VALIMAT™ – A Smart Solution for Generating and Managing Material Cards

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Outline

- Introduction
- IMPETUS™ - efficient dynamic testing
- VALIMAT™ - from test to validated material cards
- Summary

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ENGINEERING

excellence in ..

plastics simulation

testing equipment

lightweight products

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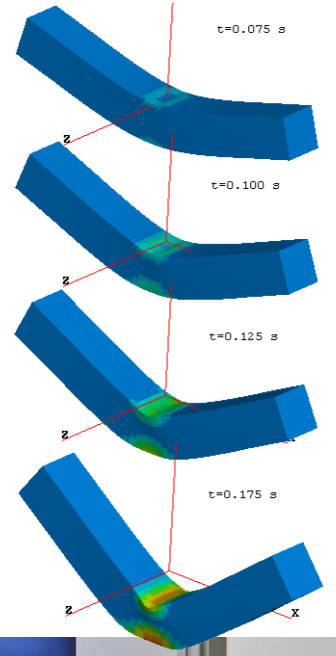
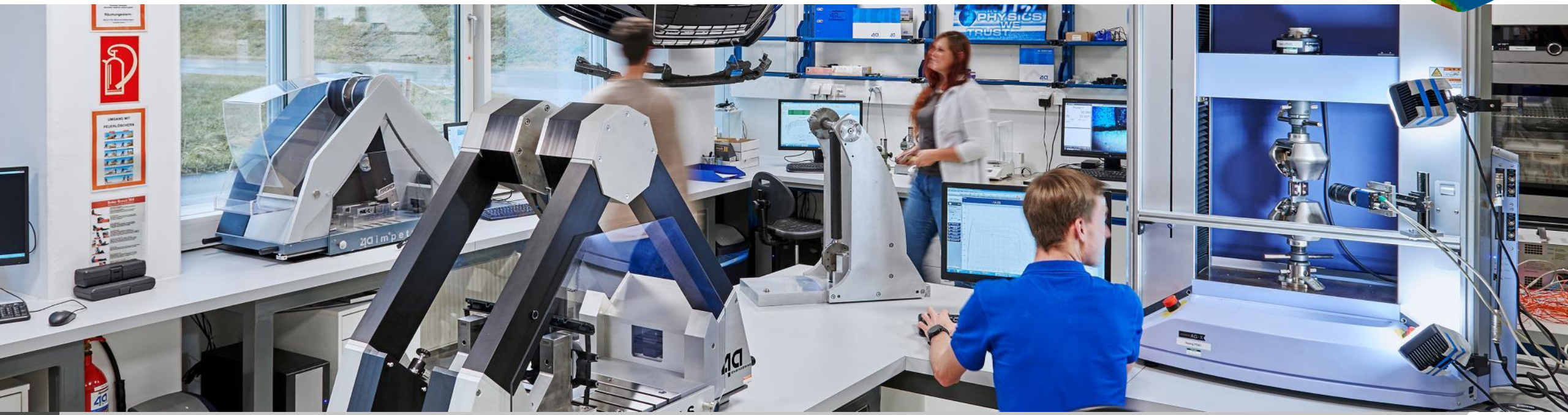
material characterization - services

- efficient high-dynamic testing
- dynamic material behaviour
- plastics, foams, composites, …
- **validated material cards ready to use for your crash-simulation**





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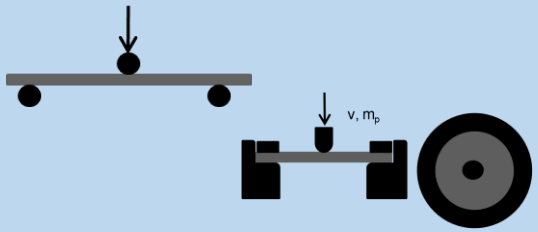
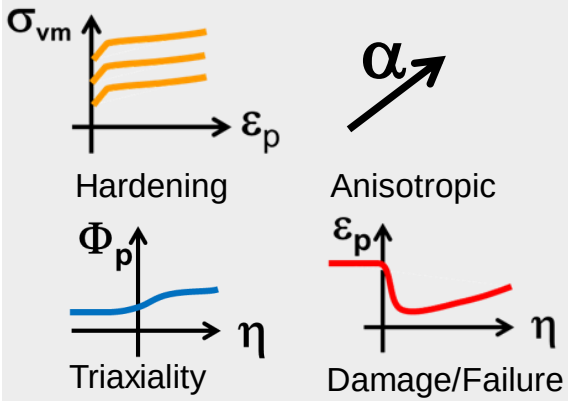
intelligent reliable solutions for plastics, composites, metals, foams, ...

