

# xrf-explorer-v0.2

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## General information on the software documentation

version: 2024 December 19

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**xrf-explorer** is a research software toolkit developed by students at Eindhoven University of Technology (TU/e), for the Van Gogh Museum Amsterdam in a partnership with ASML. The toolkit is intended to be used for the integrated exploration of multimodal images, spectral data, and chemical mappings of a painting. The toolkit is developed to assist in the conservation science practice.

### Project

The original prototype (v0.1) was created by a TU/e master's student from January–September 2023. The current version (v0.2) was developed by a team of TU/e bachelor students from April–July 2024.

### Documentation

Five documentation files were delivered by the development team. Together they form a comprehensive documentation package:

- xrf-explorer-v0.2\_userrequirementsdocument.pdf
- xrf-explorer-v0.2\_softwaredesigndocument.pdf
- xrf-explorer-v0.2\_acceptancetestplan.pdf
- xrf-explorer-v0.2\_softwaretransferdocument.pdf
- xrf-explorer-v0.2\_softwareusermanual.pdf

### Acknowledgements

For the development, testing, and documenting of xrf-explorer, test data was provided by the Museum of Modern Art (New York) to the development team. It consisted of images and xrf scanning data of the “Portrait of Joseph Roulin” painting by Vincent van Gogh. Images of this painting are included in some of the documentation files for the purpose of explaining the software usage.

For more detailed information on this painting, including image licenses, we refer to:

<https://www.moma.org/collection/works/79105>

### License

The documentation provided here is licensed under CC-0.

### Software

The xrfexplorer software itself (codebase and code documentation) can be found at the github repository “Olive-Groves/xrf-explorer” (see: <https://github.com/olive-groves> ).

### NOTE

In the documentation files a version 2.0 is mentioned. Later on, it was decided to rename the version to v0.2. Document titles and included cover pages were changed, but the rest remained unchanged, as they are the original deliverables by the TUe team.

# Software User Manual

2IPE0 SOFTWARE ENGINEERING PROJECT

July, 2024

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## **ABSTRACT**

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This document, the Software User Manual (SUM), provides help and guidance for users on how to properly and effectively utilize the XRF Explorer 2.0 application. The XRF Explorer 2.0 is a web application aimed at conservation scientists, facilitating the analysis of paintings composition. The document outlines the purpose of the application, intended readership and conventions used throughout the document. The manual includes tutorials for various sessions, references for operations, error messages together with recovery procedures, a glossary aimed at facilitating understanding and reducing ambiguity encountered while reading, and an index to aid in navigation.

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## DOCUMENT STATUS SHEET

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### GENERAL

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### DOCUMENT HISTORY

Version	Date	Authors	Reason
0.01	10-05-2024	Sonia Maxim	Document structure, initial Introduction, initial abstract
0.02	03-06-2024	Sonia Maxim	Added some tutorials in section 3.
0.03	04-06-2024	Sonia Maxim	Continued writing tutorials and some references in section 4.
0.04	09-06-2024	Sonia Maxim	Finished first draft version of document
0.05	20-06-2024	Sonia Maxim	Added screenshots for tutorials
0.06	27-06-2024	Sonia Maxim	Updated document to match current version of application
1.0	04-07-2024	Sonia Maxim	Finalized document

## DOCUMENT CHANGE RECORDS

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Version	Date	Section	Reason
0.01	10-05-2024	All sections	Initial version of document
1.0	04-07-2024	All section	Final version of document

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# 1 INTRODUCTION

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## 1.1 INTENDED READERSHIP

The XRF Explorer 2.0 is intended for conservation scientists to analyse paintings. The application won't feature any role-specific permissions or functionalities. It features only one, general, end-user role. Hence, expert cultural heritage knowledge is assumed for the interpretation of visualizations presented by the software.

## 1.2 APPLICABILITY

This document applies to XRF Explorer 2.0, which was released on 05/07/2024.

## 1.3 PURPOSE

The XRF Explorer 2.0 is a web application that allows conservation scientists to freely explore collected painting data. It builds upon the base work and research as presented in the thesis "XRF-XPLOER: An interactive visual exploration tool for micro-X-ray fluorescence scanning data on paintings" [1]. The application provides an interactive environment that facilitates in depth visual exploration of [Micro-XRF data](#). Users can view the presence of [elements](#) and pigments across a painting in relation to other [contextual data](#), and further analyse the data through means of a [lens](#), graphs and others, as will be explained in this manual. The user experience is additionally enhanced by allowing the the customization of the workspace.

The purpose of the XRF Explorer 2.0 Software User Manual (SUM) is to guide the user when using the application. This manual provides clear and concise instructions in the form of tutorials, explaining all the functionalities of the software. These tutorials are accompanied by screenshots to ensure full understanding. In the event of errors encountered while utilizing the application, the user can refer to [Appendix A](#) for assistance in identifying and resolving the issues.

## 1.4 HOW TO USE THIS DOCUMENT

This document is divided in 4 main sections and an appendix. The introduction, found in [Section 1](#), presents the context and purpose of the application and is followed by an overview, found in [Section 2](#), of the fundamental process supported.

To ensure correct usage and maximize productivity while using the product, the user can refer to the tutorials presented in [Section 3](#). These tutorials present step-by-step instructions for using various functionalities of the application, including how to prepare for and start the task, and what final results to expect.

If the user seeks further understanding regarding the functionality of specific operations, such as commands, menu items, or buttons within the application interface, they can consult the reference section present in [Section 4](#).

In the event of errors encountered while using the functionalities presented in the previous sections, the user can consult [Appendix A](#). This section covers all the possible error messages, as well as recovery procedures to assist the reader in solving the issue.

For any term that lacks clarity, the reader can consult the glossary provided in [Appendix B](#). In [Appendix C](#) a list of often recurring terms and topics and a link to their corresponding pages is provided for efficient search throughout the manual.

## 1.5 RELATED DOCUMENTS

The Software User Manual is part of a suite of [documentation](#) aimed at supporting users and developers in their interaction with the XRF Explorer 2.0 application. Other related documents include:

- The User Requirements Document (URD) [2] of the XRF Explorer 2.0 – defines the list of requirements of the application outlining its intended functionality.

- The Software Design Document (SDD) [3] – provides high-level architectural overview and a summary of the design decisions taken when building the application
- The Software Transfer Document (STD) [4] – explains the process of transferring the project to the client / users interested in further developing the application
- The Acceptance Test Plan (ATP) [5] – provides a specification of tests that need to be completed

## 1.6 CONVENTIONS

Throughout this document, the *italic font* is used to indicate views names, buttons, sliders, field names, and menu items. The words highlighted in [blue](#) contain links to their definition in the glossary or to the section they refer to. The **bold** font is used to indicate names used for example purposes.

## 1.7 PROBLEM REPORTING

To report software problems, users can open an issue on the open-source GitHub repository, accessible through the application, where they provide a clear description of the bug and any relevant details.

## 2 OVERVIEW

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In this chapter, we will specify the problem at hand, our solution, and the requirements for using the XRF Explorer 2.0.

### 2.1 PROBLEM

XRF mapping was developed by cultural heritage scientists and gained popularity in the late 2000s due to its increased accessibility to scientists. This technique has been used to identify pigments and other materials in order to elucidate the artists' use of materials, to understand how a painted surface has altered over time and to identify anachronistic uses of materials. Such insights are essential for detecting potential fakes, forgeries or past restoration interventions. The analysis method that this project will focus on is [Micro-XRF](#) (micro-X-ray fluorescence) scanning. Despite being one of the most powerful forms of painting analysis, there currently does not exist a visualization software for [Micro-XRF](#) data which is easily accessible to conservation scientists and addresses all tasks from the user.

### 2.2 SOLUTION

To solve this issue, a proof of concept was finalized in 2023 in a collaboration between Eindhoven University of Technology, the Van Gogh Museum and ASML. This proof of concept was developed by Dominique van Berkum for a Data Science and Artificial Intelligence Master's project. To transform this into a viable web application, a collaboration between the Eindhoven University of Technology, the Van Gogh Museum and ASML was again established. The intended goal was to create the XRF Explorer 2.0, an accessible browser-based application tool where conservation scientists can view different types of painting data and [contextual images](#) in one central place. Unlike previous applications, which treated [projects](#) in isolation, the XRF Explorer 2.0 combines the strengths of all individual [projects](#) and [contextual images](#) and allow for a streamlined process in which the user can view the multidimensional data through various methods such as the [lens](#) and [dimensionality reduction](#) while maintaining an understanding of the spatial context.

### 2.3 REQUIREMENTS

To fully utilize the XRF Explorer 2.0 functionality the following requirements must be met:

- The user has a computer with either Google Chrome (version 124 or higher), or Firefox (version 125 or higher).
- The user uses one of the following operating systems based on x86-64 based architectures: Windows 10, Windows 11 or Ubuntu LTS 24.04.
- The user's computer has at least 16GB of RAM.
- The server is functional and accessible while using the application.
- The user is proficient in the English language.
- The user has an understanding of painting composition analysis.

### 2.4 LIST OF REFERENCES

- [1] D. V. B. van Berkum, "Xrf-xplorer: An interactive visual exploration tool for micro-x-ray fluorescence scanning data on paintings," Master's thesis, Eindhoven University of Technology, September 2023.
- [2] "Xrf explorer 2.0: User requirements document," tech. rep., Eindhoven University of Technology, 2024.
- [3] "Xrf explorer 2.0: Software design document," tech. rep., Eindhoven University of Technology, 2024.
- [4] "Xrf explorer 2.0: Software transfer document," tech. rep., Eindhoven University of Technology, 2024.
- [5] "Xrf explorer 2.0: Acceptance test plan," tech. rep., Eindhoven University of Technology, 2024.

## 3 TUTORIALS

This section contains step-by-step tutorials for each of the functionalities the end-user can perform using XRF Explorer 2.0. For easy understanding, the tutorials are supported by screenshots of the application. Each tutorial contains a small description of the interaction, followed by the preconditions, procedure, expected outcomes, and likely errors the user may encounter. Recovery procedures for the encountered errors can be found in Appendix A. It is assumed that the preconditions are not violated for any of the tutorials.

### 3.1 MANAGING PROJECTS

#### 3.1.1 Creating a new project

<b>Functional description</b>	This tutorial describes how the user can create a new <a href="#">project</a> .
<b>Preconditions</b>	The user is on any screen of the application. The server is working.
<b>Expected result</b>	The uploaded <a href="#">projects</a> are added to the server and the new project is visible to the user in the <a href="#">projects list</a> .
<b>Cautions and warnings</b>	Files must conform to the file type requirements. The allowed file formats are: <ul style="list-style-type: none"> <li>• ".RAW" together with "RPL" for the <a href="#">spectral data</a> and the associated metadata.</li> <li>• ".CSV" and ".DMS" for the <a href="#">elemental data</a>.</li> <li>• ".TIFF", ".JPG", ".BMP" and ".PNG" for the <a href="#">contextual images</a>.</li> <li>• ".CSV" to use as a <a href="#">recipe</a> for <a href="#">registering the data</a>.</li> </ul> Uploading a base image is required. <a href="#">Project</a> names must be unique. The name cannot be changed afterwards.
<b>Likely errors</b>	During the process of creating a new project the following errors in the form of <a href="#">toast messages</a> can be encountered: "Failed to create project" (in this case the project might already exist, see <a href="#">Error 1</a> ), "Uploading file name failed" (this can occur when pressing the <i>Upload files</i> button, see <a href="#">Error 5</a> ), "Failed to initialize elemental channels" (this can occur if the provided elemental cube is incorrectly configured, see <a href="#">Error 6</a> ), "Failed to set up workspace" (see <a href="#">Error 7</a> ), "Configured files are not valid" (see <a href="#">Error 8</a> ) and "Failed to gather registering recipe" (see <a href="#">Error 10</a> )

#### Procedure

- 1 Click on the *File* menu present in the header (Figure 1).
- 2 The user is presented with a drop-down menu displaying the items of the *File* menu.
- 3 Click on the *New project* button (Figure 2).
- 4 The user is presented with a [dialog](#) box to create a new [project](#).
- 5 Introduce a unique name for the [project](#) in the *Project name* field (Figure 3).
- 6 Click the *Next* button (Figure 4).
- 7 *Optional*—If there already exist files for the project, the user will be presented with an *Existing files* window that allows them to keep/delete the existing files (Section 4.2.2).
- 8 The user is presented with a [dialog](#) box to set up the workspace.
- 9 Click on the *Upload files* button to upload the new data necessary for the exploration (Figure 5).

Continued on next page

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**Procedure**


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- 10 The user is presented with an *Uploading files* [dialog](#).
  - 11 Click on the *Choose files* field. Navigate to and select the desired files to upload (Figures 6).
  - 12 When all the necessary files have been selected, click on the *Upload files* button (Figure 7).
  - 13 A message indicating that the files are being uploaded is shown and will disappear when the files are uploaded.
  - 14 Introduce a name for the base image in the *Name* field (Figure 8).
  - 15 Click the associated selection menu *Select an image file* (Figure 9).
  - 16 The valid files for this field are presented. If no valid files are available, the "No valid files" message is displayed.
  - 17 *Optional*—If the user wishes to use files other than the available ones, repeat the steps 9 to 13 at any time.
  - 18 Select the desired file for this field.
  - 19 *Optional*—To begin the process of uploading the spectral cube, click the selection menu at the bottom of the window and select *Spectral datacube* (Figures 10 & 11).
  - 20 *Optional*—Click the *Add component* button (Figure 12).
  - 21 *Optional*—The fields necessary for the uploading spectral cube process are displayed in the window.
  - 22 *Optional*—Introduce a name for the spectral data in the associated *Name* field (Figure 13).
  - 23 *Optional*—Click the associated selection menu *Select a raw file*.
  - 24 *Optional*—The valid files for this field are presented. If no valid files are available, the "No valid files" message is displayed.
  - 25 *Optional*—Select the desired file for this field.
  - 26 *Optional*—Repeat steps 23 to 25 for the remaining fields *Select a rpl file* and *Select a recipe file*.
  - 27 *Optional*—To crop and bin the spectral data for a faster processing, click the *Additional parameters* button (Figure 14).
  - 28 *Optional*—The user is presented with the *Spectral datacube parameters* [dialog](#).
  - 29 *Optional*—Input values for the channel boundaries and bin size in the respective fields respecting the presented restrictions and click the *Save* button (Figure 15).
  - 30 *Optional*—To begin the uploading of the elemental cube process, click on selection menu at the bottom of the window and select *Elemental datacube*.
  - 31 *Optional*—Repeat the same process followed for the uploading of the spectral data.
  - 32 *Optional*—To add more [contextual images](#), click on the selection menu and select *Contextual image*.
  - 33 *Optional*—Repeat the same process for the [contextual images](#).
  - 34 When all the necessary data has been selected, click the *Save* button (Figure 16).
  - 35 The [dialog](#) to set up the workspace closes and a [dialog](#) to set up elemental channels opens automatically.
  - 36 Select the elemental channels to work with in the workspace ( Figure 17).
  - 37 When all the desired elements have been selected, click the *Save* button ( Figure 18).
- 

Continued on next page

## Procedure

- 38 The *Set up elemental channels* dialog closes and a toast with the message "Created workspace" is displayed.

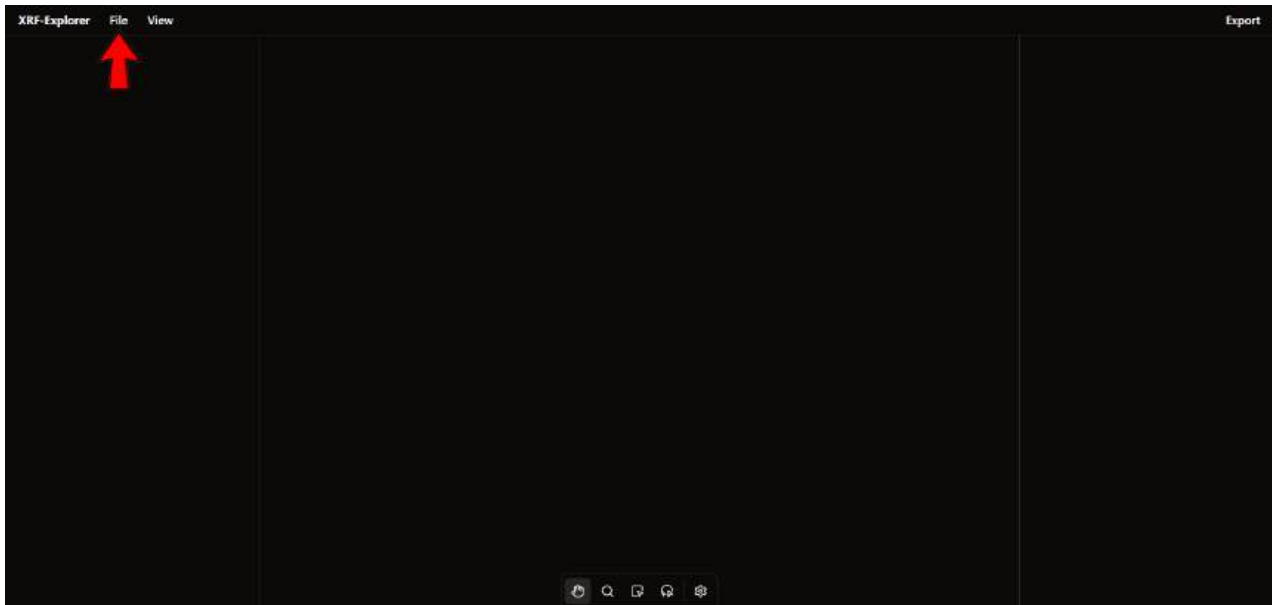


Figure 1: Open the *File* menu

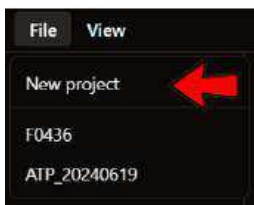


Figure 2: New project



Figure 3: Enter name for project



Figure 4: Click next

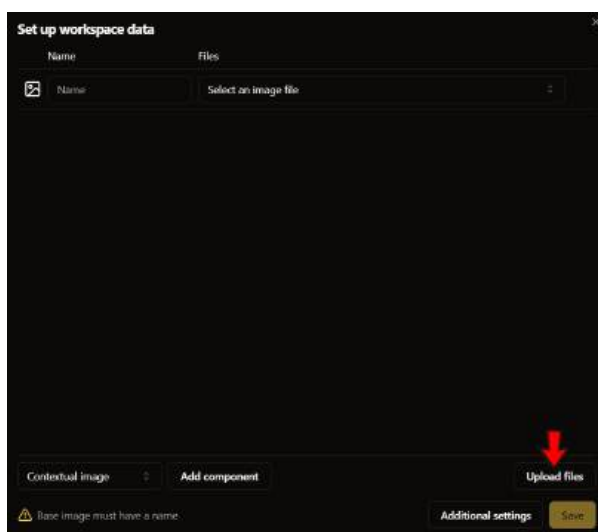


Figure 5: Click upload files

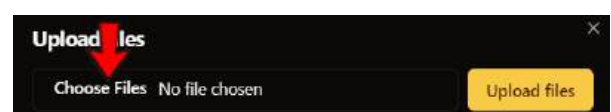


Figure 6: Click to choose files



Figure 7: Upload the chosen files

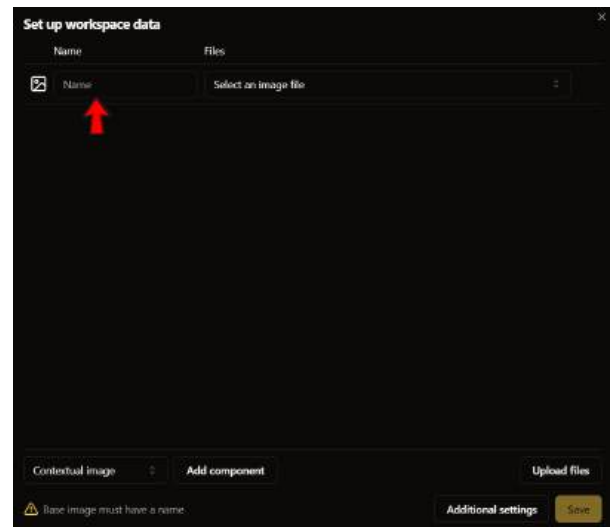


Figure 8: Choose a name for the base image

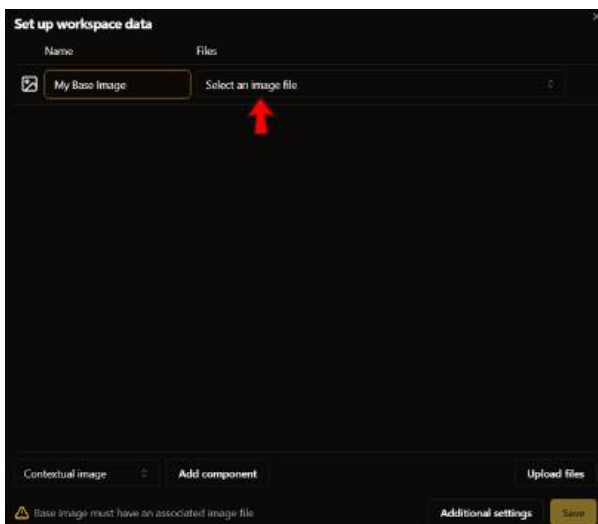


Figure 9: Choose the base image

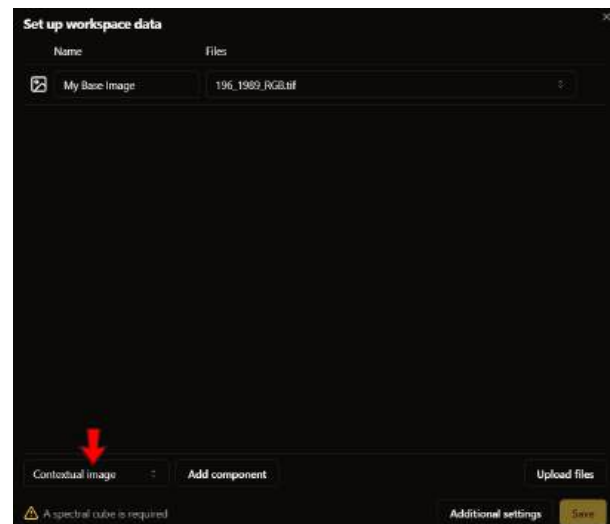


Figure 10: Switch to another data type

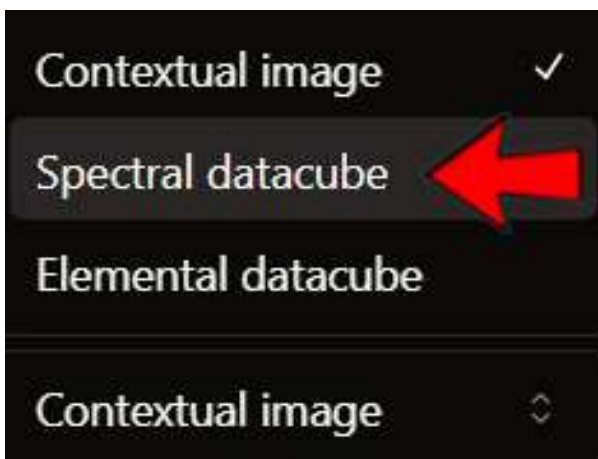


Figure 11: Select spectral cube

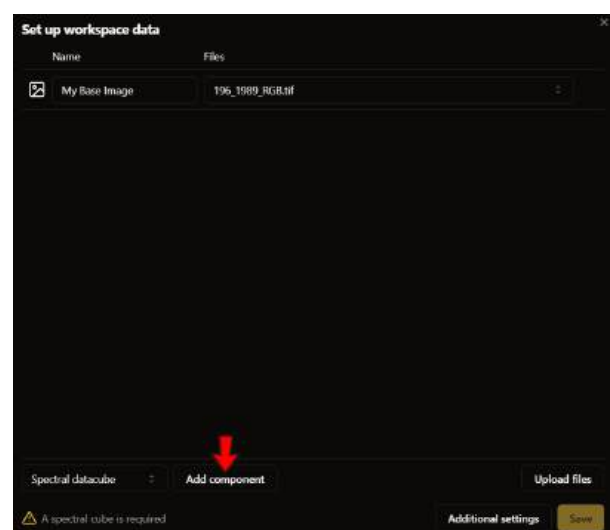


Figure 12: Click to add spectral component

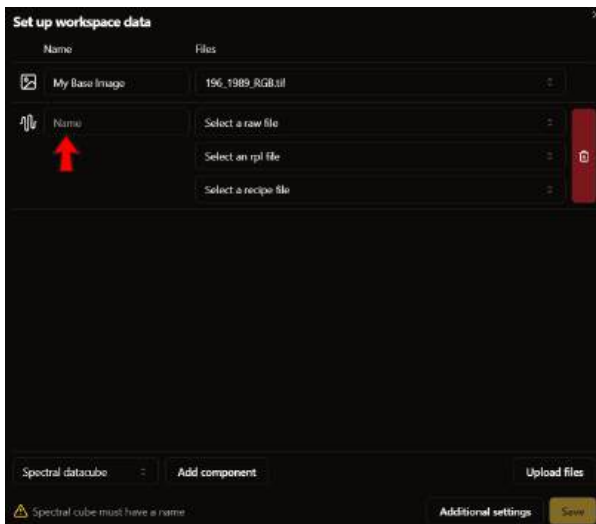


Figure 13: Set the name for the spectral data

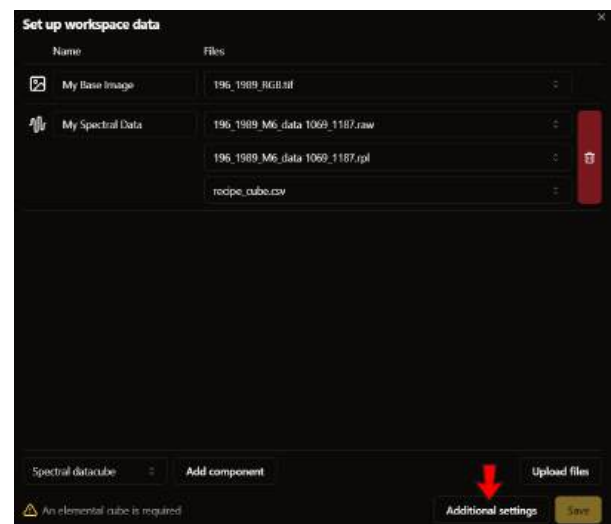


Figure 14: Open additional settings

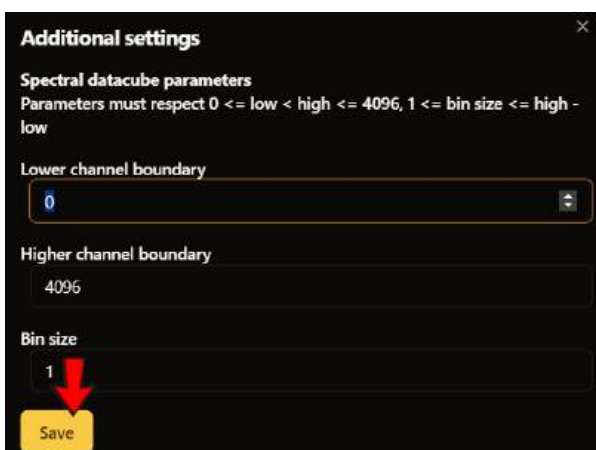


Figure 15: Save the additional settings

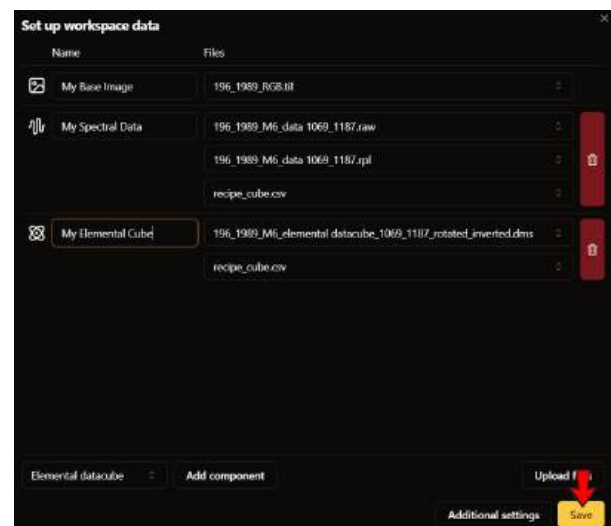


Figure 16: Save the upload

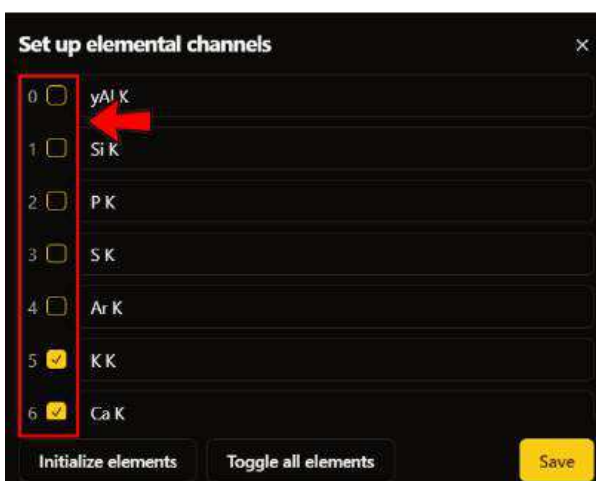


Figure 17: Set up elemental channels



Figure 18: Save the elemental channels setup



### 3.1.2 Available projects

<b>Functional description</b>	This tutorial describes how the user can view all available <a href="#">projects</a> .
<b>Preconditions</b>	There is at least one <a href="#">project</a> created.
<b>Expected result</b>	A list of the available <a href="#">projects</a> is displayed.
<b>Cautions and warnings</b>	If no <a href="#">projects</a> have been created, this will be indicated to the user.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *File* menu present in the menu bar (Figure 1).
  - 2 The user is presented with a dropdown menu displaying the items of the *File* menu
  - 3 The available [projects](#) are displayed within the *File* menu items (Figure 19).
- 

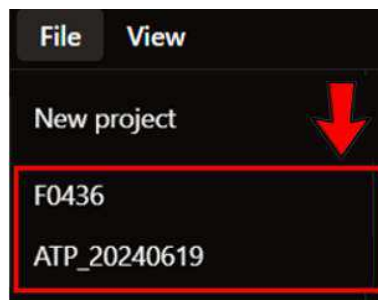


Figure 19: Available projects

### 3.1.3 Loading a project

<b>Functional description</b>	This tutorial describes how the user can choose a <a href="#">project</a> to be loaded into the application.
<b>Preconditions</b>	There is at least one <a href="#">project</a> created and the list of available <a href="#">projects</a> is opened.
<b>Expected result</b>	The chosen <a href="#">project</a> is loaded into the application and the base image is visible in the main viewer.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When clicking on a <a href="#">project</a> , loading it may be unsuccessful promoting the error <a href="#">toast message</a> "Failed to load workspace" (see <a href="#">Error 2</a> ).

