indigo

STATUS-QUO 1

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

AGENDA

AGENDA

part 1 [13:30 – 14:30]

👀

AGENDA

part 1 [13:30 – 14:30]

👀

part 2 [14:45 – 16:30]

👀

AGENDA

part 1 [13:30 – 14:30]

Geert	/	INDIGO—dissemination for general & scientific audiences	**13:30**
Benjamin	/	Introducing AUTOGRAF	**13:45**
Martin	/	RTK GNSS on top of the camera	**13:55**
Geert	/	COOLPI	**14:05**
Jona & Massimiliano	/	Discussing graffiti—Knowledge organization impossible?	**14:10**
Alex, Bernhard & Nina	/	New OpenAtlas features for INDIGO	**14:20**

AGENDA

part 1 [13:30 – 14:30]

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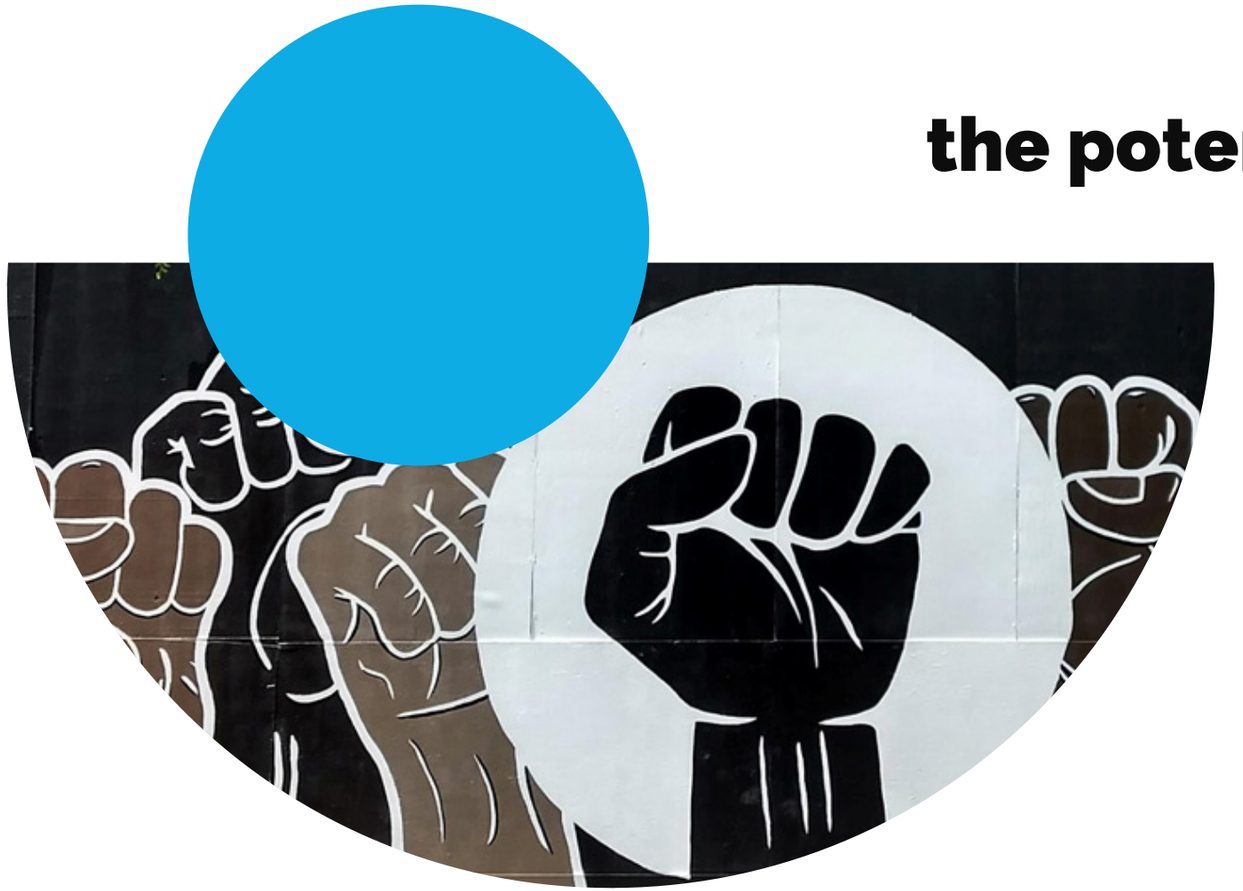
graffiti is

unique
complex
short-lived
socially relevant

cultural heritage



the potential
of graffiti
to understand
society
is under-exploited

DISSEMINATION general audience

DISSEMINATION general audience

NEWSLETTER

DISSEMINATION general audience

NewsLetter

vol 01 · Week 41 · 11-15 October 2021

Website launch

01 Wednesday 13-10-2021
undefined @ WWW
first version

Vocabs meeting

02 Friday 15-10-2021
9.00 h @ Online (Zoom)
general introduction

The amasing density and variety of graffiti on the pillars of the Augartenbrücke [23-09-2021]
Nikon D750 + Nikon AF-S NIKKOR 20mm f/1.8G ED @ f/5.6 · 1/250 s · ISO 200

last week

1. TU server meeting

Tuesday 05-10-2021 | TU Wien-GEO can provide 2 TB of server space to sync the desktop hard drives of Benjamin, Stefan and Geert

2. OpenAtlas meeting

Tuesday 05-10-2021 | introduction into the world of OpenAtlas; discussion of 3D geometries, temporal resolution, image metadata and vocabularies

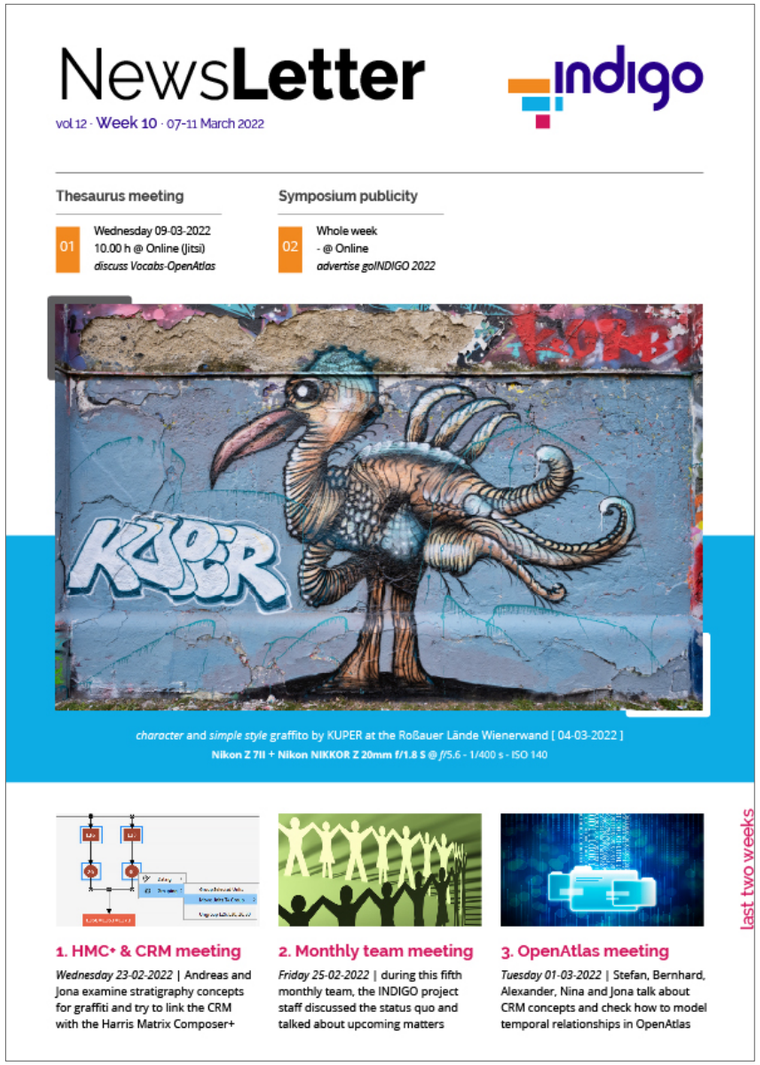
3. Total station survey

Friday 08-10-2021 | Jona and Benjamin surveyed with total station 38 photo-recogniseable points on the test wall; ± 2 cm estimated point accuracy

NEWSLETTER

1

DISSEMINATION general audience



NewsLetter

vol 12 · Week 10 · 07-11 March 2022

Thesaurus meeting

01 Wednesday 09-03-2022
10.00 h @ Online (Jitsi)
discuss Vocabs-OpenAtlas

Symposium publicity

02 Whole week
- @ Online
advertise goINDIGO 2022

character and *simple style* graffito by KUPER at the Roßauer Lände Wienerwand [04-03-2022]
Nikon Z 7II + Nikon NIKKOR Z 20mm f/1.8 S @ *f*/5.6 - 1/400 s - ISO 140

last two weeks

1. HMC+ & CRM meeting

Wednesday 23-02-2022 | Andreas and Jona examine stratigraphy concepts for graffiti and try to link the CRM with the Harris Matrix Composer+

2. Monthly team meeting

Friday 25-02-2022 | during this fifth monthly team, the INDIGO project staff discussed the status quo and talked about upcoming matters

3. OpenAtlas meeting

Tuesday 01-03-2022 | Stefan, Bernhard, Alexander, Nina and Jona talk about CRM concepts and check how to model temporal relationships in OpenAtlas

NEWSLETTER

12

DISSEMINATION general audience

NewsLetter

vol 24 · Week 40 · 03-07 October 2022

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

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

24

DISSEMINATION general audience

Gallery Wednesday

NEWSLETTER

24

INSTAGRAM

DISSEMINATION general audience

Gallery Wednesday

NEWSLETTER

24

INSTAGRAM

DISSEMINATION general audience

Flashback Friday

NEWSLETTER

24

INSTAGRAM

DISSEMINATION general audience

Flashback Friday

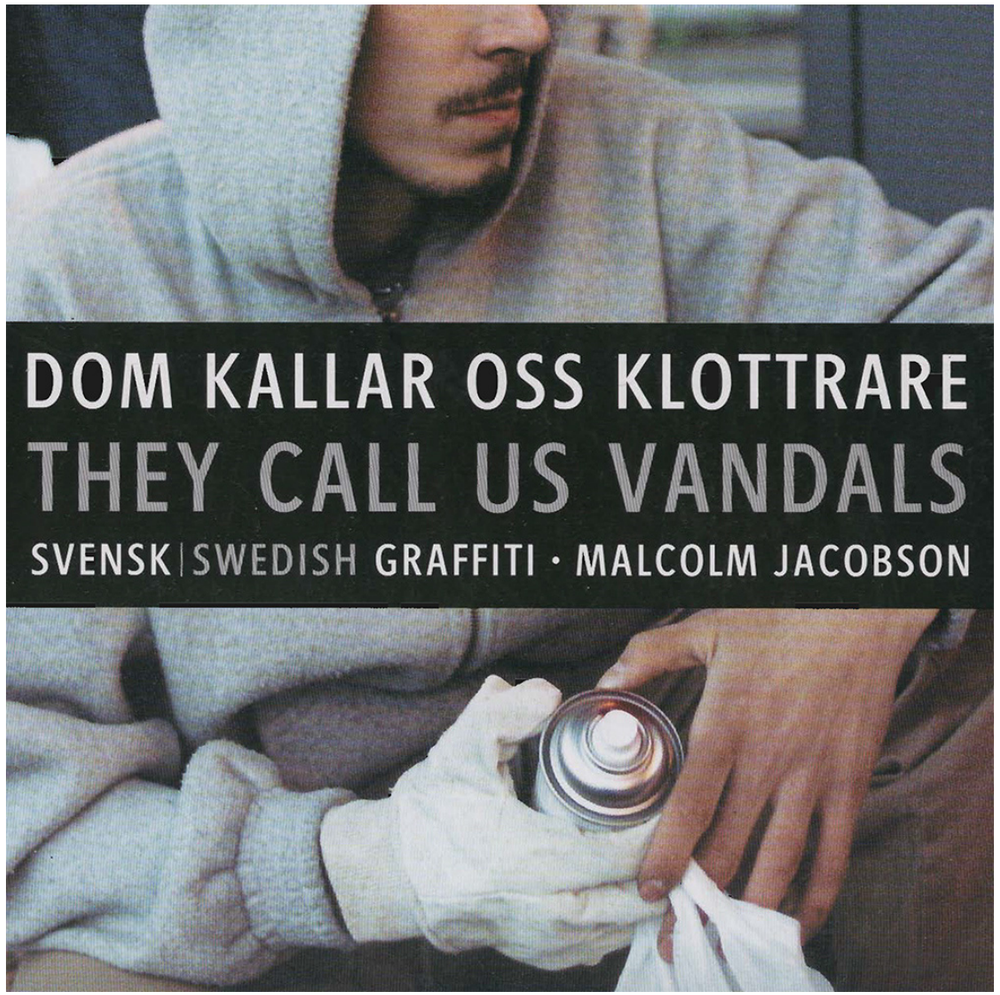
NEWSLETTER

24

INSTAGRAM

DISSEMINATION general audience

Literature Sunday



NEWSLETTER

24

INSTAGRAM

DISSEMINATION general audience

Literature Sunday

NEWSLETTER

24

INSTAGRAM

DISSEMINATION general audience

Literature Sunday

NEWSLETTER

24

INSTAGRAM

400+

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

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.

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

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 Hundertwasserhaus 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

24

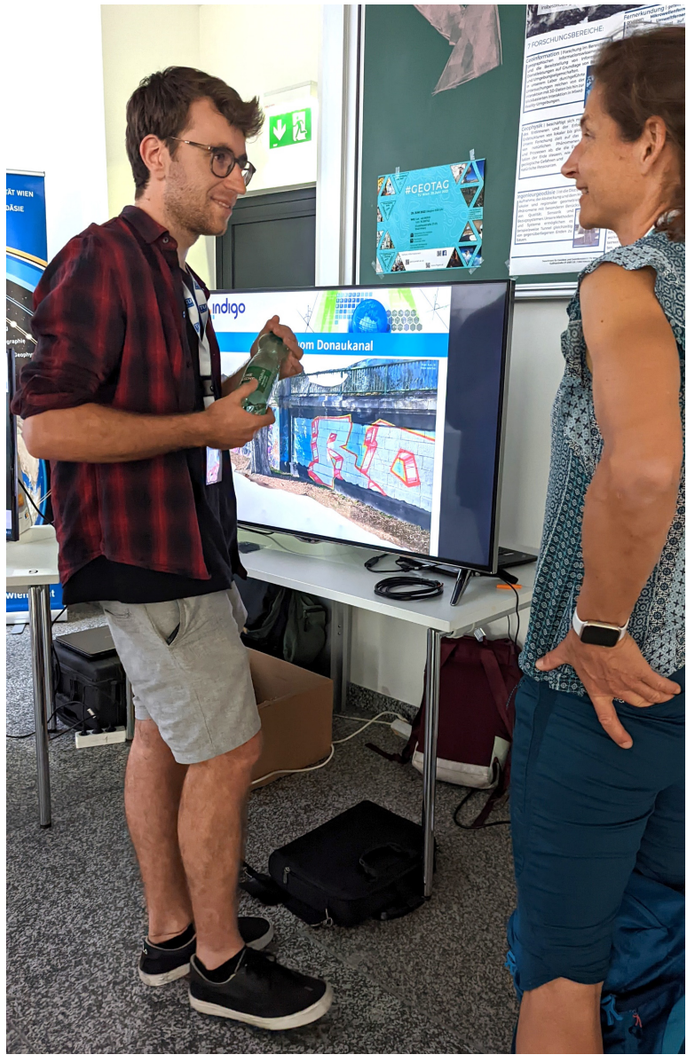
PRESS

1

INSTAGRAM

400+

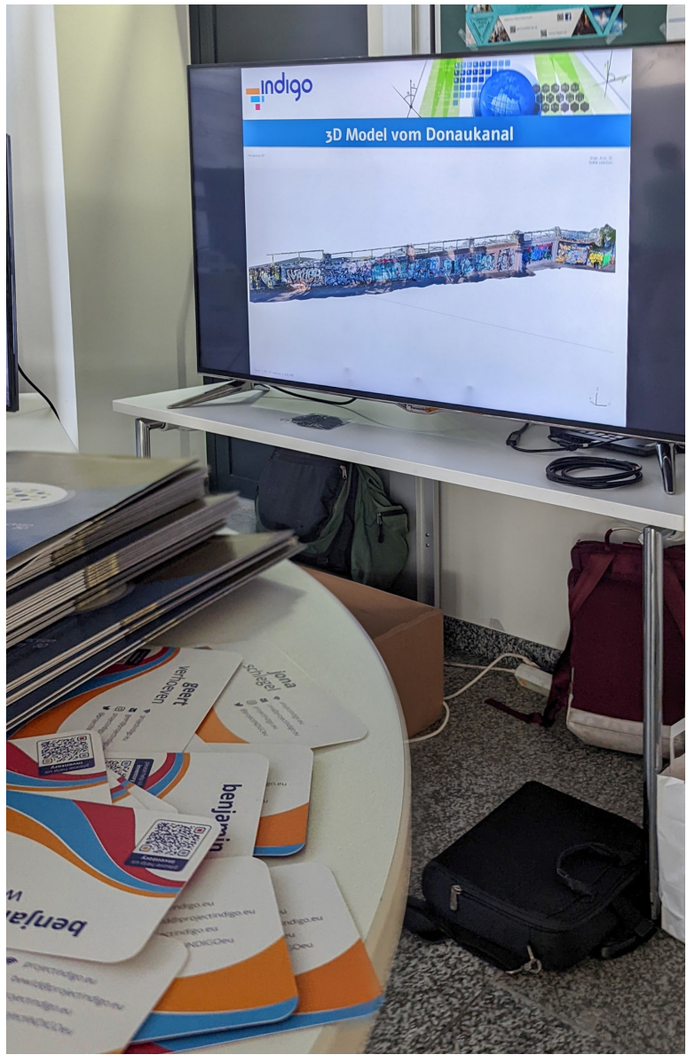
DISSEMINATION general audience



Lange Nacht Der Forschung 2022

NEWSLETTER	PRESS
24	1
INSTAGRAM	**EVENTS**
400+	1

DISSEMINATION general audience

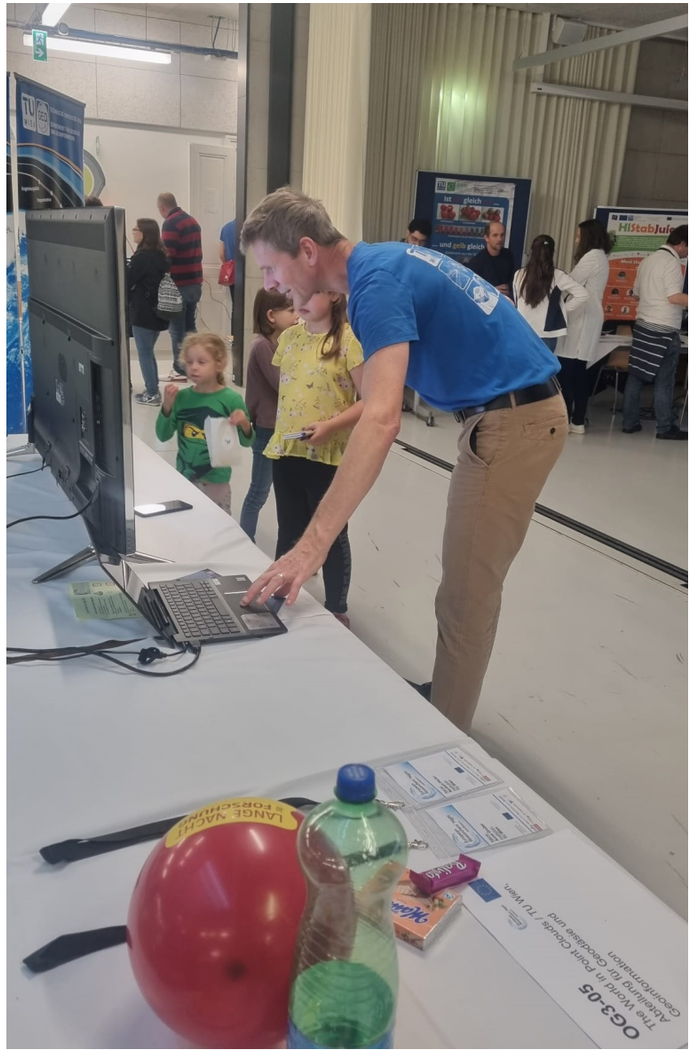


Lange Nacht Der Forschung 2022

NEWSLETTER	PRESS
24	1

INSTAGRAM	EVENTS
400+	1

DISSEMINATION general audience

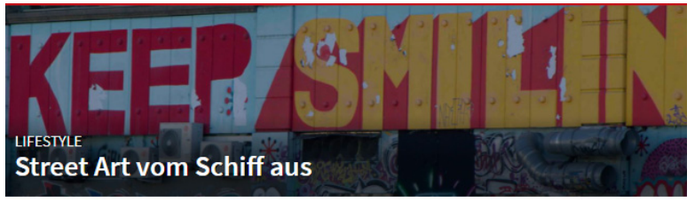


European Researchers Night 2022

NEWSLETTER	24
PRESS	1
INSTAGRAM	400+
EVENTS	2

DISSEMINATION general audience

Boat tours Levin Statzer Foundation



Eine neue Schifffahrt der MS Blue Danube bringt den Passagieren die Graffitis entlang des Donaukanals näher.

Dienstag, 30. August 2022
Verfasst am 30.08.2022 von W24 Redaktion

Die Ufer des Donaukanals sind im Bereich der Inneren Stadt nahezu durchgängig mit Graffitis verziert. Sie bilden somit ein Museum der besonderen Art und die wahrscheinlich längste Open Air-Galerie Österreichs. Auf der Street Art River Cruise können Interessierte jetzt jeden Sonntag die Kunstwerke bestaunen und Wissenswertes dazu erfahren.

