# Tackling an Urban Chameleon via Digital Graffiti Archaeology

**Geert Verhoeven** | *project coordinator*

*projectindigo.eu*

*The INDIGO graffiti project was funded by the Heritage Science Austria programme of the Austrian Academy of Sciences (ÖAW)*

iconic

# GRAFFITI

## diverse creations

iconic

# GRAFFITI
## diverse creations

multi-faceted

# GRAFFITI
## diverse creations

art <> vandalism

graphical <> textual

socio-political criticism <> entertaining

legal <> illegal

tangible <> intangible

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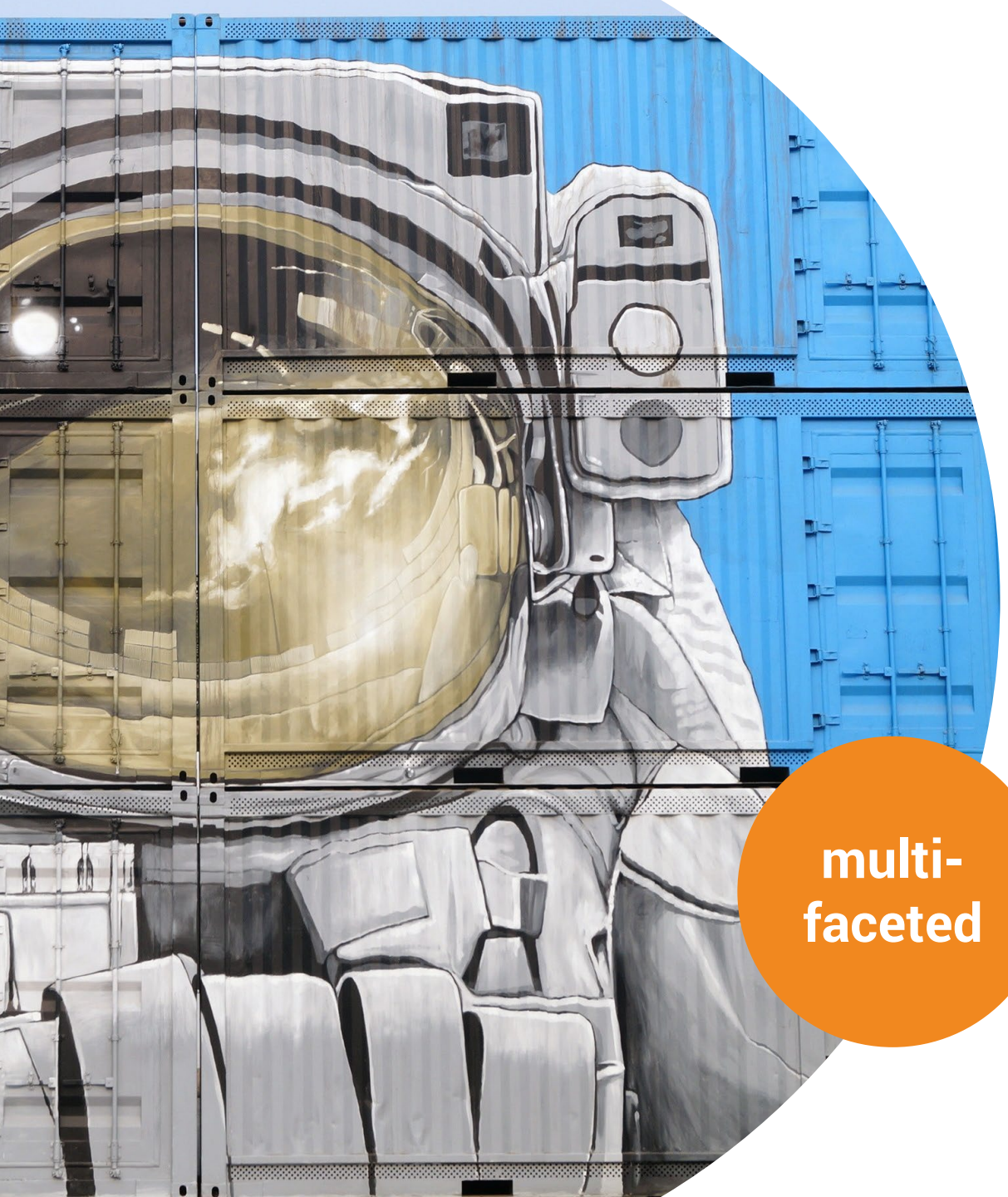

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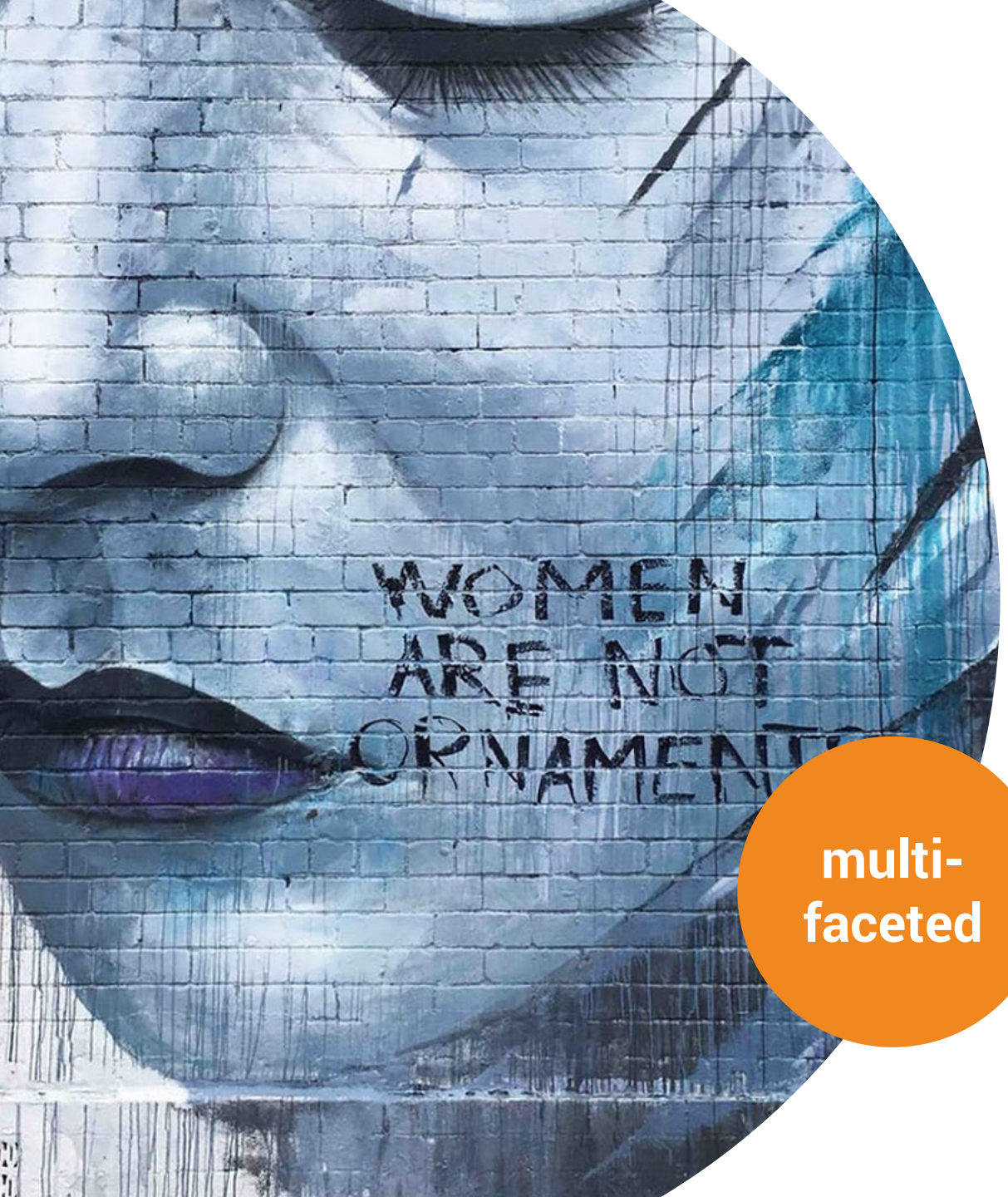


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**graffiti are**

**unique**
**complex**
**short-lived**
**socially relevant**

graffiti are

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complex

short-lived

socially relevant

cultural heritage

# ARTISTIC merit

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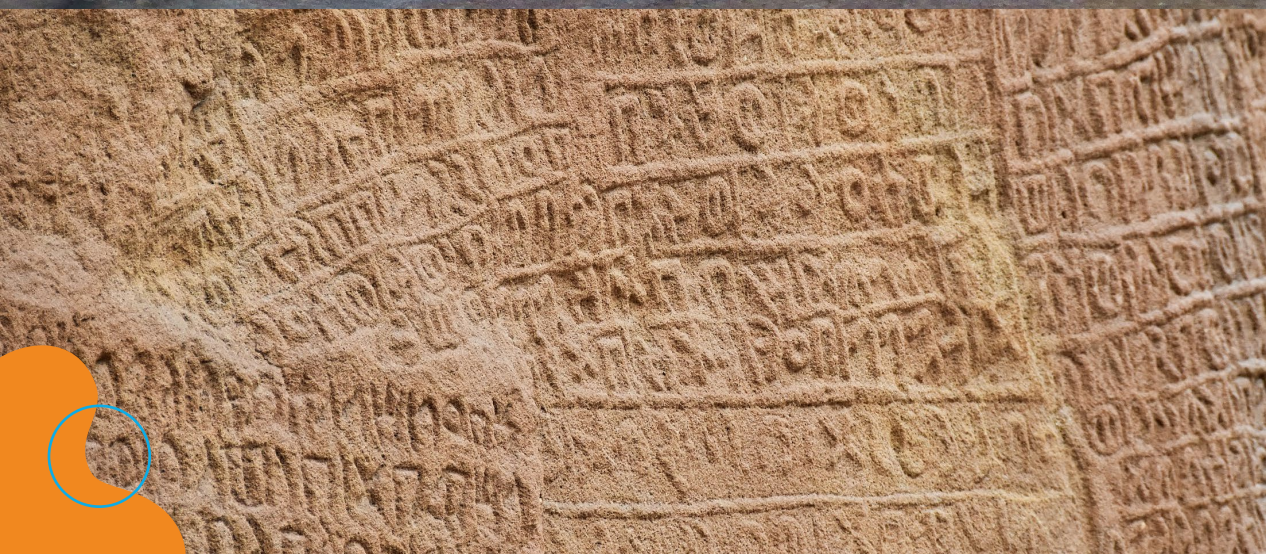
**Marcel Duchamp**
*Fountain* (1917)

# ARTISTIC merit



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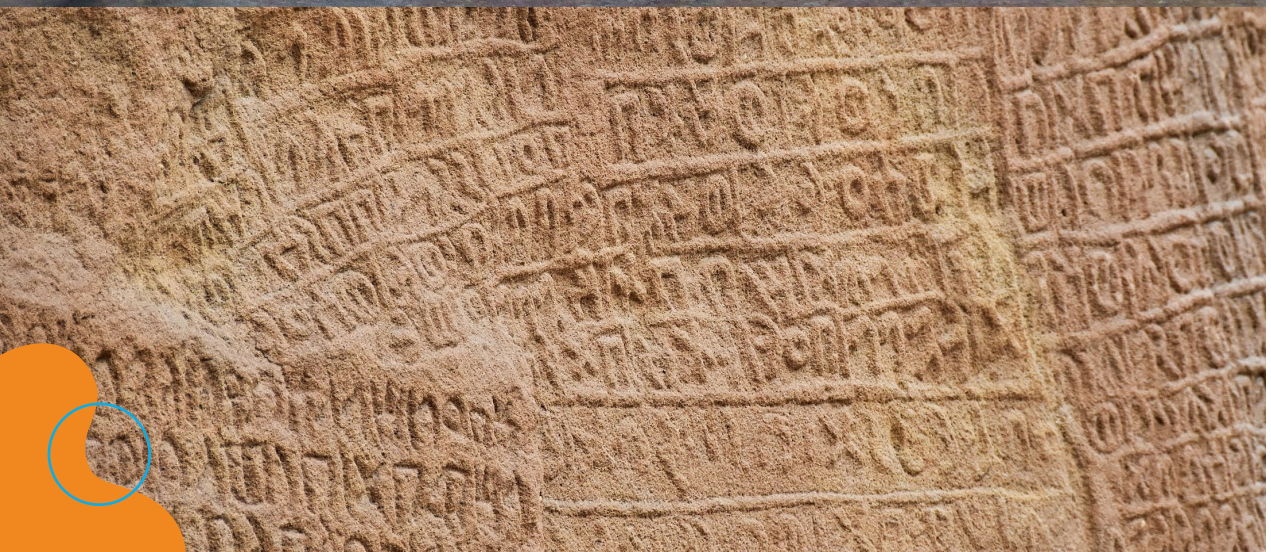

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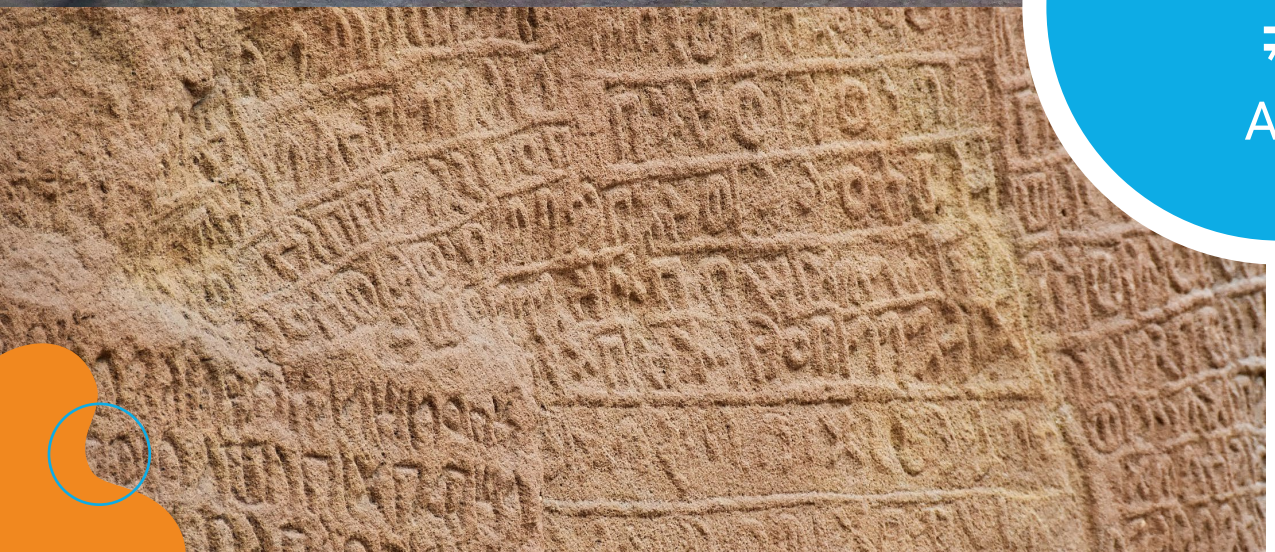

Cultural heritage

≠

Art

# HISTORICAL | POLITICAL
## relevance

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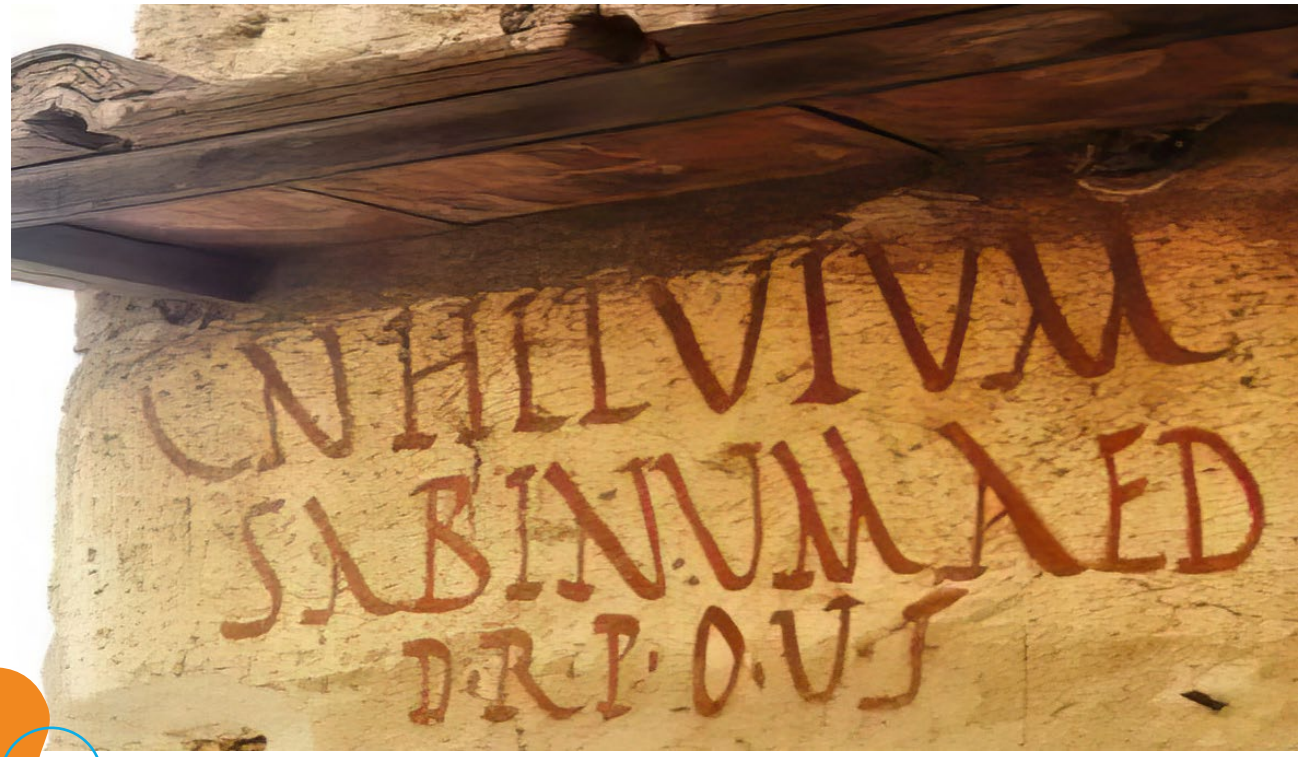
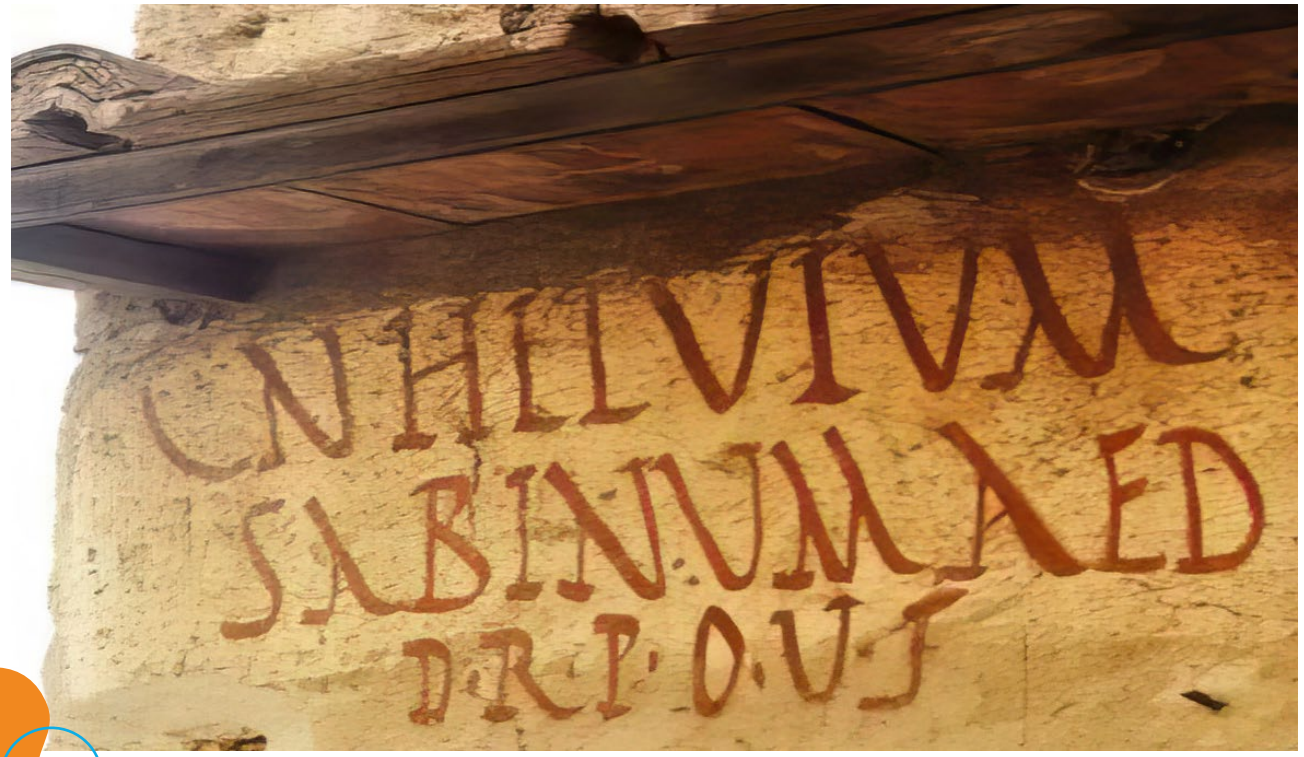
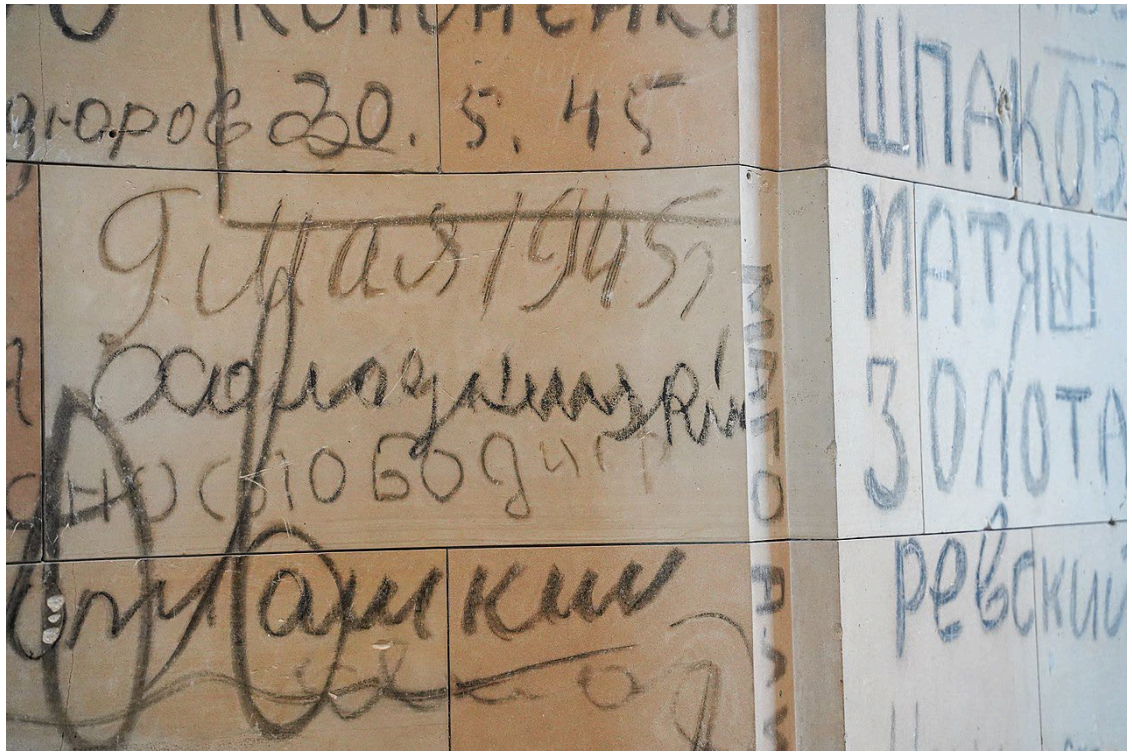
## relevance



# HISTORICAL | POLITICAL
## relevance





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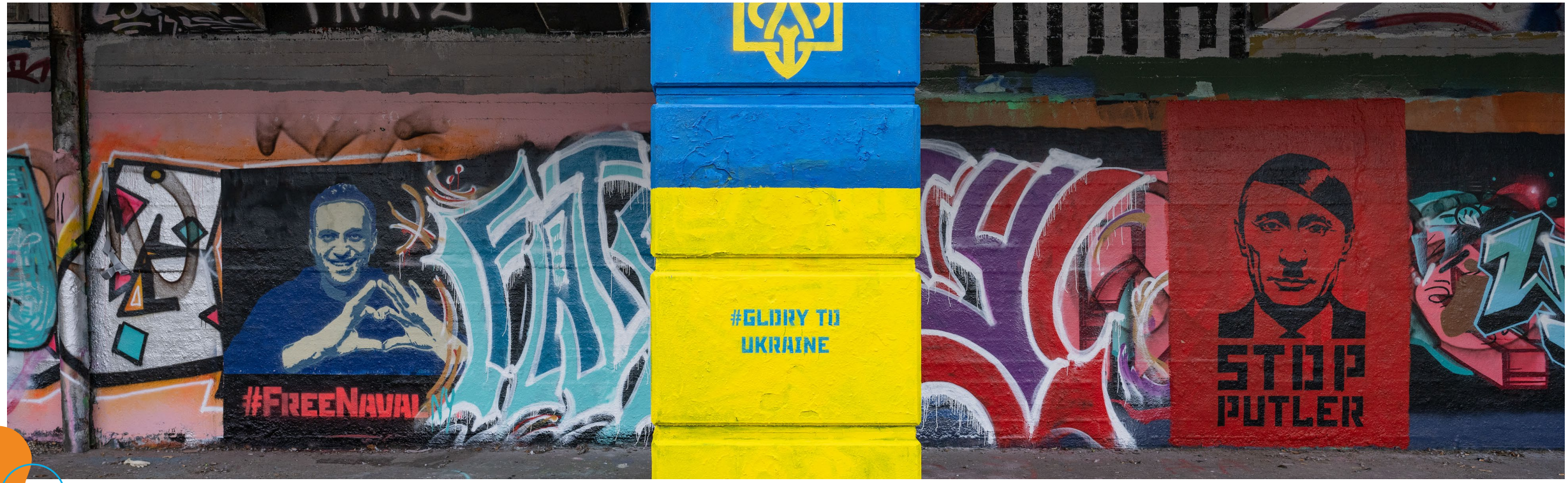

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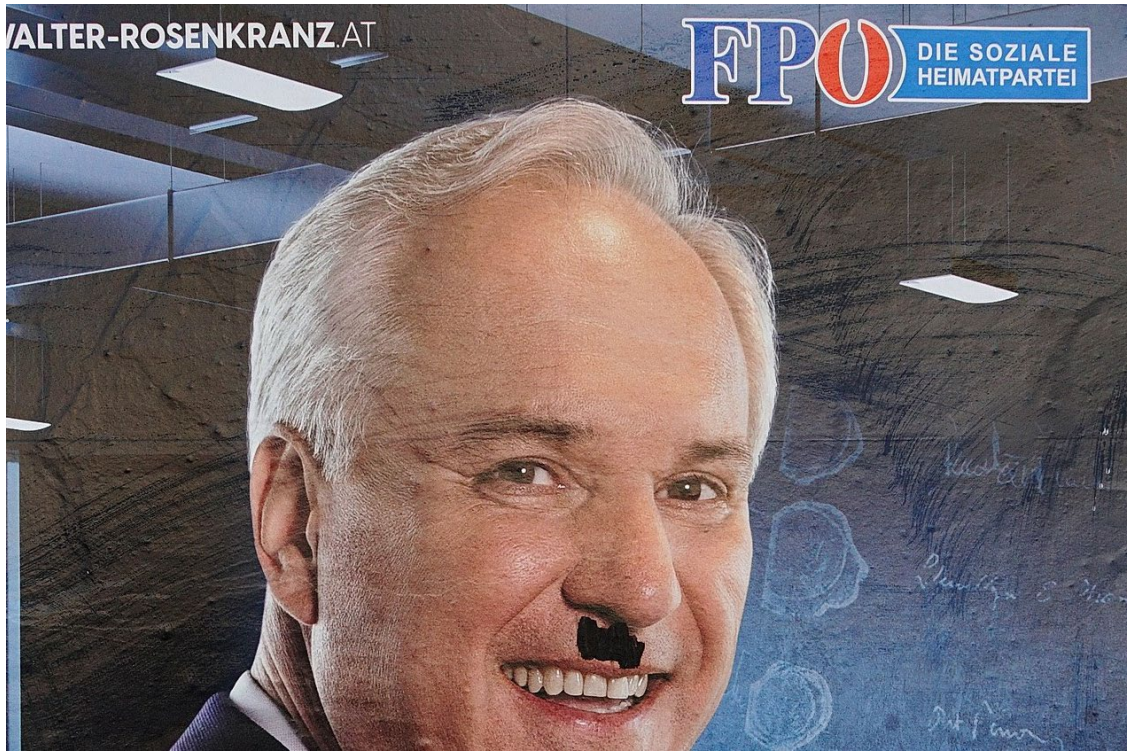
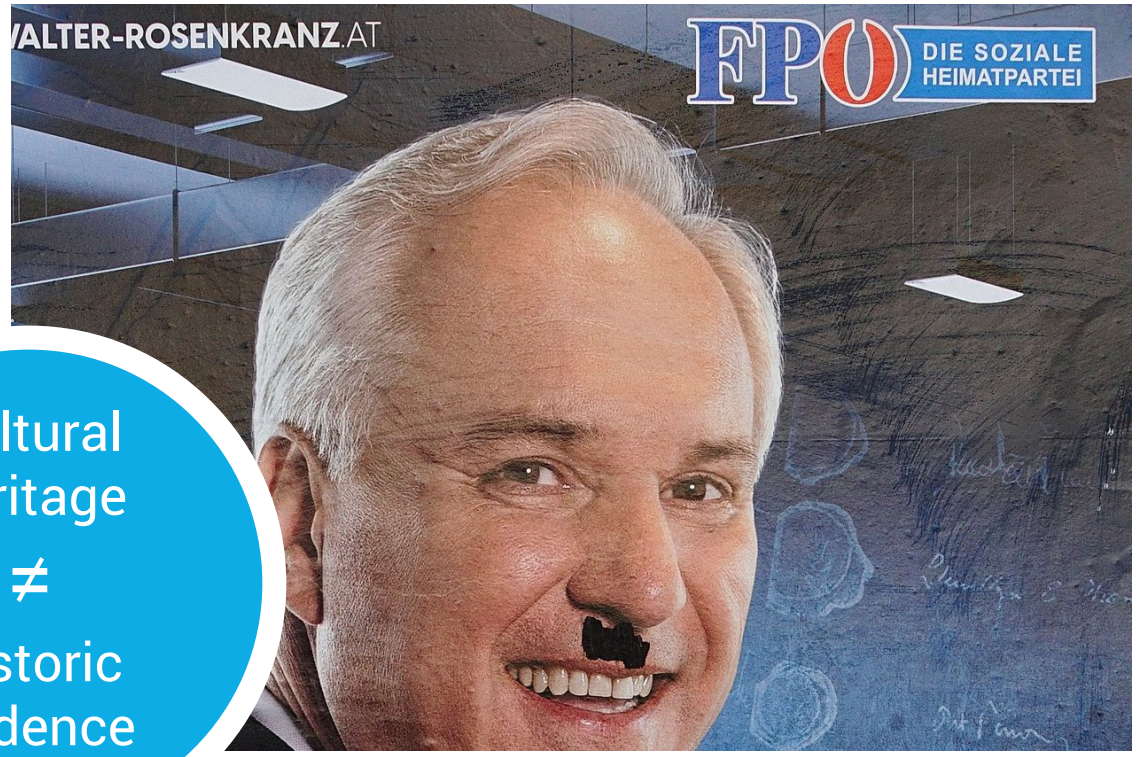
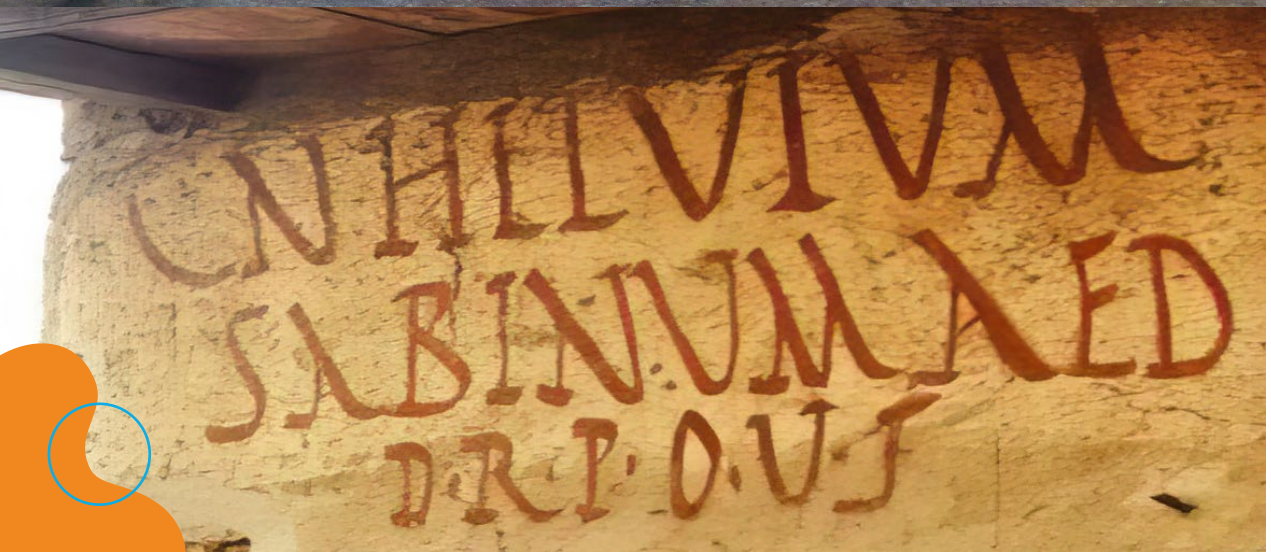


# HISTORICAL | POLITICAL
## relevance

Cultural heritage ≠ Historic evidence



# ANCIENT | contemporary

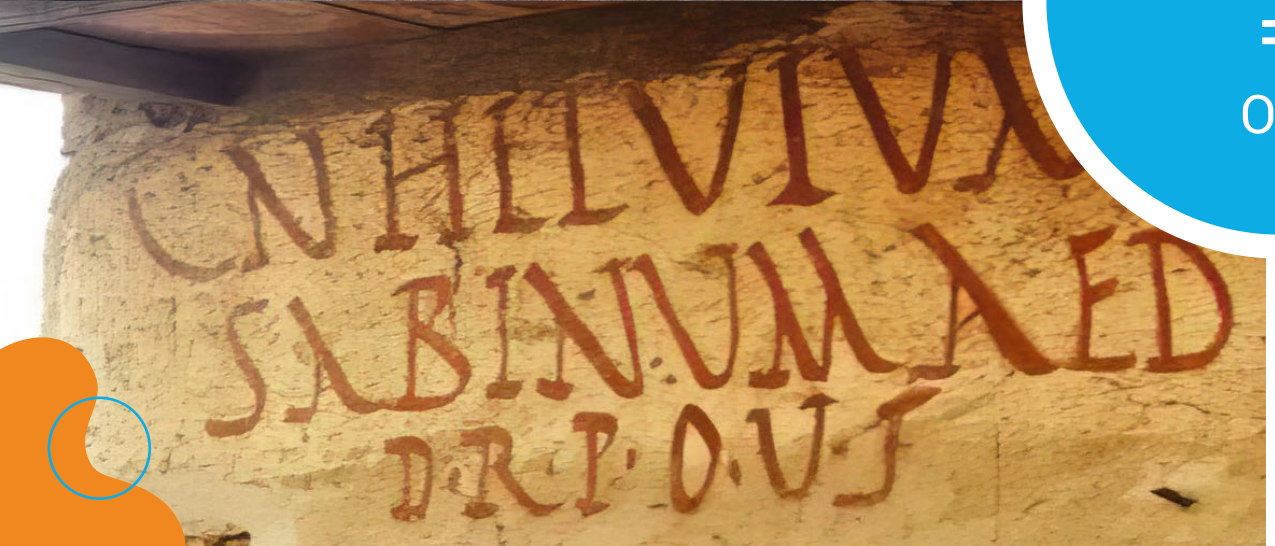


# ANCIENT | contemporary

Cultural heritage

=

Old



KZJER

graffiti are

unique

complex

short-lived

socially relevant

cultural heritage

# NEEDING
# academic rigour

*“For as long as we are imprecise about the artworks we are discussing, our research will be rightfully seen as lacking scholarly rigor.“*

*de la Iglesia 2015*

**RECORDING**

random

partial

inaccurate

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**DISSEMINATION**

unstandardised

limited interaction

closed access

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**ANALYSIS**

descriptive

fragmentary

biased

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**DISSEMINATION**

unstandardised

limited interaction

closed access

**ANALYSIS**

descriptive

fragmentary

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**SYNERGY**

one-sided

partial know-how

limited output

# NEEDING
# academic rigour

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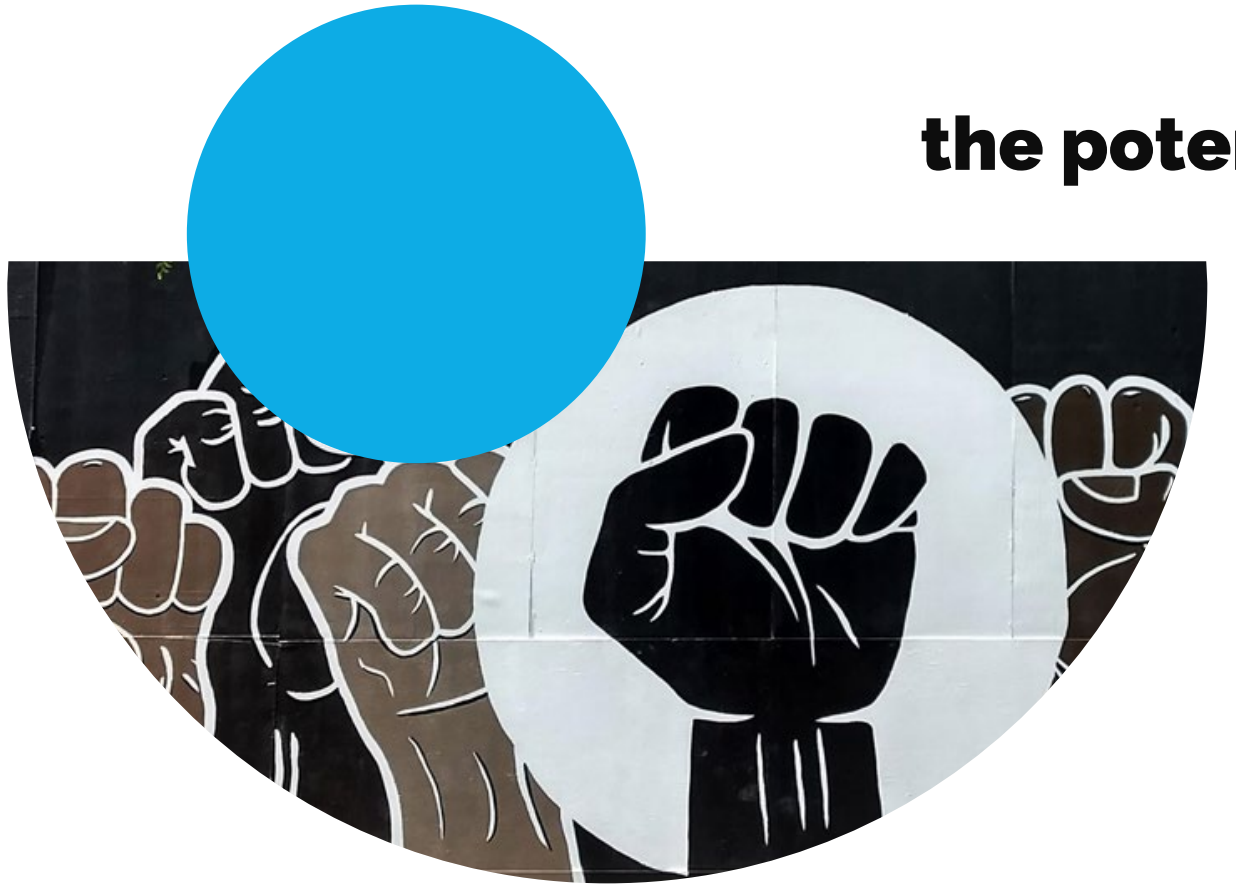

**the potential**
**of graffiti**
**to understand**
**society**
**is under-exploited**

indigo

**In**ventory and

**di**sseminate

**g**raffiti along the

d**o**naukanal

**In**ventory and

**di**sseminate

**g**raffiti along the

d**o**naukanal

WHAT

**IN**ventory and

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WHAT

WHERE

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WHAT

WHERE

WHY

digitally preserve

and

analyse

**IN**ventory and

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**9**raffiti along the

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WHAT

WHERE

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and

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WHO

ÖAW

GiFLE

TU WIEN GEO

vr|vis

Stadt Wien

SPRAY CITY.AT

LUDWIG BOLTZMANN INSTITUTE
Archaeological Prospection and Virtual Archaeology

**in**ventory and

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WHAT

WHY

digitally preserve

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WHERE

WHO

**Heritage Science Austria** programme | **€ 580 k** | **2** years

In ventory and
di sseminate
g raffiti along the
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WHAT

WHERE

? HOW ?

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WHO

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# INDIGO approach

5 research pillars

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creation

# INDIGO approach

5 research pillars

creation

acquisition

# INDIGO approach

5 research pillars

creation

acquisition

processing

# INDIGO approach

5 research pillars

creation

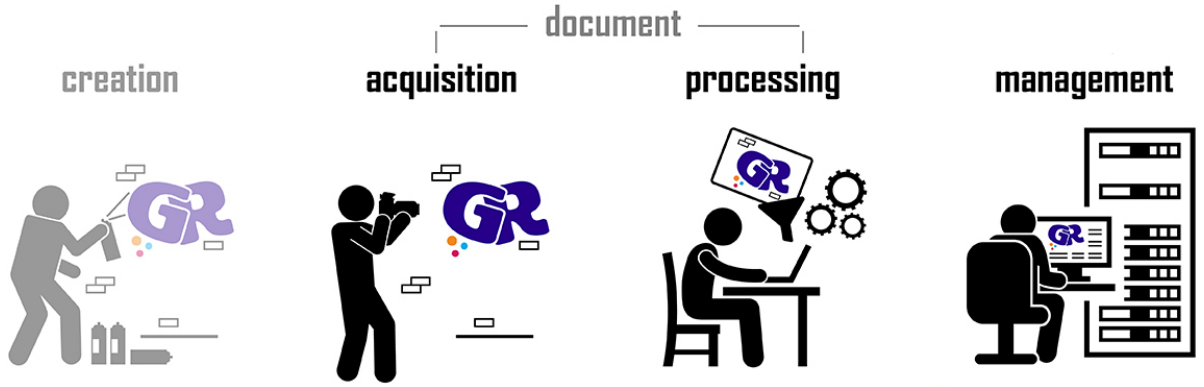
acquisition

processing

management

# INDIGO approach

5 research pillars



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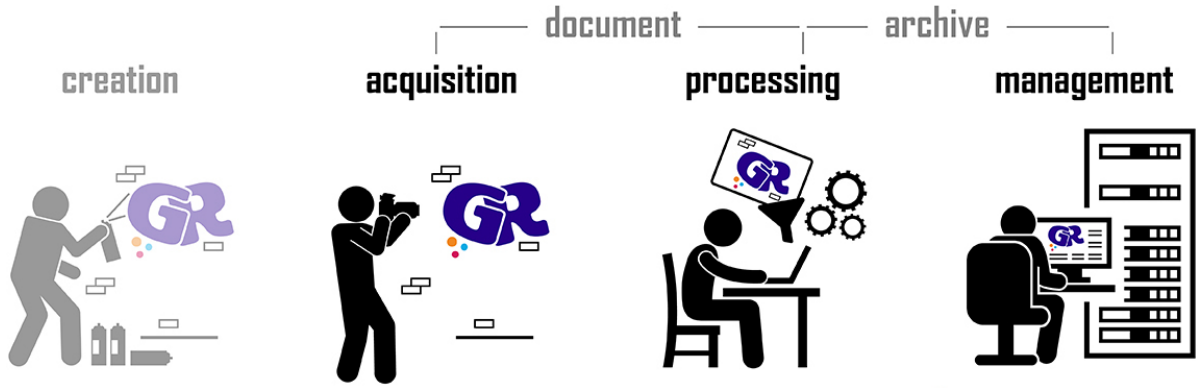

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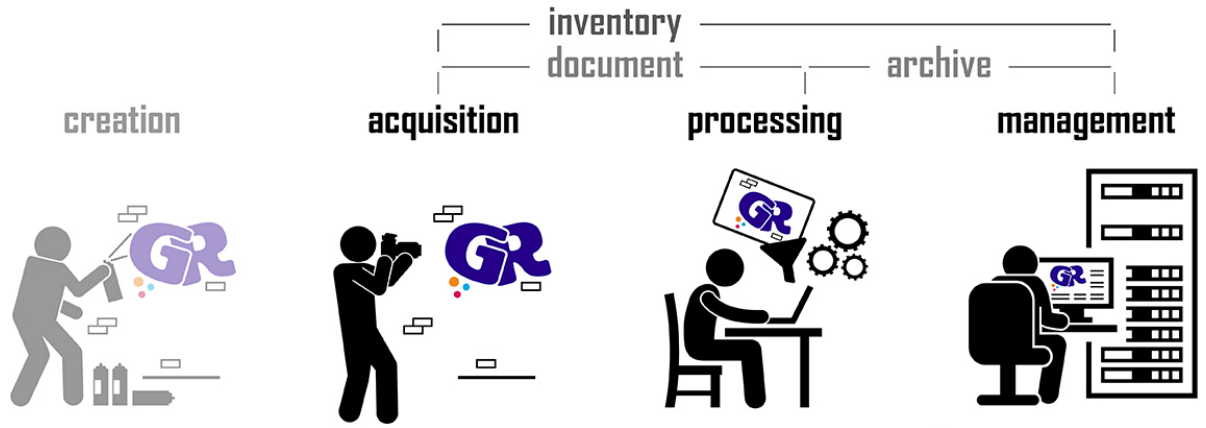

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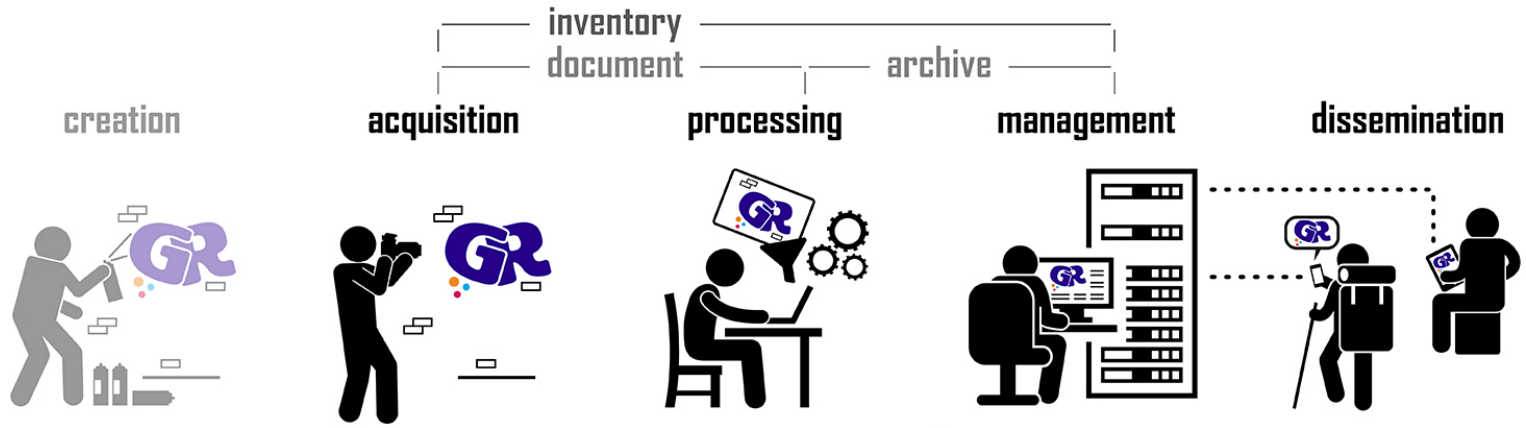

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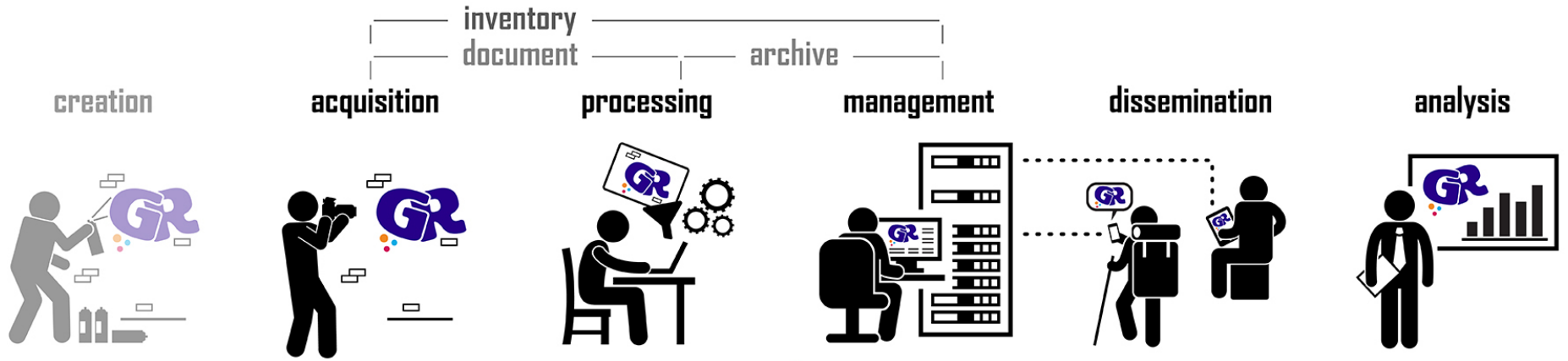
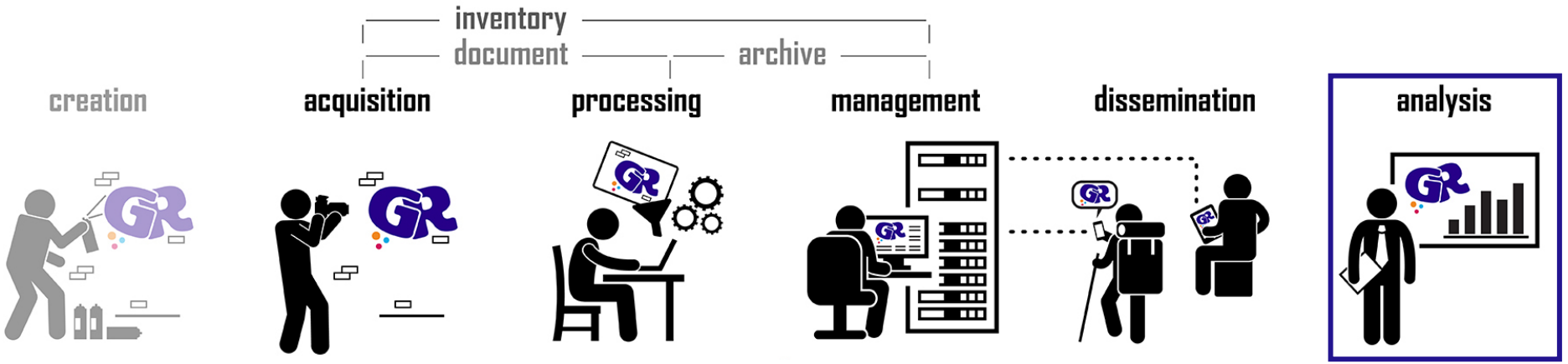


# POTENTIAL questions

5 research pillars



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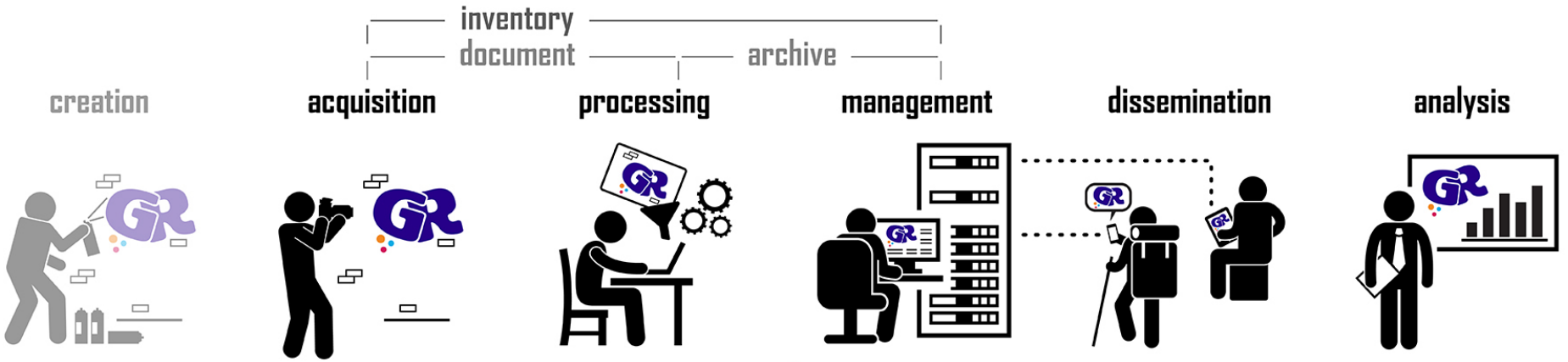
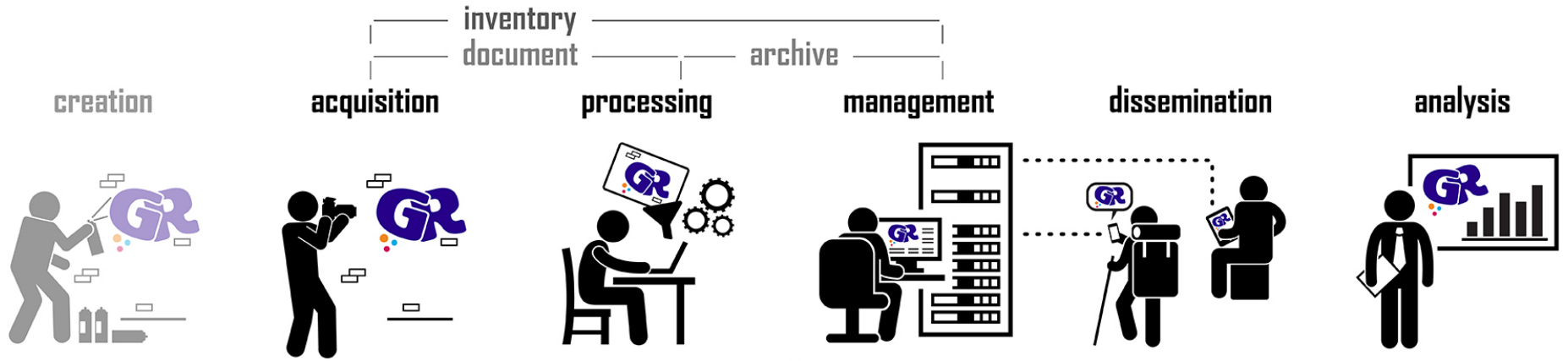



When and where do political graffiti typically appear ?

