Bonding multimaterials and thermal issues at elevated temperatures

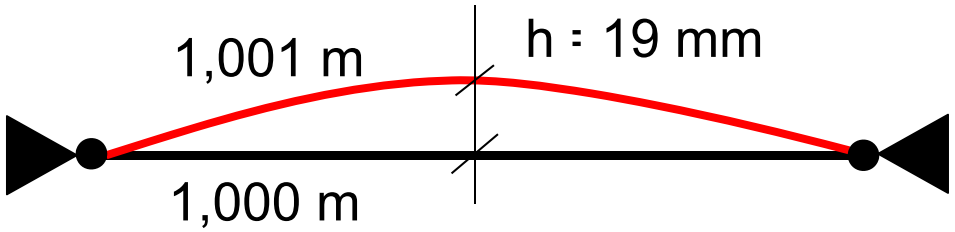
Joining Sub-platform General Assembly
4 July 2014, Brussels

Jan Skogsmo
Jan.skogsmo@swerea.se
Swerea IVF, Sweden



Swerea IVF
A non-profit organisation
550 employees
Turnover €73 million
600 member companies
3,000 industrial customers

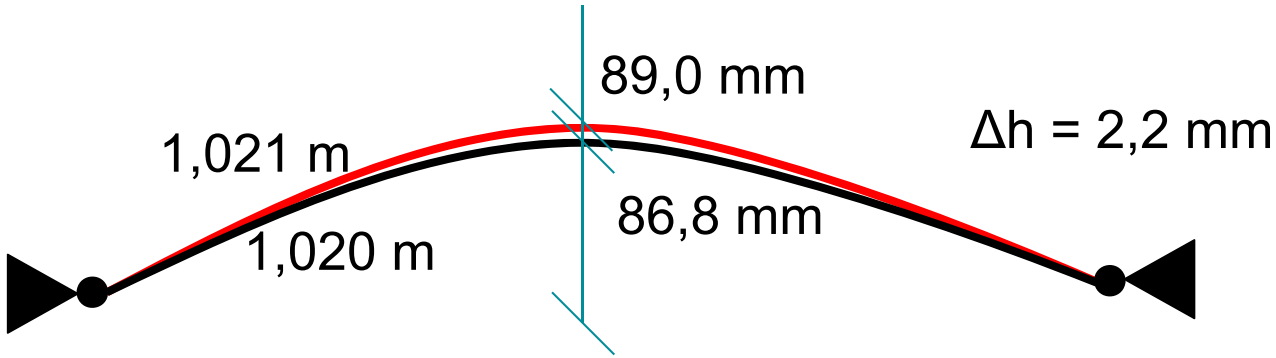
Background, Thermal elongation (1)



Temperature change

Steel
90ºC ≈ 1 mm/m

- When materials with different thermal elongation are joined a change in temperature will cause changes in geometry.

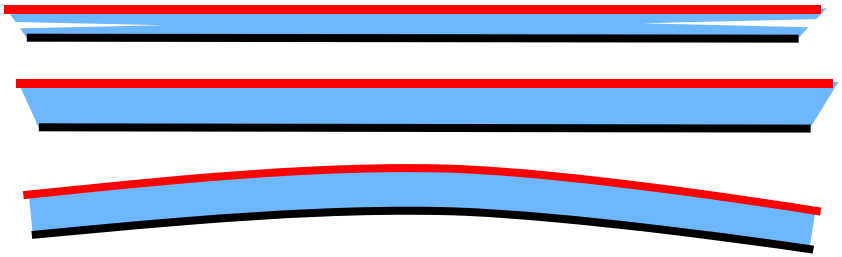


Joining and elongation of different materials at heating

Spot joining



Adhesive Bonding



Configuration?

