



Simple methods to make your aerodynamics work

Tuning Akademie

Content

- ▶ Who we are
- ▶ Race cars in summer 2013
- ▶ Methods to verify aerodynamic performance
 - Cotton threads
 - Flow visualisation paint
 - Data logging
 - Laser sensor
- ▶ Simulation knowledge
- ▶ Future RS5

Who we are

- ▶ Private VLN Team
- ▶ VLN class D3T/AT
- ▶ From Ingolstadt
- ▶ Founded in 2007
- ▶ Members: Audi Employees from Ingolstadt
- ▶ Philosophy:
Using knowledge of different departments of AUDI AG Ingolstadt. Scientific development on the racetrack



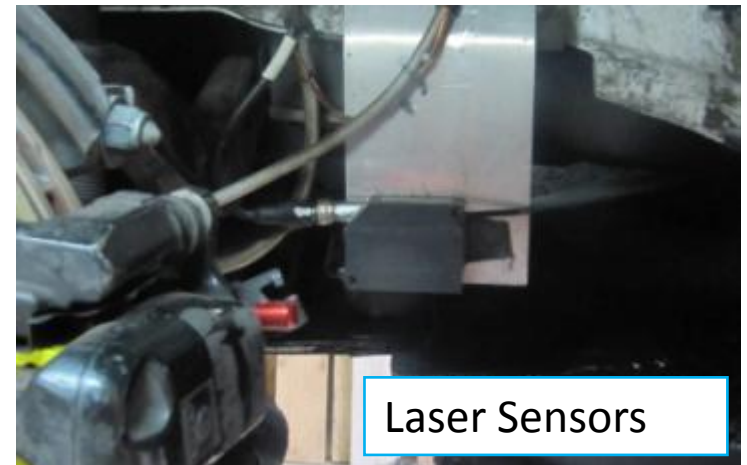
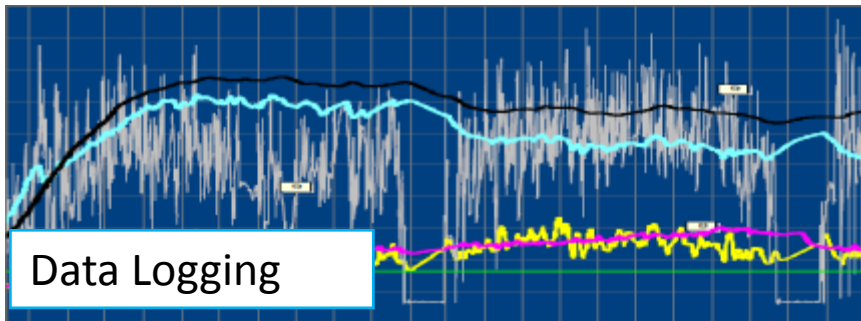
Race cars in summer 2013



Race cars in summer 2013



Methods to verify aerodynamic performance



Cotton Threads



- Simple
- Cheap
- Camera or photographer to watch
- Good colour: neon pink
- Difficult in rainy conditions

Flaps

2013

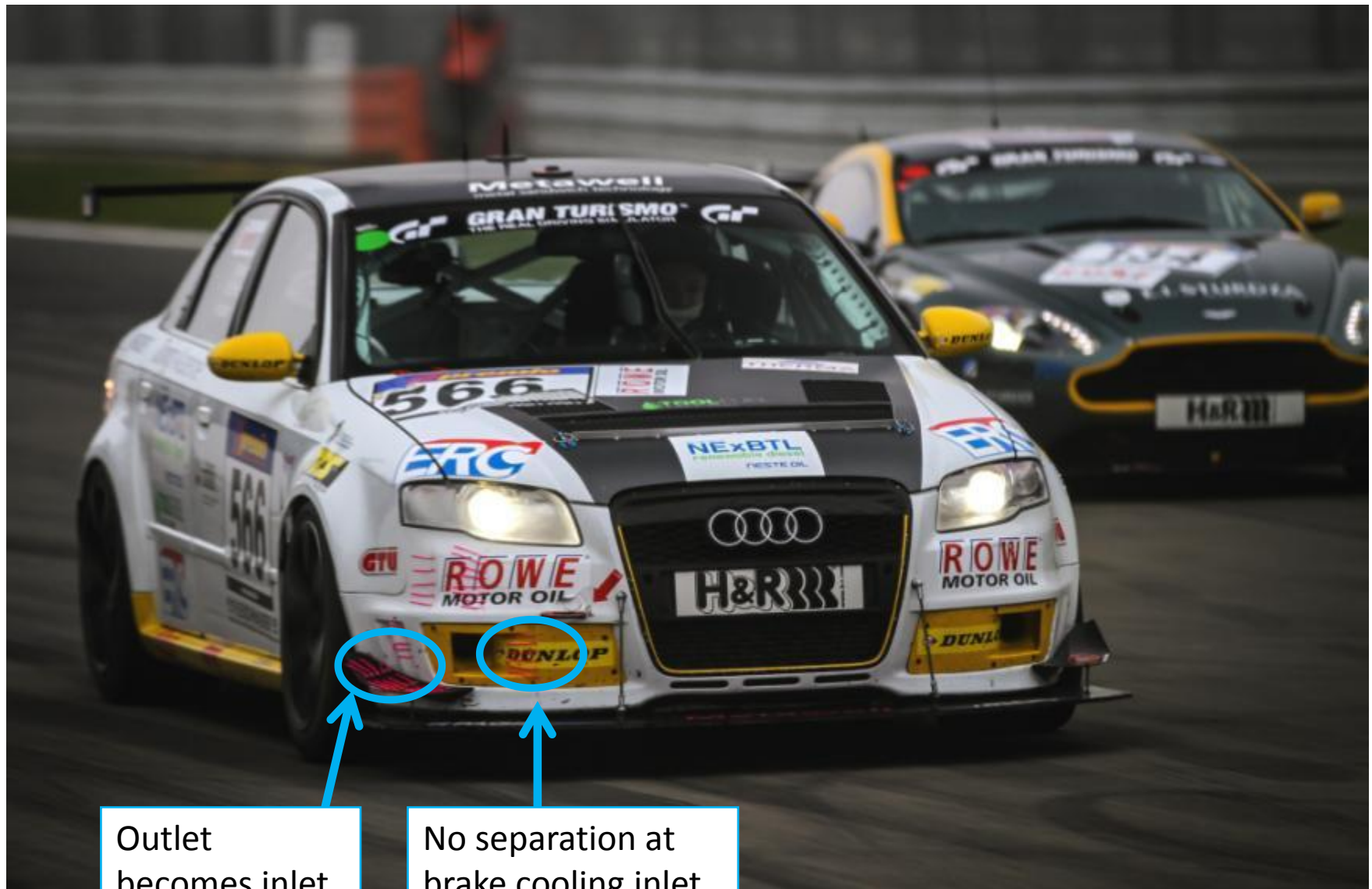


Changes:

- Larger flaps
- Smaller angle
- Smooth surfaces

2014

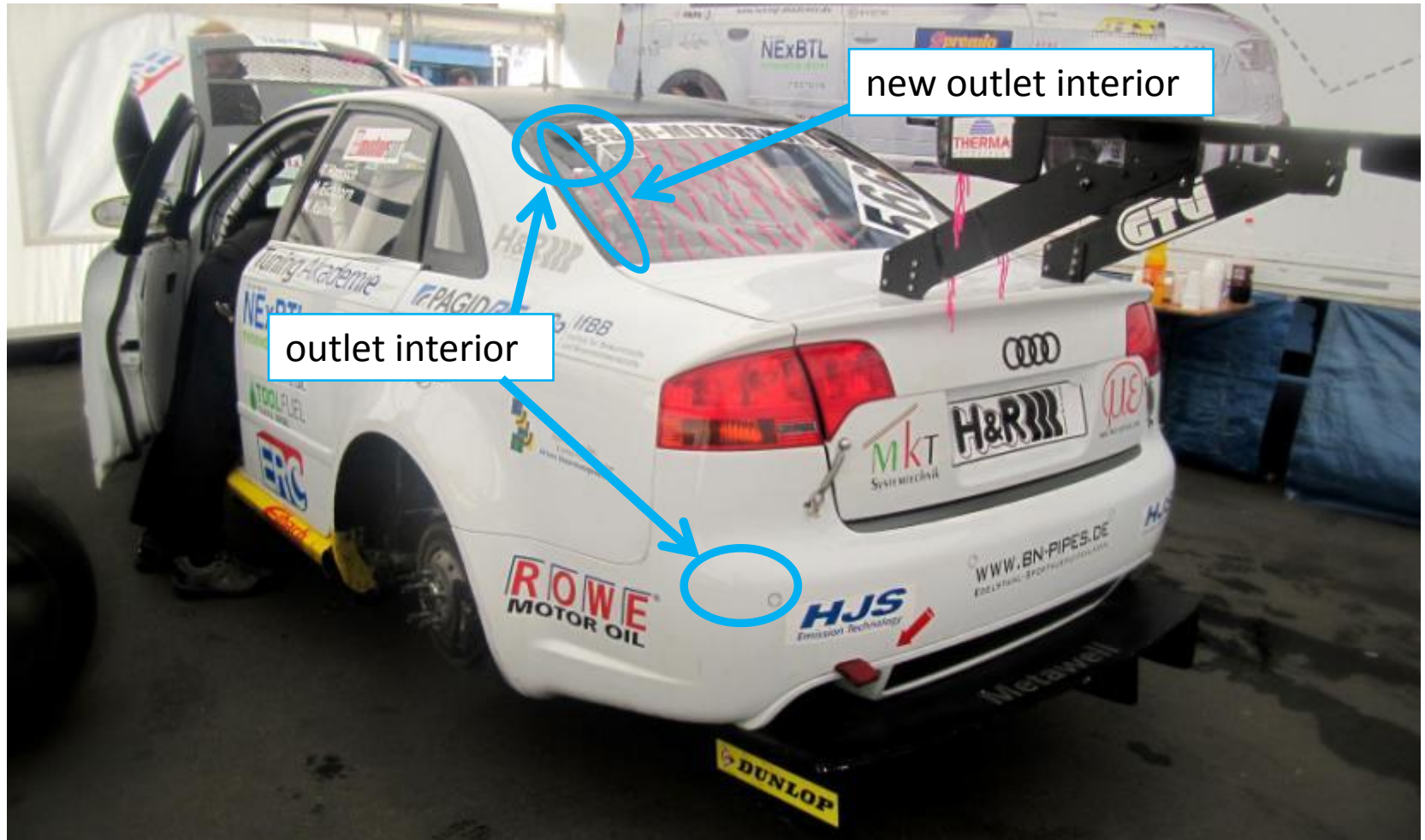




Outlet
becomes inlet

No separation at
brake cooling inlet

Interiour



Flow Visualisation Paint

do it yourself



petroleum + chalk particles
= flow visualisation paint

- Cheap
- Easy to produce
- Should dry while driving
- Not working on hot surfaces
- Using brush or spray



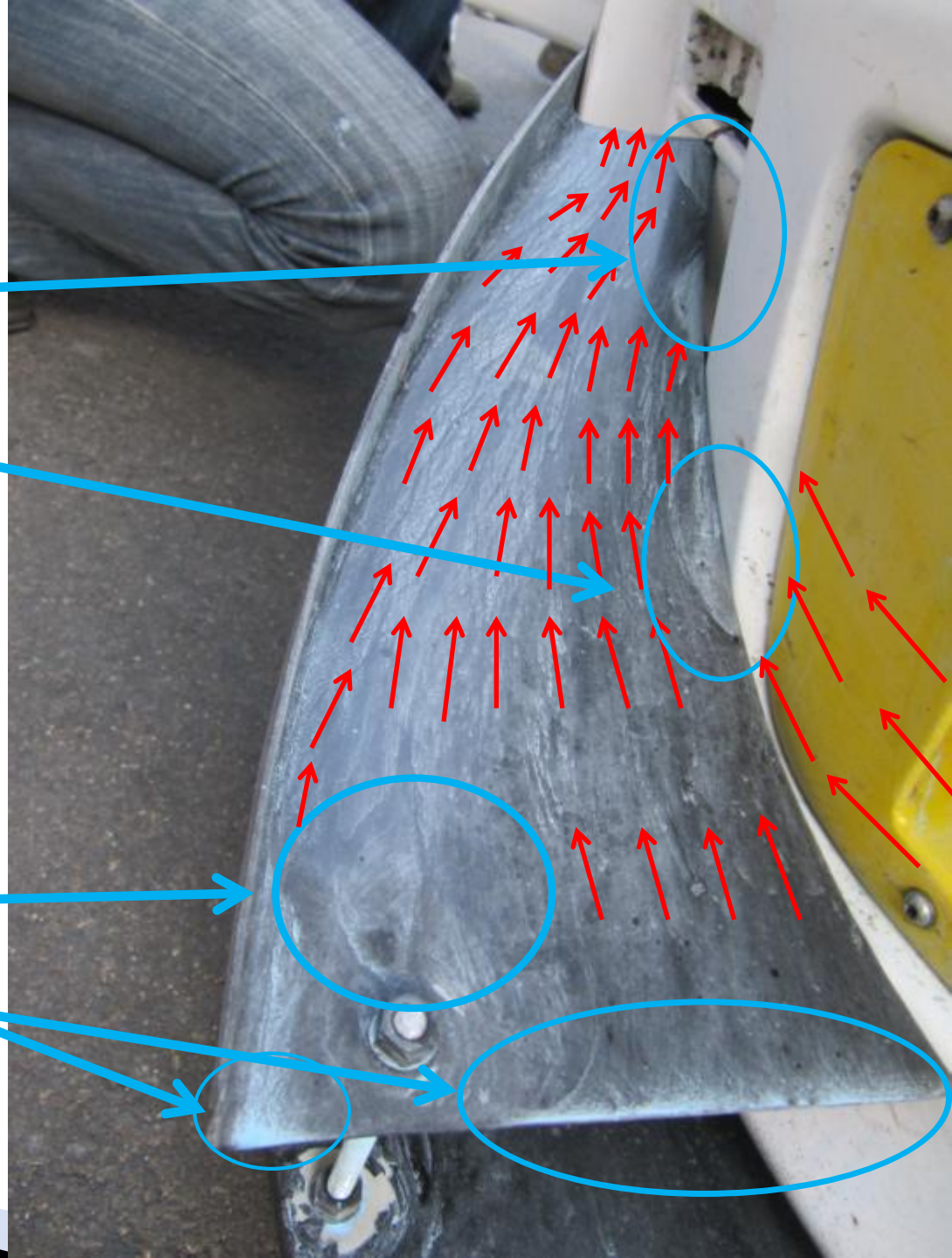
Flap (Front)

