

# FAA Structural Health Monitoring SHM

Presented to: Airlines for America NDT Forum

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Federal Aviation  
Administration

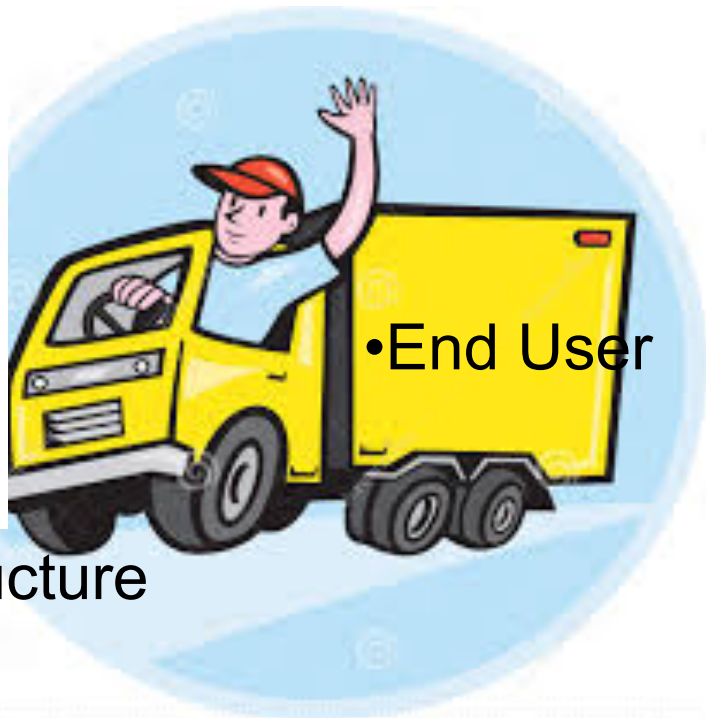


# Outline

- **Past**
- **Present**
- **Future**
- **Conclusion**



# •Paving the Path for SHM Innovation



•Building the Infrastructure

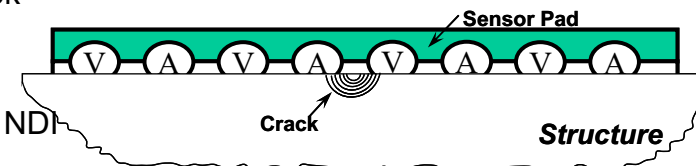
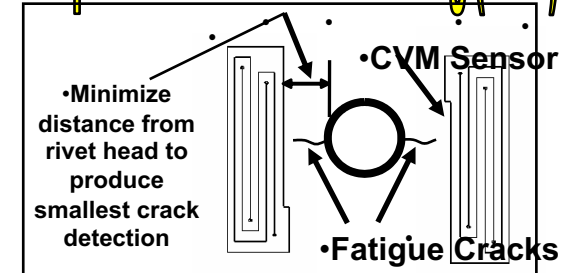
# Past

- **Why does the FAA care about SHM?**
- **Transport Standards Branch (Transport Aircraft Directorate)**
  - Certification Issues
- **FY11 with AANC**
- **Started with survey, review of SHM capabilities, gap analysis**
- **Perform a mock certification**



# Past-Emerging Technologies

## Comparative Vacuum Monitoring (CVM)



## Monitoring Cracks in B737 Wing Box Fitting



- Objective: Partner with the AANC, Delta Air Lines, SMS/AEM and Boeing to conduct trial SHM certification & integration activity
- Application: Boeing 737 NG Wing Box fitting cracking problem as application Boeing issued a service bulletin as a result of cracking after 21k cycles
- Accomplishments:
  - Install on Delta's 737-700 Fleet going thru Atlanta for 5 ½ day checks (6k cycles)
  - 7 aircraft completed in Feb/March 2014
  - Delta collected CVM data every 90 days as well as performing required NDI inspection
  - Boeing approved CVM Dec 2015 use –updated SB - June 2016
  - Review CVM project against SAE guidelines and determine what has been validated
  - Assess FAA rules and determine if adequate for SHM use
- Outcome:
  - Ensure safe implementation of emerging technologies
  - Develop FAA webinar for FAA ACO engineers
  - Delta/Boeing investigating further SHM numerous platforms

