MODERNISM ON THE PRAIRIE

Session 13

Non-Destructive Investigation of Concrete

Non-Destructive Investigation of Concrete

CHARLES BRANSBY-ZACHARY, GB GEOTECHNICS USA

Chas will use his 18 years of hands-on experience and an assortment of case studies to demonstrate what technologies are available, when to request this type of service for their project, and how to use the information provided. Project types will include advanced structural assessments of buildings (old and new), leak detection services, construction arrangement and conditions assessments, laser scanning and photogrammetry and its combined use with Impulse radar, metal detection, infrared thermal imaging, Ultrasonics, and impact echo.

DOCOMOMO 2015

Non-Destructive Investigation of Concrete: Demonstration on the St. John's Abbey

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VICE PRESIDENT / GBG USA INC

GB GEOTECHNICS USA INC. IS INCORPORATED IN NY STATE. MEMBER OF THE GBG GROUP OF COMPANIES

NEW YORK LOS ANGELES CAMBRIDGE LONDON SYDNEY PERTH

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been doing this for a while…

In the **UK**

And In the US

So what is NDE?

Actually… Its Using **Technology** (and ingenuity) to **Provide Information** about **Hidden Structure**

Why do we need to Investigate?

- DOES AS-BUILT MATCH DESIGN?
- WHAT IS CAUSING VISIBLE FAILURE?
  (LEAKS, CORROSION, VOIDS, CONSTRUCTION CHANGES…)
- HOW DO YOU AVOID STRUCTURE & UTILITIES DURING PROBING?
- RANDOM PROBES MISS VITAL CONDITIONS
- IS THERE A PATTERN TO THE DAMAGE
- WHAT IS HAPPENING BEYOND THE SURFACE?

Investigative techniques – LOTS!

1. Ground Penetrating Radar (GPR)
2. Infrared Thermography
3. Metal Detection

X-Ray & Gamma Radiography

Half-Cell Potentiometry

Inherent or Induced Electromagnetic Radiation or Radio Detection

Magnetometry & Gradiometry Resistivity

Seismics, Micro Gravimetry

Fibre-Optic & Digital Endoscopy

Doppler Vibrometer

Eigen Frequency & Modal Analysis

1. INFRARED THERMOGRAPHY
2. IMPULSE RADAR [GPR]
3. ACOUSTICS
4. MAGNETIC METHODS [METAL DETECTORS]

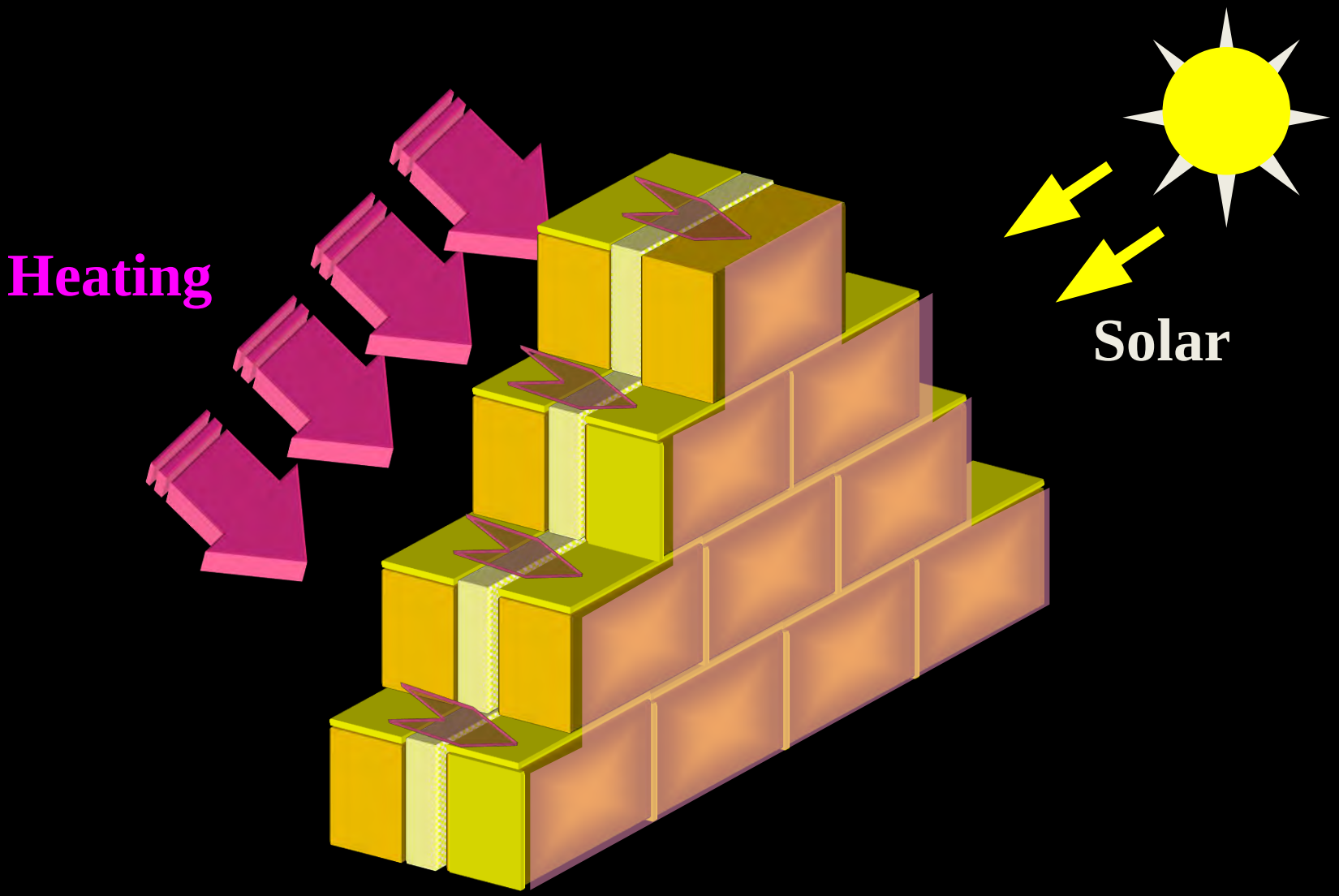
THERMAL IMAGING

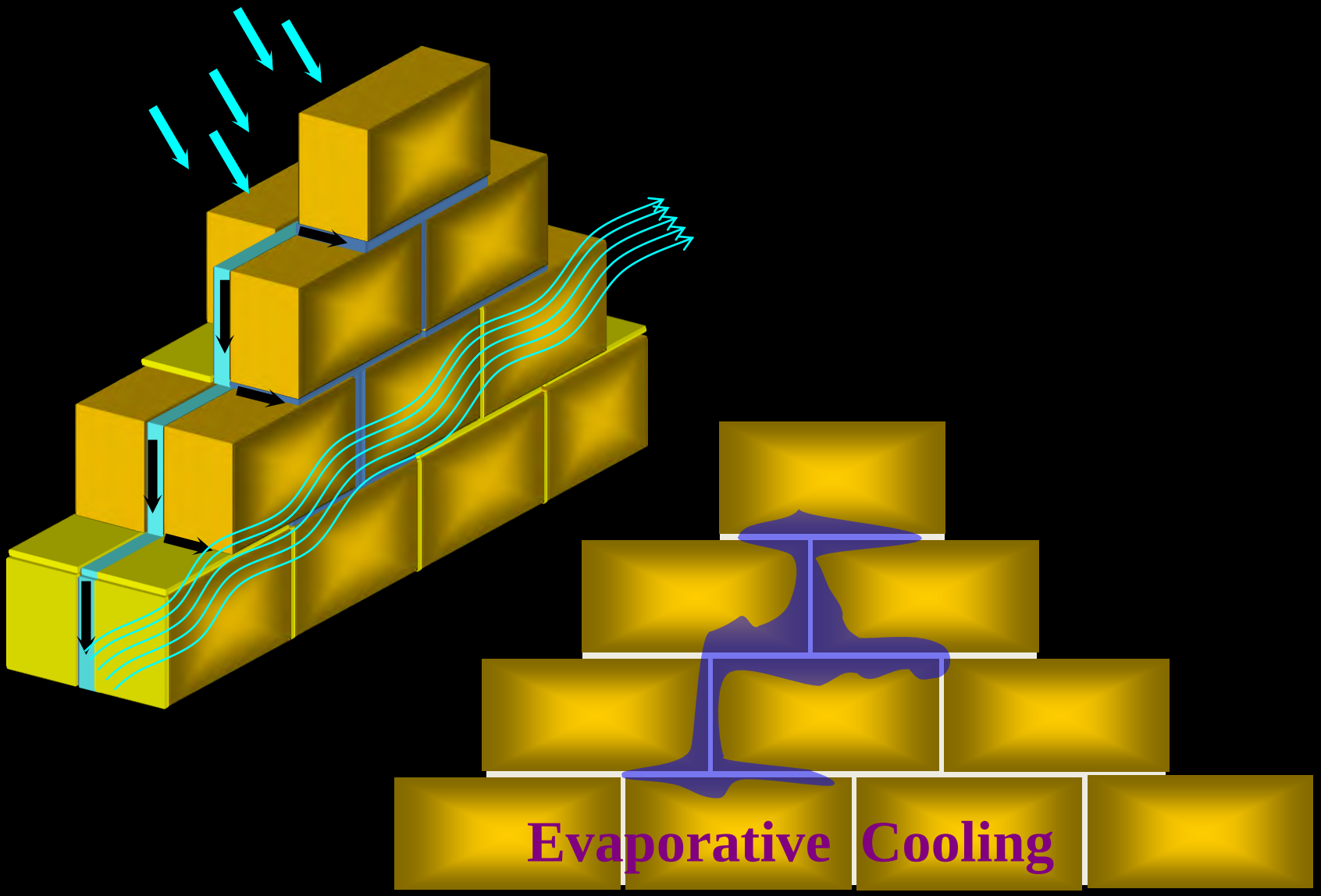
OVERVIEW

THERMOGRAPHY IS THE PROCESS OF ACQUIRING AND ANALYZING THE SURFACE TEMPERATURE OF AN OBJECT.