# POTENTIAL questions

5 research pillars

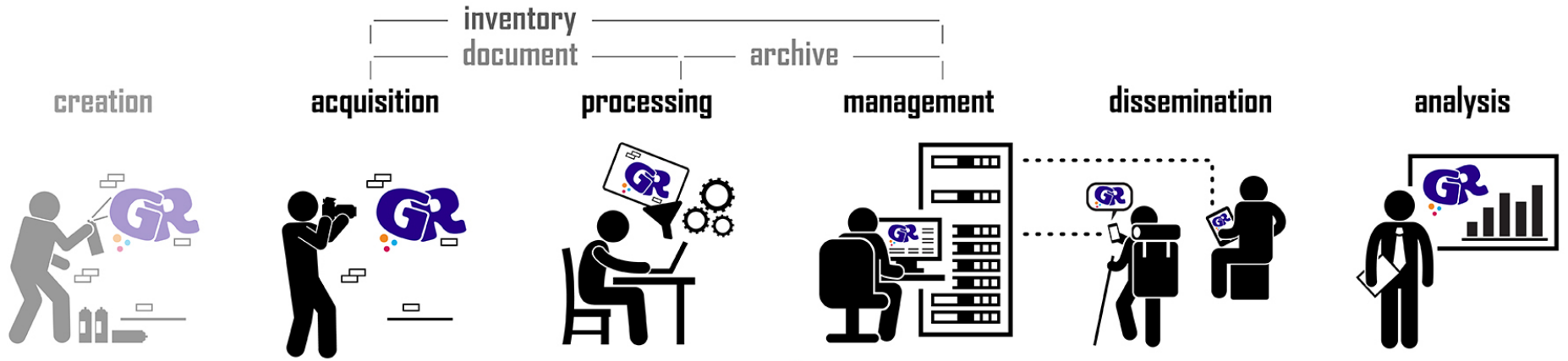



**When and where do political graffiti typically appear ?**

**What are the main styles and colours of those graffiti, and how long do they – on average – stay visible before they are (partly or entirely) covered ?**

# POTENTIAL questions

5 research pillars

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What type of graffito commonly covers political messages ?

# POTENTIAL questions

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## GRAFFITI *TEMPORALITY*

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GRAFFITI *TEMPORALITY*

GRAFFITI *TERMINOLOGY*

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GRAFFITI *TEMPORALITY*
GRAFFITI *TERMINOLOGY*
GRAFFITI *CHARACTERISATION*

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# GRAFFITI archaeology

ARTEFACT

*LOCATION*
*TEMPORALITY*
*TERMINOLOGY*
*CHARACTERISATION*

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# SOME results

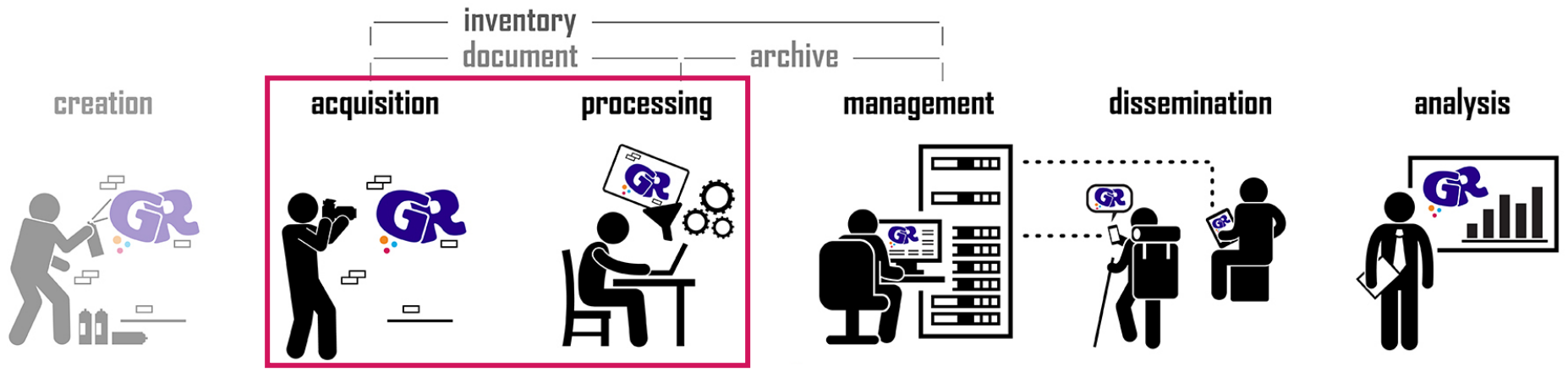
GRAFFITI *LOCATION*

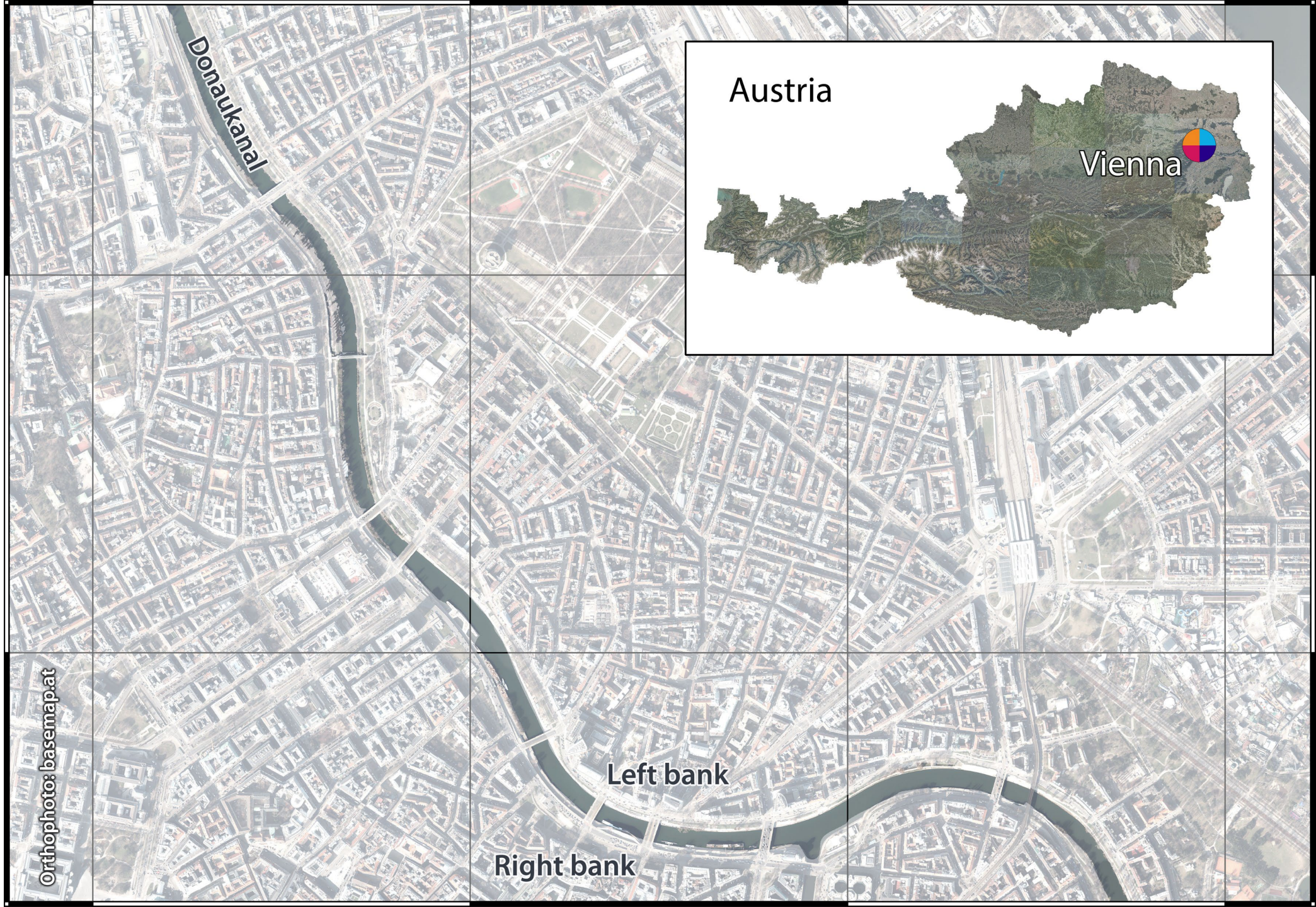
GRAFFITI *TEMPORALITY*

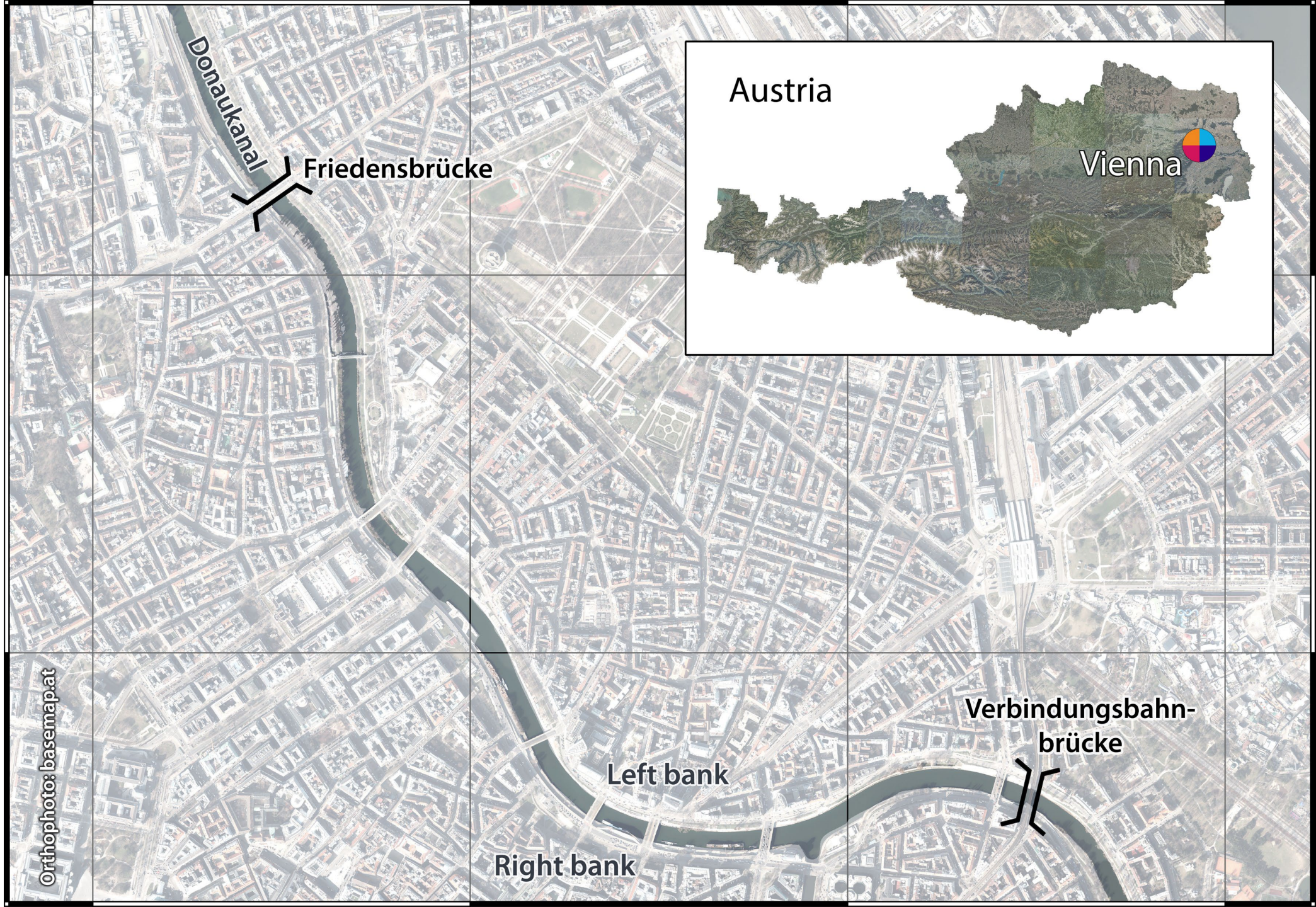
GRAFFITI *TERMINOLOGY*

GRAFFITI *CHARACTERISATION*

5 research pillars

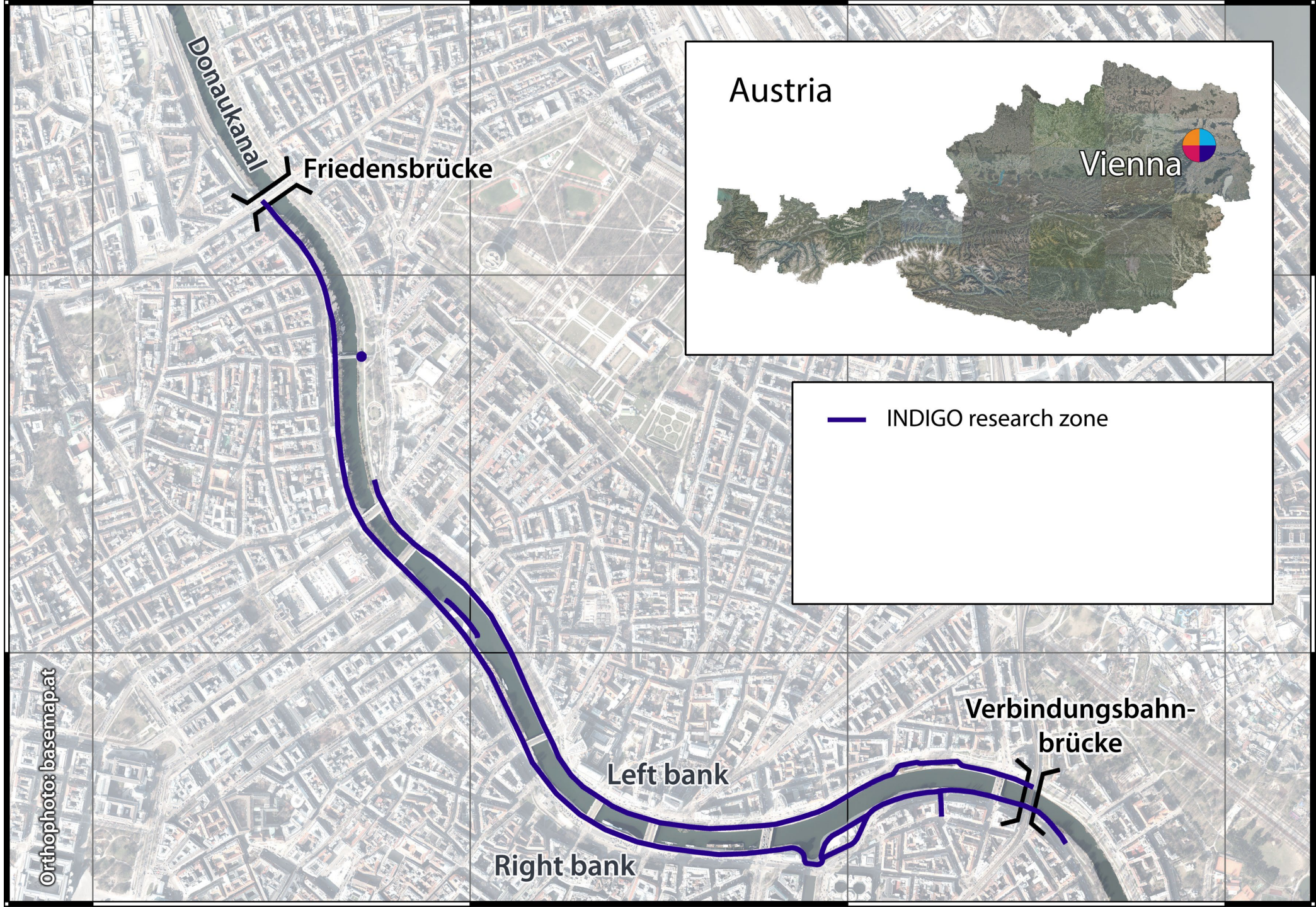



Donaukanal
Austria
Vienna
Left bank
Right bank
Orthophoto: basemap.at


Donaukanal
Friedensbrücke
Austria
Vienna
Orthophoto: basemap.at
Left bank
Right bank
Verbindungsbahn-
brücke

## STRETCH

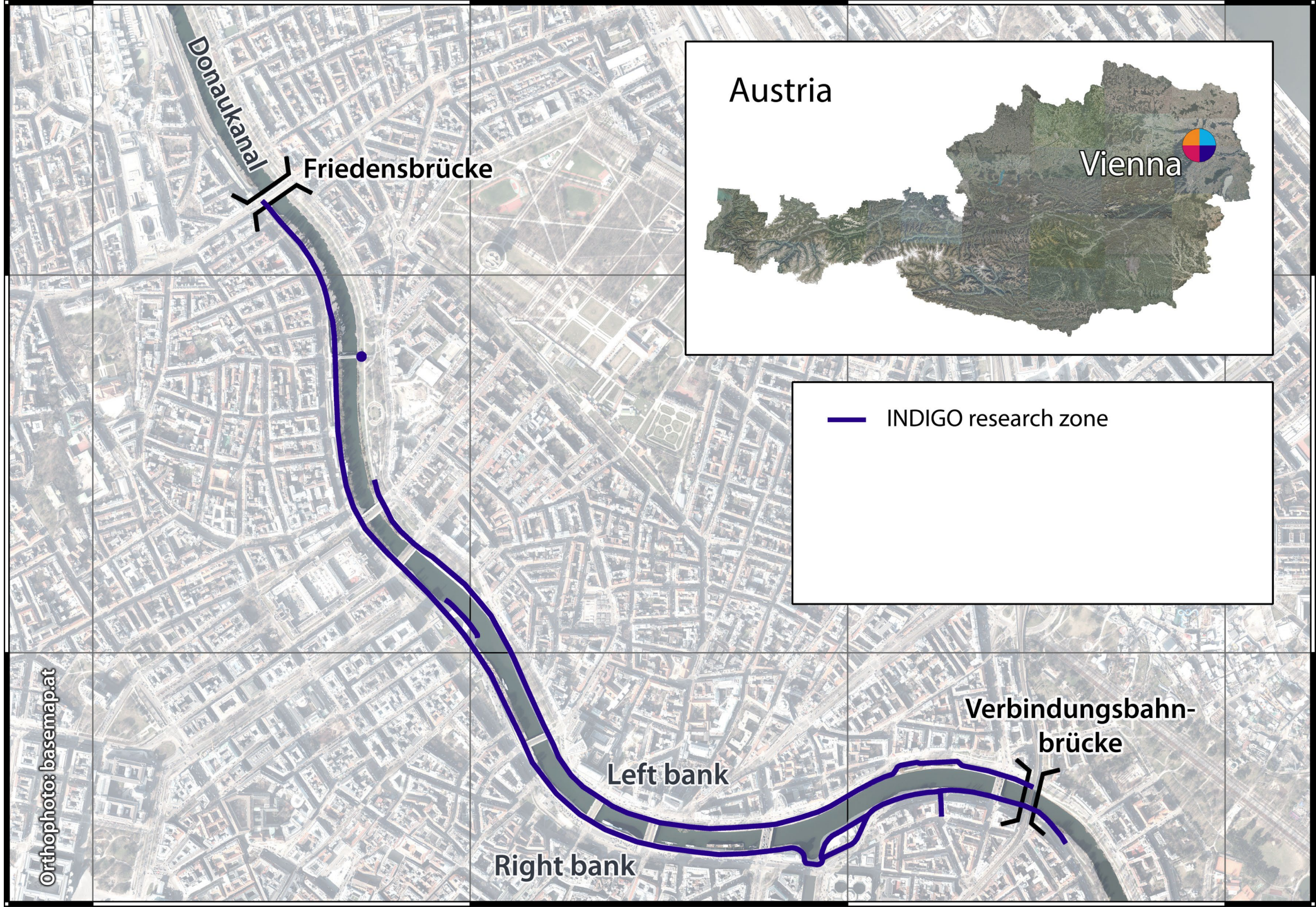
3.3 km



**STRETCH**

3.3 km

**LEFT** **RIGHT**



**STRETCH**

3.3 km

**LEFT** **RIGHT**

## STRETCH

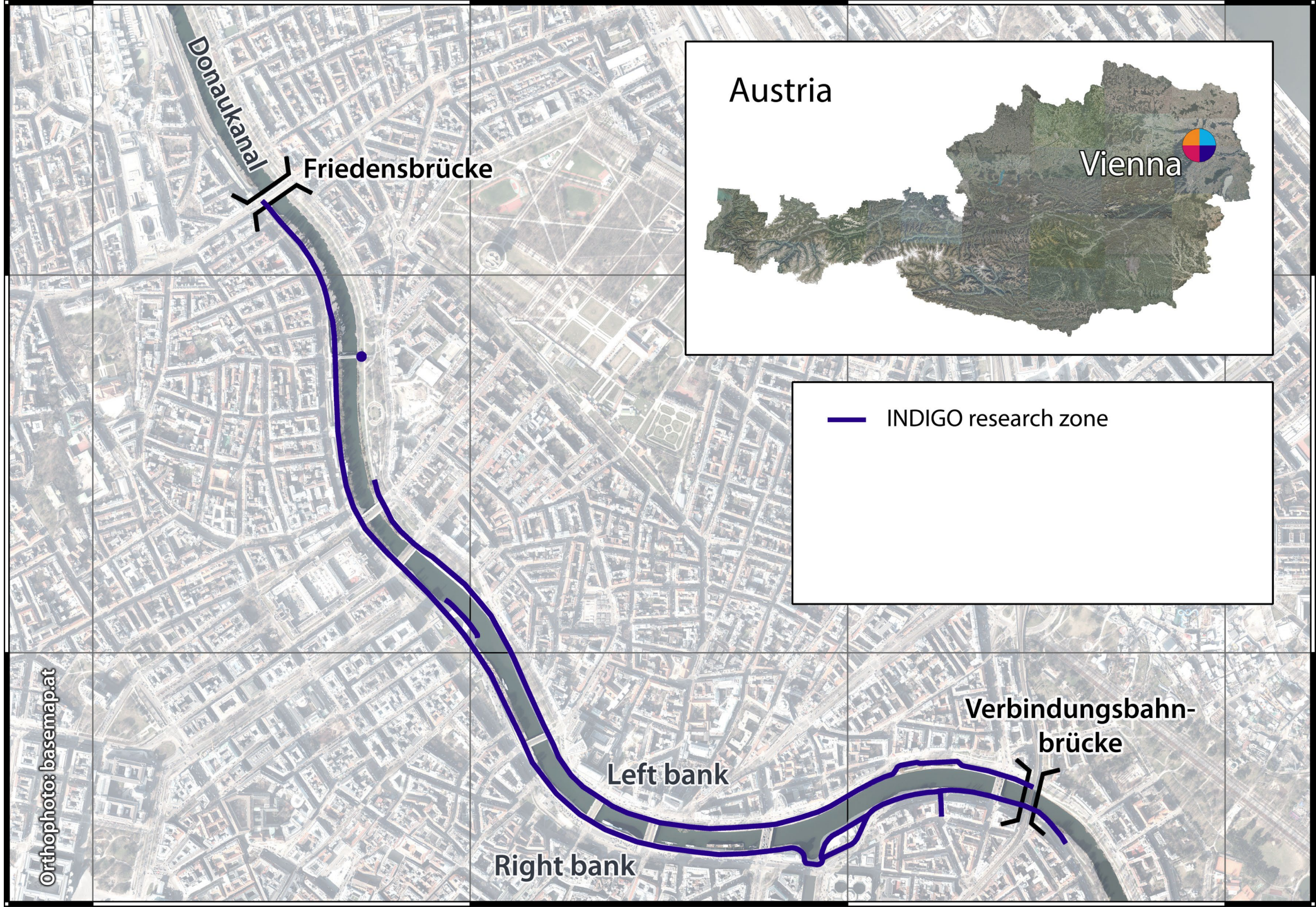
3.3 km

| LEFT | RIGHT |
| --- | --- |
| UP | UP |
| DOWN | DOWN |

## STRETCH

3.3 km

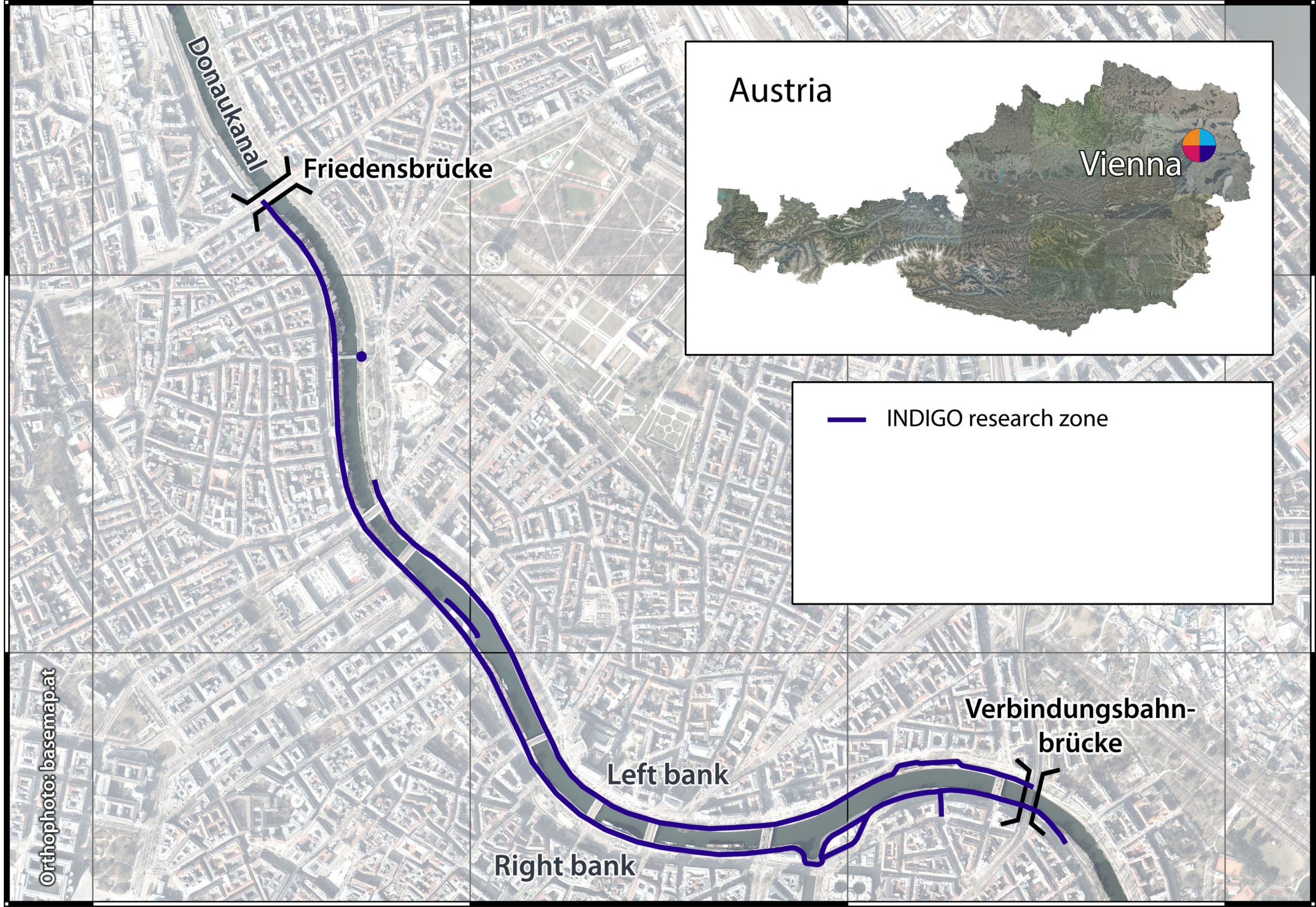
| LEFT | RIGHT |
|---|---|
| UP | UP |
| 3.2 km | 5.3 km |
| DOWN | DOWN |



## STRETCH

3.3 km

| LEFT | RIGHT |
|---|---|
| UP | UP |
| 3.2 km | 5.3 km |
| DOWN | DOWN |
| 2.1 km | 2.3 km |



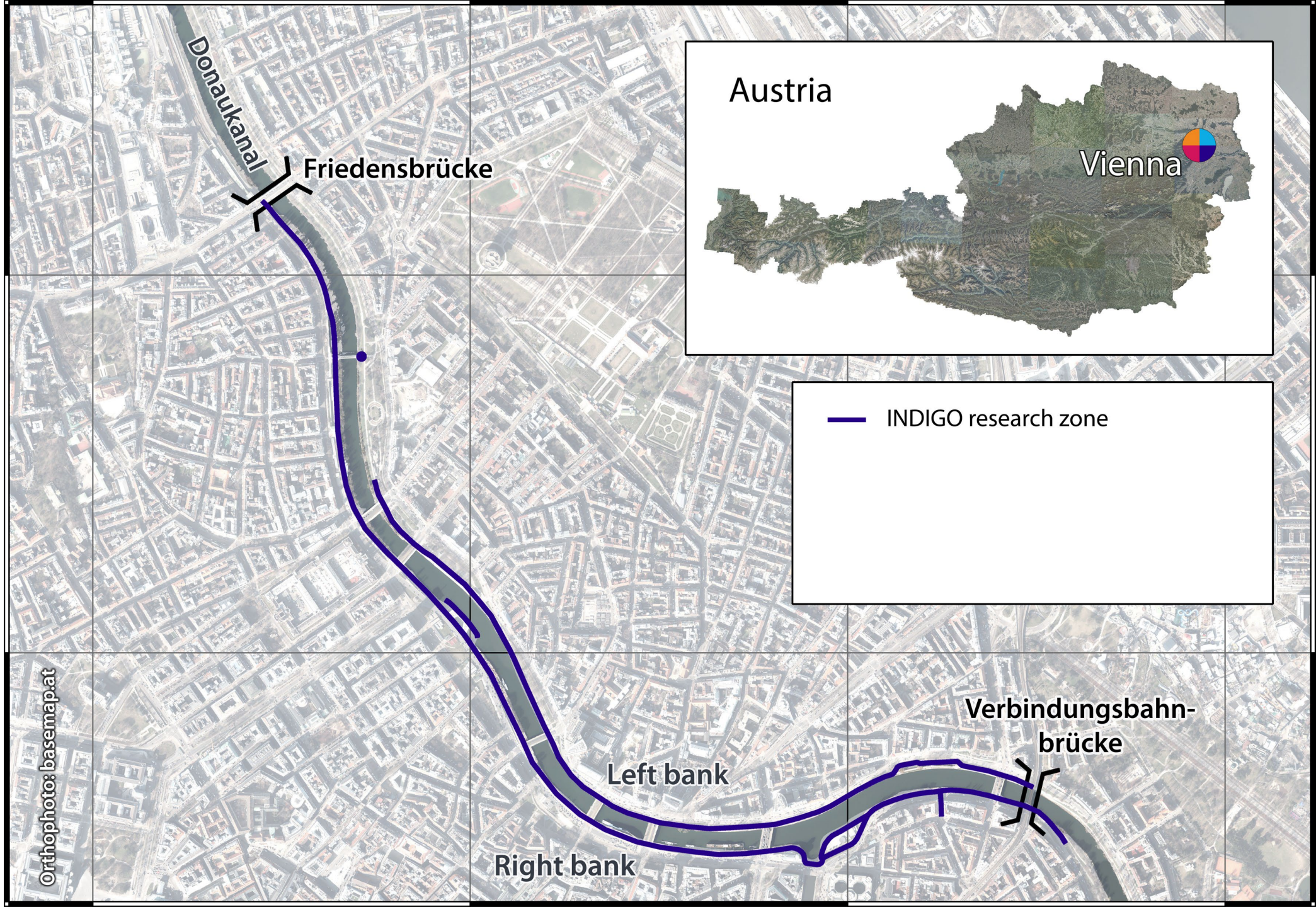
## STRETCH

3.3 km

| LEFT | RIGHT |
|---|---|
| UP | UP |
| 3.2 km | 5.3 km |
| DOWN | DOWN |
| 2.1 km | 2.3 km |

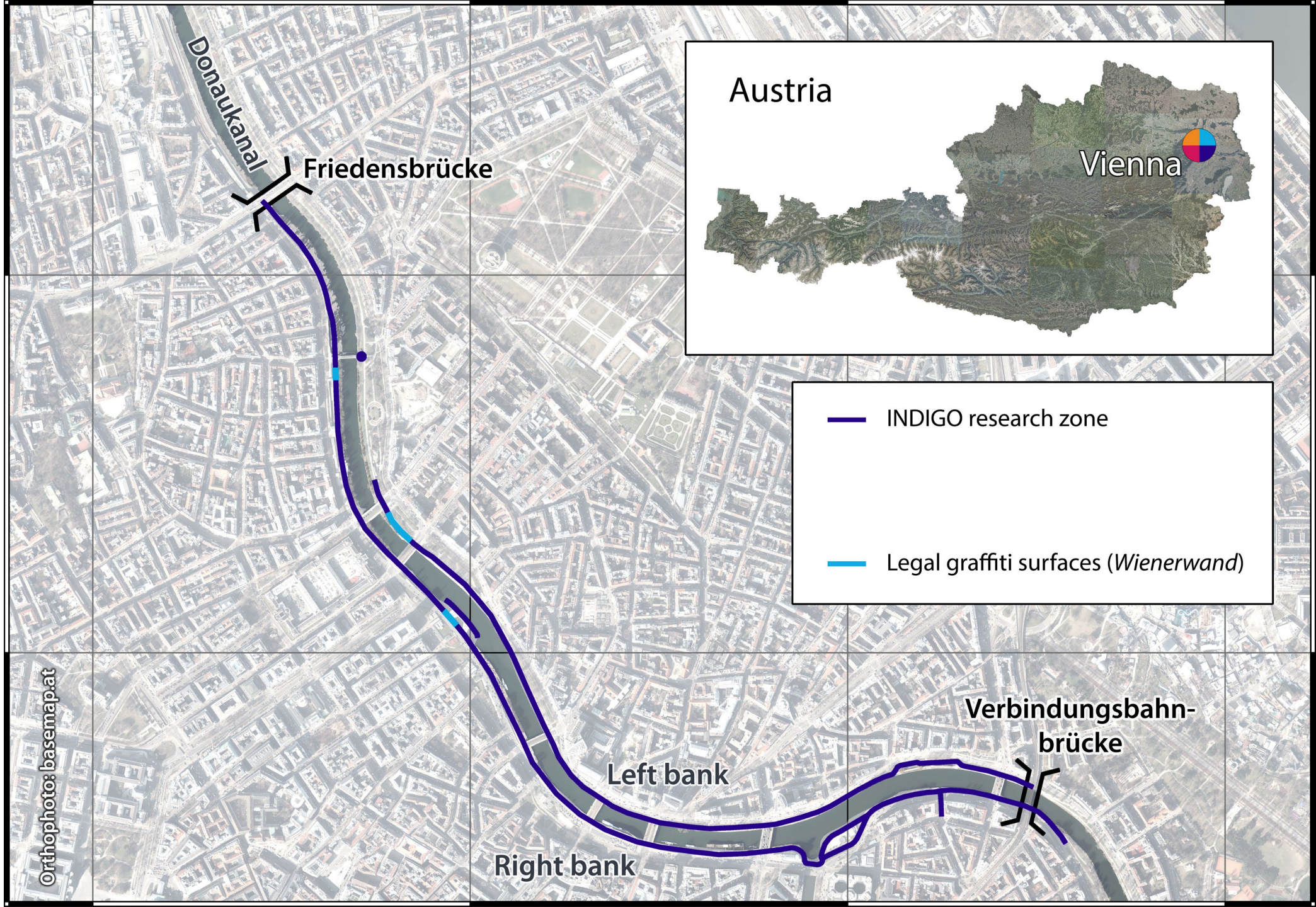
## MONITORED SURFACES

12.9 km



## MONITORED SURFACES

12.9 km

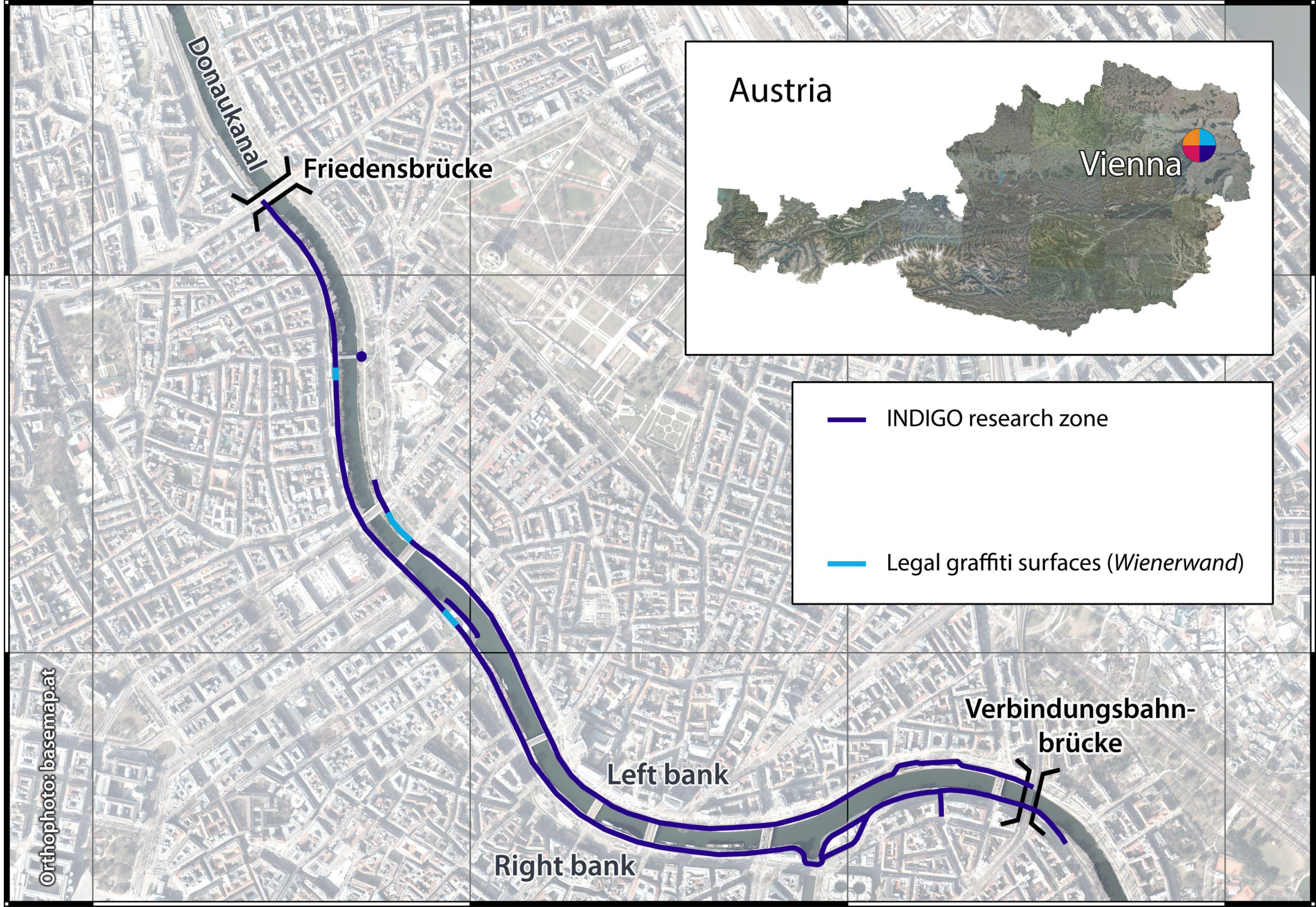


**LEGAL SURFACES**

0.3 km

**MONITORED SURFACES**

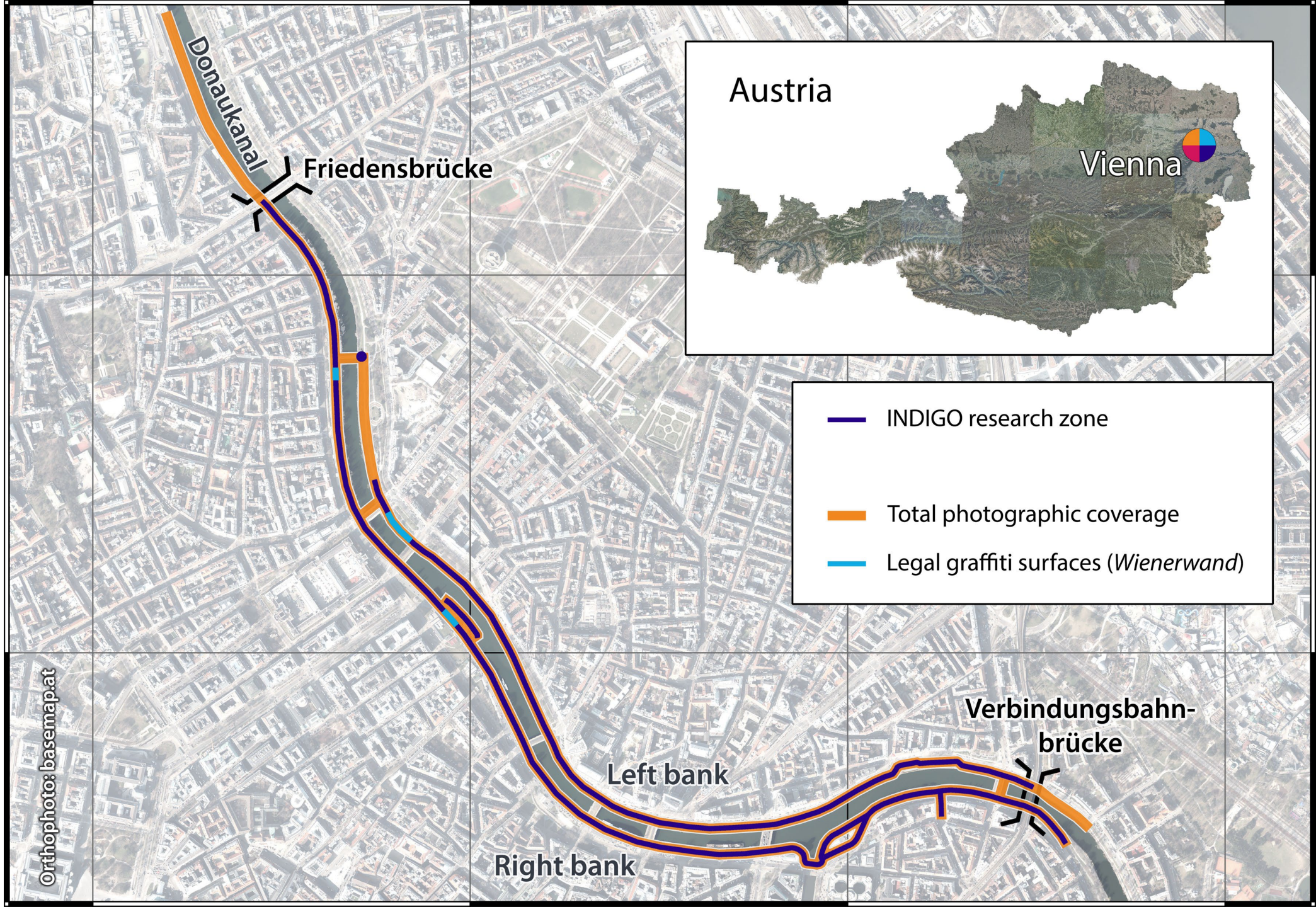
12.9 km



**TOTAL COVERAGE**
14.0 km

**LEGAL SURFACES**
0.3 km

**MONITORED SURFACES**
12.9 km



**TOTAL COVERAGE**

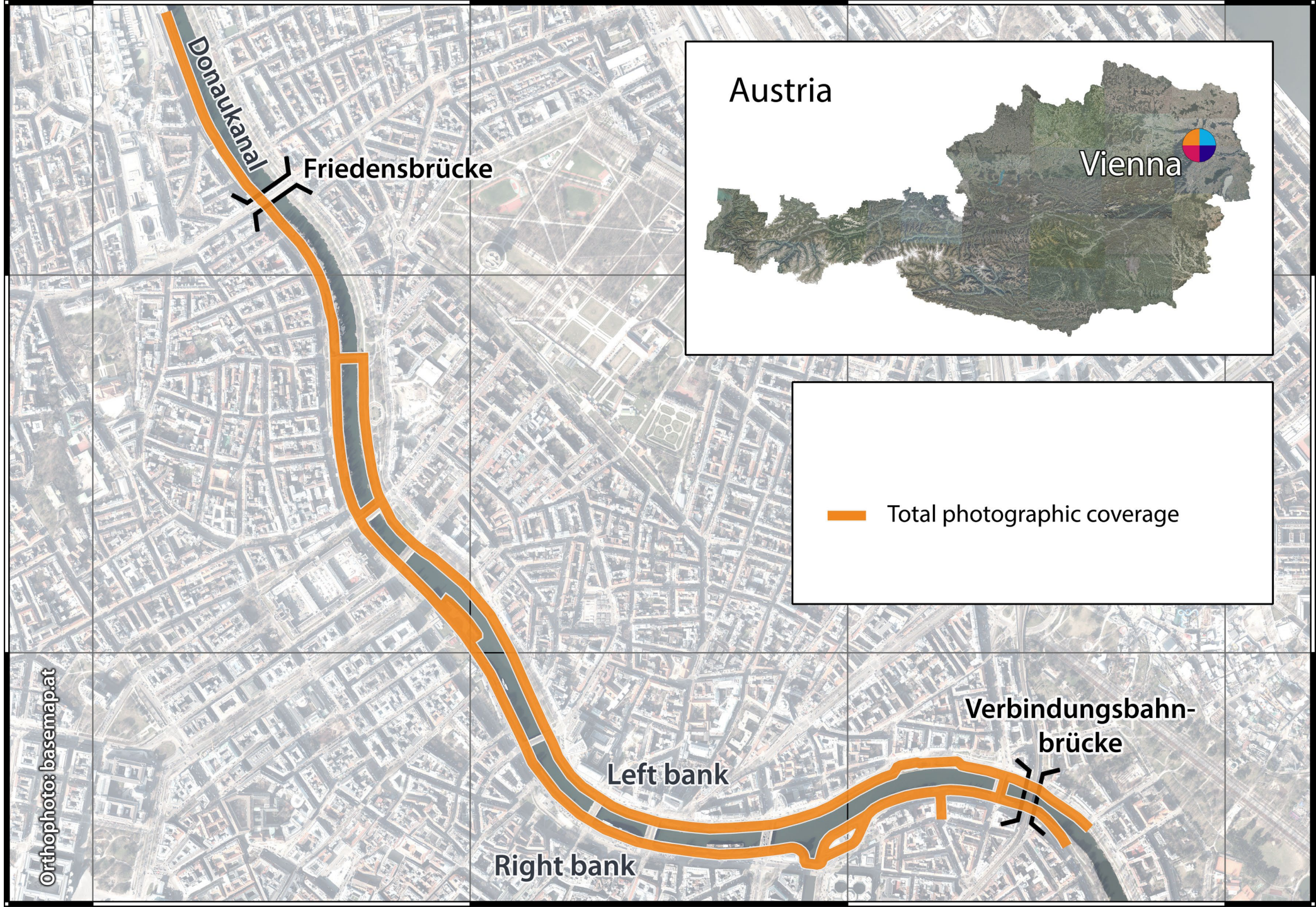
14.0 km

**LEGAL SURFACES**

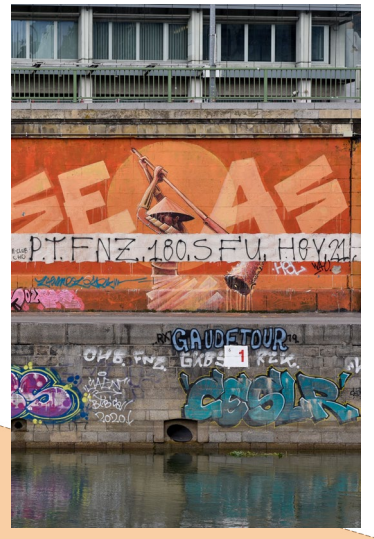
0.3 km

**MONITORED SURFACES**

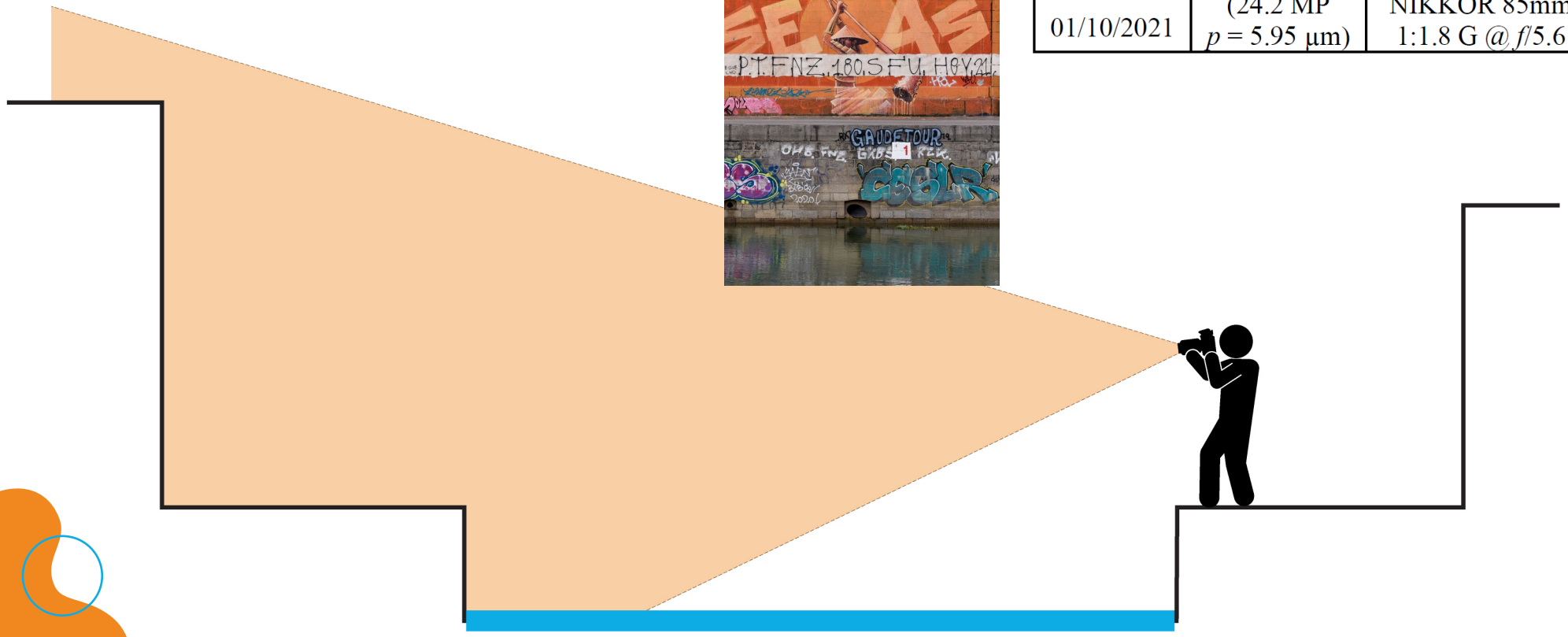
12.9 km



# TOTAL coverage



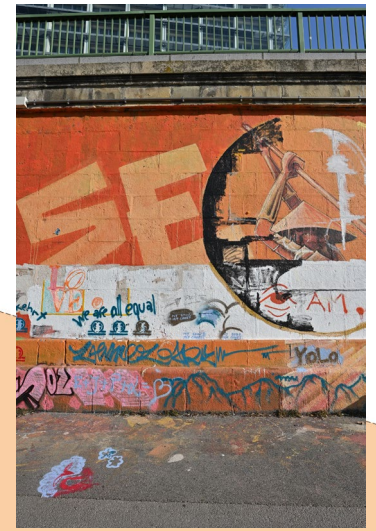
| Date | Camera | Lens | Mean GSD | Acquisition time | Image count |
|---|---|---|---|---|---|
| 30/09/2021<br>01/10/2021 | Nikon D750 (24.2 MP $p$ = 5.95 µm) | Nikon AF-S NIKKOR 85mm 1:1.8 G @ $f$/5.6 | 3.6 mm | 3 h 45 min<br>3 h 20 min | 2065<br>2544 |

