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Field Reports

Title
Florence Thermography and XR, Dec 1st - Jan 5th 2025 Florence, Italy

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Field Report:

Florence Thermography and XR

Dec 1st - Jan 5th 2025
Florence, Italy



Thermal Image of Loggia dei Lanzi

Field report prepared Jan 9th 2026
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Cultural Heritage Engineering Initiative (CHEI) and ALERTCalifornia
at the University of California San Diego

CHEI projects are directed by Professor Falko Kuester & Dr. Dominique Rissolo

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Expedition Overview:

A nice chilly December in Florence, giving perfect conditions for thermography. Working closely with Editech, UniFi, and hosting supporters from the U.S., we In this trip, 3 members of CHEI lab visited Florence with the following goals:

1. To perform a comparative analysis of thermographic sensors under optimal ambient conditions.
2. To develop a multisensor imaging array system to streamline the 3D capture and registrations of multispectral inputs with visible images and LiDAR.
3. To develop extended reality (XR) systems which would enable the real-time overlay of digital assets in complex environments.

The original plan was to perform this work inside Palazzo Vecchio's Hall of Lillies, and the church of Santa Maria Novella, but we were unable to obtain the correct permissions. The holiday season and the short rental term of the FLIR t1020 camera presented a very small window of opportunity. Instead, we focused on exterior spaces which did not require permissions. Blessed with dry and cold weather, we obtained dozens of high resolution images revealing the hidden structures lying just beneath the surface of Florence's most famous monuments.

A full listing of datasets and their contributors are provided in appendix 2.
Please contact Scott McAvoy (smcavoy@ucsd.edu) for any questions regarding access to or re-use of this data.

Special thanks to Carol Tohsaku, and to Kinsella Innovation Fund for supporting this fieldwork.

Expedition Team

Scott McAvoy*(UC San Diego), smcavoy@ucsd.edu
Jonathan Klingspon (UC San Diego)
Aviral Agarwal (UC San Diego)
Elisavetta Dvorschenko (University of Florence)
Prof. Giorgio Verdiani (University of Florence)
Prof. Maurizio Seracini (Editech)

Data Acquisition:

Our imaging tools and methodologies are outlined below:

FLIR T1020 HD



High end portable thermal camera with built in visualizations systems and RGB camera.

- 1024 × 768 pixel resolution
- < 20 mk thermal resolution @ 30°C

FLIR A615



An older model, intended for laboratory work. No RGB, no battery, requires computer attachment.

- 640 × 480 pixel resolution
- 50 mk thermal resolution @ 30°C

Data Quality and Availability

The data provided by this project is not certified by a licensed surveyor. Measurements provided are subject to error. If an application requires a particularly high level of accuracy or precision (for example, a hydrological analysis) please contact the authors of this report.

Activities

Tuesday December 2nd

Greeting with with:
Giorgio Verdiani, Professor Architecture Unifi, hoping to collaborate with Palazzo vecchio thermography
Stefano Corazzini, Architectural Historian studying Palazzo Vecchio
Loarasa Zenjati, masters student at UNIFI, Thesis is San Egidio Reconstruction of original structure (used out thermography to help locate windows
Alexia Charalambous, Cypriot! Doctoral student involved in many of the scanning activities

Wednesday December 3rd
Scott Planning, writing, getting things ready for Jonny, arrivinh in the evening

Thursday December 4th
Jonny's Birthday (surprise!)
Cancelling meeting with Valentino Bonara (sick)
Visiting Santa Maria Novella for tour with Jonny, noting areas of interest. Strozzi Chapel has been restored, flattened
Rented FLIR 1020 arrives early from Belgium!
Meeting with Aviral (online)

Evening Thermography (Jonny, Scott, Maurizio)
- about 40 degrees F, 93% humidity, very light snow
- Uffizi from outside Maurizio's office
- Maurizio in Piazza Della Signoria

Friday December 5th

Scott - Early morning thermography (5:30-7:00)

