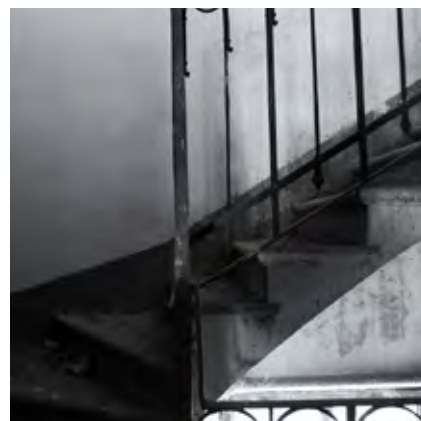


Optimisation of survey procedures and application of integrated digital tools for seismic risk mitigation of cultural heritage: The Emilia-Romagna damaged theatres.



APPEDIX A: PHOTOGRAPHIC SURVEY



PhD Candidate: Suppa Martina

PhD Programme: International Doctorate in Architecture and Urban Planning (IDAUP)
Cycle: XXXIV

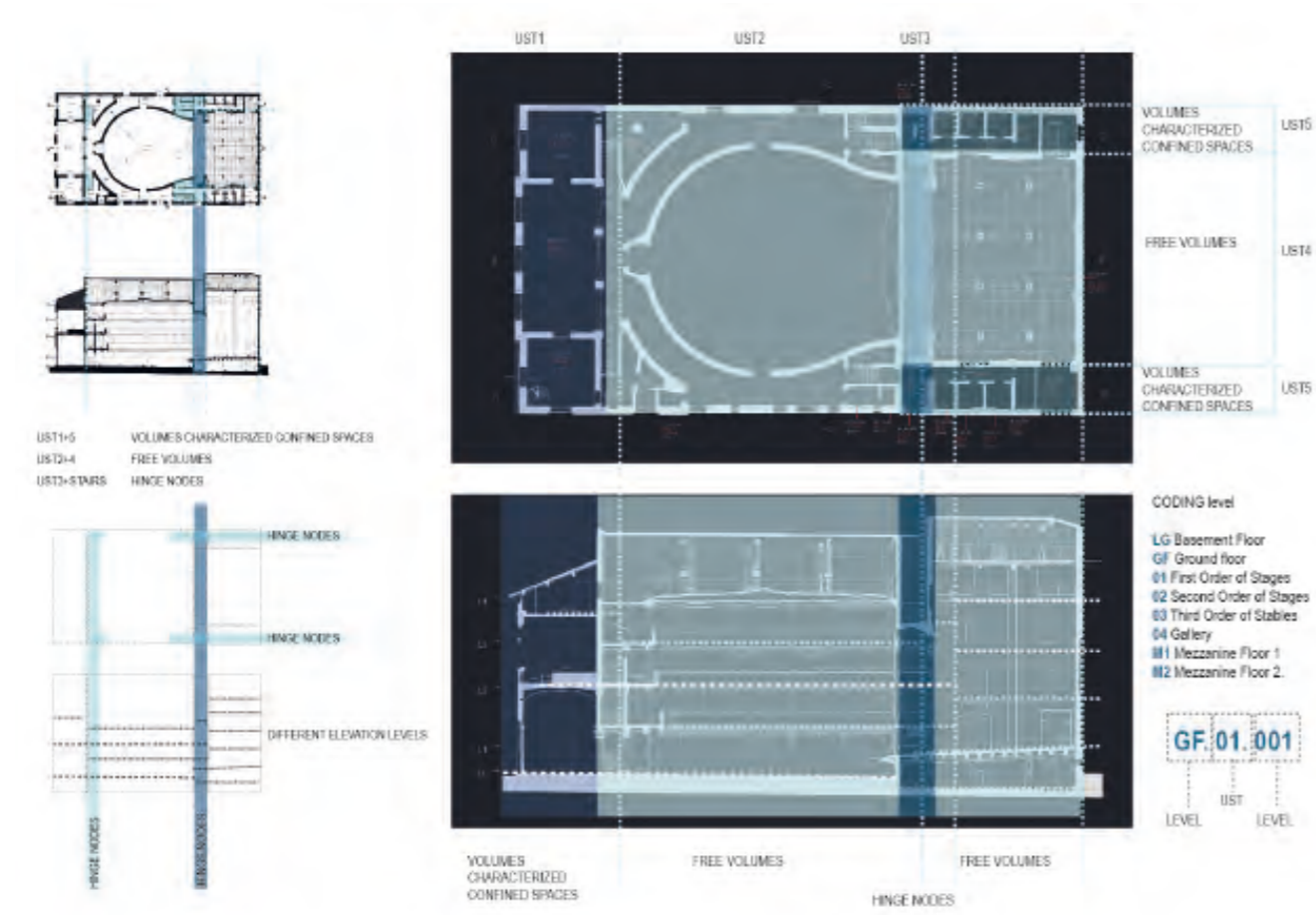
ICAR 17

Supervisor (DA/POLIS): Prof. Balzani Marcello

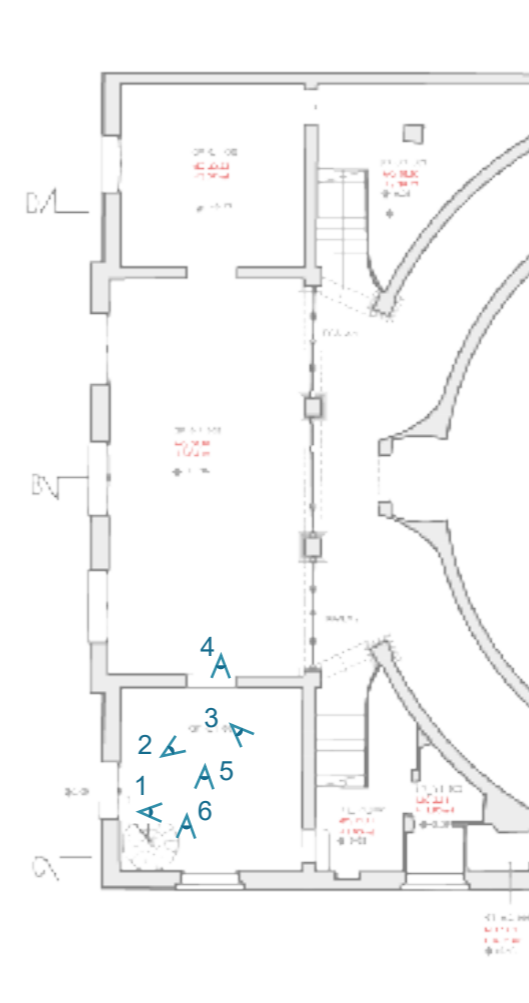
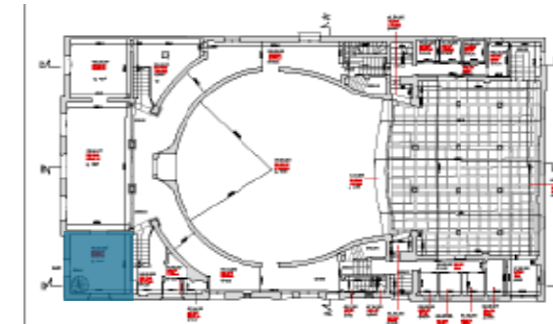
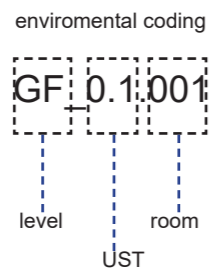
Co-Supervisor (DA/POLIS): Prof. Arben Shtylla

External Expert: Prof. Maietti Federica; Dott.ssa Raco Fabiana

GF_0.1.001



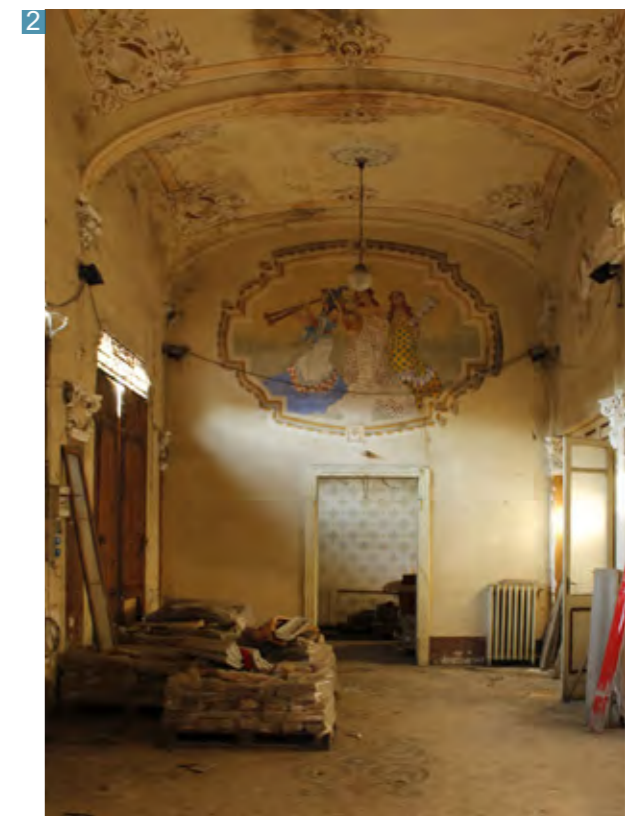
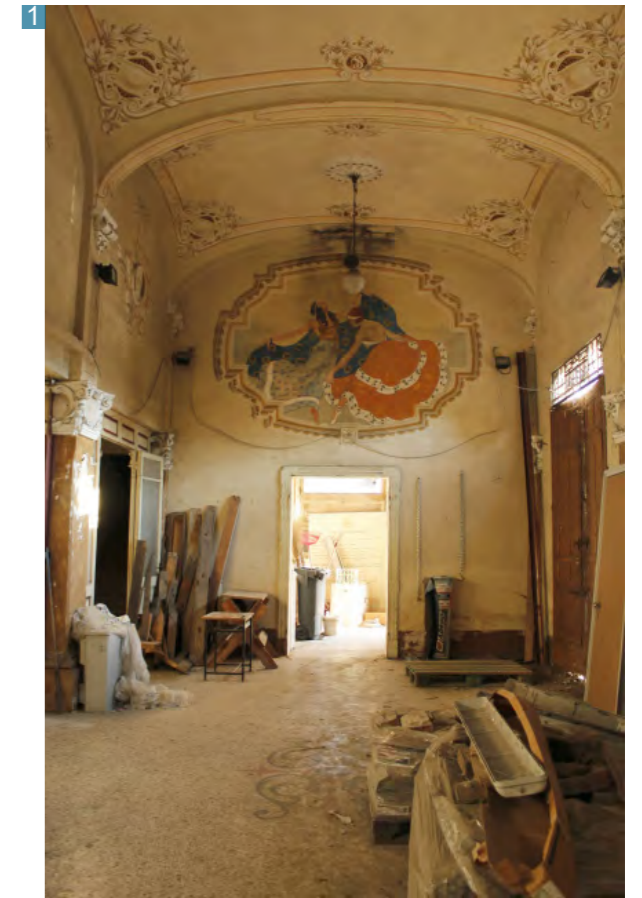
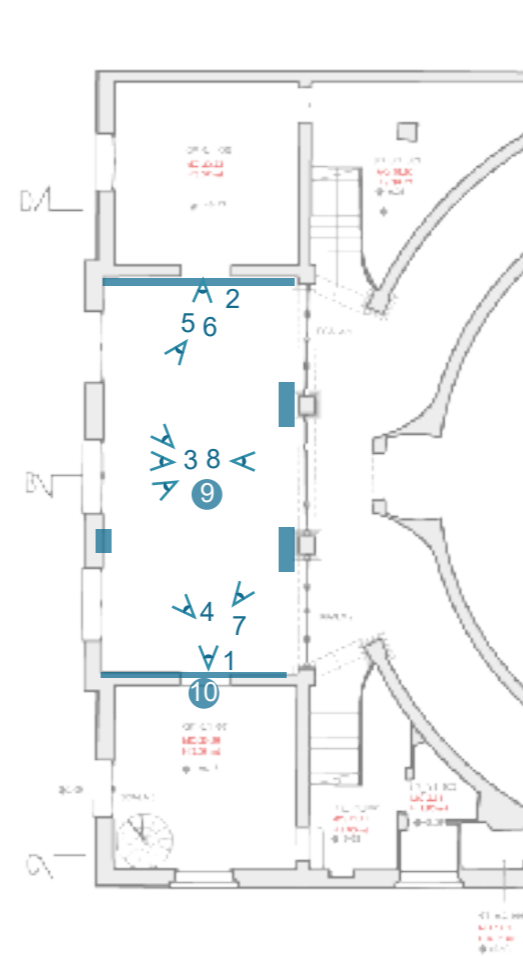
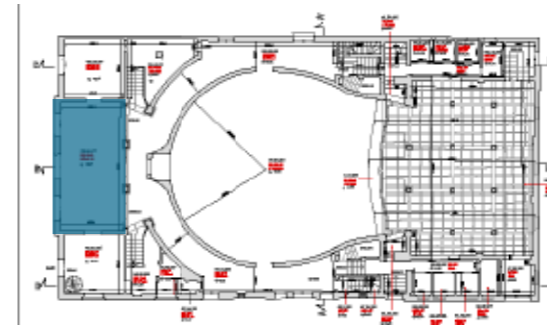
- UST
- 0.1 forepart
 - 0.2 cavea
 - 0.3 proscenium arc
 - 0.4 stage
 - 0.5 ulity space
 - 0.6 foundations
- section level
- LG sottoparco
 - GF piano terra_livello platea
 - 01 ordine primo
 - 02 ordine secondo
 - 03 loggione
 - M piano amezato



GF_0.1.001



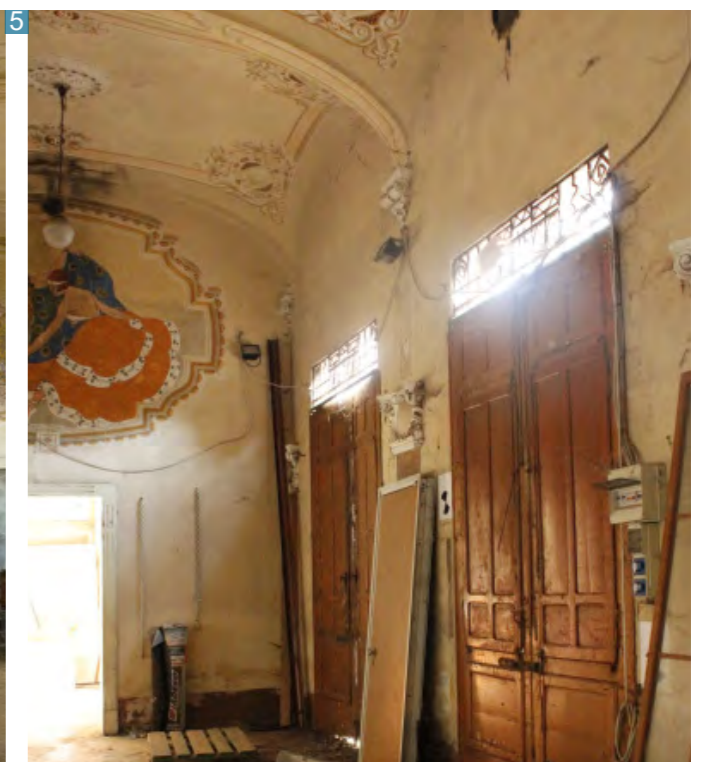
GF_0.1.002



GF_0.1.002 - painting decoration detail

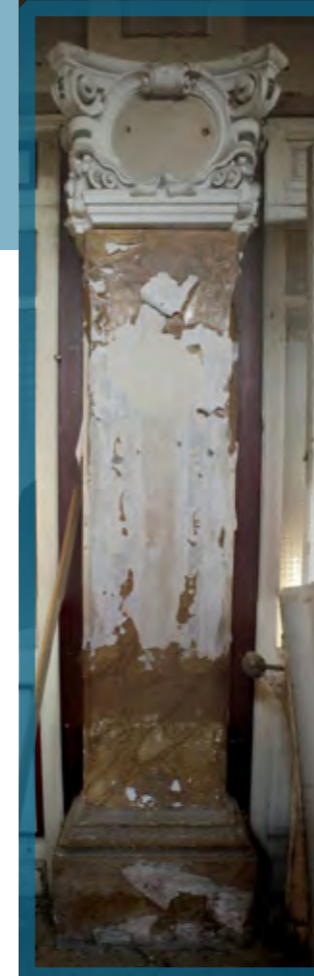


GF_0.1.002
detail architectural elements

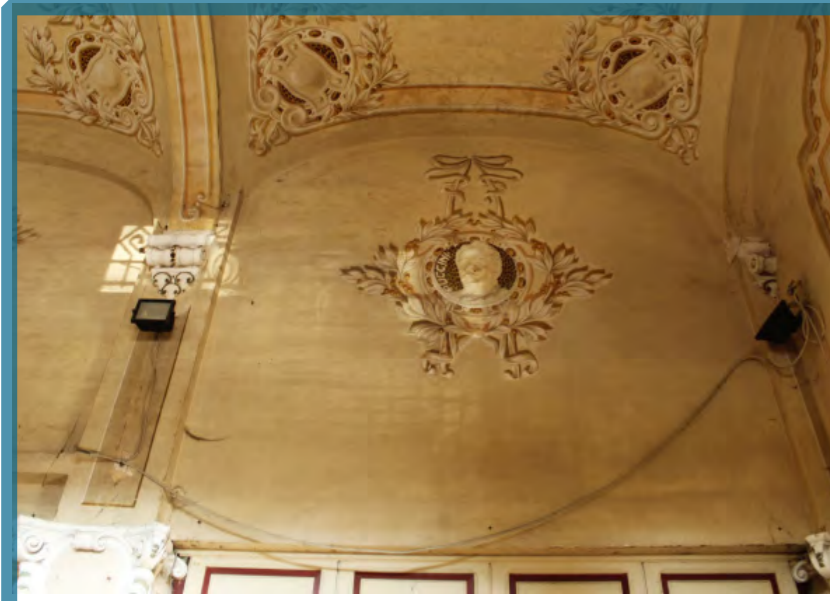




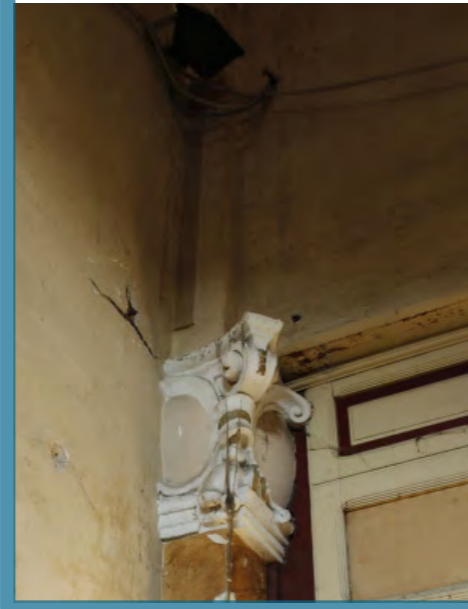
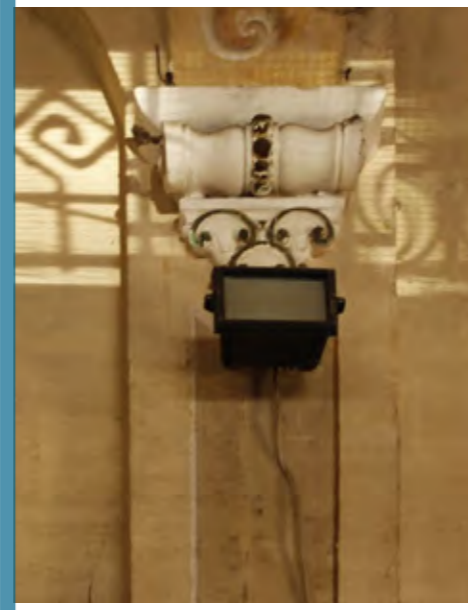
GF_0.1.002
detail detail
architectural
elements



GF_0.1.002 - detail painting decorations vault



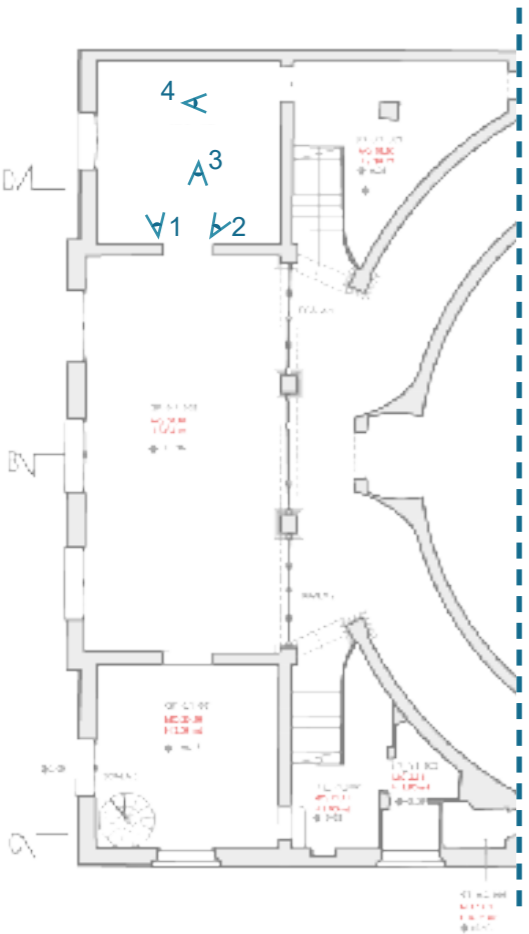
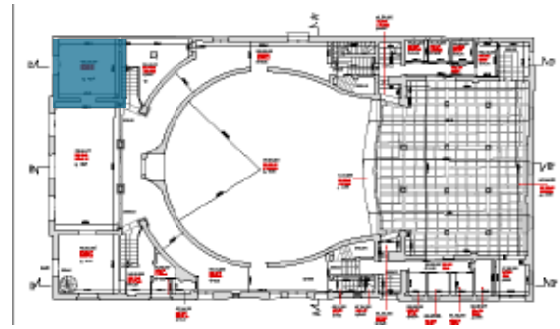
GF_0.1.002 - detail architectural elements



GF_0.1.002 - flooring detail

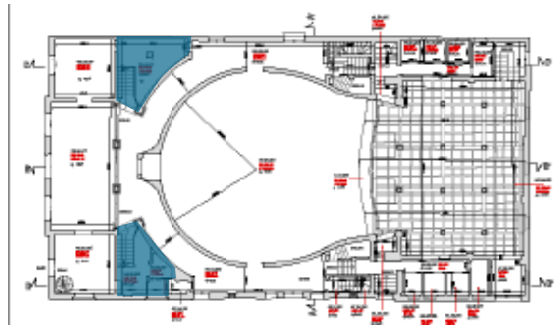


GF_0.1.003

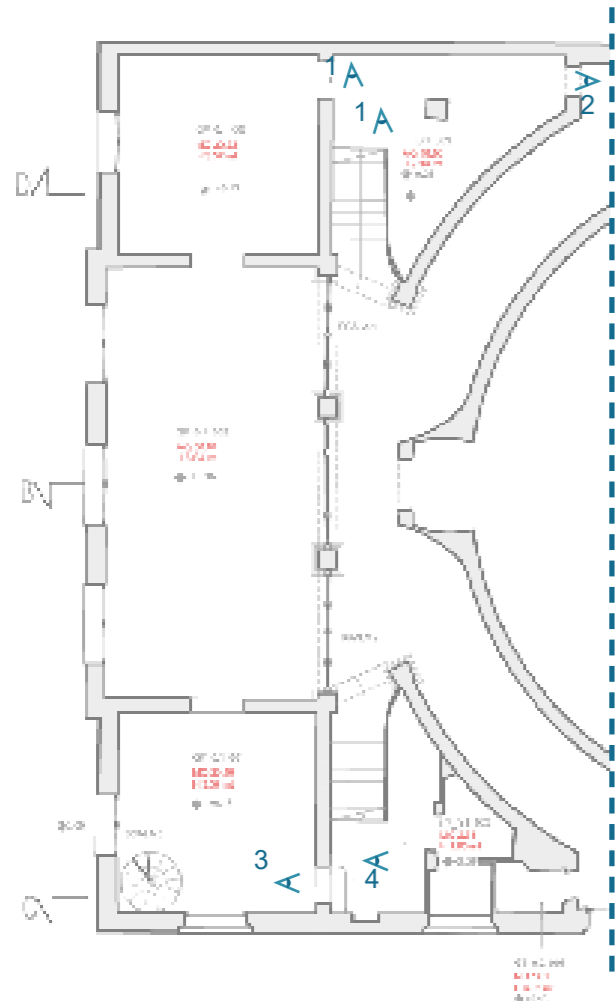
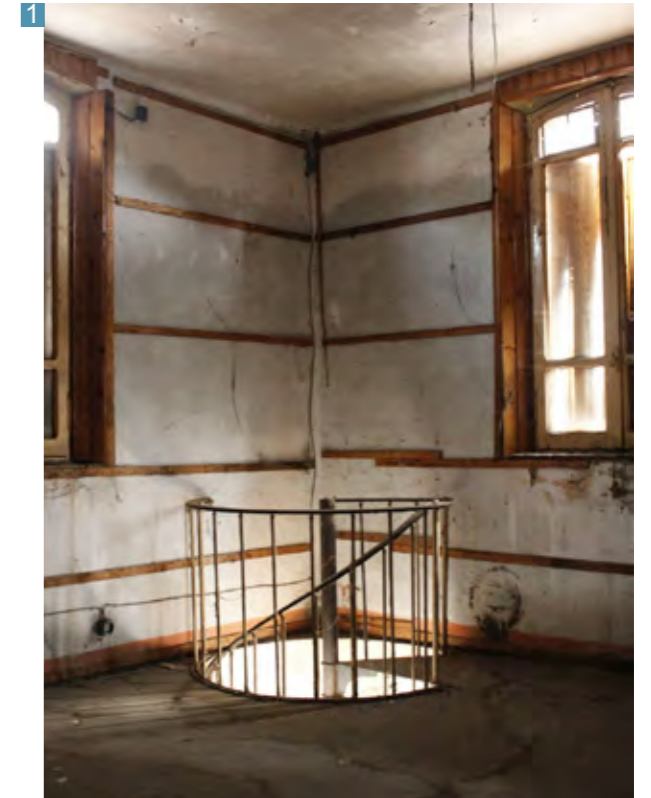
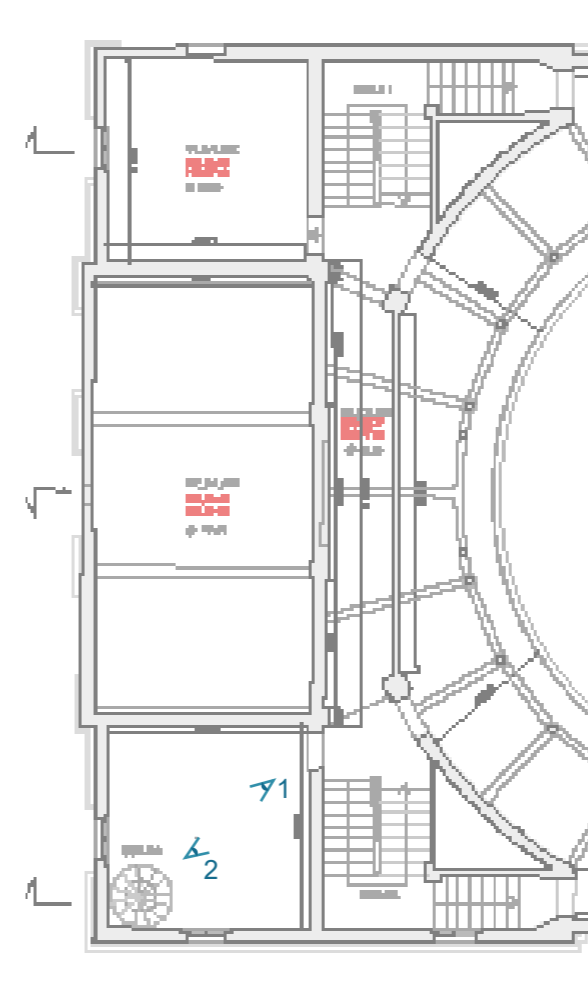
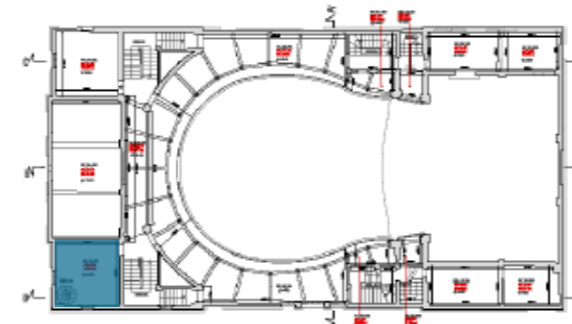


LG_0.1.001_002

01_0.1.001



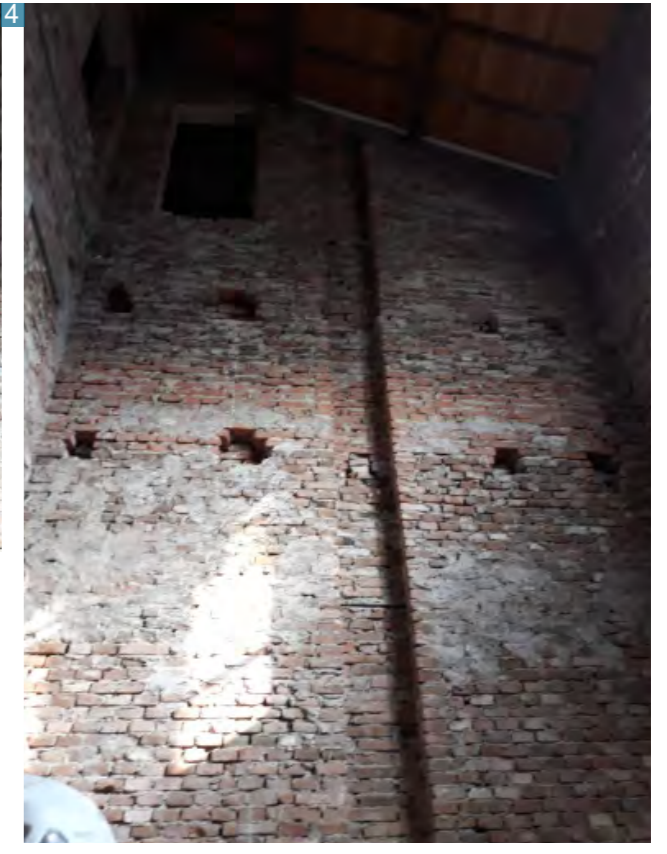
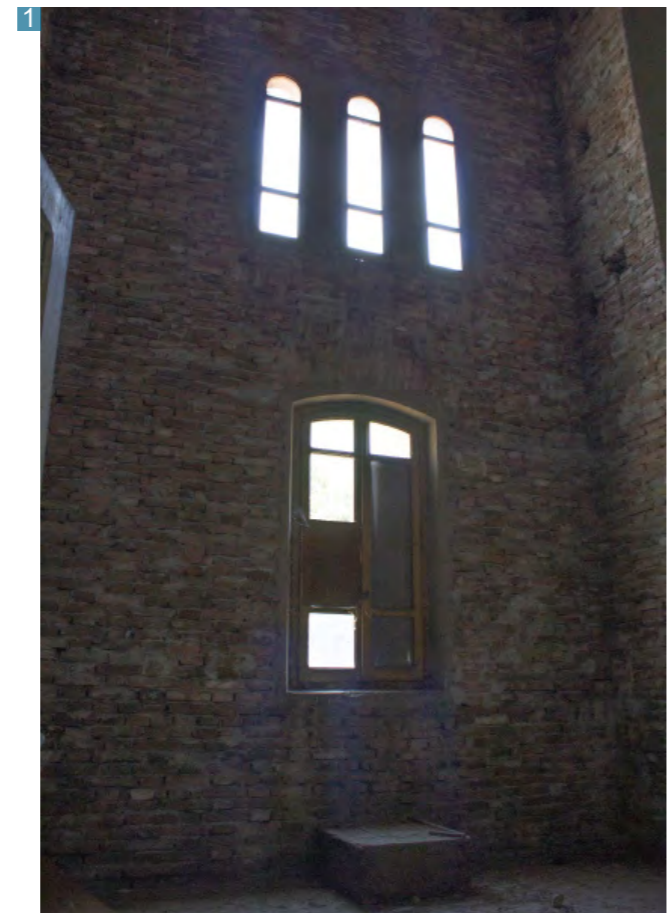
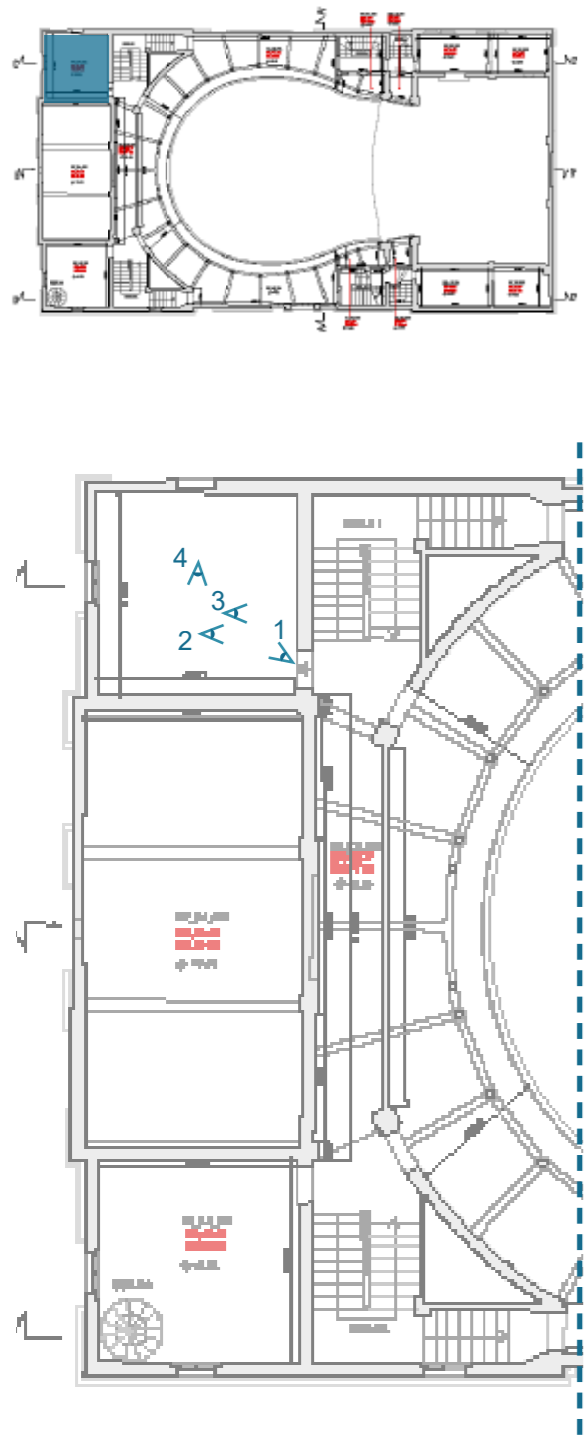
LG_0.1.001



