

EADS INNOVATION WORKS

UT Laser dans l'aéronautique

Journée Technique CND sans contact - PRECEND

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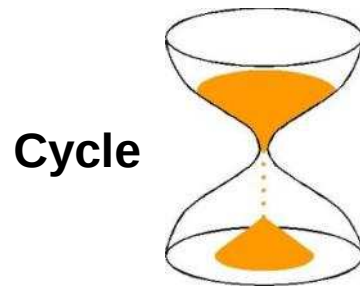
2013-05-16

Contenu

- Contexte
- Principes
- Specifications
- Axes de développements
- Exemples de pièces inspectées

Aeronautical context

Quality Control: A new challenge for NDT to face
of composite

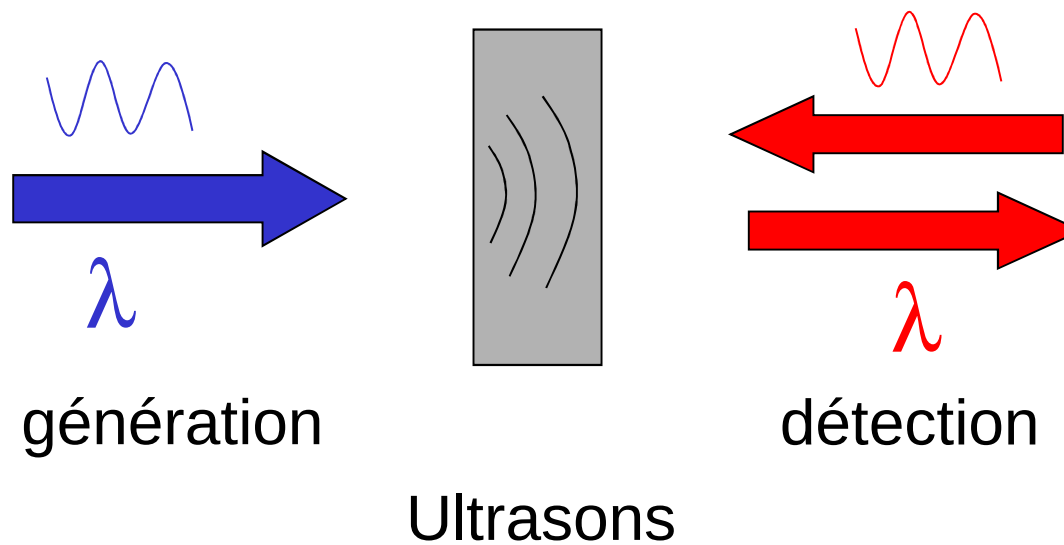


Recurring Costs
&
Non Recurring Costs



CFRP Increase → Huge Quantity m²
+
Structural Functions → Severe Criteria
=
STRONG NEED FOR AUTOMATION AND FLEXIBILITY

