





Content of Presentation



- Product lines
- Shearography principle
- Materials to be inspected
- Defects to be found typically
- Applications
- Systems
- References
- Summary



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Products for Aerospace Applications



3D Scanners:

- Geometry (COMET & T-SCAN):
 - Compare (CAD data)
 - Measure
 - Distance
 - Radius

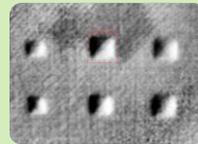


- Shearography NDT (ISIS)

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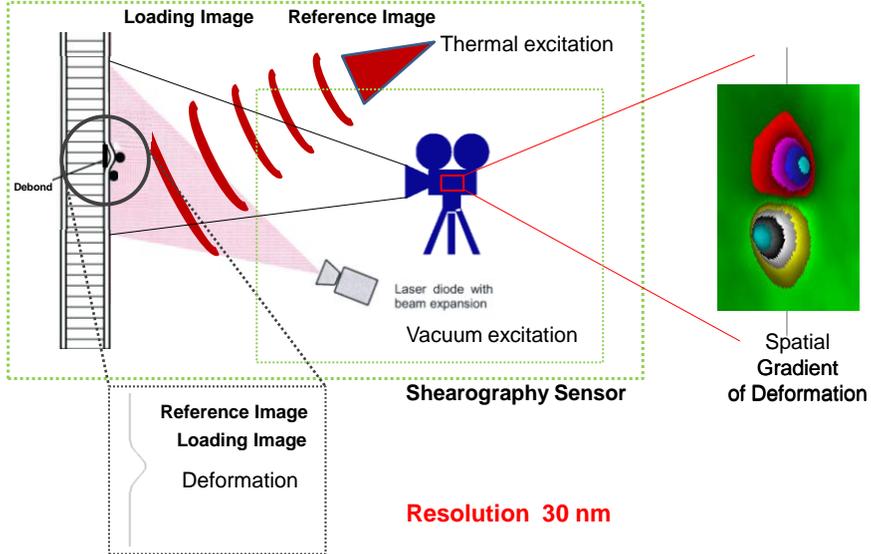


- **NEW** approach to NDT: Shearography (ST) method
- Enables **Non-contact inspection**
- Delivers **Full-field results**
 - 1.4 Million datapoints
- **Very Fast** method
 - Image was obtained in 10s
- Included into international inspection standards:
 - **NAS 410/ EN4179 (ST)** training & certification standard
 - **ASNT SNT-TC-1A** (Visual and optical testing procedure)
 - **ASTM E 2581-07** (Standard practice of Shearography for composites & aerospace applications)





Technical Basics – Shearographic Principle

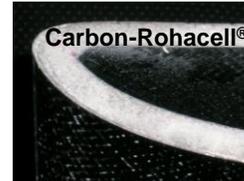
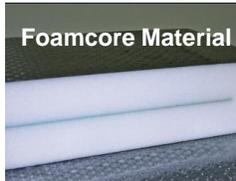
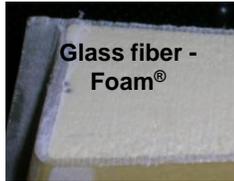


Fields of Application





Materials To Be Inspected



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Defects To Be Found Typically



- Debondings
- Delaminations
- Cracks
- Impacts, Dents, BVID's
- Tooldrop impacts
- Failed repair areas
- Wrinkles, Waves
- Inclusions:
 - Air, Water, Foil
 - Foreign Material (FOD)

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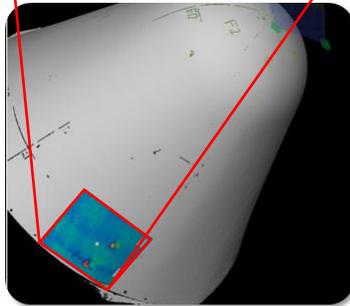
C-130 Hercules

- Inspection of CFRP/ GRP nose
- Detection of delaminations
- Matching results with 3D-CAD data





C-130 Hercules



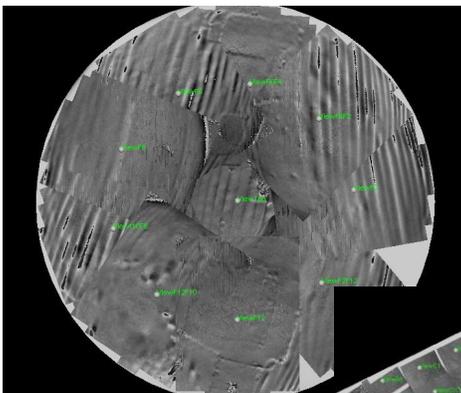
- Detection of two laminate debonds
- Merging and matching of results with imported 3D CAD data



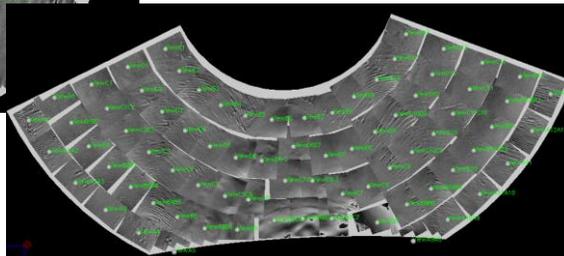
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C-130 Hercules



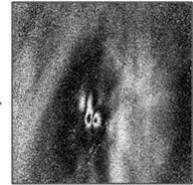
- 100% documentation
- Complete stitching of results



