The potential of High Pressure Die Casting for the production of highly stressed components in automotive applications

Dr. Klaus Greven
KSM Castings Group GmbH

KSM Castings Group

Agenda

- KSM Castings
- Motivation
- Controlled Vacuum Casting (CVC™)
- Potential Applications
  - Chassis
  - Body

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Key Figures

Turnover: ~ 450 Mio. EUR

Employees: ~ 2.900

Production Technologies:

- High Pressure Die Casting
- Gravity Die Casting
- Counter Pressure Casting
- Multi-Tilt Casting
- Low Pressure Sand Casting
- Machining & Assembly

Development Capability:

- Simultaneous Engineering
- Technology Engineering
- System Development

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Global Footprint

Hildesheim 1
- **Headquarters**
- High Pressure Die Casting
- Gravity Die Casting
- Machining & Assembly

Wuppertal 2
- High Pressure Die Casting
- Machining & Assembly

Radevormwald 3
- High Pressure Die Casting
- Machining & Assembly

Wernigerode 4
- Gravity Die Casting
- Machining & Assembly

Hrádek nad Nisou 5
- High Pressure Die Casting
- Machining & Assembly

Changchun 6
- High Pressure Die Casting
- Grtavity Die Casting
- Machining & Assembly

USA 7
- High Pressure Die Casting
- Permanent Mould Casting
- Machining & Assembly

in preperation - 2014

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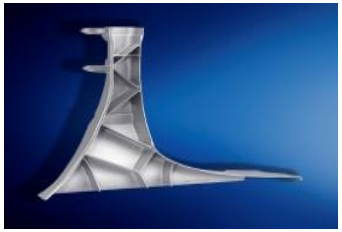
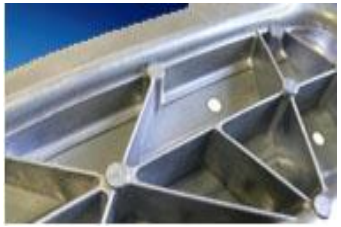
Product Portfolio

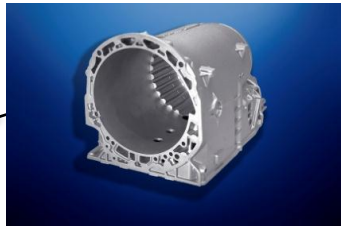

Steering gear box


Pillar - prototype


Cross member
(Variostruct)


Cylinder head cover


Front axle subframe

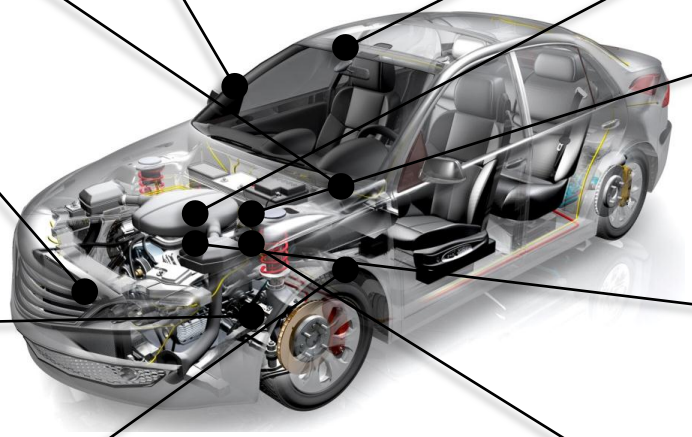

Transmission housing


Knuckle


Pump housing


Pedal bracket


Valve body



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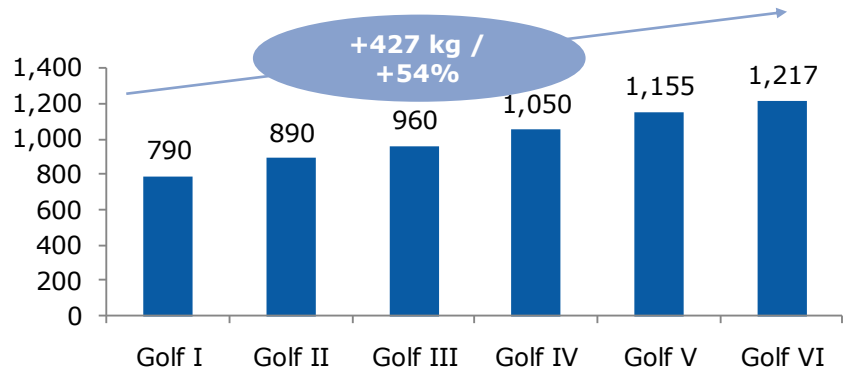
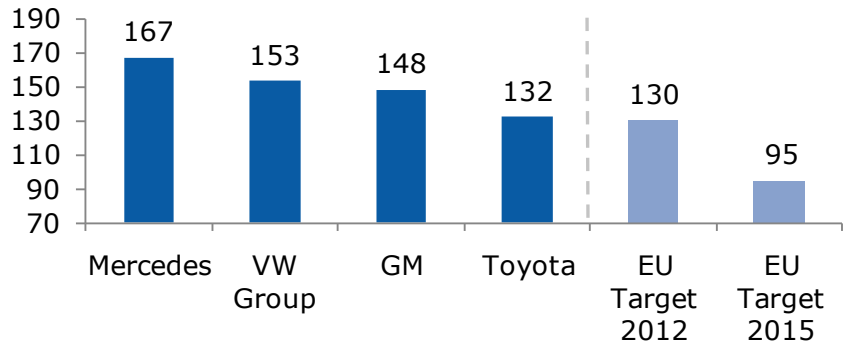
Motivation

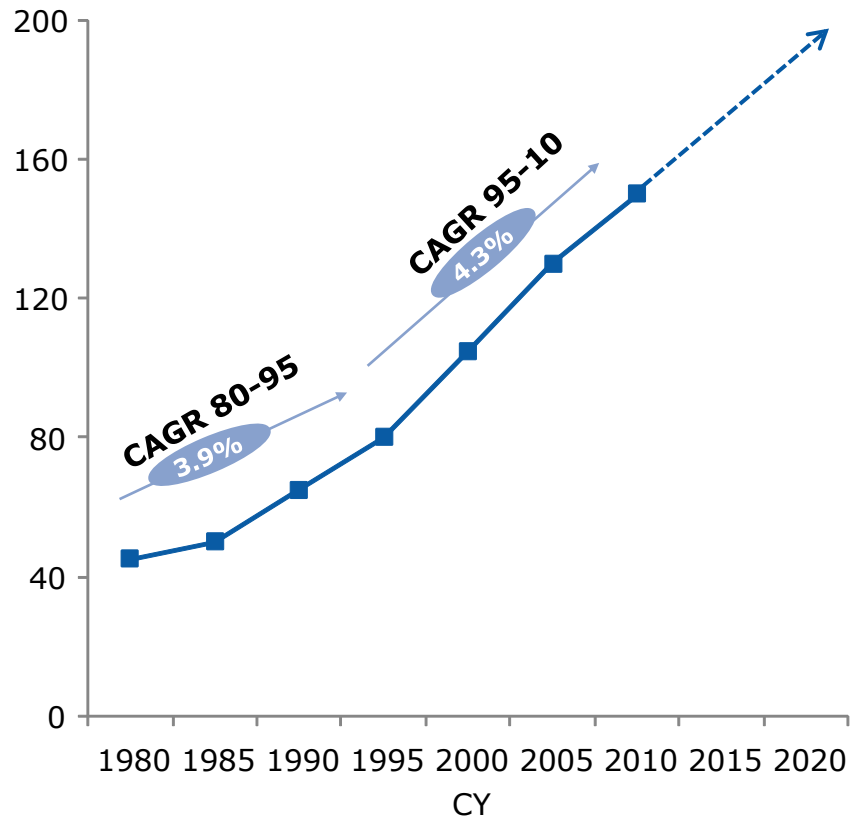
Development of Curb Weight
Example VW Golf (weight in kg)