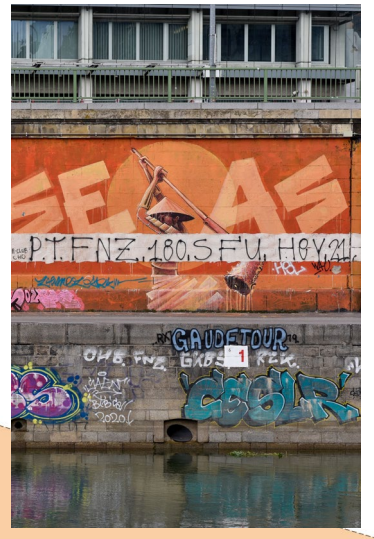


# TOTAL coverage

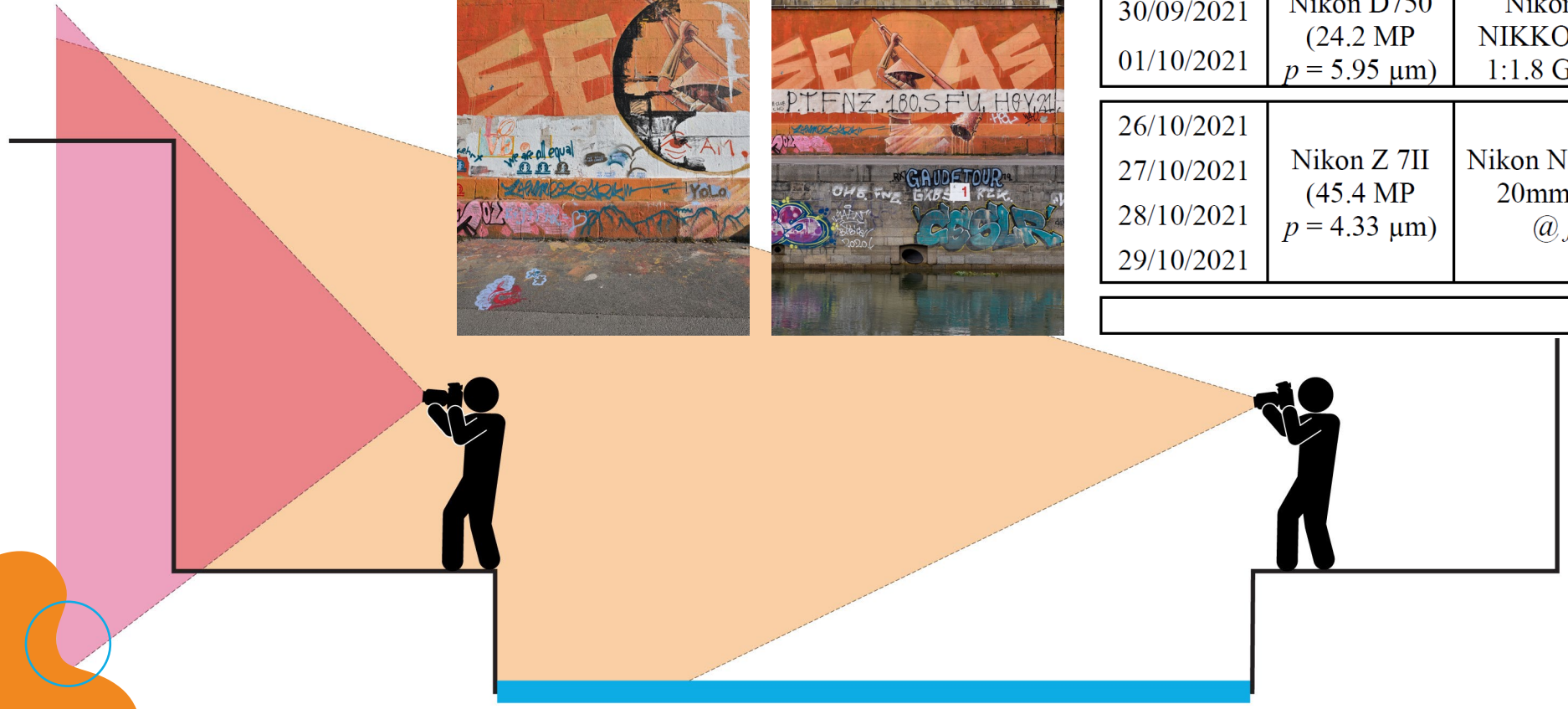
| Date | Camera | Lens | Mean GSD | Acquisition time | Image count |
|---|---|---|---|---|---|
| 26/10/2021 | Nikon Z 7II (45.4 MP $p$ = 4.33 µm) | Nikon NIKKOR Z 20mm f/1.8 S @ $f$/5.6 | 0.9 mm | 7 h | 6042 |
| 27/10/2021 | | | | 7 h 45 min | 6591 |
| 28/10/2021 | | | | 3 h 40 min | 2856 |
| 29/10/2021 | | | | 7 h | 6608 |

# TOTAL coverage

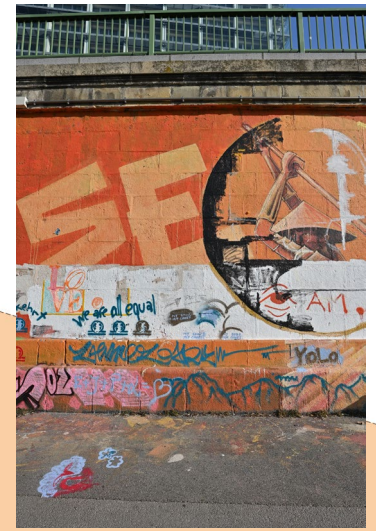


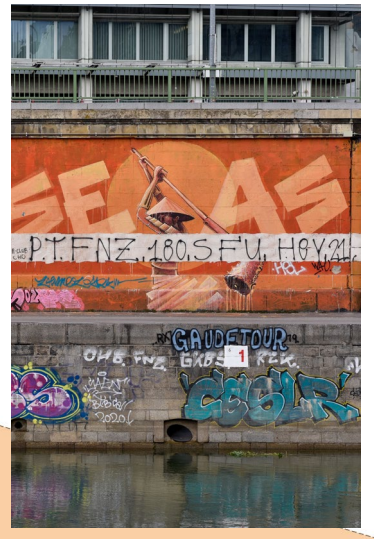


| Date | Camera | Lens | Mean GSD | Acquisition time | Image count |
|---|---|---|---|---|---|
| 30/09/2021 | Nikon D750 (24.2 MP $p$ = 5.95 µm) | Nikon AF-S NIKKOR 85mm 1:1.8 G @ *f*/5.6 | 3.6 mm | 3 h 45 min | 2065 |
| 01/10/2021 | | | | 3 h 20 min | 2544 |
| 26/10/2021 | Nikon Z 7II (45.4 MP $p$ = 4.33 µm) | Nikon NIKKOR Z 20mm f/1.8 S @ *f*/5.6 | 0.9 mm | 7 h | 6042 |
| 27/10/2021 | | | | 7 h 45 min | 6591 |
| 28/10/2021 | | | | 3 h 40 min | 2856 |
| 29/10/2021 | | | | 7 h | 6608 |
| | | | **Total** | **32 h 30 min** | **26706** |



# TOTAL coverage





| Date | Camera | Lens | Mean GSD | Acquisition time | Image count |
|---|---|---|---|---|---|
| 30/09/2021 | Nikon D750 (24.2 MP $p$ = 5.95 µm) | Nikon AF-S NIKKOR 85mm 1:1.8 G @ $f$/5.6 | 3.6 mm | 3 h 45 min | 2065 |
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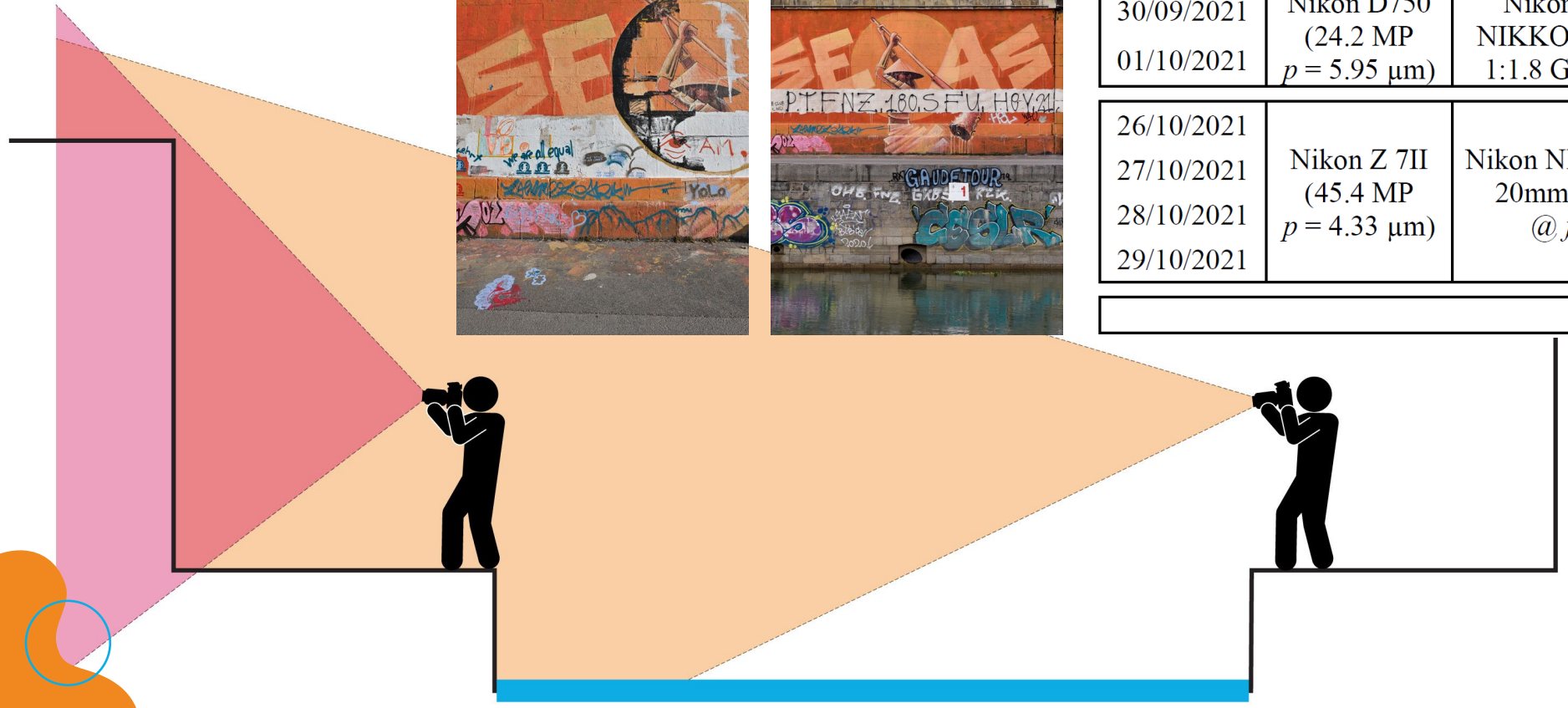
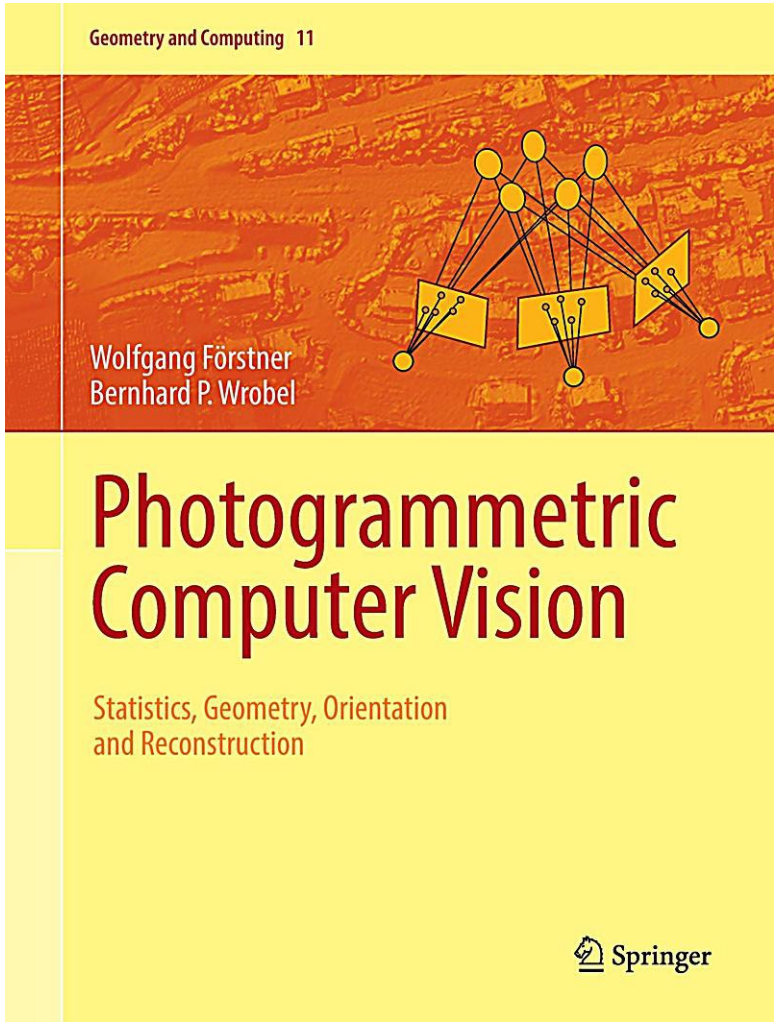
| 29/10/2021 | | | | 7 h | 6608 |
| | | | **Total** | **32 h 30 min** | **26706** |

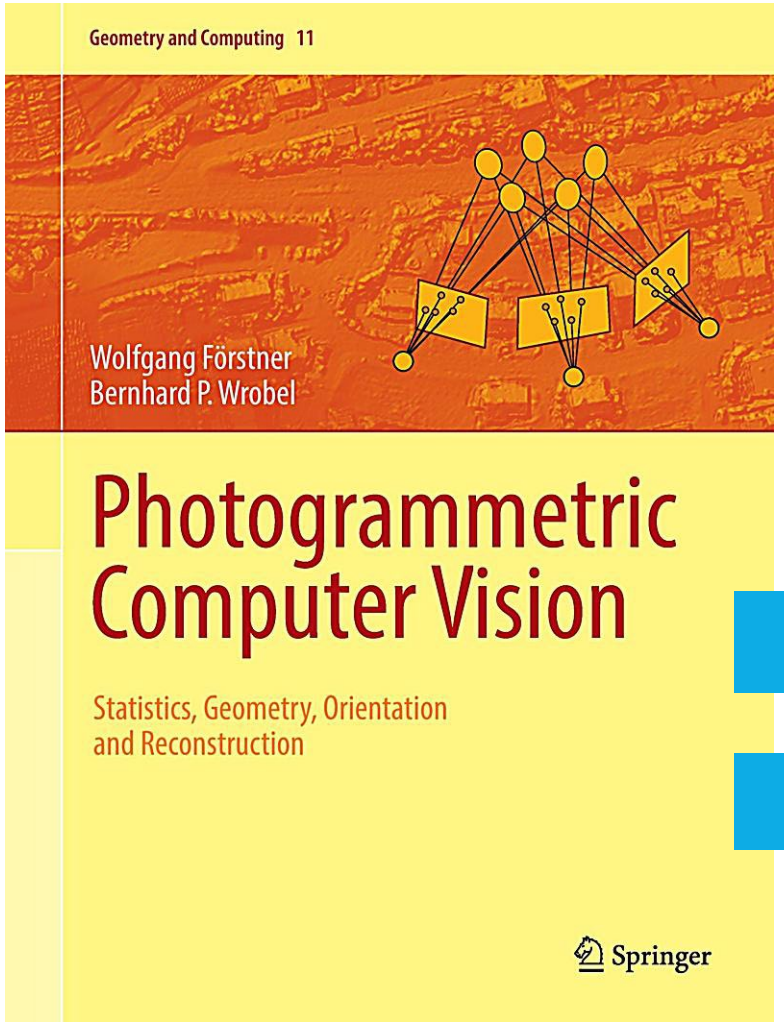


processing

# PHOTOGRAMMETRIC computer vision



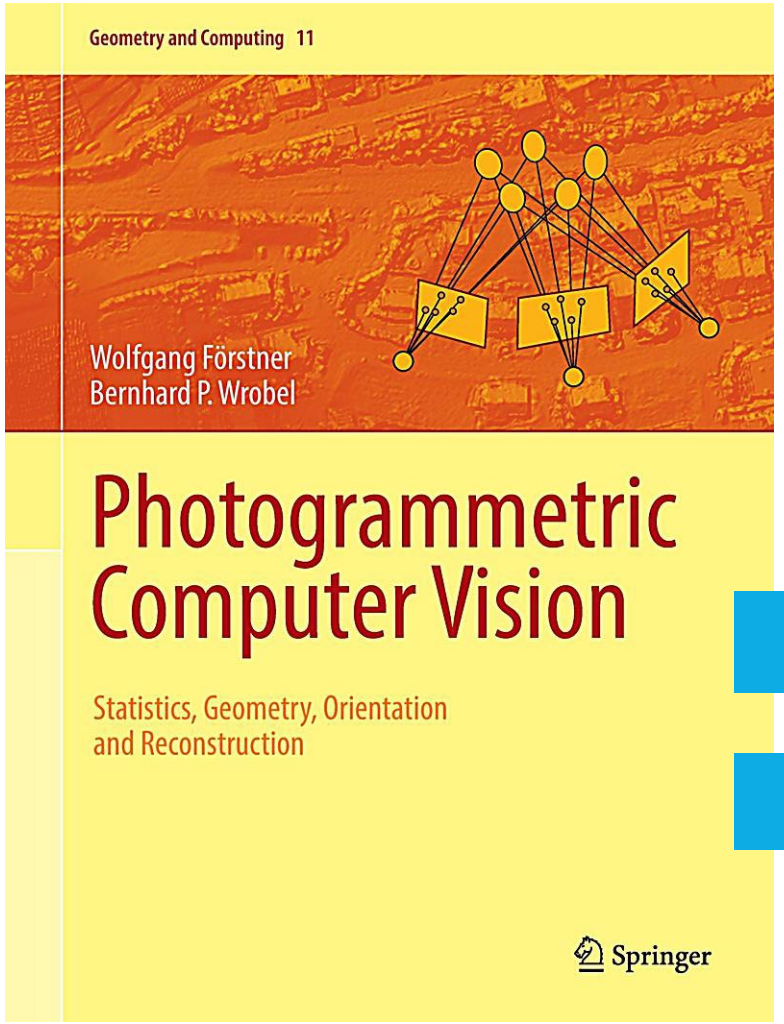
# PHOTOGRAMMETRIC computer vision




Structure from Motion

Multi-View Stereo

# PHOTOGRAMMETRIC computer vision

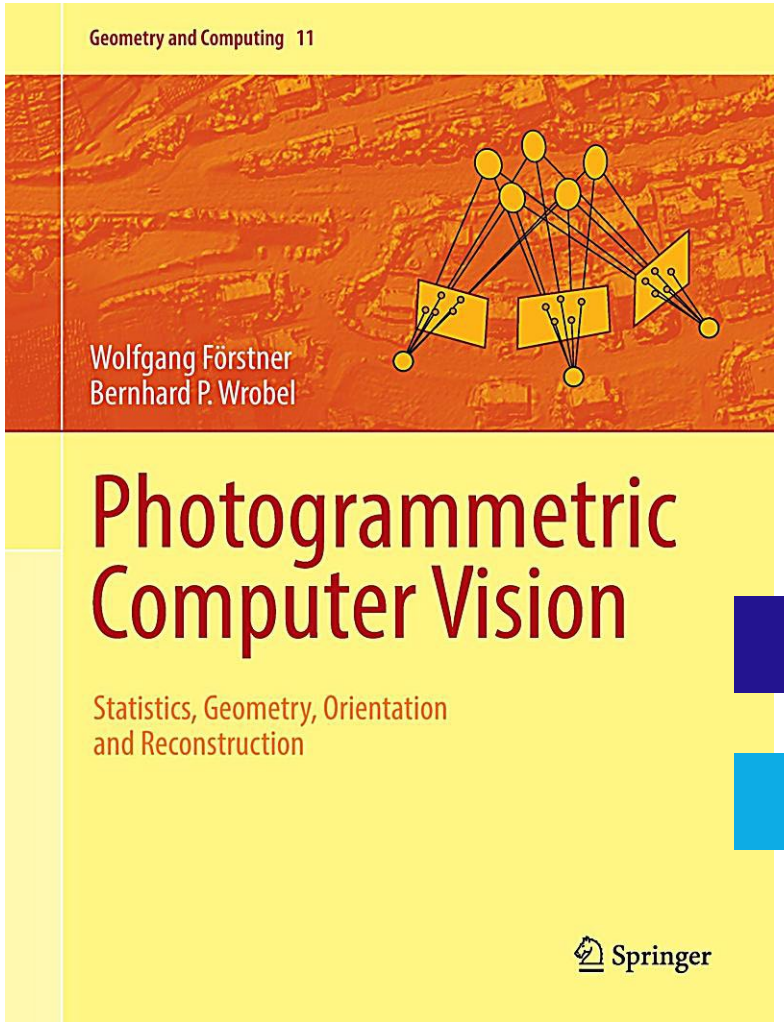



Metashape

Structure from Motion

Multi-View Stereo

# PHOTOGRAMMETRIC computer vision




Metashape

Structure from Motion

Multi-View Stereo

# STRUCTURE from motion

# STRUCTURE from motion

## DETECT *FEATURES*

# STRUCTURE from motion

DETECT *FEATURES*

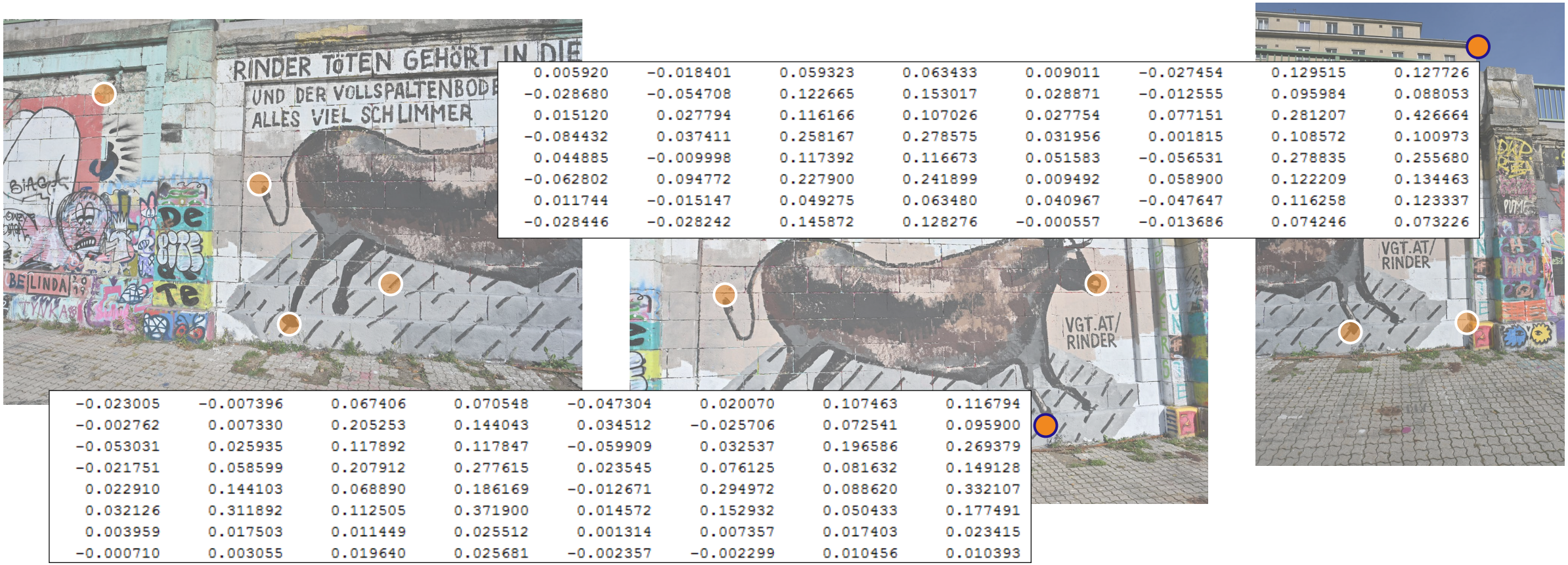
# STRUCTURE from motion

DETECT *FEATURES*

# STRUCTURE from motion

## DESCRIBE *FEATURES*

# STRUCTURE from motion




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.005920 | -0.018401 | 0.059323 | 0.063433 | 0.009011 | -0.027454 | 0.129515 | 0.127726 |
| -0.028680 | -0.054708 | 0.122665 | 0.153017 | 0.028871 | -0.012555 | 0.095984 | 0.088053 |
| 0.015120 | 0.027794 | 0.116166 | 0.107026 | 0.027754 | 0.077151 | 0.281207 | 0.426664 |
| -0.084432 | 0.037411 | 0.258167 | 0.278575 | 0.031956 | 0.001815 | 0.108572 | 0.100973 |
| 0.044885 | -0.009998 | 0.117392 | 0.116673 | 0.051583 | -0.056531 | 0.278835 | 0.255680 |
| -0.062802 | 0.094772 | 0.227900 | 0.241899 | 0.009492 | 0.058900 | 0.122209 | 0.134463 |
| 0.011744 | -0.015147 | 0.049275 | 0.063480 | 0.040967 | -0.047647 | 0.116258 | 0.123337 |
| -0.028446 | -0.028242 | 0.145872 | 0.128276 | -0.000557 | -0.013686 | 0.074246 | 0.073226 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| -0.023005 | -0.007396 | 0.067406 | 0.070548 | -0.047304 | 0.020070 | 0.107463 | 0.116794 |
| -0.002762 | 0.007330 | 0.205253 | 0.144043 | 0.034512 | -0.025706 | 0.072541 | 0.095900 |
| -0.053031 | 0.025935 | 0.117892 | 0.117847 | -0.059909 | 0.032537 | 0.196586 | 0.269379 |
| -0.021751 | 0.058599 | 0.207912 | 0.277615 | 0.023545 | 0.076125 | 0.081632 | 0.149128 |
| 0.022910 | 0.144103 | 0.068890 | 0.186169 | -0.012671 | 0.294972 | 0.088620 | 0.332107 |
| 0.032126 | 0.311892 | 0.112505 | 0.371900 | 0.014572 | 0.152932 | 0.050433 | 0.177491 |
| 0.003959 | 0.017503 | 0.011449 | 0.025512 | 0.001314 | 0.007357 | 0.017403 | 0.023415 |
| -0.000710 | 0.003055 | 0.019640 | 0.025681 | -0.002357 | -0.002299 | 0.010456 | 0.010393 |

## DESCRIBE *FEATURES*

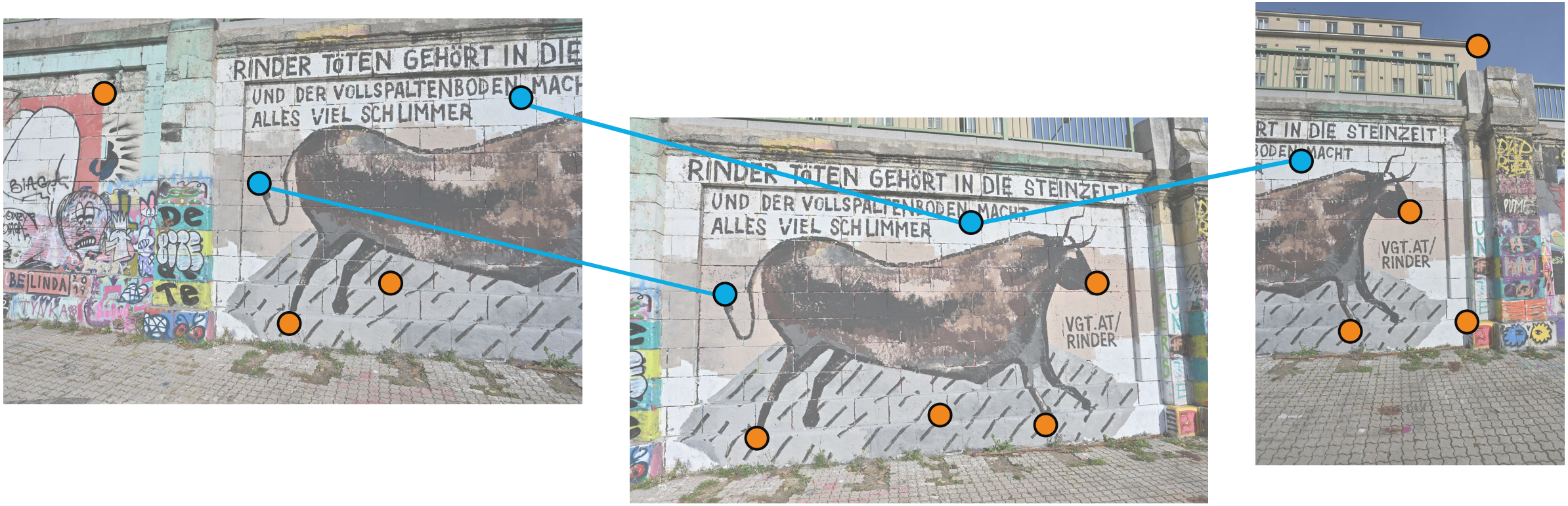
# STRUCTURE from motion

## MATCH *DESCRIPTORS*

# STRUCTURE from motion

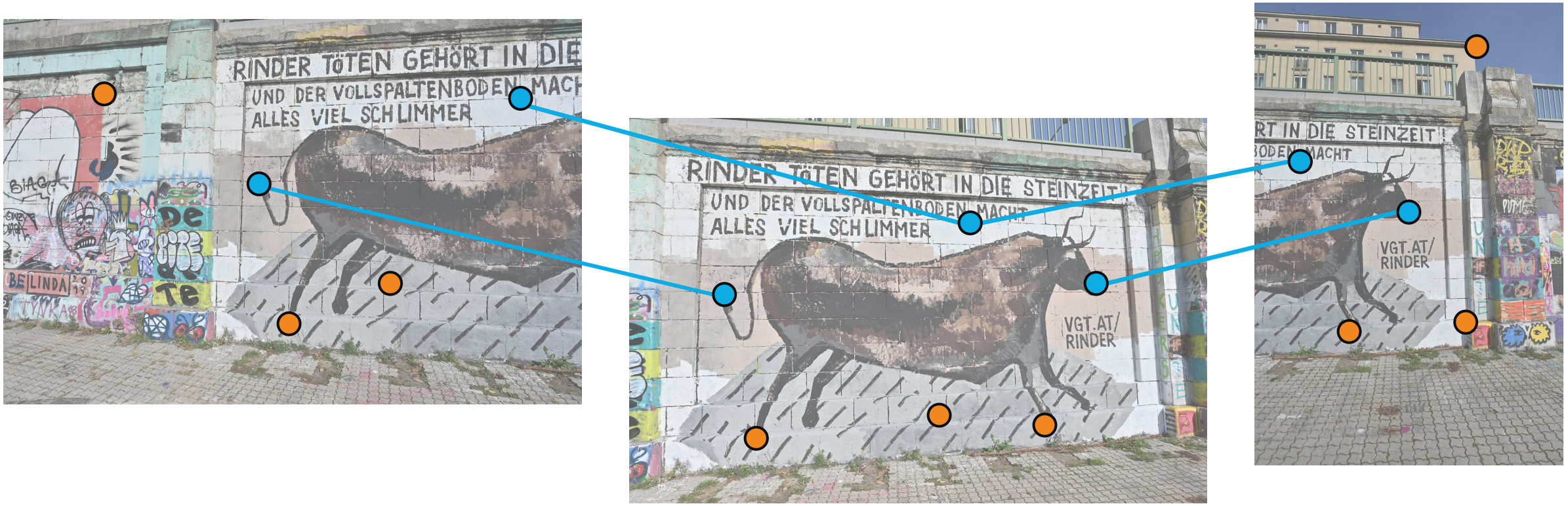
## MATCH *DESCRIPTORS*

# STRUCTURE from motion



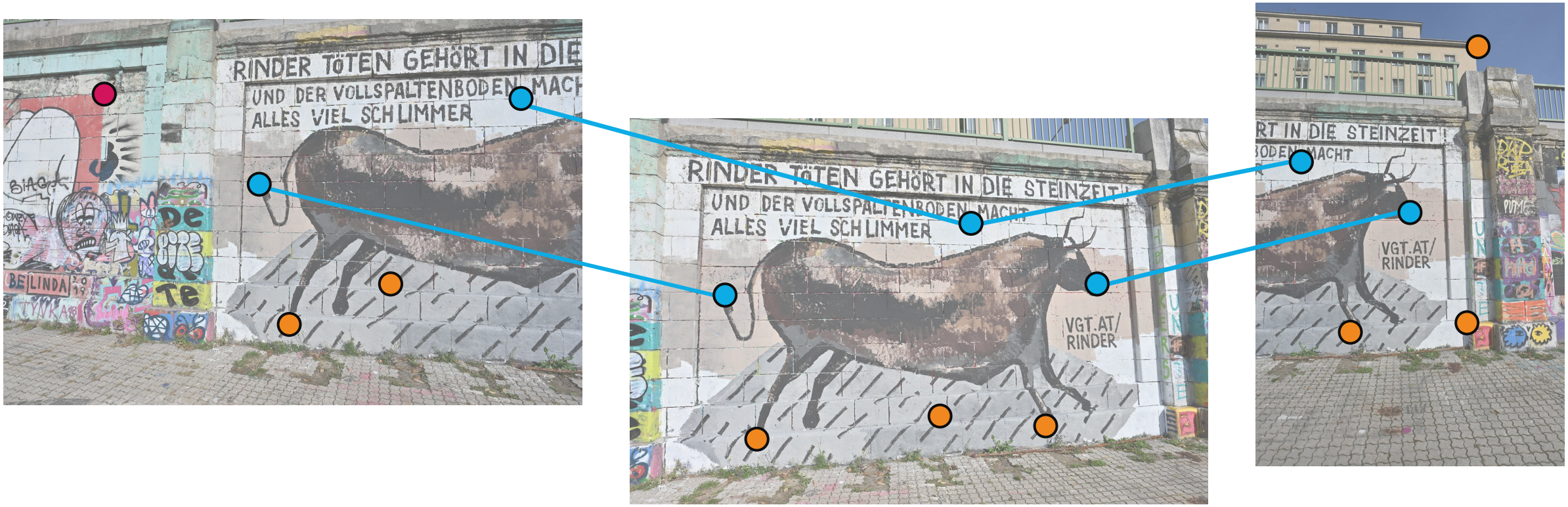

## MATCH *DESCRIPTORS*

# STRUCTURE from motion



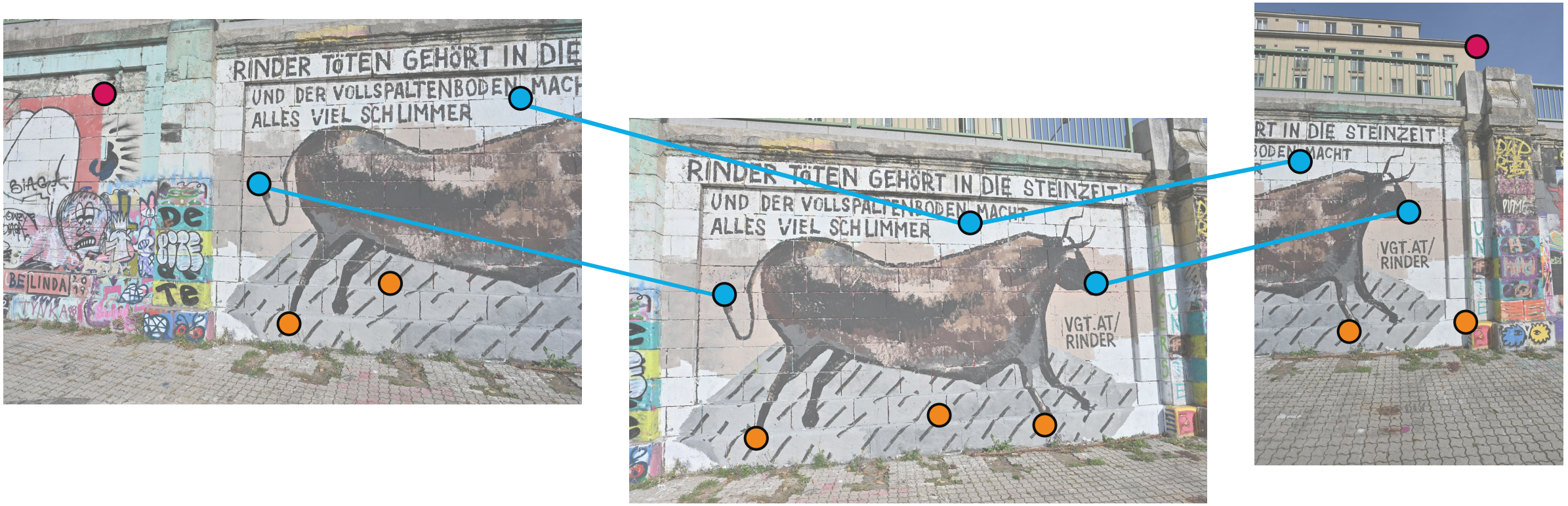

## MATCH *DESCRIPTORS*

# STRUCTURE from motion



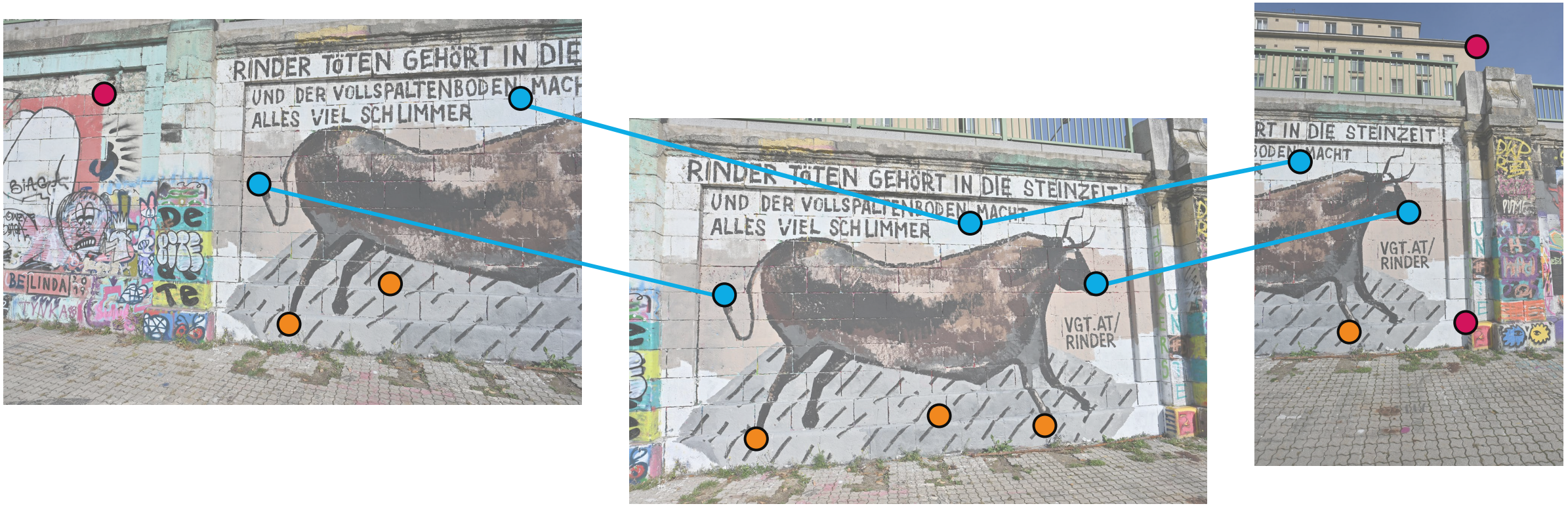

## MATCH *DESCRIPTORS*

# STRUCTURE from motion



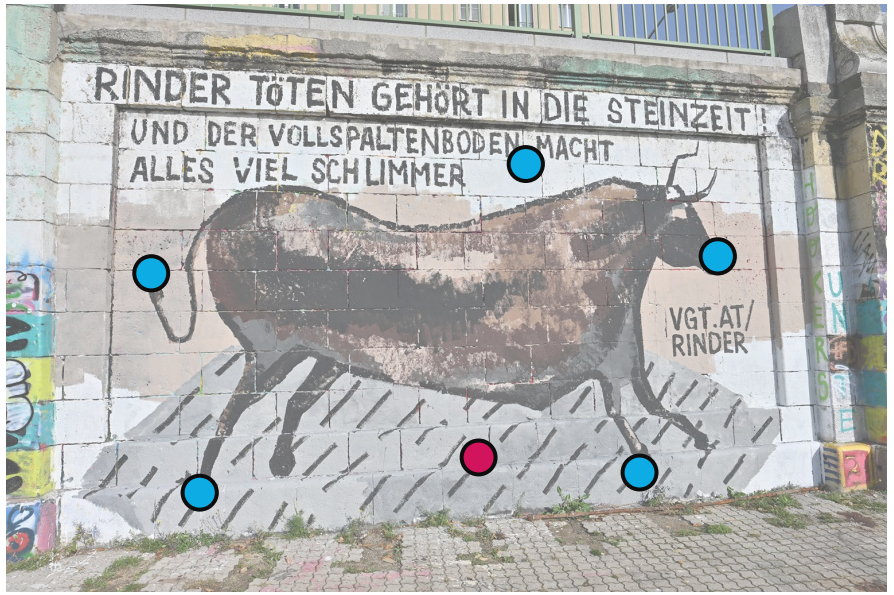

## MATCH *DESCRIPTORS*

# STRUCTURE from motion




## MATCH *DESCRIPTORS*

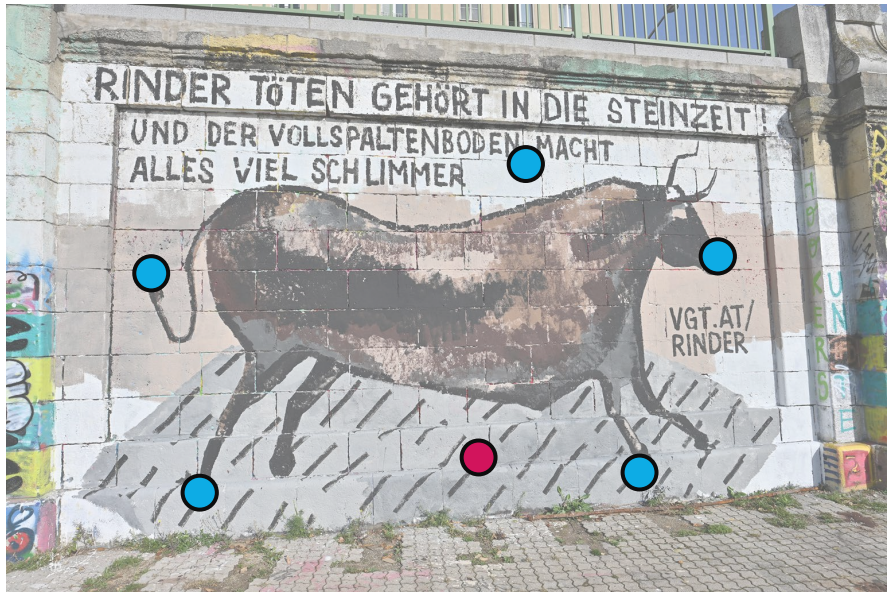
# STRUCTURE from motion



## MATCH *DESCRIPTORS*

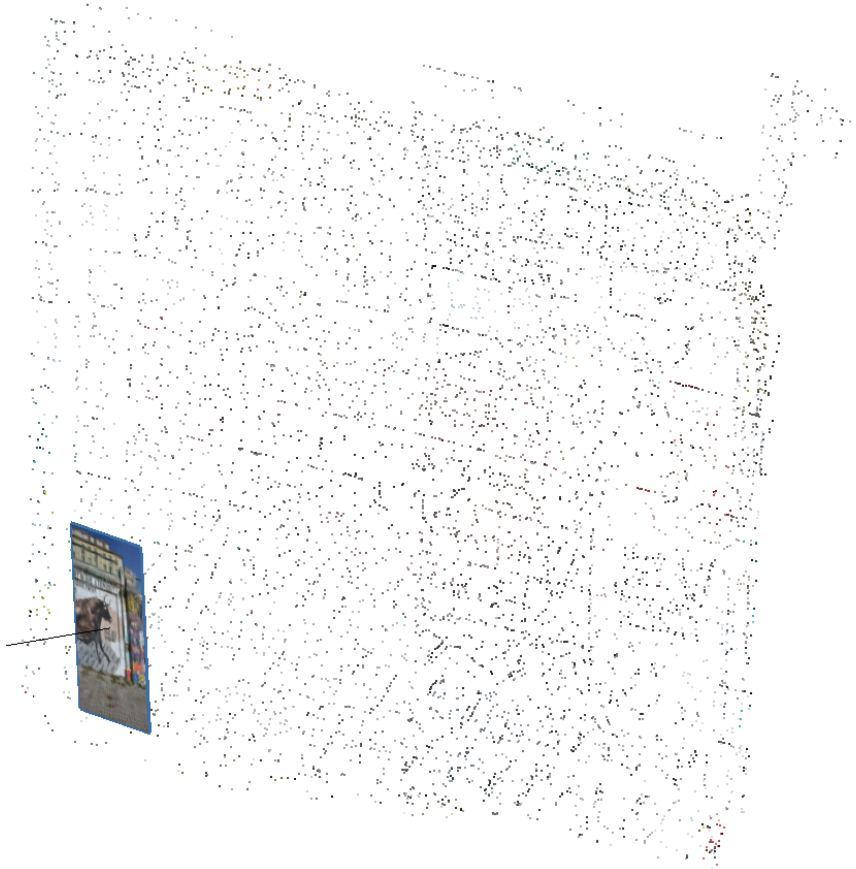
# STRUCTURE from motion

TIE POINTS



# STRUCTURE from motion

TIE POINTS

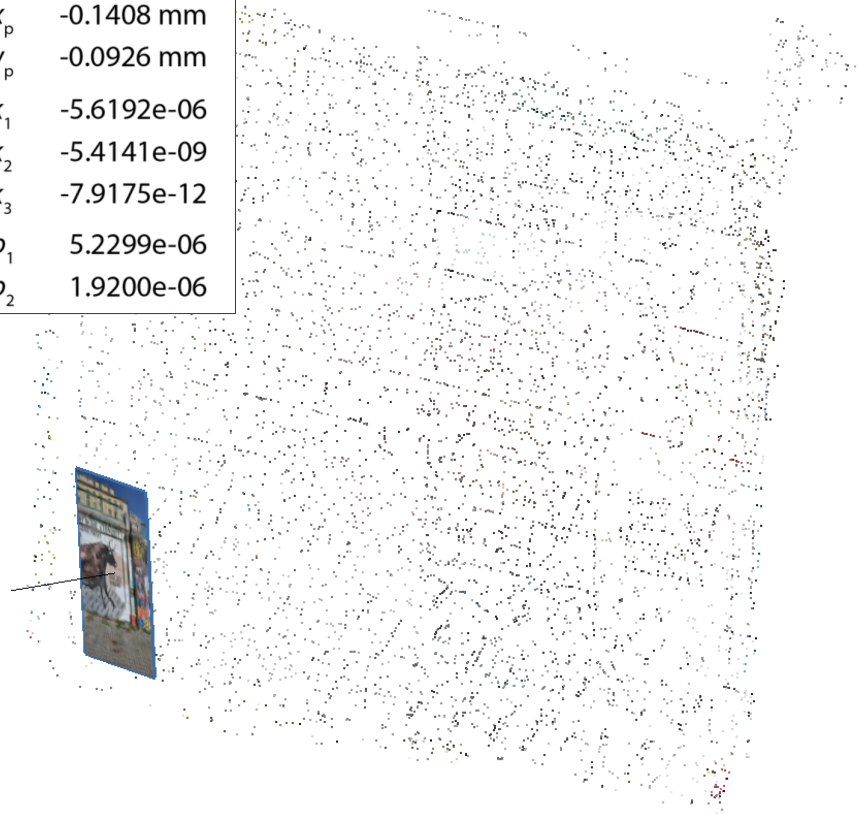


ESTIMATE *CAMERA EXTERIOR ORIENTATION*

# STRUCTURE from motion

TIE POINTS

| | | |
|---|---|---|
| principal distance | $c$ | 20.1546 mm |
| principal point location | $x_p$ | -0.1408 mm |
| | $y_p$ | -0.0926 mm |
| radial distortion parameters | $k_1$ | -5.6192e-06 |
| | $k_2$ | -5.4141e-09 |
| | $k_3$ | -7.9175e-12 |
| decentring distortion parameters | $p_1$ | 5.2299e-06 |
| | $p_2$ | 1.9200e-06 |



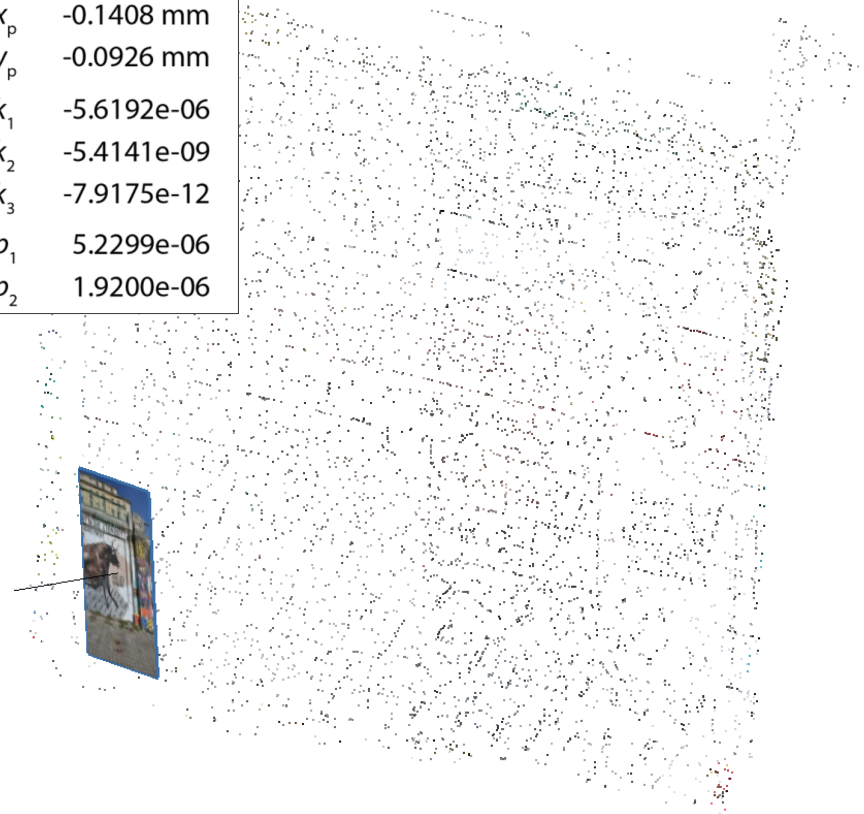
ESTIMATE *CAMERA EXTERIOR ORIENTATION*

ESTIMATE *CAMERA INTERIOR ORIENTATION*

# STRUCTURE from motion

TIE POINTS

| | | |
|---|---|---|
| principal distance | $c$ | 20.1546 mm |
| principal point location | $x_p$ | -0.1408 mm |
| | $y_p$ | -0.0926 mm |
| radial distortion parameters | $k_1$ | -5.6192e-06 |
| | $k_2$ | -5.4141e-09 |
| | $k_3$ | -7.9175e-12 |
| decentring distortion parameters | $p_1$ | 5.2299e-06 |
| | $p_2$ | 1.9200e-06 |



