

GREAT DESIGNS IN **STEEL**

COST EFFECTIVE COLD FORMING SOLUTIONS WITH TAILOR ROLLED PRODUCTS

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Torben Wilks – Group Leader TRB

Mubea Tailor Rolled Blanks

COMPANY FACTS



- Owner-operated family company since 1916
- Lightweight component design specialist
- Vertical integration from raw material to finished product
- Internal development of products and production processes

NORTH & SOUTH AMERICA:

- 5 locations
- 2,500 employees

EUROPE:

- 31 locations
- 9,700 employees

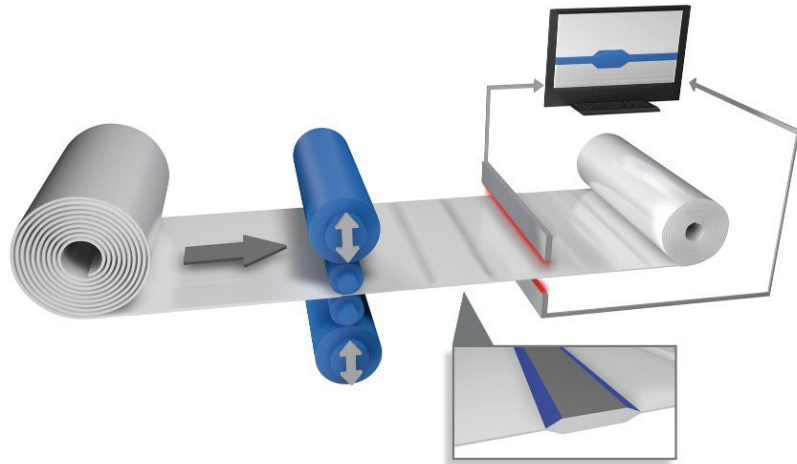
ASIA:

- 14 locations
- 1,800 employees



FLEXIBLE ROLLING PROCESS

Flexible rolling:



Idea

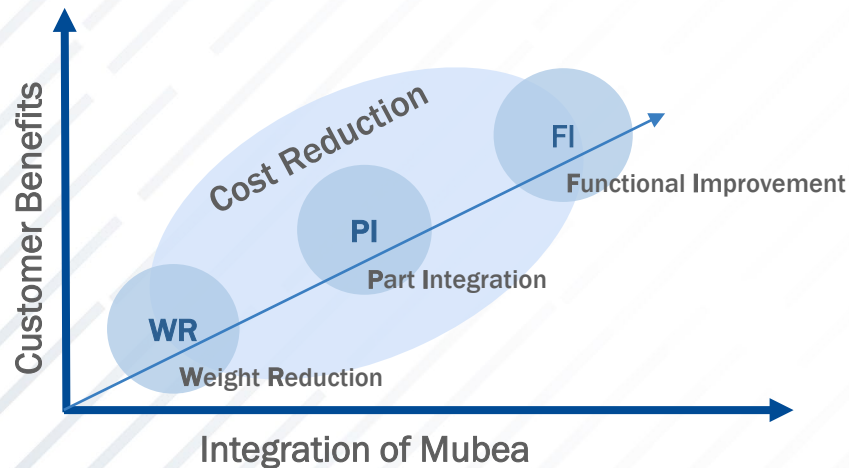
- Lightweight parts with load and function-optimized material usage and improved performance

Implementation

- Flexible Cold-Rolling process
- Flat material with repeated, varying thicknesses and harmonious transition zones
 - No heat affected zone
 - No notch effect
 - No stress peaks at thickness changes
- Thickness distribution change is software driven
 - **Thickness run optimization drives the cost efficiency**

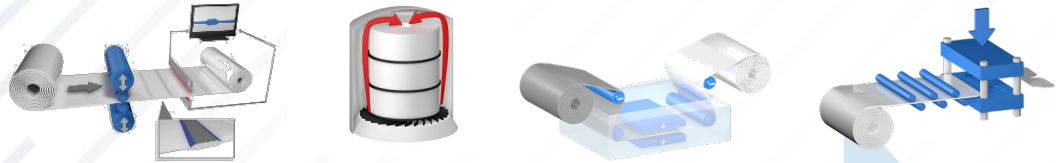
Targets / Benefits

- Weight reduction
- Part integration/design simplification led to cost reduction
- Functional improvement (crash, manufacturing, etc.)

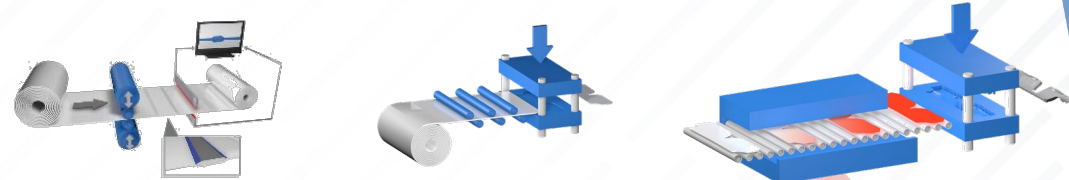


COLD FORMING VS. HOT FORMING

Cold Form Material



Hot Form Material

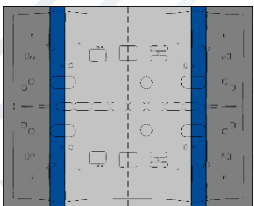


Product portfolio:

Rectangular Blanks [TRB]

Tailor Shaped Blanks [TRS]

Cold Stampings & Assemblies [TRP-C]

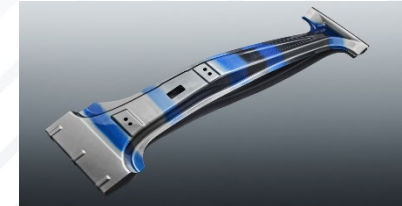
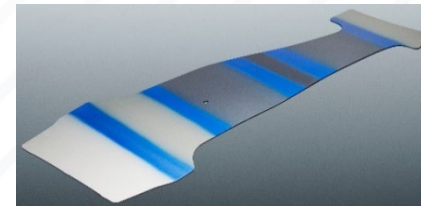
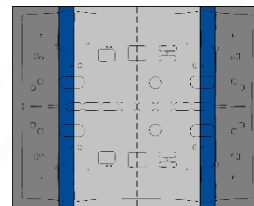


Product portfolio:

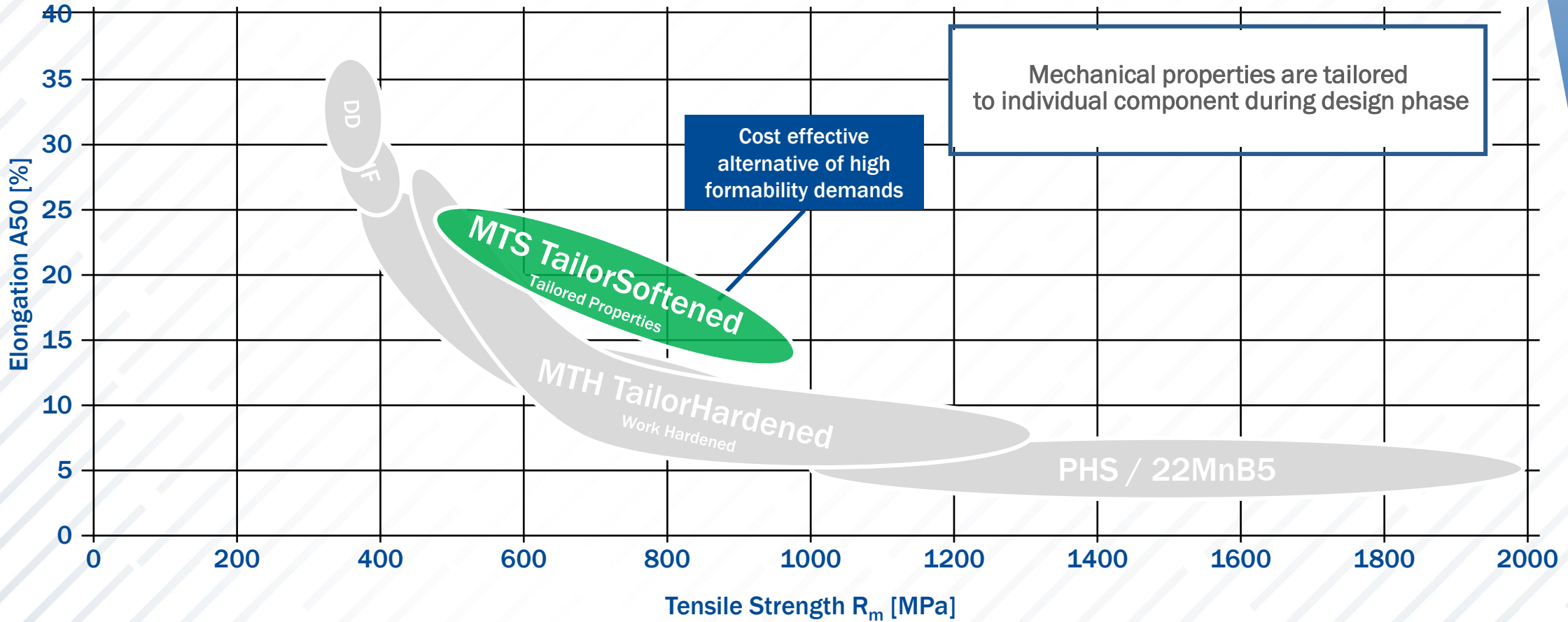
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Tailor Shaped Blanks [TRS]