Spot joining and adhesive

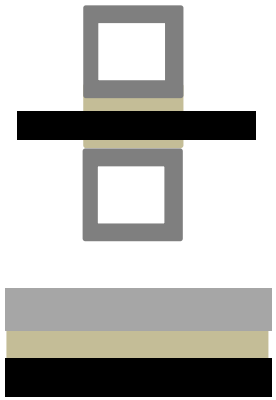


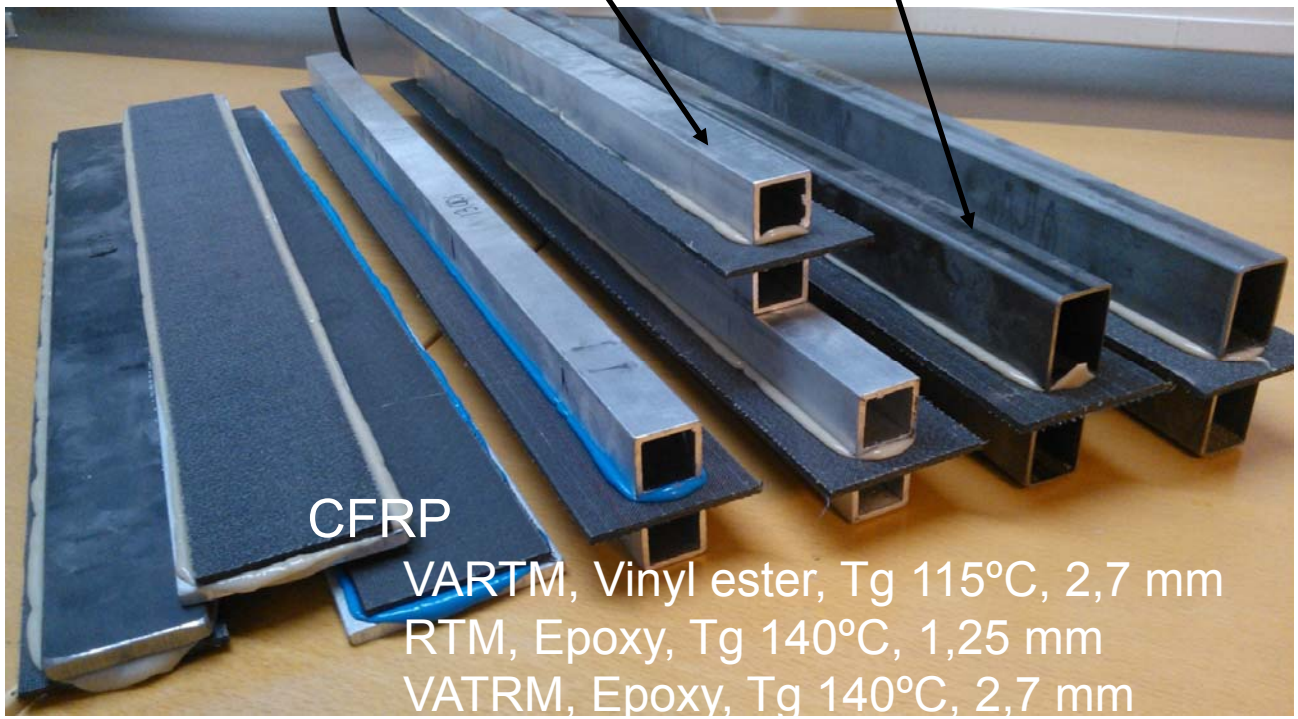
Boundary conditions to the rest of the structure?

Test specimens

- Fails at elevated temperatures
- Simple to make, practical, 50 cm (Al 20x20; 2mm) (Fe 20x30; 1,5mm)
- Symmetrical
- RT - curing

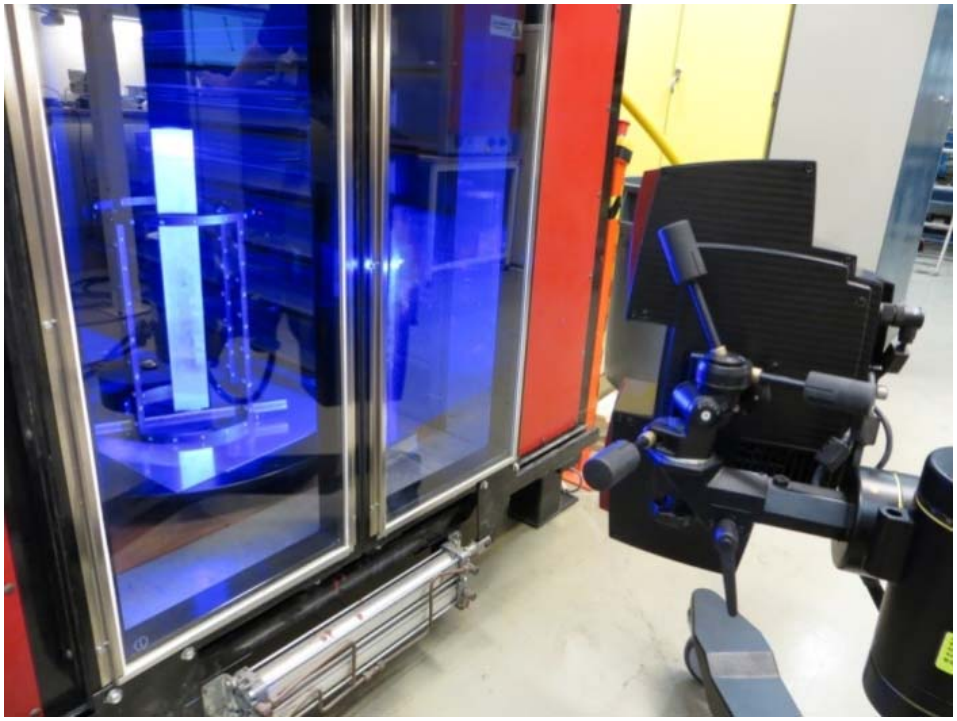
2K epoxy adhesive,
Araldite 2015
4% elongation at break,
Tg ≈ 75°C