Outlet becomes inlet

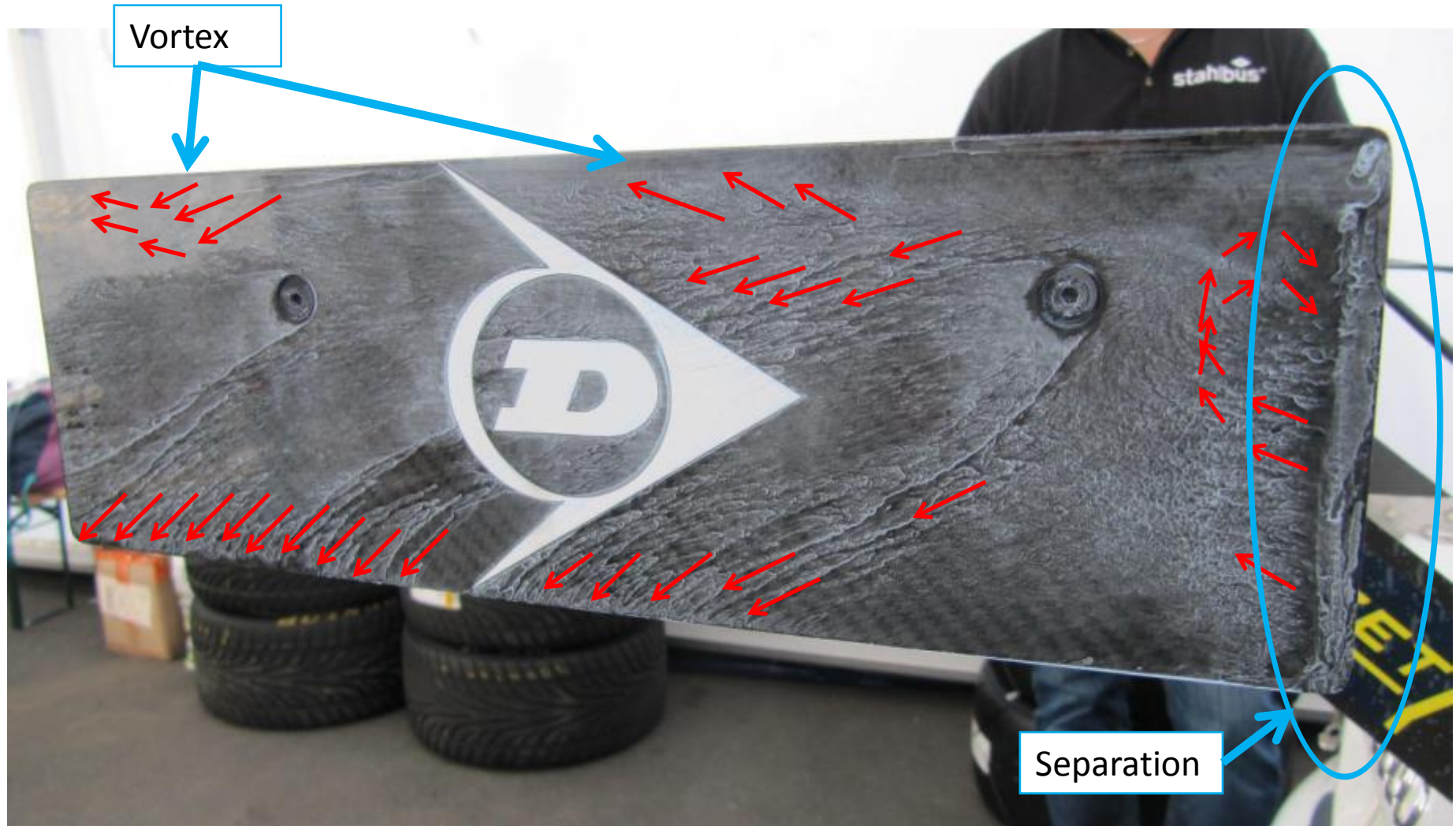
Separation

Separation behind screw

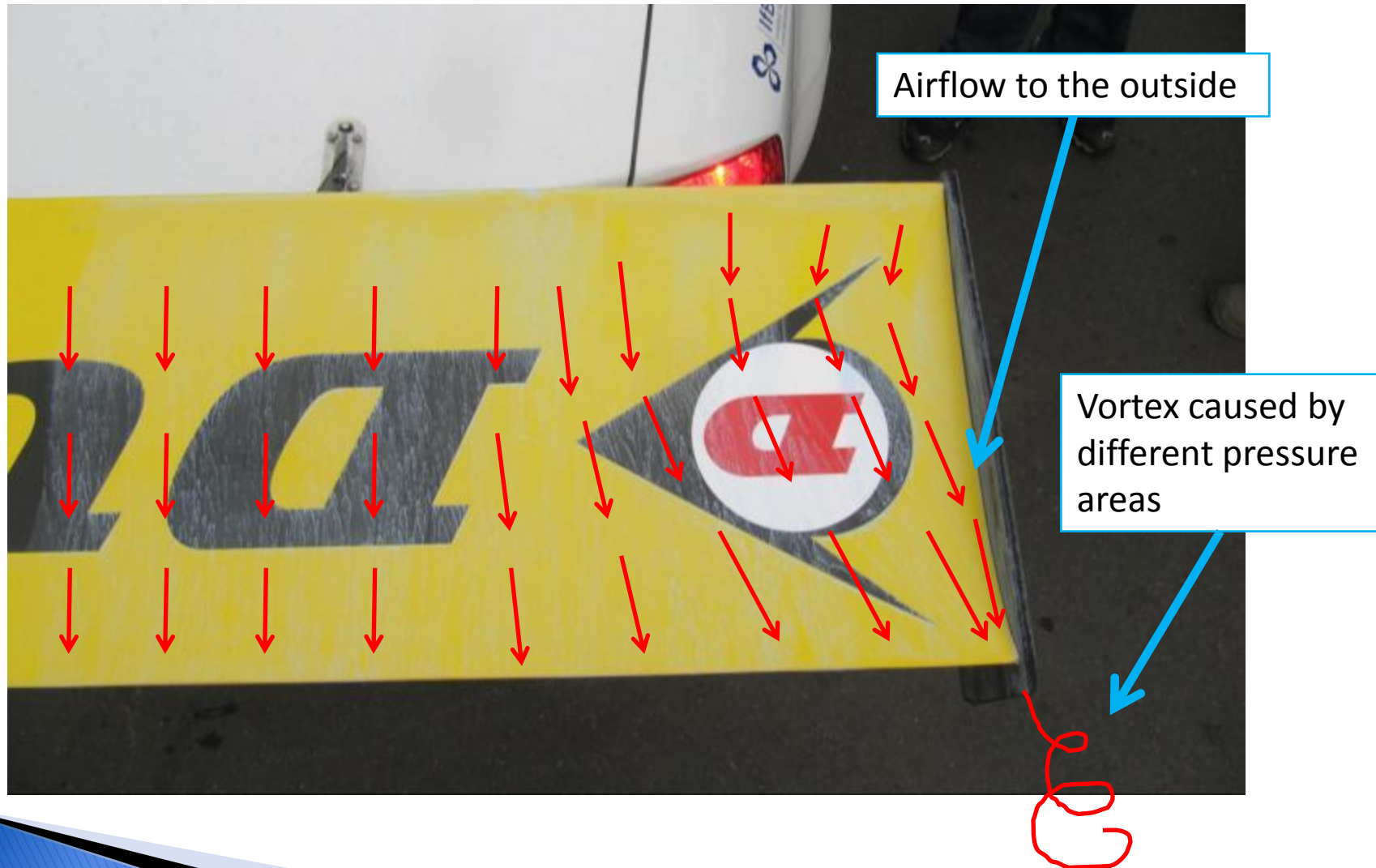
Separation at leading edge



Rear Wing Endplate



