

# Introducing the COLOURS Project: Colour Management for Cultural Heritage

Collaborative On-cloud Lab for the conservation and digital restoration of ColOUred heritage collectionS



## COLOURS

 NTNU

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Colourlab, NTNU

# AGENDA

- Project overview: why colour matters for cultural heritage
- Consortium and project structure
- NTNU's role across the project
- Spotlight: WP5 Colour Management Definition and Requirements (NTNU-led)
- Spotlight: WP6 Colour Management Implementation and Deployment (NTNU-led)
- Publication 1: AIC2026: surveying colour management practice in the field
- Publication 2: LIM2026: virtual varnish removal and re-varnishing
- Conclusions and Future Work

# What is COLOURS?

A HORIZON-IA project building digital tools that let conservators, curators and scientists analyse, simulate and restore colour in cultural heritage across a shared cloud platform.

- Full name: Collaborative On-cloud Lab for the conservation and digital restoration of ColOUred heritage collectionS
- Call: HORIZON-CL2-2024-HERITAGE-ECCCH-01 · Type: HORIZON-IA
- Duration: 36 months — 1 October 2025 to 30 September 2028
- Coordinator: CNR (Consiglio Nazionale delle Ricerche, Italy)
- Builds on 2 years of prior R&D under the PERCEIVE project
- Fully interoperable with the European Collaborative Cloud for Cultural Heritage (ECCCH/ECHOES)

# Why colour, why now?

- Colour is central to the historical and artistic meaning of artefacts
- E.g. Paintings, polychrome sculpture, textiles, historic film and photographs
- Colour fades, alters or is lost over time
- The Notre-Dame fire and the public reaction to the Sistine Chapel restoration show the need for tools that predict and communicate restoration outcomes
- To deliver high-precision colour analysis and restoration-simulation tools and hybrid collaboration spaces for inclusive, remote decision-making

# The Consortium

| Acronym     | Legal Name                                              | Country       | Role                                    |
|-------------|---------------------------------------------------------|---------------|-----------------------------------------|
| CNR         | Consiglio Nazionale delle Ricerche                      | Italy         | Coordinator                             |
| FhG         | Fraunhofer Gesellschaft                                 | Germany       | Beneficiary                             |
| FORTH       | Idryma Technologias Kai Erevnas                         | Greece        | Beneficiary                             |
| <b>NTNU</b> | <b>Norwegian University of Science and Technology</b>   | <b>Norway</b> | <b>Beneficiary — WP5 &amp; WP6 lead</b> |
| FBA         | FundingBox Accelerator                                  | Poland        | Beneficiary                             |
| FBC         | FundingBox Communities                                  | Spain         | Beneficiary                             |
| ECE         | Erasmus Centre for Entrepreneurship                     | Netherlands   | Beneficiary                             |
| ZVKDS       | Slovenian Institute for Protection of Cultural Heritage | Slovenia      | Beneficiary                             |
| BCS         | Brakebusch Restaurierungswerkstatt                      | Germany       | Beneficiary                             |
| GMB         | Galeria Mesta Bratislavy                                | Slovakia      | Beneficiary                             |
| MIC         | Ministero della Cultura                                 | Italy         | Beneficiary                             |

# Work Package Landscape

| WP         | Title                                                    | Lead        | NTNU role    |
|------------|----------------------------------------------------------|-------------|--------------|
| WP1        | Coordination and Management                              | CNR         | —            |
| WP2        | Community Engagement & User Needs Analysis               | FORTH       | —            |
| WP3        | Technology Adaptation & Development                      | FhG         | Contributor  |
| WP4        | Hybrid Collaborative Simulation Environment              | CNR         | Contributor  |
| <b>WP5</b> | <b>Colour Management Definition &amp; Requirements</b>   | <b>NTNU</b> | <b>Leads</b> |
| <b>WP6</b> | <b>Colour Management Implementation &amp; Deployment</b> | <b>NTNU</b> | <b>Leads</b> |
| WP7        | ECCCH Interoperability — Requirements Planning           | FORTH       | Contributor  |
| WP8        | ECCCH Interoperability — Semantic/Cloud Implementation   | FORTH       | —            |
| WP9        | ECCCH Interoperability — Deployment & Validation         | FORTH       | —            |
| WP10       | Internal Pilots — Application on Case Studies            | CNR         | Contributor  |
| WP11       | External Pilots — Open Calls & Applications              | FBA         | —            |
| WP12       | Testing & Validation — Internal                          | FORTH       | Contributor  |
| WP13       | Testing & Validation — External Hybrid Environment       | CNR         | —            |
| WP14       | Impact Generation & End-User Engagement                  | FBC         | Contributor  |
| WP15       | Impact Generation — Testing & Re-usability               | FBA         | Contributor  |