IMPETUS



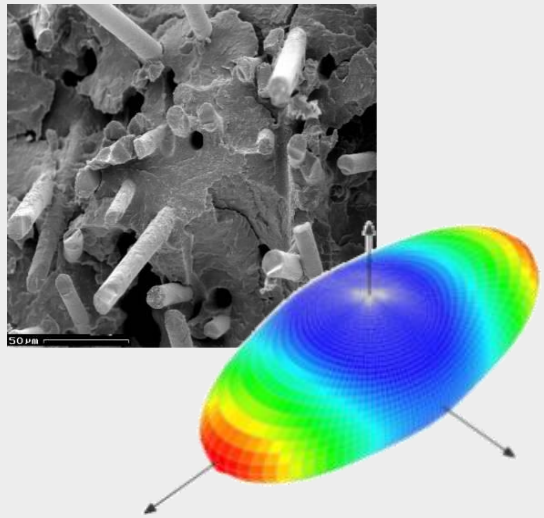
efficient
dynamic testing

VALIMAT



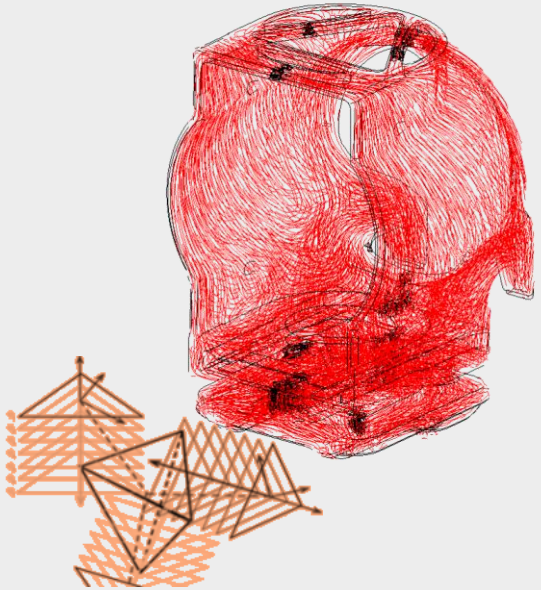
from test to validated
material cards

MICROMEC



3D anisotropic
material cards

FIBERMAP



individual mapping
process information

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IMPETUS

plastics

engineering

production

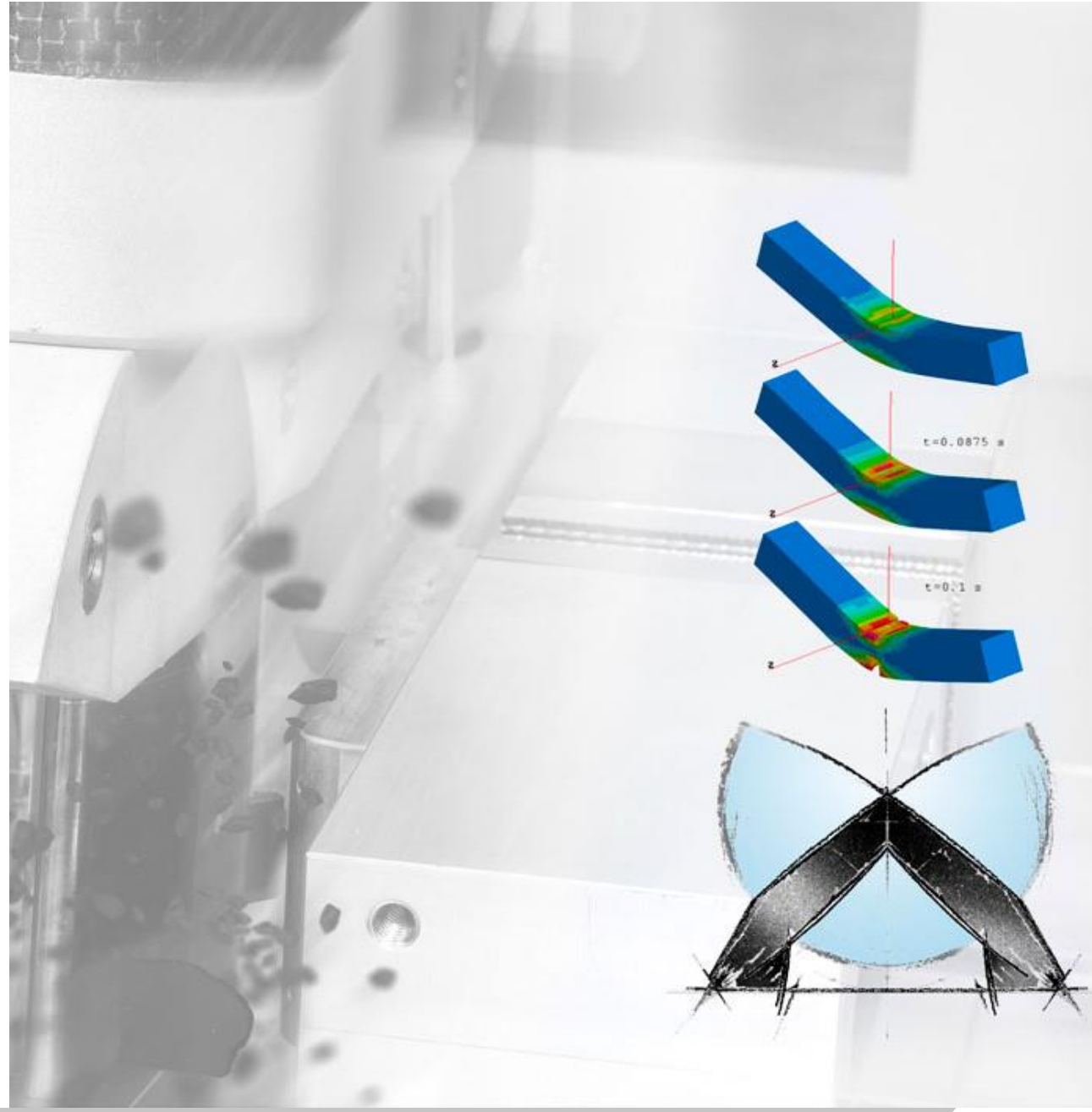
excellence in testing

concepts

simulation

lightweight

prototypes



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IMPETUS™ - efficient dynamic testing

- instrumented high speed testing
  - Acceleration → Force / Displacement
- High speed camera
  - Sync. Recording
- impact speed 0.5 – 4.5 m/s
- maximal energy up 50 J

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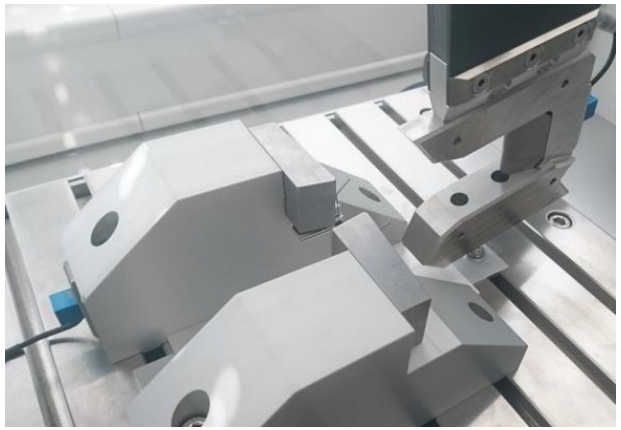
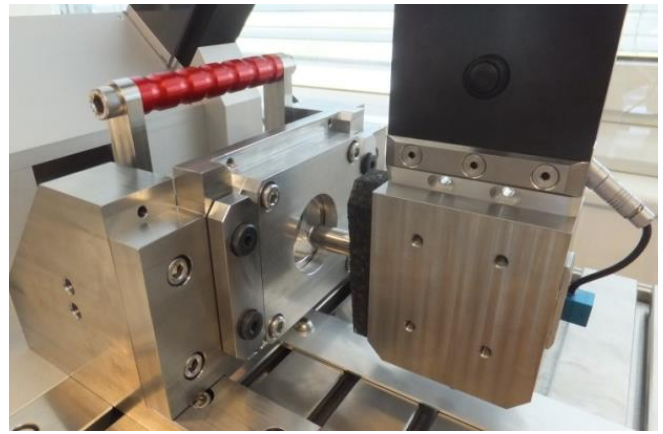
IMPETUS™ - efficient dynamic testing

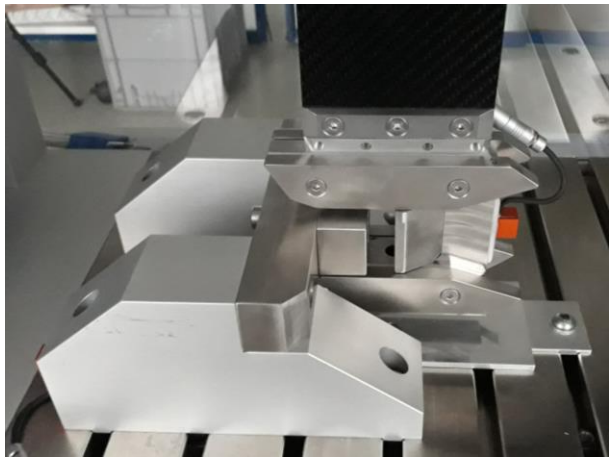


bending test

tension bending test



puncture test



compression test

tensile test

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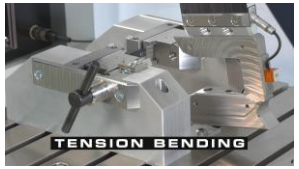
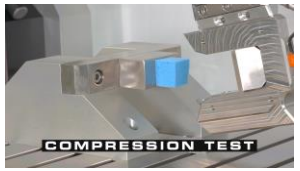
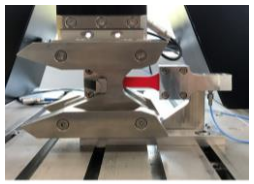
IMPETUS™ - efficient dynamic testing






tensile test

						typical thickness
Plastic	✓	✓		✓	✓	(1 - 4 mm)
Foam	~		✓			(20 - 30 mm)
Composite	✓			✓		(1 - 4 mm)
Aluminum	✓	✓			✓	(1 – 2.5 mm)
Metals	✓					(0.5 – 1.5 mm)

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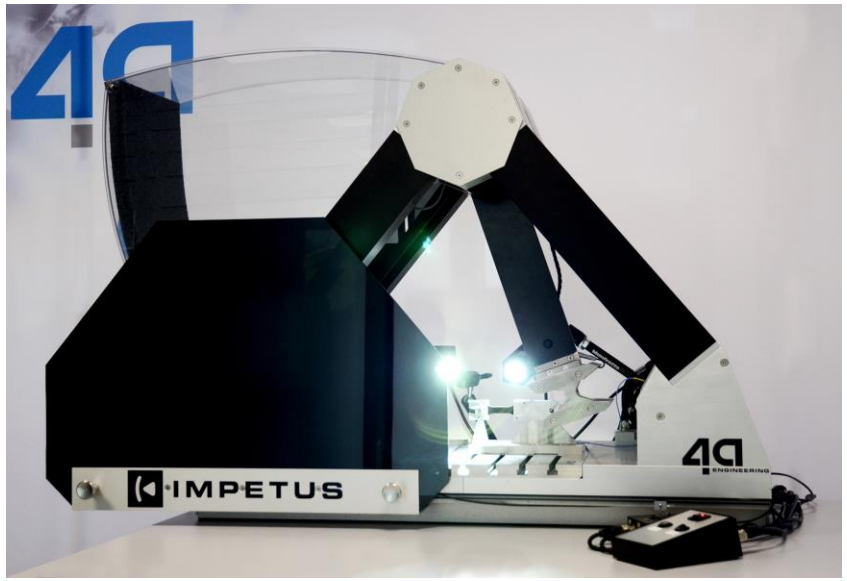
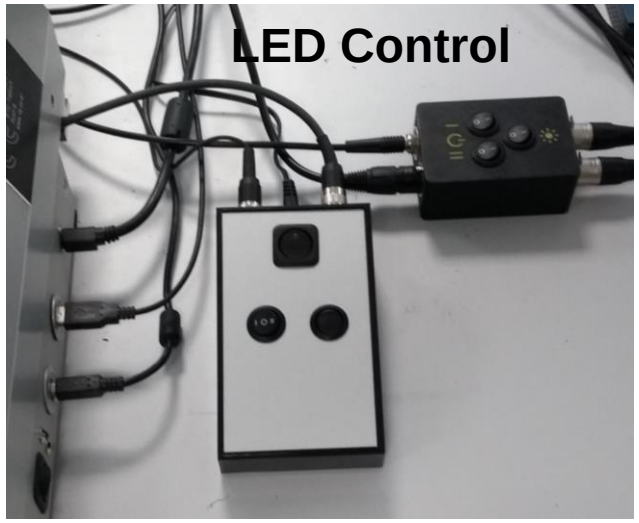
IMPETUS™ - dynamic tensile test

