Objectives of Work Package

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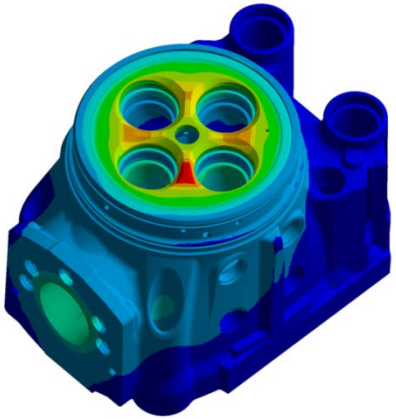
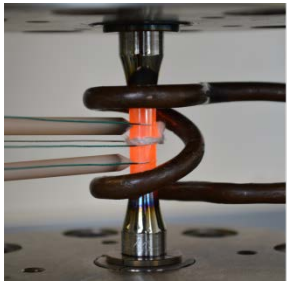
WP 4.1 New materials and design for cylinder heads

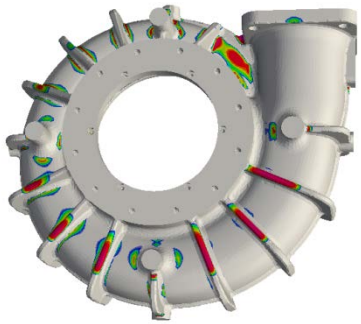
- Improvement of thermomechanical cycle resistance of factor 2 under increased temperature of 50 K
- decreased weight of cylinder head of 20%





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

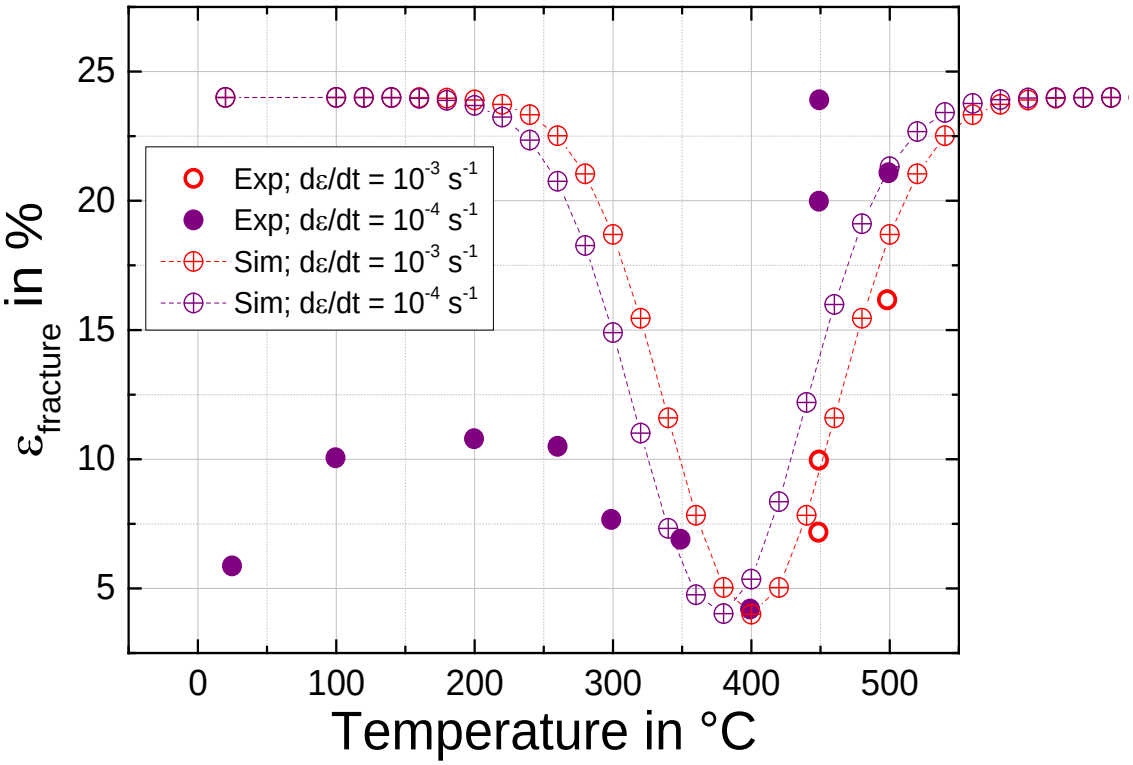
Hochschule Offenburg
University of Applied Sciences

