

# New NDI Technologies & Tools for CFRP Inspection in Service

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**Holger Speckmann**  
CEO TESTIA GmbH



1. Introduction
2. State of the Art for In-Service CFRP Inspection
3. New NDI Technologies and Applications for CFRP Inspection
  - Ultrasonic Camera
  - Paint Thickness Measurement with Microwaves
  - Thermal Damage Detection with Infrared Spectroscopy
  - Dent Size Determination
  - Scratch analysis
4. Inspection Support Tool „Online Maintenance assistance“ (OMA)
5. CFRP Reference Standards
6. CFRP Specific Training
7. Conclusion

# 1. Introduction

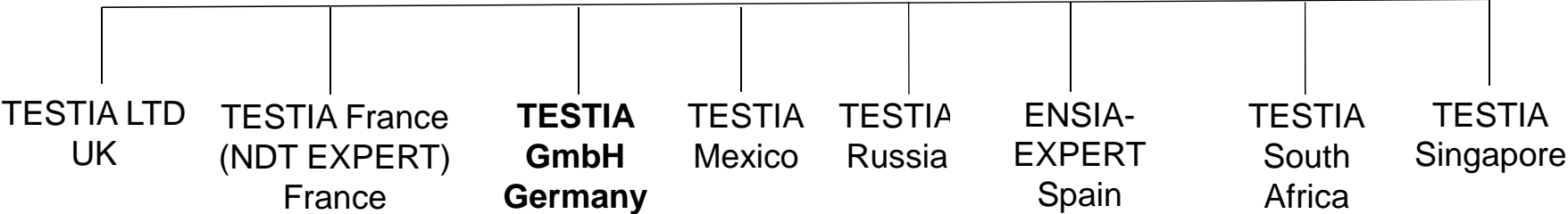
# Who and what is Testia?

Testia is a newly founded, small and very reactive company providing all kinds of services for Nondestructive Testing (NDT):

- Training (EN4179/NAS410)
- Training on the job
- Engineering Services
- Inspection
- Special NDT Equipment
- Reference Standards
- Consultancy



# Testia Locations



## 2. State of the Art for In-Service CFRP Inspection

# Taptest



## Manual Tap Test

Simple tool  
Fits into each pocket  
Cheap & everywhere available.  
Proven Probability of Detection (POD)



## Mitsui Woodpecker

Simple to use,  
Traffic Light Indication, cheap



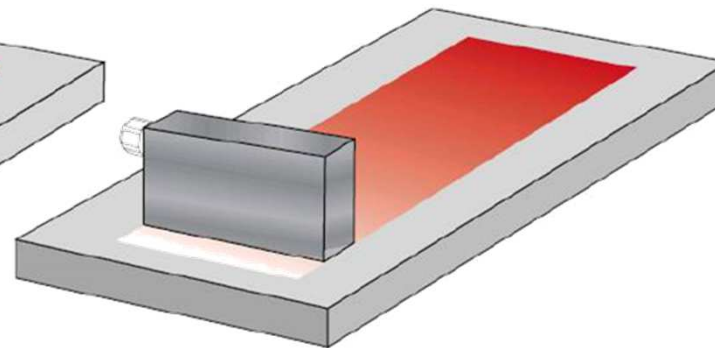
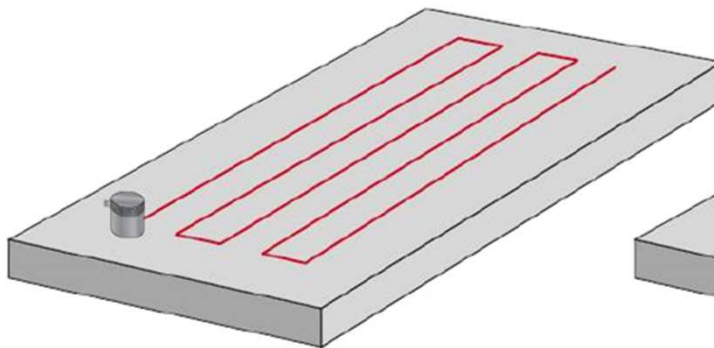
Both are approved standard processes in Aerospace



# Ultrasonic Variances

Manual, Single-Channel  
Standard Handheld Device

Ultrasonic Array Systems

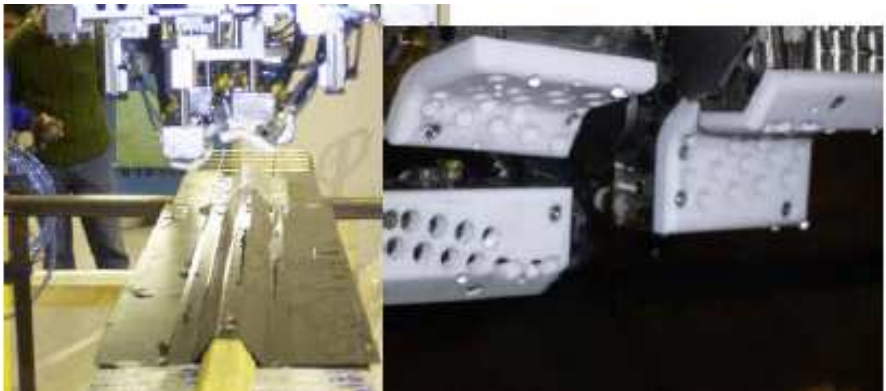
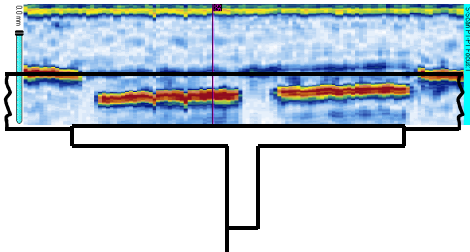
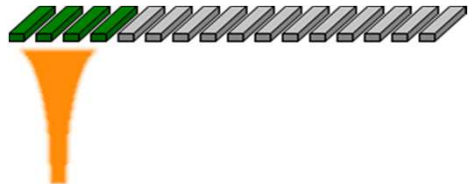
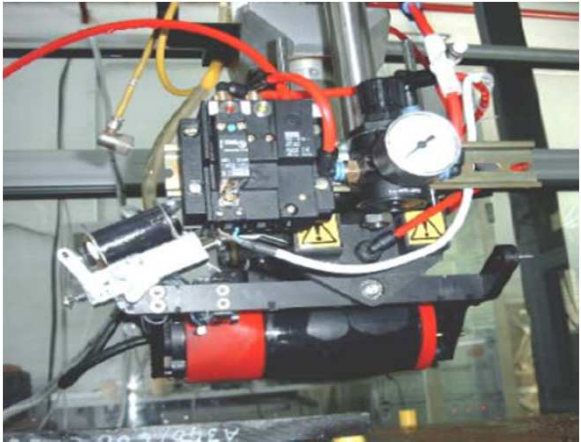