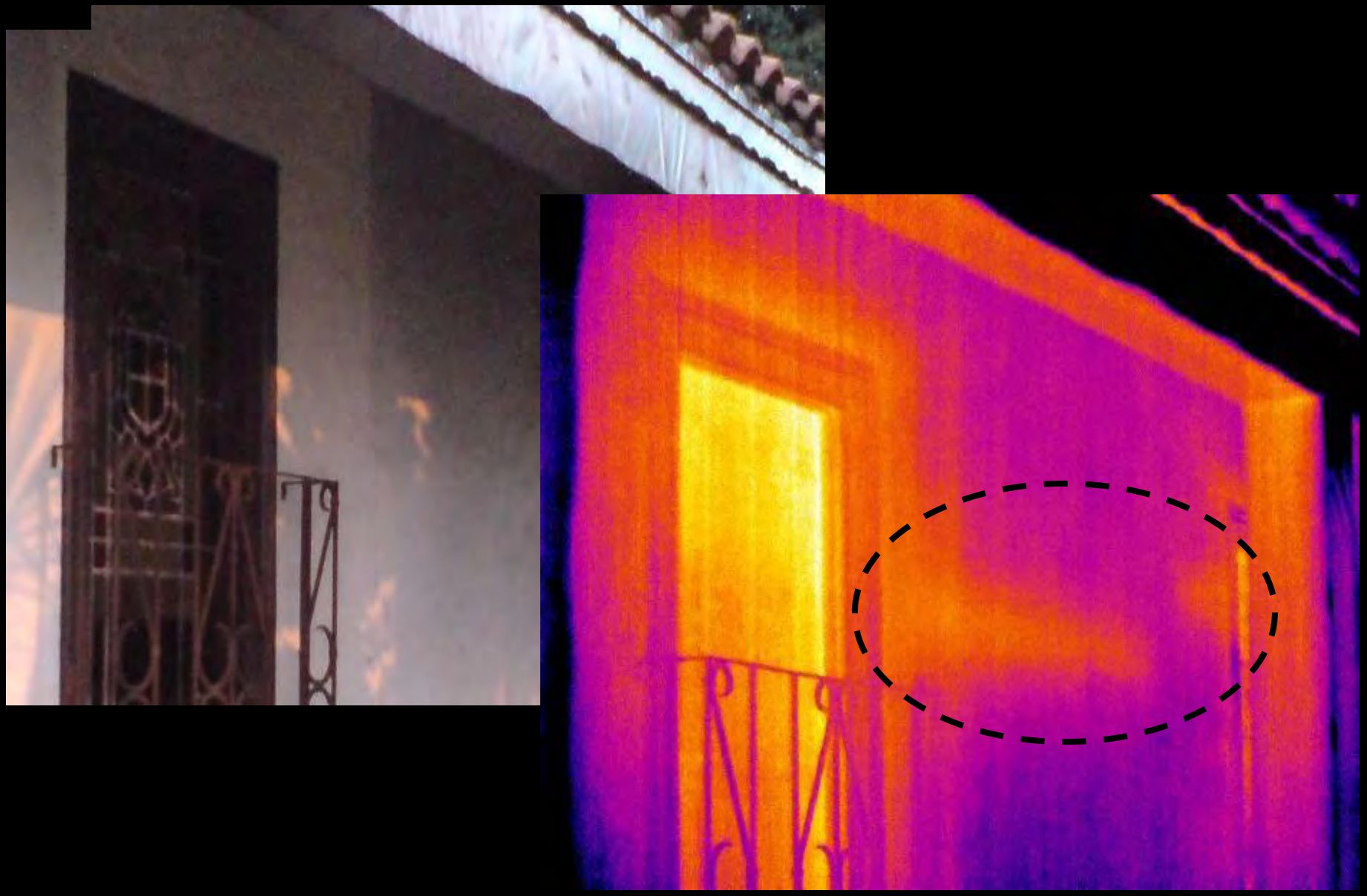
No Other Tricks Involved…

FLIR
FLIR
FLIR

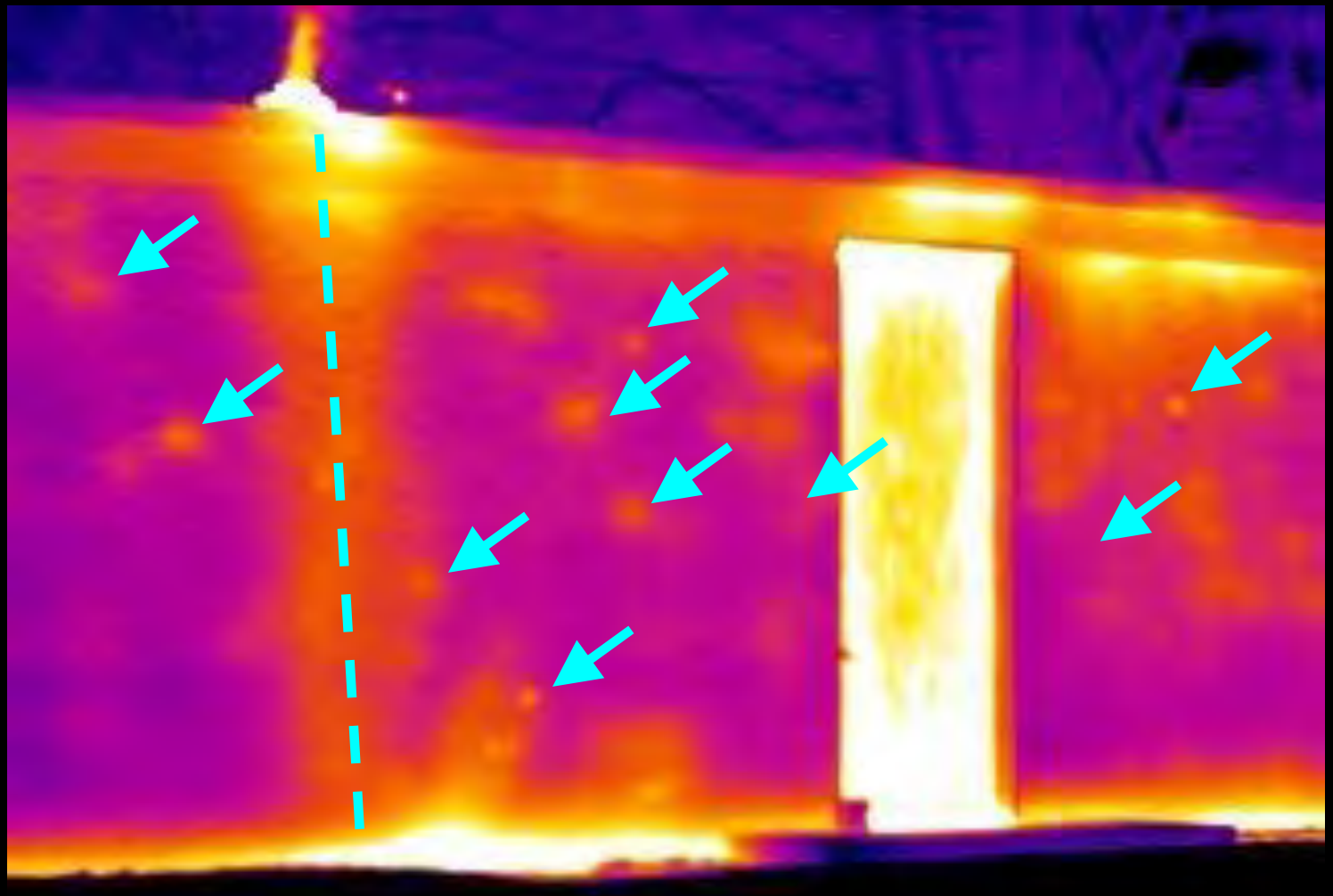

Heating
Solar


Evaporative Cooling

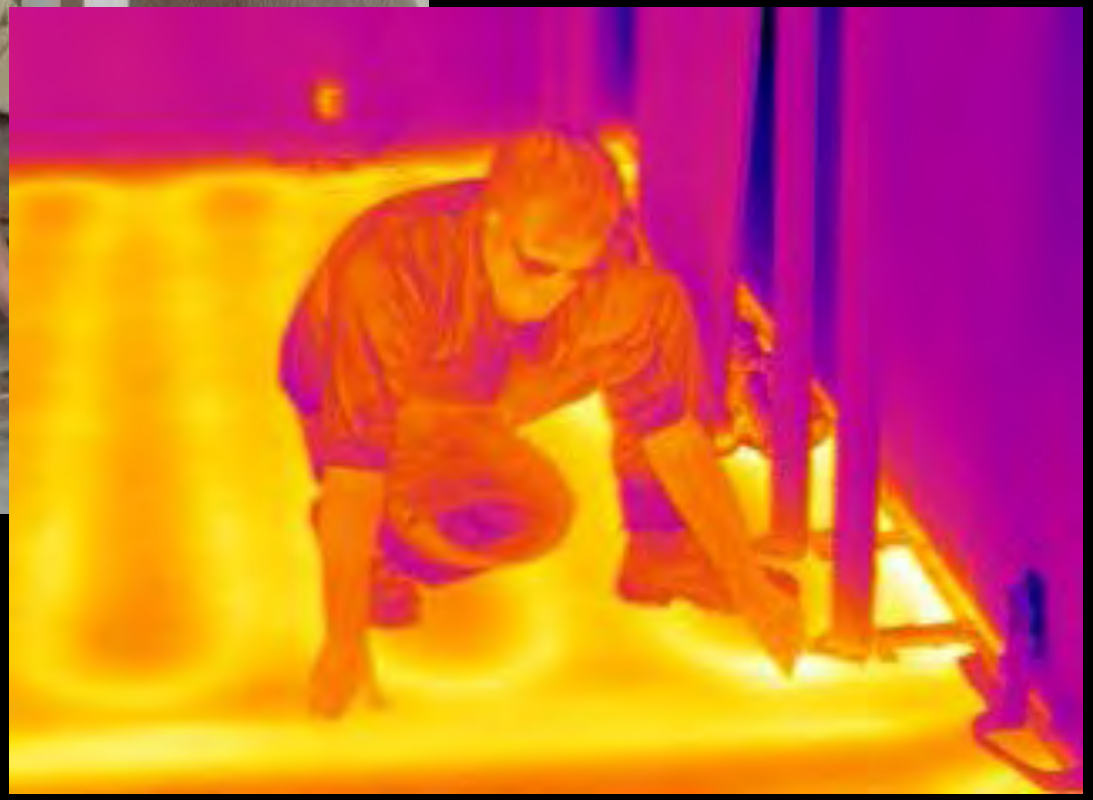
EXAMPLE: TIMBER FRAME



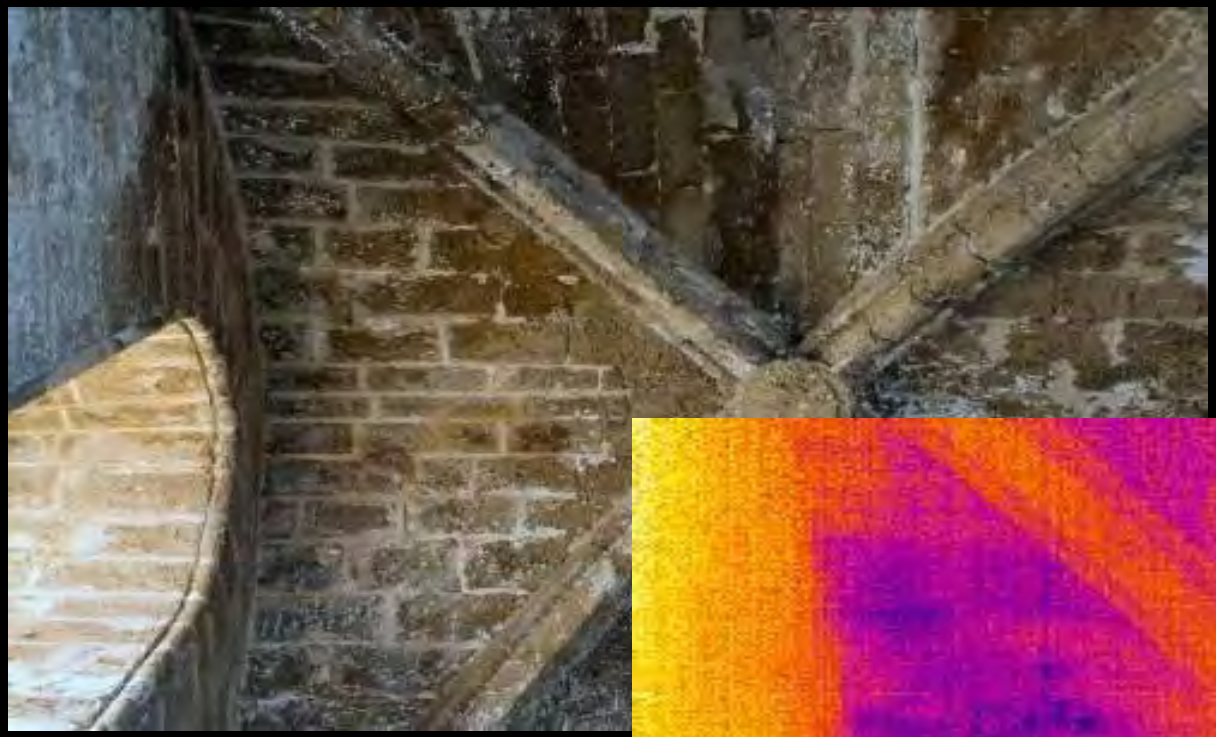
EXAMPLE: CAVITY WALL ASSESSMENT

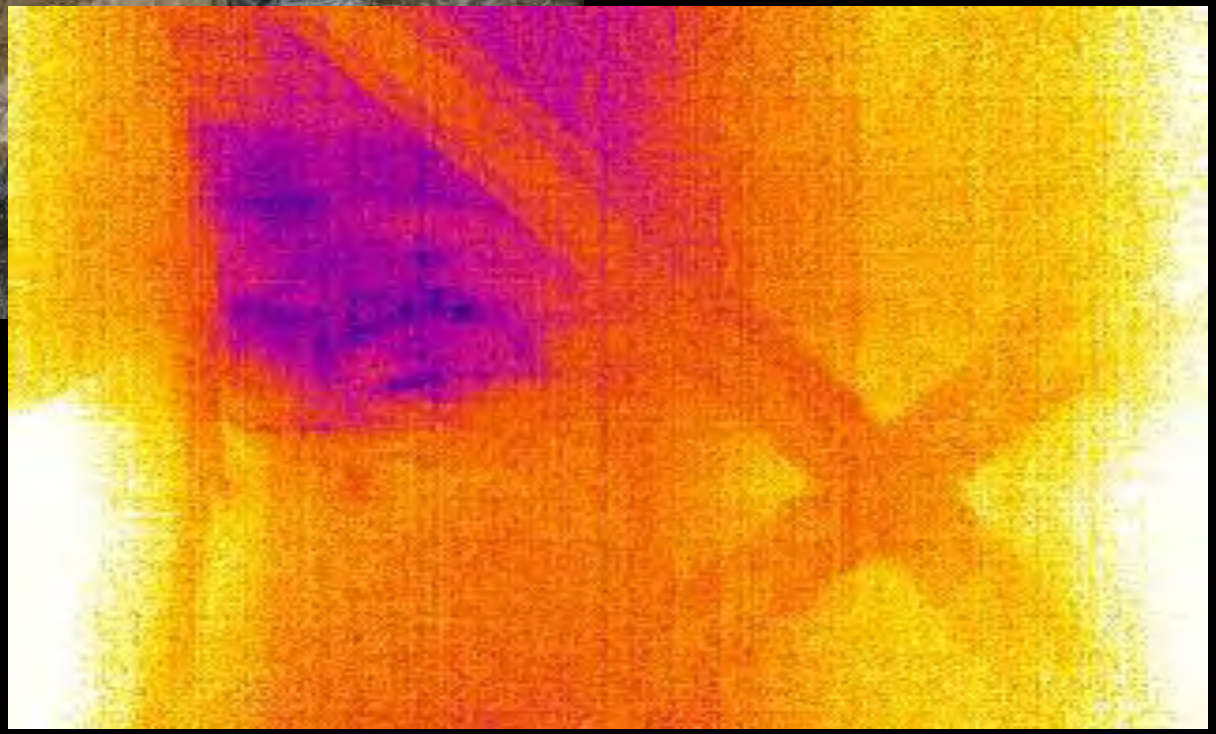


EXAMPLE: UNDERFLOOR HEATING

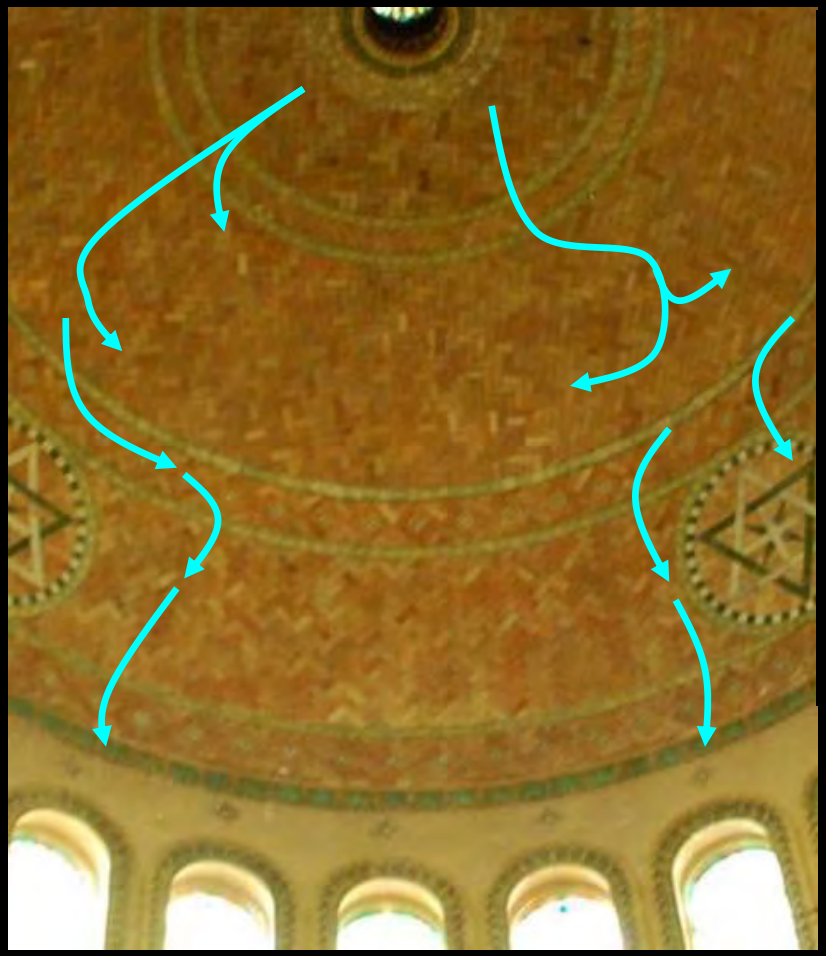


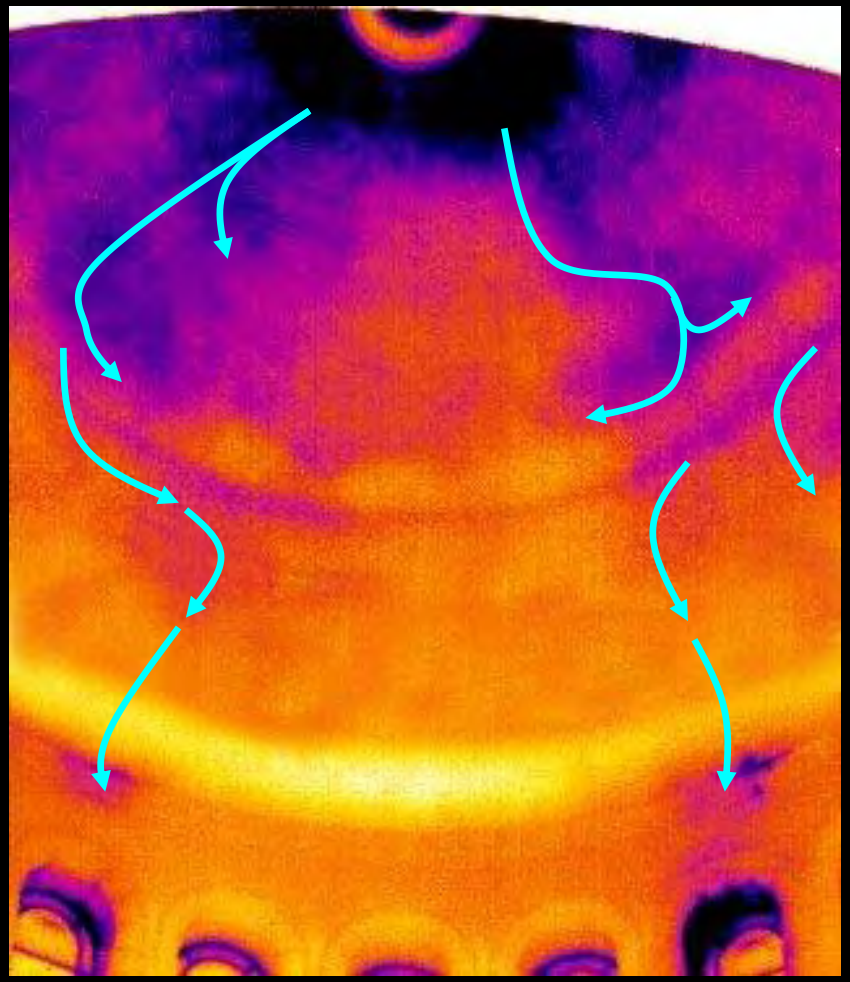
EXAMPLE: SURFACE MOISTURE





EXAMPLE: MOISTURE TRACKING





EXAMPLE: FULL FAÇADE

Critical Info…

Technology *Does not*
necessarily
make anything better

Interpretation

The latest in NDE…

1. INFRARED THERMOGRAPHY
2. GROUND PENETRATING RADAR [GPR]
3. ACOUSTICS
4. MAGNETIC METHODS [METAL DETECTORS]

GROUND PENETRATING RADAR [GPR]

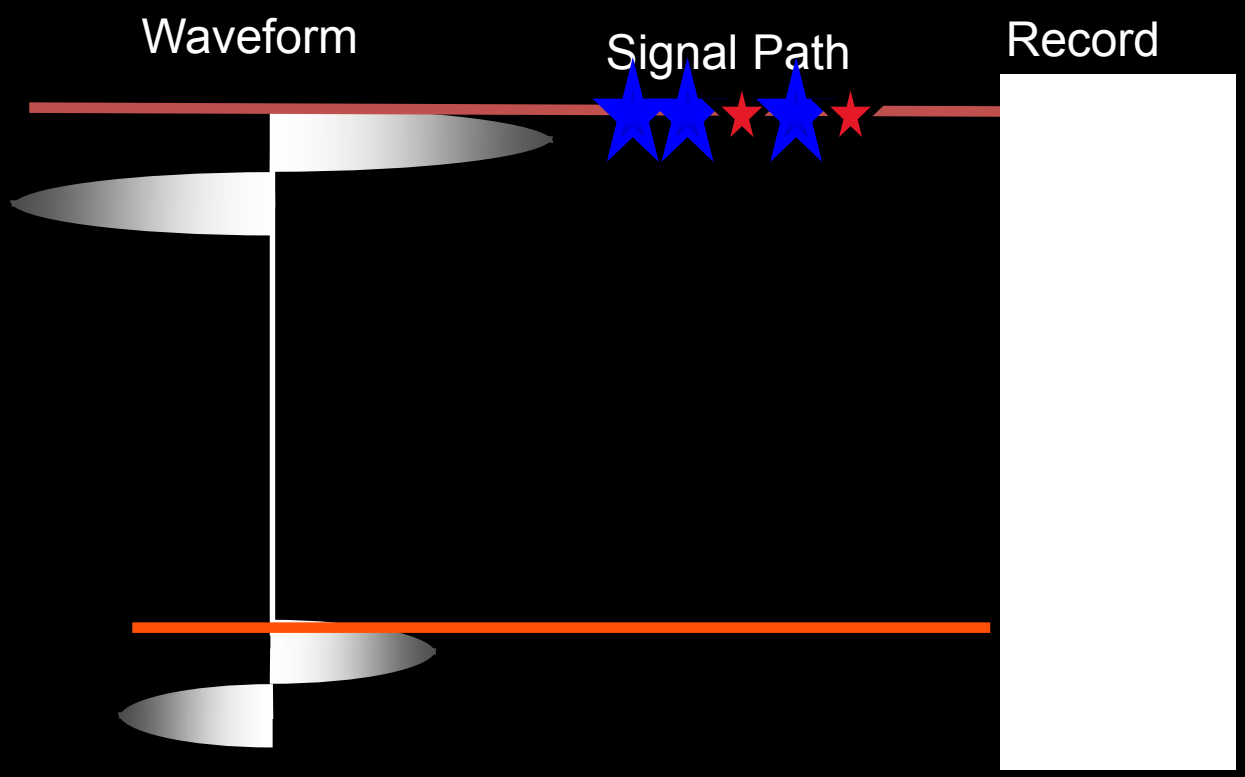
OVERVIEW

GROUND PENETRATING RADAR USES RADIO WAVES TO ASSESS THE FORM AND CONDITION OF SUBSURFACE STRUCTURE.