- Santa Maria Novella area, from train station back

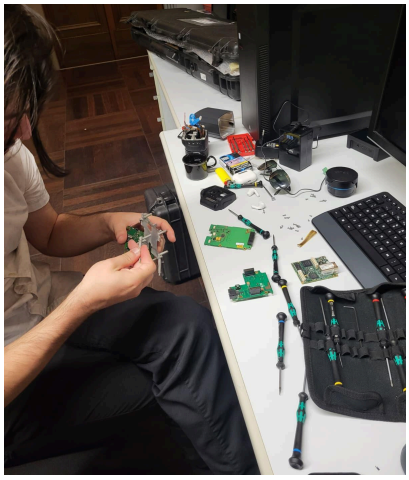


- Two hidden arches on Arno side of the Uffizi (below)



10am at at Maurizio's

Jonny working on FLIR A615 build, not powering on



- After 4pm, fixing stuff, breaking stuff,
-Scott doing some comparisons, we can see much more detail under the optimal cold conditions

	
February 23rd 2025 ~9pm FLIR t1020	December 4th 2025 ~9pm. FLIR t1020



Above: FLIR autopano of Ponte Vecchio, from southwest viewpoint



Above: FLIR Autopano from across the Uffizi, outside Editech.

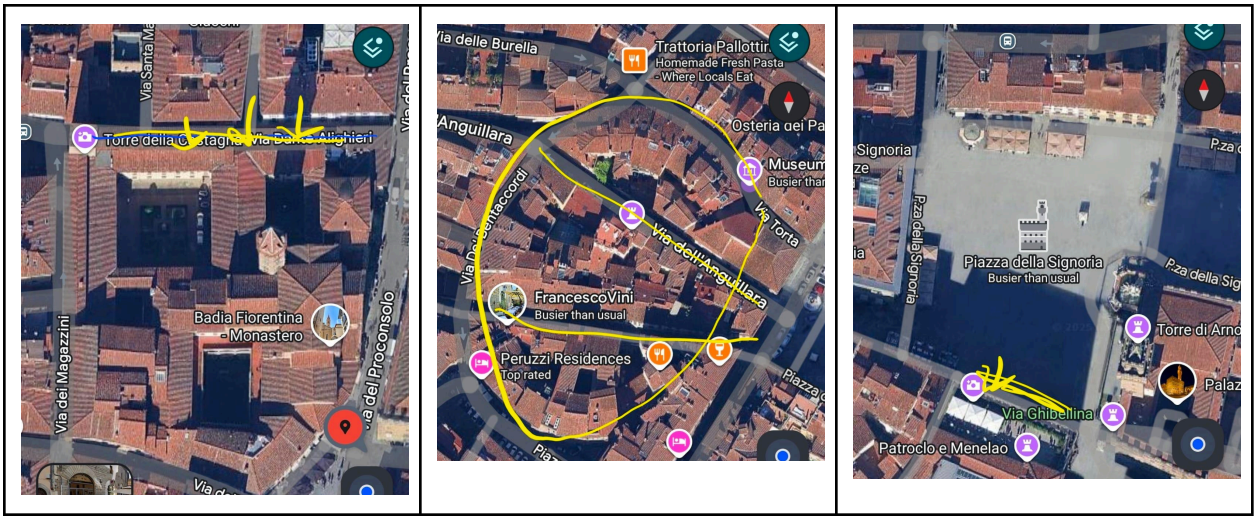
Saturday December 6th

- Presentation: San Egidio (appendix 1). Our work from February was represented by Giorgio and Loarsa, helping to find windows and doors from the original church of San Egidio.