Optical scanning in oven

Athos ’blue light’ scanner, rotating index table
Preheated oven, fast ramping
About 1,5 min to get acceptable measurements

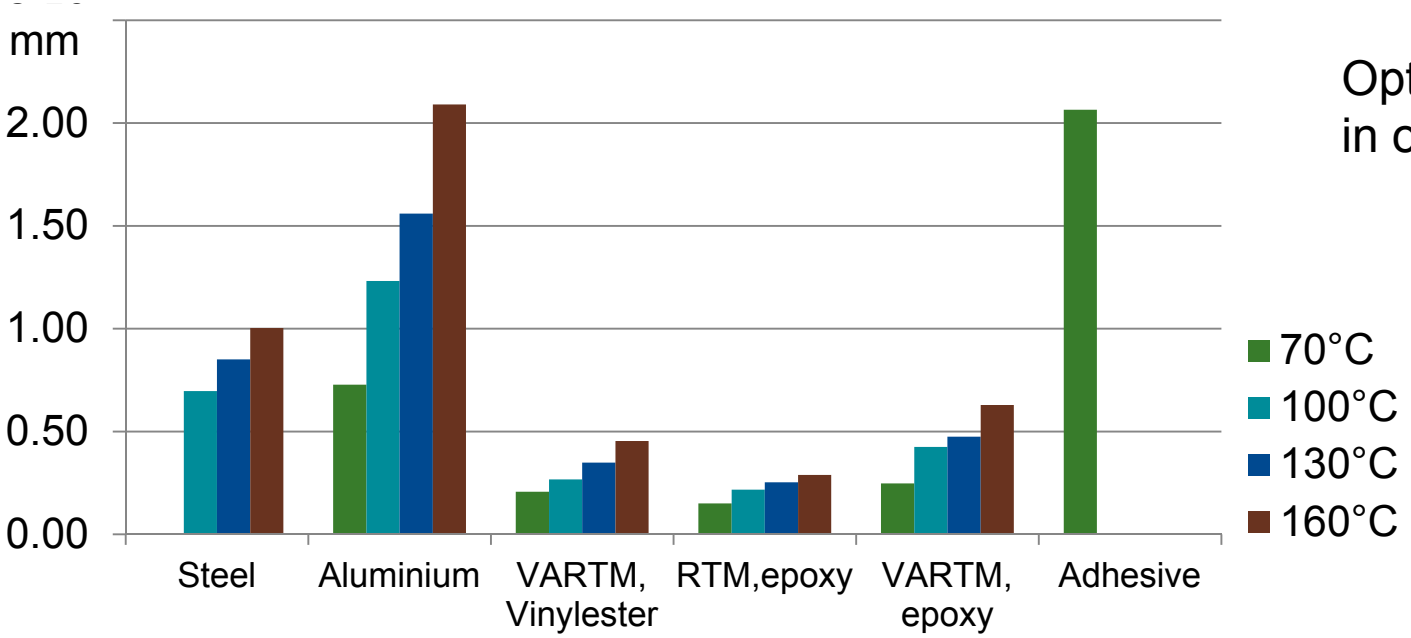




Oven size: 2 x 1,7 x 1 m

CLTE- measurement by scanning

- Test material (50 cm) scanned in a guiding fixture



Optical measurement in oven through glass

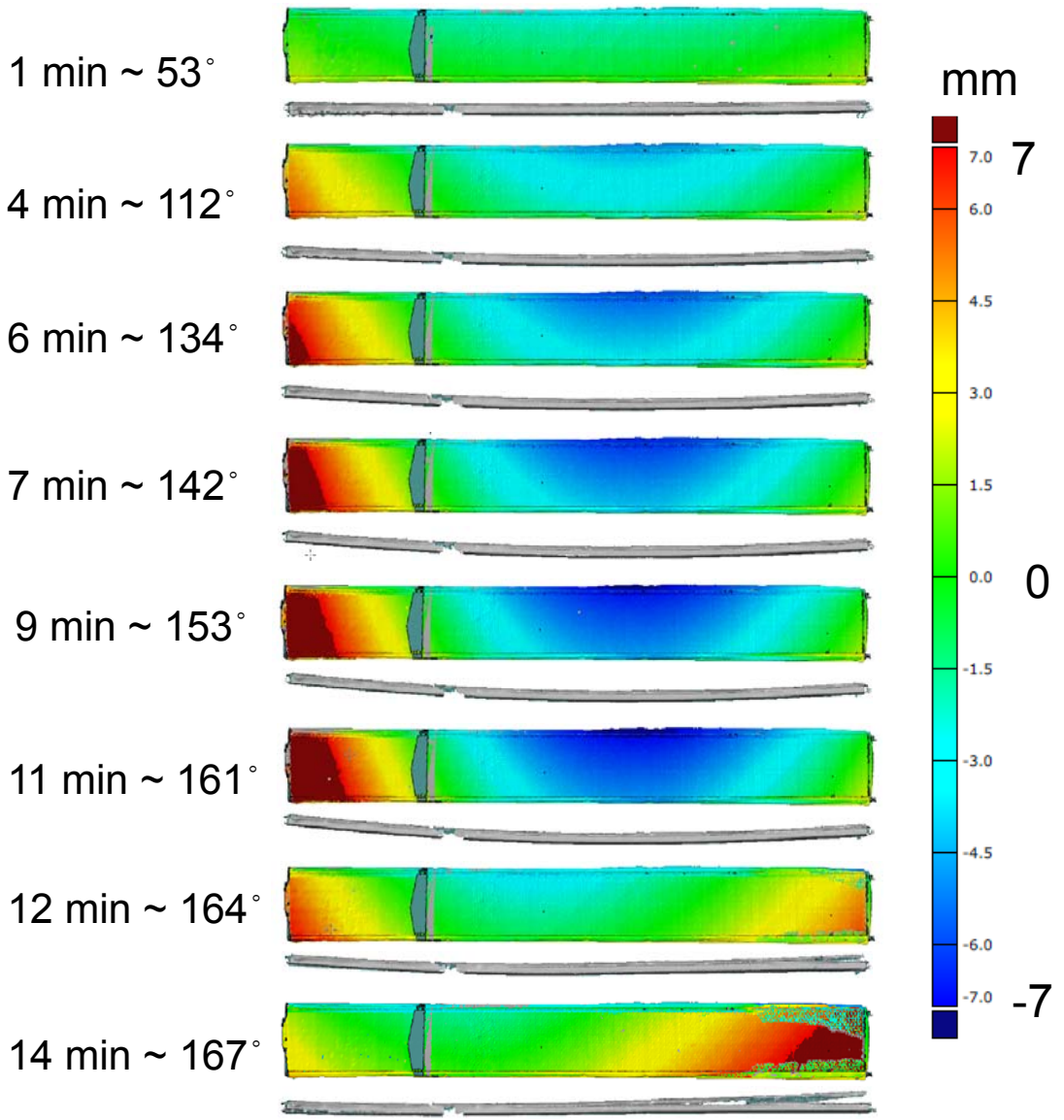
Measured CLTE x 10^{-6} m/m°C (Reference value)					
14(11)	29(23)	6	4	9	80