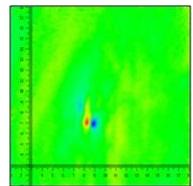
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NDT on Tornado



real-time image

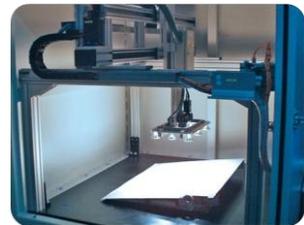


test result

- Shearography inspection on Tornado hull
- Time saving full-field inspection method necessary in maintenance for detection of dents and impacts



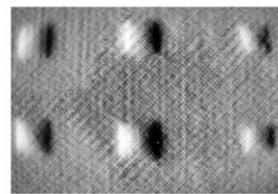
Acoustic liner material



Full automatic testing by stationary unit

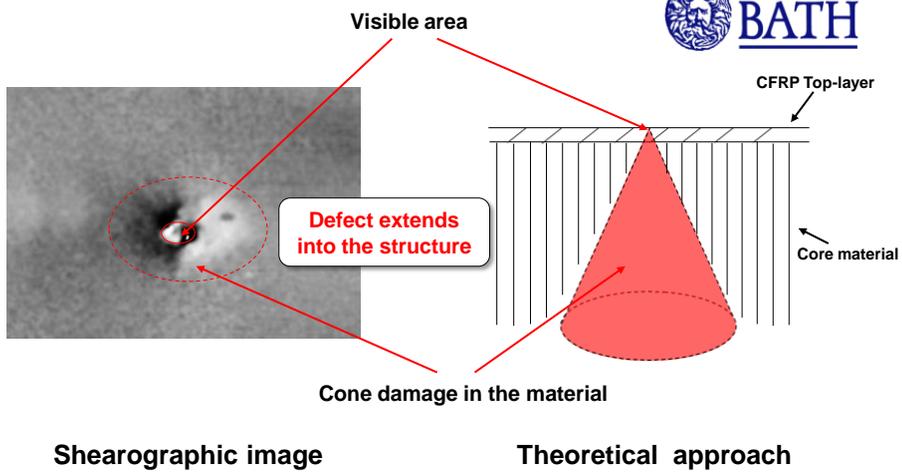


Acoustic liner material:
Detection of
laminated-honeycomb
core defects





- Barely visible impact damages on a stringer panel
- Inspection of impact
- Damage assessment of surrounding area



Barely visible impact damages

steinbichler

UNIVERSITY OF BATH

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NDT on UAV Wing

steinbichler

- NDT on UAV wing
- Shearography enables fastest inspection procedure
- Defect detection with thermal excitation

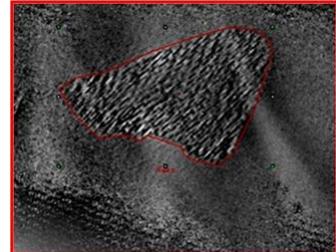
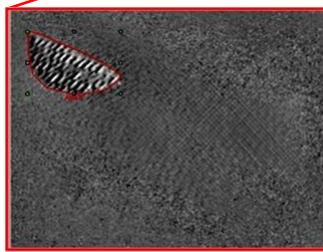
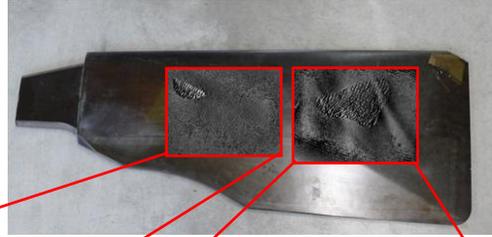
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NDT on Drone Wing



- Two fields of dry fibres were detected
- Flaws not visible
- Easy localization of defects



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Nitrogen Satellite Tank



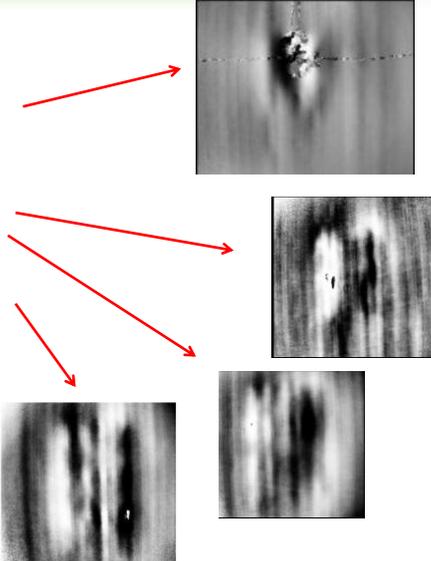
- Set-up: Optical Shearography NDT System (ISIS1100)
- Tank measurement on cylindrical and dome area
- Detection of artificial inserts
- Radome area stiffer than cylindrical area

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Cylindrical area defects







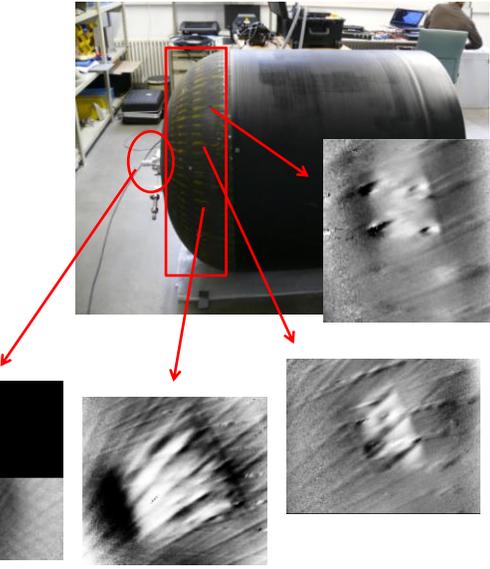
- Cylindrical area inspected
- All 4 defects found
- Defects of inserts in CFRP
- Thermal excitation of 4s