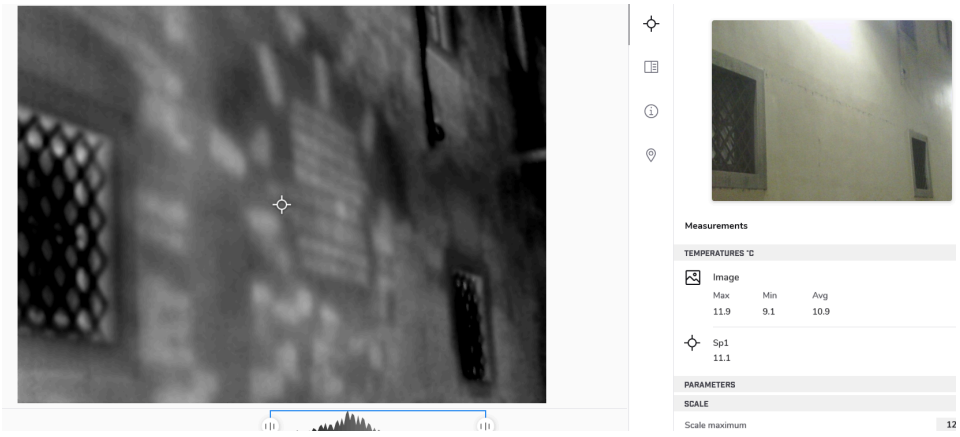


- Site Recommendations
    - Via Peruzzi and “La Torta” area where the roman colosseum had been near Santa Croce, still in oval shape. (Verdiani)
    - Badia for changed entrance (Gaia)
    - Carabinieri’s office at SMN, (scott did on the morning of the 5th) as the height kept changing, we expect to see evidence of the windows raised.

- Thermography (Scott)
Badia, The Colosseum Area, Panos of Loggia in Piazza della Signoria. My thermometer said 11C 43% humidity, online said 6C 98% humidity. Big difference.



-Badia - Good prospects on north wall near piazza Alighieri, archway with differing materials hidden (below). A tight alleyway makes it difficult to approach these features head-on.



Sunday Dec 7th

Scott working on Data, meeting with Elisabeth Dvorschenko (UniFi)

iPhone tests loggia backwall (from outside) and Palazzo Vecchio courtyard. It seems the FLIRone camera will not give us stone by stone images.

Monday Dec 8th

A holiday, the feast of the immaculate conception
-Maurizio's office - reviewing FLIRone paper. Importance of "data fusion" theme vs image optimization.
-Review various pano data and plans for FIAW data fusion methodology with Maurizio
-Meeting with Marco Ferri, journalist, author, press agent for Florence sopra-intendenza. Gave me an email from the secretary of the mayor to request scanning permission for the Medici corridor.
-Battle of Anghiari historical data/archive (1970-2019) review, Scott and Maurizio. Lots of stuff to copy, raw thermal data for Palazzo Vecchio, awaiting book publication.
-Meeting with Aviral
- bringing Samsung phone, unity project
- packaging palazzo vecchio

- Jonny, lots of tech to fix and upgrade.
- Maurizio's camera battery upgrade
- Spectrograph repair, xp computer emulation

Thermography, Jonny Scott, Elisabeth (6:30 to 11pm)
- Santo Spirito Panos, and south side hidden window views. iPhone tests showed inability to see stone variation beneath plaster.
- San Romolo Pano, Piazza della Signoria
- Uffizi arches pano, southwest side, riverside
- Badia north pano, via dante alighieri

Tuesday Dec 9th



Data review with Maurizo
Power issues in lab abound

Jonny to Palazzo Vecchio and San Lorenzo/Capella Medici. Continuing calibration efforts for the FLIR camera.

Meeting with Stefano 2pm, great chat. Stefano wants to organize something new with Nat Geo photographer Dan Yoder, who'd worked on the Anghiari documentary. Maurizio is very reluctant.

Jonny, calibration, ordering parts, Palazzo Vecchio

Maurizio reviewing data, learning about photoshop tricks for facades. Using brightness, then gamma, then exposure, then unsharp mask, in blocks. Image below, MS worked only in the center, see the difference.

