991 PORSCHE GT3 RS

PERFORMANCE OF VERUS ENGINEERING VENTUS PACKAGES

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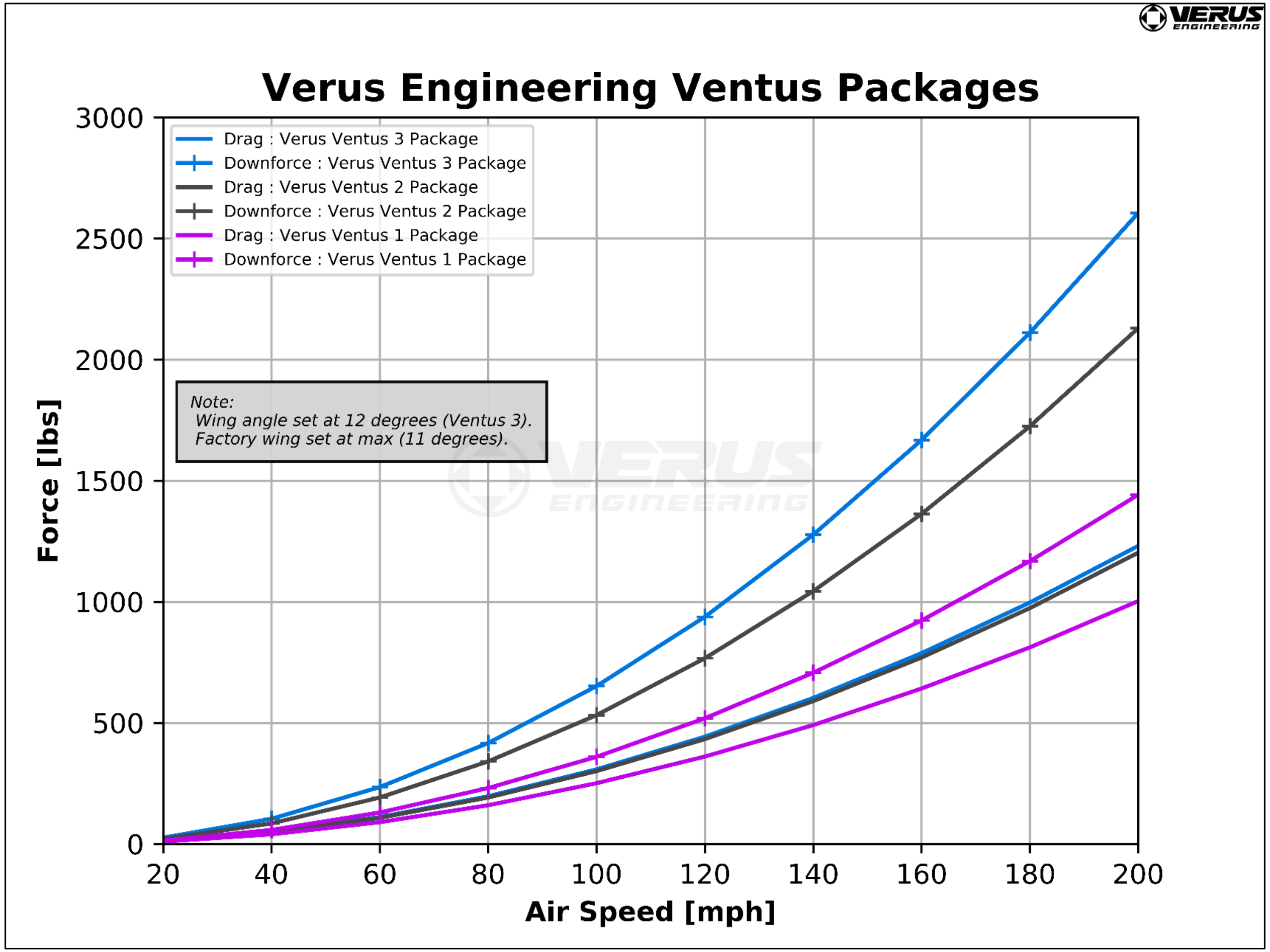
SUMMARY : AERODYNAMIC FORCES

Aerodynamic forces change with the square of vehicle speed which is why we share graphs of the data instead of listing a force.

When developing an aerodynamic package, Verus Engineering focuses on maximizing efficiency while increasing downforce significantly. In other words, we look at creating downforce while keeping drag increases minimal or negligible.

Efficient downforce will decrease lap times and improve vehicle performance. The benefit of an entire package is keeping a factory like aerodynamic balance while increasing vehicle downforce.

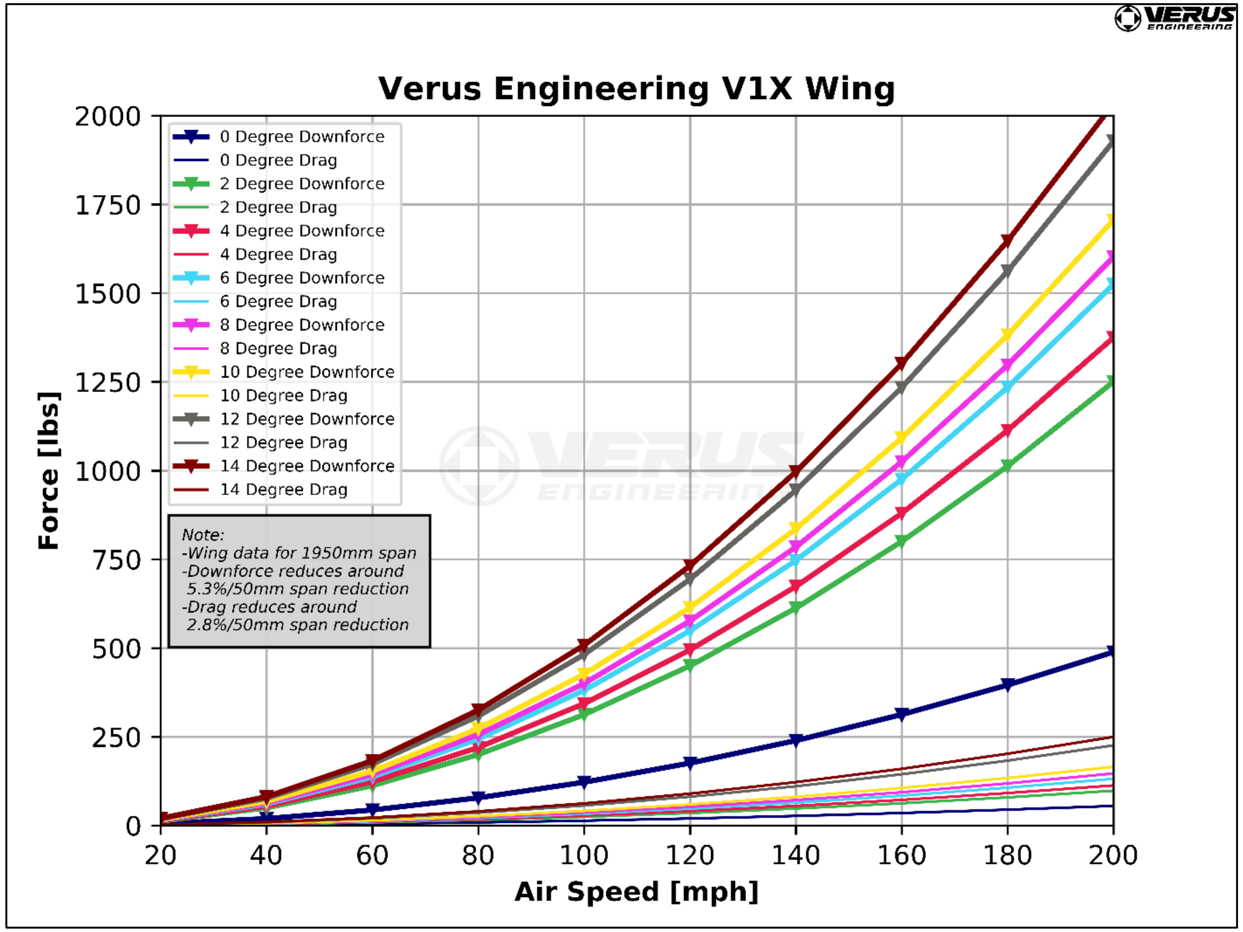


SUMMARY : REAR WING FORCES

The V1X might need to be adjusted to fine tune the balance for driver preference.