NEWSLETTER
24

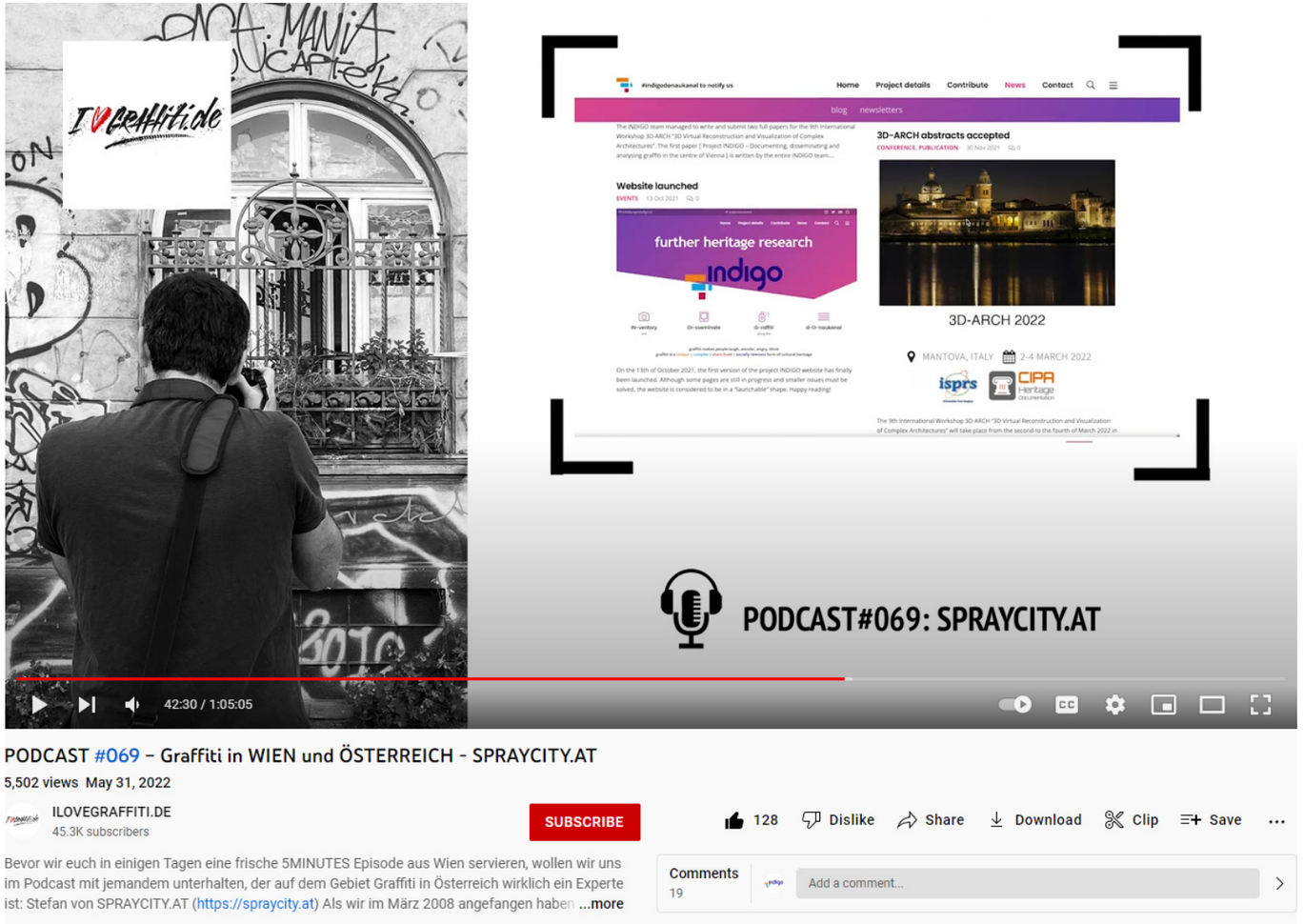
PRESS
1

INSTAGRAM
400+

EVENTS
2+1

DISSEMINATION general audience

ILOVEGRAFFITI.DE Podcast 69

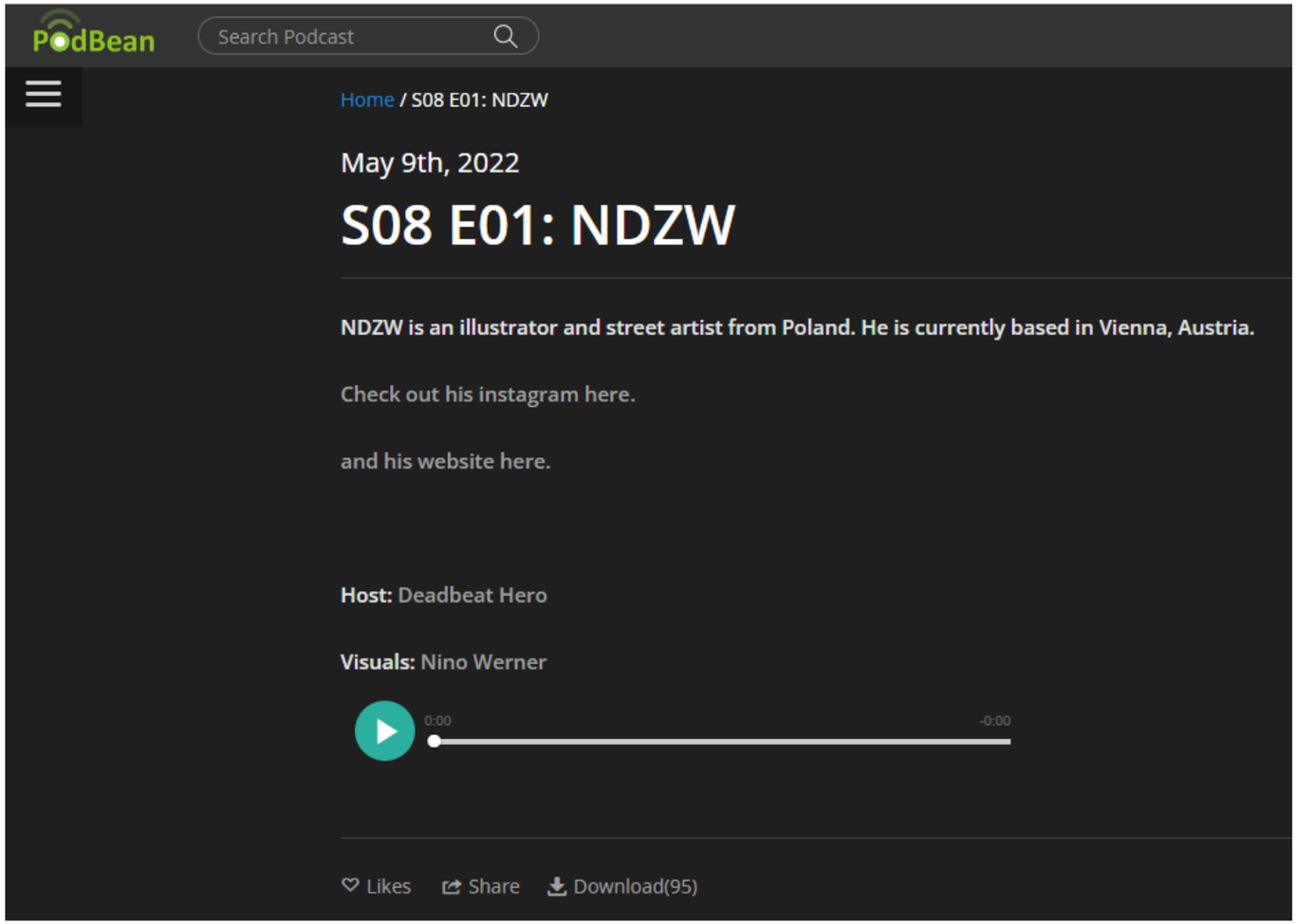


PODCASTS

1

DISSEMINATION general audience

Artcade podcast S08 E01



PODCASTS

2

DISSEMINATION general audience

theworldinpointclouds

PODCASTS

2

BLOGS

1

DISSEMINATION general audience

CIPA Heritage Documentation

Visualisation of present-day Bassianae using an image fusion of the UAS imagery-based orthophoto with a particular relief rendering, PC: Geert Verhoeven

Interview with Geert Verhoeven, CIPA Expert

CIPA Heritage Documentation Emerging Professionals
Published Oct 4, 2022

+ Follow

PODCASTS

2

BLOGS

2

DISSEMINATION scientific audience

DISSEMINATION scientific audience

COOLPi

SOFTWARE

1

DISSEMINATION scientific audience

COOLPi

SOFTWARE

2

AUTOGRAF

DISSEMINATION scientific audience

SOFTWARE

2

HARDWARE

1

DISSEMINATION scientific audience

SOFTWARE

2

HARDWARE

1

DISSEMINATION scientific audience

SOFTWARE

2

HARDWARE

1

DISSEMINATION scientific audience

ISPRS Archives *[open-access]*

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVI-2/W1-2022
9th Intl. Workshop 3D-ARCH "3D Virtual Reconstruction and Visualization of Complex Architectures", 2–4 March 2022, Mantua, Italy

PROJECT INDIGO – DOCUMENT, DISSEMINATE & ANALYSE A GRAFFITI-SCAPE

Geert Verhoeven[1], Benjamin Wild[2], Jona Schlegel[1], Martin Wieser[3], Norbert Pfeifer[2], Stefan Wogrin[4], Lothar Eysn[5], Massimiliano Carloni[6], Bernhard Koschiček-Krombholz[6], Adolfo Molada Tebar[7], Johannes Otepka-Schremmer[2], Camillo Ressl[2], Martina Trognitz[6], Alexander Watzinger[6]

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Commission II

KEY WORDS: graffiti, heritage science, image-based modelling, laser scanning, photography, street art, structure from motion

ABSTRACT:

Graffiti is a short-lived form of heritage balancing between tangible and intangible, offensive and pleasant. Graffiti makes people laugh, wonder, angry, think. These conflicting traits are all present along Vienna's *Donaukanal* (Eng. Danube Canal), a recreational hotspot – located in the city's heart – famous for its endless display of graffiti. The graffiti-focused heritage science project INDIGO aims to build the basis to systematically document, monitor, and analyse circa 13 km of Donaukanal graffiti in the next decade. The first part of this paper details INDIGO's goals and overarching methodological framework, simultaneously placing it into the broader landscape of graffiti research. The second part of the text concentrates on INDIGO's graffiti documentation activities. Given the project's aim to create a spatially, spectrally, and temporally accurate record of all possible mark-makings attached in (il)legal ways to the public urban surfaces of the Donaukanal, it seems appropriate to provide insights on the photographic plus image-based modelling activities that form the foundation of INDIGO's graffiti recording strategy. The text ends with some envisioned strategies to streamline image acquisition and process the anticipated hundreds of thousands of images.

1. INTRODUCTION

Graffiti and street art are multifaceted, 'self-authorised' (Blanché, 2015) forms of personal expression that exploit the public space using a visual intervention. Graffiti and street art have found their detractors and admirers, their collectors and destroyers, and even their superstar artists. In the past three decades, there has been a considerable expansion of the techniques in which those 'graffitists' express themselves in the public sphere: from graffiti writing to murals, cut-outs, stencils and stickers (Monschein-Oberreither, 2019).

This ever-evolving nature and constant need to reinvent itself are characteristic of graffiti and street art (Lewisohn, 2009; Kimvall, 2014), but they also explain the lack of scholarly agreement on the scope of these terms. This paper considers 'graffiti' to be the umbrella term for all mark-making practices, including engravings, paintings, sprayings, stickers, and other personal expressions attached to public (urban) surfaces in legal or illegal ways. This definition allows us to state that graffiti have been created for millennia (Lovata and Olton, 2015).

Despite its long history, the phenomenon remains fascinating and debateable because it continually fluctuates between tangible and intangible heritage, between vandalism and art, between graphical and textual, between legal and illegal, between subversive and humorous, between pleasingly acceptable and socio-political criticism. These contradicting features are also present along the *Donaukanal* (Eng. Danube Canal) in the city centre of Vienna (Austria). The public surfaces surrounding this central waterway have constituted a graffiti hotspot since the early 1980s (Ringhofer and Wogrin, 2018), with works ranging from colourful murals, anarchistic symbols on bridge pillars to bike stand writings (Figure 1).

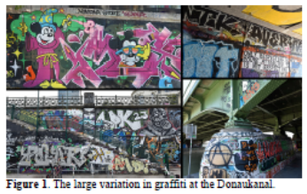

Figure 1. The large variation in graffiti at the Donaukanal.

Every day, new graffiti appear along the Donaukanal. However, a graffito's mere creation automatically implies the (complete or partial) destruction of one or more existing graffiti beneath. Although graffiti are subject to similar post-depositional processes found on archaeological sites and in landscape formation, one does usually not 'excavate' a graffiti-scape. Pre-existing graffiti simply become a lost and forgotten part of the Anthropocene's global stratification (Edgeworth et al., 2014).

That is why in the summer of 2020, the idea arose to monitor, digitally safeguard, and analyse a large part of this unique, complex, ever-changing, and socially fascinating cultural heritage that flanks Vienna's central waterway. More than a year

This contribution has been peer-reviewed.
https://doi.org/10.5194/isprs-archives-XLVI-2-W1-2022-513-2022 | © Author(s) 2022. CC BY 4.0 License.

SOFTWARE 2

ARTICLES 1

HARDWARE 1

DISSEMINATION scientific audience

ISPRS Archives *[open-access]*

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVI-2/W1-2022
9th Intl. Workshop 3D-ARCH "3D Virtual Reconstruction and Visualization of Complex Architectures", 2–4 March 2022, Mantua, Italy

GOOD VIBRATIONS? HOW IMAGE STABILISATION INFLUENCES PHOTOGRAMMETRY

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Commission II

KEY WORDS: image and video stabilisation, motion blur, accuracy potential, camera calibration, interior orientation

ABSTRACT:

Image stabilisation (IS) is a family of approaches whose aim is to reduce motion blur in still images and shaking effect in video frames. A variety of techniques are currently implemented in cameras and camcorders: some involve hardware solutions, other are software approaches. In general, IS for still photography entails hardware in-camera or in-lens solutions. Video stabilisation, on the other hand, can be accomplished with software algorithms, either in real-time within the camera or in post-processing. Whereas IS aids photography and video making, its influence on the photogrammetric 3D modelling process has not been investigated. This article addresses this aspect. To this purpose, several laboratory and real-world tests were carried out, whose results showed that IS must be disabled when accuracy matters in photogrammetric projects. Details are provided in the manuscript.

1. INTRODUCTION

Many factors contribute to the sharpness of an image: the wavelength of the imaged electromagnetic radiation, the size of the lens aperture (the primary influencer of depth of field and the amount of diffraction softening), incorrect focusing, monochromatic lens aberrations (such as coma, astigmatism, and spherical aberration), longitudinal/axial and transverse/lateral chromatic aberrations, the amount and type of image noise plus possible denoising measures. Finally, there are also various causes for motion-induced unsharpness. This paper mainly focuses on the latter.

Unsharpness due to motion is either caused by movement of the object/scene to be photographed or motion of the camera (known as camera shake). Camera shake is not only present when shooting from very dynamic platforms like aeroplanes, satellites, UAVs, or cars, but even applicable when photographing hand-held as user tremor can result in vibrations whose magnitude is too big to be counteracted by the shutter speed. This hand-shake induced blur worsens with longer focal length lenses. To still obtain a sharp image from a hand-held camera and lens combination, the general rule-of-thumb is that the exposure time should be equal or shorter than the reciprocal of the 35mm format equivalent focal length in use. As an example: a 50 mm lens necessitates a shutter speed of at least 1/50 s. In photography, this guideline is known as the reciprocal rule.

In situations where the object/scene is static, several techniques exist to extend this exposure time (i.e. slowing down the shutter speed): either via extra camera support (passive like a tripod or active via a gimbal) or exploiting a function available in most photographic systems, i.e. the image stabilisation. Although this function can mean the difference between a blurry picture and a sharp one, its use in photogrammetric image acquisition is usually discouraged as it continuously changes the camera's interior orientation. This paper wants to check if this advice is valid by delving into image stabilisation techniques and quantifying their possible negative influence on the photogrammetric process.

1.1 Image stabilisation techniques

The term image stabilisation (IS) refers to a range of techniques developed to reduce motion blur in images and frame-to-frame jitter in videos (Figure 1).

A first, basic distinction can be made between hardware and software stabilisation. In the first case, it is referred to as optical stabilisation (OIS), which can take place in the lens (lens-based IS), in the camera body on the imaging sensor (sensor-shift or in-body IS) or via a combination of the two methods (dual IS).

The different OIS techniques are named differently depending on the camera manufacturer. For example, the in-lens IS implemented by Nikon is called vibration reduction (VR), while Canon dubs its system image stabilizer (IS).

Software stabilisation implemented in some video cameras can perform in real-time and it is called digital IS (DIS) or electronic IS (EIS). If, on the other hand, videos are edited in post processing (offline), then stabilisation algorithms, also known as stabilisation filters, are used.

While OIS is effective in reducing blur due to the motion of a camera, including involuntary hand shaking, EIS does not solve the problem of motion blur but improves the smoothness of the video by reducing the trembling or jitter between frames.

OIS uses sensors, such as gyroscopes, to detect camera movement and actuators to move the lens and/or sensor to counteract the motion. Over time, systems have evolved from techniques based on inertial sensors arranged on 2-axis to current 5-axis methods such as those implemented in Olympus or Sony.

In EIS, gyroscopes or accelerometers are also employed to measure hand jitter and the frames are shifted by a commensurate number of pixels. EIS requires the frames to be cropped with respect to the full sensor size, as the sensor edges are used as buffer zones to compensate for the motion (Sachs et al., 2006).

This contribution has been peer-reviewed.
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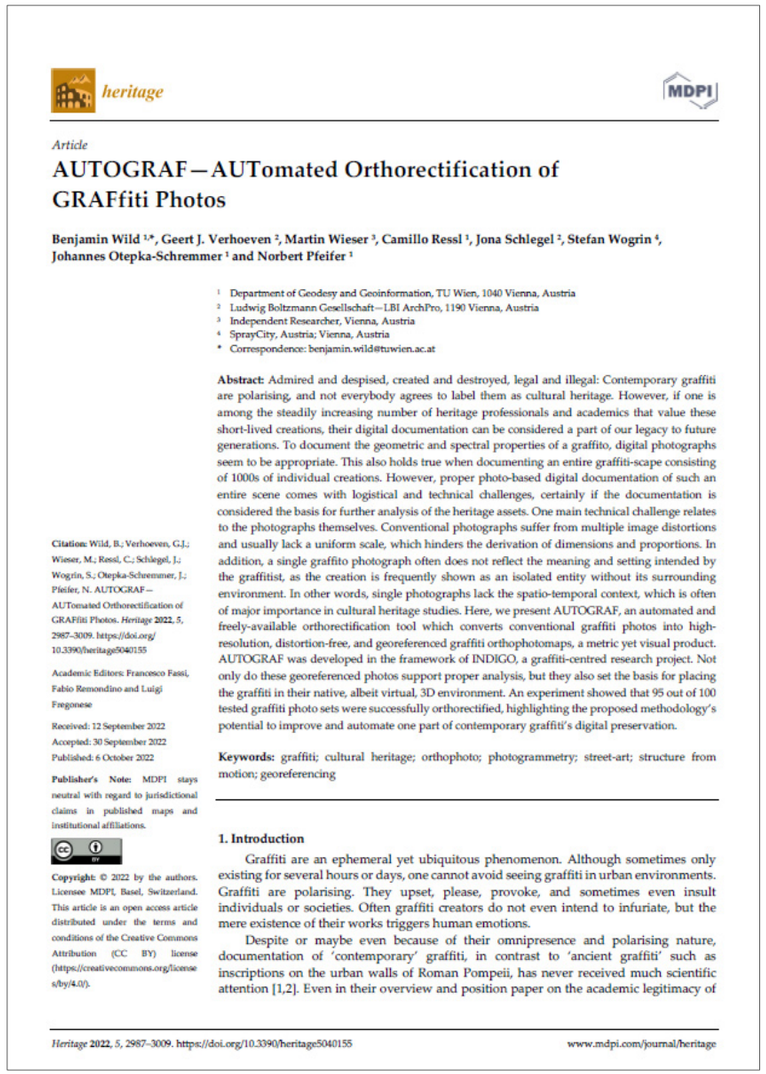

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AUTOGRAF—AUTomated Orthorectification of GRAFfiti Photos

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

Citation: Wild, B.; Verhoeven, G.J.; Wieser, M.; Ressl, C.; Schlegel, J.; Wogrin, S.; Otepka-Schremmer, J.; Pfeifer, N. AUTOGRAF—AUTomated Orthorectification of GRAFfiti Photos. *Heritage* **2022**, *5*, 2987–3009. https://doi.org/10.3390/heritage5040155

Academic Editors: Francesco Fassi, Fabio Remondino and Luigi Fregonese

Received: 12 September 2022
Accepted: 30 September 2022
Published: 6 October 2022

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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

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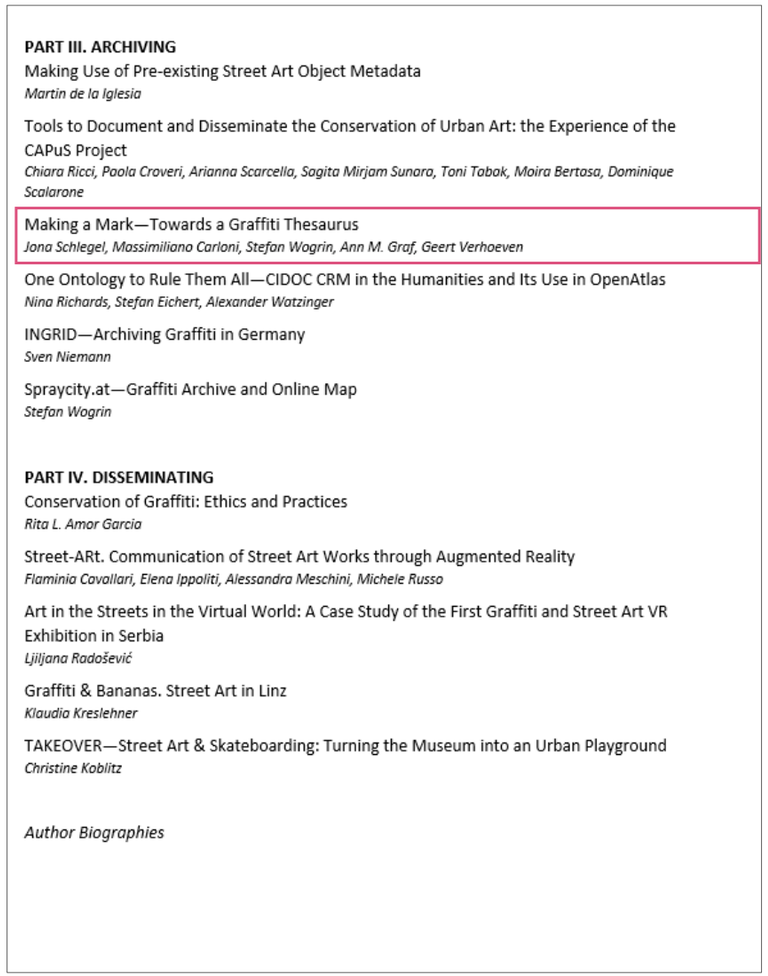

