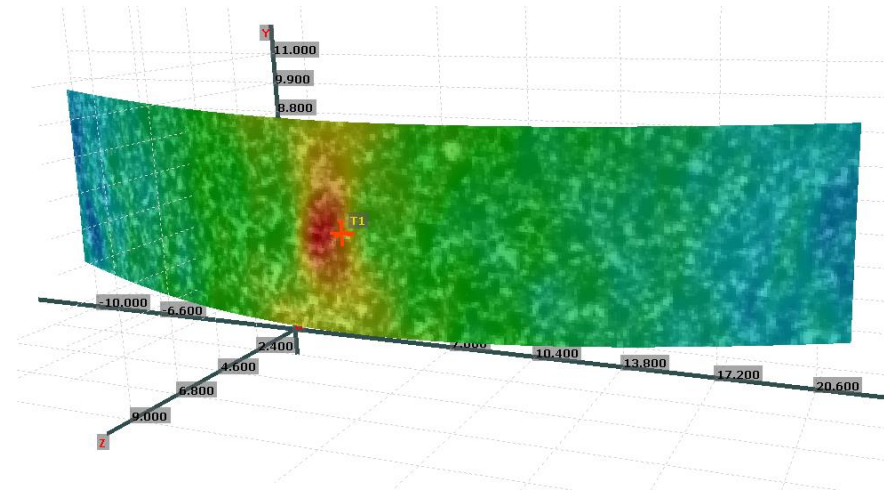


Dynamic testing with automated local strain measurement using IMPETUS®

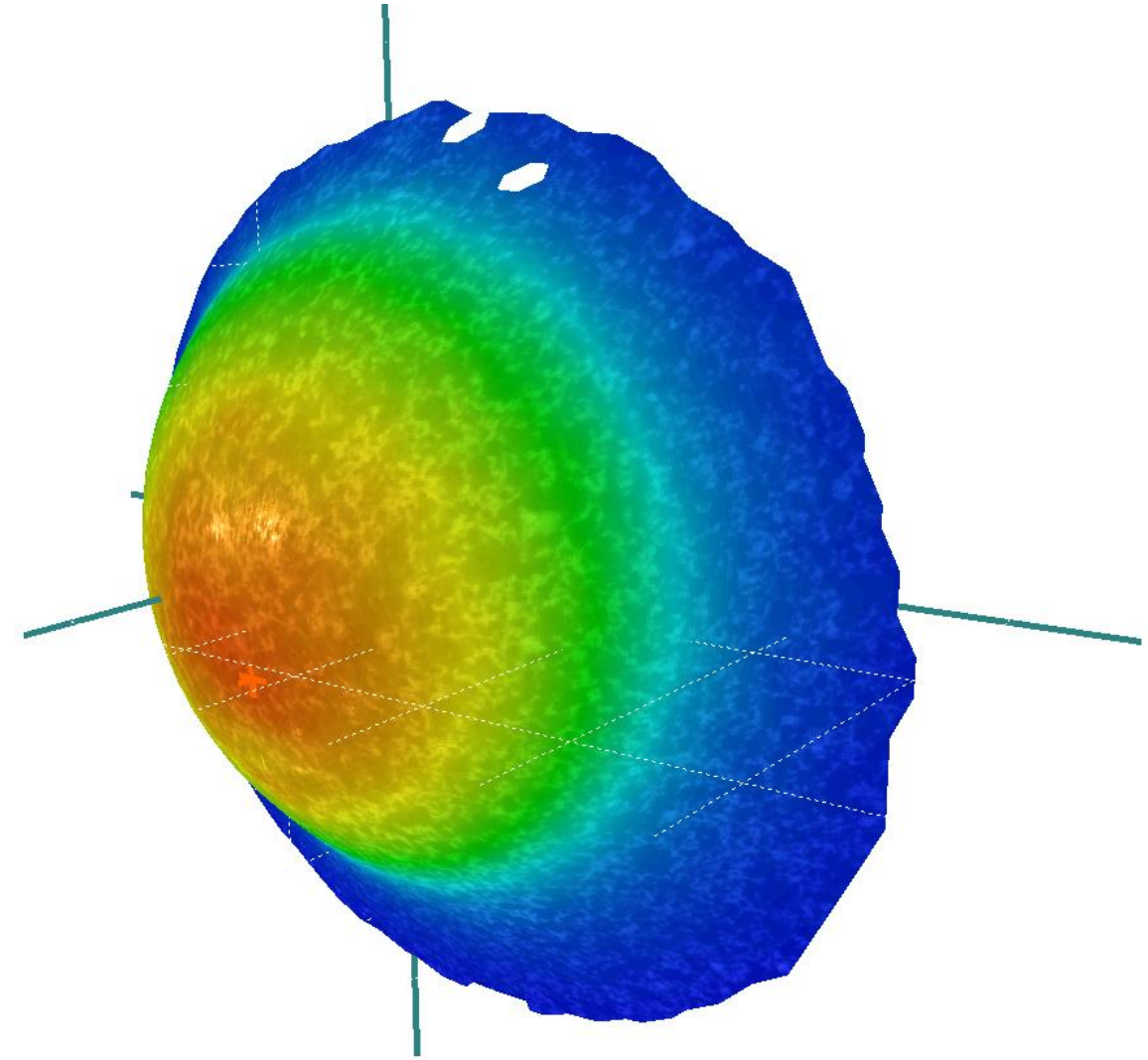
13th European LS-DYNA Conference 2021

S. Riemelmoser, M. Schwab, M. Rollant - 4a engineering GmbH



Outline

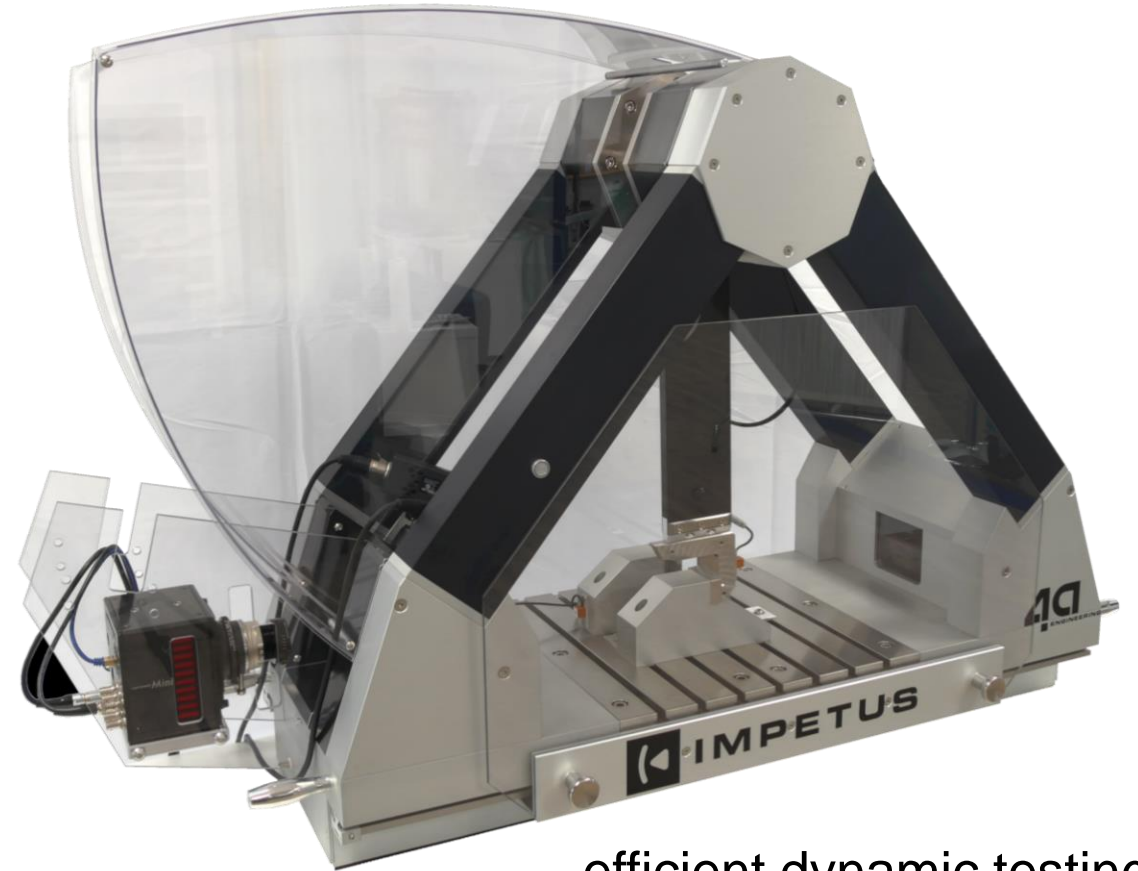
- IMPETUS® - main characteristics
- Measurement technique at 2D DIC
- Automated local strain measurement
- Setup for the 3D DIC
- 3D DIC recording results



IMPETUS® - main characteristics



- Desktop testing device
 - ready to use
- Instrumented high speed testing
 - measured → force / displacement
- Impact speed 0.5 – 4.5 m/s
- Maximal energy up to 50 J
- High speed camera
 - sync. recording

