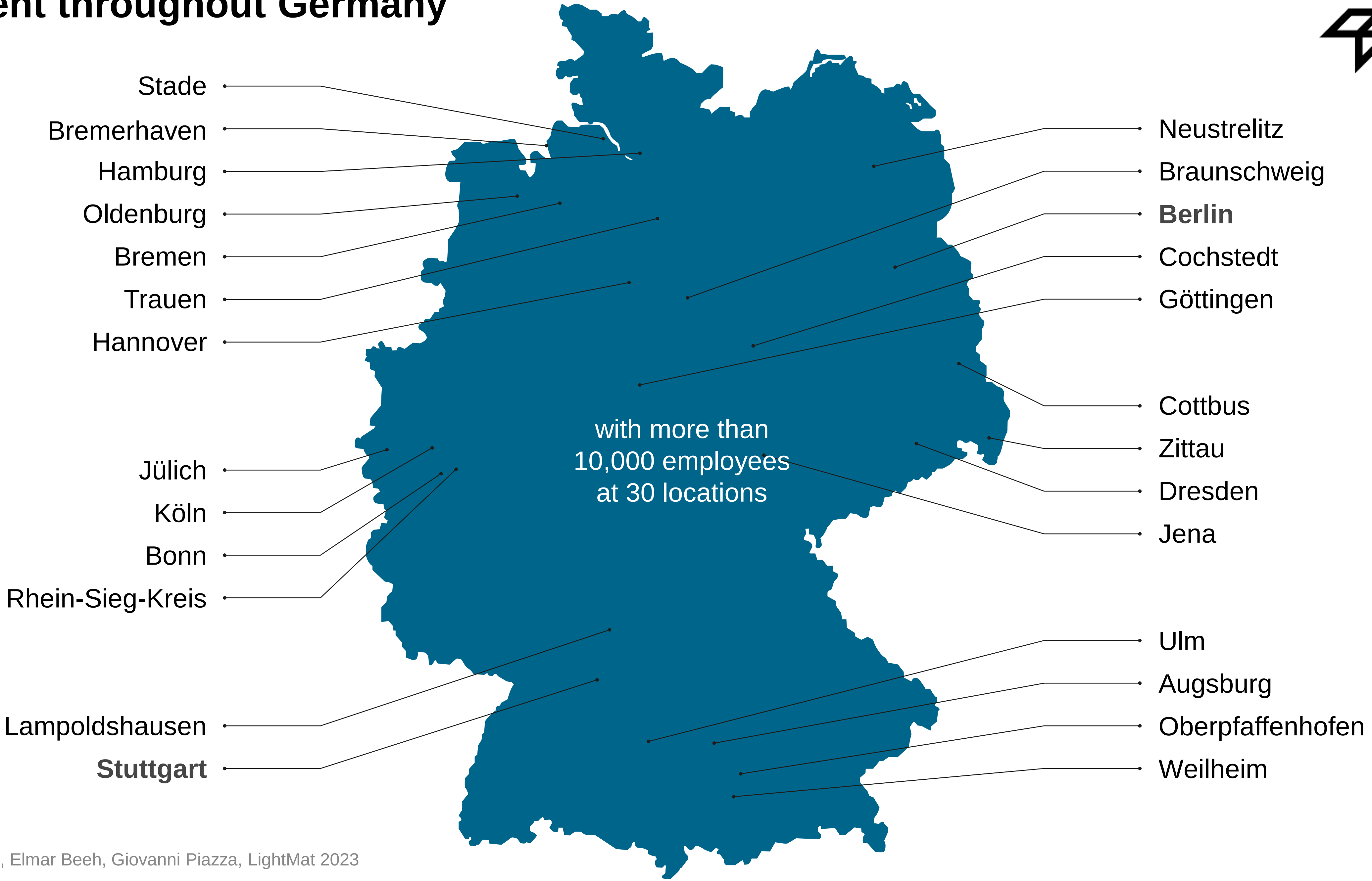
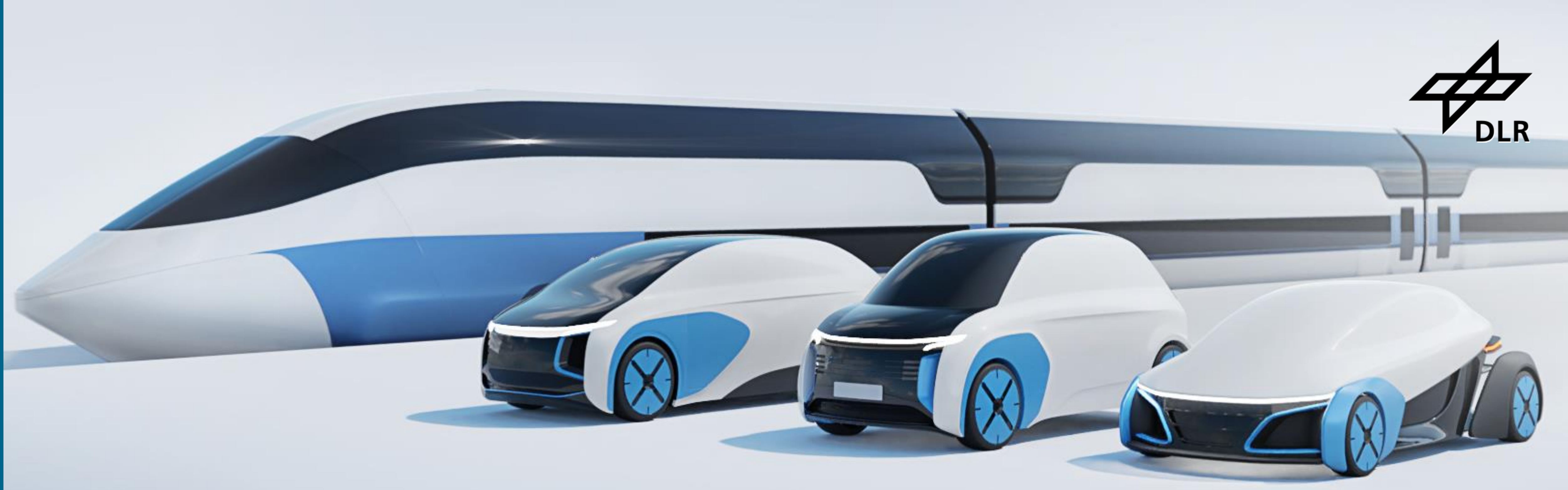
INDRUTEC-E

