Validating Simulation Using Digital Image Correlation

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DatapointLabs
SIMULIA Community Conference 2013

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DatapointLabs

expert material testing

- Physical properties of materials
  - Mechanical properties
  - Thermal properties
  - Flow properties
- Globally available at

  www.datapointlabs.com

  visit | browse | buy | download

tensile
compressive
flexural
stress-strain
Poisson's ratio
high strain rate
bulk modulus
fatigue
visco-elasticity
stress relaxation
creep
friction
hyperelasticity
thermal expansion
thermal conductivity
specific heat
PVT
rheology

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Material testing expertise

- Product development / R&D support
  - Over 1,800 materials tested each year
  - All kinds of materials
  - Over 200 kinds of physical properties

–Plastic
–Rubber
–Film
–Metal
–Foam
–Composite
–Cement
–Ceramic
–Paper
–Wire
–Fiber

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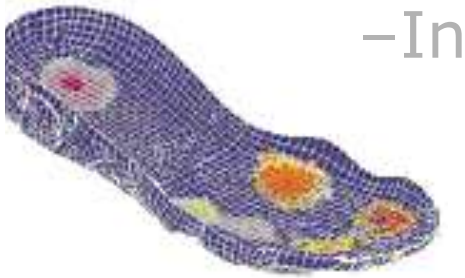
Customer base

- 1200 companies
- 34 countries worldwide
- 11 manufacturing verticals
- Product development / R&D

–Aerospace
–Automotive
–Appliance
–Biomedical
–Consumer products
–Electronics
–Industrial Goods
–Materials
–Petroleum
–Packaging



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TestPaks: CAE Material Model Parameters for Abaqus

- FEA of Non-linear materials
  - Hyperelastic
  - Elastic-Plastic
  - Rate Dependency
  - Hyper/Crush Foam
  - Creep/Viscoelasticity
  - All available with temperature effect

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Hyperelastic

- Tensile
- Compressive
- Planar
- Volumetric
- Range
  - Pre-cycled or first pull
  - -50 to 200 C
  - Rate dependency

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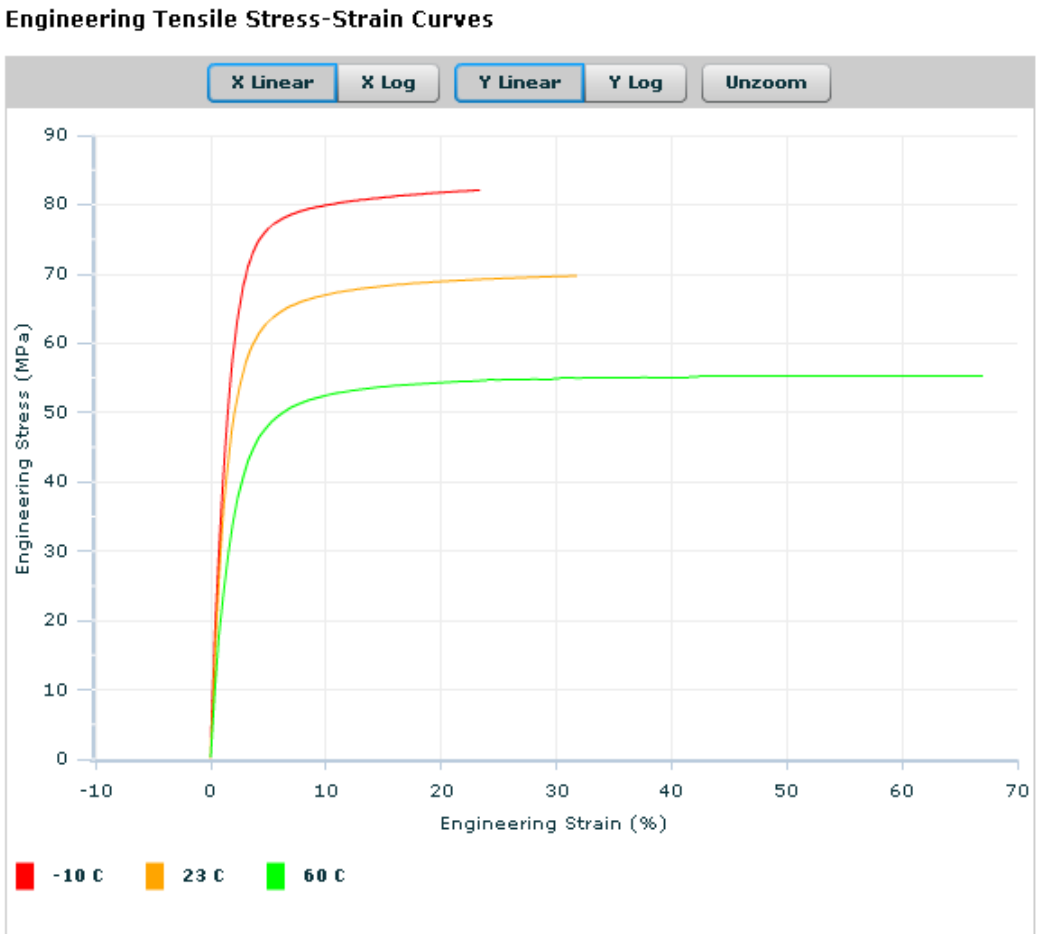
Plastics non-linear stress-strain



