



Presented by

Morgan Troedsson

Market and Sales Manager
NDT, Polymers & Composites
FORCE Technology

Automated ultrasonic field inspection on aircrafts with CFRP composite structure

- Development trends in aerospace
Aircraft material breakdown
- P-scan
Automated scanners
- From manual to automated inspection
Case: ATR72 inspection
- Conclusions



Advanced engineering materials

- Aluminium alloys
- Fibre Metal laminates
- Carbon Fibre composites

(Al, Li, Ti)

(Glare[®], TiGr[®])

(CFRP)

Structure material breakdown

CFRP in aircrafts:

- Vertical Tail Plane
- Horizontal Tail Plane
- Pressure Bulkhead
- Rear Fuselage Tail Cone
- Landing Gear Doors
- Centre Wing Box
- Wing Skin Panels, Up & Down
- Complete Main Wing Assembly
- Winded Fuselage Sections



Courtesy: Airbus



Courtesy: Boeing

CFRP composites in aircrafts



Courtesy: Airbus



Courtesy: Boeing

- Light-weight design -> CFRP
- Different assembly technology
- Stiff and strong, but sensitive to impact
- More inspection in MRO procedures
- SRM requires fine grid inspection
- Automated ultrasonic scanners

With present aircraft fleet:

- Traditional manual NDT methods:

- Visual inspection
- Magnetic particle
- Eddy current
- Ultrasonic

(A-scan)

- Automated NDT methods:

- X-ray transmission
- Ultrasonic inspection
on CFRP composites

(C-scan)

(P-scan)

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P-scan System 4

A commercially available NDT control system
with graphic interface for 3-D interpretation
full scanner control with precise positioning
adaptable to any kind of transducer for inspection
of anisotropic as well as isotropic materials