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Radome area defects







- Thermal excitation 5s
- All 4 defects found

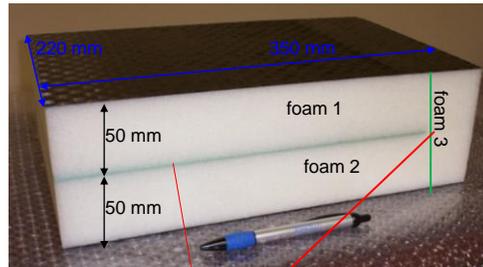
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Shearography on Rohacell material



- NDT of ROHACELL® material
- Thermal excitation
- Testing time less than 15 seconds
- Carbon top skin
- Adhesive layers

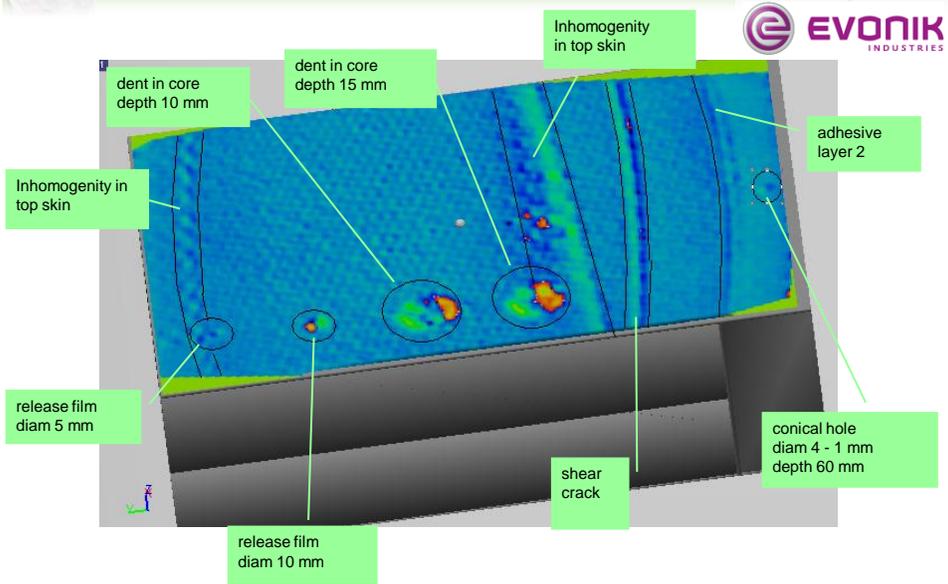


- Material is used for :
 - Body panels of Boeing's Delta II, III & IV rockets
 - Stringer structures in the pressure bulkheads of the Airbus A380/ A340
 - Helicopter applications as main and tail rotor blades and fuselage panels

adhesive layers



Shearography on Rohacell material





Composite Vessel Testing



- Composite pressure vessel
- Breathing tank demonstrator
- Type 4, 6,8 l
- Drop tests according to norm EN12245:2002 (D)
- Loaded via internal pressure
- Sensor in pressure chamber



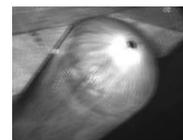
27



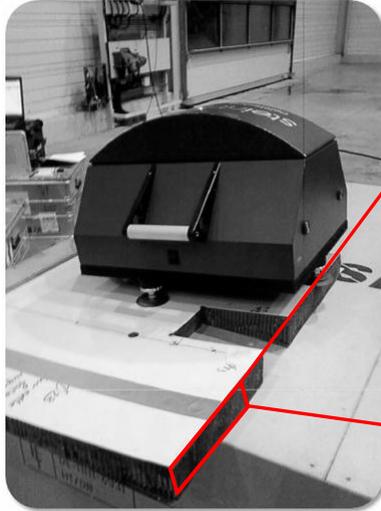
Composite Vessel Testing



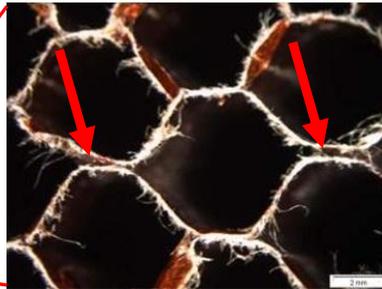
- Defects found on all impacted areas
- Pressure variation for detection (0,5 Bar)
- Analysis shows metric of defects
- Results transferable to other tank designs



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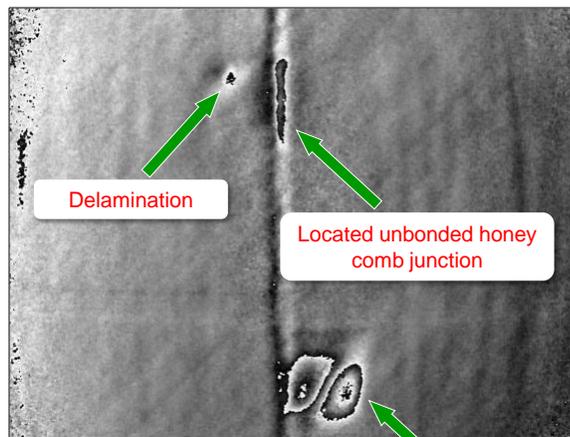
« Performing technical evaluation of shearography to inspect sandwich structures after assembly »



