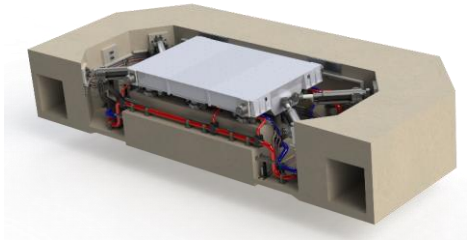
National Science Foundation

University of California at San Diego
NHERI
Natural Hazards Engineering Research Infrastructure

UC San Diego
JACOBS SCHOOL OF ENGINEERING
Structural Engineering

IT Resources, Cybersecurity, Instrumentation, and DAQ

Koorosh Lotfizadeh, UC San Diego

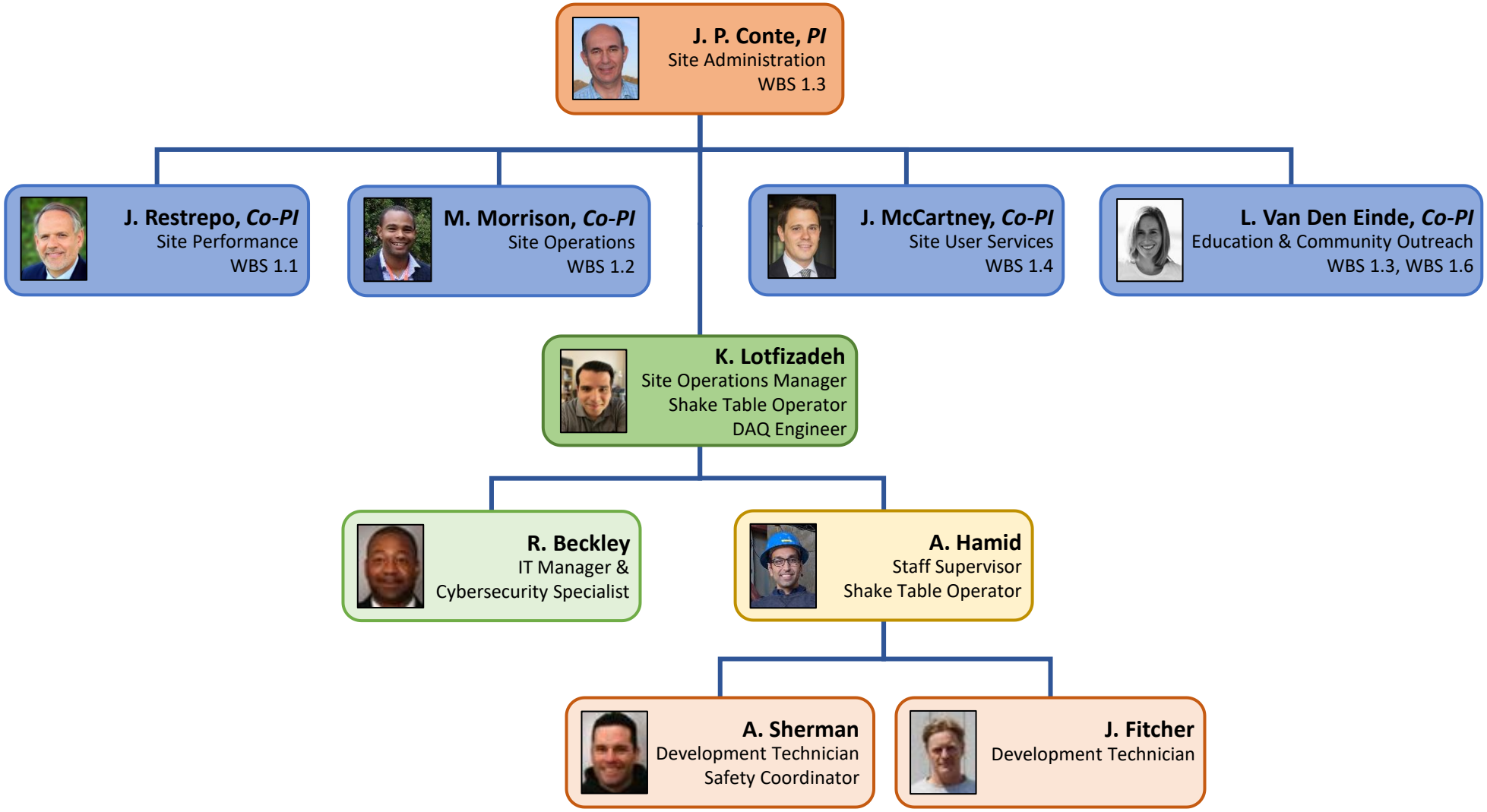


NHERI@UC San Diego User Training Workshop

December 15-16, 2022
University of California, San Diego

NHERI Operations Personnel

NHERI Operations Organization Chart

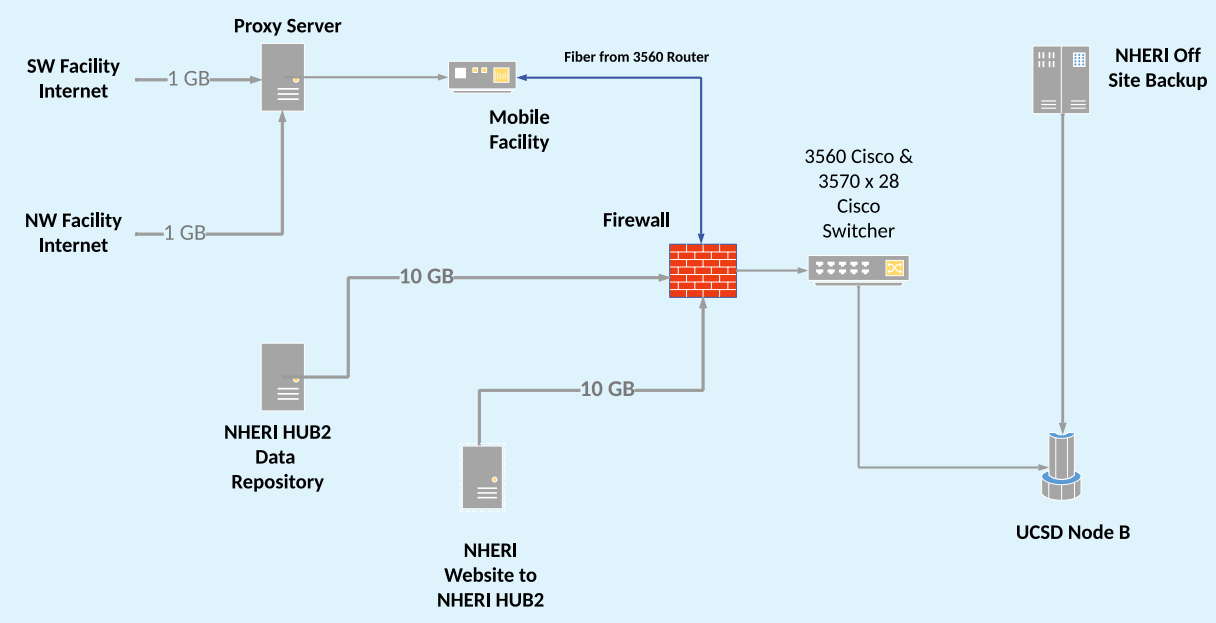


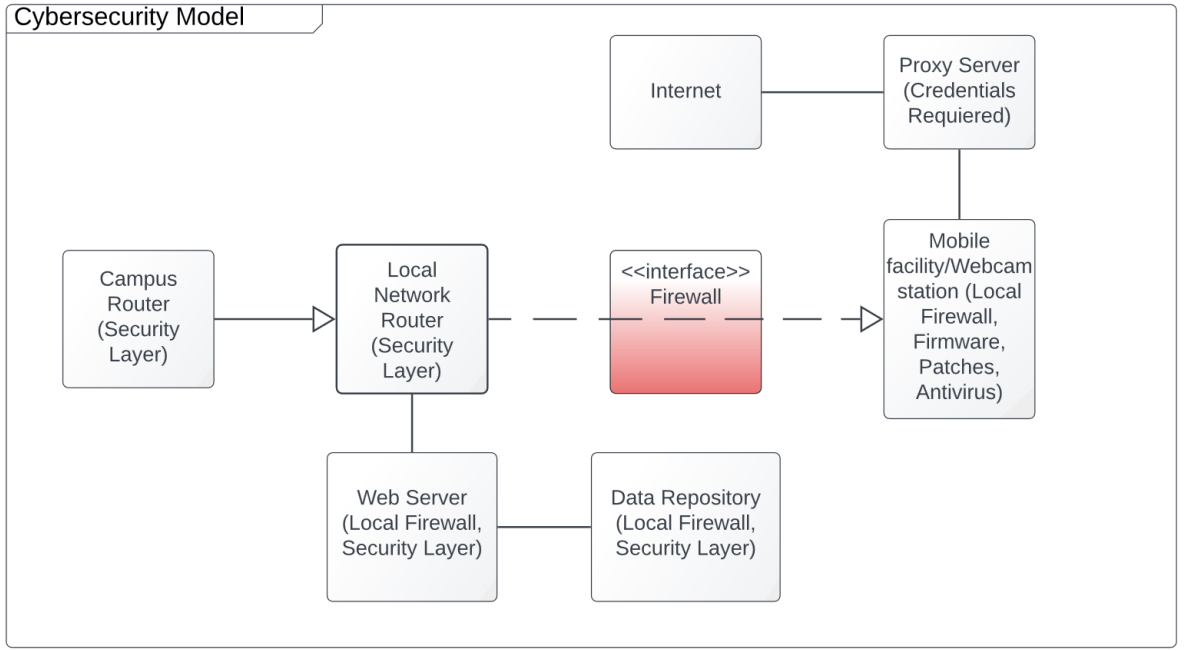
IT Infrastructure and Cybersecurity

IT Infrastructure and Cybersecurity

- UPS to provide “clean” power to DAQ and provide buffer in event of power outages
- Off-site data backup for redundancy
- Cyber security audits
