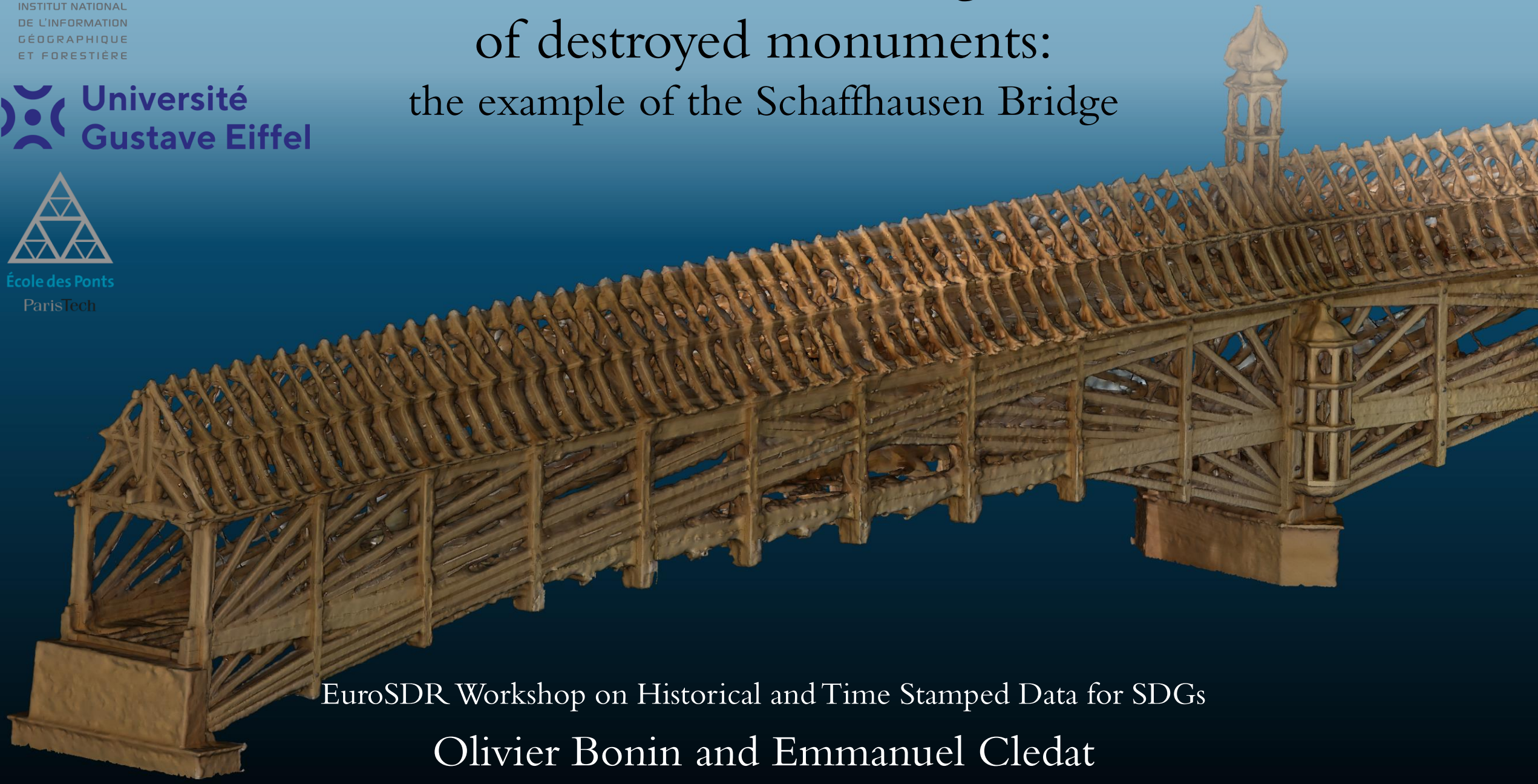
Creation and Geo-referencing of 3D data of destroyed monuments:

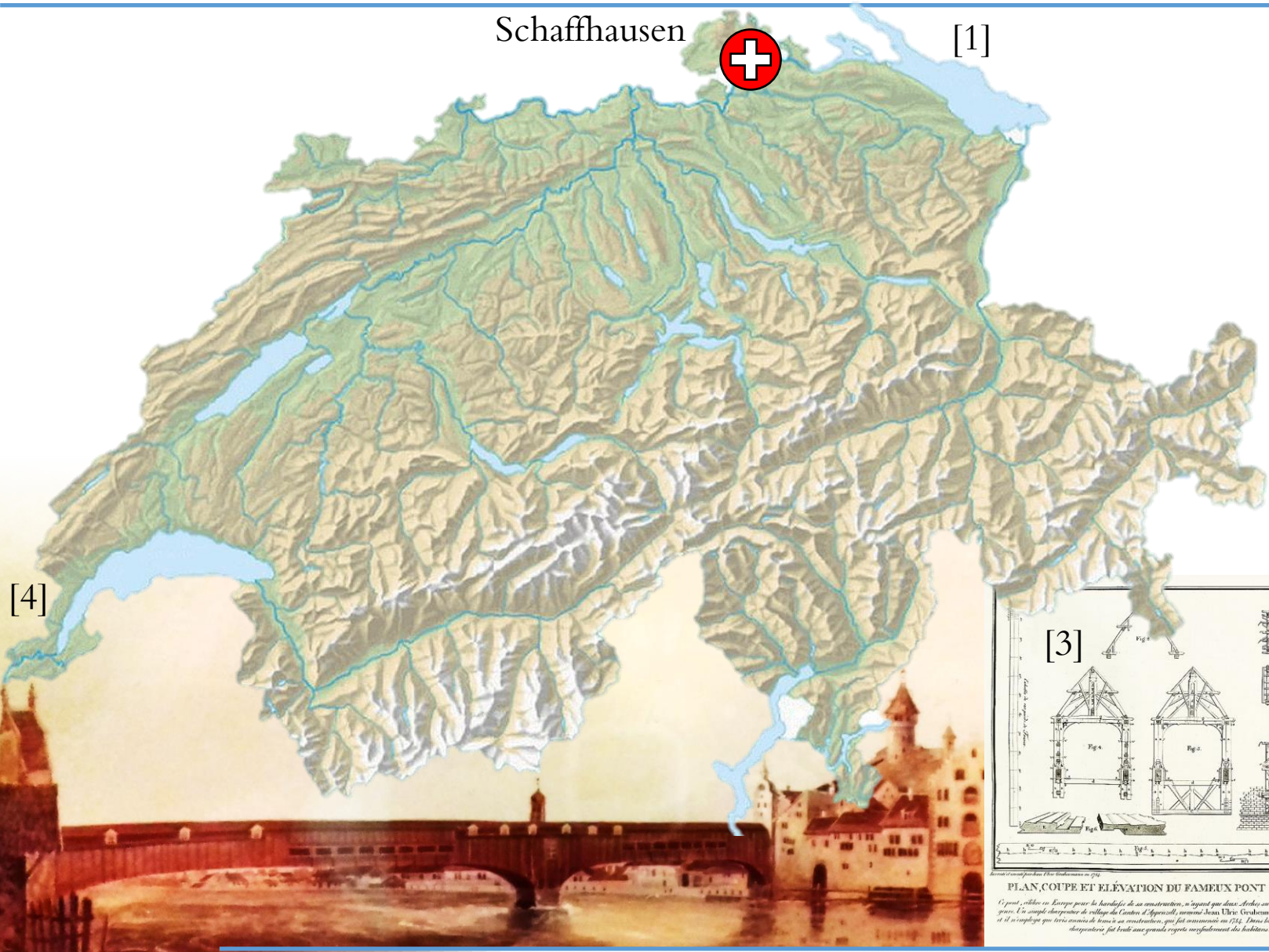
the example of the Schaffhausen Bridge

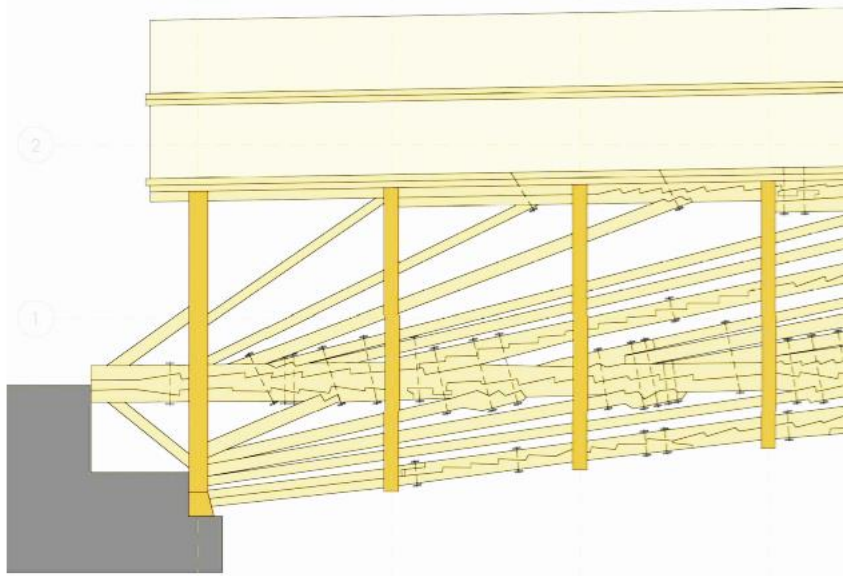


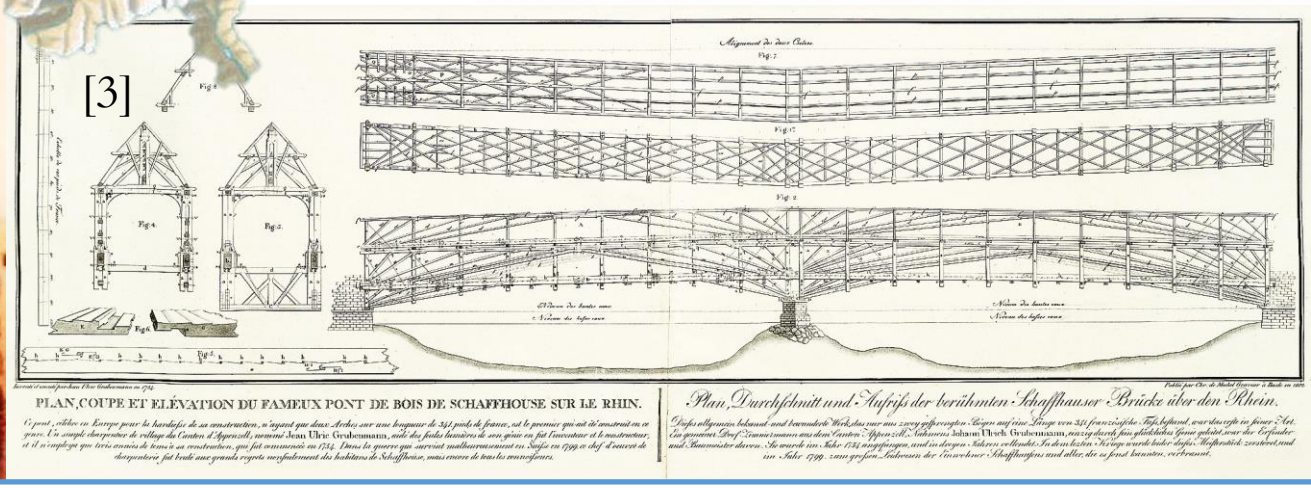
EuroSDR Workshop on Historical and Time Stamped Data for SDGs

Olivier Bonin and Emmanuel Cledat

The Schaffhausen bridge history







1799

[5]

[6]

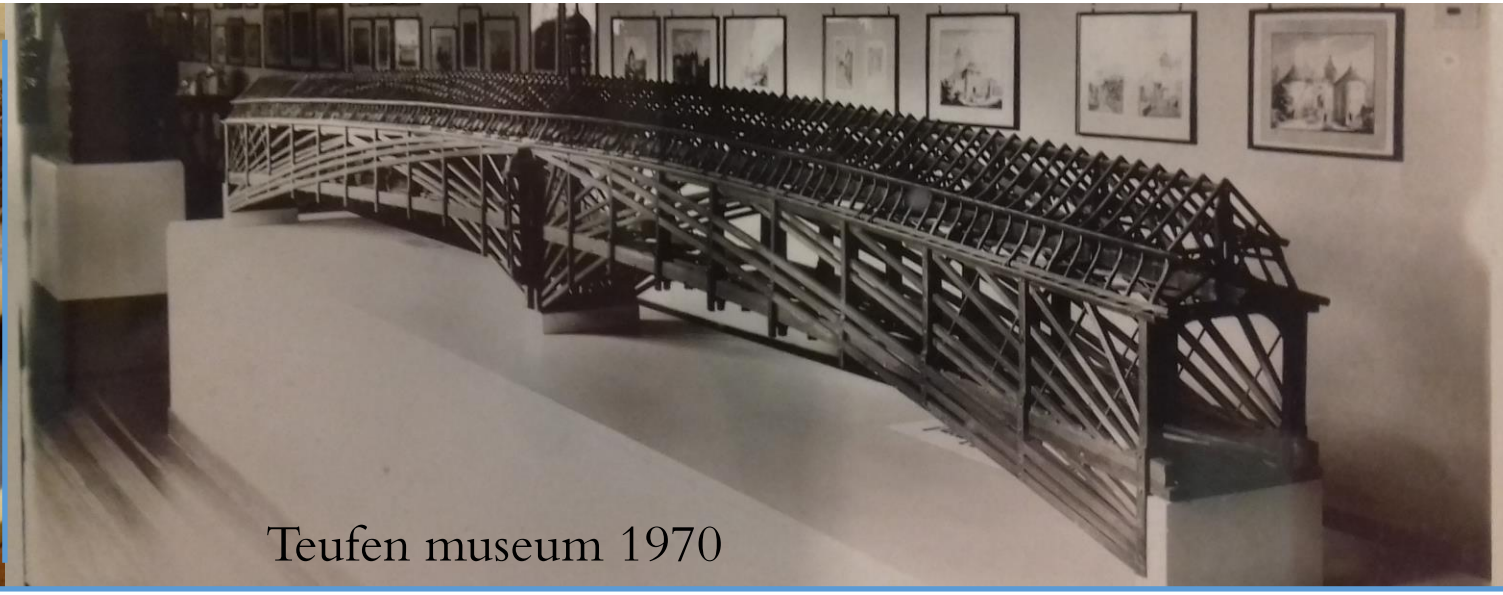
The models of the Schaffhausen bridge

Collection of the *Ecole des Ponts*, 1757?

?

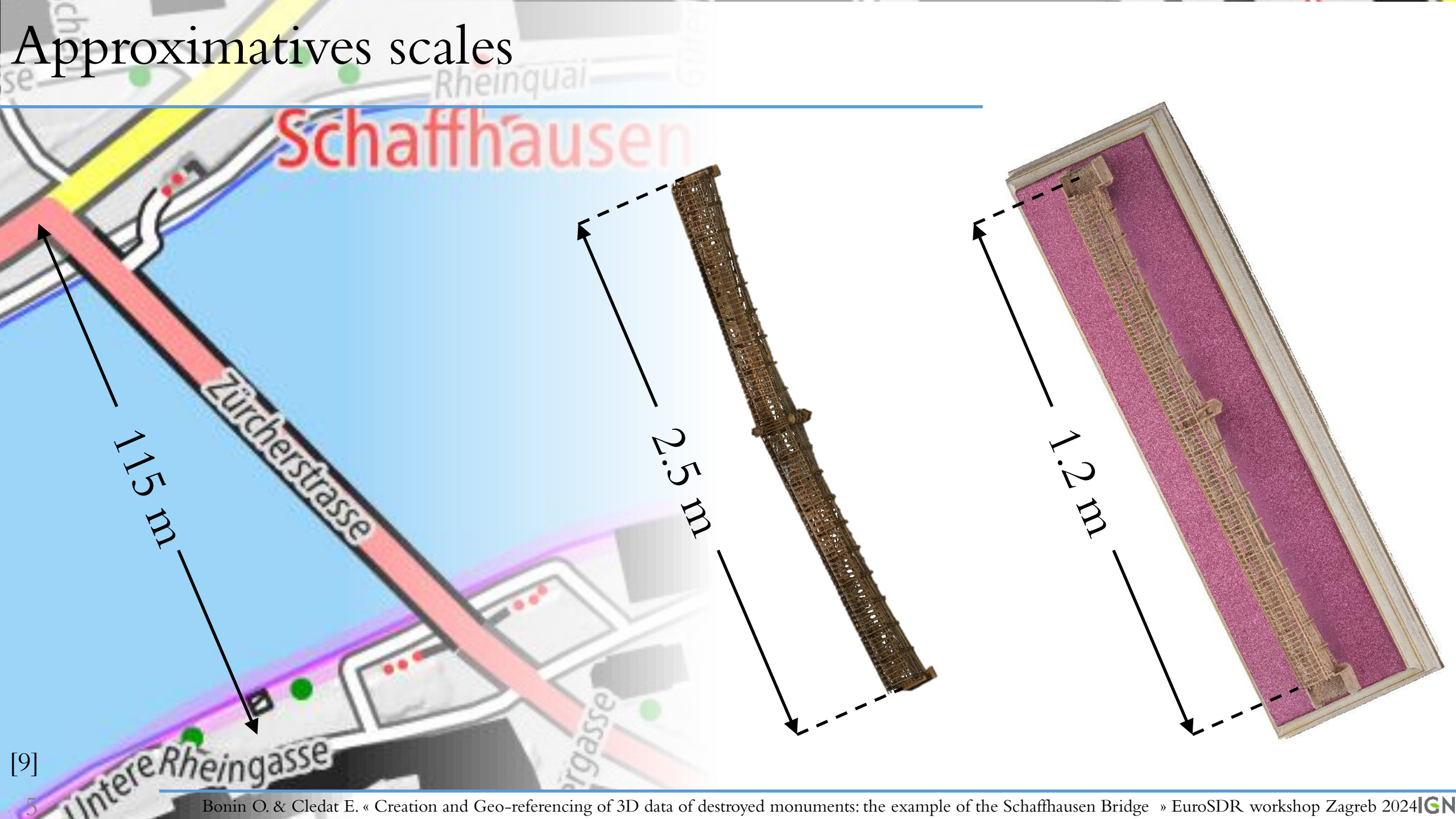
Model demonstrated to the heads of the city of Schaffhausen, 1757?