LG_0.1.002



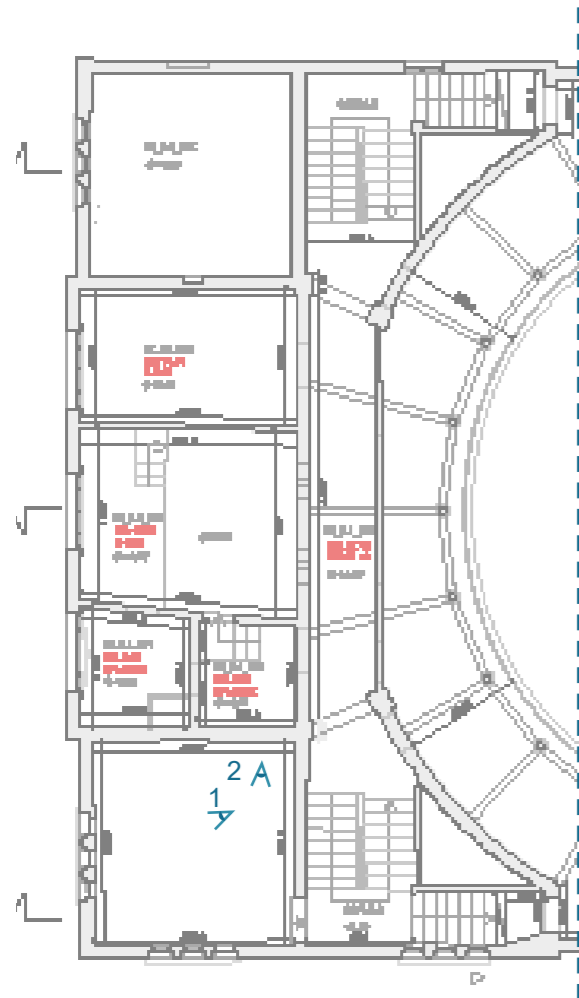
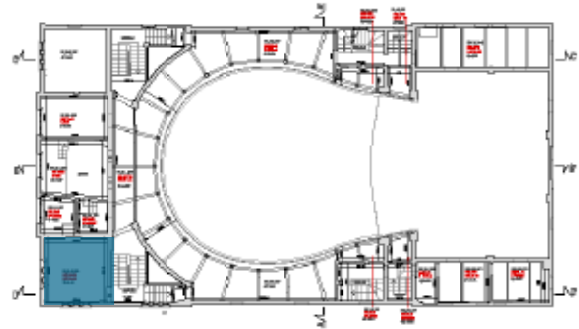
01_0.1.002



01_0.1.002 - ceiling detail

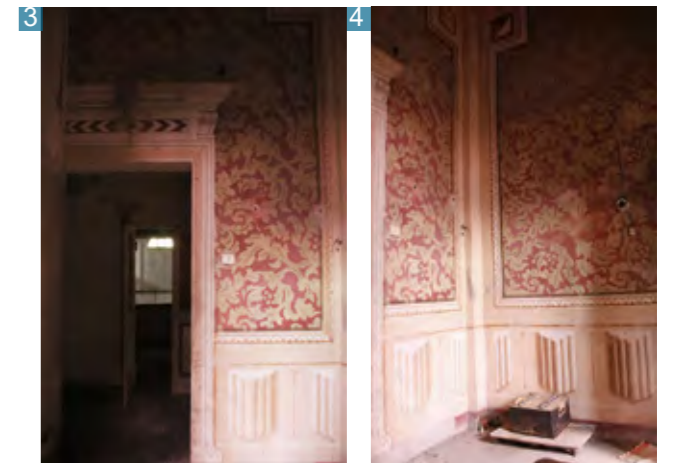
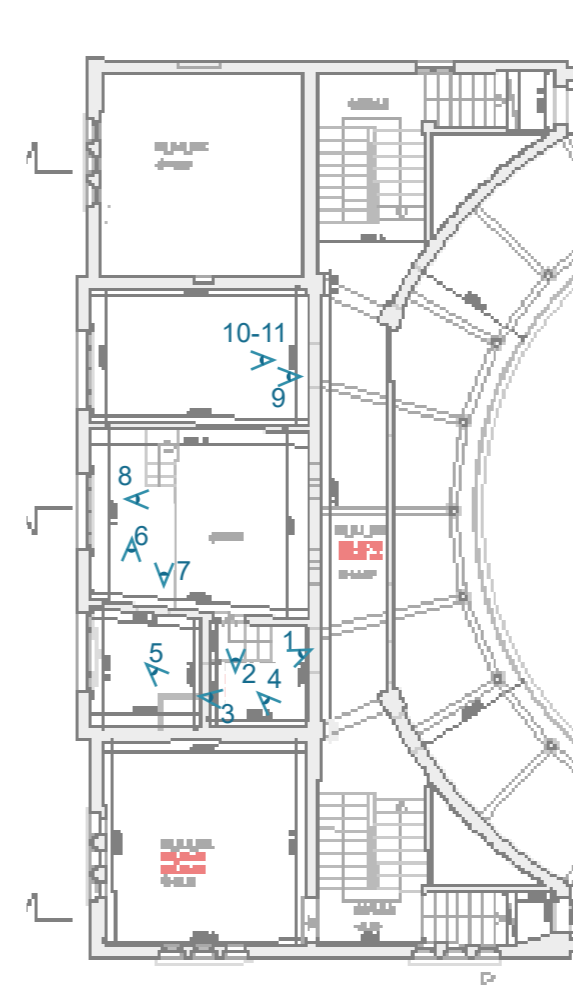
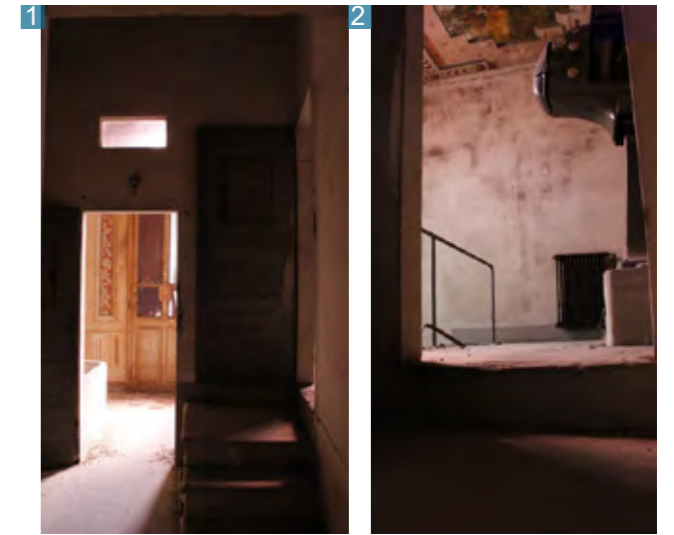
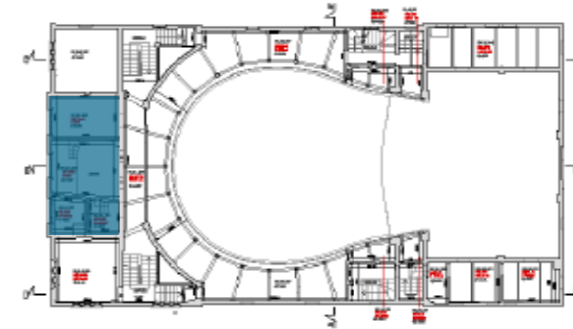


02_0.1.002



02_0.1.003-04-05-06

02_0.1.003



02_0.1.003 - decoration detail ceiling painting



02_0.1.004_005



02_0.1.005 - decoration detail ceiling painting



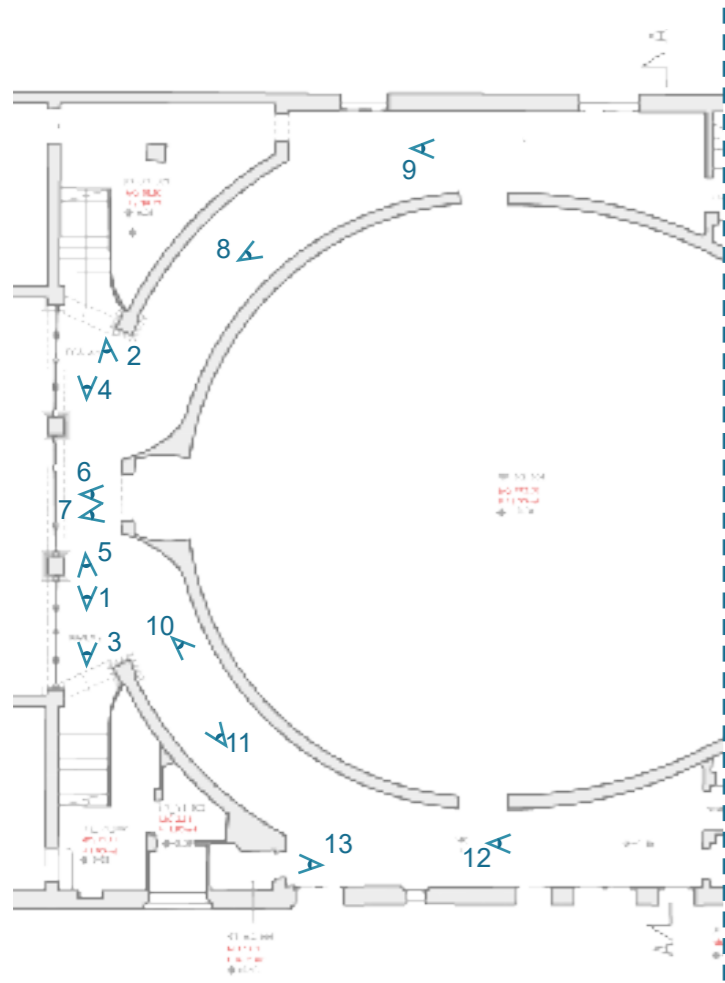
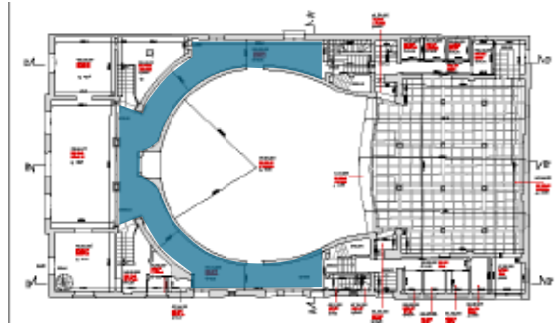
02_0.1.006



02_0.1.006 - decoration detail ceiling painting



GF_0.2.005

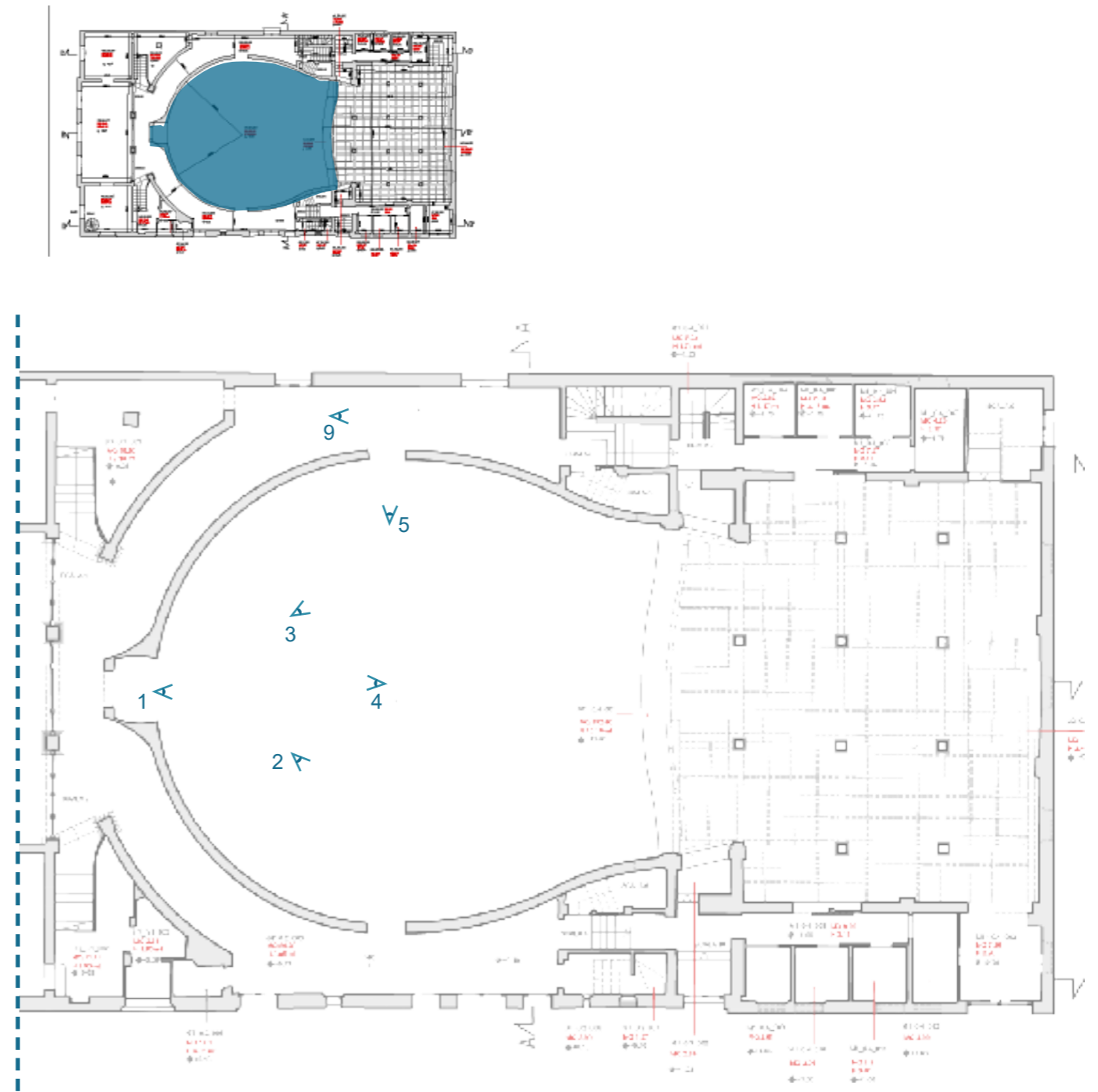




GF_0.2.006



GF_0.2.004

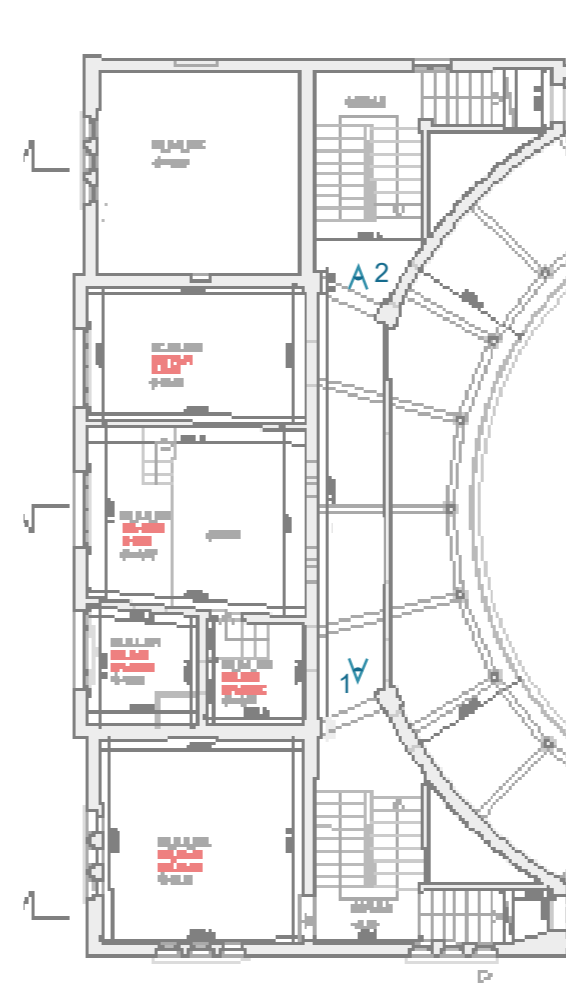
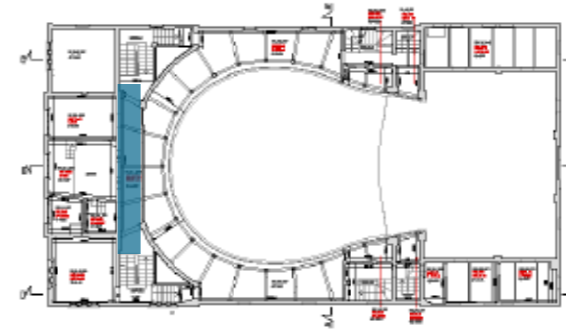




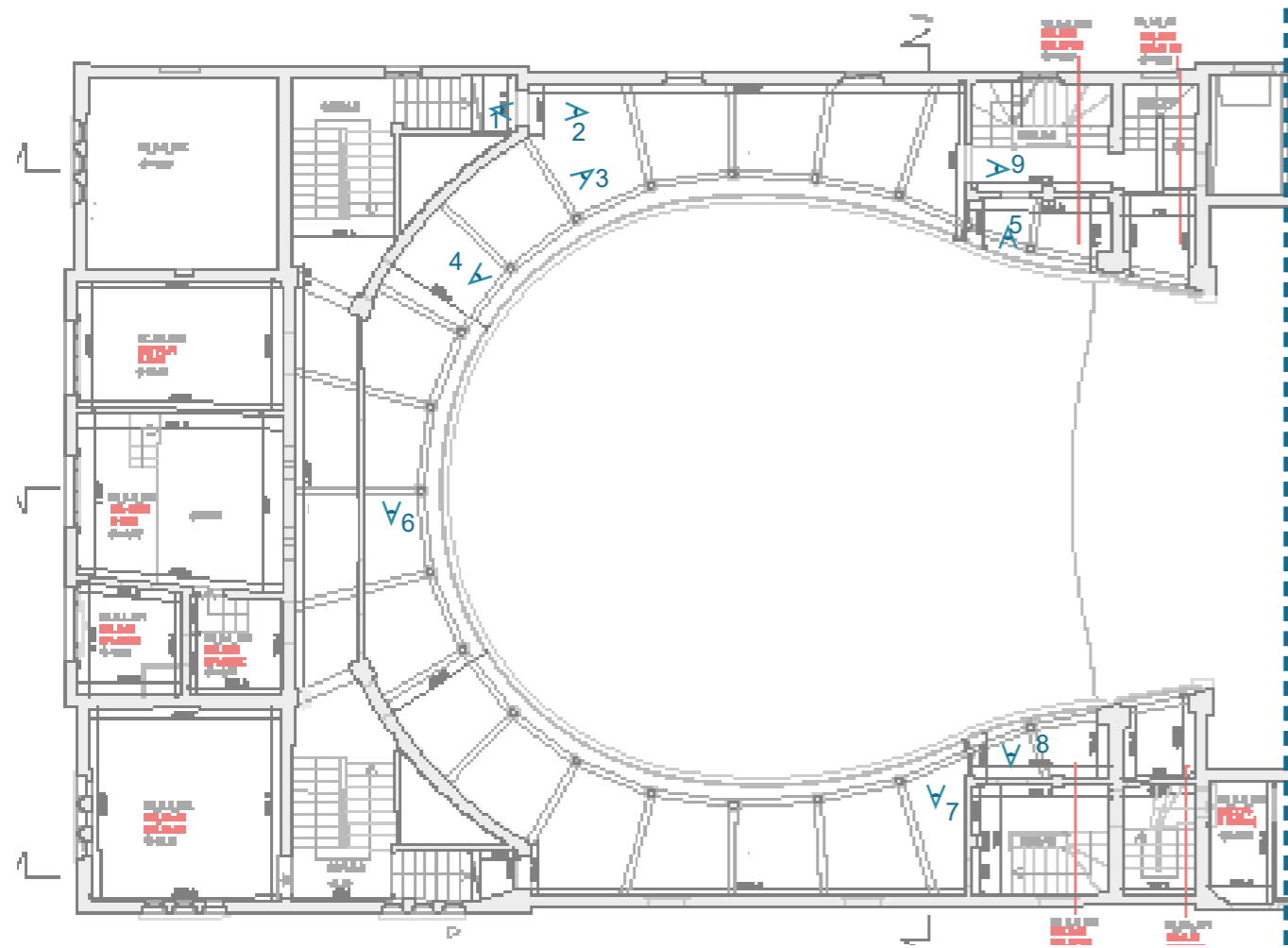
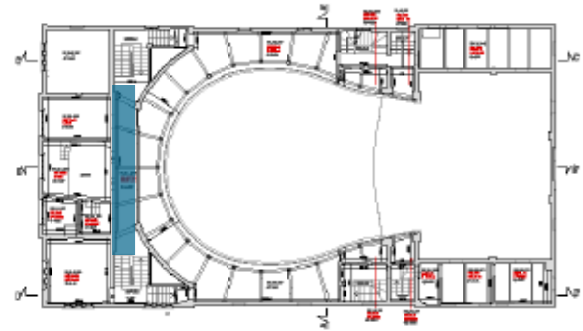
GF_0.2.004 - detail of the decorative features in the stalls



01_0.2.001

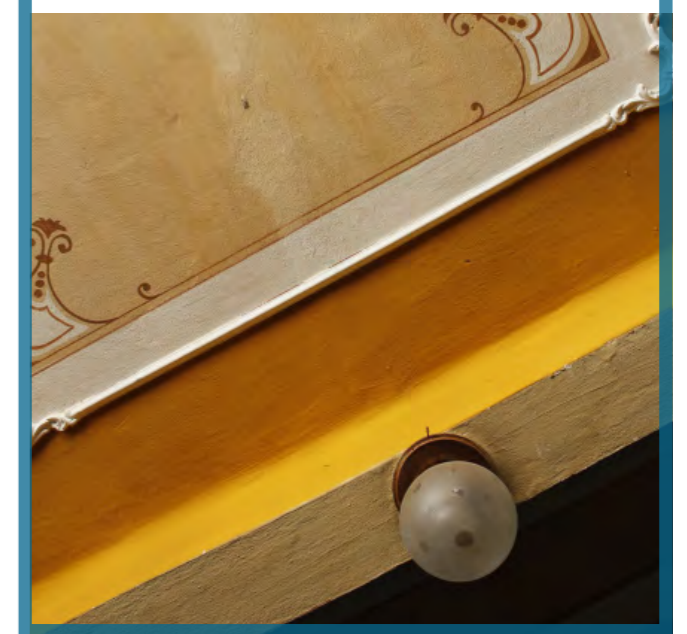


01_0.2.004

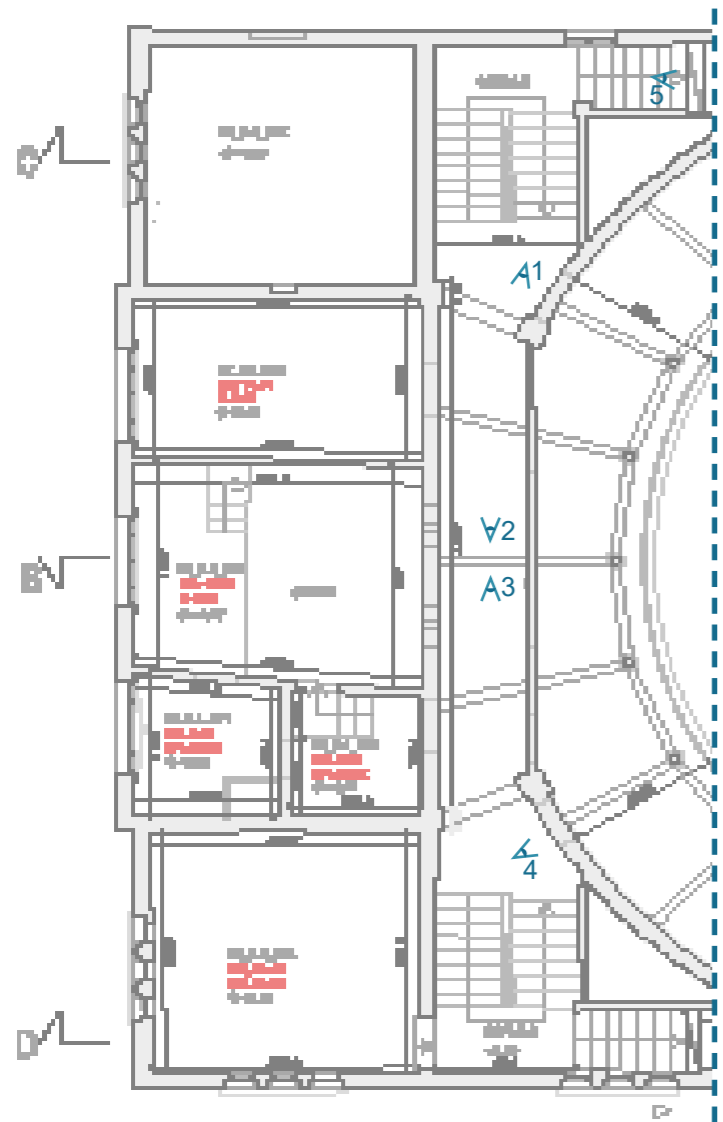
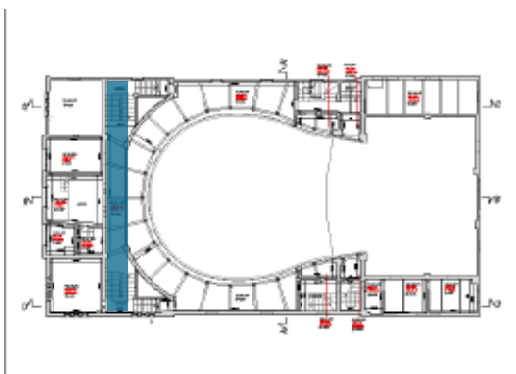




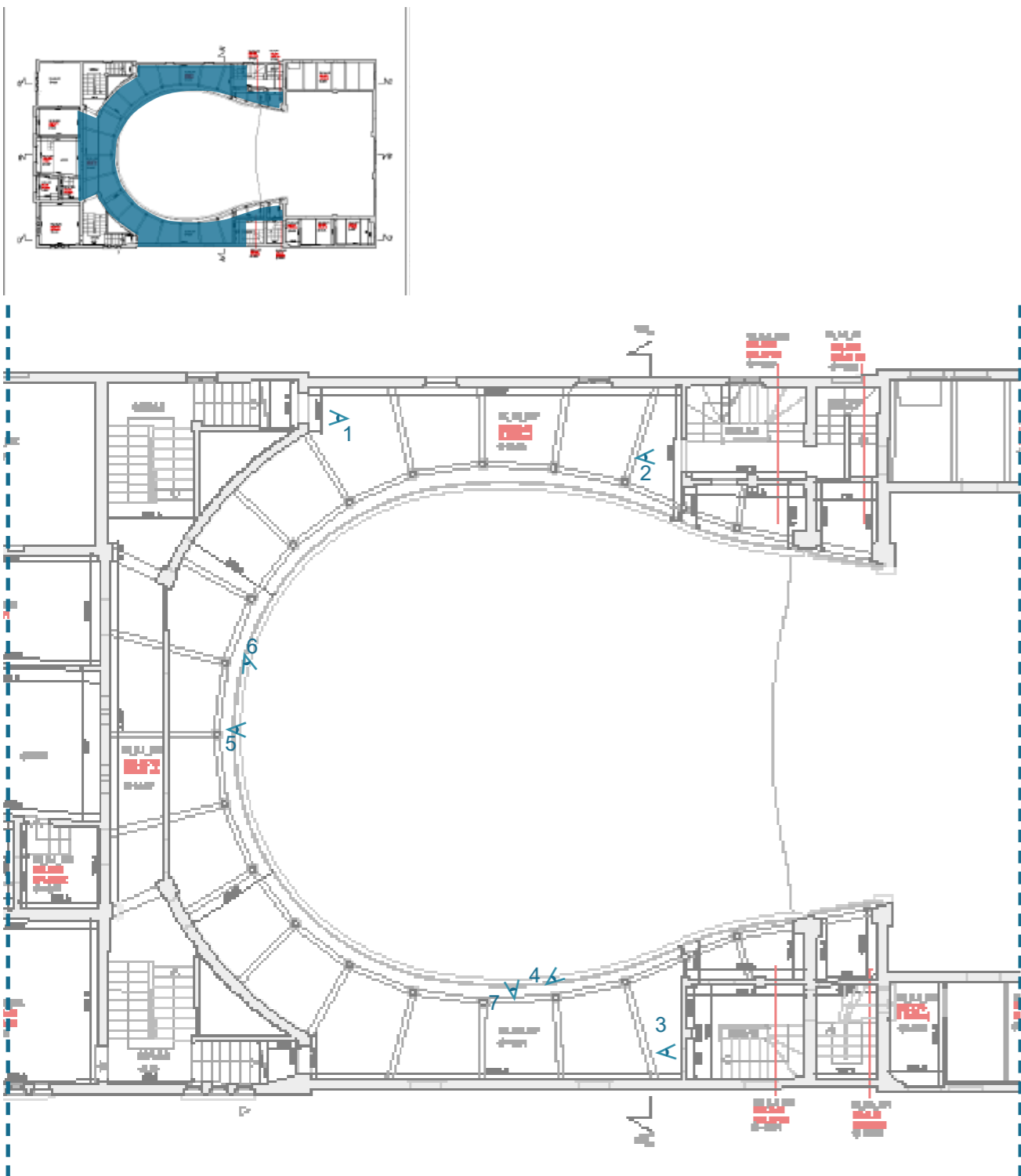
01_0.2.004 - detail of the decorative features in galleries



02_0.2.001

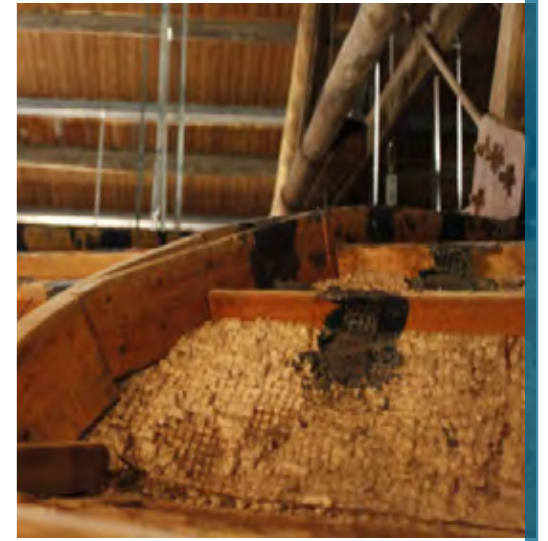
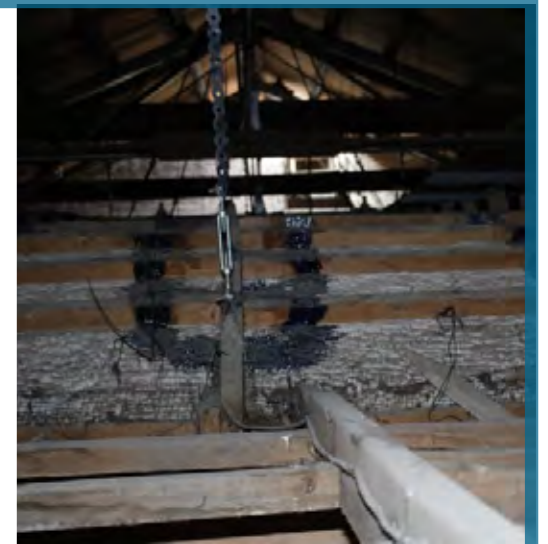


02_0.2.001

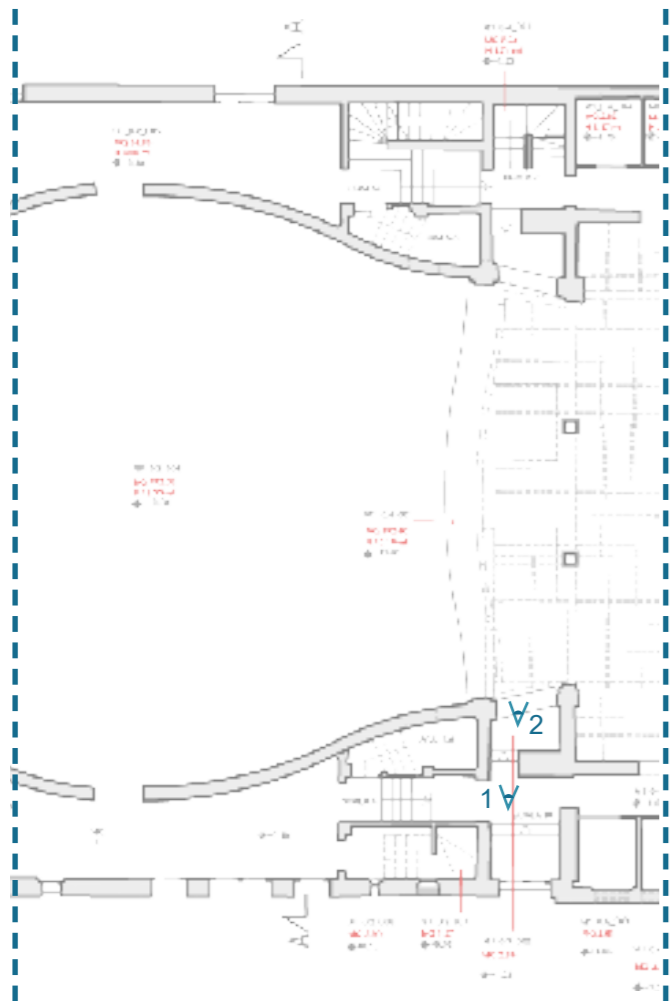
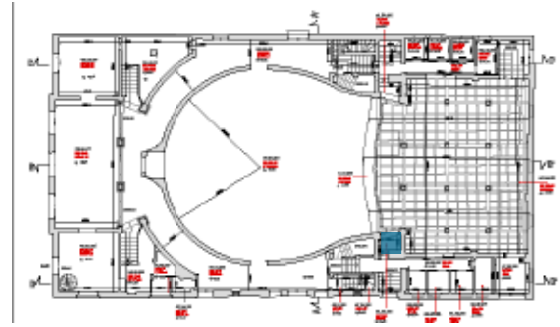