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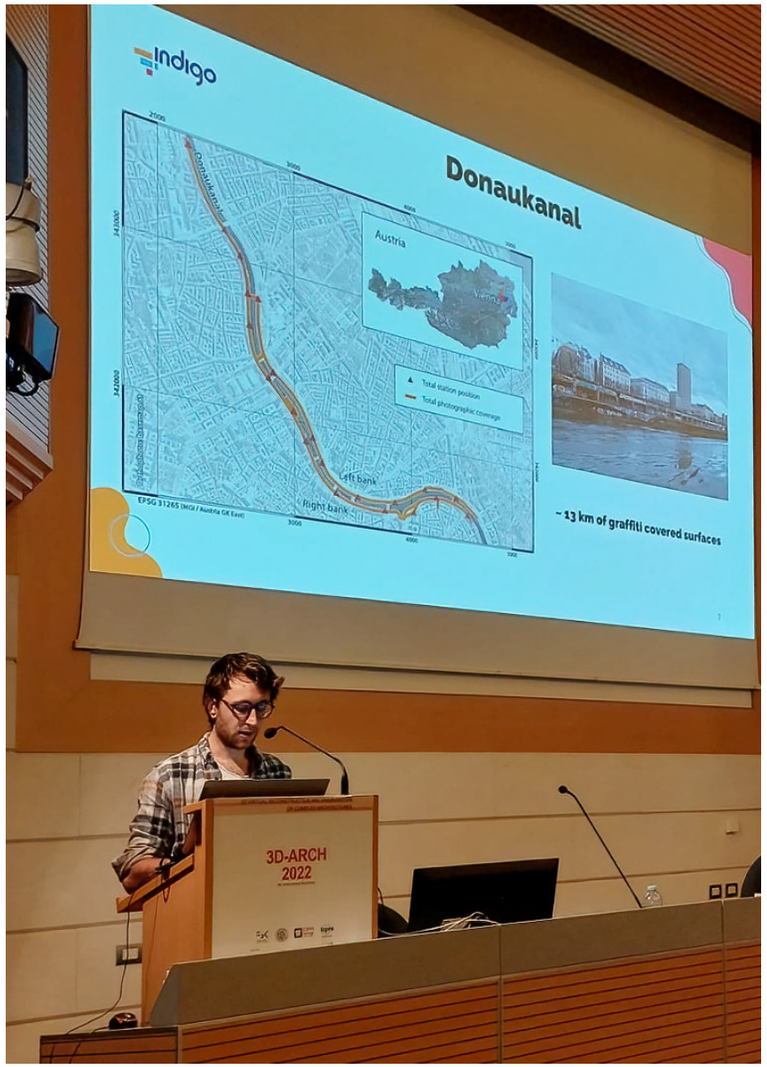

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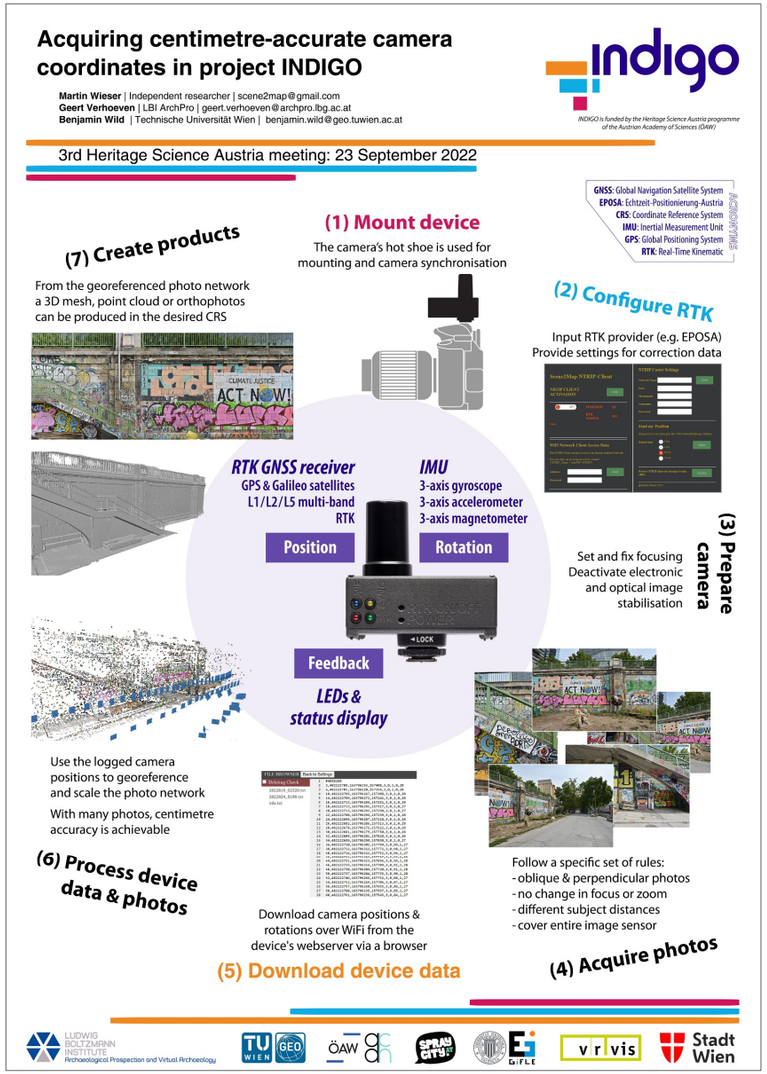

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How project INDIGO automatically turns graffiti photos into orthophotomaps

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INDIGO is funded by the Heritage Science Austria programme of the Austrian Academy of Sciences (ÖAW)

3rd Heritage Science Austria meeting: 23 September 2022

1 - Why orthophotomaps?

Conventional photographs suffer from various distortions:
(1) Perspective distortions
(2) Topographic distortions
(3) Lens distortions (not well visible but they exist!)

Orthophotomaps have the distortions removed, making them:
Distortion-free
High-resolution
Georeferenced
} maps of graffiti

Area: 51.2 m² Perimeter: 36.82 m

2 - How to make them?

Four types of data are required:
(a) a set of **graffito-specific photographs**
(b) the **camera orientations** (interior and exterior)
(c) a **3D model** of the graffito-covered **surface**
(d) a **reference plane** to project the orthophotomap on

3 - INDIGO's AUTOGRAF tool

To **automatically** generate orthophotomaps from 1000s of photos, the open-source tool **AUTOGRAF** was developed within INDIGO
[*AUTomated Orthorectification of GRAFfiti photos*]

Initial quality and consistency checks
Derivation of camera orientations via incremental SfM
3D surface mesh and reference plane
Computation of the orthophotomap

4 - The 100-graffiti test

AUTOGRAF was tested on a sample dataset of **826 images** corresponding to **100 graffiti** along the Donaukanal

97% of the tested graffiti were sucessfully orthorectified

AUTOGRAF needed <6min to process one graffito photo set

The average orthophotomap raster cell size is below 1mm

[1] Benjamin W., Geert V., Stefan W., Martin W., Johannes O.-S. and Norbert P. Urban creativity meets engineering. Automated graffiti mapping along Vienna's Donaukanal. *gis4OOD symposium 2022 proceedings, Urban Creativity, in preparation.*
[2] Benjamin W., Geert V., Jona G., Stefan W., Martin W., Camila K., Johannes O. S. and Norbert P.: AUTOGRAF – Automated Orthorectification of GRAFfiti photos. *Heritage, in preparation.*

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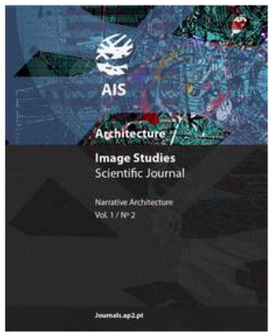
DISSEMINATION scientific audience

UC

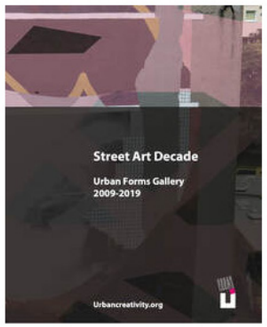


Architecture Image Studies - Narrative Architecture

Much of the work published here was initially exhibited in a series of exhibitions, most recently as part of the Shanghai Urban Space Art Season 2019 in the exhibition 'Sensorium'. Through the production of these drawings and texts, the contributors seek to align themselves with a tradition of visionary narratives and use the multiple platforms of dissemination to communicate those ideas to a wider set of audiences beyond architectural academia.

AUTHORS
Nic Clear, Hyun Jun Park

Check here the contents
Request here the printed copy



Street Art Decade Urban Forms Gallery 2009-2019

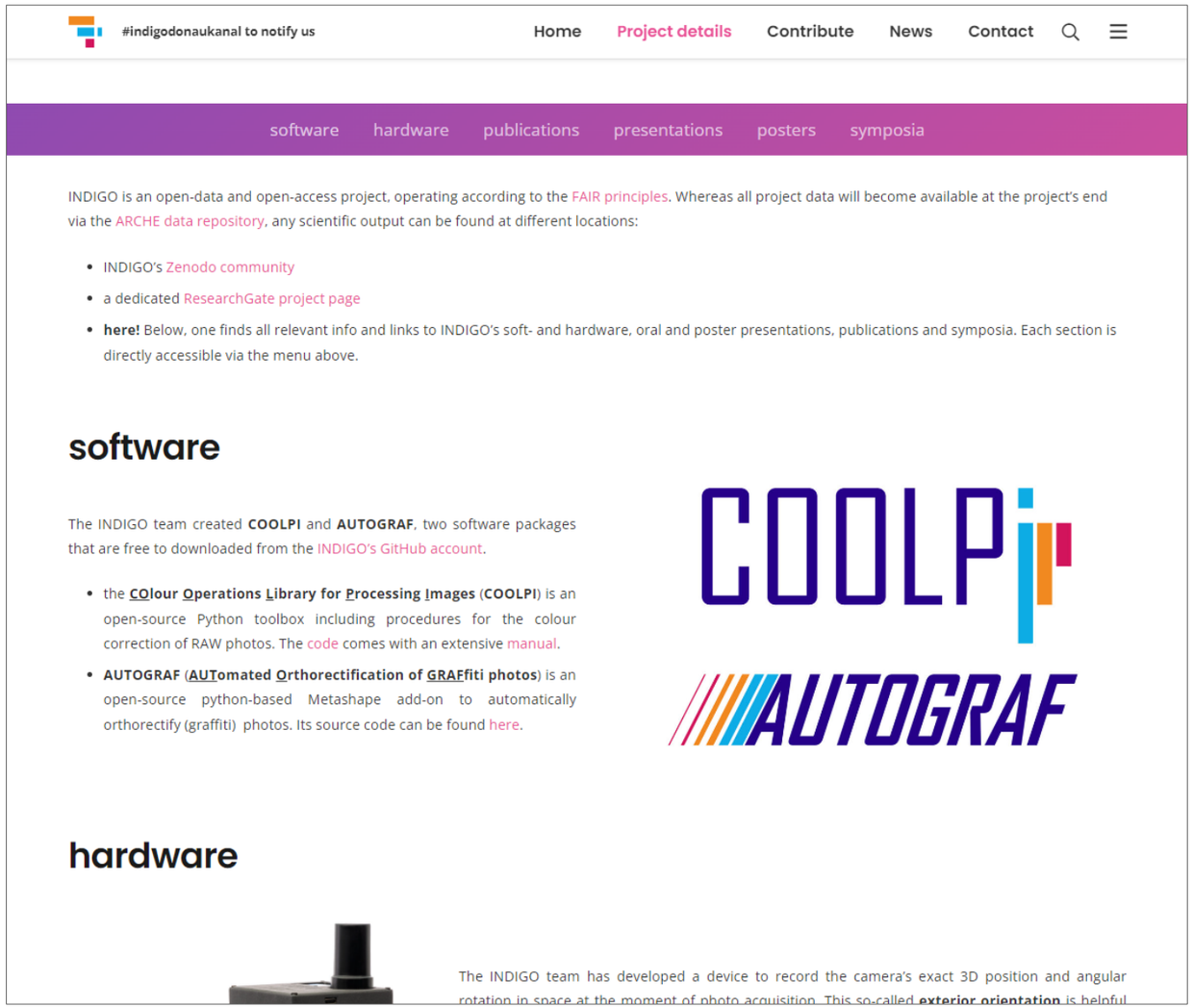
The book has been created for admirers of urban art interested in learning about and experiencing cityspace. It contains photos and standardised descriptions of all external works completed by the Urban Forms Foundation in the years 2009–2019 mainly in Łódź (Poland).

AUTHORS

TALKS 11	SYMPOSIUM 1
POSTERS 2	EDITED VOLUME (1)

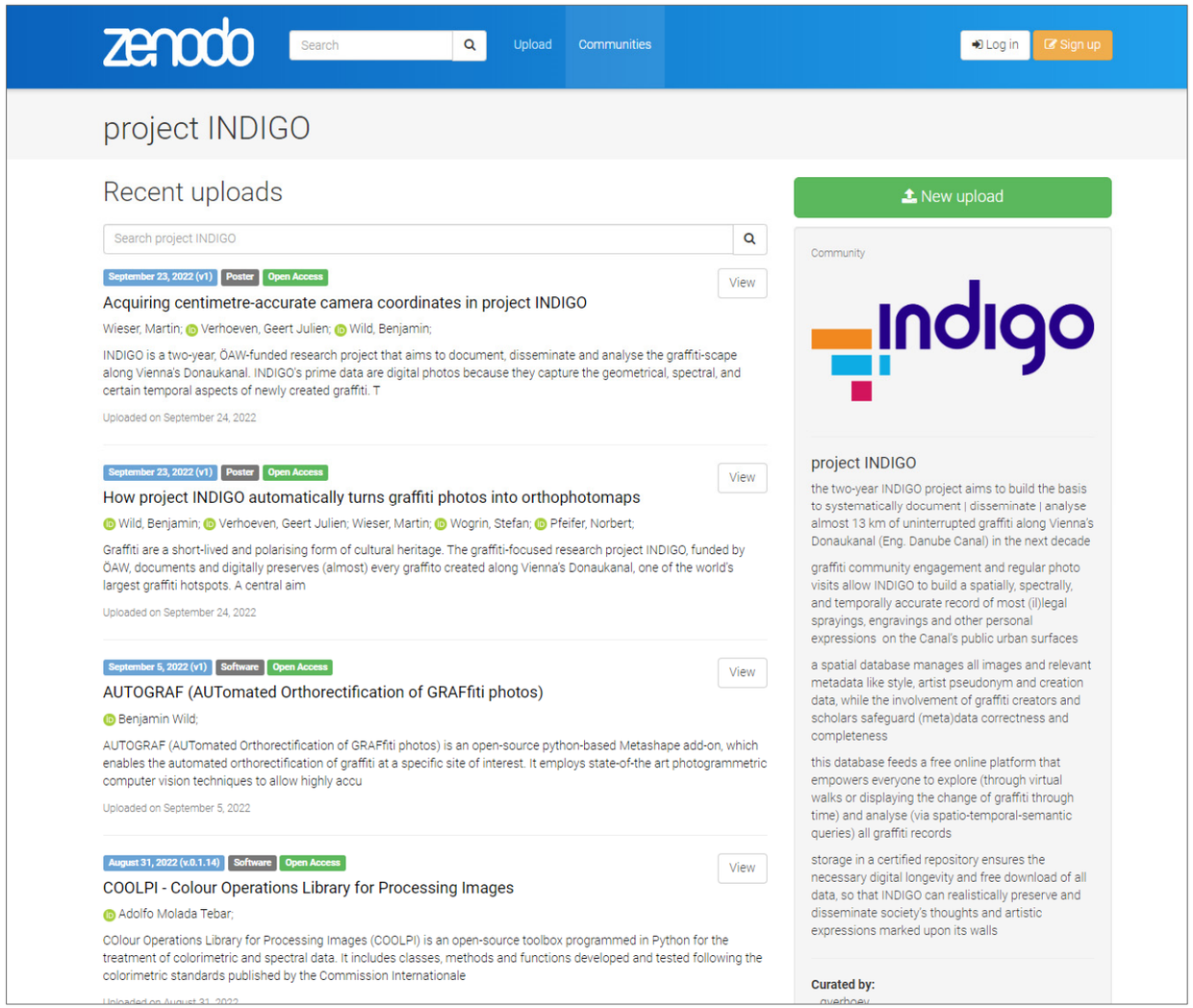
INDIGO website

https://projectindigo.eu



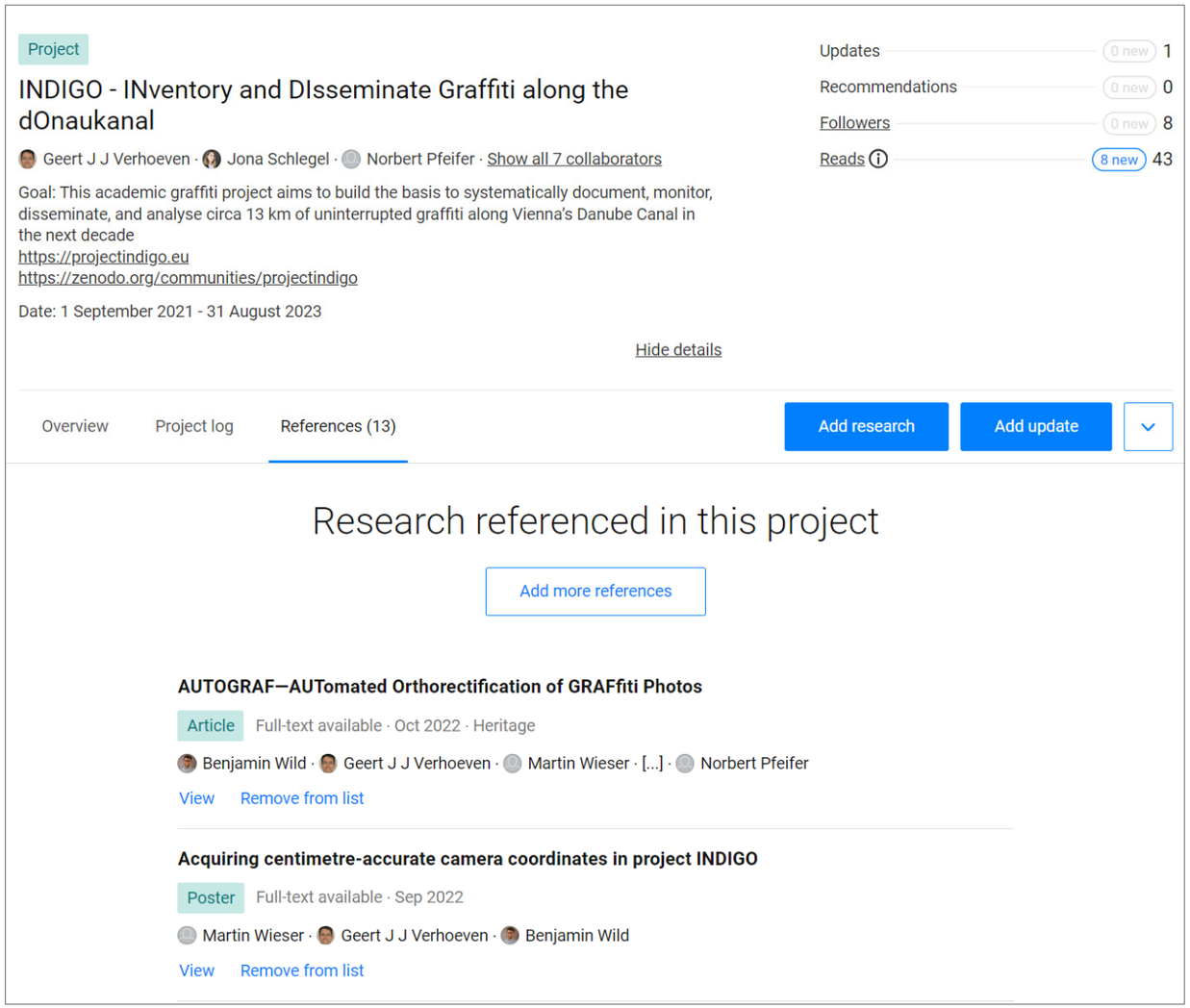
ZENODO community

https://zenodo.org/communities/projectindigo



RESEARCHGATE project page

https://www.researchgate.net/project/INDIGO-INventory-and-DIsseminate-Graffiti-along-the-dOnaukanal



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part 1 [13:30 – 14:30]

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AUTomated Orthorectification of GRAFfiti Photos

Benjamin Wild, Norbert Pfeifer, Geert Verhoeven, Martin Wieser, Camillo Ressl, Johannes Otepka-Schremmer, Stefan Wogrin

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

26779

What does this number represent?

of Photos taken by INDIGO

January	1620
February	2957
March	2552
April	4093
May	6315
June	2954
July	6288
	26779

What does this number represent?

No matter what we do with the photos, it must be automated and fast...

AUTOGRAF

AUTomated Orthorectification of GRAFfiti Photos

Why Orthophotos?

Why Orthophotos?

- Distortions
  - Perspective

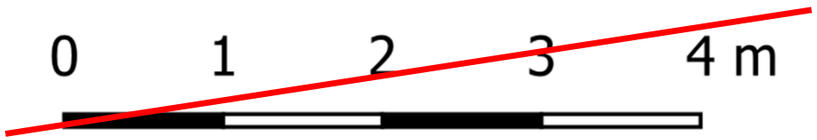
Why Orthophotos?