Schaffhausen museum 1757?



Teufen museum 1970

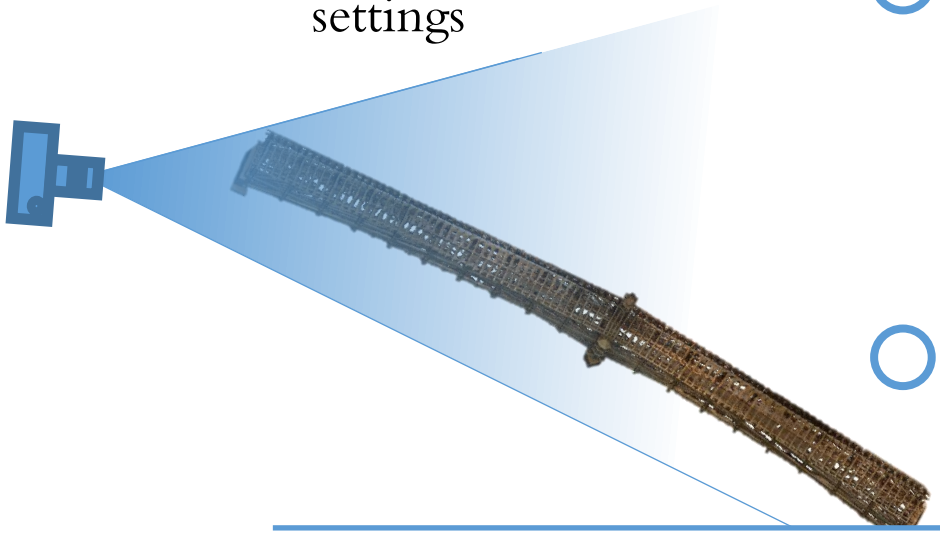
Approximatives scales



[9]

Photogrammetry of small objects: Sharpness and depth of field

SOTA : Use Duct-tape to lock the focusing ring ⇒ maintain the same settings



Trade-off between sharpness and quality of distortion pattern

- If high ***focus breathing*** :

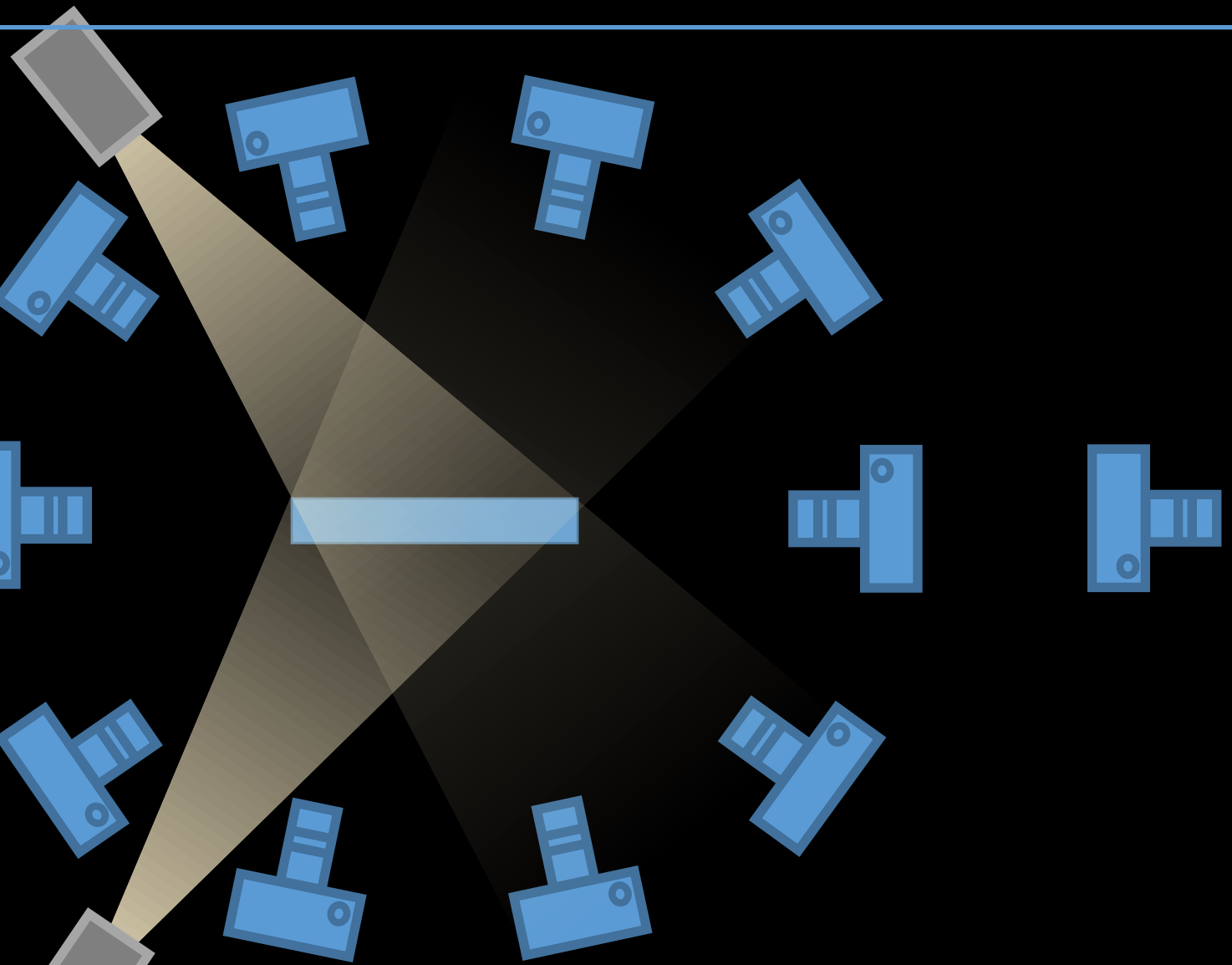
  Focus modification ↑ ⇒ Principal Distance modification ↑

- If low ***focus breathing*** :

  Focus modification ↑ ⇒ Principal Distance modification →

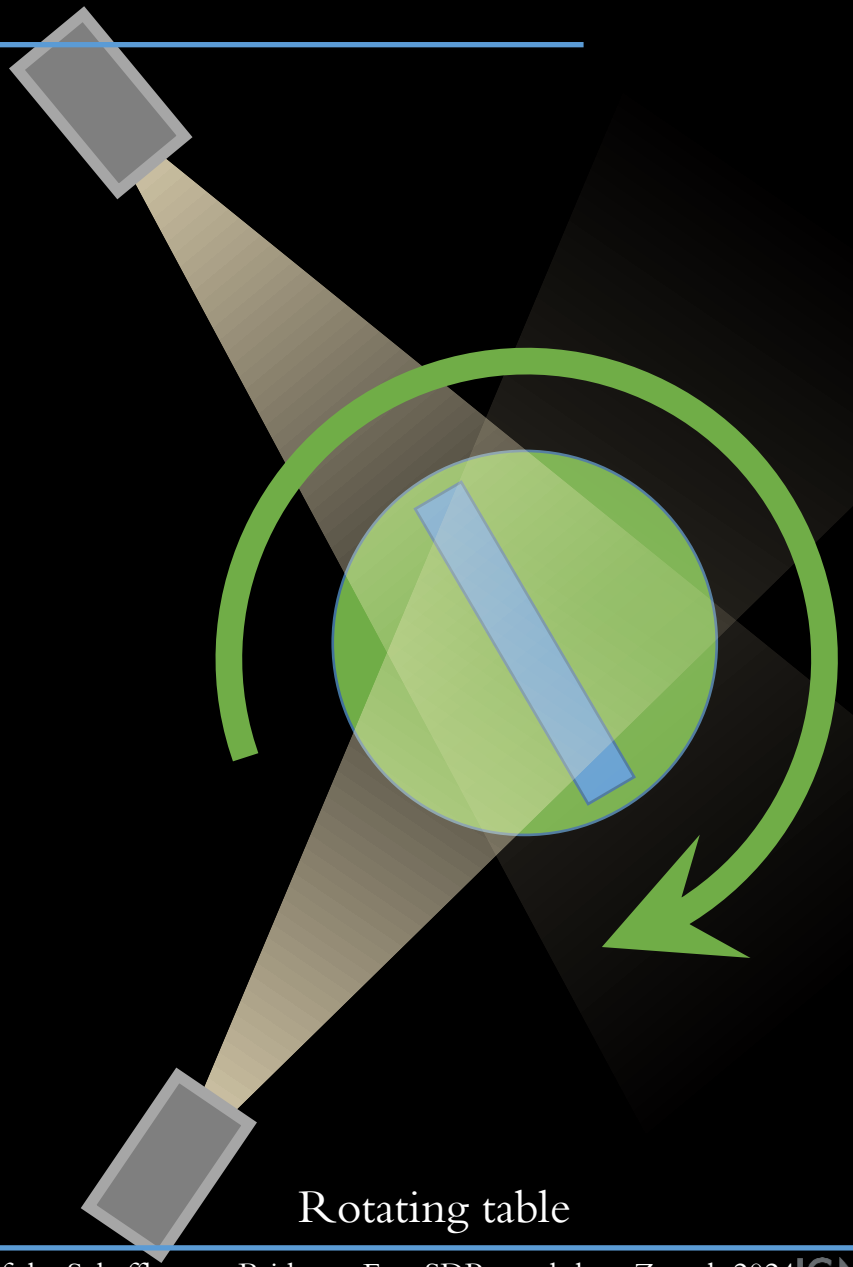
- In macro photogrammetry, we prefer to use auto-focus, but choose a lens that generates little ***focus breathing***

Photogrammetry of small objects: set-up



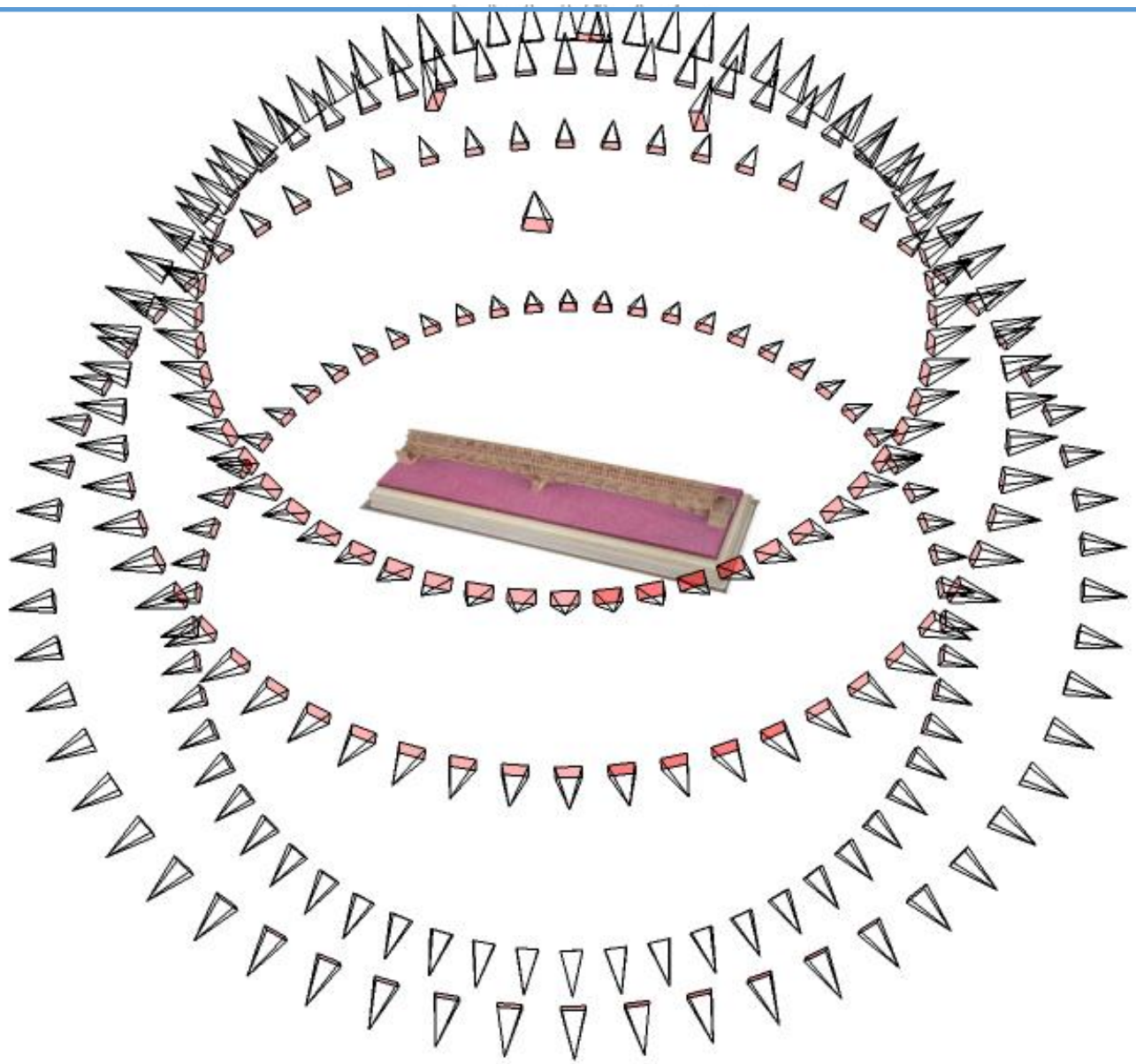
Rotate around the object

Vs



Rotating table

Photo shooting of the model from the Ecole des Ponts: External Orientation



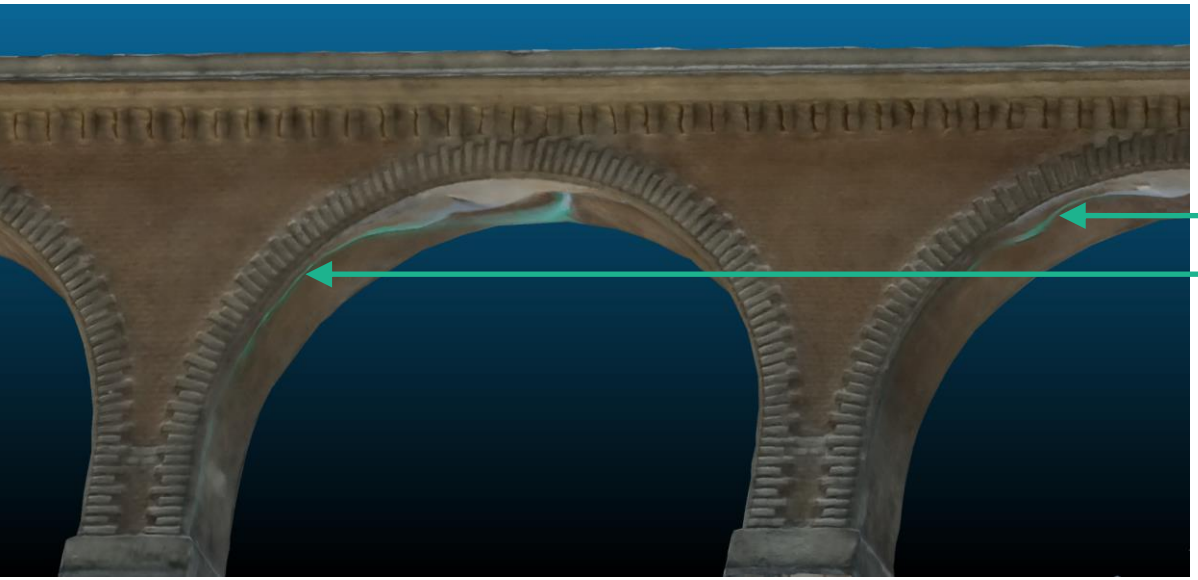
Photogrammetry of small objects: Background color

Existing background

Blue background

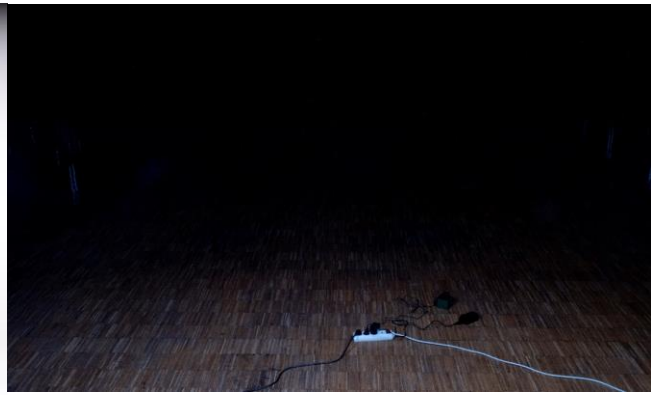
White background

Black background : *in the void*



White background removal

Black background removal



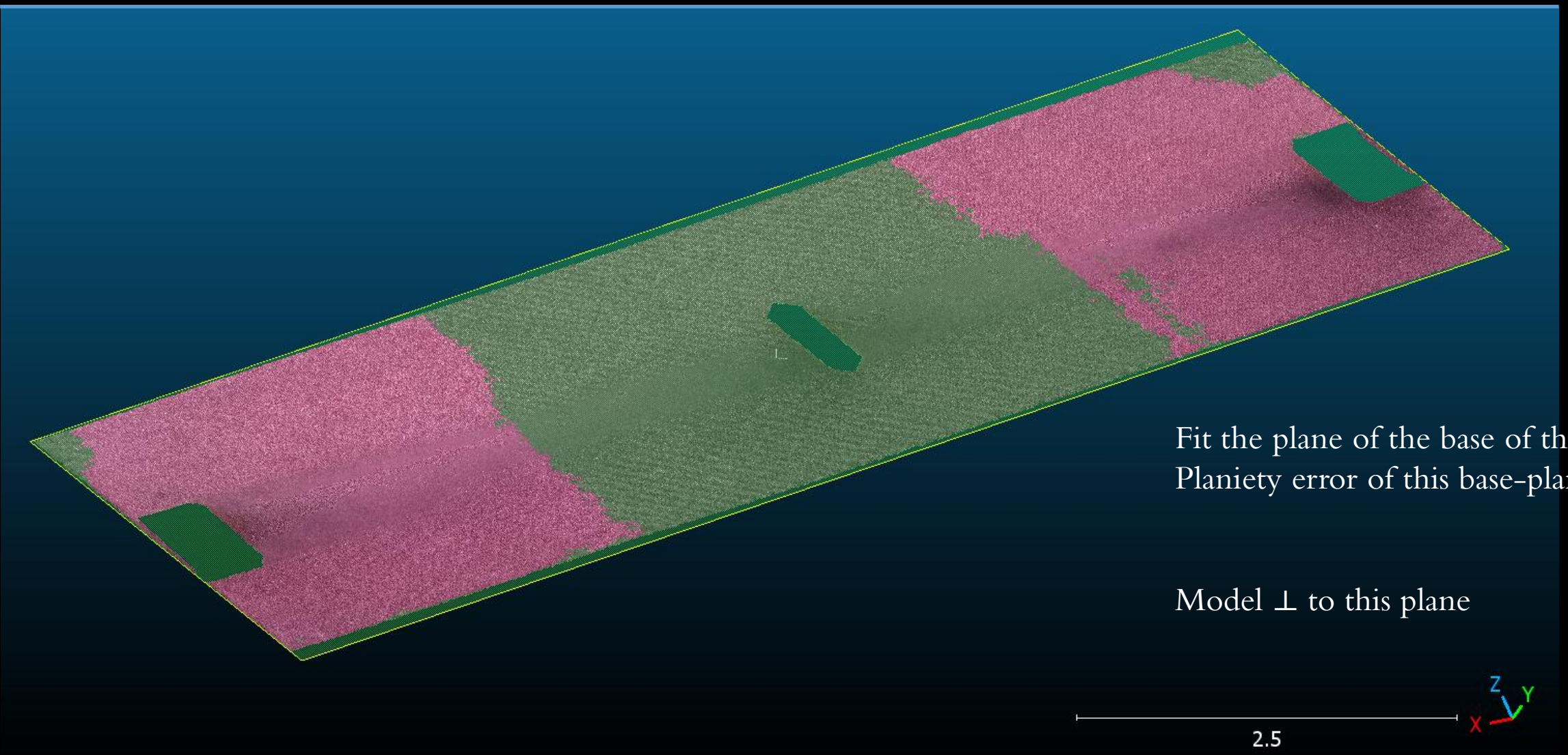
3D model to be georeferenced

Georeferencing of old models of town: Easy!