ISISmobile 3000 on thick sandwich structures at Airbus in Toulouse



by courtesy of Airbus Toulouse



by courtesy of Airbus Toulouse

Delamination



Measuring head

Top layer

Core

Bottom layer

Separations

Field of View (FOV)

Sector 2

Sector 1

Delaminations on back side

AIRBUS

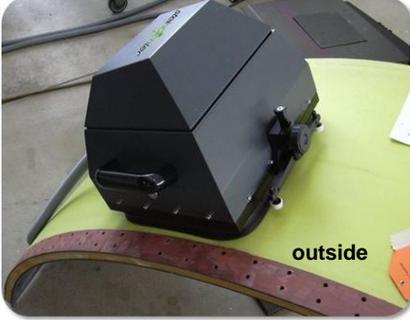
by courtesy of Airbus Bremen



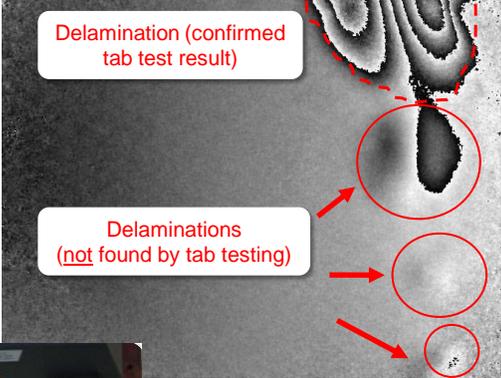
Stringer delamination – difference of stiffness visible

Delaminations

Aircraft Engine Cover steinbichler



outside



Delamination (confirmed tab test result)

Delaminations (not found by tab testing)



inside

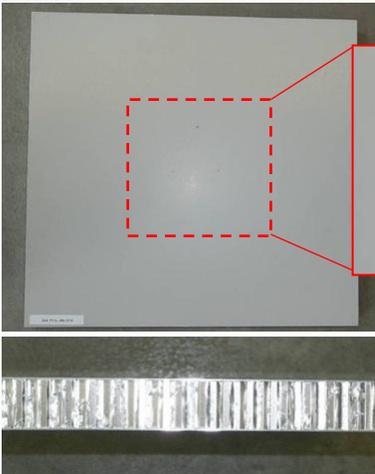


found with tap test

- One shot > 4 results
- Thermal loading
- Field of view: A4 paper size

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Aluminium Honeycomb steinbichler



Impact
(7 mm depth with sphere 32 mm diameter)

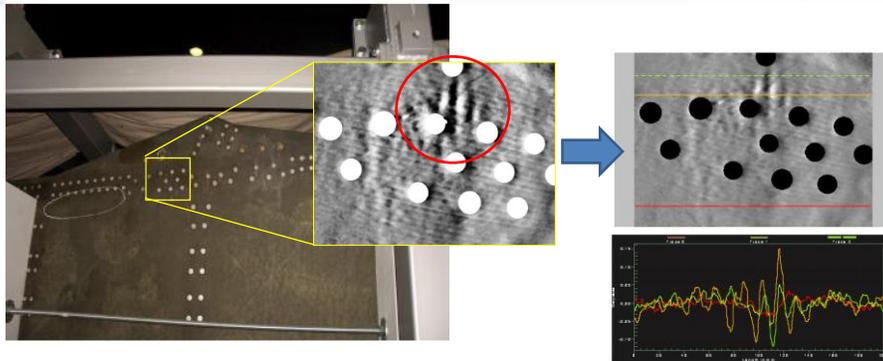
Delamination: Top Layer - Core
(25 mm diameter, depth 25 mm)

Delamination: Core - Rear Layer
(30 mm diameter, depth 12 mm)

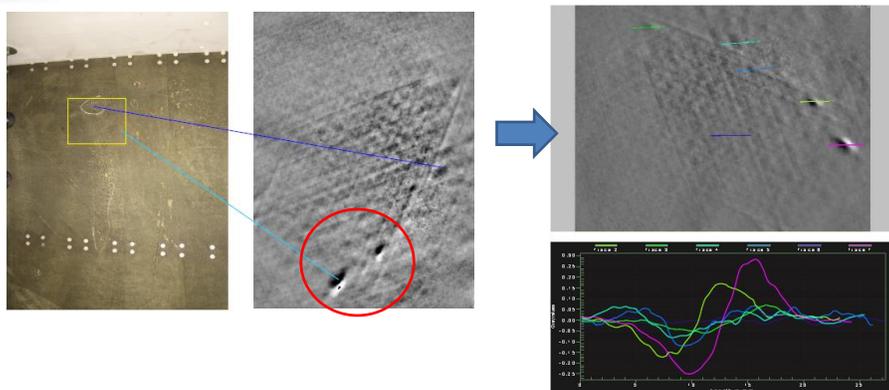


Detection of artificially induced defects on backside with ISISmobile 3100

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- NDI of wing box panel
- Wrinkles detected by Shearography
- Section analysis shows cut wrinkle details



