FLUID STRUCTURE INTERACTIONS
RESEARCH GROUP

UNIVERSITY OF Southampton
School of Engineering Sciences

Digital Image Correlation for High Strain Rate Behaviour Investigation on Glass Fibre Reinforced Polymers

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Aim and Objectives

Establish a methodology that, involving high resolution optical techniques, informs a model of the high strain rate behaviour of composite materials:

- Develop an experimental apparatus for high strain rate testing that involves full-field optical techniques.
- Validate the optical techniques strain results.
- Obtain a data-rich stress-strain curve of the tested materials:
  - Extract material information
  - Link the experimental results with the constitutive model equation

Why DIC?

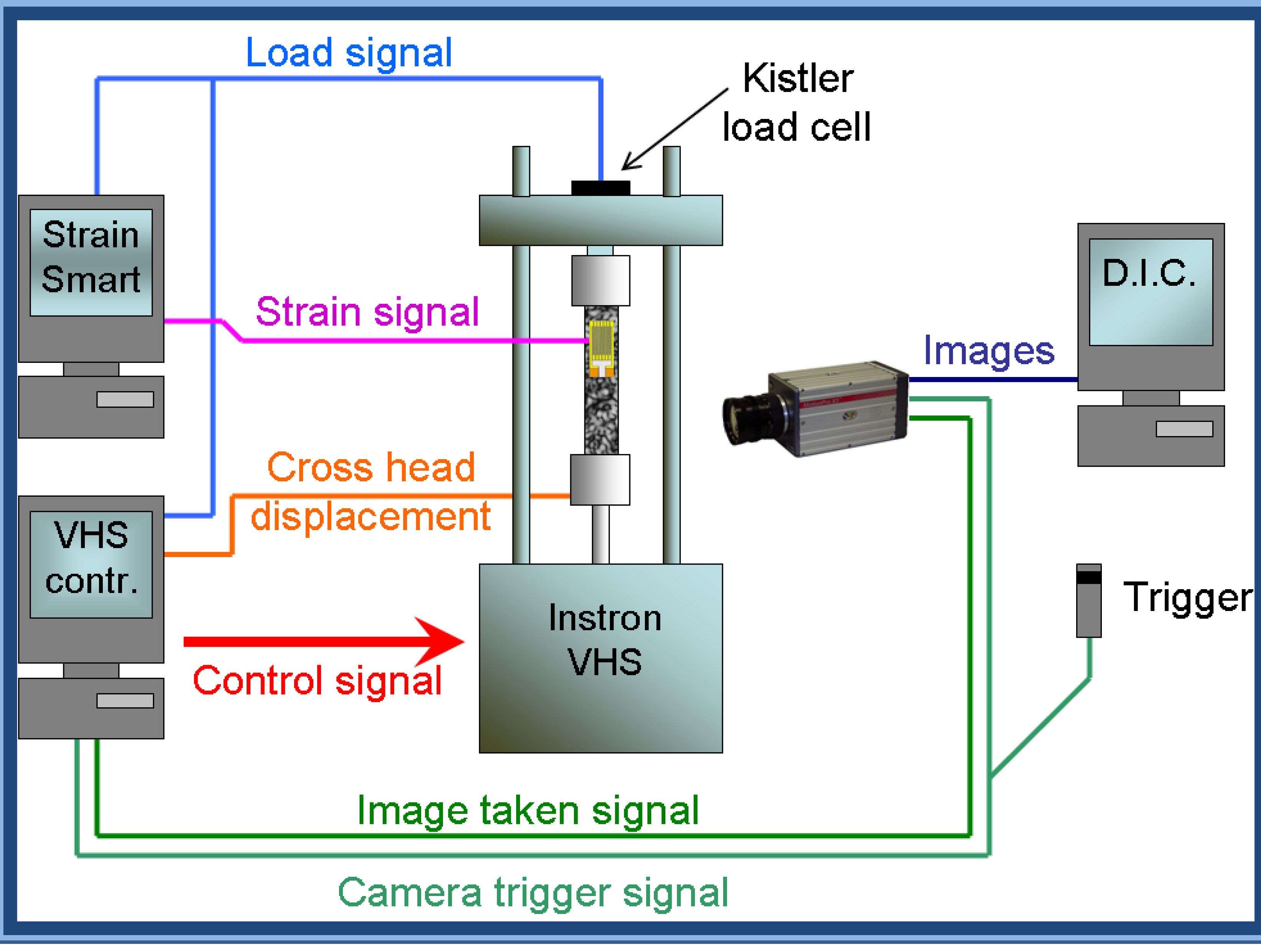
- No mechanical interaction between measurand and sensor: the measurement process does not modify the system.
- Allows full-field measurements of deformation and strain:
  - All the strain components can be determined contemporaneously.
  - The number of experiments and sensors needed to characterise a material is reduced
- The limitations are in the hardware and not in the method: the constant improvement of CCD technology enhances the spatial and temporal resolution of DIC strain measurements.

