Objectives of Work Package

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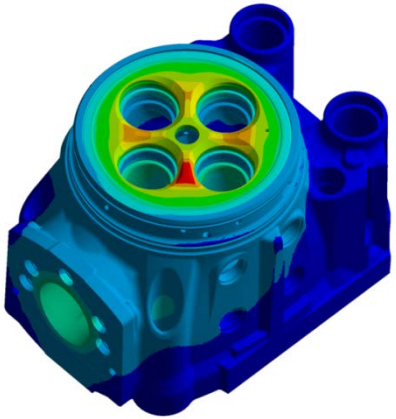
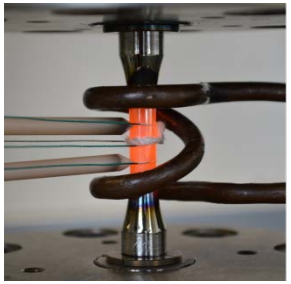
Deputy: Santiago Uhlenbrock , MDT-AUG

WP 4.1 New materials and design for cylinder heads

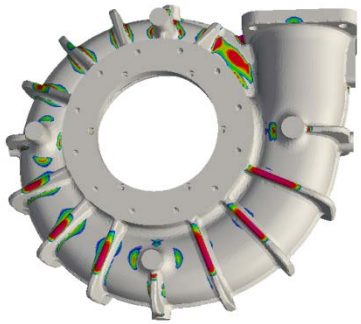
- Improvement of thermomechanical cycle resistance of factor 2 under increased temperature of 50 K
- decreased weight of cylinder head of 20%





WP 4.2 New materials for the turbocharger turbine casing

- Typical Load Cycles for Ferry Applications
- Improvement of thermomechanical cycle resistance under increased temperature of 70 K under corrosion environment



Partners:

Fraunhofer IWM

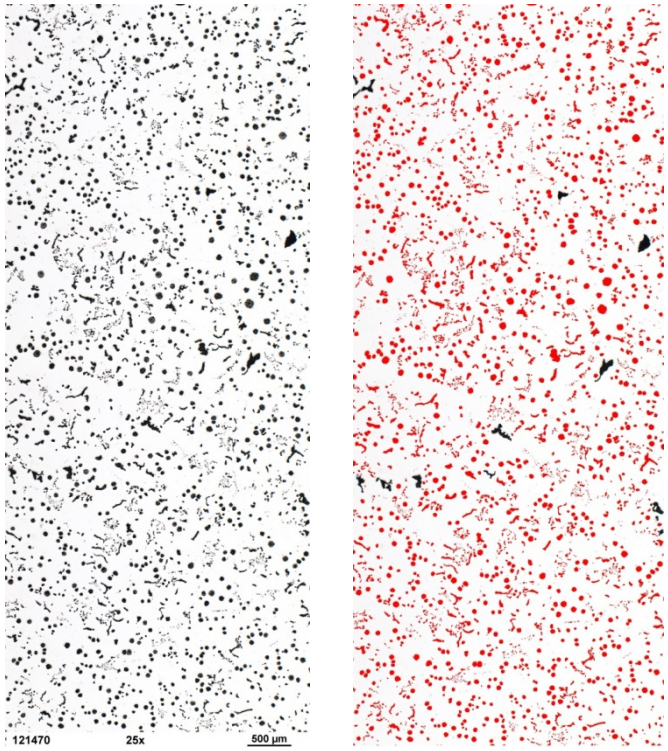
Hochschule Offenburg
University of Applied Sciences

Fraunhofer ICT

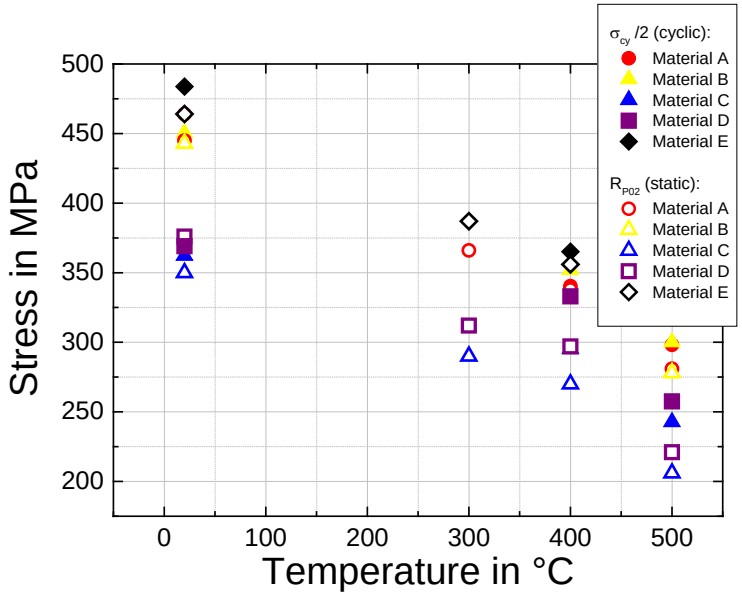
BAM
Bundesanstalt für Materialforschung und -prüfung