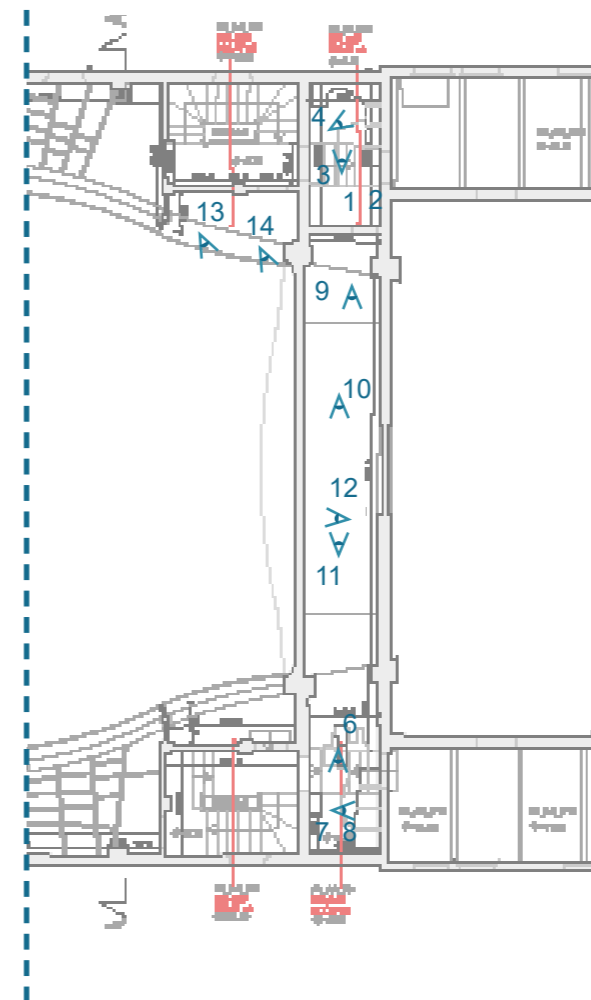
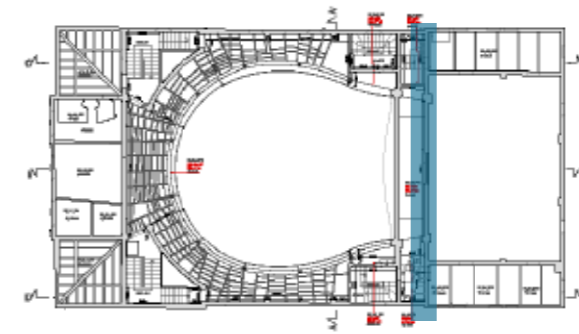
03_0.2.001 - Plafond structure detail



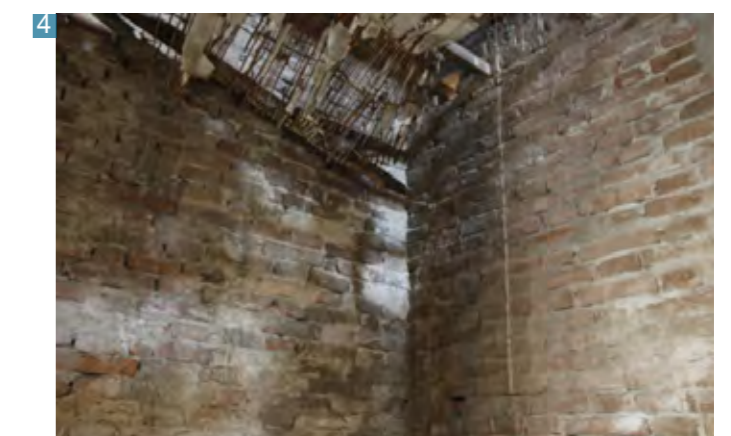
M1_0.3.002



03_0.3.004-05-06



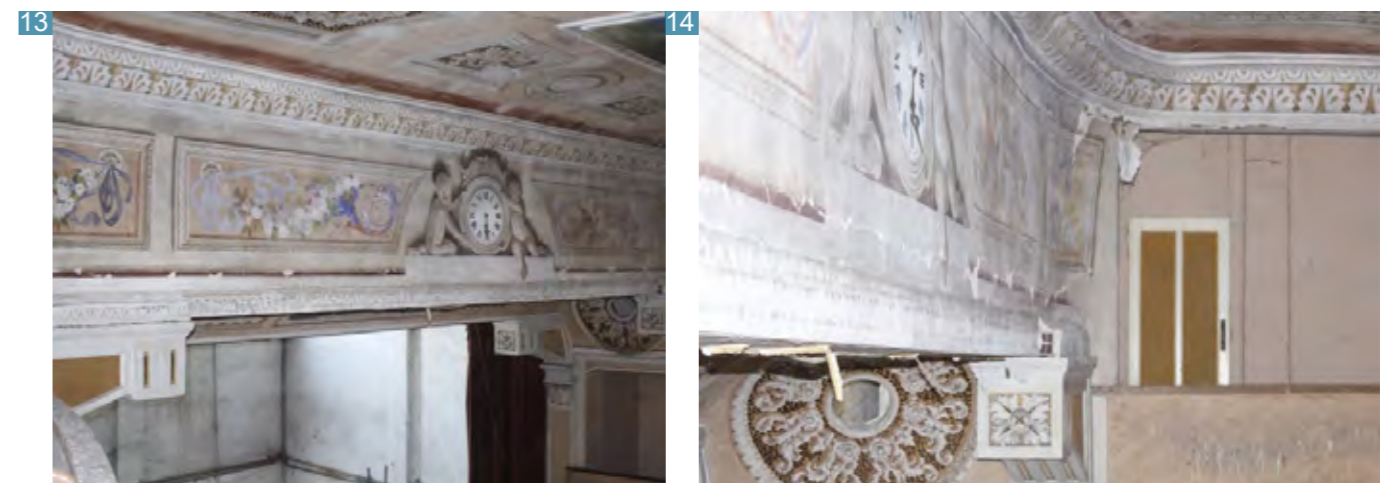
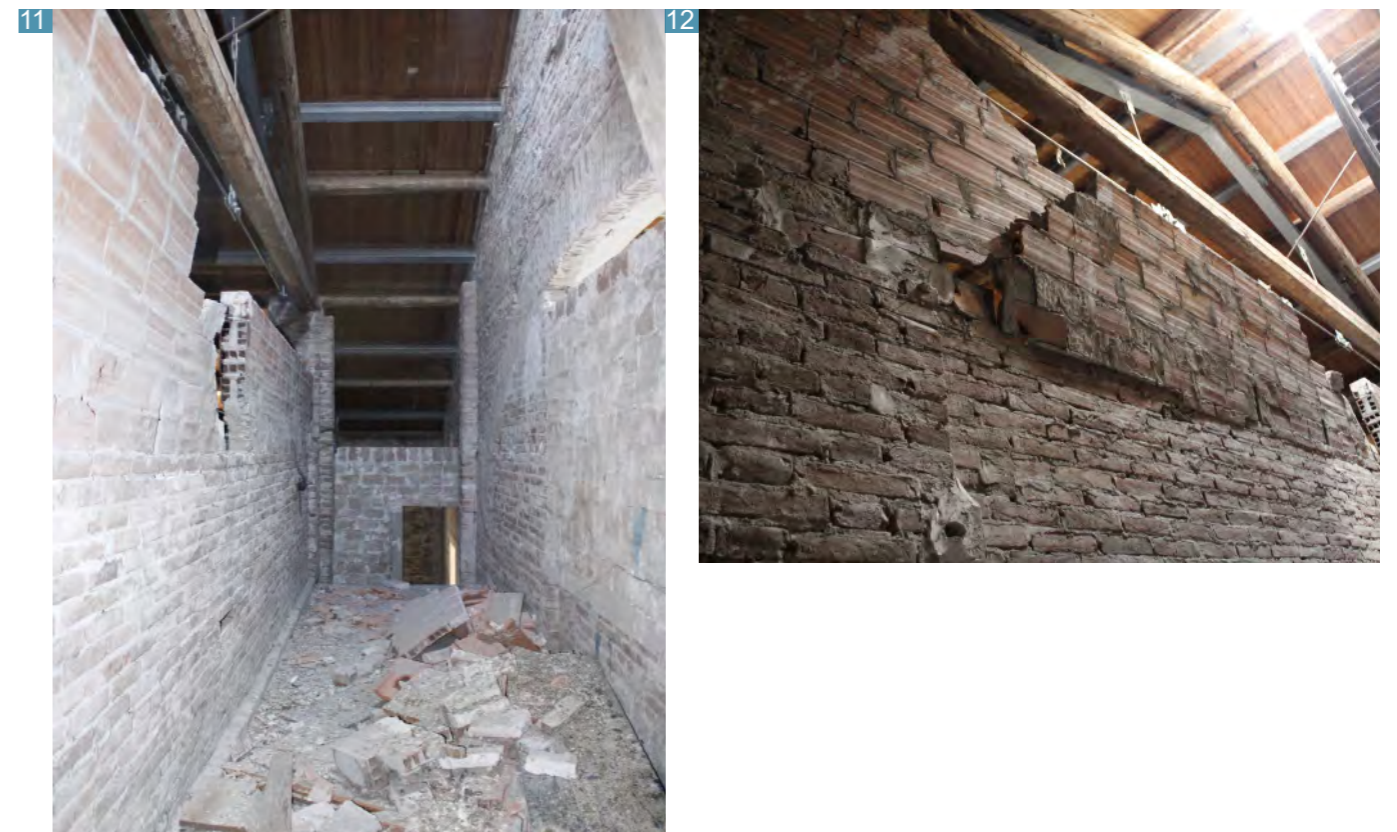
03_0.3.004



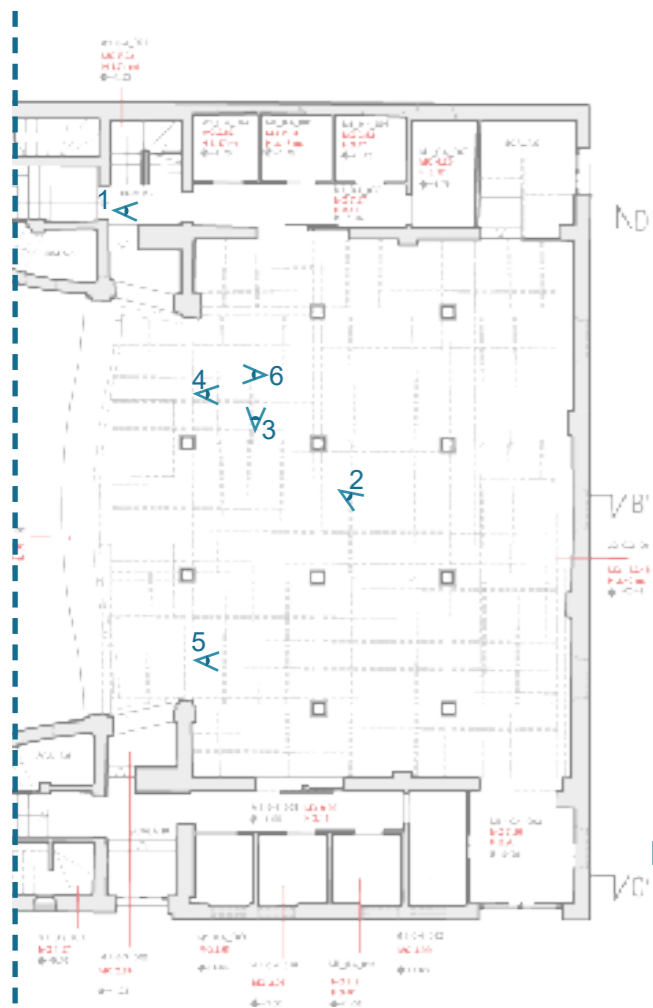
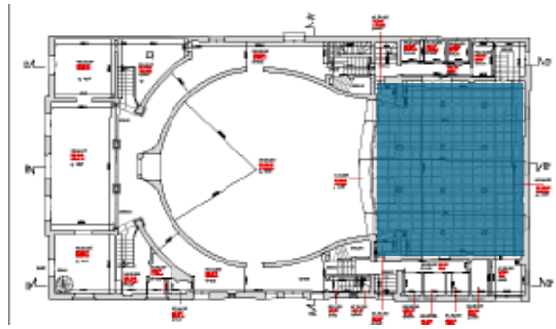
03_0.3.005



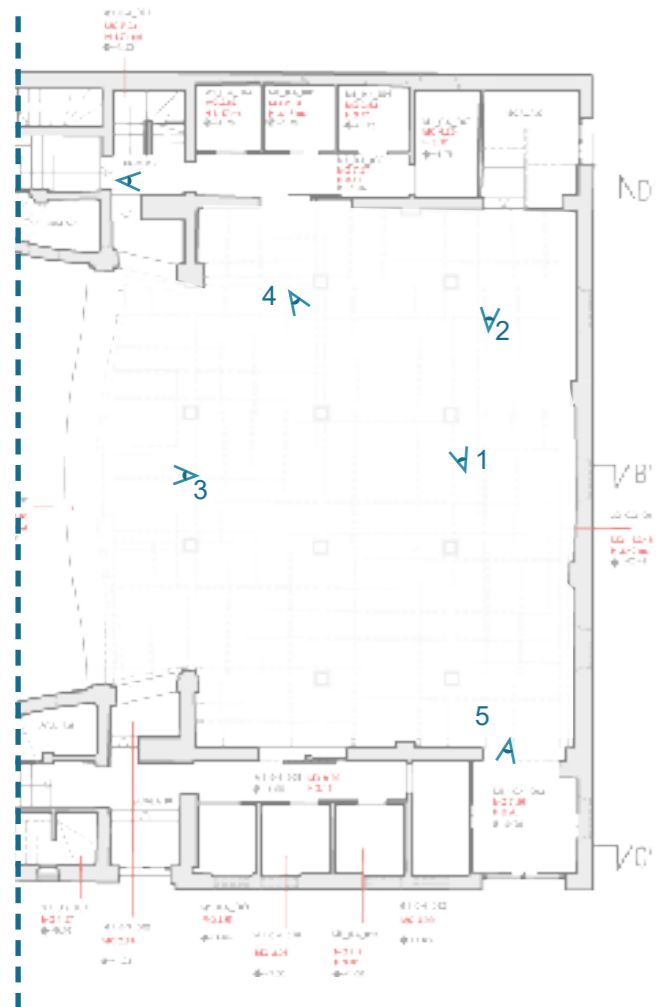
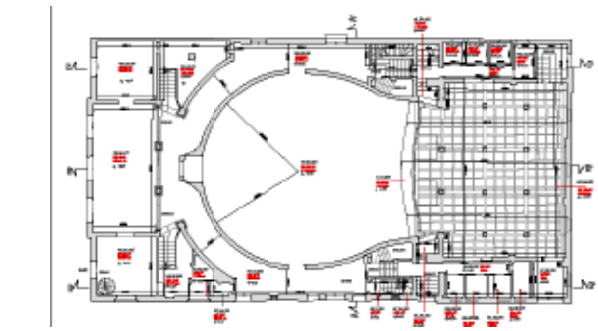
03_0.3.006



LG_0.4.001



M1_0.4.004



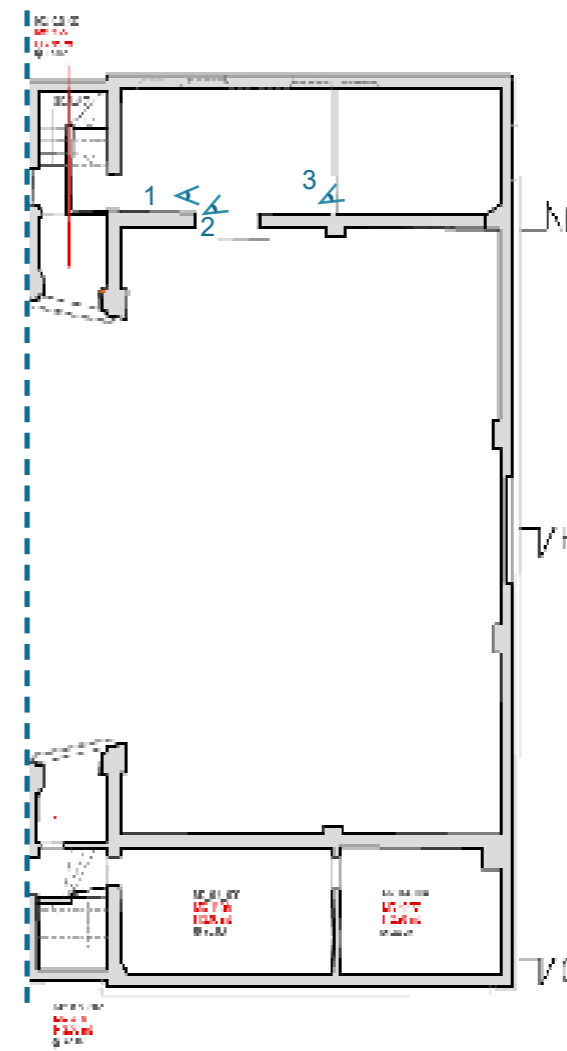
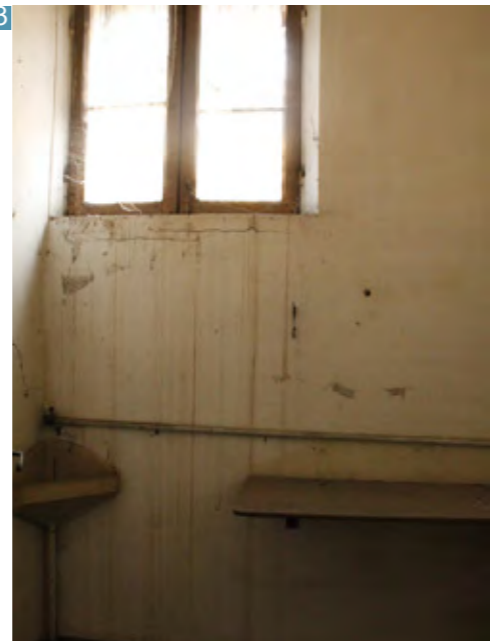
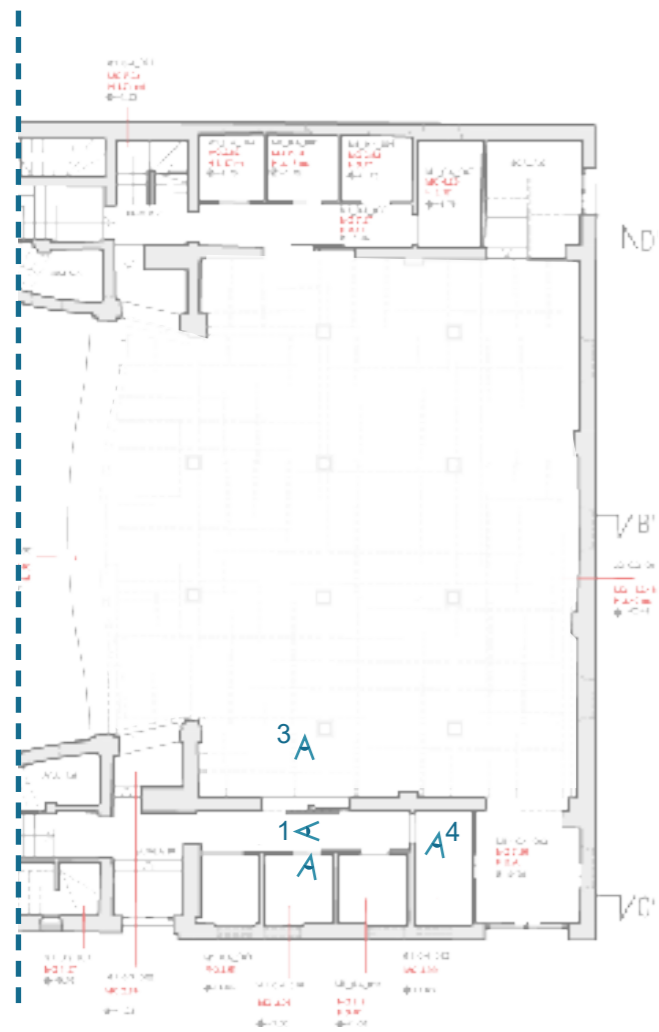
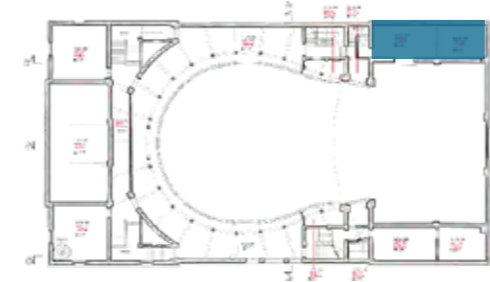
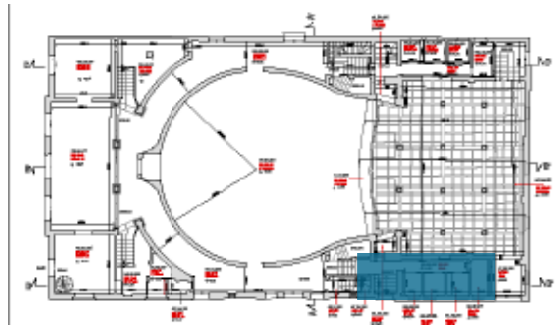
M1*_0.4.002 -



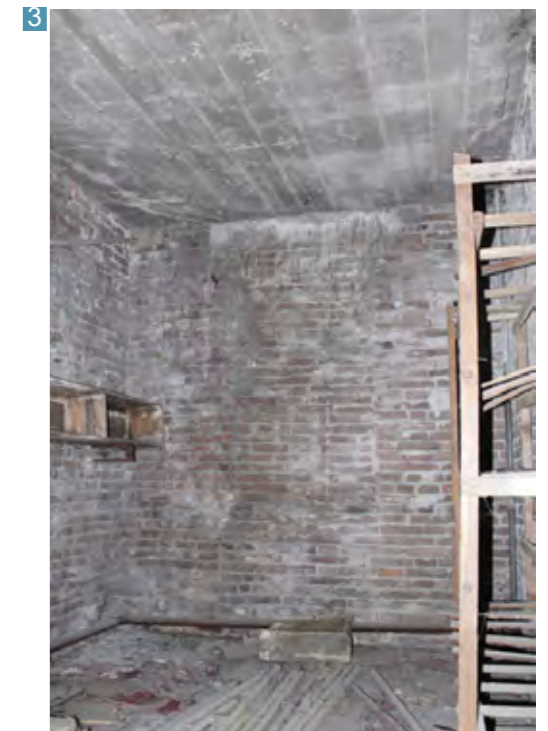
M1_0.5.001

M2_0.5.001-002

M2_0.5.001

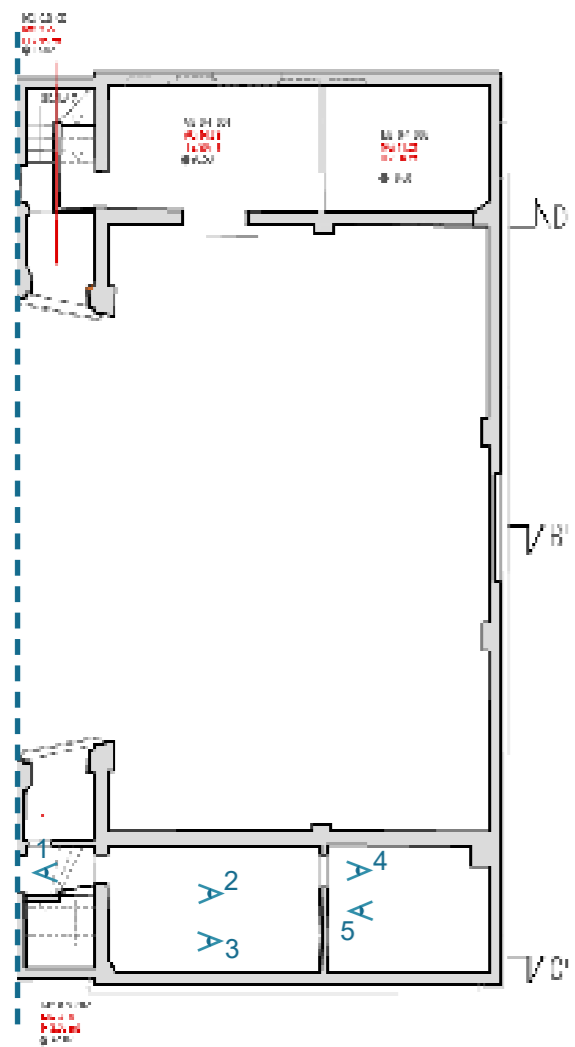
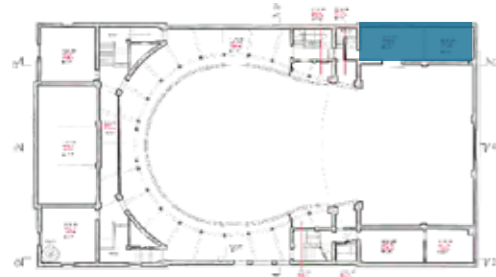


M2_0.5.002



M2_0.5.003-004

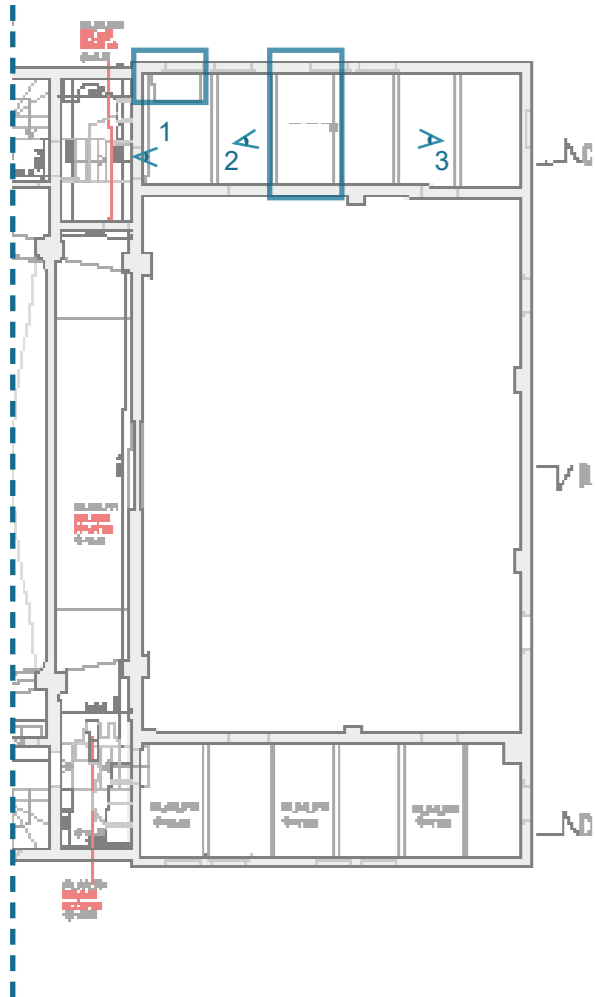
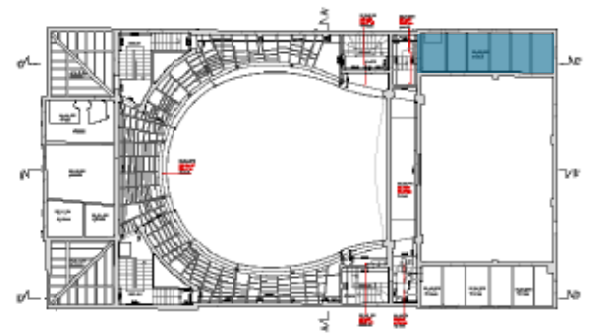
M2_0.5.003



M2_0.5.004



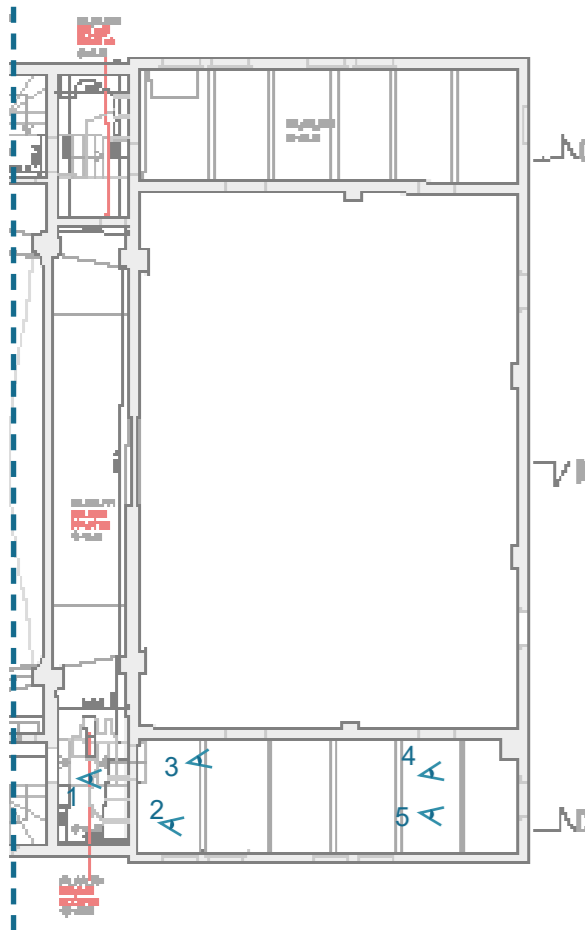
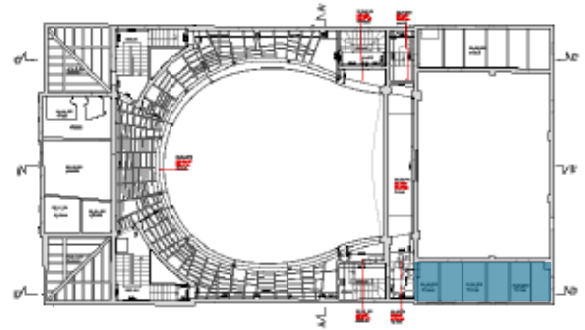
03_0.5.012



03_0.3.012 - ceiling detail



03_0.5.013-14-15



- STAIRS

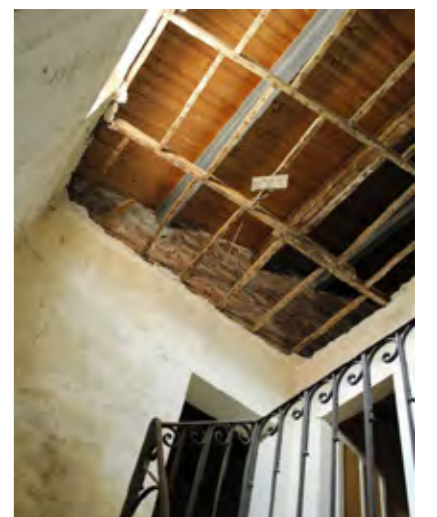
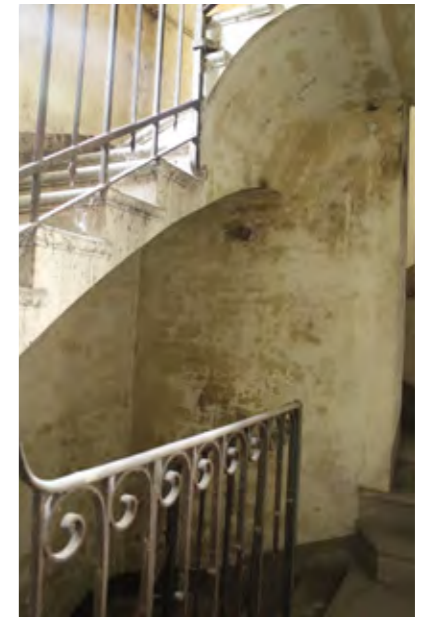
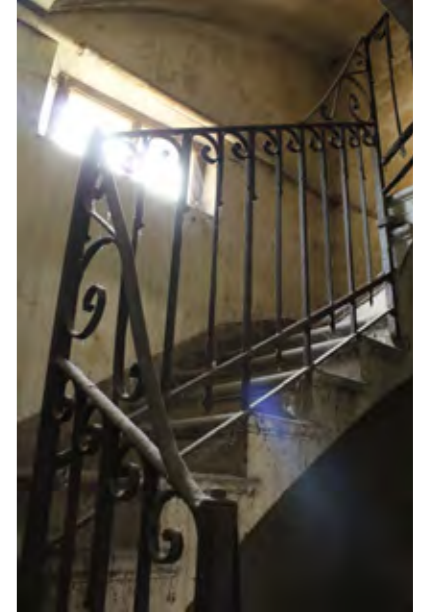
STAIRS 0



