



ThyssenKrupp

InCar – the Modular Automotive Solution Kit

Timo Faath

ThyssenKrupp Steel USA



Introduction



InCar[®]

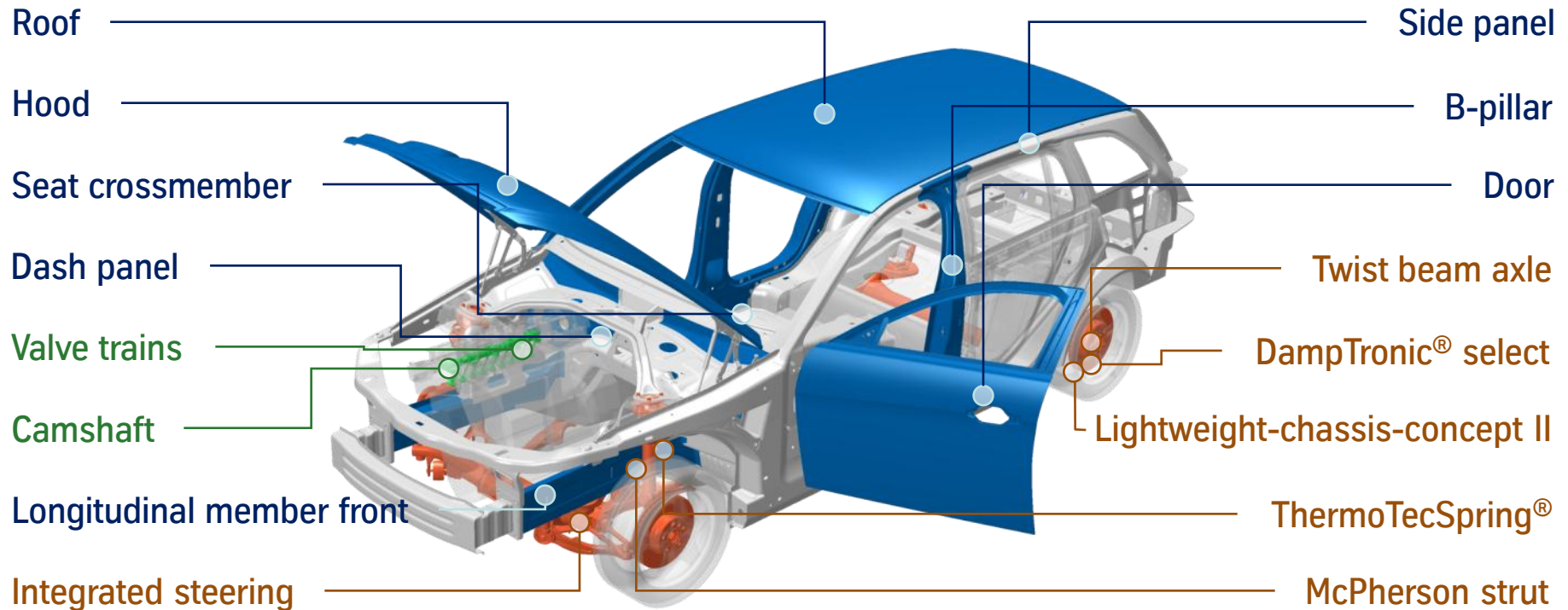


InCar - Modular Solution Kit for the Automotive Industry

- The InCar – solution kit includes over 30 innovative solutions for body-in-white, chassis and powertrain
- Focus on key-requirements for the automotive industry: weight, cost, function and emissions
- In-house development of a validated reference structure as the basis for comparing all solutions
- InCar solutions have a high level of product maturity



InCar - Offers over 30 Innovative Solutions



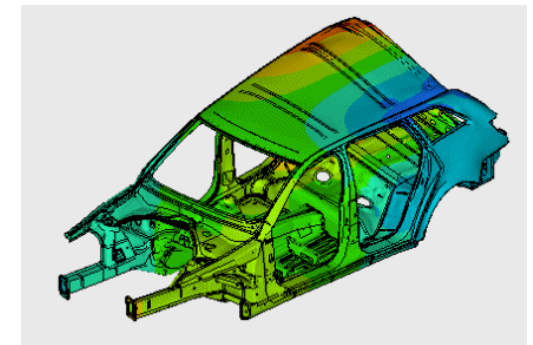
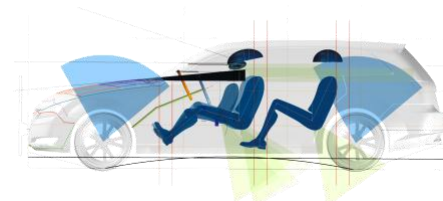
■ Solutions for body

■ Solutions for chassis

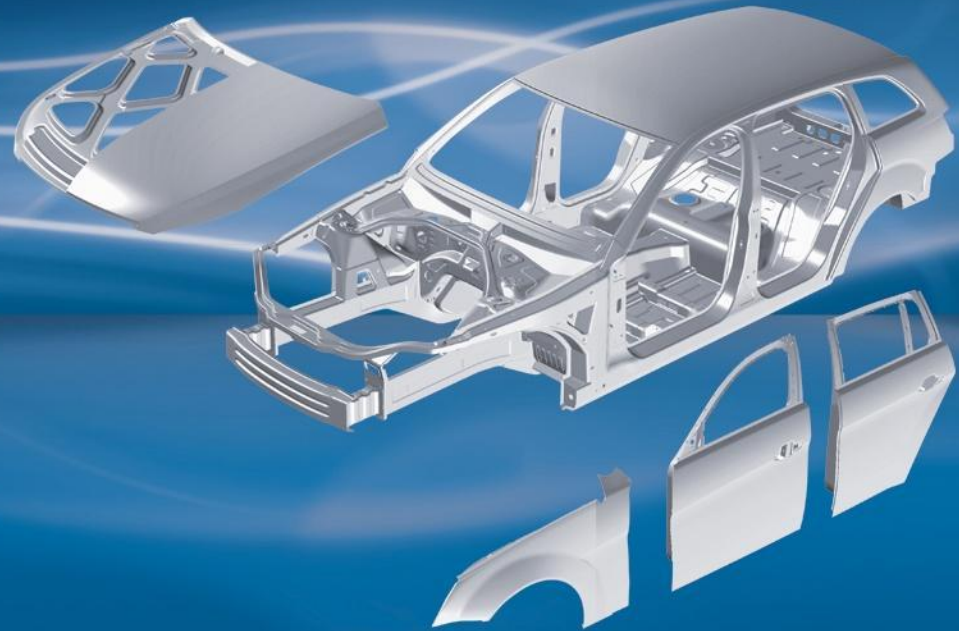
■ Solutions for powertrain

Reference – Independent Design and Intensive Validation

- Vehicle structure represents state-of-the-art
- Full-size station wagon
- Validated through extensive calculations and simulations
- Basis of solution kit and reference for functional, technical and cost evaluation of all innovations
- Customer-independent database will be used for future projects



