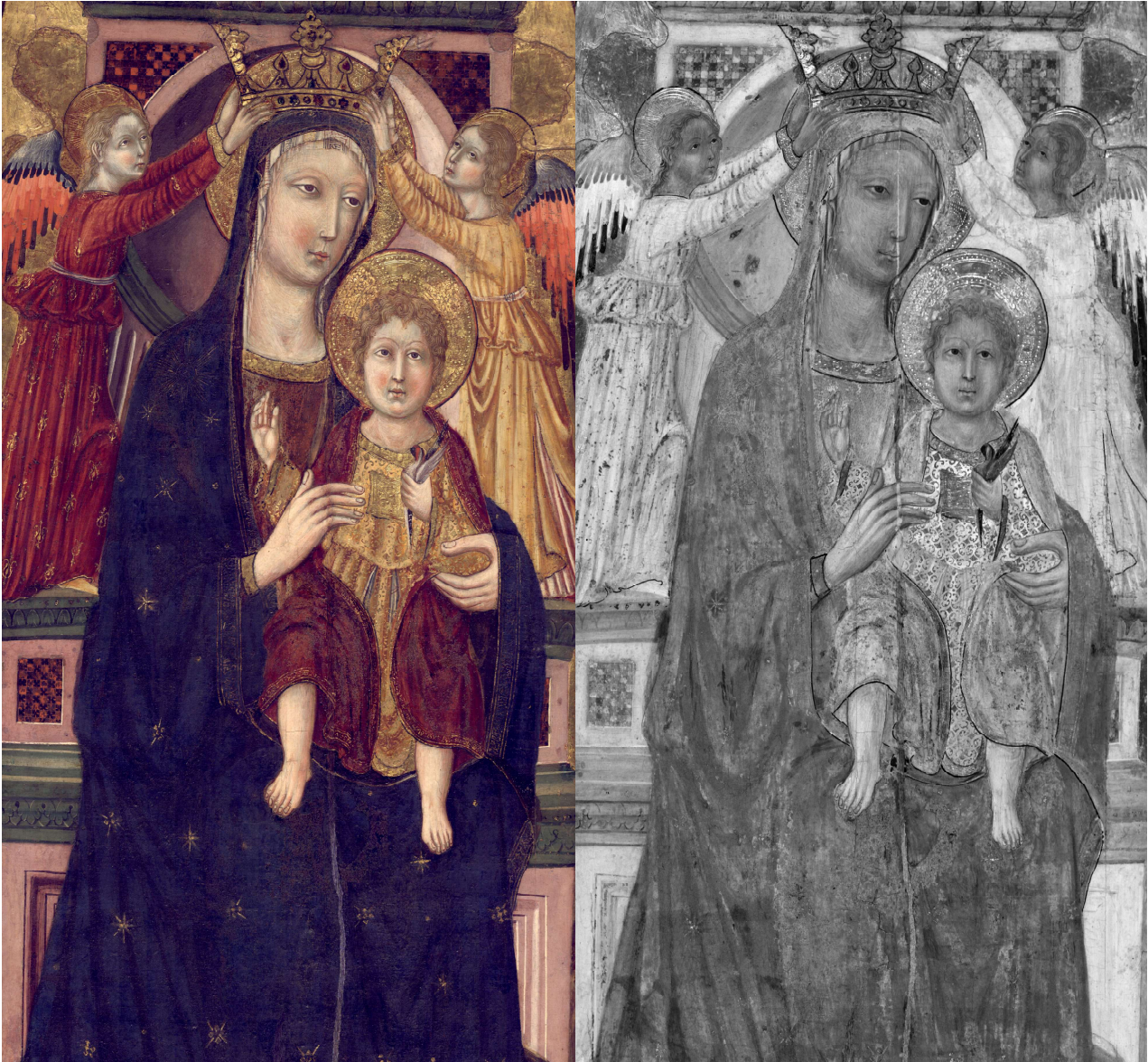




INFRARED REFLECTOGRAPHY



See Beneath the Surface

*Unlocking Hidden Layers in Art and Materials
with Advanced Infrared Reflectography Cameras*

What is Infrared Reflectography (IRR)?