Lightweight design and resource conservation potentials for die cast components

Present throughout Germany





Material and Process Applications for Road and Rail Vehicles

Vehicle Architectures and Lightweight Design Concepts

Vehicle Energy Concepts

Alternative Energy Converters

Vehicle Systems and Technology Assessment

INSTITUTE OF VEHICLE CONCEPTS – OUR RESEARCH FIELDS

InDrutec- E
The consortium

Industry partner

BOSCH

FRECH

GÜHRING

Research institutes

Hochschule Aalen

DLR

Associated partners

EJOT

STIHL

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

Objectives and Measures

Objectives

Reduction of the component weight	Cost reduction	Reduction of the CO_2 footprint	Reduction of scrap rates
- Constructive optimization - Alloys of higher strength - Magnesium as a lightweight option	- Reduced material usage - Improved manufacturing processes - High recycled material content	- Optimized aluminum secondary alloys - Lightweight construction	- Vacural casting for magnesium as an improved production technology - New mech. machining solutions

Measures

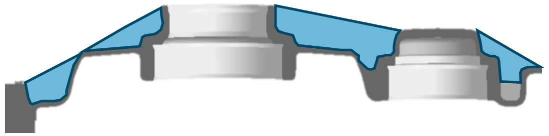
DESIGN METHODOLOGY

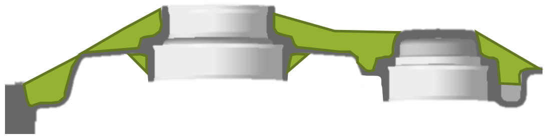
Weaknesses of current digitized development processes for castings

Step 1- Functional concept
Draft contour and design space

Step 2- Topology optimization
Proposal rib pattern

Step 3- Detail design
Casting design





Problem: The effects of specifications from the first step "function concept" for the design space of the topology optimization is often strongly underestimated.

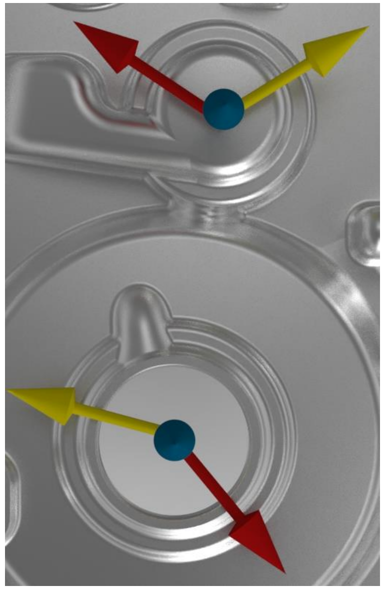
Improved design method

Step 1- Functional concept
Draft contour and design space

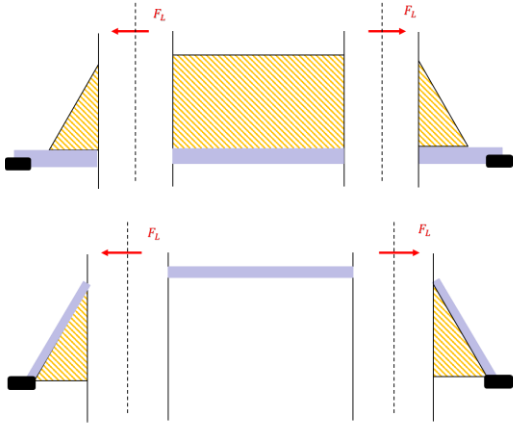
Step 2- Topology optimization
Proposal rib pattern

Step 3- Detail design
Casting design

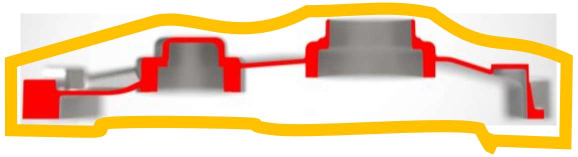
1. Accurate (manual) analysis of the force vectors in different load cases.