- Distortions
  - Perspective
  - Topography
  - Lens distortions

Why Orthophotos?

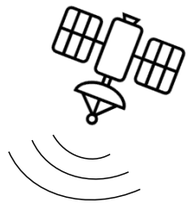
- Distortions
  - Perspective
  - Topography
  - Lens distortions
- Georeferenced
  - Locate it in space
  - Measure proportions
  - Stitch photos together

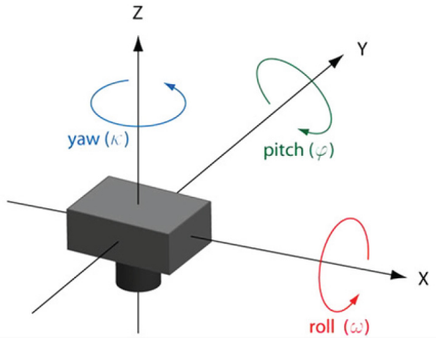
Why Orthophotos?



- Distortions
  - Perspective
  - Topography
  - Lens distortions
- Georeferenced
  - Locate it in space
  - Measure proportions
  - Stitch photos together

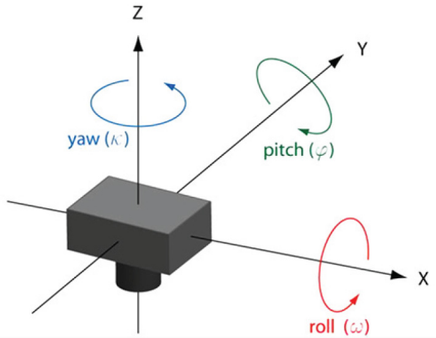
Orthophoto recipe

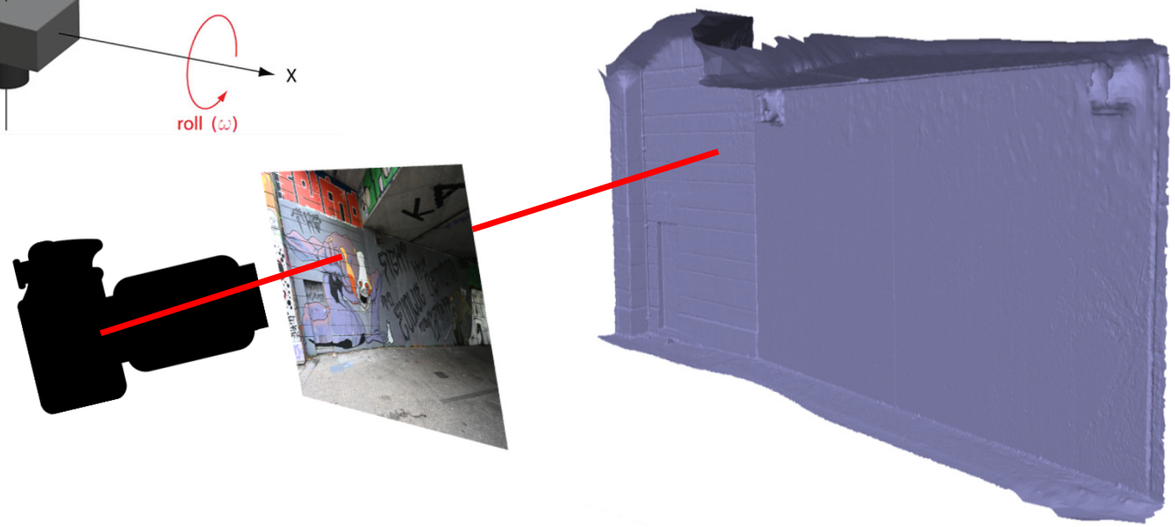




Camera orientation

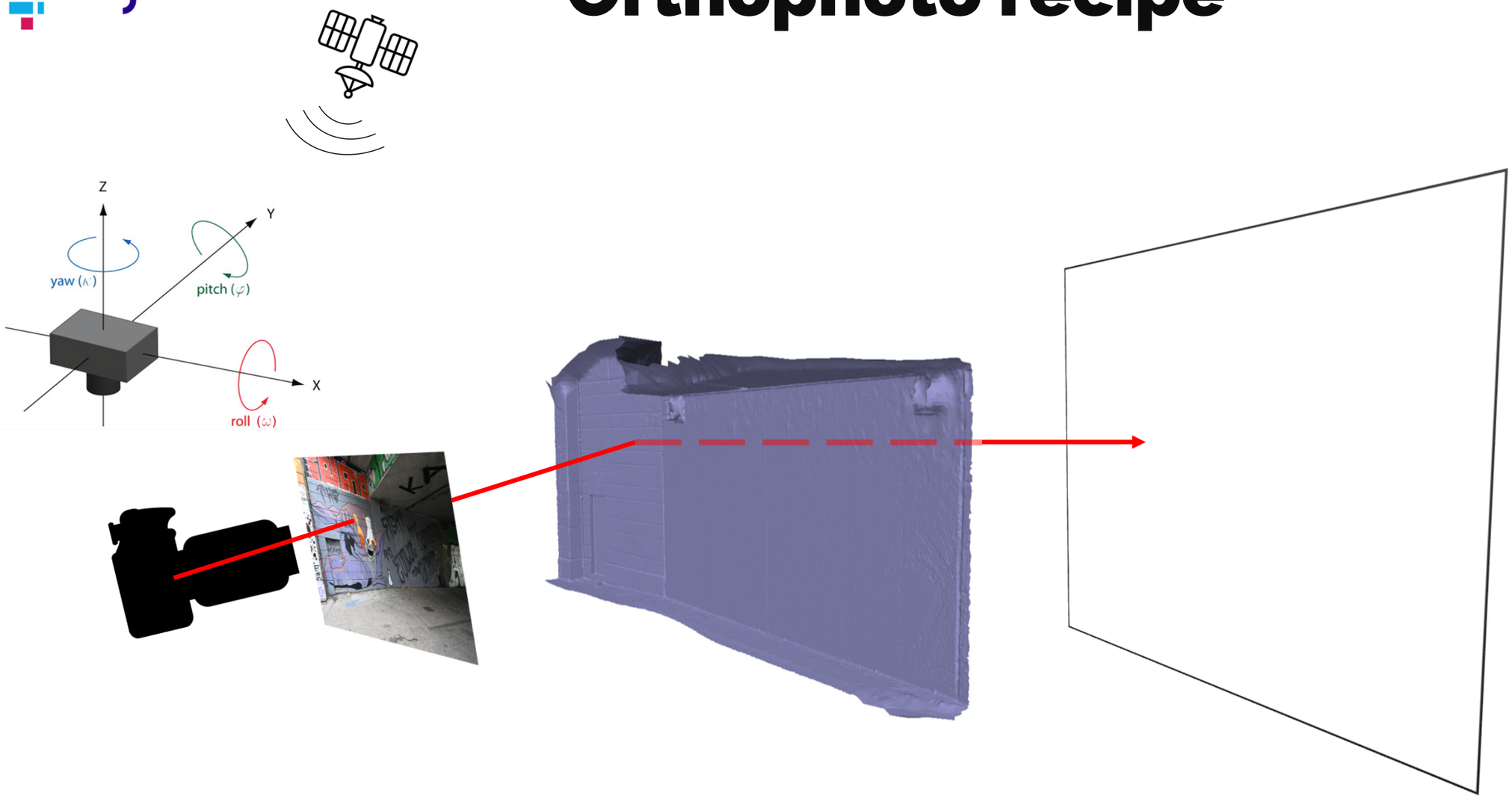
Orthophoto recipe





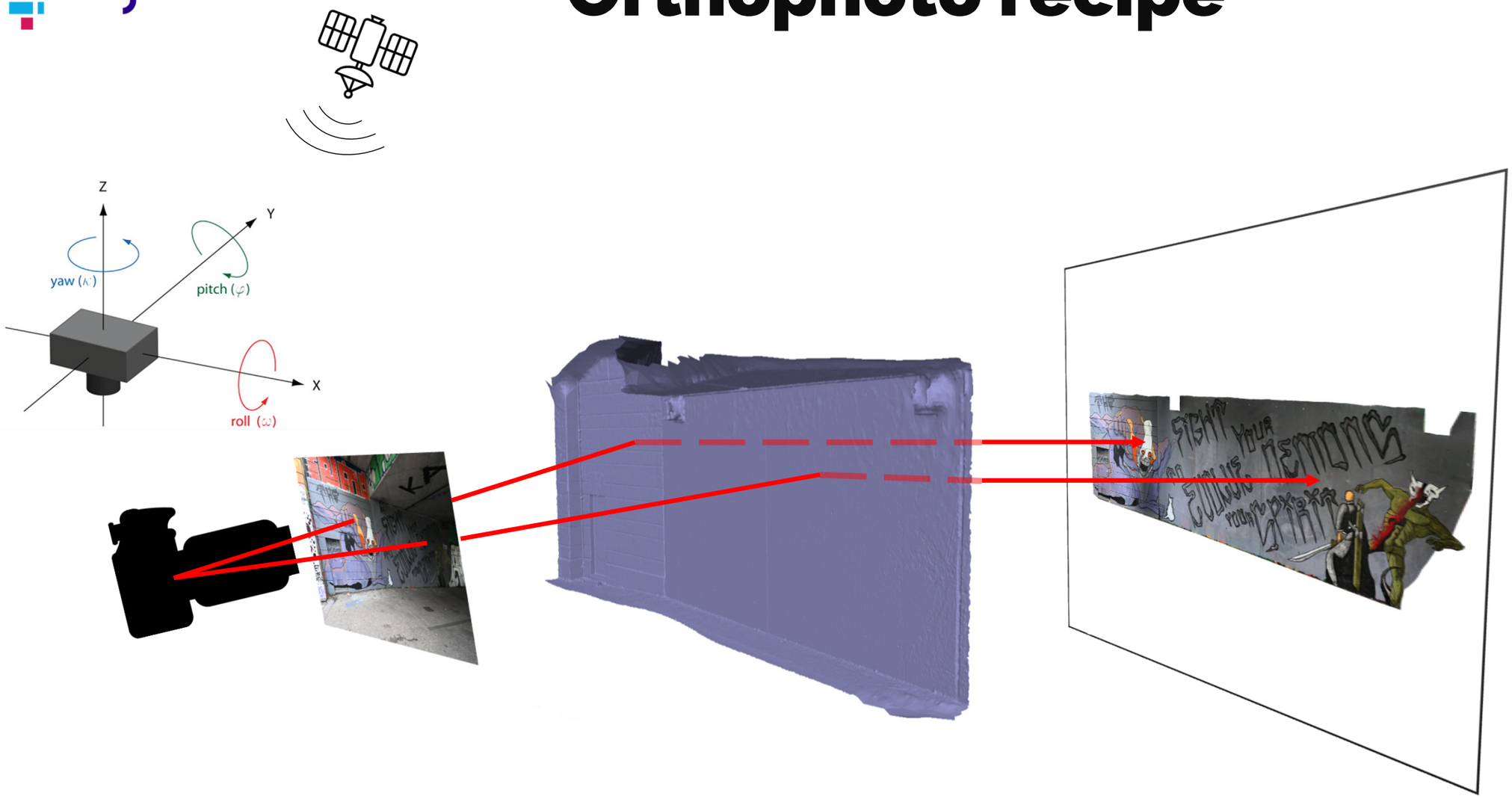
Camera orientation + 3D model

Orthophoto recipe



Camera orientation + 3D model + Projection plane

Orthophoto recipe

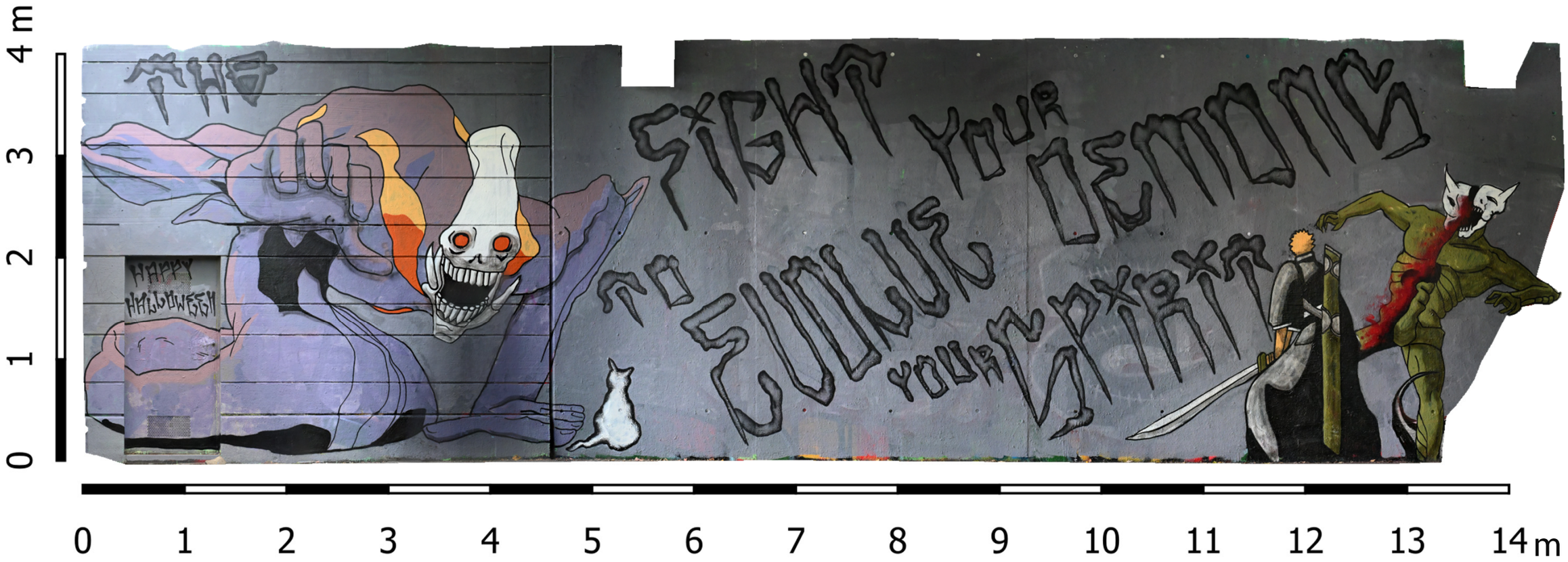


Camera orientation + 3D model + Projection plane

Orthophoto

THE
HAPPY
HALLOWEEN
FIGHT YOUR DEMONS
TO EVOLVE YOUR SPIRIT

Orthophoto



Perimeter	36.82 m
Area	51.2 m^2

FIGHT YOUR DEMONS
TO SAVE YOUR SPIRIT
INDIGO_2022_11_13
Research area
0
10
20 m
EPSG: 31256 (MGI / Austria GK East)

HOW?

HAPPY
HALLOWEEN
TO FIGHT YOUR DEMONS
YOUR SPIRIT

HAPPY
HALLOWEEN
TO FIGHT YOUR DEMONS
YOUR SPIRIT
0 1 2 3 4 m
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 m

Ca. 10 images of a new graffito (different viewing directions/tilts/positions)

INDIGO_2021-12-28_Z7II-B_0292.jpg

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

INDIGO_2021-12-28_Z7II-B_0297.jpg

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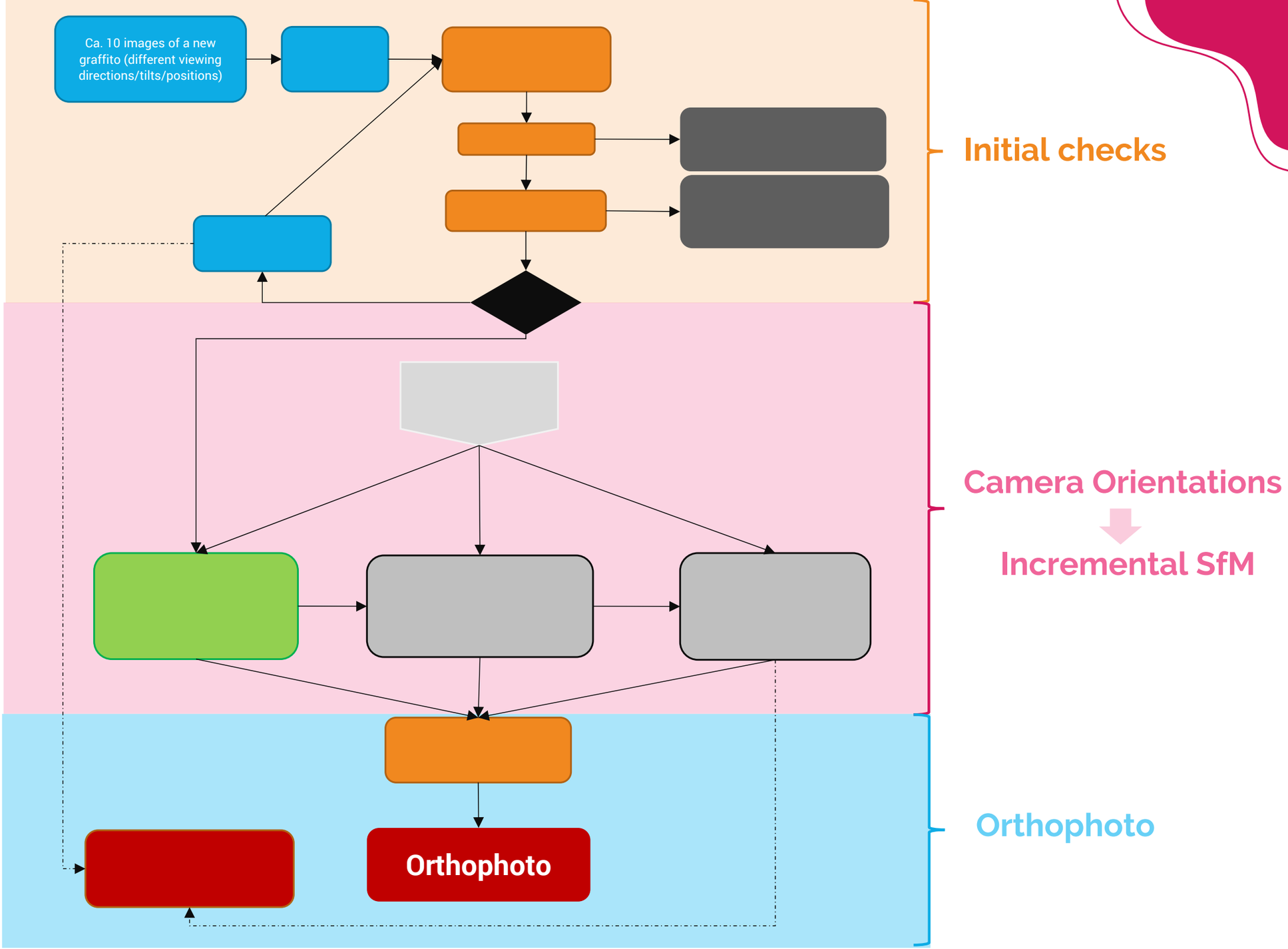
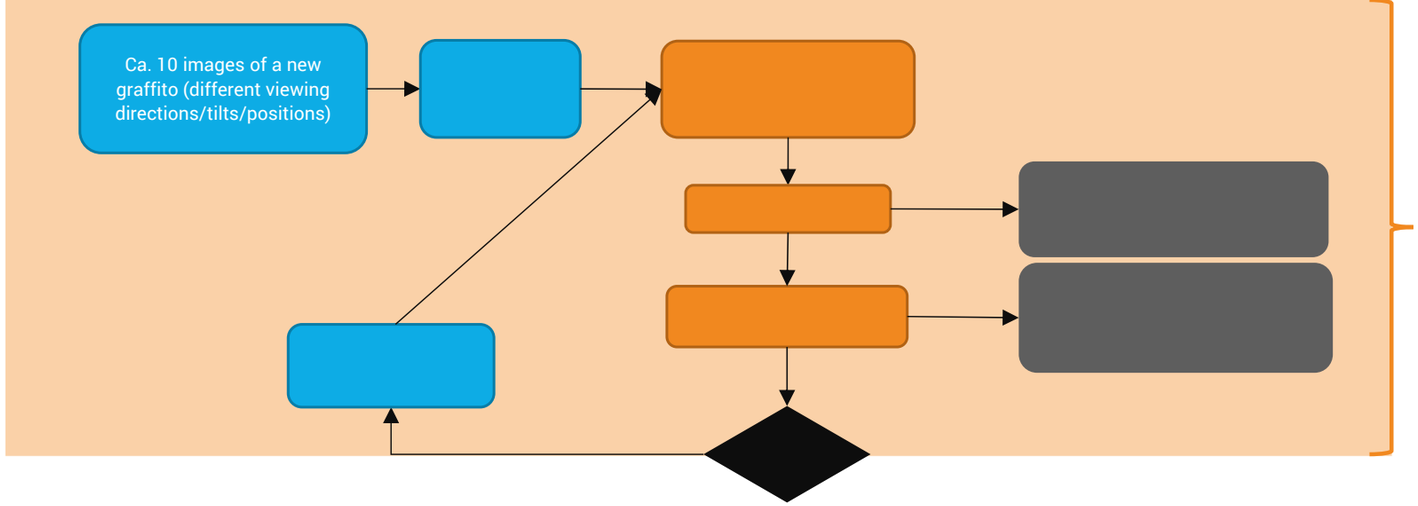
INDIGO_2021-12-28_Z7II-B_0299.jpg

Orthophoto


Ca. 10 images of a new graffito (different viewing directions/tilts/positions)
Orthophoto
Initial checks
Camera Orientations
Incremental SfM
Orthophoto