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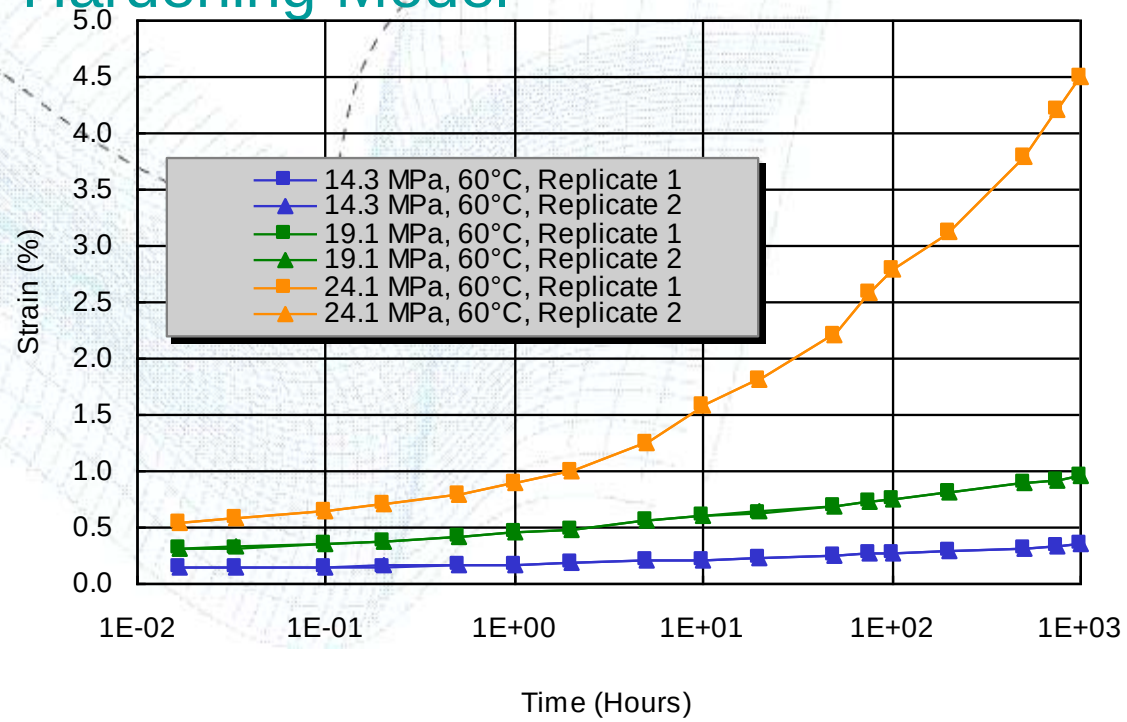
Creep Modeling