# NTNU's Role Across COLOURS

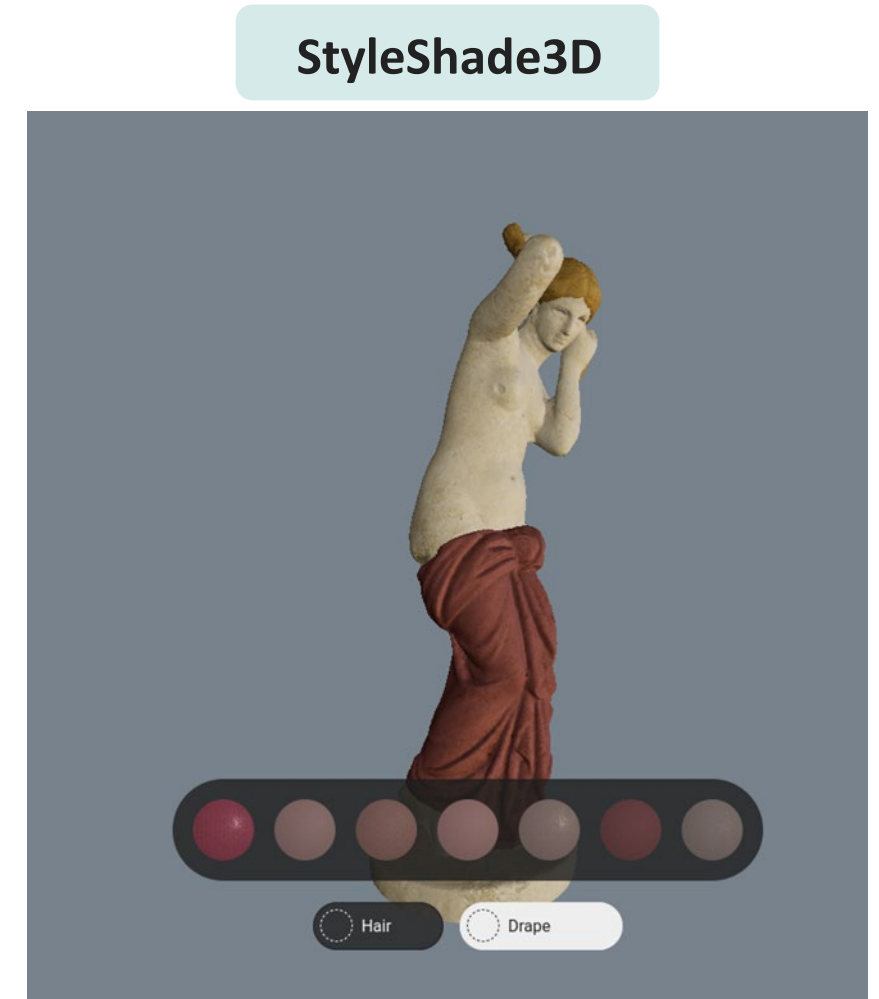
- Leads WP5: Colour Management Definition and Requirements
- Leads WP6: Colour Management Implementation and Deployment
- Contributes to WP3: Colour management strategy for AI-based semantification and Colour Knowledge Repository
- Contributes to WP4 : Specification input for colour-consistent digital twin visualisation
- Contributes to WP7 : Interoperability Requirements Planning
- Contributes WP10/WP12 : Validating colour protocols on real case studies
- Acts as a Mentor partner for External Pilots (WP13) and contributes to dissemination (WP14/WP15)

# ECHOES/ ECCCH platform

- ➔ ECHOES builds the shared European cloud ECCCH (European Collaborative Cloud for Cultural Heritage)
- ➔ A shared, EU-wide cloud infrastructure and "Digital Commons framework" meant to host digital twins, tools and services for heritage conservation across many projects, including COLOURS
- ➔ By project's end, COLOURS' outputs are meant to be integrated into ECCCH
- ➔ Made available more broadly via the Common European Data Space for Cultural Heritage and the European Open Science Cloud

# PERCEIVE

- ➔ **MuLaX: A Web3D viewer for 3D visualisation and exploring multiple diagnostic imaging layers on 2D and 3D heritage objects.**
- ➔ **Light Damage Estimator (LDE): A web-based tool that predicts and visualizes how an artwork's colours will fade under different lighting and exposure conditions over time.**
- ➔ **StyleShade3D: An AI-assisted tool that segments and stylizes 3D scanned objects by mapping different materials and effects onto specific regions of the mesh.**



# PERCEIVE TOOLS

## MuLaX



MuLaX: A Web3D viewer for exploring multiple diagnostic imaging layers on 2D and 3D heritage objects.