3D POINTS

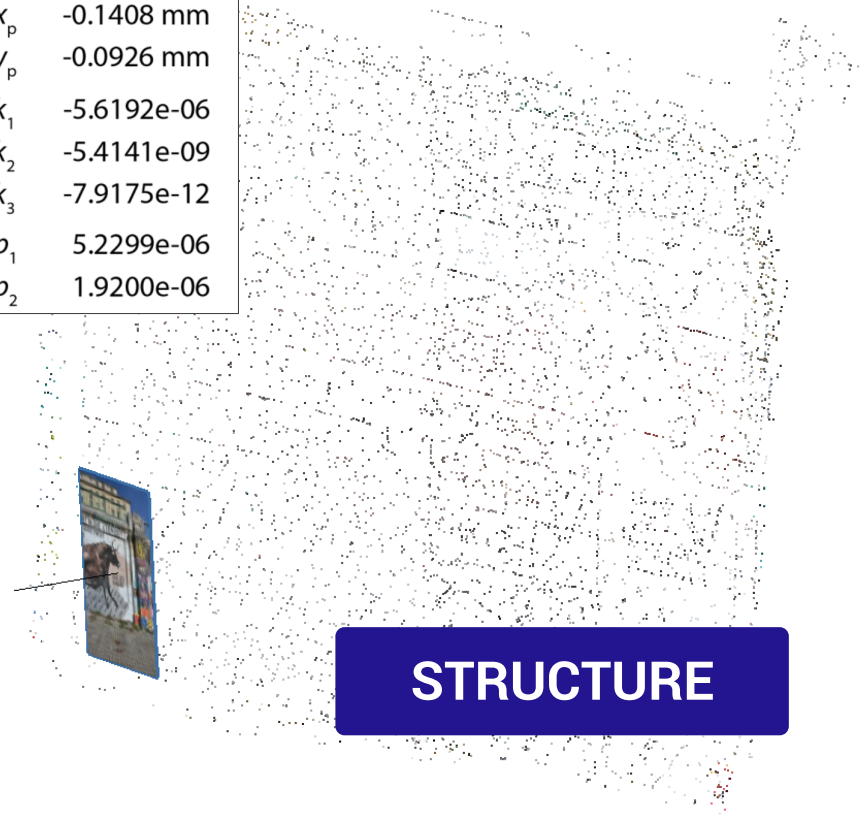
ESTIMATE *CAMERA EXTERIOR ORIENTATION*

ESTIMATE *CAMERA INTERIOR ORIENTATION*

# STRUCTURE from motion

TIE POINTS

| | | |
|---|---|---|
| principal distance | $c$ | 20.1546 mm |
| principal point location | $x_p$ | -0.1408 mm |
| | $y_p$ | -0.0926 mm |
| radial distortion parameters | $k_1$ | -5.6192e-06 |
| | $k_2$ | -5.4141e-09 |
| | $k_3$ | -7.9175e-12 |
| decentring distortion parameters | $p_1$ | 5.2299e-06 |
| | $p_2$ | 1.9200e-06 |



STRUCTURE

3D POINTS

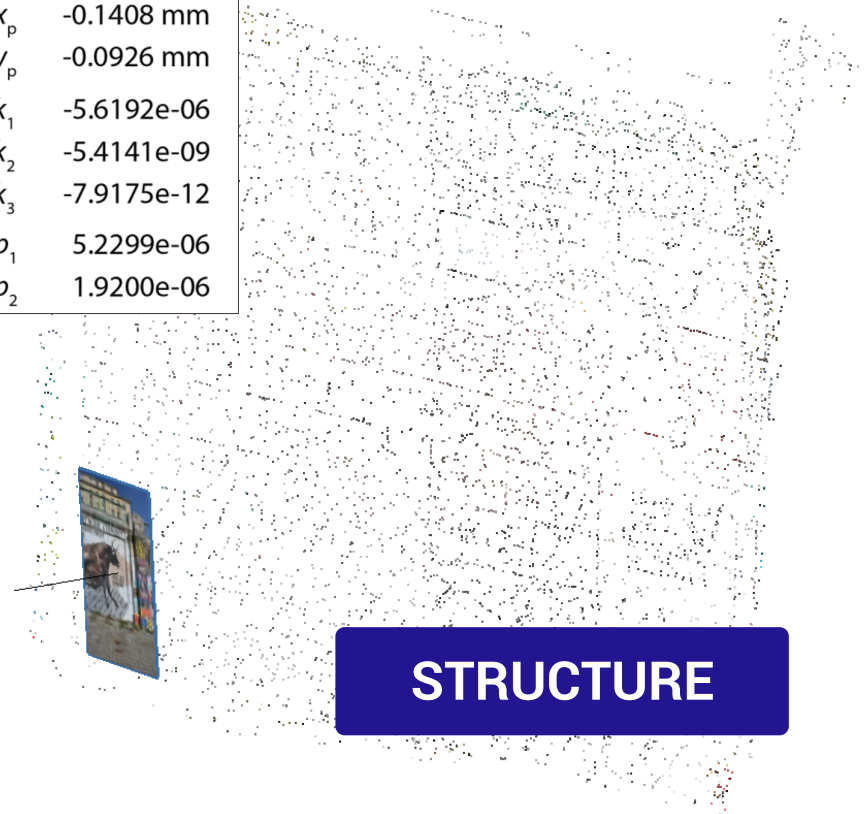
ESTIMATE *CAMERA EXTERIOR ORIENTATION*

ESTIMATE *CAMERA INTERIOR ORIENTATION*

# and
# STRUCTURE from motion

TIE POINTS

| | | |
|---|---|---|
| principal distance | $c$ | 20.1546 mm |
| principal point location | $x_p$ | -0.1408 mm |
| | $y_p$ | -0.0926 mm |
| radial distortion parameters | $k_1$ | -5.6192e-06 |
| | $k_2$ | -5.4141e-09 |
| | $k_3$ | -7.9175e-12 |
| decentring distortion parameters | $p_1$ | 5.2299e-06 |
| | $p_2$ | 1.9200e-06 |



STRUCTURE

3D POINTS

ESTIMATE *CAMERA EXTERIOR ORIENTATION*

ESTIMATE *CAMERA INTERIOR ORIENTATION*

# STRUCTURE from motion

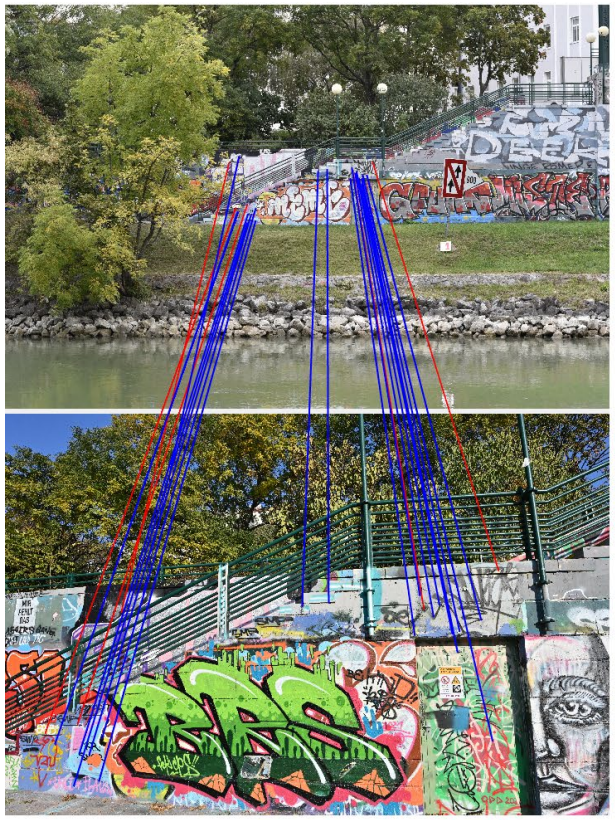
*CAMERA EXTERIOR ORIENTATION*

*CAMERA INTERIOR ORIENTATION*

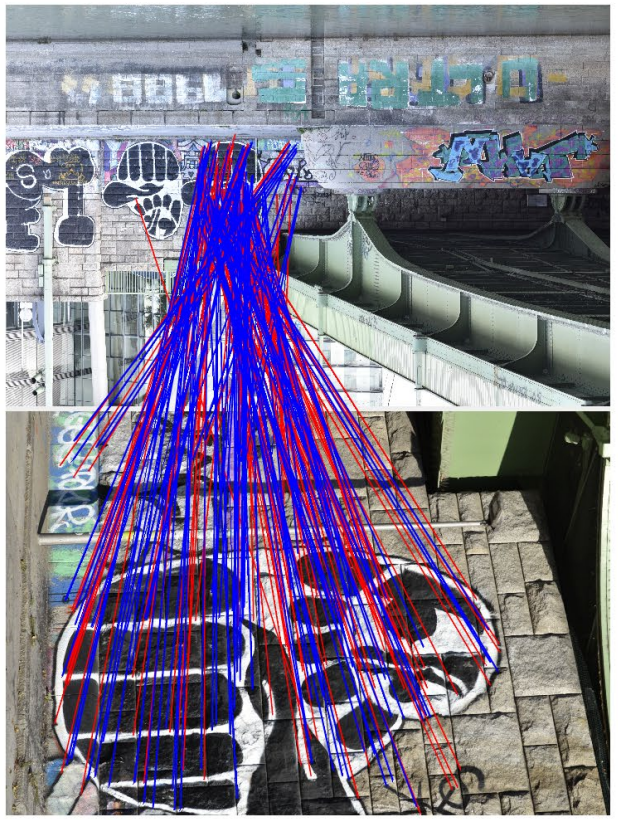
**3D POINTS**

# CAMERA orientation

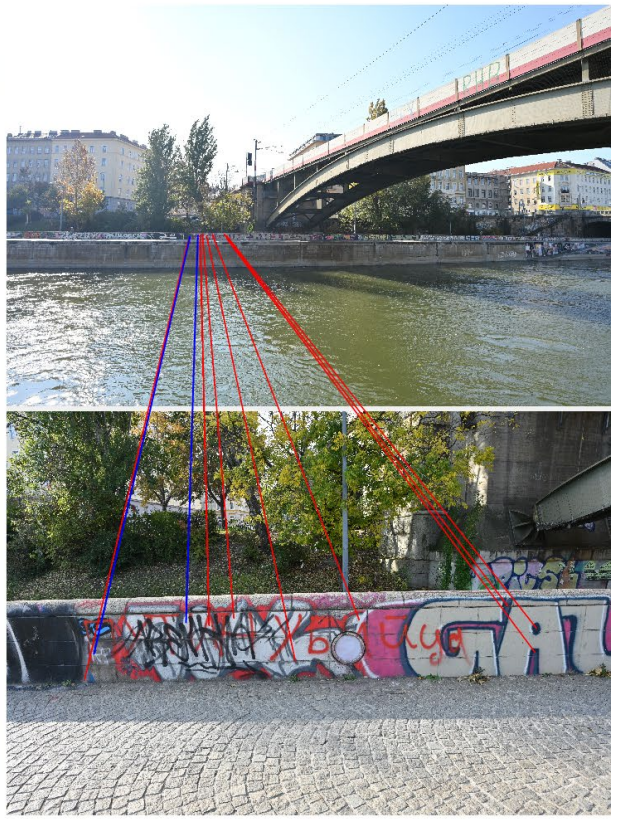
Nikon D750 + 85 mm
30-09-2021



Nikon D750 + 85 mm
30-09-2021



Nikon Z7 II + 20 mm
28-10-2021

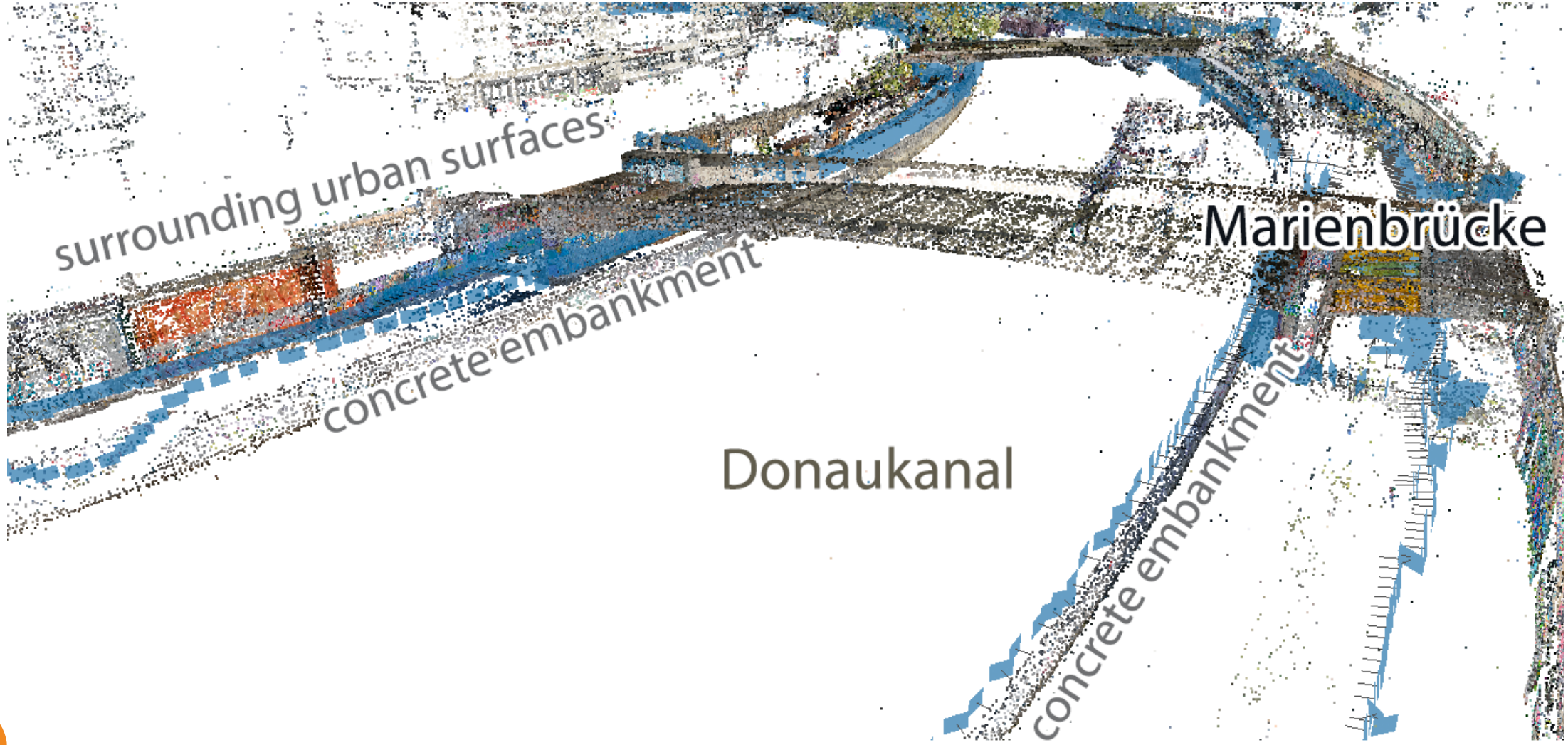


Nikon Z7 II + 20 mm
29-10-2021

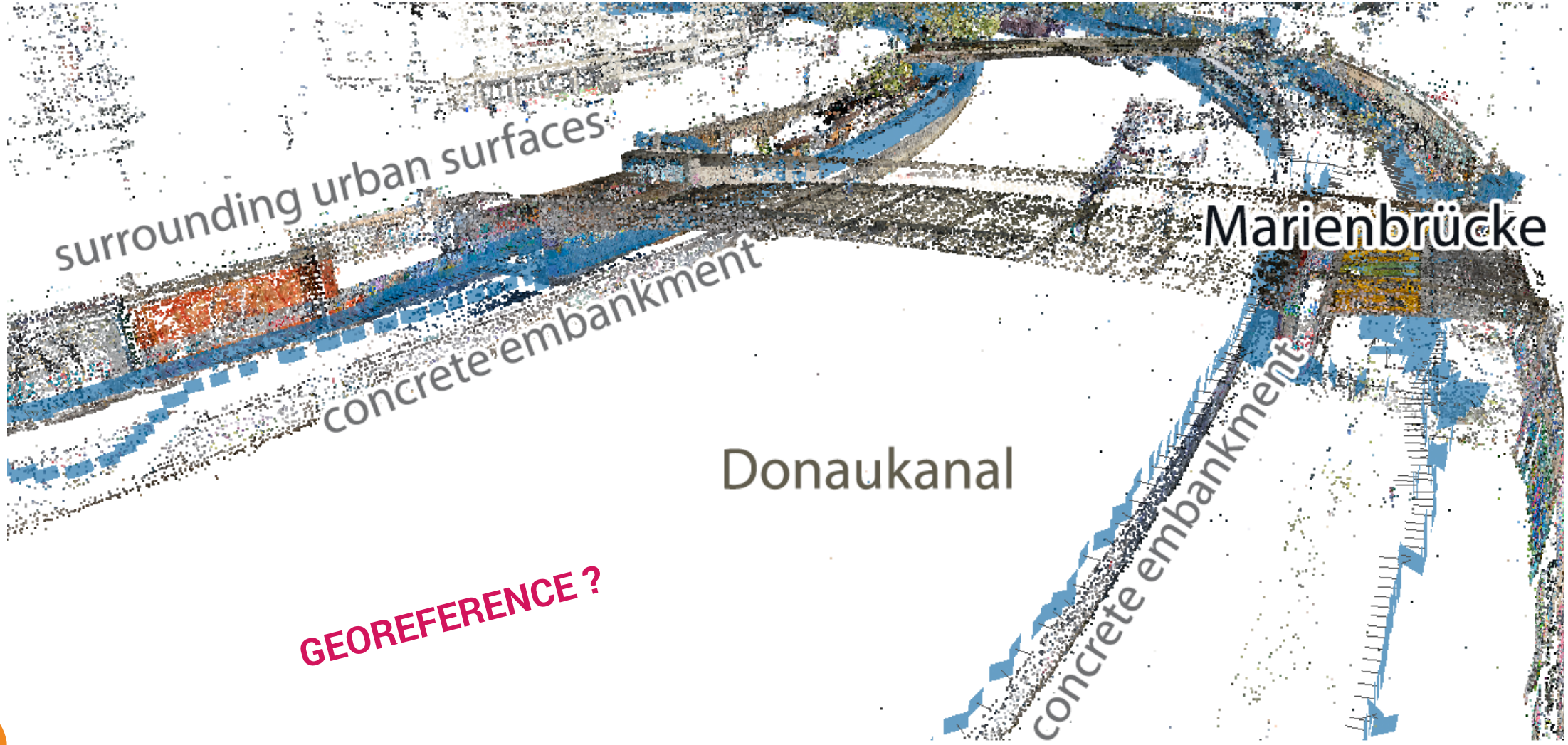
Nikon D750 + 85 mm
01-10-2021

Nikon Z7 II + 20 mm
26-10-2021

# CAMERA orientation



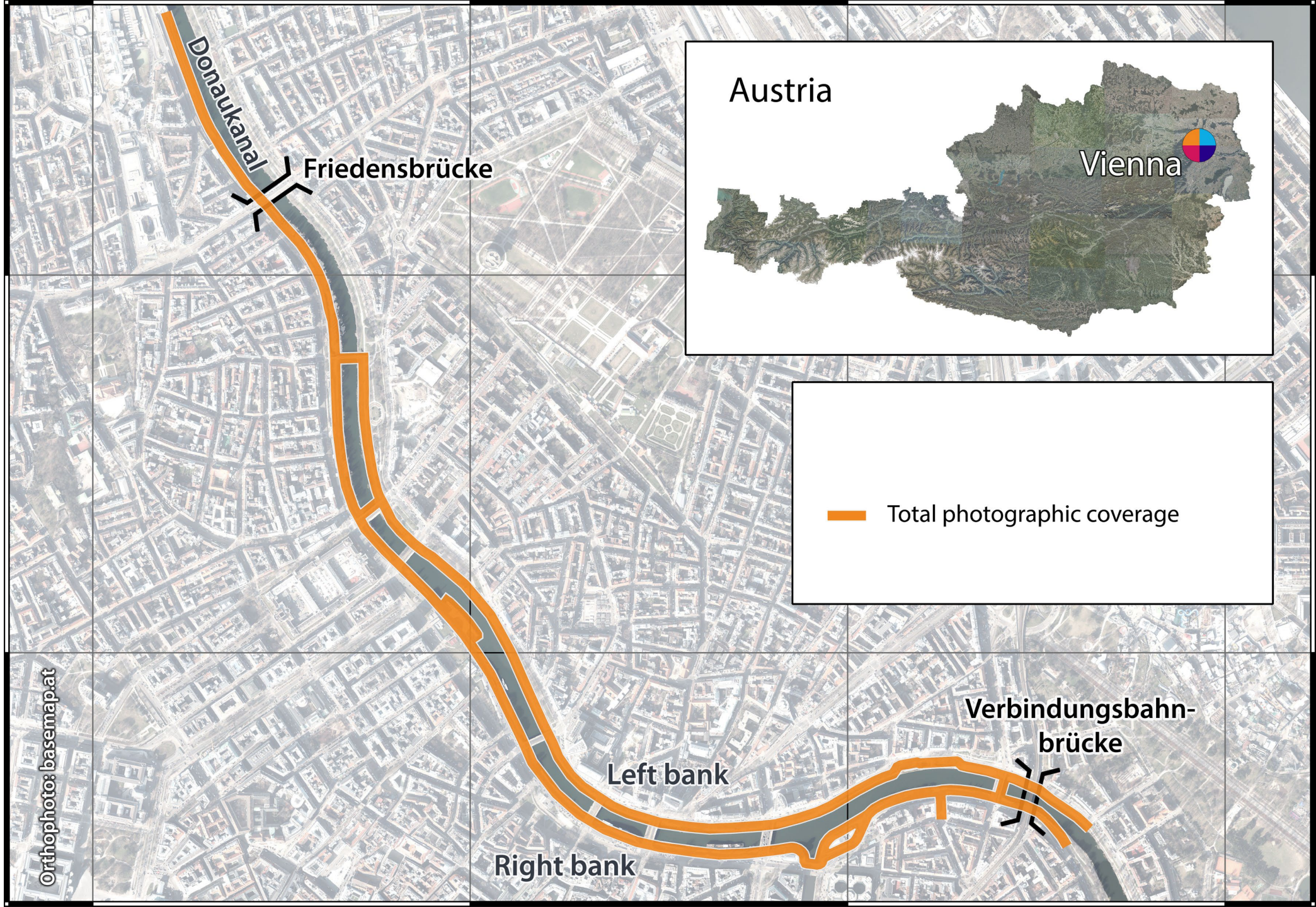
# CAMERA orientation




GEOREFERENCE ?

## TOTAL COVERAGE

14.0 km

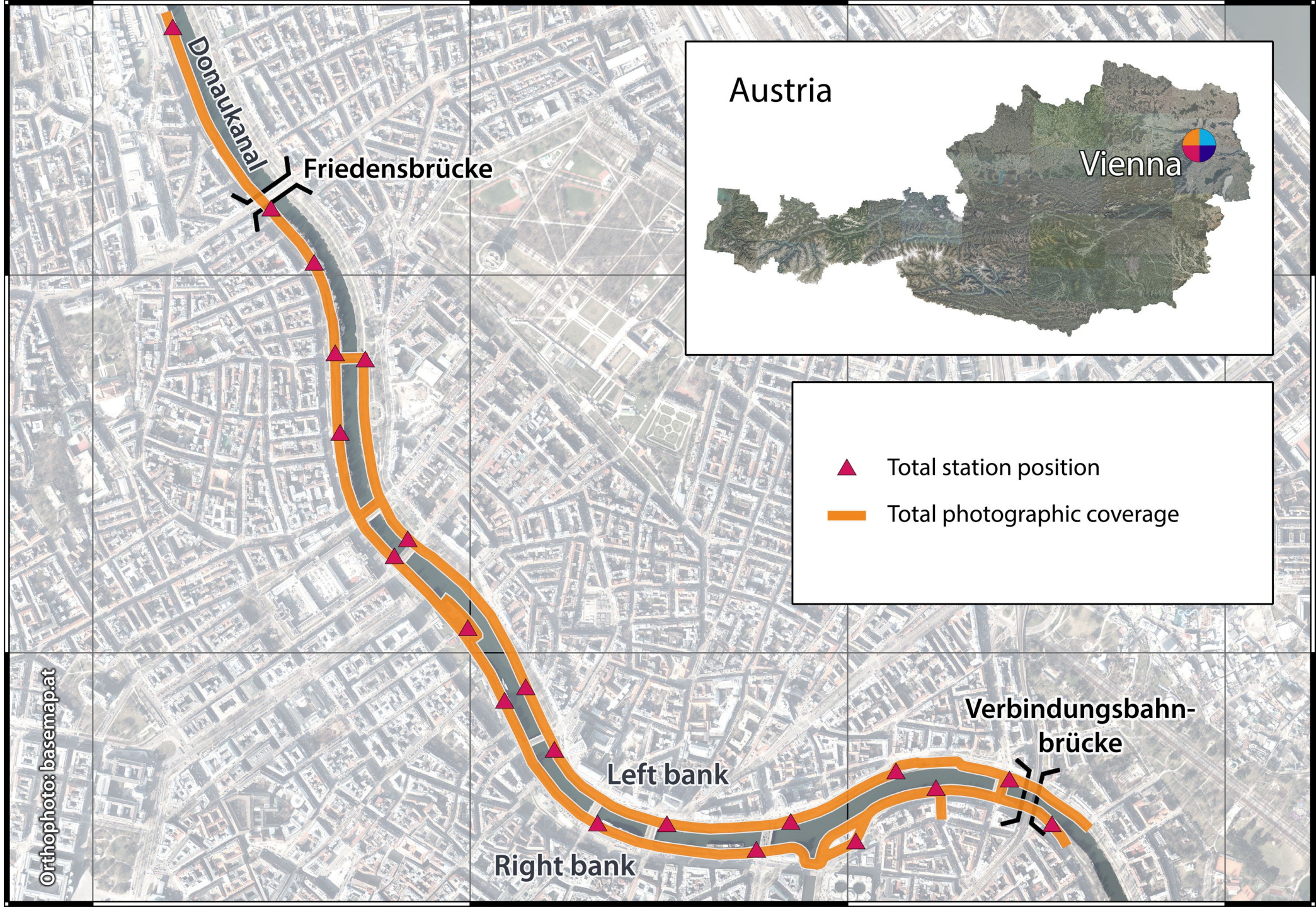


## TOTAL COVERAGE

14.0 km

## TOTAL STATION POSITIONS

21



## TOTAL COVERAGE

14.0 km

## TOTAL STATION POSITIONS

21

**TOTAL COVERAGE**

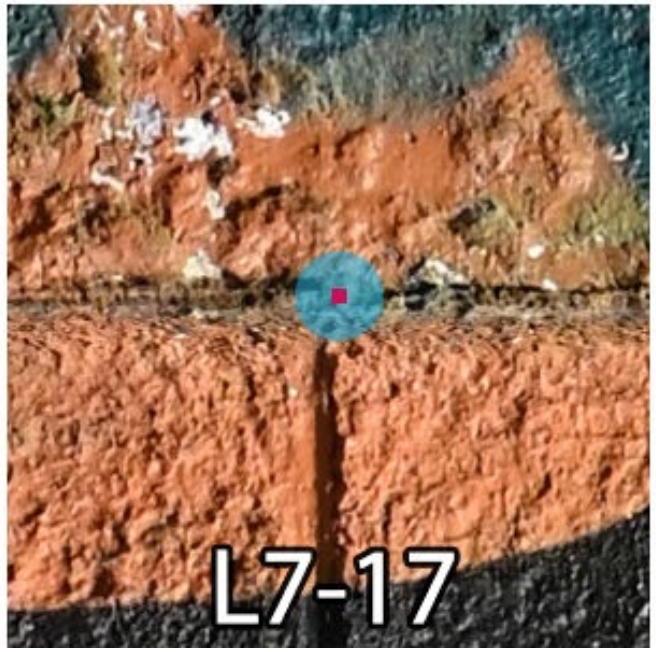
14.0 km

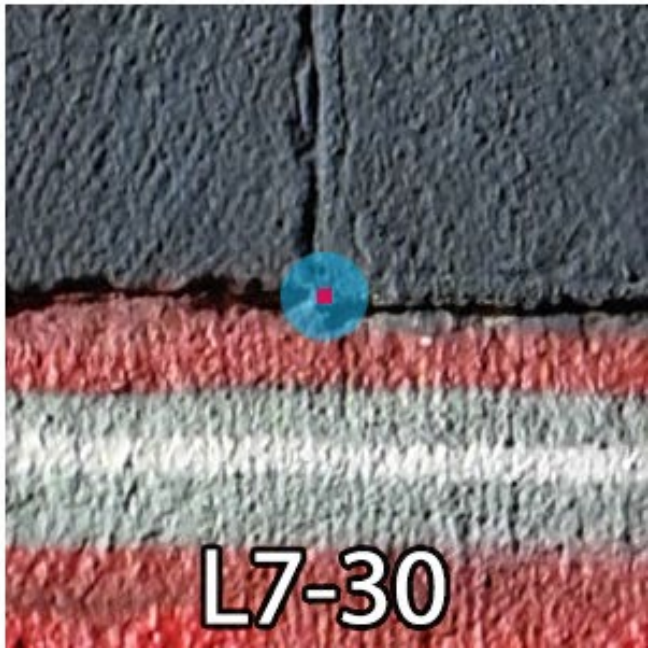
**TOTAL STATION POSITIONS**

21

**GRAFFITI-SCAPE POINTS**

624



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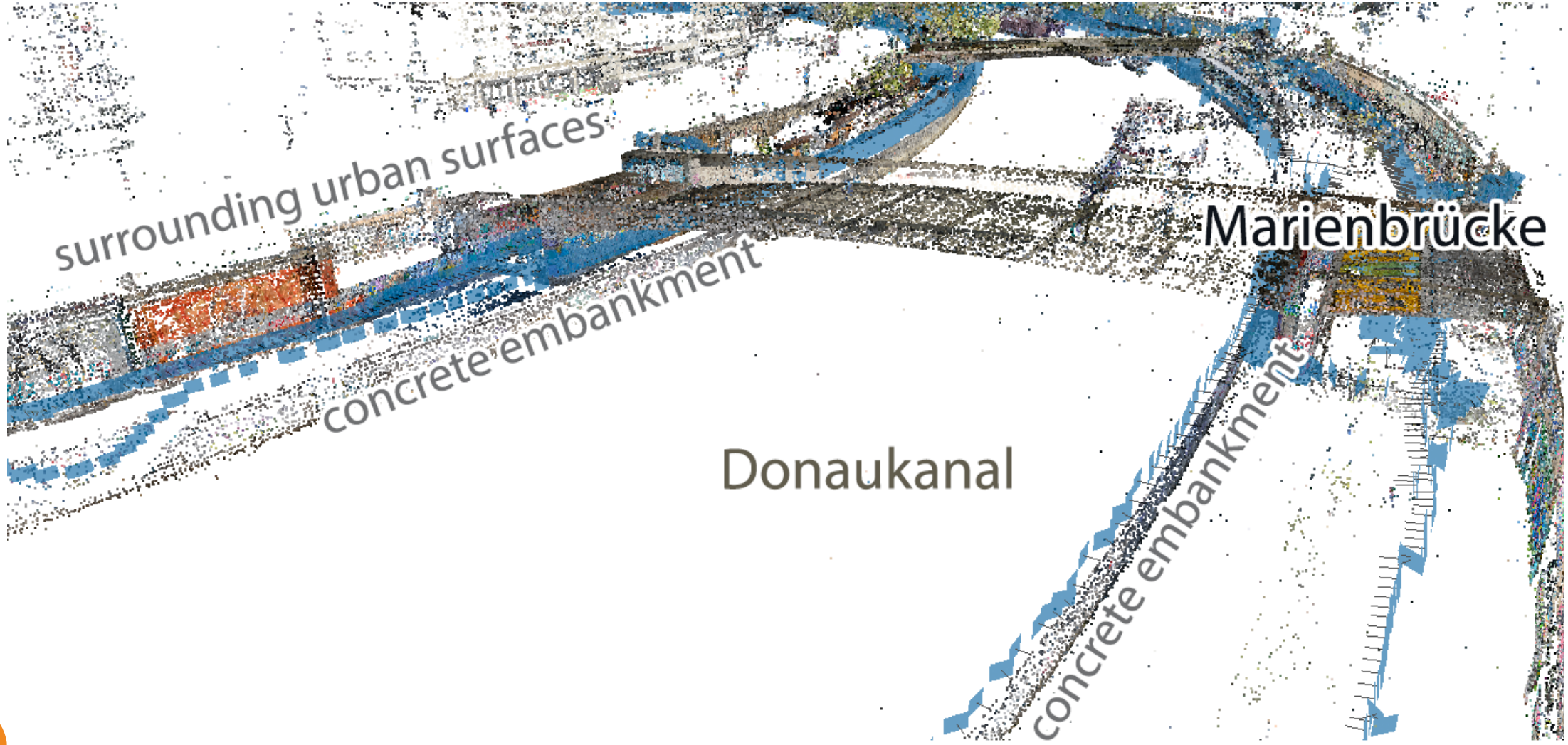
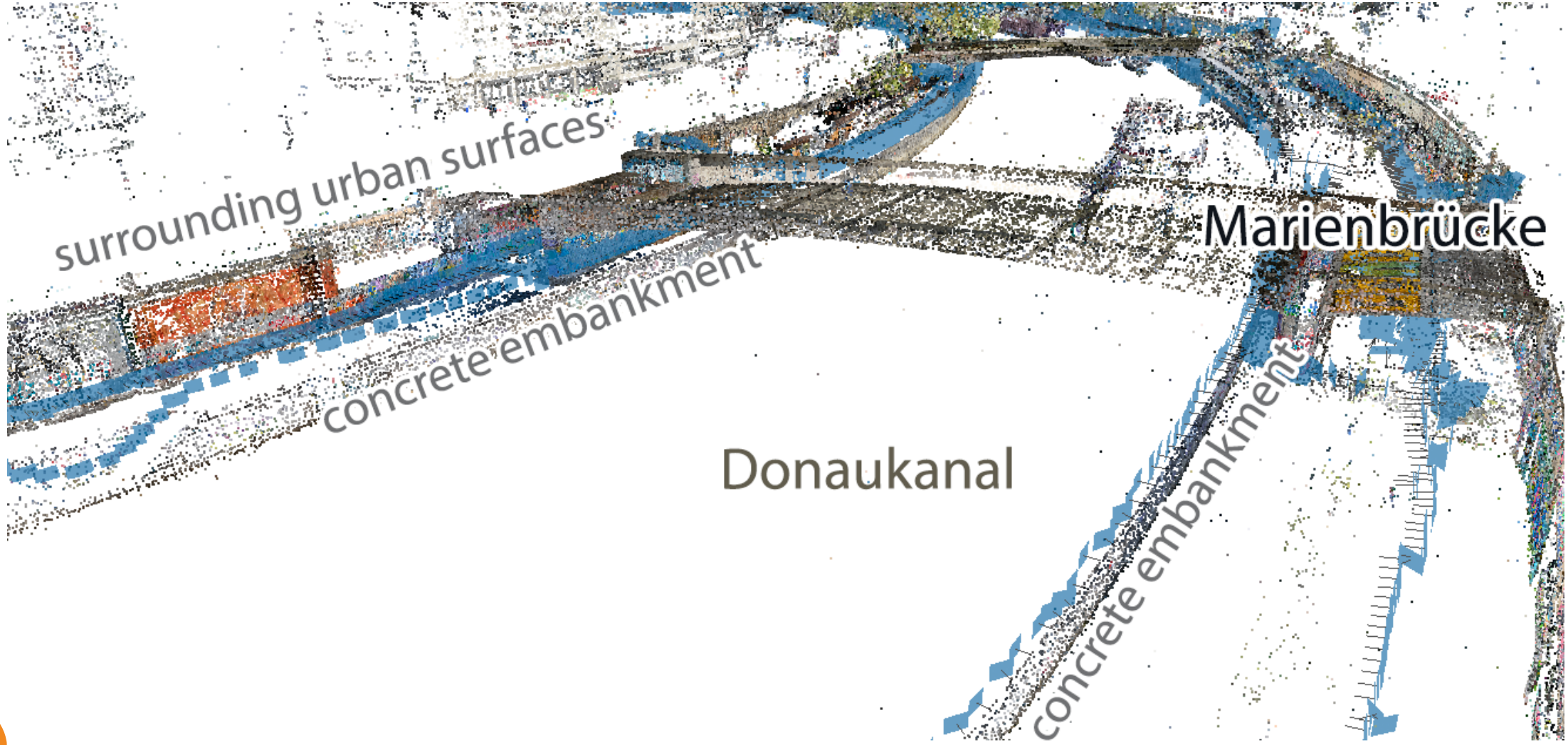
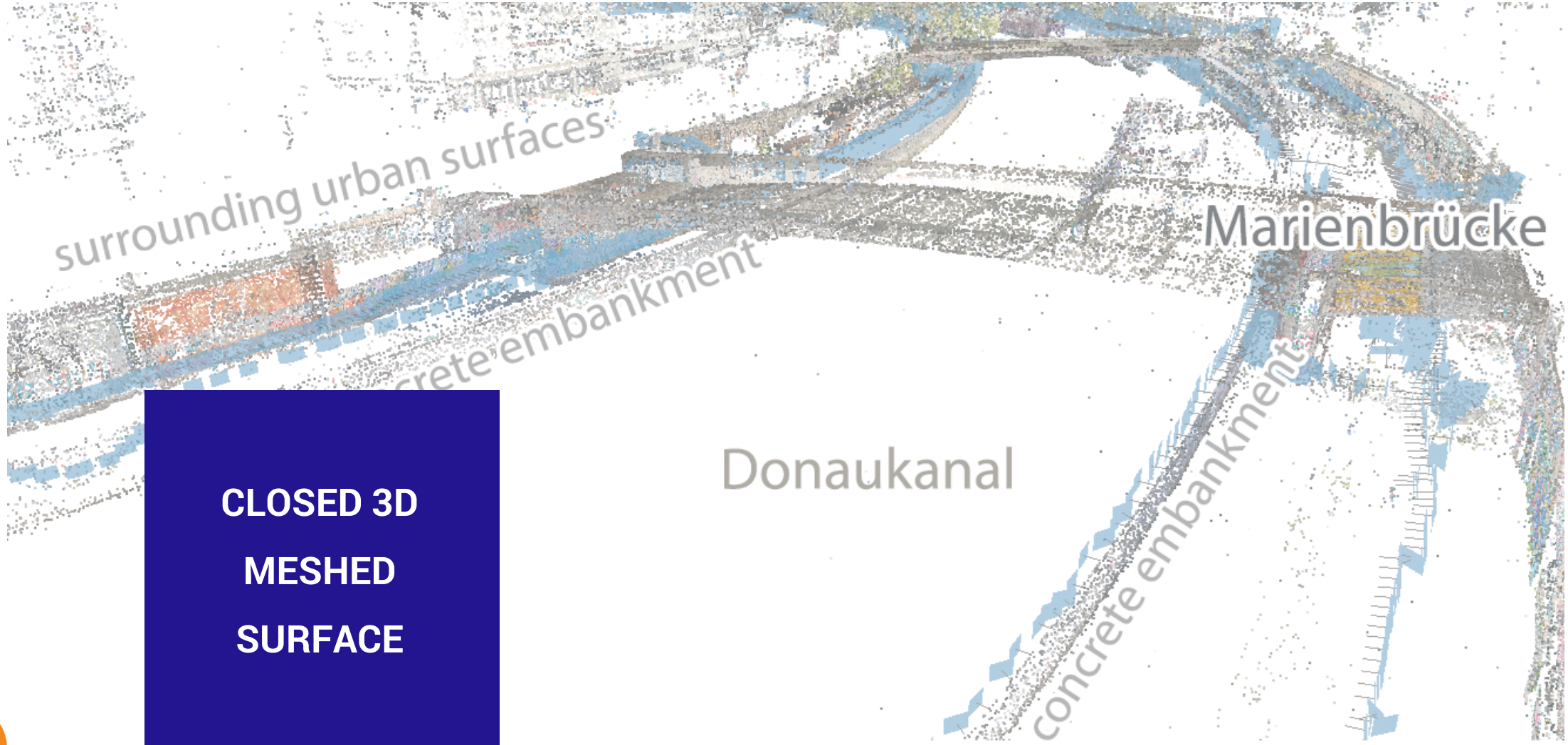


# THREE purposes

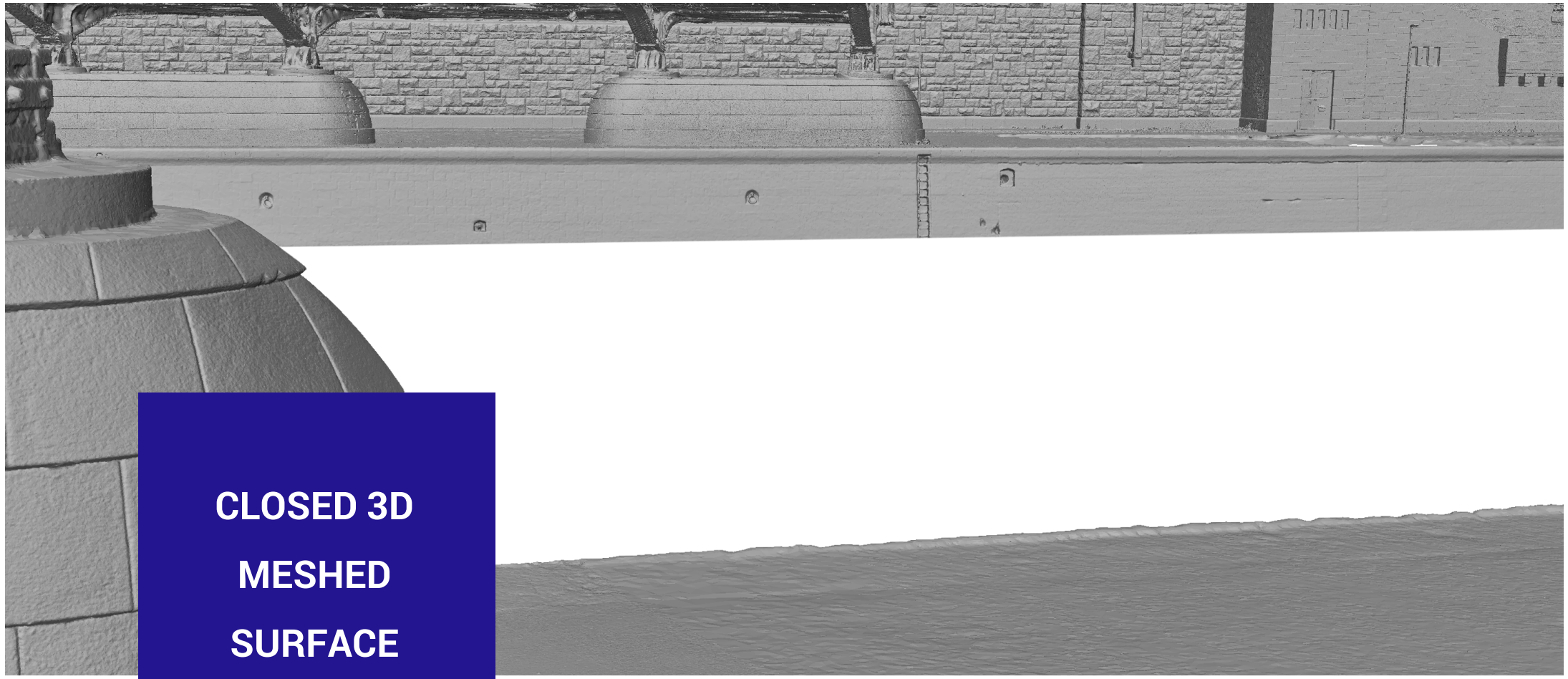


# THREE purposes




**CLOSED 3D MESHED SURFACE**

# THREE purposes

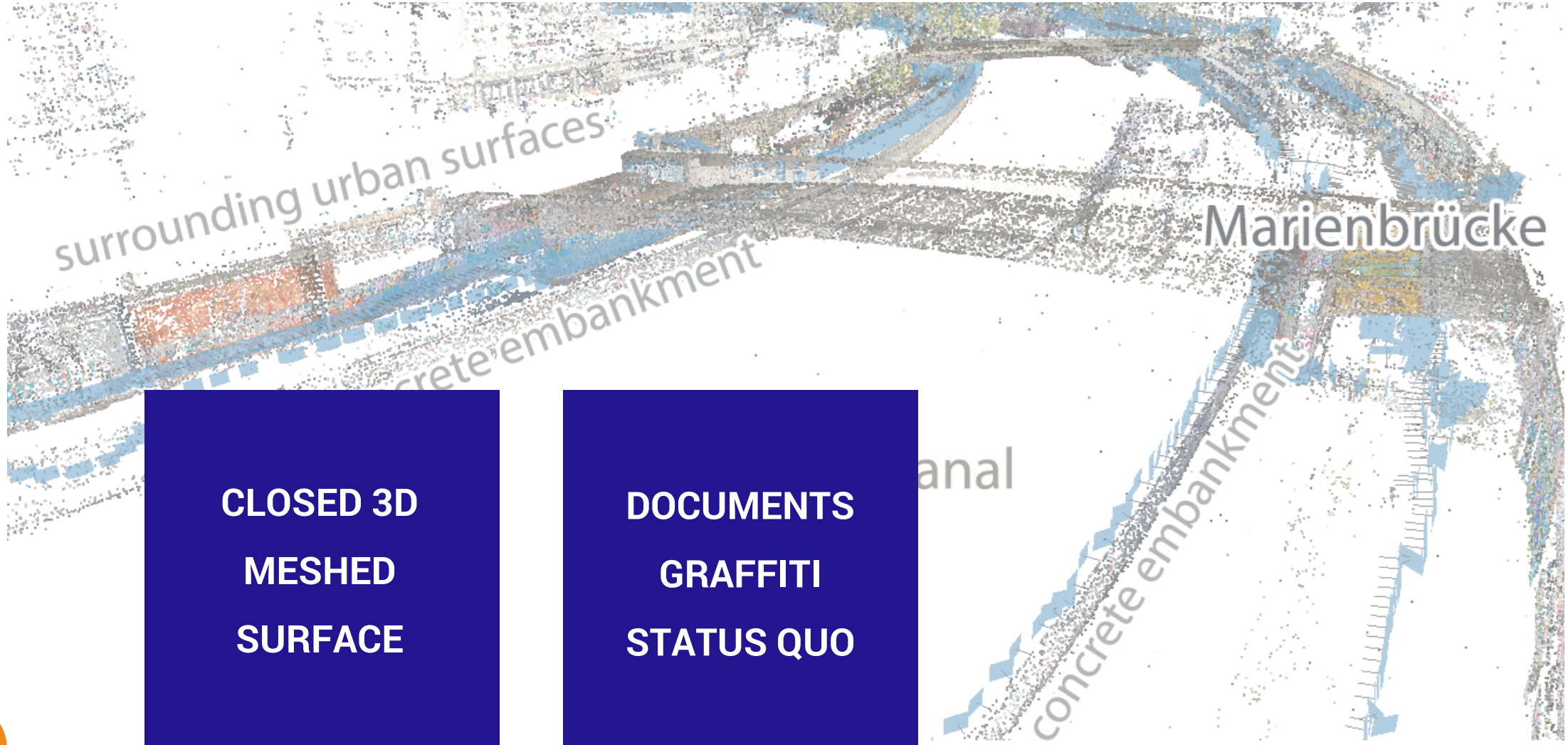


CLOSED 3D

MESHED

SURFACE

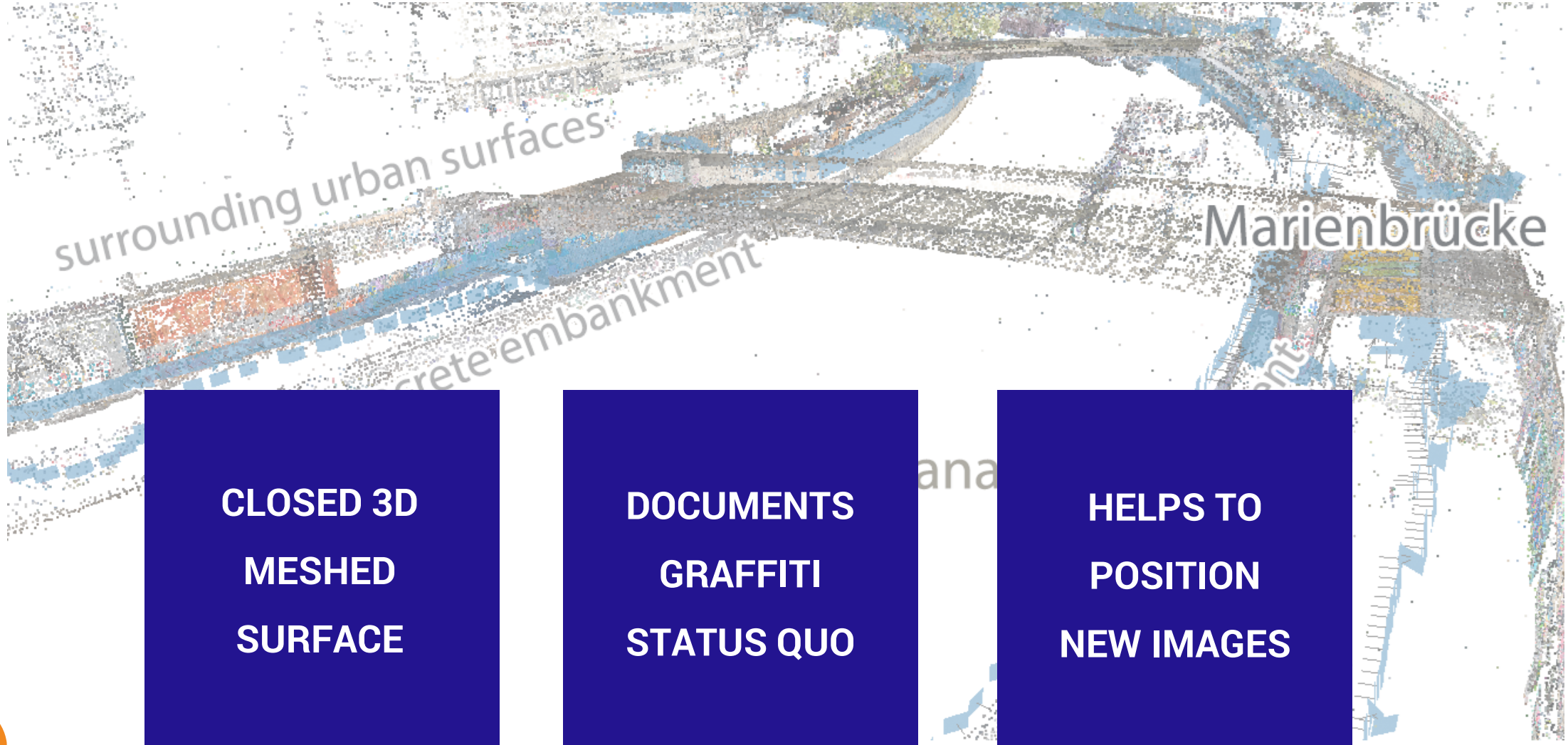
# THREE purposes




**CLOSED 3D MESHED SURFACE**

**DOCUMENTS GRAFFITI STATUS QUO**

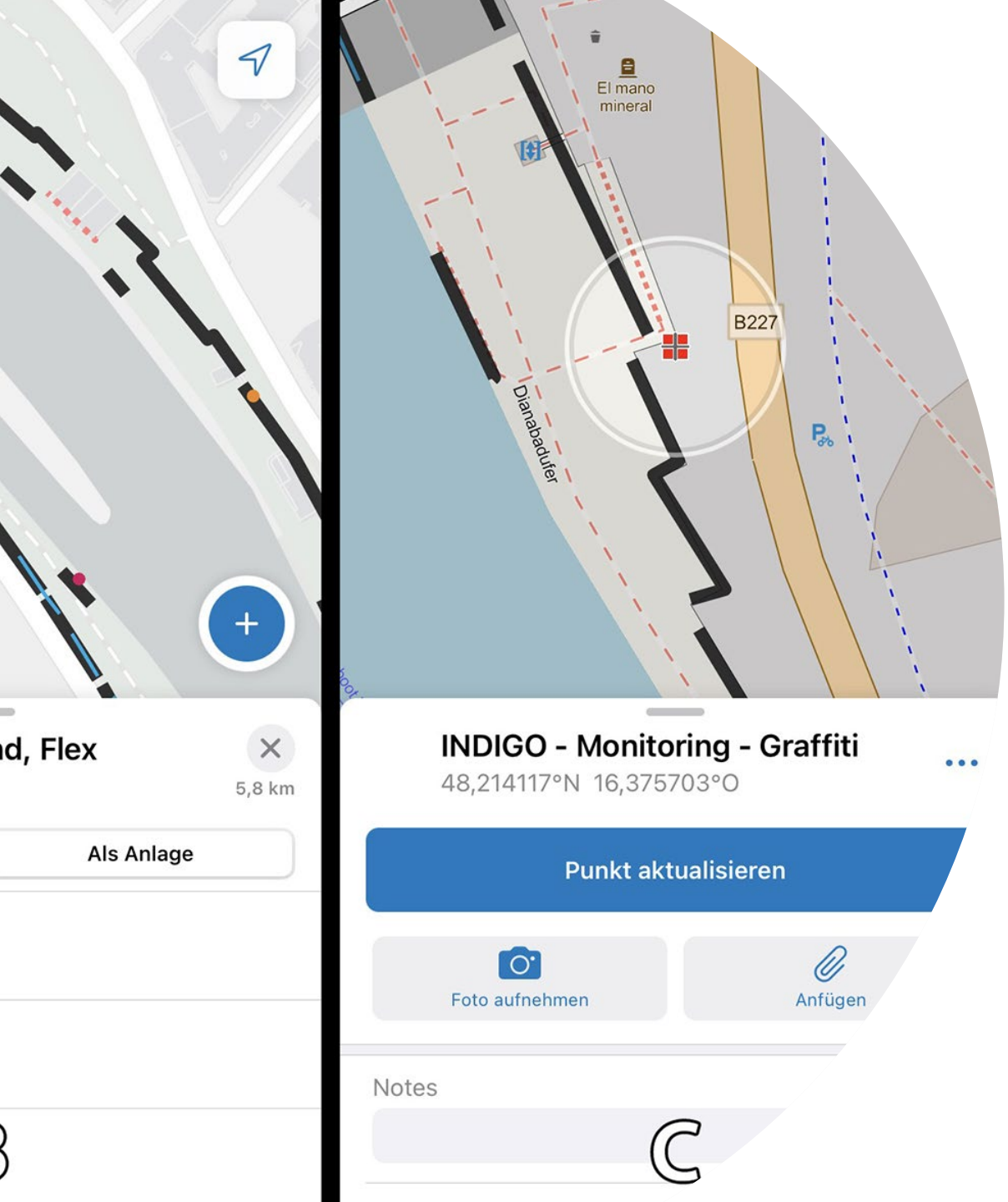
# THREE purposes




**CLOSED 3D MESHED SURFACE**

**DOCUMENTS GRAFFITI STATUS QUO**

**HELPS TO POSITION NEW IMAGES**




# FOLLOW-UP
# photography

**Instagram + monitoring app**

# FOLLOW-UP
# photography

Instagram + monitoring app

2 photographers

# FOLLOW-UP
# photography

Instagram + monitoring app

2 photographers

2 cameras + 2 spectrometers + 2 tablets

identically programmed

# FOLLOW-UP
# photography

Instagram + monitoring app

2 photographers

2 cameras + 2 spectrometers + 2 tablets

identically programmed

fixed acquisition procedure

Hardware
relies on
'Follow-up' workflow
generates
Output
has
Purpose

Hardware *relies on* 'Follow-up' workflow *generates* Output *has* Purpose

Check the map

Hardware *relies on* 'Follow-up' workflow *generates* Output *has* Purpose

Check the map

↓

Move to closest new graffito

Hardware *relies on* 'Follow-up' workflow *generates* Output *has* Purpose

- Check the map
- Move to closest new graffito
- Focus on ColorChecker

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|

Check the map

↓

Move to closest new graffito

↓

Focus on ColorChecker

↓

Photograph ColorChecker

1 ColorChecker photo

1. Subdivide photo series

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|

Check the map

↓

Move to closest new graffito

↓

Focus on ColorChecker

↓

Photograph ColorChecker

↓

Measure illumination

1 ColorChecker photo

1 illumination spectrum

1. Subdivide photo series
2. Establish link with spectrometer file
3. Generate correct photo colours (backup)

Generate correct photo colours

| Hardware | *relies on* | 'Follow-up' workflow | *generates* | Output | *has* | Purpose |
|---|---|---|---|---|---|---|

