

**Door module from fibre reinforced
plastics - a positive contribution to car
manufacturing**



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Door Module from FRP

- Development in Door System

**Actual STEEL
Door System**

Steel Outside
Panel

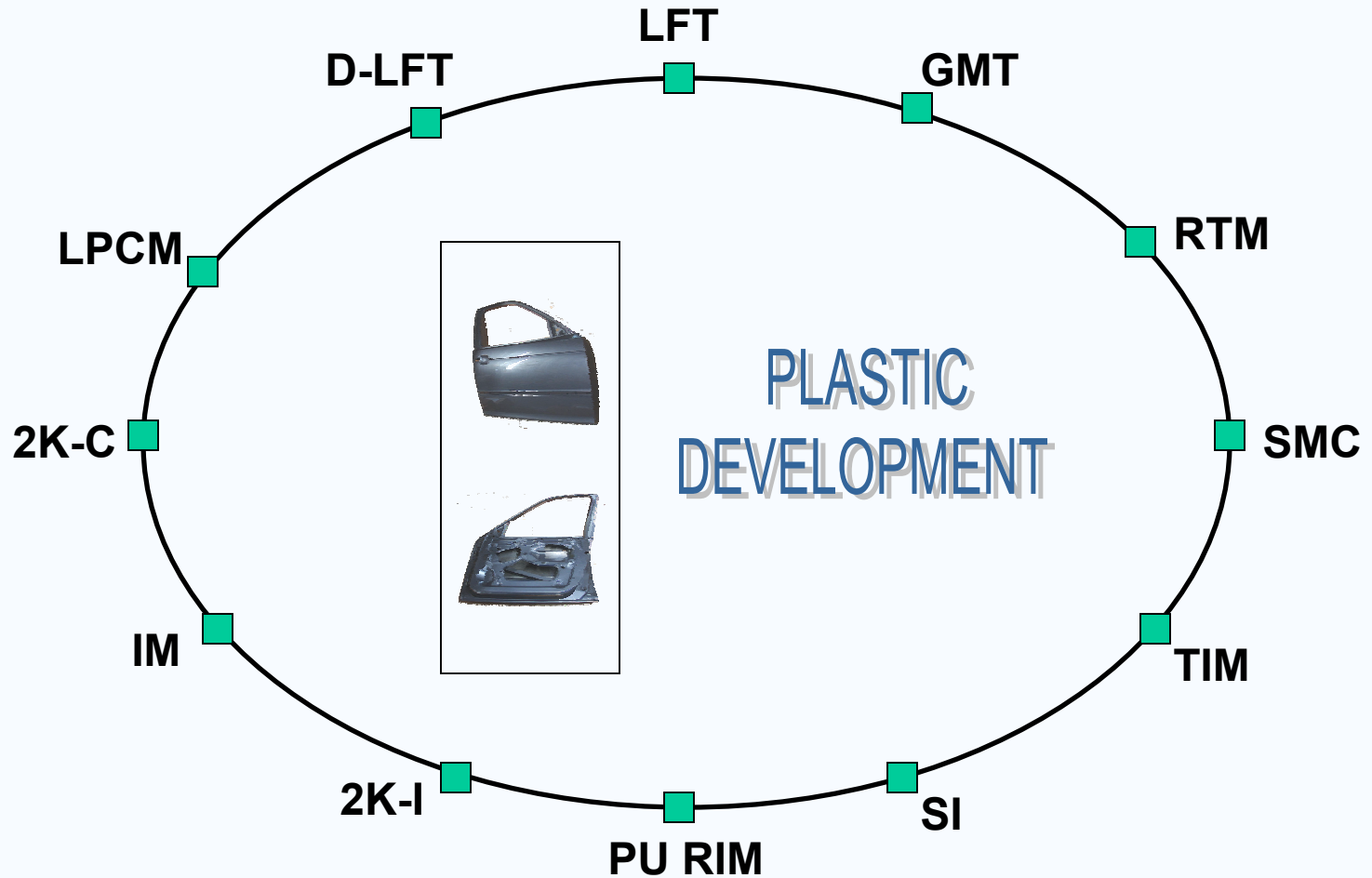


Steel Door
Carrier

HEAVY WEIGHT and DIFFICULT FUNCTION INTEGRATION

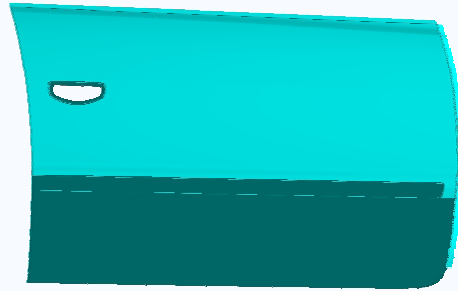
Door Module from FRP

- Development in Door System



Door Module from FRP

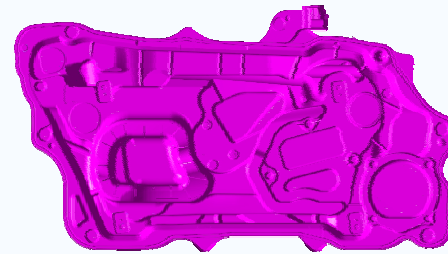
Exterior Door Panel



SMC / Thermoplastic



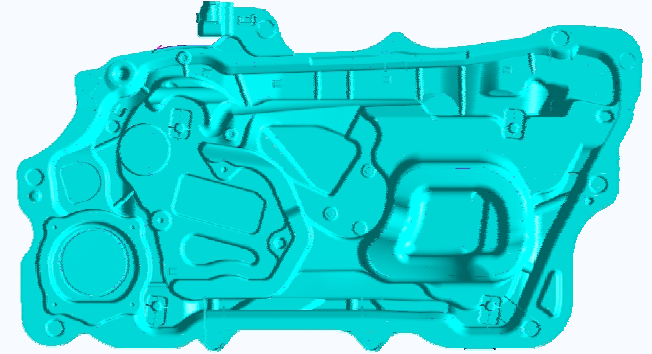
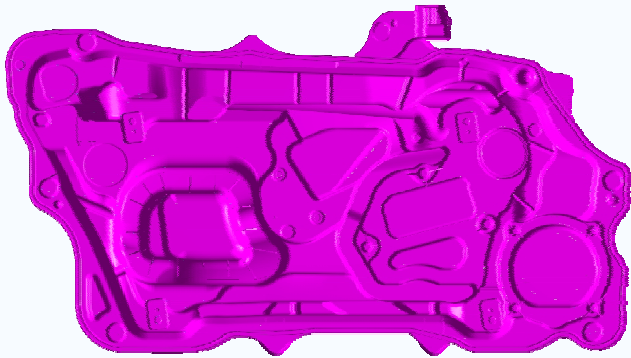
Door Carrier



GMT / D-LFT



Door Module from FRP

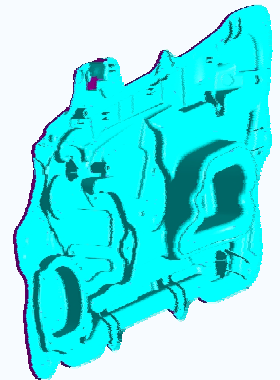


Technology Compression
Molding

Material GMT / D-LFT (PP GF)

Weight 2 kg

Thickness 2.5 mm



Door Module from FRP

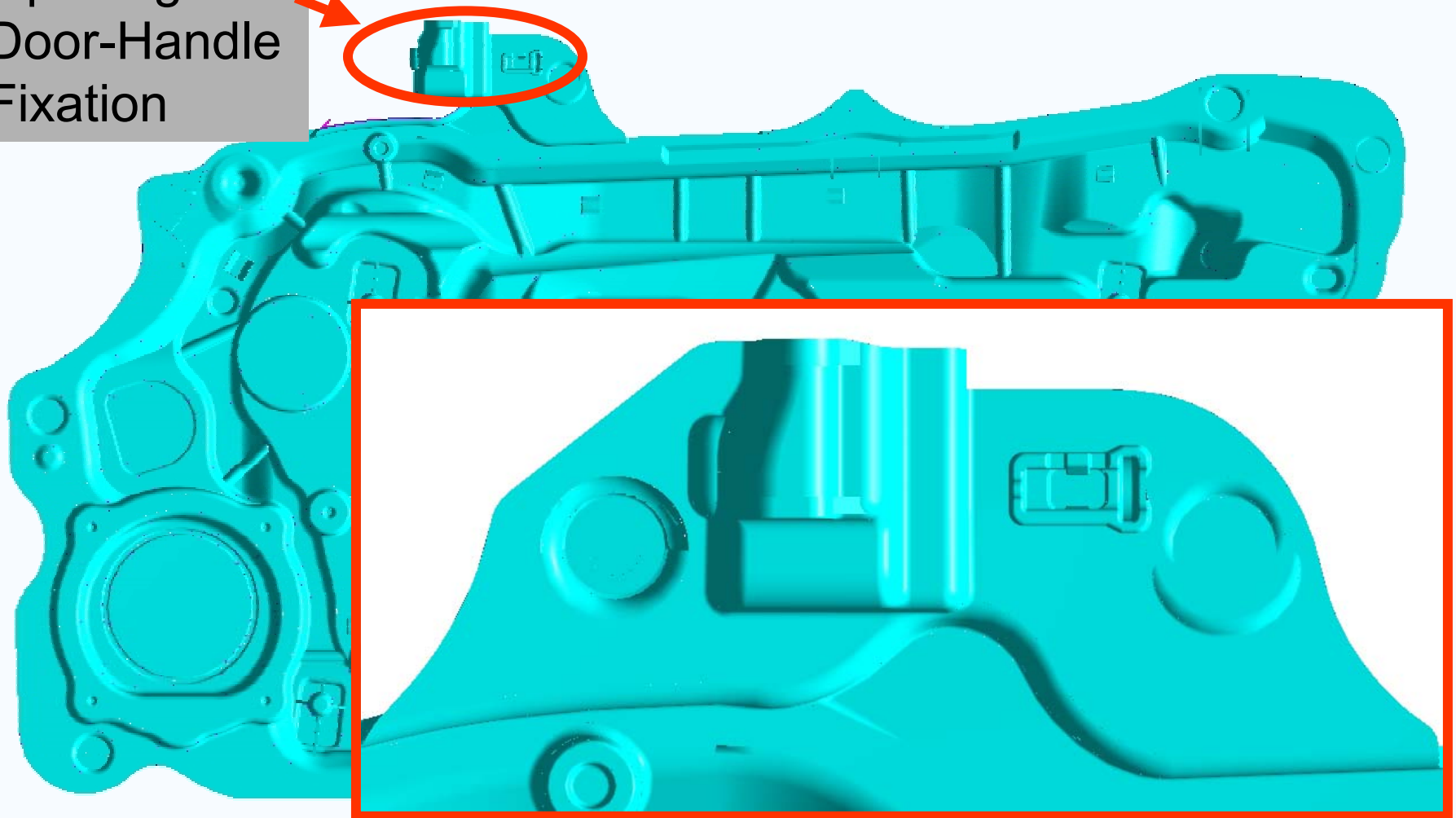
GMT / D-LFT Advantages

- Cost Reduction
 - Weight Reduction
 - Free Design
 - Function Integration
 - Sound Absorption
 - Crash Resistance
 - Easy Assembly
 - Corrosion Resistance
 - Recyclability
-

