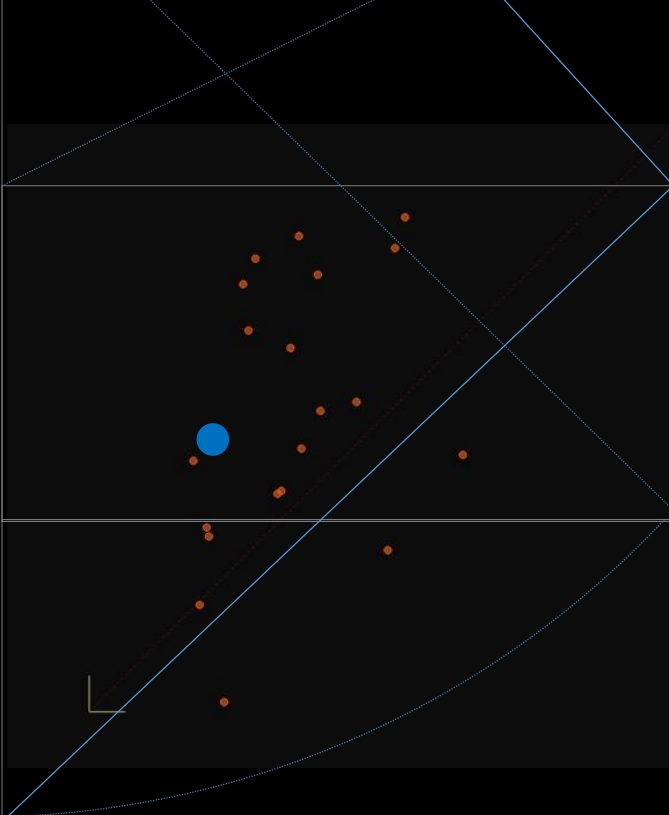
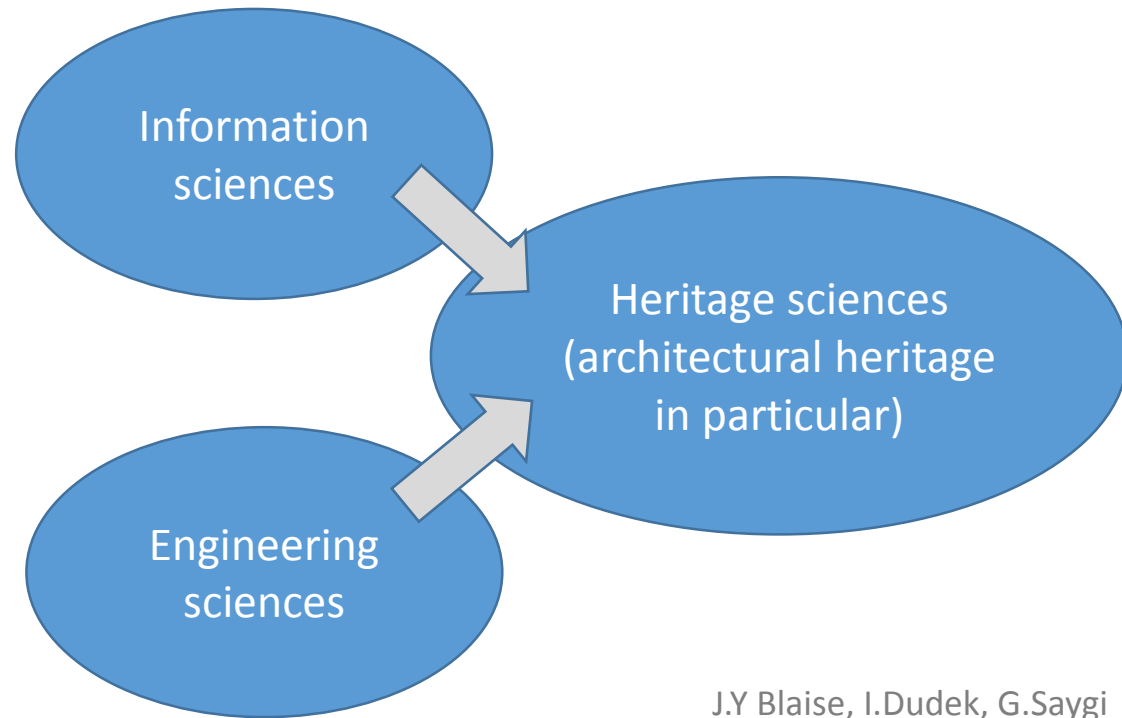
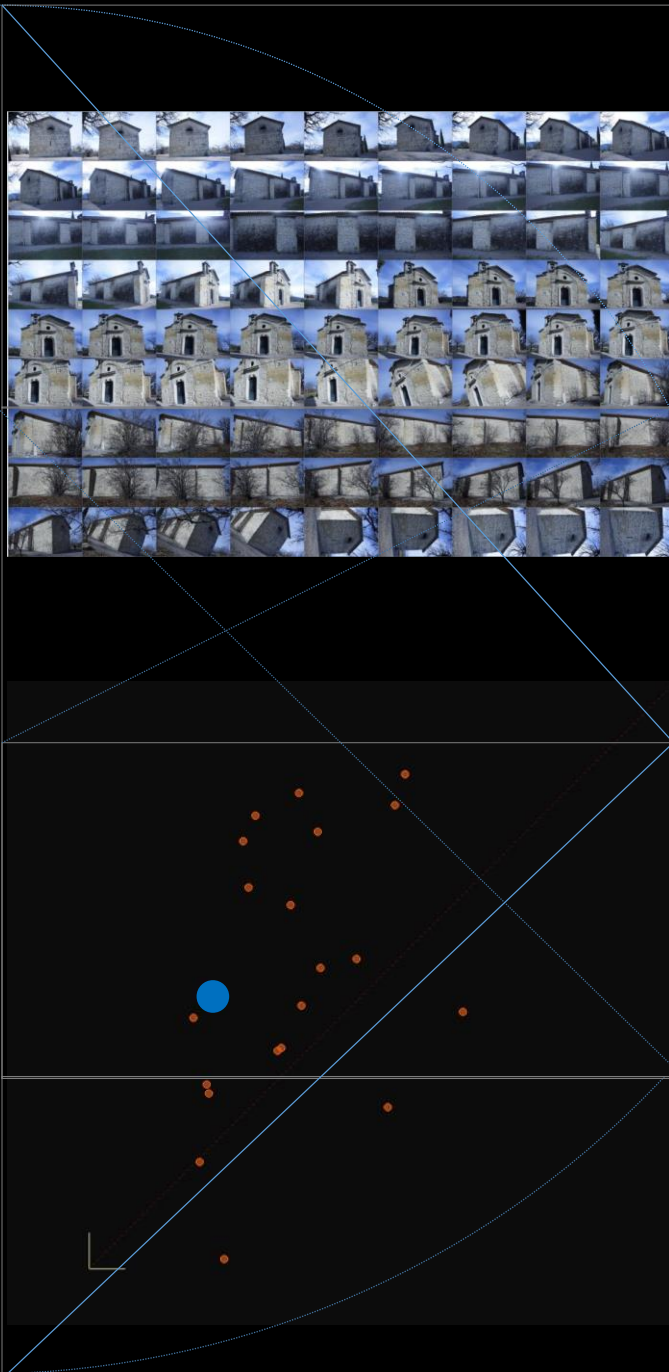




Proportions vs dimensions: shedding a different light on the analysis of 3D datasets

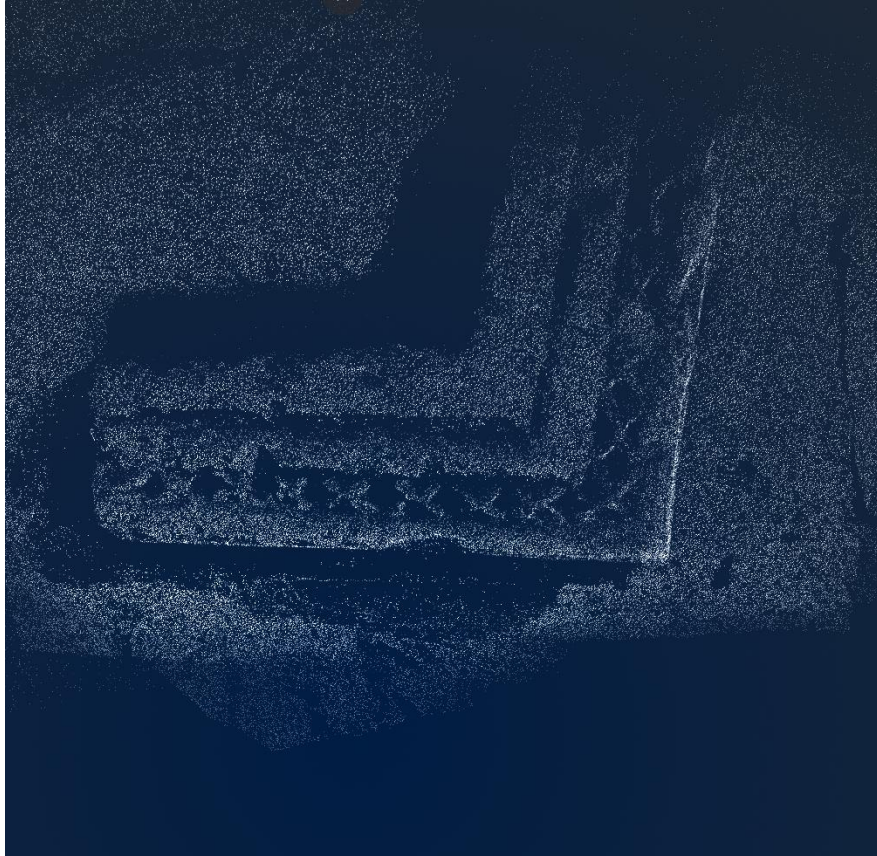
J.Y Blaise, I.Dudek, G.Saygi
UMR CNRS/MC 3495 MAP





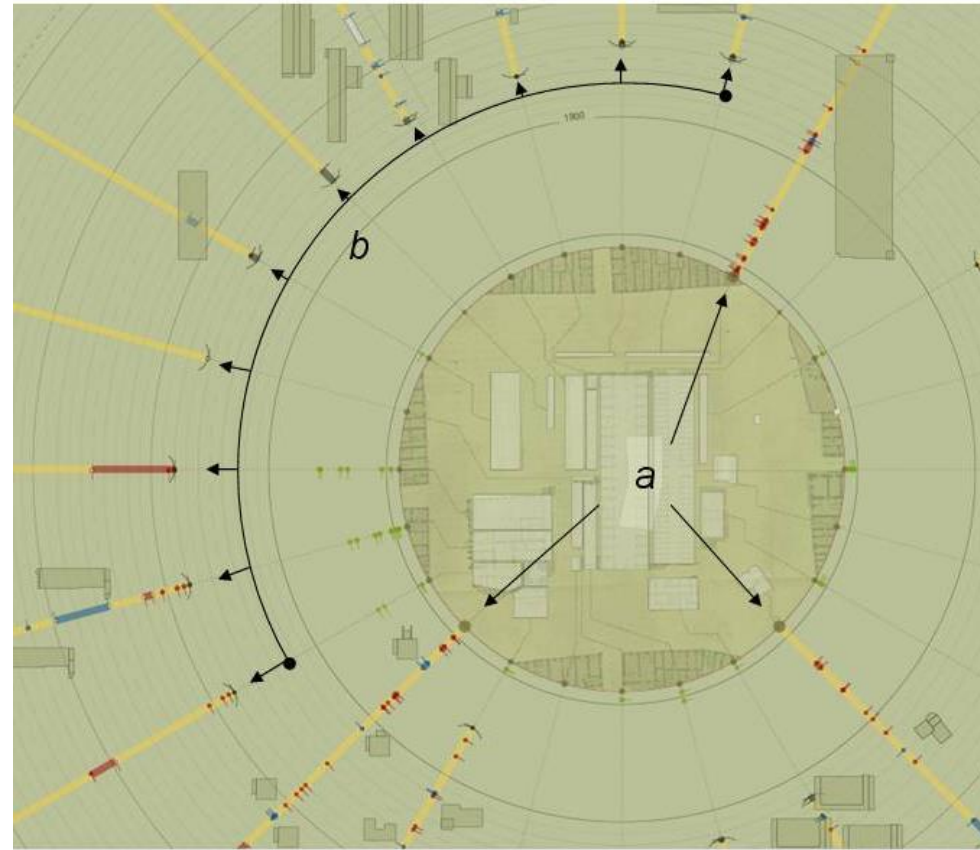
J.Y Blaise, I.Dudek, G.Saygi
UMR CNRS/MC 3495 MAP

Models and Simulations for Architecture and the Heritage



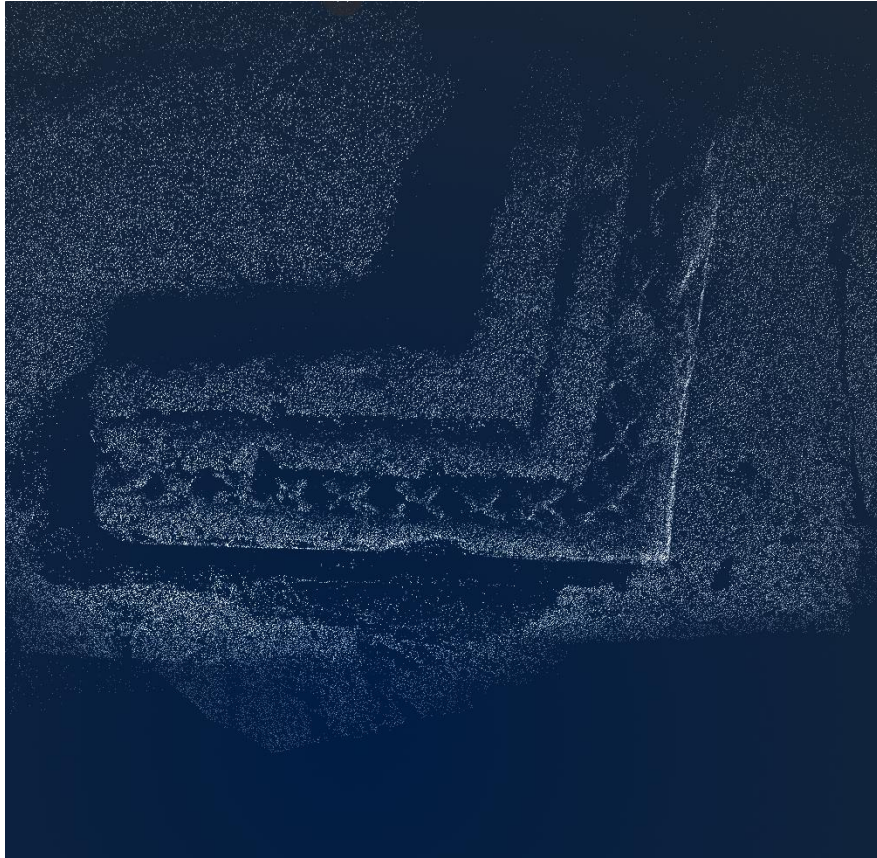
Survey protocols : acquisition and processing of raw 3D data

Photogrammetry, laser scanning, image-based modelling, etc.

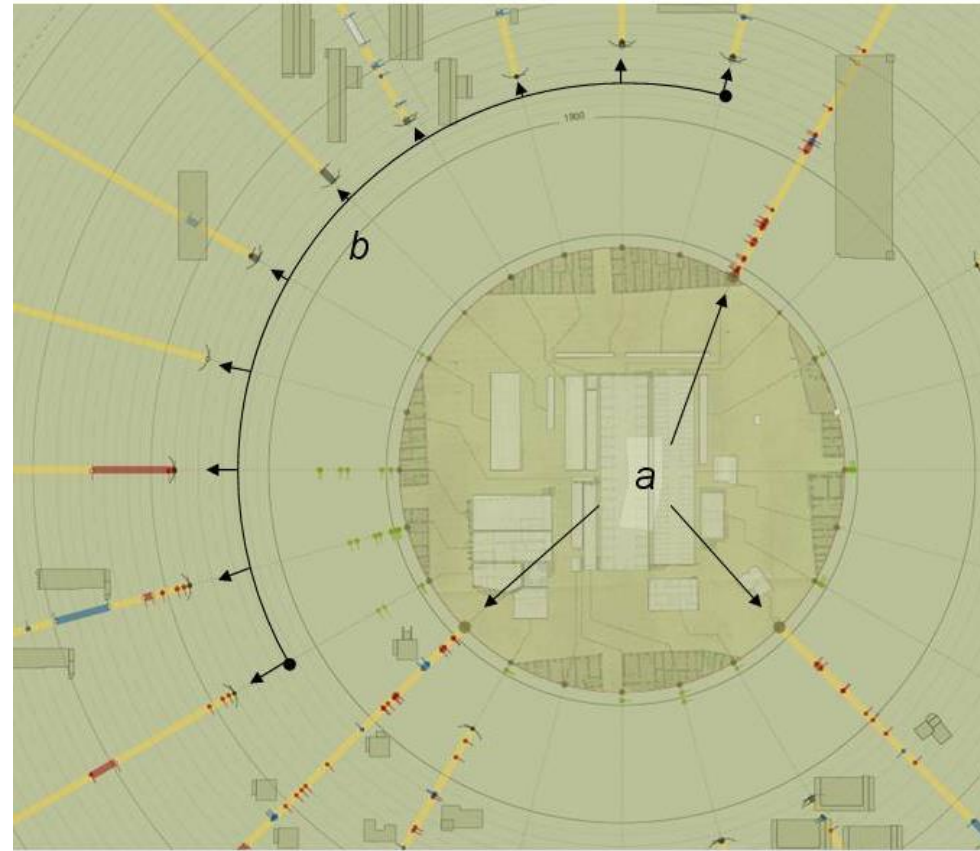


Information visualisation : providing tools for reasoning on historical evidence, spotting trends and exceptions.

J.Y.Blaise, I.Dudek - *Concentric Time: Enabling Context + Focus Visual Analysis of Architectural Changes*
 Foundations of Intelligent Systems, M. Kryszkiewicz, H. Rybinski, A. Skowron, W. Raś (Ed.), Lecture Notes in Computer Science, Springer-Verlag, Berlin, Heidelberg, ISBN 978-3-642-21915-3, ISSN 0302-9743, pp. 632-641



Focuses on depicting one particular item, with exhaustiveness, from the point of view of its geometrical features

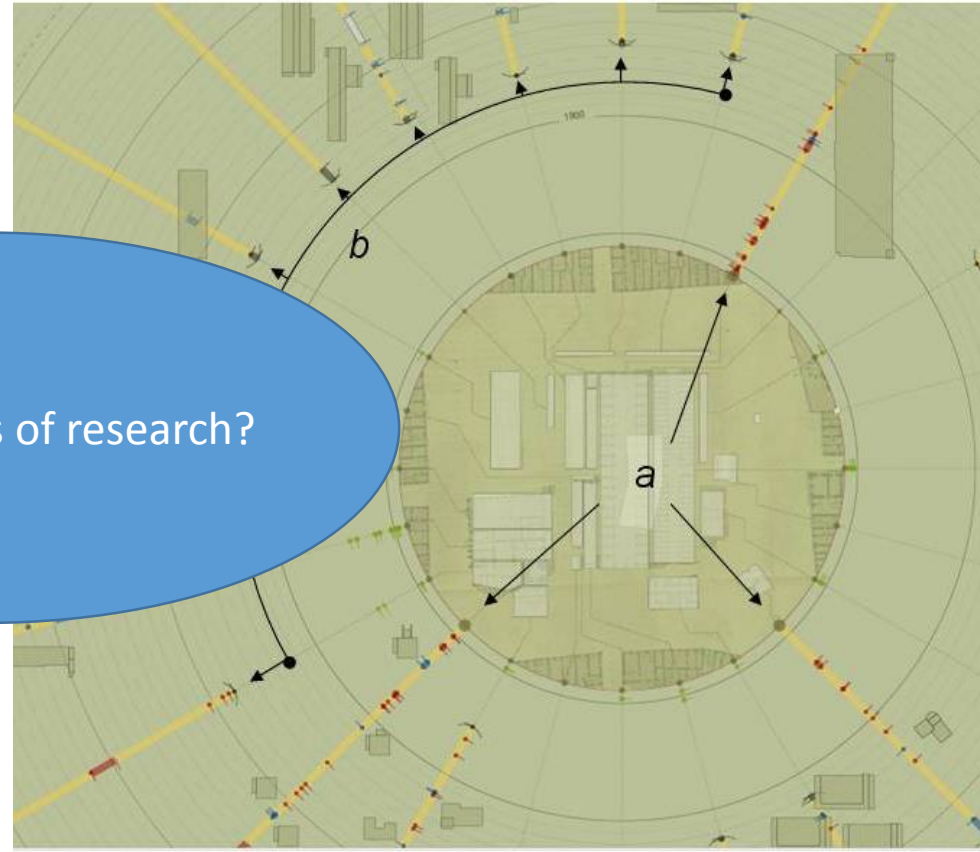


Focuses on helping analysts to investigate a collection of items, to cross-examine data (beyond geometrical features)

J.Y.Blaise, I.Dudek - *Concentric Time: Enabling Context + Focus Visual Analysis of Architectural Changes*
 Foundations of Intelligent Systems, M. Kryszkiewicz, H. Rybinski, A. Skowron, W. Raś (Ed.), Lecture Notes in Computer Science, Springer-Verlag, Berlin, Heidelberg, ISBN 978-3-642-21915-3, ISSN 0302-9743, pp. 632-641



Divergent lines of research?



