DIA-STRON

DELIVERING MEASUREMENT SOLUTIONS

9th International Conference on Applied Hair Science

Knowledge transfer from the technical fibre world

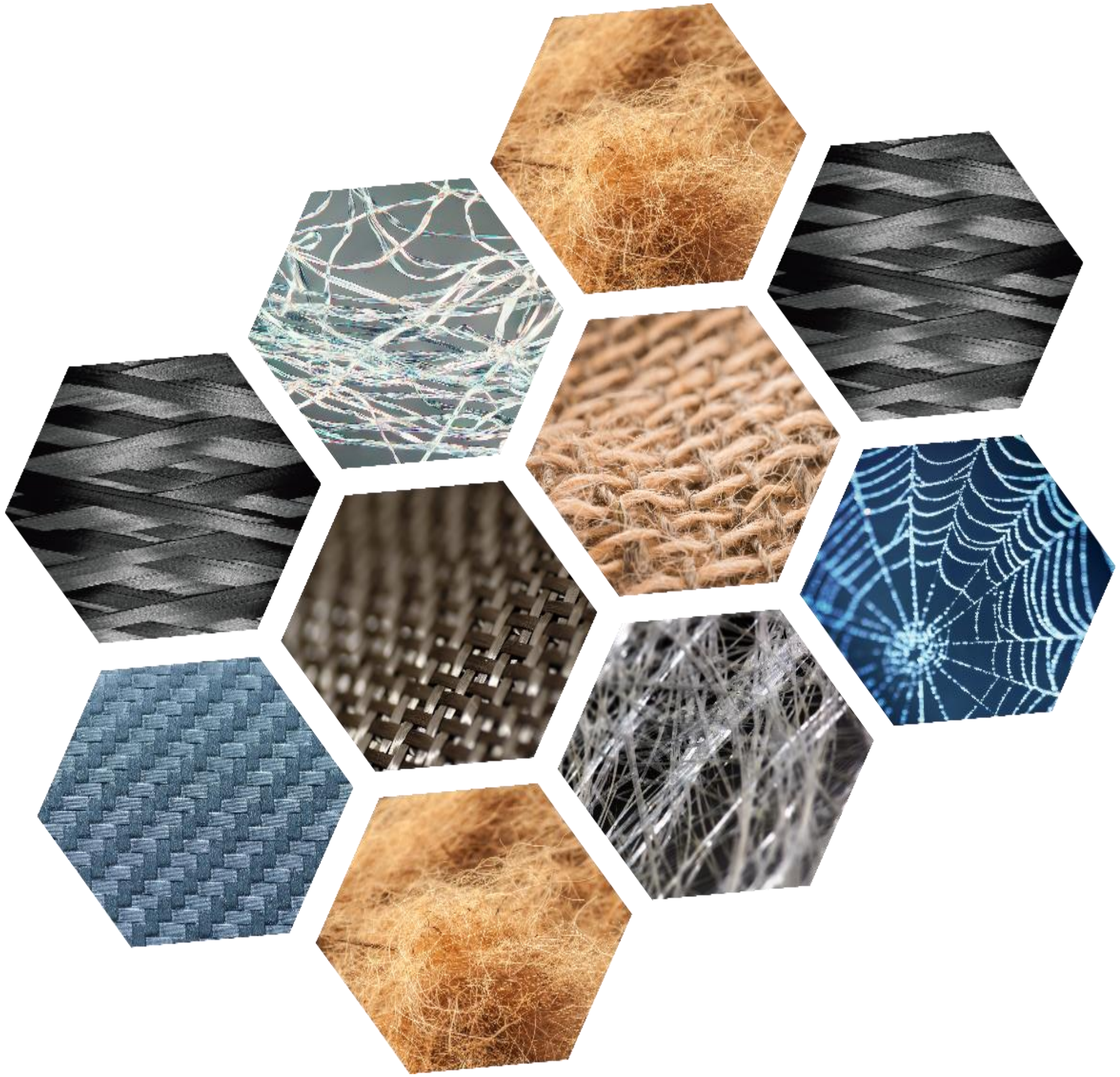
A few ideas to share with the hair fibre scientific community

Yann Leray, Rebecca Lunn, Steve Bucknell and Daniel Stringer

DIA–STRON
DELIVERING MEASUREMENT SOLUTIONS

We live in a fibre world!

"Fibres are long, fine forms of matter with diameters generally of the order of ten or a few tens of microns and lengths ranging from a few millimetres to virtually being continuous."