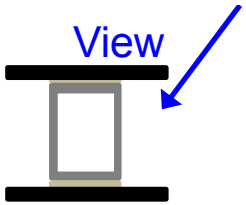
Oven scanning

Deviation from
RT reference scan

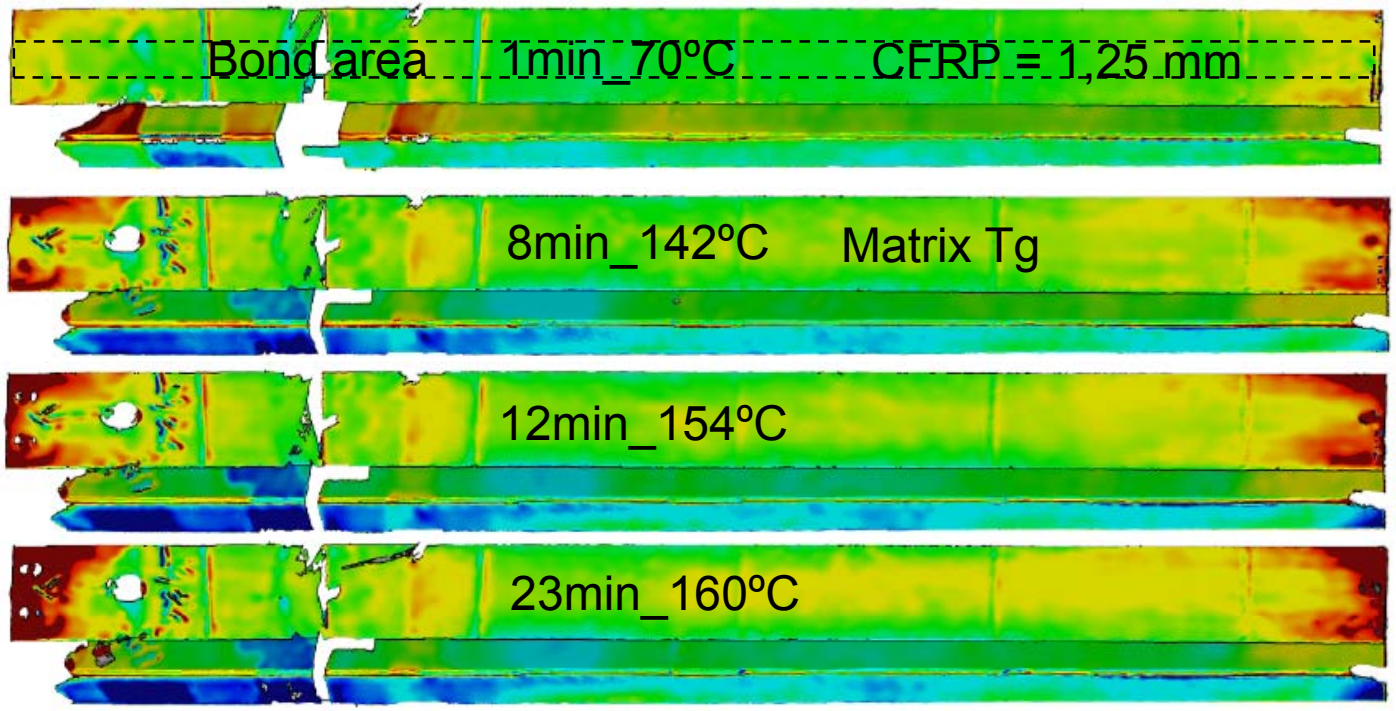
Aluminium 5 mm
to CFRP 2,7 mm
50 cm long

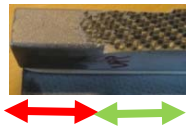
- Large deformations
- Crack after 11 min