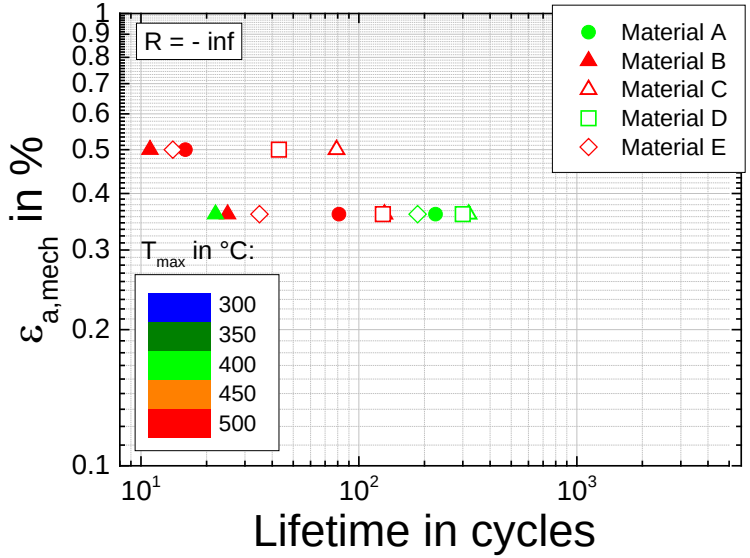
New Results within WP4.1

- Material Tests for Material D



Graphit content: 9.5 %. (Shrinkage cavities marked in black.





New Results within WP4.1

- Material Modelling

  - Chaboche Plasticiy Model for time and temperature dependent cyclic plasticity (UMAT)

stress:

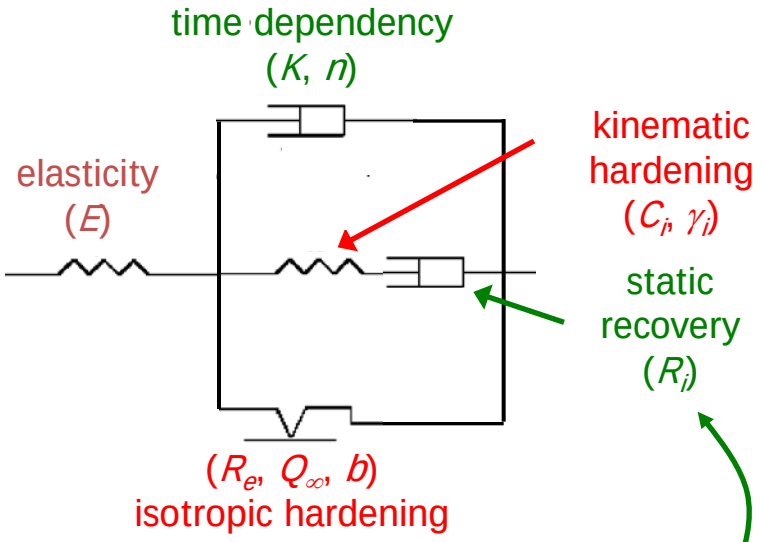
$$\sigma = E \cdot \varepsilon^{el} = E \cdot \left(\varepsilon - \varepsilon^{th} - \varepsilon^{vp} \right)$$

viscoplastic strain rate:

$$\dot{\varepsilon}^{vp} = \dot{\bar{\varepsilon}}^{vp} \cdot \frac{\sigma - \alpha}{|\sigma - \alpha|}$$

mit

$$\dot{\bar{\varepsilon}}^{vp} = \left\langle \frac{|\sigma - \alpha| - R_p}{K} \right\rangle^{n}$$



kinematic hardening:

$$\alpha = \sum_i \alpha_i$$

mit

$$\dot{\alpha}_i = C_i \cdot \dot{\varepsilon}^{vp} - \gamma_i \cdot \dot{\bar{\varepsilon}}^{vp} \cdot \alpha_i - R_i \cdot \alpha_i + \frac{\partial C_i}{\partial T} \cdot \frac{1}{C_i} \cdot \dot{T} \cdot \alpha_i$$

isotropic hardening:

$$R_p = R_e + Q_\infty \cdot \left(1 - e^{-b \cdot \bar{\varepsilon}^{vp}} \right)$$

