BINDT WORKSHOP

‘NDT REQUIREMENTS FOR AUTOMOTIVE COMPOSITES’

30 YEARS OF COMPOSITES IN F1

APPLICATIONS OF NDT

Brian O’Rourke

Chief Composites Engineer,
Williams Grand Prix Engineering Ltd.
23rd. March, 2017.

FW39/40 OF 2017

F1 CAR PERFORMANCE

A few general facts:-

- 690kg minimum weight (incl. driver)
- 350kph top speed (at Monza)
- 3.5g cornering, 5.5g braking, 1.5g accelerating
- 25 kN down-force at 300 km/hr, typ.

Power unit (2017):- 145 kg. min.

- 950 bhp (?) engine, 1.6 l. V6 turbo-charged limited to 15,000rpm, hybrid. Fuel 100kg., rate 100 kg/hr max.
- ERS capacity 4MJ/lap power output
- MGU-K**:** 50,000 rpm, 200 Nm, 2MJ/lap max, 120 kW
- MGU-H: 125,000 rpm max, unlimited power in/out

ADVANCED MATERIALS IN F1 USE

Materials are chosen to be correct for the application

The range of types used covers:

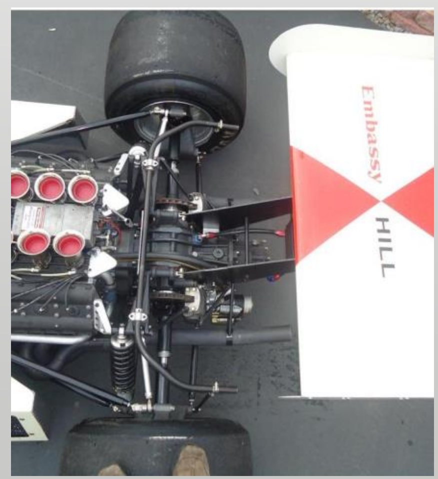
- High-spec steels
- Titanium
- Aluminium alloys
- Magnesium

- Polymeric matrix composites
- Metal matrix composites
- Carbon/carbon composites

EARLY F1 PRIMARY STRUCTURES IN COMPOSITE MATERIALS

The McLaren MP4-1 (1981)

Hill GH1 (ex-Lola T371 1975)



FIRST WILLIAMS COMPOSITE MONOCOQUE – FW10 (1985)

