



ANALYSIS CFD PIKES PEAK CAR



AUTHORS:

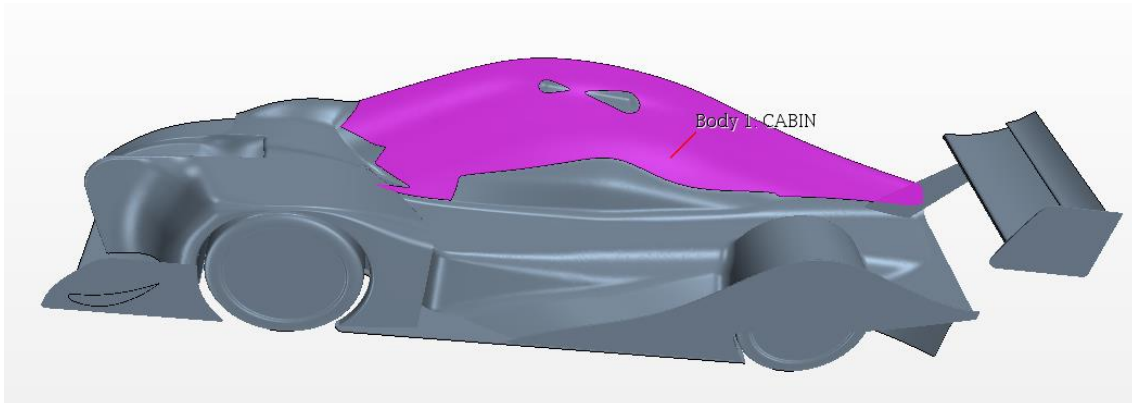
Timoteo Briet Blanes

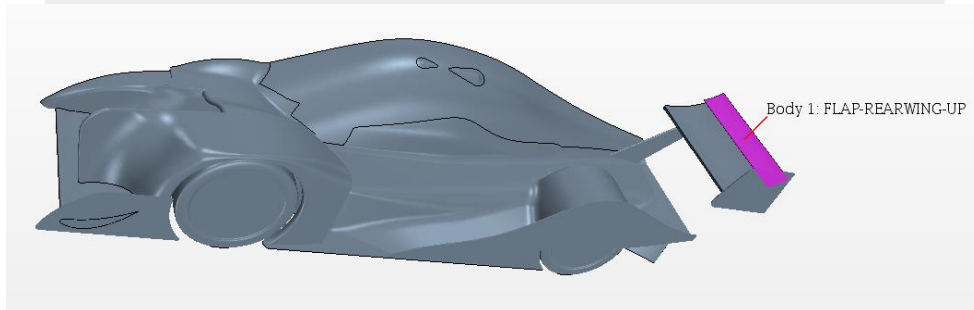
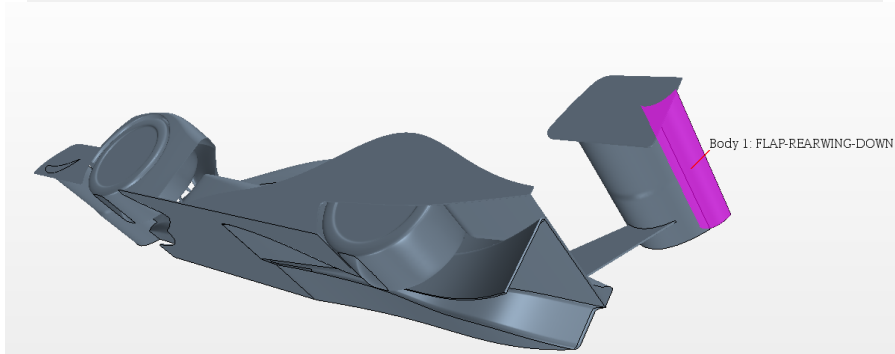
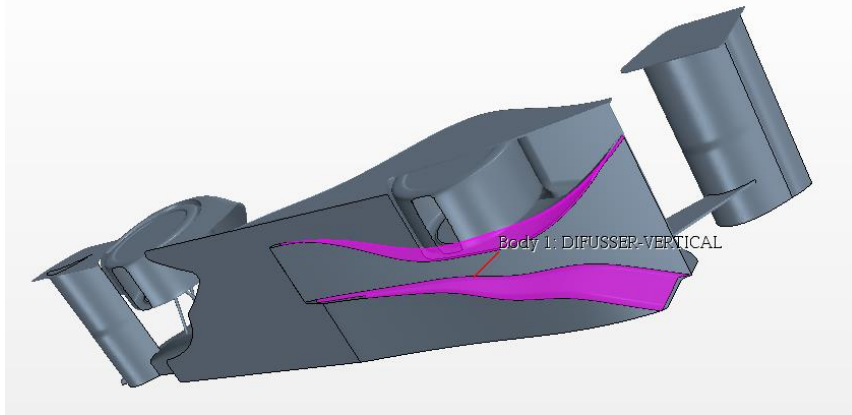
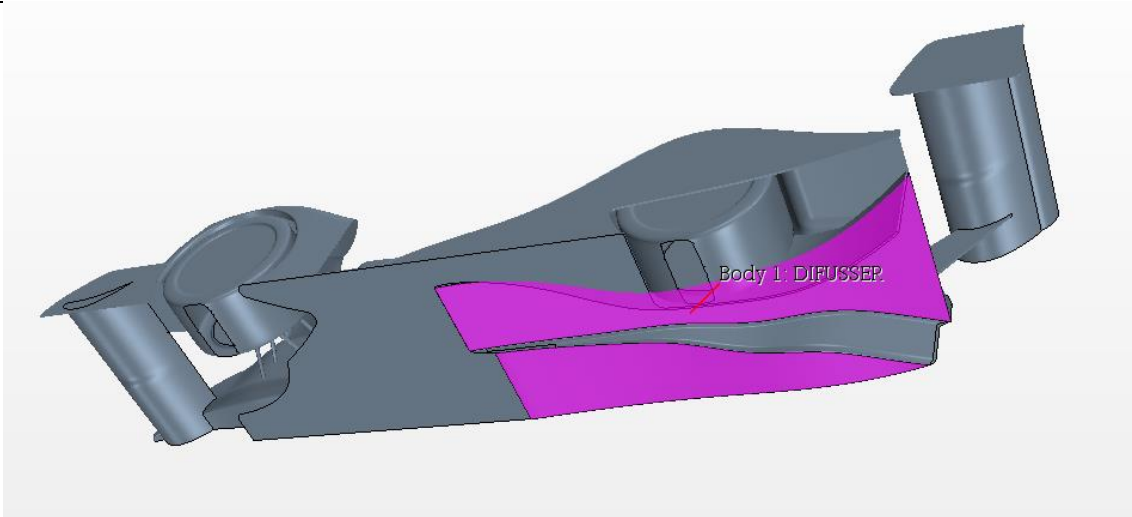
AERODYNAMICS RESEARCH GROUP 

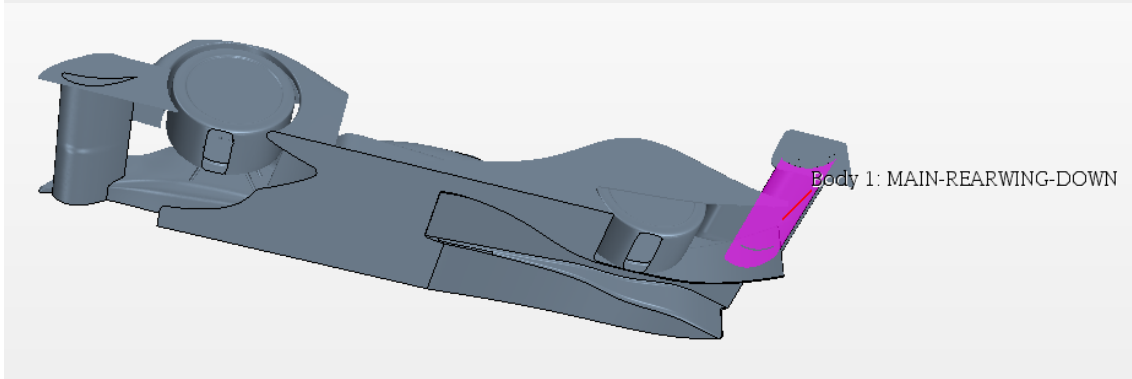
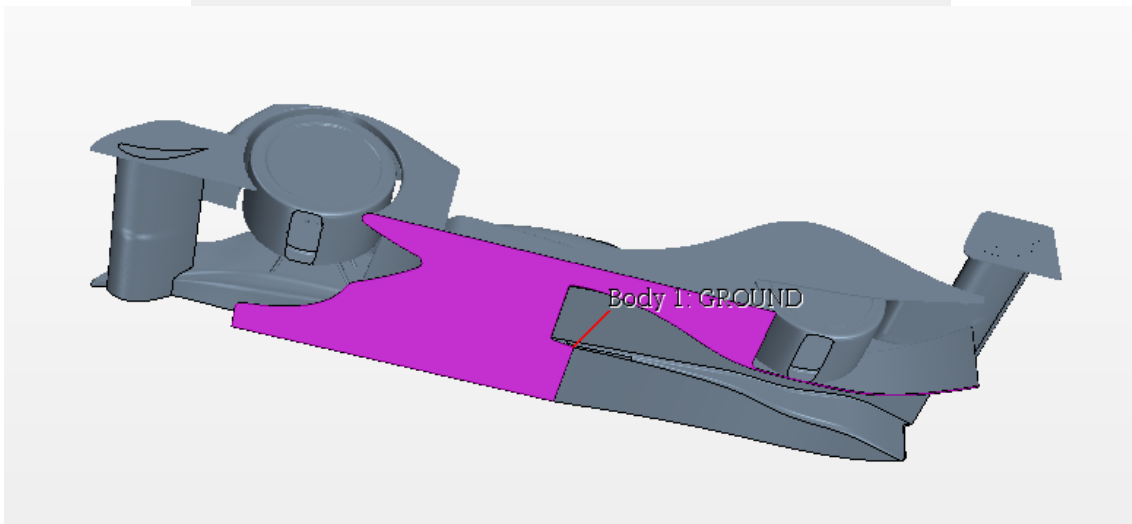
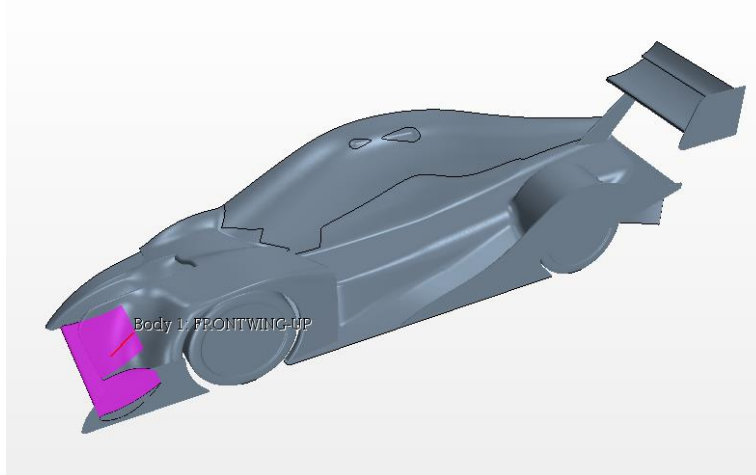
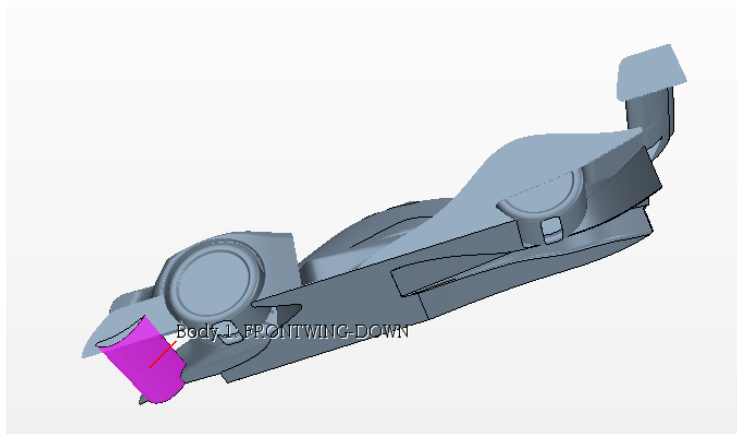
PIKES PEAK

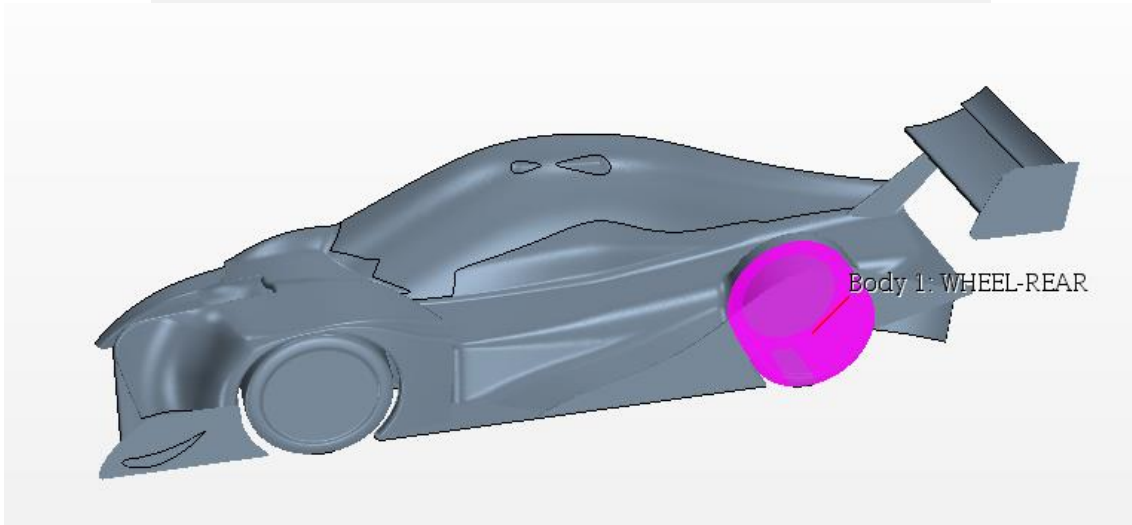
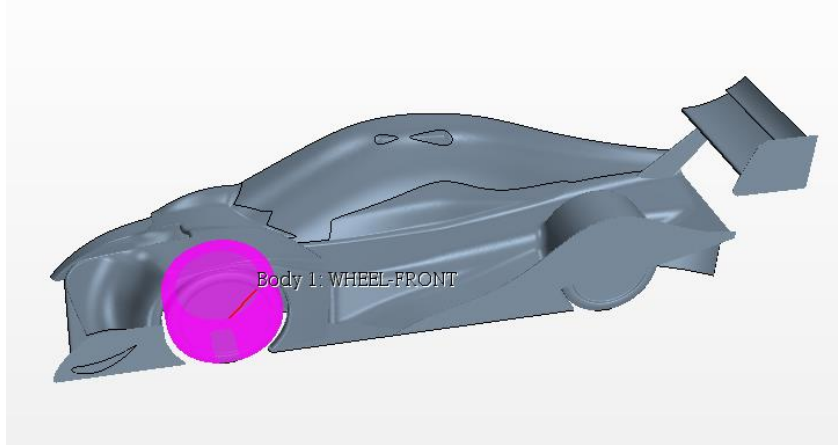
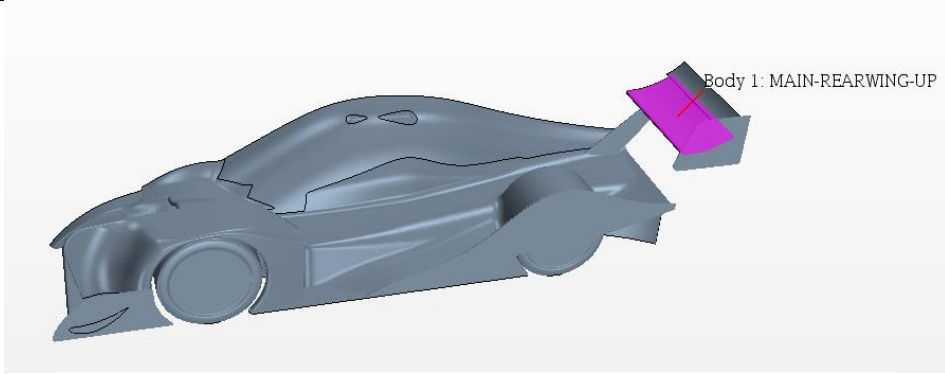
The main goal is improve a “real” car, for that, is necessary test in CFD some different designs:

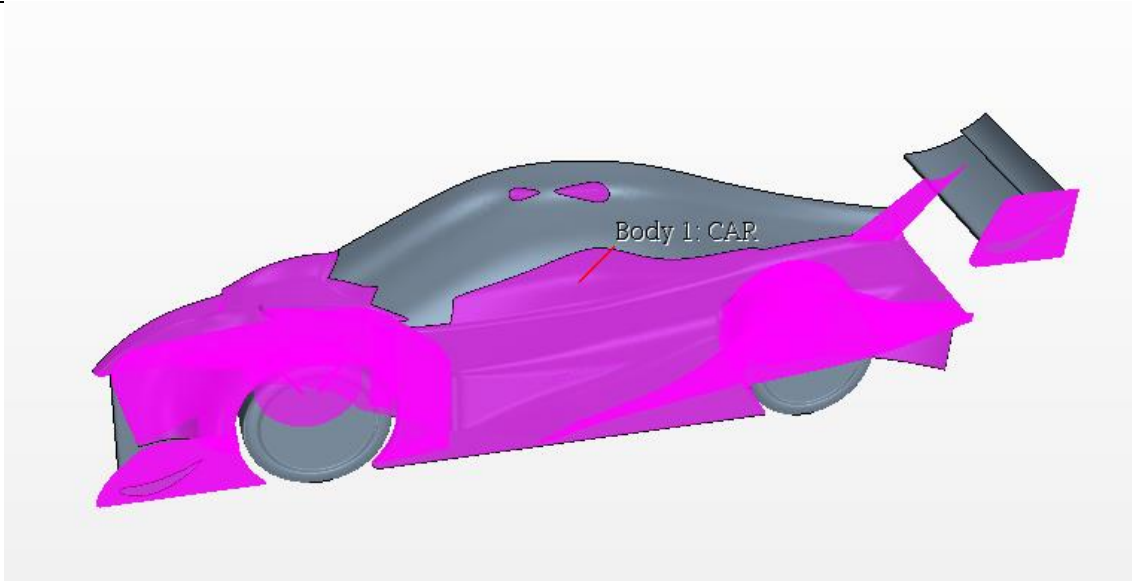
VERSION 1











Downforce / Lift each part
150 Km/h, ground moving and wheels rotating:

Half Car		
Parts	Newtons	Kg
CABIN	212	21,63265
WHEEL FRONT	98	10
WHEEL REAR	36	3,673469
FLAP REAR WING DOWN	-24	-2,44898
FRONT WING DOWN	-31	-3,16327
DIFFUSER VERTICAL	-55	-5,61224
FLAP REAR WING UP	-58	-5,91837
FRONT WING UP	-196	-20
MAIN REAR WING UP	-309	-31,5306
DIFFUSER	-595	-60,7143
GROUND	-633	-64,5918
MAIN REAR WING DOWN	-710	-72,449

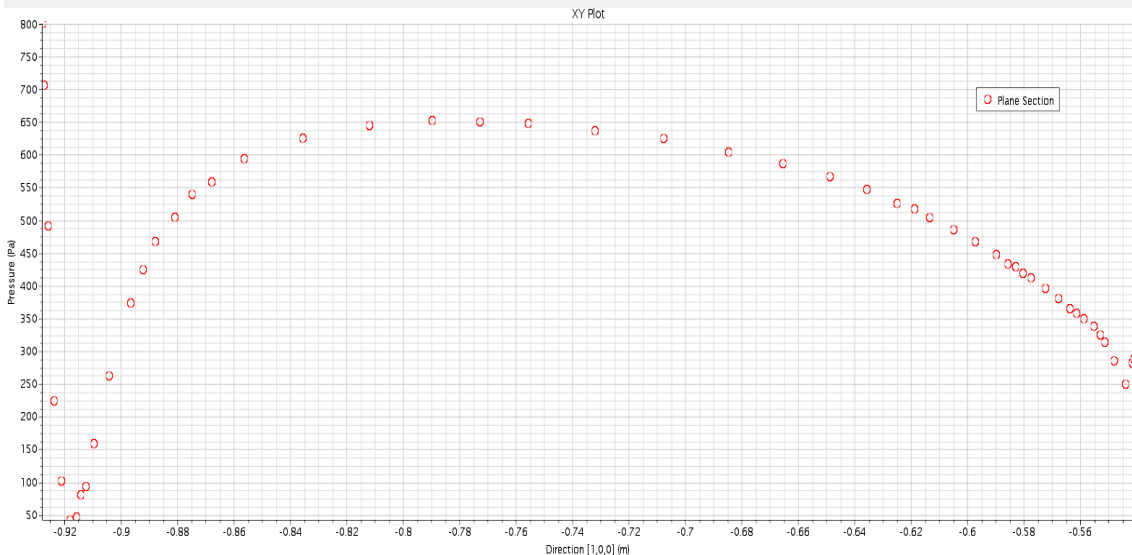
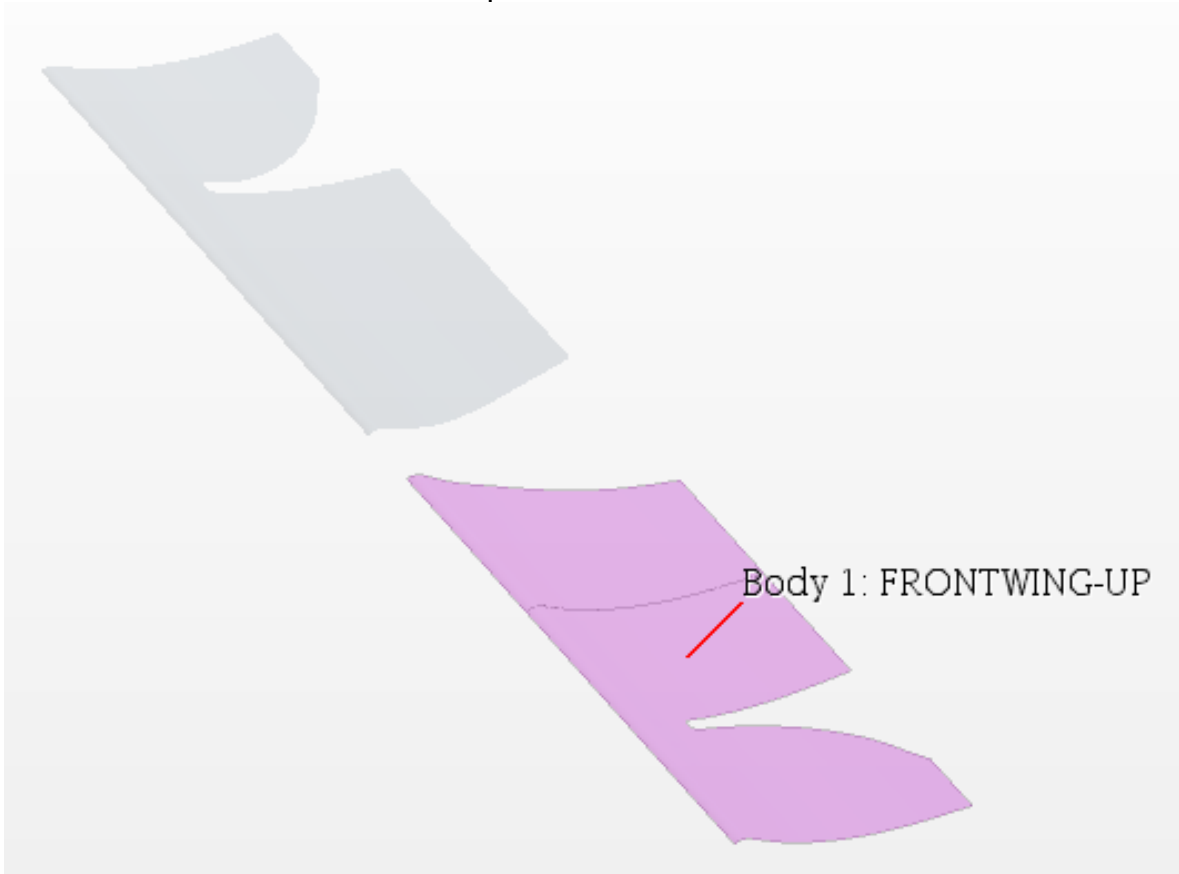
Total: -231,122 Kg

Full car: -462,244898 Kg

Drag half car: 861 Newtons.



