MatchID
Metrology Beyond Colors

UNIVERSITY OF Southampton

10º off-axis test for in-plane shear strength measurement

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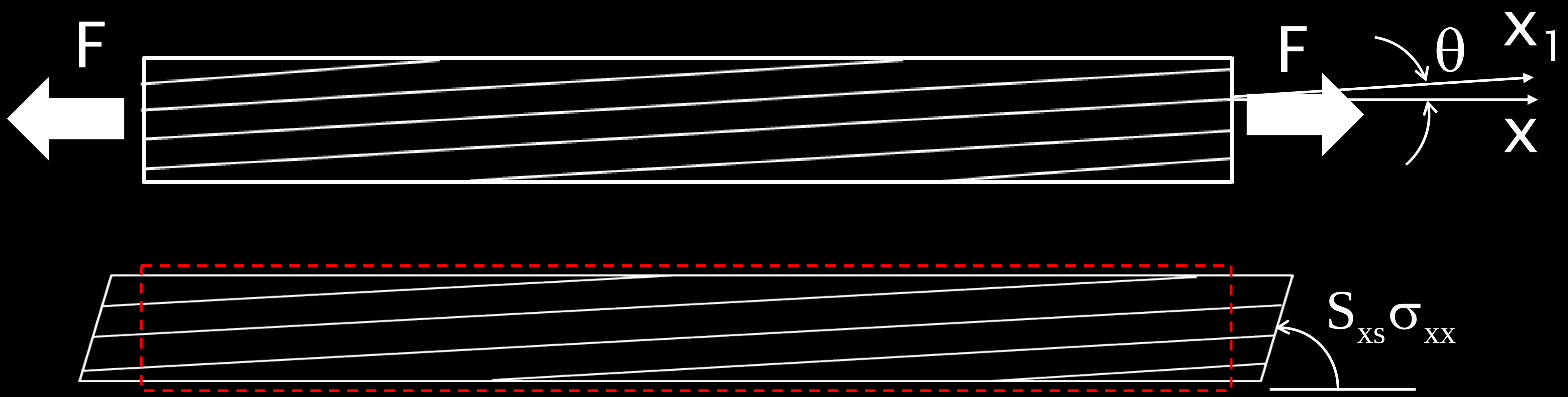
Principle