Door Module from FRP

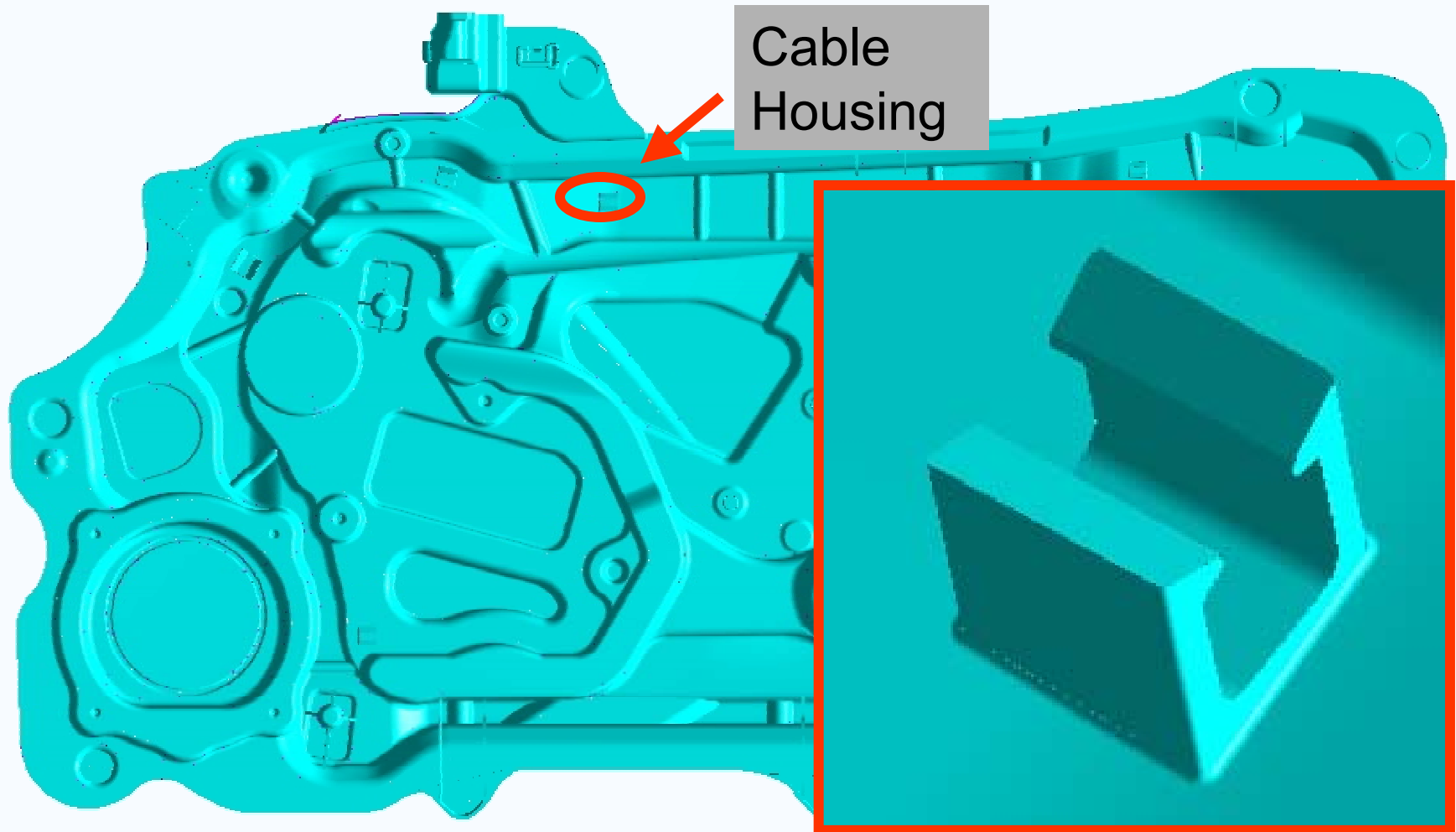
Function Integration

Opening
Door-Handle
Fixation



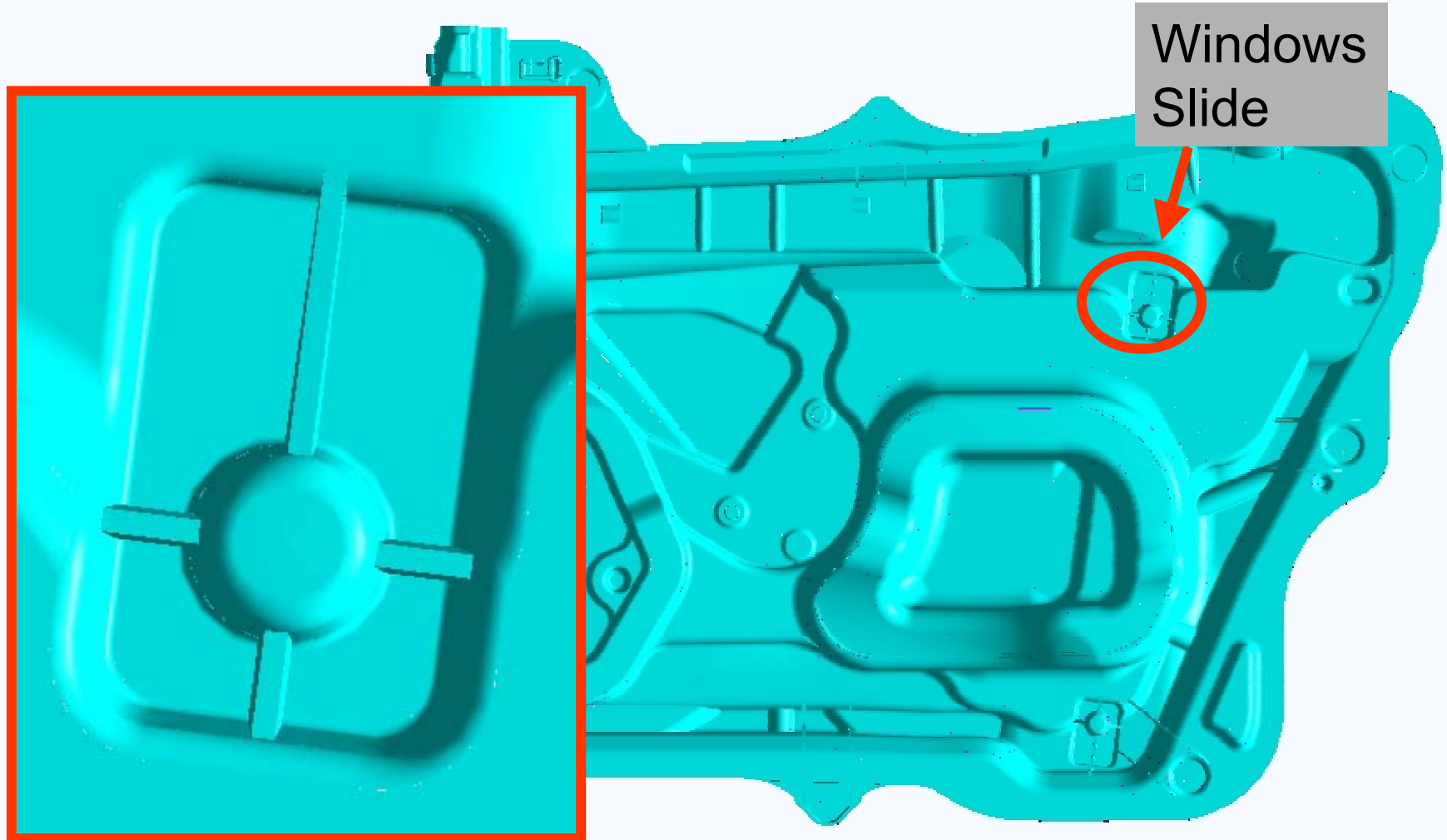
Door Module from FRP

Function Integration



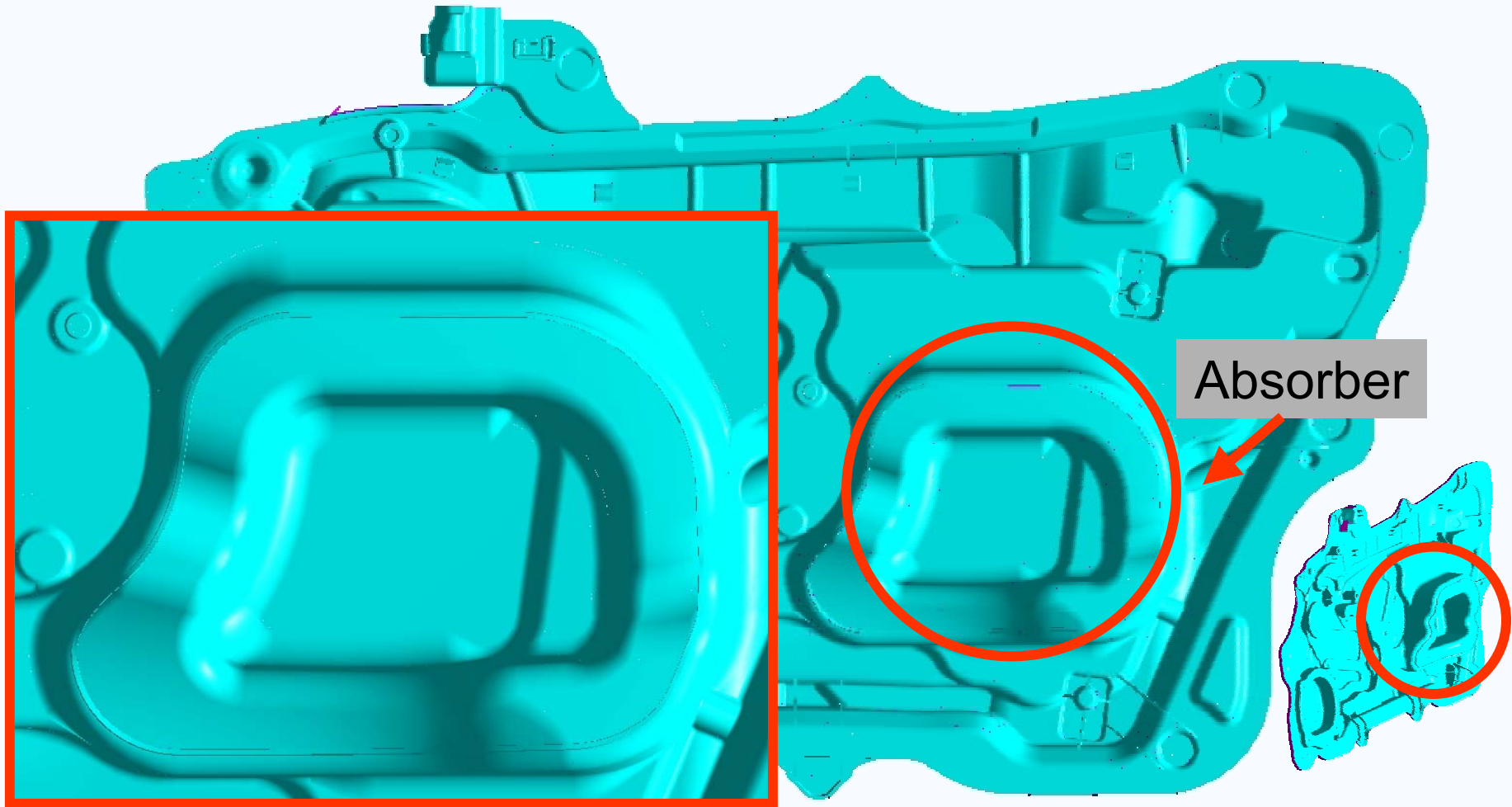
Door Module from FRP

Function Integration



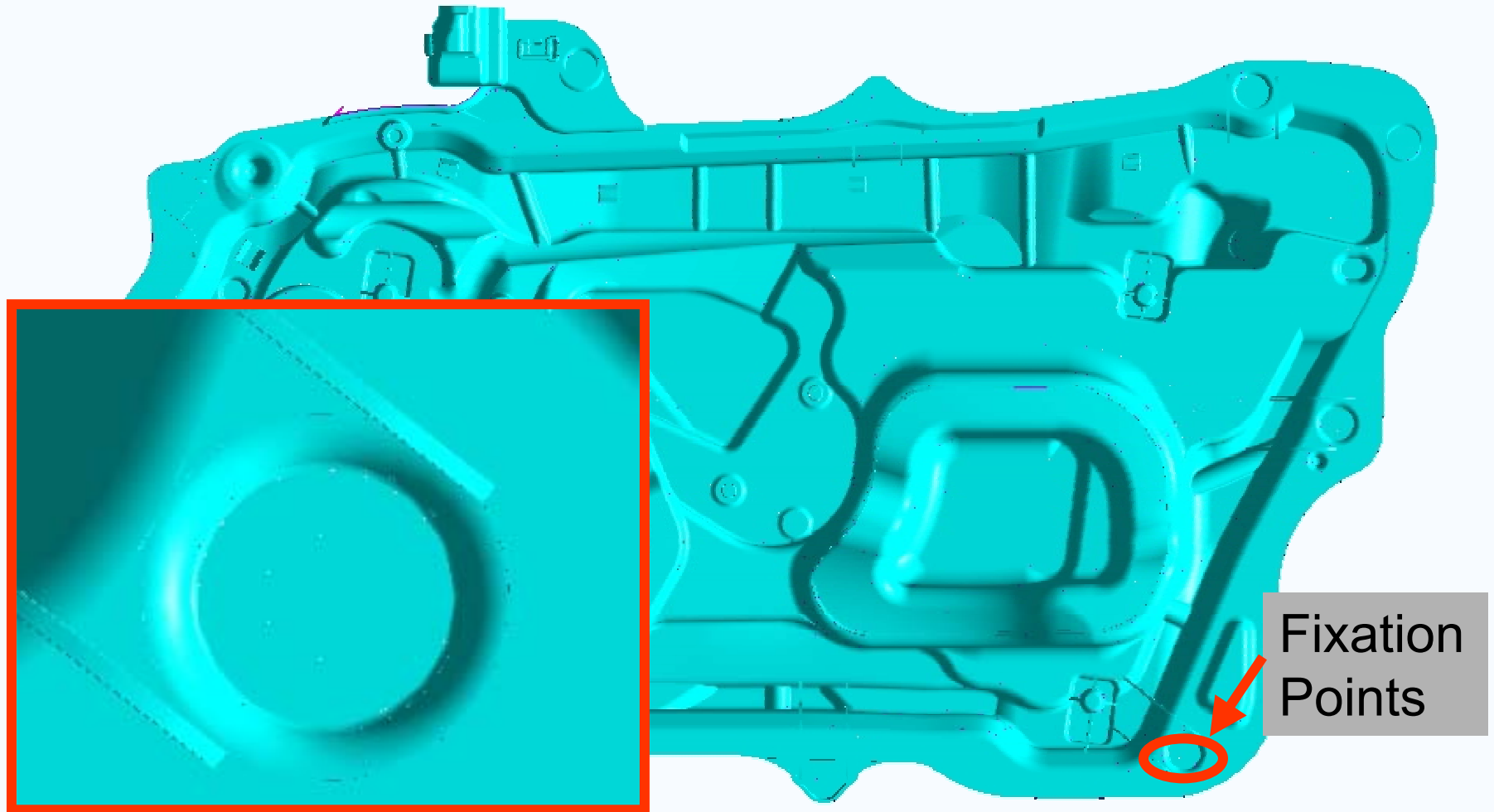
Door Module from FRP

Function Integration



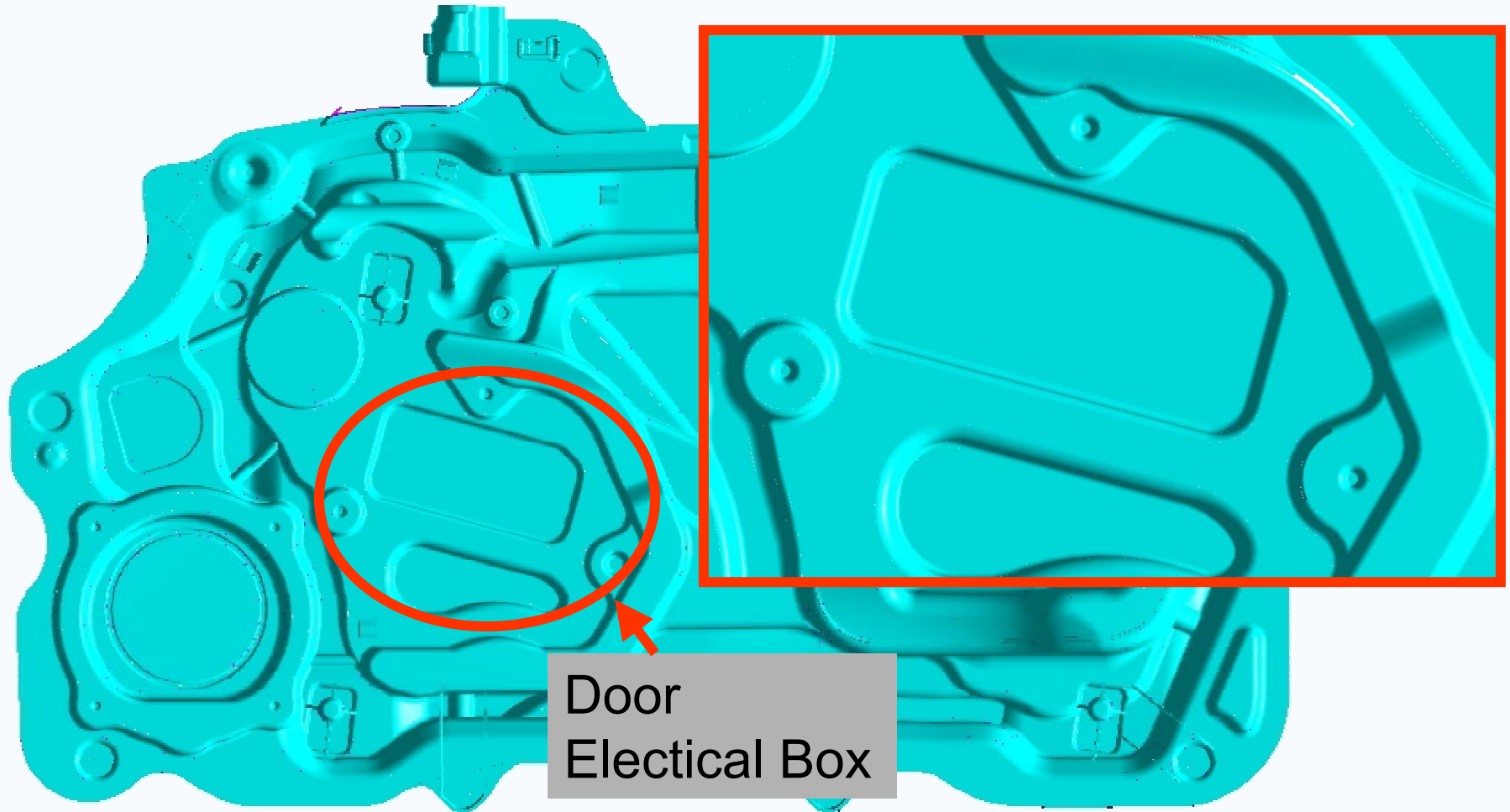
Door Module from FRP

Function Integration



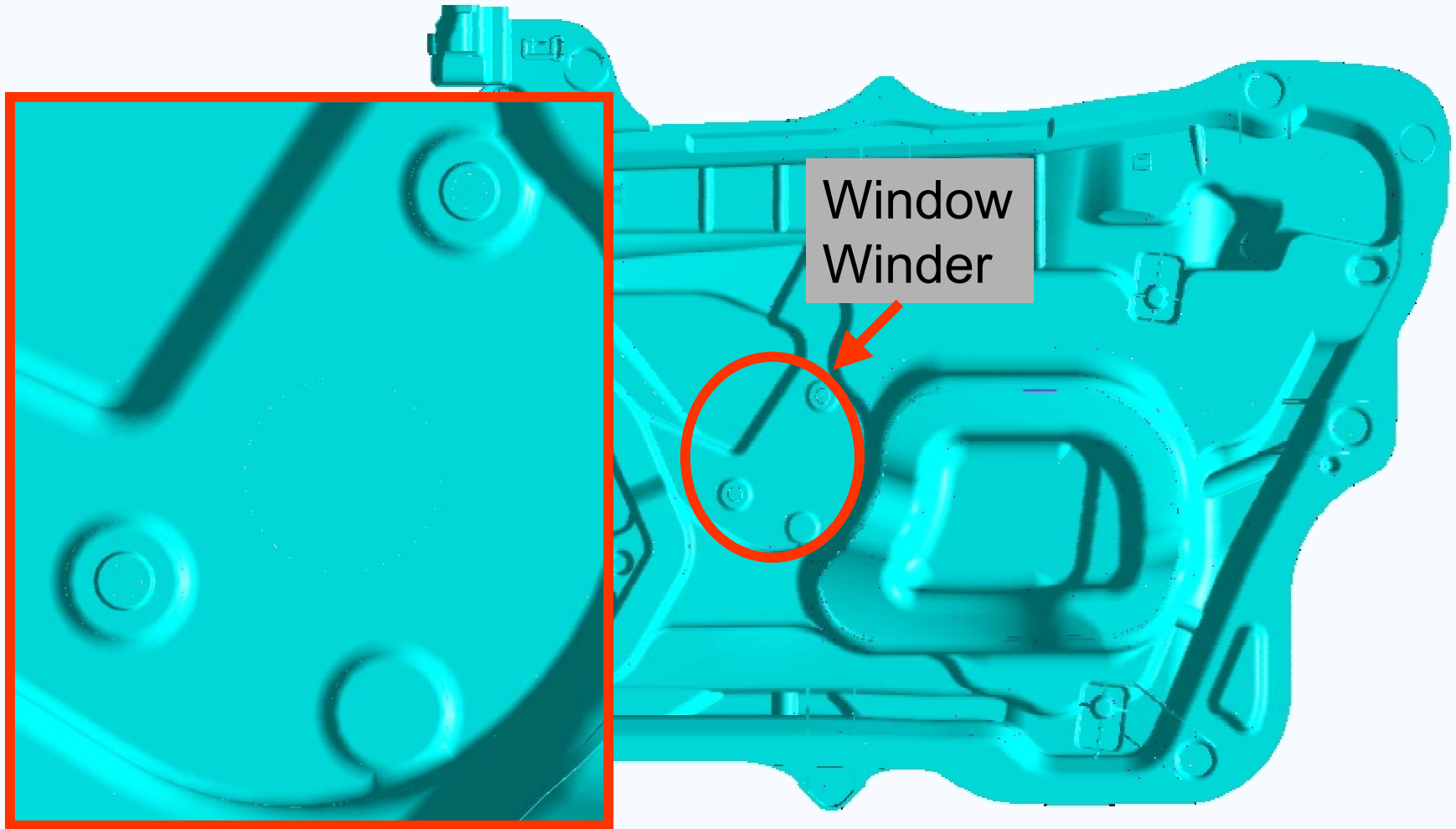
Door Module from FRP

Function Integration



Door Module from FRP

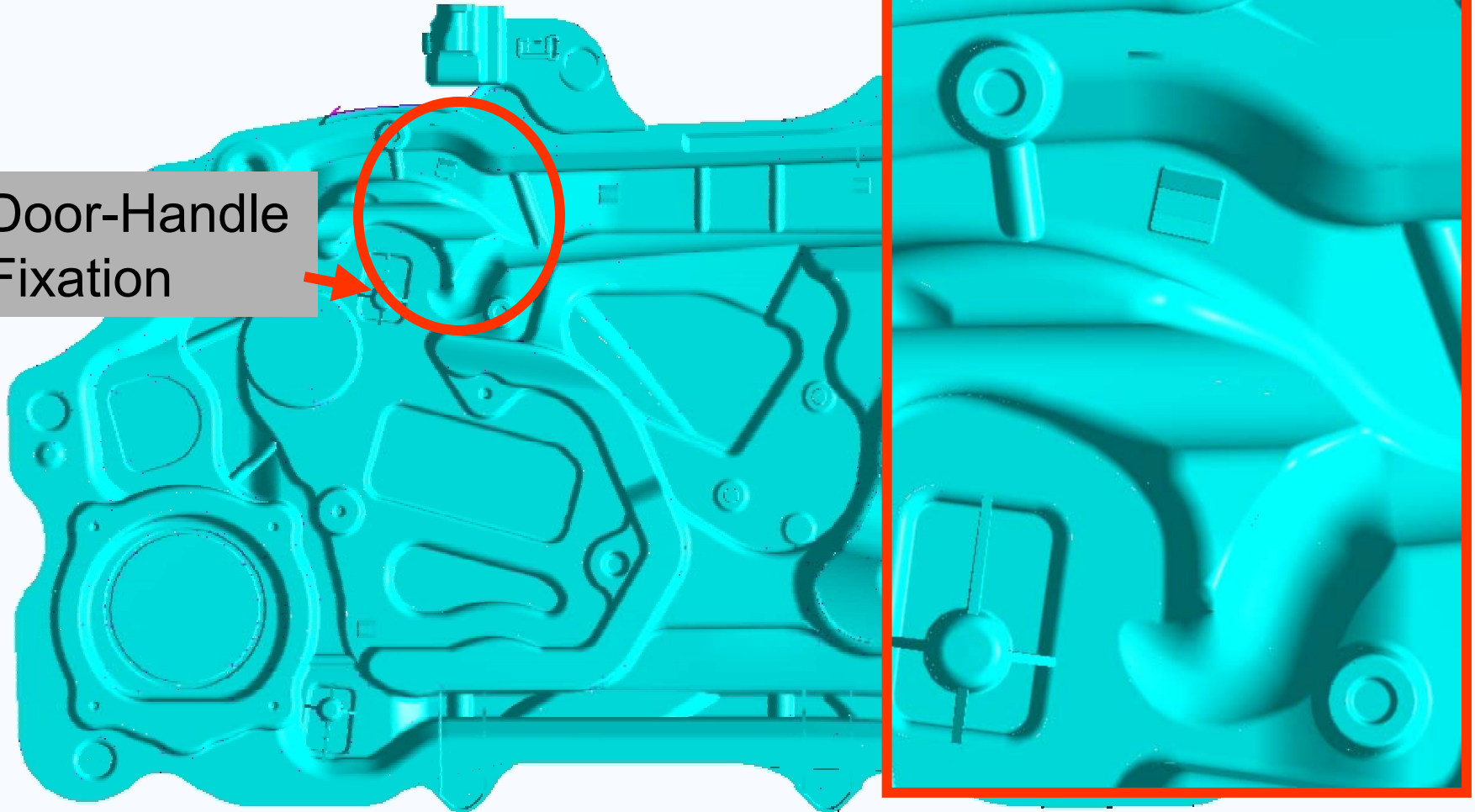
Function Integration



Door Module from FRP

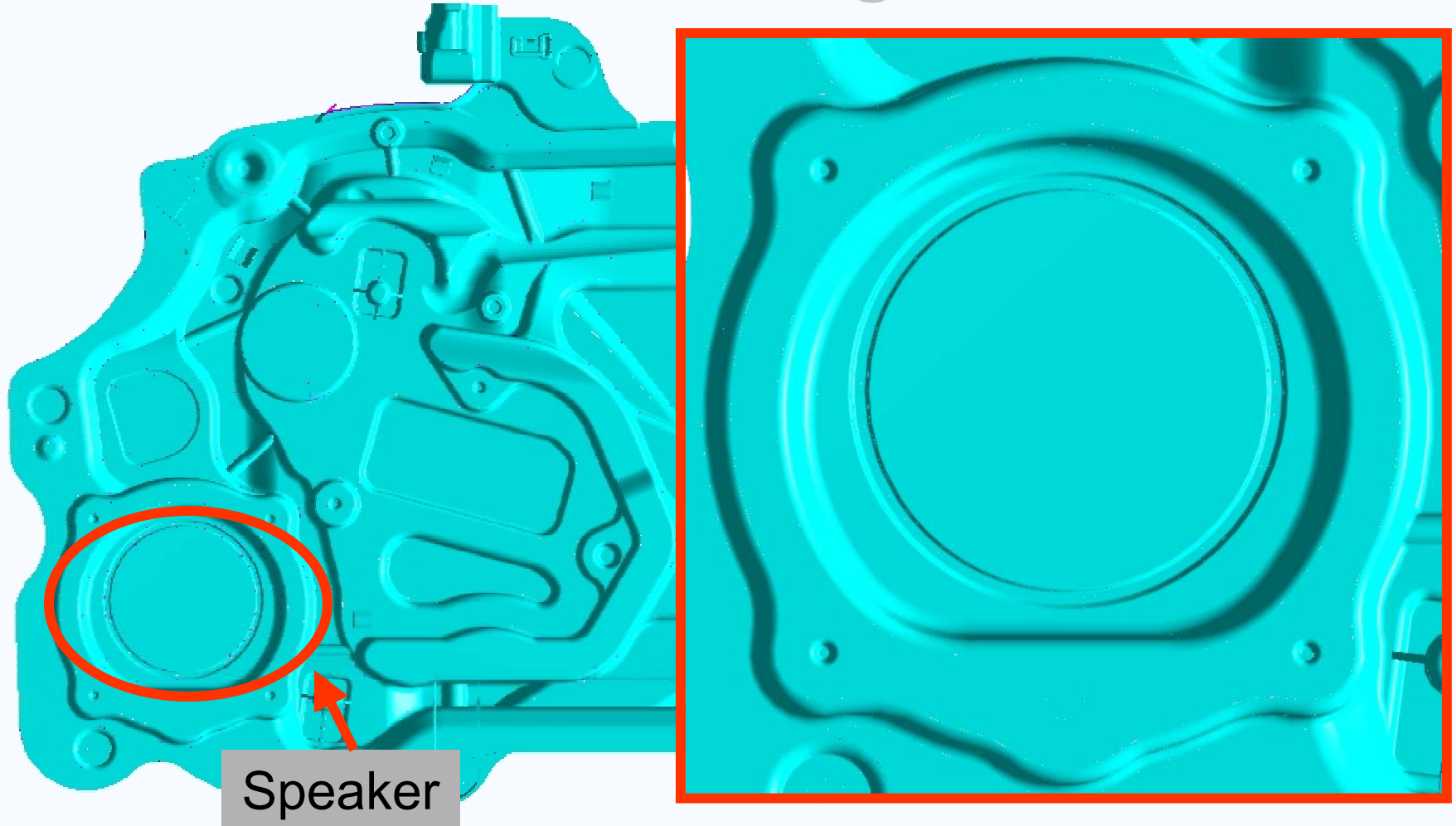
Function Integration

Door-Handle
Fixation



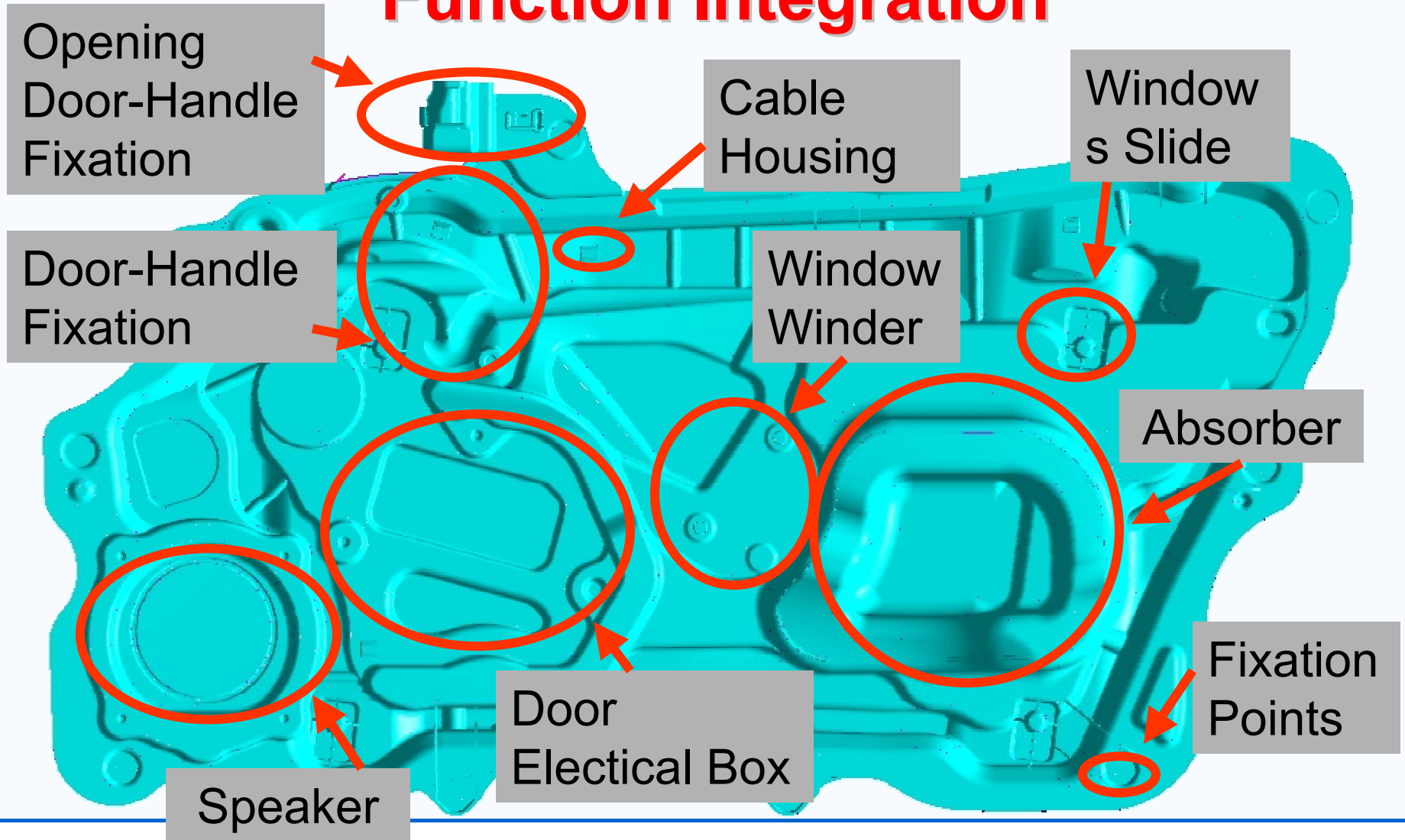
Door Module from FRP

Function Integration



Door Module from FRP

Function Integration



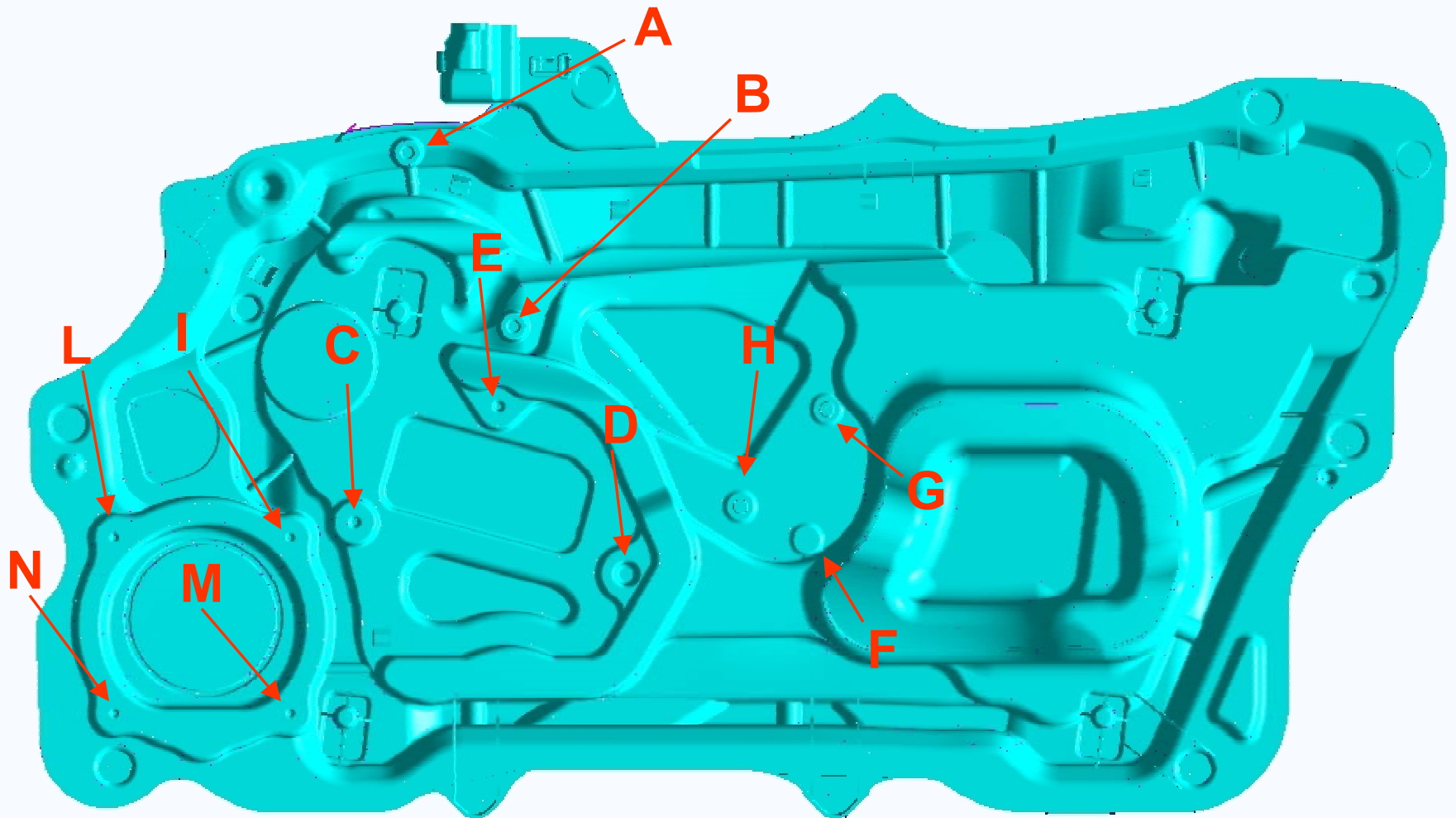
Door Module from FRP

Price Evaluation