CHASSIS CONSTRUCTION – COMPOSITE MATERIALS

FW07: 1979-82

FW11: 1986

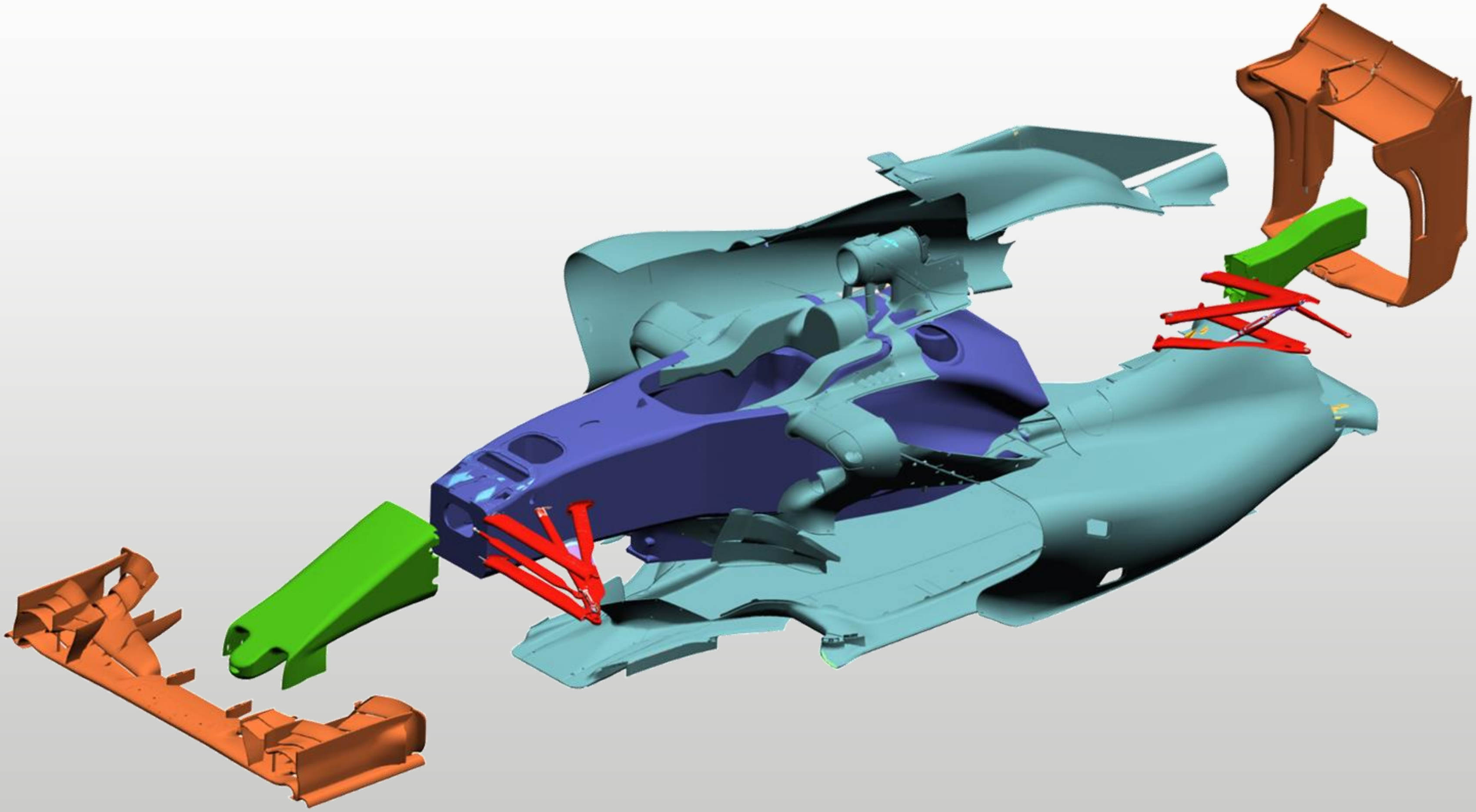
CHASSIS CONSTRUCTION – COMPOSITE MATERIALS

FW07: 1979-82

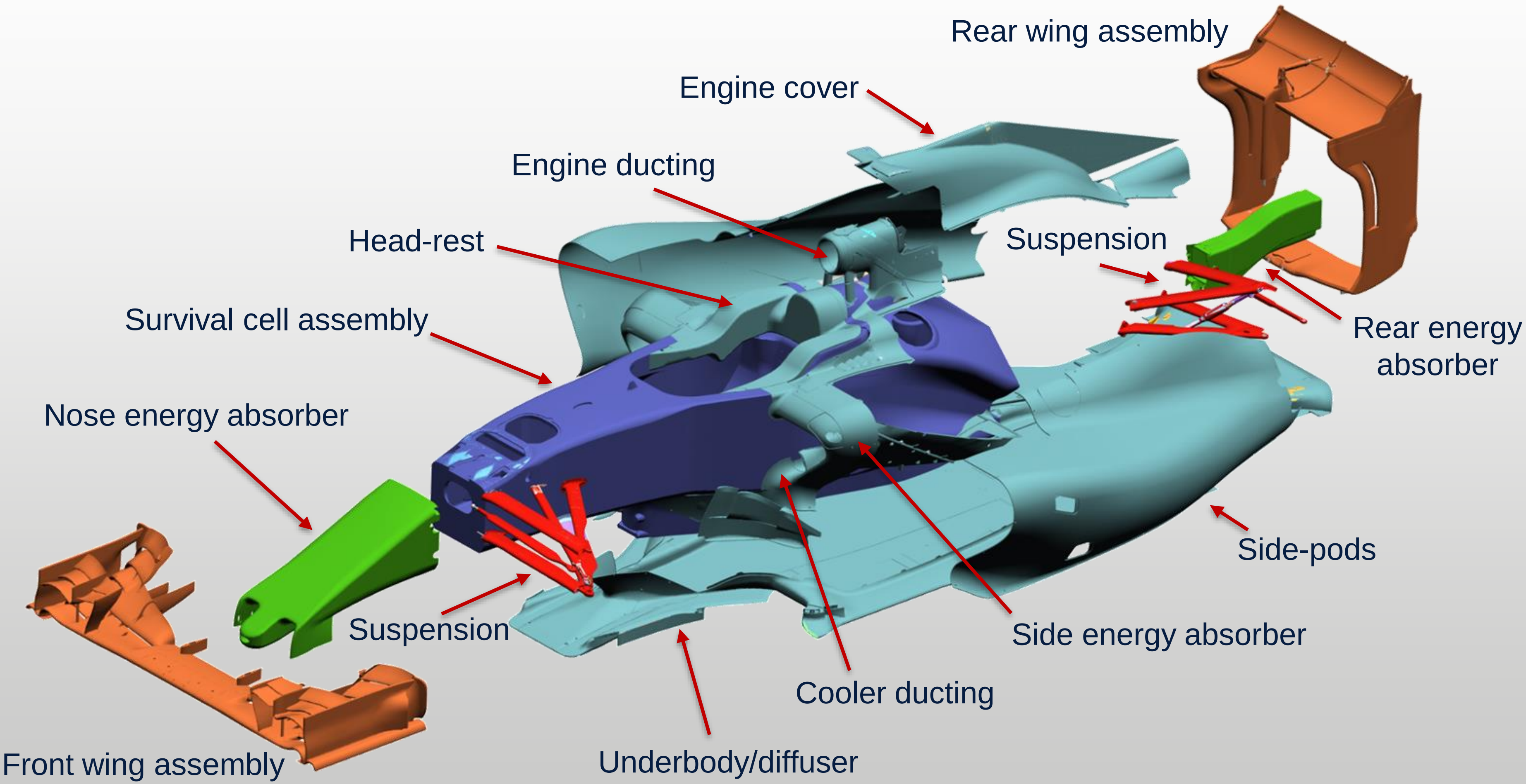
FW11: 1986

FW39 OF 2017

COMPOSITE MATERIALS – EXTENT OF USE