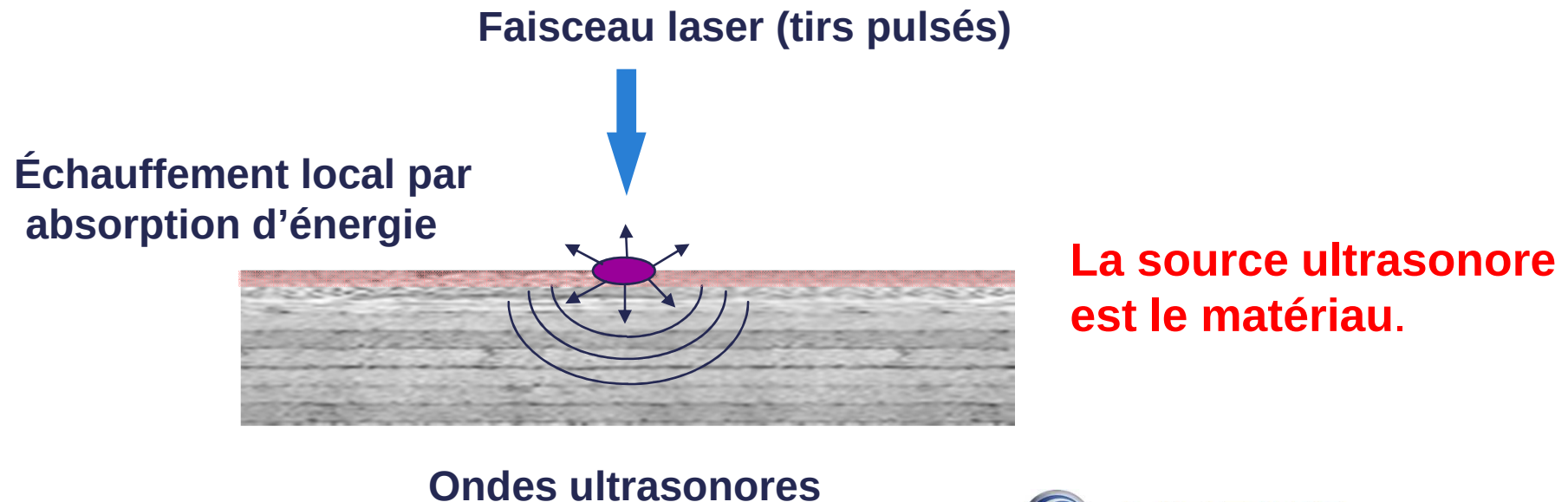
Principes du Laser-Ultrason



Mécanismes de génération

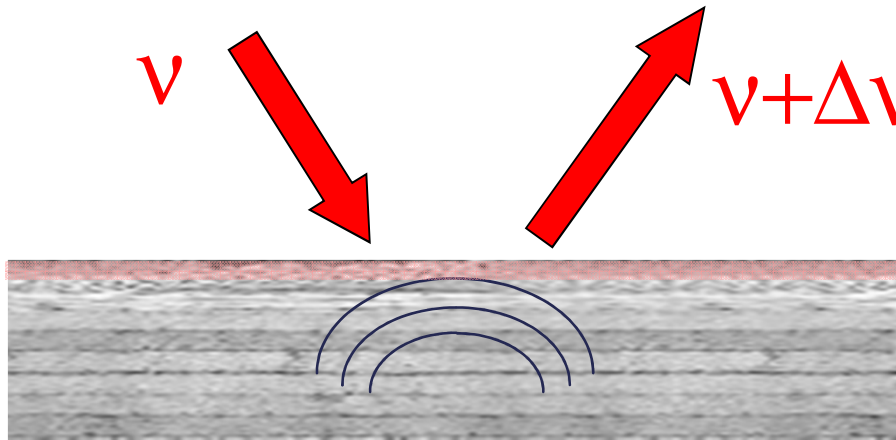
Interaction lumière-matière

- Régime thermoélastique (dilatation thermique)
- *Régime ablation (arrachement d'e-, plasma)*



Principe de la détection

Éclairage avec un laser long pulse ou cw



$$\text{Effet Doppler: } \Delta v = 2 \frac{v}{\lambda}$$

v: vitesse de déplacement de surface

Principe de la détection

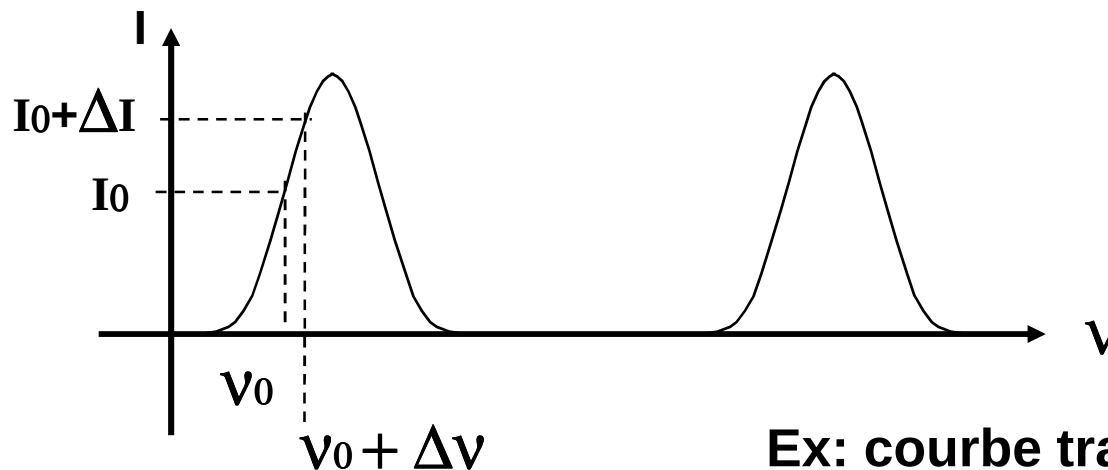
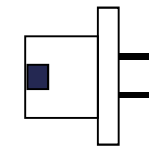
Interférométrie optique (michelson, Fabry-Pérot confocal, TWM)

Faisceau laser de détection

$\nu + \Delta\nu$



Photodétecteur



$$\Delta I = f(\Delta \nu)$$

Ex: courbe transmission Fabry-Perot

Laser ultrasonics technology

- PROS:
 - ✓ Less positioning constraints
 - ✓ Can access difficult positions
 - ✓ Suitable for large/complex parts
 - ✓ flexibility
 - ✓ No need of coupling
 - ✓ No manutention
 - ✓ No specific tools

