

Application and Visualization Techniques for Advanced Sensor Networks

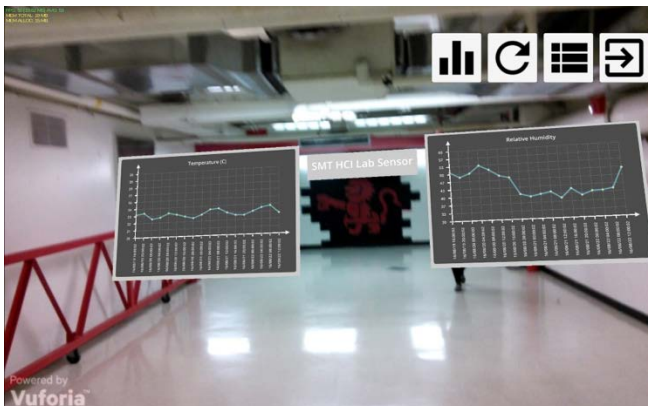
Case Study: Sensor Installation in Skilled Trades and Technology Centre

SIMTReC Innovation Day 2017

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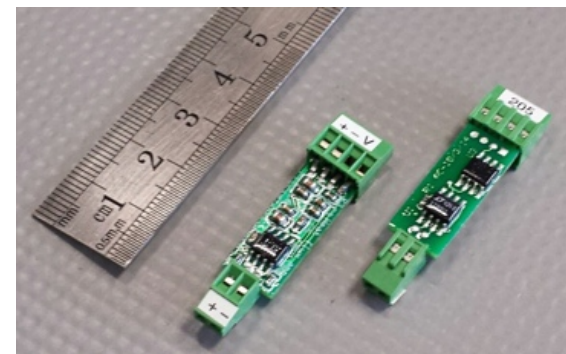
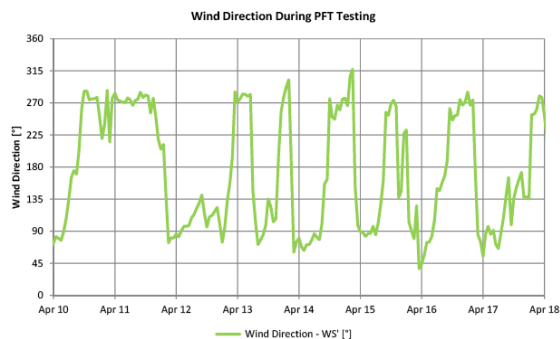


- Background
- Case Study - RRC STTC
- Data Visualization Techniques and Analysis Tools
- Research Projects



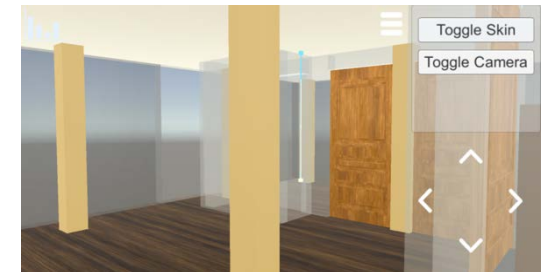
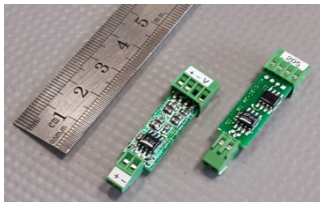
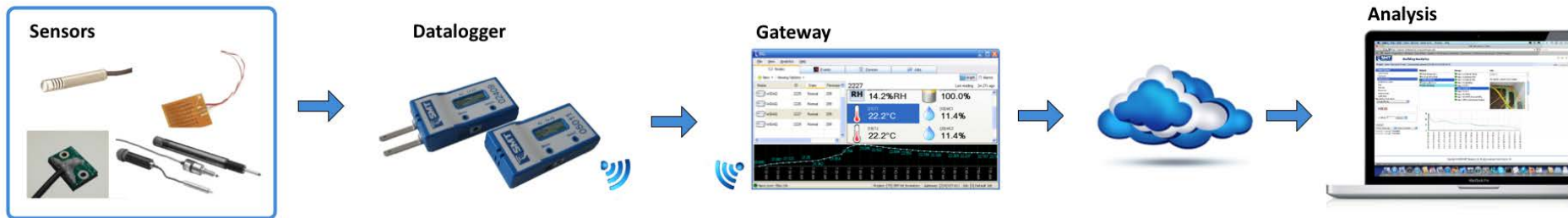


- SMT designs software and electronics used to evaluate the integrity and performance of buildings.
- Incorporated in 2006 in Manitoba
- Primary technology was designed for NRC-IRC to validate materials and methods to produce more durable and efficient buildings.
- Sensors and DAQs used for Investigative Research
- Headquarters is now in Vancouver, BC





Monitoring Technology



- See <http://www.smtresearch.ca/smt-product-list> for list of Compatible Products
- High resolution sensors can be connected to wireless, wired and cellular based DAQS.
- Cloud based software allows for easy data retrieval and analysis.



Structural Health Monitoring Technology

- Examples of SHM sensor deployments



Monitor moisture absorption in masonry - Tomb of Jesus



Moisture monitoring at Parliament NWT



Compression and moisture analysis of the worlds tallest wood building located at UBC





- Goal is to instrument RRC-STTC with sensors and technology to create an educational living-lab
- One of the first comprehensive buildings to be “Connected” using IoT (Internet of Things) concepts
- Sensor suite provides complete analysis of the roof integrity as well as specialized sensors to monitor the performance of the green roof.
- Building envelope sensors monitor the thermal performance of all building components throughout the building.
- Real world research is possible in Building Science, Civionics, Material Engineering and Mechatronics.





Roof Sensor Installation Grid

Roof Monitoring – 10' x 10' spaced grid placed on roof for moisture detection. 5' x 5' grid on the green roof. Monitors for leaks over the entire roof membrane.

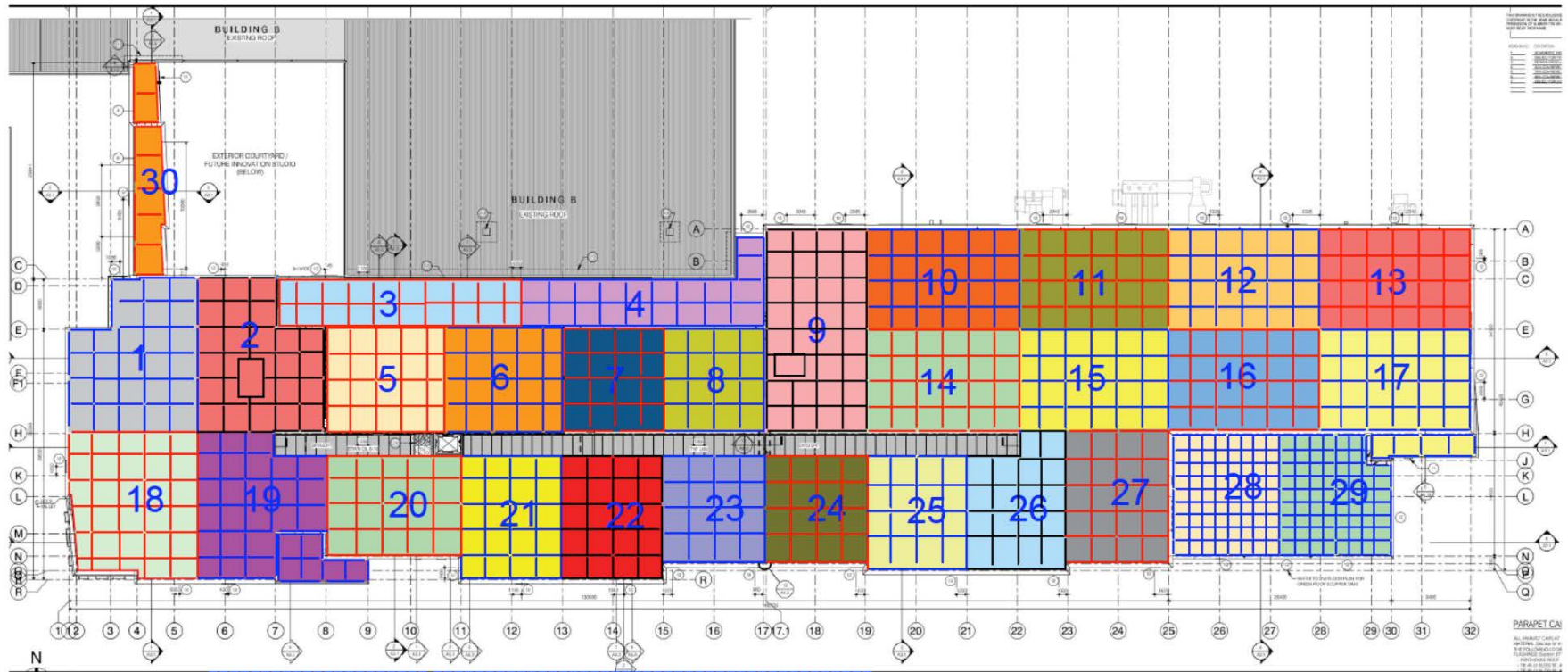




Roof Sensor Installation Grid

Installation grid shown below.