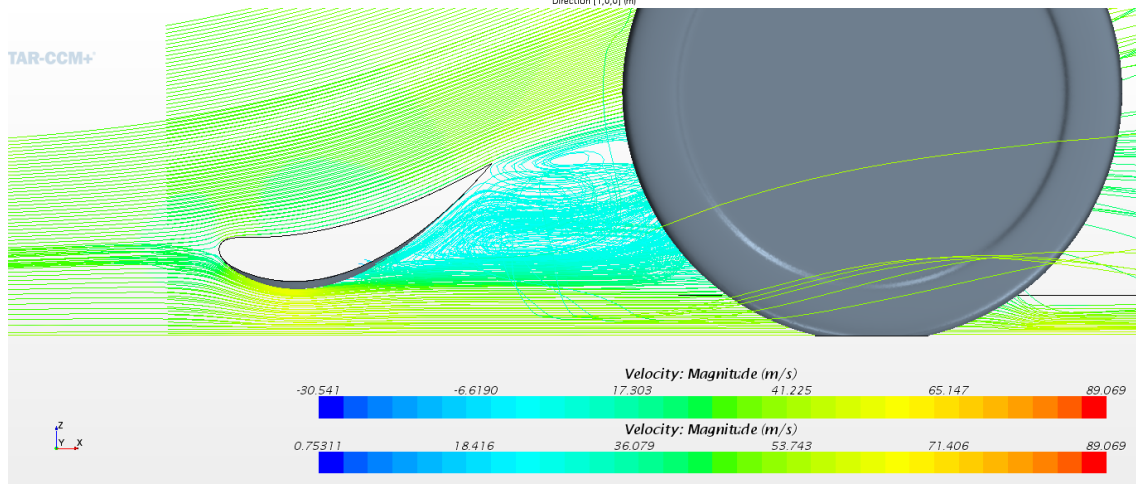
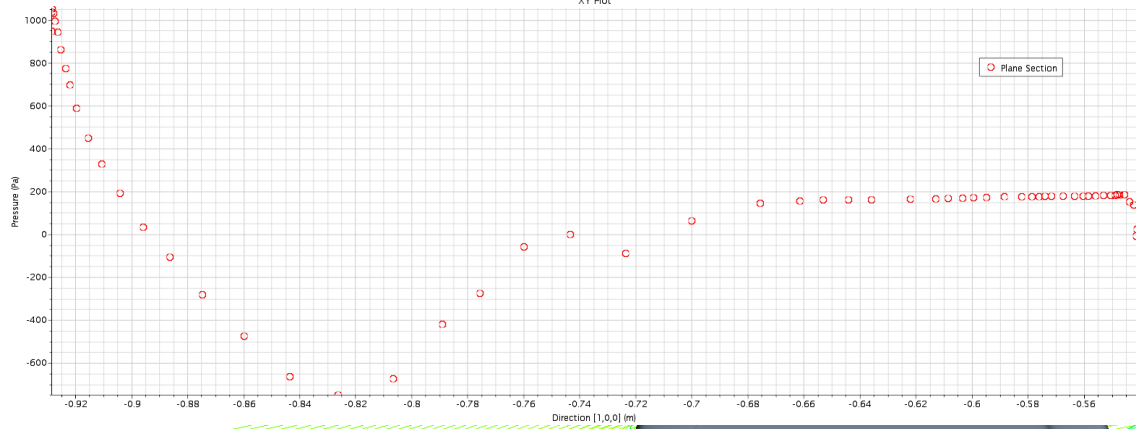
FRONT WING – UP
Graphic in Y=0.4 m



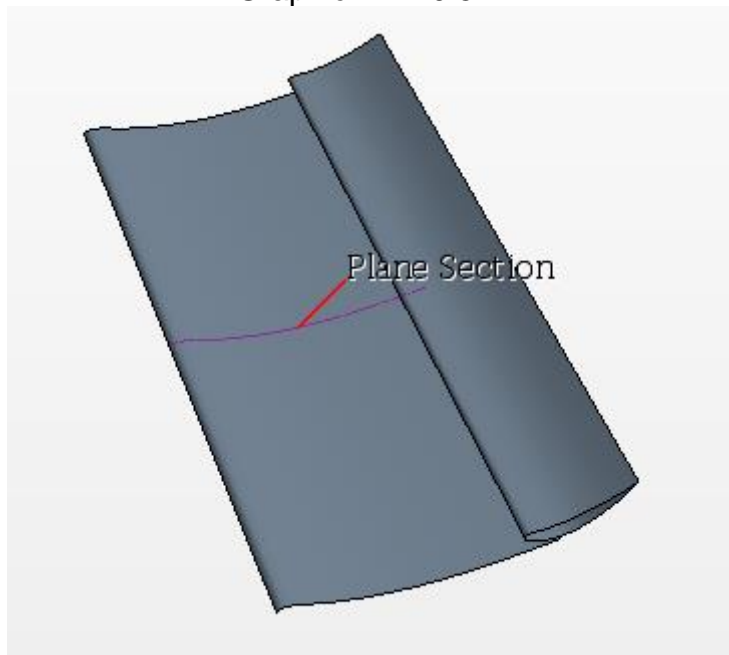
FRONT WING – DOWN
Graphic in Y=0.4 m

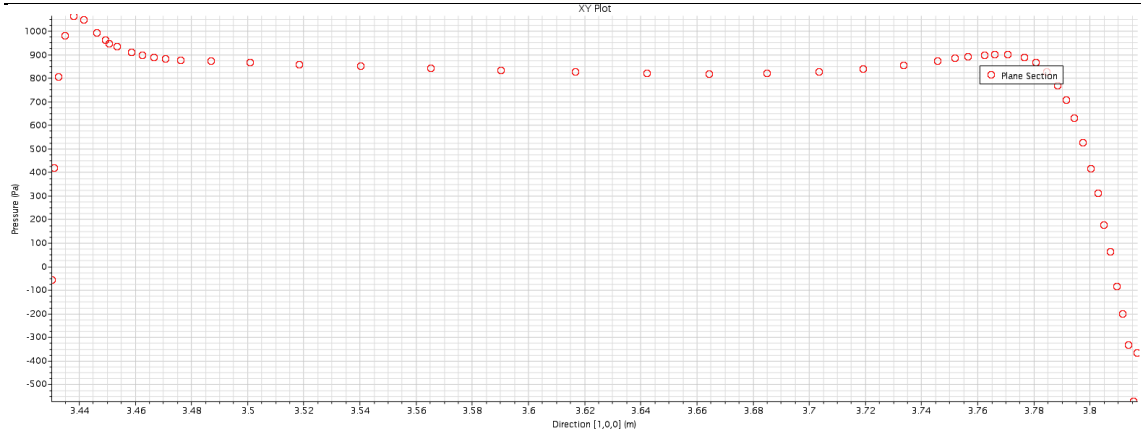


XY Plot

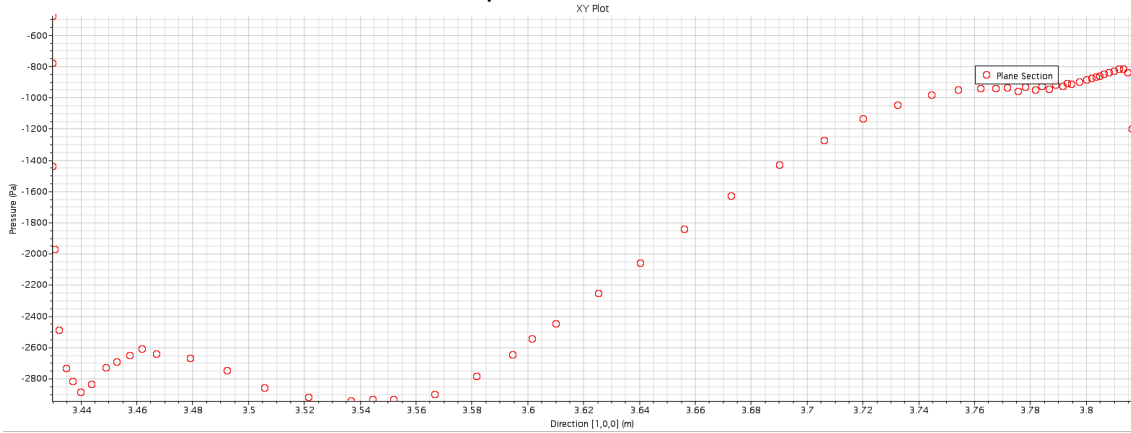


Is possible so, create more downforce from front wing; the streamlines, not are in contact to surface.
REAR WING MAIN – UP
Graphic in Y=0.5 m

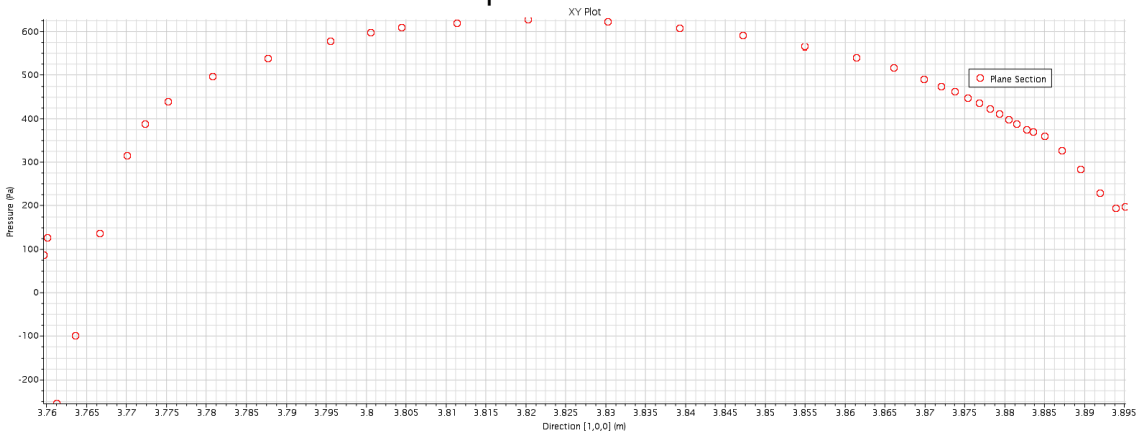




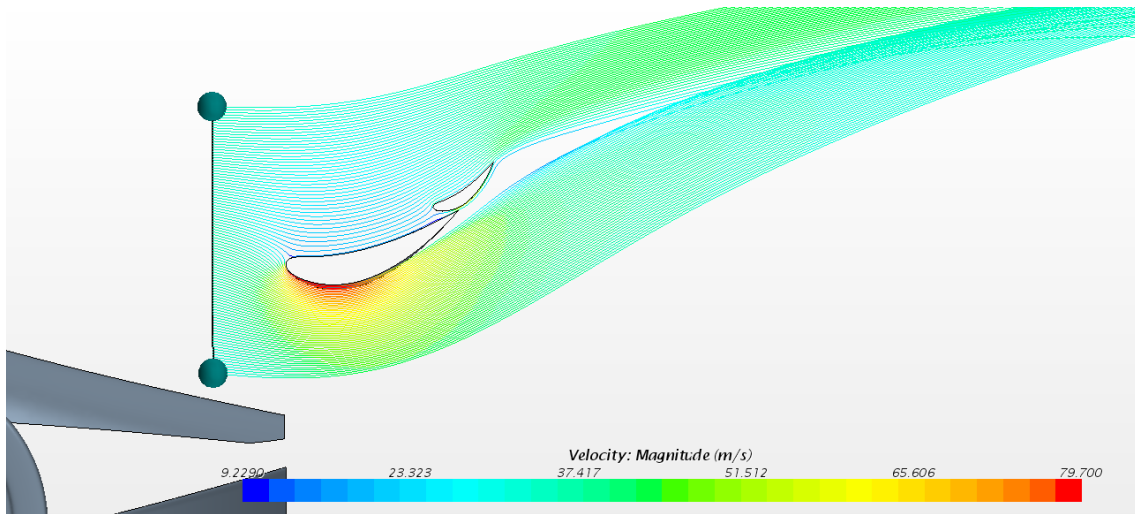
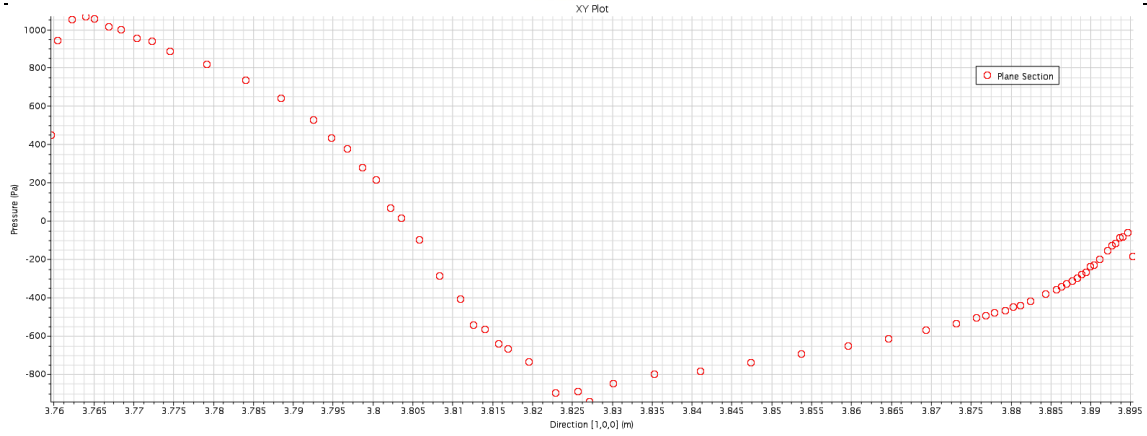
REAR WING MAIN – DOWN
Graphic in Y=0.5 m



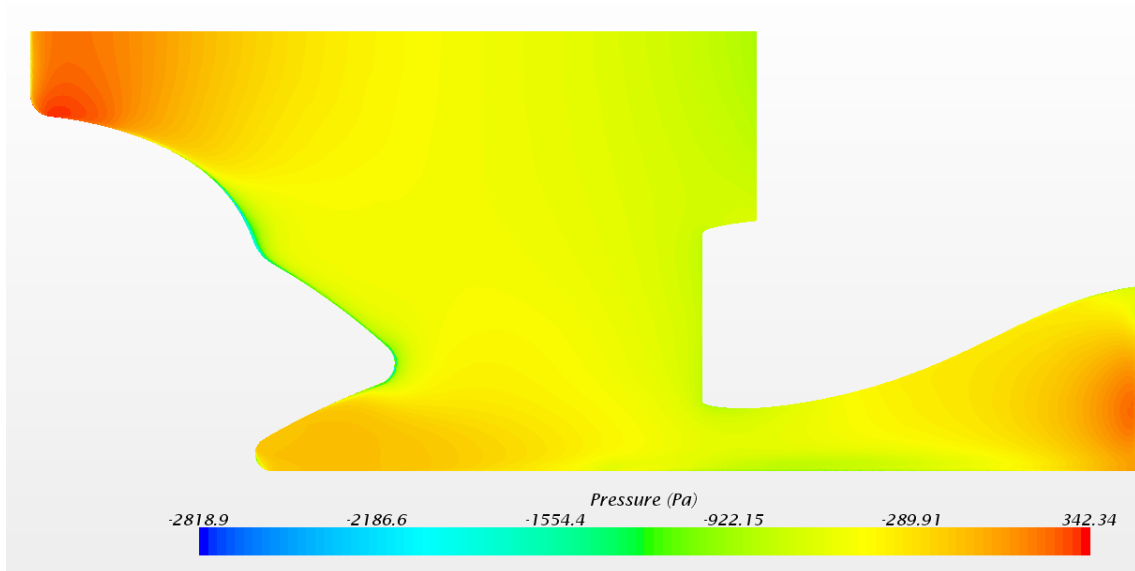
REAR WING FLAP – UP
Graphic in Y=0.5 m



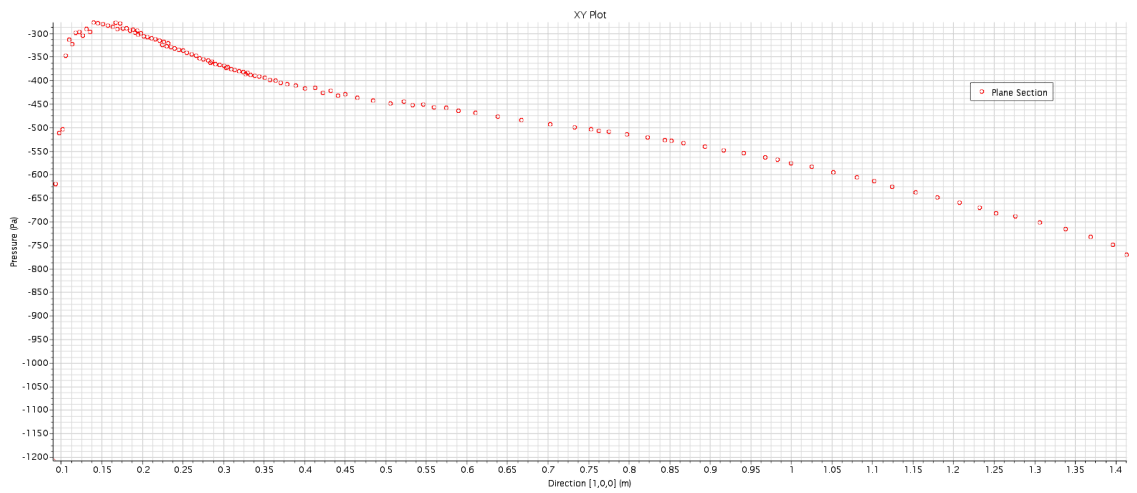
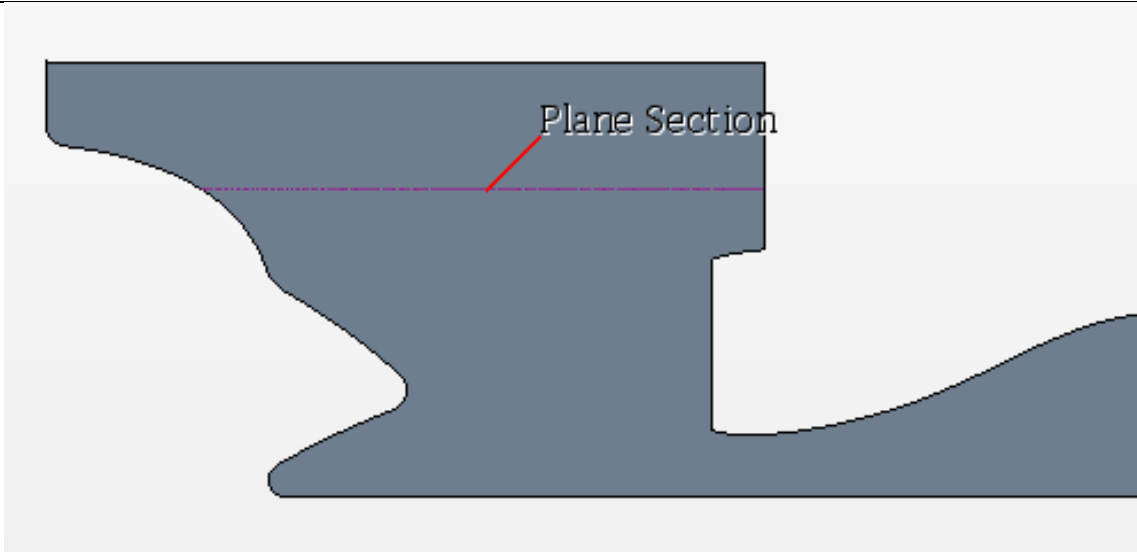
REAR WING FLAP – DOWN
Graphic in Y=0.5 m



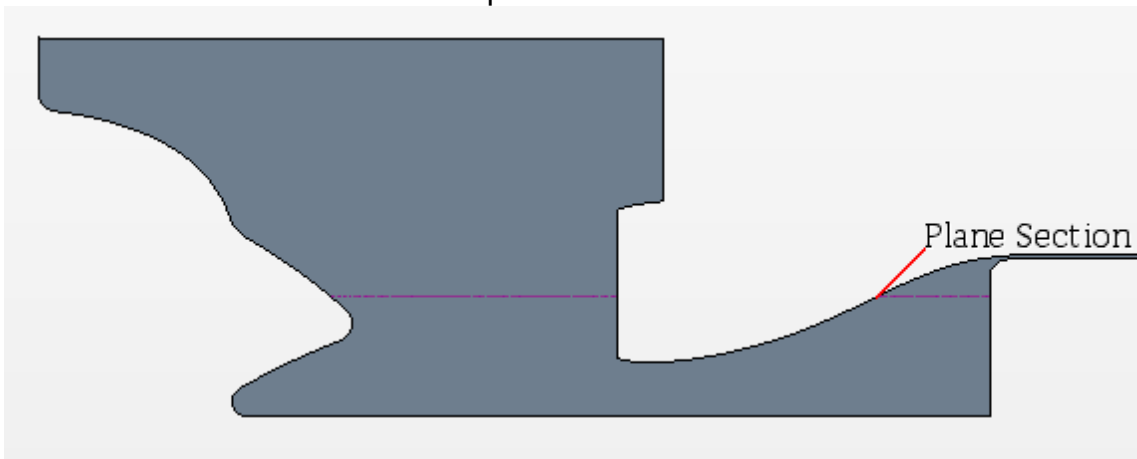
Is better than front wing....
GROUND

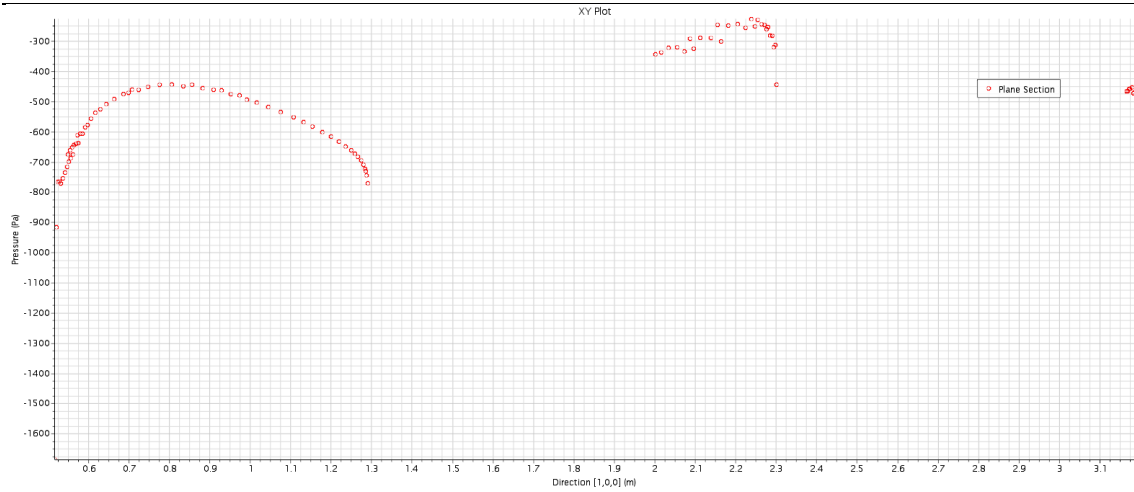


Graphic in Y=0.3 m

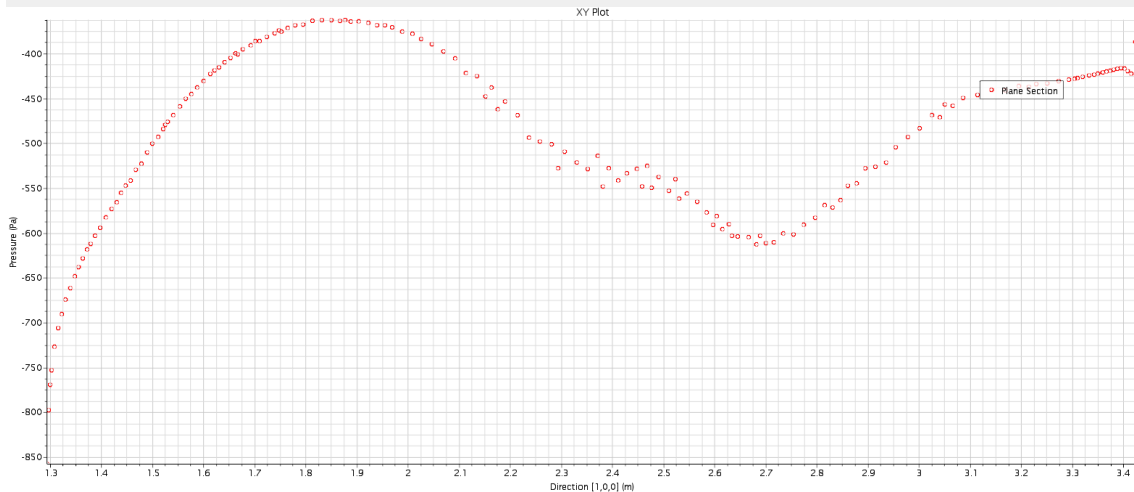
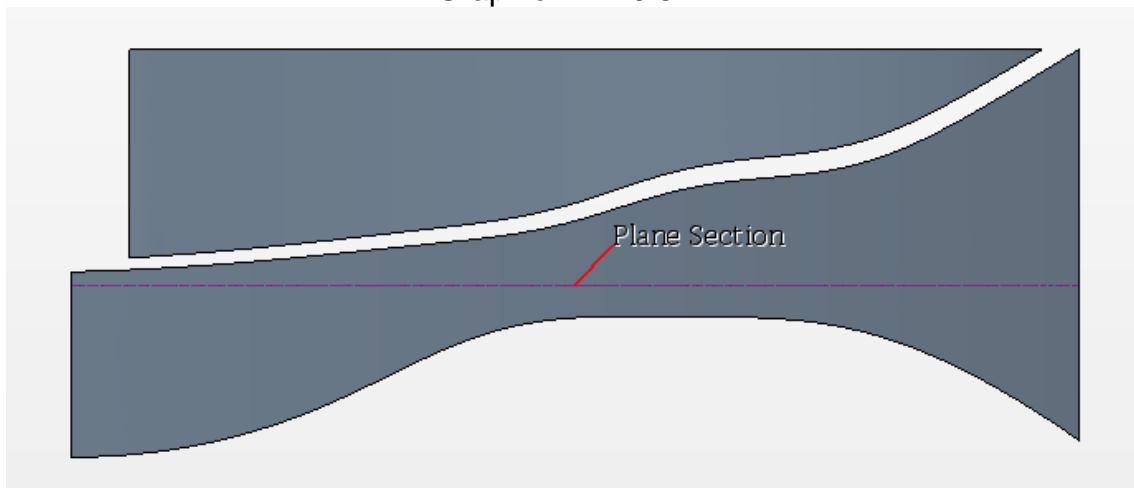