- Compatible with IMPETUS™ Gen. 4 & 5

- Parts of the dynamic tensile test
  - Test setup
  - Piezo load cell
  - Pendulum Head
  - Sample holder
  - Mounting kit for sample holder
  - Highspeed Camera for DIC
  - LED-Lights





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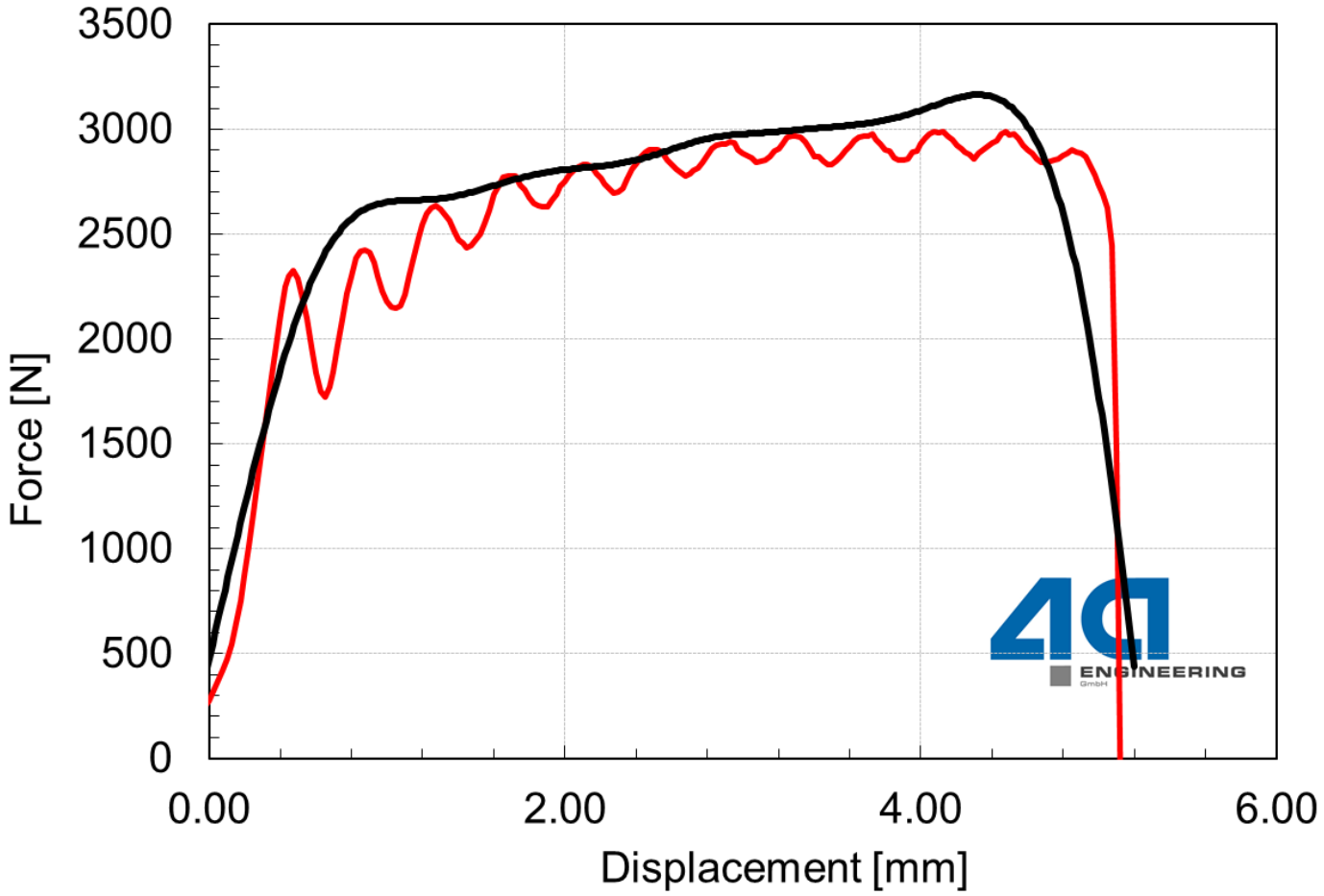
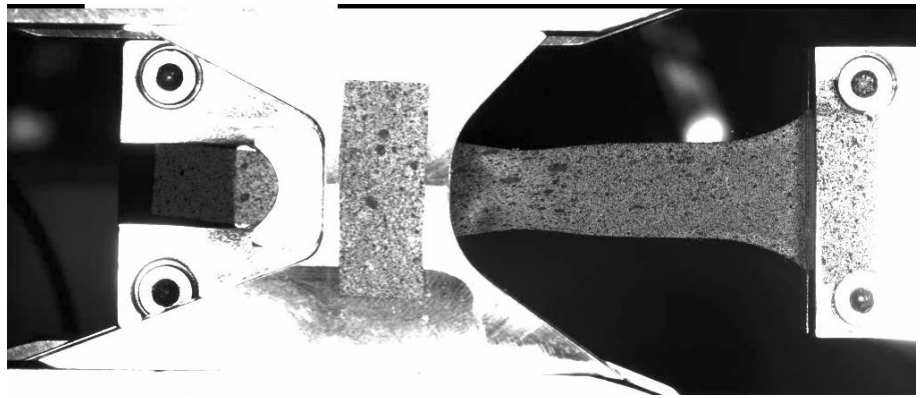
Dynamic tensile test setup

- Comparison Aluminum



servo hydraulic test machine
IMPETUS™ new dynamic tensile test



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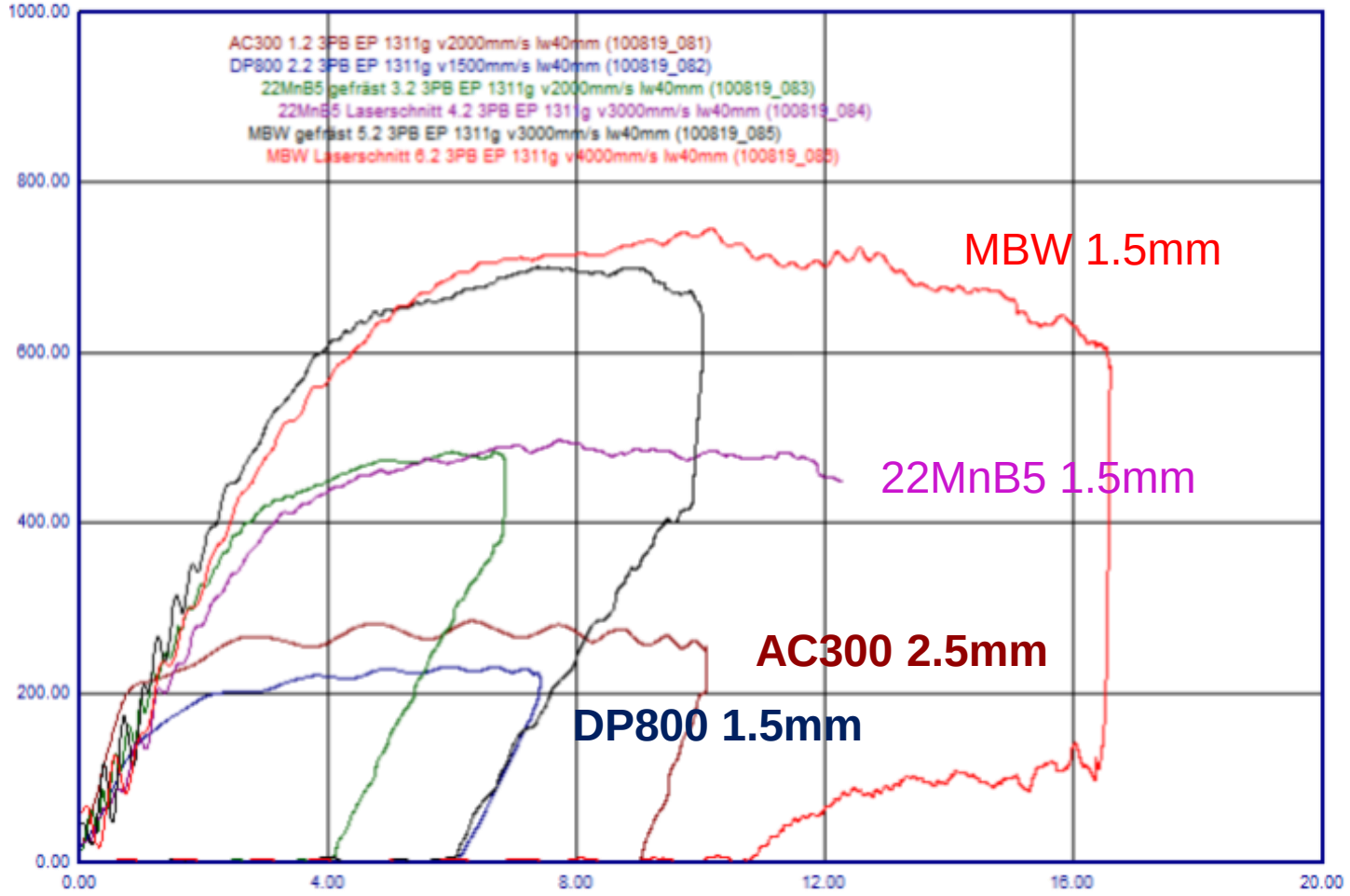
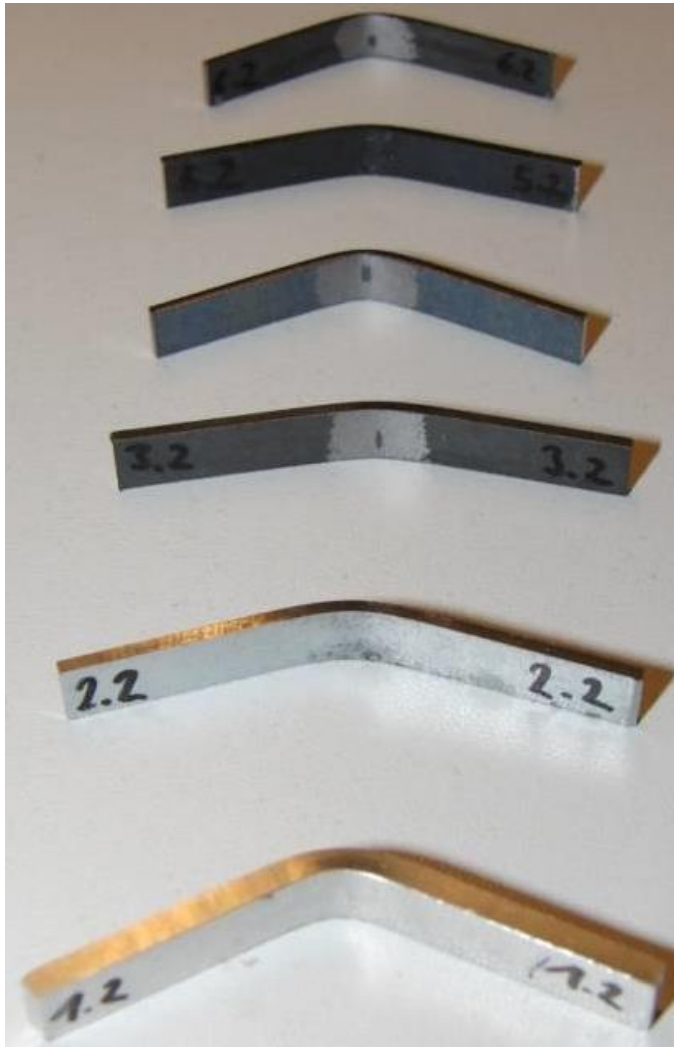
IMPETUS™ - bending tests strain rates ~20 1/s