Capable of locating the first signs of a leak within 10' x 10'.

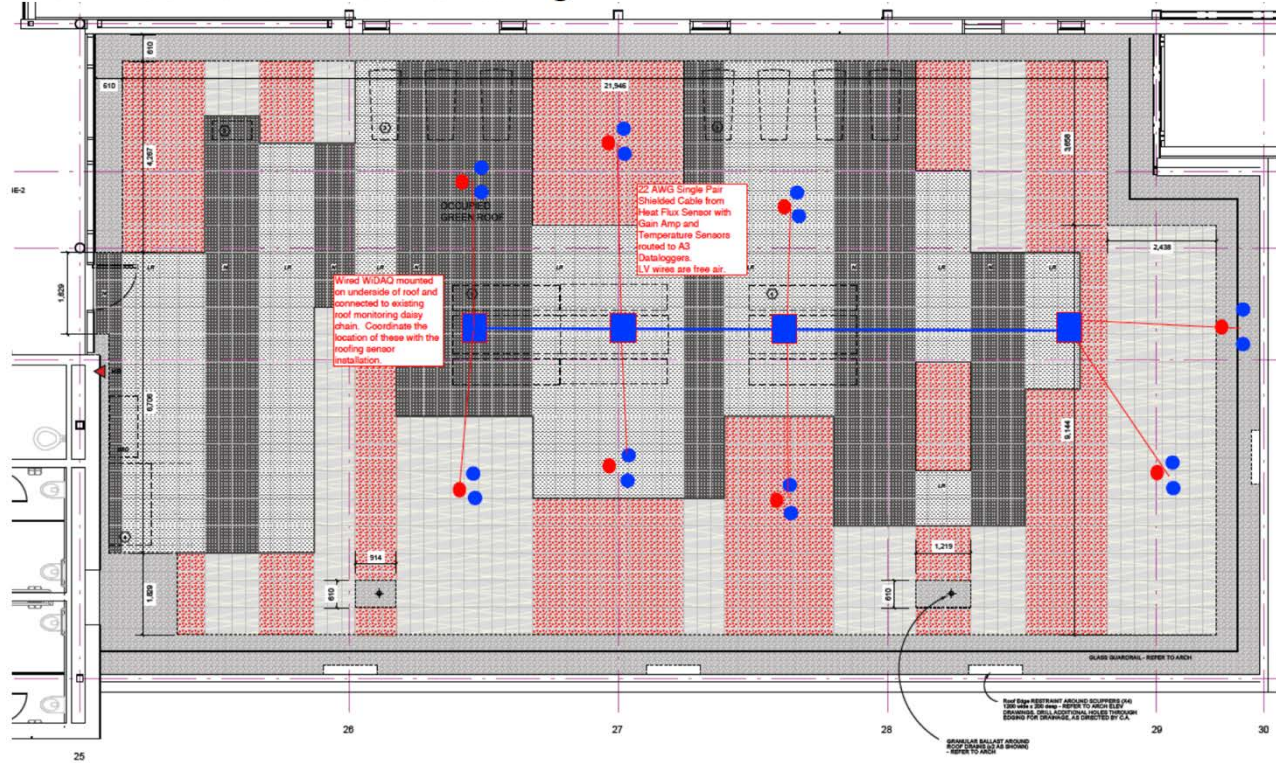




Green Roof Sensor Installation

- Green Roof Performance Monitoring
- Thermal Transfer (Temperature and Heat Flux)

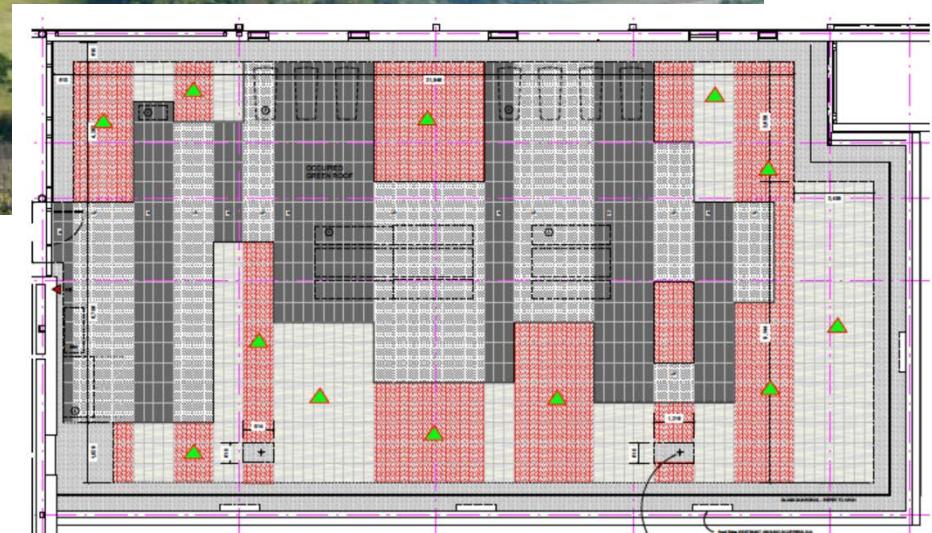
Green Roof Performance Monitoring





Automated Data Collections Methods

- Green Roof Monitoring using Drone Technology
- Drone will collect moisture and temperature data by hovering/driving over sensors embedded in the roof/soil.





Building Envelope Sensor Installation

2nd Floor East (6 locations)



- Moisture detection around curtain wall windows
- Temperature differential through wall assemblies
- Solar effectiveness from Skylights
- RH in different assemblies to detect condensation
- Thermal transfer through different materials



Building Envelope Sensor Installation

- Thermal transfer analysis of different wall systems
- New heat flux sensors were designed in conjunction with BETAC to allow us to analyze in-situ R-value of full assemblies.