- Creep Strain vs. Time Fit to Time Hardening Model



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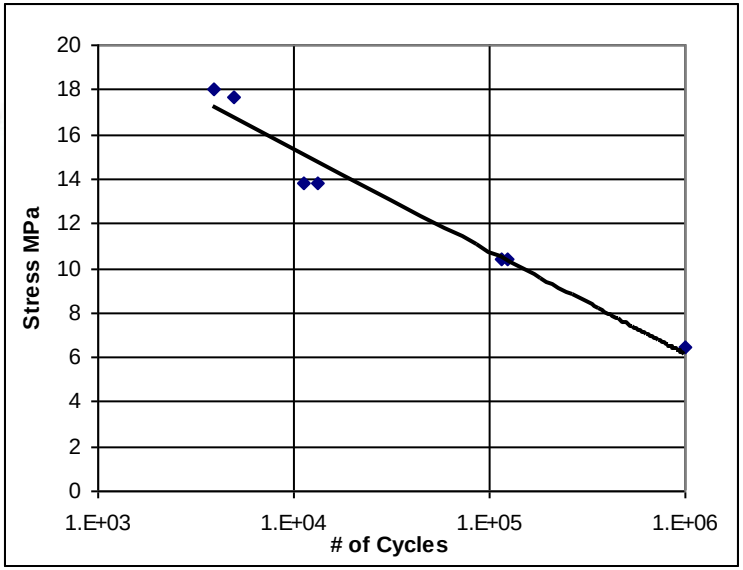
Fatigue Modeling

- S/N curves
- Tensile or flex
- Frequency issue



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US test laboratory

EST 1995
ISO 17025 Quality

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Verification and Validation (V&V)

Reasons for V&V

- The selected material model captures the behavior
- Calibrated starting point
- Traceability of simulation
- Boundary condition determination
- Failure modes
- Saves time and money chasing down deviations

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Material Model Generation and Verification

Perform accurate tests required for your material model

Generate material model and any material parameters

```
** Output generated by Matereality
** Abaqus Plastic Model
*MATERIAL, name=Delrin8753K13
*ELASTIC
3607.59123689013, 0.2413, -10
3183.7938807461, 0.323571664399527, 23
2174.59568965032, 0.39415, 60
****
*PLASTIC
46.381708640637, 0,-1.000E+01
59.3182190072696, 0.0028490427305577354,-1.000E+01
71.8736400512504, 0.01017006174294555,-1.000E+01
76.7156702762688, 0.016802750802138691,-1.000E+01
79.8204244473178, 0.0246331420035193,-1.000E+01
83.7520014704219, 0.042400203020399568,-1.000E+01
88.44580120706, 0.07511425176203515,-1.000E+01
101.286187380666, 0.18221125102592156,-1.000E+01
**
```

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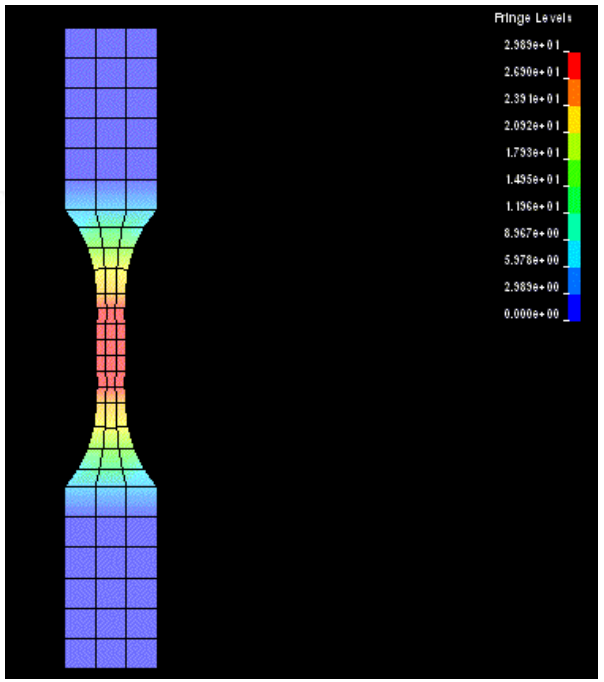
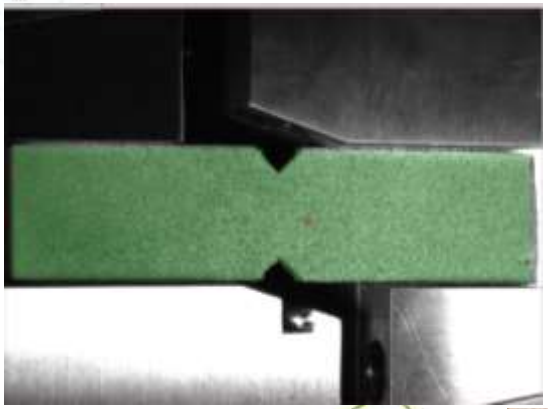
Material Model Generation and Verification

Perform simulation of test to ensure model stability



Perform a well controlled physical test that includes deformations that your actual part may experience. Measure strain field using DIC.



