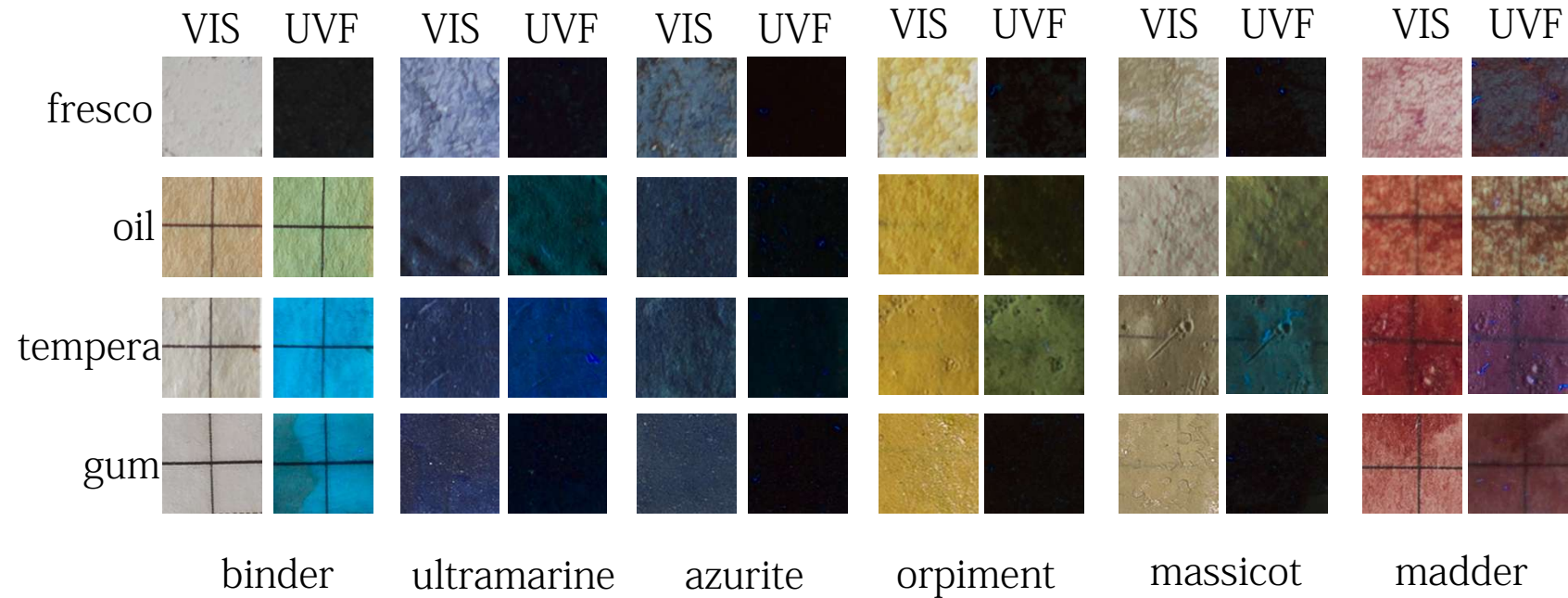
VIS



UVF

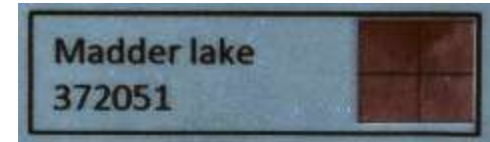


UVF: applications

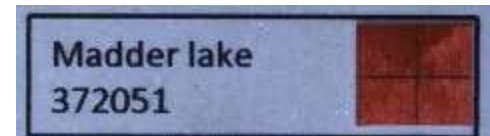


UVF photo can be useful for a **tentative** identification of the pigments. Though, must be kept clear that there are number of factors that can change the actual fluorescence colors of pigments in a real painting. The main factors are: ageing, the varnishes and the binders. The example shows some pigments laid with different binders. Water based binders, tempera and gum arabic, contribute a bluish fluorescence to the final emission. On the other hand, oil contributes a yellow color. Fresco technique does not fluoresce. So, for example, massicot UVF photo shows a yellowish fluorescence is the pigment is laid with oil, while it shows a bluish fluorescence if laid with tempera.

UVF: lamp 254 nm



UVF



UVF 254

VIS

UVF

UVF 254

We could do a UVF photo using a different lamp emitting ultraviolet radiation at shorter wavelengths, such as 254 nm. This kind of lamps are easily available, because used by stamps collectors. Stamps are printed with specific phosphors that are excited by this specific wavelength. In the case of art materials, we didn't notice any improvement in using this kind of UV lamps. The main advantage is that since this is a stronger UV, we get a stronger emission. Though, this UV range 254 nm is dangerous for eyes and skin, so much better to keep working with our safe Fabrizio lamp at 365 nm.

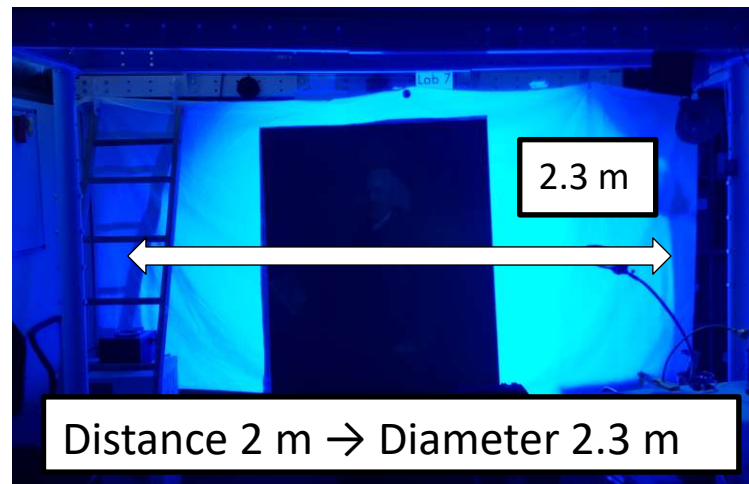
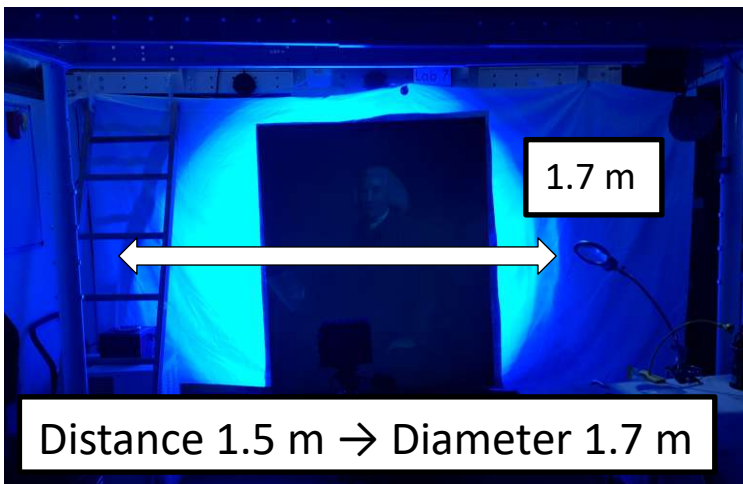
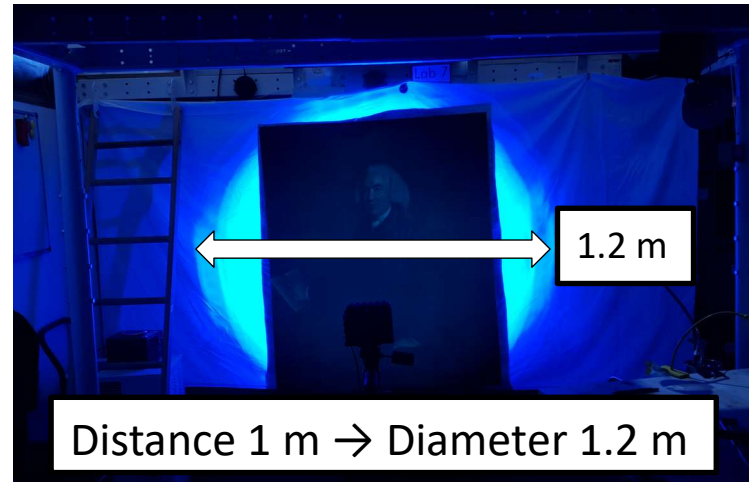
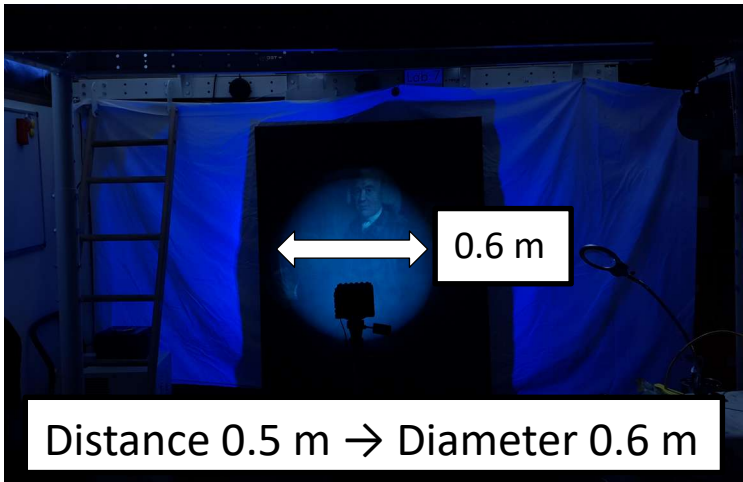
UVF: UV lamp Fabrizio



We developed Fabrizio because we needed a strong and still lightweight UV lamp. You can use Fabrizio to examine easel paintings in your conservation studio as well as traveling to document large wall paintings climbing scaffoldings with this light lamp.

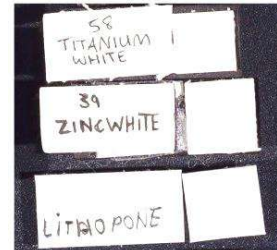
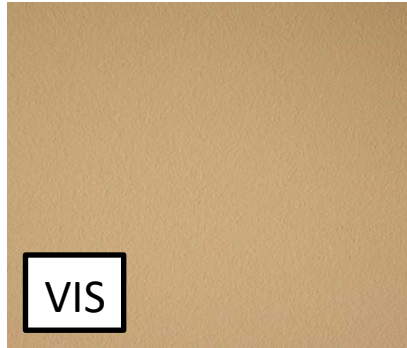
Fabrizio is manufactured in the CHSOS workshop in Italy. Plastic components are 3D printed with high quality reinforced PLA.