Hot Stampings & Assemblies [TRP-H]

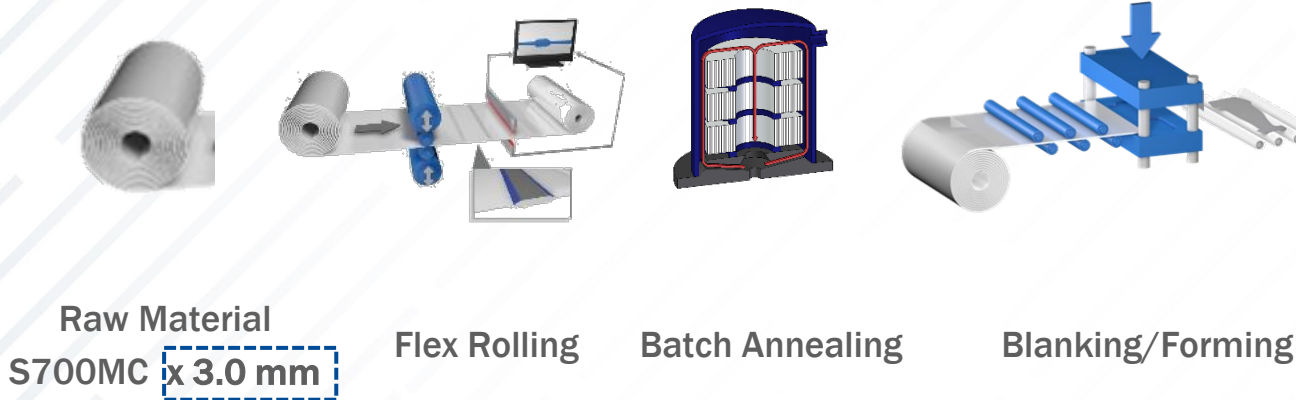


Mubea TailorSoftened: GENERAL IDEA



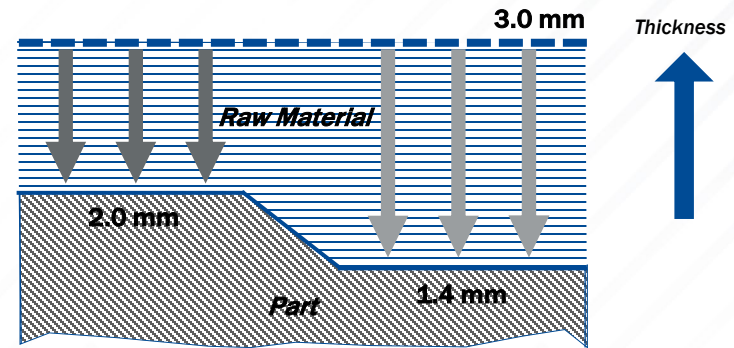
MUBEA TAILORSOFTENED-PRINCIPLE

Conventional TRB process flow

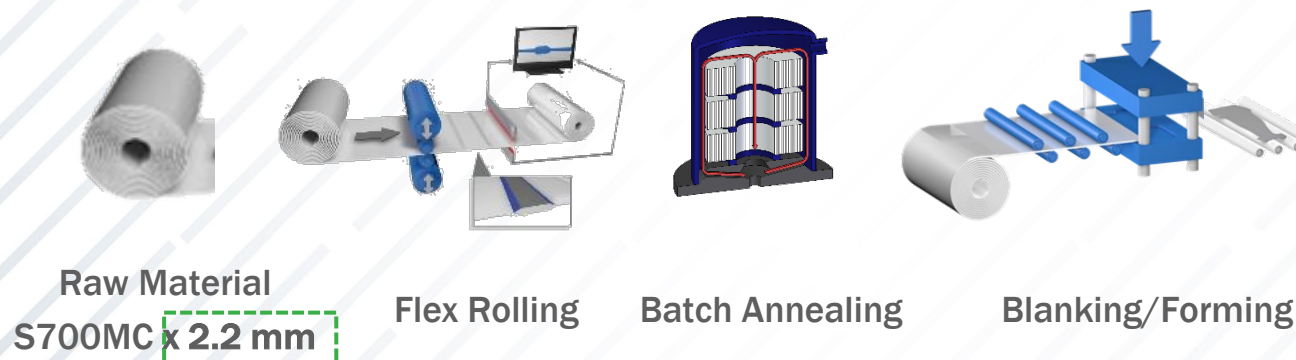


Homogeneous mech. properties

CR500LA TRB

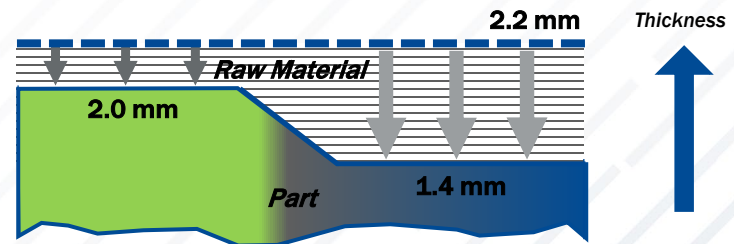


Conventional TRB process flow



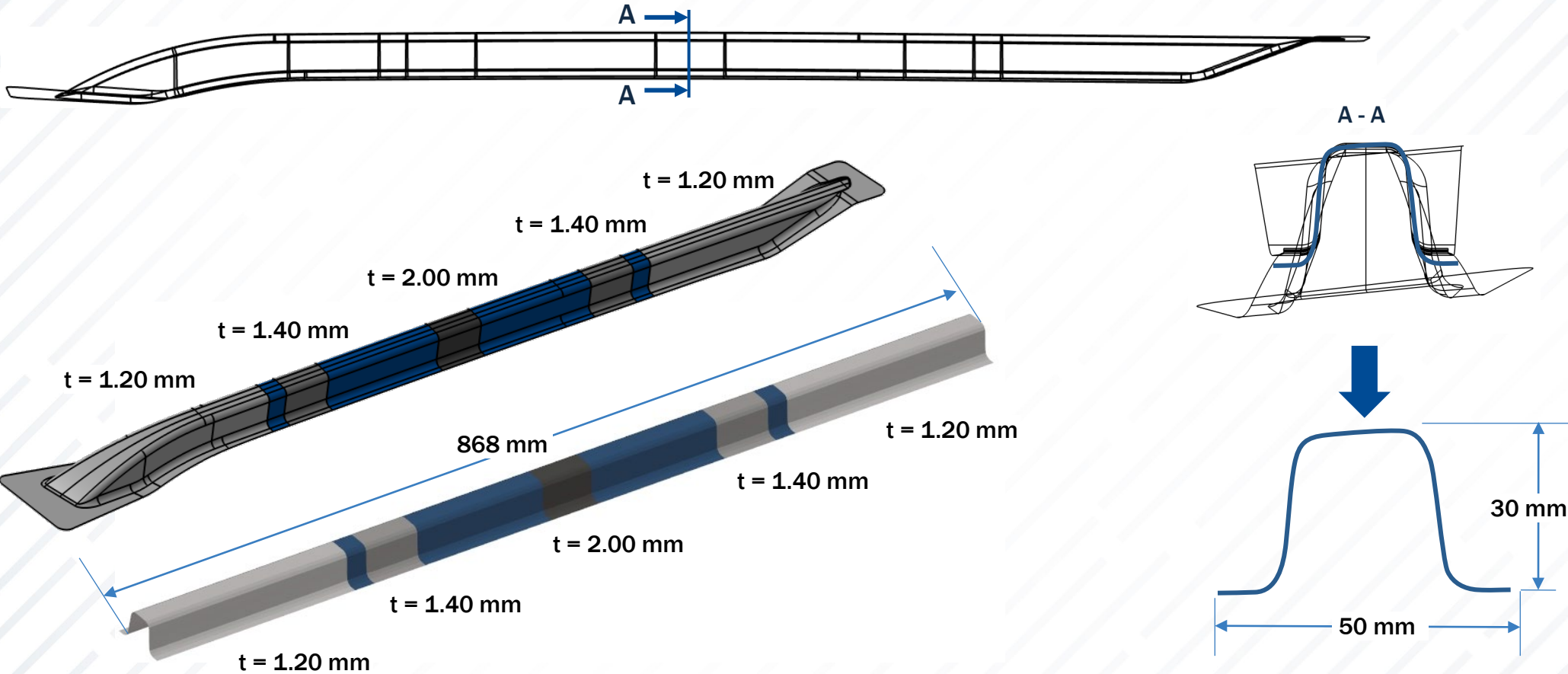
Mubea TailorSoftened

MTS 700Y/500Y TRB



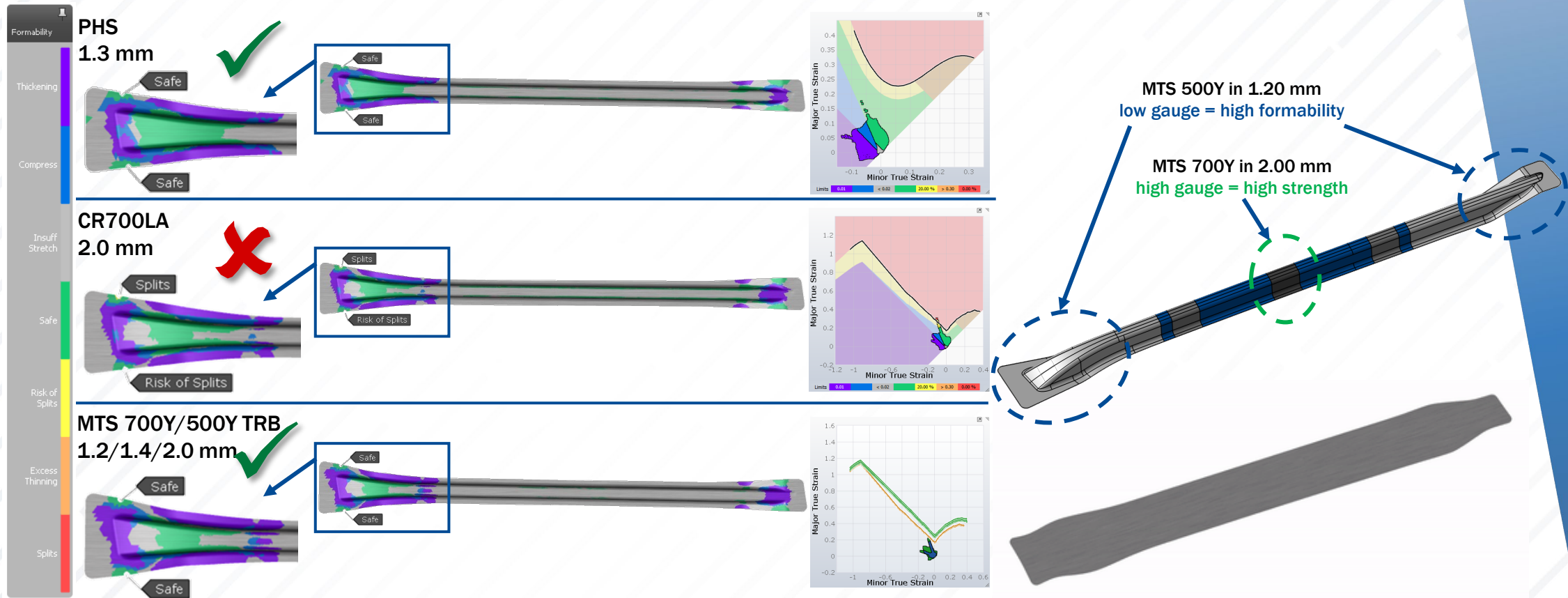
- light* recrystallization → Yield Strength min. 700+ MPa
- full* recrystallization → Yield Strength min. 500+ MPa

