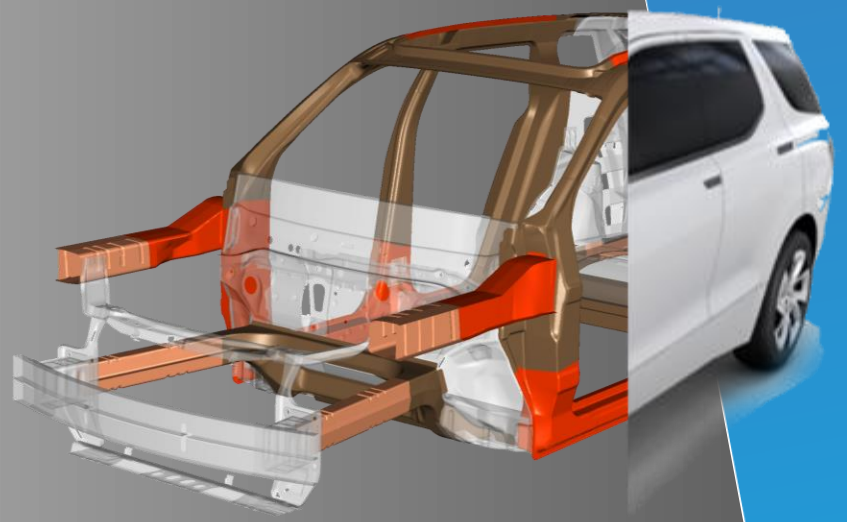
GREAT DESIGNS IN STEEL

Innovation in Body-in-White Reinforcements Using Wire Laser Additive Manufactured B-Pillar Concept

Cristian Alvarez Robledo
Additive Manufacturing Solutions Team Leader
ArcelorMittal Global R&D

