

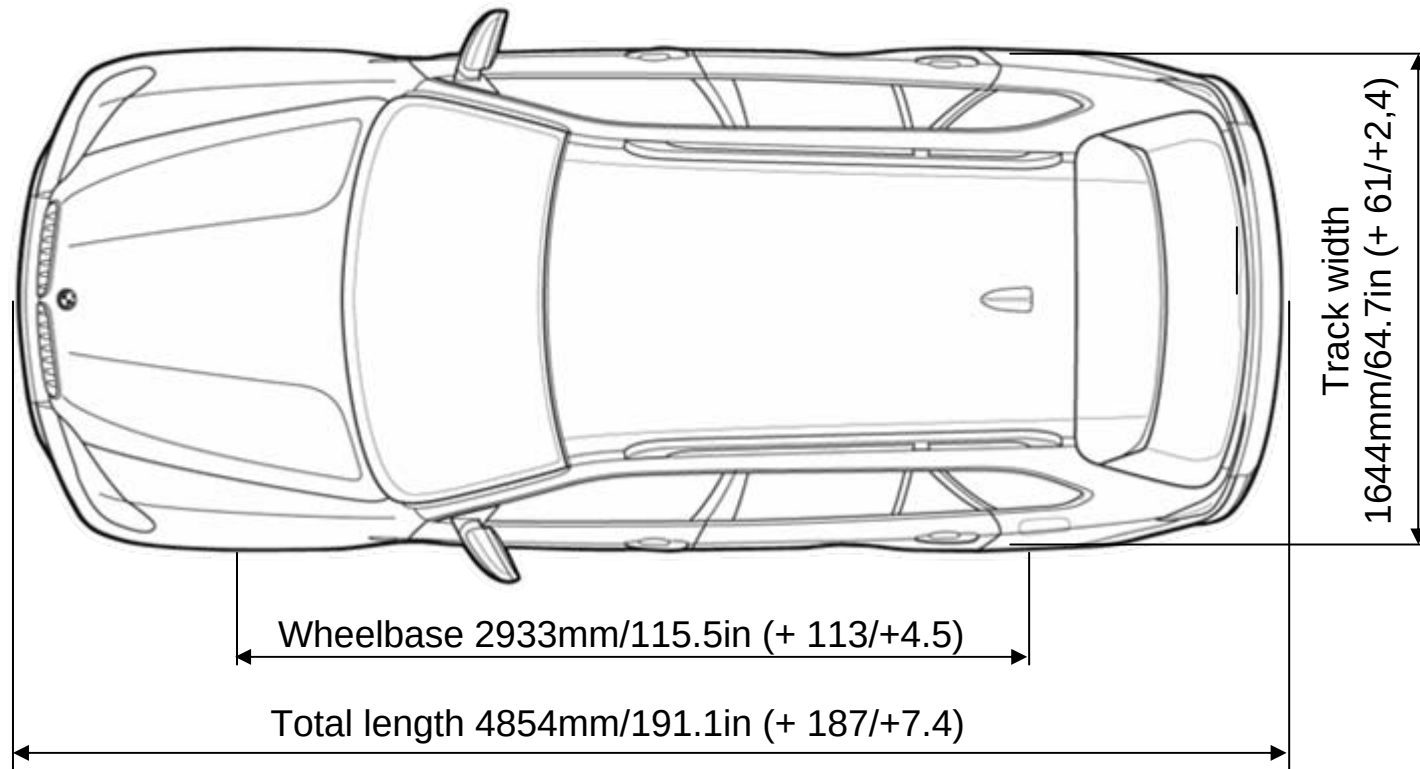
The mixed Material Concept of the new BMW X5

Markus Pfestorf
BMW Group

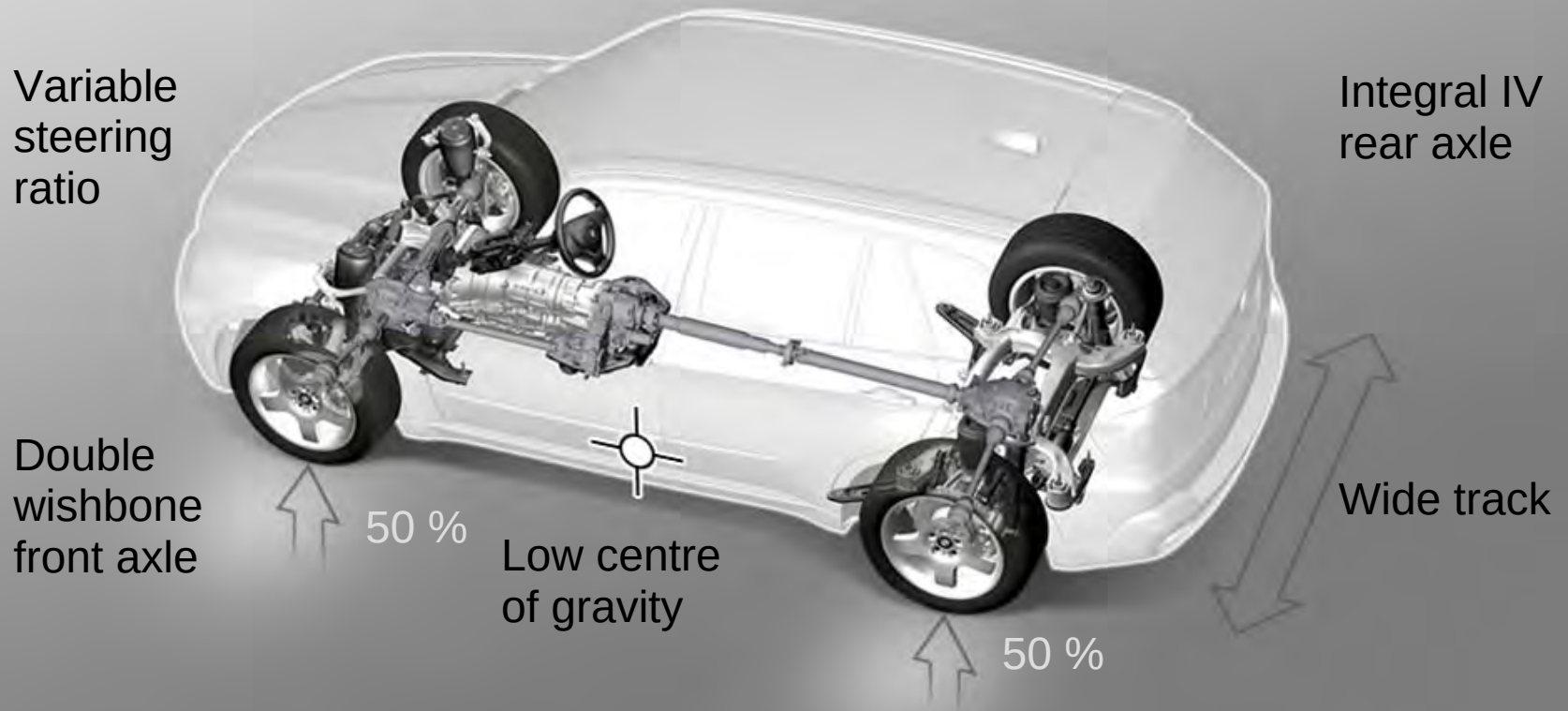
- Technical Features
- Stiffness
- Passive Safety
- Materials
- Components
- Driving Performance
- Conclusion