MTS APPLICATION DOOR INTRUSION BEAM



- Mubea generic Door Intrusion Beam concept geometry
- Hat shape design with same center cross section and percent rolling reduction
- Surrogate hat shaped part used for material card validation

MTS INTRUSION BEAM FORMABILITY

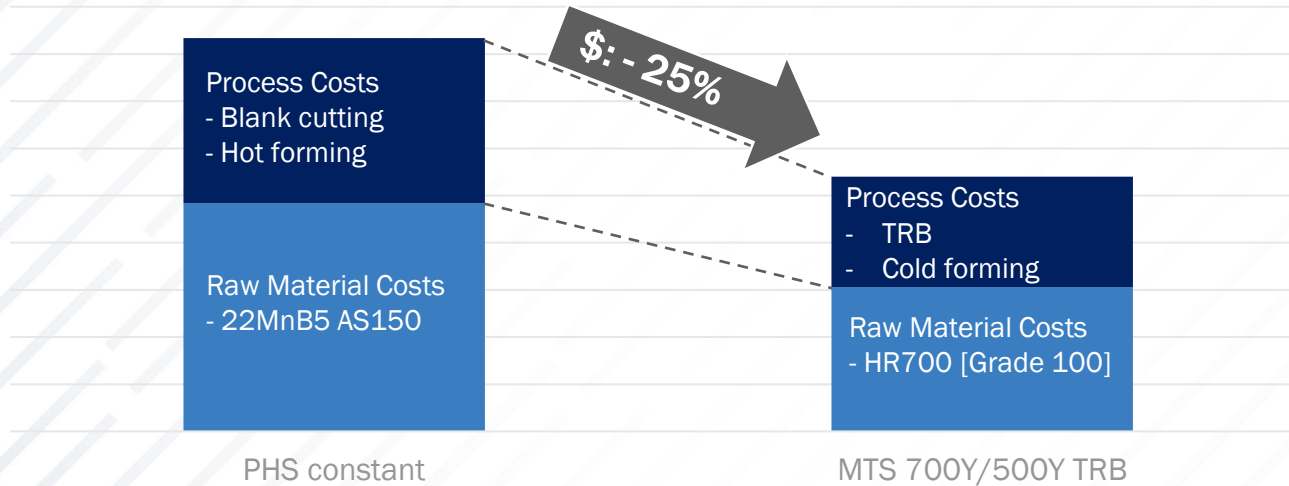


- Hot forming simulation with 1.30 mm monolithic PHS material => safe
- Cold forming simulation with 2.00 mm monolithic CR700LA => not feasible
- Cold forming simulation with 1.20/1.40/2.00 mm MTS 700Y/500Y TRB => safe

Cost effective cold forming alternative with two property zones → high strength and high formability