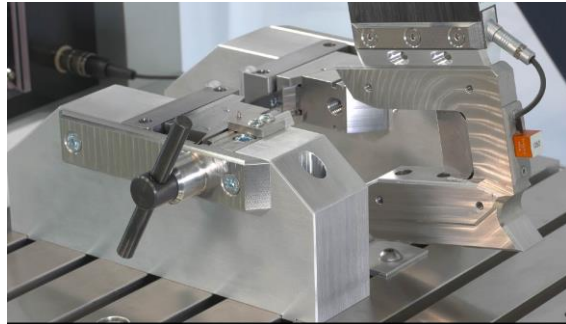


efficient dynamic testing
plastics and composites

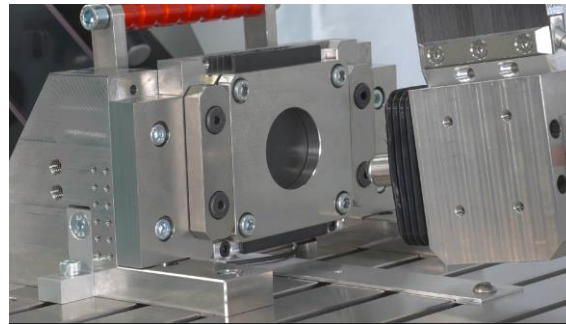
IMPETUS® - universal testing machine



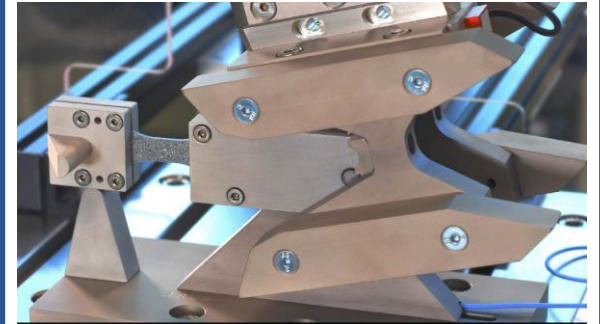
3 POINT BENDING



TENSION BENDING



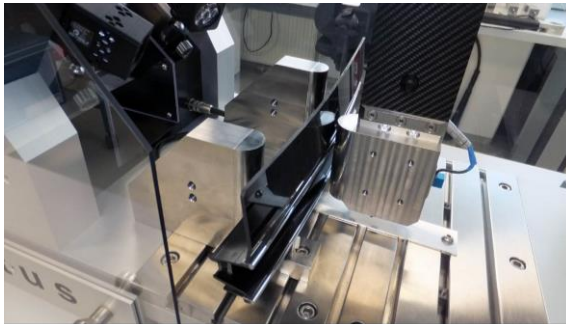
PUNCTURE TEST



TENSION TEST



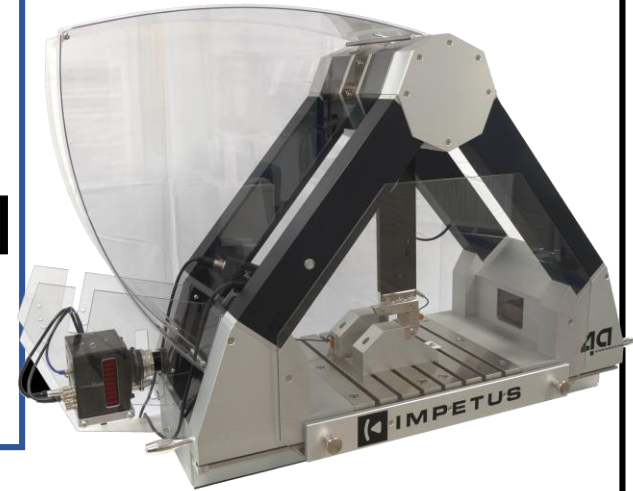
COMPRESSION TEST



COMPONENT TEST



SAMPLE MAGAZIN



BASIC

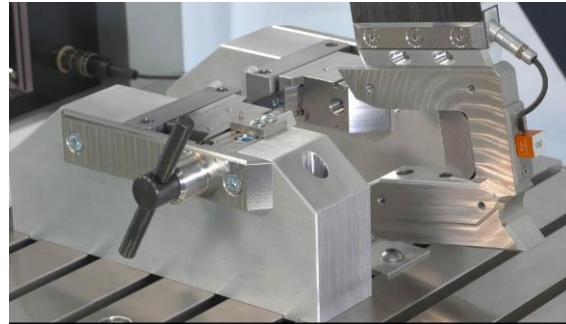
STANDARD

PROFESSIONAL

IMPETUS® - 2D/3D DIC measurement



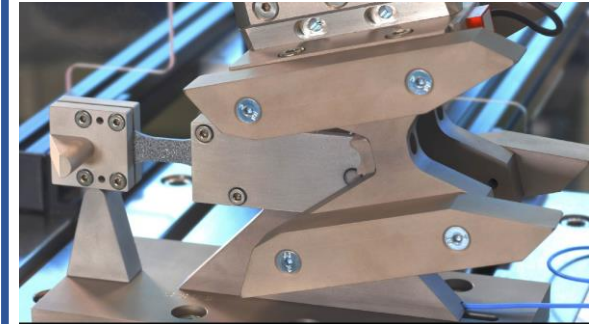
3 POINT BENDING



TENSION BENDING

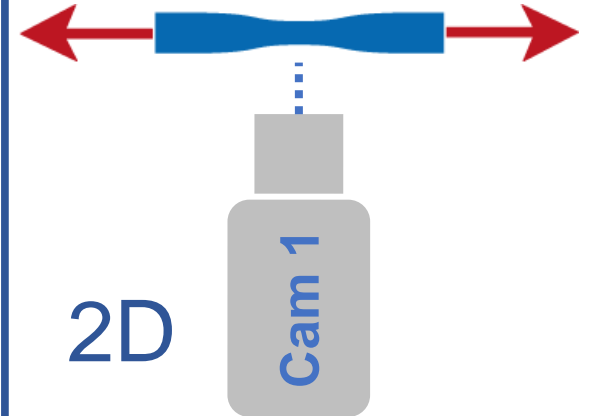
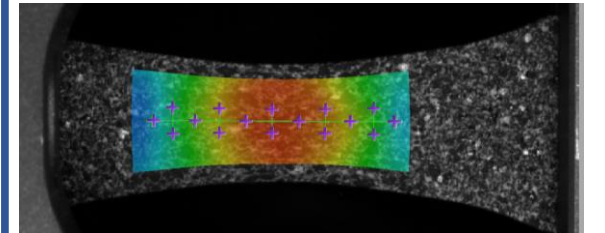
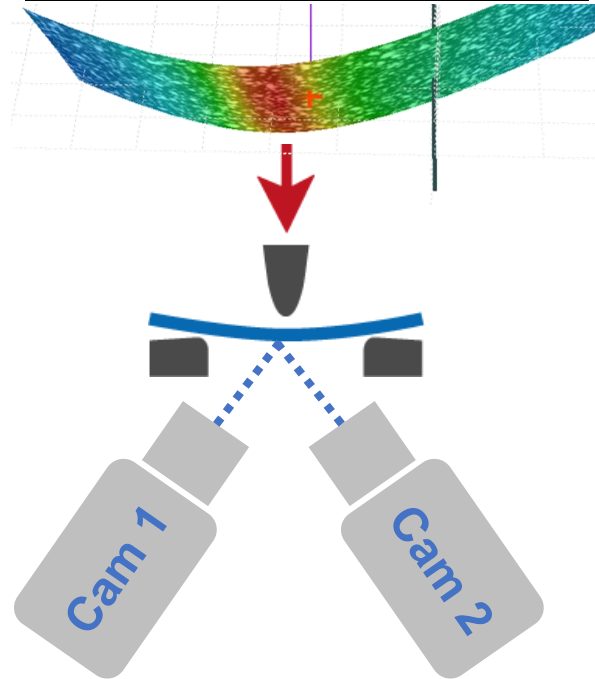


PUNCTURE TEST

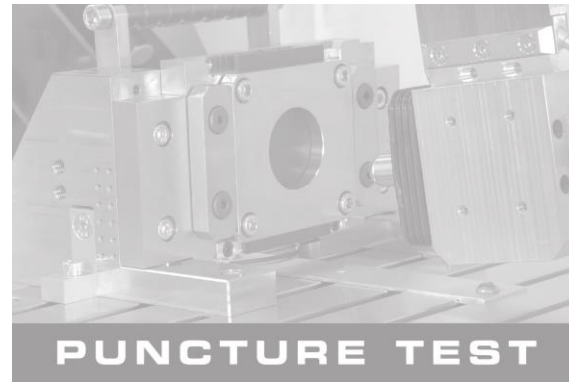
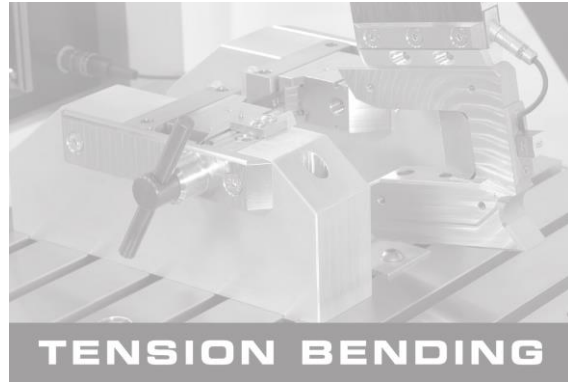
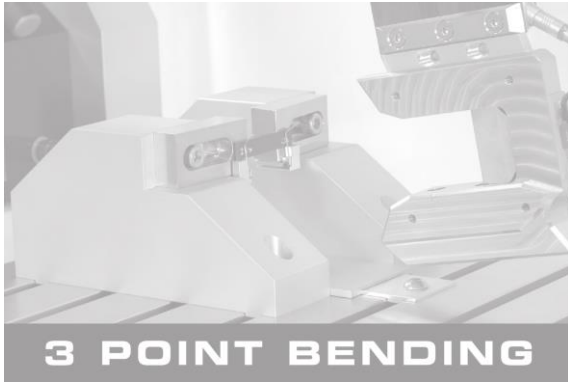