UVF: UV lamp Fabrizio



Fabrizio delivers even and intense UV radiation over a 60 degree angle

UVF: UV lamp Fabrizio



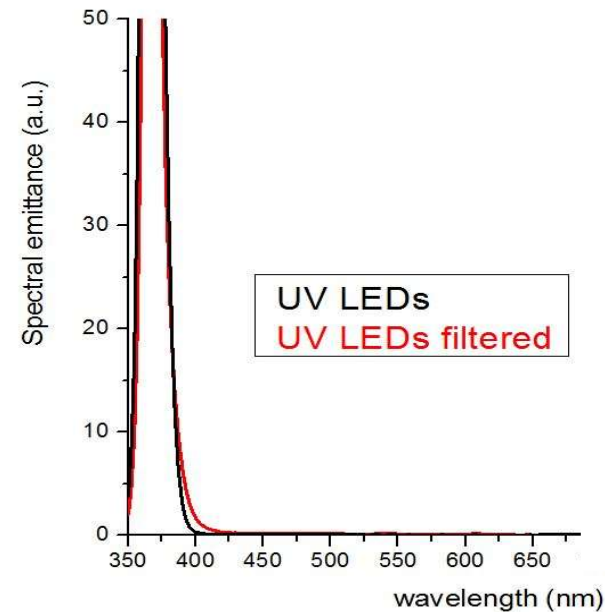
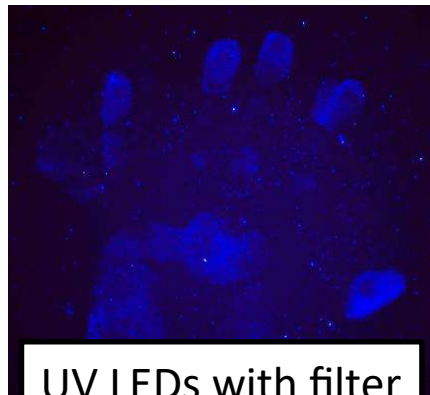
VIS



No VIS filter



VIS filter



Fabrizio's core is a powerful UV LED emitting at 365 nm, the standard UVA spectral region used for UVF and UVR technical photography.

Fabrizio mounts a filter to cut off all the visible light and allow only pure UV radiation for perfect UVF photos.

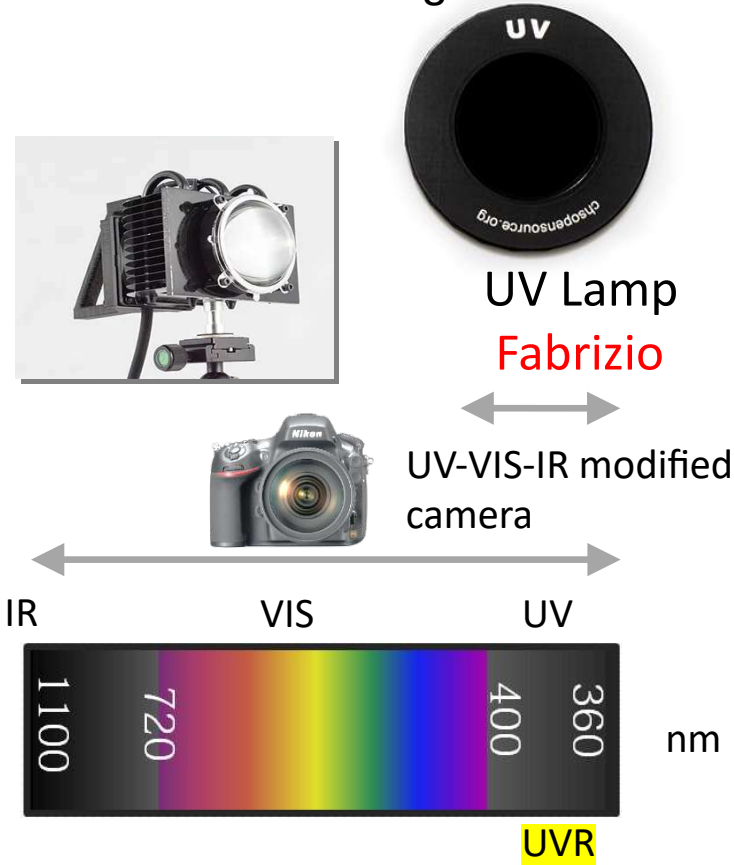
The examples above show that the removal of the visible bluish emission from the LED is mandatory to better document colors and dim fluorescence emission. The example on the left shows how the dim fluorescence of an hand print cannot be detected without filtering the bluish light. The example on the right, shows that the yellow emission of zinc white becomes clear with the pure UV lamp.



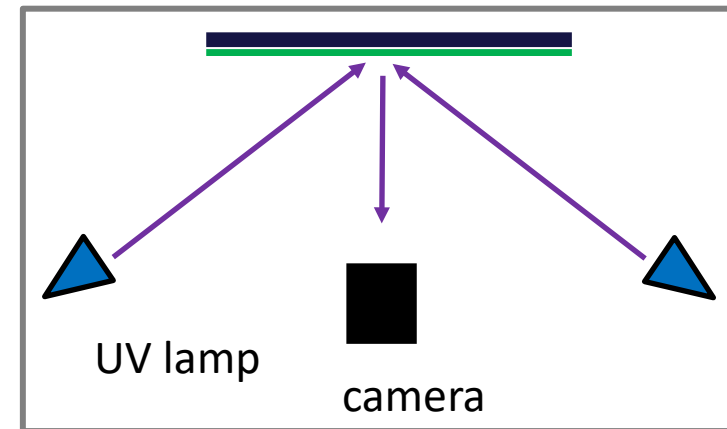
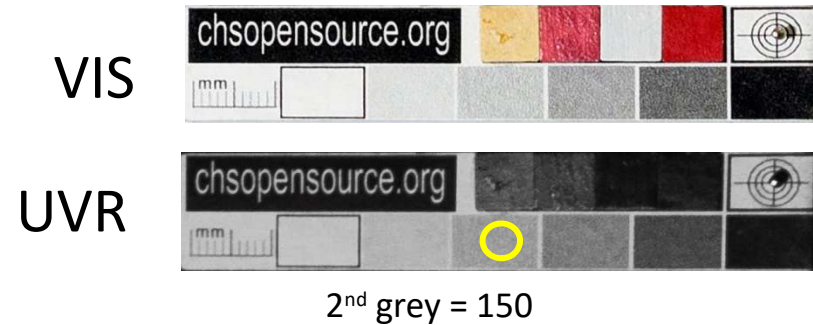
Reflected Ultraviolet Photography (UVR)

UVR: setup

----- Shooting ----->>>>>----- Raw image editing -----



See the Raw Therapie manual.pdf for detailed info on editing the UVR RAW images.

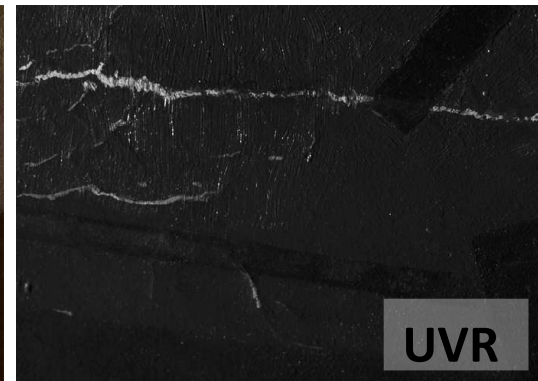


UVR setup uses the UV filter and the Fabrizio UV lamp. We are interested in documenting the invisible UV radiation from the lamp, as it is reflected by the observed surface.

IMPORTANT: after changing filters, check the focus! It's likely that the object is no longer on focus due to the different spectral range going through the lens of the camera.

See the **video course lesson UVR** for more practical advices for this shooting.

UVR: applications



Pigments checker

Lithopone 48200	Titanium white 48000	Zinc white 48000	Lead white 48000
Chalk 58000	Carbon 58000	Iron black 47000	Very black 47000
Lamp black 47000	Bone black 47000	Viny black 47000	Very black 47000
Cobalt violet 45000	Prussian blue 45200	Maya blue 39007	Indigo 39007
Smalt 39000	Phthalic blue 23000	Ultramarine red 18000	Egyptian blue 29000
Acrylic 45000	Cobalt blue 45000	Blue black 47000	Blue black 47000
Malachite 33000	Van Dyke 44000	Van Dyke 44000	Van Dyke 44000
Green earth 13000	Cadmium green 43000	Cadmium green 43000	Chrome green 44000
Cadmium yellow 23000	Cadmium yellow 43000	Cadmium yellow 43000	Cadmium yellow 43000
Lead Tin yellow I 30000	Lead Tin yellow II 30000	Lead Tin yellow II 30000	Lead Tin yellow II 30000
Yellow ochre 40000	Manganese 43000	Manganese 43000	Manganese 43000
Vermilion 30000	Cadmium red 43000	Cadmium red 43000	Madder lake 37000
Alizarin 23000	Cadmium red 43000	Red lead 43000	Red ochre 43000
New Senesal 13000	Iron ochre 43000	Iron ochre 43000	Iron ochre 43000
Burnt umber 40000	Burnt umber 40000	Burnt umber 40000	Burnt umber 40000

Pigments identification

VIS

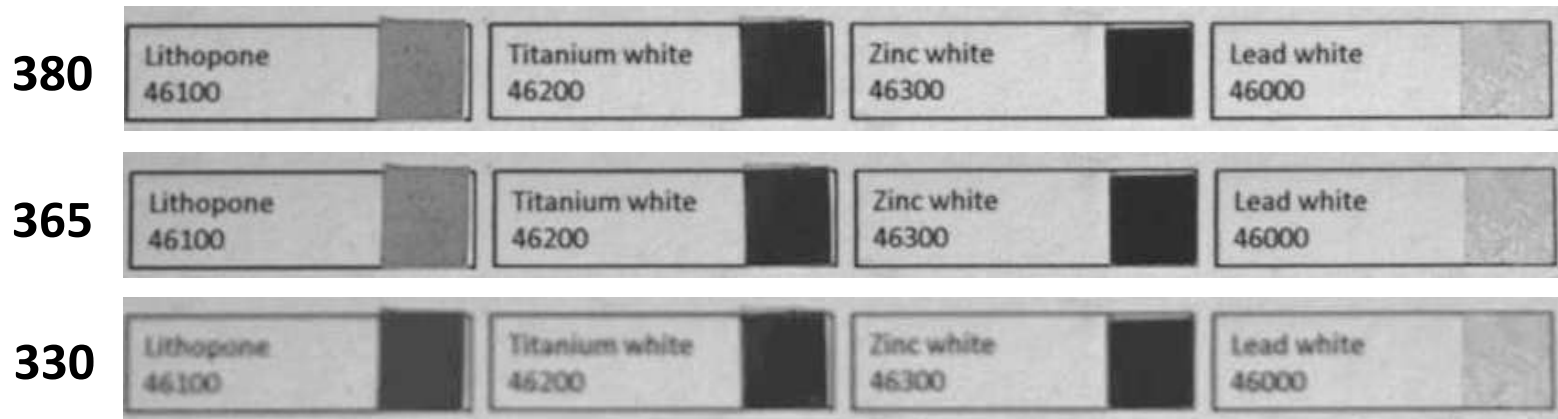
UVR

Cultural Heritage Science Open Source
chsopensource.org

Ultraviolet Reflected photography can reveal retouched area and different pigments even better than UVF.