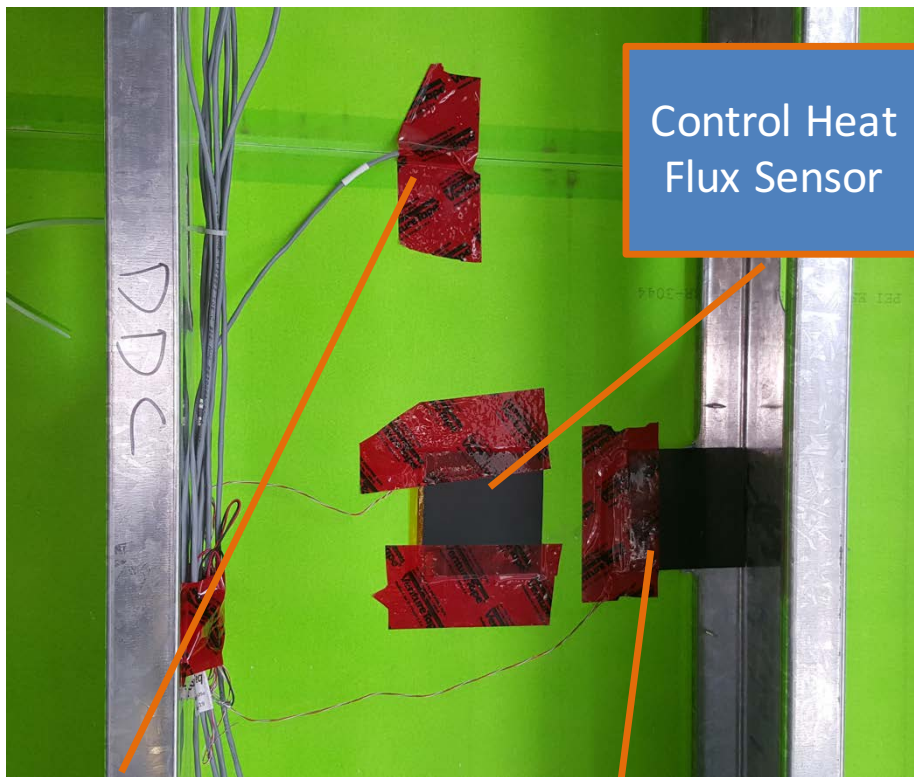


Evaluating Heat Flux sensors in CARSI Dual chamber

Designed new heat flux sensor capable of covering larger areas



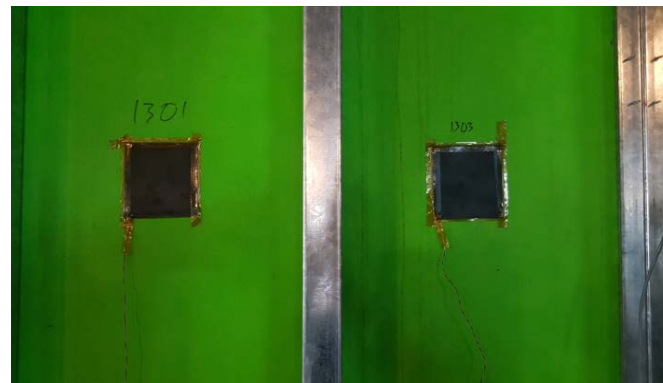
Heat Flux Sensor Installation



Control Heat Flux Sensor

Temperature Sensors

Monitoring heat flux over complex assemblies

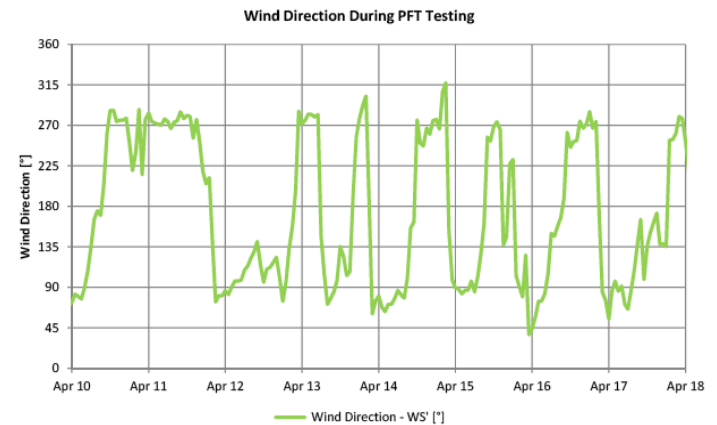
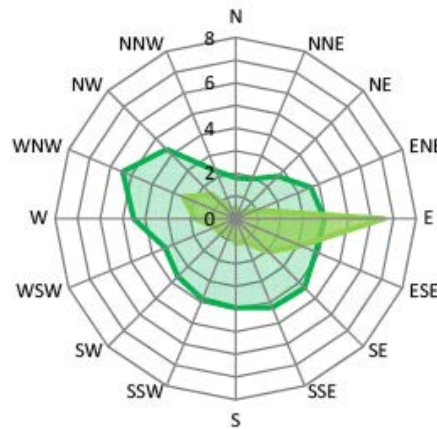


Test Heat Flux on Different Insulation Types and Configurations



Environmental Weather Correlation

- Correlation of weather data with building systems.
- Weather station on roof will provide pertinent data that can be correlated with building performance data for cause and effect analysis.





Monitor Specific Details

- Monitoring specific details
- Parapet details, Sky lights etc.
- Helps validate new materials and processes and construction techniques.

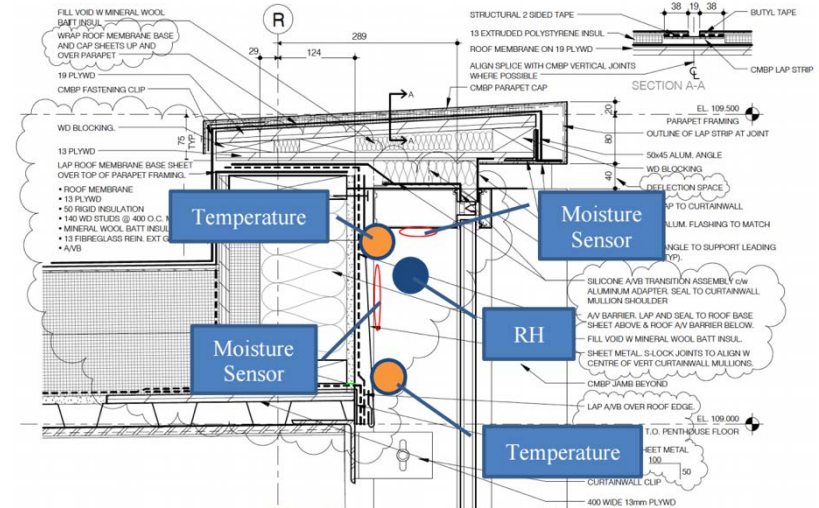


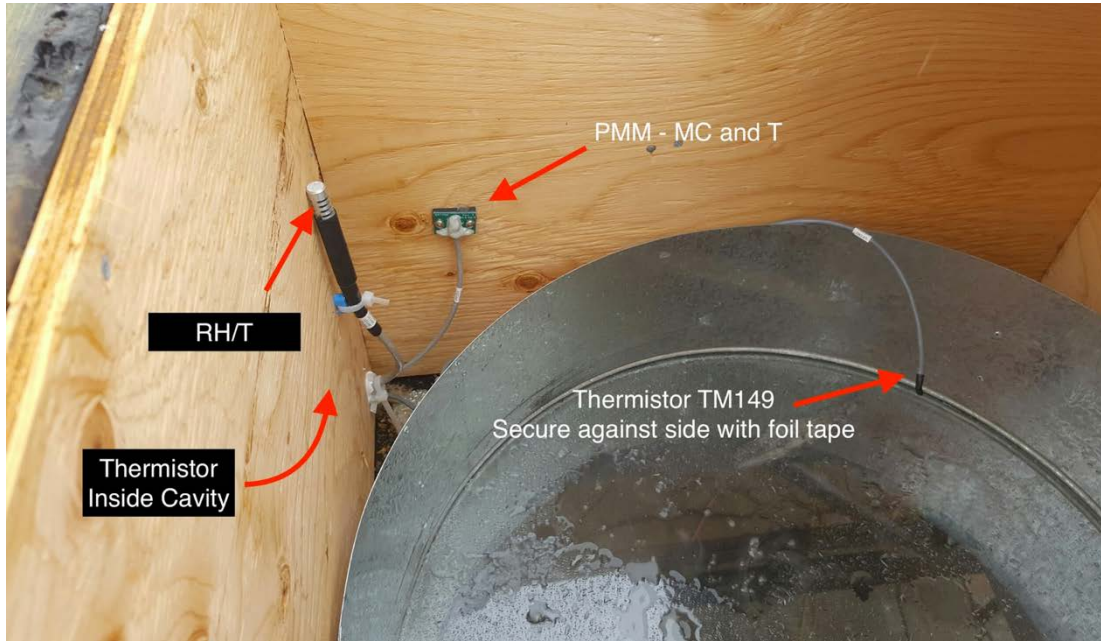
Figure 1. Parapet to curtain wall assembly