TENSION TEST

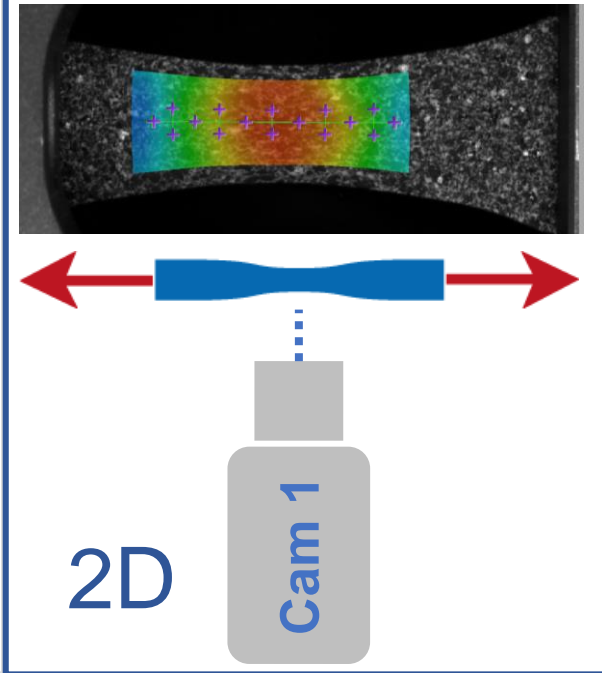
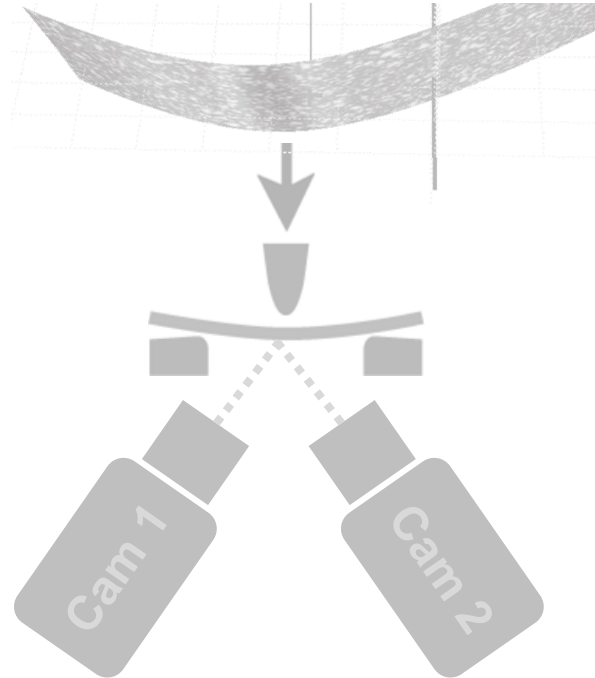
3D - DIC



IMPETUS® - 2D DIC measurement



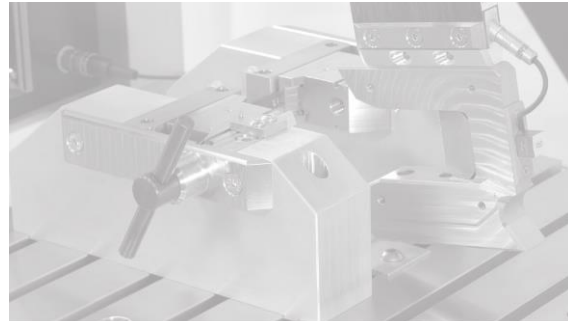
3D - DIC



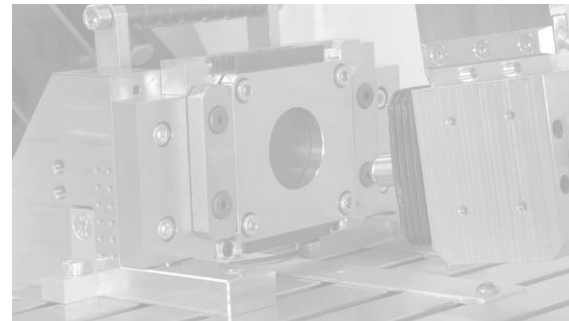
IMPETUS® - 2D DIC measurement



3 POINT BENDING



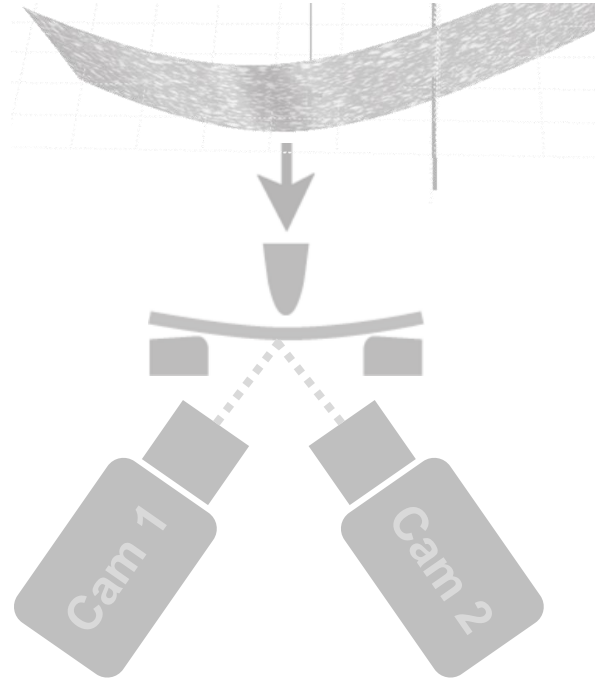
TENSION BENDING



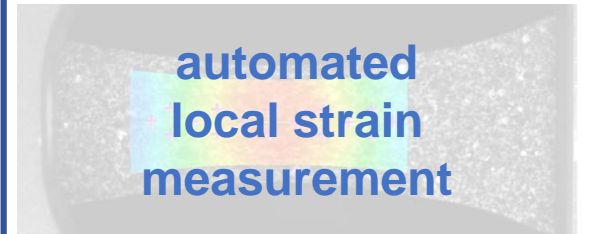
PUNCTURE TEST



TENSION TEST



3D - DIC



automated local strain measurement



2D

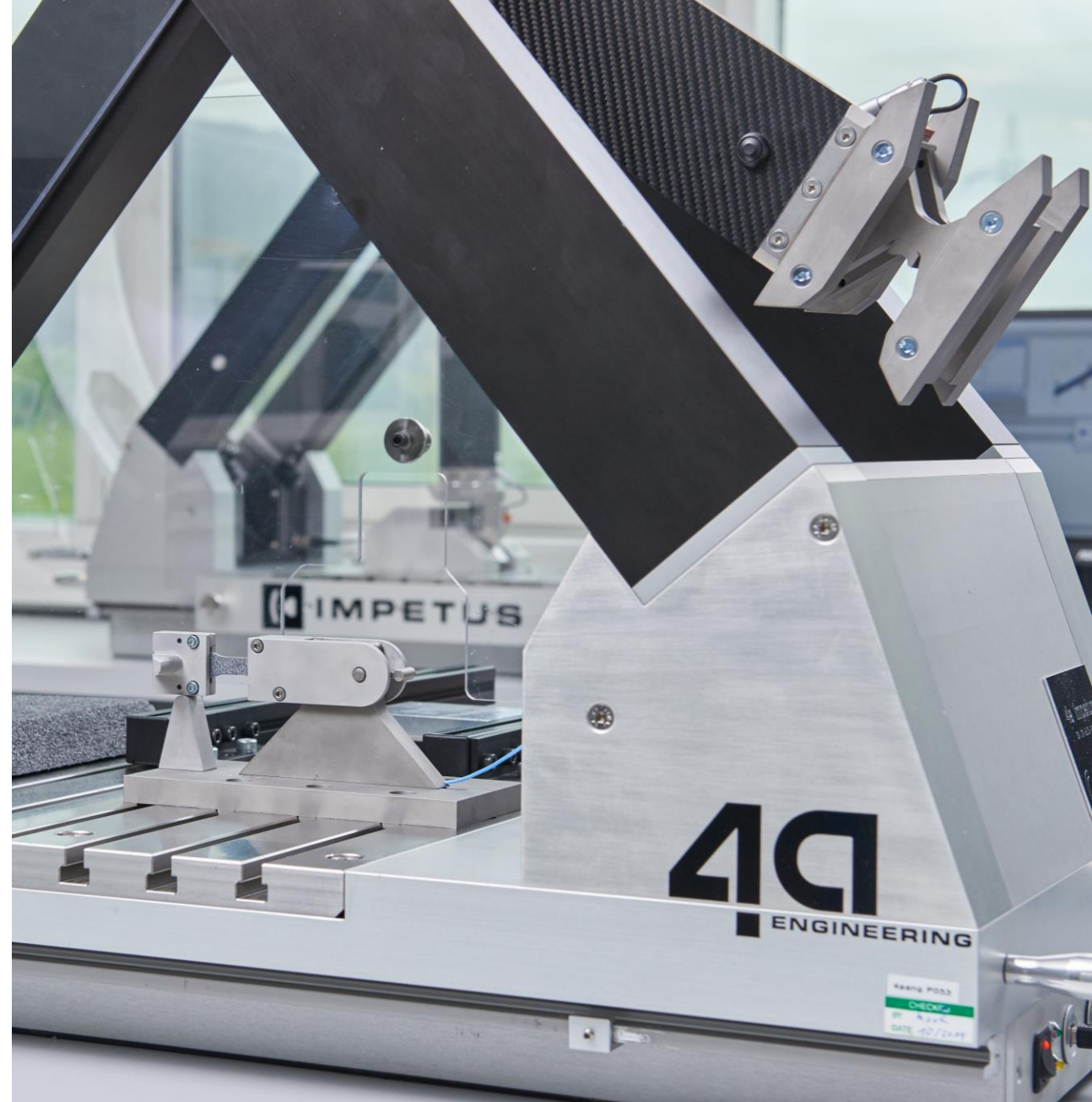
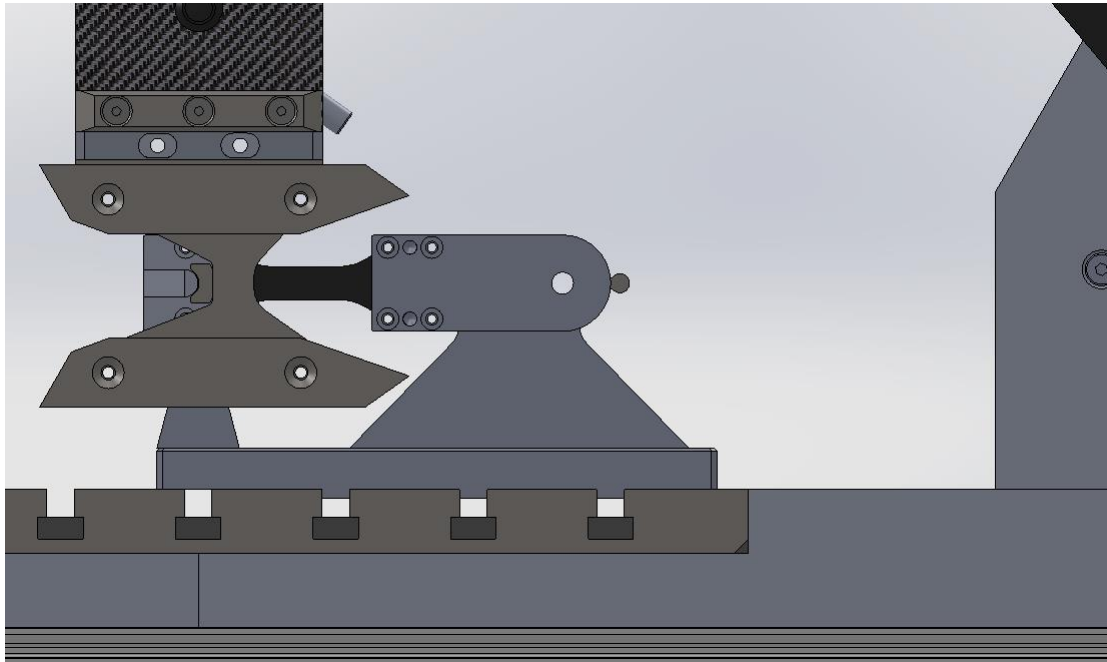


