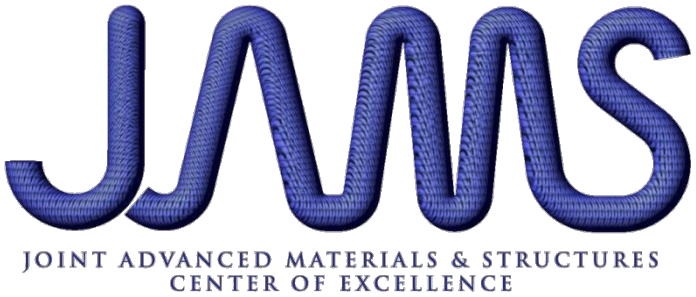

Dynamic Response of Composite Structures Subjected to Blast Loading

2015 Technical Review

Waruna Seneviratne

Wichita State University/NIAR

Dynamic Response of Composite Structures Subjected to Blast Loading

- **Motivation and Key Issues**
  - The studies have shown the terrorist attacks against civil transport aircraft is a significant threat, i.e., loss rate of 1 per 10^7 flights worldwide averaged over 30 years. Therefore, the structural improvements augment the added security measures following the Aviation Security Act of 1990 to mitigate the vulnerability of civil aircraft to improvised explosive device (IED) attacks.
- **Objective**
  - Primary goal of this investigation is to assess the vulnerability of modern composite fuselage structures to a damage caused by an internal explosion from an IED.
- **Approach**
  - Partnership with FAA and DHS Science and Technology Directorate Organization to leverage unique capabilities (safety and security) of each agency in pursuit of this effort.
  - The applications of composite materials in modern commercial aircraft are evaluated through a literature survey of composite structural details.
  - Composite panels are fabricated to simulate fuselage details for subsequent blast testing.
    - Initial phase of the research will focus simple (flat, unstiffened) composite panel configurations (repeatability)
    - Subsequent phases will incorporate fabrication and testing of increasingly complex (curved stiffened) composite panel.

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Dynamic Response of Composite Structures Subjected to Blast Loading

- **Principal Investigators & Researchers**
  - John Tomblin, *PhD*, and Waruna Seneviratne, *PhD*
- **FAA Aircraft Structures Division, Technical Monitor**
  - Edward M. Weinstein, *PhD*
  - Lynn Pham
- **Department of Homeland Security, Science & Technology Directorate**
- **Industry Participation**
  - Airbus
  - Spirit Aerosystems