---

#### Procedure

---

- 1 Within the list of available projects (Figure 19), click on the [project](#) which should be opened.
  - 2 The base image of the [project](#) is visible in the main viewer after it has finished loading.
-

## 3.2 CUSTOMIZING WORKING ENVIRONMENT

### 3.2.1 Changing the Theme

<b>Functional description</b>	This tutorial describes how the user can choose the theme of the working environment between light/dark and automatic mode.
<b>Preconditions</b>	The user is on any screen of the application without any <a href="#">dialog</a> open.
<b>Expected result</b>	After changing the theme, the working environment is changed according to the user's selection.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *XRF-Explorer* icon in the header (Figure 20).
  - 2 The user is presented with a dropdown menu containing the available themes (Figure 21).
  - 3 Click on the preferred theme (for example the *Light mode* as presented in Figure 22).
  - 4 The user is presented with a working environment updated according to the chosen theme (Figure 23 with *Light mode* activated).
- 

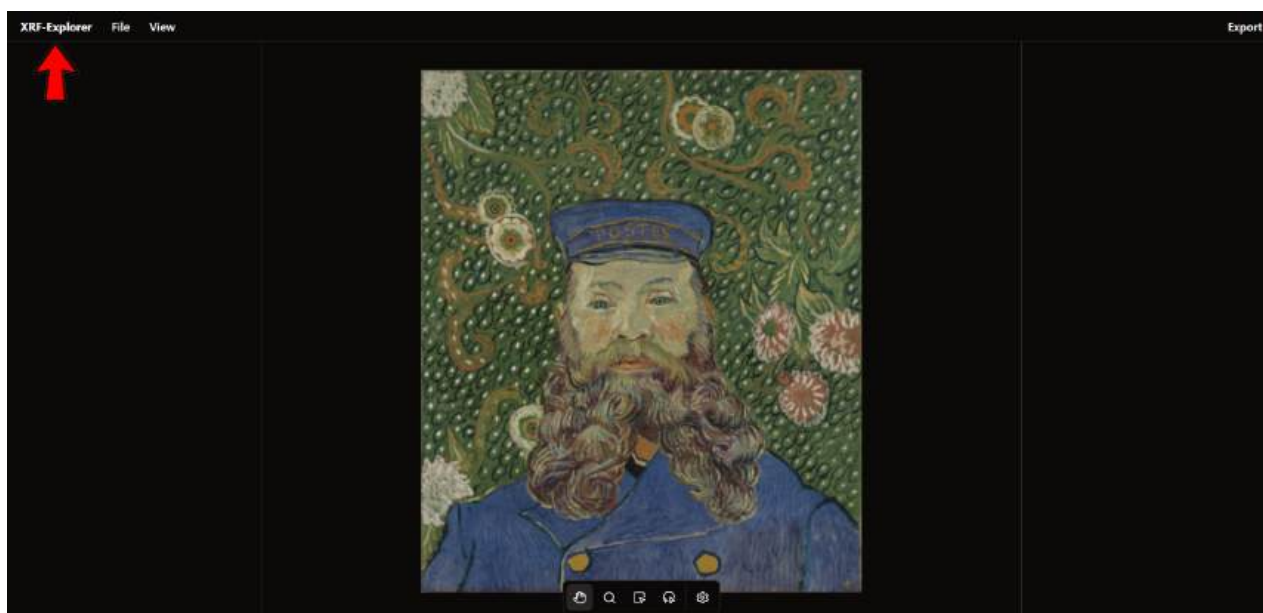


Figure 20: *XRF-Explorer* icon

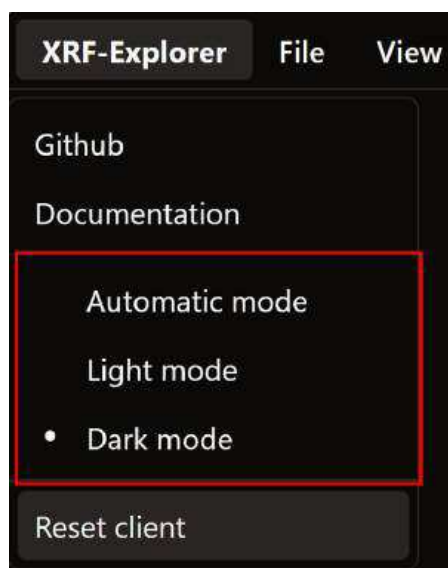


Figure 21: Available themes

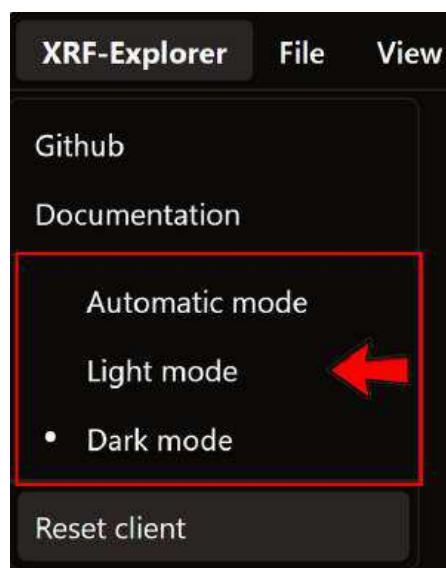


Figure 22: Light mode theme

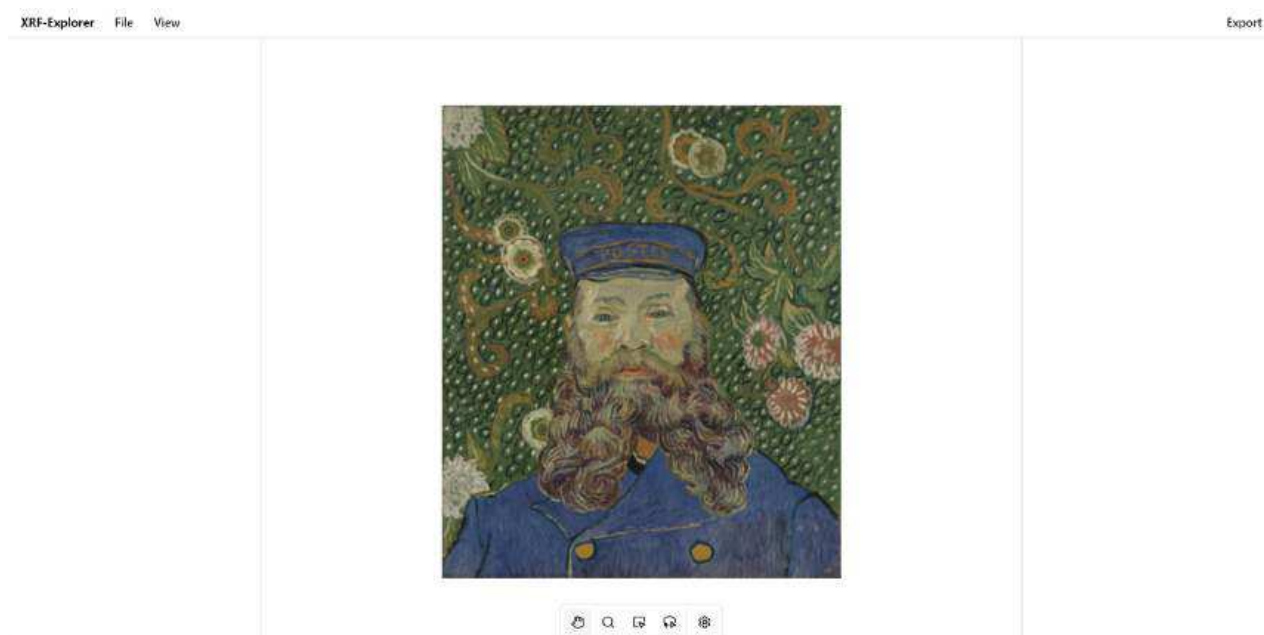


Figure 23: Workspace with Light mode activated

### 3.2.2 Enabling views from the header

<b>Functional description</b>	This tutorial describes how the user can enable the <b>views</b> to be displayed in the workspace.
<b>Preconditions</b>	There is at least one disabled <b>view</b> . A <b>view</b> can only be enabled if the data necessary for it has been uploaded.
<b>Expected result</b>	After enabling a <b>view</b> , the <b>view</b> will be visible in one of the workspace sidebars.
<b>Cautions and warnings</b>	The enabled <b>view</b> will be placed automatically in their default sidebar (either left or right). The user can change later in which of the sidebars the <b>view</b> is displayed.
<b>Likely errors</b>	None.

#### Procedure

- 1 Click on the *View* menu in the header (Figure 24).
- 2 The user is presented with the available **views** options.
- 3 The disabled **view** will be indicated by the absence of a tick mark next to them (Figure 25).
- 4 Click on any disabled **view** to be enabled (for example as shown is Figure 26).
- 5 The newly enabled **view** will be visible in one of the sidebars (Figure 27).

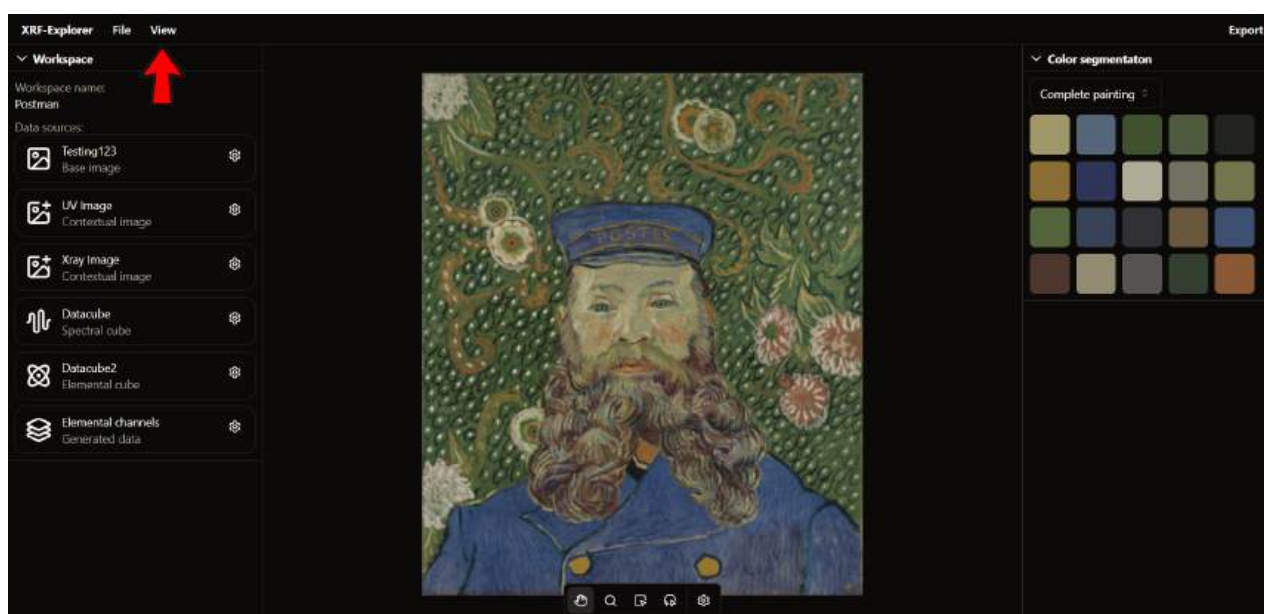


Figure 24: *View* menu

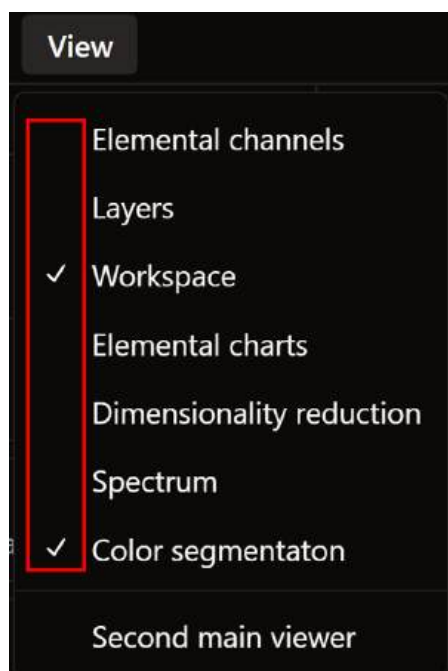


Figure 25: Enabled views indicated by tick marks

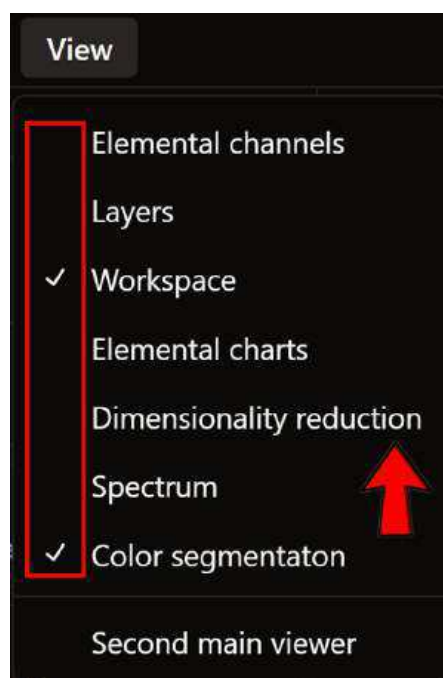


Figure 26: Disabled view without tick mark

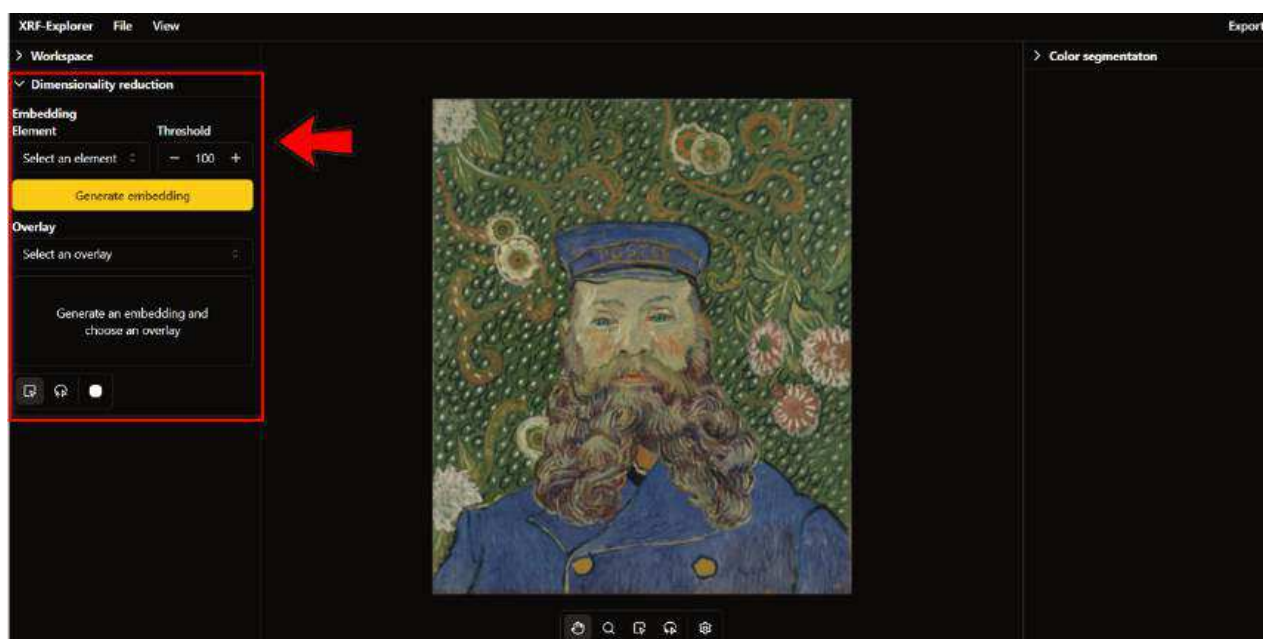


Figure 27: The newly enabled view

### 3.2.3 Disabling views from the header

<b>Functional description</b>	This tutorial describes how the user can disable the <a href="#">views</a> to not be displayed anymore in the workspace.
<b>Preconditions</b>	The user is on any screen of the application. There is at least one enabled <a href="#">view</a> .
<b>Expected result</b>	After disabling a <a href="#">view</a> , the <a href="#">view</a> will not be visible anymore in the workspace sidebars.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *View* menu in the header (Figure 24).
  - 2 The user is presented with the available [views](#) options.
  - 3 The enabled [views](#) will be indicated by the presence of a tick mark next to them (Figure 25).
  - 4 Click on any enabled [view](#) to be disabled.
  - 5 The newly disabled [view](#) will not be visible anymore in the sidebars.
- 

### 3.2.4 Enabling views directly in the desired sidebar

<b>Functional description</b>	This tutorial describes how the user can enable a <a href="#">view</a> directly in the desired sidebar.
<b>Preconditions</b>	The sidebar in which the <a href="#">view</a> is to be enabled is opened, and all necessary files for this <a href="#">view</a> are uploaded to the <a href="#">project</a> . The <a href="#">view</a> to be enabled is not already enabled in the bar.
<b>Expected result</b>	After enabling a <a href="#">view</a> , this will appear directly in the desired sidebar, rather than in the default one.
<b>Cautions and warnings</b>	Opening a <a href="#">view</a> that is already displayed in the other sidebar will automatically close the <a href="#">view</a> from the other bar.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Right click within the sidebar in which the [view](#) is to be displayed (but outside any enabled views from that sidebar).
  - 2 The user is presented with the available [views](#). The [views](#) indicated by a tick mark represent the [views](#) already enabled in this particular sidebar.
  - 3 Click on the desired [view](#) (for example as in Figure 28).
  - 4 The selected [view](#) will appear in the chosen sidebar (Figure 29).
-



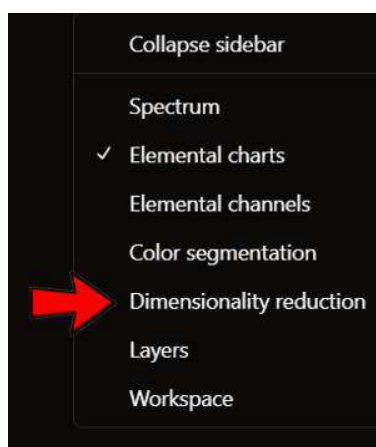


Figure 28: Views presented on right click

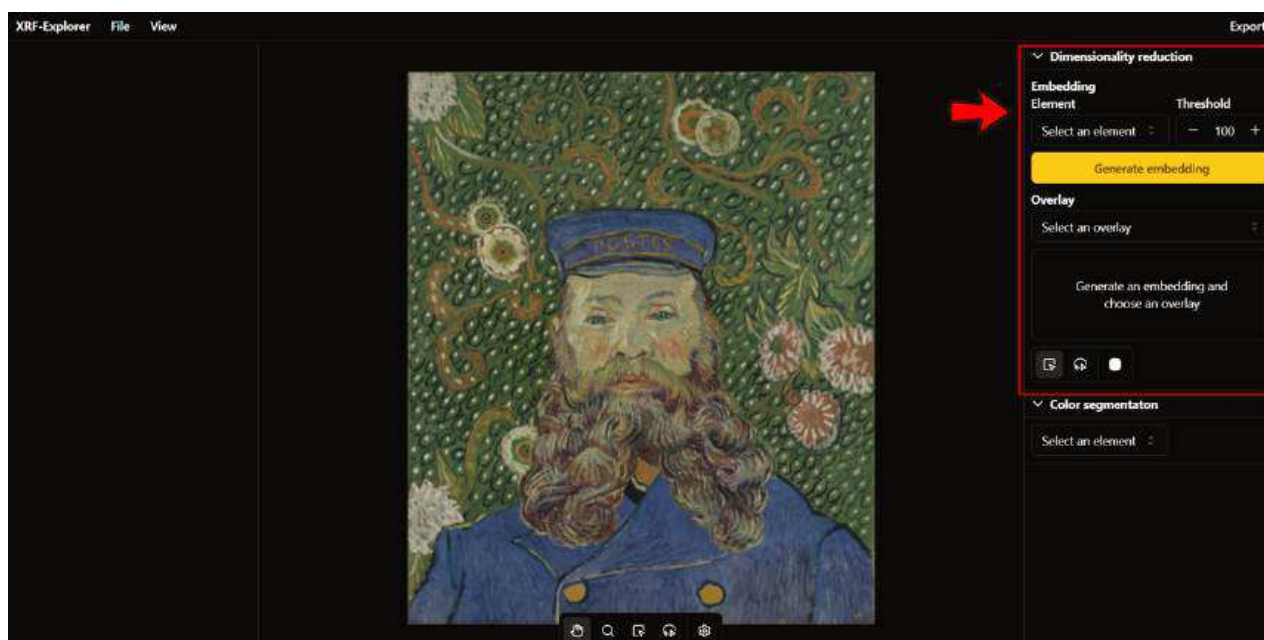


Figure 29: The view opened in the right sidebar

### 3.2.5 Disabling views directly from the sidebar

<b>Functional description</b>	This tutorial describes how the user can disable a <a href="#">view</a> directly from the sidebar.
<b>Preconditions</b>	There is at least one enabled <a href="#">view</a> .
<b>Expected result</b>	After disabling a <a href="#">view</a> , the <a href="#">view</a> will not be visible anymore in the workspace sidebar.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Right click on the [view](#) to be disabled.
  - 2 The user is presented with a list of actions options.
  - 3 Click on the *Closed* option (Figure 30).
  - 4 The respective [view](#) will disappear from the sidebar (Figure 31).
- 

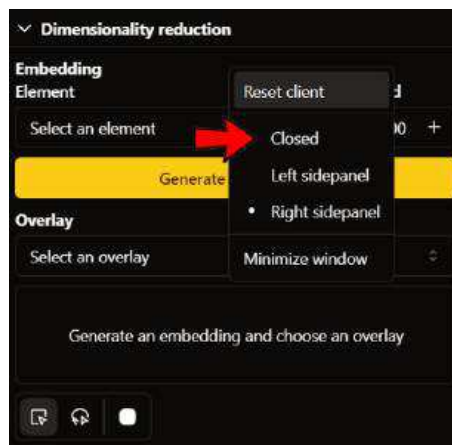


Figure 30: The *Closed* option

### 3.2.6 Switching the position of a view

<b>Functional description</b>	This tutorial describes how the user can switch the position of a <a href="#">view</a> from one sidebar to the other.
<b>Preconditions</b>	There is at least one <a href="#">view</a> enabled.
<b>Expected result</b>	The sidebar in which the <a href="#">view</a> is positioned is changed.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.



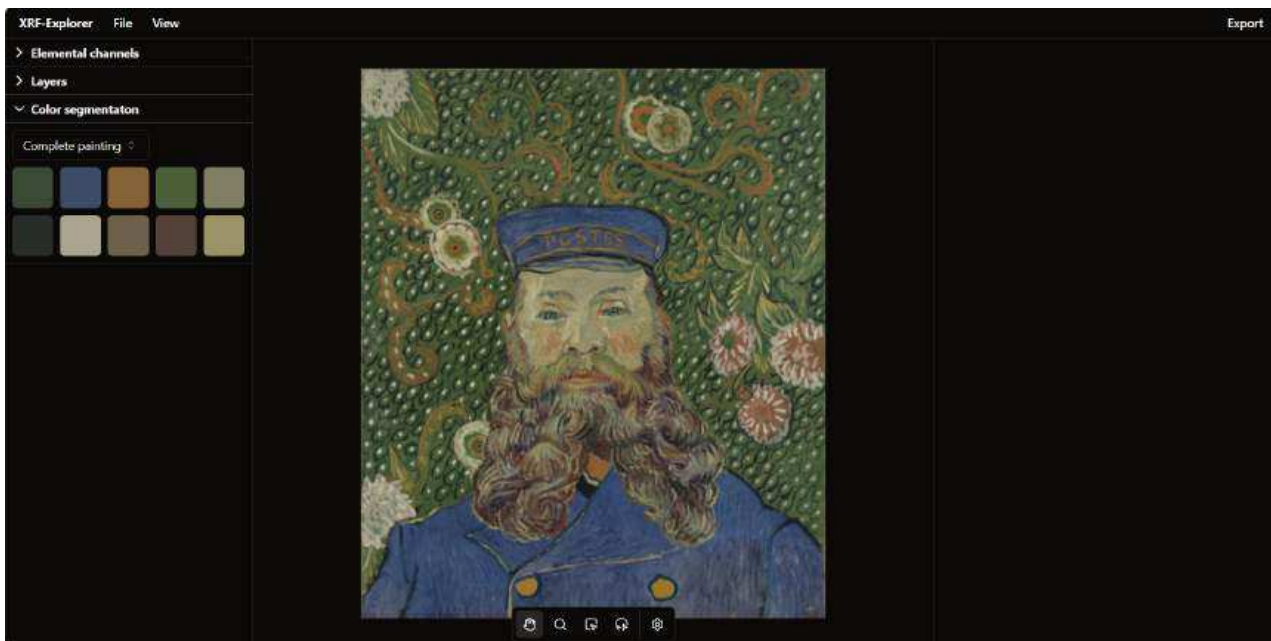


Figure 31: The view is closed

### Procedure

- 1 Right click within the **view** whose position is to be switched.
- 2 The user is presented with a set actions options (Figure 32).
- 3 Click on the option *Left sidepanel* if the **view** is to be moved to the left sidebar, or the option *Right sidepanel* if the **view** is to be moved to the right sidebar (Figure 32).
- 4 The **view** is switched to the other sidebar (Figure 33).

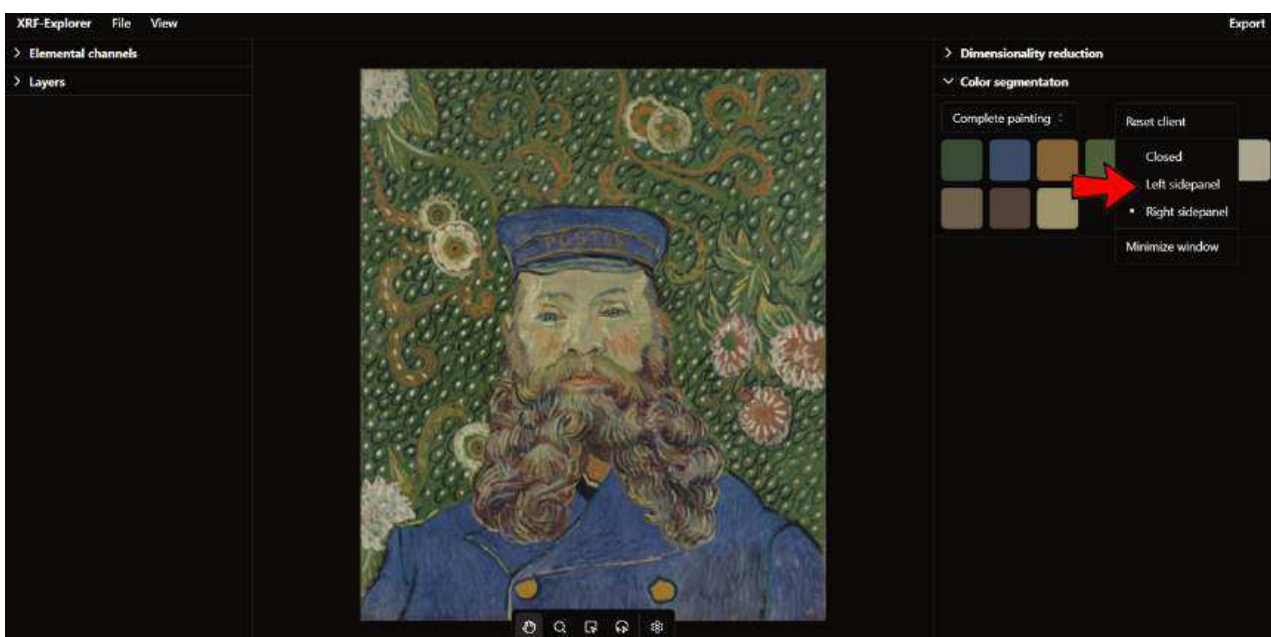


Figure 32: View currently in the right sidebar

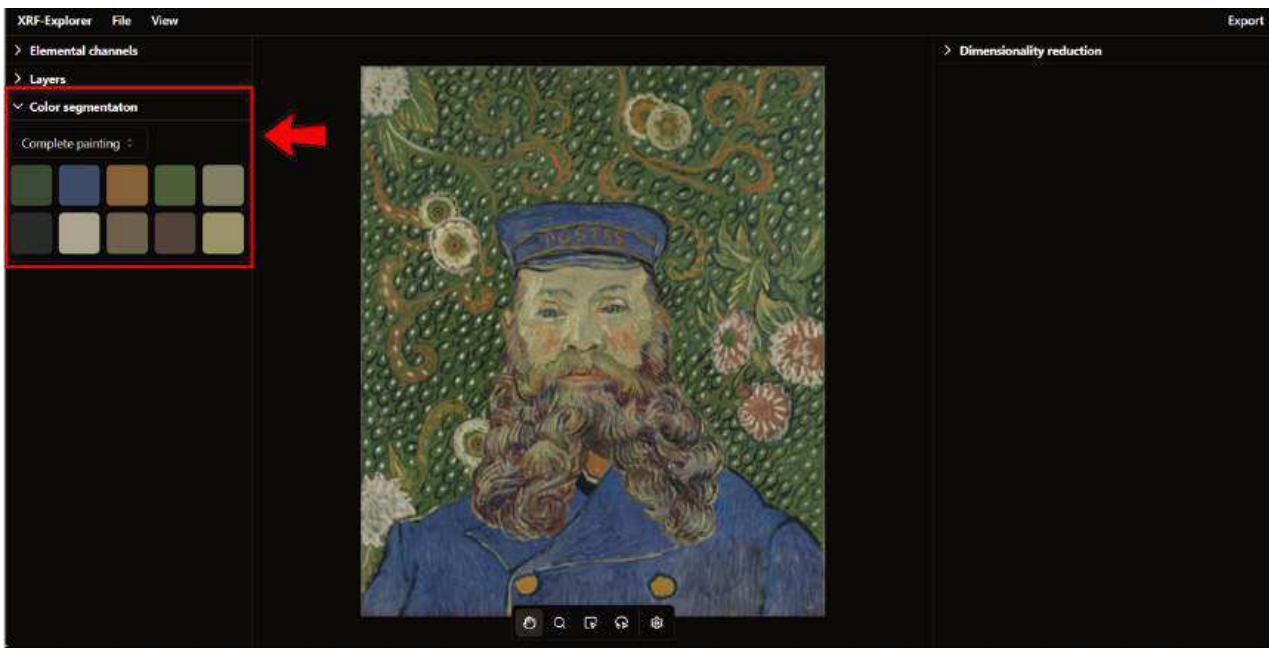


Figure 33: View switched to the left sidebar

### 3.2.7 Collapse sidebar

#### Functional description

This tutorial describes how the user can collapse the sidebar.

#### Preconditions

There is at least one sidebar visible.

#### Expected result

After collapsing the sidebar, the respective sidebar is not visible anymore.

#### Cautions and warnings

After collapsing the sidebar, the [views](#) belonging to it will be collapsed as well and the only way to restore the bar with the [view](#) is by dragging it from the corresponding side of the screen.

#### Likely errors

None.

---

#### Procedure

---

- 1 Right click within the sidebar to be collapsed.
  - 2 The user is presented with a set of actions options (Figure [28](#)).
  - 3 Click on the *Collapse sidebar* option.
  - 4 The respective sidebar will not be visible anymore (Figure [34](#)).
-

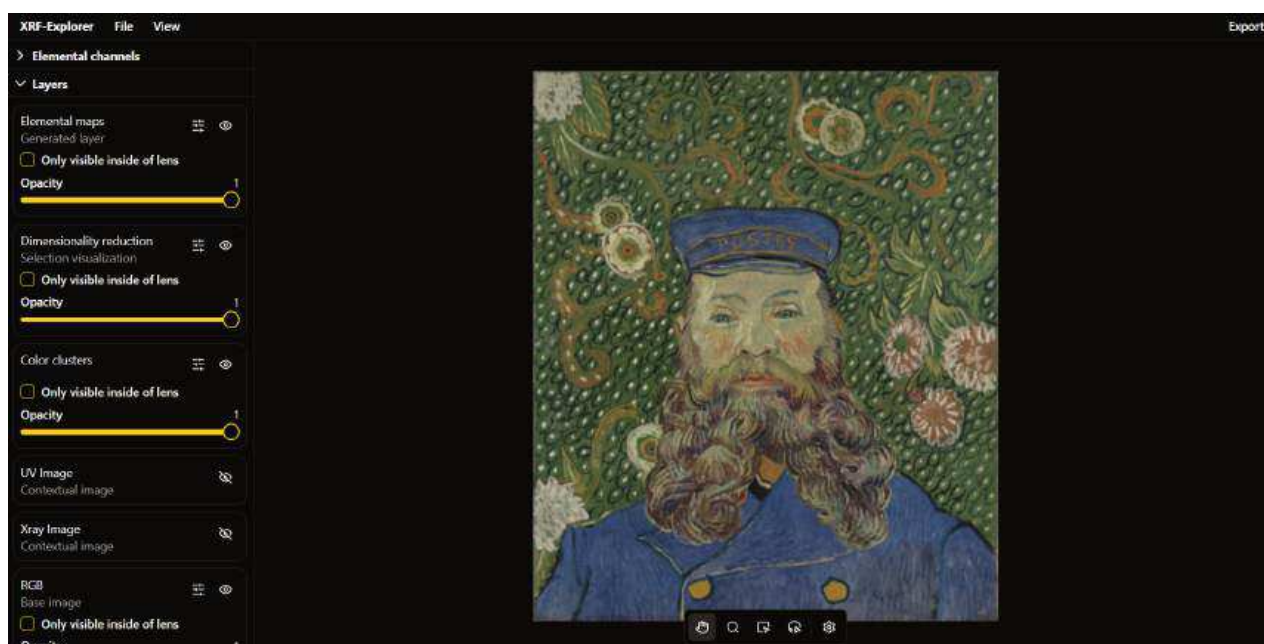


Figure 34: Right sidebar collapsed

### 3.2.8 Enabling the second main viewer

<b>Functional description</b>	This tutorial describes how the user can enable the second <a href="#">main viewer</a> to be displayed in the workspace.
<b>Preconditions</b>	The user is on any screen of the application. The second <a href="#">main viewer</a> is disabled.
<b>Expected result</b>	After enabling the <a href="#">main viewer</a> , the two <a href="#">main viewers</a> will be visible in the center of the application.
<b>Cautions and warnings</b>	Enabling the second <a href="#">main viewer</a> is not instantaneous and may take a couple of seconds to load.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *View* menu in the menu bar (Figure 24).
  - 2 The user is presented with the option to enable the second [main viewer](#) (Figure 35).
  - 3 The disabled *Second main viewer* will be indicated by the absence of a tick mark next to it.
  - 4 Click on the *Second main viewer* item.
  - 5 The newly enabled [main viewer](#) will be visible in the center of the application.
-

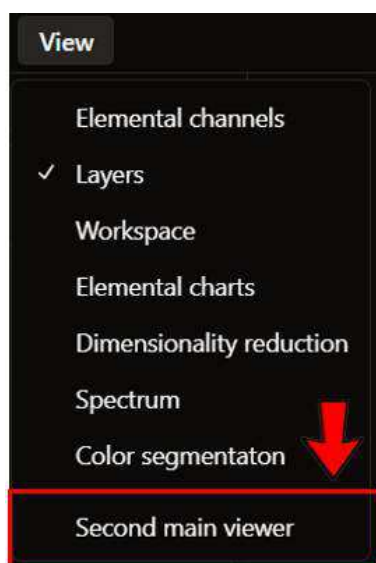


Figure 35: Second main viewer option



Figure 36: Second main viewer enabled

### 3.2.9 Disabling the second main viewer

<b>Functional description</b>	This tutorial describes how the user can disable the second <a href="#">main viewer</a> from being displayed in the workspace.
<b>Preconditions</b>	The user is on any screen of the application. The second <a href="#">main viewer</a> is enabled.
<b>Expected result</b>	After disabling the second <a href="#">main viewer</a> , one <a href="#">main viewer</a> will be visible in the center of the application.
<b>Cautions and warnings</b>	Disabling the second <a href="#">main viewer</a> is not instantaneous and may take a couple of seconds to load.
<b>Likely errors</b>	None.