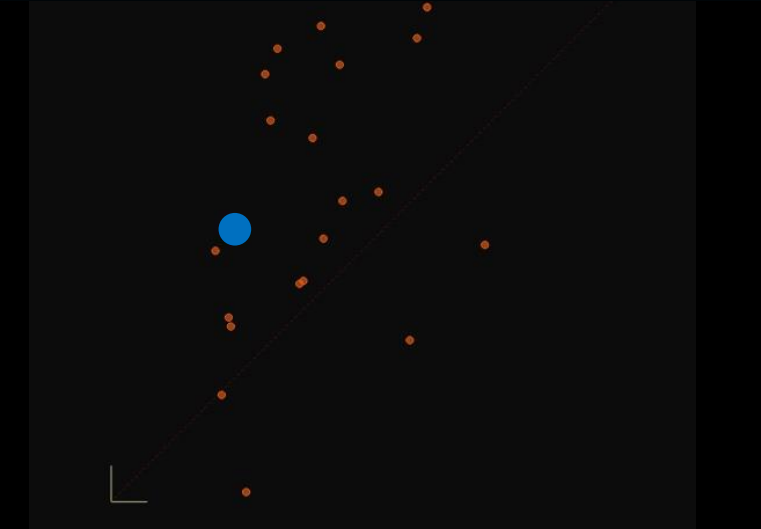
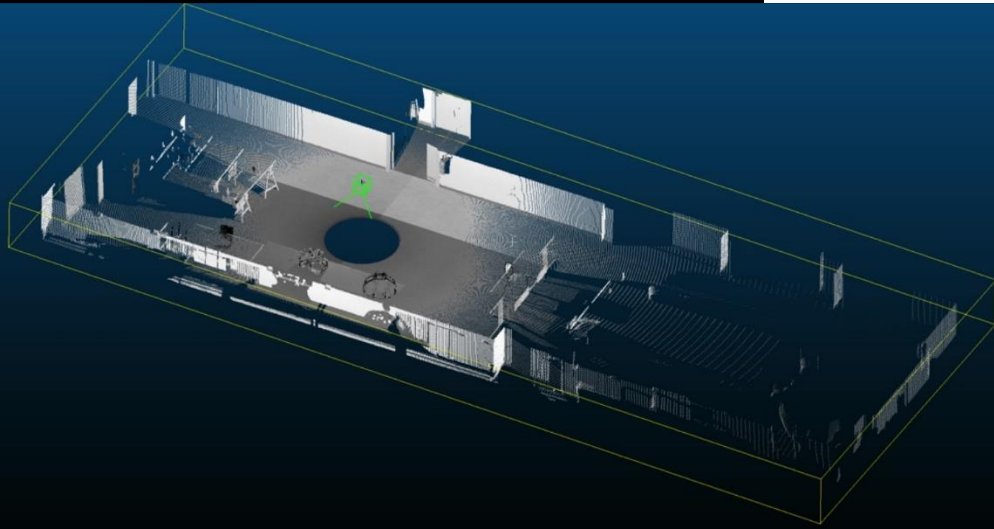
The “observation” side

The “abstraction” side

J.Y.Blaise, I.Dudek - *Concentric Time: Enabling Context + Focus Visual Analysis of Architectural Changes*
 Foundations of Intelligent Systems, M. Kryszkiewicz, H. Rybinski, A. Skowron, W. Raś (Ed.), Lecture Notes in Computer
 Science, Springer-Verlag, Berlin, Heidelberg, ISBN 978-3-642-21915-3, ISSN 0302-9743, pp. 632-641

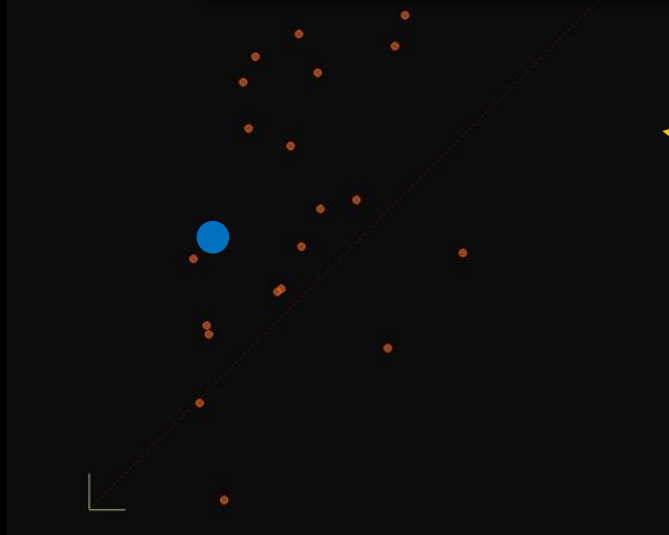
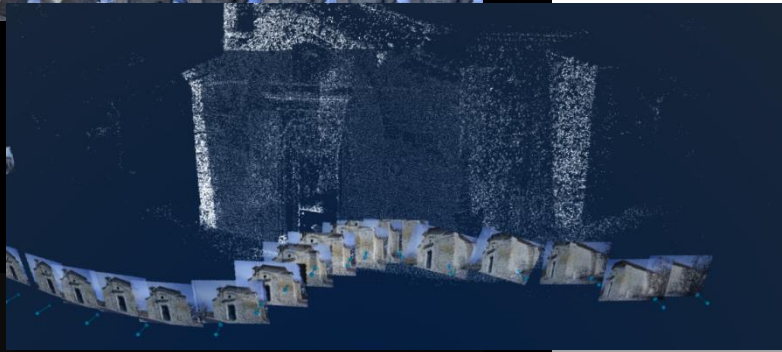
Bedrock observations founding this experiment:

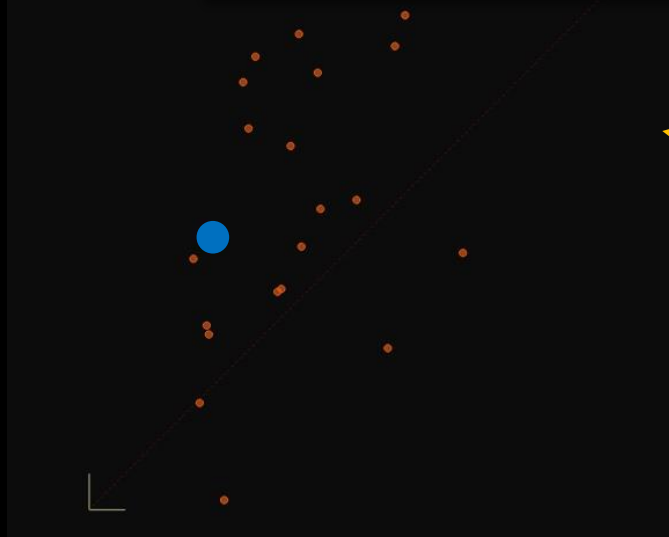
- > a growing capacity of academics to produce large 3D datasets
- > the emergence of low-cost survey techniques
- > with that renewed capacity a methodological question is raised : what interpretation lines, what sensemaking opportunities does that move open?



Bedrock observations founding this experiment:

- > a growing capacity of academics to produce large 3D datasets
- > the emergence of low-cost survey techniques
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Bedrock observations founding this experiment:

- > a growing capacity of academics to produce large 3D datasets
- > the emergence of low-cost survey techniques
- > with that renewed capacity a methodological question is raised : what interpretation lines, what sensemaking opportunities does that move open?

This is basically a « proof of worthiness » experiment

investigating the feasibility and added value of using a low-res, low-cost, “amateur” 3D point cloud in order to re-read pieces of architecture through simple **proportions, ratios and geometric relations**, in other words in order to **extract architectural features for comparisons**.

outline

- Terminological disambiguation
- On proportions (briefly)
 - The use of proportions in architecture over time
 - Proportions as prescriptions vs. proportions as an analytical tool
- The experiment –29 rural, « non-elaborate » chapels
 - Acquisition and data extraction step: building on the MAP unit's Aïoli experimental platform
 - Analysis step: some infovis-inspired solutions
- Future works: the SESAMES research programme

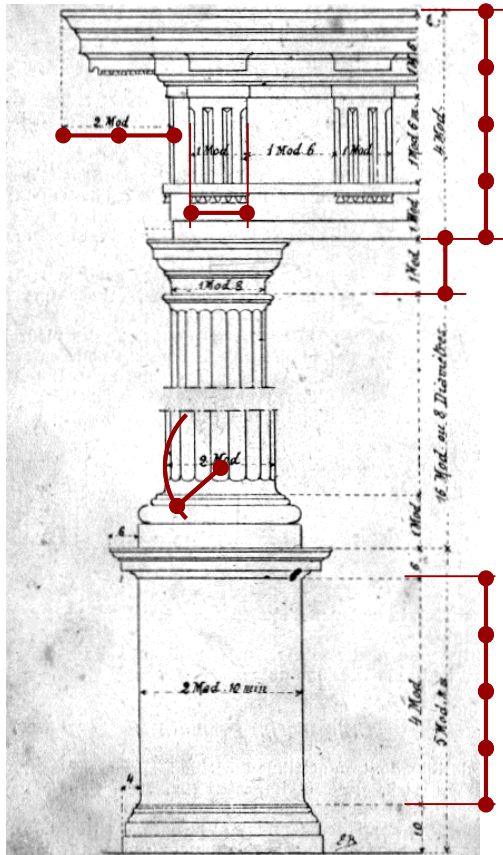


Terminological disambiguation: proportions (vs.?) ratios

In Vitruvius' ten books of architecture

“The design of a temple depends on **symmetry**, the principles of which must be most carefully observed by the architect. They are **due to proportion**, in Greek ἀναλογία. Proportion is **a correspondence among the measures of the members of an entire work, and of the whole to a certain part selected as standard.**

http://www.hellenicaworld.com/Greece/Literature/Vitruvius/en/Architecture.html#Page_69 [last visited 08/04/2019]



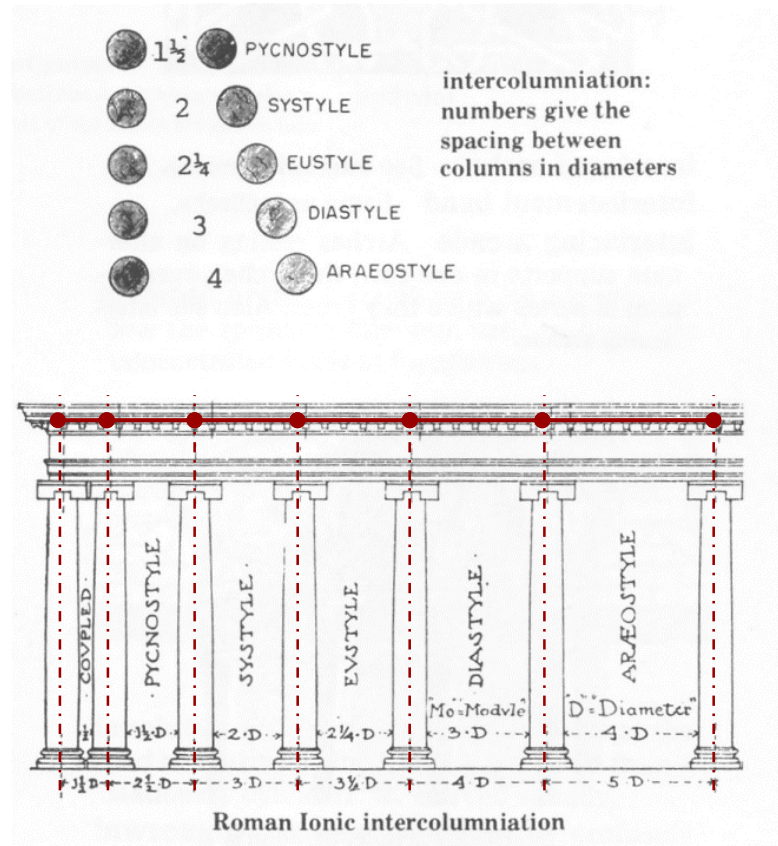
Correspondence of the measures of an entire column, in relation with a « standard » : the module (bottom radius of the shaft)

E. Barberot
Aide mémoire de l'architecte et du constructeur
 Ch. Béranger 1922

In Vitruvius' ten books of architecture

“The design of a temple depends on **symmetry**, the principles of which must be most carefully observed by the architect. They are **due to proportion**, in Greek ἀναλογία. Proportion is **a correspondence among the measures of the members of an entire work, and of the whole to a certain part selected as standard.**

http://www.hellenicaworld.com/Greece/Literature/Vitruvius/en/Architecture.html#Page_69 [last visited 08/04/2019]



intercolumniation in
relation with a certain
part, a « standard » :
dimension D (module)

C.R Harris

Illustrated dictionary of historic architecture ,
Dover Publications 1983

In Vitruvius' ten books of architecture

“The design of a temple depends on **symmetry**, the principles of which must be most carefully observed by the architect. They are **due to proportion**, in Greek ἀναλογία. Proportion is **a correspondence among the measures of the members of an entire work, and of the whole to a certain part selected as standard.**

http://www.hellenicaworld.com/Greece/Literature/Vitruvius/en/Architecture.html#Page_69 [last visited 08/04/2019]

In Two Kinds of Proportion by Matthew A Cohen

Introduction to “Objects of Belief: Proportional Systems in the History of Architecture”

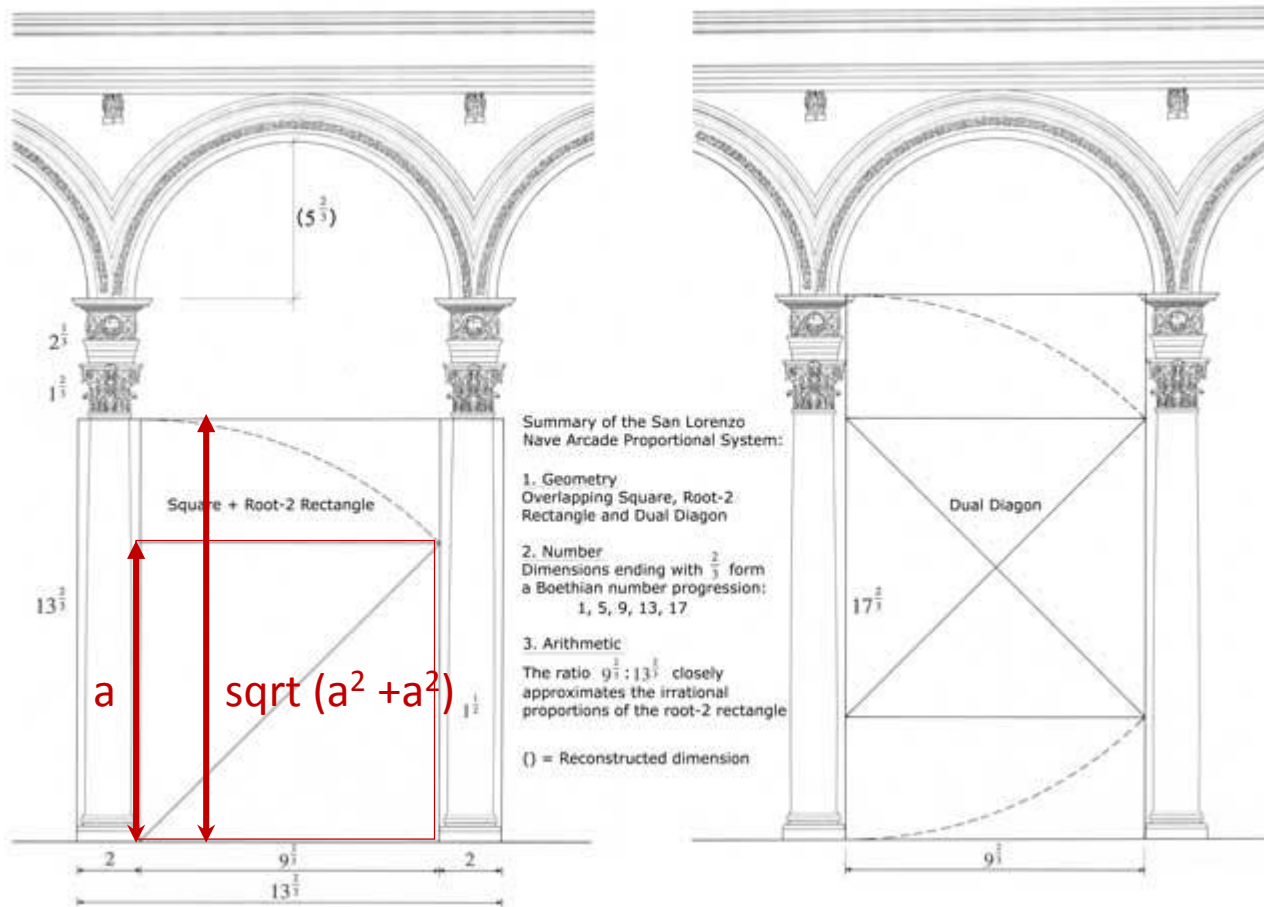
Special collection of Architectural Histories, the EAHN (European Architectural History Network) international, blind peer-reviewed scholarly journal.

<https://journal.eahn.org/articles/10.5334/ah.bv/> [last visited 08/04/2019]

Proportion can refer to **ratios**, or it can refer to **architectural beauty**. In this introduction to the papers that follow, Matthew A. Cohen proposes a simple clarification of this ambiguity as a framework for continued discussion of this subject: that whenever scholars use the word proportion, they specify whether they intend ‘**proportion-as-ratio**’ or ‘**proportion-as-beauty**’.

Terminological disambiguation: proportions vs. ratios

What will be intended in what follows intend is 'proportion-as-ratio'

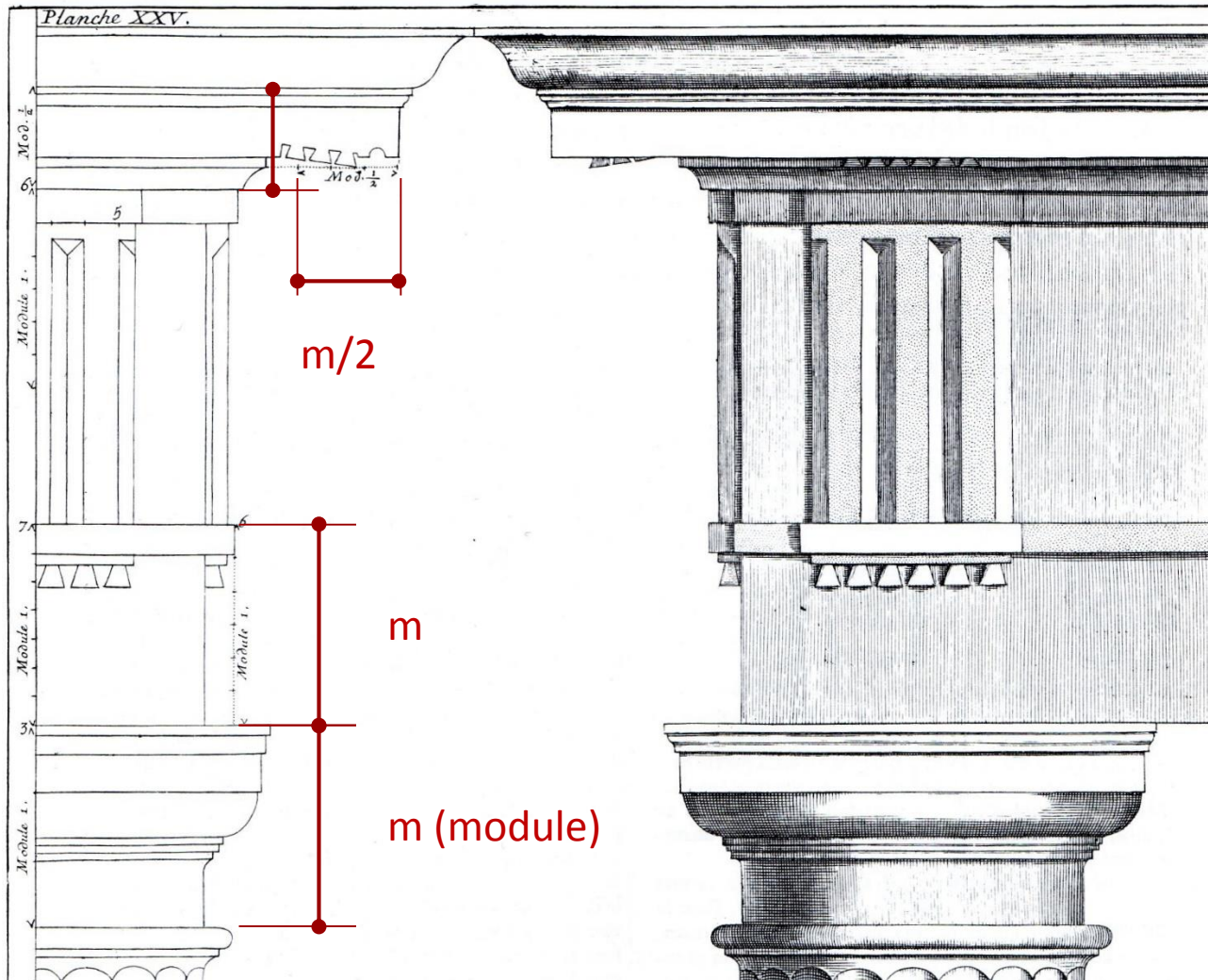


Summary of the San Lorenzo [Basilica San Lorenzo in Florence, 1424 > Filippo Brunelleschi] nave arcade bay proportional system (spread between two drawings for clarity).