Material	Thickness [mm]	Weight [kg]	Material Price / pcs	Investment	Assembled price / pcs	Function Integration
Steel	0.8	3.9	0.8	1.6	1.2	<i>Low</i>
GMT	2.5–3.5	2	1	1	1	<i>High</i>

Door Module from FRP

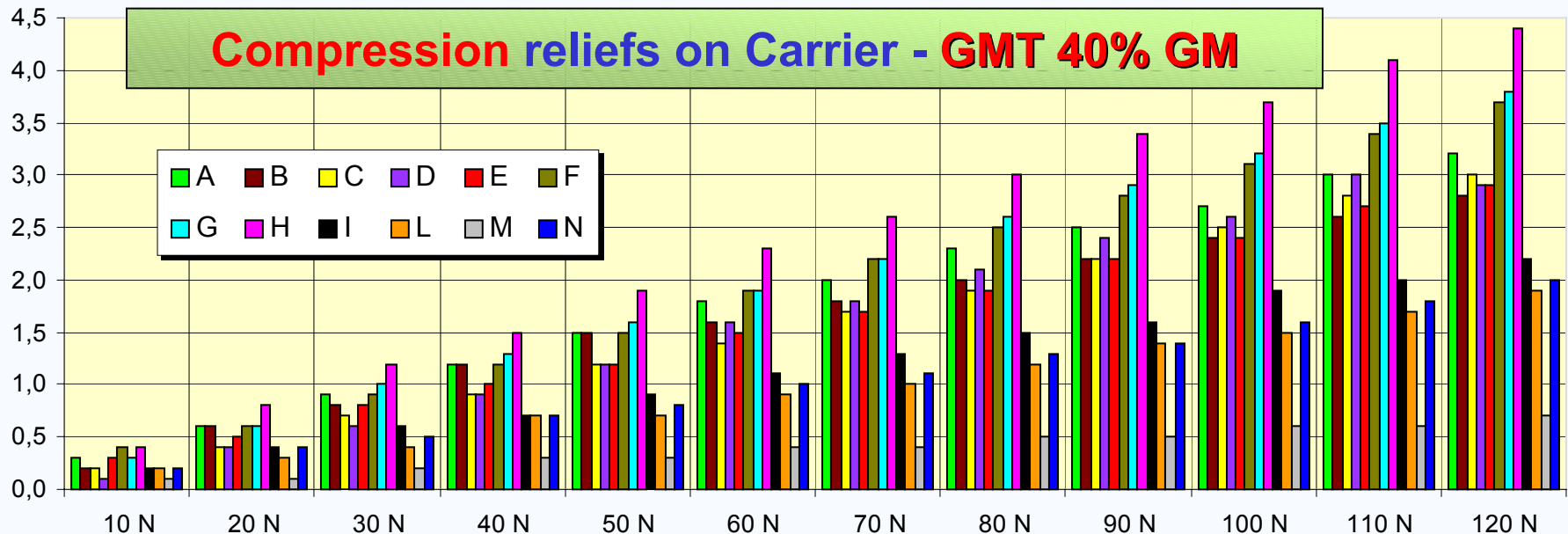
Development in Door System TESTS



Door Module from FRP

Development in Door System TESTS

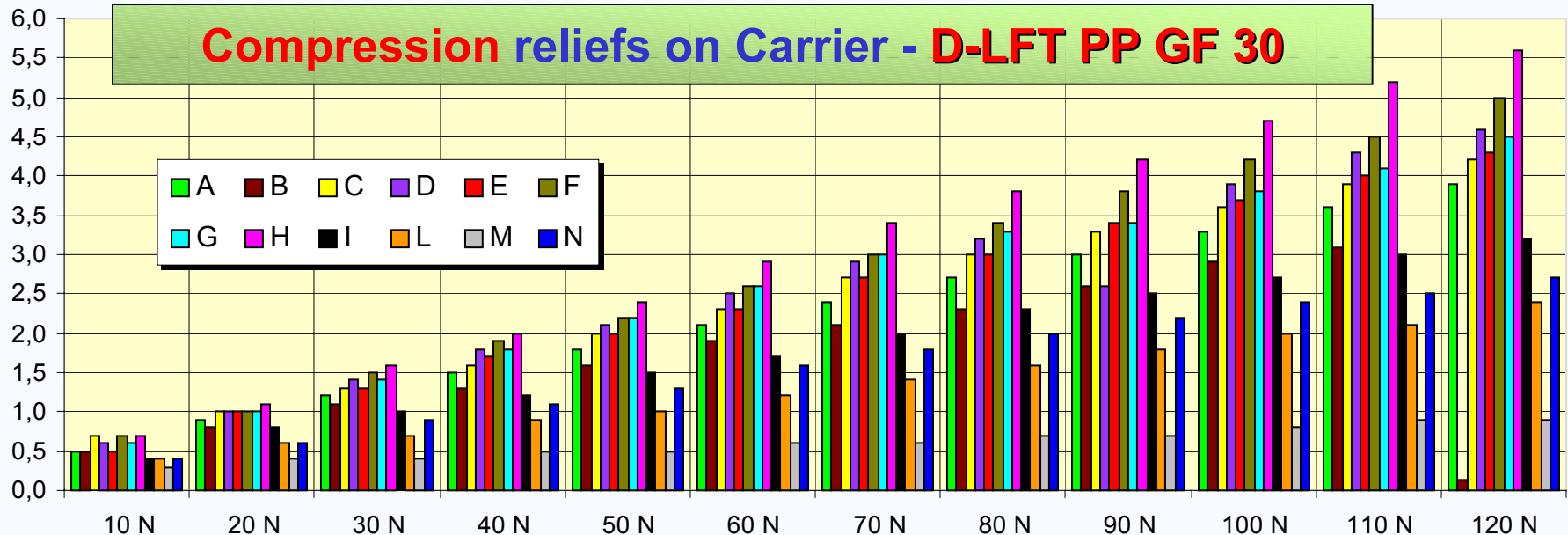
Measuring point	Checked shifting (mm)											
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A	0,3	0,6	0,9	1,2	1,5	1,8	2,0	2,3	2,5	2,7	3,0	3,2
B	0,2	0,6	0,8	1,2	1,5	1,6	1,8	2,0	2,2	2,4	2,6	2,8
C	0,2	0,4	0,7	0,9	1,2	1,4	1,7	1,9	2,2	2,5	2,8	3,0
D	0,1	0,4	0,6	0,9	1,2	1,6	1,8	2,1	2,4	2,6	3,0	2,9
E	0,3	0,5	0,8	1,0	1,2	1,5	1,7	1,9	2,2	2,4	2,7	2,9
F	0,4	0,6	0,9	1,2	1,5	1,9	2,2	2,5	2,8	3,1	3,4	3,7
G	0,3	0,6	1,0	1,3	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8
H	0,4	0,8	1,2	1,5	1,9	2,3	2,6	3,0	3,4	3,7	4,1	4,4
I	0,2	0,4	0,6	0,7	0,9	1,1	1,3	1,5	1,6	1,9	2,0	2,2
