

FD&E Meeting | MTS, Eden Prairie

## LEARN HOW TO MEASURE NON-CONTACT STRAINS AND DISPLACEMENTS WITH ADVANCED OPTICAL METROLOGY

*Jonathan Pickworth*  
Sales Director, Trilion America



*"Strain gages, LVDT and accelerometers  
are so painful to install."*

## COMMON ISSUES IN MECHANICAL TESTING



*"It's really hard to predict  
where to install my sensor."*

*"I need to validate my FEA,  
but I don't have enough data points."*

## COMMON ISSUES IN MECHANICAL TESTING

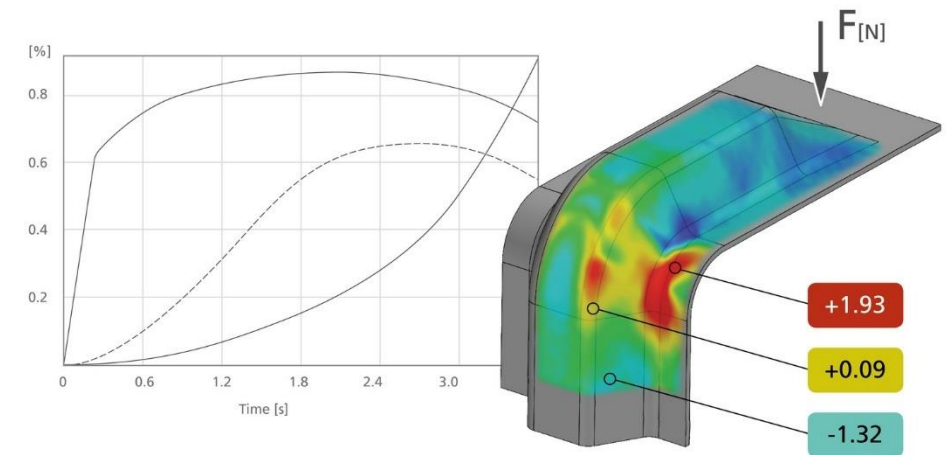


*"I need more data points,  
but it takes so long to setup."*

# ARAMIS WAS DESIGNED TO SOLVE THESE PROBLEMS

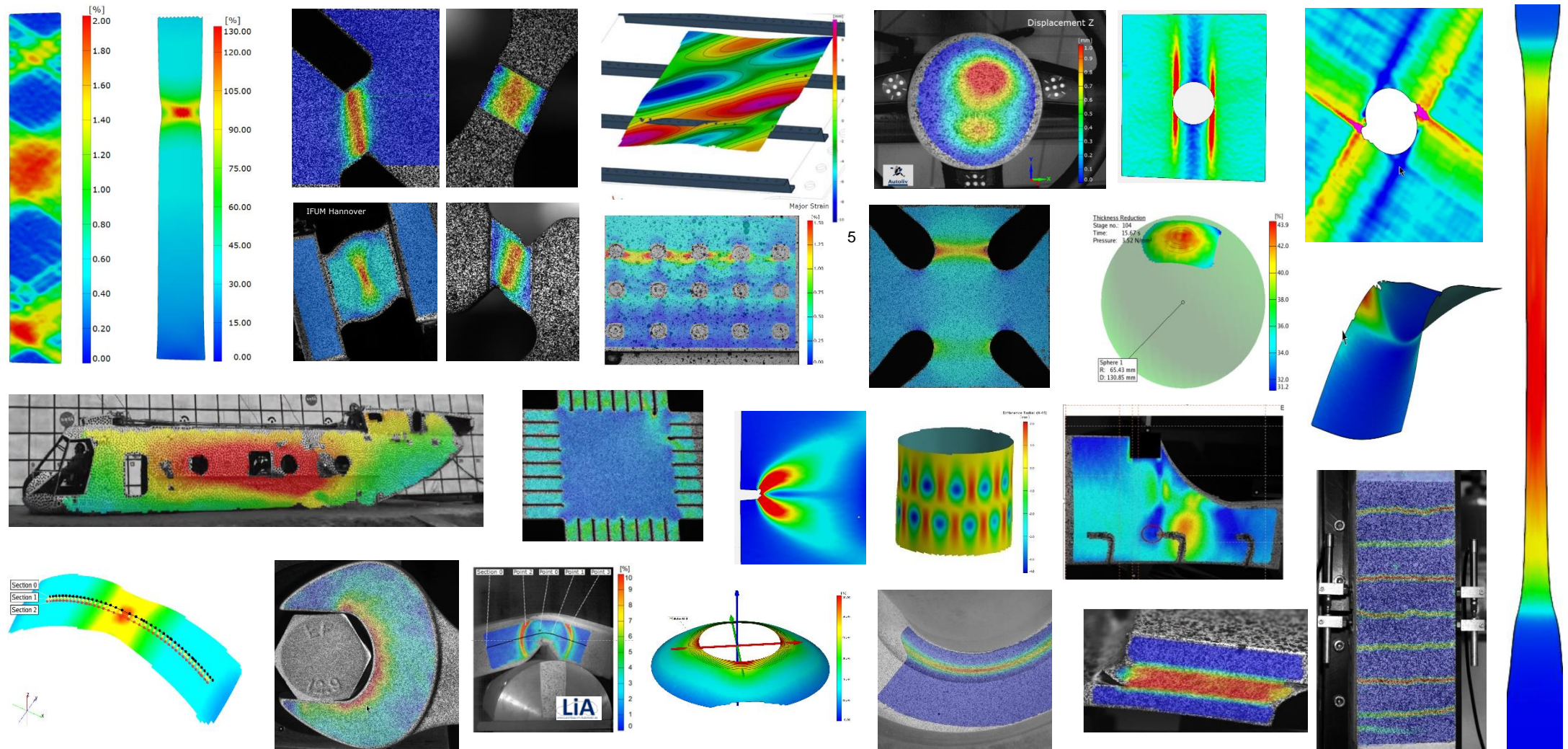
trilion

- Non-contact
- Full field
- Displacement and strain map
- Micro scale to large scale
- Static to high-speed testing
- FEA validation
- Modal analysis



# DIC IS THE ULTIMATE ALL-PURPOSE SENSOR

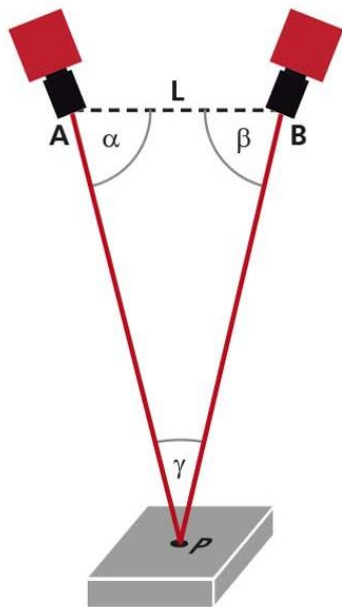
trilion



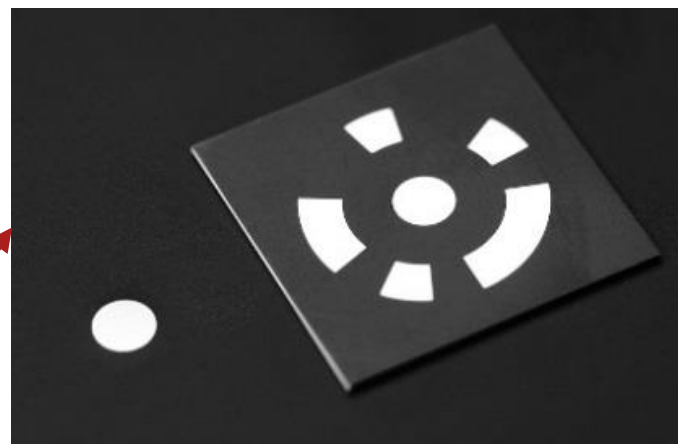


# ARAMIS is based on Digital Image Processing

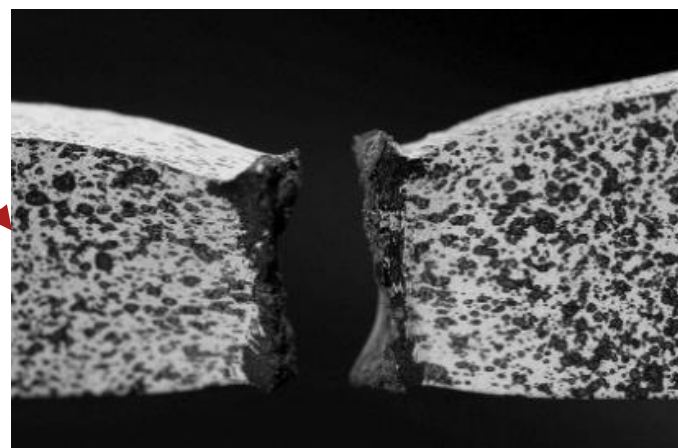
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Stereo camera sensor