Cam 1



IMPETUS® - dynamic tensile test

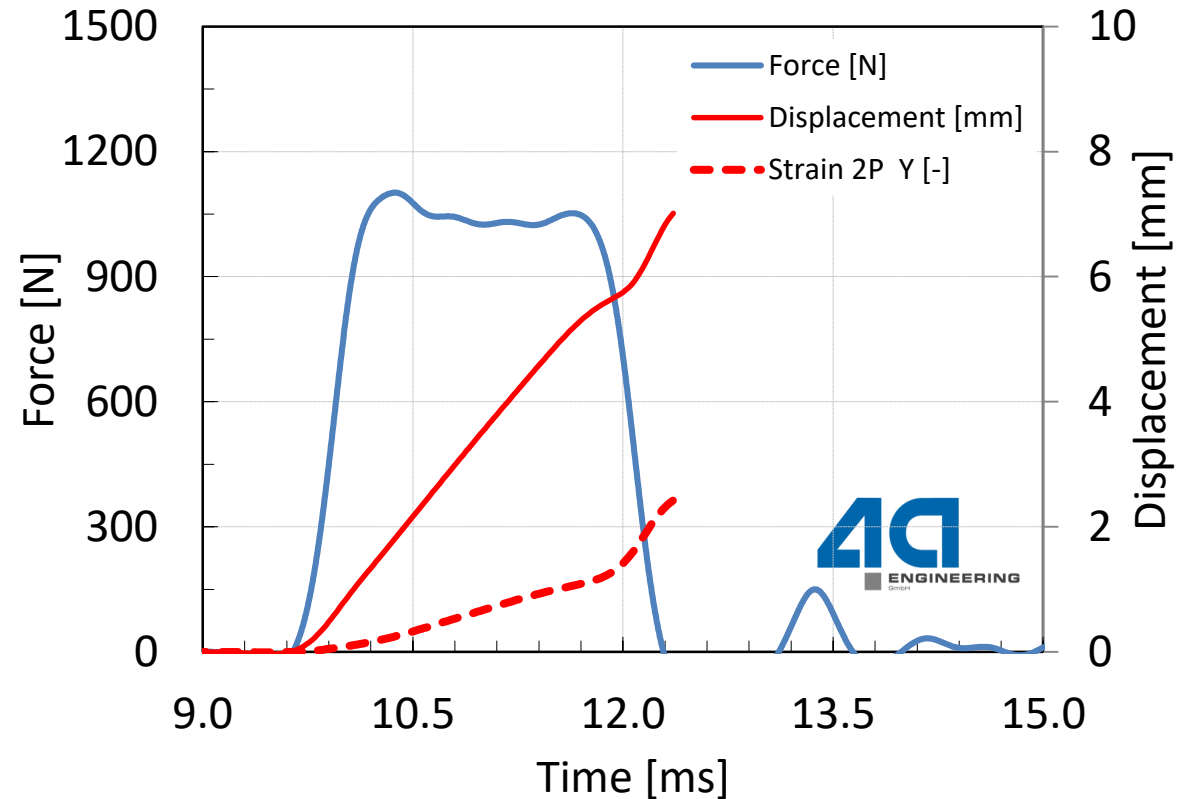
- Hardware consists of 3 main parts
 - counter bearing system
 - sample clamping
 - pendulum impactor head
→ Ease of use operation!



Measurement technique

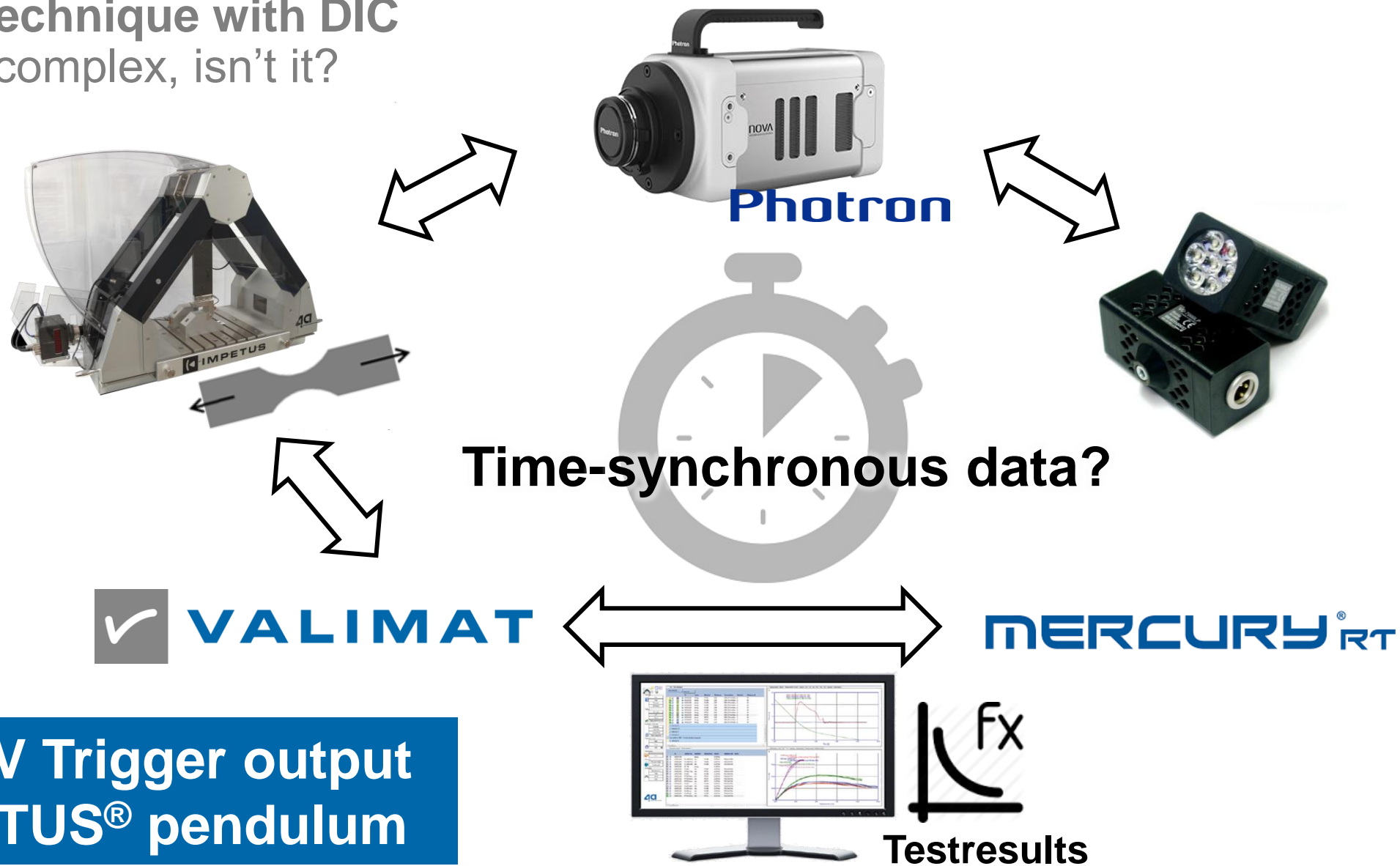
What we basically measure during the test?

- Force [N]
 - piezo load cell 20 kN
- Displacement [mm]
 - incremental angle sensor
 - **digital image correlation (DIC)**
 - **Now it's getting complex, isn't it?**
- Time [ms]
 - time-synchronous data is essential



Measurement technique with DIC

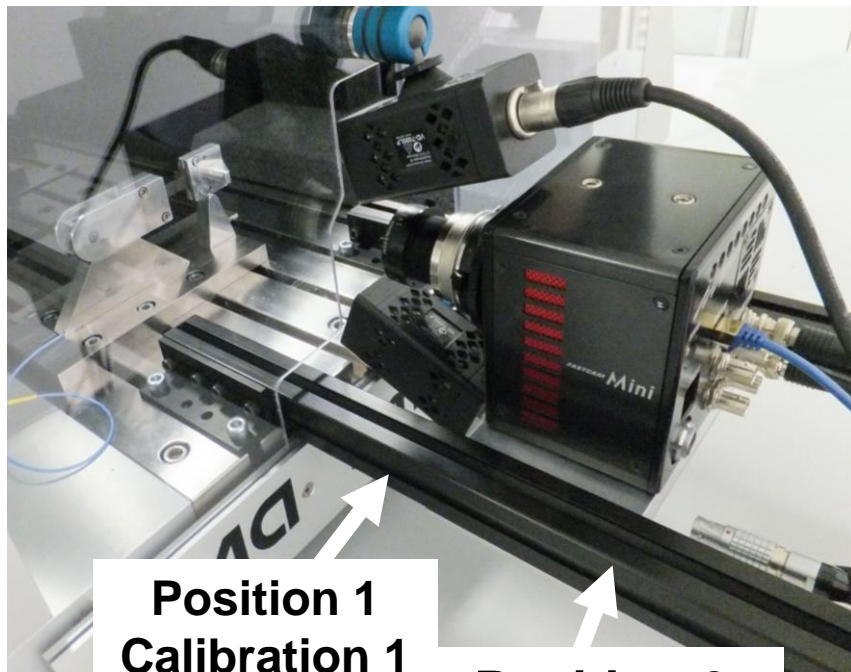
Now it's getting complex, isn't it?