Infrared reflectography (IRR) is a non-invasive imaging technique used to reveal features hidden beneath the visible surface of an object. It works by using infrared light, which can penetrate many paint layers that appear opaque to the human eye.

When infrared radiation is directed at an artwork, some materials allow this radiation to pass through, while others absorb it. Many historical pigments become more transparent at longer wavelengths, but carbon-based materials, commonly used in underdrawings, absorb infrared strongly and appear dark in the resulting image. This contrast makes it possible to visualise preparatory sketches, compositional changes, and earlier design stages that are otherwise invisible.

The images produced, known as reflectograms, provide a view of the underlying structure of an object without the need for sampling or physical intervention. This makes IRR particularly valuable in conservation, where preserving the integrity of the object is essential.

For conservators, IRR can offer direct insight into how an object was made and how it may have changed over time. It can reveal an artist's working process, distinguish original material from later additions, and identify features that may influence treatment decisions. By making hidden or obscured information accessible, infrared reflectography supports more informed, precise, and responsible conservation practice.

TIRR-Series Key Features:

Typically 950-1700nm

Ultra-high spatial resolution

High-speed acquisition minimises heat-load on artwork

Suitable for artworks of all shapes and sizes

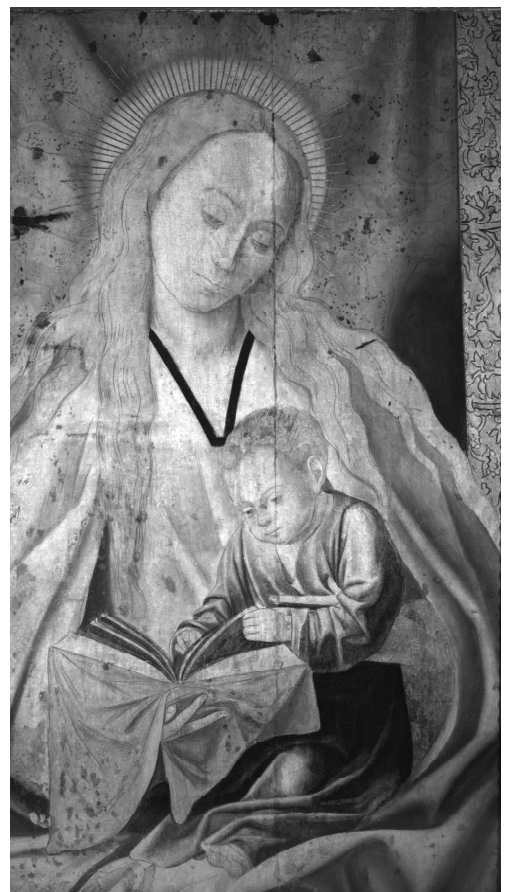
Reveals underdrawings and compositional changes

Completely non-contact, non-destructive

Reflectance or transmission mode

Transportable with no user assembly required

Infrared reflectography allows us to study the creative process without interfering with the artwork.



The Reason Infrared Reflectography Matters for Heritage Conservation

Infrared reflectography (IRR) is a well-established tool in conservation because it provides access to structural information that cannot be obtained through visual examination alone. By revealing what lies beneath the surface, it allows conservators to better understand both the making of an object and the changes it has undergone over time.

One of its primary uses is the study of underdrawings. IRR can reveal preparatory sketches and compositional adjustments, offering insight into an artist's working process and, in some cases, workshop practices. These features can also support questions of attribution and authenticity by allowing comparisons with known techniques.

IRR is equally important for condition assessment. It can expose hidden damages

such as cracks, losses, or alterations concealed beneath overpaint, as well as identify areas of previous restoration. This information is critical when evaluating the stability of an object and determining appropriate treatment approaches.

In practical conservation work, IRR contributes directly to treatment planning. By distinguishing original material from later additions, it helps define safe boundaries for cleaning and intervention, reducing the risk of unintentional removal of historically significant layers.