CO2 Fleet Emission vs. Regulatory Targets (g CO2 per km)



Aluminium Content in Light Vehicles
(kg aluminium per vehicle)

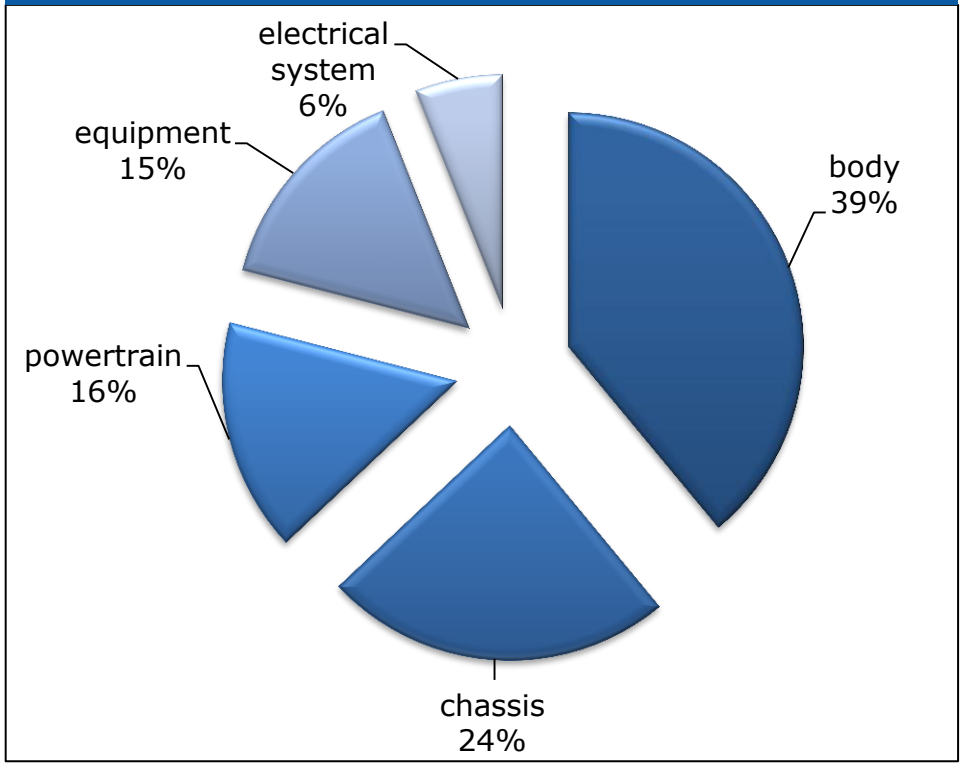


➢ Every OEM has the need to reduce weight

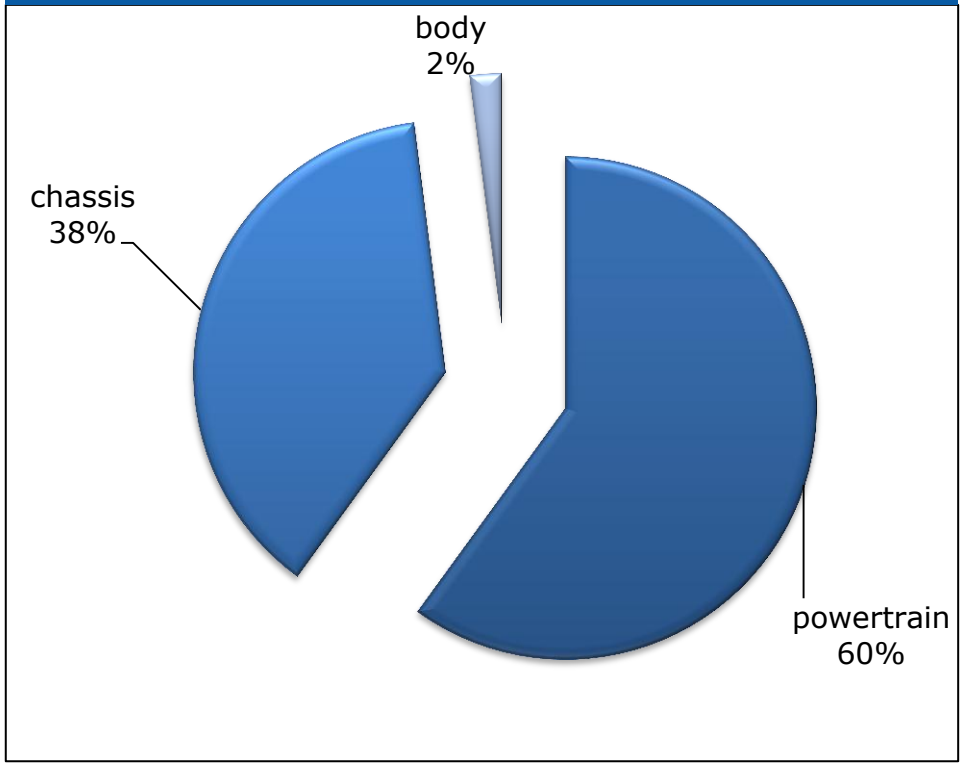
Source: Roland Berger

Motivation

Typical distribution of mass



Aluminum share by application



- Chassis: potential for weight saving by design optimization of aluminum components
- Body: potential for weight saving by substitution of steel components