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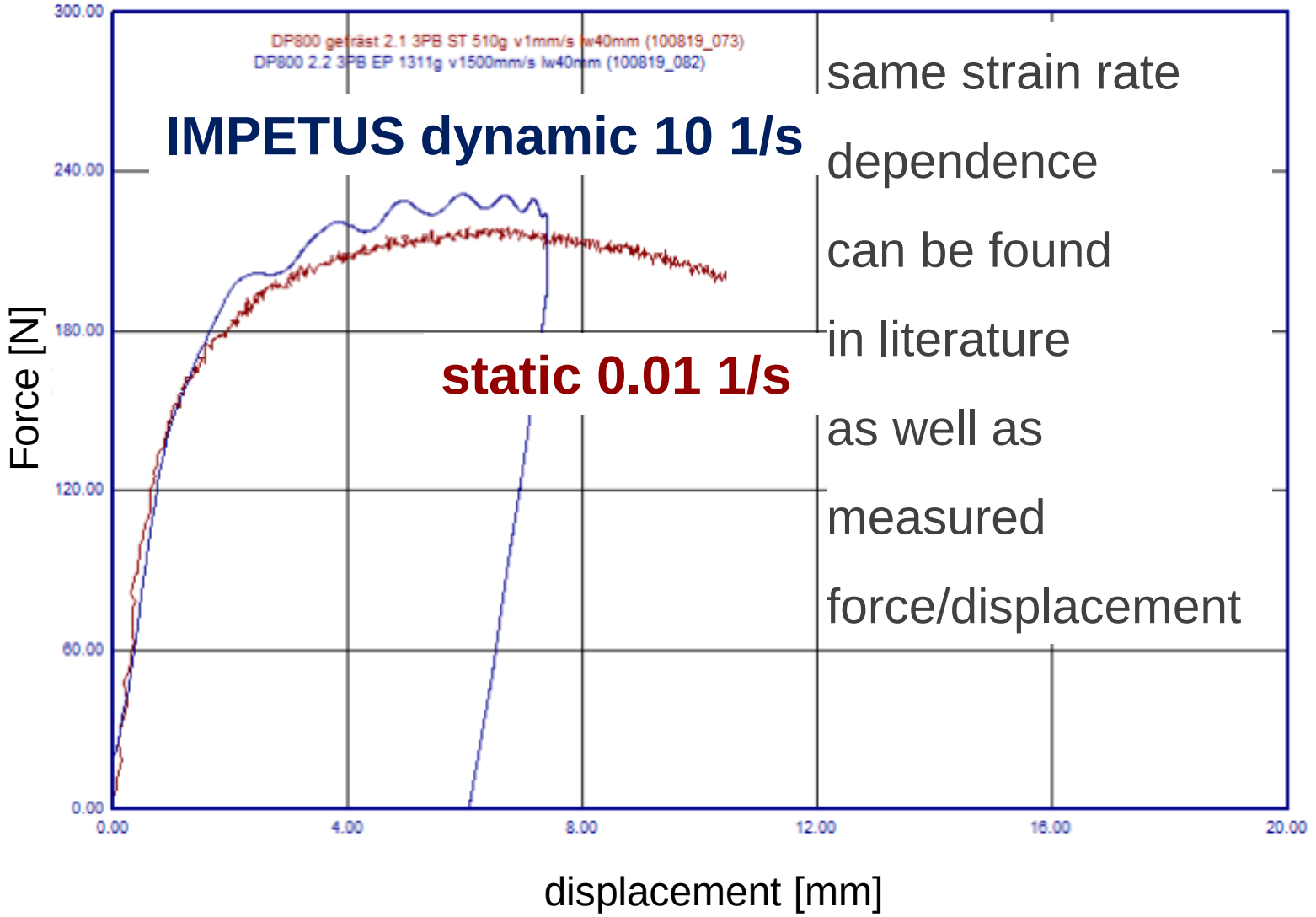
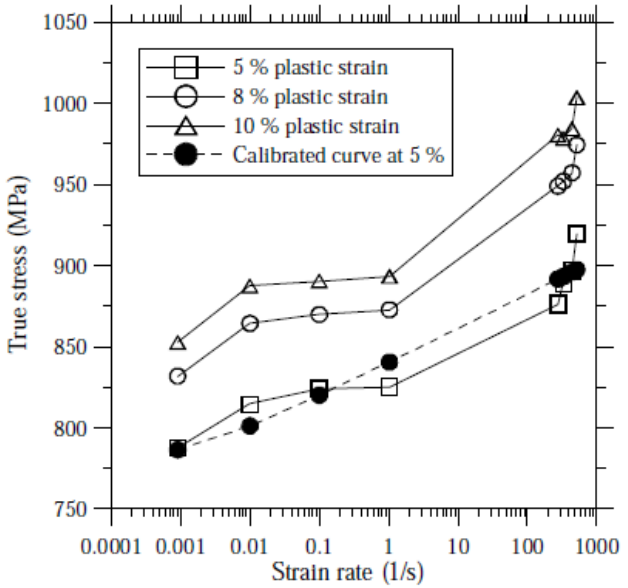
IMPETUS™ - bending tests strain rate dependence



same strain rate dependence can be found in literature as well as measured force/displacement



(d) True stress vs. strain rate at different plastic strains

Source: An experimental and numerical study of energy absorption in thin-walled high-strength steel sections, Venkatapathi Tarigopula, Magnus Langseth, Odd Sture Hopperstad & Arild Holm Clausen Structural Impact Laboratory (SIMLab), Department of Structural Engineering, Norwegian University of Science and Technology (NTNU), Norway