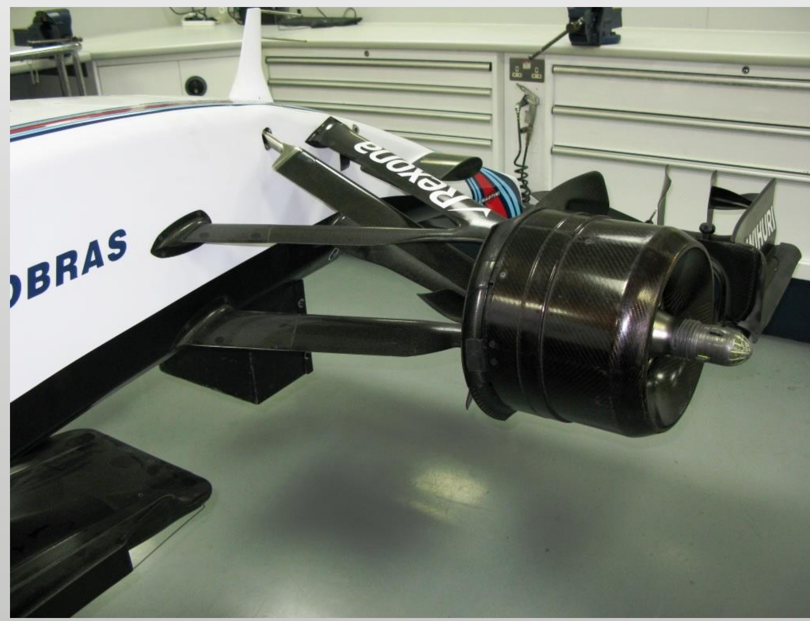
COMPOSITE MATERIALS – EXTENT OF USE



COMPOSITE MATERIALS APPLICATIONS

Suspension assemblies

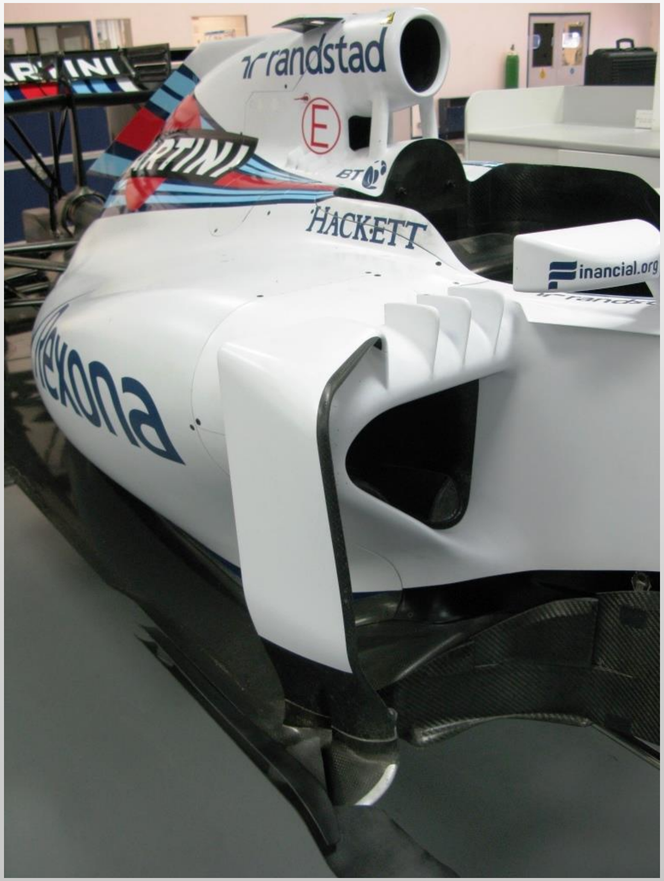
Brake ducting



COMPOSITE MATERIALS APPLICATIONS

Front wing assembly

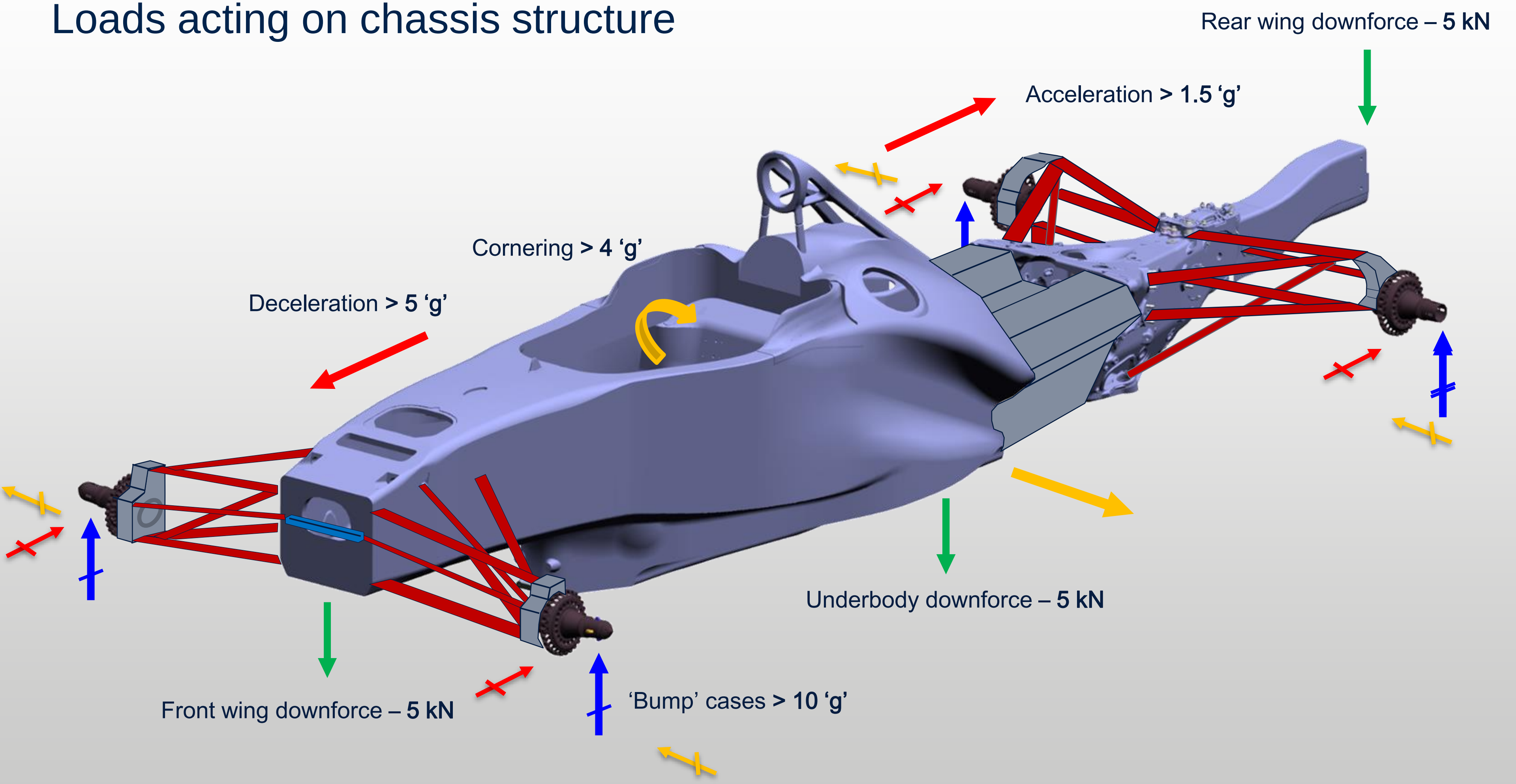
‘Bodywork’



