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AffordabLe LIghtweight Automobiles AlliaNCE

Future of Automotive Lightweighting Day

September 19, 2019

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Impact on Lightweighting

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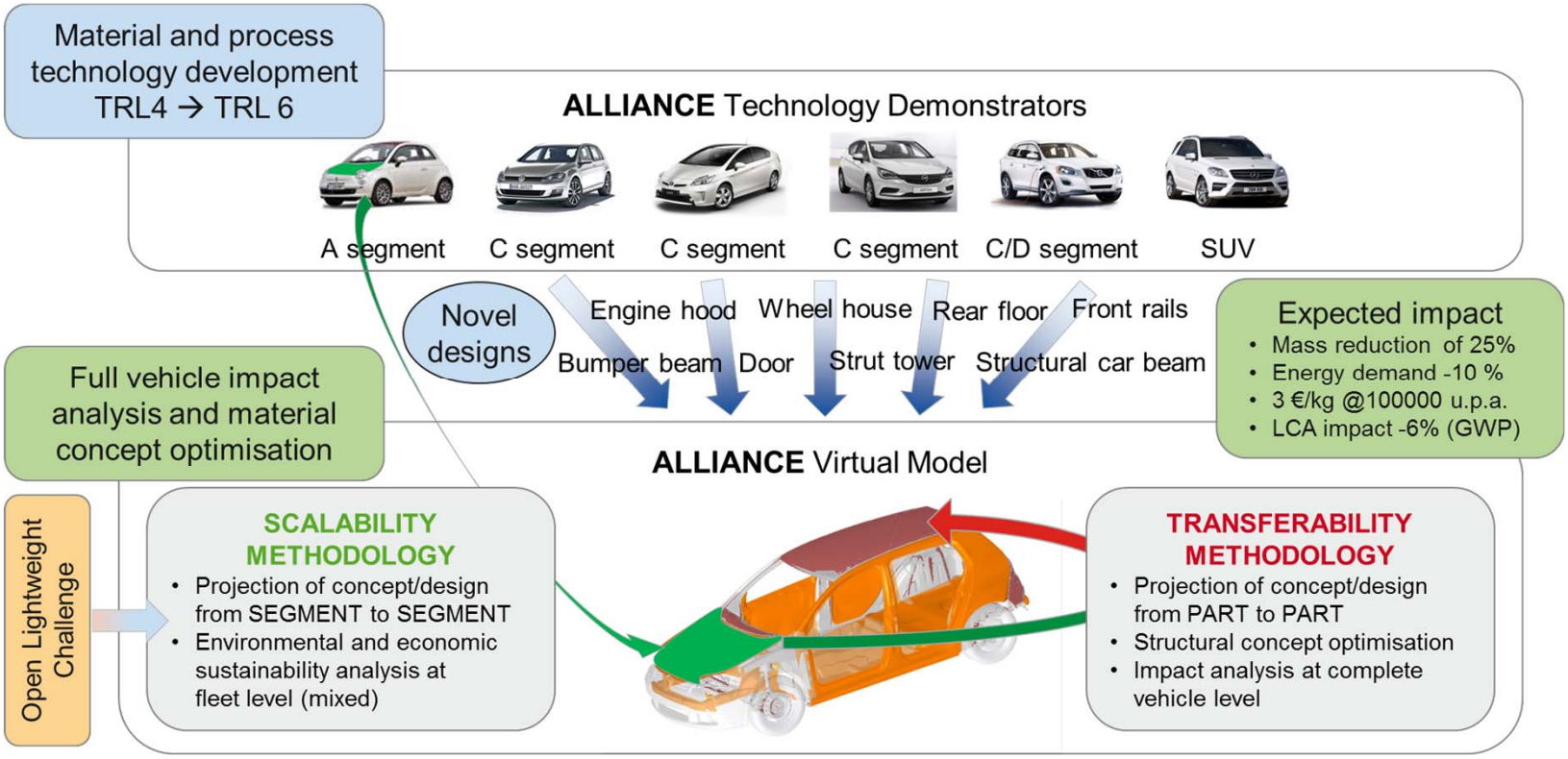
Motivation