2. construction of a functional model suitable for the load path

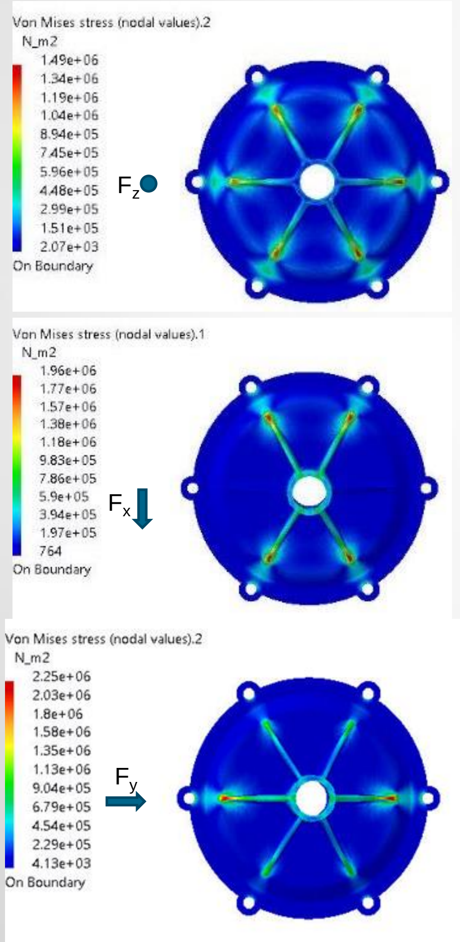


3. fine optimization through topology optimization

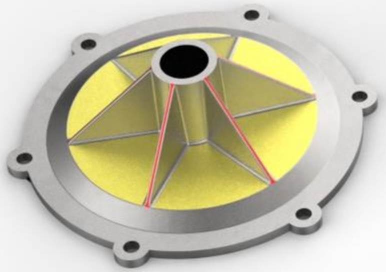


Potentials of the design methodology for castings

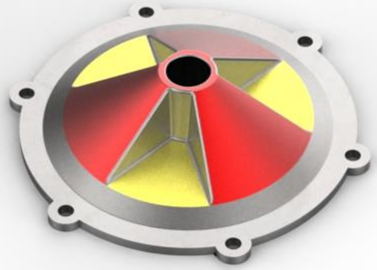
Example: Lid with bearing under alternating load

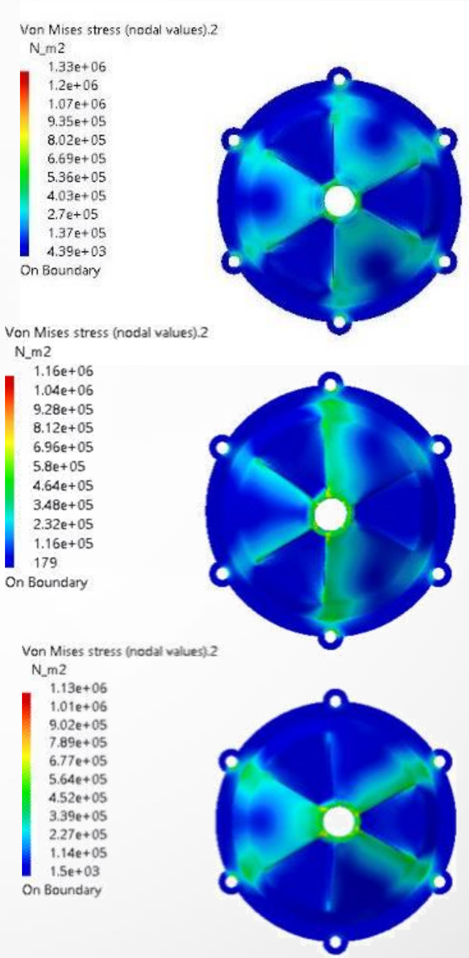


Conventional design



Alternative designs





Effects

σ_{max}: -11%

Δs : -34%

σ_{max}: -41%

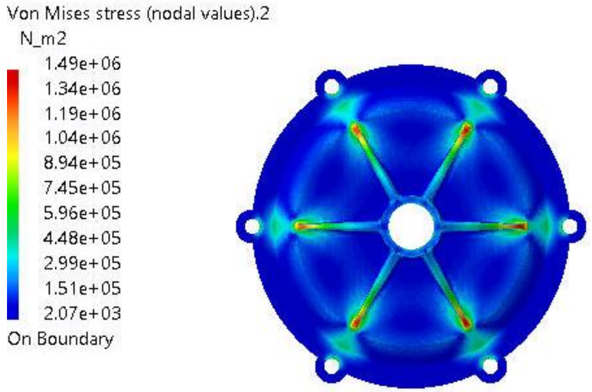
Δs : -59%

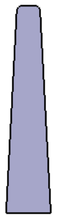
σ_{max}: -50%

Δs : -54%

Potentials of the design methodology for castings

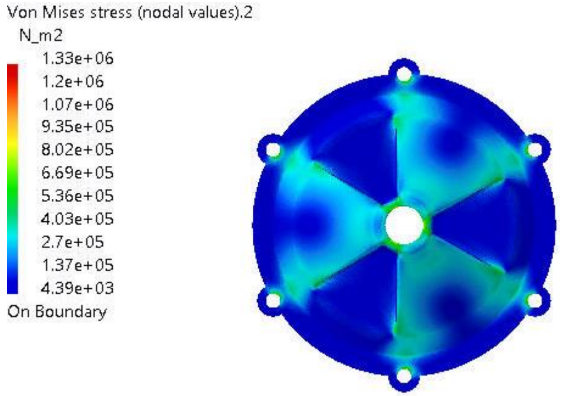
Example: Lid with bearing under alternating load