‘MONOCOQUE’ CHASSIS ASSEMBLY

Hybrid sandwich assembly

Loads acting on chassis structure

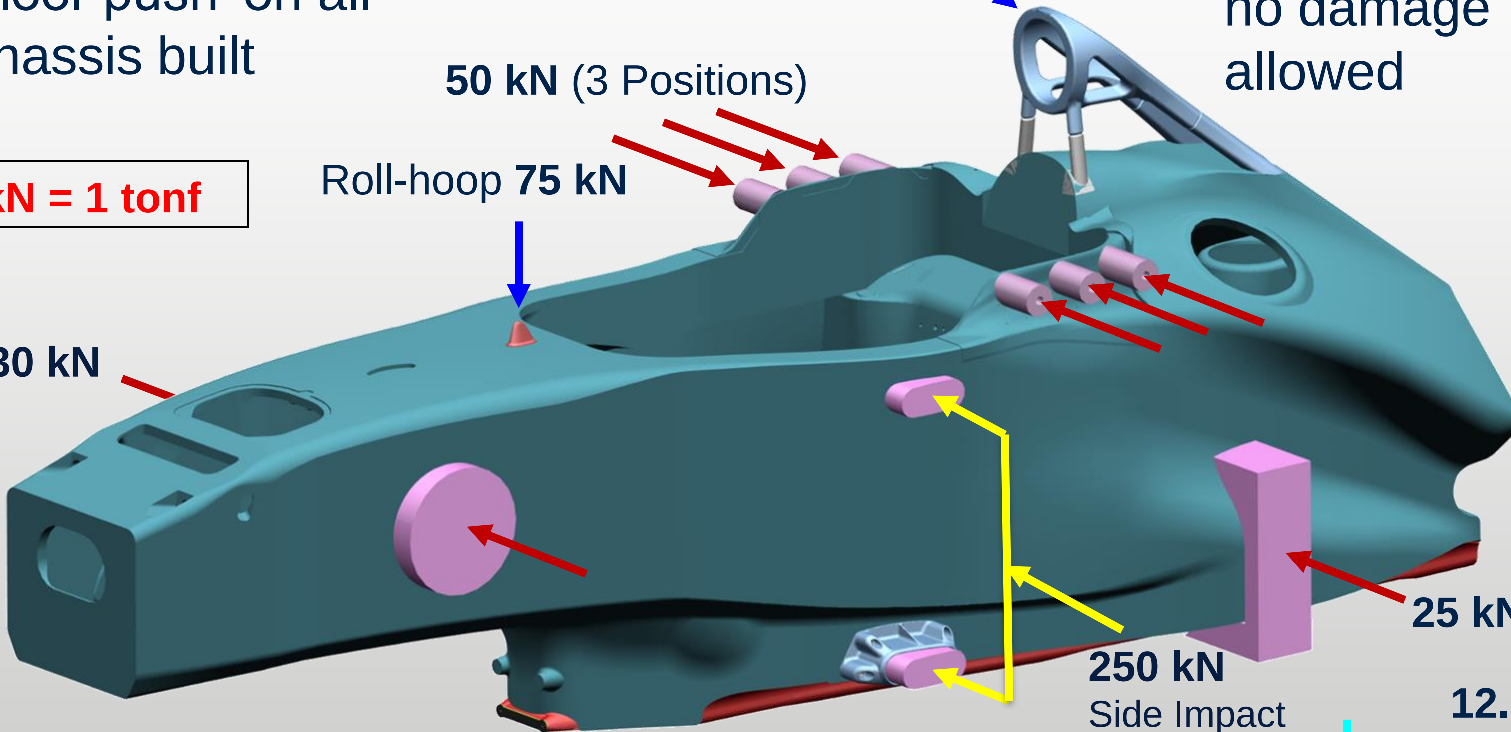


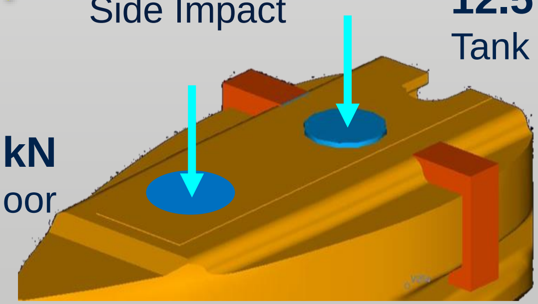
FIA STATIC PROOF TESTS

‘Squeeze’ loads
+ ‘floor push’ on all
chassis built

Stiffness criteria and no damage allowed

10 kN = 1 tonf

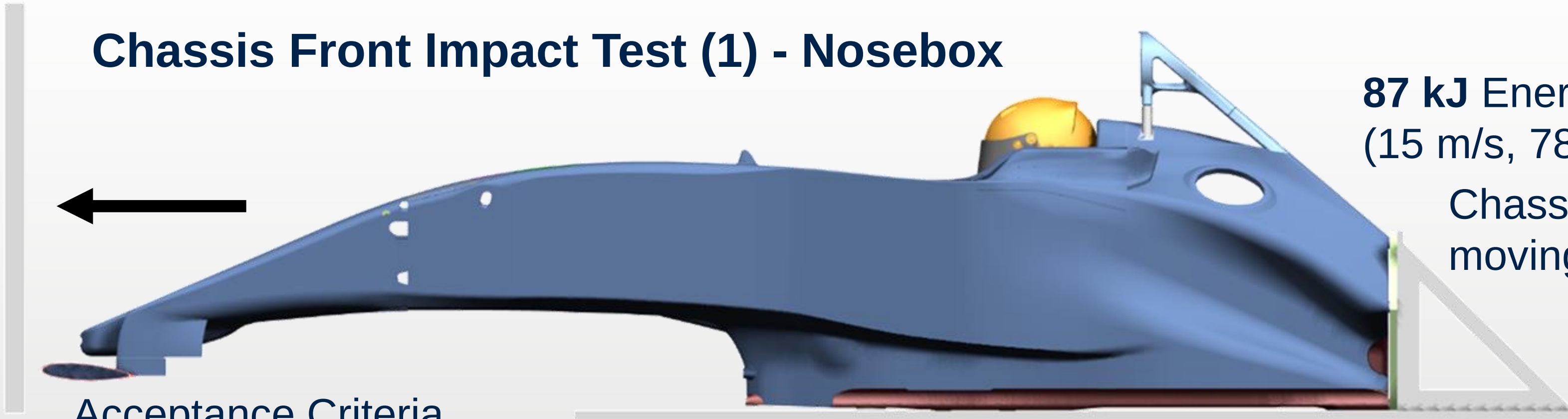




‘Push-off’ tests on
- Nose: **40 kN**
- Rear absorber: **40 kN**
- Side absorbers: **60 kN (Lwr.) + 40 kN (Upr.) simultaneous**

FIA FRONT AND REAR IMPACT TESTS

Chassis Front Impact Test (1) - Nosebox



87 kJ Energy
(15 m/s, 780 kg.)

Chassis on moving trolley

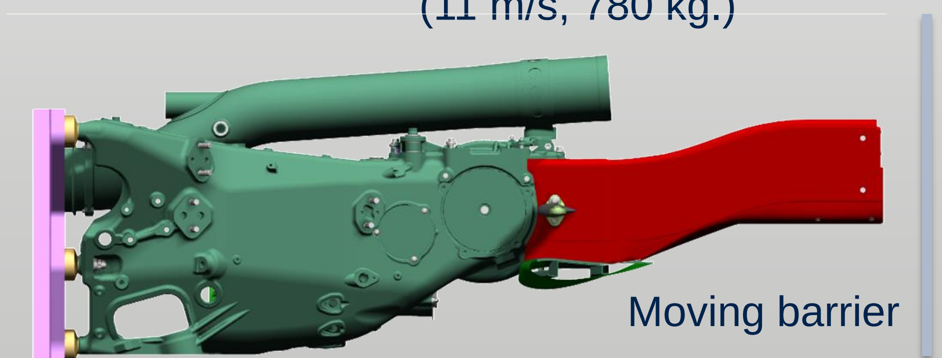
Acceptance Criteria

- **Peak ‘g’ < 10** (front 100 mm.)
- **Av. ‘g’ > 2.5** (front 150 mm.
- **Peak ‘g’ < 20** (up to 60kJ)
- **Av. ‘g’ < 40** (Overall)
- **Peak. ‘g’ > 60** (<3 ms at dummy)
- **No damage to chassis**

[15 m/s = 54 km/hr
= **33.5 m.p.h.**]

Rear Impact Test

47 kJ Energy
(11 m/s, 780 kg.)

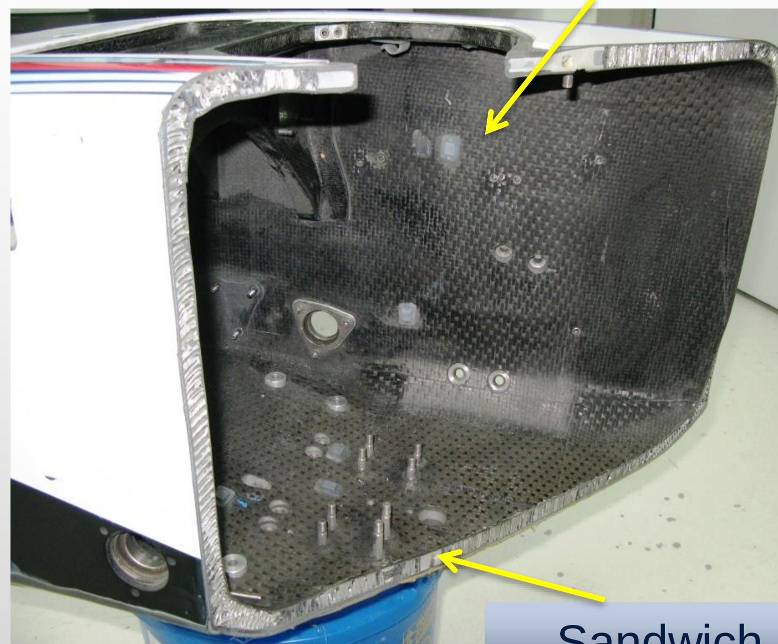


Acceptance Criteria:

- **Peak ‘g’ < 20** (up to 225mm.)
- **Peak ‘g’ > 20** (< 15 ms remainder)
- **Damage rear of axle line**