- CONS:
 - ✓ Slower than classic ultrasonics
 - ✓ Surface condition constraints
 - ✓ Laser security issues

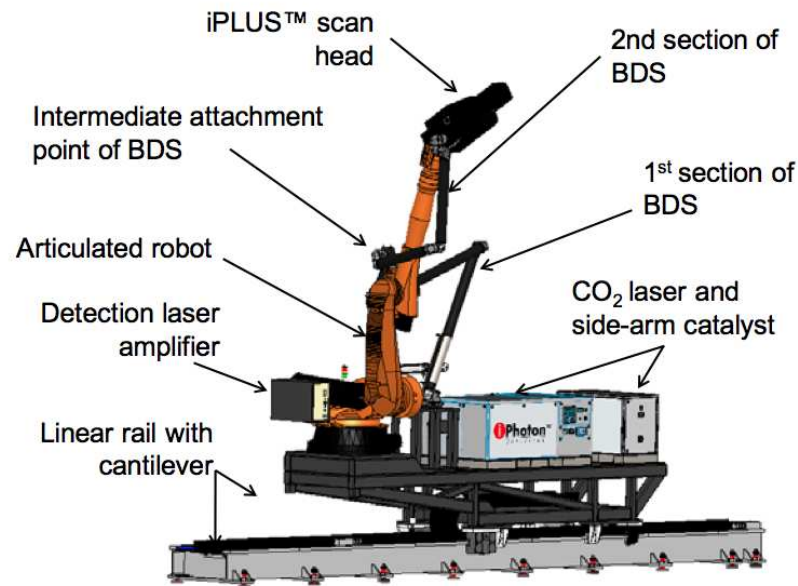
Le système LUIS (1994→...)



- Generation laser: CO2 (max: 270mJ), **180mJ**, 120ns, Ø5mm
- Detection laser: Nd:YAG (max: 60mJ), 60µs, Ø5mm
- Interferometer:
 - Confocal Fabry-Perot in Transmission [1-15MHz]
 - TWM interferometer [10kHz-15MHz]
- Digitizer: 14 bits, 50MS/s
- Repetition rate: 100Hz.
- Working distance: [1.2-2.1m]

1,4m²/h

Le système LUCIE (2011→...)



- Generation laser: CO₂ 270mJ, 100ns, Ø [3-15mm]
- Detection laser: Nd:YAG 160mJ, 230µs, Ø5mm
- Interferometer: Dual Confocal Fabry-Perot [0.1-15MHz]
- Digitizer: 14 bits, 50MS/s
- Repetition rate: 400Hz.
- Working distance: [1.6-2.1m]
- Robot KUKA KR210 L100
- Linear axis Güdel 6m