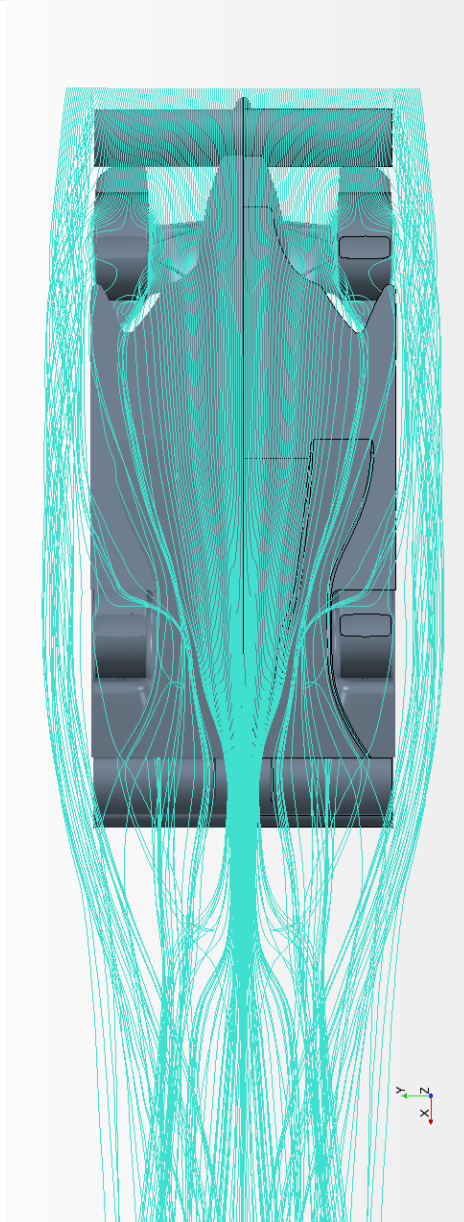
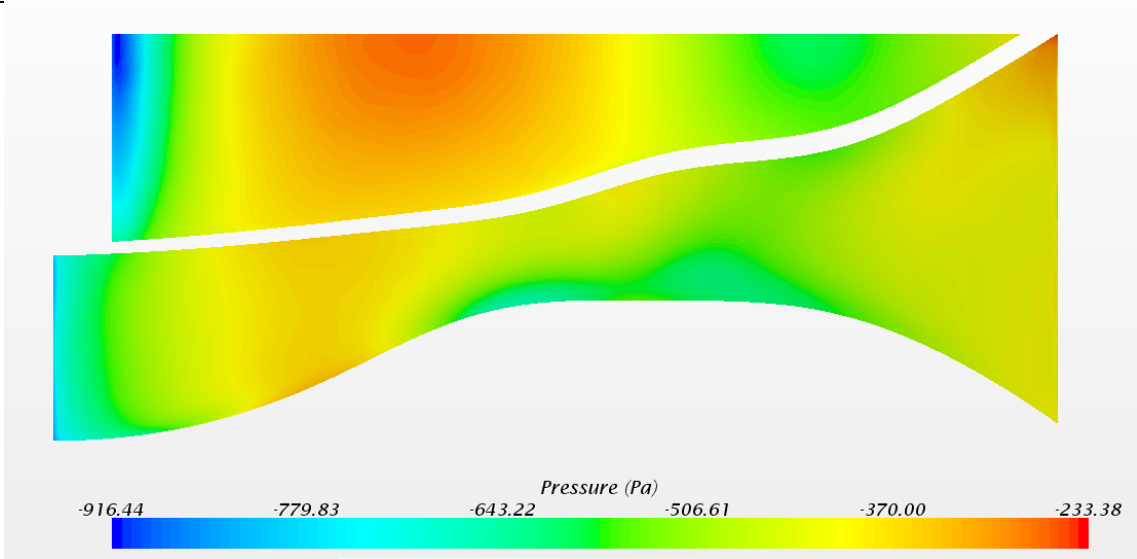
Graphic in Y=0.7 m





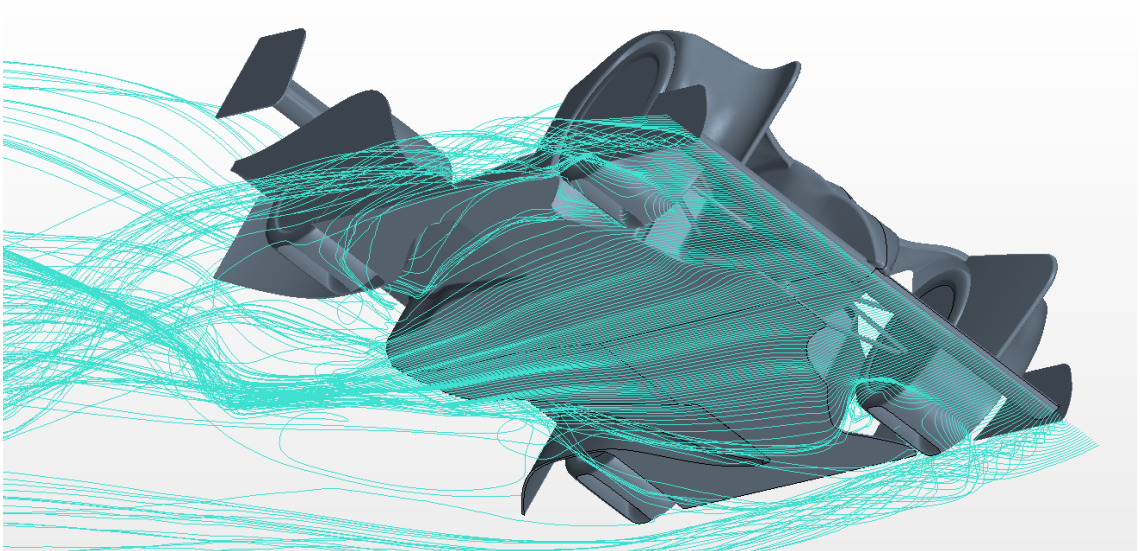
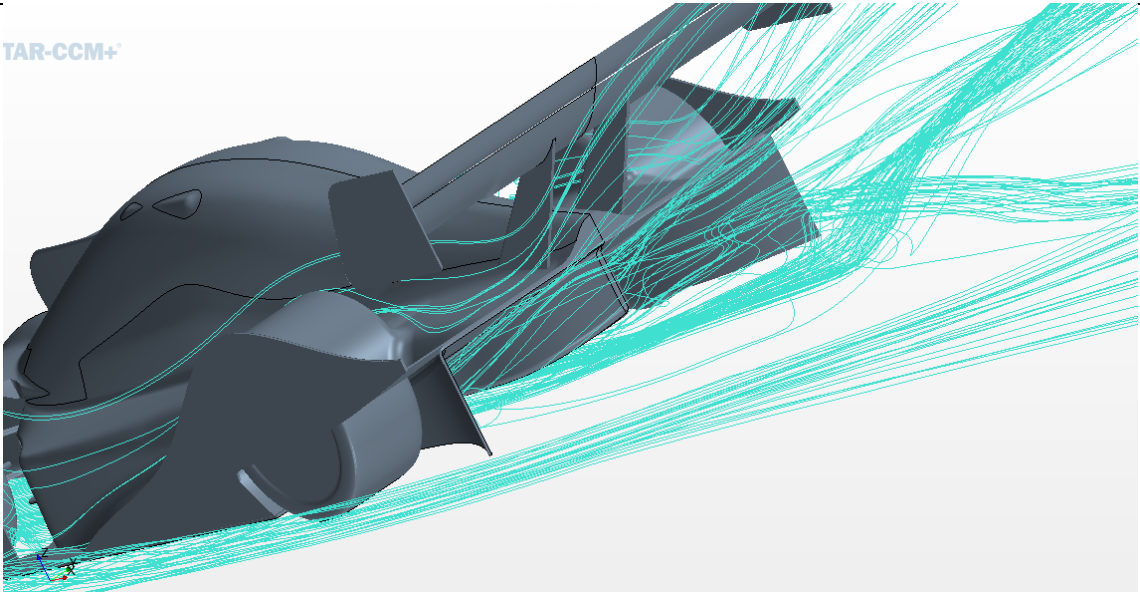
DIFFUSER
Graphic in Y=0.5 m

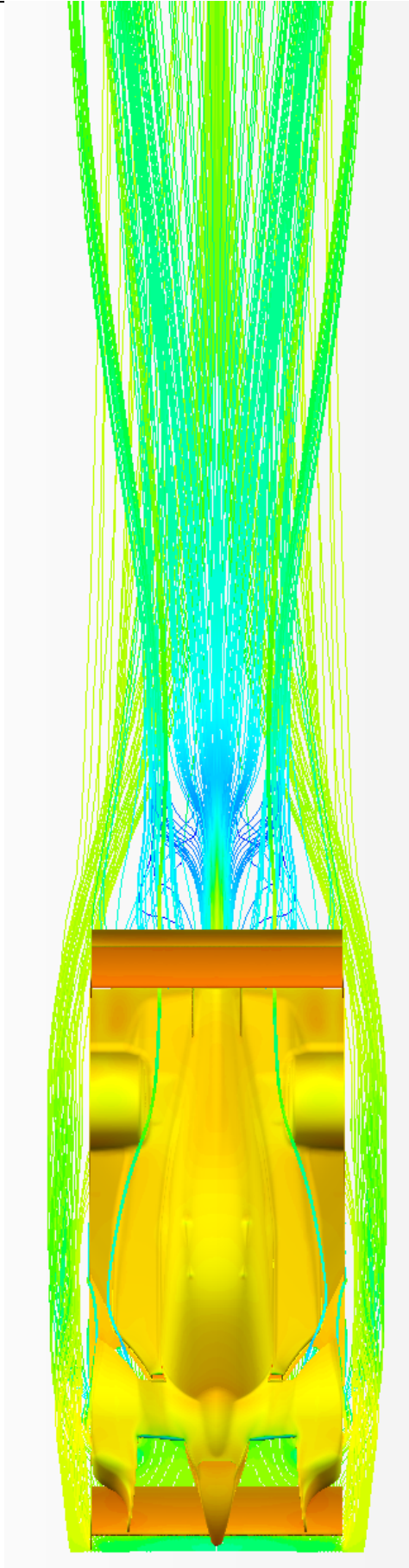


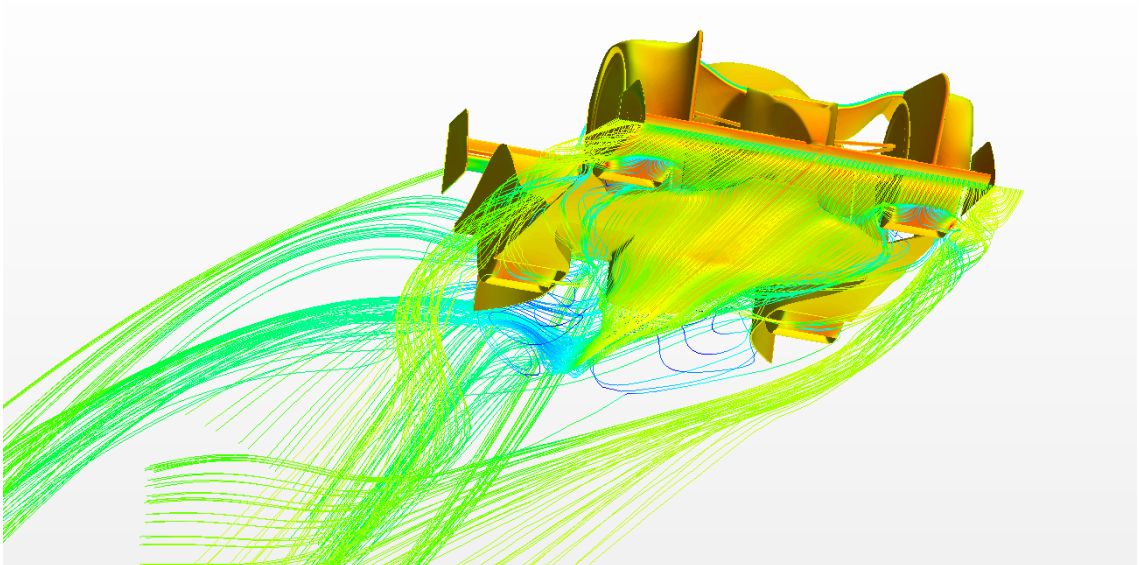
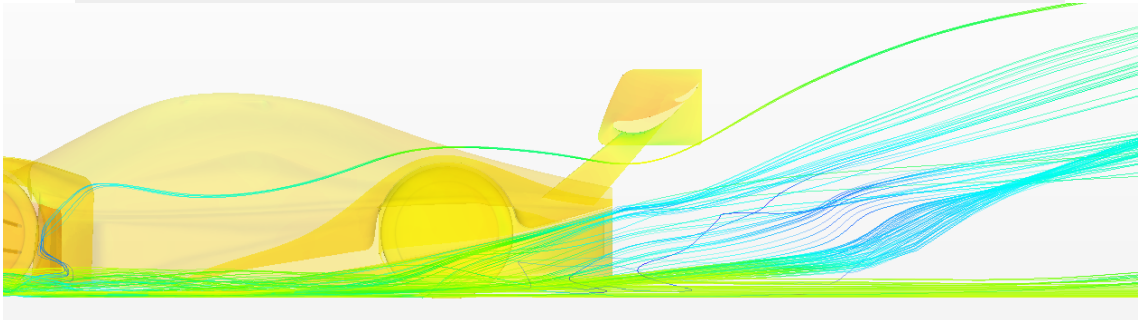
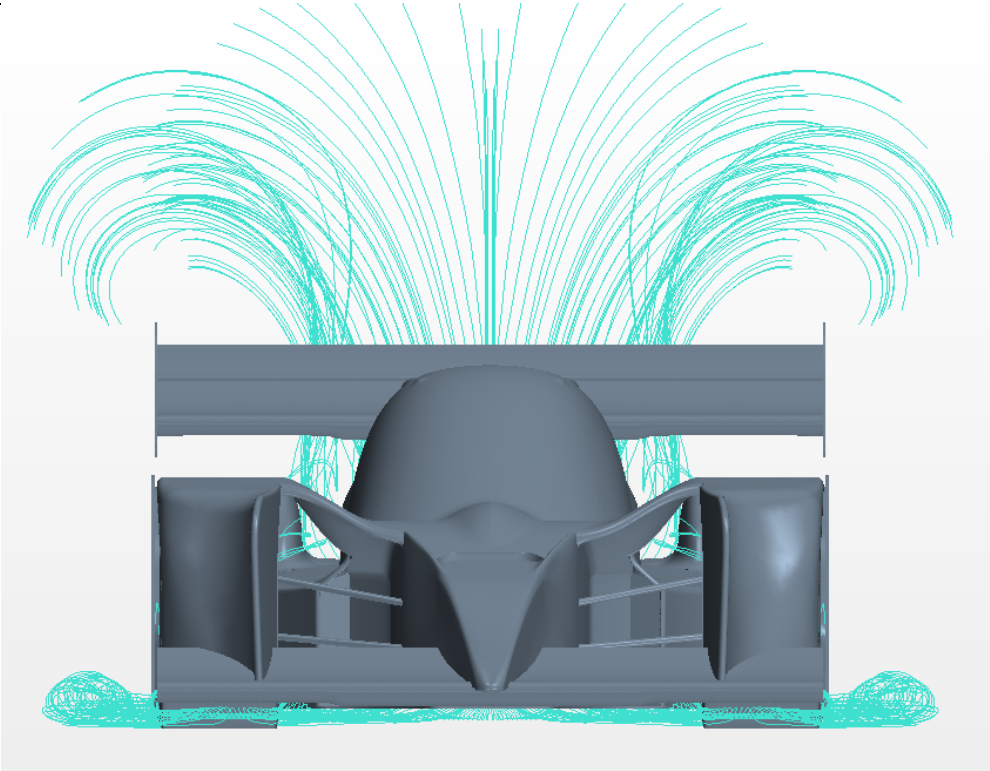




TAR-CCM+







- Diffuser: ok



- Rear wing: ok
- Front wing: may be improving it.
- Ground: ok

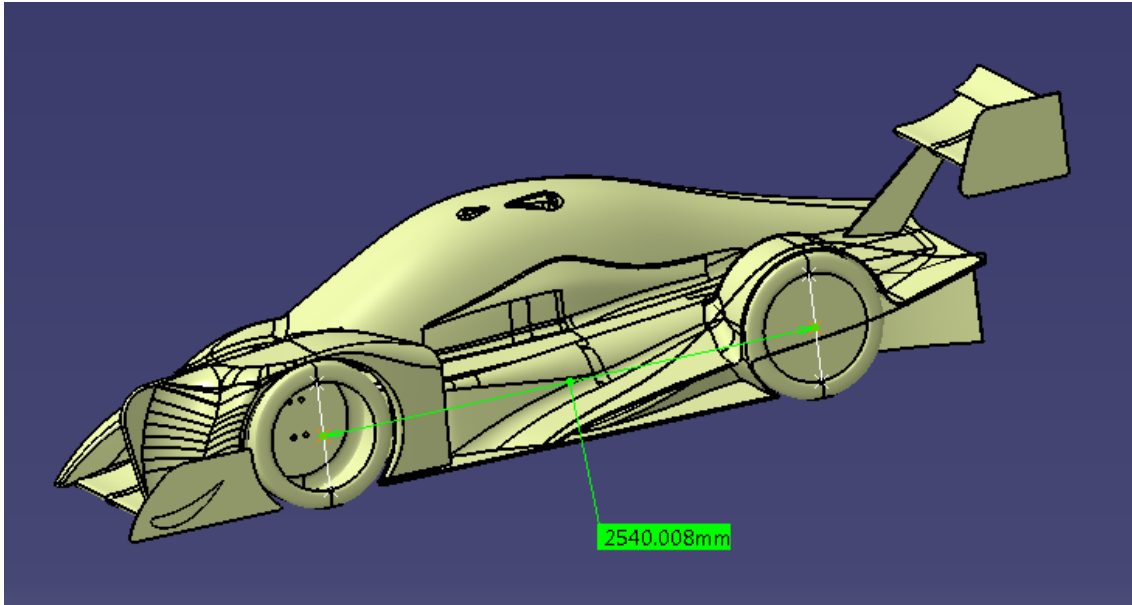
PRESSURE CENTRE – BALANCE (150 km/h)

(0,0,0) → axis front wheel.

Pressure Centre:

X = 2.39 m

Z = 0.271 m



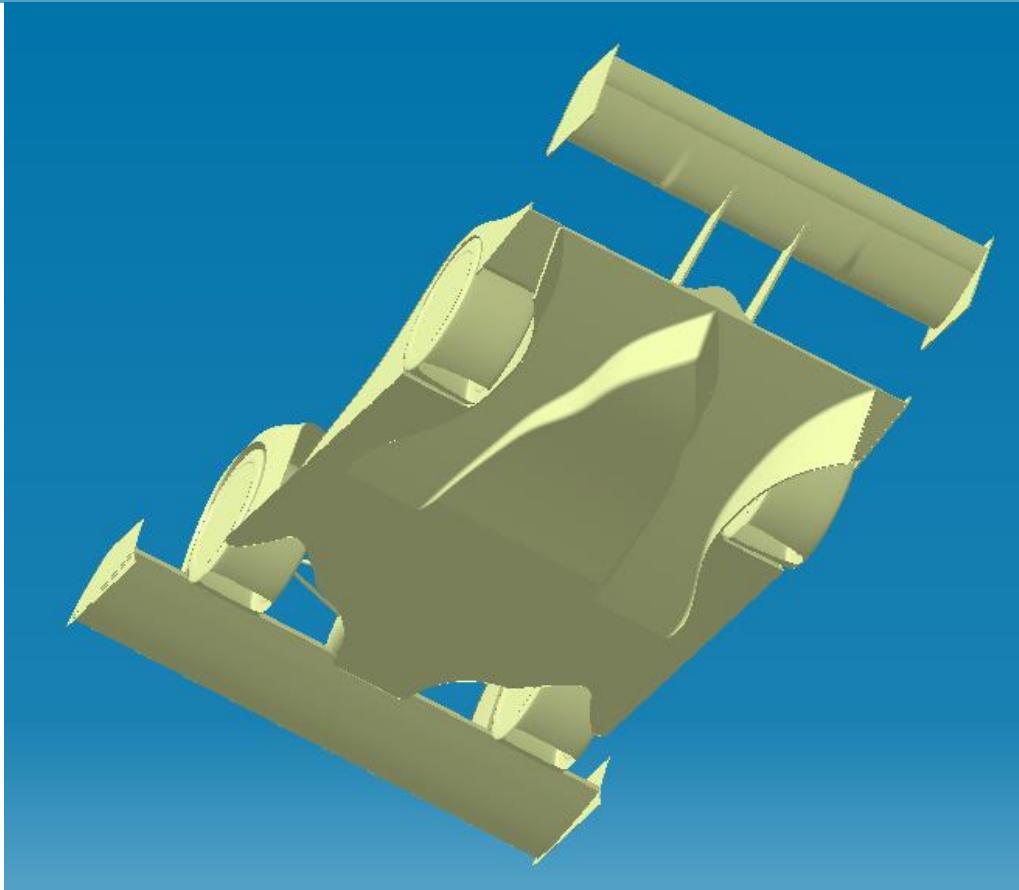
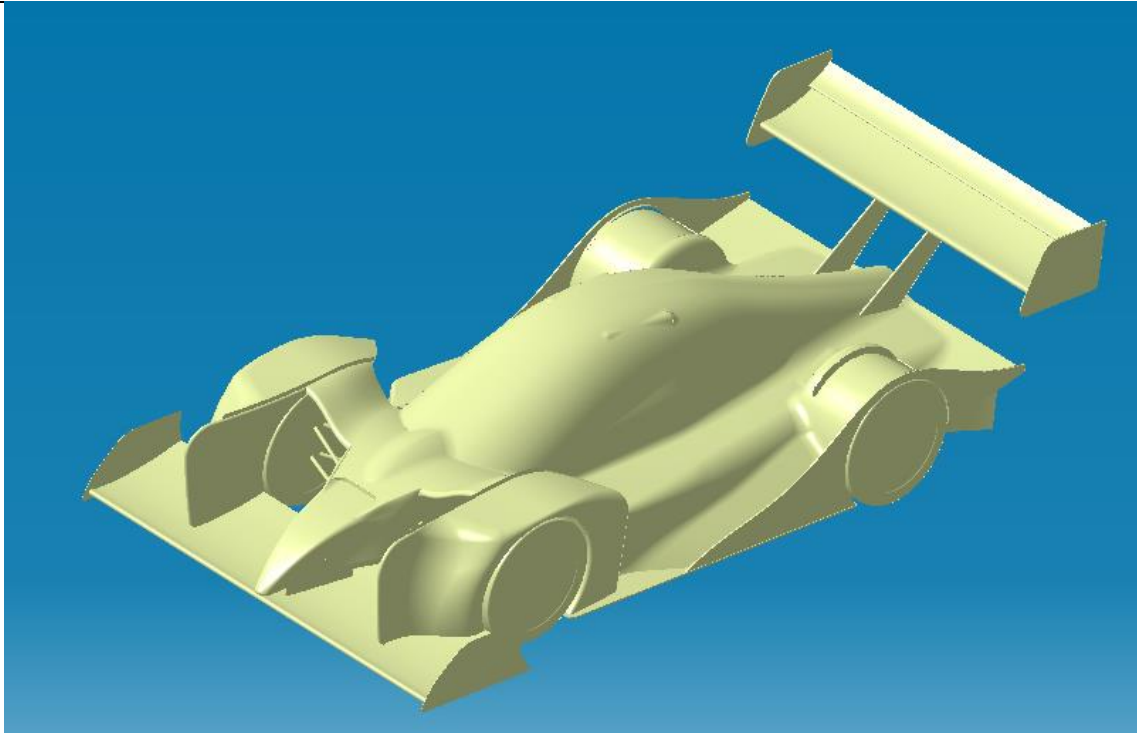
Is located far behind axis rear wheel.
The diffuser, the ground and rear wing, have a lot downforce.