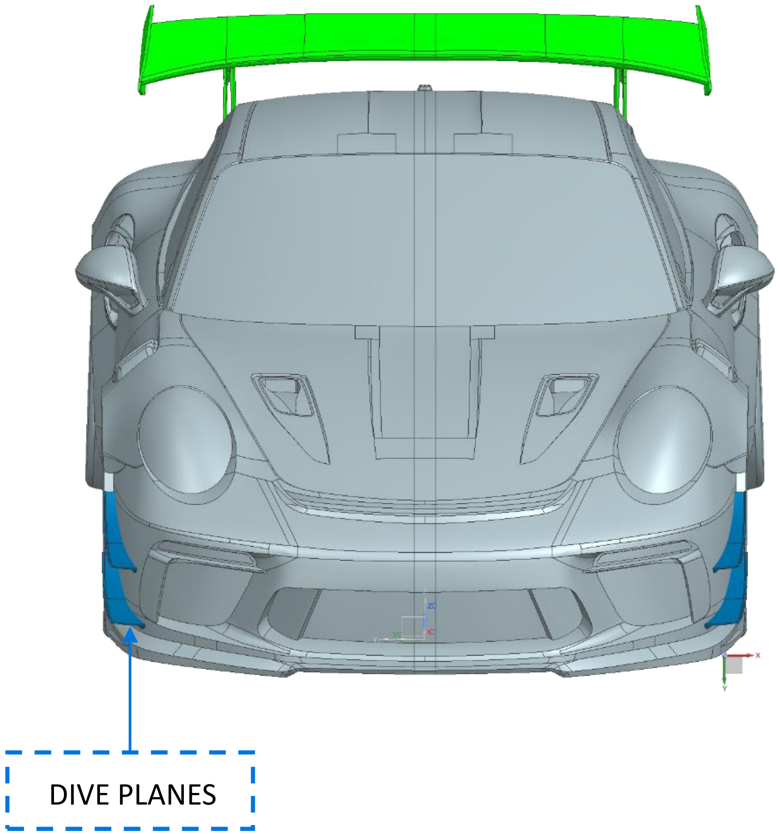
The V1X was developed in CFD and optimized using adjoint and optimization methods. The wing makes outstanding downforce while keeping efficiency high. The V1X also was engineered to have a trailing edge stall or slow stall. More adjustment and tuning is available with this type of stall.

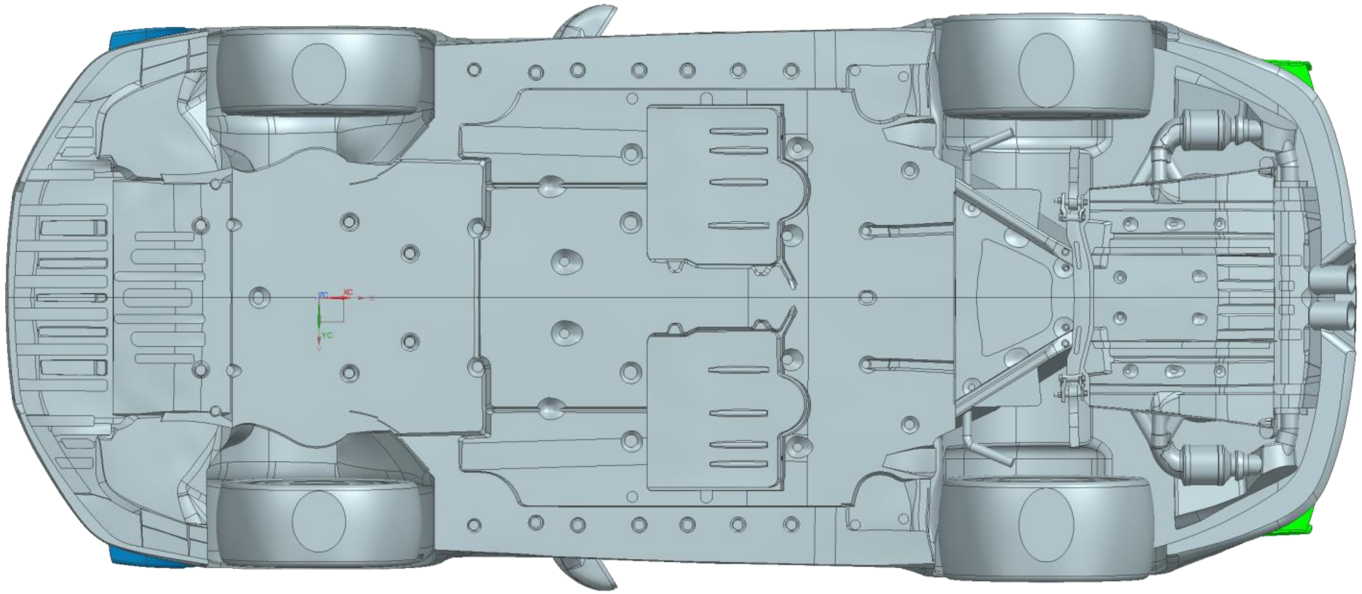
Confidence in our numbers is key. Testing in the wind tunnel for correlation was key to this confidence.