Integrated 5V Trigger output at the IMPETUS® pendulum

Measurement technique with DIC

Now it's getting complex, isn't it?

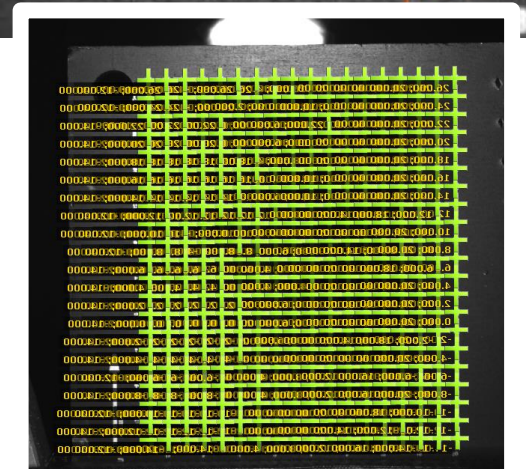
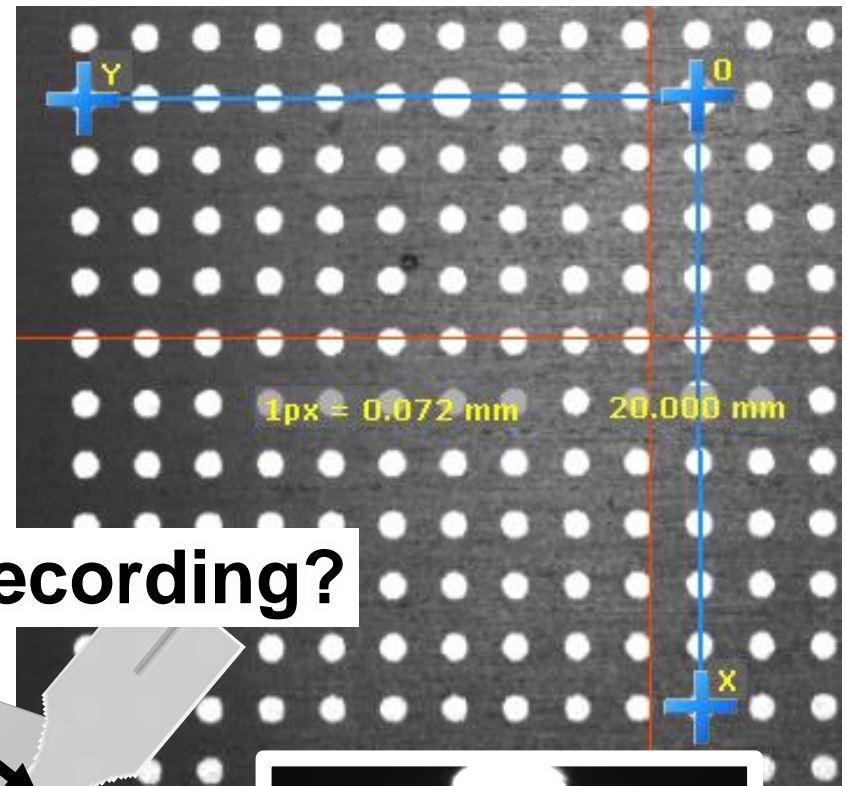


Position 1
Calibration 1

Position 2
Calibration 2

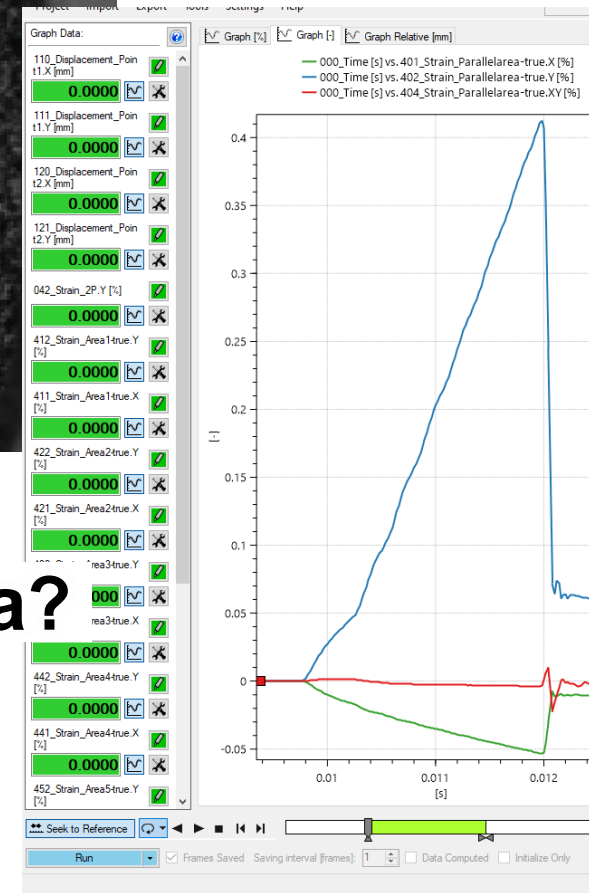
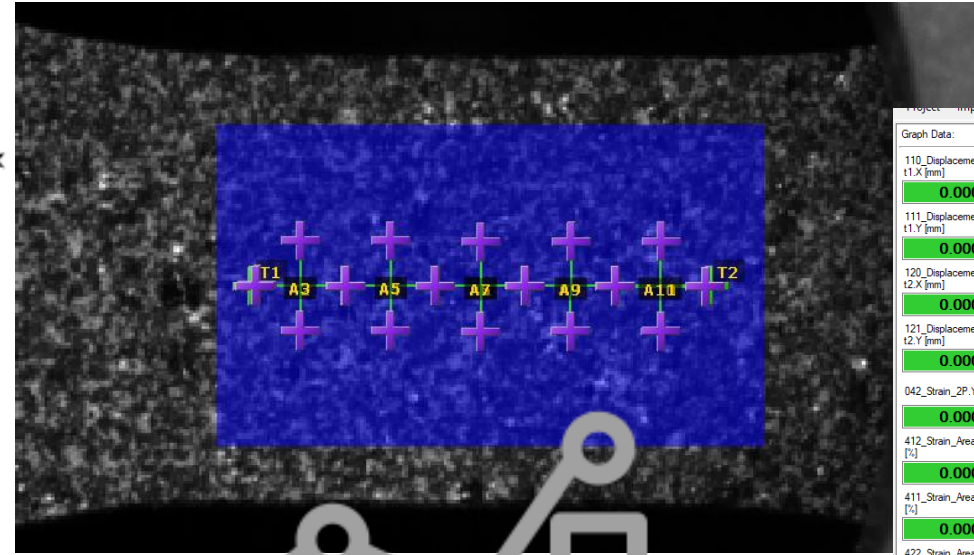
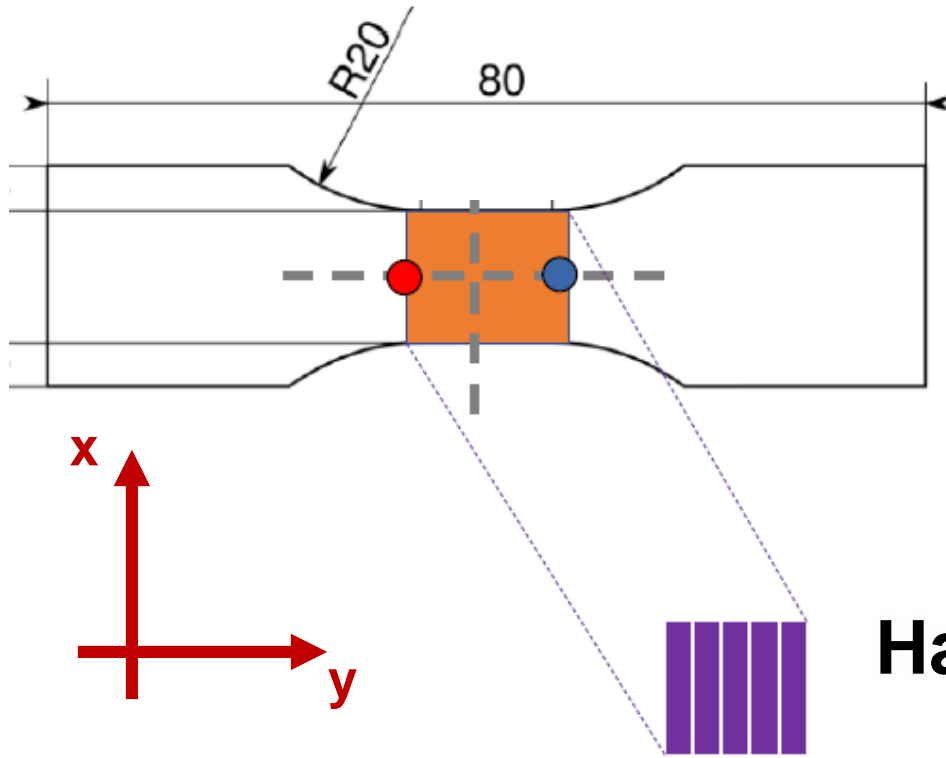
Predefined camera positions attached to the pendulum

Calibrated DIC recording?



Measurement technique with DIC

Now it's getting complex, isn't it?



Handling the recorded data?

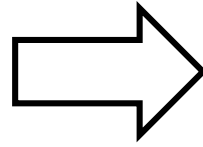
DIC "standard" nomenclature for optical measurement data

Measurement technique with DIC

It's not complicated!

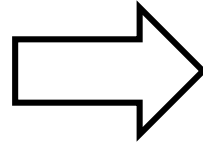


Integrated 5V Trigger output
at the IMPETUS[®] pendulum



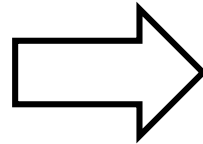
Time-synchronous data!

Predefined camera positions
attached to the pendulum

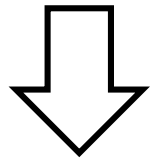


Calibrated DIC recording!