  - Weekly audits by UC San Diego IT security department
  - Network vulnerability scanning and penetration testing
- Security cameras and locks for physical security

- NHERI@UC San Diego EF equipped with gigabit LAN
- Secure high-speed Wi-Fi available throughout facility
- Two independent networks for security
  - General facility network connected to the internet for users (accessible from anywhere)
  - DAQ and video local network, restricted to key personnel (not accessible from the outside)





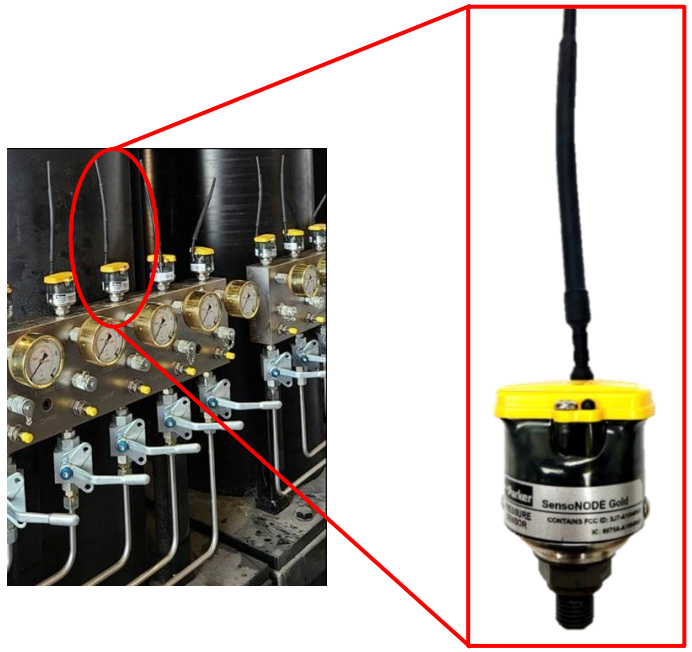
Realtime Monitoring of Subsystems

Accumulator Bank Pressure Monitoring

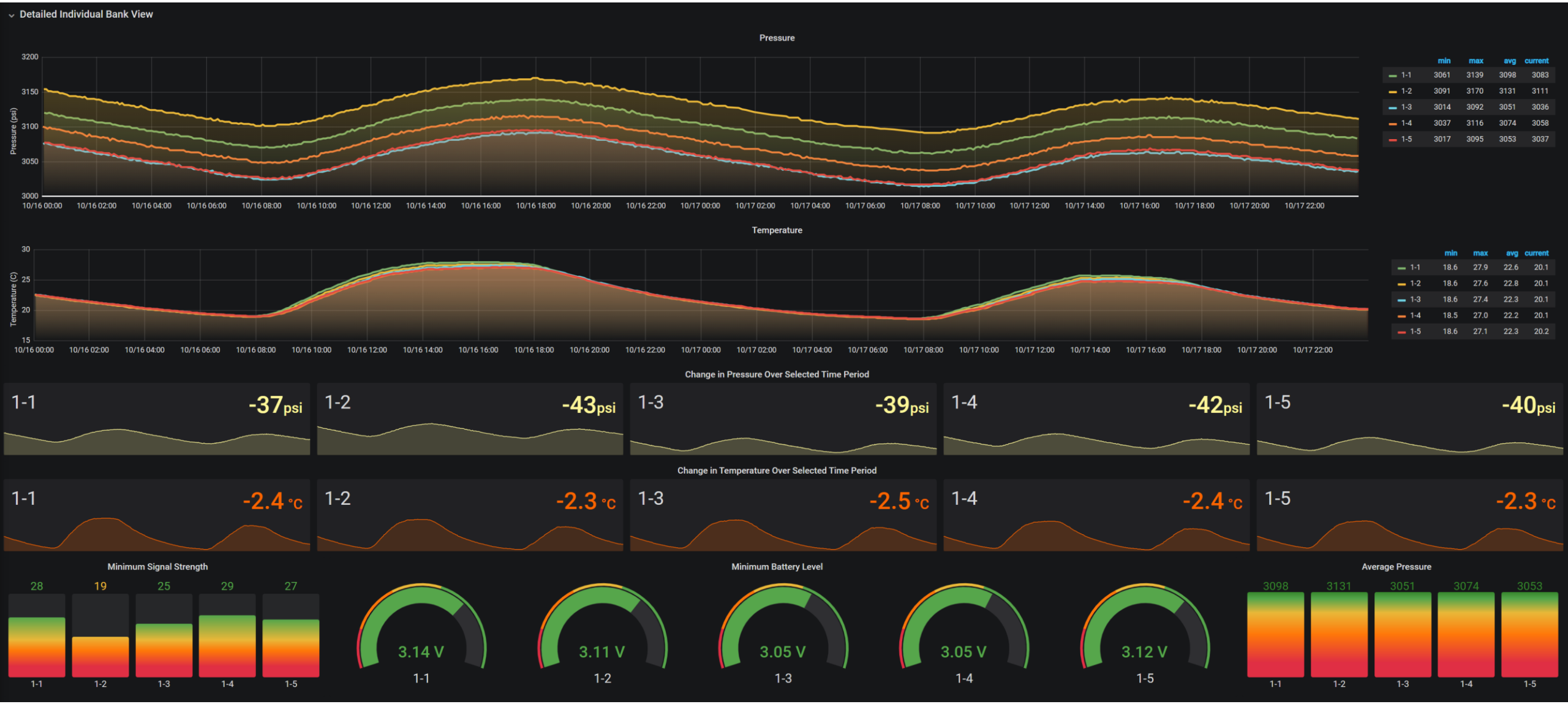
- Accumulator banks
  - 75 bottles total, 15 skids with 5 bottles each
  - 130 gallons per bottle
  - 3000 psi minimum Nitrogen pressure in each bottle in idle condition