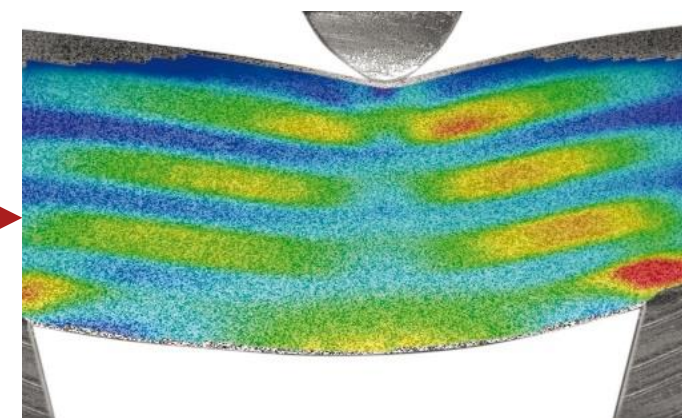
Marker identification



Speckle pattern tracking



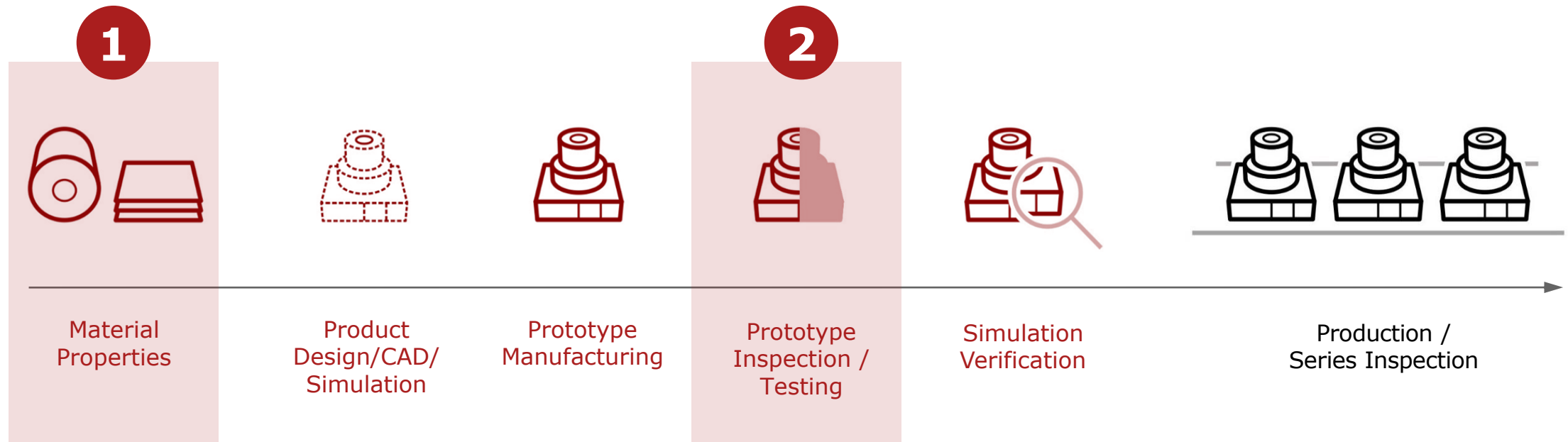
Point tracking



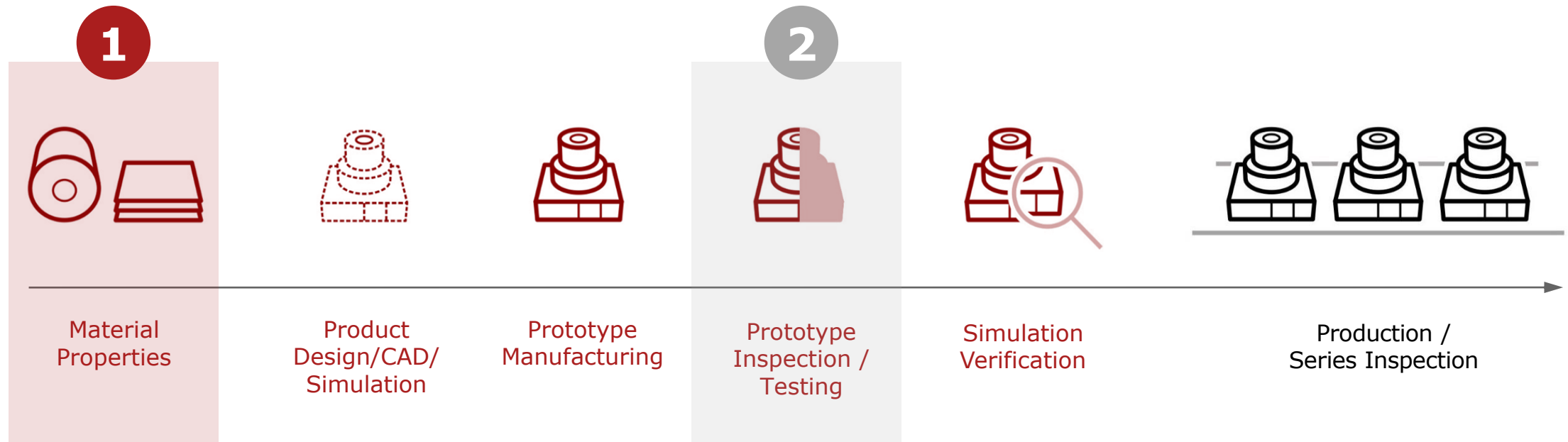
Digital Image Correlation



Testing is present all along the product development

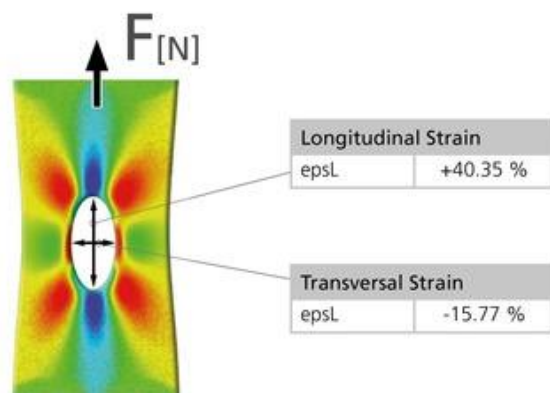


Testing is present all along the product development

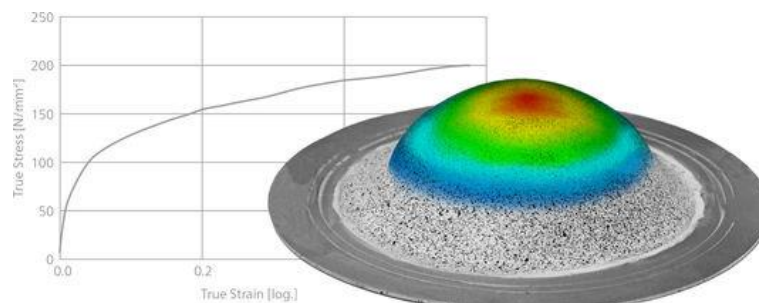


# Automated non-contact material testing

trillion



**Tensile testing**



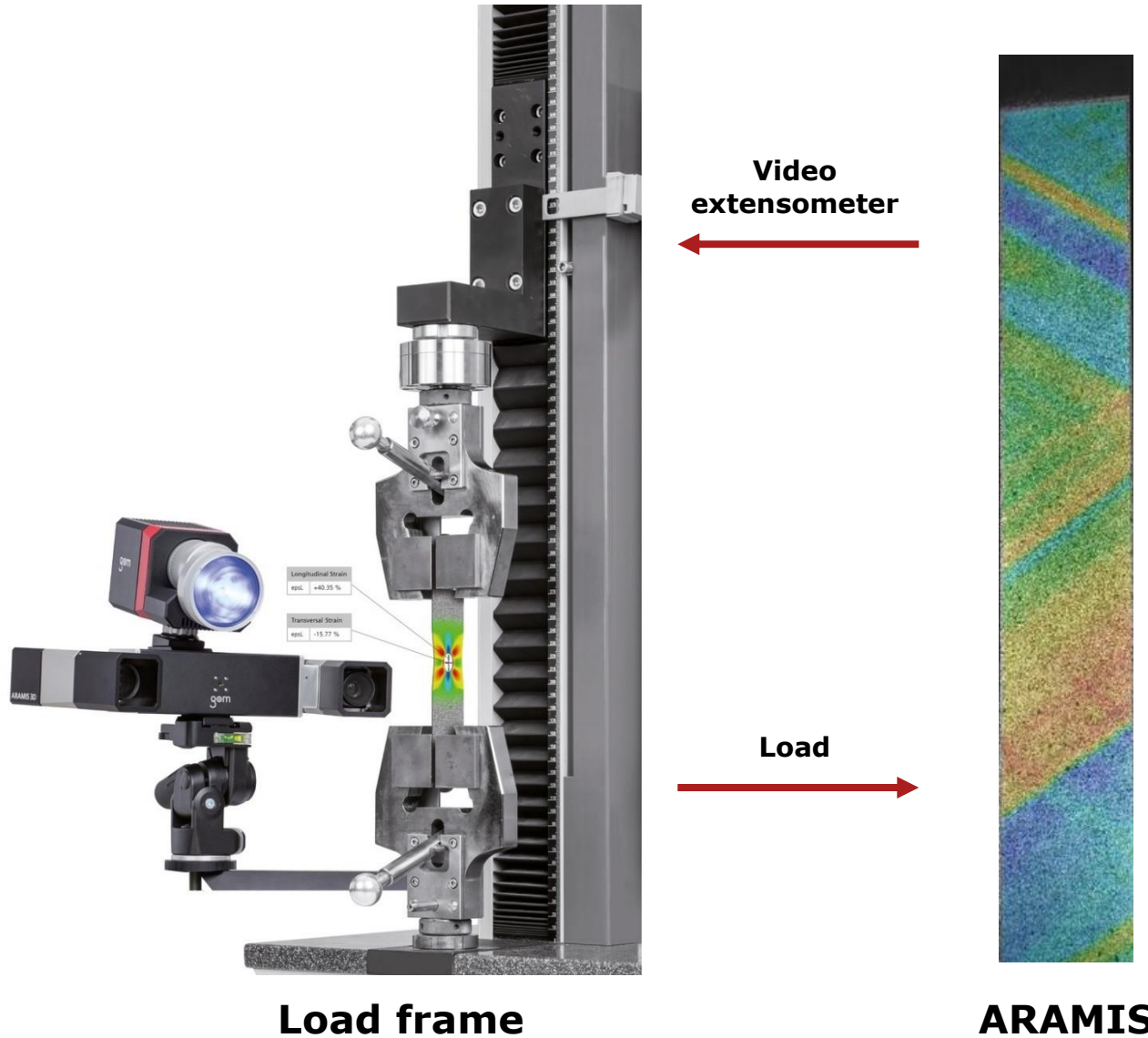
**Bulge testing**



**Forming Limit Curve**

# ARAMIS for tensile testing

trillion



# ARAMIS for tensile testing

trilion



Video  
extensometer

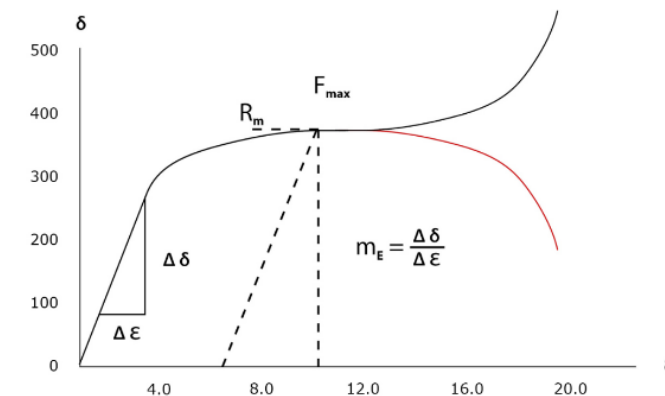


Load



ARAMIS

Automated  
stress strain  
curve



Automated  
material  
properties

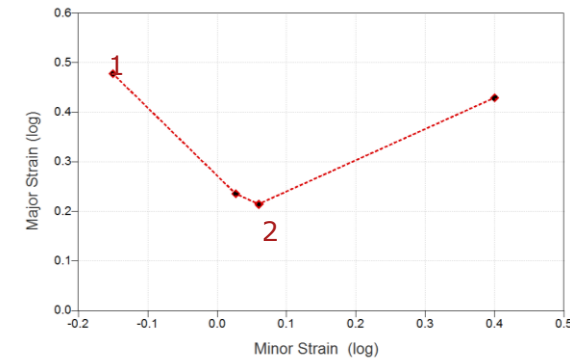


Tensile Test Region	
n	+0.326
r	+0.788
mE	+194856.252 MPa
Poisson	+0.250
Rp02	+332.970 MPa
Rm	+609.701 MPa
Ag	+31.712 %
Agt	+32.024 %
At	+38.199 %

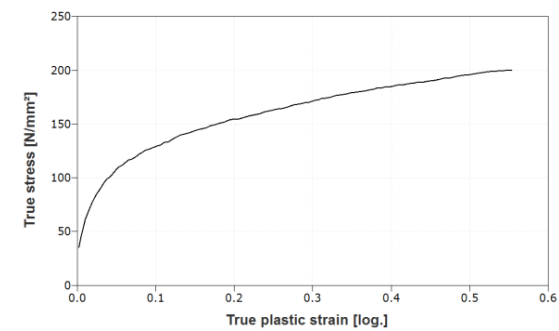
ISO / ASTM Standards