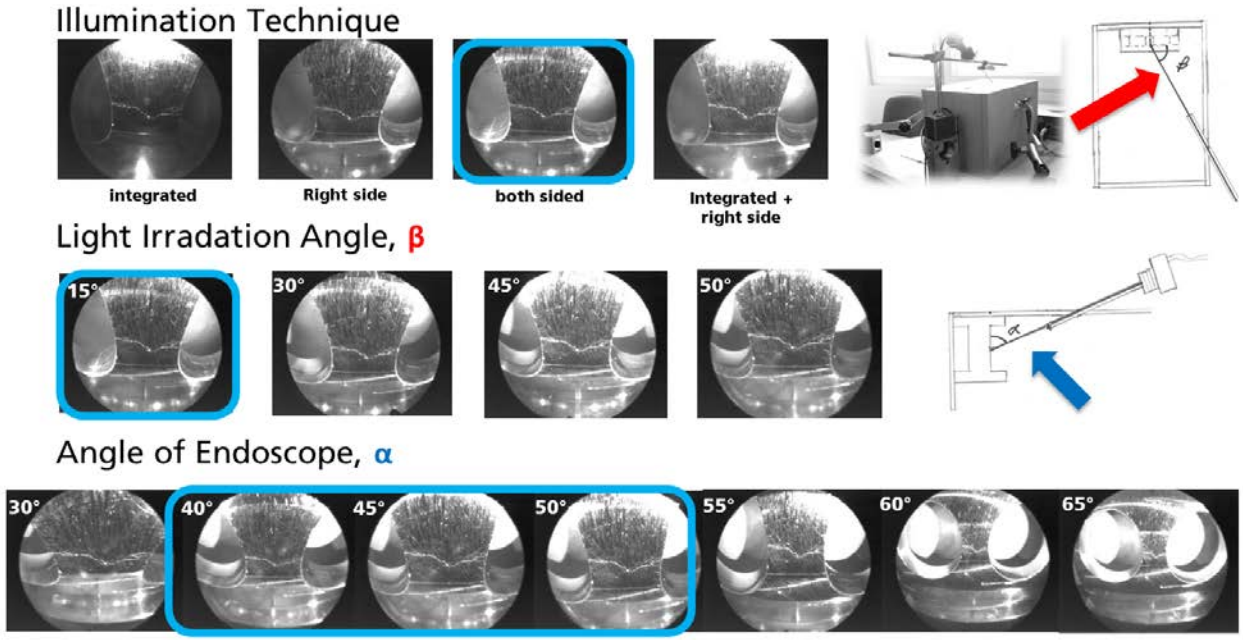
time depended recovery of kinematic hardening (e.g. hold time on high temperatures)

New Results within WP4.1

- Online Crack Detection
  - Hardware for optical crack detection during hot and cold cycle
    - Preliminary tests to determine optimal hardware and geometric dimensions
    - Endoscope with integrated water cooling
    - Optical fibres with integrated water cooling
    - Camera with high resolution and simultaneously small image section

New Results within WP4.1

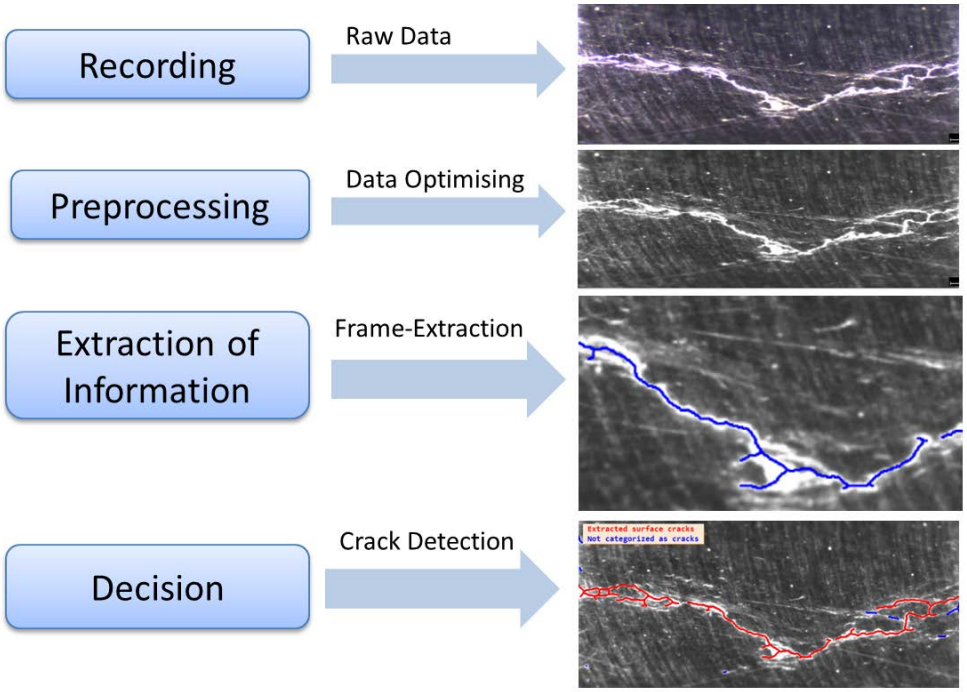
- Online Crack Detection
  - Determination of geometric boundaries
    - Light irradiation angle
    - Angle of view
    - Operating distance