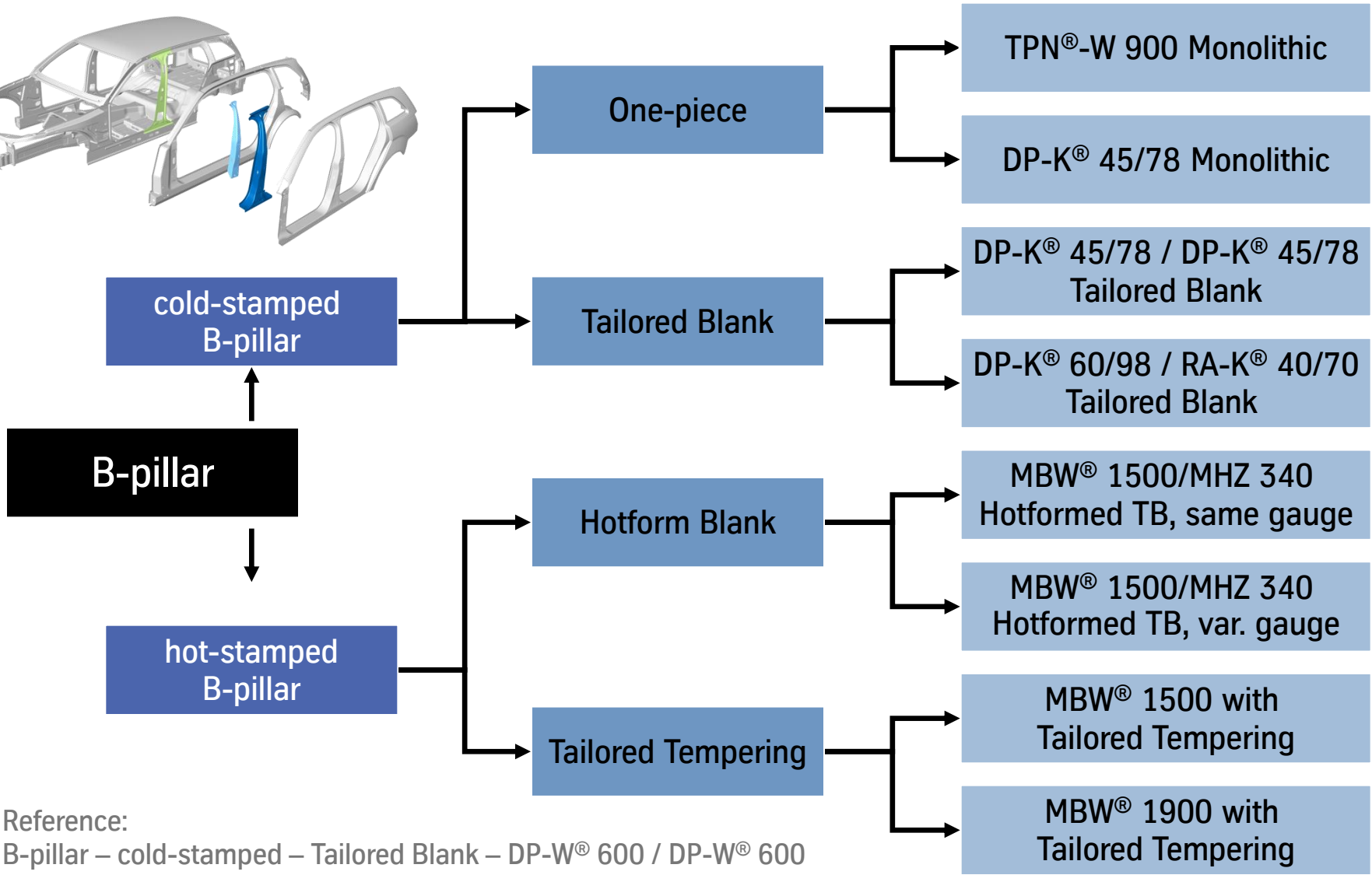
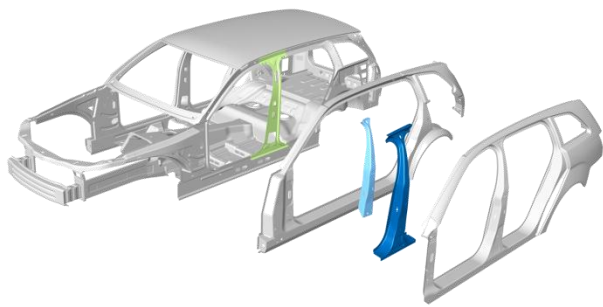
Highlights



InCar[®]



B-Pillar Solution Kit Overview



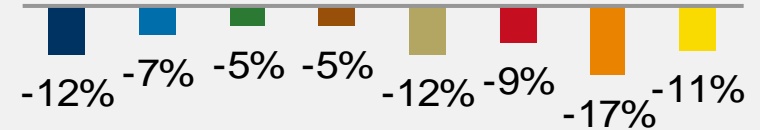
Reference:
 B-pillar – cold-stamped – Tailored Blank – DP-W® 600 / DP-W® 600



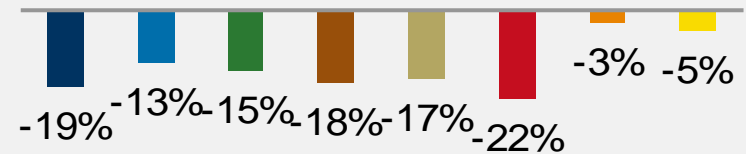
B-Pillar Solution Kit Overview

No.	Solutions
REF	DP-W [®] 600 Tailored Blank (TB)
_01	TPN [®] -W 900 Monolithic
_02	DP-K [®] 60/98 / RA-K [®] 40/70 TB
_03	MBW [®] 1500/MHZ 340 Hotformed TB Same Thickness
_04	MBW [®] 1500/MHZ 340 Hotformed TB Variable Thickness
_05	MBW [®] 1500 with Tailored Tempering
_06	MBW [®] 1900 with Tailored Tempering
_07	DP-K [®] 45/78 Monolithic
_08	DP-K [®] 45/78 / DP-K [®] 45/78 TB

