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Installing Optimus System for Wall Pressures at 14x22

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14-by 22-Foot Subsonic Tunnel
NASA Langley Research Center

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Agenda

- Overview
- 14x22 and WICS Description
- Project Objectives
- Development Timeline
- Installation and Integration
- Validation Testing & Results
- Challenges
- Future Enhancements

Overview

- NASA recently invested in upgrading 14x22's aging PSI 8400 electronically scanned pressure (ESP) measurement system with the TE Connectivity Optimus System
- The focus for the project was two-fold
 - Hardware replacement and installation
 - Software integration with Test SLATE
- This presentation provides a summary of the project objectives, development timeline, validation process and results, challenges, and future upgrade plans

14x22 Description

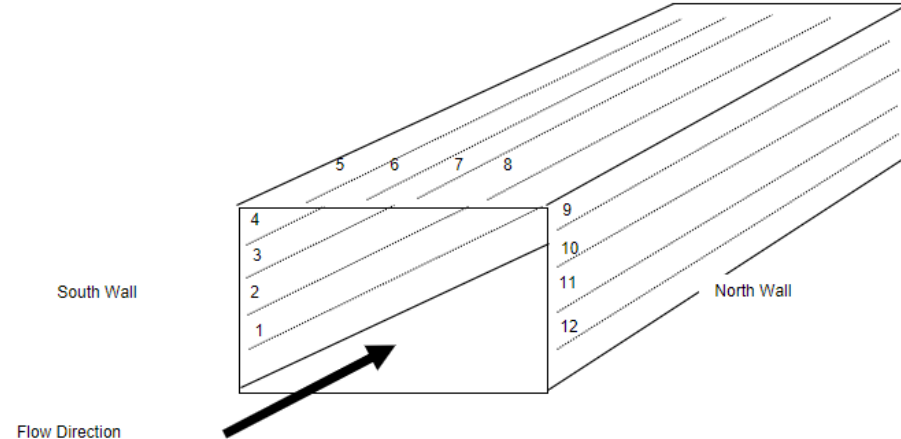
- Test Section Size
 - 14.5 ft x 21.75 ft x 50 ft
4.4 m x 6.6 m x 15.2 m
- Closed Jet
 - Max Speed: 348 ft/sec
(106 m/sec)
 - Max unit Reynolds Number:
 $2.2 \times 10^6/\text{ft}$ ($7.2 \times 10^6/\text{m}$)
- Open Jet
 - Max Speed: 275 ft/sec
(84 m/sec)
 - Max unit Reynolds Number:
 $1.7 \times 10^6/\text{ft}$ ($5.6 \times 10^6/\text{m}$)
- Usage
 - Aircraft, Spacecraft, Rotorcraft
 - Ground Effect, Acoustic



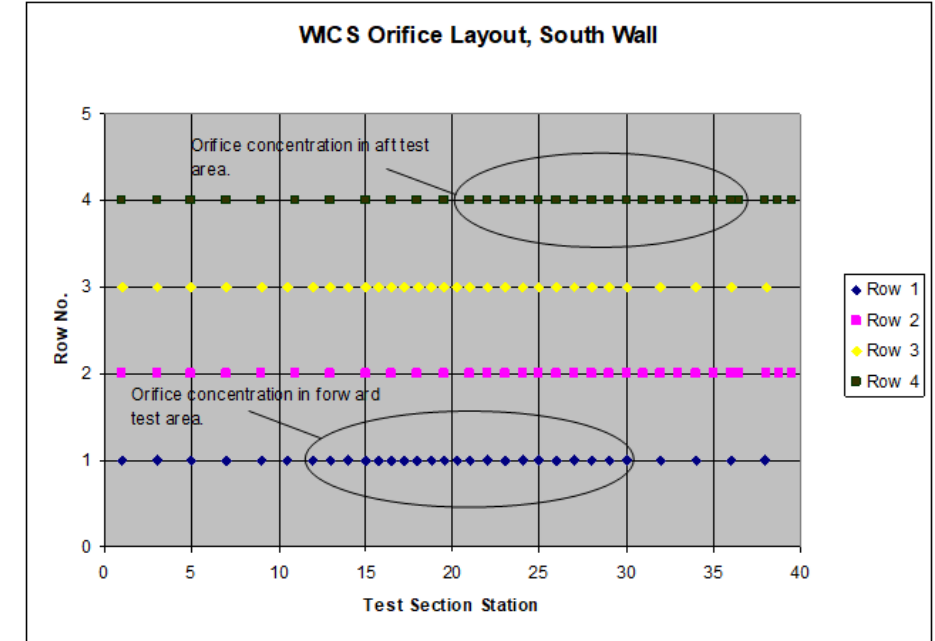
Wall Interference Correction System (WICS) at 14x22