GROUND PENETRATING RADAR [GPR]

COLLECTION

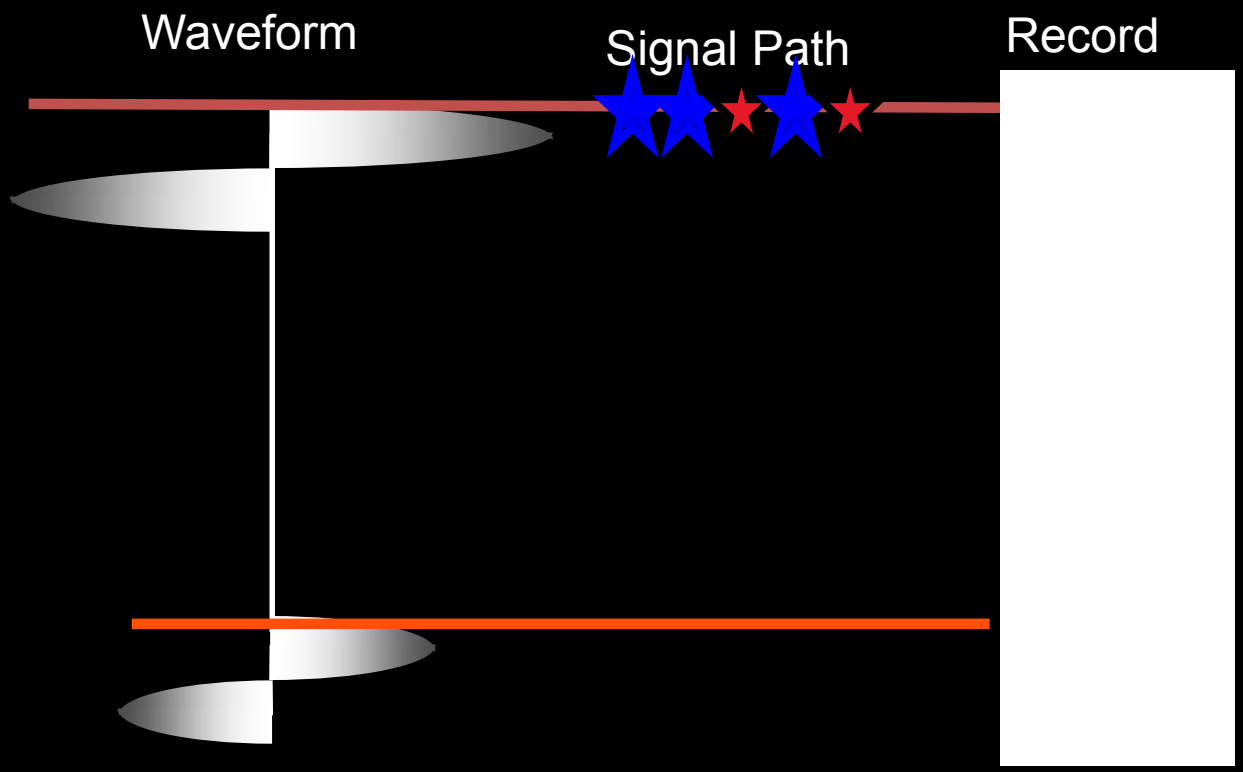
Radio Echo Sounding



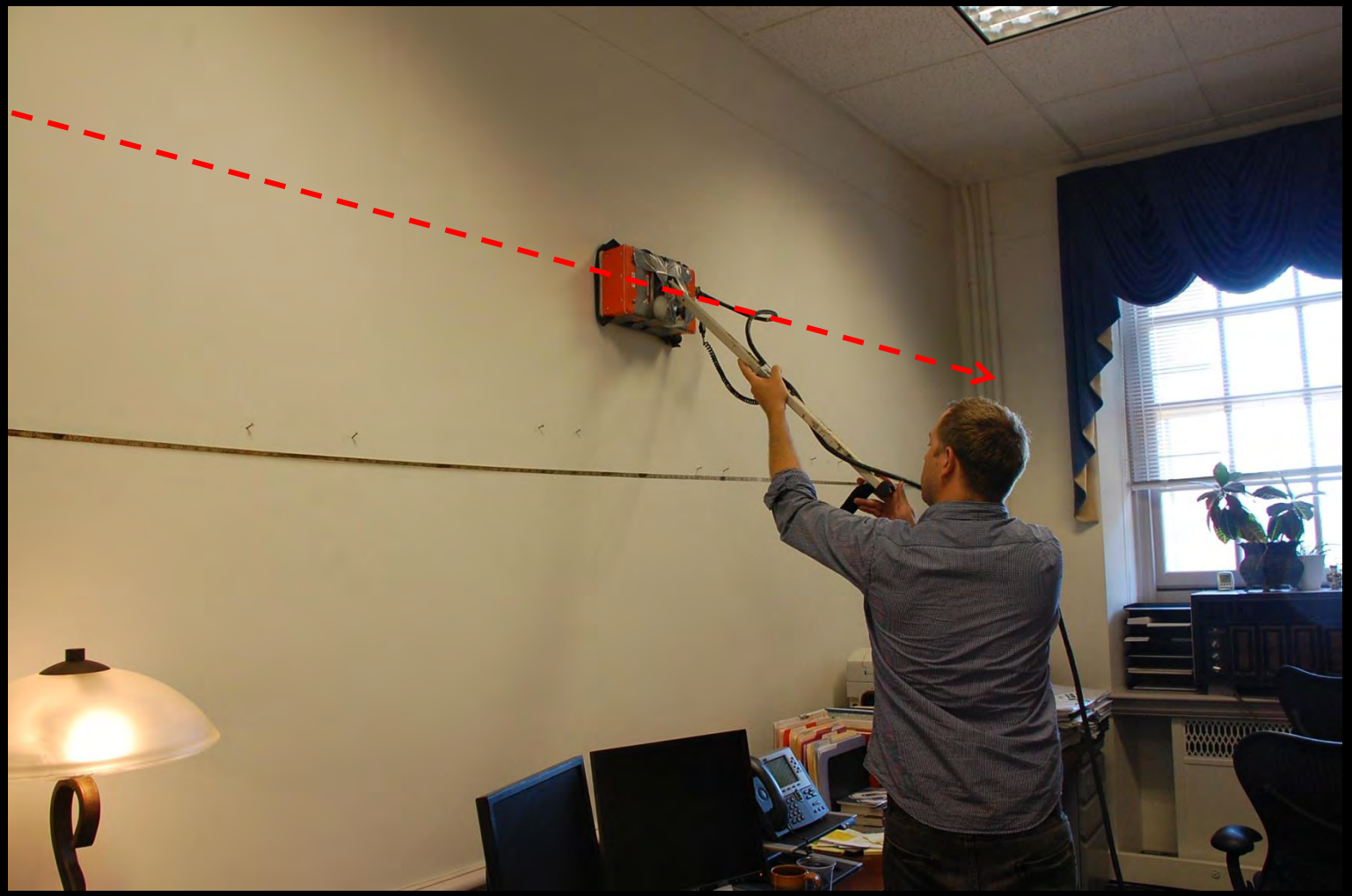
GSSI

ALWAYS TURN OFF BEFORE CHANGING TRANSDUCER OR LEAD
PLEASE DO NOT ADJUST THESE SETUPS
SETUP 1 1.5GHZ SHALLOW
SETUP 2 1.5GHZ DEEP
SETUP 3 900MHZ SHALLOW
SETUP 4 900MHZ DEEP
SETUP 5 400MHZ SHALLOW
SETUP 6 400MHZ DEEP
GBG
RADAR 16
CAUTION

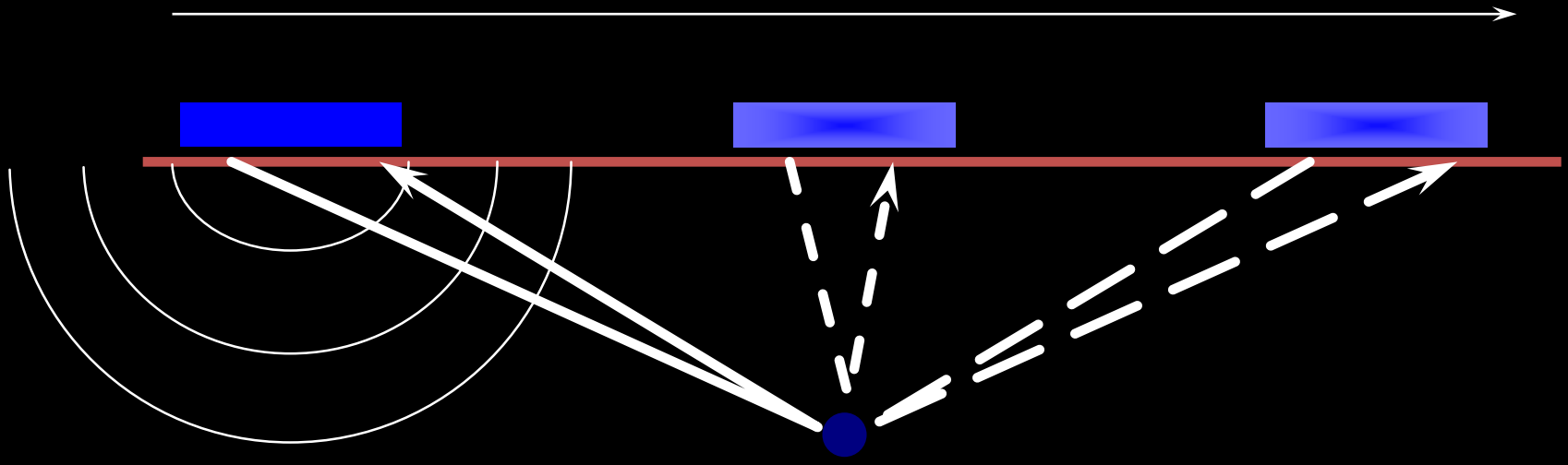
Radio Echo Sounding



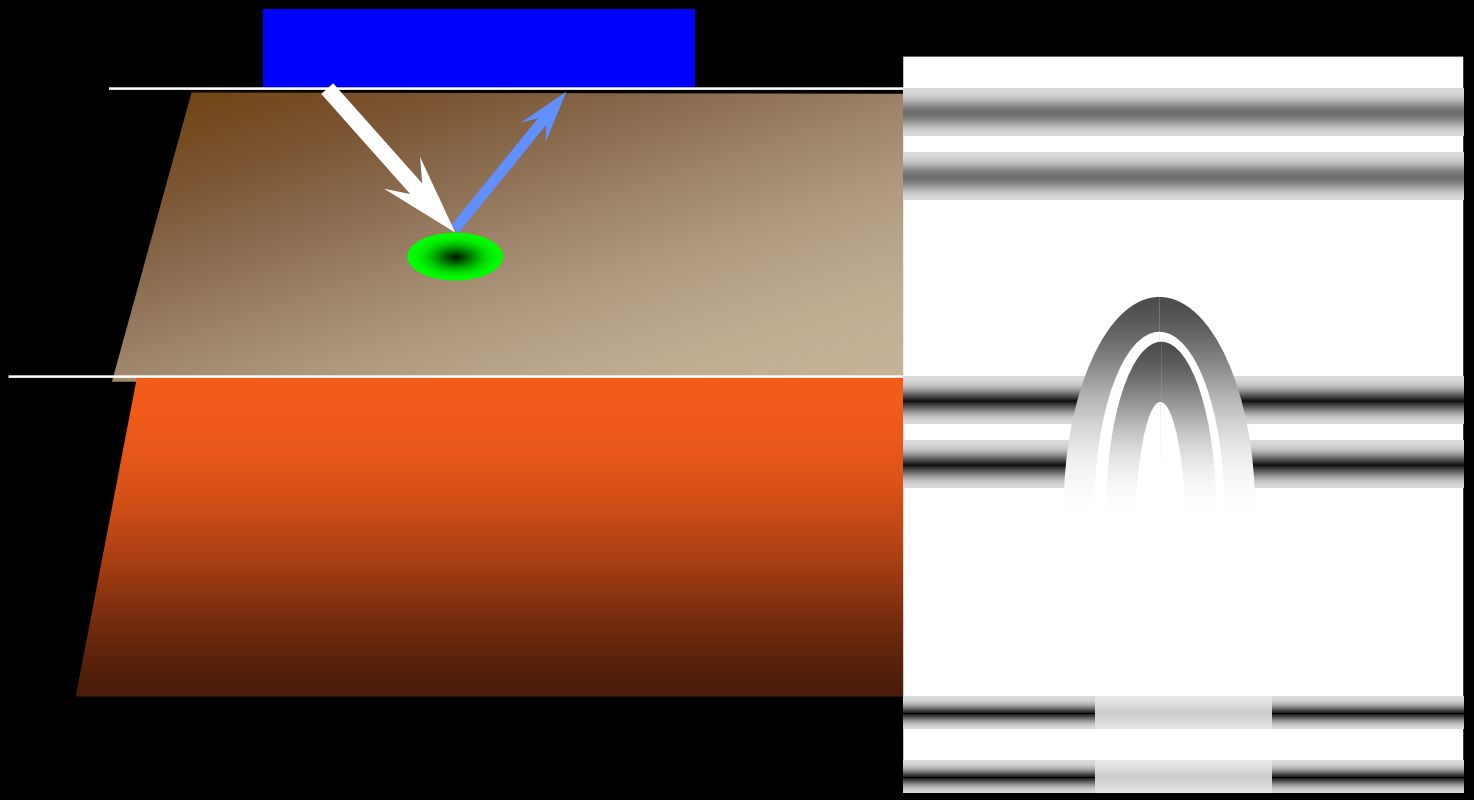
Radar – in action



Hyperbolic Response

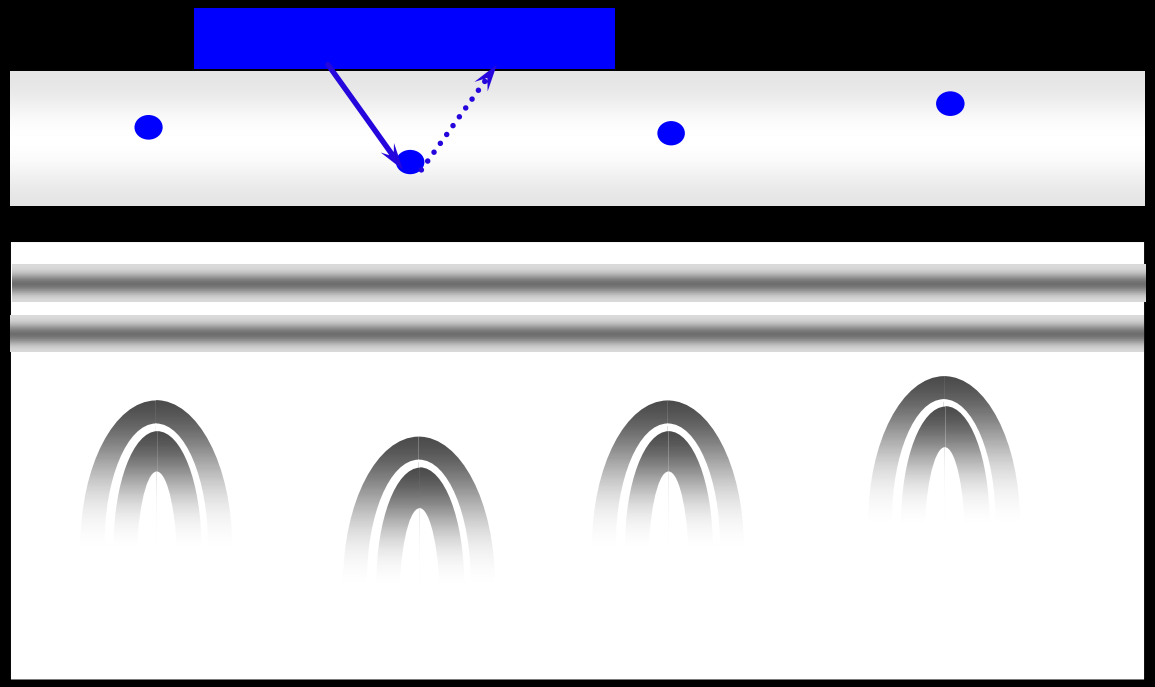


Locating Inclusions

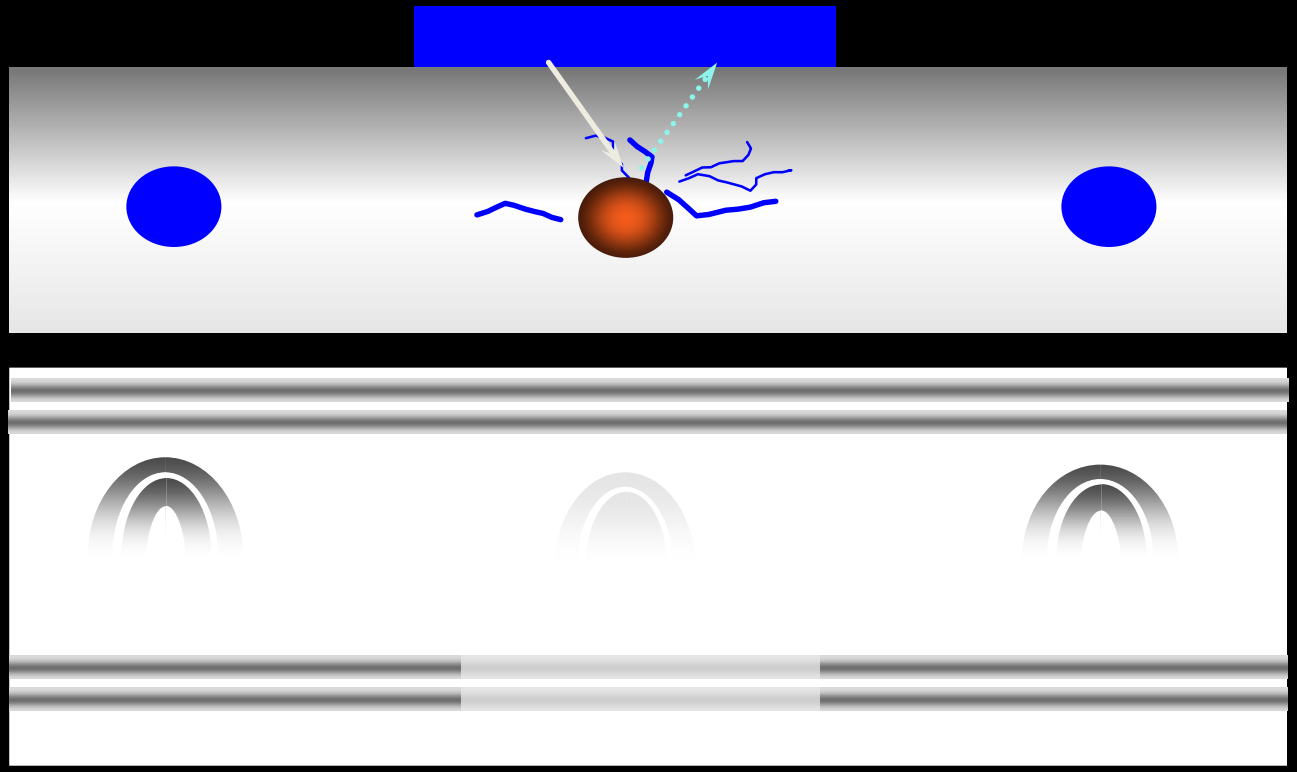


Calibration is key...