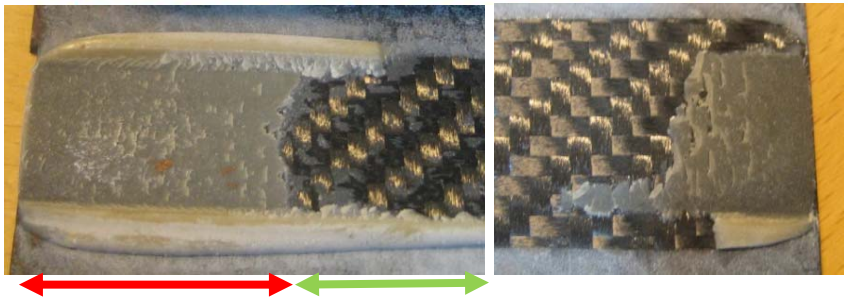


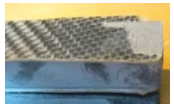


Scanning, Steel – CFRP, RTM epoxy

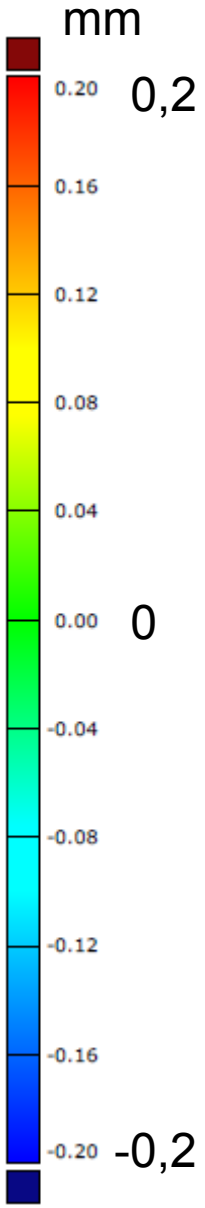




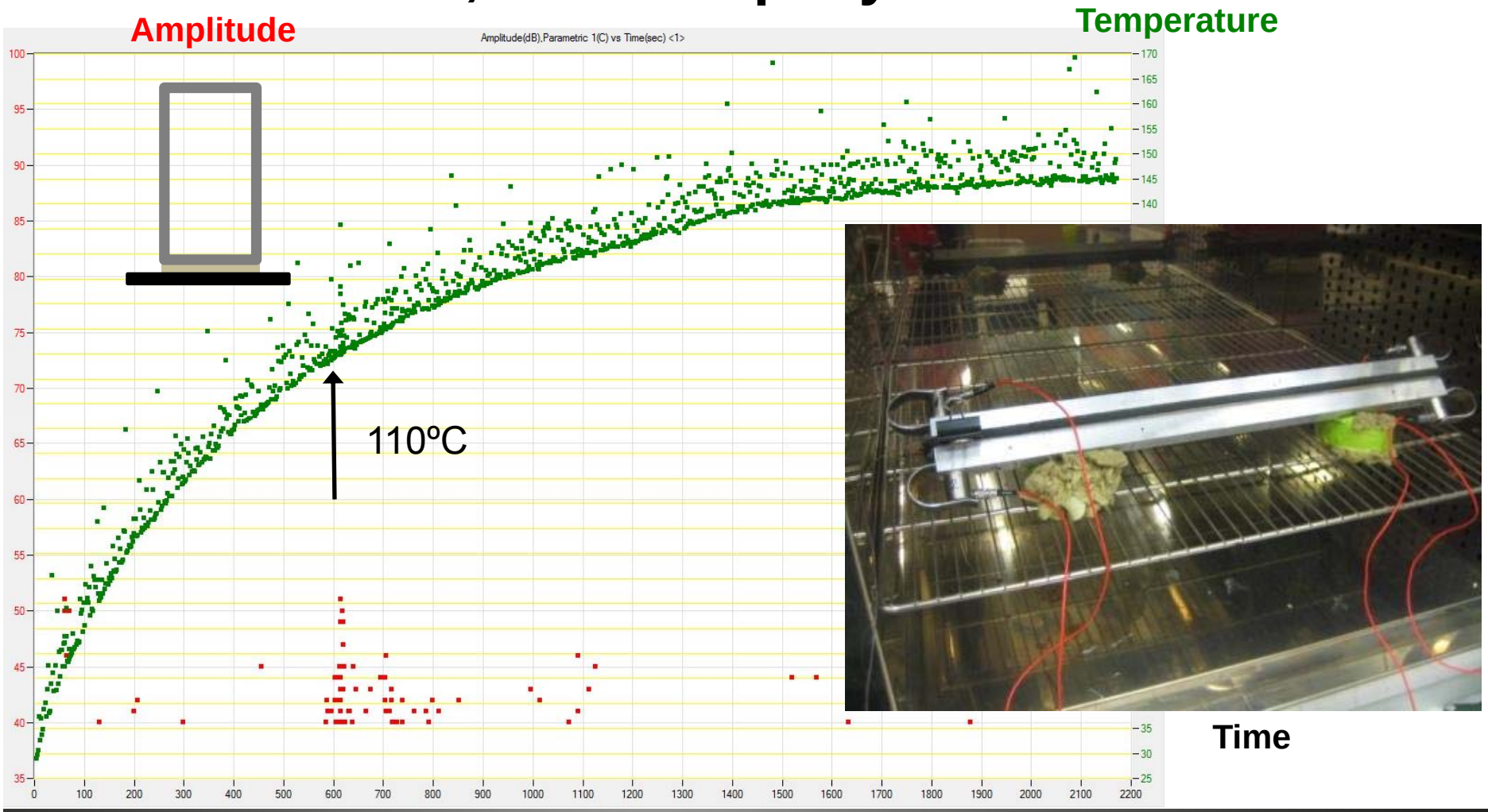