# Selection of UTPA Applications

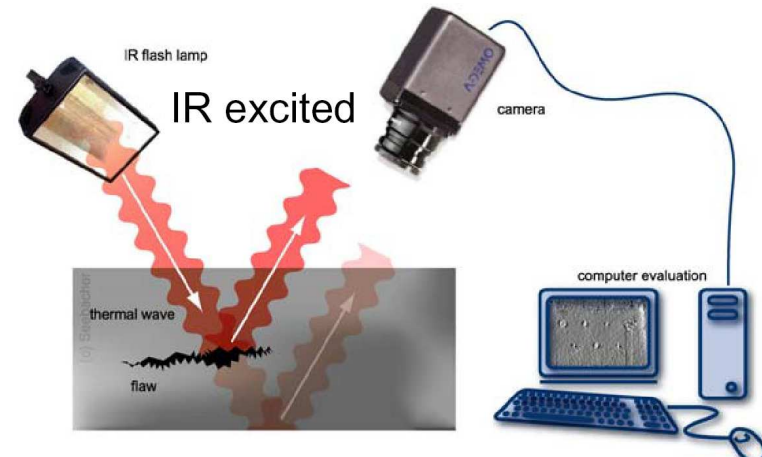
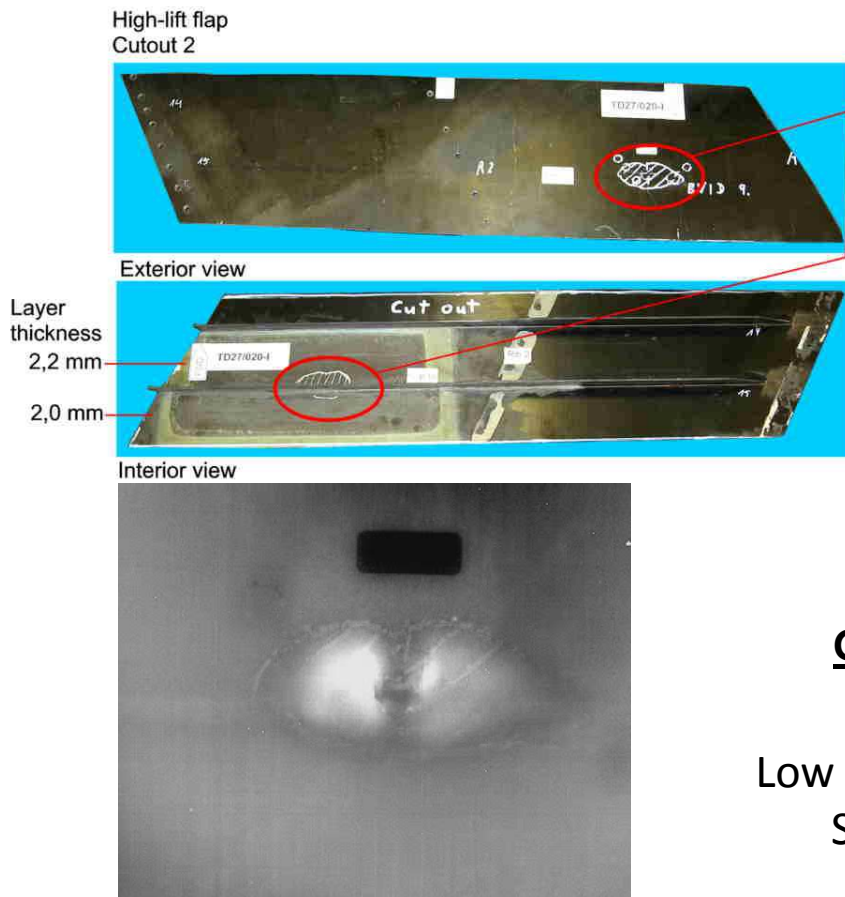


Phased Array  
Roller Probe  
for manual and  
automated  
Inspection



Automated  
Inspection of  
 $\Omega$ -Stringer

# Thermography



**GECKO**  
New  
Low Budget IRT  
System



Source: Airbus

### 3. New or adapted NDI Technologies and Applications for CFRP Inspection

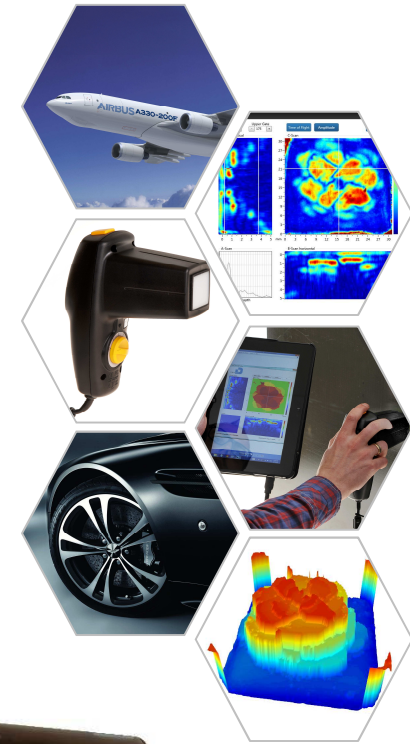
## 3.1. Ultrasonic Camera - DolphiCam



# General Information

## Ultrasound video camera for inspection of CFRP

- High resolution images
- 16.000 transducer elements
- CFRP up to 16 mm thickness
- 2D and 3D images
- A-, B-, and C-scan (Amplitude & Time of Flight)
- Cover large areas with manual stitching
- Compact, ergonomic and easy to transport
- Easily operated by non-experts
- Runs on Windows Tablets and Laptops



## Main applications in Aerospace

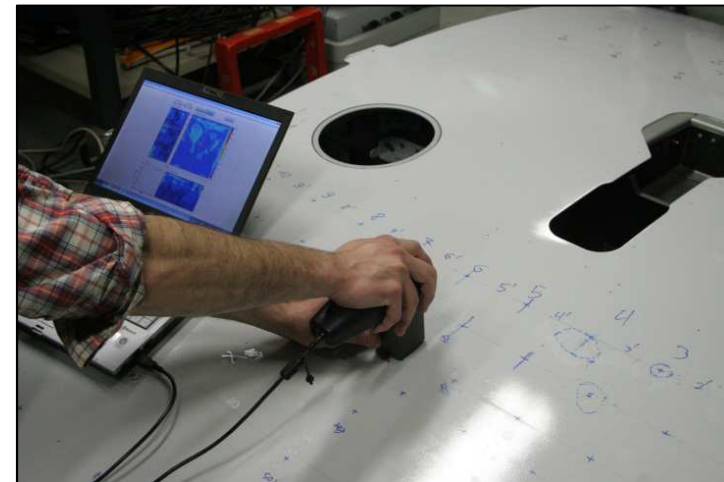
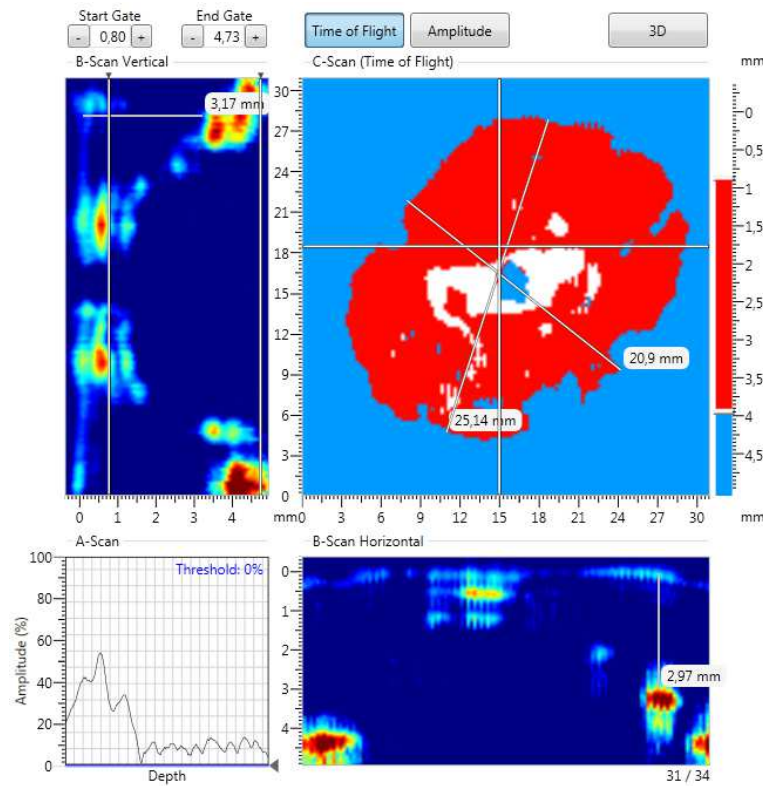
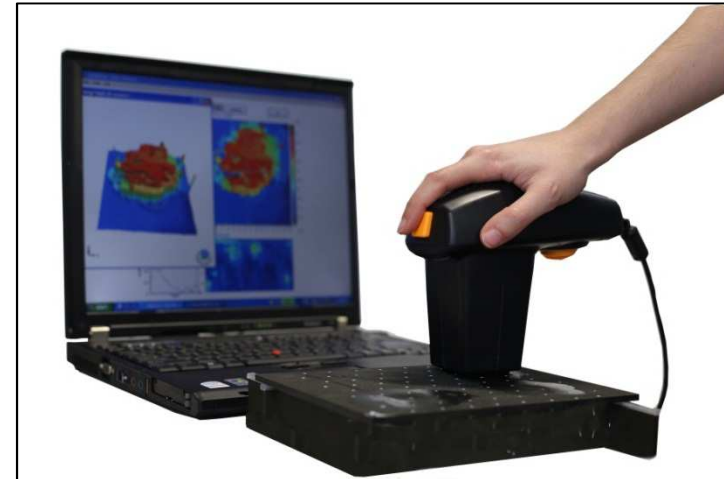
- Impact damages, debonding and delamination detection
- Detection of delaminations around drilled holes