MTS – COST BENEFITS

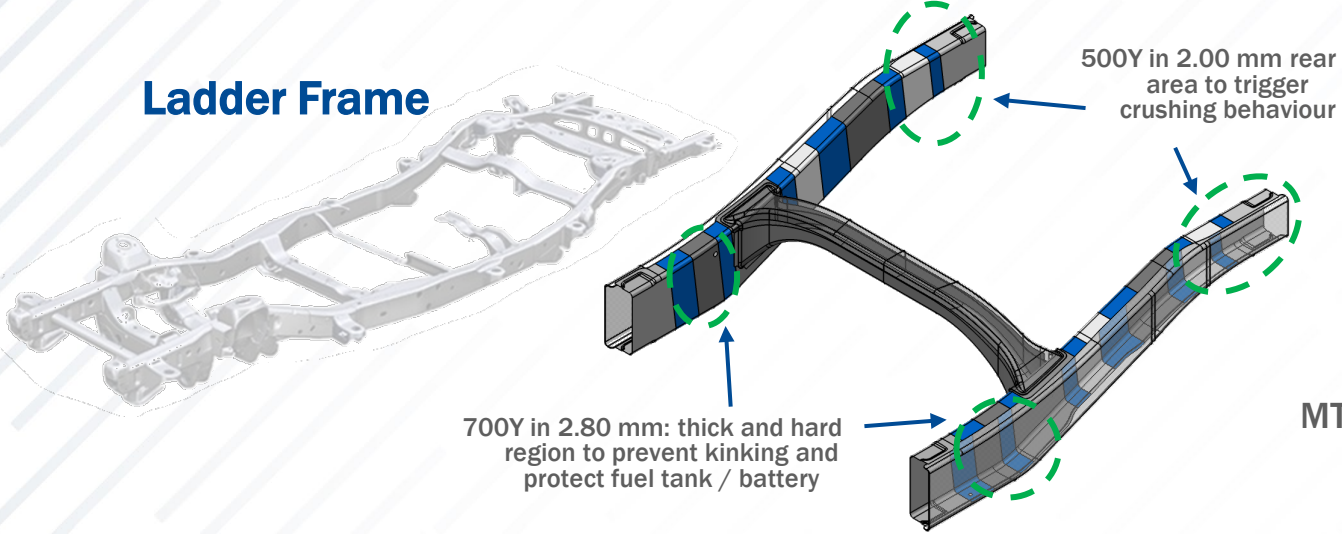
MTS Cost Efficiency vs. PHS (Door Beam Application)



- MTS TRB achieves same performance as benchmark
- MTS TRB offers cost reduction potential with comparable weight

MTS POTENTIAL APPLICATIONS

Ladder Frame



Body in White

MTS TRB Door Intrusion Beams

MTS 700Y/500Y TRB
1.2 mm - 2.0 mm

MTS TRB Kick-Up Rail Inner

MTS 700Y/500Y TRB
2.00 mm - 2.80 mm

MTS TRB Hinge Pillar

MTS 700Y/500Y TRB
1.00 mm - 1.85 mm

500Y & improved formability at side areas

700Y in 2.80 mm central region to prevent kink on side crash

MTS TRB Fuel Tank Cross Member

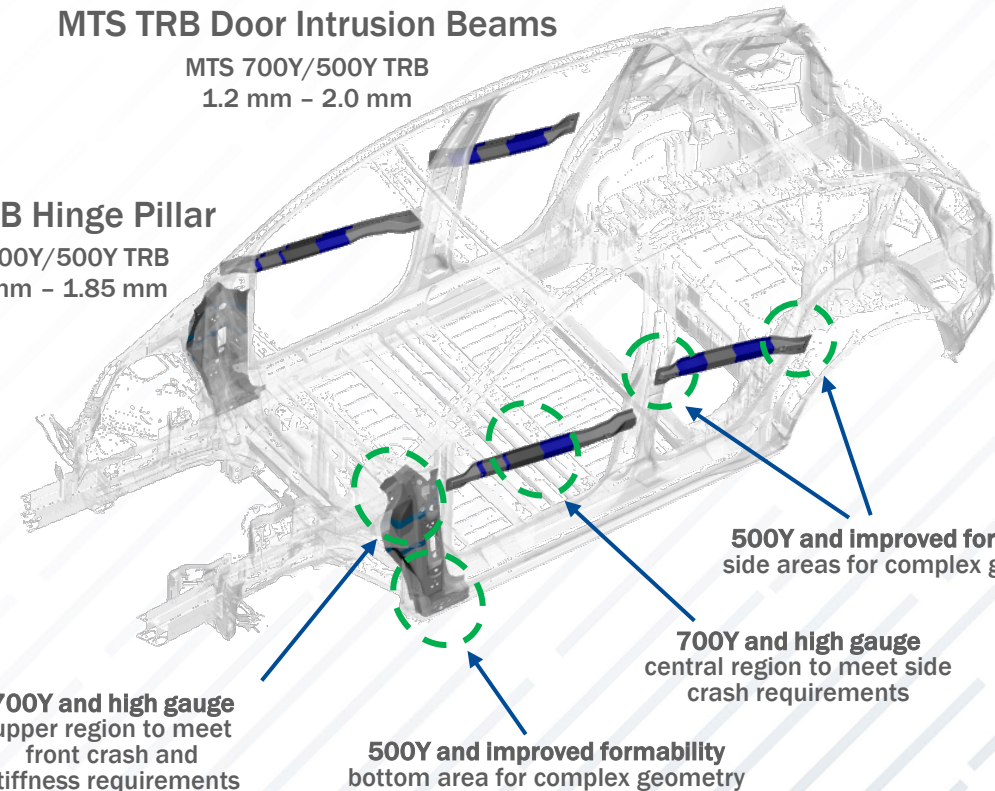
MTS 700Y/500Y TRB
2.00 mm - 2.80 mm

700Y and high gauge upper region to meet front crash and stiffness requirements

500Y and improved formability bottom area for complex geometry

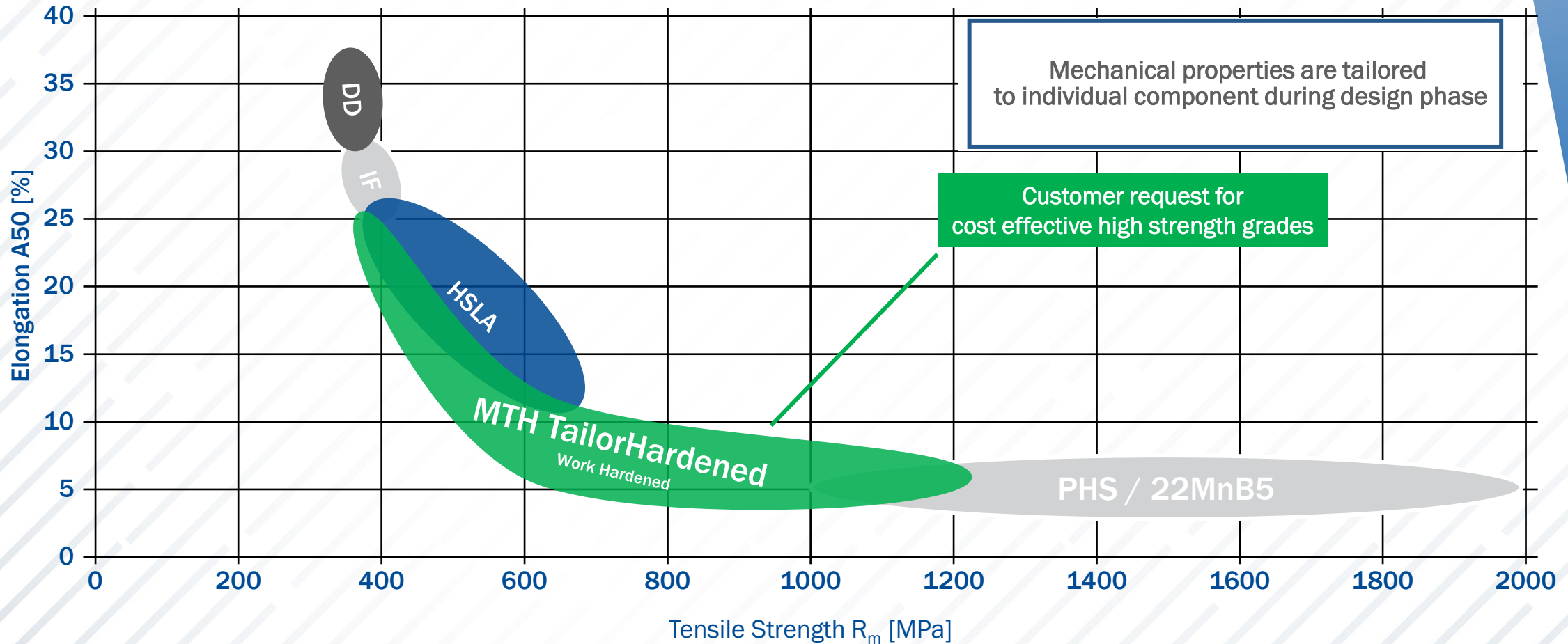
500Y and improved formability side areas for complex geometry