Technical Features Dimension of the Car



Technical Features Unique Chassis Technology

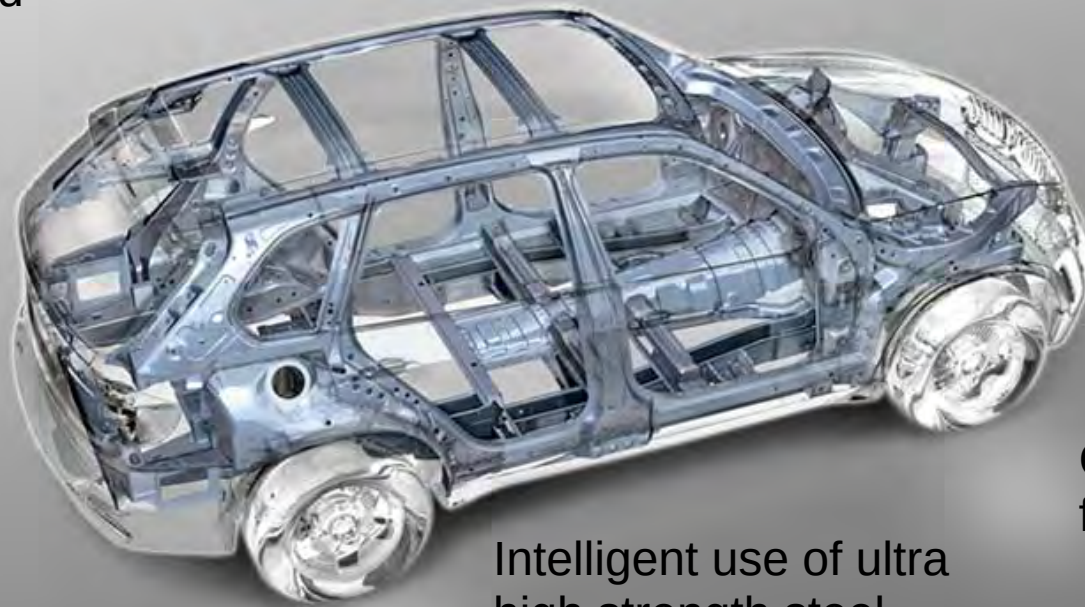


Excellent handling and roadholding capabilities
and a comfortable ride without compromise

Handles like a true BMW

Technical Features Intelligent Light Weight Construction

Runflat tyres 4th generation fitted as standard



Aluminium engine hood

Magnesium carrier for instrument panel

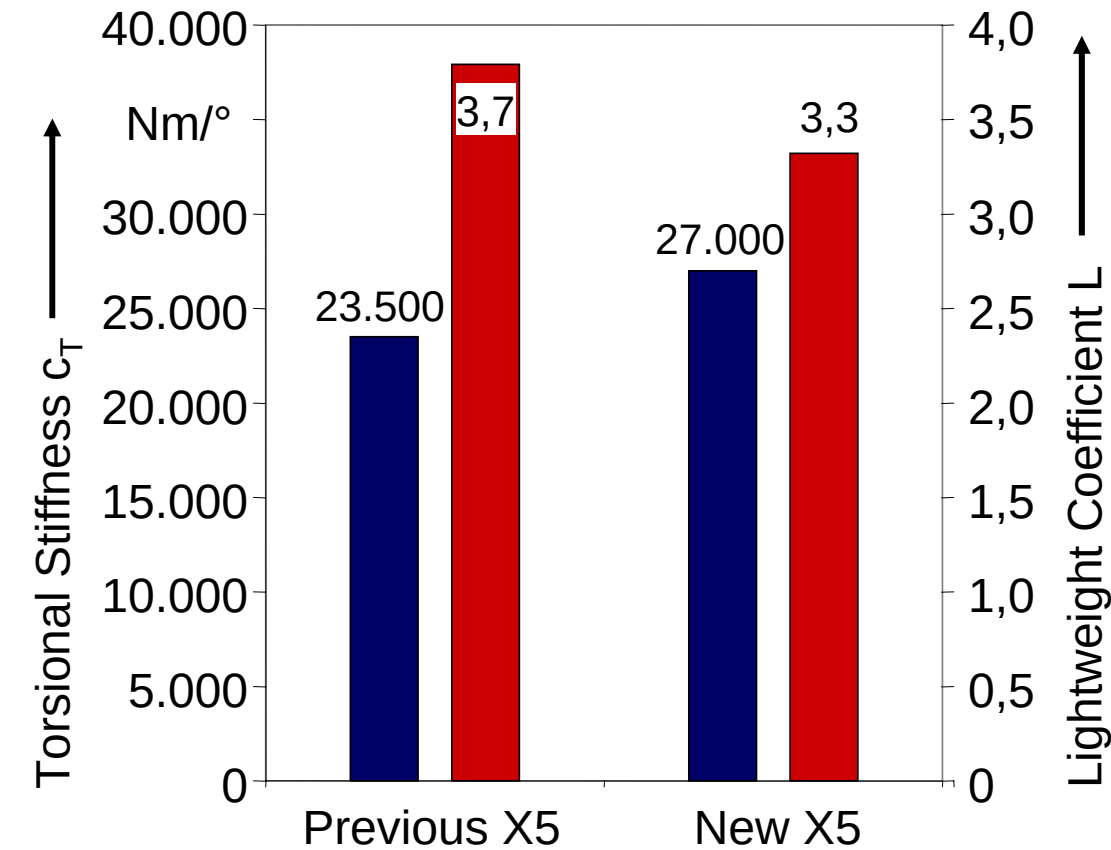
Cast aluminium front strut tower

Intelligent use of ultra high strength steel

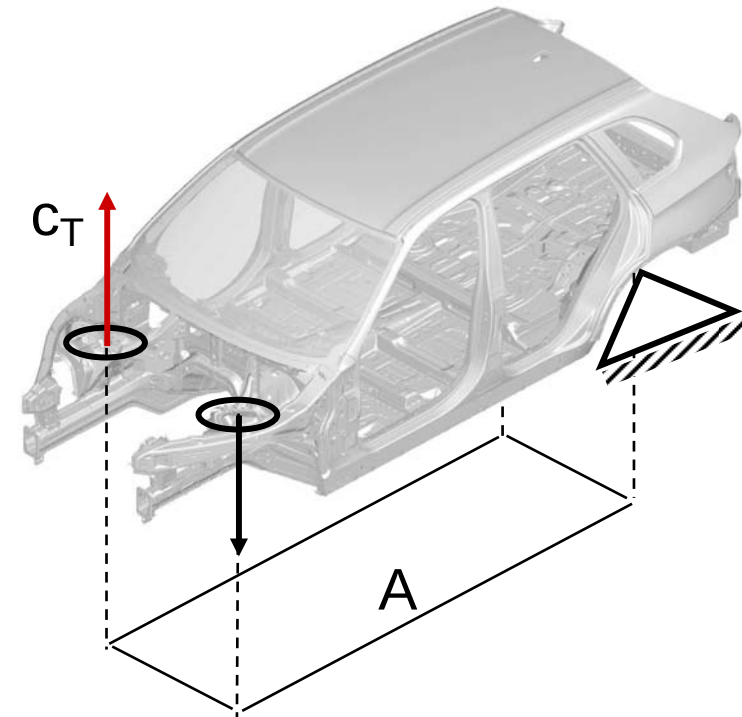
15 per cent higher torsional stiffness $\sim 27.000 \text{ Nm/}^\circ$