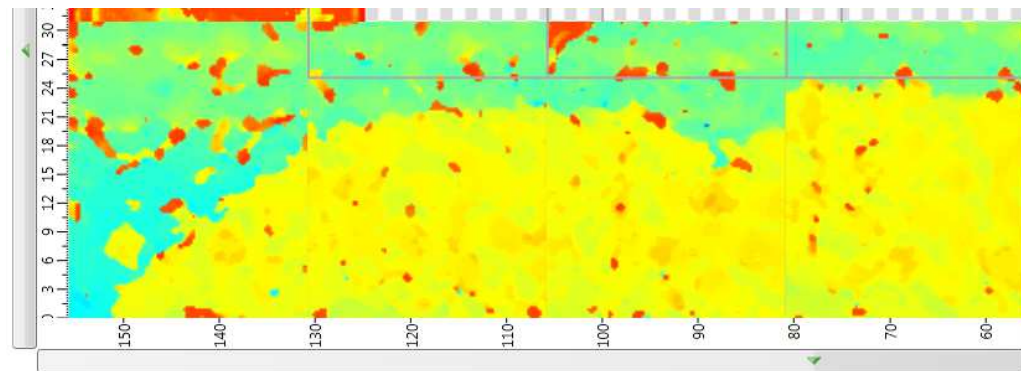
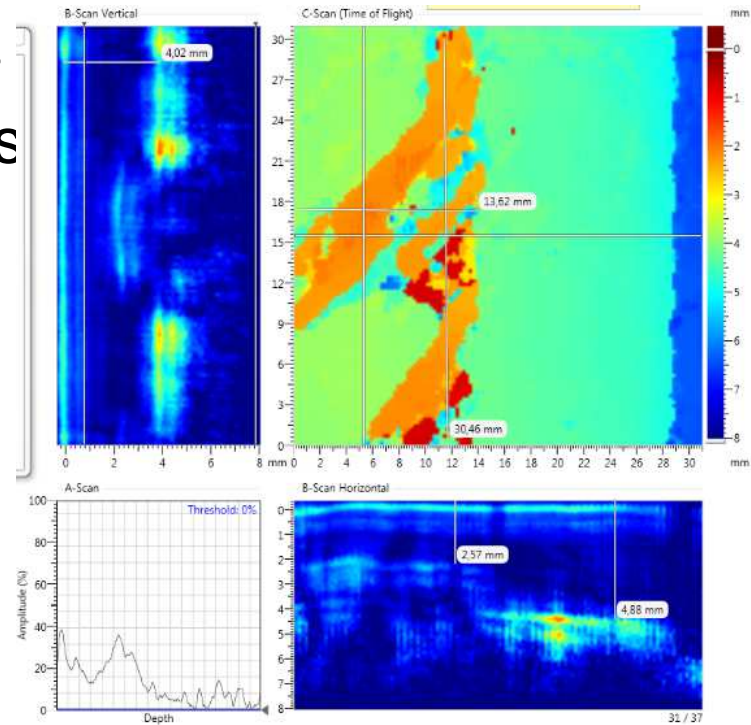
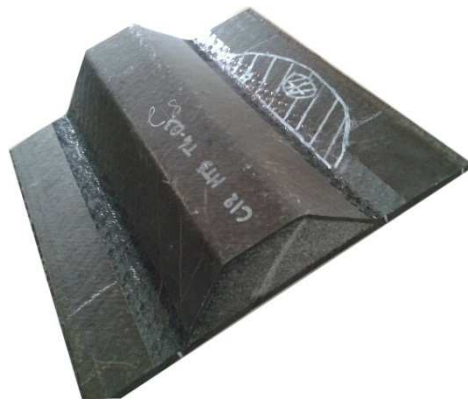
# CFRP-Delaminations

- Detection after „Impact“.
- Damages directly measured



# Debondings

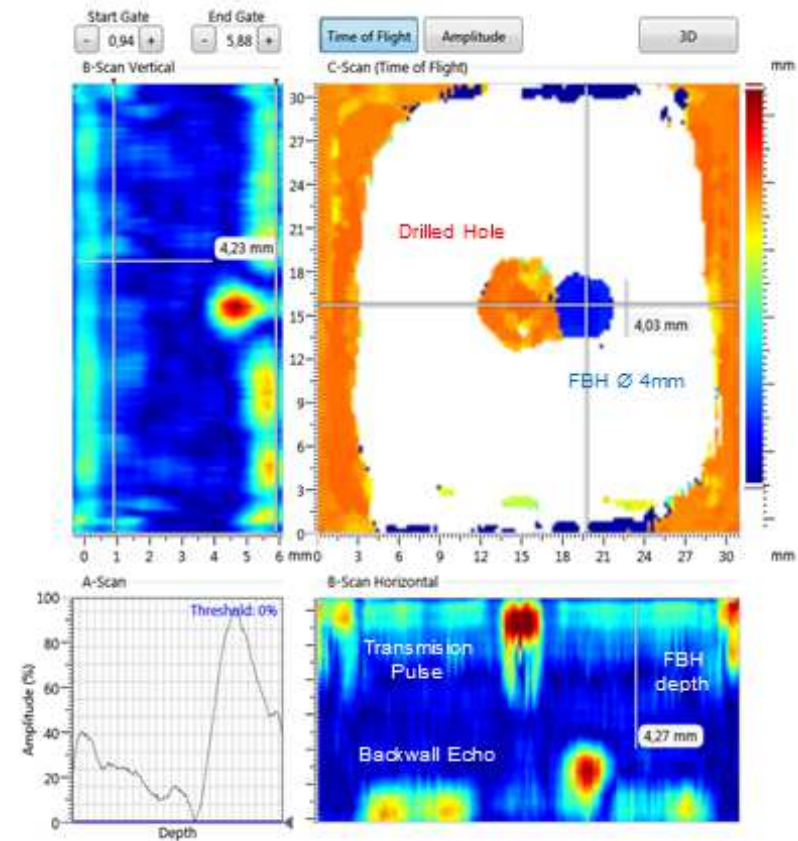
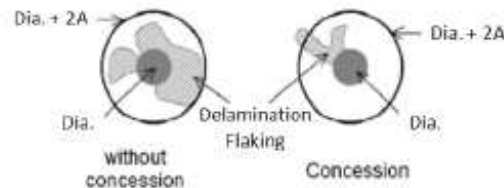
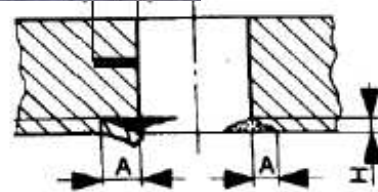
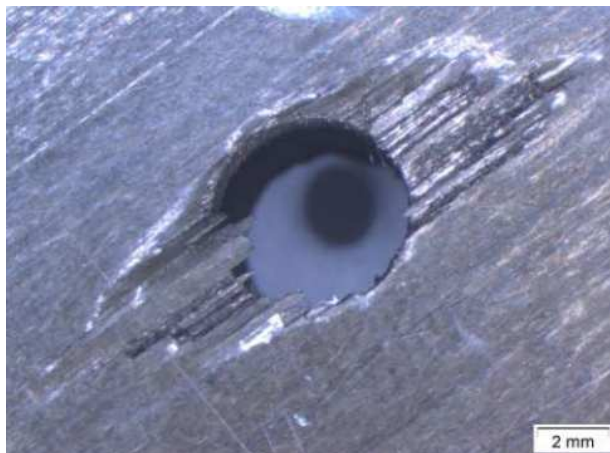
- $\Omega$ - or T-Stringer CFRP-Structures
- „Manual Stitching“ for larger areas





# Drilled Hole Inspection

- Detection of delaminations in CFRP-Structures around holes
- „Flaking“ after drilling
- Detected by DVI (visual inspection)