- Pressure changes throughout the day with ambient temperature fluctuations

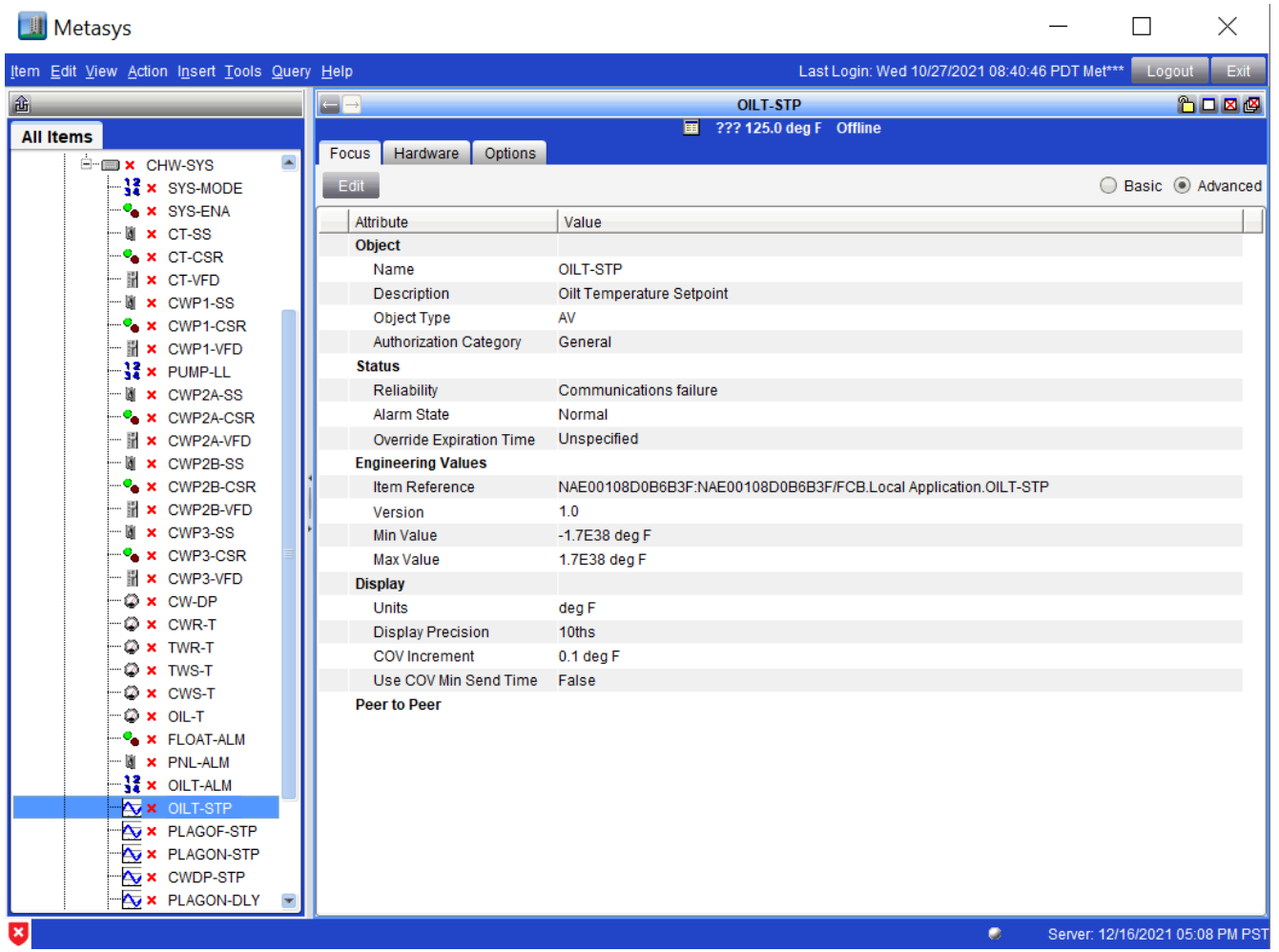
- Wireless real-time monitoring of pressure and temperature in each bottle
  - Equipped with wireless Sensonode Gold by Parker
  - Data captured by wireless gateway and passed to SQL server
  - Web-based user interface for local or remote monitoring