Initial checks

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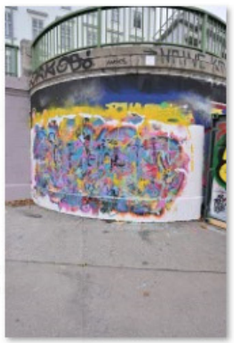
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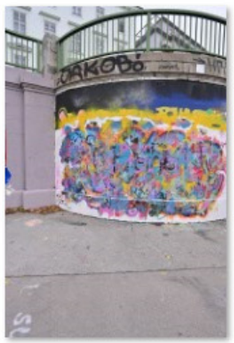
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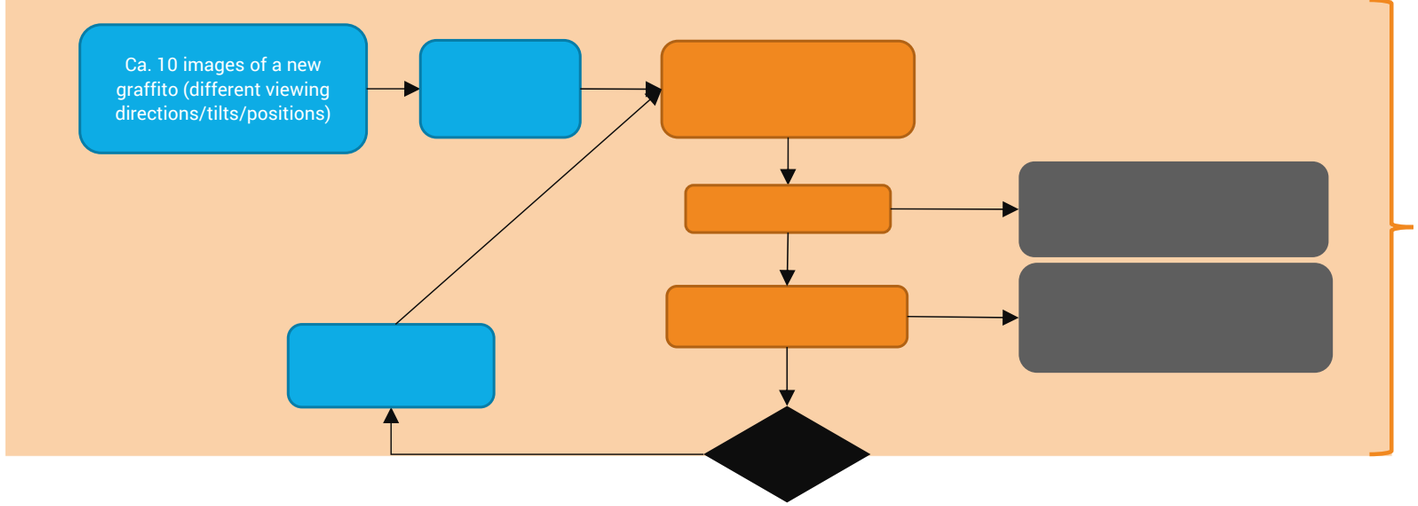
Initial checks



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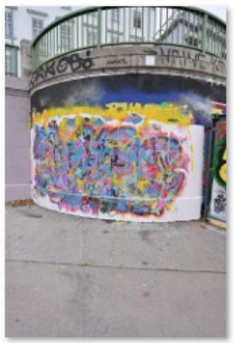
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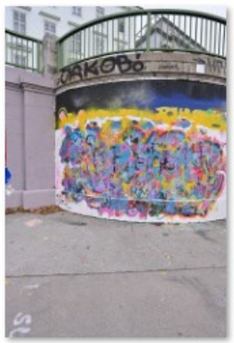
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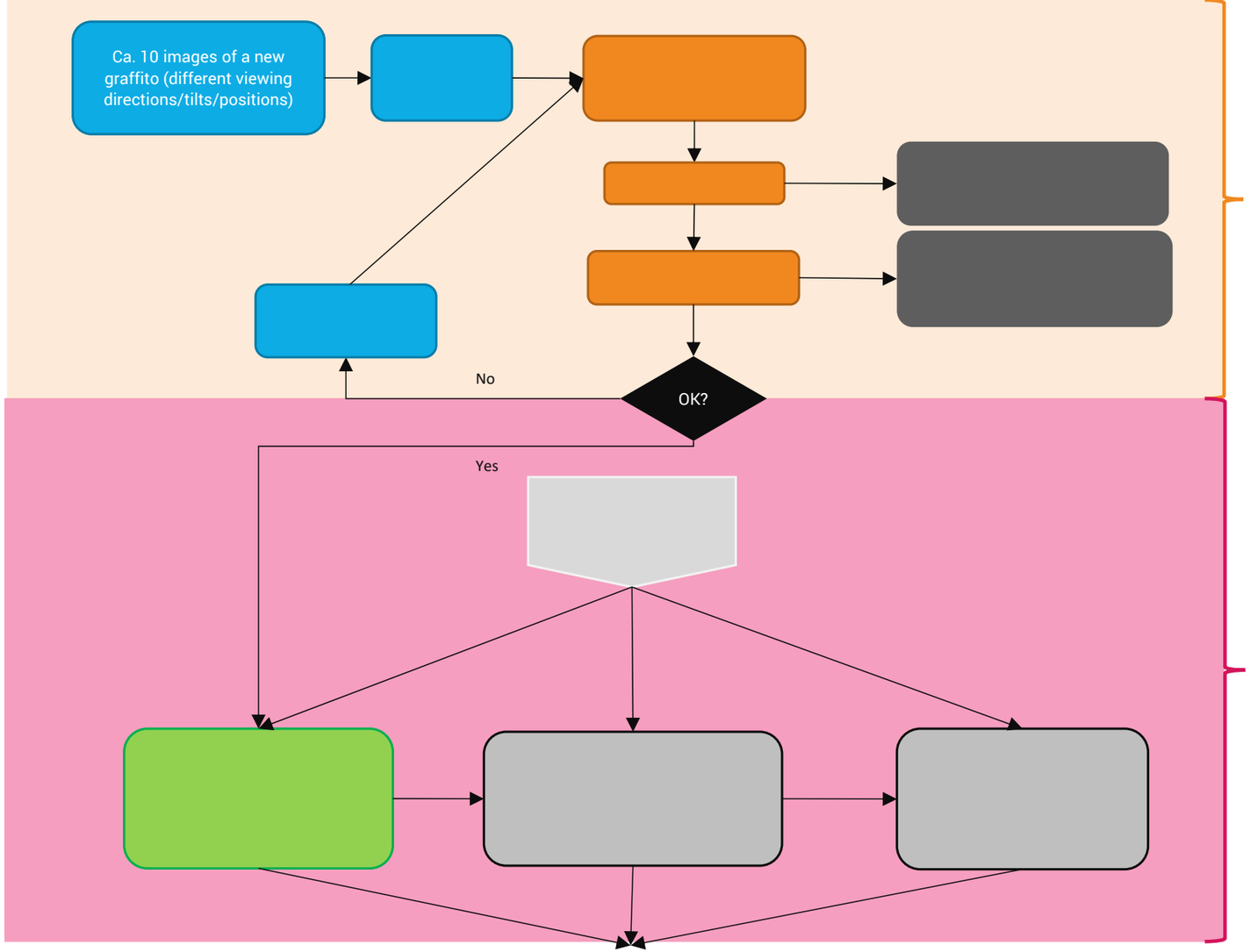
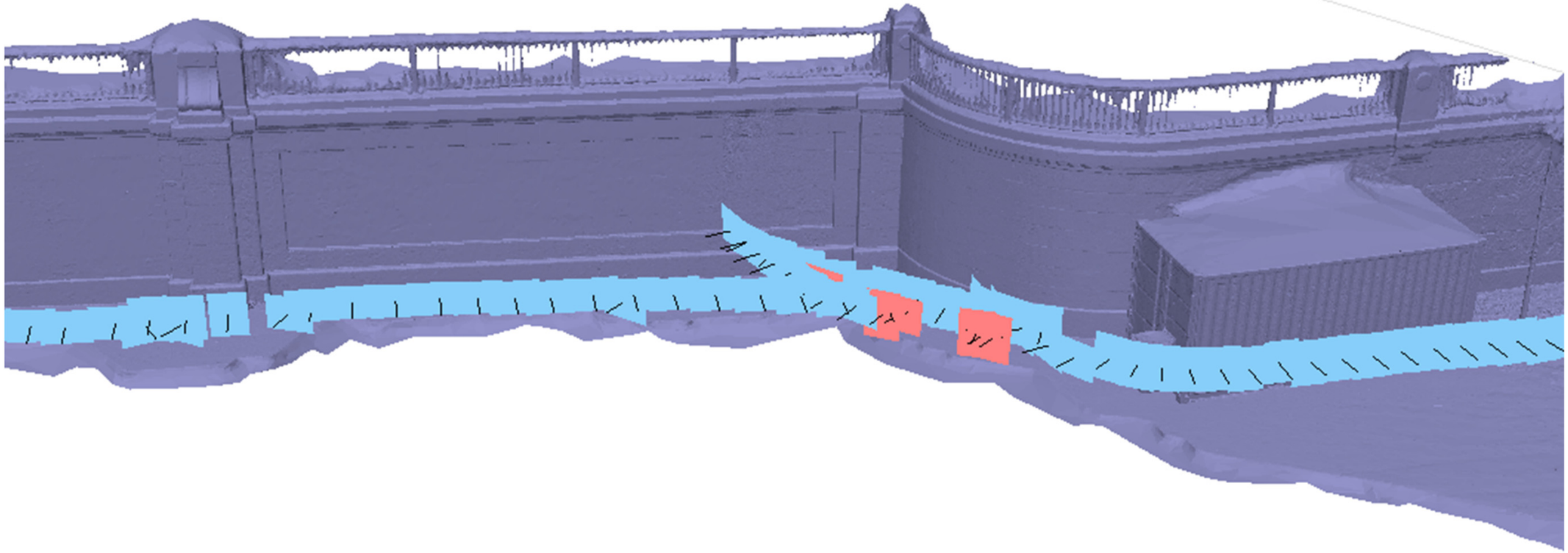


Initial checks

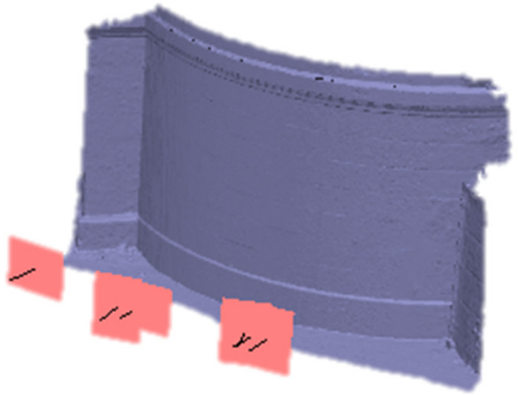
Camera Orientations

Incremental SfM

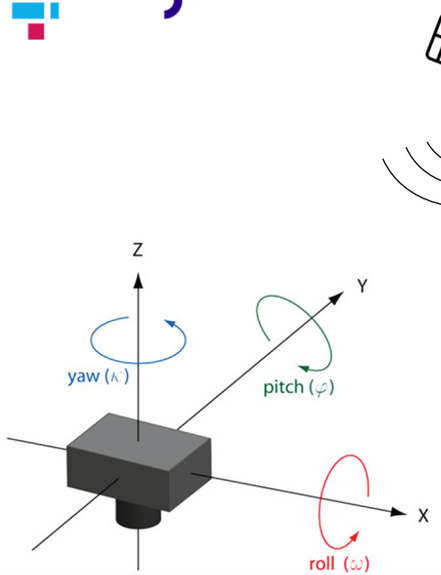
Incremental SfM

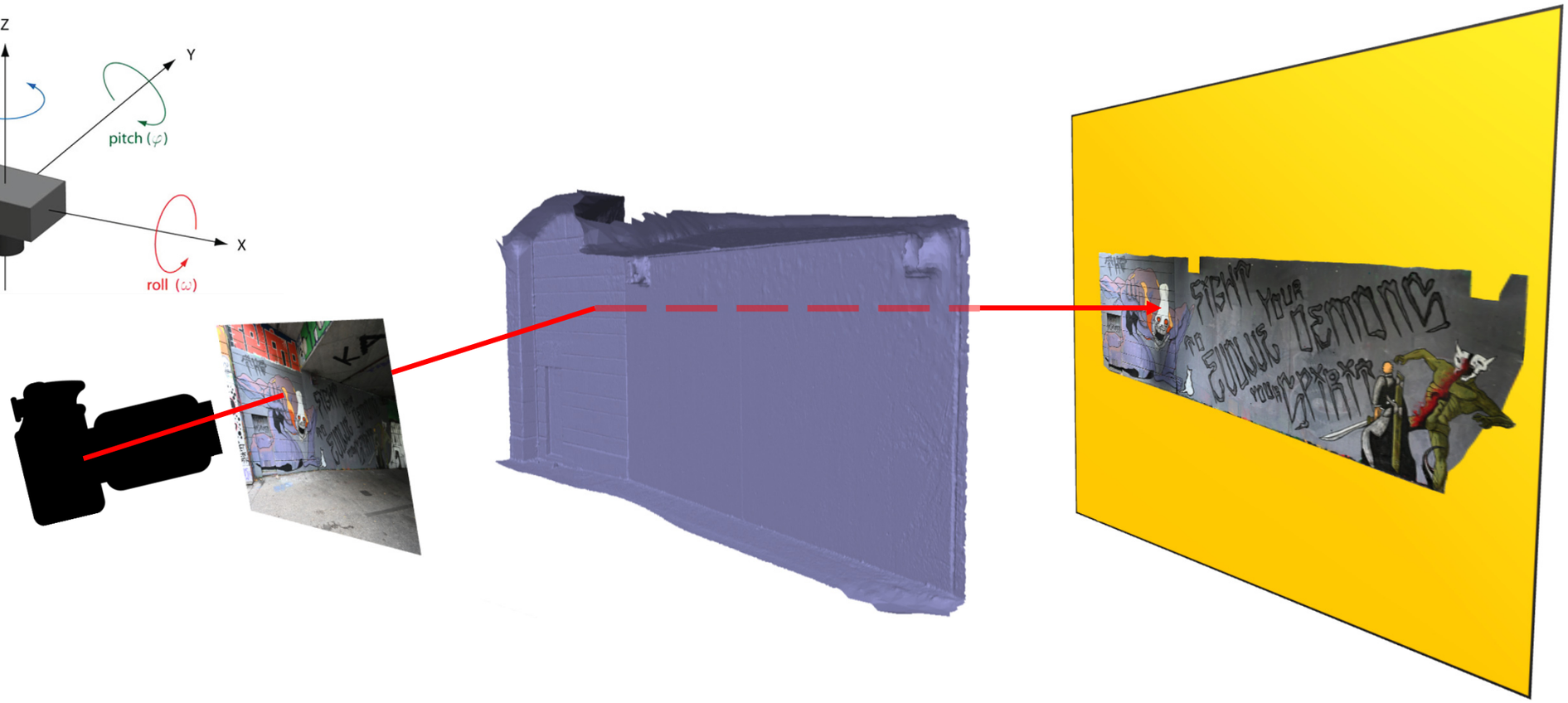


3D Model



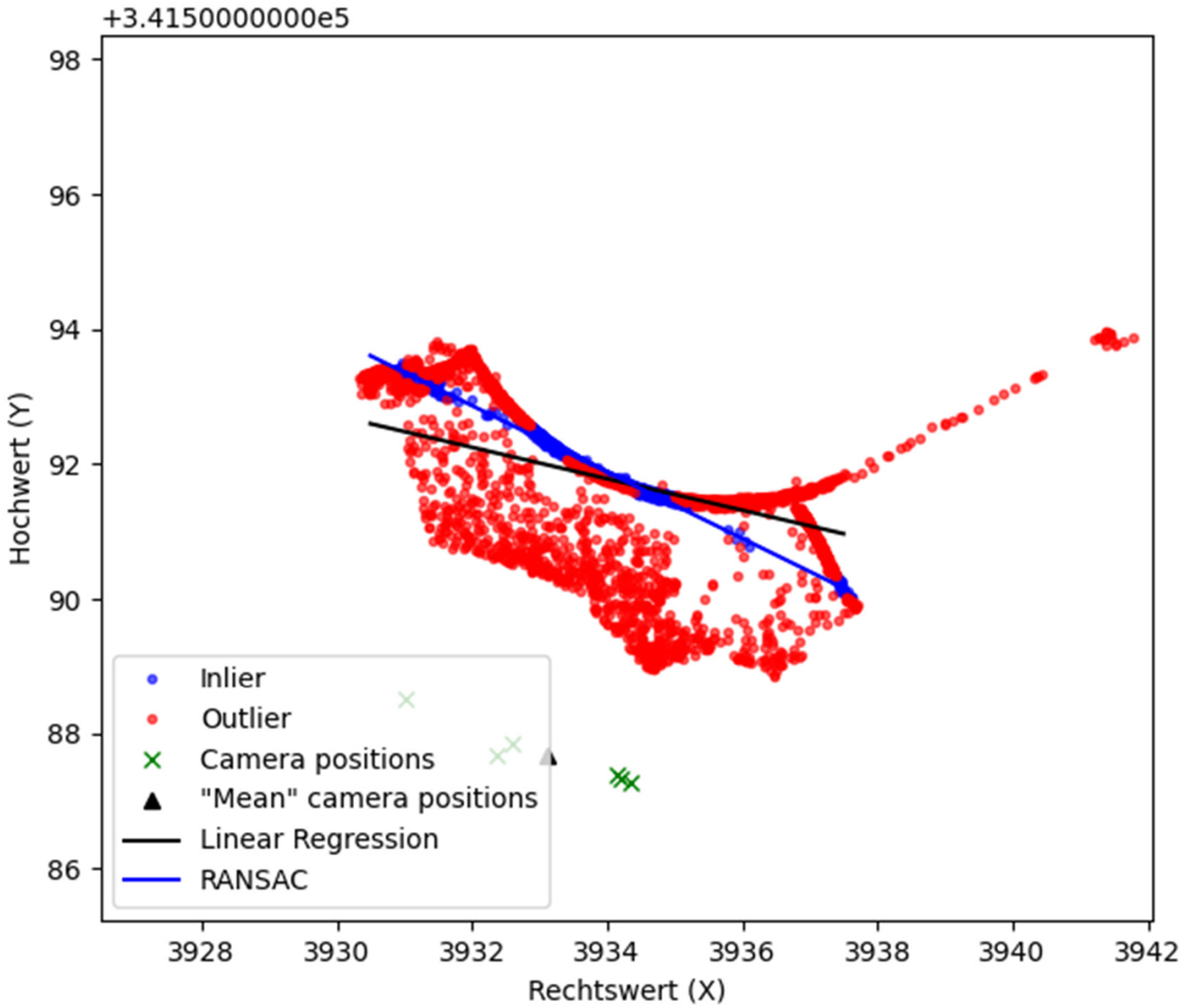
Projection plane





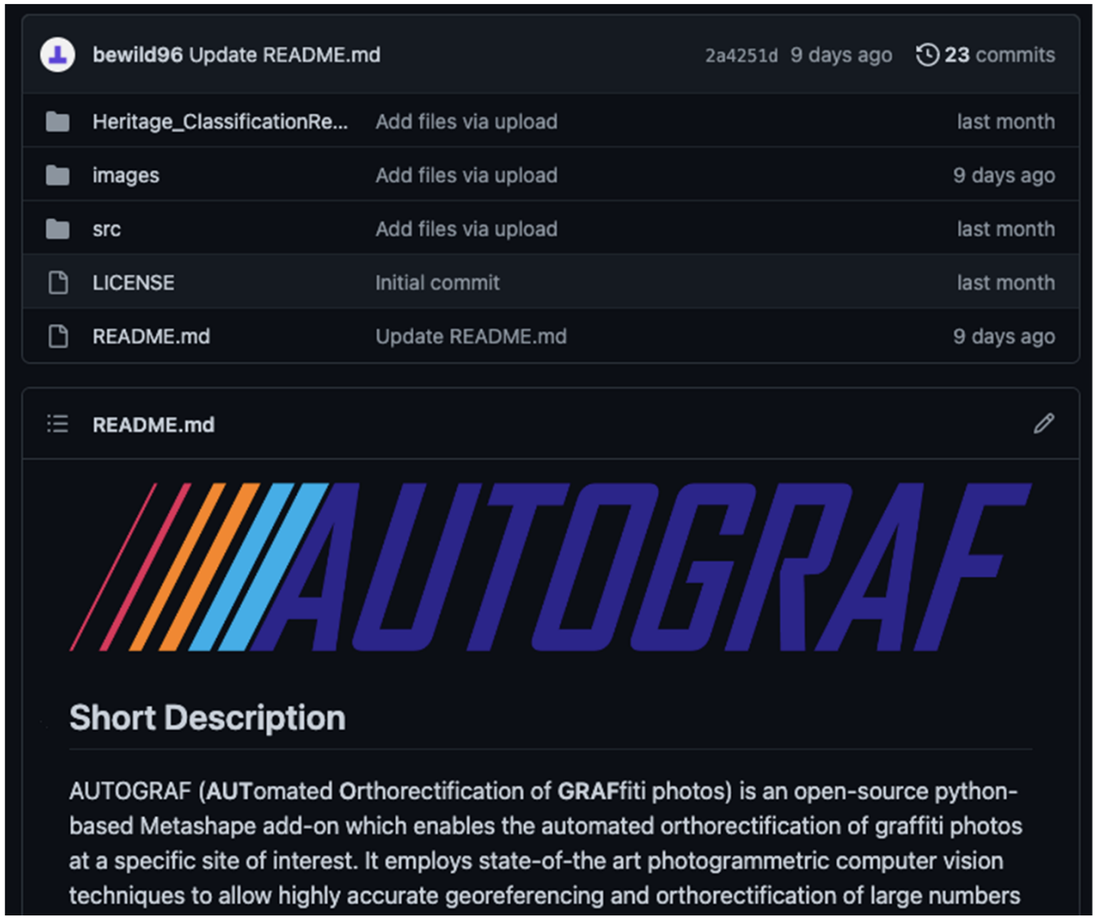
Camera orientation ✓ + 3D model ✓ + **Projection plane**

Projection plane



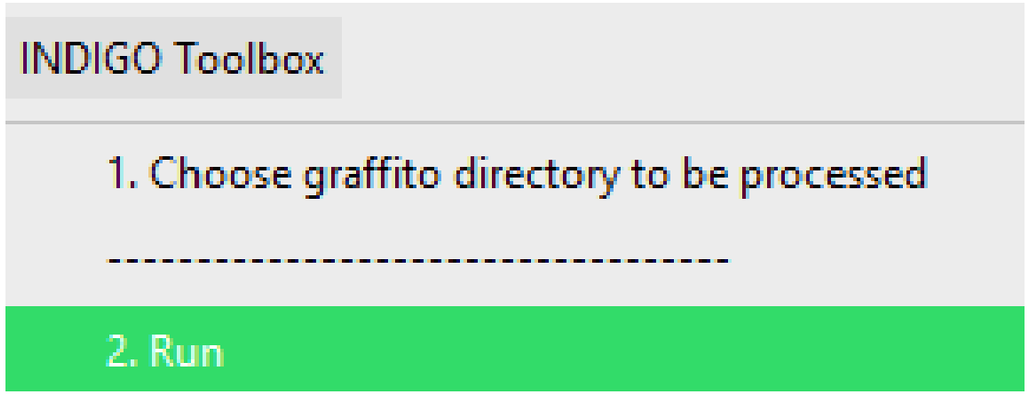
One click = Hundreds of Orthophotos

AUTOGRAF



python™

Metashape



- **Processing times:**
  - **ca. 1800 photos (ca. 220 graffiti) per day**

indigo

This is an early access version, the complete PDF, HTML, and XML versions will be available soon.

