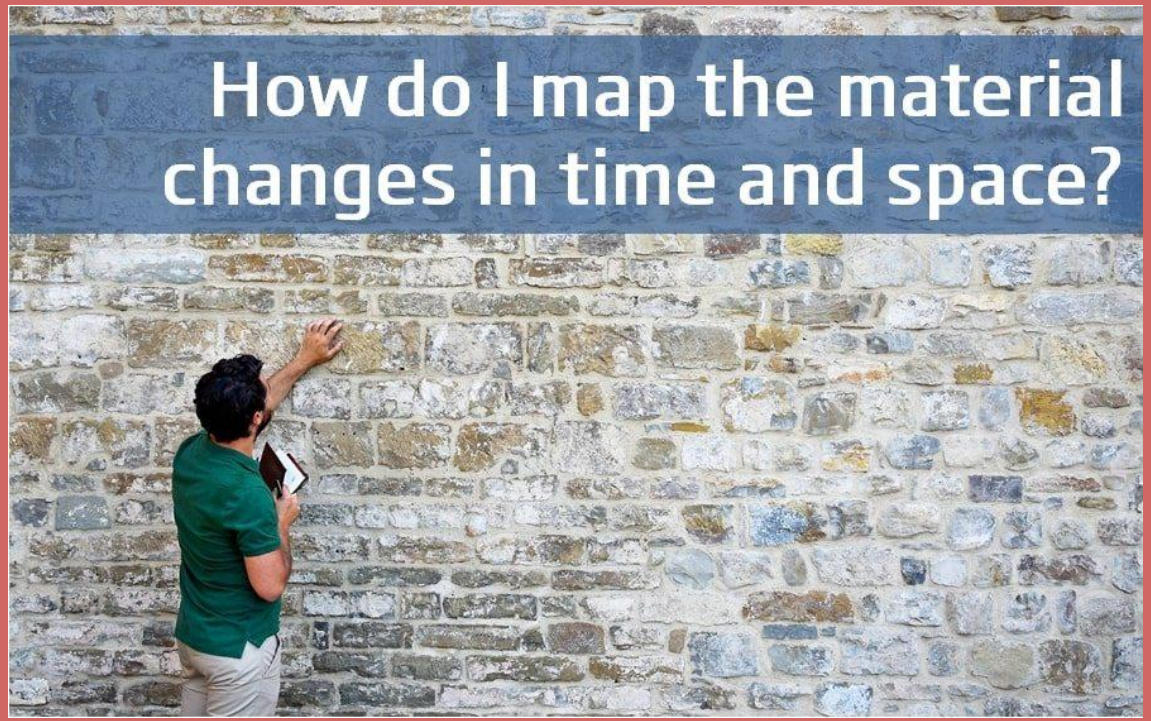
LIGHT Archaeology

TOOL HANDBOOK

DEEP CITIES
TOOLBOX



LIGHT Archaeology

The Deep Cities team of the University of Florence explored the potential of 'Light Archaeology' at the urban level, a combined application of non-destructive archaeological stratigraphic and topographic methods, as an efficient tool to model the historical transformations of an urban area.

Light Archaeology can be defined as:
1. non-destructive
2. historical
3. territorial (urban in the considered case studies)
4. stratigraphic

Urban transformations are by nature dynamic. They have in fact a duration, and a material transformation of the urban environment might work as a trigger for further changes, planned or unplanned, both in the short and in the long terms. For instance, it is worth considering the role played by pre-existing material remains and settings, in the site-formation processes in the longue durée.
For understanding the deep historical continuity of an urban area, it is then necessary to model the material transformations in time and space considering this cause and effect relationship, material transformation-enduring impact, mapping not a single event of change, but the urban transformation as a dynamic phenomenon.

To this end, two distinct Light Archaeology applications were developed, respectively devoted to mapping the material transformation of an urban environment (**Millennium Square Diagram or 'MSD'**) and of particularly relevant buildings or architectural complexes (**Stratigraphic Building Archaeology**).

WHEN?

SUGGESTED
Planning Phase

We recommend to apply the Light Archaeology Tools in the preparatory planning phase, in particular during the first assessments and exploring stages.

WHO?