**DolphiCam**  
**„Measurement in one shot“**

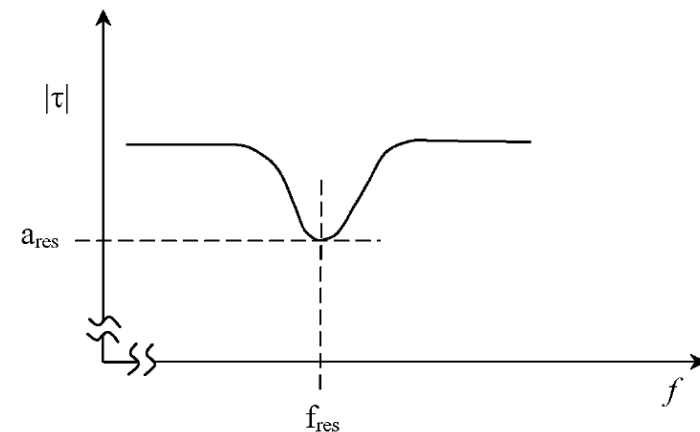
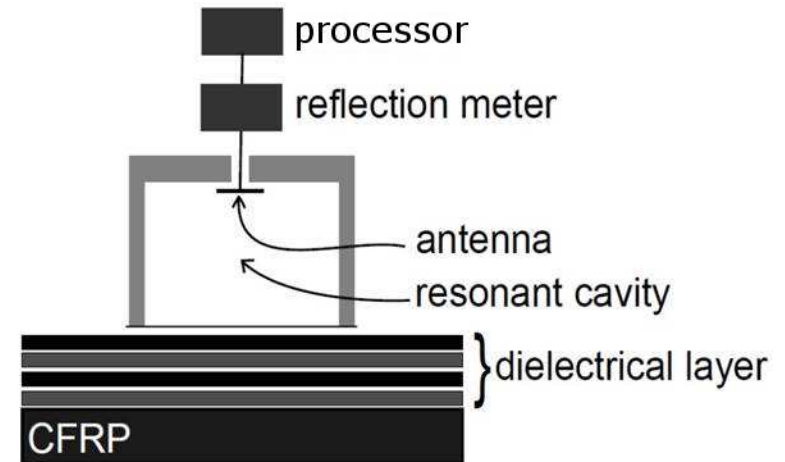
## 3.2. Paint Thickness Measurement with Microwaves

**FSC1**  
**FSC2**



# FSC1/2 – Measuring Principle

- An antenna radiates and detects an electromagnetic field
- CFRP (with or without ECF) acts as one side wall of the resonator
- The cavity resonant frequency depends on the thickness of the dielectric layer(s)
- A reflection meter, measures the resonant frequency
- The module sweeps a frequency band and measures the reflection coefficient
- A processor calculates the thickness of the dielectric layer



# FSC1/2 – Paint Thickness on CFRP

- The measurement system consists of a handheld probe (sensor  $\varnothing \approx 2$  cm) and a control module
- Measurements possible on electrically conductive substrates (e.g. CFRP, CFRP with ECF, metal) – no GFRP
- FSC1            0 to 400  $\mu\text{m}$
- FSC2            0 to 1000  $\mu\text{m}$
- Measuring time < 1 sec
- The measurement data can be exported via USB



**FSC1 – Qualified by Airbus**  
**FSC2 – Qualification in progress**

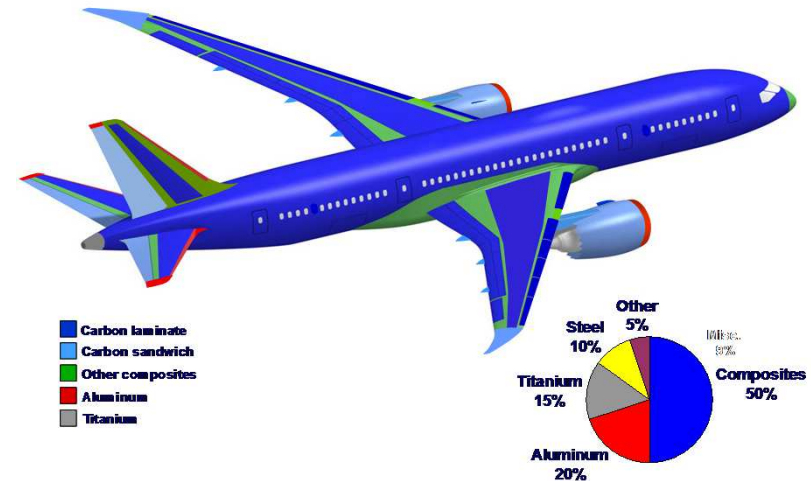
## 3.3. Thermal Damage Detection with Infrared Spectroscopy





# Heat Damage in Composite

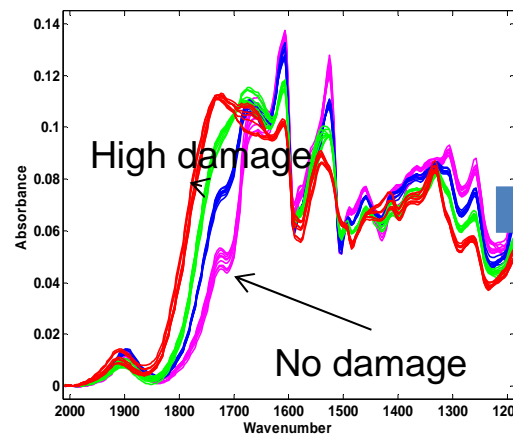
- Aircraft and other structures will increasingly be constructed from composite material
- Composites are susceptible to heat and oxidative damage → Chemical damage of the epoxy resin
- Exoscan provides new type of non destructive testing to detect heat damage
- Exoscan specified in Boeing 787 NDT Manual



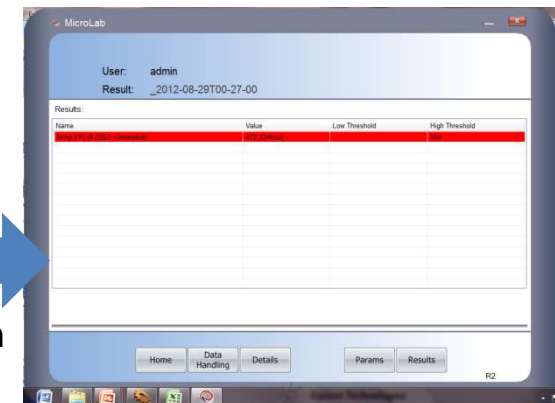
Source: Boeing/Agilent



Source: Agilent



PLS  
Calibration



Source: Agilent

## FTIR 4100

- Handheld (~3 kg and 17\*12\*22 cm<sup>3</sup>)
- Local measurement (IR spot size: 1,5 mm<sup>2</sup>)
- Interchangeable sample interface



***FTIR 4100 Exoscan with docking station (left) and with PDA (right)***

### Measurements

- Contact with structure required
- About 30 sec for one measurement
- PC or PDA controlled

## FTIR 4200 Flexscan

- Handheld (~2 kg)
- Local measurement (IR spot size: 1,5 mm<sup>2</sup>)
- Separated electronic and optical systems
- Dedicated sample interface