Failure close to steel

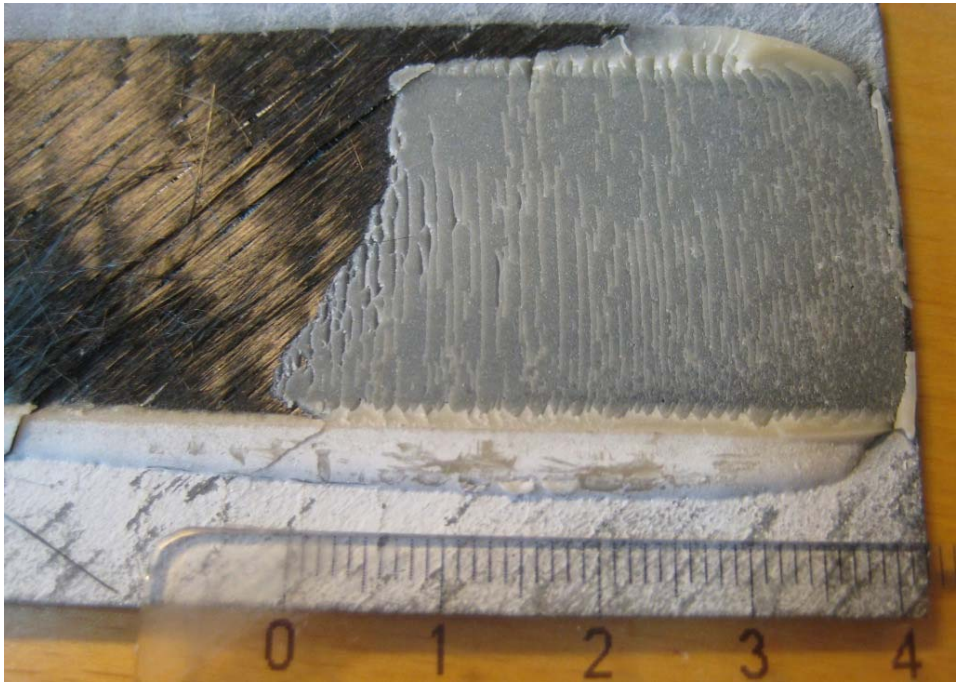


Acoustic emission – when does damage occur?
Steel – CFRP, VARTM epoxy NCF



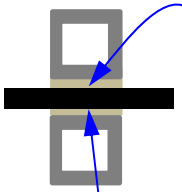
