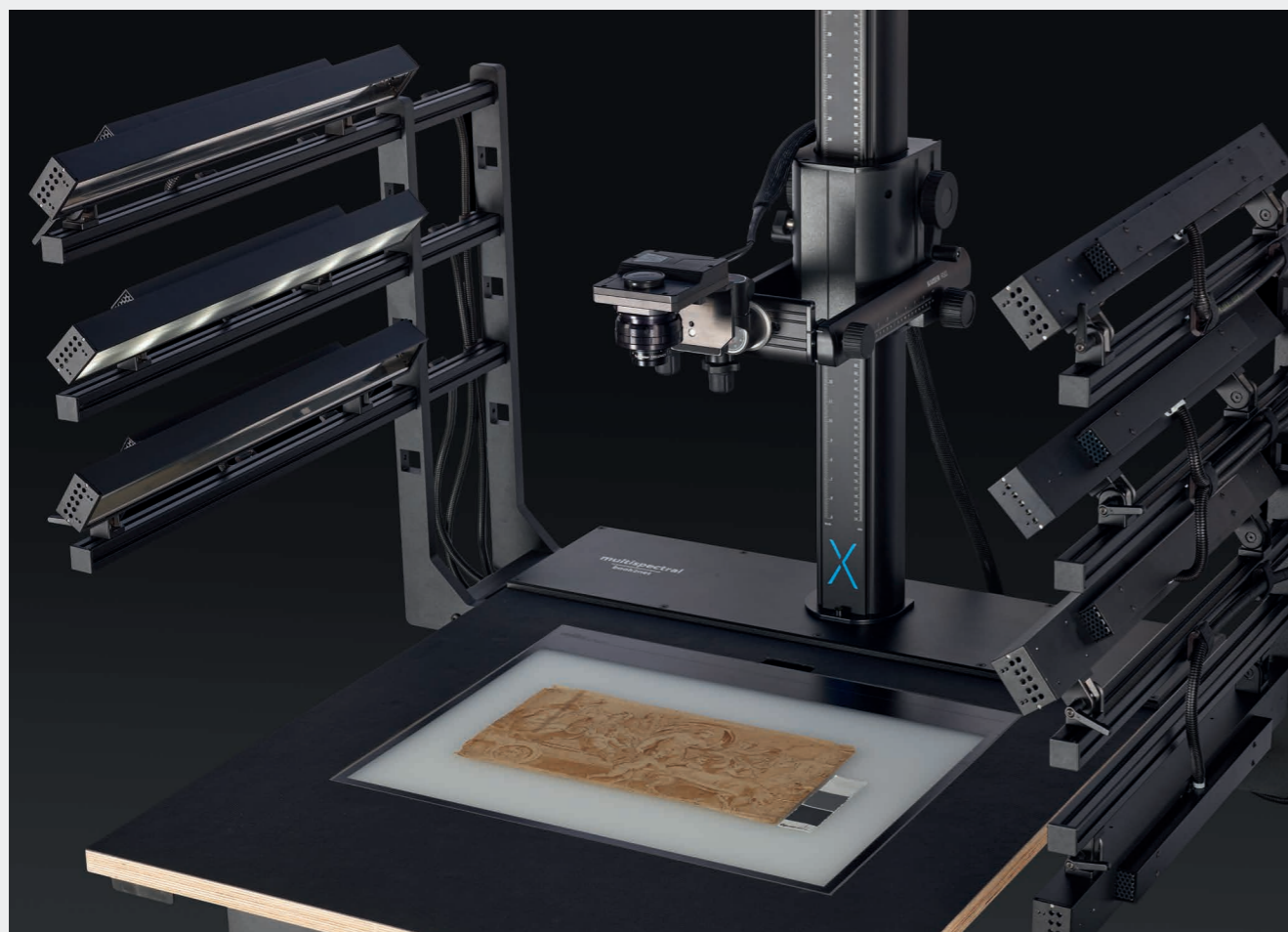


# Multispectral Imaging





## The X71 Multispectral

The X71 Multispectral is a unique multispectral camera for the analysis of documents, artworks and archival materials. As a system, the book2net multispectral system bridges the gap between pure UV photography and infrared photography beyond 1000 nm. In this range, the camera works constantly with a resolution of 71 MP through high-resolution CMOS sensor technology.