Fraunhofer ICT

BAM
Bundesanstalt für Materialforschung und -prüfung

New Results within WP4.1

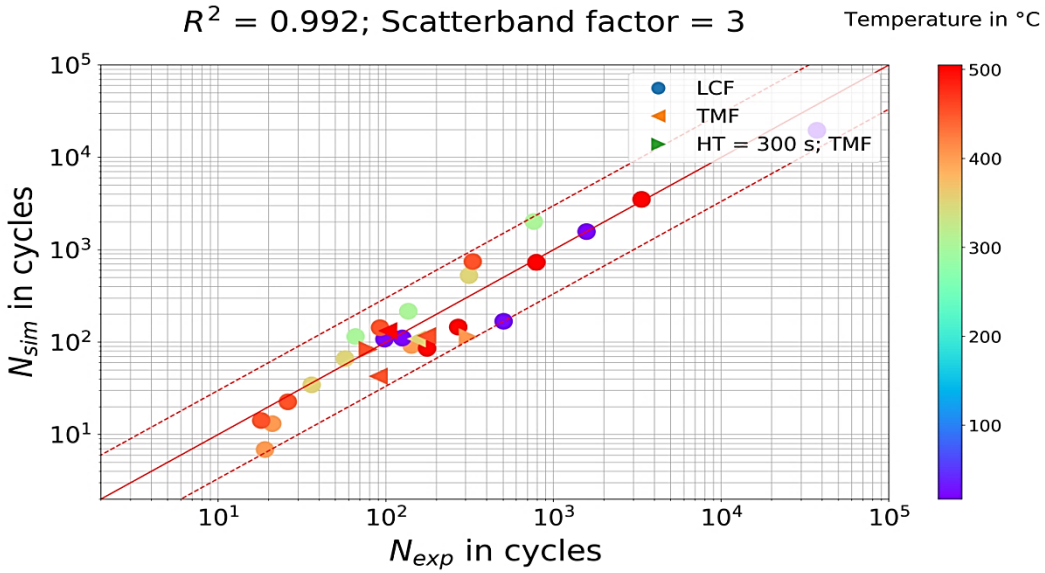
Experimental vs. simulated fracture strain values



$$\varphi(T) = e^{-\frac{(T-T_m)^2}{w^2}}$$

New Results within WP4.1

Life Prediction for LCF / TMF



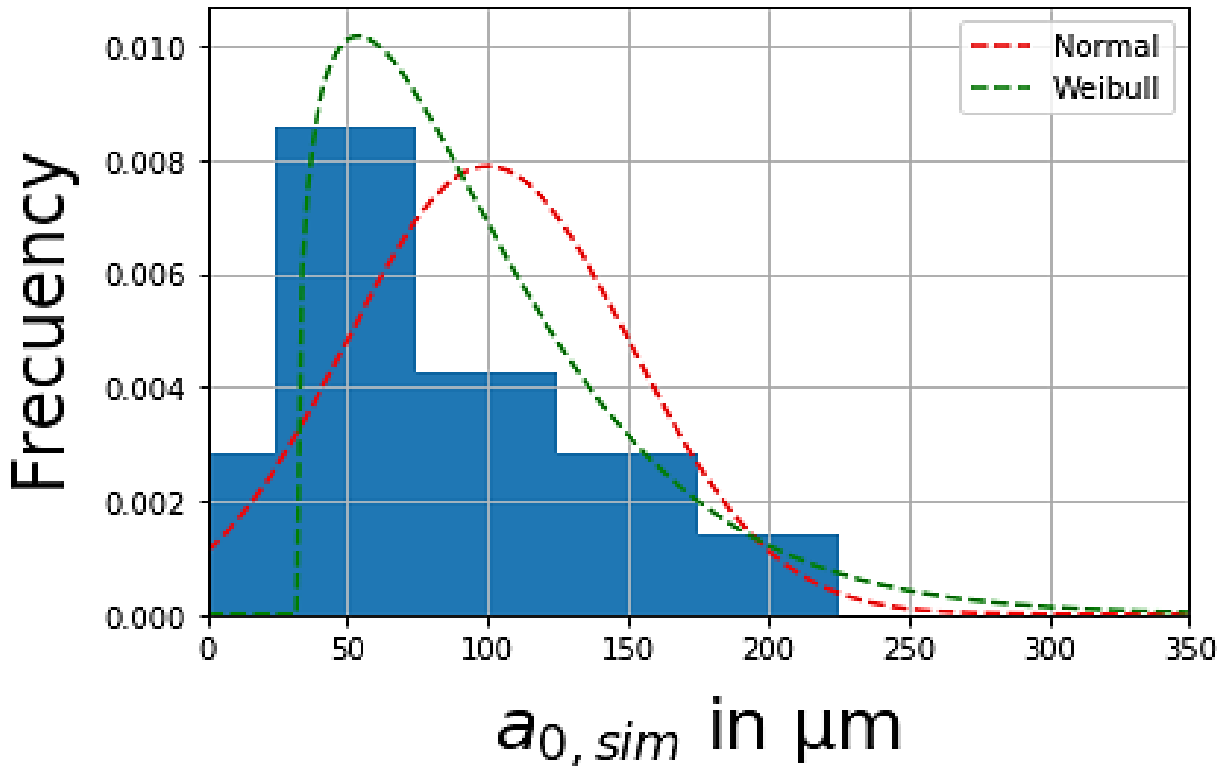
$$N_{tot} = \frac{a_f^{1-B} - a_0^{1-B}}{\beta_{IE}(T) * (1-B)} * \left(\frac{Z_D}{\sigma_{cy}}\right)^{-B}$$

includes:

- intergranular embrittlement
- time dependent behaviour

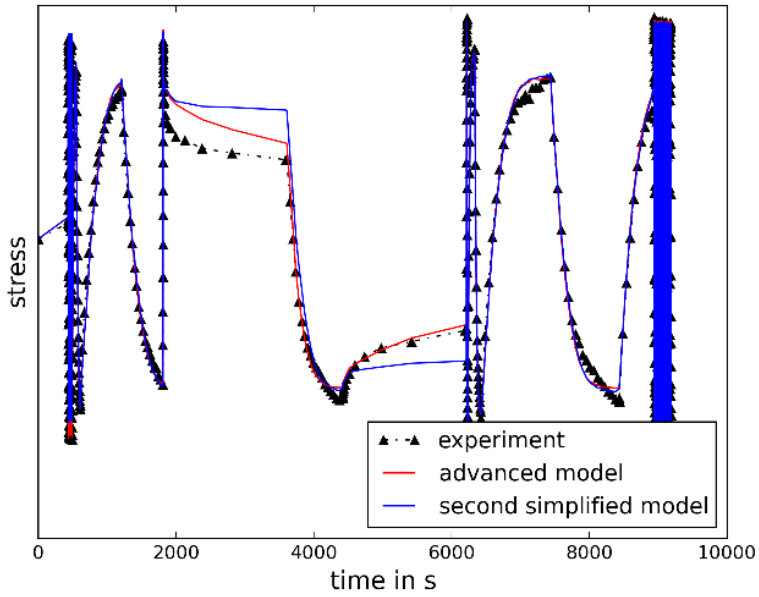
New Results within WP4.1

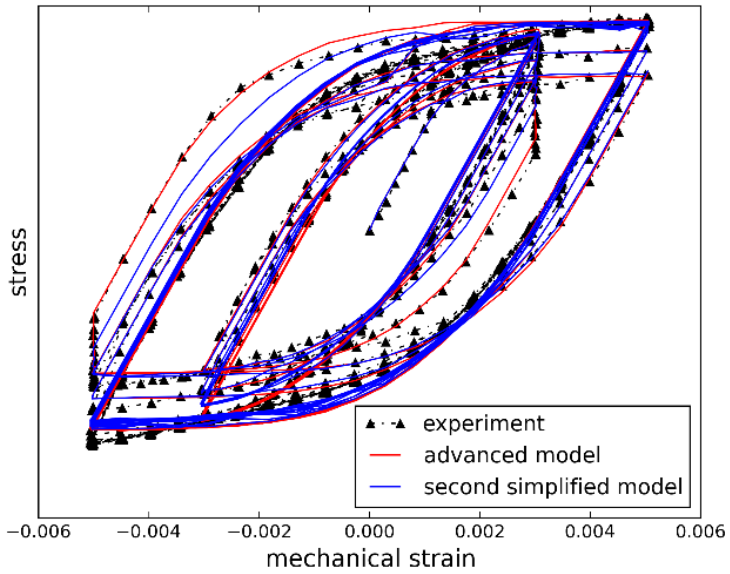
Probability distribution function of the inferred initial defect size