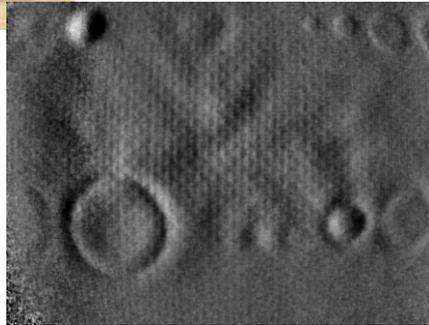
- NDI of wing box panel
- Delaminations and linear anomalies detected by Shearography
- Section analysis shows delamination details



Carbon Nomex Fuselage Material



- Fuselage material
- Artificially induced defects
- Defects displayed in right image
- Image below: side view of material



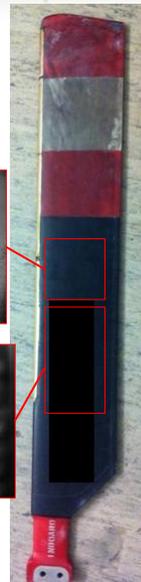
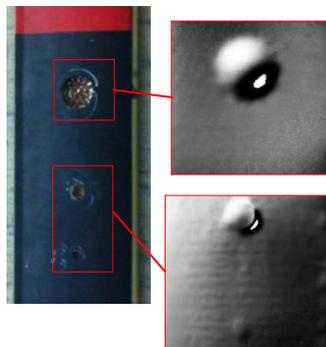
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Shearography on helicopter tail rotor blade



Backside



- Helicopter tail rotor blade
- Artificially induced drillings (50mm, 20mm, 10mm)
- Delams simulated
- Found defects displayed on the right side

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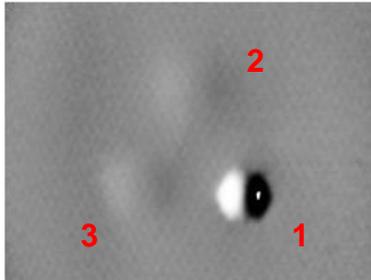


Aluminium Honeycomb

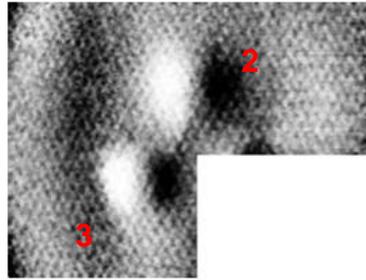


Vacuum excitation (Δ 40 mbar)

- 1: Delamination Top Layer – Core Impact
- 2: Impact
- 3: Delamination Core - Rear Layer



Unscaled result image

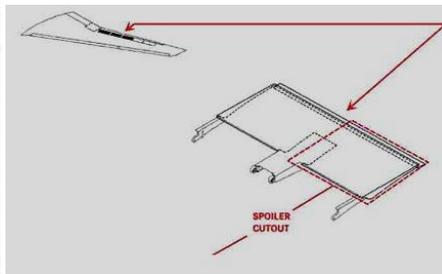


Scaled result image

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Delaminations on Spoiler

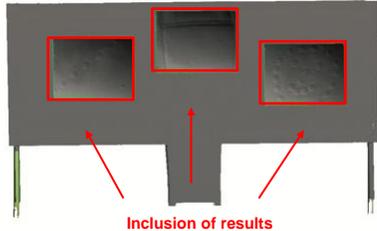


- Scanning of complete spoiler
- Detection of delaminations on composite material
- Comparison between ultrasonic and shearography

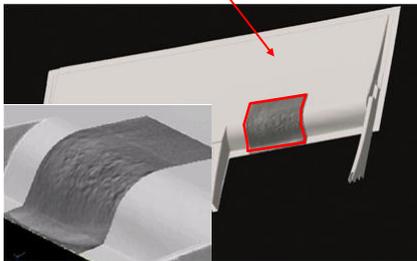




Delaminations on Spoiler



Inclusion of results



- Automatic inclusion of results into report and CAD data
- Comparison of scanning time:
(complete spoiler scanned)

Ultrasonic approx. 1 hour

Shearography approx. 5 minutes

AIRBUS by courtesy of Airbus Bremen, Mr. Scherling

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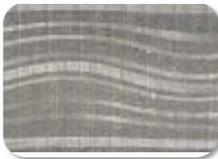


GKN – NDT on Wrinkles

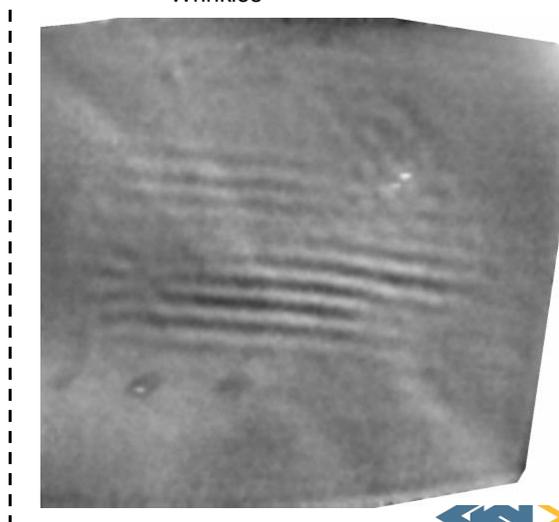
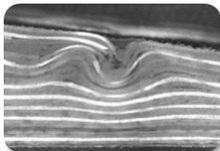