Connected to technical fibre academics

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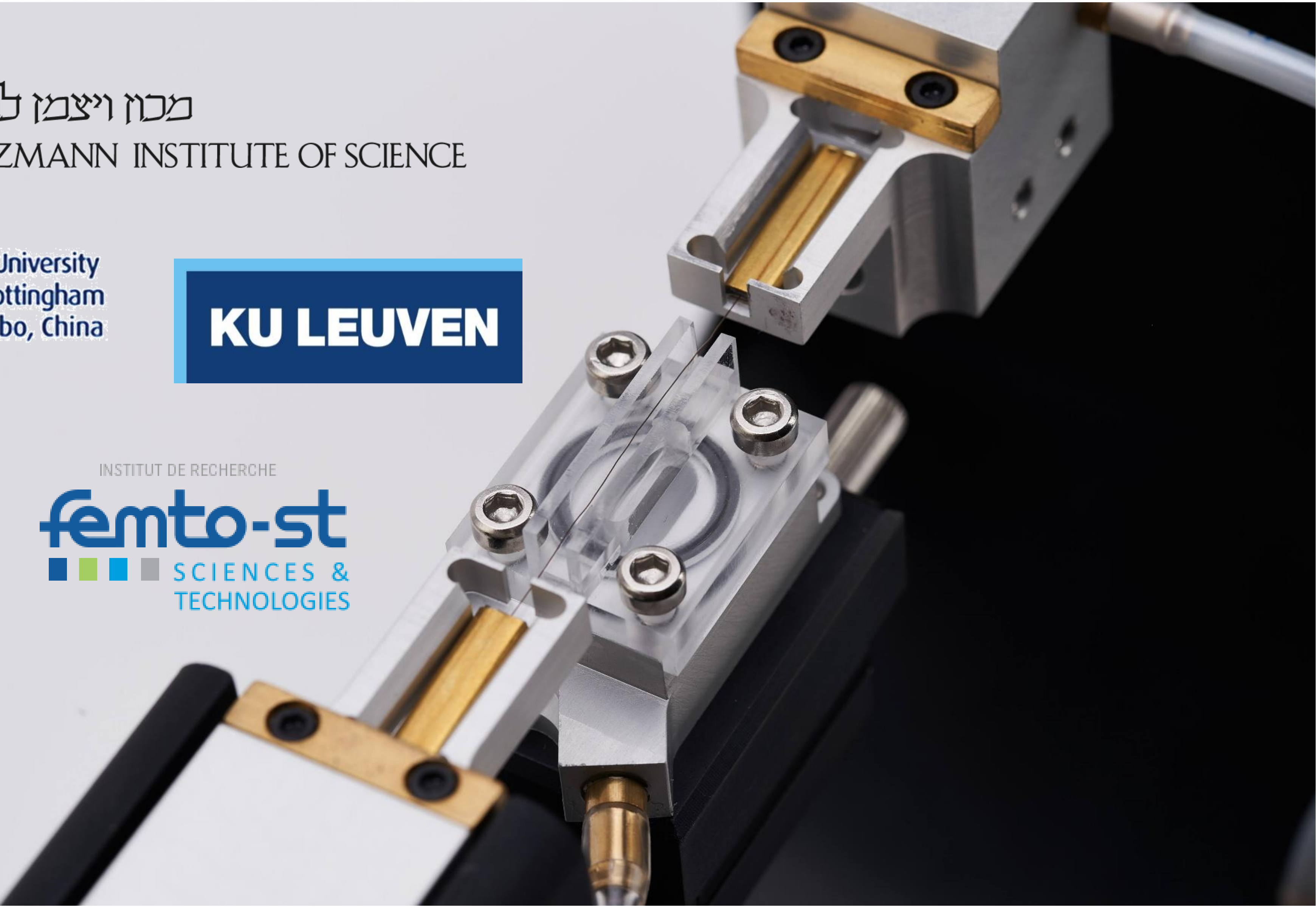
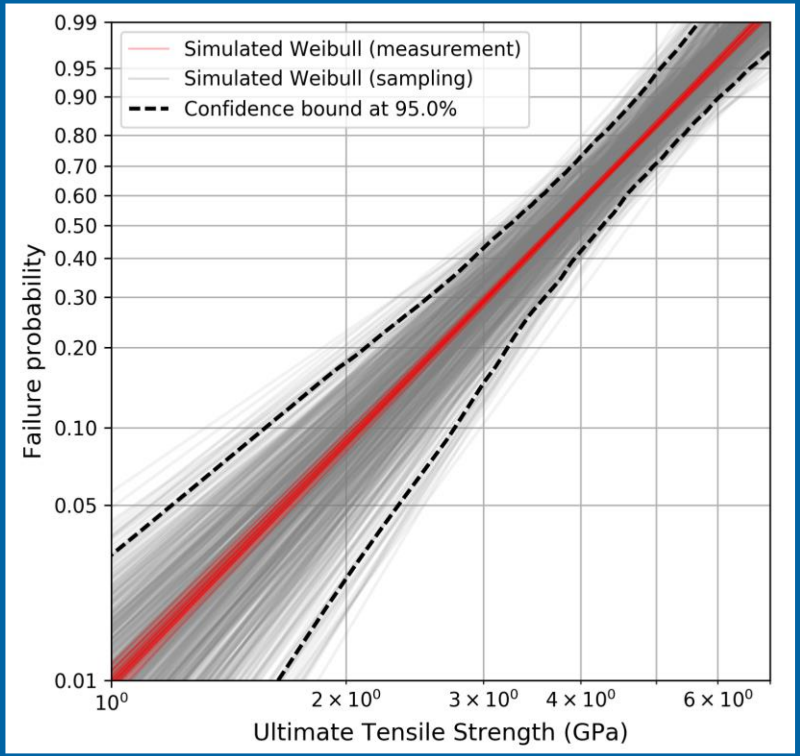


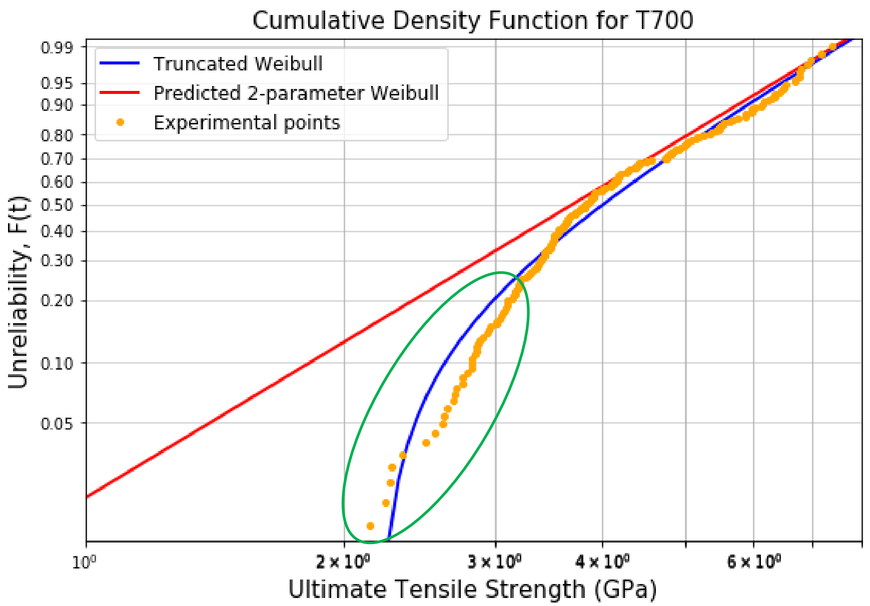
New approaches to fibre mechanical data analysis