3D model to be georeferenced

GCPs almost aligned => Bad determination of the verticality

Verticalization of the 3D model

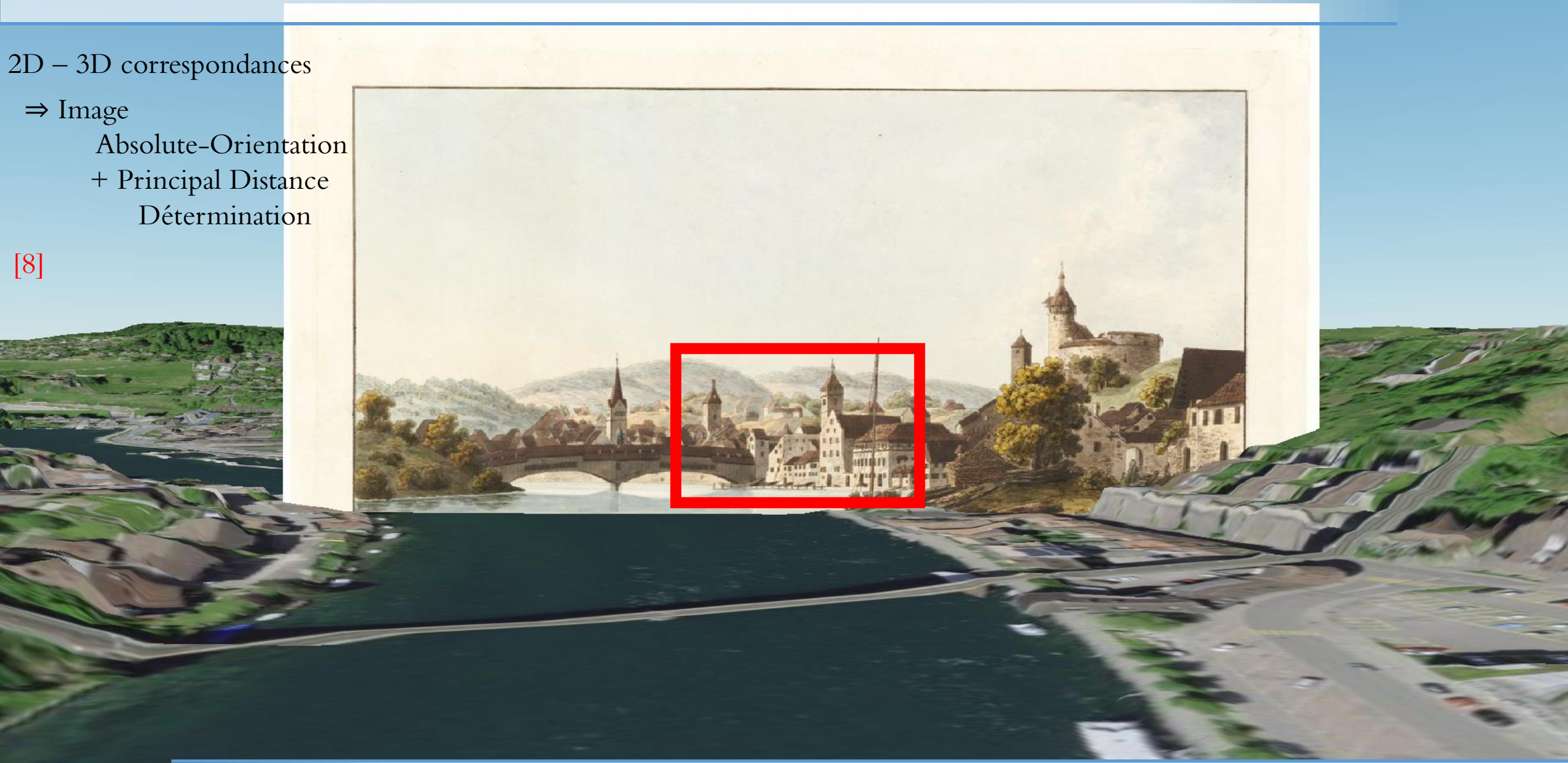


2D documents georeferencing

2D – 3D correspondances

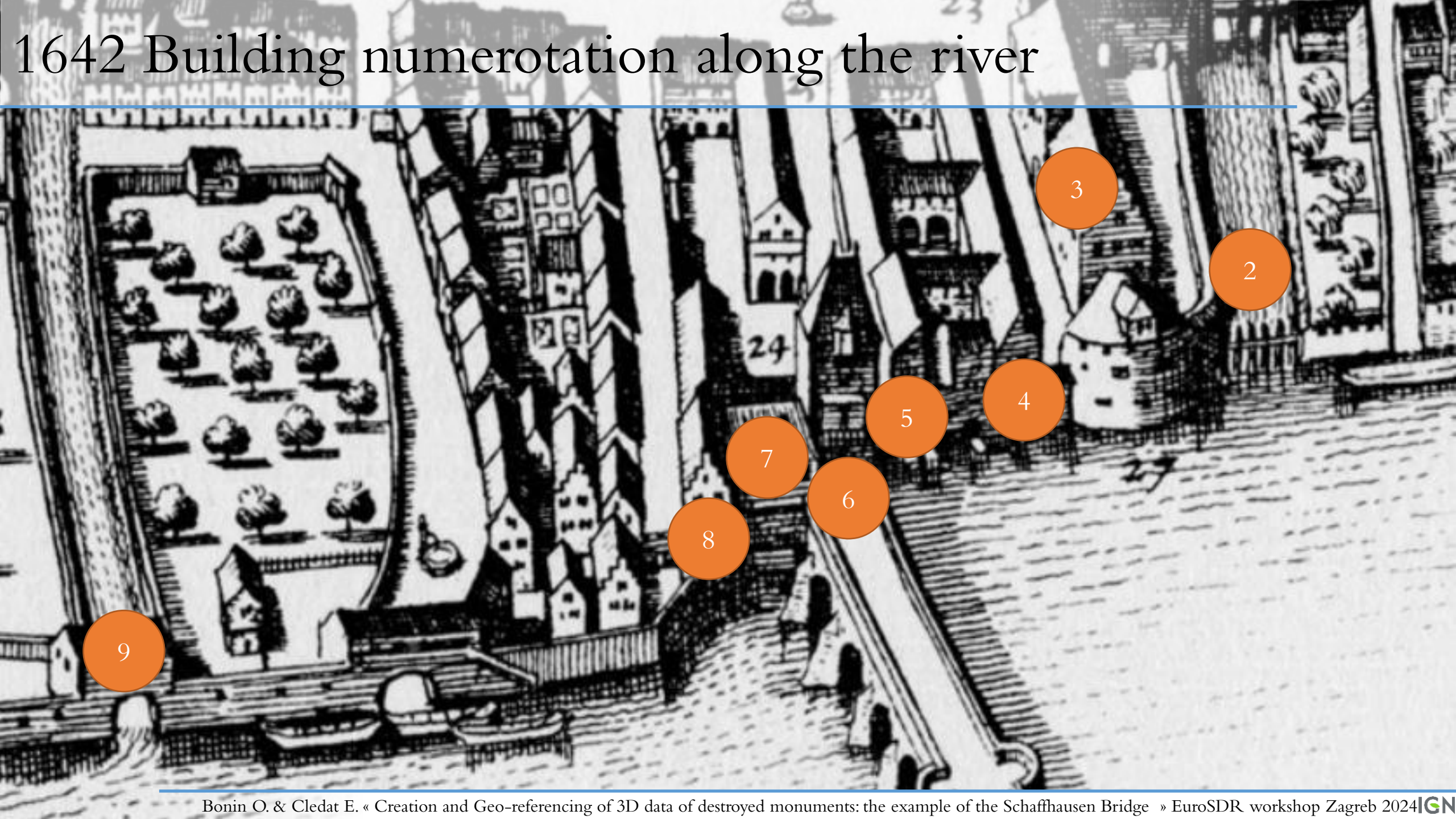
⇒ Image
Absolute-Orientation
+ Principal Distance
Détermination

[8]