Accumulator Bank Pressure Monitoring

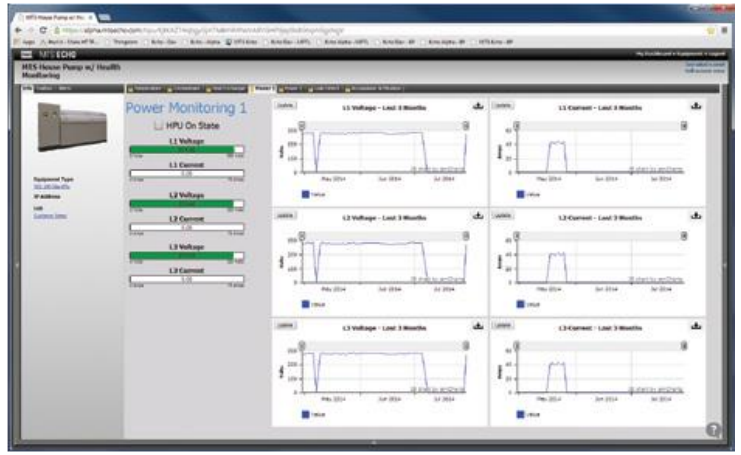


Cooling Tower Monitoring



MTS Echo Health Monitoring

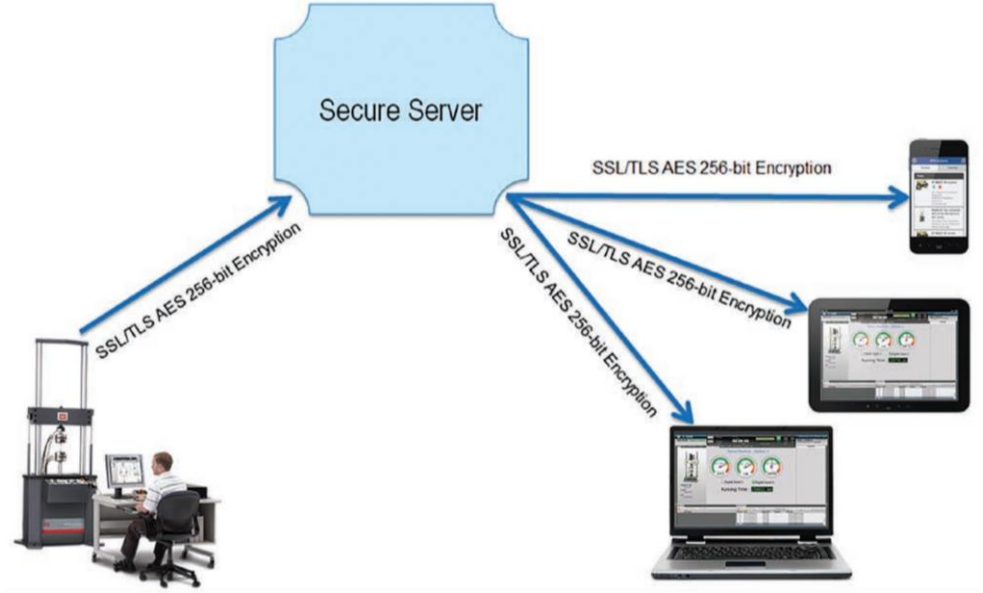
- Real-time health monitoring of HPUs



- Protect system performance
  - Minimize system downtime
  - Minimize likelihood of expensive catastrophic events

- Monitor various critical metrics
  - HPU temperature
  - Heat exchanger water saturation
  - Fluid contamination
  - Current and energy consumption
  - High-pressure and return filtration effectiveness

- Secure server infrastructure, highly scalable
  - SSL/TLS AES 256-bit encryption



Courtesy: MTS Systems Corporation

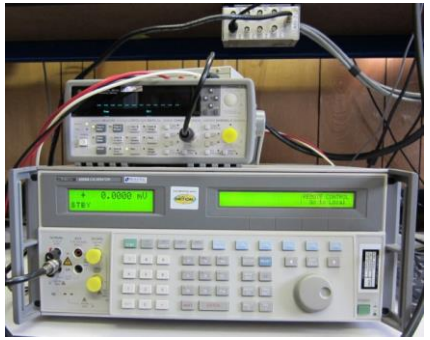
Instrumentation and Data Acquisition System

Instrumentation and Data Acquisition

- Objectives
  - Provide quality management system
  - Provide nationally and internationally recognized testing data and reports
  - Maintain a calibrated sensor and equipment inventory
- Documentation
  - Documentation master log file
  - General documentation
  - Standard operation procedures
  - In-house calibration procedures
  - Sensory inventory
  - Equipment inventory
  - Calibration reports

Accelerometers

Accelerometer linearity



Reference equipment

Displacement transducers

Instrumentation and Data Acquisition

- Instrumentation available:
  - 251 MEMS-Based Accelerometers (±5g and ±10g)
  - 305 Linear Displacement Transducers (1 to 20 in)
  - 154 String Potentiometer Displacement Transducers (2 to 120 in)
  - 28 Inclinometers (±15 deg)
  - 4 Load Jacks
  - 31 Load Cells (up to 20,000 lbs)
  - 32 Soil Pressure Transducers
- GNSS System:
  - 10 Receivers Operating at 100 Hz
- Cameras:
  - Drones (DJI Phantom 4 Pro)
  - GoPro Cameras (4K and 1080p)
  - End-to-end Live Video Streaming Production System

Data Acquisition System

- Old DAQ system was obsolete with many non-functional channels
- One of three selected by the University for MRI
- Highly competitive, we were granted MRI for new state-of-the-art DAQ
  - Acquisition of a High-Performance Data Acquisition System to Enable Experimental and Computational Research on the System Level Response of the Built Environment

