

Presented by

Holger Speckmann

Focal Point for SHM

Airbus
Bremen, Germany

Structural Health Monitoring (SHM)



AIRBUS

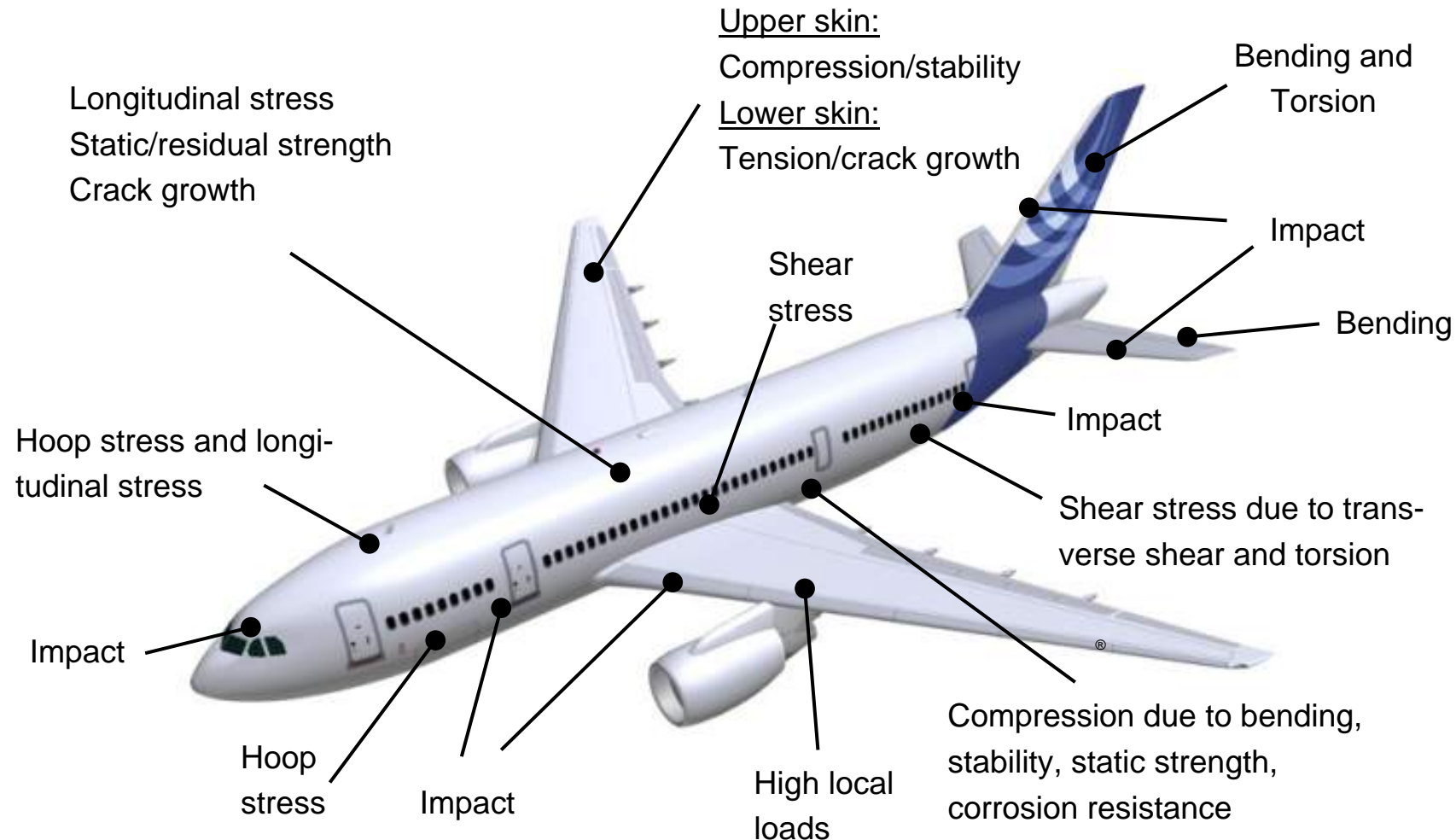
Content

1. What is SHM?
2. Why SHM
3. SHM Technologies
4. Qualification of SHM technologies
5. Roadmap (Airbus)
6. AISC
7. MSG3 Changes

What is SHM?



Airframe Loading / Non-Destructive Testing



Non-destructive testing (NDT) is needed in order to ensure the integrity of the airframe.