---

#### Procedure

- 1 Click on the *View* menu in the header (Figure [24](#)).
  - 2 The user is presented with the option to disable the second [main viewer](#).
  - 3 The enabled *Second main viewer* will be indicated by the presence of a tick mark next to them.
  - 4 Click on the *Second main viewer* to be disabled.
  - 5 Only one [main viewer](#) will be visible in the center of the application.
- 

### 3.2.10 Reset workspace

<b>Functional description</b>	This tutorial describes how the user can reset the working environment to the initial state of the application.
<b>Preconditions</b>	The user is on any screen of the application, and no <a href="#">dialogs</a> are opened.
<b>Expected result</b>	After resetting, the workspace is cleared.
<b>Cautions and warnings</b>	The resetting action is irreversible.
<b>Likely errors</b>	None.

---

#### Procedure

- 1 Click on the *XRF-Explorer* icon in the header (Figure [20](#)).
  - 2 The user is presented with a dropdown menu.
  - 3 Click on the *Reset client* item (Figure [37](#)).
  - 4 A window asking the user to confirm the refreshing of the webpage pops up.
  - 5 Click the *Confirm* button (Figure [38](#)).
  - 6 The current workspace is cleared (Figure [39](#)).
-

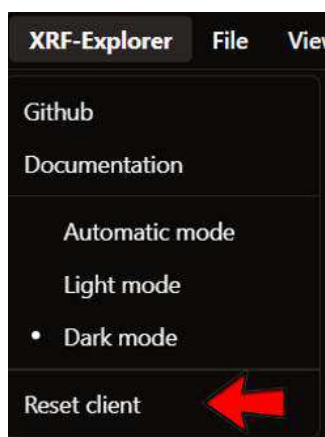


Figure 37: The reset button



Figure 38: Confirm resetting

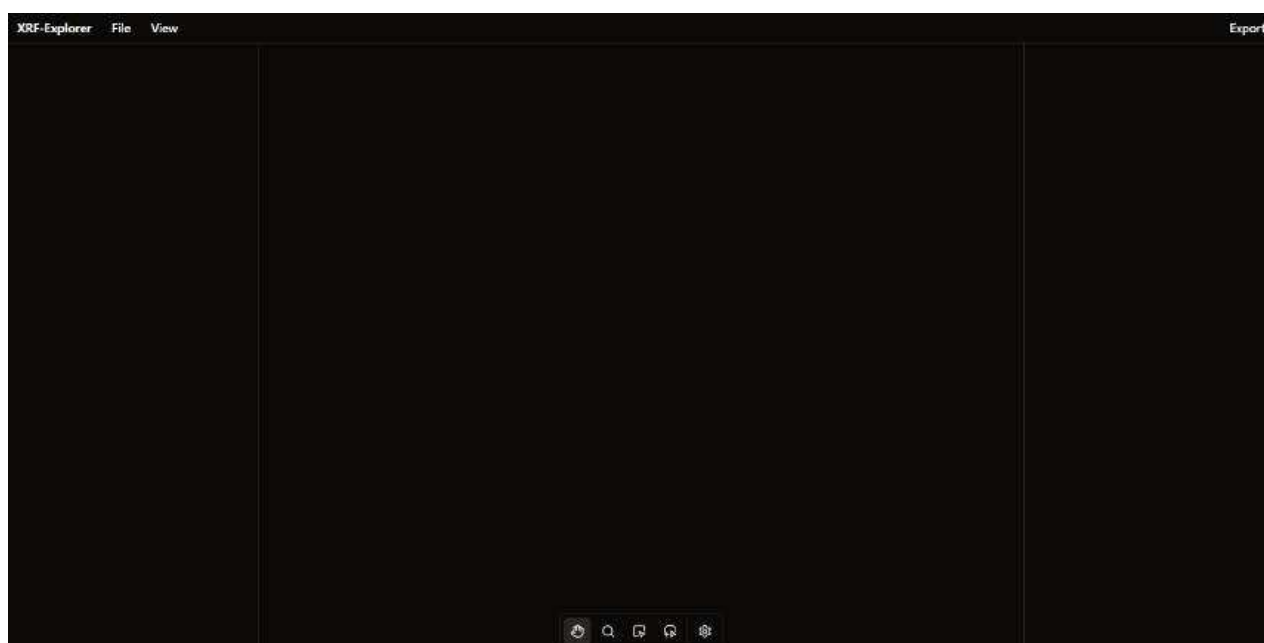


Figure 39: The cleared workspace



### 3.3 LAYER SYSTEM TUTORIALS

#### 3.3.1 Reordering the layer hierarchy

<b>Functional description</b>	This tutorial describes how the user can change the order in which the <a href="#">layers</a> are displayed in the <a href="#">main viewer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There are at least 2 <a href="#">layers</a> present.
<b>Expected result</b>	After reordering the <a href="#">layers</a> , the <a href="#">layer stack</a> and <a href="#">main viewer</a> are updated in accordance to this change in <a href="#">layer</a> position.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

#### Procedure

- 1 Drag and drop the [layer](#) to be moved into the desired position (Figure 40).
- 2 The order in which the [layers](#) will be displayed in the [main viewer](#) will follow the top-to-bottom order of the [layers](#) in the *Layers* view (Figure 41).

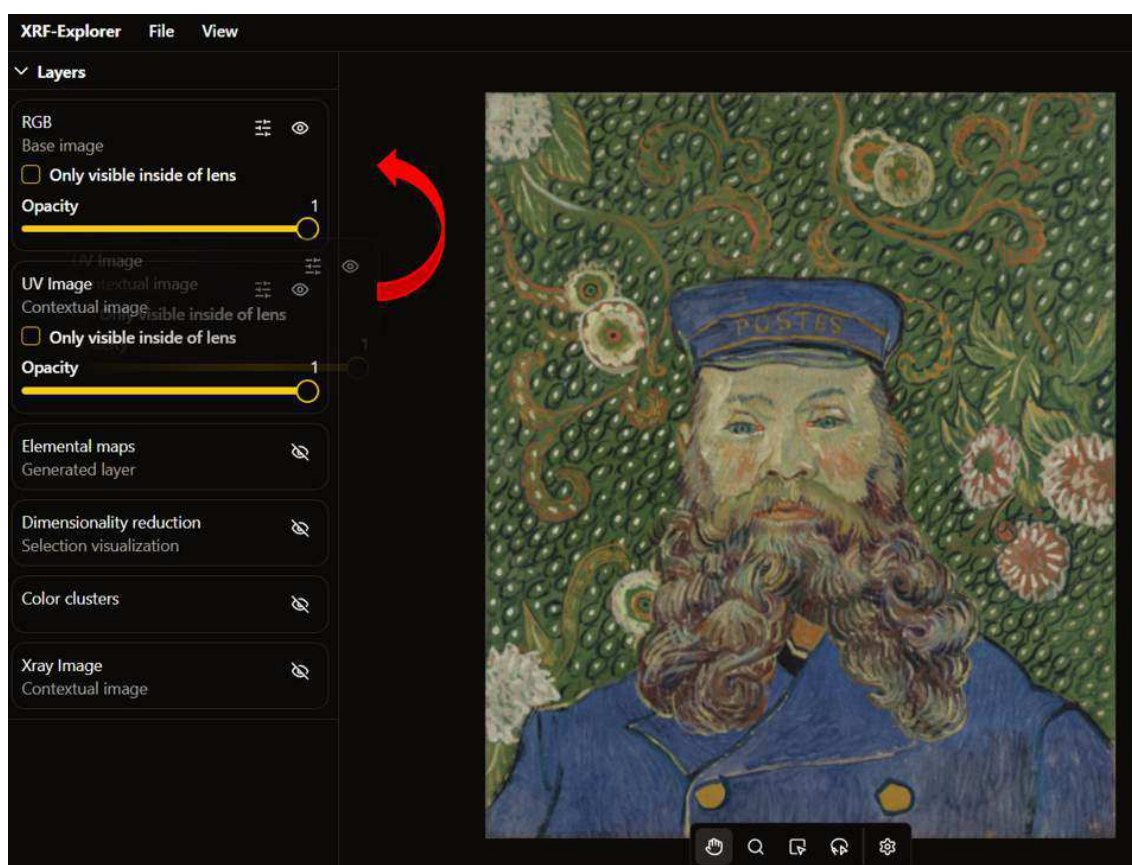


Figure 40: Drag and drop layer

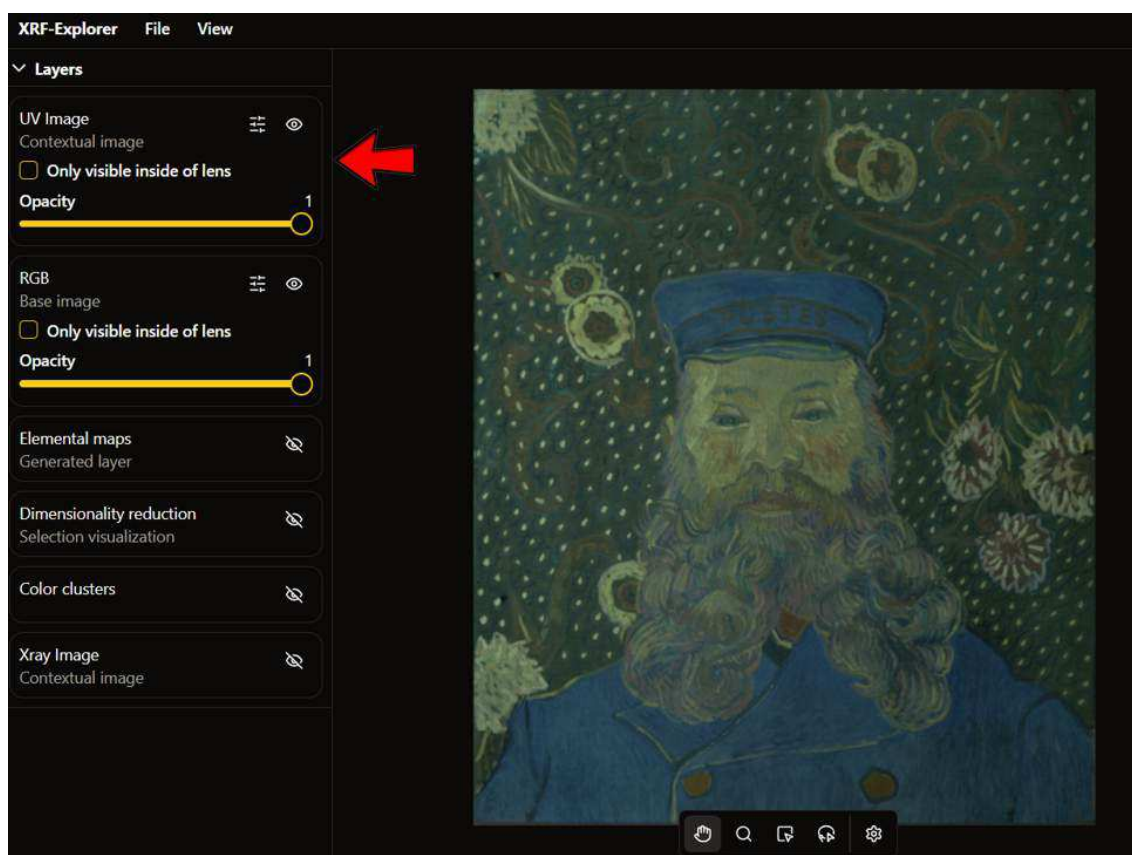


Figure 41: The Layer in the new position

### 3.3.2 Enabling a layer

#### Functional description

This tutorial describes how the user can enable a [layer](#) to be displayed in the [main viewer](#).

#### Preconditions

The *Layers* view is enabled. There is at least one disabled [layer](#).

#### Expected result

After enabling a [layer](#), it will be visible in the [main viewer](#), respecting the [layer hierarchy](#).

#### Cautions and warnings

When two [main viewers](#) are enabled, this will update both [main viewers](#).

#### Likely errors

None.

---

#### Procedure

- 1 Within the *Layers* view, choose a disabled [layer](#) (indicated by the 'Hide' icon) to enable and click the *Toggle visibility* icon (Figure 42).
  - 2 The enabled [layer](#) will be displayed in the viewer with respect to the chosen [layer hierarchy](#) (Figure 43).
-



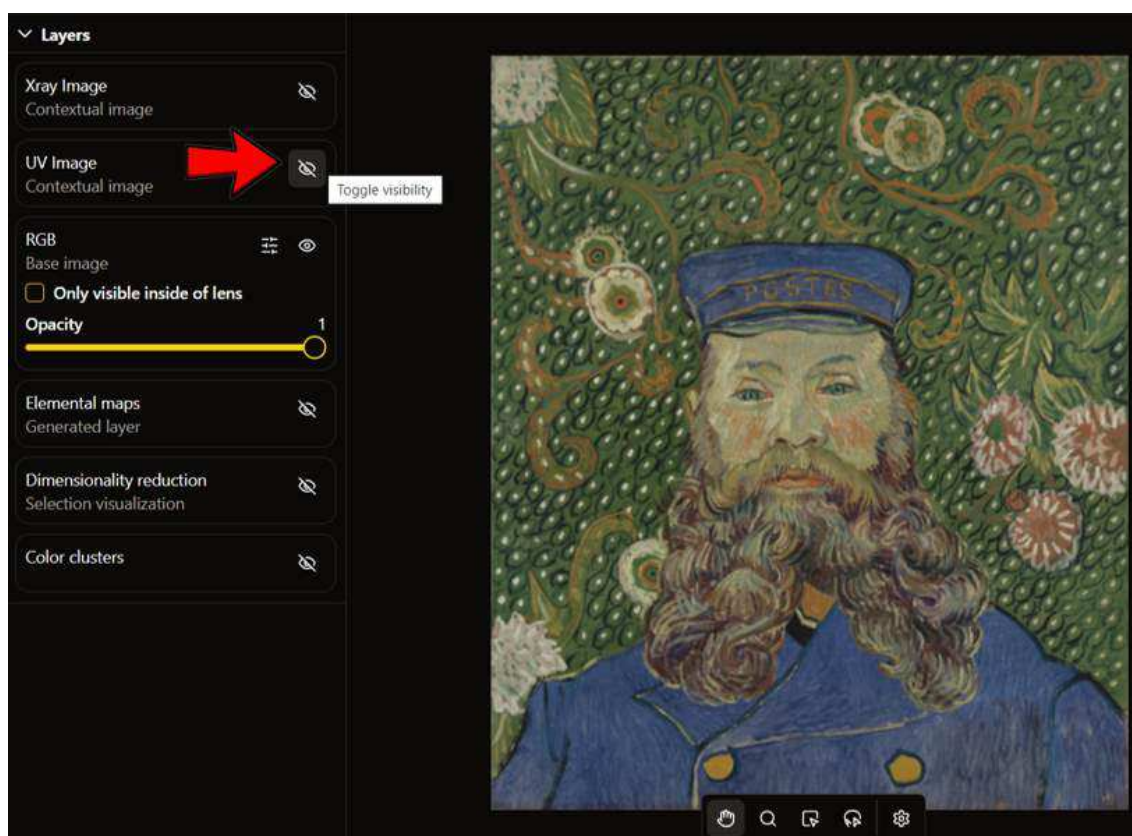


Figure 42: Toggle visibility icon

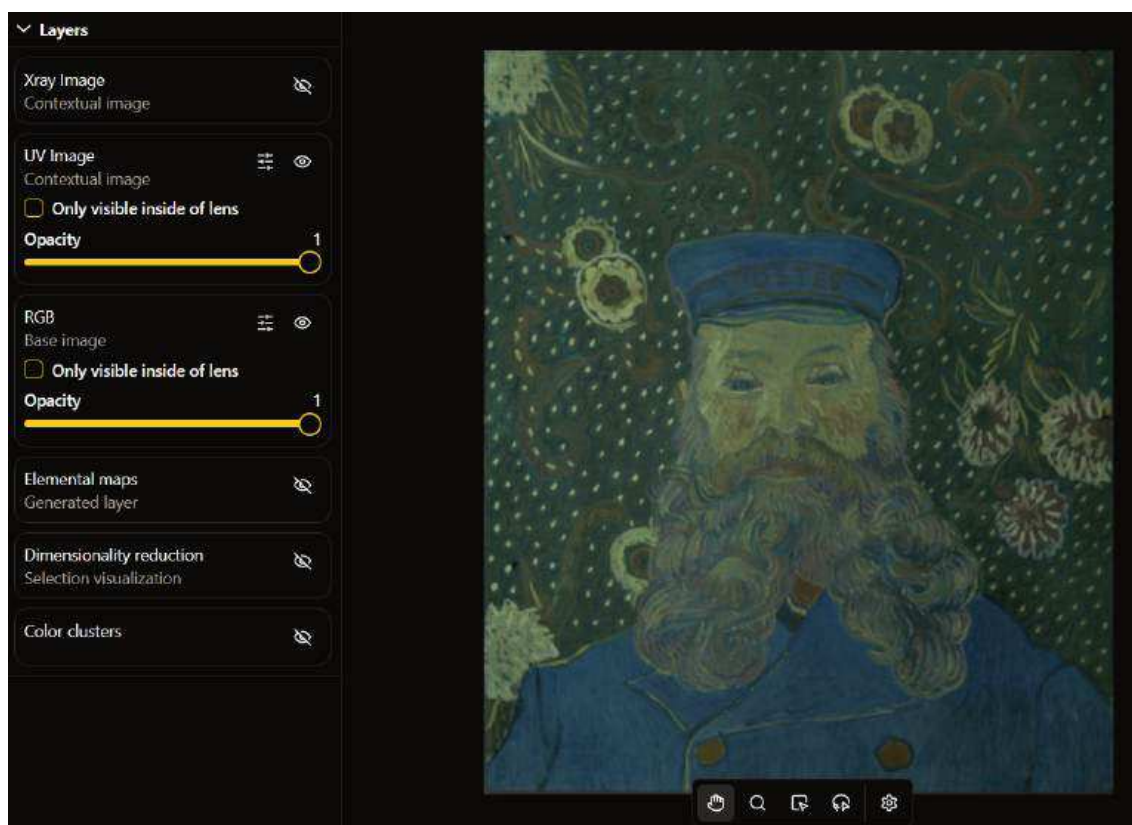


Figure 43: The layer enabled

### 3.3.3 Disabling a layer

<b>Functional description</b>	This tutorial describes how the user can disable a <a href="#">layer</a> to not be displayed anymore in the <a href="#">main viewer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There is at least one enabled <a href="#">layer</a> present.
<b>Expected result</b>	After disabling a <a href="#">layer</a> , it will not be visible anymore in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

#### Procedure

- 1 Within the *Layers* view, choose an enabled [layer](#) (indicated by the 'Show' icon) to disable and click the *Toggle visibility* icon (Figure 44).
- 2 The disabled [layer](#) will not be displayed in the viewer anymore (Figure 45).

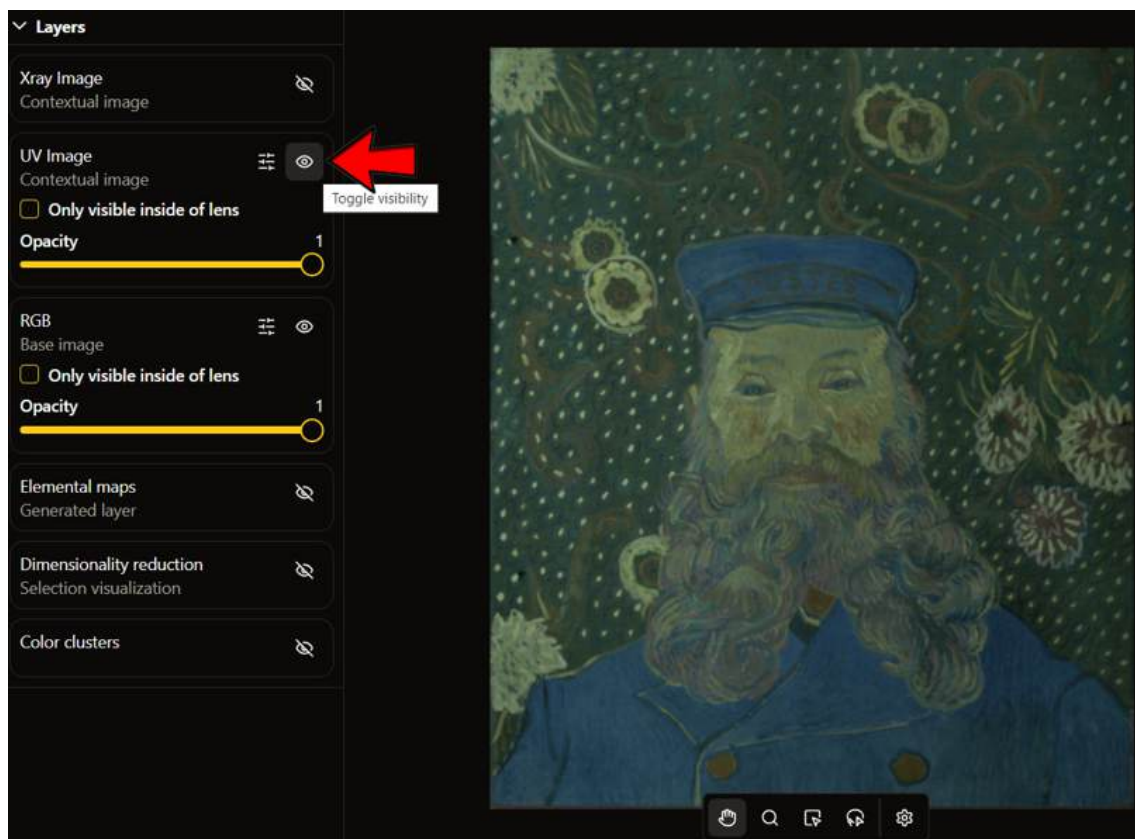


Figure 44: Toggle visibility icon

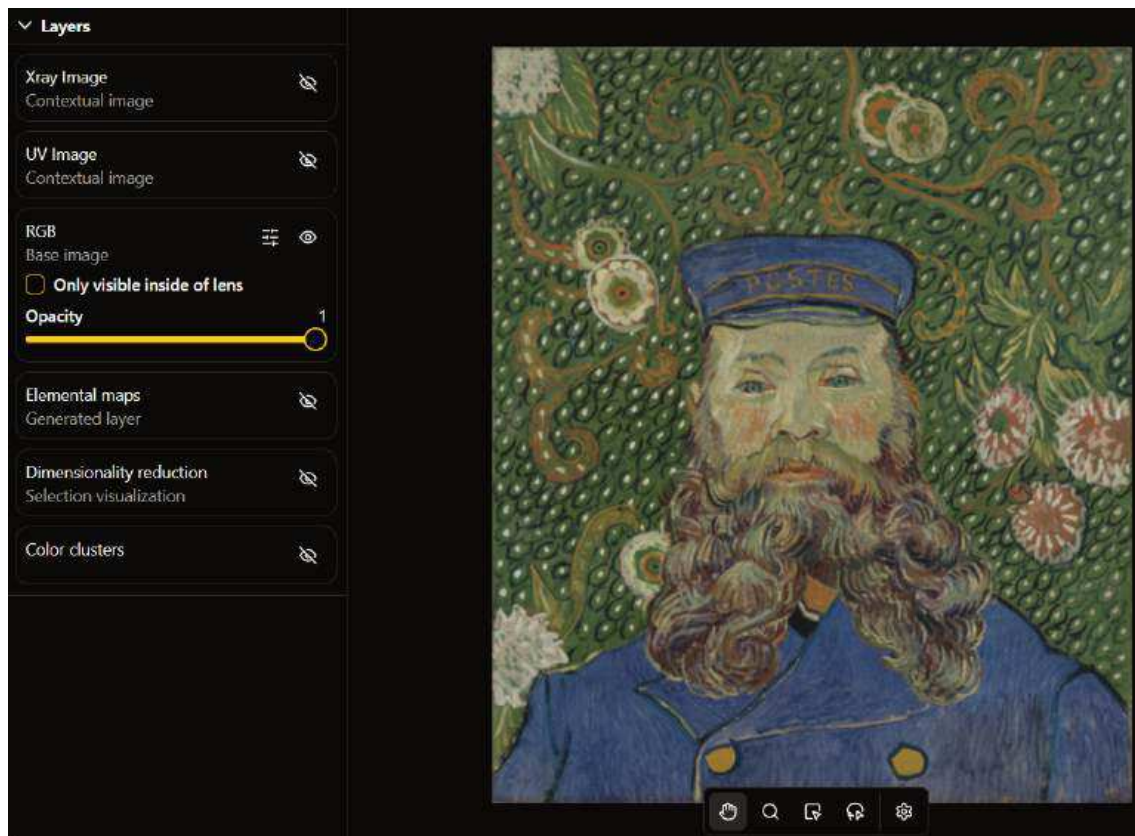


Figure 45: The layer disabled

### 3.3.4 Opacity of layers

<b>Functional description</b>	This tutorial describes how the user can change the opacity of a <a href="#">layer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There is at least one <a href="#">layer</a> enabled.
<b>Expected result</b>	The opacity of the adjusted <a href="#">layer</a> is updated accordingly and is visible in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

---

#### Procedure

- 1 Within the enabled [layer](#)'s section, adjust the opacity of this [layer](#) by moving the *Opacity* slider.
  - 2 The [main viewer](#) will update to display the [layer](#) with the adjusted opacity (Figure 46).
-



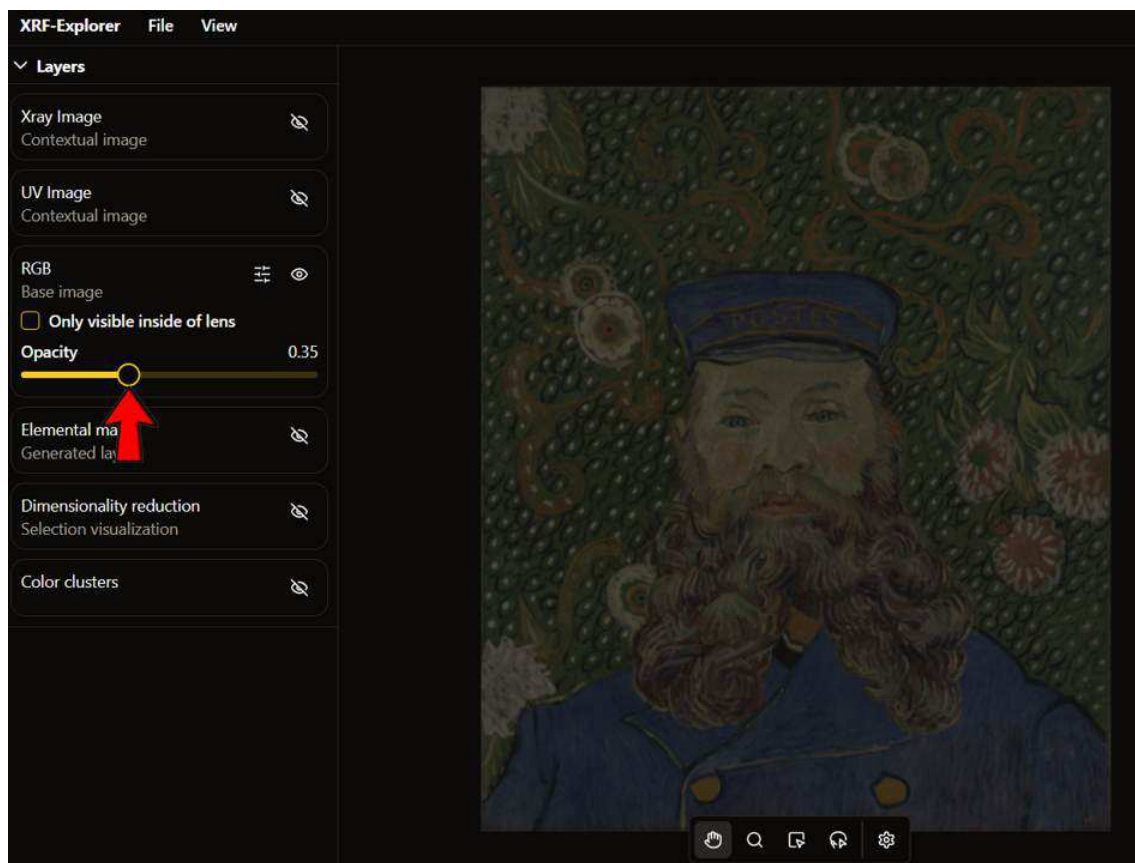


Figure 46: Changed opacity

### 3.3.5 Contrast of layers

<b>Functional description</b>	This tutorial describes how the user can change the contrast of a <a href="#">layer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There is at least one <a href="#">layer</a> enabled.
<b>Expected result</b>	The contrast of the adjusted <a href="#">layer</a> is updated accordingly and is visible in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Within the [layer](#)'s section, click on the *Additional sliders* icon (Figure 47).
  - 2 The user is presented with a set of sliders to adjust the visual settings of that specific [layer](#).
  - 3 Adjust the contrast of this [layer](#) by moving the *Contrast* slider.
  - 4 The [main viewer](#) will update to display the [layer](#) with the adjusted contrast (Figure 48).
-

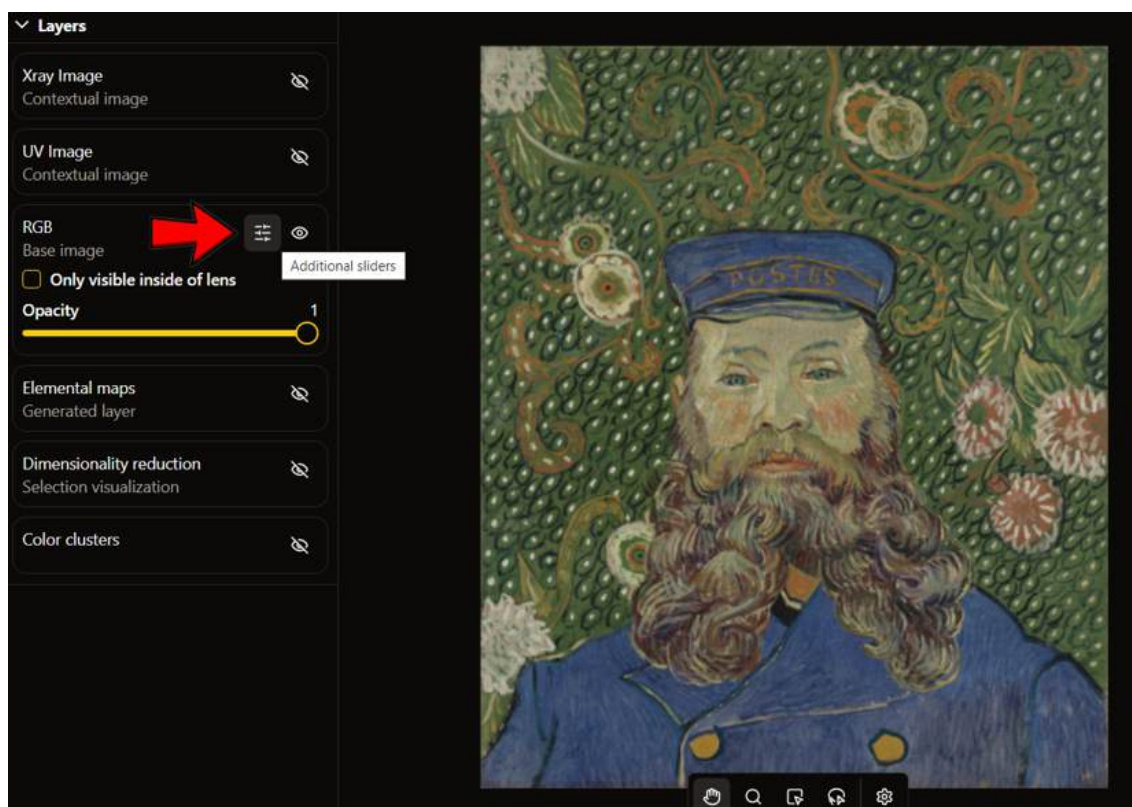


Figure 47: Additional sliders icon

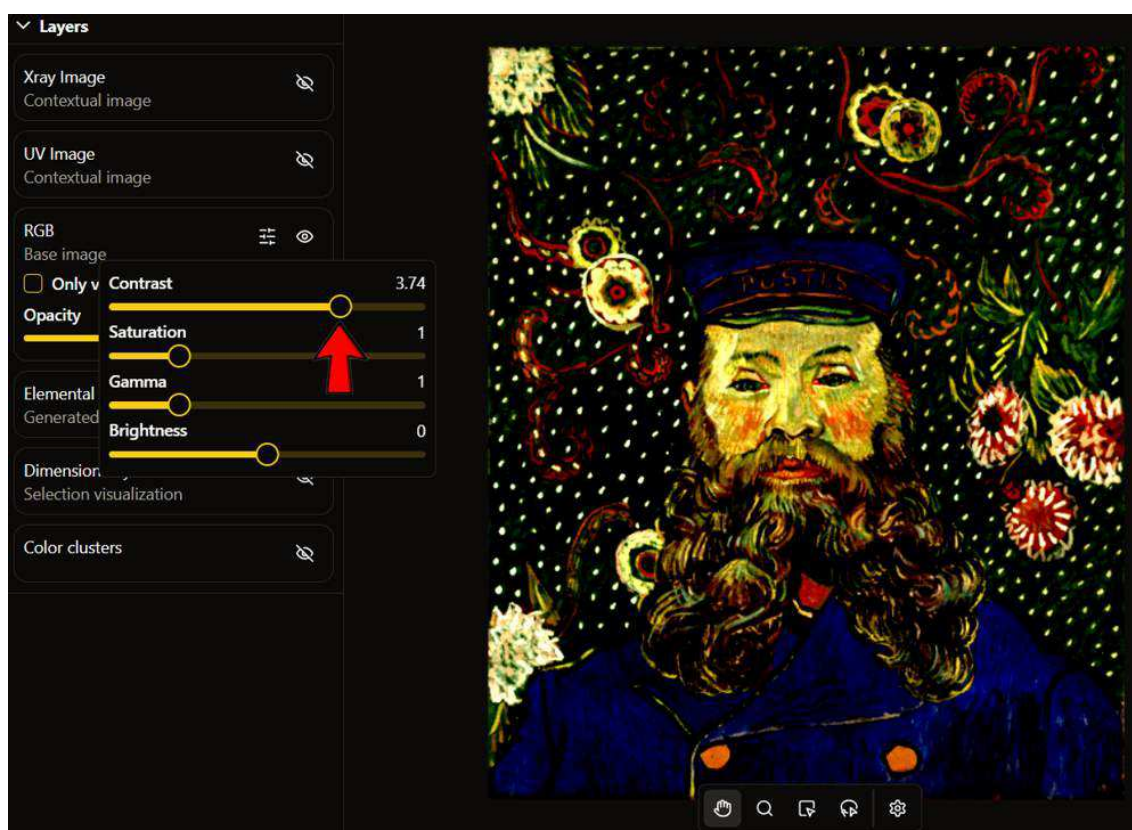


Figure 48: Changed contrast

### 3.3.6 Saturation of layers

<b>Functional description</b>	This tutorial describes how the user can change the saturation of a <a href="#">layer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There is at least one <a href="#">layer</a> enabled.
<b>Expected result</b>	The saturation of the adjusted <a href="#">layer</a> is updated accordingly and is visible in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

#### Procedure

- 1 Within the enabled [layer](#)'s section, click on the *Additional sliders* icon (Figure 47).
- 2 The user is presented with a set of sliders to adjust the visual settings of that specific [layer](#).
- 3 Adjust the saturation of this [layer](#) by moving the *Saturation* slider.
- 4 The [main viewer](#) will update to display the [layer](#) with the adjusted saturation (Figure 49).