CHASSIS CONSTRUCTION

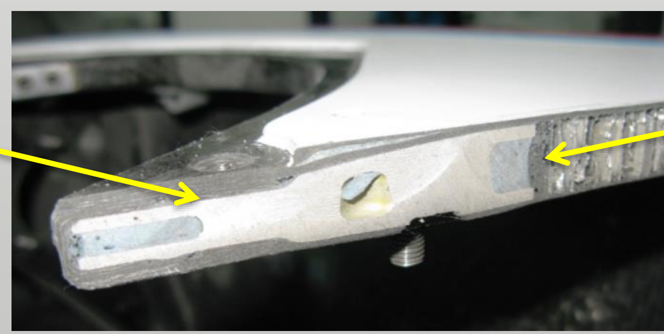
Irregular inner surface



Front segment

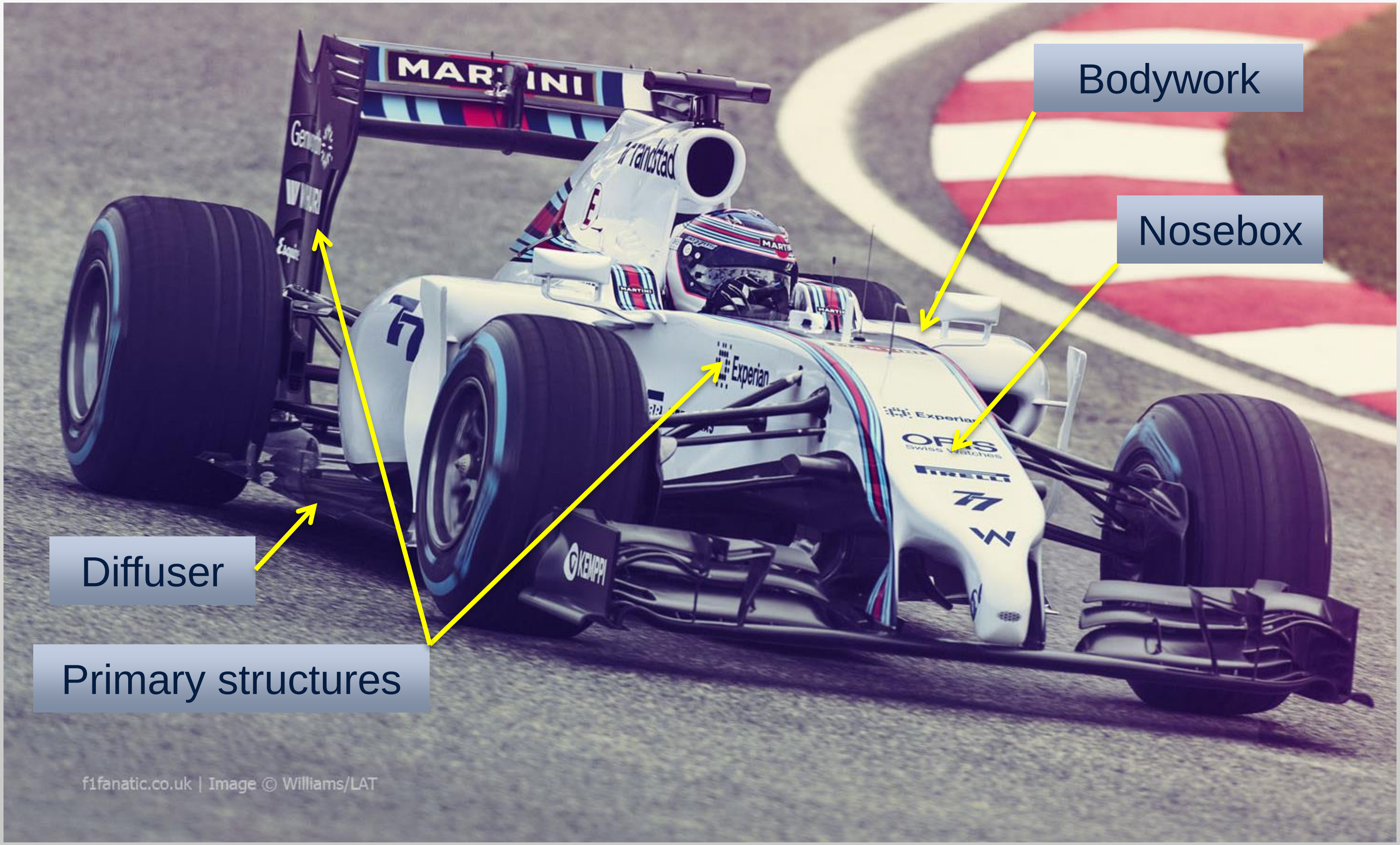
Sandwich shell

Insert



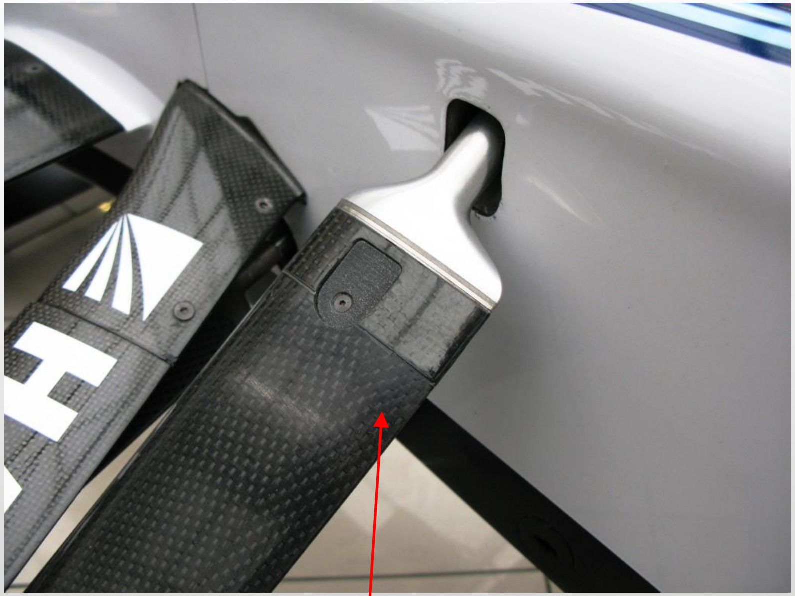
Core splice

Where used

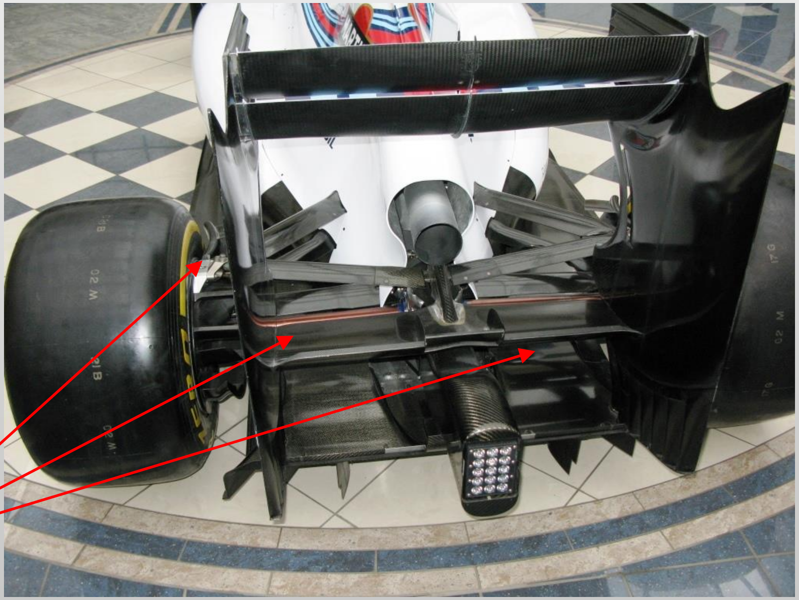

Bodywork
Nosebox
Diffuser
Primary structures
f1fanatic.co.uk | Image © Williams/LAT

STRENGTH-CRITICAL BONDED JOINTS

STRENGTH-CRITICAL BONDED JOINTS



Suspension elements: adhesively bonded joints connect the wheels to the car!