New Results within WP4.1

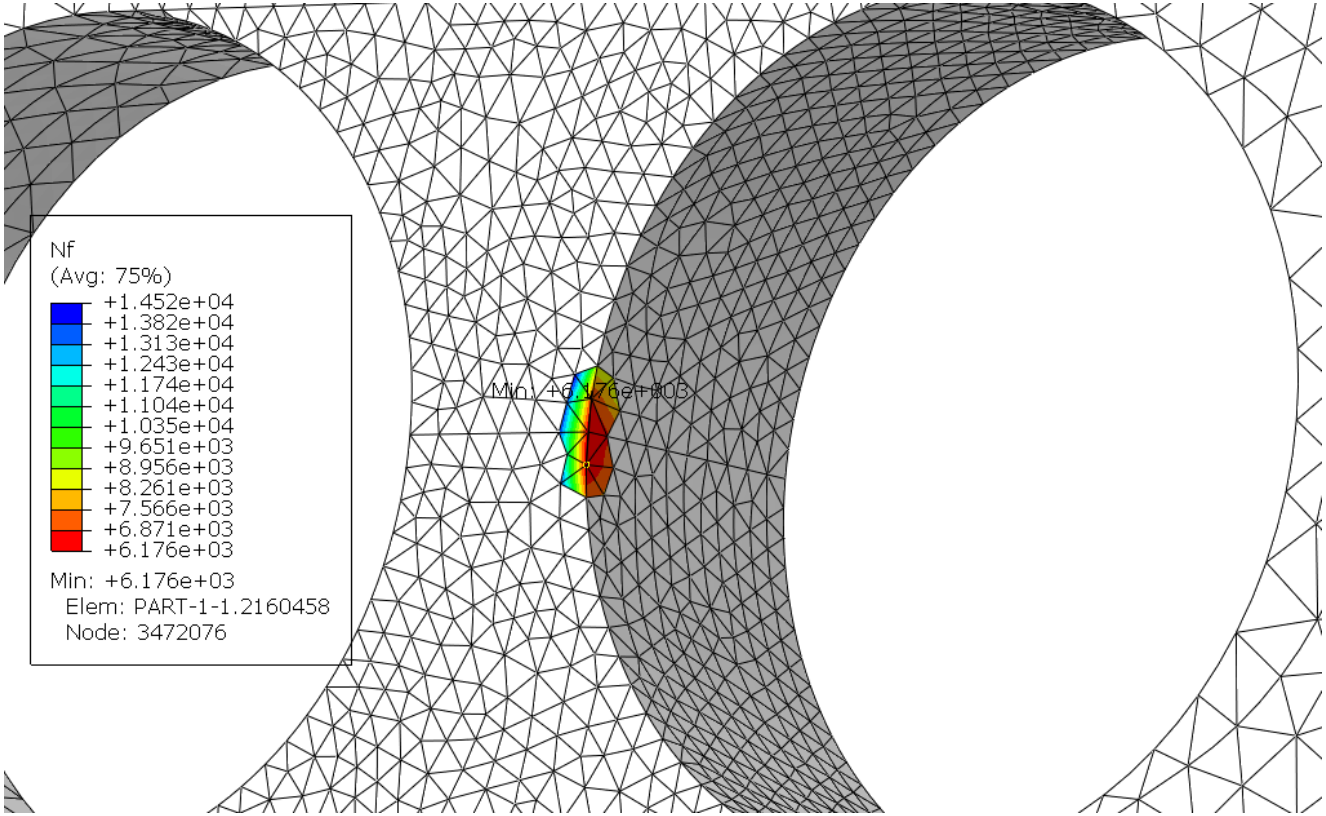
Advanced vs. Simplified Model





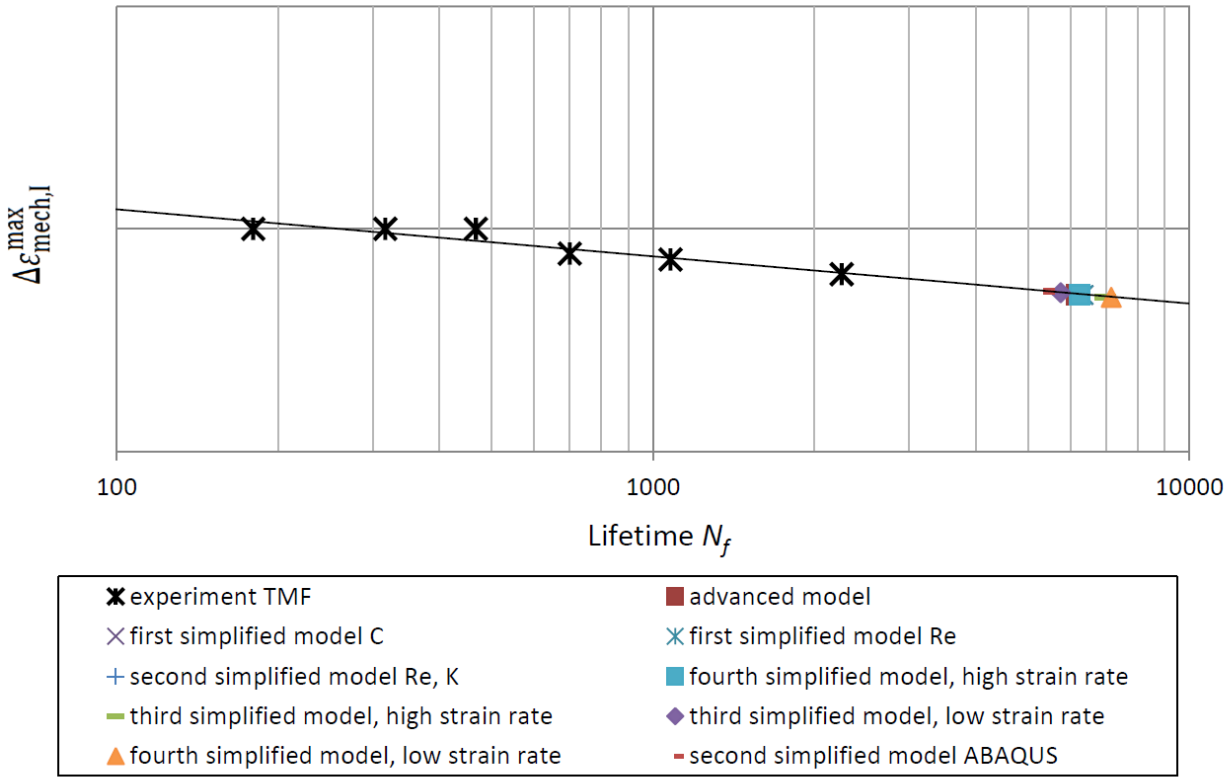
New Results within WP4.1

Finite-element model of the cylinder head specimen showing the number of cycles to failure *Nf* in the critical area of the advanced model for material F