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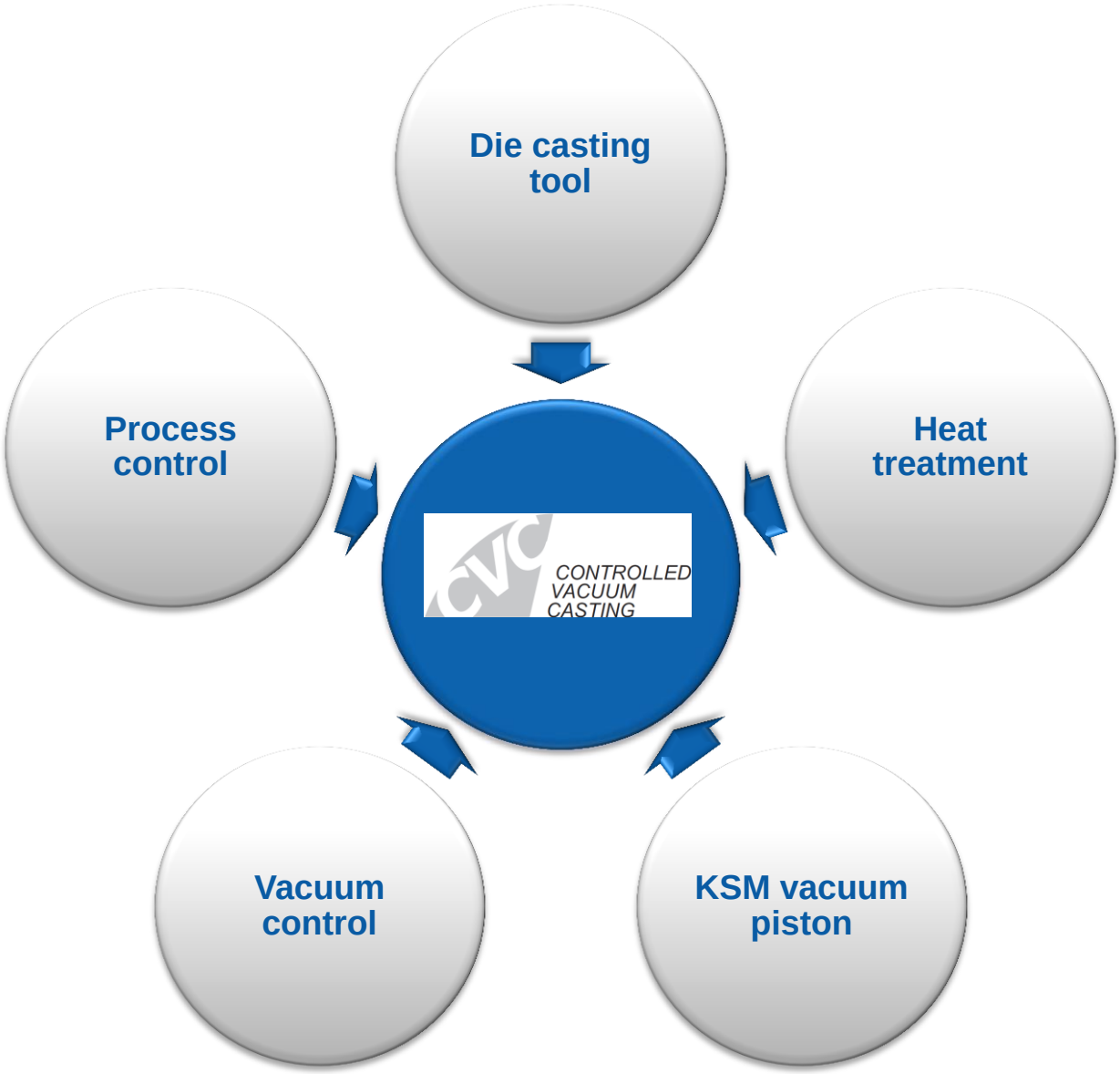
Controlled Vacuum Casting (CVC™)

Main objectives

- No restriction concerning process stability
- No restriction concerning OEE
- Welding of cast parts without surface treatment
- Optimized heat treatment concerning distortion



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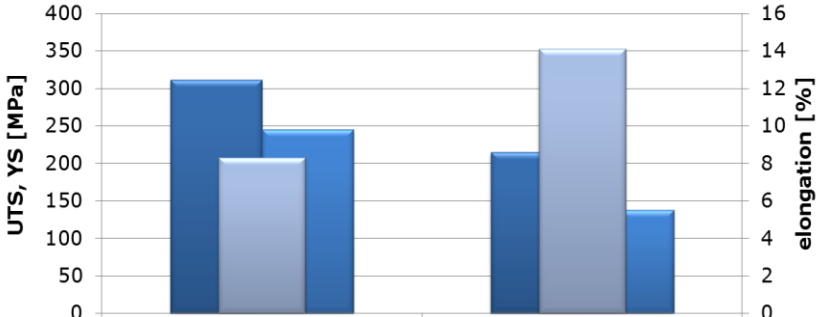
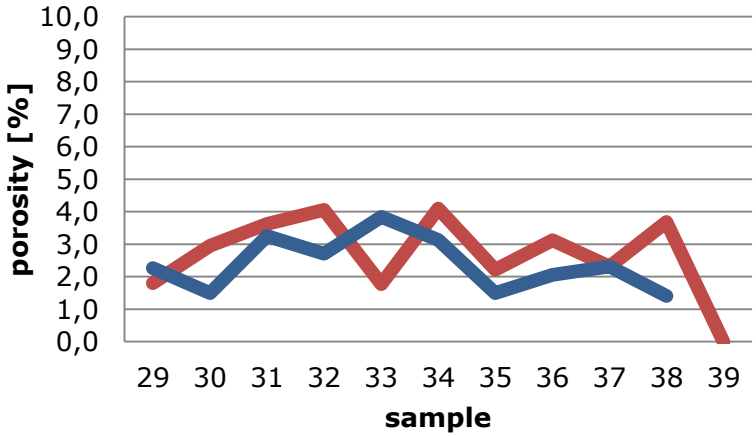
Controlled Vacuum Casting (CVC™)

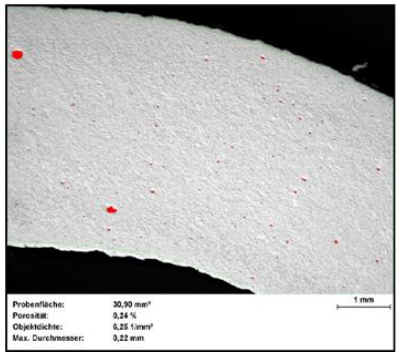
Heat Treatment

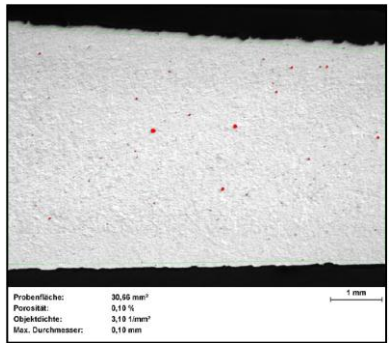


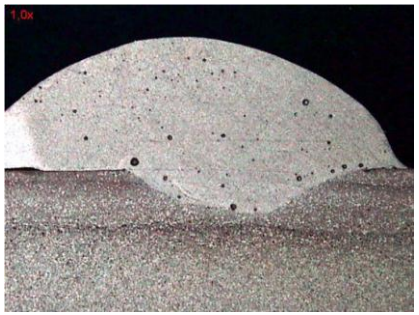
	CVC T6	CVC T7
UTS [MPa]	312	215
YS [MPa]	245	138
elongation [%]	8,3	14,1

