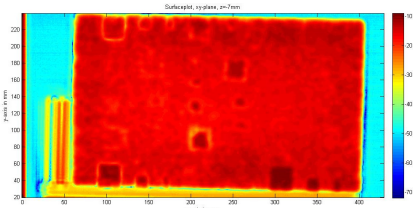


# FMCW THz Potential

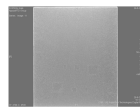
## CALIBRATION | Samples with induced defects



C-Sandwich sample (RHC) with sticks, paper sheets & teflons between adhesive & core.



Radiography

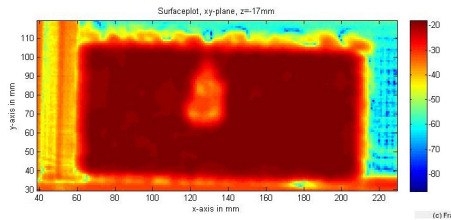


Better results with FMCW THz, compared to RT (radiography), also compared to IRT (Infrared Thermography).

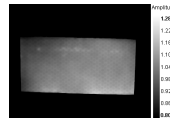


C-Sandwich sample (H/C) with water inclusions in one core.

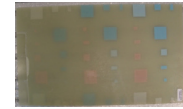
### Backside Inspections



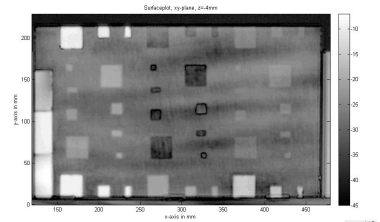
Infrared Thermography



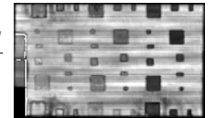
Better results with FMCW THz when the backside is inspected, compared to IRT (Infrared Thermography) or UT immersion.



Fiberglass solid with sticks, paper sheets & teflons.

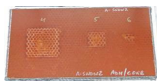


UT Pulse Echo C-Scan

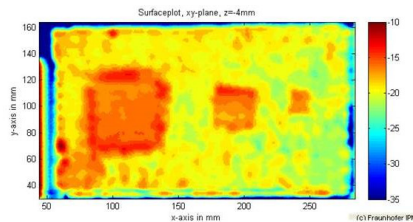


Better results with FMCW THz compared to RT (radiography).

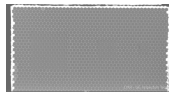
## VALIDATION | Samples with real defects



A-Sandwich sample (H/C) with debond between adhesive & core.



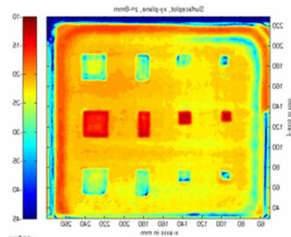
Radiography



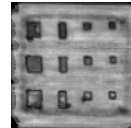
Slightly better general results of relative detection for the FMCW THz system, compared to RT (radiography), IRT (infrared thermography) and UT (immersion).



Fiberglass solid laminate with real delaminations.



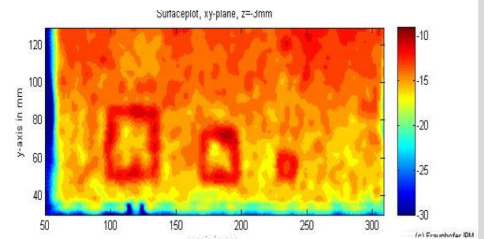
UT C-Scan



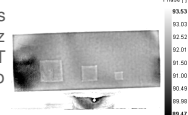
Practically comparable to the best detection results obtained by IRT (thermography IR) and UT (pulse-echo or immersion).



A-Sandwich sample (RHC) with debond between skin & adhesive sheet.



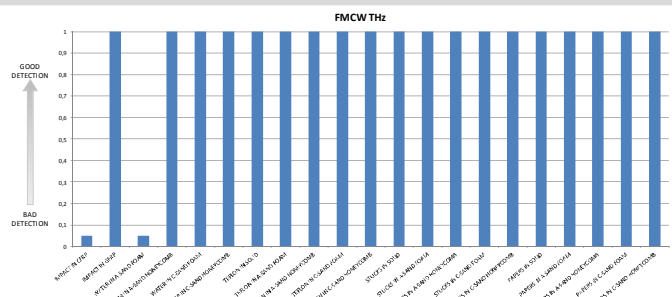
Infrared Thermography



Better general relative results of detection for the FMCW THz system, than IRT and UT (immersion or air-coupled) / No results by RT (radiography).