Instrumentation During Construction

Solar Tube Monitoring Sensor Installation

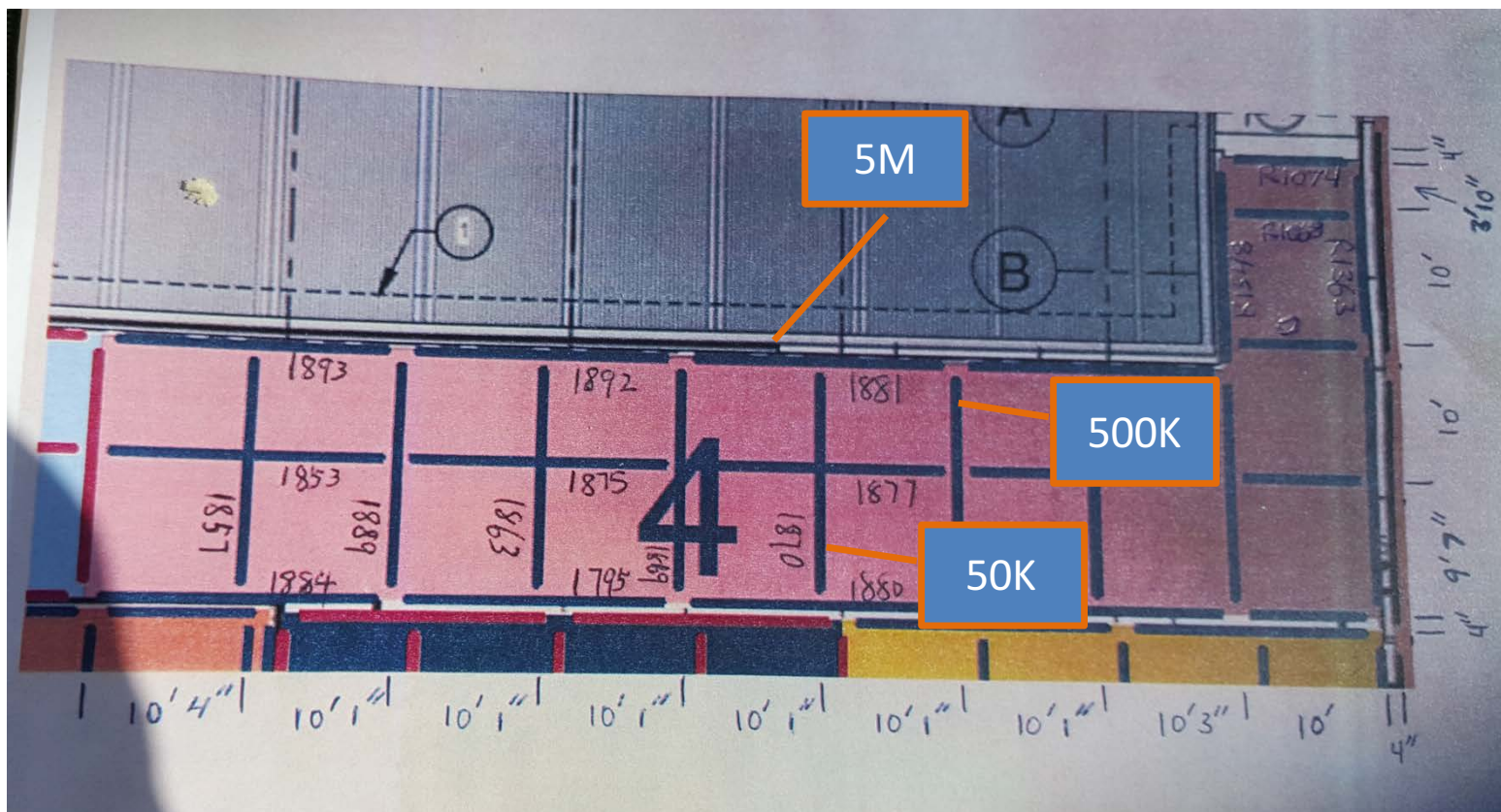




Present Solar Tube



Leaks Identified on System Software



Tape sensors revealed potential moisture under the roof membrane
Dry tape sensors are 10M ohms



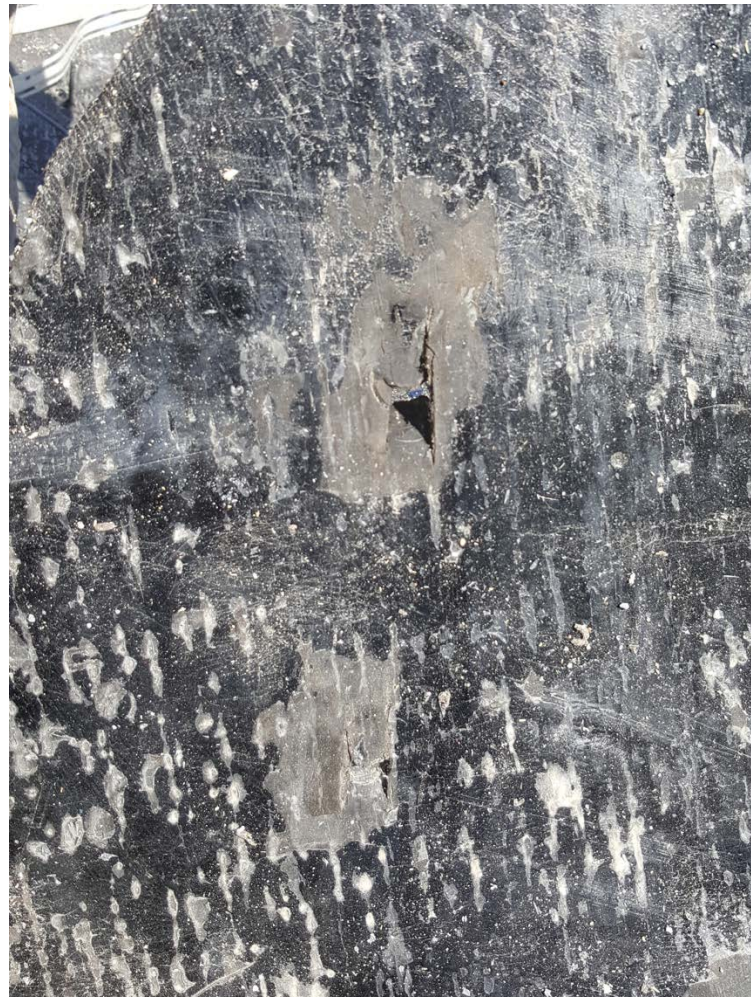
Roof Leak Investigation



Cut roof section open, confirmed water was present.



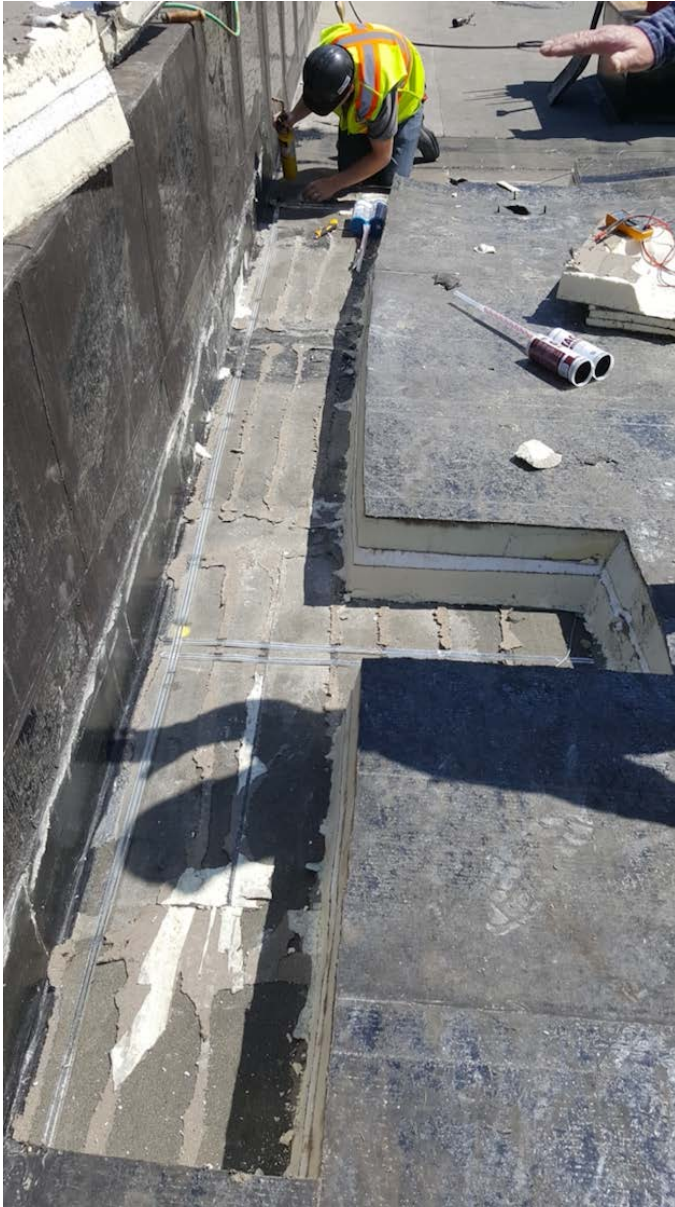
Identified Breaches in Roof Membrane



Leak may have been due to this puncture in the membrane.



