

A photograph of photography equipment for art and archaeology. In the top left, a Nikon camera is mounted on a tripod. To its right is a color calibration chart with various color patches and the text 'CHSOPENSOURCE.ORG'. In the center, a magnifying glass with the number '405' on its handle is placed over an open black box. The box has a white label that reads 'Antonello 52'. In the bottom left, a lens cap is visible with the text 'LENS 52mm' and 'chsopensource.org'. A yellow ruler is partially visible at the bottom.

Antonello - MSI System for Art and Archaeology

Antonello 52

LENS 52mm

chsopensource.org

CHSOPENSOURCE.ORG

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In Brief

Conservators and art historians need non-invasive methodologies to identify and map pigments on works of art and archaeology. These tools allow them to select appropriate conservation procedures, acquire information on the workshop practices, distinguish original sections from inpaints, and to enhance visualization of faded pigments and inks.



Antonello v.2. The set of 18 spectral filters, 52 mm.

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Antonello is our simple [MSI](#) system composed of 18 bandpass filters and a digital camera, covering the 400-925 nm spectral range. Using a digital camera rather than a monochromatic scientific dedicated camera has the advantage that the same camera can be used for other technical photographic methods, making the overall imaging equipment lighter, compact and affordable.



[Antonello](#) V.2. All you need is in this box! 18 spectral filters, calibration card, and filter adapter.

We developed [Antonello](#) to spread the use of this methodology across Art Conservation professionals and institutions. [Antonello](#), our low-cost [MSI](#) system for Art and Archaeology uses specifically designed in-scene gray reference targets and it is versatile and adaptable to the specific needs of different art or archaeology examination projects, such as manuscripts, wall paintings, and easel paintings.

We developed [Antonello](#) to be: user-friendly, compact and lightweight, easy to understand, tune-up and upgrade.

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Download "MSI pigments checker GIF - Full Resolution" msi.gif – Downloaded 9 times – 23 MB

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How MSI works?

Images of an object in a series of spectral bands are acquired, and once the images are registered and calibrated, they are uploaded into the reflectance image cube. This represents the pixels of each image in the X and Y axes, while the Z dimension denotes the wavelength of each spectral image. From the cube, it is then possible to reconstruct the reflectance spectrum for each pixel of the image. [MSI](#) analysis is based on the same concepts of Reflectance Spectroscopy but [MSI](#) has the added advantage that the pigments can be identified and mapped remotely on large areas rather than just a spot.

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Applications in Art and Archaeology

Multispectral Imaging ([MSI](#)) is used to map and tentatively identify pigments and retouchings on works of art. It is also used to visually enhance old and faded documents. Conservators can use this technique to distinguish original sections from inpaints and to select the proper conservation procedures.

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Publications on Multispectral Imaging

A. Cosentino [“Imaging Multispettrale low-cost con filtri interferenziali”](#) Archeomatica, 2, 12-17, 2015..

A. Cosentino [“Multispectral imaging and the art expert”](#) Spectroscopy Europe, 27 (2) 6-9, 2015.

A. Cosentino [“Multispectral Imaging of Pigments with a digital camera and 12 interferential filters”](#) e-Preservation Science, 12, 1-7, 2015..

A. Cosentino [“Panoramic, Macro and Micro Multispectral Imaging: An Affordable System for Mapping Pigments on Artworks”](#) Journal of Conservation and Museum Studies, 13(1): 6, 1–17, 2015

A. Cosentino [“Multispectral imaging system using 12 interference filters for mapping pigments”](#) Conservar Património 21, 25-38, 2015.

A. Cosentino [“Crowd funded research: low-cost multispectral imaging”](#) RECH3, International meeting on Retouching of cultural heritage. 2015.

A. Cosentino [“Transmittance spectroscopy and transmitted multispectral imaging to map covered paints”](#) Conservar Património 24, 37-45, 2016.

[Download “Our Catalog and Prices - PDF”](#) Catalog-2020.pdf – Downloaded 3264 times – 83 KB

Software is simple and just need to follow step-by-step instructions.

The filters set

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The system is composed of **18 bandpass filters** whose labels clearly indicate their center wavelengths and their order number. This is the list of filters (center wavelength (nm)): 405, 430, 450, 467, 480, 500, 532, 560, 580, 610, 640, 671, 700, 730, 760, 840, 860, 920. The 18 filters are not equally spaced but have the same bandwidth (10 nm). The center wavelengths of these filters have been chosen in order to better represent the spectral features of historical pigments and they correspond to specific absorption or inflection points.

Whites. **Titanium white** has a strong UV absorption band (filter at 405 nm) that goes until the violet region and distinguishes it from the other white pigments. **Lithopone** features the absorption bands (filters at 670 nm and 725 nm) in the red- infrared region due to its zinc sulfide component [22].

Blues. **Prussian blue** and **cobalt violet** have maxima in the blue region (respectively, filters at 450 nm and 700 nm). **Maya blue** and **indigo** have inflection points in the infrared (respectively, filters at 760 nm and 840 nm).