■ WICS Concept

- The WICS system provides test-time wall pressure distributions for comparison to empty-tunnel data to define changes in the wall boundary condition resulting from the presence of the model
- Provides corrections to dynamic pressure and model angle of attack
- Utilizes large array of pressure orifices
- Accuracy requirements for pressure measurements are stringent
- Measurement stability is critical



Pressure Orifice Row Numbering



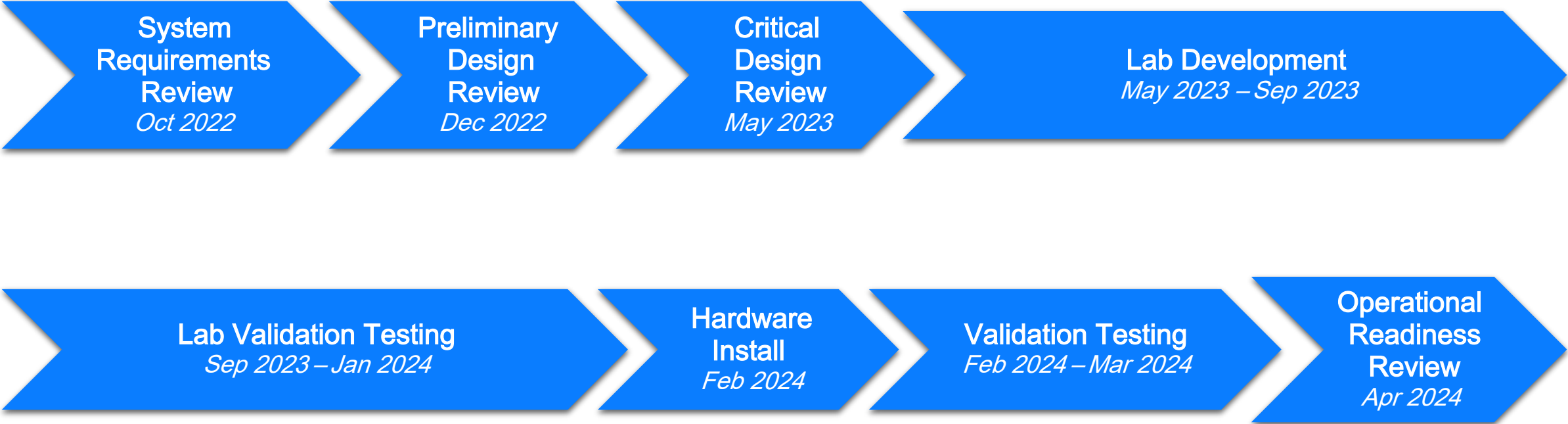
Pressure Orifice Spacing



Project Objectives

- Replacement of aging PSI 8400 system with newest generation TE Connectivity Optimus
- Integration of Optimus software into Test SLATE data acquisition system by Ground Data Systems (GDS)
- Why Optimus?
 - “Like for Like” system replacement
 - Familiarity with ESP modules and troubleshooting methodologies
 - Signal stability with Digital Temperature Compensation (DTC) and fiber optic data transfer
 - Higher scan rates than the 8400
 - Scalability
 - Utilizes legacy components and infrastructure

Development Timeline



Installation and Integration

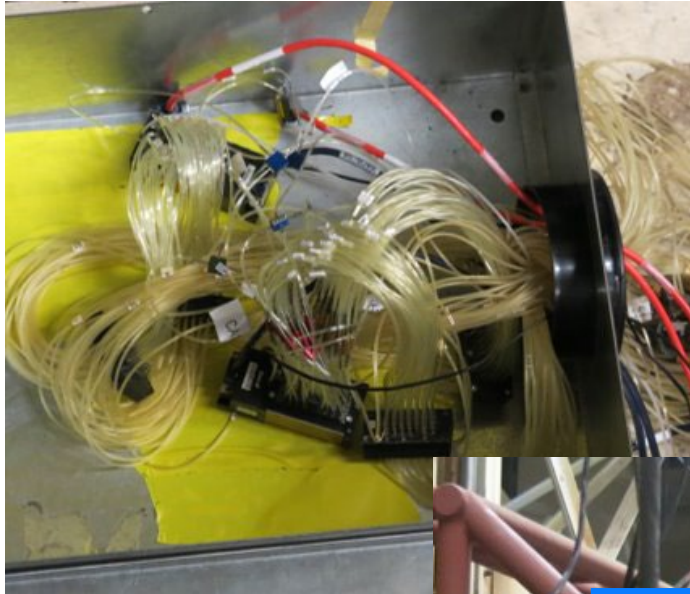
- WICS Hardware:
 - 6 64-port DTC ESP modules with $\pm 10''$ H₂O range
 - 1 Optimus System Processor
 - 1 remote Power Supply for mSDI
 - 1 remote Processor to house and control the PCUs and driven reference pressure
 - Various cabling
- Software integration
 - Benchtop testing in lab environment offsite
 - 14x22 Test Engineers performed the lab acceptance testing of the system
 - Able to resolve numerous software issues before tunnel installation
 - Ongoing support from GDS