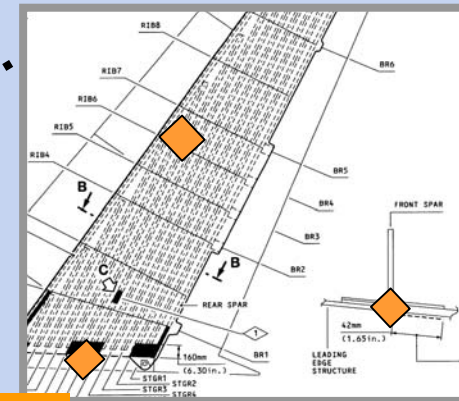
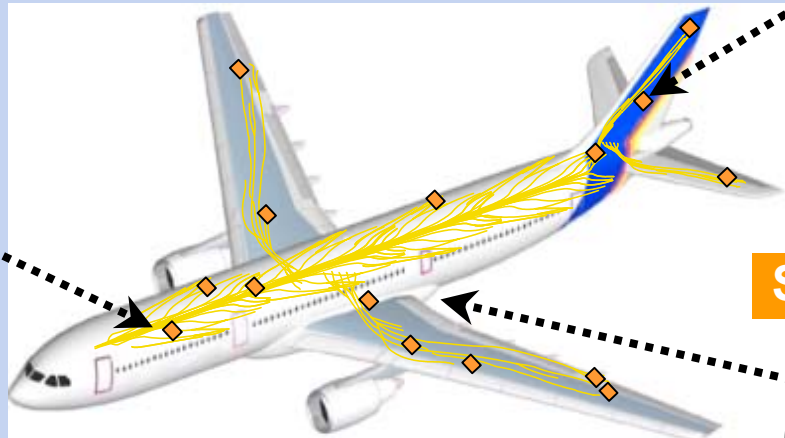
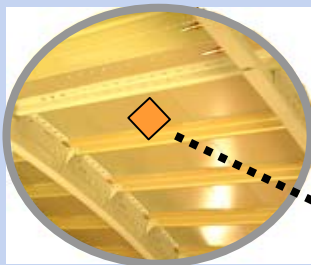
Possibilities for NDI inspection

1. Visual Inspection (VI)
2. Non-Destructive Testing (NDT)
3. Structural Health Monitoring (SHM)

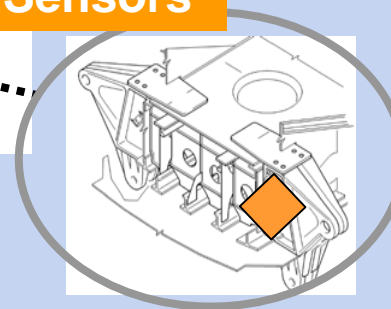
The optimum solution for structural inspections must be chosen out of these 3 options

SHM (Structural Health Monitoring)

- SHM = innovative Non Destructive Testing (NDT) method
- Peculiarity: Sensor remains attached / embedded in the structure
- Advantage vs. NDT: Information on structural events or states to arbitrary times available