700Y and high gauge central region to meet side crash requirements



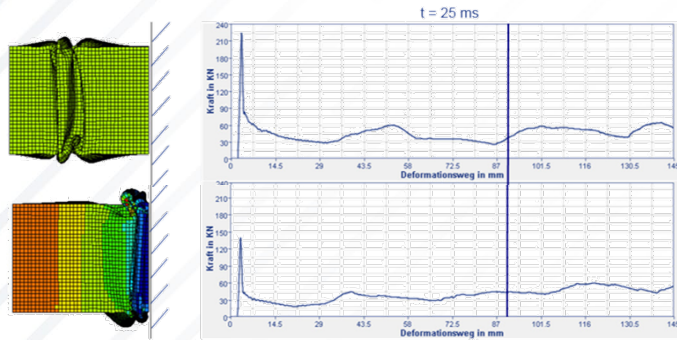
MUBEA TAILORHARDENED: GENERAL IDEA

- Idea of TailorHardened TRB was driven by filling gap in material portfolio (CR500 <--> PHS)



CUSTOMER BENEFITS BEYOND WEIGHT REDUCTION

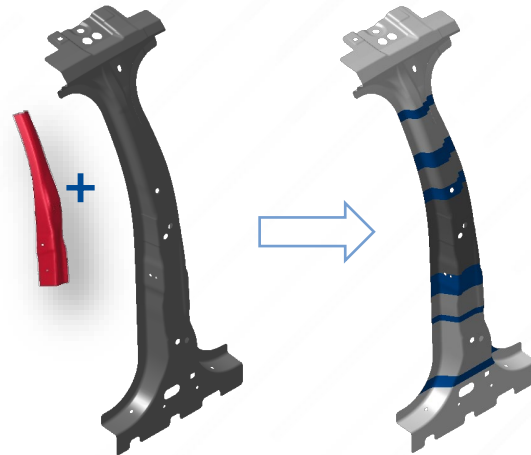
Functional Improvement:



Benefits

- Crash optimization
- Optimal definition of deformation pattern

Part Integration:

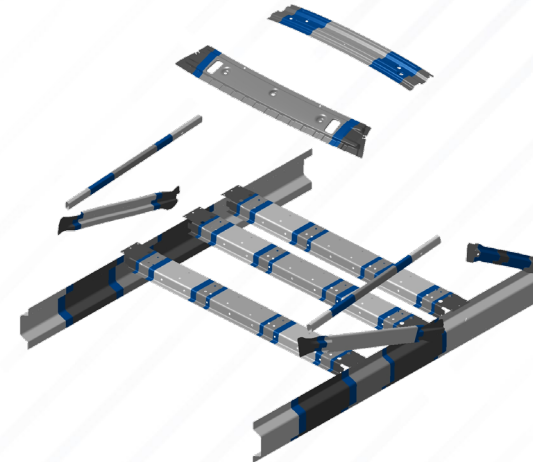


Benefits

- No sub-assembly
- Less investment
- Reduced supply chain cost
- Improved CO₂ footprint
- Weight reduction

Cost Reduction by MTH*

* Mubea TailorHardened



Benefits

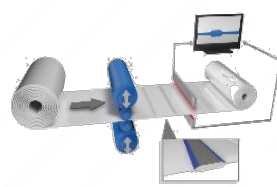
- Cost reduction by...
 - elimination of process steps
 - lower grade raw material usage
- Performance improvement
- Weight reduction as side effect

MUBEA TAILORHARDENED: PROCESS

Conventional TRB process flow



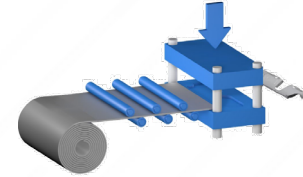
Raw Material
(e.g. HR550LA)



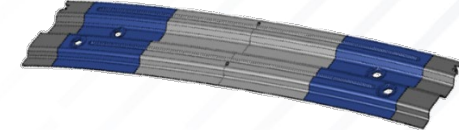
Flex Rolling



Batch Annealing



Forming

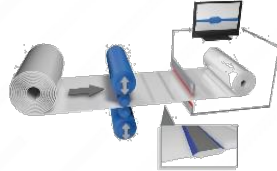


Homogeneous
mechanical properties
„CR420 LA TRB“

TailorHardened cost effective process flow



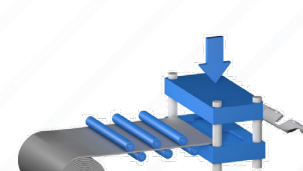
Raw Material
(e.g. HR315LA)



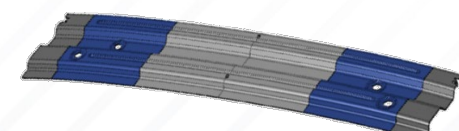
Flex Rolling



Batch Annealing



Forming

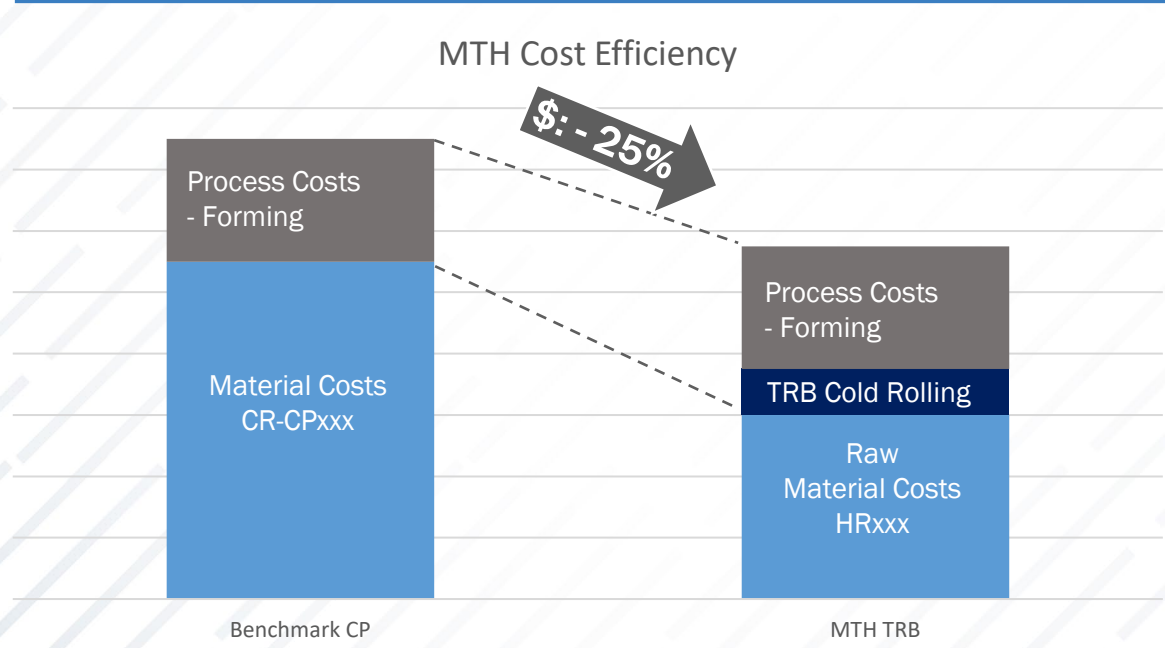


TailorHardened
mechanical properties
e.g. „MTH 420Y/550Y TRB“

- Cost efficiency of Mubea TailorHardened material is realized by:
 - usage of inexpensive grade raw material
 - elimination of process step (annealing)

MUBEA TAILORHARDENED: EFFICIENCY

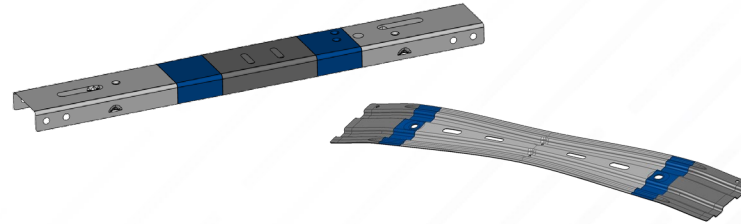
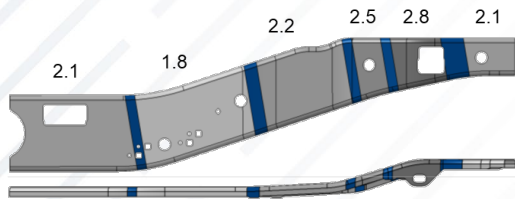
TailorHardened cost effective process flow