Open Access Article

MDPI

heritage

AUTOGRAF—AUTomated Orthorectification of GRAFfiti Photos

by 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]

[1] Department of Geodesy and Geoinformation, TU Wien, 1040 Vienna, Austria
[2] Ludwig Boltzmann Gesellschaft—LBI ArchPro, 1190 Vienna, Austria
[3] Independent Researcher, Vienna, Austria
[4] SprayCity, Austria; Vienna, Austria
* Author to whom correspondence should be addressed.

Academic Editors: Francesco Fassi, Fabio Remondino and Luigi Fregonese

Heritage **2022**, *5*(4), 2987-3009; https://doi.org/10.3390/heritage5040155 (registering DOI)

Received: 12 September 2022 / Revised: 29 September 2022 / Accepted: 30 September 2022 / Published: 6 October 2022

(This article belongs to the Special Issue **3D Virtual Reconstruction and Visualization of Complex Architectures**)

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

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Geert /	COOLPI	14:05
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Alex, Bernhard & Nina /	New OpenAtlas features for INDIGO	14:20

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COOLPI

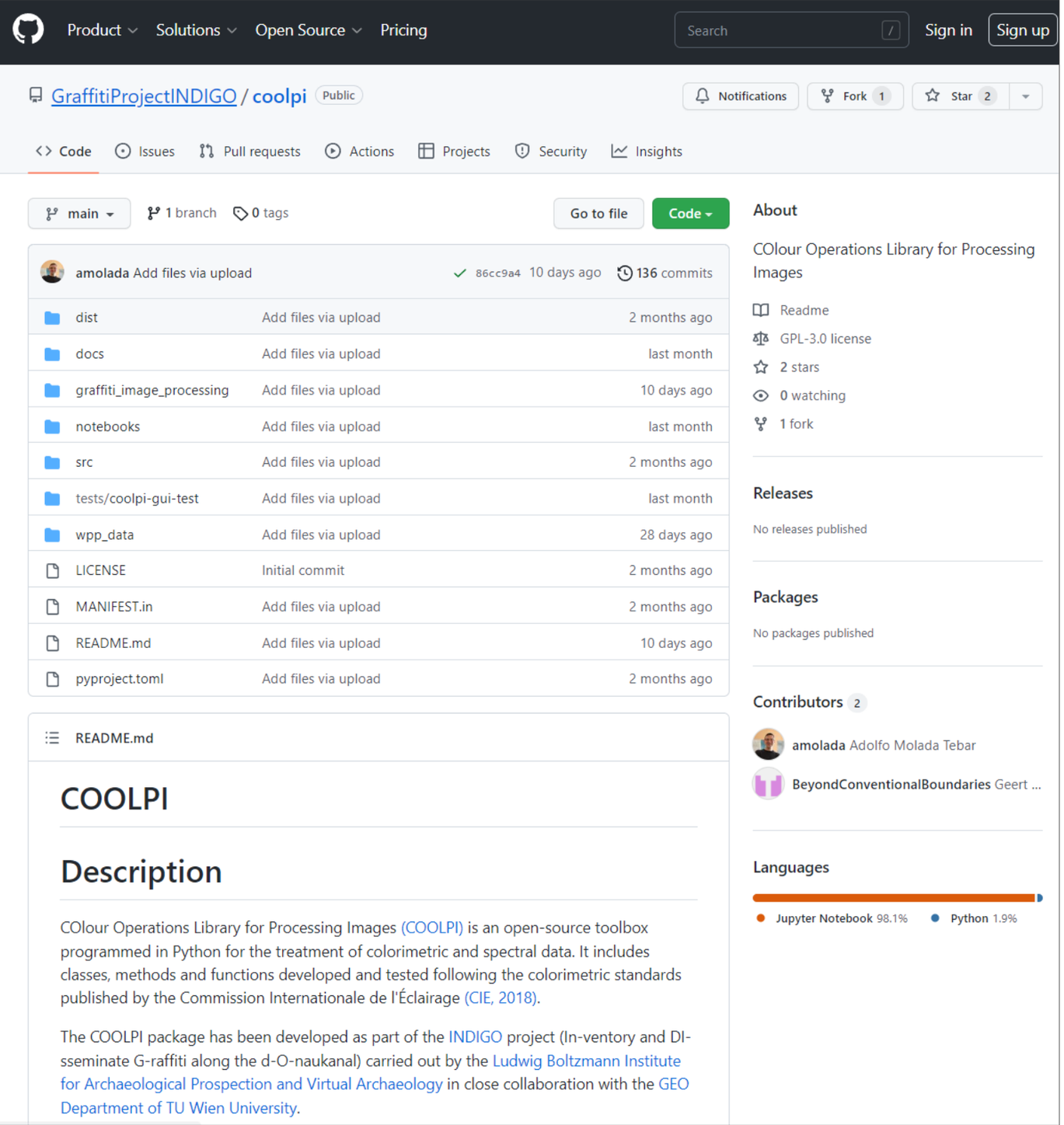
colour-accurate pixels

COOLPI

COOLPI

COOLPI

colour-accurate pixels



COOLPI

colour-accurate pixels

COOLPI

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2.1 Dependencies
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3.1.1 Create an instance
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3.2 Component
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4.2.1 Create an instance
4.2.2 Attributes
4.2.3 Methods
4.2.4 Plot
4.3 CIEuvY
4.3.1 Create an instance

Alert

The dependencies should have been installed automatically along with COOLPI. Please check that everything is correct.

3 CIE

The Commission Internationale de l'Éclairage (CIE) establishes standards of response functions, models and procedures of specification relevant to photometry, colorimetry, colour rendering, visual performance and visual assessment of light and lighting (CIE, Division 1: Vision and Colour).

The COOLPI package follows in a rigorous manner the recommendations published by the CIE concerning the standard colorimetric observers, illuminants, the computation of tristimulus values, the colour space conversions formulae and colour difference equations among other colorimetric practices (CIE, 2018).

The CIE objects implemented into the COOLPI package are based on the abstract class *CIE*, and can include other abstract classes according to their requeriments. The *CIE* main classes are: *Observer*, *SComponents*, *CMF*, *CFB*, and *RGBCMF*.

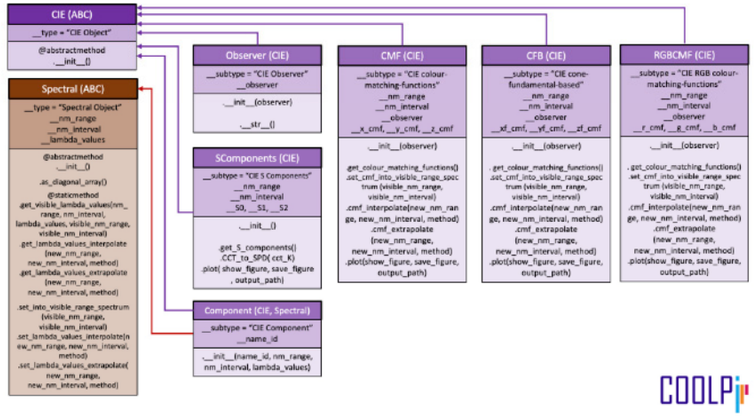

Figure 2: *UML Diagram for the CIE classes*

Info

For further explanation of some of the calculations applied, we highly recommend users to consult the standards published by the CIE, particularly the Technical Report CIE 015:2018, Colorimetry, 4th Edition (CIE, 2018). This publication provides the recommendations of the CIE concerning colorimetry, particularly the use of the standard colorimetric observers and standard illuminants, colour spaces, colour difference metrics and other colorimetric practices and formulae.

Practical use of *CIE* classes

Users are encouraged to previously take a look at the Jupyter Notebook:

COOLPI

colour-accurate pixels

COOLPI

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Discussing graffiti – knowledge organisation impossible?

Jona Schlegel
Massimiliano Carloni

STATUS-QUO GATHERING

LOOKING BACK | AHEAD

14 October 2022 Vienna, Austria

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

A triple concept

"the creation of a mark"

"the mark resulted from graffiti as activity"

"the mark looking like *graffiti writing*"

Graffiti as activity

"the creation of a mark"

By human (+tool)

Done on purpose

Is a visual intervention

Real world

On all public, communal, and private surfaces

Involves the appropriation of a surface

Done with different techniques – additive or reductive

Graffiti as objects

"the mark resulted from graffiti as activity"

Anthropogenic

Has a purpose

Visual intervention

Situated in the real world

On or through any possible surface (except a private surface only accessible by the mark-maker)

Appropriated surface

In different styles with various techniques

Mark-making

A
B
9449
535
D2
9449
535
D2
C
STOP
THE
GROVE
SOLIDAR
MIT ALLEN
ANTIFA
D

(Non-) practical reasons

Graffiti as style

"the mark looking like *graffiti writing*"

The Getty AAT

Associated Concepts | Styles and Periods | Agents | Activities | Brand Names | Objects

Objects Facet

.... Visual and Verbal Communication (hierarchy name) (G)

..... Information Forms (hierarchy name) (G)

..... information forms (objects) (G)

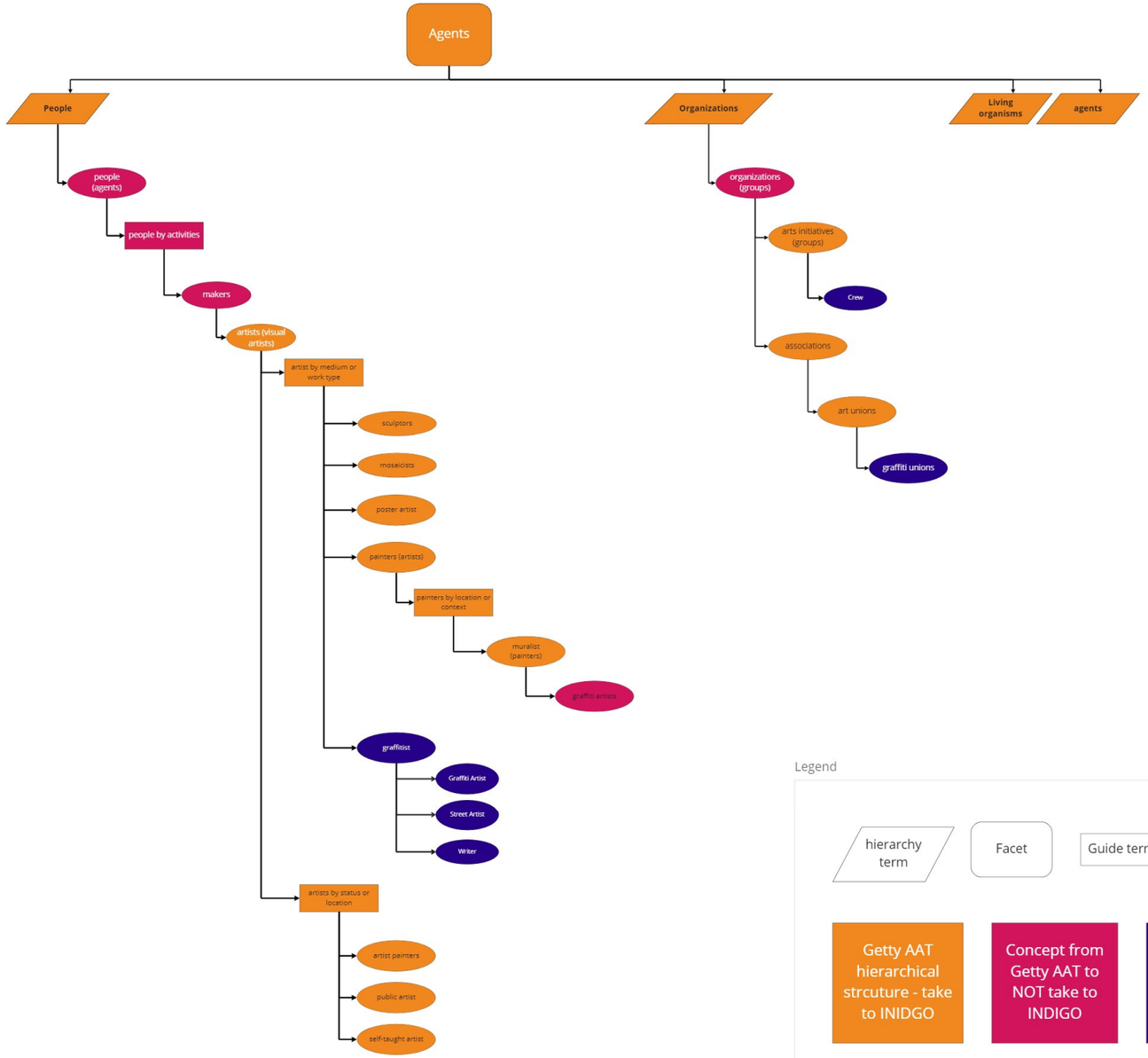
..... document genres (G)

..... <documents by form> (G)

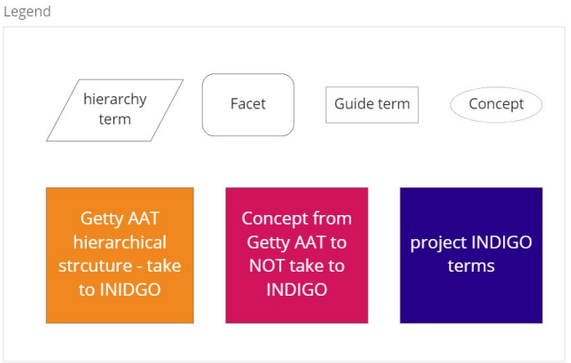
..... inscriptions (G)

..... graffiti (casual notations) (G)

The Getty AAT



Legend



Outlook

- **SKOS (Simple Knowledge Organization System)**
  - Hierarchical + associative
  - Preferred/alternative labels

- **Publication on Vocabs**
  - Based on Skosmos
  - Easy navigation
  - Accessibility and reusability

Vocabs

AGENDA

part 1 [13:30 – 14:30]

Geert	INDIGO—dissemination for general & scientific audiences	13:30
Benjamin	Introducing AUTOGRAF	13:45
Martin	RTK GNSS on top of the camera	13:55
Geert	COOLPI	14:05
Jona & Massimiliano	Discussing graffiti—Knowledge organization impossible?	14:10
Alex, Bernhard & Nina	New OpenAtlas features for INDIGO	**14:20**

Status quo -
OpenAtlas features for INDIGO

OpenAtlas - https://openatlas.eu

- Open source, browser based database software
  - available on GitHub: https://github.com/craws/OpenAtlas
- Initiated about 10 years ago by Stefan Eichert
- Now mainly developed at the ACDH-CH
- Used to acquire, edit and manage research data
- CIDOC CRM as model

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OpenAtlas and INDIGO

INDIGO workshop 2021

- INDIGO's research focuses on the present time
- Different workflow: e.g. media is stored in ARCHE (https://www.oeaw.ac.at/acdh/tools/arche)
- Providing metadata for various applications through the API
- Each project adds features to OpenAtlas
  - cf. https://redmine.openatlas.eu/projects/uni/roadmap

OpenAtlas Features for INDIGO

- Implemented
  - Record production of artefacts, e.g. graffiti (#1500)
  - Improved time tracking with hours, minutes and seconds (#1574)
  - Improved database model to store 3D geometries (#1631)

- In Progress
  - Importing INDIGO vocabulary from Vocabs (#1663)
  - Display 3D geometries (#1573)
  - Connecting to ARCHE to get image files (#1575)
  - More detailed structure, e.g. track individual components of graffiti (#1587, #1647)
  - Relative chronological and spatial relation between graffiti (#1648)

AGENDA

part 1 [13:30 – 14:30]

👀

part 2 [14:45 – 16:30]

👀

INDIGO approach

INventory and
DIsseminate
Graffiti along the
DOnaukanal

WHAT

WHY

digitally preserve
and
analyse

WHERE

WHO

ÖAW
GiFLE
TU WIEN GEO
vrvis
Stadt Wien
SPRAY CITY.AT
LUDWIG BOLTZMANN INSTITUTE
Archaeological Prospection and Virtual Archaeology

INDIGO approach

goals

inventory

create

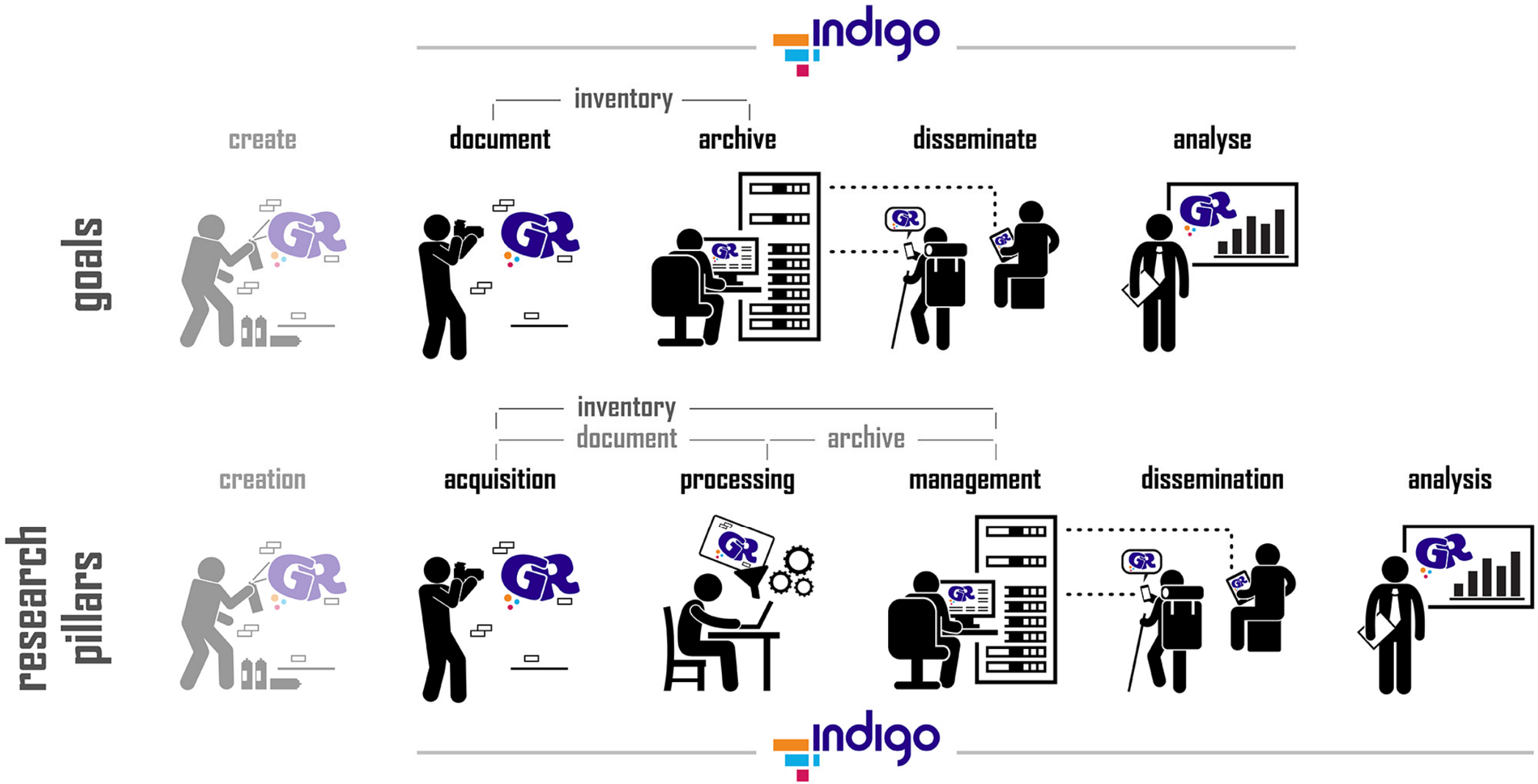
document

archive

disseminate

analyse

INDIGO approach



STRUCTURE 5 pillars

A. ACQUISTION

3D surfaces

photographs + GNSS/IMU

auxiliary

(spectra, metadata, video)