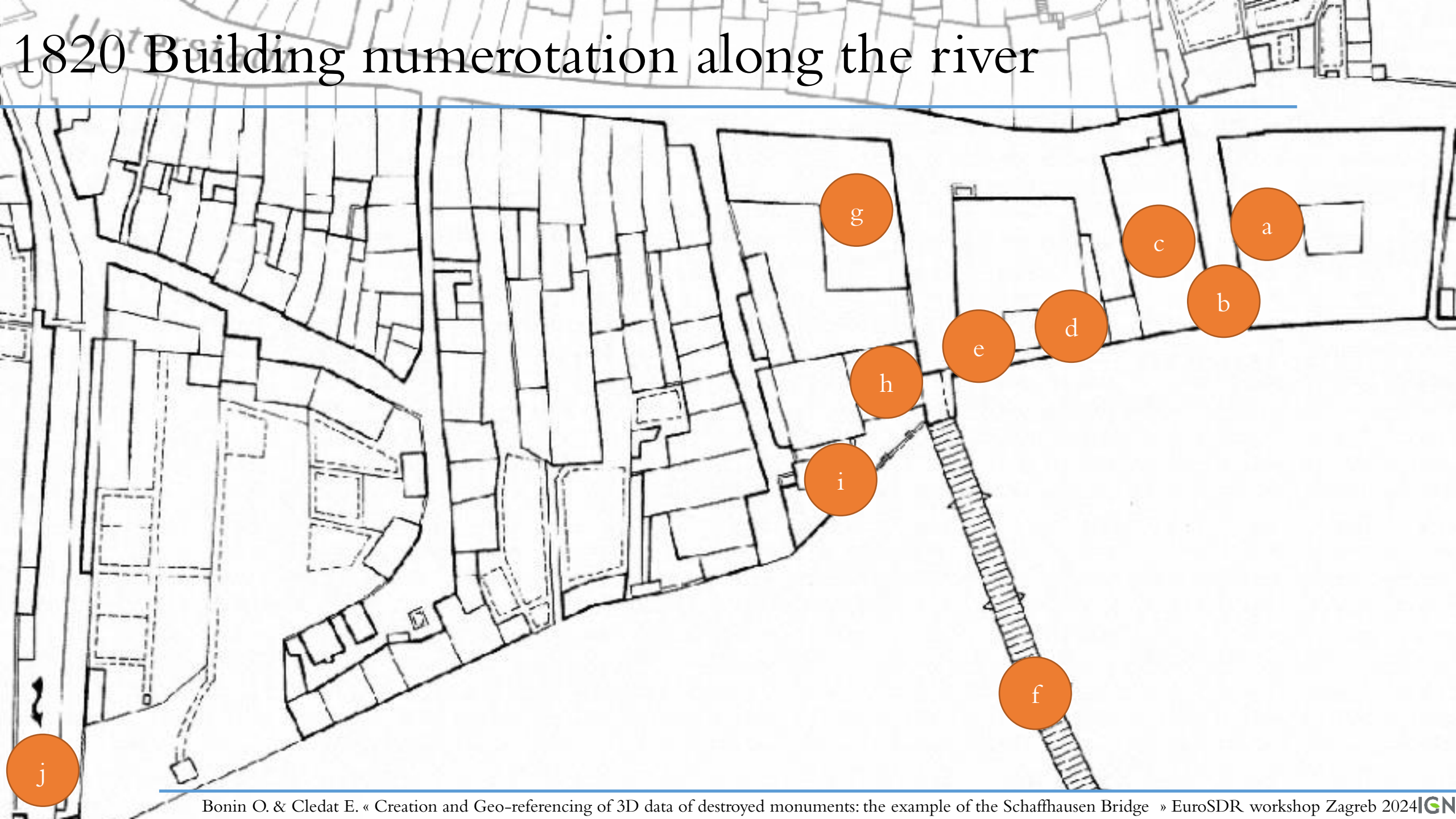


1760 Building numerotation along the river

1642 Building numerotation along the river

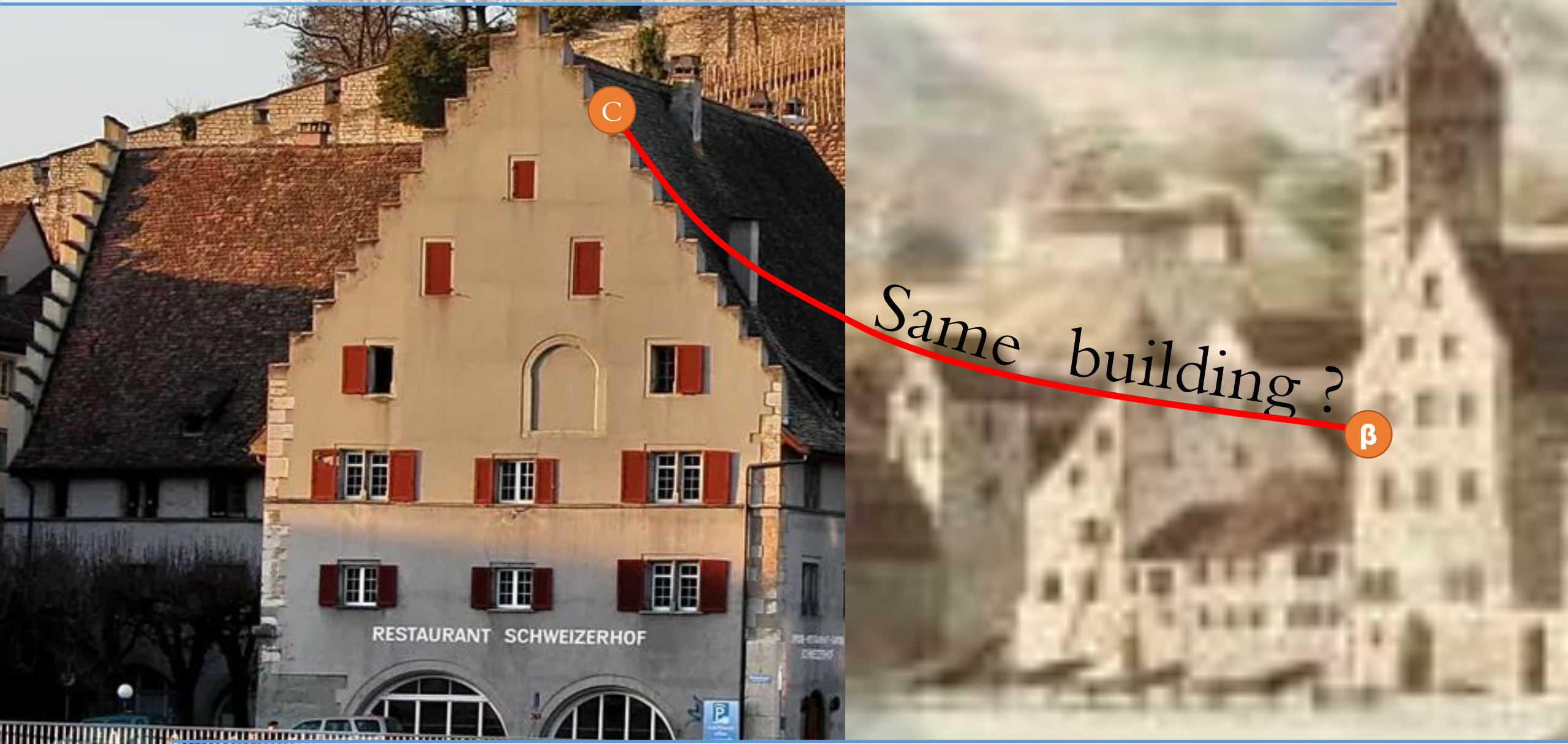


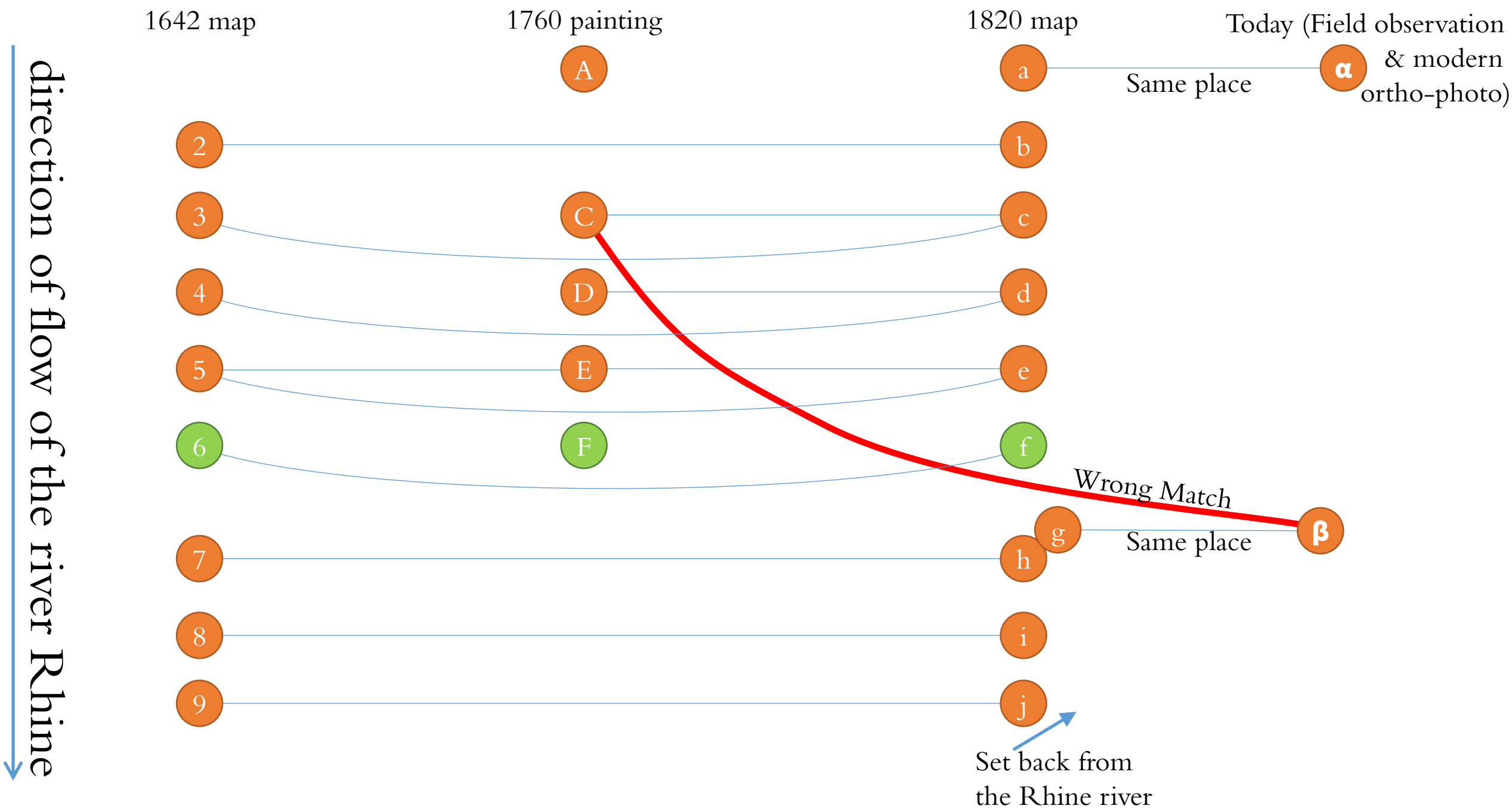
1820 Building numerotation along the river



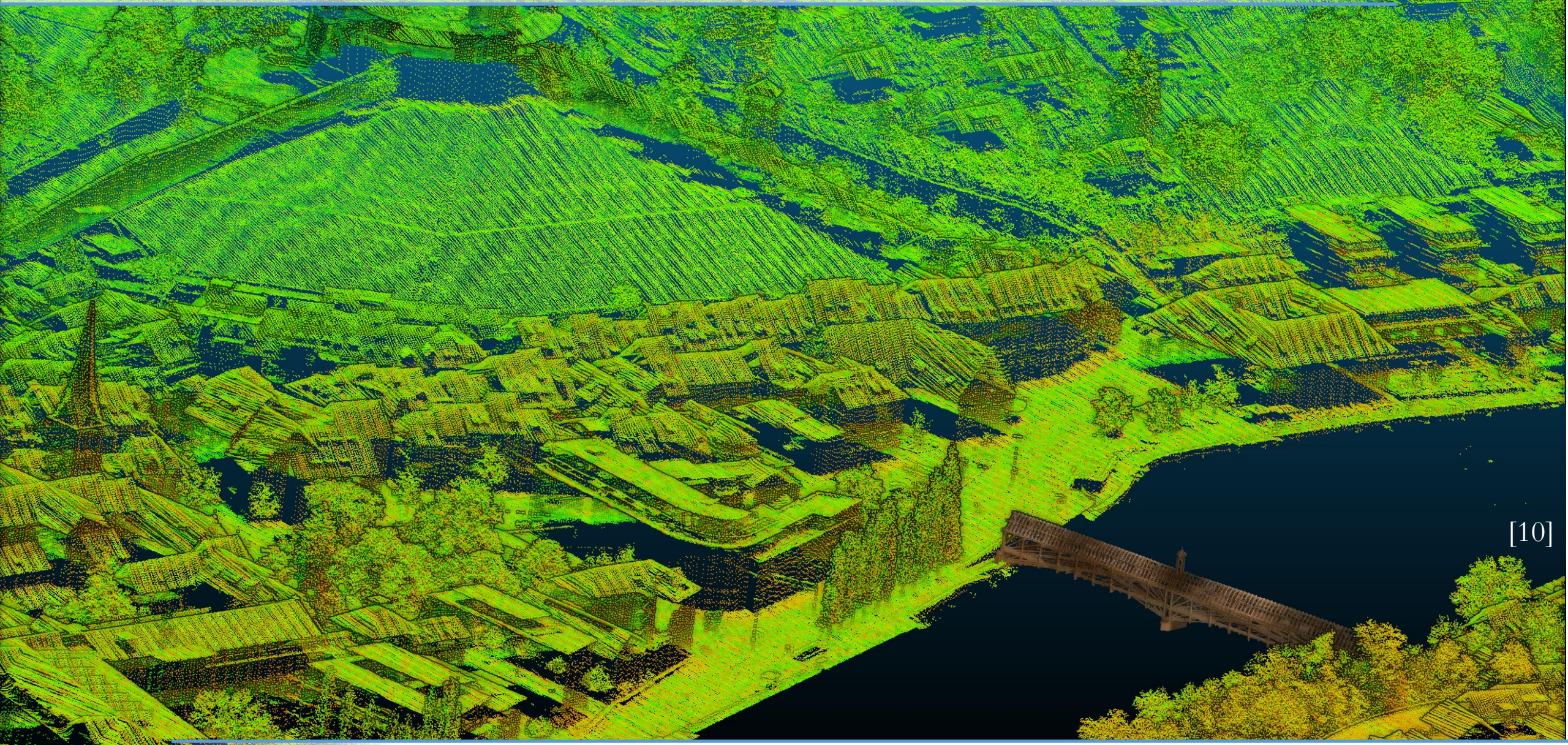
RESTAURANT SCHWEIZERHOF
β
α
güterhof

Build edges if buildings matches (looks similar)



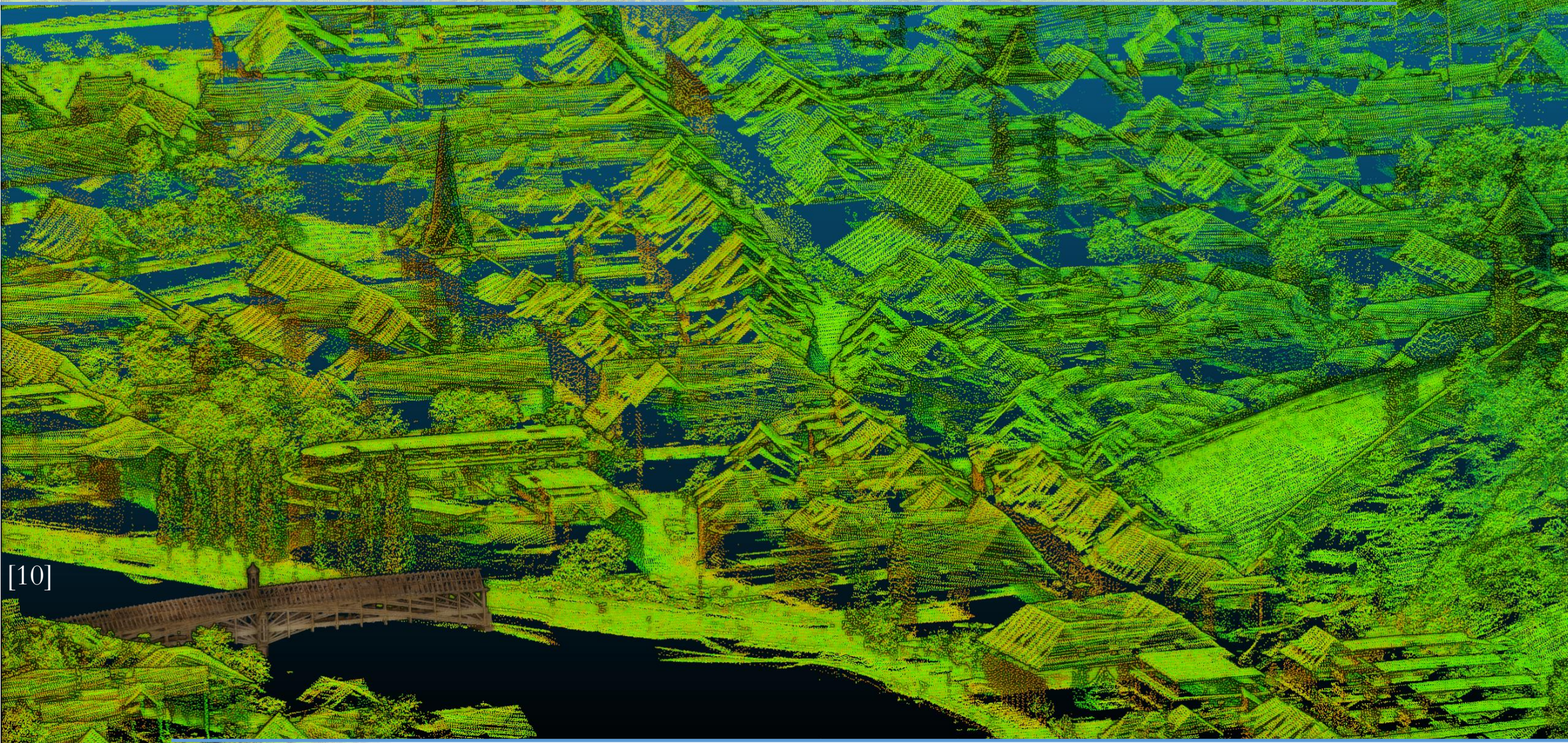

1642 map
1760 painting
1820 map
Today (Field observation & modern ortho-photo)
direction of flow of the river Rhine
A
a
α
Same place
2
b
3
C
c
4
D
d
5
E
e
6
F
f
Wrong Match
g
β
Same place
7
h
8
i
9
j
Set back from the Rhine river

Geo-referencing of 3D data over LIDAR HD



[10]

Geo-referencing of 3D data over LIDAR HD



[10]

Technical conclusions on photogrammetry

Conclusion

- The Schaffhausen Bridge: a manifesto of difficulties of small objects 3D reconstruction
- Cross sourcing from 2D maps, 2D perspective illustrations, 3D data
- Various methods: maps visualization, graph theory drawing, 2D map georeferencing, Photogrammetry

Techniques Perspectives, Outlooks

- Establish an experimental protocol for *Focus Breathing* quantification and correction
- Create a BIM from these 3D models, with the help of the 2D drawings for Structure simulation

Perspectives: entire city district 3D modellisation

Acknowledgment

IGN
INSTITUT NATIONAL
DE L'INFORMATION
GÉOGRAPHIQUE
ET FORESTIÈRE

Université
Gustave Eiffel

swiss young
academy

Sponsor

École des Ponts
ParisTech

Conservation, cultural heritage,
documentation, archiving

References

[1] Suisse geographique SwissTopo, https://upload.wikimedia.org/wikipedia/commons/f/f6/Suisse_geographique.png

[2] Weinand Yves « Le pont en bois des frères Grubenmann aurait pu être réalisé » Tracés n°17, pp13—21, 6 septembre 2006

[3] Hans Ulrich Grubenmann "Plan coupe et élévation du fameux pont de bois de Schaffhouse sur le Rhin". Gravure sur cuivre d'après les plans originaux de Grubenmann par Christian von Mechel, publiée à Bâle en 1803 (Bibliothèque nationale suisse).

[4] Bleuler, Johann Heinrich "der Ältere" (Feuerthalen) „Vûe du Pont de Schaffhause » 1950/K.1752/Utc GS-GRAF-ANSI-SH-18 HelveticArchives https://www.helveticarchives.ch/detail.aspx?ID=891040 1788

[5] Beschiessung der Rheinbrücke in Schaffhausen am 13. April 1799, Aquarell, H. Bleuler zugeschrieben

References

[6] Brand der Rheinbrücke in Schaffhausen, 1799, kolorierte Lithographie von Johann Jakob Billwiller, um 1800, drei Varianten

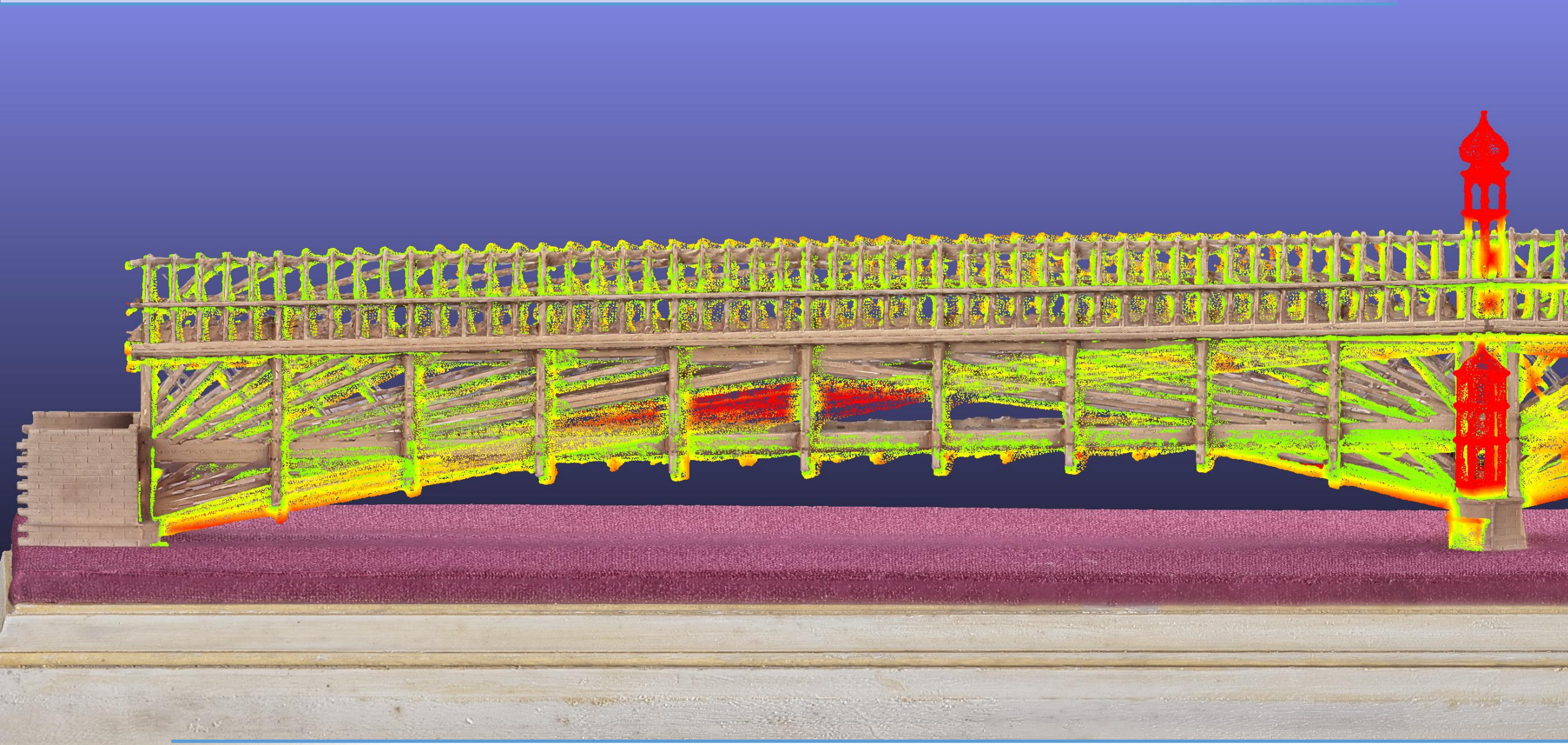
[7] Poliarnyi Nikolai « Out-of-Core Surface Reconstruction via Global TGV Minimization" ICCV arXiv pp5641—5650 doi: 10.48550/ARXIV.2107.14790

[8] SmapShot La machine à remonter le temps participative https://smapshot.heig-vd.ch/