Experimental apparatus

•CEA-06-240UZ-120 Vishay:
- •Gauge length: 6 mm
- •Maximum strain: 3-5 %

•Vishay Strain Smart 6000:
- •Sampling Freq: 10.2 kHz

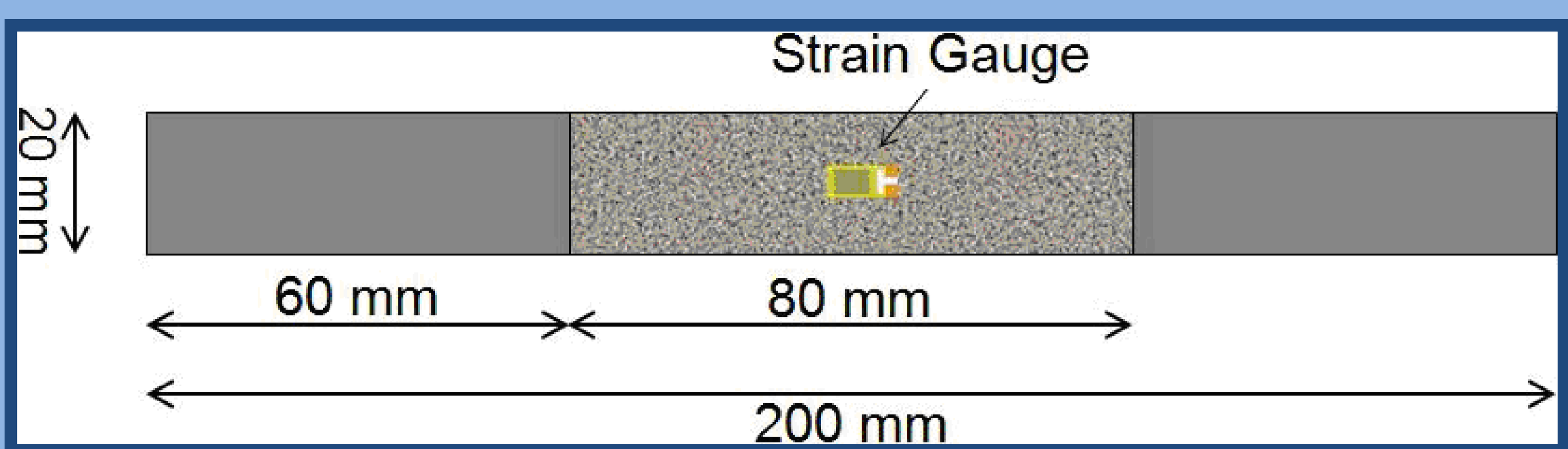
•Instron VHS control system:
- •Sampling Freq: 32 kHz
- •Cross head speed: 1, 5, 10 m/s



•Redlake Motion Pro X3 camera:
- •Resolution: 1280 x 300
- •Frame rate: 7 kHz

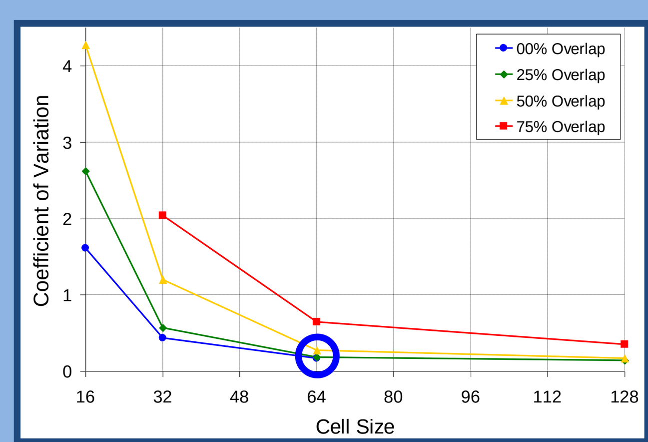
•DaVis 7.4 for 2D DIC software:
- •Cells size: 64 x 64 pixel
- •Overlapping 0%
- •Number of passes 0
- •Pixel per speckle: 7
- •Strain resolution: 200 μstrains