CONTRACTOR
Essential Skills

To apply this tool we suggest to hire a contractor with the following skills:
-Stratigraphic Building Archaeology
-Territorial/Urban Archaeology
-Archival Research
-GIS Implementation

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URBAN LEVEL - THE MILLENNIUM SQUARE DIAGRAM

The MSD is an experimental methodology born in the Deep Cities framework with the aim of elaborating a comprehensive snapshot of material transformations in a given area over a millennium.
The diagram is fed by direct (material/archaeological/cartographic) and indirect (written/iconographic) sources, elaborated through a GIS in order to gather metric data on land use.

The Millennium Square Diagram has been developed joining Allen's time relations to the Light Archaeology approach at an urban scale.

The MSD allows to **visualize, order, and communicate** the material changes of an urban context in time and space

The vertical axis shows the temporal scan, a millennium, while the horizontal axis represents the space, so the different territorial units identified, where the size of the polygons represent their percentage of soil occupation. The 100% is the whole urban area analysed. In this sample, relates to Deep Cities case study of San Donato in Florence, a semi logarithmic graph is used, since the major changes occured in the last century, and this graph is more suitable to highlight them.

The MS is a GIS based tool, built on the definition of units, and their percentage of soil occupation in definite time phases, levels that consist of primary sources such as cartography records with geometric references. These are indicated on the right of the diagram. The color indicates the land use: religious, residential/commercial, industrial, open area, street or square, rural, education, institutional, military. The zig zaeg lines represent the destructions, unit's main demolition moments. To indicate if the units' representation draws by primary or secondary sources. a different opacity level of the colour is used, solid in the case of a primary source, at the 50% where secondary, such as written sources.

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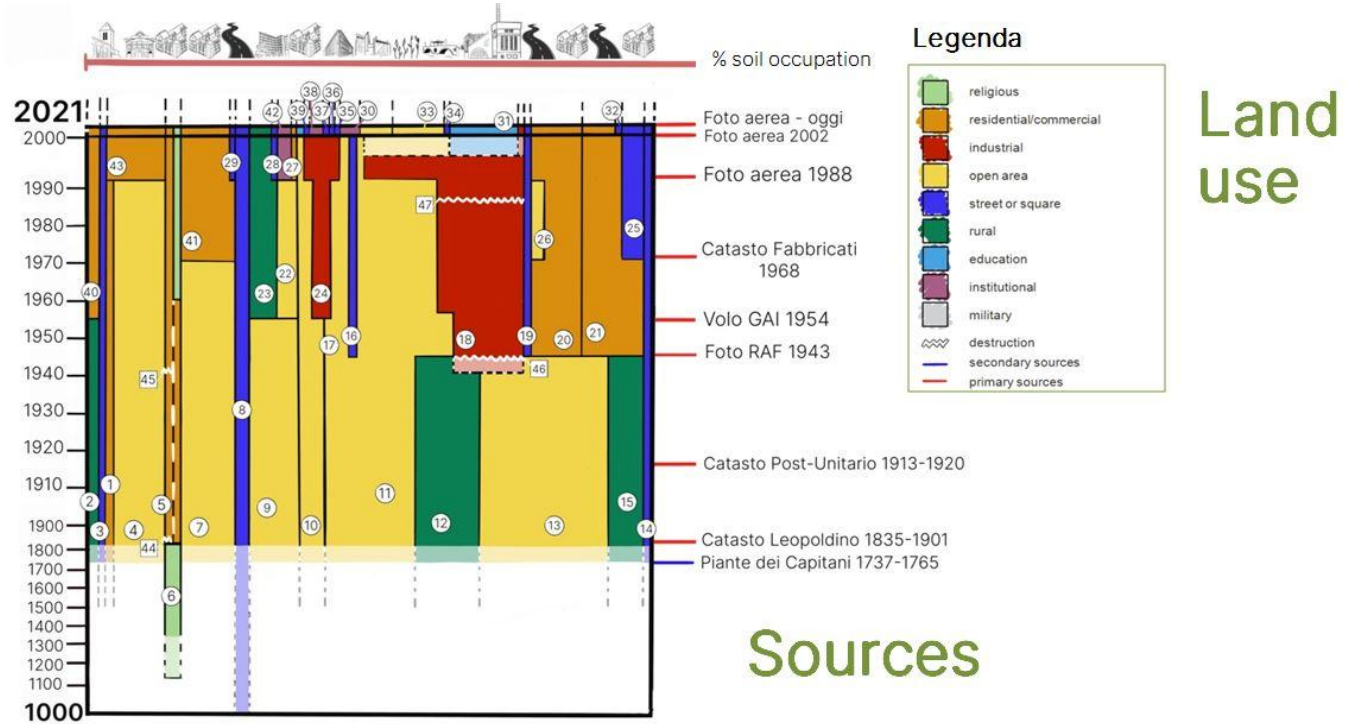