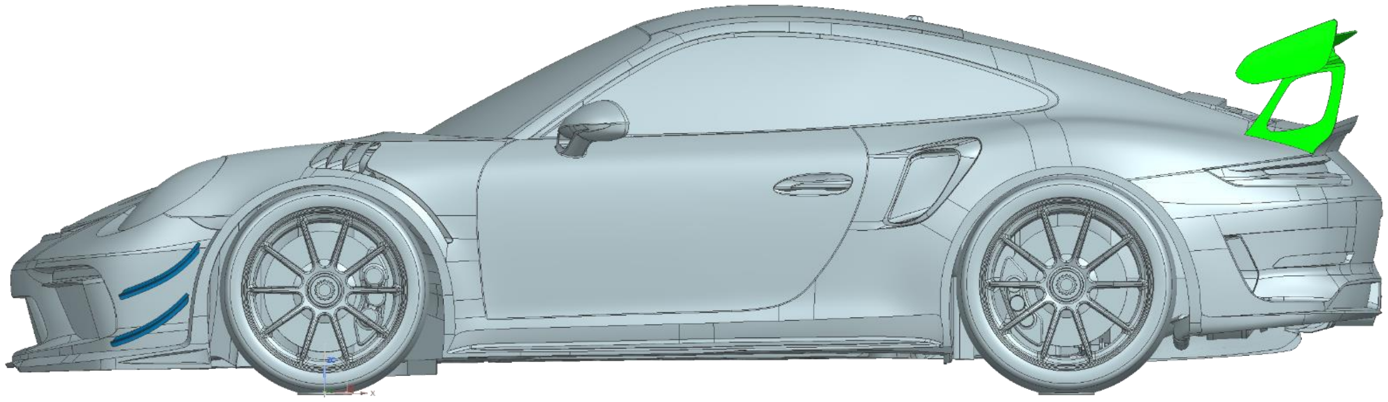


V1X is 300mm Chord

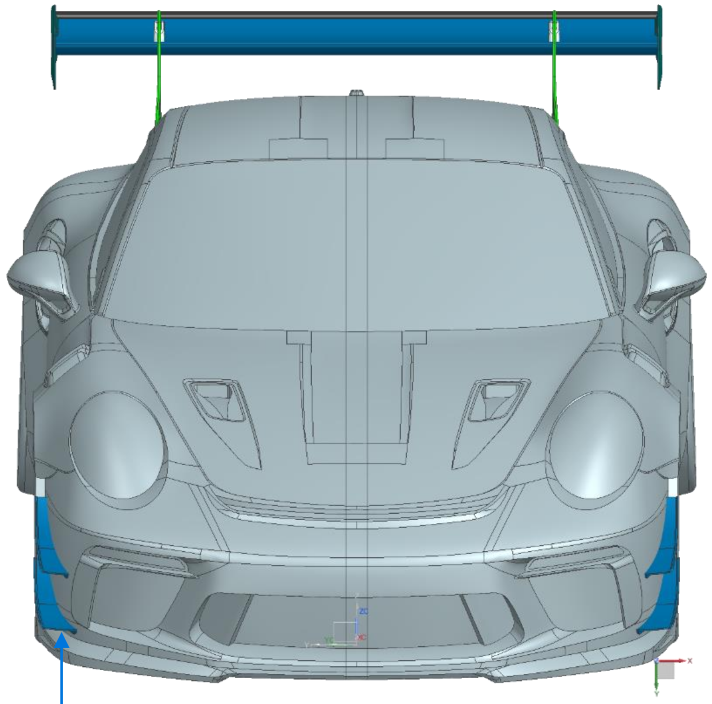
VENTUS 1 PACKAGE



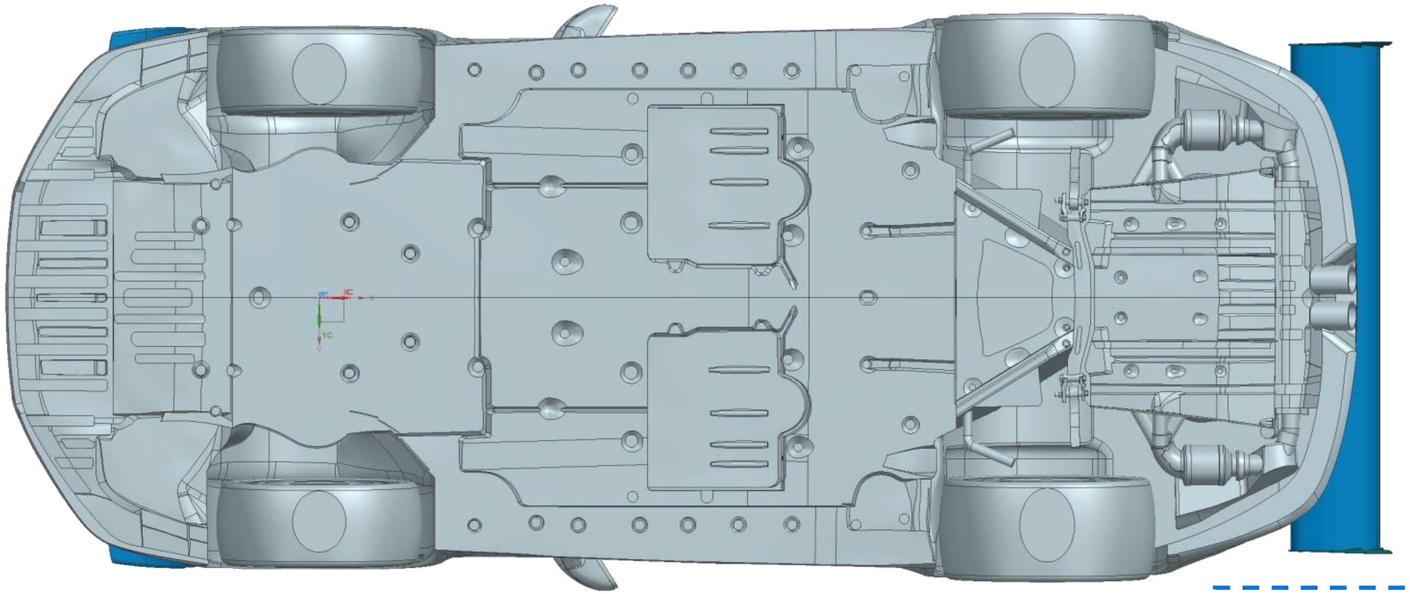


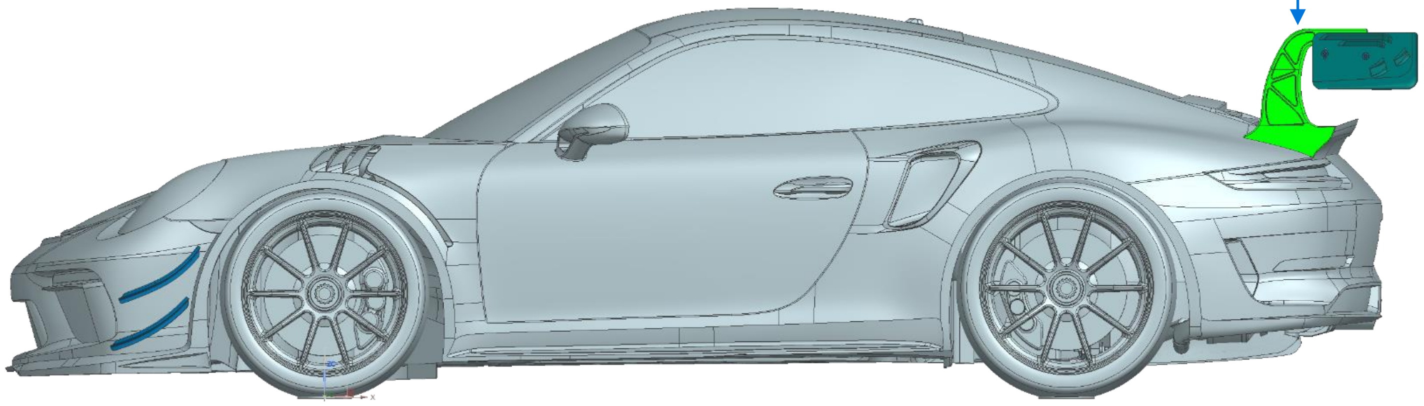


VENTUS 2 PACKAGE



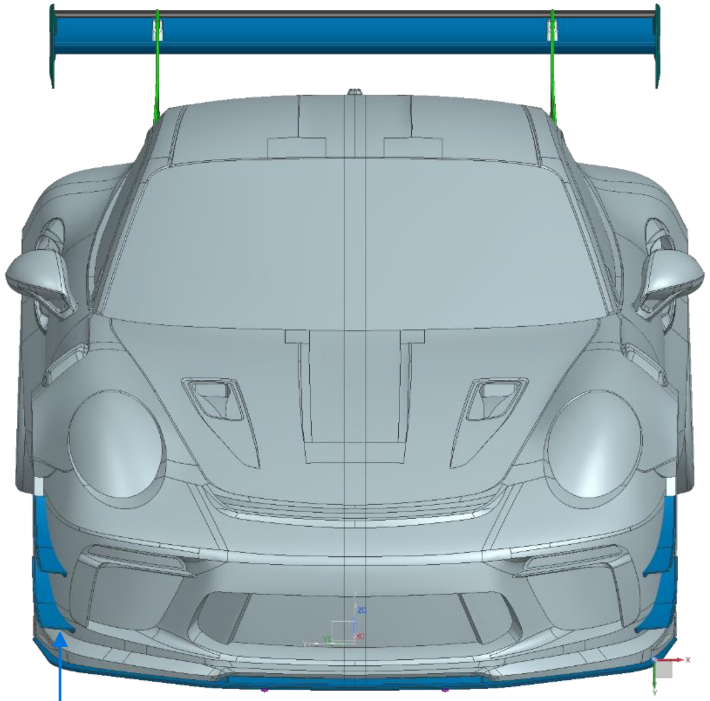
DIVE PLANES



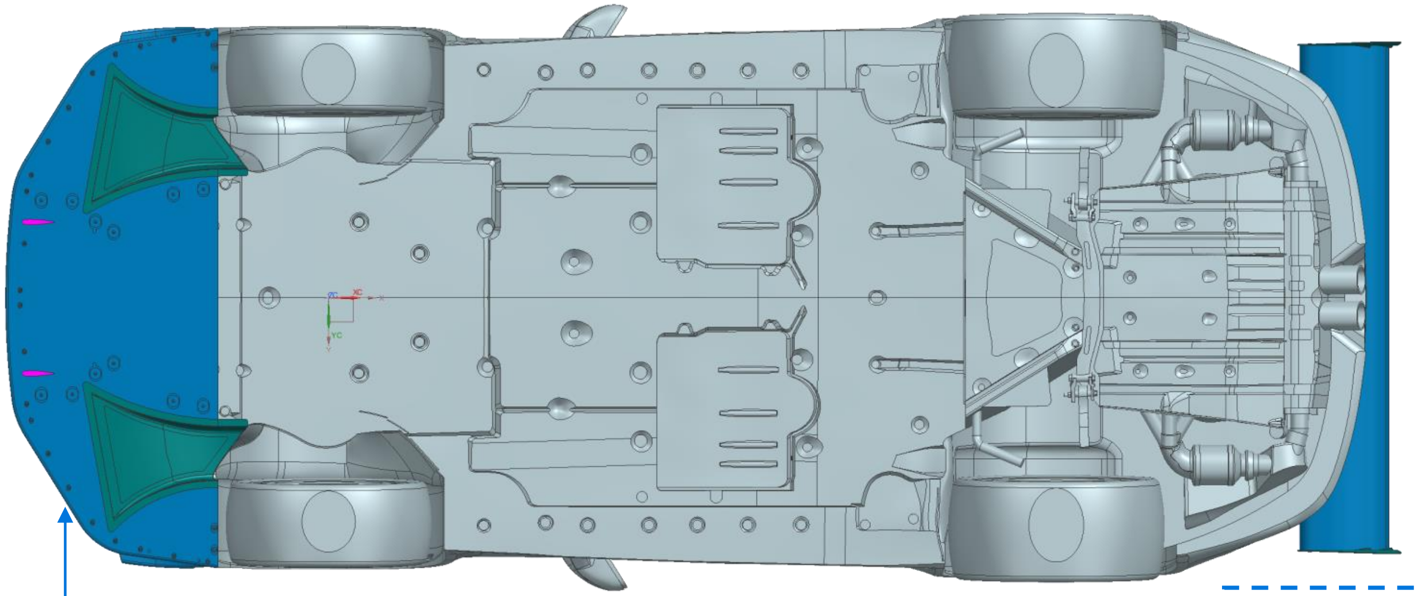


V1X WING

VENTUS 3 PACKAGE

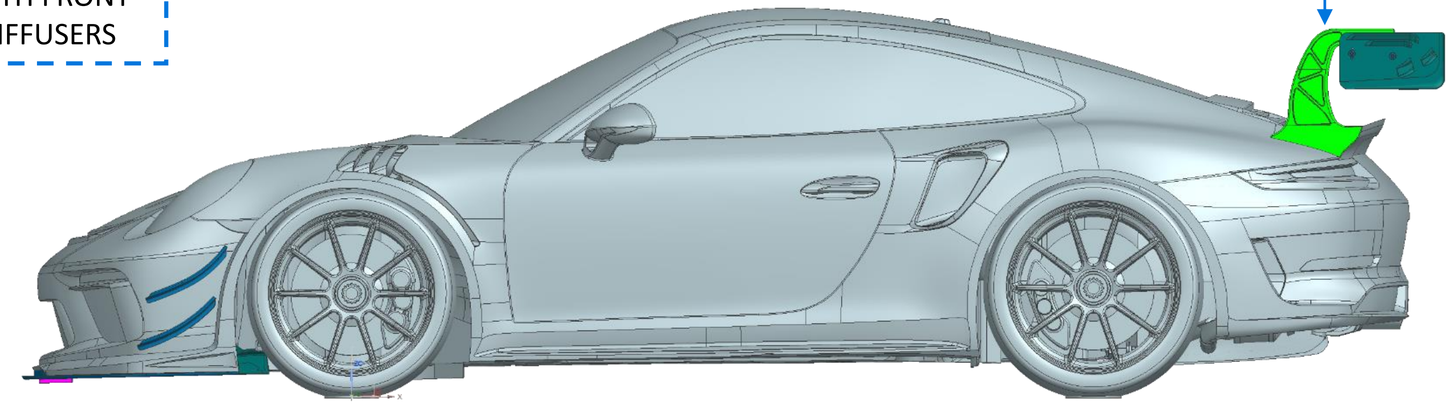


DIVE PLANES

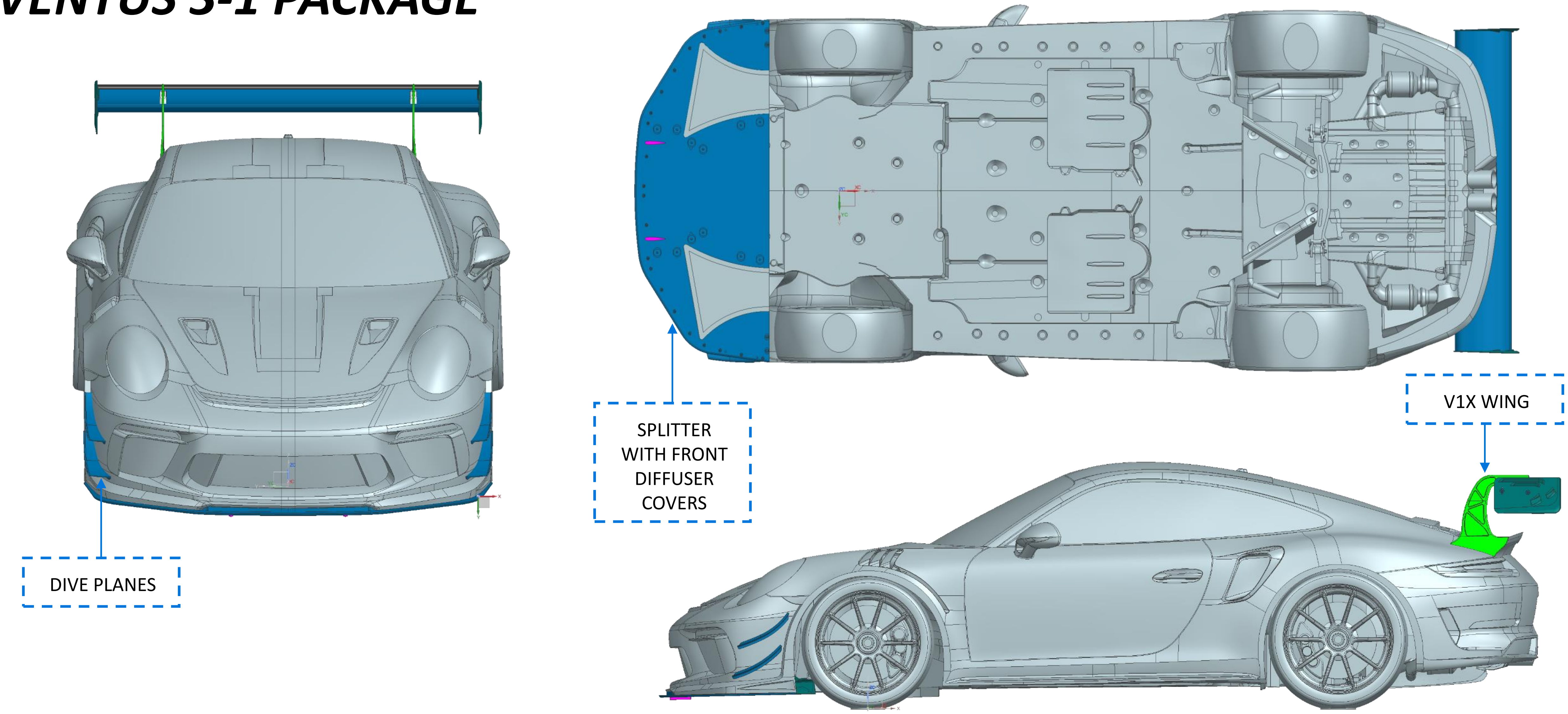


SPLITTER WITH FRONT DIFFUSERS

V1X WING



VENTUS 3-1 PACKAGE



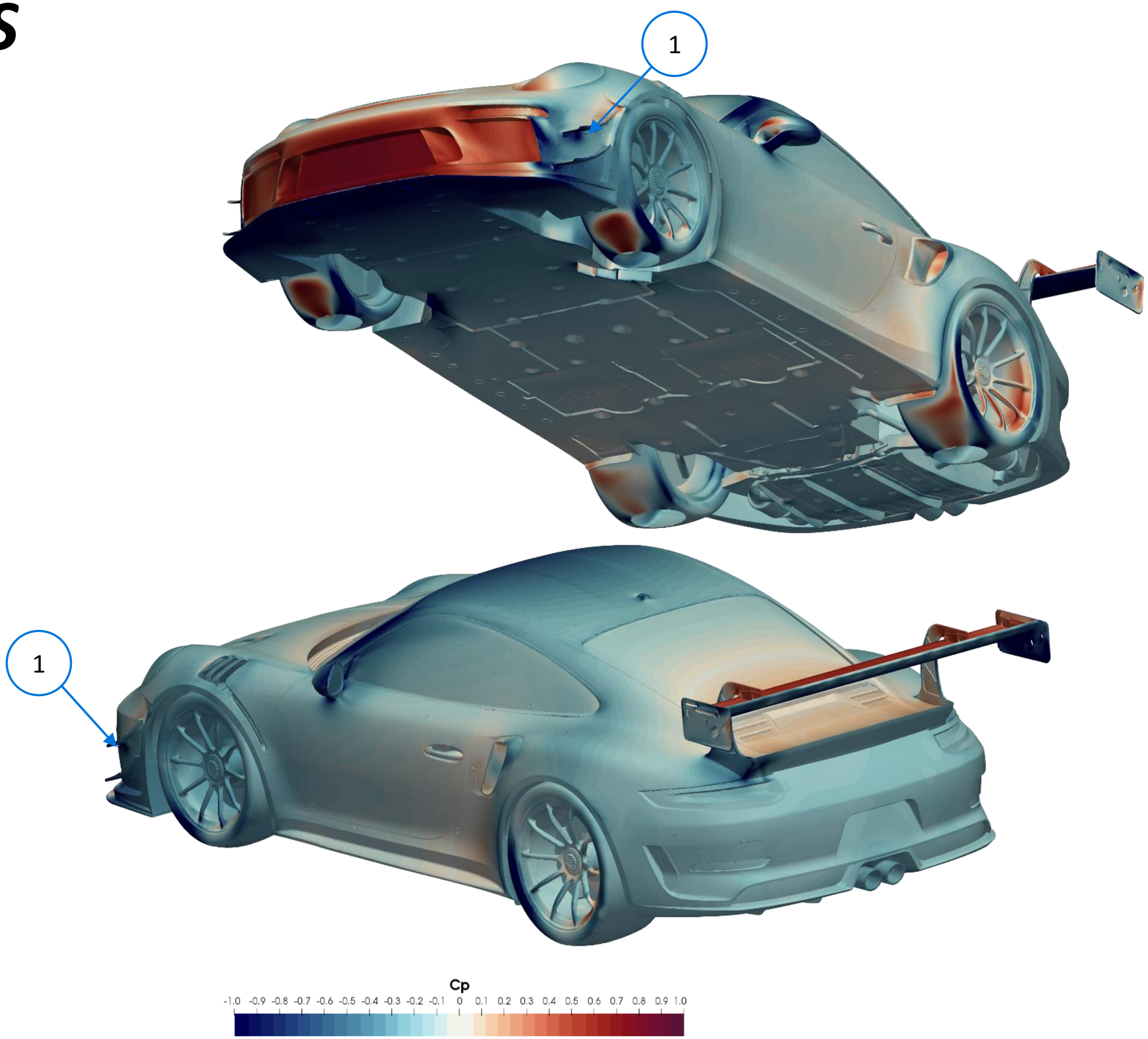
DEFINITIONS

1. **Coefficient of Pressure (Cp)** = This is a dimensionless number which describes relative pressure to atmospheric pressure. A Cp of 0 equates to atmospheric pressure while a number below 0 represents low pressure and a number above 0 represents high pressure.
2. **CpX** = This is a dimensionless number which describes Cp normal to the x-direction. This helps us visualize locations which create drag. Red represents locations which are creating drag, while blue represents locations where thrust is created.
3. **CpZ** = This is a dimensionless number which describes Cp normal to the z-direction. This helps us visualize location which create downforce or lift. Red represents locations which are creating lift, while blue represents locations where downforce is created.
4. **Total Pressure Coefficient (CpT)** = This is a dimensionless number which describes total energy of the airstream. It is the sum of static pressure and dynamic pressure.
5. **Wall Shear** = This is a force per unit area due to fluid friction on the wall. This is used to visualize areas of separation and rapid changes on the surface.
6. **LIC Plot** = Line integral convolution (LIC) is used to visualize “oil” flow on the surface. It is a great way to correlate to flow vis testing and to study the flow on the surface of the vehicle.
7. **Streamline** = These are fluid tracers which are used to visualize where the air is going or coming from. These are normally colored as velocity where red is high-velocity and blue is low-velocity.
8. **Points** = One point is considered 0.001 of a coefficient. This is used in coefficient of drag (Cd) and coefficient of lift (Cl).