# SAE AISCSHM Committee

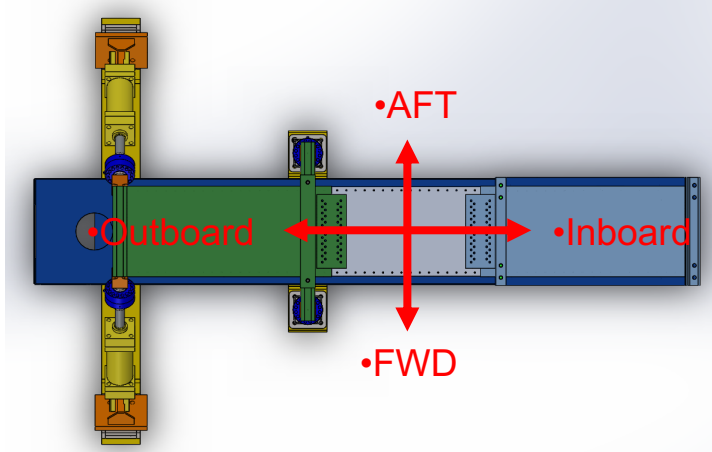
- **Develop standards for SHM for aviation community**
- **ARP6461 “Guidelines for Implementation of Structural Health Monitoring on Fixed Wing Aircraft” published Sept 2013**
- **Probability of Detection area of concern**
- **Reliability workshop April 2015 to determine path forward**
- **Developed 2 POD methodologies for SHM**
- **ARP being developed for POD**
- **Planning a second workshop in 2019**
  - Develop the test program for validation of the methodologies
  - Develop useable data for public use





# Present-Emerging Technologies

- To provide **SHM** capability to the TC Labs:
  - Emerging Technologies (Al-Li Panels)
  - Wing Box (ABST)



- To assess **SHM** capabilities and collect data



# Full-Scale Aircraft Structural Test Evaluation and Research (FASTER)

- History and Background:

Established: Dec. 1998 through partnership with Boeing

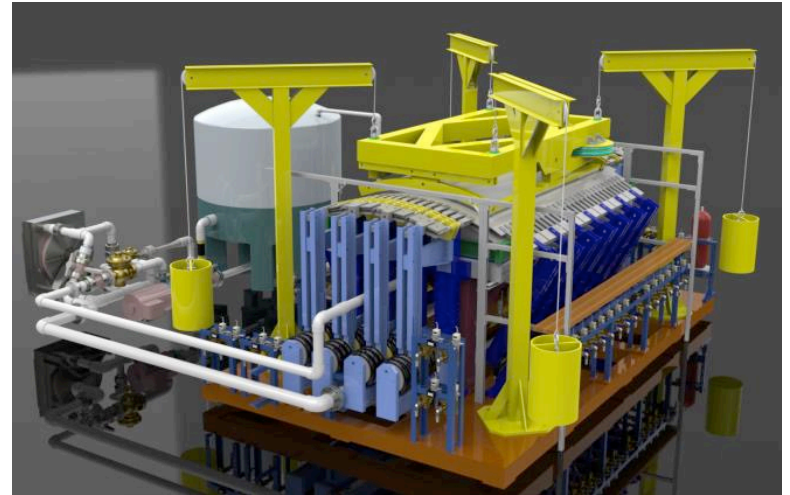
- Applies Major Modes of Loading to Fuselage Panels:

- Pressure

- Hoop

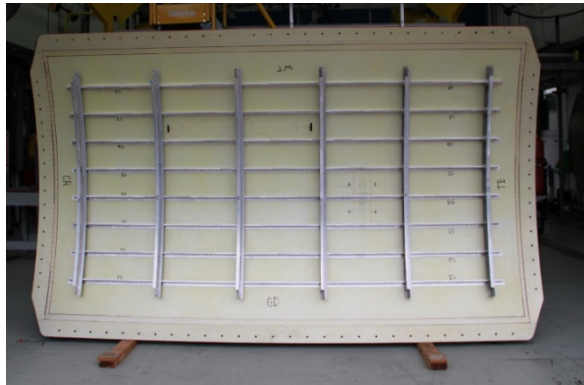
- Axial

- Shear

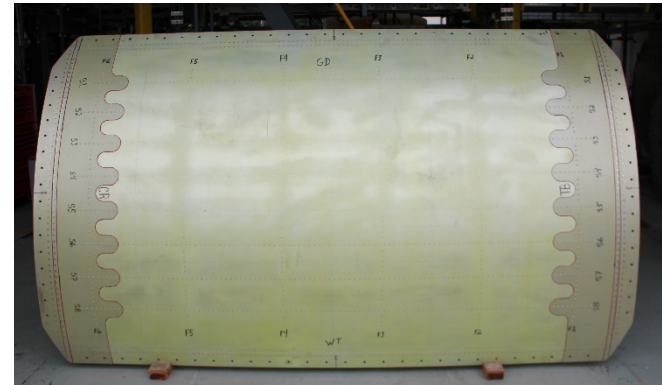




# Baseline Panel Design

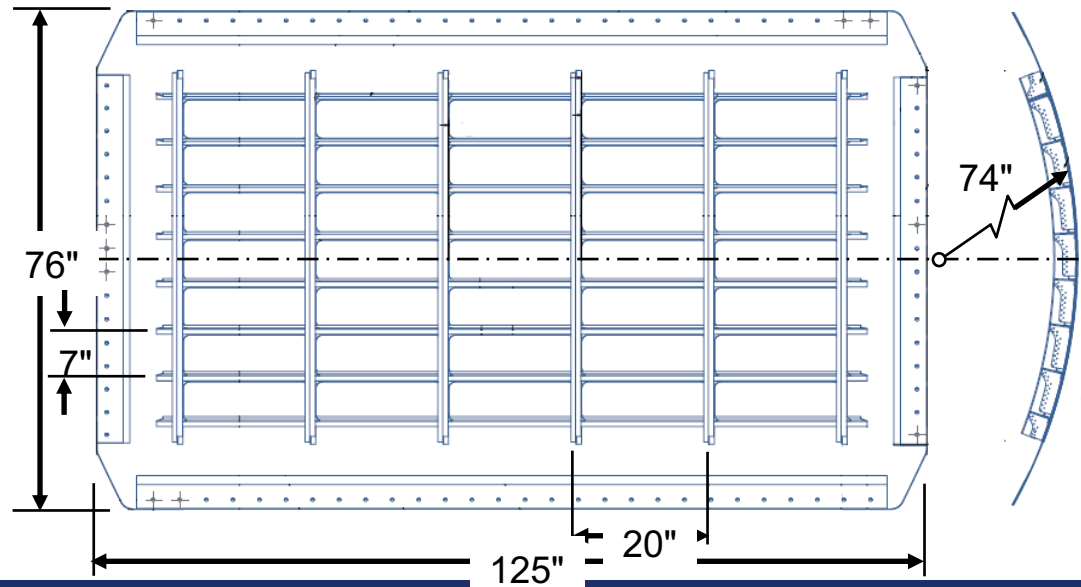


•Internal View



•External View

Panel Length	125 inch
Panel Width	76 inch
Panel Radius	74 inch
No. of Frames	6
No. of Stringers	8
Frame Spacing	20 inch
Stringer Spacing	7.0 inch
Skin Thickness	0.055 inch