Check the map

↓

Move to closest new graffito

↓

Focus on ColorChecker

↓

Photograph ColorChecker

↓

Measure illumination

↓

*large graffito* → Move maximum 3 m away from graffito

*small graffito* → Move maximum 2 m away from graffito

↓

Focus on graffito

1 ColorChecker photo

1 illumination spectrum

1. Subdivide photo series
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Generate correct photo colours

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|

Check the map

↓

Move to closest new graffito

↓

Focus on ColorChecker

↓

Photograph ColorChecker

↓

Measure illumination

↓

*large graffito* → Move maximum 3 m away from graffito

*small graffito* → Move maximum 2 m away from graffito

↓

Focus on graffito

↓

Move farther away / Move closer or farther

↓

Acquire overview photo

1 ColorChecker photo

1 illumination spectrum

1. Subdivide photo series
2. Establish link with spectrometer file
3. Generate correct photo colours (backup)

Generate correct photo colours

1 overview photo

1. Extract graffito outlines
2. Generate tour overview photos
3. Estimate interior & exterior camera orientations

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|

Check the map

Move to closest new graffito

Focus on ColorChecker

Photograph ColorChecker

Measure illumination

*large graffito* / *small graffito*

Move maximum 3 m away from graffito

Move maximum 2 m away from graffito

Focus on graffito

Move farther away

Move closer or farther

Acquire overview photo

Move again to 3 m from graffito

Move again to 2 m from graffito

Acquire strong network of many overlapping photos of the graffito and its surroundings

1 ColorChecker photo

1. Subdivide photo series
2. Establish link with spectrometer file
3. Generate correct photo colours (backup)

1 illumination spectrum

Generate correct photo colours

1 overview photo

1. Extract graffito outlines
2. Generate tour overview photos
3. Estimate interior & exterior camera orientations

[5, ∞[ detailed graffito photos

1. Estimate interior & exterior camera orientations
2. Produce 3D model texture
3. Generate orthophoto mosaic

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|
| | | Check the map | | | | |
| | | ↓ | | | | |
| | | Move to closest new graffito | | | | |
| | | ↓ | | | | |
| | | Focus on ColorChecker | | | | |
| | | ↓ | | | | |
| | | Photograph ColorChecker | | 1 ColorChecker photo | | 1. Subdivide photo series<br>2. Establish link with spectrometer file<br>3. Generate correct photo colours (backup) |
| | | ↓ | | | | |
| | | Measure illumination | | 1 illumination spectrum | | Generate correct photo colours |
| | | *large graffito* ↓ | *small graffito* ↓ | | | |
| | | Move maximum 3 m away from graffito | Move maximum 2 m away from graffito | | | |
| | | ↓ | ↓ | | | |
| | | Focus on graffito | | | | |
| | | ↓ | ↓ | | | |
| | | Move farther away | Move closer or farther | | | |
| | | ↓ | ↓ | | | |
| | | Acquire overview photo | | 1 overview photo | | 1. Extract graffito outlines<br>2. Generate tour overview photos<br>3. Estimate interior & exterior camera orientations |
| | | ↓ | ↓ | | | |
| | | Move again to 3 m from graffito | Move again to 2 m from graffito | | | |
| | | ↓ | ↓ | | | |
| | | Acquire strong network of many overlapping photos of the graffito and its surroundings | | [5, ∞[ detailed graffito photos | | 1. Estimate interior & exterior camera orientations<br>2. Produce 3D model texture<br>3. Generate orthophoto mosaic |
| | | ↓ | | | | |
| | | Update the map | | Updated monitoring map | | Guide follow-up photography |

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|

Check the map

Move to closest new graffito

Focus on ColorChecker

Photograph ColorChecker

Measure illumination

*large graffito* / *small graffito*

Move maximum 3 m away from graffito / Move maximum 2 m away from graffito

Focus on graffito

Move farther away / Move closer or farther

Acquire overview photo

Move again to 3 m from graffito / Move again to 2 m from graffito

Acquire strong network of many overlapping photos of the graffito and its surroundings

Update the map

1 ColorChecker photo



1. Subdivide photo series
2. Establish link with spectrometer file
3. Generate correct photo colours (backup)

1 illumination spectrum



Generate correct photo colours

1 overview photo



1. Extract graffito outlines
2. Generate tour overview photos
3. Estimate interior & exterior camera orientations

[5, ∞[ detailed graffito photos

1. Estimate interior & exterior camera orientations
2. Produce 3D model texture
3. Generate orthophoto mosaic

Updated monitoring map

Guide follow-up photography

| Hardware | relies on | 'Follow-up' workflow | generates | Output | has | Purpose |
|---|---|---|---|---|---|---|
| | | Check the map | | | | |
| | | Move to closest new graffito | | | | |
|  | | Focus on ColorChecker | | | | |
| | | Photograph ColorChecker | | 1 ColorChecker photo  | | 1. Subdivide photo series<br>2. Establish link with spectrometer file<br>3. Generate correct photo colours (backup) |
|  | | Measure illumination | | 1 illumination spectrum  | | Generate correct photo colours |
| | | *large graffito* / *small graffito* | | | | |
| | | Move maximum 3 m away from graffito / Move maximum 2 m away from graffito | | | | |
|  | | Focus on graffito | | | | |
| | | Move farther away / Move closer or farther | | | | |
|  | | Acquire overview photo | | 1 overview photo  | | 1. Extract graffito outlines<br>2. Generate tour overview photos<br>3. Estimate interior & exterior camera orientations |
| | | Move again to 3 m from graffito / Move again to 2 m from graffito | | | | |
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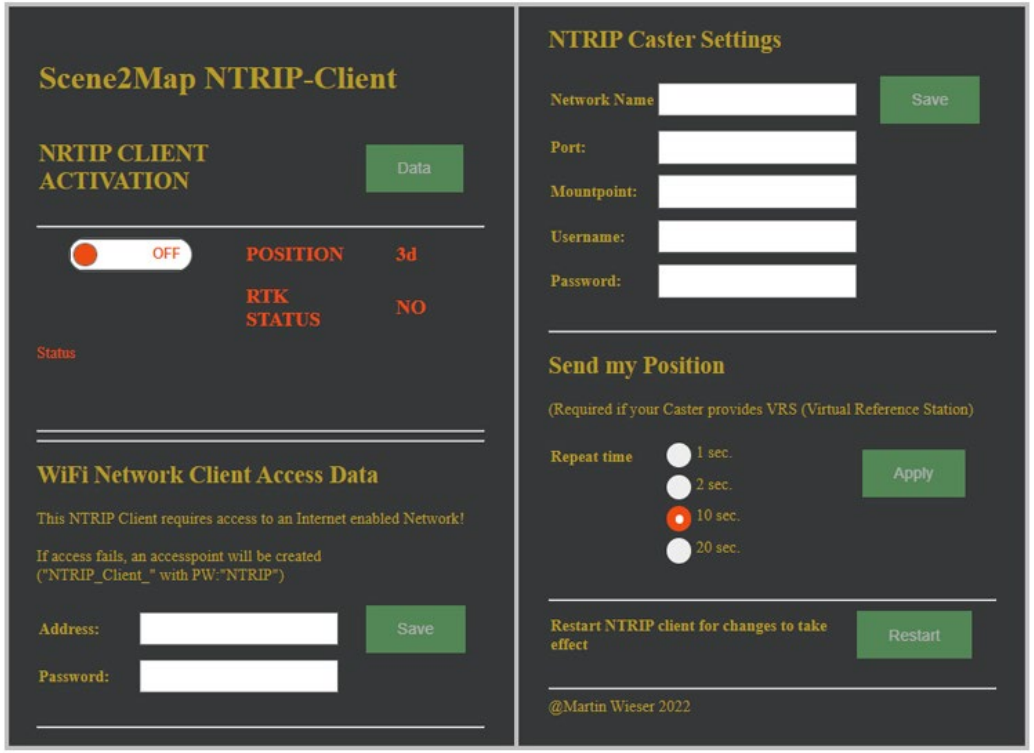
| | | Update the map | | Updated monitoring map | | Guide follow-up photography |

# ACCURATE photo coordinates

# ACCURATE photo coordinates



# IMAGE positioning

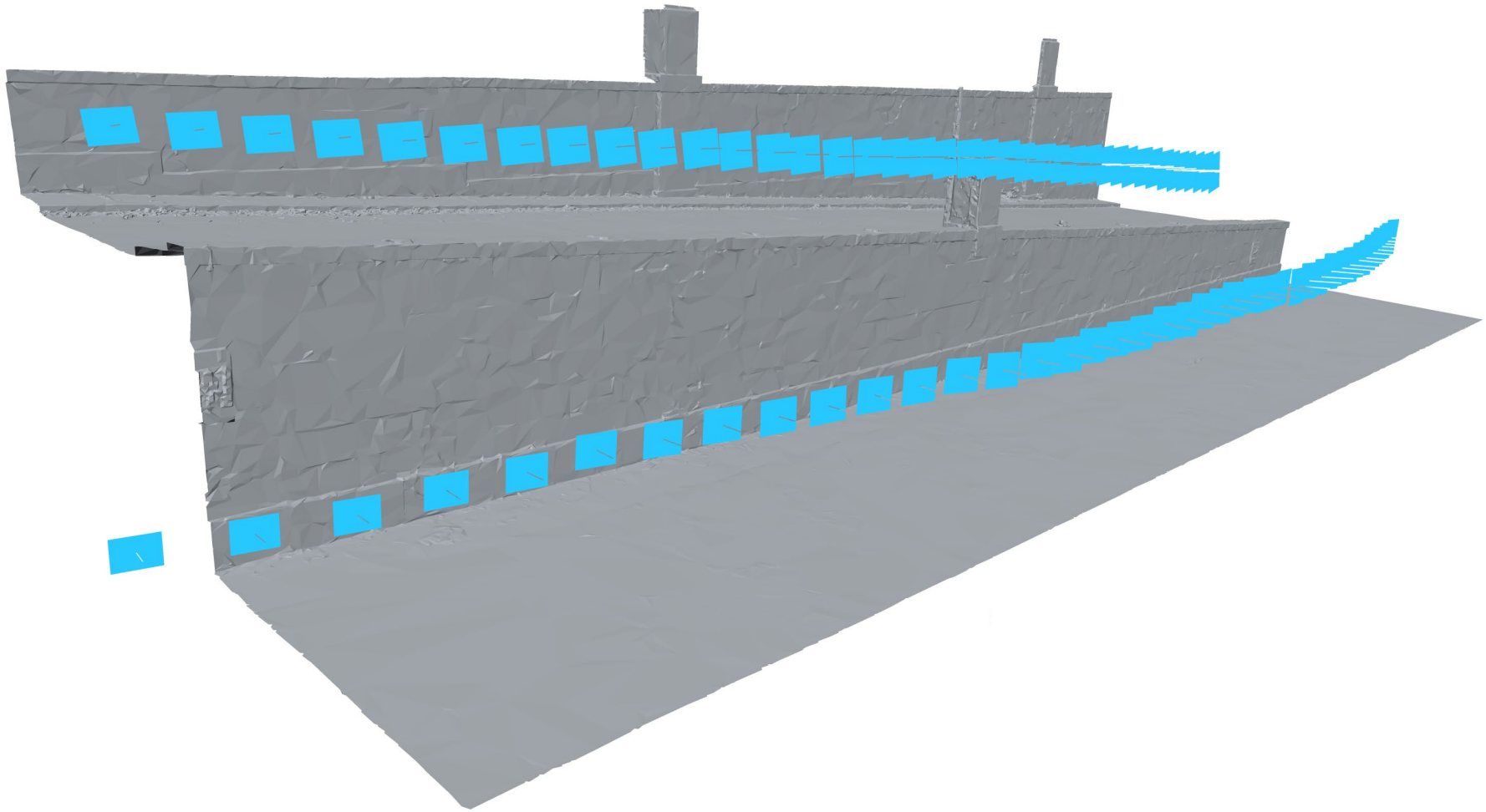


Illustration by Benjamin Wild

# IMAGE positioning

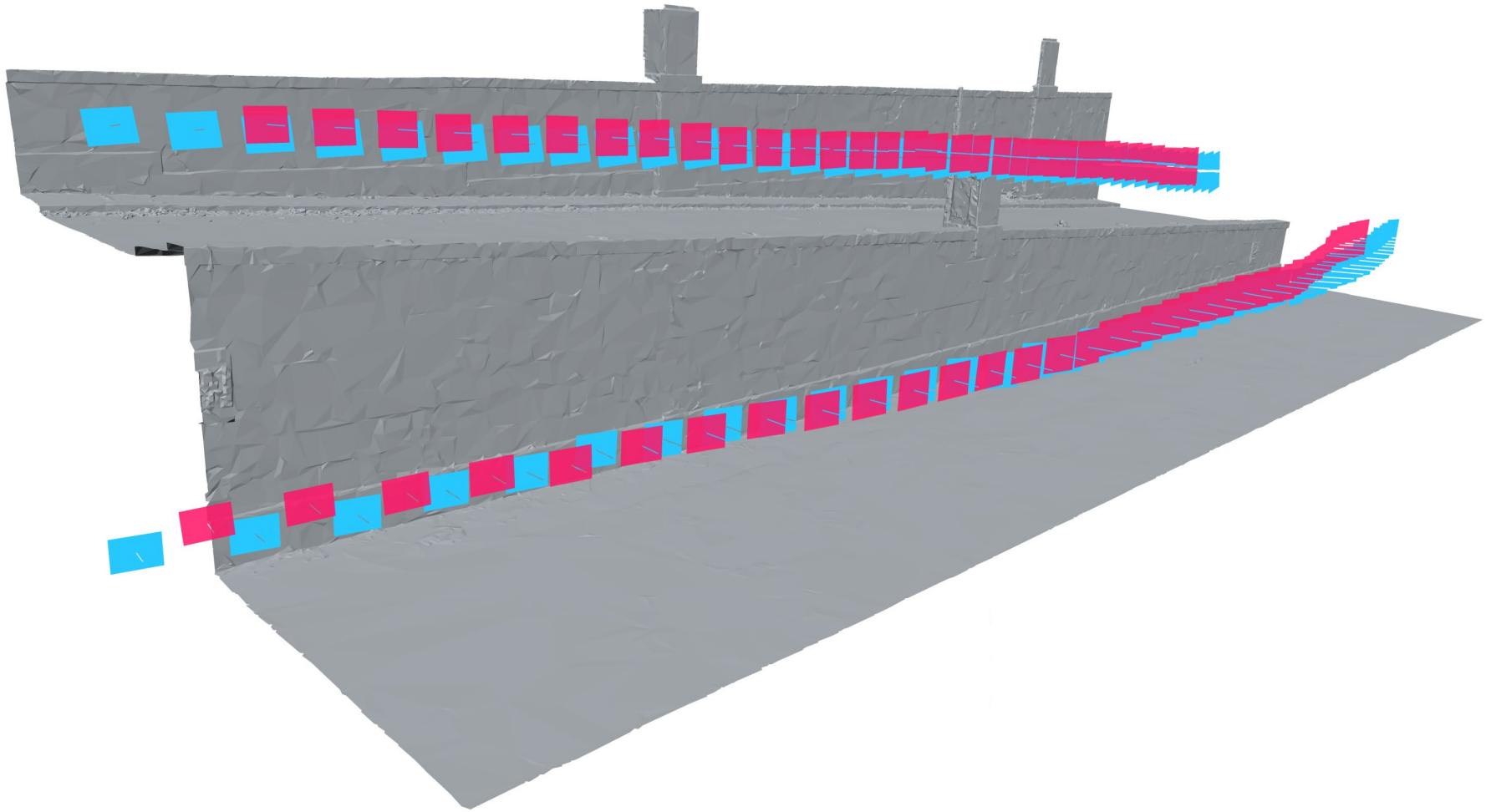
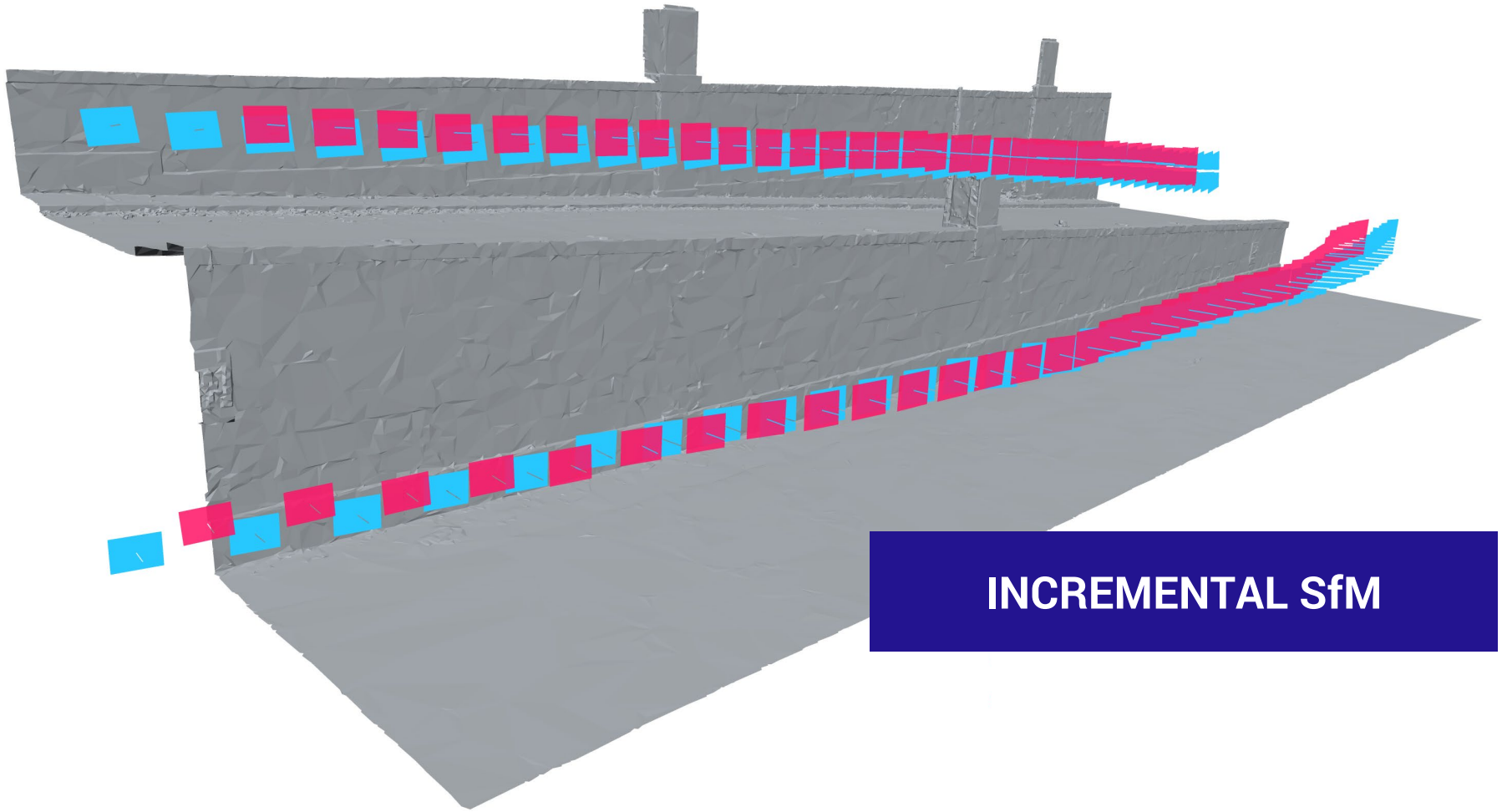


Illustration by Benjamin Wild

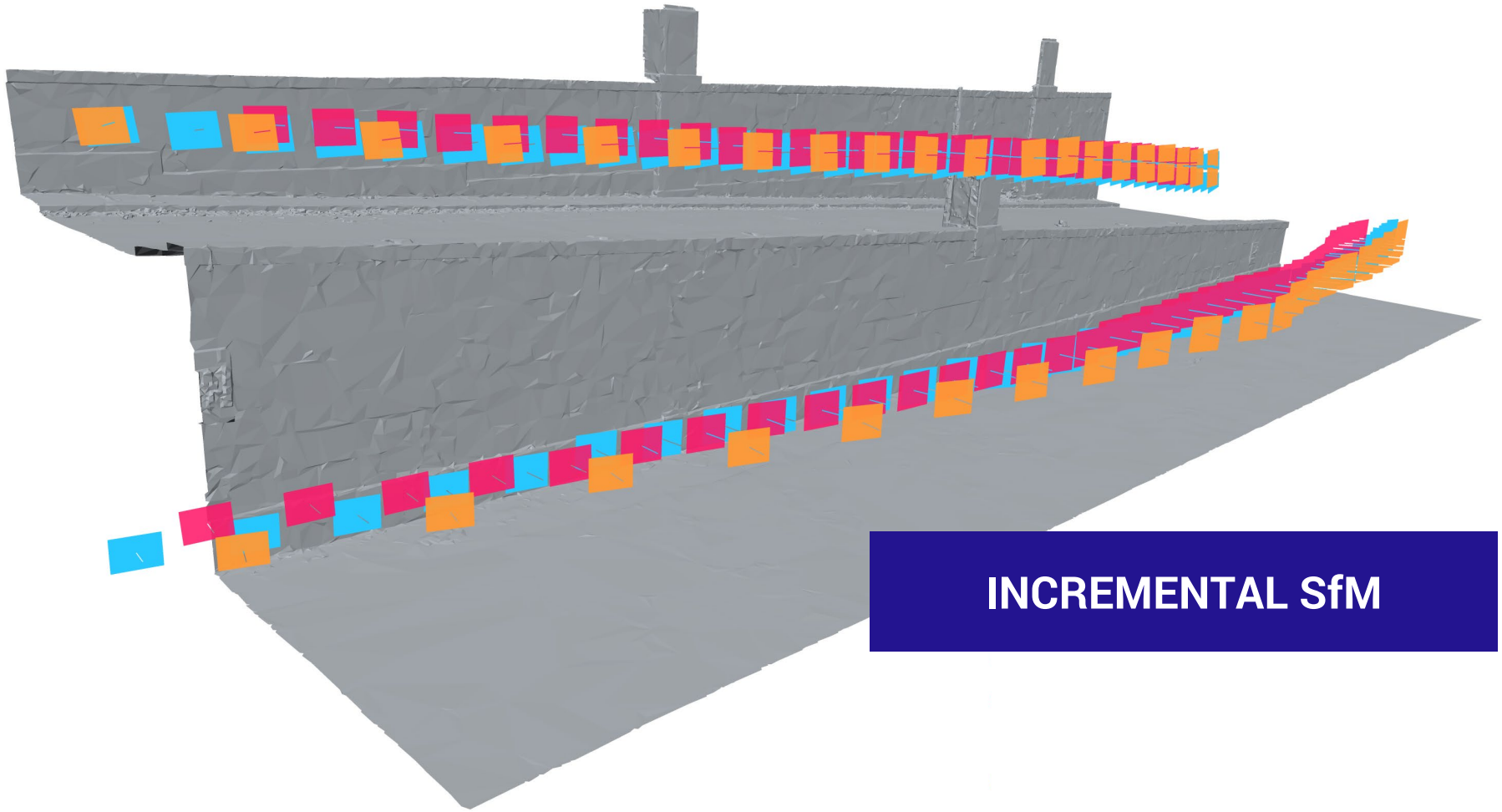
# IMAGE positioning



INCREMENTAL SfM

Illustration by Benjamin Wild

# IMAGE positioning



INCREMENTAL SfM

Illustration by Benjamin Wild

# IMAGE positioning

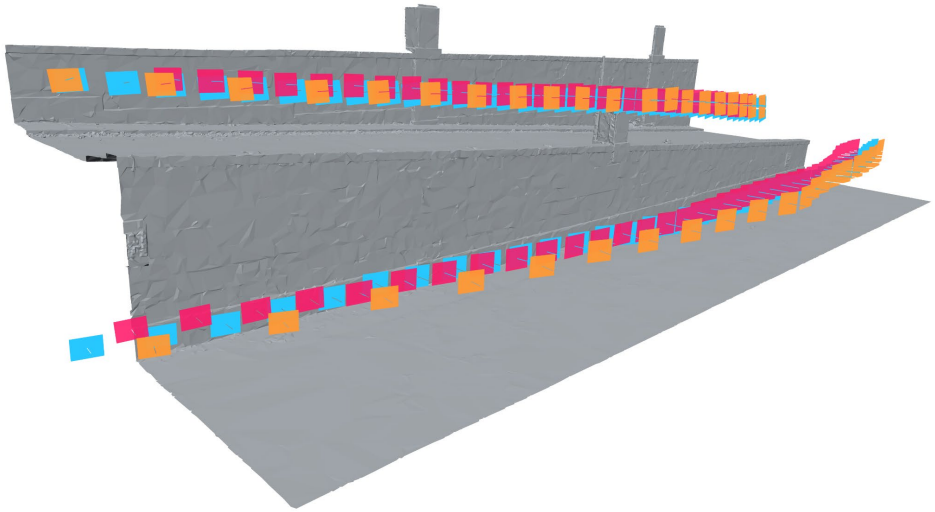
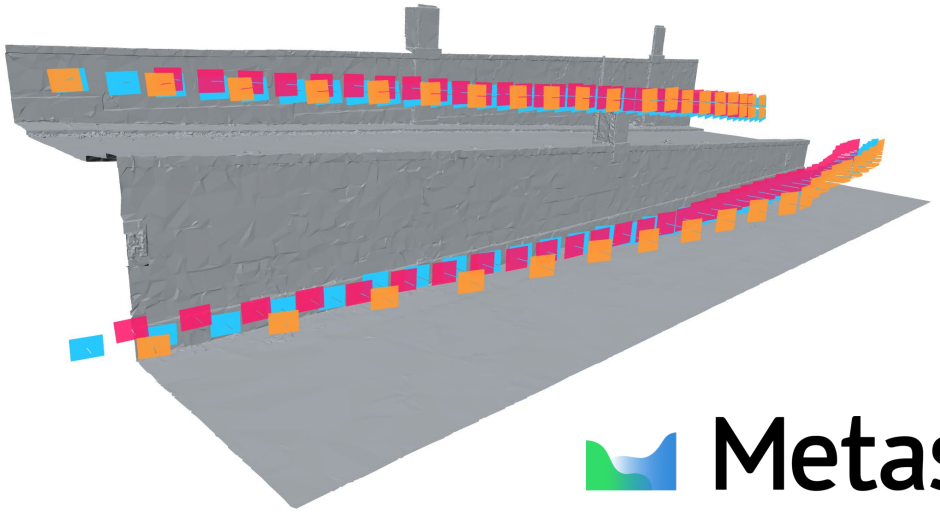


Illustration by Benjamin Wild

# IMAGE positioning

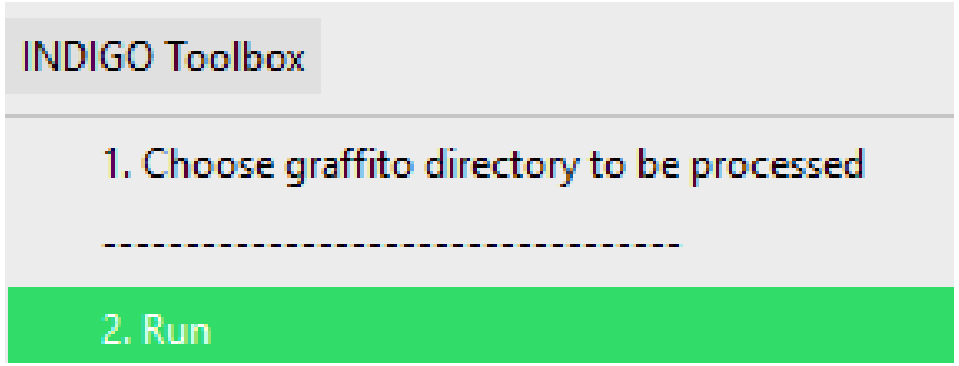


Metashape

Illustration by Benjamin Wild

python™

Metashape




# AUTOGRAF

## position-accurate pixels

AUTOGRAF

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GraffitiProjectINDIGO / AUTOGRAF Public

Notifications Fork 0 Star 6

Code Issues Pull requests Actions Projects Security Insights

main 1 branch 0 tags Go to file Code

| | | |
|---|---|---|
| bewild96 Update README.md | 75d27bb 15 days ago | 24 commits |
| Heritage_ClassificationResults | Add files via upload | 2 months ago |
| images | Add files via upload | last month |
| src | Add files via upload | 2 months ago |
| LICENSE | Initial commit | 2 months ago |
| README.md | Update README.md | 15 days ago |

README.md

## Short Description

AUTOGRAF (**AUT**omated **O**rthorectification of **GRAF**fiti photos) is an open-source python-based Metashape add-on which enables the automated orthorectification of graffiti photos at a specific site of interest. It employs state-of-the art photogrammetric computer vision techniques to allow highly accurate georeferencing and orthorectification of large numbers of photographs. A paper detailing AUTOGRAF's methodology will soon be submitted to Heritage (an MDPI journal).

AUTOGRAF is developed as part of the INDIGO project (In-ventory and DI-sseminate G-raffiti along the d-O-naukanal) carried out by the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology in close collaboration with the GEO Department of TU Wien University.

## How to set up AUTOGRAF

Before AUTOGRAF can be used, the following preparatory steps [1-3] need to be performed:

### 1 - Install Agisoft's Metashape

About

AUTomatic Orthorectification of GRAFfiti photos

photographs graffiti orthorectification

Readme
GPL-3.0 license
6 stars
1 watching
0 forks

Releases

No releases published

Packages

No packages published

Contributors 2

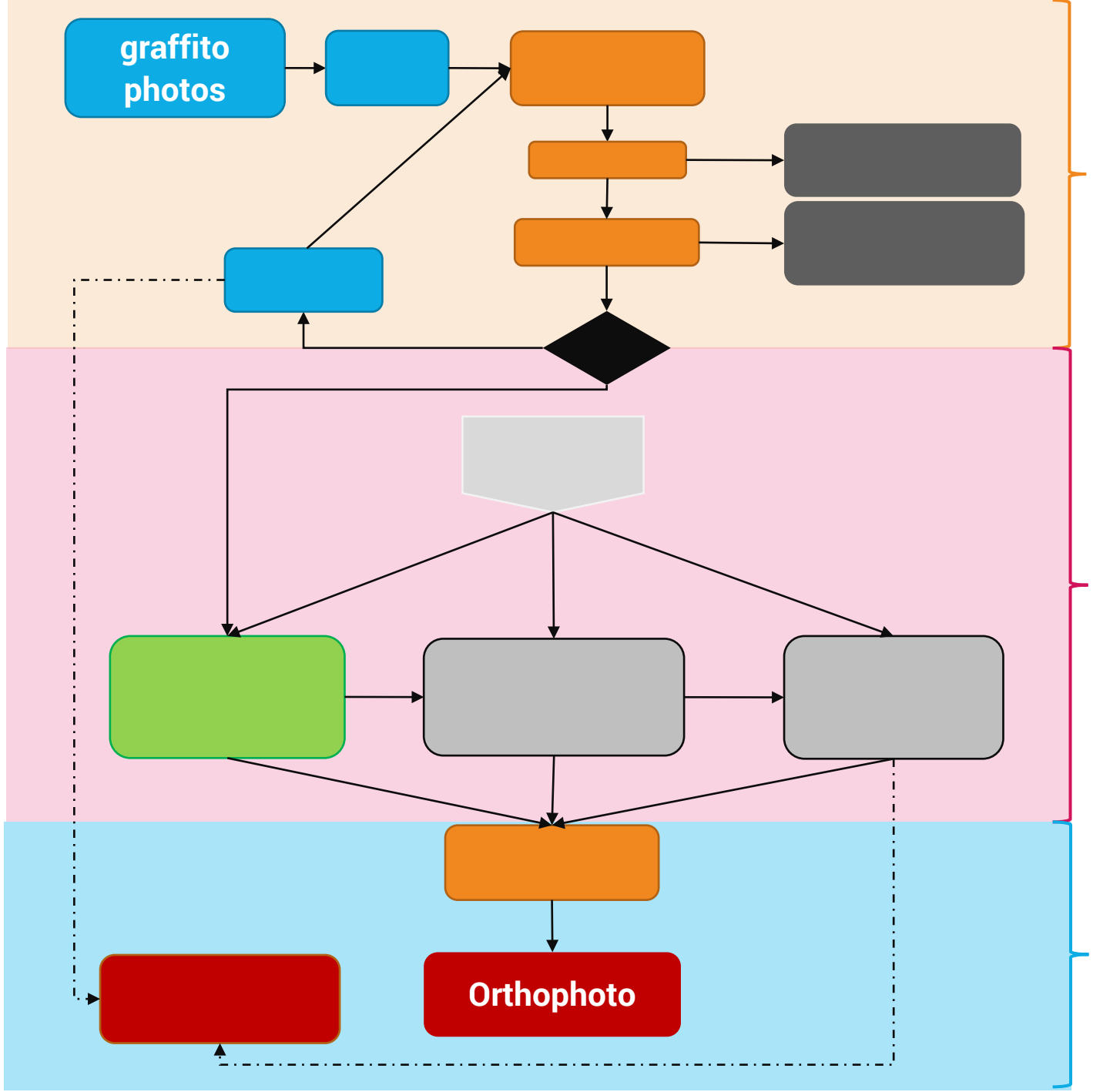
bewild96
BeyondConventionalBoundaries Geert ...

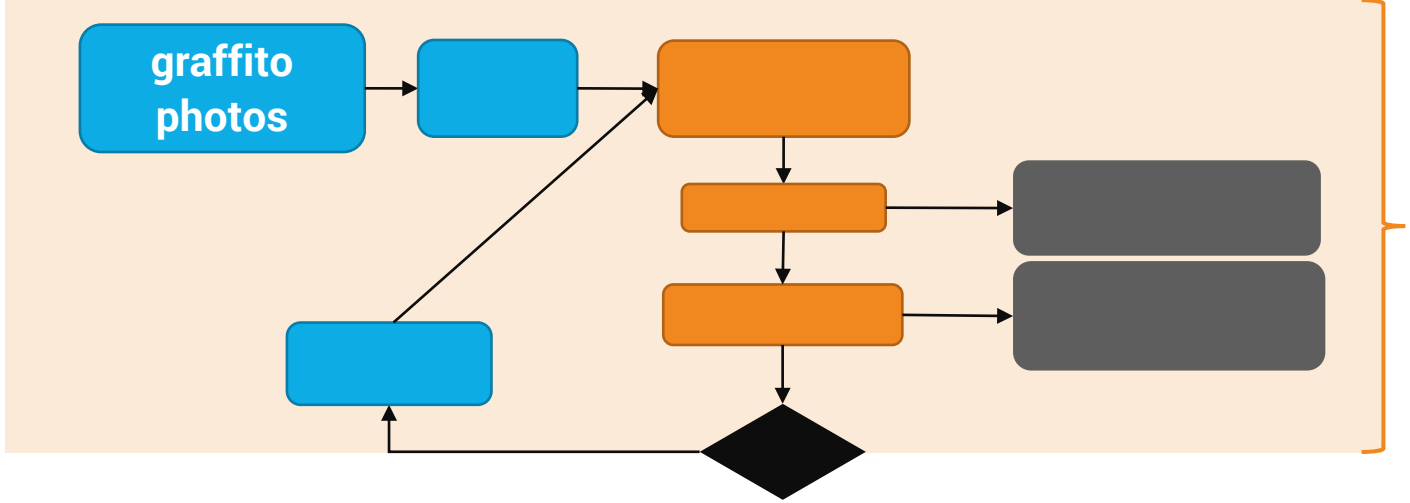
Languages

Python 100.0%

# AUTOGRAF

## position-accurate pixels


graffito photos
Orthophoto
Initial checks
Camera orientations
Incremental SfM
3D surface model
Orthophoto



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INDIGO_2021-12-28_Z7II-B_0293.jpg

INDIGO_2021-12-28_Z7II-B_0294 - Copy.jpg

INDIGO_2021-12-28_Z7II-B_0294.jpg

INDIGO_2021-12-28_Z7II-B_0295.jpg

INDIGO_2021-12-28_Z7II-B_0296.jpg

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INDIGO_2021-12-28_Z7II-B_0297.jpg

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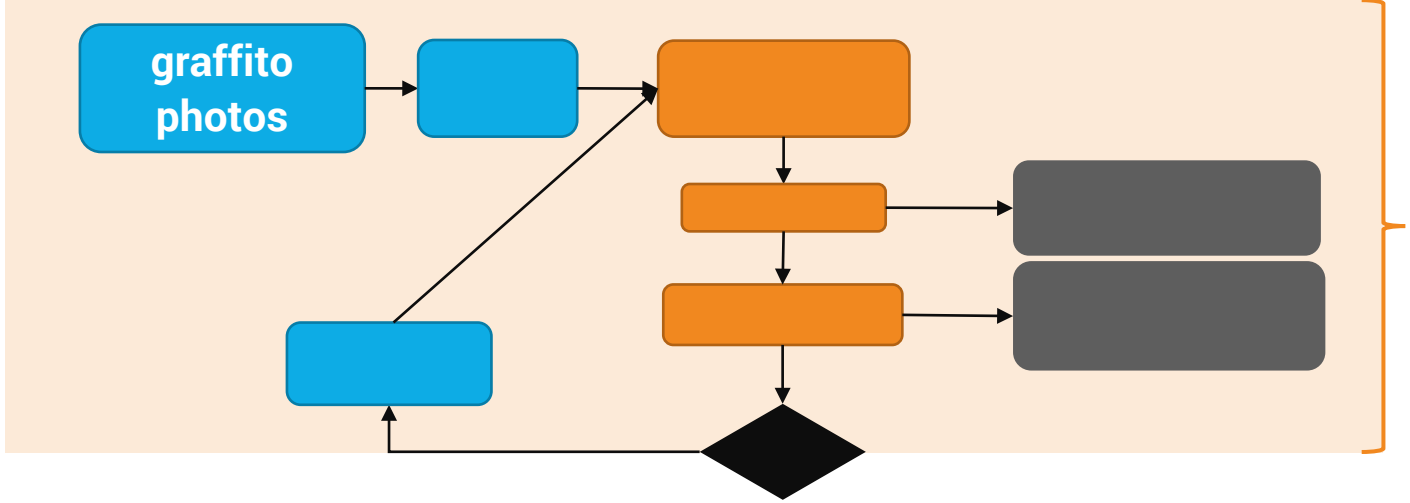
INDIGO_2021-12-28_Z7II-B_0300.jpg



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INDIGO_2021-12-28_Z7II-B_0294.jpg

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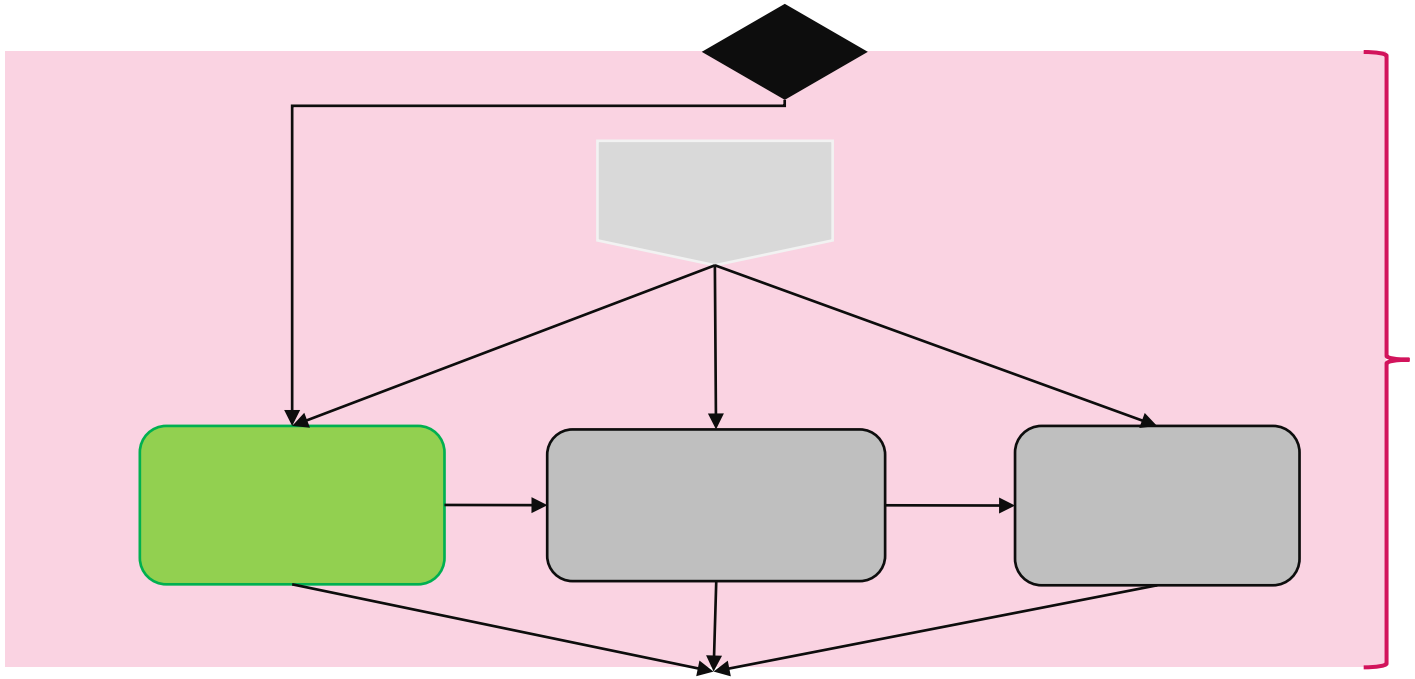
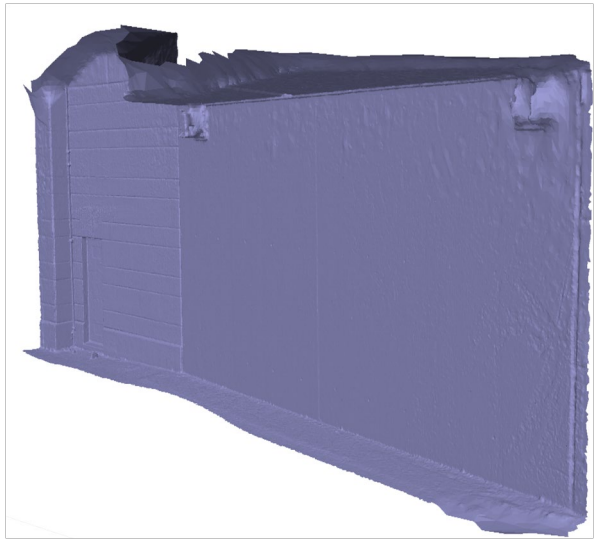


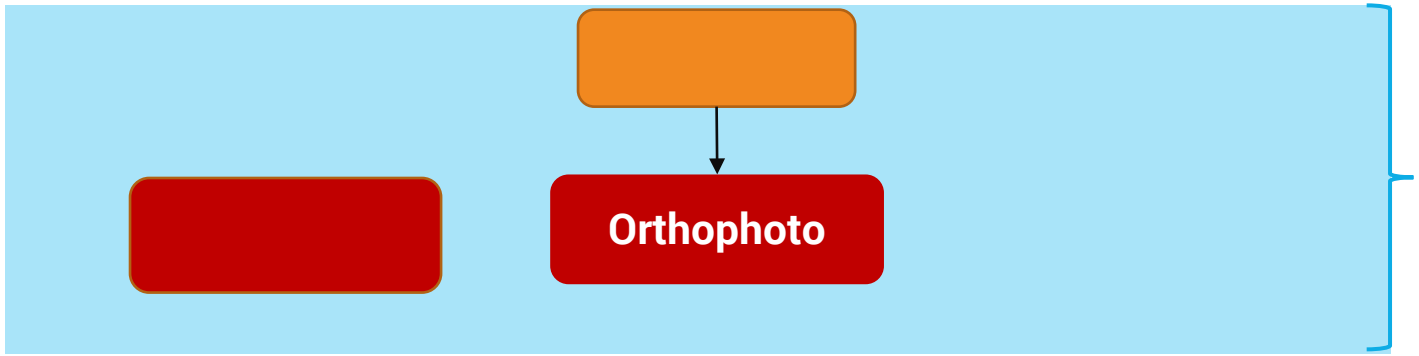
Camera orientations

↓

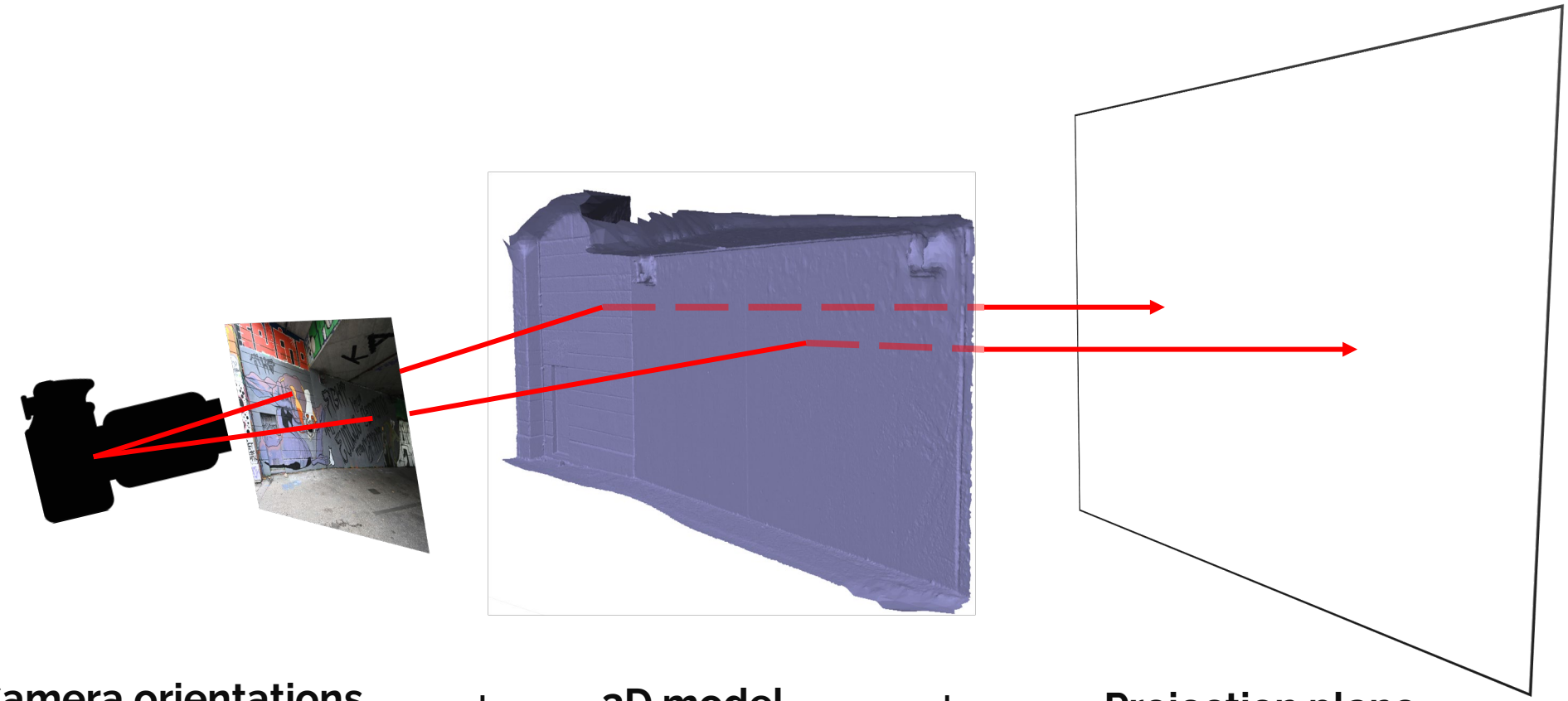
Incremental SfM



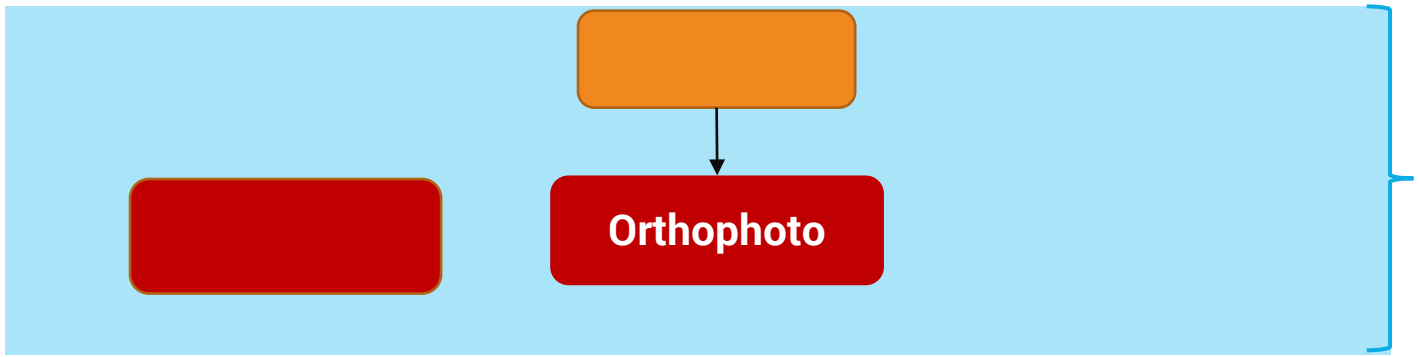
**Camera orientations** + **3D model**



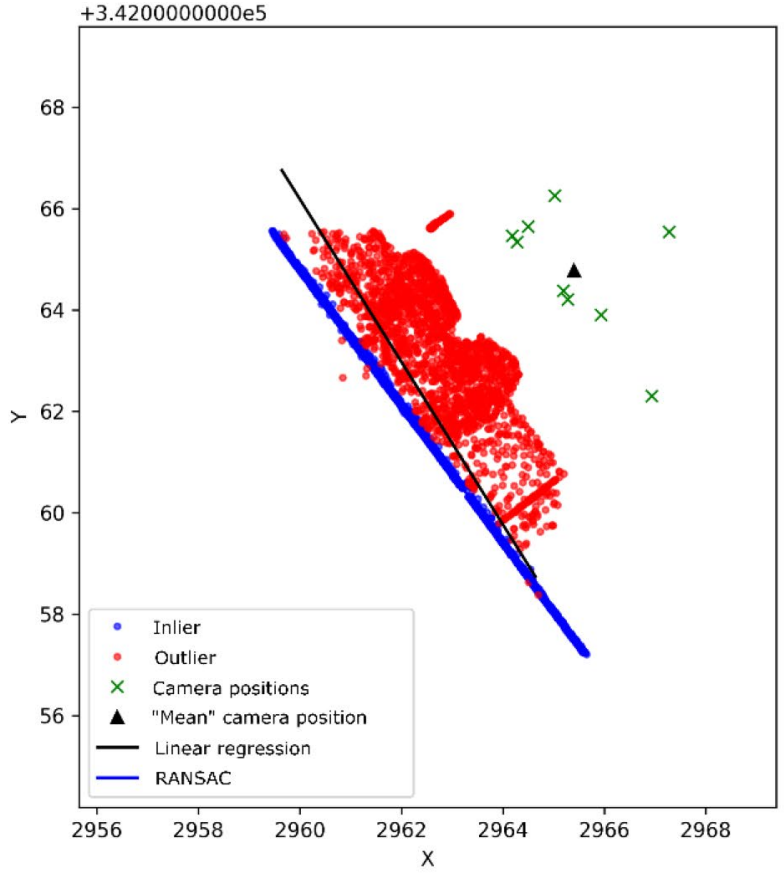

3D surface model
Orthophoto

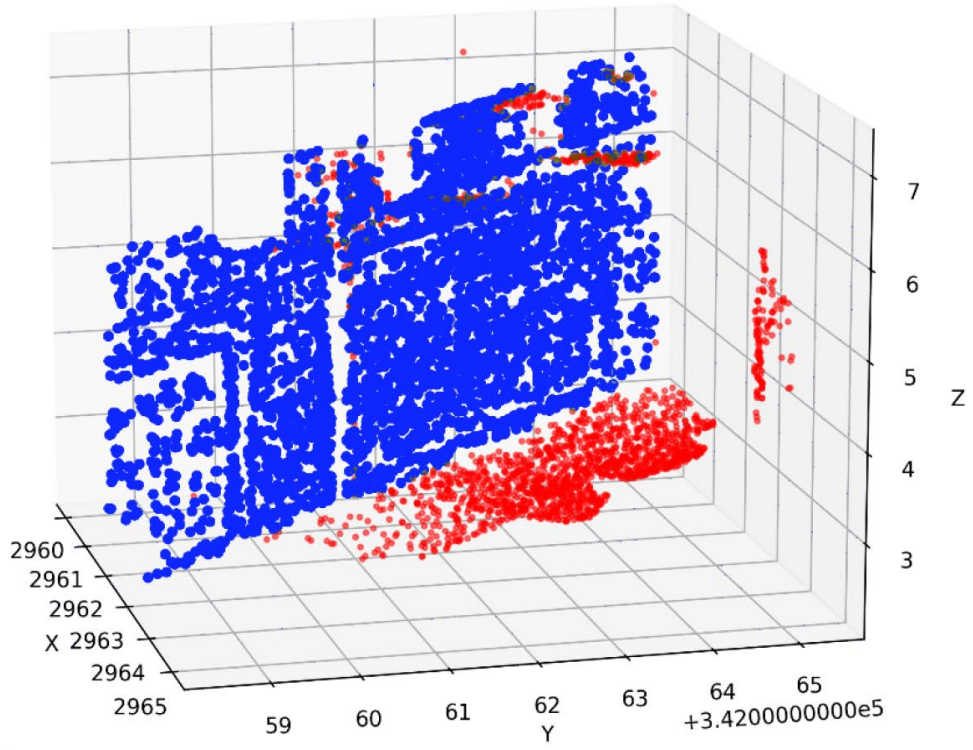


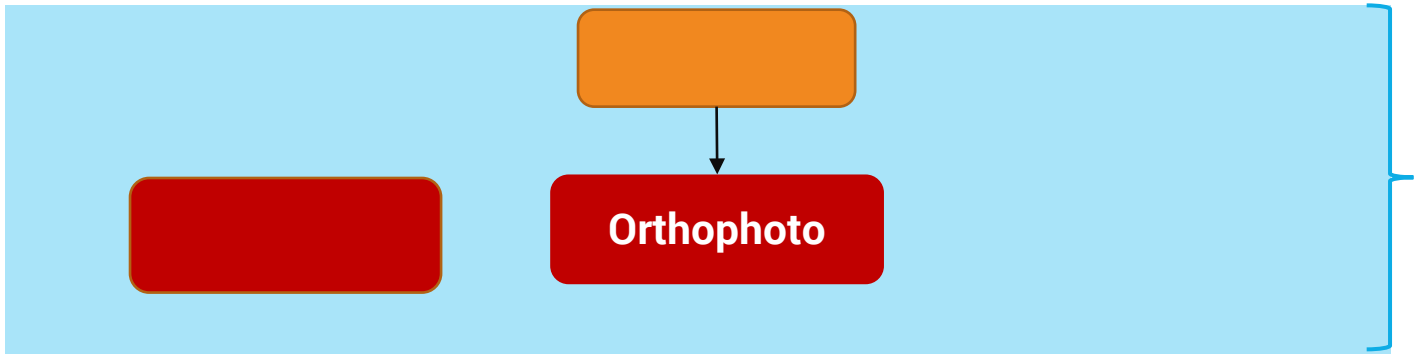
Camera orientations + 3D model + Projection plane



