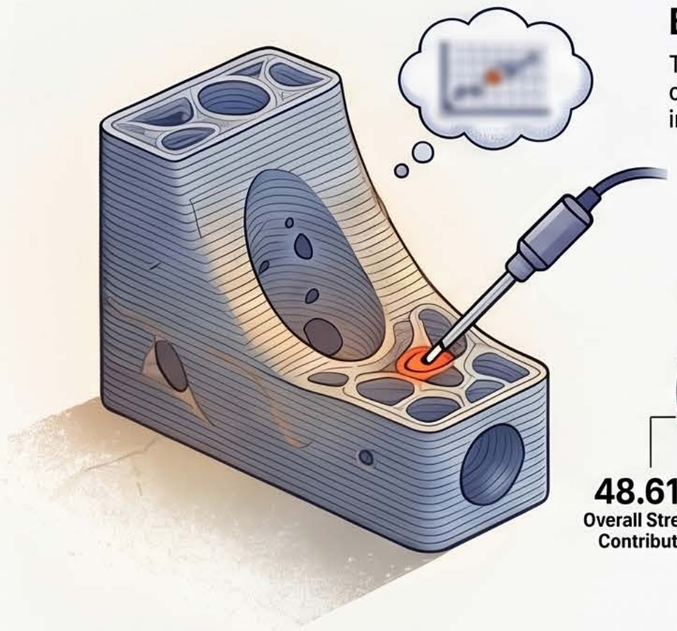
Mapping the Invisible: Digital Image Correlation for 3D-Printed Polymers

Additively manufactured polymers are inherently complex, exhibiting mechanical anisotropy and microstructural defects that traditional sensors cannot capture. Digital Image Correlation (DIC) provides a non-contact, full-field metrological solution to map strain and displacement with sub-pixel precision, enabling the industrial certification of 3D-printed components.

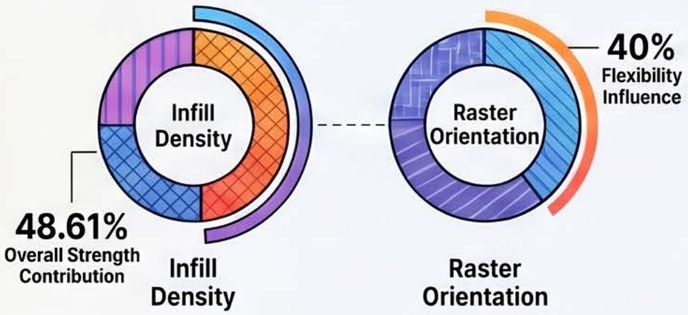
THE METROLOGICAL CHALLENGE OF AM



Beyond Single-Point Sensing

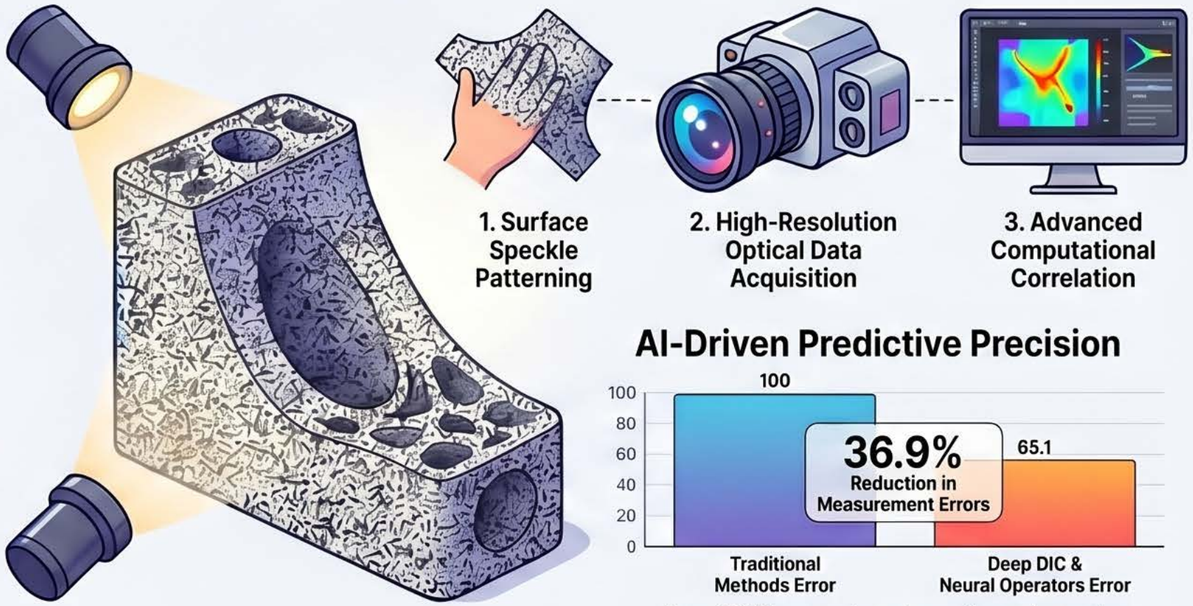
Traditional sensors average out data, obscuring critical localized strain concentrations at filament interfaces and voids.

Anisotropy and Infill Impact



ADVANCING TO INDUSTRY 4.0

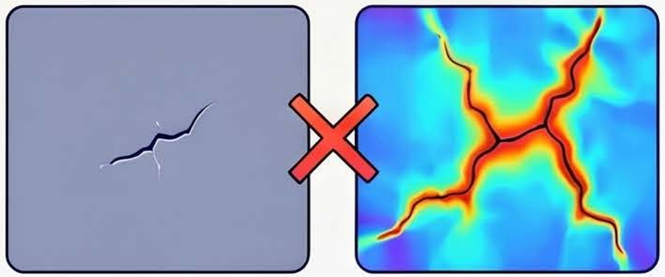
The Three-Stage DIC Workflow



AI-Driven Predictive Precision

'Deep DIC' frameworks and neural operators reduce measurement errors by 36.9% over traditional methods.

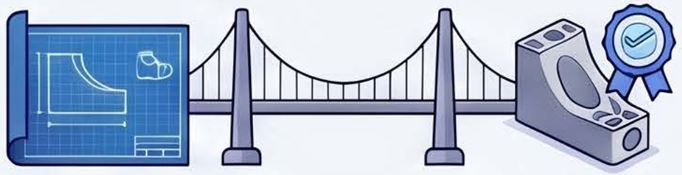
Captured vs. Obscured Failure



DIC Parameter Impact Table

DIC Parameter	Impact on Characterisation	Technical Implication
Subset Size	Signal-to-noise ratio	Larger subsets smooth over filament-level strain concentrations
Step Size	Strain map density	Smaller steps increase the resolution of localized shear bands
Correlation Criterion	Lighting invariance	ZNSSD is required for monitoring environments with flickering heat sources

Standardised Industrial Certification



Adopting the Metrological Efficiency Indicator (MEI) bridges the gap between as-designed simulations and as-built validation.