5,6m²/h

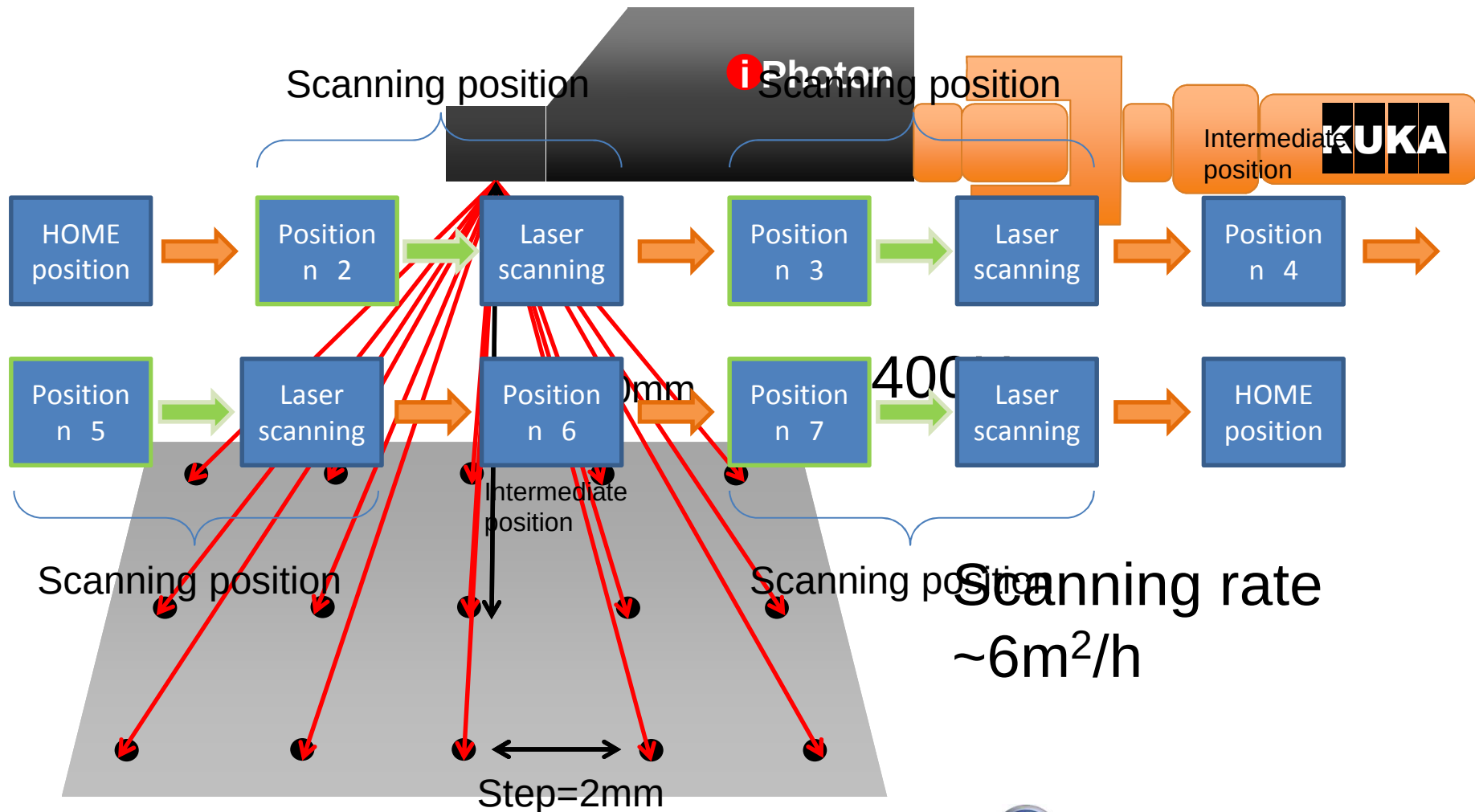
Nose Fuselage Demonstrator

System sized for NoFudem inspection

- Room size: 16m x 10m x 6m



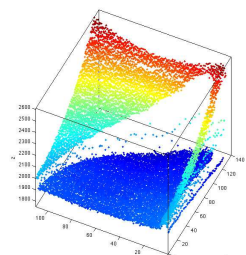
Scanning settings



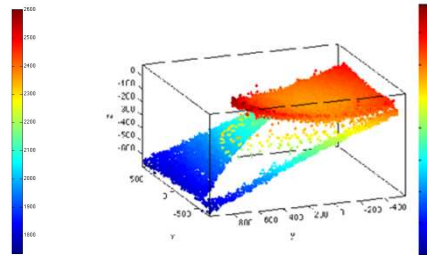
Axis of developments : 3D representation