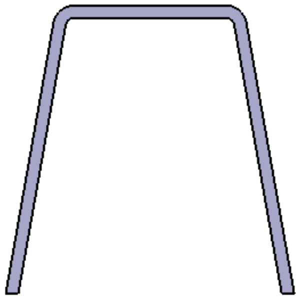




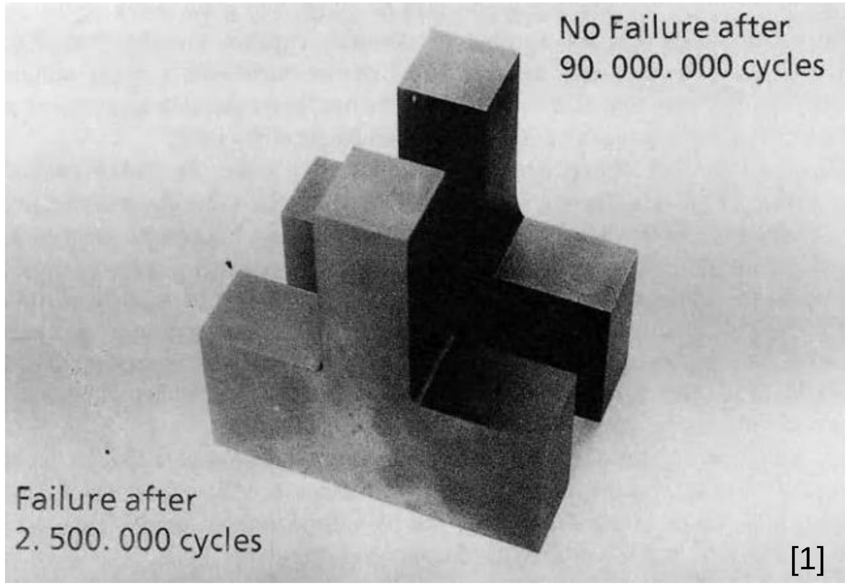
$$K_{t1} = \frac{\sigma_{max}}{\sigma_n} = 719$$

$$\frac{K_{t1}}{K_{t2}} = 2.38$$





$$K_{t2} = \frac{\sigma_{max}}{\sigma_n} = 302$$

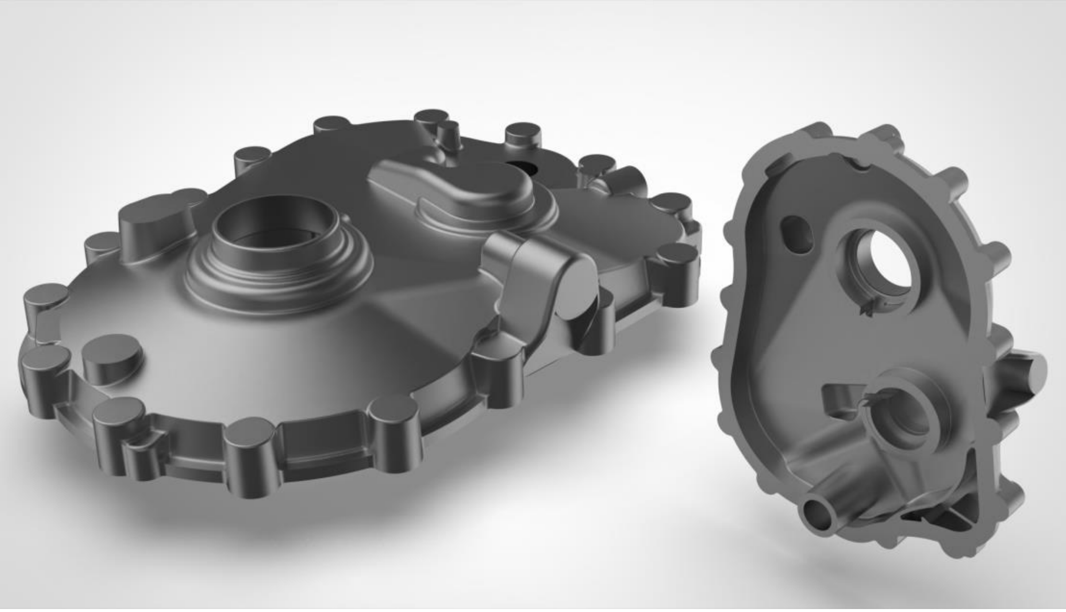


$$Increased\ cycles\ by\ 36\ times$$
$$for\ a\ ratio\ of\ stress\ factors = 1.72$$

[1] Claus Mattheck, Design in der Natur, Rombach Verlag, 1997,S. 265, ISBN: 3-7930-9150-3