# ARAMIS for sheet metal material properties

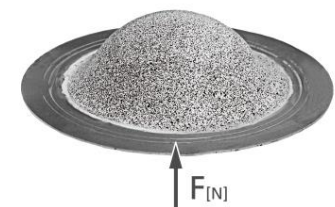
trilion



**Forming Limit Curve**  
**(Nakazima, Marciniak...)**

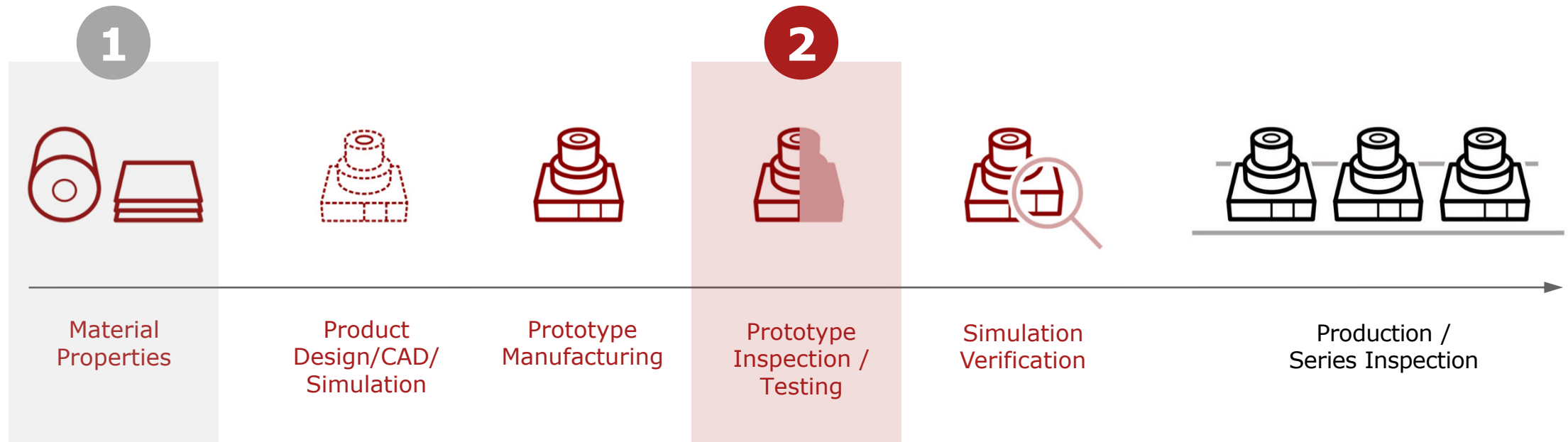


**Biaxial Yield Curve**  
**(bulge test)**





Testing is present all along the product development



# Industries and Applications



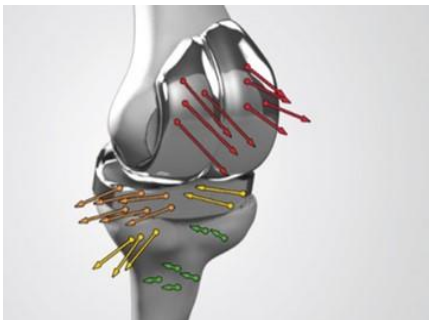
## Automotive

- Crash and safety testing
- Aerodynamics
- Environmental testing
- Stiffness analysis



## Aerospace

- Structural and fatigue testing
- NVH / vibrations / acoustics
- Impact and crash tests
- Aerodynamics

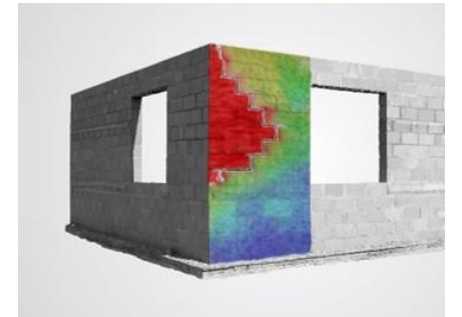


## Biomechanics

- Implant research
- Prostheses /orthopedics
- Motion analysis

## Civil Engineering

- Monitoring and damage analysis
- Concrete structure testing
- Buildings and brickworks
- Lightweight structure design



## Consumer goods

- Drop testing
- Motion analyses
- Fatigue testing
- Electronics warpage evaluation



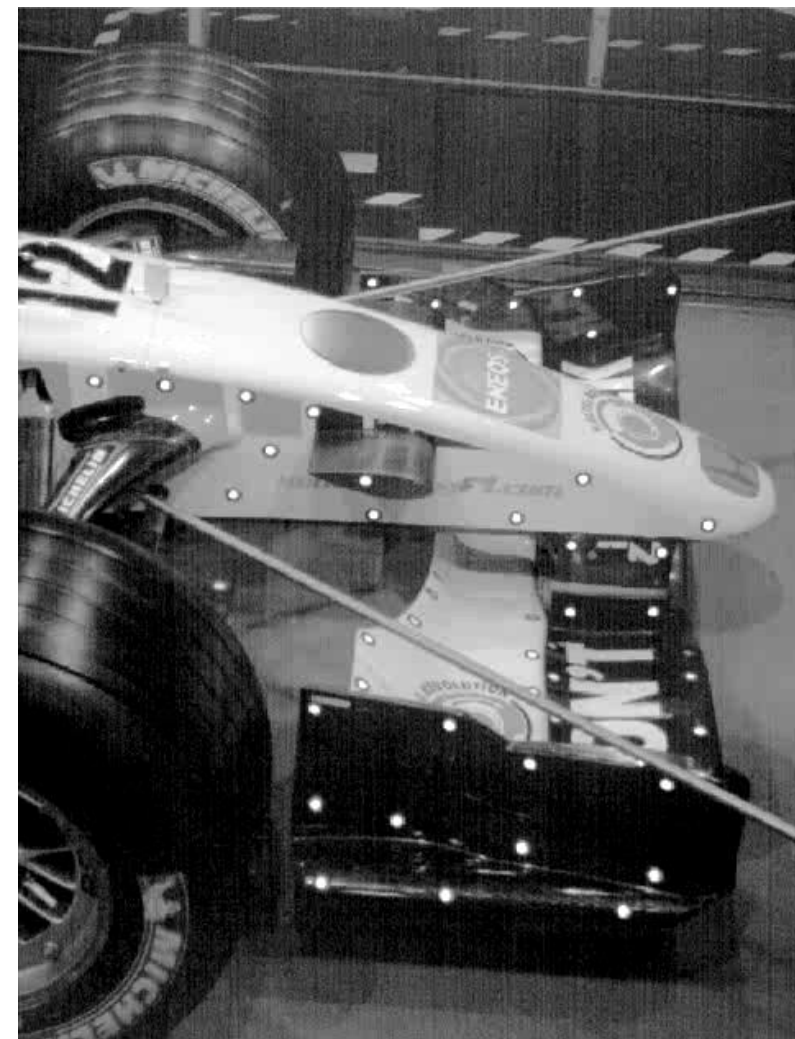
# Dynamic Deformation in Wind Tunnel Testing