L	0,2	0,3	0,4	0,7	0,7	0,9	1,0	1,2	1,4	1,5	1,7	1,9
M	0,1	0,1	0,2	0,3	0,3	0,4	0,4	0,5	0,5	0,6	0,6	0,7
N	0,2	0,4	0,5	0,7	0,8	1,0	1,1	1,3	1,4	1,6	1,8	2,0



Door Module from FRP

Development in Door System TESTS

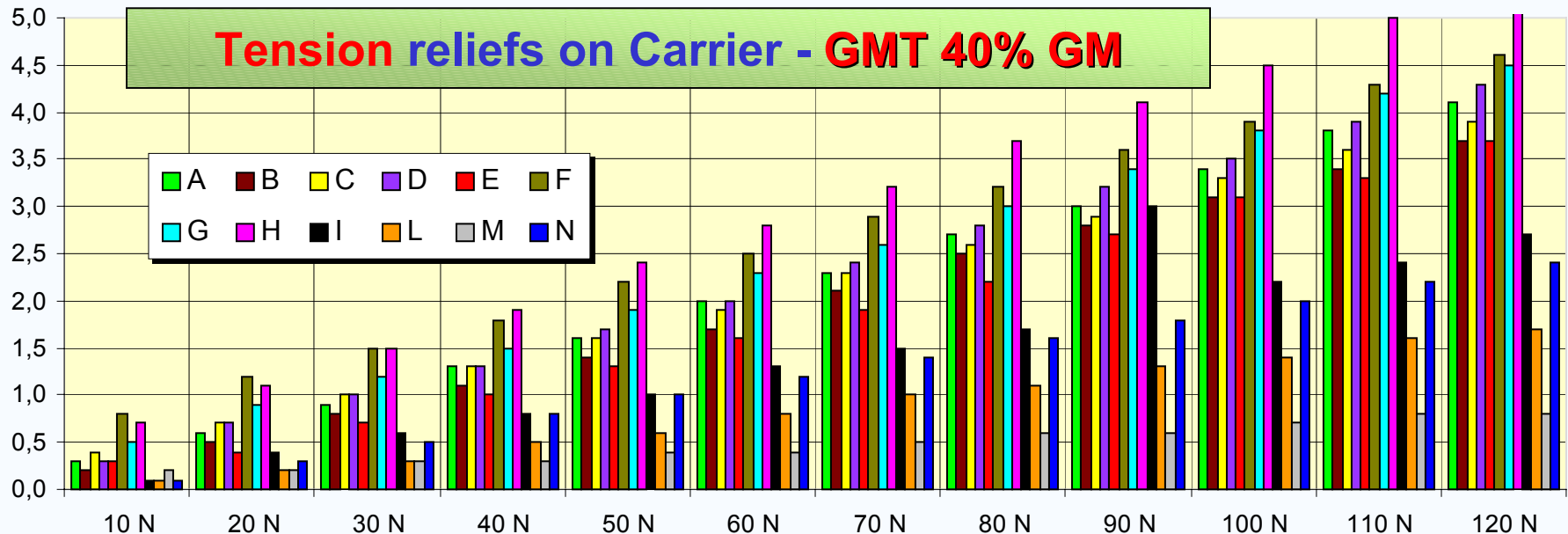
Measuring point	Checked shifting (mm)											
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A	0,5	0,9	1,2	1,5	1,8	2,1	2,4	2,7	3,0	3,3	3,6	3,9
B	0,5	0,8	1,1	1,3	1,6	1,9	2,1	2,3	2,6	2,9	3,1	0,1
C	0,7	1,0	1,3	1,6	2,0	2,3	2,7	3,0	3,3	3,6	3,9	4,2
D	0,6	1,0	1,4	1,8	2,1	2,5	2,9	3,2	2,6	3,9	4,3	4,6
E	0,5	1,0	1,3	1,7	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
F	0,7	1,0	1,5	1,9	2,2	2,6	3,0	3,4	3,8	4,2	4,5	5,0
G	0,6	1,0	1,4	1,8	2,2	2,6	3,0	3,3	3,4	3,8	4,1	4,5
H	0,7	1,1	1,6	2,0	2,4	2,9	3,4	3,8	4,2	4,7	5,2	5,6
I	0,4	0,8	1,0	1,2	1,5	1,7	2,0	2,3	2,5	2,7	3,0	3,2
L	0,4	0,6	0,7	0,9	1,0	1,2	1,4	1,6	1,8	2,0	2,1	2,4
M	0,3	0,4	0,4	0,5	0,5	0,6	0,6	0,7	0,7	0,8	0,9	0,9
N	0,4	0,6	0,9	1,1	1,3	1,6	1,8	2,0	2,2	2,4	2,5	2,7