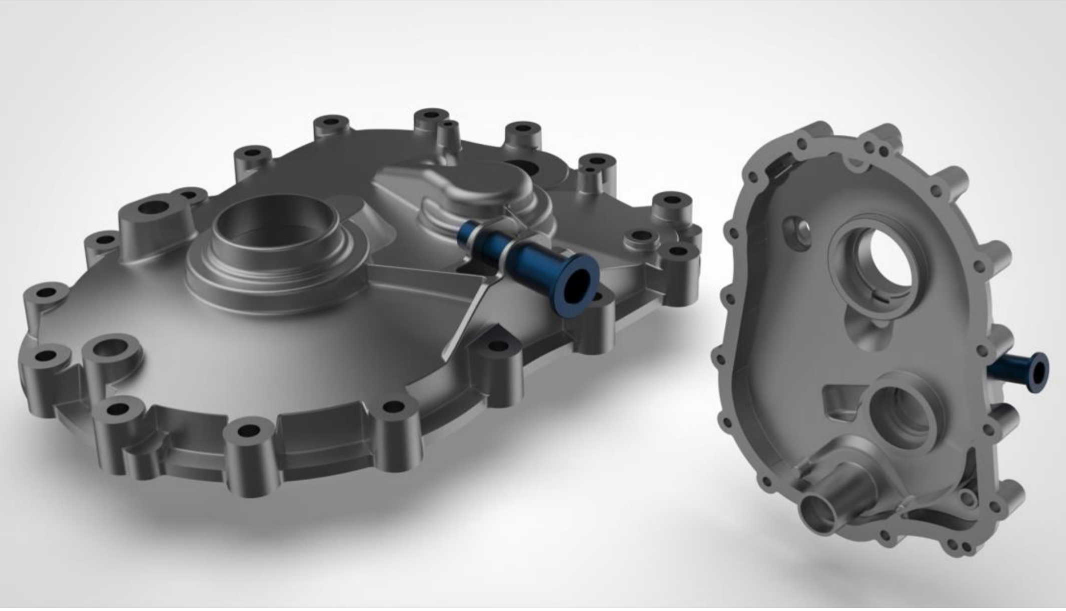
Component evolution gearbox cover

Stepwise optimization of the reference



Basic concept using the described design method

- Bearing rings closed
- Variable sleeve as mounting point
- Air outlet rotated 90°



Further iterative optimization through topology optimization and simulation

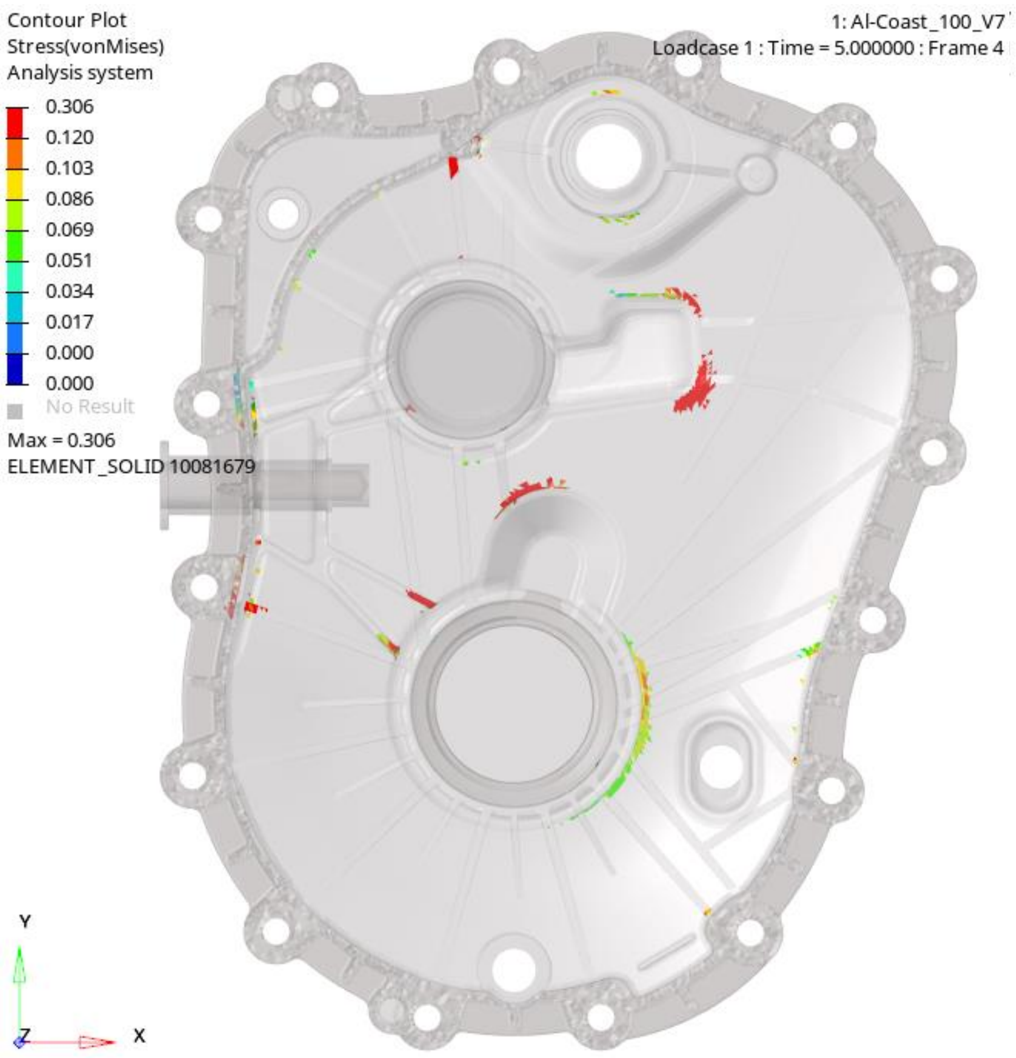
Design for static strength

- Investigation of overload cases as well as tightness at the flange
- Automated analysis according to FKM guideline