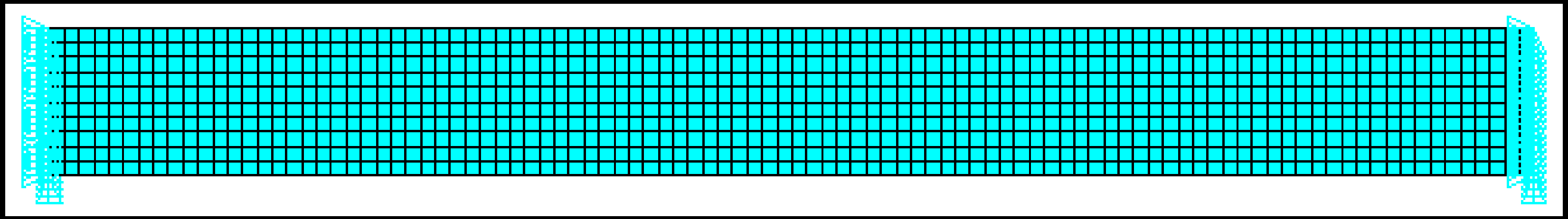


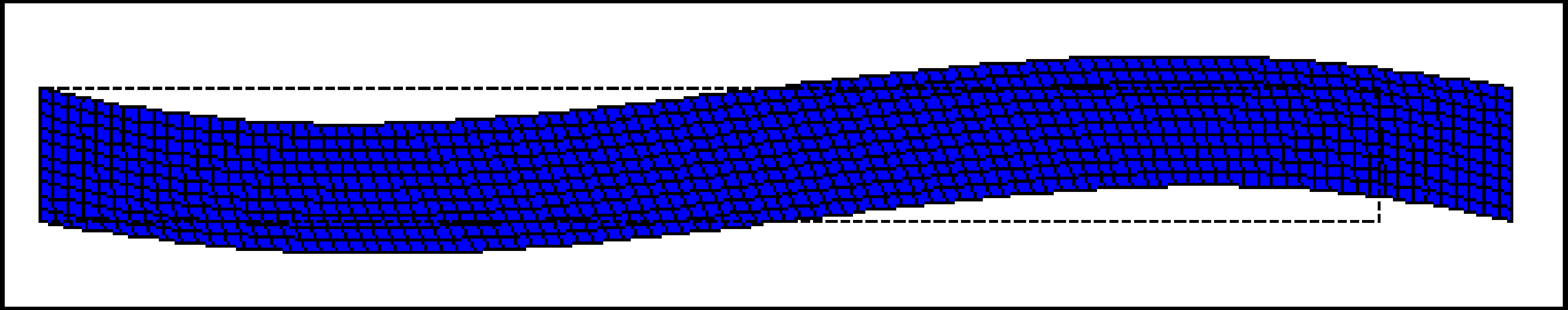
$$\begin{pmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ 2\varepsilon_{xy} \end{pmatrix} = \begin{bmatrix} S_{xx} & S_{xy} & S_{xs} \\ S_{xy} & S_{yy} & S_{ys} \\ S_{xs} & S_{ys} & S_{ss} \end{bmatrix} \begin{pmatrix} \sigma_{xx} \\ 0 \\ 0 \end{pmatrix}$$

M.-J. Pindera, C. Herakovich, Shear characterization of unidirectional composites with the off-axis tensile test, Experimental Mechanics, 26 (1986) 103-112

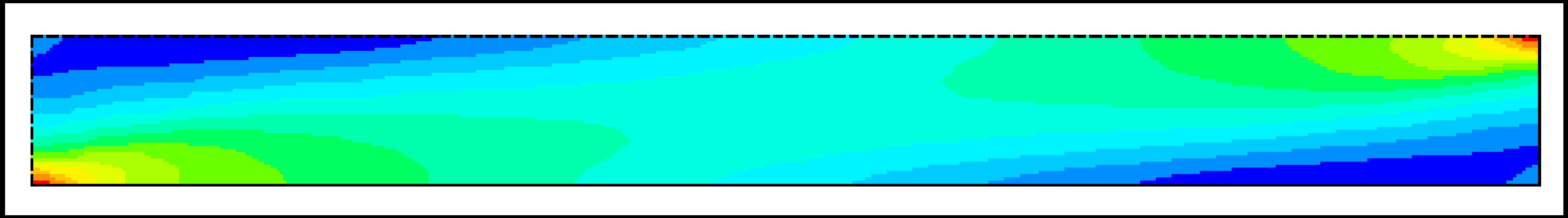
Mechanical analysis

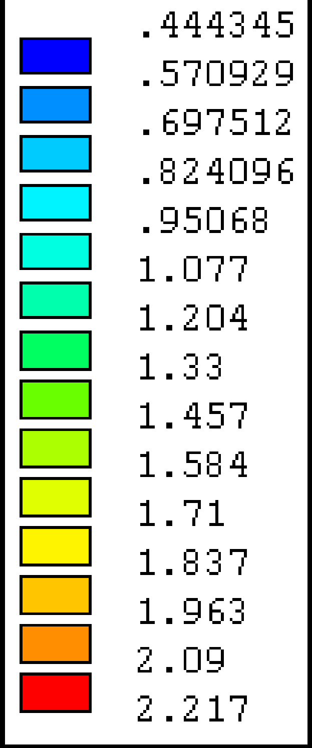
- Real boundary conditions (T300/914 C/E UD)



