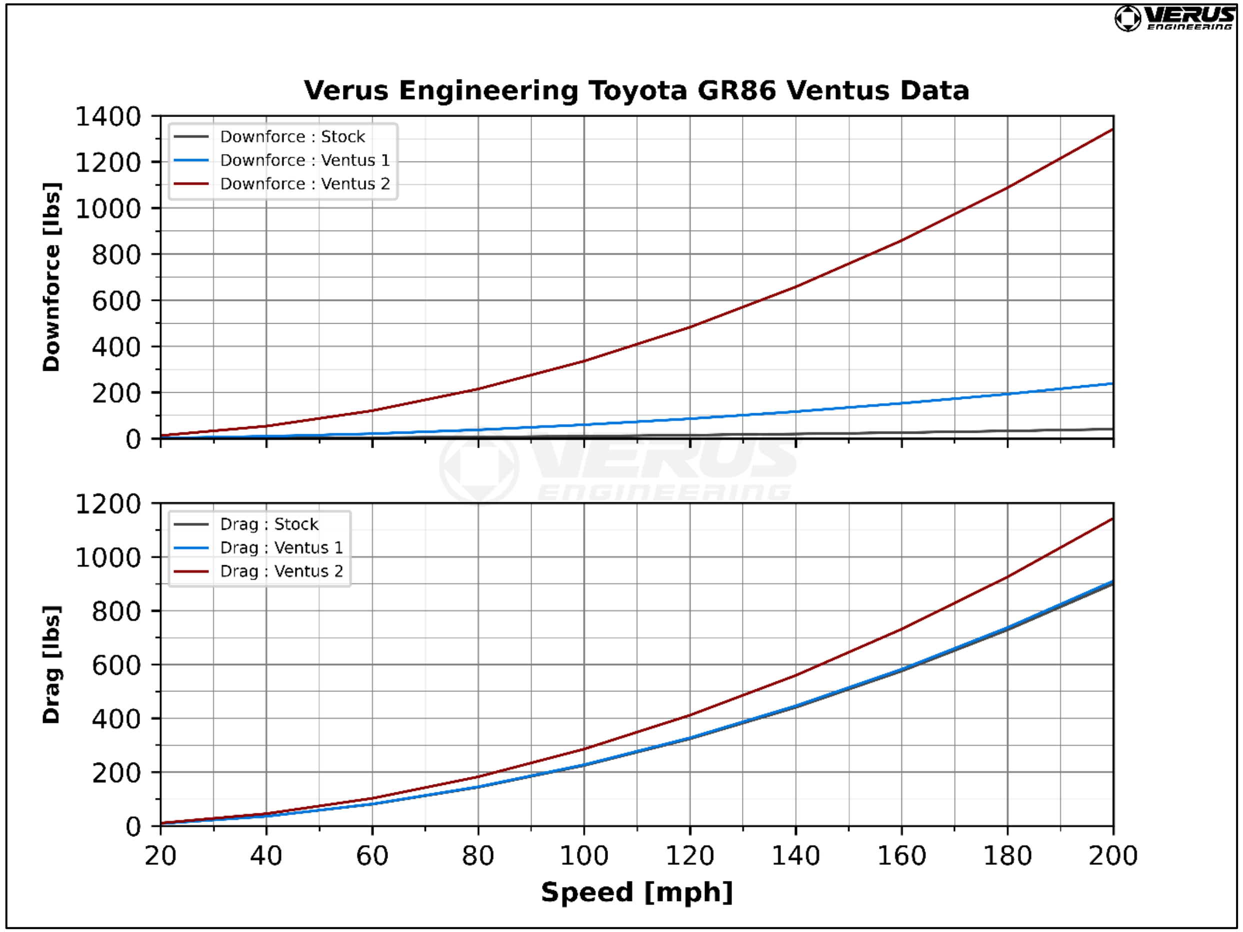
TOYOTA GR86

PERFORMANCE OF VERUS ENGINEERING VENTUS1 & 2 PACKAGES

SUMMARY : AERODYNAMIC FORCES

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

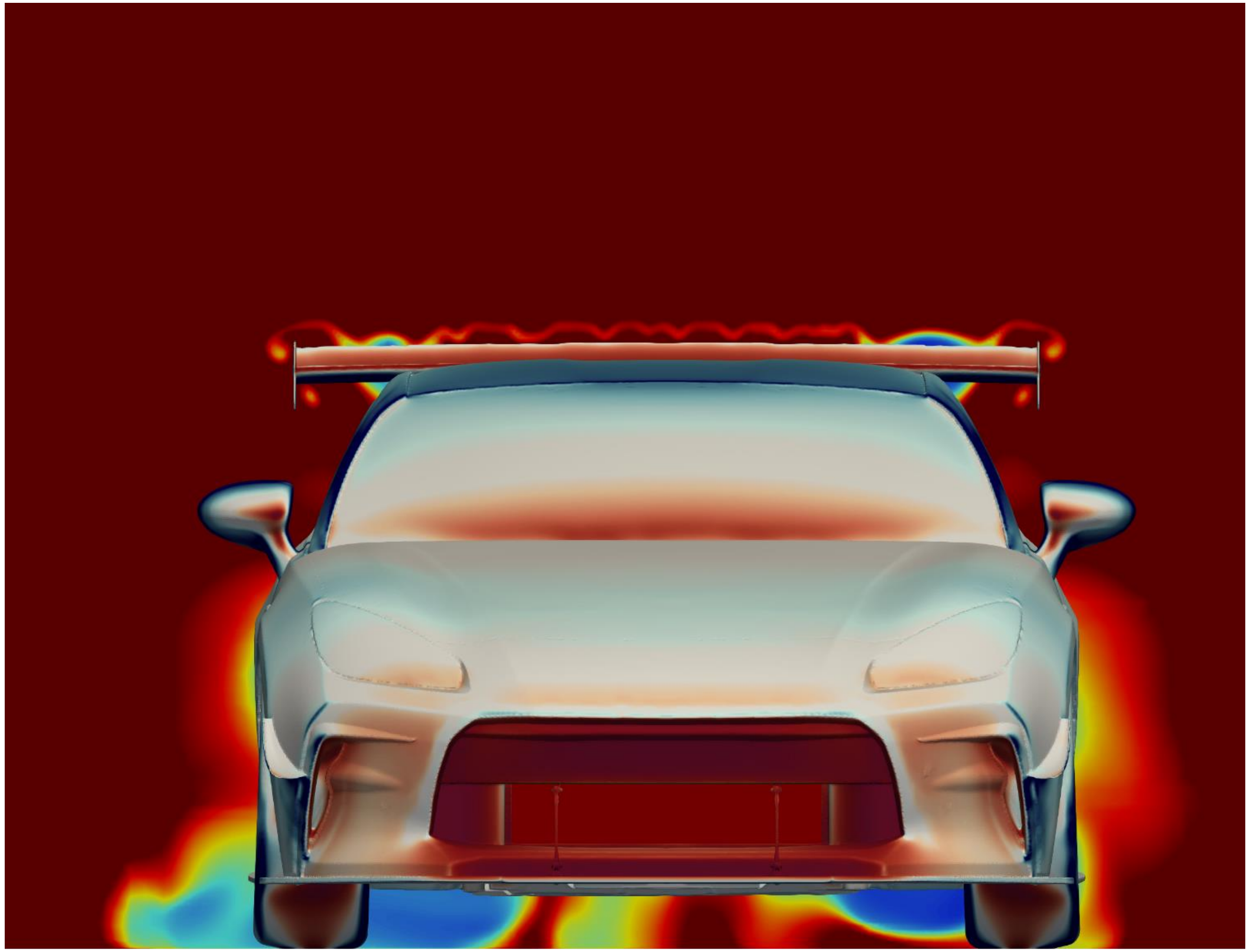
The Ventus 1 package increases downforce over stock with minimal changes to drag. The Ventus 2 package increases downforce significantly with a small bump in drag. The wing angle for the graphing on the Ventus 2 is 10 degrees AOA. The angle change for the rear wing helps dial in aerodynamic balance. This balance is critical for the car feel to maximize the driver's ability to improve lap times. This package is designed and tested to make your GR86 faster around the track.