Identified Roof Leaks



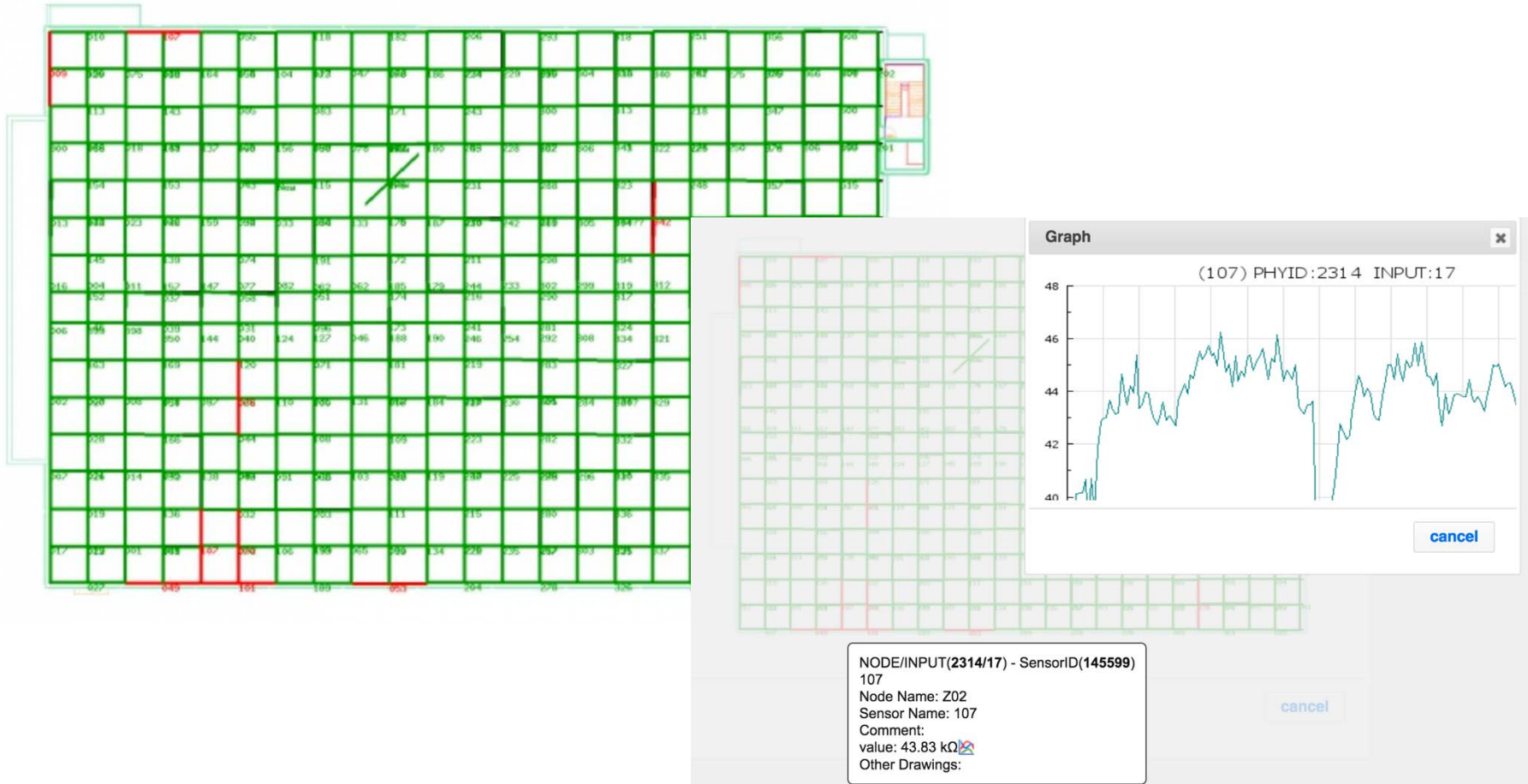
Entire area was dried, tapes retested and area was re-roofed.

Similar issues were identified in other areas.

System will be activated next week to validate entire roof system.



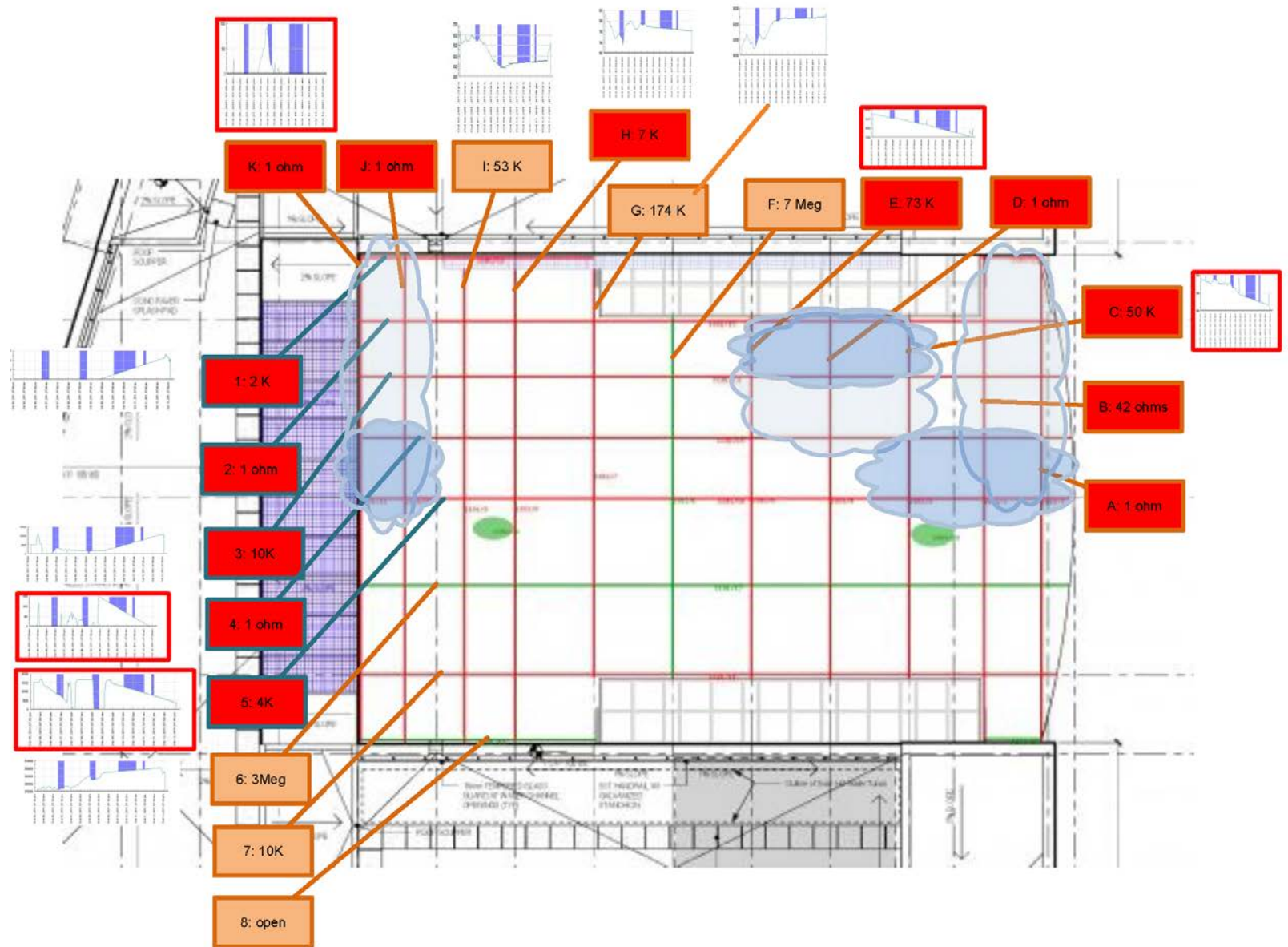
Analytics Output – Standard Visualization



Using standard graphing tools and color coded graphics to indicate leaks and/or areas that exceed a specific threshold.