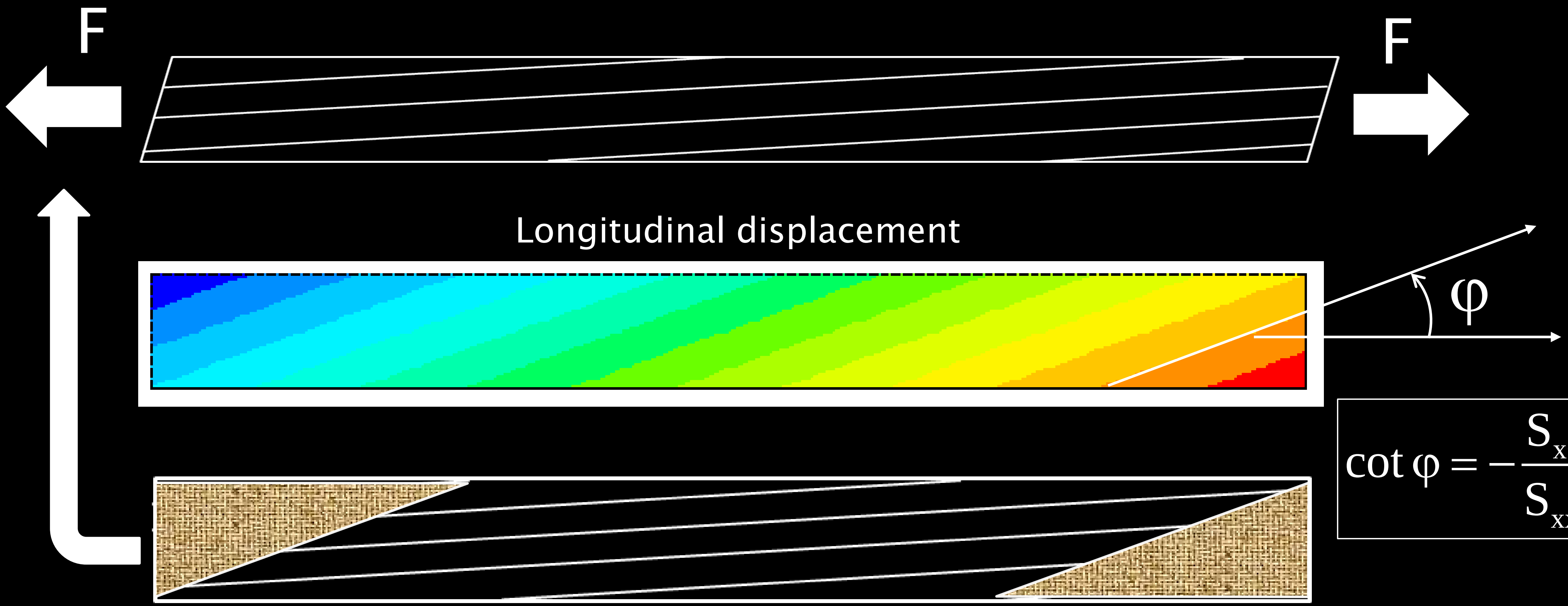


F/A Normalized longitudinal stress σ_{xx}





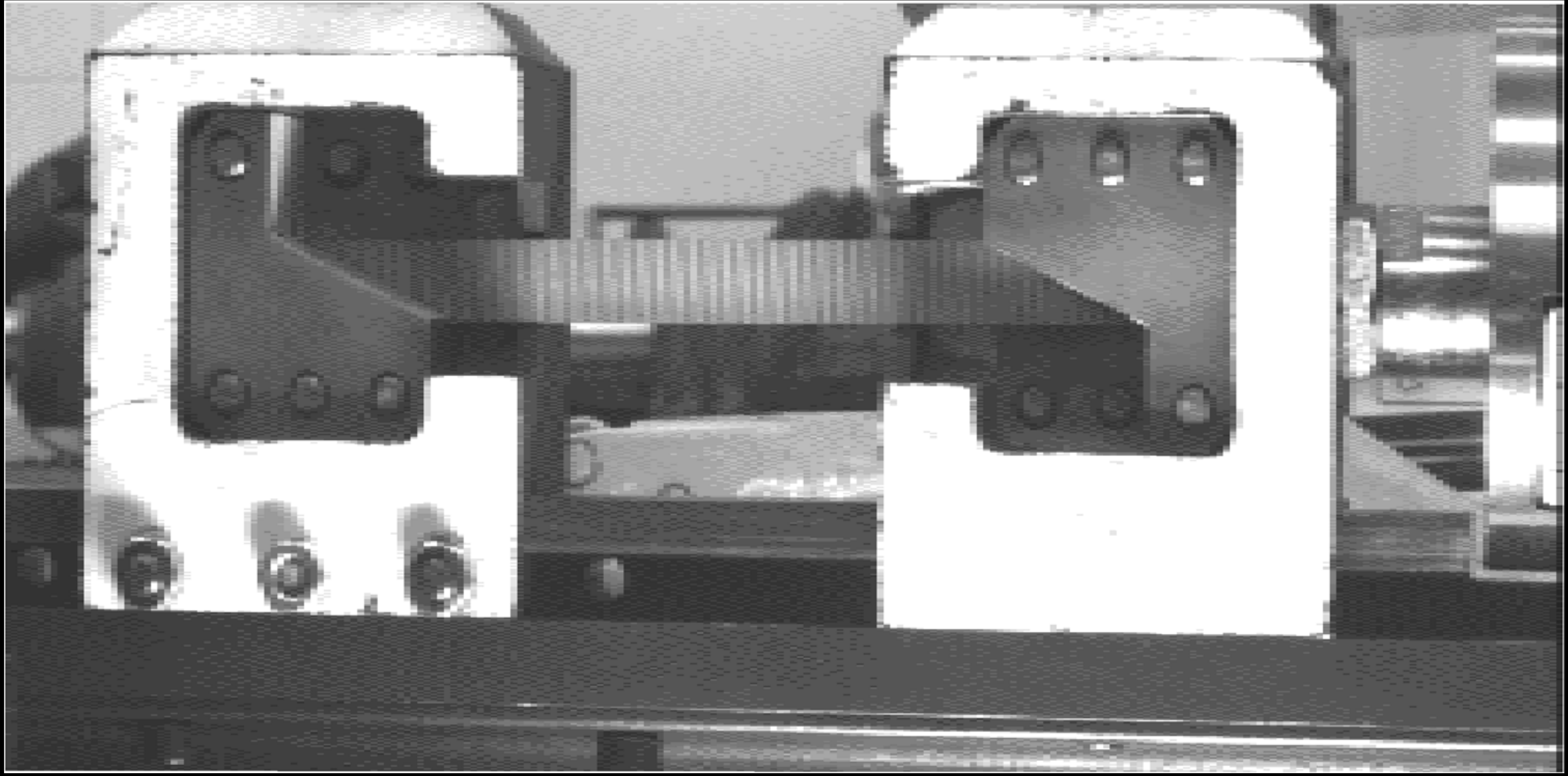