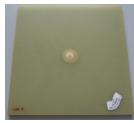
## Conclusions

- Improvement required for THz on inspections of real defects.
- For laminates and A-sandwich THz is generally comparable to UT, but can also provide depth information.
- Very good defect detection on :
  - A-/C-sandwich honeycomb with water (trapped moisture).
  - A-/C-sandwich foam with foreign inclusions.
  - A-/C-sandwich honeycomb with foreign inclusions.
  - Solid laminate with foreign inclusions.
  - A-/C-sandwich (H/C) panels with debonds or delaminations.
  - A-sandwich foam panels with debonds.
  - Solid laminate (fiberglass) panels with delaminations.

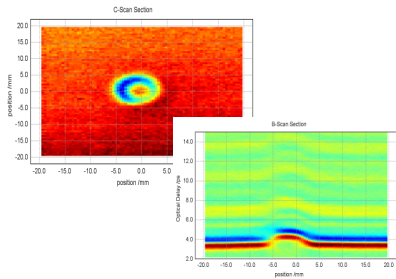


# TD THz Potential

## CALIBRATION | Samples with induced defects

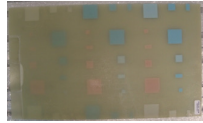
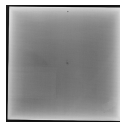


GFRP solid laminate with impacts.

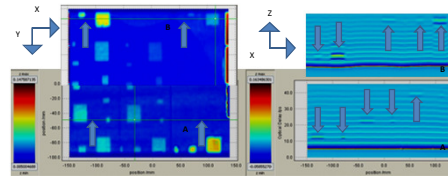


Better results with TD THz, compared to RT (radiography).

Radiography

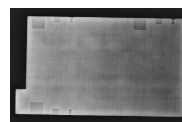


Fiberglass solid with sticks, paper sheets & teflons.

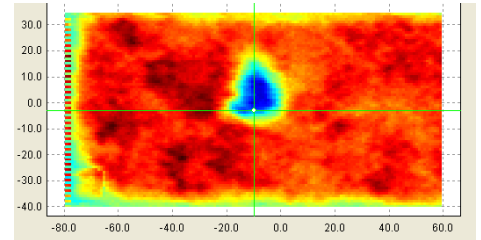


Better results with TD THz compared to RT (Radiography).

Radiography



C-Sandwich sample (H/C) with water inclusions in one core.



Better results with TD THz compared to RT (radiography) and to Infrared Thermography when backside is inspected in transmission.

Ultrasounds



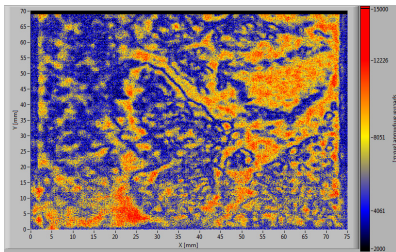
Infrared Thermography



## VALIDATION | Samples with real defects

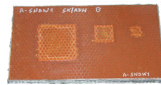
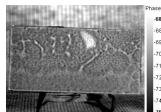


Rain erosion coating. Surface contamination by oil.

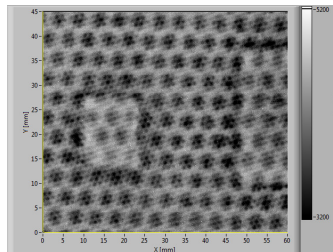


Infrared Thermography

Better detection contrast than RT (radiography) and IRT (thermography IR). No detection by ultrasound (UT) NDT techniques.

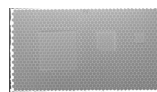


A-Sandwich sample (H/C) with debond between skin & adhesive sheet.

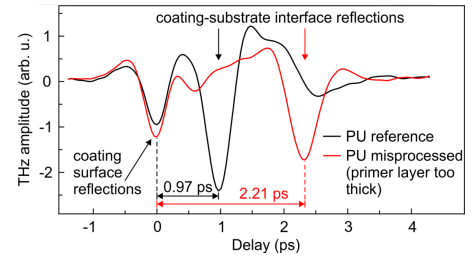


Radiography

Better results with the TD THz system when the backside is inspected, compared to RT (radiography), IRT (thermography IR) and UT (immersion).

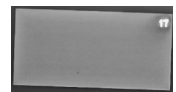


Polyurethane coating, incorrect primer layer thickness 60 microns - 100 microns.



Radiography

Better results of detection contrast and level. None of the used NDT conventional techniques have provided positive detections.



## Conclusions

- Strong NDT defect detection for various types of GFRP (Glass-Fiber Reinforced Plastic) and coatings on CFRP (Carbon Fiber Reinforced Plastic).
- Very good defect detection on:
  - GFRP A/C-sandwich foam with water (trapped moisture).
  - Solid laminate (fiberglass) panels with foreign inclusions.
  - A-sandwich honeycomb with foreign inclusions, debonds and delaminations.
  - Coating misprocesses on CFRP panels.