Failure Steel – CFRP, VARTM epoxy NCF

- Appears to be intact from the outside
- Easy to break apart both ends

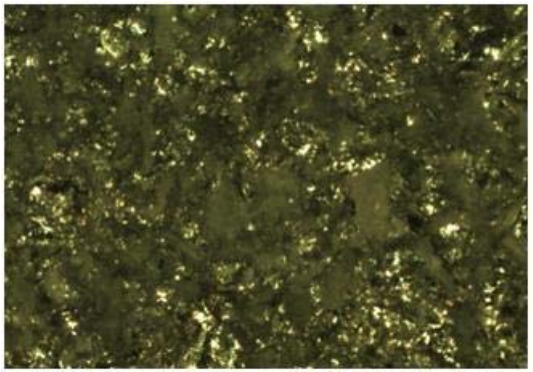


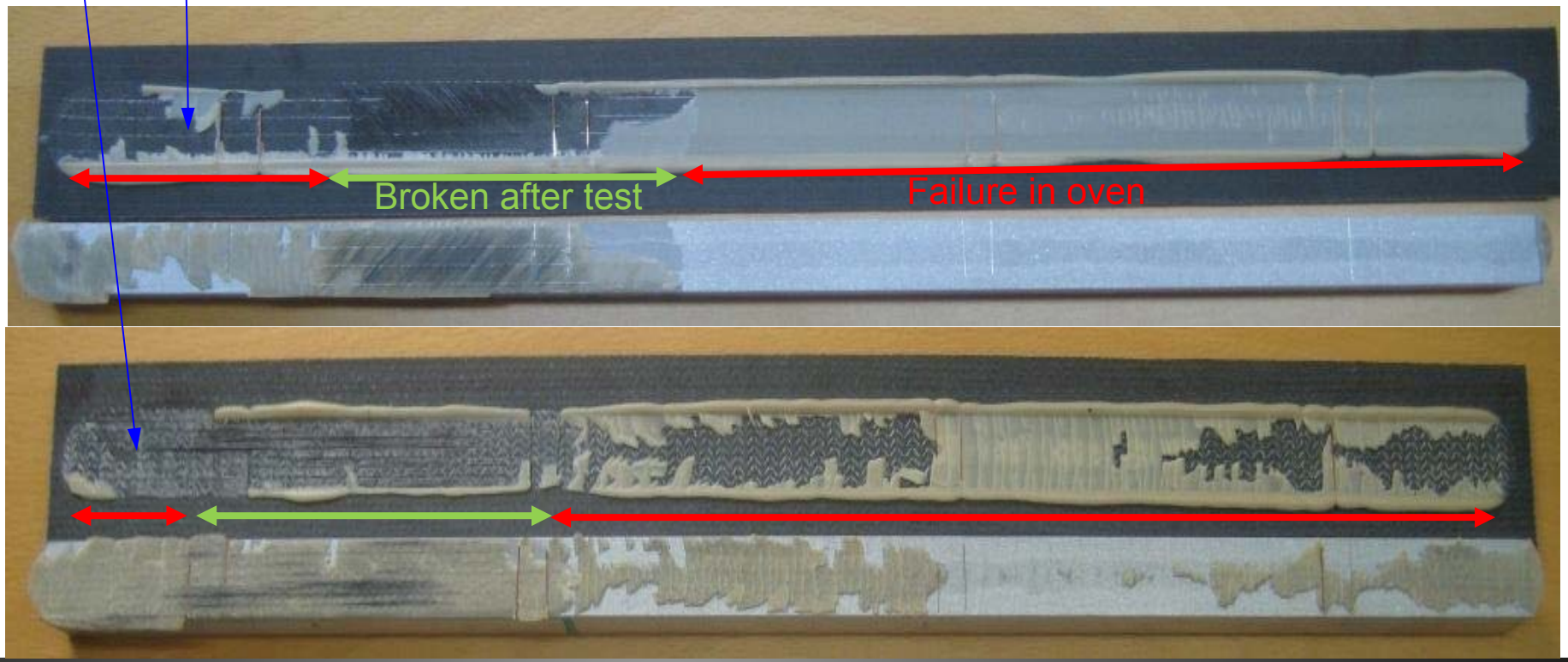
Damage accumulation!