Tested Specimens

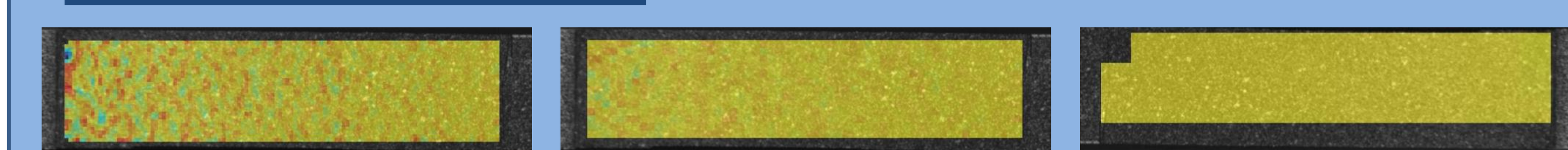


- MTM28-1 epoxy resin reinforced with E-GLASS-200 with 32% fibres content
- Pure MTM28-1 epoxy resin

Effects of the DIC parameters



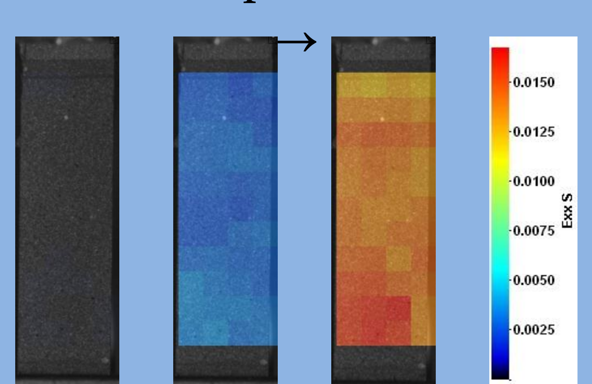
- Reducing the size of the interrogation cell increases the spatial resolution and increases the scattering.
- Increasing the cell overlapping increases the spatial resolution and the scattering.

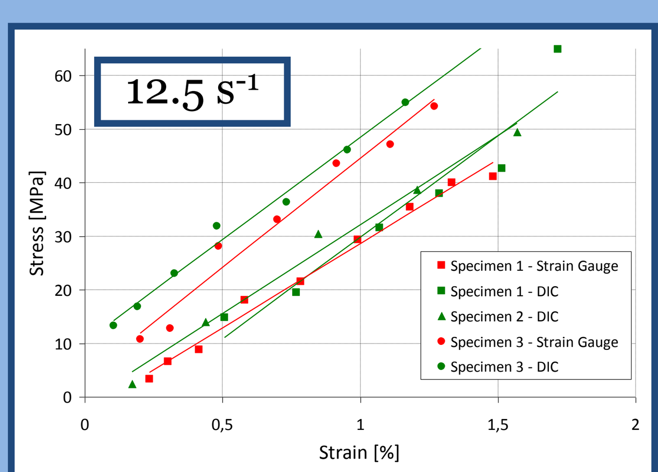


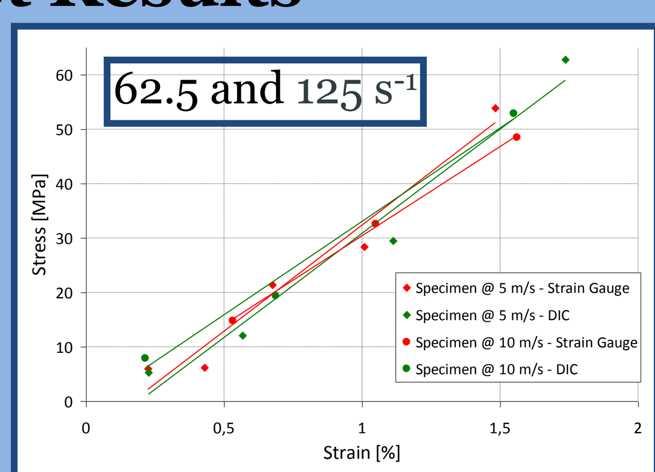
16x16 - 50% Overlap 16x16 - 00% Overlap 128x128 - 00% Overlap