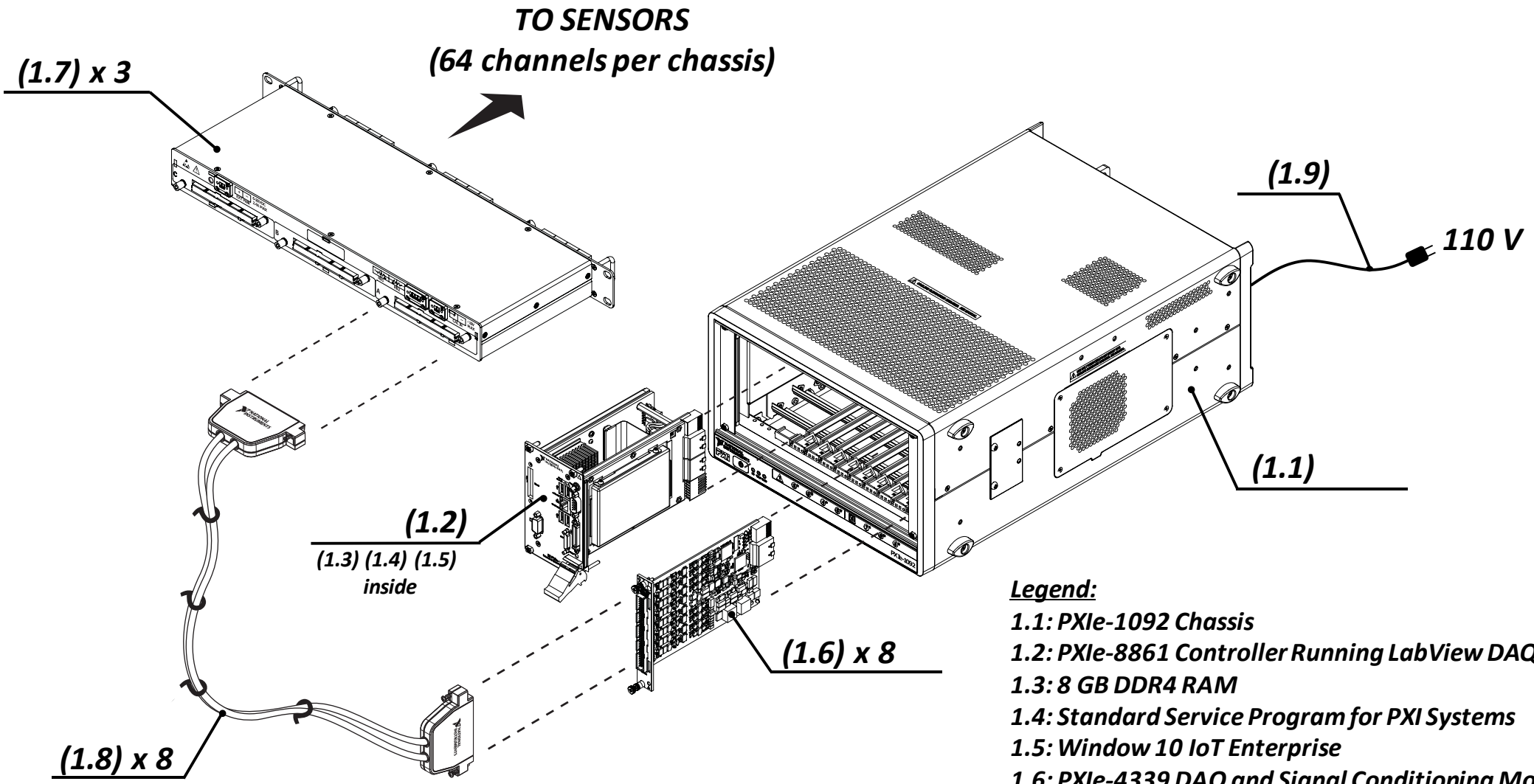
    PI: Lelli Van Den Einde

    Co-PIs: Joel Conte, Veronica Eliasson, Machel Morrison, Jose Restrepo

    CMMI #: 2020745

    $868,148 (Total) = $607,704 (NSF) + $260,444 (UCSD Cost-Sharing)
- Data Acquisition System:
  - Expected lifespan of 15+ years
  - 13 DAQ “Nodes”
  - 64 channels in each node
  - 24 bit analog to digital resolution
  - 25 kS/sec simultaneous sampling per channel
  - Readily scalable
- Will enable NHERI@UC San Diego to continue the collection of invaluable seismic response data, at yet a higher level of resolution and accuracy

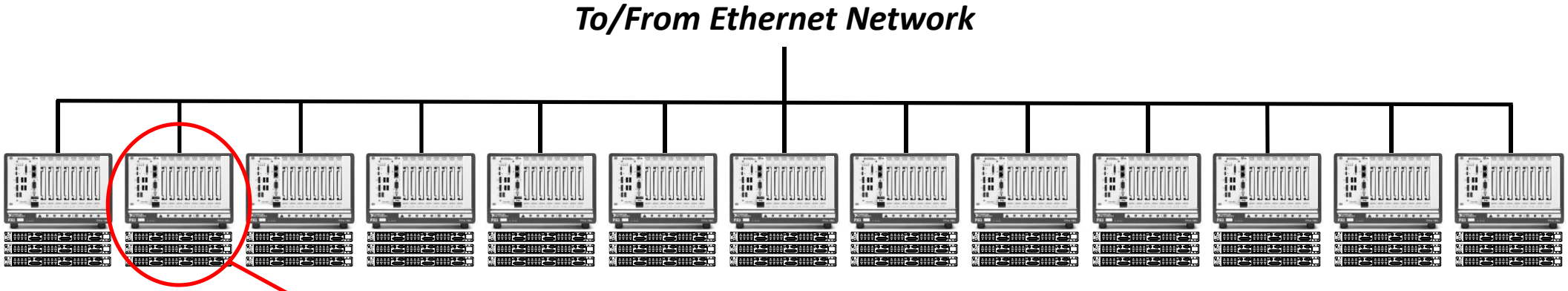
Data Acquisition System

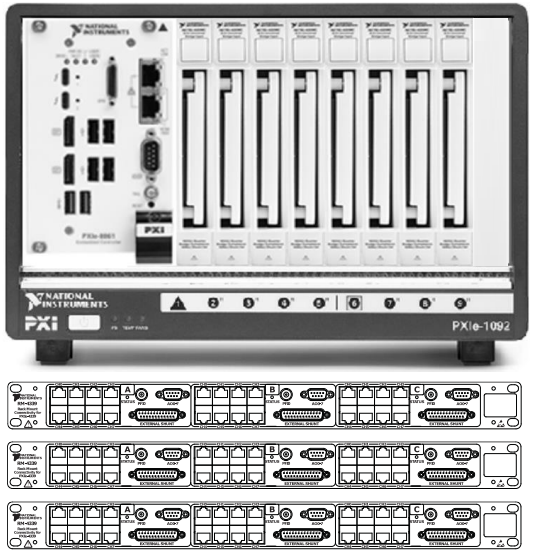


Legend:

1.1: PXIe-1092 Chassis
1.2: PXIe-8861 Controller Running LabView DAQ Software
1.3: 8 GB DDR4 RAM
1.4: Standard Service Program for PXI Systems
1.5: Window 10 IoT Enterprise
1.6: PXIe-4339 DAQ and Signal Conditioning Module
1.7: RM-4339 Rackmount Terminal Block
1.8: SH-96-96-2 Cable for PXIe-4339 to Terminal Block