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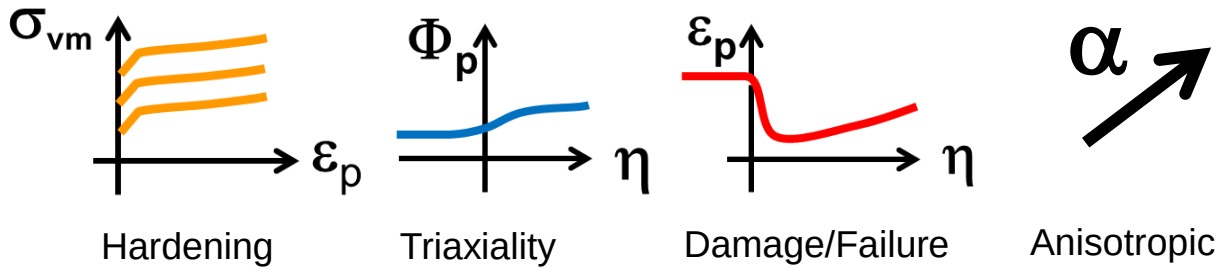
VALIMAT

plastics
engineering
production
excellence in validation
concepts
simulation
lightweight
prototypes



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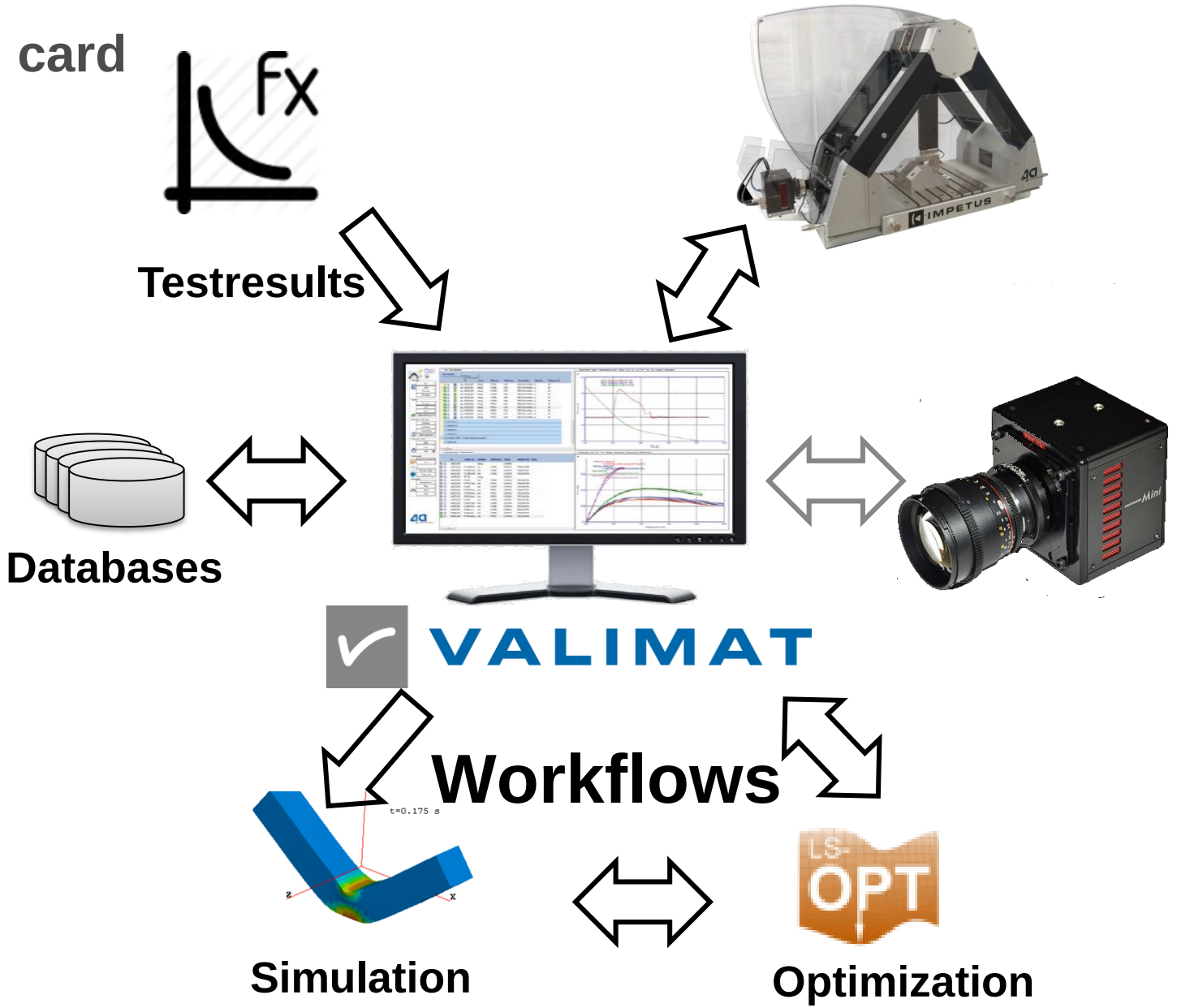
VALIMAT ™ - from test to material card

VALIMAT™

Advantage

- Handling of bigdata
- Complex models
- Good correlation to simulation



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VALIMAT ™ - from test to material card

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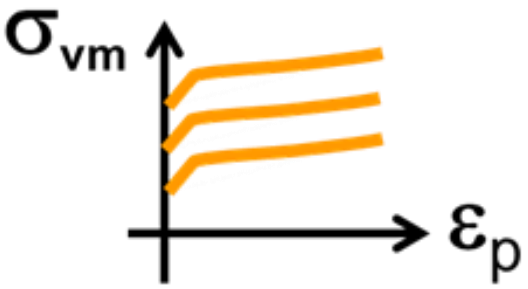
Material behaviour	
Material source	Implemented
Material card	MATER103
Deformation	Elastic Viskoplastic
Damage/Failure	None
Materialcard id	1000000
Density	-948.374
Plasticity	vonMISES
Function (Hardening, Elastic curve form)	
Curve 1	Voce generalised
Strain range upto	
Sampling points	
Bias factor	
Strain rate dependency	
Fracture	
Postfracture	
Loadcases	
Casename	
Results	

Hollomon
Swift
Voce
Hockett/Sherby
Gosh
Swift-Voce
Swift-Hockett/Sherby
El-Magd
Voce generalised
Bergström*



Hardening

$$h_{vocegC1} + \left(h_{vocegC2} + h_{vocegC3} \cdot \varepsilon_{pl}\right) \cdot \left(1 - e^{-h_{vocegC4} \cdot \varepsilon_{pl}}\right)$$

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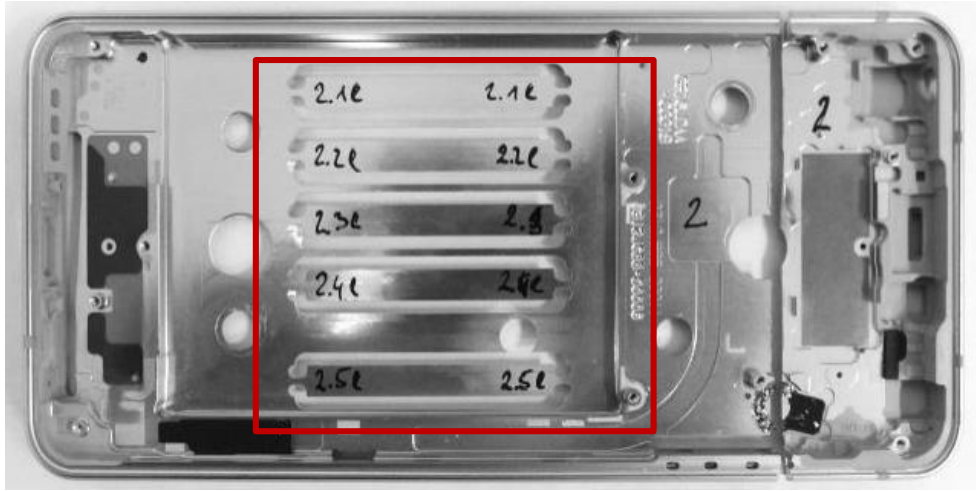
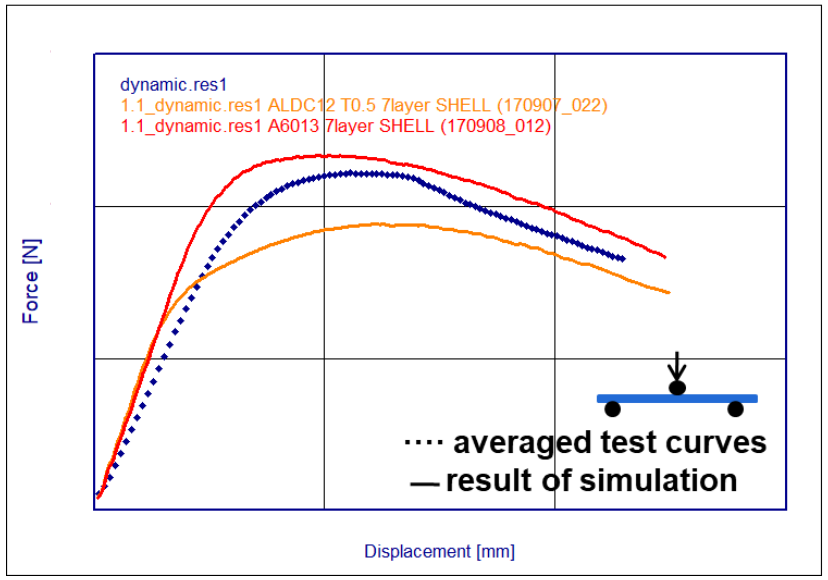
Case: Smartphone Cover