DIC "standard" nomenclature
for optical measurement data



Easy data handling!



Efficient dynamic testing!

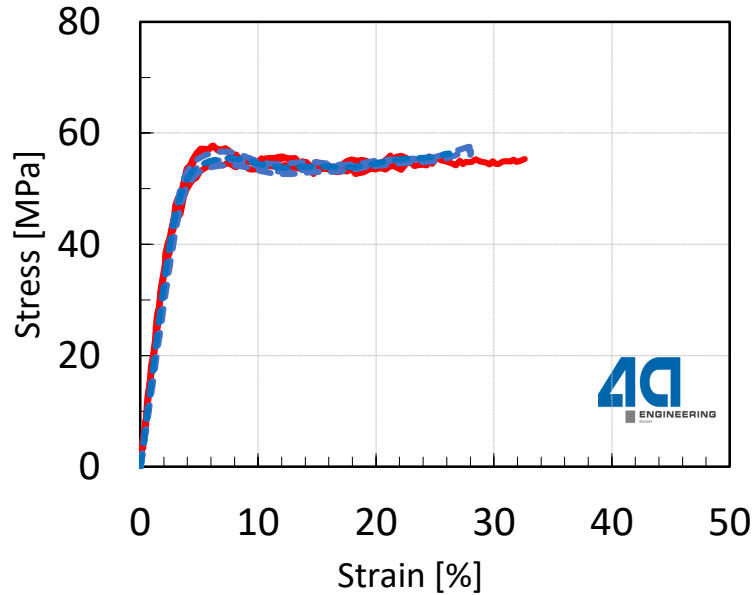
Dynamic tensile test - video



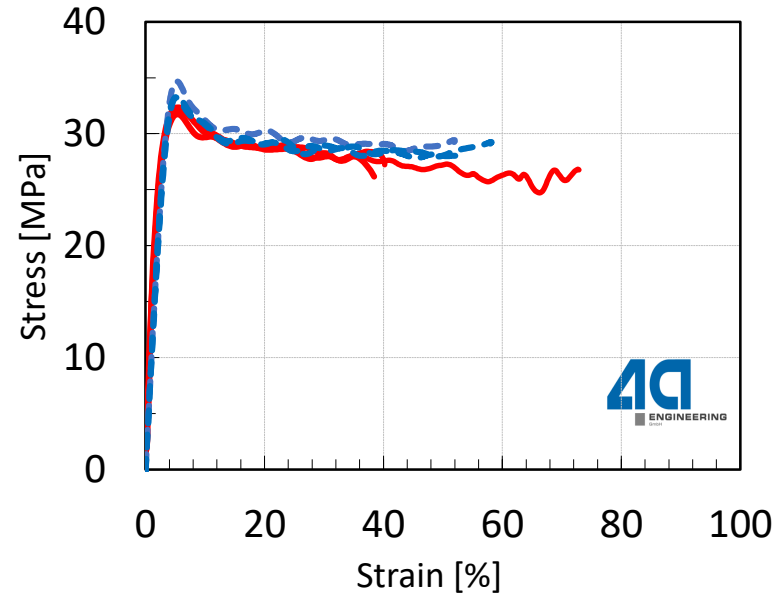
Dynamic tensile test - unreinforced plastic comparison 4a IMPETUS / external ZWICK

External ZWICK
4a IMPETUS

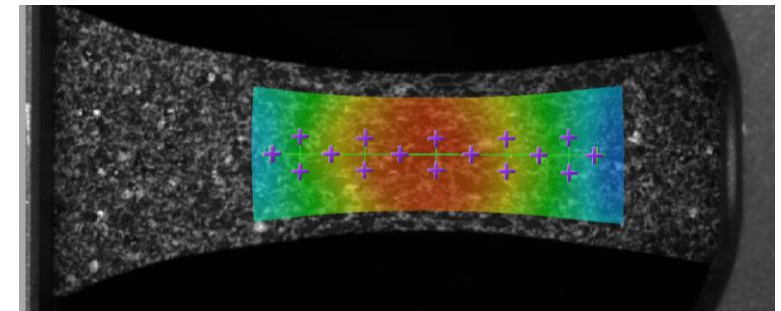
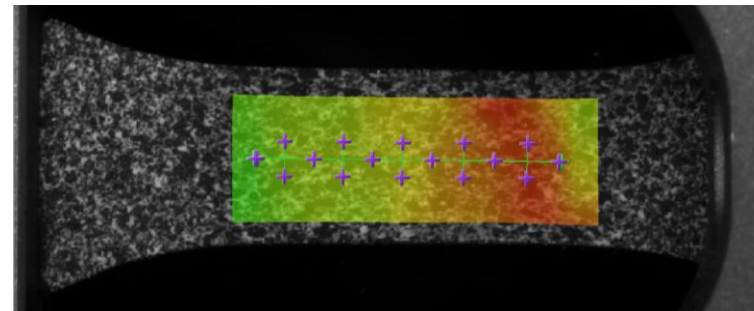
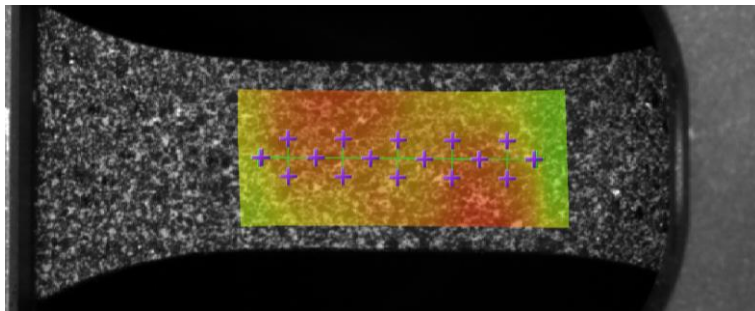
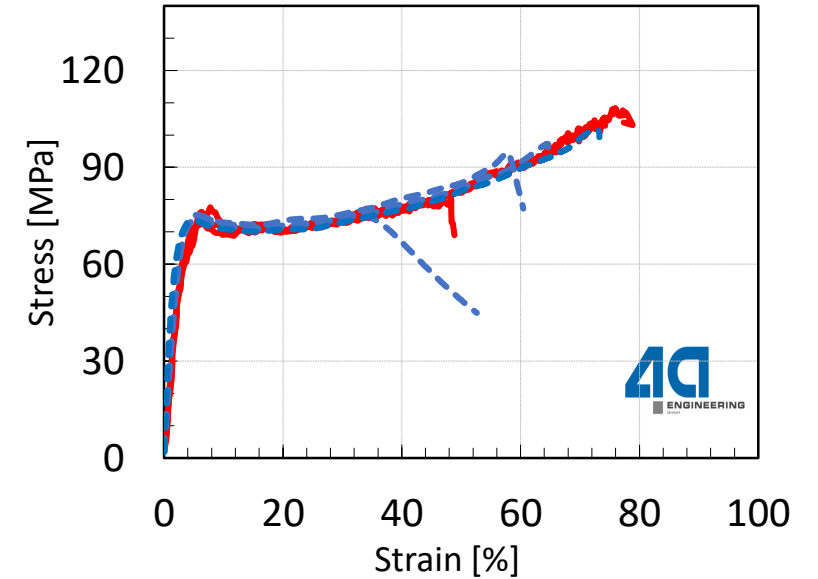
Typ A, 3m/s