Automotive



# Aerodynamic Study of a Front Bumper

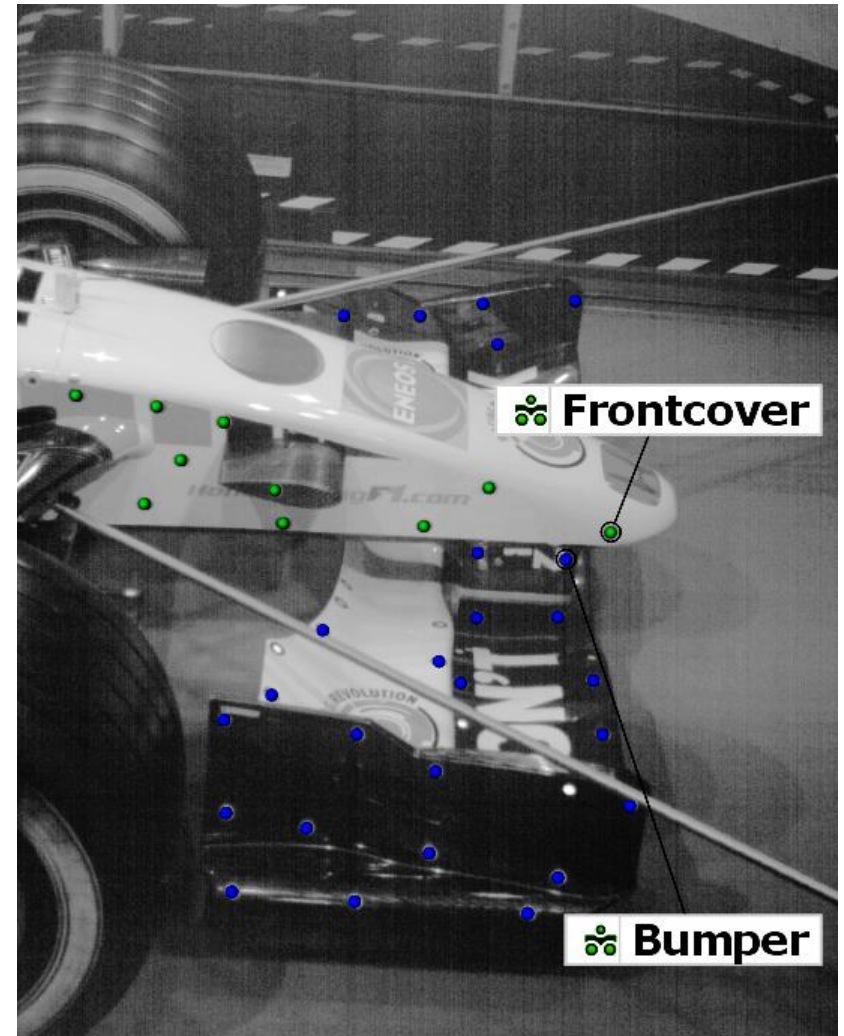
Formula 1 car tested inside the wind tunnel on flat track test rig



## Aerodynamic Study of a Front Bumper

Formula 1 car tested inside the wind tunnel on flat track test rig

3D coordinates derived from the markers on the "Frontcover" (green points) are used for the compensation of rigid body motion

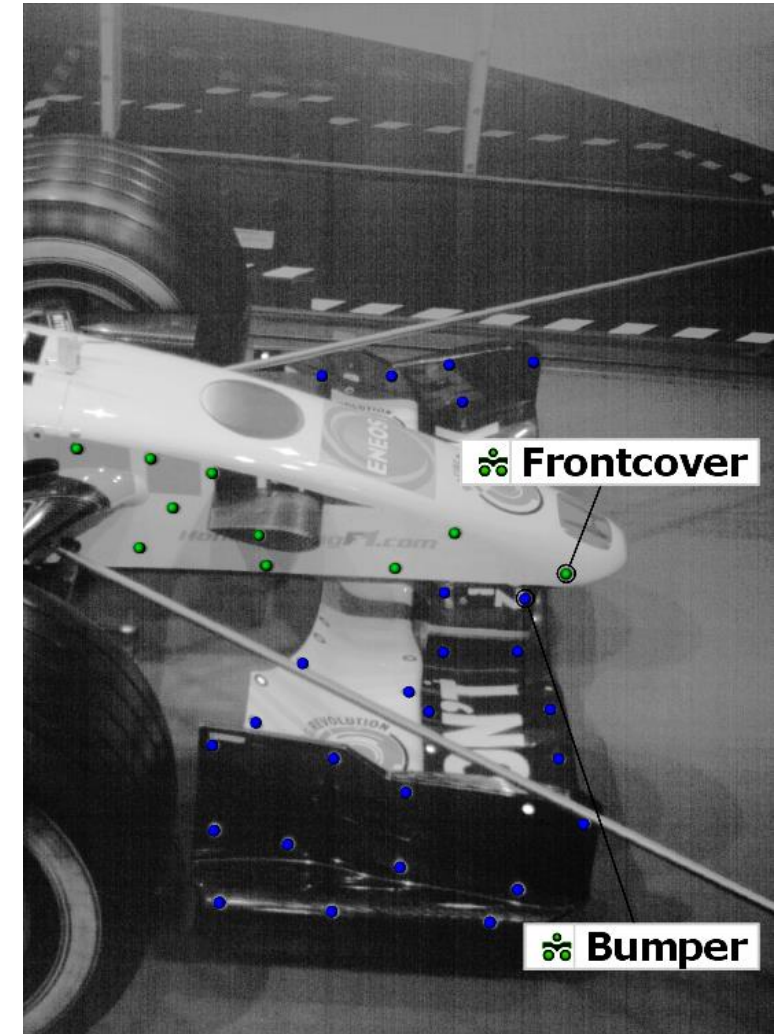
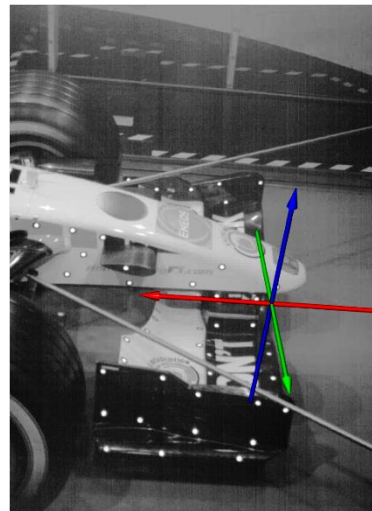


## Aerodynamic Study of a Front Bumper

Formula 1 car tested inside the wind tunnel on flat track test rig

3D coordinates derived from the markers on the "Frontcover" (green points) are used for the compensation of rigid body motion

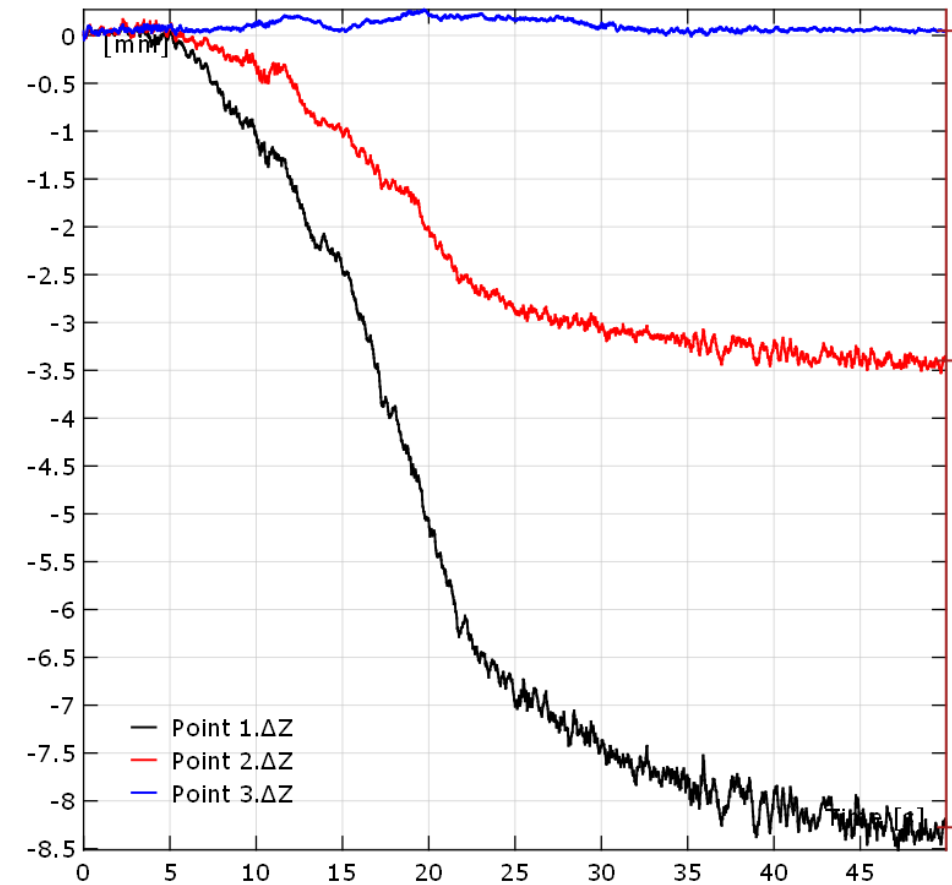
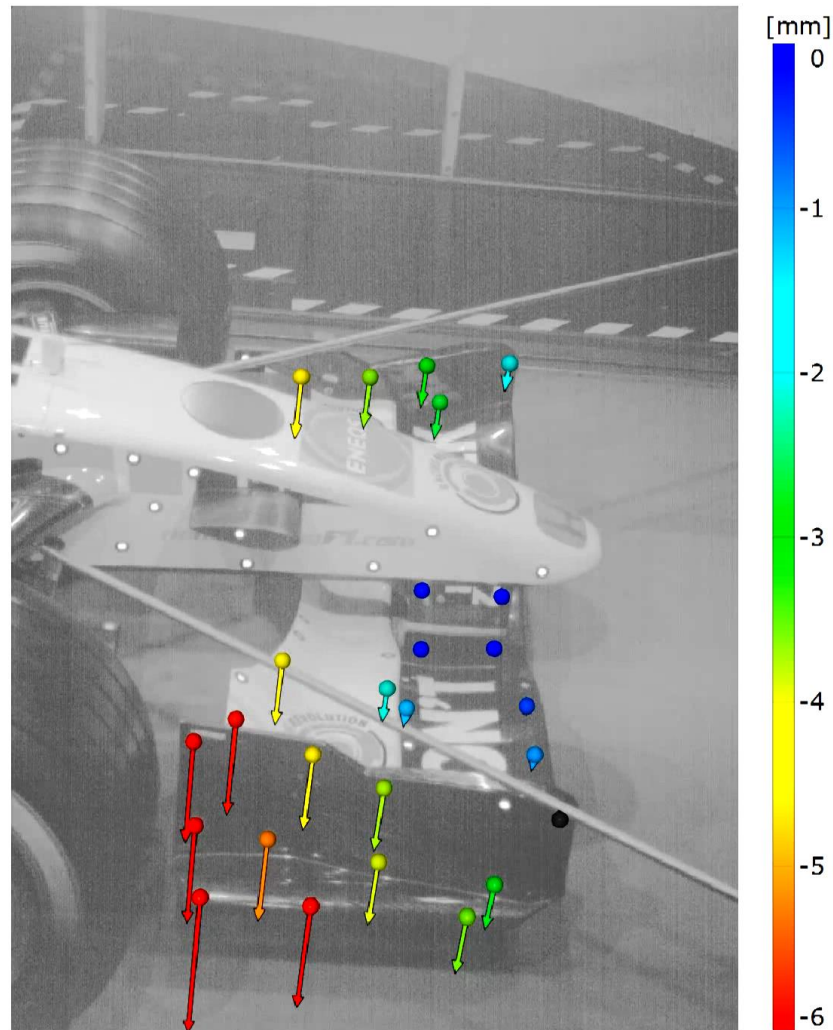
The evaluation of the "Bumper" (blue points) will be carried out considering the Z-direction perpendicular to the ground