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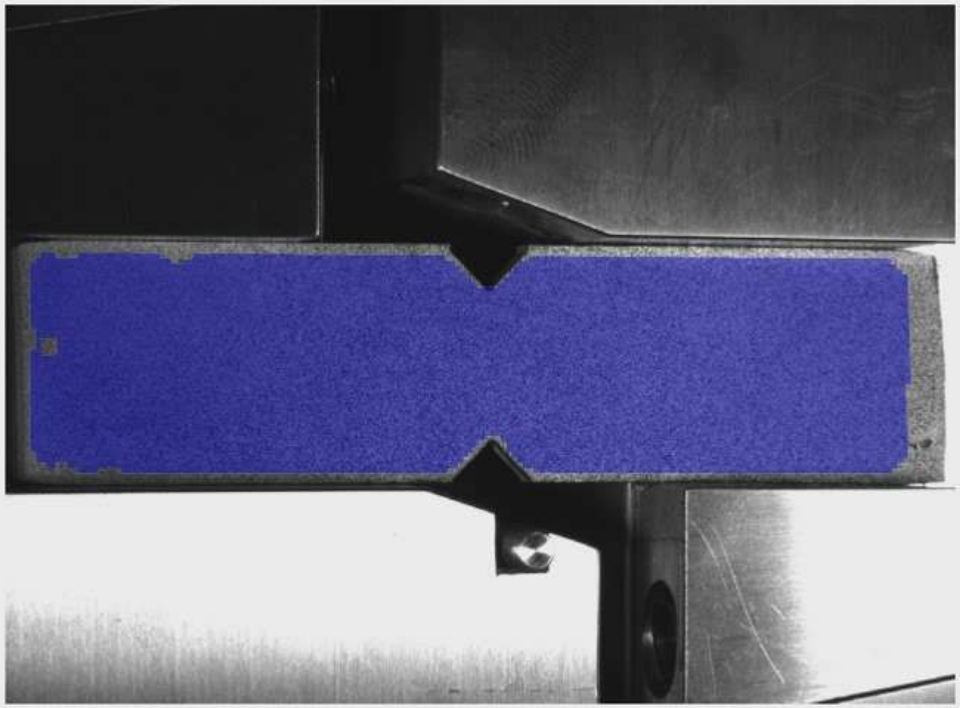
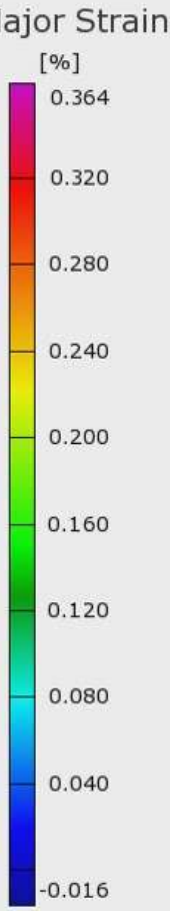
Material Model Generation and Verification