The X71 Multispectral is the world's first filterless multispectral camera that enables pixel-precise imaging between 365 and 1,100 nm without refocusing and fixed aperture. This makes it a new and innovative tool for scientific and material technology analyses, as well as for forensics and for the comprehensive documentation of works of art. Work genesis, authenticity or condition – with the aid of the X71 Multispectral, numerous exposure sets in a wide variety of wavelength ranges can be generated and combined within a few seconds in fully automated processes:

- UVL Ultraviolet luminescence
- UVR Ultraviolet reflectography
- VIS image in repro quality
- NIR Infrared photography (940 nm)
- Transmitted lighting
- Material or paper structure with watermark recognition
- UV false color image
- IR false color image
- Sided lighting

## Multispectral analysis

### Non-contact analysis of drawings, documents and archival materials

The system allows the visualization of faded inks, underdrawings, combinations of materials used in writing, drawings or paintings, as well as the detection of traces of organic aging processes. This enables the verification of originals for their material completeness as well as detailed authenticity analyses.

#### ■ Standardized processes and profile management at one click

The intuitive software user interface is designed for the easiest handling. Preset standards and profiles can be freely modified or reconfigured in expert mode and linked as automated scan, light and analysis processes to form scan series.

Thanks to our one-button strategy, users can trigger the most complex processes reliably and reproducibly at the touch of a button, allowing them to concentrate on the essentials.

#### ■ Calibration and new quality standard

The reproducibility of scan results and their comparability between all devices of the book2net multispectral series worldwide is the objective of the new calibration procedure, compliant with quality standards such as ISO 19264, METAMORFOZE and FADGI. An automatic illumination correction for optimal brightness distribution guarantees the high capturing quality of the X71 Multispectral even with large originals up to – depending on the model – DIN A1 format.

#### ■ Conservation standard

The book2net multispectral system has been developed by engineers and conservators and consistently takes into account the special sensitivity of colorants and works of art. Thus, the camera itself controls all light sources directly and exclusively for the respective images. Since no filters are used, the light yield is optimal, which is a unique selling point, especially compared to filter-based systems. Specially selected quality LED light sources in combination with the shortest possible illumination times ensure a particularly gentle exposure process. The intelligent profile and analysis management reduces scanning processes to a minimum.

# Device control and information processing

## ■ Software Profiscan MSP

**Basis functions:** intuitive menu navigation for professional requirements, thumbnail display (insert, delete, display), color selection (color, gray scale, black and white), format selection (TIFF, PDF, JPEG), contrast control, zoom function, print section, multipage.

Frame setting, multiple job functions (save job, load job, edit job, thumbnail directory/archive, edit archived jobs). The software is Windows 10/11 optimized and updateable.

**Multispectral functions for professional requirements:** freely definable buttons for selecting spectral ranges, predefined selection fields with incident light or with incident light plus transmitted light as well as profile settings for different types of originals. Automated scan processes are freely programmable and can be easily triggered with the process button for starting scan sequences.

Thus, the system needs only approx. 24 seconds for 6 scans in 6 spectral ranges. Automatic saving, standardized generation of file names by default and automatic generation of metadata allow efficient management of all files.

## ■ Software ImageProcess MSP

ImageProcess MSP realizes the control of the camera, the camera carrier and column, the LED illumination units and the synchronization of the camera sequences. Timing and functions are permanently monitored by the process control. The software is Windows 10/11 optimized and updateable.

ImageProcess synchronizes the light control incl. regulation of the UV, IR, VIS LED light line and the triggering of the individual scans. The storage and structuring of the scan files is automated. Interval widths, the number of scans and the corresponding spectral range are defined by the operator himself according to the specific requirements of the object.

Process sequences are programmable and can be stored as standards. This means that even trained employees can take over the task of multispectral scanning.



## ■ MSP Filter Imager

The MSP filter imager is a core development of our multispectral analysis. As intelligent software filter, it replaces mechanical lens filters and narrowband LED series (UV/ IR) for narrowing down spectral ranges; it is Windows 10/11 optimized and updateable.

The pixel values of the matrix sensor used are evaluated on an analog basis as pure native voltage values. Via our software filter, only the respective values of the desired spectral range are analyzed and merged into one image. Optionally, a color image, a grayscale image, individual gray images of the color image channels or gray image channels as well as a false color image UV, VIS, IR can be generated. The selection is made via the menu control.