DIVE PLANE / CANARD DETAILS

Dive planes can serve a variety of purposes. While most people believe dive planes produce downforce by the airflow on the units themselves; Verus Engineering does significantly more with the development of these units to increase effectiveness.

1. A small part of the downforce created by the dive planes is from the forces on the surfaces of the dive planes themselves. The bottom side of the dive planes are lower pressure while the top side is higher pressure. This creates a downward force. This is not the full story however.

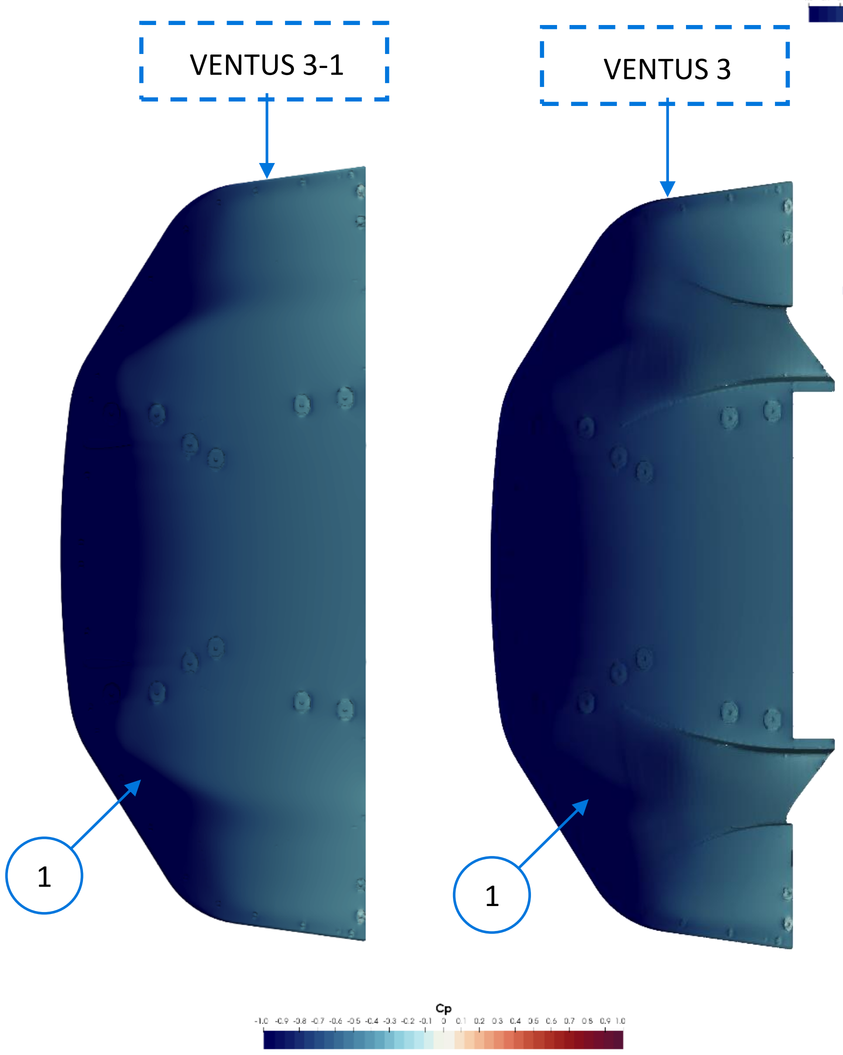


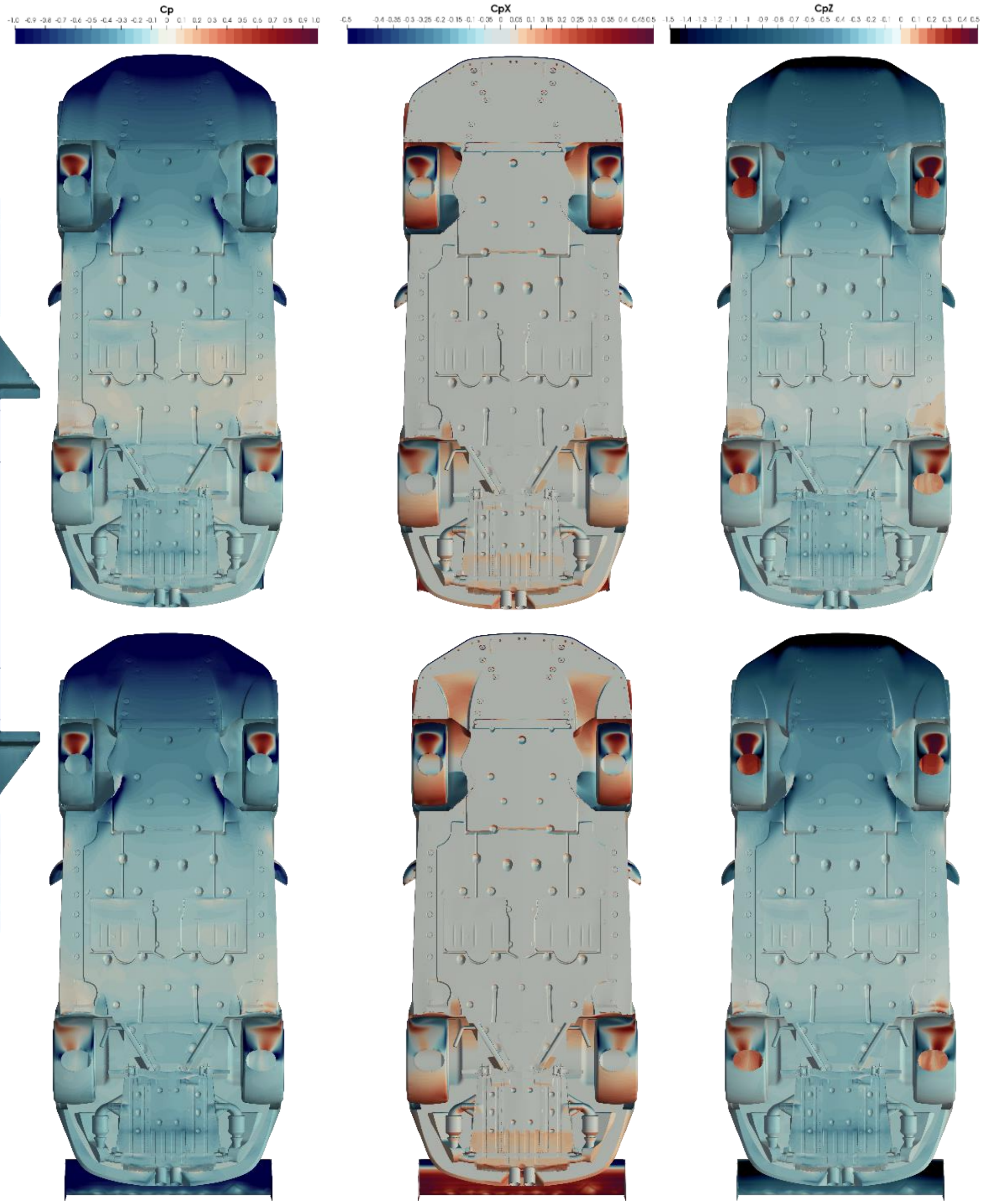
DIVE PLANE / CANARD DETAILS

1. The main way downforce is created with Verus Engineering Dive Planes / Canards is controlling airflow around the car. We use the dive planes to create a vortex which helps pull air out of the fender wells. This helps reduce lift on the body of the car. We have specific templates for the dive planes since location and placement are critical for maximum performance.

SPLITTER DETAILS

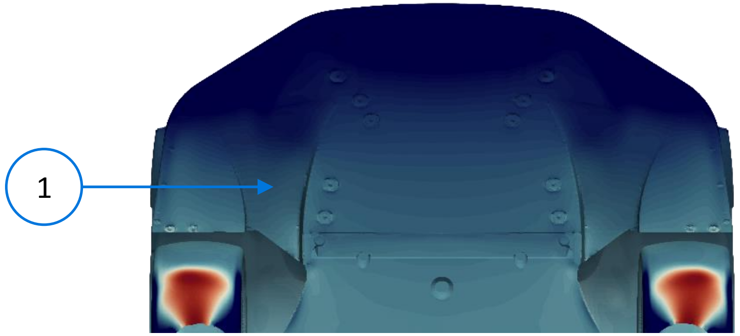
The Verus Engineering Front Splitter is ideal for increasing front-end downforce. The front splitter makes significant front downforce since it is using ground effects. The splitter comes with 2-options; flat panel or front diffusers. The flat panel is for the stock wing and the front diffusers is when the Verus Engineering Wing is applied to the GT3 RS. The full splitter assembly is simulated. The full splitter assembly has an efficiency [L/D] of 46 with the covers and 26 with front diffusers. Splitters are a very efficient downforce creating component for vehicles.