Scott practicing applying MS techniques to other panos



Thermography - Scott 7:30 - 10:30pm

Very humid, it rained just a bit. 12 degrees, 63%.
-Santa Maria Del Carmine
-return to Santo Sprito for east side buildings

December 10th

Meeting with Valentina Bonora, Erica Parisis (Unifi)

Erica works with GeCo lab, and has access to the following sensors: Ulephone, T860
Planning with Maurizio, Beginning data review, Anghiari

Alternate Sites (anticipating failures in SMN and PV)
Figuring out FLIR return protocol (back to Belgium)

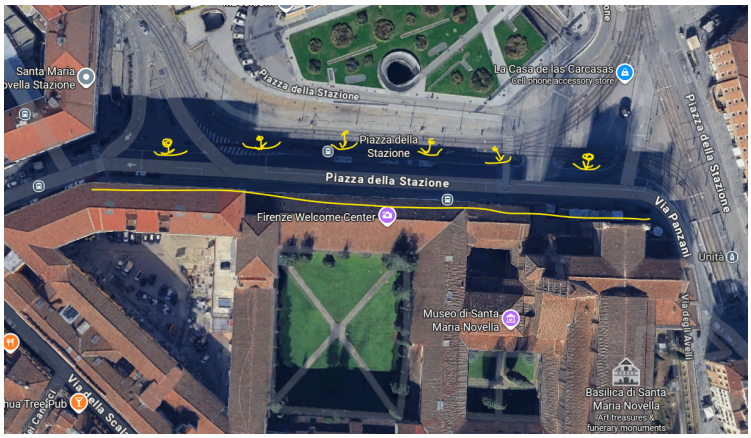
Network world/Western Digital/ OpenHeritage3D interview
12/10/2025 10:00-10:30 PST (19:00-19:30 Italy)

Thurs Dec 11th

T.W. comes to town, lots of stories with Maurizio. T.W. has data for Anghiari that MS doesn't.
Getting Maurizio's camera on battery, fixing other thermal camera

Thermography Scott 5:30-7:30

- Santa Maria Novella Piazza Della Stazione, carabinieri
- Some scattered shots around San lorenzo
- incomplete Lavatoi/S. Simone. Huge wall, with tons of hidden arches/windows
- incomplete church converted to school just north of baptistery







Friday December 12th (morning)

Thermography

- Pitti (not much)
- scattered uffizi, ponte vecchio, piazza della signoria
- Via Lavatoi, by San Simone
- some shots of San Romolo, with reverse on via della condotta





Friday 12 7-11
PERFECT weather for thermography. With Maurizio around uffizi, piazza san firenze, church next to signoria, The one George Bent works with also San Romolo and lots at loggia

Giorgio Verdiani arrived later, we did some more thermography in preparation for his team's future survey at Orsan Michele.

Saturday 13th -14th
Returned FLIR 1020hd today
To Genoa with T.W. and Jonny, and Aviral

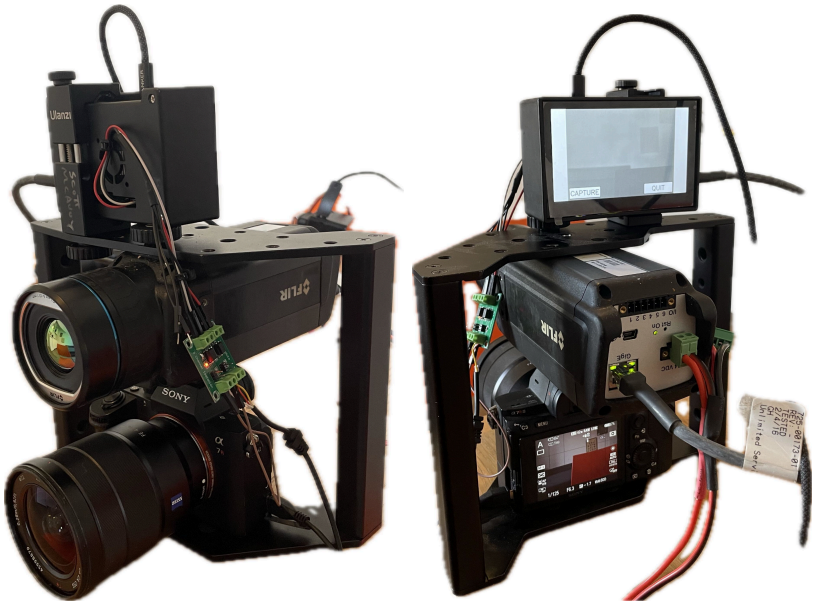
Monday 15th
Torino - Scott and Aviral travel day
Florence - Jonny and T.W.
Aviral:Walked around Valentino park and visited the Twelve Months fountain
Visited the Geomatics lab of Polito