Proof of technical feasibility on full vehicle level (virtually), while considering the impact targets

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Approach

WP2 / WP3

Technology upscaling TRL → TRL6

WP4 / WP5

Technology application in demonstrators

WP1

Analysis of potential application fields on full vehicle level ✓

Impact pre-assessment with full vehicle assessment model ✓

Technical layout of lightweight vehicle ✓

Validation of vehicle performance (crash load cases)

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Approach

Analysis of potential application fields on full vehicle level

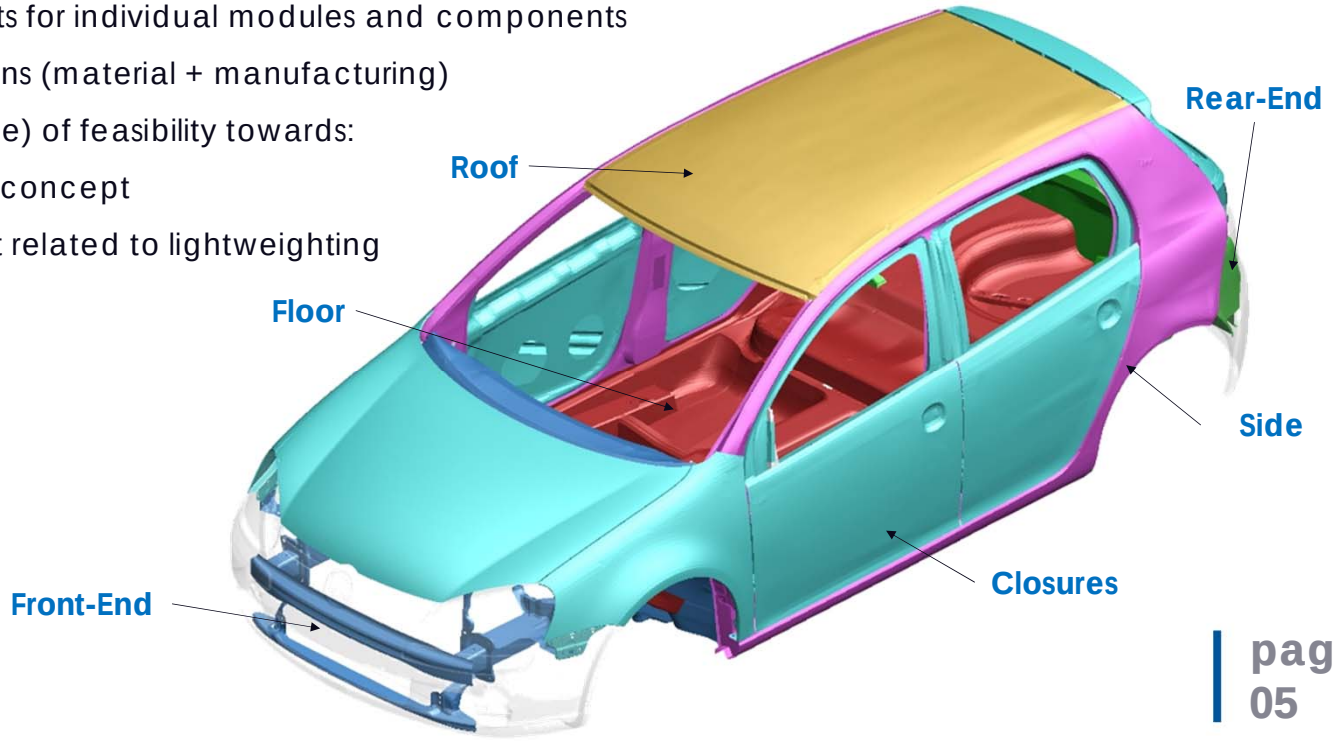
- Breakdown of full vehicle into different modules
- Analysis of technical requirements for individual modules and components
- Analysis of potential design options (material + manufacturing)
- Assessment (engineering expertise) of feasibility towards:

→ Integration into overall structural concept

→ Ratio between benefit and effort related to lightweighting

→ Impact on cost

→ Effect on environmental impact



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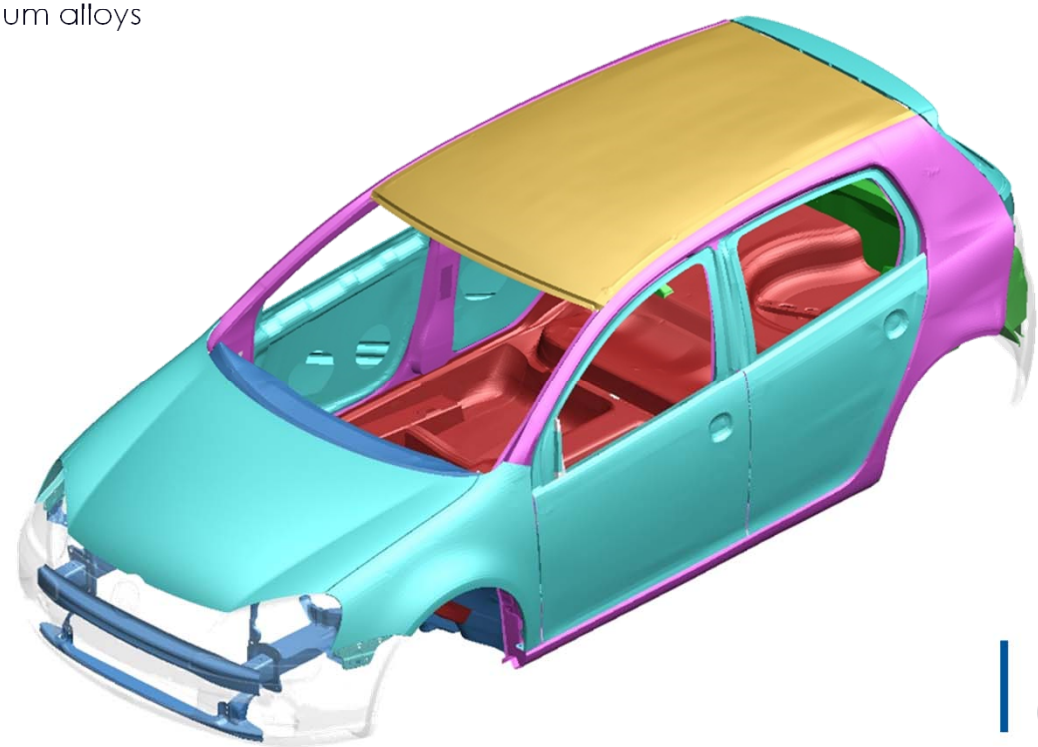
Approach

Selection process for lightweighting technologies

- **Material technologies** considered are:
  - Advanced high strength steel and aluminum alloys
  - Fibre-reinforced plastics (FRP)
  - Metal-FRP hybrids
- **Manufacturing technologies** considered:
  - Advanced metal forming
  - Tailored Extruded Blanks (TEB)
  - Hybrid technologies
  - Injection Moulding Compound (IMC)