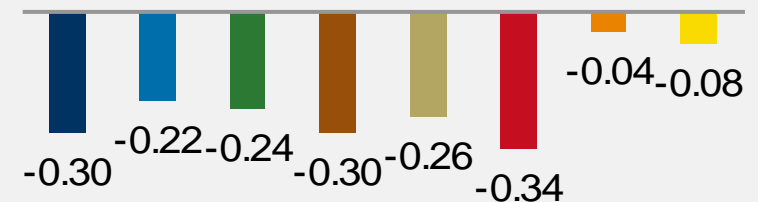
Costs



Weight



CO₂-emissions (g/km)



Reference: DP-W[®] 600 Tailored Blank

MBW 1500 / MHZ 340 Hot-formed Tailored Blank B-Pillar

Highlights

- Cost reduction of \$2.50
- Weight reduction of 2.80 kg

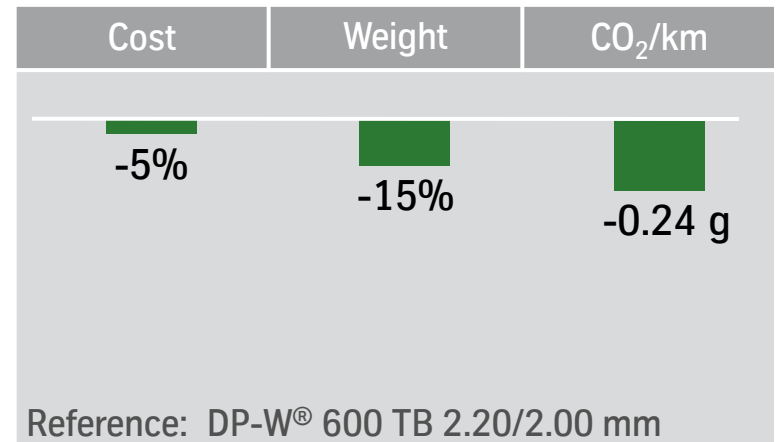
Customer Benefits

- Provides good elongation (> 15%) at foot of B-pillar
- Excellent dimensional accuracy
- High volume series production achieved

MBW® 1500 / MHZ 340



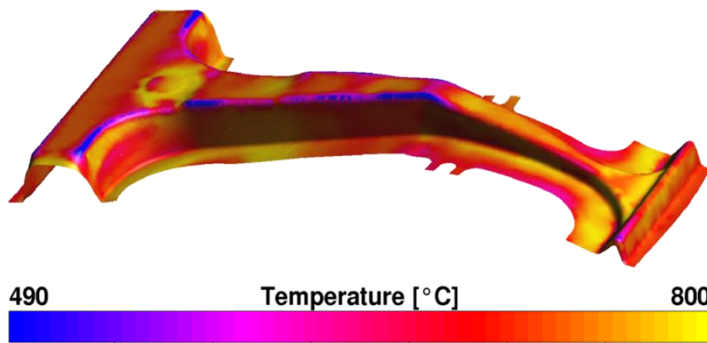
Sheet thickness:
1.80/1.80 mm



Hot-forming Simulation

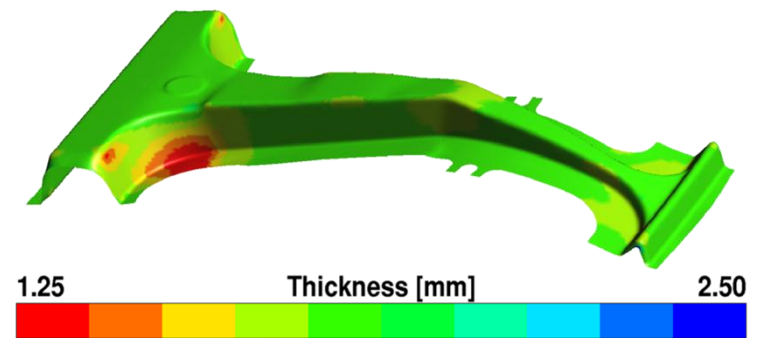
- The B-pillars were validated for production using AutoForm
- Input for simulation: Process parameters, heat transfer coefficients, flow properties, friction, phase transformation, forming limit curve

Temperature distribution:



min. temp approx. 400°C

Thickness distribution:



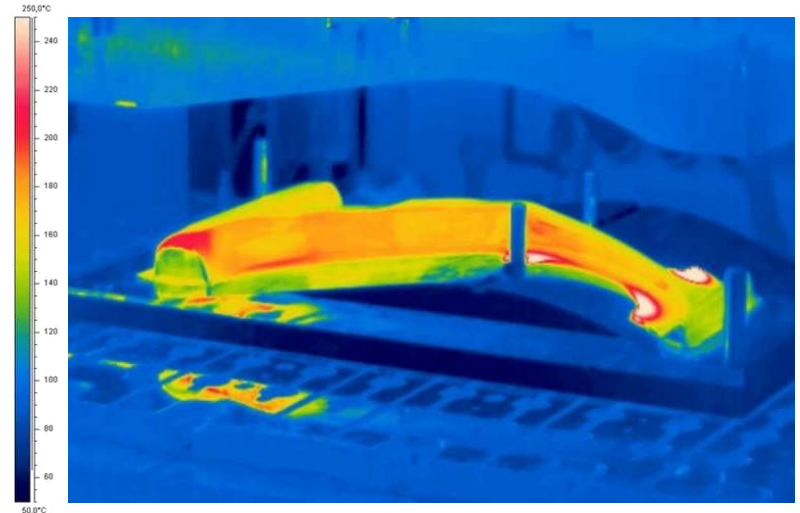
min. sheet thickness: 1.11 mm
initial sheet thickness: 1.80 mm

Material Properties and Prototyping

* Depending on process parameters

	Steel Grade	Min. yield strength [MPa]	Tensile strength [MPa]	Min. elongation [A ₈₀ %]
Before heat treatment	MHZ 340	340	410	21
	MBW 1500	310	480	10
After heat treatment*	MHZ 340	450	550	15
	MBW 1500	1,100	1,600	5