Analysis Using Sparkmaps





Data Visualizations – Augmented Reality

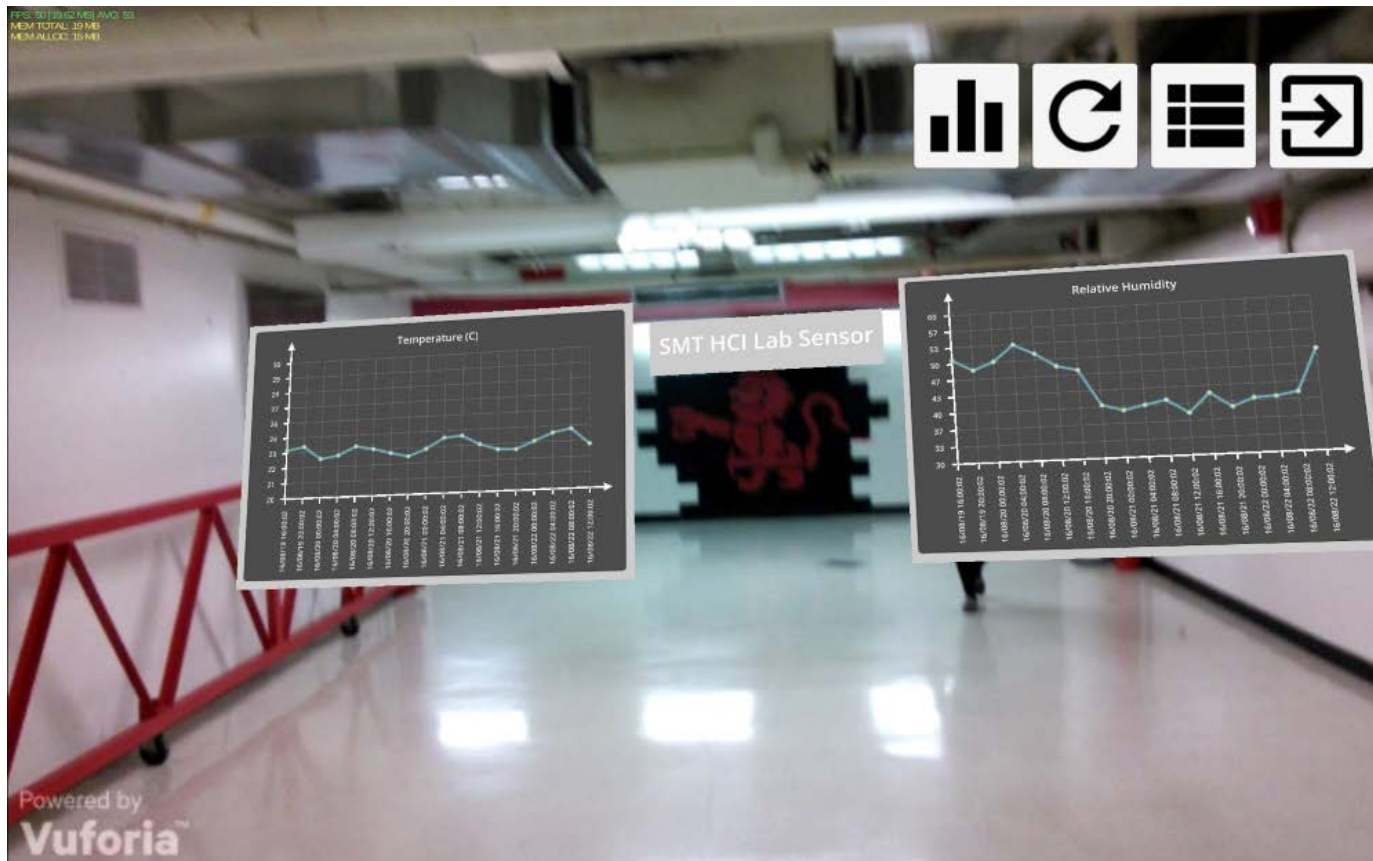


Extract data from embedded sensors and overlay on smart phone display



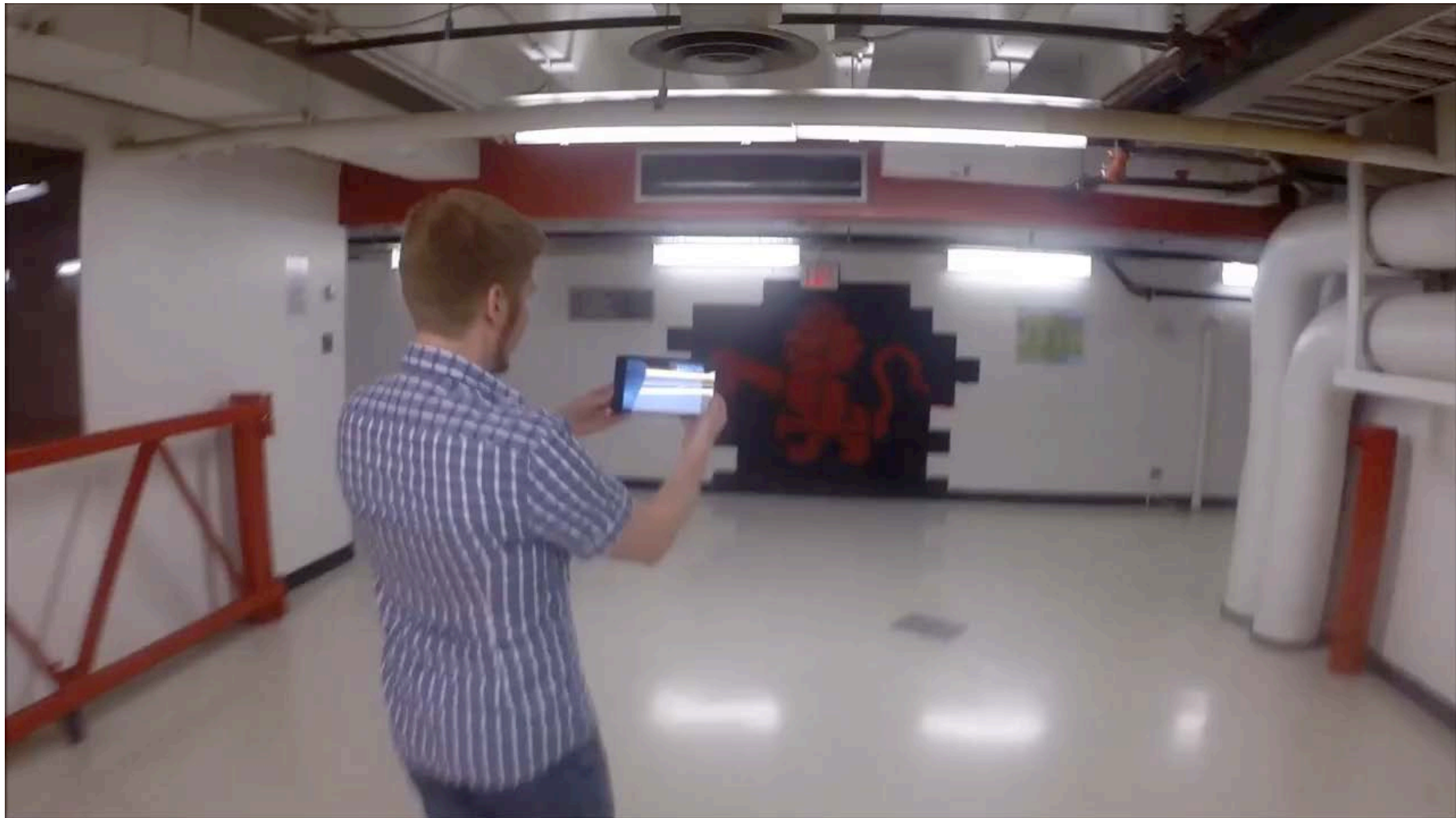
Data Visualizations – Augmented Reality

Using a Smartphone camera, identify the surface in view and augment the surroundings by overlaying sensor data on the image.





Data Visualizations - Interactive Interface





Data Visualizations - Interactive Interface

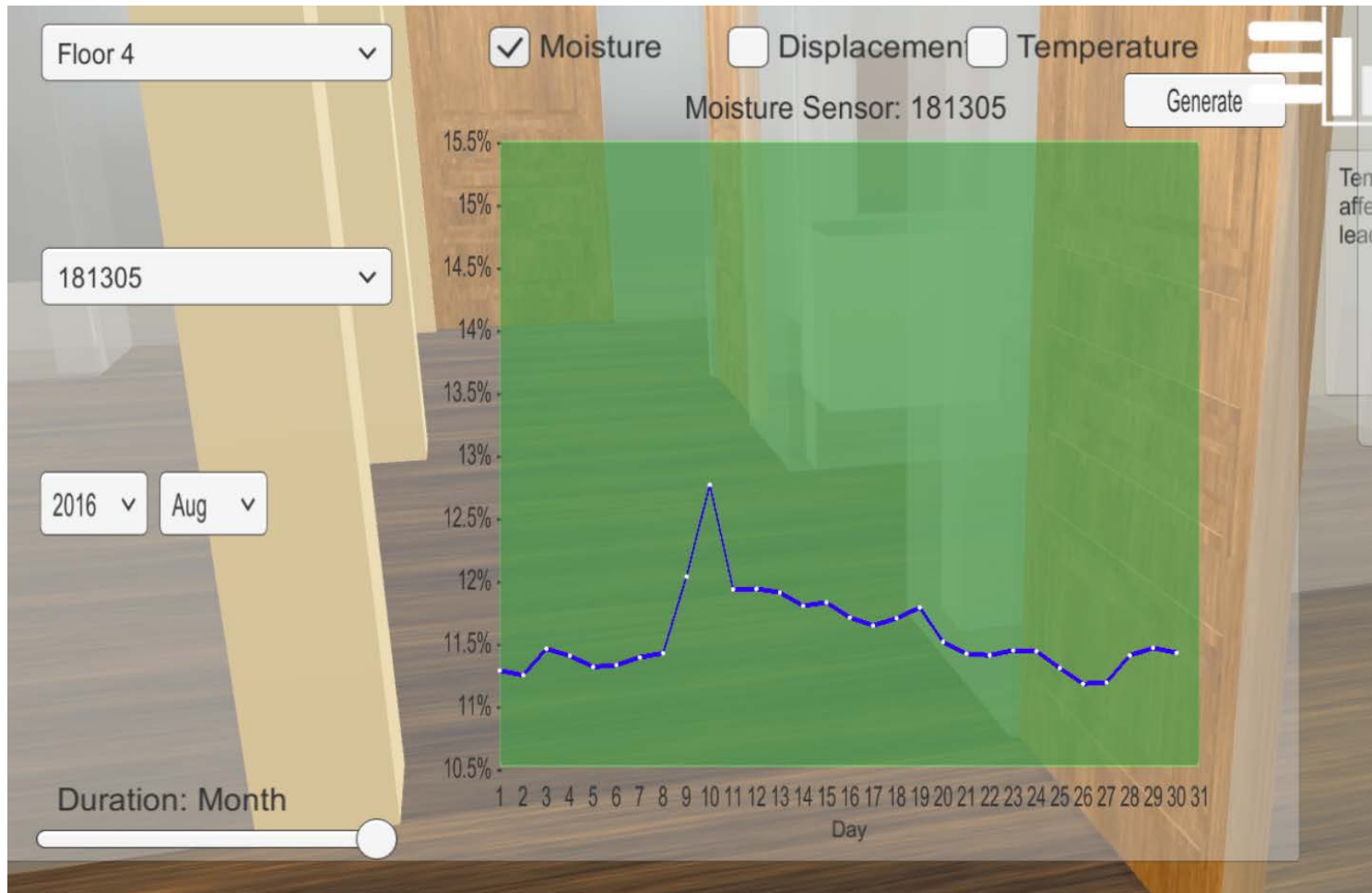
Using Unity Gaming Engine users will be able to navigate building and view sensors embedded through building