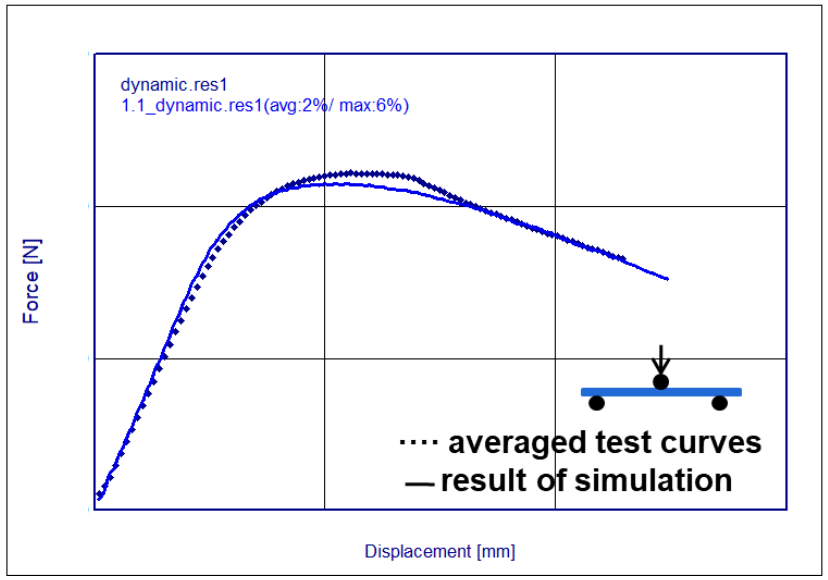
- Cut out samples from real cover
- Check quality of provided material cards
- Calibrate material card



provided material card



generated material card (swift law)



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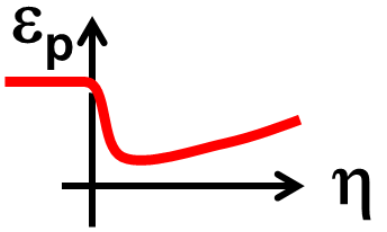
fracture models → *MAT_ADD_EROSION

VALIMAT



Damage/Failure

Parameter model* | Model database

170503_024 | Material | Designvariables | Layers | Materialcard | MMEC | Image | Comment

- Material behaviour
  - Material source
    - Elasticity
    - Plasticity
    - Failure/Damage
  - Material card
    - Materialcardcase
    - Damage/Failurecase
    - Materialcard id
    - Density
    - Plasticity
    - Function (Hardening, Elastic curve form)
      - Curve 1
      - Curve 2
      - Strain range upto
      - Sampling points
      - Bias factor
    - Strain rate dependency
      - Strain rate dependency
    - Fracture
      - Ductile Damage Settings
        - lower triax value
        - upper triax value
        - step size triax
      - Shear Damage Settings
      - FLC Damage Settings
      - Strainrate Settings
      - Postfracture
- Loadcases
- Results

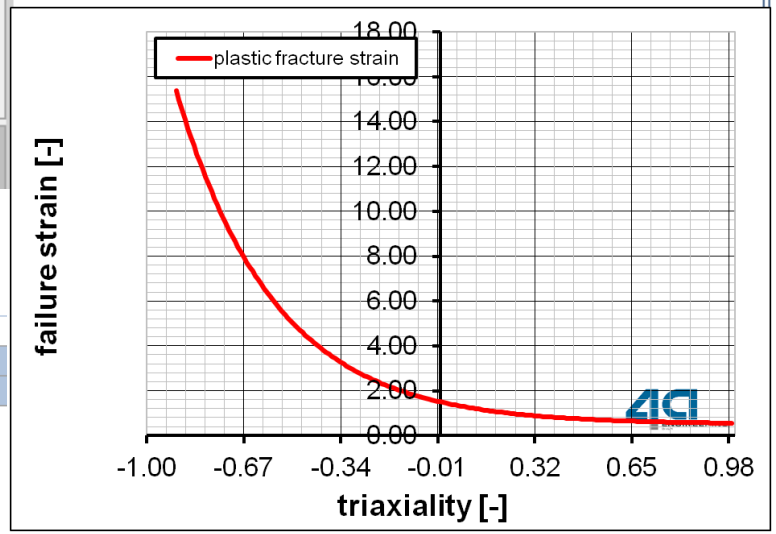
Density	-1
Plasticity	vonMISES
Function (Hardening, Elastic cur	
Strain rate dependency	Table
Fracture	Damage
Ductile Damage Settings	Johnson Cook
Shear Damage Settings	None
FLC Damage Settings	plastic equivalent strain
Strainrate Settings	simple criteria
Postfracture	4a picewise linear
Loadcases	Johnson Cook
Casename	mod Xue-Wierzbicki
Tests	Xue-Wierzbicki
Settings opimization	Mohr-Coulomb
Weighting case	1

Ductile Damage Settings

lower triax value	
upper triax value	
step size triax	0.33
Shear Damage Settings	None
FLC Damage Settings	None
Strainrate Settings	Johnson Cook
Postfracture	Fracture Energy (TRIAX)

Johnson Cook
mod Xue-Wierzbicki
Xue-Wierzbicki
Mohr-Coulomb

$$f d_{JCD1} + f d_{JCD2} \cdot e^{-f d_{JCD3} \cdot \eta}$$



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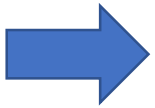
Case: Ultra-high strength steel

VALIMAT

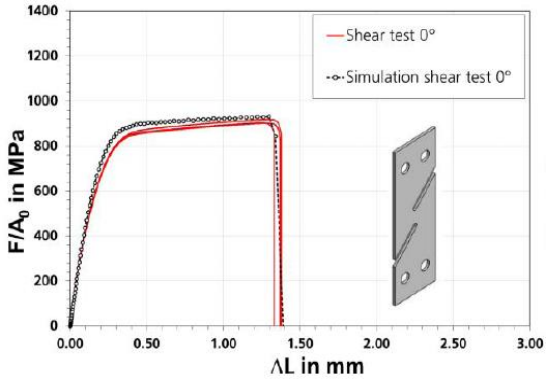
1. Tests provided by customer
2. **Import in VALIMAT™**

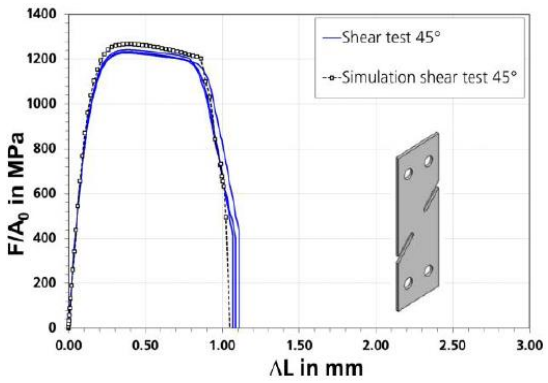
INSTRON
MTS
Zwick / Roell
3om Optical Measuring Techniques
SHIMADZU

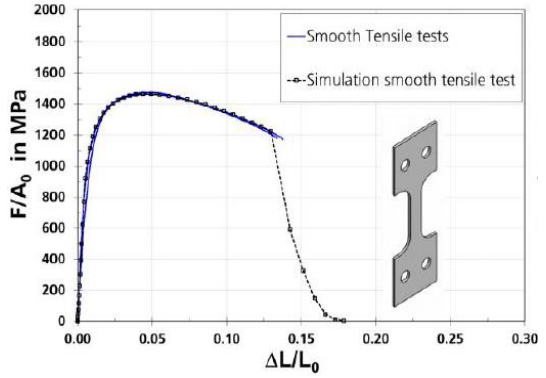


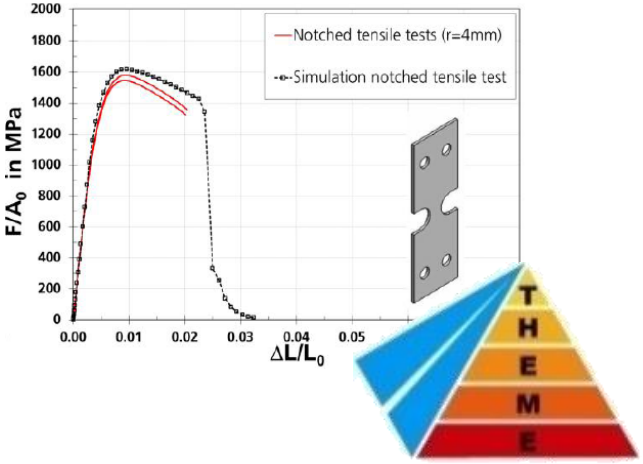
Databases

Double Notched Shear (0°)	Double Notched Shear (45°)	Tensile	Notched Tensile (r=4mm)