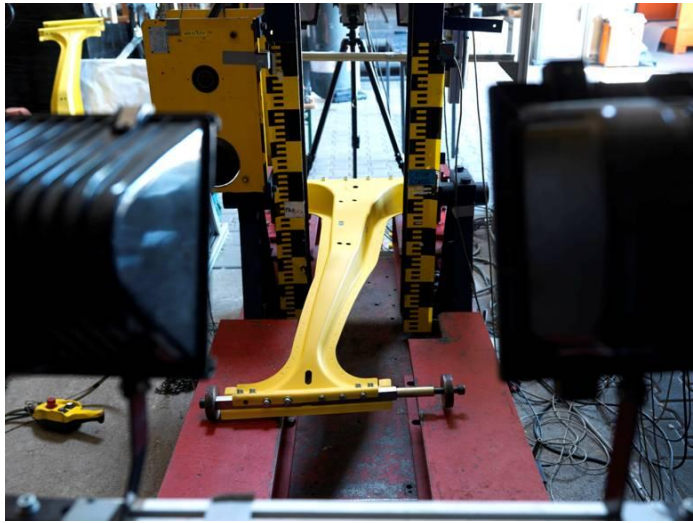
Die	Pre-production prototype die
Die entry temp	approx. 800 ° C
Transfer time	approx. 6 sec
Press holding time	20 sec
Test material	MBW 1500 +AS, MHZ 340 +AS
Thickness	2.00 mm (test only)
No. of parts	> 30 prototypes



Thermal image of part after forming process

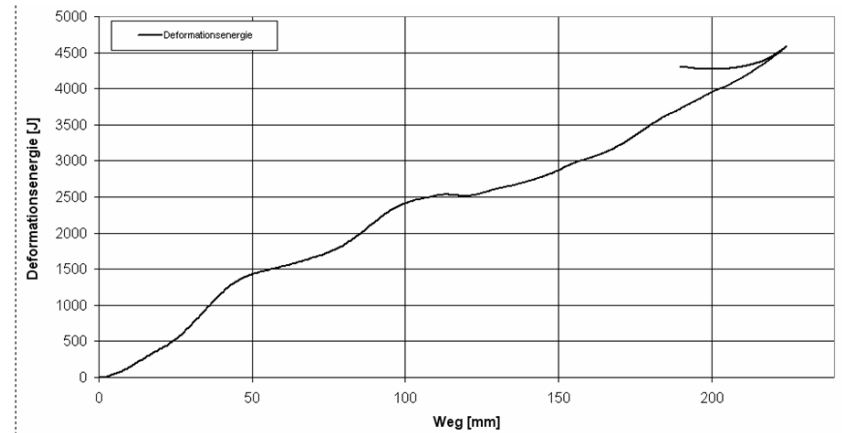


Crash Behavior of Laser Weld



Test setup

- Mass: 130 kg
- Impact velocity: 30 km/h (18.6 mph)
- Impactor positioned on laser weld
- No cracking in laser weld



Energy-distance diagram, MBW1500/MHZ 340



Advanced Door Hot-stamped

Highlight

- Weight reduction of 1.96 kg per door at no additional cost
- Highly integrative Mid Panel design

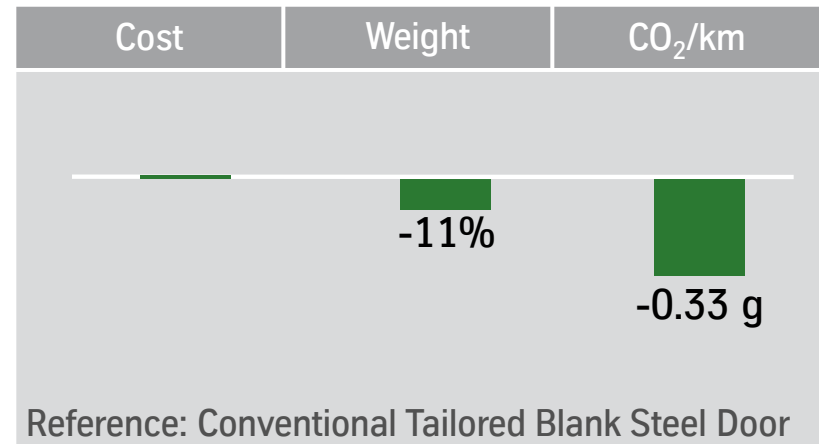
Customer Benefits

- Most weight savings through use of DP 500 Outer Panel
- Mid Panel provides additional support for Outer Panel improving oil canning performance
- Improved side impact performance using hot-stamped TB Mid Panel

Advanced Door HS

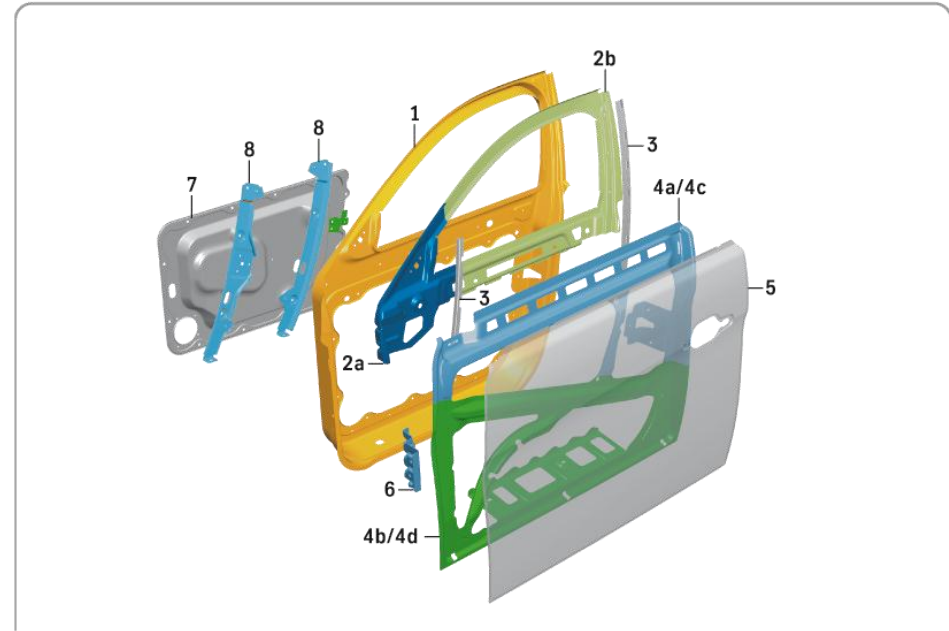


- Mid Panel; MBW 1500 TB, 1.10/0.70 mm
- Outer Panel; DP-K 30/50, 0.55 mm



Advanced Door - Design Characteristics

- Modular Design
- Outer Panel: 0.55 mm DP 500
- Inner Panel: 0.75 mm HX160
- Window Frame: 2.30/1.00 mm Tailor Welded Blank with integrated Hinge Rnf Upper
- Total Weight: 15.21 kg