- MTH achieves same performance as benchmark by lifting properties of inexpensive raw material
- MTH TRB offers additional weight advantage up to ~15% → max. customer benefit in weight & cost

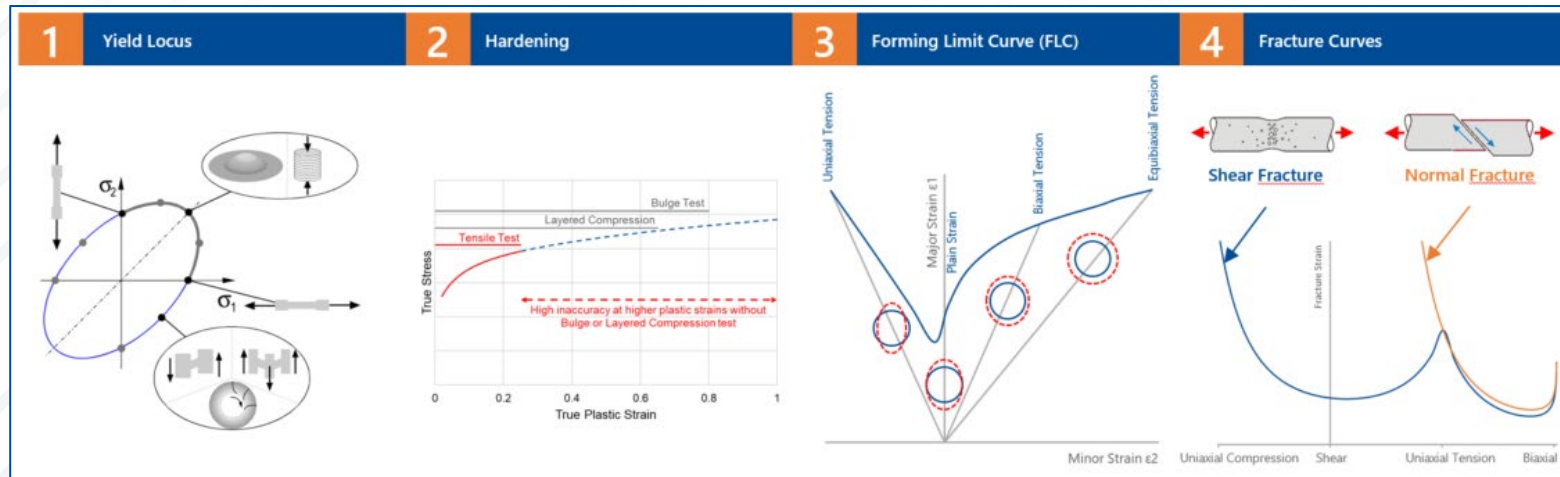
MUBEA TAILORHARDENED: FORMING TRIALS

- Performed multiple forming trials in existing series tooling & built prototype dies
- Great results during forming trials with formability & dimensional stability
 - up to 3-point bending trials without any crack indications
 - results beyond expectations if only considering elongation properties A_{50}
 - → S550MC / 35% rolling red
 - → 910Y / 960T / 5.0% A_{50}



MUBEA TAILORHARDENED: VALIDATION

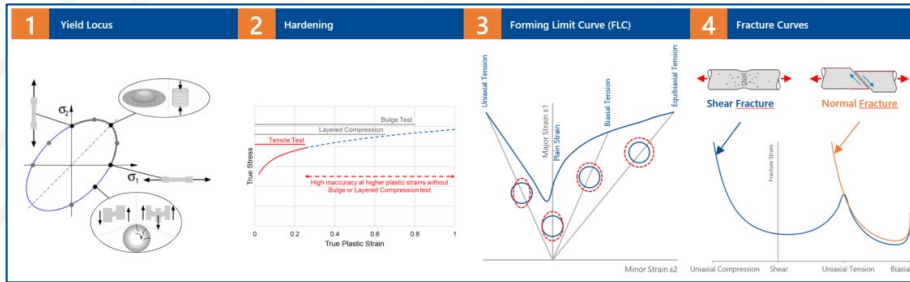
1. Development of MTH Material Cards



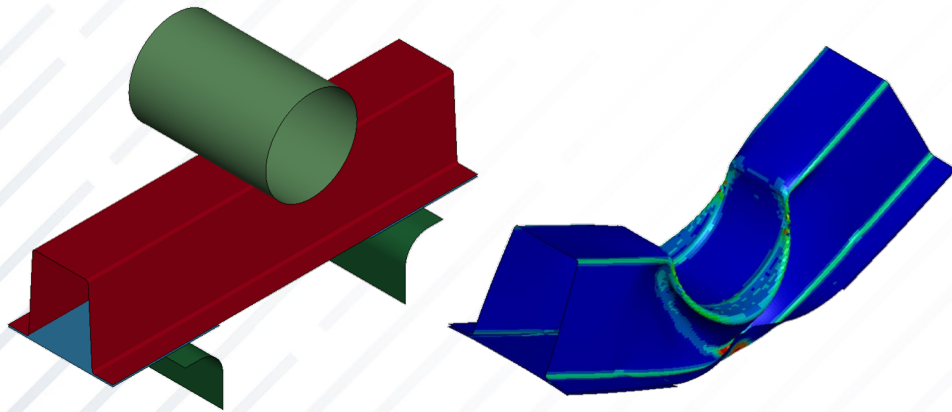
- Based on DD13, S420, S700, CP800 further base materials in progress
- Characterization of material quasi static & dynamic
- Forming limit curves
- Fracture limit curves

MUBEA TAILORHARDENED: VALIDATION

1. Development of MTH Material Cards

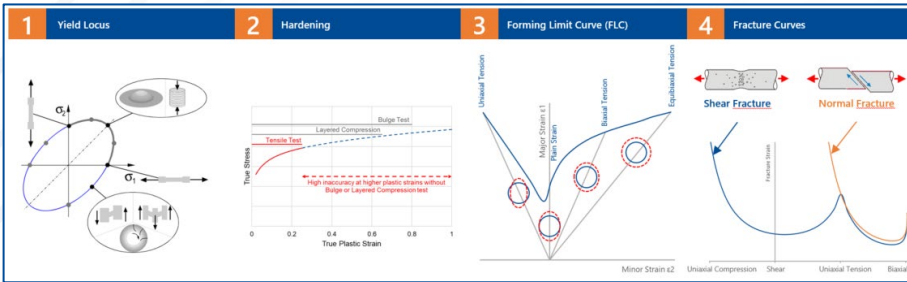


2. CAE Simulations including failure (CrachFem/Gissmo)

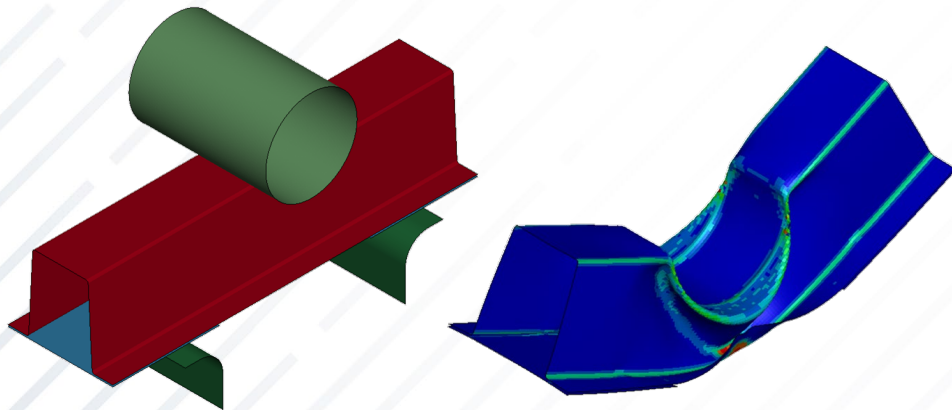


MUBEA TAILORHARDENED: VALIDATION

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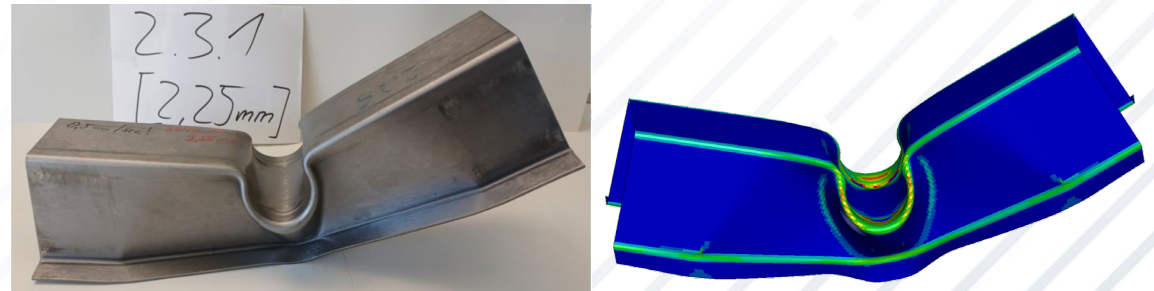
2. CAE Simulations including failure (CrachFem/Gissmo)