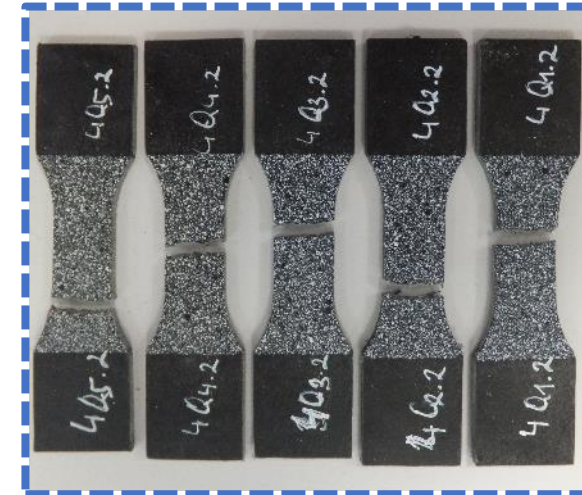
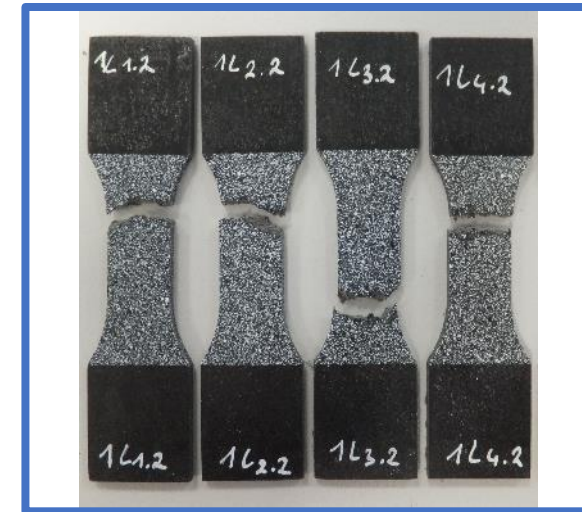
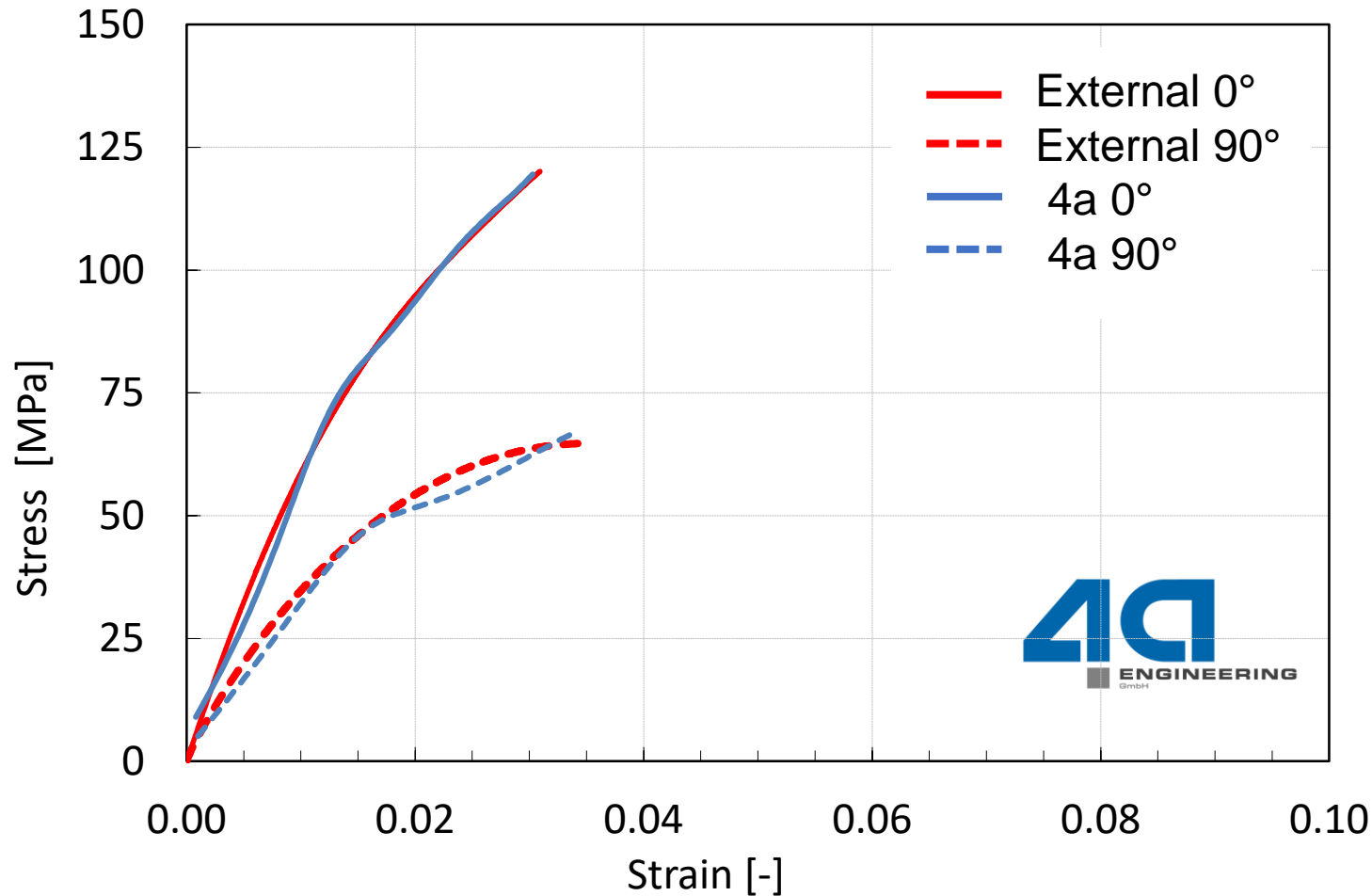
Typ B, 3m/s



Typ C, 3m/s



Dynamic tensile test – reinforced plastic PPLGF30 comparison 4a / external

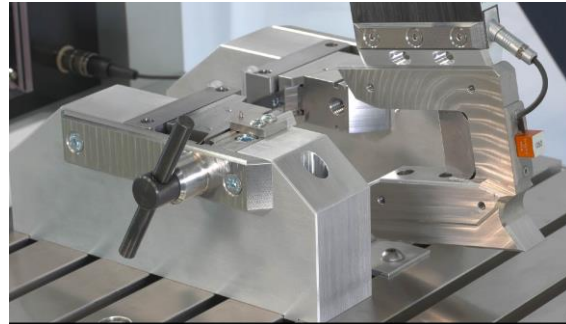


With the kind support by  **Celanese**

IMPETUS® - 3D DIC measurement



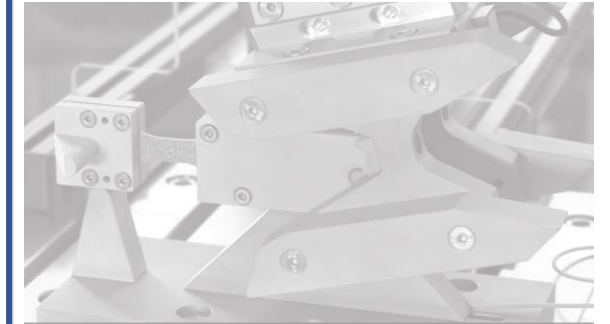
3 POINT BENDING



TENSION BENDING

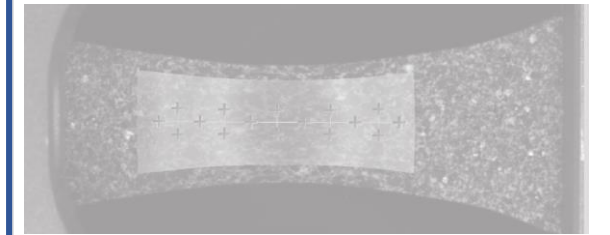
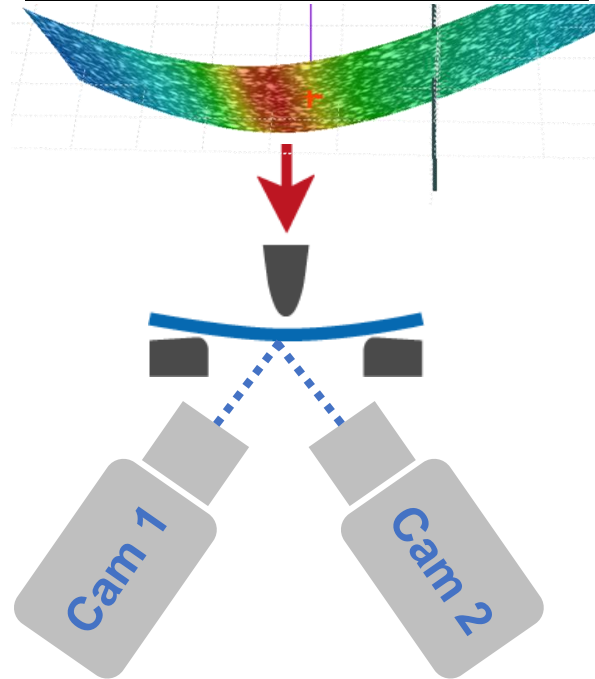


PUNCTURE TEST



TENSION TEST

3D - DIC



2D



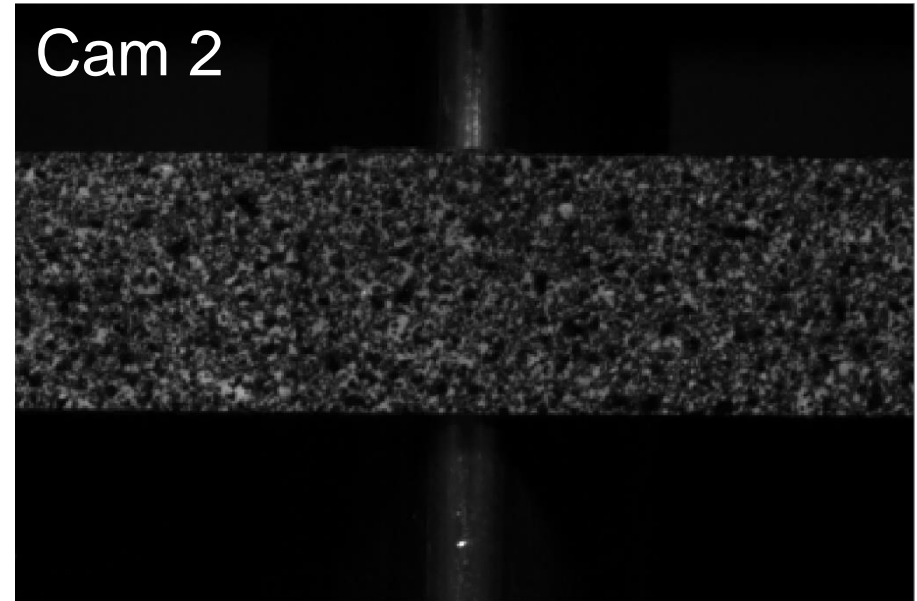
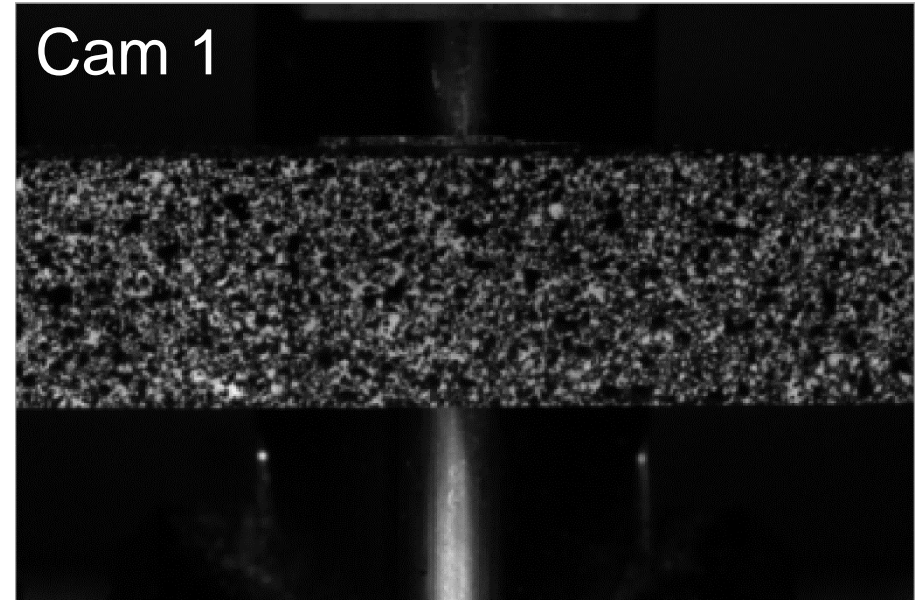
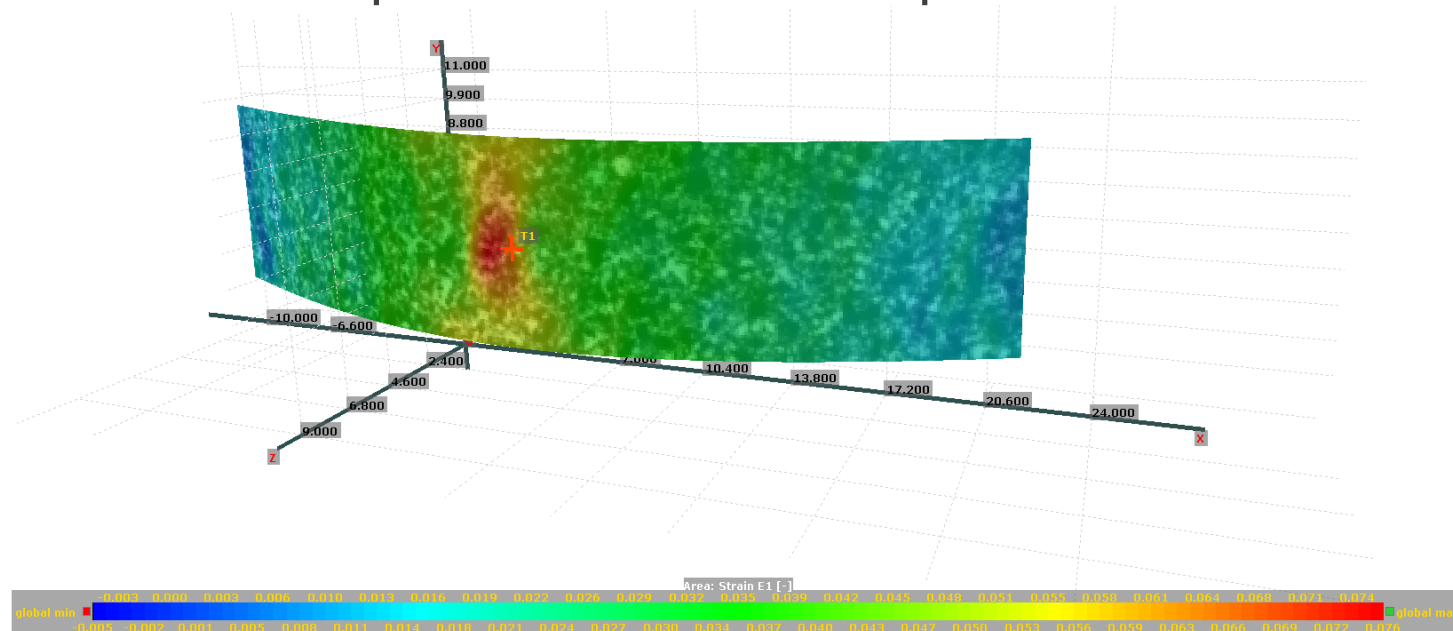
IMPETUS® - 3D DIC Setup