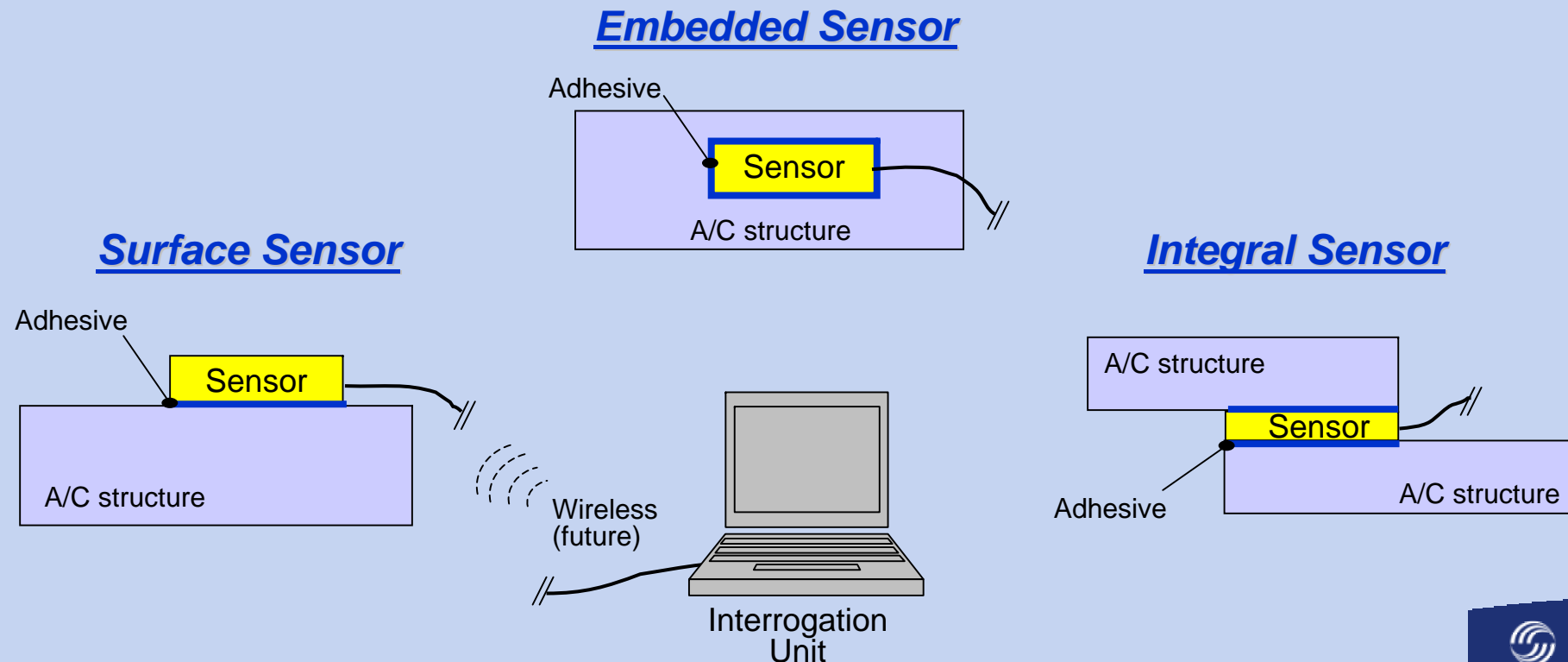
Sensors



Evaluation

SHM System – Principle and Set-up

- Physical Probe (acoustic, electro-magnetic, optic) + Material/Structure
 - ⇒ Interaction
 - ⇒ Analysis
 - ⇒ Diagnostic
 - ⇒ Detection and Monitoring of flaws, stress/strain, parameters
 - ⇒ Prognosis



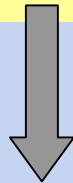
Why SHM?



Benefits of SHM

SHM

Continuous and autonomous monitoring of defects, stress/strain, environmental and flight parameters by means of permanently attached or embedded sensor systems in order to ensure the structural integrity.



Maintenance / Operatability

- Reduction of inspection time
- Deferred maintenance / repair
- Maintenance on demand
- **Reduced DOC, DMC**
- **Increased Availability**



Design

- Optimised structural efficiency
- New design philosophies
- **Weight saving**

SHM Technologies



SHM Technologies for Metal Applications

Metal Structure Application Scenarios

Detection of...

- Cracks (localisation, size)
- Crack growth (localisation, size)
- Accidental damage (localisation, intensity)
- Corrosion (localisation, severeness)
- Loads/Strain (localisation, intensity)

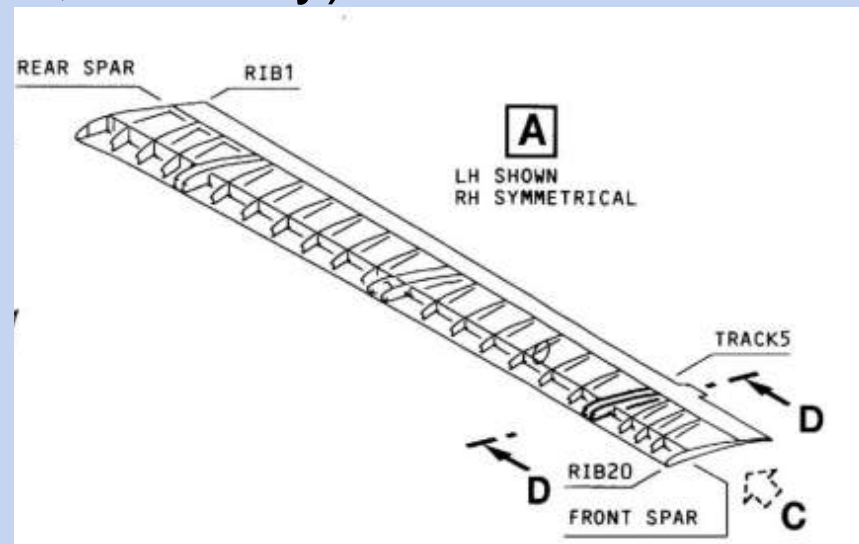
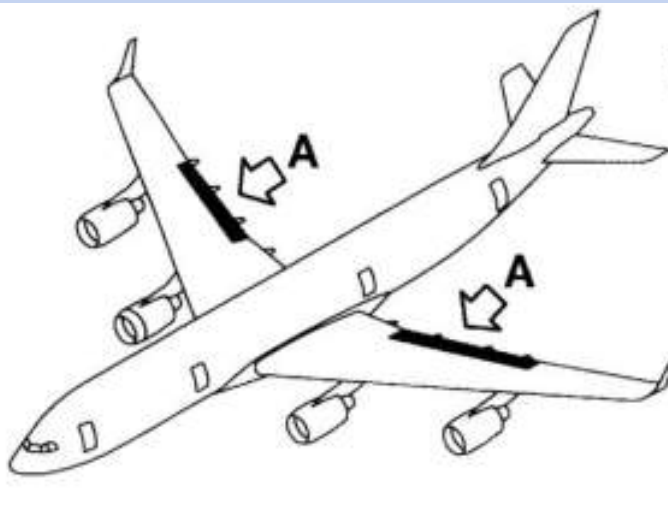


SHM Technologies for Composite Applications.