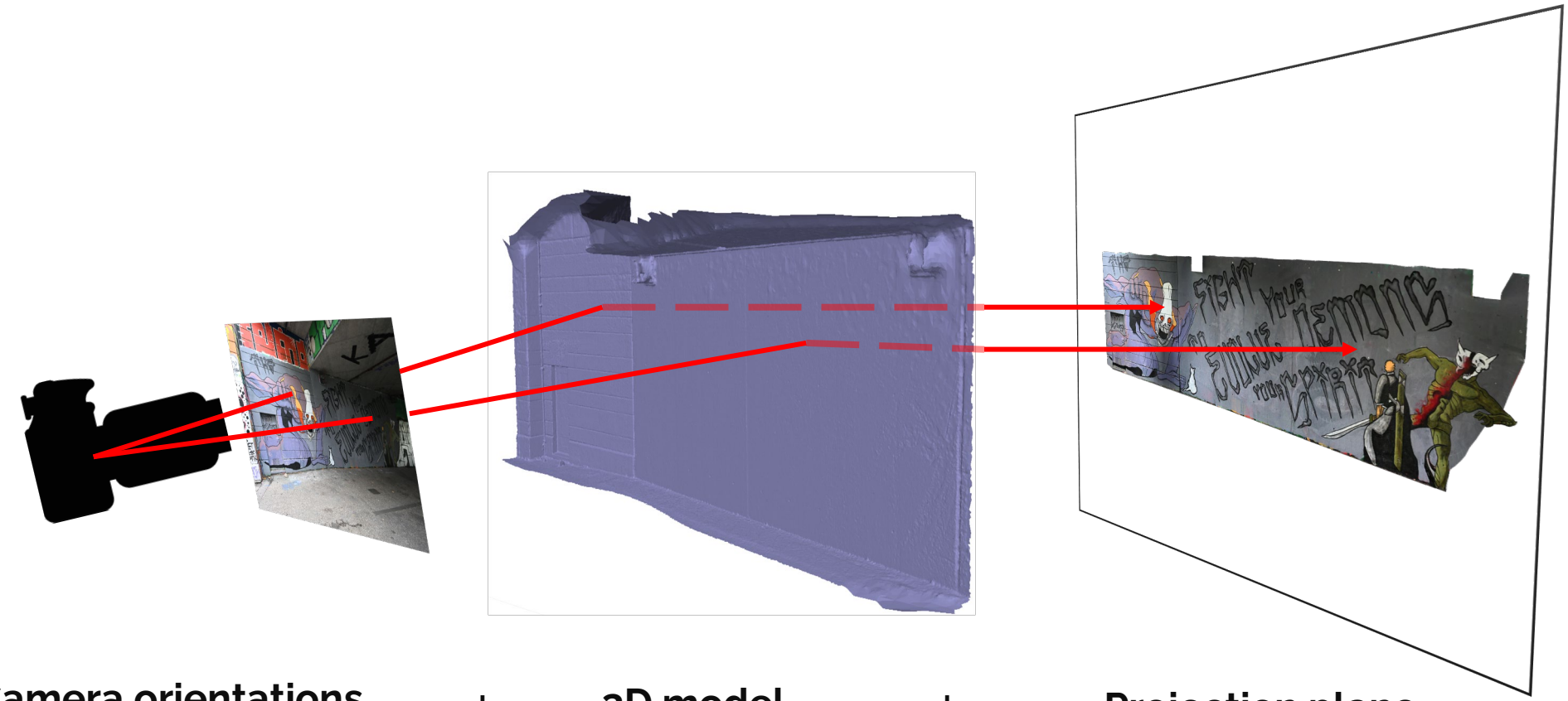

3D surface model
Orthophoto



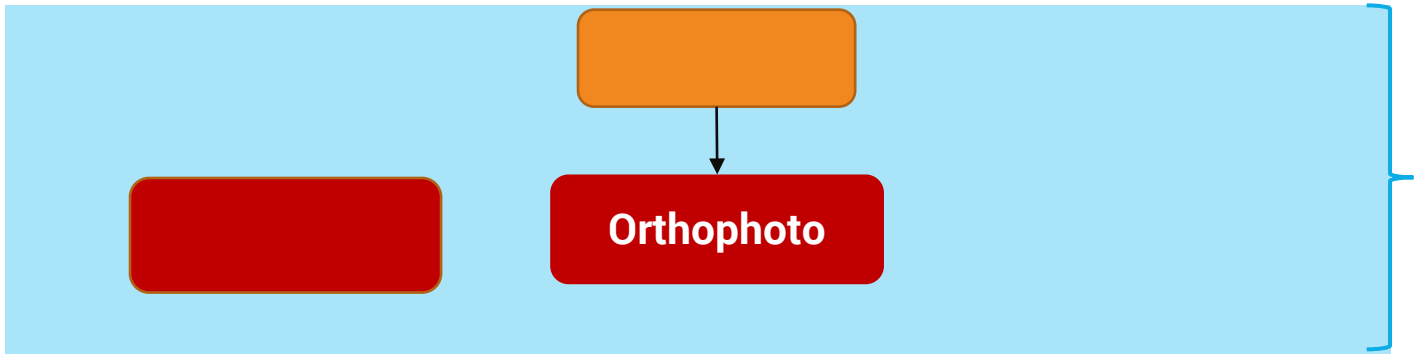




3D surface model
Orthophoto




Camera orientations + 3D model + Projection plane




3D surface model
Orthophoto

# AUTOGRAF

## position-accurate pixels

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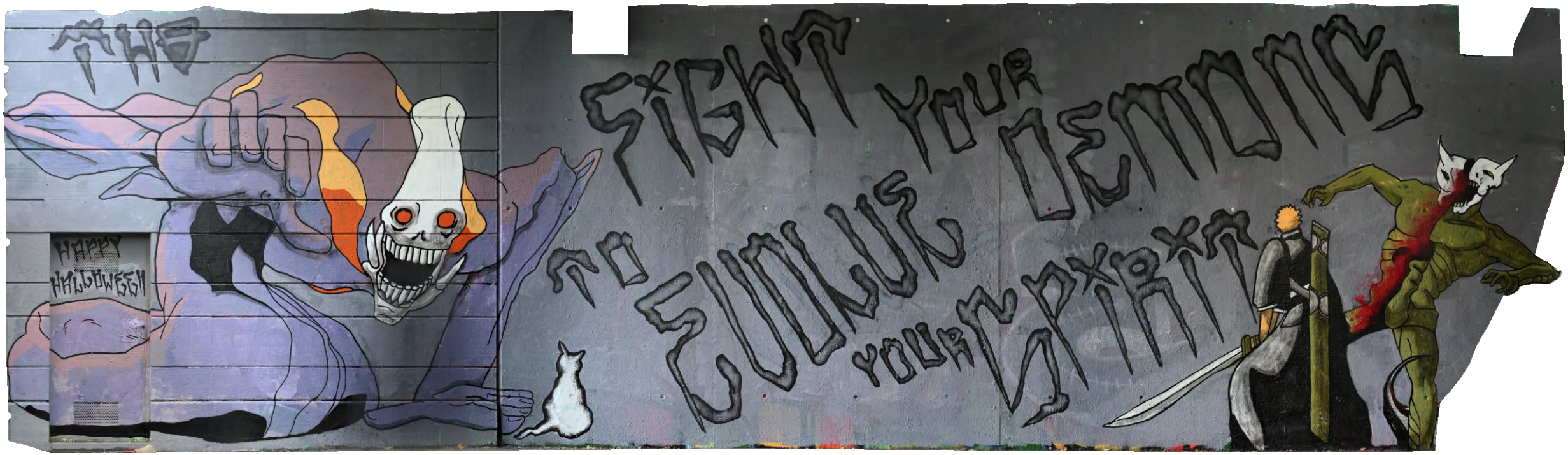
## AUTOGRAF
## position-accurate pixels



# GRAFFITI monitoring

# GRAFFITI monitoring

## BASEMAP

ESRI ArcGIS Field Maps

areas with overview photos

cloud-based | tablets

# GRAFFITI monitoring

## BASEMAP

ESRI ArcGIS Field Maps

areas with overview photos

cloud-based | tablets

## MONITOR

check social media

memory

hashtags + form (unused)

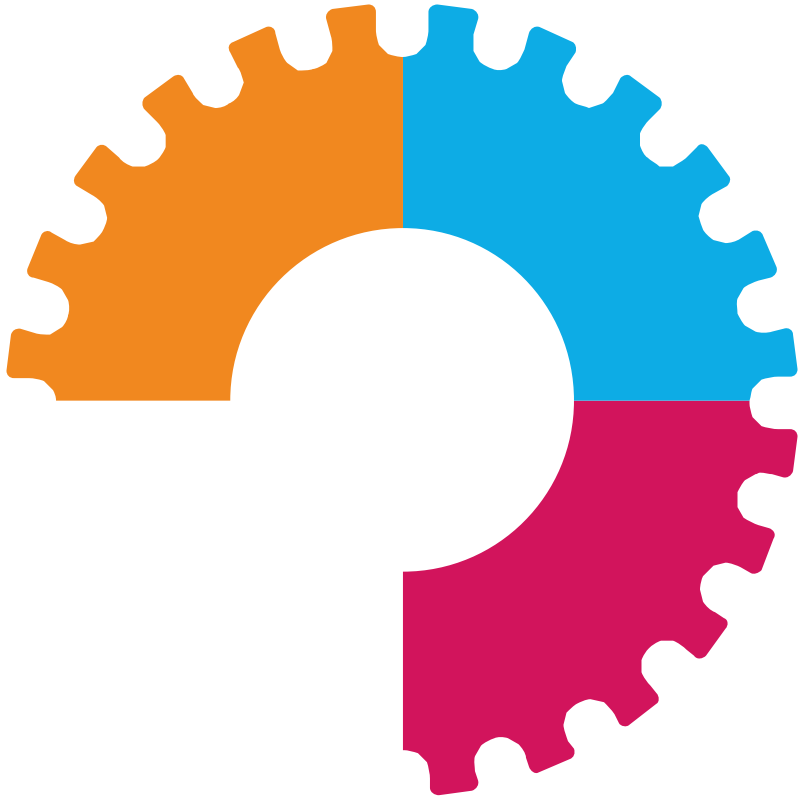
# GRAFFITI monitoring

## BASEMAP

ESRI ArcGIS Field Maps

areas with overview photos

cloud-based | tablets



## MONITOR

check social media

memory

hashtags + form (unused)

## ADD TO APP

point: “not photographed”

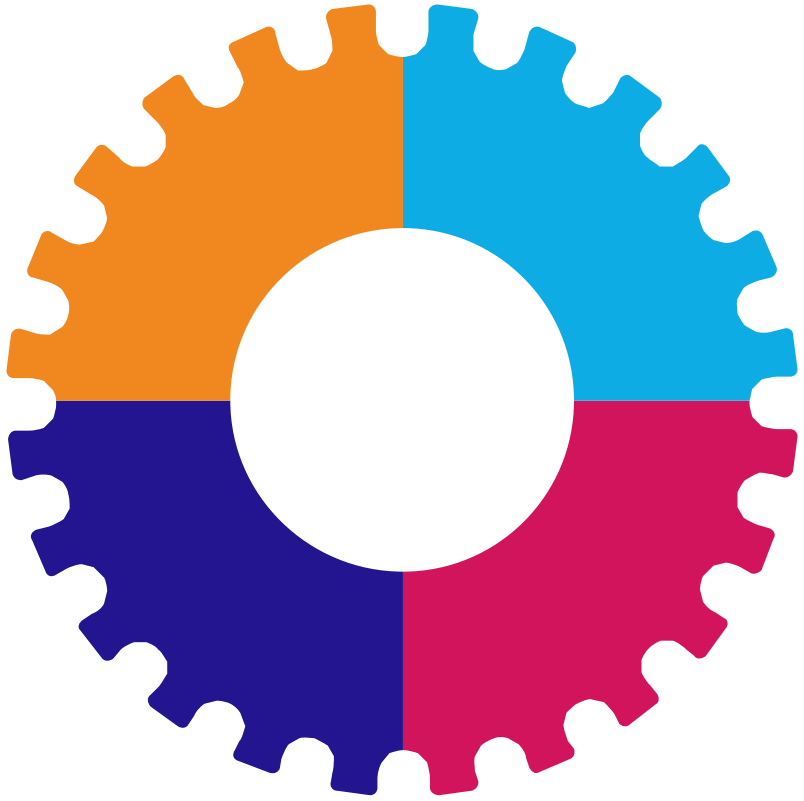
# GRAFFITI monitoring

## BASEMAP

ESRI ArcGIS Field Maps

areas with overview photos

cloud-based | tablets



## MONITOR

check social media

memory

hashtags + form (unused)

## DOCUMENT

± 10 photos

spectrometer reading

change status point

new overview photo

## ADD TO APP

point: “not photographed”

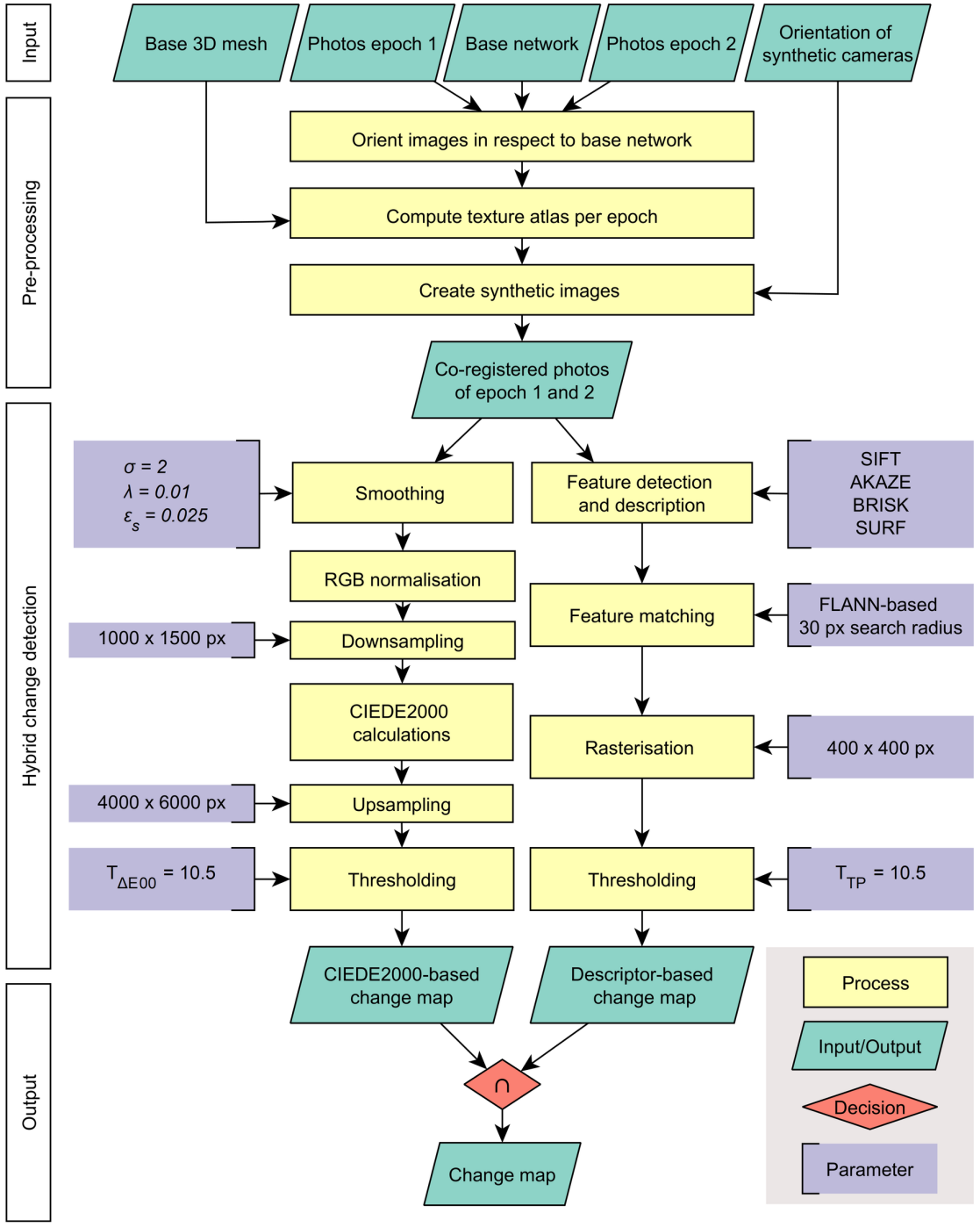
# CHANGE
# detection

# CHANGE
# detection

# CHANGE
# detection

# CHANGE
# detection

# CHANGE detection



# CHANGE
# detection

# CHANGE
# detection

# CHANGE
# detection

# CHANGE
# detection

# CHANGE
# detection

# CHANGE detection

Published October 11, 2023 | Version 1.0.0

Dataset Open

## INDIGO Change Detection Reference Dataset

Wild, Benjamin[1]; Verhoeven, Geert[2]; Muszyński, Rafał[3]; Pfeifer, Norbert[1]

Show affiliations

**Citation** Style APA

Wild, B., Verhoeven, G., Muszyński, R., & Pfeifer, N. (2023). INDIGO Change Detection Reference Dataset (1.0.0) [Data set]. TU Wien. https://doi.org/10.48436/ayj4e-v4864

### Description

#### The INDIGO Change Detection Reference Dataset

##### Description

This graffiti-centred change detection dataset was developed in the context of INDIGO, a research project focusing on the documentation, analysis and dissemination of graffiti along Vienna's Donaukanal. The dataset aims to support the development and assessment of change detection algorithms.

The dataset was collected from a test site approximately 50 meters in length along Vienna's Donaukanal during 11 days between 2022/10/21 and 2022/12/01. Various cameras with different settings were used, resulting in a total of 29 data collection sessions or "epochs" (see "EpochIDs.jpg" for details). Each epoch contains 17 images generated from 29 distinct 3D models with different textures. In total, the dataset comprises 6,902 unique image pairs, along with corresponding reference change maps. Additionally, exclusion masks are provided to ignore parts of the scene that might be irrelevant, such as the background.

# COLLECTED photos

# COLLECTED photos

**TOTAL COVERAGE**

**2**

# COLLECTED photos

**TOTAL COVERAGE**

2

**TC PHOTOS**

26.7 k

42.0 k

# COLLECTED photos

**TOTAL COVERAGE**

2

**FOLLOW-UP**

106

**TC PHOTOS**

26.7 k

42.0 k

# COLLECTED photos

**TOTAL COVERAGE**
2

**FOLLOW-UP**
106

**TC PHOTOS**
26.7 k
42.0 k

**FU PHOTOS**
94.6 k

# SOME results

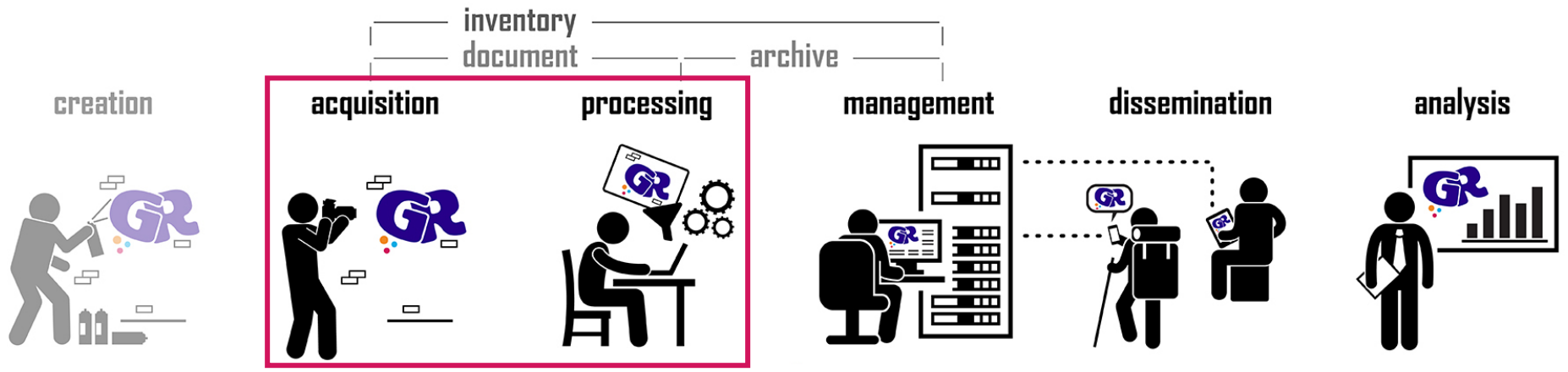
GRAFFITI *LOCATION*

GRAFFITI *TEMPORALITY*

GRAFFITI *TERMINOLOGY*

GRAFFITI *CHARACTERISATION*

5 research pillars



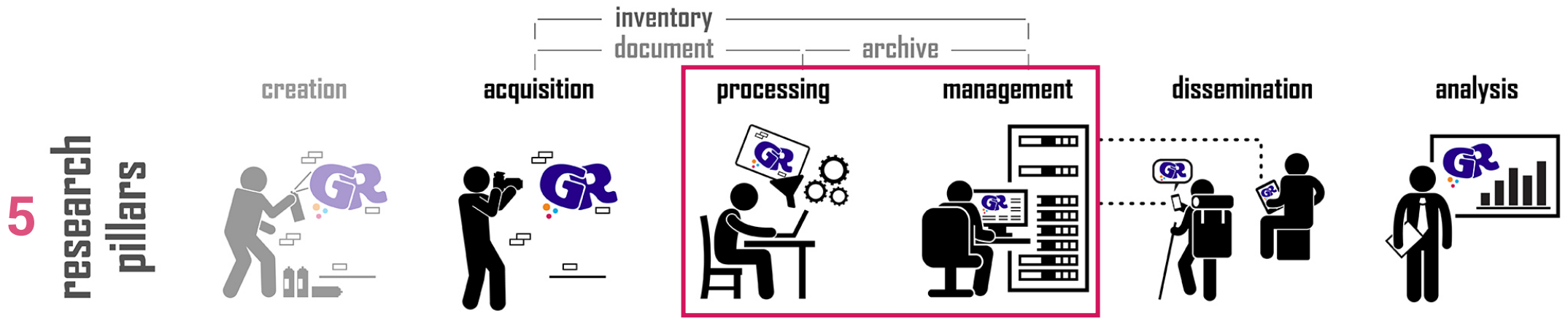
# SOME results

GRAFFITI *LOCATION*

GRAFFITI *TEMPORALITY*

GRAFFITI *TERMINOLOGY*

GRAFFITI *CHARACTERISATION*



# MOMENTS of creation

16 June 2023 @ 10:25 CET

# MOMENTS of creation

16 June 2023 @ 10:25 CET

# MOMENTS of creation

16 June 2023 @ 10:25 CET

© Sophie Hay

# MOMENTS of creation

date + time

© Sophie Hay

16 June 2023 @ 10:25 CET

date + time

# MOMENTS of creation

*creation event*
**date + time**

© Sophie Hay

**16 June 2023 @ 10:25 CET**

**date + time**
*creation event*

# MOMENTS of creation

*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**16 June 2023 @ 10:25 CET**

**date + time**
*creation event*
*photo | ~~graffito~~*

# MOMENTS of creation

*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**16 June 2023 @ 10:25 CET**

**between 02 & 06 June 2023**

**date + time**
*creation event*
*photo | ~~graffito~~*

# MOMENTS of creation

*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**between AD 41 & AD 79**

**16 June 2023 @ 10:25 CET**

**between 02 & 06 June 2023**

**date + time**
*creation event*
*photo | ~~graffito~~*

# MOMENTS of creation

*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**between AD 41 & AD 79**

**12 days ± 2 days**

**16 June 2023 @ 10:25 CET**

**between 02 & 06 June 2023**

**date + time**
*creation event*
*photo | ~~graffito~~*

# MOMENTS of creation

*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**between AD 41 & AD 79**

**1963 years ± 19 years**

**16 June 2023 @ 10:25 CET**

**12 days ± 2 days**

**between 02 & 06 June 2023**

**date + time**
*creation event*
*photo | ~~graffito~~*

# MOMENTS of creation

12 days ± 2 days

between 02 & 06 June 2023

*~~related to temporal fuzziness~~*
*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

between AD 41 & AD 79

16 June 2023 @ 10:25 CET

1963 years ± 19 years

**date + time**
*creation event*
*photo | ~~graffito~~*
*~~related to temporal fuzziness~~*

# MOMENTS of creation

*extended*
***temporal uncertainty***

*~~related to temporal fuzziness~~*
*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**between AD 41 & AD 79**

**1963 years ± 19 years**

**16 June 2023 @ 10:25 CET**

**12 days ± 2 days**

**between 02 & 06 June 2023**

**date + time**
*creation event*
*photo | ~~graffito~~*
*~~related to temporal fuzziness~~*

***temporal uncertainty***
*narrow*

# MOMENTS of creation

*visibility (interrupted)*
*extended*
***temporal uncertainty***

*~~related to temporal fuzziness~~*
*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**between AD 41 & AD 79**

**1963 years ± 19 years**

**16 June 2023 @ 10:25 CET**

**12 days ± 2 days**

**between 02 & 06 June 2023**

**date + time**
*creation event*
*photo | ~~graffito~~*
*~~related to temporal fuzziness~~*

***temporal uncertainty***
*narrow*
*visibility*

***INDIGO METADATA***

*real graffito*
*vs*
*digital derivatives*

# MOMENTS of creation

*visibility (interrupted)*
*extended*
***temporal uncertainty***

*~~related to temporal fuzziness~~*
*photo | ~~graffito~~*
*creation event*
**date + time**

© Sophie Hay

**between AD 41 & AD 79**

**1963 years ± 19 years**

**16 June 2023 @ 10:25 CET**

**12 days ± 2 days**

**between 02 & 06 June 2023**

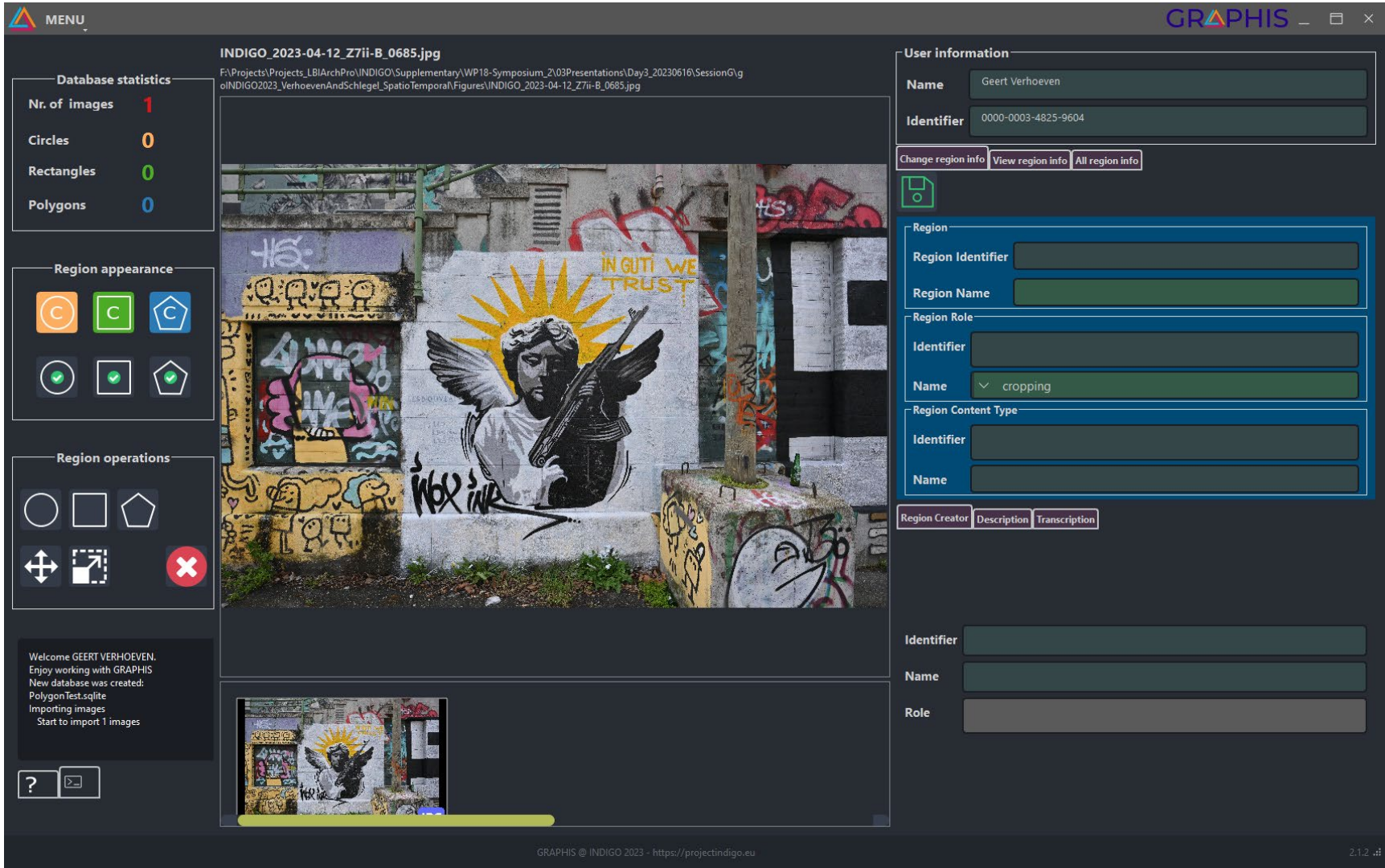
**date + time**
*creation event*
*photo | ~~graffito~~*
*~~related to temporal fuzziness~~*

***temporal uncertainty***
*narrow*
*visibility*

# CREATING location

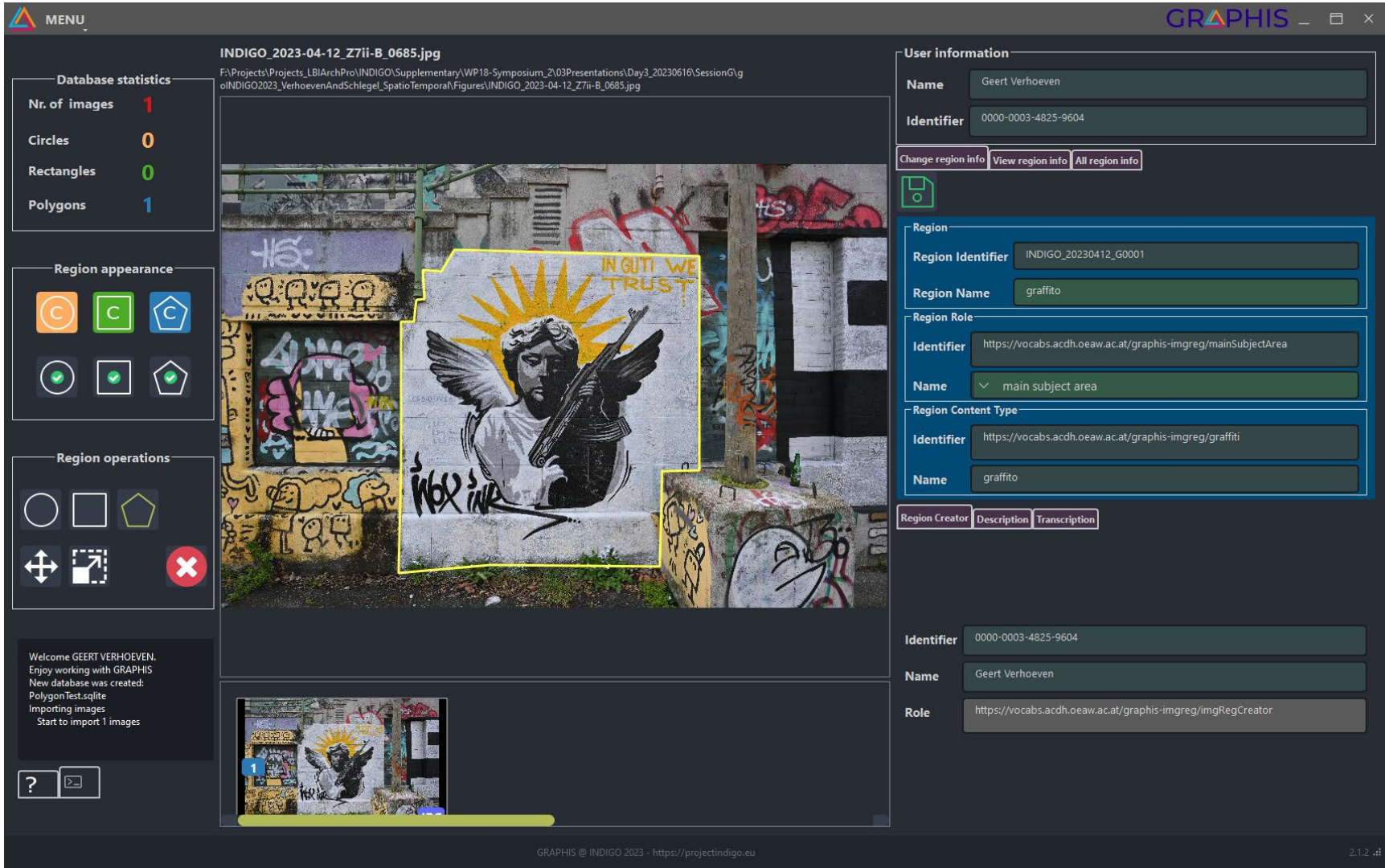
# CREATING location

GRAPHIS



# CREATING location

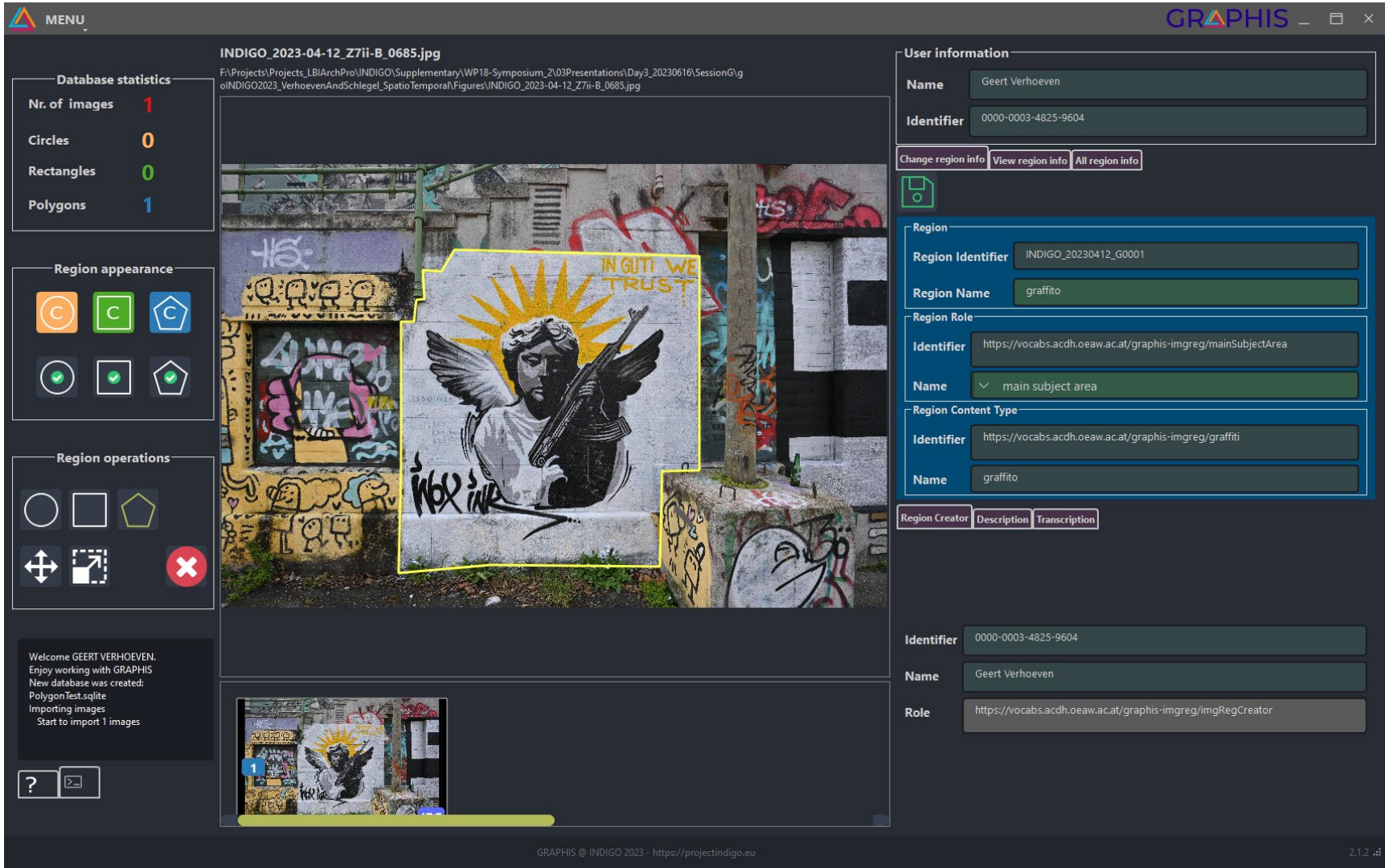
GRAPHIS



# CREATING location

GRAPHIS

2D polygon (pixel coordinates)

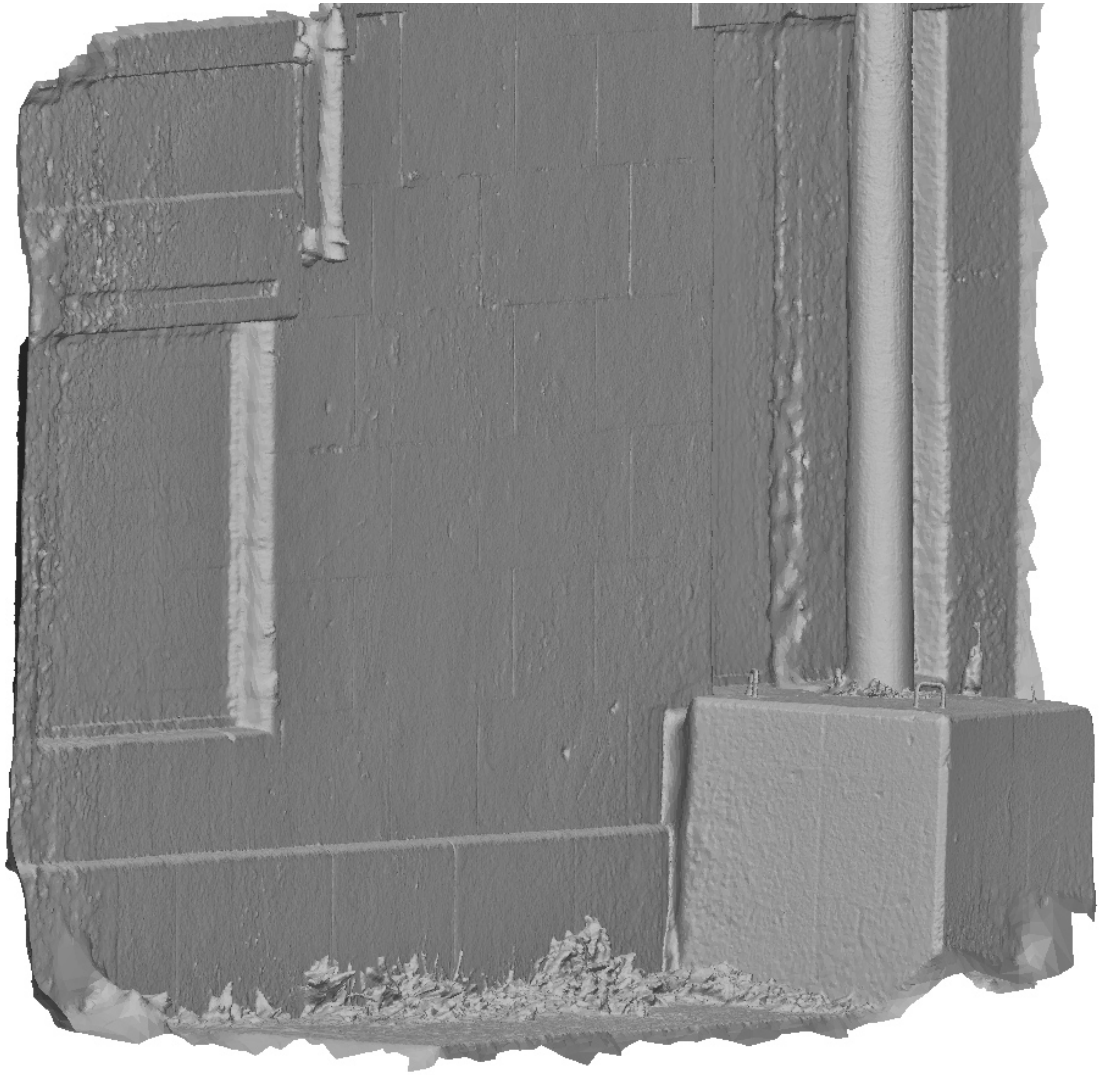


# CREATING location

GRAPHIS

2D polygon (pixel coordinates)

AUTOGRAF



# CREATING location

GRAPHIS

2D polygon (pixel coordinates)

AUTOGRAF

# CREATING location

GRAPHIS

2D polygon (pixel coordinates)

AUTOGRAF

# CREATING location

GRAPHIS

2D polygon (pixel coordinates)

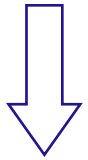
AUTOGRAF

3D polyline (real-world coordinates)

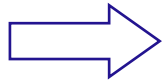
# CREATING location

GRAPHIS

2D polygon (pixel coordinates)



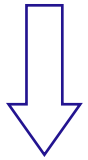
AUTOGRAF

3D polyline (real-world coordinates)  2D polygon (pseudo real-world coordinates)

# CREATING location

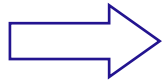
GRAPHIS

2D polygon (pixel coordinates)



AUTOGRAF

3D polyline (real-world coordinates)



2D polygon (pseudo real-world coordinates)

?