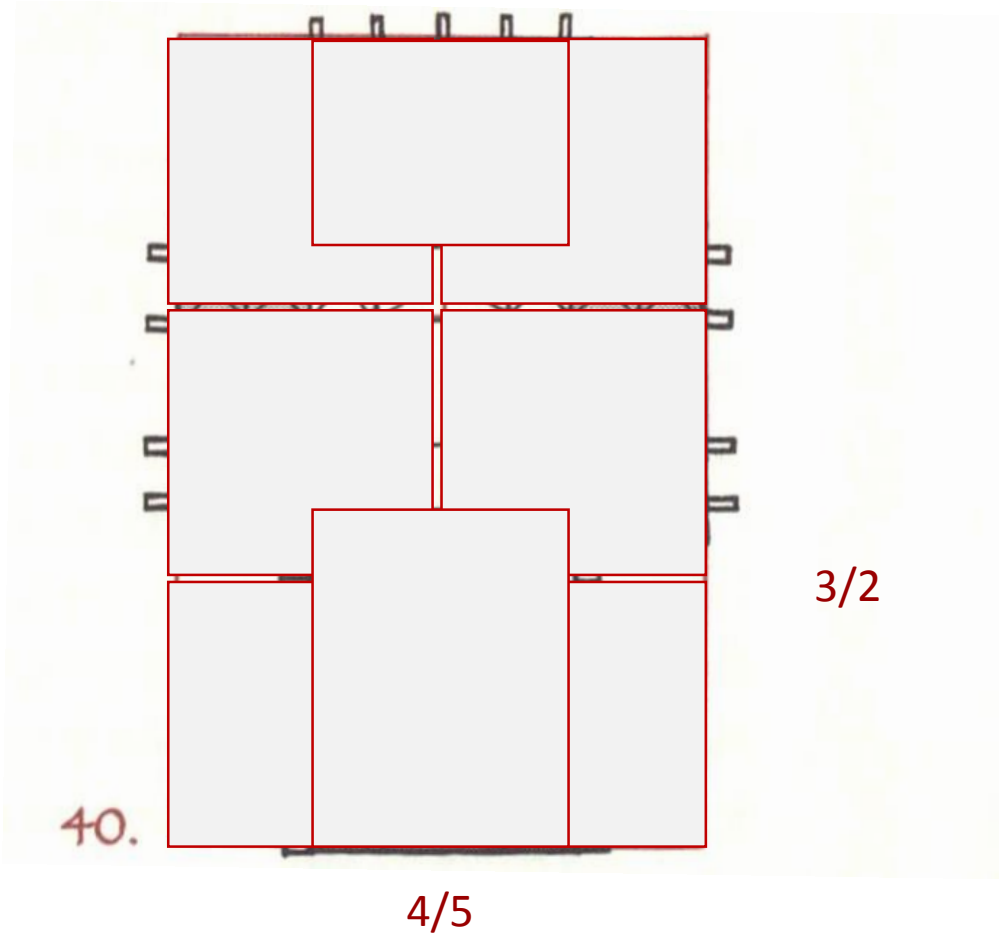
Cohen, M.A., 2014.
Introduction: Two Kinds of Proportion.
Architectural Histories, 2(1), p.Art. 21.
DOI: <http://doi.org/10.5334/ah.bv>

On proportions : use over time

A (very) quick overview of *when* they mattered



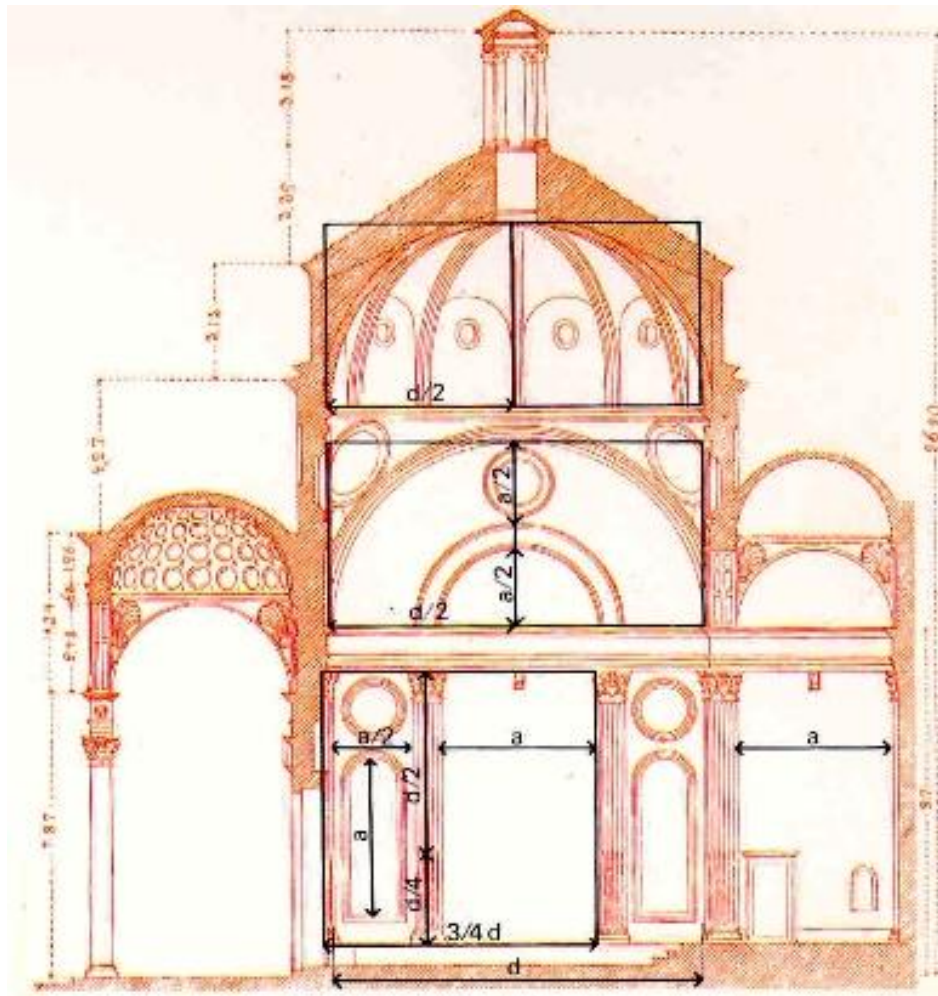
Rome : Vitruvius



Romanesque period: simple ratios

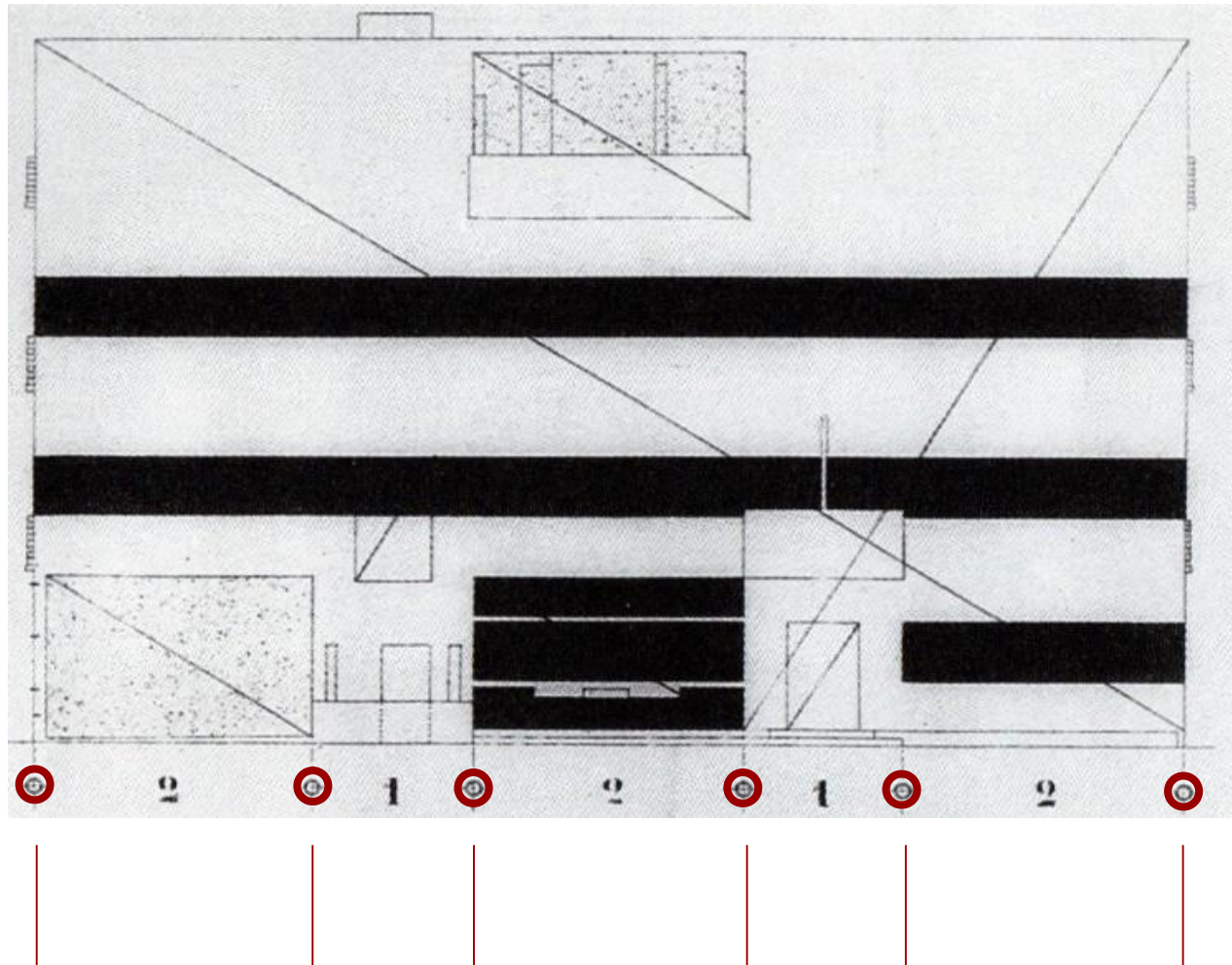
L'église cistercienne "ad quadratum", dessinée par Villard de Honnecourt (XIII^e siècle), est régie par des proportions musicales. Son plan est contenu dans un rectangle qui est un triple double carré (3/2), correspondant à la quinte. Son chœur (4/3) représente la quarte ; chaque bras de transept (4/2) est associé à l'octave, ainsi que le transept entier (8/4). Le croisement de la nef et du transept est un carré (4/4), symbole de l'unité. La nef enfin évoque la tierce (5/4).

T. Hatot
Bâisseurs au Moyen-Age. L'instant Durable 1999



Renaissance period:
Brunelleschi's *Cappella dei Pazzi*

G.Fanelli *Brunelleschi*



Up to modernist architecture

Le Corbusier's *Villa Stein*

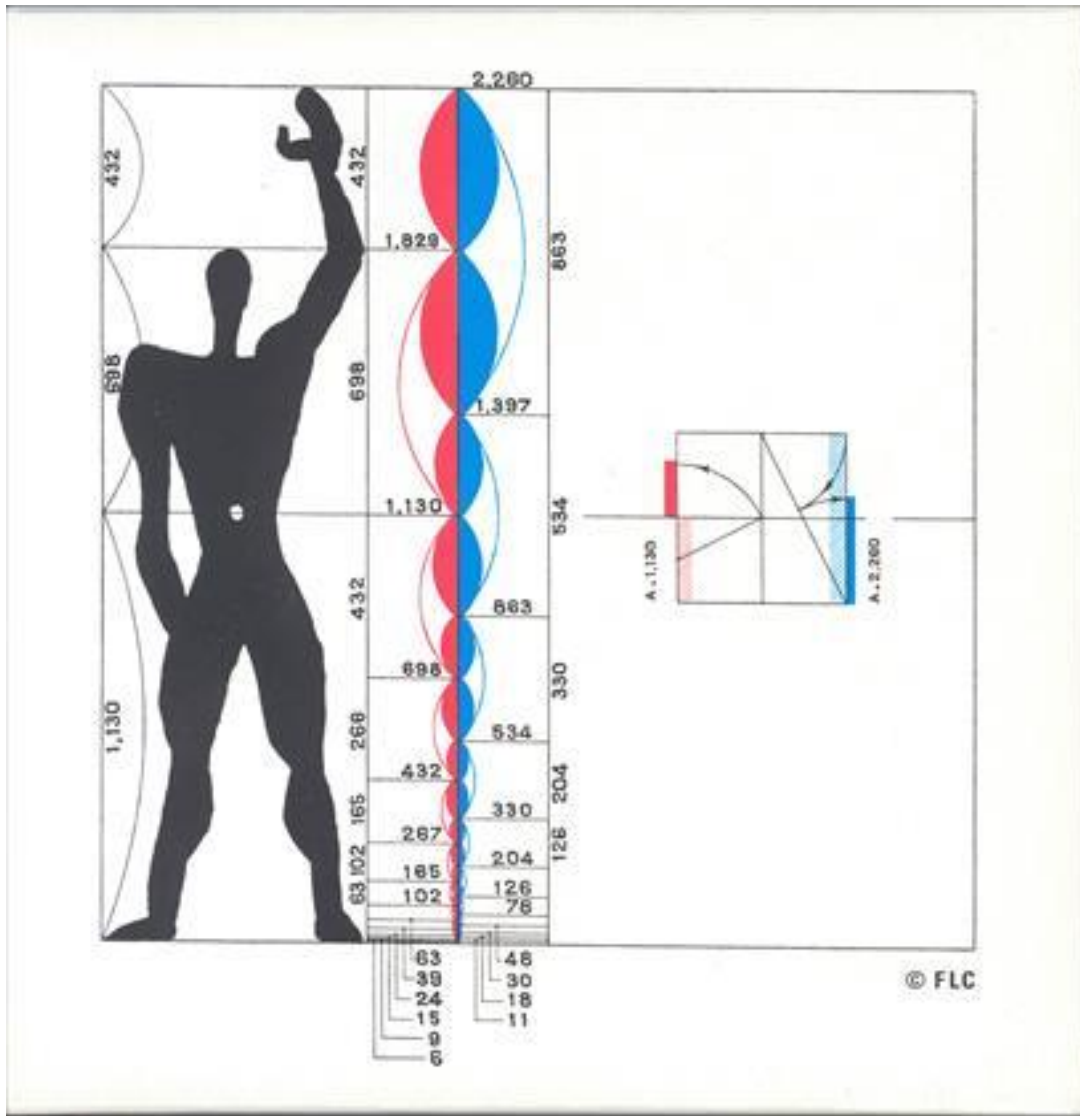
Le Corbusier et la méditerranée
Editions Parenthèses /
Musées de Marseille 1987

On proportions : prescriptions vs. analytical tool

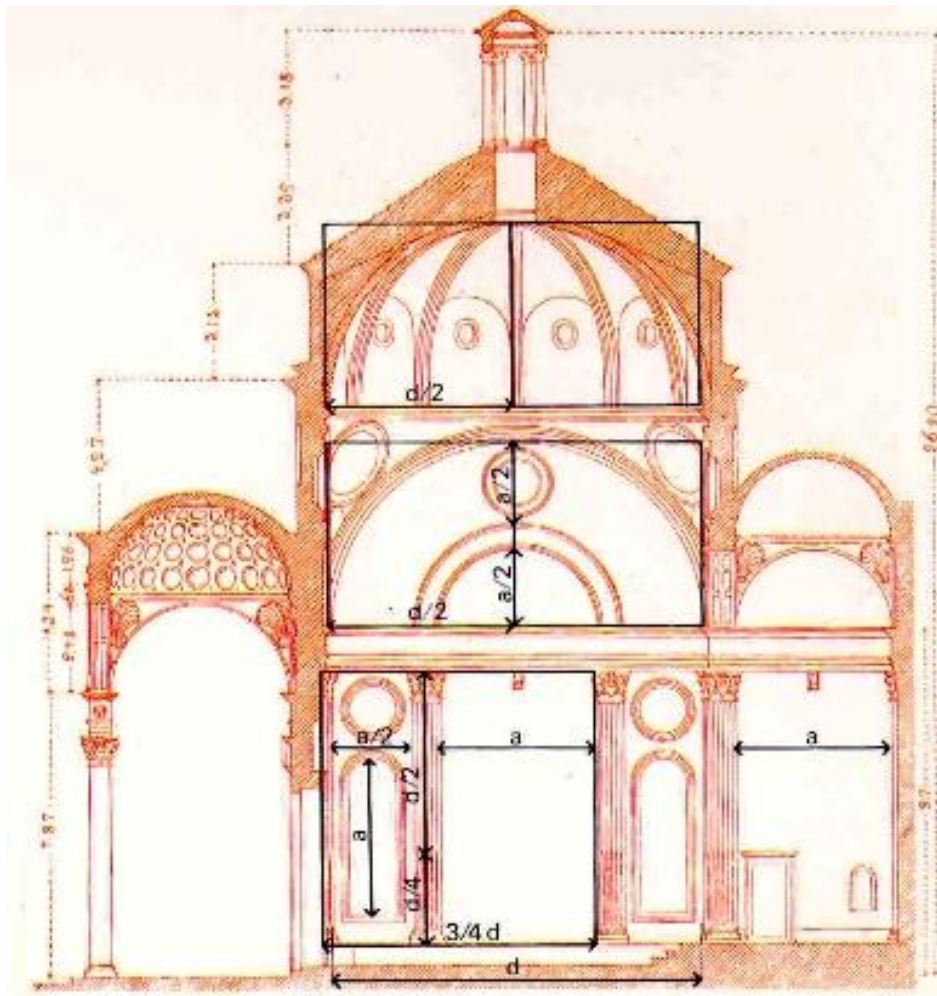
Proportions as quantitative relations
to be applied by builders ,

Proportions as a *prescription*

Le Corbusier's *Modulor*



Fondation Le Corbusier
<http://www.fondationlecorbusier.fr>
 Le Modulor, sans lieu
 © FLC/ADAGP
 Retrieved 17-04-2019

On proportions : prescriptions vs. **analytical tool**

Re-reading, analysing choices made by builders,

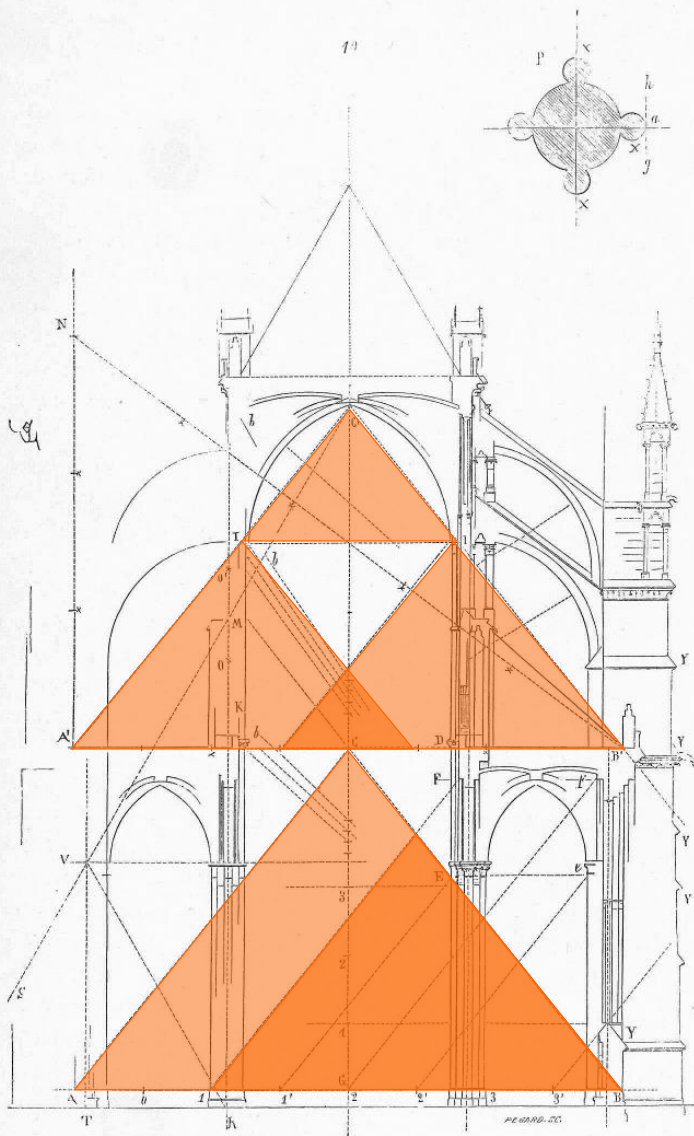
Proportions as an *analytical tool*

Ratios are here used in retrospect, as a tool in analysing Brunelleschi's design

G.Fanelli *Brunelleschi*

NEUVIÈME ENTRETIEN

(fig. 10)