Wrinkles

wave



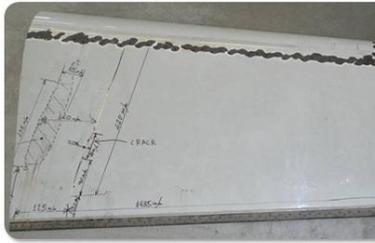
wrinkle



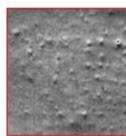
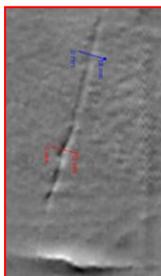
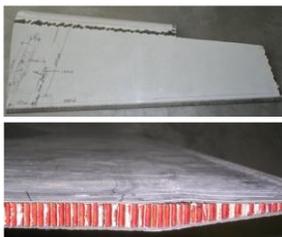
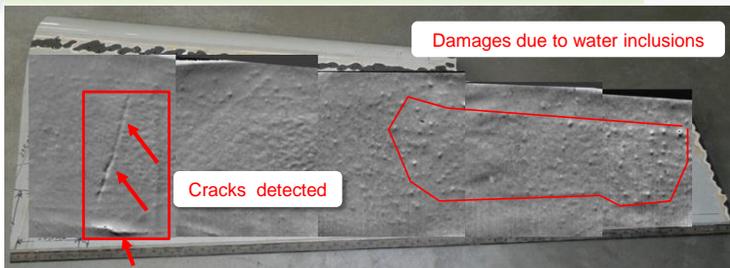
by courtesy of

GKN GKN AEROSPACE
GKN AEROSPACE GmbH

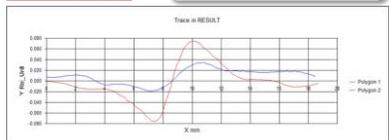
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- Inspection of wing section cut
- Detection of delaminations due to water inclusions and cracks



Amplitude comparison of cracks

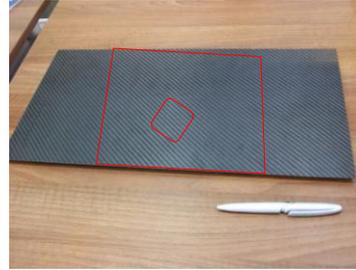




Kissing bond NDT



- NDT of a Kissing Bond
- CFRP top-layer foam core material
- First approach with demonstrator material for in-field detection
- Artificially prepared with foil insert before lamination



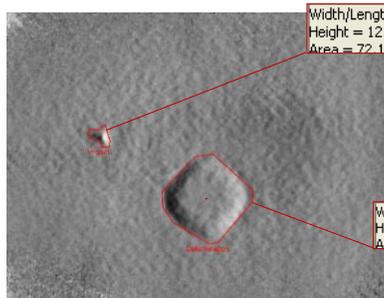
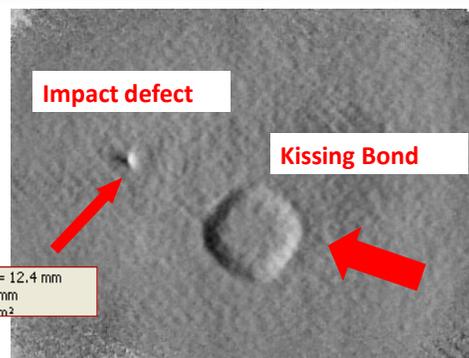
45



Kissing bond NDT



- Kissing Bond detected
- Thermal excitation (1s)
- Impact detected
- Result within 10s obtained



Kissing Bond is defined as a bonded area with only 10% of mechanical properties

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System for non-contact NDT:

- Portable System
- Flexible
- Easy to use
- On tripod
- Compact Electronic
- Adjustable to various tasks
- Easy upgradable





Modularity of ISIS Systems



Sensors

Electronic Unit



ISIS 3100

ISIS 3010



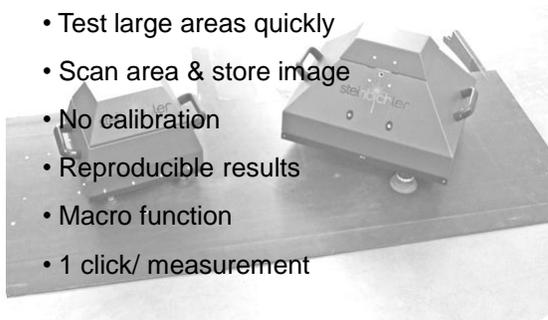
Hood systems – Two Inspection Sizes



Industrial solutions

AOI:
A4 Paper Size

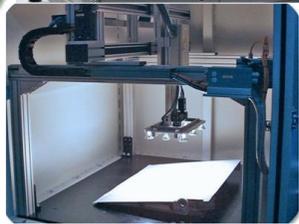
Excitation:
Heat & Vacuum



- Test large areas quickly
- Scan area & store image
- No calibration
- Reproducible results
- Macro function
- 1 click/ measurement

AOI:
A3 Paper Size

Excitation:
Heat



- Robot solutions
- Stationary units (x,y,z axis rail)

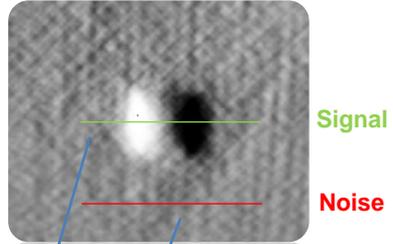
100 % Automation

- From qualitative Testing...
...**quantitative** Evaluation
- Numerical data export as csv
- Enables postprocessing in
xls, Matlab, etc.