Oblique tabs



$$\cot\varphi = -\frac{S_{xs}}{S_{xx}}$$

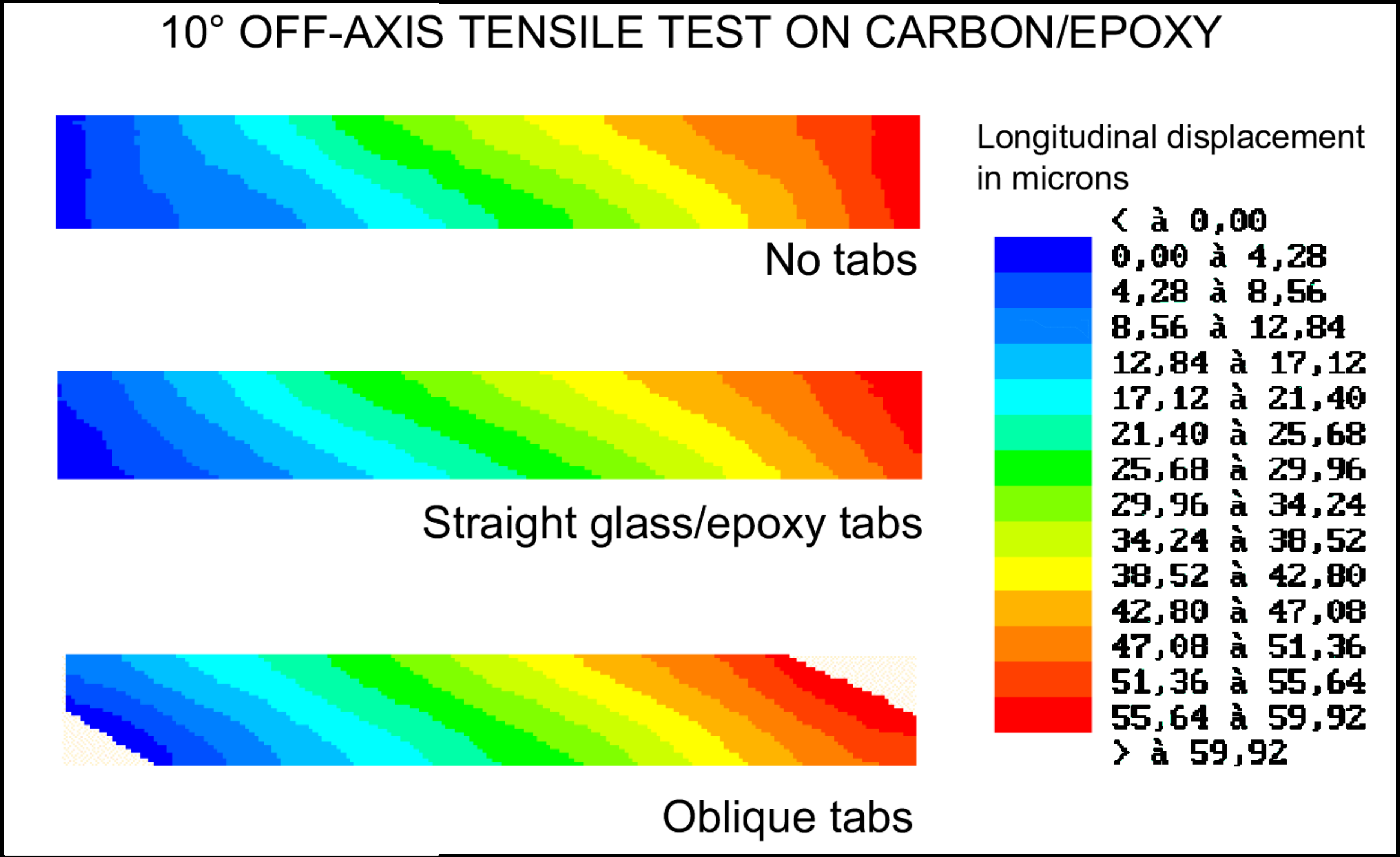
C. T. Sun, I. Chung, An oblique end-tab design for testing off-axis composite specimens, Composites, 24(8) (1993) 619-623