Tuesday 16th
Scott and Aviral in Torino
Scott:
meeting with Enrico
PoliTo DAD department party at Castello Valentino
Aperitivo with G4CH Lab

Tour of Roman Ruins in downtown Torino (with Daniel Mangano)

Aviral: Visited Nietzsche's house and the Egyptian Museum
Took note of some of the interesting display methods and visualizations
Data review with Scott, Fixed some issues with the OH3D
Aperitivo with G4CH Lab

MEANWHILE: Jonny and T.W. in Florence, Reviving A615 thermal camera, the issue was the old coin cell battery. Image below, a615 build including coregistered RGB camera and PI.



Wednesday 17th

Scott in Torino, OH3D meetings at g4ch.
- Culluccia, planning 3D atlas for Sardinian site.
- La Scarzuola, an esoteric, surrealist "Ideal City" built by architect Tomaso Buzzi

Lunch with Daniel Mangano
Graduate Defense Enrico Rocca, Graduation, Enrico Rocca!

Thursday 18th

Scott and Aviral Leave Torino for Florence
Brief exterior tours, getting setup
All meet Maurizio in the Evening

Friday 19th

Scott and Stefano Corazinni meet to discuss available models, thermography of Palazzo Vecchio. Especially Sala delle Otto and missing places (both in verdiani and bent/mcavoy models)

- in between vasari ramps and the mezzanine
- and space between sala delle 500 and exterior south facade
    - These spaces are visible in the 3d models in the vanoni archives here

Data review with Scott, Aviral, and Jonny. Looking through Maurizio's archive.
Scott searches and prepares high res (15kx9k) image of Battle of Marciano for potree.

Aviral: Visited Uffizi and tested ARtifact_2 with the restored Adoration. Noted some room for improvement.

Saturday 20th - Meeting with Aviral in morning, going over AR demos to build (here)

Aviral:Visited Pitti Palace and the Boboli Gardens
Carol arrives in the evening.
Changed the Adoration images to match the new target

Sunday 21st - Carol Tohsaku in town,
Scott submitted Europeana proposal with Josep

Monday 22nd - Carol in town, Meeting with Maurizio
Aviral: Spent time making AR demos in Potree at Editech.

December 23rd-27th - Scott's Christmas in Antrodoco
26th - Mt. Giano
27th - Roman ruins (baths of Vespasian) and sunken church

Sunday December 28th - Working on FLIR A615 system, making ready for tripod, removing Sony camera

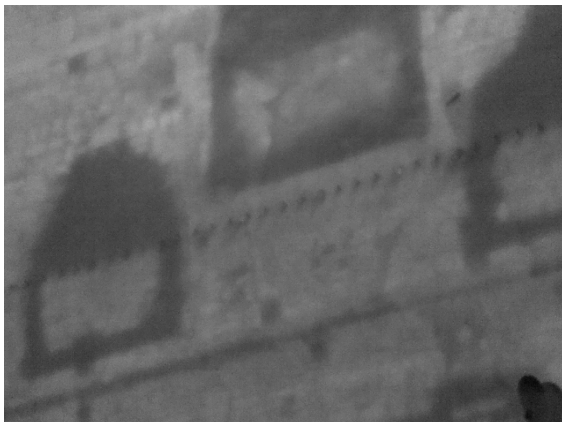


Monday December 29th - Working on AR concepts with Aviral, Videos in Piazza della Signoria

in morning.




Testing A615 in evening at Piazza Della Signoria. Luckily the A615 images contain enough detail to see key material features. And with the telephoto lens, we have very nice images.