1	Inner panel inner	HX 160 +ZE, CPP on both sides	0.75 mm
2a	Sash	HX 220 +Z	2.30 mm
2b	Sash	HX 180 +Z	1.00 mm
3	Window guide	MHZ 260 +Z	0.70 mm
4a	Inner panel outer CS	RA-K® 40/70 +Z	0.70 mm
4b	Inner panel outer CS	DP-K® 60/98 +Z	1.10 mm
4c	Inner panel outer HS	MHZ 340 +AS	0.70 mm
4d	Inner panel outer HS	MBW® 1500 +AS	1.10 mm
5	Outer panel	DP-K® 30/50 +ZE, CPP inner	0.55 mm
6	Hinge reinforcement lower	MHZ 340 +Z	2.40 mm
7	Carrier plate		
8	Liftrail		

Advanced Door Hot-stamped Forming Simulation

Temperatur [°C]
Temperature [°C]
800
756
711
667
623
579
534
490



Simulation Temperature

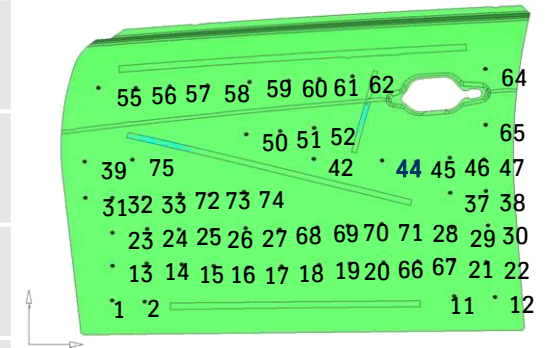
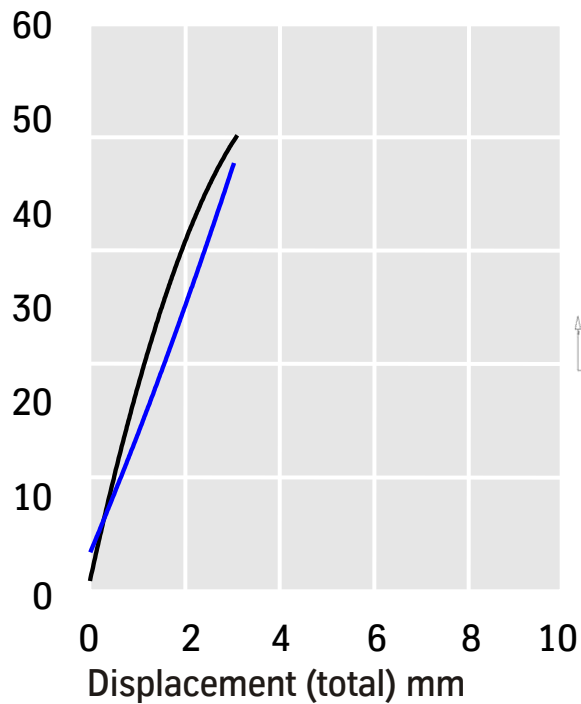
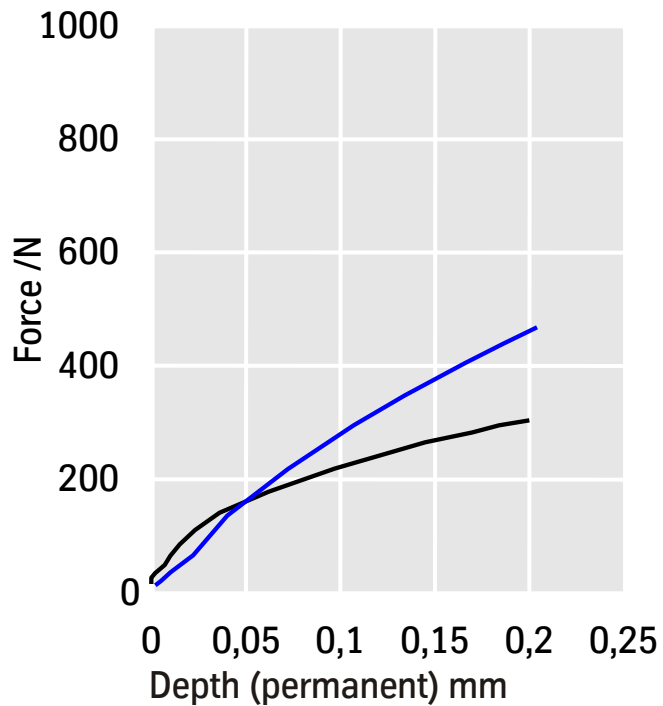
Ausdünnung []
Thinning []
0.05
0.02
-0.01
-0.05
-0.08
-0.11
-0.14
-0.17
-0.20
-0.24
-0.27
-0.30