New Results within WP4.1

- Online Crack Detection

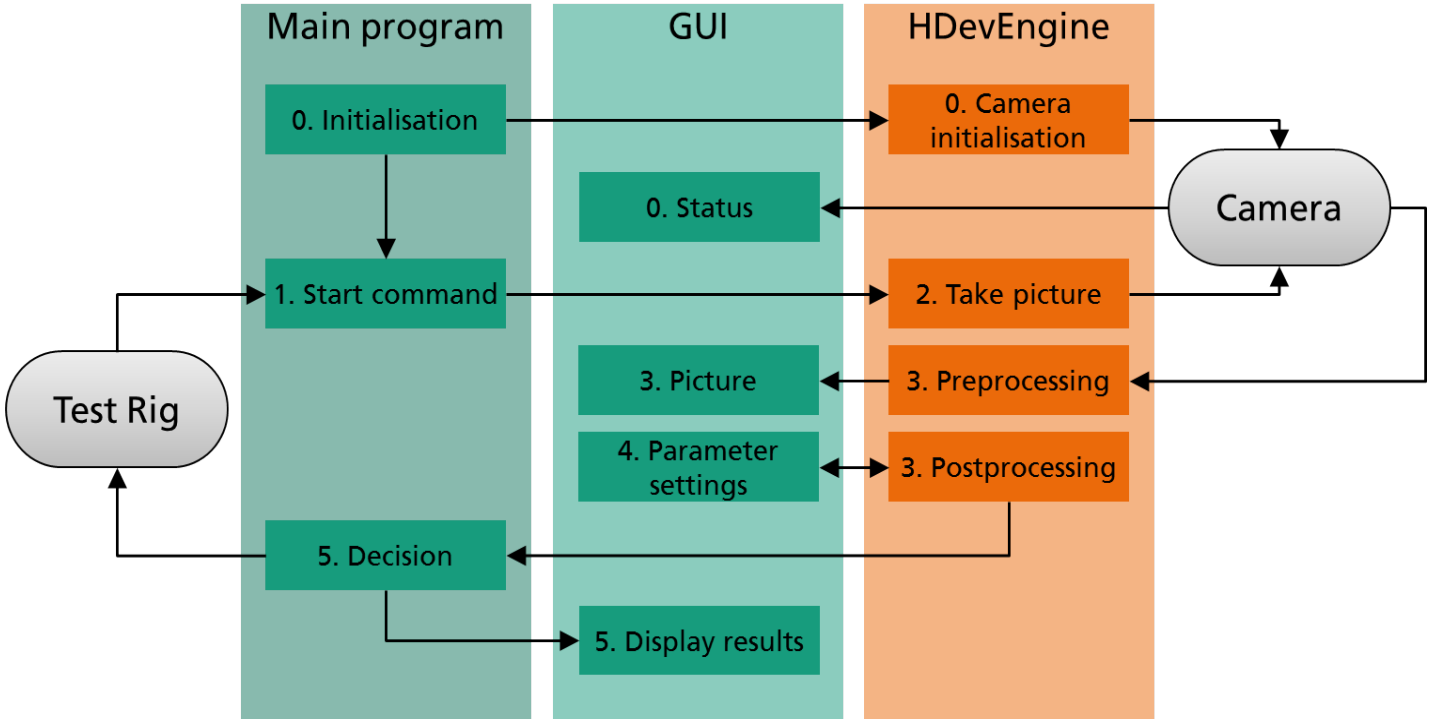
  - Applied Algorithm
    - Commercial software HALCON updated with adapted code
    - Analyses process using 4 steps