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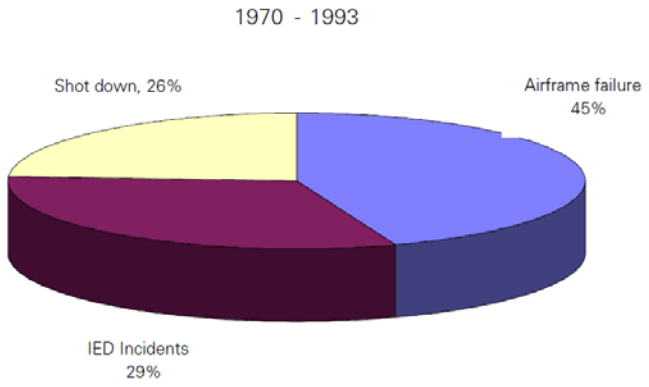
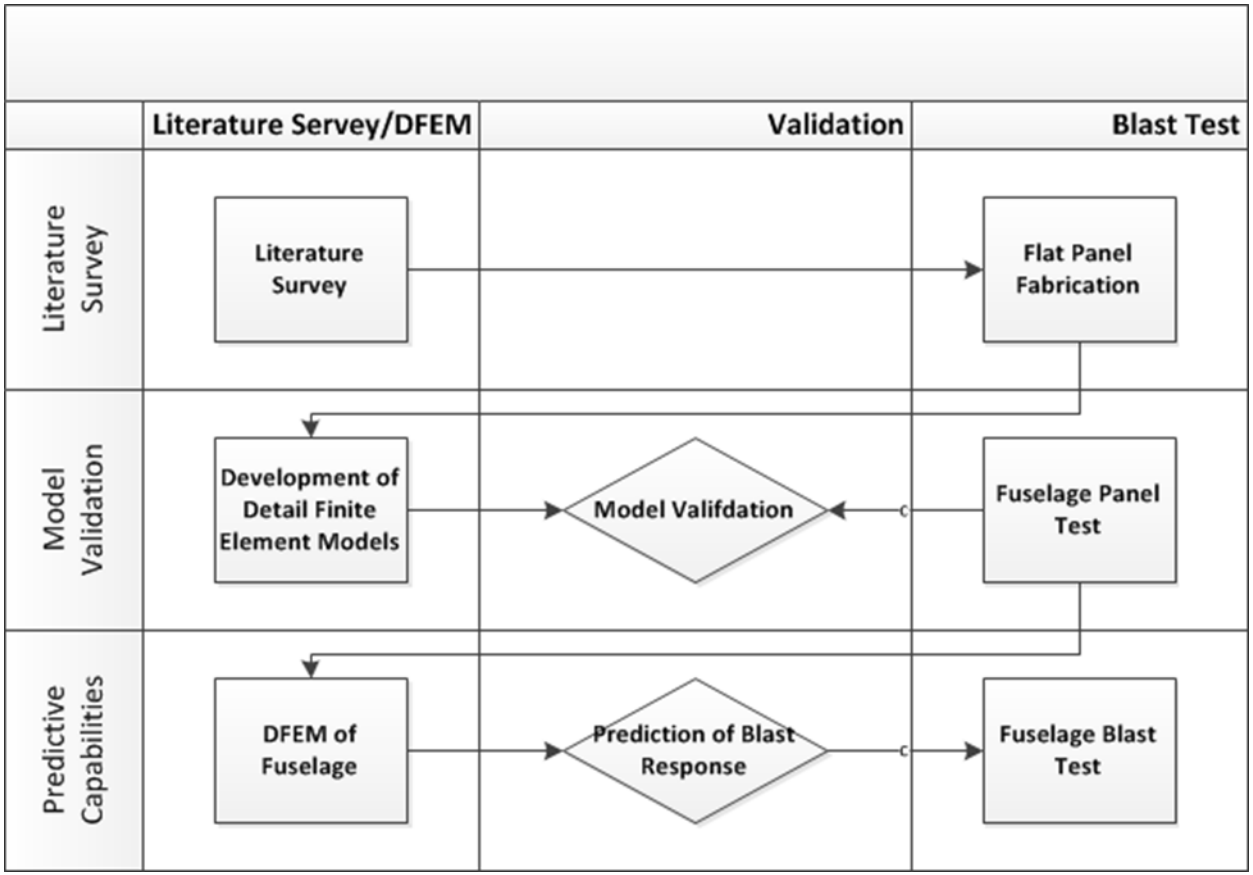
Goals

Primary goal of this investigation is to assess the vulnerability of modern composite fuselage structures to a damage caused by an internal explosion from an improvised explosive device.



Comparison IED incidents between 1970 and 1993 to airframe failures (non-sabotage) and incidents involving aircraft being shot/forced down

Road Map


Literature Servey/DFEM
Validation
Blast Test
Literature Survey
Model Validation
Predictive Capabilities
Literature Survey
Flat Panel Fabrication
Development of Detail Finite Element Models
Model Valifdation
Fuselage Panel Test
DFEM of Fuselage
Prediction of Blast Response
Fuselage Blast Test

Phase I

- Literature Review [A380/B787/A350]
  - Thickness variations in fuselage
    - Map [min/max]
  - Riveted Joints
  - Cocure/Cobonded Joints
  - Longitudinal Beams
  - Aft Pressure Bulkhead
  - Strain Rate Test Data
- Fabricate Representative Flat Panels
  - Blast testing at Aberdeen Test Center in Aberdeen Proving Ground