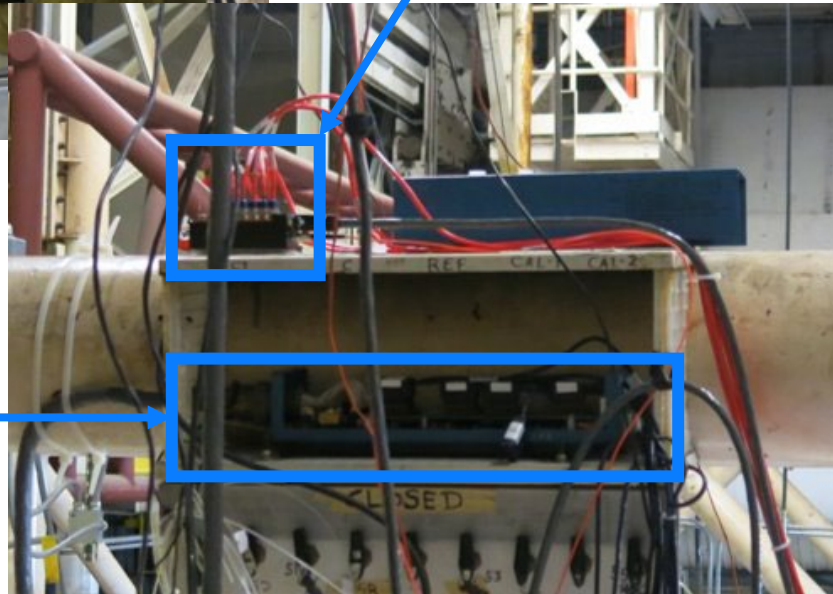
Validation Testing Focus

- Data Repeatability
 - The test used the Common Research Model – High Lift (CRM-HL)
 - A 10% scale model with significant blockage to fully test out the WICS system
 - CRM-HL has been tested at 14x22 several times over many years so there is a database of historical data to compare to
 - Model was already installed in the tunnel to prepare for upcoming test after maintenance downtime
- Temperature Compensation
 - Each DTC module was put in existing WICS module enclosures that used heaters for signal stability
 - Heat was applied in each enclosure and then shut off and monitored over a period
- Usability of the system
 - Making sure test setup and calibration processes are clear and that personnel are trained and able to operate independently of the integration team