New analysis techniques

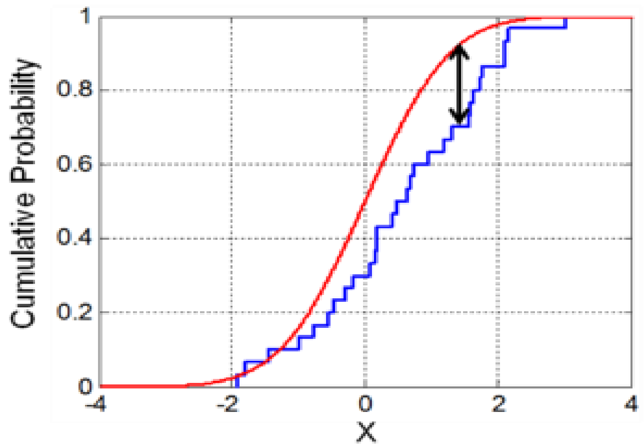
Weibull distribution fitting

- 2-parameter Weibull distribution does not fit particularly well weak fibres
- A truncated Weibull distribution proposed
- Considering fibres broken during sample mounting
- Can be applied to hair fibre fatigue or break stress data



Kolmogorov-Smirnov goodness-of-fit test

- Used to decide if a sample comes from a population with a specific distribution
- Returns 2 values: D-statistic and P-value
- Ideal to test if fatigue data fit Weibull distributions



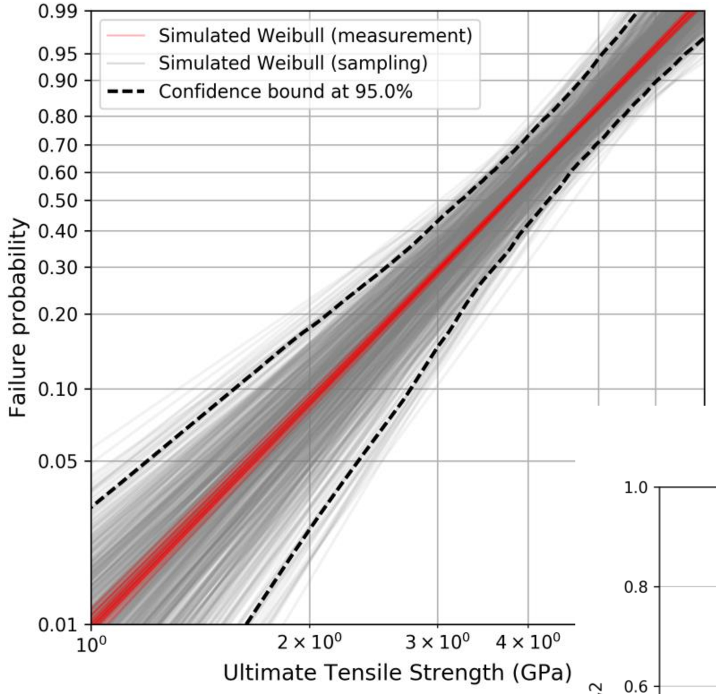
New analysis techiques

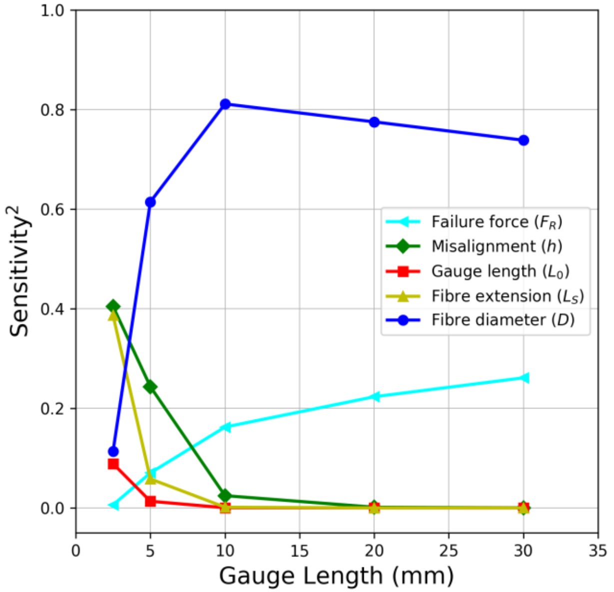
Calculation of confidence interval for Weibull parameters

- Based on Monte-Carlo simulation (Bootstrap method)
- Is your fatigue data significantly different?
- How many specimens do you need to achieve differentiation?