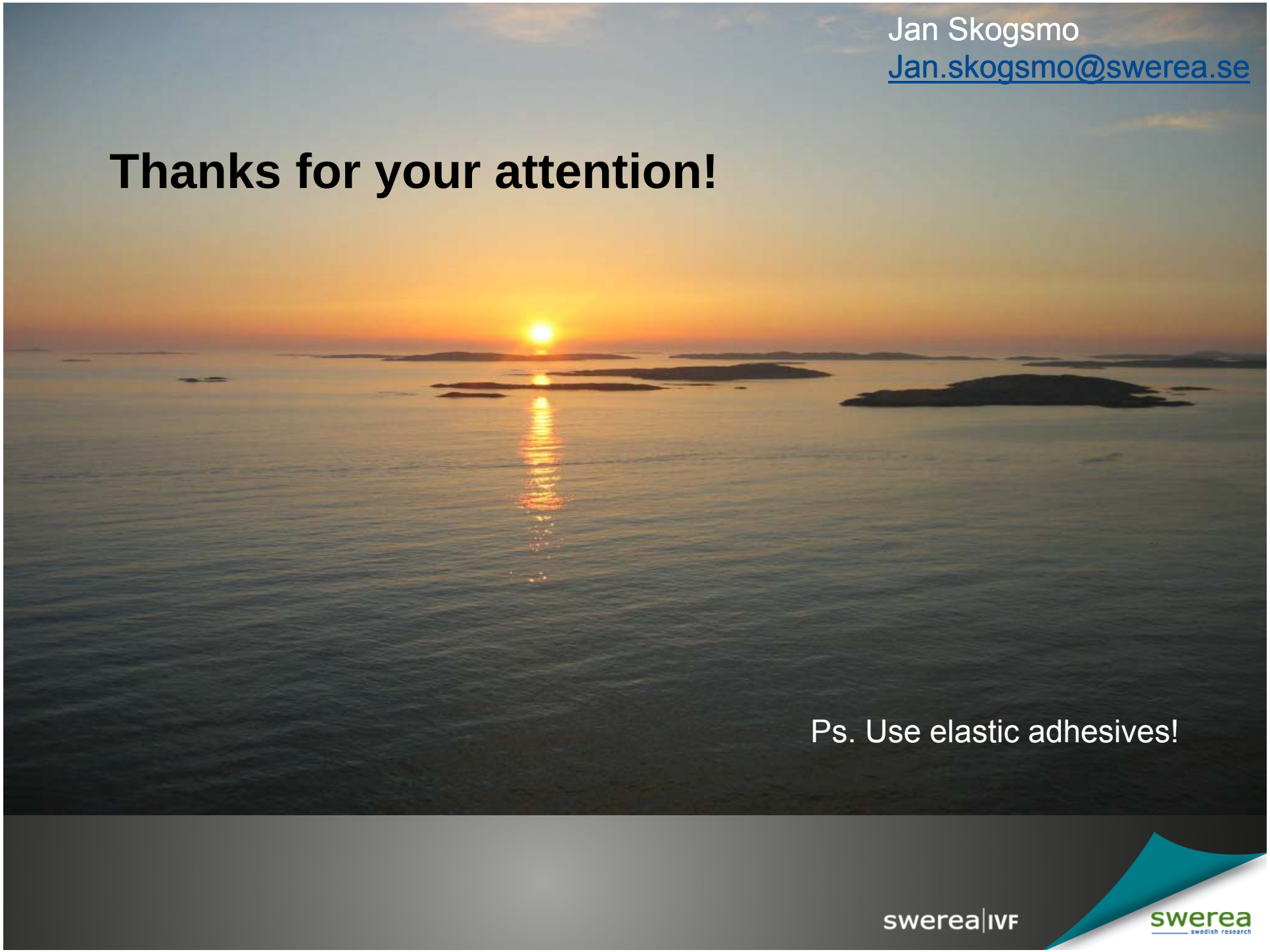
Failure surface 1



Aluminium to CFRP, Vinylester
Joint thickness 0,75 mm
Cohesive failure to Al at 130ºC







Jan Skogsmo
Jan.skogsmo@swerea.se

Thanks for your attention!

Ps. Use elastic adhesives!