For each spectral range specific parameters such as optimal exposure time and optimal channel gains of the color or grayscale channels in relation to each other are determined. This is done depending on the type of original and allows the creation of different profiles. Simulations support individual examinations of each individual original in the respective spectral range.

## ■ MSP Image Analyser

Intelligent software for analyzing image content. Windows 10/11 optimized and updateable.

## ■ Pixel-perfect overlay technology

Vibration-free scans (no filter change) and pixel-precise resolution (no focus change) deliver images with the highest resolution, sharpness and detail and are the prerequisite for pixel-precise overlay technology.

## ■ Detail analysis

The high resolution of the scans opens up the possibility of analyzing defined image areas across the individual spectral planes. For example, positional changes in the image formation and differences in content can be detected at the pixel level. For each spectral range, the color, gray, false color images and the corresponding color or gray scale images can be accessed.

Mathematical algorithms are used to add, subtract or divide the image content of selected scans. Intelligent analysis processes automatically generate standardized cleaned images, e.g. for displaying material structure and watermarks.

# Infrared and ultraviolet photography

Underdrawings such as preliminary drawings can be made visible if the layers of ink covering them are masked out by suitable methods. Faded or erased inks can be made visible by selective excitation with light of specific wavelengths.

## ■ Visualization of underdrawings

Infrared reflectography is based on the characteristic interaction between infrared light and the materials under investigation. Depending on their composition, the substances absorb the IR light in a characteristic way.

Substances that contain elemental carbon, such as soot or stone chalk, absorb IR light strongly in a certain wavelength range and appear black in the IR image, while other drawing materials become transparent in the same wavelength range. Preliminary drawings made with metallic or lead pencils can also be made visible using this method.

Digital image processing methods such as image subtraction or channel shifts often play an important role in post-processing. This requires correspondingly optimal and pixel-accurate results from the preceding capturing processes.

## ■ Visualization of faded or erased inks

Faded or erased inks can be made visible by selective excitation with light of specific wavelengths. If the object is irradiated with UV light, binders and colorants that may exhibit fluorescence in the visible range can be detected.

The fluorescence properties of the binders vary; shellac, for example, shows an orangeyellow fluorescence, while gum arabic does not fluoresce at all in the visible range. The method thus offers the possibility of identifying fluorescent substances. In addition, irradiation with UV light allows the visualization of faded or washed-out inks.

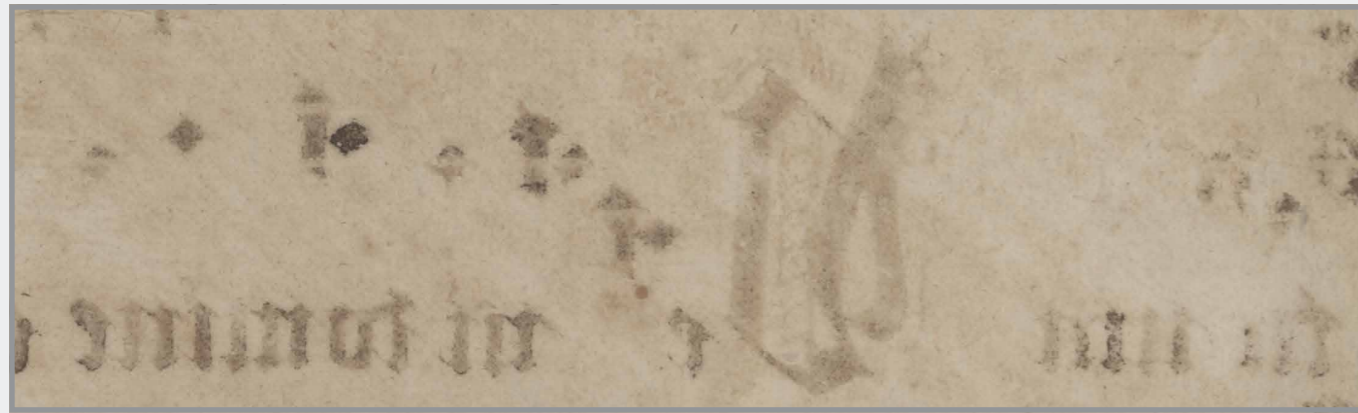


VIS image (top) and NIR image (bottom)

The ink pattern and almost all washings are no longer visible. Thus, the evaluation of the preliminary drawing is possible without any problems.