Almost the same weight in spite of enlarged dimensions

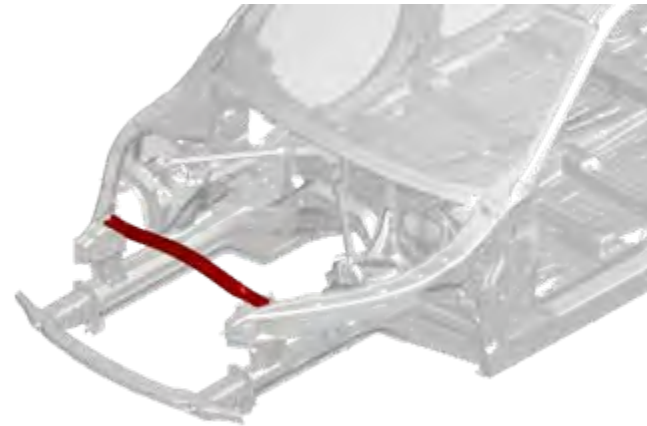
Innovative technologies for optimum active and passive safety



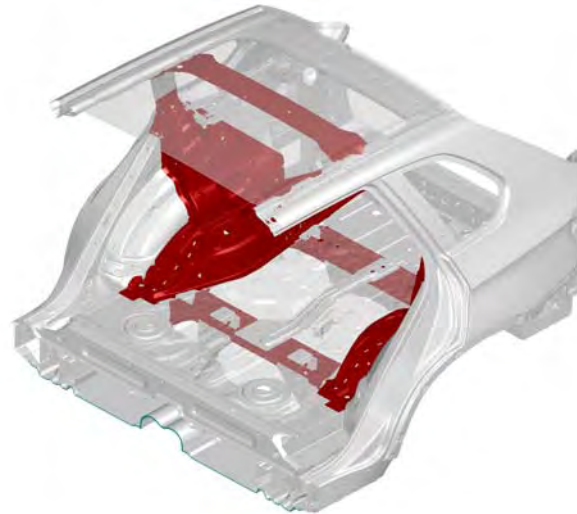
$$L = \frac{m_{\text{Ger}}}{C_t \times A} \left[\frac{\text{Kg}}{\text{Nm}/^\circ \times \text{m}^2} \times 10^3 \right]$$



- L Lightweight coefficient
- $m_{\text{Ger.}}$ Weight of body in white (without doors and closures)
- c_t Static torsion (including screens)
- A Area (wheel base x track width)



Stiff Front End by
Diagonal Strut
(Aluminium)



Stiff Rear End due to
the Torsion Ring



Additional Stiffness by
bracing the trunk lid
between the D-pillars
(Weight Saving: 6 kg)

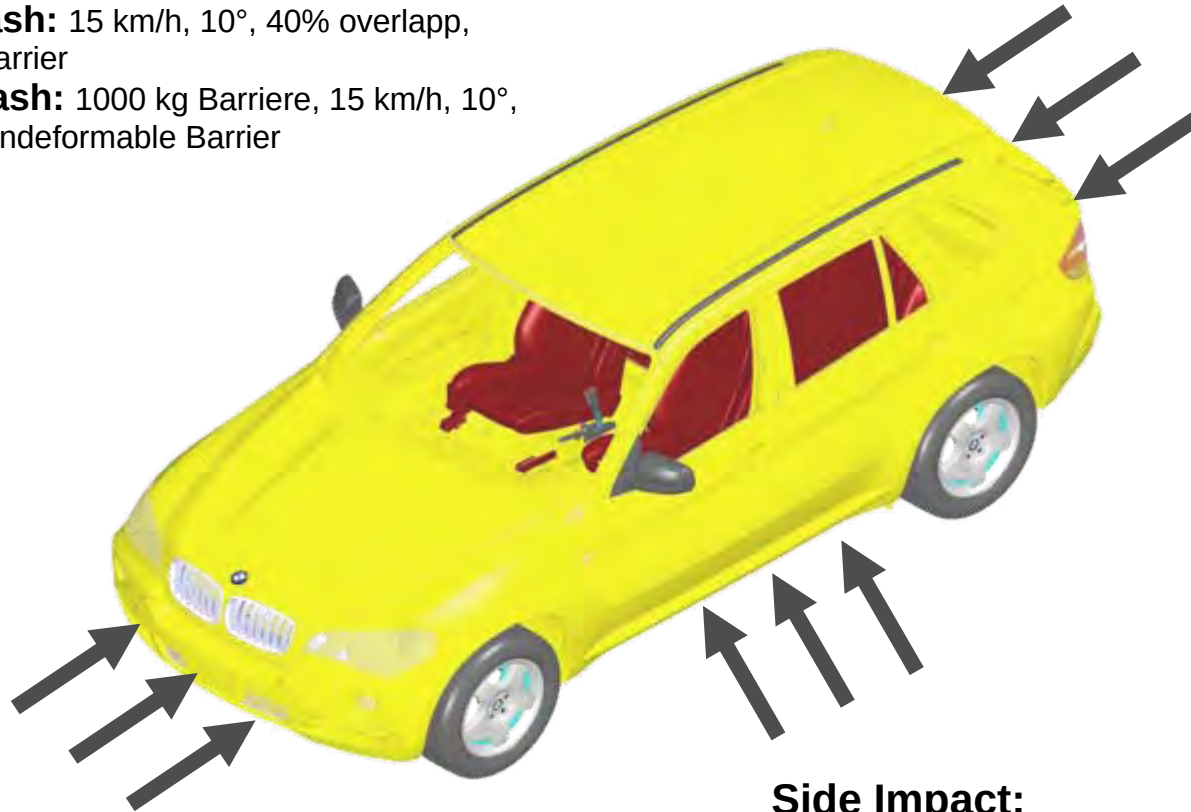
Passive Safety Most Important Crash Tests

Others:

- **AZT Frontcrash:** 15 km/h, 10°, 40% overlapp, undeformable Barrier
- **AZT Rear-Crash:** 1000 kg Barriere, 15 km/h, 10°, 40% overlapp, undeformable Barrier
- **Roll Over**

Rear Impact:

- **FMVSS 301:** 80 km/h, 70% overlapp, undeformable Barrier



Front Impact:

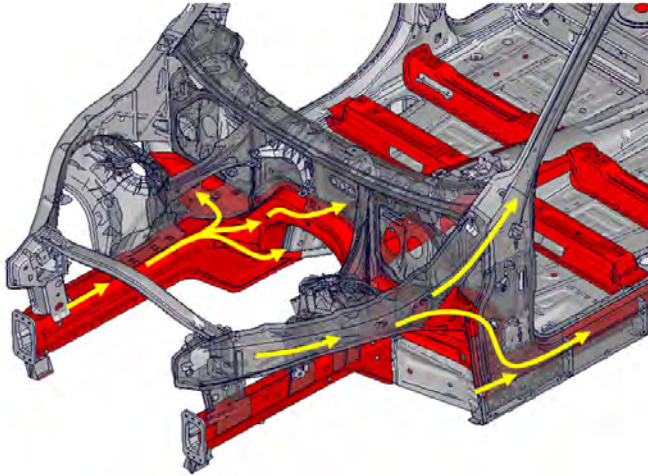
- **EU-NCAP:** 64 km/h, 40% overlap, deformable Barrier
- **US-NCAP 0°:** 35mph, 100% overlap, undeformable Barrier
- **US IIHS 40%:** 64 km/h, 40% overlap, special Barrier

Side Impact:

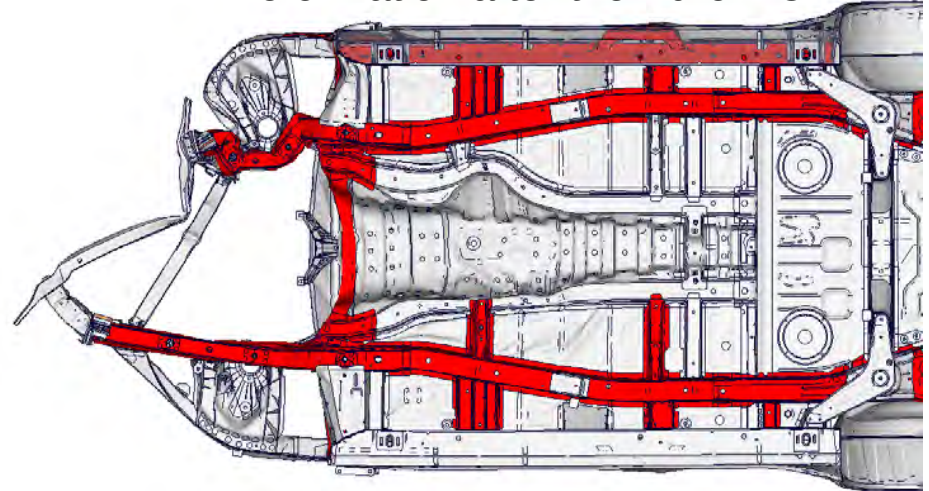
- **EU-NCAP Side:** 950 kg Barrier, 50 km/h
- **EU-NCAP Side Pole:** 29km/h to Pole
- **US IIHS Side:** 1500 kg Barrier, 50 km/h

Passive Safety Loadpath for Front Crash

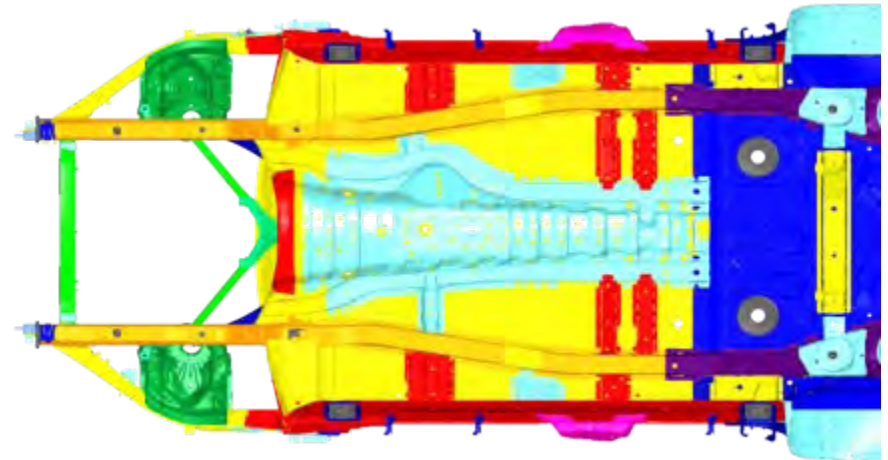
Distribution of induced Forces



Deformation after the Euro-NCAP

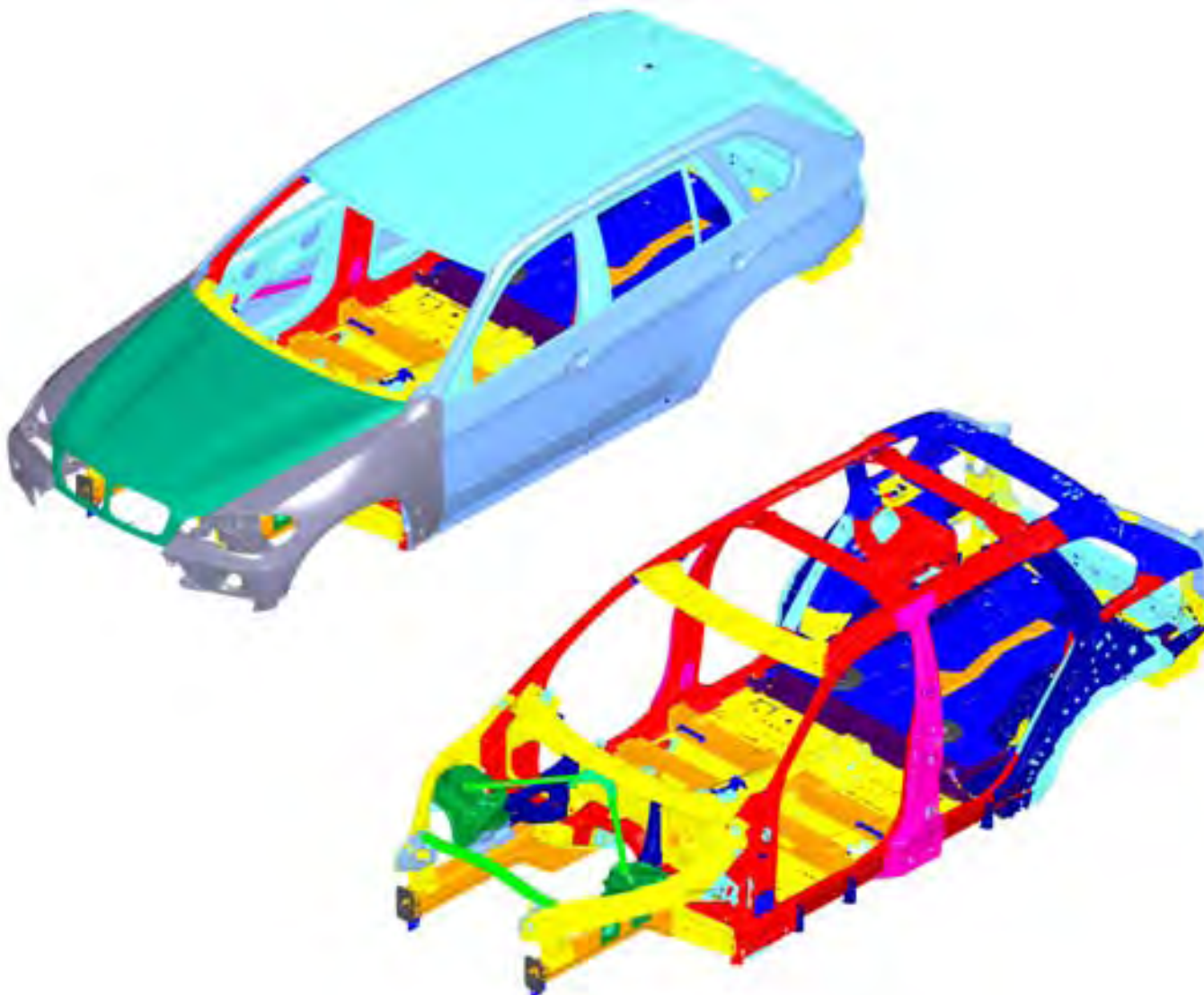


Minimum Yield Strength





Body in White Materials Overview of Materials



Steel Grades (min. yield Strength)

- CR4 (DDQ) HD, CR4 (DDQ) HDG, CR4 (DDQ) HSDG, CR5 (EDDQ) HD
- CR 180B HD, CR 180B HDG, CR 180A HD, CR 180AT HD
- CR 210B HD, CR 210B HDG, CR 210AT HD
- CR 250B HD, CR 250B HDG, CR 250 A HD, CR 250 AT HD
- CR 280B HD, CR 280B HDG
- CR 380X (HSLA) HD
- CR 420X (HSLA) HD, CR 420X (HSLA) HDG
- CR 950DL (Dual Phase), HD 680C
- 22MnB5