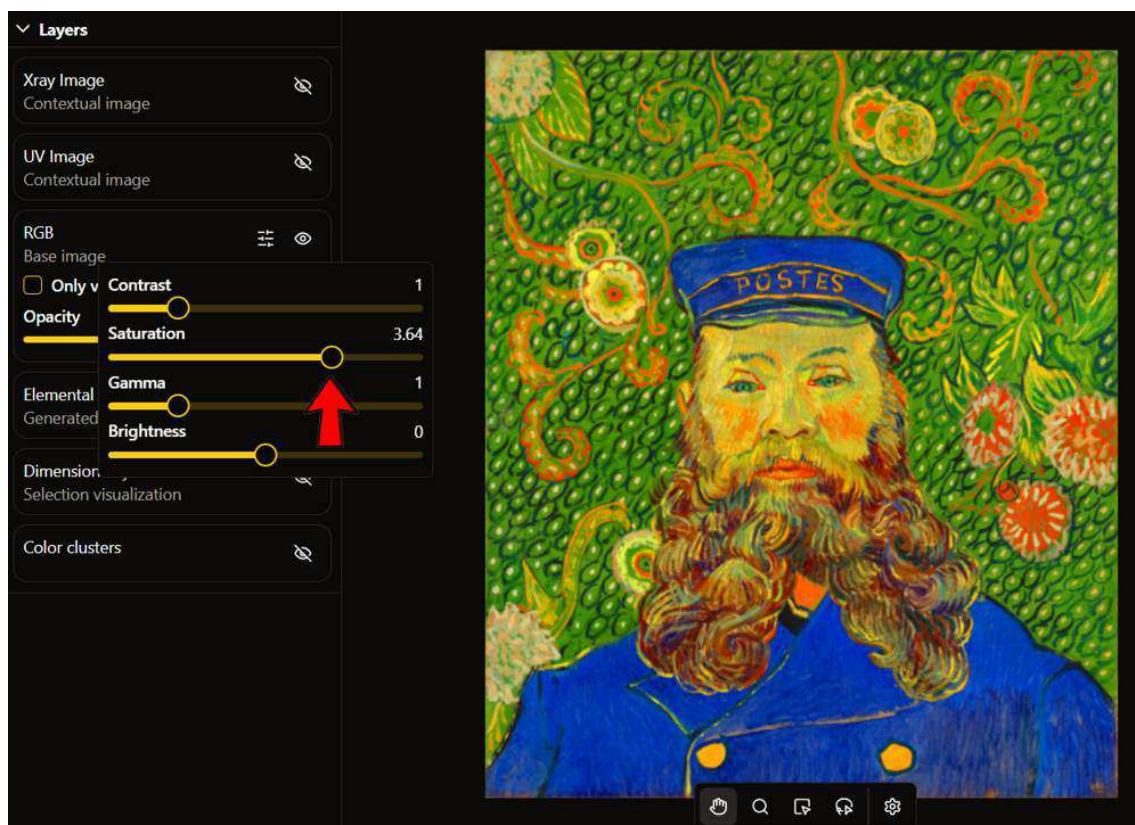


Figure 49: Changed saturation



### 3.3.7 Gamma correction of layers

<b>Functional description</b>	This tutorial describes how the user can change the gamma correction of a <a href="#">layer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There is at least one <a href="#">layer</a> enabled.
<b>Expected result</b>	The gamma correction of the adjusted <a href="#">layer</a> is updated accordingly and is visible in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

#### Procedure

- 1 Within the enabled [layer](#)'s section, click on the *Additional sliders* icon (Figure 47).
- 2 The user is presented with a set of sliders to adjust the visual settings of that specific [layer](#).
- 3 Adjust the gamma correction of this [layer](#) by moving the *Gamma* slider.
- 4 The [main viewer](#) will update to display the [layer](#) with the adjusted gamma correction (Figure 50).

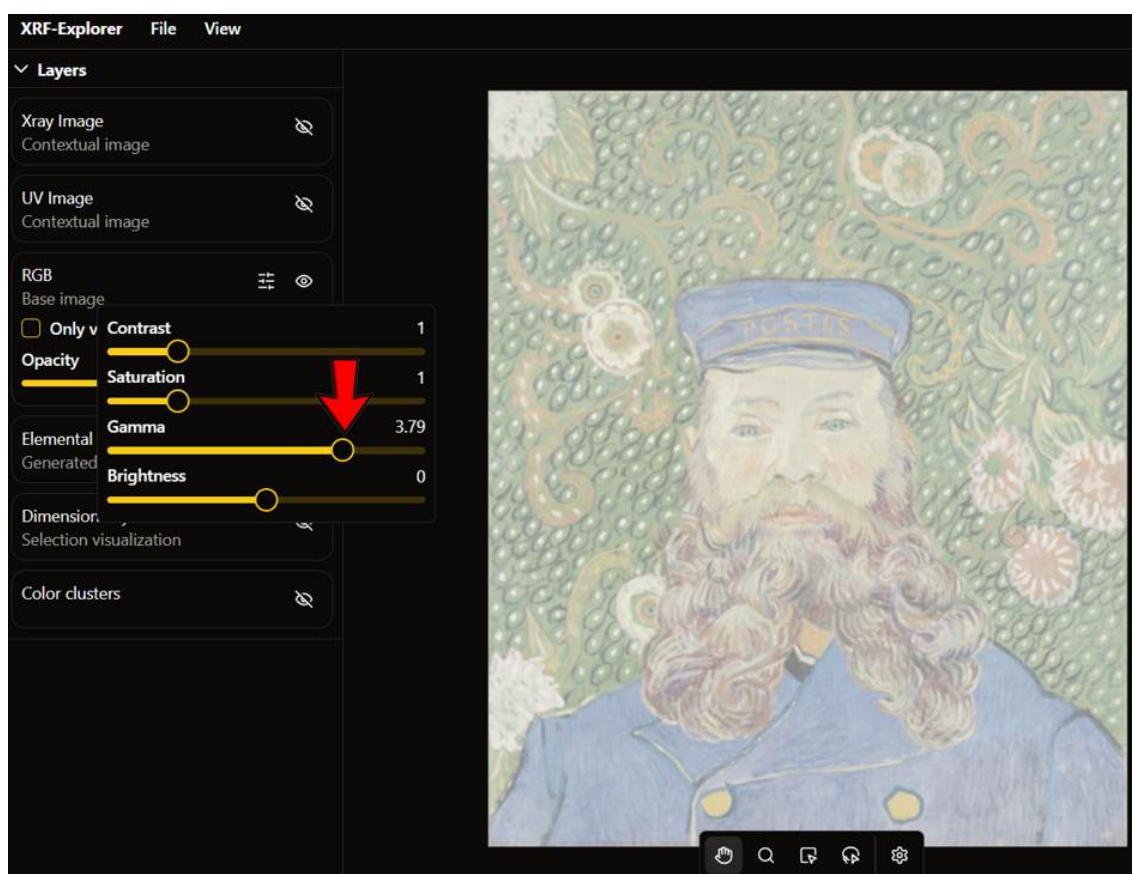


Figure 50: Changed gamma value

### 3.3.8 Brightness of layers

<b>Functional description</b>	This tutorial describes how the user can change the brightness of a <a href="#">layer</a> .
<b>Preconditions</b>	The <i>Layers</i> view is enabled. There is at least one <a href="#">layer</a> enabled.
<b>Expected result</b>	The brightness of the adjusted <a href="#">layer</a> is updated accordingly and is visible in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

#### Procedure

- 1 Within the enabled [layer](#)'s section, click on the *Additional sliders* icon (Figure 47).
- 2 The user is presented with a set of sliders to adjust the visual settings of that specific [layer](#).
- 3 Adjust the brightness of this [layer](#) by moving the *Brightness* slider.
- 4 The [main viewer](#) will update to display the [layer](#) with the adjusted brightness (Figure 51).

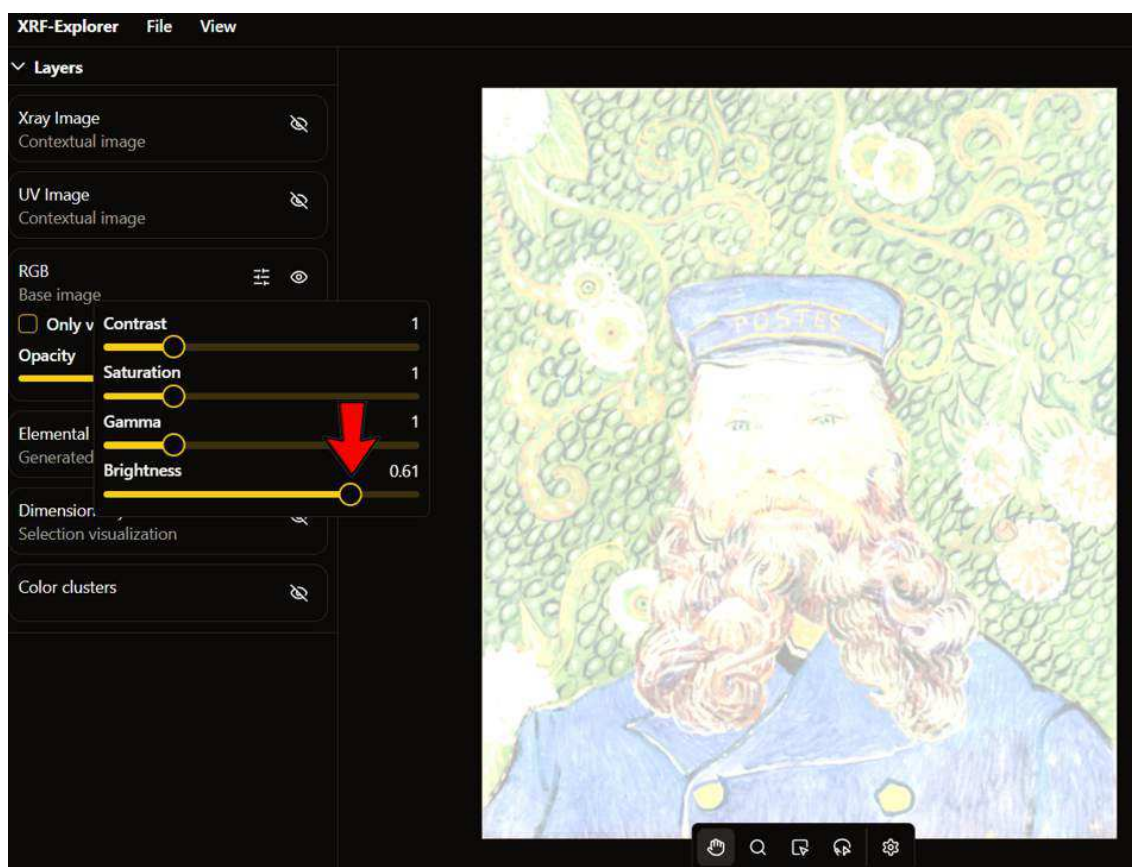


Figure 51: Changed brightness



### 3.3.9 Resetting a slider

<b>Functional description</b>	This tutorial describes how the user can reset the value of the slider to the default one.
<b>Preconditions</b>	The user has adjusted any of the available sliders and this slider is visible.
<b>Expected result</b>	After resetting the slider, its value is set to the default one.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Double click anywhere on the slider to reset it.
  - 2 The value of the slider is reset to the default value.
- 

## 3.4 WORKSPACE TUTORIALS

### 3.4.1 Edit workspace data

<b>Functional description</b>	This tutorial describes how the user can edit the workspace data.
<b>Preconditions</b>	A <a href="#">project</a> has been loaded. The <i>Workspace</i> view is enabled.
<b>Expected result</b>	The <a href="#">project</a> is edited based on the user's changes.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When pressing the Save button, a <a href="#">toast message</a> could appear with the error "Failed to update workspace" (see <a href="#">Error 4</a> ).

---

#### Procedure

---

- 1 Within the *Workspace* view, click on the *Configure* icon associated with any of the projects (except the *Elemental channels*) (Figure [52](#)).
  - 2 The user is presented with the window to set up workspace data (Section [4.2.3](#)).
  - 3 Make the desired changes in the workspace data as presented in Tutorial [3.1.1](#).
  - 4 Click the *Save* button.
- 

### 3.4.2 Edit elemental channels

<b>Functional description</b>	This tutorial describes how the user can edit the <a href="#">elements</a> channels.
<b>Preconditions</b>	A <a href="#">project</a> has been loaded. The <i>Workspace</i> view is enabled.
<b>Expected result</b>	The elemental channels are filtered according to the user's changes.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When pressing the Save button, a <a href="#">toast message</a> could appear with the error "Failed to initialize elemental channels" (see <a href="#">Error 6</a> ).



Figure 52: Configure icons to edit workspace

---

### Procedure

---

- 1 Within the *Workspace* view, click on the *Configure* icon associated with the *Elemental channels* (Figure 53).
  - 2 The user is presented with a window to set up the elemental channels.
  - 3 Choose which *elements* to enable by selecting the associated checkboxes (Figure 17).
  - 4 When the final selection has been made, click the *Save* button (Figure 18).
- 



Figure 53: Configure icon to set up elemental channels

### 3.4.3 Deleting a project

<b>Functional description</b>	This tutorial describes how the user can delete a project from the application.
<b>Preconditions</b>	There is at least one <a href="#">project</a> created.
<b>Expected result</b>	After deleting the <a href="#">project</a> , it will be removed from the server and it will not be visible in the <a href="#">projects list</a> anymore.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When pressing the <i>Delete project</i> button, it may be unsuccessful, promoting the error <a href="#">toast message</a> "An error occurred while deleting project" (see <a href="#">Error 3</a> ).

#### Procedure

- 1 Enable the *Workspace* view from the *View* menu in the header.
- 2 Click the *Delete project* button within the *Workspace* view (Figure 54).
- 3 A confirmation [dialog](#) pops up asking the user to confirm that the current [project](#) should be deleted.
- 4 *Optional*—Check the *Also delete all associated files* checkbox (Figure 55).
- 5 Click the *Delete* button to confirm (Figure 56).
- 6 A toast message indicating that the deletion process was successful pops up.
- 7 The [project](#) closes.



Figure 54: Delete project button



Figure 55: Delete associated files checkbox



Figure 56: Confirm deletion

## 3.5 LENS TUTORIALS

### 3.5.1 Viewing a layer through the lens

<b>Functional description</b>	This tutorial describes how the user can choose which <b>layers</b> are only visible inside the <b>lens</b> .
<b>Preconditions</b>	A <b>project</b> has been loaded. The <b>Layers view</b> is enabled. At least 2 <b>layers</b> are enabled and the layer to be viewed through the <b>lens</b> is above the other <b>layers</b> in the <b>layer hierarchy</b> .
<b>Expected result</b>	After selecting a <b>layer</b> to be only visible inside the <b>lens</b> , the respective <b>layer</b> will not be visible outside the <b>lens</b> anymore.
<b>Cautions and warnings</b>	When selecting a <b>layer</b> to be only visible inside the <b>lens</b> , make sure that this <b>layer</b> is not obstructed by another enabled <b>layer</b> placed higher in the <b>layer hierarchy</b> , as this could leave the impression of the <b>lens</b> not functioning. When two <b>main viewers</b> are enabled, this will update the chosen <b>lens layer</b> for both <b>main viewers</b> .
<b>Likely errors</b>	None.

#### Procedure

- 1 Choose a **layer** to be visible only inside the **lens** and place it above any other enabled **layer** in the **layer hierarchy**.
- 2 Tick the *Only visible inside the lens* checkbox of the respective **layer** (Figure 57).
- 3 Enable the lens by clicking on the *Lens* icon present in the toolbar at the bottom of the page (Figure 58).
- 4 A circular **lens** tool is enabled around the mouse cursor and the selected **layer** is only visible inside the lens. (Figure 59).



Figure 57: Only visible inside lens checkbox



Figure 58: Lens icon

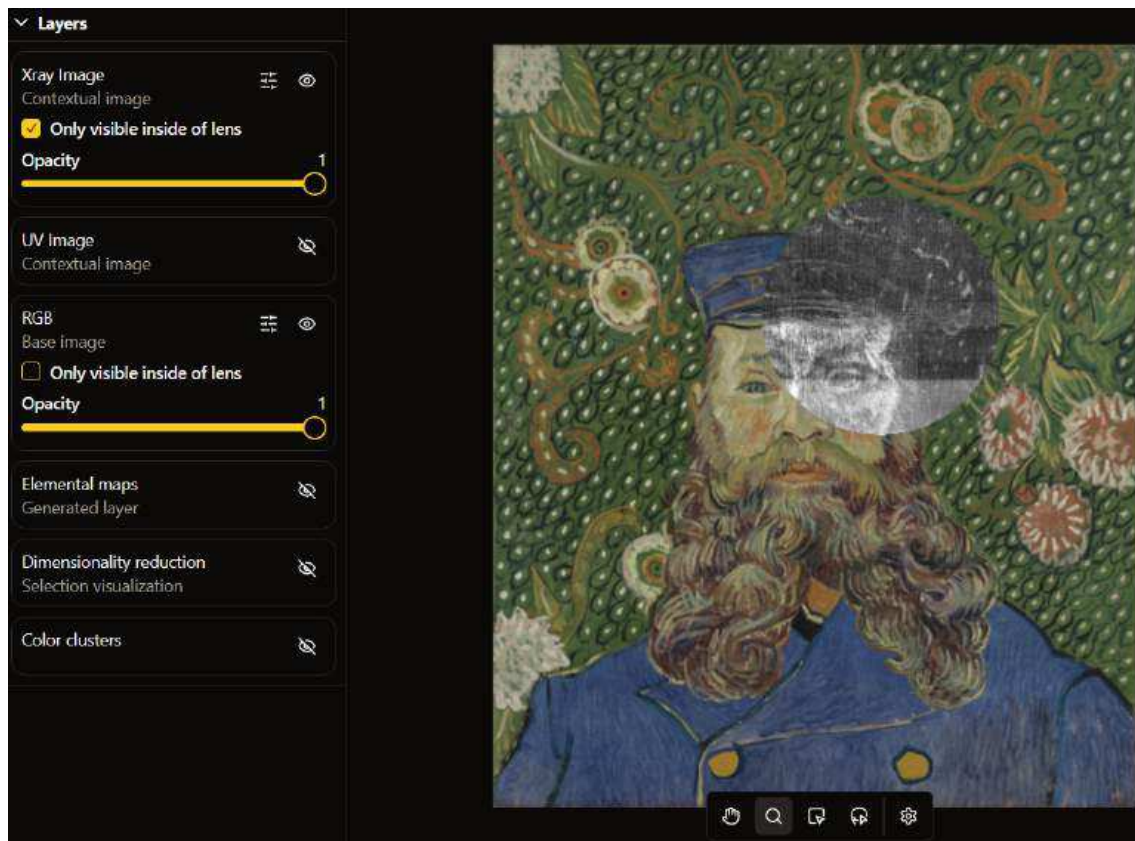


Figure 59: The layer visible only inside the lens

### 3.5.2 Disabling the lens

#### Functional description

This tutorial describes how the user can disable the [lens](#).

#### Preconditions

The user is on any screen of the application and no [dialos](#) are opened. The [lens](#) tool is enabled.

#### Expected result

The [lens](#) tool is disabled and the mouse cursor is visible again.

#### Cautions and warnings

When two [main viewers](#) are enabled, the [lens](#) needs to be disabled for each [main viewer](#) separately.

#### Likely errors

None.

---

#### Procedure

---

- 1 Click on the *Lens* icon present in the toolbar at the bottom of the page (Figure 58).
  - 2 The [lens](#) tool is disabled and the mouse cursor is visible again.
-

### 3.5.3 Locking the lens

<b>Functional description</b>	This tutorial describes how the user can lock the <a href="#">lens</a> in a position within the <a href="#">main viewer</a> .
<b>Preconditions</b>	The <a href="#">lens</a> tool is enabled.
<b>Expected result</b>	The <a href="#">lens</a> tool stays in a selected position while the user is able to move the mouse cursor to other areas.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

#### Procedure

- 1 Right click on the desired position within the [main viewer](#).
- 2 The [lens](#) tool will stay in a selected position while the user is able to move the mouse cursor to other areas.

### 3.5.4 Changing the lens' size

<b>Functional description</b>	This tutorial describes how the user can change the size of the <a href="#">lens</a> within the <a href="#">main viewer</a> of the application.
<b>Preconditions</b>	The user has the <a href="#">lens</a> enabled in the <a href="#">main viewer</a> .
<b>Expected result</b>	The size of the <a href="#">lens</a> is changed according to the user's preference and the updated <a href="#">lens</a> size is reflected in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, the <a href="#">lens</a> size needs to be changed for each <a href="#">main viewer</a> separately.
<b>Likely errors</b>	None.

#### Procedure

- 1 Click on the *Tool configuration* button found in the toolbar at the bottom of the screen (Figure 60).
- 2 The user is presented with a set of sliders.
- 3 Click and drag the *Lens size* slider to adjust the [lens](#) size.
- 4 The [lens](#) size is adjusted according to the user's changes.

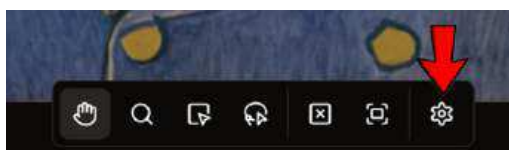


Figure 60: Tool configuration icon

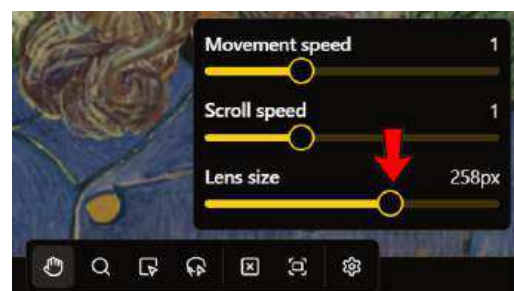


Figure 61: Lens size slider

### 3.5.5 Changing the lens' opacity

<b>Functional description</b>	This tutorial describes how the user can change the opacity of the <a href="#">lens</a> to improve the visibility of underlying <a href="#">layers</a> while using the application.
<b>Preconditions</b>	The <a href="#">lens</a> tool is enabled. There are at least two <a href="#">layers</a> available for comparison.
<b>Expected result</b>	The opacity of the <a href="#">lens</a> is adjusted, allowing the user to see through the <a href="#">lens</a> with the desired transparency.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Identify the opacity slider of the [layer](#) visible inside the [lens](#).
  - 2 Click and drag the slider to the left to decrease opacity (making the [lens](#) more transparent) or to the right to increase opacity (making the [lens](#) less transparent).
- 

## 3.6 ZOOMING AND PANNING

### 3.6.1 Zooming in/out

<b>Functional description</b>	This tutorial describes how the user can zoom in/out on the visualization of the <a href="#">main viewer</a> to get a closer look at the details of the painting.
<b>Preconditions</b>	The user is on the <a href="#">main viewer</a> screen of the application. The painting image or relevant visualization is loaded and visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	The user successfully zooms in/out on the <a href="#">main viewer</a> , providing a closer, more detailed view of the painting.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, zooming is done individually for each <a href="#">main viewer</a> .
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Make a zoom-in/out scrolling motion (scroll wheel on mouse, two fingers on touchpad) while hovering over the image in the [main viewer](#).
  - 2 The image in the [main viewer](#) gets zoomed in/out.
-



### 3.6.2 Panning

<b>Functional description</b>	This tutorial describes how the user can pan on the image within the <a href="#">main viewer</a> , allowing them to navigate different parts of the image smoothly.
<b>Preconditions</b>	A <a href="#">project</a> has been uploaded and an image is visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	The user can pan across the painting, moving the visible area to different parts of the image.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, panning is done individually for each <a href="#">main viewer</a> .
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Hover over the [main viewer](#), click on the image and drag it to pan in the viewer.
  - 2 The image in the [main viewer](#) is panned in the user-specified direction.
- 

### 3.6.3 Zooming speed

<b>Functional description</b>	This tutorial describes how the user can adjust the zooming speed.
<b>Preconditions</b>	A <a href="#">project</a> is loaded in and an image is visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	After adjusting the corresponding slider, the zooming speed is updated to the user's changes.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, changing the zooming speed is done individually for each <a href="#">main viewer</a> .
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *Tool configuration* icon displayed in the toolbar (Figure 60).
  - 2 The user is presented with a set of sliders.
  - 3 Move the *Scroll speed* slider to adjust the zooming speed (Figure 62).
- 

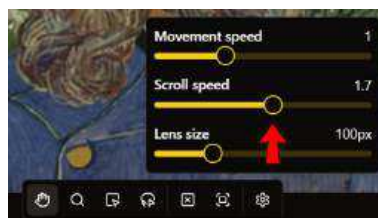


Figure 62: Zooming speed slider



### 3.6.4 Panning speed

<b>Functional description</b>	This tutorial describes how the user can adjust the panning speed.
<b>Preconditions</b>	A <a href="#">project</a> is loaded in and an image is visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	After adjusting the corresponding slider, the panning speed is updated to the user's changes.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, changing the panning speed is done individually for each <a href="#">main viewer</a> .
<b>Likely errors</b>	None

---

#### Procedure

- 1 Click on the *Tool configuration* icon displayed in the toolbar (Figure 60).
  - 2 The user is presented with a set of sliders.
  - 3 Move the *Movement speed* slider to adjust the panning speed (Figure 63).
- 

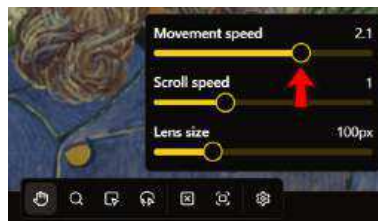


Figure 63: Panning speed slider

### 3.6.5 Reset painting location

<b>Functional description</b>	This tutorial describes how the user can reset the location and zooming level of the painting back to the default setting.
<b>Preconditions</b>	A <a href="#">project</a> is loaded in and an image is visible in the <a href="#">main viewer</a> . A series of zooming and panning actions have been performed in the <a href="#">main viewer</a> .
<b>Expected result</b>	After resetting the location, the image in the <a href="#">main viewer</a> is repositioned to the default setting.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None

---

#### Procedure

- 1 Navigate to the toolbar at the bottom of the page and click the *Reset painting location* icon (Figure 64).
  - 2 The image in the [main viewer](#) is repositioned to the default location (Figure 65).
-

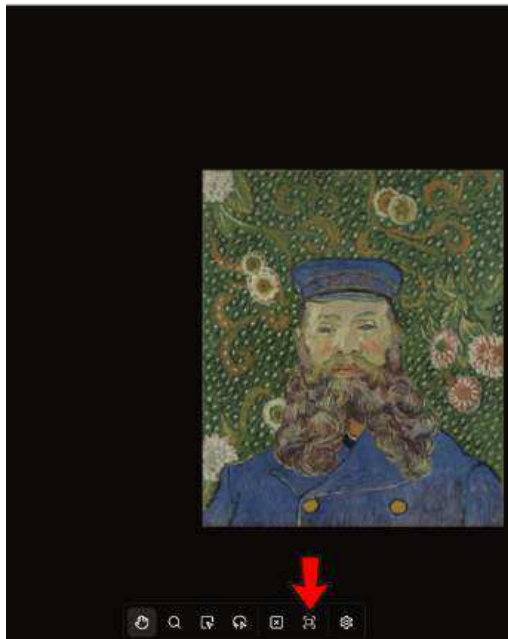


Figure 64: Reset painting location icon



Figure 65: The image in the main viewer after resetting

## 3.7 ELEMENTAL CHANNELS TUTORIALS

### 3.7.1 Enabling elemental channels

<b>Functional description</b>	This tutorial describes how the user can enable an elemental channel in order to highlight the areas containing that <a href="#">element</a> in the <a href="#">main viewer</a> .
<b>Preconditions</b>	The <i>Elemental channels</i> <a href="#">view</a> is enabled. There is at least one disabled elemental channel.
<b>Expected result</b>	After enabling an elemental channel, the pixels of the image in the <a href="#">main viewer</a> containing that respective <a href="#">element</a> will be highlighted in a color of the user's choice.
<b>Cautions and warnings</b>	Multiple <a href="#">elements</a> can be enabled at once. In this case, the pixels containing more than one of <a href="#">elements</a> enabled will be highlighted using a combination of the colors chosen for the respective elemental channels. When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Identify the disabled channel containing the desired [element](#).
  - 2 Click on the *Toggle visibility* icon corresponding to that channel (Figure 66).
  - 3 The pixels of the image in the [main viewer](#) containing the [element](#) will be highlighted in the chosen color (Figure 67).
-



Figure 66: Enable element icon

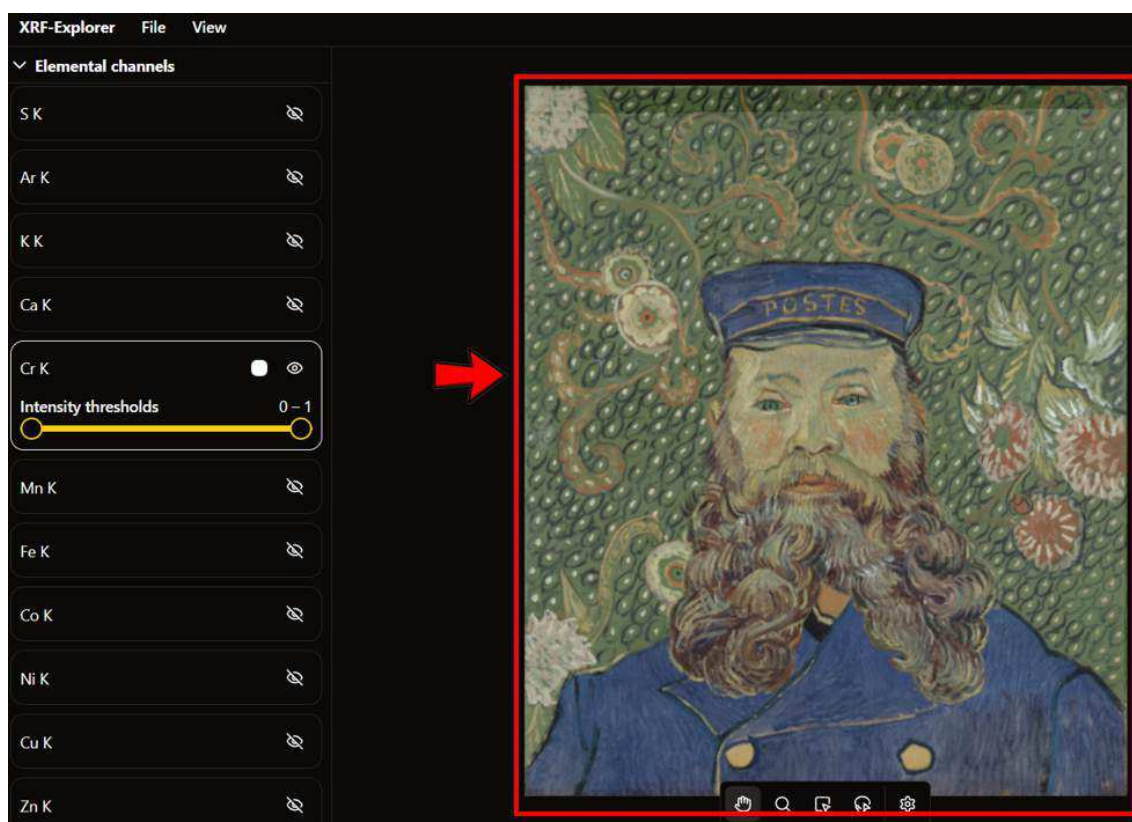


Figure 67: Element highlighted in the main viewer

### 3.7.2 Disabling elemental channels

<b>Functional description</b>	This tutorial describes how the user can disable an elemental channel in order to stop highlighting the corresponding areas containing that <a href="#">element</a> from the <a href="#">main viewer</a> .
<b>Preconditions</b>	The <i>Elemental channels</i> <a href="#">view</a> is enabled. There is at least one enabled elemental channel and the corresponding pixels are highlighted in the <a href="#">main viewer</a> .
<b>Expected result</b>	After disabling an elemental channel, the pixels of the image in the <a href="#">main viewer</a> containing that respective <a href="#">element</a> will be stop being highlighted.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

---

#### Procedure

- 1 Identify the enabled channel containing the desired [element](#).
  - 2 Click on the *Toggle visibility* icon corresponding to that channel (Figure 68).
  - 3 The pixels of the image in the [main viewer](#) containing the [element](#) are not highlighted anymore.
- 

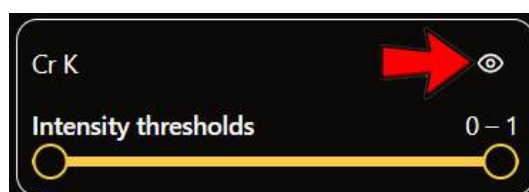


Figure 68: Disable element icon

### 3.7.3 Highlighting color of an element

<b>Functional description</b>	This tutorial describes how the user can choose the highlighting color of an <a href="#">element</a> .
<b>Preconditions</b>	The <i>Elemental channels</i> <a href="#">view</a> is enabled. There is at least one enabled elemental channel.
<b>Expected result</b>	The corresponding <a href="#">element</a> is highlighted with the selected color in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	The color palette for highlighting elements can differ based on the browser used. When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

---

#### Procedure

- 1 Within the elemental channel of the desired [element](#) click on the *Select color* icon (Figure 69).
  - 2 The user is presented with a color palette to pick the highlighting color of the [element](#) (Figure 70).
- 

Continued on next page

## Procedure

- 3 Choose the color for the [element](#).
- 4 The highlighting color of the [element](#) will be updated in the [main viewer](#) based on the user's selection (Figure 71).