Simulation Thinning



Dent Resistance and Oil Canning Performance

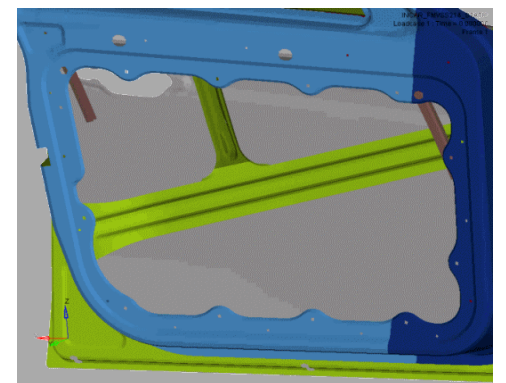
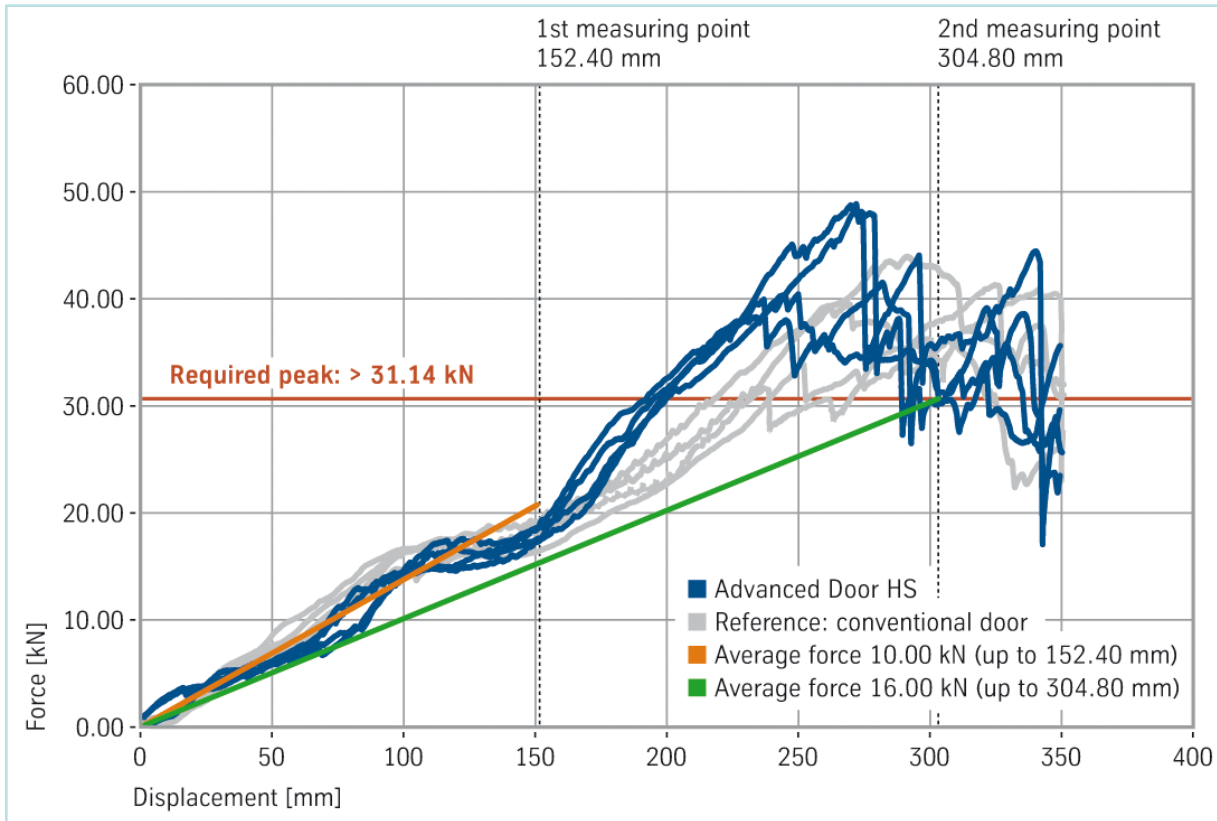


■ Reference door
■ Advanced Door

→ Improved dent resistance, comparable oil canning

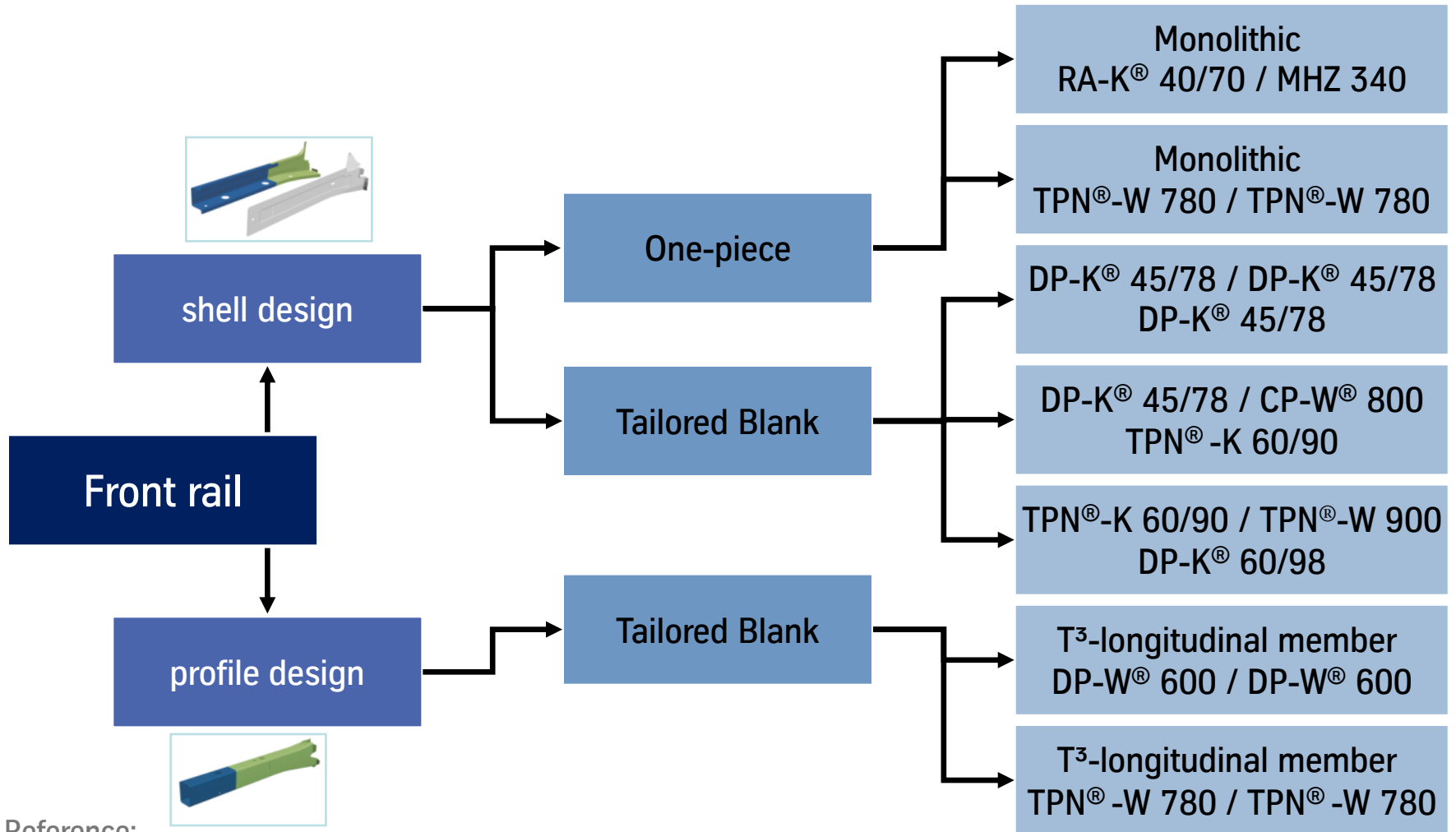


FMVSS 214 Crash Testing



➔ Forces approx. 20% higher than Reference Door

Front Rail Solution Kit Overview



Reference:

Longitudinal member – cold-stamped – Tailored Blank – DP-W® 600 / DP-W® 600



InForm T³ Longitudinal Member

Highlights

- Cost reduction of \$4.51
- Weight reduction of 2.52 kg

Customer Benefits

- Improved material utilization
- InForm T³ technology can be adapted to conventional stamping press
- Spot-weldable subassembly for simple production integration
- Innovative solutions for integration of bulkheads and bushings developed

DP-W 600; 1.90/2.20 mm

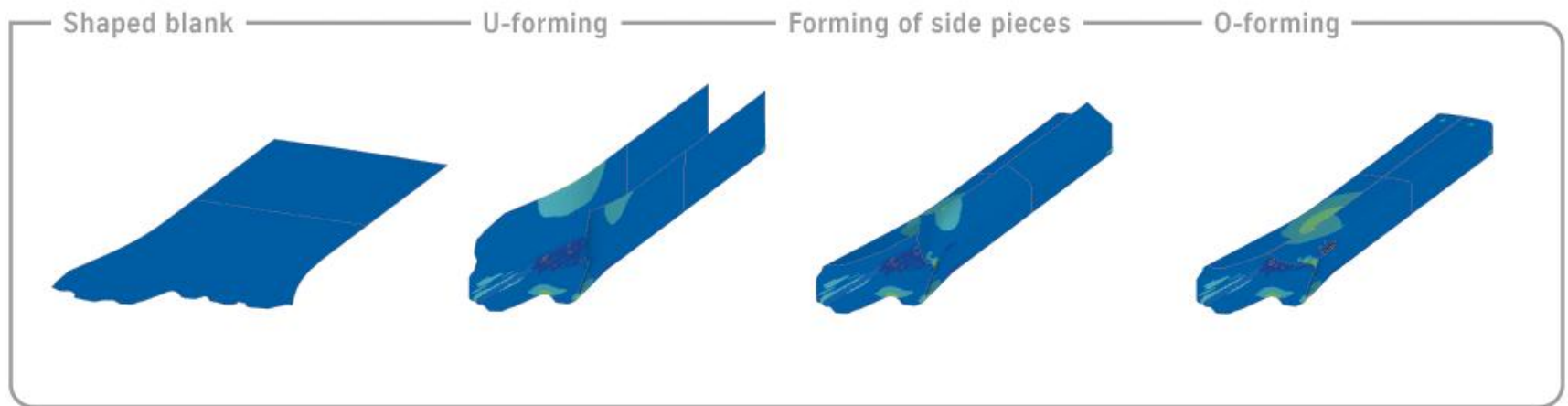


Cost*	Weight*	CO ₂ /km*
-11%	-16%	-0.21 g

* Longitudinal member (not sub-assembly)
Reference: DP-W 600 TB C-section 1.80/2.00
DP-W 600 Side Member 1.80

InForm T³ Process Steps

- Blank is positioned above U-shaped die
- U-forming through vertical movement of punch
- Cam side forming with core inserted
- O-forming by punch with core inserted
- End flange forming, holes punching
- Die opened, core removed, edges welded

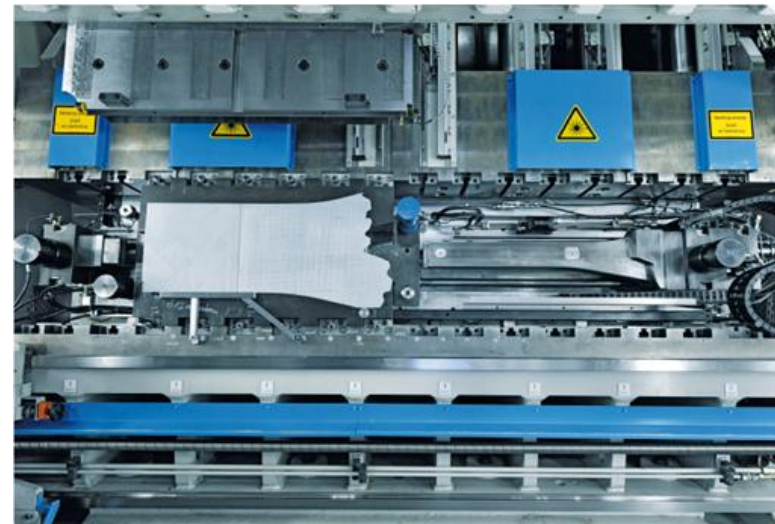


InForm T³ Process Video



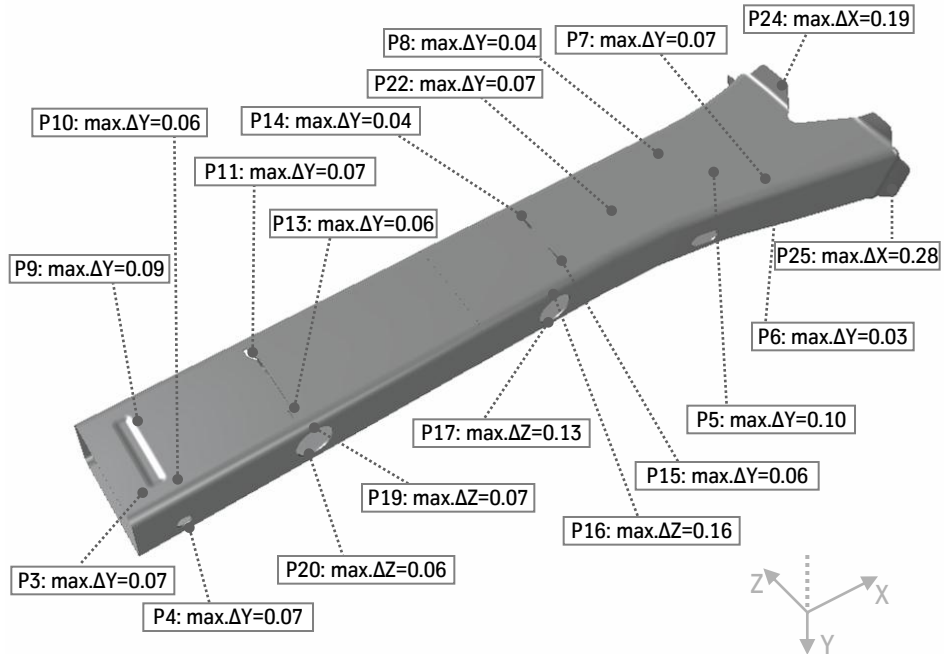
InForm T³ Pilot Line

- Double-acting servohydraulic press with 5 controlled main axes and several auxiliary axes
- Multifunctional die to test process variants, flanges and piercing
- Close-to-production 3D longitudinal welding through integrated laser optics and sensors