Composite Structure Application Scenarios

Detection of...

- Impact (localisation, intensity)
- Delaminations (localisation, size)
- Debondings (localisation, size)
- Water ingress (localisation, intensity)
- Loads/Strain (localisation, intensity)



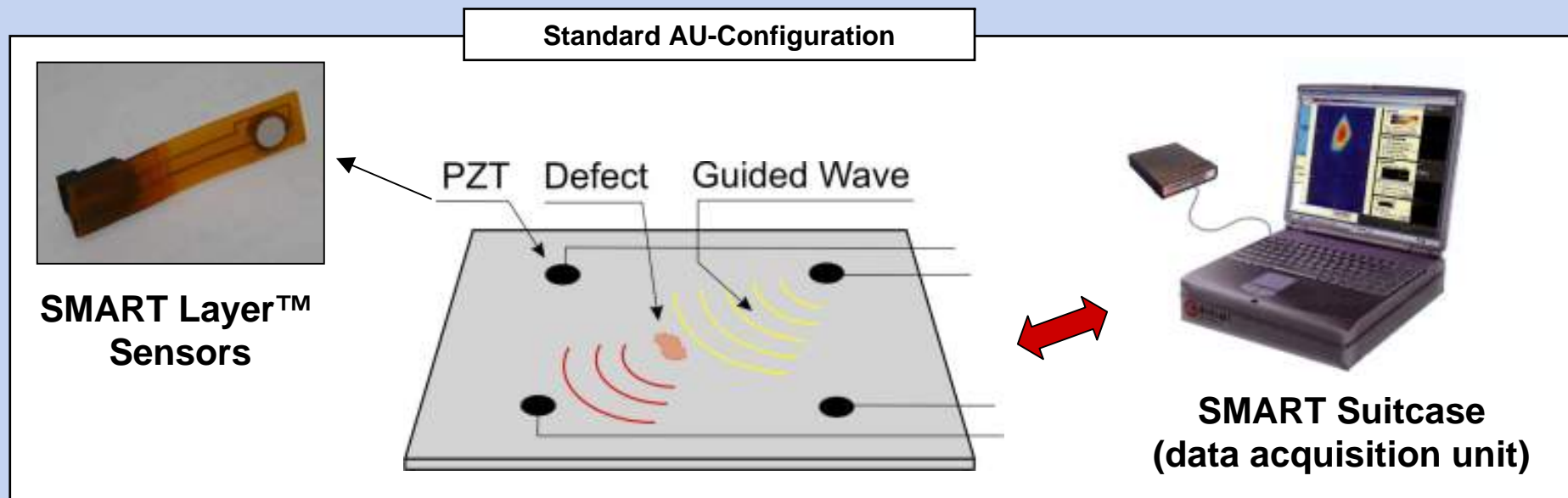
Examples for SHM Technologies



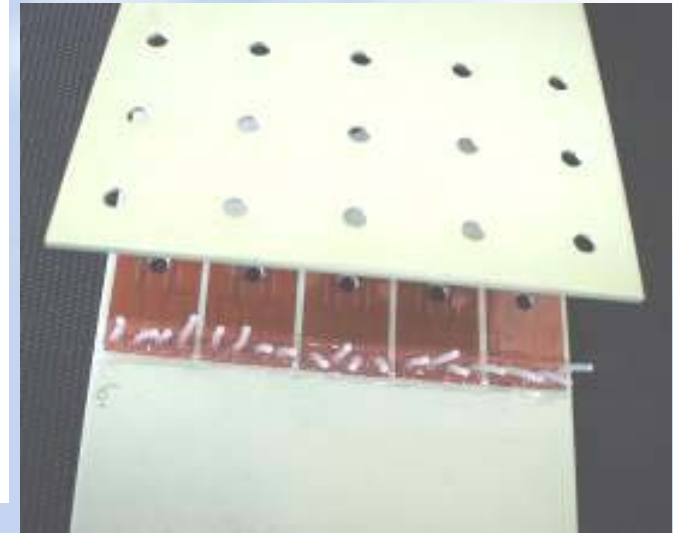
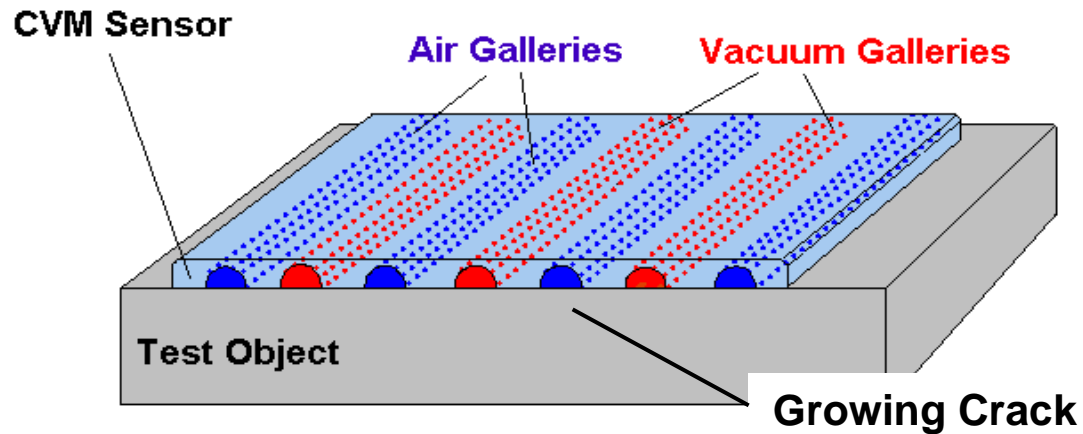
Acousto-Ultrasonics (AU) for Composite Structures

AU – Damage Detection System

- Network of PZT actuators / sensors
- Utilisation of guided elastic waves (lamb waves)
- Detection of debonding & delamination in composite structures



CVM-Technology