3. Physical Static 3-point bending testing

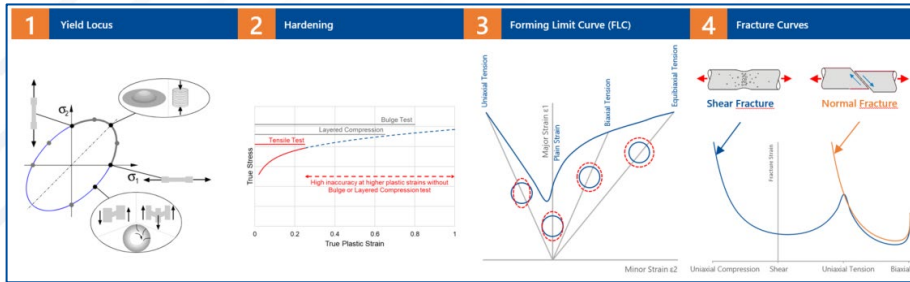


- Performed trials on hat profiles with different:
 - materials (DD13, S700)
 - rolling degrees (5% - 50%)
- No cracking of the material
 - great correlation to static simulation

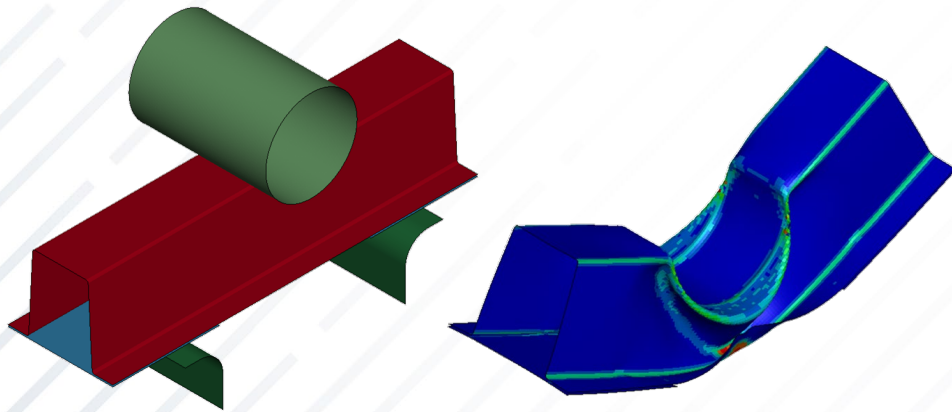


MUBEA TAILORHARDENED: VALIDATION

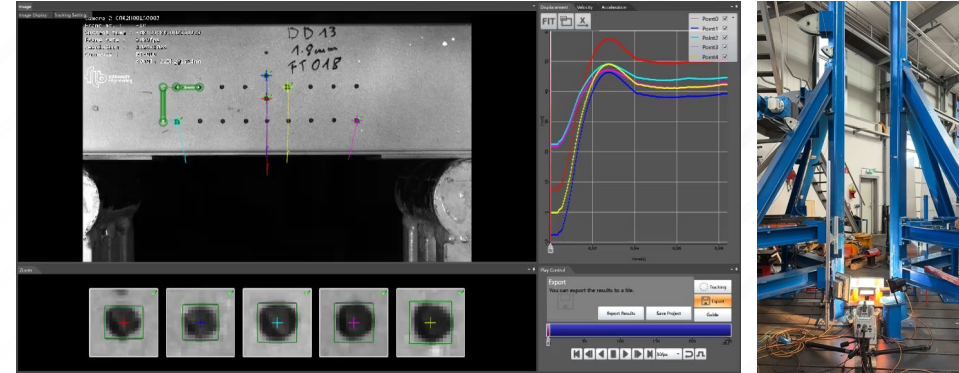
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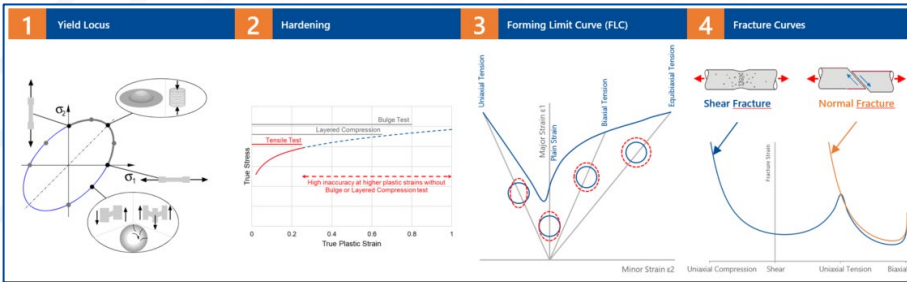
- Performed drop tower testing on hat profiles with different:
 - materials (DD13, S700)
 - rolling degrees (5% - 50%)
 - energies (4 -8kJ)



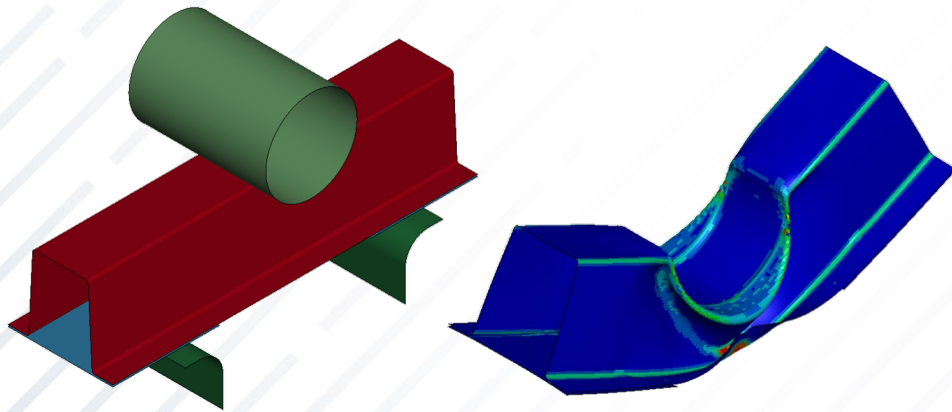
- Target to initiate cracking on higher energy levels for optimized correlation analysis

MUBEA TAILORHARDENED: VALIDATION

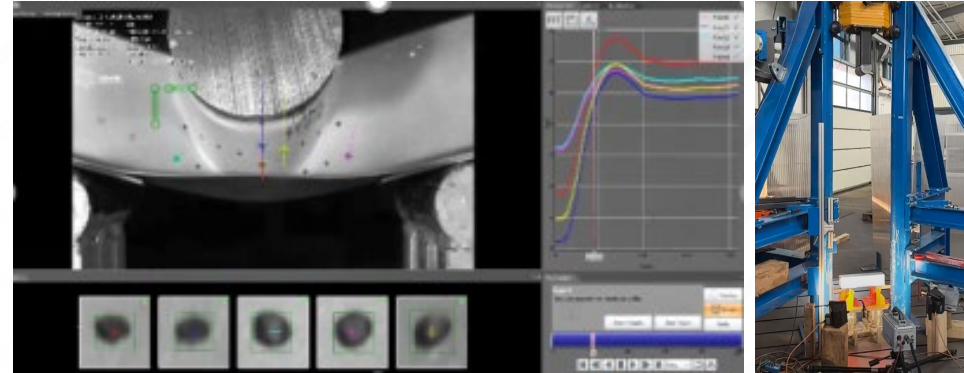
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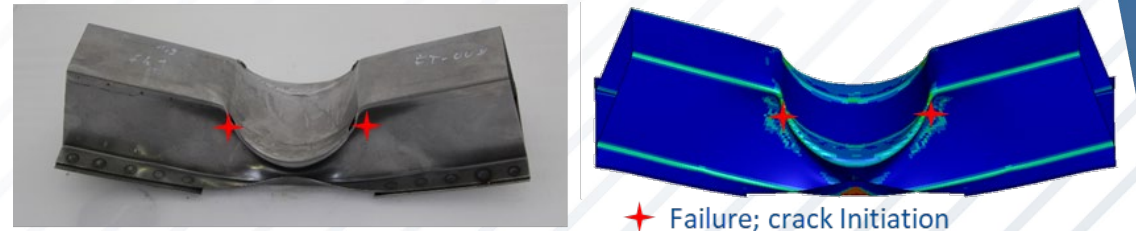