B. PROCESSING

colour correction

orthorectification & texturing

segmentation & annotation

change detection

C. MANAGEMENT

adding metadata

thesaurus

spatial database(s)

data archiving

D. DISSEMINATION

online platform

social media & QR codes

symposium 1

articles & presentations

symposium 2

E. ANALYSIS

thesaurus

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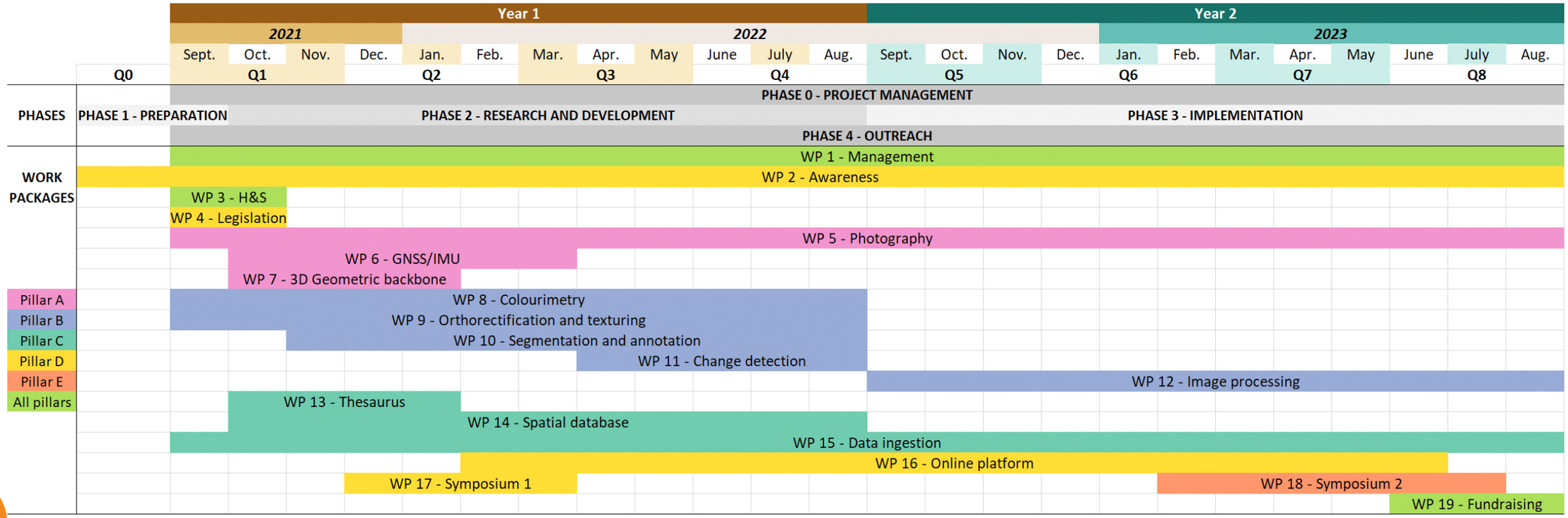
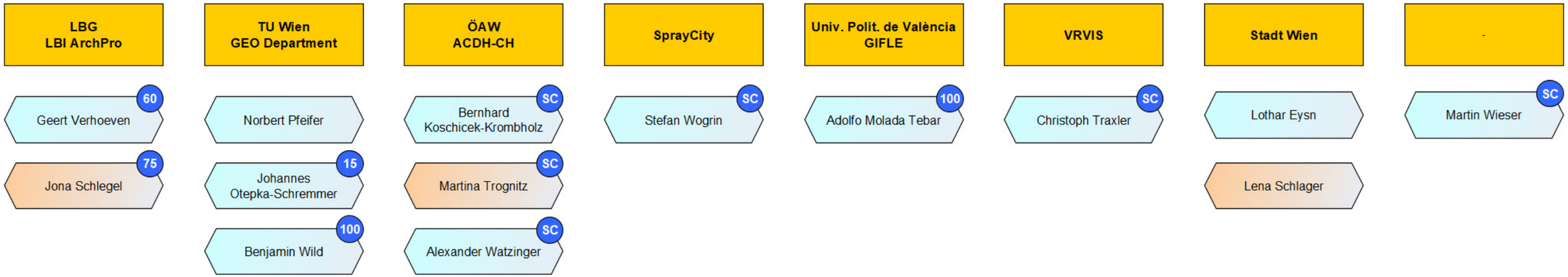


STRUCTURE 7 “institutes”



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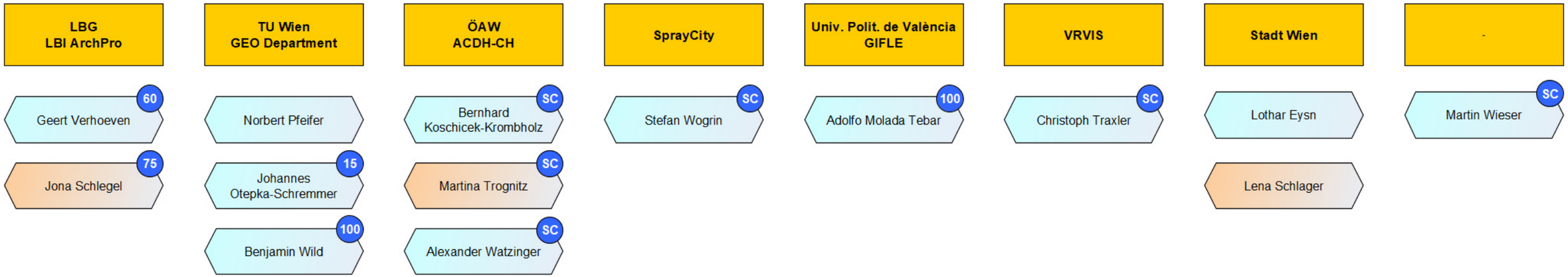

Nina Richards

STRUCTURE 6 “institutes”

Nina Richards

STRUCTURE 5.5 “institutes”

Nina Richards

STRUCTURE 6 “institutes”

Nina Richards

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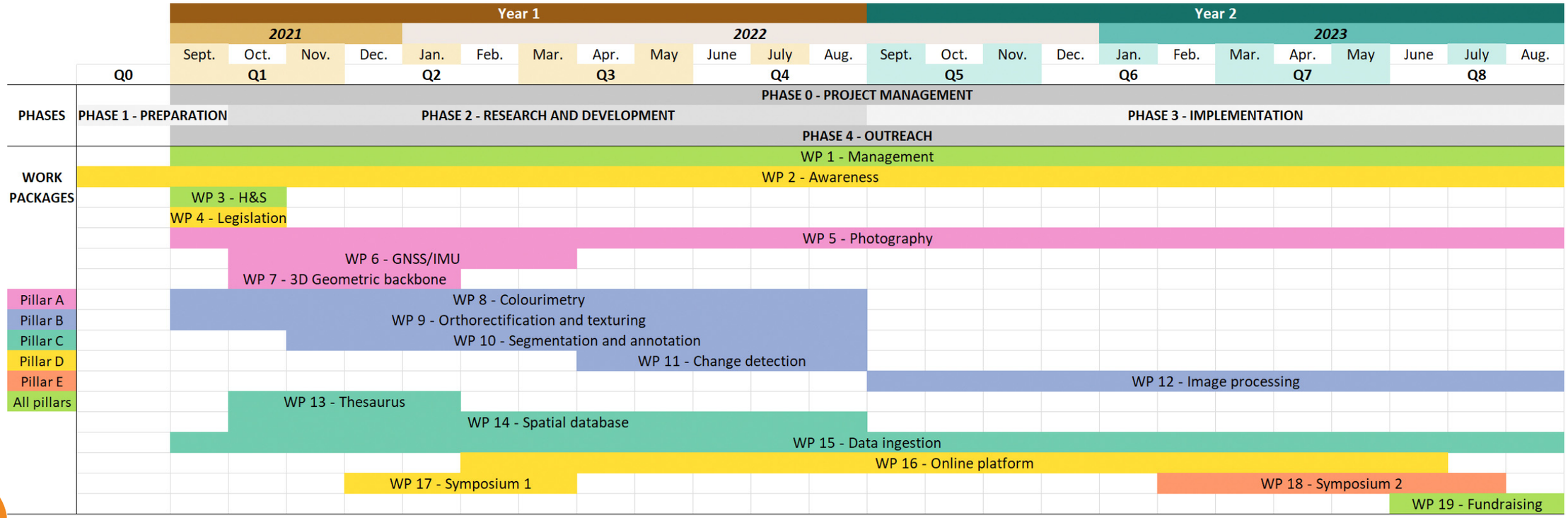

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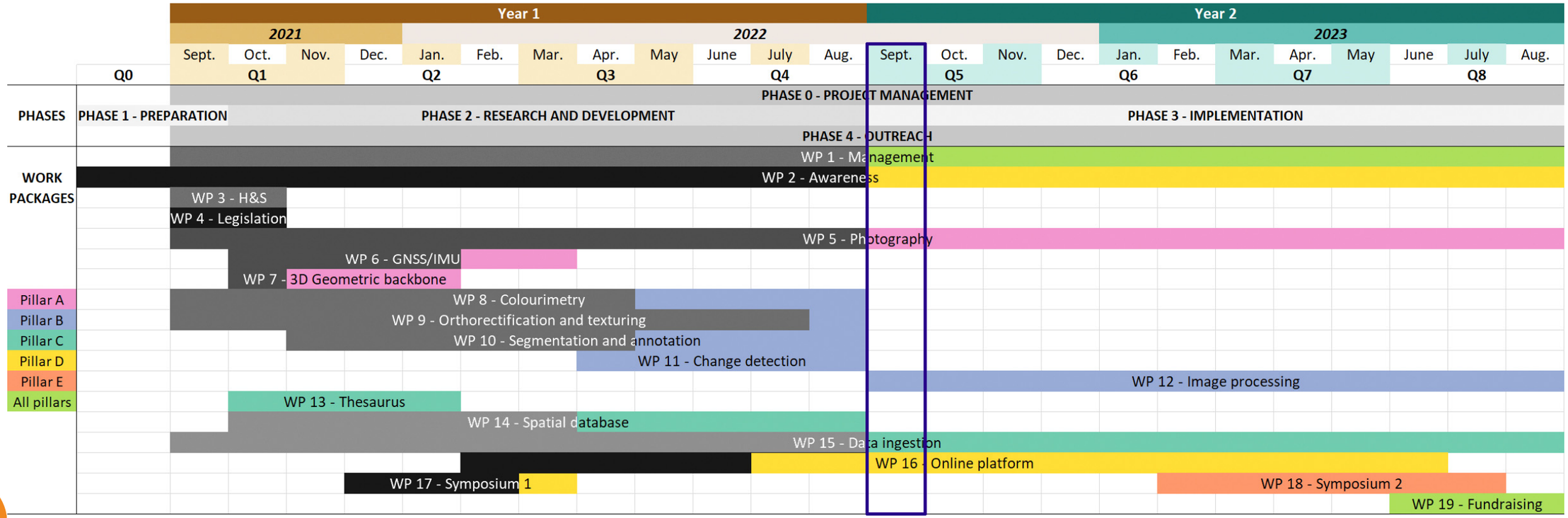

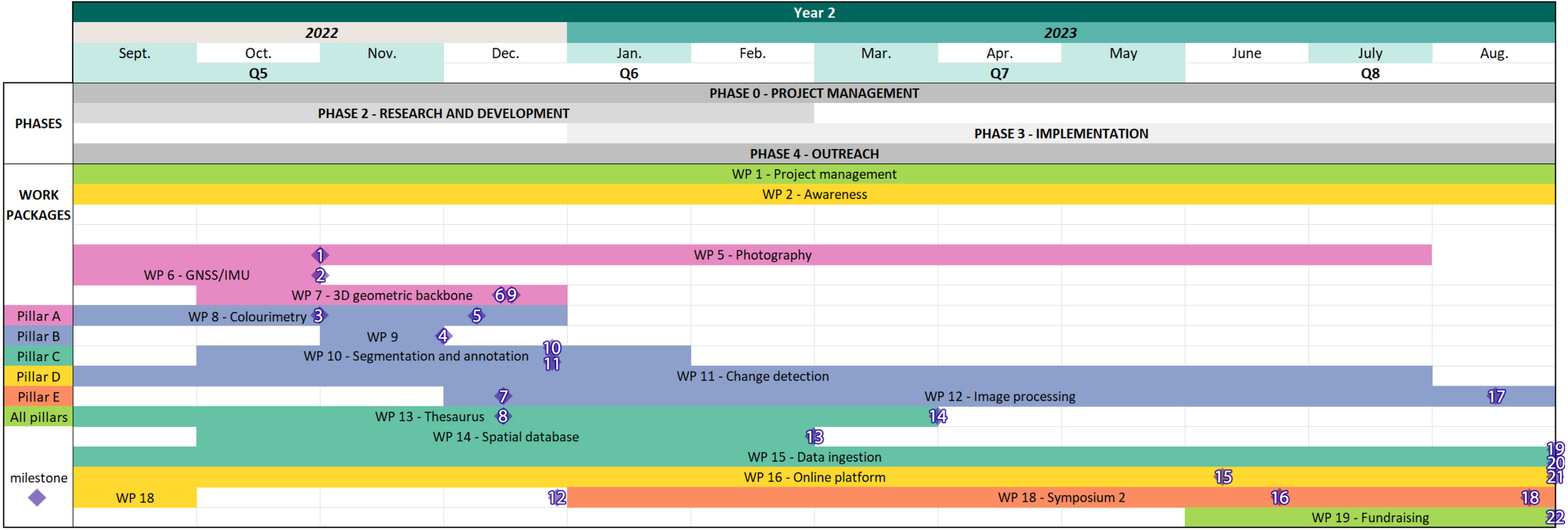

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3	Paper COOLPI (sensors)	B	8	31/10/2022	Publication
4	Optimised version AUTOGRAF	B	9	30/11/2022	Software
5	Graffiti reference target	B	10	05/12/2022	Hardware
6	Final 3D mesh DK	A	7	16/12/2022	Data
7	Image processing pipeline	B	12	19/12/2022	Software
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11	XMP namespace	B	10	20/12/2022	Software
12	Publication goINDIGO 2022 proceedings	D	18	27/12/2022	Publication
13	Final structure OpenAtlas	C	14	27/02/2023	Software
14	Final version thesaurus + paper	C	13	31/03/2023	Publication
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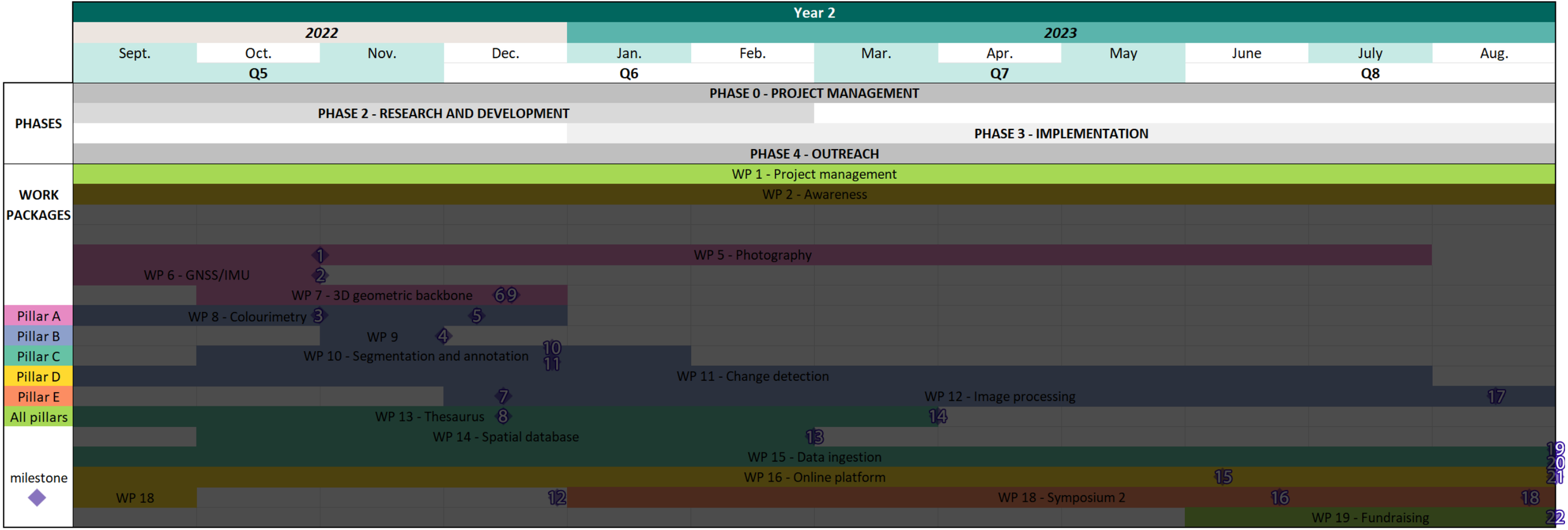

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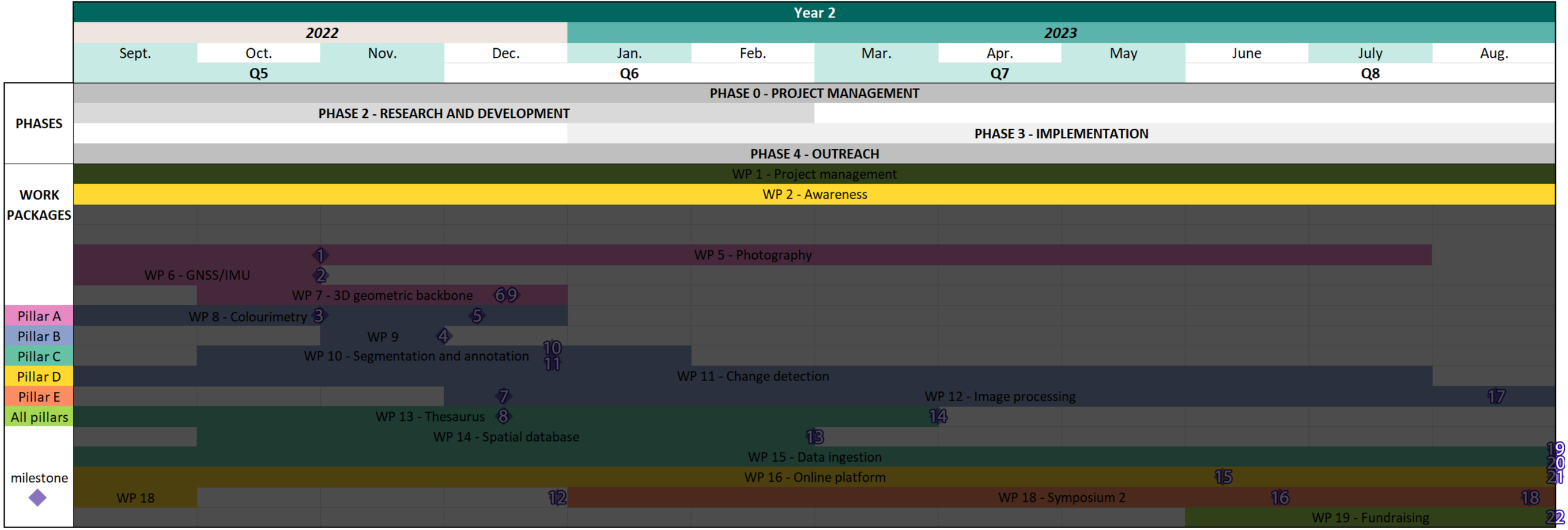

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18	Symposium 2	E	18	21/08/2023	Publication
16	Submit proceedings symposium 2	E	18	21/06/2023	Symposium
22	New project proposal	A-B-C-D-E	19	31/08/2023	Funding

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6	Final 3D mesh DK	A	7	16/12/2022	Data
17	All images processed	B	12	14/08/2023	Data
19	All data ingested in OpenAtlas	C	15	31/08/2023	Data
20	All data ingested in ARCHE	C	15	31/08/2023	Data
22	New project proposal	A-B-C-D-E	19	31/08/2023	Funding
5	Graffiti reference target	B	10	05/12/2022	Hardware
2	Second GNSS/IMU device + manual	A	6	31/10/2022	Hardware + software
3	Paper COOLPI (sensors)	B	8	31/10/2022	Publication
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7	Image processing pipeline	B	12	19/12/2022	Software
10	Segmentation tool	B	10	20/12/2022	Software
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13	Final structure OpenAtlas	C	14	27/02/2023	Software
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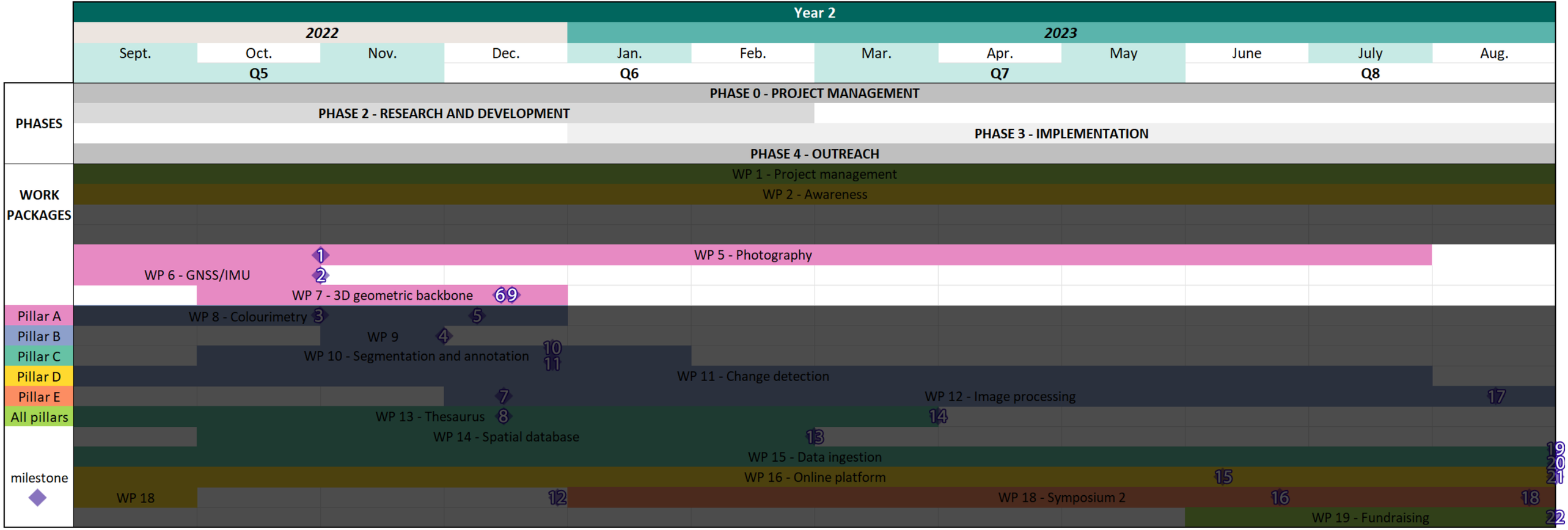
9	LOOCV script and paper	A	7	20/12/2022	Software + publication
16	Symposium 2	E	18	21/06/2023	Symposium