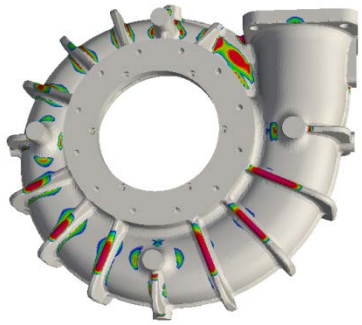
New Results within WP4.1

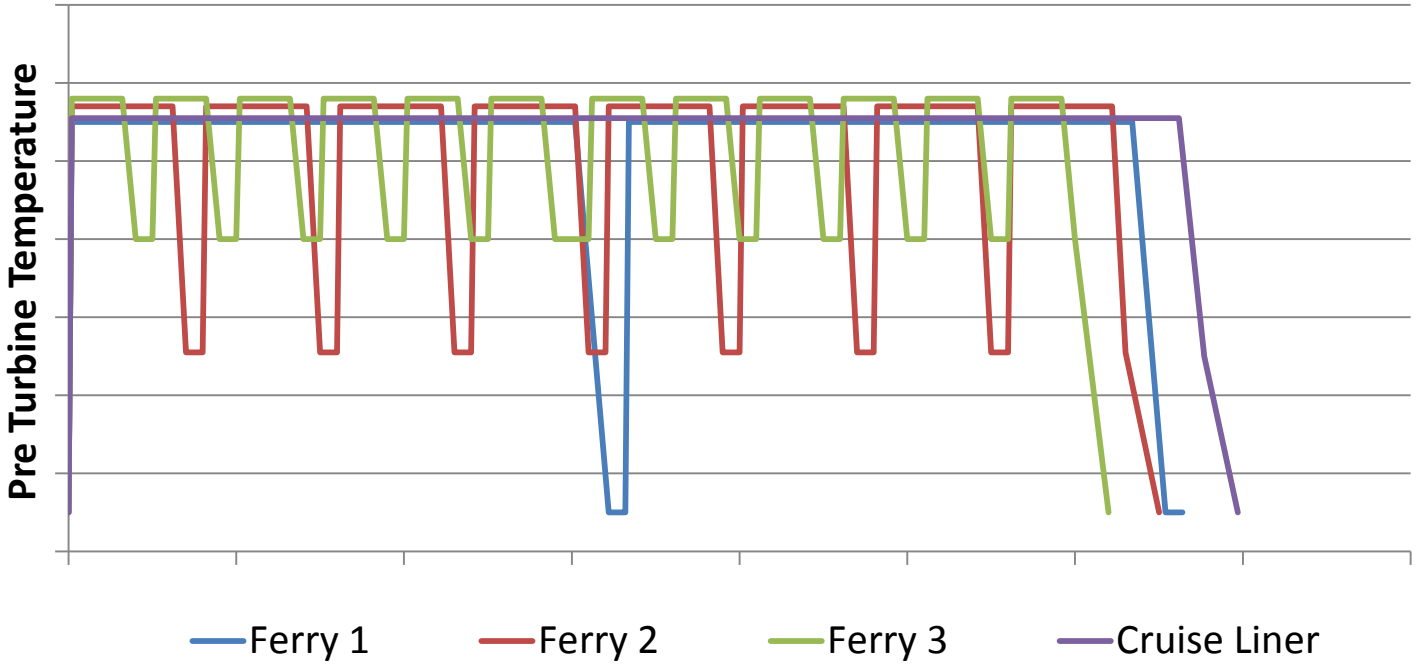
Wöhler curve with calculated lifetimes of the different models for material F



Introduction WP4.2

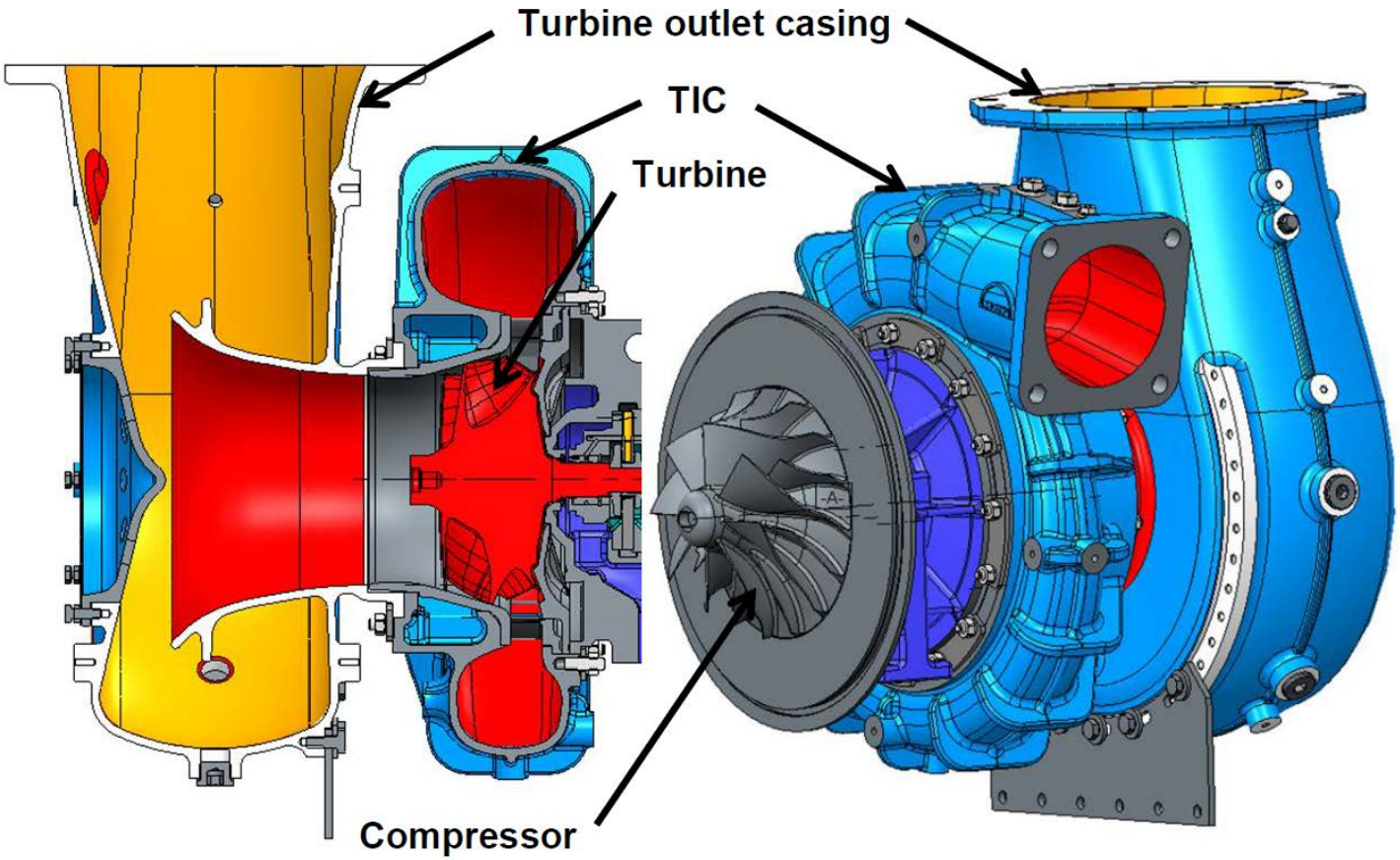
- Ferry applications are very cyclic marine applications. Thermo-mechanic fatigue damage is dominant compared to creep damage.
- Cruise liner applications are stationary applications with large dwell times at elevated temperature. Creep damage is dominant compared to thermo-mechanic fatigue damage.