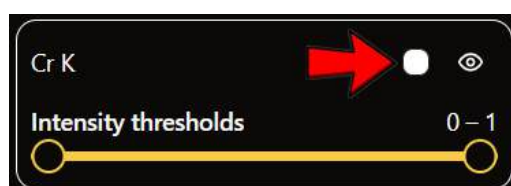


Figure 69: Change color icon

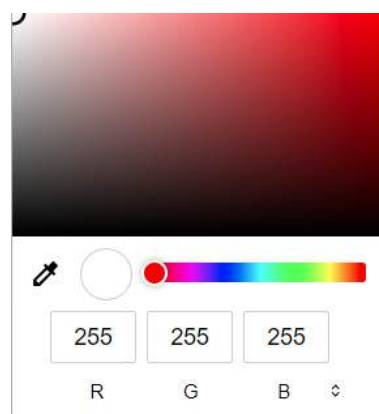


Figure 70: Color window

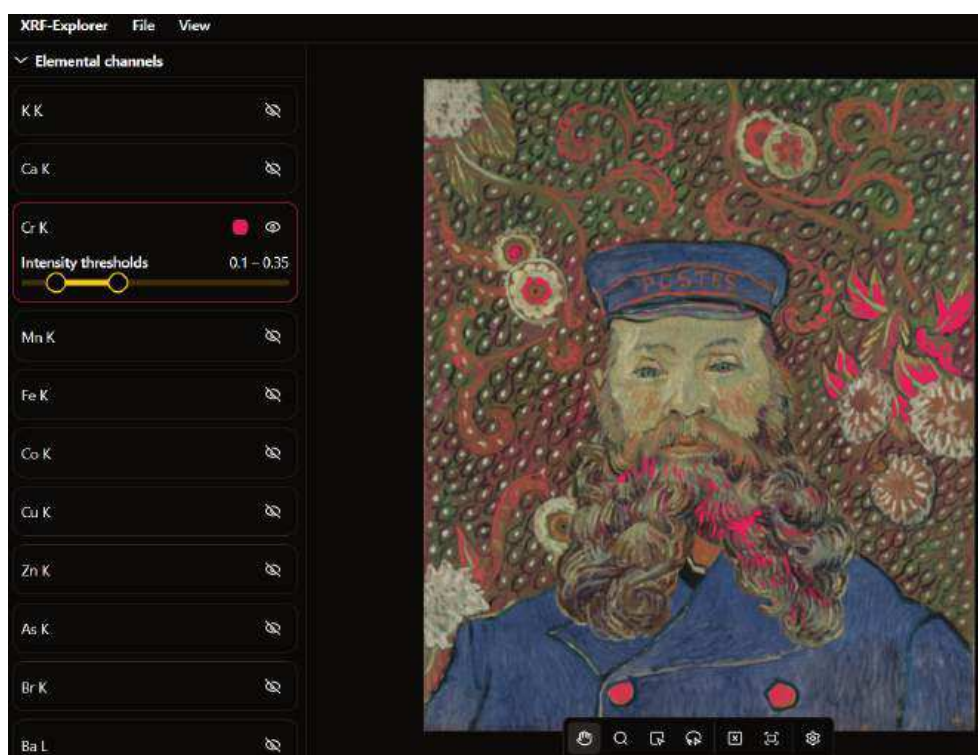


Figure 71: The element highlighted in a chosen color



### 3.7.4 Elemental intensity thresholds

<b>Functional description</b>	This tutorial describes how the user can adjust the elemental thresholds. The lower threshold aims to filter the noise, disregarding the pixels having an elemental intensity lower than the chosen threshold, while the upper threshold sets all the pixels having an elemental intensity higher than the upper threshold to the maximum value, emphasizing the regions with high elemental intensity.
<b>Preconditions</b>	The <i>Elemental channels</i> view is enabled. There is at least one enabled elemental channel.
<b>Expected result</b>	After adjusting the elemental thresholds, the highlighting of the pixels in the <i>main viewer</i> is adjusted according to the user's changes.
<b>Cautions and warnings</b>	When two <i>main viewers</i> are enabled, this will update both <i>main viewers</i> .
<b>Likely errors</b>	None.

---

#### Procedure

- 1 Within the desired elemental channel, adjust the leftmost end of the *Intensity threshold* slider corresponding to the lower threshold (Figure 72).
  - 2 The highlighting of the pixels in the *main viewer* will change accordingly.
  - 3 Adjust the rightmost end of the *Intensity threshold* slider corresponding to the upper threshold.
  - 4 The highlighting of the pixels in the *main viewer* will change accordingly.
- 

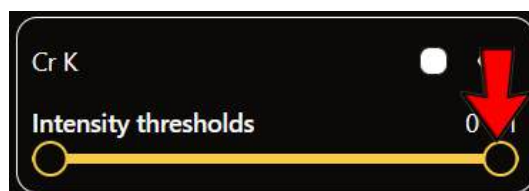


Figure 72: Change elemental intensity slider

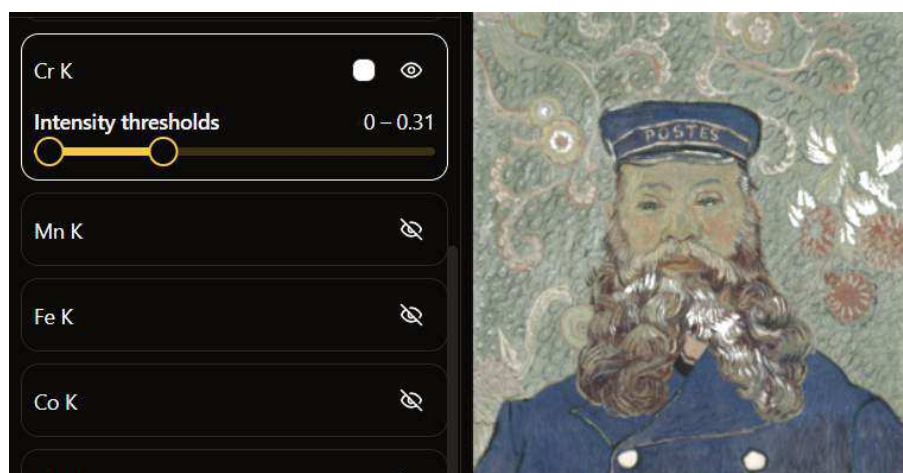


Figure 73: Intensity changed

## 3.8 SELECTION TOOL TUTORIALS

### 3.8.1 Creating rectangle selection in the main viewer

<b>Functional description</b>	This tutorial describes how the user can highlight a selected rectangle shaped region within the <a href="#">main viewer</a> when using the rectangle selection feature of the application.
<b>Preconditions</b>	A <a href="#">project</a> has been uploaded and visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	The selected region within the <a href="#">main viewer</a> is highlighted, making the <a href="#">selected area</a> distinctly visible to the user.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *Rectangle selection* tool in the toolbar (Figure 74).
  - 2 Click on a point on the image in the [main viewer](#), drag the cursor to a different point on the image in the [main viewer](#) and release when the selection has taken the desired shape (Figure 75).
  - 3 The rectangular selection is highlighted in the [main viewer](#) (Figure 76).
- 

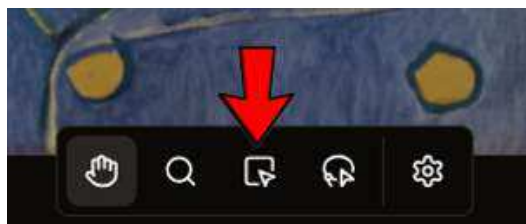


Figure 74: The rectangle selection tool

### 3.8.2 Creating polygon selection in the main viewer

<b>Functional description</b>	This tutorial describes how the user can highlight an irregular shaped region within the <a href="#">main viewer</a> when using the polygon selection feature of the application.
<b>Preconditions</b>	A <a href="#">project</a> has been uploaded and visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	The selected region within the <a href="#">main viewer</a> is highlighted, making the <a href="#">selected area</a> distinctly visible to the user.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 Click on the *Polygon selection* tool in the toolbar (Figure 77).
  - 2 Click on a point on the image in the [main viewer](#) (Figure 78).
- 

Continued on next page



Figure 75: Click and drag

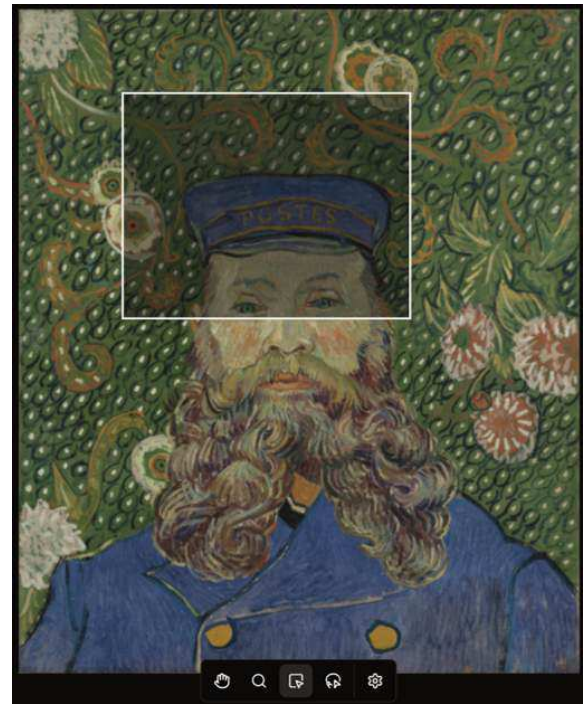


Figure 76: Selection highlighted

---

### Procedure

- 3 Move the cursor to a different point on the image in the [main viewer](#) (Figure 79).
  - 4 Click on this point.
  - 5 Repeat steps 2 through 4 until the selected region has taken on the desired shape (Figure 78 and 78).
  - 6 The selection is highlighted in the [main viewer](#).
- 

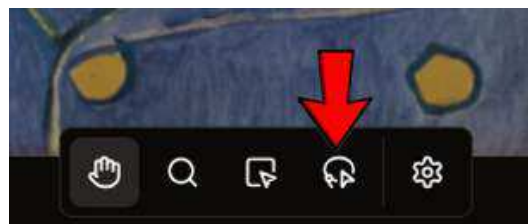


Figure 77: The polygon selection tool

### 3.8.3 Removing a selection

<b>Functional description</b>	This tutorial describes how the user can clear a previously made selection within the <a href="#">main viewer</a>
<b>Preconditions</b>	A <a href="#">project</a> has been loaded in and a selection has been made
<b>Expected result</b>	The previously made selection is cleared and is no longer highlighted in the <a href="#">main viewer</a>
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.





Figure 78: Click anywhere

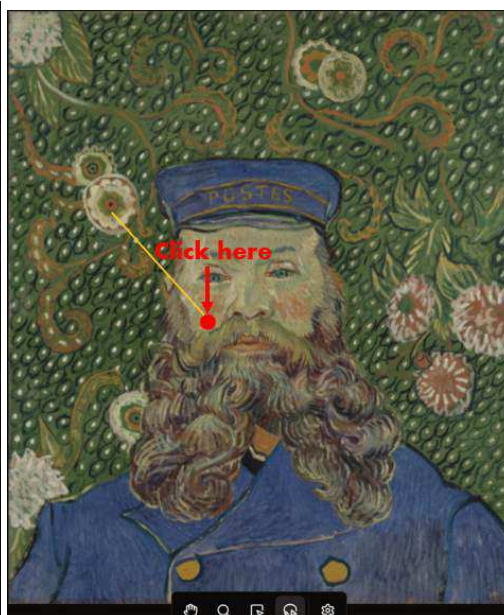


Figure 79: Move cursor and click



Figure 80: Repeat

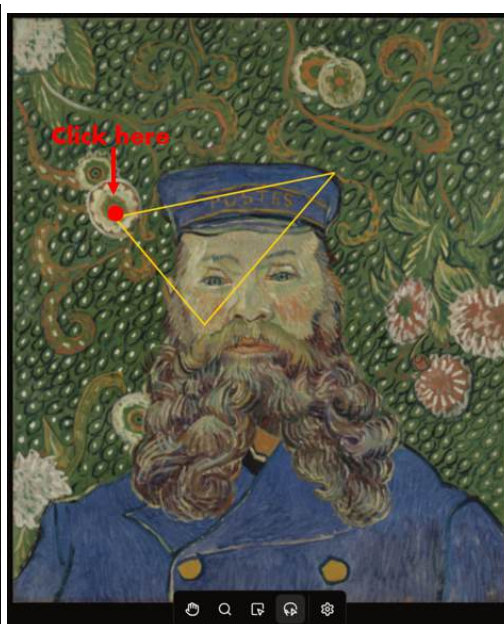


Figure 81: Click on first point

---

**Procedure**


---

- 1 Navigate to the [toolbar](#) in the bottom middle of the screen.
  - 2 Press the *Clear selection* button (Figure 82).
  - 3 The selection is cleared and is no longer highlighted in the [main viewer](#).
- 

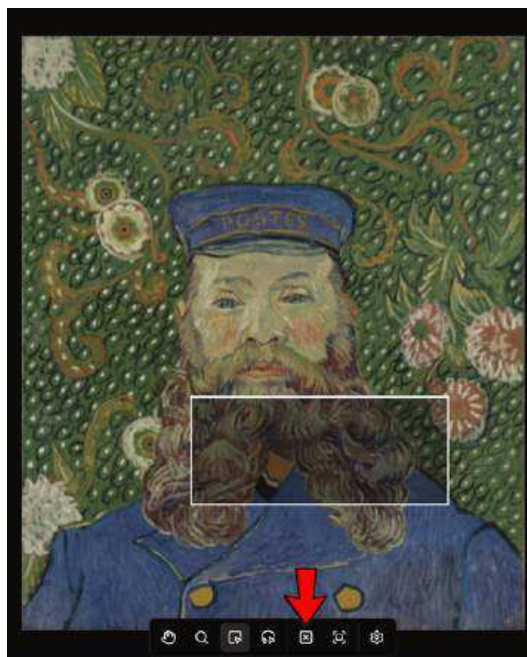


Figure 82: Clear selection icon

### 3.9 ELEMENTAL CHART TUTORIALS

#### 3.9.1 Depicting the average elemental abundance over the entire painting

<b>Functional description</b>	This tutorial describes how the user can visualize the average <a href="#">elemental abundance</a> over the entire painting as a bar chart using the <i>Elemental charts</i> view.
<b>Preconditions</b>	A <a href="#">project</a> has been uploaded. The <i>Elemental charts</i> view is enabled.
<b>Expected result</b>	A bar chart displaying the average <a href="#">elemental abundance</a> over the entire painting per <a href="#">element</a> is shown.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

**Procedure**


---

- 1 Within the *Elemental charts* [view](#), (if it is not ticked) tick the *Bar chart(global data)* box (Figure 83).
  - 2 Within the *Options* section, (if it is not ticked) tick the *Display all elements* box (Figure 84).
  - 3 The bar chart will be generated and displayed.
-

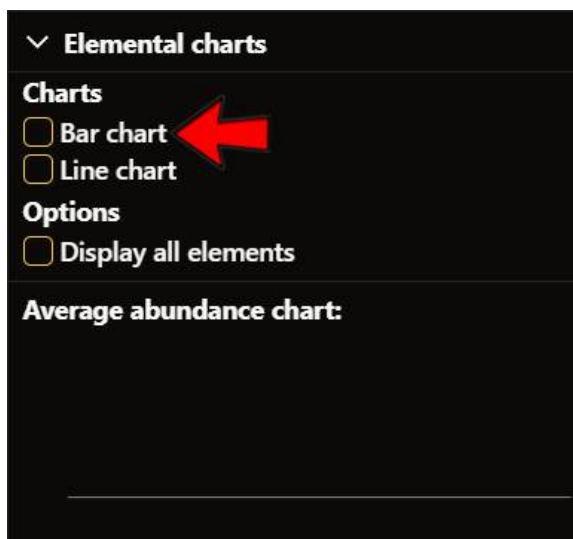


Figure 83: Select bar chart option

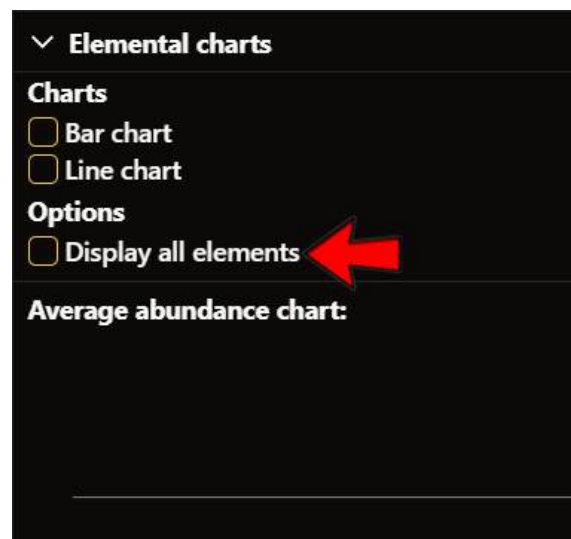


Figure 84: Click to display all elements

### 3.9.2 Depicting the average elemental abundance of a selected subarea

<b>Functional description</b>	This tutorial describes how the user can depict a line chart showing the average <a href="#">elemental abundance</a> of a selected subarea of the painting.
<b>Preconditions</b>	A <a href="#">project</a> is uploaded and an image is visible in the <a href="#">main viewer</a> . One of the available selection tools is enabled. The <i>Elemental charts</i> <a href="#">view</a> is enabled.
<b>Expected result</b>	A line chart representing the average <a href="#">elemental abundance</a> of the selected subarea is displayed.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

#### Procedure

- 1 Within the *Elemental charts* [view](#), tick the *Line chart (selection data)* checkbox (Figure 85).
- 2 Make a selection of a subarea of the image in the [main viewer](#) using one of the selection tools available in the toolbar (Figure 75 or 78).
- 3 After the region is selected and highlighted accordingly, the system will process the selected area and generate a line chart representing the average [elemental abundance](#) of the selected subarea.

## 3.10 SPECTRAL CHART TUTORIALS

### 3.10.1 Generating spectral chart of the global average

<b>Functional description</b>	This tutorial describes how the user can generate a <a href="#">spectral chart</a> of the global average.
<b>Preconditions</b>	The <i>Spectrum</i> view is enabled.
<b>Expected result</b>	A <a href="#">spectral chart</a> of the global average is shown.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

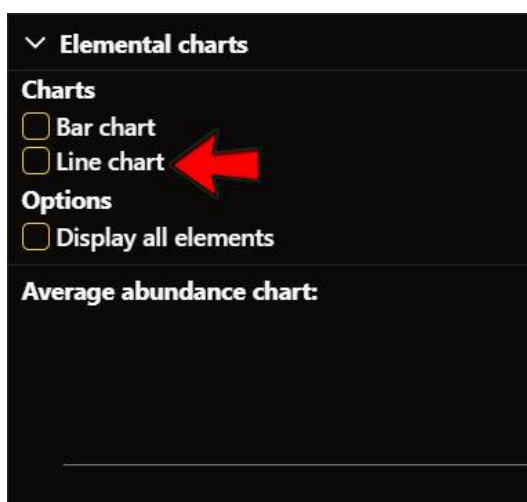


Figure 85: Click Line chart checkbox

### Procedure

- 1 Within the *Spectrum* window, tick the *Global average* box (Figure 86).
- 2 A [spectral chart](#) is generated and displayed.

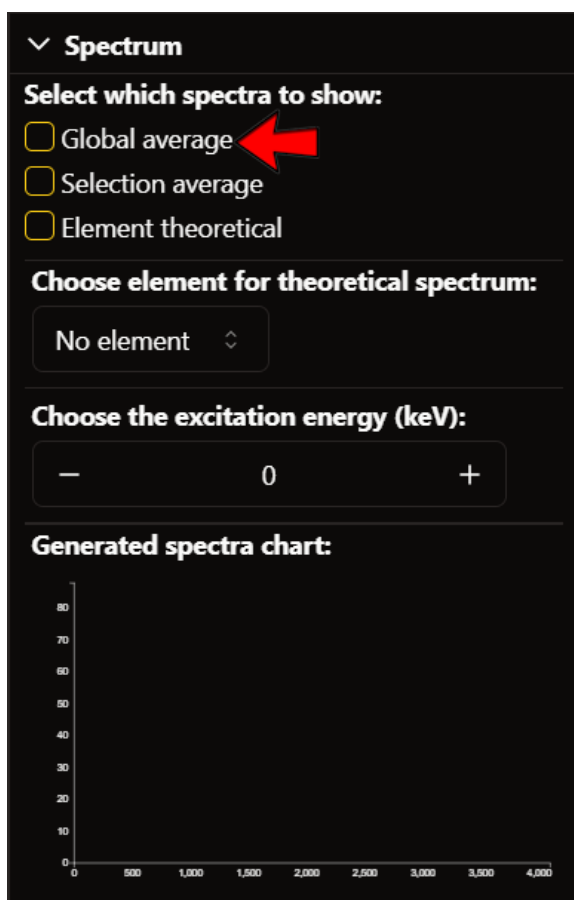


Figure 86: Select the global average option

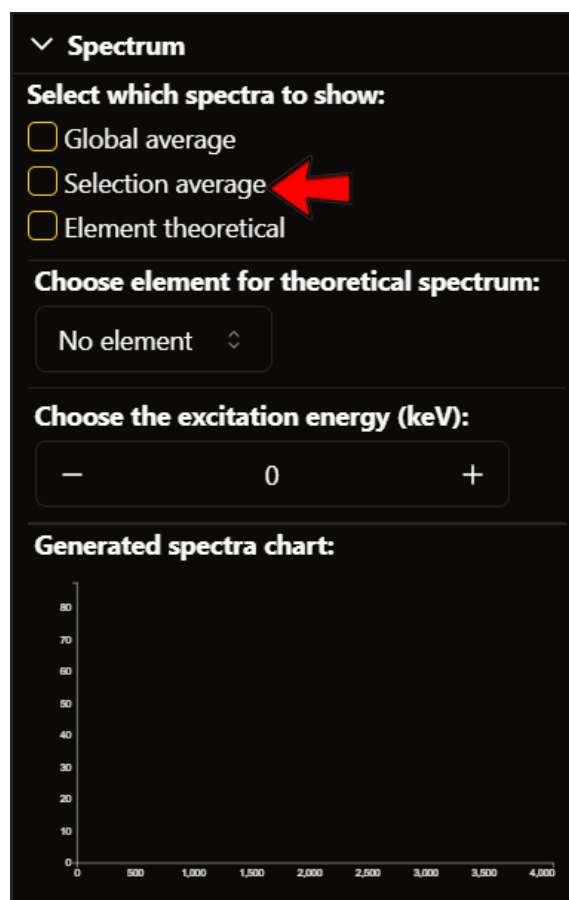


Figure 87: Select the selection average option

### 3.10.2 Generating spectral chart of a selection

<b>Functional description</b>	This tutorial describes how the user can generate a <a href="#">spectral chart</a> of a <a href="#">selected area</a> .
<b>Preconditions</b>	The <i>Spectral charts</i> view is enabled. A selection of an area has been made in the <a href="#">main viewer</a> .
<b>Expected result</b>	A <a href="#">spectral chart</a> of the selection is shown.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 In the *spectral charts* window, tick the box next to selection average (Figure 87).
  - 2 Make a selection with a selection tool (Figure 75).
  - 3 A spectral chart of the selection is displayed.
- 

### 3.10.3 Generating theoretical spectral chart of an element

<b>Functional description</b>	This tutorial describes how the user can generate a theoretical <a href="#">spectral chart</a> of an <a href="#">element</a> .
<b>Preconditions</b>	The <i>Spectral charts</i> view is enabled.
<b>Expected result</b>	The theoretical <a href="#">spectral chart</a> of the <a href="#">element</a> is shown, together with its emission peaks.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	None.

---

#### Procedure

---

- 1 In the *Spectral charts* window, tick the *Element theoretical* box (Figure 88).
  - 2 Choose an [element](#) to view the [spectral chart](#) of in the *elements* dropdown menu (Figures 89 & 90).
  - 3 Choose the excitation energy level in the corresponding number selection field. It must not be zero (Figure 91).
  - 4 The theoretical [spectral chart](#) of the [element](#) with its emission peaks is displayed,
-



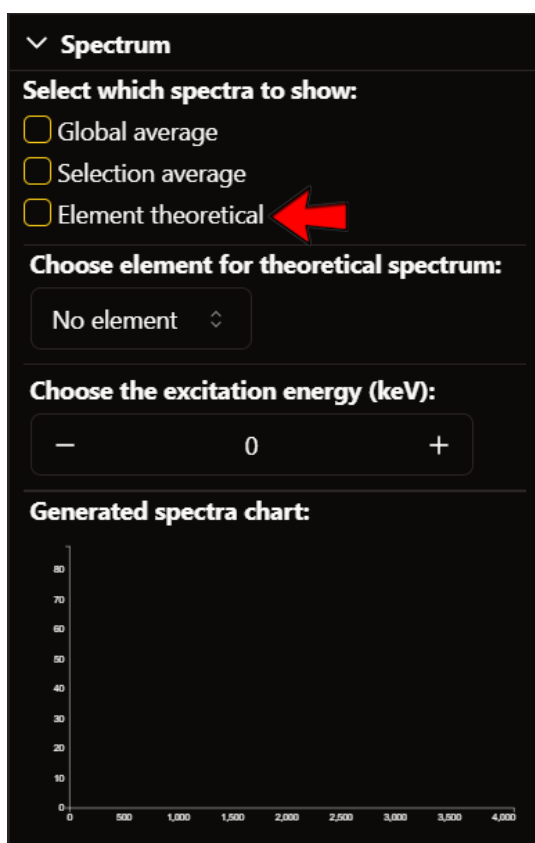


Figure 88: Select the element theoretical option

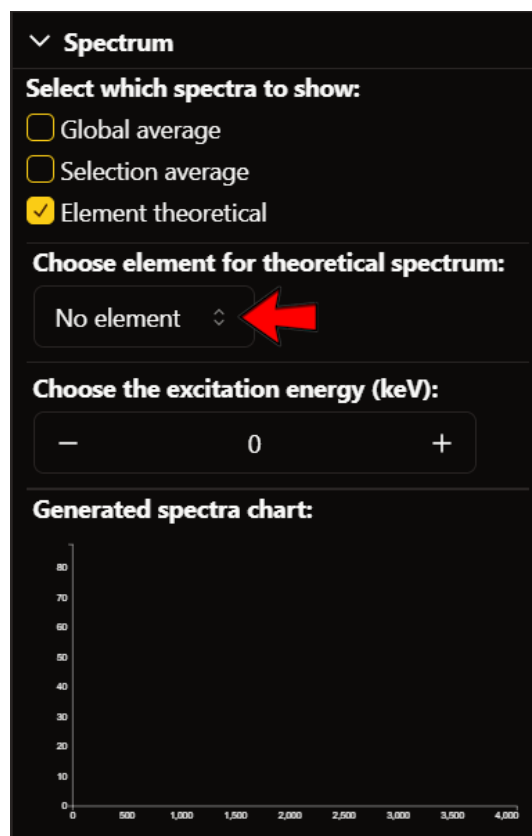


Figure 89: Click to select an element



Figure 90: Select element

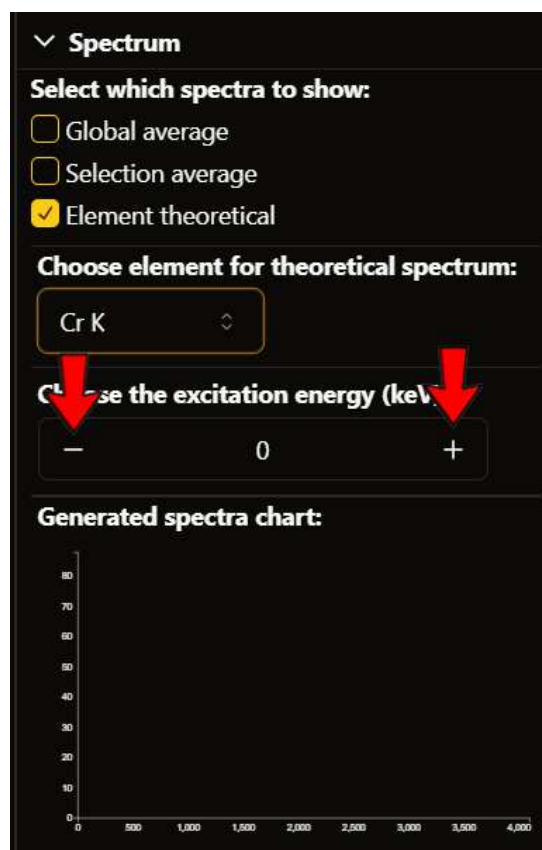


Figure 91: Set the excitation energy

### 3.11 COLOR SEGMENTATION TUTORIALS

#### 3.11.1 Highlighting colors using the color segmentation view

<b>Functional description</b>	This tutorial describes how the user can use the <a href="#">color segmentation view</a> provided to highlight particular colors in the <a href="#">main viewer</a> .
<b>Preconditions</b>	The user has loaded a <a href="#">project</a> . The <a href="#">color segmentation view</a> is enabled.
<b>Expected result</b>	After selecting a color to be explored, the corresponding pixels are highlighted in the <a href="#">main viewer</a> . Multiple colors can be selected at once.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	When loading the colors, a <a href="#">toast message</a> could appear with the error "Failed to retrieve colors" (see <a href="#">Error 11</a> ).