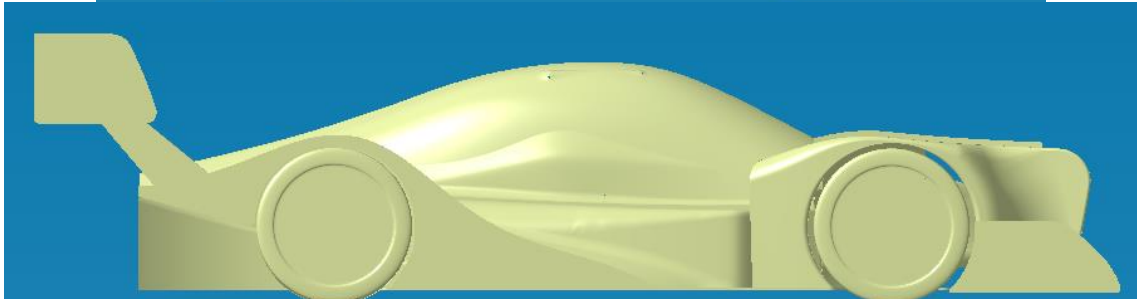
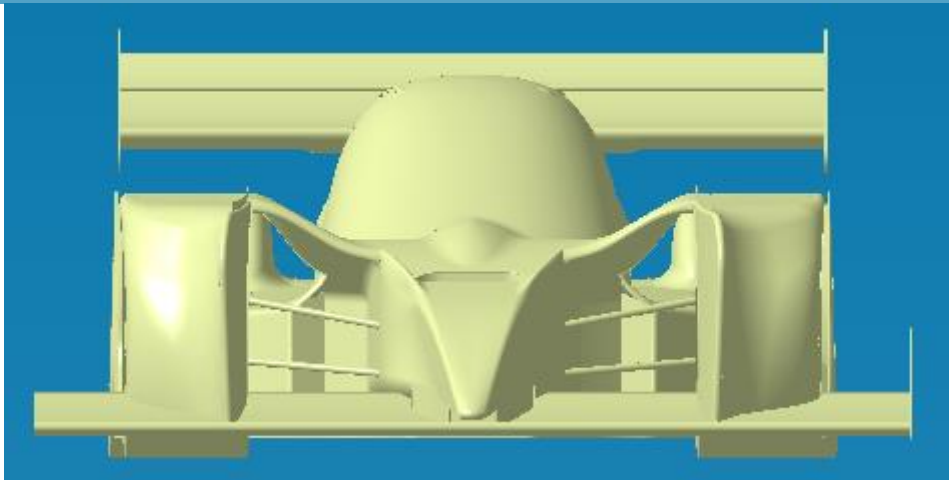
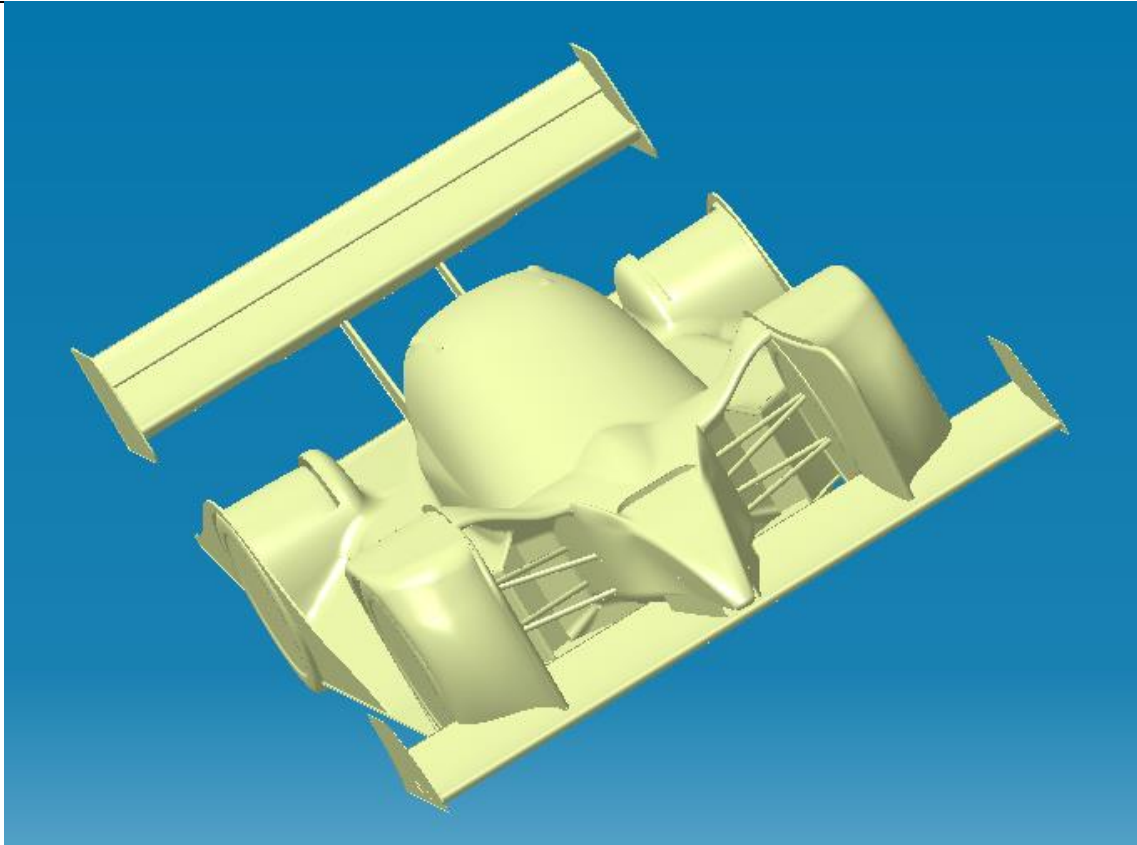
VERSION 2

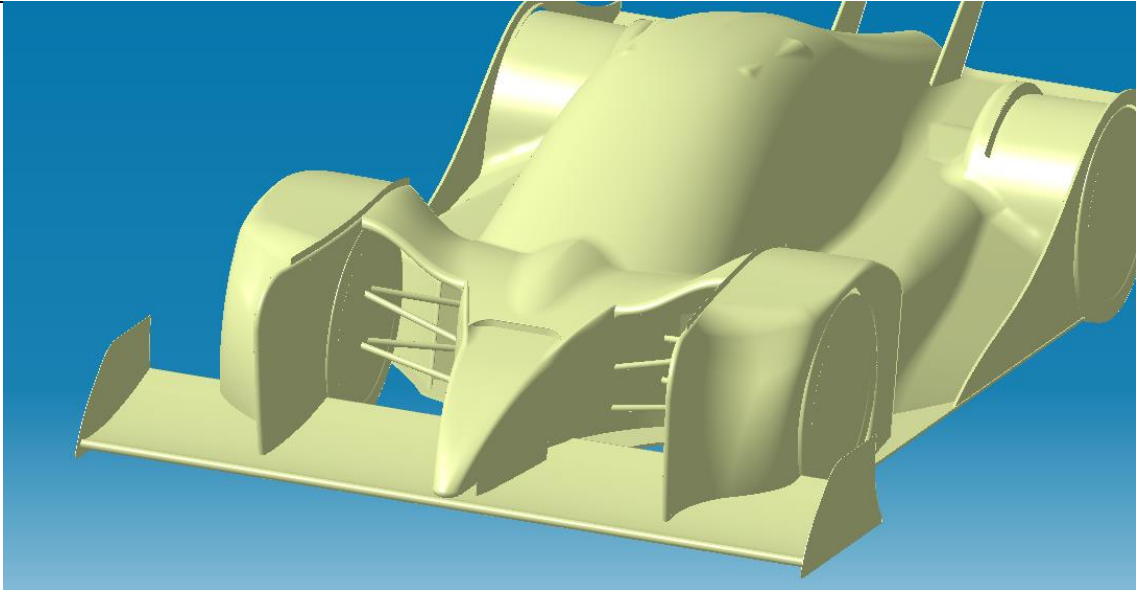
150 Km/h, ground moving and wheels rotating:

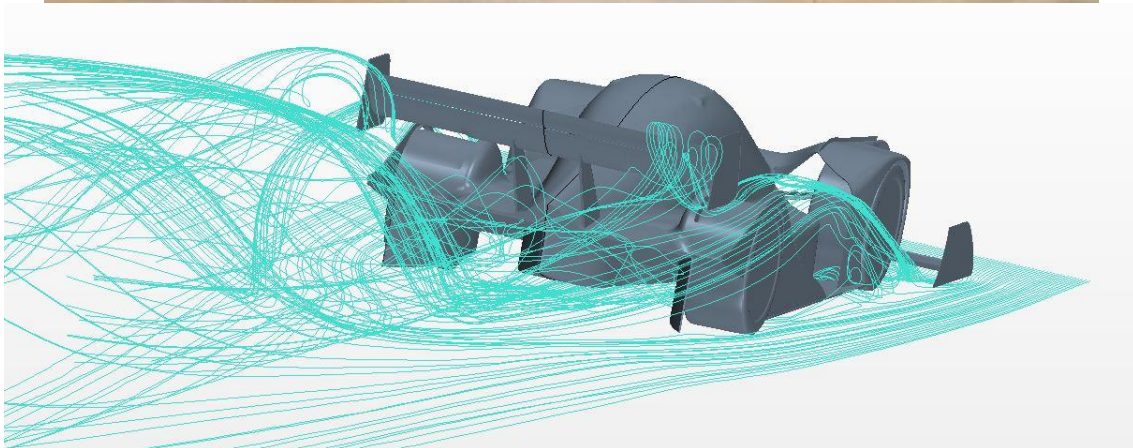
This version, change, about the first model, in:

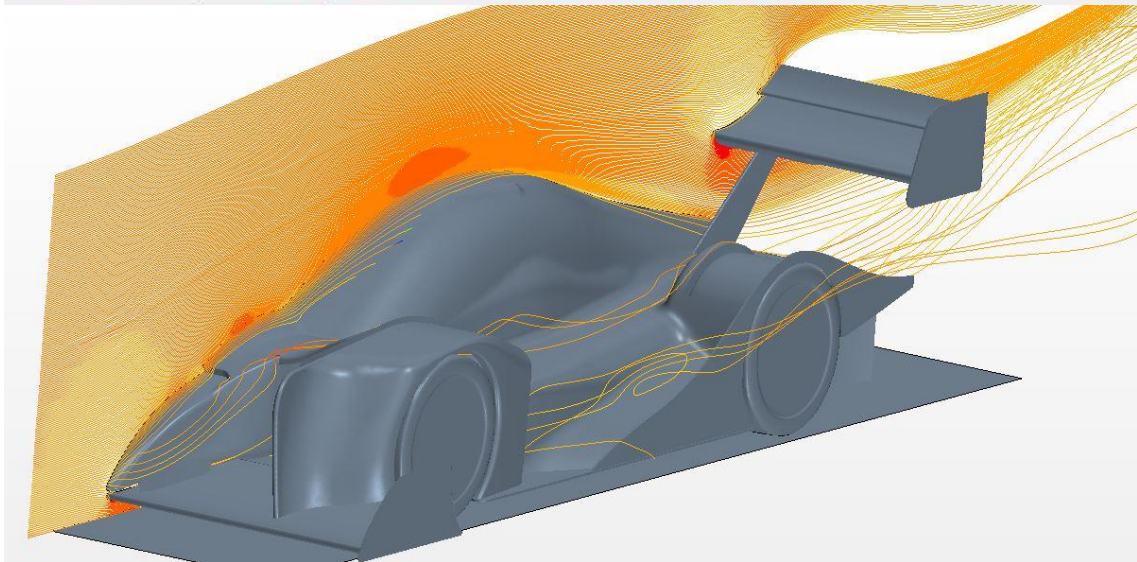
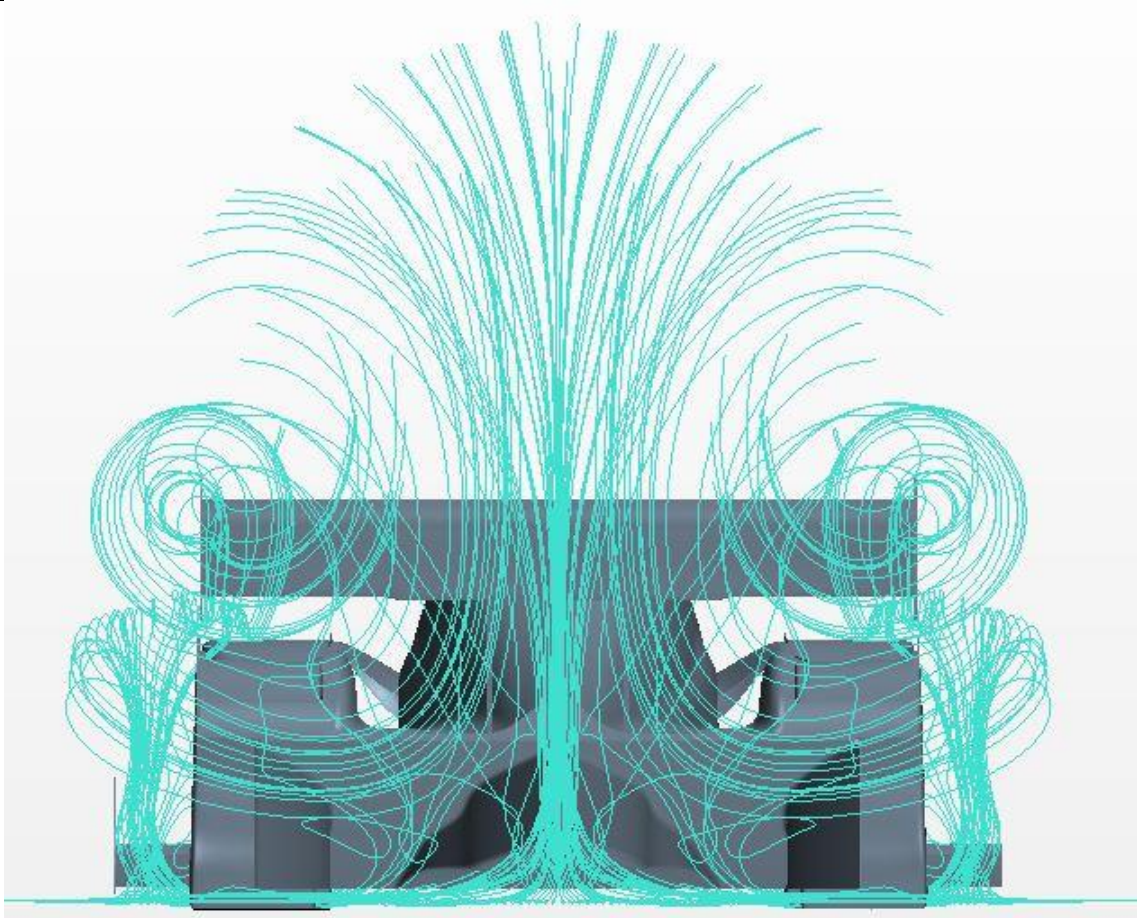
Wider and modified front splitter profile-wider venturi channel in diffuser-increase rear track width-rear wheel arch cutout.