New Results within WP4.1

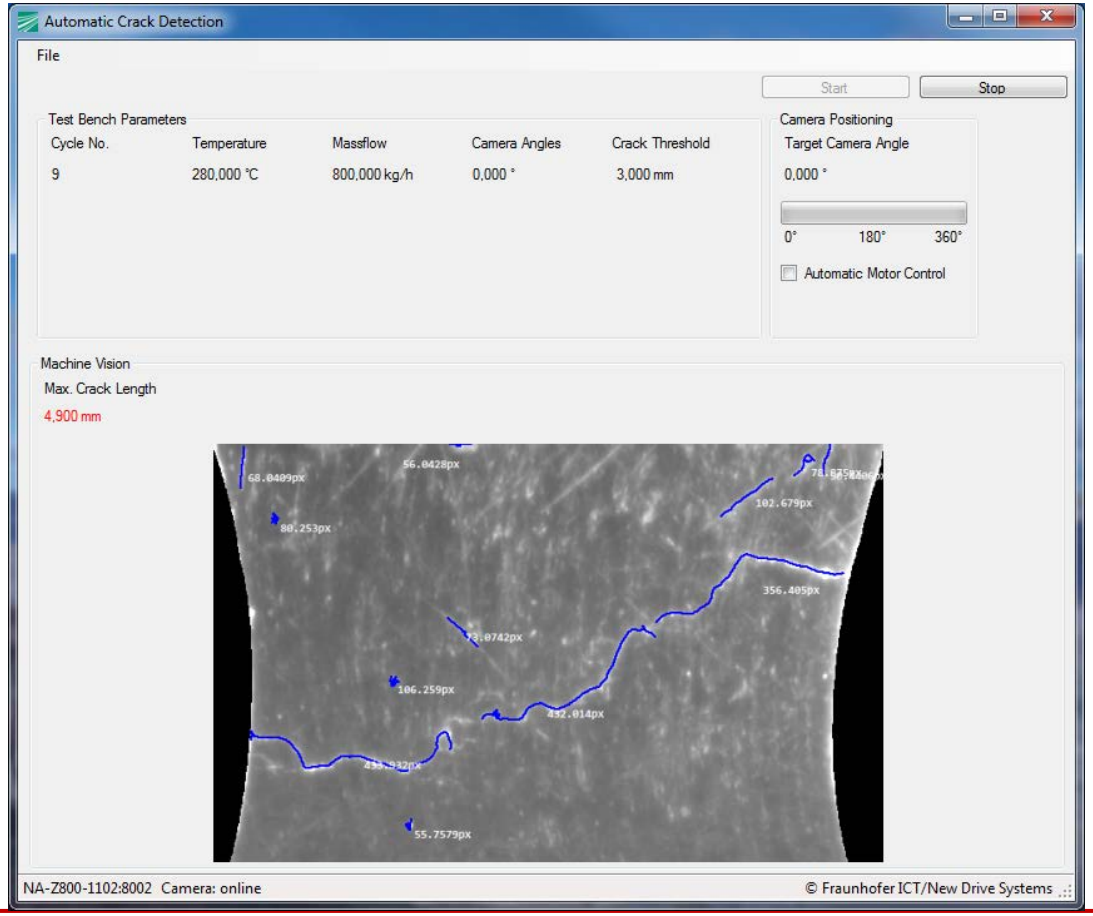
- Online Crack Detection

  - Superior program for controlling all sequences
    - C# to cover HALCON library and test bench communication



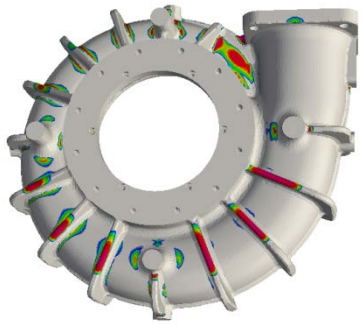
New Results within WP4.1

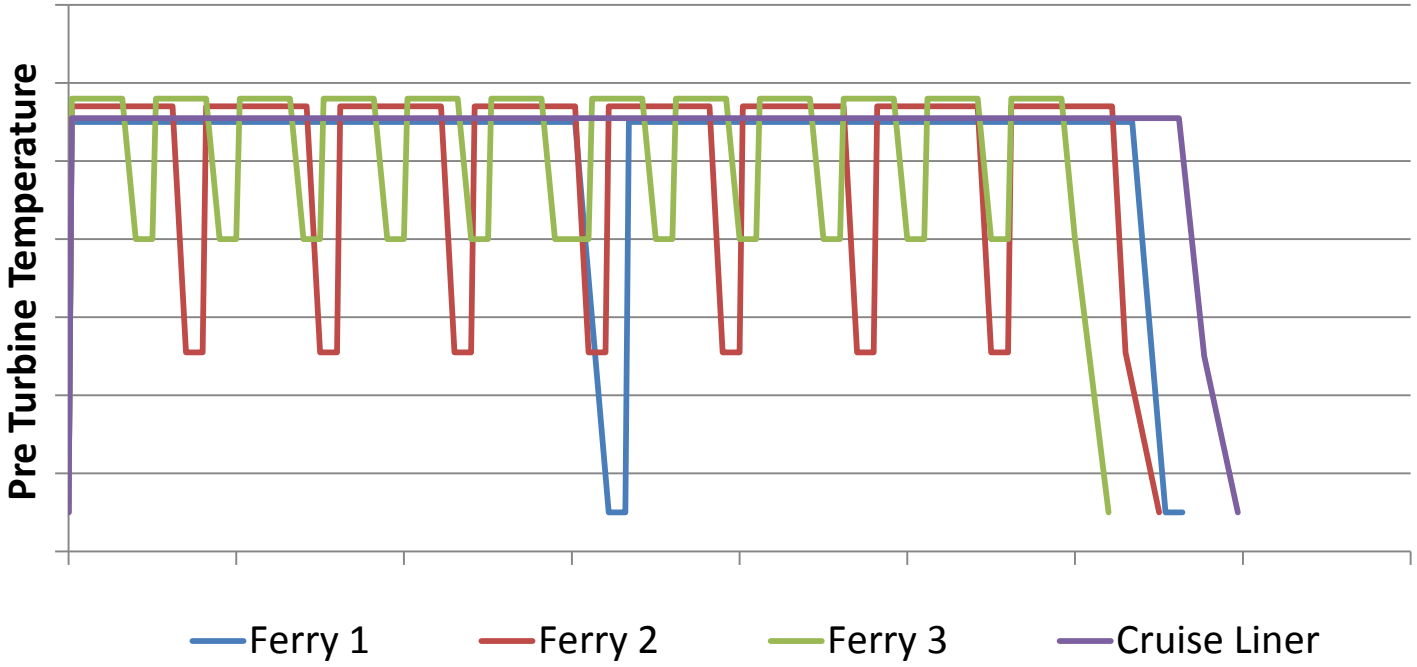
- Online Crack Detection
  - Graphical user interface
    - To view and change settings regarding the crack detection process