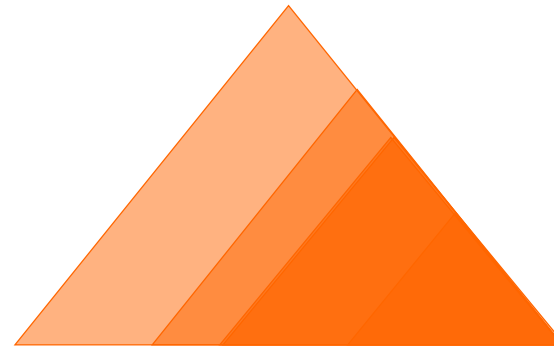
COUPE DE LA CATHEDRALE D'AMIENS

On proportions : prescriptions vs. **analytical tool**

Re-reading, analysing choices made by builders,

Proportions as an **analytical tool**

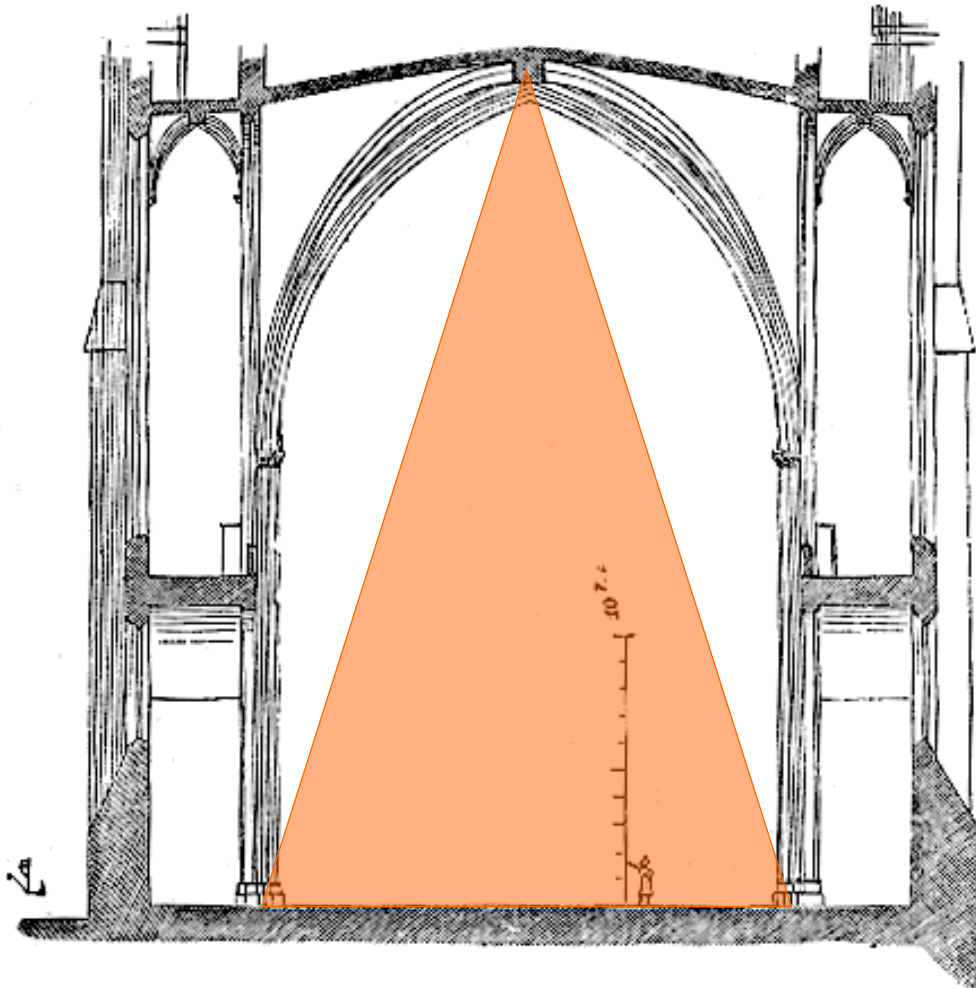
These 3 triangular figures are used by Viollet Le Duc to back up his theory, or observations, on one specific edifice .



E. Viollet Le Duc
Entretiens sur l'Architecture
 Éditions Pierre Mardaga 1977 (ed.orig 1863)

On proportions : prescriptions vs. **analytical tool**

51



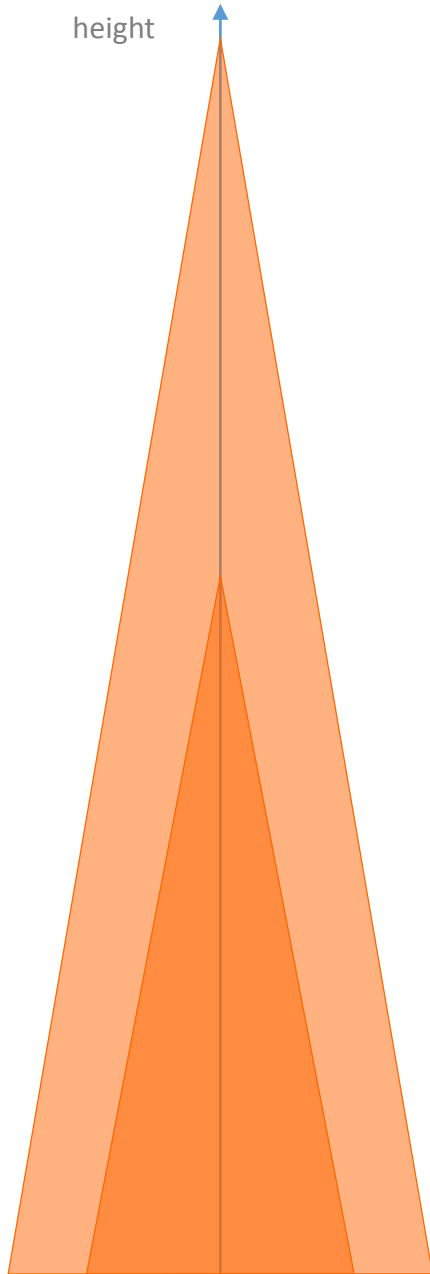
Re-reading, analysing choices made by builders,

Proportions as an *analytical tool*

But such triangular figures can also be used to question the homogeneity (or heterogeneity) of a set of comparable edifices.

E. Viollet Le Duc
 Coupe de la nef de la cathédrale d'Alby.
 Issue du *Dictionnaire raisonné de l'architecture française du XIe au
 XVIe siècle*, par Eugène Viollet-Le-Duc, 1856.

height



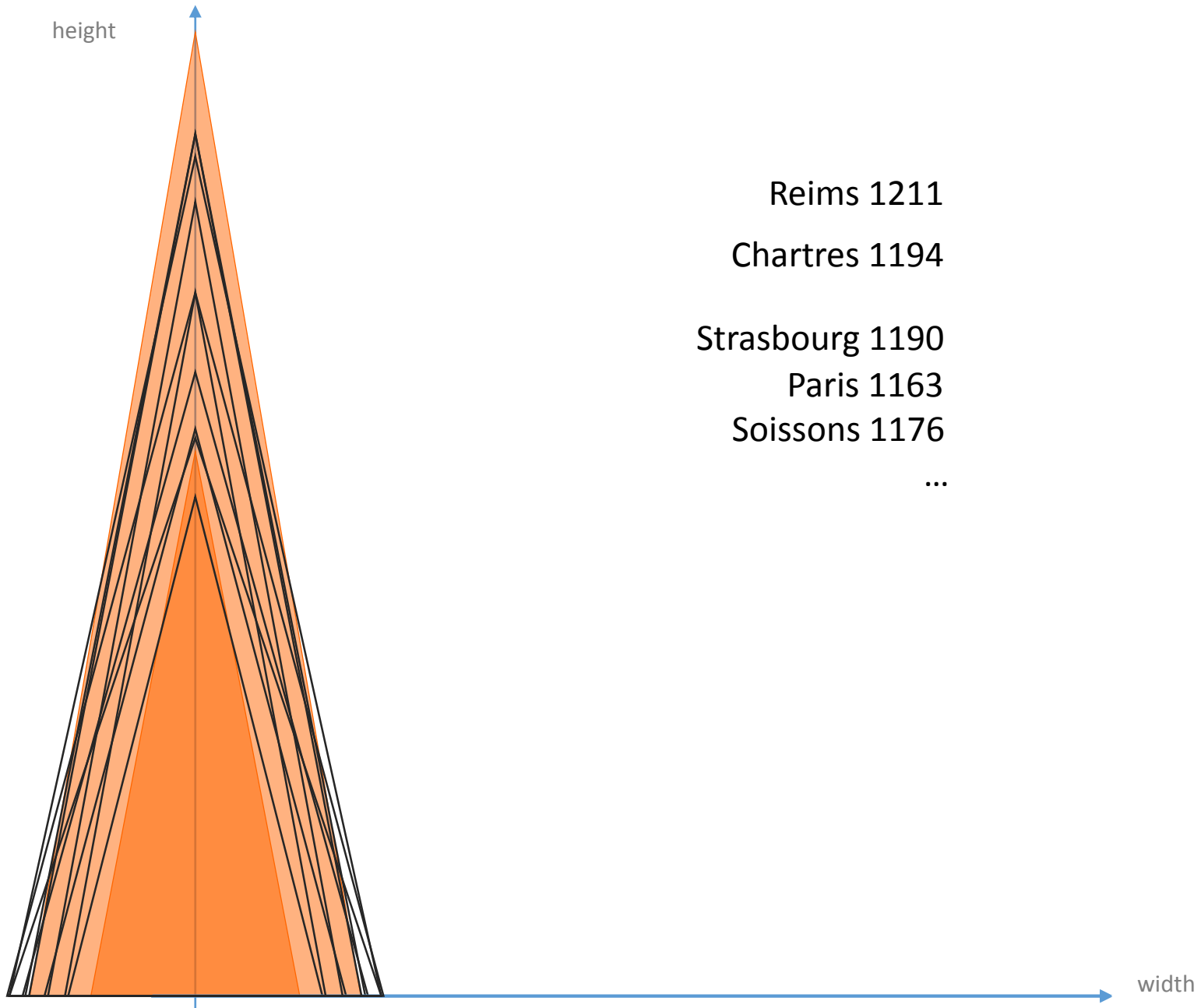
Senlis 1145

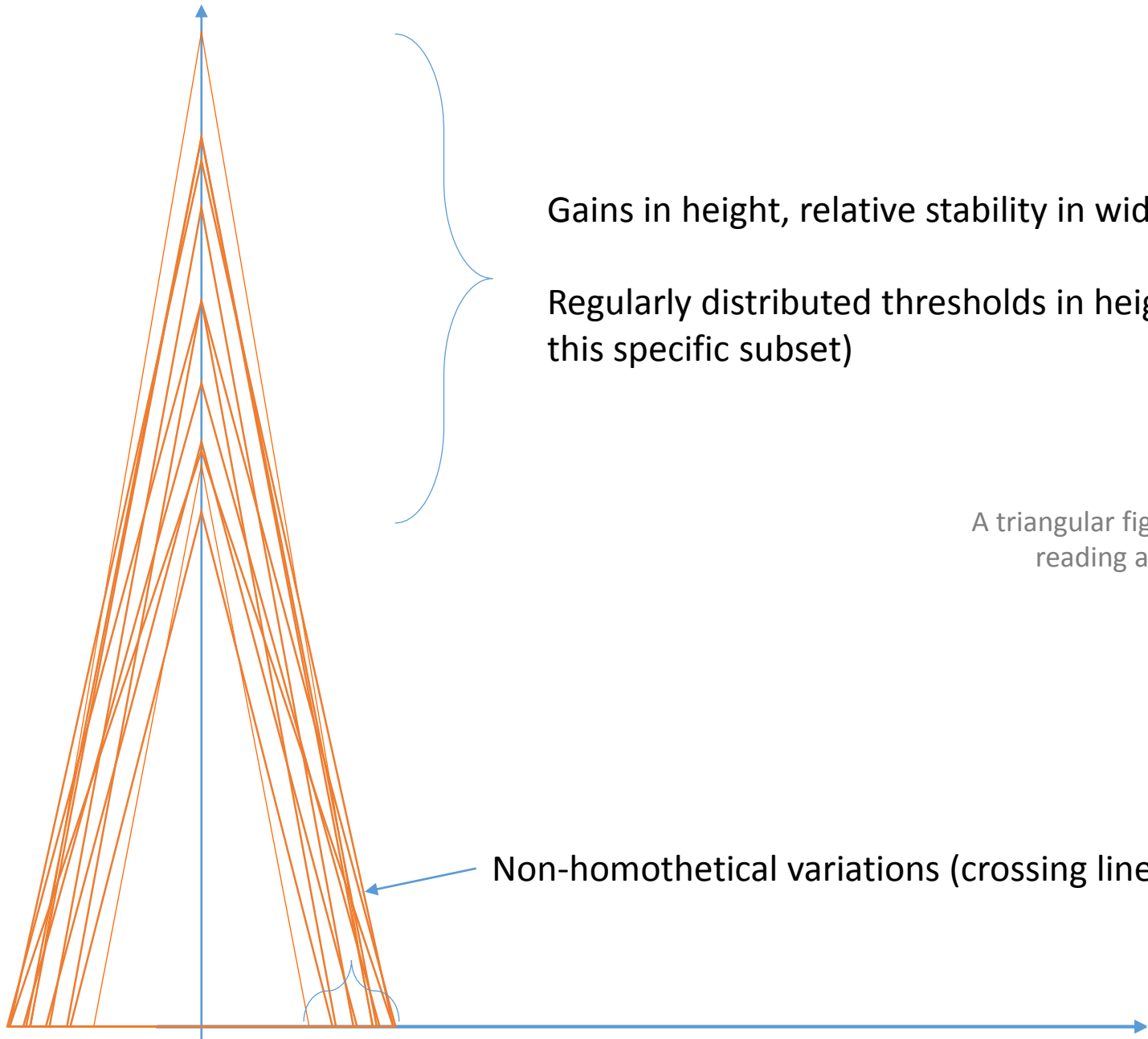
But such triangular figures can also be used to question the homogeneity (or heterogeneity) of a set of comparable edifices.



Amiens- 1220

width



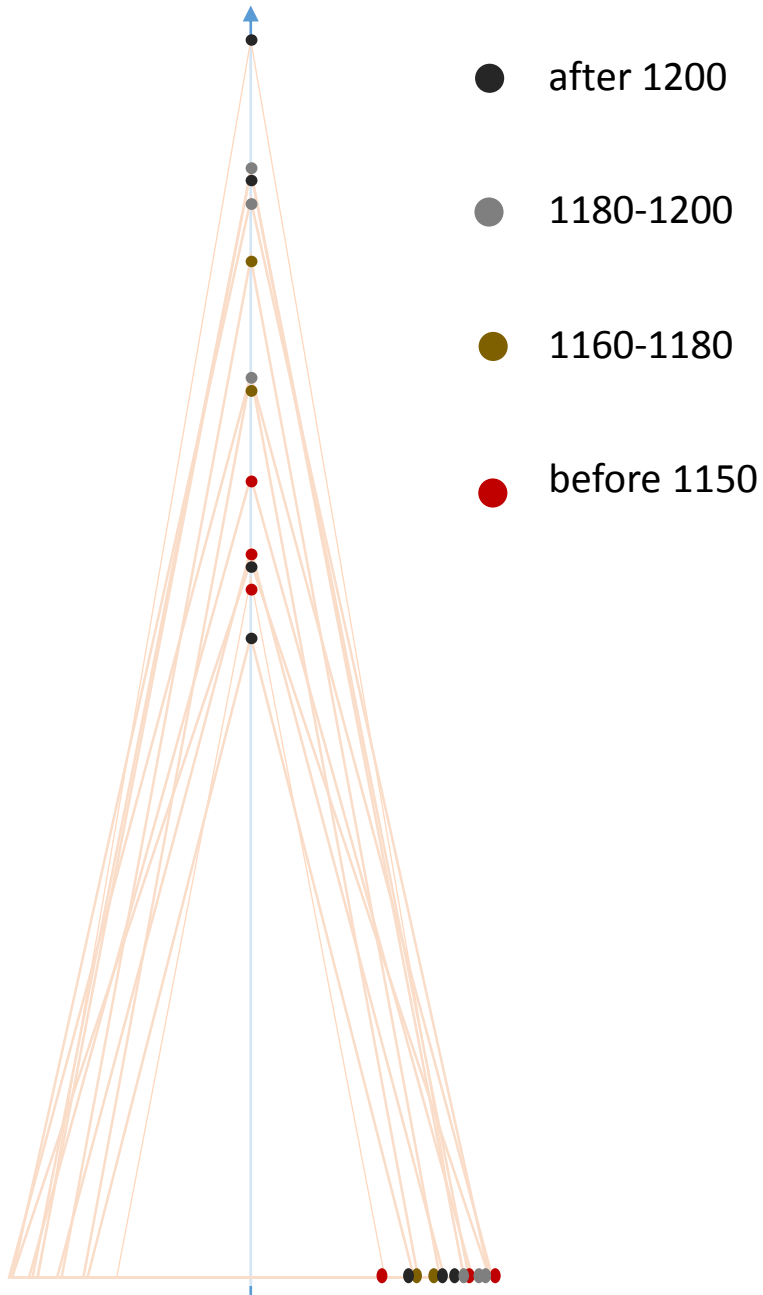


Gains in height, relative stability in width

Regularly distributed thresholds in height (on this specific subset)

A triangular figure that helps re-reading a whole collection.

Non-homothetical variations (crossing lines)



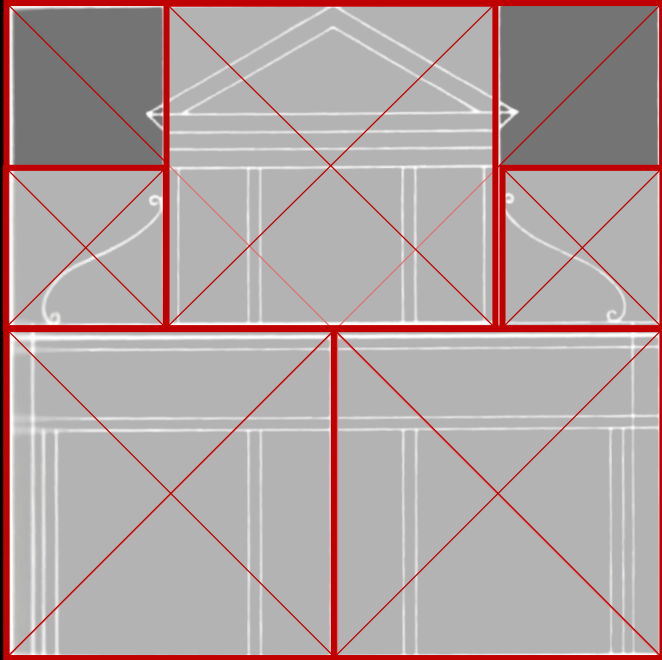
Correlation with period of construction

On this subset, a tendency to build higher naves, but that does NOT sum up what can be observed: the « lowest » nave is a « recent » one.

Analysing, through visual means, ratios, proportions, figures, does not necessarily mean coming to an assertive conclusion, but rather working on comparisons, providing food for thinking.

> proportions can be an effective, rewarding lecture grid when observing « elaborate » pieces of architecture.

But can they be of any benefit when observing small-scale vernacular architecture? What exactly is there to uncover in that particular context?



*Santa Maria Novella (Alberti, Florence 1458 >)
Analysis by R. Wittkower
« Architectural principles in the age of Humanism »
Academy Editions 1998 (first ed. 1949)*



> proportions can be an effective, rewarding lecture grid when observing « elaborate » pieces of architecture.

But can it be of any benefit when observing small-scale vernacular architecture? What exactly is there to uncover in that particular context?

That is precisely an issue that the emergence of lightweight, low-cost survey techniques allows us to address.

No claim that this experiment did help uncover significant trends in terms of « ways of building », but a confirmation that there is a line of research within reach.

The experiment – 29 rural, « non-elaborate » chapels



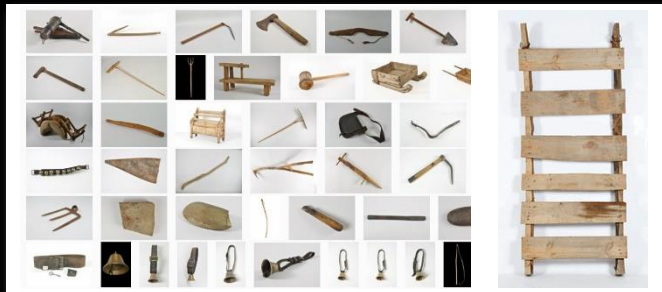
Context: a short-term research programme called « Territographie » questioning the applicability and scientific added-value of the *citizen science* paradigm in the documentation and analysis of minor heritage items.

< territoire.map.cnrs.fr >

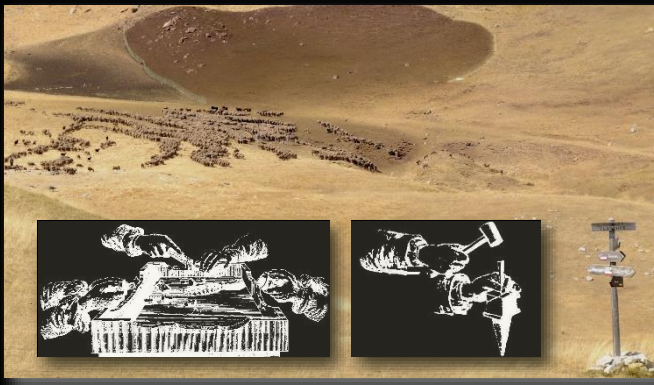
Mucem



A concern for different collections



As part of the initiative, the idea that a low cost protocol for the acquisition of raw 3D data, including through citizen contributions, could be tried out.



The experiment – 29 rural, « non-elaborate » chapels

Context: a short-term research programme called « Territographie » questioning the applicability and scientific added-value of the *citizen science* paradigm in the documentation and analysis of minor heritage items.