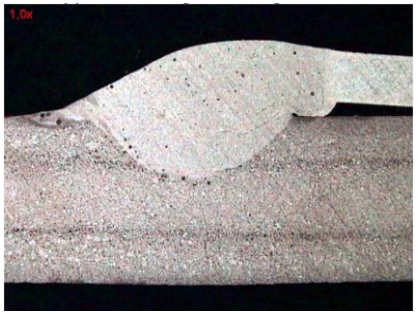
Welding











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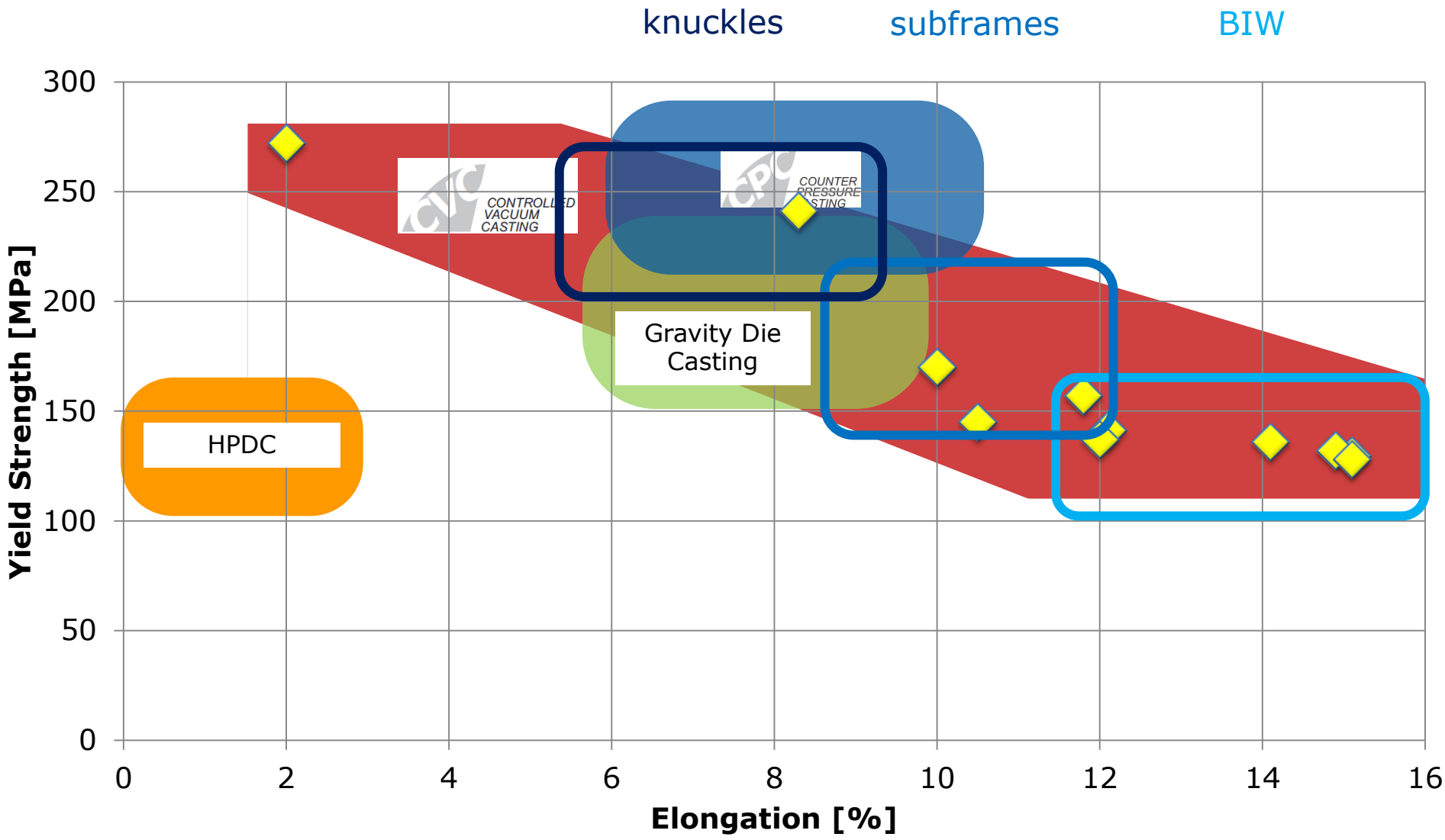
Controlled Vacuum Casting (CVC™)



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CONTROLLED VACUUM CASTING

Subframe BMW 5,6,7 series 4WD

Product Information

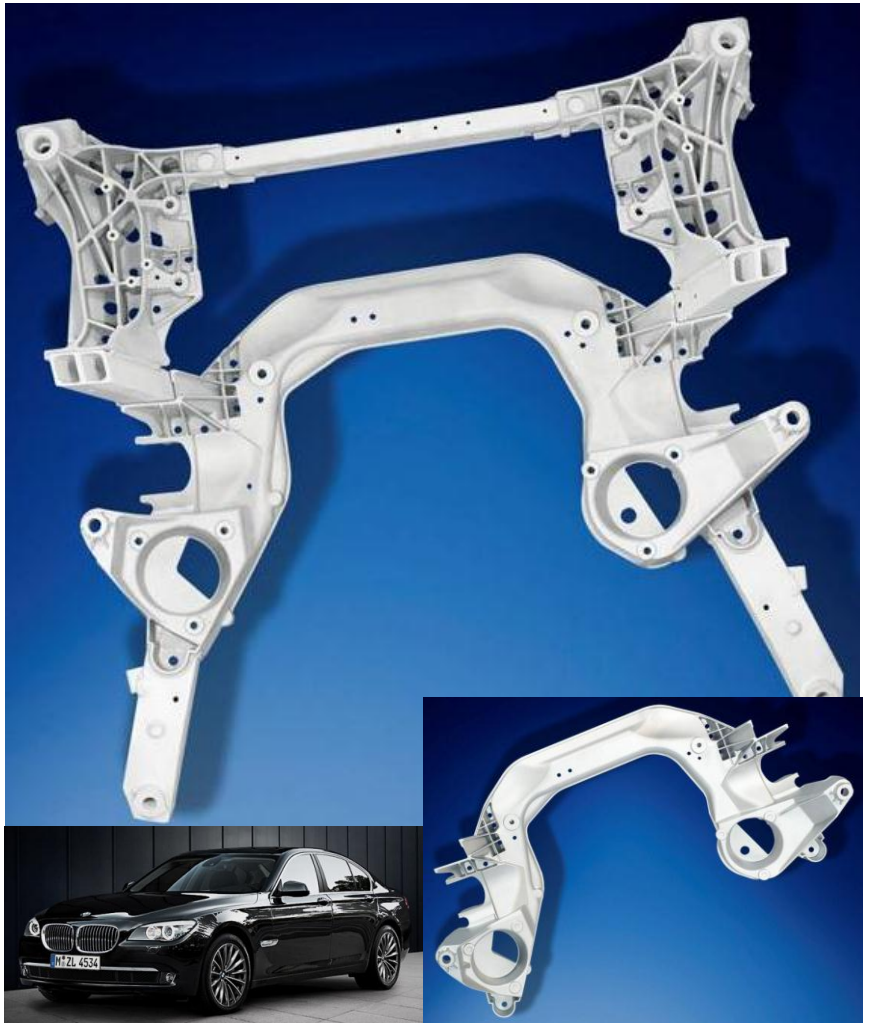
Process:	Controlled Vacuum Casting
Material:	Aluminum
Alloy:	Al Mg5 Si2 Mn
Weight:	7.82 kgs
Volume:	60,000 parts p. a.

Characteristics

- Weldable die casting for chassis components
- Weldability without any surface treatment
- Mechanical properties are achieved in as cast condition