- Test setup
 - 2 x Photron FASTCAM NOVA S9
 - Camera 1 from above tilt angle 20°
 - Camera 2 from below tilt angle -5°

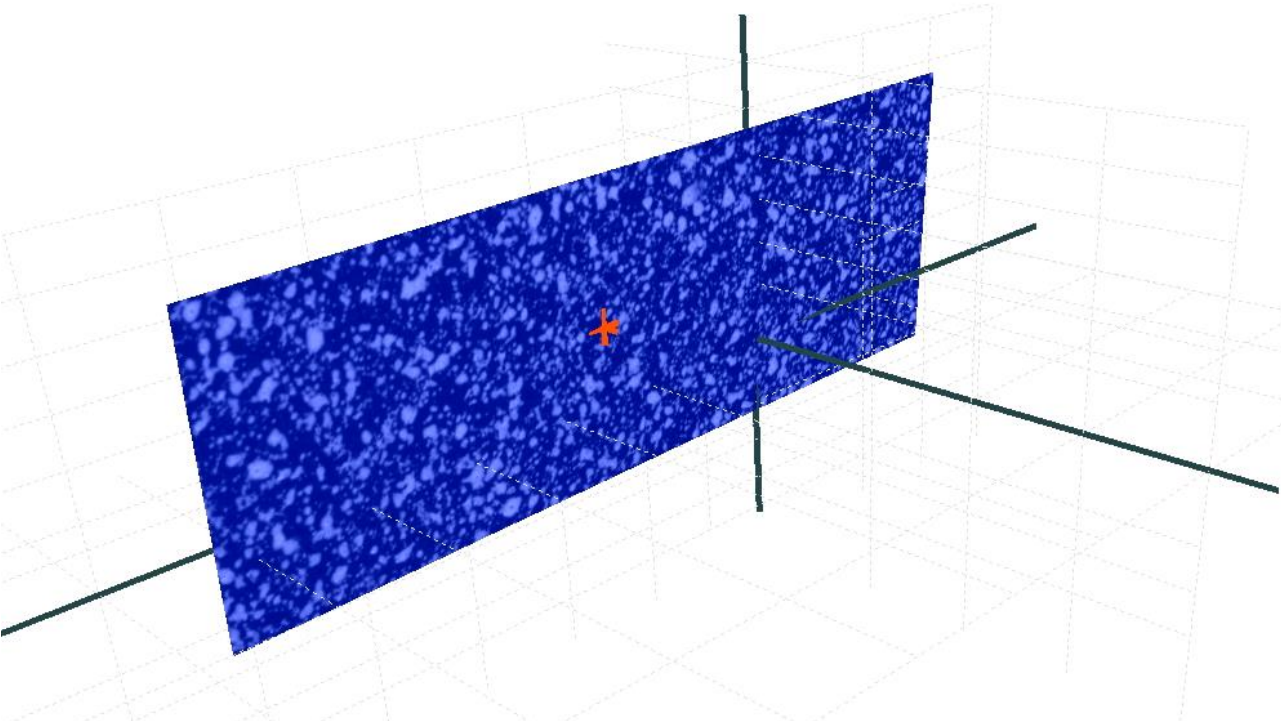


IMPETUS® - 3D DIC Setup

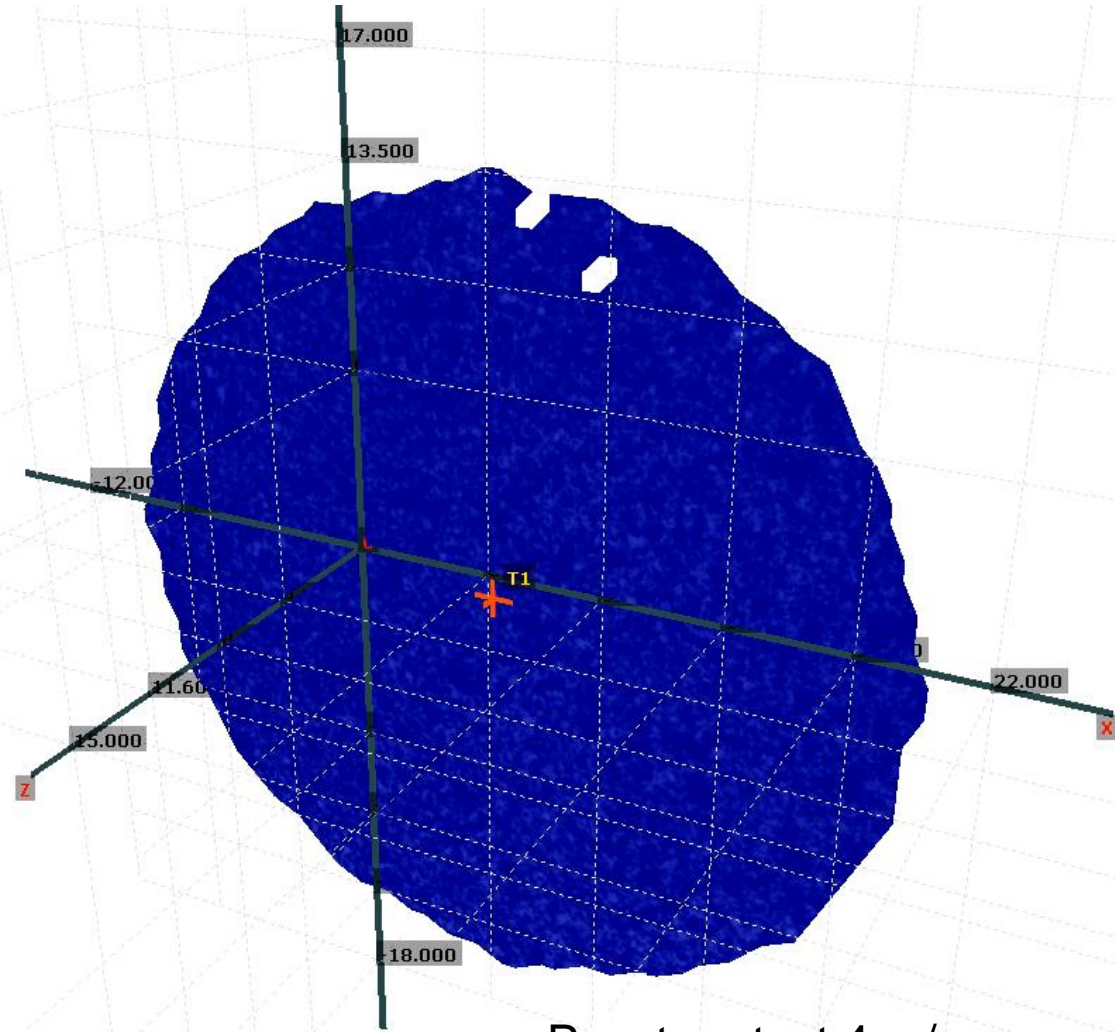
- DIC settings
 - Resolution of 384x256 px
 - Recorded frame rate of 15.000 fps
 - Strain measuring with a Full-Field Area
 - True Strain E1maximum
 - Template Size of 24 x 24 px



IMPETUS® - 3D DIC recordings



3-point-bending test 1 m/s
unreinforced plastic



Puncture test 4 m/s
unreinforced plastic

Thank you for your attention

S. Riemelmoser - 4a engineering GmbH
13th European LS-DYNA Conference 2021