Finally, infrared reflectography supports high-quality documentation. Reflectograms provide a permanent visual record of subsurface features, which can be used in condition reports, shared with collaborators, and revisited for future study. Repeatable imaging also allows conservators to monitor changes over time.

IRR strengthens conservation practice by reducing uncertainty and enabling evidence-based decision-making.

Art Conservation & Restoration:

Reveal underdrawings, corrections (pentimenti), and previous restoration procedures to guide conservation decisions.

Inform authentication & attribution efforts

Understand artistic techniques and working methods

Material & structural analysis

Differentiate between layers and materials, helping identify pigments and construction methods.

Beyond Art Conservation & Restoration:

Infrared imaging can also be used in:

Forensic analysis

Industrial inspection

Coatings and material research

Seeing beneath the surface transforms observation into evidence-based decision-making.

How Infrared Reflectography Works

Infrared reflectography is based on how infrared radiation interacts with layered materials. When an object is illuminated with infrared light, this radiation can pass through certain surface layers, particularly those containing pigments that are partially transparent at longer wavelengths.

As the infrared radiation penetrates these layers, it reaches underlying structures such as preparatory drawings or ground layers. Some of this radiation is then reflected back toward the surface. Materials within these lower layers interact differently with the radiation: carbon-based underdrawings tend to absorb infrared and appear dark, while surrounding materials reflect more strongly, creating visible contrast.

A specialised infrared-sensitive camera detects this reflected radiation and converts it into an image known as a reflectogram. For larger objects, multiple images are typically captured and combined to produce a complete, high-resolution view of the subsurface features.

For conservators, the reliability of this process depends on stable imaging conditions and appropriate system sensitivity. Consistent illumination, accurate capture, and careful image assembly are essential to ensure that the resulting reflectogram accurately represents the underlying structure. When these conditions are met, IRR provides a dependable and repeatable method for examining objects without physical intervention.



By translating subsurface interactions into visible images, infrared reflectography makes hidden structures accessible for study and conservation.

Limitations of Conventional Infrared Reflectography Systems

While infrared reflectography is a powerful technique, the quality and usefulness of the results depend strongly on the capabilities of the imaging system. Earlier or lower-specification systems can restrict what can be detected and how reliably it can be interpreted.

A common limitation is restricted spectral sensitivity. Systems operating at shorter infrared wavelengths may not penetrate sufficiently through dense or complex paint layers, resulting in incomplete or unclear visualisation of subsurface features. In such cases, underdrawings or earlier compositions may remain partially or entirely obscured.

Sensitivity and noise performance also play a critical role. Low signal-to-noise ratios can make faint features difficult to distinguish from background variation, particularly in works with subtle or degraded underdrawings. This can reduce confidence

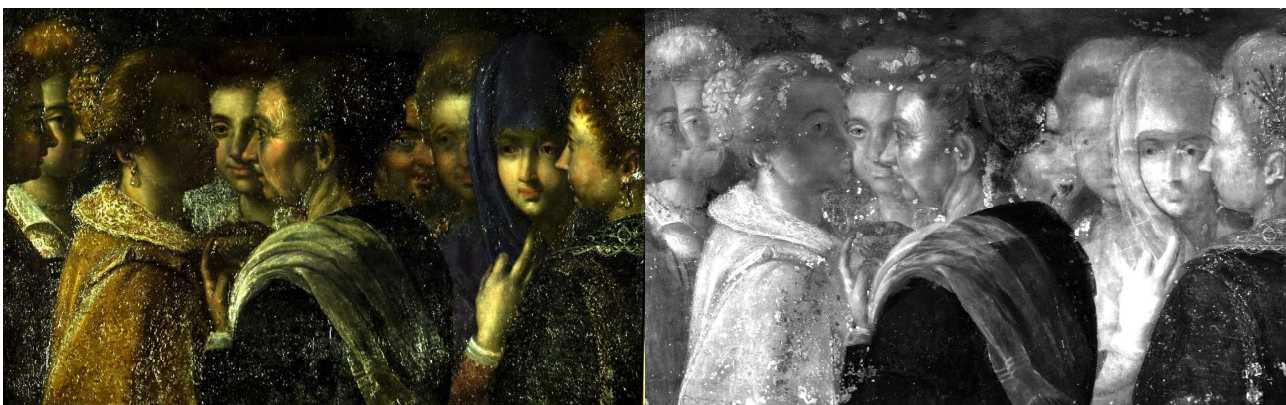
in interpretation and increase reliance on subjective judgement.