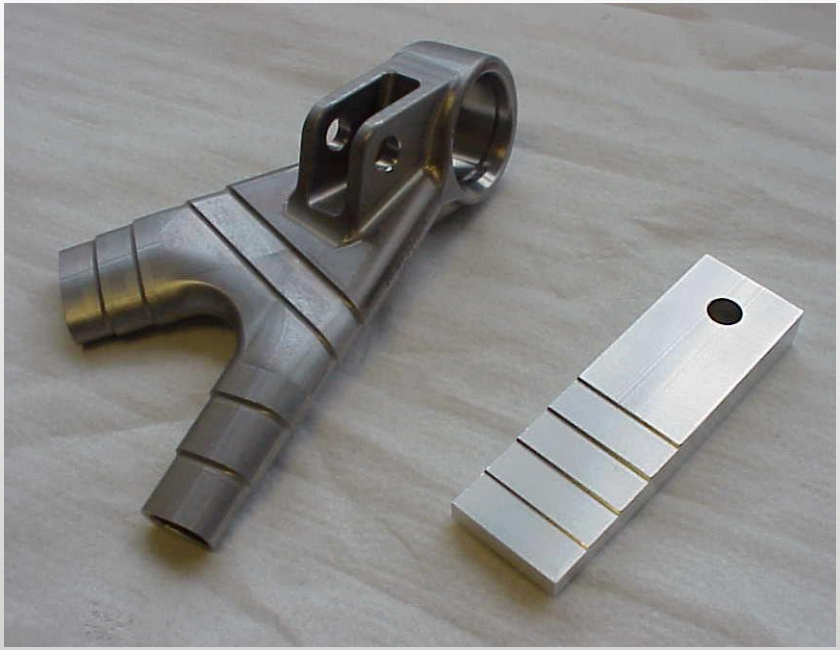
Inboard joint

Rear assembly – hot!

STRENGTH-CRITICAL BONDED JOINTS

STRENGTH-CRITICAL BONDED JOINTS

STRENGTH-CRITICAL BONDED JOINTS

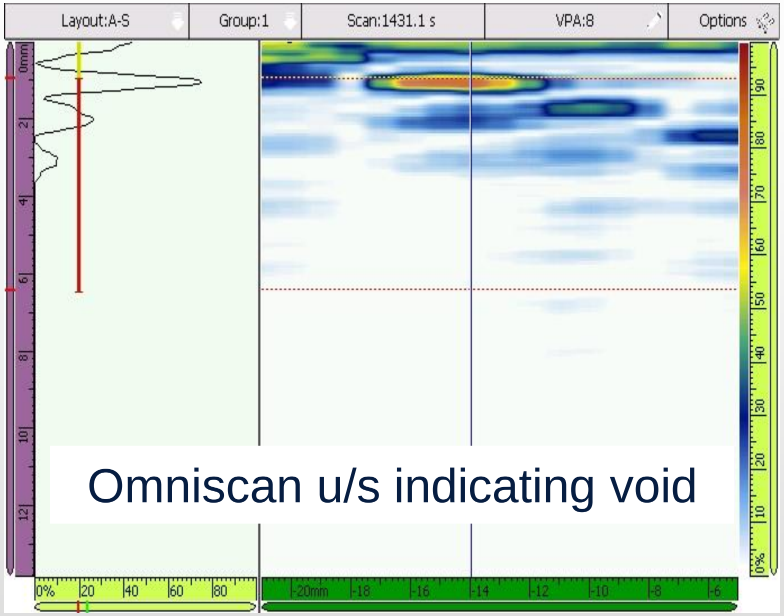


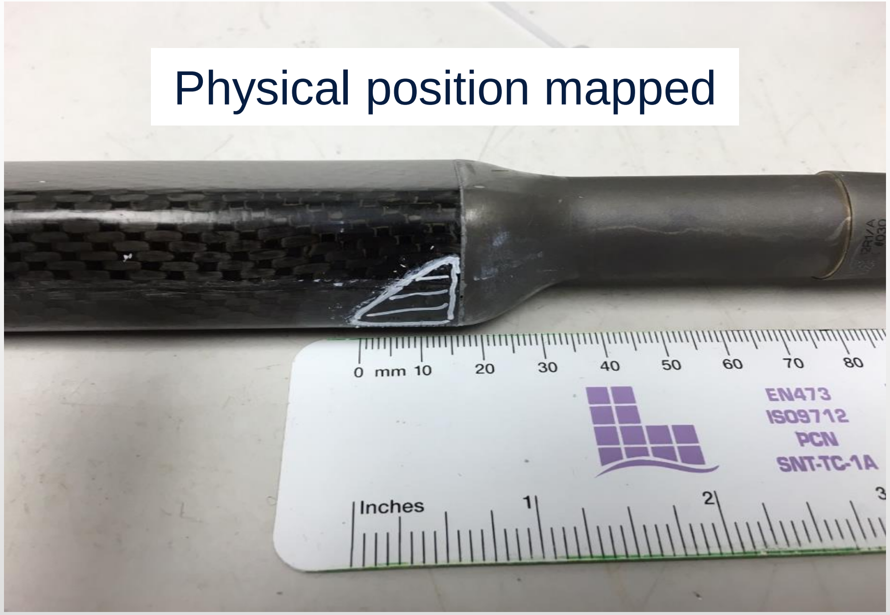
NDT TECHNIQUES

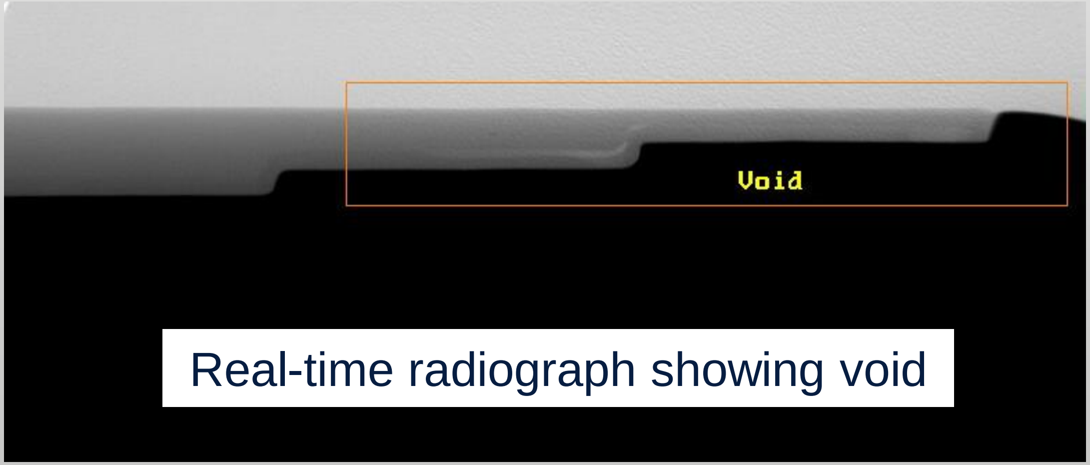
Early: ‘Audiosonic’