Ultraviolet Reflected photography is used to enhance reading of faded paints and inks and to detect two modern white pigments, zinc white and titanium white.

UVR: other UV sources



Pigments checker			
Lithopone 46100	Titanium white 46200	Zinc white 46300	Lead white 46000
Chalk 39000	Opaline 39000		
Carbon black 47000	Black black 47000	Very black 47000	Very black 47000
Carbon violet 49000	Prussian blue 49000	Blue blue 49000	Indigo 49000
Black 49000	Prussian blue 49000	Prussian blue 49000	Prussian blue 49000
Acrylic 49000	Carbon blue 49000	Blue blue 49000	Indigo 49000
Aluminum 49000	Carbon blue 49000	Blue blue 49000	Indigo 49000
Green earth 49000	Carbon green 49000	Green green 49000	Chlorine green 49000
Carbon yellow 49000	Carbon yellow 49000	Yellow yellow 49000	Saffron 49000
Lead Tin yellow 49000	Lead Tin yellow 49000	Yellow yellow 49000	Cambridge 49000
Yellow ochre 49000	Yellow ochre 49000	Yellow ochre 49000	Yellow ochre 49000
Vermilion 49000	Carmine lake 49000	Red red 49000	Madder lake 49000
Alizarin 49000	Alizarin lake 49000	Red red 49000	Red ochre 49000
Raw Sienna 49000	Raw Sienna 49000	Raw Sienna 49000	Raw Sienna 49000

365

Pigments checker			
Lithopone 46100	Titanium white 46200	Zinc white 46300	Lead white 46000
Chalk 39000	Opaline 39000		
Carbon black 47000	Black black 47000	Very black 47000	Very black 47000
Carbon violet 49000	Prussian blue 49000	Blue blue 49000	Indigo 49000
Black 49000	Prussian blue 49000	Prussian blue 49000	Prussian blue 49000
Acrylic 49000	Carbon blue 49000	Blue blue 49000	Indigo 49000
Aluminum 49000	Carbon blue 49000	Blue blue 49000	Indigo 49000
Green earth 49000	Carbon green 49000	Green green 49000	Chlorine green 49000
Carbon yellow 49000	Carbon yellow 49000	Yellow yellow 49000	Saffron 49000
Lead Tin yellow 49000	Lead Tin yellow 49000	Yellow yellow 49000	Cambridge 49000
Yellow ochre 49000	Yellow ochre 49000	Yellow ochre 49000	Yellow ochre 49000
Vermilion 49000	Carmine lake 49000	Red red 49000	Madder lake 49000
Alizarin 49000	Alizarin lake 49000	Red red 49000	Red ochre 49000
Raw Sienna 49000	Raw Sienna 49000	Raw Sienna 49000	Raw Sienna 49000

330

We tested shorter wavelengths UV lamps to check if there is any advantage. Among the pigments tested only lithopone shows a change in its UV absorbance, see example above. Bottom line, we can keep using the safe Fabrizio UV lamp. Remember: shorter UV wavelengths become dangerous for eyes and skin.

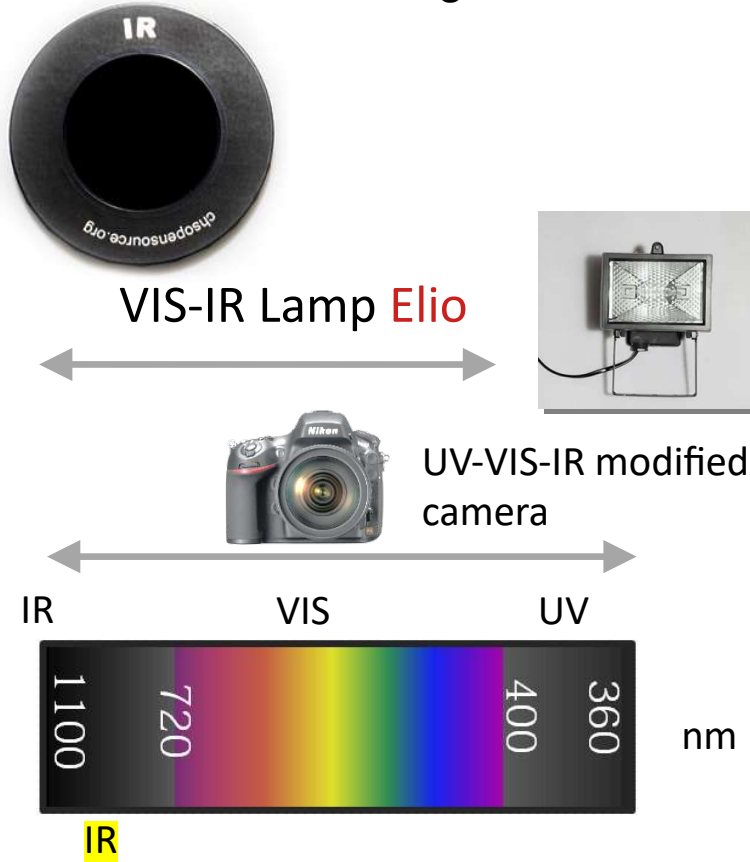
A grayscale infrared photograph of a chair, likely made of wood, set against a textured, light-colored background. The chair's frame and legs are visible, though the image is in a spectral range where colors are not visible. A white rectangular box with a thin black border is positioned in the upper left quadrant of the image, containing the text 'Infrared Photography (IR)'.

Infrared

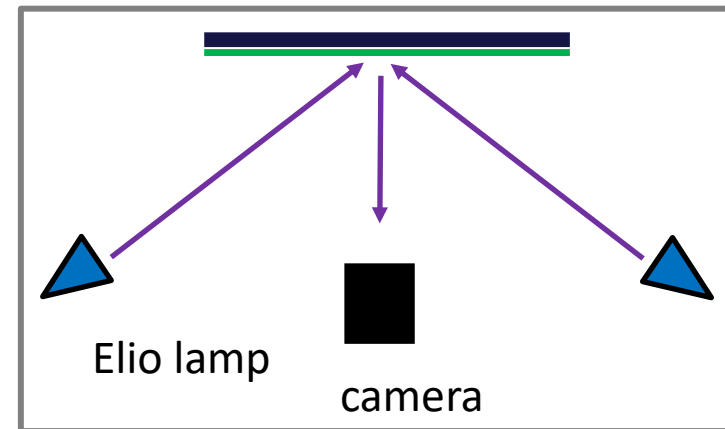
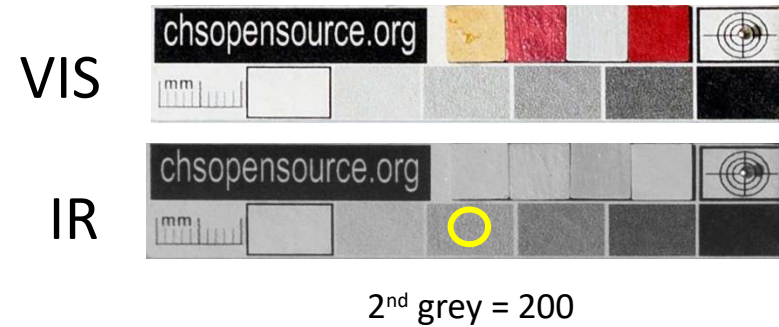
Photography (IR)

IR: setup

----- Shooting ----->>>>>----- Raw image editing --



See the Raw Therapie manual.pdf for detailed info on editing the IR RAW images.



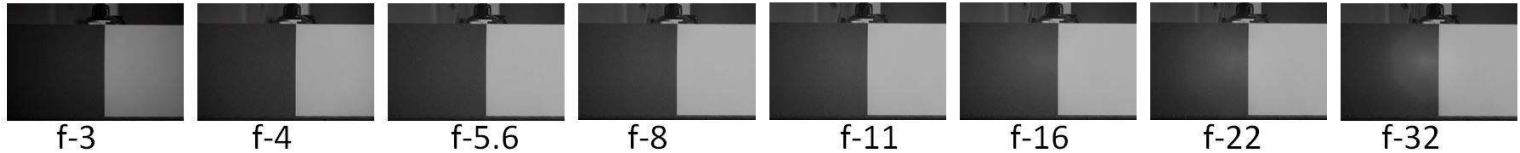
IR setup uses the Elio lamp and the IR filter. We are interested in documenting the invisible IR radiation from the lamp, as it is reflected by the observed surface.

IMPORTANT: after changing filters, check the focus! It's likely that the object is no longer on focus due to the different spectral range going through the lens of the camera.

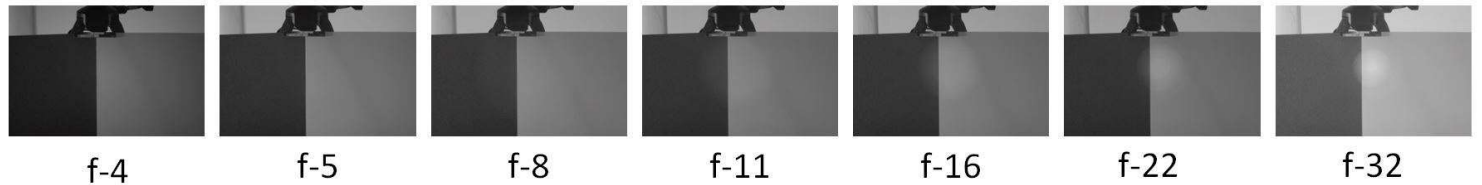
See the **video course lesson IR** for more practical advices for this shooting.