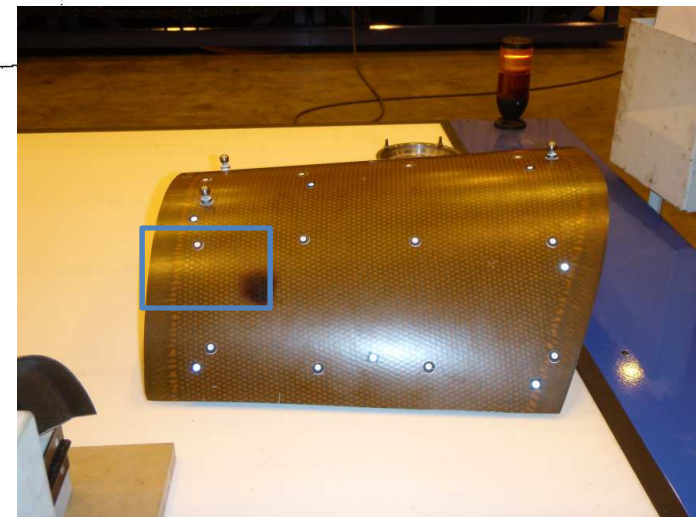
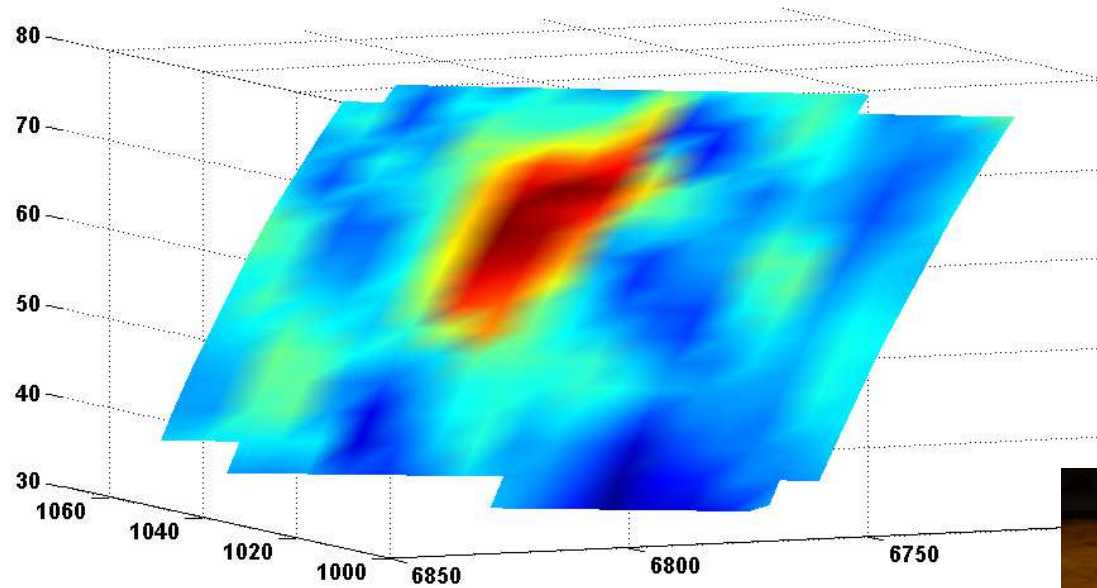


Source: Agilent

***FTIR 4200 Flexscan with PDA***



# Heat Damage



Source: Agilent

## 3.4. Dent Check



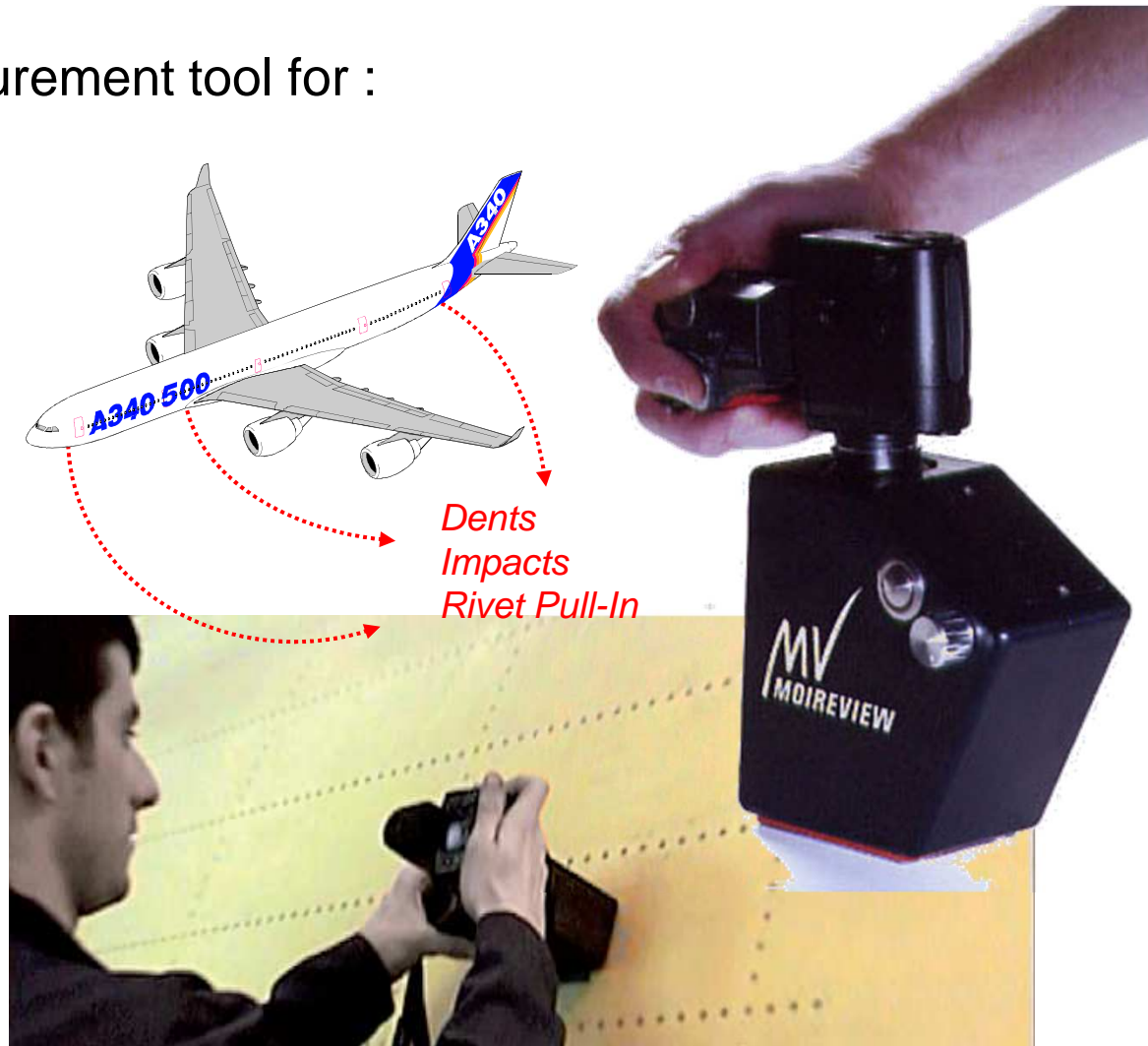
# MoireView

3D mapping and measurement tool for :

- Dents
- Impacts
- Rivet pull-in
- Blending
- ...

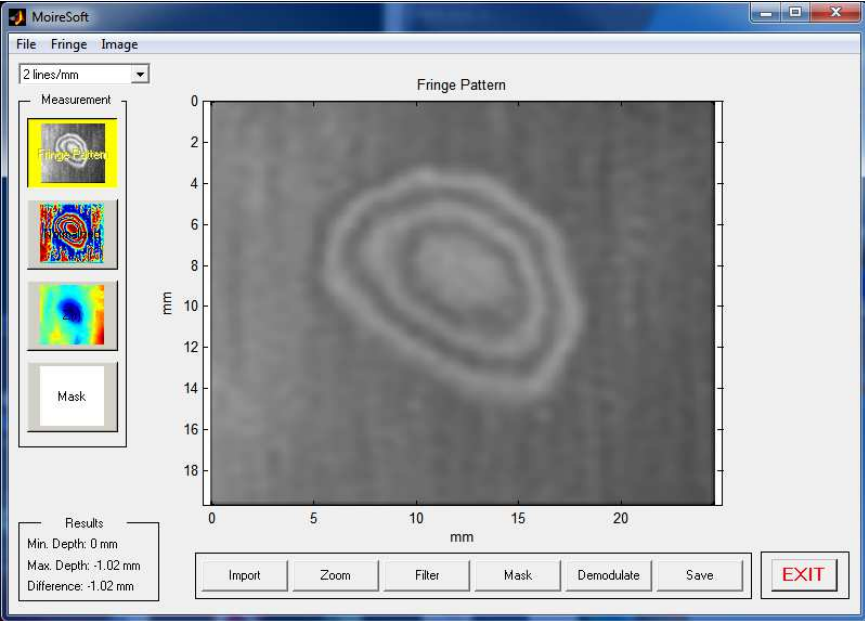
Key features:

- Wireless
- Autonomous
- Lightweight
- Low cost

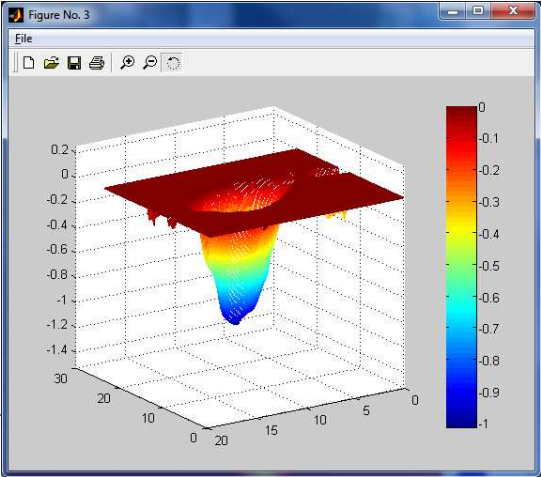
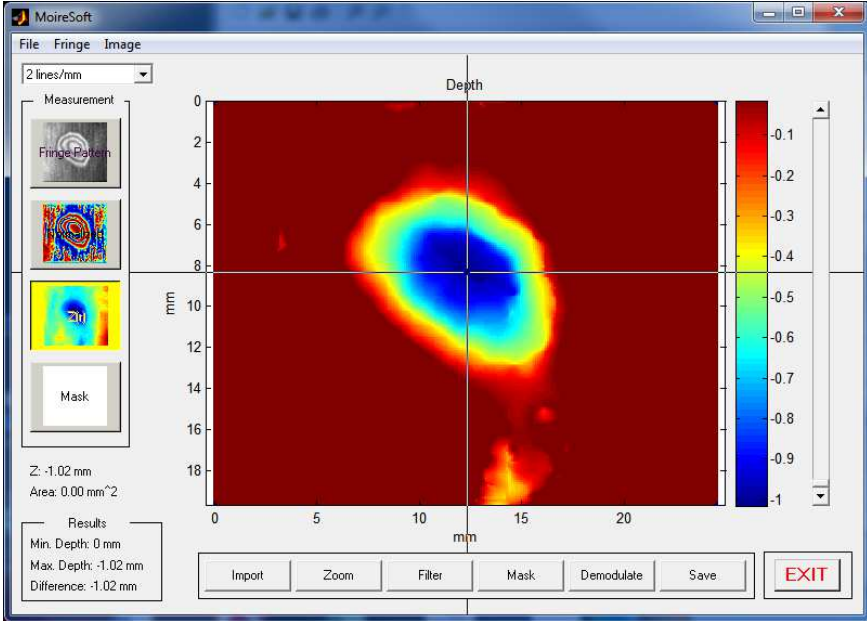


# Easy Dent Sizing

## Size of dented area



## Depth of dent



**3-D**

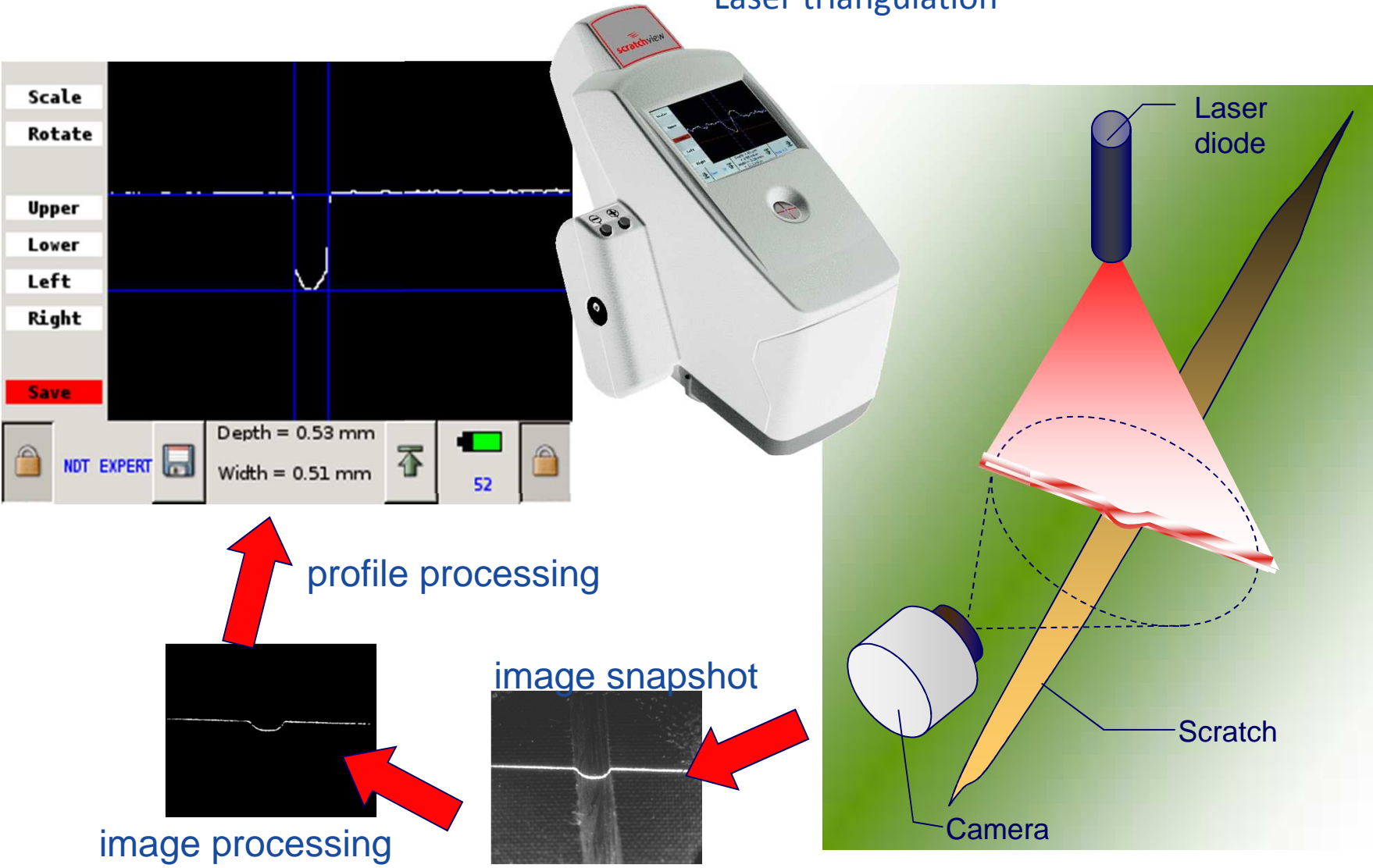
## 3.5. Scratch Analysis

  
**scratch***view*



# Measurement Principle

Laser triangulation





# Ergonomic / Easy to use system

- Ergonomic : only 4 control buttons
- Measurement range:
  - 0.02 mm < Depth < 1 mm
    - For 0.02 mm < Depth < 0.05 mm, accuracy =  $\pm 0.005$  mm
    - For 0.05 mm < Depth < 1 mm, accuracy =  $\pm 10\%$
  - 0.03 mm < Width < 2 mm
- Weight: 1.7 kg
- External USB port for data saving and reporting
- Autonomy : 6 h



For a wider measurement range or for gap & flush applications, the dedicated tool is:

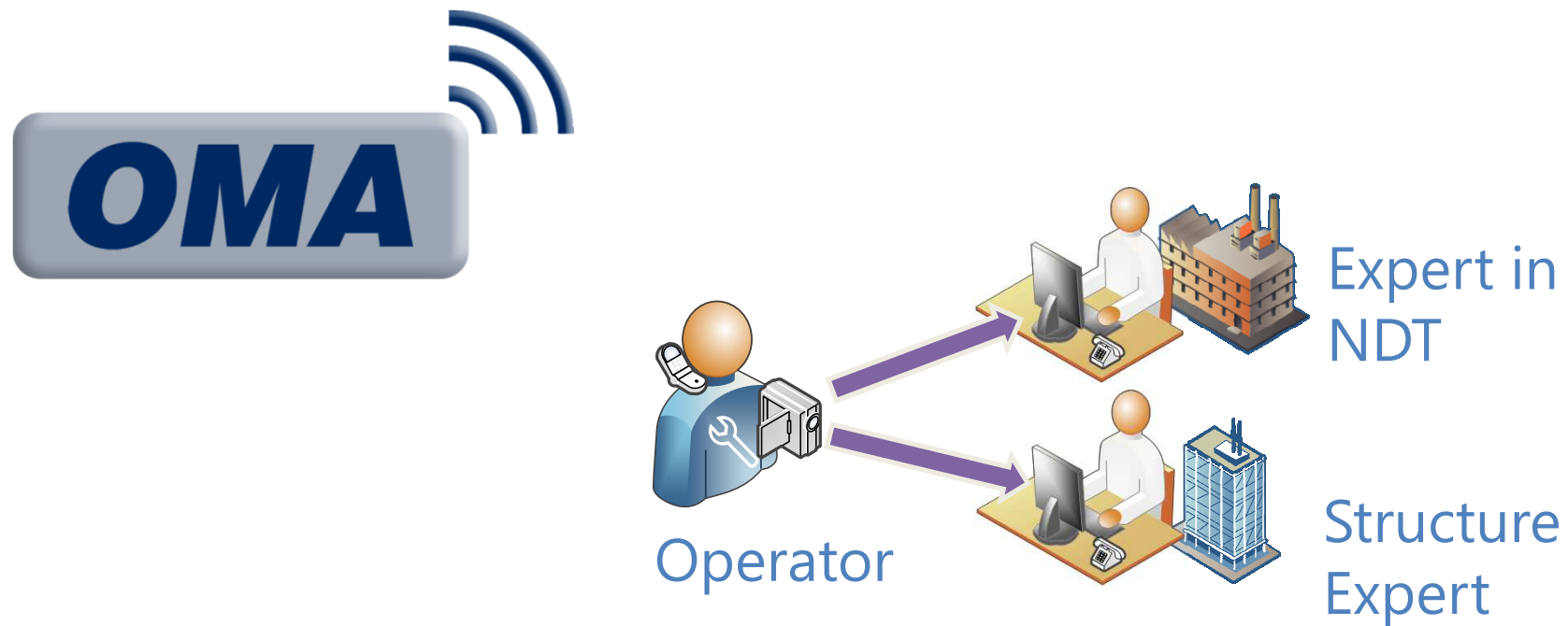


**lineview**

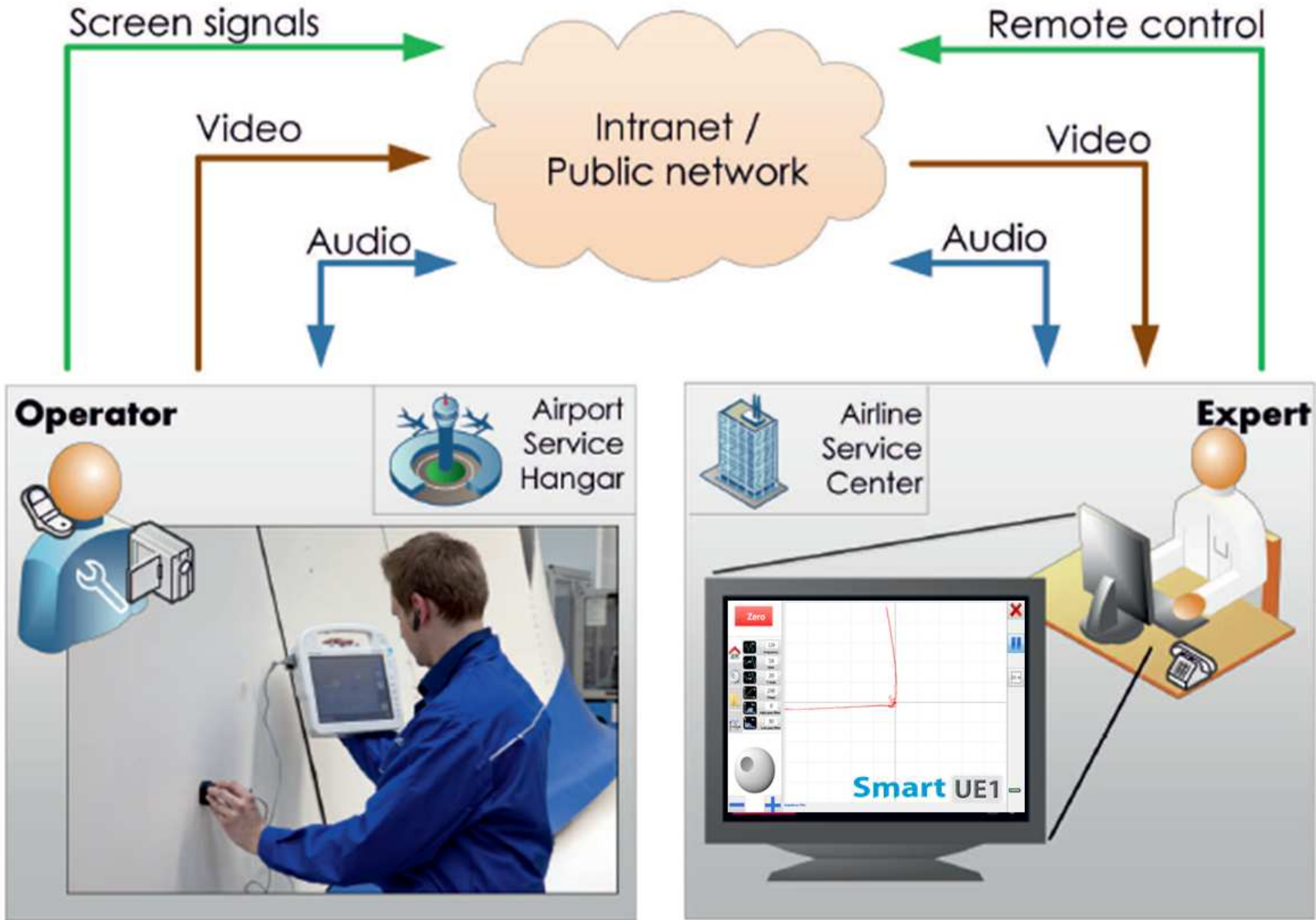




## 4. Online Maintenance Assistance (OMA)

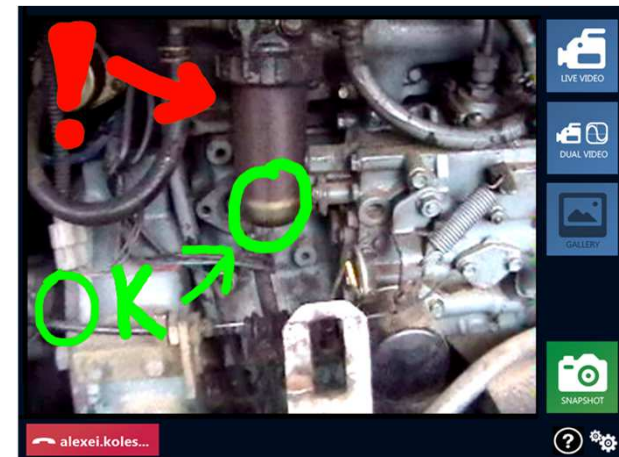


# OMA Concept



# OMA

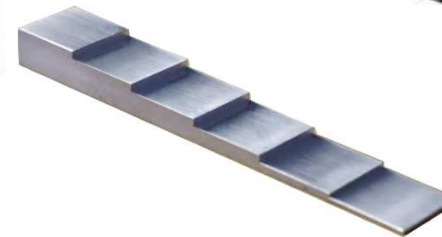
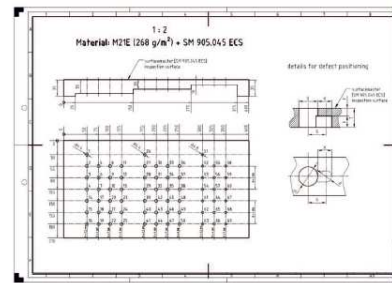
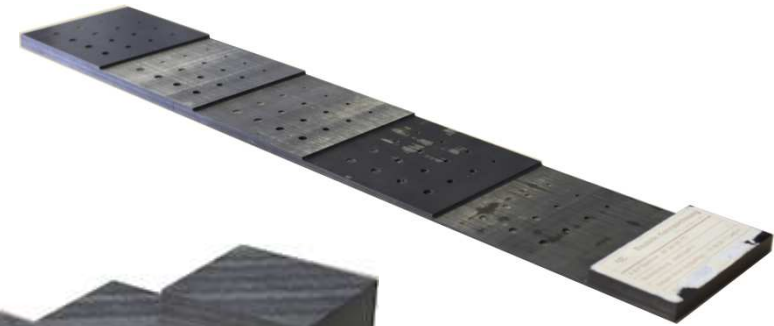
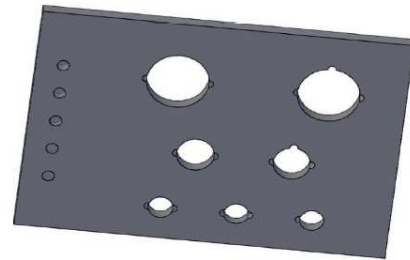
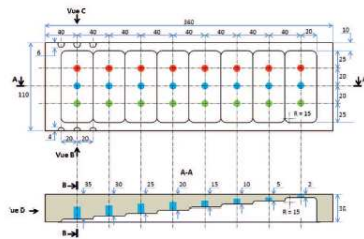
- Video based assistance in real time
- Remote control of NDT Equipment
- Usable ad hoc without complex installations (browser based)
- More effective support as using eMail
- Cost saving by:
  - Reduction of travel time
  - Less downtime of aircrafts
- Usable on all IT platforms
- High quality service by having always the best experts available
- Specific developed for NDT



**Basic Tool to enable Remote NDI**

## 5. CFRP Reference Standards

# CFRP Reference Standards (RS)



- Appropriate RS are essential for a proper inspection
- Have to be adapted to inspection task
- Development, Manufacturing and Sale by Testia
- Certified acc. to Production or In-Service needs
- Worldwide delivery

**High Quality of RS = High Quality of Inspection**

## 6. Training

# CFRP Training - General

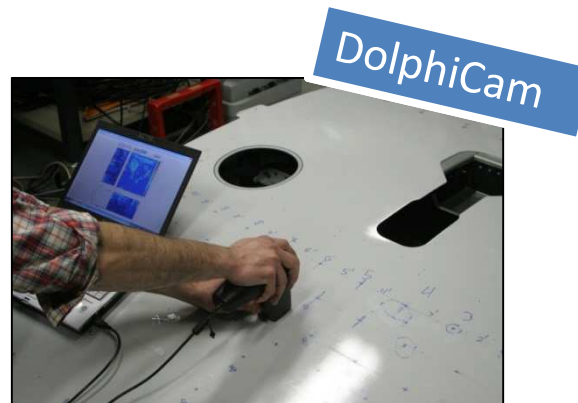
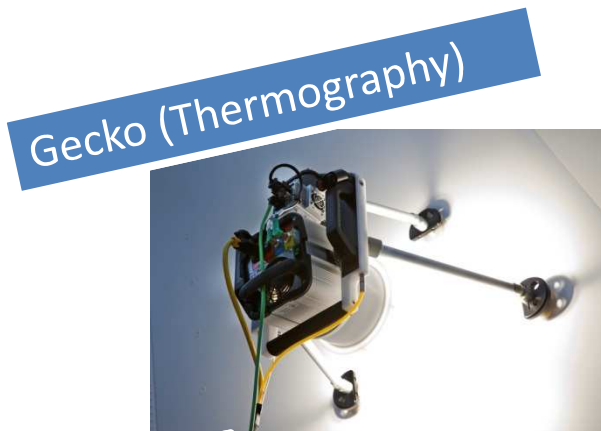
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- Need for specific CFRP trainings identified by OEM, Airlines, MRO, etc.
  - Phased Array training course is available already in Europe (5 days training – incl. examination)
- International groups work on general content of trainings, e.g.