out1	Phase1	out2	Phase2
295.823	-0.00981918	618.798	-0.0120242
297.436	-0.00981918	617.778	-0.0120242
299.050	-0.00981918	616.758	-0.0120242
300.664	-0.00981918	615.738	-0.0120242
302.278	-0.00981918	614.718	-0.0120242
303.892	-0.00981918	613.698	-0.0120242
305.506	-0.00981918	612.678	-0.0120242
307.120	-0.00981918	611.658	-0.0120242
308.734	-0.00981918	610.638	-0.0120242
310.348	-0.00981918	609.618	-0.0120242
311.962	-0.00981918	608.598	-0.0120242
313.576	-0.00981918	607.578	-0.0120242
315.190	-0.00981918	606.558	-0.0120242
316.804	-0.00981918	605.538	-0.0120242
318.418	-0.00981918	604.518	-0.0120242
320.032	-0.00981918	603.498	-0.0120242
321.646	-0.00981918	602.478	-0.0120242
323.260	-0.00981918	601.458	-0.0120242
324.874	-0.00981918	600.438	-0.0120242
326.488	-0.00981918	599.418	-0.0120242
328.102	-0.00981918	598.398	-0.0120242
329.716	-0.00981918	597.378	-0.0120242
331.330	-0.00981918	596.358	-0.0120242
332.944	-0.00981918	595.338	-0.0120242
334.558	-0.00981918	594.318	-0.0120242
336.172	-0.00981918	593.298	-0.0120242
337.786	-0.00981918	592.278	-0.0120242
339.400	-0.00981918	591.258	-0.0120242
341.014	-0.00981918	590.238	-0.0120242
342.628	-0.00981918	589.218	-0.0120242
344.242	-0.00981918	588.198	-0.0120242
345.856	-0.00981918	587.178	-0.0120242
347.470	-0.00981918	586.158	-0.0120242
349.084	-0.00981918	585.138	-0.0120242
350.698	-0.00981918	584.118	-0.0120242
352.312	-0.00981918	583.098	-0.0120242
353.926	-0.00981918	582.078	-0.0120242
355.540	-0.00981918	581.058	-0.0120242
357.154	-0.00981918	580.038	-0.0120242
358.768	-0.00981918	579.018	-0.0120242
360.382	-0.00981918	577.998	-0.0120242
362.000	-0.00981918	576.978	-0.0120242
363.614	-0.00981918	575.958	-0.0120242
365.228	-0.00981918	574.938	-0.0120242
366.842	-0.00981918	573.918	-0.0120242
368.456	-0.00981918	572.898	-0.0120242
370.070	-0.00981918	571.878	-0.0120242
371.684	-0.00981918	570.858	-0.0120242
373.298	-0.00981918	569.838	-0.0120242
374.912	-0.00981918	568.818	-0.0120242
376.526	-0.00981918	567.798	-0.0120242
378.140	-0.00981918	566.778	-0.0120242
379.754	-0.00981918	565.758	-0.0120242
381.368	-0.00981918	564.738	-0.0120242
382.982	-0.00981918	563.718	-0.0120242
384.596	-0.00981918	562.698	-0.0120242
386.210	-0.00981918	561.678	-0.0120242
387.824	-0.00981918	560.658	-0.0120242
389.438	-0.00981918	559.638	-0.0120242
391.052	-0.00981918	558.618	-0.0120242
392.666	-0.00981918	557.598	-0.0120242
394.280	-0.00981918	556.578	-0.0120242
395.894	-0.00981918	555.558	-0.0120242
397.508	-0.00981918	554.538	-0.0120242
399.122	-0.00981918	553.518	-0.0120242
400.736	-0.00981918	552.498	-0.0120242
402.350	-0.00981918	551.478	-0.0120242
403.964	-0.00981918	550.458	-0.0120242
405.578	-0.00981918	549.438	-0.0120242
407.192	-0.00981918	548.418	-0.0120242
408.806	-0.00981918	547.398	-0.0120242
410.420	-0.00981918	546.378	-0.0120242
412.034	-0.00981918	545.358	-0.0120242
413.648	-0.00981918	544.338	-0.0120242
415.262	-0.00981918	543.318	-0.0120242
416.876	-0.00981918	542.298	-0.0120242
418.490	-0.00981918	541.278	-0.0120242
420.104	-0.00981918	540.258	-0.0120242
421.718	-0.00981918	539.238	-0.0120242
423.332	-0.00981918	538.218	-0.0120242
424.946	-0.00981918	537.198	-0.0120242
426.560	-0.00981918	536.178	-0.0120242
428.174	-0.00981918	535.158	-0.0120242
429.788	-0.00981918	534.138	-0.0120242
431.402	-0.00981918	533.118	-0.0120242
433.016	-0.00981918	532.098	-0.0120242
434.630	-0.00981918	531.078	-0.0120242
436.244	-0.00981918	530.058	-0.0120242
437.858	-0.00981918	529.038	-0.0120242
439.472	-0.00981918	528.018	-0.0120242
441.086	-0.00981918	526.998	-0.0120242
442.700	-0.00981918	525.978	-0.0120242
444.314	-0.00981918	524.958	-0.0120242
445.928	-0.00981918	523.938	-0.0120242
447.542	-0.00981918	522.918	-0.0120242
449.156	-0.00981918	521.898	-0.0120242
450.770	-0.00981918	520.878	-0.0120242
452.384	-0.00981918	519.858	-0.0120242
454.000	-0.00981918	518.838	-0.0120242
455.614	-0.00981918	517.818	-0.0120242
457.228	-0.00981918	516.798	-0.0120242
458.842	-0.00981918	515.778	-0.0120242
460.456	-0.00981918	514.758	-0.0120242
462.070	-0.00981918	513.738	-0.0120242
463.684	-0.00981918	512.718	-0.0120242
465.298	-0.00981918	511.698	-0.0120242
466.912	-0.00981918	510.678	-0.0120242
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470.140	-0.00981918	508.638	-0.0120242
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473.368	-0.00981918	506.598	-0.0120242
474.982	-0.00981918	505.578	-0.0120242
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478.210	-0.00981918	503.538	-0.0120242
479.824	-0.00981918	502.518	-0.0120242
481.438	-0.00981918	501.498	-0.0120242
483.052	-0.00981918	500.478	-0.0120242
484.666	-0.00981918	499.458	-0.0120242
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605.718	-0.00981918	422.958	-0.0120242
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613.788	-0.00981918	417.858	-0.0120242
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618.630	-0.00981918	414.798	-0.0120242
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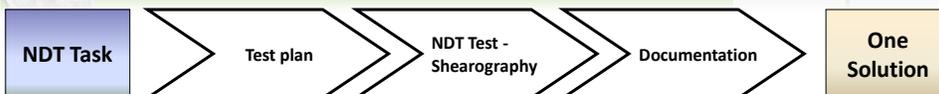
Signal to noise ratio (SNR) steinbichler