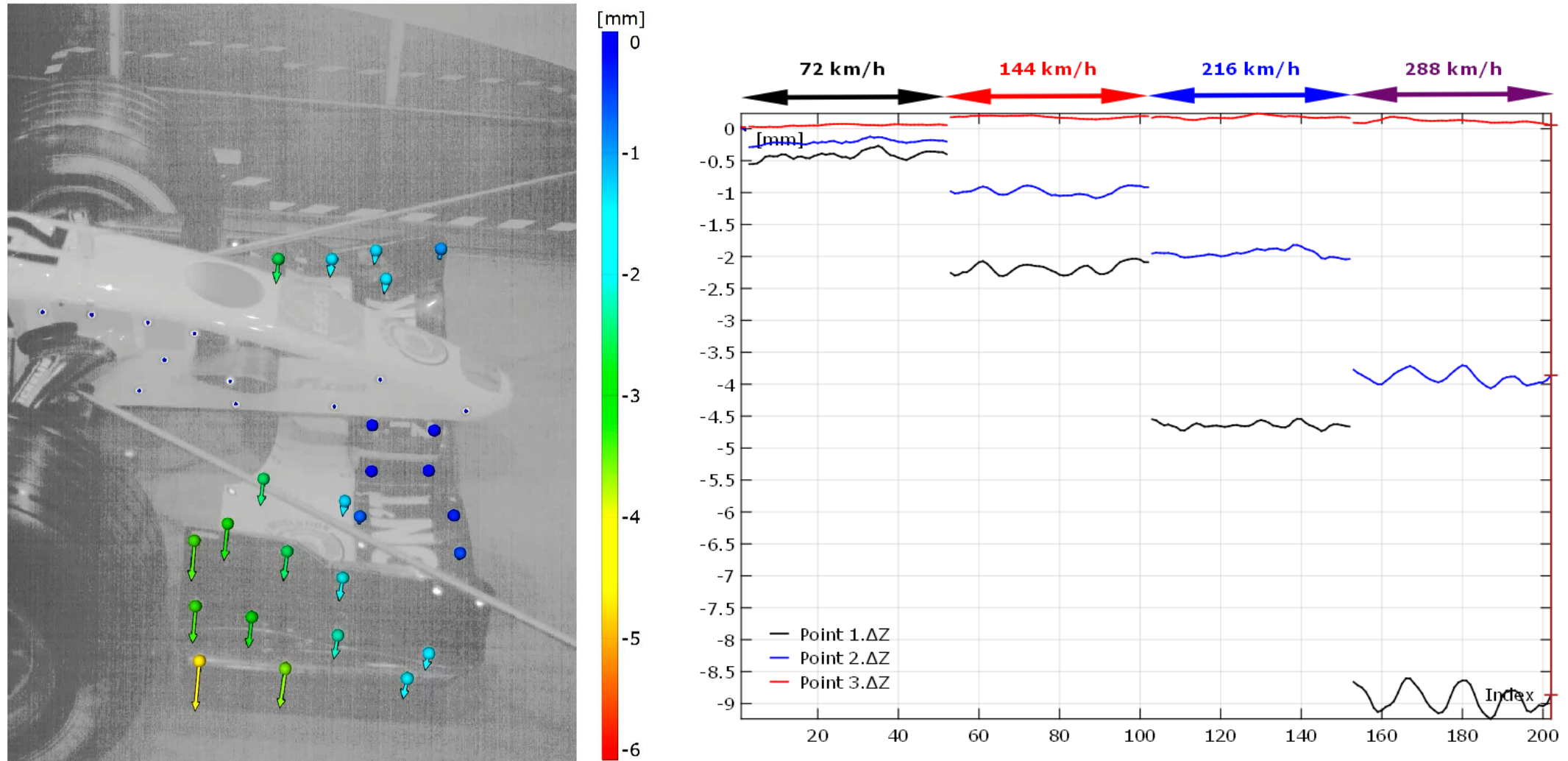
## Bumper Deflection in Z-Direction

Bumper deflection in Z-direction during speeding up to top speed



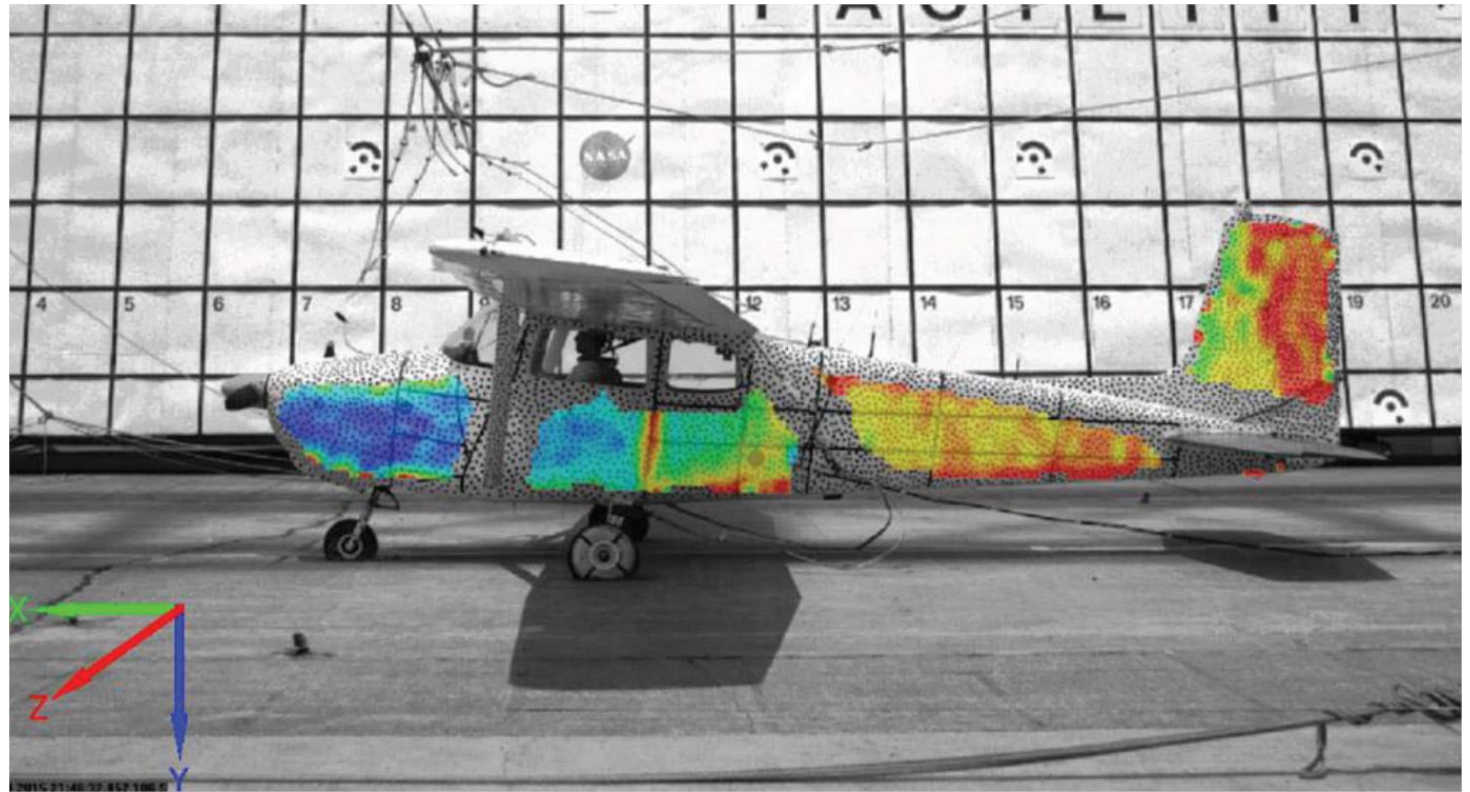
## Bumper Deflection in Z-Direction

Bumper deflection in Z-direction at different velocities



## Full size aircraft crash test

Aerospace



Courtesy of NASA Langley Research Center – Dr. Justin Littell



## Full size aircraft crash test

Former Apollo Astronauts training facility converted into a large scale crash test structure

### Goals

- Study safety features and avionics
- AeroStructures
- Crash Dummy testing
- ...