- 3D Reconstruction

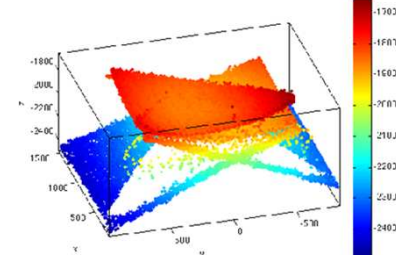
Example with double curvature panel



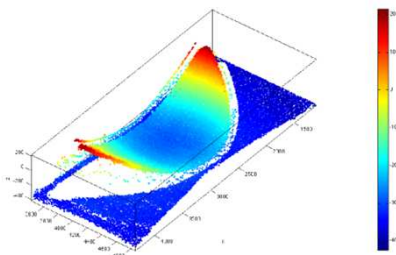
Raw data telemetry



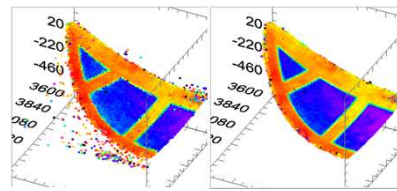
3D coordinates in the tool frame



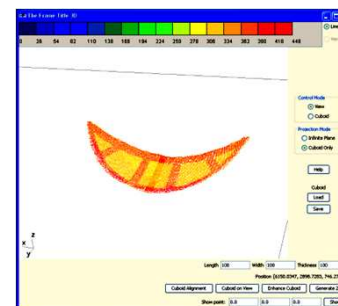
Two acquisitions in the same tool frame



Transformation of coordinates into World frame



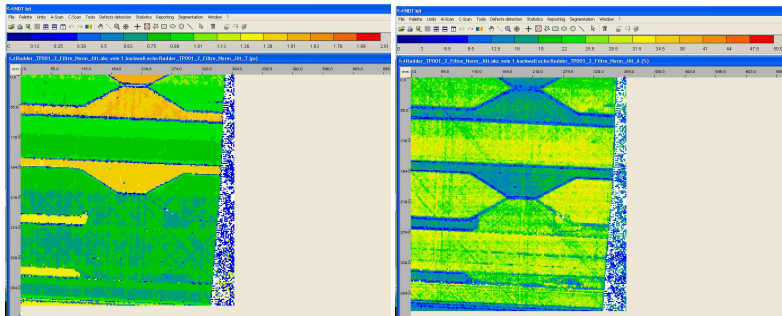
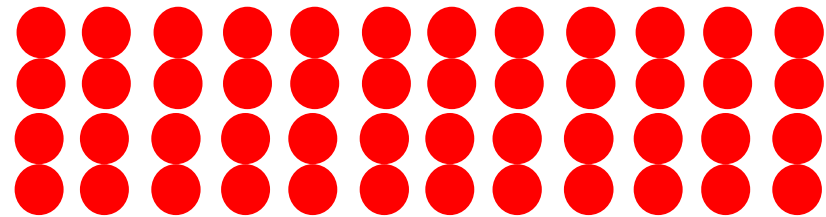
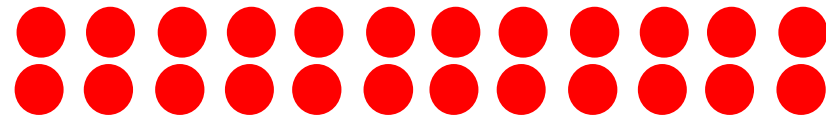
Spatial filtering to improve the signal



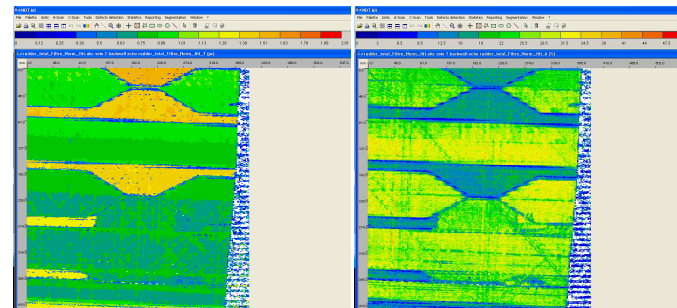
Export data to NDT-Kit analysis software