Integral sensor to detect crack initiation

- Connection of an air gallery with a vacuum gallery
- Increasing pressure in the vacuum gallery
- Crack detection by equipment






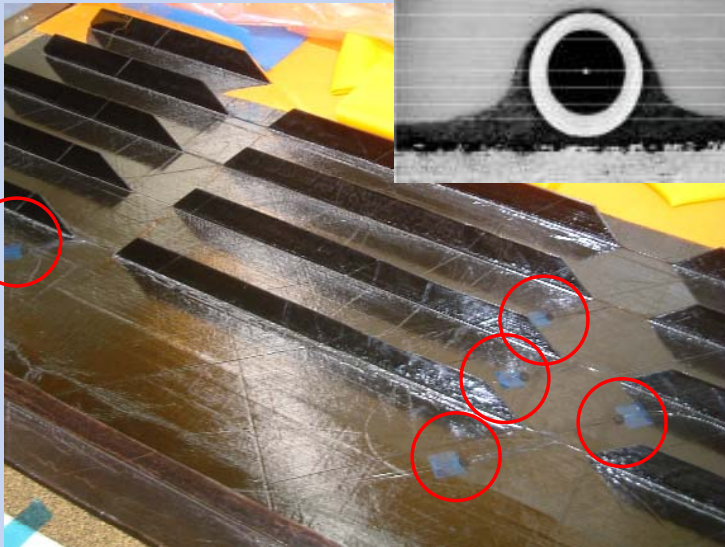
Sensor for surface crack detection

Optical fiber sensors – potential applications

Vision on future airframe technology




Optical fiber sensors

-  Structural Health Monitoring
-  In-service condition monitoring
-  Composite manufacturing process monitoring



Embedded Fiber Bragg Grating sensors

Advantages

-  Robust in terms of electromagnetic interference and corrosion
-  Handling in terms of geometry, size
-  Lightweight, low costs, sensing & data transmission, networking