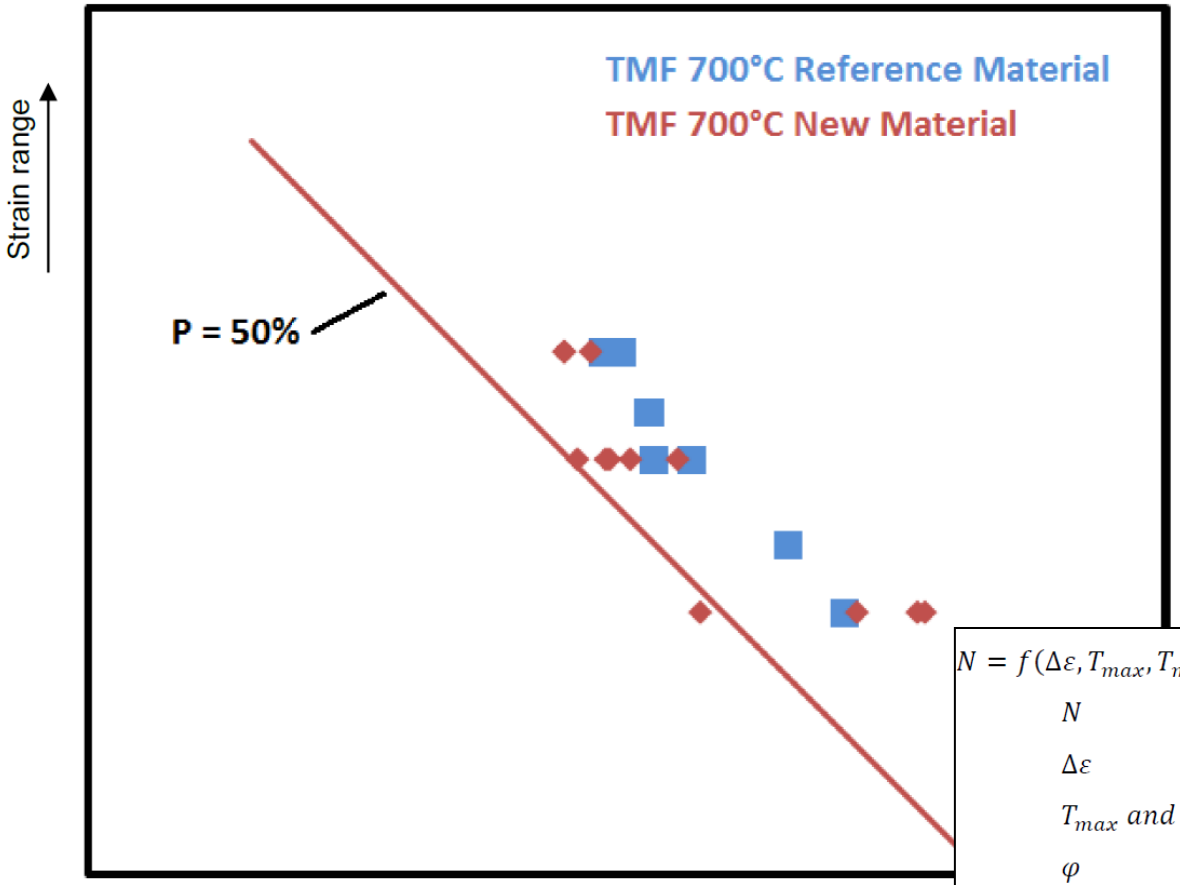
New Results within WP4.2

- Hot end of a radial turbocharger



New Results within WP4.2

- TMF model for 700°C and P = 50%

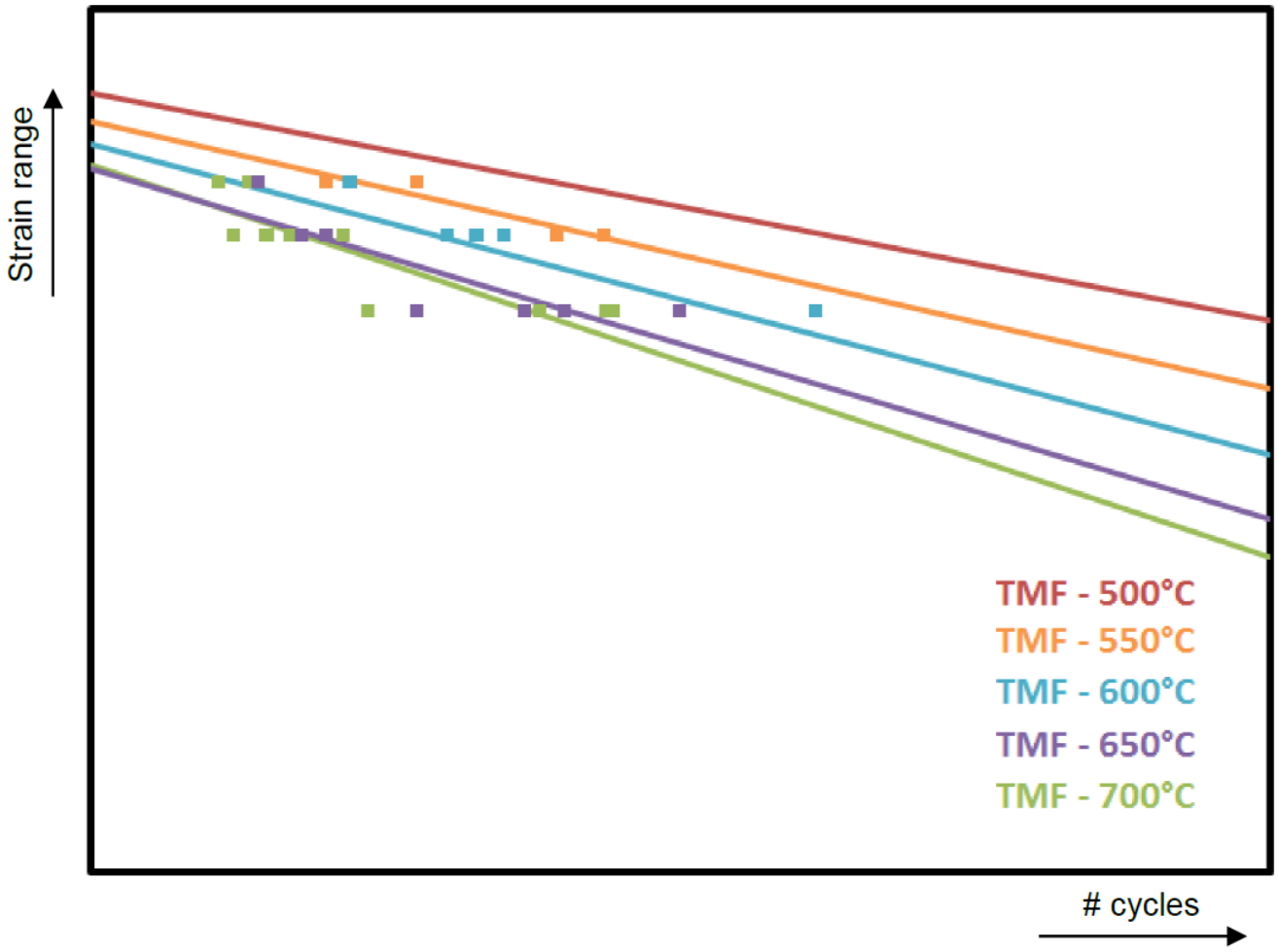


$N = f(\Delta\varepsilon, T_{max}, T_{min}, \varphi, P)$

N	– Attainable number of cycles
$\Delta\varepsilon$	– Strain Range
T_{max} and T_{min}	– Maximum and Minimum Temperature
φ	– Phase Angle
P	– Probability Level