Tejas Chillale
Senior Product Development Specialist
ArcelorMittal Global R&D

Agenda



Changes in the Automotive Industry

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Electrification Challenges

Cost increase

+40-50%

Fleet CO_2 targets

<100 gms per km

Assembly line upgrades

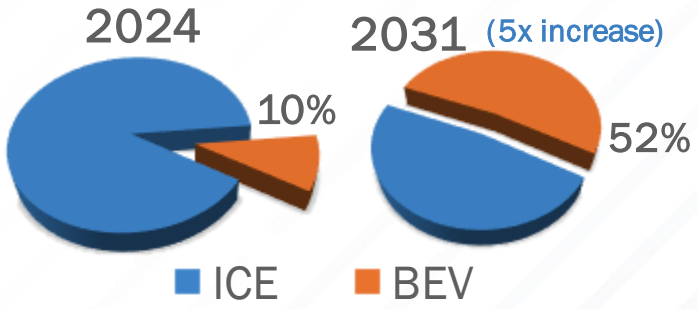
Heavy vehicles

+20-30%

Battery & Occupant protection

Battery Pack Logistics

BEV Production Volume



Ongoing Development & Implementation

Part Consolidation

Tailored Steel Blanks

Additive Manufacturing

Die Castings

Modular Platforms

Flexible Cell Manufacturing

Low Volume Heavy EV Variants

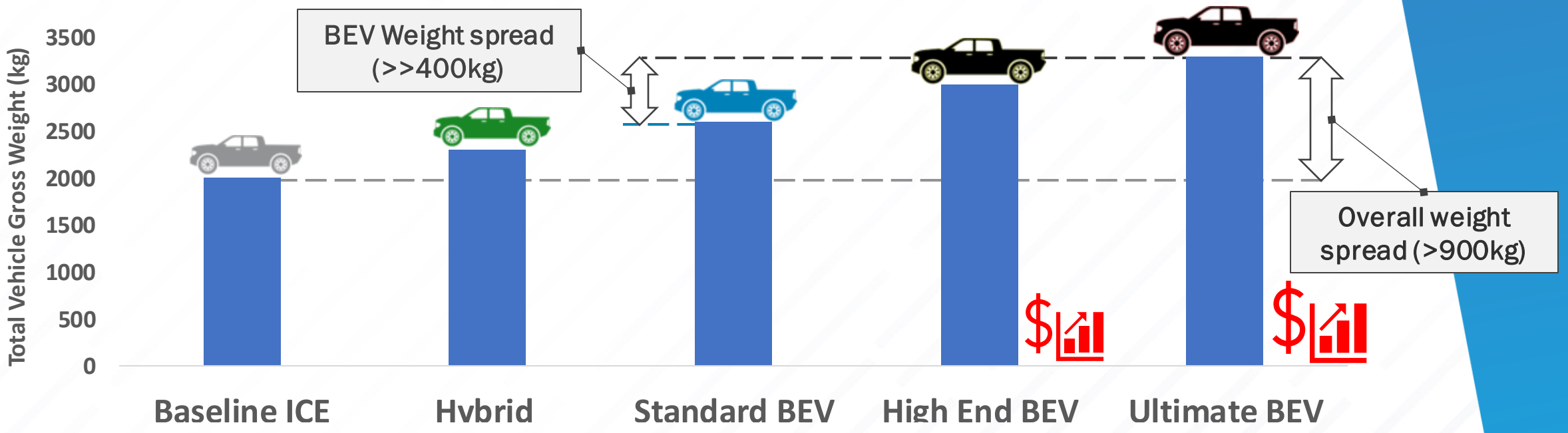
Supply Chain Sustainability

Mix Material Light-weighting

Source: S&P Forecast – March 2024

Weight spread in vehicle platforms is increasing with electrification

- **Higher weight spread in BEV** compared to ICE - Weight increase across vehicle platform more significant (Example – light duty pickup truck below)
- **Premium variants are even heavier** and costlier – extended-range battery and premium trim options

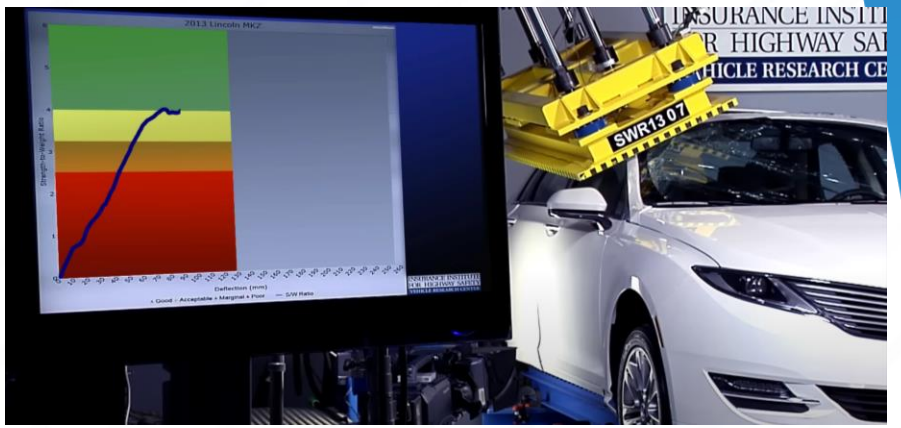


Body structures must be designed to comply with crash regulations

Roof-strength is key for crash safety, specially for heavy variants

- **Good roof-strength allows to maintain survival space** inside the vehicle in case of rollover accident
- IIHS roof strenght test protocol allows to evaluate rollover crashworthiness:
  - A steel platen is pushed by four hydraulic actuators on the driver's side of the roof
  - Reaction force is continously measured for a min. 127mm of displacement at a 5mm/s disp. rate
  - **Strength-to-weight ratio (SWR)** is calculated **= Max.Force/Curb Weight of the vehicle**

SWR	Rating
≥4,00	Good
≥3,25 to <4,00	Acceptable
2,50 to <3,25	Marginal
<2,50	Poor

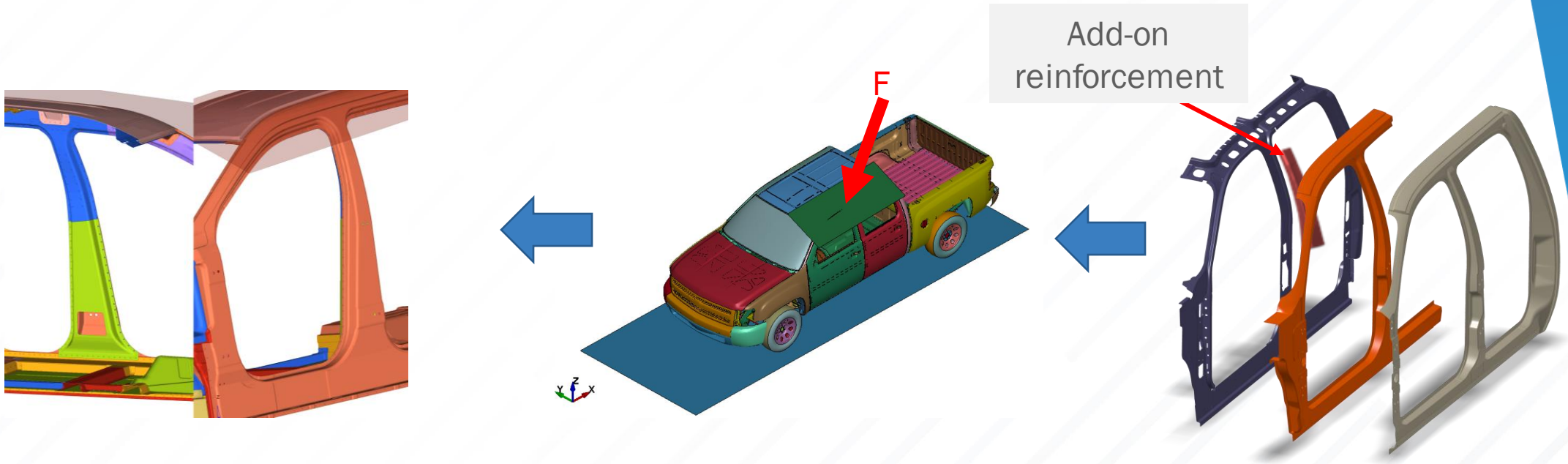


Roof Strength Rating Boundaries as defined by IIHS

A good SWR ratio (≥4,00) ensures good roof-strength and survival space in case of roll-over