---

#### Procedure

---

- 1 Click on the dropdown menu to make a selection for which to display the color palette for (Figure 92).
  - 2 The user will be presented with a list of choices (complete painting or shorthand notation of the [elements](#) present in the painting).
  - 3 Click on the *Complete painting* option (Figure 93).
  - 4 *Optional*—Adjust the number of [color segments](#) to be displayed in the *Number of clusters(1-50)* field (Figure 94).
  - 5 Click on the *Generate color clusters* button (Figure 95).
  - 6 The user will be presented with the color palette corresponding to the whole painting.
  - 7 Click on one of the [segments](#) present in the palette (Figure 96).
  - 8 The pixels corresponding to the selected [color segment](#) are highlighted in the [main viewer](#).
  - 9 *Optional*—To make the highlighting of the pixels more visible, decrease the opacity of the base image (Figure 97).
- 

#### 3.11.2 Highlighting element colors using the color segmentation view

<b>Functional description</b>	This tutorial describes how the user can use the <a href="#">color segmentation view</a> provided to highlight colors in which a selected element is found, in the <a href="#">main viewer</a> .
<b>Preconditions</b>	The user has loaded a <a href="#">project</a> . The <a href="#">color segmentation view</a> is enabled.
<b>Expected result</b>	After selecting an element color to be explored, the pixels of that color and containing the selected element are highlighted in the <a href="#">main viewer</a> . Multiple colors can be selected at once.
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, this will update both <a href="#">main viewers</a> .
<b>Likely errors</b>	None.

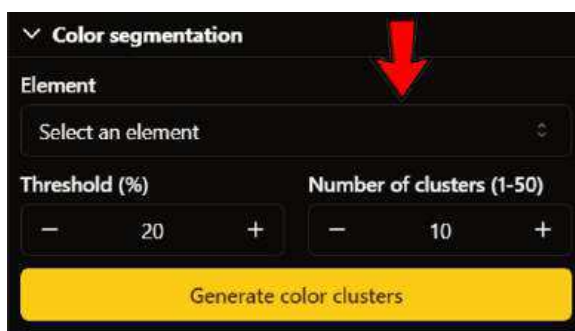


Figure 92: Dropdown selection menu

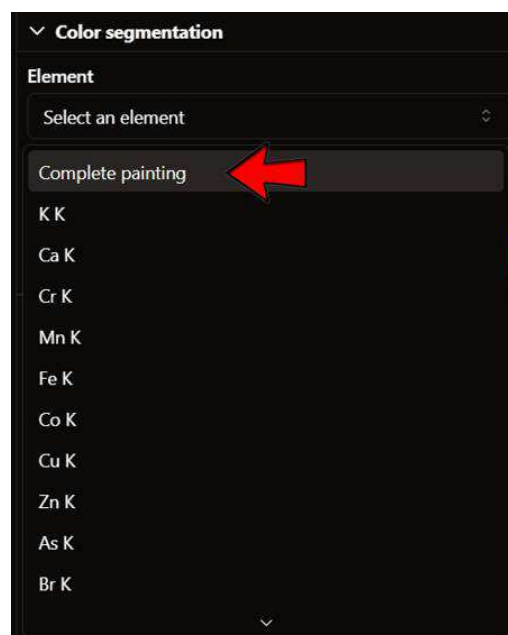


Figure 93: Choose the Complete painting option

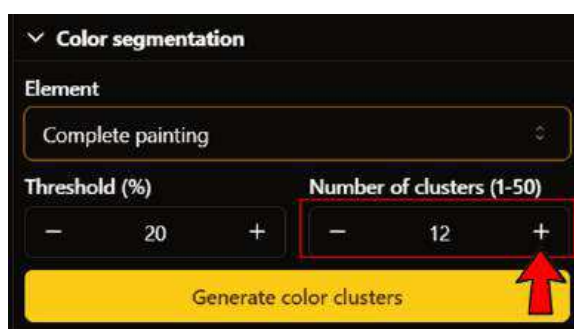


Figure 94: Adjust the number of clusters

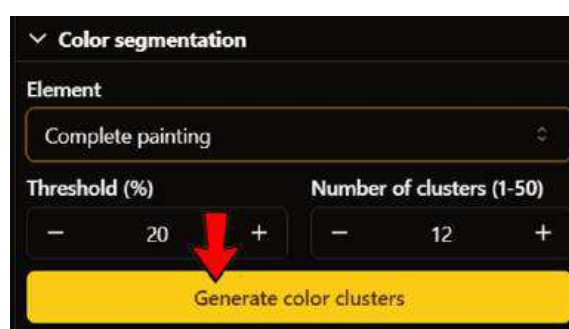


Figure 95: Generate clusters button

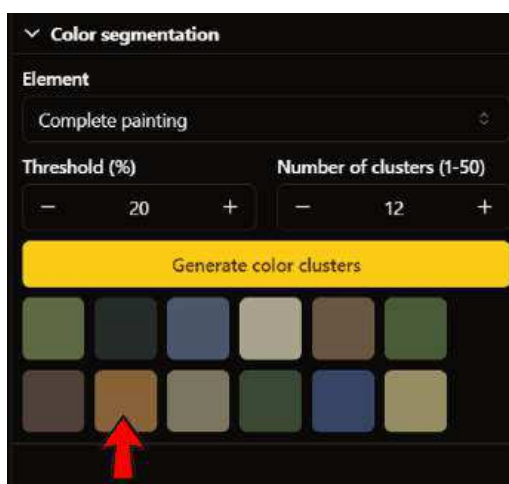


Figure 96: Click on a color cluster

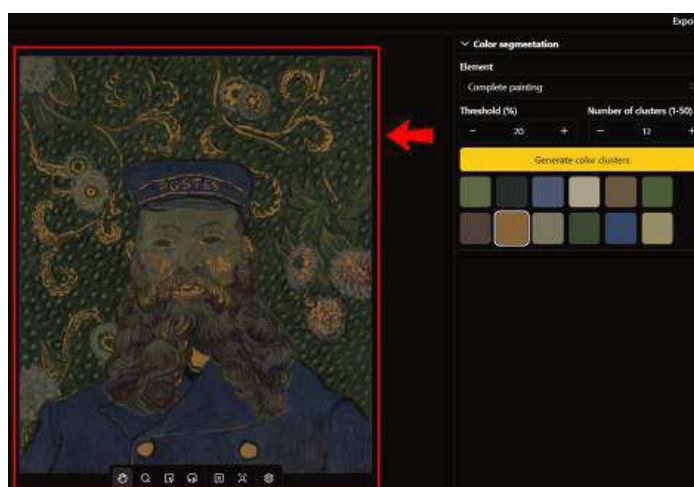


Figure 97: The color highlighted in the main viewer with decreased opacity of the base image



## Procedure

- 1 Click on the dropdown menu to make a selection for which to display the color palette for (Figure 92).
- 2 The user will be presented with a list of choices (complete painting or shorthand notation of the [elements](#) present in the painting).
- 3 Click on an [element](#) of choice (Figure 98).
- 4 *Optional*—Adjust the threshold to filter the pixels based on the elemental intensity in the *Threshold* field (Figure 99).
- 5 *Optional*—Adjust the number of [color segments](#) to be displayed in the *Number of clusters(1-50)* field (Figure 94).
- 6 Click on the *Generate color clusters* button (Figure 95).
- 7 The user will be presented with the color palette corresponding to the selection.
- 8 Click on one of the [segments](#) present in the palette (Figure 96).
- 9 The pixels corresponding to the selected [color segment](#) are highlighted in the [main viewer](#).

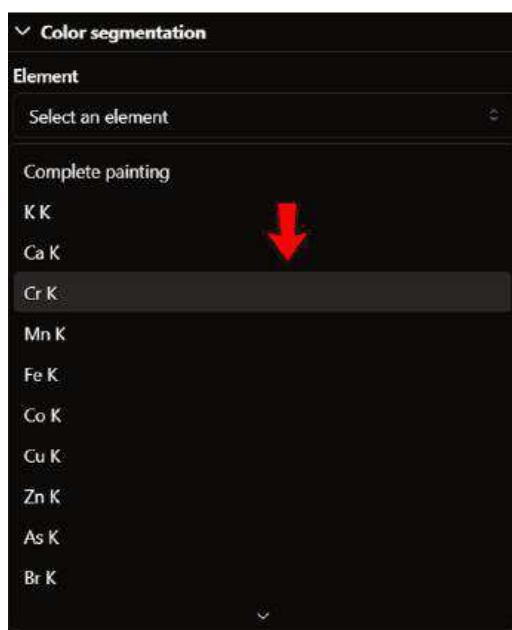


Figure 98: Pick an element for color segmentation

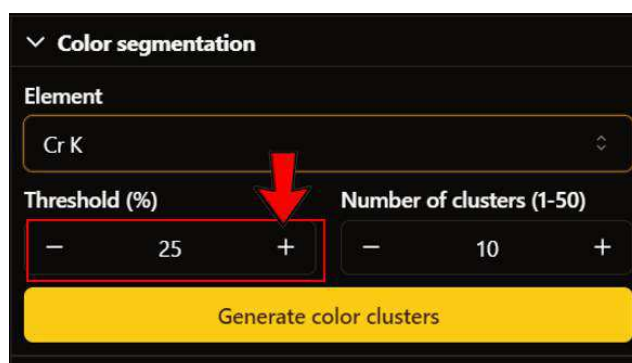


Figure 99: The color highlighted in the main viewer with decreased opacity of the base image

## 3.12 DIMENSIONALITY REDUCTION TUTORIALS

### 3.12.1 Generating an embedding with an overlay

<b>Functional description</b>	This tutorial describes how the user can generate a <a href="#">dimensionality reduction</a> embedding with a chosen overlay.
<b>Preconditions</b>	The <i>Dimensionality reduction</i> view is enabled.
<b>Expected result</b>	The <a href="#">dimensionality reduction</a> embedding is generated and displayed in within the view with the chosen overlay.
<b>Cautions and warnings</b>	Generating an embedding can take over a minute. The total number of data points for the embedding may be reduced to prevent excessive waiting times. While generating an embedding, the rest of the software can be interacted with.
<b>Likely errors</b>	An embedding cannot be generated if another one is already being generated, in which case a <a href="#">toast message</a> will appear with the error "Embedding is currently already being generated" (see <a href="#">Error 12</a> ). Similarly, the generation of an embedding cannot start if an overlay is currently loading, in which case a <a href="#">toast message</a> will appear with the error "Embedding generation can not be started while overlay is loading" (see <a href="#">Error 13</a> ).

---

#### Procedure

---

- 1 Within the *Dimensionality reduction* window, select an [element](#) from the *elements* dropdown menu (Figures [100](#) & [101](#)).
  - 2 *Optional*—Adjust the *Threshold* value. The threshold value is used to determine the indices in the elemental data cube for which the normalized intensity of the given [element](#) (selected in the previous step) is higher than the threshold (Figure [102](#)).
  - 3 Click the *Generate* button (Figure [103](#)).
  - 4 The *Dimensionality reduction* window will display a loading icon indicating that an embedding is being generated.
  - 5 An embedding is generated.
  - 6 Select an overlay from the *Overlay* drop-down menu (Figures [104](#) & [105](#)).
  - 7 The generated embedding is displayed with the selected overlay.
-

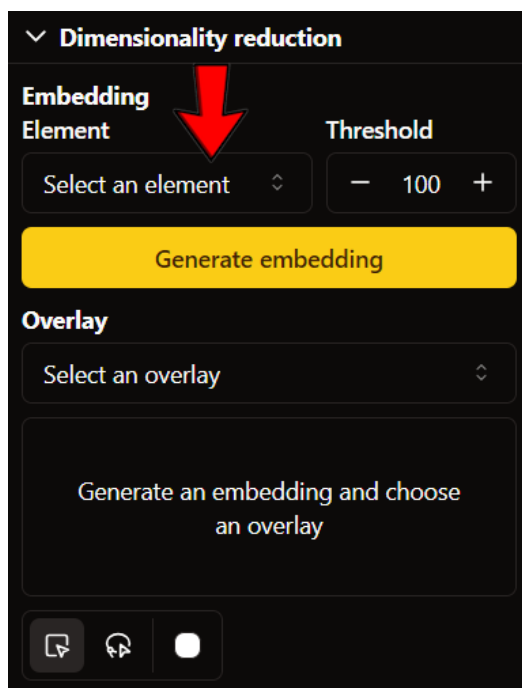


Figure 100: Select an element



Figure 101: Choose an element

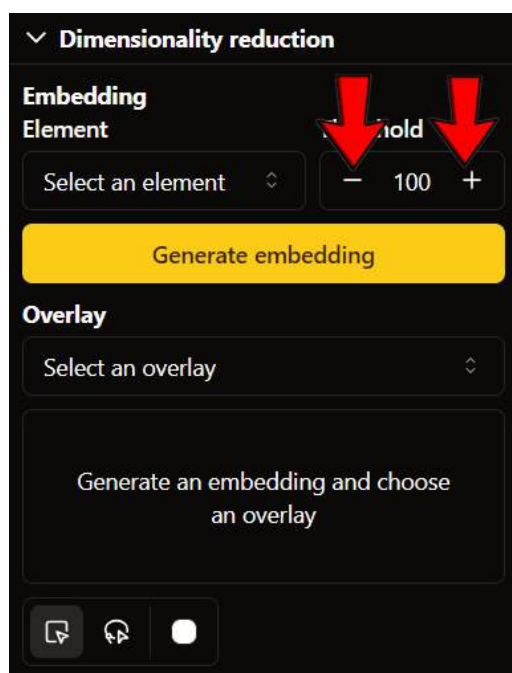


Figure 102: Adjust the threshold value

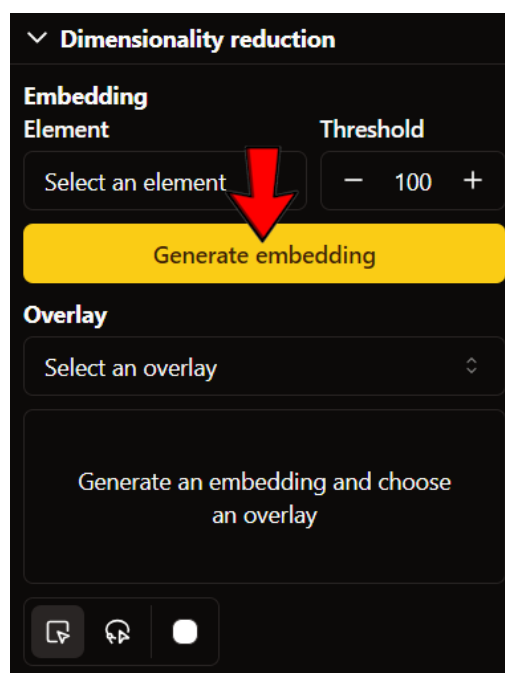


Figure 103: Click generate



Figure 104: Click overlay menu

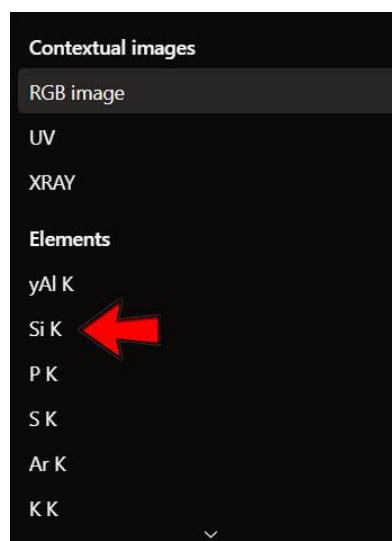


Figure 105: Choose overlay

### 3.12.2 Dimensionality reduction selection

<b>Functional description</b>	This tutorial describes how the user can make a selection within the generated <a href="#">dimensionality reduction</a> embedding.
<b>Preconditions</b>	The <i>Dimensionality reduction</i> view is enabled. An embedding with overlay is being shown.
<b>Expected result</b>	The areas corresponding to the selected region within the embedding are highlighted in the <a href="#">main viewer</a> .
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	A selection cannot be made if an embedding is being generated, in which case a <a href="#">toast message</a> will appear with the error "Embedding is currently already being generated" (see <a href="#">Error 12</a> ). Similarly, a selection cannot be made if an overlay is currently loading, in which case a <a href="#">toast message</a> will appear with the error "Embedding generation can not be started while overlay is loading" (see <a href="#">Error 13</a> ).

---

#### Procedure

---

- 1 Click on one of the available selection tools in within the *Dimensionality reduction* view (for example the rectangle selection as shown in [Figure 106](#)).
  - 2 Make a selection of a region on the generated embedding ([Figure 107](#)).
  - 3 *Optional*—Click on the *Selection color* icon to choose the color to highlight the corresponding pixels ([Figures 108 & 70](#)).
  - 4 The areas corresponding to the selected region in the embedding are highlighted in the [main viewer](#) ([Figure 109](#)).
-

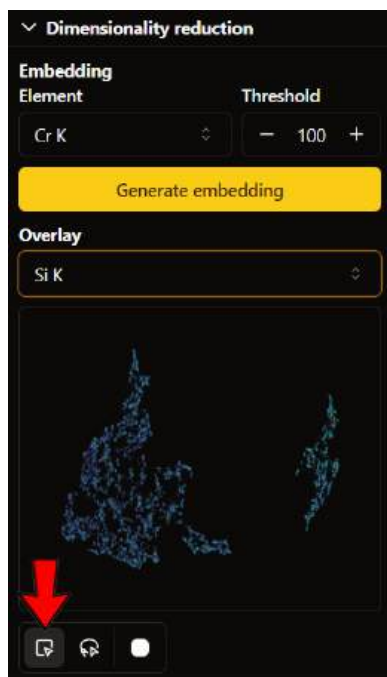


Figure 106: Pick selection tool

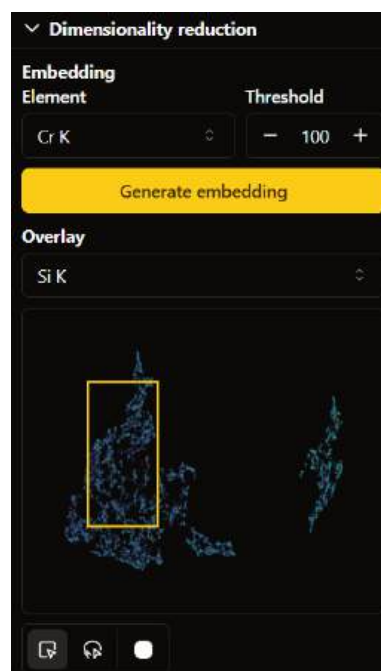


Figure 107: Make a selection

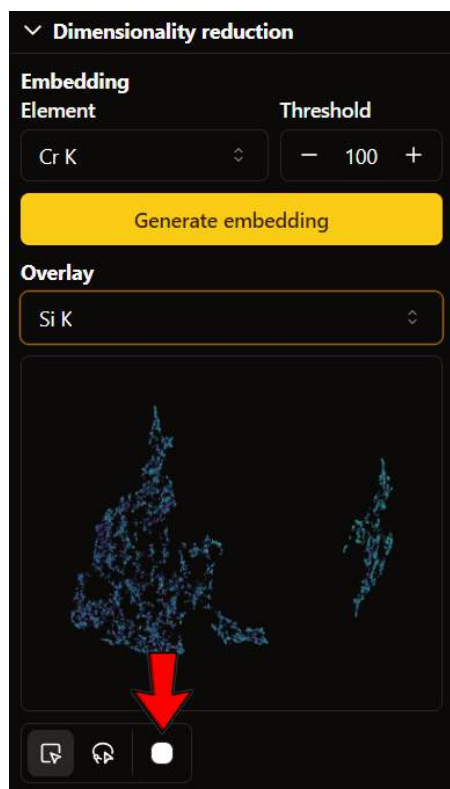


Figure 108: Click the color change button

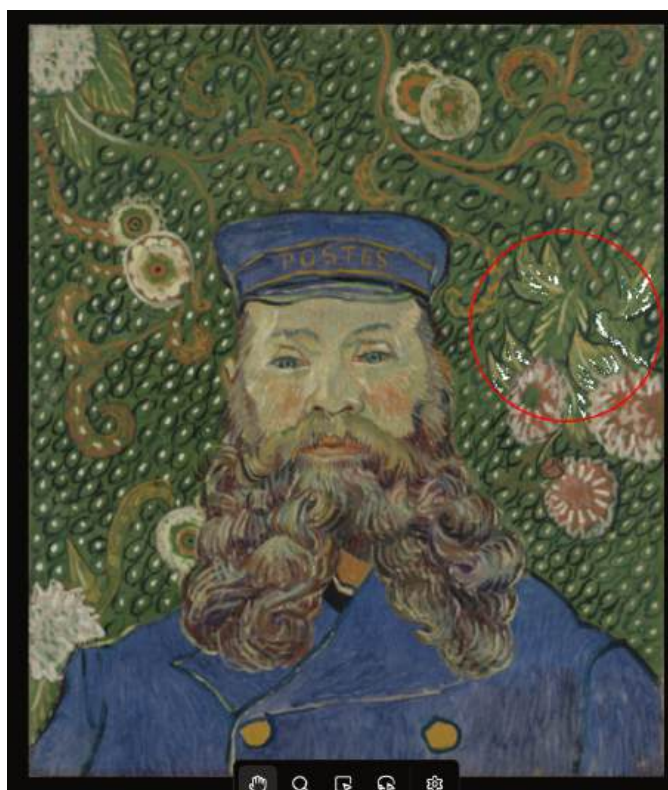


Figure 109: Selection displayed in the main viewer

### 3.13 EXPORTING RELATED TUTORIALS

#### 3.13.1 Exporting the main viewer's image

<b>Functional description</b>	This tutorial describes how the user can export the image currently displayed in the <a href="#">main viewer</a> to their device.
<b>Preconditions</b>	A <a href="#">project</a> is loaded and an image is currently visible in the <a href="#">main viewer</a> .
<b>Expected result</b>	The image is saved as a JPEG to the user's standard download location.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When clicking the <i>Painting</i> option, a <a href="#">toast message</a> could appear with the error "Failed to export painting" (see <a href="#">Error 15</a> ).

---

#### Procedure

---

- 1 Locate and click on the *Export* menu in the header (Figure 110).
  - 2 The user is presented with the exporting options.
  - 3 Select the *Painting* option (Figure 111).
  - 4 The 'Exporting painting' message pops up.
  - 5 Wait until 'Exporting painting' message disappears.
  - 6 Browser's download icon pops up with the downloaded viewer's image.
- 

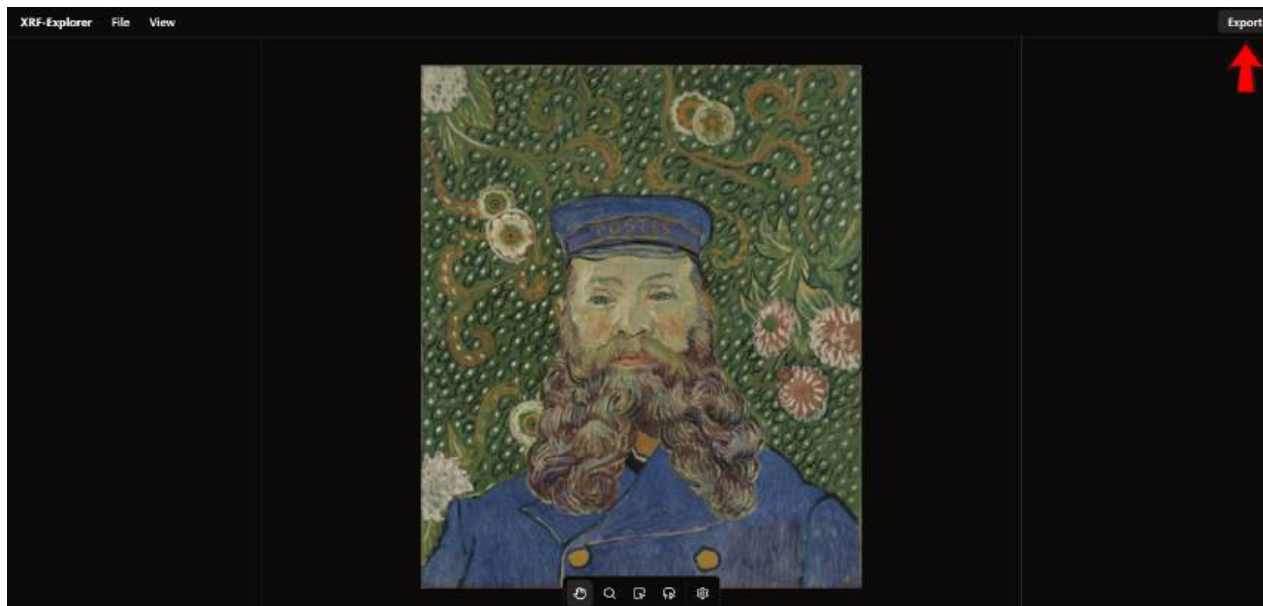


Figure 110: Click export



### 3.13.2 Exporting the elemental chart visualization

<b>Functional description</b>	This tutorial describes how the user can export the generated elemental chart visualization to their device.
<b>Preconditions</b>	The <i>Elemental charts</i> <a href="#">view</a> is enabled. An elemental chart is displayed within the <i>Elemental charts</i> <a href="#">view</a> .
<b>Expected result</b>	The visualization is saved as a JPEG to the user's standard download location.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When clicking the <i>Elements</i> option, a <a href="#">toast message</a> could appear with the error "Failed to export painting" (see <a href="#">Error 14</a> ).

---

#### Procedure

- 1 Locate and click on the *Export* menu in the header (Figure [110](#)).
  - 2 The user is presented with the exporting options.
  - 3 Select the *Elements* option (Figure [112](#)).
  - 4 The 'Exporting elemental chart' message pops up.
  - 5 Wait until 'Exporting elemental chart' message disappears.
  - 6 Browser's download icon pops up with the downloaded visualization image.
- 

### 3.13.3 Exporting the dimensionality reduction embedding

<b>Functional description</b>	This tutorial describes how the user can export the generated <a href="#">dimensionality reduction</a> embedding to their device.
<b>Preconditions</b>	The <i>Dimensionality reduction</i> <a href="#">view</a> is enabled. A <a href="#">dimensionality reduction</a> embedding is displayed within the <i>Dimensionality reduction</i> <a href="#">view</a> .
<b>Expected result</b>	The image is saved as a JPEG to the user's standard download location.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When clicking the <i>Embedding</i> option, a <a href="#">toast message</a> could appear with the error "Failed to export painting" (see <a href="#">Error 15</a> ), or "Failed to export window" (see <a href="#">Error 14</a> ).

---

#### Procedure

- 1 Locate and click on the *Export* menu in the header (Figure [110](#)).
  - 2 The user is presented with the exporting options.
  - 3 Select the *Embedding* option (Figure [113](#)).
  - 4 The 'Exporting embedding' message pops up.
  - 5 Wait until 'Exporting embedding' message disappears.
  - 6 Browser's download icon pops up with the downloaded visualization image.
-

### 3.13.4 Exporting the spectral chart visualization

<b>Functional description</b>	This tutorial describes how the user can export the <a href="#">spectral chart</a> to their device.
<b>Preconditions</b>	The <i>Spectrum view</i> is enabled. A <a href="#">spectral chart</a> is displayed within the <i>Spectrum view</i> .
<b>Expected result</b>	The image is saved as a JPEG on the user's standard download location.
<b>Cautions and warnings</b>	None.
<b>Likely errors</b>	When clicking the <i>Spectral</i> option, a <a href="#">toast message</a> could appear with the error "Failed to export painting" (see <a href="#">Error 15</a> ), or "Failed to export window" (see <a href="#">Error 14</a> ).

---

#### Procedure

---

- 1 Locate and click on the *Export* menu in the header (Figure [110](#)).
  - 2 The user is presented with the exporting options.
  - 3 Select the *Spectral* option (Figure [114](#)).
  - 4 The 'exporting spectral chart' message pops up.
  - 5 Wait until 'exporting spectral chart' message disappears.
  - 6 Browser's download icon pops up with the downloaded visualization image.
- 



Figure 111: Click painting

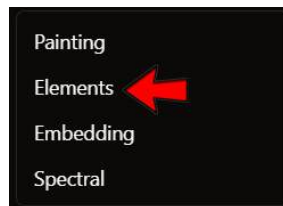


Figure 112: Click elements

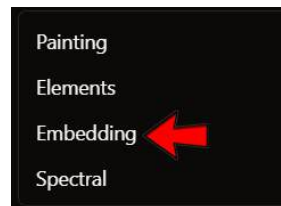


Figure 113: Click embedding



Figure 114: Click spectral

## 4 REFERENCE

In this section, the main components of the XRF Explorer 2.0 are presented in more detail. The items the components consist of are described with the operations the user can perform on them and the expected result. For a clearer understanding, examples are also provided. This section can be used to cover all required understanding that is not explained fully in depth in the tutorials in Section 3.

### 4.1 XRF-EXPLORER HEADER

<b>Functional description</b>	This component of the application's interface consists of the <i>XRF-Explorer</i> icon that the user can click on and 3 other dropdown menus (Figure 115).
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 View options	Click on the <i>XRF-Explorer</i> icon	The user is presented with a dropdown menu with the link to the GitHub repository of the project, a link to the project's <a href="#">documentation</a> , options to change the theme of the working environment and a resetting option
2 View file options	Click on the <i>File</i> menu in the header to display the file options	The user is presented with an option to create new <a href="#">projects</a> and can view the available <a href="#">projects</a> .
3 Display views options	Click on the <i>View</i> menu in the header	The user is presented with the available views that can be enabled/disabled. Additionally, the option for toggling the second <a href="#">main viewer</a> is given here.
4 View exporting options	Click on the <i>Export</i> menu in the header	The user is presented with the available exporting options



Figure 115: Header components

#### Examples

Operation	Example
1 View options	The user clicks on the <i>XRF-Explorer</i> icon to view the available options.
2 View file options	The user clicks on the <i>File</i> menu to view the available <a href="#">projects</a> .
3 Display views options	The user clicks on the <i>View</i> menu to view the available views that can be enabled/disabled.
4 View exporting options	The user clicks on the <i>Export</i> menu to view the available exporting options.

#### 4.1.1 XRF-Explorer icon

**Functional description** This component of the application's interface consists of the *XRF-Explorer* icon that the user can click on to access the [documentation](#) of the application, change the theme or reset the workspace (Figure 20).

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 View GitHub	Click on the <i>XRF-Explorer</i> icon and then on the <i>GitHub</i> item	The user is redirected to the the project's GitHub repository page.
2 Access <a href="#">documentation</a>	Click on the <i>XRF-Explorer</i> icon and then on the <i>Documentation</i> item	The user is redirected to a webpage containing the <a href="#">documentation</a> of the project.
3 Change the theme	Click on the <i>XRF-Explorer</i> icon. Click on one of the available themes displayed in the dropdown menu	The theme of the working environment is changed according to the user's selection
4 Reset the workspace	Click on the <i>XRF-Explorer</i> icon and then on the <i>Reset client</i> option.	The workspace is reset

#### Examples

Operation	Example
1 Access GitHub repository	The user clicks on the <i>GitHub</i> option to access the project's GitHub repository page
2 Access <a href="#">documentation</a>	The user clicks on the <i>Documentation</i> option to access the project's <a href="#">documentation</a>

Continued on next page

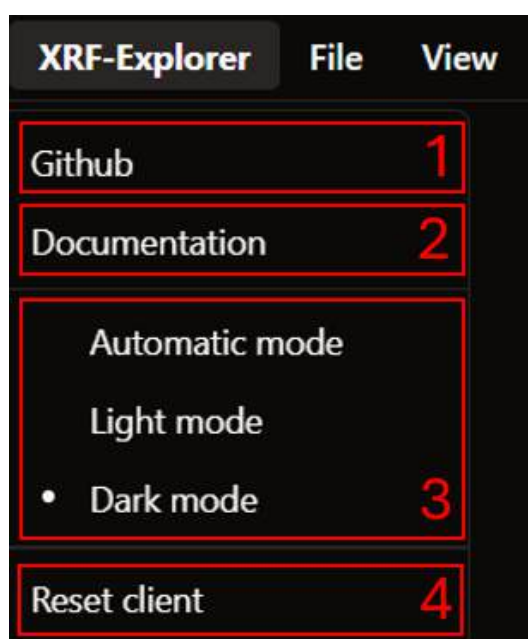


Figure 116: XRF-Explorer icon options

Operation	Example
3 Change the theme	The user clicks on the <i>Dark mode</i> theme option and the workspace theme is updated
4 Reset the workspace	The user clicks on the <i>Reset client</i> option to reset the workspace

#### 4.1.2 File menu

<b>Functional description</b>	This component of the application's interface consists of the <i>File</i> dropdown menu (Figure 117) that allows the user to manage the <a href="#">projects</a> .
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Create new <a href="#">project</a>	Click on the <i>File</i> menu in the header and select the <i>New project</i> item	The user is presented with a series of windows to set up the new workspace data needed for the exploration
2 View available <a href="#">projects</a>	Click on the <i>File</i> menu in the header	The user is presented with a list of available <a href="#">projects</a>

#### Examples

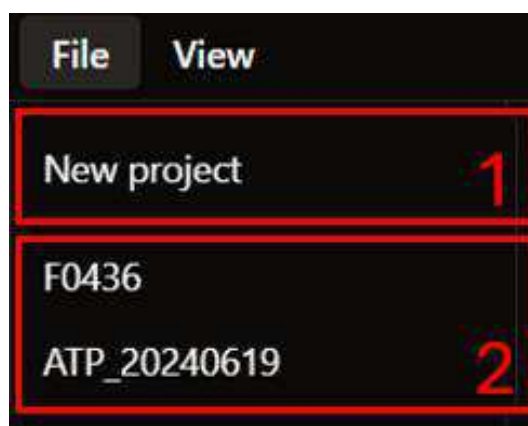


Figure 117: File Menu items

Operation	Example
1 Create new <a href="#">project</a>	The user clicks on the <i>New project</i> item to upload new data needed for the exploration
2 View available <a href="#">projects</a>	The user clicks on the <i>File</i> item to view what <a href="#">projects</a> are available

#### 4.1.3 View menu

**Functional description** This component of the application's interface consists of the *View* dropdown menu that allows the user to customize which [views](#) are displayed and to enable a second [main viewer](#) (Figure 118).