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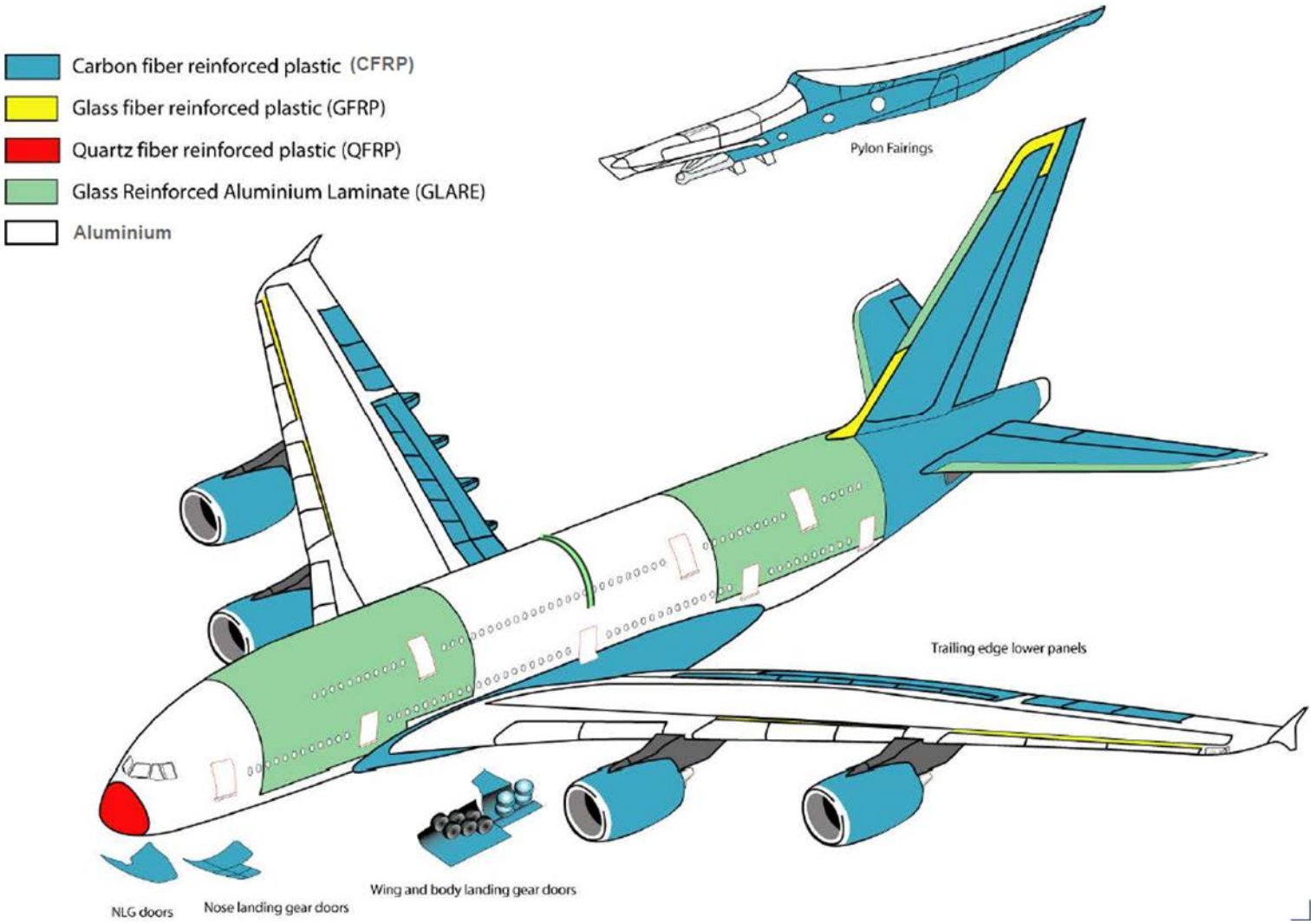
Airbus A380