Design challenge for OEMs to meet roof-crush requirements

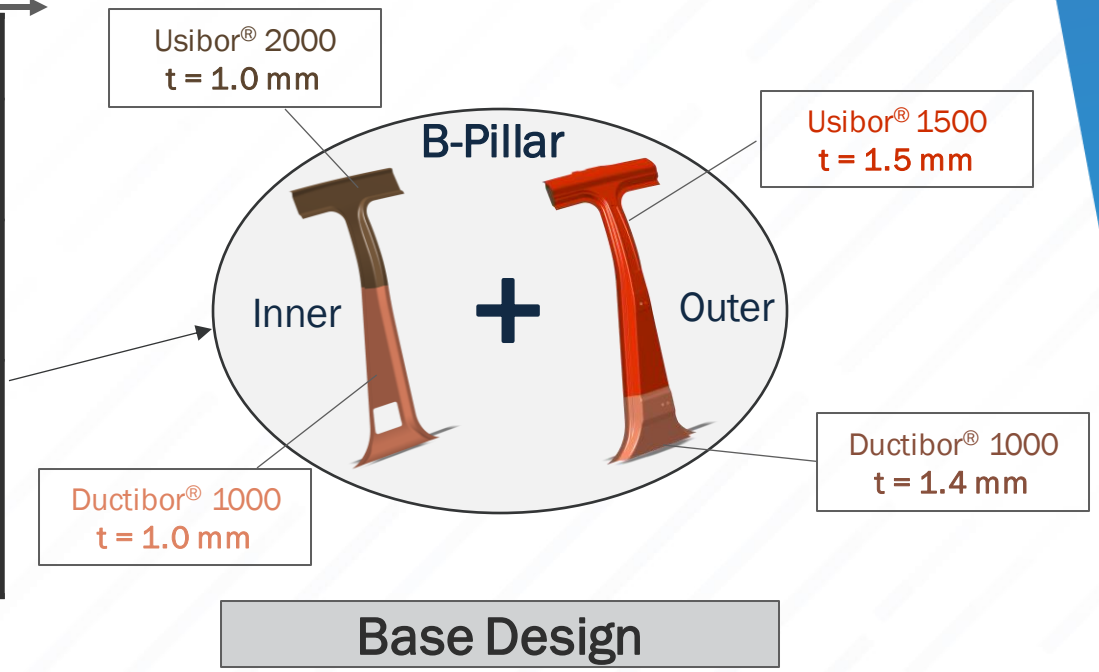
- Three design strategies OEMs can pursue to comply with roof-crush requirements:
  - Common upperbody design for all variants (validated for heaviest = overdesign/overcost for most)
  - Redesign upperbody parts for heaviest variants (specific tooling = overcost for heavy variants)
  - **Common upperbody design and added reinforcements in the assembly line for heaviest variants**



BIW redesign strategies are needed to meet performance of low volume heavy BEVs

Common upperbody design strategy for different model variants
LWB B-Pillar Baseline design for ICE and hybrid

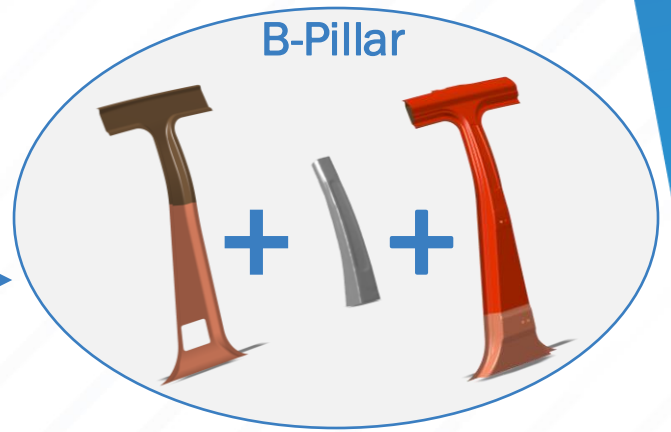
Vehicle Model	Baseline ICE	Hybrid
BiW Strategy	Base Design	Base Design
Annual Veh. Volume	High volume (250k+)	80,000-150,000
Add On Parts	NO 	NO 
	No reinforcement	



IIHS Roof Strength Target for All Variants ≥ 4.0 SWR

Common upperbody design strategy for different model variants
LWB B-Pillar with add-on PHS stamped reinforcement