Spatial resolution is another important factor. Insufficient resolution limits the ability to resolve fine line work, which is often essential for identifying drawing techniques or distinguishing between original and later interventions.

Practical constraints can further affect usability. Slow acquisition speeds, inconsistent image stitching, and system instability can make it difficult to examine large objects efficiently or to produce coherent, high-quality reflectograms suitable for documentation and comparison.

For conservators, these limitations can lead to longer examination times, incomplete information, and greater uncertainty in decision-making.

The quality of infrared reflectography is directly linked to the performance of the imaging system, making modern solutions such as the Titan-Series dramatically more powerful than earlier technologies



The effectiveness of infrared reflectography is defined not only by the method itself, but by the performance of the system used to carry it out.



TITAN SERIES

Engineered for cultural heritage professionals who demand precision, reliability, and insight

Based on over 20 years experience in ultra-high resolution hyperspectral imaging for cultural heritage applications, the ClydeHSI Titan-Series is an infrared reflectography system developed to meet the specific requirements of cultural heritage imaging.

It combines extended spectral sensitivity, high image quality, and stable acquisition to support reliable examination and documentation of subsurface features.

See the invisible: visualise underdrawings and hidden features like never before, with best-in-class spatial resolution of up to 400Mpix images in measurement times as little as under 10 minutes*.

A fully portable solution for use in the laboratory, photography studio, or on-site. The system is provided with an airline compatible transport case for easy and safe transport between measurement sites.



Key Features:

- Up to 400MP Images
- Up to 250,000 Grey Levels
- Ultra-high Dynamic Range Mode
- Thermoelectric Sensor Cooling
- Auto-focus and Auto-exposure Options

The Titan-Series provides the sensitivity, resolution, and stability required for dependable infrared reflectography in conservation.

Infrared Reflectography Designed for Conservation Practice

High sensitivity and low noise performance, along with a high resolution sensor that is highly temperature stabilised, are critical for detecting weak reflected signals from beneath the surface. The Titan-Series is designed to capture these low-contrast features with clarity, reducing the need for extensive post-processing and improving the reliability of interpretation.

The system also provides very high spatial resolution, allowing fine details, such as line quality in underdrawings or subtle structural variations to be resolved accurately. This level of image sharpness and detail is essential for distinguishing

artistic techniques and identifying later interventions.

For practical use, the Titan-Series supports stable and repeatable image acquisition. This is particularly important when imaging large works that may require multiple captures and image stitching. Consistent results enable reliable mosaics and facilitate comparison across examinations over time, enhanced by robust white-field corrections.

Efficient data acquisition further supports its use in conservation environments, where time and access to objects may be limited. The system is designed to integrate into studio or in situ workflows without compromising image quality.

Benefits in Conservation Workflows

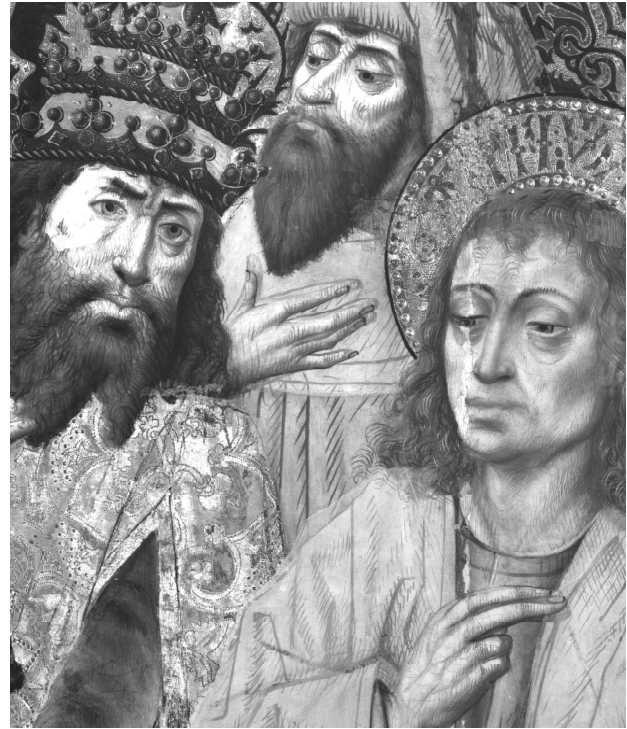
The ClydeHSI TIRR400 is designed to provide consistent, high-quality data that can be readily used in conservation practice.