Experimental validation – grid method

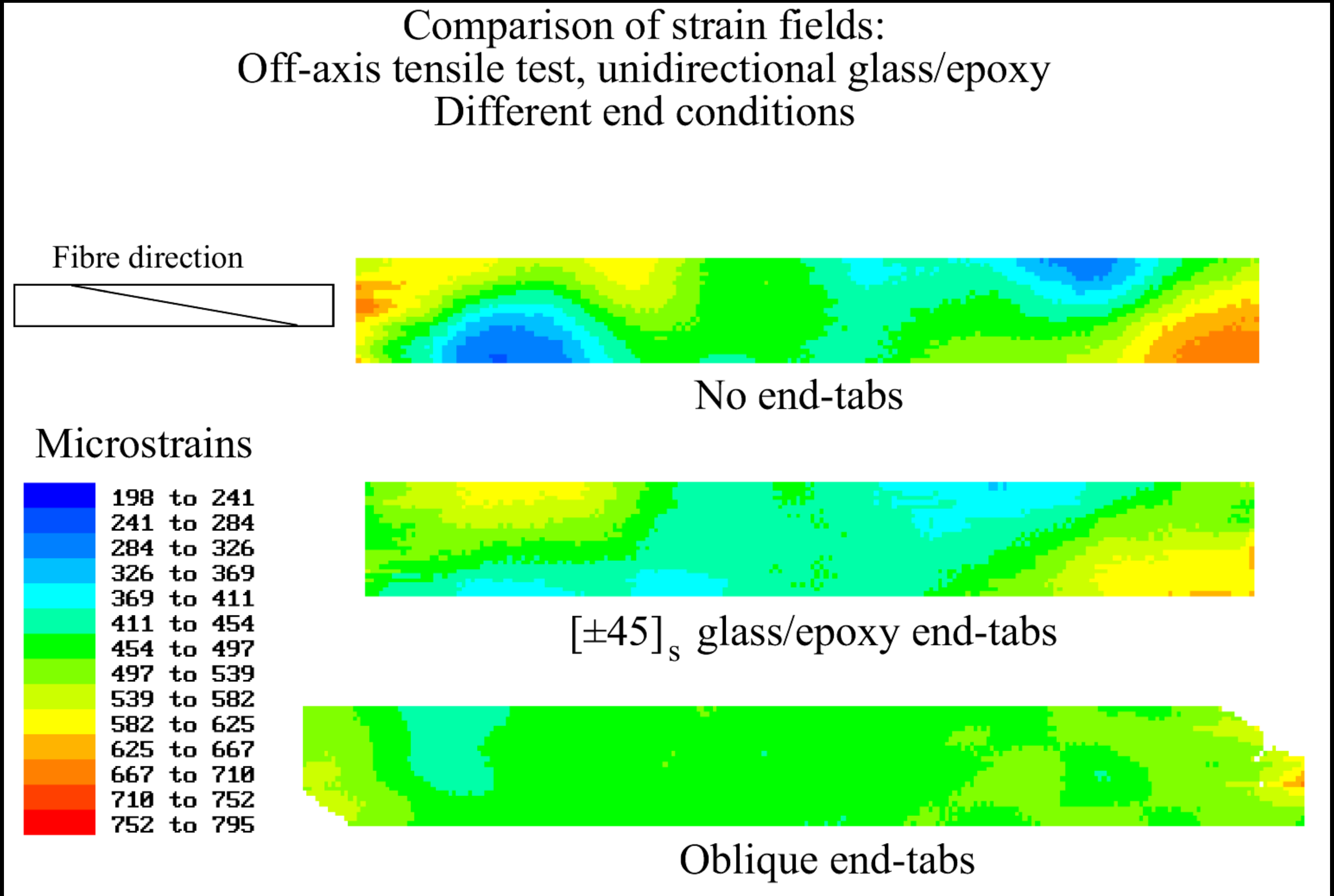


F. Pierron, E. Alloba, Y. Surrel, A. Vautrin, Whole-field assessment of the effects of boundary conditions on the strain field in off-axis tensile testing of unidirectional composites, Comp. Sci. & Tech. 58(12) (1998) 1939-1947.