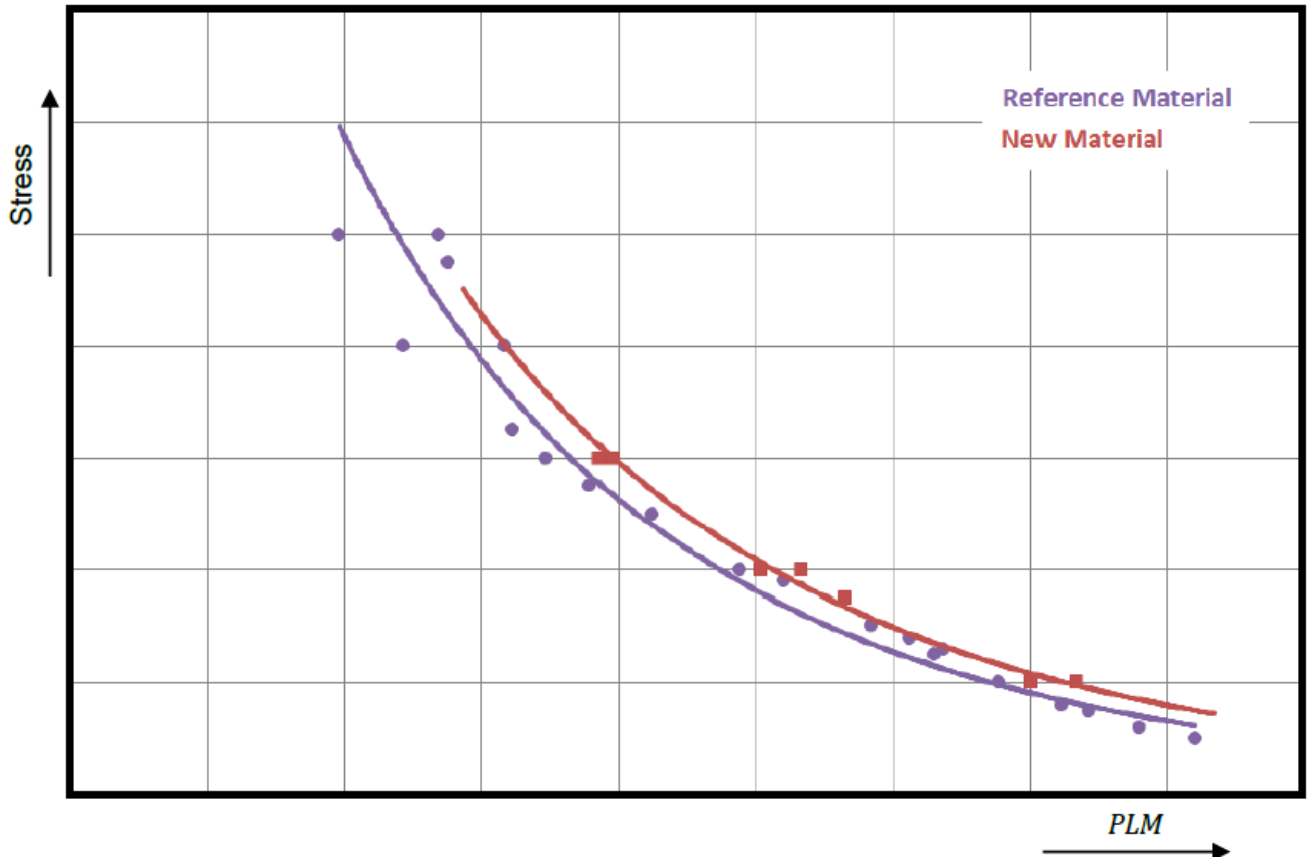
New Results within WP4.2

- Average lifetime model for test sample size

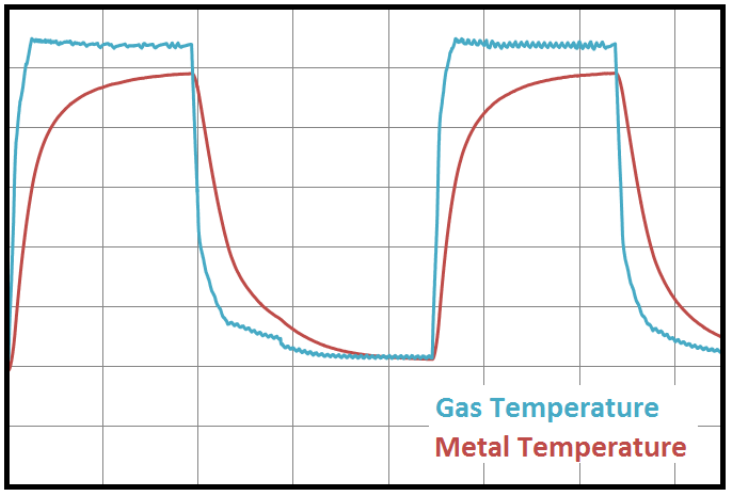


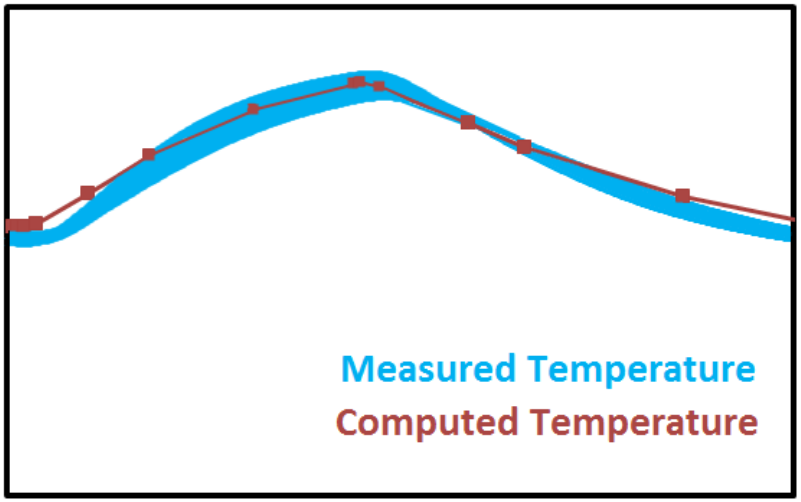
New Results within WP4.2

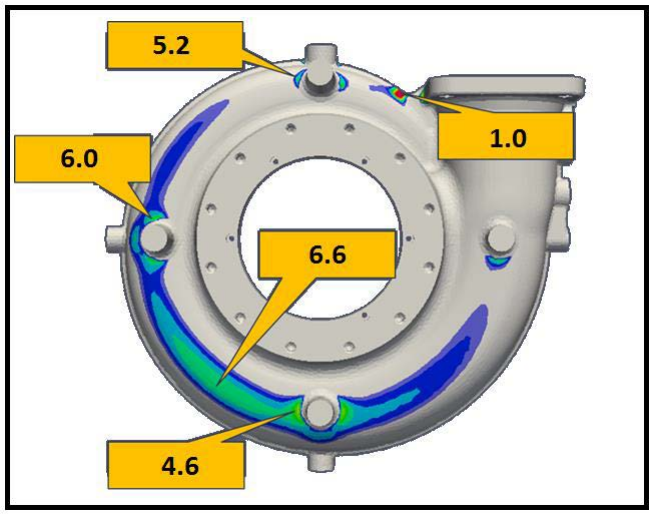
- Comparison of creep behaviour reference/new material



New Results within WP4.2







Location	Prediction accuracy
1	-23%
2	-20%
3	-16%
4	-16%
5	8%
6	33%
7	>100%
8	>100%

Prediction accuracy of TMF lifetime