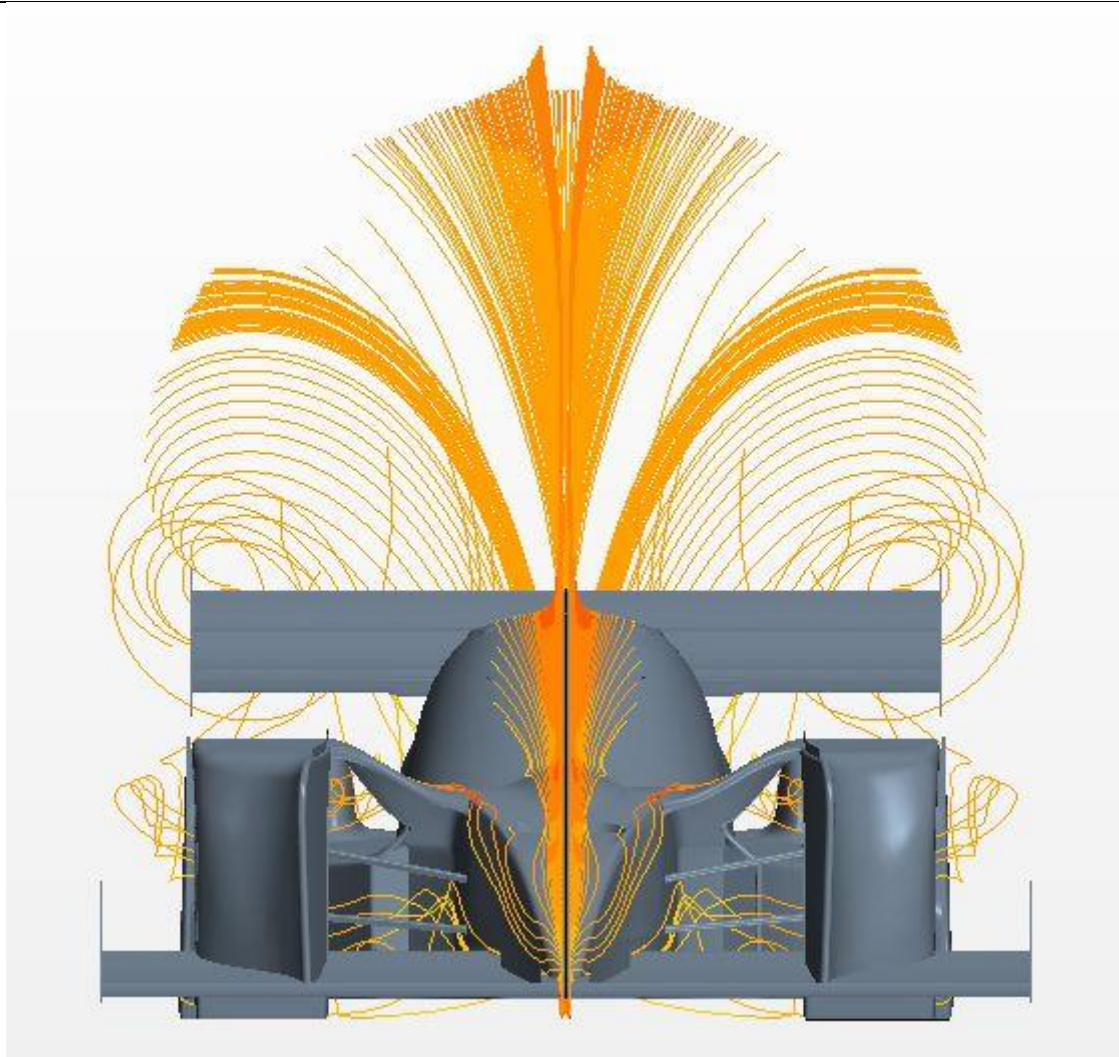


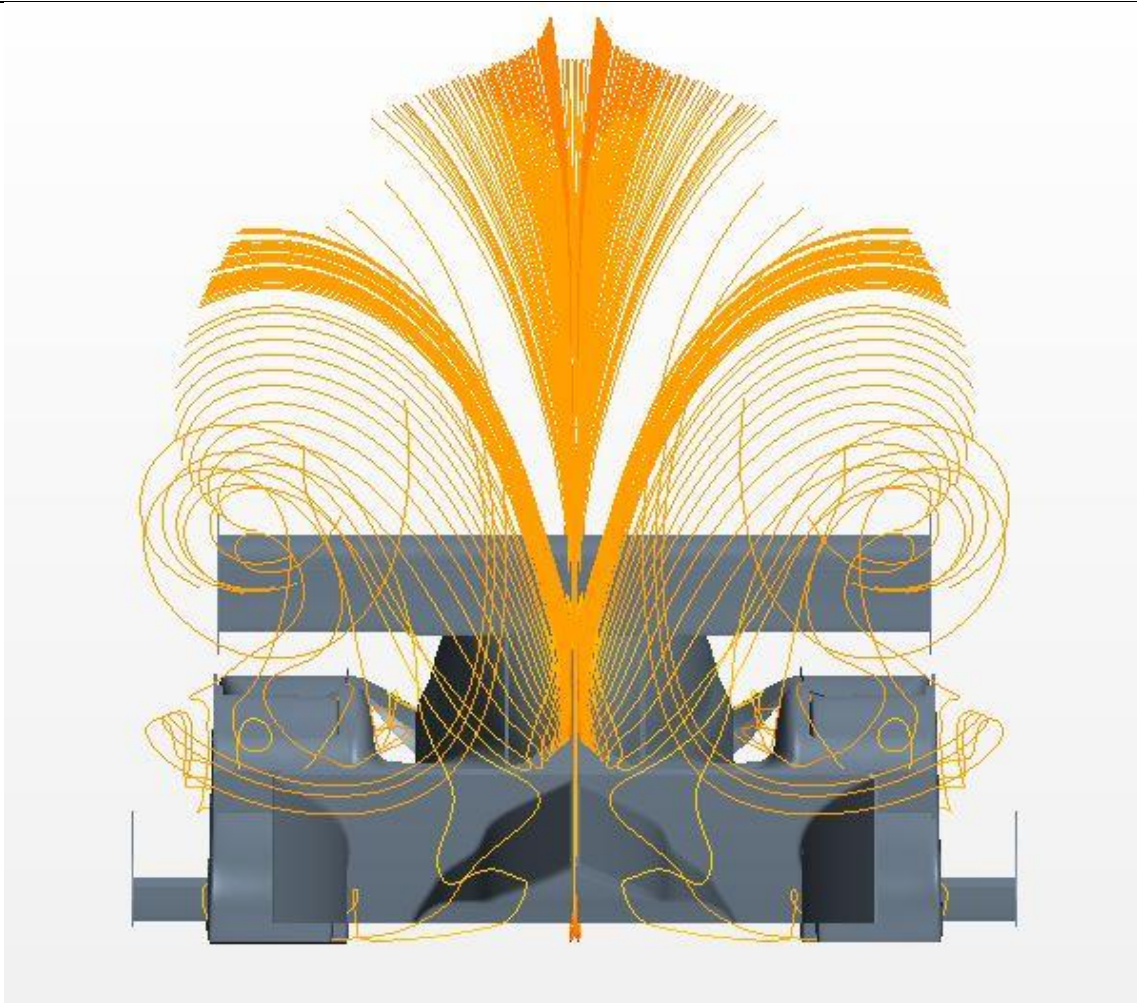


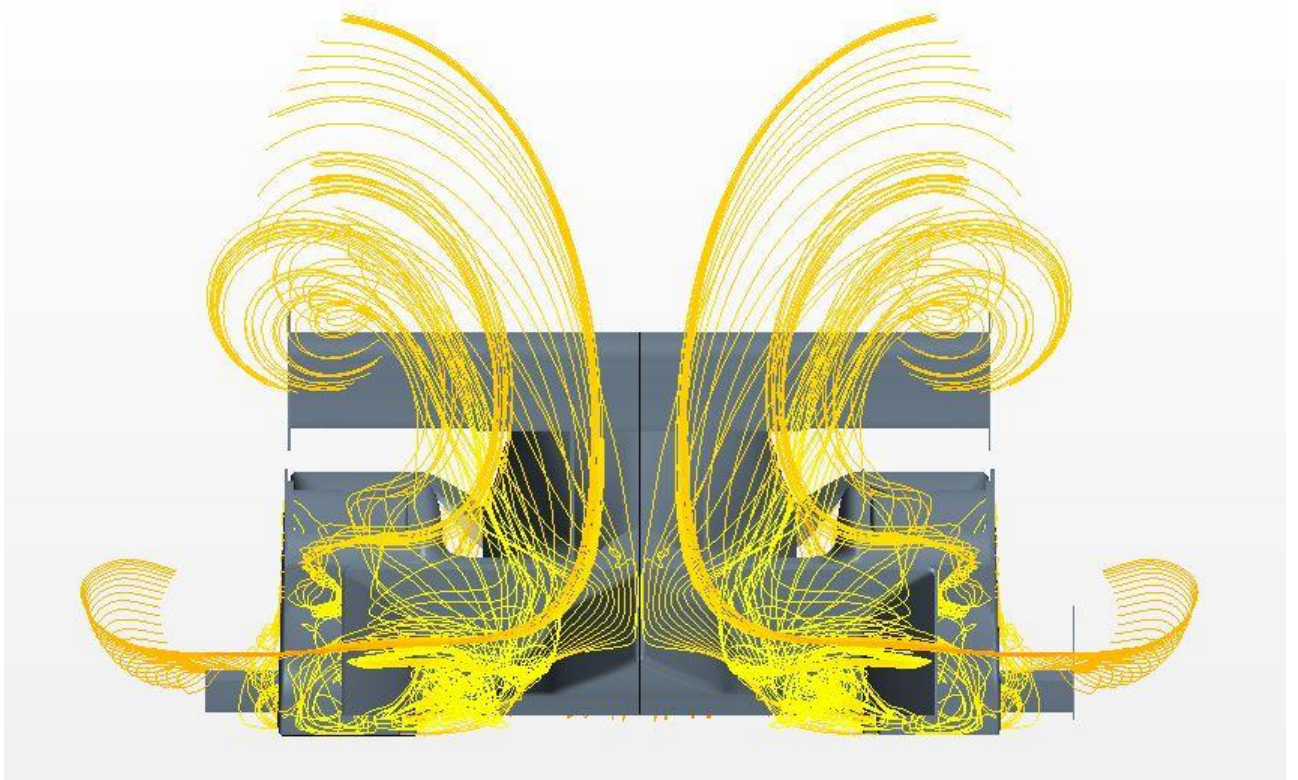
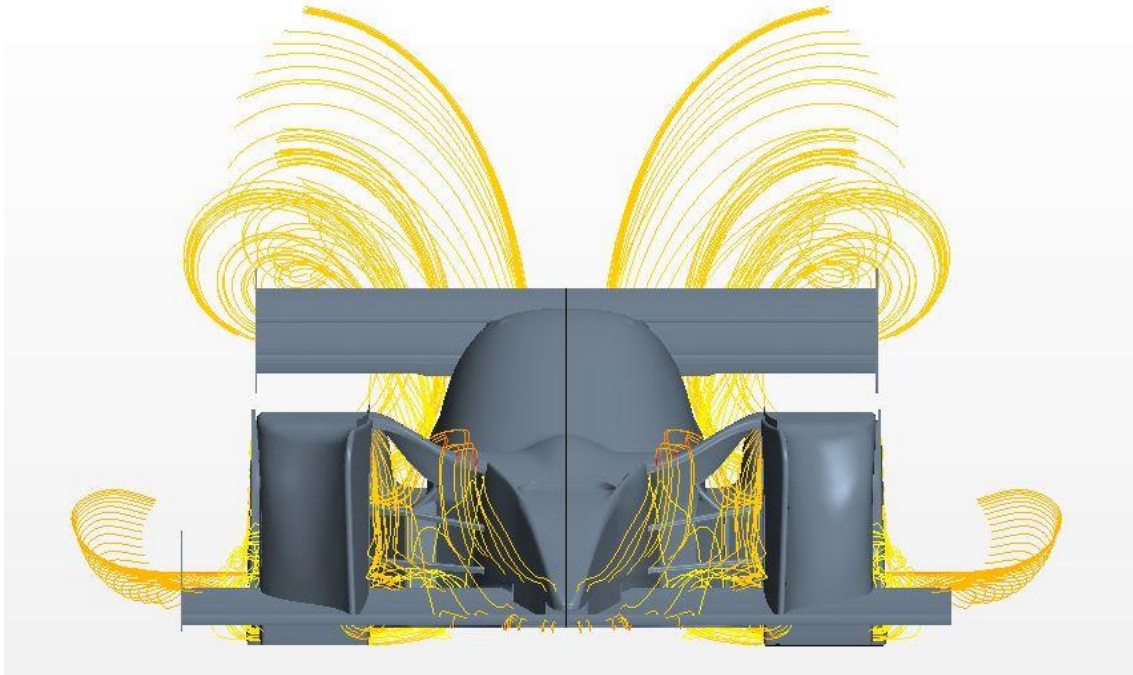




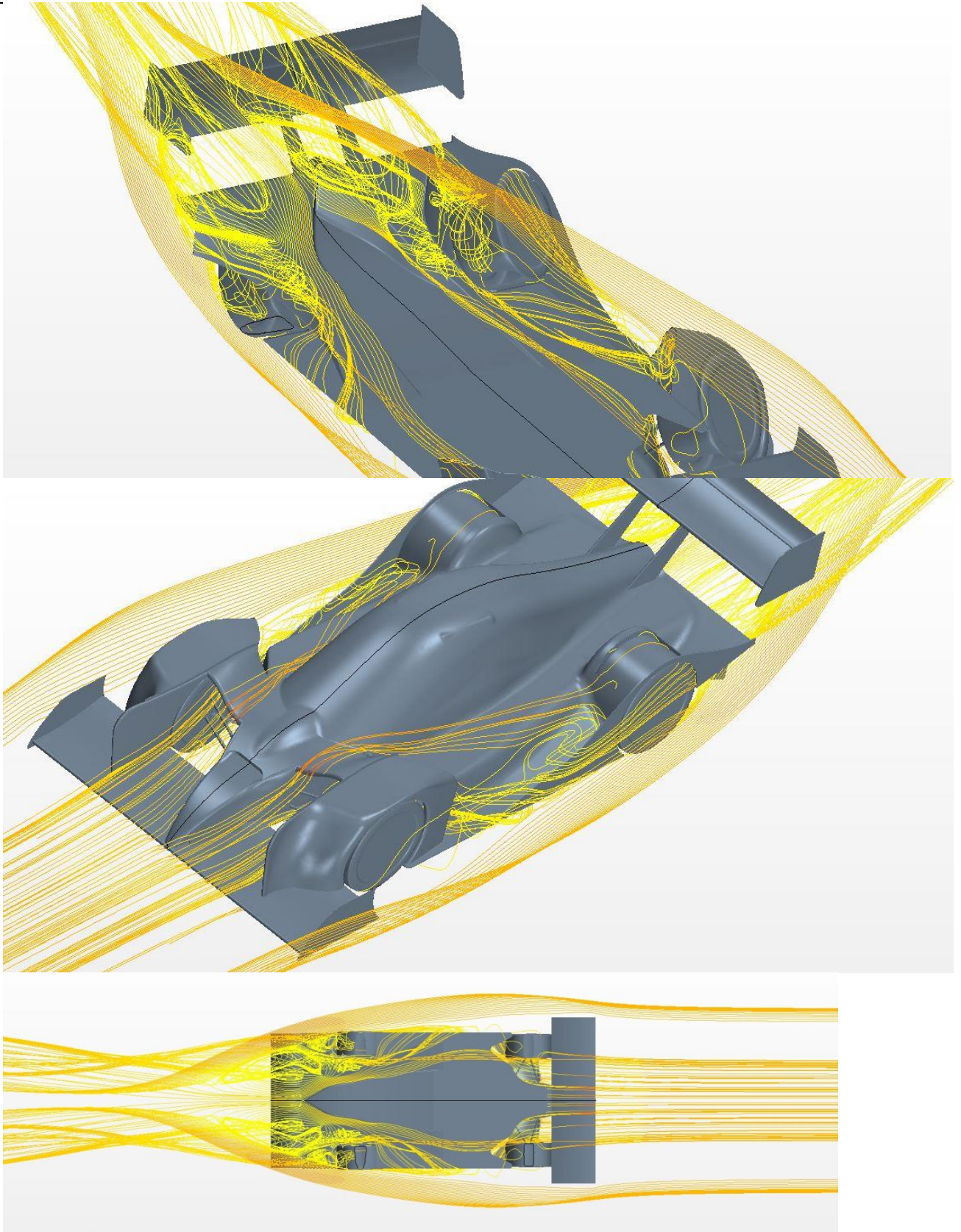




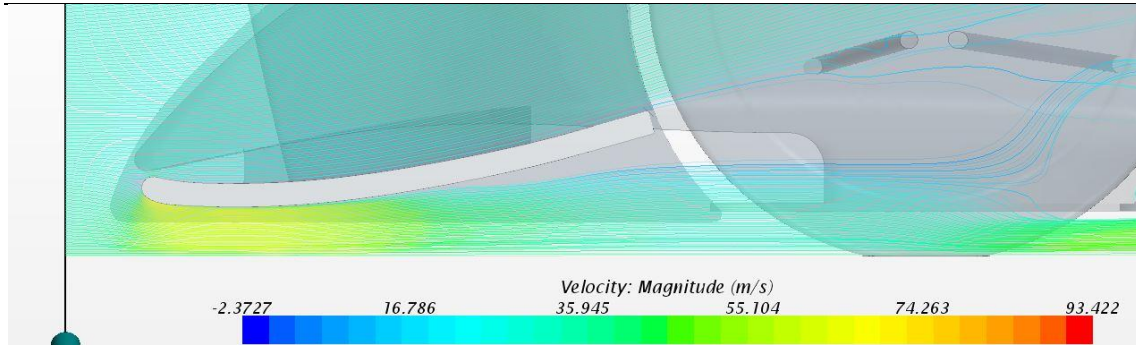




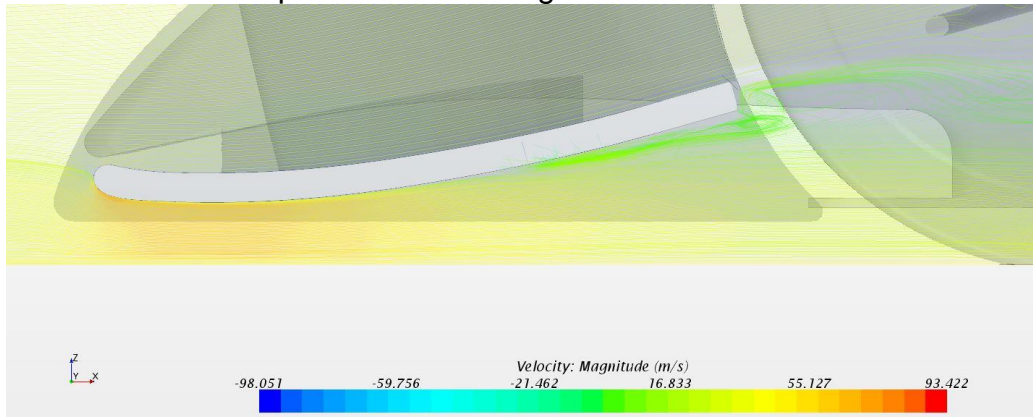
Very important these laterals vortex....



About the front wing, is better than first car version:



There is little separation in the wing end:



That, may be, is as that, because the ground suction a lot.
Sure that with a gurney flap or some thinks as that, the problem will be less.

The full downforce is: 469 Kg

And the pressure center is located:

PRESSURE CENTRE – BALANCE

(0,0,0) → axis front wheel.

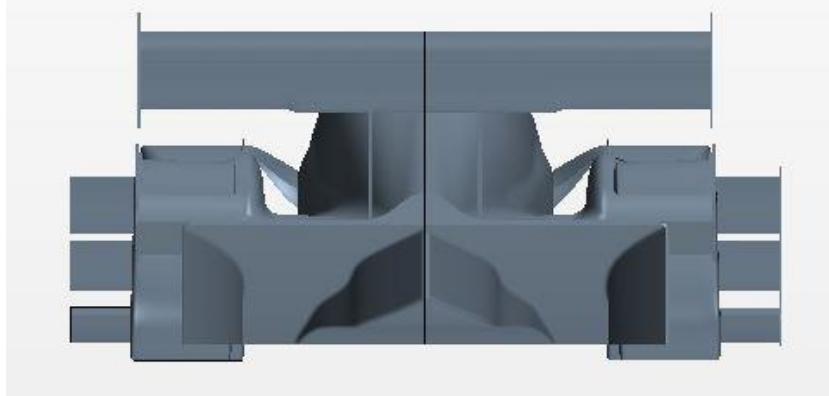
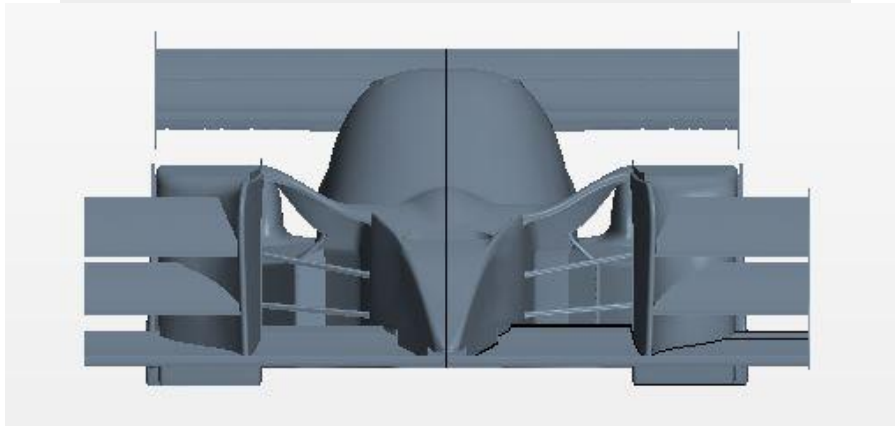
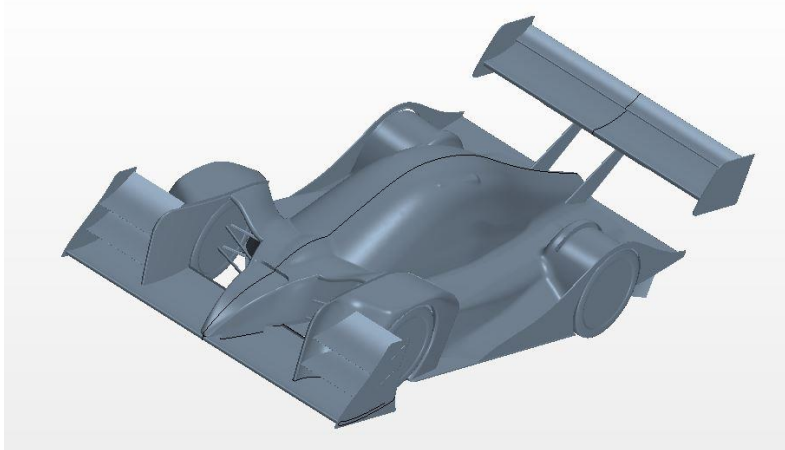
Pressure Centre:

X = 2.24 m

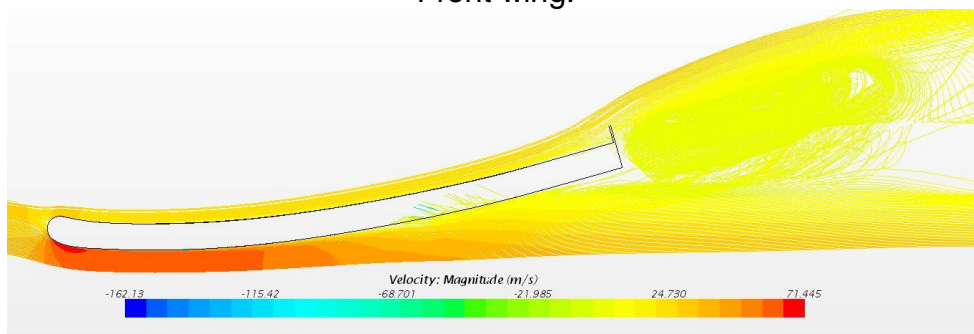
Drag half car: 907 Newtons; drag full car 185 Kg.

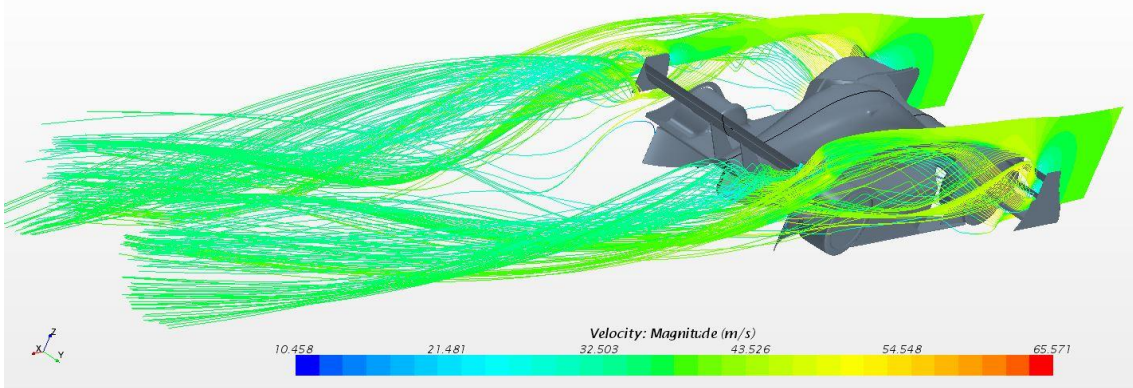
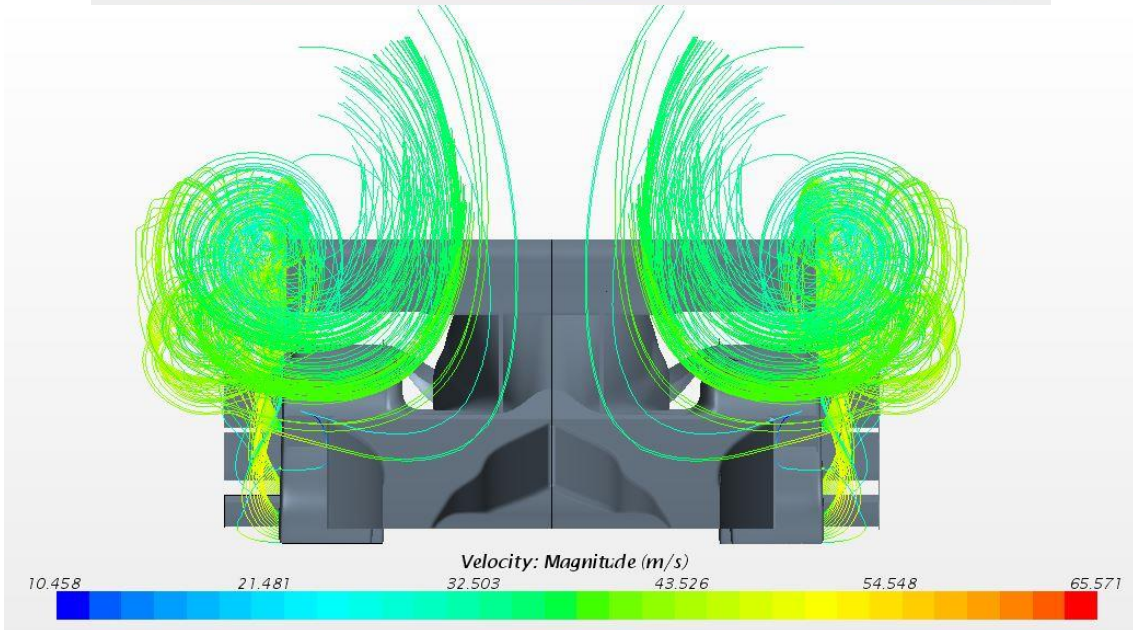
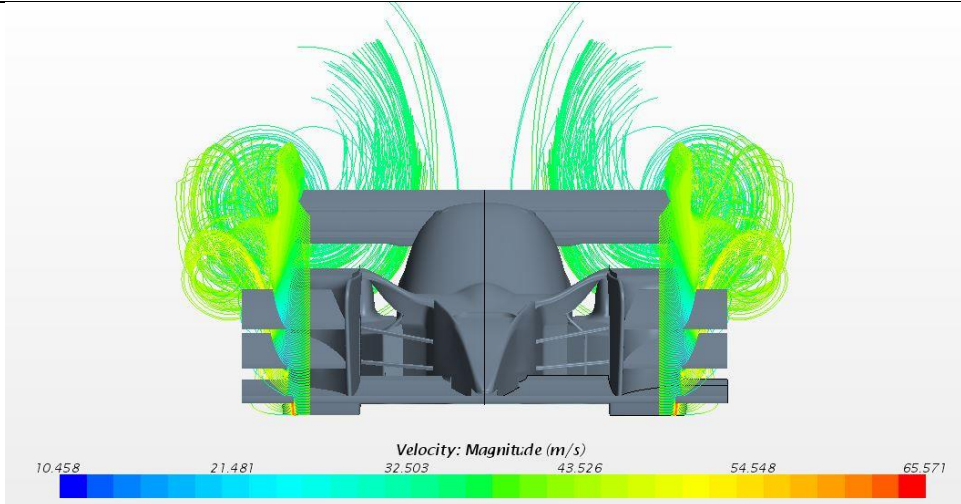
VERSION 3

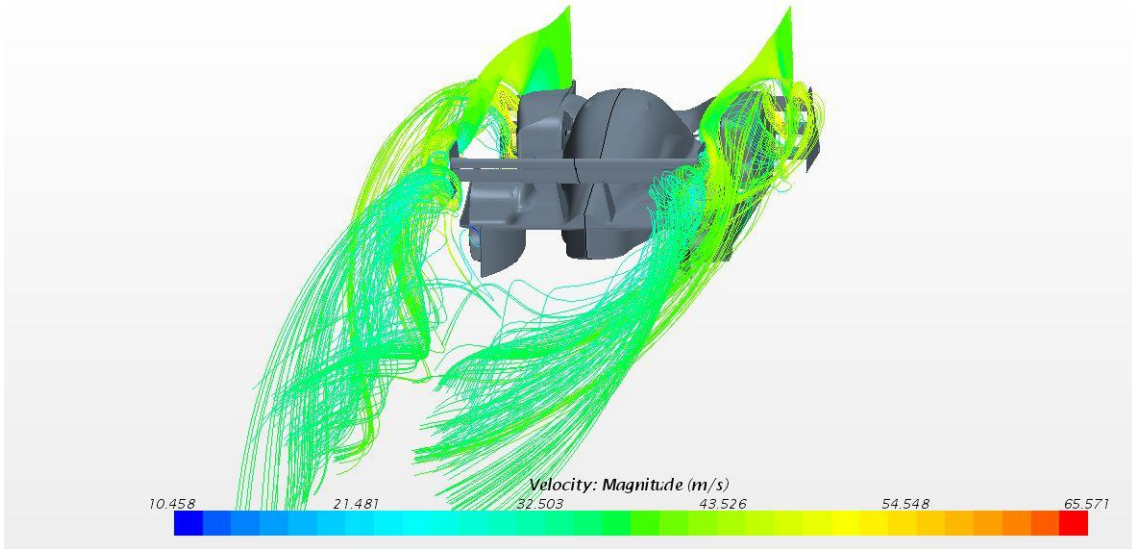
150 Km/h, ground moving and wheels rotating:
Add front wings and gurney front main wing.