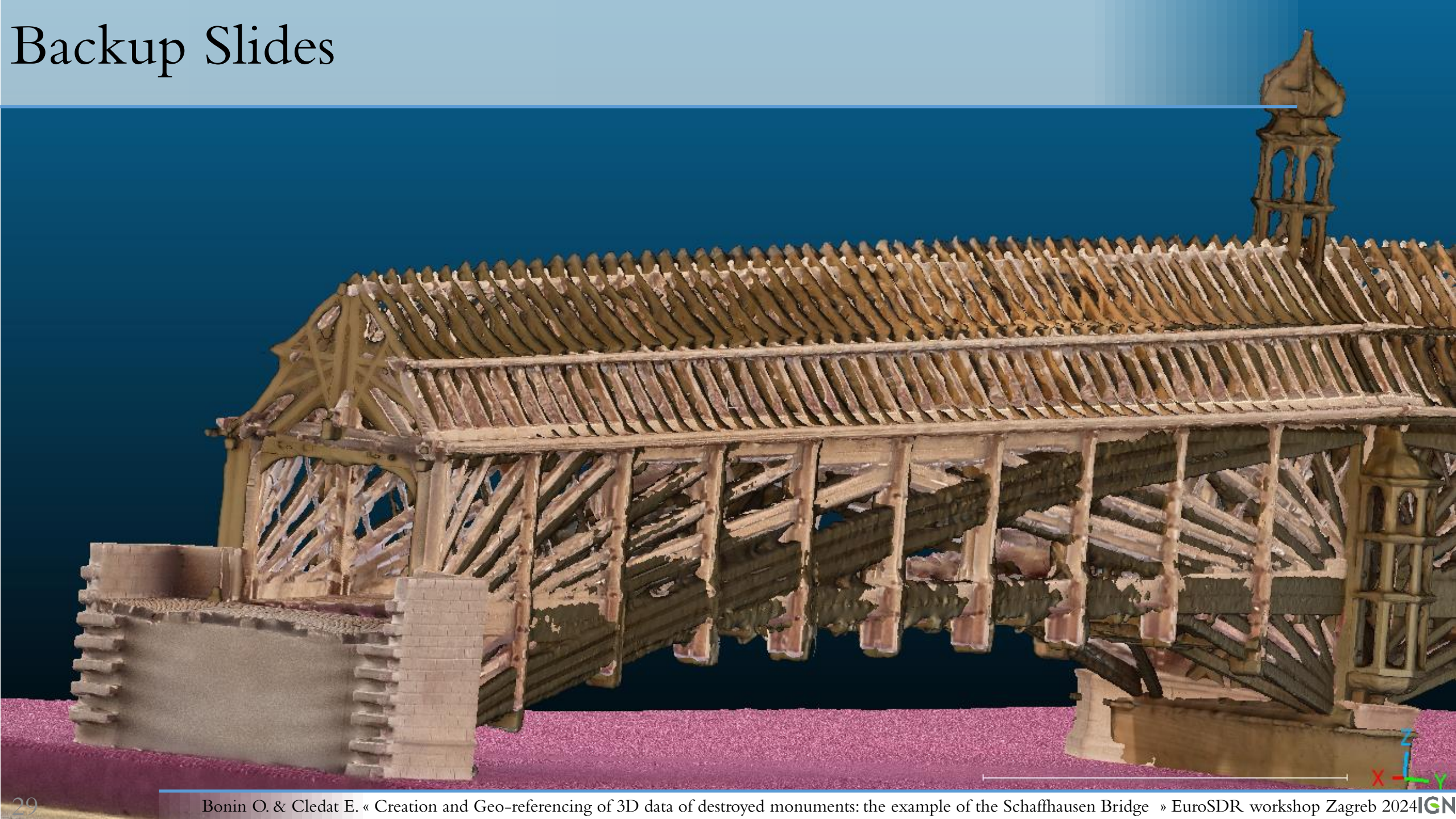
[9] Géoportail Suisse https://map.geo.admin.ch/

[10] SwissTopo OpenDATA LIDAR https://www.swisstopo.admin.ch/en/geodata/height.html

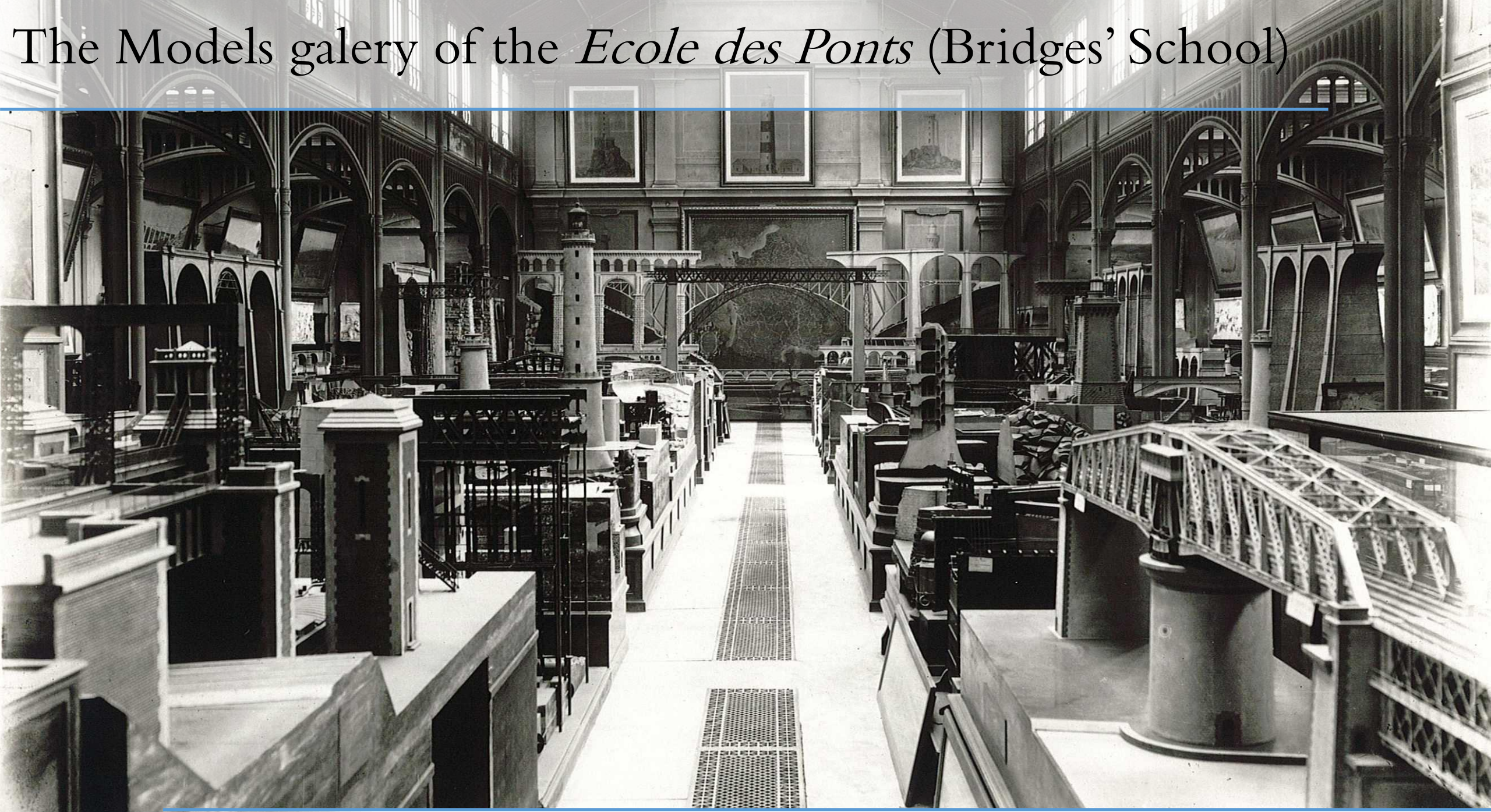
Questions ?



Backup Slides



The Models galery of the *Ecole des Ponts* (Bridges' School)



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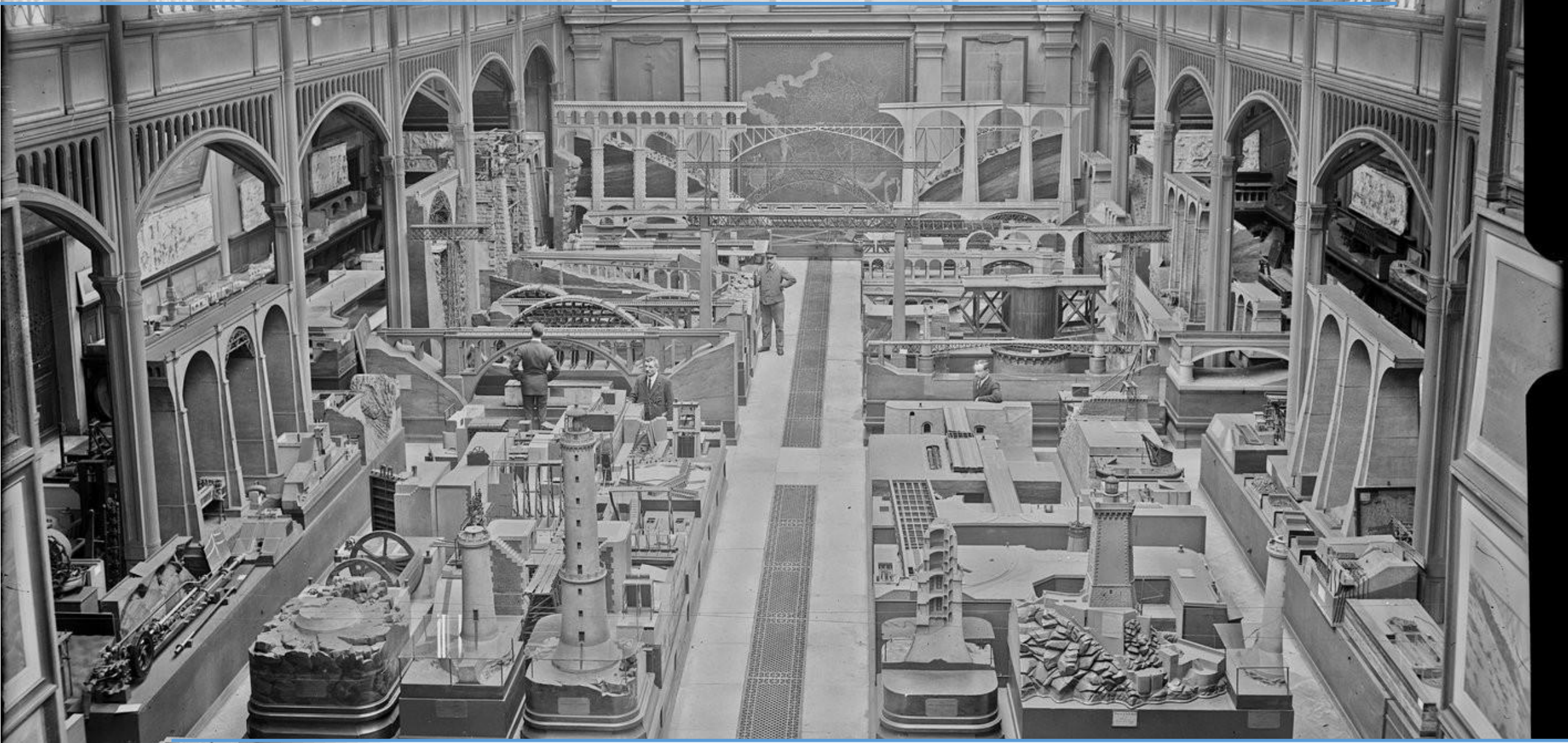
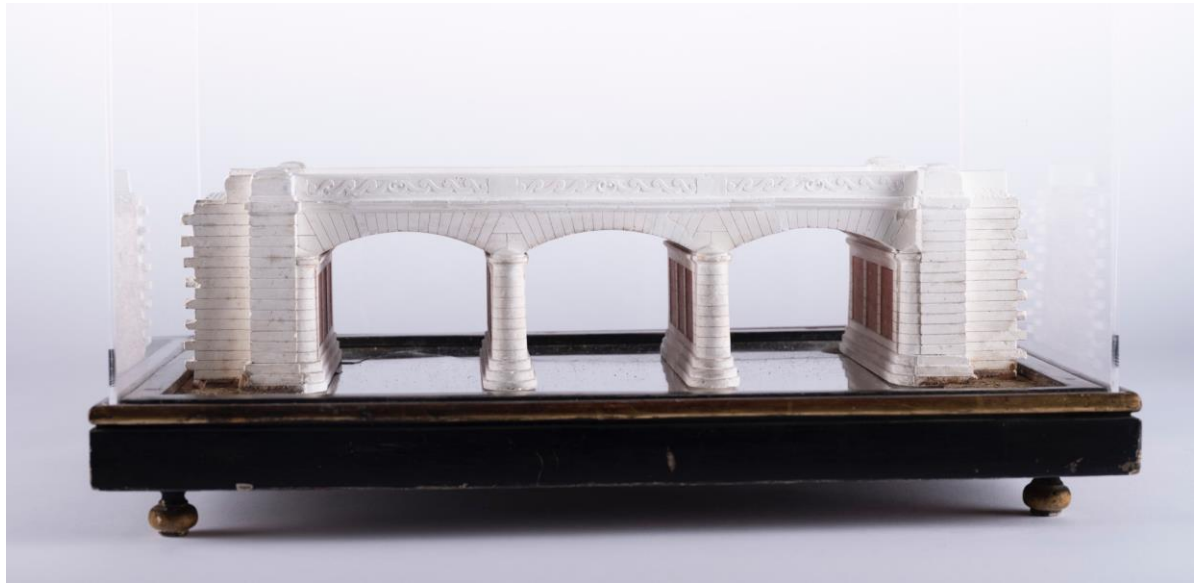


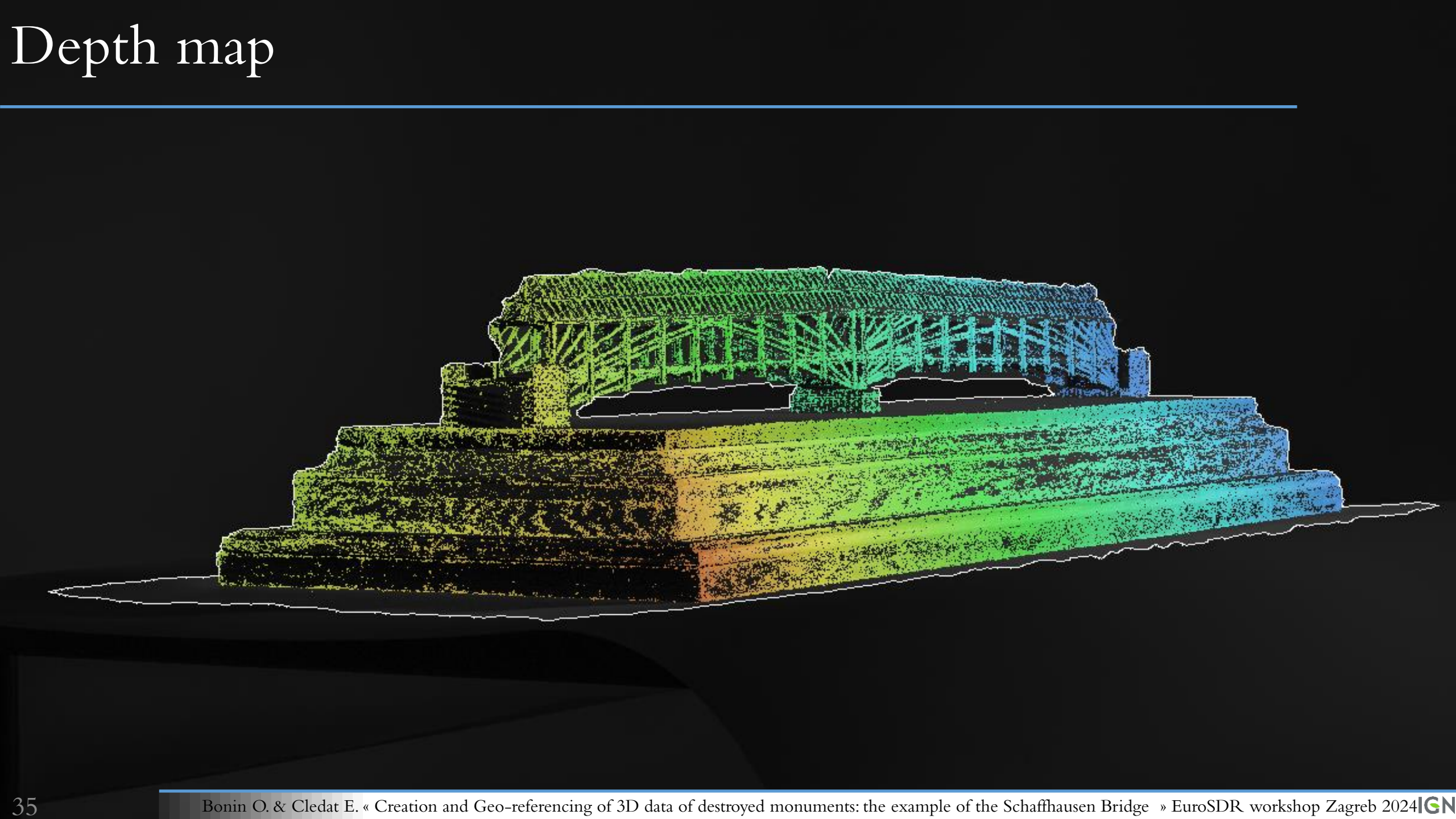
Few models of the *Ecole des Ponts* collection



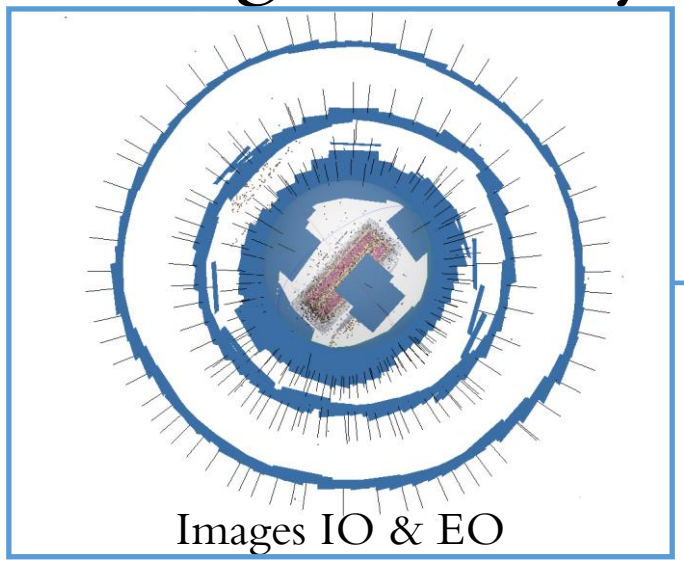
Photogrammetric 3D modelling of models is not trivial…