Vehicle Model	Baseline ICE	Hybrid	Standard BEV
BiW Strategy	Base Design	Base Design	Modified Base
Annual Veh. Volume	High volume (250k+)	80,000-150,000	40,000-100,000
Add On Parts	NO	NO	YES
	No reinforcement		Stamped reinforcement



IIHS Roof Strength Target for All Variants ≥ 4.0 SWR

Base + PHS stamped reinforcement

Low part cost for medium to high veh. volume

Common upperbody design strategy for different model variants
LWB B-Pillar with add-on WLAM steel reinforcement

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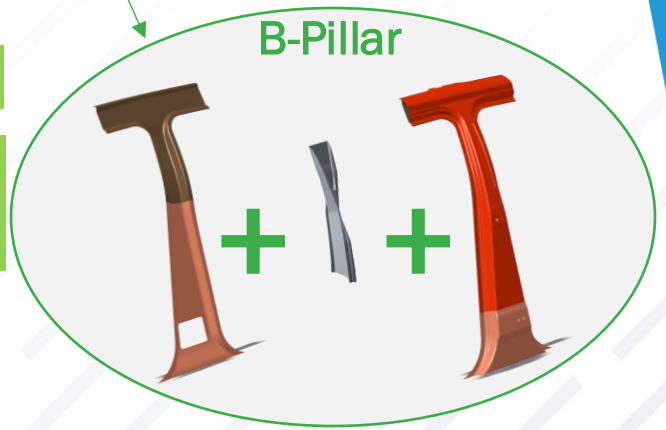
Vehicle Model	Baseline ICE	Hybrid	Standard BEV	High-End BEV	Ultimate BEV
BiW Strategy	Base Design	Base Design	Modified Base	Carryover Standard BEV	Carryover Standard BEV
Annual Veh. Volume	High volume (250k+)	80,000-150,000	40,000-100,000	Up to 10,000	Up to 5,000
Add On Parts	NO	NO	YES	YES	YES
	No reinforcement		Stamped reinforcement	WLAM reinforcement	

IIHS Roof Strength Target for All Variants ≥ 4.0 SWR

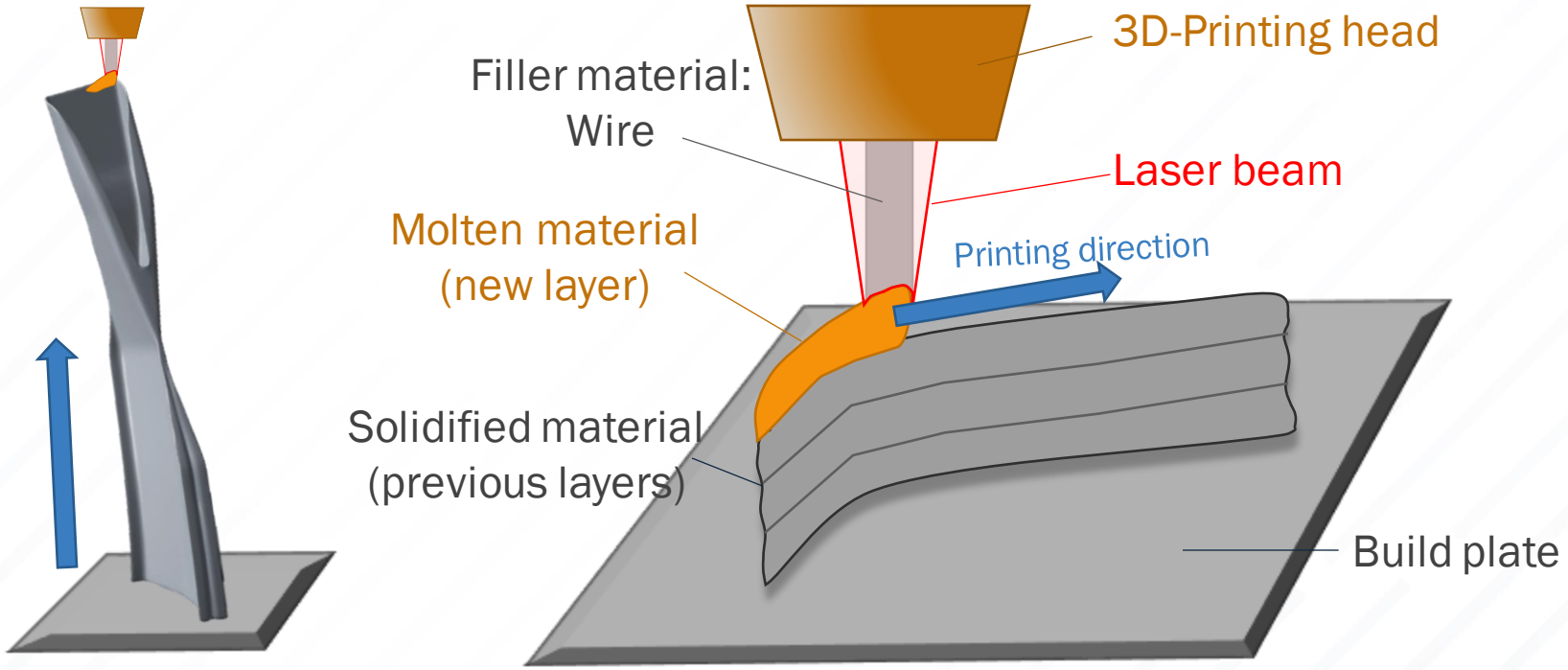
Base + WLAM reinforcement

Good cost-performance ratio for low veh. volume (<10,000 veh/yr)