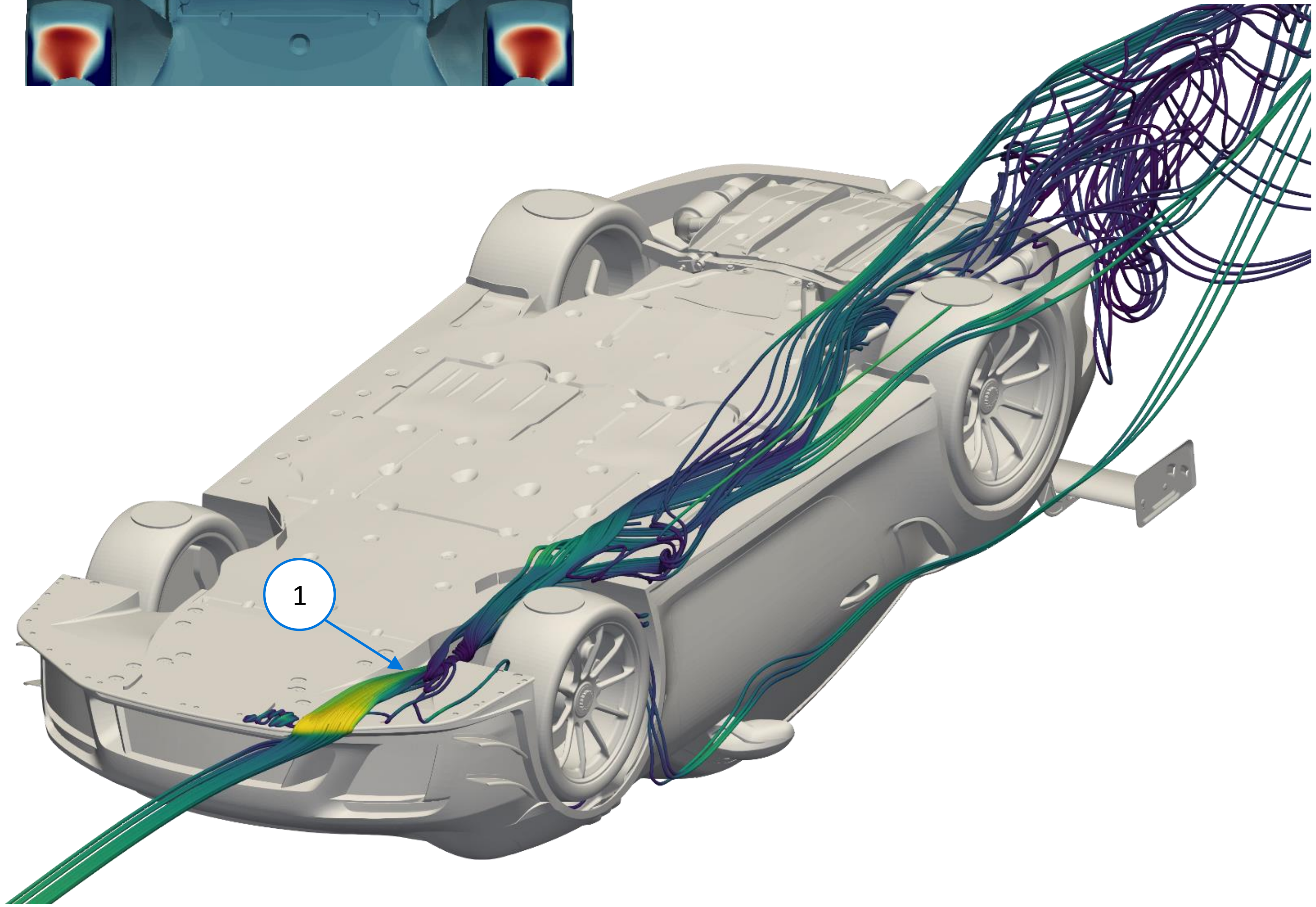


1. Peak low pressure region on splitter

SPLITTER DETAILS



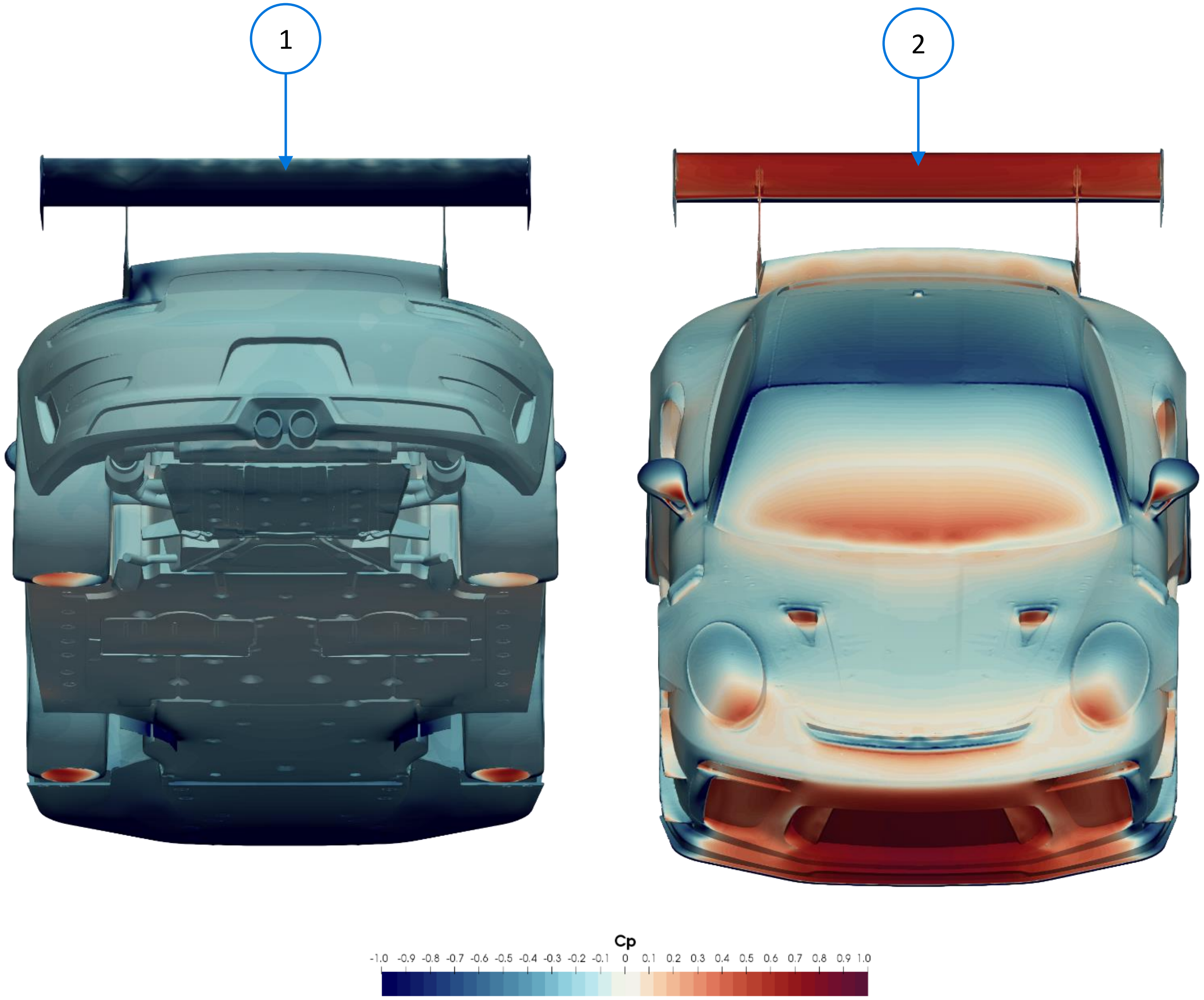
1. The front diffuser increases downforce significantly and allows more angle of attack on the wing to produce more downforce. The diffusers work by increasing the low pressure area on the front splitter.



REAR WING DETAILS

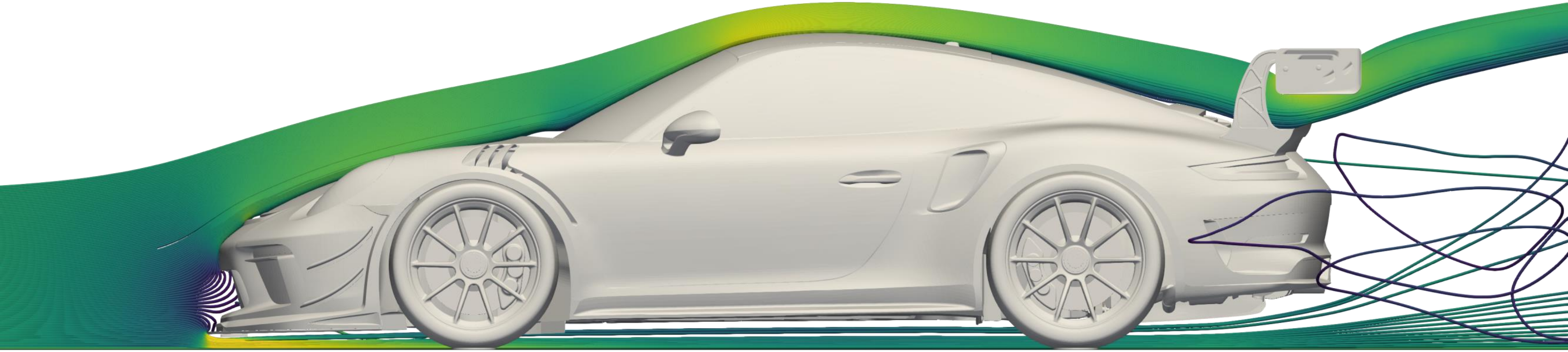
The Verus Engineering Rear Wing for the 991 GT3 RS utilizes our V1X airfoil, which was developed specifically for medium to high downforce levels. The profile was developed and maximized using optimization software and produces efficient downforce for rear wings.