Aluminum

- AlMg3
- AlMg4,5Mn0,4
- AlSi9Cu3(Fe)
- AlMgSi
- AlMg0,4Si1,2
- AlSi10MgMn

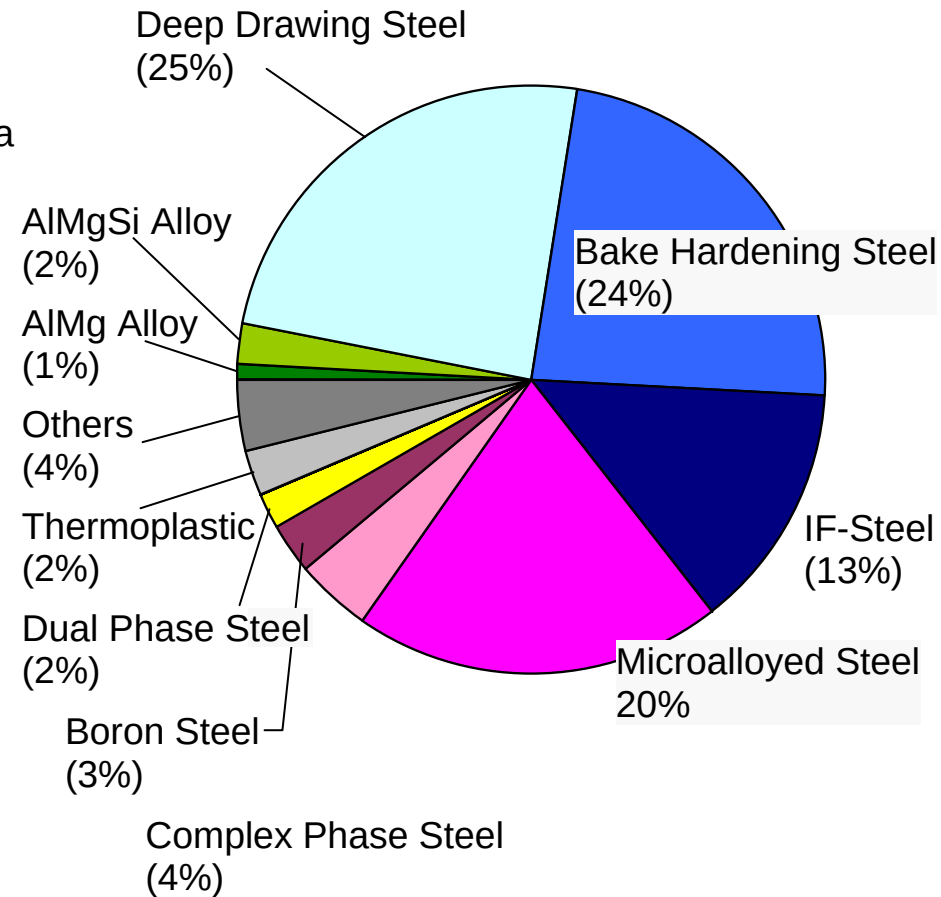
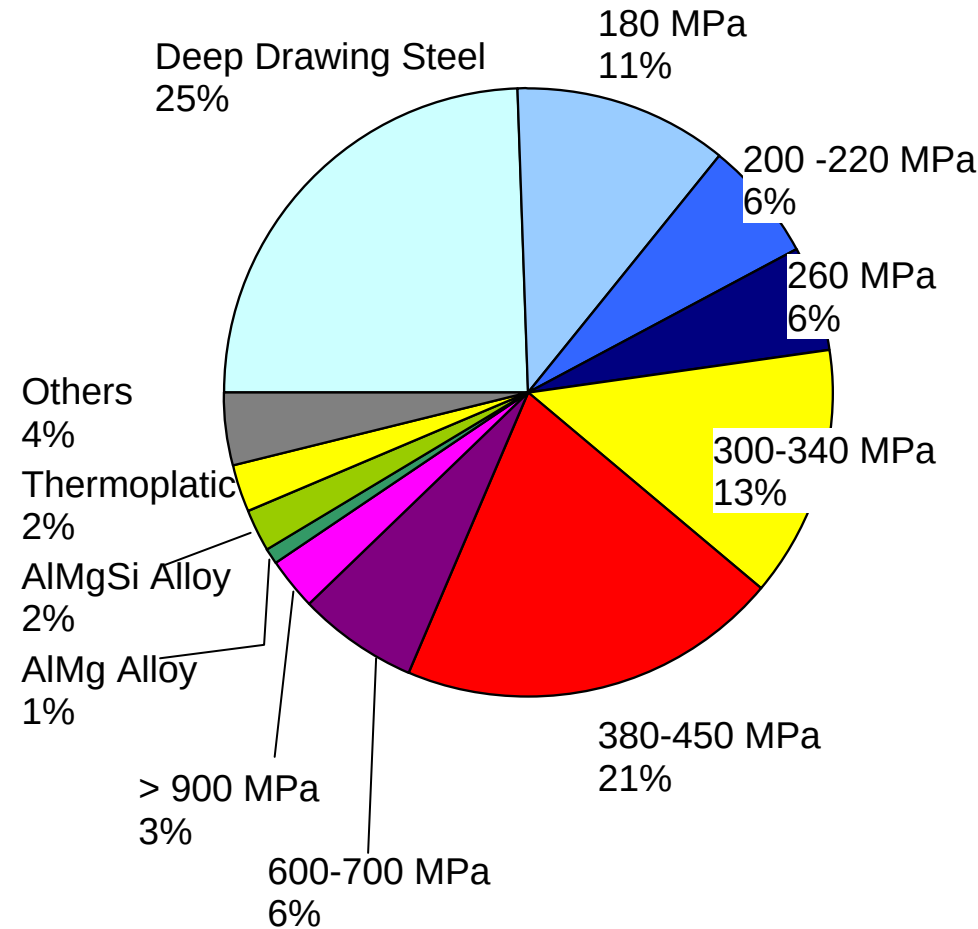
Plastics