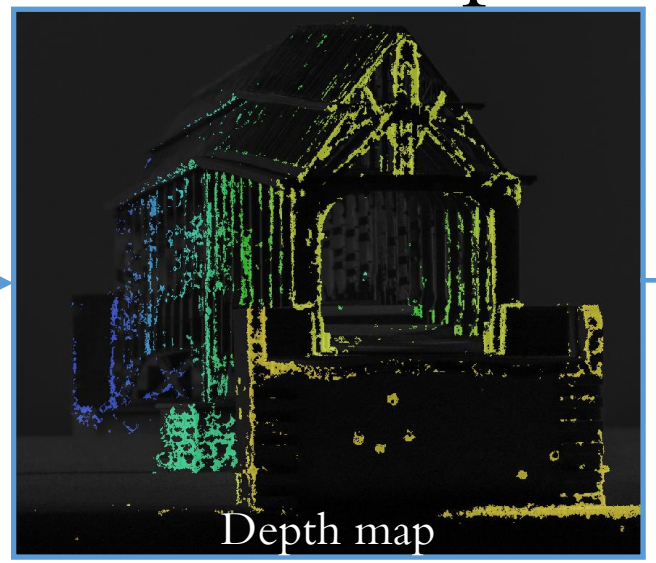
White background removal

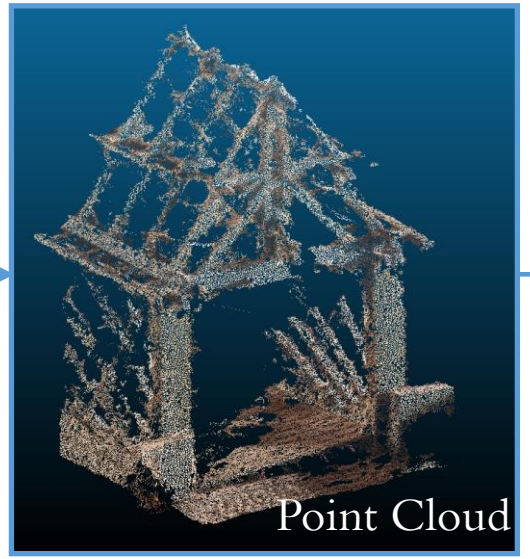
Depth map

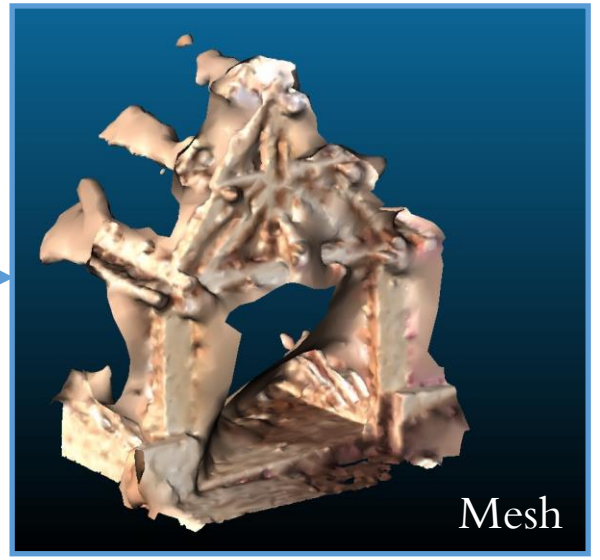


Photogrammetry of small complex models: mesh creation

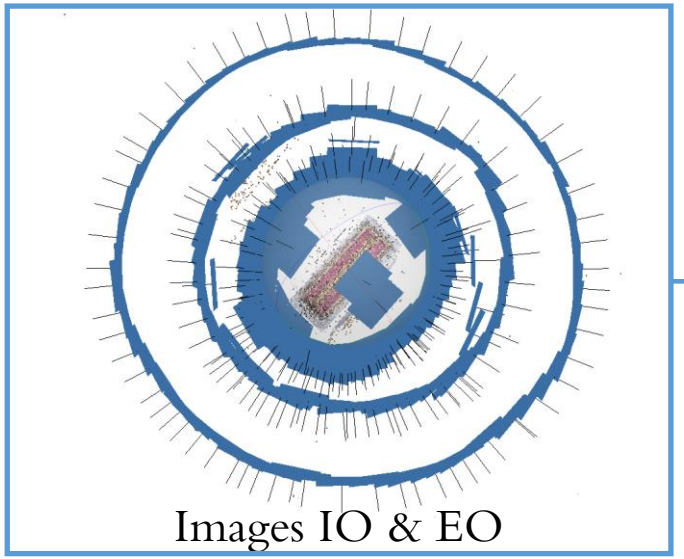


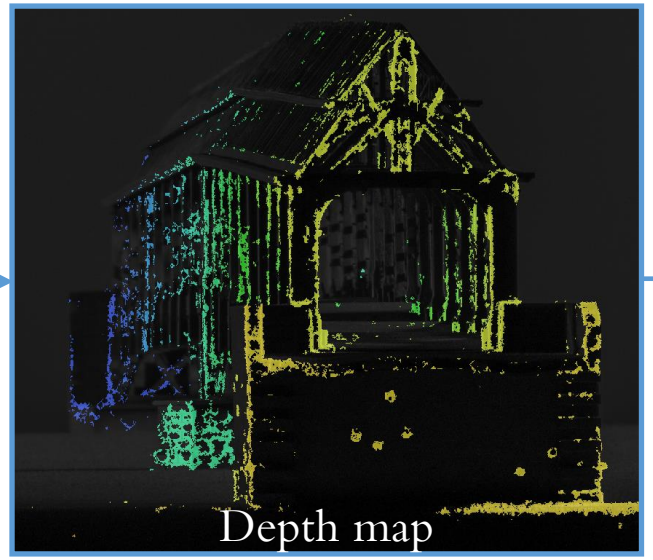






Classic Workflow





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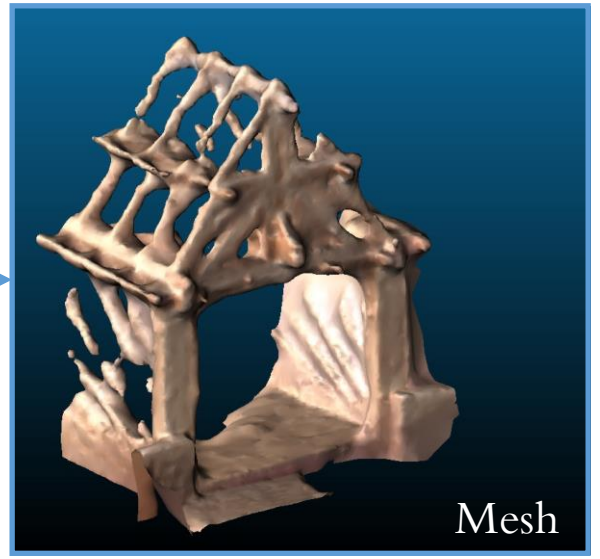
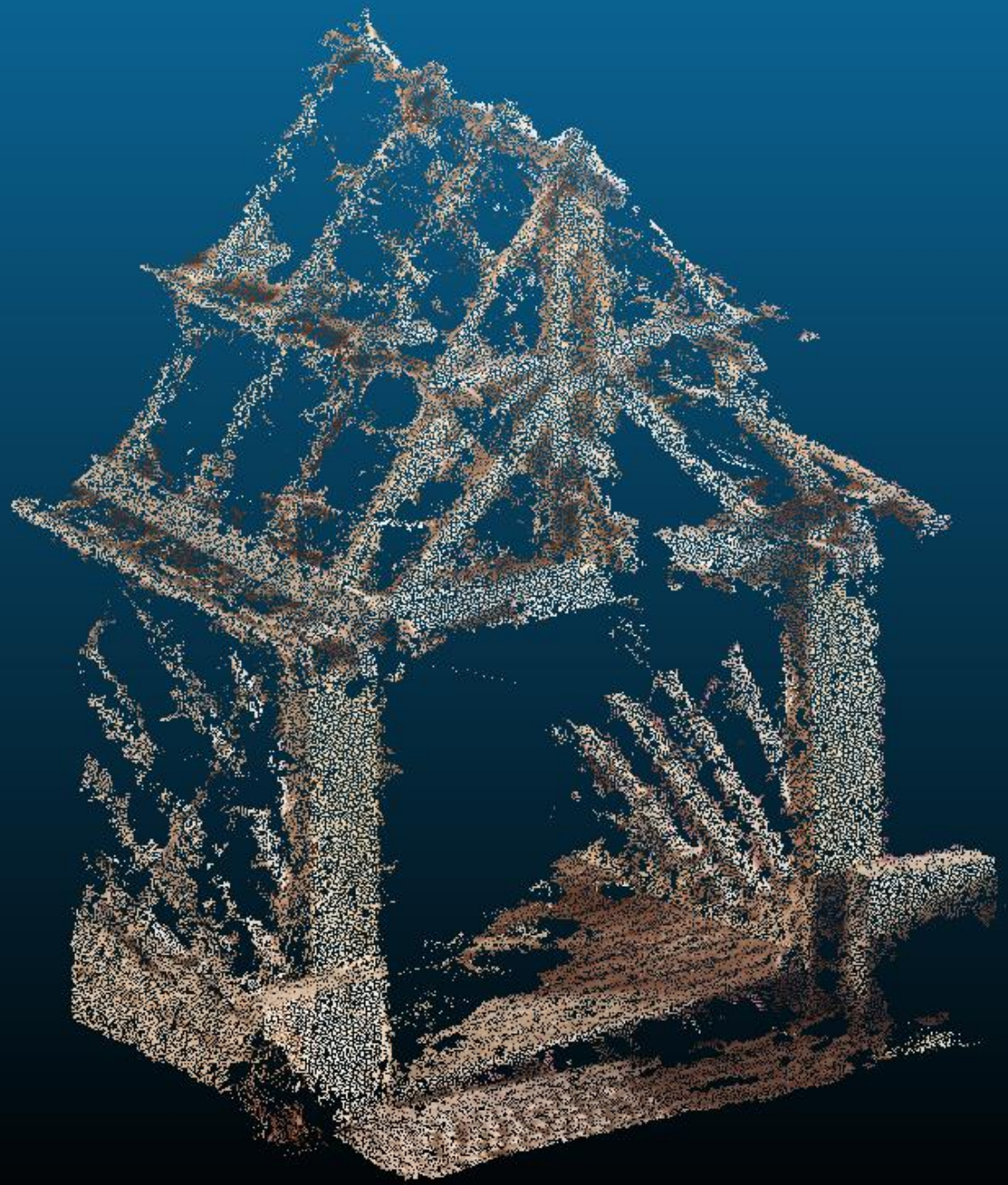
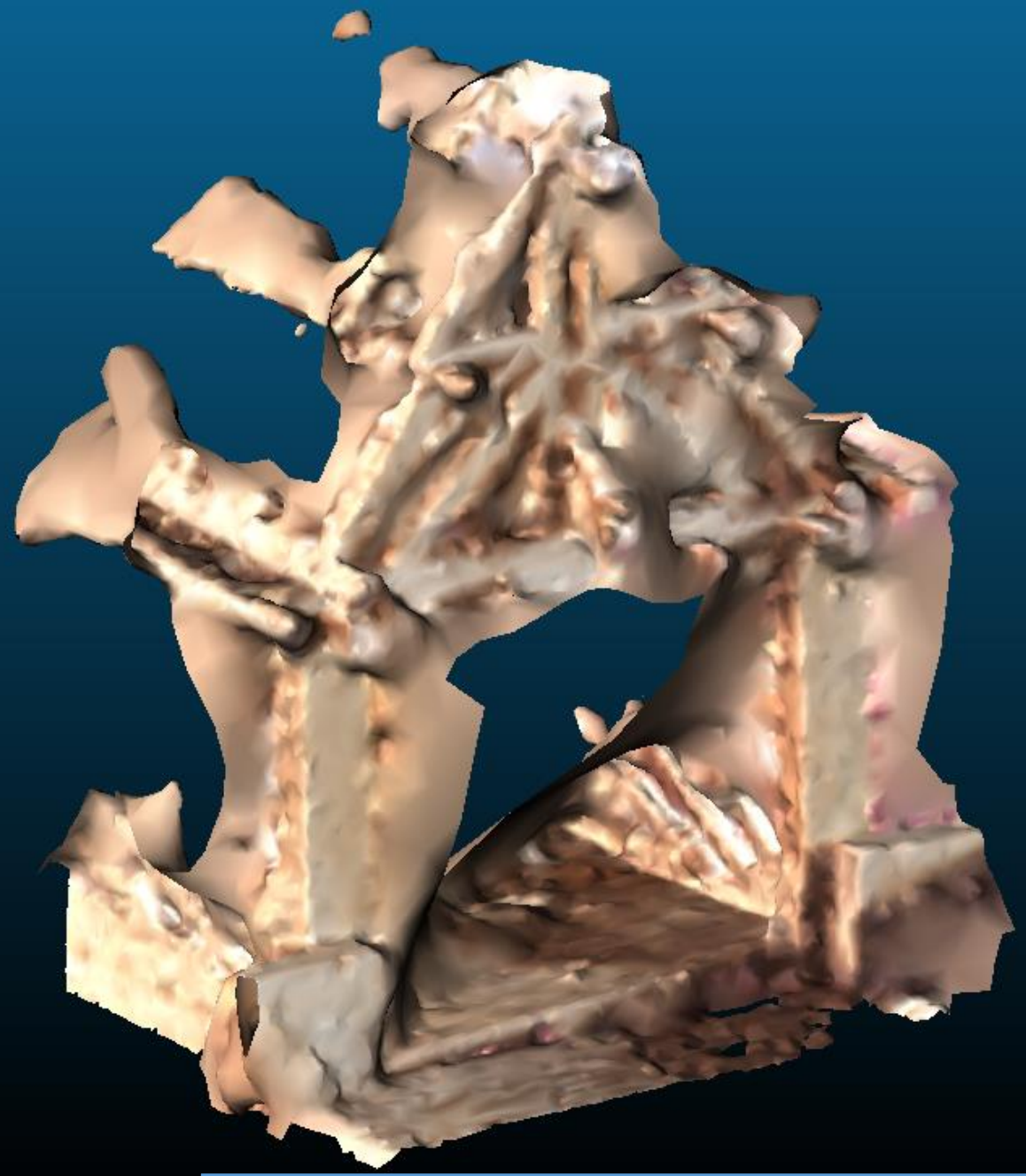


Integrated Workflow

Point-Cloud



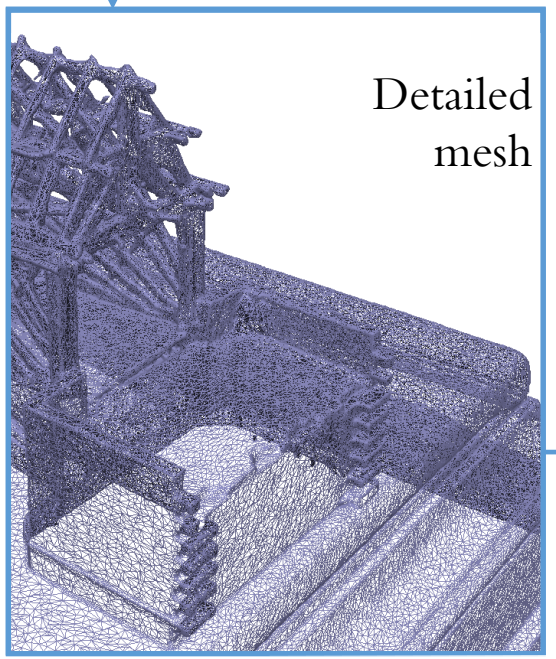
Mesh from Point-Cloud

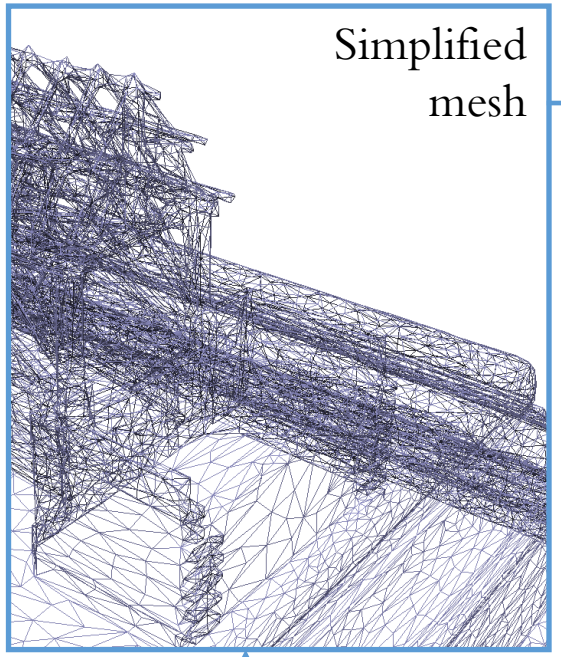


The best Mesh from Depth-map!