Introduction WP4.2

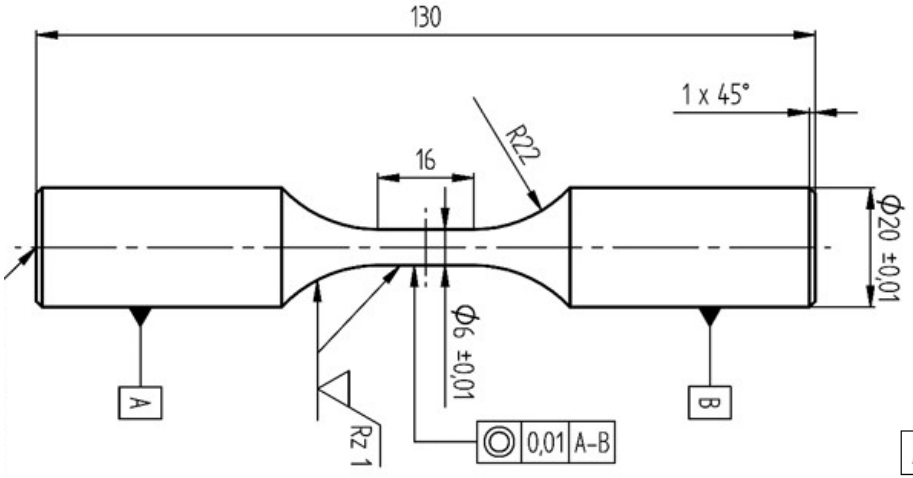
- Ferry applications are very cyclic marine applications. Thermo-mechanic fatigue damage is dominant compared to creep damage.
- Cruise liner applications are stationary applications with large dwell times at elevated temperature. Creep damage is dominant compared to thermo-mechanic fatigue damage.