- Thermoplastic Resin

Body in White Materials Percentage of Steel Grade

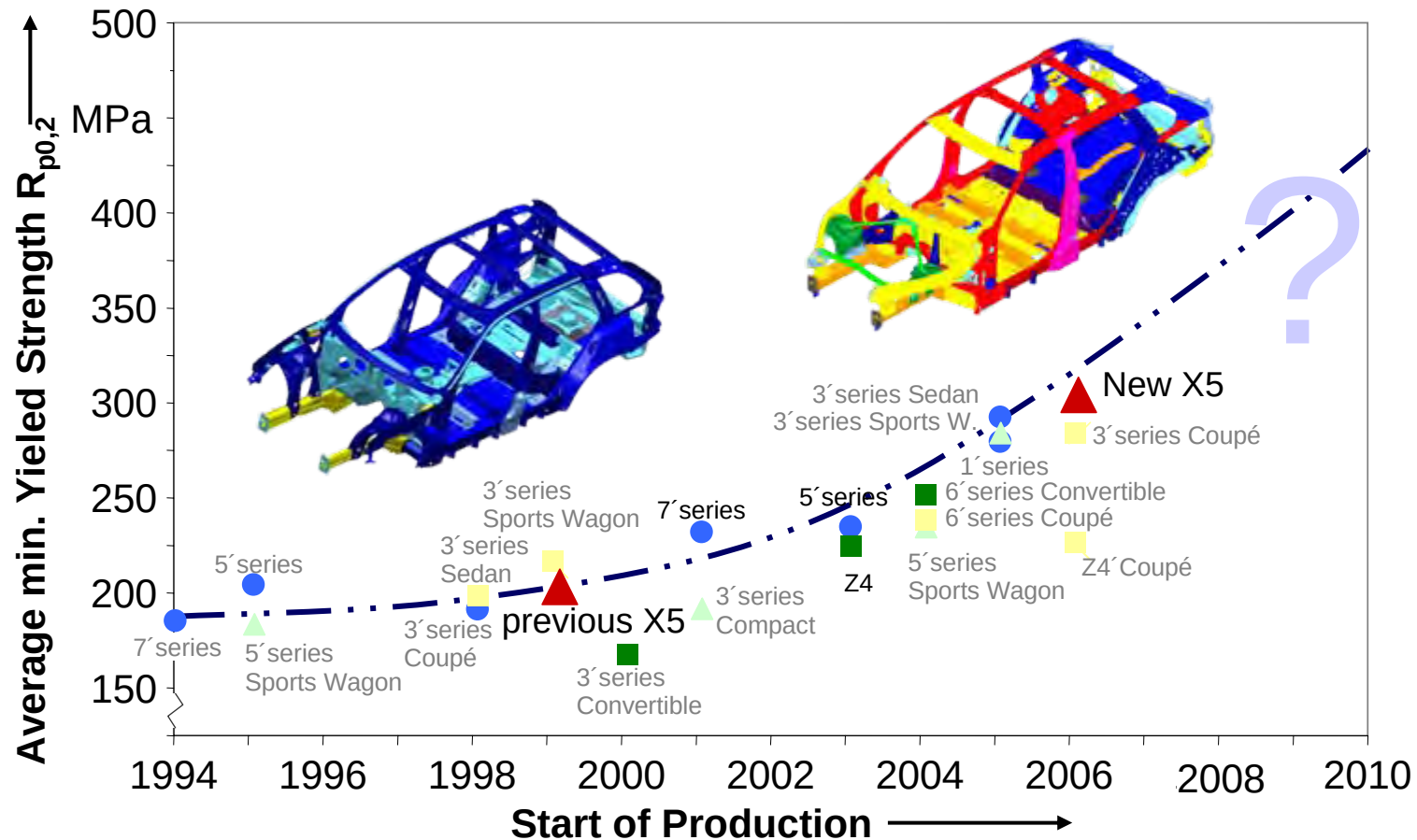
Minimum Yield Strength

Steel Grade



Body in White Materials

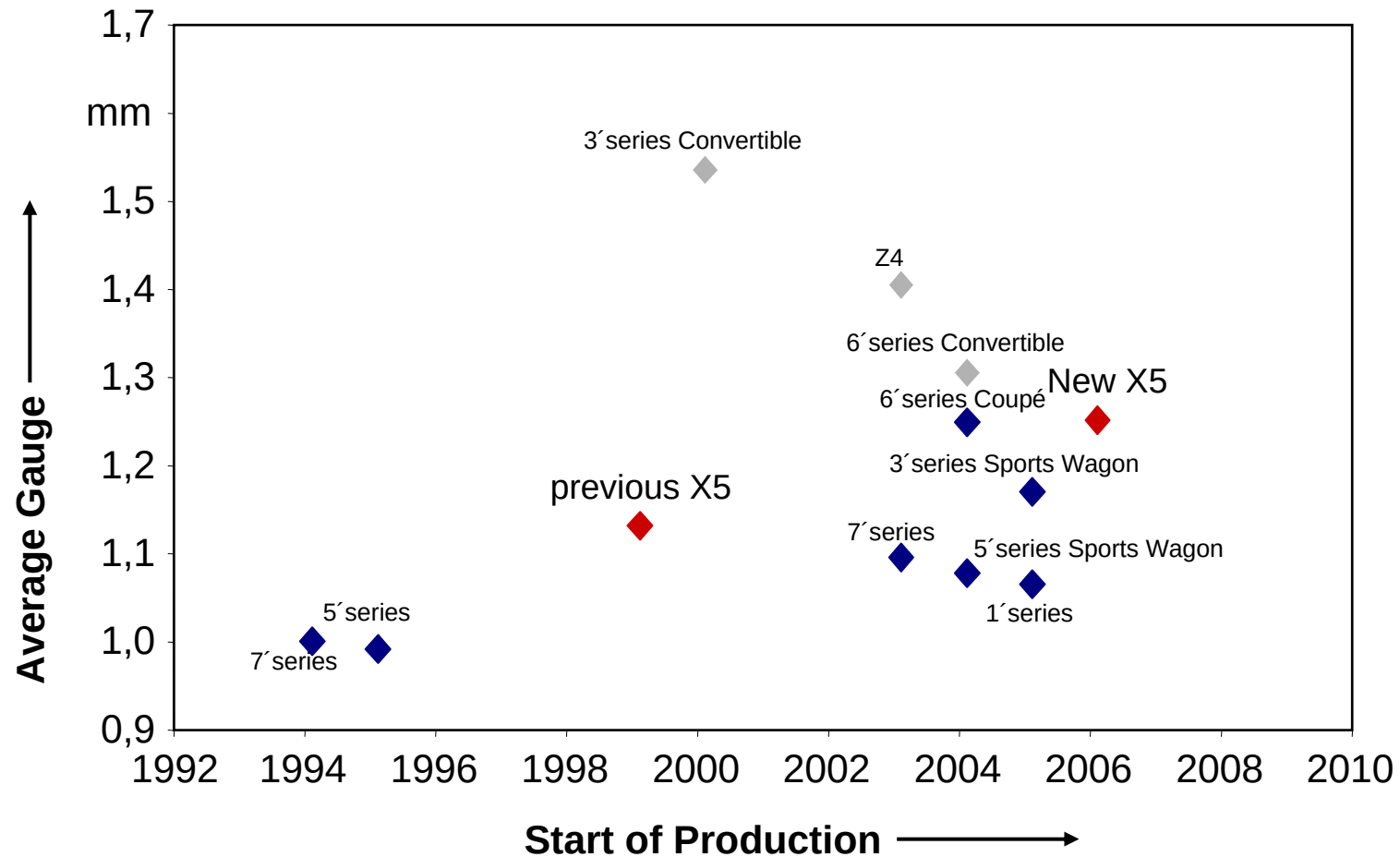
Average minimum Yielded Strength



$$\bar{R}_{p0,2} = \frac{\sum_{i=1}^n R_{p0,2,i} \cdot m_i}{\sum_{i=1}^n m_i}$$

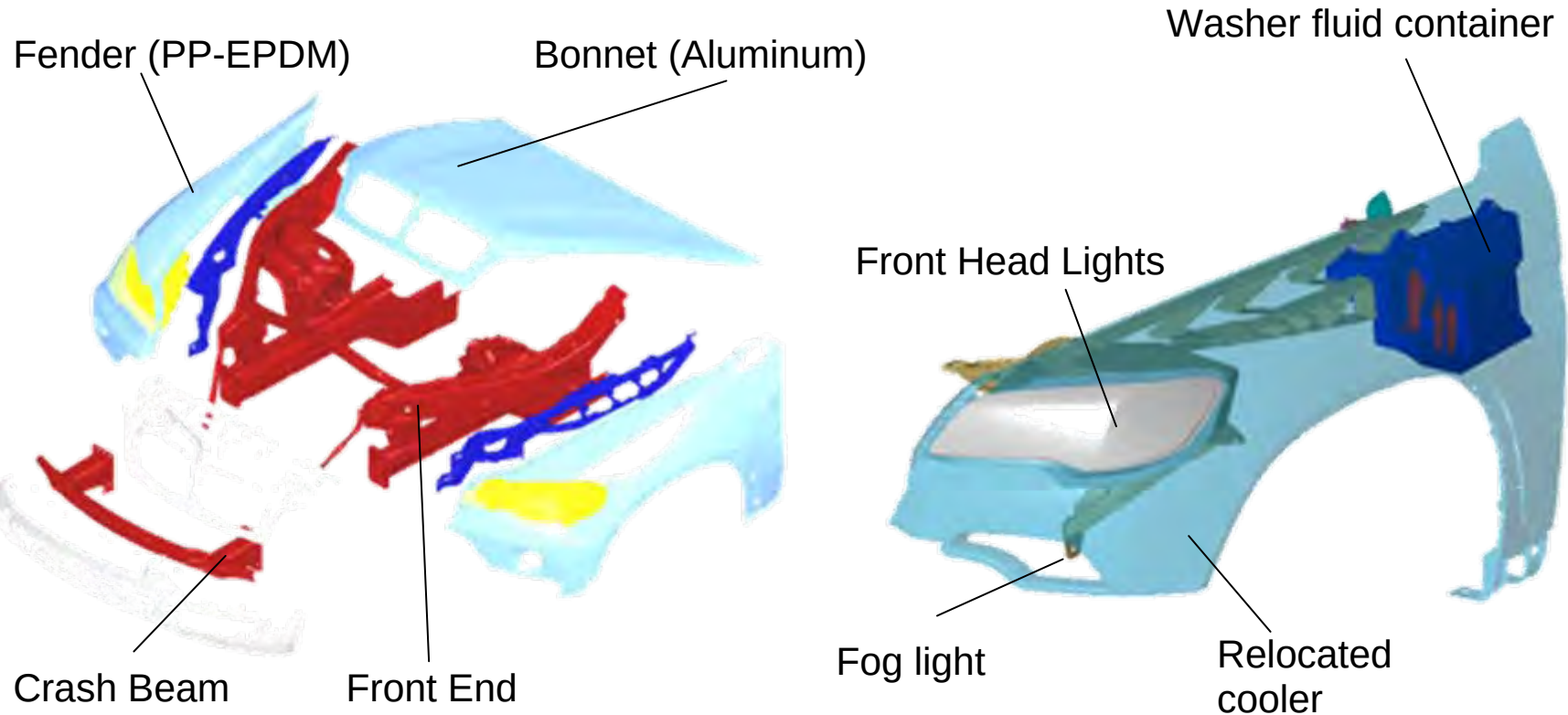
n number of parts
m weight of the part
 $R_{p0,2}$ min. yield strength

Body in White Materials Average Gauge