STAIRS 1



STAIRS 3



STAIRS 8



FACADES

east facade- via martiri della liberta



east facade- via martiri della liberta



east facade- via martiri della liberta



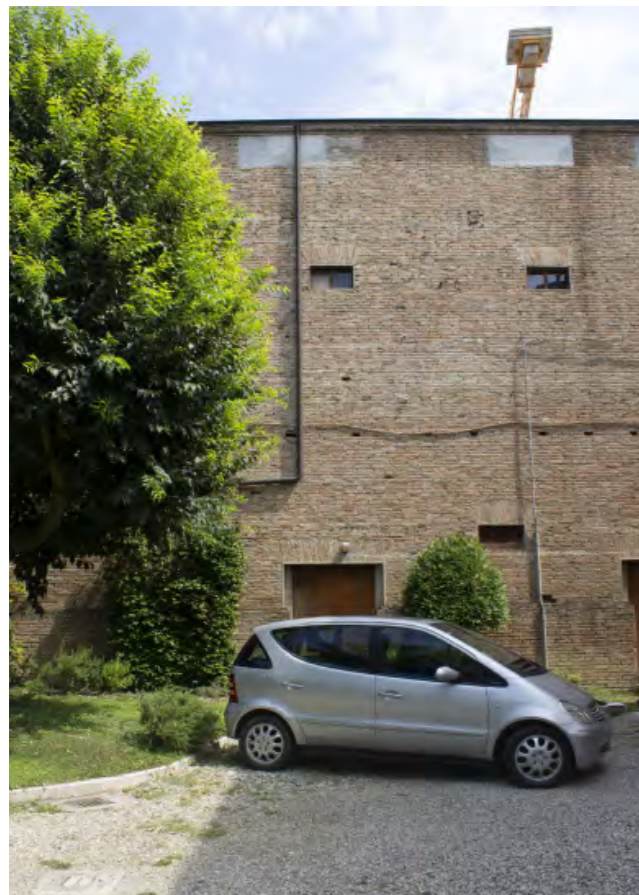
north facade



north facade



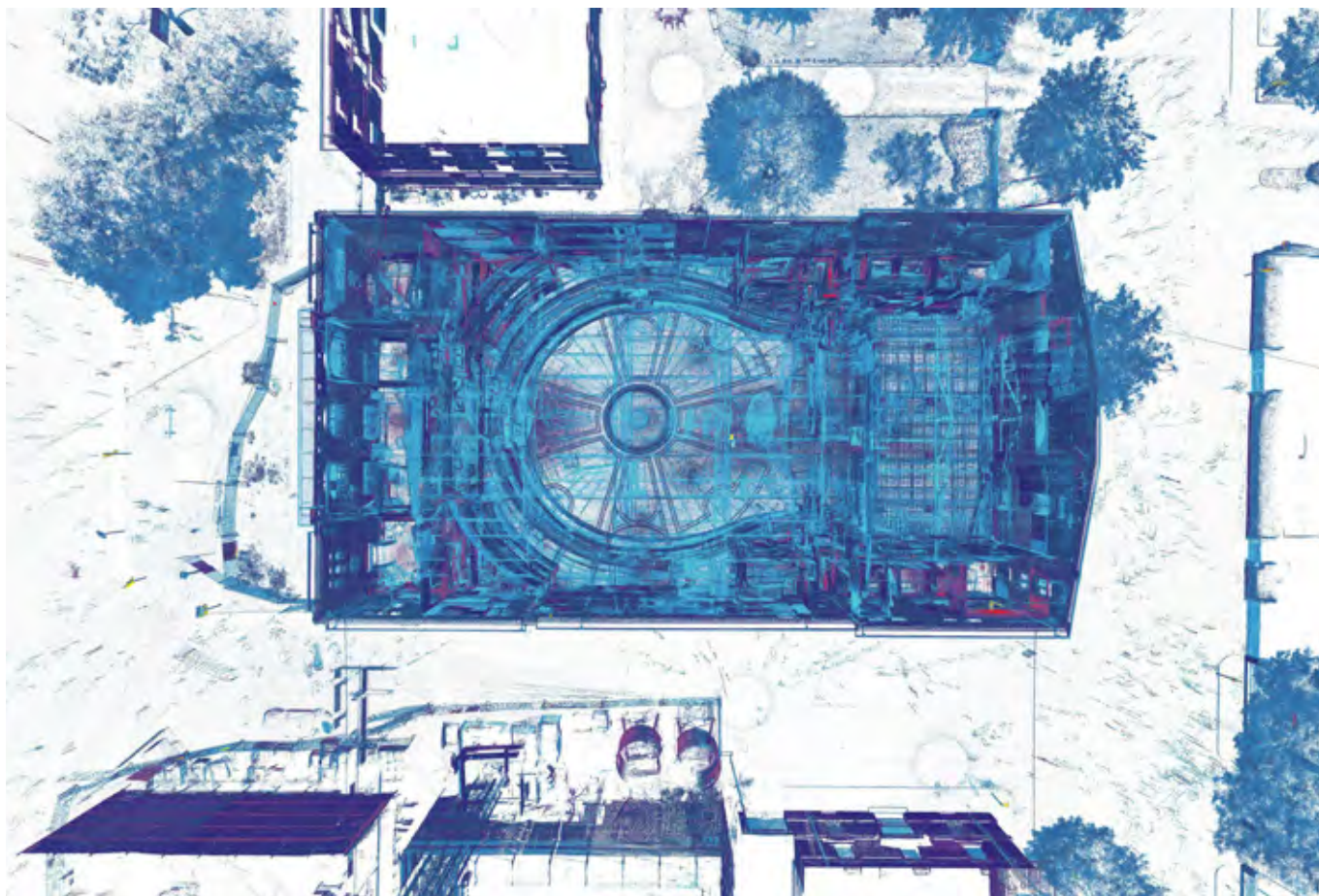
south facade



west facade



Optimisation of survey procedures and application of integrated digital tools for seismic risk mitigation of cultural heritage: The Emilia-Romagna damaged theatres.



APPEDIX B: DAMAGE SURVEY

PhD Candidate: Suppa Martina

PhD Programme: International Doctorate in Architecture and Urban Planning (IDAUP)
Cycle: XXXIV

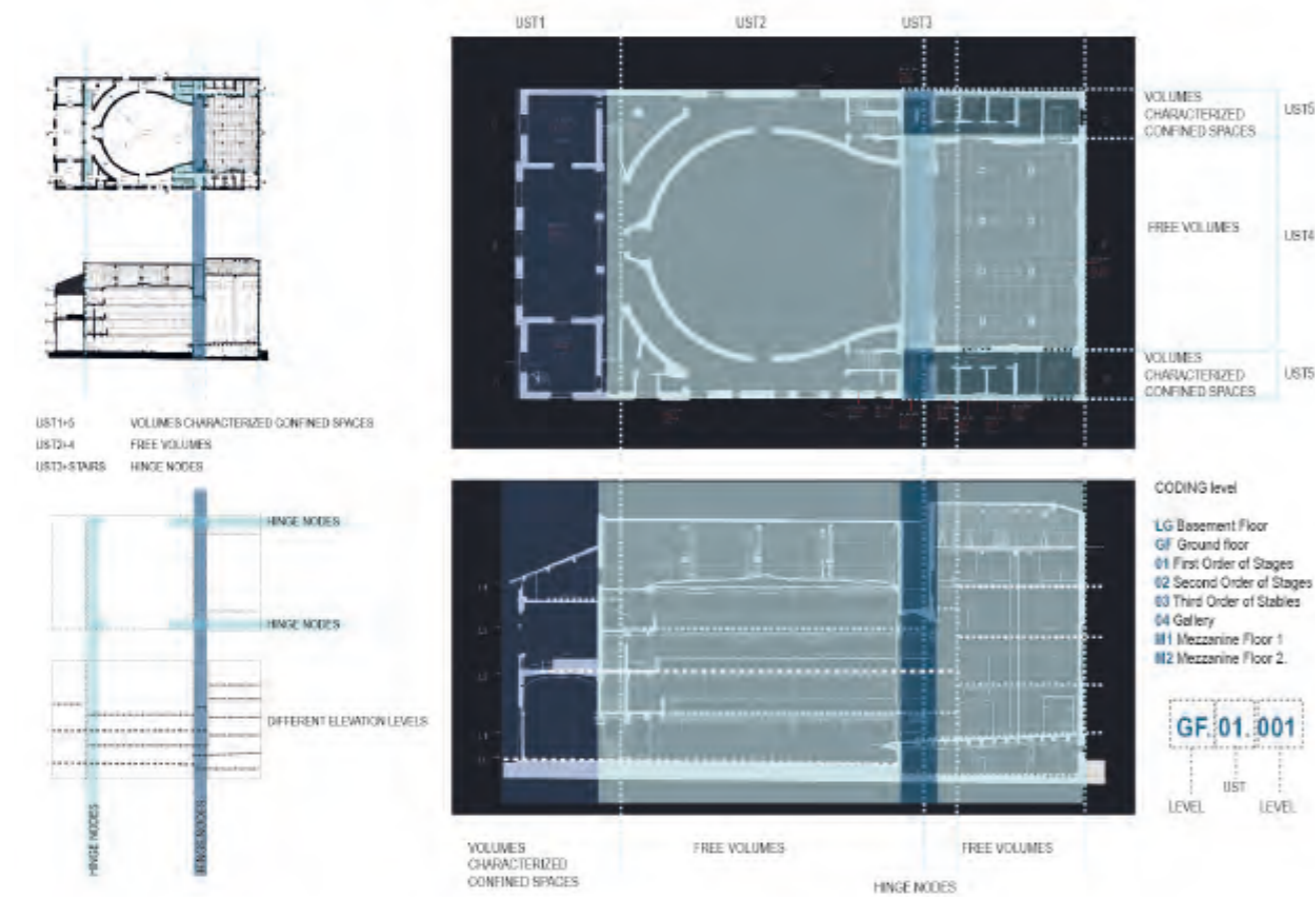
ICAR 17

Supervisor (DA/POLIS): Prof. Balzani Marcello

Co-Supervisor (DA/POLIS): Prof. Arben Shtylla

External Expert: Prof. Maietti Federica; Dott.ssa Raco Fabiana

SYNOPTIC DIAGRAM



- | | | |
|--------------------|--------------------------------|---------------------|
| UST | section level | enviromental coding |
| 0.1 forepart | LG sottopalco | GF.01.001 |
| 0.2 cavea | GF piano terra_ livello platea | level |
| 0.3 proscenium arc | 01 ordine primo | room |
| 0.4 stage | 02 ordine secondo | UST |
| 0.5 ulity space | 03 loggione | |
| 0.6 foundations | M piano amezato | |

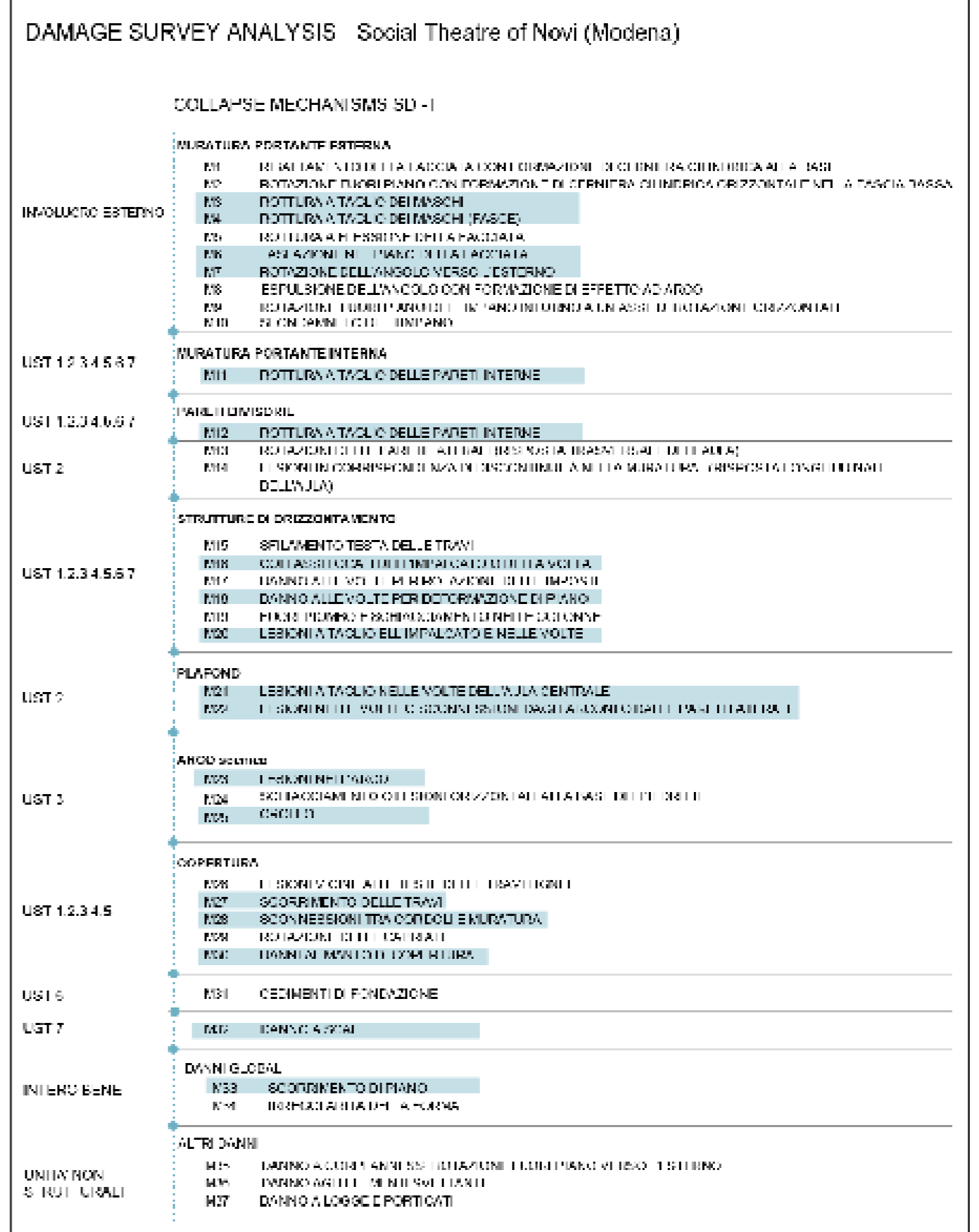
B_DP FORM (MIC BUILDING MODEL)

identification of the collapse mechanisms concerning the macro elements of the structure

B PD form - Social Theatre of Novi (Modena)

B23 field

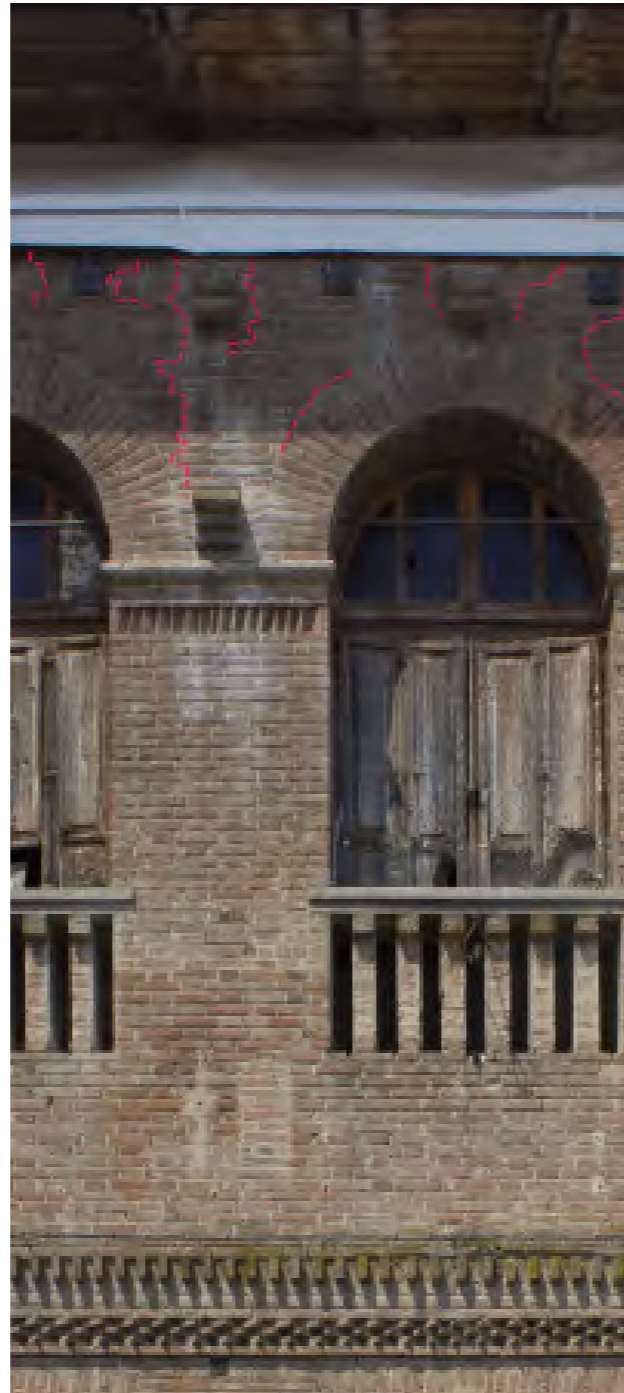
COLLAPSE MECHANISMS B-DP



M3



east elevation



east elevation

M3



south elevation



south elevation



south elevation



west elevation



north elevation

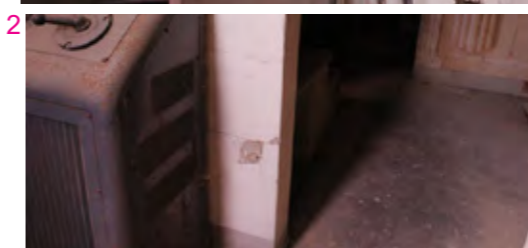
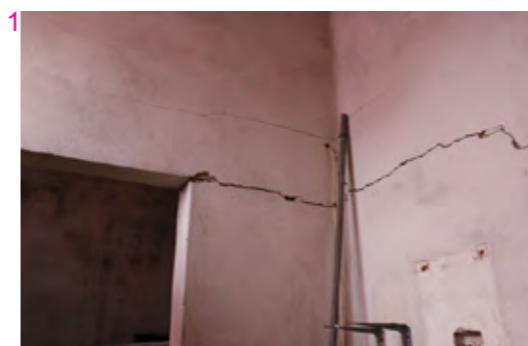
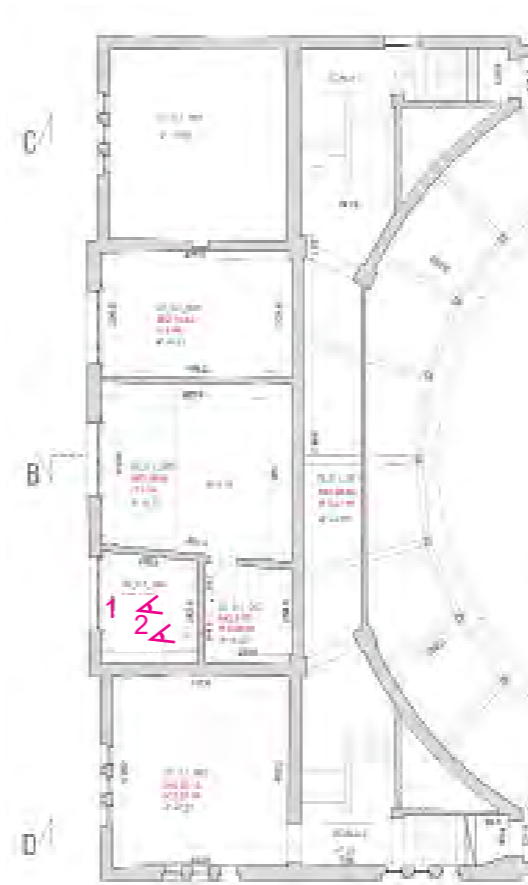
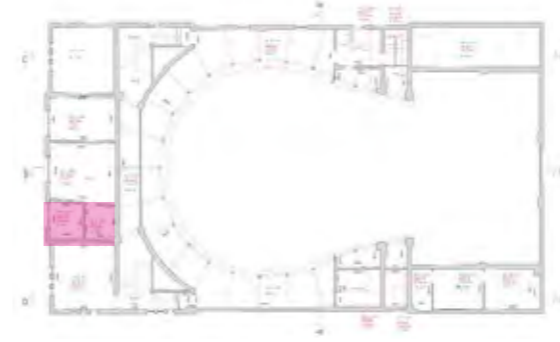
M3-M4
US 0.1



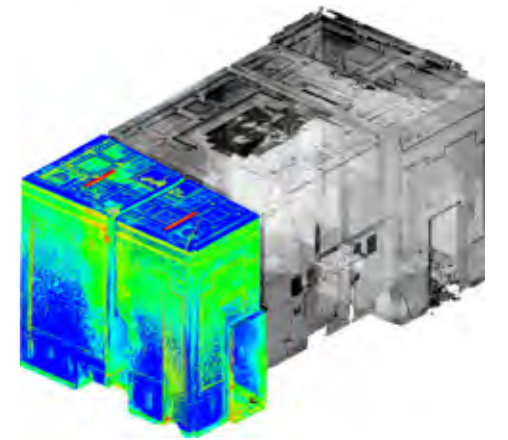
west elevation



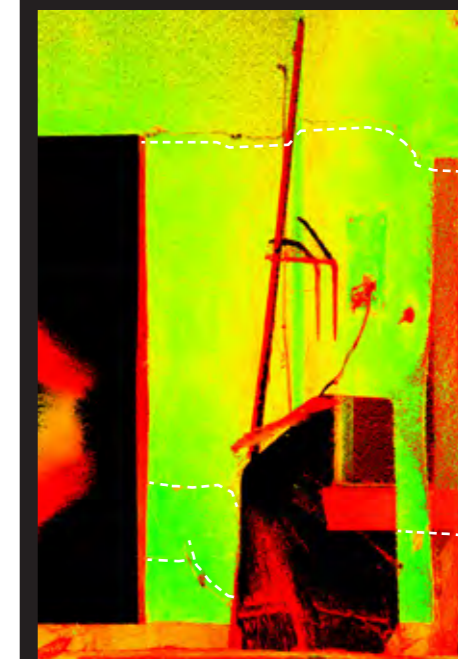
north elevation



M12
US 0.1
02_01_003



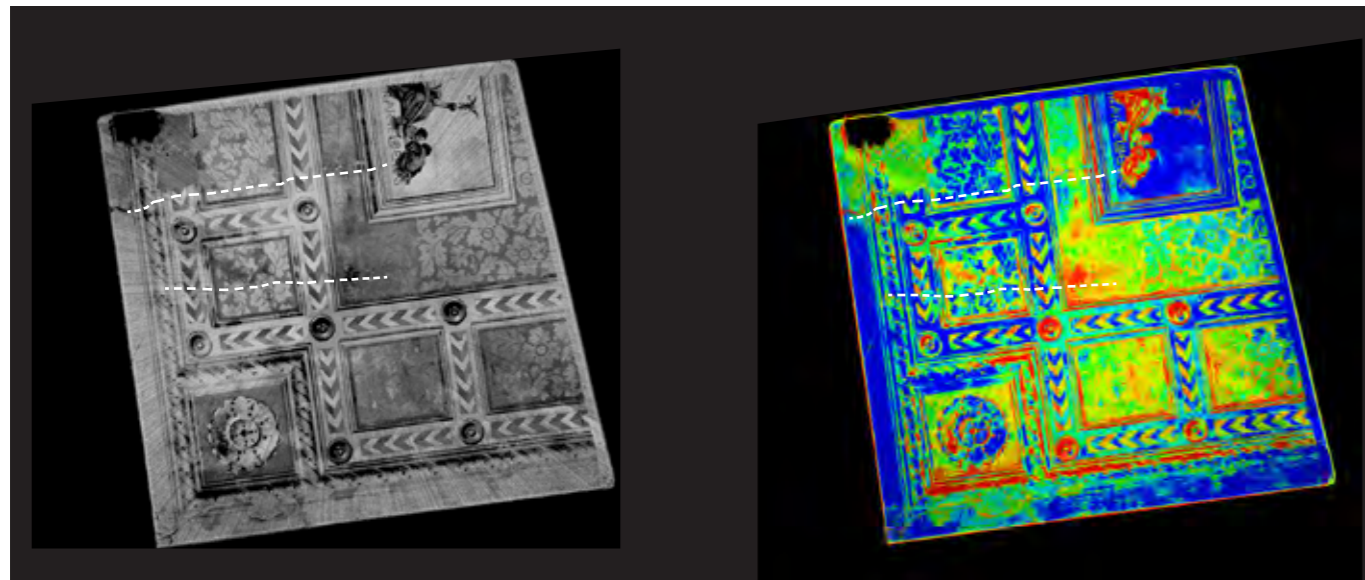
reflectance values
scanner colour method:
grayscale
min: 0,10
max:0,65
gamma:0,65



reflectance values
scanner colour method:
multi hue
min: 0,10
max:0,50
gamma:0,45

M20
US 0.1
02_01_003

Significant damage and excessive deformability of the horizon affected the rooms of the ridotto (unit 02; second-order; rooms 003, 004, 005), which were affected by partial collapses of the ceiling and a significant cracking framework. Since these rooms were subject to alterations to adapt the theatre's functions to the cinema, significant cracks are visible along the partition walls, indicating that they are not well bonded to the load-bearing masonry. In addition, partial collapse of the roof affected Body A, which occurred in correspondence with the rooms described above.

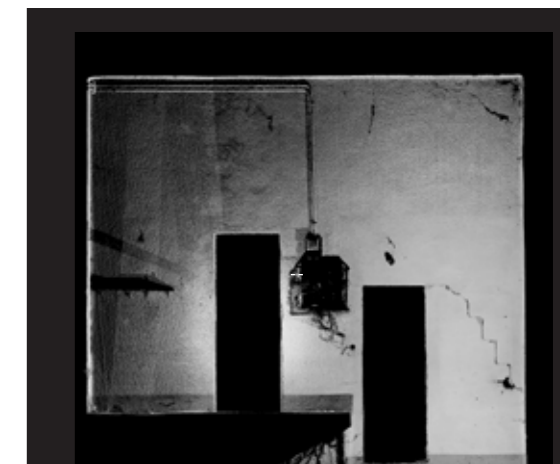
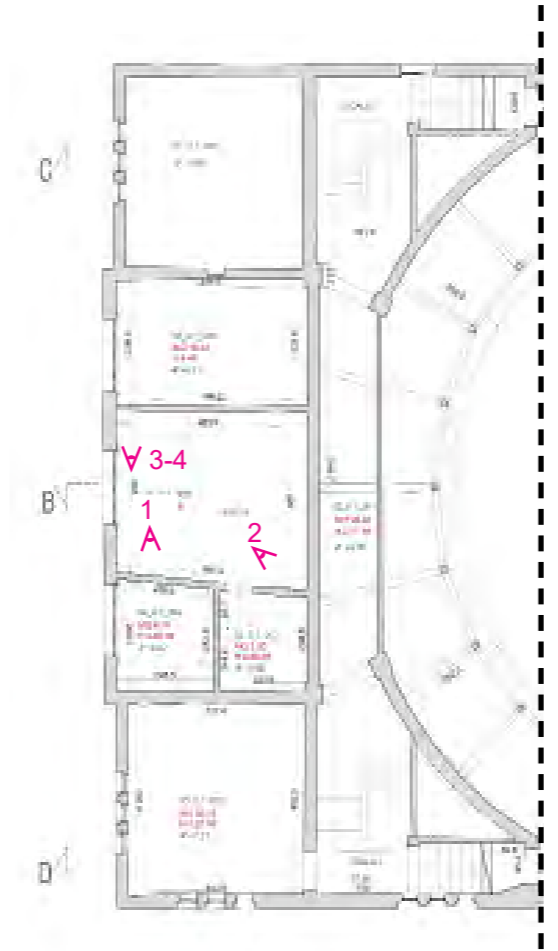
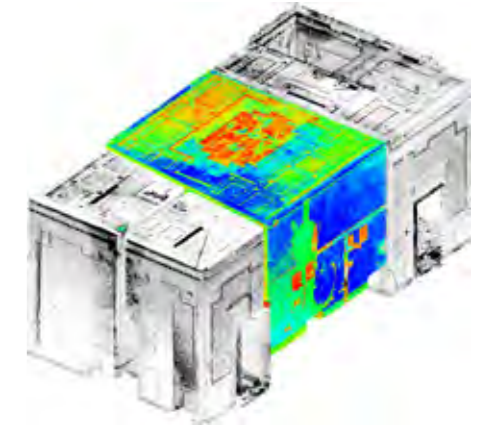
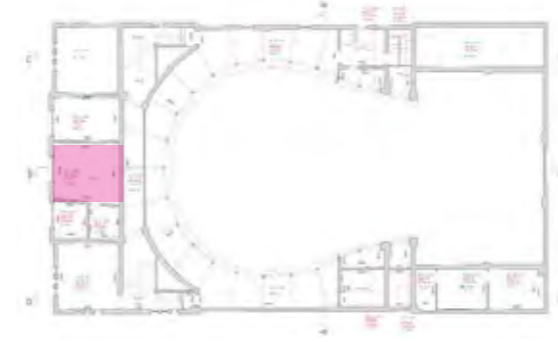


reflectance values
scanner colour method: grayscale
min: 0,10
max:0,60
gamma:0,65

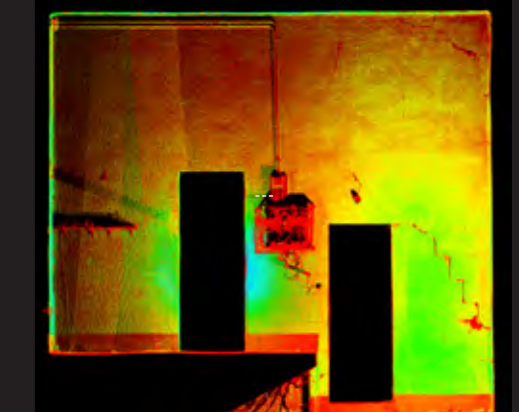
reflectance values
scanner colour method: multi hue
min: 0,10
max:0,30
gamma:0,45

Detail views of the cracking framework of the space intra-slab 02_01_003

M12
US 0.1
02_01_004



reflectance values
scanner colour method:
grayscalee
min: 0,10
max:0,60
gamma:0,65

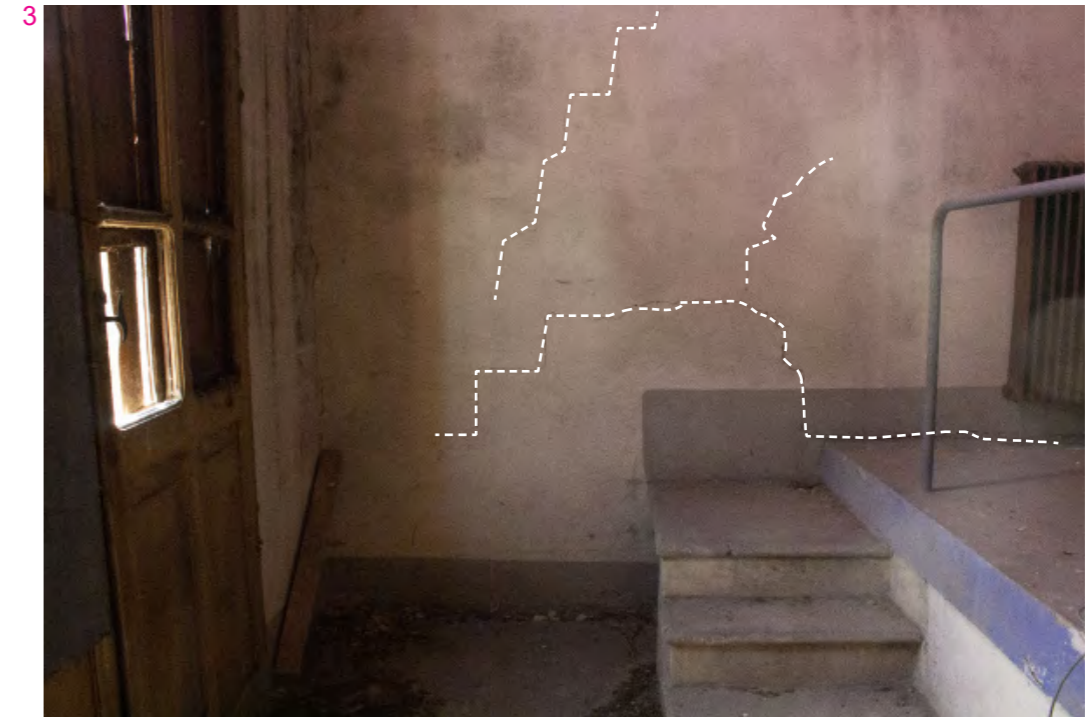


reflectance values
scanner colour method:
multi hue
min: 0,10
max:0,50
gamma:0,45