Sensitivity analysis

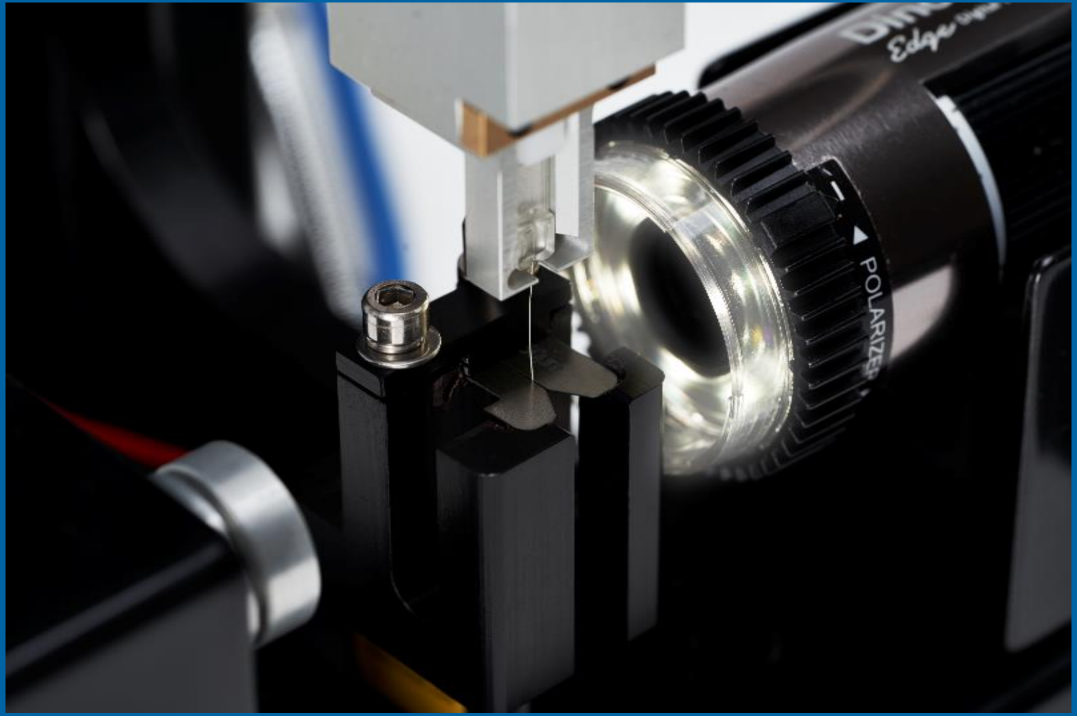
- Quantifying measurement uncertainties
- Relating calculated uncertainties to method parameters
- Determining best specimen gauge lengths
- Sensitivity analysis can help reducing data variation and increase treatment differentiation

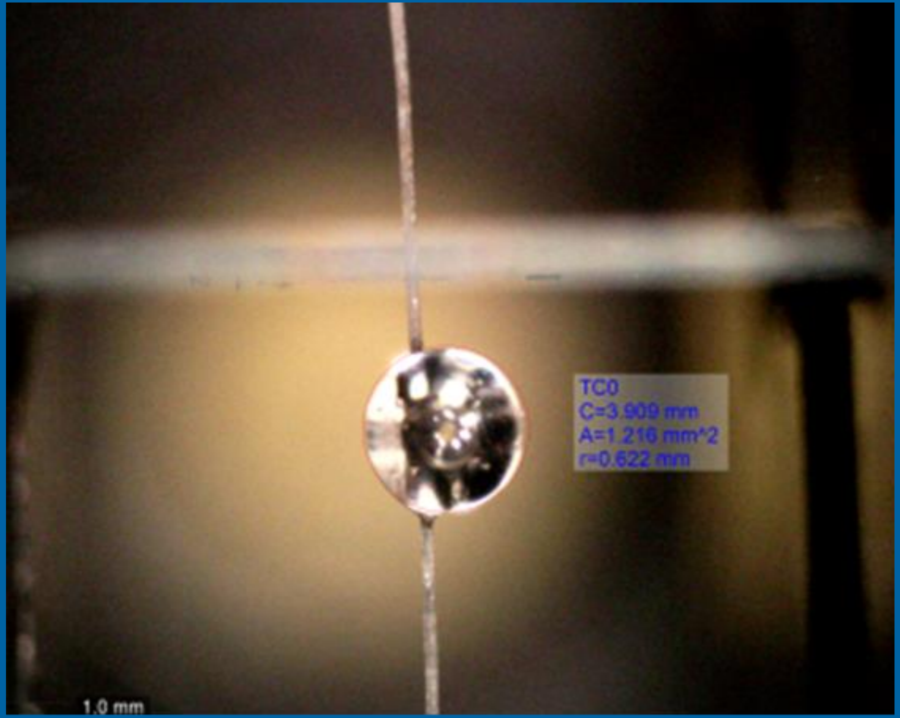




Sensitivity indices for different quantities of fibre strength at different gauge lengths