The Millennium Square Diagram of San Donato, Florence © University of Florence

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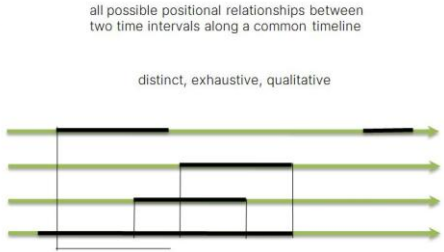
TIME - Allen's Time Relations

Relation	Illustration	Interpretation
$X < Y$ $Y > X$	X Y	X takes place before Y
$X\ \mathbf{m}\ Y$ $Y\ \mathbf{mi}\ X$	X Y	X meets Y (*i* stands for *inverse*)
$X\ \mathbf{o}\ Y$ $Y\ \mathbf{oi}\ X$	X Y	X overlaps with Y
$X\ \mathbf{s}\ Y$ $Y\ \mathbf{si}\ X$	X Y	X starts Y
$X\ \mathbf{d}\ Y$ $Y\ \mathbf{di}\ X$	X Y	X during Y
$X\ \mathbf{f}\ Y$ $Y\ \mathbf{fi}\ X$	X Y	X finishes Y
$X = Y$	X Y	X is equal to Y



J. F. Allen, 1981 *Interval based representation of temporal knowledge*

In the 1983 James Allen described all possible positional relationships between two time intervals along a common timeline. He proposed thirteen basic relations that are distinct, because no pair of definite intervals can be related by more than one of the relationships; exhaustive, because any pair of definite intervals are described by one of the relations, and qualitative, (rather than quantitative) because no numeric time spans are considered.
Allen's time model allows to represent duration and change over time.

SPACE - Topographic Unit and Architectural Complex

Novoli, San Donato Urban Area- Florence

In terms of space, in archaeology time relations could be inferred after the identification of spatial relations, which bond material traces of past events observable in the stratification. The space to model is in this case the urban area, which, following a Light archaeology approach, is broken up into different units of variable extent, but distinguished by a determined time Interval, and in terms of materiality, by a design or functional consistency. The reference unit is a Topographic Unit or an Architectural Complex.

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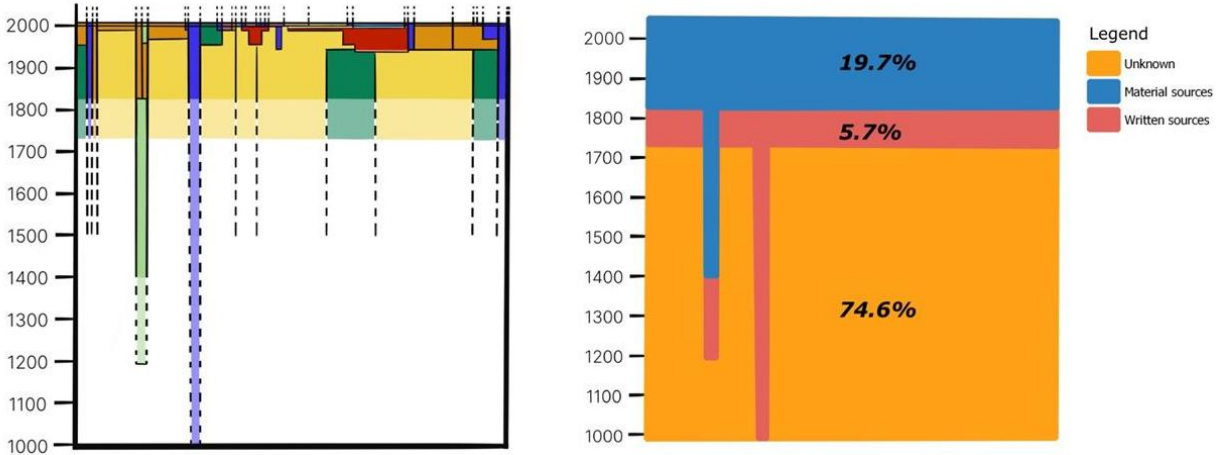
Quantifying Knowledge

of the deep history of the urban area



Since also the secondary sources are considered, the diagram offers another important information: the knowledge status of the deep history of the urban area. Quantifying the knowledge of San Donato Millennium Square Diagram © University of Florence