NASA Langley

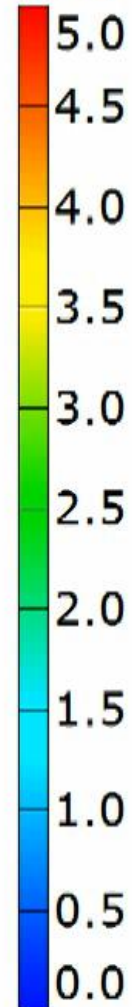
trillion

## ELTSAR Crash Test 2 3D Analysis



Major Strain

[%]



Langley Research Center

Justin Littell Ph.D.

(757) 864-5095 / [Justin.D.Littell@nasa.gov](mailto:Justin.D.Littell@nasa.gov)

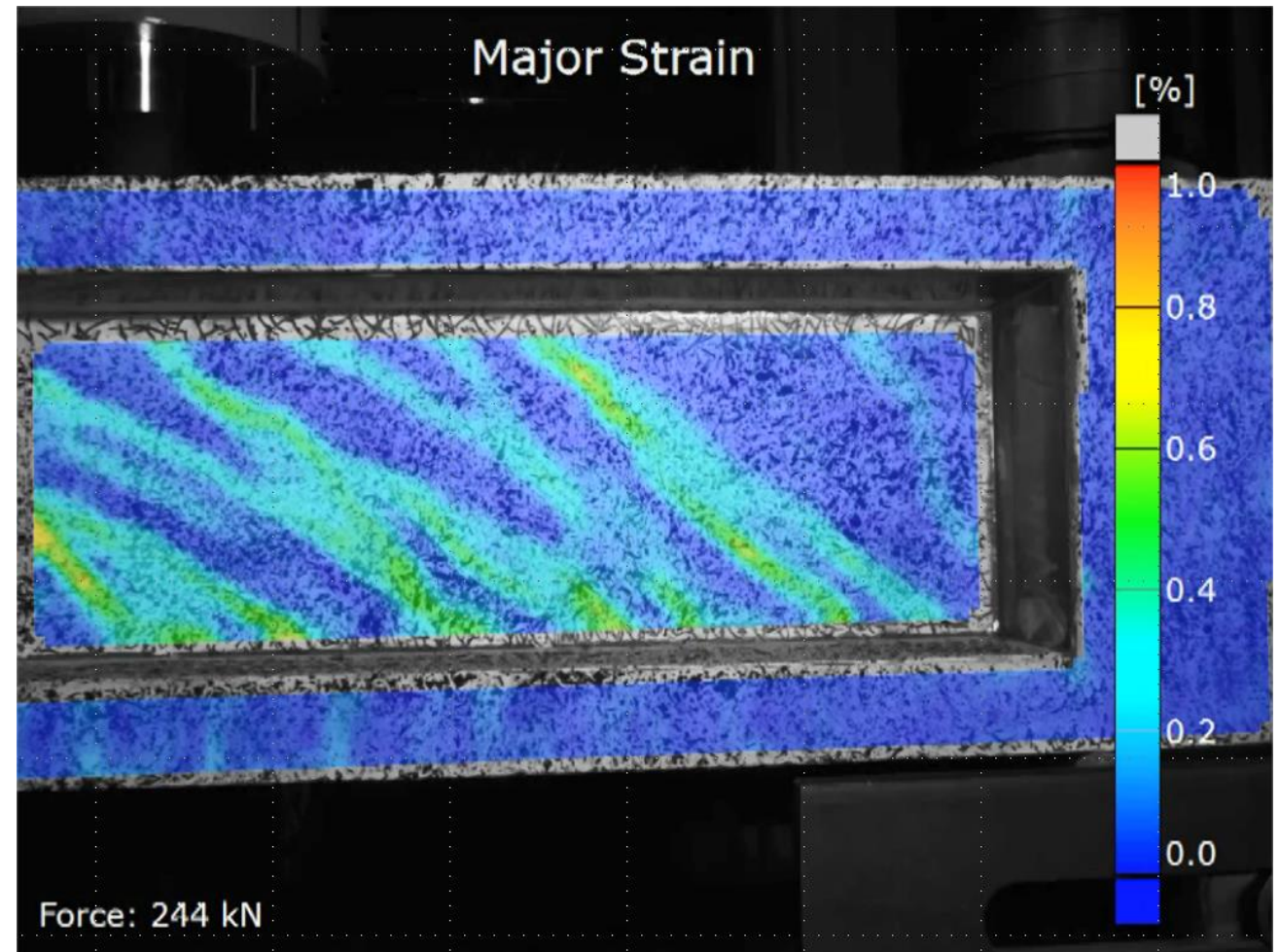






## Crack detection

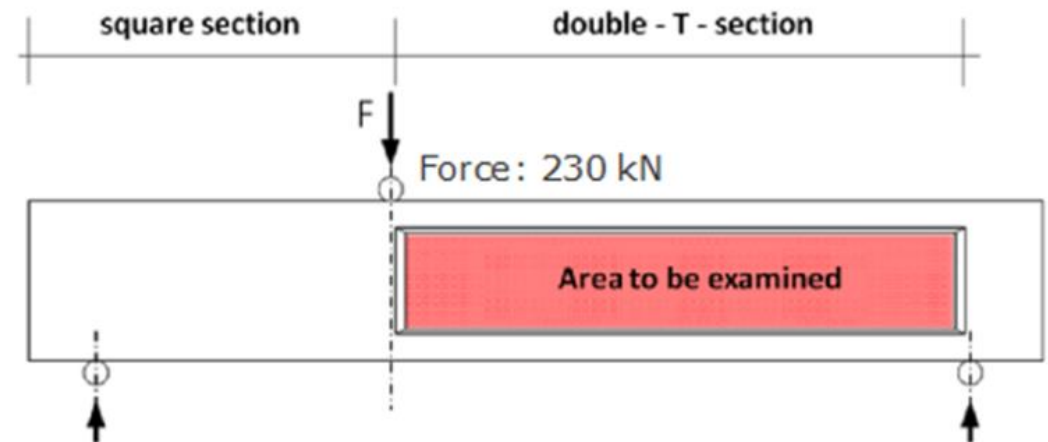
Civil engineering



## Reinforced Concrete – 3 Point Bending Test

Measuring area: 700x300mm<sup>2</sup>

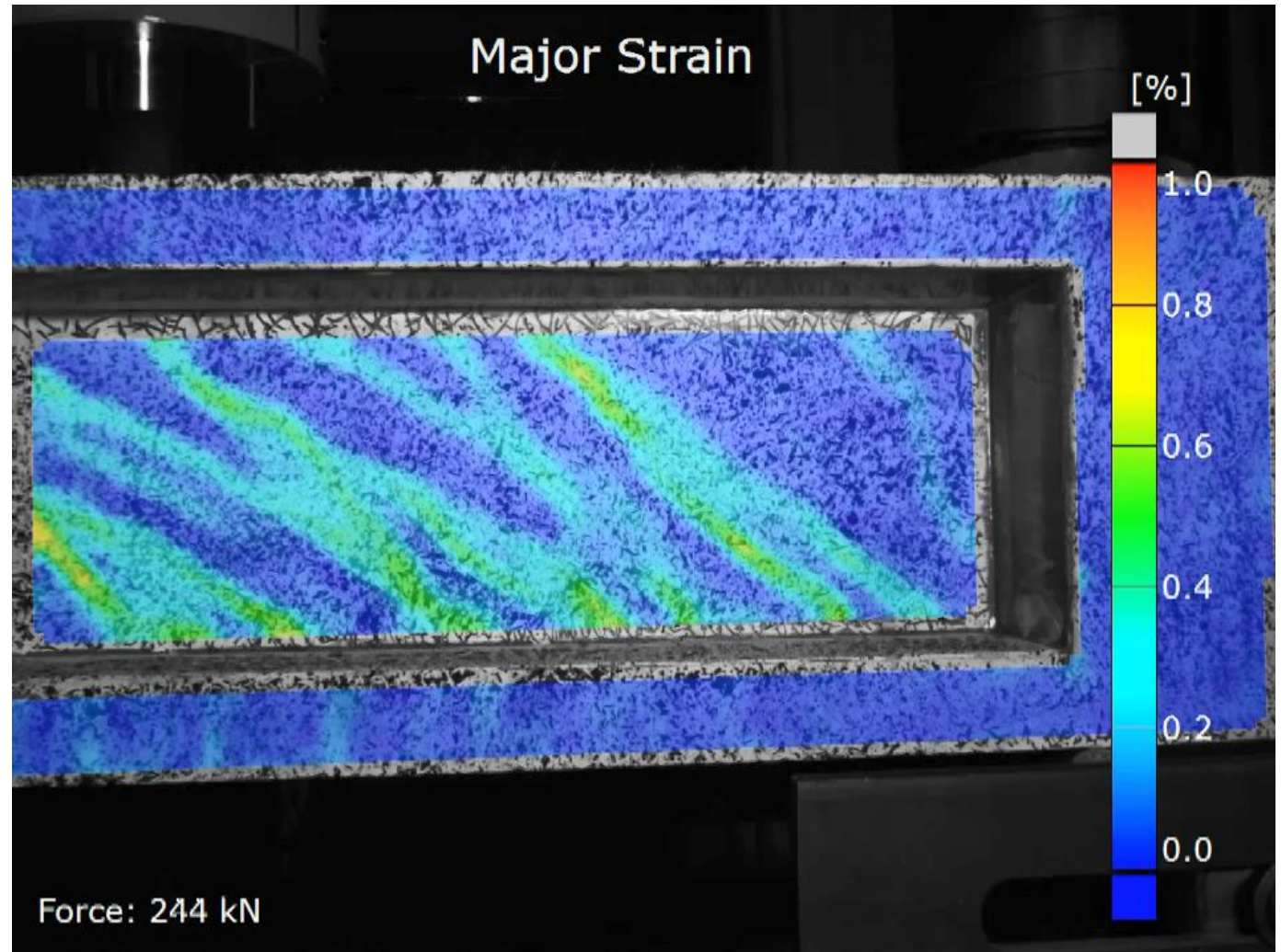
Reinforced high strength concrete