Mechanical Characteristics

Yield strength:	YS	>270 MPa
Tensile strength:	UTS	>150 MPa
Elongation:	A5	>5 %



CONTROLLED VACUUM CASTING

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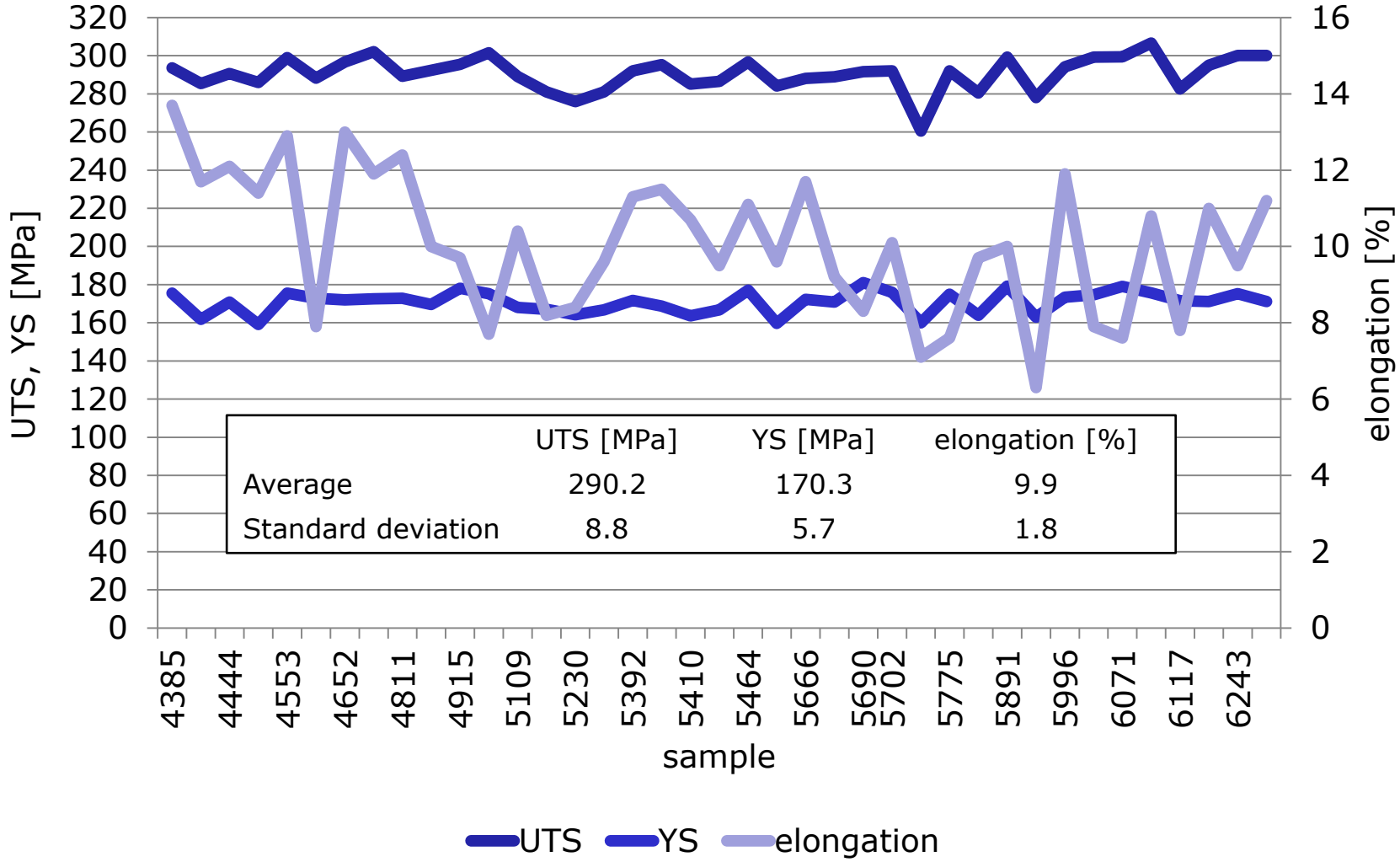
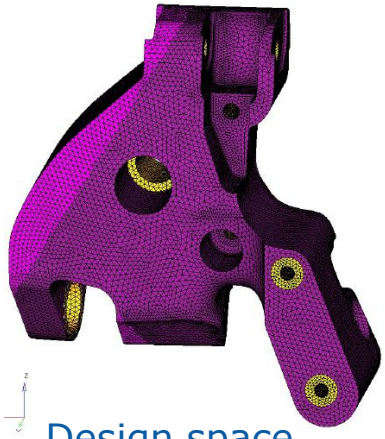
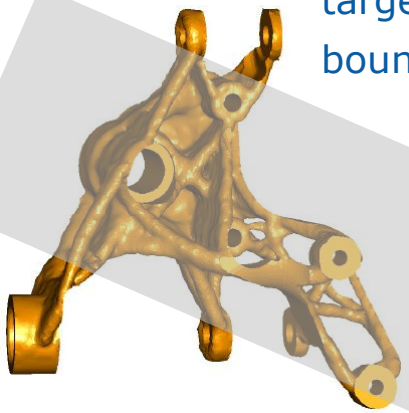


Rear Knuckle (load per axle ~1.000 kg)

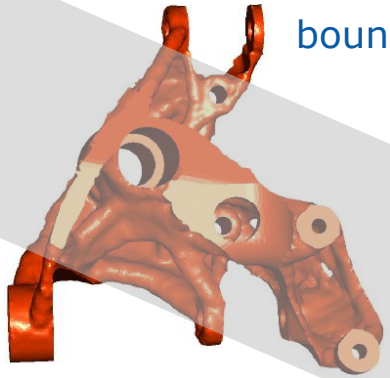


Design space

target: minimizing mass
boundary condition: stiffness



target: minimizing stresses
boundary condition: mass, stiffness



Rear Knuckle (load per axle ~1.000 kg)