Maturation and Qualification of SHM Technologies

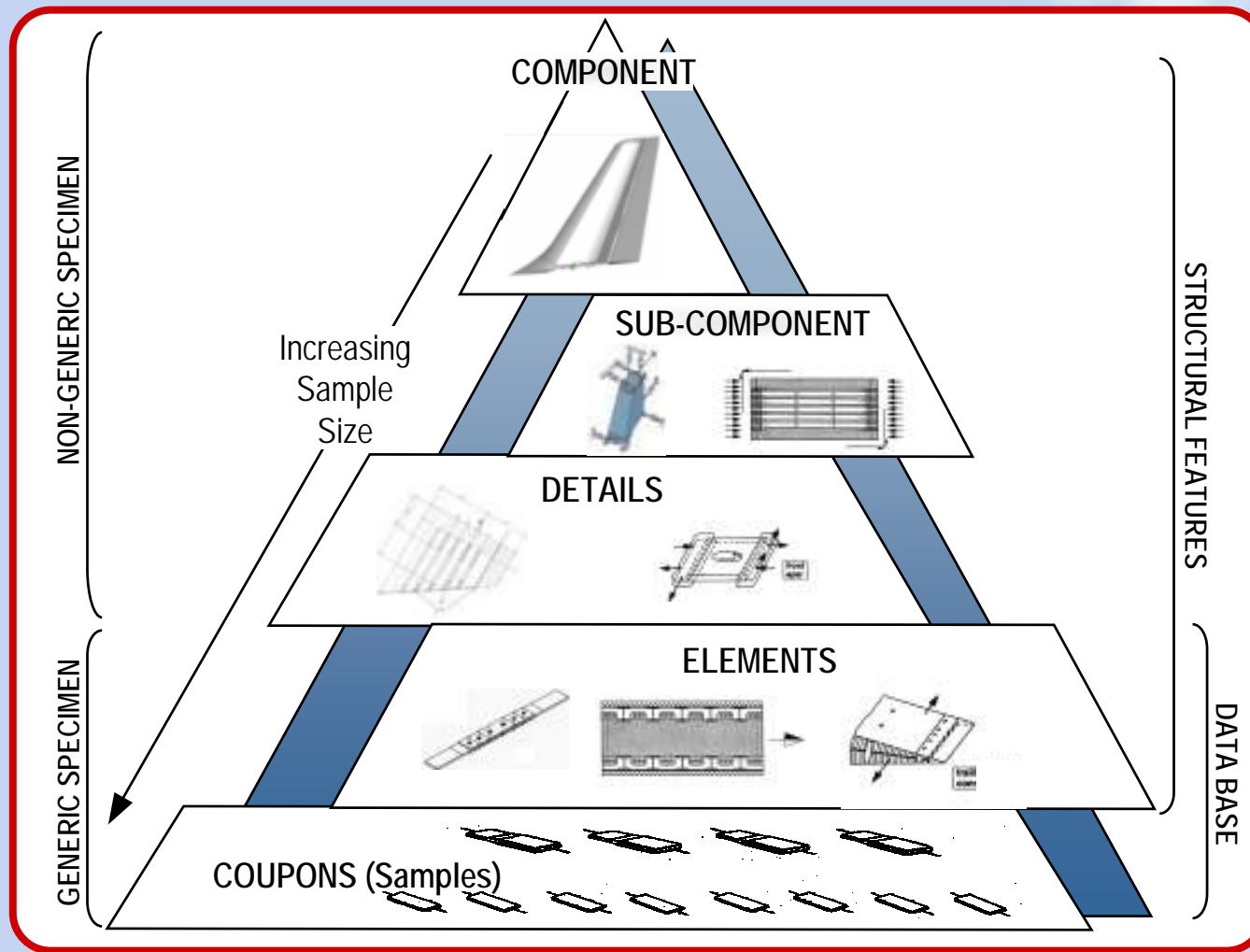


Qualification of Technology: Requirements

Basic Technology Requirements Range

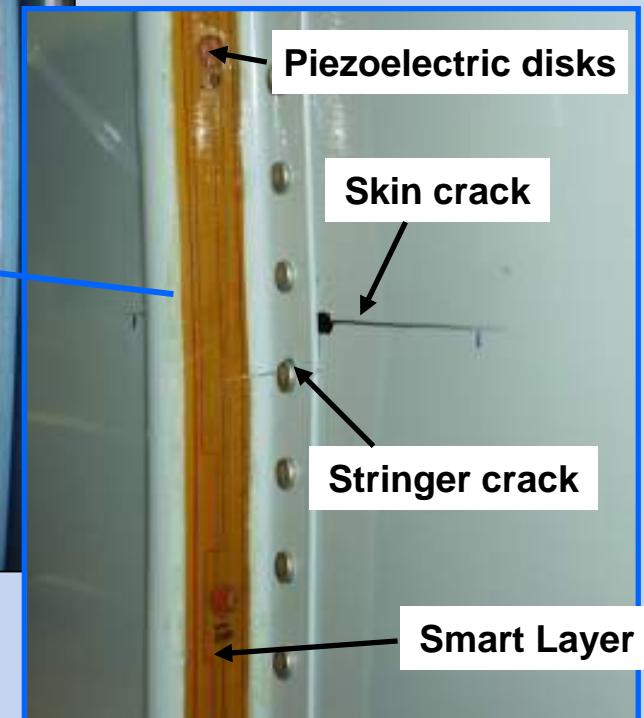
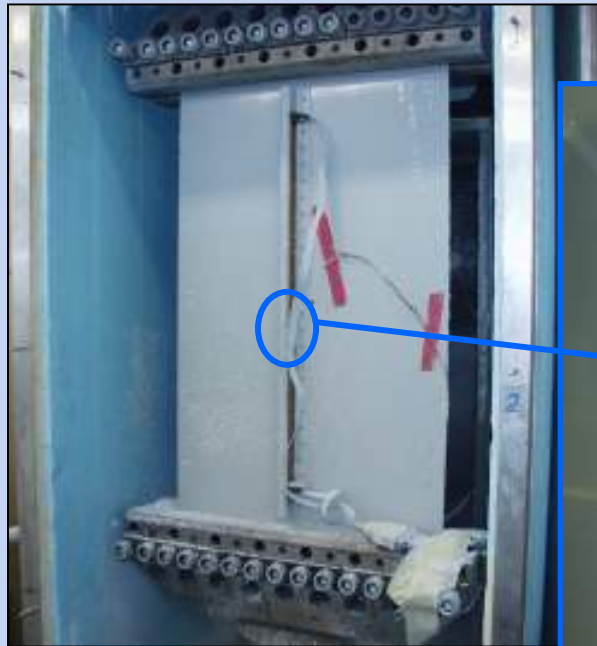
- Detection capability (POD)
 - Durability
 - Temperature loading
 - Chemical loading
 - Mechanical loading
 - Manufacturing aspect
 - System integration aspect
 - Maintainability
 - Reparability
 - Self-diagnostic capability
- Reliability > 30 years***