3. Physical Dynamic 3-point bending testing



4. Correlation Simulation vs. Physical Testing

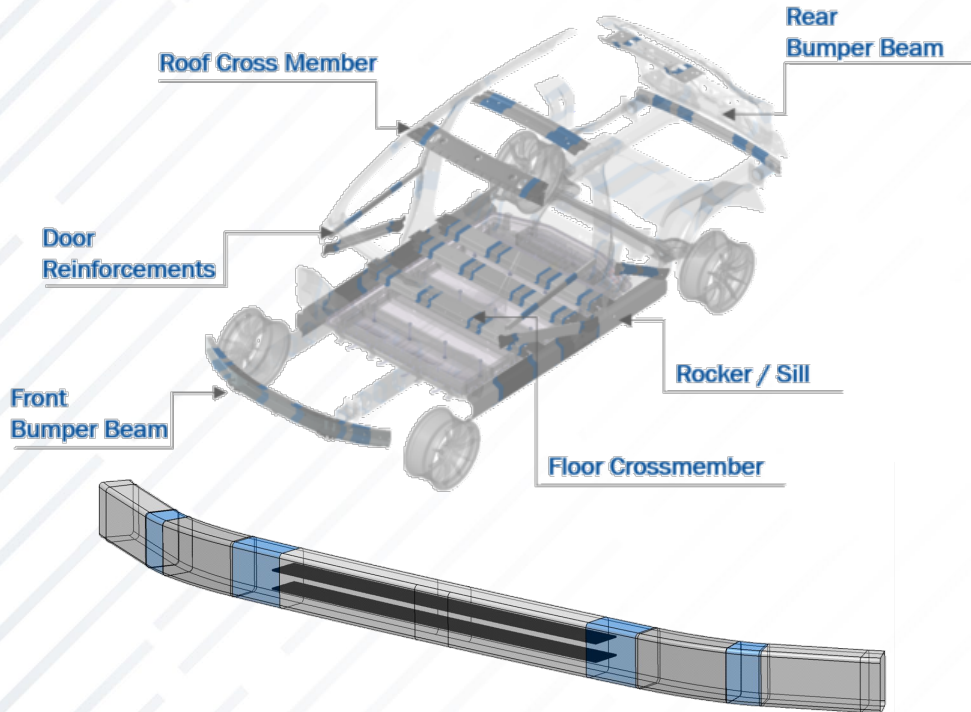
- Successful correlation could be stated on:
 - detailed element tracking
 - crack initiation (time & location)



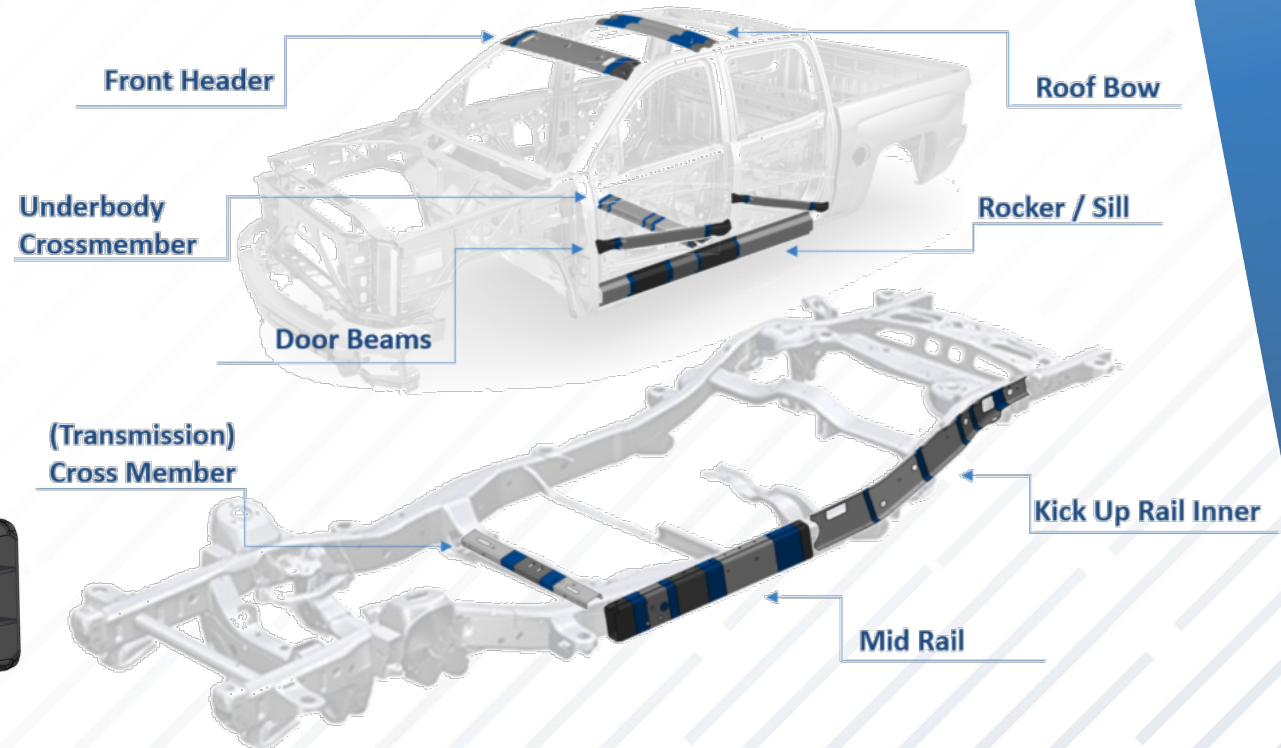
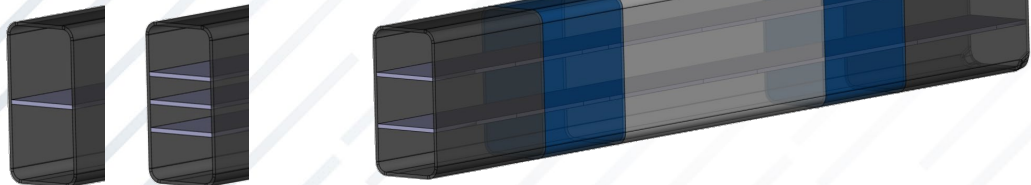
★ Failure; crack Initiation

MTH APPLICATIONS IN UNIBODY & BOF

- Multiple potential applications for MTH have been identified and are currently in development
- BEV architectures in Unibody & BoF have geometry and performance requirements to enhance MTH advantages



Alternative design solution in development:
MTH closed profile with horizontal layers for
Bumper and Frame Rail applications



MTH: RESUME & OUTLOOK

- Idea TailorHardened TRB driven by filling gap in current material portfolio
 - Simple ferritic hot rolled raw material properties are being “lifted up” by cold rolling
 - Cost reduction by ...
 - usage lower grade material (lifting properties)
 - elimination of process step (annealing)
 - Multiple successful forming trials in ...
 - existing series tooling
 - specifically built prototype dies
 - Creation of material cards for forming and crash (Partner: MatFem)
 - first material cards available (DD13 / S700) since Dec 2022
 - S420 & CP800 will be available in Q2/2023
 - S315 & S500 planned for Q4/2023
- ➔ Design and validation of MTH ideas with the OEM begins NOW!

FOR MORE INFORMATION

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