## Light Damage Estimator

### Light Damage Estimator

**Artwork**



The Scream (ca. 1910), by Edvard Munch, housed by Munch Museum

**Prediction method**  
Method 2 (NTNU)

**Pigments**  
Vermillion

**Light source**  
XENON

**Light intensity (Irradiance)**  
100  $\mu\text{W}/\text{cm}^2$

**Time of exposure**  
 Years: 187  
 Days per year: 350  
 Hours per day: 5  
 Dose: 32725000  $\mu\text{Wh}/\text{cm}^2$  / max: 34350000  $\mu\text{Wh}/\text{cm}^2$

**Result**



**Pigments**

|            | New                                                                                   | Aged                                                                                  |
|------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Vermillion |  |  |

[Download result data](#)

[Submit](#)

# WP5 Colour Management Definition & Requirements

**Objective:** Define protocols for consistent colour appearance across devices and platforms, covering the full workflow from data acquisition to presentation on the ECHOES/ECCCH platform.

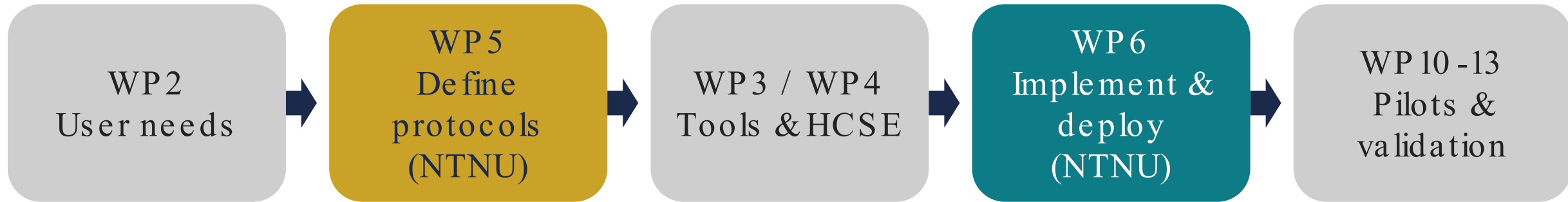
- ➔ Spectral-based colour management protocols for 2D/3D imaging and displays, extending ICC standards to account for illumination, viewing angle and display gamut
- ➔ Investigates whether the platform's colour handling goes beyond default device/browser profiles and defines requirements for precise appearance simulation under varying illumination
- ➔ Evaluates the protocols on Internal Pilot case studies (paintings, sculptures) through controlled-lab, and uncontrolled-display viewing conditions

# WP6 Colour Management Implementation & Deployment

**Objective:** To ensure restored artefacts are displayed consistently across mixed-reality devices (headsets, smartphones, large screens), each with different display type, brightness, contrast, gamut and virtual lighting.

- ➔ Selecting and analysing cases that expose challenges of maintaining consistent colour across media/platforms
- ➔ Adapting and generalising the colour management methods to the diverse requirements of the External Pilots
- ➔ Delivers a fully operational, scalable colour reproduction system across media and platforms, aligned with ISO 15076 and ISO 20677

# WP5 and WP6 in the Project Ecosystem



- ➔ WP5 sets spectral-based colour protocols for both digitisation and ECHOES/ECCCH visualisation, validated by psychovisual experiments on Internal Pilot data
- ➔ WP6 scales those protocols into a deployable, standards-aligned colour management workflow for Internal and External Pilots
- ➔ Both WPs directly inform AI-based restoration tools, digital-twin visualisation and the Internal/External Pilot testing chain

# COLOURS in Action: AIC2026 Florence Midterm Meeting

**“Surveying colour management practices in conservation/restoration of cultural heritage objects”, Deborah, Habib, Trumpy, Hardeberg & Brakebusch**



**Grounds spectral colour-management protocol design in real practitioner behaviour, not just theory**



**Online survey of 49 photographers, conservators and restorers across equipment, lighting, calibration, software and archiving practices**



**73.5% use physical colour targets during capture, but only 45.8% use dedicated colour-management software to build ICC profiles from them**



**Nearly half of respondents (47.6%) follow standard workflow recommendation: a large, informal minority follows FADGI**



Fig 1: Summary of standard workflow recommendation followed by users

# COLOURS in Action: LIM 2026 London

**“Virtual varnish removal and re-varnishing of paintings using hyperspectral imaging”,  
Habib, Deborah, Trumpy, Hardeberg & Brakebusch**

- ➔ **Case study: View of the Watterhorn : ‘Blick auf das Wetterhorn’, a 19th-century oil landscape by August Wilhelm Leu, scanned with a Specim IQ hyperspectral camera**
- ➔ **Physics-based optical model separates interface reflection from body (pigment) reflection to simulate removing aged, yellowed varnish : non-invasively**
- ➔ **Model extended to simulate re-varnishing as a transparent overlay, previewing the aesthetic effect of a new coat before physical application**
- ➔ **Virtually cleaned results closely match physically cleaned regions**