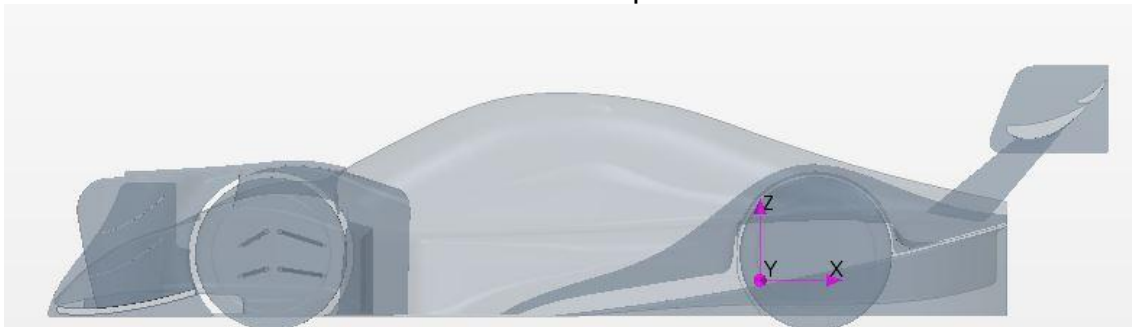
Front wing:







518 Kg down force full / 197 Kg full drag.
1.88 m cdp

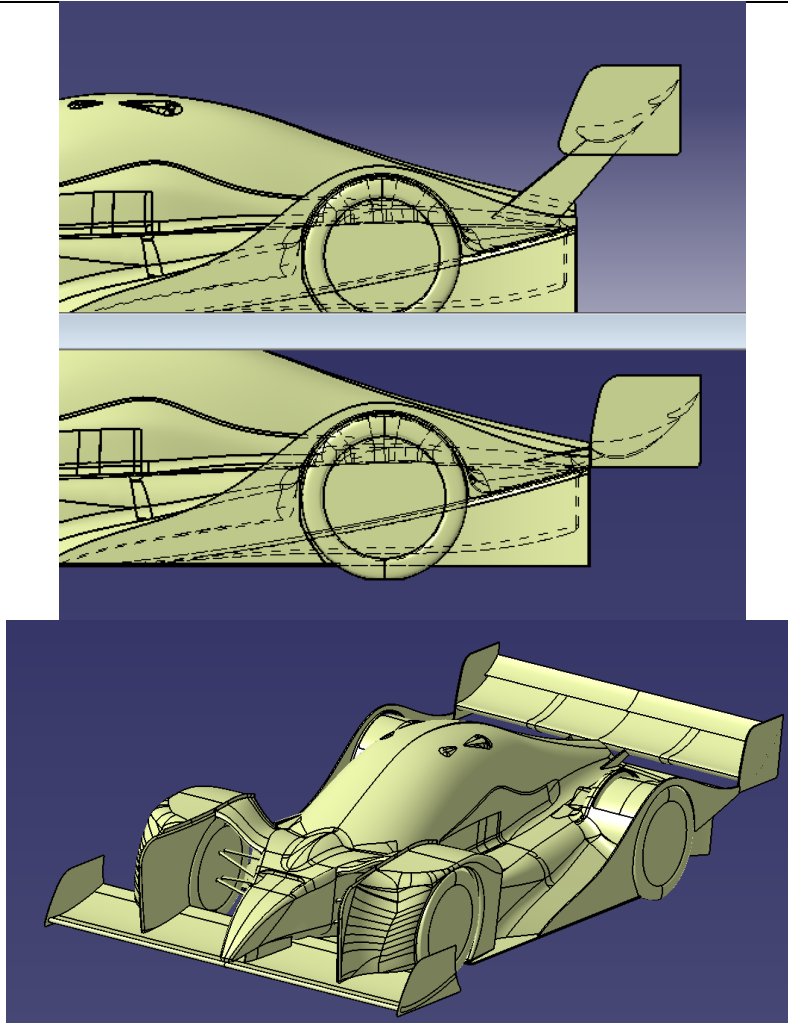


VERSION 4

150 Km/h, ground moving and wheels rotating:

Is a variation of Version 2. That is:

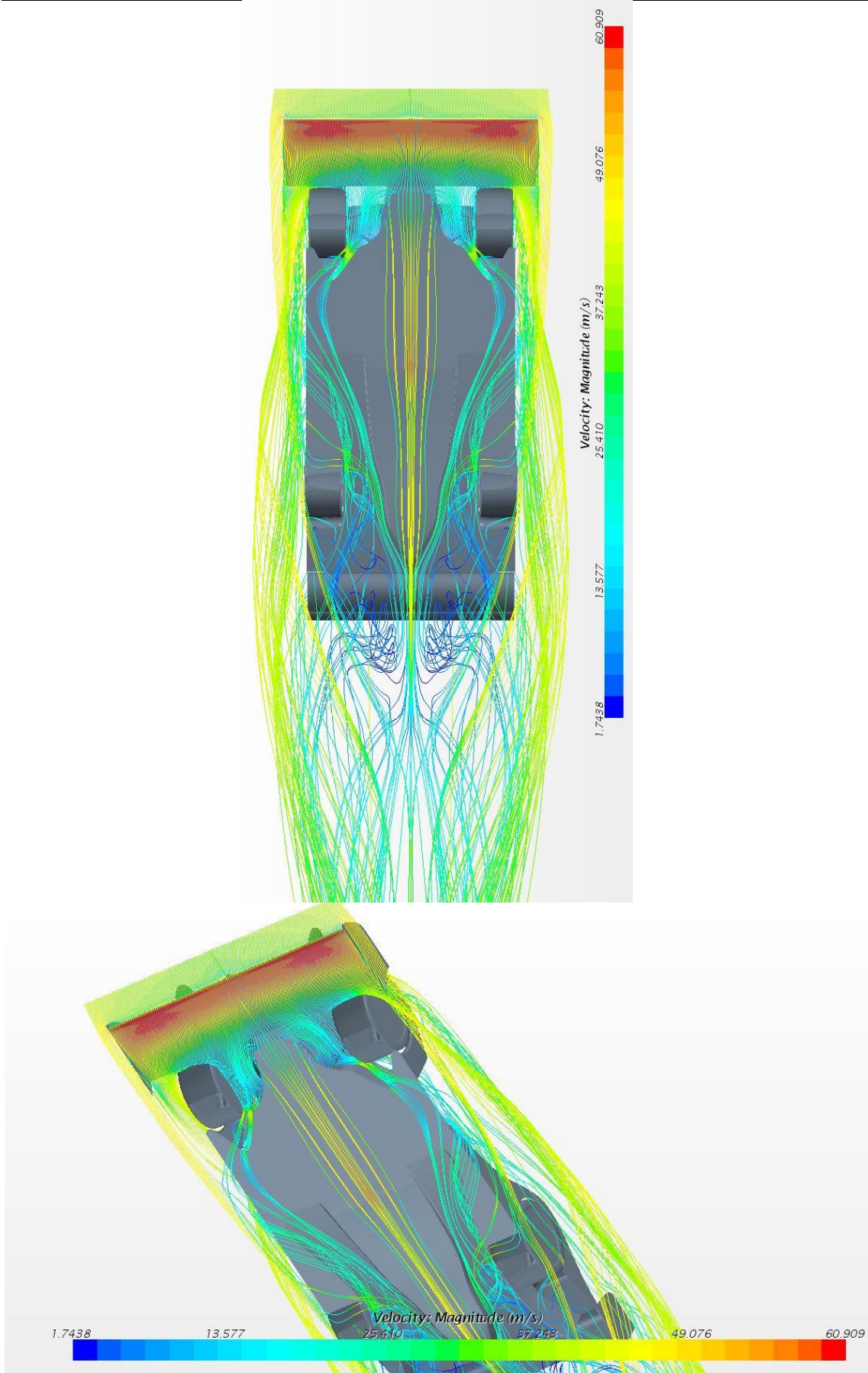
Rear wing different, in order to advance the aero balance:

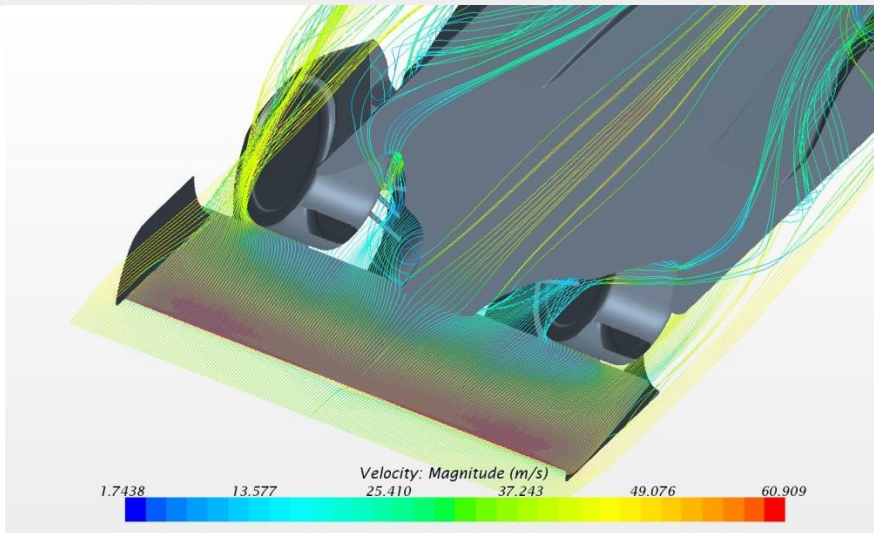
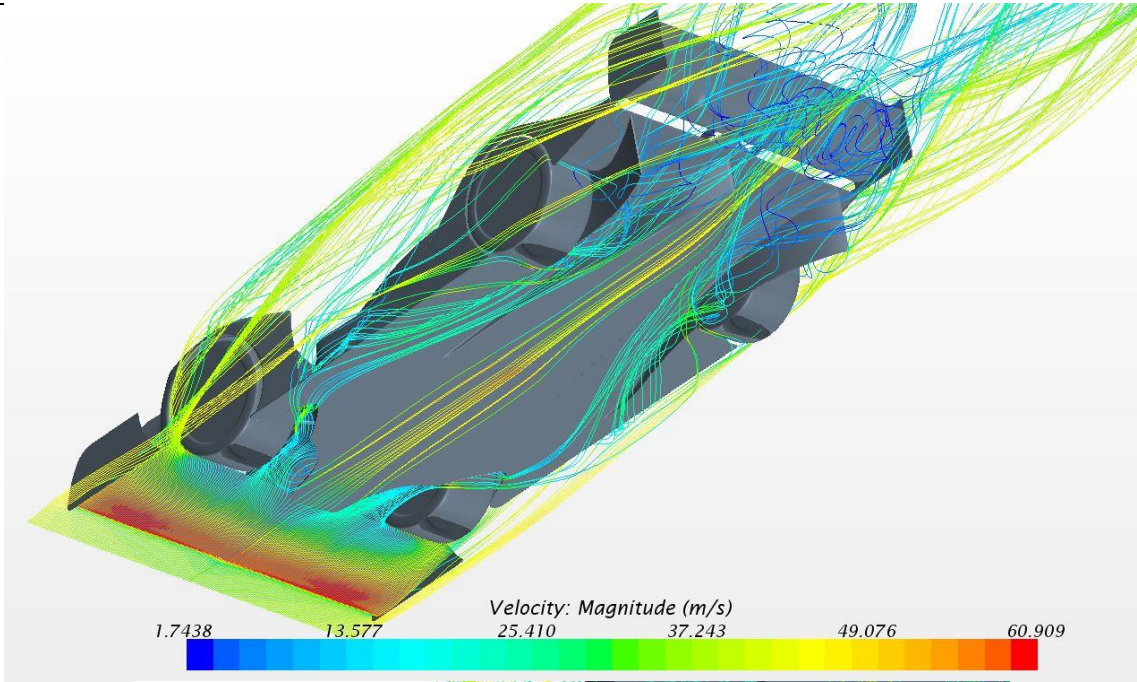


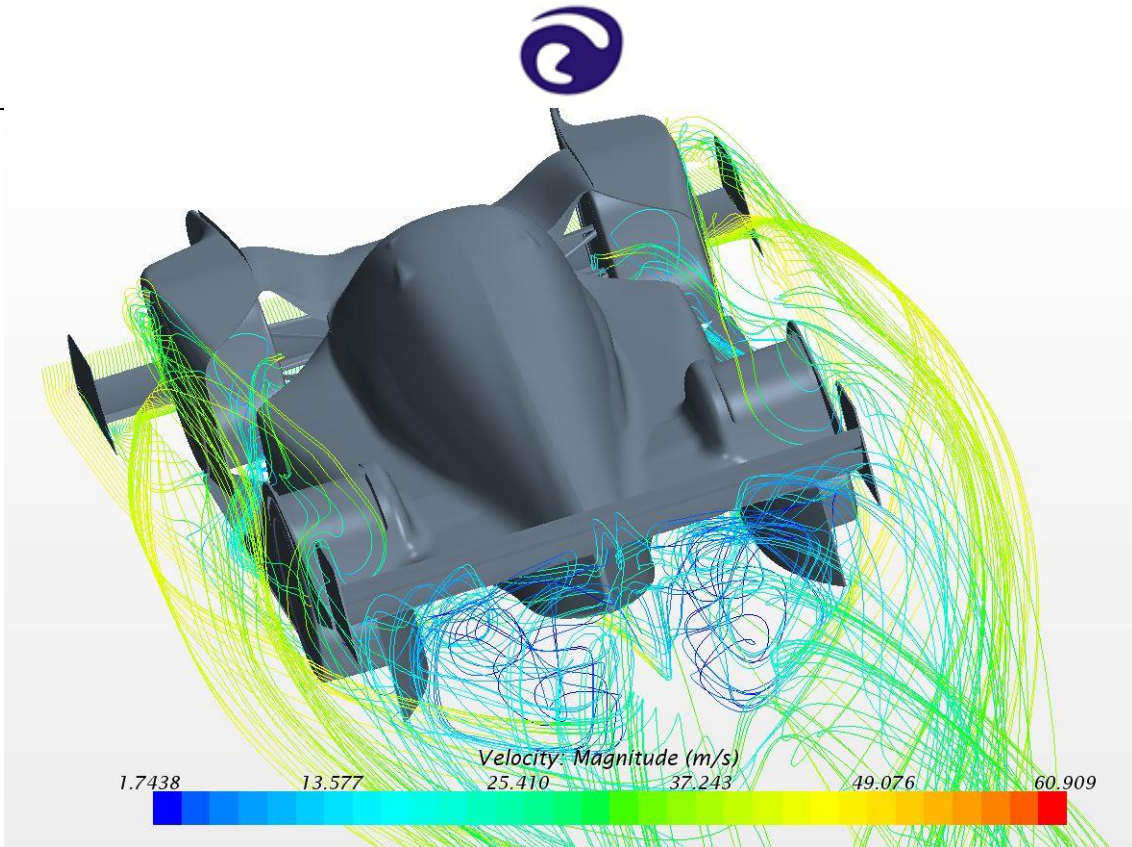
Down force full V2 = 469 Kg
 Position center pressure V2 = 2.07 m
 Drag full = 185 Kg
 V4:

Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	1.2 (lift)	21 (lift)	-143	-113	-150	-151	-443
Drag	7	17	8.5	54	0.8	22	181

Car without rear and front wheel, rear and front wing, floor and diffuser: 96 Kg lift and 70 Kg drag.



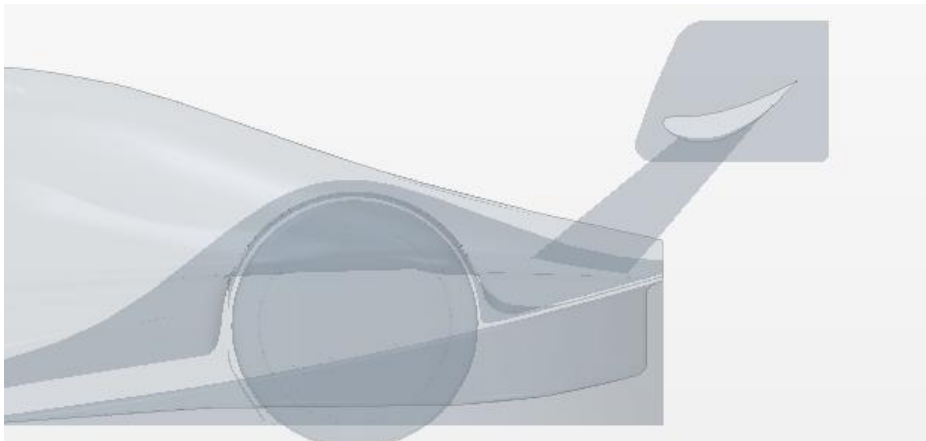




VERSION 5

150 Km/h, ground moving and wheels rotating:

Is also a variation of version 2. That is: without second element rear wing:







Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	10 (lift)	25 (lift)	-156	-143	-121	-94	-331
Drag	2.6	15.3	9.3	23	0.81	14	140

Car without rear and front wheel, rear and front wing, floor and diffuser:

150 Kg lift

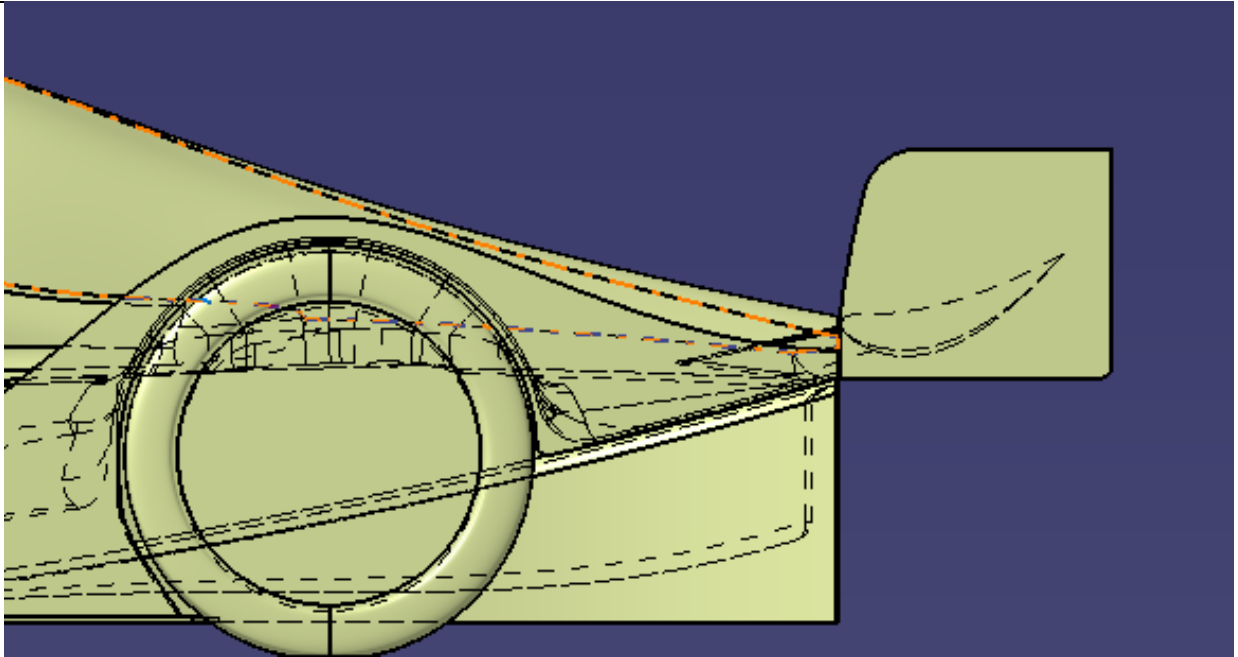
74 Kg Drag

Position center pressure $V_2 = 1.94 \text{ m}$

VERSION 6

150 Km/h, ground moving and wheels rotating:

Is a variation of Version 2. That is:



The cdp position: 1.68 m

Aero datas:

Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	6,22 (lift)	24,3 (lift)	-136	-60	-134.5	-96.2	- 281.5
Drag	4.8	14.9	8.57	22.05	0.86	14.2	133

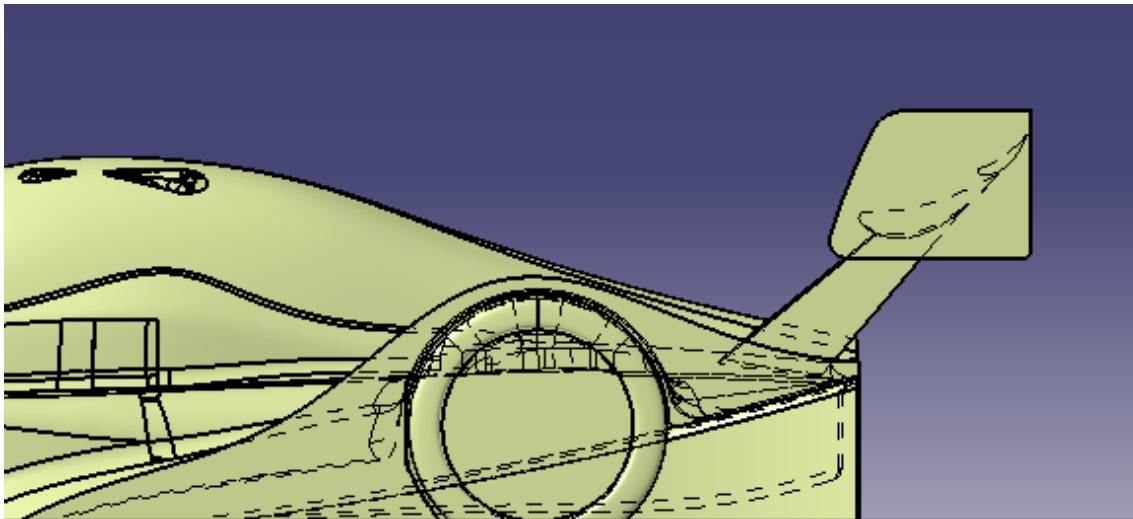
Car without rear and front wheel, rear and front wing, floor and diffuser:

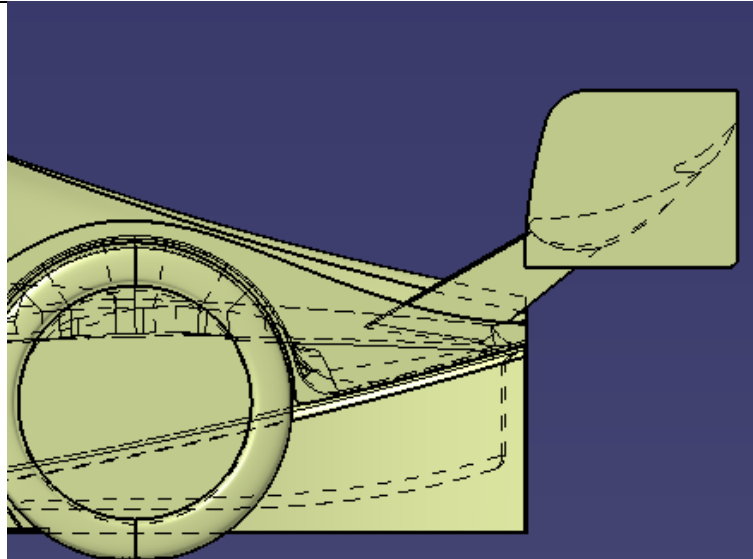
115 Kg lift
Kg
67 Drag

VERSION 7

150 Km/h, ground moving and wheels rotating:

Is a variation of Version 2. That is:





Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	2,73 (lift)	20,54 (lift)	-153	-224.9	-167.5	-175.9	-596
Drag	7.69	15.46	9.64	68.04	0.9	27.3	212

Car without rear and front wheel, rear and front wing, floor and diffuser:

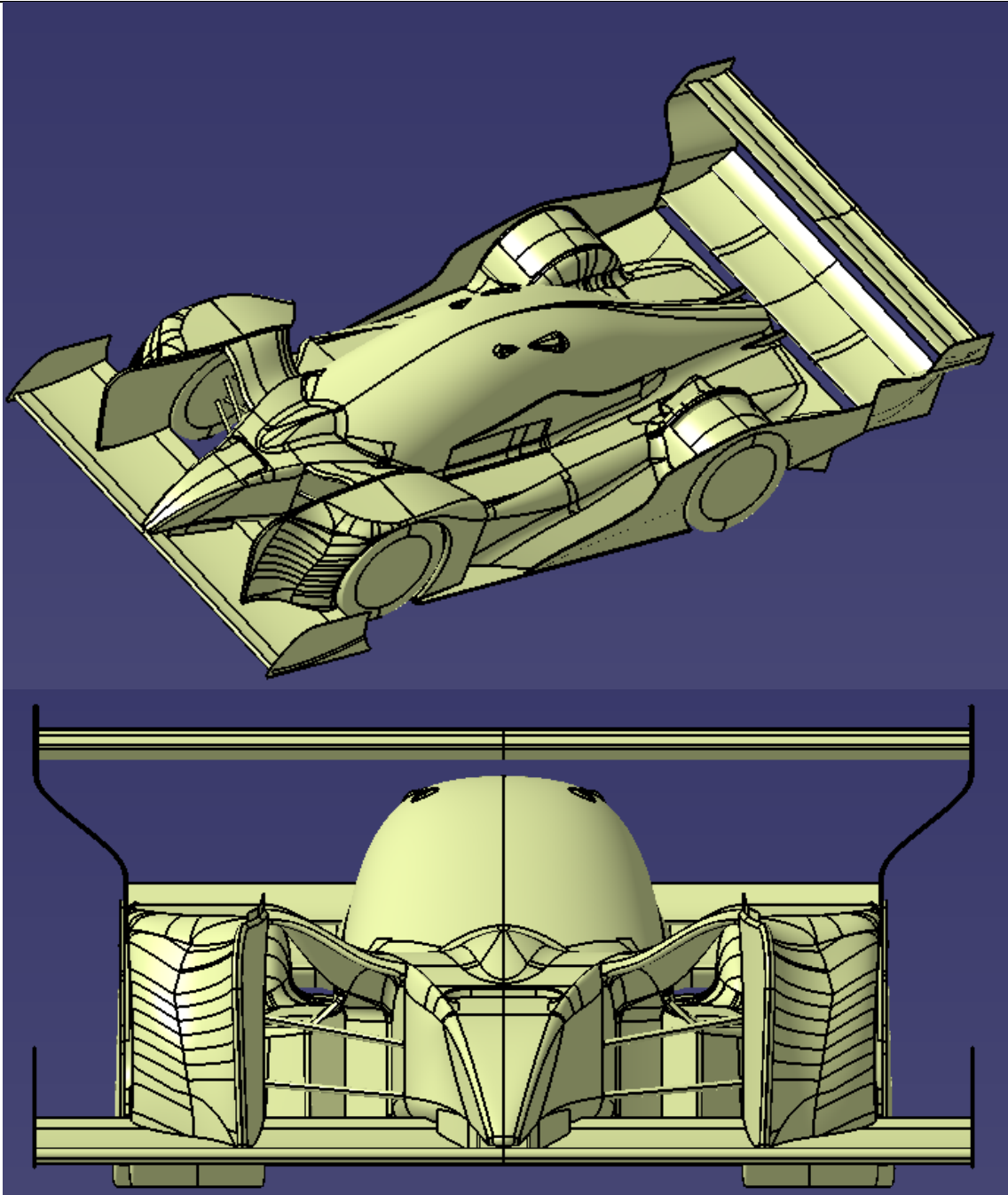
102 Kg lift
 Kg
 83 Drag

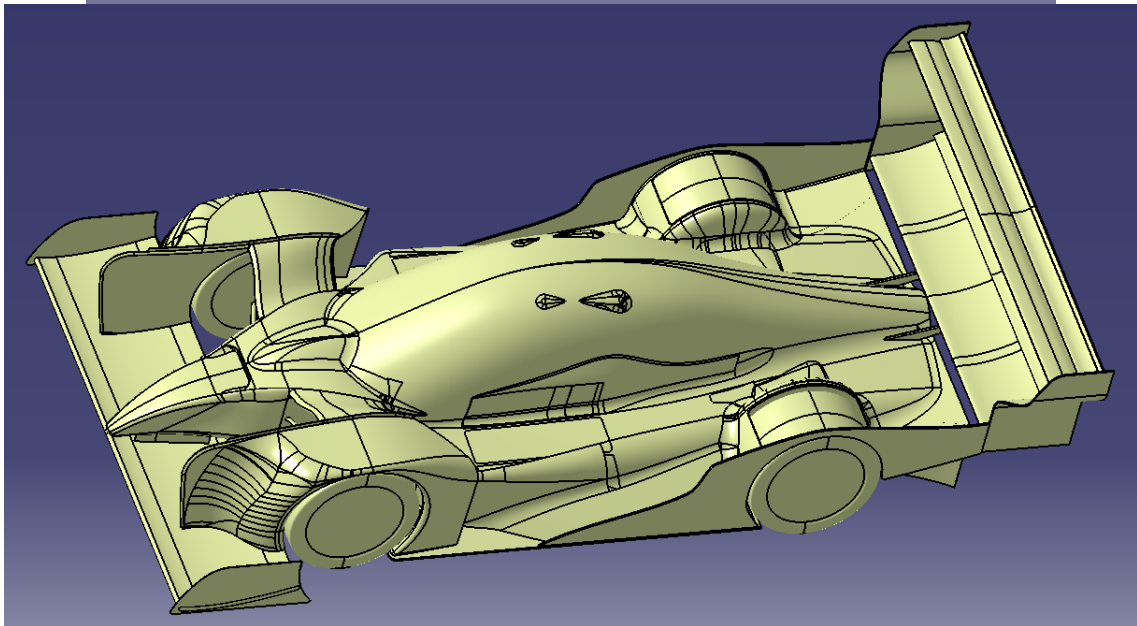
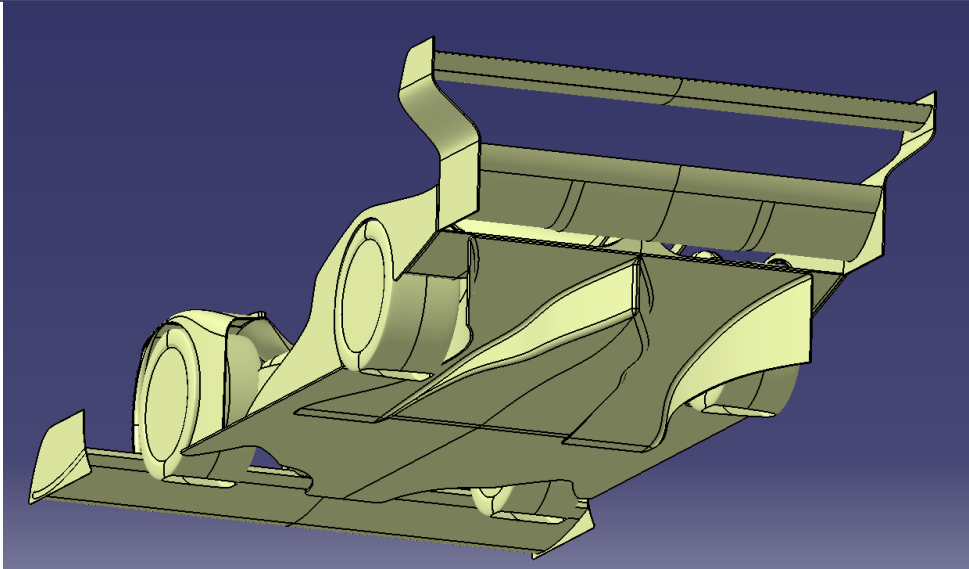
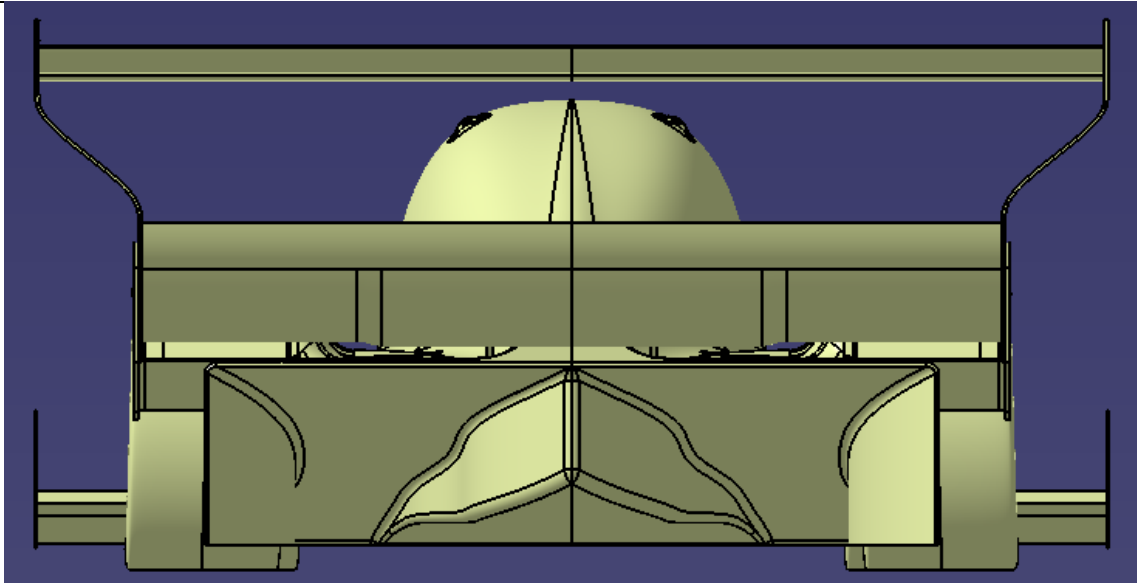
Position center pressure 2.27 m

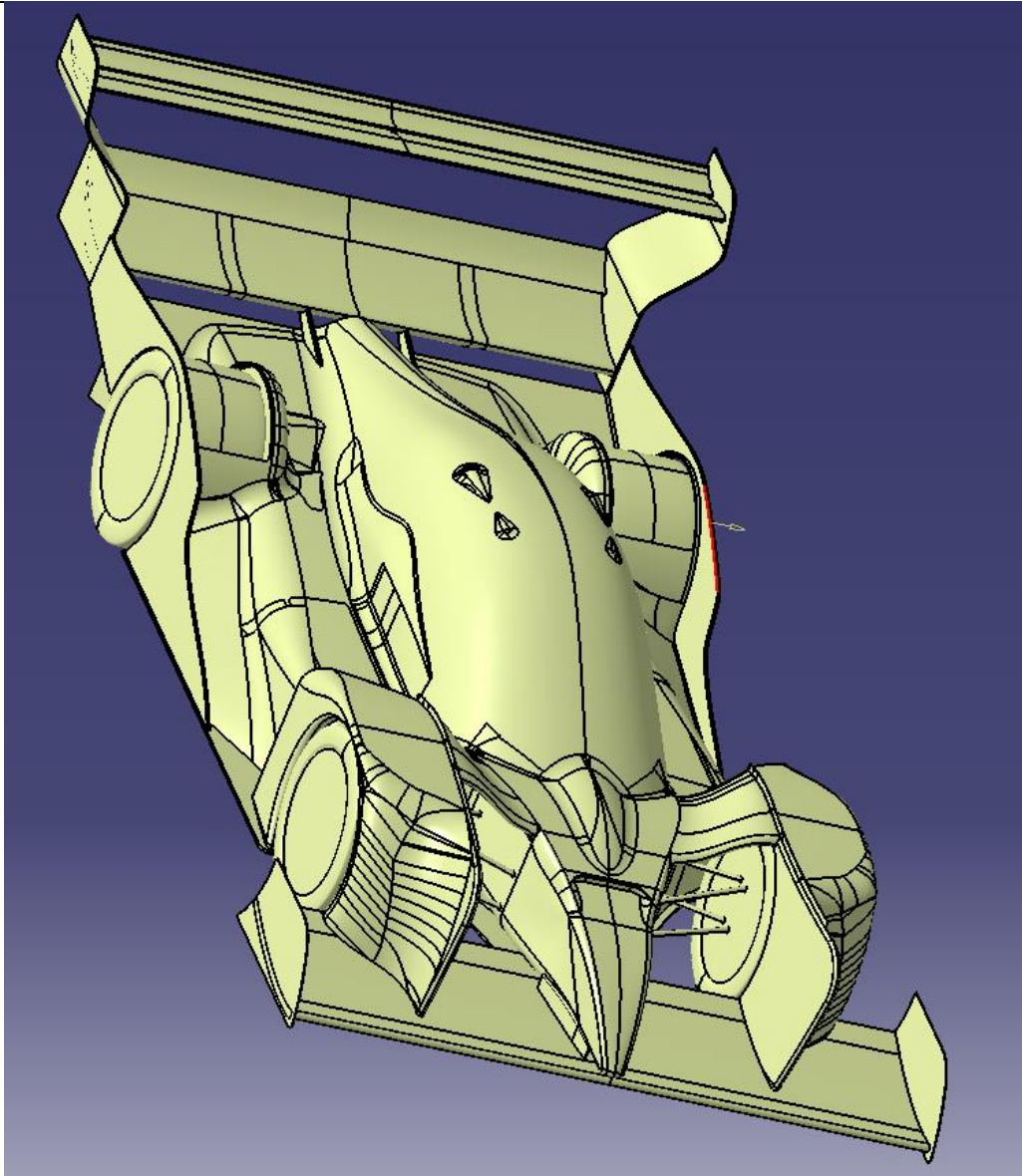
VERSION 8

150 Km/h, ground moving and wheels rotating:

New rear wing layout like 90's group C; lower rear wing (long chord) – upper rear wing (short chord):







Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	3,58 (lift)	21,49 (lift)	174.06	178.11	188.88	178.38	654.97
Drag	1.57	8.03	11.95	76.16	1.12	26.37	205.76

Car without rear and front wheel, rear and front wing, floor and diffuser:

41.38 Kg lift

Kg

2,12 cdp

78.5 Drag

VERSION 9

150 Km/h, ground moving and wheels rotating:

Variation: 4 exhaust (258 mph speed inlet from exhausts):

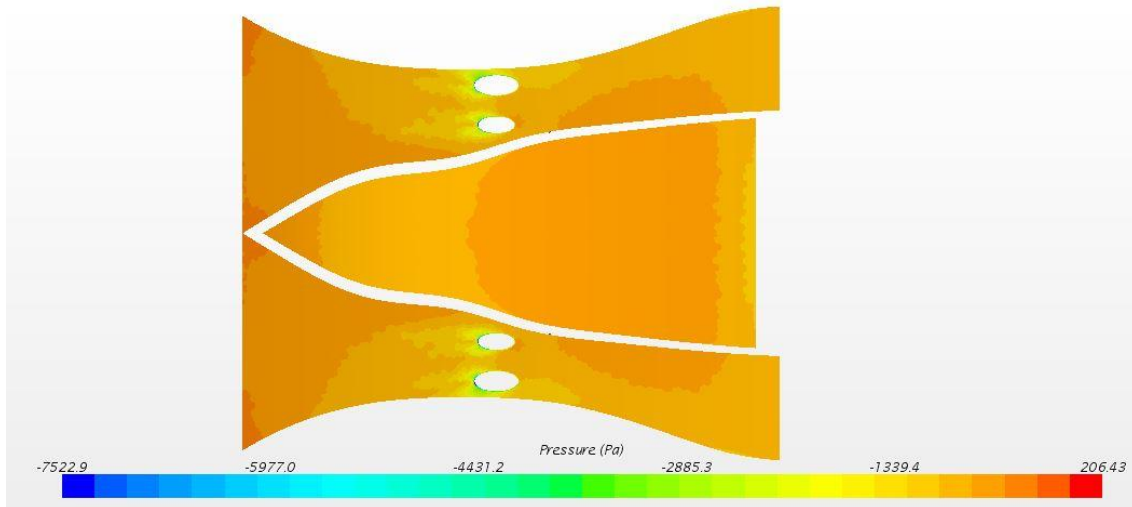


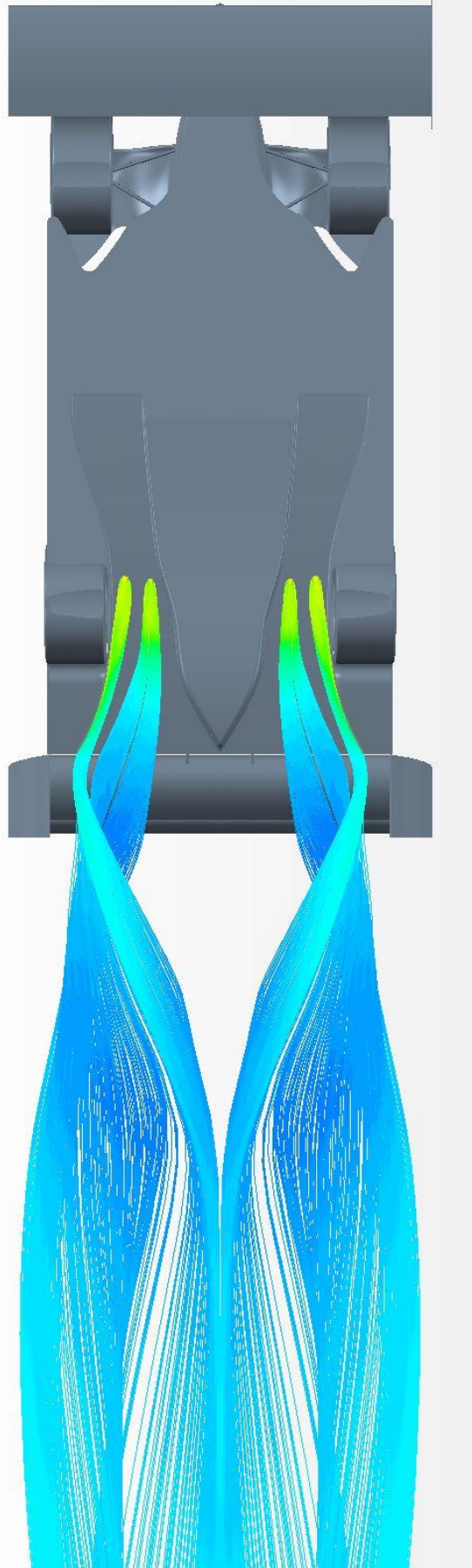
Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	3.2	21,33 (lift)	152.85	179.6	191	207.25	670.3
Drag	4.3	15.2	9.6	75.26	0.98	31.4	221

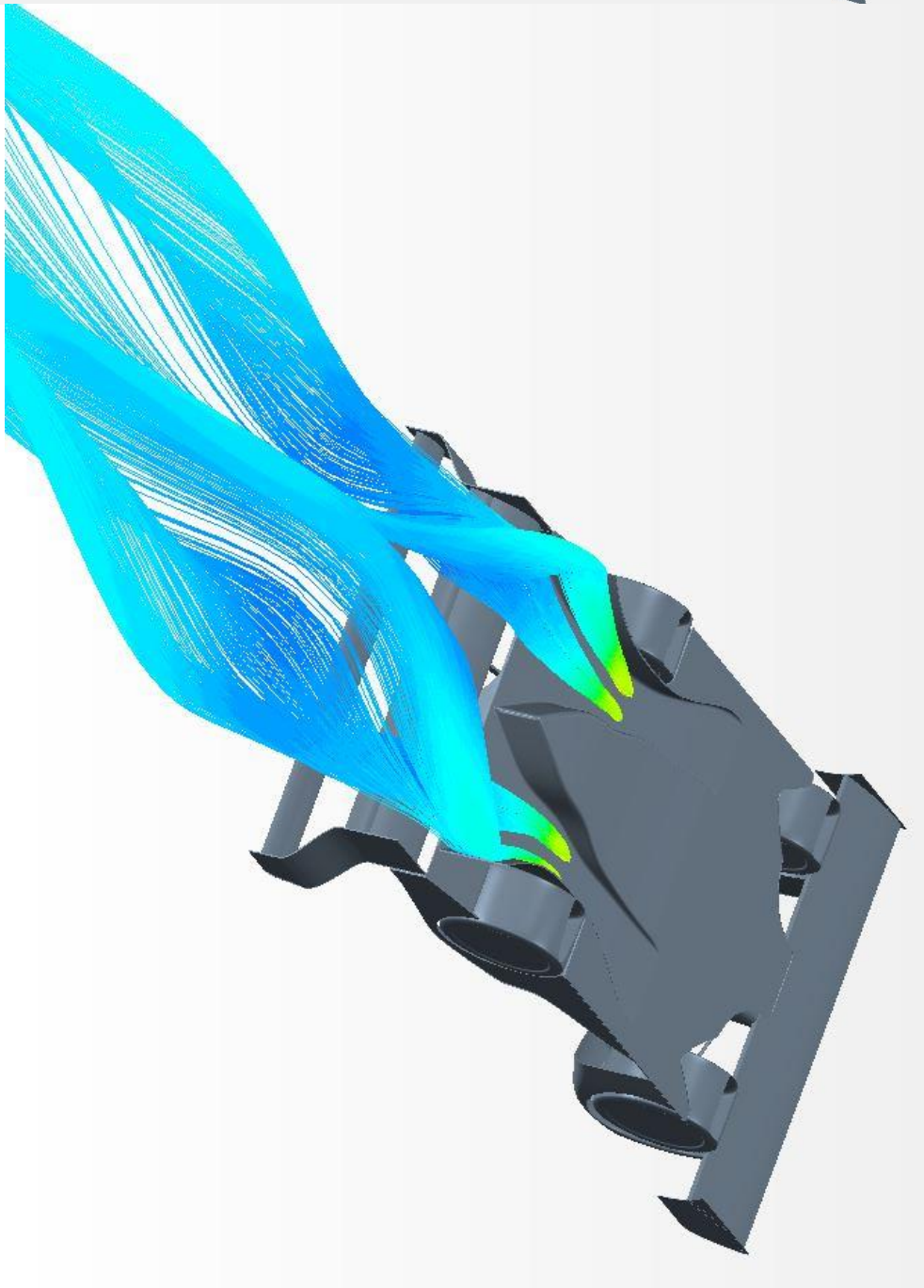
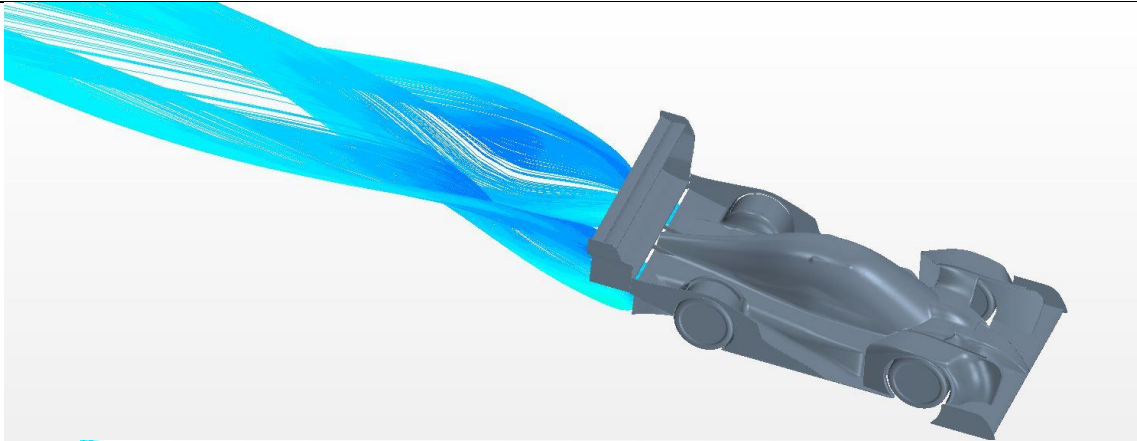
Car without rear and front wheel, rear and front wing, floor, diffuser and exhausts:

2,24 cdp

42.34 Kg lift
Kg
84.12 Drag





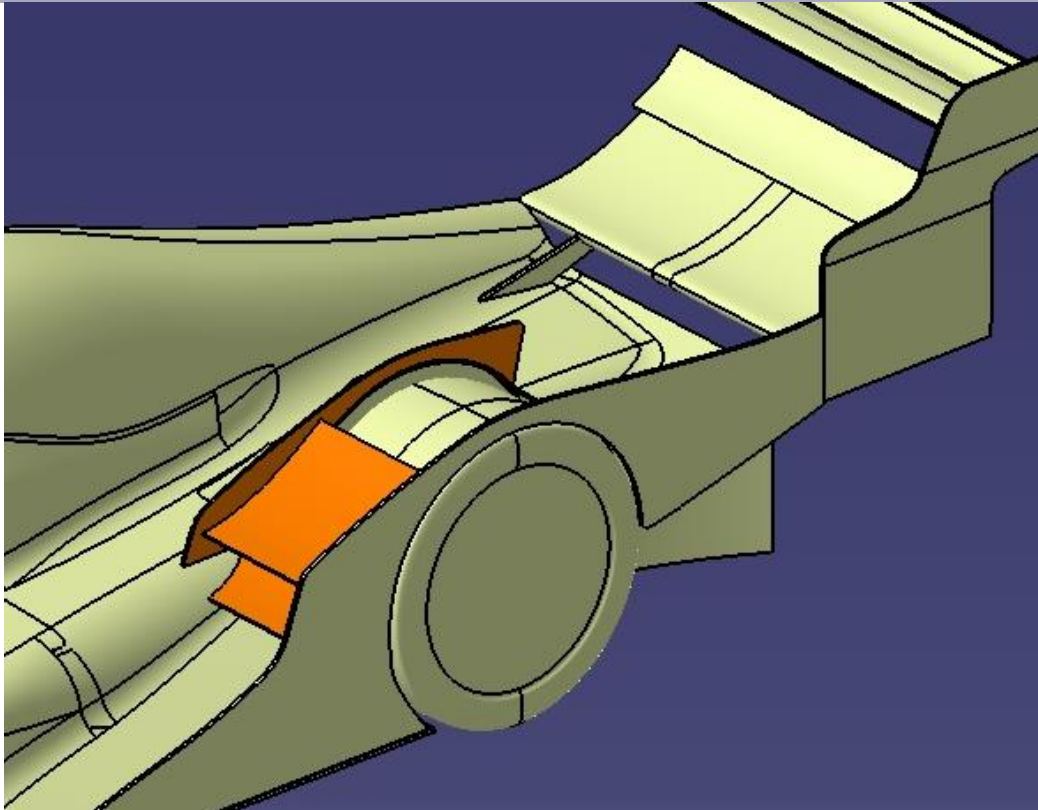
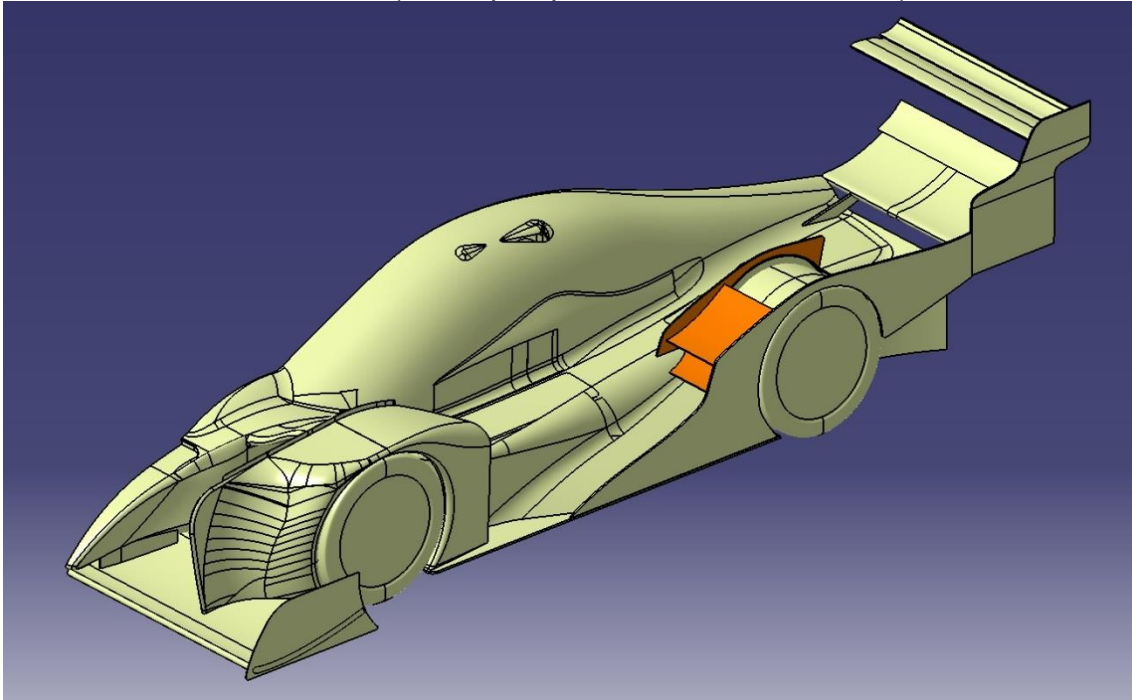