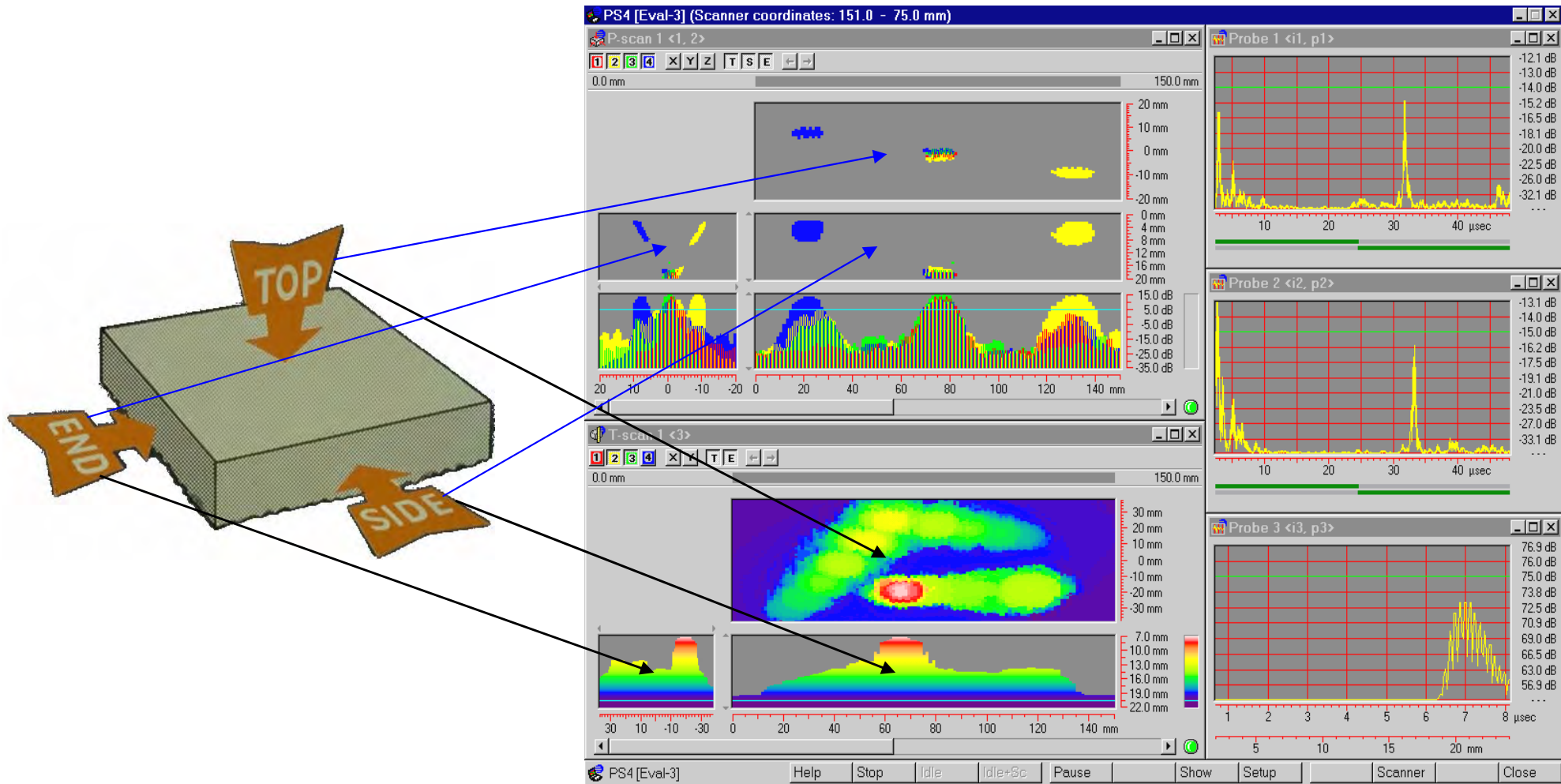
P-scan System 4



High performance automated ultrasonic inspection system

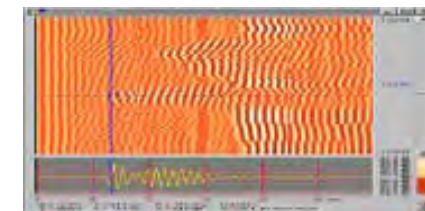
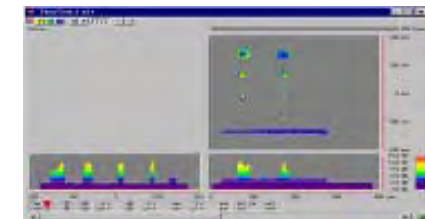
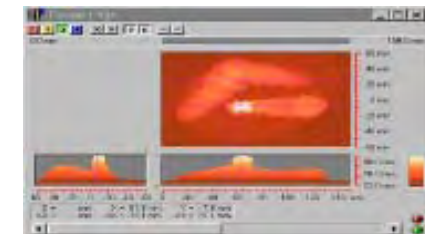
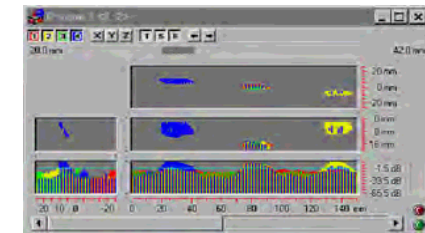
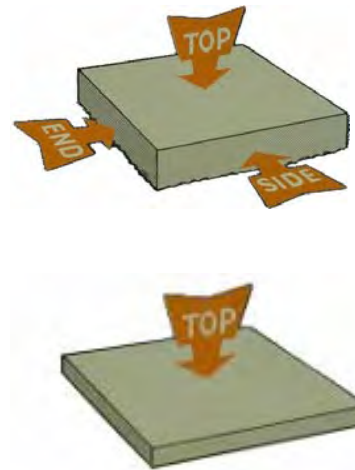