# STORING location

GRAPHIS

2D polygon (pixel coordinates)

AUTOGRAF

3D polyline (real-world coordinates)

# STORING location

XMP metadata

GRAPHIS

2D polygon (pixel coordinates)

AUTOGRAF

3D polyline (real-world coordinates)

# STORING location

XMP metadata

GRAPHIS

2D polygon (pixel coordinates)

GeoJSON

AUTOGRAF

3D polyline (real-world coordinates)

# STORING location

XMP metadata

GRAPHIS

2D polygon (pixel coordinates)

GeoJSON

AUTOGRAF

3D polyline (real-world coordinates)


```
"type": "FeatureCollection",
"features": [
  {
    "type": "Feature",
    "properties": {
    },
    "geometry": {
      "type": "Polygon",
      "coordinates": [
        [
          [16.369211789142078, 48.220322928177943, 47.592282951099342],
          [16.369218883807932, 48.220332028088414, 49.952191243997014],
          [16.369262616499576, 48.220260963475802, 49.899587087985907],
          [16.369256646544585, 48.220262672660212, 47.281441048933353],
          [16.369211789142078, 48.220322928177943, 47.592282951099342]
```

# STORING time

XMP metadata

GRAPHIS

2D polygon (pixel coordinates)

GeoJSON

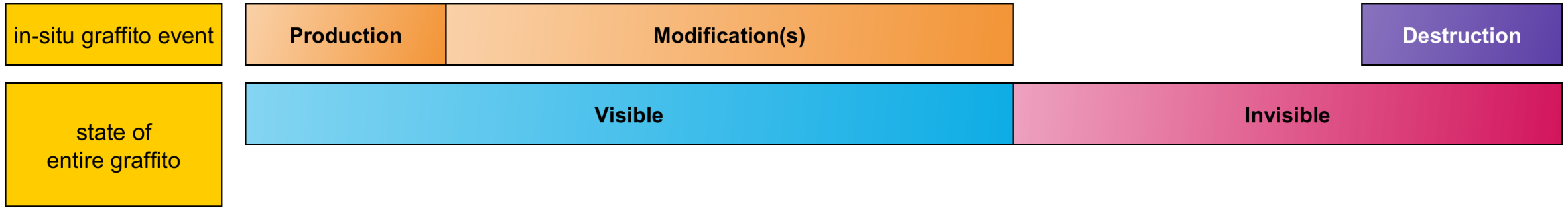
AUTOGRAF

3D polyline (real-world coordinates)

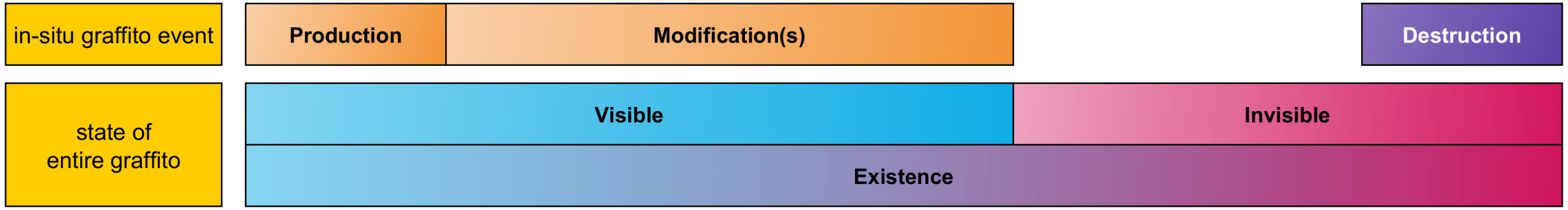

```
"type": "FeatureCollection",
"features": [
  {
    "type": "Feature",
    "properties": {
    },
    "geometry": {
      "type": "Polygon",
      "coordinates": [
        [
          [16.369211789142078, 48.220322928177943, 47.592282951099342],
          [16.369218883807932, 48.220332028088414, 49.952191243997014],
          [16.369262616499576, 48.220260963475802, 49.899587087985907],
          [16.369256646544585, 48.220262672660212, 47.281441048933353],
          [16.369211789142078, 48.220322928177943, 47.592282951099342]
```

# STORING time

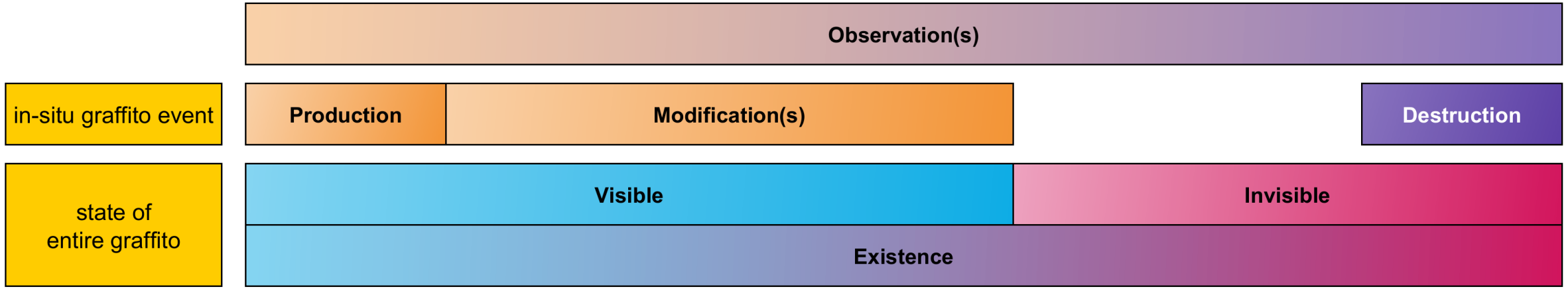
# STORING time



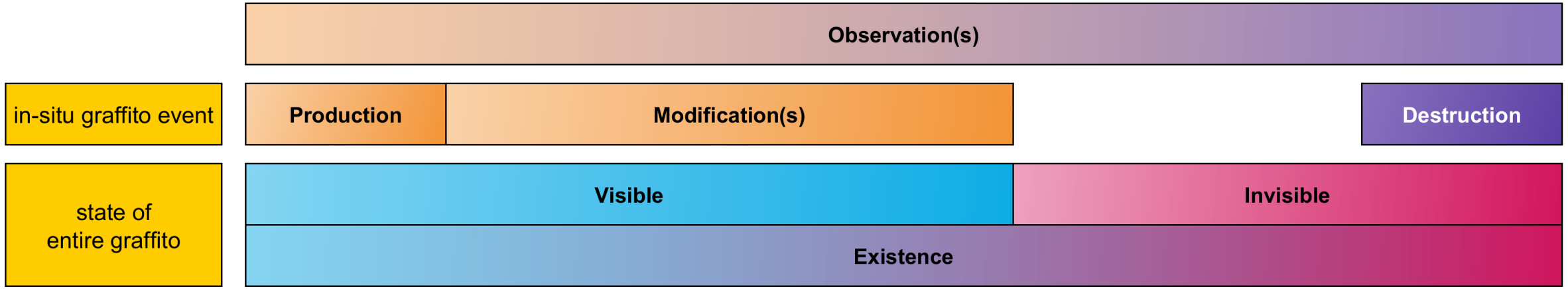
# STORING time



# STORING time



# STORING time





```
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"properties": {
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  "polygon_state": "initial or derived",
  "polygon_creation": "manual, semi-automatic or automatic",
  "graffito_ID": "INDIGO_20230316_G0016",

  "observation": {···
  },

  "production": {···
  },
```
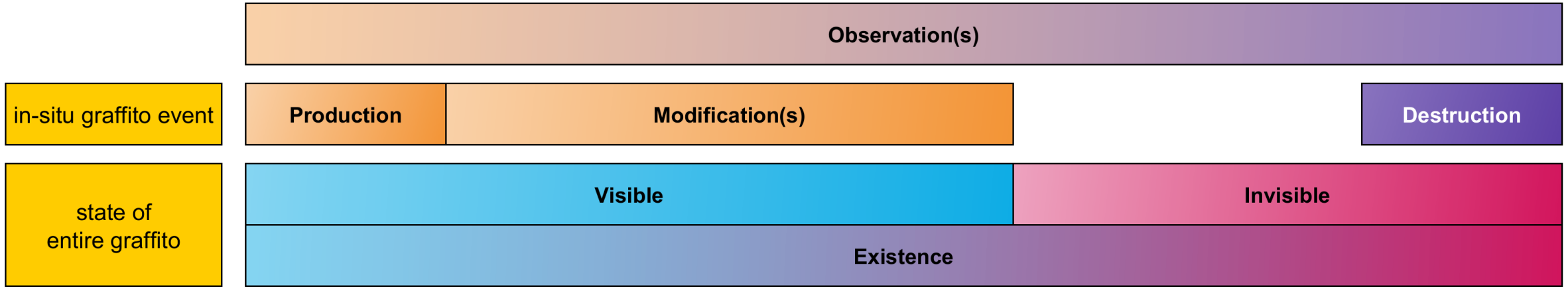

```
  "modification": [···
  ],

  "destruction": {···
  },

  "visible": {···
  },

  "invisibile": {···
  },

  "existence": {···
  }
```

# STORING time

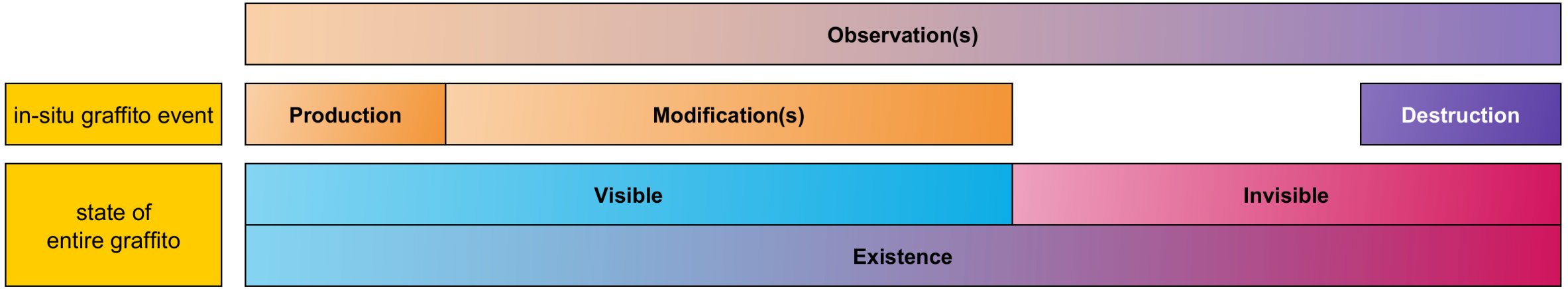




```
"type": "Feature",
"properties": {
  "polygon_ID": "INDIGO_2023-03-16_Z7ii_0016 + string made by GRAPHIS",
  "polygon_state": "initial or derived",
  "polygon_creation": "manual, semi-automatic or automatic",
  "graffito_ID": "INDIGO_20230316_G0016",

  "observation": {···
  },

  "production": {···
  },
```

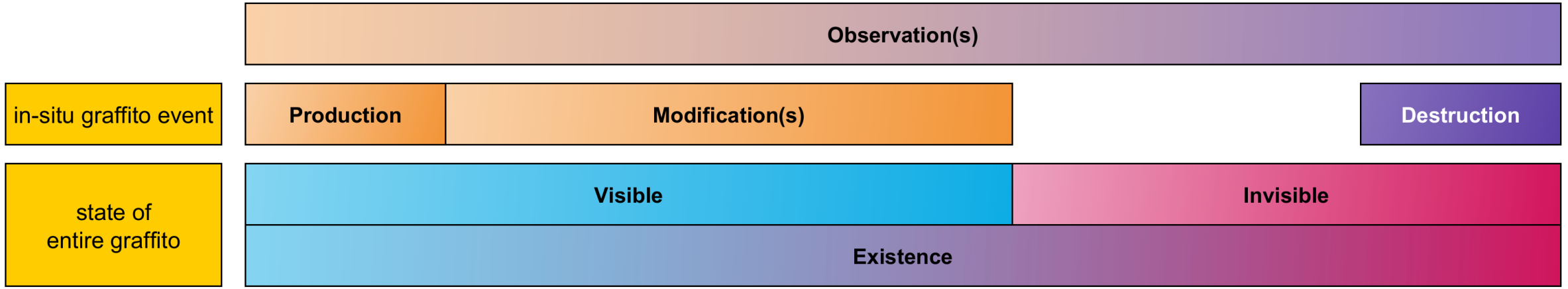
```
  "modification": [···
  ],

  "destruction": {···
  },

  "visible": {···
  },

  "invisibile": {···
  },

  "existence": {···
  }
```

# STORING time




```
"visible": {
  "start": {                    "end": {                    "span": {
```

# STORING time

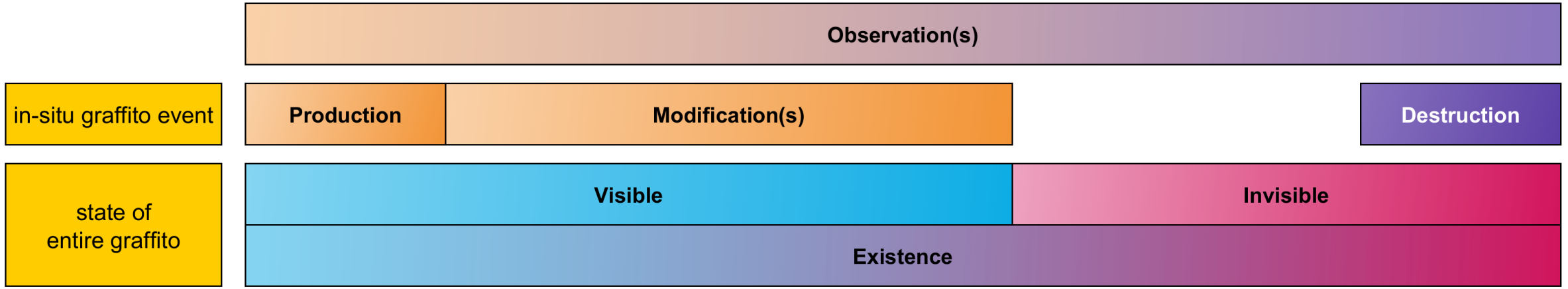



```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
```

```
"end": {
```

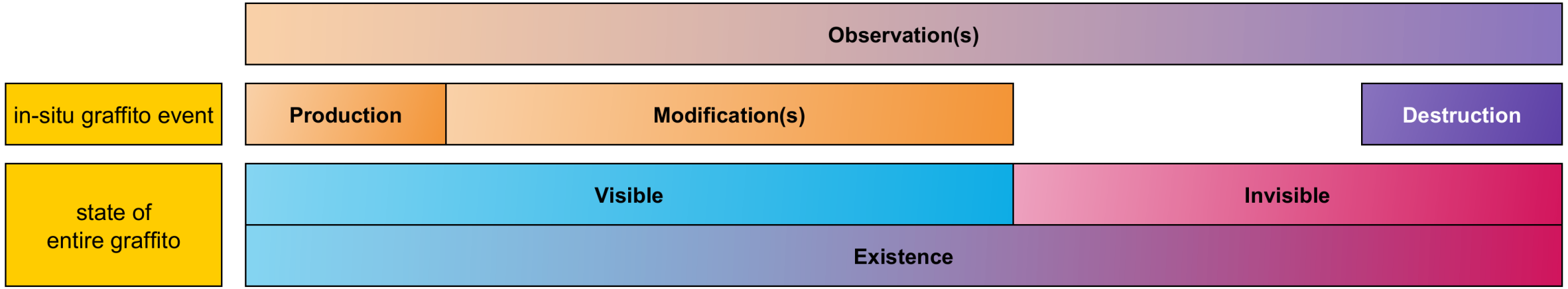
```
"span": {
```

# STORING time




```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
"span": {
```

# STORING time




```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
```

```
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
```

```
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
```

```
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
```

```
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest":
    "latest_source":
  },
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
"visible": {
  "start": {
    "earliest":
    "earliest_source":
    "latest": "2022-09-12T12:36",
    "latest_source": "photoTour"
  },
```

```
"end": {
  "earliest":
  "earliest_source":
  "latest":
  "latest_source":
},
```

```
"span": {
  "minimum":
  "maximum":
}
```

# STORING time

```
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  "start": {                          "end": {                          "span": {
    "earliest": "2022-09-05T10:20",     "earliest":                       "minimum":
    "earliest_source": "photoTour",     "earliest_source":                "maximum":
    "latest": "2022-09-12T12:36",       "latest":                       }
    "latest_source": "photoTour"        "latest_source":
  },                                  },
```

# STORING time

```
"visible": {
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    "latest": "2022-09-12T12:36",
    "latest_source": "photoTour"
  },
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```

# STORING time

```
"visible": {
  "start": {
    "earliest": "2022-09-05T10:20",
    "earliest_source": "photoTour",
    "latest": "2022-09-12T12:36",
    "latest_source": "photoTour"
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                                                                    "span": {
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```

# STORING time

```
"visible": {
  "start": {
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    "maximum":
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```

# STORING time