- Signal to noise ratio (SNR)
- Numerical values
- Indication of quality to NDT staff
- Direct comparison to UT → **dB** values



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Documentation process chain steinbichler



100% Process chain



Sectors in test plan

Sectors on test

Automatic reporting

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Successful Cooperation with the Industry steinbichler



ISISmobile 3000 in operation at Airbus Hamburg



ISISmobile 3000 in operation at Airbus Toulouse

...for constant improvement of our products

References steinbichler



Summary



- **Non-Contact analysis**
- **Fast inspection**
- **Full-Field results**
- **Ideal for composite materials**
- **Numeric data export**
- **SNR**
- **Production & maintenance**



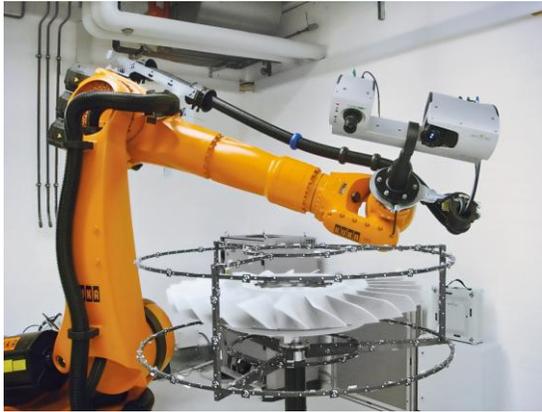
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Turbine Blade NDT in MRO

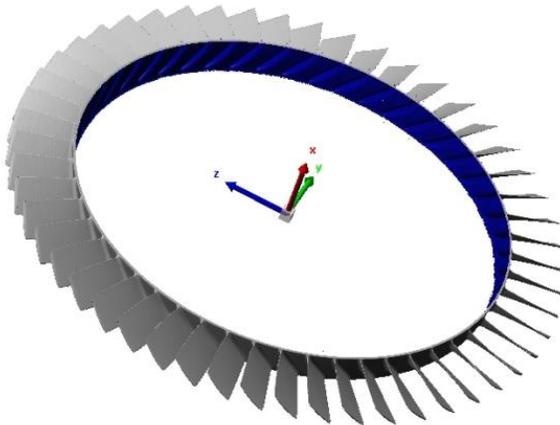


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Areas of use:

- Blade designers
- Blade manufacturers
- Turbine manufacturers
- Turbine & Blade MRO

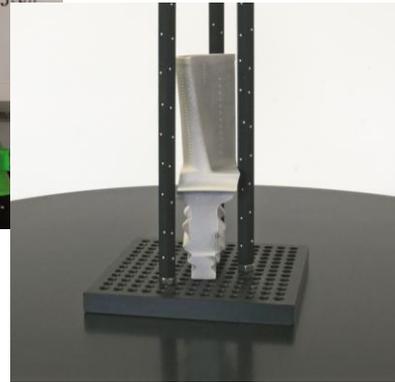


Results:

- 3D point cloud
- STL generation
- Result to CAD fit
 - Detection of abrasion
- Feature measurement
 - Length
 - Centre point
 - Angles
 - Radius



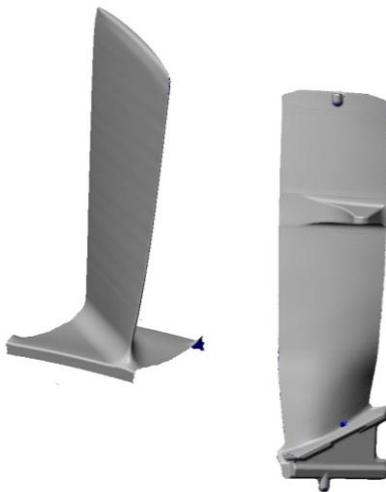
Single Blade Digitizing



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Single Blade Digitizing



Results:

- 3D point cloud
- STL generation
- Result to CAD fit
 - Detection of abrasion
- Feature measurement
 - Length
 - Centre point
 - Angles
 - Radius

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New approach:

- Mobile modular measuring cell with L3D 5M Digitizing Sensor