Experimental validation - displacements

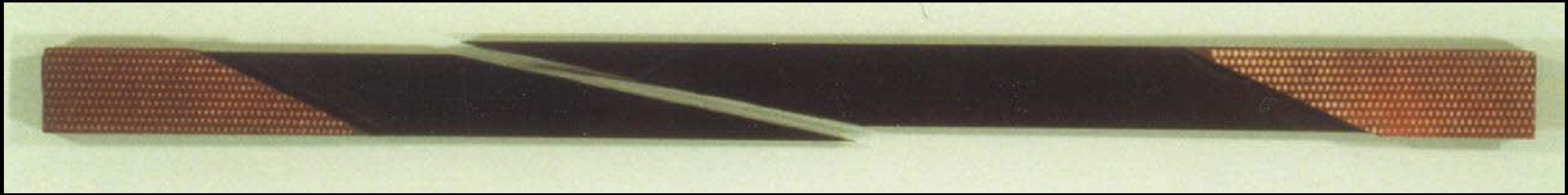


Experimental validation - displacements



Failure

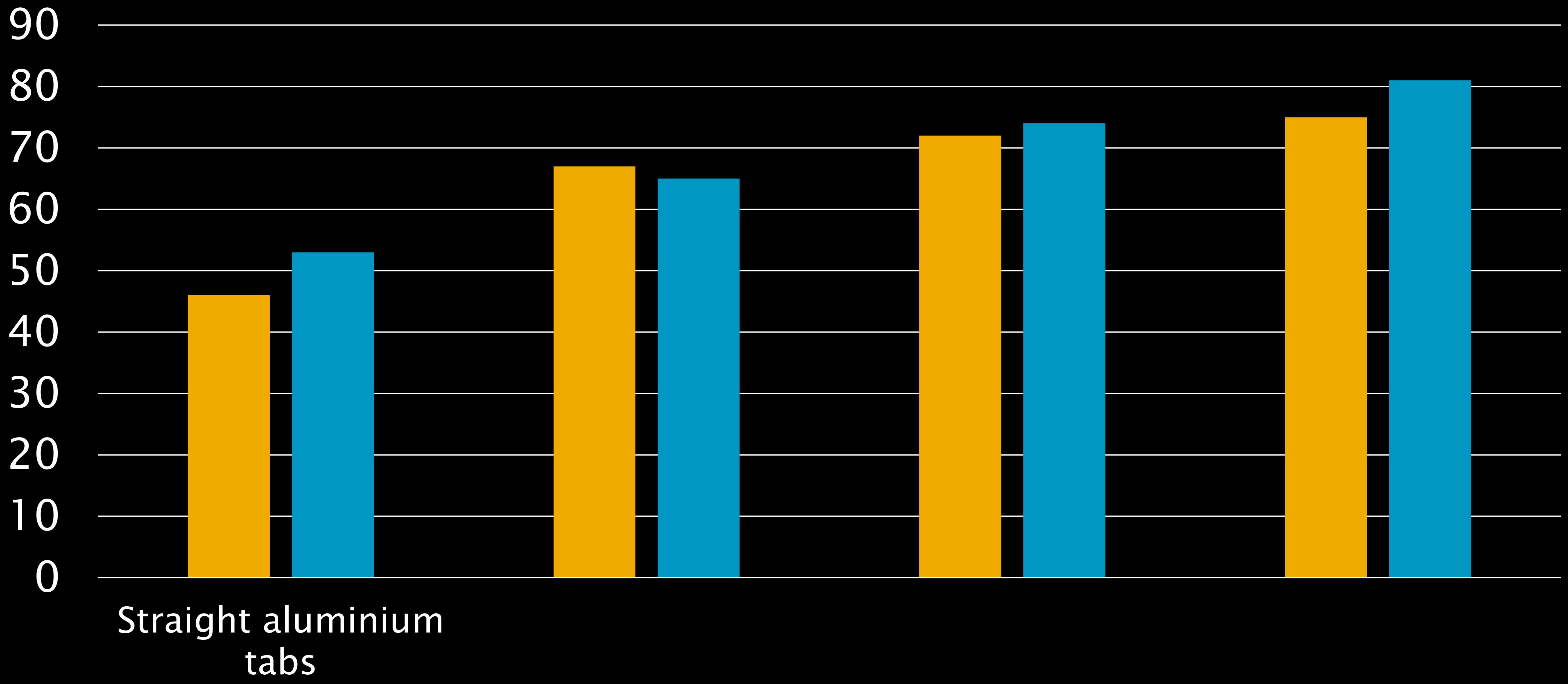
Mean fracture shear stress: 66 MPa



Mean fracture shear stress: 78 MPa

F. Pierron, A. Vautrin, The 10º off-axis tensile test: a critical approach, Comp. Sci. & Tech. 56(4) (1996) 483-488.

Shear failure stress (MPa)



Not pure shear

- In the materials axes (normalized by F/A)

$$\sigma_{11} = 0.96 \; ; \sigma_{22} = 0.04 \; ; \sigma_{12} = -0.17$$

23% of the shear stress

- Need for a failure model
  - In [1], Tsai-Wu was used

78 MPa shear fracture stress → 95 MPa shear strength

- Iosipescu 0º shear test $\sigma_{22} = -0.3 \; ; \sigma_{12} = -1.02$

29%

122 MPa shear fracture stress → 98 MPa shear strength

[1] F. Pierron, A. Vautrin, New ideas on the measurement of the in-plane shear strength of unidirectional composites, Journal of Composite Materials 31(9) (1997) 889-895.