Door Module from FRP

Development in Door System TESTS

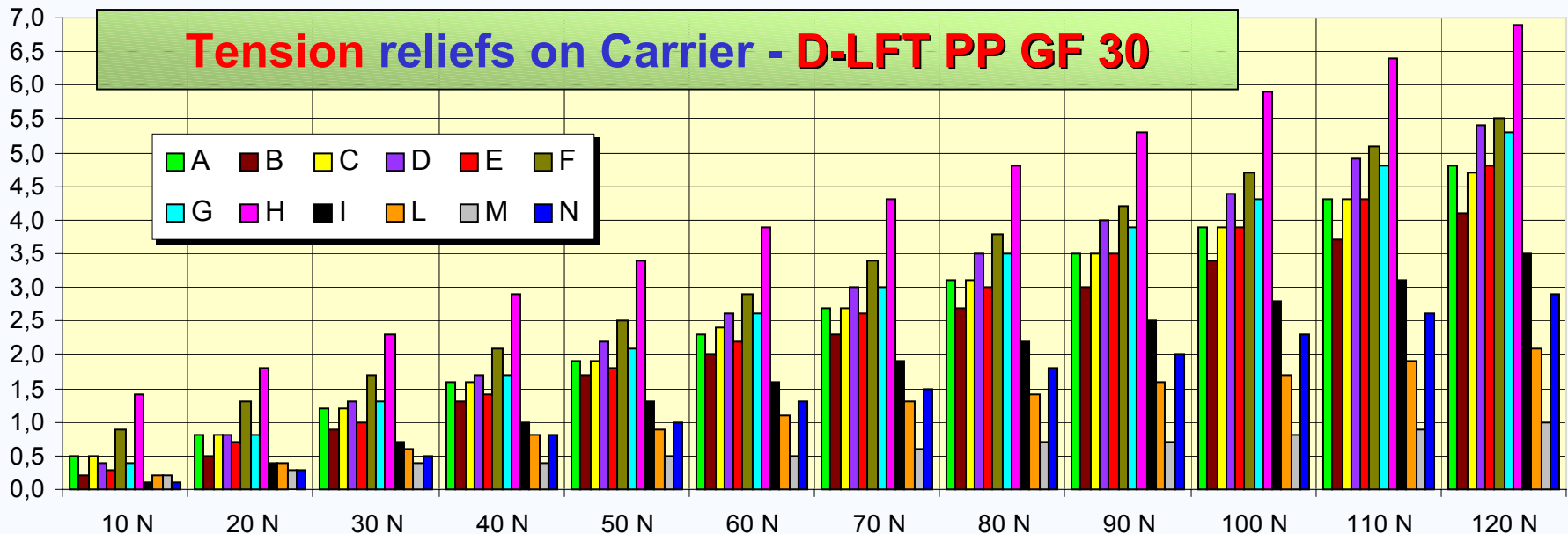
Measuring point	Checked shifting (mm)											
	10 N	20 N	30 N	40 N	50 N	60 N	70 N	80 N	90 N	100 N	110 N	120 N
A	0,3	0,6	0,9	1,3	1,6	2,0	2,3	2,7	3,0	3,4	3,8	4,1
B	0,2	0,5	0,8	1,1	1,4	1,7	2,1	2,5	2,8	3,1	3,4	3,7
C	0,4	0,7	1,0	1,3	1,6	1,9	2,3	2,6	2,9	3,3	3,6	3,9
D	0,3	0,7	1,0	1,3	1,7	2,0	2,4	2,8	3,2	3,5	3,9	4,3
E	0,3	0,4	0,7	1,0	1,3	1,6	1,9	2,2	2,7	3,1	3,3	3,7
F	0,8	1,2	1,5	1,8	2,2	2,5	2,9	3,2	3,6	3,9	4,3	4,6
G	0,5	0,9	1,2	1,5	1,9	2,3	2,6	3,0	3,4	3,8	4,2	4,5
H	0,7	1,1	1,5	1,9	2,4	2,8	3,2	3,7	4,1	4,5	5,0	5,4
I	0,1	0,4	0,6	0,8	1,0	1,3	1,5	1,7	3,0	2,2	2,4	2,7
L	0,1	0,2	0,3	0,5	0,6	0,8	1,0	1,1	1,3	1,4	1,6	1,7
M	0,2	0,2	0,3	0,3	0,4	0,4	0,5	0,6	0,6	0,7	0,8	0,8
N	0,1	0,3	0,5	0,8	1,0	1,2	1,4	1,6	1,8	2,0	2,2	2,4



Door Module from FRP

Development in Door System TESTS

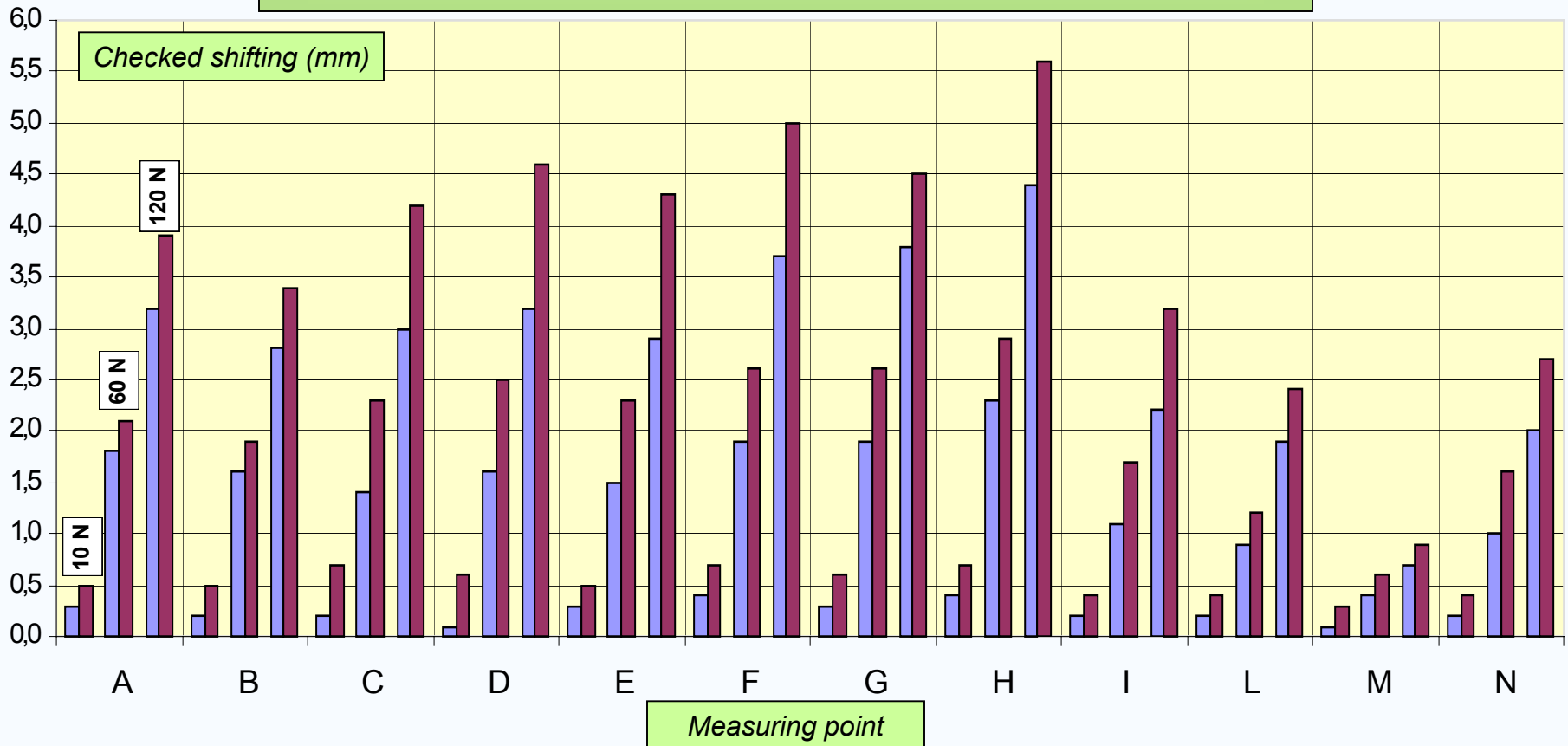
Measuring point	Checked shifting (mm)											
	10 N	20 N	30 N	40 N	50 N	60 N	70 N	80 N	90 N	100 N	110 N	120 N
A	0,5	0,8	1,2	1,6	1,9	2,3	2,7	3,1	3,5	3,9	4,3	4,8
B	0,2	0,5	0,9	1,3	1,7	2,0	2,3	2,7	3,0	3,4	3,7	4,1
C	0,5	0,8	1,2	1,6	1,9	2,4	2,7	3,1	3,5	3,9	4,3	4,7
D	0,4	0,8	1,3	1,7	2,2	2,6	3,0	3,5	4,0	4,4	4,9	5,4
E	0,3	0,7	1,0	1,4	1,8	2,2	2,6	3,0	3,5	3,9	4,3	4,8
F	0,9	1,3	1,7	2,1	2,5	2,9	3,4	3,8	4,2	4,7	5,1	5,5
G	0,4	0,8	1,3	1,7	2,1	2,6	3,0	3,5	3,9	4,3	4,8	5,3
H	1,4	1,8	2,3	2,9	3,4	3,9	4,3	4,8	5,3	5,9	6,4	6,9
I	0,1	0,4	0,7	1,0	1,3	1,6	1,9	2,2	2,5	2,8	3,1	3,5
L	0,2	0,4	0,6	0,8	0,9	1,1	1,3	1,4	1,6	1,7	1,9	2,1
M	0,2	0,3	0,4	0,4	0,5	0,5	0,6	0,7	0,7	0,8	0,9	1,0
N	0,1	0,3	0,5	0,8	1,0	1,3	1,5	1,8	2,0	2,3	2,6	2,9



Door Module from FRP

Development in Door System TESTS

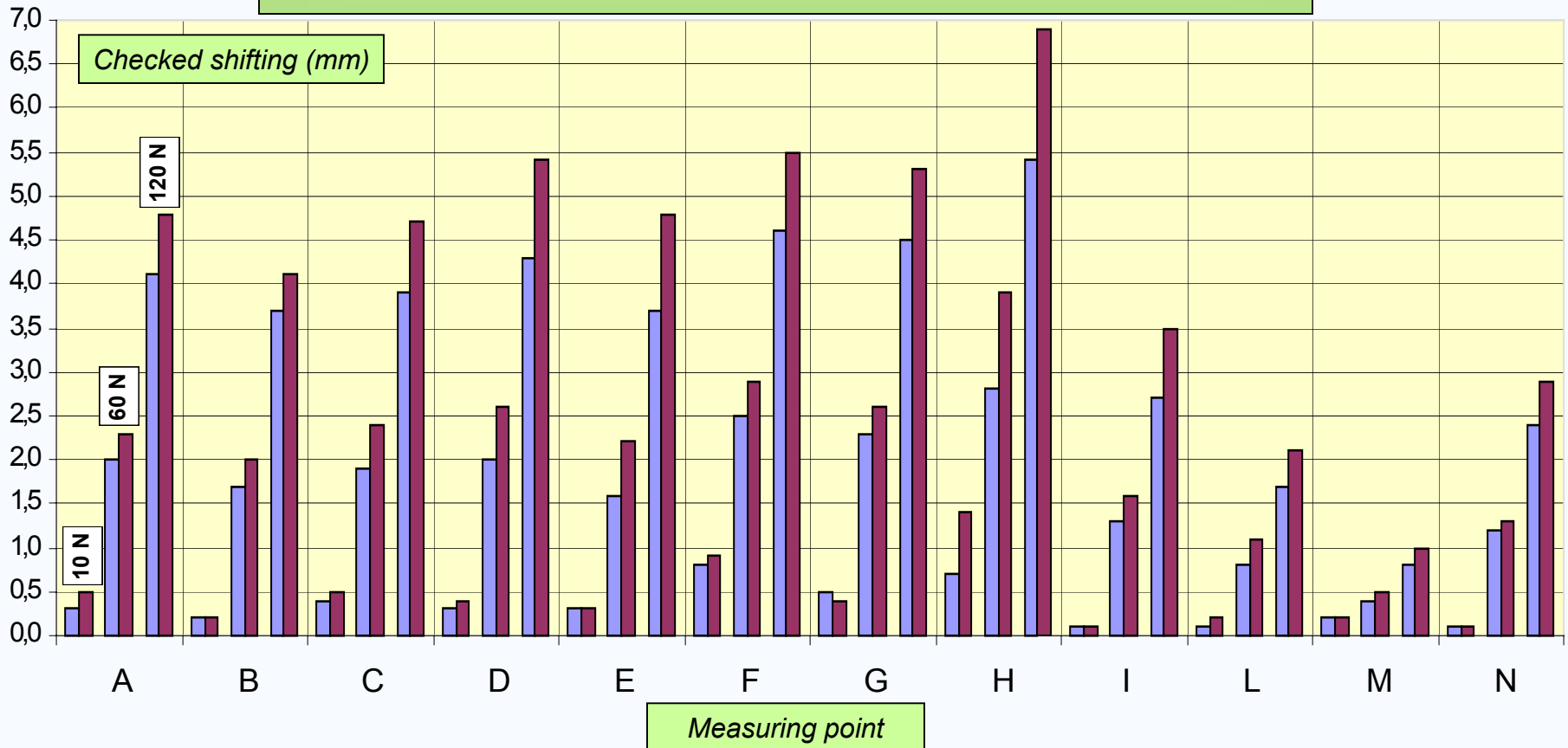
Compression reliefs on Carrier
GMT 40% GM vs D-LFT PP GF 30