P-scan imaging



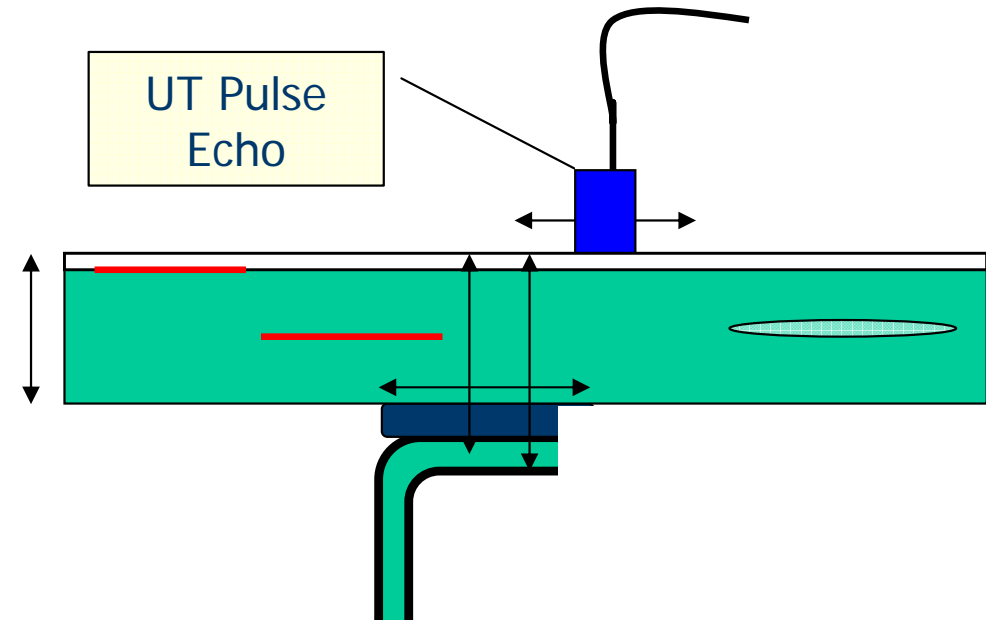
Inspection Types

- P-scan for composite structure inspection
- P-scan for weld inspection
- T-scan for erosion mapping
- T-scan for surface coating inspection
- Transmission scan for composite sandwich testing
- Full A-scan recording for off-line processing



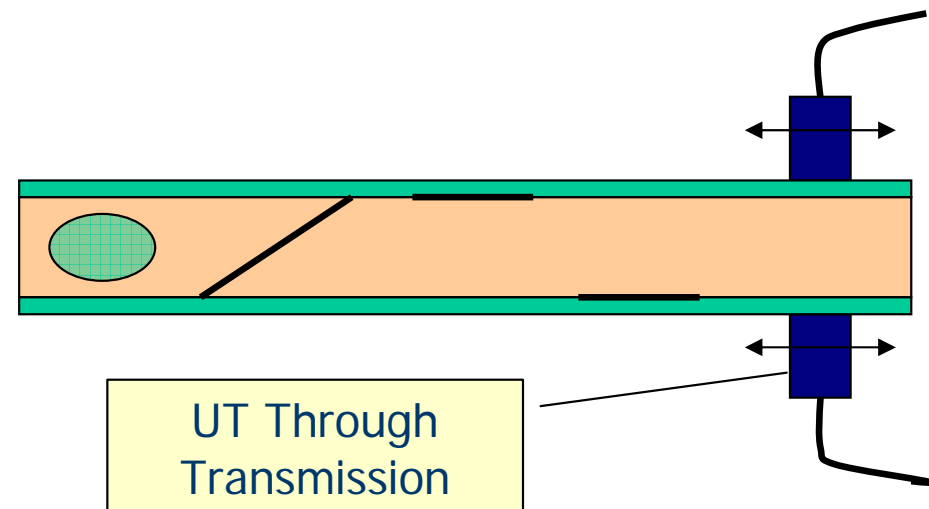
Laminates with stringers:

- Delaminations
- Dry areas (*porosity*)
- Dry bond line
- Missing cohesion (*kissing bond*)
- Thickness estimation
- Missing layers in laminate