WLAM technology for B-Pillar steel reinforcements

- WLAM (Wire Laser Additive Manufacturing) is an Additive Manufacturing or 3D-Printing technology
- Printing process consists of a laser beam that melts a steel filler wire to build a part layer by layer
- WLAM shows a good balance between cost, productivity and printing resolution compared to other technologies adapted to metals



ArcelorMittal is actively developing WLAM technology for automotive applications

Example of design sequence for WLAM reinforcement

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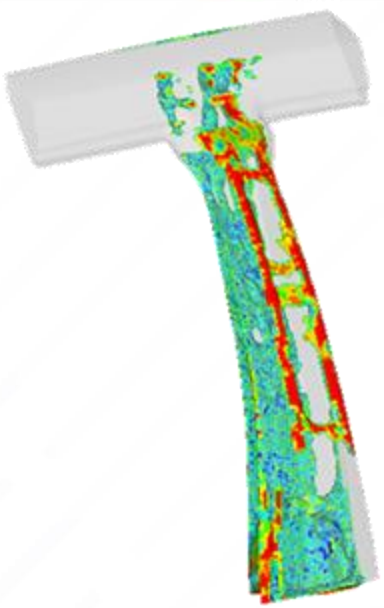
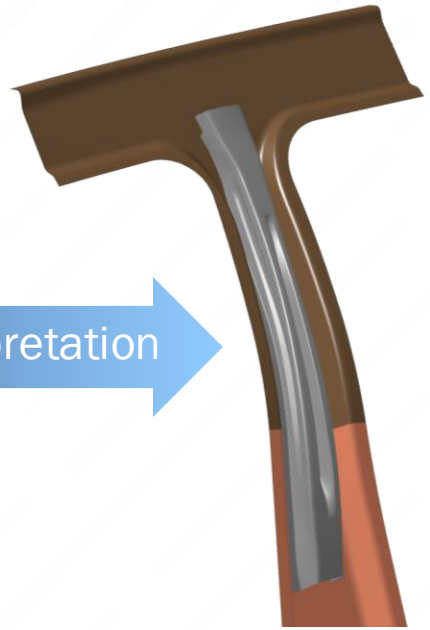
Optimized Topology



✓ Performance

Interpretation

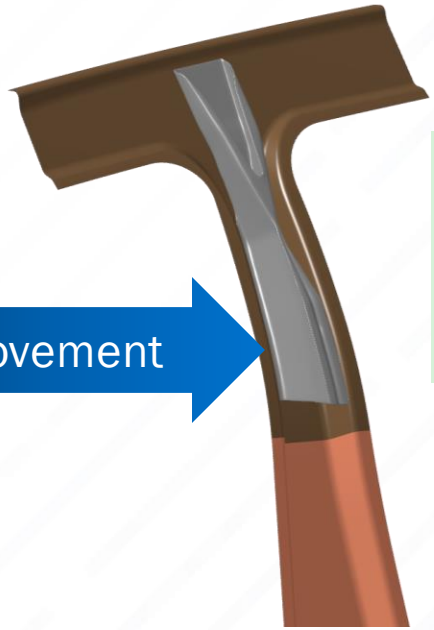
Interim Design Iteration



✓ Performance
✓ WLAM feasability

Improvement

Final Design



✓ Performance
✓ WLAM feasibility
✓ Improved productivity

Strategic material placement and iterations for best performance and productivity
➔ quick turnarounds

WLAM reinforcements for B-Pillar are designed for the best performance and processability

WLAM Reinforcements adapted for the strongest loadcases
Evolutive LWB B-Pillar design adapted to each variant