  - ATA ITG CACRC on the way to define syllabus
  - German Society of NDT install task force to define Level training
- Additional awareness trainings for composite could cover:
  - New equipment, like UT Cameras
  - New paint thickness measurement devices
  - Thermography
  - Scratch measurement and other CFRP specific procedures
  - Specific NTM, SRM and other OEM standards
  - etc.



# CFRP Training: CFRP Equipment

- Trainings on applications of specific equipment in cooperation with equipment manufacturer and aircraft OEM
- Trainings can be done In-Situ or by webinars



## 7. Conclusion

# Conclusion

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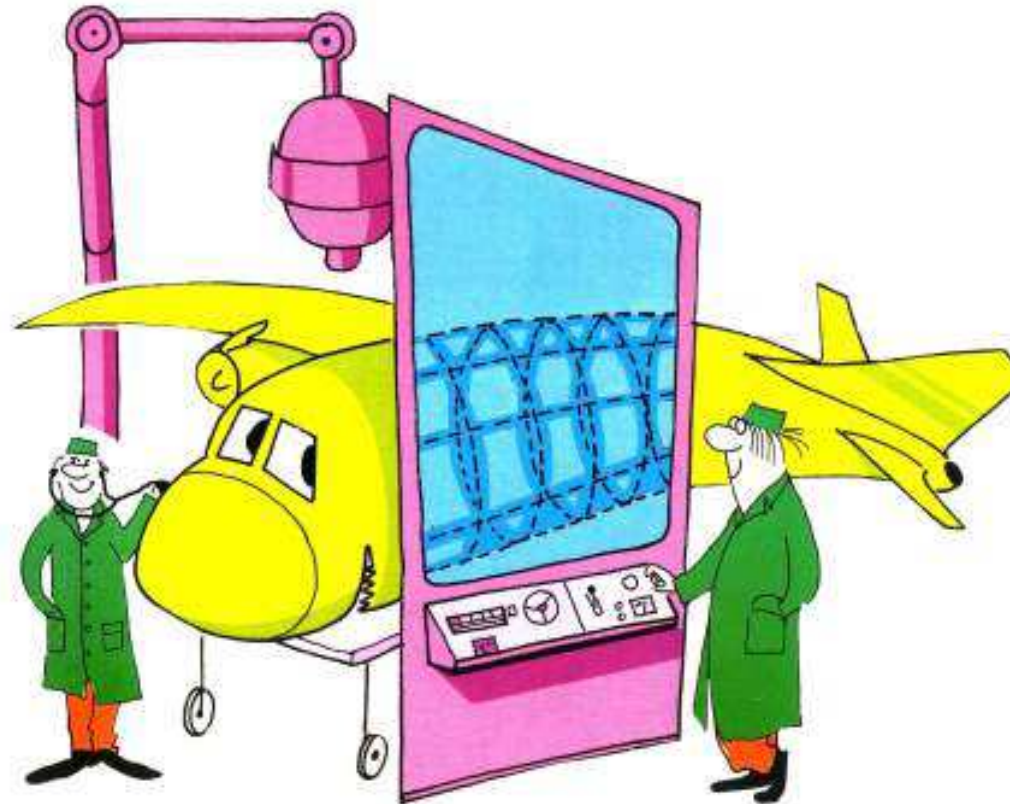


## NDT inspection of CFRP requires

- **New technologies**
  - Microwave
  - Infrared Spectroscopy
  - Scratch Inspection
- **Adaptation of existing technologies**
  - Ultrasonic
  - Dent Inspection
- **Use of advanced support tools**
  - OMA
- **Availability of High Quality Reference Standards**
- **New Trainings on Processes and Equipment**

.....and all of this is what Testia offers you!

## NDT – A technique which gets under your skin



**Thank you for your attention!**

*For more information about equipment,  
training and service contact*  
**testia@airbus.com**

Holger Speckmann  
*CEO Testia GmbH*

Airbus Allee 1  
28199 Bremen  
Germany

T: +49 421 538 4823

M: +49 151 16 70 09 15

[www.testia.com](http://www.testia.com)

eMail:

[holger.speckmann@testia.com](mailto:holger.speckmann@testia.com)

[testia@airbus.com](mailto:testia@airbus.com)