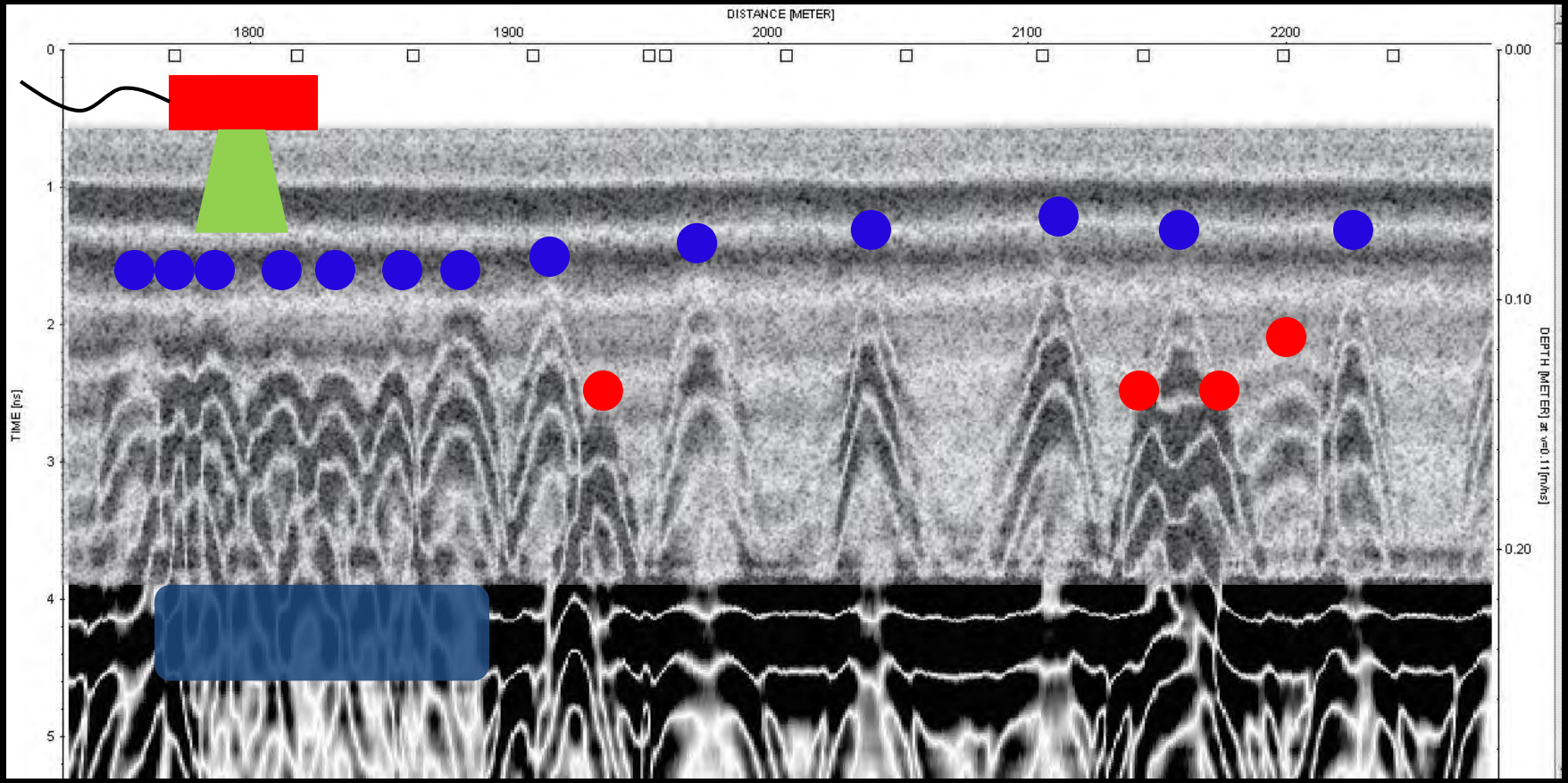
Hyperbolic Series



Condition / Corrosion

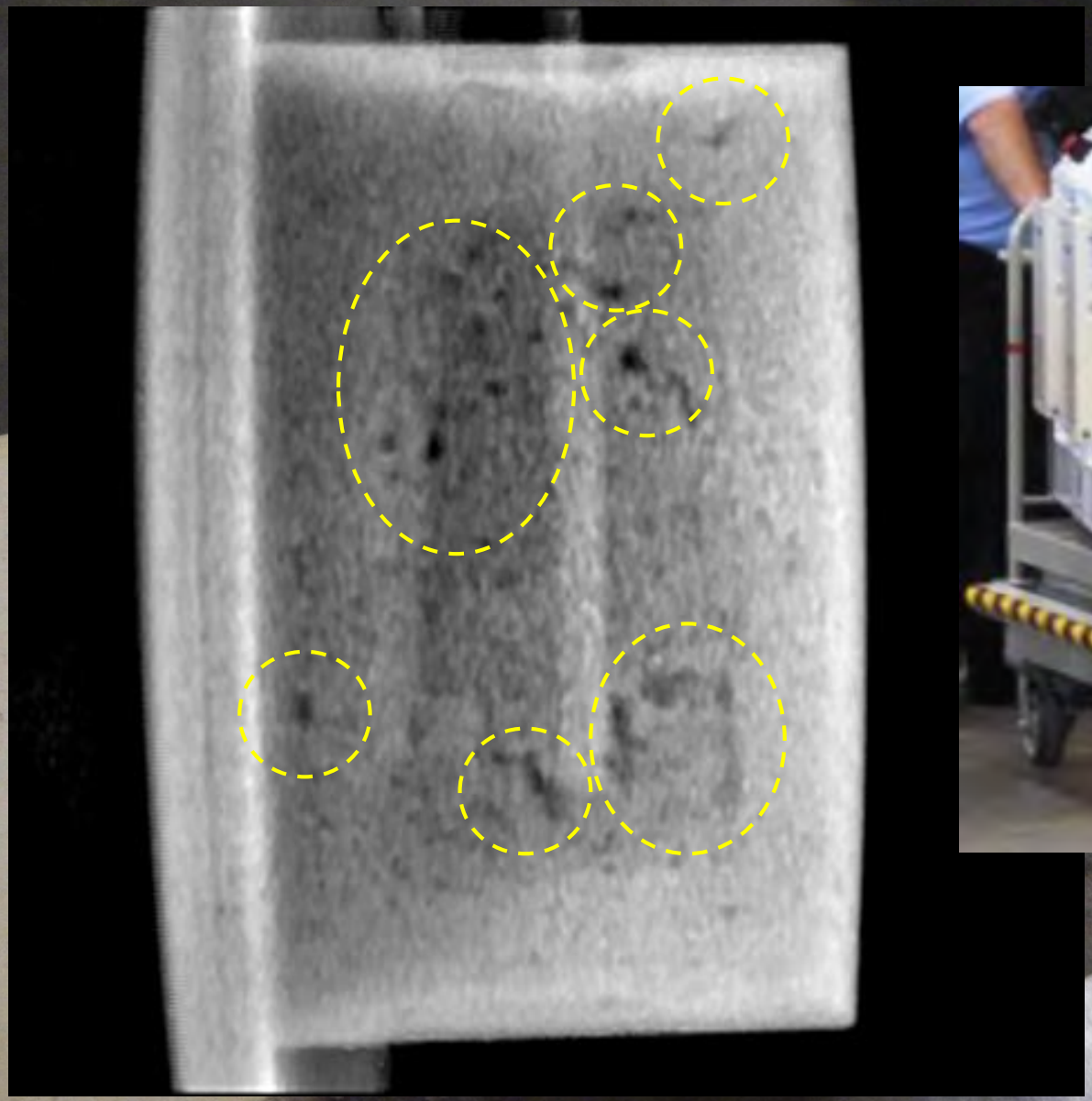


Data Explanation



What's Next?

X-Ray?



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ACOUSTICS

COLLECTION

MAGNETIC METHODS

DATA COLLECTION

COMMON THEME?

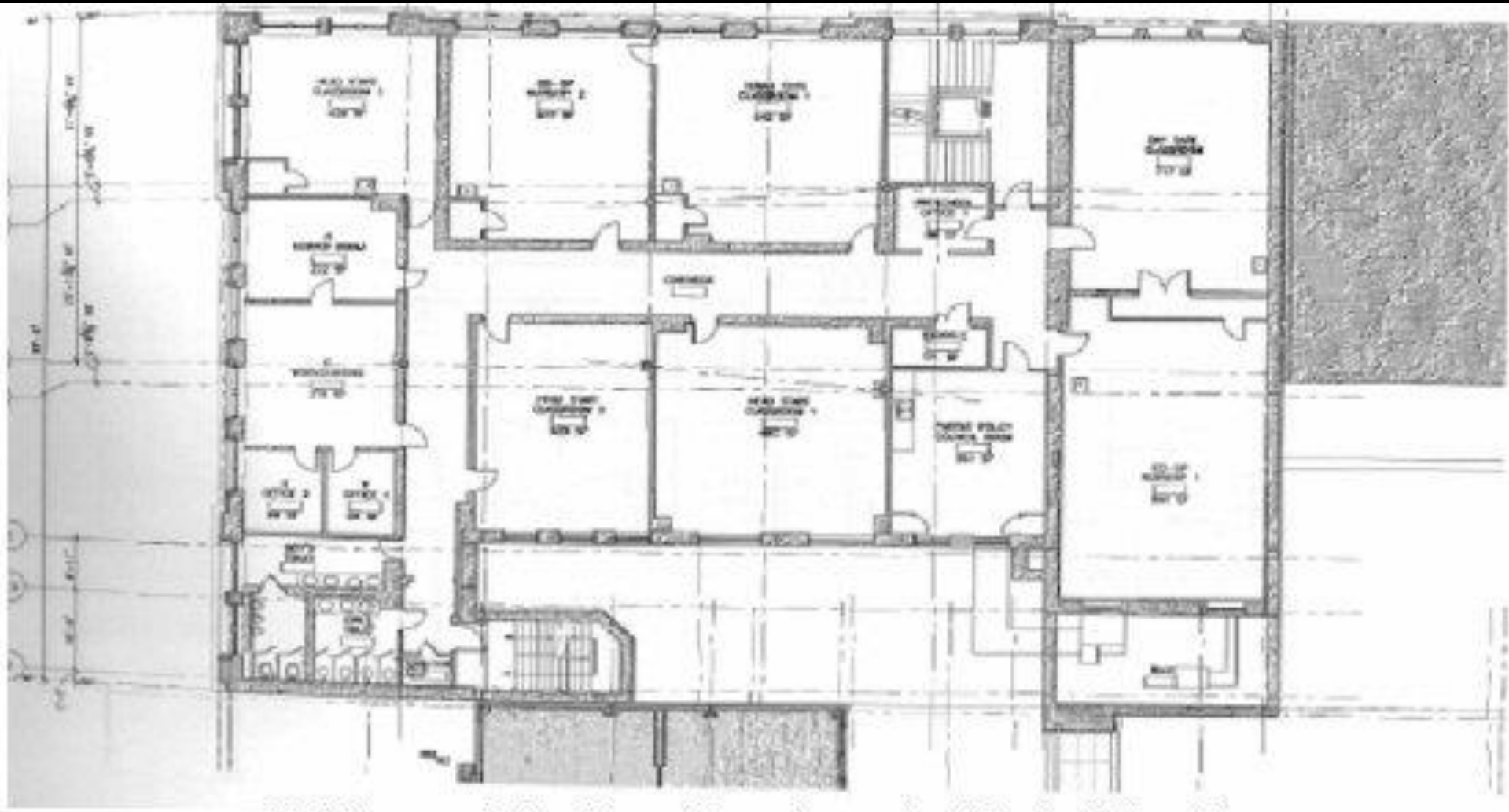
INTERPRETATION...

Case Studies

CASE STUDY – Education Alliance Building

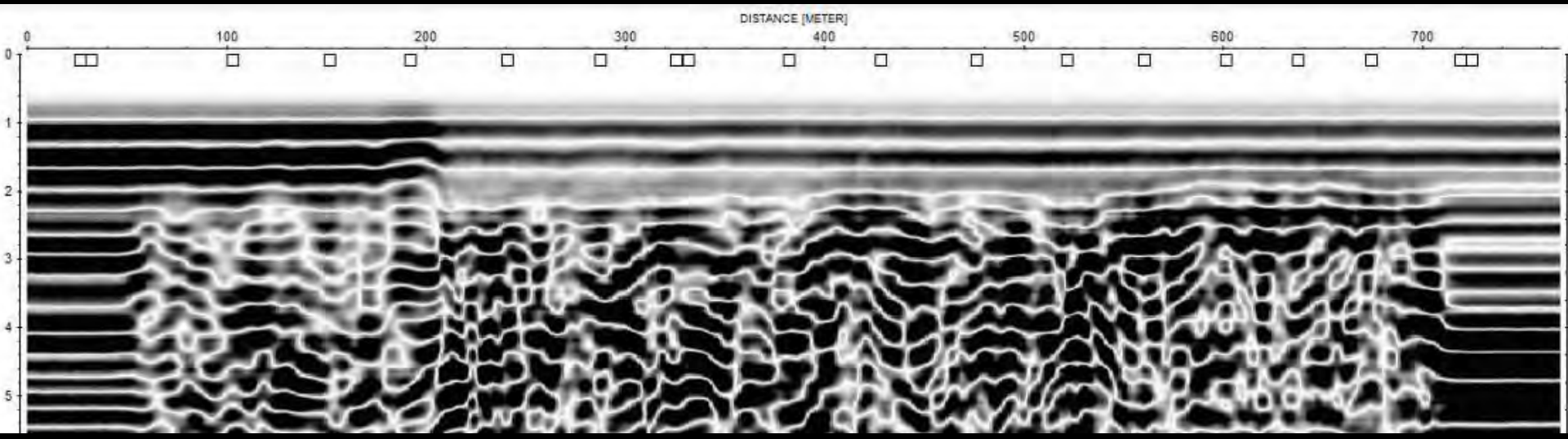
197 East Broadway, New York, NY

Existing Information Provided

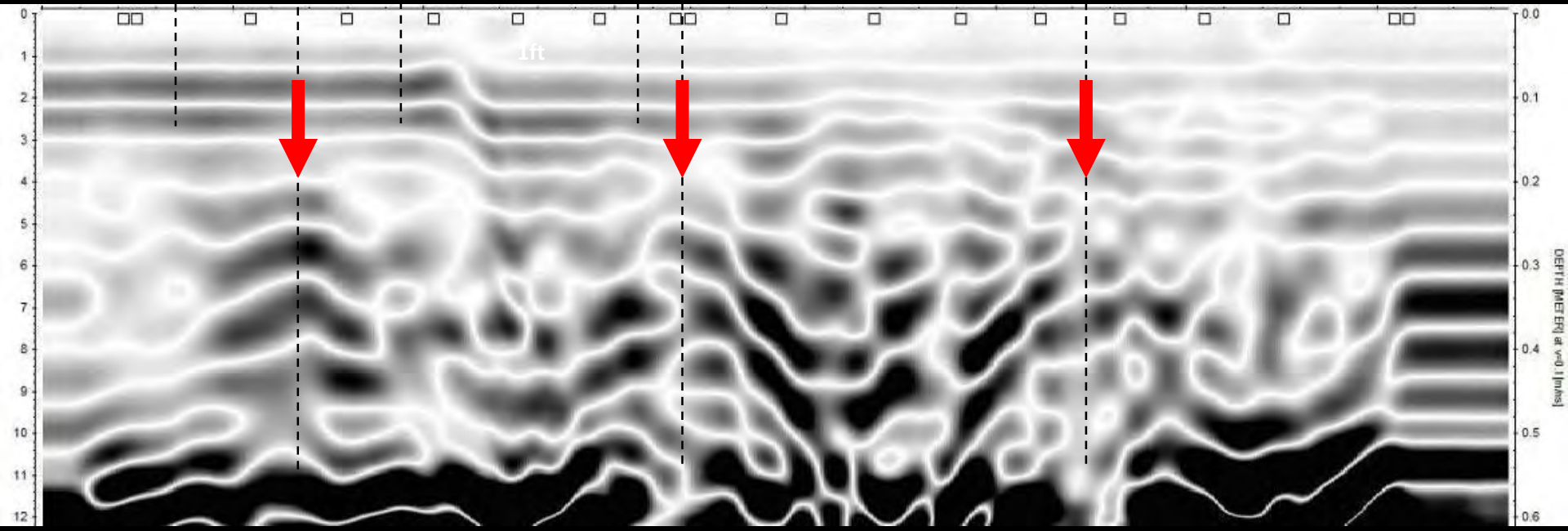


Third Floor existing Floor Plan - Example of Typical Floor Plan
(Provided by Platt, Byard, Dovell, White Architects, LLC)