Data Acquisition System

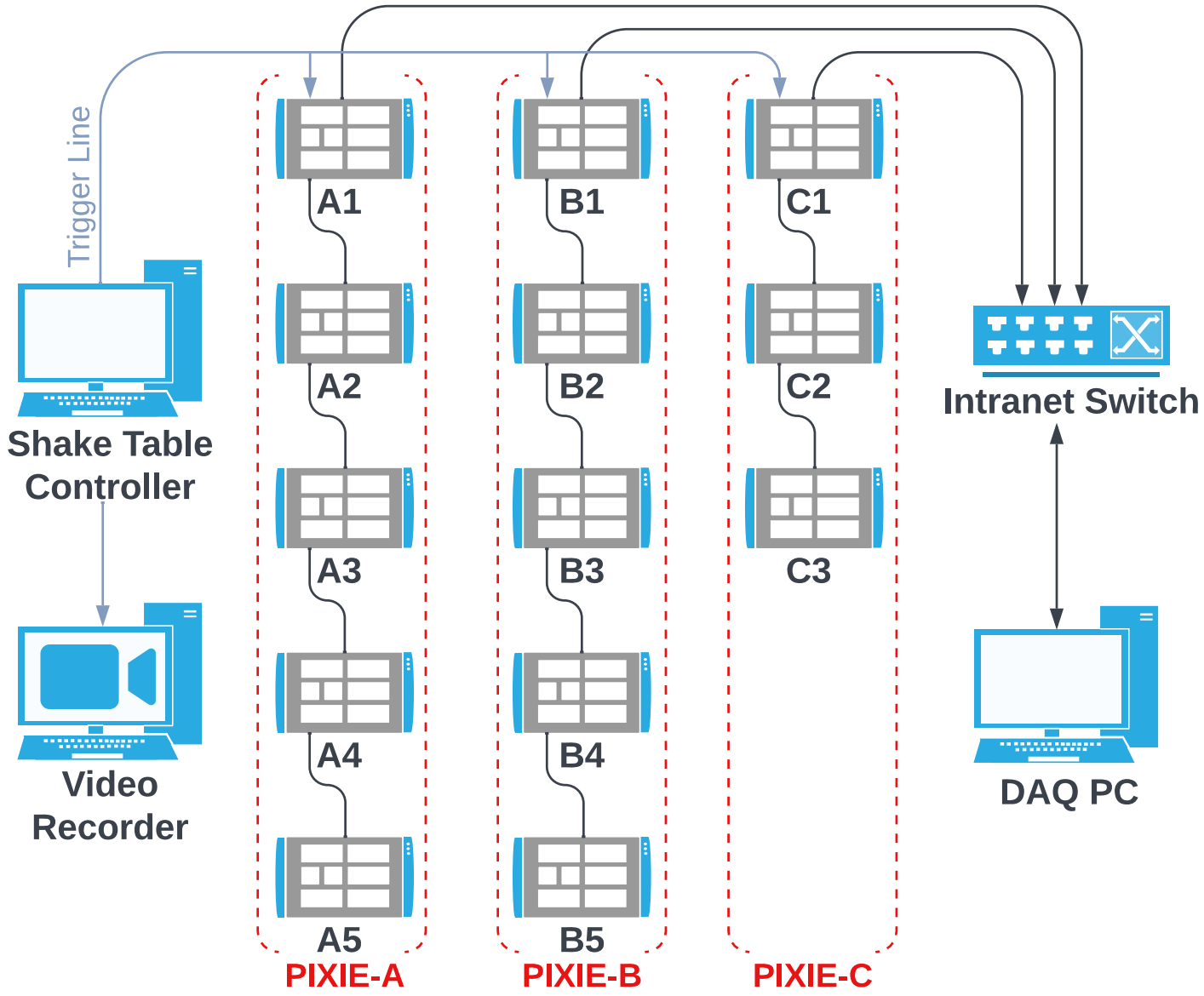




PXIe-1092 Chassis with
1 PXIe-8861 Controller &
8 PXIe-4339 Modules

3 RM-4339
Terminal Blocks

Data Acquisition System



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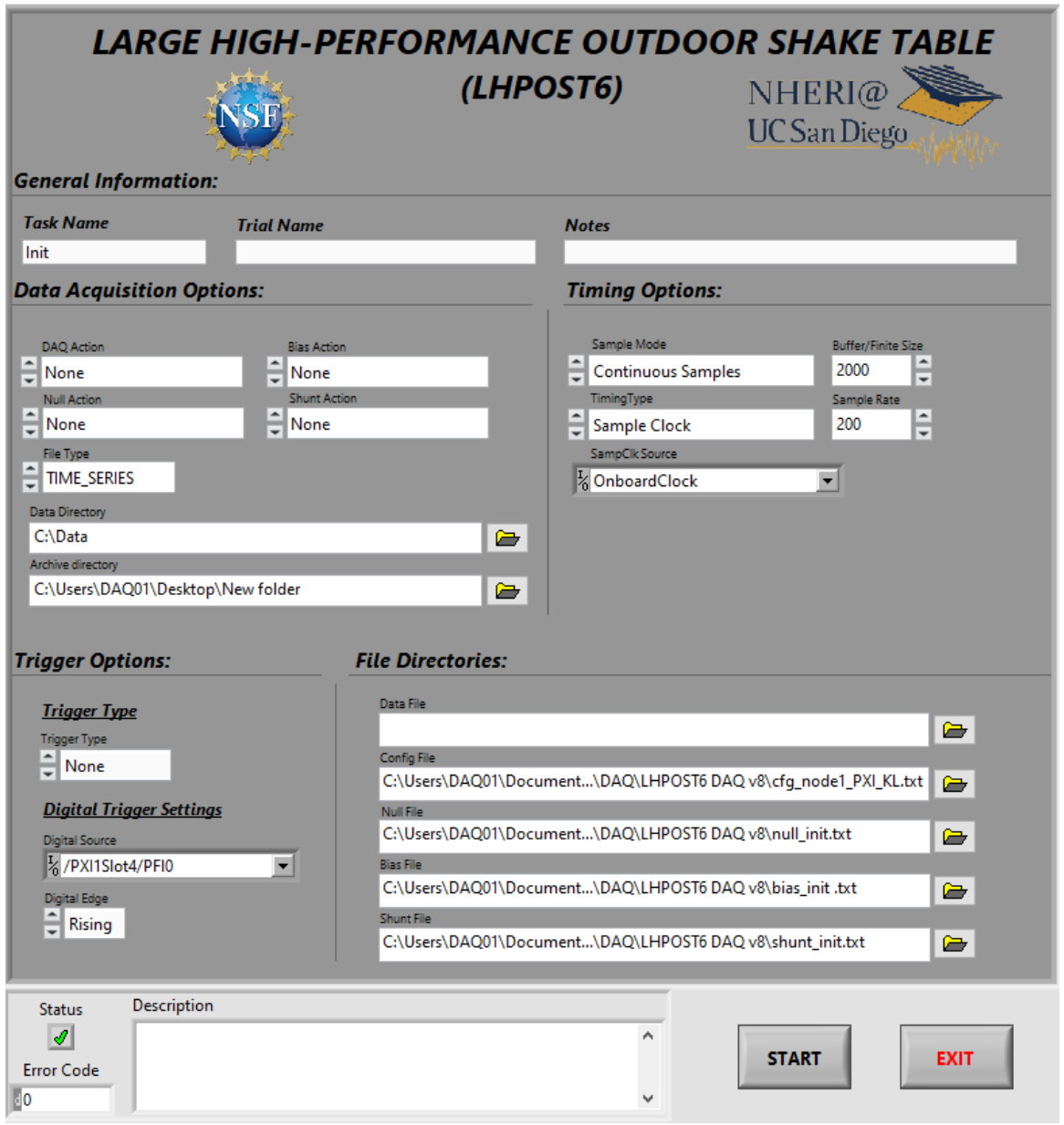