IFSS – Interfacial Shear Strength



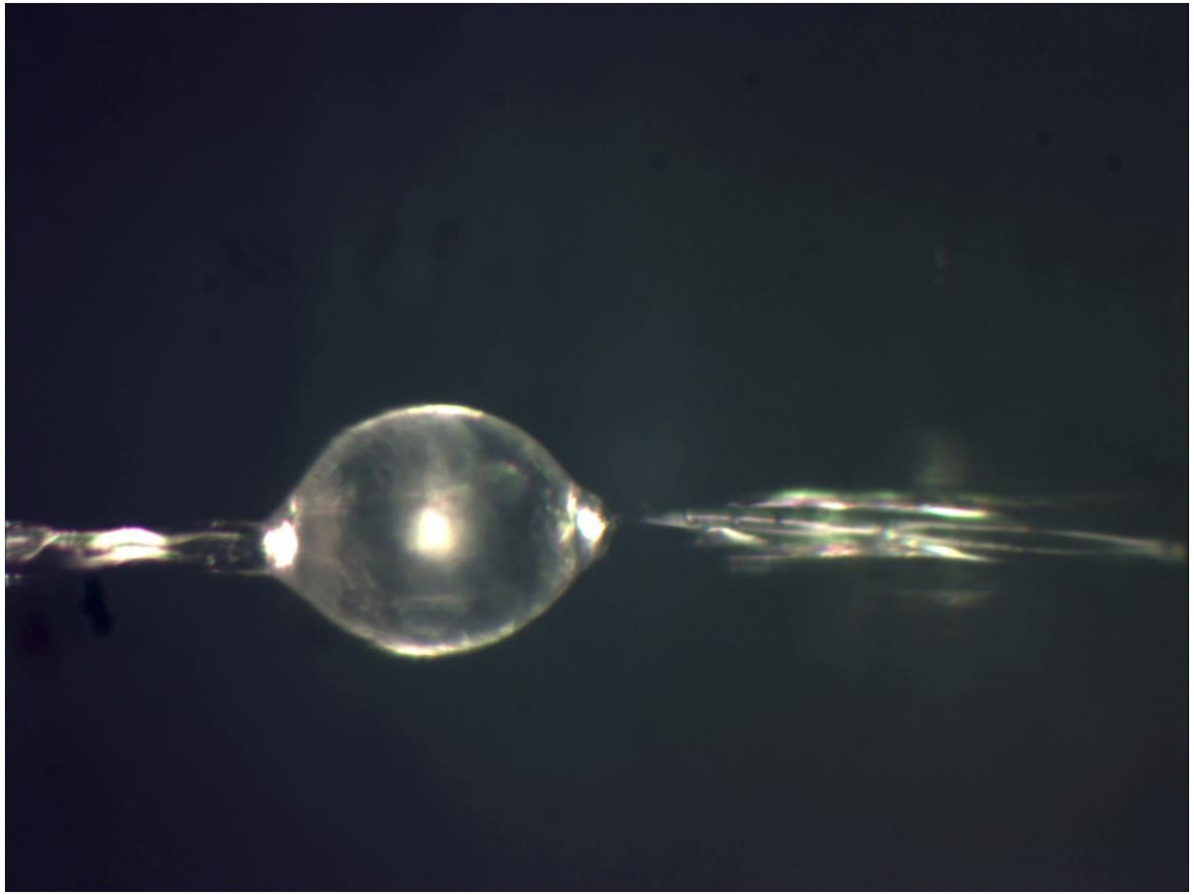


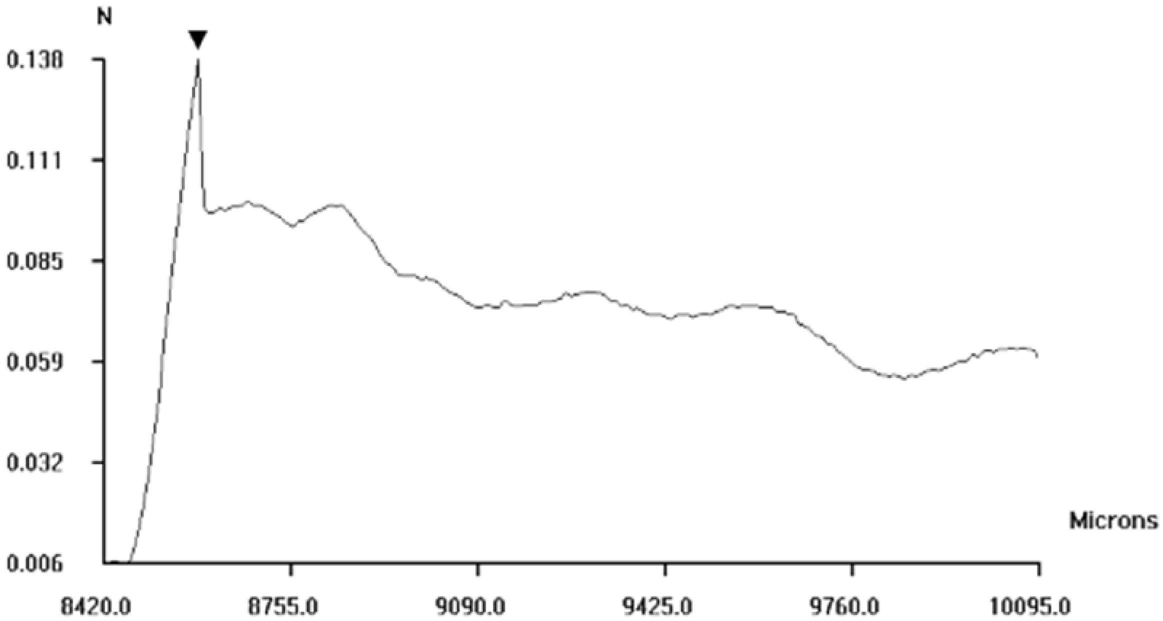
Interfacial Shear Strength (IFSS)

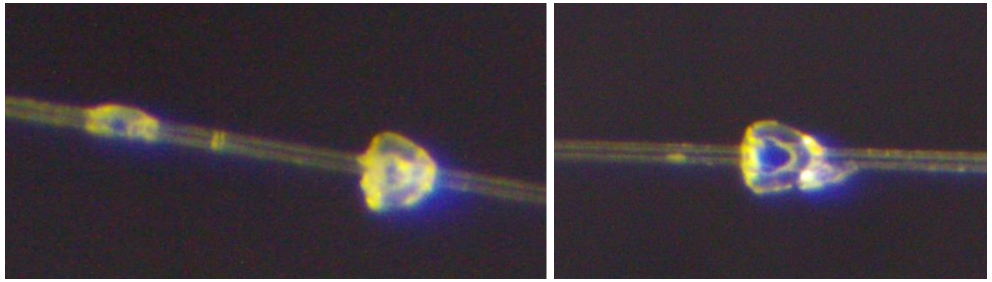
LEX IFSS module with camera

- Measures the fibre-matrix interface
- Based on the micro-bond set-up
- Detailed interfacial shear data
- Image calibration and droplet measurements
- High speed video and image capture via USB connection
- High positional repeatability and accurate speed control
- Adjustable magnification (10 - 220x) and built-in polarization

Interfacial Shear Strength (IFSS)