VERSION 10

150 Km/h, ground moving and wheels rotating:

Variation: 4 exhaust (258 mph speed inlet from exhausts) and:



Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	3,8 (lift)	21,2 (lift)	153.5	201.8	183.7	205.2	654.6
Drag	1.17	14.7	9.63	74.34	0.98	31.22	221.2



Car without rear and front wheel, rear and front wing, floor, diffuser and exhausts:

2,23 cdp

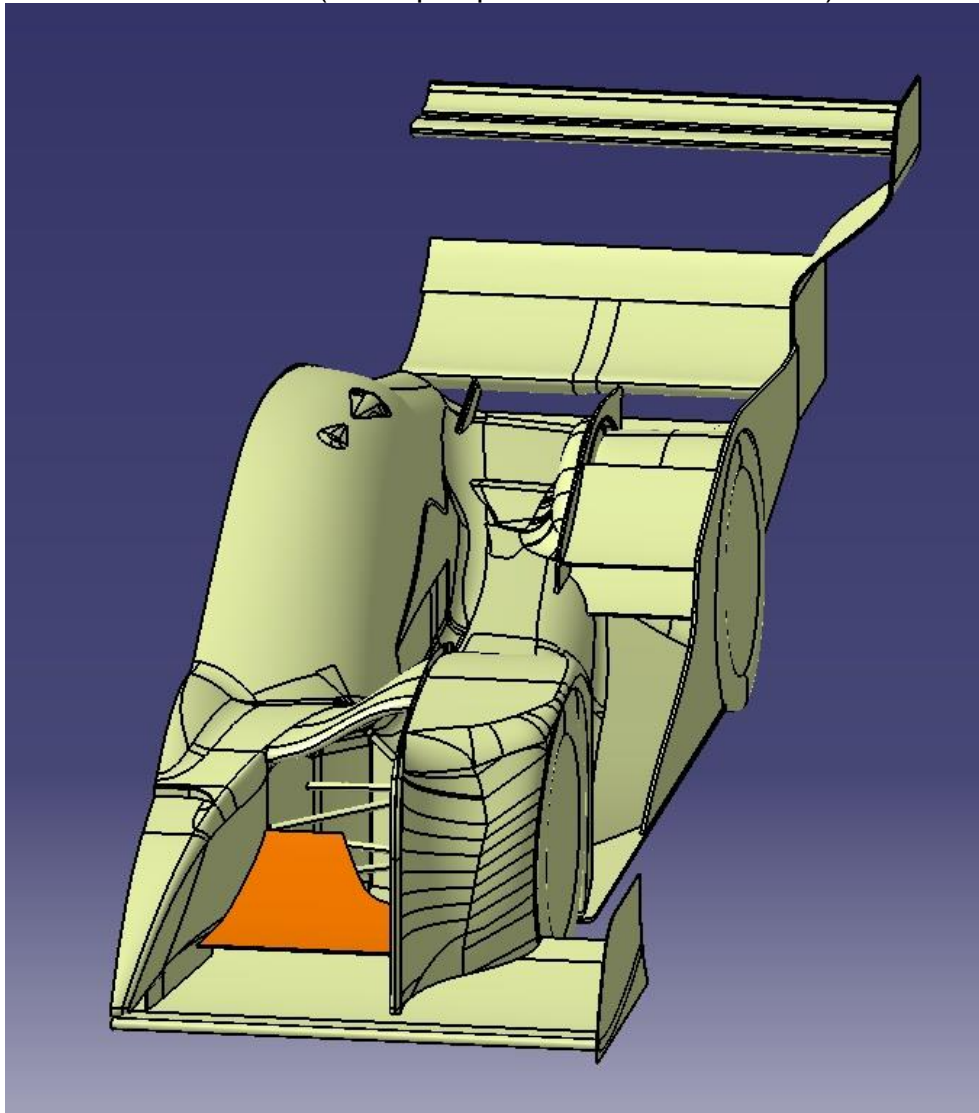
54.18 Kg lift

88.7 Kg Drag

VERSION 11

150 Km/h, ground moving and wheels rotating:

Variation: 4 exhaust (258 mph speed inlet from exhausts) and:



Kg	Rear Wheel	Front Wheel	Front Wing	Rear Wing	Floor	Diffuser	Full Car
Downforce	2.9	21,6 (lift)	198.4	182.8	202.55	209.15	710.2
Drag	5.5	14.8	17.3	70.26	1.05	32.31	220.08

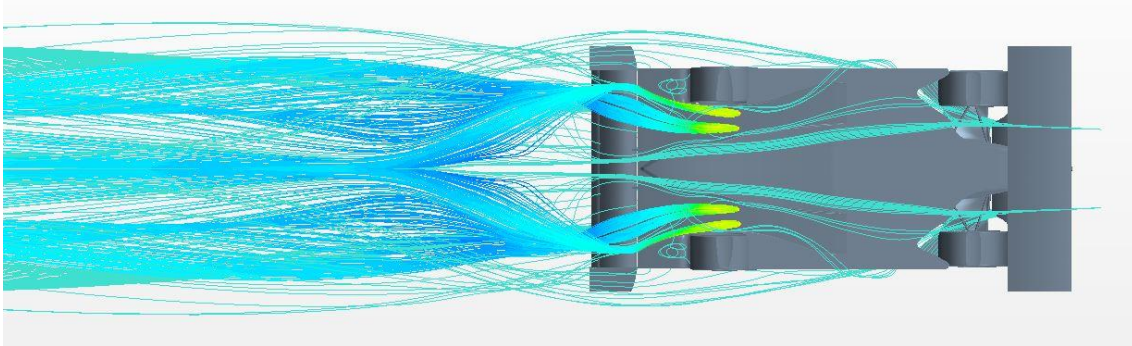
Car without rear and front wheel, rear and front wing, floor, diffuser

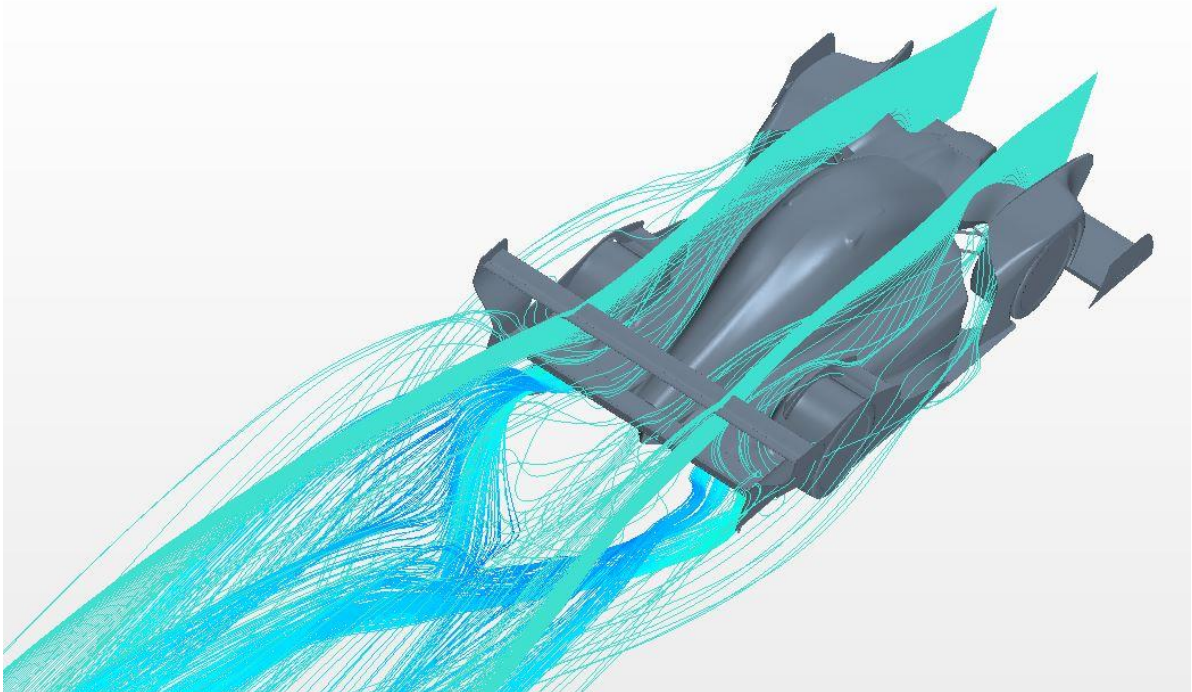
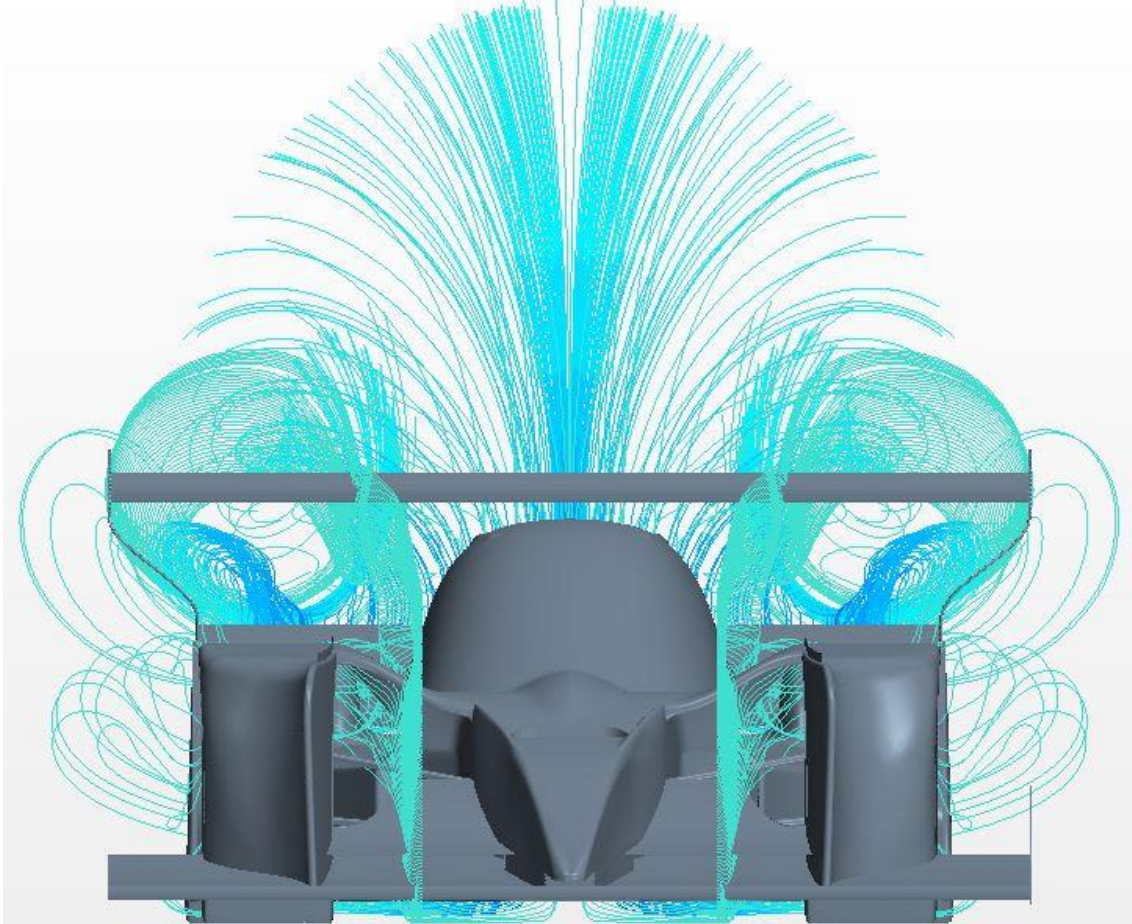


and exhausts:

1.99 cdp

64.02 Kg lift
Kg
78.63 Drag



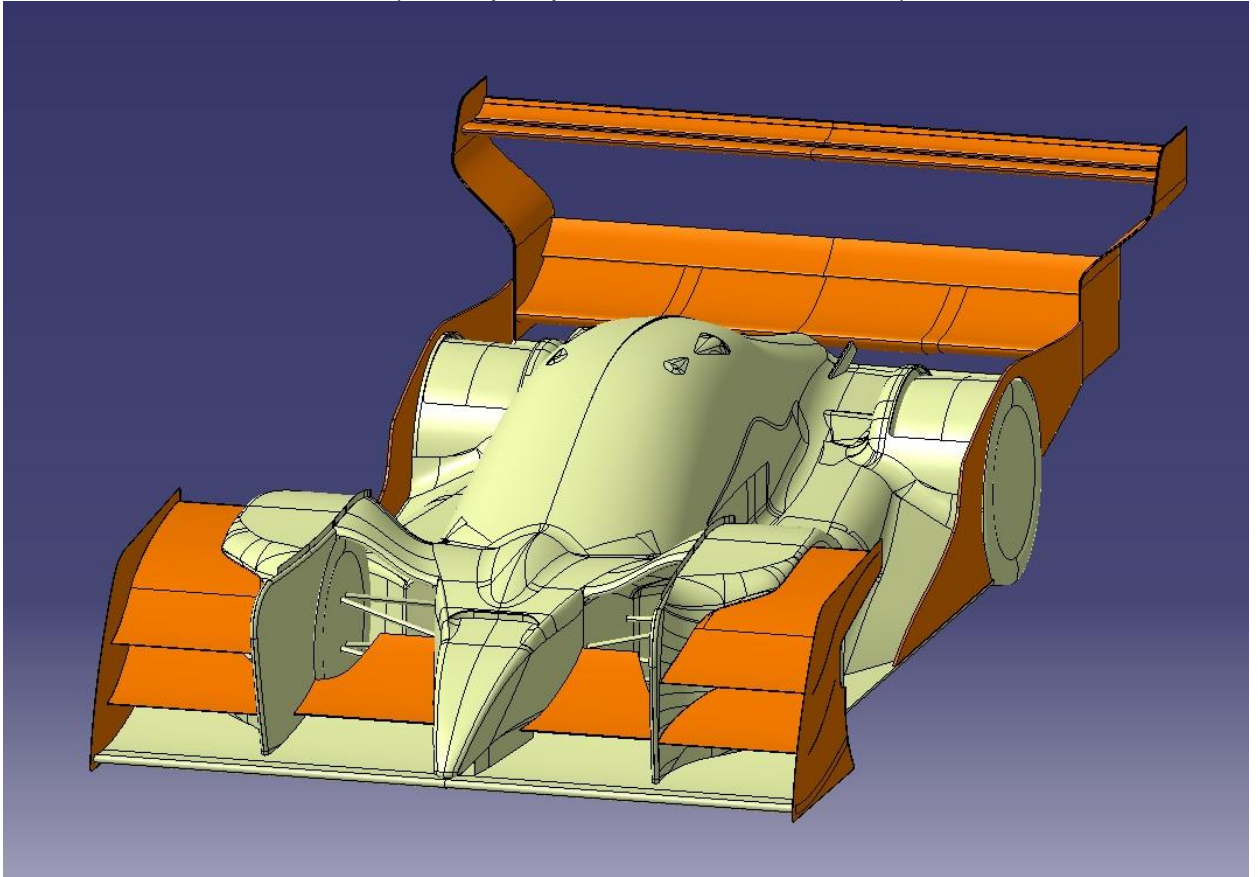




VERSION 12

150 Km/h, ground moving and wheels rotating:

Variation: 4 exhaust (258 mph speed inlet from exhausts) and:





Half Car

Drag

Lift

Part	Net (N)		
CAR2	[3.819401e+02, -6.513866e+02, 2.671987e+02]		
DIFUSSER	[1.550717e+02, -2.737156e-01, -1.016310e+03]		
FRONT-WHEEL	[8.610829e+01, -2.015783e+02, 8.238100e+01]		
FRONT-WING	[4.166150e+01, -6.249088e-01, -8.454487e+02]		
GROUND	[4.859521e+00, 7.016009e-01, -9.507613e+02]		
INLET2	[9.753109e-01, 1.045219e-10, -2.613338e-01]		
INLET3	[-3.484542e-01, -5.707198e-11, 9.336803e-02]		
REAR-WHEEL	[2.998895e+01, 1.283120e+02, -2.750514e+01]		
REAR-WING	[3.293724e+02, -3.216888e+00, -8.588689e+02]		
Totals:	[1.029629e+03, -7.280667e+02, -3.349483e+03]		

The cdp is located: 1.87 m

VERSION 13

The same version than V12, but 0.4° pitch (front 40 mm and rear 60 mm):

Half Car

Drag

Lift

Part	Net (N)		
CAR2	[3.345293e+02, -6.743376e+02, 2.036562e+02]		
DIFUSSER	[1.557097e+02, -4.077540e-01, -9.896887e+02]		
FRONT-WING	[5.959825e+01, -9.764157e-01, -9.393935e+02]		
GROUND	[1.269604e+01, 1.294641e+00, -1.116612e+03]		
INLET2	[1.136846e+00, 1.040123e-10, -2.961262e-01]		
INLET3	[-4.390965e-01, -6.812765e-11, 1.143761e-01]		
REAR-WING	[3.321665e+02, -3.138717e+00, -8.159411e+02]		
WHEEL-FRONT	[8.547022e+01, -1.949755e+02, 8.248933e+01]		
WHEEL-REAR	[4.218554e+01, 1.123971e+02, -2.657097e+01]		
Totals:	[1.023053e+03, -7.601442e+02, -3.602243e+03]		

The cdp is located: 1.865 m



VERSION 14

The same version than V12, but 0.9° pitch (front 40 mm and rear 80 mm): also half car, as always:

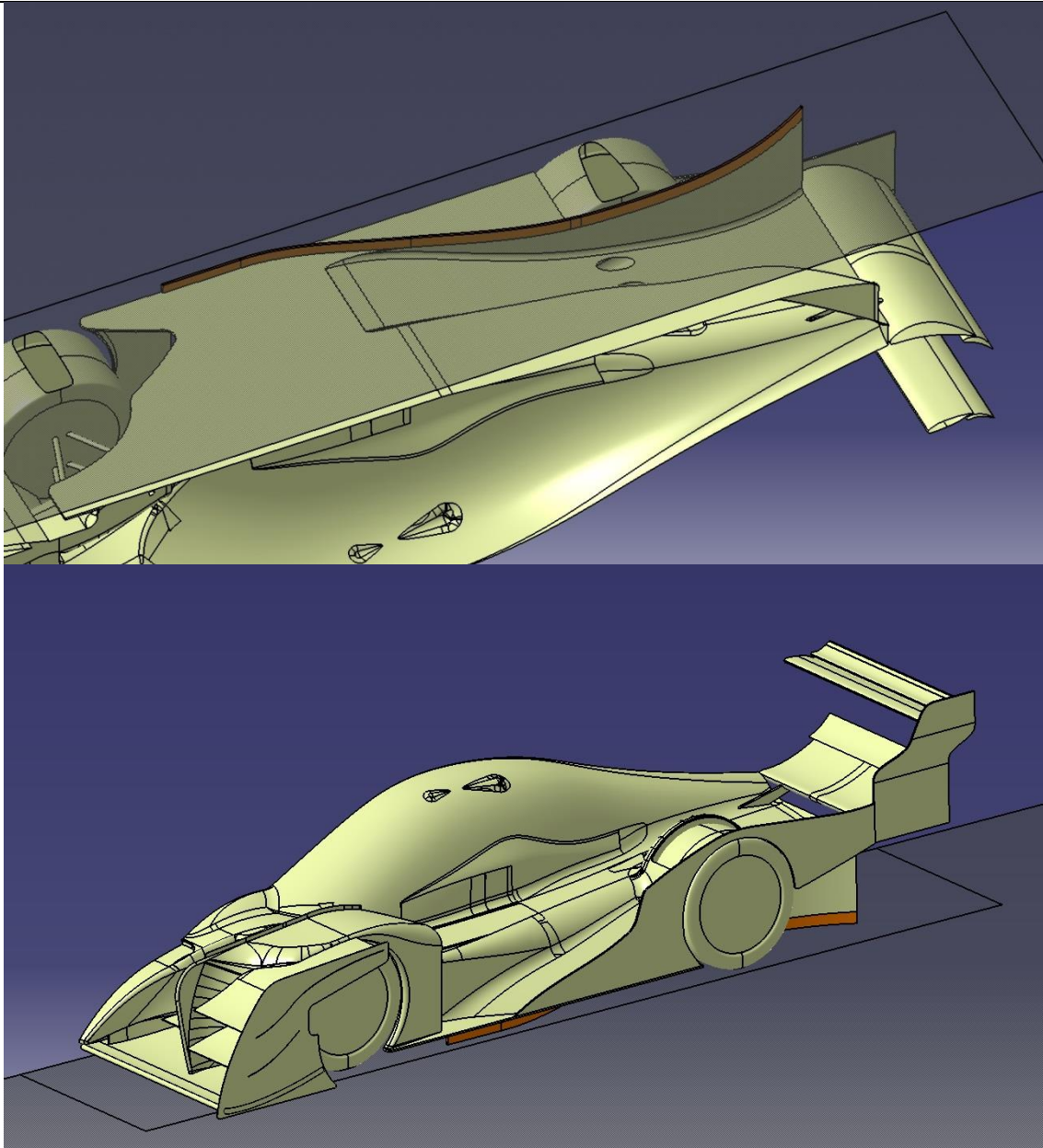
Part	Net (N)
car2	[3.626621e+02, -7.557007e+02, 1.153401e+02]
difusser	[1.615965e+02, -4.688142e-01, -9.325565e+02]
front-wheel	[6.965215e+01, -1.872754e+02, 7.716135e+01]
front-wing	[7.296807e+01, -1.201965e+00, -1.041668e+03]
ground	[1.951127e+01, 1.161050e+00, -9.858639e+02]
inlet2	[-5.209637e-01, -1.226765e-11, 1.308570e-01]
inlet3	[7.415226e-01, 2.364564e-10, -1.862576e-01]
rear-wheel	[5.342350e+01, 1.449316e+02, -2.224190e+01]
rear-wing	[3.719809e+02, -3.356651e+00, -8.295135e+02]
Totals:	[1.112015e+03, -8.019109e+02, -3.619398e+03]

The cdp is located now to 1.825 m.

Is more advanced, because the front wing have more downforce and also the reer wing. Also is interested, that the drag is higher, with the same downforce....

VERSION 15

The same version than V13, but with skirts in the diffuser:



Part	Net (N)
car2	[2.918156e+02, -5.562665e+02, 2.265678e+02]
difusser	[1.578347e+02, 1.510134e-04, -1.081753e+03]
frontwheel	[8.239309e+01, -1.878445e+02, 7.868349e+01]
frontwing	[5.525601e+01, -9.646499e-01, -9.502608e+02]
ground	[1.495270e+01, 4.653668e-01, -1.426382e+03]
inlet2	[1.029992e-01, -2.869433e-11, -2.682928e-02]
inlet3	[4.209830e-01, 1.188685e-10, -1.096579e-01]
rearwheel	[7.307820e+01, 1.467885e+01, 5.288183e-01]
rearwing	[3.292228e+02, -3.641163e+00, -8.855661e+02]
Totals:	[1.005077e+03, -7.335724e+02, -4.038318e+03]

The cdp is located: 1.72 m.