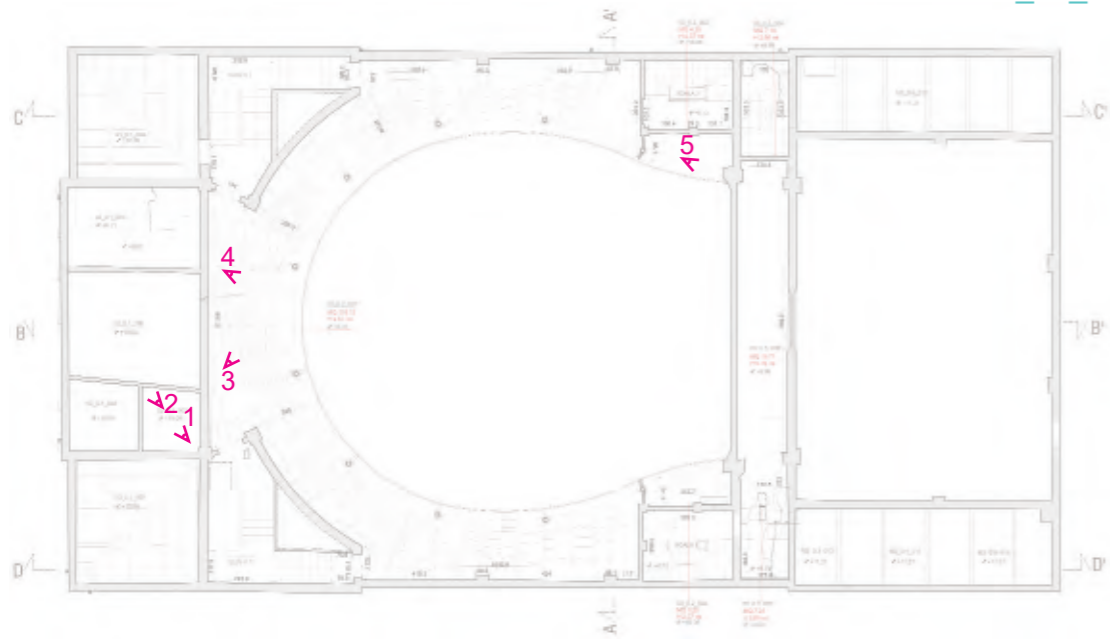
M12
US 0.1
02_01_004



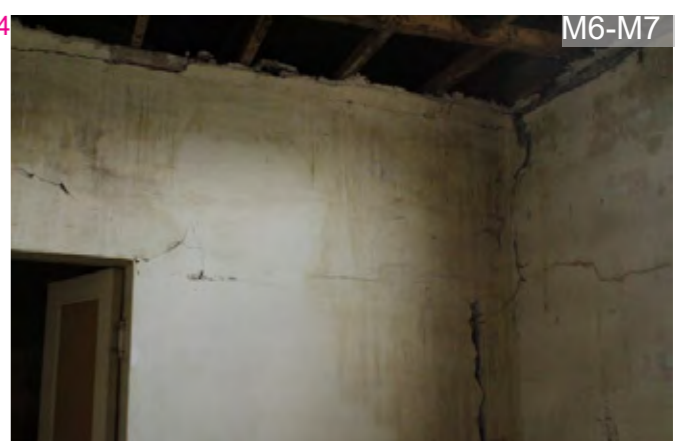
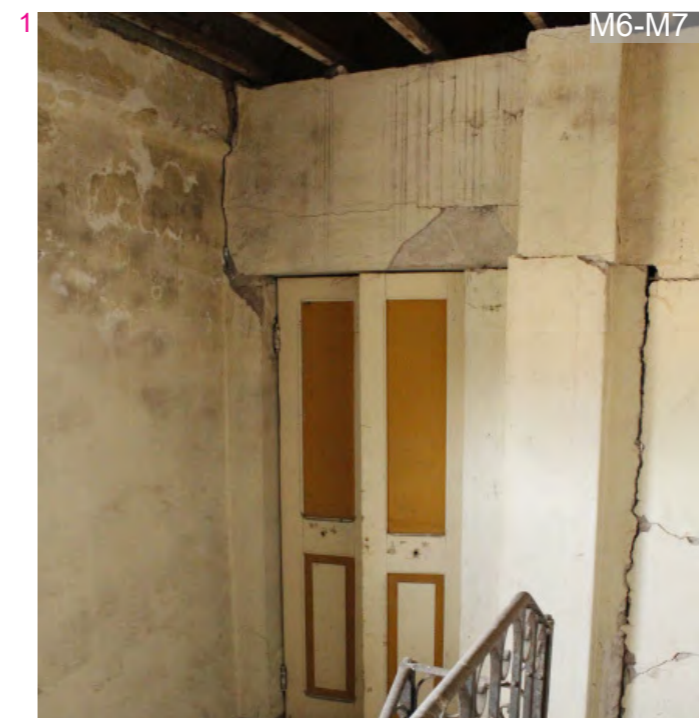
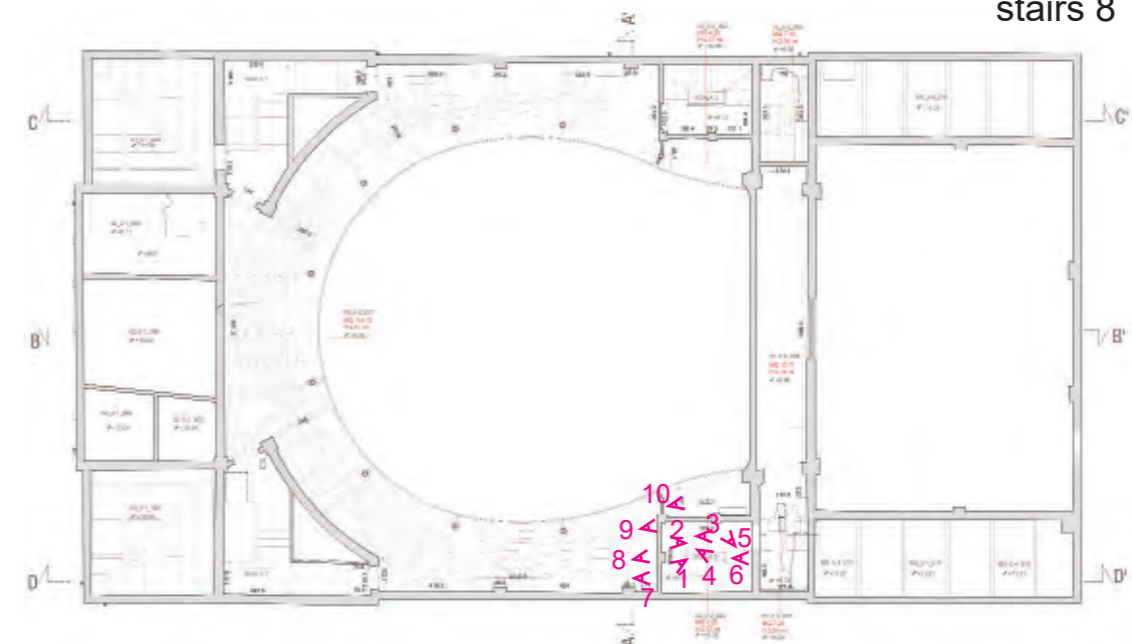
M12
US 0.1
02_01_004



M12
US 0.1
02_01_001/003



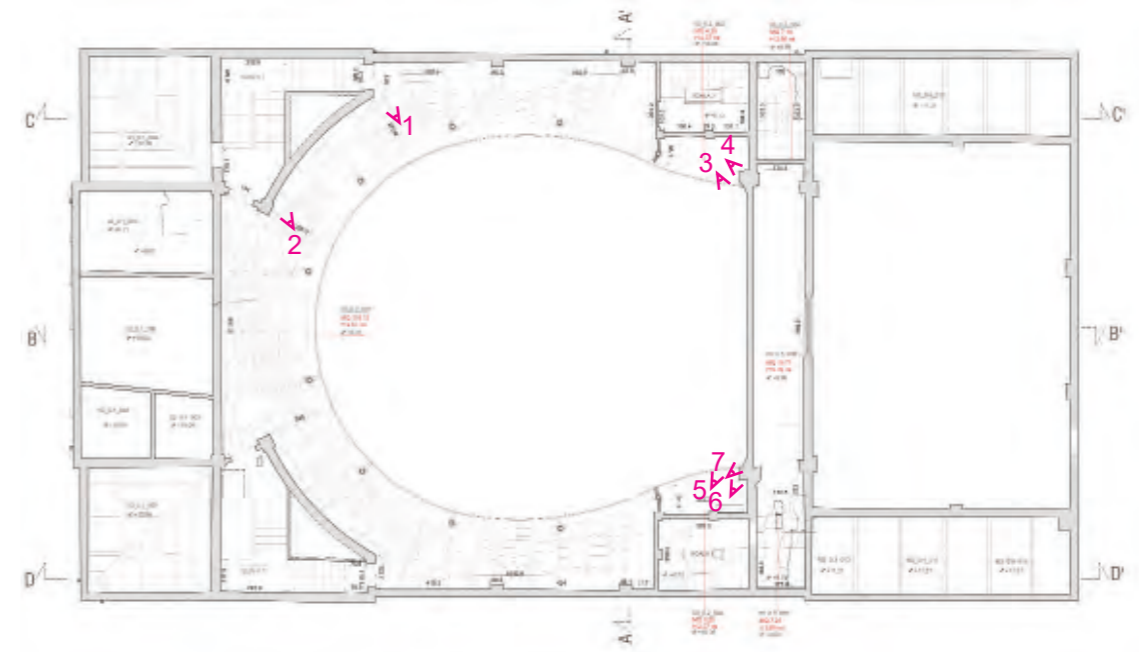
M11-M12
M16
M 32
stairs 8



M11-M12
US 0.2
03



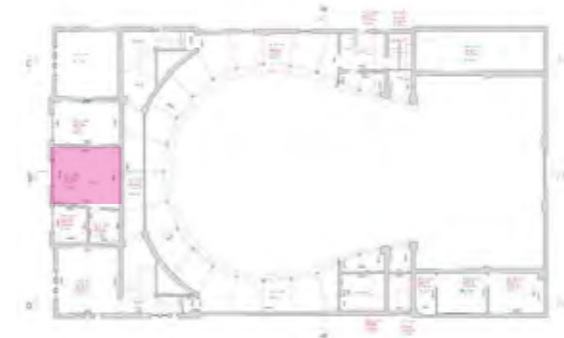
M22
US 0.2_03
03_0.2_001



M22



M12
US 0.1
02_01_005



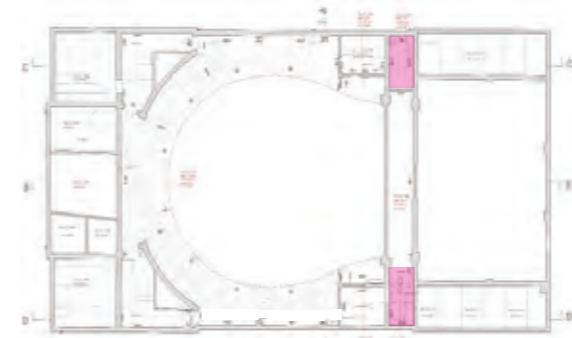
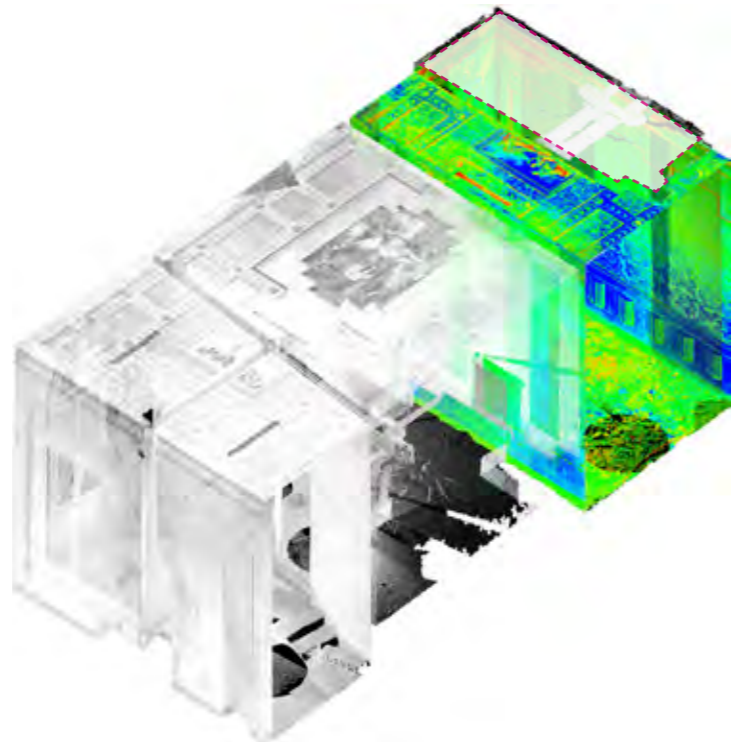
reflectance values
scanner colour method: grayscale
min: 0,10
max:0,85
gamma:0,65

reflectance values
scanner colour method : multi hue
min: 0,10
max:0,60
gamma:0,45

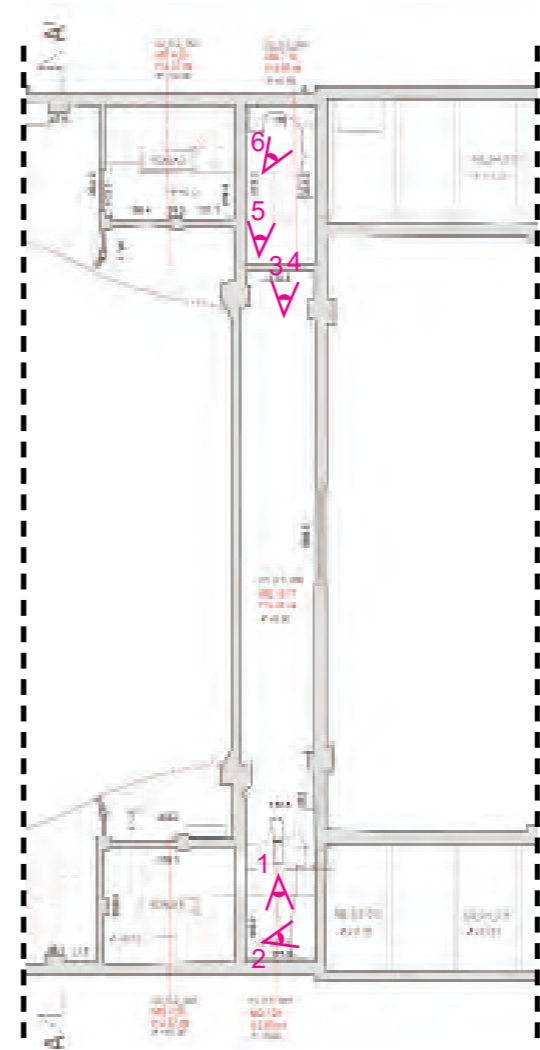
A multi-hue reflectance map of the same wall area, showing a color gradient from yellow to red, indicating different reflectance levels. A dashed white line is also present on this map.



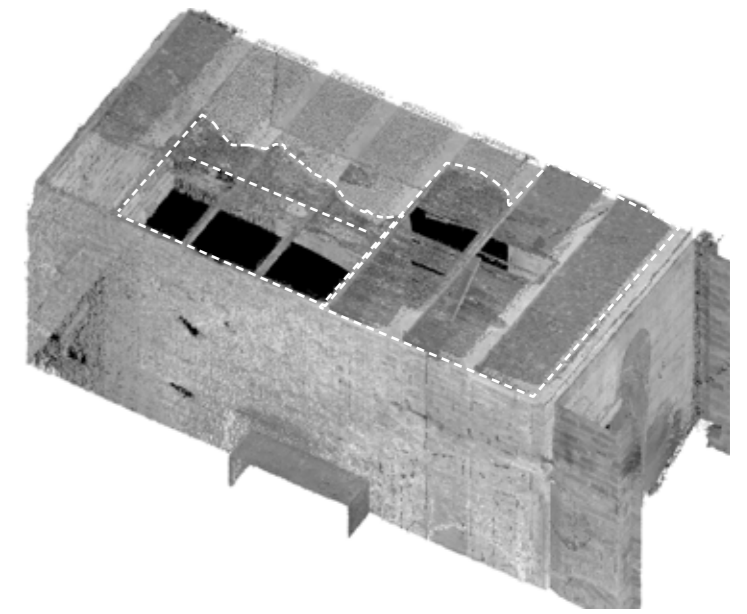
M11
US 0.1
02_01_005



piano 03_ unità strutturale 03

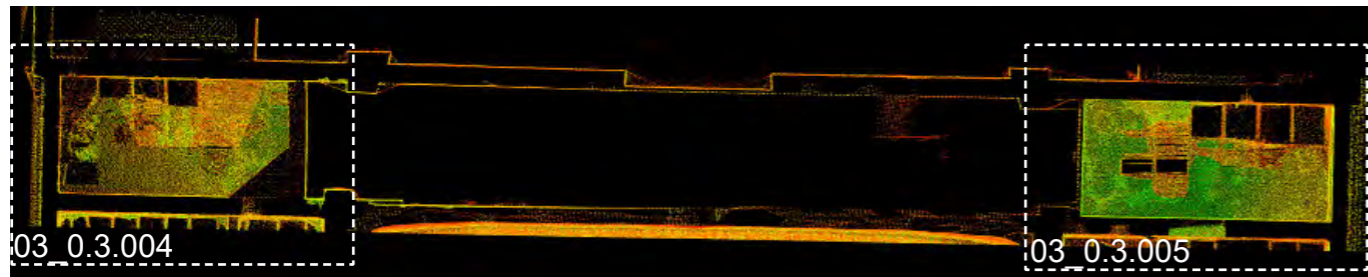


M16
US 0.3
03_0.3.005

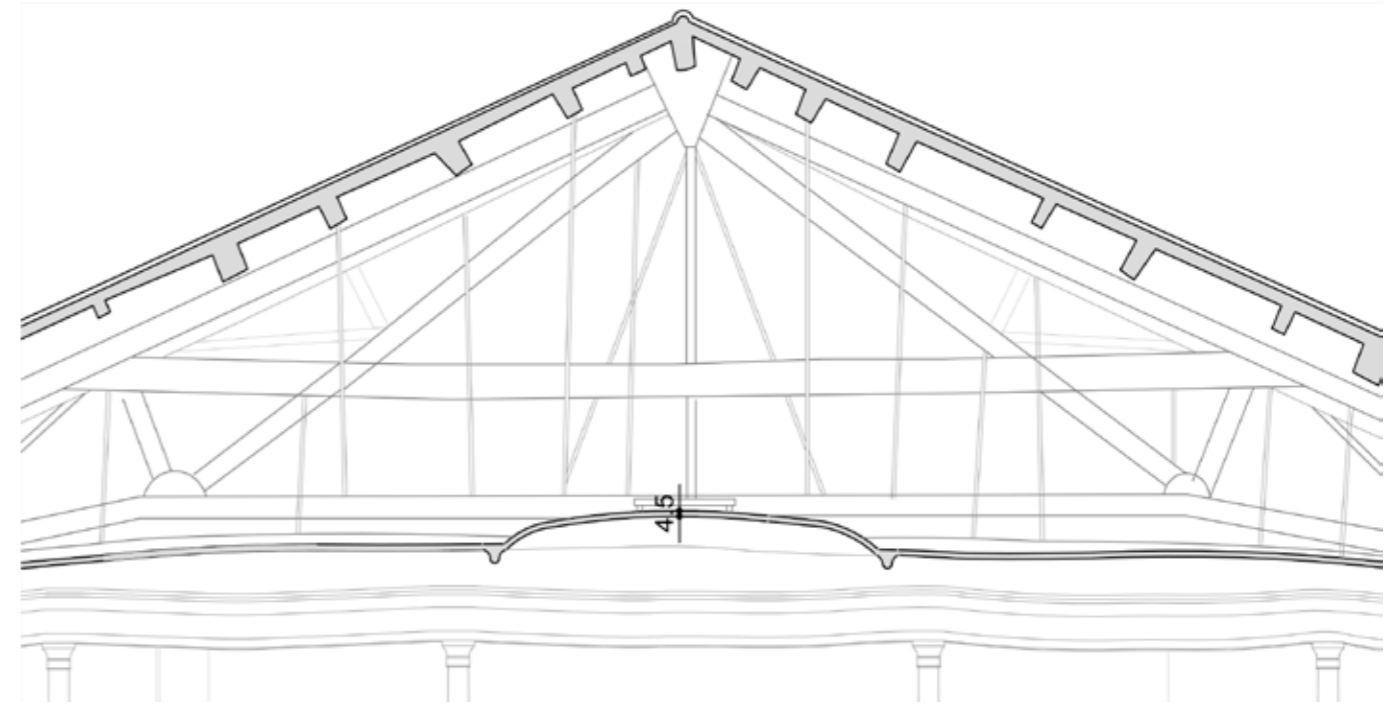


Note: A comparable cracking pattern is found in the diametrically opposite space 03_0.3.004

M16
US 0.3
03_0.3.004



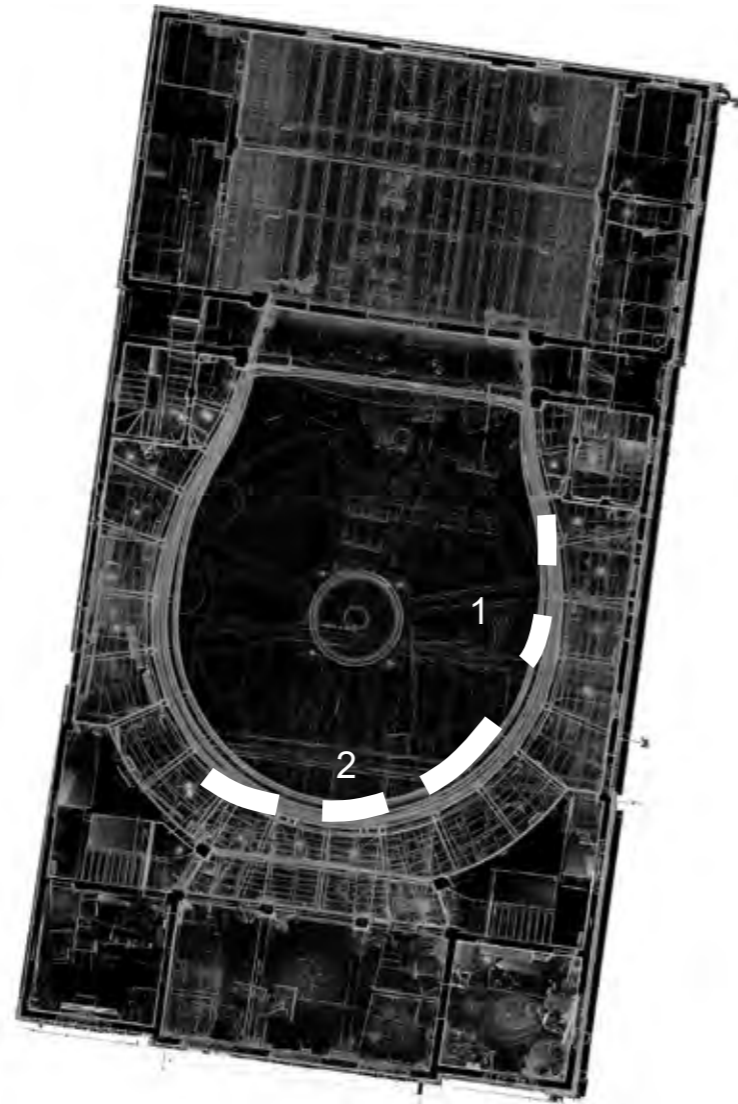
M18-M22
US 0.2
03_0.2_001



Detailed plafond system views

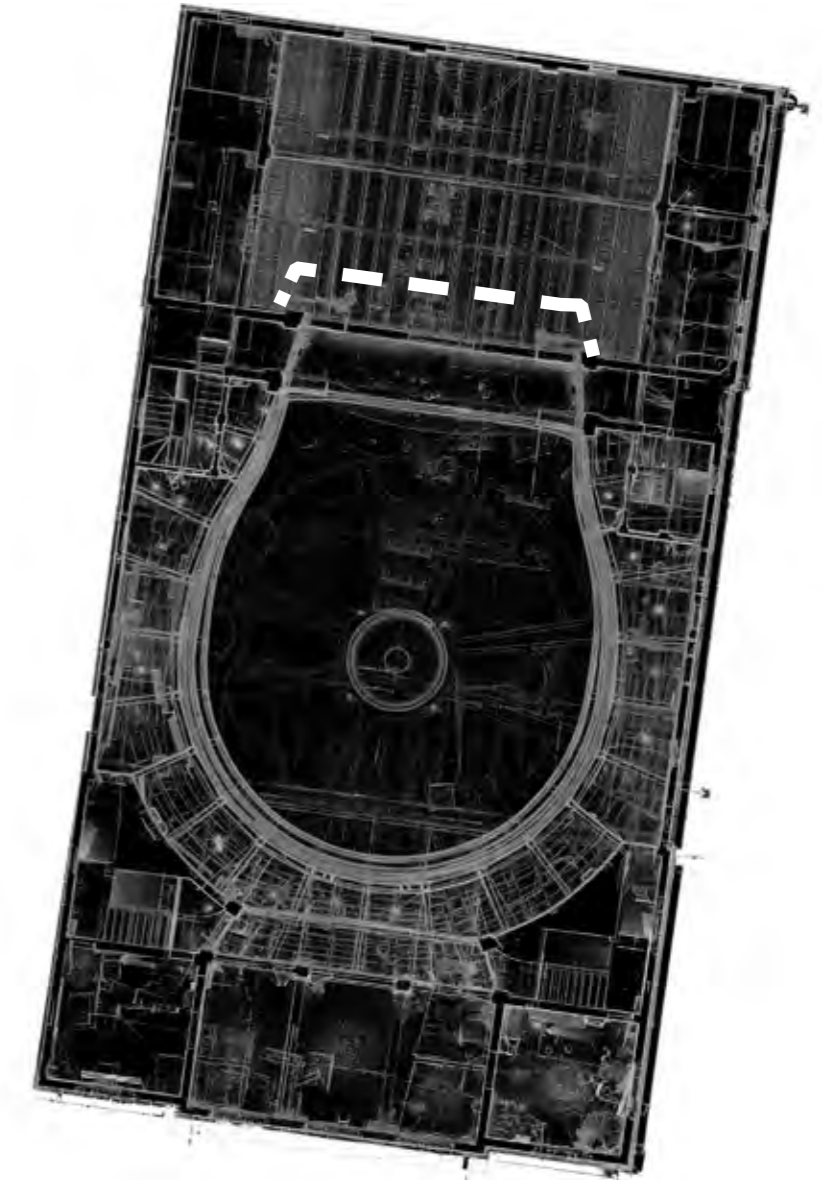
Surface area 167 sqm
Volume 60 cu m
Construction 1923-26
Horseshoe shape floor plan
Modified 1996-97; 2009
Plafond dimensions 13.7 x 15.2 m

M18-M22
US 0.2
03_0.2_001



Detailed views of the damage found across the gallery border

M18-M22
US 0.2
03_0.2_001



Detail views showing beam and scenic arch injuries

M18-M22
US 0.2
03_0.2_001

2



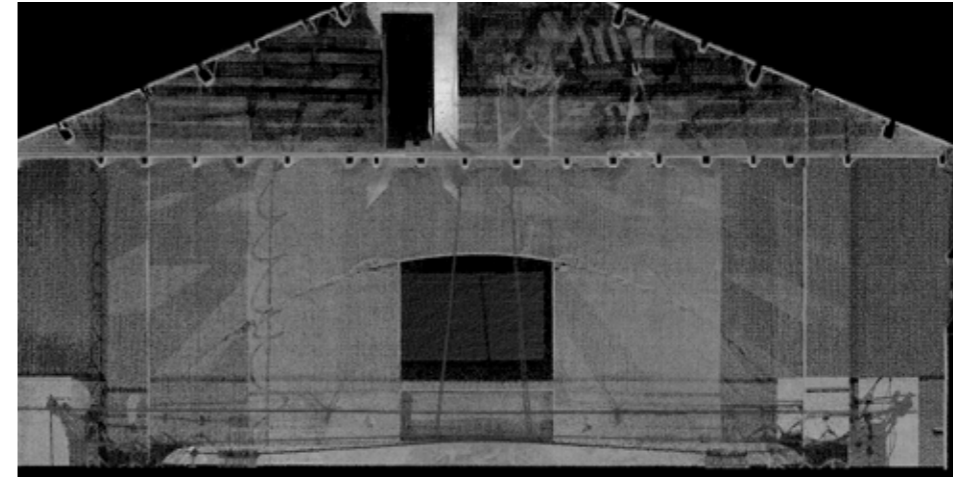
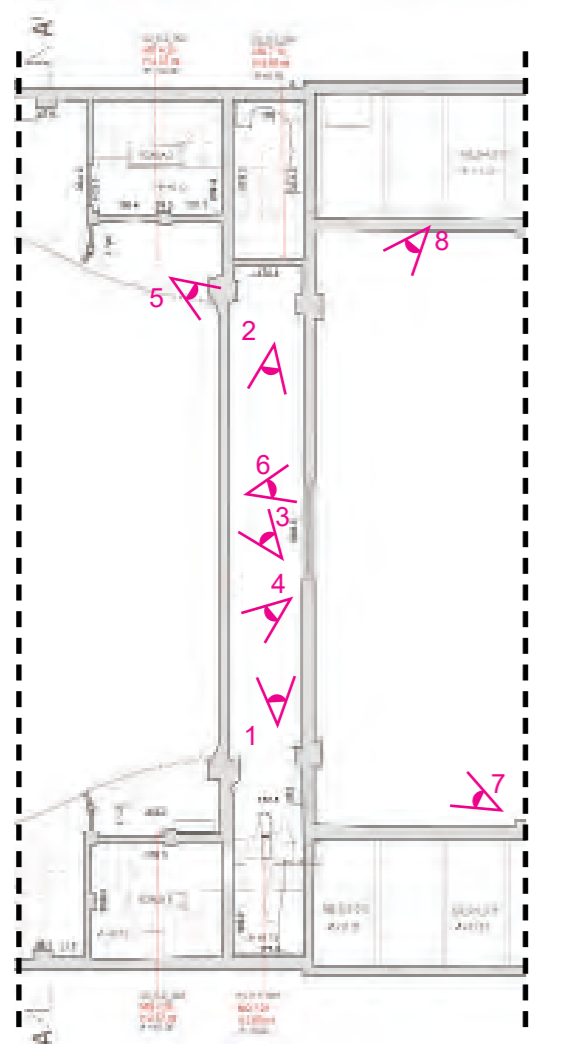
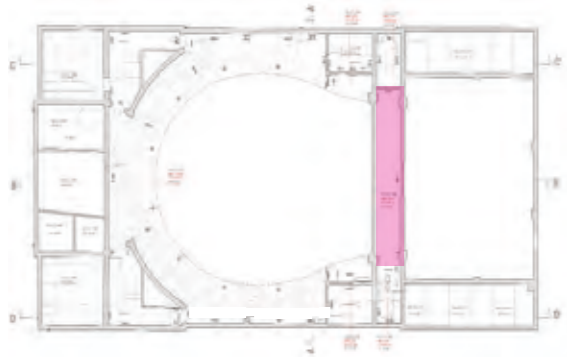
Detailed views of the damage found across the gallery border

M18-M22
US 0.2
03_0.2_001

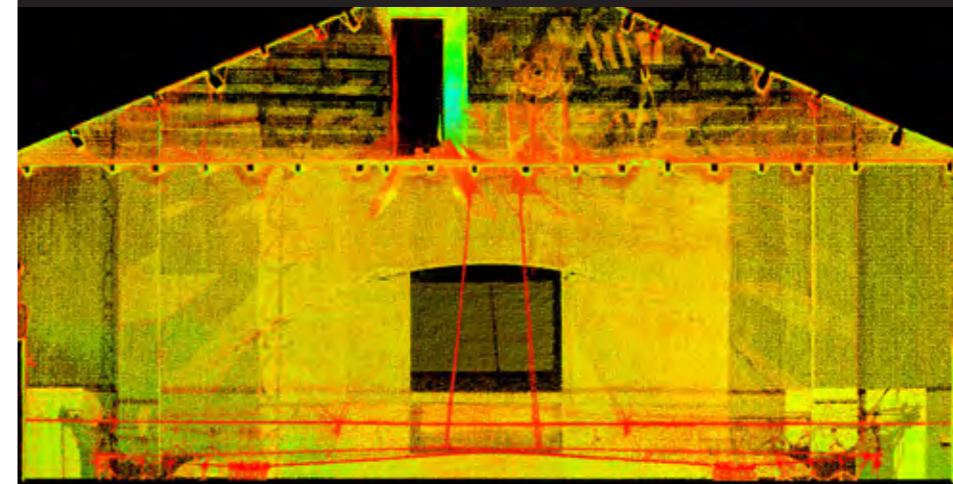


Detailed views of the damage found across the gallery border

M23/25
US 0.3
03_0.3_006



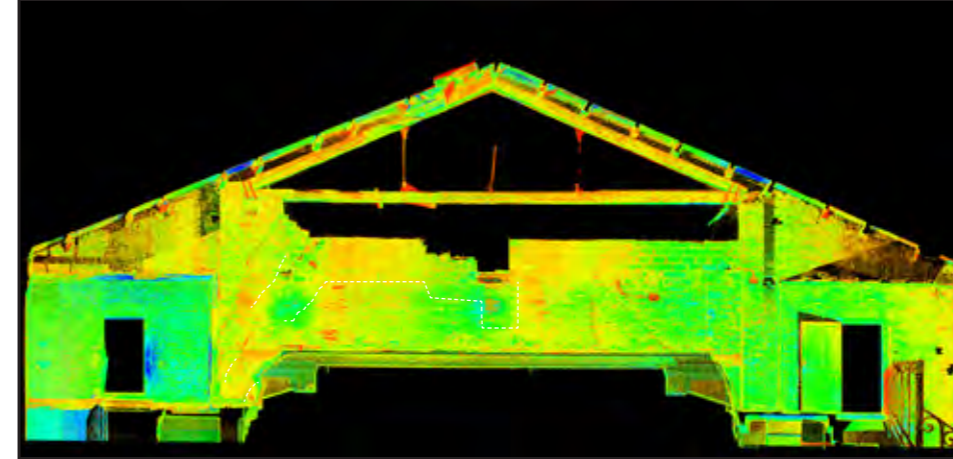
reflectance values
scanner colour method:
grayscalee
min: 0,01
max:0,65
gamma:0,65