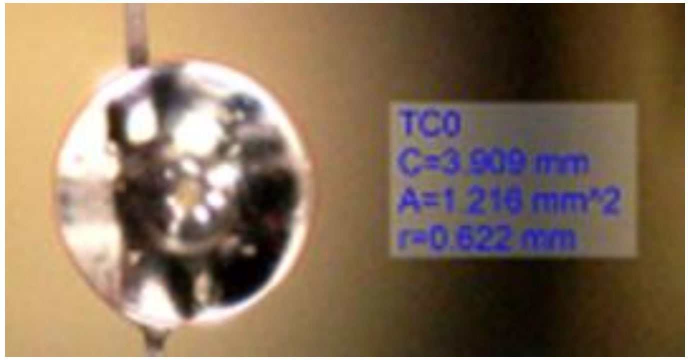






Visualising modes of failure

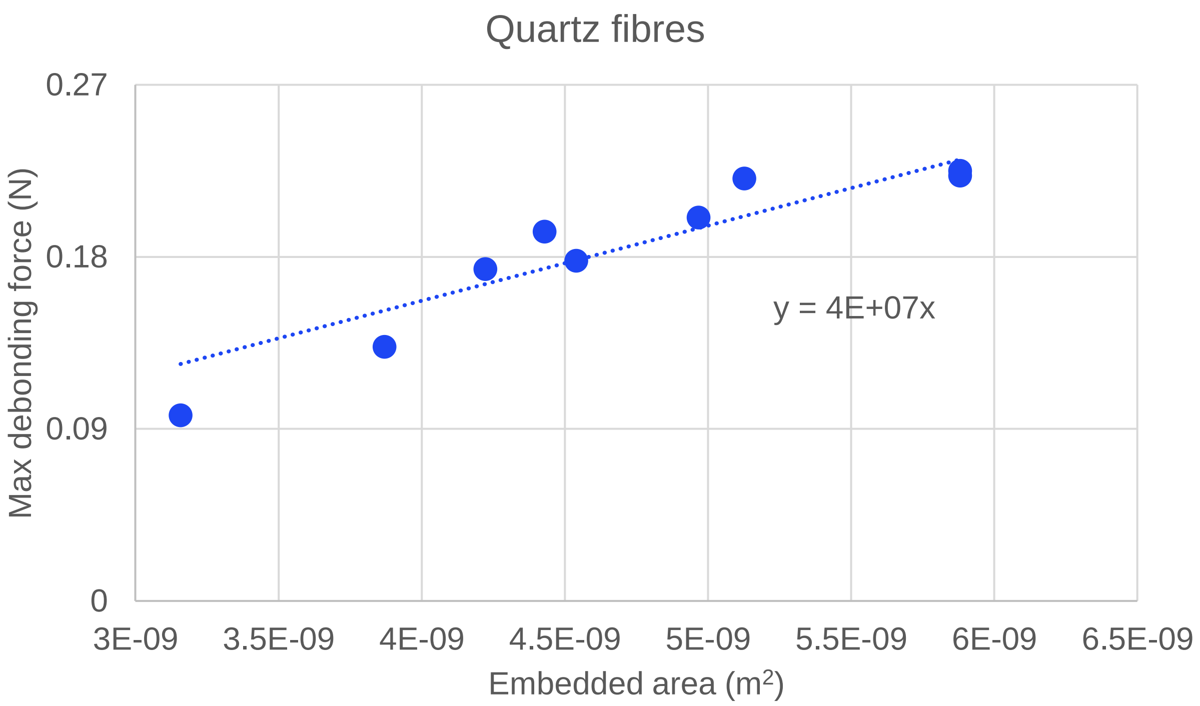
Interfacial Shear Strength (IFSS)



Estimation of interfacial shear strength

- Fibre diameter measured by laser scanning
- Droplet size measured by microscopy
- ⇢ embedded length

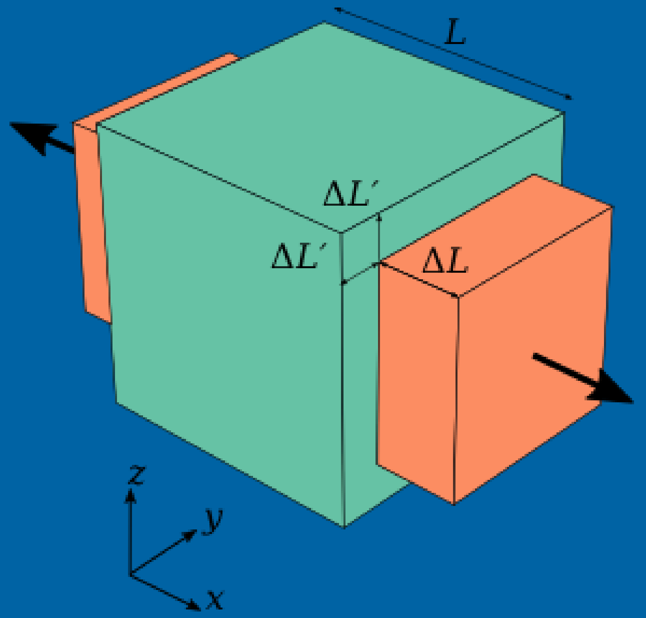
$$\mathrm{IFSS} = \frac{F}{\pi D L}$$



Applications for hair

- Adhesion between styling polymers and hair fibres
- Failure modes and hysteresis (cyclic)
- Impact of relative humidity on interfacial strength
- Hair fibre surface compatibility to styling ingredients