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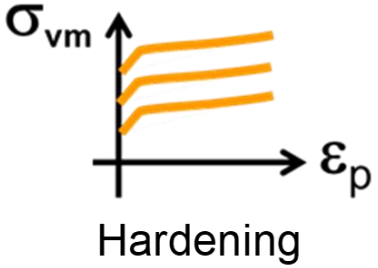
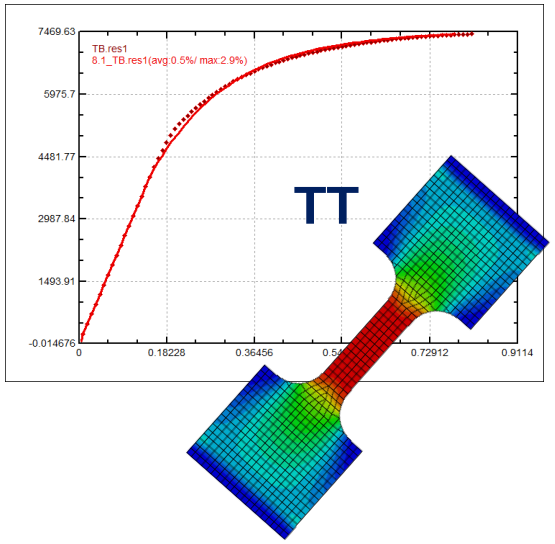
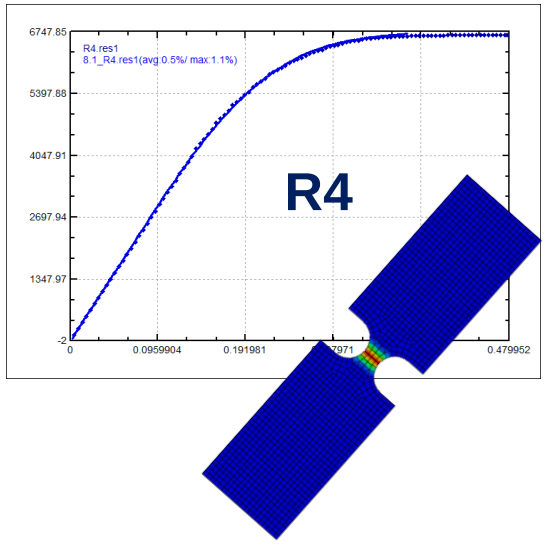
Case: Ultra-high strength steel

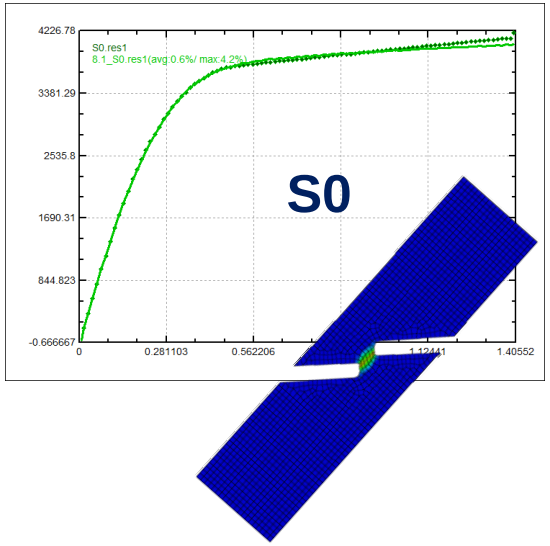
1. Tests provided by customer
2. Import in VALIMAT™
3. ***MAT_024 – Hardening**

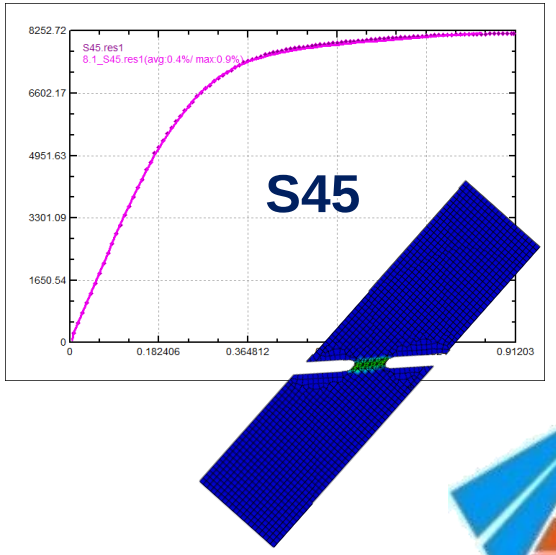


Parametric Hardening function - Validation









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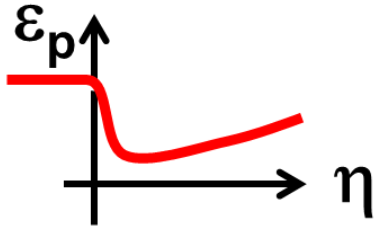
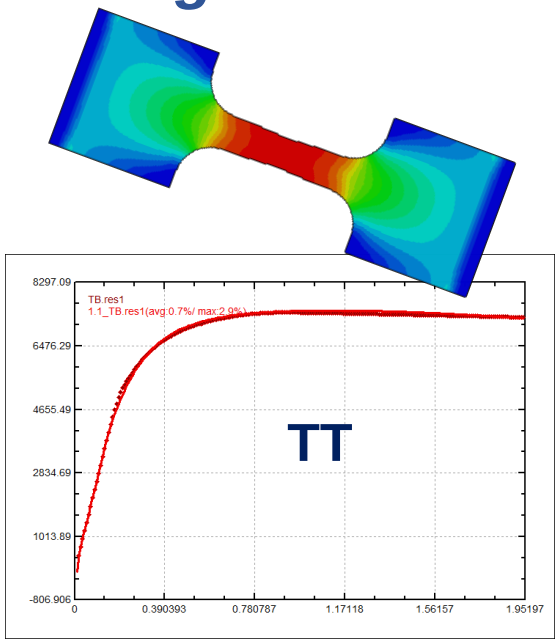
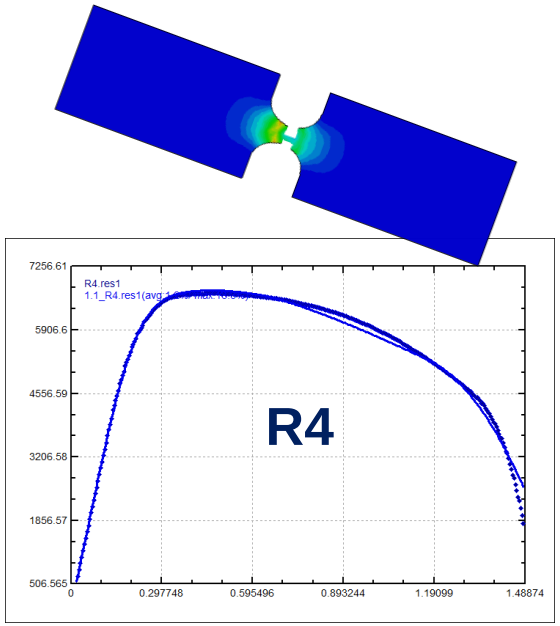
Case: Ultra-high strength steel

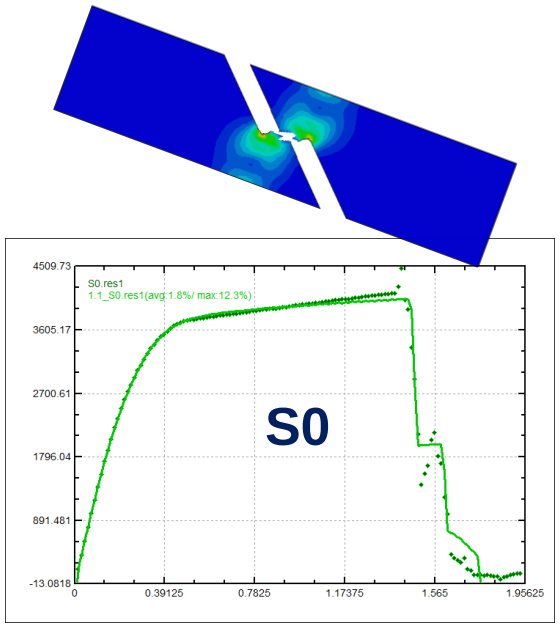
1. Tests provided by customer
2. Import in VALIMAT™
3. *MAT_024 – Hardening
4. ***MAT_ADD_EROSION - Failure**