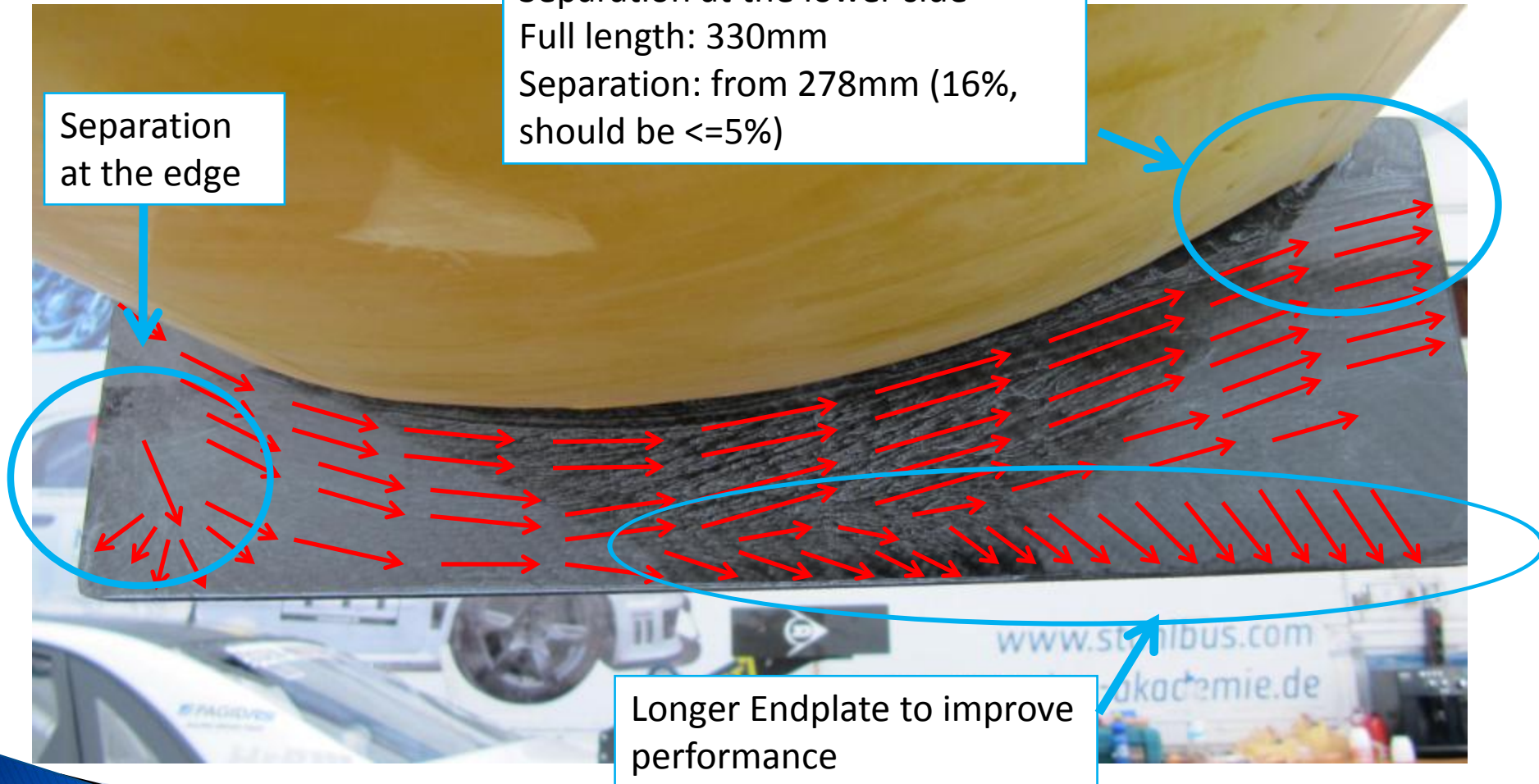
Rear Wing upper side



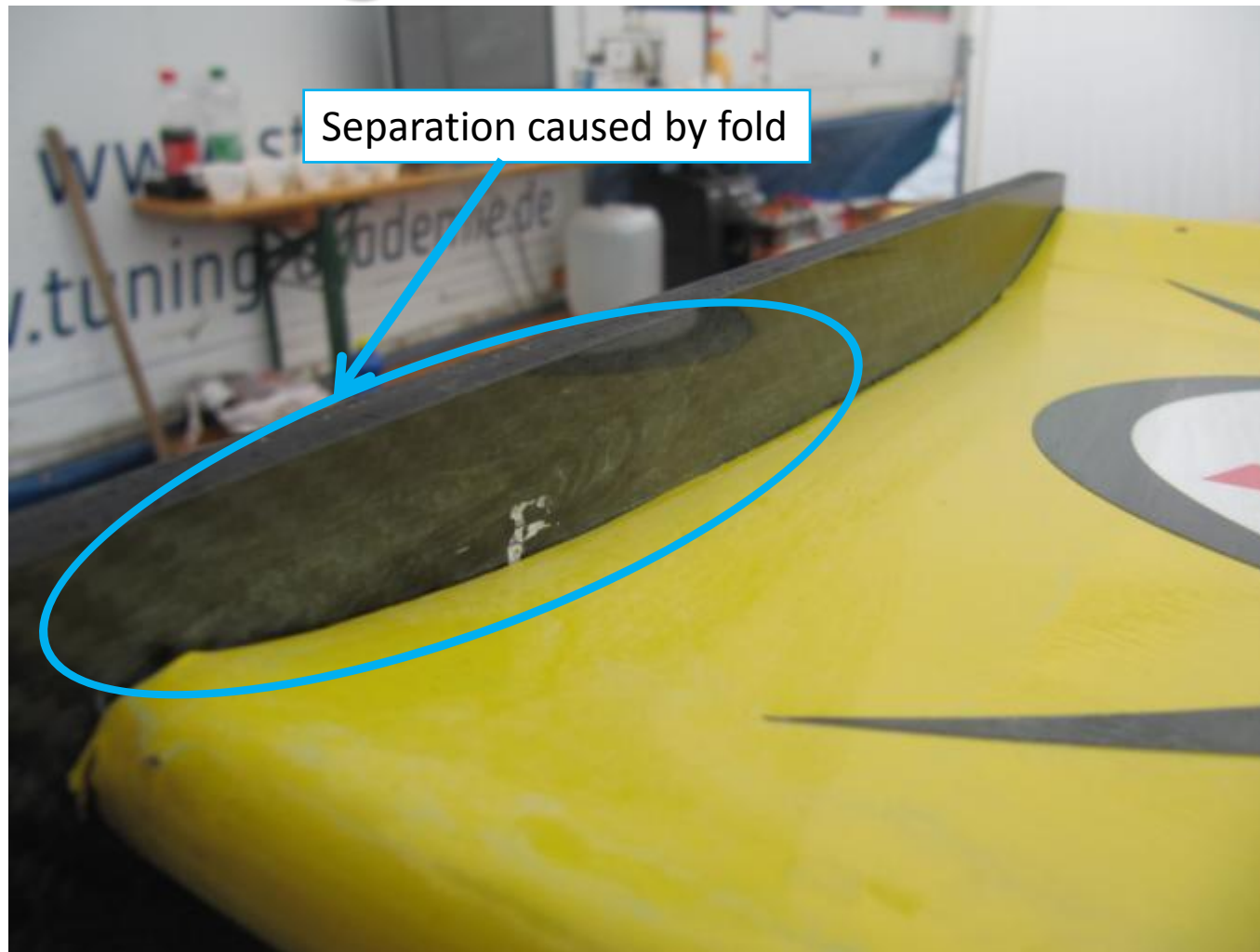
Rear Wing lower side

Separation at the lower side
Full length: 330mm