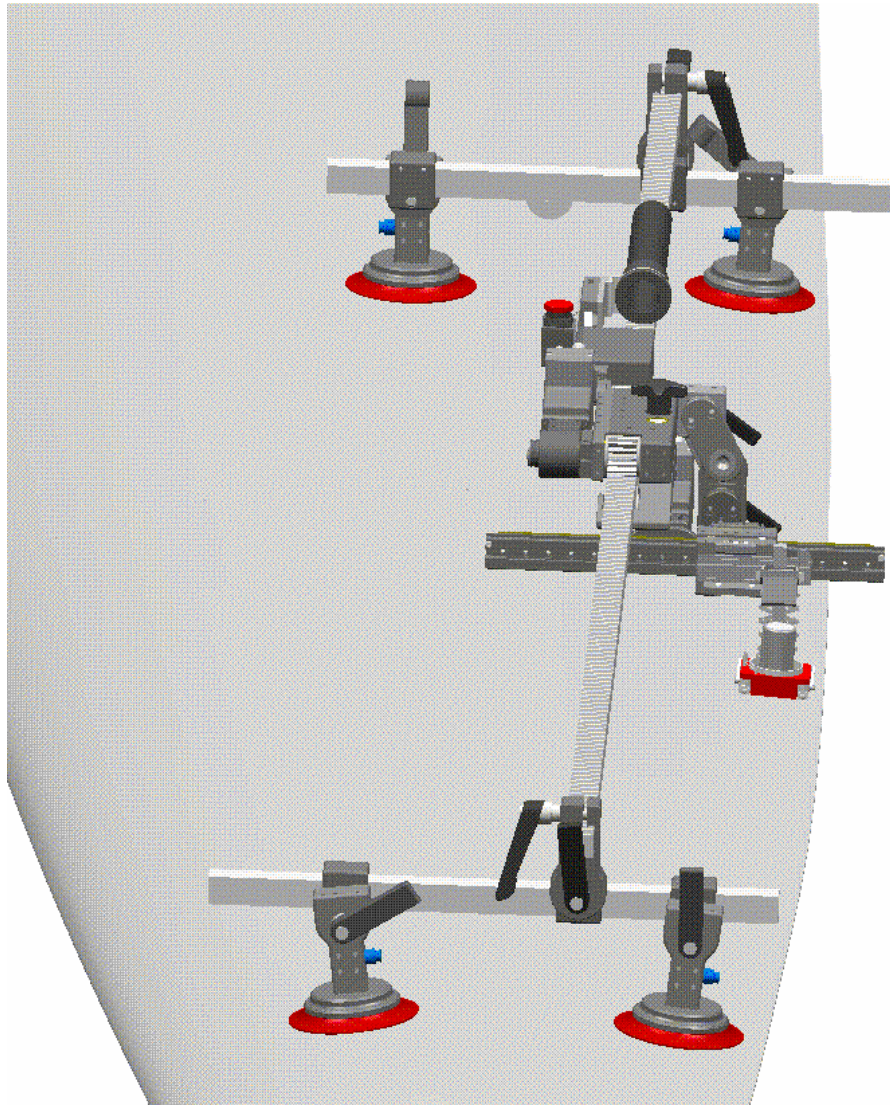


Sandwich structure:

- Core splicing during assembly
- Skin debonded from core
- Dry bond line
- Thickness estimation
- Cracks and voids in core



Automated Track Scanners



- Portable lightweight design
- True scanner movement
- Accurate positioning
- X-Y encoders
- Multi-channel operation
- Smart and universal
- Modular concept
- True positioning of defects in 3-D projection view

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From manual to automated inspection



Intercontinental jumbo-jets and twin-isle aircrafts shift towards advanced materials for their primary structure

- 60 %

Airbus
Boeing

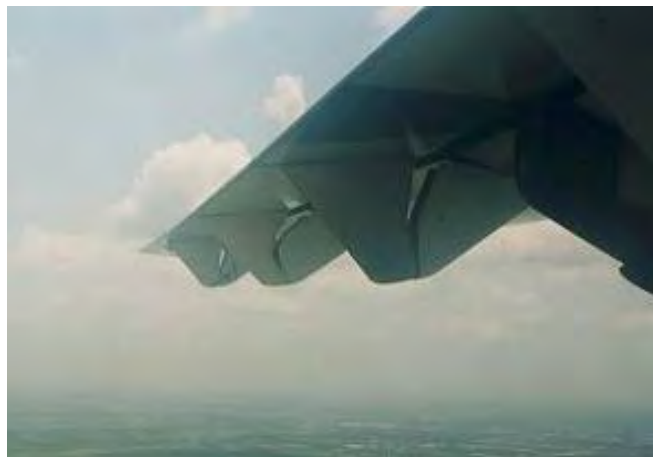
Commercial regional aircrafts are applying CFRP composites for some structural components