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Enable <a href="#">view</a>	Click on a disabled <a href="#">view</a> in order to enable a <a href="#">view</a>	The newly enabled <a href="#">view</a> will be displayed in the workspace
2 Disable <a href="#">view</a>	Click on an enabled <a href="#">view</a> in order to disable a <a href="#">view</a>	The newly disabled <a href="#">view</a> will not be displayed in the workspace anymore
3 Enable/Disable second <a href="#">main viewer</a>	Click on the (disabled) <i>Second main viewer</i> option order to enable/disable the second <a href="#">main viewer</a>	The newly enabled second <a href="#">main viewer</a> will be displayed in the workspace

#### Examples



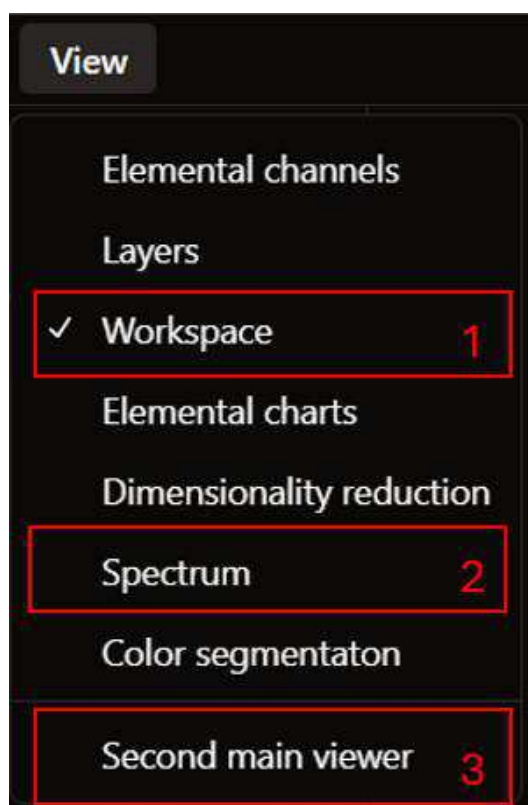


Figure 118: View menu items

Operation	Example
1 Enable <a href="#">view</a>	The user enables the currently disabled <i>Dimensionality reduction</i> <a href="#">view</a> by clicking on it.
2 Disable <a href="#">view</a>	The user disables the currently disabled <i>Layers</i> <a href="#">view</a> by clicking on it.
3 Enable second <a href="#">main viewer</a>	The user enables the currently disabled <i>Second main viewer</i> by clicking on it.

#### 4.1.4 Export menu

##### Functional description

This component of the application's interface consists of the *Export* dropdown menu (Figure 119) that allows to export the visualizations generated in the application.

##### Cautions and warnings

None.

##### Possible errors

None.

##### Formal description

Operation	Description	Result
1 Export painting	Click on the <i>Painting</i> item in the menu	The image displayed in the main viewer is downloaded to the user's standard downloads folder.
2 Export elements chart	Click on the <i>Elements</i> item in the menu	The generated elemental chart is downloaded in the user's standard downloads folder.
3 Export <a href="#">dimensionality reduction</a> embedding	Click on the <i>Embedding</i> item in the menu	The generated embedding is downloaded to the user's standard downloads folder.
4 Export spectral chart	Click on the <i>Spectral</i> item in the menu	The generated spectral chart is downloaded to the user's standard downloads folder.

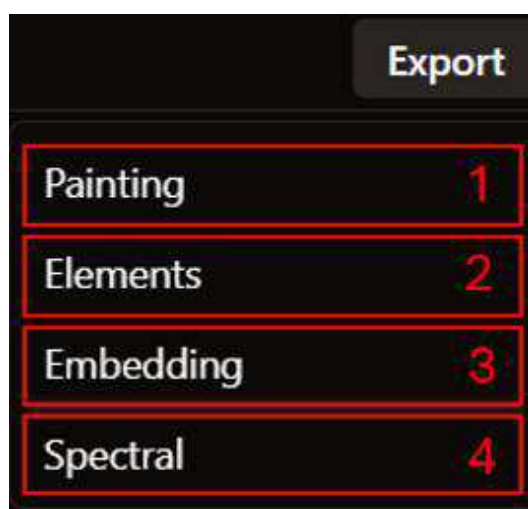


Figure 119: Export menu items

### Examples

Operation	Example
1 Export painting	The user clicks on the <i>Painting</i> item in the menu to export the image displayed in the main viewer having <b>K K</b> highlighted.
2 Export elements chart	The user clicks on the <i>Elements</i> item in the menu to export the generated bar chart.
3 Export <a href="#">dimensionality reduction</a> embedding	The user clicks on the <i>Embedding</i> item in the menu to export the <a href="#">dimensionality reduction</a> embedding of <b>K K</b> with the overlay <b>RGB</b> .
4 Export spectral chart	The user clicks on the <i>Spectral</i> item in the menu to export generated global average spectral chart.

## 4.2 SETTING UP THE WORKSPACE WINDOWS

### 4.2.1 Create new project dialog

<b>Functional description</b>	This component consists of a <a href="#">dialog</a> box (Figure 120) to name the <a href="#">project</a> .
<b>Cautions and warnings</b>	The names given to the <a href="#">projects</a> must be unique.
<b>Possible errors</b>	Giving a <a href="#">project</a> a name that is already in use will result in an error.
<b>Formal description</b>	

Operation	Description	Result
1 Naming a <a href="#">project</a>	Click on the <i>Project name</i> field and give the <a href="#">project</a> a unique name	The created <a href="#">project</a> will have the given name.
2 Go to next step	Click on the <i>Next</i> button	The window for the next step is displayed
3 Cancel creation	Click on the <i>X</i> icon	The project creation is cancelled



Figure 120: Project dialog operations

### Examples

Operation	Example
1 Naming a <a href="#">project</a>	The user names the <a href="#">project name</a> <sup>1</sup>
2 Go to next step	The user clicks on the <i>Next</i> button to go to the next step
3 Cancel creation	The user decides to stop the creation of the project and clicks on the <i>X</i> icon

### 4.2.2 Existing files window

<b>Functional description</b>	This component consists of a window that allows the user to keep or delete the existing files for a project <a href="#">121</a> .
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Delete files	Click on the <i>Delete files</i> button	The existing files are deleted
2 Keep files	Click on the <i>Keep files</i> button	The existing files are kept and available to use in the new <a href="#">project</a>
3 Close window	Click the X button in the corner	The window is closed

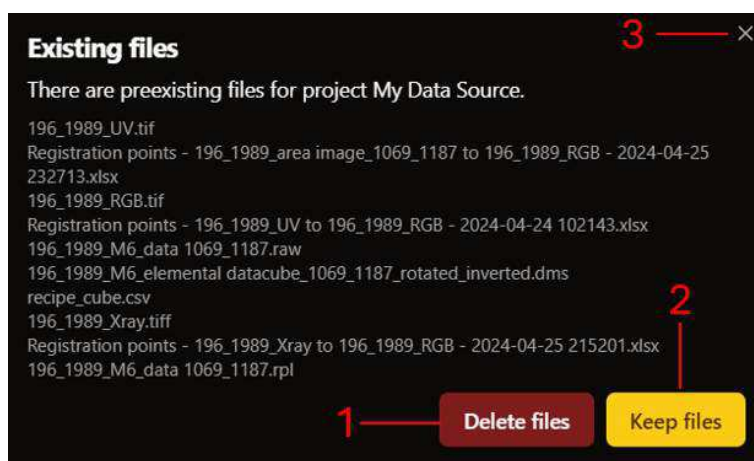


Figure 121: Existing files window operations

### Examples

Operation	Example
1 Delete files	The user decides to not use the existing files and clicks the <i>Delete files</i> button
2 Keep files	The user decides to use the existing files for the new <a href="#">project</a> and clicks the <i>Keep files</i> button
3 Close window	The user wants to close the window and clicks the X button

#### 4.2.3 Set up workspace window

<b>Functional description</b>	This component allows the user to upload new <a href="#">projects</a> to be explored. It consists of a window with several fields that allow the uploading of different file types necessary for the exploration (Figure 122).
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation		Description	Result
1	Upload files	Click on the <i>Upload files</i> button and navigate through the file browser to choose the desired files to upload	The selected files will be uploaded and available in the exploration
2	Name the base image	Introduce a name for the base image in the corresponding <i>Name</i> field	The base image will use the introduced name
3	Select an image file	Select a file from the available valid files in the corresponding selection menu	The selected file will be used as the base image in the exploration
4	Select a type of data to upload	Make a selection between <i>Contextual data</i> , <i>Spectral datacube</i> and <i>Elemental datacube</i>	A selection is made
5	Add component	Click the <i>Add component</i> button	The fields necessary for the selection type are added to the window
6	Name the spectral cube	Introduce a name for the spectral cube in the corresponding <i>Name</i> field	The spectral cube will use the introduced name
7	Select raw file	Select a file from the available valid files in the corresponding selection menu	The selected file will be used as the spectral data in the exploration
8	Select rpl file	Select a file from the available valid files in the corresponding selection menu	The selected file will be used as the spectral data in the exploration
9	Name the elemental cube	Introduce a name for the elemental cube in the corresponding <i>Name</i> field	The elemental cube will use the introduced name
10	Select data file	Select a file from the available valid files in the corresponding selection menu	The selected file will be used as the processed data in the exploration
11	Name the <a href="#">contextual image</a>	Introduce a name for the <a href="#">contextual image</a> in the corresponding <i>Name</i> field	The <a href="#">contextual image</a> will use the introduced name
12	Select <a href="#">recipe</a> file	Select a file from the available valid files in the corresponding selection menu	The selected file will be used as the <a href="#">recipe</a> data in the exploration
13	Adjust spectral cube parameters	Click on the <i>Additional settings button</i>	A window with fields for adjustable parameters for the spectral cube is displayed
14	Delete data	Click on the <i>Delete</i> icon corresponding o the data to be deleted	The fields and data introduced for the respective deletion are erased

Continued on next page

Operation	Description	Result
15	Uploading the files to the server	Click on the <b>Save</b> button within the uploading window
16	Cancel uploading	Click the <b>X</b> icon on the top right corner of the window to cancel the uploading process

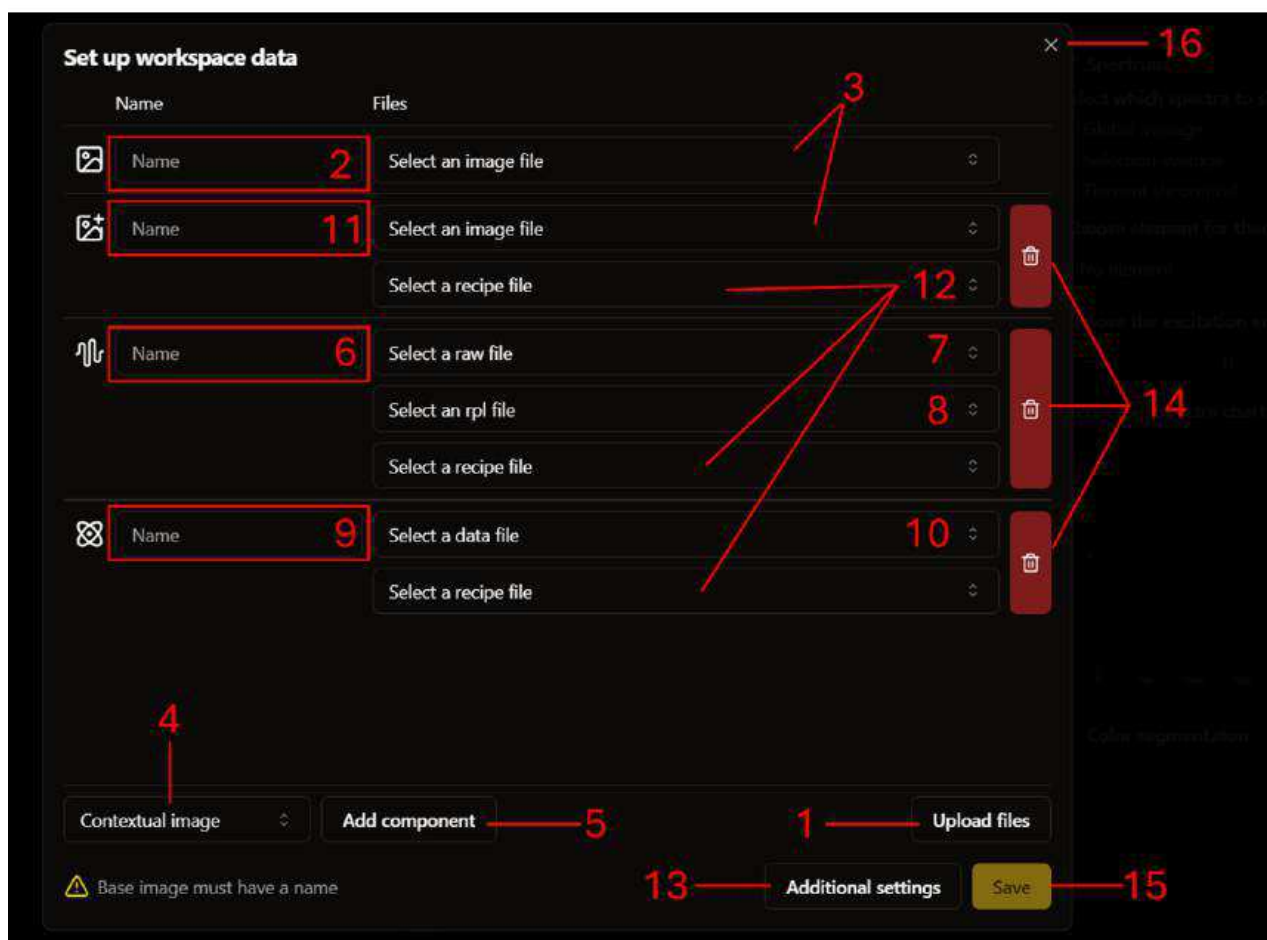


Figure 122: Set up workspace window operations

### Examples

Operation	Example
1	Upload files
2	Name the base image

The user selects files **fileRGB**, **fileUV**, **fileRAW**, **fileRPL**, **fileDMS** and **fileRecipe** and clicks the *Upload files* button

The user names the base image **RGB image**

Continued on next page



Operation	Example
3 Select an image file	The user clicks on the selection menu corresponding to the base mage and selects the <b>fileRGB</b>
4 Select a type of data to upload	The user clicks on the selection menu at the bottom of the window, selects the <i>Spectral datacube</i> option
5 Add component	The user clicks the <i>Add component</i> button and the fields necessary for the selection type are added to the window
6 Name the spectral cube	The user names the spectral cube data <b>Spectral data</b>
7 Select raw file	The user clicks on the selection menu corresponding to the spectral cube and selects the <b>fileRAW</b>
8 Select rpl file	The user clicks on the selection menu corresponding to the spectral cube and selects the <b>fileRPL</b>
9 Name the elemental cube	The user names the elemental cube <b>Elemental data</b>
10 Select data file	The user clicks on the selection menu corresponding to the elemental cube and selects the <b>fileDMS</b>
11 Name the <a href="#">contextual image</a>	The user names the <a href="#">contextual image</a> <b>UV image</b>
12 Select <a href="#">recipe</a> file	The user clicks on the selection menu corresponding to the <a href="#">recipe</a> files and selects the <b>fileRecipe</b>
13 Adjust spectral cube parameters	The user clicks on the <i>Adjustable parameters</i> button to adjust the spectral cube parameters
14 Delete data	The user clicks on the <i>Delete</i> icon corresponding o the <a href="#">contextual image</a> data to delete it
15 Uploading the files to the server	The user clicks on the <i>Save</i> button within the uploading window to upload the files to the server
16 Cancel uploading	The user decides to cancel the uploading process and clicks the X icon on the top right corner of the window

#### 4.2.4 Additional settings window

<b>Functional description</b>	This component consists of a window (Figure 123) that allows the user to adjust the spectral cube parameters.
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Input lower channel boundary	Input a value in the field <i>Lower channel boundary</i>	The introduced value is converted to a channel number to be used as the lower <b>channel boundary</b> when binning.
2 Input higher channel boundary	Input a value in the field <i>Higher channel boundary</i>	The introduced value is converted to a channel number used as the higher <b>channel boundary</b> when binning.
3 Input bin size	Input a value in the field <i>Bin size</i>	The introduced value will be converted to a number of channels to be used as the <b>bin size</b> when binning
4 Save the parameters	Click the <i>Save button</i> within the <i>Additional settings</i> window	The inputted parameters are saved and applied to the spectral cube

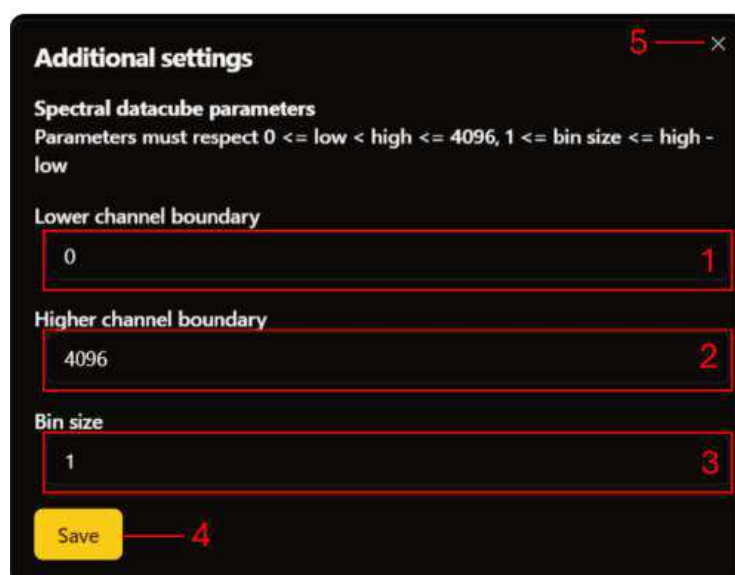


Figure 123: Additional Settings window operations

### Examples

Operation	Example
1 Input lower channel boundary	The user inputs the lower boundary <b>10</b>
2 Input higher channel boundary	The user inputs the higher boundary <b>30</b>
3 Input bin size	The user inputs the bin size <b>1</b>
4 Save the parameters	The user clicks the <i>Save</i> button to save the inputted parameters

### 4.2.5 Abort uploading window

**Functional description** This component consists of a window (Figure 124) that allows the user to cancel the uploading process.

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Abort uploading	Click the <i>Abort</i> button	The uploading process is terminated
2 Continue uploading process	Click the <i>Next</i> button	The uploading process is resumed to the state it was left.

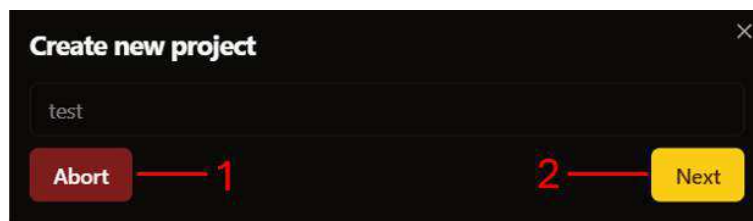


Figure 124: Abort uploading process operations

### Examples

Operation	Example
1 Abort uploading	The user decides to not upload the data entered and clicks the <i>Abort</i> button
2 Continue uploading process	The user decides not to terminate the uploading process and clicks the <i>Next</i> button

### 4.2.6 Set up elements window

**Functional description** This component consists of a window (Figure 125) that allows the user to customize the presence of elements in the workspace.

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Select/Deselect an element	Select/Deselect the checkbox corresponding to the element to enable/disable	The element will/will not appear in the workspace.
2 Deselect all elements	Click the <i>Initialize all elements</i> button	All elements are deselected.
3 Select all elements	Click the <i>Toggle all elements</i> button	All elements are selected.
4 Save selection	Click the <i>Save</i> button	The workspace is configured to only use the selected elements.

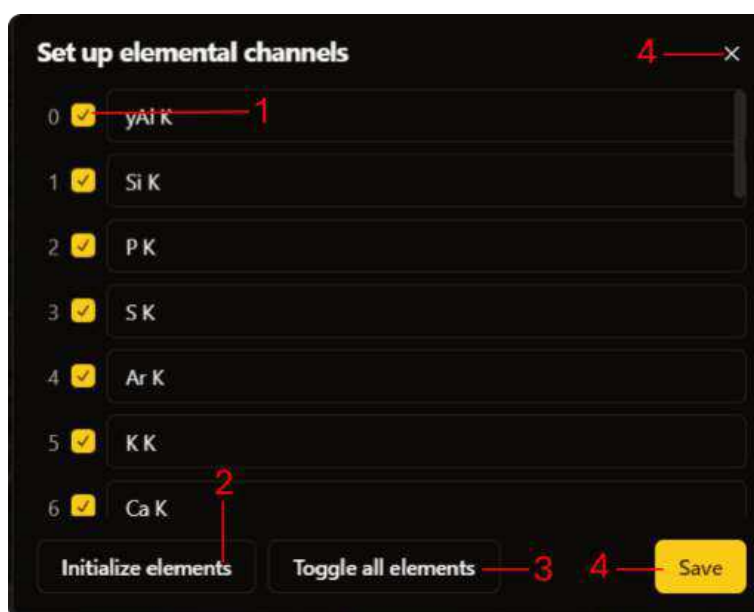


Figure 125: Set up elemental channels operations

### Examples

Operation	Example
1 Select/Deselect an element	The user selects the checkbox corresponding to the <b>Cr K</b> element which is currently disabled
2 Deselect all elements	The user clicks the <i>Initialize all elements</i> button to deselect all elements
3 Select all elements	The user clicks the <i>Toggle all elements</i> button to make sure that all elements are selected.
4 Save selection	The user made their final selection and decides to save the changes by clicking on the <i>Save</i> button

### 4.3 SIDEBARS

**Functional description** This component of the application's interface encompasses the enabled [views](#). The application has two sidebars situated on the left and right sides of the [main viewer](#) on which the user is allowed to perform various operations (Figure 126) and 127).

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Collapse sidebar	Right click within a sidebar (but outside of any <a href="#">view</a> , Figure 126) and click on the <i>Collapse sidebar option</i>	The sidebar closes
2 Enable <a href="#">view</a>	Right click within a sidebar (but outside of any <a href="#">view</a> , Figure 126) and click on any disabled <a href="#">view</a>	The selected <a href="#">view</a> will opened in the respective sidebar
3 Disable <a href="#">view</a>	Right click within any enabled <a href="#">view</a> (Figure 127) and click on the <i>Closed</i> option	The <a href="#">view</a> is disabled
4 Switching a <a href="#">view</a> to left side panel	Right click on any enabled <a href="#">view</a> (Figure 127) and select <i>Left sidepanel</i>	The <a href="#">view</a> will be displayed on the left sidebar
5 Switching a <a href="#">view</a> to right side panel	Right click on any enabled <a href="#">view</a> (Figure 127) and select <i>Right sidepanel</i>	The <a href="#">view</a> will be displayed on the right sidebar
6 Minimize window	Right click within any enabled <a href="#">view</a> (Figure 127) and click on the <i>Minimize window</i> option	The <a href="#">view</a> is minimized

#### Examples

Operation	Example
1 Collapse sidebar	The user right clicks within the left sidebar and clicks on the <i>Collapse sidebar</i> option. The left sidebar closes
2 Enable <a href="#">view</a>	The user right clicks within the right sidebar and clicks on the <i>Layers <a href="#">view</a></i> . The <i>Layers <a href="#">view</a></i> is opened in the right sidebar
3 Close <a href="#">view</a>	The user right clicks within the currently enabled <i>Layers <a href="#">view</a></i> and click on the <i>Closed</i> option. The <i>Layers <a href="#">view</a></i> is disabled

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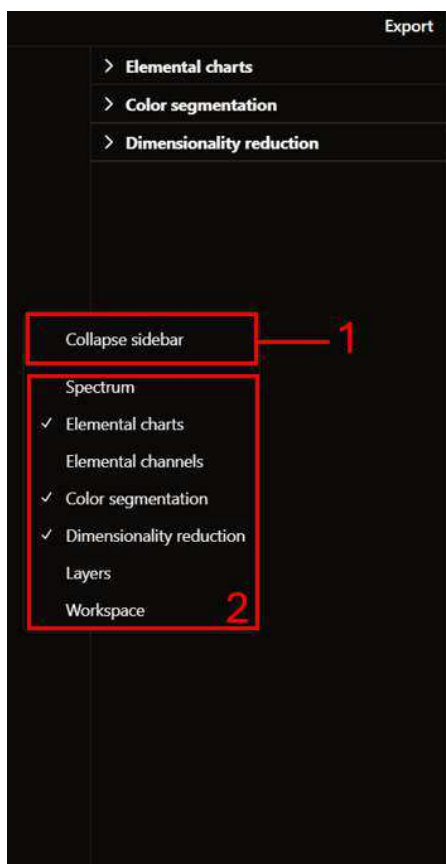


Figure 126: Right Click within sidebar outside views

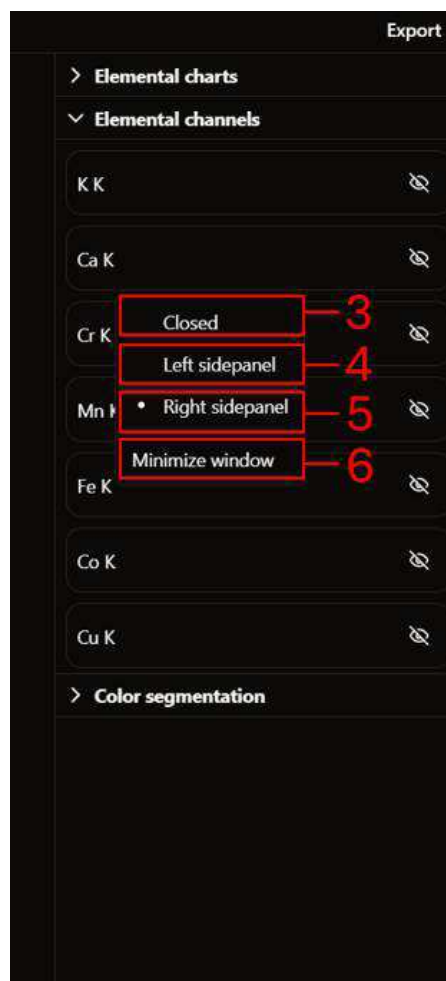


Figure 127: Right Click within sidebar within view



Operation	Example
4 Switching a <a href="#">view</a> to left side panel	The user right clicks on the <i>Spectrum view</i> currently enabled in the right sidebar and selects <i>Left sidepanel</i> . The <a href="#">view</a> will be displayed on the left sidebar
5 Switching a <a href="#">view</a> to right side panel	The user right clicks on the <i>Dimensionality reduction view</i> currently enabled in the left sidebar and selects <i>Right sidepanel</i> . The <a href="#">view</a> will be displayed on the right sidebar
6 Minimize window	The user right clicks within the currently enabled <i>Color segmentation view</i> and clicks on the <i>Minimize window</i> option. The <a href="#">view</a> is still enabled but it is minimized

## 4.4 TOOLBAR

<b>Functional description</b>	This component of the application's interface consists of the tools the user can use in the exploration within the <a href="#">main viewer</a> , along with a tool configuration option (Figure 128).
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, each <a href="#">main viewer</a> has its own toolbar.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Switching to grab mode	Click on the <i>Grab</i> icon within the toolbar	The application will switch to grab mode
2 Switching to lens mode	Click on the <i>Lens</i> icon within the toolbar	The application will switch to lens mode
3 Use rectangle selection tool	Click on the <i>Rectangle selection</i> icon within the toolbar	The application will enable the rectangle selection
4 Use polygon selection tool	Click on the <i>Polygon selection</i> icon within the toolbar	The application will enable the polygon selection
5 Clear selection	Click on the <i>Clear selection</i> icon	The selection made in the main viewer is cleared
6 Reset painting location	Clicks on the <i>Reset painting location</i> icon	The positioning of the image in the main viewer is reset to the default setting
7 View tool configuration options	Click on the <i>Tool configuration</i> icon	The tool configuration options are displayed
8 Change lens size	Click on the <i>Tool configuration</i> icon and adjust the <i>Lens size</i> slider	The size of the <a href="#">lens</a> will be adjusted according to the user's changes

Continued on next page

Operation	Description	Result
9 Change zooming speed	Click on the <i>Tool configuration</i> icon in the toolbar and adjust the <i>Scroll speed</i> slider	The zooming speed will be adjusted according to the user's changes.
10 Change panning speed	Click on the <i>Tool configuration</i> icon in the toolbar and adjust the <i>Movement speed</i> slider	The panning speed will be adjusted according to the user's changes.

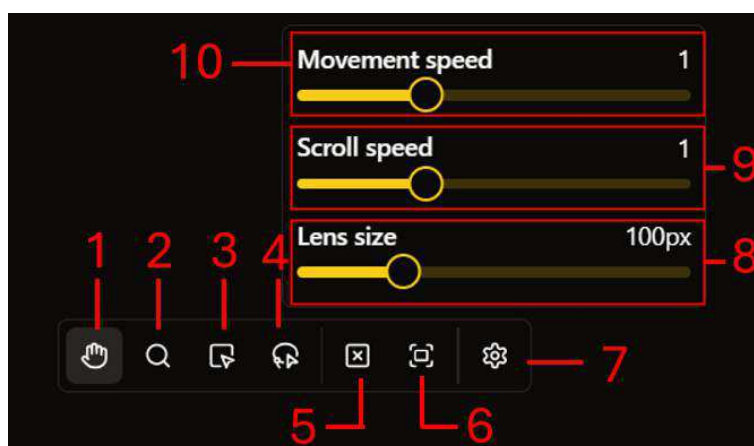


Figure 128: Toolbar operations

### Examples

Operation	Example
1 Switching to grab mode	The user clicks on the <i>Grab</i> icon within the toolbar and the application switches to grab mode
2 Switching to lens mode	The user clicks on the <i>Lens</i> icon within the toolbar and the <a href="#">lens</a> is enabled around the mouse cursor
3 Use rectangle selection tool	The user click on the <i>Rectangle selection</i> icon within the toolbar and and makes rectangle selection in the viewer
4 Use <a href="#">polygon selection tool</a>	The user click on the <i>Polygon selection</i> icon within the toolbar and and makes a hexagon shaped selection in the viewer
5 Clear selection	The user wants to clear the currently made selections and clicks on the <i>Clear selection</i> icon
6 Reset painting location	After zooming out on the painting the user wants to reset the image in the <a href="#">main viewer</a> to its original size and clicks on the <i>Reset painting location</i> icon
7 View tool configuration options	The user wants to see the tool configuration options and clicks on the <i>Tool configuration</i> icon

Continued on next page

Operation		Example
8	Change <b>lens</b> size	The user clicks on the <i>Tool configuration</i> icon and adjusts the <i>Lens size</i> slider to <b>400px</b> such that the <b>lens</b> has maximum size
9	Change zooming speed	The user clicks on the <i>Tool configuration</i> icon in the toolbar and adjusts the <i>Scroll speed</i> slider to <b>0.1</b> such that the zooming speed is minimal
10	Change panning speed	The user clicks on the <i>Tool configuration</i> icon in the toolbar and adjusts the <i>Movement speed</i> slider to <b>3</b> such that the panning speed is maximal

## 4.5 WORKSPACE VIEW

**Functional description** This component of the application's interface consists of a **window** that allows the editing of the configuration of the workspace and the deletion of the **project** (Figure 129).