< territographie.map.cnrs.fr >

Mucem



A concern for different collections

As part of the initiative, the idea that a low cost protocol for the acquisition of raw 3D data, including through citizen contributions, could be tried out.

> A baseline choice : photographic captors,



Acquisition and data extraction step : builds on the Aioli collaborative platform

> L.De Luca, A.Manuel, A.Alaoui

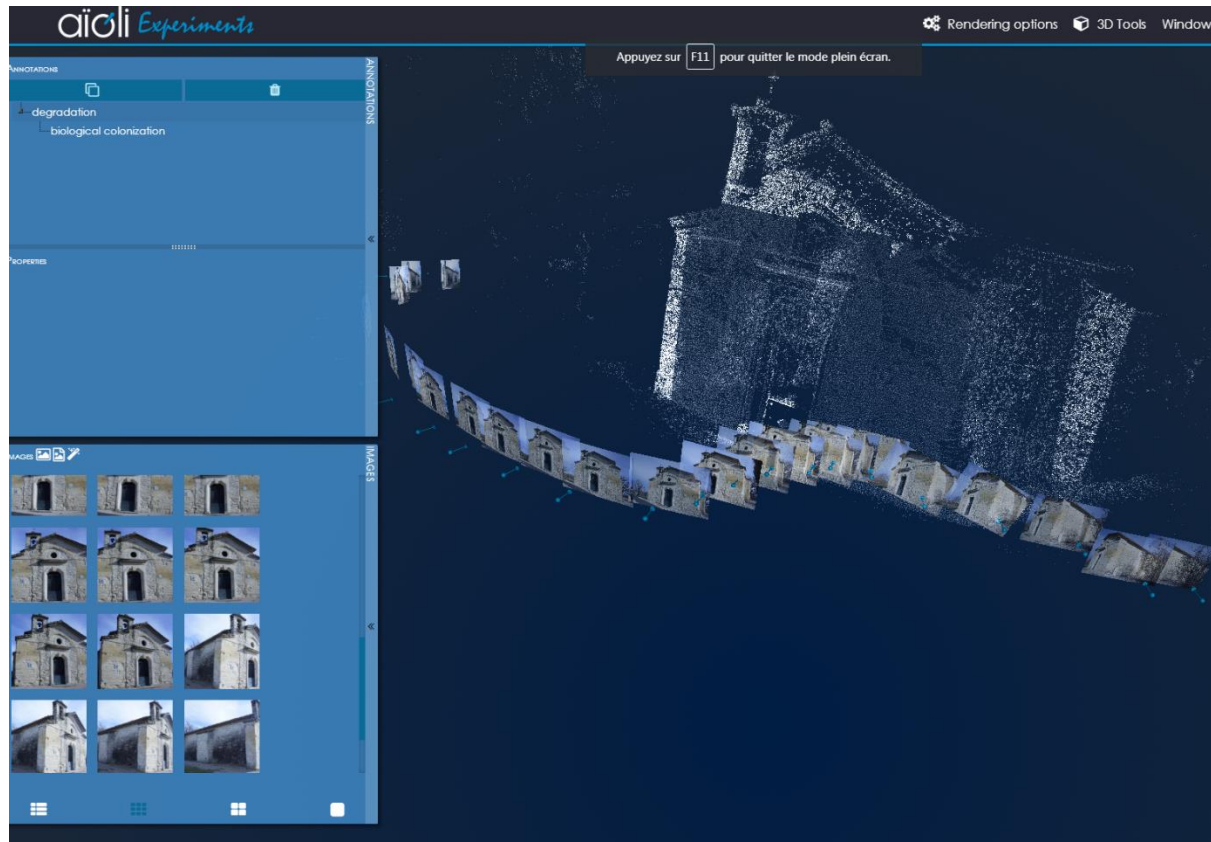
www.aioli.cloud

A reality-based 3D “annotation” platform (collaborative annotation of 3D regions in point clouds).

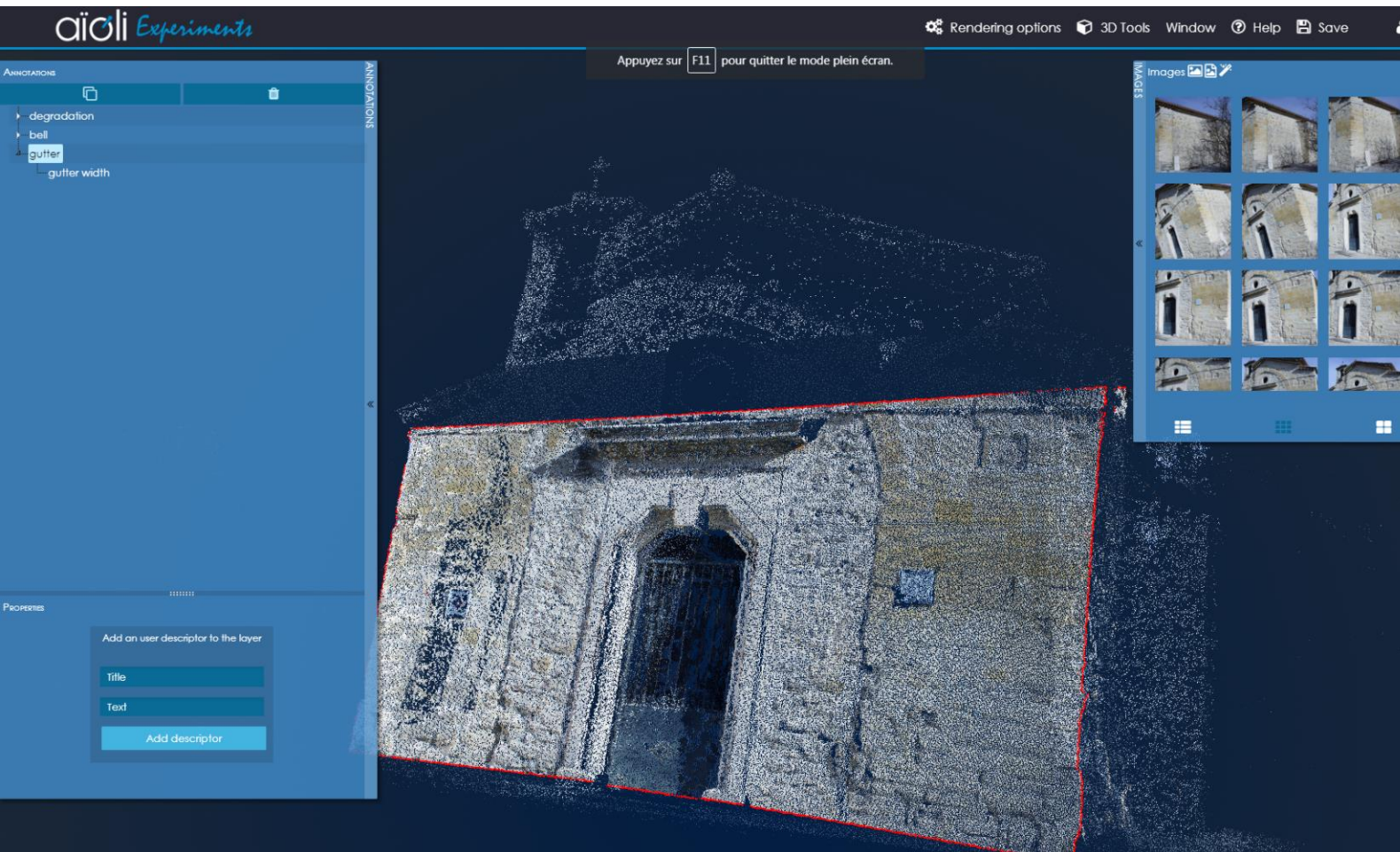
The application generates a 3D point cloud from photographs, which can then be annotated.

Based on two technological developments:

- > photogrammetry techniques, (computing of a 3D model by correlation of images)
- > massive processing and sharing gathered data through the cloud.

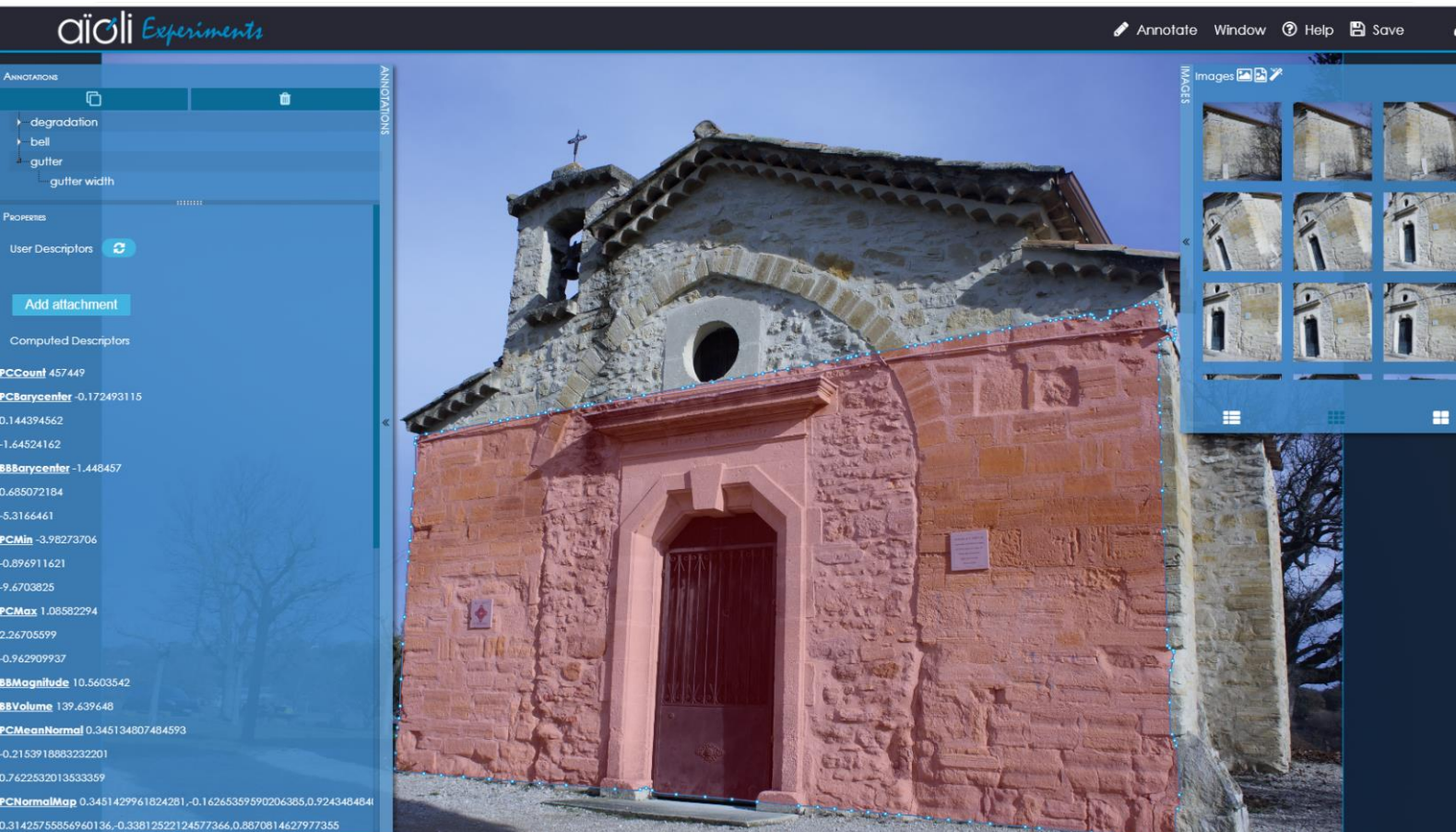


> L.De Luca, A.Manuel, A.Alaoui

www.aioli.cloud

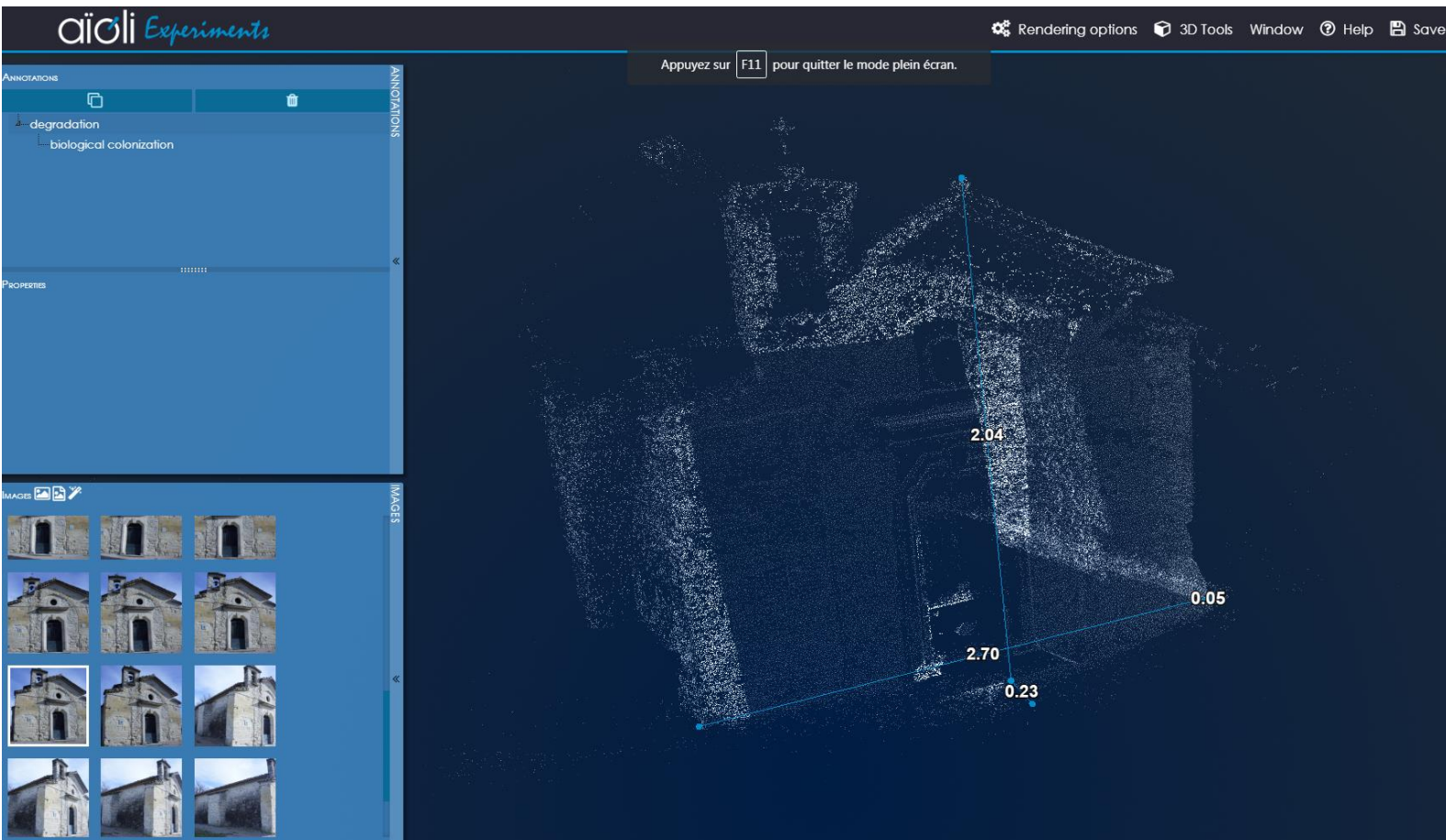
3D “regions” (subsets of the point cloud) can be isolated and annotated in the 3D space

> L.De Luca, A.Manuel, A.Alaoui

www.aioli.cloud

And the result reprojected on each photograph used to compute the point cloud3D

> L.De Luca, A.Manuel, A.Alaoui

www.aioli.cloud

In this experiment we make use of another feature : retrieving “relative dimensions”, i.e. quantities that will be saved as ratios (and not as metric information)

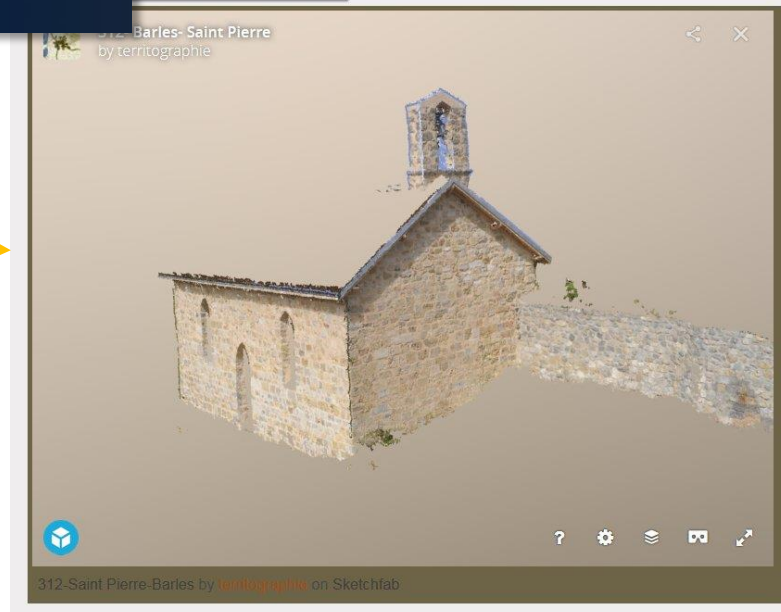
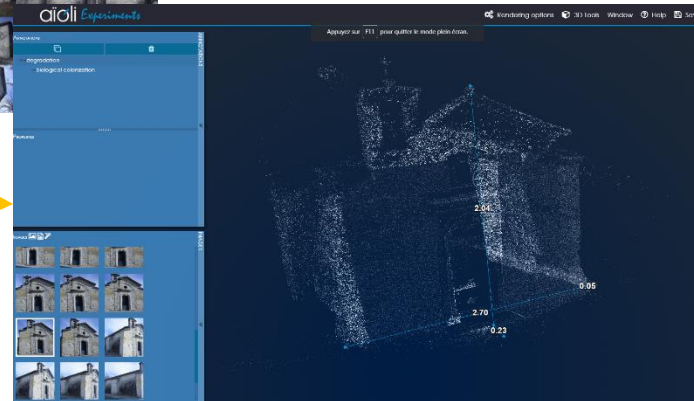


Input: photographs (multi-captors)

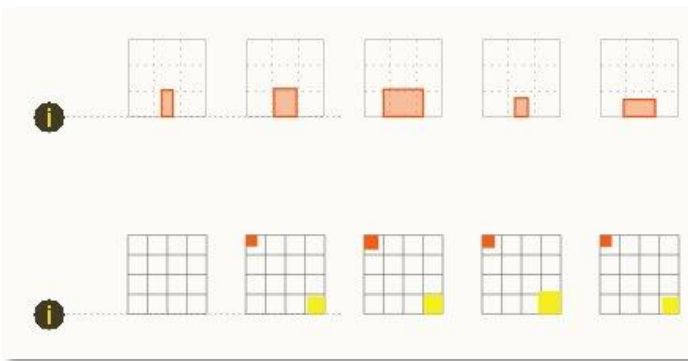
The overall protocol

Processing pipeline:

- feature detection*
- Calibration and orientation*
- Dense matching*



Output: raw 3D point clouds



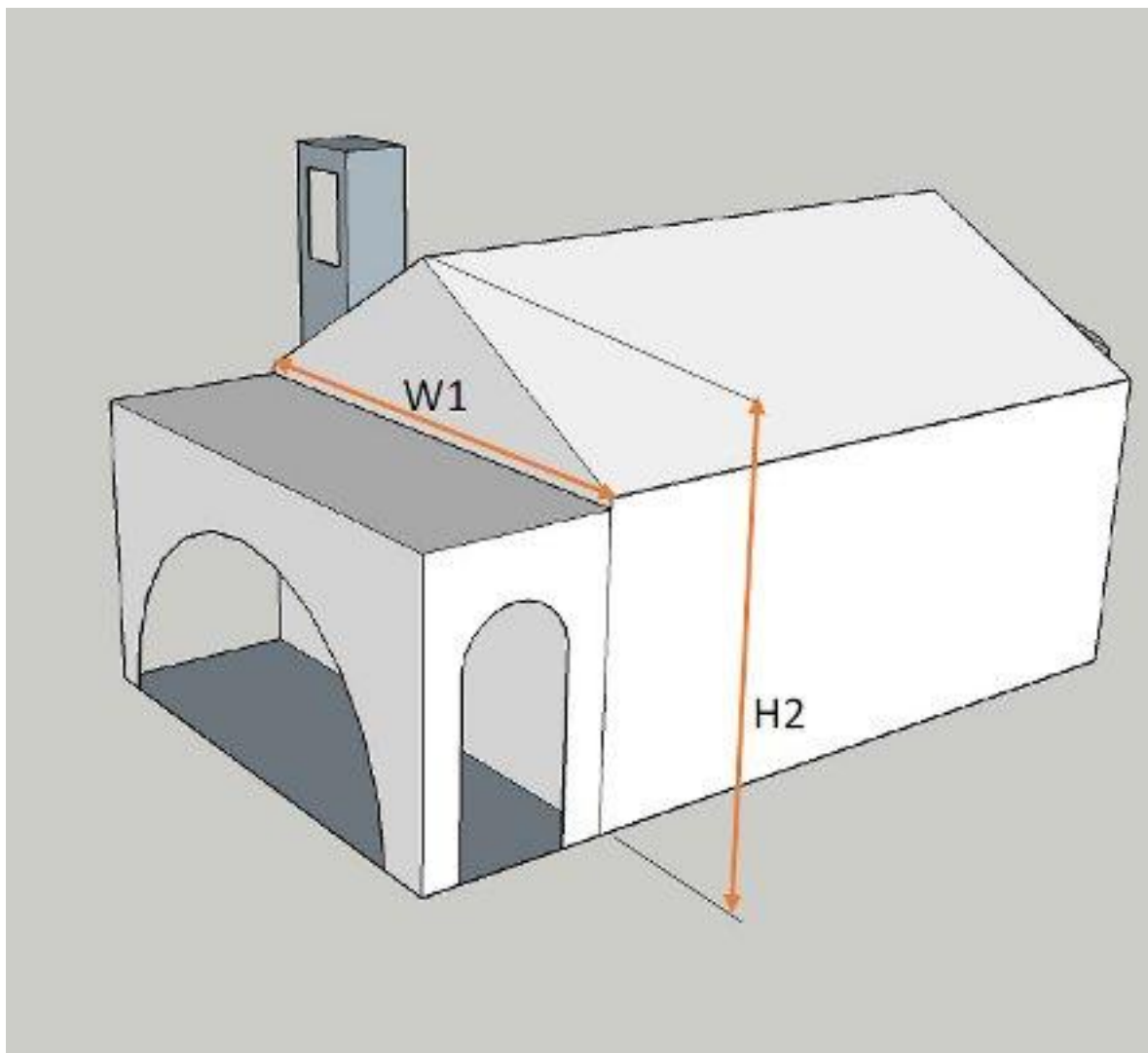
Output: ratios (transferred into a visual language)