Infrared Photography Lenses Database

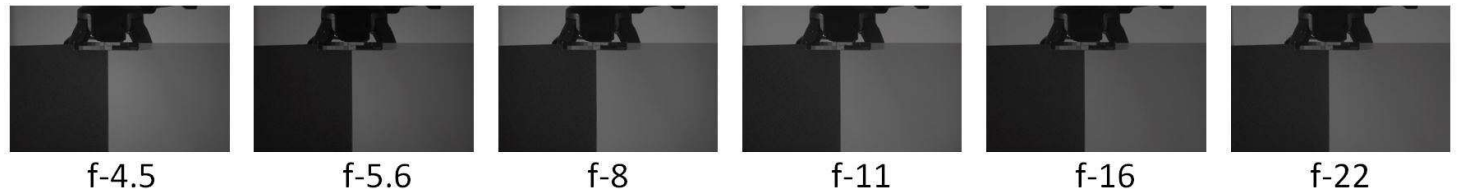
Nikon Nikkor Micro 105mm f2.8 D



Nikon Nikkor 200mm f4 AI



Nikon Nikkor 300mm f4.5 AI



Photographic lenses are designed for standard photography which means to work in the visible region. When we use them for the infrared photo, the lens could have some artifacts. Generally, these look like bright areas, so the name “hot spots”. Since we are exploring the infrared region, this brightness is associated with “heat”, like in Thermography, even if in this case we are in the very near infrared, definitely far from the region used in Thermography.

These hot spots appear when we close down the aperture and depend on each lenses and the focusing distance. So, test your lens to check if there is any hot spot for your specific setup. In general, hot spots are not an issue if working with the low F-number.

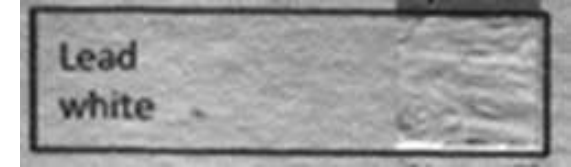
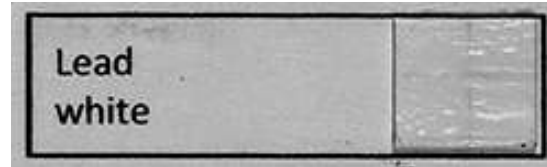
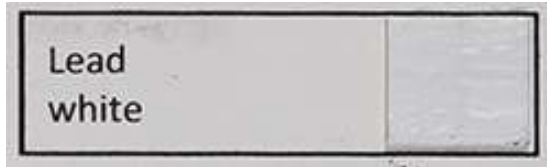
IR: applications

VIS

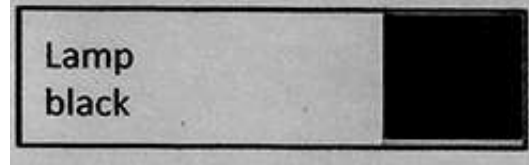
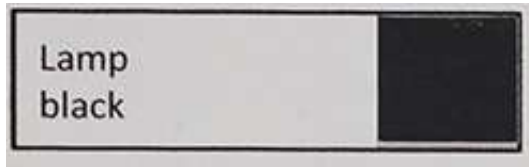
IR

IRR

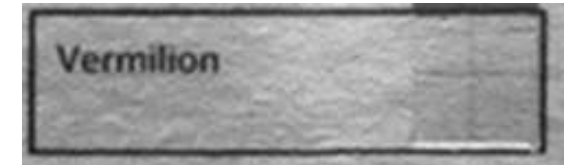
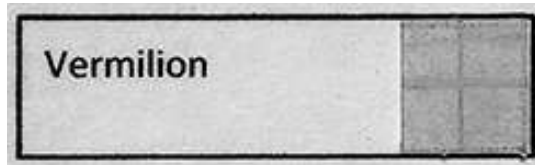
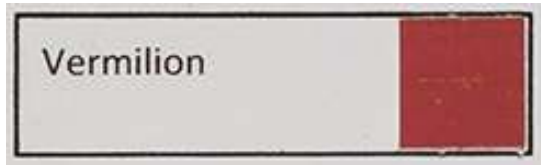
Opaque in IR and IRR – reflects all



Opaque in IR and IRR – absorbs all



Equally transparent in IR as well as in IRR



IR photography makes pigments transparent and allows to detect underdrawing. In this slide we compare it with IRR, infrared reflectography. This is another technique which uses a class of instruments that can see in the far infrared where the pigments become the most transparent. This class of instruments are more expensive, so, let's discuss if it is really necessary to have an IRR camera, or IR photography is enough.

There is a class of pigments, the whites, in particular, that are opaque both in the IR and IRR. So, the whites are always difficult to see through because they reflect all the infrared and appears just bright. On the other hand, the black pigments, based on carbon are always opaque, because they absorb all the infrared.

Then there are pigments, such as vermilion, which become a bit transparent with IR and the transparency does not improve with the IRR.

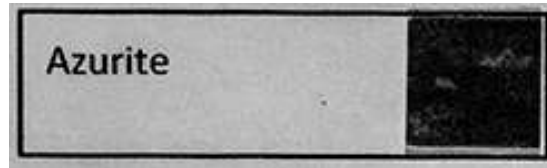
IR: applications

VIS

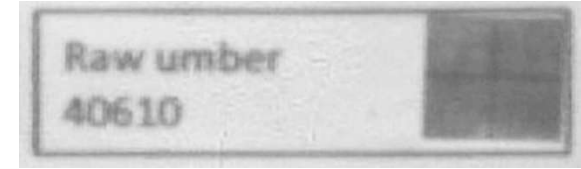
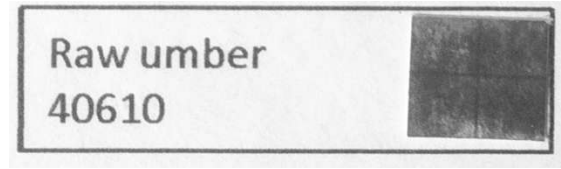
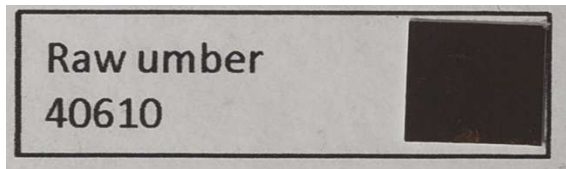
IR

IRR

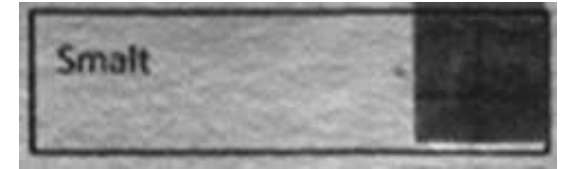
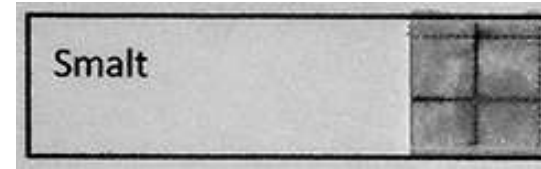
Transparent only in IRR



Transparent in IR and more in IRR



Transparent in IR and opaque in IRR



We have pigments, among them the most relevant, azurite, which are only transparent with the IRR camera. They absorb strongly the IR and appear dark with the modified camera.

Some pigments, such as raw umber, become transparent in the IR and can be more transparent using the IRR. This behaviour is common with the earth pigments (red ochre, yellow ochre, raw sienna...)

The last class is that of pigments containing cobalt, such as smalt and cobalt blue. These pigments have a very peculiar behaviour. They are very transparent in the IR but become opaque in the IRR. This behaviour can be used to map these pigments.

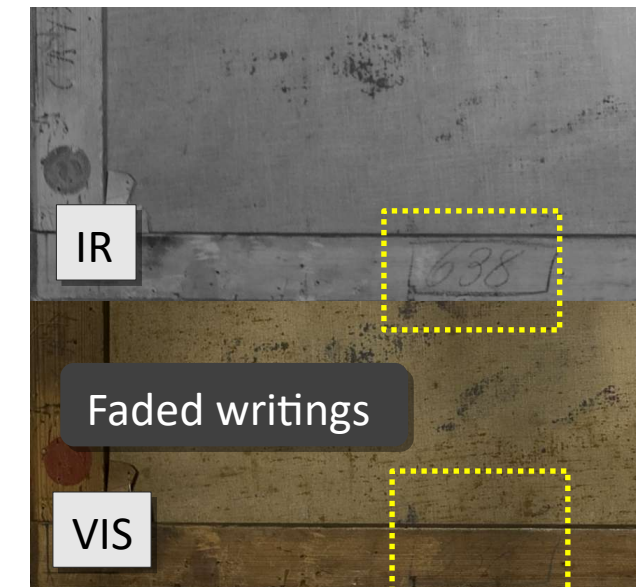
IR: applications



Faded signs



Infrared photography can reveal underdrawing, changes and even faded signs, as in this example. Some pigments become transparent already in the near infrared range that a modified digital camera can detect. The dark pigments in this example disappear in the IR image revealing the white support and the sign which was written with a carbon-containing paint which remains opaque in IR.



IR: applications

In the case of strong iron gall ink corrosion, IR photography helps in reading original writing



IR: cold lamps

Advantages

- manuscripts, parchment



Halogen
- affordable



LEDS 950 nm
- Long exposure



Flashes
- Large surfaces

Pigments Checker v.2.1

Gum Arabic	Chalk 5800	Gypsum 5830			
Lithopone 4610	Titanium white 4620	Zinc white 4630	Lead white 4600		
Lamp black 4725	Bone black 4710	Vine black 4700	Ivory black 1200		
Cobalt violet 4580	Prussian blue 4520	Maya blue 3607	Indigo 3600		
Smalt 1000	Phthalo blue 2305	Ultramarine nat. 10510	Egyptian blue 10060		
Azurite 10200	Cobalt Cerulean b. 45730	Blue bice 10184			
Malachite 10300	Verdigris 44450	Phthalo green 2300	Viridian 44250		
Green earth 11000	Cadmium green 44510	Cobalt titanate g. 44100	Chrome green 44200		
Cadmium yellow 21010	Cobalt yellow 43500	Orpiment 10700	Saffron 36300		
Lead Tin yellow I 10110	Lead Tin yellow II 10120	Naples yellow 37050	Gamboge 37050		
Yellow ochre 40010	Massicot 43010	Y. lake reseda 36262	Realgar 10800		
Vermilion 10610	Carmine lake 42100	Lac dye 36200	Madder lake 372051		
Alizarin 23600	Cadmium red 21120	Red lead 42500	Red ochre 11574		
Raw Sienna 17050	Burnt Sienna 40430	Van Dyke brown 41000	Raw umber 40610		
Burnt umber 40710	<p>This is a collection of 54 swatches of historical pigments applied using gum arabic on a cellulose and cotton watercolor paper, acids and lignin free, Fabriano 270g/m². This paper is not treated with optical brighteners, it's not UV fluorescent, and it reflects IR. Two cross-hair lines, 0.2 mm and 0.4 mm, were printed on each swatch of paper before the application of paint, in order to have a means to evaluate the pigment transparency in the infrared range (IR and IRB imaging).</p>				

Attention
All these 54 pigments are distributed by Kremer Pigments and their relative information (handling, composition, manufacturing process and disposal) can be accessed on Kremer's website (www.kremerpigments.com) searching for the product code listed under each pigment's name. Some of these historical pigments are toxic. Please, do not eat, drink or smoke while using this board and wash up your hands after use.