Smalt features a maximum in the blue region (filter at 430 nm) and a large absorption band in the yellow region (filter at 580 nm). **Phthalo blue** has a maximum in the blue region (filter at 465 nm) and an absorption band in the infrared (filter at 920 nm). **Cobalt blue** features an inflection point in the green region (filter at 525 nm). **Azurite** and **ultramarine** large maxima in the blue region are covered by all the 5 filters already mentioned from 405 nm to 480 nm.

Greens. **Malachite**, **verdigris** and **phthalo green** have their maxima in the green region (respectively filters at 525 nm and 500 nm). **Viridian** has its inflection point in the infrared (filter at 760 nm). **Green earth** has weak absorption bands which cannot be resolved with this system and consequently it will produce a flat spectrum. **Cadmium green** is identified by its infrared fluorescence and no filter was selected for its spectral features. **Cobalt green** maximum is represented by the filter at 532 nm. The filter at 405 nm outlines the **chrome green** maximum in the violet region.

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Yellows. **Cadmium yellow** has its sharp inflection point in the blue-green region (filter at 480 nm) while **cobalt yellow** has a weak absorption band in the red region (filter at 610 nm). **Orpiment** and **saffron** have their inflection point outlined by the filter at 532 nm. **Lead tin yellow I** has a sharp inflection point covered by the filter at 467 nm. **Lead tin yellow II**, **naples yellow** and **gamboge** inflection points are represented by the filter at 532 nm. Yellow and **red ochre** as well as **sienna** show an S-shape spectral feature with maxima at 600 nm and 770 nm and minima at 645 nm, 860 nm and 915 nm (respectively filters at 610 nm, 760 nm, 640 nm and 920 nm). **Massicot** has an inflection point at 450 nm (filter at 450 nm) and **yellow lake reseda** at 490 nm (filter at 500 nm). **Realgar** has its inflection point at 560 nm and a filter was added to cover it.

Reds. **Vermilion**, **cadmium red**, **alizarin**, and **madder lake** have inflection points at 600 nm (filter at 610 nm). **Lac dye** spectrum is heavily dependent on the binders with an inflection point varying widely and so no specific filter was added for it. **Carmine lake** has an inflection at 630 nm (filter at 640 nm). **Red lead** has its inflection point at 575 nm (filter at 580 nm).

Browns and black. They don't have spectral features useful for their identification.

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center (nm)	notes
405	Titanium white absorption; chrome green maximum
430	Smalt, malachite maxima
450	Prussian blue maximum, massicot inflection
467	Phthalo blue maximum (465), lead tin yellow I (465) inflection
480	Cadmium yellow inflection
500	Verdigris, phthalo green maxima; yellow lake R. (490) inflection
532	Cobalt blue inflection; cobalt green maximum; orpiment, lead tin yellow II (525), naples yellow (515), gamboge (535) and saffron inflections
560	Realgar inflection
580	Red lead (575) inflection
610	Cobalt yellow absorption (615); ochre (600) maxima, vermilion, cadmium red, alizarin, madder lake inflection
640	Ochre (645) minimum; carmine lake (630) inflection
671	Lithopone absorption (670)
700	Cobalt violet maximum
730	Lithopone absorption (725)

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760 [Maya blue](#), [viridian](#) (770) inflections; ochre (770) maximum

840 [Indigo](#) inflection (830)

860 Ochre minimum

920 [Phthalo blue](#), ochre (915) minima

TP and MSI calibration card

We cannot use commercial gray cards for photography with [Antonello](#) since they absorb near UV and violet radiation and cannot be used for the filter at 405 nm. The [MSI](#) calibration card covers the 400-925 nm spectral range. It has 6 swatches, pure white, 4 grays and pure black. Learn more on our [Technical Photography and MSI calibration card](#).

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A) MSI calibration card (large lab version). B) MSI calibration card gray swatches reflectance spectra (gray values). C) Reflectance of the white swatch of MSI calibration card and of two color checkers for professional photography showing the absorption band in the violet region.

Splitting raw images

The photosensors of each pixel of a digital camera cannot distinguish the wavelength of the incoming light. Tiny color filters cover the pixels to select only red green or blue light (RGB). The on-camera processor converts the raw image to a full-color image using a demosaicing algorithm. We cannot use this image to reconstruct correct reflectance spectra since the demosaicing algorithm introduces arbitrary interpolation. [Antonello](#) splits the raw images into their RGB native components without any interpolation.

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[Pigments Checker](#). Raw format spectral images and calibrated split components (gray values).

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Registration

Registration is the operation of aligning and scaling in order to make all the images overlap with each other. We register the 18 spectral images taking the first spectral image as a reference for all the others (differently than progressive methods that register one image to the previous).

Our Research on Multispectral Imaging

Publications on Multispectral Imaging

A. Cosentino [“Imaging Multispettrale low-cost con filtri interferenziali”](#) Archeomatica, 2, 12-17, 2015..

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FAQ

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Does it only work with that particular camera or with any model?

Yes, [Antonello](#) works with any digital camera modified to cover the 360-1000 nm spectral range. We suggest 2 Nikon cameras, but [Antonello](#) can be used with any other model. You can use [Antonello](#) (filters set and software) with the modified digital camera that you already have and use for infrared photography and / or UV photography. No need to buy a new one.

Does the software only work with this particular filter set and camera?

No, the software can be adapted to different filters set and cameras, as well as develop your own workflow.

Previous versions

[Antonello v.1](#)