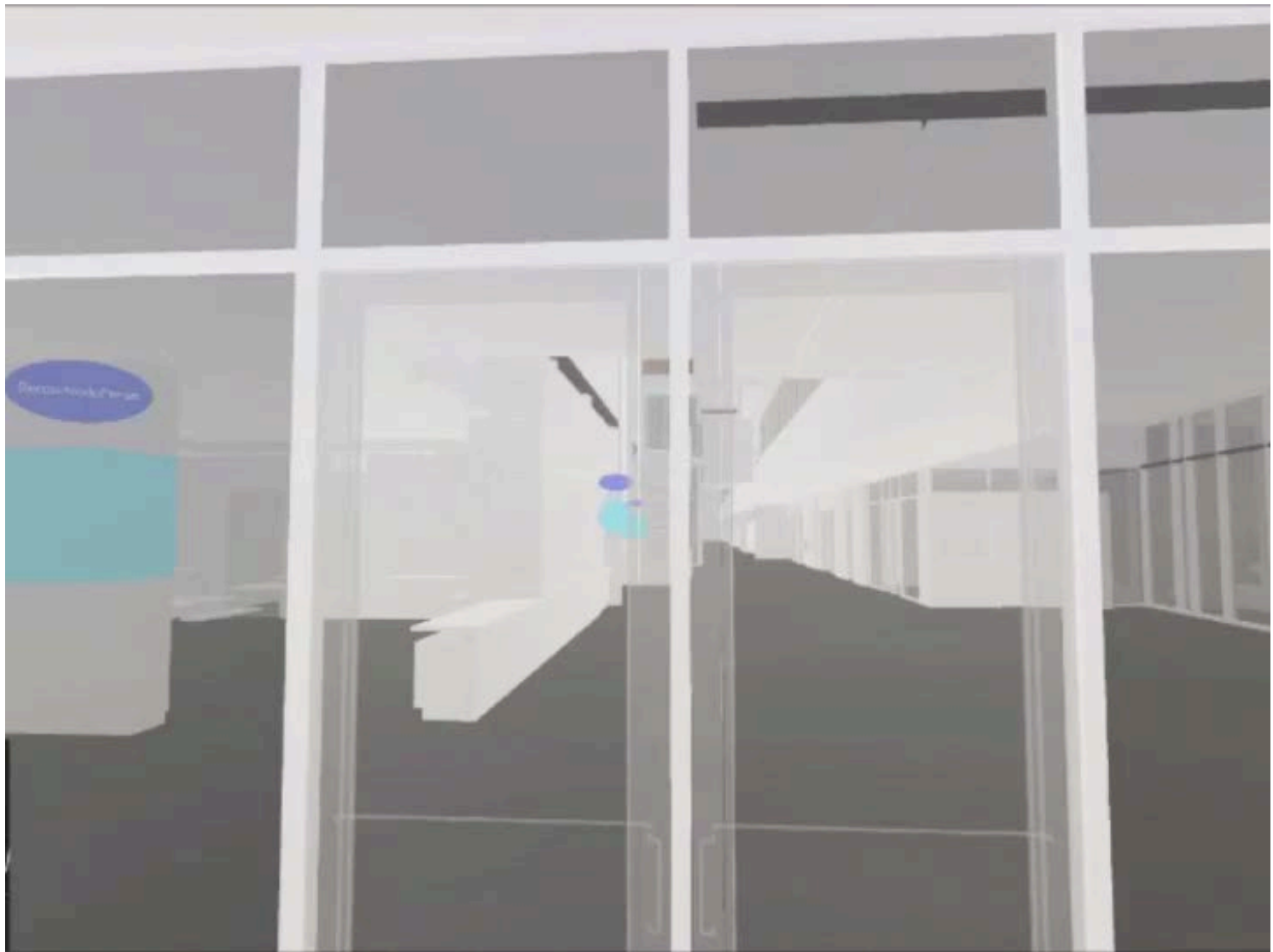
Data Visualizations - Interactive Interface

Select sensors to view historical data trends





Data Visualizations - Interactive Interface





Data Visualizations – BIM/Sensor Interface

- Integrate sensor data with Building Information Modelling (BIM) Tools.
- Project Initiated by RRC



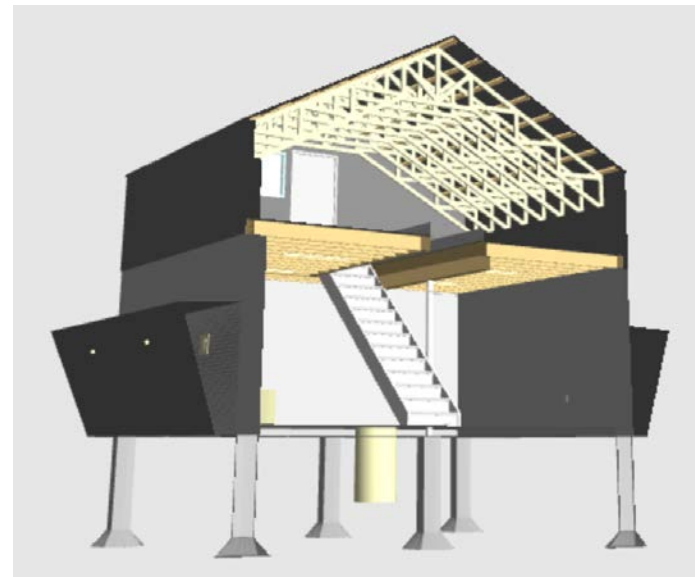
<http://bim.aceproject.space>



Main Goals

1. Create a web browser and mobile device visualization of BIM model

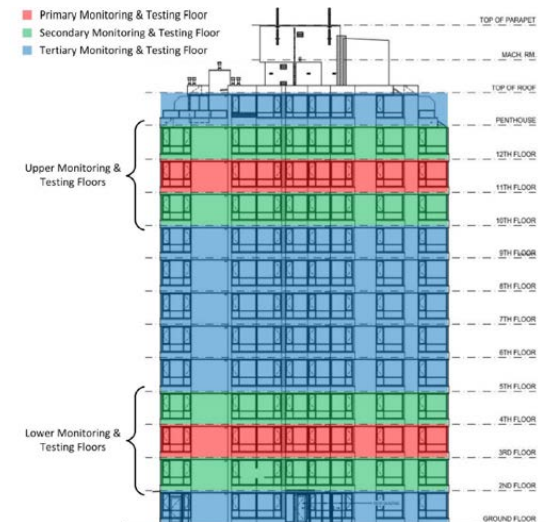
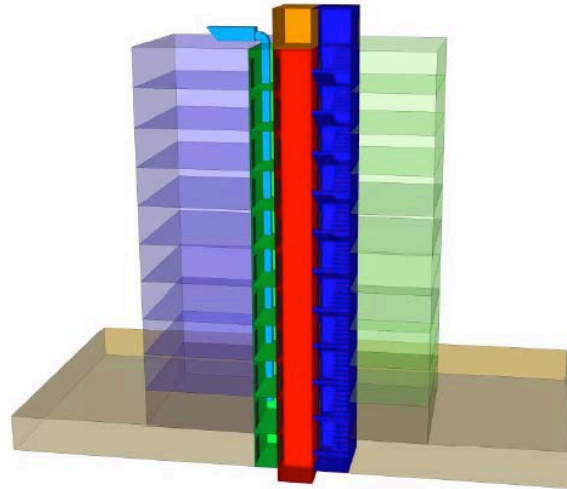
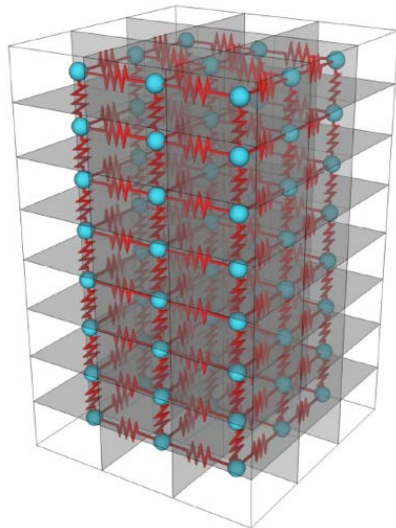
2. Provide advanced analysis and processing tools including:
 - a. Machine learning for data filtering
 - b. Deep learning for pattern analysis of alert conditions
 - c. Heat map visualization