Test Results

Pure resin specimens results

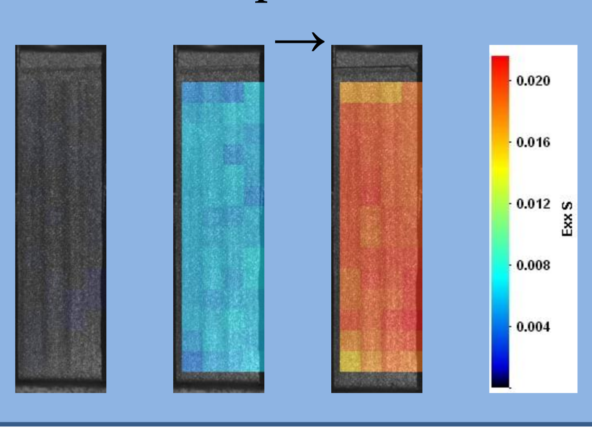


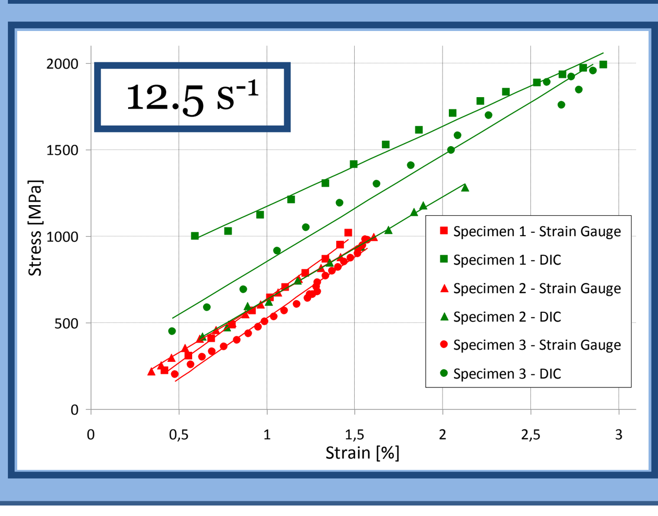


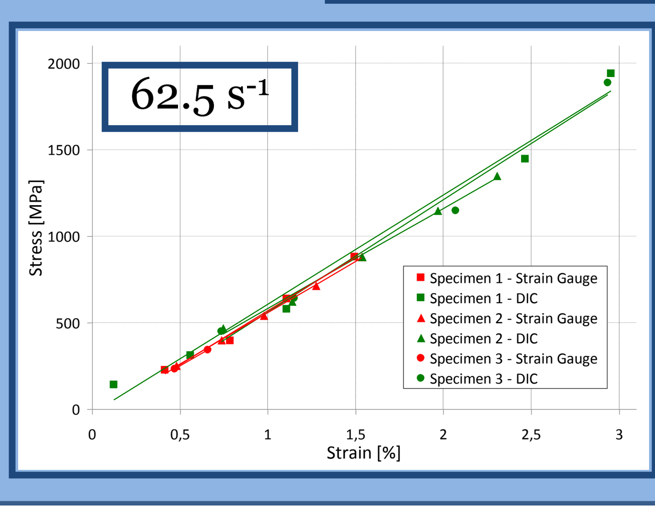


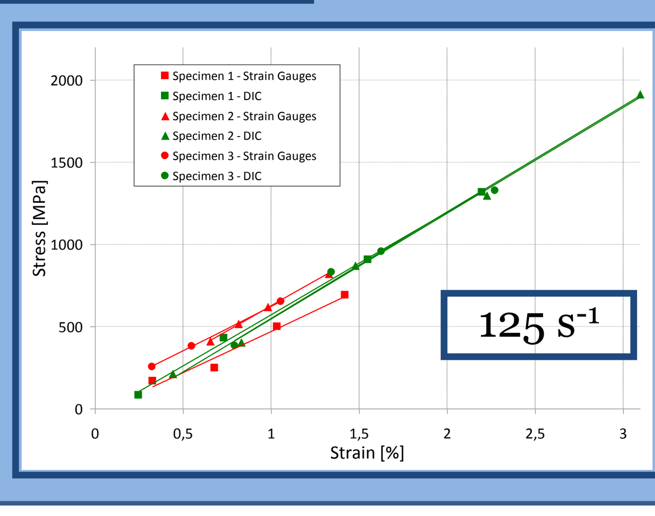
Strain rate [s⁻¹]	Young's Modulus [GPa]	
	From strain gauge	From DIC
12.5	3.6 ± 0.7	3.1 ± 0.15
65.5	3.8 ± 0.2	3.8 ± 0.15
125	N.A.	N.A.

Glass fibre specimens results









Strain rate [s⁻¹]	Young's Modulus [GPa]	
	From strain gauge	From DIC
12.5	69.3 ± 5.8	55.6 ± 6.7
65.5	59.9 ± 1.9	61.2 ± 3.2
125	54.9 ± 5.2	64.8 ± 1.3

Conclusions

•Experimental methodology and apparatus have been developed.

•The Young's modulus has been defined for pure resin and fibre reinforced specimens.

•The experimental errors have been identified in the load-strain synchronisation.

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