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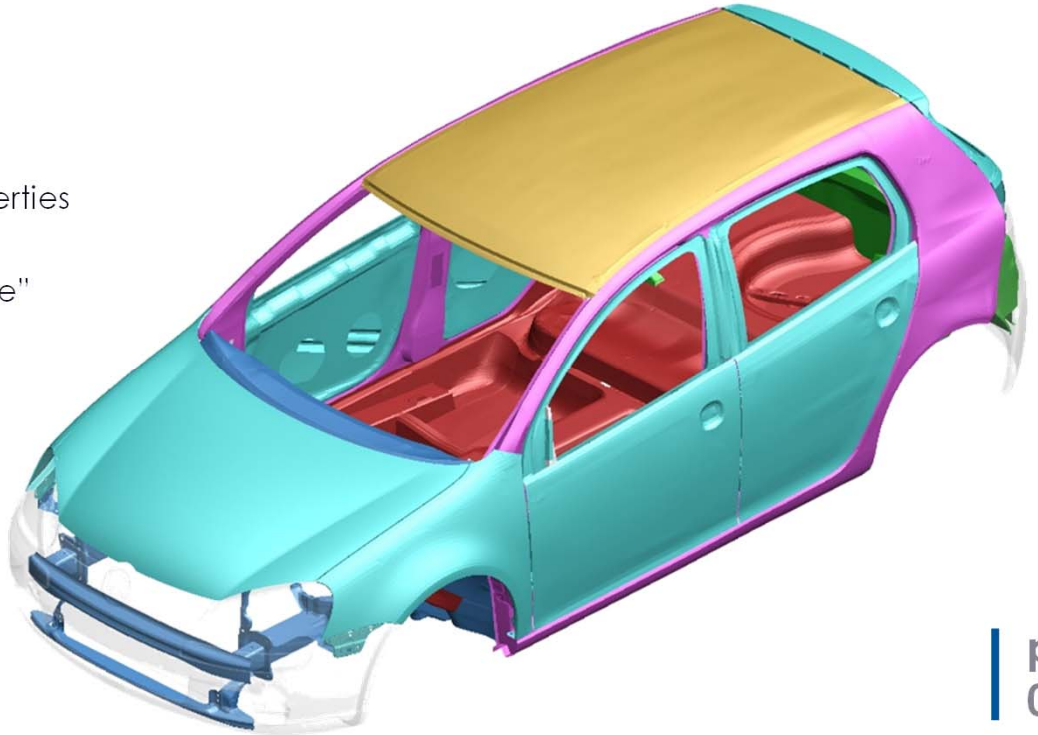
Concept Design – General

Consequent realization of lightweight design principles

- **Reduction of number of components and manufacturing efforts by**
  - Functional integration
  - One-piece solutions
  - Reduced joining efforts
- **Selection of material with respect to**
  - Exploitation of material benefits and properties
  - Fulfillment of component requirements
  - Application of “right material at right place”



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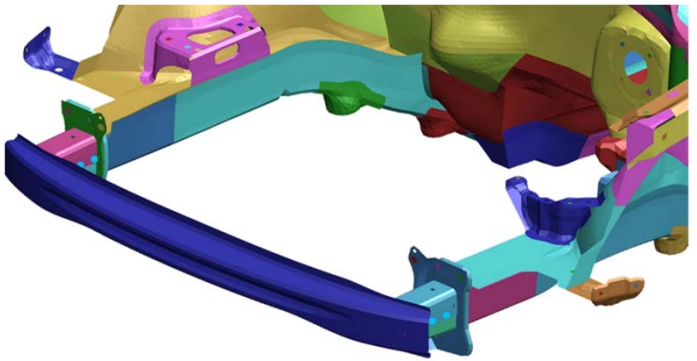
Concept Design – Front End

Bumper System

- Reengineered by CRF
- TEB 7003 aluminum crossmember and crash boxes
- Deep-drawn 7003 aluminum flange plates
- 29% weight reduction