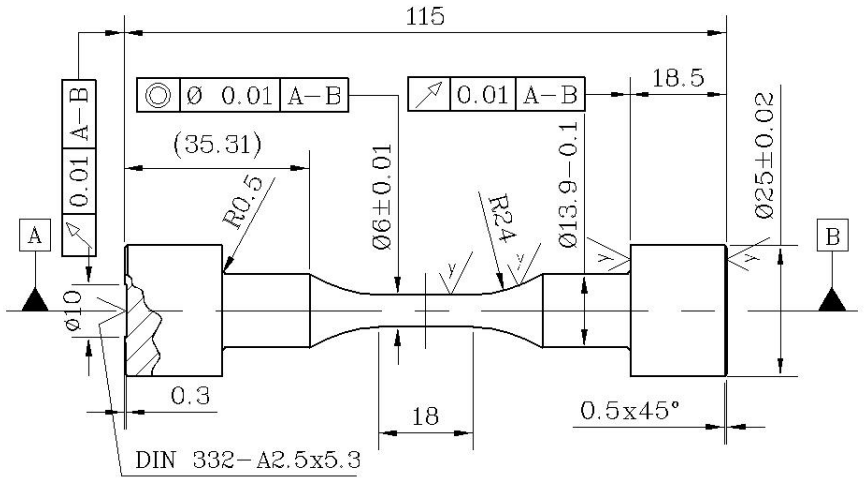


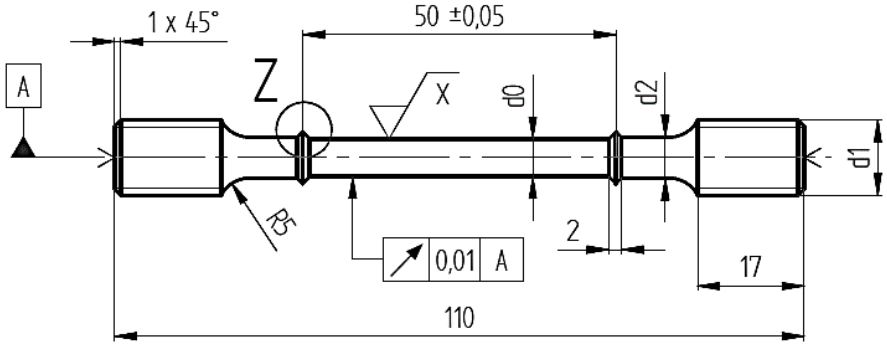


New Results within WP4.2

- Finish of Material Test @BAM
- LCF, TMF and Creep material Test

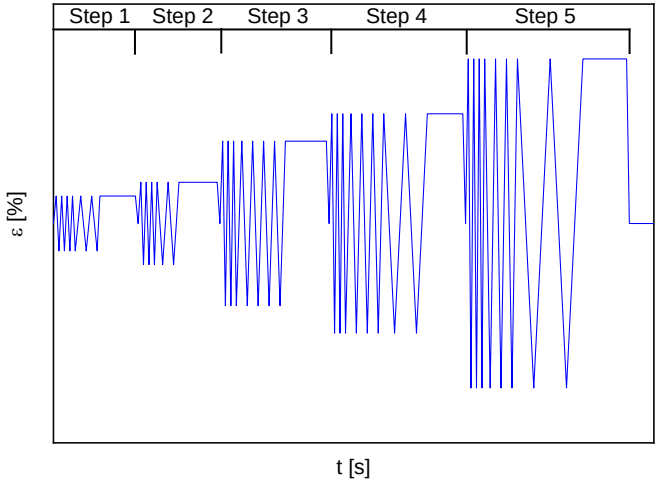


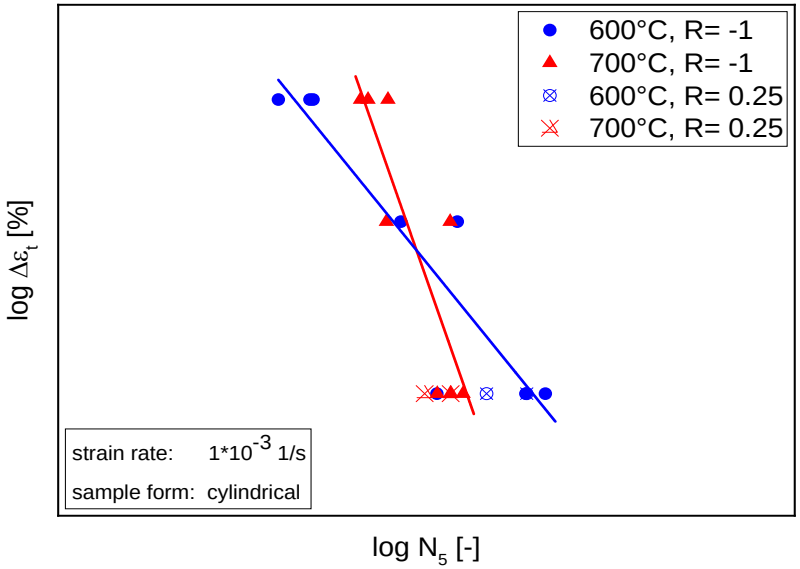


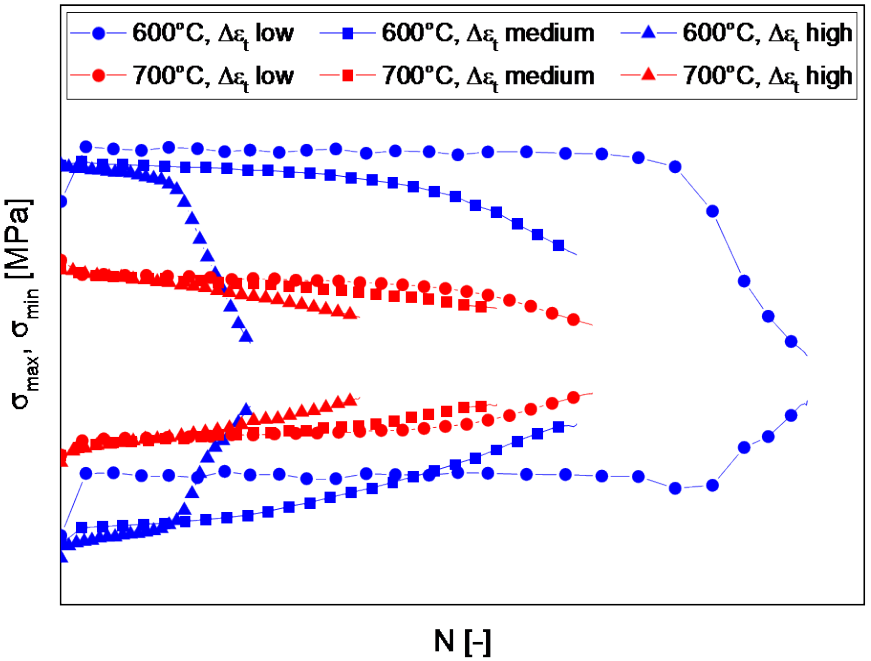


New Results within WP4.2

- LCF

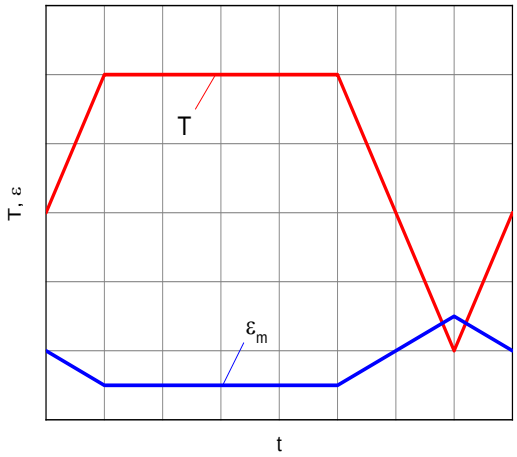


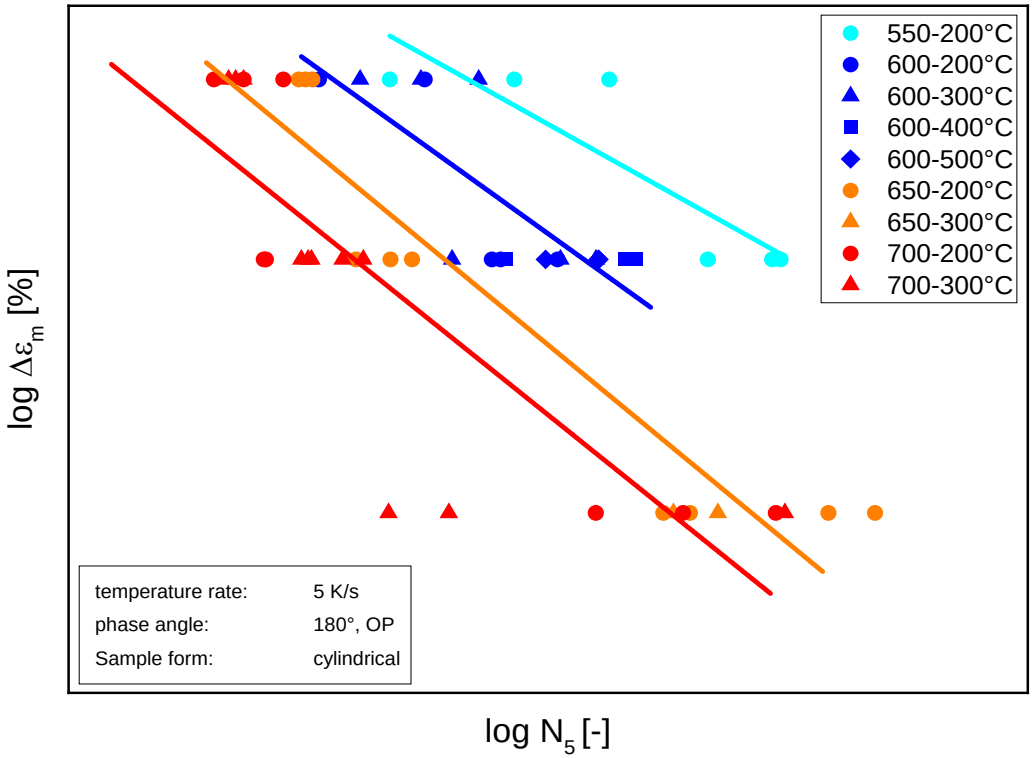




New Results within WP4.2