# Visualization of watermarks



VIS image and UV 365nm image  
The note lines and a sketch around the majuscule are clearly visible.



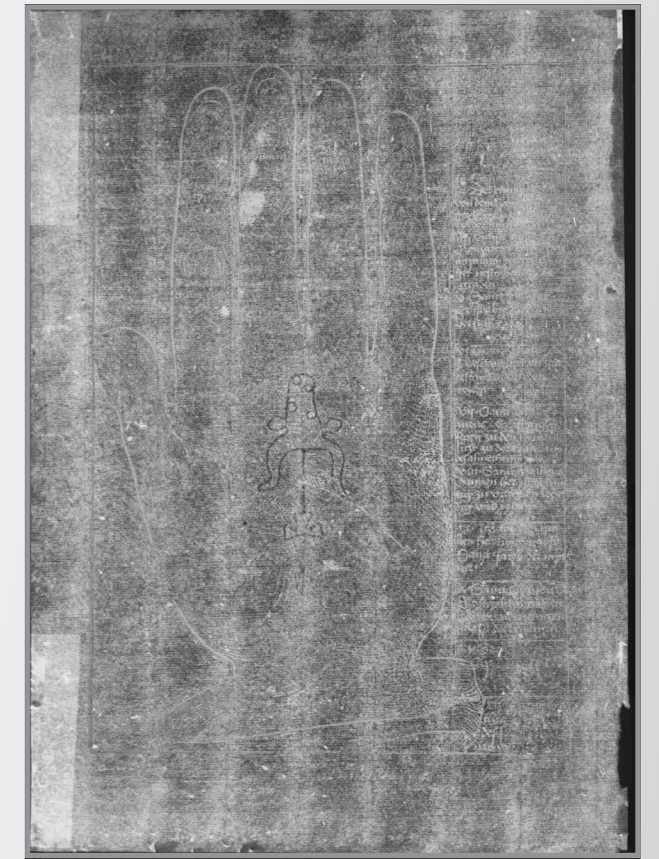
## ■ Non-destructive analysis of pigments

The X71 Multispectral is an indispensable tool for the non-destructive analysis of pigments in connection with multispectral photography.

The characteristic of pigments to reflect light of diverse wavelengths differently allows a quick specification of pigments used in artworks by direct comparison with a ColorGuide.