Dimensional Accuracy of Prototypes

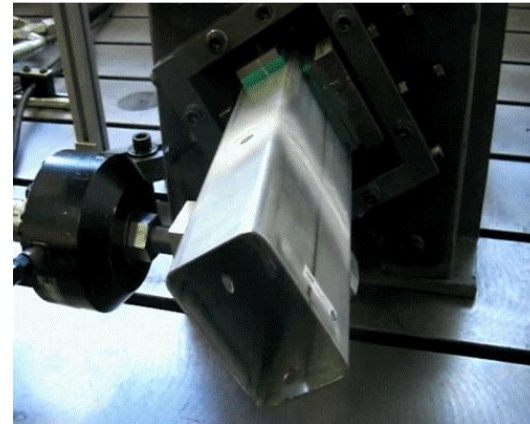
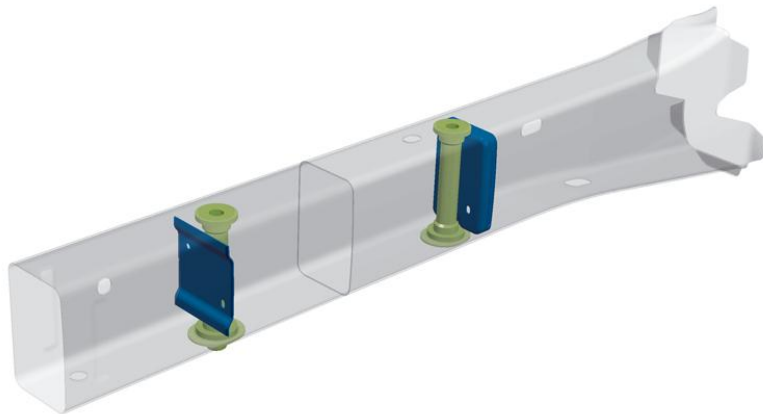
- More than 100 parts produced
- Good correlation with simulation
- Repeatability accuracy for prototyping: ± 0.2 mm
- Expected dimensional accuracy for production:
 - General: ± 0.3 mm
 - Ends/flanges: ± 0.5 mm



Maximum variances from mean value

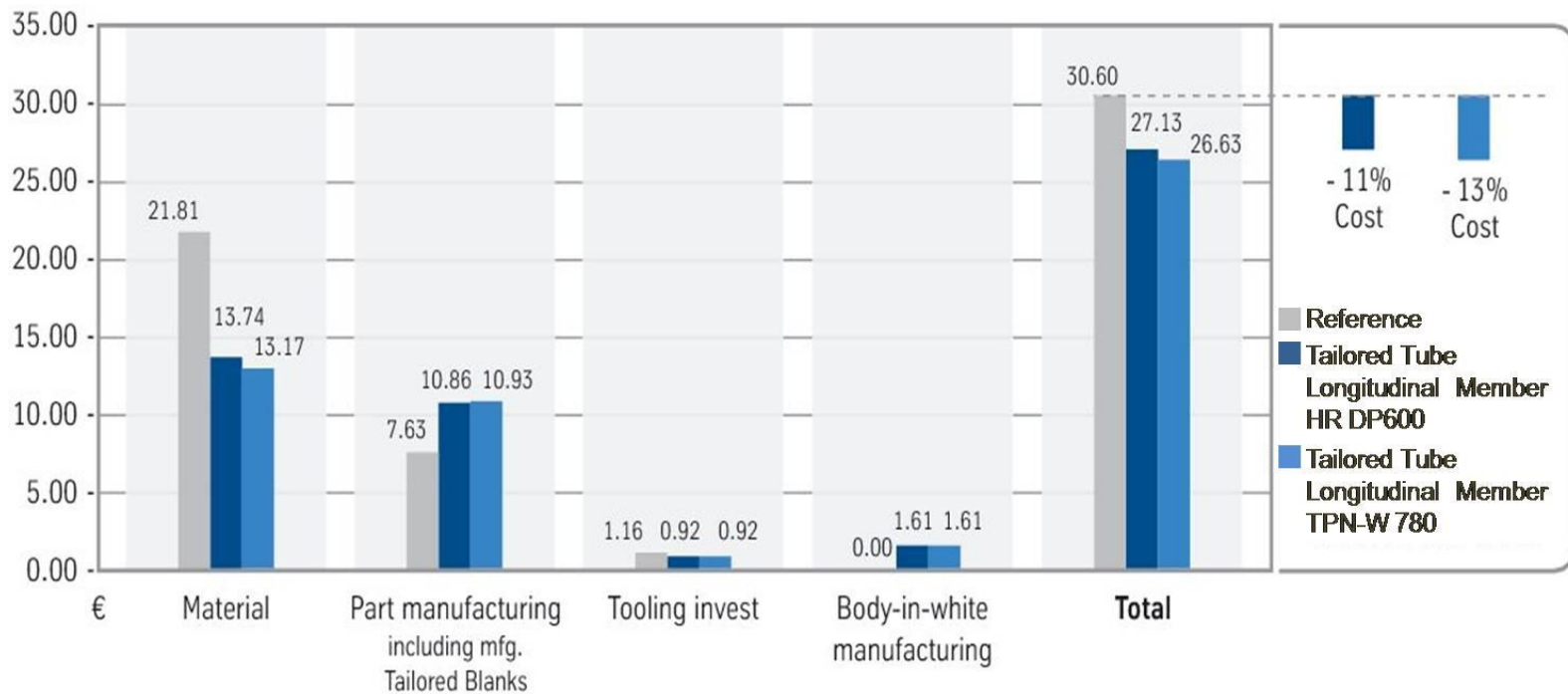
Tubular Member Bulkhead and Bushing Integration

- Front bulkhead inserted from the side and attached by MAG welding
- Remote laser welding used to join Bulkheads to Bushings
- Fatigue testing showed comparable performance to reference design



InForm T³ Longitudinal Member Cost Comparison

- European cost analysis based on production volume of 200,000 veh/year for an eight year life cycle
- 11 - 13% cost reduction obtained for tubular longitudinal members
- Most cost savings achieved through improved material utilization



InCar - Summary

- Over 30 innovative solutions to meet current auto industry requirements
- Validated, reliable information on cost, weight and function/performance
- Objective comparability of solutions by benchmarking against reference structure
- Use of innovative and production-ready materials, processes and technologies
- More than 100 dies built, 329 parts in total, 3 complete body-in-whites built
- InCar will be continued beyond 2011, delivering new results permanently



InCar[®]