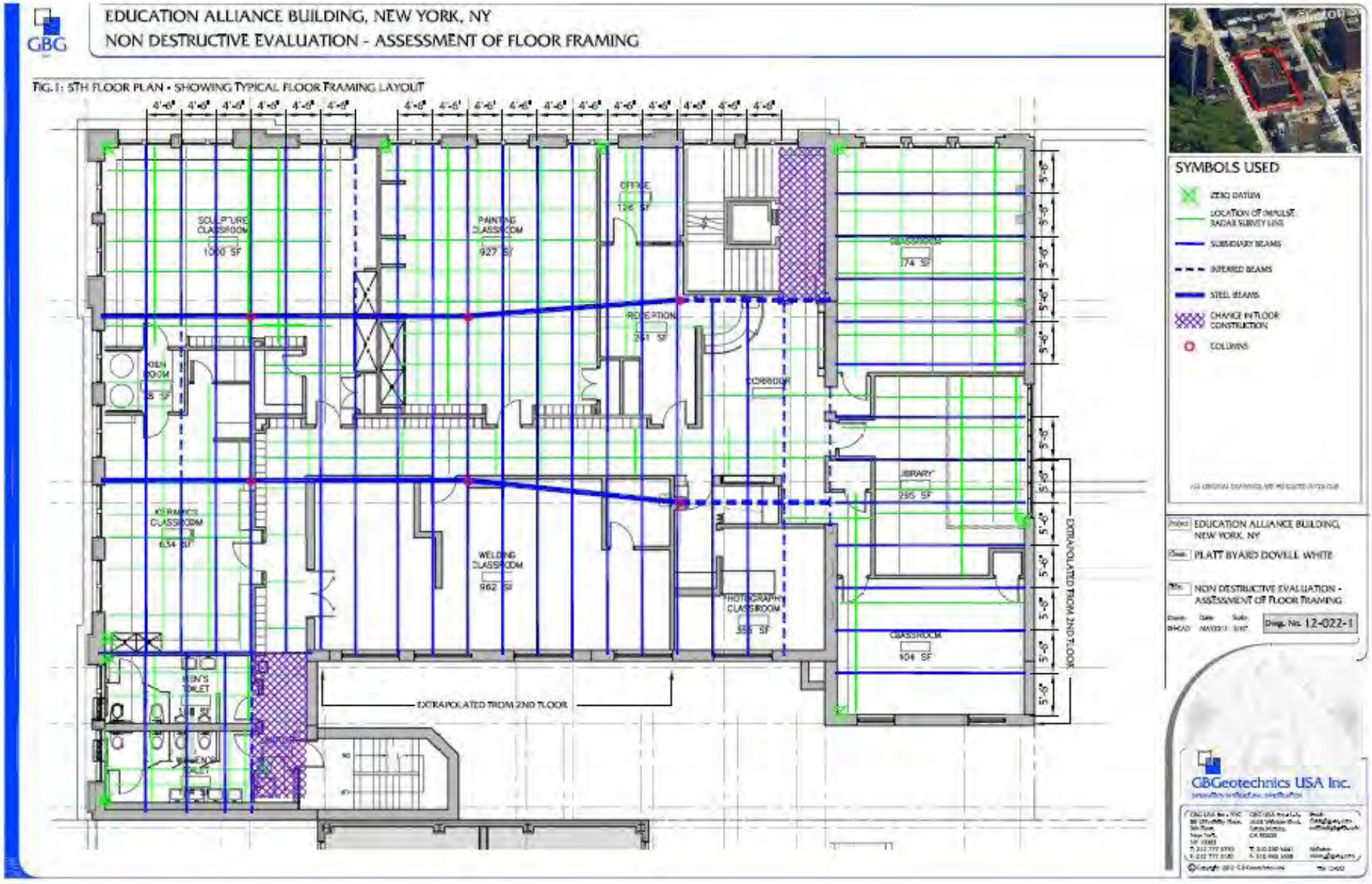
Previous Attempts - High Frequency



Low Frequency



New Framing Plans Provided



Solomon R Guggenheim Museum, New York

Scope

Drawings not accurate – confirmed through exposure

Question:

As-Built Construction?

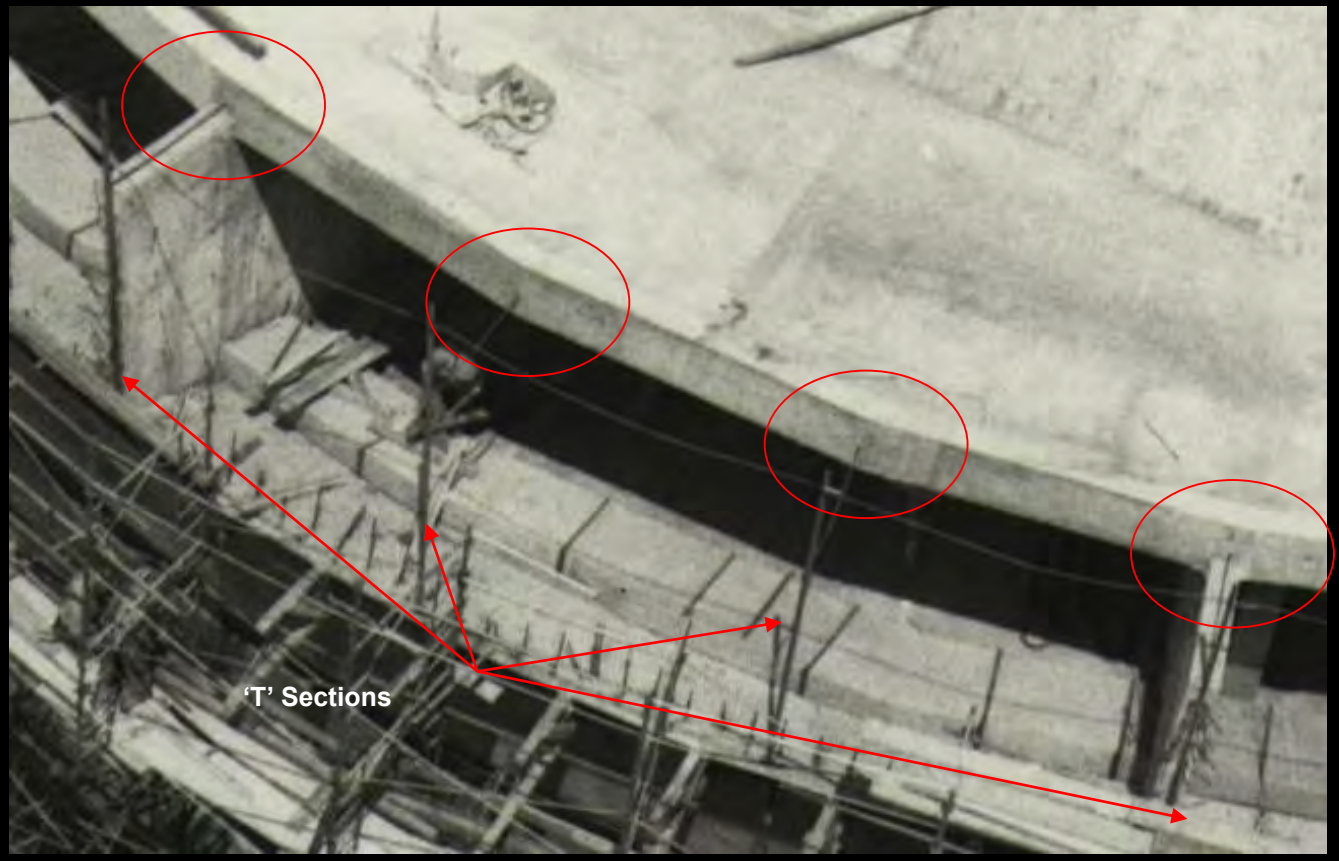
Detailing?

Condition?

NDE Survey:

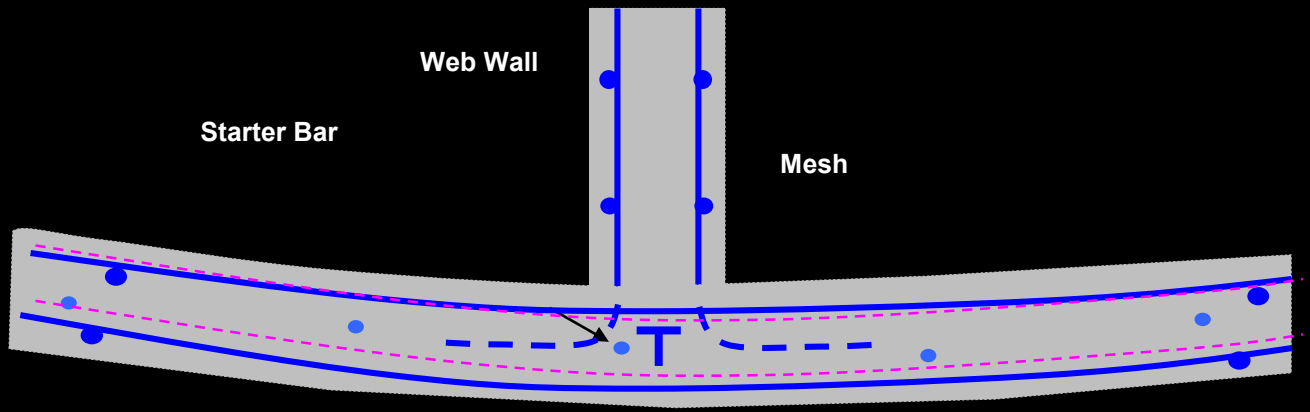
Impulse Radar, Impact Echo, Metal Detection

Use of Historical Information

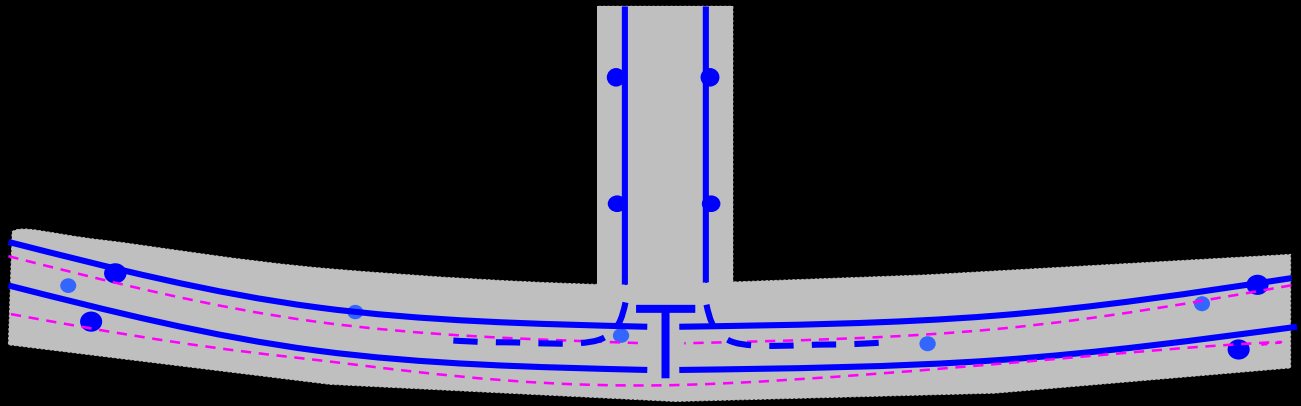


Historical photograph showing 'T' sections and associated tie rod connections

Data Collection



Sketched plan section through exterior wall
Ramps 3, 4 & 5 only

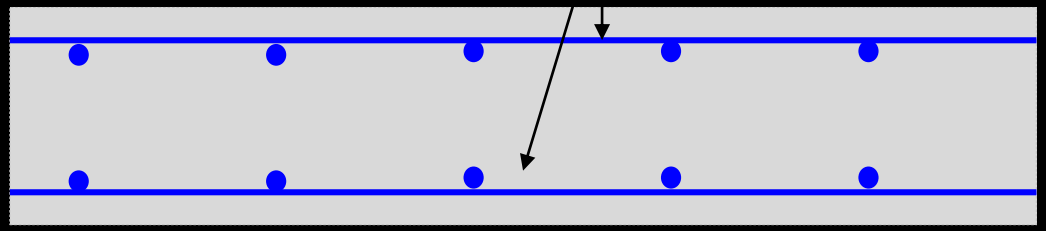


Sketched plan section through exterior wall
Ramp 6 only

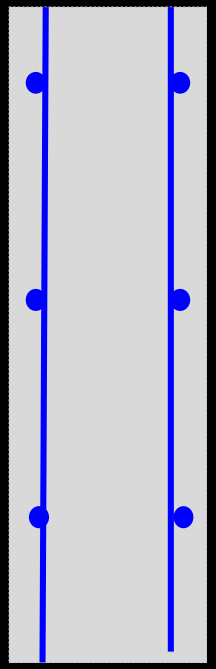
Web Wall
Plan Section

Vertical
Section

Horizontal Reinforcement
12”o.c. (doc approx 1”)

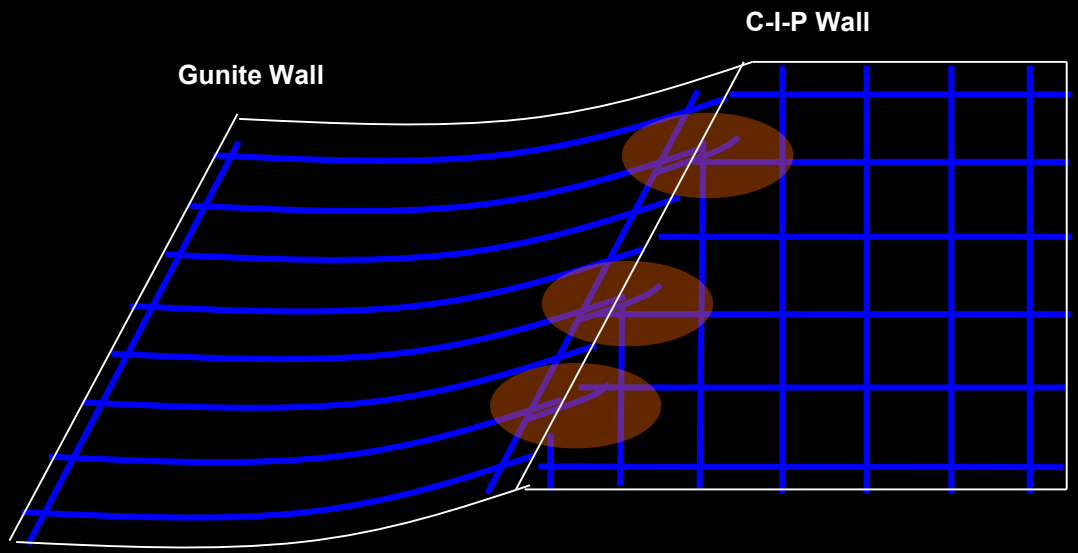


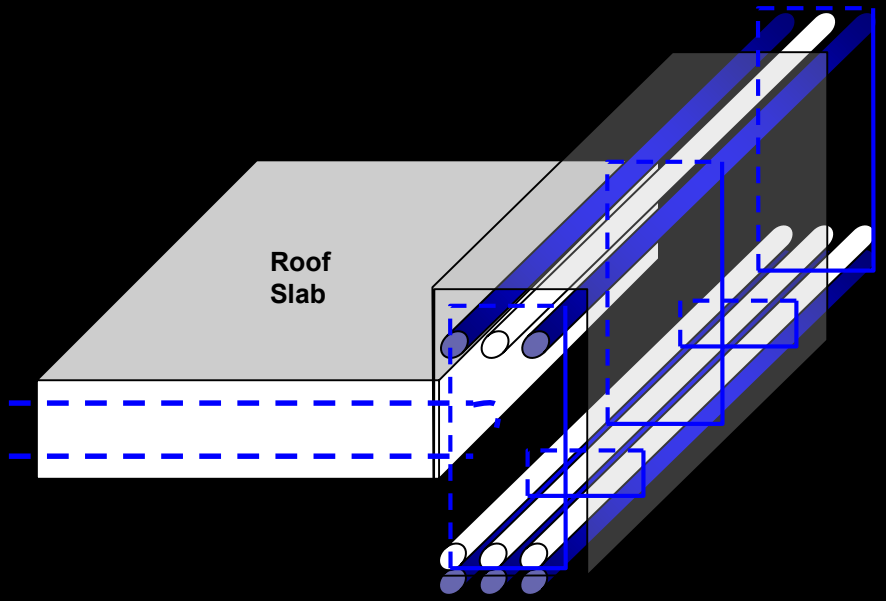
Vertical Reinforcement
11”- 12” o.c. (doc approx 2”-3”)