Components Max. Styling Freedom in Front End

Pedestrian Safety

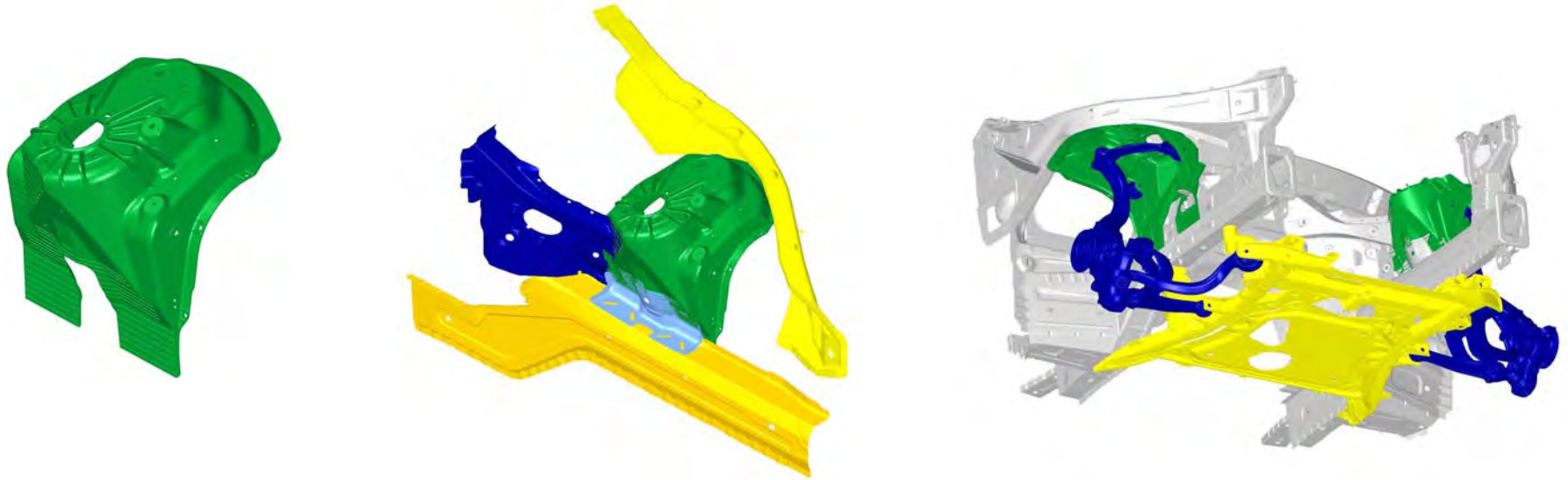


Passive Safety / Stiffness

Benefits:

- Flexible Design
- Less Gaps / reduced Gap Dimensions
- Weight Saving
- Pedestrian Safety (ACEA, Japan, Europe)

Components Cast Aluminum Front Strut Tower



Mechanical Values:

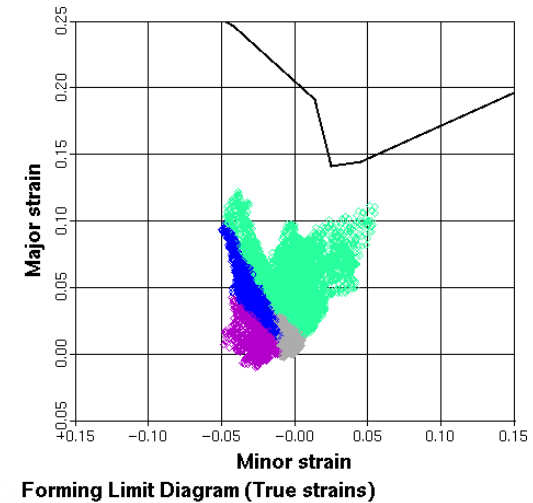
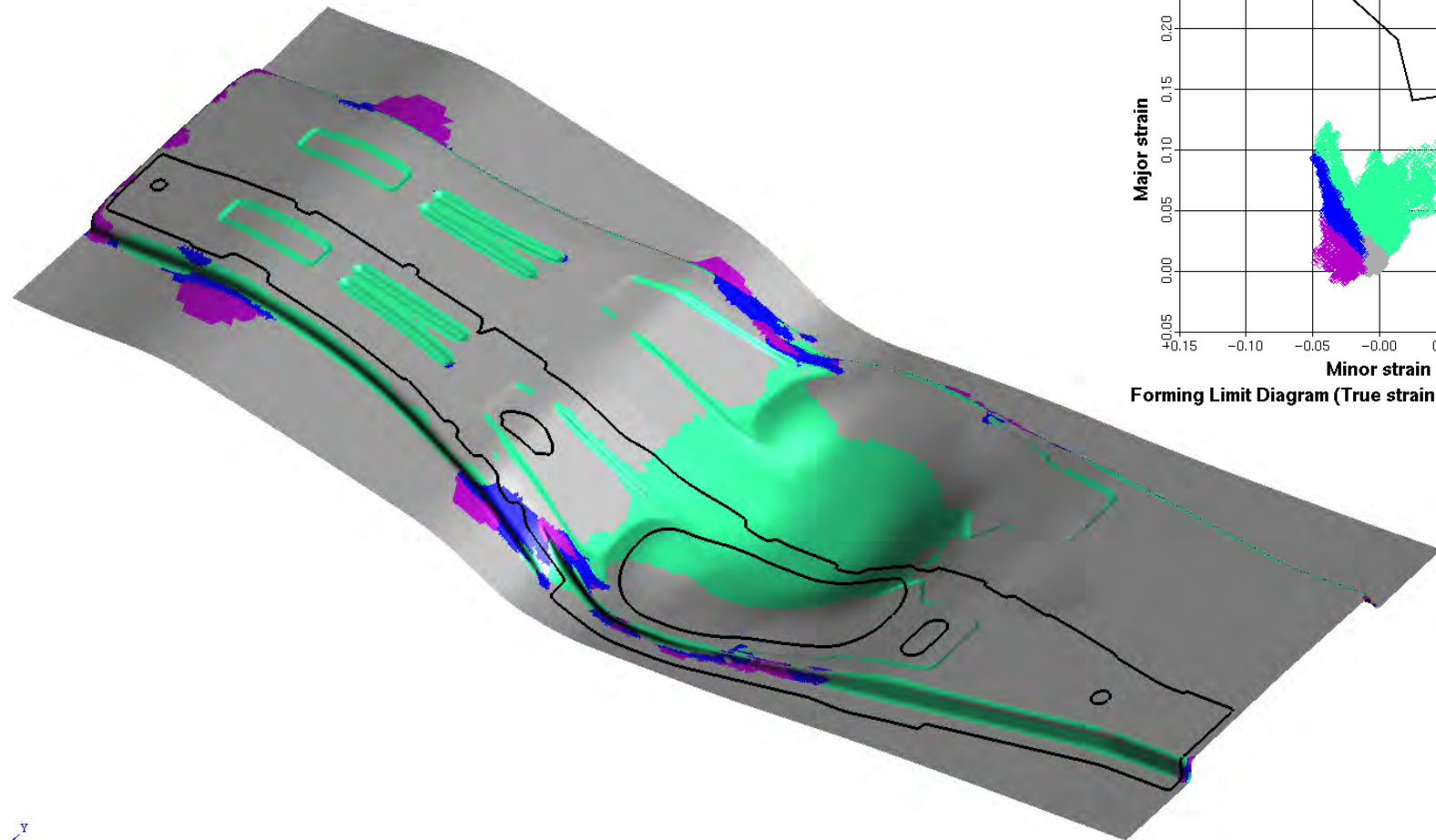
Yield Strength $R_{p0,2}$: 120 - 140 MPa