Door Module from FRP

Development in Door System TESTS

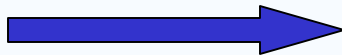
Tension reliefs on Carrier
GMT 40% GM vs D-LFT PP GF 30



Door Module from FRP

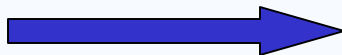
Background + History

- Various door module concepts introduced into the market over the past years (e.g. steel, Bayer Hybrid, LFT, IM)



**most systems only act as „part carrier“ (Aggregateträger)
no crash worthiness, no hip protection function**

- Several LFT door modules on the market now (e.g. Mini, Ford B platform)
- Hip protection is normally achieved by adding separate part (e.g. foam pad)
- GMT door module developed for Lancia Y



**integration of hip protection pad
various functional integrations**

- Ranger and QPC started joint evaluation of crash worthiness to quantify GMT capabilities in comparison with alternative materials
-

Door Module from FRP



Inmolded integrations Lancia Y door module :

- Multiple fixation holes and domes**
- Loudspeaker pockets**
- Door opening system guidance & fixations**
- Wiring fixations and guidances**
- Window opening system and guidance**
- Hip protection system**

Door Module from FRP

Crash test setup:

- Side impact test (pole test) with increasing speed/energy
- Hip protection pad impact (flat impactor) with increasing speed/energy

Range of test materials:

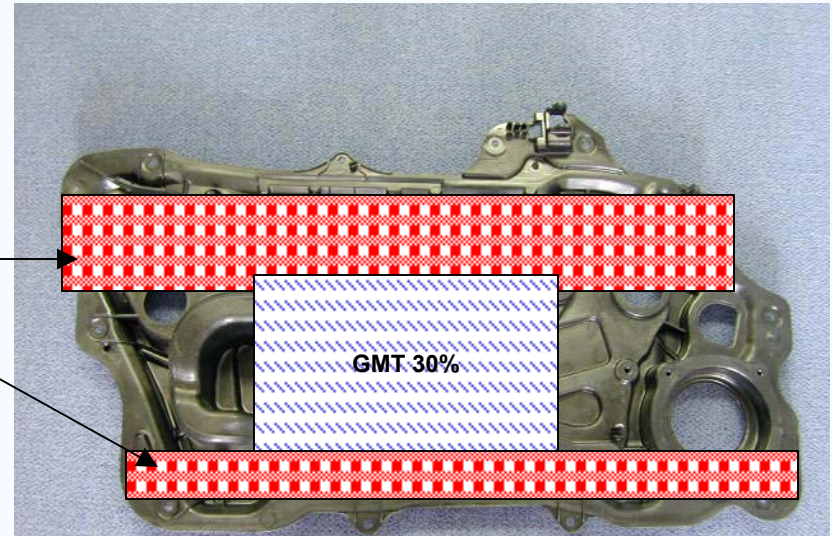
- GM40PP (serial material), GM30PP
 - D-LFT 40%, D-LFT 30%
 - PP GF G-LFT 40% LFT
 - Combination GMTex ML / GMT, GMTex Toplayer / GMT, GMTex TL +/- 45° / GMT
-

Door Module from FRP

Blank layout for GMTex reinforced versions for side impact testing (pole test)

GMTex ML or TL stripes (single stack)

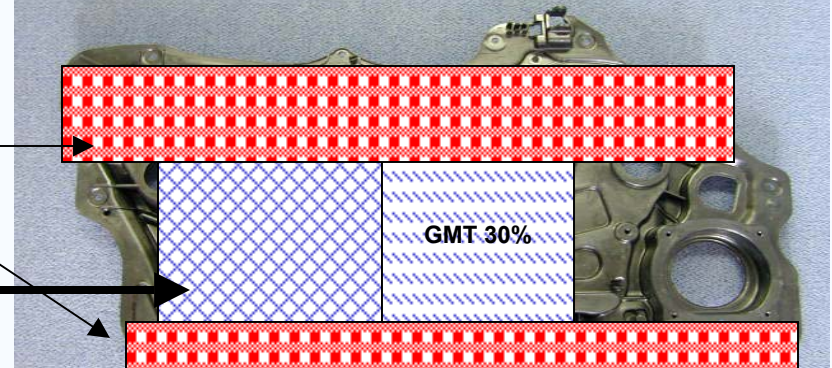
GMT 30% to fill the rest of the part



Blank layout for GMTex reinforced versions for hip pad testing (flat impactor)

GMTex stripes (single stack)

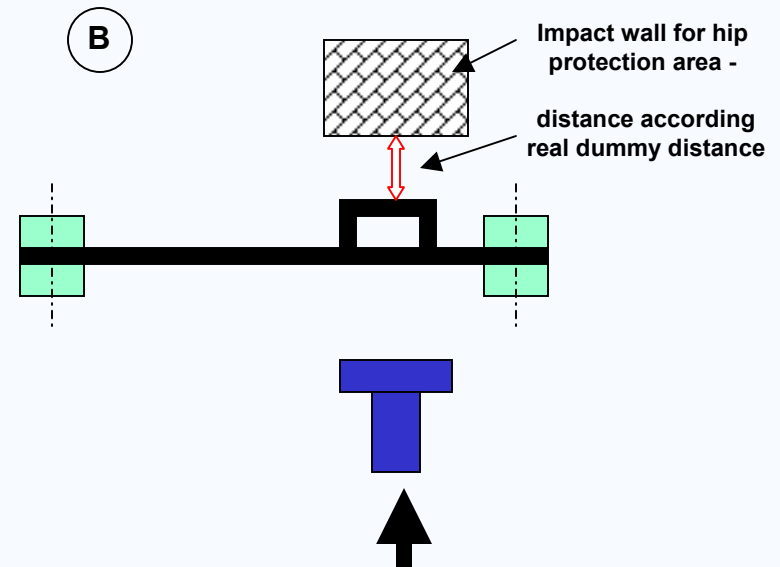
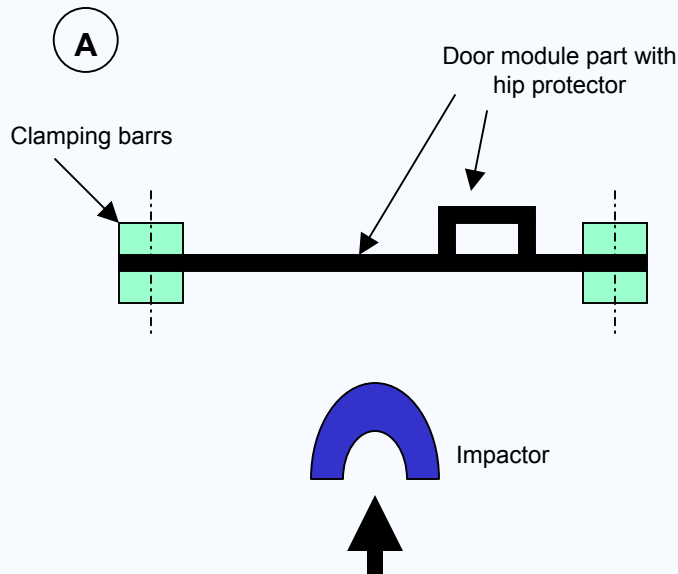
GMTex Toplayer 1/1, +/- 45°



Door Module from FRP

Impact test proposal - to demonstrate energy absorption of various materials:

- Molding trials using different materials (GMT, GMTex, D-LFT, G-LFT, LFT)
- Side impact testing with increasing energy at RT (based on lowest failure / material)
- Video taping to demonstrate failure behaviour of the different materials
- Additional crash testing of the hip protection area (Version B)

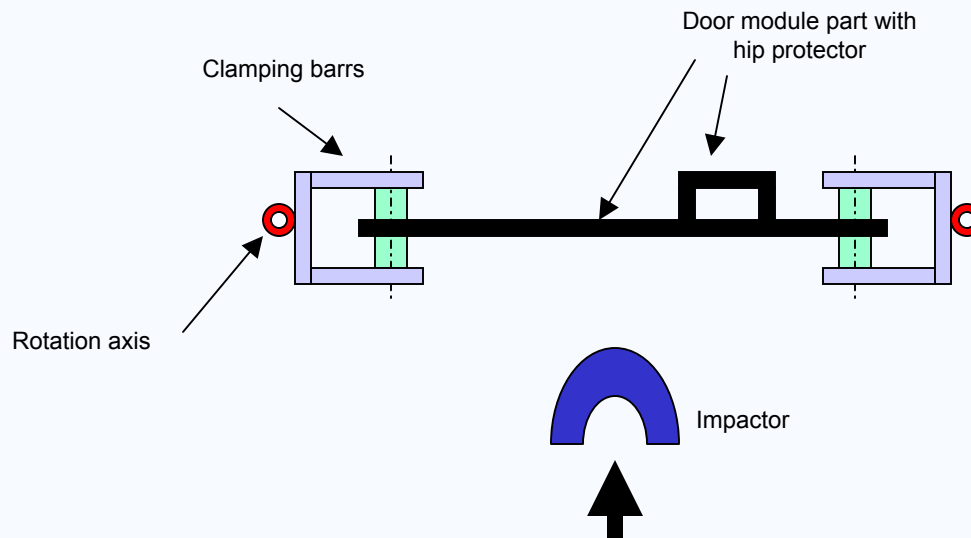


Door Module from FRP

Impact test proposal - to demonstrate energy absorption of various materials:

Additional options:

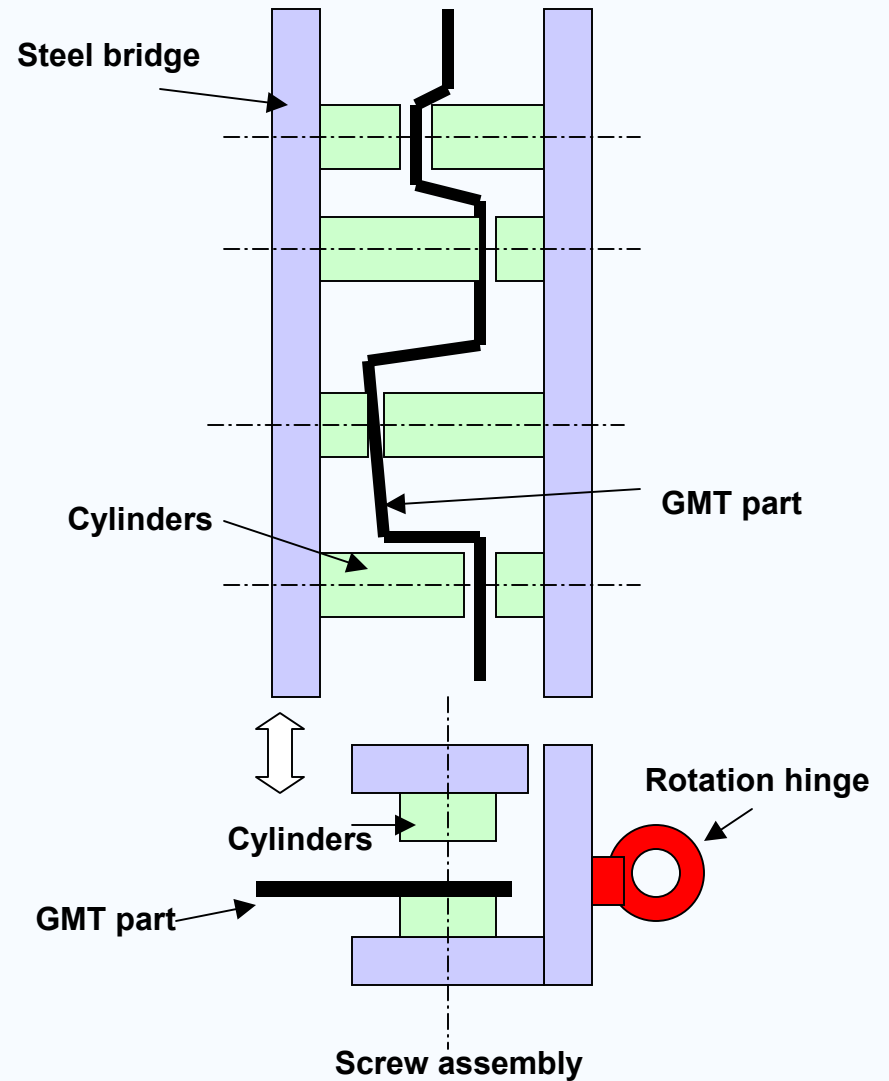
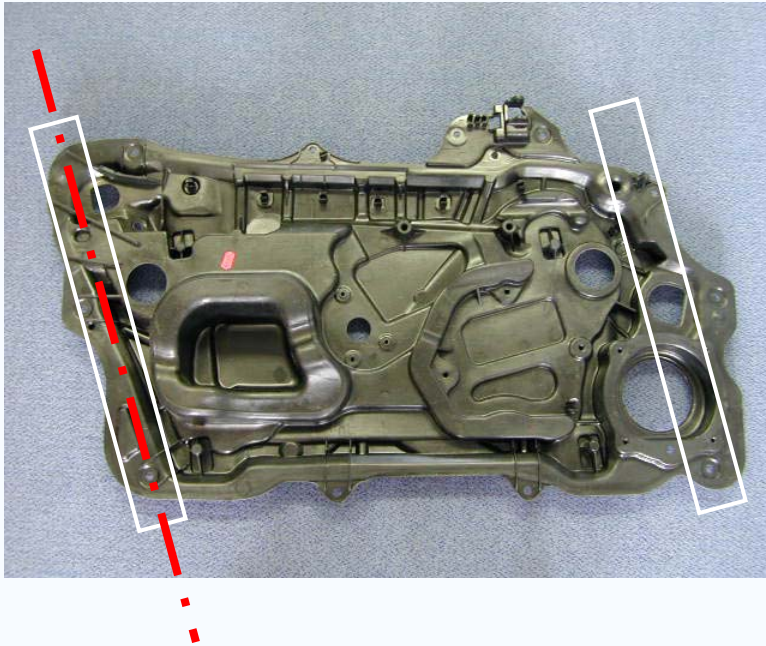
- additional improved clamping ideas to allow steel-like deformation
- use limited rotating steel bracket to allow first deformation with low stress for the part



Door Module from FRP

Door module clamping solution

steel cylinders in dedicated lengths,
bridged with steel barr,
from both sides, screwed together,
hinge welded to bridge to allow rotation



Door Module from FRP

Crash test setup:

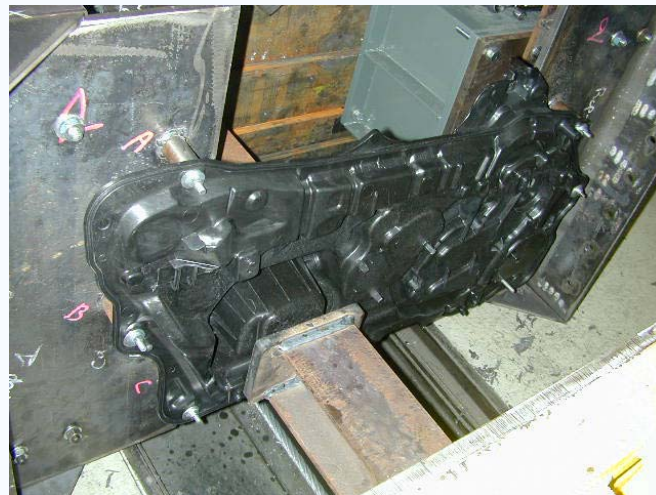
- Sled weight 912 kg
- Pole diameter 200 mm (UTAC)
- Energy levels

Side / pole impact test

400 J (0.92 m/s)
600 J (1.15 m/s)
800 J (1.31 m/s)
1000 J (1.47 m/s)

additional for Hip pad test

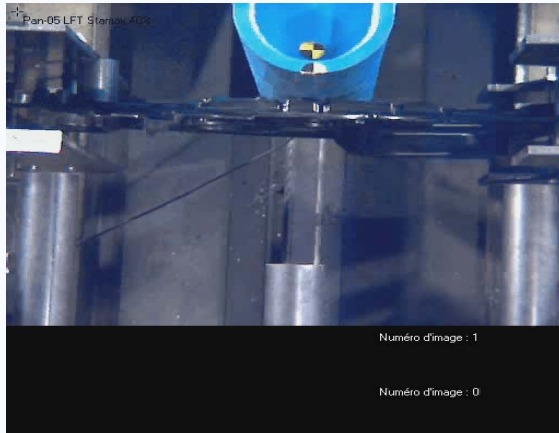
1200 J (1.62 m/s)
1440 J (1.78 m/s)



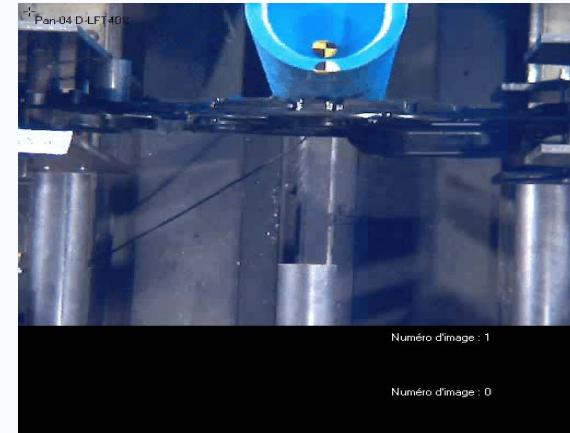
Door Module from FRP

Comparison of energy absorption and break behavior at side impact test

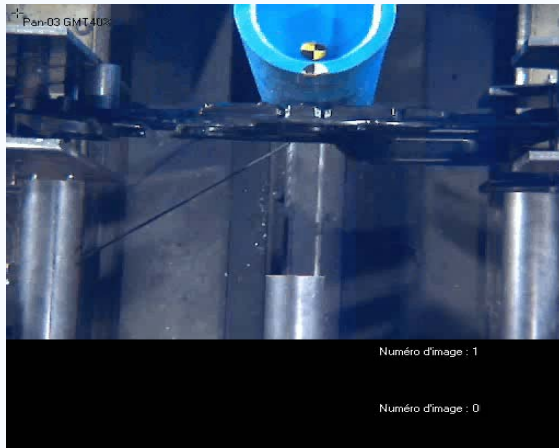
PP GF 40% Long fibre G-LFT@400J - Absorption 120 J



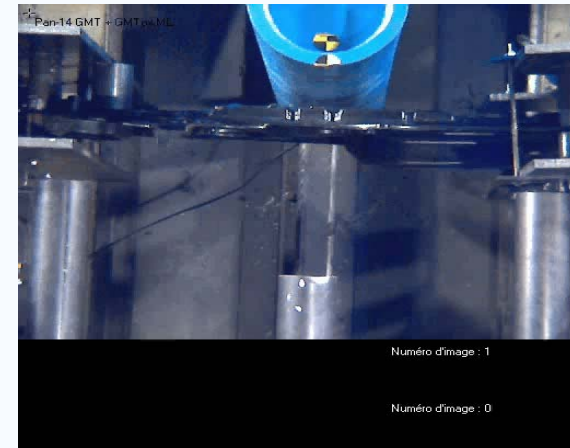
D-LFT 40% @400J - Absorption 250 J



GMT 40% @ 400J - Max. Absorption 800 J



GMTex ML @1000J - Absorption 1000 J



Door Module from FRP

Comparison of energy absorption and break behavior at side impact test

PP GF 40% Long fibre G-LFT@400J - Absorption 120 J



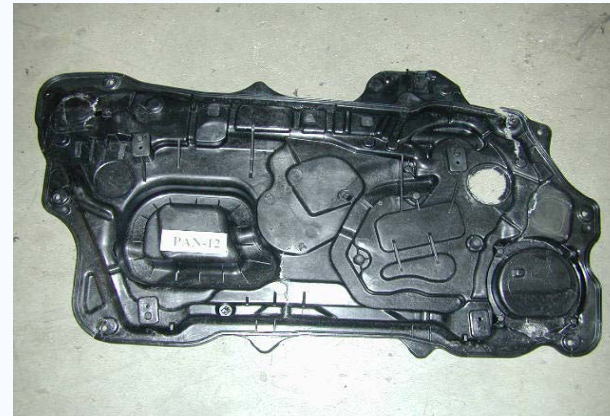
D-LFT 40% @400J - Absorption 250 J



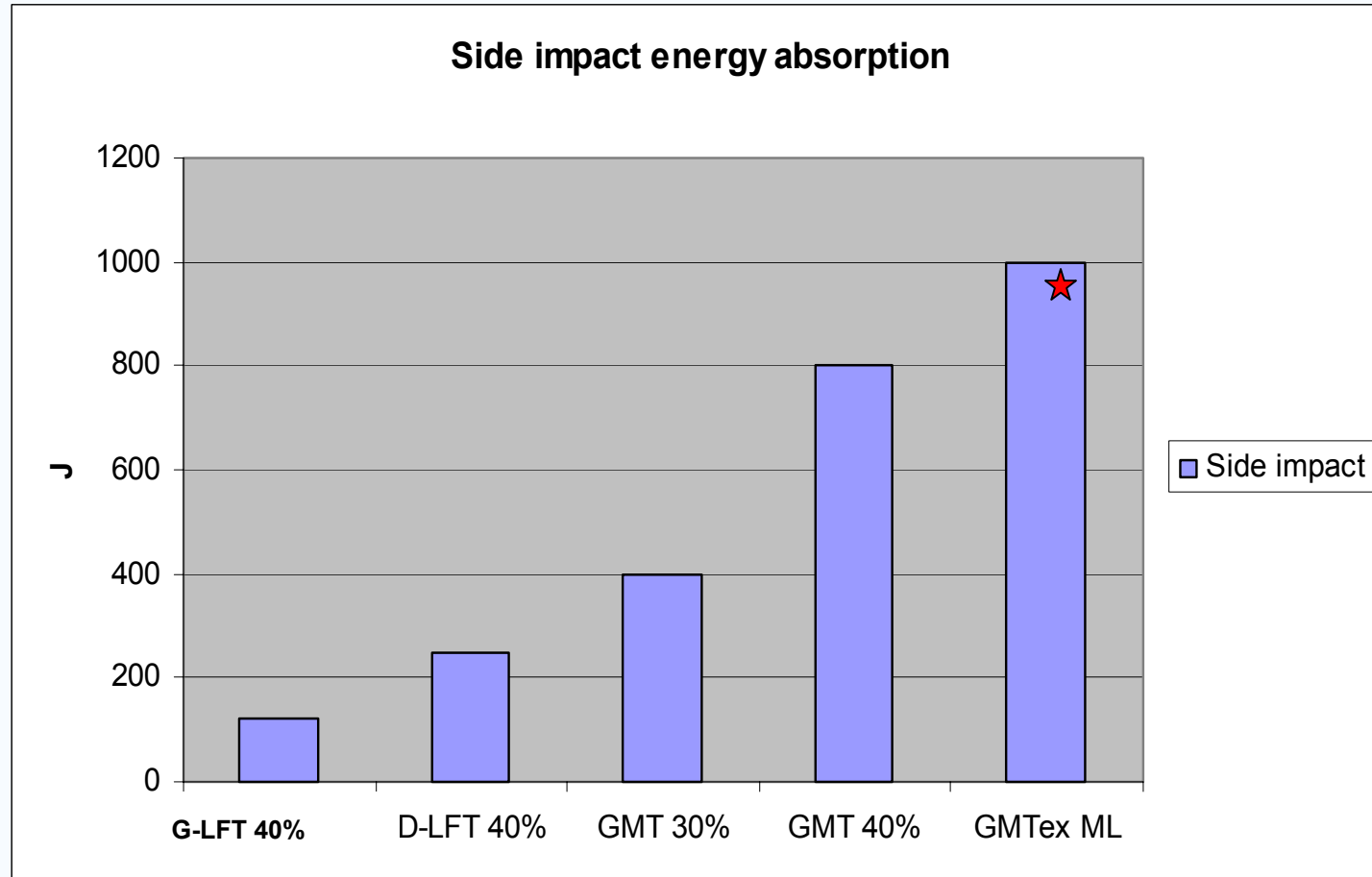
GMT 40% @ 400J - Max. Absorption 800 J



GMTex ML @1000J - Absorption 1000 J



Door Module from FRP

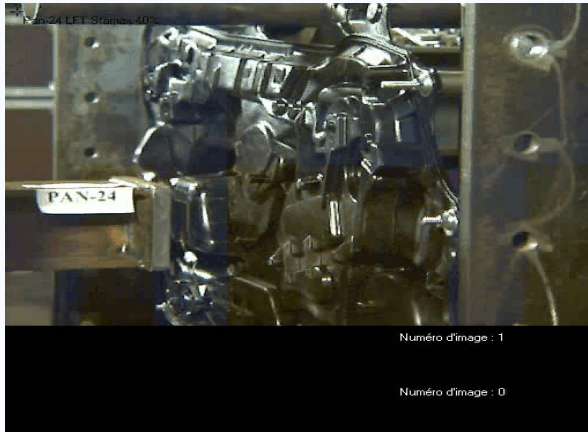


★ GMTex performance is limited by weak fixation points !

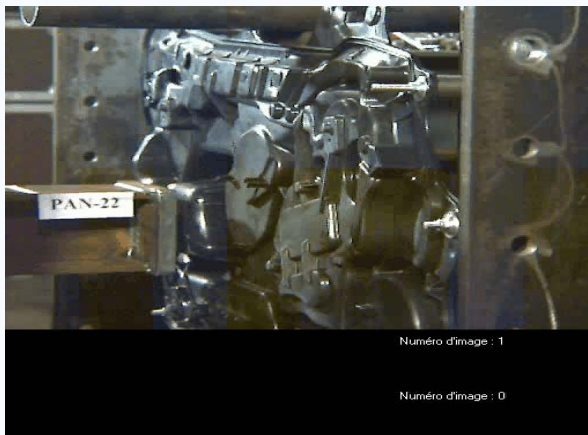
Door Module from FRP

Comparison of energy absorption and break behavior at hip pad impact test

PP GF 40% Long fibre G-LFT @ 900 J - max. absorption 450 J D-LFT 40% @ 900 J - max. absorption 500 J



GMT 40% @ 1200 J - max. absorption 900 J



GMTex TL +/-45° @ 1440 J - max. absorption 1300 J



Door Module from FRP

Comparison of energy absorption and break behavior at hip pad impact test

PP GF 40% Long fibre G-LFT @ 900 J - max. absorption 450 J D-LFT 40% @ 900 J - max. absorption 500 J



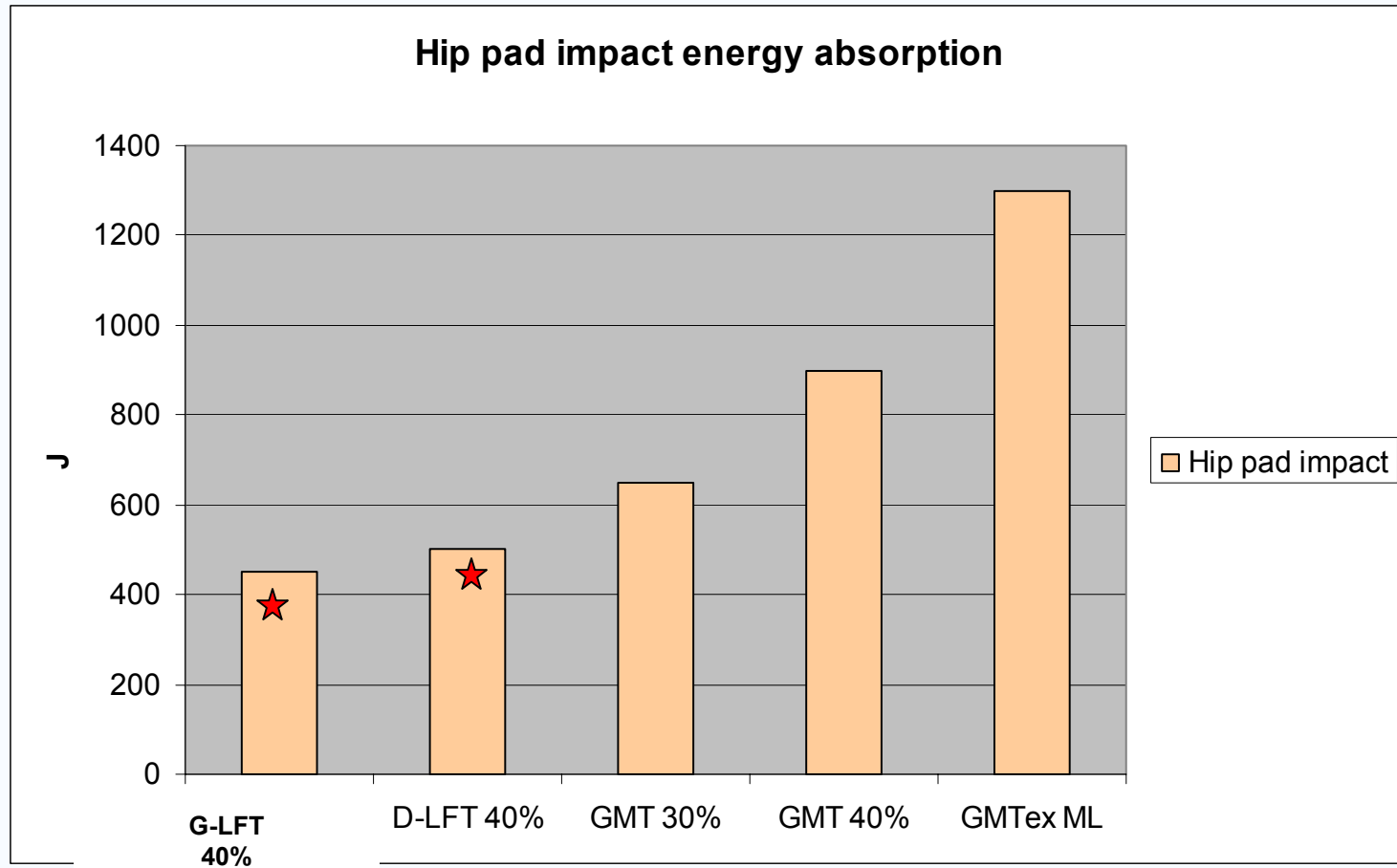
GMT 40% @ 1200 J - max. absorption 900 J