Dr. A. Cosentino
ITALY
chsopensource.org

Pigments Checker v.2.1

Gum Arabic	Chalk 5800	Gypsum 5830			
Lithopone 4610	Titanium white 4620	Zinc white 4630	Lead white 4600		
Lamp black 4725	Bone black 4710	Vine black 4700	Ivory black 1200		
Cobalt violet 4580	Prussian blue 4520	Maya blue 3607	Indigo 3600		
Smalt 1000	Phthalo blue 2305	Ultramarine nat. 10510	Egyptian blue 10060		
Azurite 10200	Cobalt Cerulean b. 45730	Blue bice 10184			
Malachite 10300	Verdigris 44450	Phthalo green 2300	Viridian 44250		
Green earth 11000	Cadmium green 44510	Cobalt titanate g. 44100	Chrome green 44200		
Cadmium yellow 21010	Cobalt yellow 43500	Orpiment 10700	Saffron 36300		
Lead Tin yellow I 10110	Lead Tin yellow II 10120	Naples yellow 37050	Gamboge 37050		
Yellow ochre 40010	Massicot 43010	Y. lake reseda 36262	Realgar 10800		
Vermilion 10610	Carmine lake 42100	Lac dye 36200	Madder lake 372051		
Alizarin 23600	Cadmium red 21120	Red lead 42500	Red ochre 11574		
Raw Sienna 17050	Burnt Sienna 40430	Van Dyke brown 41000	Raw umber 40610		
Burnt umber 40710	<p>This is a collection of 54 swatches of historical pigments applied using gum arabic on a cellulose and cotton watercolor paper, acids and lignin free, Fabriano 270g/m². This paper is not treated with optical brighteners, it's not UV fluorescent, and it reflects IR. Two cross-hair lines, 0.2 mm and 0.4 mm, were printed on each swatch of paper before the application of paint, in order to have a means to evaluate the pigment transparency in the infrared range (IR and IRB imaging).</p>				

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Pigments Checker v.2.1

Gum Arabic	Chalk 5800	Gypsum 5830			
Lithopone 4610	Titanium white 4620	Zinc white 4630	Lead white 4600		
Lamp black 4725	Bone black 4710	Vine black 4700	Ivory black 1200		
Cobalt violet 4580	Prussian blue 4520	Maya blue 3607	Indigo 3600		
Smalt 1000	Phthalo blue 2305	Ultramarine nat. 10510	Egyptian blue 10060		
Azurite 10200	Cobalt Cerulean b. 45730	Blue bice 10184			
Malachite 10300	Verdigris 44450	Phthalo green 2300	Viridian 44250		
Green earth 11000	Cadmium green 44510	Cobalt titanate g. 44100	Chrome green 44200		
Cadmium yellow 21010	Cobalt yellow 43500	Orpiment 10700	Saffron 36300		
Lead Tin yellow I 10110	Lead Tin yellow II 10120	Naples yellow 37050	Gamboge 37050		
Yellow ochre 40010	Massicot 43010	Y. lake reseda 36262	Realgar 10800		
Vermilion 10610	Carmine lake 42100	Lac dye 36200	Madder lake 372051		
Alizarin 23600	Cadmium red 21120	Red lead 42500	Red ochre 11574		
Raw Sienna 17050	Burnt Sienna 40430	Van Dyke brown 41000	Raw umber 40610		
Burnt umber 40710	<p>This is a collection of 54 swatches of historical pigments applied using gum arabic on a cellulose and cotton watercolor paper, acids and lignin free, Fabriano 270g/m². This paper is not treated with optical brighteners, it's not UV fluorescent, and it reflects IR. Two cross-hair lines, 0.2 mm and 0.4 mm, were printed on each swatch of paper before the application of paint, in order to have a means to evaluate the pigment transparency in the infrared range (IR and IRB imaging).</p>				

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Pigments Checker v.2.1

Gum Arabic	Chalk 5800	Gypsum 5830			
Lithopone 4610	Titanium white 4620	Zinc white 4630	Lead white 4600		
Lamp black 4725	Bone black 4710	Vine black 4700	Ivory black 1200		
Cobalt violet 4580	Prussian blue 4520	Maya blue 3607	Indigo 3600		
Smalt 1000	Phthalo blue 2305	Ultramarine nat. 10510	Egyptian blue 10060		
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Cadmium yellow 21010	Cobalt yellow 43500	Orpiment 10700	Saffron 36300		
Lead Tin yellow I 10110	Lead Tin yellow II 10120	Naples yellow 37050	Gamboge 37050		
Yellow ochre 40010	Massicot 43010	Y. lake reseda 36262	Realgar 10800		
Vermilion 10610	Carmine lake 42100	Lac dye 36200	Madder lake 372051		
Alizarin 23600	Cadmium red 21120	Red lead 42500	Red ochre 11574		
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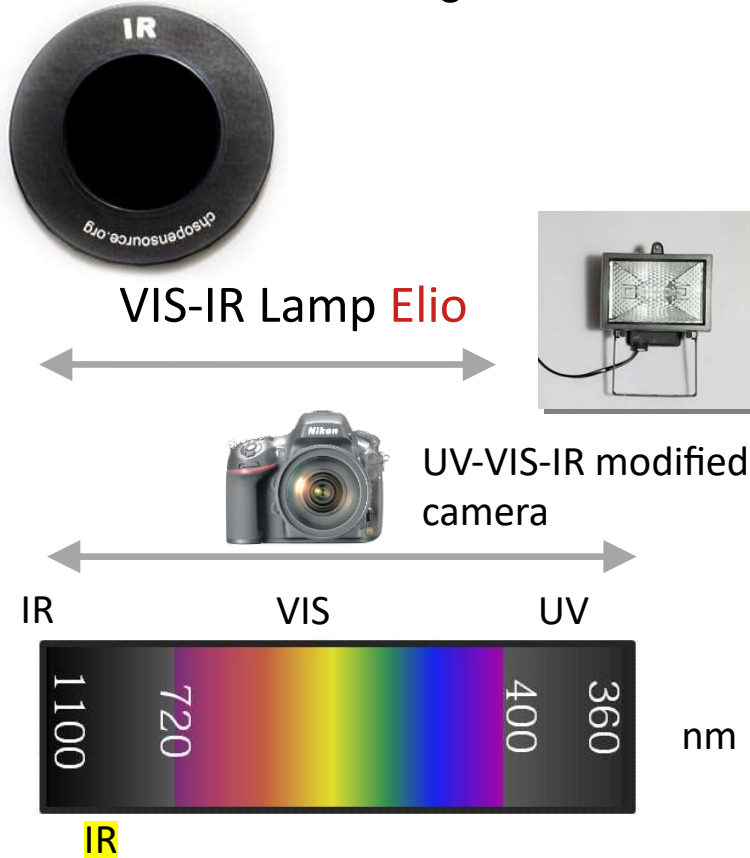
The TP kit comes with 2 Elio lamps. These lamps emit heat and become hot. For documentation of sensitive objects you want to use cold lamps. There are valuable alternatives to the Elio lamps. You can use infrared LEDs (950 nm) or even flashes. In this case, you must first test your flash to check if there is enough infrared. Take an infrared photo of the pigments checker and verify if the pigments become transparent.



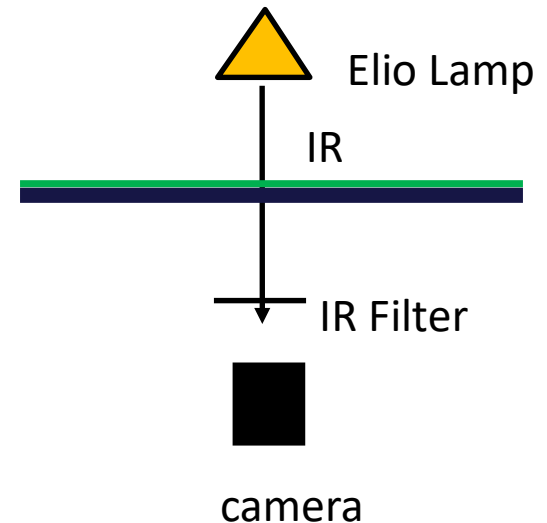
Transmitted Infrared Photography (IRT)