VIS Image



Paper structure with watermark

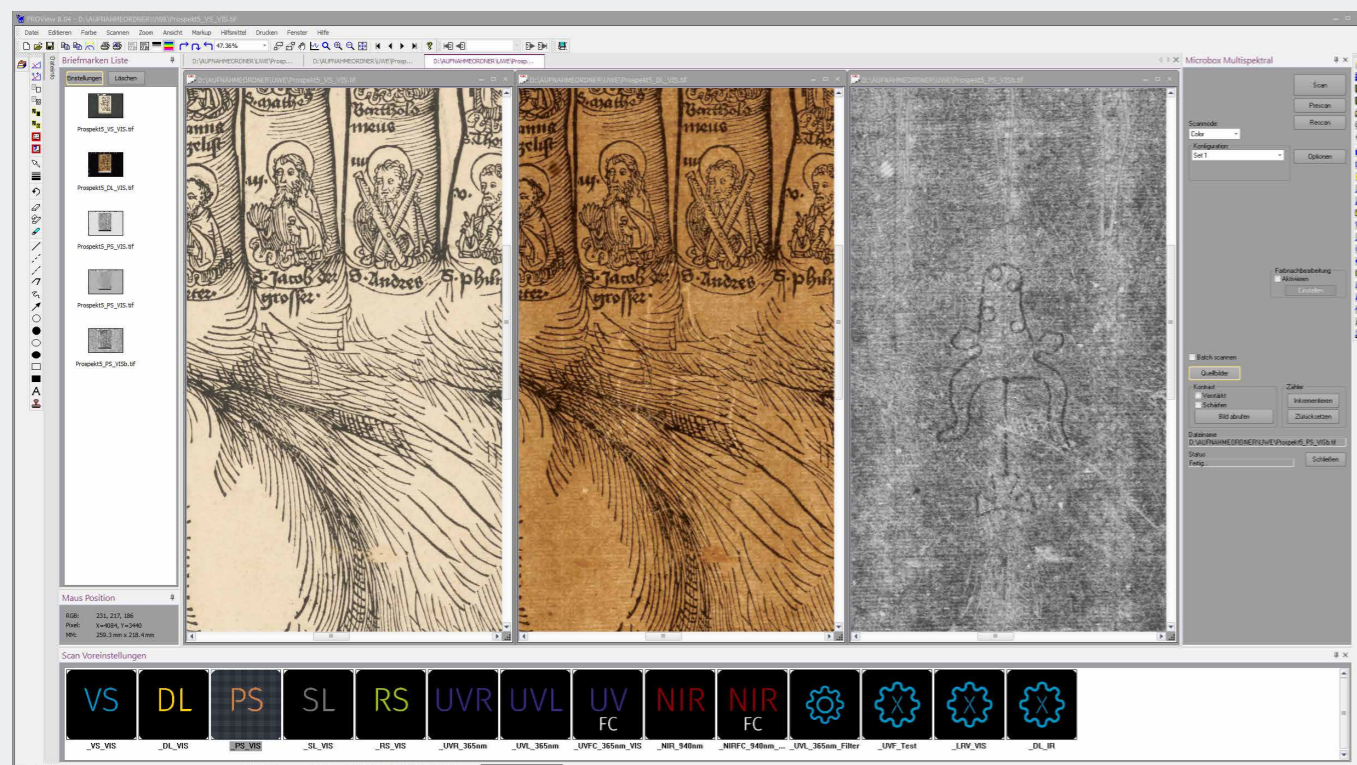
The identification of substrates, writing and drawing materials is just as much a part of everyday conservation, restoration, or valuation issues as the visualization of paper structures, watermarks, surface features, or the reverse of glued or full-surface mounted originals on cardboard.

For this purpose, we have developed this unique camera system to be able to collect and read