~10 %

Embraer
Bombardier
Dassault
ATR

CASE: Inspection on ATR72

ATR72



- Some wing panels in CFRP
- Fine grid UT inspection required (SRM)
- Tedious manual inspection
- Rational automated inspection
- Request to Type Certificate Holder (ATR)

CASE: Inspection on ATR72

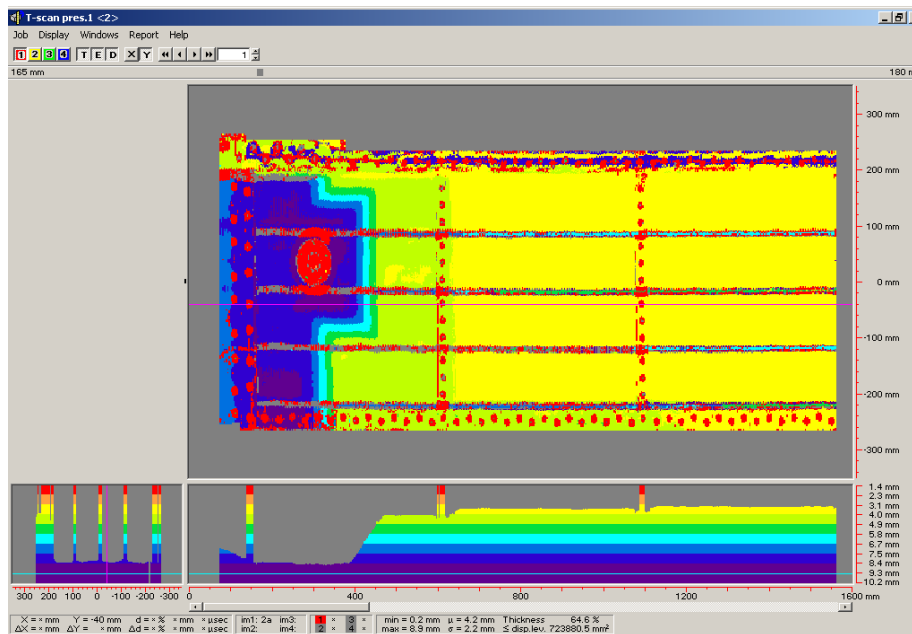


FORCE Track Scanner in operation on an ATR72 aircraft during in-service inspection (MRO) at Cimber Air Maintenance Centre