1. The bottom surface is where nearly all the work is done for making downforce on the wing. It is low pressure which is pulling the rear of the vehicle down.
2. The top surface also creates downforce, just not as much. The Cp does not go above 0.6 compared to the bottom which is less than -1. In other words, the bottom side is working significantly harder than the top at producing downforce.



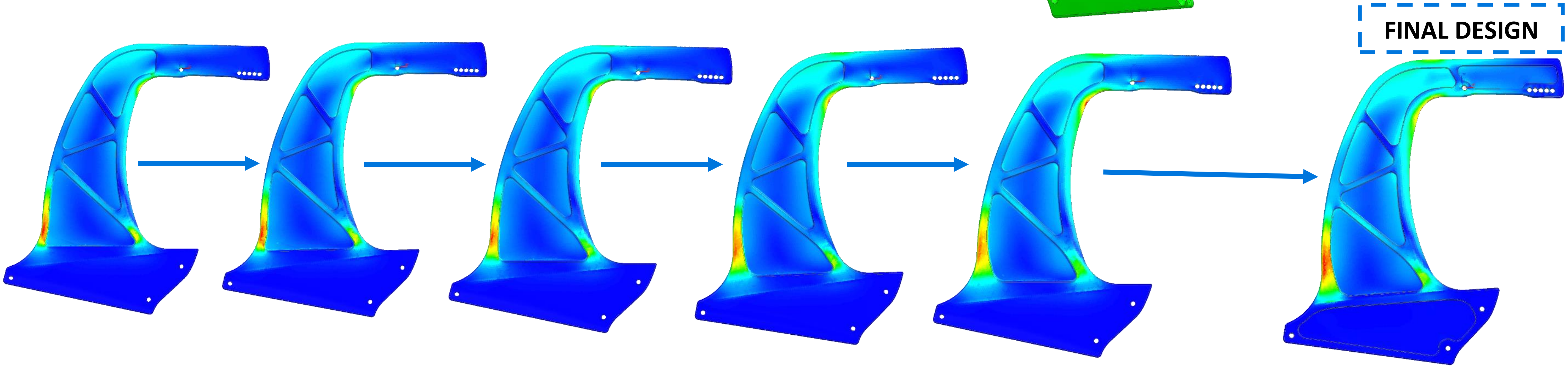
REAR WING DETAILS

The velocity on the bottom side of the wing is higher than the top side which causes the pressure differential between the top and bottom surfaces. The wing also changes the direction of the overall airflow on the rear of the car from aiming downward to straight rearward/slightly up. This is a positive change and signifies the rear wing is working well with the entire car's geometry.



REAR WING DETAILS

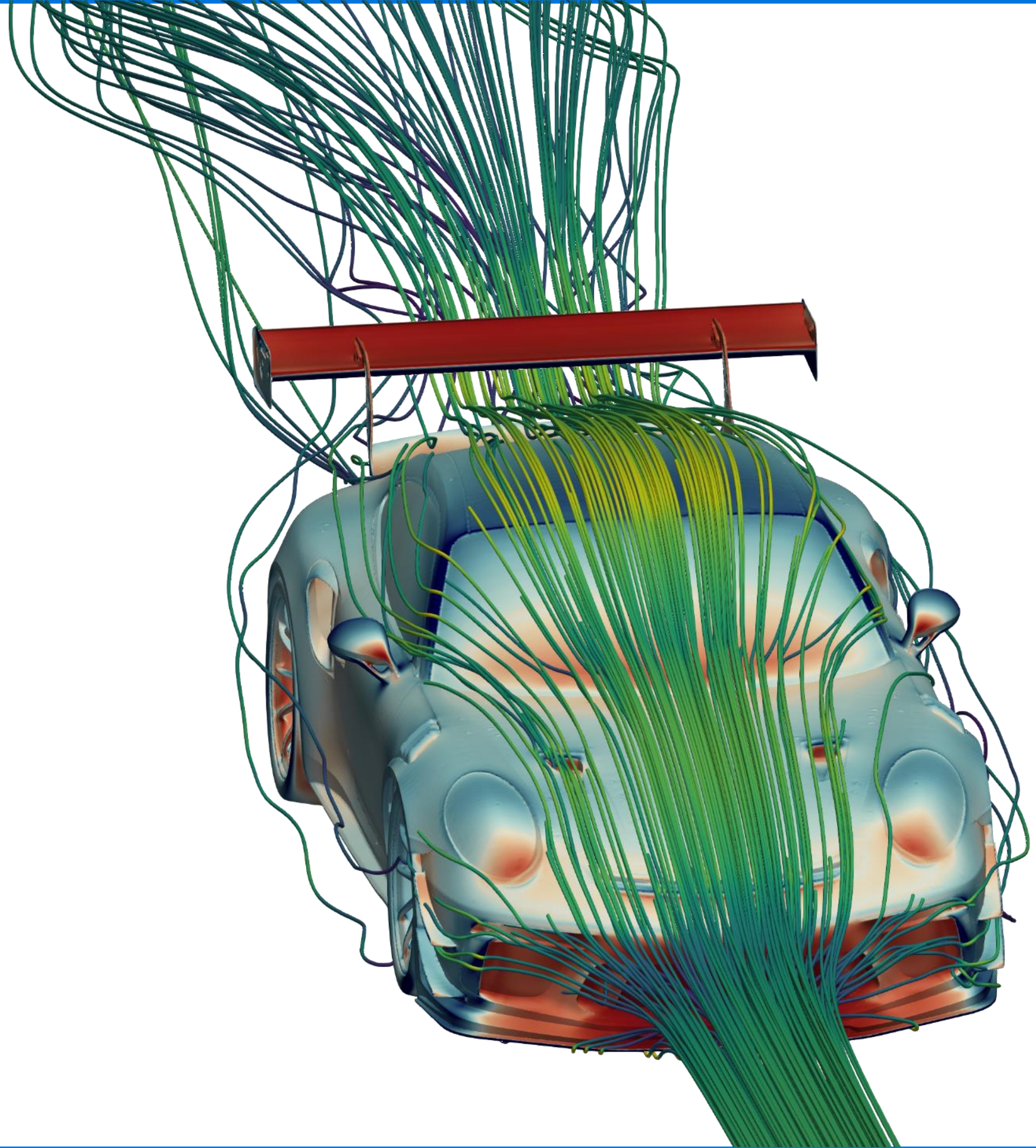
The uprights for the Porsche 991 GT3 RS were optimized using FEA for weight and strength. The shape was first optimized for aerodynamics with the leading edge radius and the rear edge is knifedged. The pockets decrease weight while keeping the upright strong enough to handle the V1X. The pockets do not hurt the aerodynamics.



SUMMARY

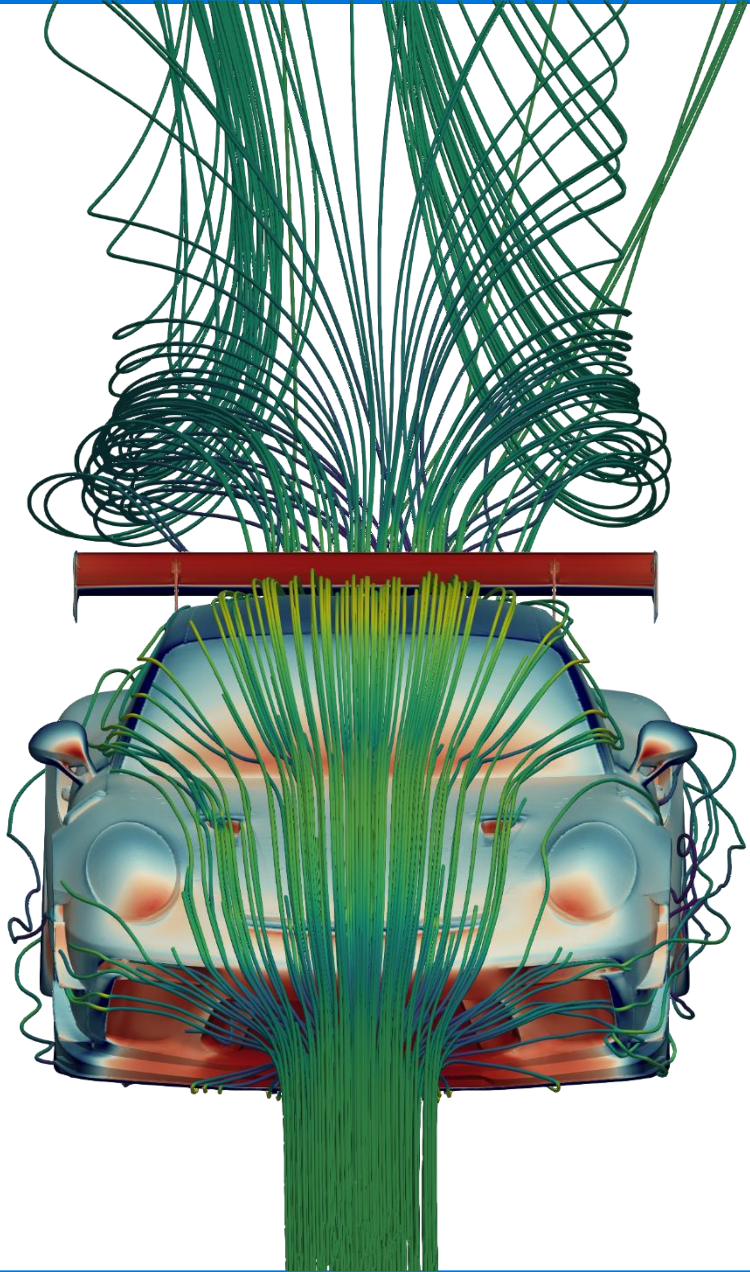
The Verus Engineering Ventus Packages for the 991 Porsche GT3 RS are designed to decrease lap times utilizing well developed and functional aerodynamic components. These packages are designed to fit like an OEM component and increase the factory performance **all while keeping the factory warranty.** The research and development of the package was done using cutting edge technology in CFD and proven designs from previous work.