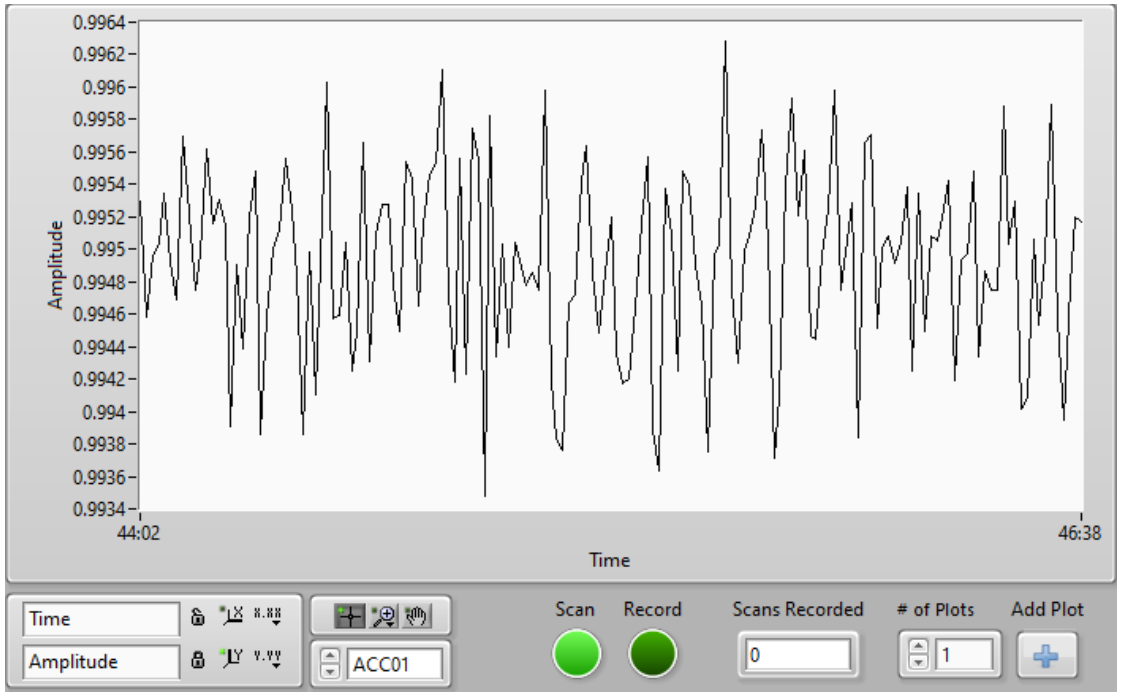

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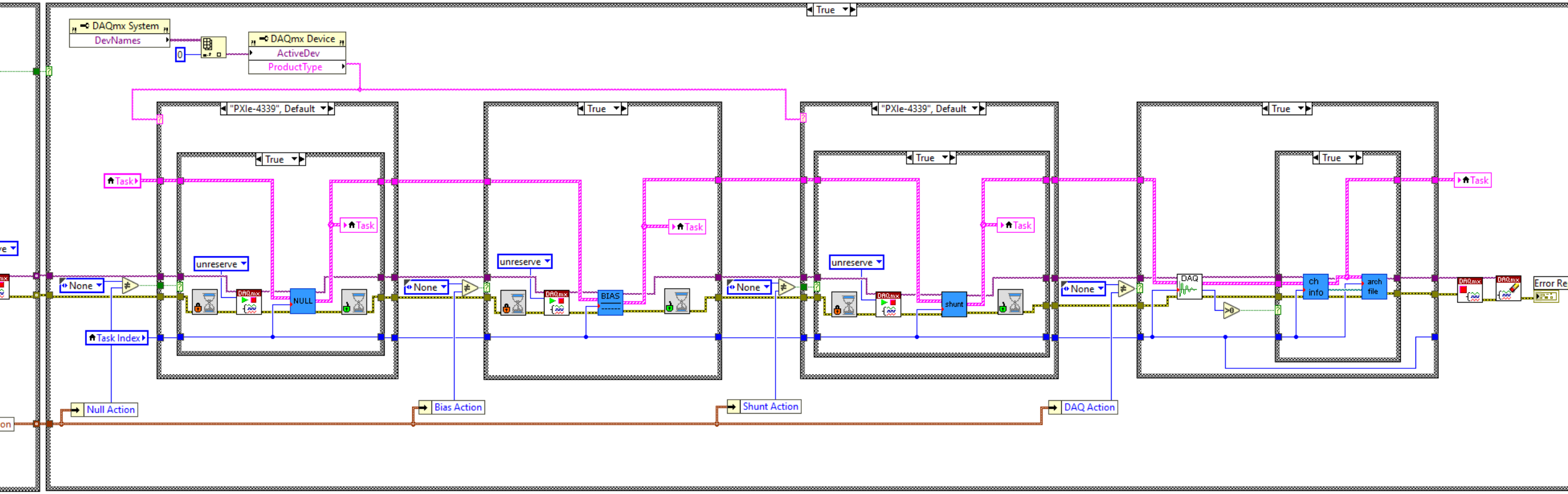

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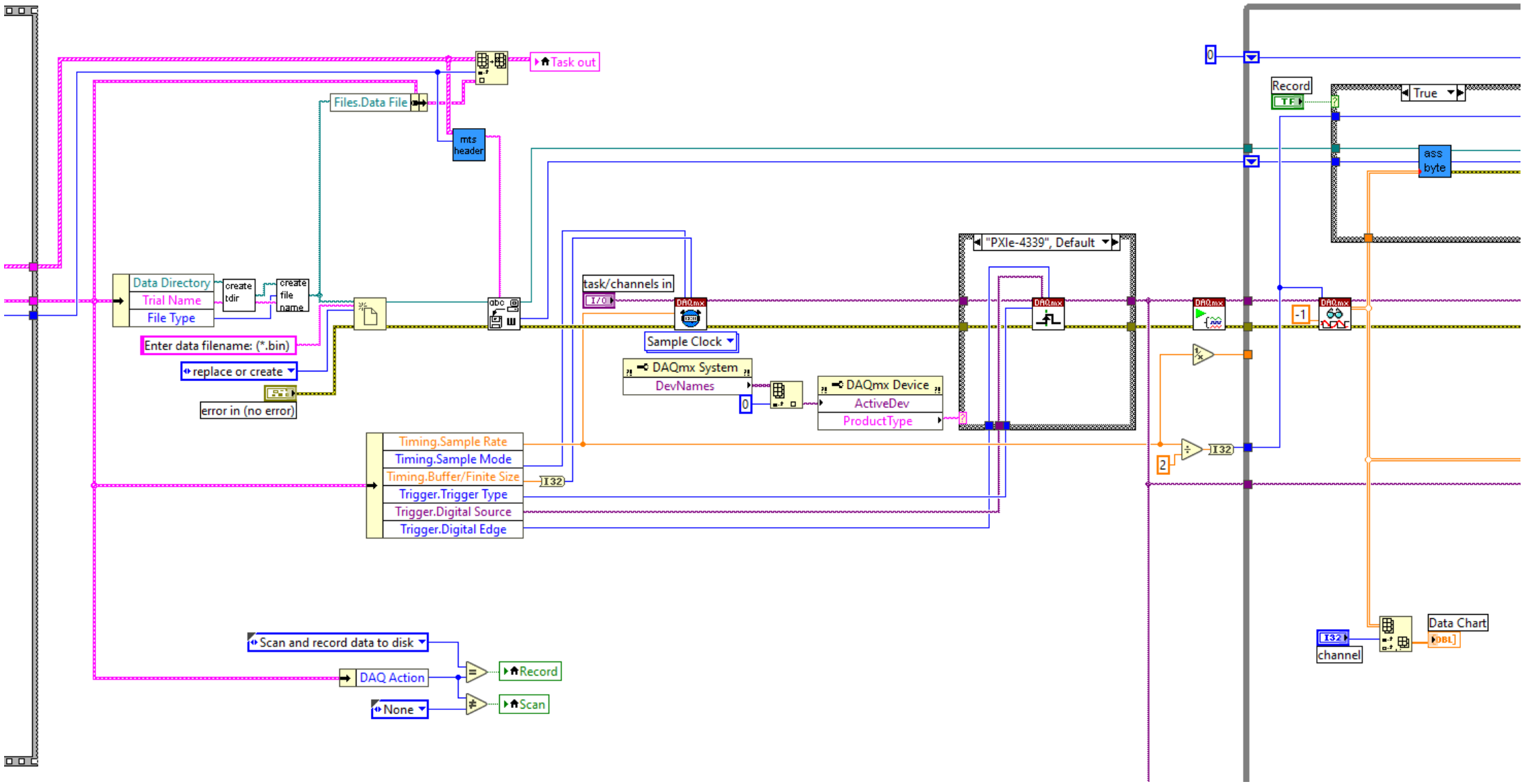

Website and Social Media

Visit us:
ucsd.designsafe-ci.org

UC SAN DIEGO
NHERI EXPERIMENTAL FACILITY

DESIGNSAFE-CI
A NATURAL HAZARDS ENGINEERING COMMUNITY

Facility Overview | Equipment Portfolio | Experimental Protocol | Payload Projects | Workshops | Resources | Contact

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FACILITY OVERVIEW

The National Science Foundation sponsored Natural Hazards Engineering Research Infrastructure (NHERI) Experimental Facility at the University of California, San Diego will provide a large, high performance, outdoor shake table (LHPOST) to support research in structural and geotechnical earthquake engineering. Earthquakes have had considerable destructive effects on society in terms of human casualties, property and infrastructure damage, and economic losses. Building a multi-hazard, disaster-resilient, and sustainable environment requires the understanding and ability to predict more reliably the system-level response of buildings, critical facilities, lifelines, and other civil infrastructure systems to these extreme events. This facility will enable research, with extensively instrumented large- or full-scale structural, geotechnical, and soil-foundation-structural systems tested under extreme earthquake loads, to produce the experimental data essential to advancing predictive seismic performance tools. Research experiments performed using LHPOST will provide life-size investigation that will transform the practice of earthquake engineering and educate graduate, undergraduate, and K-12 students, as well as the general public, about natural disasters and the national need to develop effective technologies and policies to prevent these natural hazard events from becoming societal disasters.