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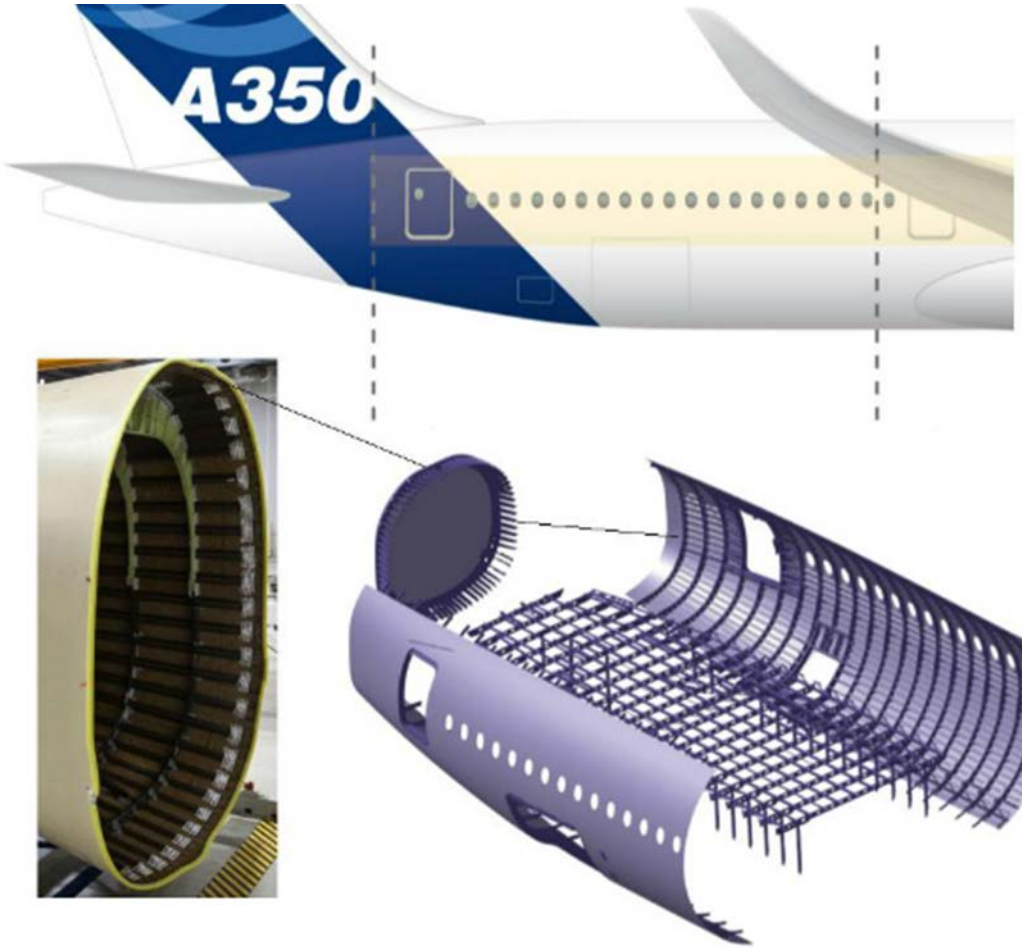
Airbus A350



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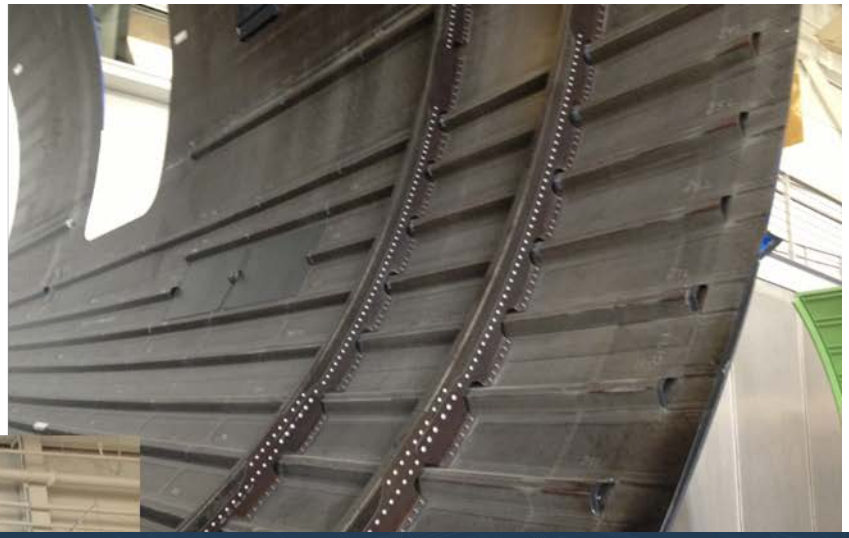
Boeing 787