out such information. Not only the actual series of images, but also the fully automatic calculation of paper structure and watermarks are performed in just a few seconds.

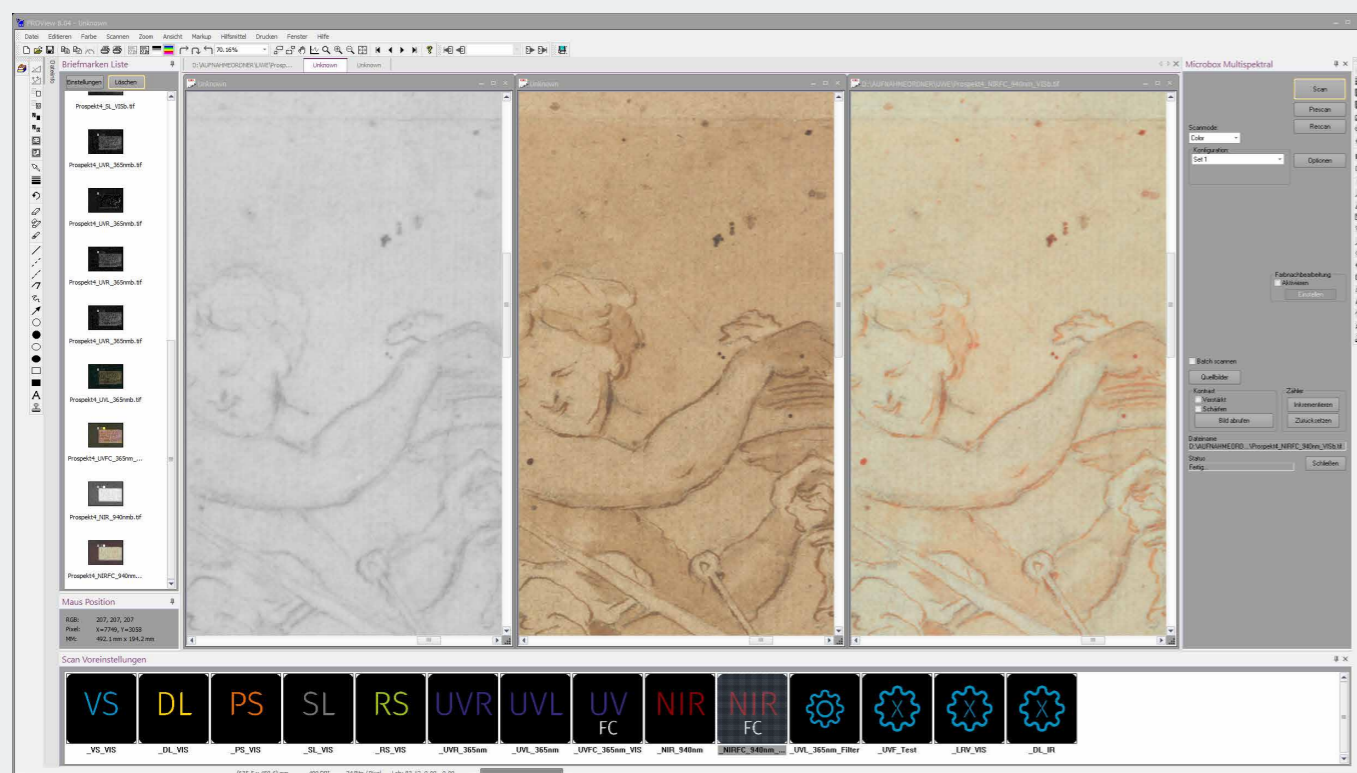
Apart from the system's wide range of capabilities using the expert mode, the X71 Multispectral congenially supports daily work in the field of conservation, restoration and research, especially in the graphic arts and the library or archive sectors.