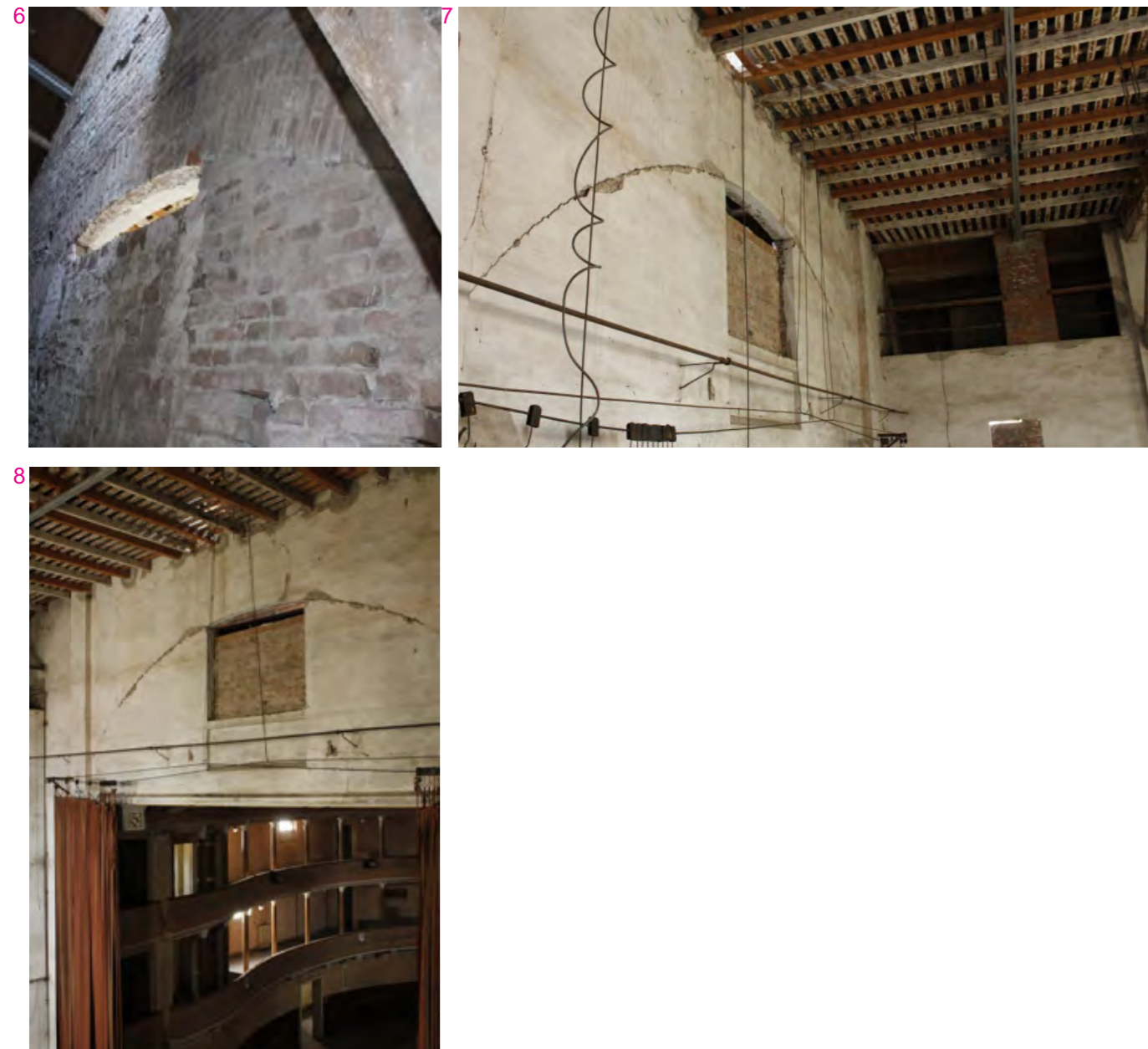
reflectance values
scanner colour method:
multi hue
min: 0,10
max:0,70
gamma:0,45



reflectance values
scanner colour method:
grayscalee
min: 0,01
max:0,50
gamma:0,65

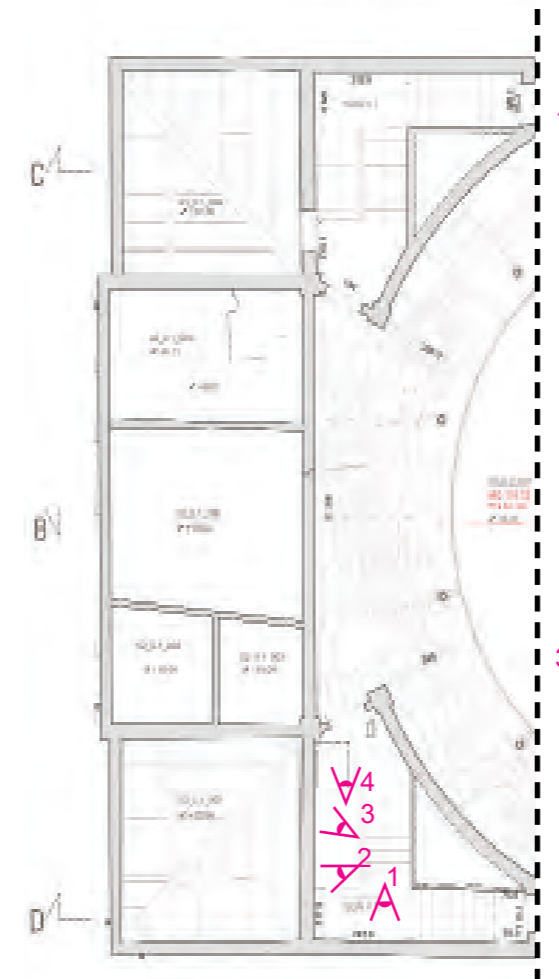
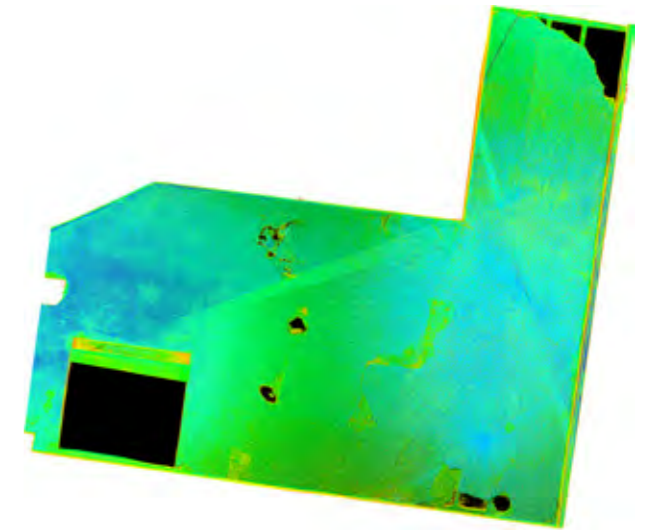
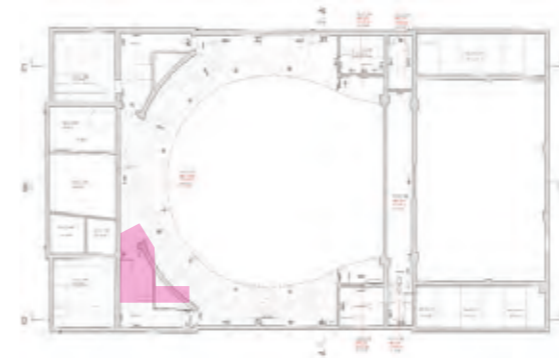


reflectance values
scanner colour method:
multi hue
min: 0,10
max:0,50
gamma:0,45



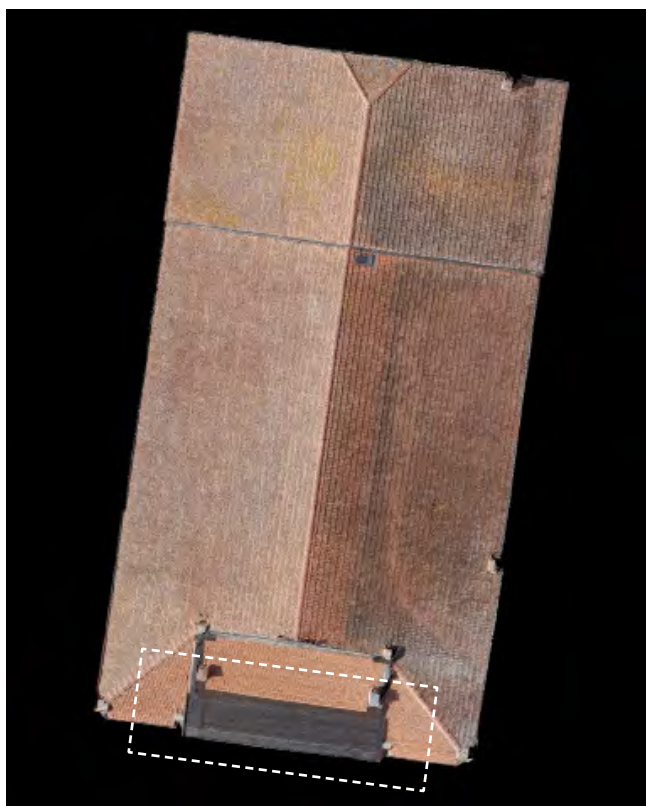
M14
stair 2
UST 01. 03

The staircase (2), a hinge between body A (reduced) and body B (cavea), is particularly damaged in the third-order (northeast quadrant), with significant cracking along the attachment of the perimeter walls to the ceiling and local collapse of the ceiling itself. The cracking of the roof of the opposite staircase (8) is significant (see appendices pp. 19-20).



M15-M16-M1-M18

roof



Optimisation of survey procedures and application of integrated digital tools for seismic risk mitigation of cultural heritage: The Emilia-Romagna damaged theatres.



PhD Candidate: Suppa Martina

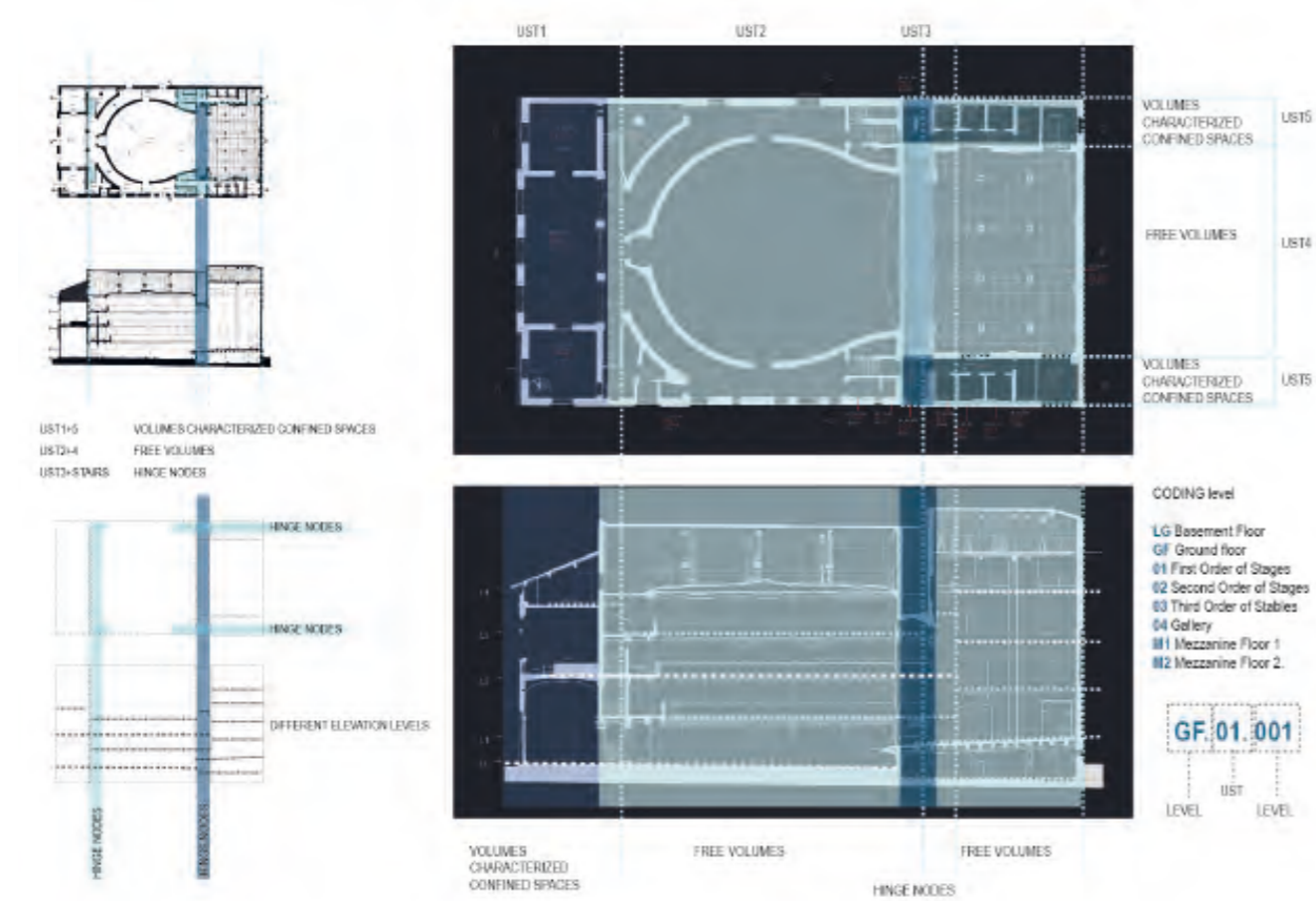
PhD Programme: International Doctorate in Architecture and Urban Planning (IDAUP)
Cycle: XXXIV

ICAR 17

Supervisor (DA/POLIS): Prof. Balzani Marcello

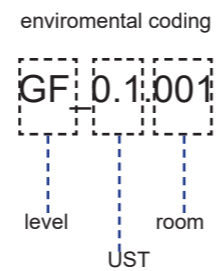
Co-Supervisor (DA/POLIS): Prof. Arben Shtylla

External Expert: Prof. Maietti Federica; Dott.ssa Raco Fabiana

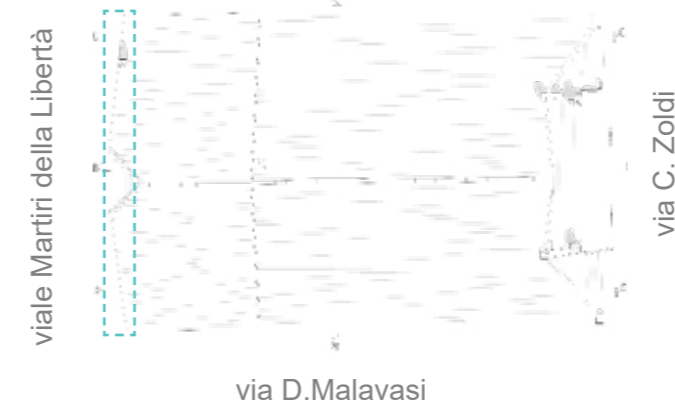


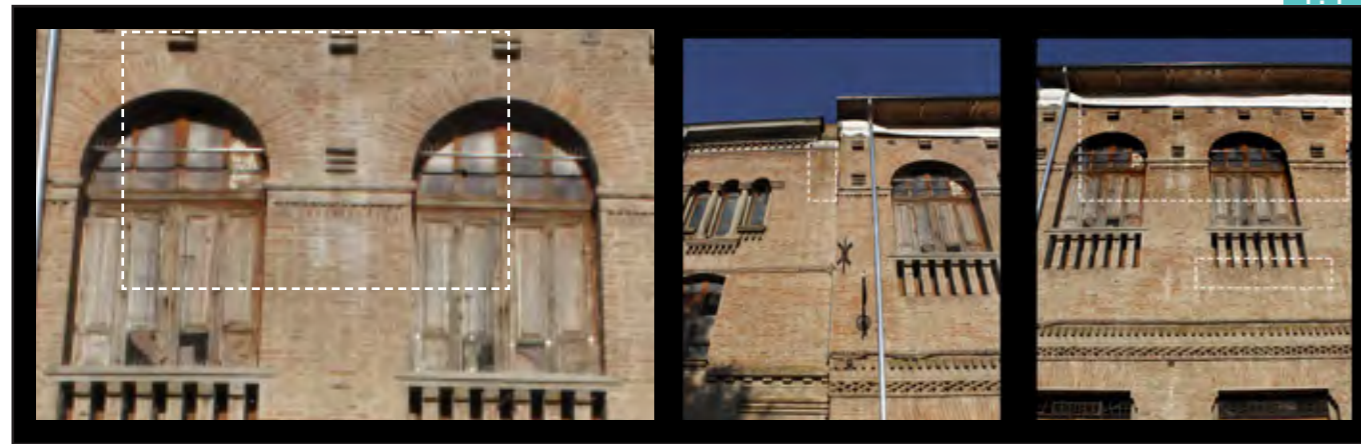
- UST
- 0.1 forepart
 - 0.2 cavea
 - 0.3 proscenium arc
 - 0.4 stage
 - 0.5 utility space
 - 0.6 foundations

- section level
- LG sottopalco
 - GF piano terra _livello platea
 - 01 ordine primo
 - 02 ordine secondo
 - 03 loggione
 - M piano amezato

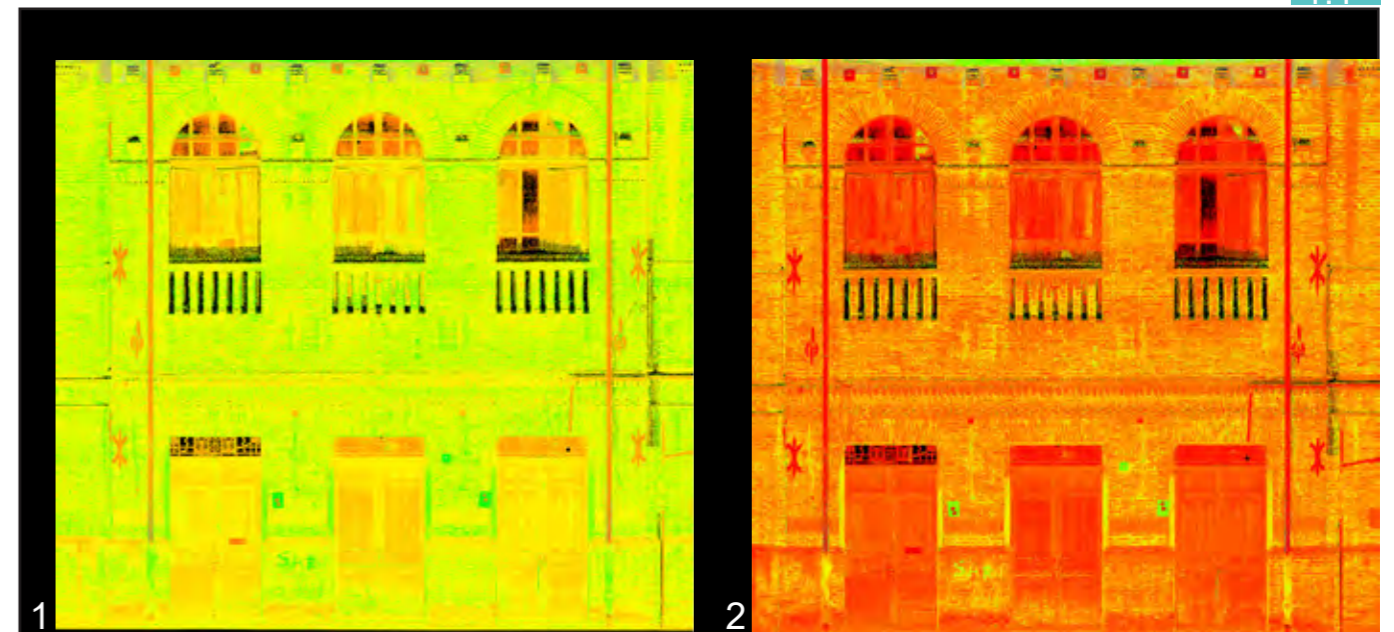
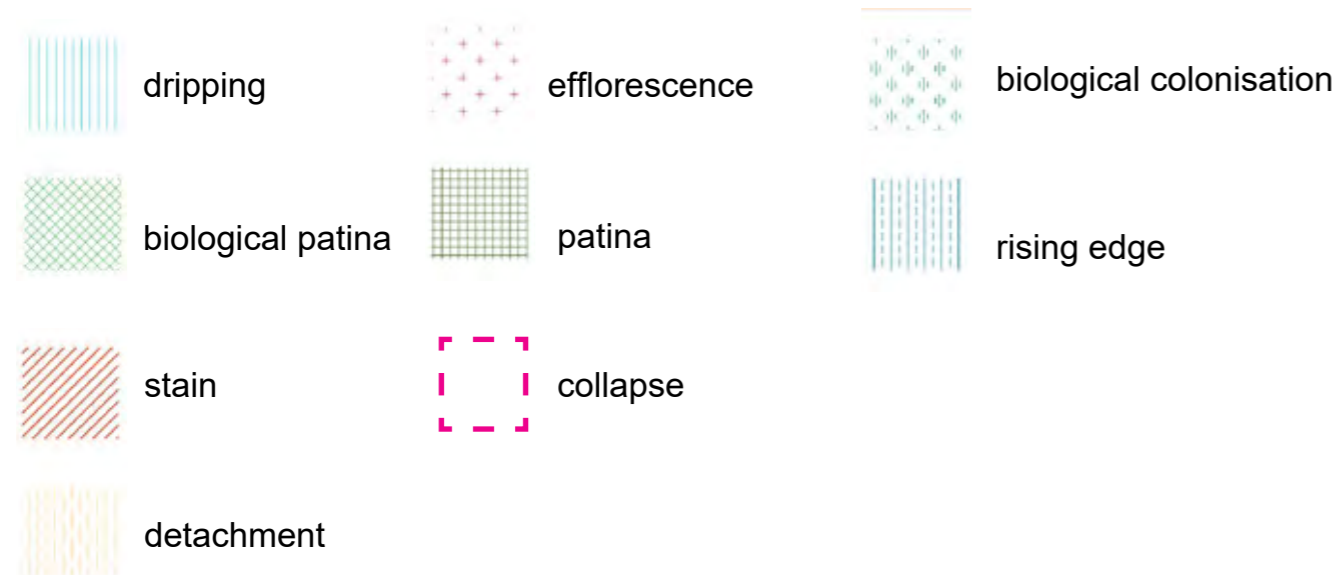


Degradation morphology survey: east elevation (viale dei Martiri della Libertà)





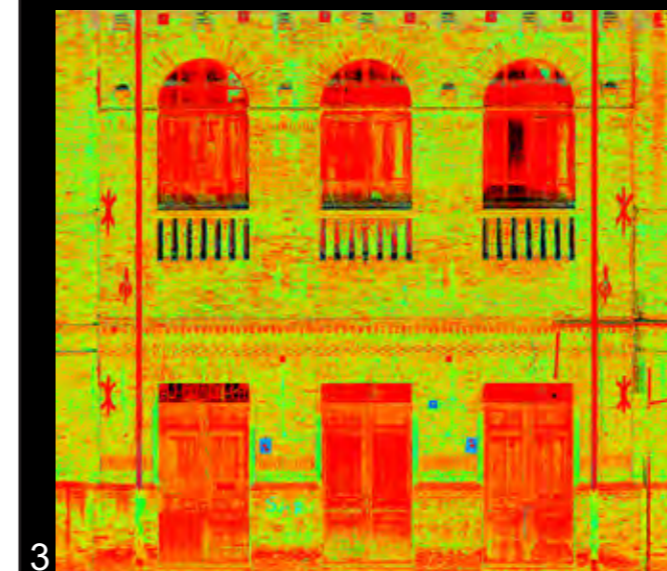
Map of degradation morphologies



reflectance values
 scanner colour method: multi hue
 min: 0,0010
 max:0,99
 gamma:0,45

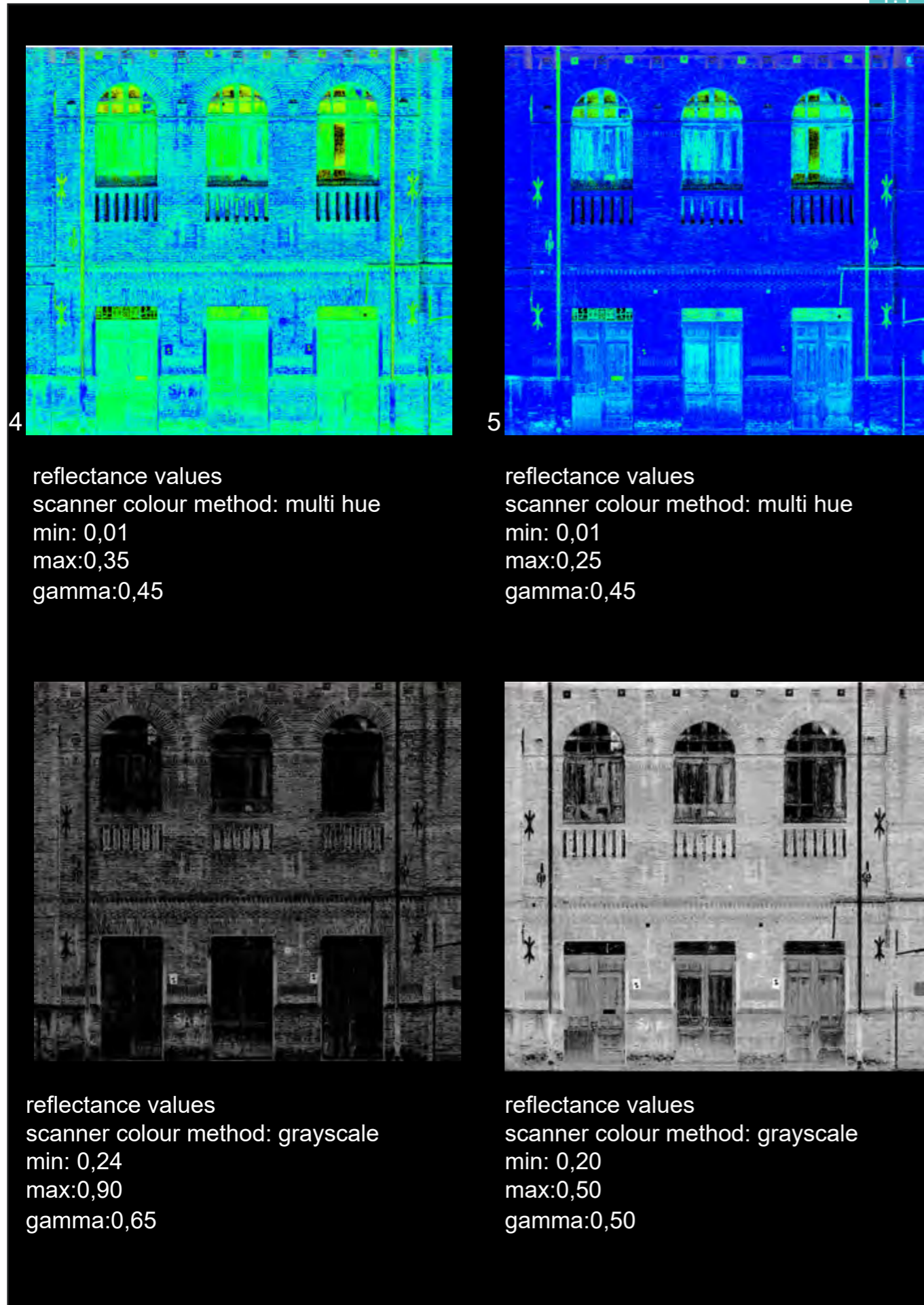
reflectance values
 scanner colour method: multi hue
 min: 0,10
 max:0,99
 gamma:0,45

Interpretation data of reflection values.



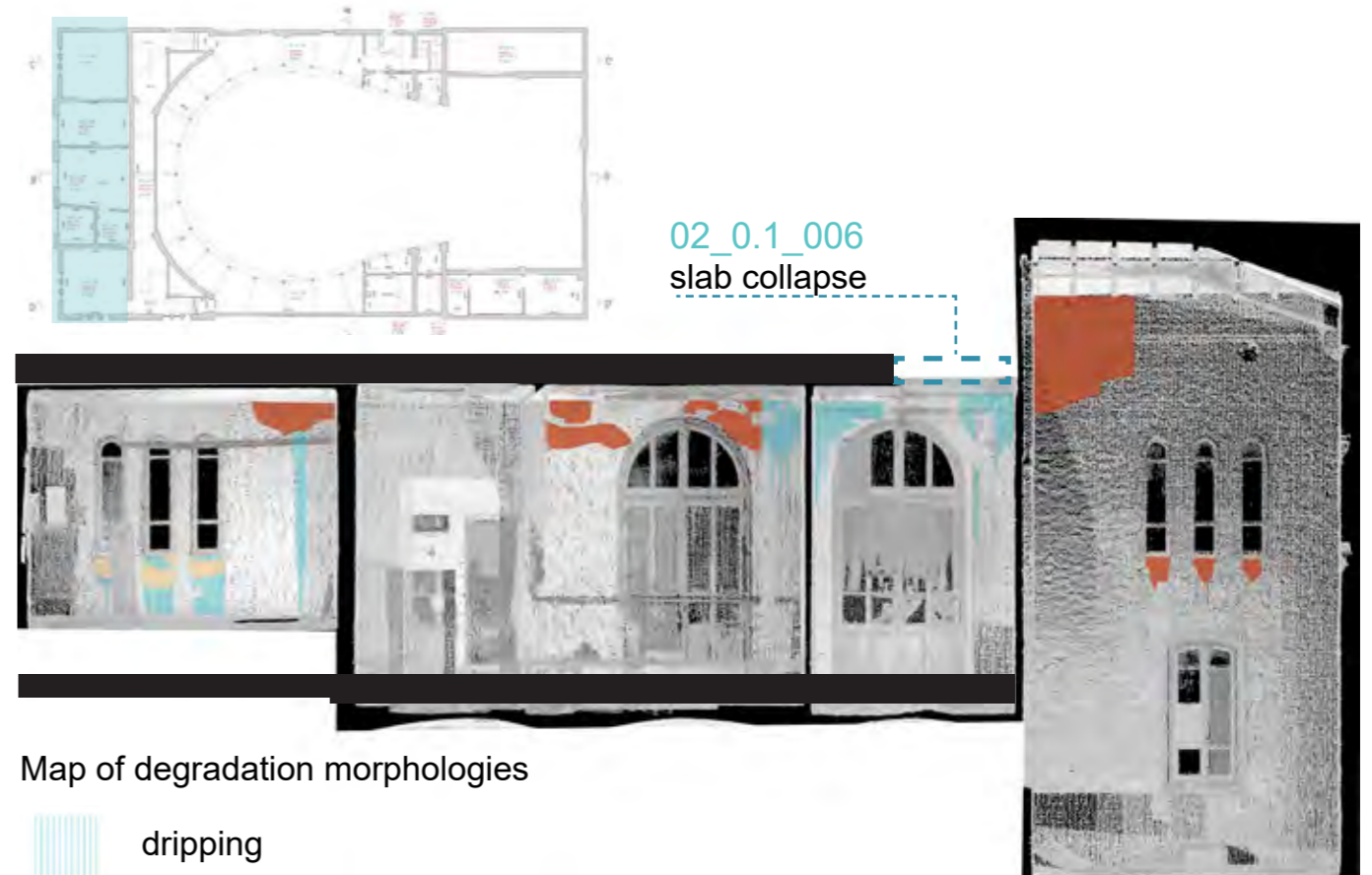
valori di riflettanza
 scanner colour method: multi hue
 min: 0,20
 max:0,50
 gamma:0,45

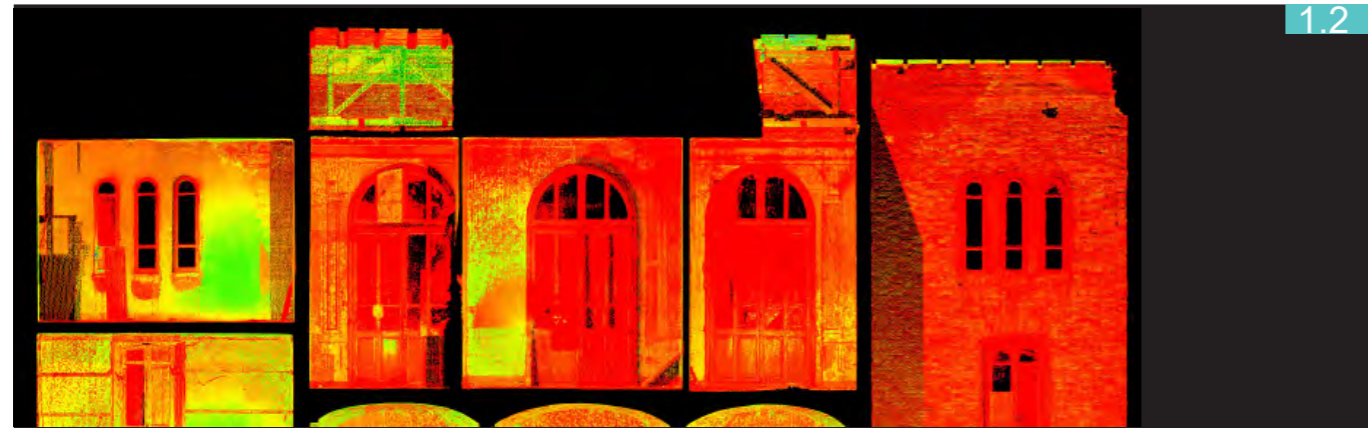
- 1) green: brick surface
 yellow: biological patina
 orange: biological colonisation
- 2) yellow: efflorescence
 dense orange: efflorescence
 red: biological patina
 dense red: rising front
- 3) dense green: efflorescence
 orange: run-off; biological patina
 red: biological colonisation
 dense red: rising front
- 4) dense blue: efflorescence
 cyan: efflorescence, biological patina
 green: biological colonisation
- 5) blue: brick surface
 cyan: biological patina, dripping
 green: biological colonisation



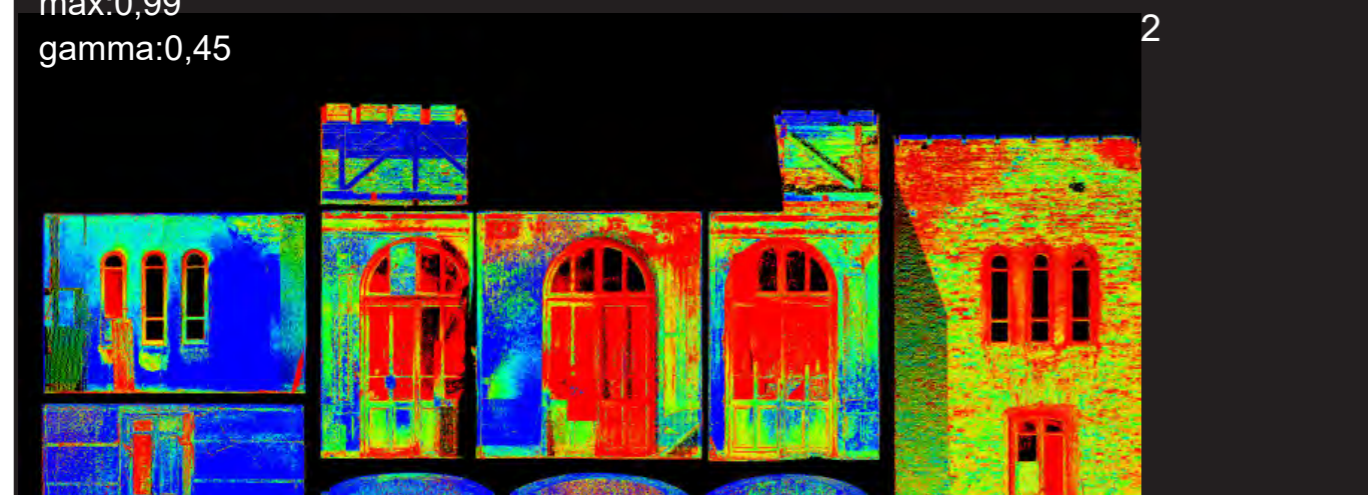
Interior surface degradation related closely to seismic damage (east view)