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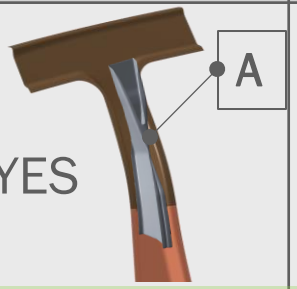
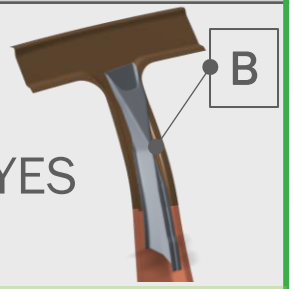
Vehicle Model	Baseline ICE	Hybrid	Standard BEV	High-End BEV	Ultimate BEV
BiW Strategy	Base Design	Base Design	Modified Base	Carryover Standard BEV	Carryover Standard BEV
Add On Parts	NO 	NO 	YES  Reinf.weight +1.2kg	YES  Reinf.weight +1.0kg	YES  Reinf.weight +1.3kg
	No reinforcement		Stamped reinforcement	WLAM reinforcement	
Vehicle Curb Weight	Roof-strength				
Up to 2300kg	SWR>>4.0	SWR>4.0	SWR>>4.0	SWR>>4.0	SWR>>4.0
+300kg			SWR>4.0	SWR>>4.0	SWR>>4.0
+500kg				SWR>4.0	SWR>>4.0
+900kg					SWR>4.0

Extra weight

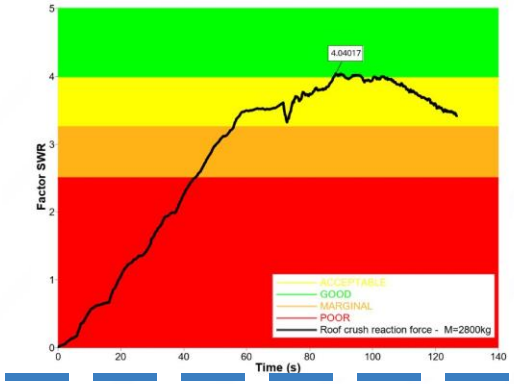
OEMs can now simplify platform design and still produce low volume variants

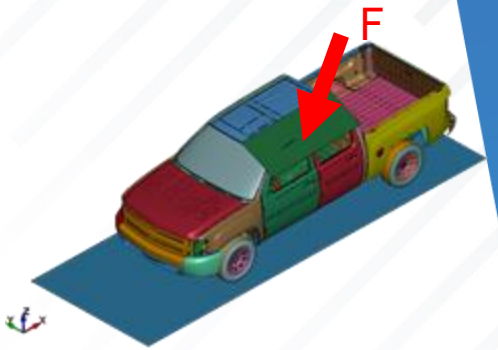
WLAM design can be optimized for required strength
Evolutive LWB B-Pillar design adapted to each variant

Vehicle Model	High-End BEV	Ultimate BEV
BiW Strategy	Carryover Standard BEV	Carryover Standard BEV
Add On Parts	YES 	YES 
	WLAM reinforcement	
Curb Weight	Roof-strength	
Up to 2300kg	SWR>>4.0	SWR>>4.0
+300kg	SWR>>4.0	SWR>>4.0
+500kg	SWR>4.0	SWR>>4.0
+900kg		SWR>4.0

Extra weight

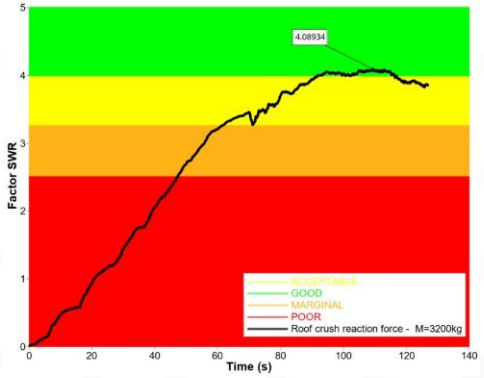
WLAM Reinforcement A

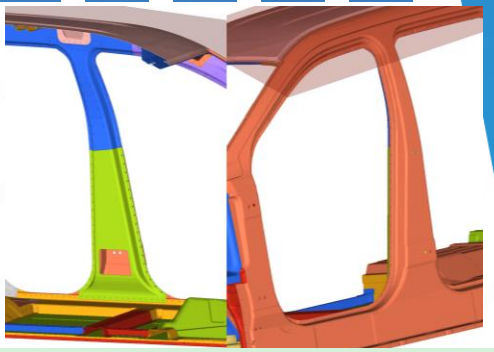




- ✓ Low weight: 1.0 kg
- ✓ Up to 500kg of extra load
- ✓ Also validated in side impact (MDB 2.0)

WLAM Reinforcement B





- ✓ Low weight: 1.3 kg
- ✓ Up to 900kg of extra load
- ✓ Also validated in side impact (MDB 2.0)