With Telephoto Lens from across the piazza



Appendix 1 - Sant'Egidio conference



Appendix 2 - Dec 2025 - Data Inventory

#	Description	Collector	Sensor	CHEI Data Location
1	TIR - iPhone tests loggia backwall (from outside) and Palazzo Vecchio courtyard	S McAvoy	iPhone FLIRone	"Y:\italy\italy_florence\florence_thermal_december_2025\master\iphone_tests_smcavoy_12_7_2025"
2	TIR - Uffizi, Piazza della Signoria, Ponte Vecchio panoramas	S McAvoy J Klingspon M Seracini	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\jklingspon_smcavoy_mseracini_12_04_2025"
3	TIR - Santa Maria Del Carmine, return to Santo Sprito for east side buildings	S McAvoy	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_20-2230_12_09_2025"
4	TIR- Santa Maria Novella area, from train station back, Uffizi	S McAvoy	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_530-700_12_05_2025"
5	TIR - Santa Maria Novella Piazza Della Stazione, carabinieri, scattered shots around San Lorenzo, incomplete Lavatoi/S. Simone. incomplete church converted to school just north of baptistery	S McAvoy	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_530-730_12_11_2025"
6	TIR - - Pitti (not much) scattered uffizi, ponte vecchio, piazza della signoria, Via Lavatoi, by San Simone, some shots of San Romolo, with reverse on via della condotta	S McAvoy	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_530-730_12_12_2025"
7	TIR - Badia, The Colosseum Area, Panos of Loggia in Piazza della Signoria	S McAvoy	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_1930-2200_12_06_2025"
8		S McAvoy A Agarwal	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_agarwal_12_29_25_9pm-930"

9	TIR - Santo Spirito Panos, San Romolo Pano, Piazza della Signoria, Uffizi arches pano, southwest side, riverside, Badia north pano, via dante alighieri	S McAvoy J Klingspon E Dvorshenko	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_jklingspon_edvorshchenko _12_07_2025"
10	TIR - Uffizi, Piazza San Firenze, church next to signoria, The one George Bent works with also San Romolo and lots at loggia. With G. Verdiani at Orsan Michele.	S McAvoy M Seracini G Verdiani	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\smcavoy_seracini_verdiani_12_12_2025_1900-2200"
11	Video - in Piazze della Signoria, to be used for XR overlay concepts.	S McAvoy A Agarwal	Sony A7 r3	"Y:\italy\italy_florence\florence_thermal_december_2025\master\xr_video_backgrounds_pz_signoria"
12	TIR - calibration files for t1020	J Klingspon	FLIR t1020 hd	"Y:\italy\italy_florence\florence_thermal_december_2025\master\jklingspon_calibration"
13	Video - series of XR app screen recordings, showing the functionality of ARtifact.	A Agarwal	iPhone	"Y:\italy\italy_florence\florence_thermal_december_2025\master\aviral_artifact_FlorenceDecember2025_Videos"

Appendix 3 - Select Videos - ARtifact XR system

#	Description	Creator	Link
1	ARtifact 2025 Tornabuoni Chapel - SMN	Aviral Agarwal	https://youtu.be/FxAFxAXn1BQ
2	ARtifact 2025 Piazza Della Signoria - Historic	Aviral Agarwal	https://youtu.be/U3u1d1QEgRM
3	ARtifact 2025 Loggia Dei Lanzi	Aviral Agarwal	https://youtube.com/shorts/vyhtWSzzRzA?feature=share
4	ARtifact 2025 Battle of Marciano - PV	Aviral Agarwal	https://youtube.com/shorts/hrdSMOkIdic?feature=share
5	ARtifact 2025 Adoration of the Magi in Uffizi	Aviral Agarwal	https://youtube.com/shorts/uevV8kpUKWE?feature=share
6	ARtifact 2025 Palazzo Vecchio LiDAR overlay	Aviral Agarwal	https://youtube.com/shorts/0cySkaz1mBA?feature=share