The ratios selected

> Proportions of Facade

$H1/W1$

$H2/W1$



The ratios selected

> Proportions of Facade

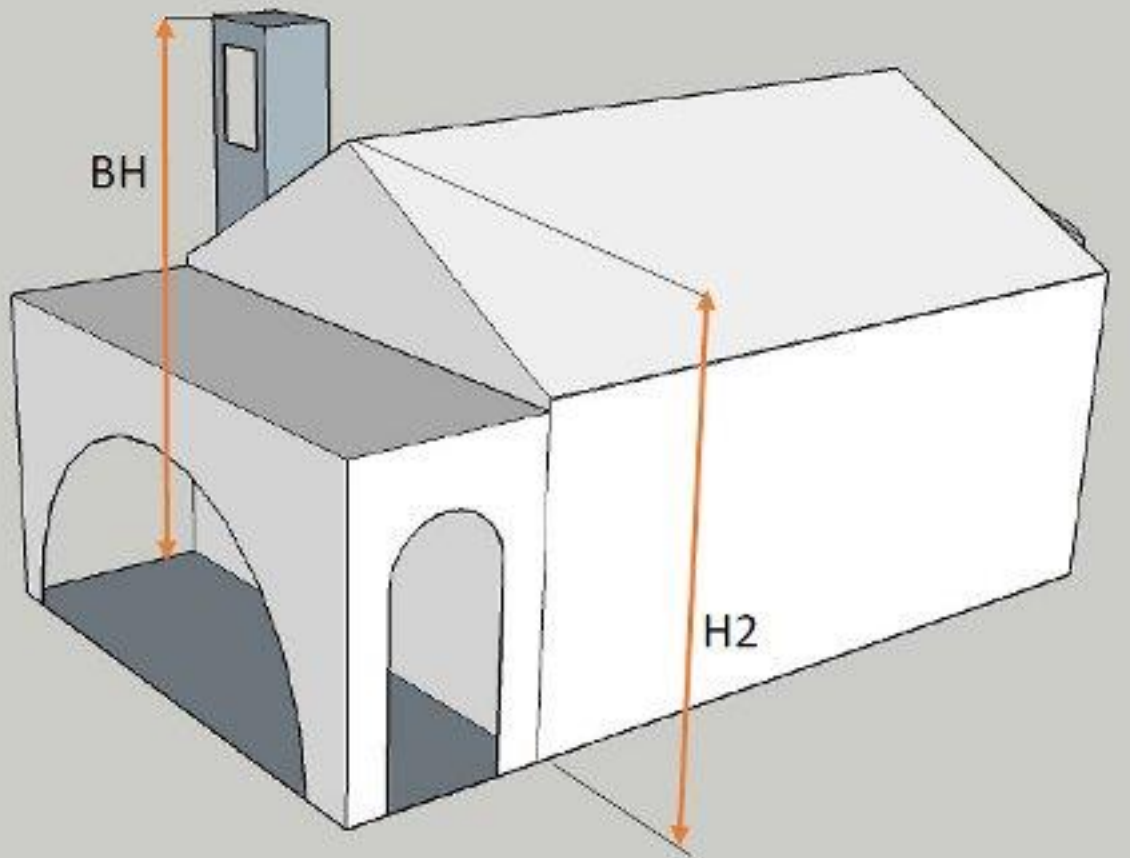
$H1/W1$

$H2/W1$

> Facade vs. bell tower

$BW/W1$ (widths)

$BH/H2$ (heights)



The ratios selected

> Proportions of Facade

$H1/W1$

$H2/W1$

> Facade vs. bell tower

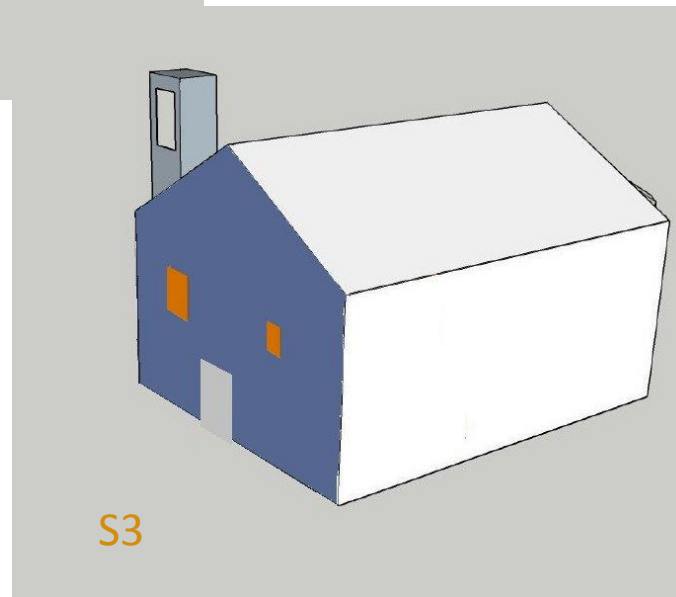
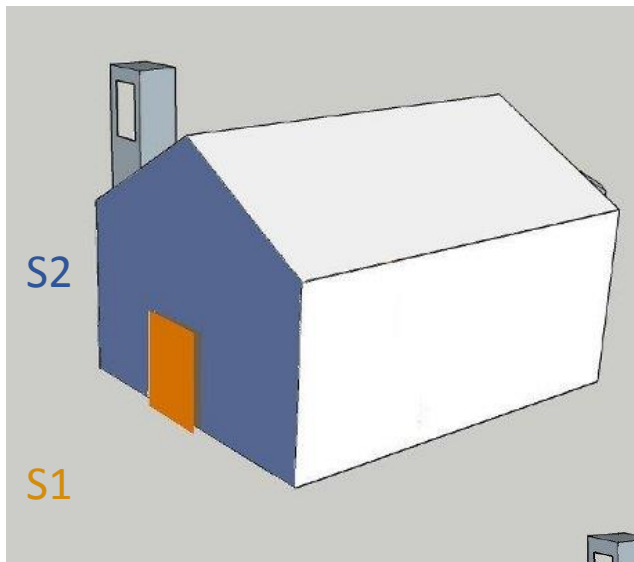
$BW/W1$ (widths)

$BH/H2$ (heights)

> Surface of openings vs. of Facade

$S1/S2$

$S3/S2$

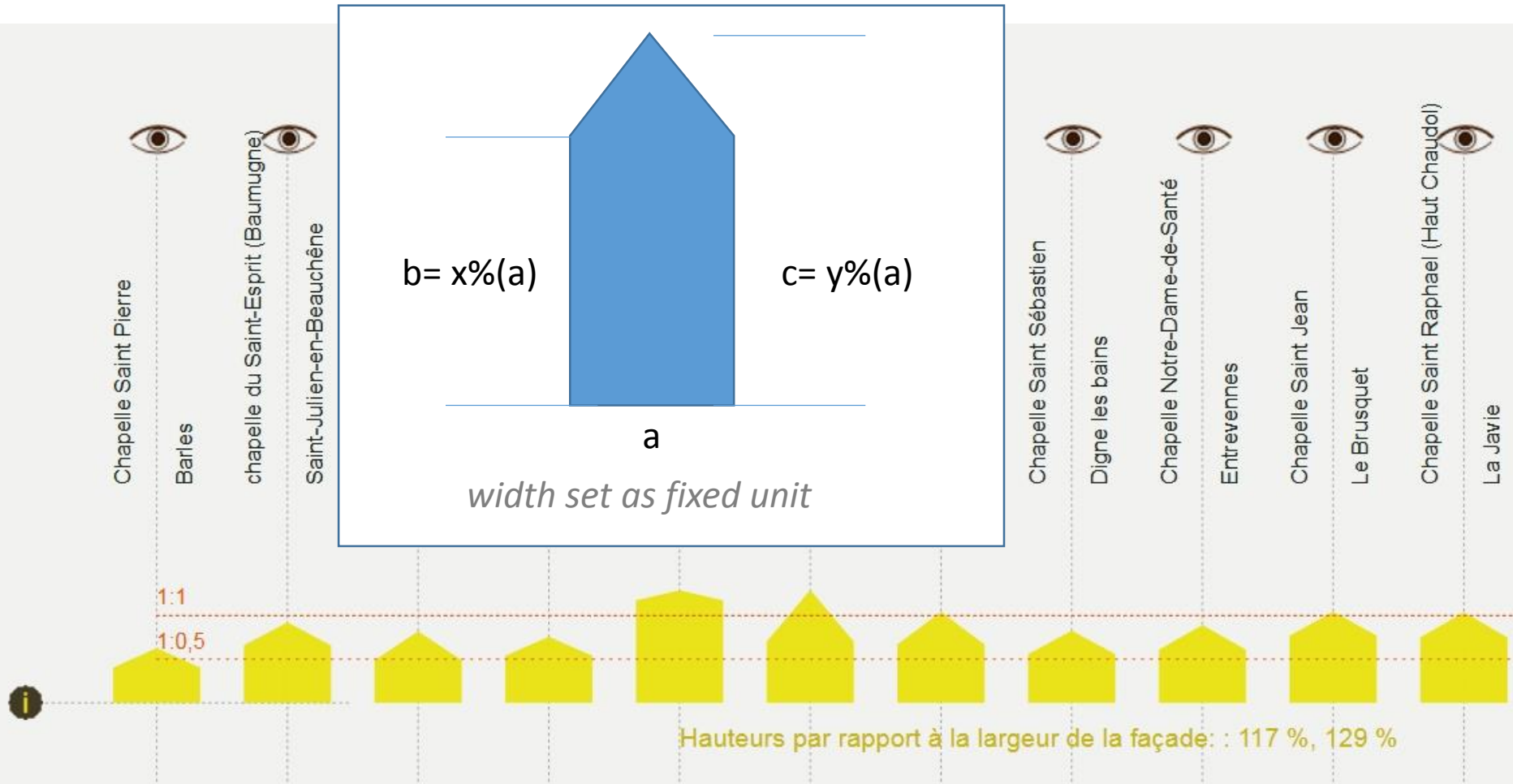


Visualisation of ratios, edifice per edifice



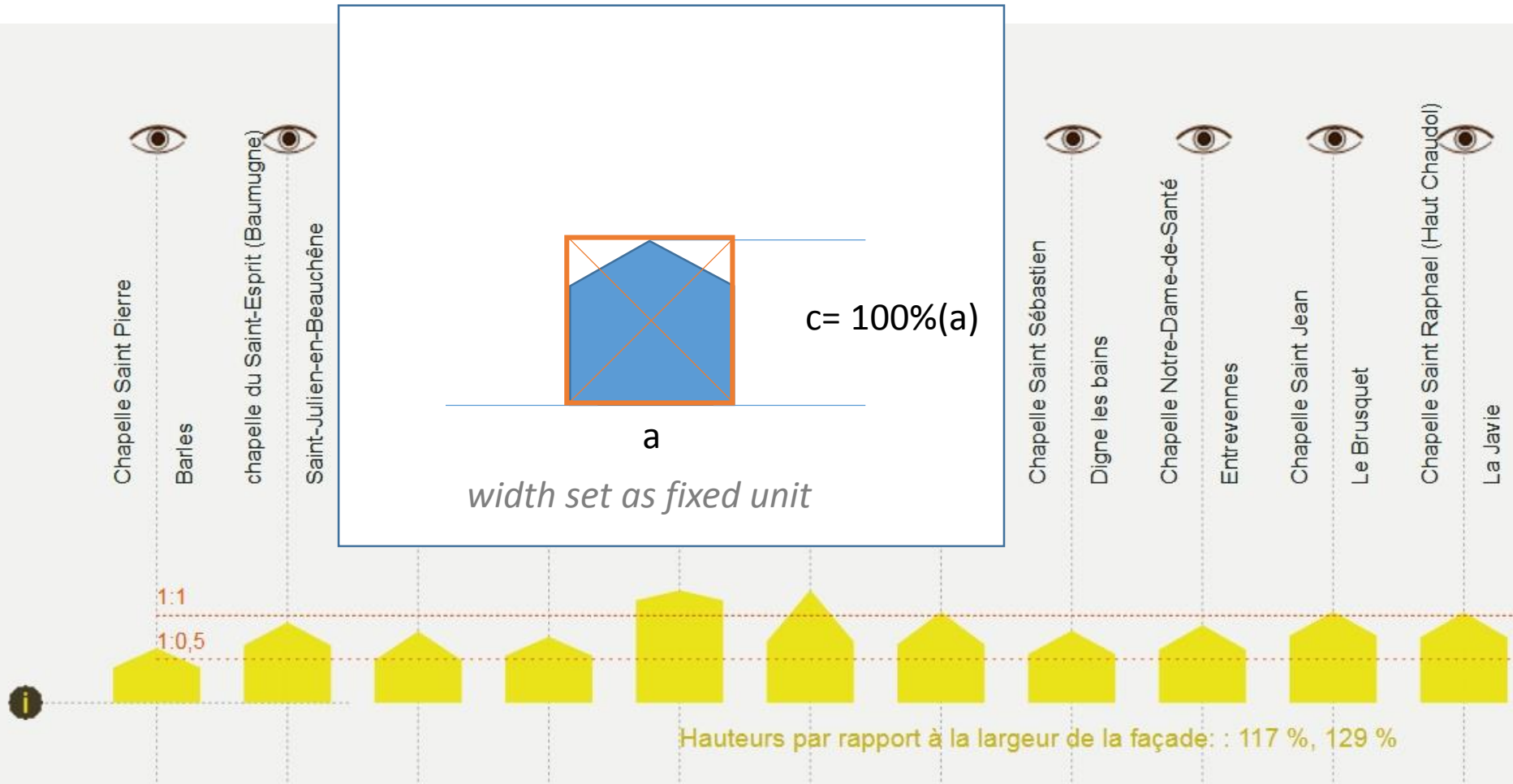
Visualisation of ratios, edifice per edifice

> Proportions of Facade



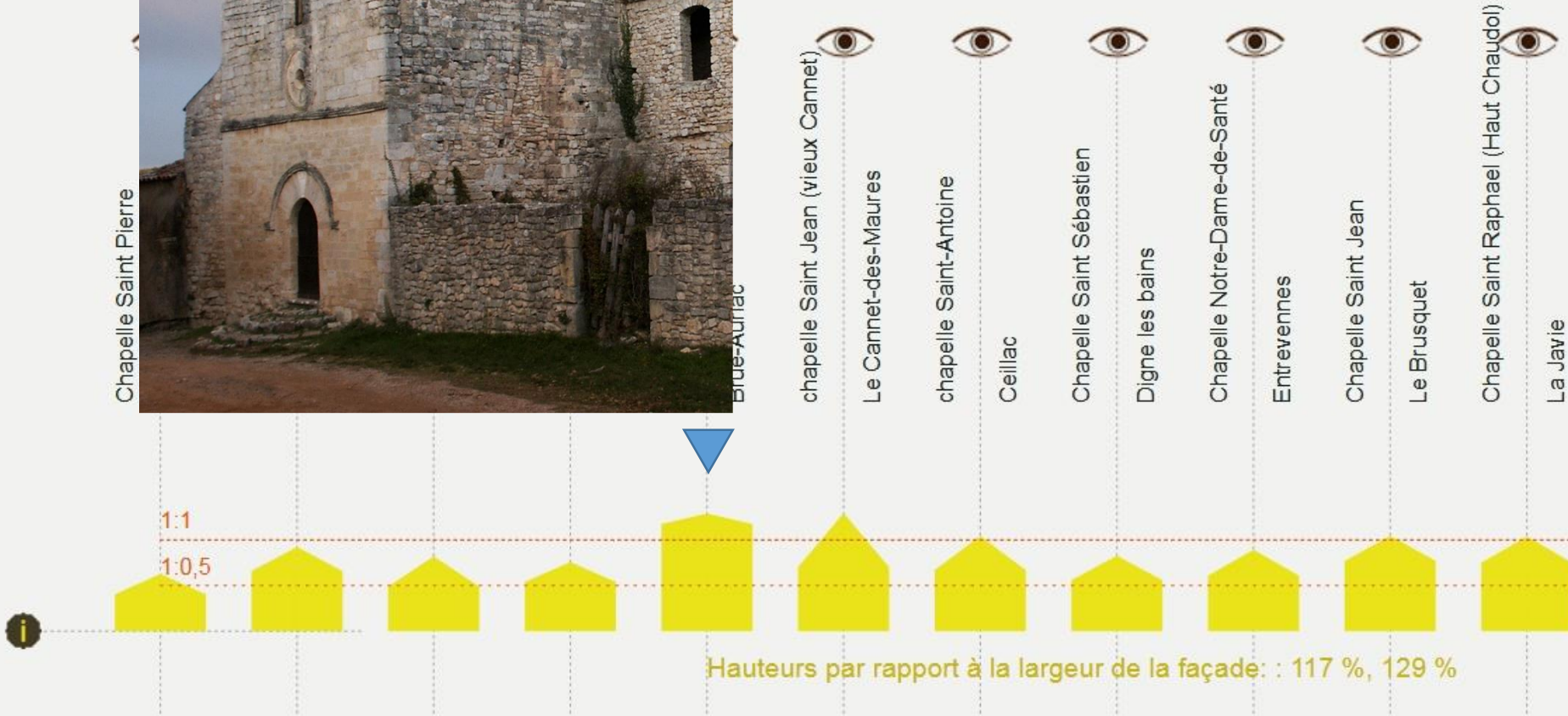
Visualisation of ratios, edifice per edifice