# Reinforced Concrete – 3 Point Bending Test

Major Strain

Identify cracks location

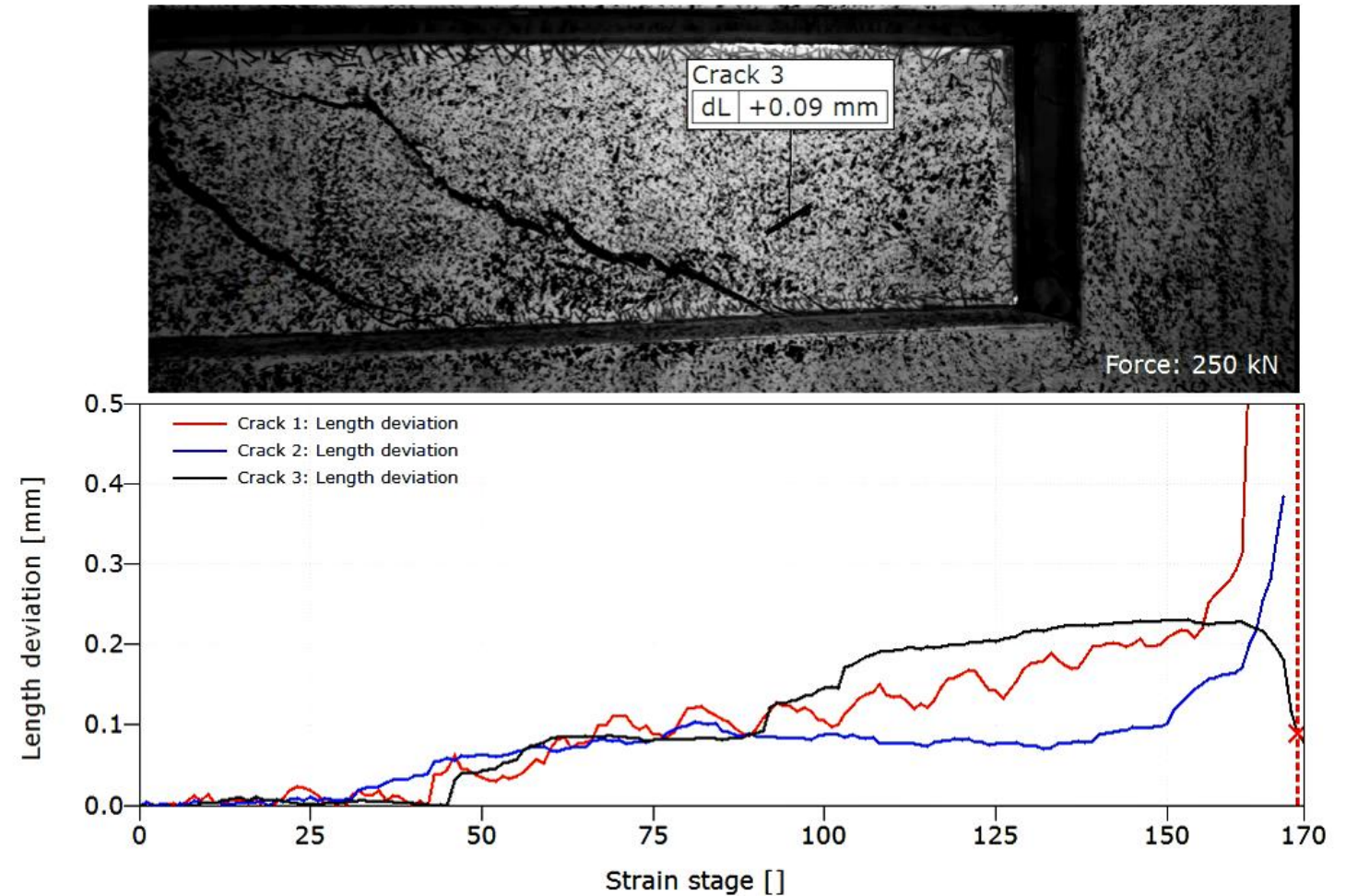




# Reinforced Concrete – 3 Point Bending Test

Crack Opening Analysis

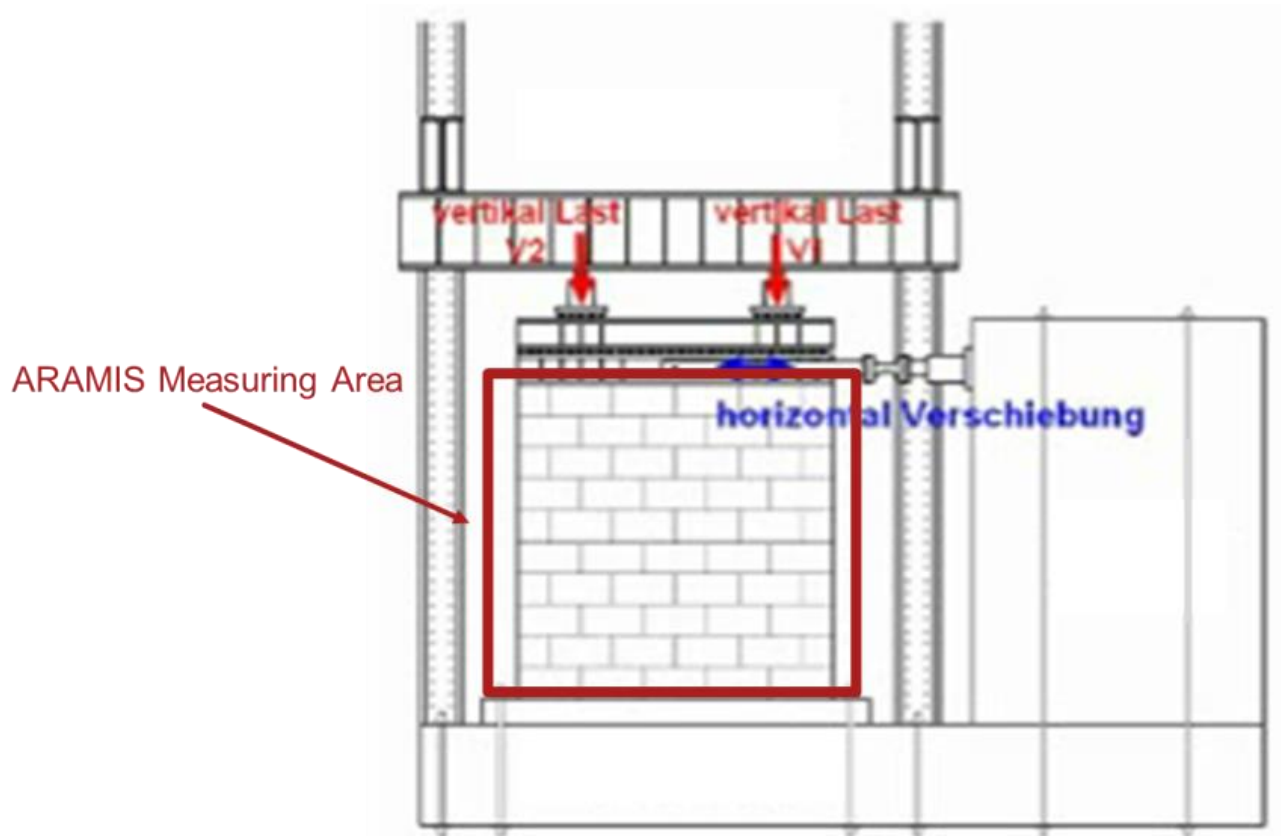
Virtual sensors in post processing



## Structural Testing

Testing of a Brick Wall

Earthquake simulation



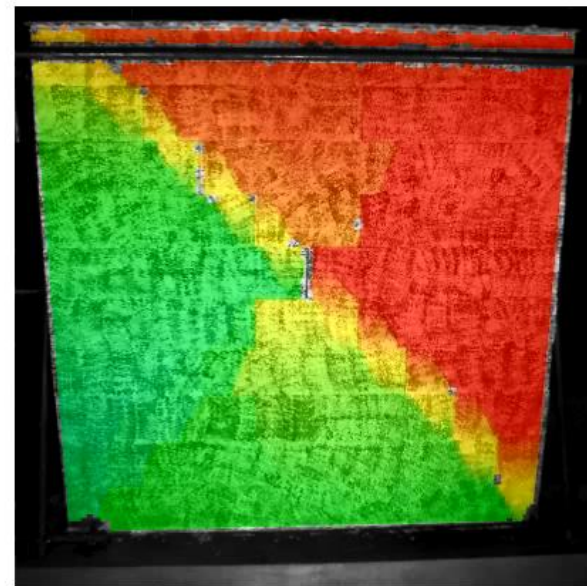
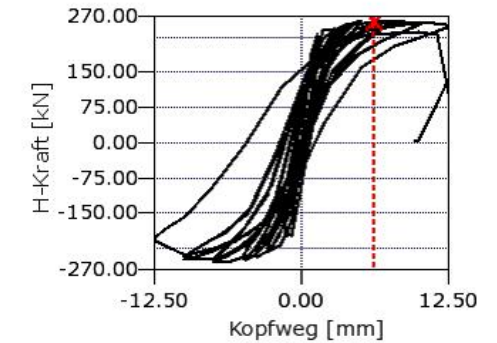
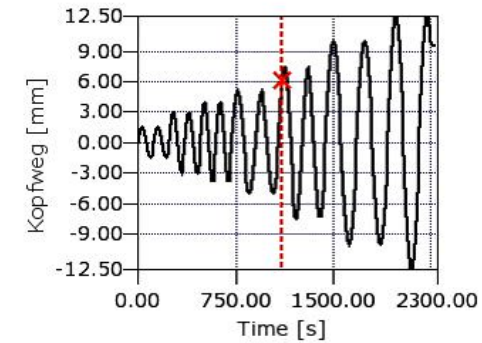
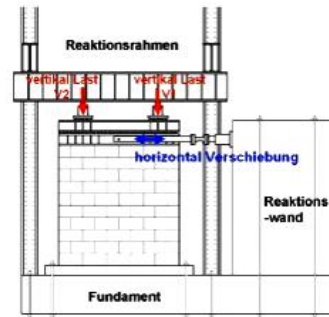
# Structural Testing