Axis of developments : Increase scanning speed

- Bi-spot technology implemented in LUIS: **Scanning speed X2**



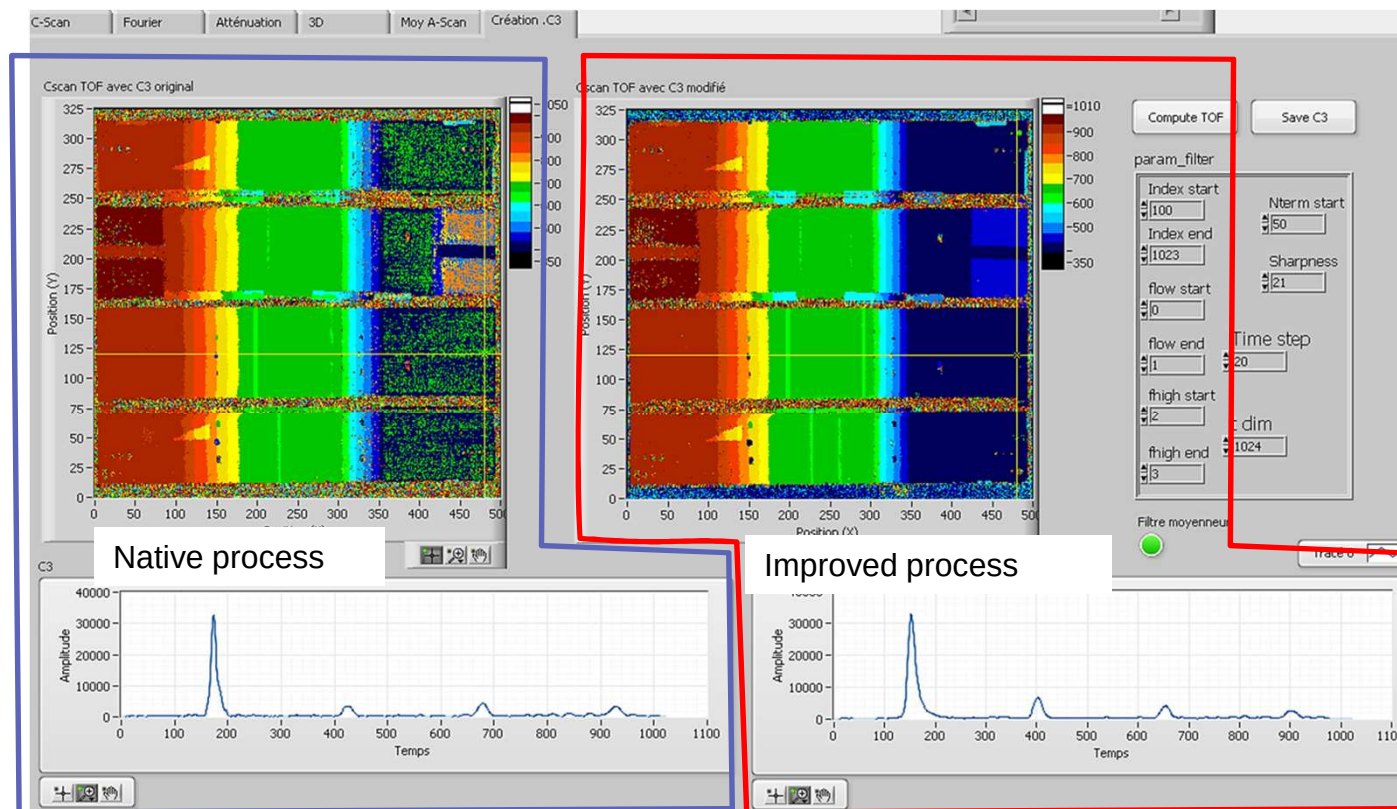
TOF C-scan
One Channel



Two Channels

Axis of developments : Signal Processing

Optimisation of SNR ultrasonic data



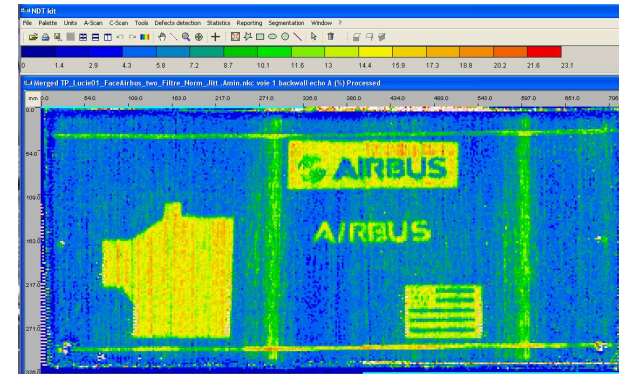
Axis of developments : Optical properties of top layers deposited on CFRP parts

For ultrasonic generation: how to improve the energy transfer (photon to mechanics)?

type of epoxy resin

master surface layer

etc...

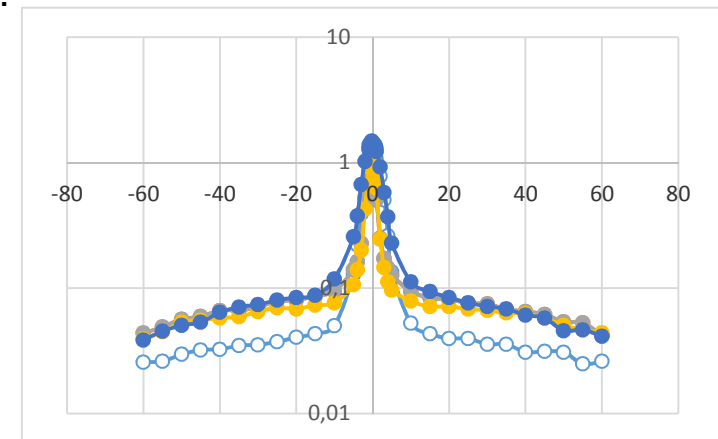


For ultrasonic detection: how to improve the collected light?

lambertian surfaces (matt)

non absorbing surfaces (white instead of black)

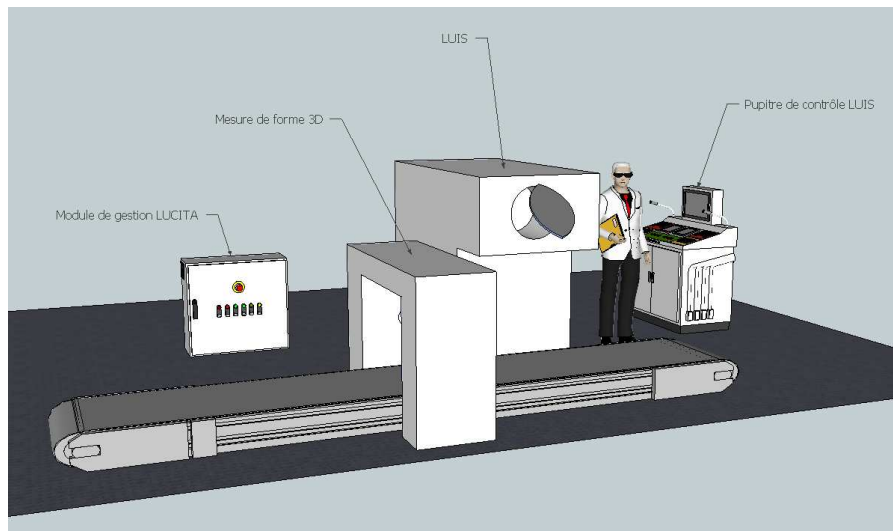
etc...