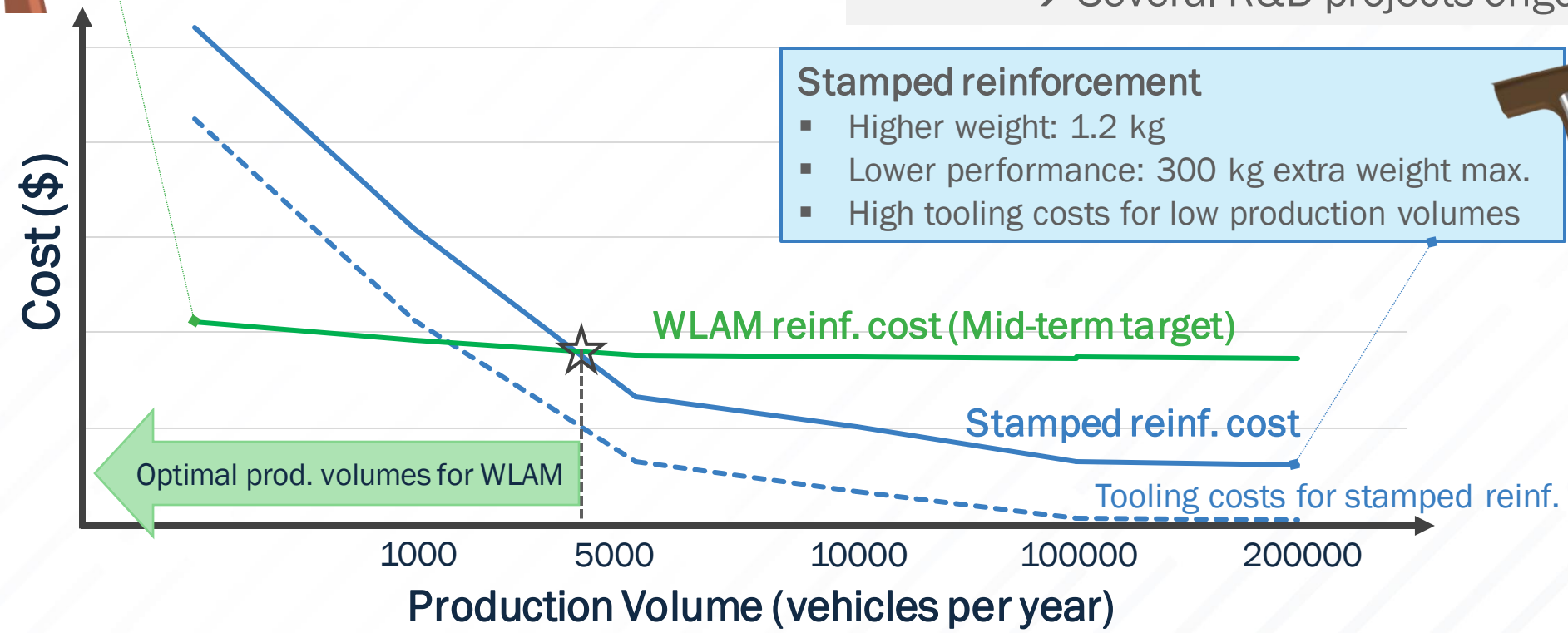
Very important increase in roof-strength can be obtained with light WLAM reinforcements

WLAM Reinforcements as a complementary design solution for OEMs

WLAM Reinforcement A:
- ✓ Low weight: 1.0 kg
- ✓ High performance: Up to 500kg extra weight

To match mid-term cost targets for WLAM:
- Process maturity and scalability has to be improved
  → Several R&D projects ongoing at ArcelorMittal

Stamped reinforcement
- Higher weight: 1.2 kg
- Lower performance: 300 kg extra weight max.
- High tooling costs for low production volumes



At mid-term, WLAM can be good cost-performance solution for low volume variants

WLAM reinforcements for low volume production

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- **WLAM reinforcements can be a good alternative for heaviest and low volume production variants**
  - ✓ No dedicated tooling investment – ability to produce flexible designs across multiple variants
  - ✓ Plug-in solution for increased roof-crush performance with low extra weight
  - ✓ Allows Midcycle Actions to react quickly
    - Upgrades
    - Battery weight changes
    - Content Additions
  - ✓ Good compromise between cost and performance (mid-term)

Tool less manufacturing for lower production parts while being efficient from the start of the production

Other ArcelorMittal Global R&D initiatives
Additive Manufacturing for Automotive

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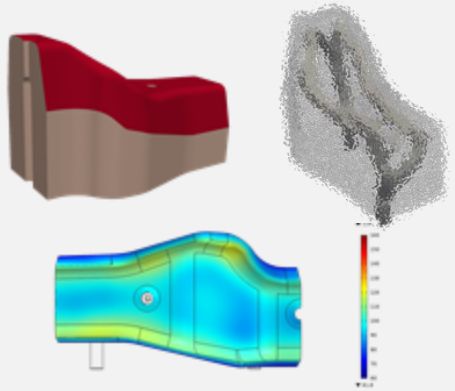
Applications:



Tooling

Brake cladding

Small parts

Reinforcements

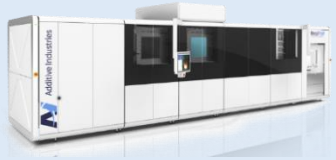
Medium size to large components

And more…

Material and technology developments:

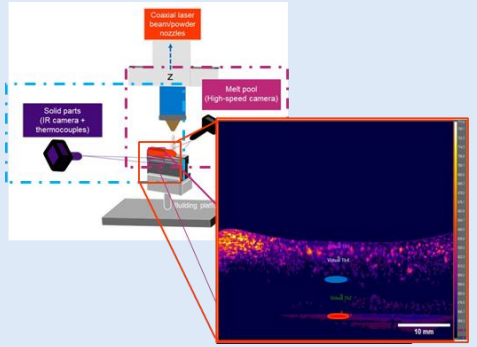
Powders and wires

Atomisation



Additive mfg. process

Process monitoring



ArcelorMittal Global R&D is actively working in Additive Manufacturing since 2016

ArcelorMittal Powders

Steel. And only steel.
Steel Powders for Additive Manufacturing.

Coming from **7 years of research on Additive.**

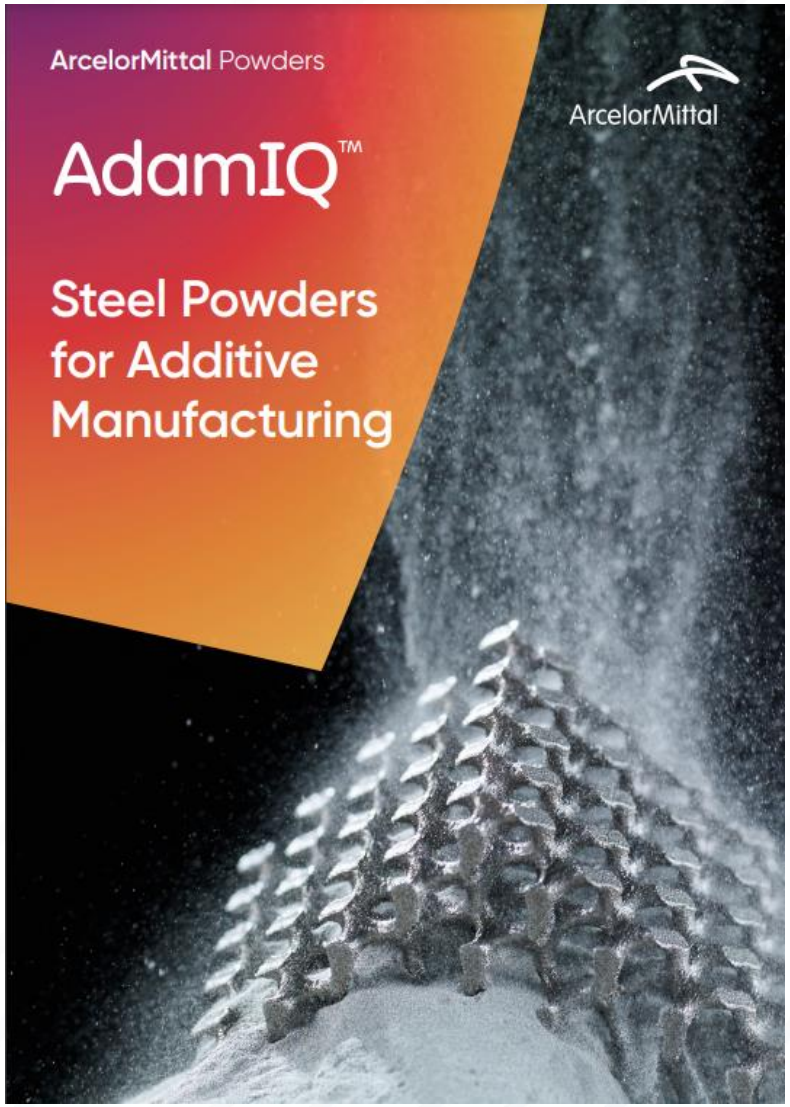
- Our Research Center in Spain focuses ArcelorMittal expertise in process, metallurgy and digital towards Additive Manufacturing both materials and parameters.
- Our ISO 9001 certified powder to part lab includes Lab Atomizing, Printing and Post Processing, Powder and Part Characterization.
- Efforts are directed at improving productivity and removing variability, supporting applications.

Large batch production and state-of-the-art sieving

1000 tons capacity, Aviles, Spain. Batch sizes from 200 kg to 3 tonnes; quality, reliability and traceability meeting the high standards and specifications of the Additive Manufacturing industry. Accurate sizing of the powder for your application.

First, productivity: Powders at scale, Standard Grades
Productivity as a Service

Next, variations in steel grades
Steels with improved processability and final properties



https://powders.arcelormittal.com/

For More Information

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THANK YOU

Cristian Alvarez
Additive Manufacturing Solutions Team Leader
ArcelorMittal Global R&D
cristian.alvarez@arcelormittal.com

ArcelorMittal
corporate.arcelormittal.com

Tejas Chillale
Senior Product Development Specialist
ArcelorMittal Global R&D
tejas.chillale@arcelormittal.com

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