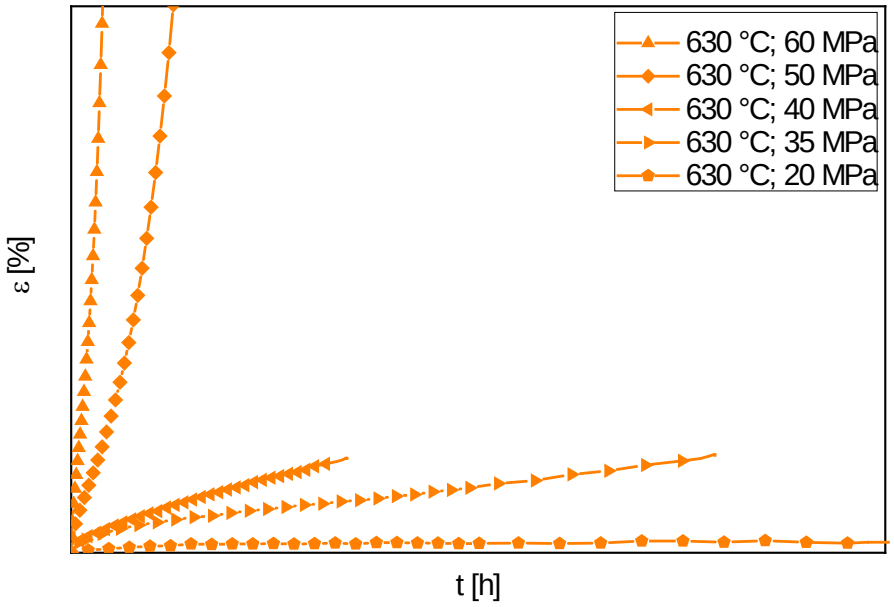
- TMF

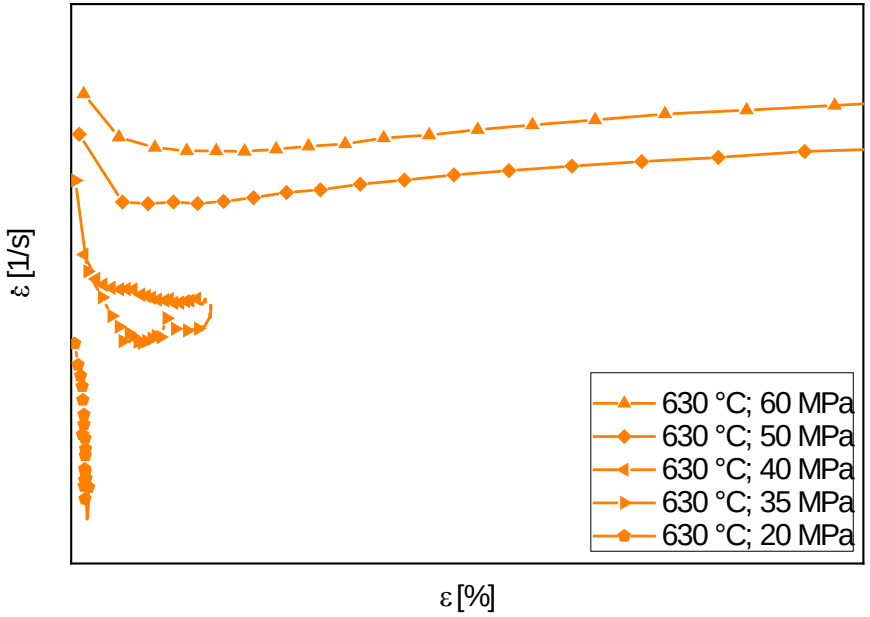




New Results within WP4.2

- Creep





Future Work

WP4.1

- Numerical studies material modeling,advanced plasticity model, simplified plasticity models, multiaxial TMF life prediction model
- TMF loaded component like specimen - test and validation
- Optimization of cylinder head regarding TMF resistance and weight

WP 4.2

- Material model development
- Validation