Current: Ultrasonic Phased-Array + Real-time Radiography

ANOMALY DETECTED BY NDT - EXAMPLE

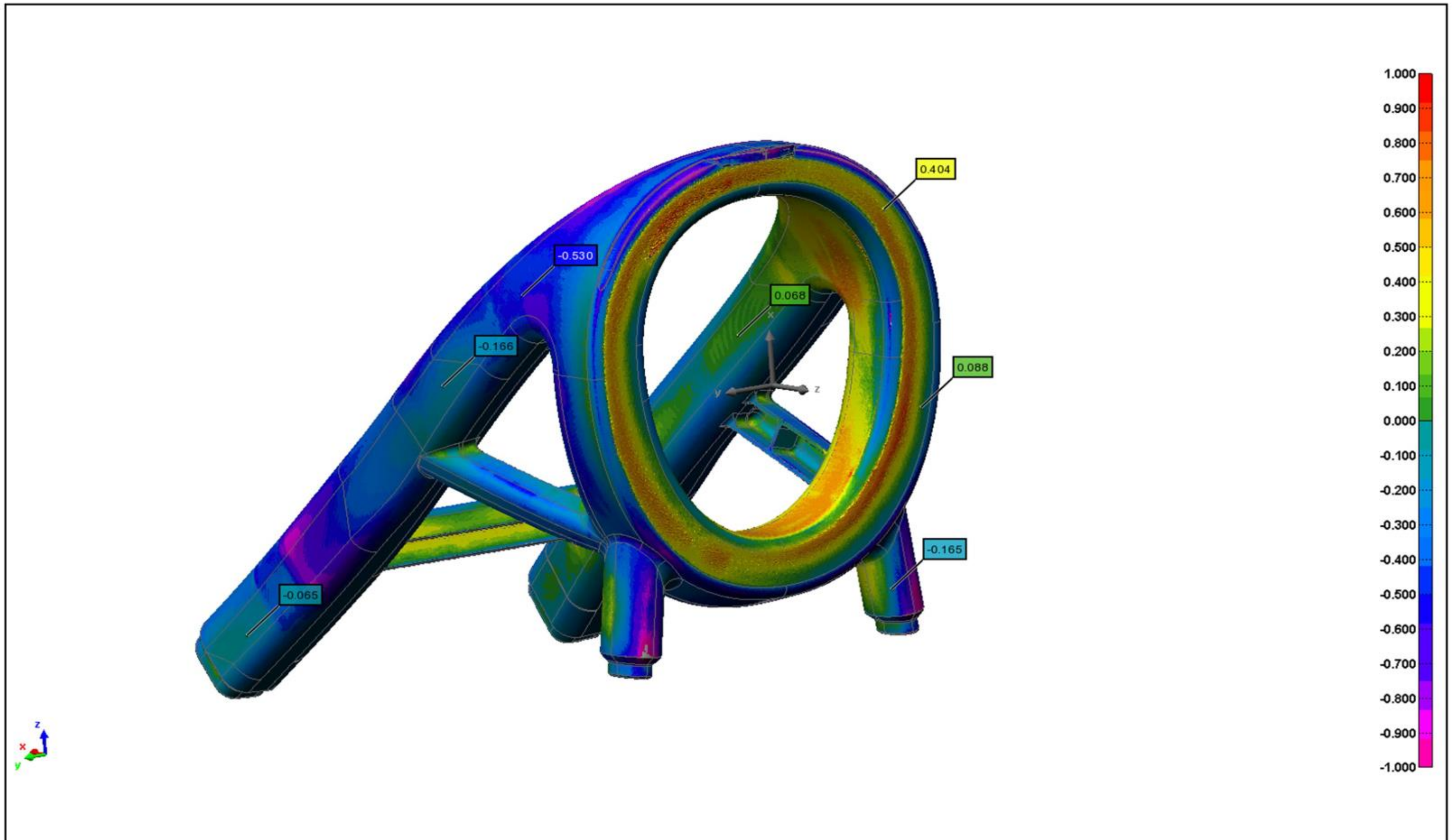






DRIVER ROLL-OVER PROTECTION

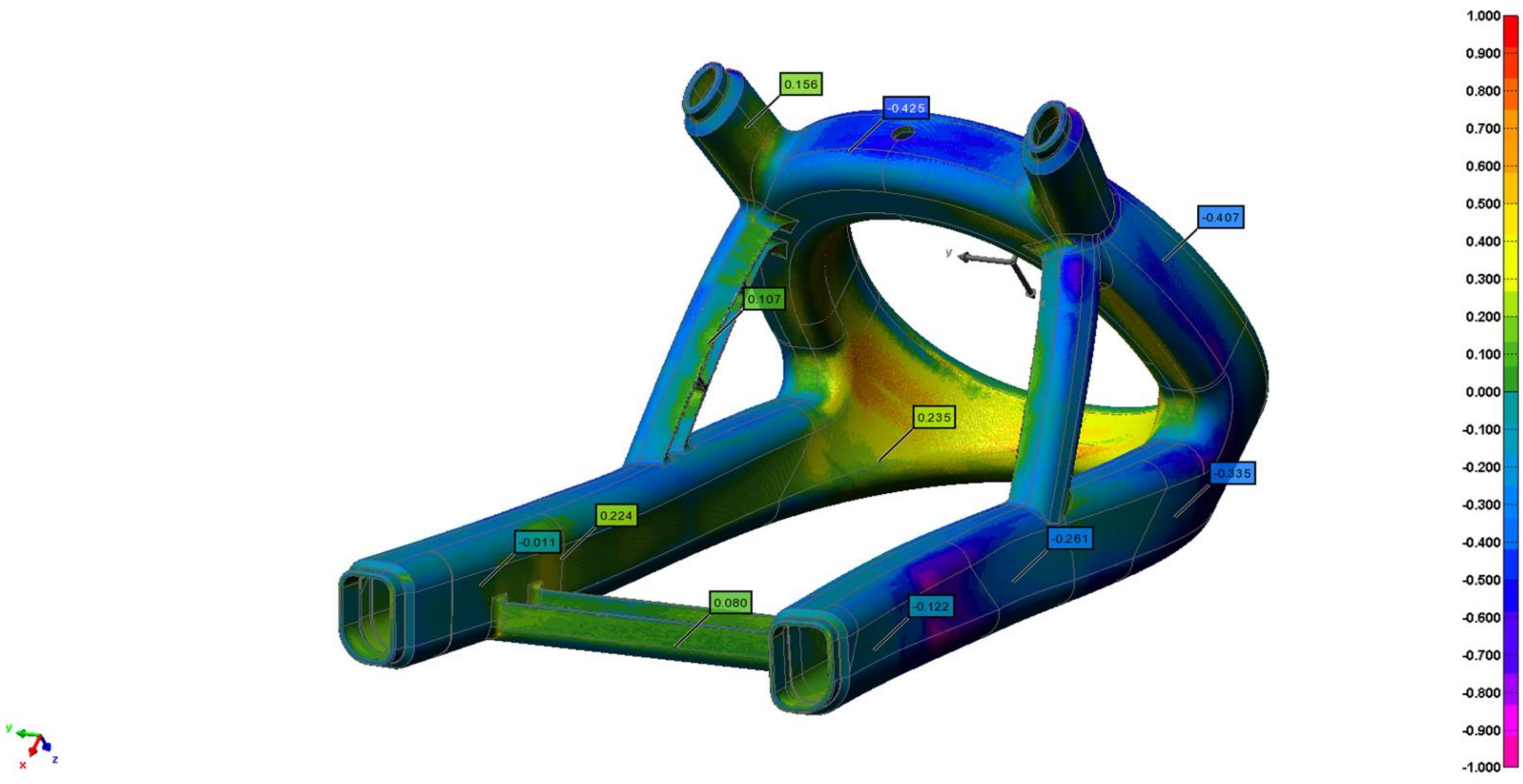
ROLL-OVER HOOP – CT OUTPUT



Operator: Matt Parker **Piece:** #04 **Part name:** DA-07854-N-001_A

27/01/2016 1/12

ROLL-OVER HOOP – CT OUTPUT