The LHPOST, with a steel platen that is 12.2 meters long by 7.6 meters wide, has performance characteristics that allow the accurate reproduction of near- and far-field earthquake ground motions. The facility will support seismic testing, under near real-world conditions, of large structural, nonstructural, geotechnical, and geostructural systems, as well as soil-foundation-structural systems, up to a weight of 20 MN. Two large soil boxes can be used in conjunction with the shake table to investigate the seismic response of soil-foundation-structural systems. Software and hardware are available to support hybrid testing with substructures on the shake table. Systems tested at the facility can utilize extensive data acquisition and instrumentation capabilities, including a broad array of state-of-the-art sensors and high-definition video cameras, to support detailed monitoring, through hundreds of data channels, of the system response. The landmark system-level tests performed using this facility will provide fundamental knowledge and data to support the development, calibration, and validation of high-fidelity, physics-based computational models of structural, geotechnical, and soil-foundation-structural systems that will progressively shift the current reliance on physical testing to model-based simulation for the seismic design and performance assessment of civil infrastructure systems. These simulation tools will directly benefit the full realization of performance-based design to evaluate and reduce the risks of the built environment to natural hazards. This shake table facility can provide the validation tests for retrofit methods, protective systems, and the use of new materials, components, systems, and construction methods for disaster-resilient and sustainable civil infrastructure.

See our Science Plan for more information on research that can be conducted using LHPOST.

The University of California, San Diego Experimental Facility is supported by a grant from the National Science Foundation (#1520904).

NHERI@UC San Diego Website

Updated Website Coming Soon!

Visit us:
nheri.ucsd.edu

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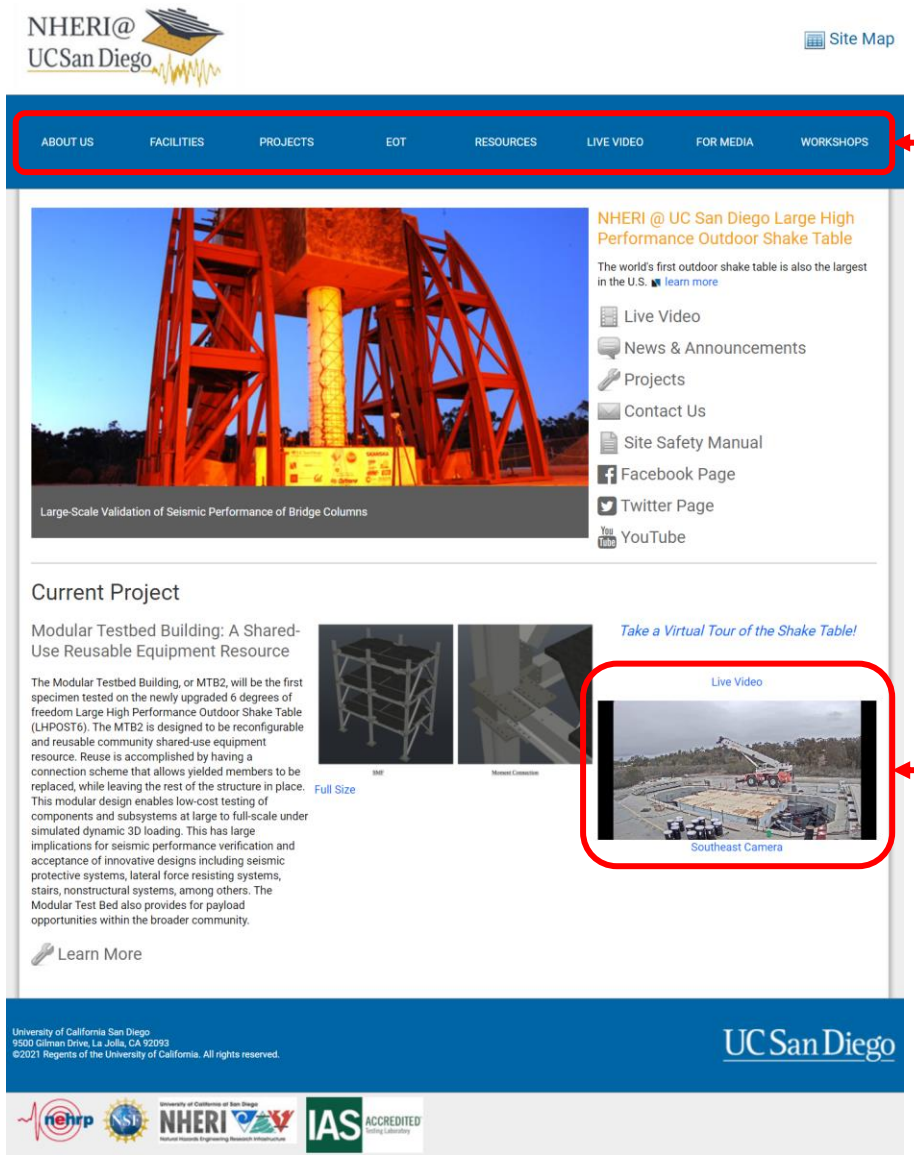


Navigation toolbar for additional information

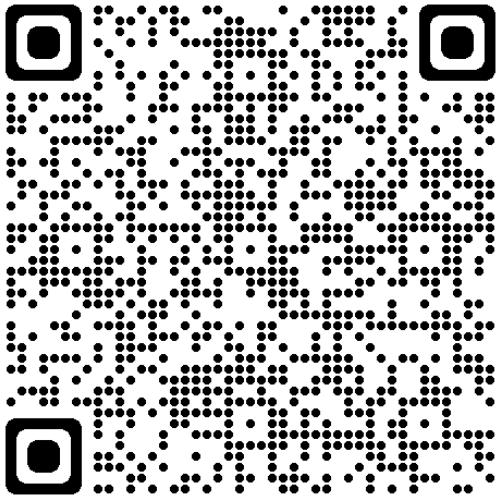
Livestream of daily activities at LHPOST6

NHERI@UC San Diego Workshop Survey

Workshop Survey

- Survey is completely anonymous
- Can leave your email if you would like us to contact you
- Will give us feedback to improve delivery of future workshops

https://docs.google.com/forms/d/e/1FAIpQLSfiqYFYKiIuW_L9JawS-gZGWgGACTEeyhF880M9yJxLP4GhWQ/viewform



Thank you!