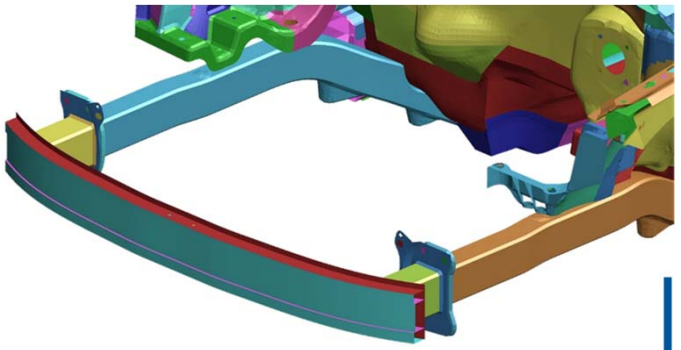
Old Concept



Front Longmember

- Detailed analysis of lightweight design options based on the Opel Demonstrator
- Application of hydroformed longmembers
- Single part concept
- Tribond 1200

New Concept



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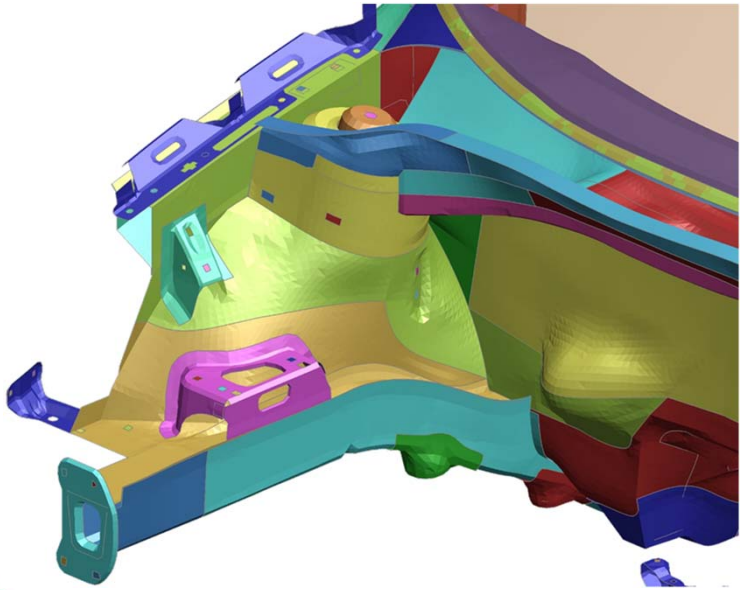
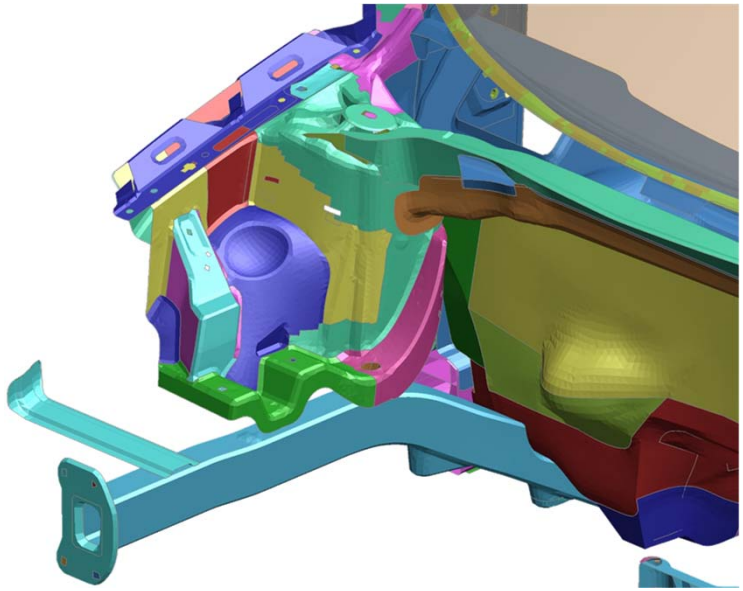
Concept Design – Front End

Front Wheelhouse

- Redesigned strut tower, shotgun and wheelhouse
- Technology change from deep-drawn steel sheets to aluminum casting components