02_0.1.002-03-04-05-06

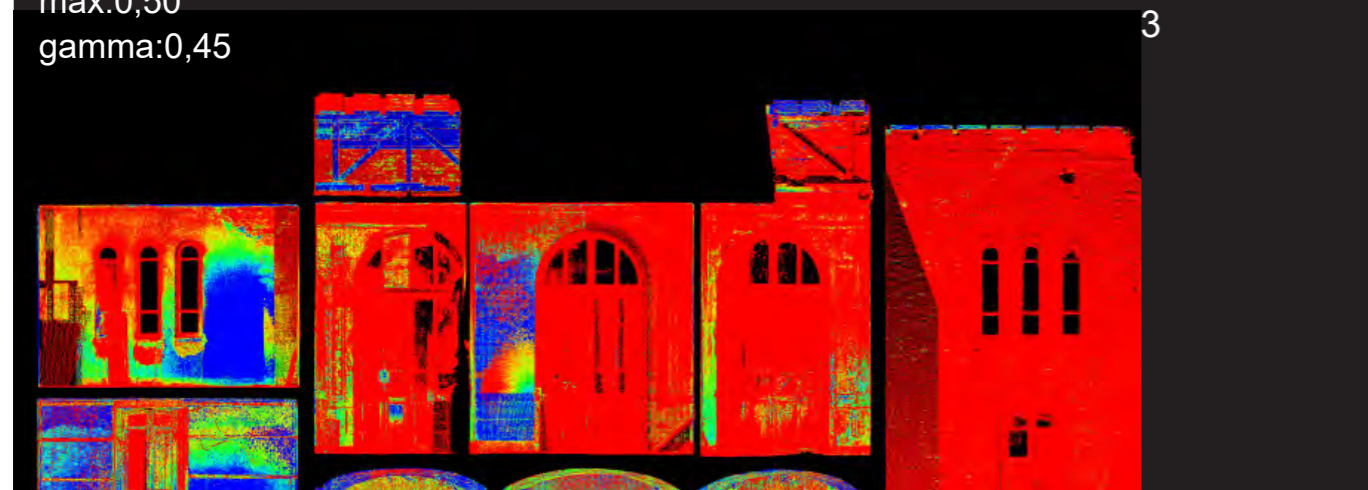




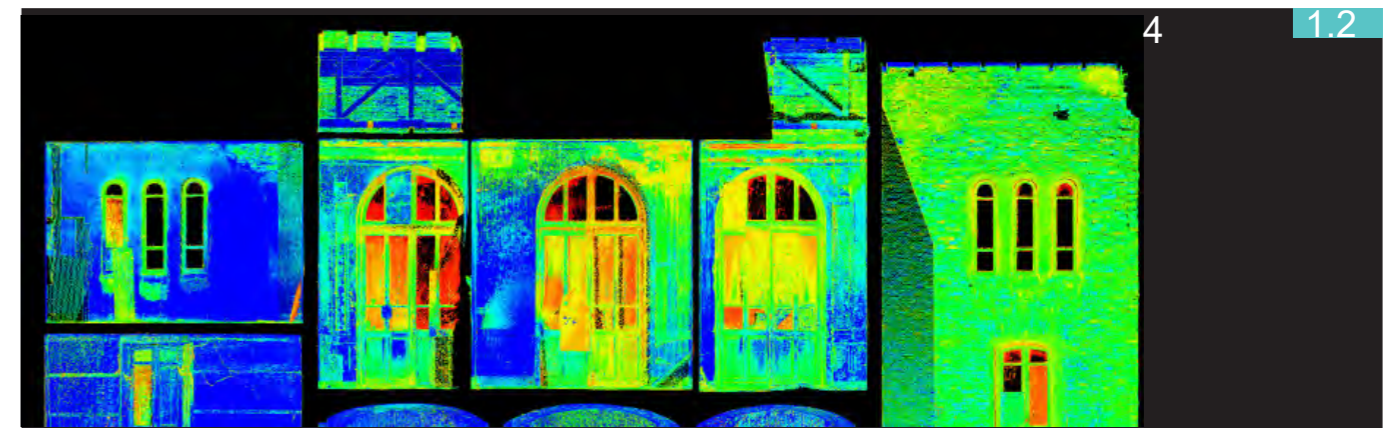
reflectance values
 scanner colour method: multi hue
 min: 0,01
 max:0,99
 gamma:0,45



reflectance values
 scanner colour method: multi hue
 min: 0,20
 max:0,50
 gamma:0,45



reflectance values
 scanner colour method: multi hue
 min: 0,010
 max:0,25
 gamma:0,45



reflectance values
 scanner colour method: multi hue
 min: 0,01
 max:0,25
 gamma:0,45



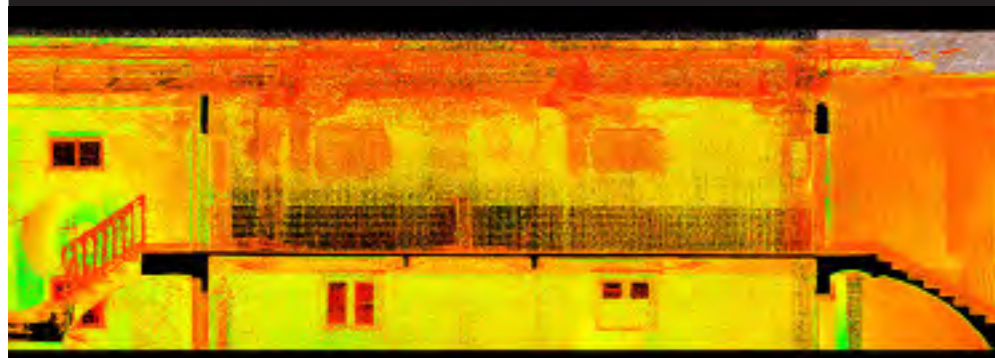
reflectance values
 scanner colour method: grayscale
 min: 0,15
 max:0,45
 gamma:0,50



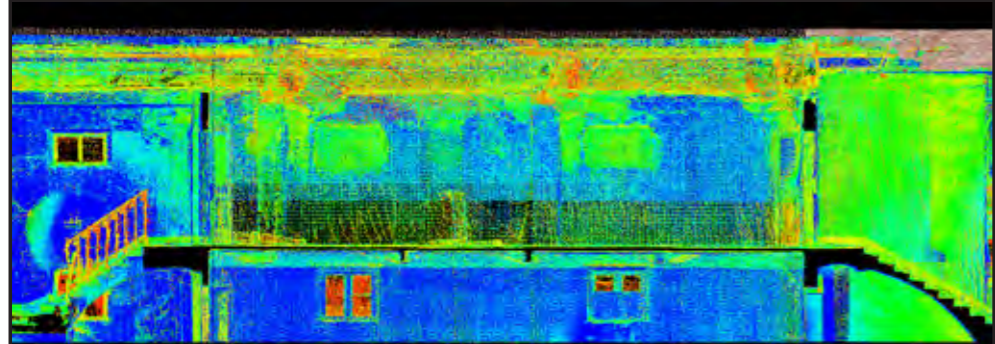
reflectance values
 scanner colour method: grayscale
 min: 0,10
 max:0,35
 gamma:0,65

Interior surface degradation related closely to seismic damage (south view)

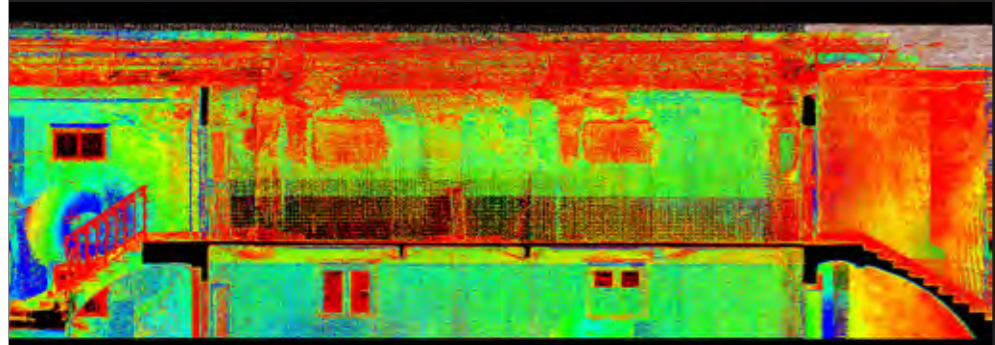
1.3



reflectance values
scanner colour
method: multi hue
min: 0,0010
max:0,99
gamma:0,45



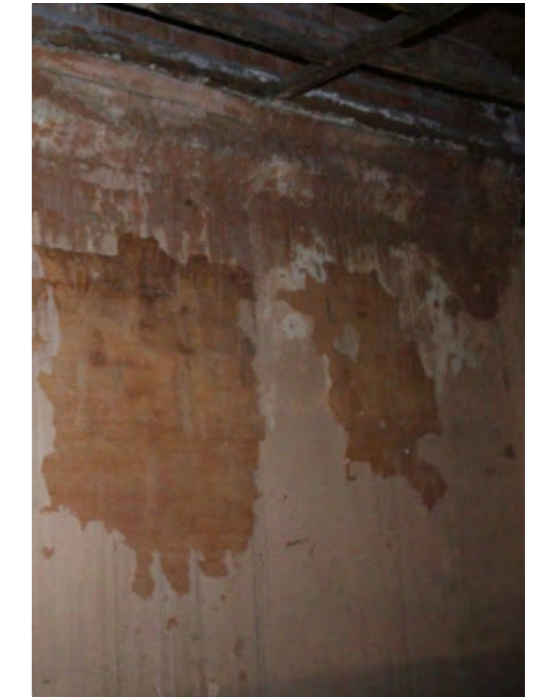
reflectance values
scanner colour
method: multi hue
min: 0,10
max:0,25
gamma:0,45



reflectance values
scanner colour
method: multi hue
min: 0,10
max:0,35
gamma:0,45



1.2



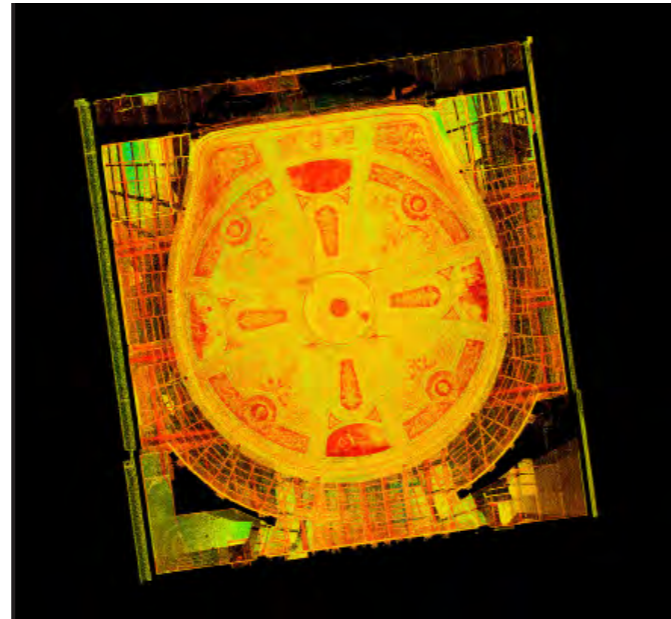
Analysis of decay morphologies of the ceiling vault.

Causes of decay: the presence of water.

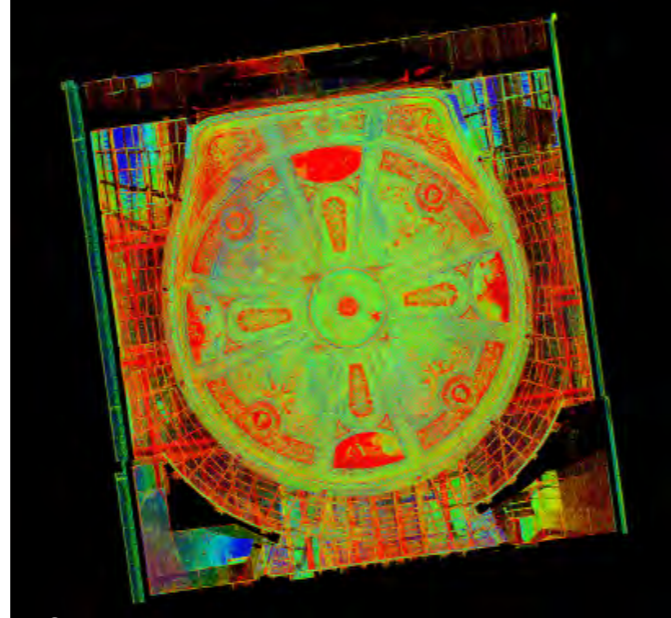
Phenomenon: "darkening" of the vault due to thermo-hygrometric conditions of the vault.

Reflectance data.

1.4

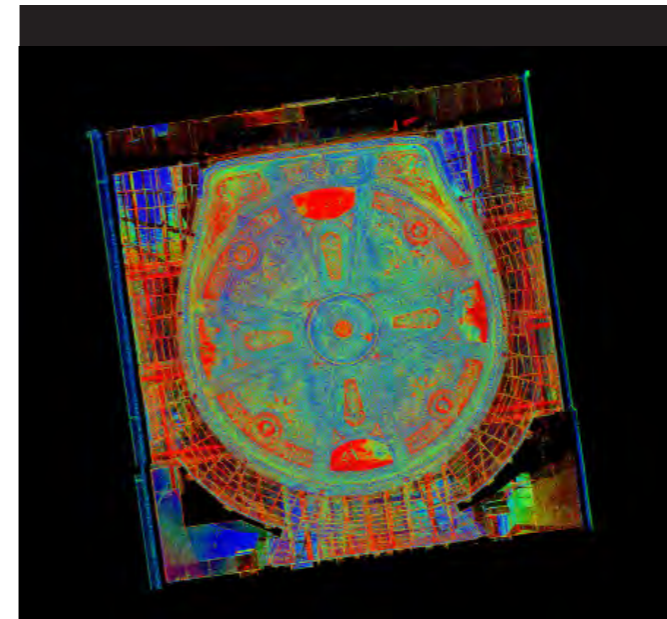


reflectance values
scanner colour method: multi hue
min: 0,0010
max:0,99
gamma:0,45

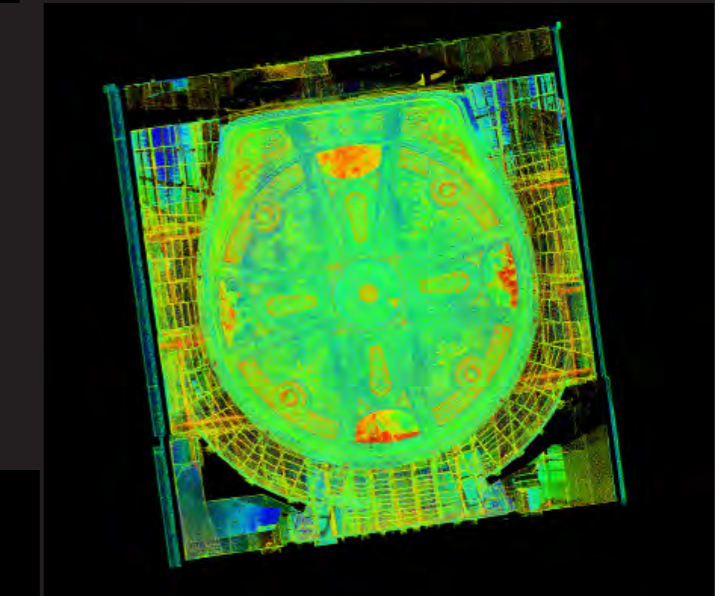


reflectance values
scanner colour method : multi hue
min: 0,10
max:0,25
gamma:0,45

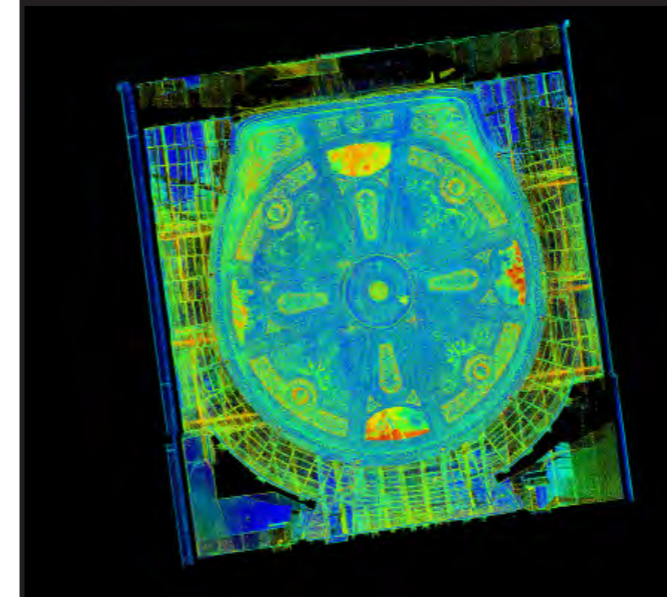
1.4



reflectance values
scanner colour method: multi hue
min: 0,10
max:0,35
gamma:0,45

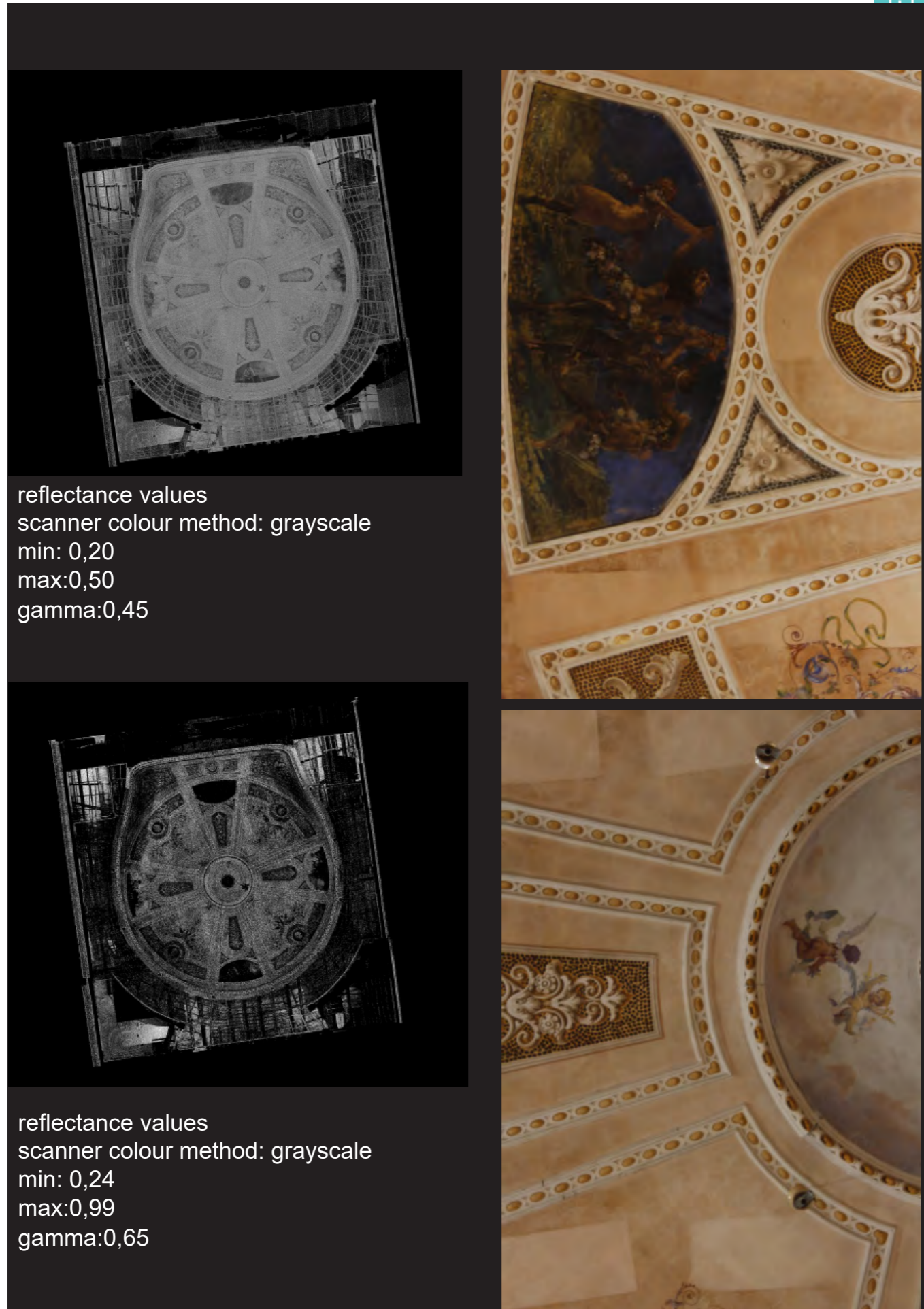


reflectance values
scanner colour method: multi hue
min: 0,10
max:0,35
gamma:0,45



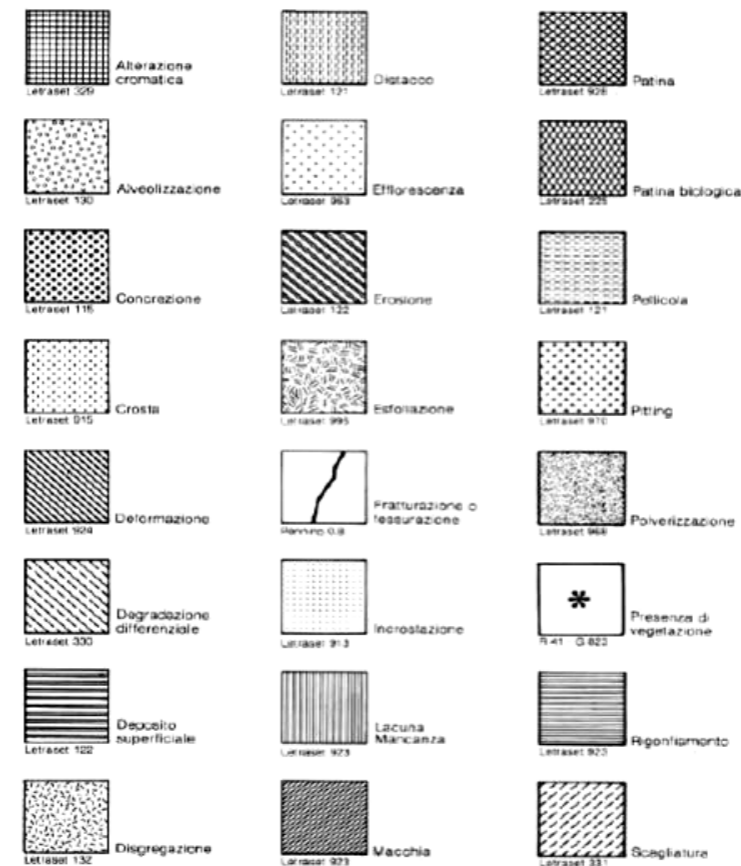
reflectance values
scanner colour method: multi hue
min: 0,0010
max:0,25
gamma:0,45





Interpretation data of the reflection values.

- 1) red: patina, casting
dense orange: stain
- 2) red: stain, biological patina on brickwork
dense red: casting on plastered surface
orange: casting
green: detachment
- 3) red: brick surface
blue: surface deposit on the plastered surface (not analysed in degradation because not related to damage)
dense orange: stain
- 4) dense blue: efflorescence
cyan: dripping, biological patina
green biological colonisation
- 5) cyano: diaccacco
yellow-orange: stain
green: dripping and biological patina



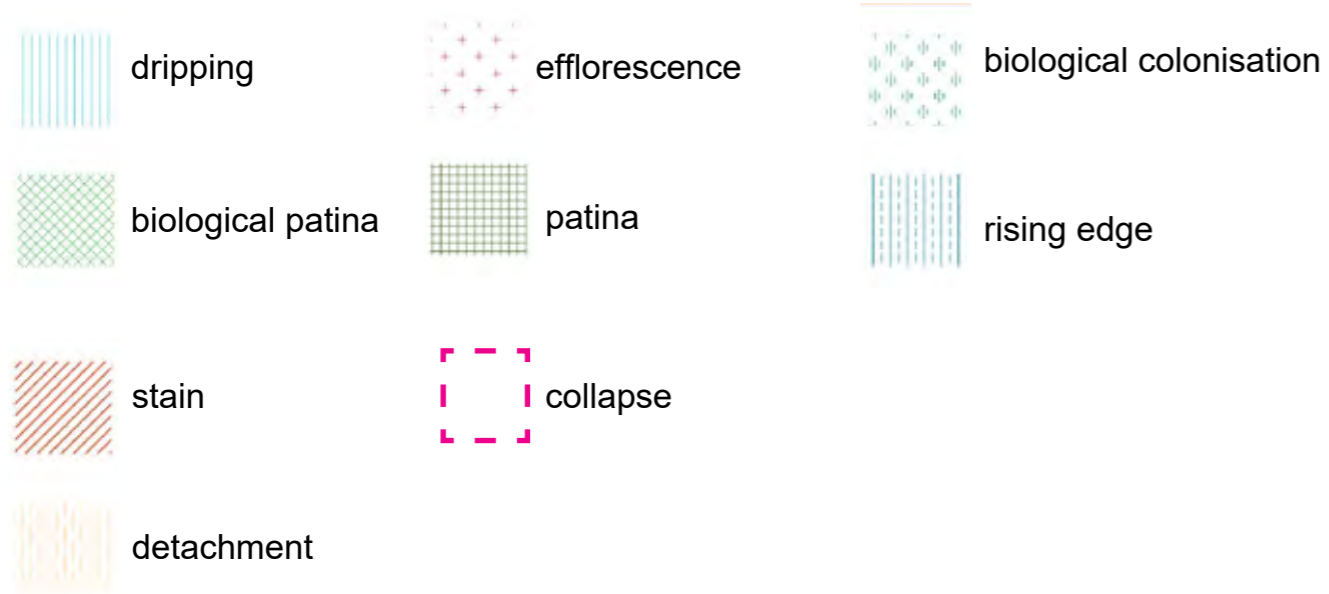
The abacus of the primary degradation morphologies was drawn up based on the reference document UNI1182.

PHOTOGRAPHIC REPORT

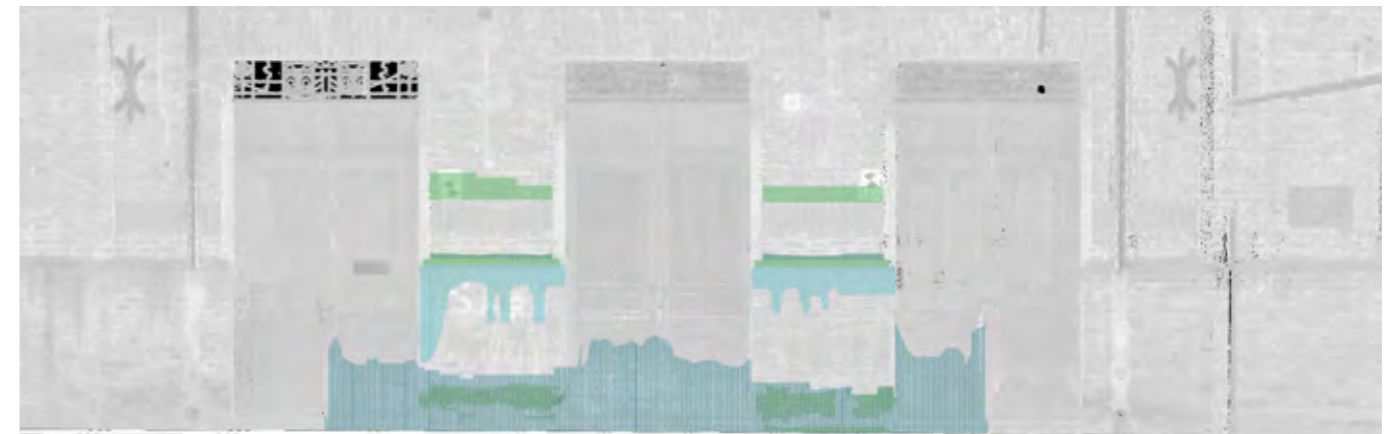
Degradation morphology survey: east elevation (viale dei Martiri della Libertà)



Map of degradation morphologies



photographic survey_ north elevation



exfoliation: present along the wooden frames (the phenomenon is most present along the lower bar of the theatre entrance doors, especially on the east and north fronts)

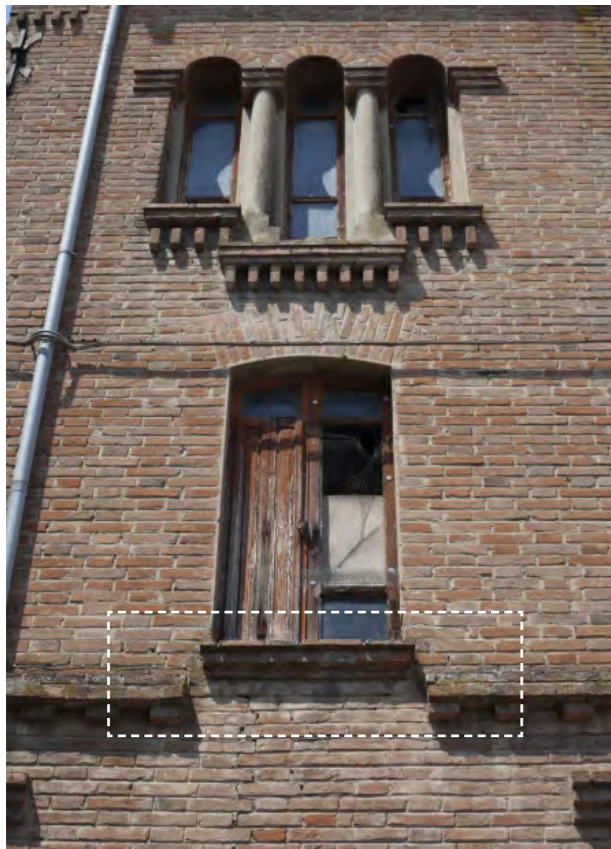
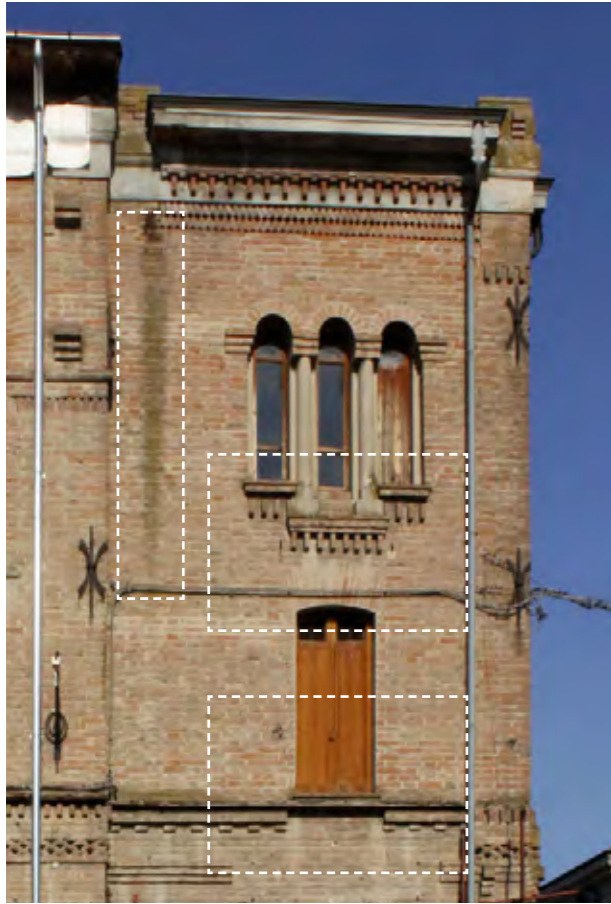
rising edge



biological colonisation

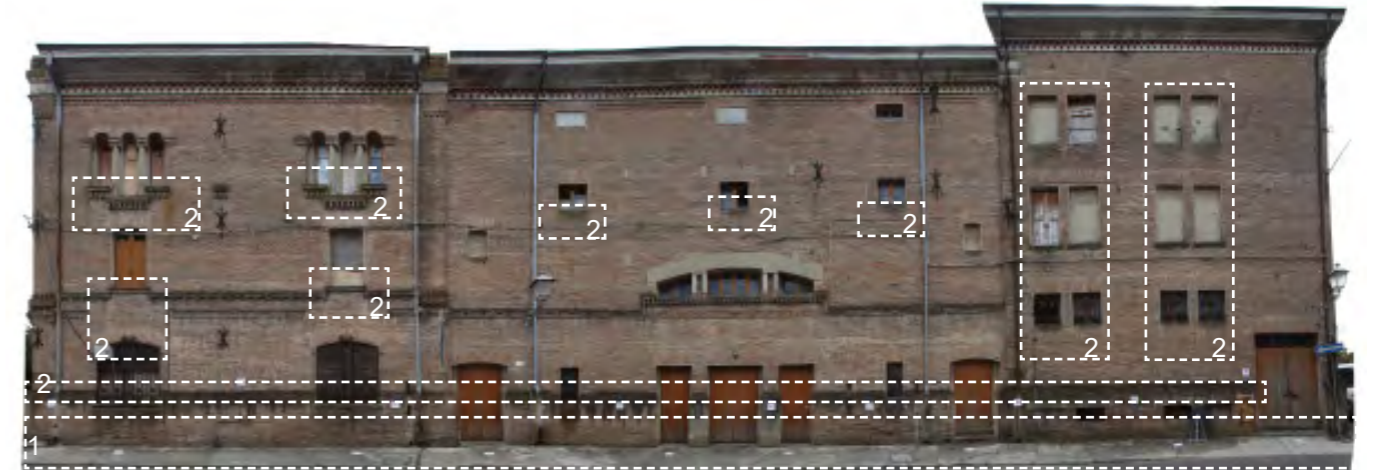


photographic survey_ north elevation



dripping; biological patina: the phenomenon is linked to inadequate water drainage, often caused by the absence of pavement markings.

photographic survey_ north elevation



photographic survey basement strip



1-rise; biological colonisation
 2-dripping; biological patina: the phenomenon is linked to inadequate water disposal..