Separation: from 278mm (16%,
should be $\leq 5\%$)

Separation
at the edge



Rear wing



Data Logging



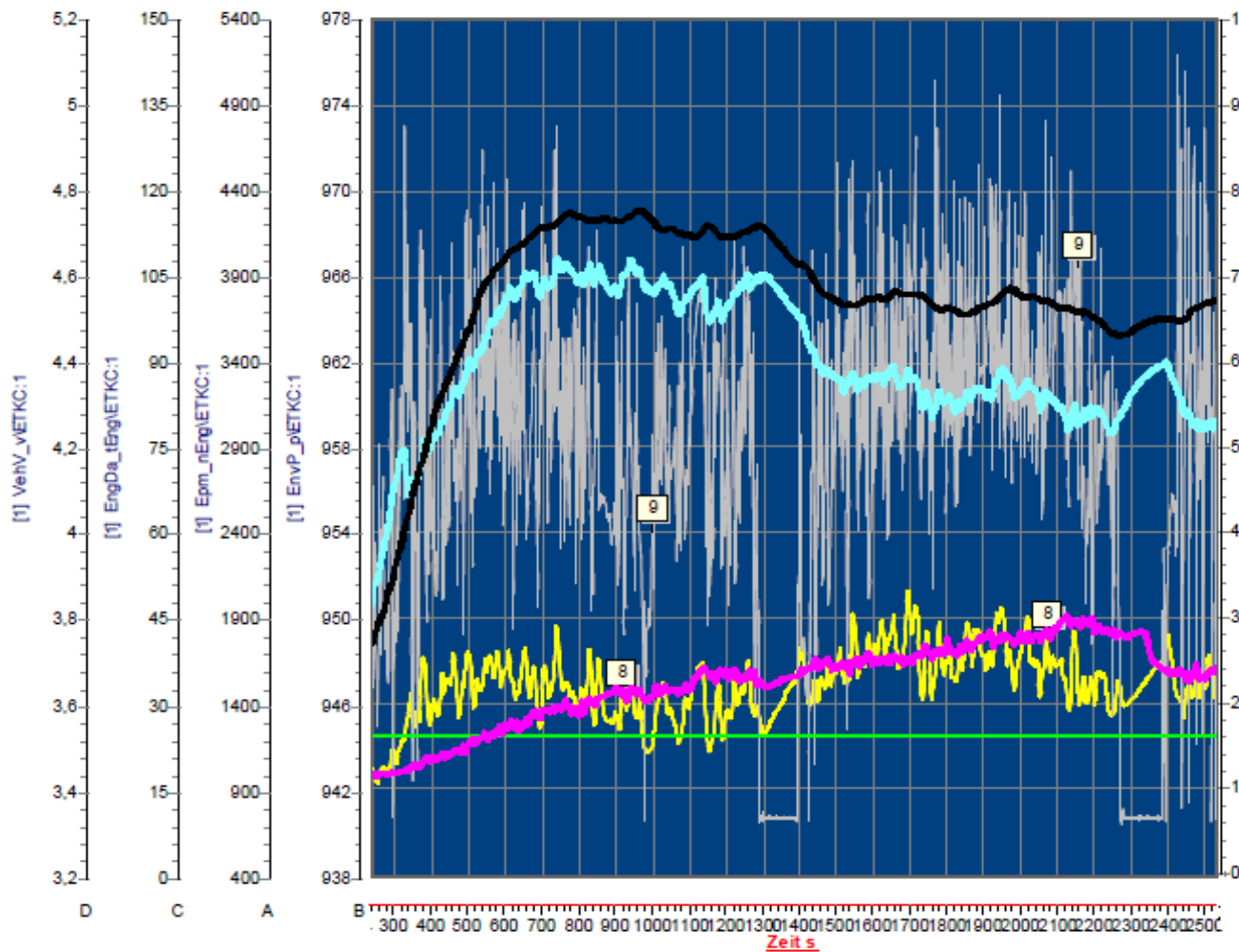
Important data for aerodynamics:

- Vehicle speed
- Water temperature
- Charged air temperature
- Laser sensors

Closing single frame inlets



Closing single frame



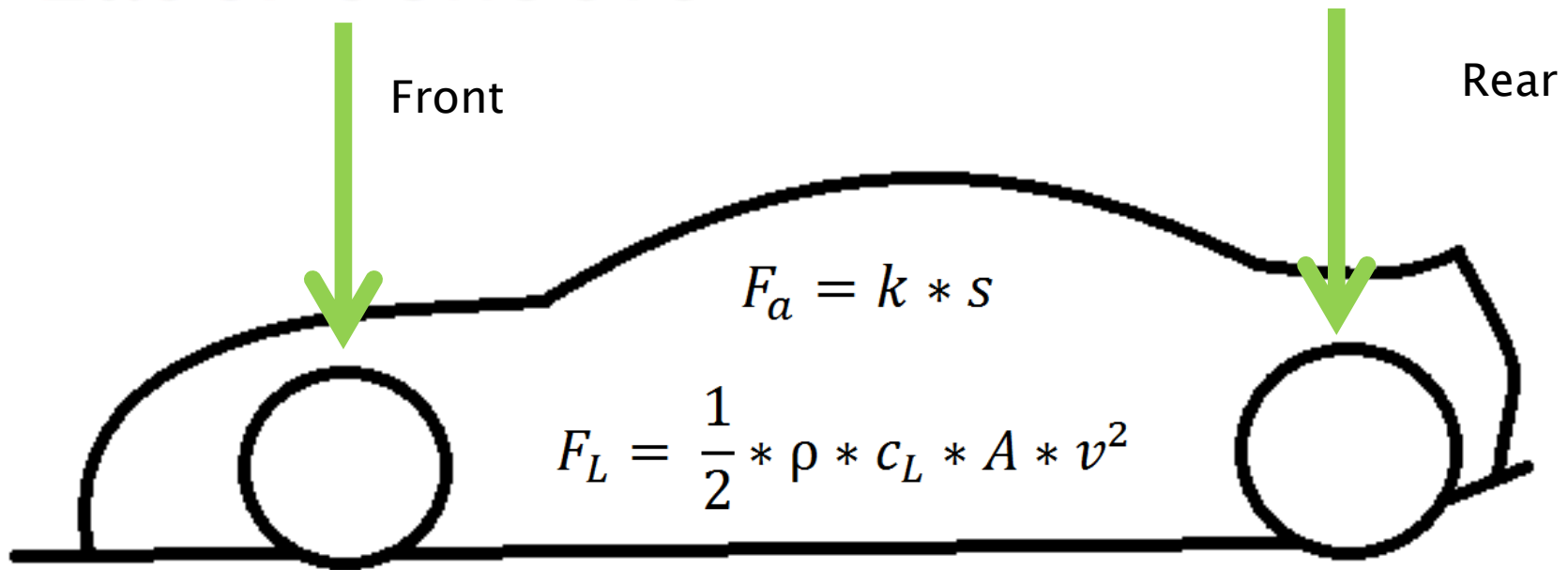
Nr.	Lin	Name	Min.	Max.	Einheit
1		 C [1] EngDa_tEnglETKC:1	50,26	108,46	deg C
3		 C [1] EnvT_tlETKC:1	24,96	24,96	deg C
5		 C [1] Fuel_tlETKC:1	17,96	45,86	deg C
6		 C [1] Oil_tSw_mPETKC:1	41,36	116,56	deg C
8		 C [1] Air_tGACDsETKC:1	16,86	50,26	deg C
9		 C [1] Epm_nEnglETKC:1	713	5190,5	rpm

EngDa_tEng ==> Kühlmitteltemperatur
EnvT_T ==> Umgebungstemperatur
FuelT_t ==> Kraftstofftemperatur Vorlauf
Oil_tSw mp ==> Öltemperatur
Air_tCACDs ==> Ansauglufttemperatur
Epm_nEng ==> Motordrehzahl

Datum:
Zeit:
Benutzer:
Firma:

Fahrzeug: TA003
Projekt: VLN7_20140823
Messdatei:

Laser sensors



- Measurement of ride height at front and rear
- Comparison of standstill and highspeed
- Calculation of downforce
- Identified bad downforce balance



Simulation knowledge

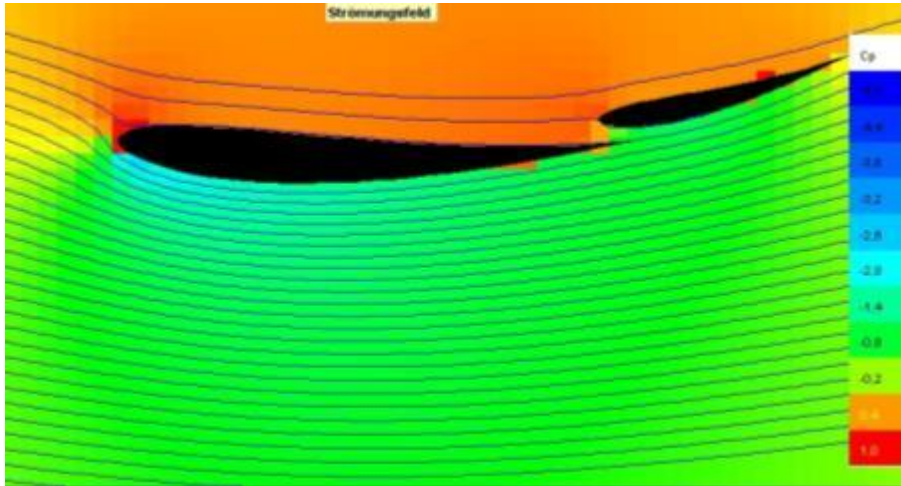


Aerodynamic Efficiency

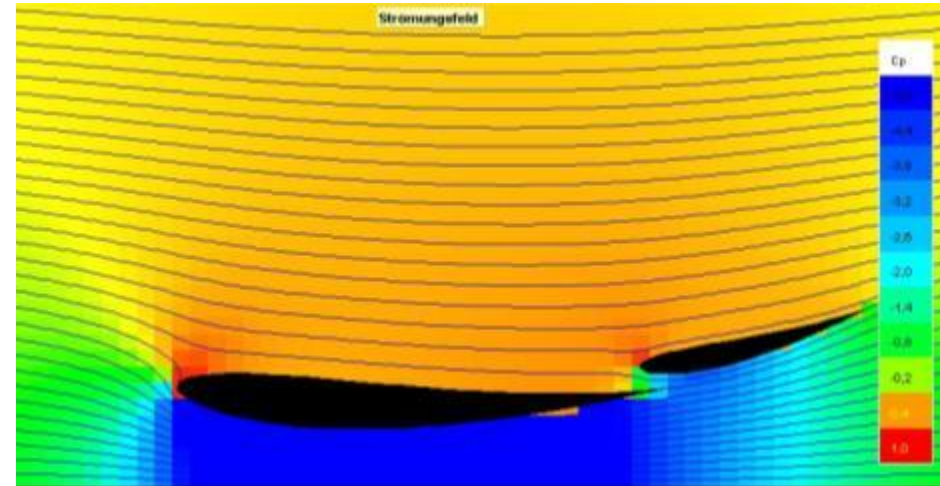
Komponente	Luftwiderstand		Abtrieb		c_A/c_W [–]
	c_W	Anteil [%]	c_A	Anteil [%]	
Frontflügel	0,123	13,2	0,9699	front wing	7,859
Heckflügel	0,297	31,8	0,899	rear wing	3,029
Unterboden	0,099	10,6	1,080	undertray	10,911
Vorderräder	0,150	16,0	–0,038	–1,4	–0,251
Hinterräder	0,187	20,1	–0,061	–2,3	–0,326
Leitbleche (barge boards)	0,023	2,4	–0,020	–0,8	–0,889
Rest	0,055	5,9	–0,210	–8,0	–3,793
Gesamt	0,934	100	2,617	100	2,802