Underdrawings, compositional changes, and concealed structures can be distinguished with greater precision, supporting more accurate assessment of an object's history and condition.

Greater penetration in the NIR range allows features beneath complex or heavily pigmented layers to be visualised more reliably.

Efficient acquisition and processing reduce the time required to examine objects, particularly large or complex works. This makes infrared reflectography more practical within time-constrained conservation projects and facilitates its integration into routine examination workflows. The system is designed to integrate into studio or in situ workflows without compromising image quality.

The system's stability and repeatability support consistent documentation. Reflectograms can be reliably compared across different sessions, enabling condition monitoring over time.



Reliable infrared imaging supports informed decisions, thus improving both the efficiency and the quality of conservation practice.

Key Technical Specifications

| Parameter | Value | | Units |
|-------------------------------------|--|----------|----------|
| Model | TIRR-100 | TIRR-400 | |
| Spectral Range | 900-1700 | | nm |
| Max Image Resolution | 100 | 400 | Mpix |
| Acquisition Time* at Max Resolution | 10 | 15 | min |
| Integration Time | User selectable exposure time from $1\mu s$ to 3.2s | | |
| Sensor Characteristics | 640 x 512 pixels InGaAs Area Sensor | | |
| Sensor Cooling | Thermoelectric cooling with temperature status display | | |
| Pixel Size | 15 | | μm |
| Objective Lens | 150 | | mm |
| Field of View | 40 horizontal x 40 vertical | | deg |
| Focus Range | 200mm - infinity | | |
| Bit Depth | User selectable: 10, 12, 14, 16 and 18 | | bit |
| File Formats | Metafile, JPEG, PNG, GIF, TIFF, FIT, VML (HTM), SVG, PDF, PostScript, XAML (WPF), Flex (Flash) | | |
| Camera Interface | USB, GigE | | |
| Dimensions | 450 x 450 x 300 | | mm |
| Tripod Mount | 1/4" and 3/8" | | |
| Power | 90-260, 50/60 | | V AC, Hz |

*acquisition time depends upon a range of operational parameters for example: resolution, exposure time, region of interest size

Supporting Evidence Based Conservation

Infrared reflectography is an established and essential method for examining the structure and history of cultural heritage objects. By revealing features that are not visible at the surface, it provides critical information for interpretation, documentation, and treatment planning.

The reliability of this information depends on the performance of the imaging system. Sensitivity, spectral range, resolution, and stability all influence the clarity and completeness of the resulting data.

The Titan-Series is designed to meet these requirements, providing consistent, high-quality infrared imaging suitable for conservation practice. Its capability to capture detailed and repeatable reflectograms supports accurate analysis and long-term documentation.

Used as part of a broader analytical approach, infrared reflectography contributes to a more thorough understanding of objects and enables more informed, evidence-based conservation decisions.



From masterpieces to modern materials, the Titan-Series is a modern advancement in IRR technology delivering insight where it matters most - in the hands of heritage professionals



About ClydeHSI

ClydeHSI are specialists in optical spectroscopy applied to cultural heritage applications.

We provide a wide range of reflectance imaging spectroscopy (hyperspectral) systems, in addition to a range of high-performance infrared reflectography cameras.

All of our products are supported by leading software for image acquisition, visualisation and analysis.

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