```
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    "maximum": "PT390H45M"
  }
```

# SOME results

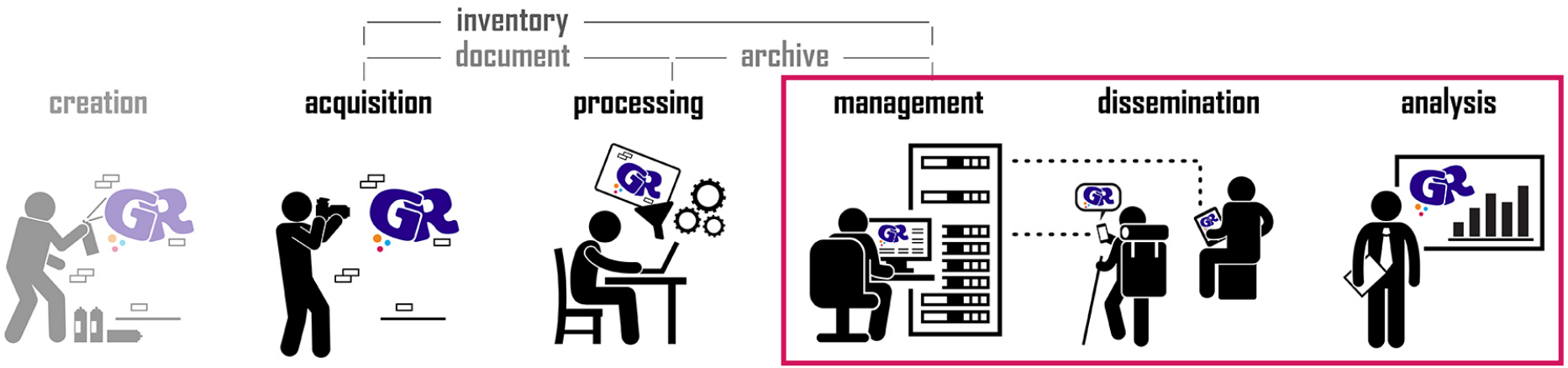
GRAFFITI *LOCATION*

GRAFFITI *TEMPORALITY*

GRAFFITI *TERMINOLOGY*

GRAFFITI *CHARACTERISATION*

5 research pillars



# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

**Graffiti**
**|___ Street Art**

# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

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**|___ Street Art**

**Street Art**
**|___ Graffiti**

# UNIFORM terminology

## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

**Graffiti**
**|___ Street Art**

**Street Art**
**|___ Graffiti**

**Graffiti | Street Art**

# UNIFORM terminology

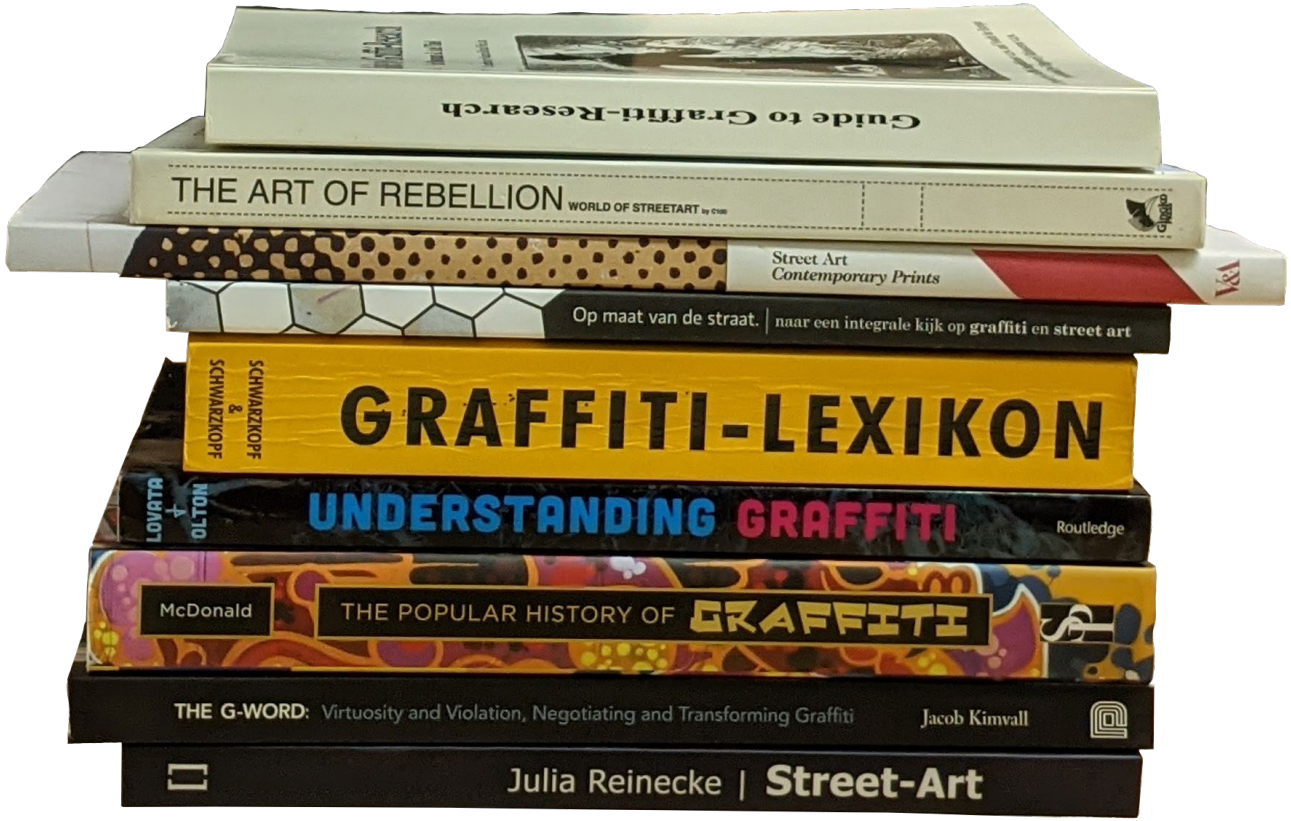
## TERMINOLOGY & HIERARCHY

**Graffiti ?  Street Art ?**

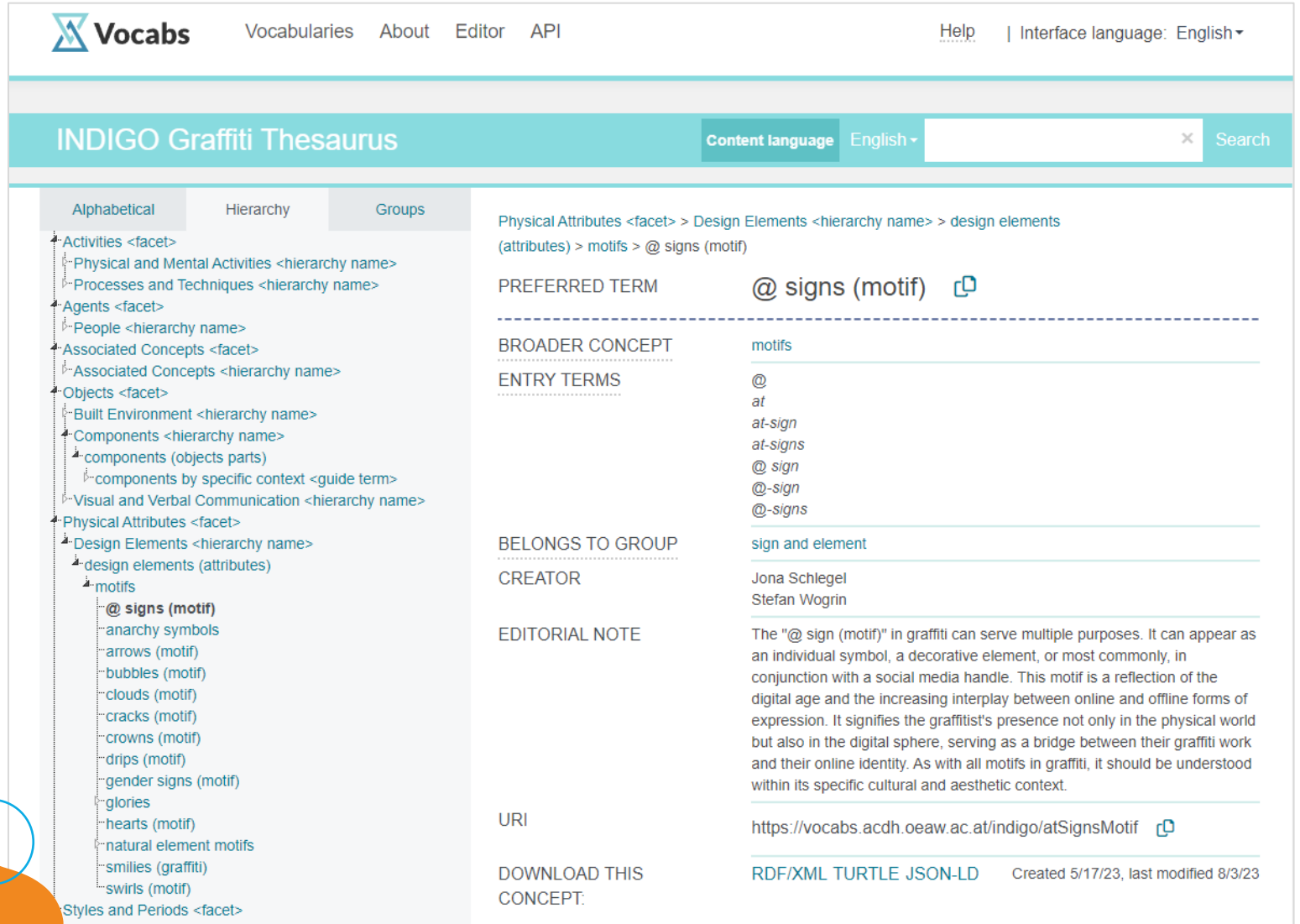
**Graffiti**
**|___ Street Art**

**Street Art**
**|___ Graffiti**

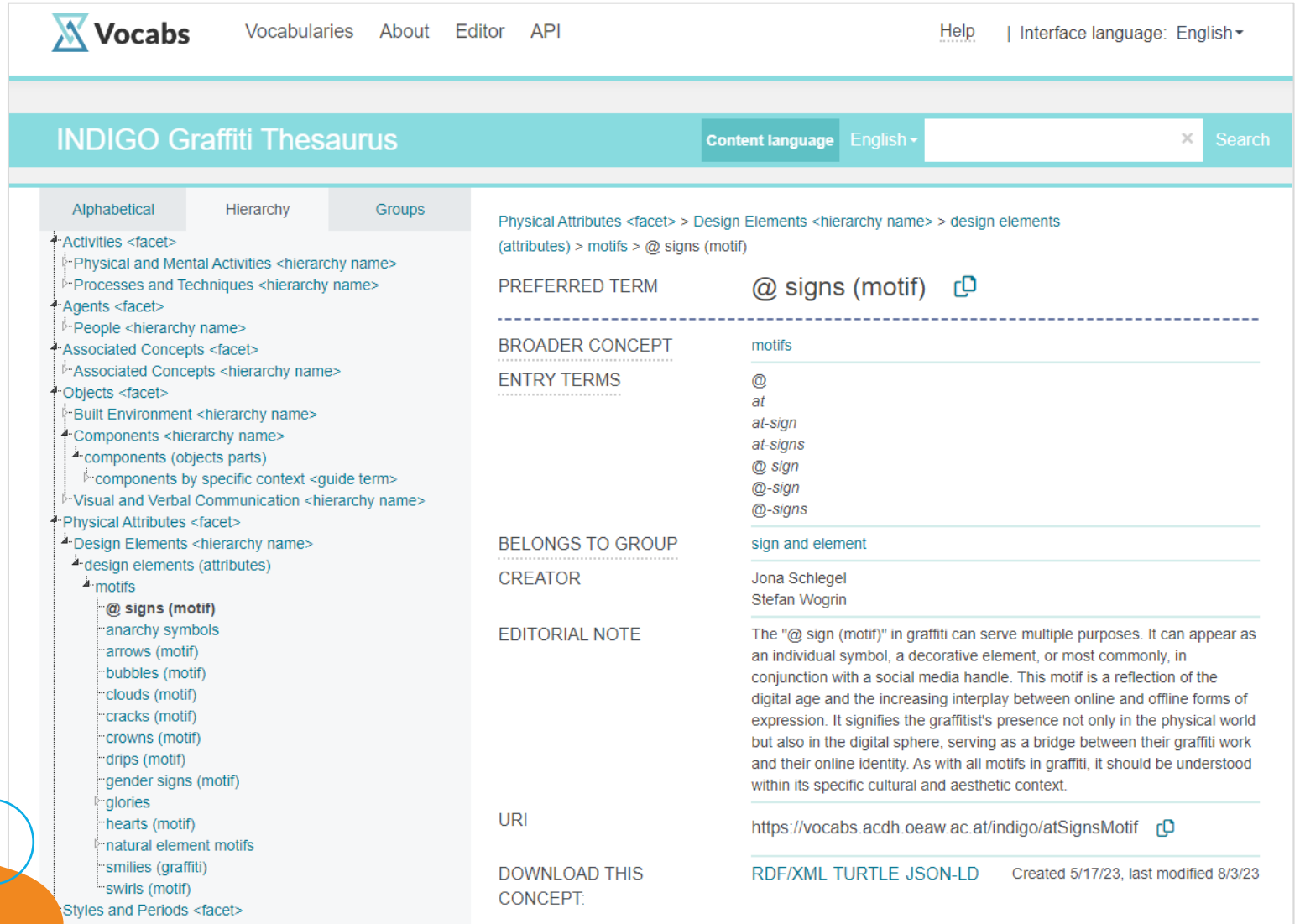
**Graffiti | Street Art**



# GRAFFITI thesaurus

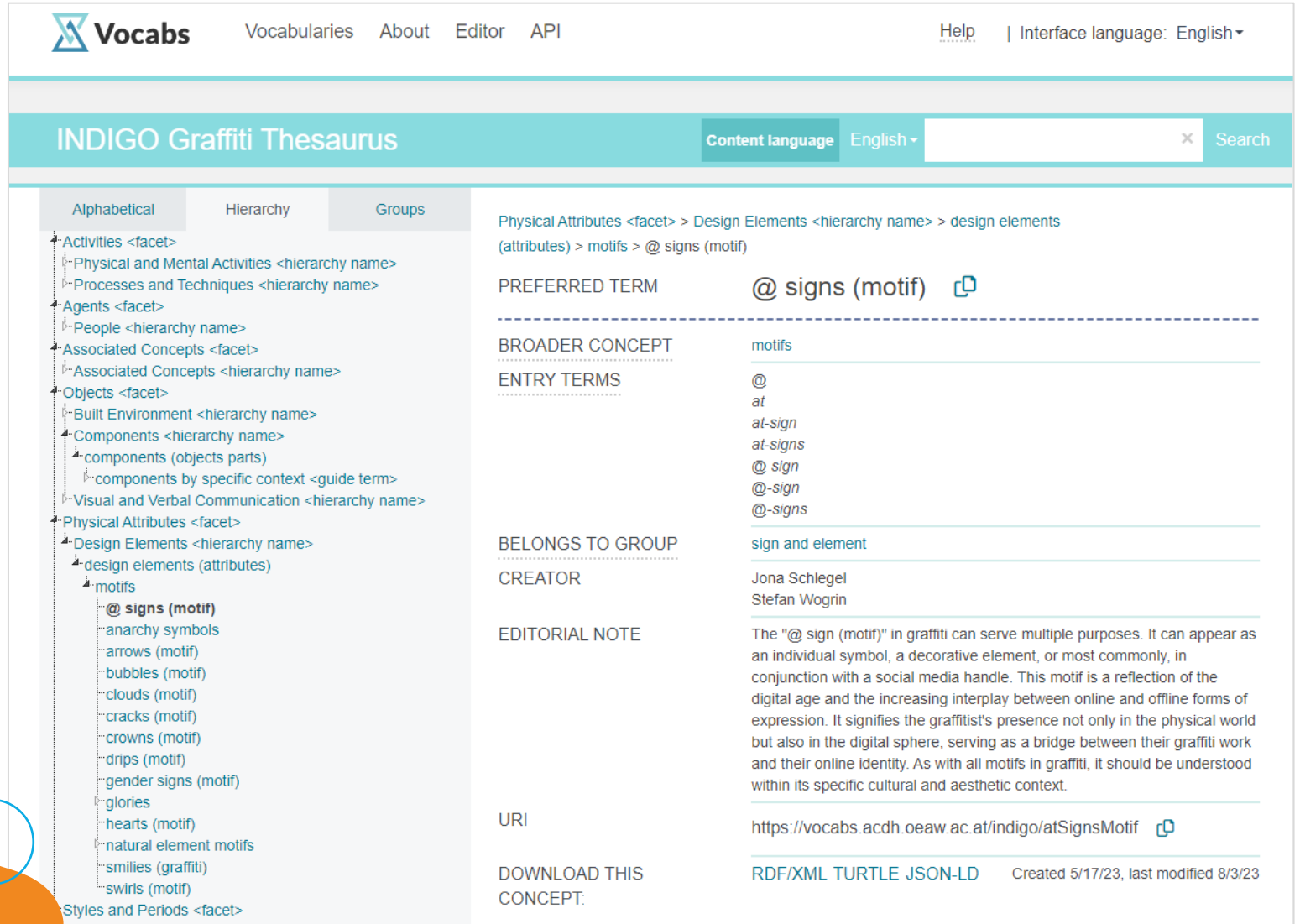


# GRAFFITI thesaurus




**Hierarchy**

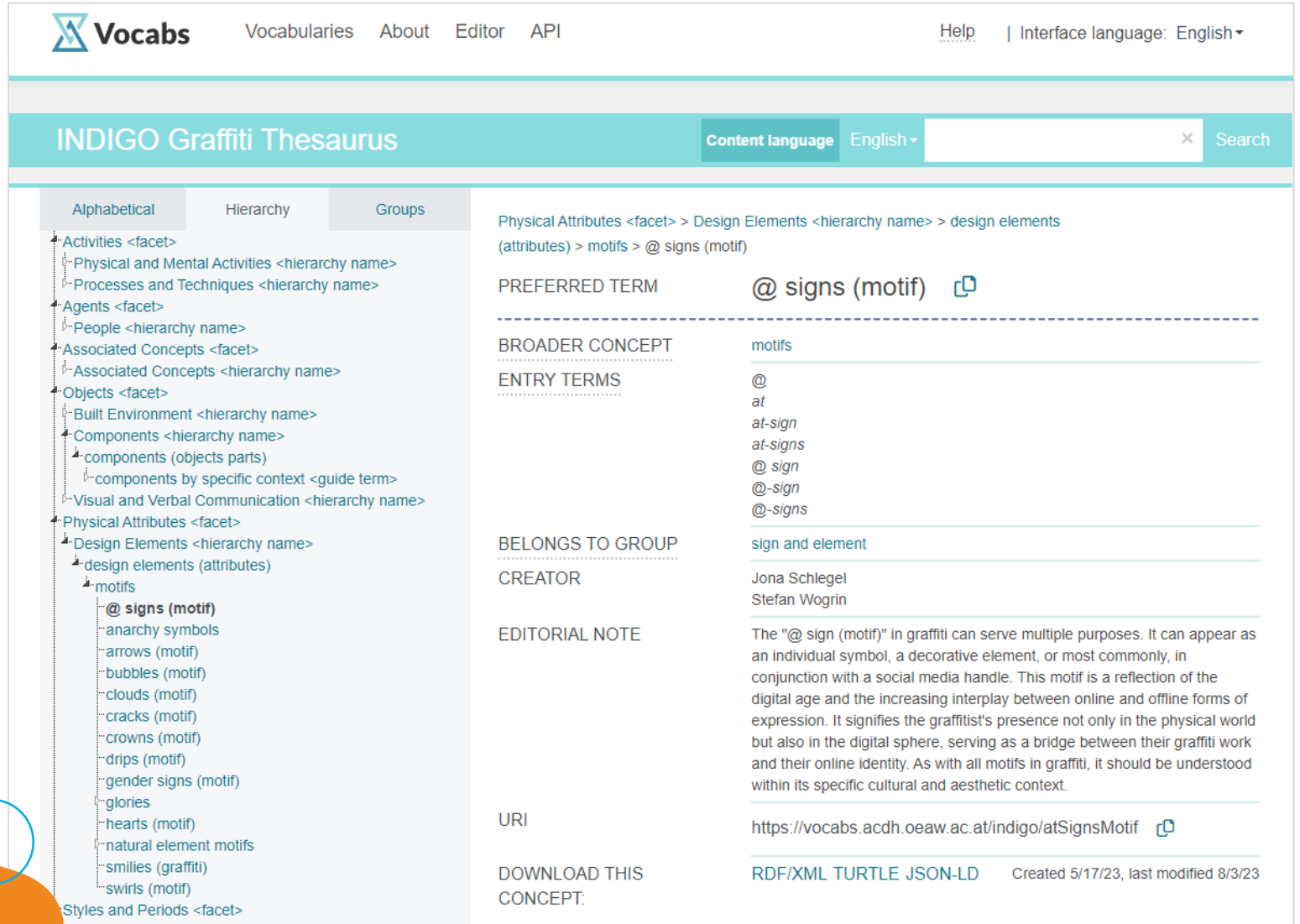
# GRAFFITI thesaurus




**Hierarchy**

**Synonyms & preferred terms**

# GRAFFITI thesaurus

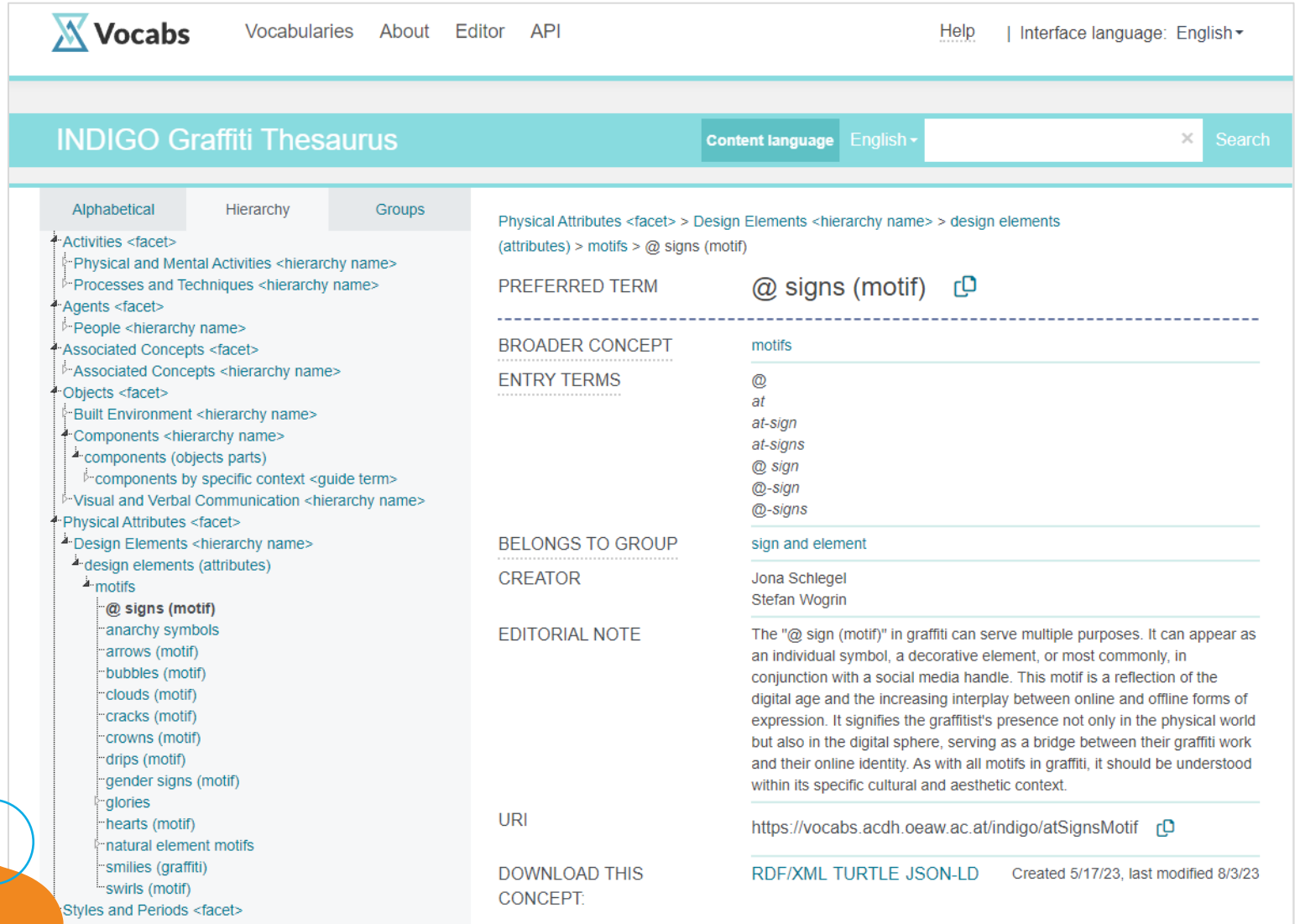



**Hierarchy**

**Synonyms & preferred terms**

**URI**

# GRAFFITI thesaurus



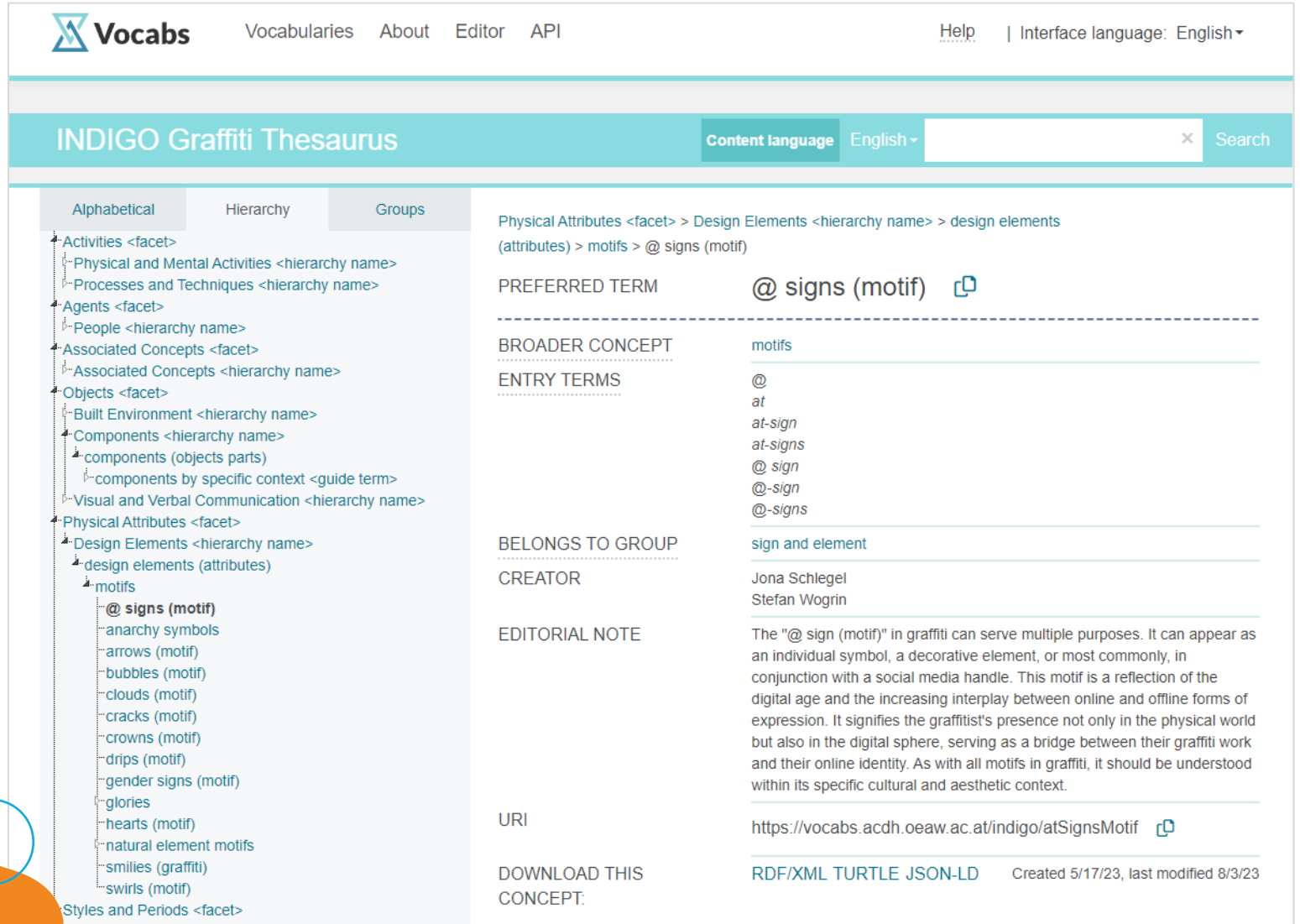

**Hierarchy**

**Synonyms & preferred terms**

**URI**

**Semantic Web**

# GRAFFITI thesaurus




**Hierarchy**

**Synonyms & preferred terms**

**URI**

**Semantic Web**

**Structure → Getty Art & Architecture Thesaurus**

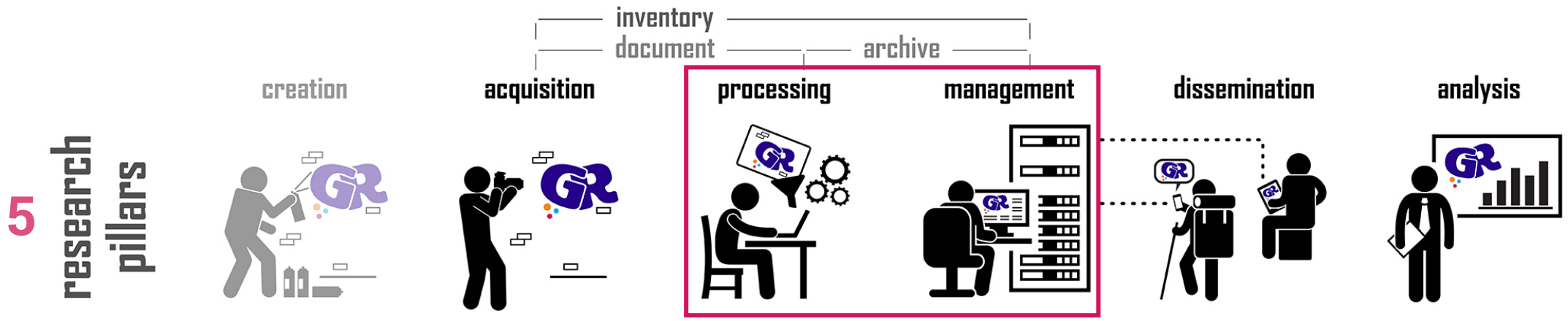
# SOME results

GRAFFITI *LOCATION*

GRAFFITI *TEMPORALITY*

GRAFFITI *TERMINOLOGY*

GRAFFITI *CHARACTERISATION*



COOLPI

# COOLPI

## colour-accurate pixels

Product Solutions Open Source Pricing Search or jump to... Sign in Sign up

GraffitiProjectINDIGO / COOLPI Public

Notifications Fork 1 Star 4

Code Issues Pull requests Actions Projects Security Insights

main 1 branch 0 tags Go to file Code

amolada Add files via upload 0bbf6c3 on Oct 20, 2022 155 commits

| | | |
|---|---|---|
| dist | Add files via upload | 9 months ago |
| docs | Add files via upload | 9 months ago |
| graffiti_image_processing | Add files via upload | 9 months ago |
| notebooks | Add files via upload | 10 months ago |
| src | Add files via upload | 9 months ago |
| tests/coolpi-gui-test | Add files via upload | 10 months ago |
| wpp_data | Add files via upload | 10 months ago |
| LICENSE | Initial commit | last year |
| LICENSE.txt | Add files via upload | 9 months ago |
| MANIFEST.in | Add files via upload | 9 months ago |
| README.md | Add files via upload | 9 months ago |
| pyproject.toml | Add files via upload | 9 months ago |

README.md

# COOLPI

## Description

COlour Operations Library for Processing Images (COOLPI) is an open-source toolbox programmed in Python for the treatment of colorimetric and spectral data. It includes classes, methods and functions developed and tested following the colorimetric standards published by the Commission Internationale de l'Éclairage (CIE, 2018).

The COOLPI package has been developed as part of the INDIGO project (IN-ventory and DI-sseminate G-raffiti along the d-O-naukanal) carried out by the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology in close collaboration with the GEO Department of TU Wien University.

The achievement of colour-accurate digital images is one of the primary research topics within the INDIGO project. Therefore, the COOLPI package also includes specific procedures for digital image processing and colour correction, particularly from images in RAW format.

About

COlour Operations Library for Processing Images

Readme
GPL-3.0, GPL-3.0 licenses found
4 stars
0 watching
1 fork
Report repository

Releases

No releases published

Packages

No packages published

Contributors 2

amolada Adolfo Molada Tebar
BeyondConventionalBoundaries Geert ...

Languages

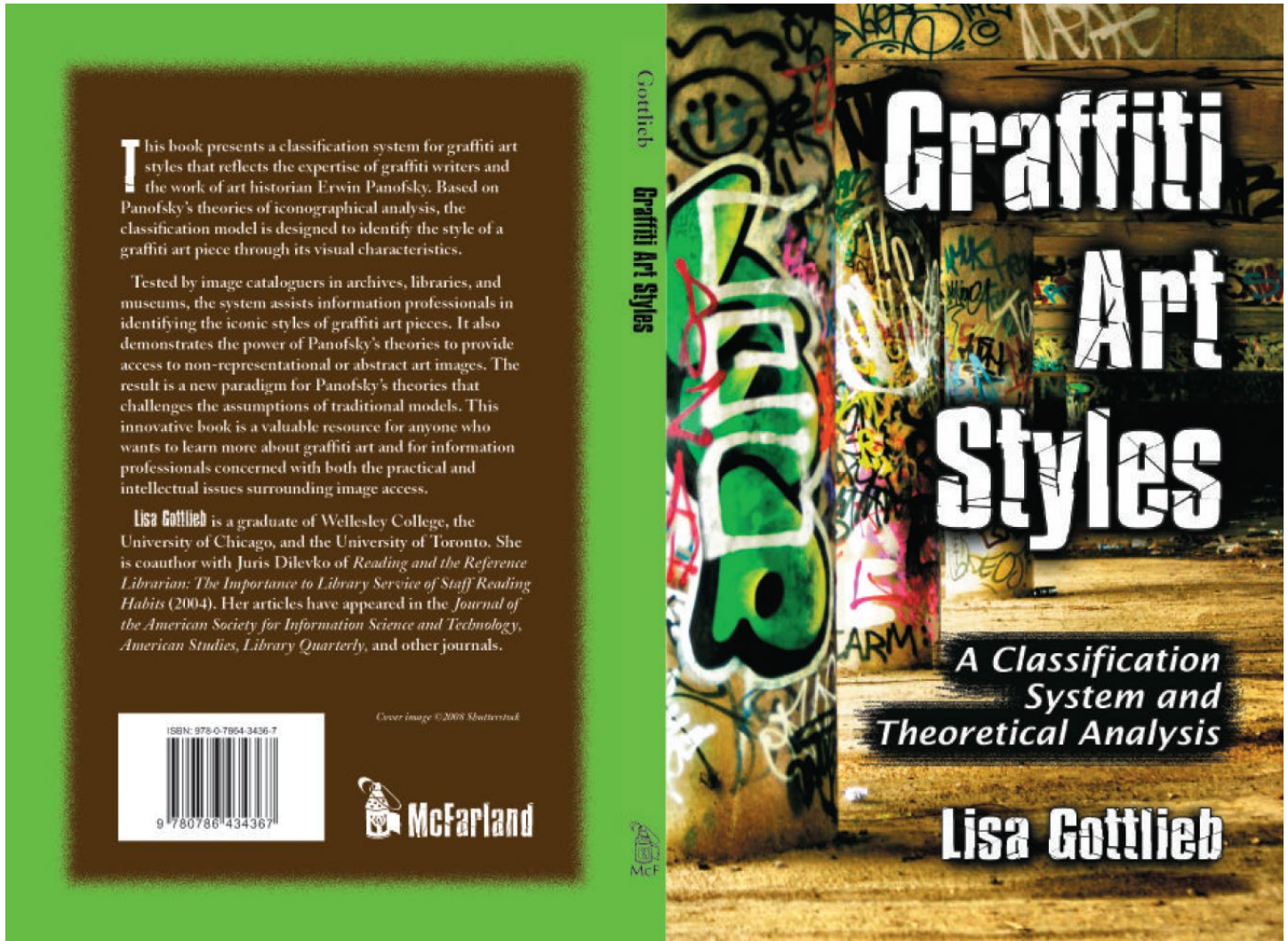
Jupyter Notebook 98.1% Python 1.9%

# COOLPI

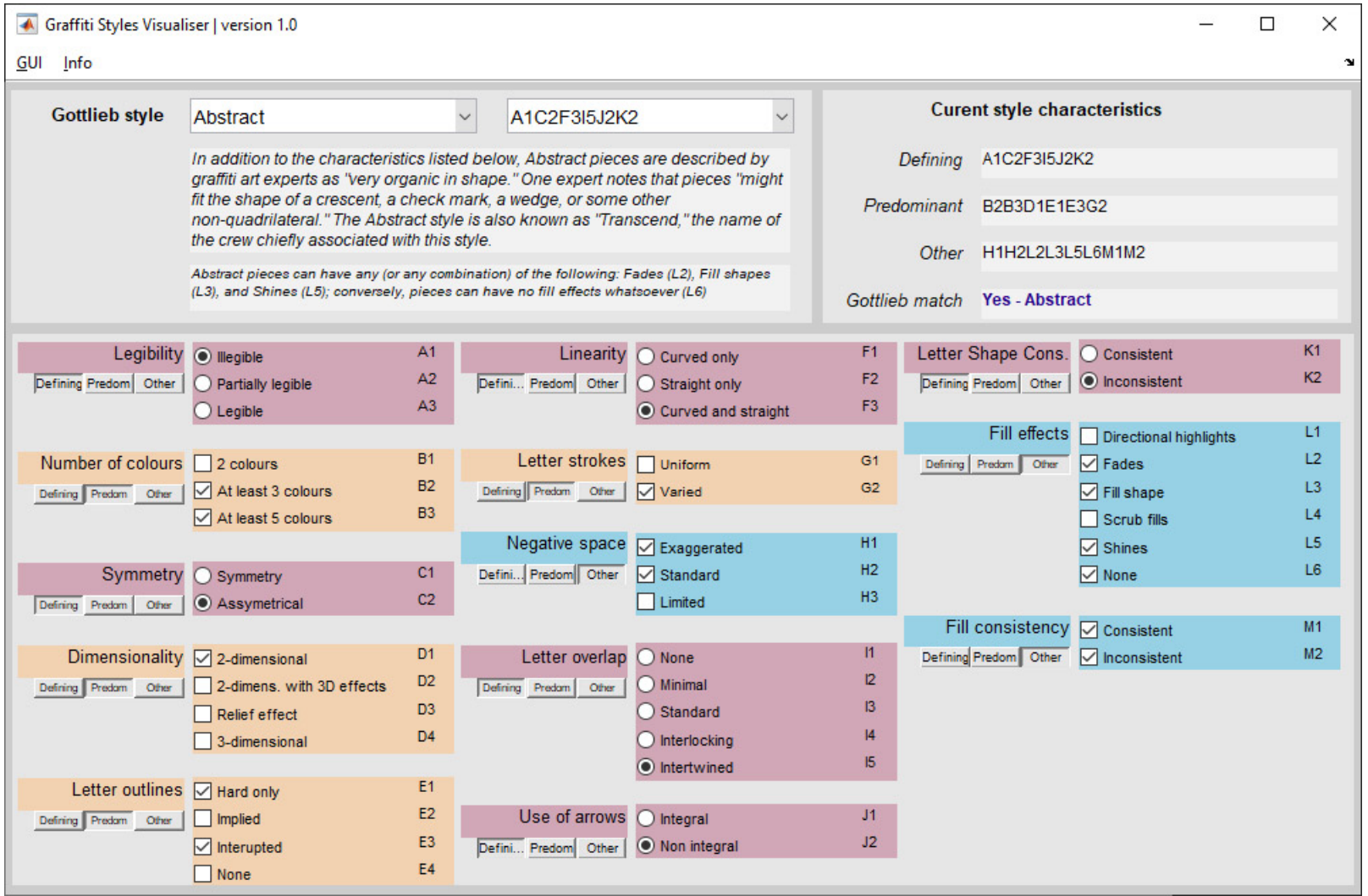
## colour-accurate pixels

COOLPI

# GRAFFITI styles



# GRAFFITI styles



# SOME results

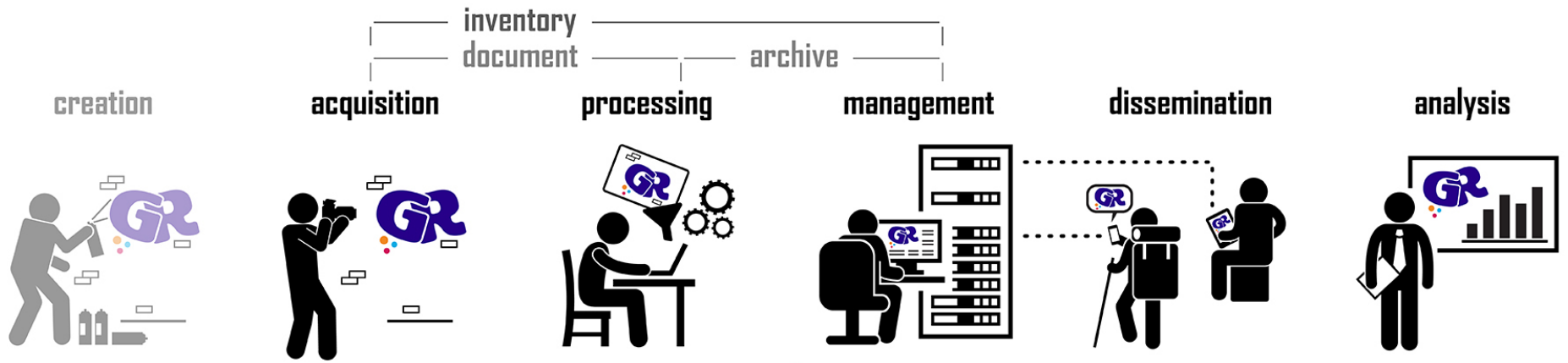
GRAFFITI *LOCATION*

GRAFFITI *TEMPORALITY*

GRAFFITI *TERMINOLOGY*

GRAFFITI *CHARACTERISATION*

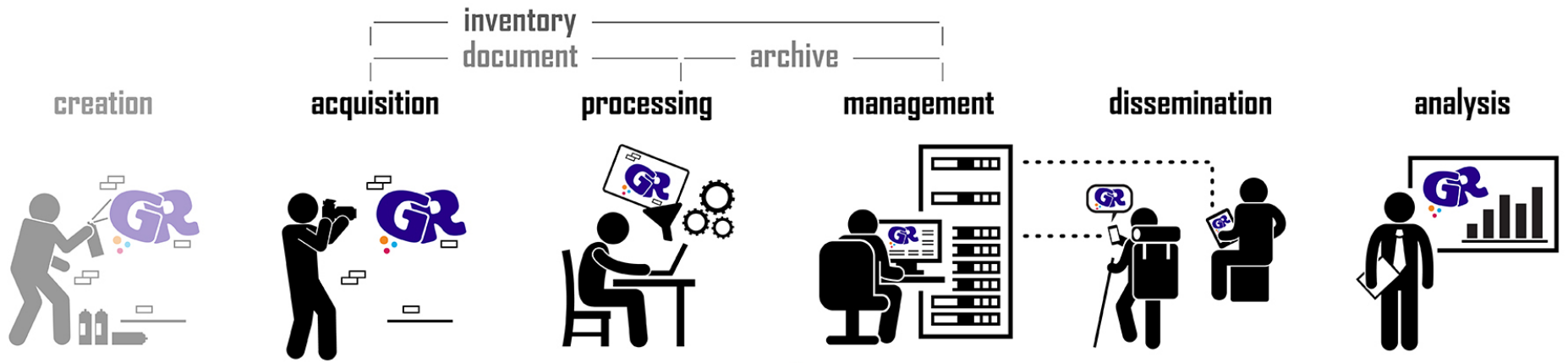
5 research pillars



# GRAFFITI metadata

GRAFFITI *LOCATION*
GRAFFITI *TEMPORALITY*
GRAFFITI *TERMINOLOGY*
GRAFFITI *CHARACTERISATION*

5 research pillars



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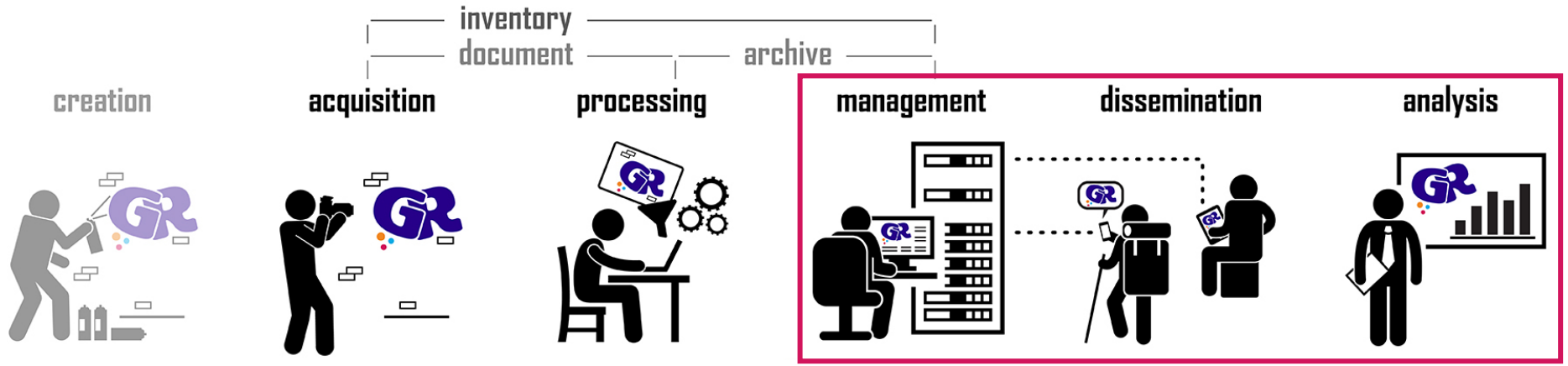

# INDIGO
## core division

# INDIGO
## core division

**real graffito**
*physical resource*

# INDIGO
## core division

**real graffito**
*physical resource*

**approximations**
*digital resources*

# INDIGO
## core division

**real graffito**
*physical resource*

**approximations**
*digital resources*

digital photos

textured 3D models

orthophotographs

polygons

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## core division

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*physical resource*

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polygons

metadata

metadata

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## core division

**real graffito**
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metadata ⇦ metadata

# INDIGO
## core division

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*digital resources*

digital photos

textured 3D models

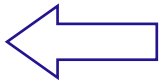
orthophotographs

polygons

**metadata**

# GRAFFITI (meta)data

| *INDIGO metadata (physical graffito)* | |
|---|---|
| **Category Level** | **Category Name** |
| **1** | **Descriptive metadata** |
| 1.1 | Core metadata |
| 1.2 | Locational metadata |
| 1.3 | Temporal metadata |
| 1.4 | Contentual / aboutness metadata |
| 1.5 | Formal / appearance metadata |
| **2** | **Administrative metadata** |
| 2.1 | Rights metadata |
| 2.2 | Access metadata |
| 2.3 | Technical metadata |
| **3** | **Structural metadata** |
| 3.1 | Origin relationships |
| 3.2 | Graffiti ensemble relationships |
| 3.2 | Spatio-temporal relationships |



metadata

digital photos

textured 3D models

orthophotographs

polygons

# GRAFFITI (meta)data

| *INDIGO metadata (physical graffito)* | |
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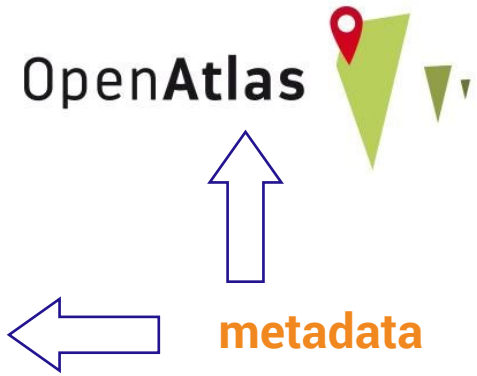


digital photos

textured 3D models

orthophotographs

polygons

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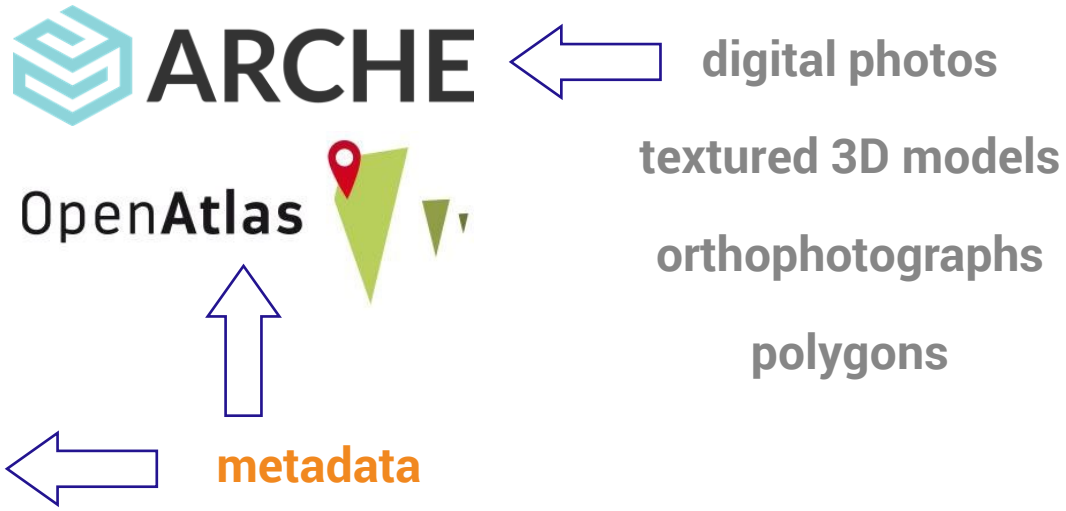
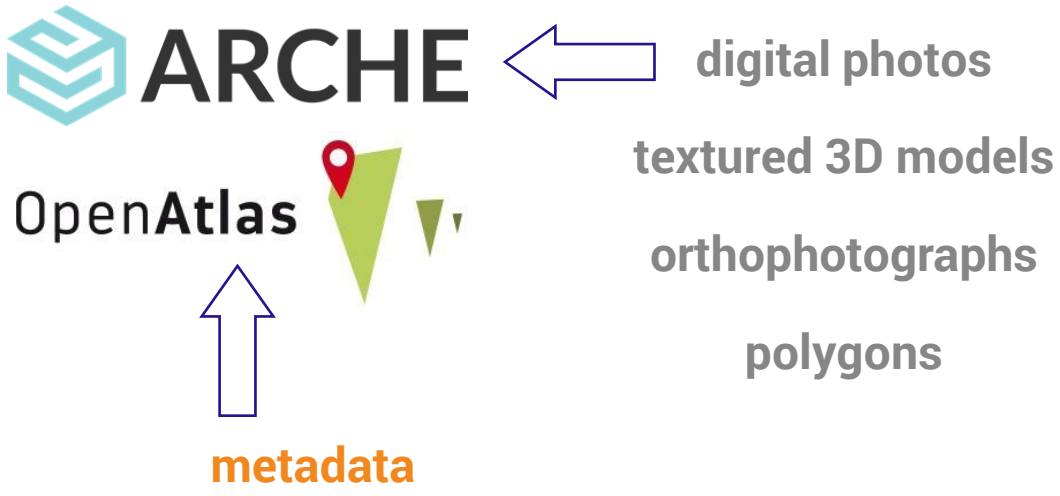
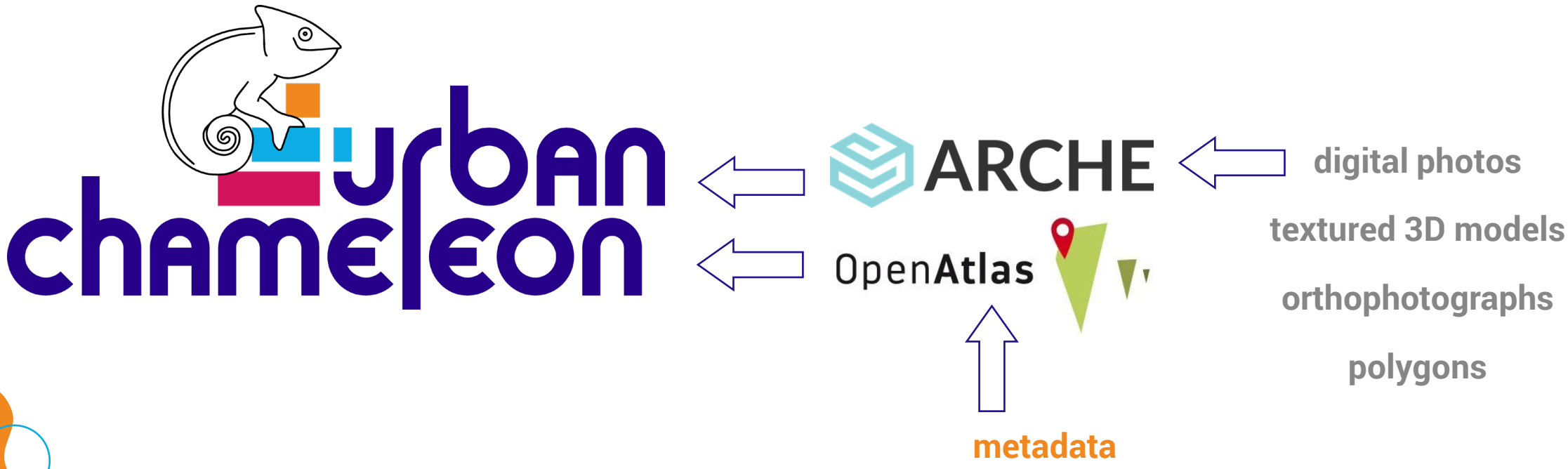


# FINAL goal

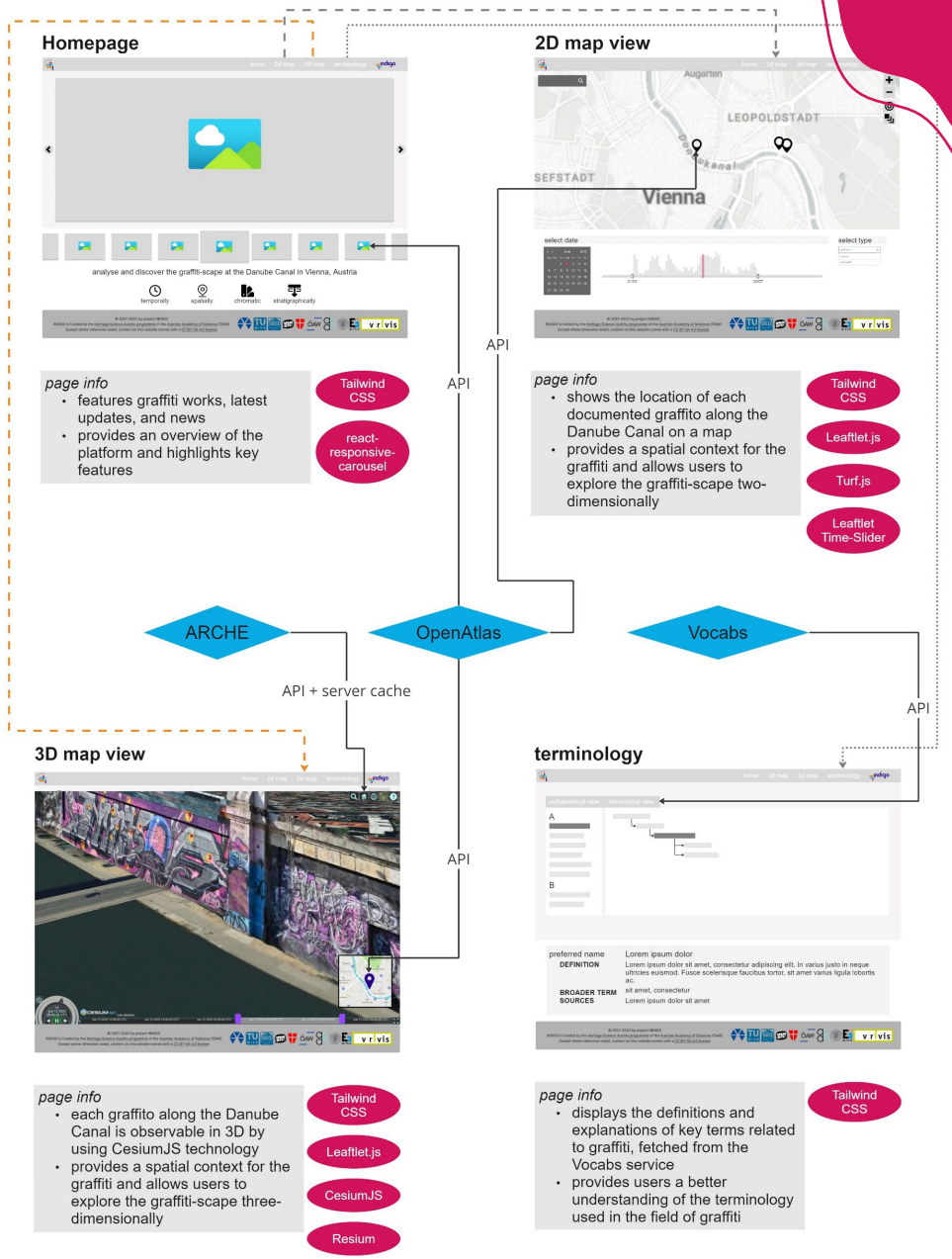

ARCHE
OpenAtlas
metadata
digital photos
textured 3D models
orthophotographs
polygons

# FINAL goal


urban chameleon
ARCHE
OpenAtlas
digital photos
textured 3D models
orthophotographs
polygons
metadata

# FINAL goal

urban chameleon



# INTERACTIVE 3D dissemination

archaeologists / art historians

sociologists / linguists

ethnographers / anthropologists

architects / geographers

# INTERACTIVE 3D dissemination

archaeologists / art historians

sociologists / linguists

ethnographers / anthropologists

architects / geographers

ETHICAL + COPYRIGHT aspects

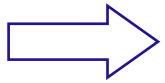
# RIGHT now

# RIGHT now

## DATA, LOTS OF DATA

# RIGHT now

DATA, LOTS OF DATA

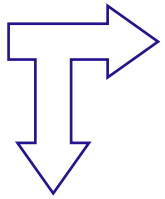


ARCHE

CoreTrustSeal certified data repository

# RIGHT now

DATA, LOTS OF DATA



ANONYMISATION

ARCHE

CoreTrustSeal certified data repository

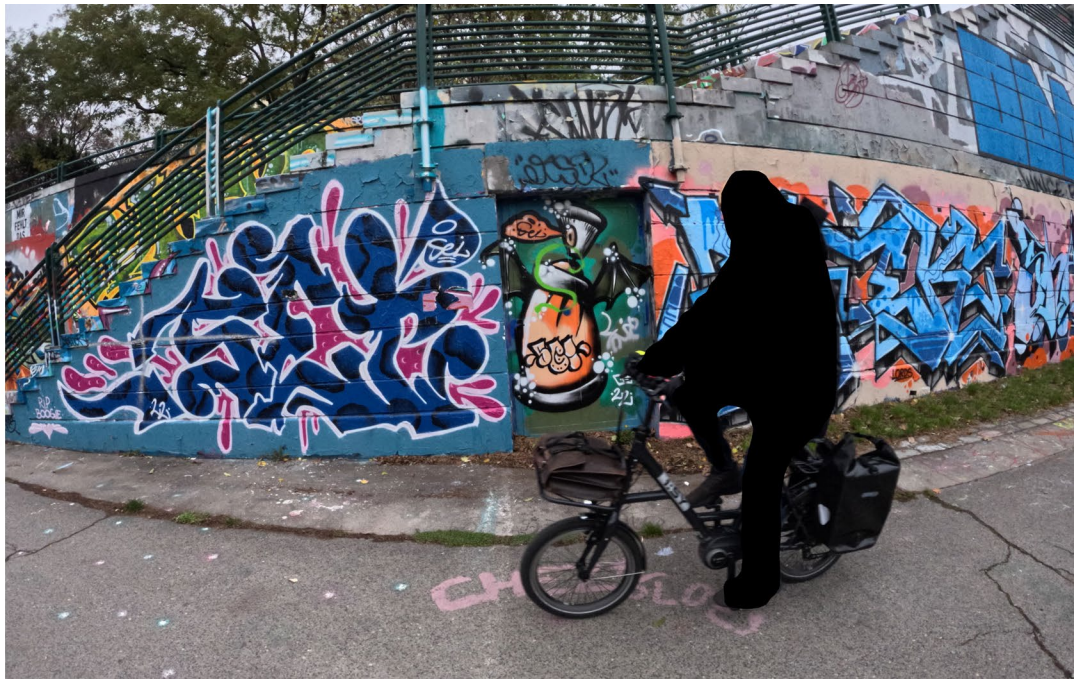
# RIGHT now

DATA, LOTS OF DATA

ARCHE

CoreTrustSeal certified data repository

ANONYMISATION



# RIGHT now

DATA, LOTS OF DATA

ANONYMISATION

ARCHE

CoreTrustSeal certified data repository

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ARCHE

CoreTrustSeal certified data repository

# DISSEMINATION general audience

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NewsLetter

vol.24 · Week 40 · 03-07 October 2022

indigo

VRVis meeting

01 Thursday 06-10-2022
10:00 @ VRVis
*discuss collaboration*

*bot character* by DEADBEAT HERO south of the Friedensbrücke on the right Donaukanal bank [ 21-09-2022 ]
**Nikon Z 7II + Nikon NIKKOR Z 20mm f/1.8 S** @ *f*/5.6 - 1/400 s - ISO 360

CVL Computer Vision Lab

UC

last two weeks

**1. CVL meeting**

*Tuesday 27-09-2022* | meeting between Sebastian Zambanini of the TU Wien's Computer Vision Lab and Geert to discuss potential thesis subjects

**2. Proceedings meeting**

*Wednesday 28-09-2022* | the editors of the goINDIGO 2022 proceedings meet to sync info about article submissions and outstanding papers

**3. Monthly team meeting**

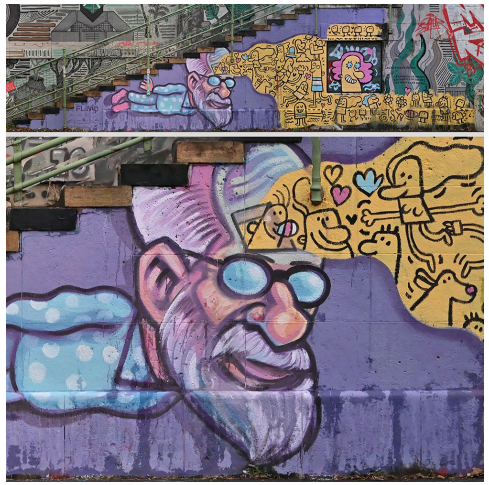
*Friday 30-09-2022* | during monthly team meeting 11, the INDIGO project staff discussed the status quo and talked about upcoming matters

NEWSLETTER

26

# DISSEMINATION general audience

Gallery Wednesday



**NEWSLETTER**

**26**

**INSTAGRAM**

**±500**

# DISSEMINATION general audience

Die Presse 16/07/2022



**Digital.** Ein Forschungsteam entwickelt ein 3-D-Modell der unzähligen Graffiti am Donaukanal: um die kurzlebigen Werke zu bewahren und eine Basis für andere Forschungen schaffen. Zu Besuch bei einer der längsten Graffitiflächen der Welt.

## Buntes Erbe zum Lachen, Ärgern und Grübeln

VON ALICE SENARCLENS DE GRANCY

Außergewöhnlicher Kulturschatz: Geert Verhoeven (l.) und Stefan Wogrin vor einem ihrer Forschungsobjekte. [ Jana Madzigon ]

Wir haben seit fast vier Jahren einen Hund und gehen mit ihm oft im Prater spazieren, aber auch entlang des Donaukanals", erzählt Geert Verhoeven von der Idee zu seinem aktuellen Forschungsprojekt. Dabei betrachtete er die Graffiti an den Wänden – „manche waren weniger schön, manche wirkten wie Kunst" – und bemerkte auch deren Vergänglichkeit: „Sie werden teilweise nach ein paar Stunden oder Tagen übersprüht." Der Archäologe begann, die oft kurzlebigen Werke als Kulturerbe zu sehen, das es zu bewahren gilt, und startete gemeinsam mit dem Kunsthistoriker Stefan Wogrin und anderen wissenschaftlichen Partnern das Projekt Indigo (Inventory and Disseminate Graffiti along the Donaukanal).

„Der Donaukanal ist heute berühmt für die vielen Graffiti, dabei wissen die meisten nicht, dass Sprayen eigentlich nur auf 300 Metern erlaubt ist", erzählen die beiden Männer an diesem windigen und untypisch kalten Sommertag vor der Kaiserbadschleuse. Hier entstand 1984 neben dem Nachtclub Flex die erste legale Graffitofläche Wiens. Anfang und Ende sind mit einer – bunt besprühten – Reliefplatte markiert, auf der eine Taube zu sehen ist: Die sogenannte Wienerwand sei ein Unikum mit klarer Botschaft, berichtet Wogrin, der sich seit rund 20 Jahren mit Graffiti befasst – und selbst anfertigt: „Man wollte die Sprayer genauso wenig wie die Tauben." Dennoch ermöglicht es die Stadt Wien Künstlerinnen und Künstlern aus der Graffito-Szene so, auf diesen Flächen zu arbeiten, ohne kriminell zu sein.

### Thema lässt niemanden kalt

Denn Graffiti polarisieren bis heute. „Die einen lieben sie, die anderen hassen sie", sagt Verhoeven, der diese Reaktionen auch von wissenschaftlichen Tagungen kennt: „Es gibt jedes Mal 100.000 Fragen." Das Interesse gefällt ihm – und auch, dass ein Beitrag aus seiner Forschungsgruppe im März einen Best Paper Award bei einer Konferenz im italienischen Mantua gewonnen hat. Üblicherweise befasst er sich als stellvertretender Leiter des Ludwig-Boltzmann-Instituts (LBI) für Archäologische Prospektion und Virtuelle Archäologie mit ganz anderen Kulturschätzen: Er begleitete die Forschungen rund um das jungsteinzeitliche Stonehenge, war bei den Arbeiten zum römischen Carnuntum oder der Wikinger-Fundstätte Birka dabei. „Und im Stephansdom habe ich Fresken dokumentiert und publiziert", schildert Geert Verhoeven, der 2010 innerhalb von vier Tagen sein Haus in Belgien verkauft hat und für die Forschungsstelle nach Wien gezogen ist. Die am LBI genutzten und weiterentwickelten Messsysteme und Simulationsmethoden bilden die Klammer über die verschiedenen Themen. Ziel ist stets, Kulturerbe digital festzuhalten.

### IN ZAHLEN

**13** Kilometer lang sind die Flächen am Donaukanal, an denen Wiener Forscher Graffiti fotografisch festhalten und daraus ein 3-D-Modell bauen.

**27.000** Fotos verknüpfte das erste Modell. Wöchentlich kommen zwischen 1000 und 3000 neue Bilder dazu.

**300** Meter misst der Bereich, in dem Sprayen am Wiener Donaukanal legal ist.

### Digitaler Spaziergang am Kanal

Diese virtuellen Werkzeuge sollen nun auch helfen, die Graffiti am Donaukanal darzustellen – auch Anwendungen für den Tourismus sind denkbar: Den Forschern schwebt ein digitaler Spaziergang am Donaukanal vor, bei dem man auch ältere, an einer Stelle vorhandene Graffiti anschauen und mehr über sie erfahren kann.

Doch noch sind große technische Hürden zu nehmen: Die Farben bei ständig wechselnden Lichtverhältnissen richtig abzubilden, sei sehr schwierig, führt das Duo aus. Auch die Orte ändern sich: „Die Container da drüben waren vor fünf Monaten noch nicht da", sagt Wogrin und zeigt auf die bunt besprühten Quader am anderen Ufer. Zumindest einmal pro Woche geht er daher den Kanal ab dem Hunderwasserhaus bis zur Friedensbrücke auf beiden Seiten ab, sichtet Neuheiten und macht unzählige Fotos, die später zum großen Ganzen kommen.

Rund 27.000 Fotos bildeten das Basismodell. Seither werden – wie bei einem Puzzle – ständig neue hinzugefügt und beschrieben: Welche Figuren sind dargestellt, was steht geschrieben? Gewaltige Datenmengen müssen richtig verknüpft werden. Dabei unterstützen auch Forschungsteams der TU Wien und der Universitat Politècnica de València in Spanien. Auch das VRVis, das Zentrum für Virtual Reality und Visualisierung in Wien, soll künftig helfen, das Neuland zu ergründen. „Es gibt noch keine Projekte, die können, was wir brauchen", erläutert Verhoeven.

Schließlich soll, unterstützt vom Förderprogramm Heritage Science Austria der Österreichischen Akademie der Wissenschaften, ein öffentlich zugängliches Archiv entstehen, das weltweit kein Pendant findet. Der Donaukanal sei, zusammen mit der Berliner Mauer, wohl die längste ununterbrochene Graffitifläche der Welt, so Verhoeven – und in Bezug auf die Graffitiforschung „definitiv die längste". Die Daten sollen dann Disziplinen wie Soziologie, Linguistik, Kriminologie oder Kunstgeschichte für ihre Forschung offenstehen.

### Putin, dargestellt als Hitler

Inhaltliche Analysen folgen also später, doch aus seinen Beobachtungen weiß Wogrin schon heute: „Die Motive haben oft einen Bezug zum Kanal. Man sieht viele Fische oder Fischskelette oder auch Oktopusse." Für politische Botschaften werde meist mit Schablonen gearbeitet, so ließen sich Parolen schnell aufsprühen. Darin habe man zuletzt auch den Beginn des Ukraine-Kriegs gespürt, fand Putin als Hitler dargestellt und einzelne Säulen mit den Farben der Ukraine gelb-blau bemalt. Aber es gibt Graffiti, die für noch mehr Diskussionsstoff sorgen: „Was tun mit homophoben oder nationalsozialistischen Botschaften?", fragt Verhoeven. „Als Forscher wollen wir alle Daten anbieten, aber freilich keine Bühne für Neonazis sein."

Überdies soll ein Thesaurus entstehen, der die Terminologie erklärt und vereinheitlicht. „Ist es Street-Art oder Graffito? Sind es Writers, Creators oder Künstler, die hier wirken?", verdeutlicht Wogrin offene Fragen. Bis zum Projektende im Juli 2023 wird die Datenbank jedenfalls noch ordentlich wachsen. Er hoffe, dass das Projekt dann immer noch gefördert werde, sagt Verhoeven. Denn er will das Neuland hier am Kanal, auf das ihn einst sein Hund geführt hat, weiter für die Nachwelt dokumentieren.

**NEWSLETTER**

**26**

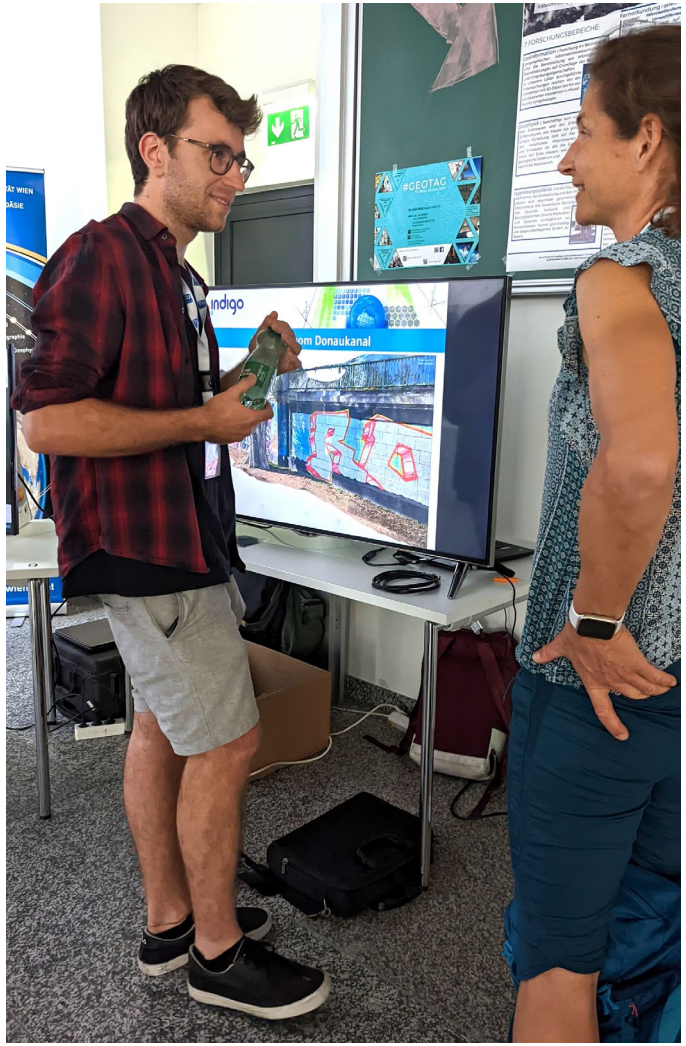
**PRESS**

**2**

**INSTAGRAM**

**±500**

# DISSEMINATION general audience




Lange Nacht Der Forschung 2022

**NEWSLETTER**
26

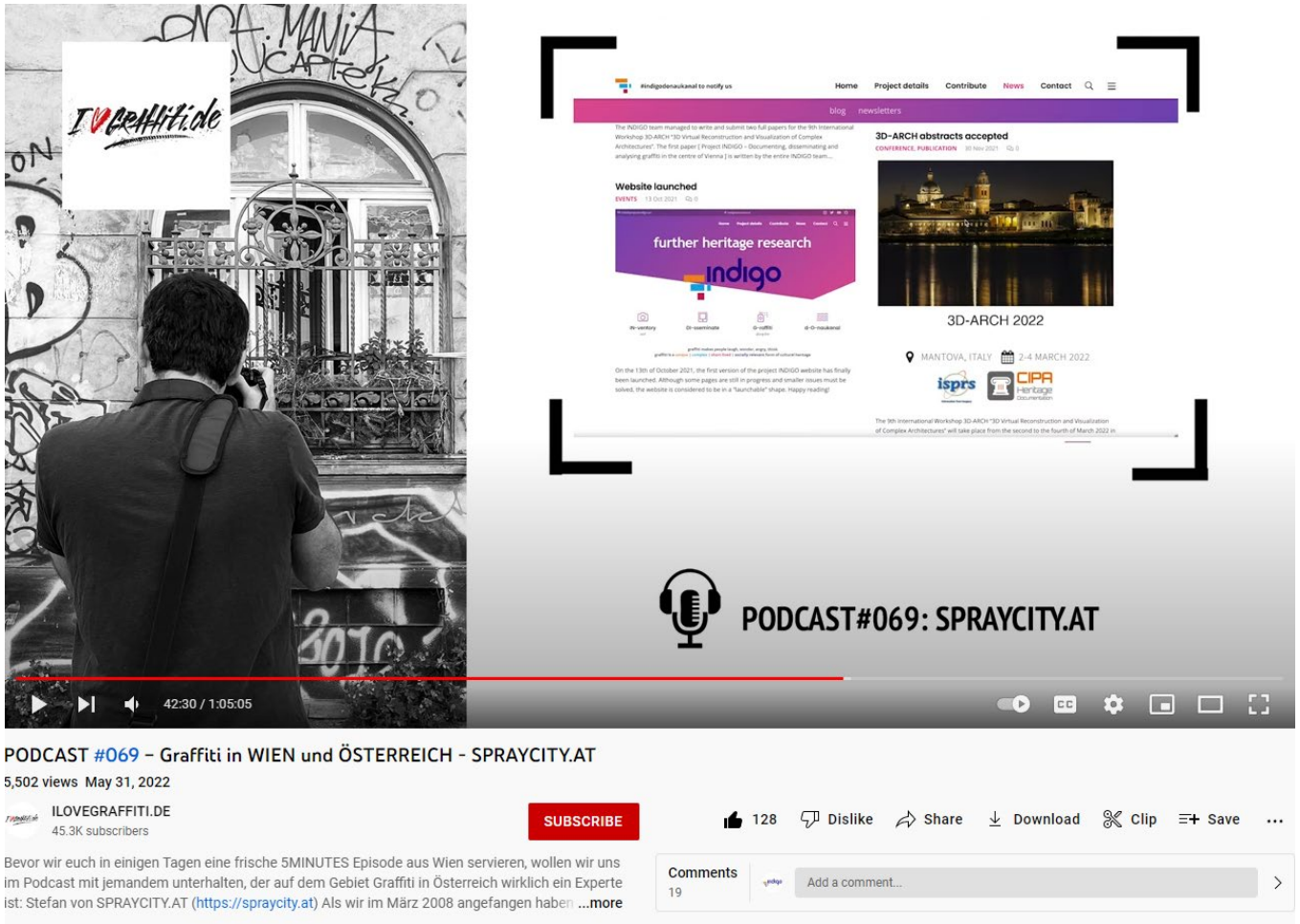
**PRESS**
2

**INSTAGRAM**
±500

**EVENTS**
5

# DISSEMINATION general audience

ILOVEGRAFFITI.DE Podcast 69




**PODCASTS**

**3**

# DISSEMINATION general audience

GEObranchen.de

**PODCASTS**

**3**

**BLOGS**

**4**

# DISSEMINATION scientific audience

# DISSEMINATION scientific audience

AUTOGRAF

COOLPIR

GRAPHIS

SOFTWARE

3

# DISSEMINATION scientific audience

**SOFTWARE**

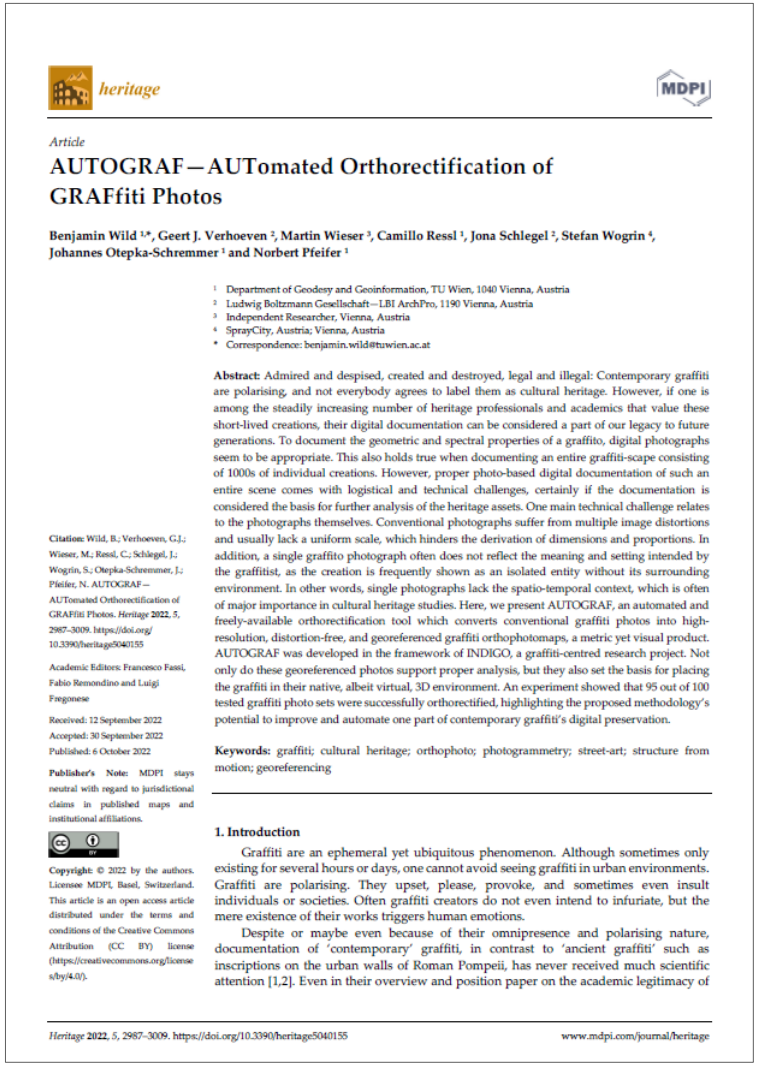
**3**

**HARDWARE**

**1**

# DISSEMINATION scientific audience

Heritage *[open-access]*



heritage

MDPI

*Article*

## AUTOGRAF—AUTomated Orthorectification of GRAFfiti Photos

**Benjamin Wild [1,*], Geert J. Verhoeven [2], Martin Wieser [3], Camillo Ressl [1], Jona Schlegel [2], Stefan Wogrin [4], Johannes Otepka-Schremmer [1] and Norbert Pfeifer [1]**

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**Abstract:** Admired and despised, created and destroyed, legal and illegal: Contemporary graffiti are polarising, and not everybody agrees to label them as cultural heritage. However, if one is among the steadily increasing number of heritage professionals and academics that value these short-lived creations, their digital documentation can be considered a part of our legacy to future generations. To document the geometric and spectral properties of a graffito, digital photographs seem to be appropriate. This also holds true when documenting an entire graffiti-scape consisting of 1000s of individual creations. However, proper photo-based digital documentation of such an entire scene comes with logistical and technical challenges, certainly if the documentation is considered the basis for further analysis of the heritage assets. One main technical challenge relates to the photographs themselves. Conventional photographs suffer from multiple image distortions and usually lack a uniform scale, which hinders the derivation of dimensions and proportions. In addition, a single graffito photograph often does not reflect the meaning and setting intended by the graffitist, as the creation is frequently shown as an isolated entity without its surrounding environment. In other words, single photographs lack the spatio-temporal context, which is often of major importance in cultural heritage studies. Here, we present AUTOGRAF, an automated and freely-available orthorectification tool which converts conventional graffiti photos into high-resolution, distortion-free, and georeferenced graffiti orthophotomaps, a metric yet visual product. AUTOGRAF was developed in the framework of INDIGO, a graffiti-centred research project. Not only do these georeferenced photos support proper analysis, but they also set the basis for placing the graffiti in their native, albeit virtual, 3D environment. An experiment showed that 95 out of 100 tested graffiti photo sets were successfully orthorectified, highlighting the proposed methodology's potential to improve and automate one part of contemporary graffiti's digital preservation.

**Keywords:** graffiti; cultural heritage; orthophoto; photogrammetry; street-art; structure from motion; georeferencing

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### 1. Introduction

Graffiti are an ephemeral yet ubiquitous phenomenon. Although sometimes only existing for several hours or days, one cannot avoid seeing graffiti in urban environments. Graffiti are polarising. They upset, please, provoke, and sometimes even insult individuals or societies. Often graffiti creators do not even intend to infuriate, but the mere existence of their works triggers human emotions.

Despite or maybe even because of their omnipresence and polarising nature, documentation of 'contemporary' graffiti, in contrast to 'ancient graffiti' such as inscriptions on the urban walls of Roman Pompeii, has never received much scientific attention [1,2]. Even in their overview and position paper on the academic legitimacy of



**SOFTWARE**

**3**

**ARTICLES**

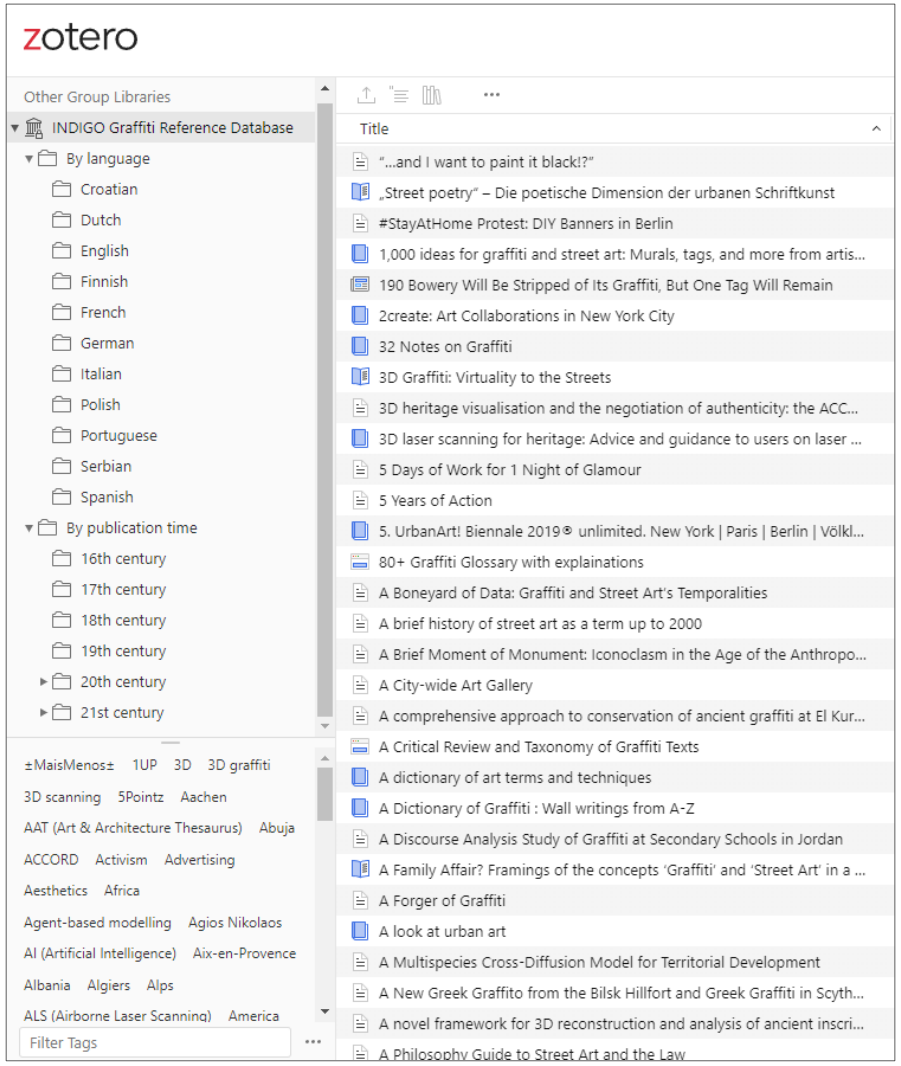
**5+9 (+6)**

**HARDWARE**

**1**

# DISSEMINATION scientific audience

Graffiti literature database




**SOFTWARE**

**3**

**ARTICLES**

**5+9 (+6)**

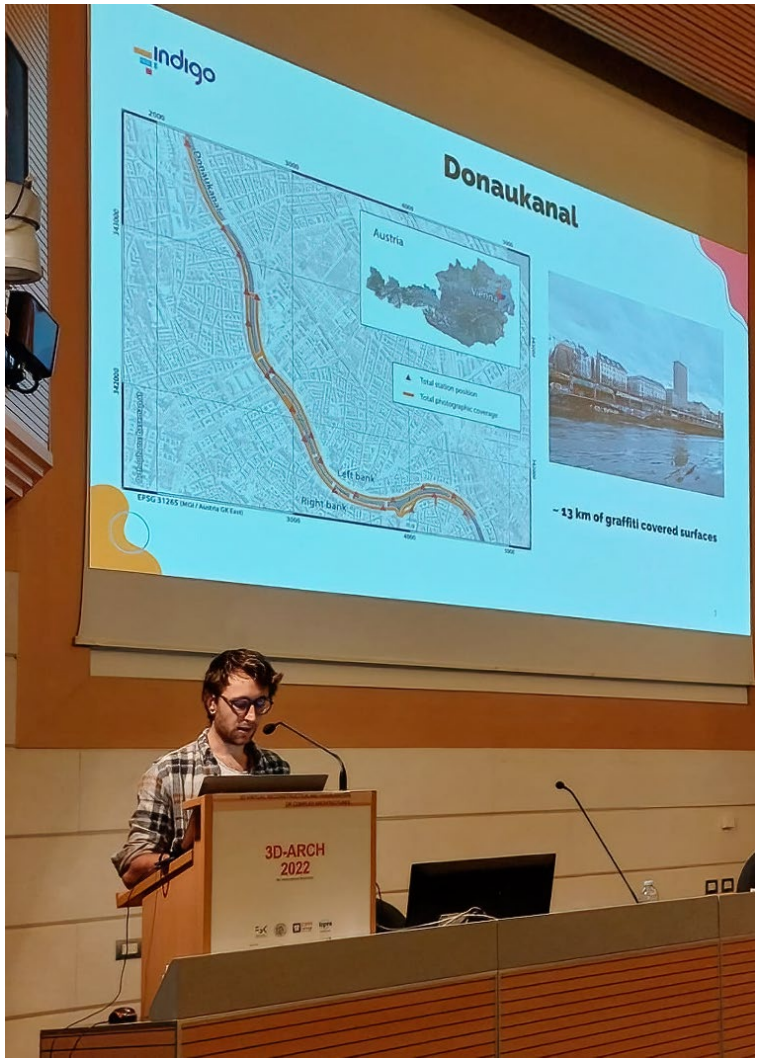
**HARDWARE**

**1**

**DATA SETS**

**5 (+1)**

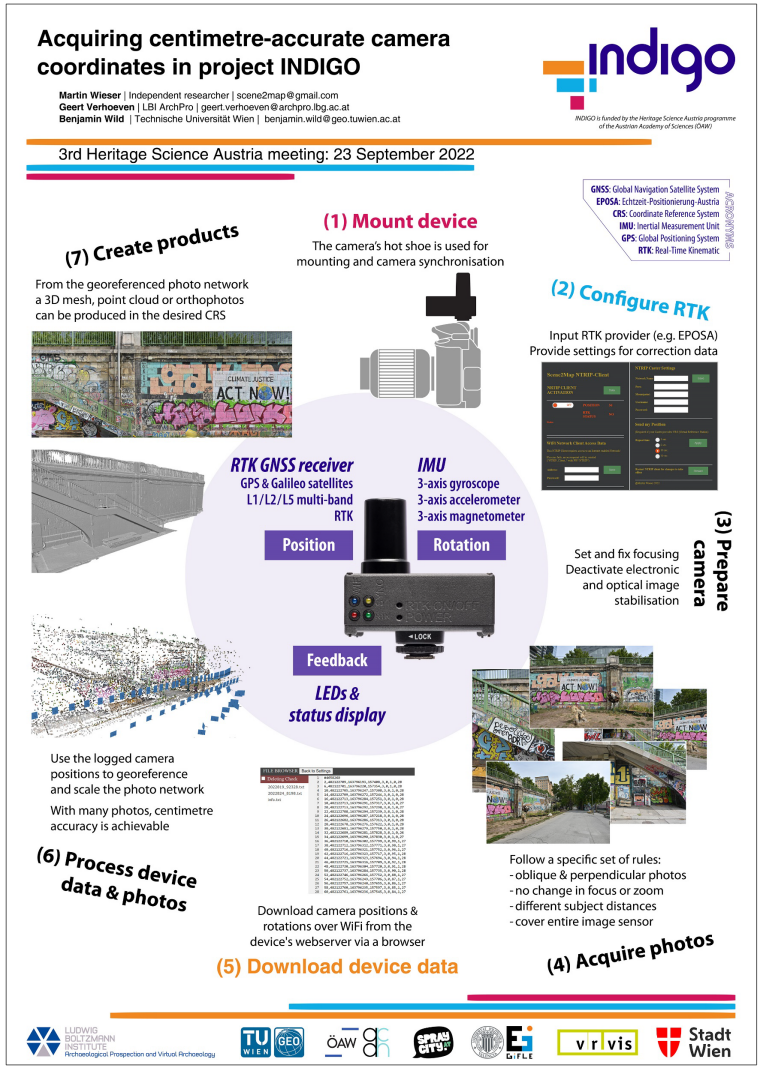
# DISSEMINATION scientific audience




TALKS

24

# DISSEMINATION scientific audience




**TALKS**

**24**

**POSTERS**

**3**

# DISSEMINATION scientific audience

**TALKS**

**24**

**SYMPOSIA**

**2**

**POSTERS**

**3**

# DISSEMINATION scientific audience

**TALKS**
24

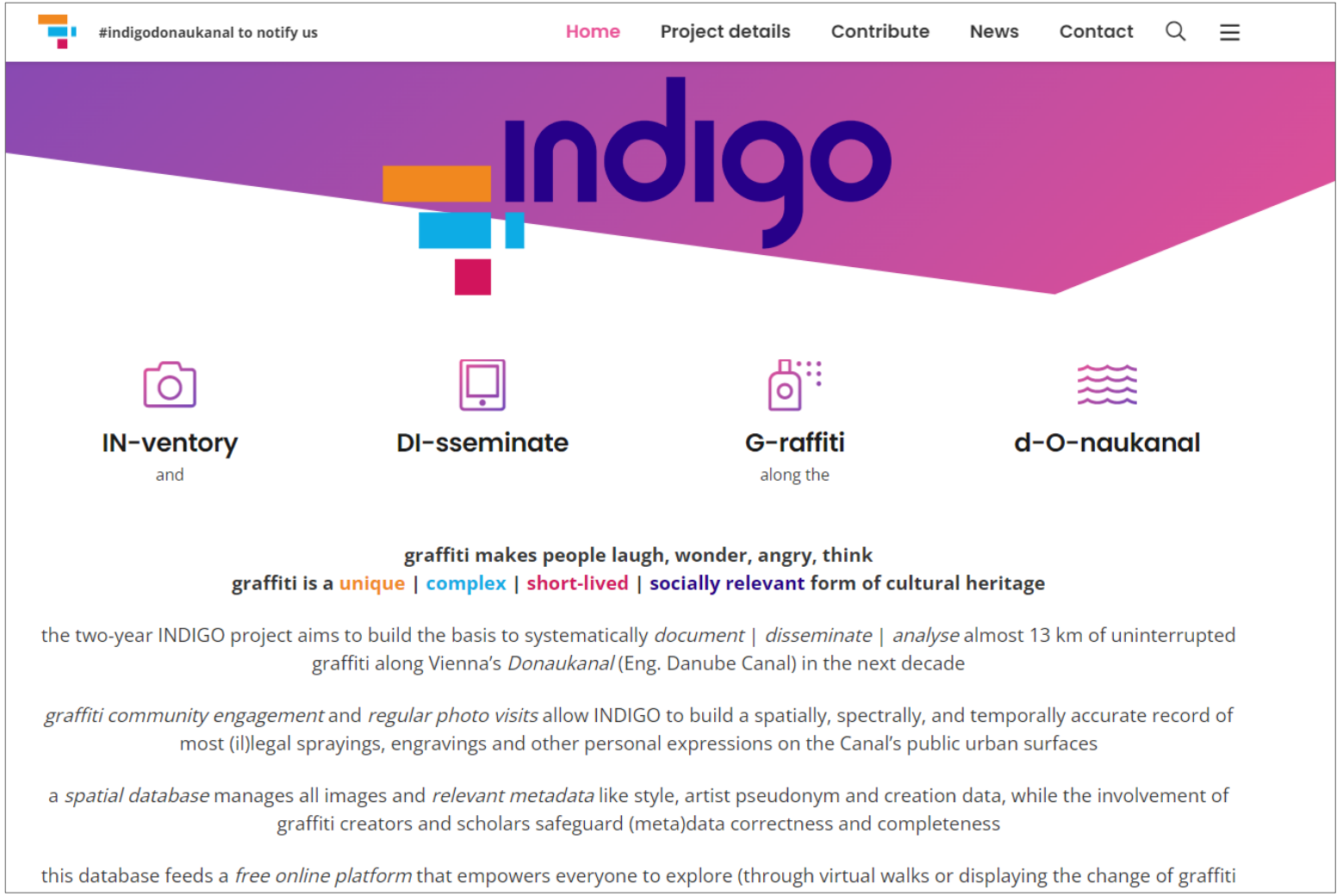
**SYMPOSIA**
2

**POSTERS**
3

**EDITED VOLUME**
1 (+1)

# INDIGO website

https://projectindigo.eu



# Tackling an Urban Chameleon via Digital Graffiti Archaeology