Axes de développement: Usine du future

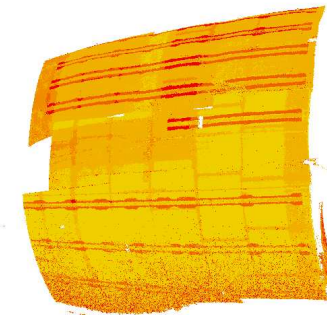
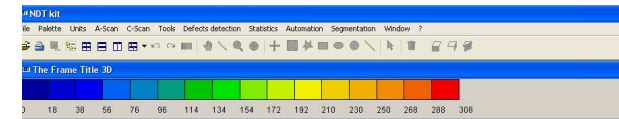
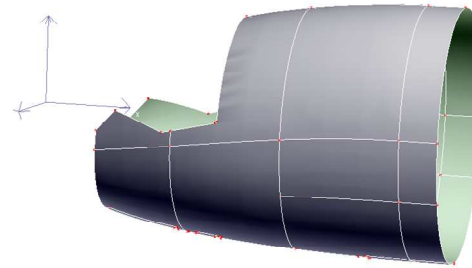
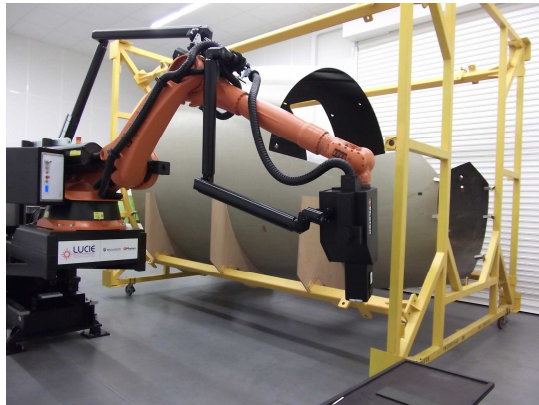


Le projet LUCITA : développement d'un démonstrateur pour le contrôle automatique santé matière et dimensionnelle de pièces carbone composite de petites dimensions et de forme complexe.

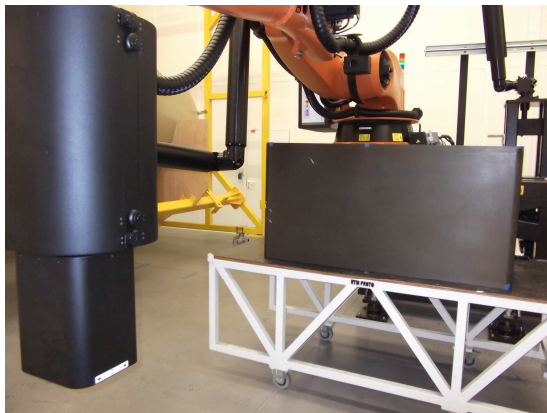


Inspected parts

- NofuDem program (Nose Fuselage Demonstrator)



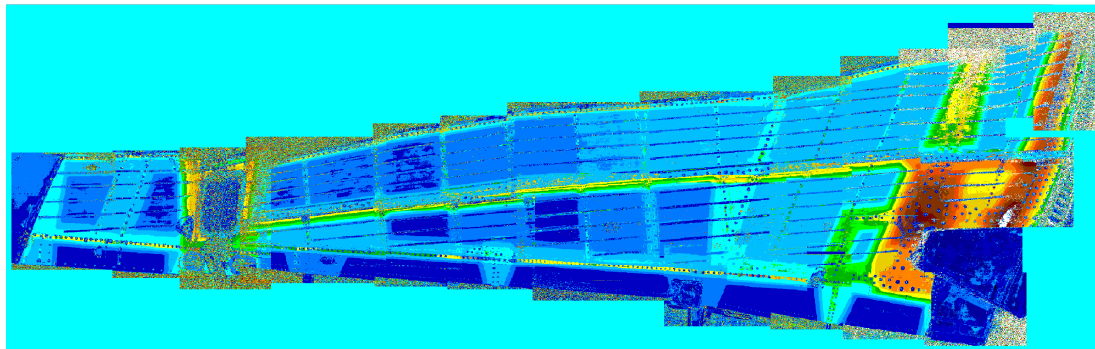
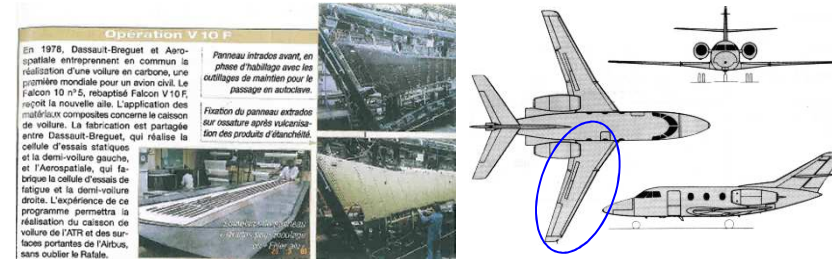
- Hirapox program