IRT: setup

----- Shooting ----->>>>>----- Raw image editing -----



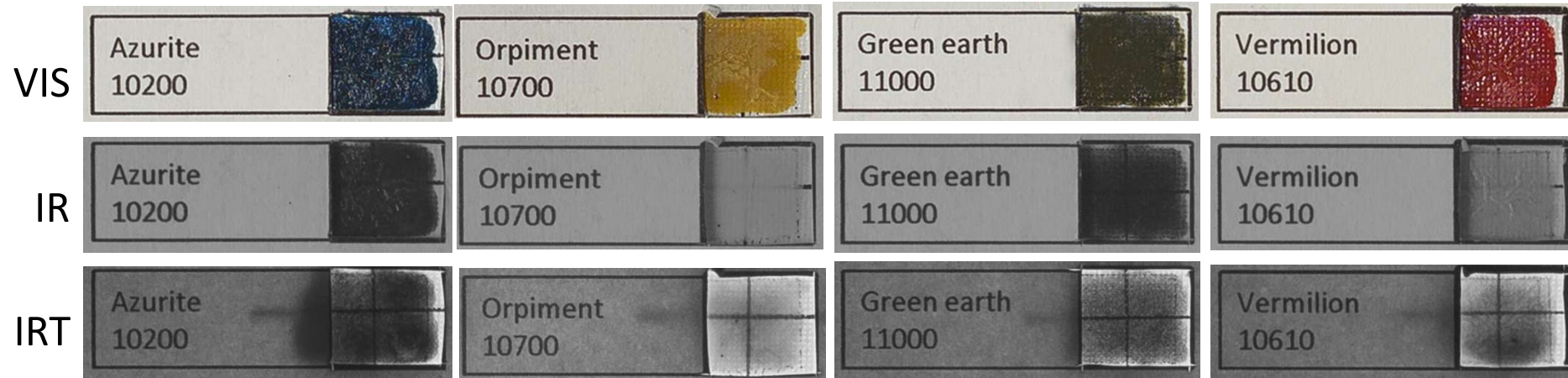
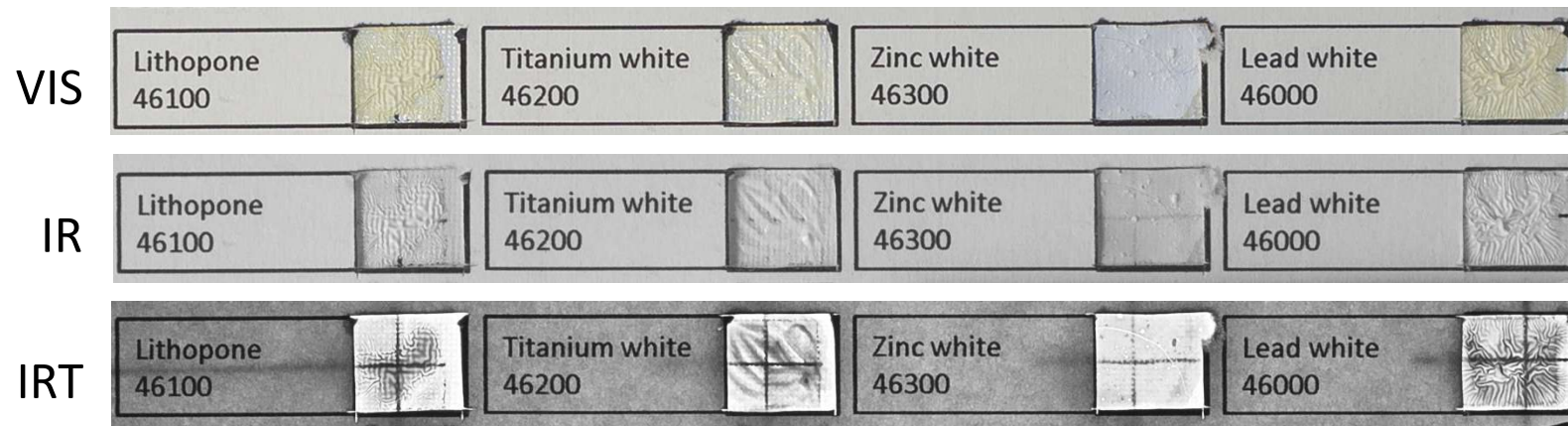
See the Raw Therapie manual.pdf for detailed info on editing the IR RAW images.



IRT setup is the same as for IR with the difference that the painting is between the camera and the lamp. We are interested in documenting the invisible IR radiation that from the lamp passes through the painting and reaches the camera.

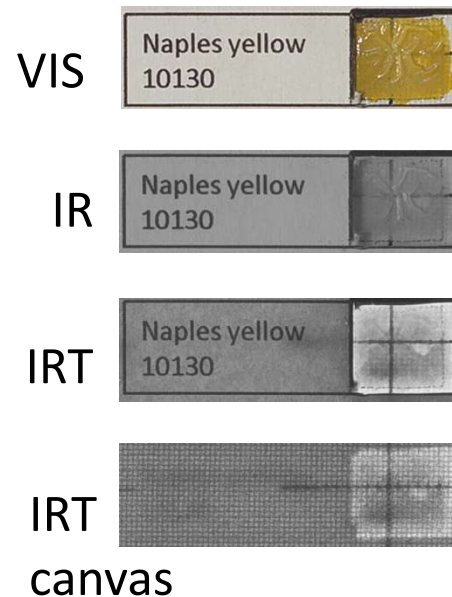
All the other observation regarding IR photo apply also to this method which is just a variation of the first. It's recommended to use cold lamps since they have to be close to the painting.

IRT: applications



The IRT method is very powerful whenever it can be applied. The pigments become much more transparent than in the standard IR method. Let's see the whites. They are very opaque in the IR photo and become transparent in the IRT. Same can be said for the other pigments. Look in particular at azurite. It is totally opaque in IR photo and we need IRR, but if IRT can be applied, azurite becomes transparent.

IRT: applications



IRT can be performed with the camera looking at the painting's front, but also looking at the support, like the canvas. As we can see in this example test, using both the 2 methods could bring further information. The IRT image shows the cross hairs without the "noise" of the canvas. On the other hand, the IRT image show the cross line that goes under the cardboard.

IRT: applications

AZURITE



VIS



IR



IRT

drawing before paint

This test panel has the sky painted with ultramarine on the left and azurite on the right. While ultramarine becomes transparent in the IR photo, azurite is opaque, but is transparent in IRT.

IRT could results even more successful than standard IR photography in revealing the underdrawing and the building up of the figures.

Infrared False Color Photography (IRFC)

IRFC: setup



VIS



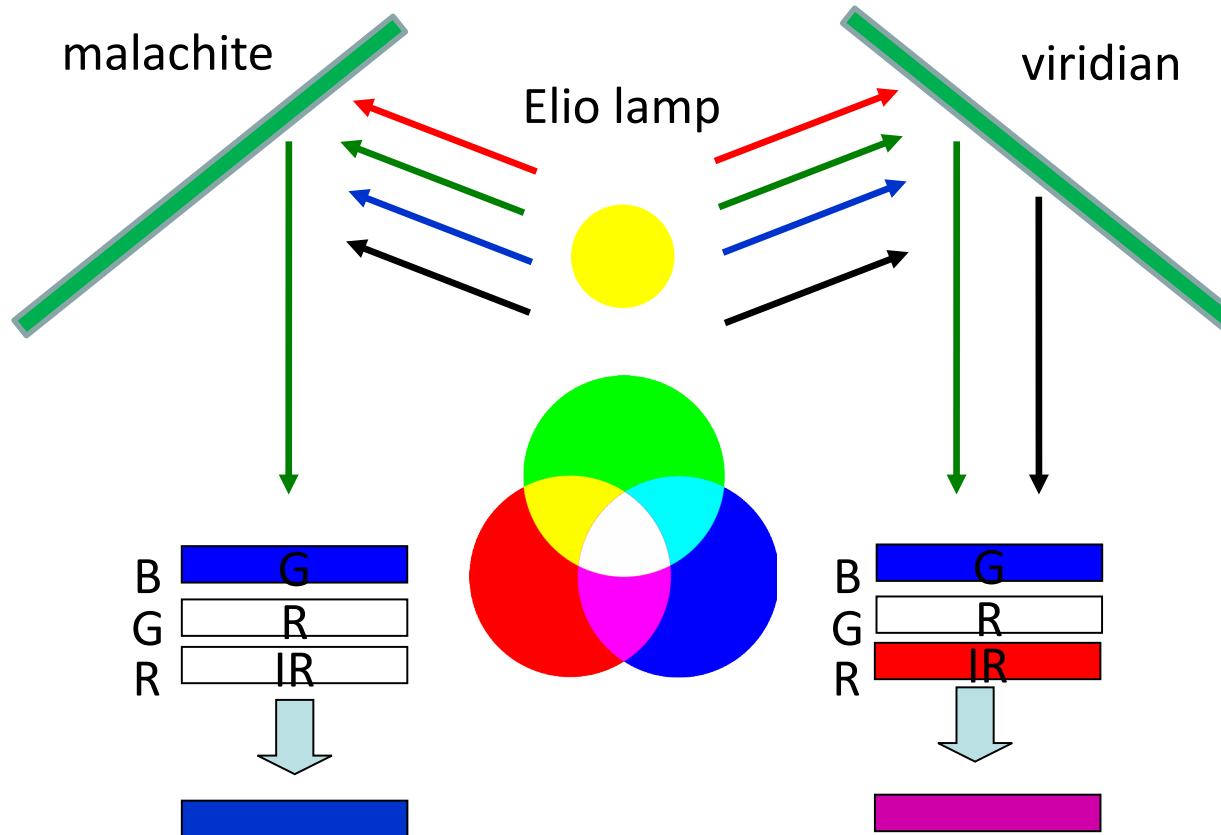
IR



IRFC

Infrared False-Color, IRFC, is done by digitally mixing the VIS and the IR image. So, there is no special setup requirement for this method. Details how to digitally create the IRFC from VIS and IR are explained in the GIMP manual.pdf. The IRFC photo is used to differentiate pigments that have the same colors but have different chemical formula.

IRFC: setup



For example, imagine you have an original paint done with green pigment “malachite” and there is a retouching done with “viridian” a modern pigment. Both the pigments are green so they reflect the green part of the light coming from the Elio lamp and they cannot be distinguished by naked eye.

The IRFC modification is done by making these rendering:

The Green component becomes Blue

The Red component becomes Green

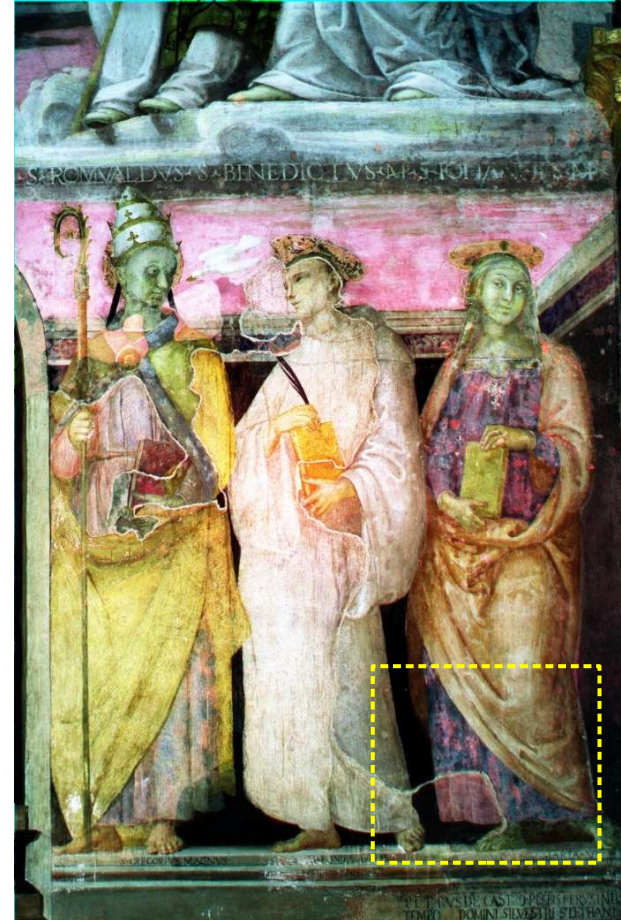
The Infrared component becomes Red

Malachite just reflects green component, so its false color is blue. On the other hand, viridian also reflects the infrared, so its false color is the combination of blue + red = violet.