Series application

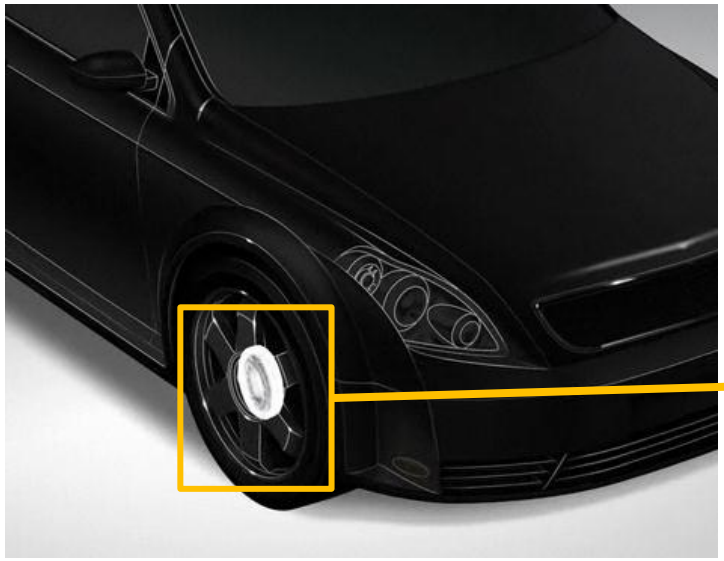
Cast aluminum knuckle

Weight -22%

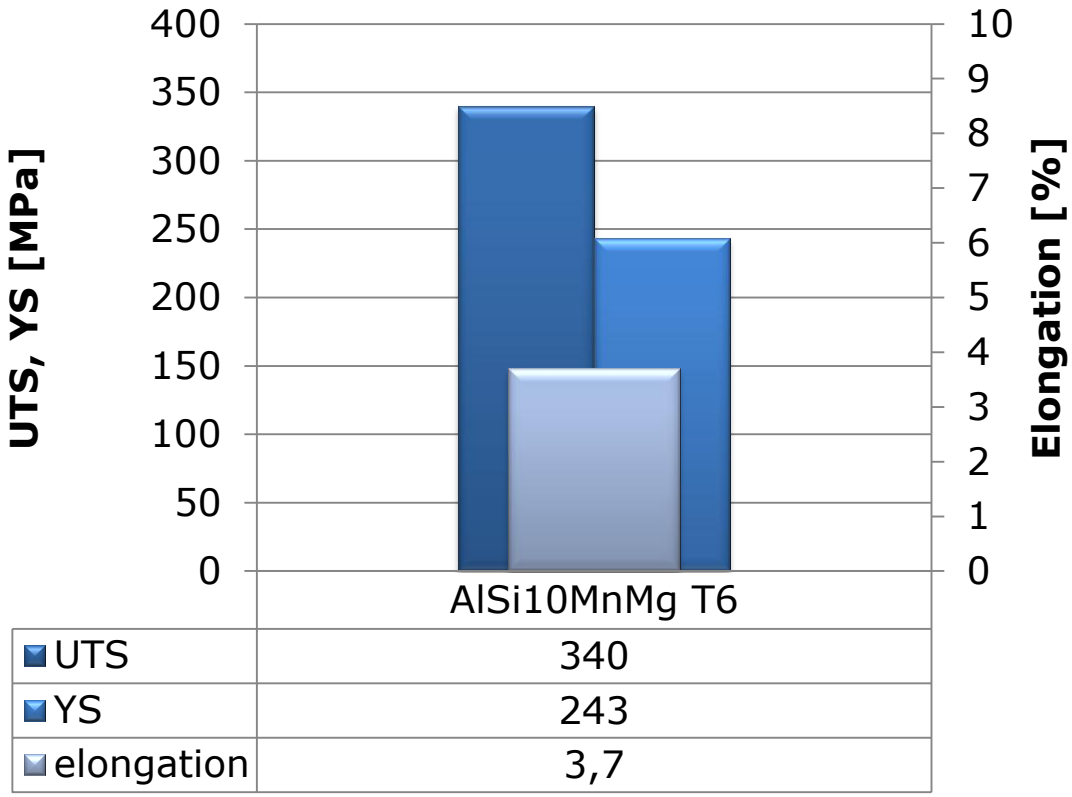
CVC concept

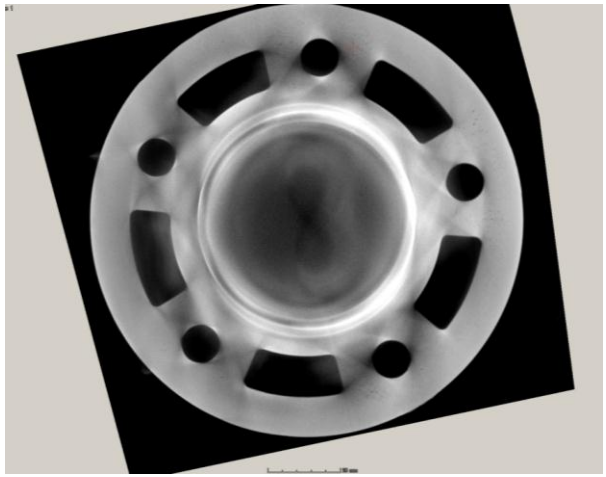
Redesigned CVC knuckle

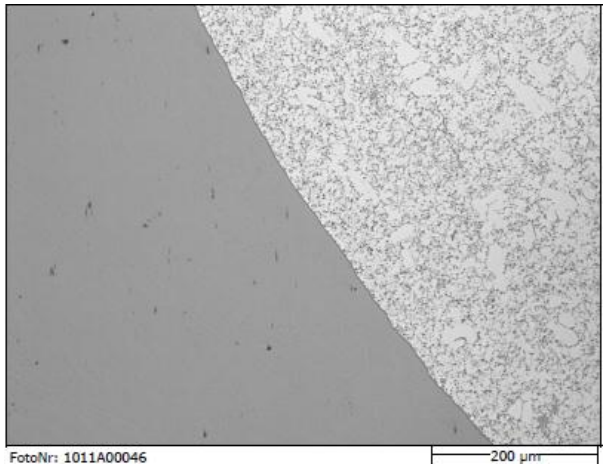
Aluminum/Steel Hybrid Wheel Hub



Aluminum/Steel Hybrid Wheel Hub







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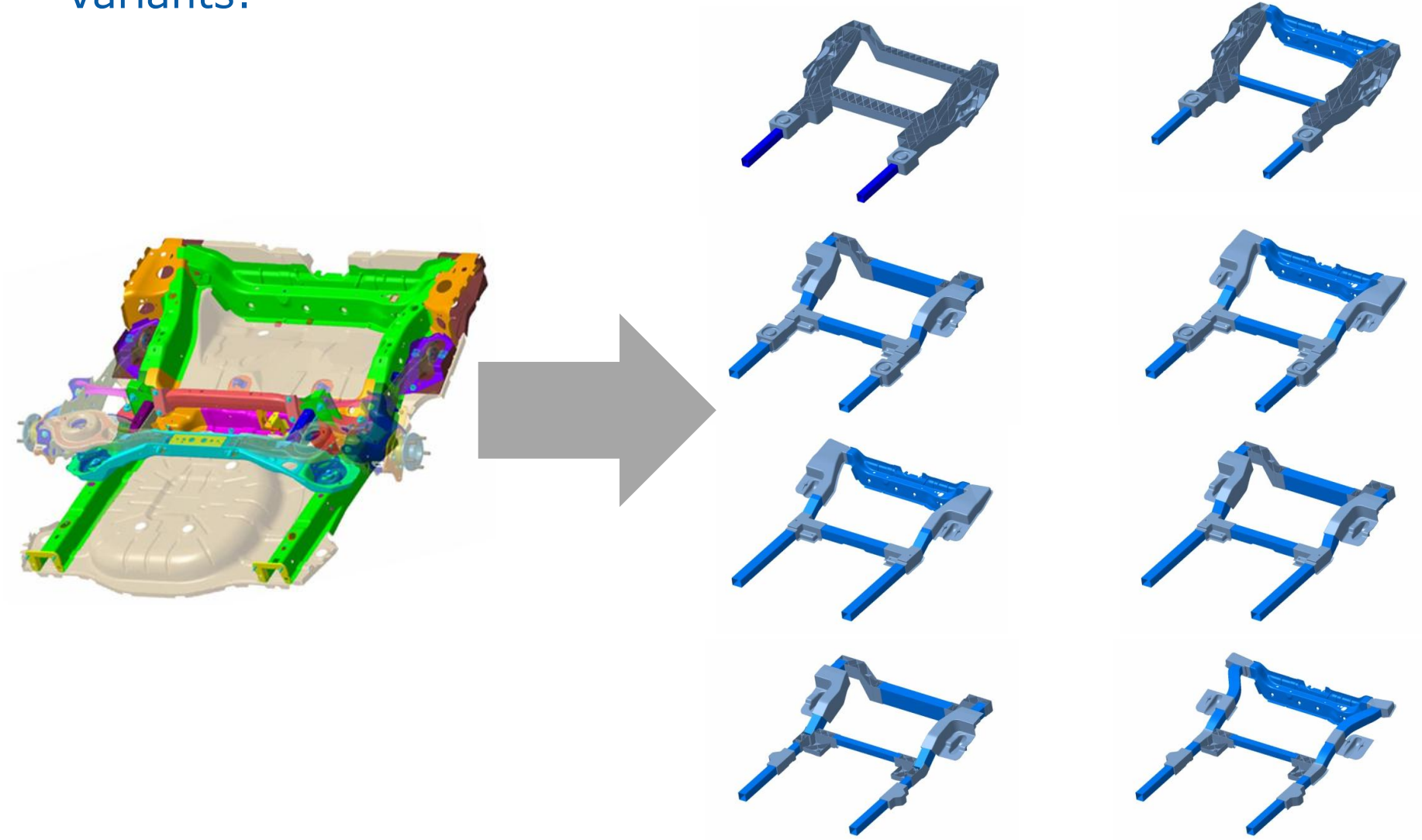
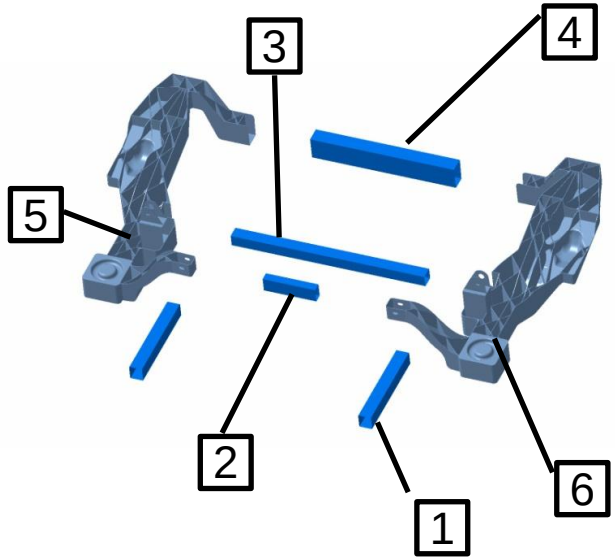
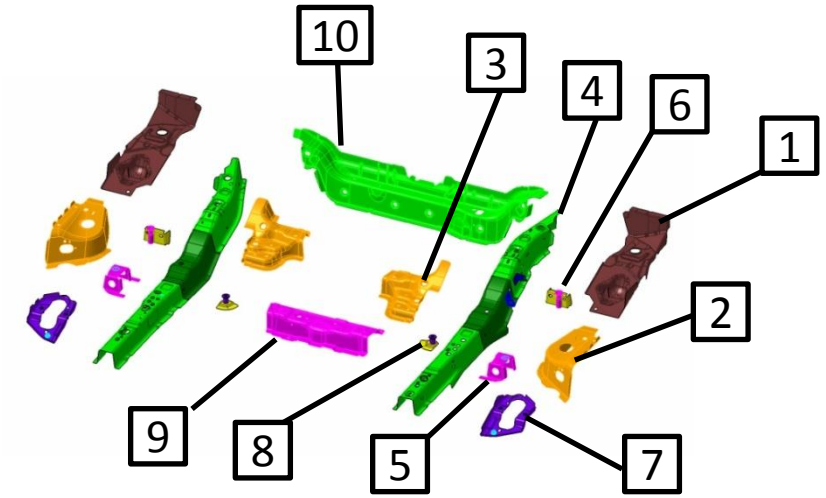
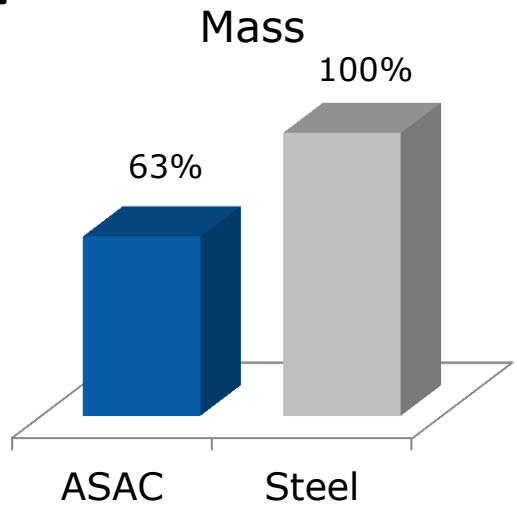
ASAC (Advanced Scalable Aluminum Casting) Variants:



ASAC (Advanced Scalable Aluminum Casting)

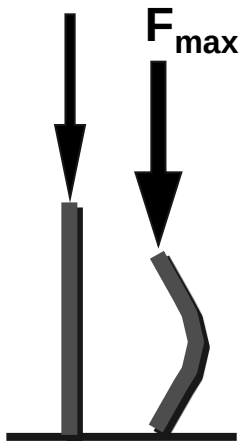




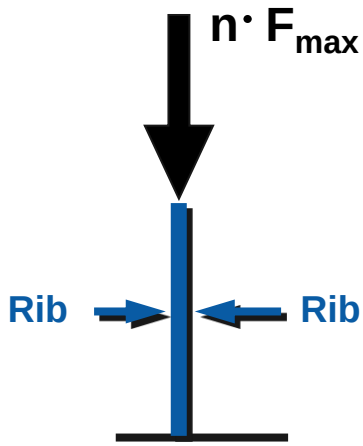


VARIOSTRUCT
multi-material-components

Cross section stabilization using ribs in the hybrid structure

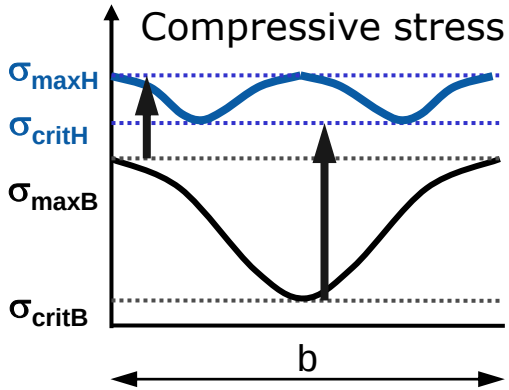


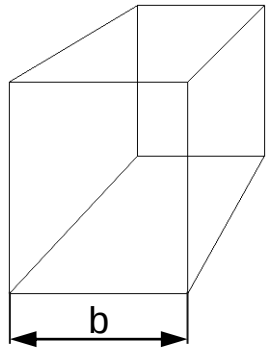
Conventional
Stamping assembly (B)



Hybrid structure (H)

Potential enhancements in buckling strength





σ_{crit} = critical buckling strength
σ_{max} = maximum buckling strength
b = section profile dimension

Lightweight potential with very high structural performance

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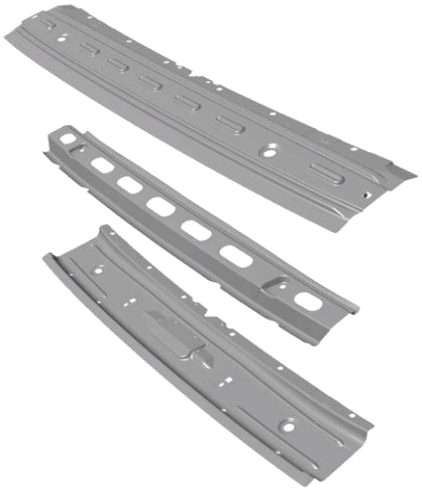
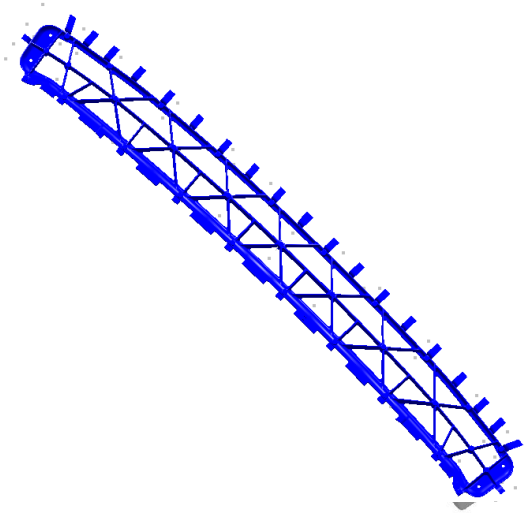
Body Applications

VARIOSTRUCT
multi-material-components





- Material: **Steel Stampings**
- Construction: **3 piece design**
- Assembly: **Spot-welding, Laser-welding, Adhesive Bonding**

- Material: **Al/steel Hybrid**
- Construction: **1 piece design**
- Assembly: **Hybrid Casting (Force- and Form-fit)**