Clip video

Contrôle en maintenance / fin de vie

Voilure V10F
après 10000 heures de vol



Inspection de pièces pendant le procédé de fabrication

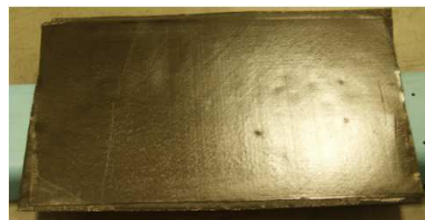
Objectif: Contrôler la diffusion de la résine avec une méthode sans contact et non polluante.

2008

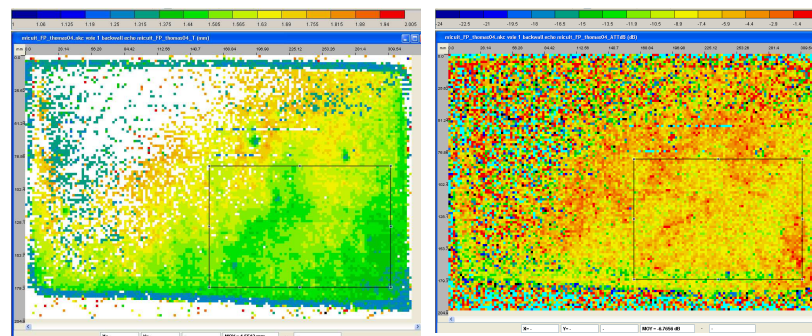
Panneau LRI



Panneau mi-cuit
40min@110 C



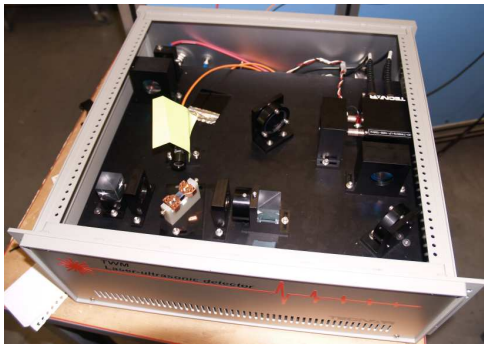
IMA-M21E 134g/m² 12 plies



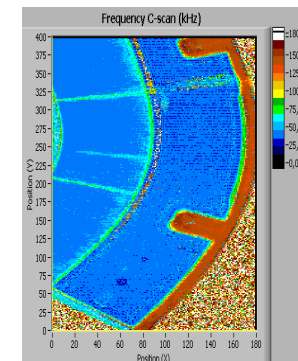
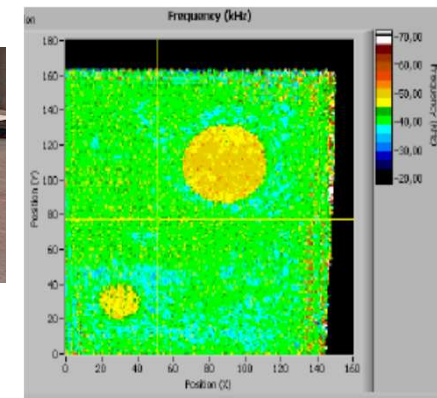
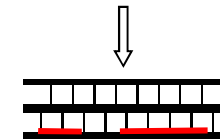
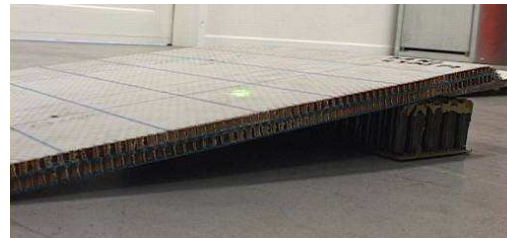
Laser Tapping

Inspection de pièces NIDA

Intégration d'un interféromètre TWM dans le LUIS



Interféromètre TWM



CONCLUSION

- Deux plateformes Laser Ultrasons implantées au centre Technocampus: LUIS et LUCIE
- Fort intérêt pour le contrôle de pièces de forme complexe
- Travaux menés sur matériaux composites (monolithiques + nida)
- Montée en TRL pour mise en production horizon 2015



**MERCI DE VOTRE
? QUESTIONS ?
ATTENTION !!!**

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