IRFC: applications



VIS



IRFC

This image is a good example for the case of malachite versus viridian and their respective false colors. The IRFC shows that the green vest of the Saint on the right is retouched. One green pigment has a blue false color while the other used for retouching has a violet false color.

IRFC: applications



Visible (VIS)



Infrared False Color (IRFC)

Infrared False Color photography (IRFC) reveals inpaints making easy to distinguish original paints from later additions. Original pigments and the modern ones used for the retouching have the same color and cannot be distinguished by naked eye.

On the other hand, the original paint and the modern one can absorb and reflect the infrared in different amount and thus they can have different infrared false colors.

IRFC, Infrared False-Color, is created by mixing digitally the VIS and the IR images.

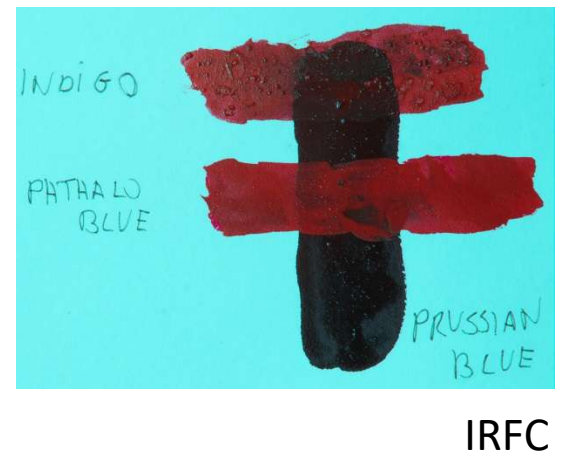
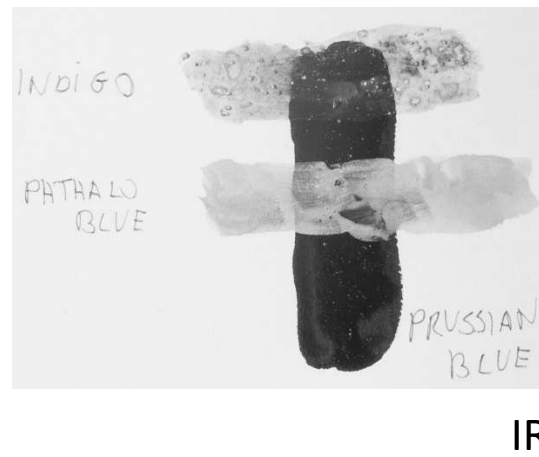
The IRFC photo is used to differentiate pigments that have the same colors but have different chemical formula.

IRFC: applications

Pigments checker			
Lithopone 48300	Titanium white 48200	Zinc white 48300	Lead white 48000
Chalk 58000	Opium 58300	AIC Photo Documentation Target	
Leiny black 42200	Bone black 42100	Vine black 42300	sooty black 22000
Cobalt violet 45800	Prussian blue 45302	Mauve blue 36007	Indigo 36005
Smalt 10000	Phthalo blue 45102	Ultramarine blue 29510	Egyptian blue 30000
Azurite 10200	Cobalt blue 45130	Blue black 45134	
Malachite 10300	Verdigris 44400	Phthalo green 34000	Vindian 44200
Green earth 11000	Cadmium green 44200	Cobalt green 44200	Chrome green 44200
Cadmium yellow 23010	Cobalt yellow 35700	Orpiment 35700	Saffron 35300
Lead Tin yellow I 30100	Lead Tin yellow II 30200	Wasley yellow 32000	Garncrge 31900
Yellow ochre 40000	Marsicc 43000	V. lake rounds 36200	Brnagar 30800
Vermilion 38000	Carmine lake 36000	Lac dye 32000	Madder lake 27000
Alizarin 38000	Cadmium red 31100	Red lead 42500	Red ochre 11574
Rose Sienna 17000	Burnt Sienna 40000	Van Dyke brown 40000	Rose umber 40000
Burnt amber 40000	Attention: All the pigments in this board are distributed by Reston Pigments and their related information, handling, transportation and manufacturing process can be found on the Reston website: http://www.restonpigments.com . Reston Pigments is not responsible for the quality of the pigments used in this board. Reston Pigments is not responsible for the quality of the pigments used in this board. Reston Pigments is not responsible for the quality of the pigments used in this board.		

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IRFC



IRFC could be used for a tentative identification of the pigments, since as we see above in the pigments checker, different pigments have respective false colors. Though, there are conditions in which this correspondence is not immediate for a number of reasons. Above we see the example of Phthalo blue and indigo. The false color of both the pigments is red when they are laid on white cardboard but the false color of indigo becomes dark when it is laid on the prussian blue. This is because indigo is transparent to the infrared while phthalo blue is reflective as a mirror for the infrared.

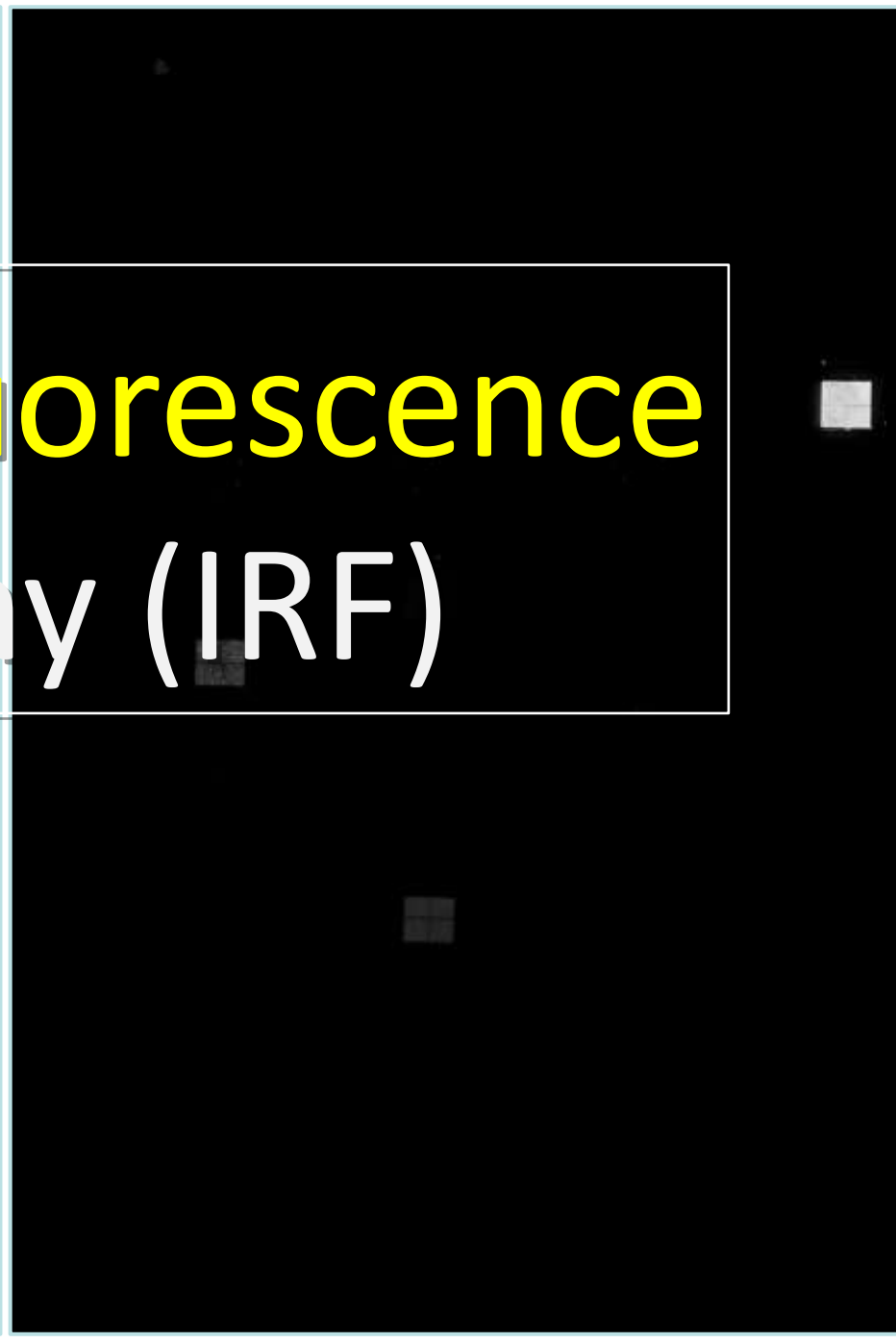
Pigments checker v.1

Lithopone 46100	Titanium white 46200	Zinc white 46300	Lead white 46000
Chalk 58000	Gypsum 58300		
Lamp black 47230	Bone black 47100	Vine black 47000	Ivory black 12000
Cobalt violet 45830	Prussian blue 45700	Maya blue 36007	Indigo 36005
Smalt 10030	Ultramarine 10500	Other ultramarine 10505	Egyptian blue 10060
Azurite 10230	Cobalt blue 45730	Blue black 10184	
Malachite 10330	Verdigris 44450	Phthalo green 23000	Vindian 44250
Green earth 11030	Ultramarine 44100	Phthalo green 44200	Phthalo green 44200
Cadmium yellow 21030	Cadmium yellow 43500	Yellow ochre 10700	Yellow ochre 36300
Lead-tin yellow I 10100	Lead-tin yellow II 10120	Naples yellow 10130	Gamboge 37050
Yellow ochre 40010	Massicot 43010	Y. lake reseda 36262	Realgar 10800
Vermilion 10610	Carmine lake 42100	Lac dye 36020	Madder lake 372051
Alizarin 23600	Cadmium red 21120	Red lead 42500	Red ochre 11574
Raw Sienna 17050	Burnt Sienna 40430	Van Dyke brown 43000	Raw umber 40610
Burnt umber 40710	<p>A collection of swatches of 56 historical pigments have been applied using gum Arabic as a binder on a cellulose and cotton watercolor paper, acids and lignin free, commercialized by "Fabriano", 270gr/m². This paper is not treated with optical brighteners, it's not UV fluorescent, and it reflects IR. Two cross hair lines, 0.2 mm and 0.4 mm, were printed on each swatch of paper before the application of paint, in order to have a means to evaluate the pigment transparency in the IR and IRF imaging modes.</p>		

Attention
All the pigments in this board are distributed by Kremer Pigments and their relative information – including composition and manufacturing process – can be found on the Kremer's website (www.kremerpigments.com) searching for the specific product code under the pigment's name. Some of these historical pigments are toxic. Please, do not eat, drink or smoke while using this board and wash up your hands after use.