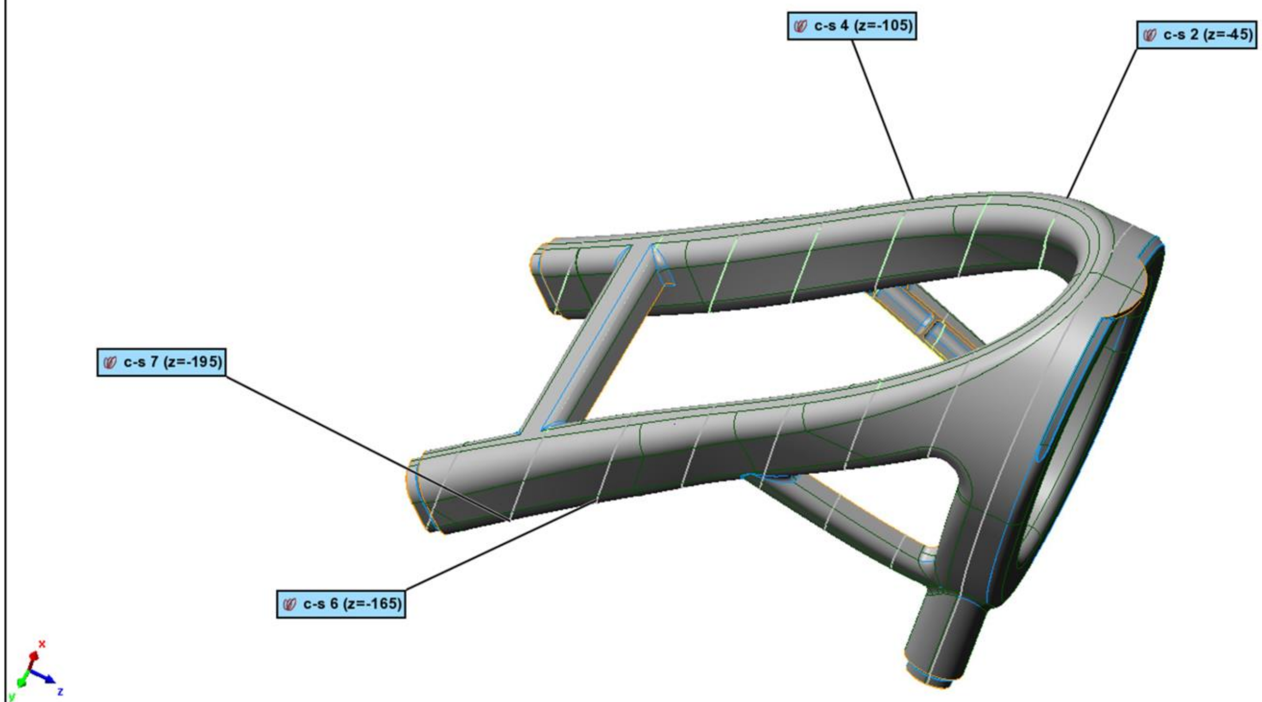


Operator: Matt Parker **Piece:** #04 **Part name:** DA-07854-N-001_A

27/01/2016 2/12

ROLL-OVER HOOP – CT OUTPUT

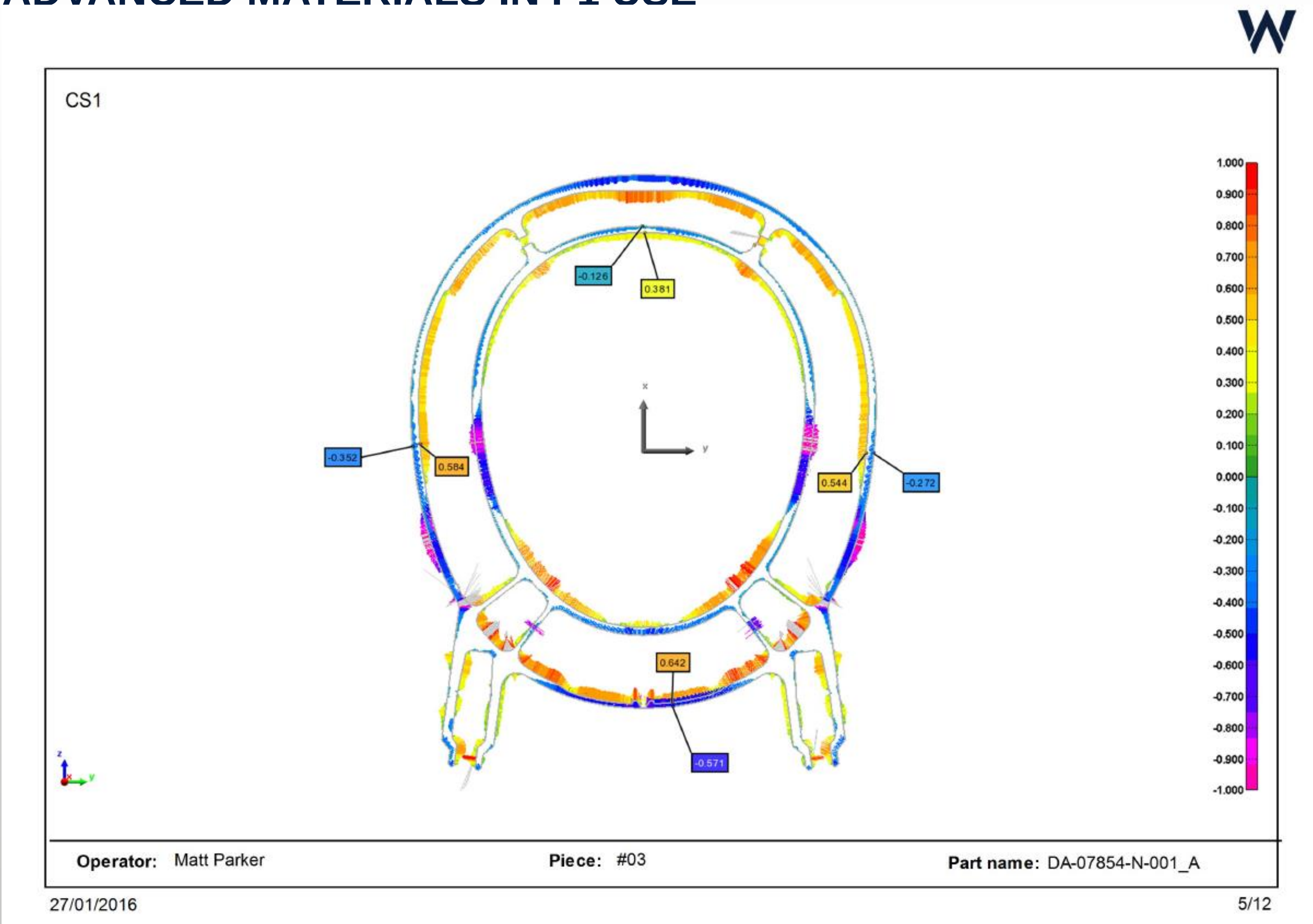
THIS SHOWS CROSS SECTIONS 1-8



Operator: Matt Parker **Piece:** #04 **Part name:** DA-07854-N-001_A

27/01/2016 4/12

ADVANCED MATERIALS IN F1 USE



THANKS FOR YOUR ATTENTION