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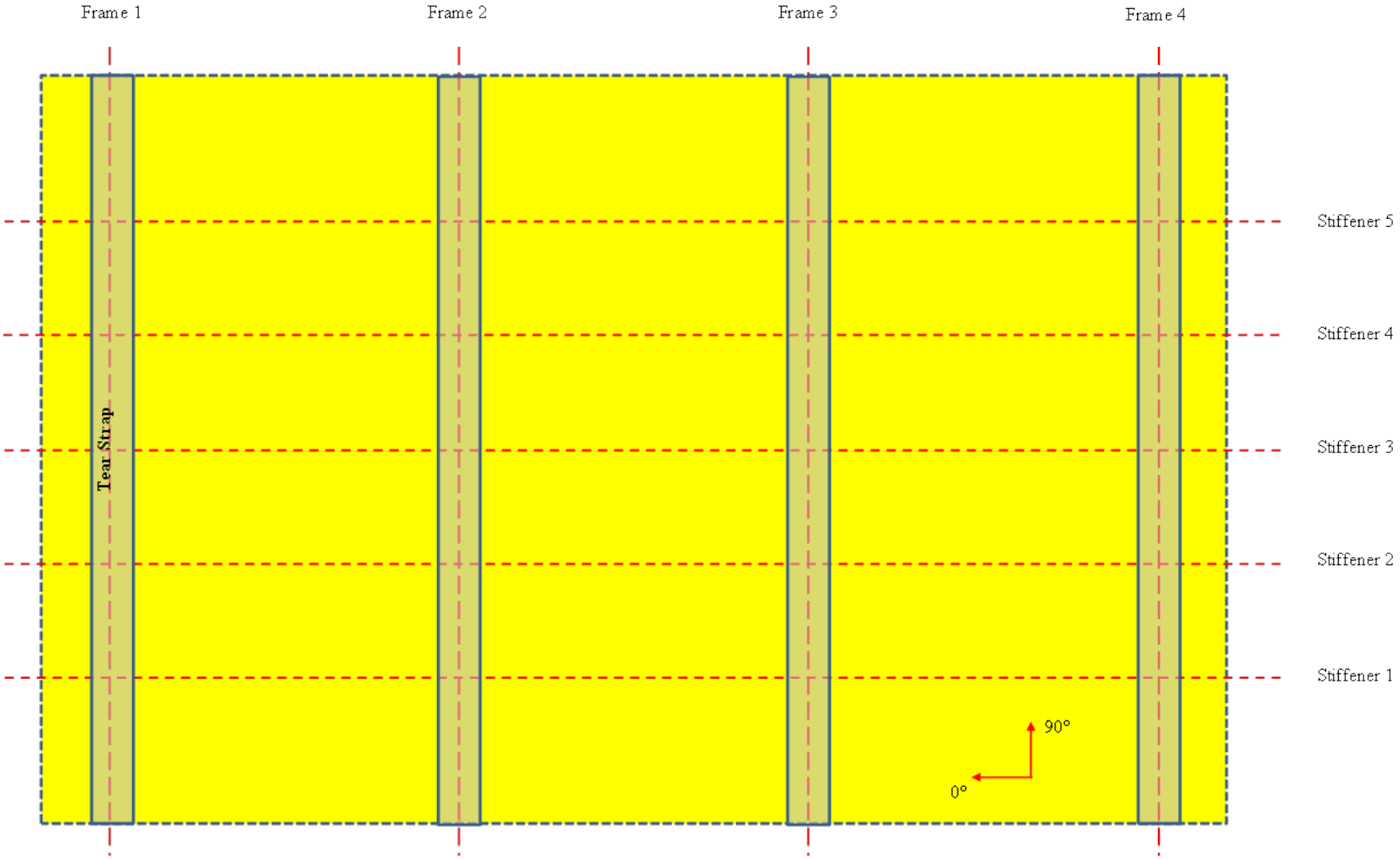
Panel Fabrication