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Configure <b>project</b>	Click one of the <i>Configure</i> icons for the <b>project</b> to be configured	A <b>window</b> that allows the configuration of that <b>project</b> pops up
2 Delete <b>project</b>	Click on the <i>Delete project</i> button within the view	A <b>dialog</b> asking to confirm the deletion pops up

### Examples

Operation	Example
1 Configure <b>project</b>	The user wants to modify the data for the <b>UV Contextual image</b> and clicks the <i>Configure</i> icon for that <b>project</b>
2 Delete <b>project</b>	The user decides to delete the current <b>project</b> and clicks on the <i>Delete project</i> button within the view

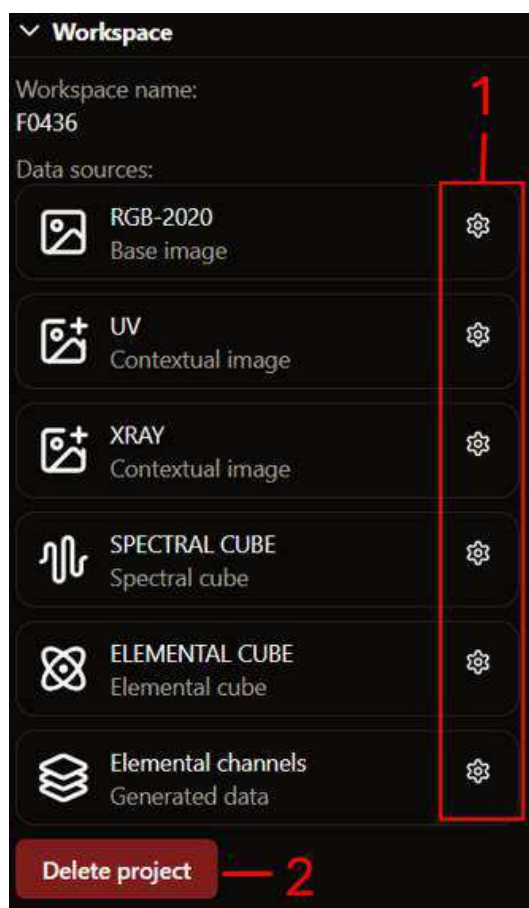


Figure 129: Workspace view operations

#### 4.5.1 Delete project window

##### Functional description

This component consists of a [window](#) (Figure 130) that asks the user for confirmation to delete the [project](#) and allows them to also delete all the associated files.

##### Cautions and warnings

None.

##### Possible errors

None.

##### Formal description

Operation	Description	Result
1 Delete all associated files	Tick the <i>Also delete all associated files</i> checkbox	All the files associated with that respective <a href="#">project</a> are deleted as well upon confirmation
2 Confirm deletion	Click the <i>Delete</i> button within the <a href="#">window</a>	The <a href="#">project</a> is deleted
3 Cancel deletion	Click the <i>Cancel</i> button within the <a href="#">window</a>	The deletion process is canceled and the <a href="#">window</a> closes
4 Close <a href="#">window</a>	Click the X icon within the <a href="#">window</a>	The <a href="#">window</a> closes and the deletion is canceled

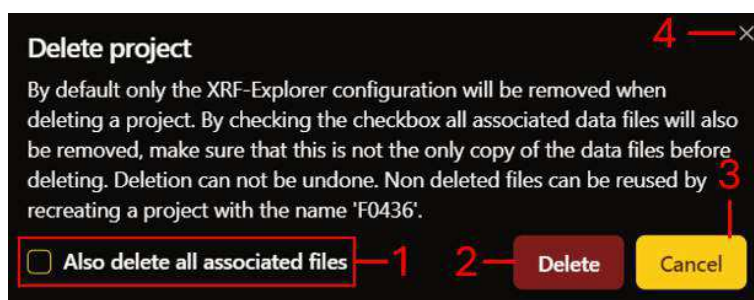


Figure 130: Delete project window operations

## Examples

Operation	Example
1 Delete all associated files	The user wants to delete all the files associated with the <a href="#">project</a> and ticks the <i>Also delete all associated files</i> checkbox
2 Confirm deletion	The user is sure that they want to delete the <a href="#">project</a> so they click the <i>Delete</i> button within the <a href="#">window</a>
3 Cancel deletion	The user decided to not delete the <a href="#">project</a> anymore and clicks the <i>Cancel</i> button within the <a href="#">window</a>
4 Close <a href="#">window</a>	The user decided to not delete the <a href="#">project</a> anymore and clicks the X icon within the <a href="#">window</a>

## 4.6 LAYERS VIEW

<b>Functional description</b>	This component of the application consists of a <a href="#">window</a> (Figure 131) that allows the customization of the the available <a href="#">layers</a> and their <a href="#">hierarchy</a> .
<b>Cautions and warnings</b>	When two <a href="#">main viewers</a> are enabled, operations done through the layers <a href="#">window</a> , will update both <a href="#">main viewers</a> .
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Enable/Disable layers	Click on the <i>Toggle visibility</i> icon	The respective <a href="#">layer</a> is enabled/disabled and visible in the <a href="#">main viewer</a> with respect to the <a href="#">layer hierarchy</a>
2 Set to be visible only inside <a href="#">lens</a>	Tick the <i>Only visible inside the lens</i> checkbox	When the <i>Lens</i> is enabled, the respective <a href="#">layer</a> will only be visible inside the <a href="#">lens</a>
3 Adjust opacity	Adjust the <i>Opacity</i> slider	The opacity of the corresponding <a href="#">layer</a> is adjusted according to the changes

Continued on next page

Operation	Description	Result
4 Show additional sliders	Click on the <i>Additional sliders</i> icon within the <i>layer</i> to be adjusted	A set of sliders is presented
5 Adjust contrast	Adjust the <i>Contrast</i> slider	The contrast of the corresponding <i>layer</i> is adjusted according to the changes
6 Adjust saturation	Adjust the <i>Opacity</i> slider	The opacity of the corresponding <i>layer</i> is adjusted according to the changes
7 Adjust gamma correction	Adjust the <i>Gamma correction</i> slider	The gamma correction of the corresponding <i>layer</i> is adjusted according to the changes
8 Adjust brightness	Adjust the <i>Brightness</i> slider	The brightness of the corresponding <i>layer</i> is adjusted according to the changes

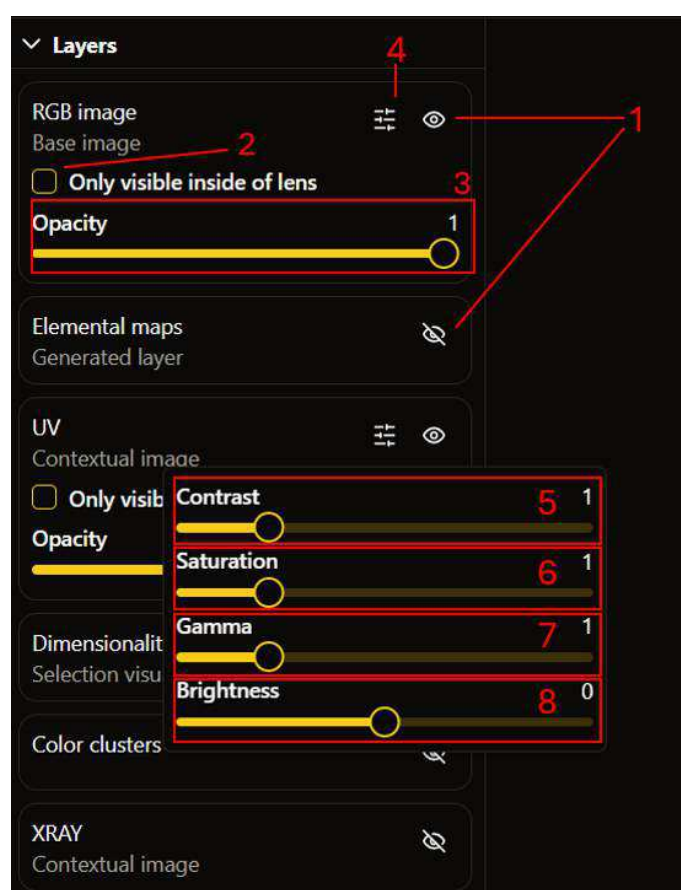


Figure 131: Layers view operations

## Examples



Operation	Example
1 Enable/Disable <a href="#">layers</a>	The user clicks on the <i>Toggle visibility</i> icon corresponding to the <b>UV image</b> which is currently disabled and first in the hierarchy. The respective <a href="#">layer</a> is enabled and visible in the <a href="#">main viewer</a>
2 Set to be visible only inside <a href="#">lens</a>	The user ticks the <i>Only visible inside the lens</i> checkbox corresponding to the <b>UV image</b> and enables the <a href="#">lens</a> . The <b>UV image</b> will now only be visible inside the <a href="#">lens</a>
3 Adjust opacity	The user adjusts the <i>Opacity</i> slider of the <b>UV image</b> to <b>0.5</b> and the opacity of the image is adjusted accordingly
4 Show additional sliders	The user clicks on the <i>Additional sliders</i> icon within the <b>UV image</b> and the available sliders are presented
5 Adjust saturation	The user adjusts the <i>Saturation</i> slider to <b>0.2</b> and the image is adjusted accordingly
6 Adjust brightness	The user adjusts the <i>Brightness</i> slider to <b>-1</b> and the image is adjusted accordingly
7 Adjust gamma correction	The user adjusts the <i>Gamma</i> slider to <b>4</b> and the image is adjusted accordingly
8 Adjust contrast	The user adjusts the <i>Contrast</i> slider to <b>5</b> and the image is adjusted accordingly

## 4.7 ELEMENTAL CHANNELS VIEW

<b>Functional description</b>	This component of the application consists of a <a href="#">window</a> (Figure 132) that allows the customization of the <a href="#">elemental maps</a> .
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Enable/Disable channels	Click on the <i>Toggle visibility</i> icon	The respective channel is enabled/disabled and the corresponding <a href="#">element</a> is highlighted in the <a href="#">main viewer</a> in the chosen color
2 Show color palette for highlighting <a href="#">elements</a>	Click on the <i>Select color</i> icon	The available color palette for highlighting <a href="#">elements</a> is displayed
3 Change highlighting color	Pick a color for the highlighting of the <a href="#">element</a>	The <a href="#">element</a> will be highlighted in the chosen color

Continued on next page

Operation	Description	Result
4 Adjust thresholds	Adjust the lower and upper thresholds of the <i>Intensity thresholds</i> slider	The filtering will be applied in the <a href="#">main viewer</a>

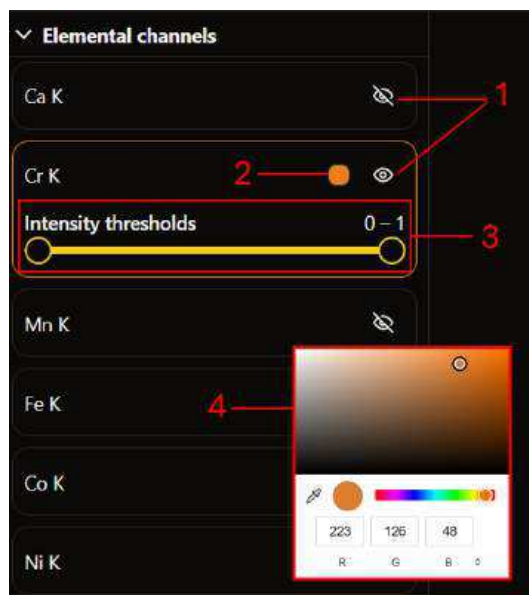


Figure 132: Elemental channels operations

### Examples

Operation	Example
1 Enable/Disable channels	The user clicks on the <i>Toggle visibility</i> icon of <b>S K</b> channel which is currently disabled. The respective channel is enabled and the the pixels containing <b>S K</b> are highlighted in the <a href="#">main viewer</a> in the chosen color
2 Show color palette for highlighting elements	The user clicks on the <i>Select color</i> icon and is presented with the available color palette for highlighting <a href="#">elements</a>
3 Change highlighting color	The user picks the RGB color (248, 119, 188) for the highlighting of the <b>S K</b>
4 Adjust thresholds	The user sets the lower threshold of the <i>Intensity thresholds</i> slider to <b>0.2</b> and upper threshold to <b>0.9</b> and the filtering is applied in the <a href="#">main viewer</a>

## 4.8 DIMENSIONALITY REDUCTION VIEW

<b>Functional description</b>	This component of the application consists of a <a href="#">window</a> (Figure 133) that allows the generation of a <a href="#">dimensionality reduction</a> embedding.
<b>Cautions and warnings</b>	None.
<b>Possible errors</b>	None.
<b>Formal description</b>	

Operation	Description	Result
1 Select an <a href="#">element</a>	Click on the elements selection menu and select the desired <a href="#">element</a> to create the embedding for	An <a href="#">element</a> selection is made
2 Change embedding threshold	Adjust the <i>Threshold</i>	The <a href="#">dimensionality reduction</a> embedding will be generated based on the chosen threshold
3 Generate embedding	Click on the <i>Generate</i> button	An embedding with the chosen parameters is generated and displayed
4 Select an overlay	Click on the <i>Overlay</i> selection menu and select the desired overlay	An overlay selection is made
5 Use rectangle selection tool	Click on the <i>Rectangle selection</i> icon within the <i>Dimensionality reduction</i> view	The application will enable the rectangle selection within the view
6 Use polygon selection tool	Click on the <i>Polygon selection</i> icon within the <i>Dimensionality reduction</i> view	The application will enable the polygon selection within the view
7 Choose highlighting color	Picks the RGB color for the highlighting from the displayed palette	The pixels will be highlighted in the <a href="#">main viewer</a> using the chosen color

### Examples

Operation	Example
1 Change embedding threshold	The user adjust the <i>Threshold</i> to <b>150</b>
2 Select an <a href="#">element</a>	The user clicks on the <a href="#">elements</a> selection menu and selects <b>Hg L</b>
3 Generate embedding	The user clicks on the <i>Generate</i> button and an embedding with the chosen parameters is displayed
4 Select an overlay	The user clicks on the <i>Overlay</i> selection menu and selects the <b>RGB</b> overlay

Continued on next page

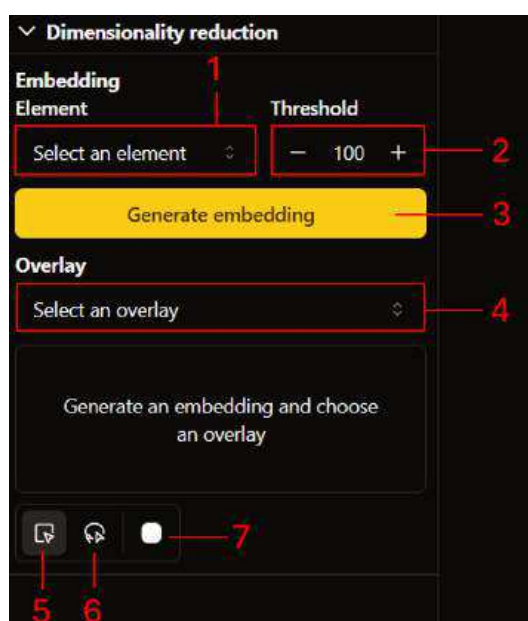


Figure 133: Dimensionality reduction view operations

Operation	Example
5 Use rectangle selection tool	The user selects the rectangle selection tool within the <i>Dimensionality reduction</i> view and makes a square selection in the embedding
6 Use polygon selection tool	The user selects the polygon selection tool within the <i>Dimensionality reduction</i> view and makes an irregular shaped selection in the embedding
7 Choose highlighting color	The user picks the RGB color (240, 11, 128) for the highlighting

## 4.9 ELEMENTAL CHART VIEW

**Functional description** This component of the application's interface consists of a [window](#) showcasing elemental charts visualizing the average [elemental abundance](#) over the whole painting or over a selected area ([134](#)).

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Show the average <a href="#">elemental abundance</a> of the entire painting	In the <i>Charts</i> section select <i>Bar Chart (global data)</i> and in the <i>Options</i> sections select <i>Display all elements</i>	The average <a href="#">elemental abundance</a> of the entire painting is displayed with a bar chart.

Continued on next page

Operation	Description	Result
2 Show the average <a href="#">elemental abundance</a> of the selected area	In the <i>Chart</i> section of the <i>window</i> , select <i>Line chart (selection data)</i>	The average <a href="#">elemental abundance</a> of selected area of the painting is displayed with a line chart.
3 Display all elements	User ticks the <i>Display all elements</i> checkbox	The elements are displayed in the elemental chart

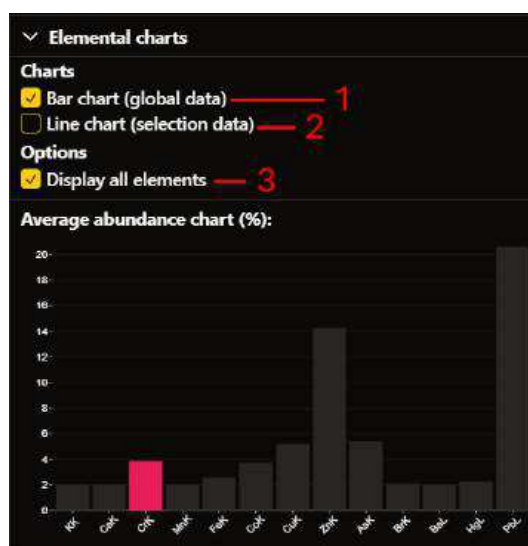


Figure 134: Elemental Charts view operations

## Examples

Operation	Example
1 Show the average <a href="#">elemental abundance</a> of the entire painting	The user selects the <i>Bar Chart (global data)</i> checkbox and in the <i>Options</i> sections selects <i>Display all elements</i> . The average <a href="#">elemental abundance</a> of the painting is displayed with a bar chart.
2 Show the average <a href="#">elemental abundance</a> of the selected area	The user selects the <i>Line Chart (selection data)</i> checkbox and in the <i>Options</i> sections selects <i>Display all elements</i> . The average <a href="#">elemental abundance</a> of the selected area of the painting is displayed with a line chart.
3 Display all elements	The user ticks the <i>Display all elements</i> checkbox and the elements are displayed in the elemental chart

## 4.10 SPECTRAL CHART VIEW

**Functional description** This component of the application consists of a [window](#) (Figure 135) that allows the user to view the average fluorescence spectrum acquired over the whole painting or selected area, along with the theoretical spectrum of the selected [element\(s\)](#).

**Cautions and warnings** None.

**Possible errors** None.

**Formal description**

Operation	Description	Result
1 Show the spectrum of the painting	Select <i>Global average</i>	The average fluorescence spectrum of the painting is displayed.
2 Show the spectrum of the area selected by the user	Select <i>Selection average</i>	A line chart with the average fluorescence spectrum of the selection is automatically added to the chart.
3 Show the theoretical spectrum of the selected <a href="#">element</a> .	Select <i>Element theoretical</i> and select the desired <a href="#">element</a> with the button below <i>Choose element for theoretical spectrum</i> . Input the excitation level in the corresponding field	The theoretical spectrum of that <a href="#">element</a> is added to the chart.
4 Choose element for theoretical spectrum	Choose an element from the selection menu	The theoretical spectrum will be generated for the selected element
5 Choose excitation energy	Input a value in the excitation energy field	The theoretical spectrum will be generate for the inputted energy

### Examples

Operation	Example
1 Show the spectrum of the painting	The user selects the <i>Global average</i> checkbox and the average fluorescence spectrum of the painting is displayed.
2 Show the spectrum of the area selected by the user	The user makes a rectangle selection in the main viewer and then selects <i>Selection average</i> checkbox. The chart is automatically updated with the average fluorescence spectrum of the selection
3 Show the theoretical spectrum of the selected <a href="#">element</a> .	The user selects the <i>Element theoretical</i> checkbox and selects <b>Co K</b> to generate the spectral chart for. The user inputs <b>200</b> in the excitation level field. The theoretical spectrum of that <a href="#">element</a> is added to the chart.

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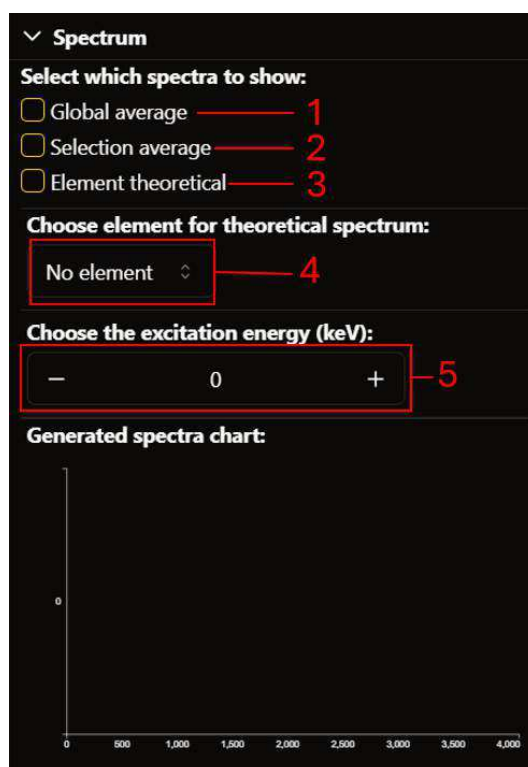


Figure 135: Spectrum view operations

Operation	Example
4 Choose element for theoretical spectrum	The user chooses element <b>Ca K</b> from the selection menu and the theoretical spectrum is generated for the selected element.
5 Choose excitation energy	The user inputs the value <b>200</b> in the excitation energy field

#### 4.11 COLOR SEGMENTATION VIEW

##### Functional description

This component of the application is part of the available [views](#). It contains a dropdown selection menu that allows the user to select the desired filter to apply the color segmentation, a field for filtering the pixels based on an elemental intensity threshold and one to specify the desired number of [color segments](#) (Figure 136).

##### Cautions and warnings

When two [main viewers](#) are enabled, this will update both [main viewers](#).

##### Possible errors

None.

##### Formal description

Operation	Description	Result
1 Make a selection	Click on the <i>Select an element</i> dropdown selection list and click on the preferred <a href="#">element</a> (or complete painting)	The palette corresponding to the selection is displayed

Continued on next page

Operation	Description	Result
2 Choose a threshold	Input a threshold value (in percentages) in the <i>Threshold</i> field that will filter the pixels having a low elemental intensity in order to avoid noise	The pixels with an elemental intensity lower than the chosen threshold will not be included when highlighting a color cluster in the <a href="#">main viewer</a>
3 Choose number of <a href="#">color segments</a>	Input a number of clusters in the <i>Number of clusters (1-50)</i> field	The application will generate the chosen number of <a href="#">color segments</a>
4 Generate color clusters	Click the <i>Generate color clusters</i> button	The application will start the generating color clusters process
5 Select <a href="#">color segments</a>	Click on the <a href="#">color segments</a> to be highlighted in the <a href="#">main viewer</a>	The corresponding pixels are highlighted in the <a href="#">main viewer</a>
6 Deselect <a href="#">color segments</a>	Click on the selected <a href="#">color segments</a> to be deselected	The corresponding pixels are no longer highlighted in the <a href="#">main viewer</a>

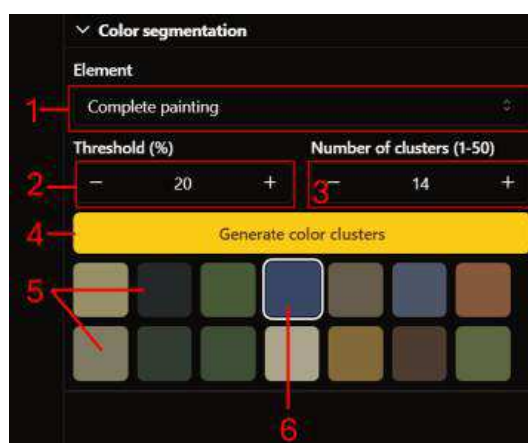


Figure 136: Color segmentation view operations

### Examples

Operation	Example
1 Make a selection	The user clicks on the <i>Select an element</i> dropdown selection list and clicks on <b>Cr K</b> . The palette of the the pixels containing <b>Cr K</b> is displayed
2 Choose a threshold	The user inputs the threshold value <b>25</b>
3 Choose number of <a href="#">color segments</a>	The user inputs the number of clusters <b>23</b>

Continued on next page

Operation	Example
4 Generate color clusters	The user clicks the <i>Generate color clusters</i> button and the application starts the generating color clusters process, eventually showing the generated color palette based on the chosen parameters
5 Select color segment	The user clicks on the first color segment displayed in the palette and the corresponding pixels are highlighted in the <a href="#">main viewer</a>
6 Select color segment	The user clicks on the second color segment displayed in the palette and the corresponding pixels are highlighted in the <a href="#">main viewer</a> on top of the previously highlighted pixels
7 Deselect color segment	The user clicks on the first color segment displayed in the palette and the corresponding pixels are no longer highlighted in the <a href="#">main viewer</a>

## A ERROR MESSAGES AND RECOVERY PROCEDURES

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### A.1 PROJECT/WORKSPACE RELATED ERRORS

<b>Error message 1</b>	<i>Failed to create project "name" The <a href="#">project</a> might already exist</i>
<b>Diagnosis</b>	The user tried to create a <a href="#">project</a> with an already existing name.
<b>Recovery procedure</b>	Choose a different name for the <a href="#">project</a> which does not already exist.
<b>Error message 2</b>	<i>Failed to load workspace "name" ("code", "workspace.json") might be missing or malformed.</i>
<b>Diagnosis</b>	Potentially network related, otherwise the <a href="#">project</a> is corrupted.
<b>Recovery procedure</b>	Try to open the <a href="#">project</a> again and if the error persists the <a href="#">project</a> has become unusable. The user will have to create a new <a href="#">project</a> .
<b>Error message 3</b>	<i>An error occurred while deleting project</i>
<b>Diagnosis</b>	Problem with removing the <a href="#">project</a> from the backend.
<b>Recovery procedure</b>	Try to delete the <a href="#">project</a> again. If the error keeps occurring, there is a network issue. Refresh the application and try again.
<b>Error message 4</b>	<i>Failed to update workspace No changes have been made</i>
<b>Diagnosis</b>	Problem with uploading the changes to the backend.
<b>Recovery procedure</b>	Redo the changes and try to upload them again. If the error keeps occurring, there is a network issue. Refresh the application and try again.
<b>Error message 5</b>	<i>Uploading file name failed</i>
<b>Diagnosis</b>	Problem with uploading the file to the backend
<b>Recovery procedure</b>	Try to upload the file again. If the error keeps occurring, there is a network issue. Refresh the application and try again.
<b>Error message 6</b>	<i>Failed to initialize elemental channels The elemental cube might be configured with an incorrect or malformed data file</i>
<b>Diagnosis</b>	Potentially network related, otherwise the elemental cube is configured with an incorrect or malformed data file.
<b>Recovery procedure</b>	Try to initialize the elemental channels again and if the error persists the file is malformed or incorrect. The user will have to upload a new elemental cube file.
<b>Error message 7</b>	<i>Failed to set up workspace</i>
<b>Diagnosis</b>	Problem with uploading the workspace.json to the backend.
<b>Recovery procedure</b>	Try again and otherwise refresh the application and try again. If the problem persists, check the network connection.
<b>Error message 8</b>	<i>Configured files are not valid</i>
<b>Diagnosis</b>	The configured workspace is of an invalid format.
<b>Recovery procedure</b>	Abort the <a href="#">project</a> creation process and try again.

<b>Error message 9</b>	<i>Failed to load layer</i> <i>Request to (code, layer image) failed</i>
<b>Diagnosis</b>	While creating a layer for the image, loading the layer's image/texture was unsuccessful.
<b>Recovery procedure</b>	Try again and otherwise refresh the application and try again. If the problem persists, the image file is likely corrupted.
<b>Error message 10</b>	<i>Failed to gather registering recipe</i> <i>Request to (code, recipe location) failed</i>
<b>Diagnosis</b>	Problem with fetching the recipe location from the backend.
<b>Recovery procedure</b>	A recipe which will not alter the layer is automatically generated, no user action is required for this.

## A.2 COLOR SEGMENTATION VIEW ERRORS

<b>Error message 11</b>	<i>Failed to retrieve colors or Failed to retrieve painting colors</i>
<b>Diagnosis</b>	Problem when retrieving color segments from the backend.
<b>Recovery procedure</b>	Try again and otherwise refresh the application and try again. If the problem persists, check that the data is correct.

## A.3 DIMENSIONALITY REDUCTION VIEW ERRORS

<b>Error message 12</b>	<i>Embedding is currently already being generated</i>
<b>Diagnosis</b>	The user attempted to update the embedding whilst an embedding was already being generated.
<b>Recovery procedure</b>	Wait for the embedding to finish generating and then update it.
<b>Error message 13</b>	<i>Embedding generation can not be started while overlay is loading</i>
<b>Diagnosis</b>	The user attempted to update the embedding whilst an overlay for the embedding was being loaded.
<b>Recovery procedure</b>	Wait for the overlay to finish loading and then update the embedding.

## A.4 EXPORTING IMAGES ERRORS

<b>Error message 14</b>	<i>Failed to export window</i>
<b>Diagnosis</b>	Problem with exporting the chosen window's image to the user's end device.
<b>Recovery procedure</b>	Try again and otherwise refresh the application and try again. If the problem persists, check that the data is correct.
<b>Error message 15</b>	<i>Failed to export painting</i>
<b>Diagnosis</b>	Problem with exporting the main viewer to the user's end device.
<b>Recovery procedure</b>	Try again and otherwise refresh the application and try again. If the problem persists, check that the data is correct.

## B GLOSSARY

Term	Description
Bin size	Number of channels contained in each bin. All channels in the same bin are averaged together into a single channel in a process called binning.
Channel boundaries	Minimum and maximum indices of the channels selected from the <a href="#">spectral data</a> . The channels lower than the minimum or higher than the maximum are removed from the file after binning.
Color segmentation view	<a href="#">View</a> that displays the distribution of <a href="#">color segments</a> throughout the painting.
Color segment	Area of pixels which all have a similar RGB color.
Contextual image	Image displaying the painting in a modality, e.g. RGB images or UV images.
Control point	A point in pixel space used to define the coordinates of a distinguished feature in an image.
Project	Collection of <a href="#">raw</a> , <a href="#">processed</a> and contextual data that correspond to the same painting and are used to analyze said painting.
Projects list	List of available <a href="#">projects</a> .
Dimensionality reduction	Transformation of data from high-dimensional space into low-dimensional space.
Data registration	The process of aligning images using (given) <a href="#">control points</a> such that all the images have the same dimension and orientation.
Documentation	The documentation refers to the set of informational resources that provide instruction on the utilization of the application as well as an explanation of the application's source code.
Elemental abundance	Abundance and distribution of the <a href="#">elements</a> present in the painting.
Elemental distribution map	Image derived from the <a href="#">processed data</a> , visualizing the distribution of one <a href="#">element</a> across the painting.
Elements	Chemical elements present in the painting.
Polygon selection tool	Selection tool for the <a href="#">dimensionality reduction</a> view.
Layer	Discrete compound that contains an individual <a href="#">contextual image</a> or <a href="#">elemental distribution map</a> .
Layer stack	Collection of all <a href="#">layers</a> within the application, ordered in a sequence that determines their display priority and visual overlap.
Layer hierarchy	The order in which the <a href="#">layers</a> are stacked on top of each other in the <a href="#">main viewer</a> . Layers at the top are displayed above layers below them, affecting what is seen in the final picture.
Lens	Mouse position driven ocular that looks through the top <a href="#">layer</a> to a selected <a href="#">layer</a> below.
Lens viewing mode	Mode in which the user controls the lens.
Micro-XRF	Advanced analytical technique used to determine the elemental abundance of materials at a microscopic scale.

Continued on next page

Term	Description
Elemental data	Elemental cube (3-dimensional) of elemental distribution data obtained from processing the <a href="#">spectral data</a> that, for each pixel, gives the abundance of the different <a href="#">elements</a> present.
Spectral data	Spectral cube (3-dimensional) of <a href="#">spectral data</a> obtained from the XRF scanner that, for each pixel, gives the intensity of the X-Ray fluorescence emitted at different energies the <a href="#">elements</a> in the painting.
Recipe	A set of <a href="#">control points</a> over a set of images of the painting, linked across multiple images for perspective correction and alignment to <a href="#">register the data</a> .
Selection tool	Tool that allows the user to select a subset of the painting.
Selected areas	Areas selected by the user using the <a href="#">selection tool</a> in the <a href="#">main viewer</a> .
Spectra	Representation of the intensity (counts) of the fluorescence emitted by the materials in the painting as a function of energy (KeV).
Toast message	Notification that appears on the user's interface, to inform the user of some action or event. It is designed to automatically disappear after a brief period, requiring no user interaction.
(Main) Viewer	Main large interactive visualization where spatial data is presented.
Window/view	Any of the visualizations that are not the main viewer, where different plots, graphs and other information can be displayed.



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