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HOW TO BUILD THE MILLENNIUM SQUARE OF YOUR AREA

BEFORE YOU START – WHAT IS NEEDED

- Define the topographic area

Define clearly the topographic area you would like to analyse.

San Donato area in Novoli, Florence © University of Florence

- Collect historical data about the area and its built environment

(existing archaeological surveys and reports, built heritage assessments, etc)

- Collect photos of the area and its built environment

(photographic archives: historical, contemporary... everything useful for the understanding of the area)

Left: Detail pf San Donato monastery from a map of the "Capitani di Parte Guelfa" dated 1737-1765 © CASTORE – Right: The FIAT factory in Novoli before the demolition © l'Unità

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HOW TO BUILD THE MILLENNIUM SQUARE OF YOUR AREA

- *Collect cartography and aerial-orthographic photography of the area for the GIS development*

• Historical cartography (Raster) - Map with geometric references!
• Contemporary cartography (Raster)
• Aerial-orthographic photography (e.g. RAF is perfect)
• Spatial dataset (Vector)

Different cartographic layers with the limits of the case study area in San Donato © University of Florence

DEVELOP THE GIS OF YOUR AREA

STEP 1
Develop the GIS of the area, integrating all the dataset you have, and building time series. These are definite time phases, levels that consist of primary sources such as cartography records with geometric references.

STEP 2
Identify in each level (time phase) the reference Units, Topographic Unit or an Architectural Complex.

STEP 3
Calculate the percentage of soil occupation of the units in each level.

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HOW TO BUILD THE MILLENNIUM SQUARE OF YOUR AREA

CREATE THE MSD UNITS' DATABASE

A crucial step in building the Millennium Square Diagram is to record all the data related to the units identified in the GIS time series.

Millennium Square Units

Unit	Name	Type	Land Use	Start (Primary)	Start (Secondary)	End (Primary)	End (Secondary)	% soil occupation
1	Borghetto sud-est (Ponte alle Mosse)	*Positive*	Residential	1825-35	19th century	1988	1988	1%
2	Futuro Isolato Baracca	*Positive*	Rural	1825-35	19th century	1954	1954	2,3 % (1825-35); 2,3% (1913-20); 2,1% (1943 a oggi)
3	Via Baracca/Via San Donato	*Positive*	Street	1825-35	1737-1765	no	no	1% (da 1825-35 a oggi).
4	Parco Villa Demidoff	*Positive*	Open Area	1825-35	1811	1943	60s 19th c	
5	Villa Demidoff	*Positive*	Residential	1825-35	1811	no	no	1% (da 1825-35 a oggi)
6	Monastero San	*Positive*	Culto	1825-35	1187	no	Interruzione	1% (da

Different cartographic layers with the limits of the case study area in San Donato © University of Florence

Crucial Units Data to Record

1. **Number and Name**
2. **Type.** Positive or Negative (demolition)
3. **Land Use.** Use one of these categories: religious, residential/retail, industrial, open area, steet/square, rural, education, institutional, military, health.
4. **Uni Start and End Date.** You need to research and record both primary and secondary sources dates.
5. **Percentage of Soil occupation**

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ARCHITECTURAL LEVEL – STRATIGRAPHIC BUILDING ARCHAEOLOGY

The goal of Stratigraphic Building Archaeology is to determine the construction phases of the buildings (analyzing signs of transformation, restoration, reconstruction, and demolition) within a relative chronology and, subsequently, their settings in an absolute chronology introducing dates or periods.

BEFORE YOU START – WHAT IS NEEDED

1. Identify the building

Find in detail the building you want to study on available maps (at least on Google maps).

2. Collect historical data, photos and documents regarding the building

Locate the chosen building on historical maps, on historical photos, on other archival documents, and on published papers or books.