Design for operational strength

- Investigation of the loads occurring during operation
- Automated fatigue analysis according to FKM guideline

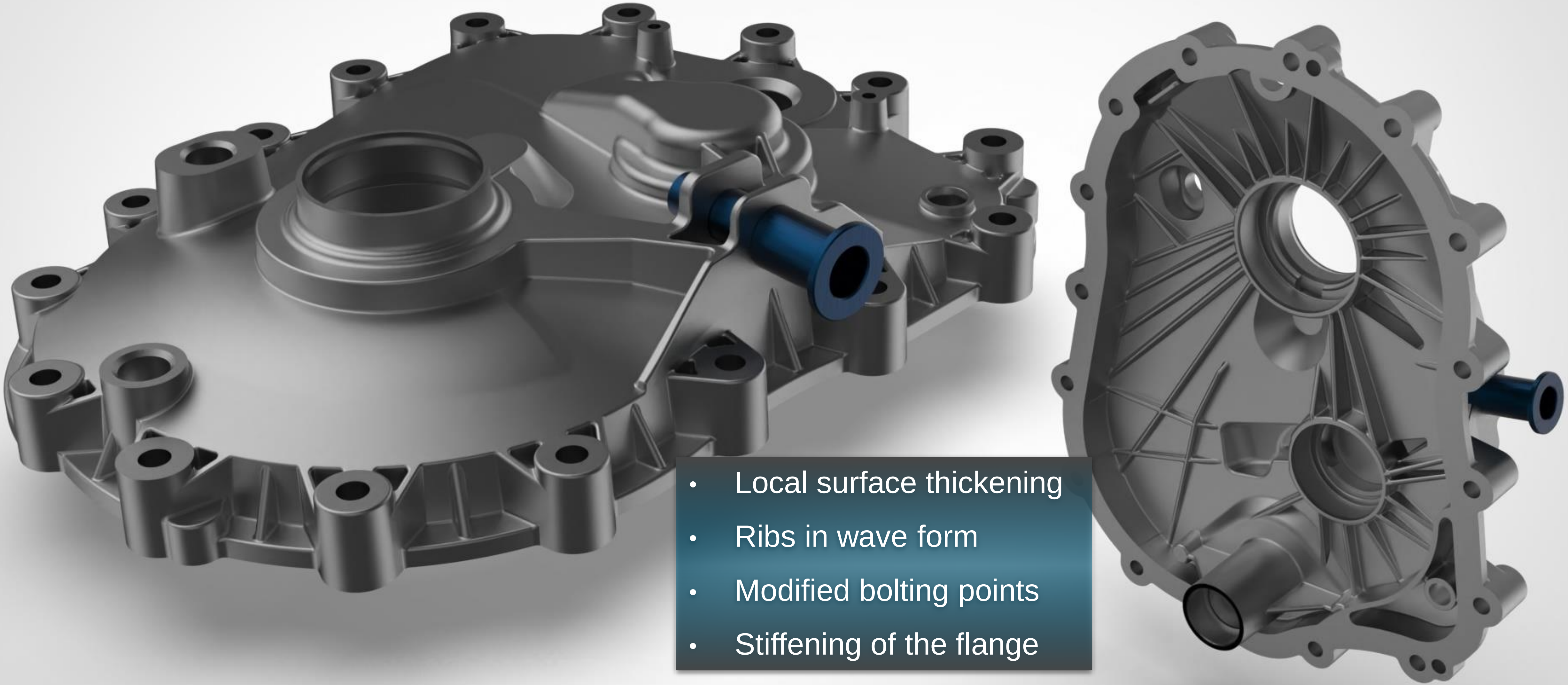
→ Optimization of the geometry



Forschungskuratorium Maschinenbau: *Rechnerischer Festigkeitsnachweis für Maschinenbauteile, 6. überarbeitete Ausgabe*. VDMA-Verlag, 2012, ISBN 978-3-8163-0605-4.