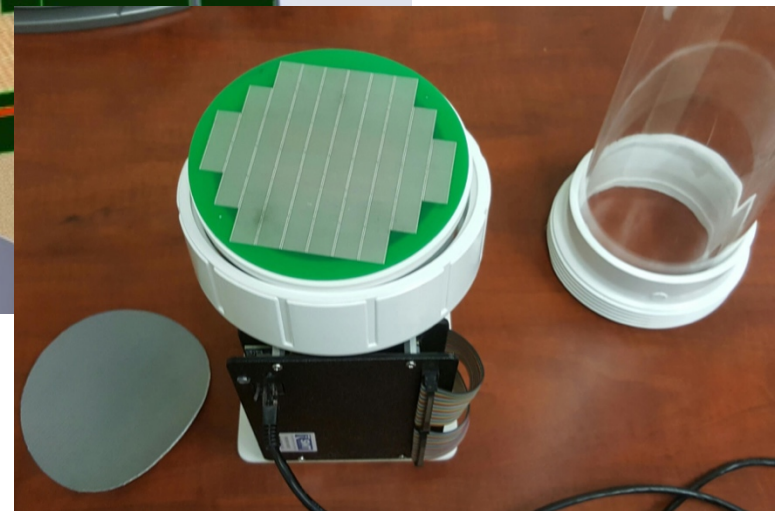
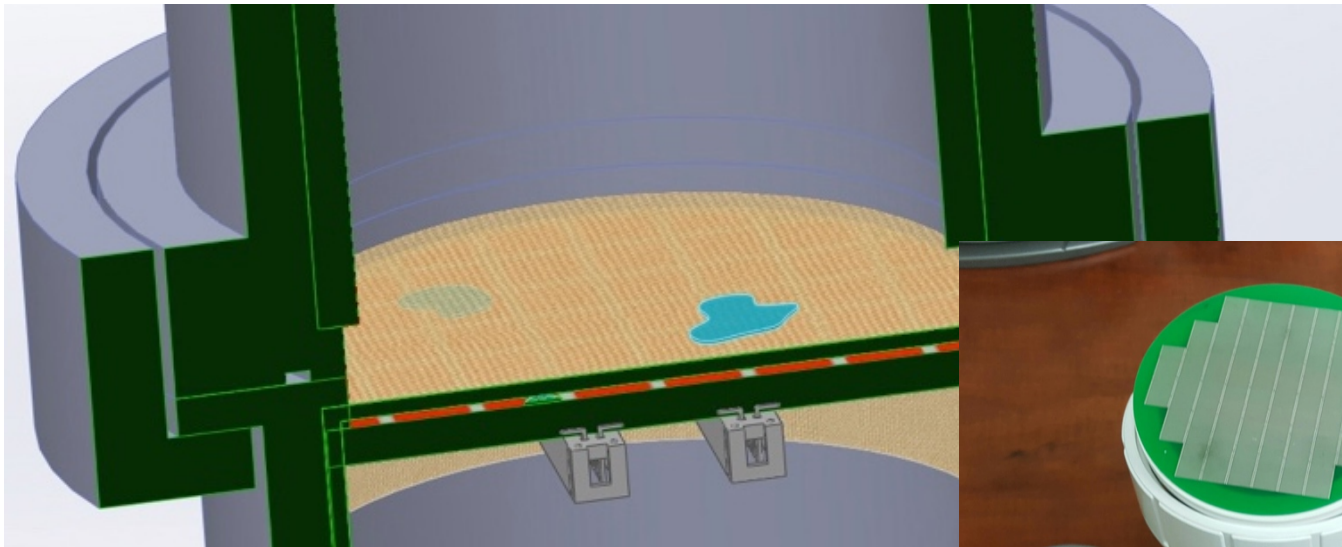
Research Projects Initiated

- Model the thermal efficiency of the building using building energy simulation tools such as WUFI, HOT2000, Therm etc.
- Compare results to actual readings from heat flux and temperature sensors installed throughout the building.
- Part II of the paper this presentation is based on.





New Methods for Material Testing
AATCC Test Method 127 Proposed with Sensor Plate
Using a Hydrostatic Pressure Test
New test apparatus devised to validate materials

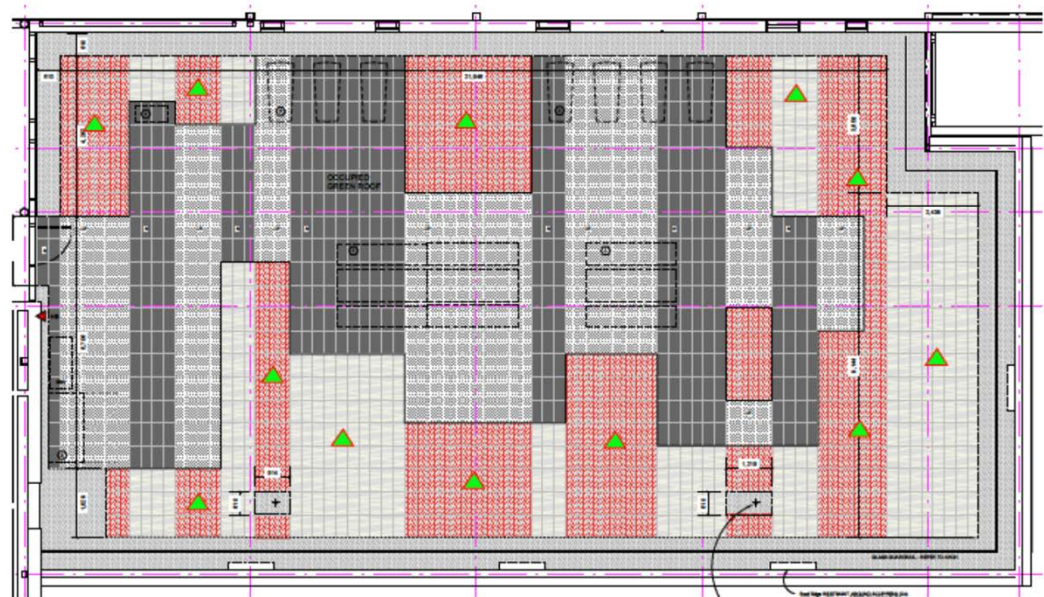




Data collection using drone technology



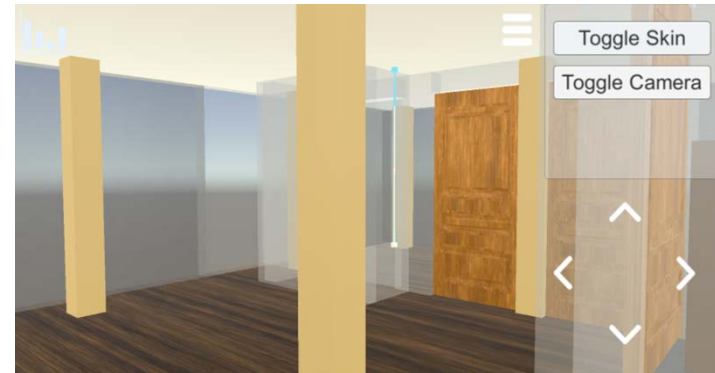
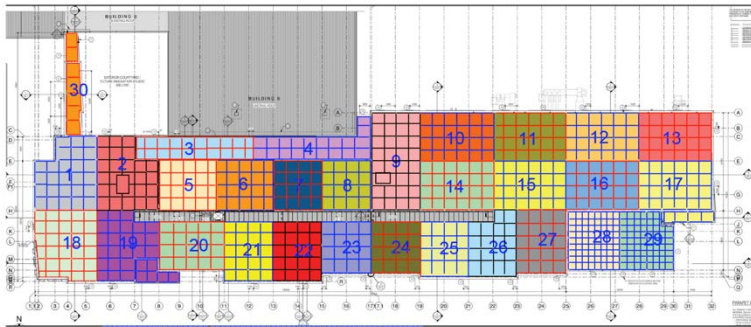
Soil Moisture Monitoring



UBC IGEN team has taken on this project. Using a land based drone to analyze roofs for leaks and presence of moisture.



Questions?



Floor 3 East Edge Weather Comparison