3. Elaborate a first historical overview of the material transformations of the building

Considering the collected data, elaborate an historical synthesis of the key transformations of the building over the centuries to use as outline later in the Light Archaeology analisys.

4. Instruments needed

Below are some objects that will serve, along with other more specific elements, the subsequent activities of Light Archaeology
- Pencils, pens (of different colours), glossy paper and graph paper
- Paper notebook
- Mobile camera or (more preferable) reflex camera (with basic auto lens 18-55 mm)

Left: View of the façade of San Donato in Polverosa in 1854 by lithographer DURAND A., 1854 ©Gabinetto delle Stampe e dei Disegni degli Uffizi, Florence – Right: © University of Florence

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Now we illustrate the 4 fundamental steps of the Stratigraphic Building Archaeology workflow.

STEP 1
Identification of the building and the stratigraphic visibility

The first step of Stratigraphic Building Archeology is to topographically identify a building in its urban context. Quickly passing by the general architectural complex and the different buildings in which it can be divided, we can identify the different particular elevations (external or internal) which have stratigraphic visibility and can, therefore, be analyzed. As a second step, we proceed with a photographic campaign to provide accurate documentation of the state of the overall stratigraphic visibility.

For example, in the case of Novoli in Florence (Italy), San Donato was initially identified as an architectural complex (fig. 1) and, subsequently, the three buildings from which it consists were defined (fig. 2): the church of San Donato, the bell tower, and the vicarage. Focusing on the church of San Donato, the internal and external elevations (fig. 3) were identified and defined and external E1 (the current façade of the church) and internal E13 were chosen due to their stratigraphic visibility (figg. 4).

Figure 1

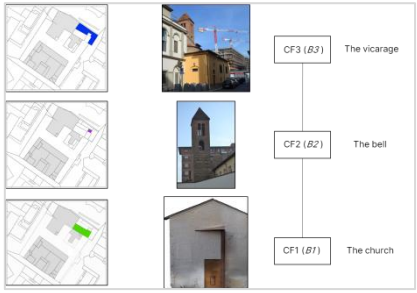

Figure 2

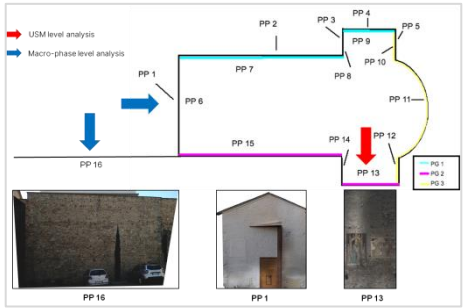

Figure 3

Figure 4

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STEP 2
Photogrammetric survey and digital model of the masonries

After choosing the elevations, the next step is the photogrammetric survey. Through a photographic session covering entirely the selected elevations, we modeled photographic photoplanes. These last were then used to report and to map the different stratigraphic units identified in the elevations of the buildings.

We follow the above-described workflow also in the case-study of San Donato church: E1 and E13 elevations were documented through photographic and photogrammetric surveys and then digitized using photographing modeling softwares (figg. 6-7).

Figure 6

Figure 7

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STEP 3
Identification and analysis of stratigraphic units

Step 3 of the analysis is the identification, definition and mapping of different stratigraphic units in the masonries. These last are intended as constructive or destructive actions with temporal autonomy. There are two different types of stratigraphic units: positive (if they result from a single constructive action) or negative (if they result from a removal action). This phase is usually carried in the field.

In this phase the analysis consists in looking for physical relationships between adjacent archaeological units and processing the temporal stratigraphic sequences (posteriority, anteriority, contemporaneity), by organizing all the stratigraphic units in temporal order. A number is assigned to each stratigraphic unit (negative unit numbers are usually underlined to immediately distinguish them graphically). The limits of archaeological units and their relationships are reported directly on a paper sketch and then digitized and vectorized on the digital photographic photoplanes (see Step 2).

The physical relationships between the different archaeological units can be positive (leans on, covers and tied to) or negative (cuts). Some units are then defined as covering units if they cover other units, such as plasters, paints, wall coverings, and flooring. Every limit and relationship are also graphically represented in a sketch and then in the vectorization by standard symbols (figg. 9-12).