Mesh texturation: naive approach

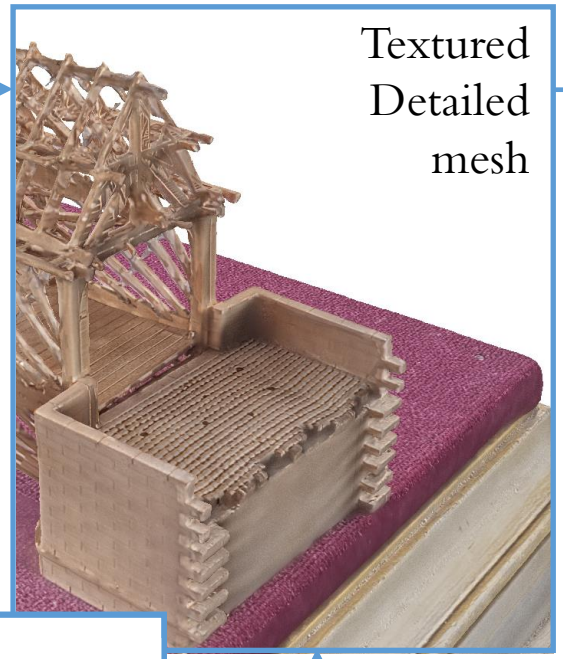
Photos

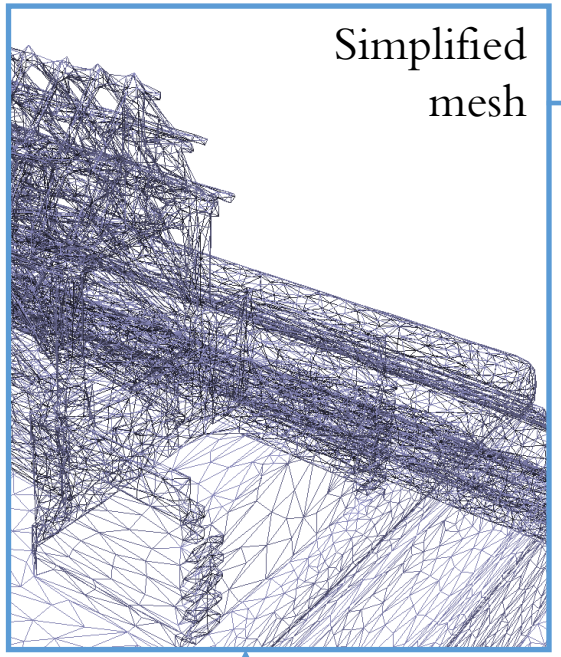


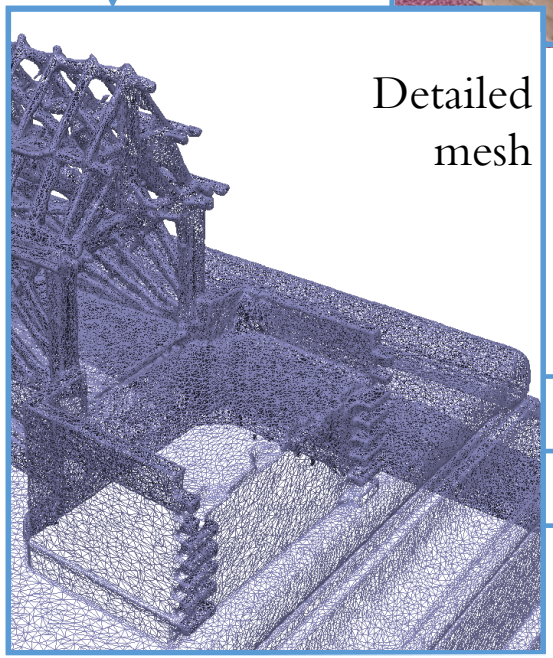


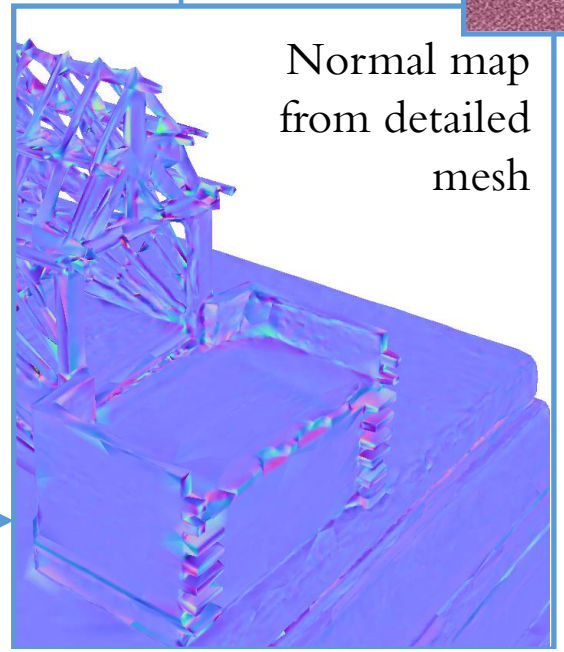
Mesh texturation: advanced approach (using UV mapping)

Photos

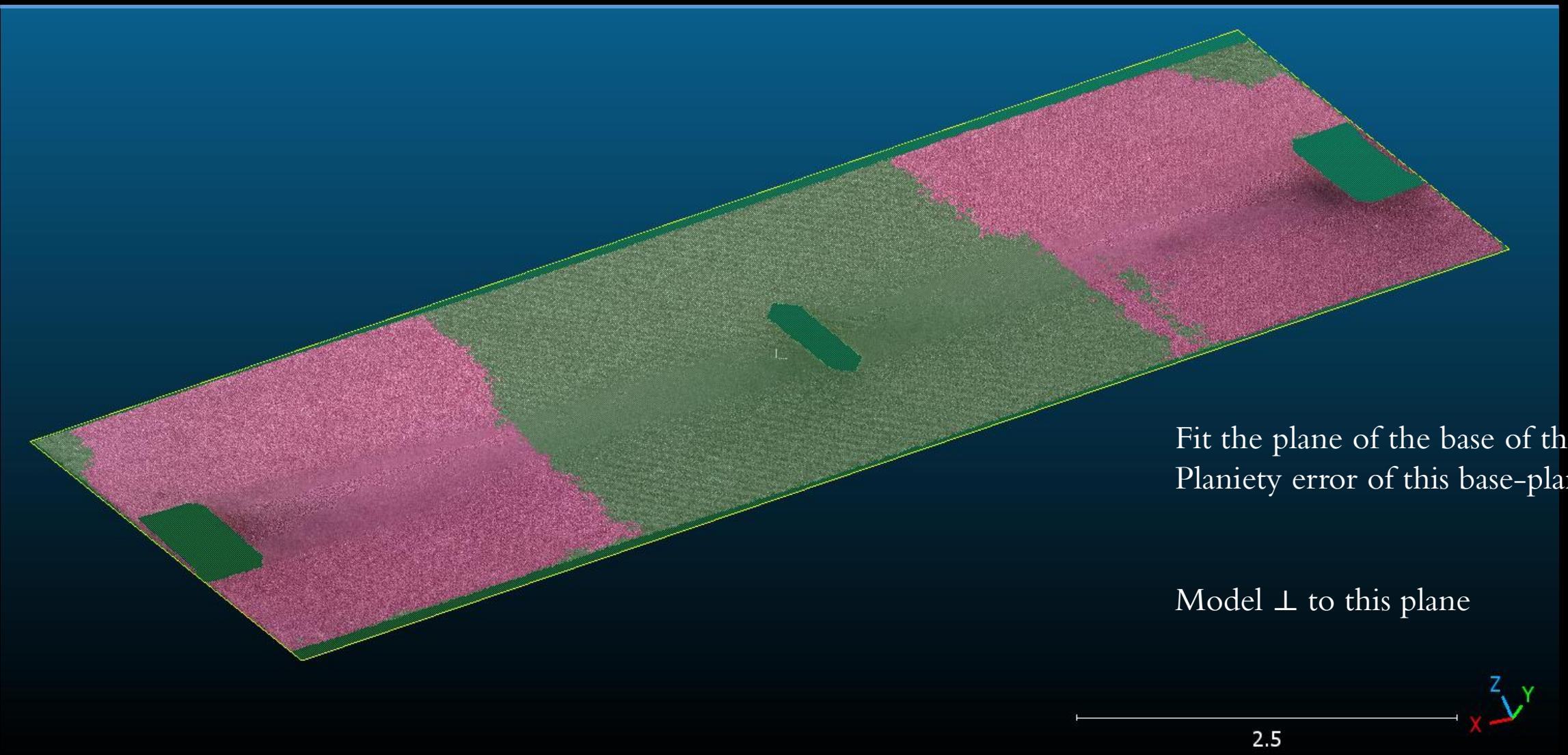






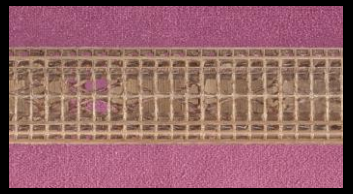


Verticalization of the 3D model

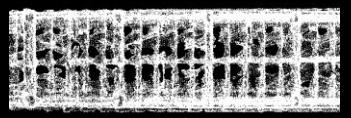


Alignement of the two models in the same frames

Legend:



Model of the *Ecole des Ponts*



Model of the Teufen museum

2.5D alignment:

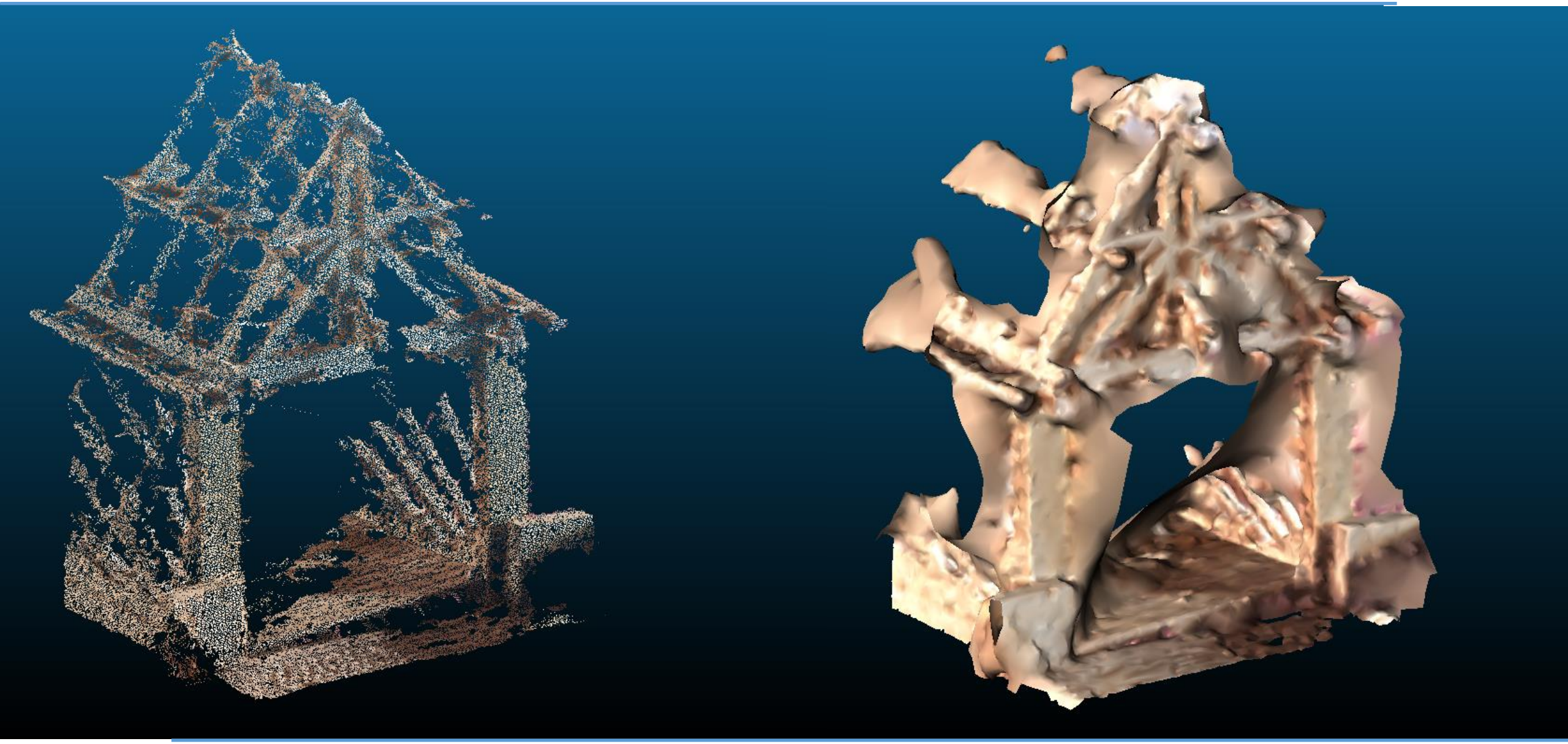
Two differents angle => Our choice was to align both segments separatly

2D points on vertical beams

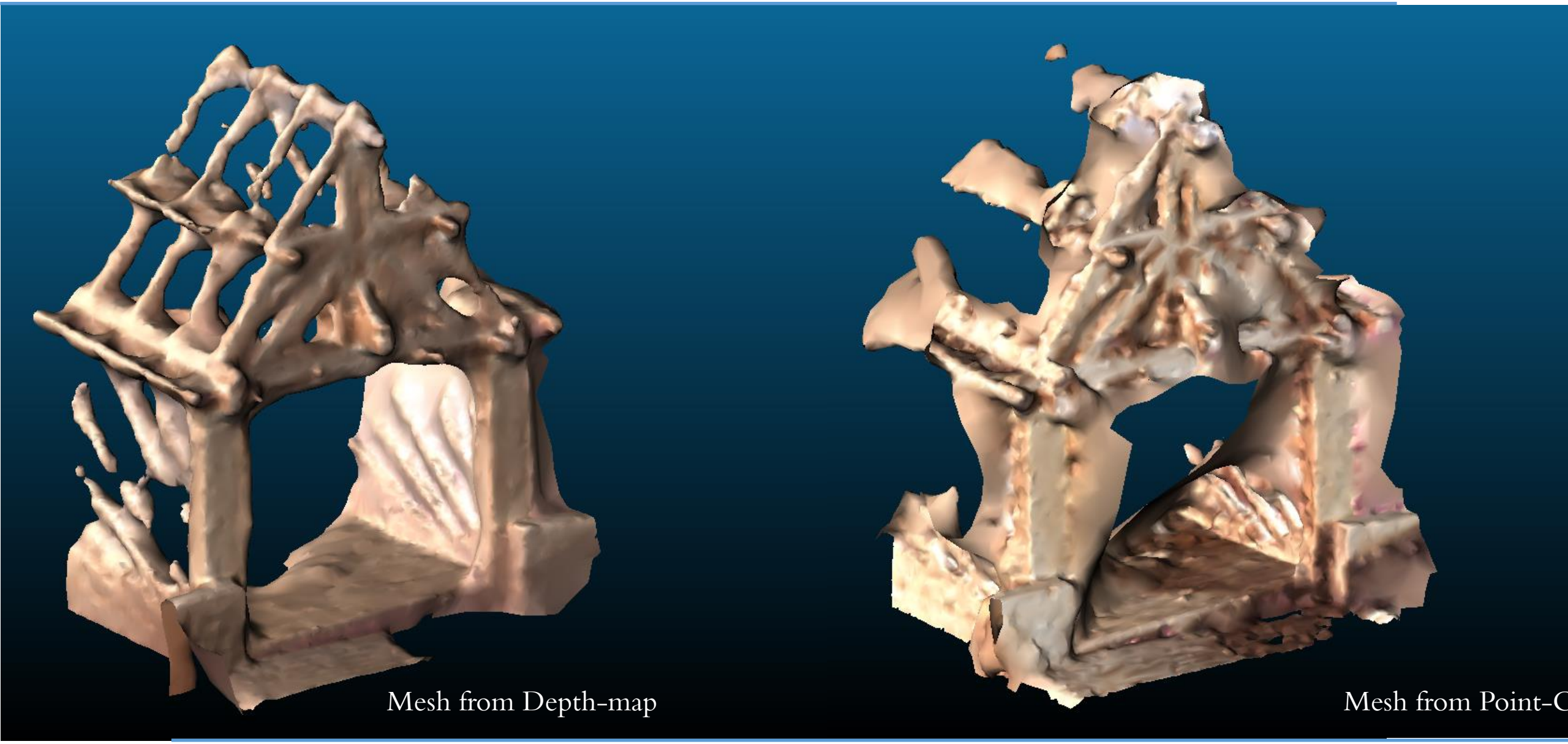
⇒ 4 parameters of the 2D Helmert transformation: scale, translation XY, rotation Z

Points on the ridge beam ⇒ translation Z

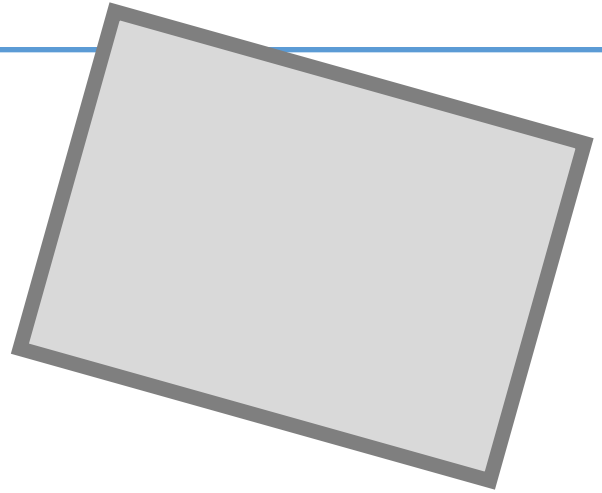
Mesh from dense Point-Cloud

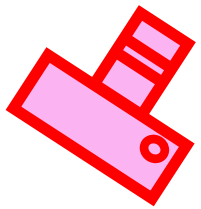


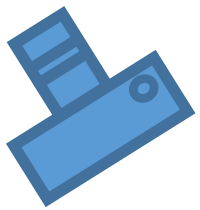
Mesh from Depth-map Vs Mesh from Point-Cloud