Component evolution gearbox cover

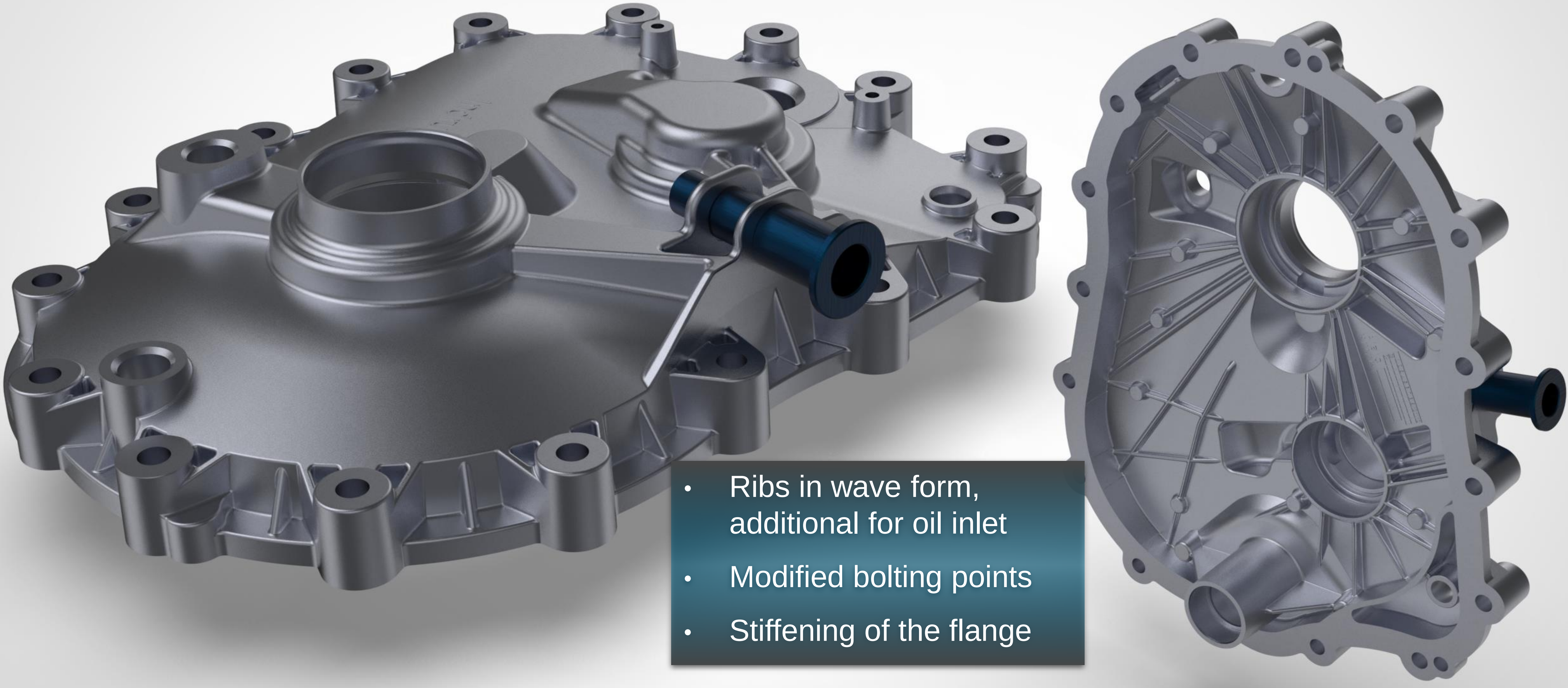
Third optimization of the reference (aluminum)



- Local surface thickening
- Ribs in wave form
- Modified bolting points
- Stiffening of the flange

Component evolution gearbox cover

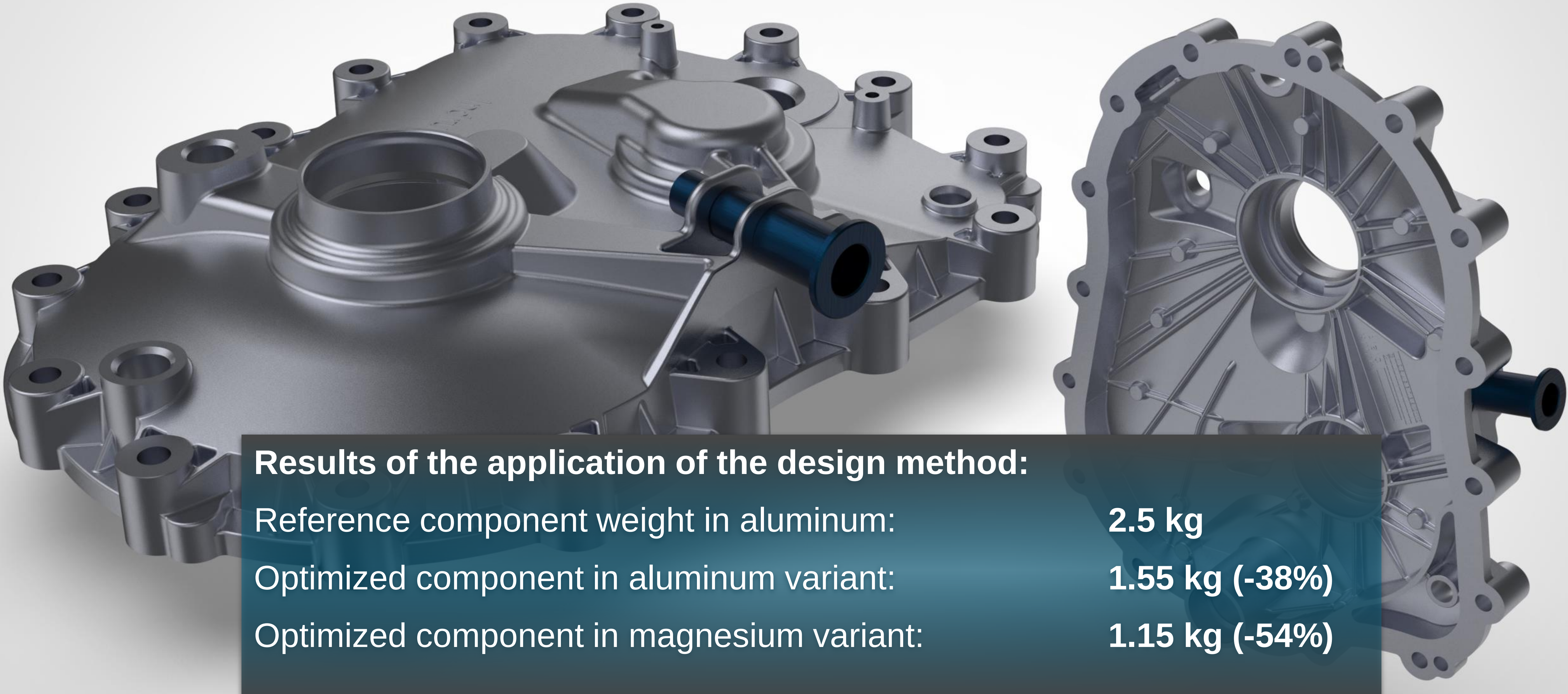
Third optimization of the reference (magnesium)