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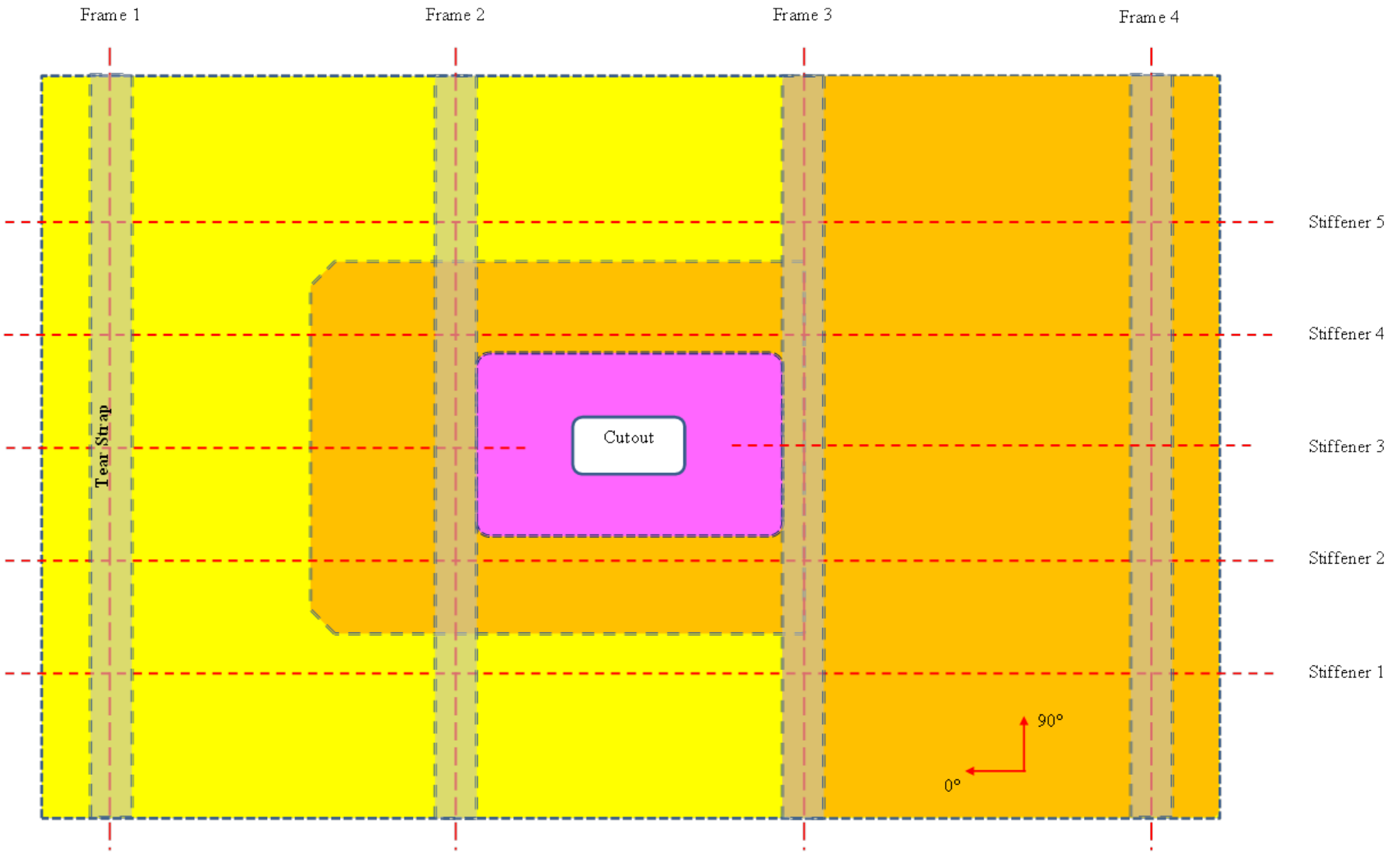
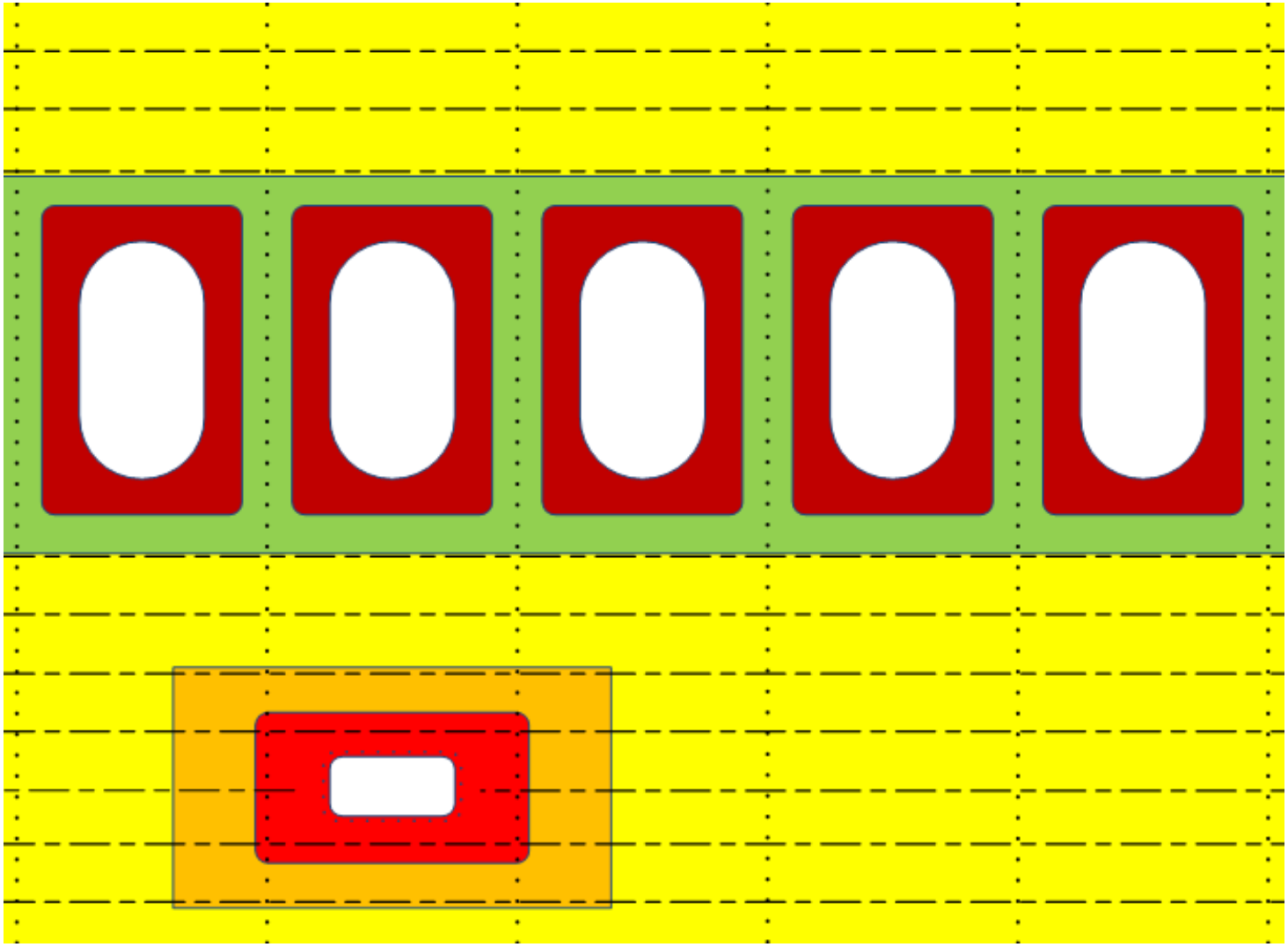
Detailed Part Testing