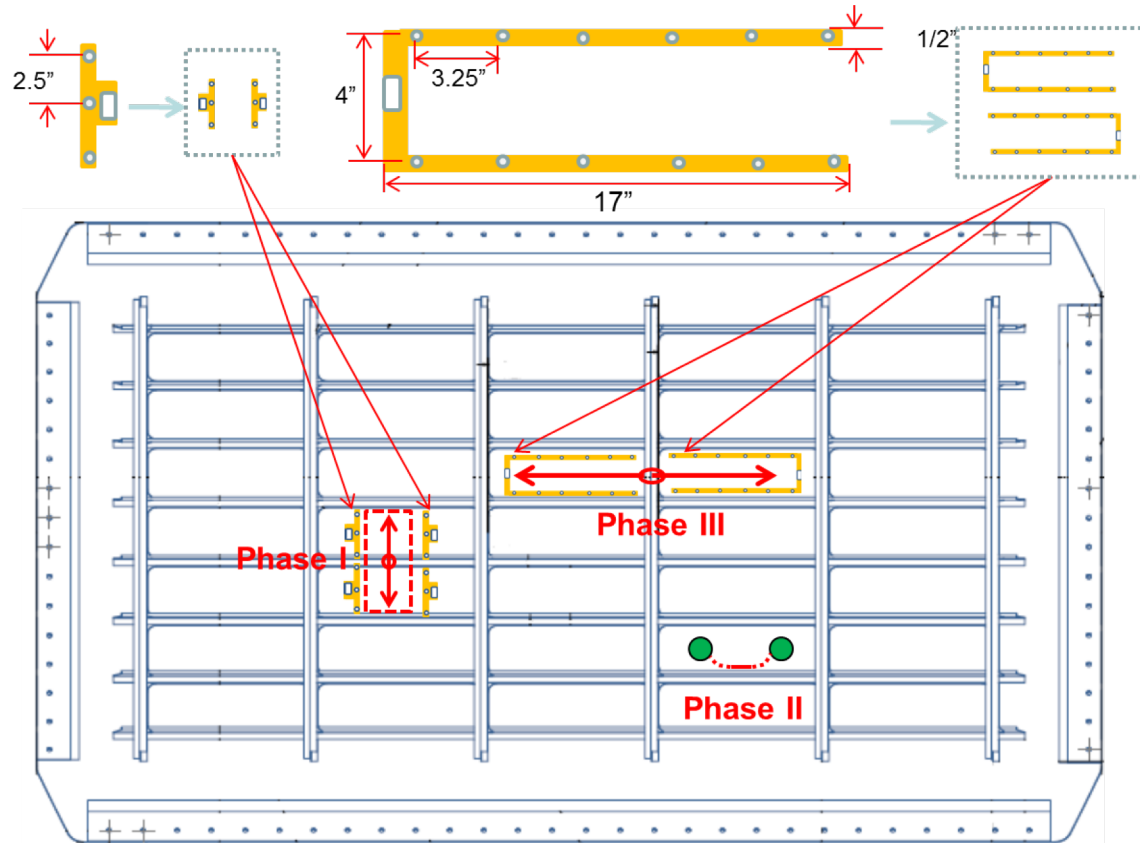


# Test Matrix – Panels

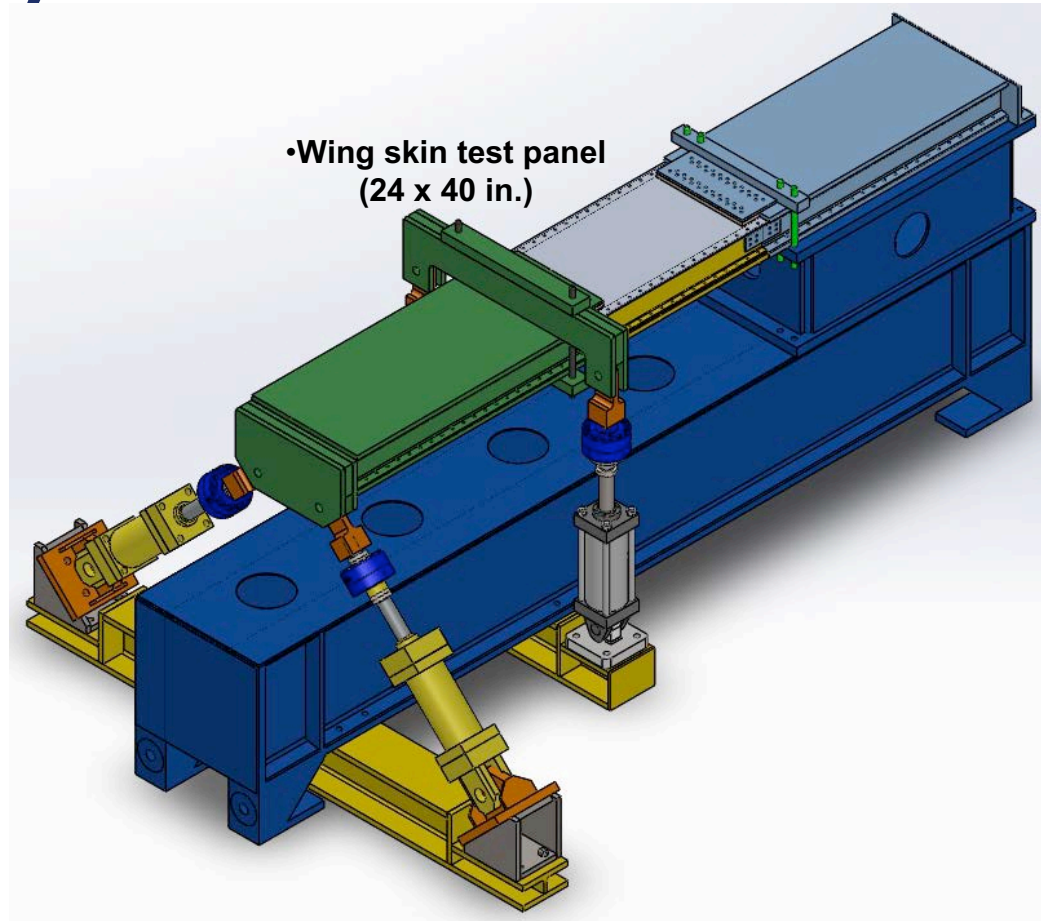
		①	②	③	④	⑤	⑥	⑦
		Baseline	Advanced Density Reduction	Advanced Materials	Advanced Materials, FSW	FSW and Bonded Stringers	Baseline MSD	Advanced Density Reduction MSD
Component	Skin	2524-T3 sheet	2060 - T8 Al-Li sheet	2029-T3 sheet	2029-T3 sheet, FSW	2060 Al-Li sheet, FSW joint and bonded FML straps	2524-T3 sheet	2060 - T8 Al-Li sheet
	Stringer	7150 extrusions, riveted	2055 or 2099 Al-Li extrusions, riveted	2055 or 2099 Al-Li extrusions, riveted	2055 or 2099 Al-Li extrusions, FSW	2055 or 2099 Al-Li extrusions, bonded	7150 extrusions, riveted	2055 or 2099 Al-Li extrusions, riveted
	Frame	7075-T62 - shear tied, extruded, riveted	2055 or 2099 Al-Li integral extrusions, riveted	2055 or 2099 Al-Li integral extrusions, riveted	2055 or 2099 Al-Li integral extrusions, FSW	2055 or 2099 Al-Li integral extrusions, riveted	7075-T62 - shear tied, extruded, riveted	2055 or 2099 Al-Li integral extrusions, riveted