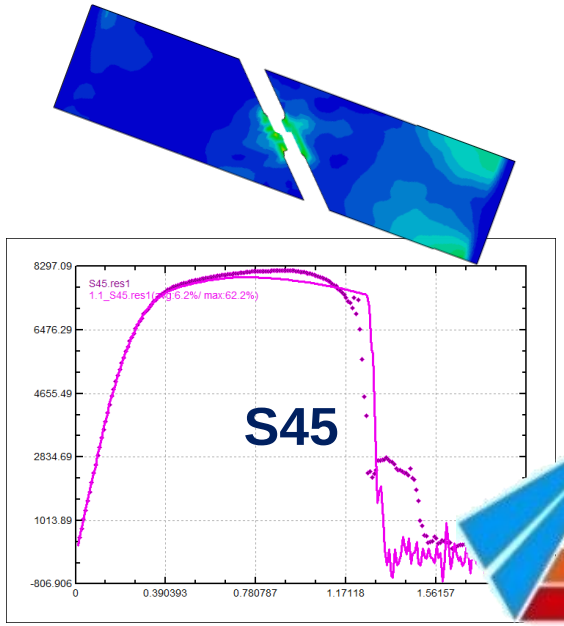


Damage/Failure model : GISSMO









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Case: Ultra-high strength steel

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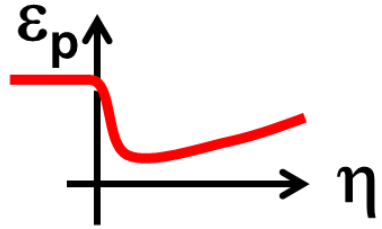
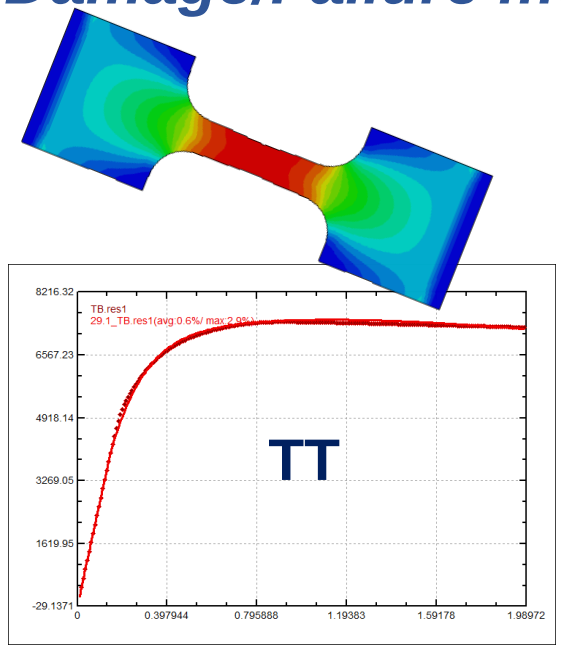
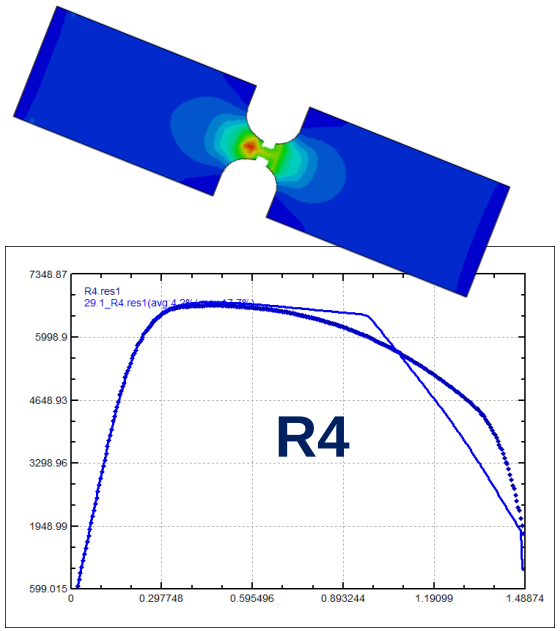
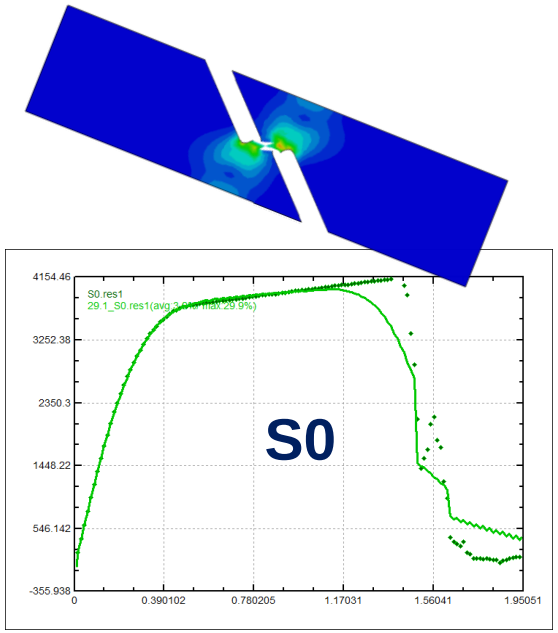
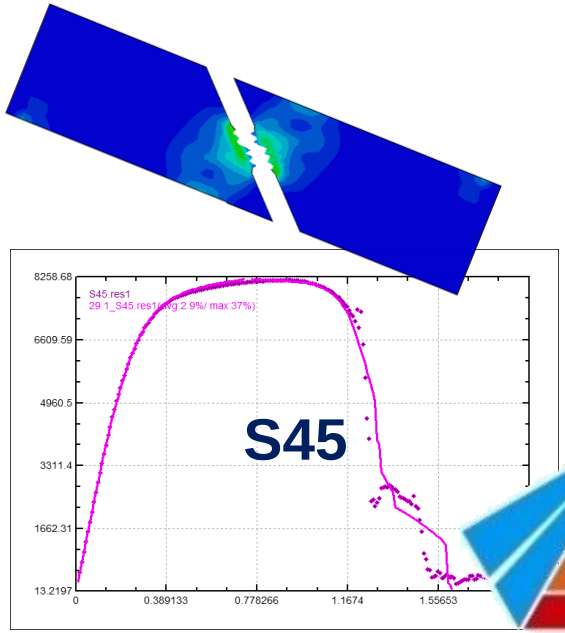


Damage/Failure model : DIEM









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VALIMAT

- manage test results
  (import, export, filter, evaluation)
- statistics
- automatic report
- material card generation
- material card validation

for all material types

from test to validated material cards

IMPETUS

- single pendulum up to 4.5 m/s
- double pendulum up to 8 m/s
- standard test methods
- specialized test methods
- component testing
- advanced measurement

efficient dynamic testing

plastics and composites

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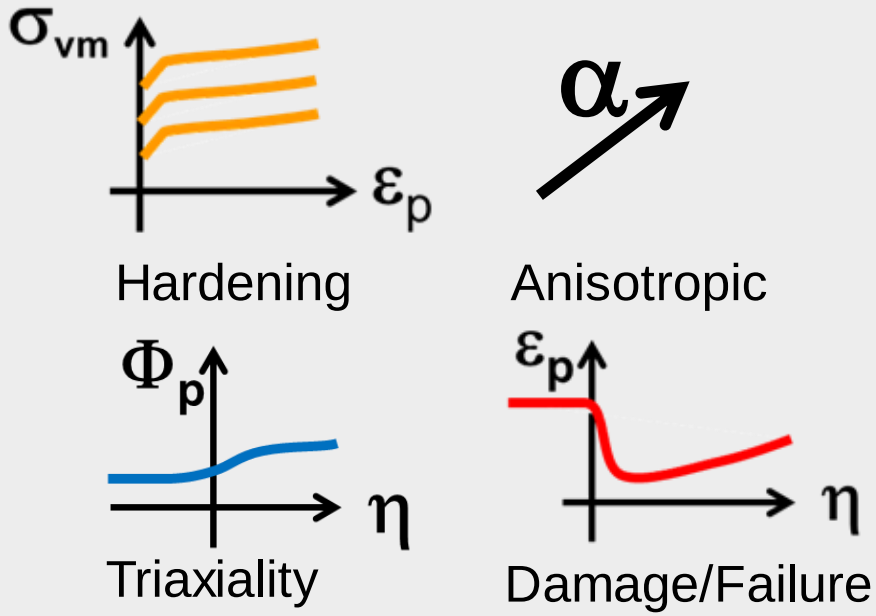

for all material types

from test to validated material cards

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Thank you for your attention!

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