10% CRM-HL and WICS Hardware



Optimus mSDI

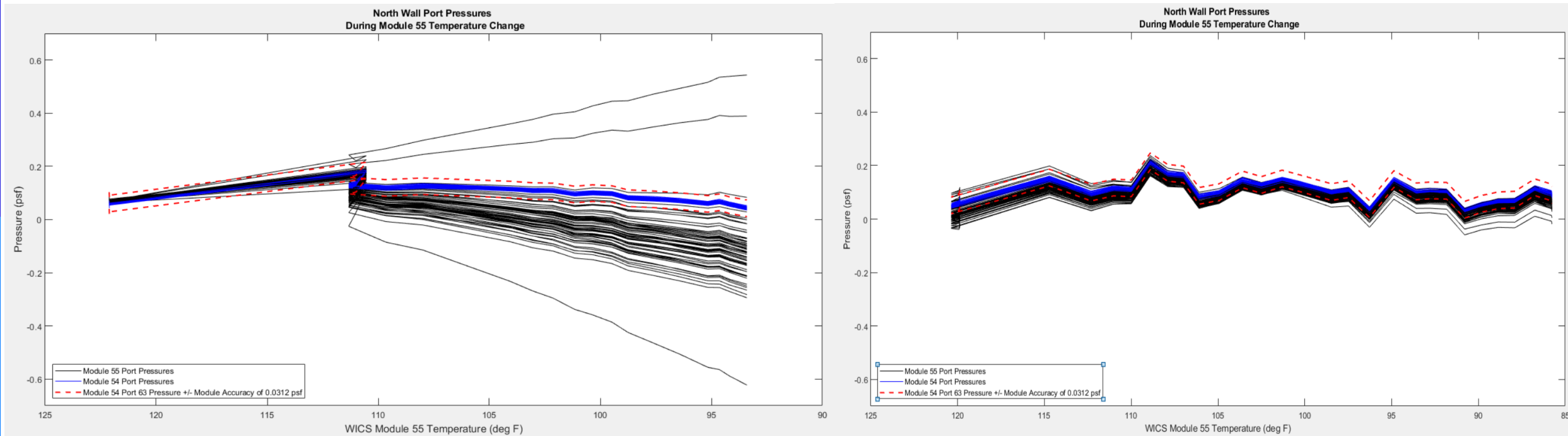


8400 IFC



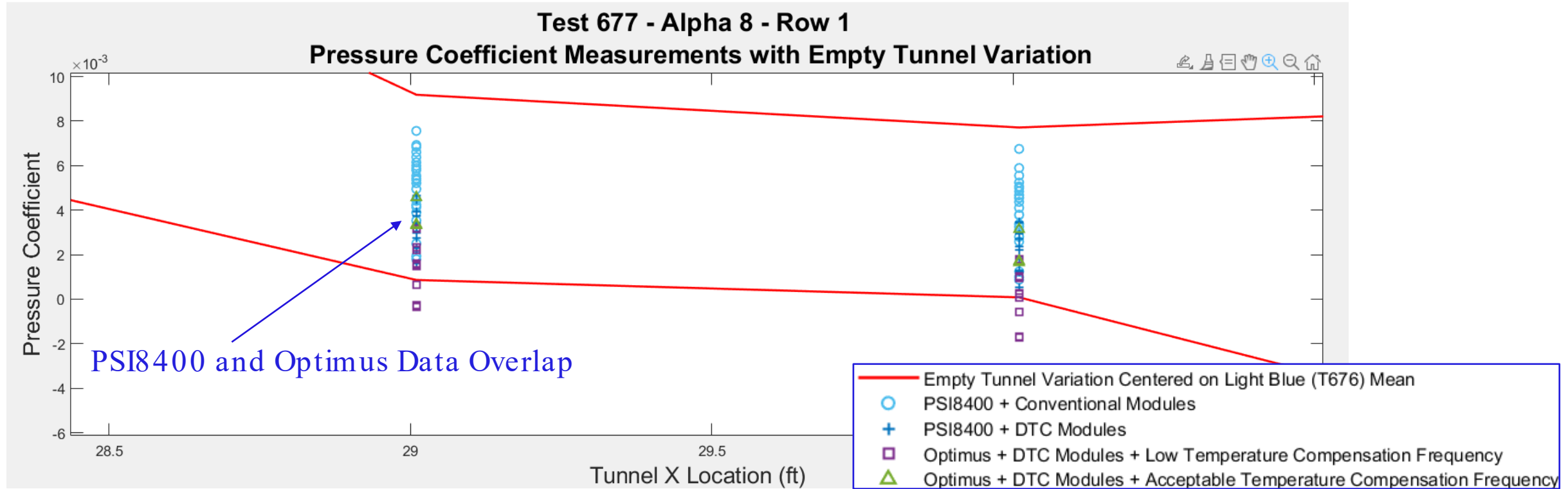
Temperature Compensation Assessment

- Initial test (left) revealed a dramatic shift in pressure data during a wind-off run with changing module enclosure temperatures
- Investigation revealed temperature compensation corrections were being applied when the Optimus system was initialized or restarted instead of at regular intervals during data acquisition
- After the temperature compensation frequency was changed to 1 Hz, the signals stabilized (right)



Repeatability Assessment

- Assessment was to ensure consistency across systems with potential for increased data quality
- Data was found to be repeatable across pressure system hardware configurations (8400 vs Optimus)
- Pressure coefficient variation is compared to database formed by multiple sets of empty tunnel data
- Purple outliers are with low temperature compensation frequency



Challenges

- Long-term product support
 - TE Connectivity has committed to providing support of purchased hardware through 2032
- TE Connectivity communication issues
 - Internal restructuring restricted previous points of contact
- Fragile fiber optic cables
 - Long cable runs
- More hardware is needed to replace model 8400 system
 - Back-to-back tests with models utilizing over 1000 pressures each
 - Long lead time on modules – 1 year+
 - Led to decision to only replace WICS hardware at this time

Future Enhancements

- Facility Operations
 - Define calibration frequency now that DTC corrections are inherent to each module
 - Establish daily checkout best practices
 - Determine system health status procedures and develop tools
 - Replace remaining 8400 hardware (model system)
 - Continued software support from GDS
- Data Analysis
 - Comparison with historical empty tunnel and characterization model data
 - Check Standard Testing
 - Measurement uncertainty characterization

Questions?



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