# SHM INSTALLED ON PANEL 1



# Airframe Beam Structural Test (ABST) Fixture

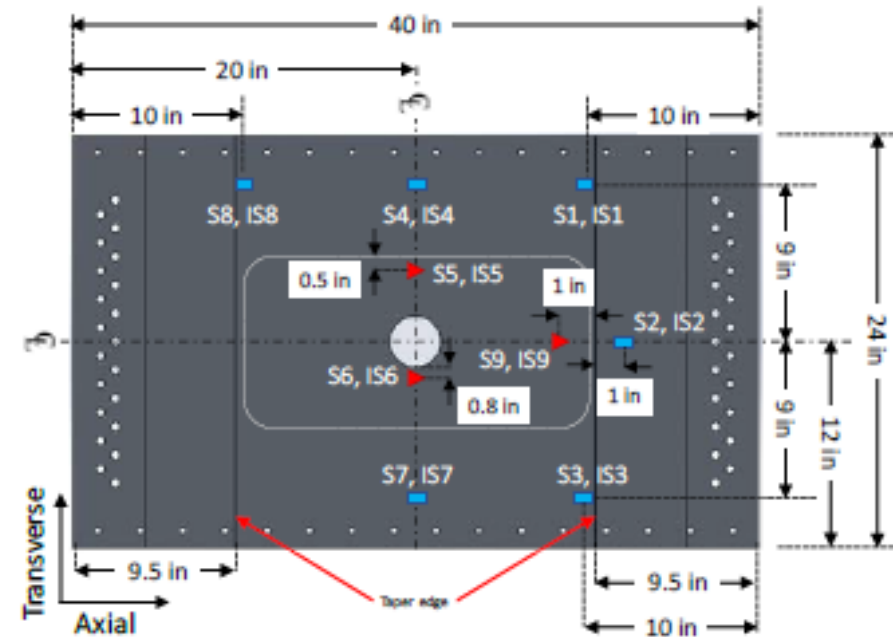
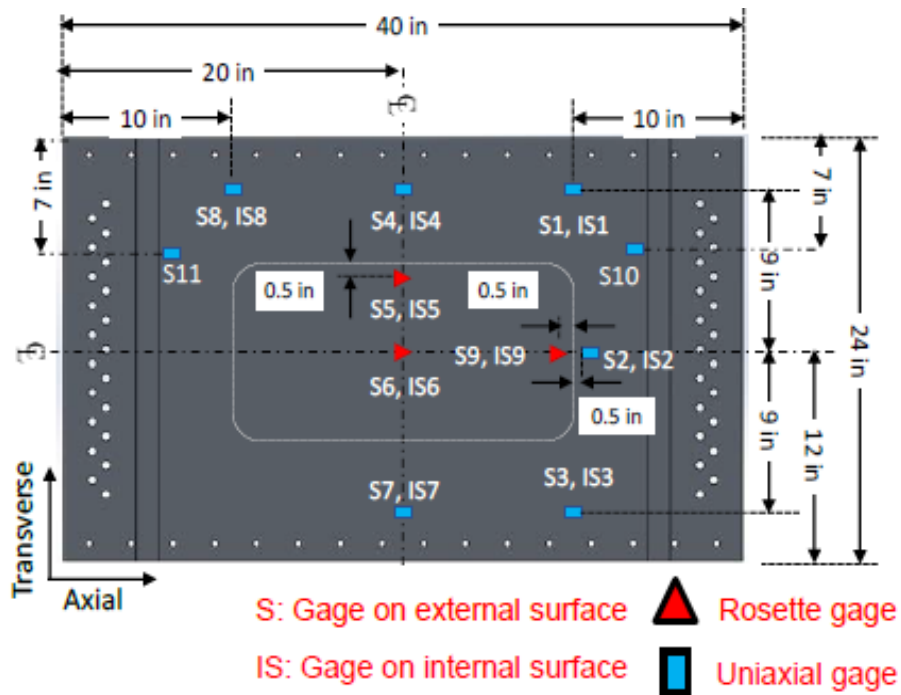


# ABST Test Program

- Phase 1: Baseline mechanical and fatigue behavior of composite panels (pristine and open hole)
- Phase 2: Bonded Repair Size Limits
- Phase 3 (proposed): Fatigue and DT performance of bonded repairs intentional made deficient to encouraging damage growth
  - Calibrate analysis methods
  - Assess NDI and SHM to detect and monitor damage growth