Testing of a brick Wall

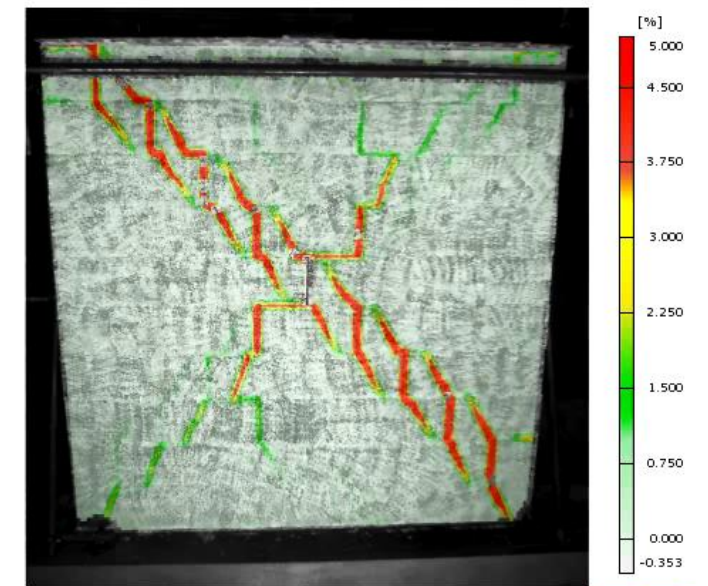
Cyclic Loading

Evaluation of Cracking Behavior

Stufe 110



Verschiebungen



Dehnungen



## Conclusion - Benefits of optical metrology

### Flexibility

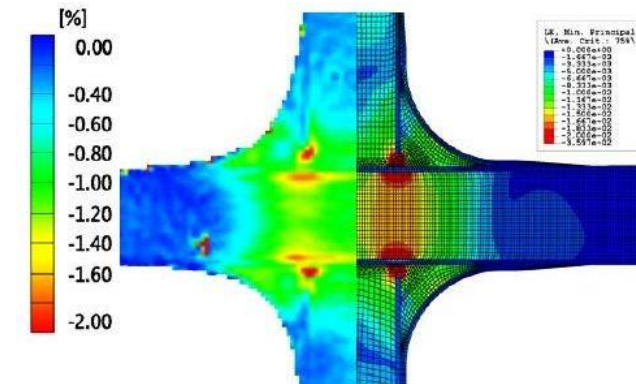
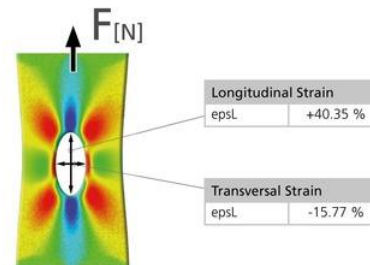
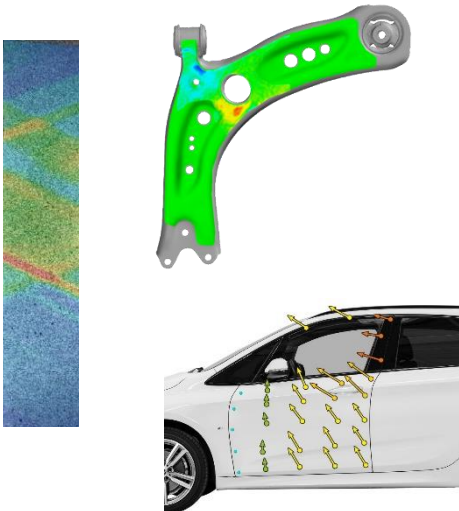
- Strain
- Displacements
- Accelerations
- 6 DoF

### Ease of use

- Material and scale independent
- Automated testing
- Live visual feedback

### Additional capabilities

- Testing environment integration
- Complex triggering
- Automation / scripting
- FEA validation
- Dynamic testing
- Vibration analysis
- Thermal imaging capability
- ...



Bonus 1/3: super fast stuff



trilion



QTECH

[peter@qtechimaging.com](mailto:peter@qtechimaging.com)

## Bonus 2/3: **FREE Software**

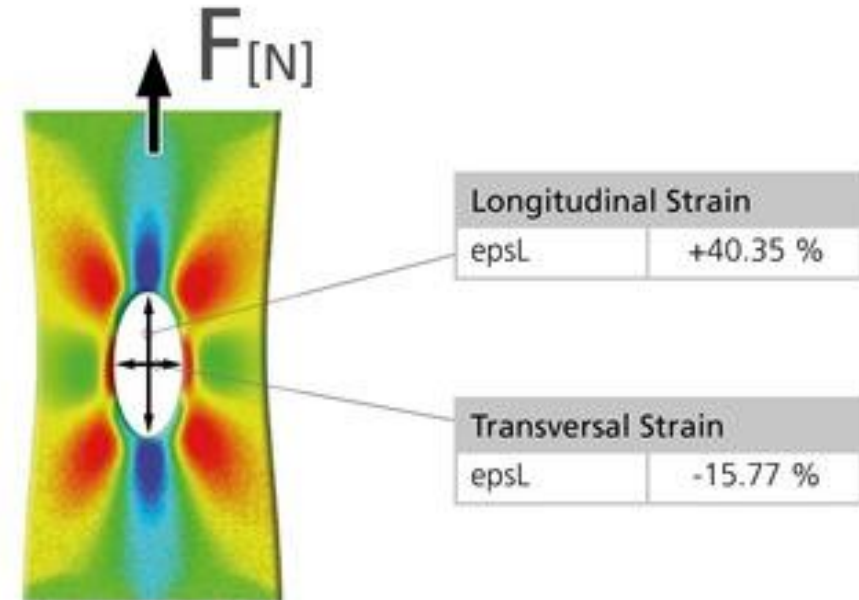
### Free GOM Correlate

2D DIC/point tracking software  
ARAMIS 3D project analysis software  
[www.gom-correlate.com](http://www.gom-correlate.com)

### Free GOM Snap 2D

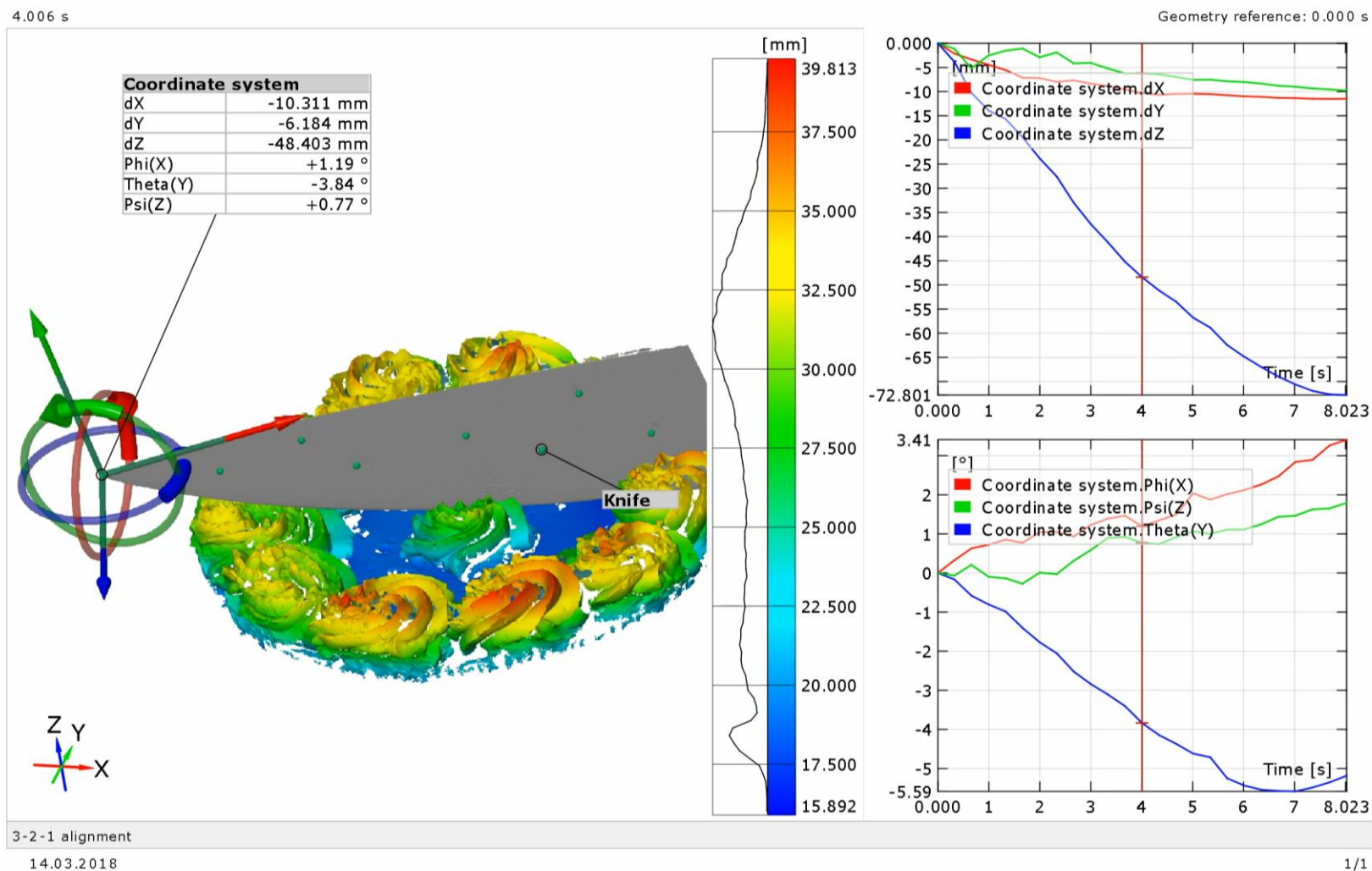
2D image acquisition tool for generic USB cameras

### Free teaching package for Universities



## Bonus 3/3: Pie day

Key lime pie - Knife 6 DoF



# trillion

gom | certified  
partner

**Trillion Quality Systems**

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