Old Concept



New Concept

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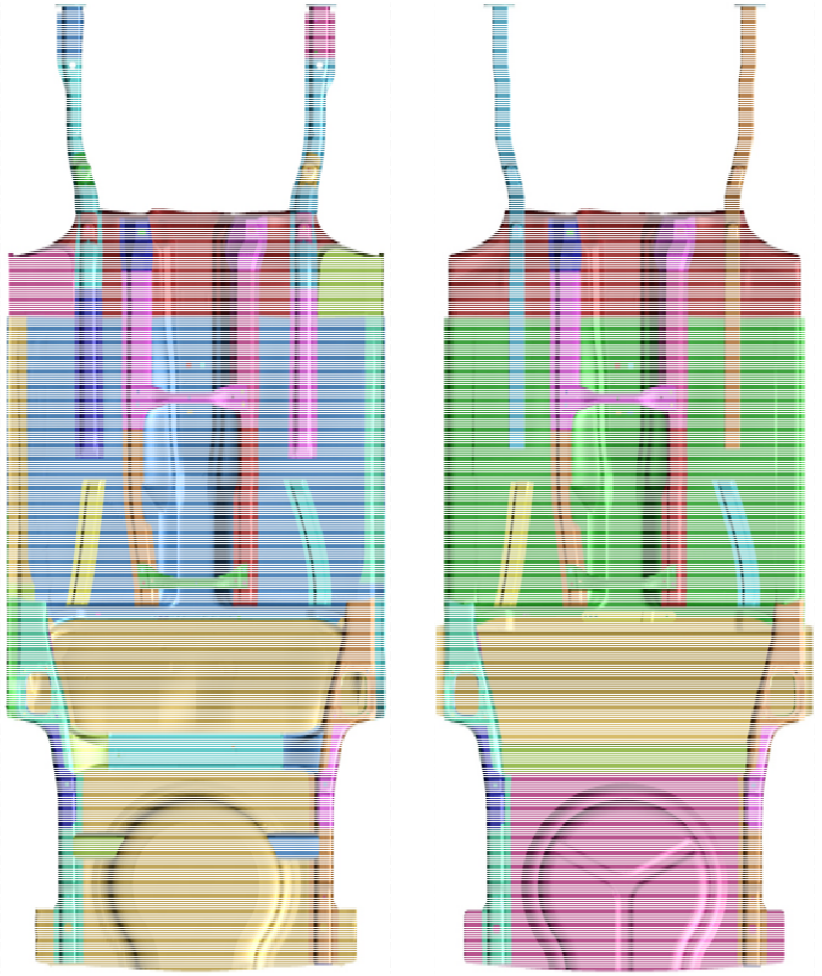
Concept Design – Floor Structure

Middle Floor Panel

- Reference: deep-drawn steel sheet (DPK 60/98+Z)
- Metal-FRP-hybrid concept
- Steel floor panel with FRP reinforcements in the tunnel area

Rear Floor Panel

- Reference: deep-drawn steel sheet (MHZ420)
- Toyota GFRP concept as an IMC with water injection technology
- Integration of rear seat bench