Technology Development Plan



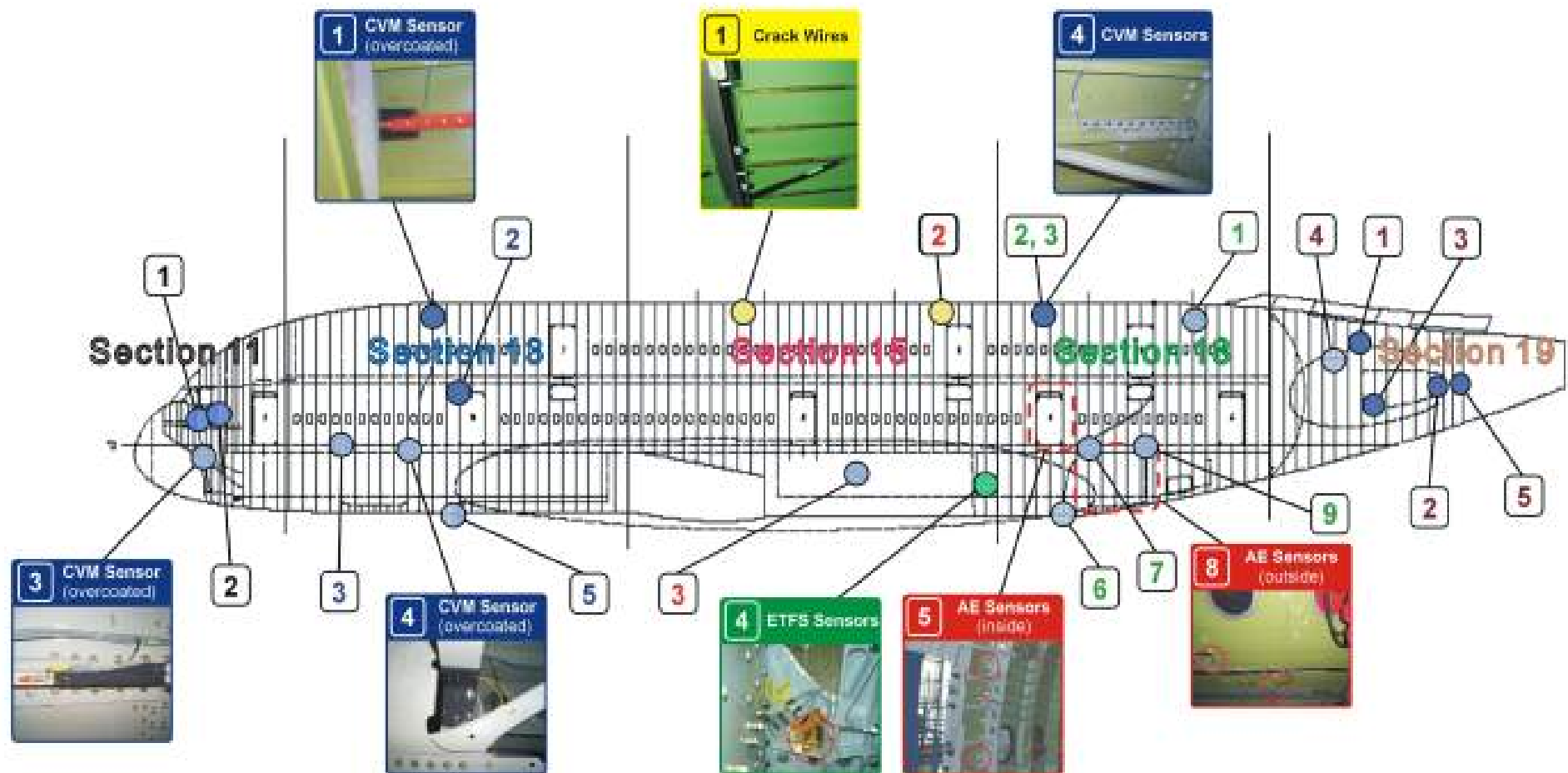
**Durability, Robustness and
Environmental Tests**