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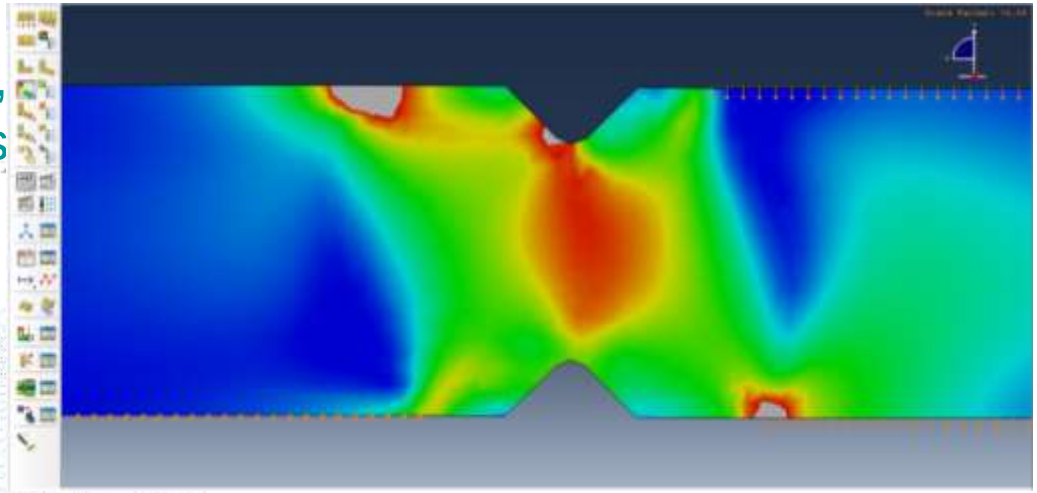
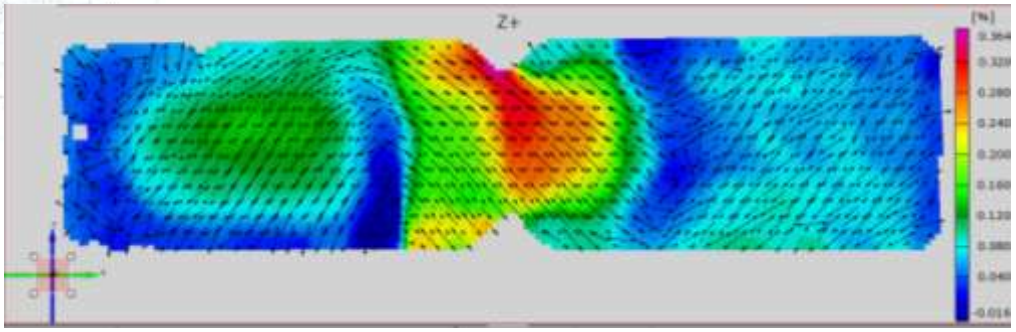
Verification of Material Model

Perform simulation of test, verify boundary conditions



Calculate actual strains during the testing using ARAMIS DIC software



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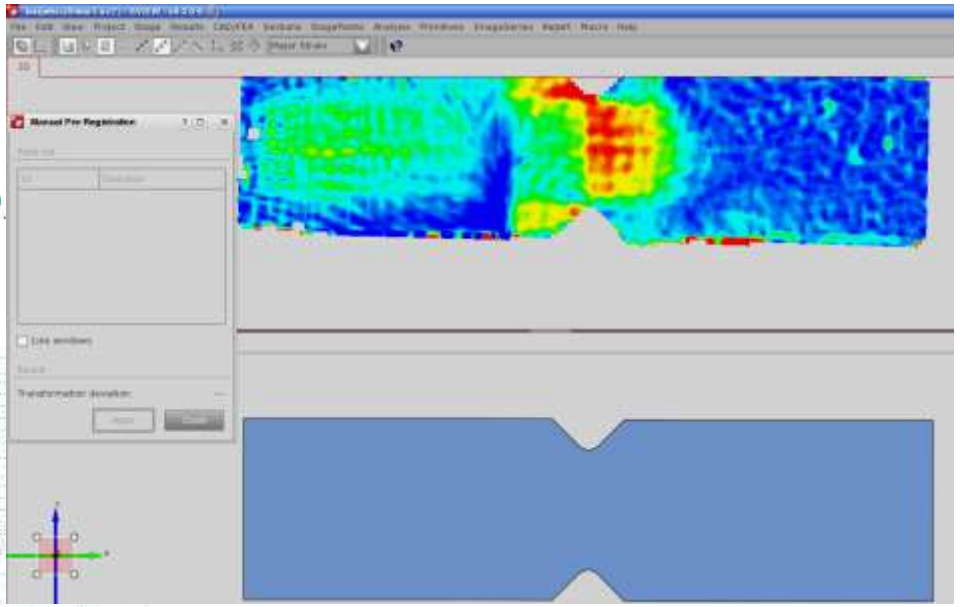
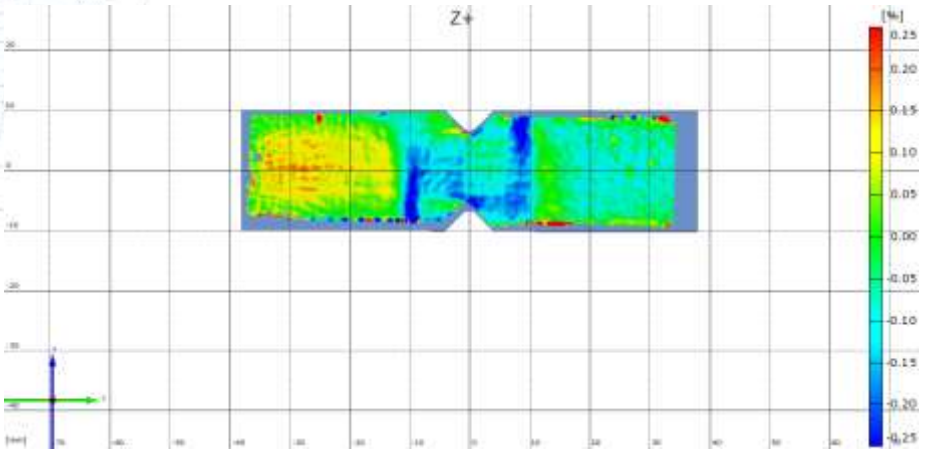
Verification of Material Model