> Proportions of Facade



Visualisation of ratios, edifice per edifice

> Proportions of Facade

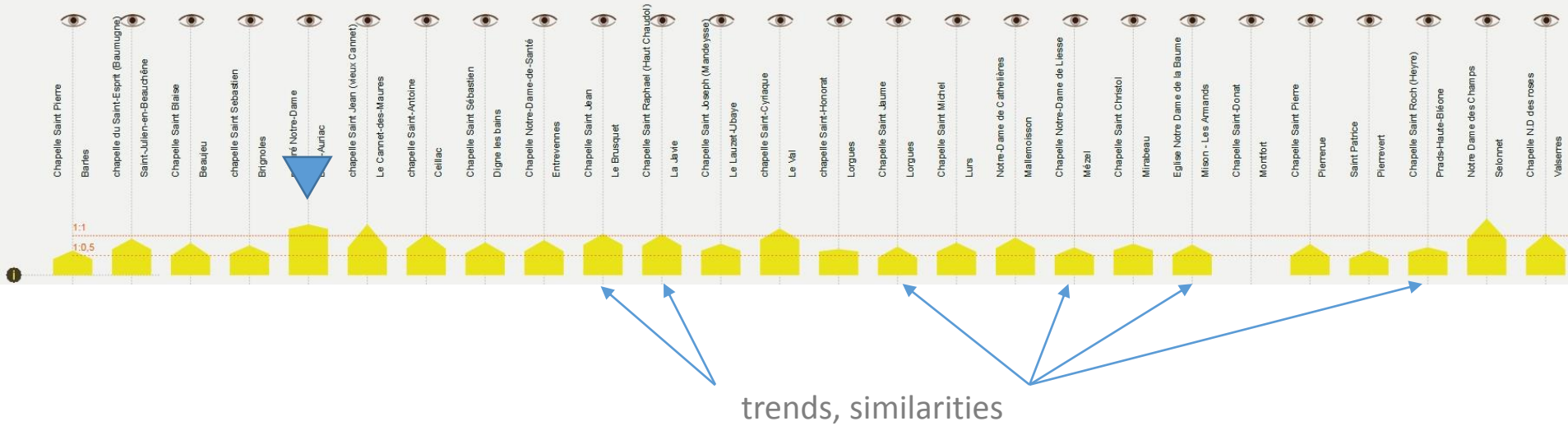




exception

Visualisation of ratios, edifice per edifice

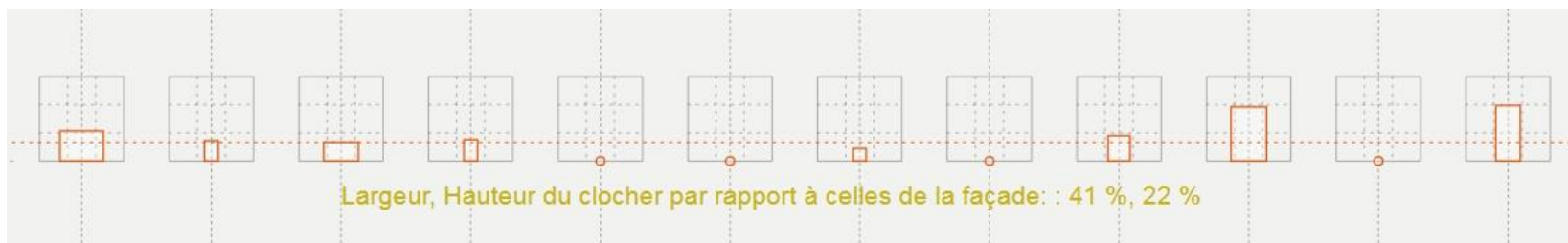
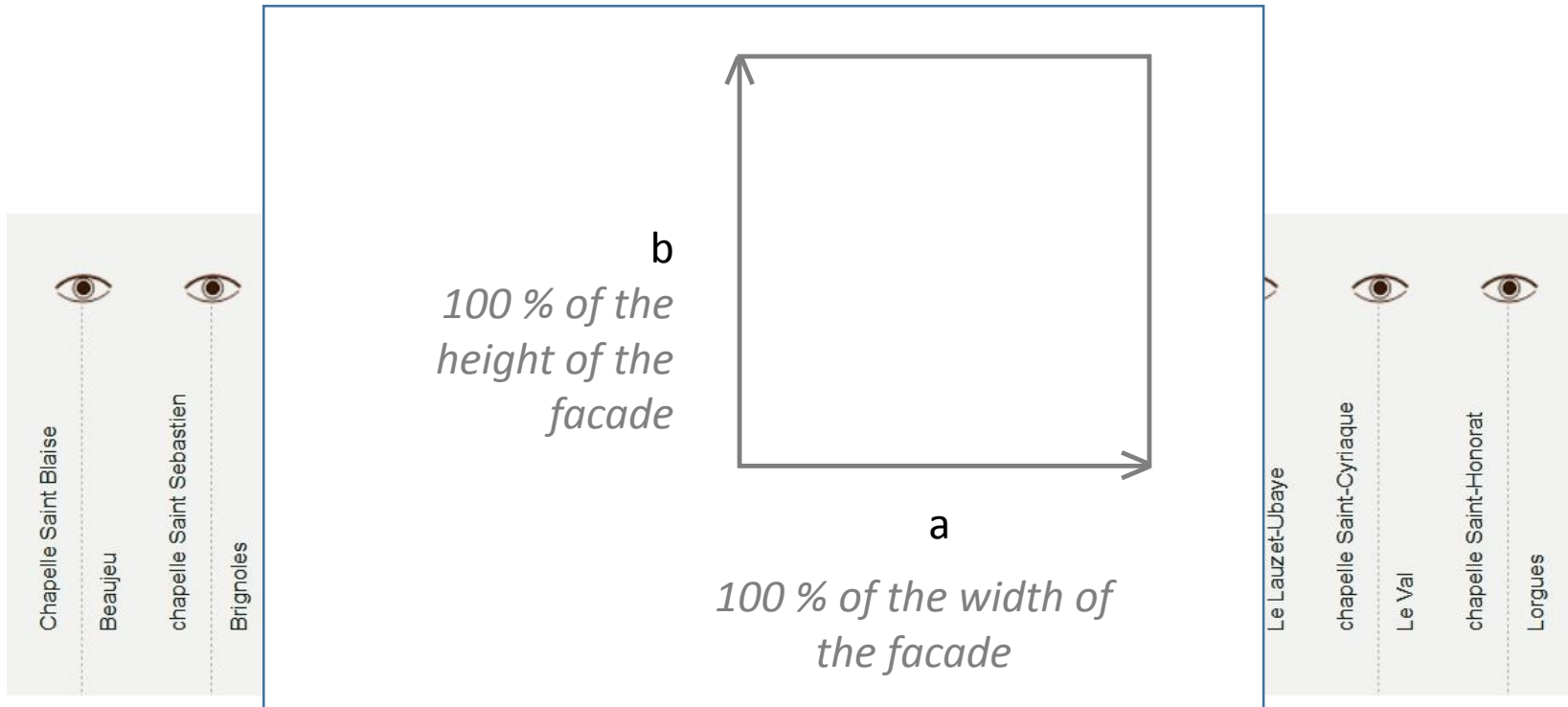
> Proportions of Facade



trends, similarities

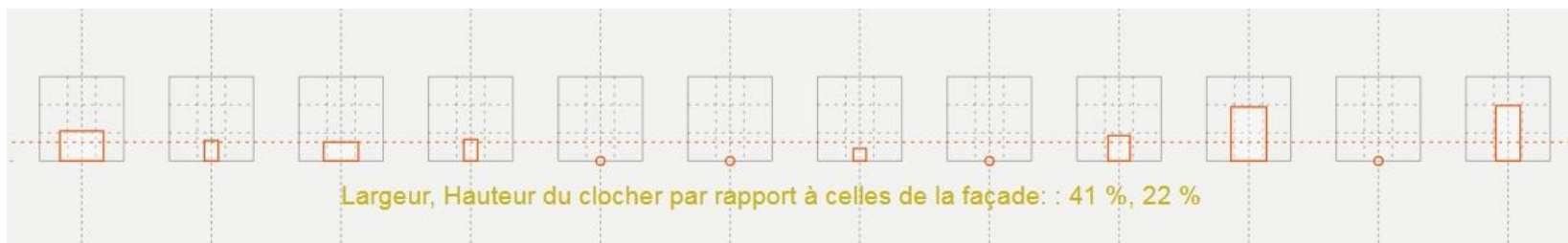
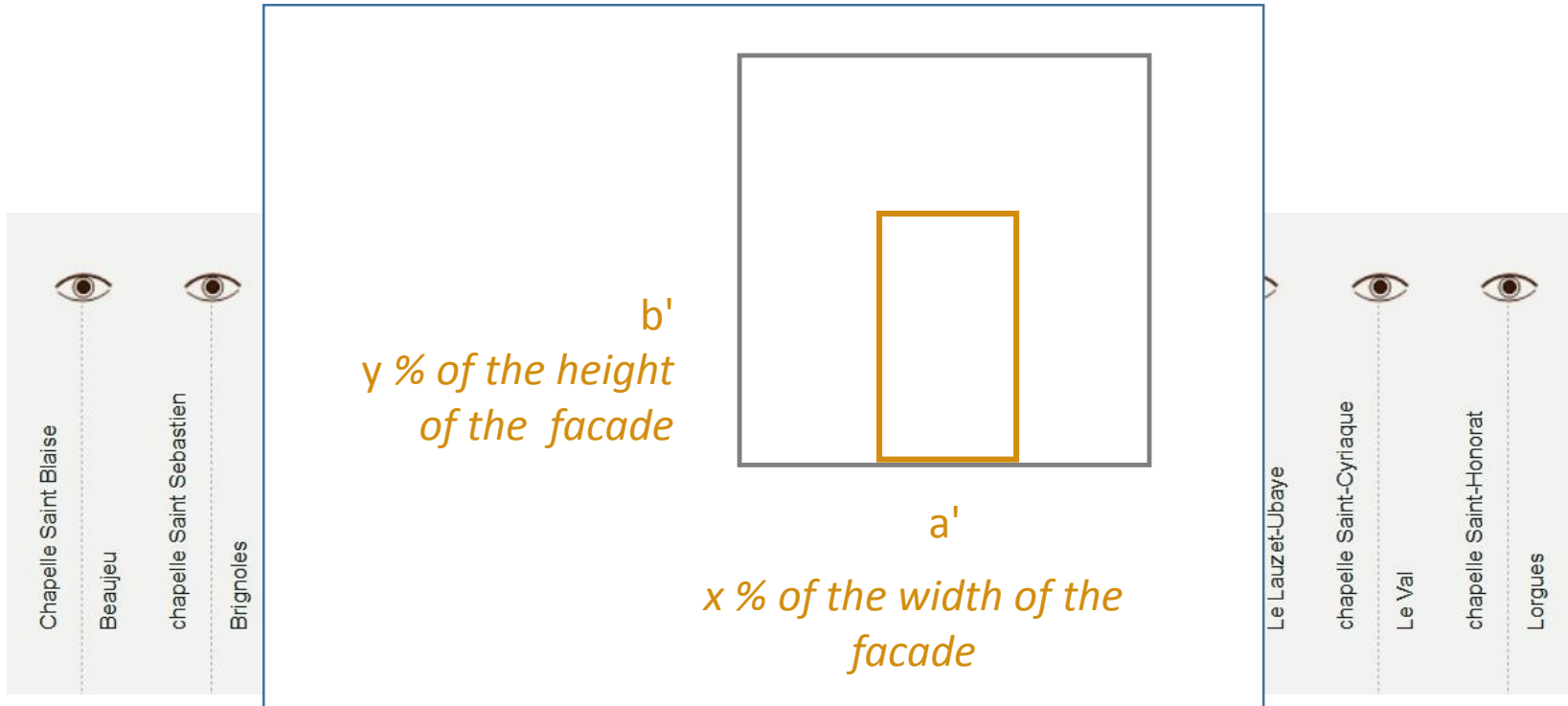
Visualisation of ratios, edifice per edifice

> Facade vs. bell tower



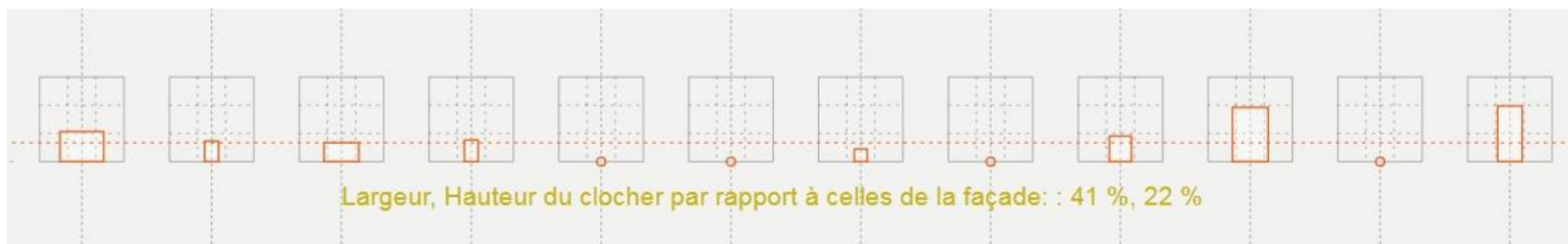
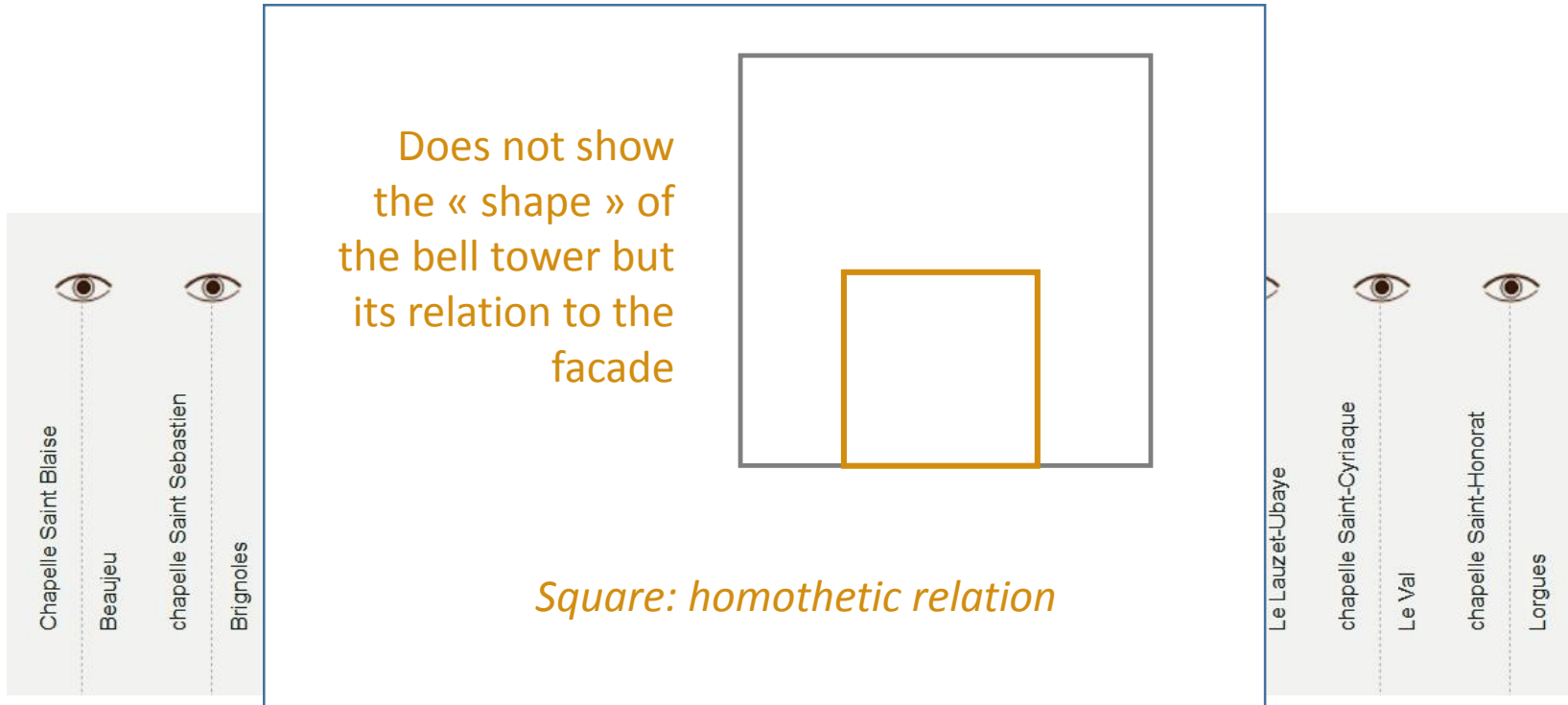
Visualisation of ratios, edifice per edifice

> Facade vs. bell tower



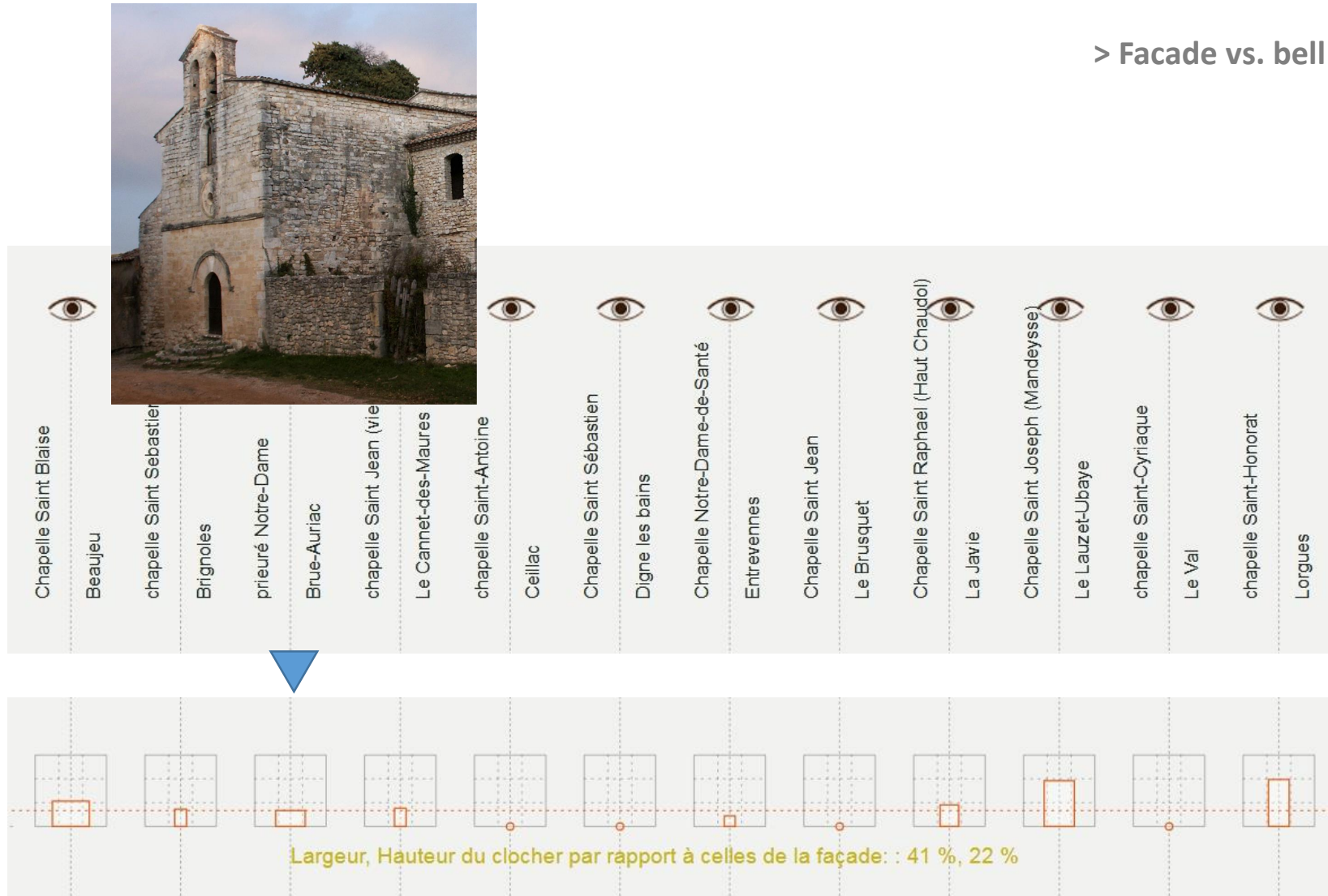
Visualisation of ratios, edifice per edifice

> Facade vs. bell tower



Visualisation of ratios, edifice per edifice

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Visualisation of ratios, edifice per edifice

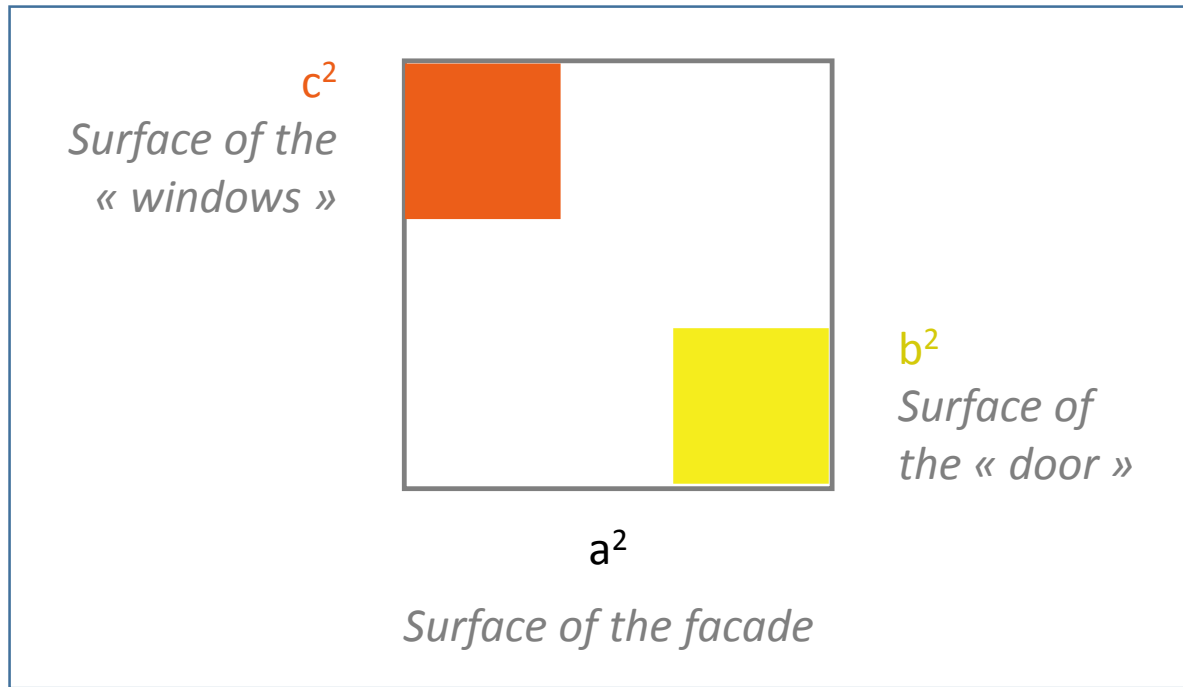
> Facade vs. bell tower

exception

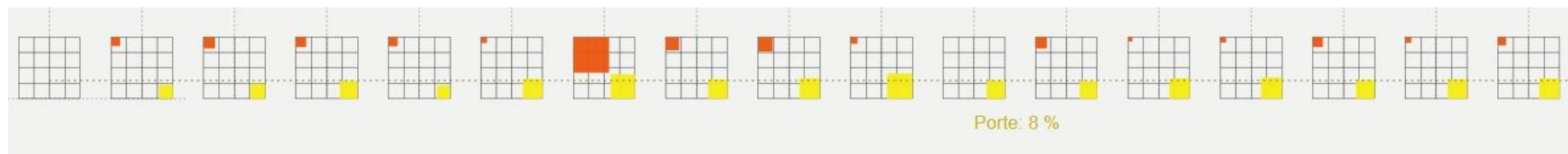
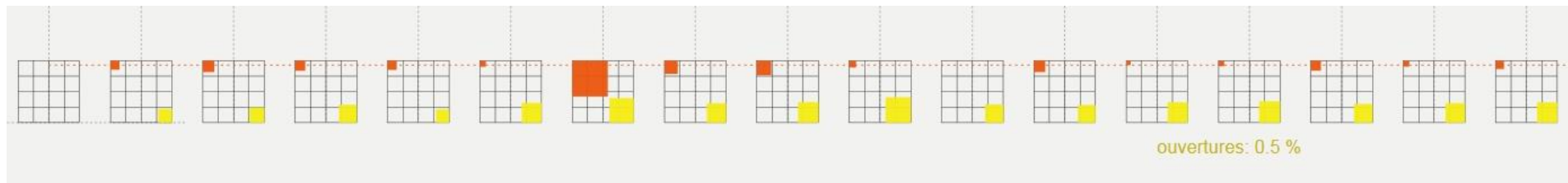


trends, similarities

Visualisation of ratios, edifice per edifice

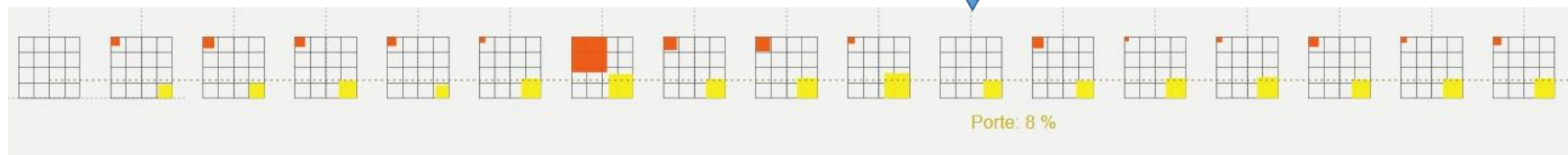
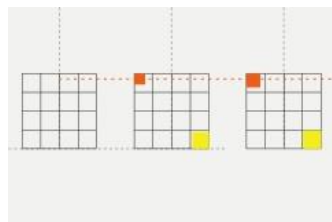


> openings



Visualisation of ratios, edifice per edifice

> openings



Visualisation of ratios, edifice per edifice

Visual solutions designed on purpose.