Impulse Radar

Metal Detector Equipment

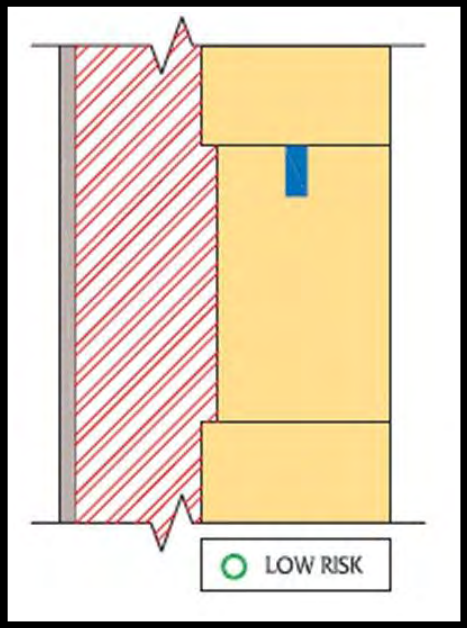


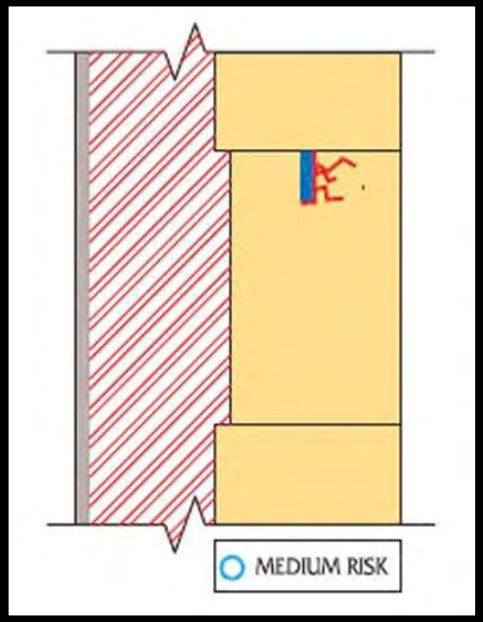


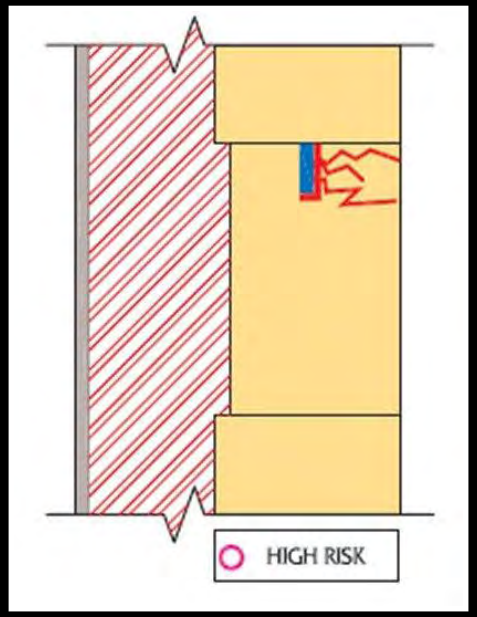
UNION STATION, TORONTO

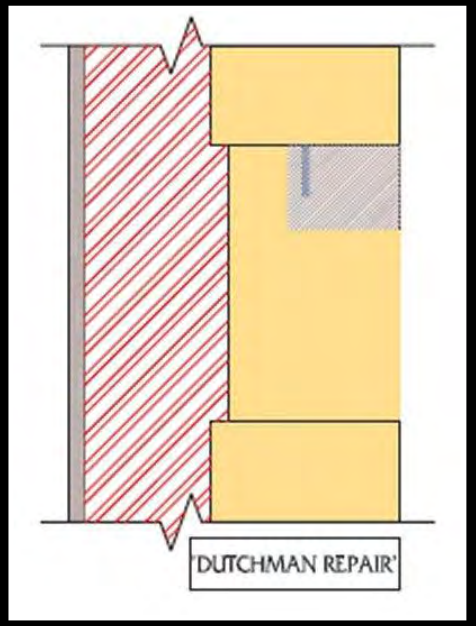
Case Study: Stone Anchor Assessment

STONE ANCHOR ASSESSMENT

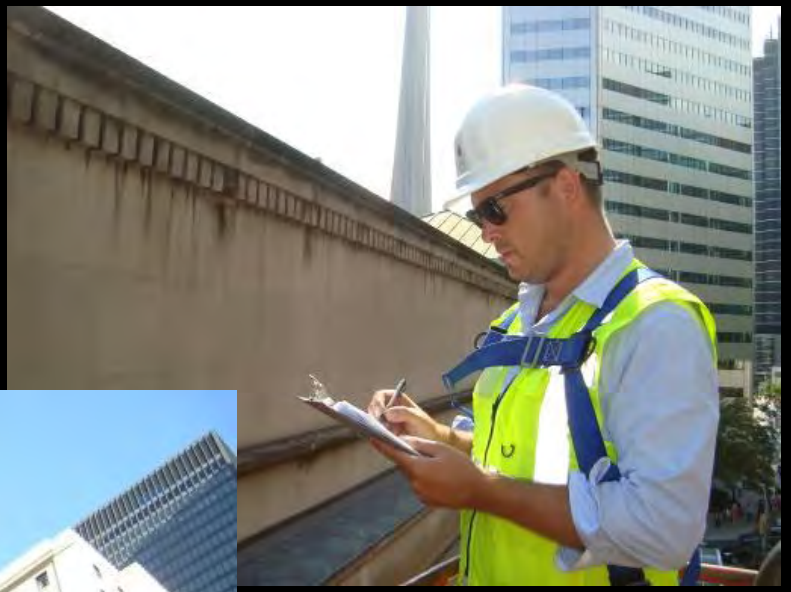


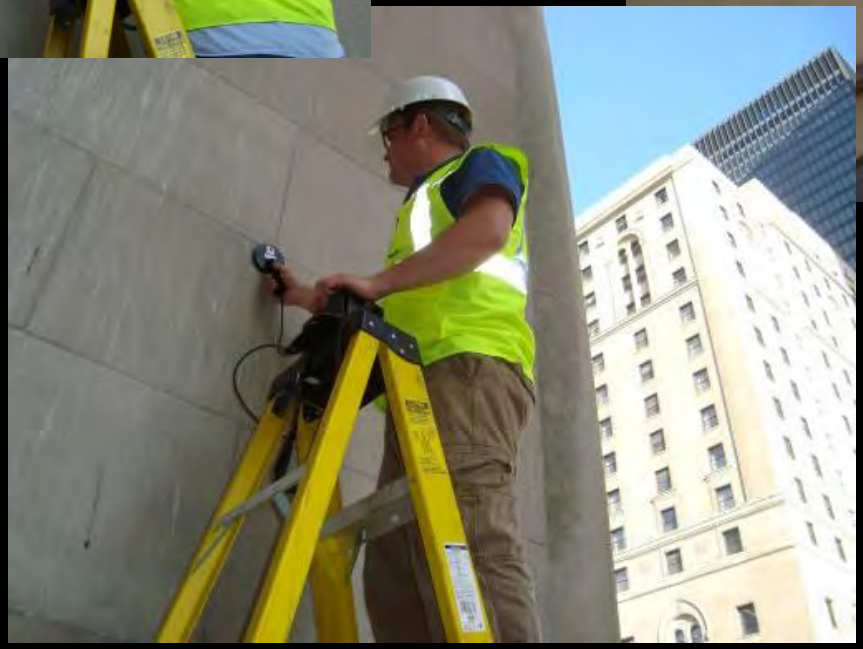






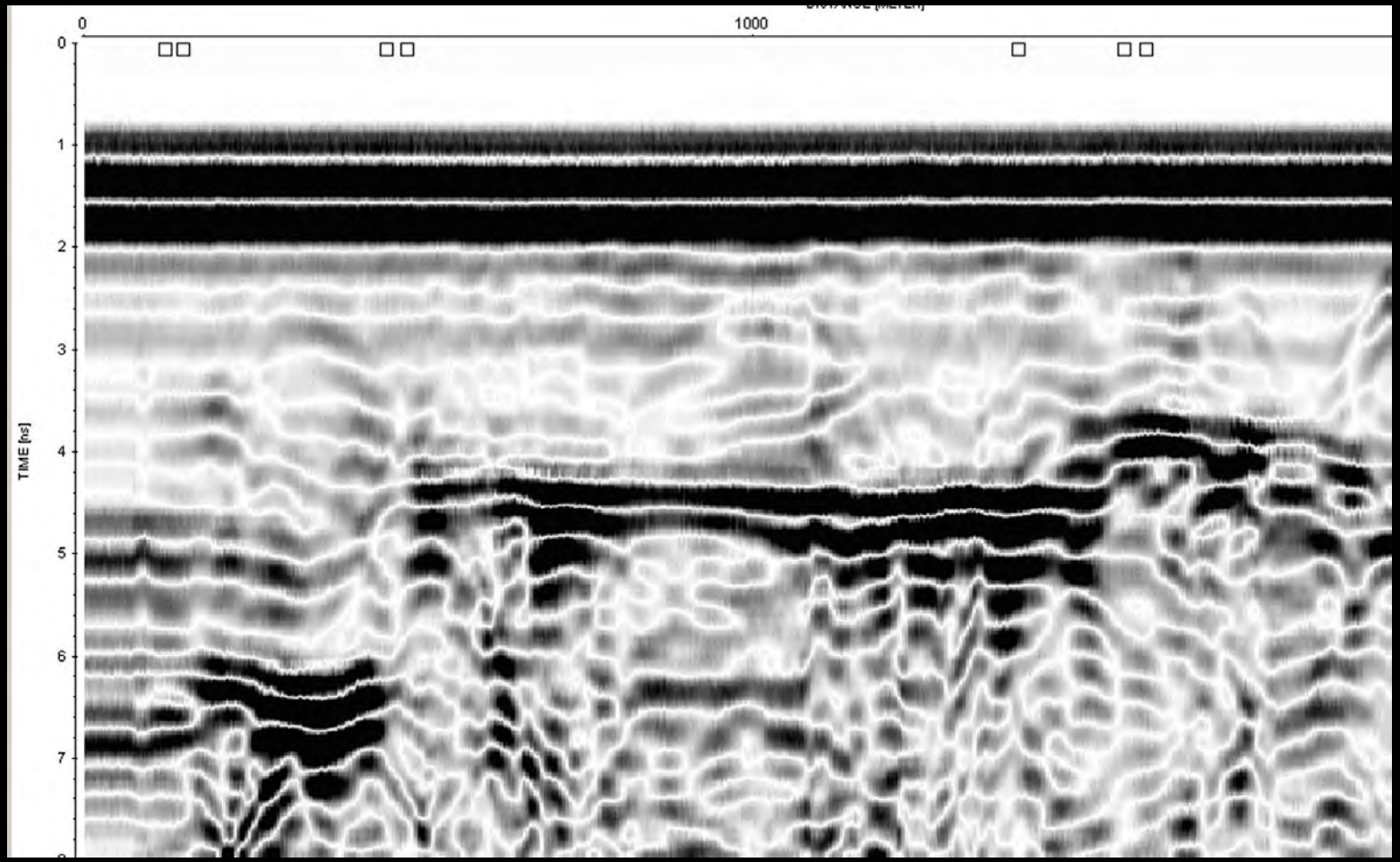
Four levels of assessment…



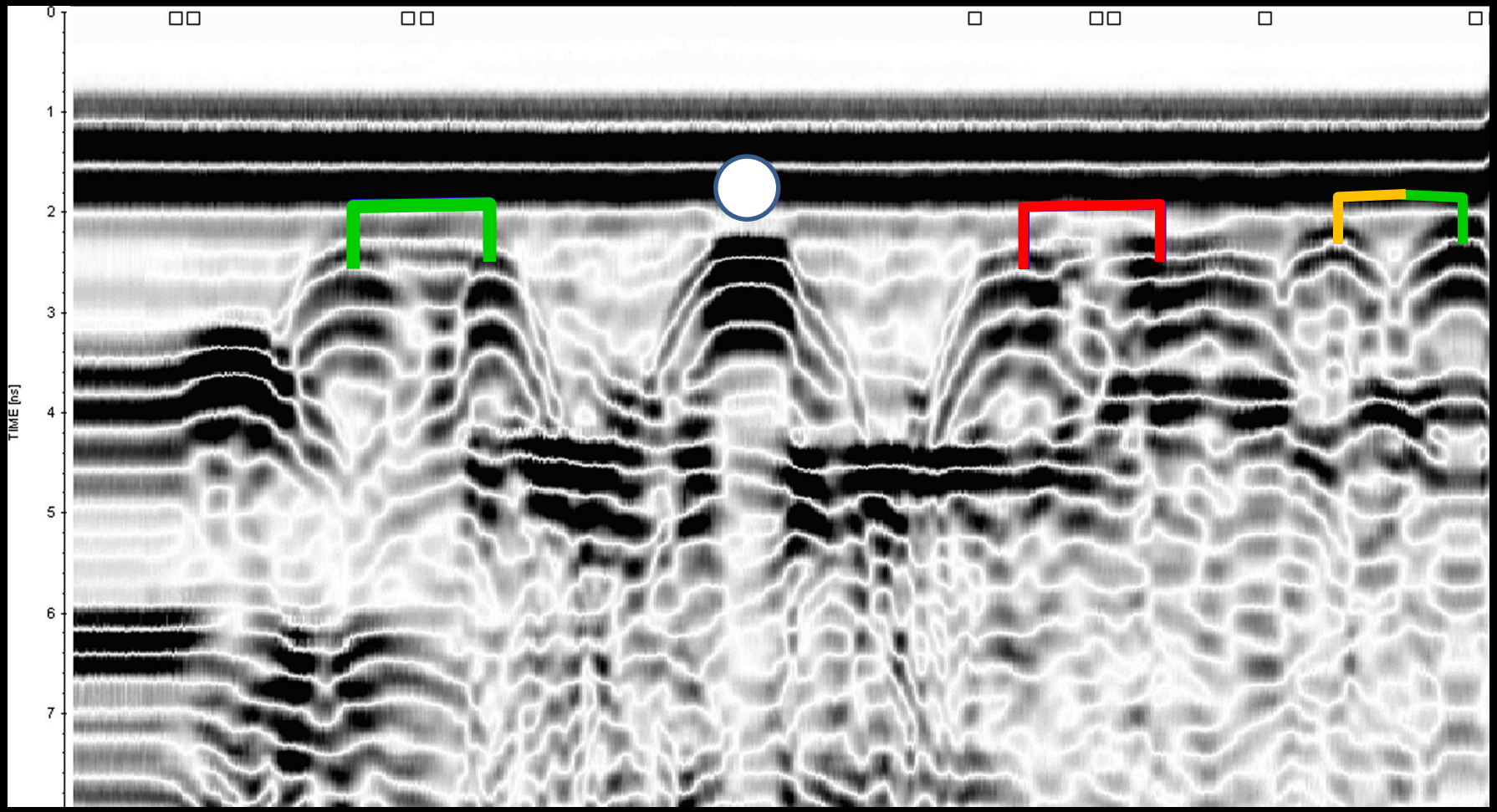


Combination of NDE

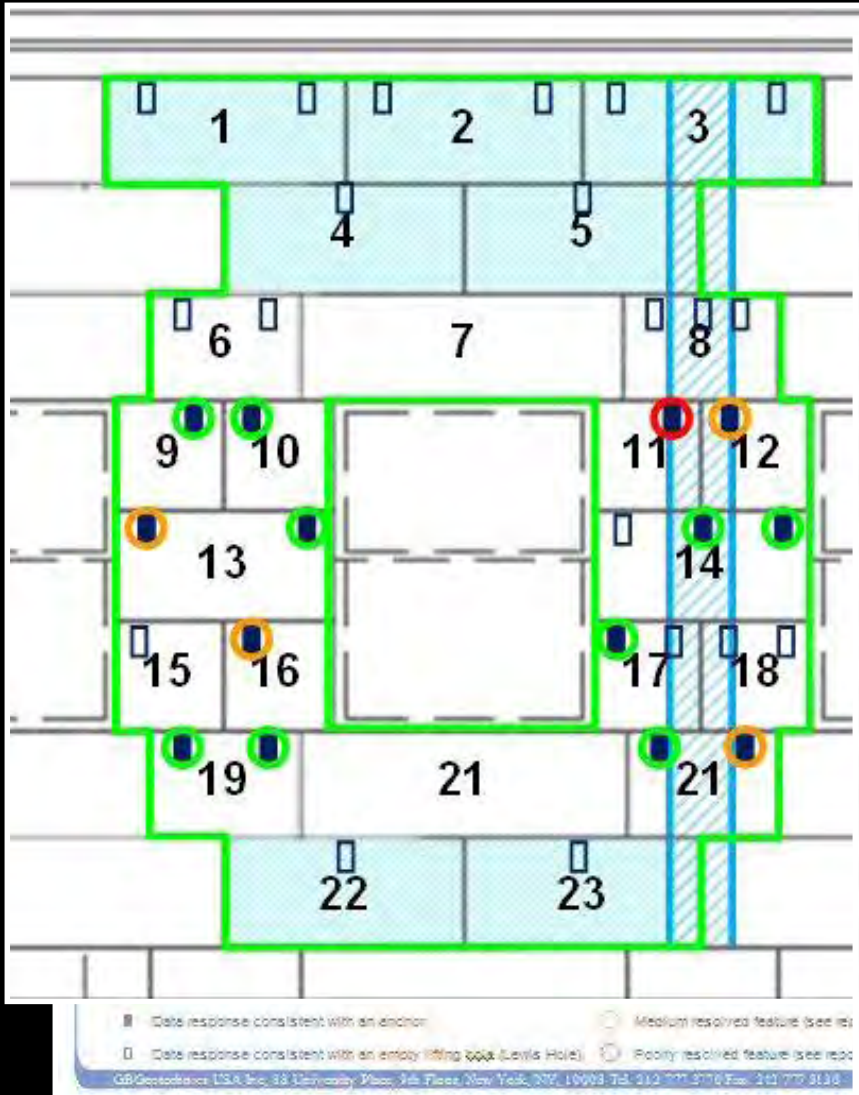
GPR Data - Stone



GPR Data - Anchors



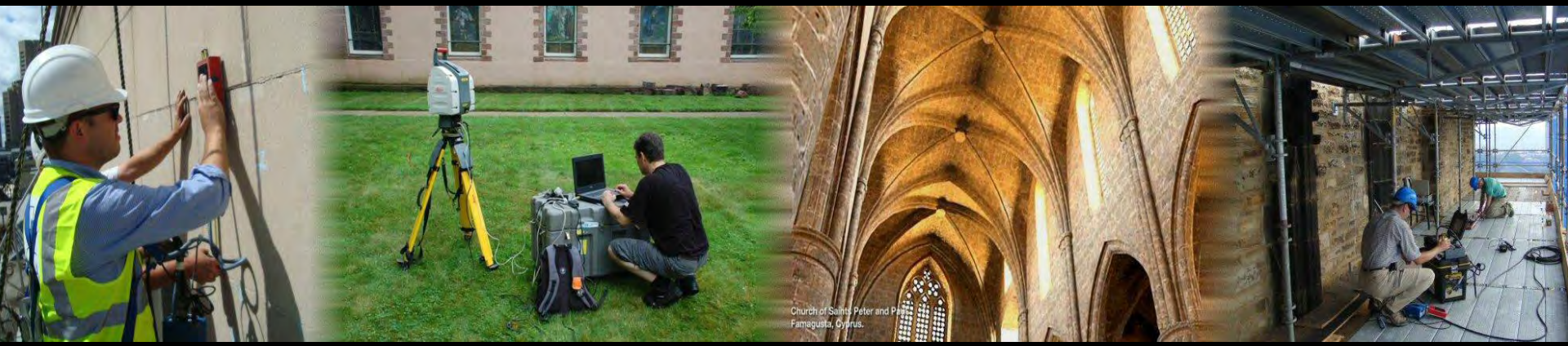
Results Presentation



Stone Ref:	All Measurements In Inches (Measured from left)					
	Features			Stone Width	Stone Thickness	Stone Height
	1	2	3			
1	48	38¼	-	52½	7	24
2	14	38¾	-	52½	7	24
3	11½	38½	-	52½	7	24
4	26½	-	-	53	3¾	24
5	26¾	-	-	53	3¾	24
6	6	17½	27½	33½	7	24
7	-	-	-	72	7¼	24
8	7	17	27½	33½	7	24
9	18½	-	-	24	7 – 4	24
10	4½	-	-	24	4 – 7½	24
11	21	-	-	24	7¼ – 3¾	24
12	7¼	-	-	24	5 – 7¼	24
13	12¼	35½	-	48	7	24
14	12½	25	36½	48	7	24
15	4	-	-	24	7 – 3¾	24
16	5½	-	-	24	3¾ – 6¾	24
17	3¾	20¼	-	24	6½ – 4	24
18	3¾	20	-	24	4 – 7	24
19	6½	27¾	-	33½	7	24
20	-	-	-	72	7½	24
21	6¼	28¼	-	33½	7	24
22	26¾	-	-	53	4	24
23	26¼	-	-	53	4	24