Import ODB file and map surfaces from Abaqus to 3D image surface



Compute deviation between measured strains and simulated strains.



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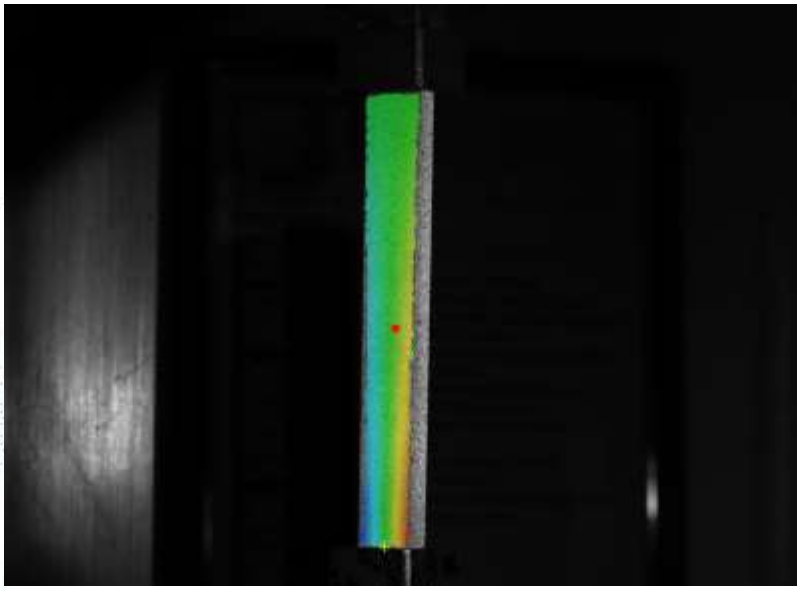
Verification with Additional Modes if Needed

Augment calibration with other modes of deformation as needed



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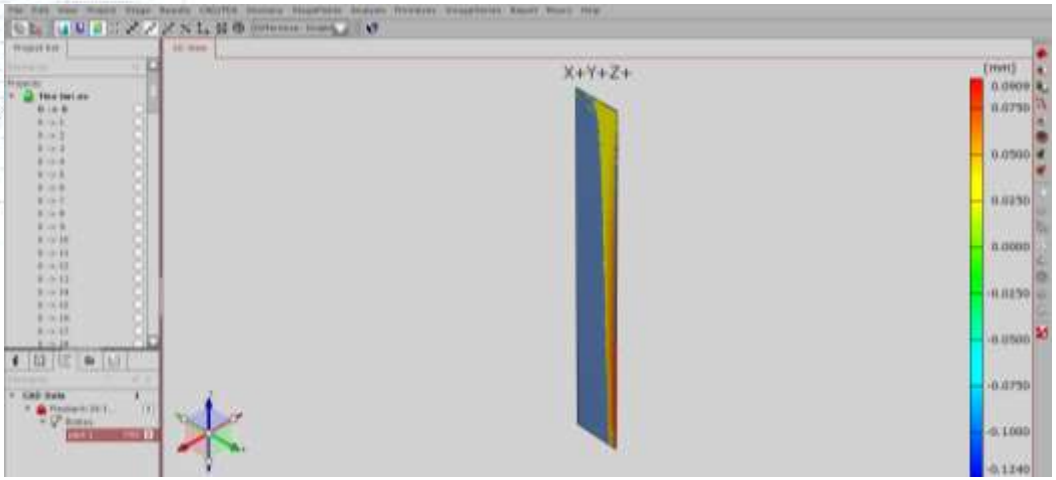