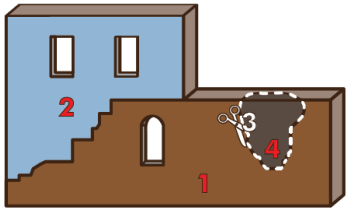

Figure 8


Figure 9


Figure 10

53	POSITIVE USM
52	NEGATIVE USM
	LEANS ON
	CUTS
	COVERS
	TIED TO

Figure 11


Figure 12

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In the same vectorization, as in the analysis of E1 and E13 of San Donato church in Florence, is foreseen the stone-by-stone design of the masonries of the elevation under analysis (fig. 14).

SITO:	N. SITO:	SIGLA:	ANNO:	COMPILATORE:	DATA:

US/USM	DEFINIZIONE: US/USM	POSTERIORE A	ANTERIORE A	COEVO A	UGUALE A	LEGATO A	COLLEGATO A	COPRE	TAGLIA	RIEMPIE	APPOGGIATO A	COPERTO DA	TAGLIATO DA	RIEMPITO DA	GLI SI APPOGGIA
1															
2															
3															
4															
5															
6															

Stratigraphical relations

Physical relations

Figure 13

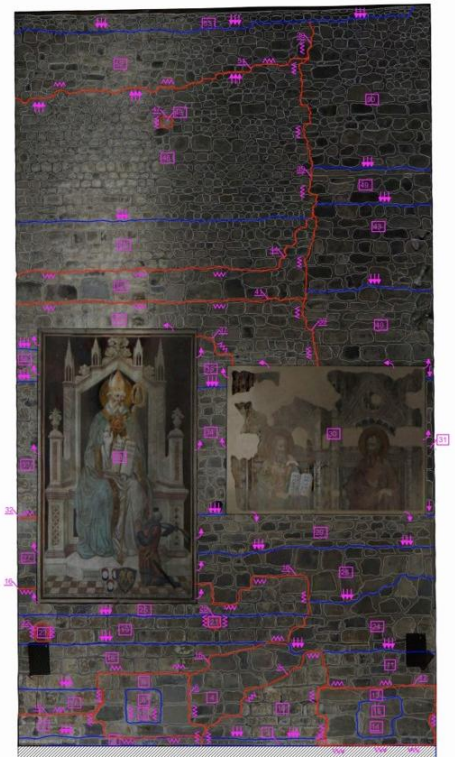

Figure 14

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STEP 4
Harris Matrix diagram and the historical phasing of buildings

Starting from the recording sheet (see Step 3), the identified and mapped stratigraphical units are organized using Harris Matrix diagram, a system of representation of the stratigraphic relationships that reports the chronological sequence (from the bottom-past to the upper part-present) of all constructive and destructive actions identifiable on masonries buildings (fig. 15).

Considering the analysis of different archaeological units, as final result of the entire described process, the archaeological units are organized in the Harris Matrix diagram into different historical phases aimed to represent the history of the buildings. Considering the case-study of the church of San Donato in Florence, and analyzing the E1 (the façade) and the interior E13, assigning to every historical phase a specific number and colour, it was possible to represent the various phase of the building between the 12th and the 20th century (figg. 16-17).