POD and Environmental Tests on Coupons



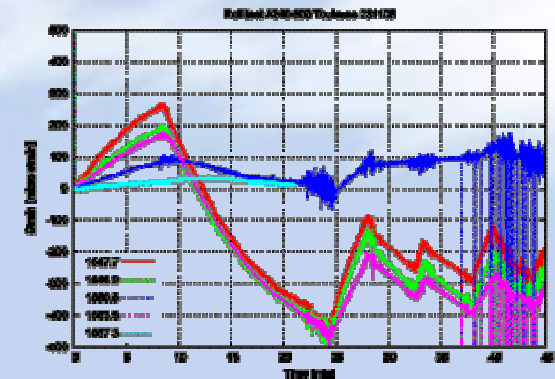
Durability testing of sensor technologies

A380 Full Scale Fatigue Test



Durability Tests on Airbus Aircraft

A340-600 Testing of Fibre-Bragg-Gratings



A320, MSN 1 Technology 'Carrier' for SHM



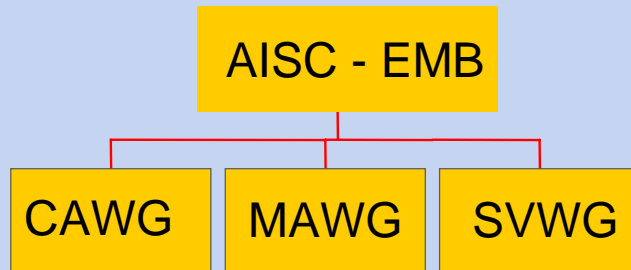
AISC

Aerospace Industry Steering Committee



AISC – SHM

Aerospace Industry Steering Committee for SHM



Mission:

- Creating a guideline and recommendation on how to use Structural Health Management (SHM) on various aircraft platforms, in order to improve operability and optimize maintenance plan where structures are concerned, considering their regulatory aspects.

Member EMB:

- OEM
 - Airbus, EADS, Boeing, Embraer
 - Bombardier, Lockheed-Martin, BAe-Systems,
- Government
 - FAA, EASA, Sandia Labs
- Customer
 - Air Force, US Army
 - NASA
 - ATA, AEA
- Academia
 - Stanford Univ.
 - Univ. of Tokyo
- Industry
 - Honeywell, Fuji HI

SHM Specification under preparation

- SHM specification needed
 - Worldwide harmonization of wording, synonyms, philosophies, etc.
 - One “guideline” for all OEM’s
- Basic document to refer from other maintenance documents (MSG3, etc.)
- Managed by SAE (negotiations ongoing)
- Approved by authorities
 - Structures&Materials
 - Maintenance
 - Systems ?

MSG 3 changes



Non Destructive Inspection possibilities

3 kind of NDI exist to ensure the structural integrity

1. Visual Inspection

- GVI (General Visual)
- DET (Detailed)
- Steered by MPD
- Performed in according to AMM, etc.

2. NDT (Non Destructive Testing)

- SDET (Special Detailed)
- Using of Tools and equipment
- Procedures mainly in NTM
- Steered by MPD, SB, etc.

3. SHM

NEW

- SDET **Issue Paper 1** (alternative to NDT)
- Permanent installed sensors
- Procedures for Off-Board use in NTM
- On-Board and/or On-Line use via IVHM architecture
“Automated SHM”

Issue Paper 2

To cover new options for maintenance, MSG3 has to be changed

© AIRBUS DEUTSCHLAND GMBH. All rights reserved.
Confidential and proprietary document.

This document and all information contained herein is the sole property of AIRBUS DEUTSCHLAND GMBH. No intellectual property rights are granted by the delivery of this document or the disclosure of its content. This document shall not be reproduced or disclosed to a third party without the express written consent of AIRBUS DEUTSCHLAND GMBH. This document and its content shall not be used for any purpose other than that for which it is supplied.

The statements made herein do not constitute an offer. They are based on the mentioned assumptions and are expressed in good faith. Where the supporting grounds for these statements are not shown, AIRBUS DEUTSCHLAND GMBH will be pleased to explain the basis thereof.

AIRBUS, its logo, A300, A310, A318, A319, A320, A321, A330, A340, A350, A380, A400M are registered trademarks.