Source: Rennwagenteknik, Michael Trzesniowski, Springer Vieweg 2012

Undertray



Wing in free air stream

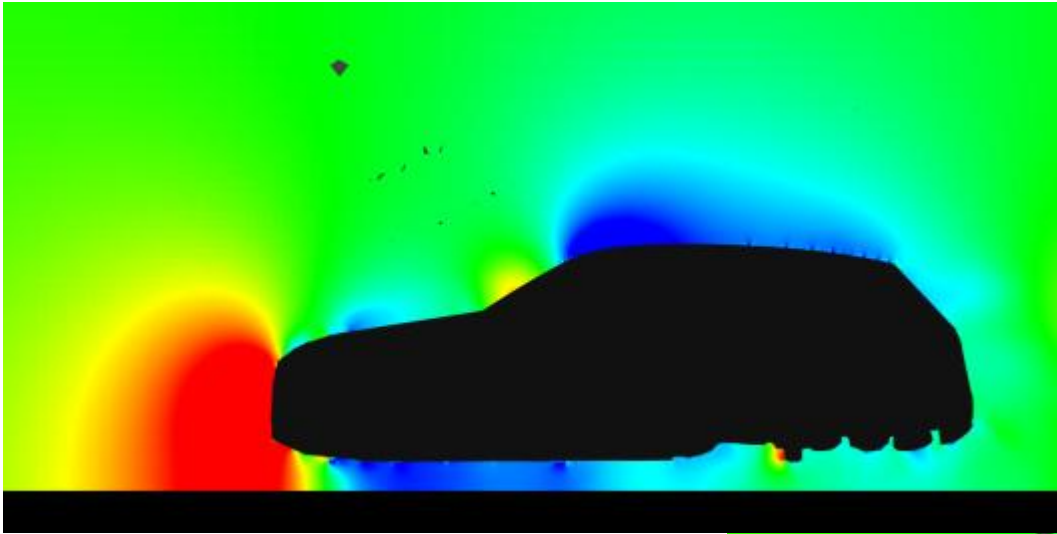


- Wing close to ground
 - Little increase in c_d
 - c_l more than doubled



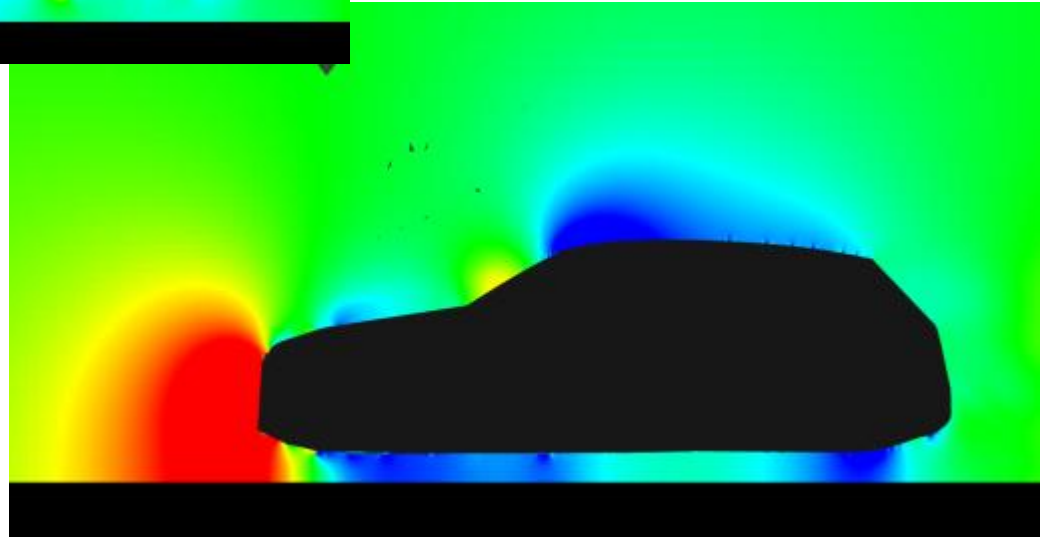
Source: www.runxbuys.com

Undertray

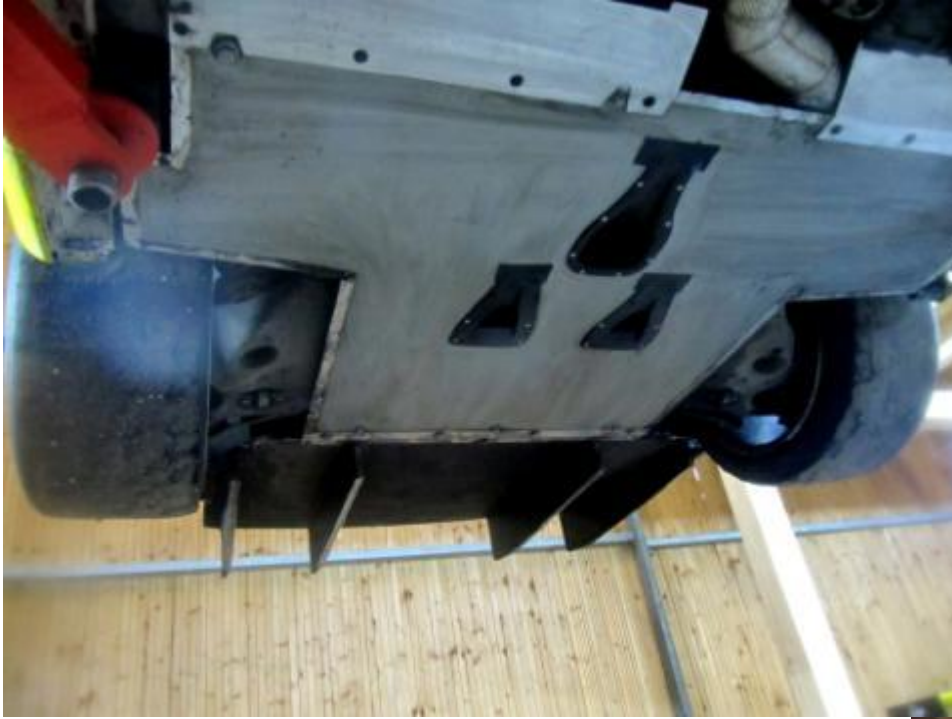


-Covered rear axle for more downforce and less drag

-Less cooling for rear differential



Undertray



- Rear axle covered
- NACA ducts for rear differential
- Maximum size diffuser with 4 diffuser fins