Figure 2b: Features (anchors / lewis holes) and stone dimension data

DOCUMENTATION: THE SURFACE



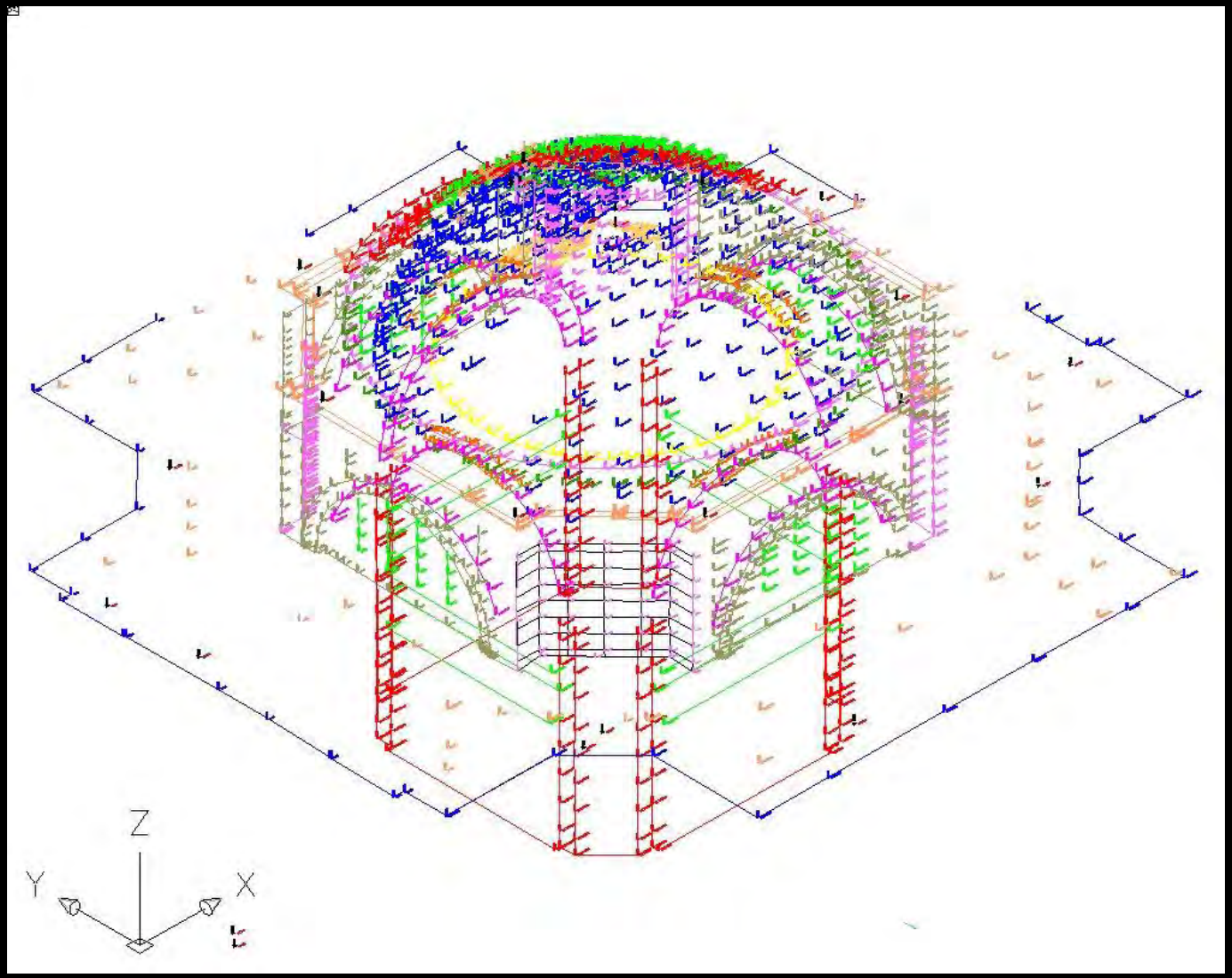
Why Document?

- New Drawings Required
- Historical Documentation
- Project Estimating
- Structural Monitoring
- Advertising / Promotion
- Rapid Response Recording

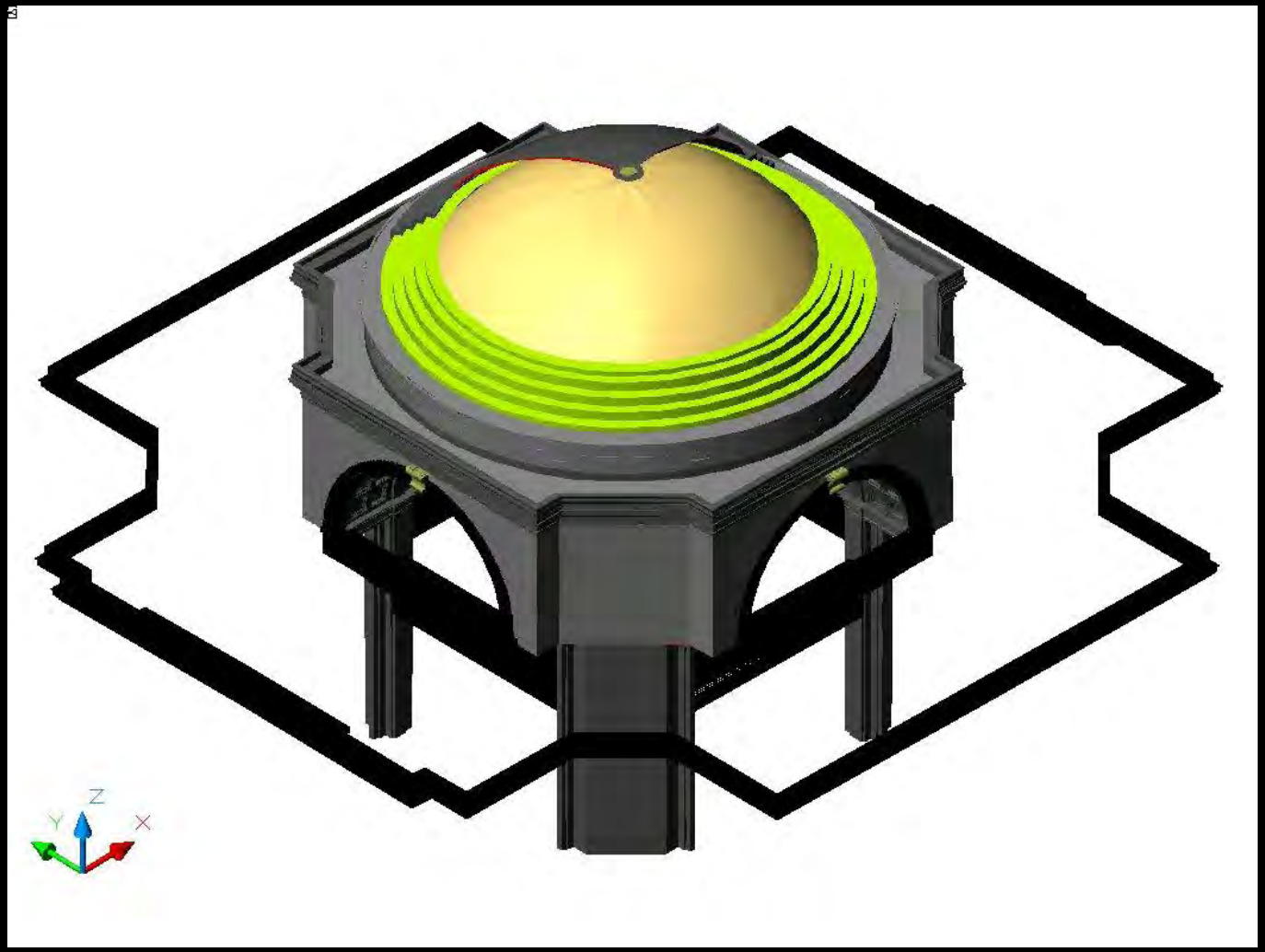
DOCUMENTATION: History

Conventional Survey

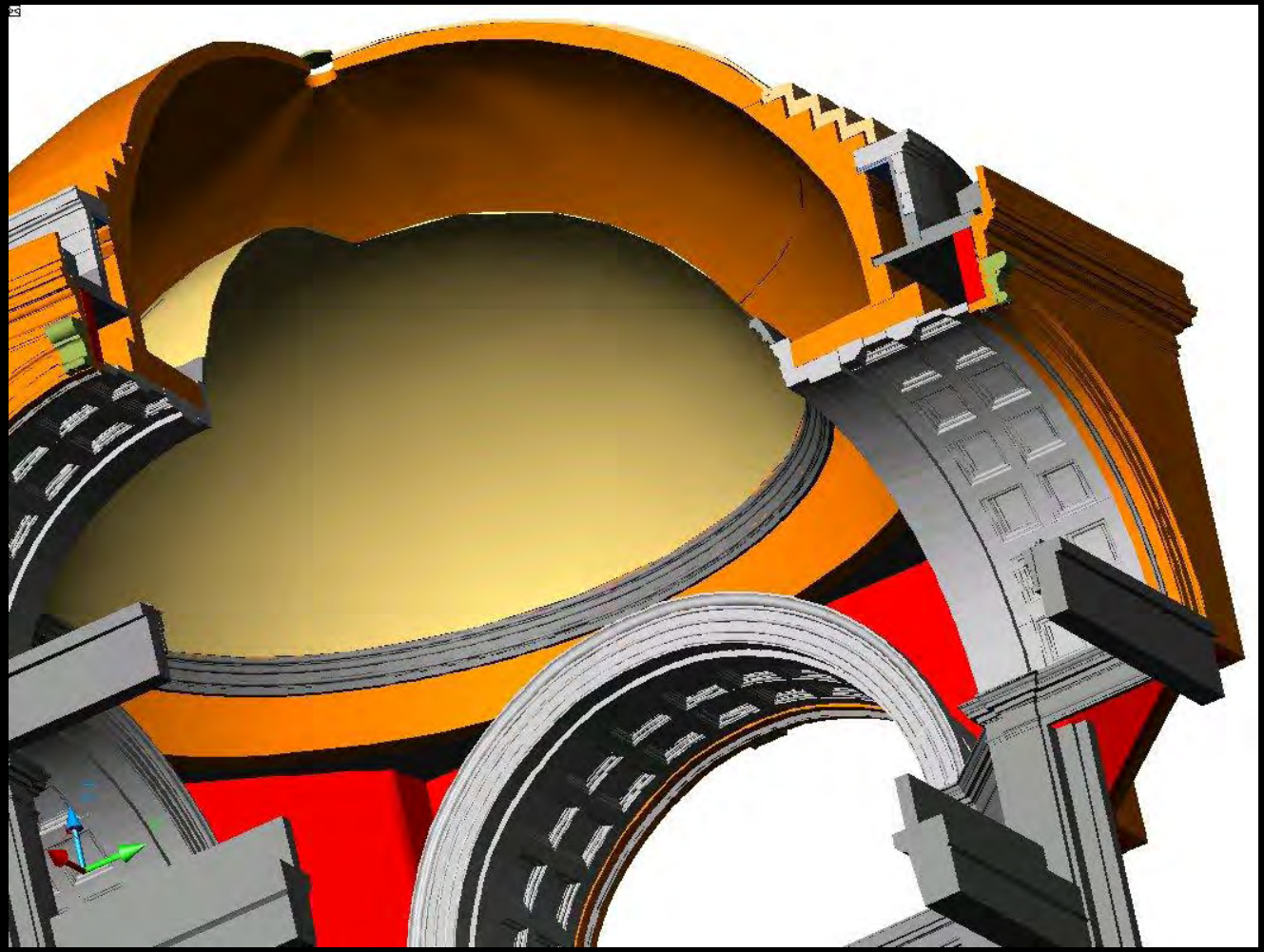
Pointcloud



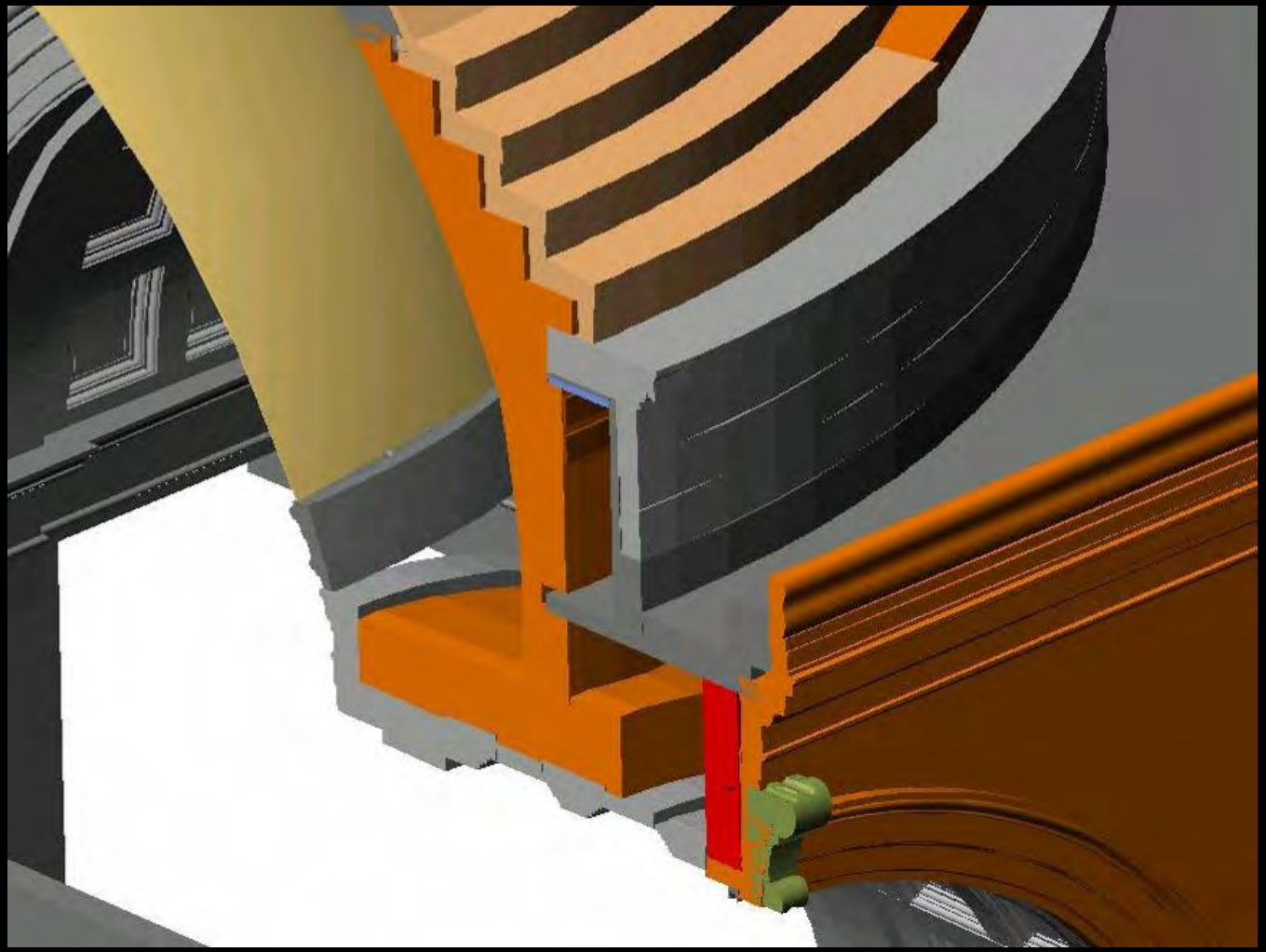
DOCUMENTATION: THE SURFACE



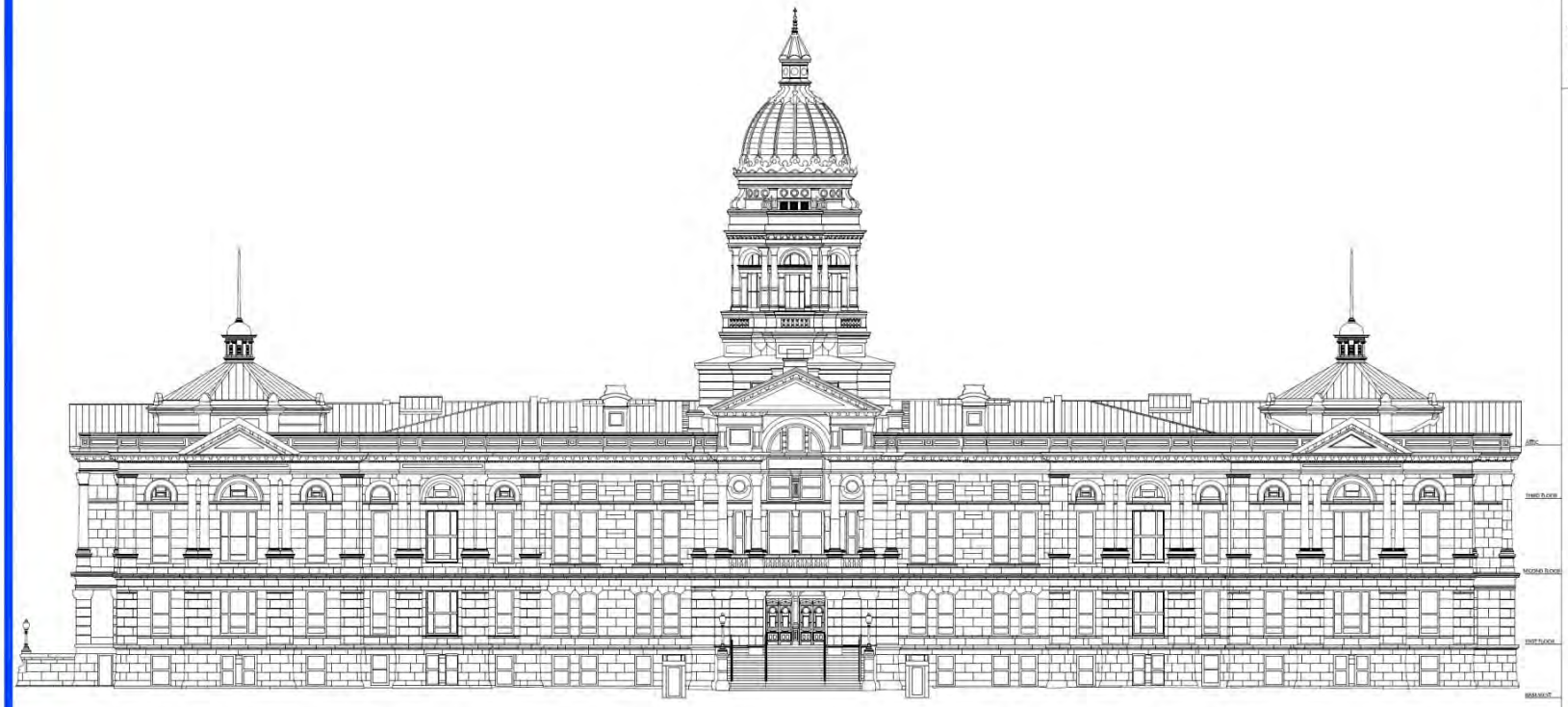
Materials Included in Model!