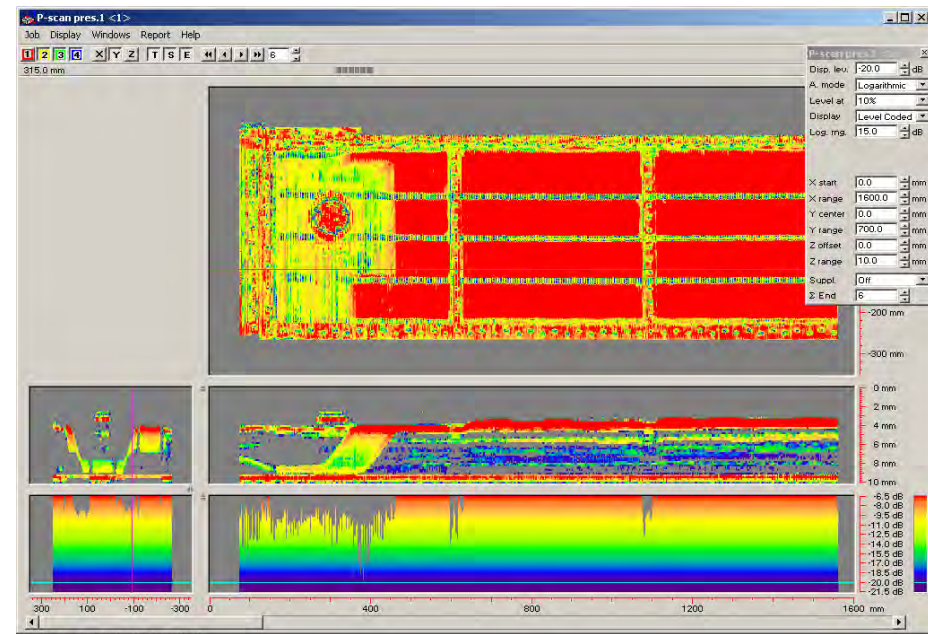
CASE: Inspection on ATR72



Rear upper panel between rib 14 and rib 17



T-scan Mode



P-scan Mode

Resolution

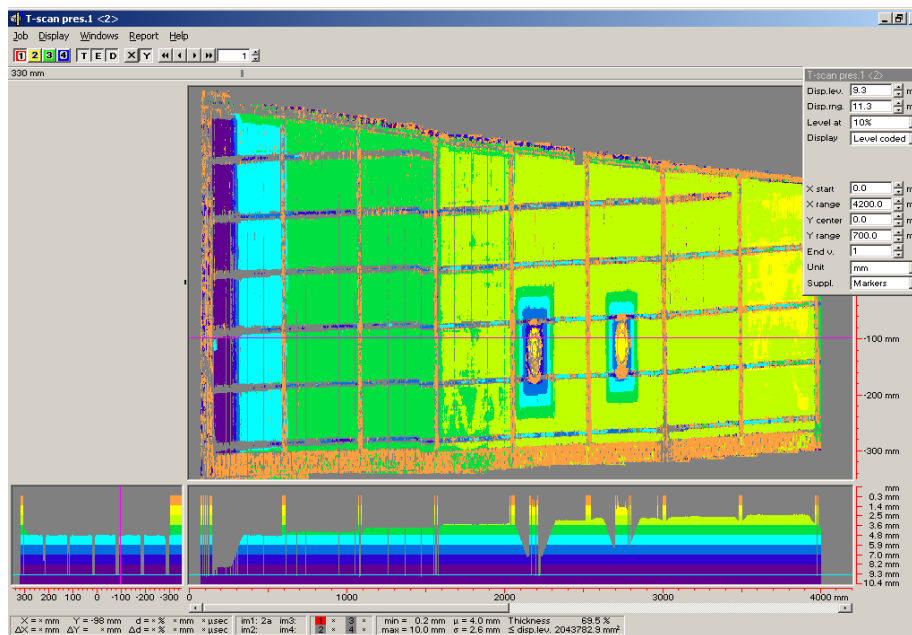
Lateral: $\pm 0,1$ mm

Size: $\pm 0,1$ mm

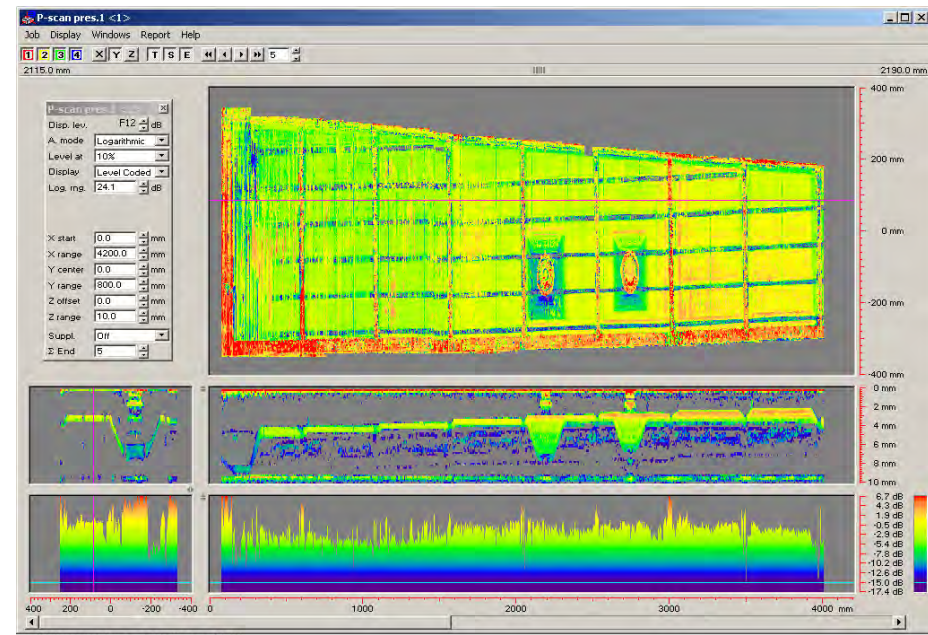
Depth: each individual ply

CASE: Inspection on ATR72

Forward upper panel between rib 14 and rib 22



T-scan Mode



P-scan Mode

Resolution

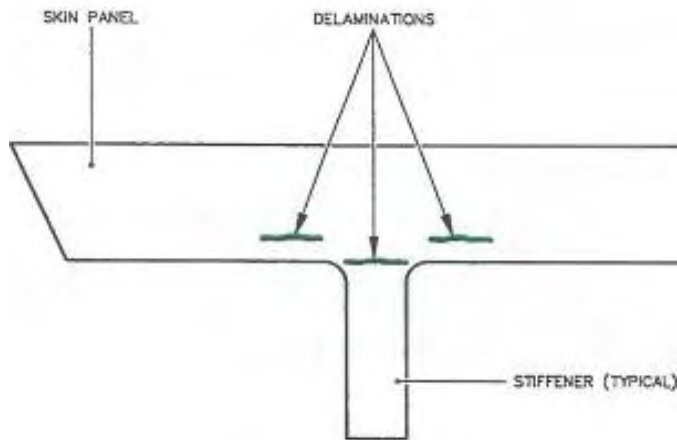
Lateral: ± 0,1 mm

Size: ± 0,1 mm

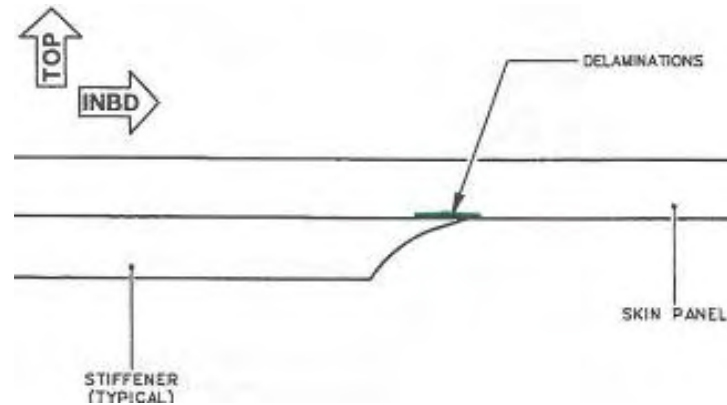
Depth: each individual ply

CASE: Inspection on ATR72

Possible defect types on CFRP wing stringer panels



Intralaminar delaminations
at T-stringer section



Delamination at
T-stringer end

1. Truly **portable** scanner equipment, easy to transport and to assemble at inspection site.
2. Easy **interpretation** of inspection result through an attractive 3-D graphic presentation.
3. Wide dynamic range with powerful UT Transducers, offering deep **penetration** into CFRP structure.
4. Strong NDT **documentation** for Quality Assurance, compared with manual UT.
5. Track Scanners dedicated to different geometries may be derived from the present **Modular** block concept.

Novel aircraft design



Courtesy: Airbus

1. FORCE successfully demonstrated some features with automated in-service inspection on aircrafts.
2. Approval from Type Certificate Holder is needed.
3. Specially applicable to aircrafts of tomorrow, with large scale implementations using advanced engineering materials.
4. Dedicated Track Scanners may be derived from the present Modular block concept.

Acknowledgements



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Authors:

P Nielsen, E Bahl Poulsen,
J Rusborg, M Troedsson