Rear wing

2013



- Smaller rear wing for less drag and better downforce balance



2014

Rear wing supports



Bonnet

2013

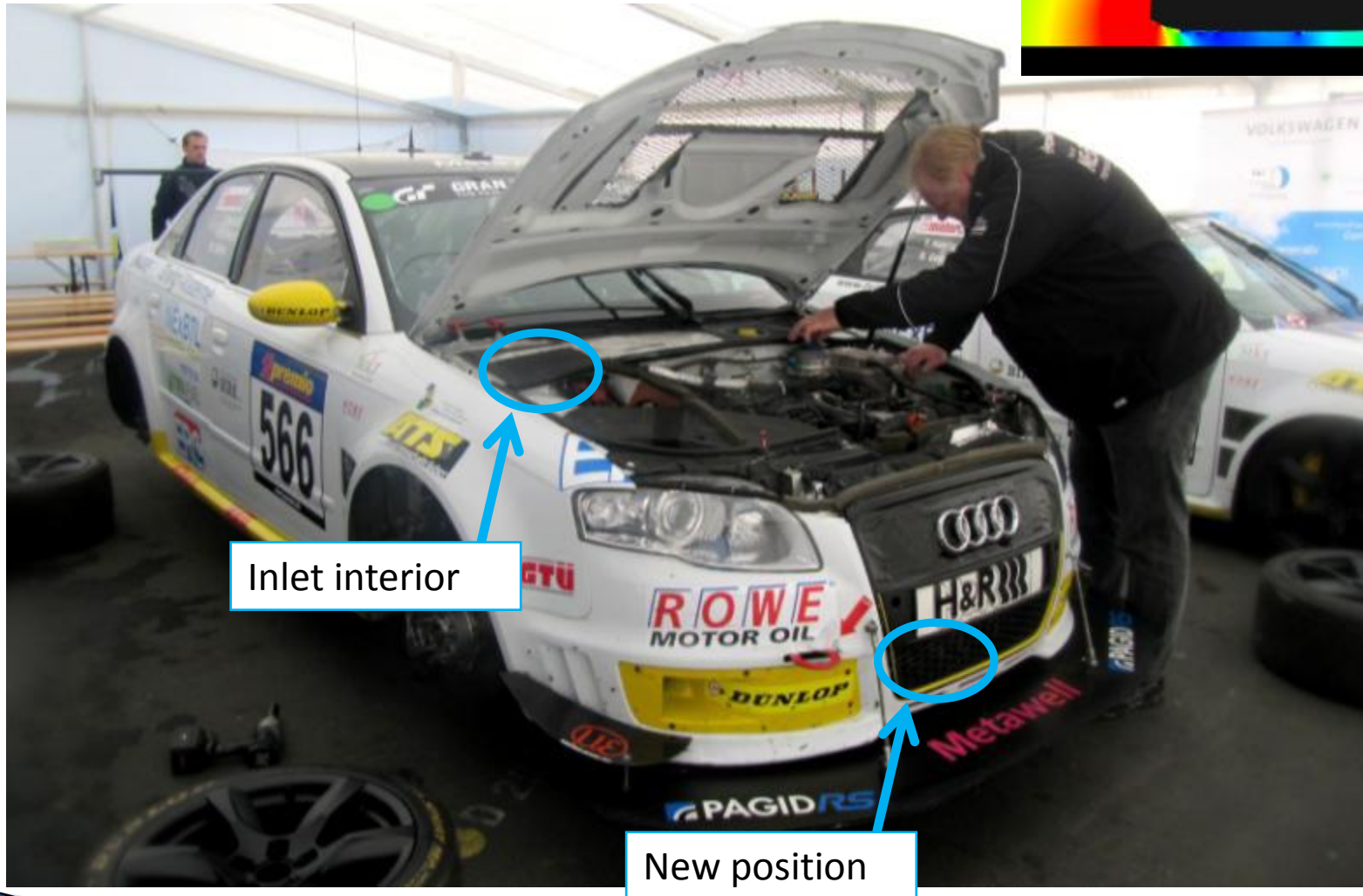
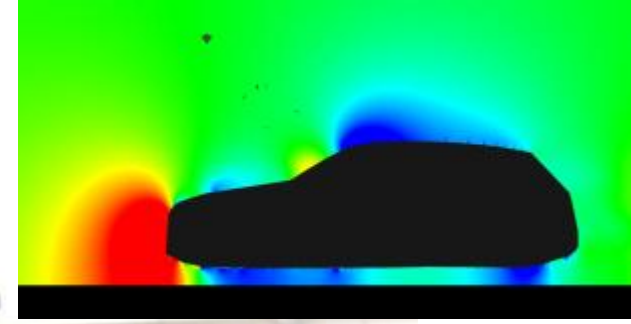


- Expanding outlet area from 600cm² to 2800cm²
- Additional 20mm gurney for more downforce and cooling performance



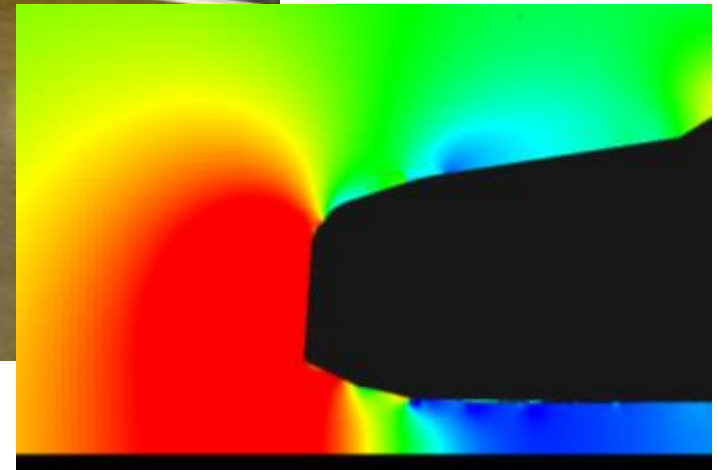
2014

Interiour



Splitter

- Expanding to maximum size of 200mm
- Possibility to use bigger flaps



Inlets



Brake cooling

Engine cooling

Brake cooling

Sealing



- Different temperature areas
- Better cooling performance
- Less drag
- Lower air temperature (engine)

Wheel Arch



Outlet for less drag

Driving direction

Result

- 
- ...after 4800km racing**
Comparison summer 2013 vs. summer 2014
- Topspeed +10km/h
 - Downforce +11%
 - Coolant temperature -10K
 - Improved downforce balance

Future RS5



- Audi RS5 body
- 3.0 V6 TDI BiTurbo
- 400hp
- 800Nm
- quattro

Thank You



NESTE OIL

Metawell
metal sandwich technology

RONAL

WWW.BN-PIPES.DE
EDELSTAHL-SPORTAUSPUFFANLAGEN

ROWE



La Lanterna



Teamfotograf



Tuning Akademie