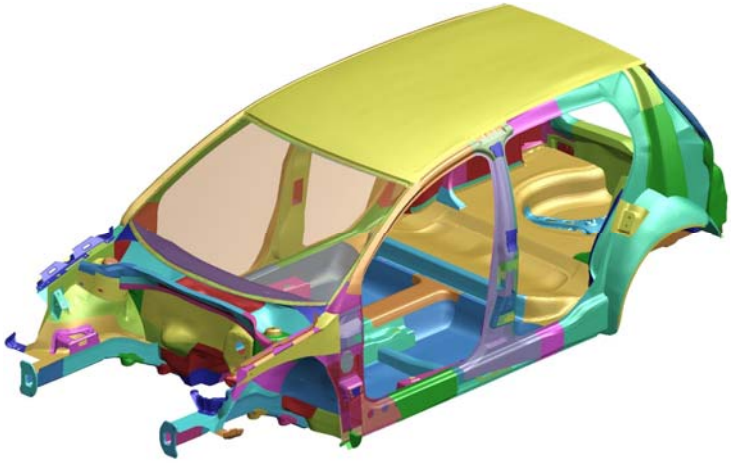


Old Concept | New Concept

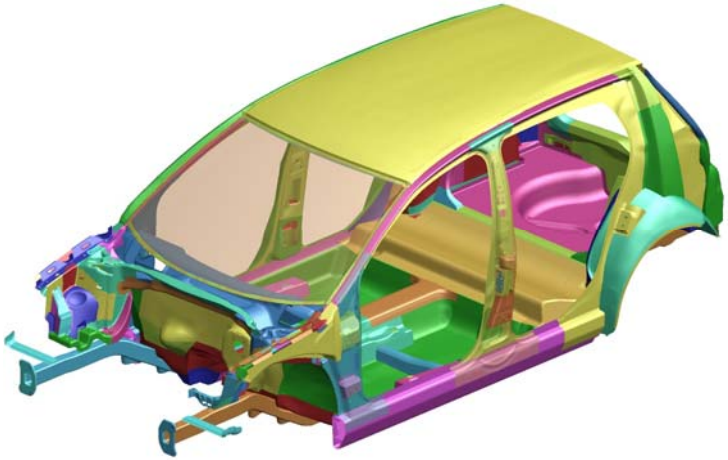
Concept Design – Side Structure

Side Panel and Pillars

- **Side panel:** no change in geometry, material substitution towards a higher strength steel grade (DPK 6098)
- **Pillars:** modified geometry, reduction of number of components, higher strength steel alloys, reduction of wall thicknesses



Old Concept

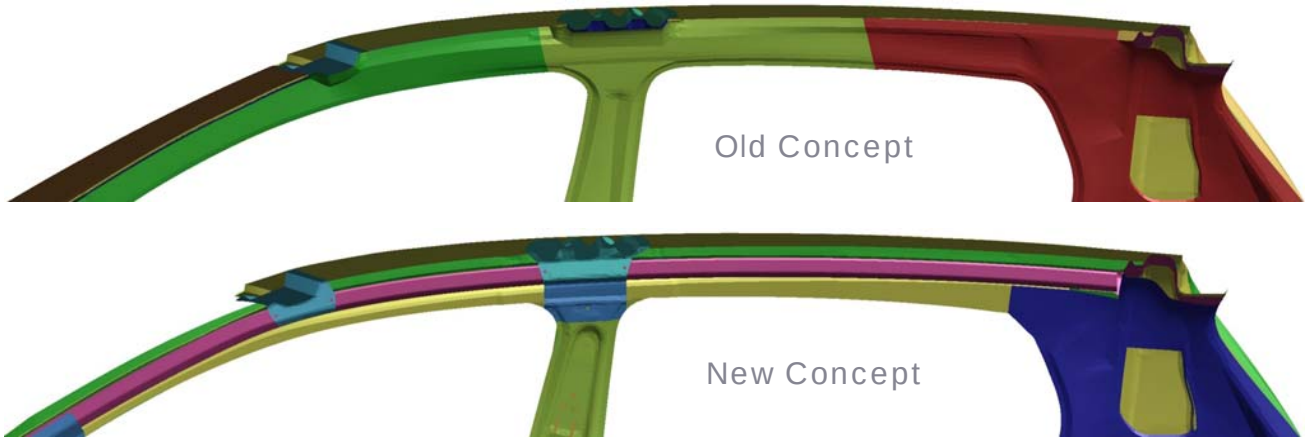


New Concept

Concept Design – Roof Structure

Roof Structure

- Comparably high weight saving potential due to the use of mild steels in the reference vehicle
- Complete redesign of roof rail and flanges
- Technology change from deep-drawn steels to aluminum extruded profiles