- Ribs in wave form, additional for oil inlet
- Modified bolting points
- Stiffening of the flange

Component evolution gearbox cover

Result overview



Results of the application of the design method:

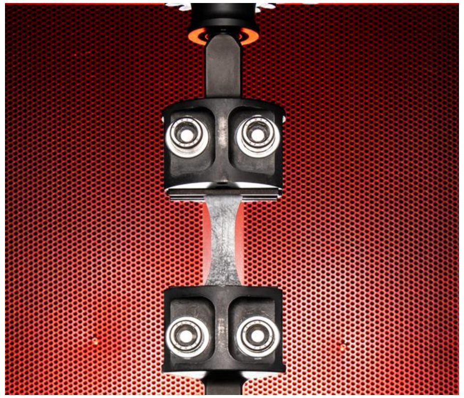
Reference component weight in aluminum:	**2.5 kg**
Optimized component in aluminum variant:	**1.55 kg (-38%)**
Optimized component in magnesium variant:	**1.15 kg (-54%)**

Achievement of project objectives to date InDruTec- E

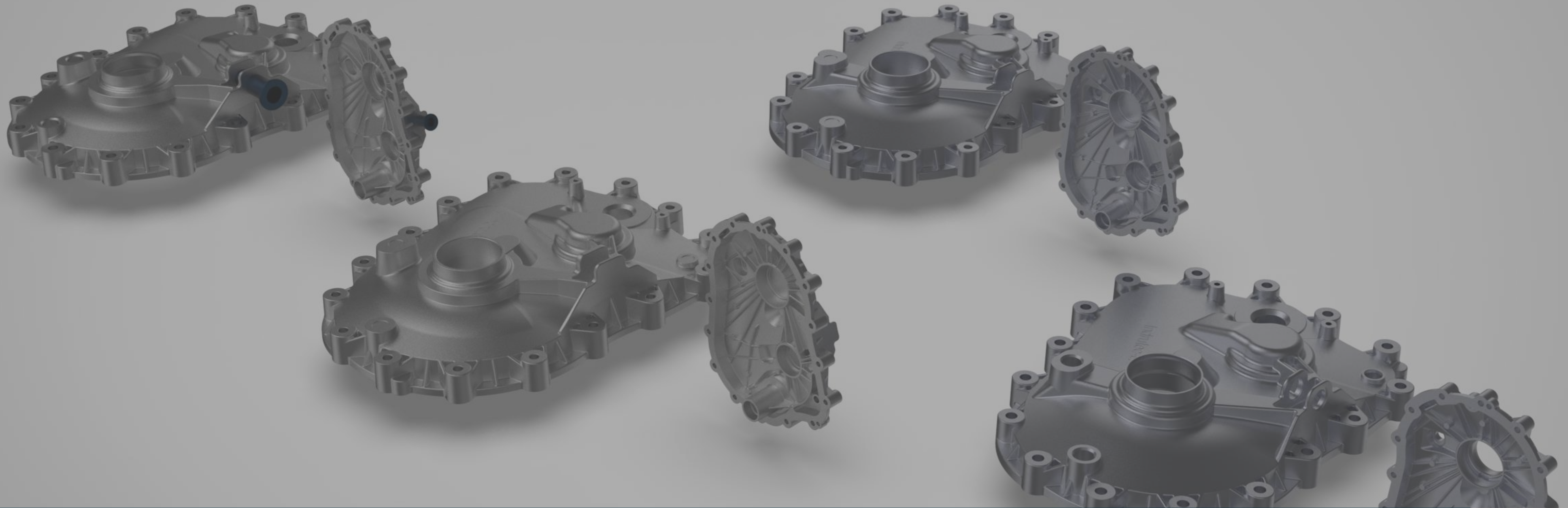
Objectives

Reduction of component weight	Cost reduction	Reduction of the CO_2 footprint	Reduction of scrap rates

Results



-38%/-54%	> -40%	> -60%	T.b.d.



THANK YOU FOR YOUR ATTENTION

QUESTIONS, PROJECT IDEAS OR INTEREST AS A PROJECT PARTNER?
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