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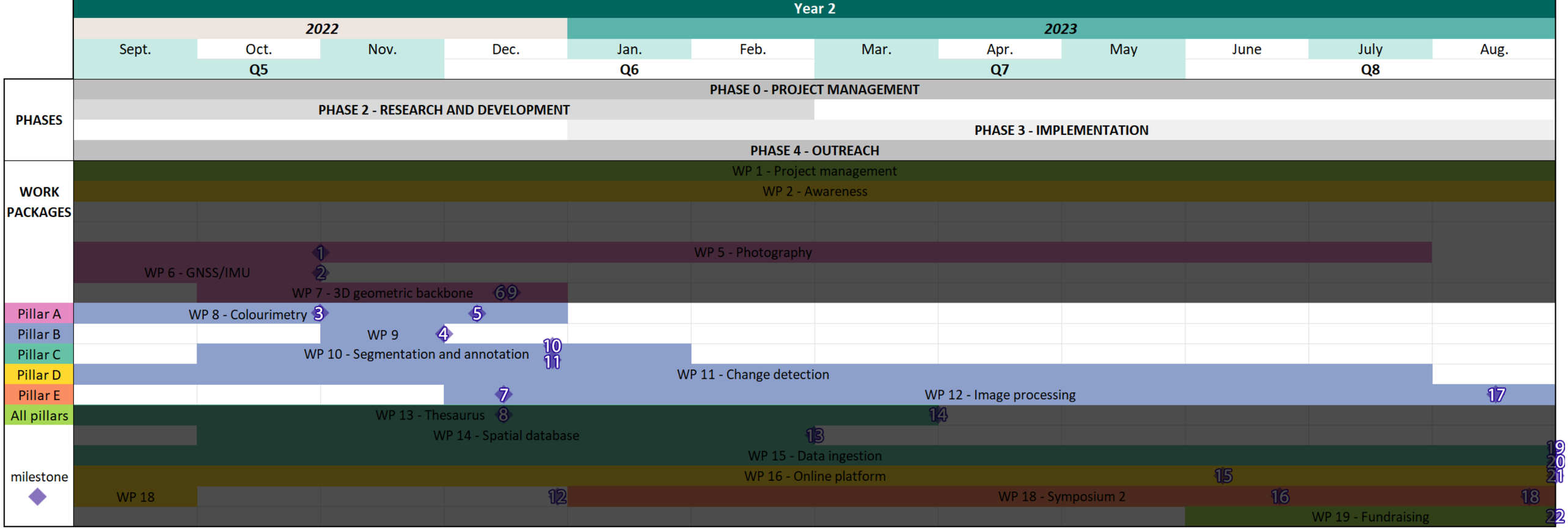

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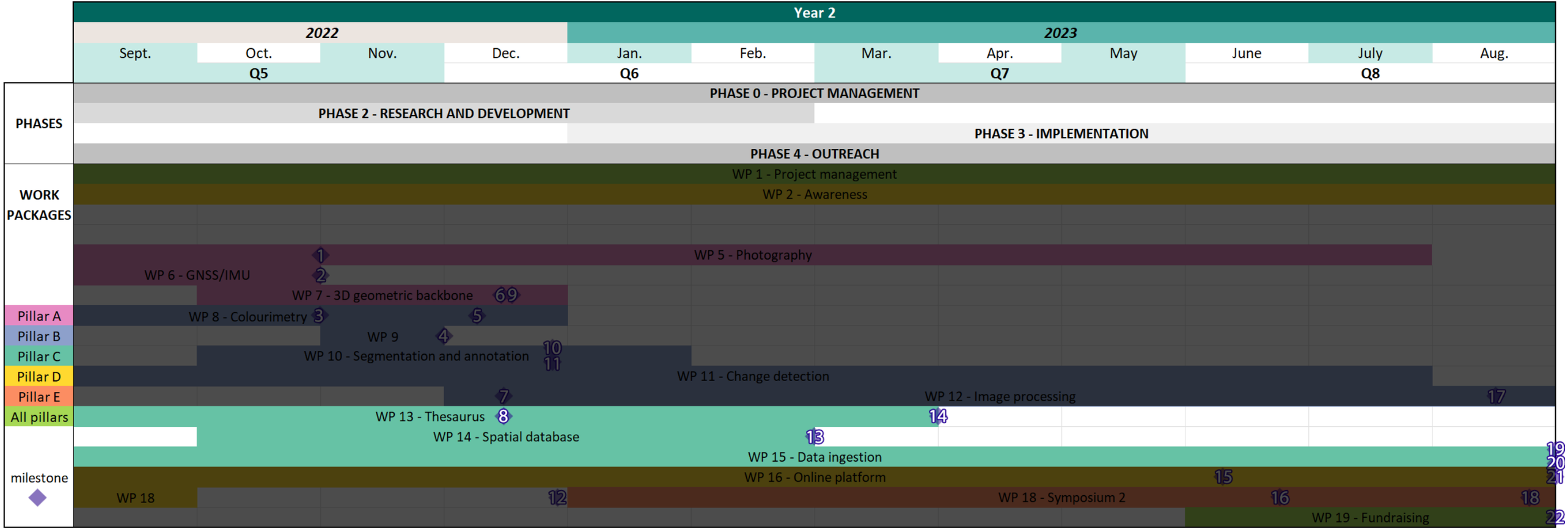

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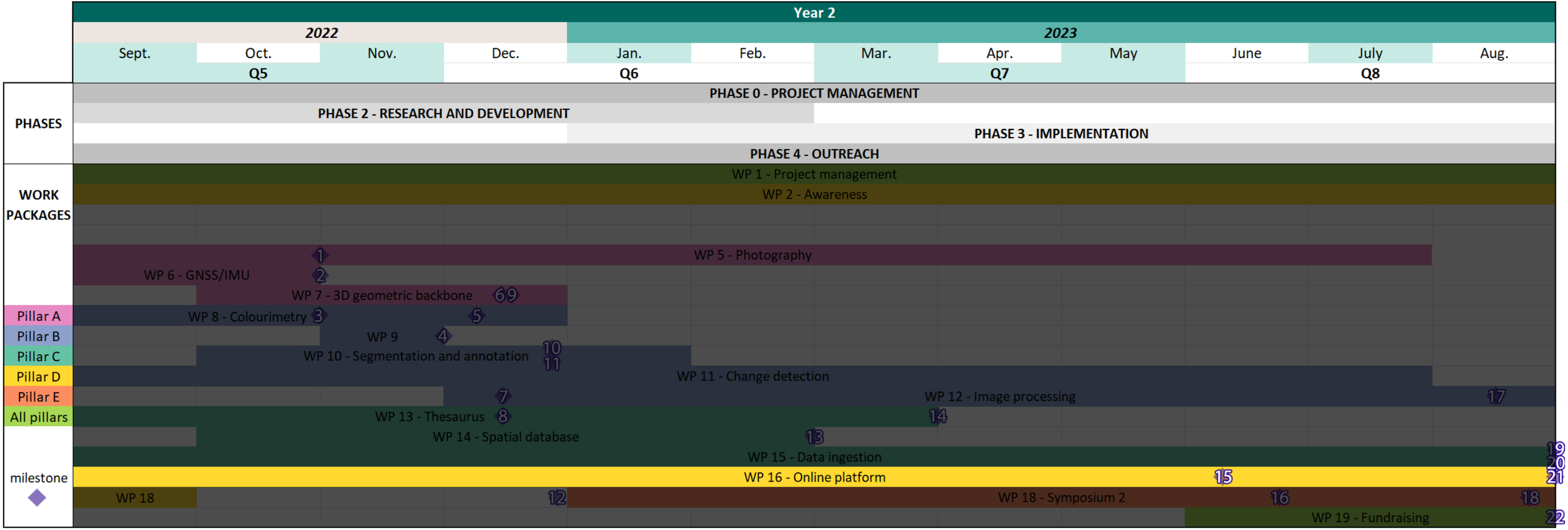

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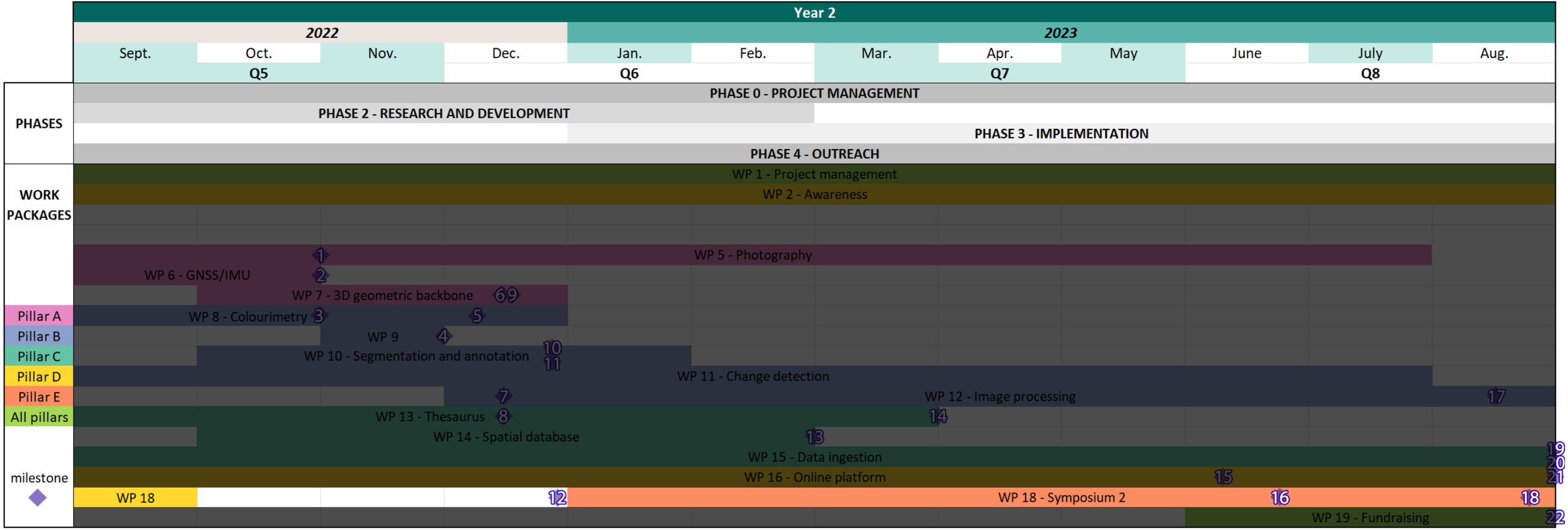

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22	New project proposal	A-B-C-D-E	19	31/08/2023	Funding

Nr	What	Pillar	WP	End data	Deliverable type
1	Total coverage survey 2	A	5	30/10/2022	Data
2	Second GNSS/IMU device + manual	A	6	31/10/2022	Hardware + software
6	Final 3D mesh DK	A	7	16/12/2022	Data
9	LOOCV script and paper	A	7	20/12/2022	Software + publication
3	Paper COOLPI (sensors)	B	8	31/10/2022	Publication
4	Optimised version AUTOGRAF	B	9	30/11/2022	Software
5	Graffiti reference target	B	10	05/12/2022	Hardware
10	Segmentation tool	B	10	20/12/2022	Software
11	XMP namespace	B	10	20/12/2022	Software
17	Image processing pipeline	B	12	14/08/2023	Data
7	All images processed	B	12	19/12/2022	Software
8	First version thesaurus	C	13	19/12/2022	Publication
14	Final version thesaurus + paper	C	13	31/03/2023	Publication
13	Final structure OpenAtlas	C	14	27/02/2023	Software
19	All data ingested in OpenAtlas	C	15	31/08/2023	Data
20	All data ingested in ARCHE	C	15	31/08/2023	Data
15	First version online platform	D	16	09/06/2023	Software
21	Updated version online platform	D	16	31/08/2023	Software
12	Publication goINDIGO 2022 proceedings	D	18	27/12/2022	Publication
18	Symposium 2	E	18	21/08/2023	Publication
16	Submit proceedings symposium 2	E	18	21/06/2023	Symposium
22	New project proposal	A-B-C-D-E	19	31/08/2023	Funding

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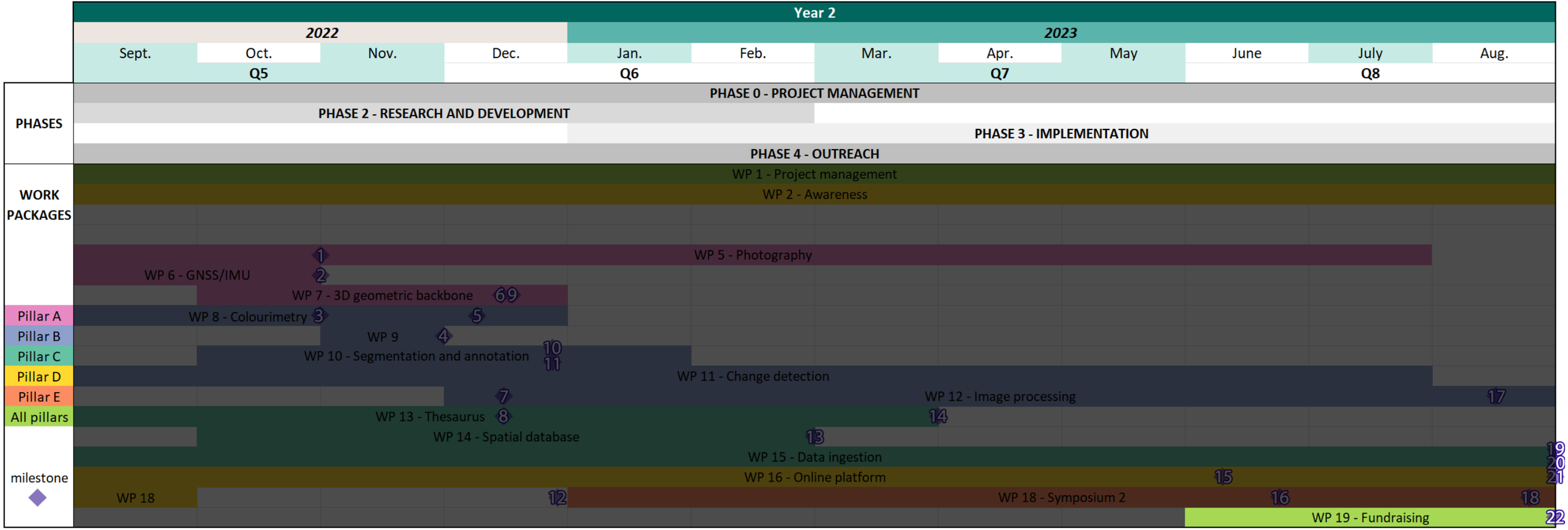

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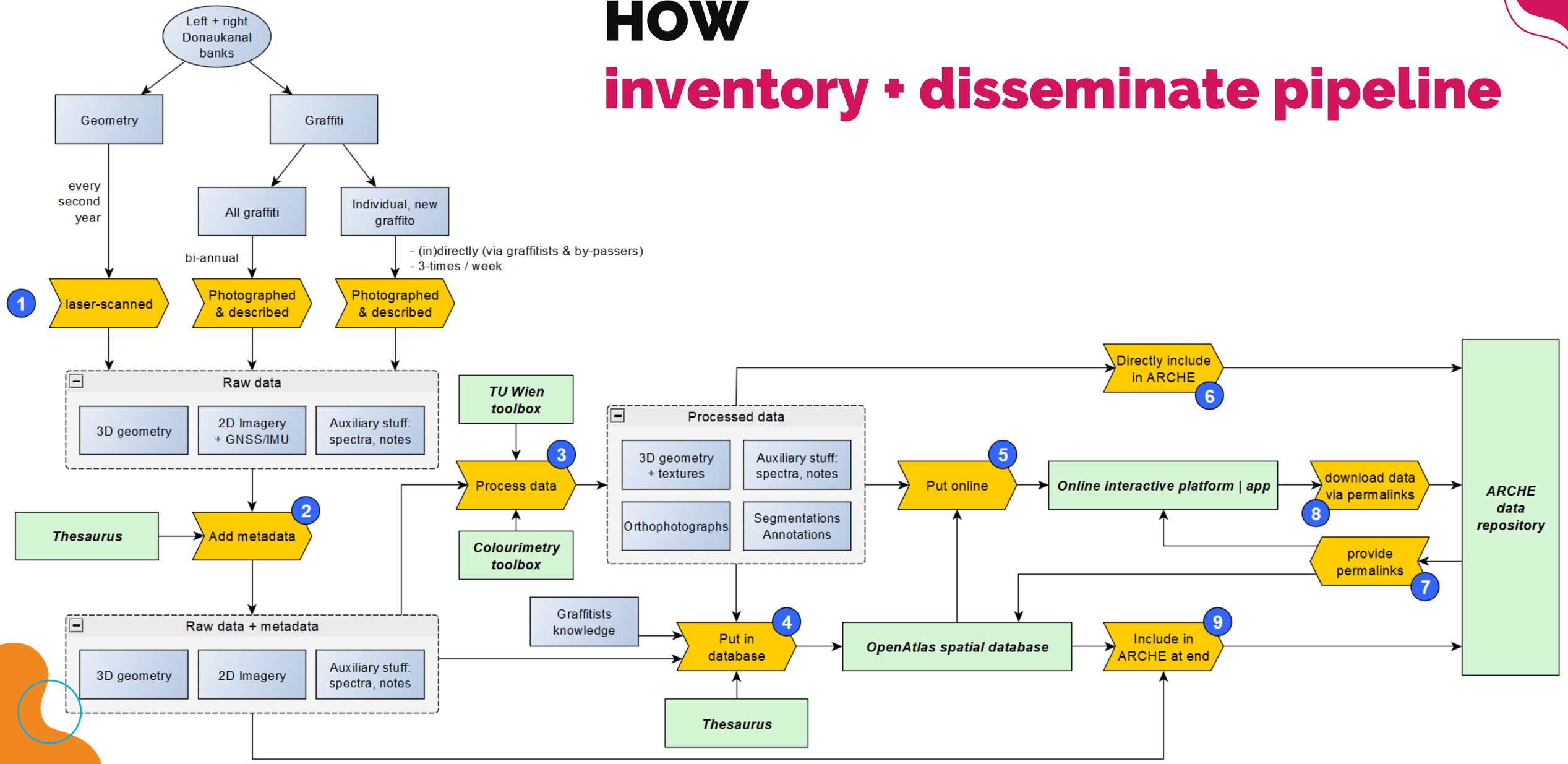
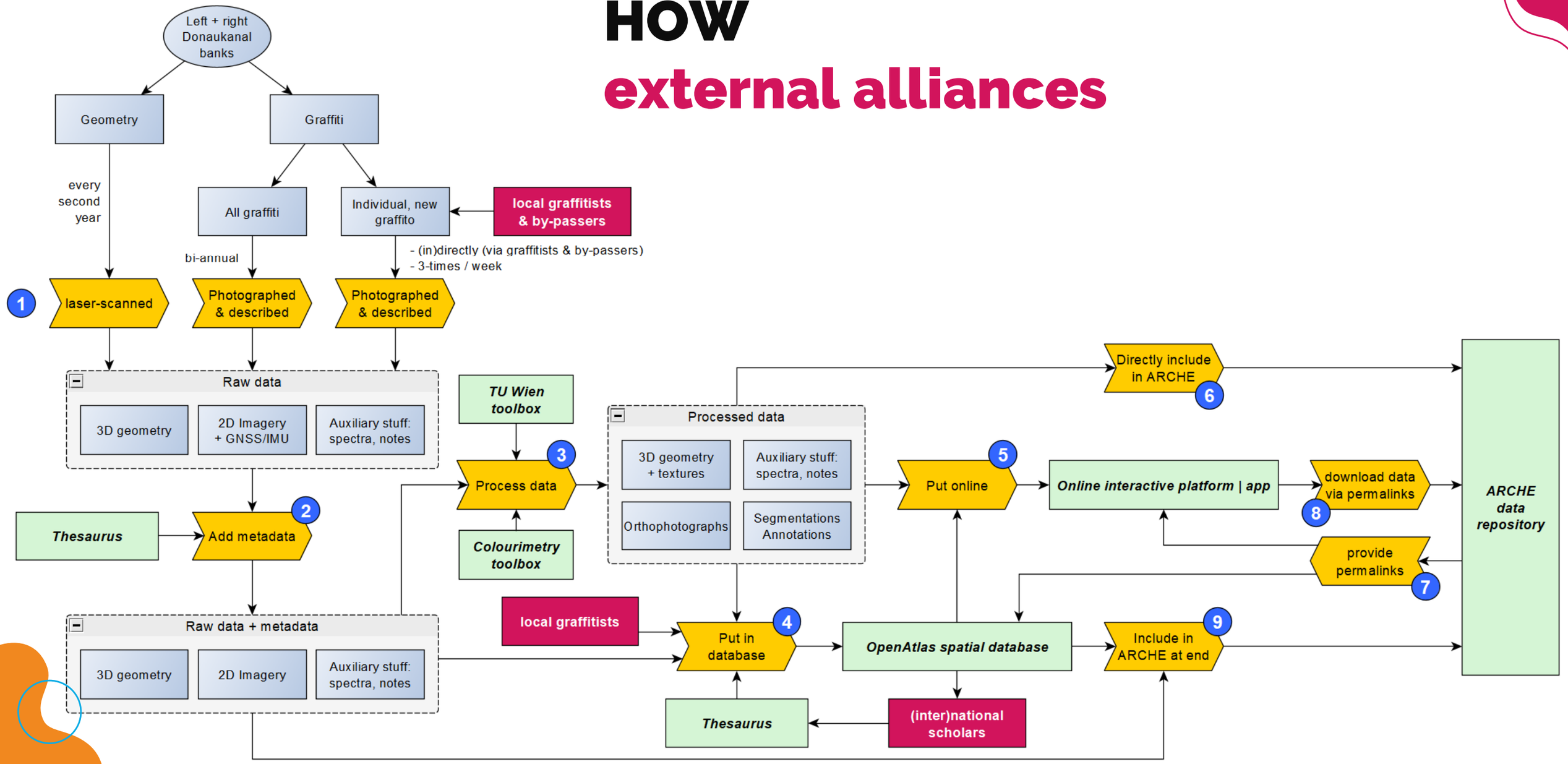
HOW

inventory + disseminate pipeline



HOW
external alliances



INDIGO road to 08-2023

- Auditor ✗
- Time sheets ✗
- Annual accounting report ✓
- Keep receipts ✓
- Other proof of compliance ✗

- ✓ Interim report
- ✓ Final report
- ✓ Notify ÖAW changes in PI | staff | cost >10% budgeted
- ✓ Mention ÖAW-funded project
- ✓ Use logo

INDIGO extra hands

GRANTS

THESES

FEMTECH

ACADEMIC VOLUNTEERS

indigo

ÖAW

GiFLE

TU WIEN

GEO

vrvis

Stadt Wien

SPRAY CITY.AT

LUDWIG BOLTZMANN INSTITUTE
Archaeological Prospection and Virtual Archaeology

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