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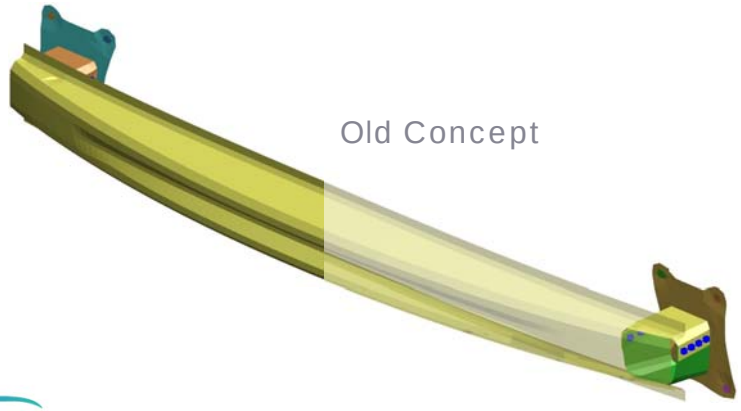
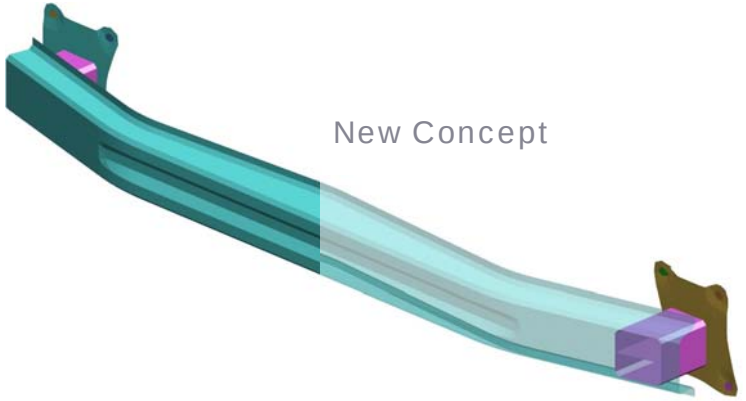
Concept Design – Rear-End

Rear Bumper System

- Similar solution to the front bumper system
- New crossmember without an additional closing plate
- Crashboxes as two-chambered profiles
- Technology change from deep-drawn steels to aluminum extruded profiles



Old Concept



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Initial results

- **Weight analysis of vehicle**
  - Weight reductions in the domains apart from body and chassis have been implemented on the basis of estimations
  - The chassis weight reduction has been achieved using lightweight wheels and reducing wall thicknesses
  - The weight savings in the body domain have been implemented as described on the preceding slides

Domain	Reference Weight	Target Weight	Current Weight
Chassis	227 kg	178 kg	178 kg
Body	389 kg	307 kg	282 kg
Total	1257 kg	1085 kg	1060 kg

- **Load cases considered for the full vehicle evaluation (ongoing) are:**
  - Euro-NCAP: Frontal Impact (Full Width, ODB), Side Impact (Pole, MDB)
  - FMVSS: 301 (Rear MDB), 216a (Roof Crush)
- **The final A to B comparison between reference and light weighting concept (intrusion, deformation behavior, accelerations) is still in the works and will follow in the corresponding deliverable**

Impact on lightweighting - Conclusion

- The presented demonstrators have shown that depending on the specific use case, the developed light weighting technologies can enable significant weight reduction potentials
- The reduction potentials have been achieved based on existing series production vehicles
- A consequent transfer of the results to full vehicle level leads to a primary weight reduction of currently 9,4 %
- The primary reduction induces secondary weight reduction potentials of 6,2 %
- In total the ICEV variant has been able to be reduced by 15,6 %
- The reduction potential leads to a reduction of energy demand by10 %, which directly impacts the environment and TCO positively

→ The technologies developed within ALLIANCE can significantly contribute to the reduction of the structural vehicle weight

→ The challenges are:
- Cost impact
- Cycle times for specific technologies
- Efforts to adapt existing processes
- Joining technologies

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Thank you very much for your attention.