The individual components do not need to be installed as a package, but that will give the best performance and likelihood for decreasing track times in a safe and predictable way.

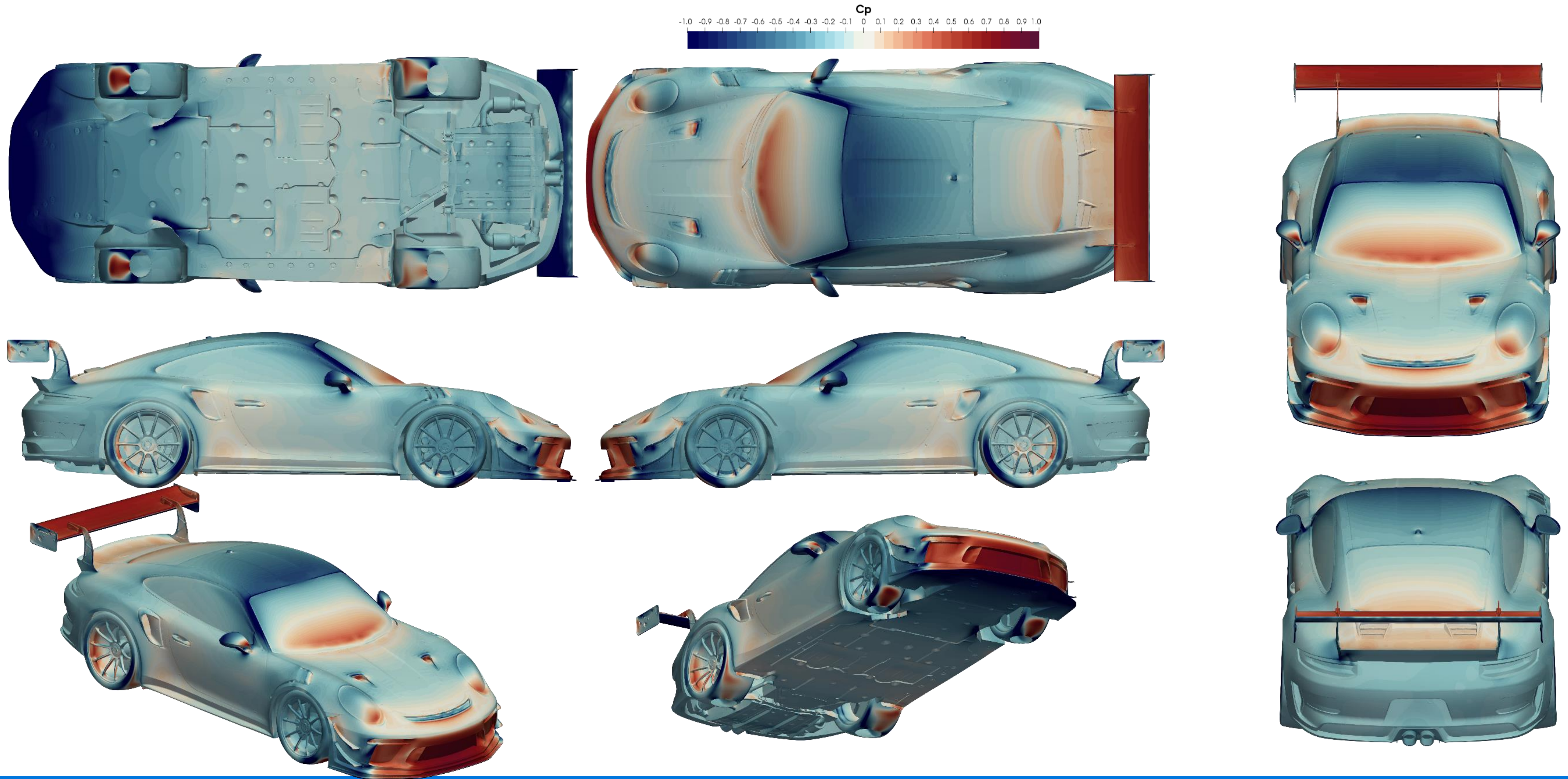


THE SCIENCE

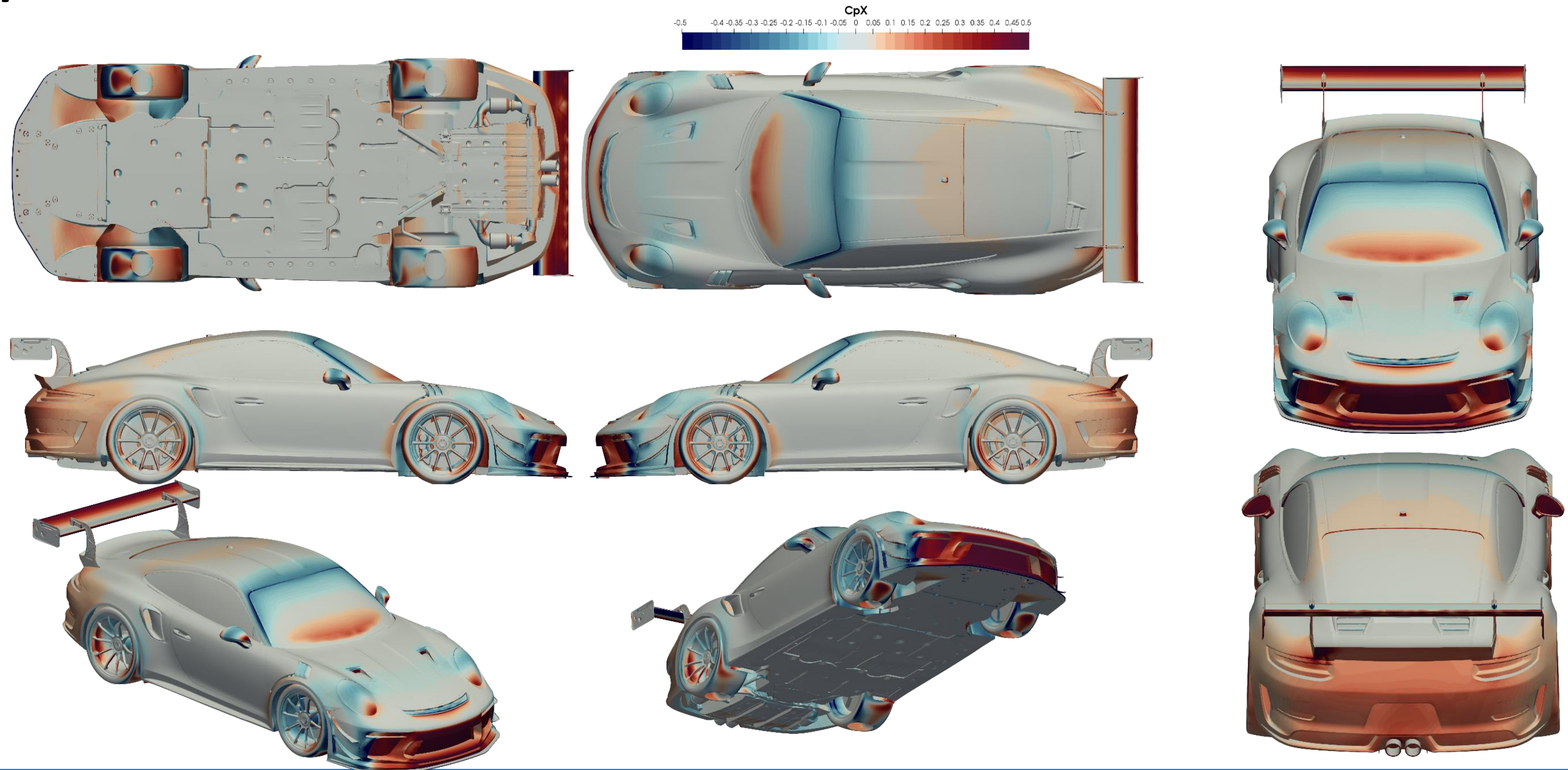
This analysis was done using OpenFOAM V6 which is a finite volume CFD software. The solver was SIMPLE and the turbulence model was K-Omega SST using standard wall conditions. We use standard automotive arrangement when setting up boundary conditions and running a full-car. The case was simulated using slight yawed airflow of 0.5 degrees. This yawed airflow is to ensure we are not analyzing a condition the car will almost never see which is perfectly straight airflow down the length of the car.



Cp PLOTS



CpX PLOTS


CpX
-0.5 -0.4 -0.35 -0.3 -0.25 -0.2 -0.15 -0.1 -0.05 0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5

CpZ PLOTS