GMTex TL +/-45° @ 1440 J - max. absorption 1300 J



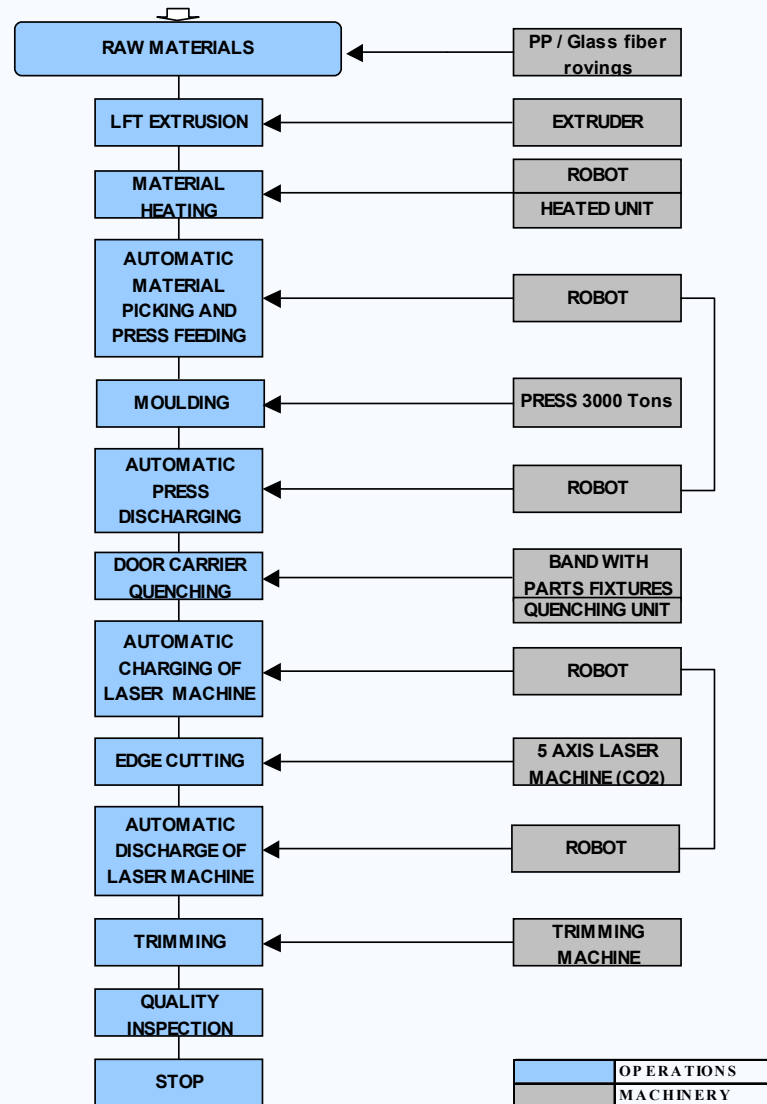
Door Module from FRP



★ Brittle failure !

Door Module from FRP

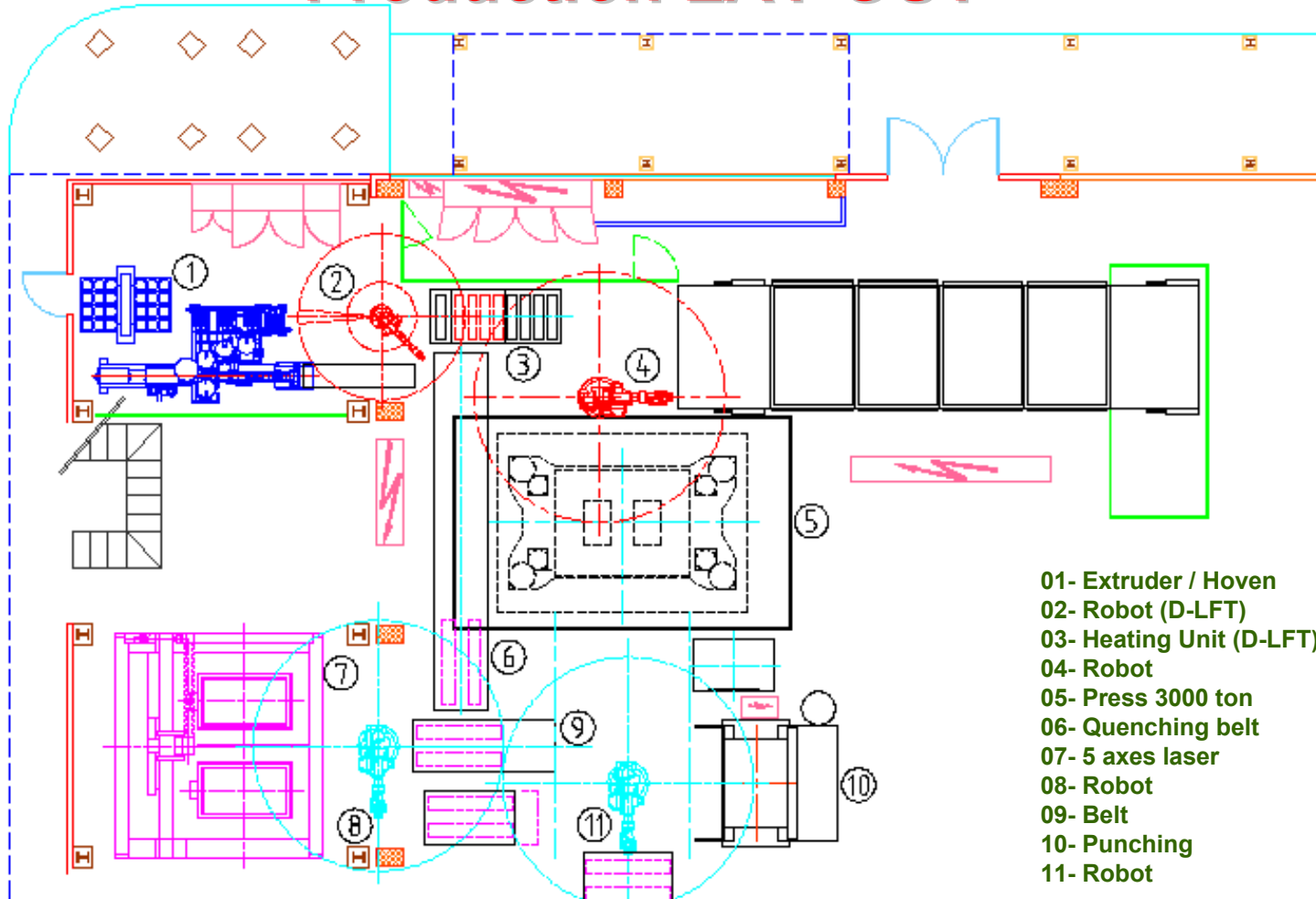
Production FLOW CHART



Door Module from FRP

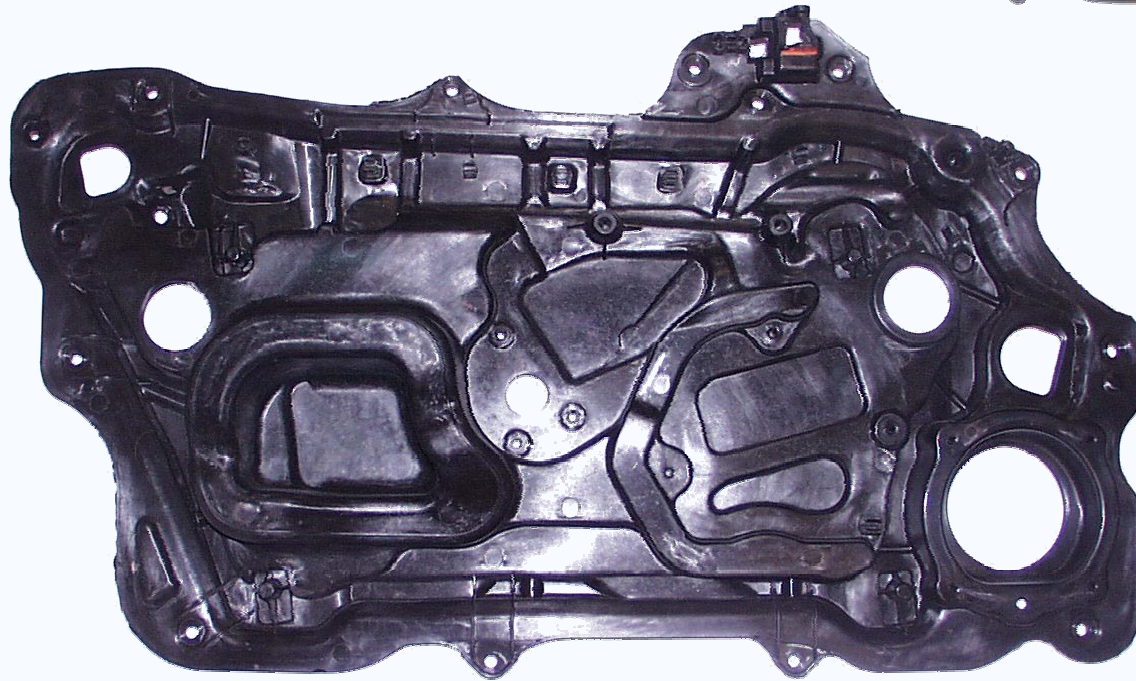
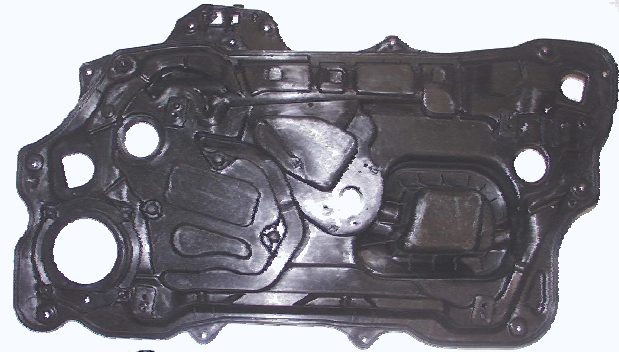
Production LAY OUT

1-



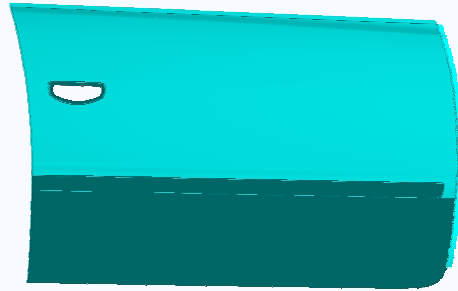
Door Module from FRP

Technology	Compression Molding
Material	GMT / D-LFT (PP GF)
Weight	2 kg
Thickness	2.5 mm



Door Module from FRP

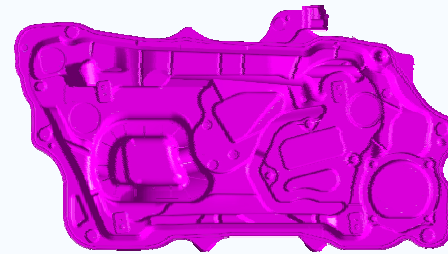
Exterior Door Panel



SMC / Thermoplastic



Door Carrier



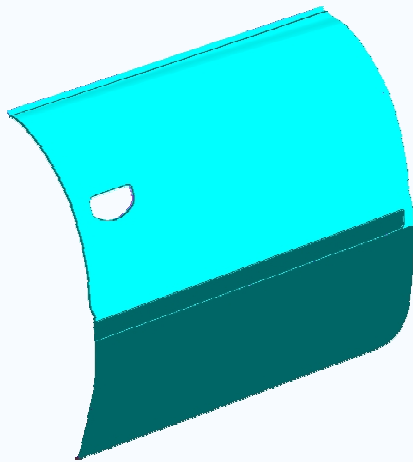
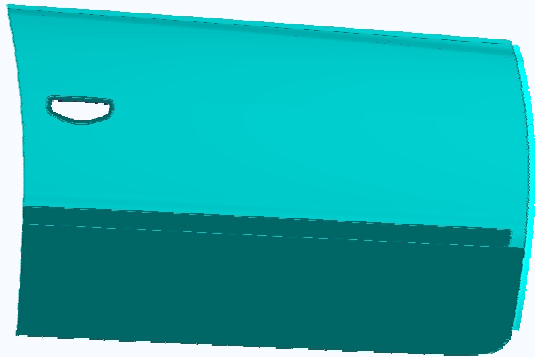
GMT / D-LFT



High Function
Integration

Total Weight of
two Modules
Kg 4,5

Door Module from FRP

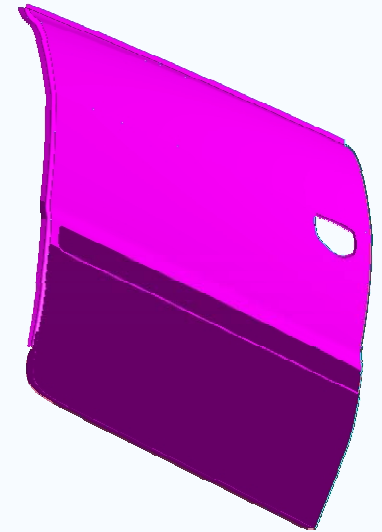


Technology Compression
Molding

Material SMC (UP GF)

Weight 2.5 kg

Thickness 2 mm



Door Module from FRP

SMC Advantages

- Design Freedom
 - Good Dimensional accuracy
 - Go through the full build and paint cycle
 - Strength of the part
 - Compatibility with steel for thermal expansion
 - Cost Advantage
 - Weight Reduction
 - Low Risk of minor damage
-

Door Module from FRP

Technology	Compression Molding
Material	SMC (UP GF)
Weight	2.5 kg
Thickness	2 mm



Door Module from FRP

Many Thanks For Your Attention

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RANGER GROUP