The fully automated scanning processes are ideal for uncomplicated yet comprehensive documentation with maximum added value for material technology issues, for research and for all considerations regarding the authenticity of objects, especially those made of and on paper.

# User interface and evaluation

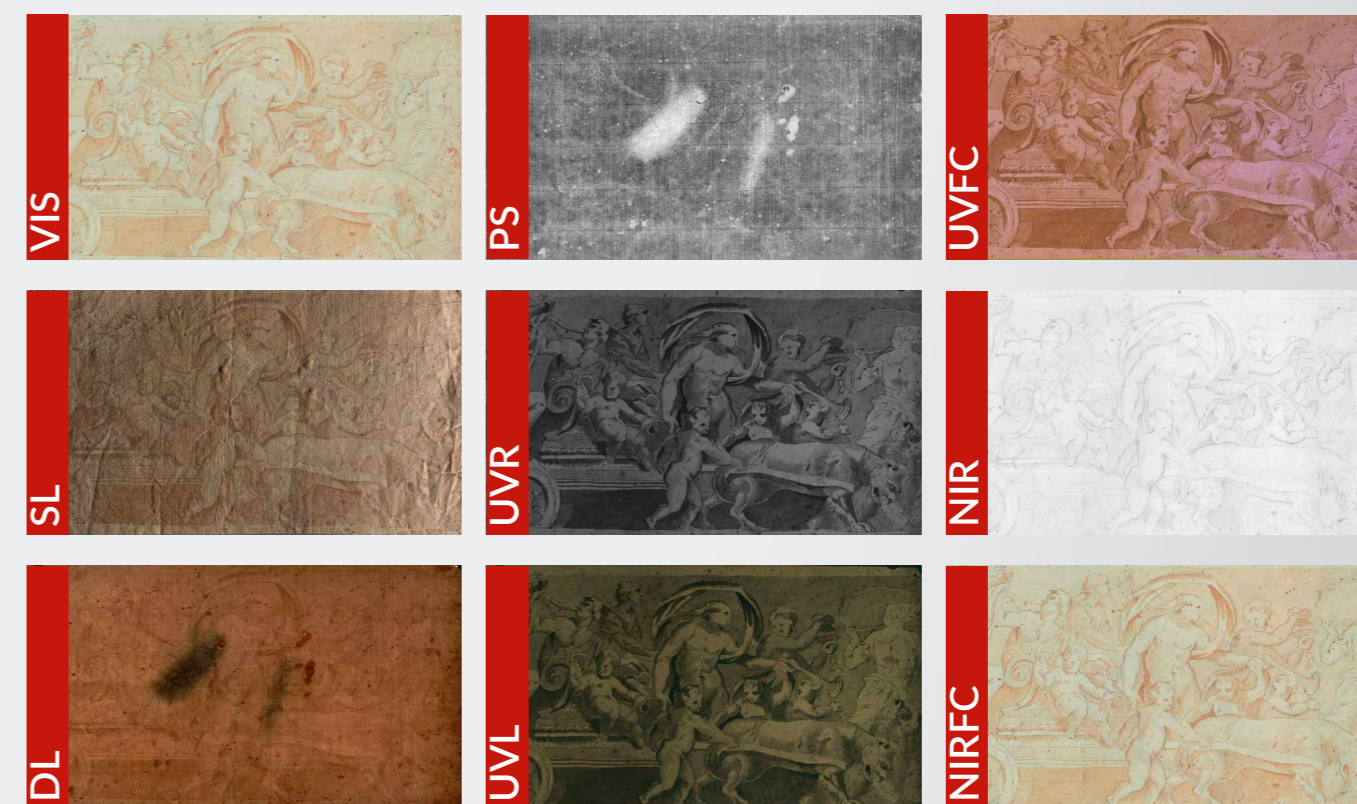


Screenshot from the user interface: paper structure and watermarks are automatically generated from the VIS and transmitted light image without any further disturbing additions. If required, these can be displayed directly



In the synchronous display, findings can be obtained directly from the respective images and analyzed further. In the display, NIR, VIS and NIRFC are compared with each other.

In the example, the false-color image immediately shows the two colorants. The preliminary drawing in black chalk remains black, while the ink drawing, which fades almost completely in the NIR, is shown in red. This makes it possible to differentiate between different colorants at a glance.



Shown above is an example set of images taken fully automatically in a single sequence with the X71. After the VIS images of the recto side (recto, sided and transmitted light), the paper structure is detected and displayed by image subtraction. This is possible with contrast enhancement if required.

Subsequently, the UVR, the UVL and, in combination with a VIS image, the UV false-color image were generated in order to make organic substances used in the material and the drawing instruments more visible. Finally, a NIR image and the corresponding NIR false color image were generated. For objects signed or marked on the reverse, the complete process can be repeated in just over a minute for this side.

It is also possible to recreate individual exposures as needed. In this case, they are correctly named and automatically replaced without manual intervention in the file structure.

# System specifications

## Technical data

Multispectral range	365 - 1.100 nm
Sensor	<ul style="list-style-type: none"><li>• 71 MP – high resolution CMOS COLOR technology</li><li>• Matrix sensor, special development, extreme dynamic range</li><li>• Analog, native signal evaluation</li></ul>
Resolution	Up to 8200 ppi
Image transfer rate	Up to 350 MByte Preview of results Focus and sharpness adjustment via digital display
Impressive depth of field	up to 8 cm
Scanning time	0.3 sec.
Adjustable exposure time	0.0001 - 2.0 sec.
Optics	<ul style="list-style-type: none"><li>• Schneider book2net 71spectral - 45 mm UV-IR-VIS multispectral lens</li><li>• Schneider book2net 71spectral - 40 mm UV-IR-VIS multispectral lens (optional)</li></ul>
PC interface	USB 3.0 interface
Support surface	depending on model, A1 maximum (stiching is not recommended)
Illumination	<ul style="list-style-type: none"><li>• Transmitted light unit with special LED and dot matrix light guide technology from 63 x 51 cm to 91 x 67 cm (optional)</li><li>• MagicBacklight X system with special LED and dot matrix light guide technology from 30 x 30 cm to 90 x 60 cm for mounted originals (optional)</li><li>• VIS LED light units approx. 450-750 nm</li><li>• Multispectral LED light units 365nm</li><li>• Multispectral LED light units 380nm (optional)</li><li>• IR light unit 940nm</li><li>• VIS LED sidelight unit approx. 450-750 nm (high-power LED of the respective wavelengths, service life approx. 60.000 h, permanently installed)</li></ul>
Color depth	48 bit color, 16 bit gray (output customizable)
Output color space	sRGB, Adobe 1998 RGB, eciRGB V1/V2, ProPhoto and according to ICC Standard
File formats	TIFF, JPEG, JPEG 2000, PNG, PDF, PDF-A, Multipage PDF and Multipage TIFF, RAW
Digitization standards	METAMORFOZE, FADGI- 4Star, ISO/TS 19264-1:2017 compliant

Maintenance possible via remote service.  
Subject to technical modifications.



### Multispectral Imaging in use

- The National Archives
- The Klassik Stiftung Weimar

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