Poisson's Ratio

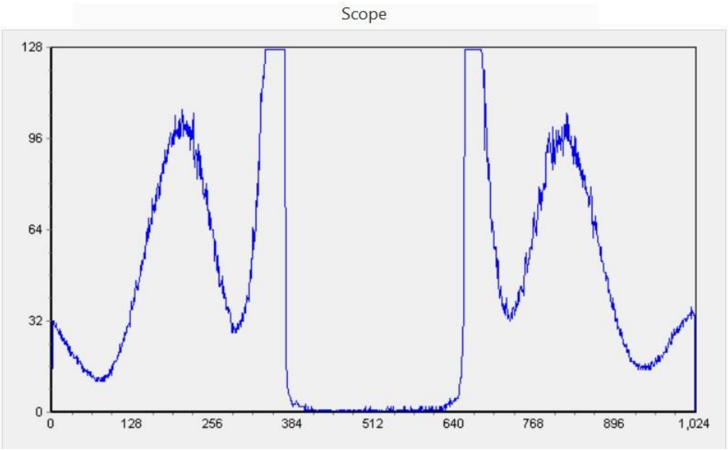


Siméon Denis Poisson (1781–1840)
French mathematician, engineer, and physicist

Evaluation of fibre Poisson's ratio

Measurement system

- Integrated LDS0200 and LEX820 instrument
- LEX: Linear Extensometer for tensile measurements
- LDS: Laser Diffraction System for diameter measurements
- Combined diameter and tensile test

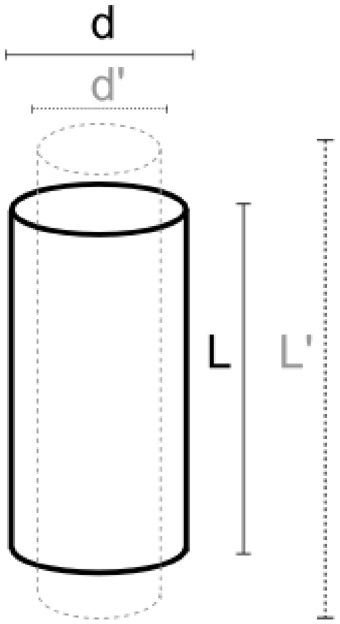


Diffraction pattern of a 7 microns carbon fibre

Evaluation of fibre Poisson's ratio

Poisson's ratio measurement on carbon filaments

- Test on 7 microns carbon fibres, extremely rigid
- Diameter monitored during uniaxial load