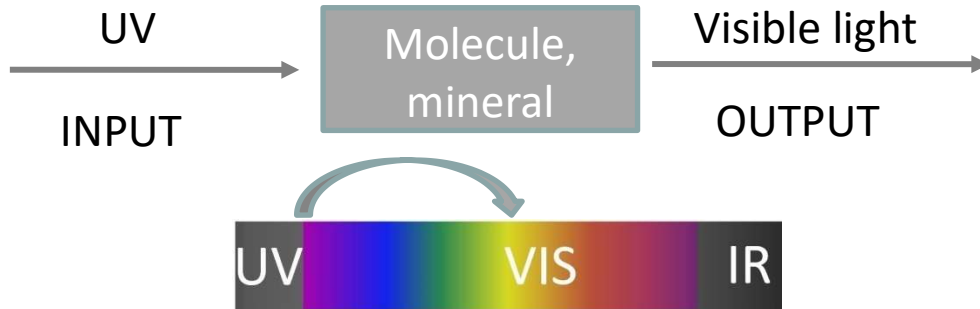
Cultural Heritage Science Open Source
Share and learn about Scientific and Technical Examination of Art
chsoopensource.org

Infrared Fluorescence Photography (IRF)

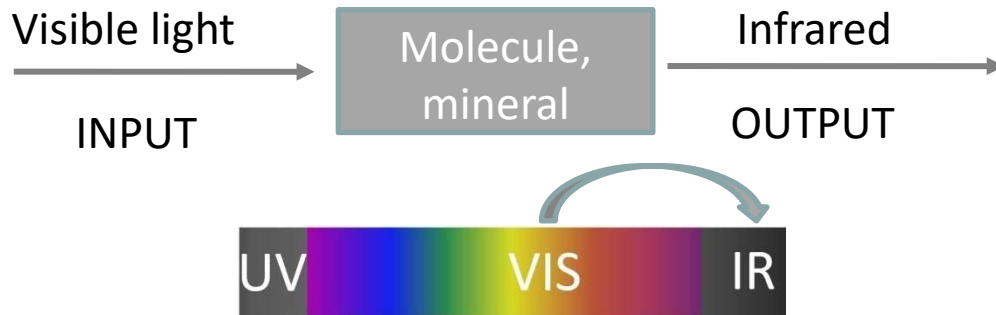


IRF: setup

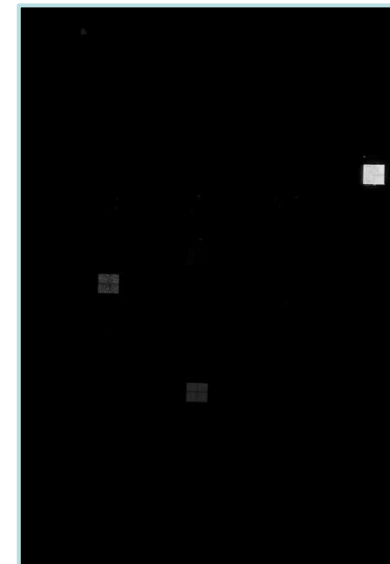
Ultraviolet Fluorescence



Infrared Fluorescence



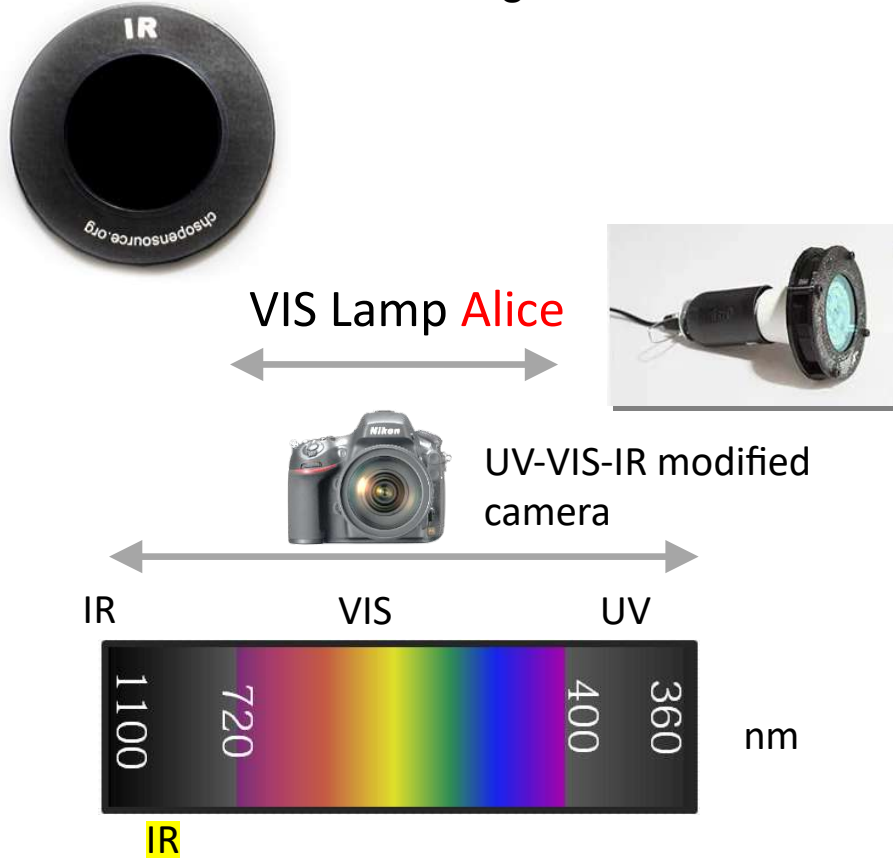
Cadmium pigments, Egyptian blue, Hun blue



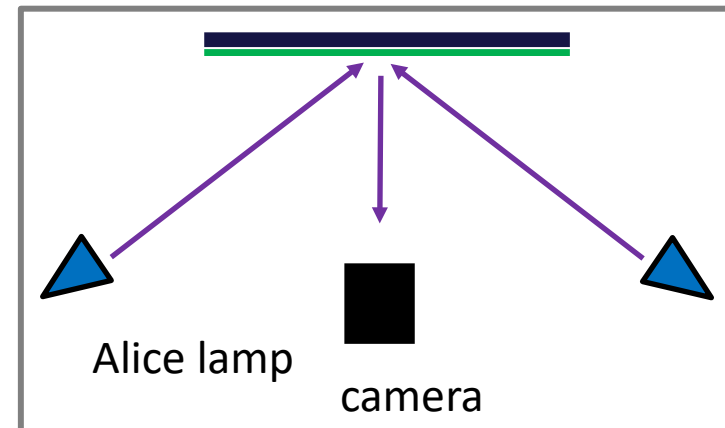
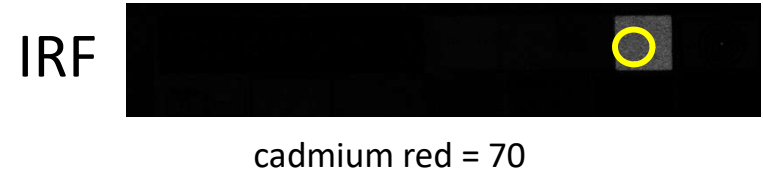
The IRF phenomenon interests, few pigments, the cadmium based pigments (cadmium red, cadmium yellow, cadmium orange, cadmium green), Egyptian blue and Hun blue. The IRF is similar to the UVF, there is just shift in the input and output. While for UVF we use the UV lamp Fabrizio, for the IRF we use the VIS lamp Alice.

IRF: setup

----- Shooting ----->>>>>----- Raw image editing -----



See the Raw Therapie manual.pdf for detailed info on editing the IR RAW images.



IRF setup uses the IR filter and the **Alice** lamp. We are interested in documenting the invisible IR radiation that fluoresces from some pigments when they receive VIS light from Alice lamp. Exposure is longer than for the other methods since we are documenting the dim IRF emission. As a reference, you want to adjust your exposure, so that the cadmium red swatch in the TP-MSI calibration card has a grey value about 70.

IRF: setup



VIS

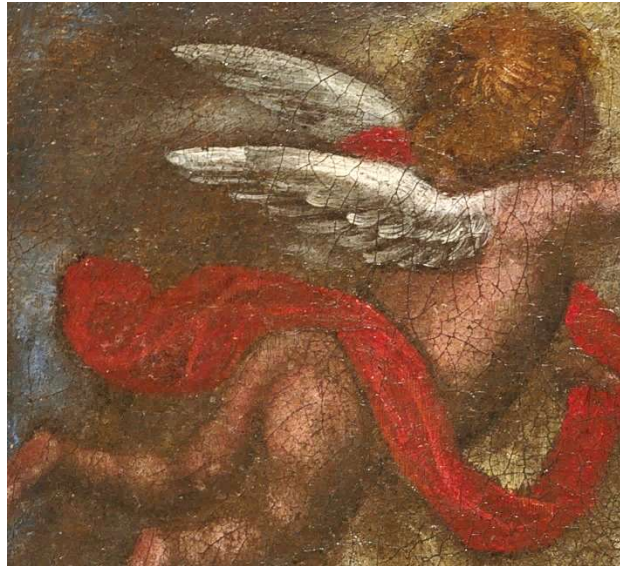


IRF

The IRF photo must be performed in a totally dark environment. The example above shows a IRF photo taken in a studio with IR “noise” All the image is bright and this suggests that what we see it is not just IRF but also IR reflected from the painting.

Check for sources of IR: i.e. security cams, switches, ...
Be sure to properly cover these sources. Many materials are transparent to IR. The best practice is to first take a IRF photo of your painting without the Alice lamp. If the image is totally dark, it means there is no infrared “noise” and the IRF photo can be taken using the Alice lamp.

IRF: applications



Visible (VIS)



Infrared Fluorescence (IRF)

IRF makes retouches with cadmium-based pigments to stand out as bright spots. In this example, the vermilion used for the red drapery of this oil painting was retouched with modern cadmium red which appears bright in the IRF image.