Photogrammétrie de maquettes: Création d'un maillage







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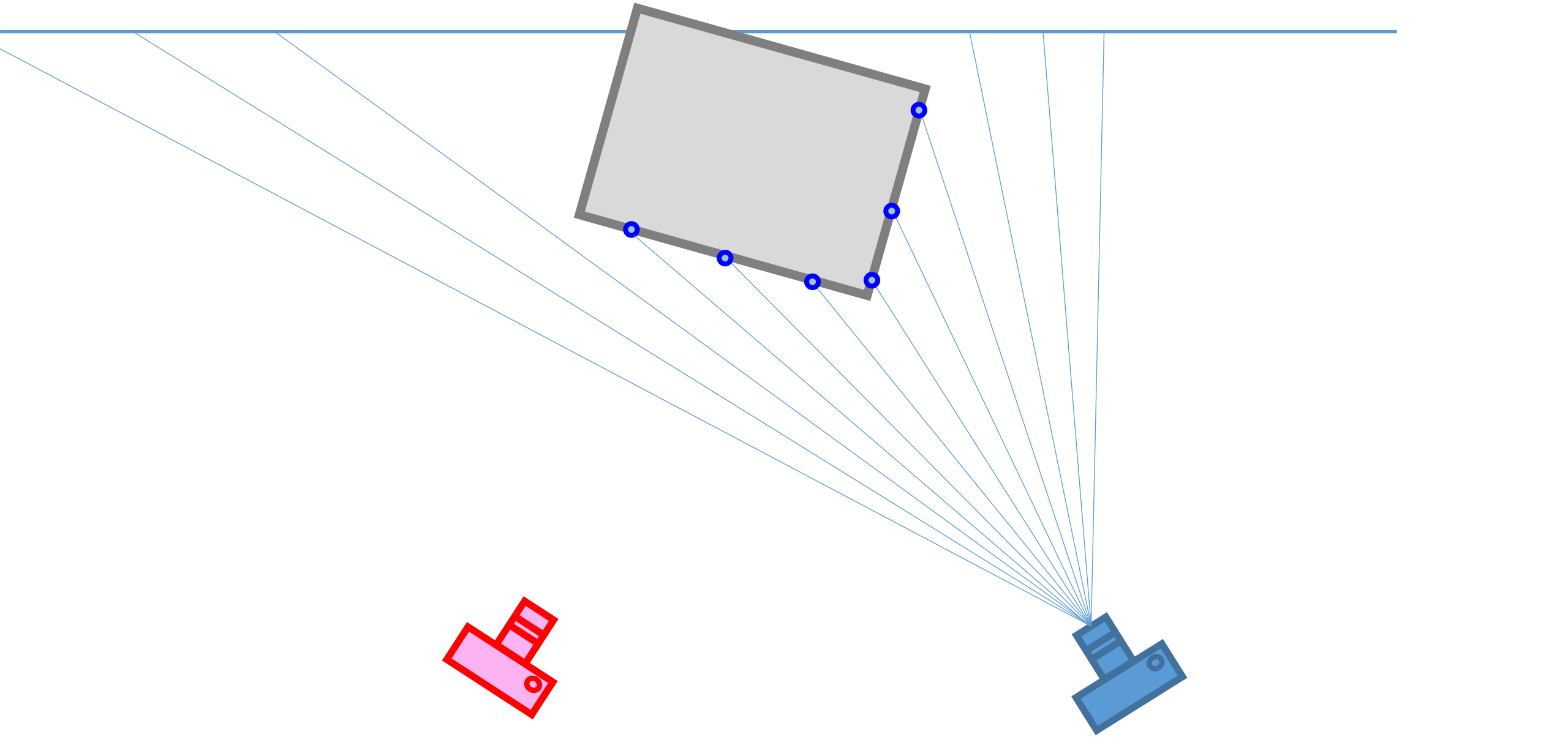

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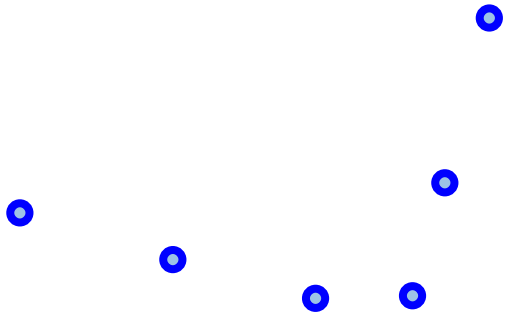

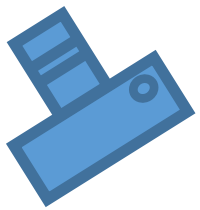

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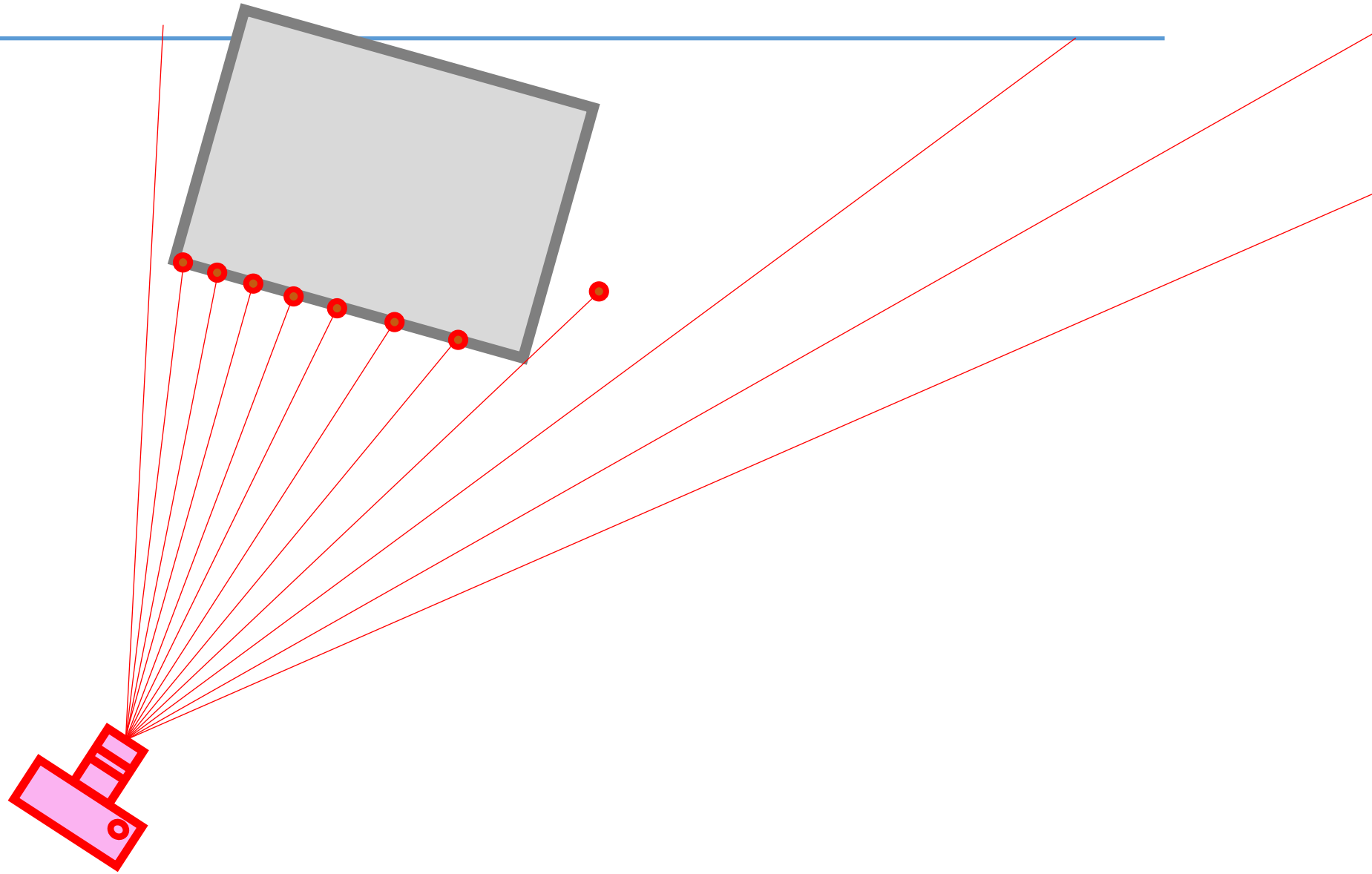

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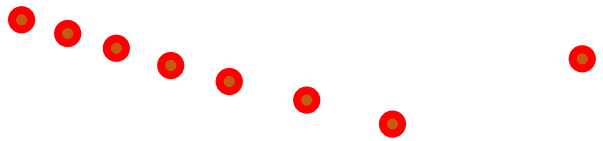

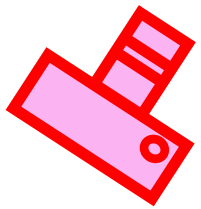

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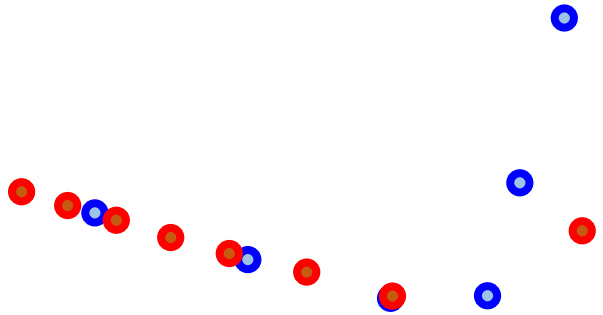

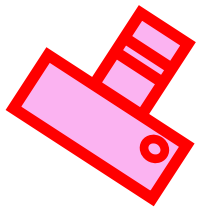

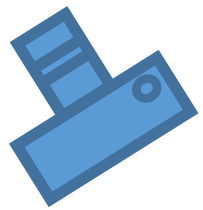

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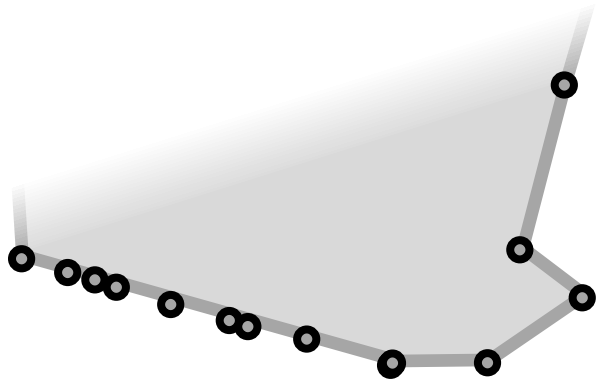

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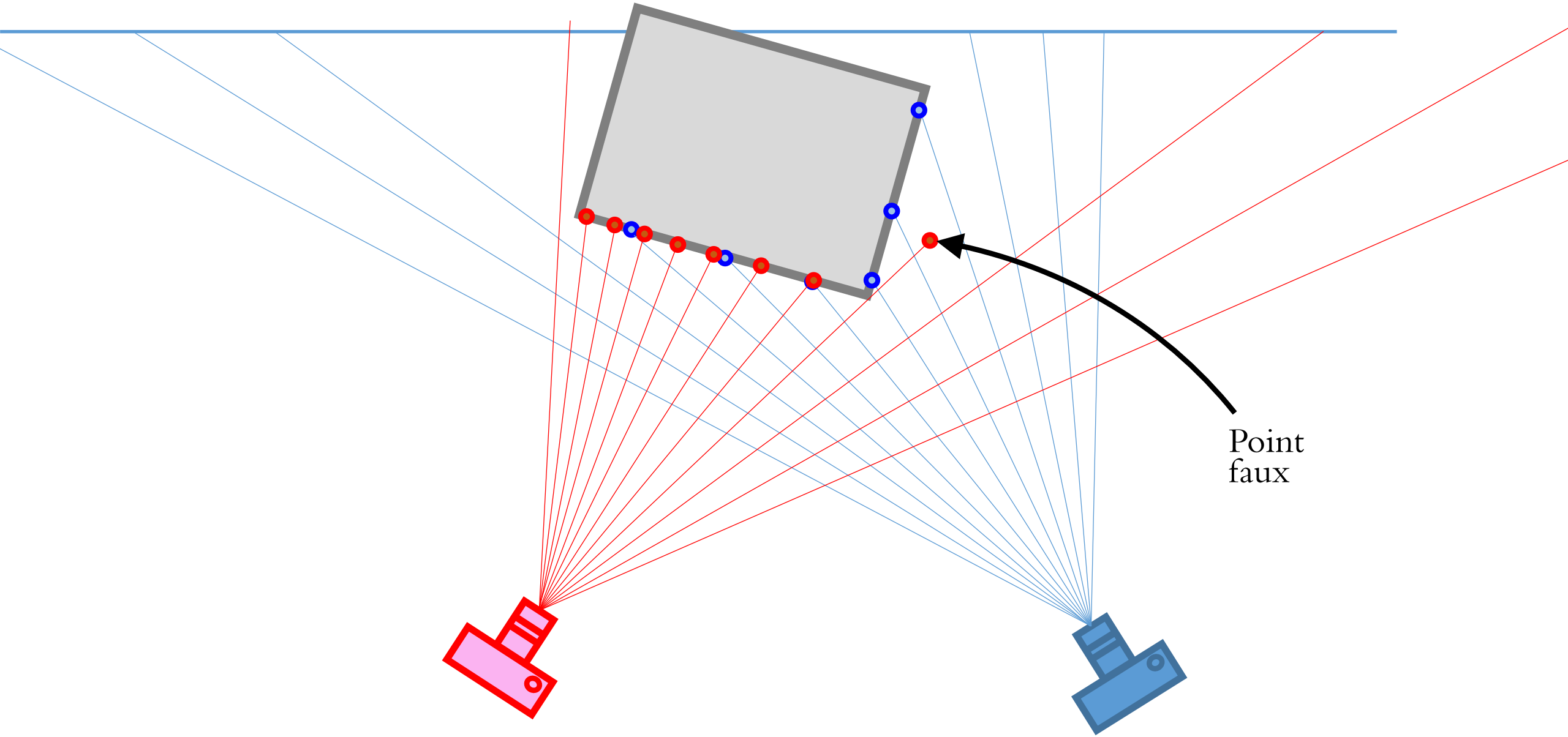

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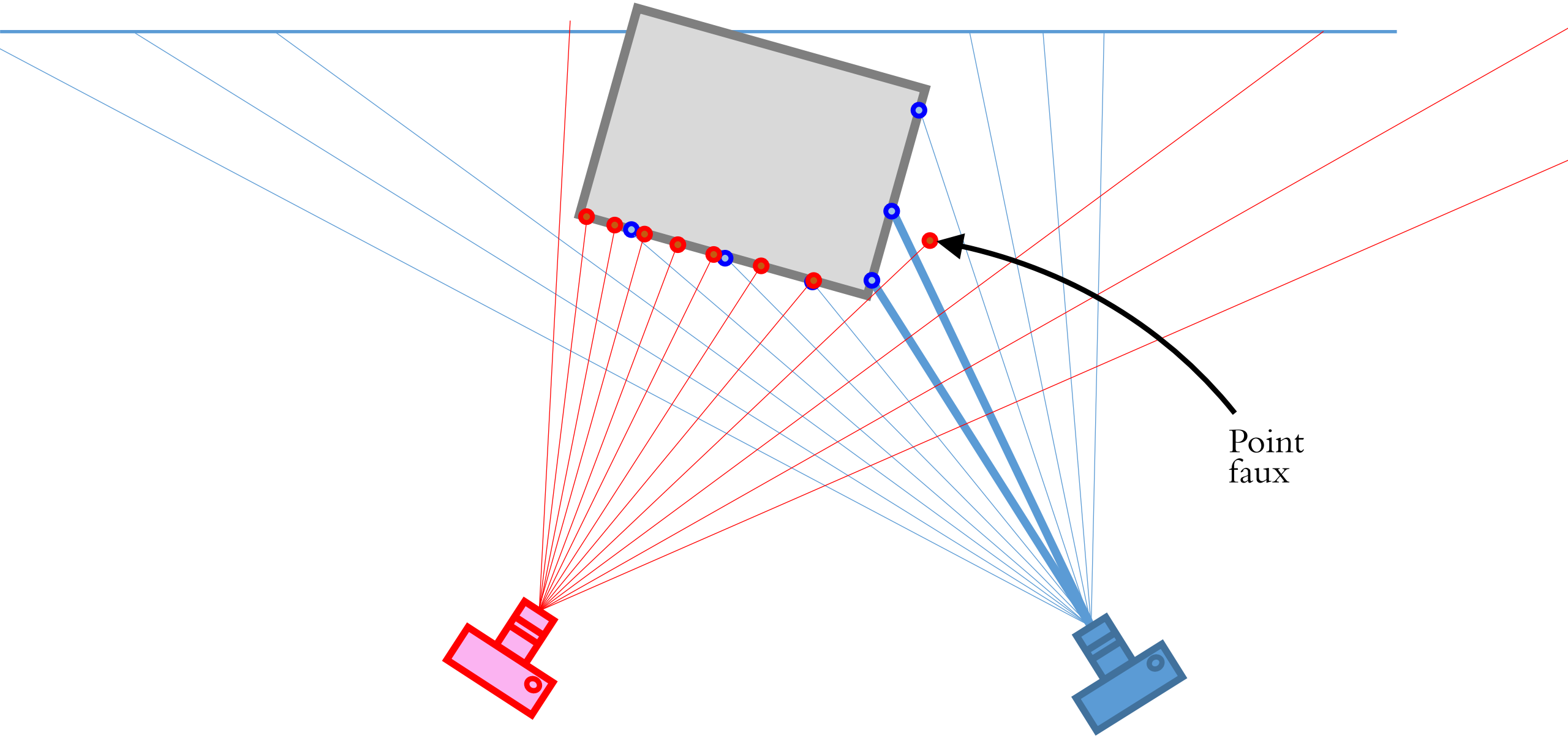
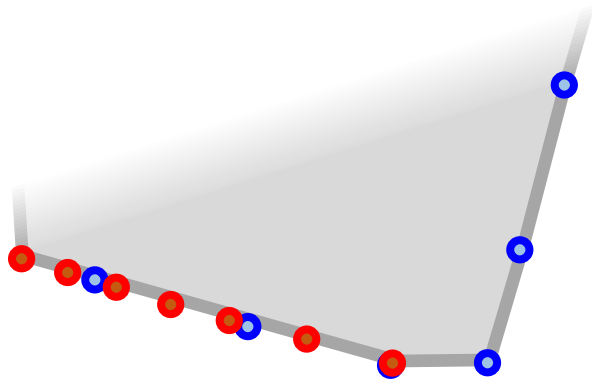
Photogrammétrie de maquettes: Création d'un maillage