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Evaluate the Material Model

- Material parameters may need to be adjusted
- New material model may need to be selected
- Conceptualize component test/simulation and verify that nothing has been left out (deformation mode, environment, etc.)
- At this point a robust material model should exist
- Model verification is complete now validate with component test

```
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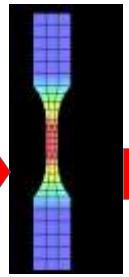

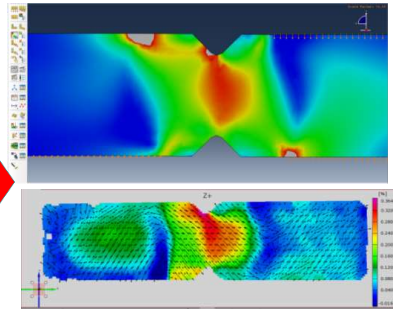

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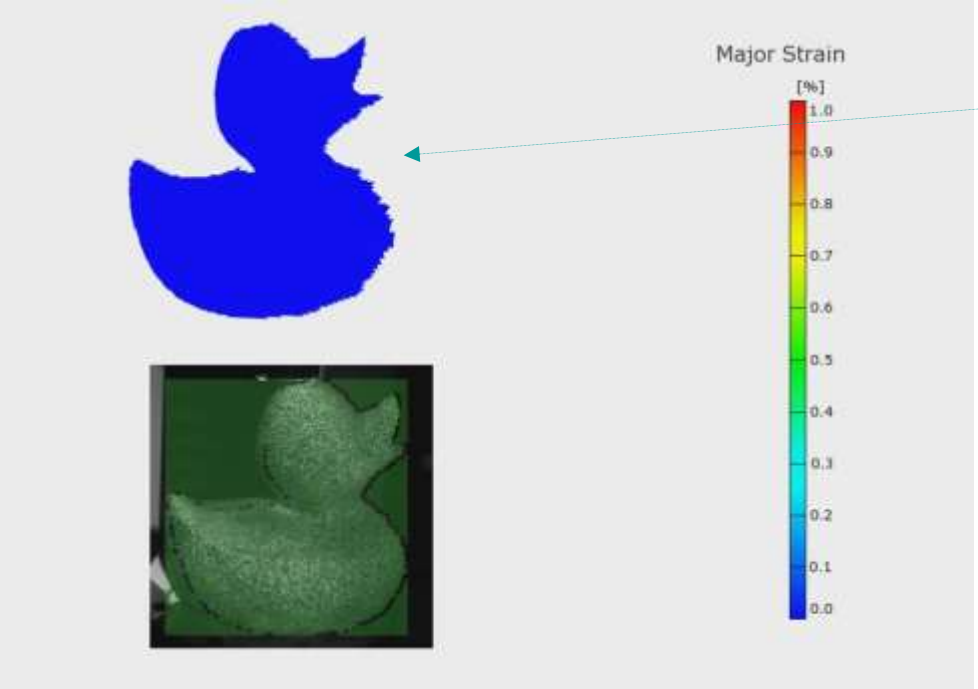
Component Measurement

- The material model can now be applied to the component simulation
- The DIC can now be used to refine boundary conditions of the actual test



Live mapped strain field

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Conclusion

- Verification and validation is an important step to robust simulation
- Have confidence in your simulation prior to component testing
- Currently only available for quasi-static testing future high speed
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ACCREDITED
1242.01 Testing

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