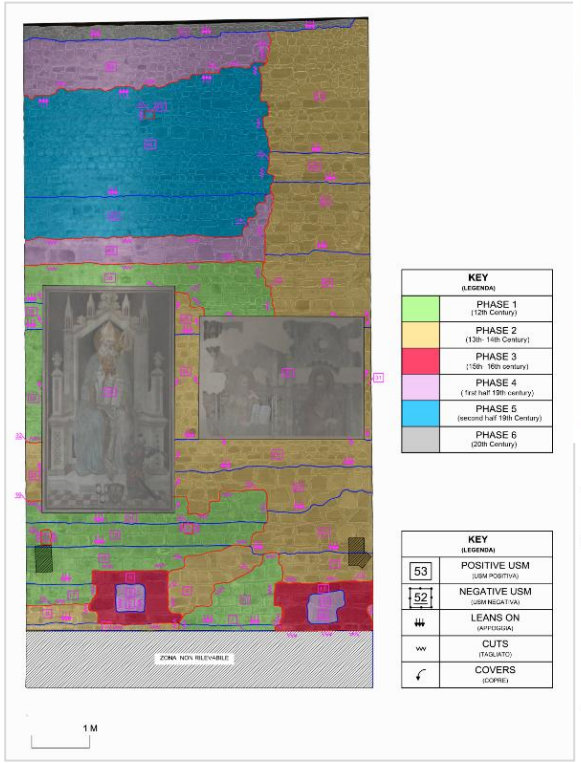

Figure 16

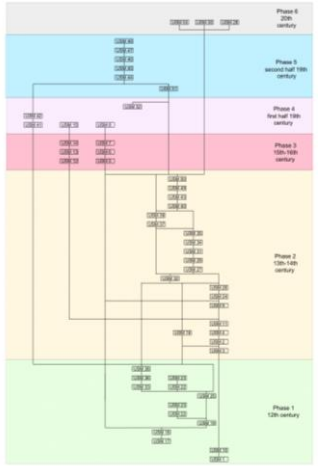

Figure 15

Figure 17

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FURTHER READINGS

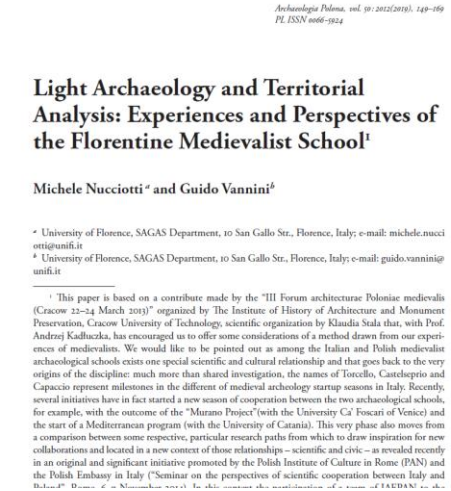
• Michele Nucciotti & Guido Vannini, 2019, **Light Archaeology and Territorial Analysis: Experiences and Perspectives of the Florentine Medieval School**, Archeologia Polona, 50: 149-169

• Gian Pietro Brogiolo & Aurora Cagnana, 2012, **Archeologia dell'Archiettura: metodi e interpretazioni**

• Gian Pietro Brogiolo, 1988, **Archeologia dell'edilizia storica**

• Pierre Drap, Odile Papini, Elisa Pruno, Michele Nucciotti & Guido Vannini, 2017, **Surveying Medieval Archaeology: A New Form For Harris Paradigm Linking Photogrammetry And Temporal Relations**, *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-2/W3, 2017:267-274, https://doi.org/10.5194/isprs-archives-XLII-2-W3-267-2017

• Michele Nucciotti, Andrea Biondi & Elisa Broccoli, **Towards sustainable new 'urban stories'. Light Archaeology as a tool to map the historical transformations across time and space**, Proceedings of the International Symposium "Heritage for the Future, Science for Heritage. A European Adventure for Research and Innovation, Louvre / Bibliothéque nationale de France, PARIS, 15-16 March 2022:198-203



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Light Archaeology and Territorial Analysis: Experiences and Perspectives of the Florentine Medievalist School[1]

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[1] This paper is based on a contribute made by the "III Forum architecturae Poloniae medievalis (Cracow 22–24 March 2013)" organized by The Institute of History of Architecture and Monument Preservation, Cracow University of Technology, scientific organization by Klaudia Stala that, with Prof. Andrzej Kadłuczka, has encouraged us to offer some considerations of a method drawn from our experiences of medievalists. We would like to be pointed out as among the Italian and Polish medievalist archaeological schools exists one special scientific and cultural relationship and that goes back to the very origins of the discipline: much more than shared investigation, the names of Torcello, Castelseprio and Capaccio represent milestones in the different of medieval archeology startup seasons in Italy. Recently, several initiatives have in fact started a new season of cooperation between the two archaeological schools, for example, with the outcome of the "Murano Project"(with the University Ca' Foscari of Venice) and the start of a Mediterranean program (with the University of Catania). This very phase also moves from a comparison between some respective, particular research paths from which to draw inspiration for new collaborations and located in a new context of those relationships – scientific and civic – as revealed recently in an original and significant initiative promoted by the Polish Institute of Culture in Rome (PAN) and the Polish Embassy in Italy ("Seminar on the perspectives of scientific cooperation between Italy and