Tensile Strength R_m : 200 - 240 MPa

Benefits:

- Weight Saving (-50% compared to Steel Sheet)
- Optimized Package
- Increased Stiffness

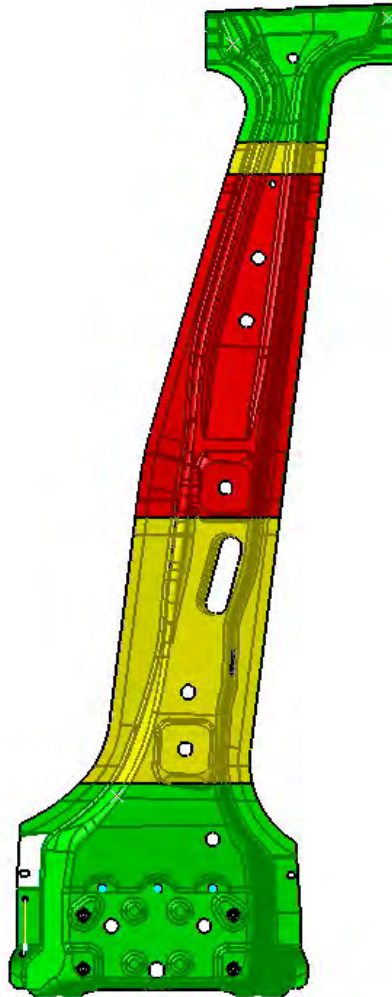
Components Simulation of the Forming Process



Formability



Components The B-Pillar Reinforcement



Thickness s

$s = 1.2$

$s = 1.6$

$s = 2.2$

$s = 1.4$

$s = 1.2$

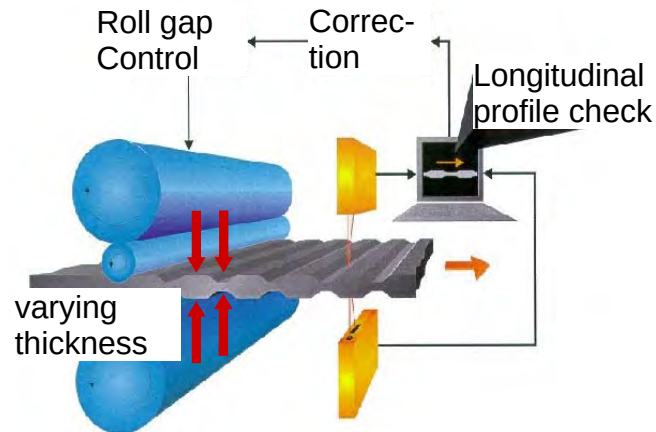


Weight Saving: 2 kg/Side
(compared to a hot stamped Part
with a constant Thickness)

Mechanical Values:

Yield Strength $R_{p0,2}$: > 950 MPa

Tensile Strength R_m : > 1300 MPa



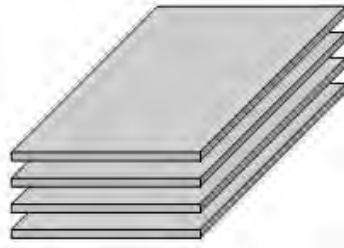
Source: Mubea

1. Manufacturing of tailored rolled blanks

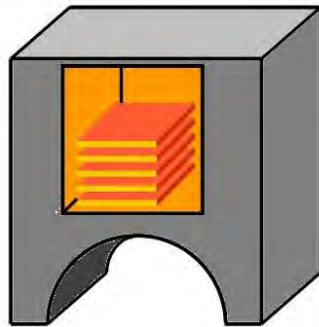
Advantages of a tailored *rolled* Blank
Compared to a tailored *welded* Blank

- With many different thicknesses: Cost Benefit
- Now weekening of strength level by a weld seem
- Notch free transition at varying thickness

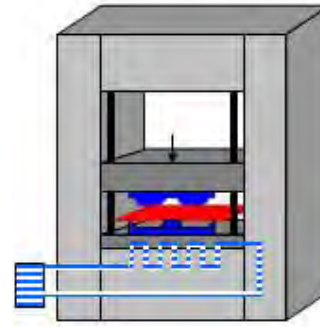
2. Direct Hot Stamping



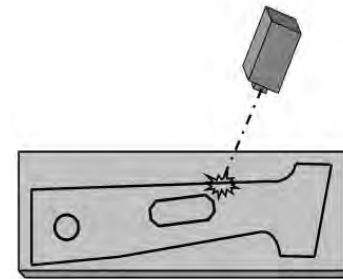
Tailored
rolled Sheet
22MnB5



Heating
> 900°C



Hot Stamping +
rapid Cooling



trimming
• By Laser
• By Tool



Scale
removal

Driving Performance

Racetrack Nuerburgring Nordschleife



Length of the Racetrack
Nuerburgring Nordschleife:
20,8 km

	Power to weight ratio [kg/HP]	time taken [s]
Previous X5	9,3	9,07
New X5	9,9	8,54



- Higher functional Requirements in the new BMW X5 are met by a consequent Implementation of innovative Light-Weight Design
- Process-suitable Design of structural Components allow for the use of Multi Phase Steels, hot formed Materials and Aluminum Castings
- Due to new Design of Carrier Structure Torsional Stiffness raised from 23500 Nm/° to 27000 Nm/°