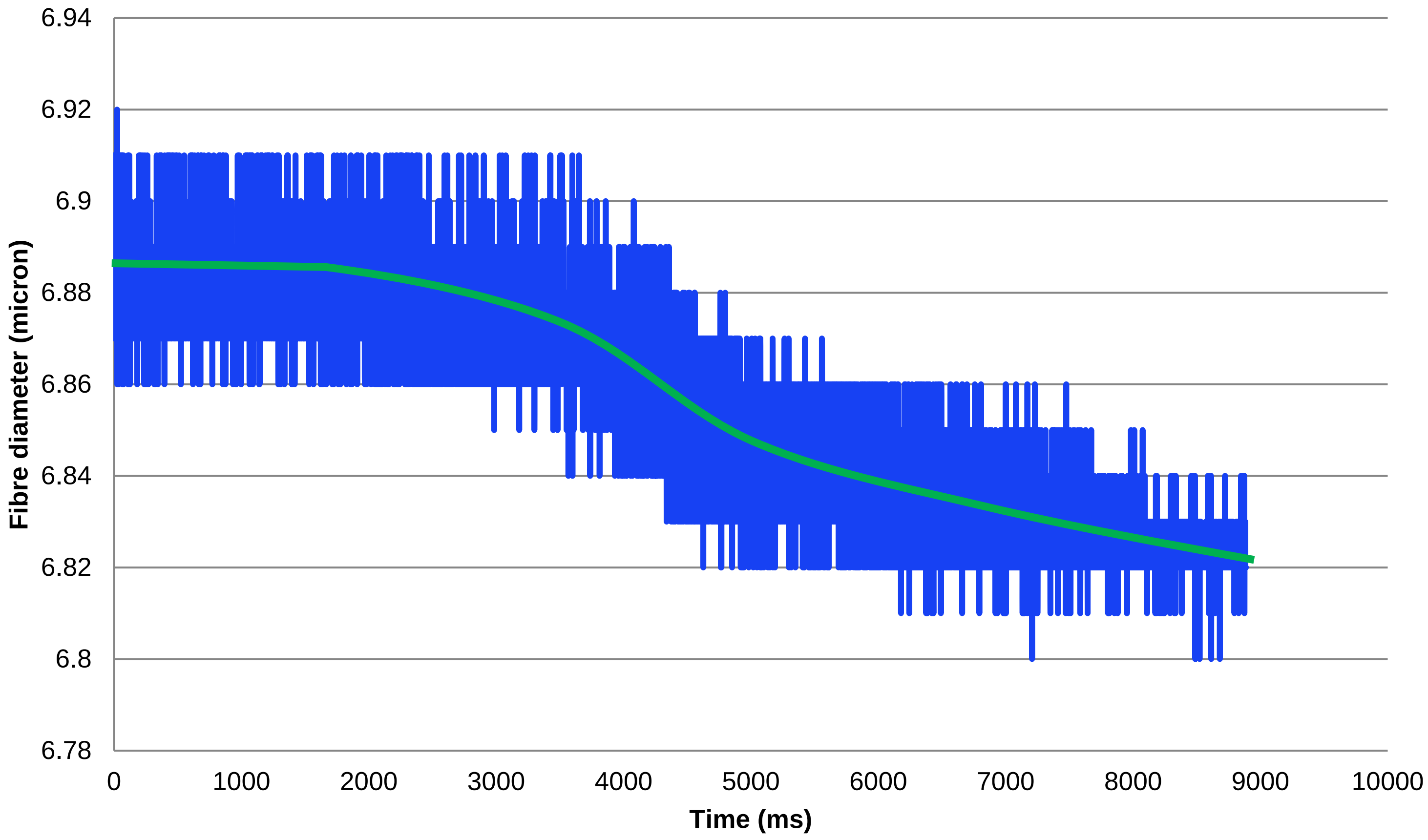


Strain

$$\varepsilon_{long} = \frac{L' - L}{L}$$

$$\varepsilon_{lat} = \frac{d' - d}{d}$$

Poisson's Ratio: $\nu = -\frac{\varepsilon_{lat}}{\varepsilon_{long}}$



Evaluation of fibre Poisson's ratio

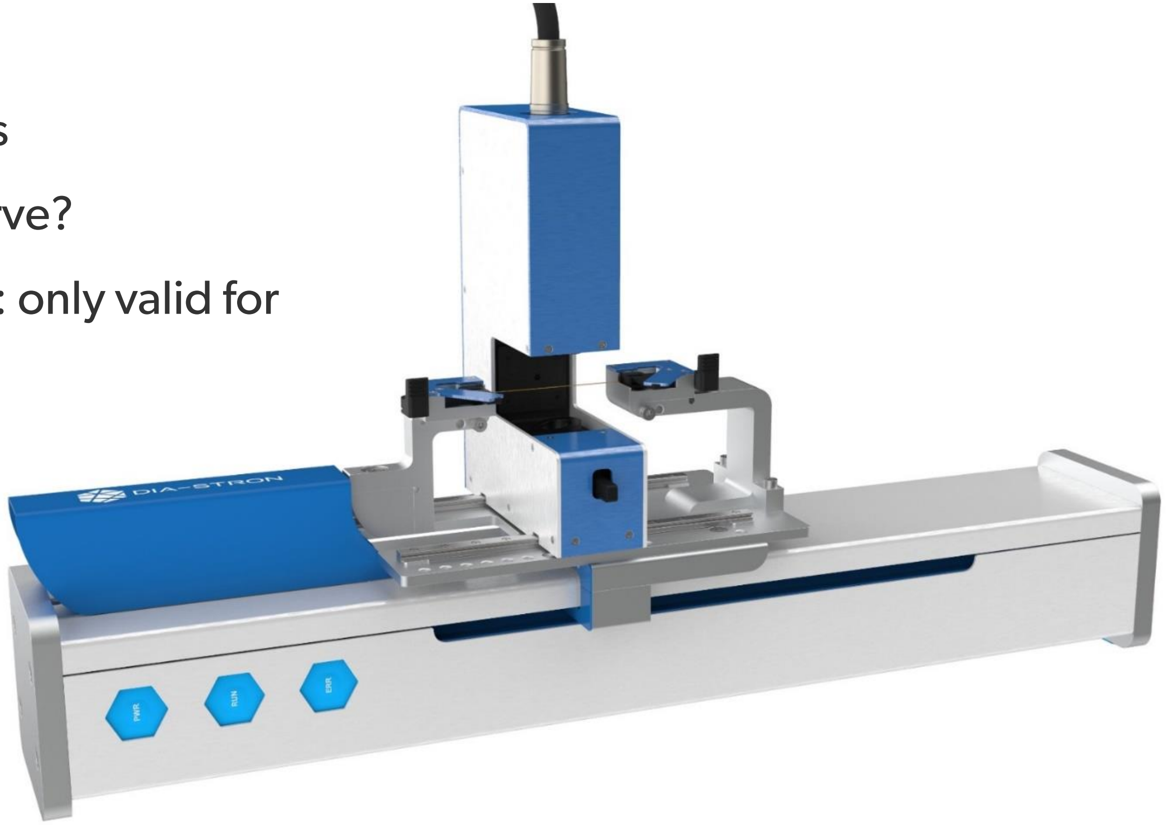
Application for hair fibres

- Test hair fibre diametral contraction under uniaxial deformation
- Hair break stress with fibre diameter prior to failure
- Understanding impact of cosmetic treatment & practices
- Testing hair fibres in water: what behaviour do we observe?
- Relate fibre elastic modulus with shear/torsion modulus: only valid for an isotropic material but worth looking at…

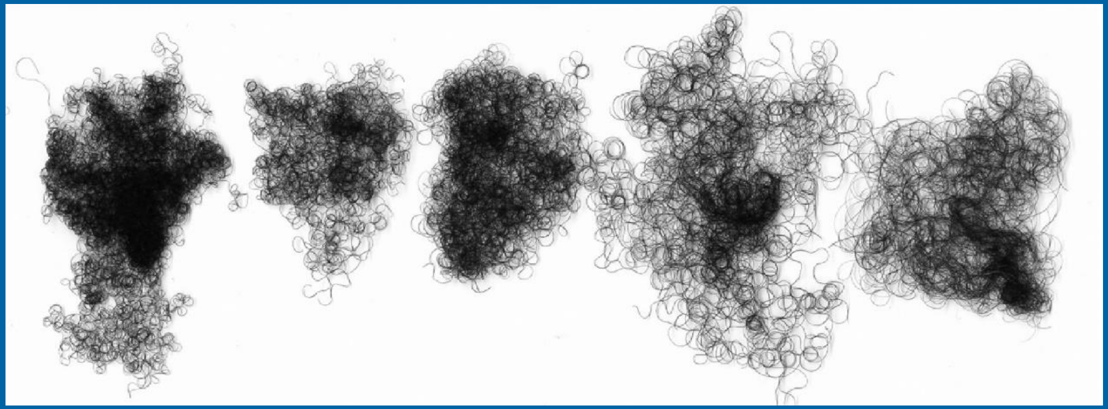
$$E = 2G(1 + \upsilon)$$

where

- υ is the Poisson's ratio
- E is the modulus of elasticity [Pa]
- G is the shear modulus [Pa]



Measuring decrimping of curly or crimped fibres



A teaser…

The biology and genetics of curly hair, Gillian E. Westgate, Experimental Dermatology. 2017;26:483–490

Video…

fibra.lex.decrimp

The first dedicated instrument for crimped fibre measurements

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Merci…

For more information, please visit our website at
www.diastron.com or email **info@diastron.com**

9 Focus Way,
Andover, Hampshire
SP10 5NY UK
+44 (0) 1264 334 700

9 Trenton Lakewood Road
Clarksburg, New Jersey
08510 USA
+1 (609) 454 6008