The Future?

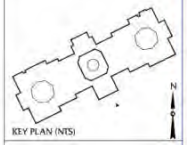


TRIMBLE



1 SOUTH ELEVATION
SCALE: 3/32"=1'-0"

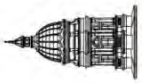
NOT FOR CONSTRUCTION USE. FOR DESIGN PURPOSES ONLY.



Wyoming State Capitol

Joint Legislative and Executive Task Force
State of Wyoming A&I Construction Management

in association with HDR and PDP



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SOUTH ELEVATIONS

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EX-006

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NOTE:
DIMENSIONS ACCORDING TO PLAN SCALE.

KEY PLAN (NTS)

Wyoming State Capitol

Joint Legislative and Executive Task Force
State of Wyoming A&I Construction Management

HDR in association with PDP PRESERVATION DESIGN PARTNERSHIP, LLC and P4

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SOUTH ELEVATIONS

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EX-022

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1 SOUTH ELEVATION - ORTHOPHOTO
SCALE: 3/32"=1'-0"

0 FEET 30
AT A SCALE OF 3/32" = 1'-0" ORIGINAL DWG SIZE 22X34

NOTE:
DIMENSIONS ACCORDING TO PLAN SCALE.

NOT FOR CONSTRUCTION USE. FOR DESIGN PURPOSES ONLY.

High Resolution

Fly Through: HEARST CASTLE

Point Could Range: HEARST CASTLE

CASE STUDY:

Recladding project
60 floors up…

Purpose of Survey

To scan the exterior to high level of accuracy

Provide accurate wall square footage for cladding prefabrication and cost estimating

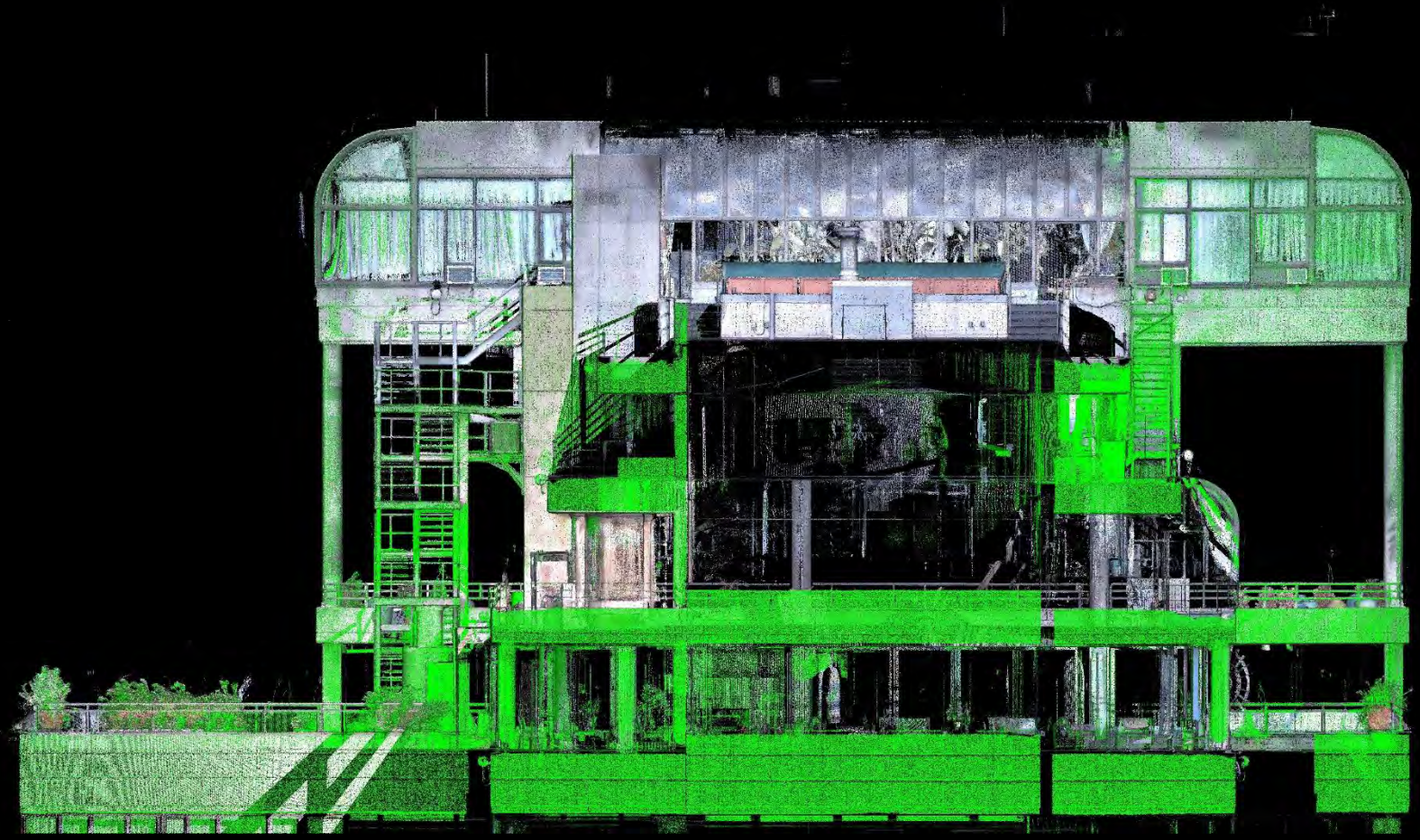
Provide drawings and model for future construction projects

So how can you scan a 60 storey building to a high level of accuracy in Manhattan?

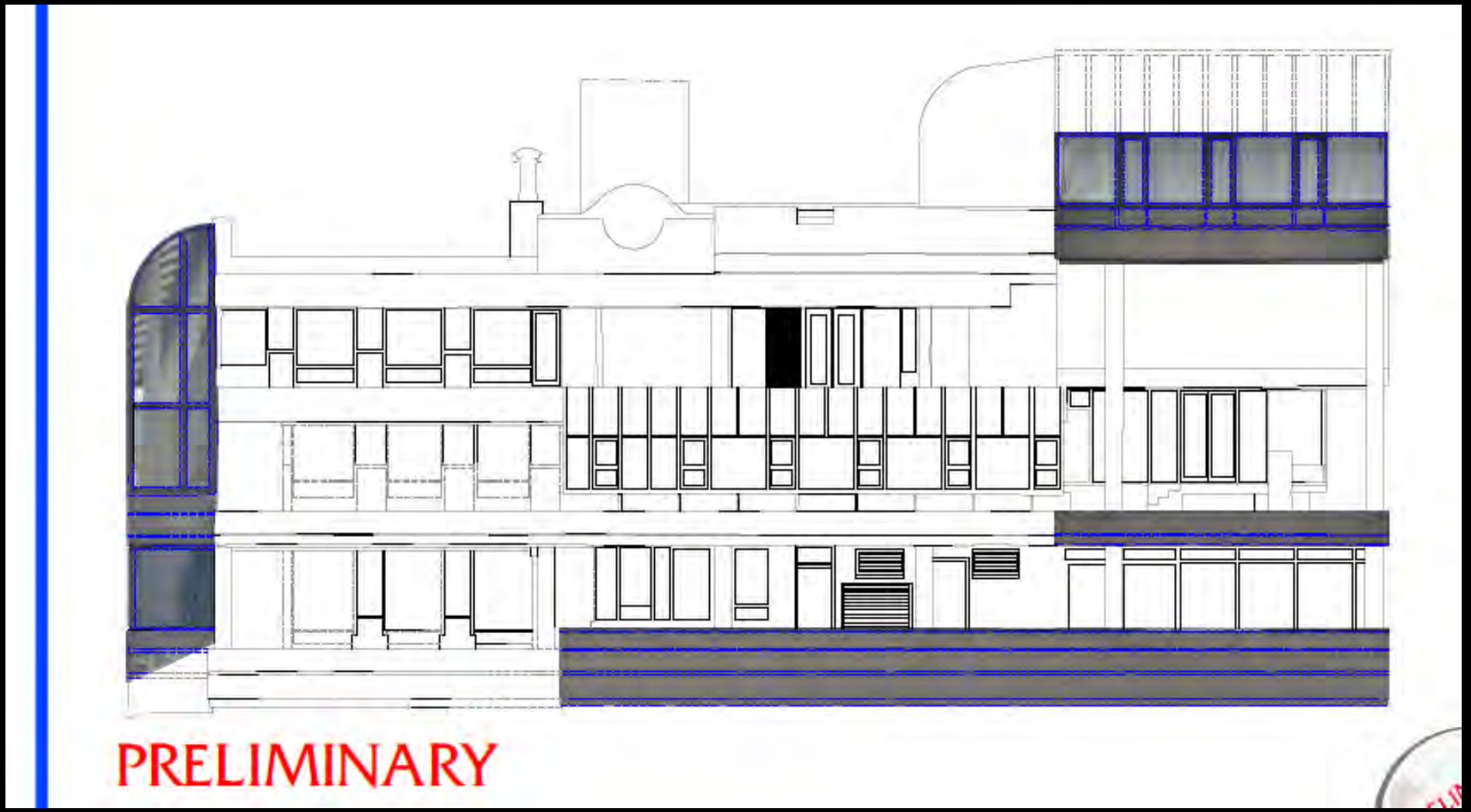
Vantage Points Refined:

Scanner positioned at vantage points

Point Cloud / Elevations Generated



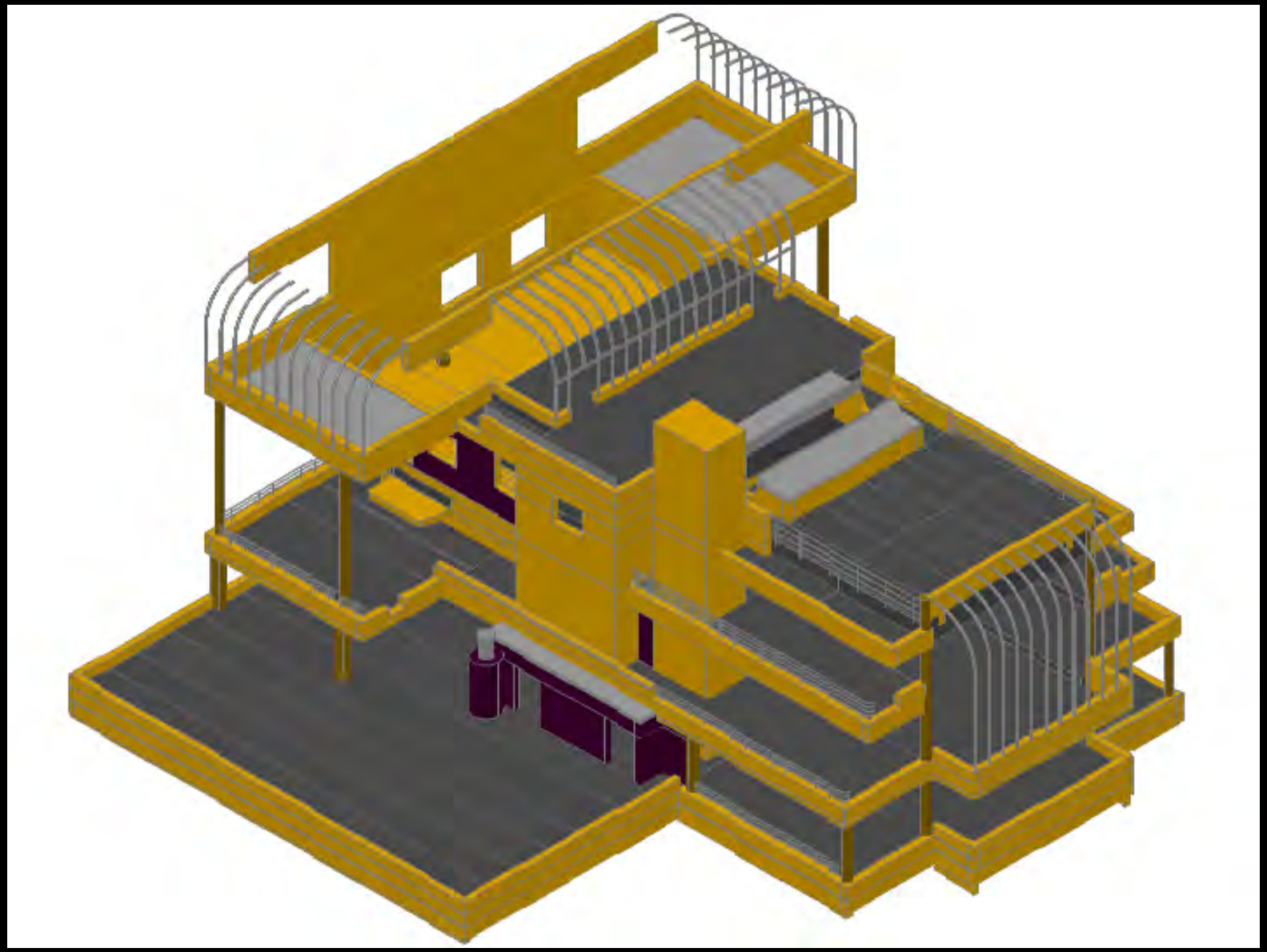
Drawings / Elevations Processed



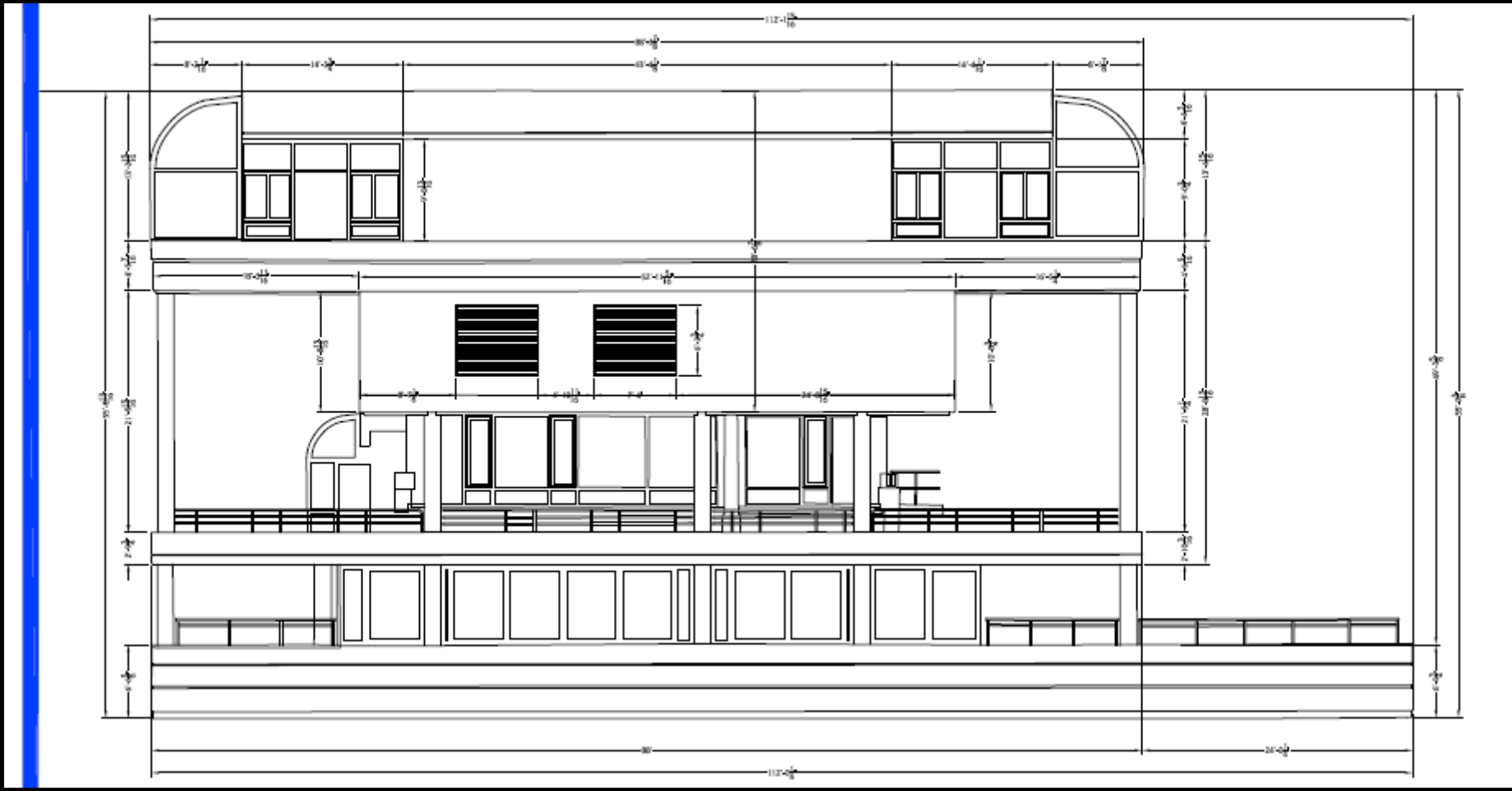
Now it gets clever…

Deformation Analysis

Model Delivery



Regular Drawings: Still required



QUESTIONS?

Questions?

The Docomomo US National Symposium - Modernism on the Prairie: Rural to Metro Regional Interpretations of the Modern Movement is a collaboration of Docomomo US and Docomomo US/Minnesota.
Please help us thank those who have made this symposium possible.

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