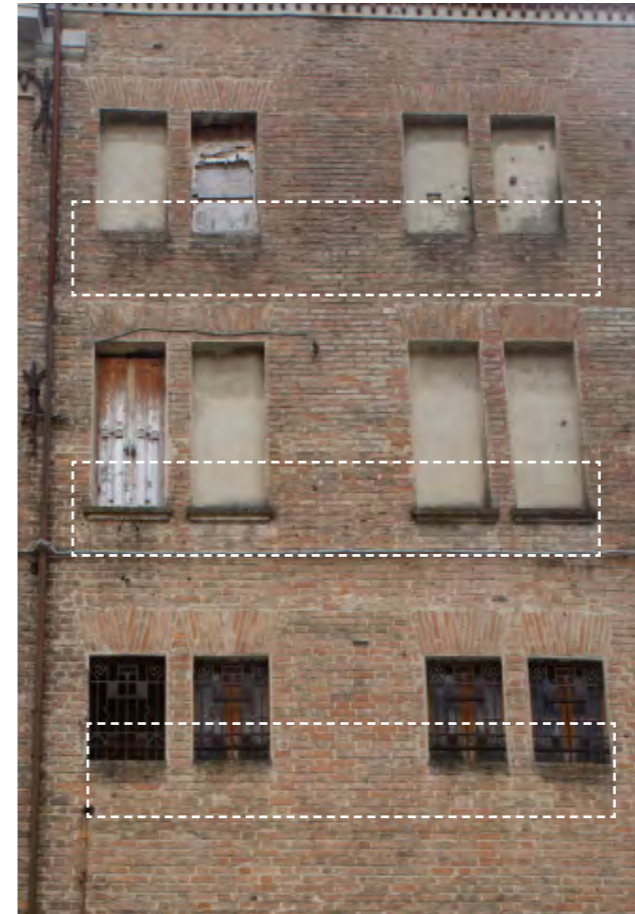
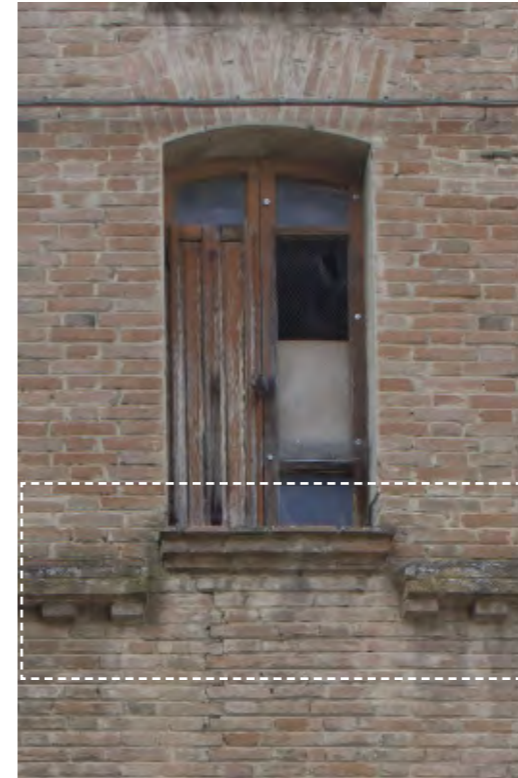
photographic survey_ north elevation



1-rise; biological colonisation

2-dripping; biological patina: the phenomenon is linked to inadequate water disposal..

photographic survey_ north elevation



2-Colouring; biological patina: the phenomenon is linked to inadequate water drainage, often caused by the absence of pavement markers.

photographic survey_ north elevation



1-rising front; biological colonisation; the presence of vegetation

2-Colouring; biological patina: the phenomenon is linked to inadequate water drainage, often caused by the absence of pavement markers.

photographic survey_ west elevation



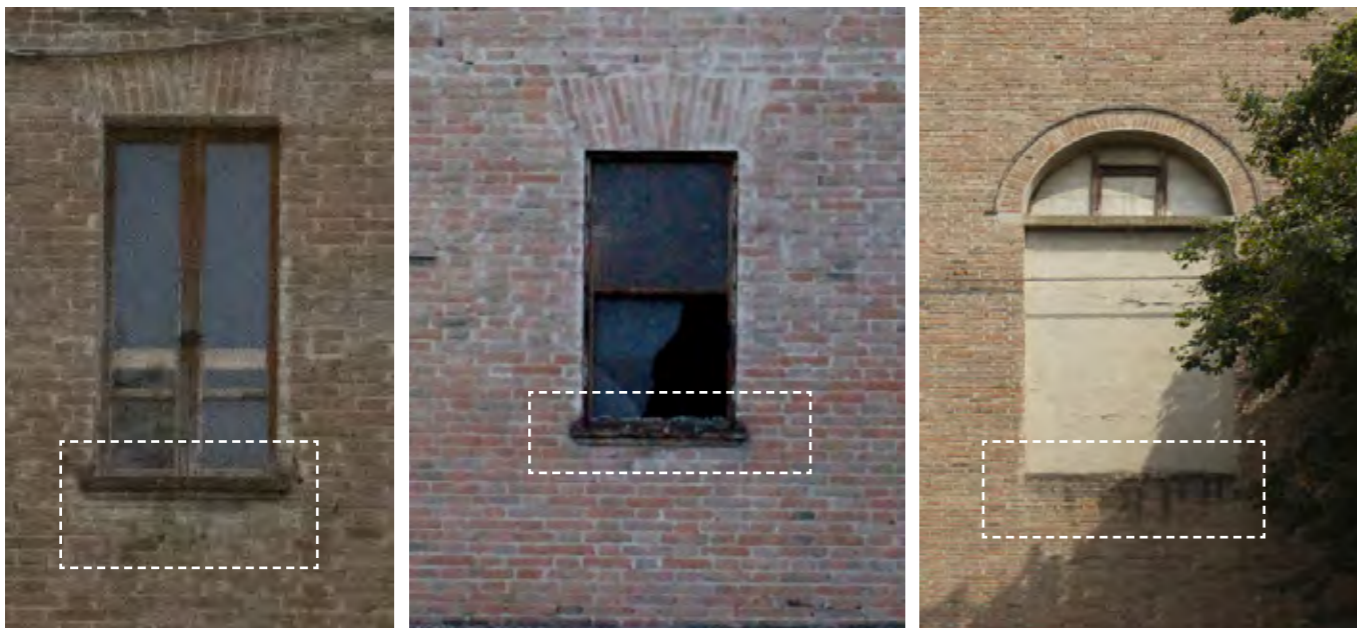
1-rise; biological colonisation; the presence of vegetation

2-colouration; biological patina: the phenomenon is linked to inadequate water disposal.

photographic survey_ west elevation

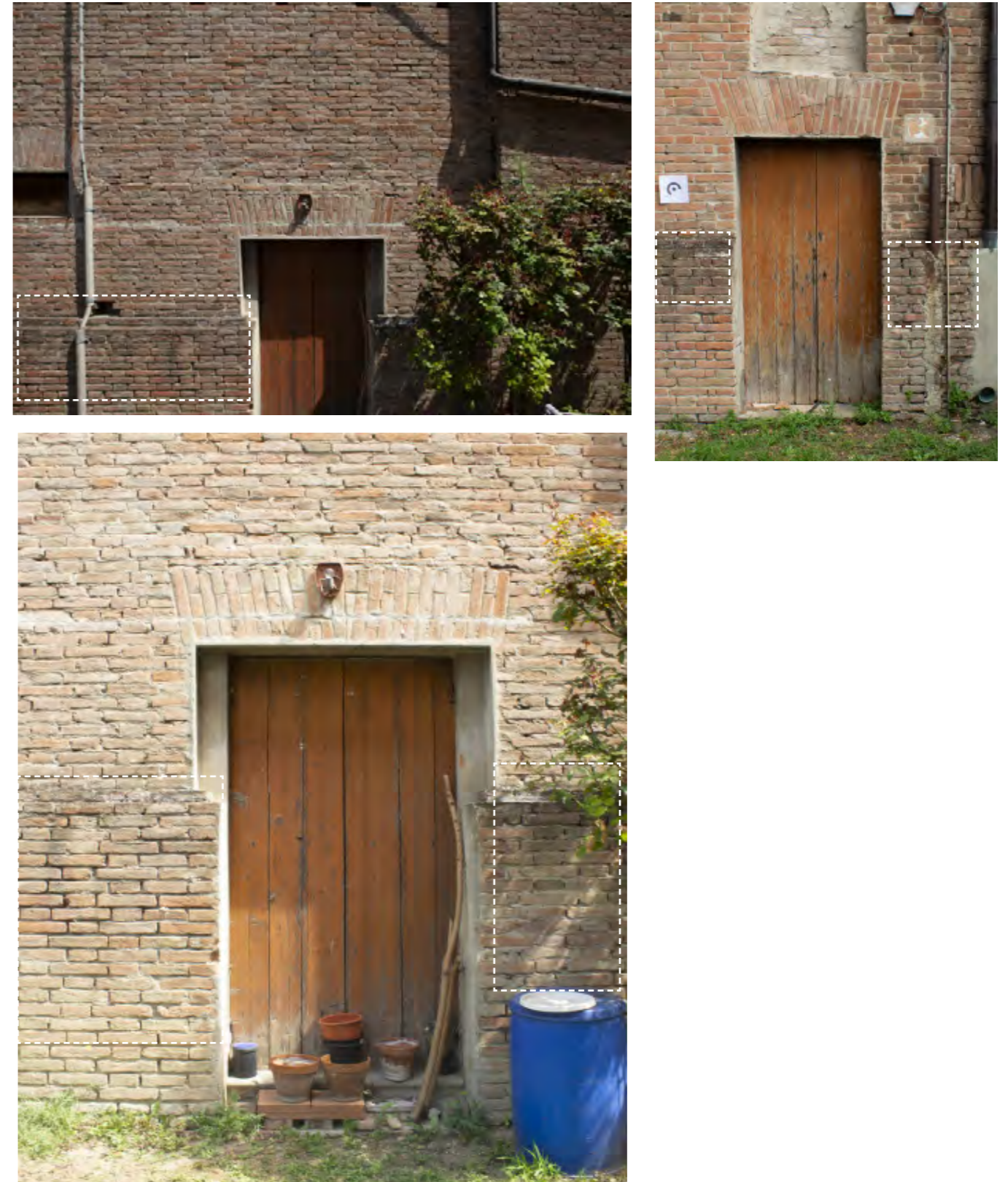


photographic survey_ south elevation



2-Colouring; biological patina: the phenomenon is linked to inadequate water drainage, often caused by the absence of surface markers.

photographic survey_ south elevation

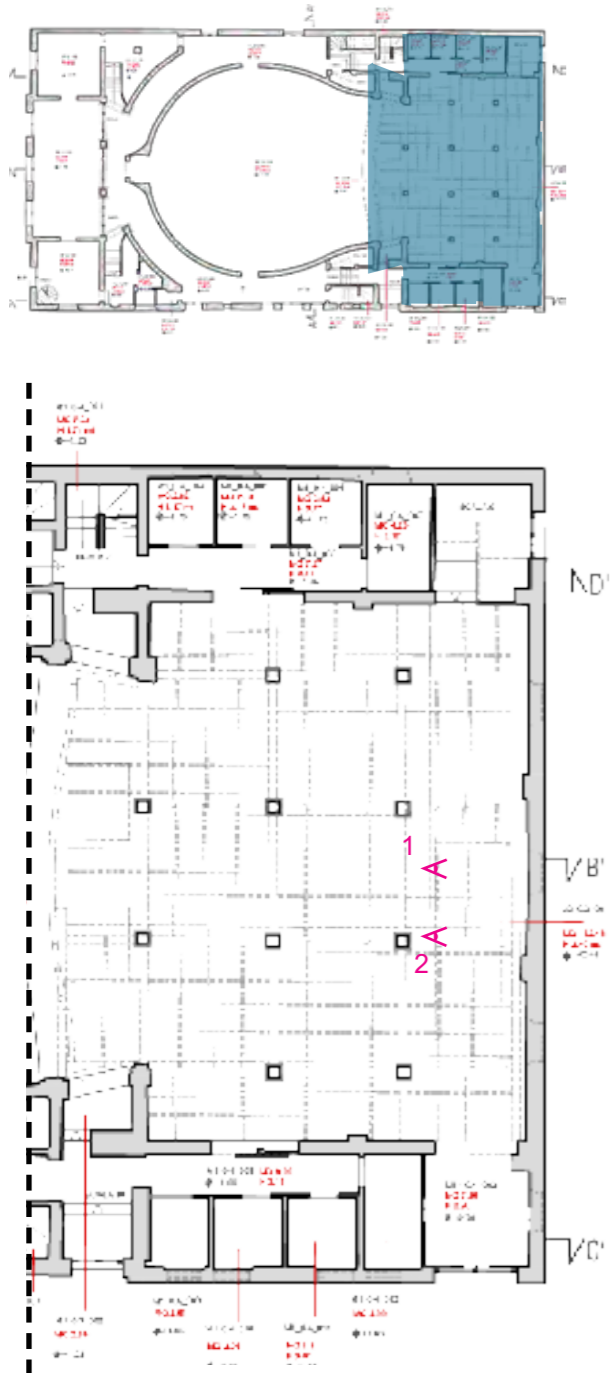


1 biological colonisation

2 dripping; biological patina: the phenomenon is linked to inadequate water disposal.

Photographic survey of the main morphologies of degradation in the theatre's interior

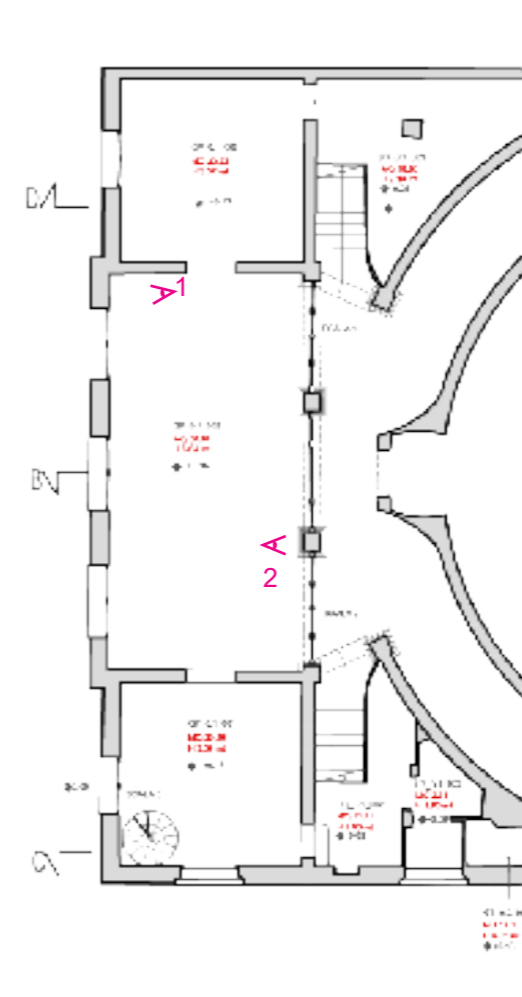
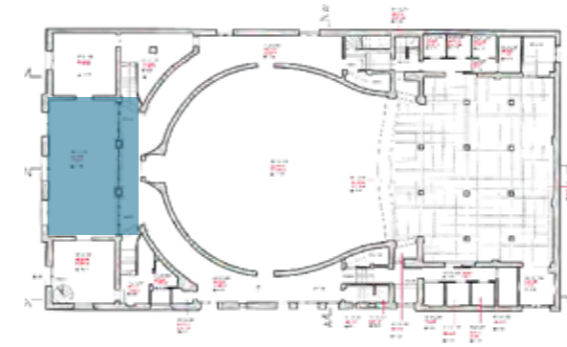
US 0.4
LG_0.4.001



1-2 rising edge

1-2 stain: localised colour change of the surface, related to the presence of water

US 0.1
GF_0.1.002



1 -detachment is a phenomenon present on plasterwork, with the layers falling off.

2 -detachment of the decorative film

2 - 3 superficial deposit

3 - biological colonisation

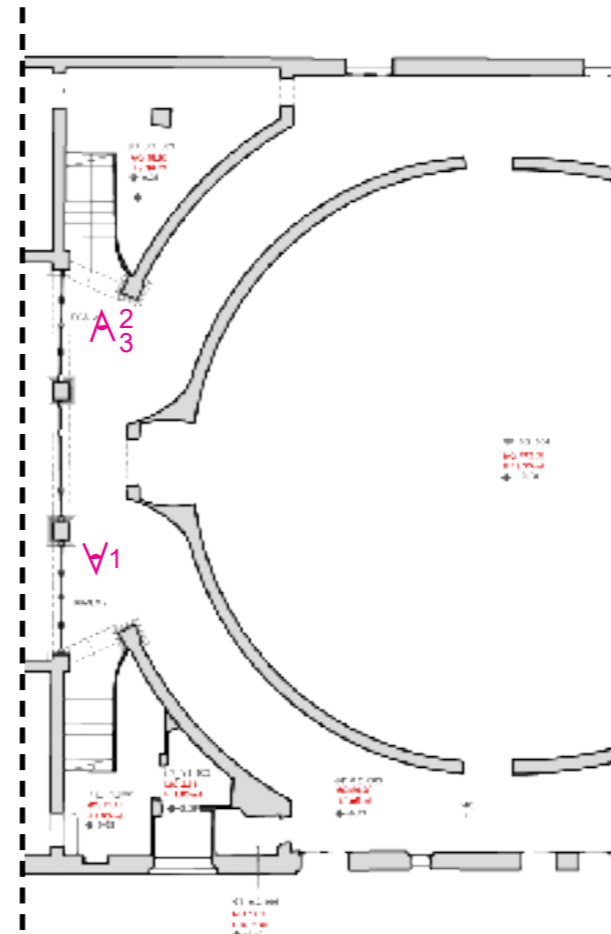
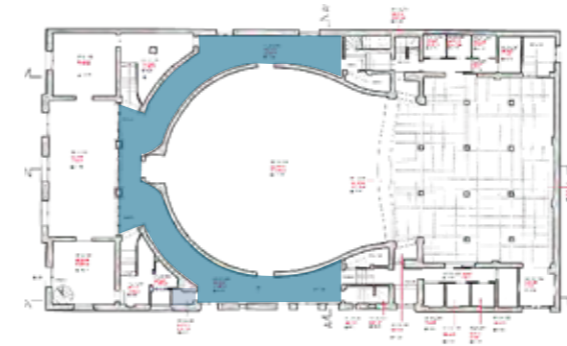
detail of the vaulted ceiling GF_0.1.002



3-4-5 staining: localised colour variation of the plaster surface

3-5 differential plaster degradation

US 0.2
GF_0.2.005



1-2-3 stain: localised colour change on the plaster surface

1-2-3 differential plaster degradation

4- detachment: a phenomenon present on plaster, with falling layers.



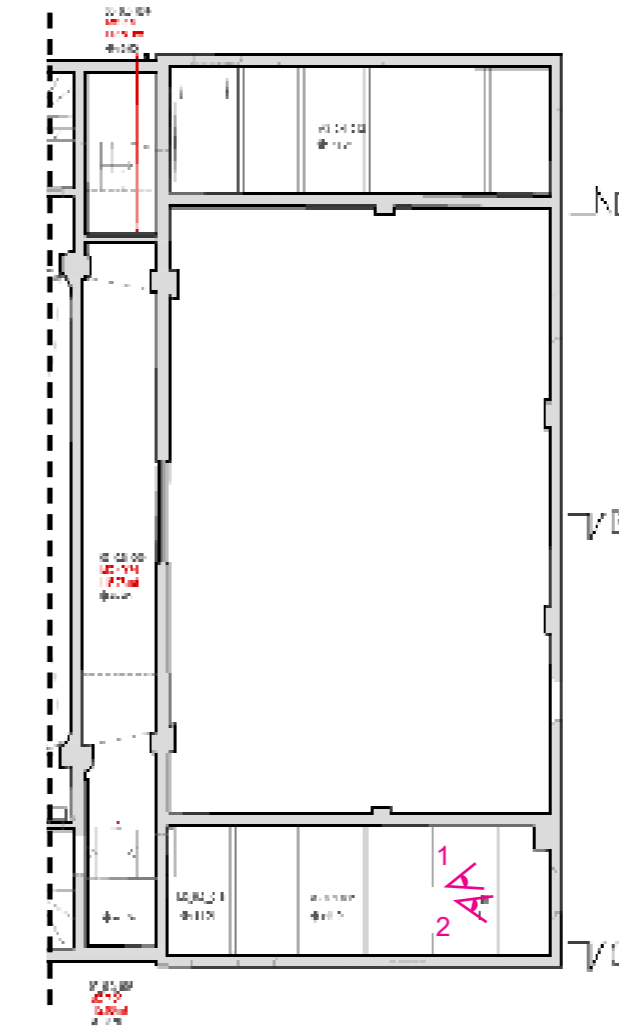
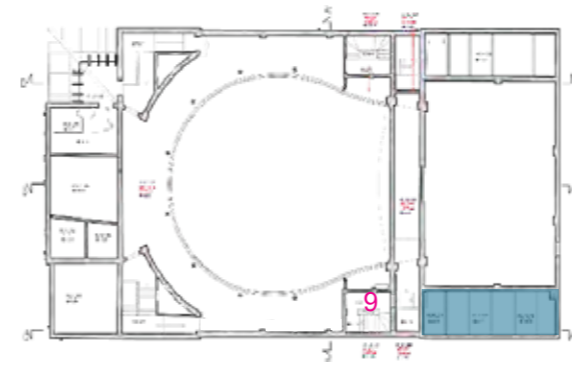
detail of the ceiling GF_0.2.005



macro detail of the plaster detachment partially visible in photo 4

US 0.4

03_0.3.013-14-15



1-2 staining: localised colour change on plaster surface

1-2 dripping

1-2 differential plaster degradation

1-2 detachment: a phenomenon present on plaster, with falling layers.

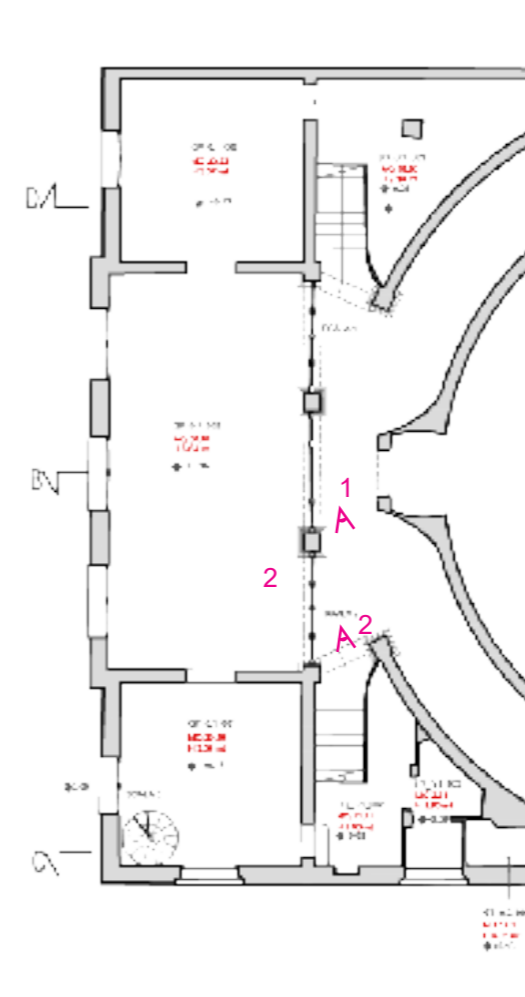
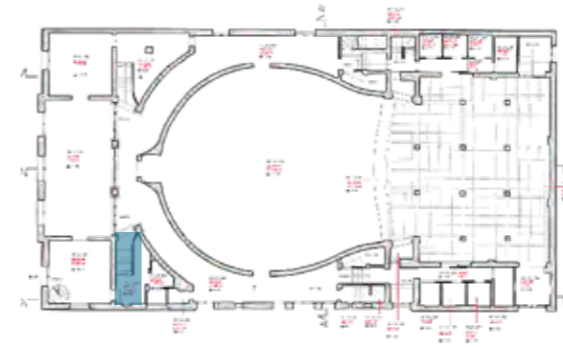


detail of the ceiling 03_0.3.013-14-15



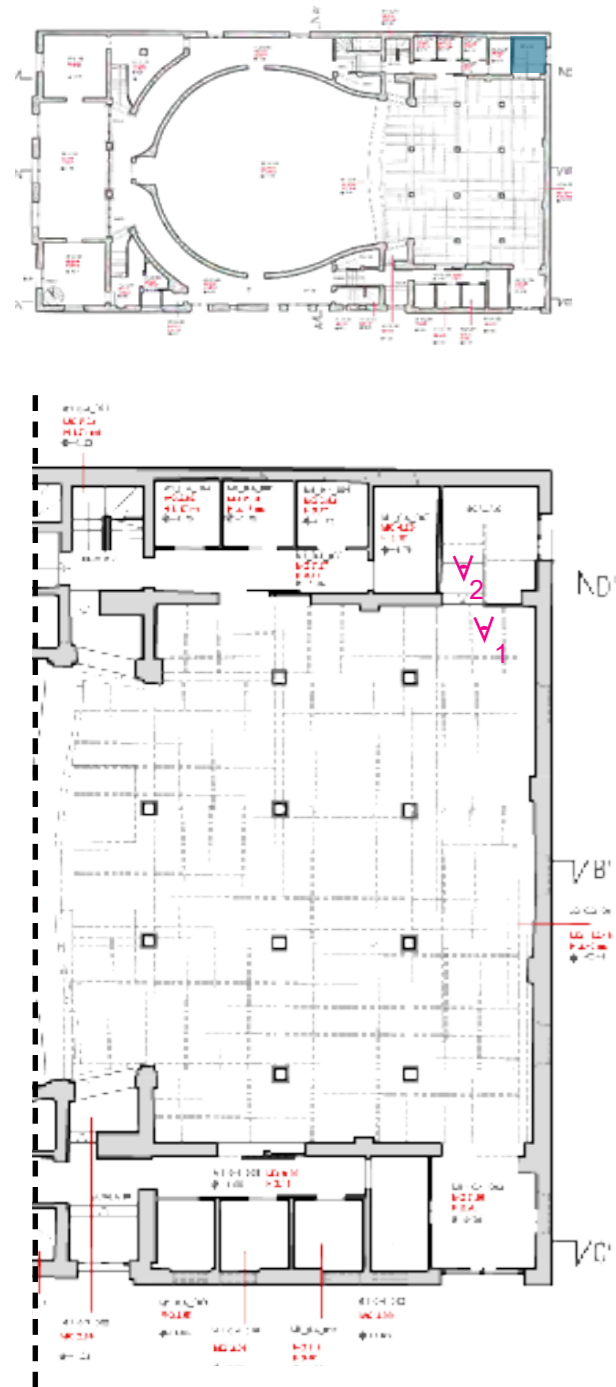
- 3-4 staining: localised colour variation of the plaster surface
- 3-4 dripping
- 3-4 differential plaster degradation
- 3-4 detachment: a phenomenon present on plaster, with falling layers.

staircase 2



- 1-2 detachment: phenomenon present on plaster, with falling layers.
- 1-2 surface deposit
- 1- vandalistic murals(corridor wall)

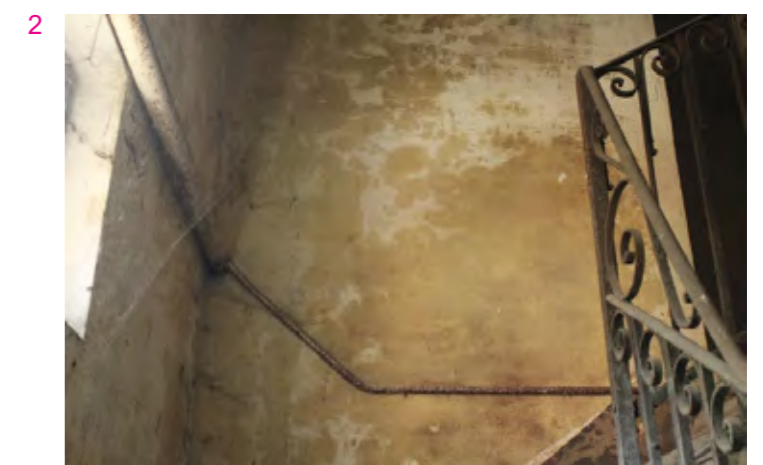
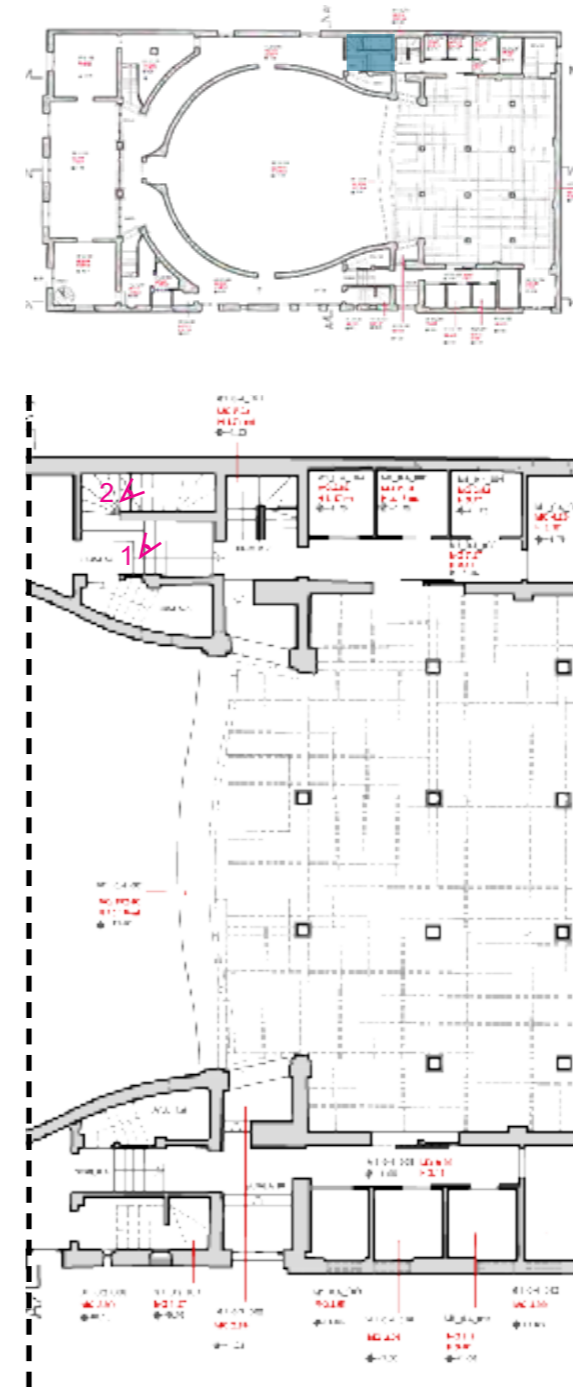
staircase 9



1-2 staining: a localised colour variation on the surface, related to the presence of water

1-2 detachment: a phenomenon present on plaster, with the layers falling off

staircase 7

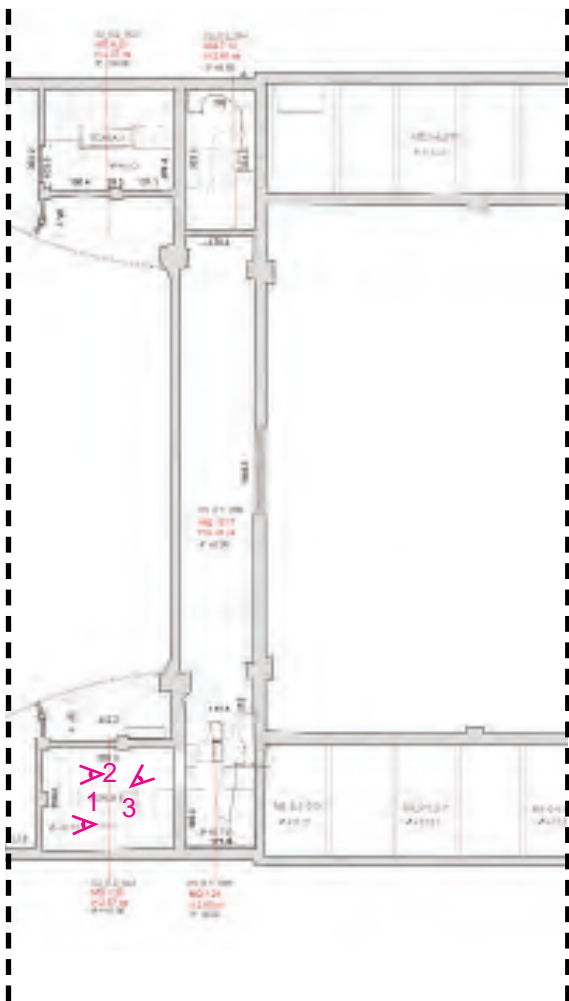
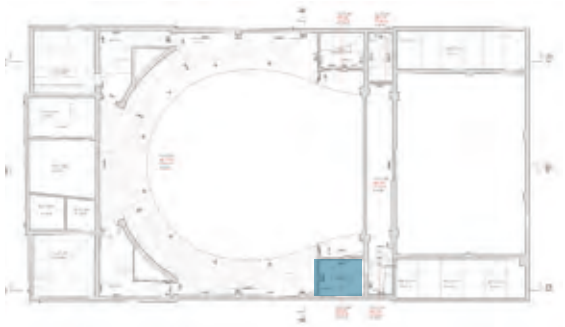


1-2 staining: localised colour variation on the surface, related to the presence of water

1-2 detachment: a phenomenon present on plaster, with the layers themselves falling off

1-2 differential plaster degradation

staircase 8



1



2



3



1-2-3 staining: localised colour change on the plaster surface

1-2-3 dripping

1-2-3 differential plaster degradation

1-2-3 detachment: phenomenon present on plaster, with falling layers