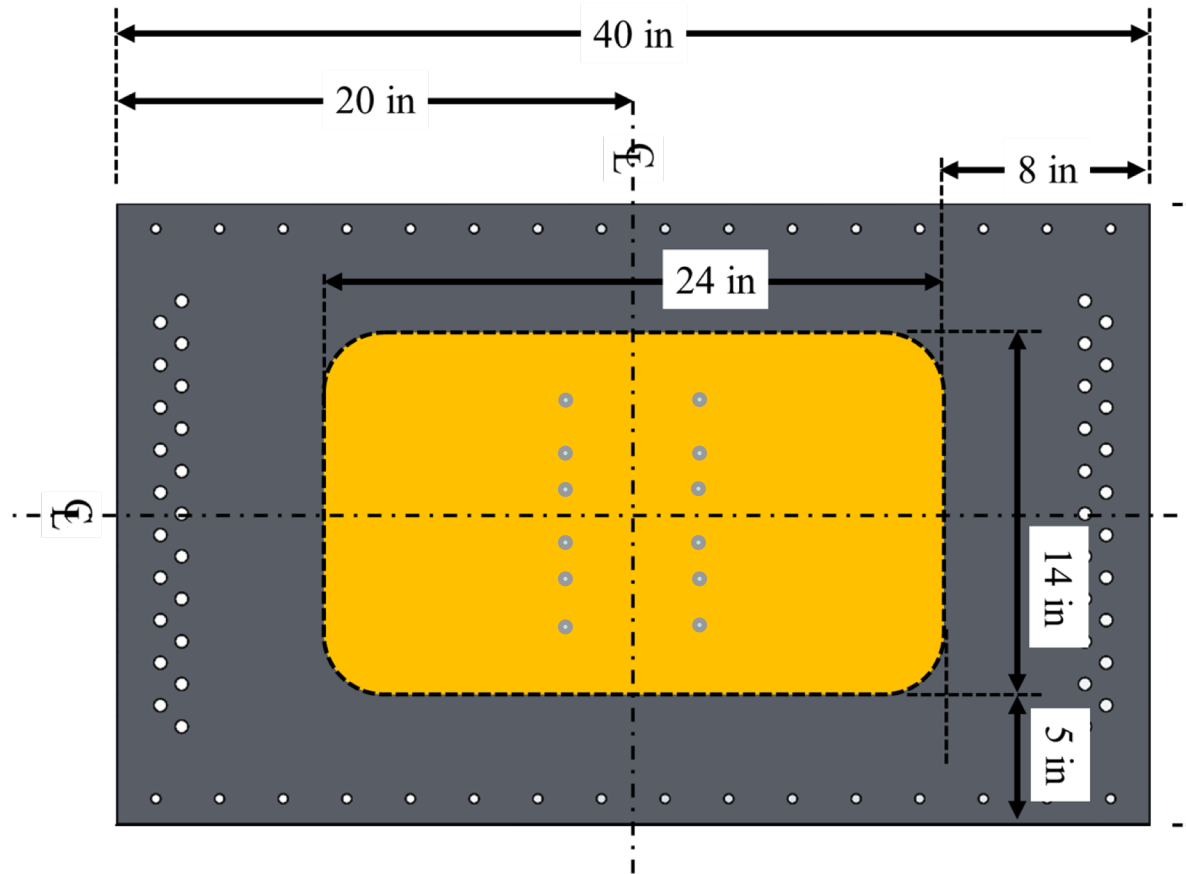


# Phase 1: Panels 1 and 2





# SHM Sensor Layout-PZT



# Future: Reliability

- **Developed 2 methodologies for POD for SHM**
- **Data from FASTER and ABST tests may be of use to this effort**
- **Working with NASA to develop a model of the FASTER test fixture with SHM**
- **Working with SAE to develop industry std**



# Conclusion

- **Boeing/Delta/AANC met in January 2018 in Seattle to discuss future SHM applications: SB - AD.**
- **SHM: “in situ” NDI. Equal or better. No new guidance needed. Evaluate on case by case basis.**
- **Dual inspections still required when SHM replaces NDI**



# Questions

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