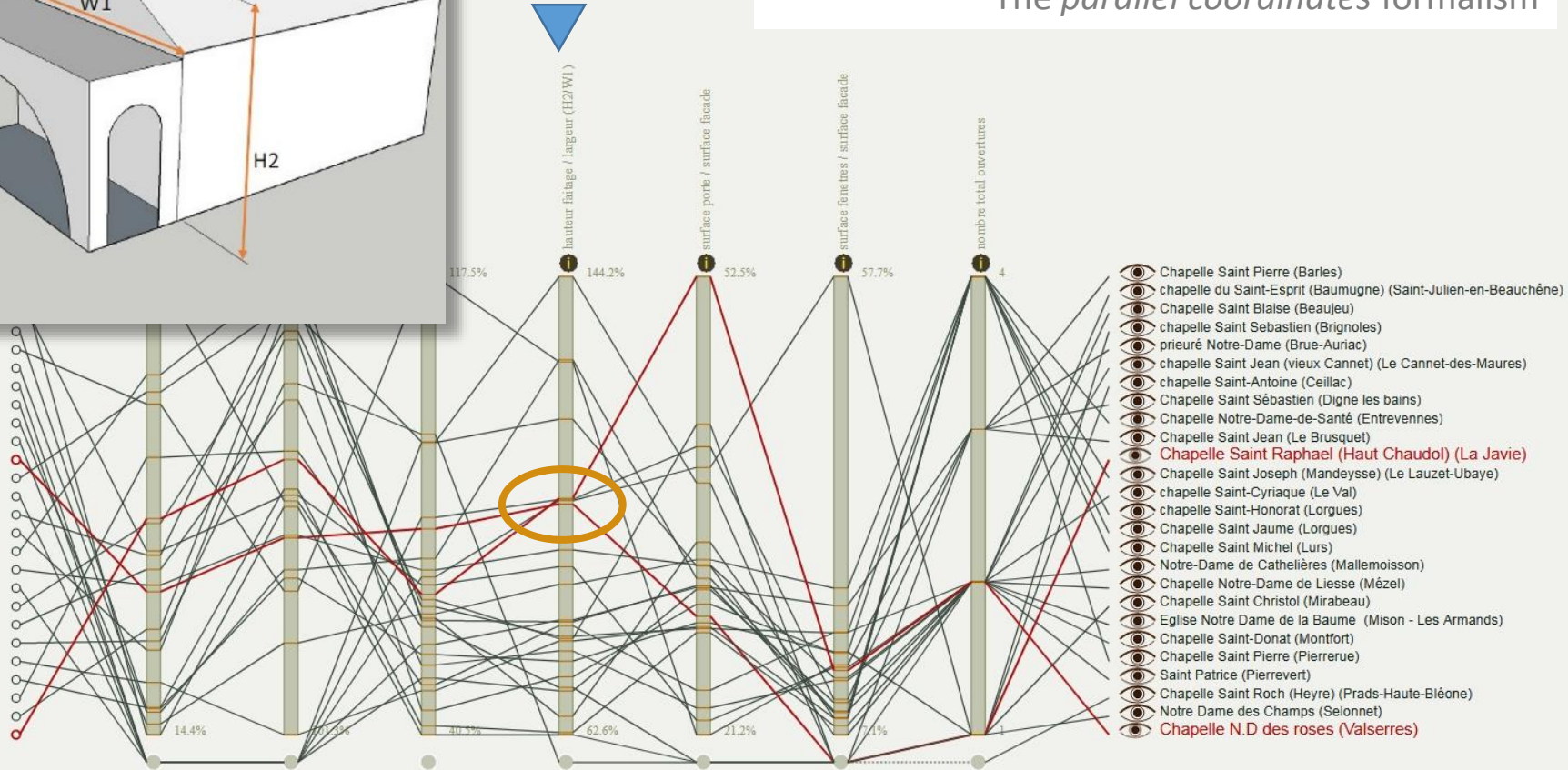
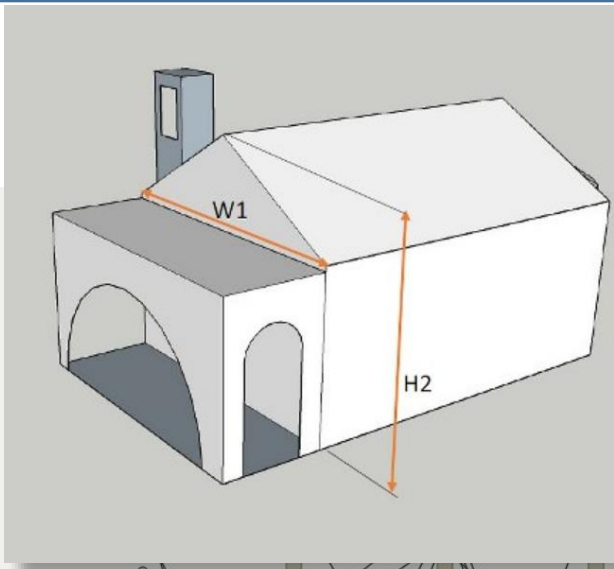
Lays the information down, helps identifying exceptions and trends, similarities.

Patterns corresponding to the collection as a whole require other visual solutions.



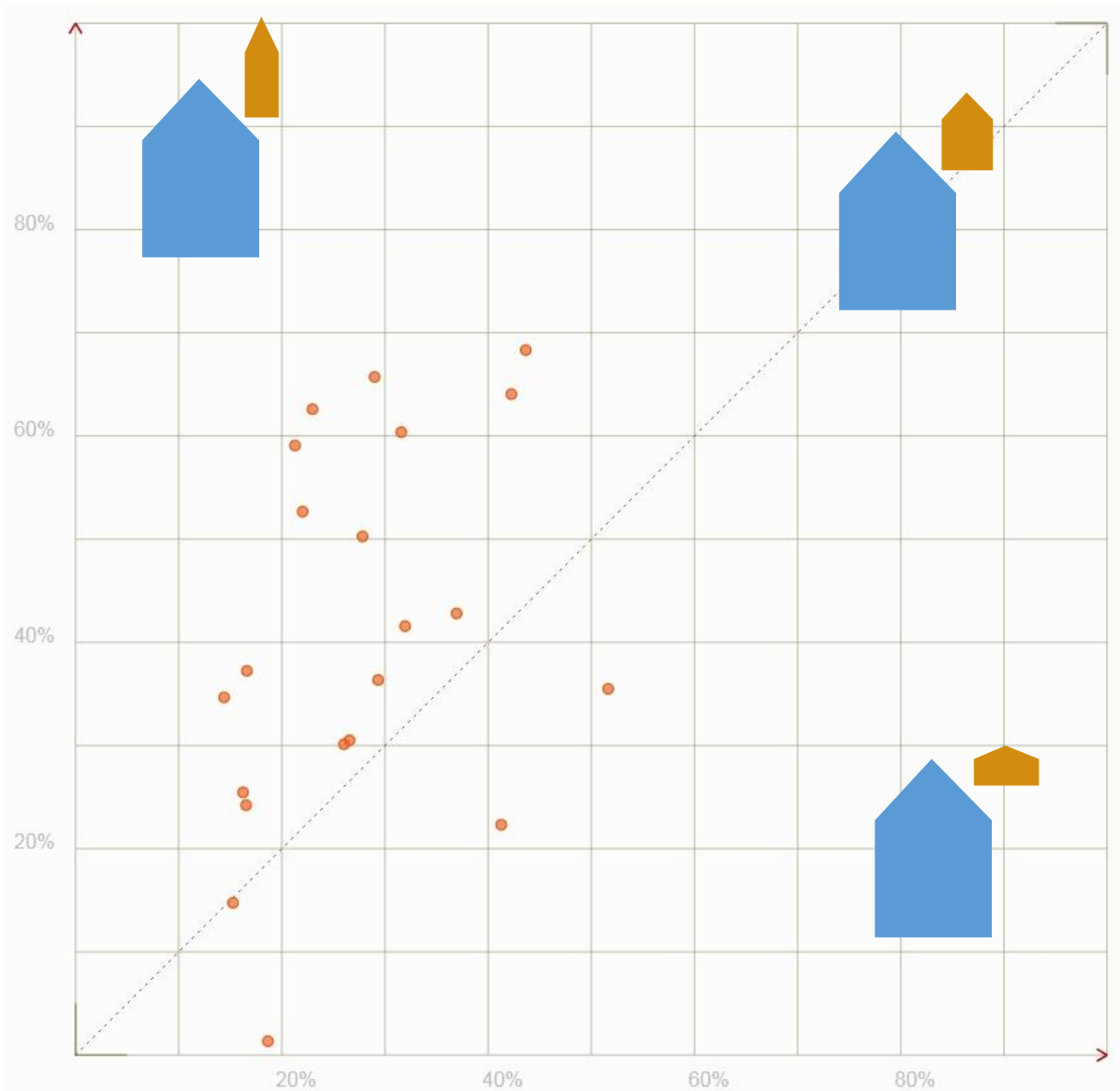
Visualisation of ratios, collection reading

The *parallel coordinates* formalism



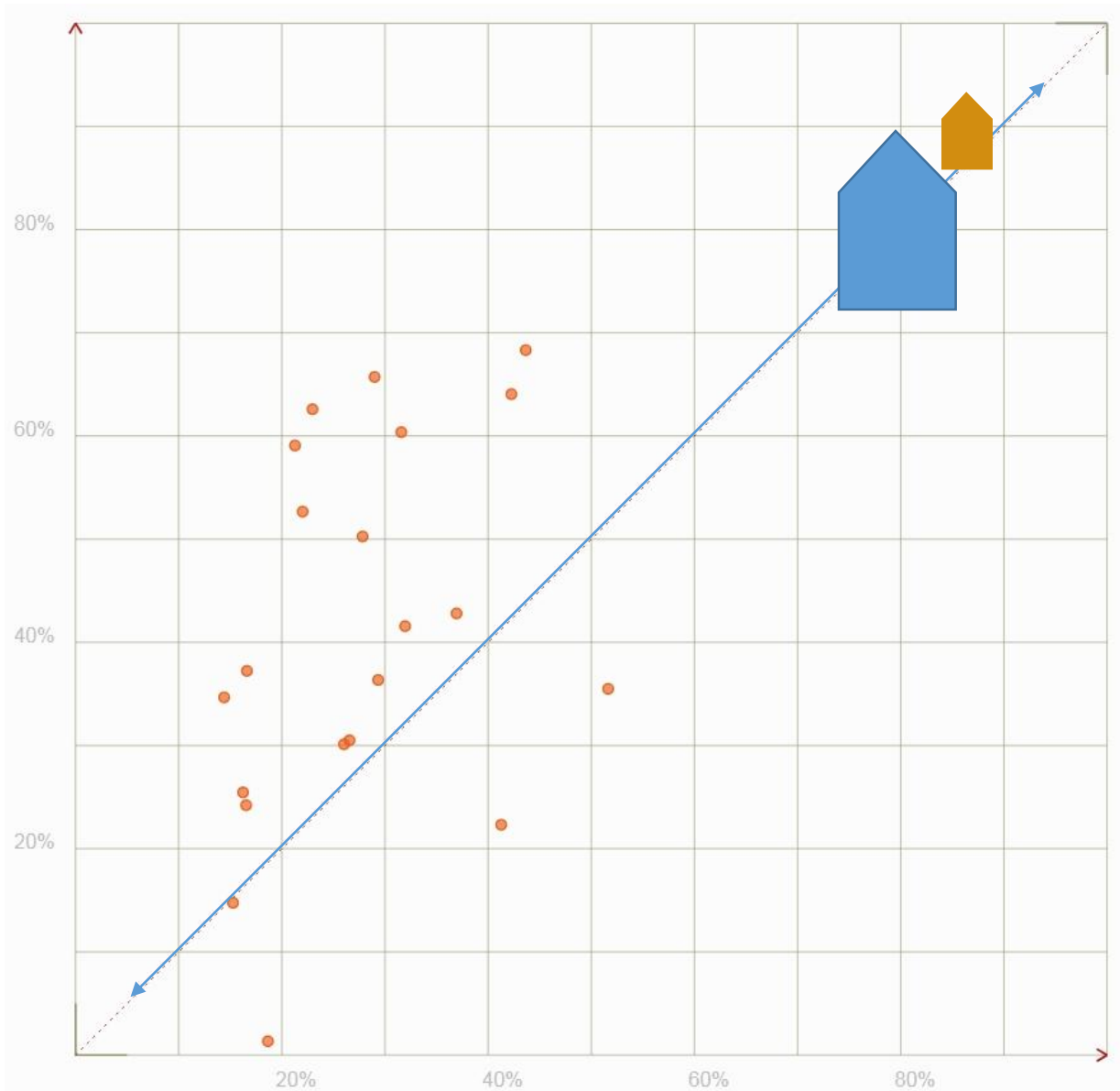
Reading of clusters

Visualisation of ratios, collection reading



A distribution plot on
bell tower
proportions in
comparison to façade
proportions

Visualisation of ratios, collection reading



A distribution plot on
bell tower
proportions in
comparison to façade
proportions

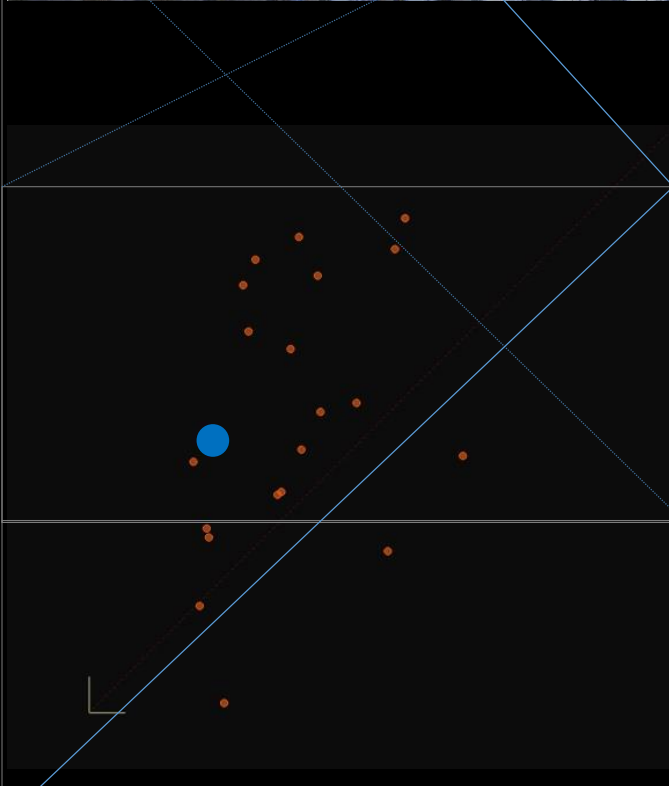
This diagonal:
homothetic relations
(A most unusual
situation)

Summary and perspectives

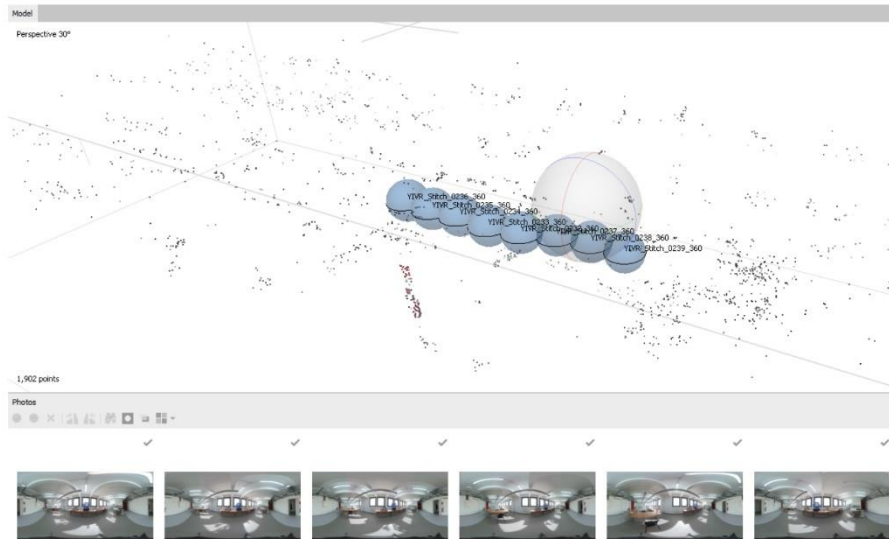
What we have done up has more to do with *delineating a playground* than with actually uncovering significant trends in terms of « ways of building »,

The experiment acts as a confirmation that there is a challenge now within reach: experimenting low-cost, lightweight survey techniques that can help analysts rethink the way they get hold of, and cross examine, 3D data seen as hints about ways of building.

Of course the whole approach does NOT require the computing of a 3D point cloud – only, having it is a mean to go back to the source, and somehow make of the 3D point cloud a repurposable content.



Summary and perspectives

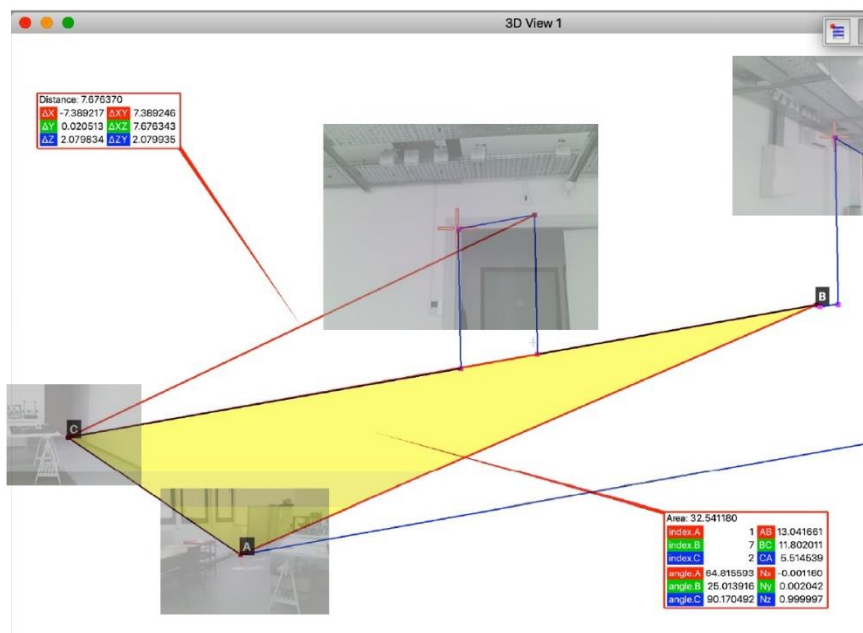


Next step: the SESAMES research programme

A multimodal, low-cost survey protocol designed for the extraction of significant architectural features

Photogrammetric protocol from Panoramic images
feature detection
Calibration and orientation
Dense matching

Point to point direct measurement (DXF)





Summary and perspectives

> Testing the approach on interiors





Thank you



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