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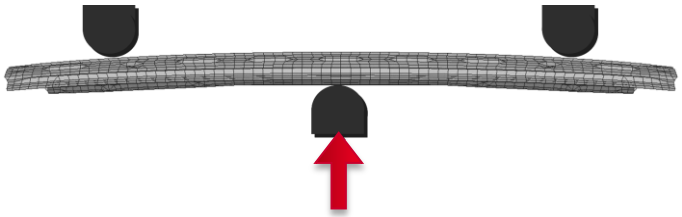
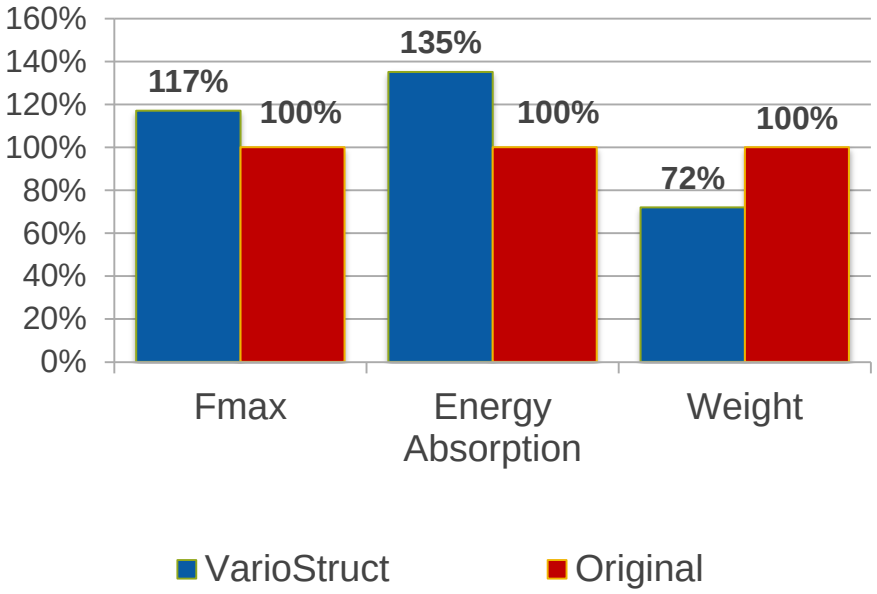
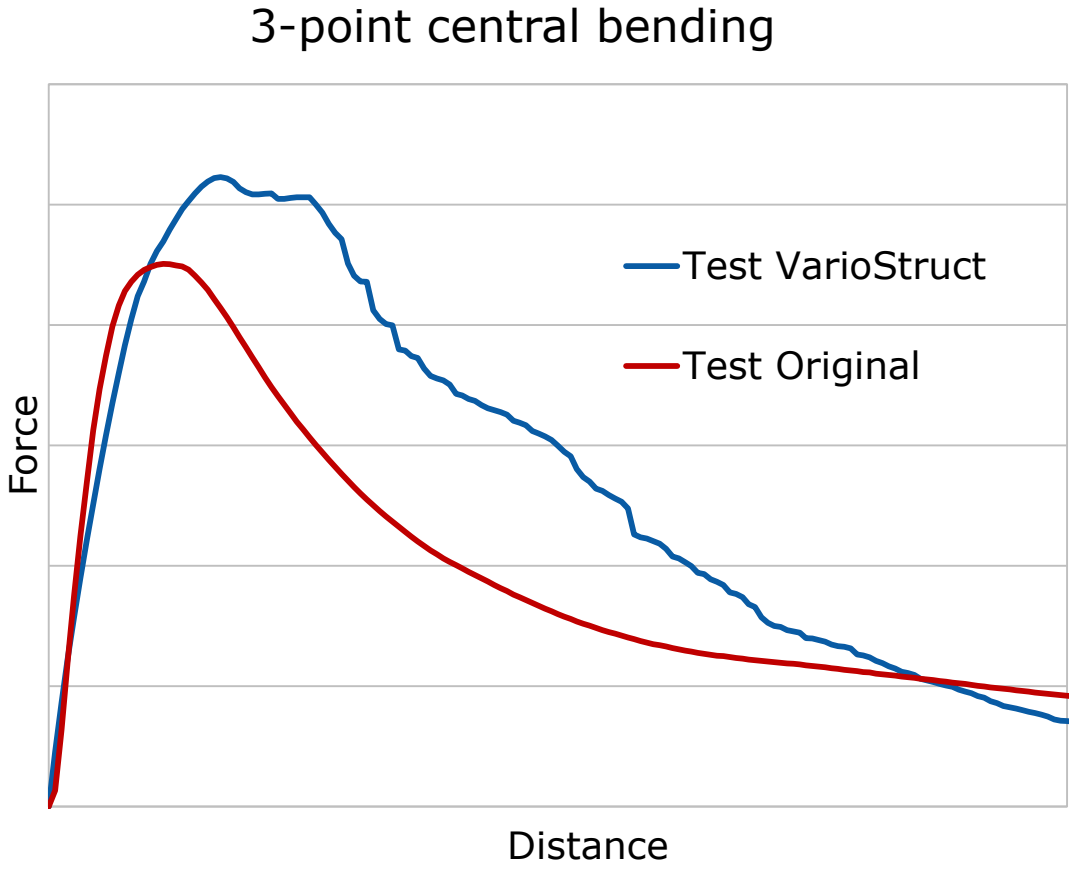
VARIOSTRUCT
multi-material-components







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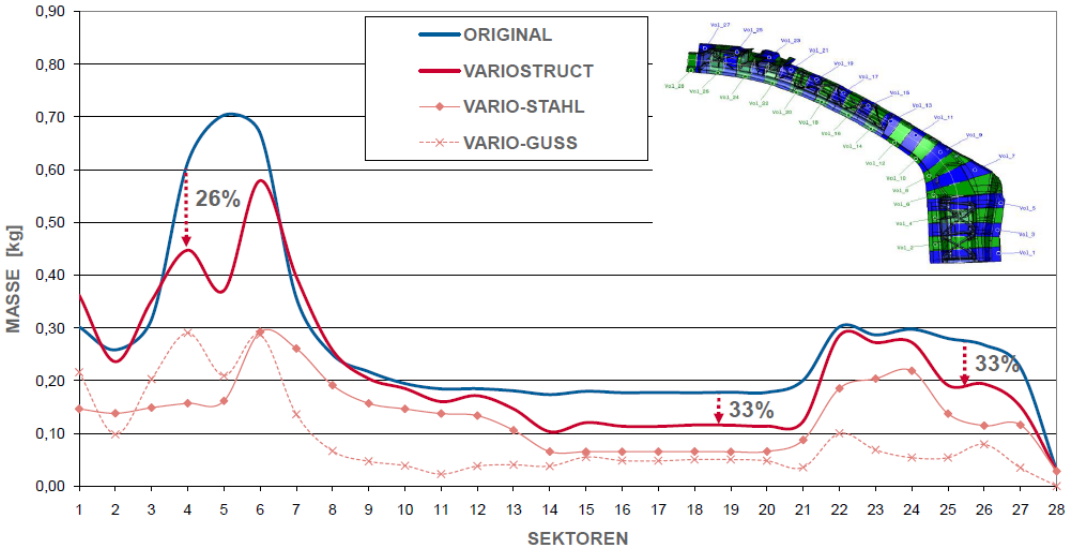

Weight reduction by target-oriented distribution of mass

Possible weight reduction: app. 20%