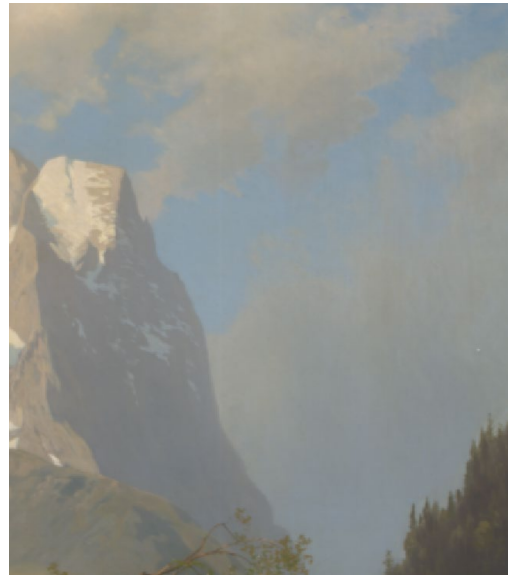
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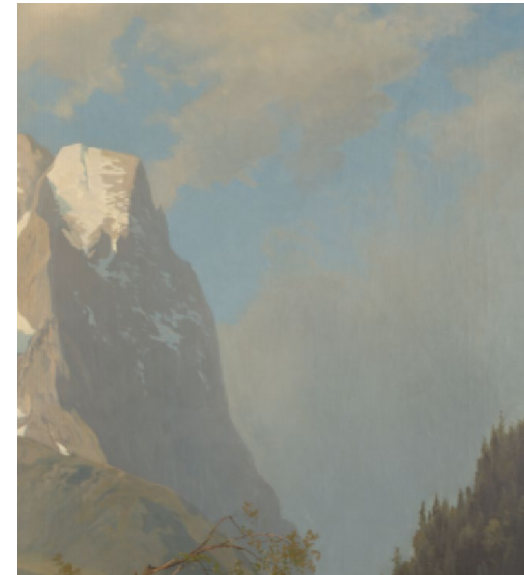
UNCLEANED



VIRTUALLY CLEANED



CLEANED



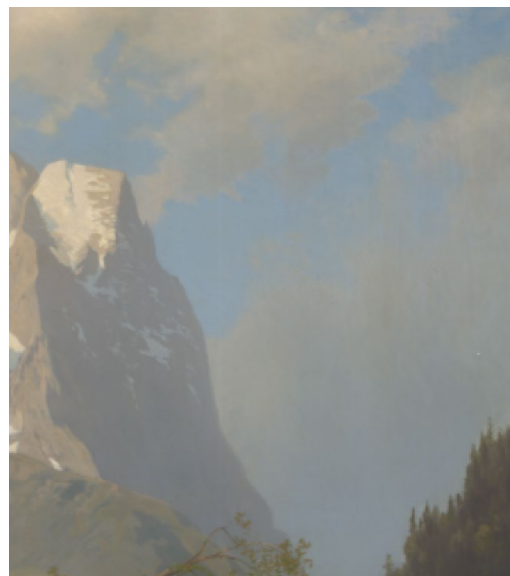
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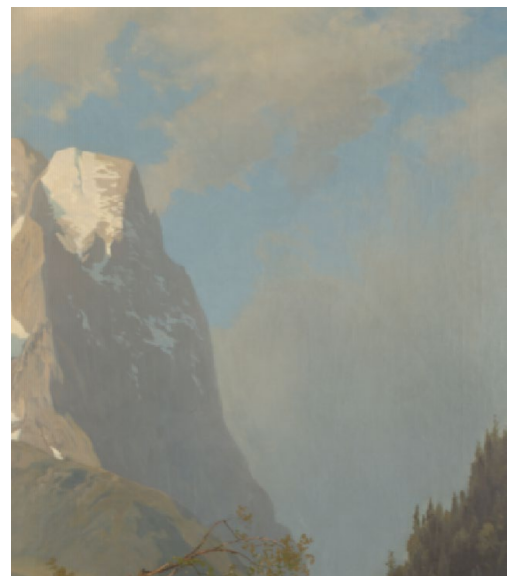
UNCLEANED



VIRTUALLY CLEANED



CLEANED



VIRTUALLY REVARNISHED



# COLOURS in Action: Data Collection at Dusseldorf

**BRAKEBUSCH Restaurierungswerkstatt**



# COLOURS in Action: Data Collection at Bratislava City Gallery



# NEXT STEPS

- ➔ Building the varnish removal and revarnishing tool
- ➔ Analysing colour management workflows with different types of colour targets for digital twins of flat and 3D cultural heritage objects
- ➔ Testing spectral based colour management workflows on internal pilots

# THANK YOU

*Questions & discussion — Colour Management for Cultural Heritage*

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<https://cordis.europa.eu/project/id/101233413>