Detailed Part Testing



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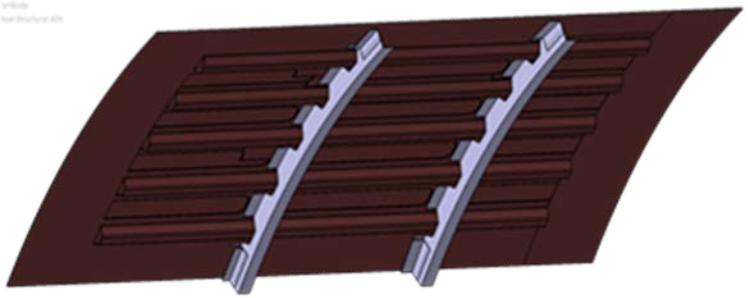
Summary

- Phase I
  - Survey of commercial composite aircraft materials and structures properties and configurations.
  - High speed imaging and digital image correlation data acquisition system evaluation for flat composite panel explosive testing is completed.
  - Explosive tests (series I) of 48" x 48" unstiffened flat composite panels have been completed.

- Phase II
  - Generic and representative curved stiffened composite panel design
  - Unpressurized and pressurized tests at Aberdeen Test Center in Aberdeen Proving Ground



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Looking Forward

- **Benefit to Aviation**
  - Assessment of the vulnerability of modern composite fuselage structures to a damage caused by an internal explosion from an improvised explosive device.
  - Increased understanding and insight on strain rate dependent composite material properties and composite aircraft structures failure modes subjected to high rate dynamic loading and potential benefits to the design and safety of commercial composite aircraft.

- **Future needs**
  - Representative composite fuselage structures

End of Presentation.

Thank you.

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