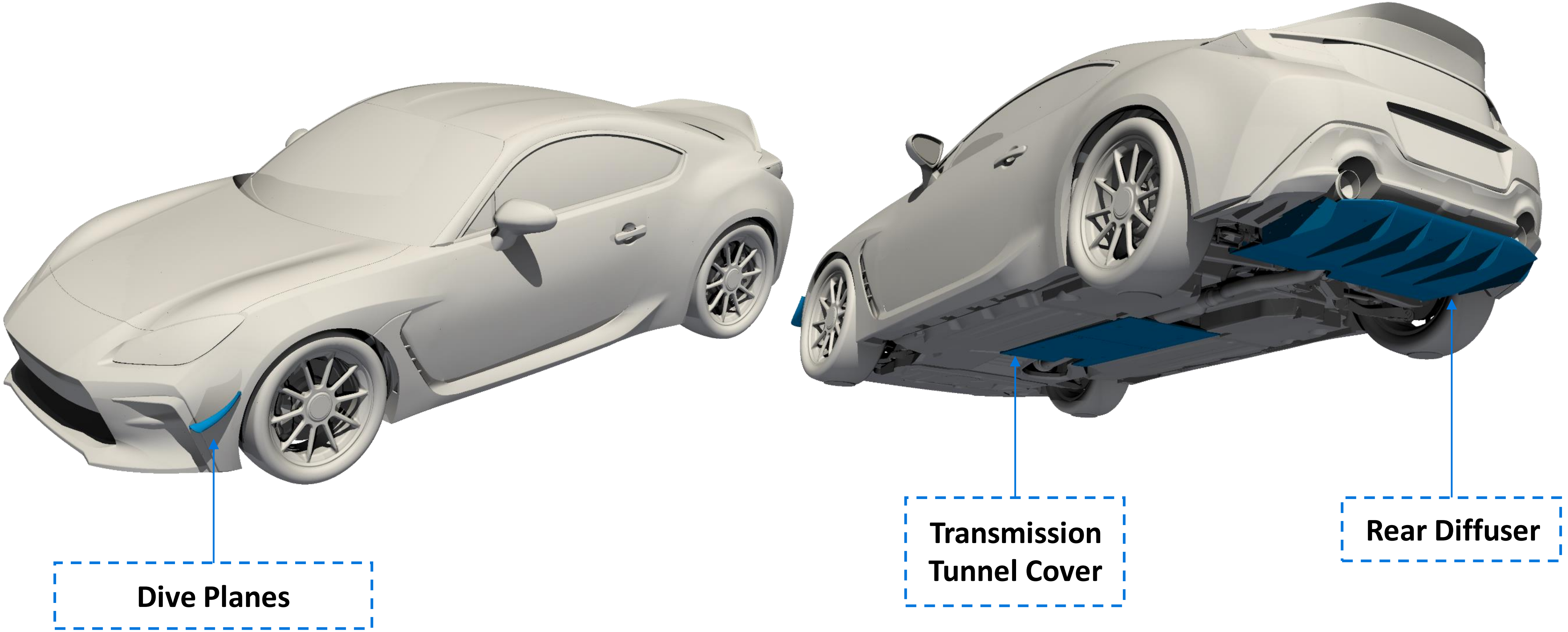
SUMMARY : GENERAL

The Verus Engineering Ventus 1 & 2 Packages for the Toyota GR86 are designed to decrease lap times utilizing well developed and functional aerodynamic components. These packages are designed to fit like OEM 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, wind tunnel testing, track testing with professional driver, and proven designs from previous work.

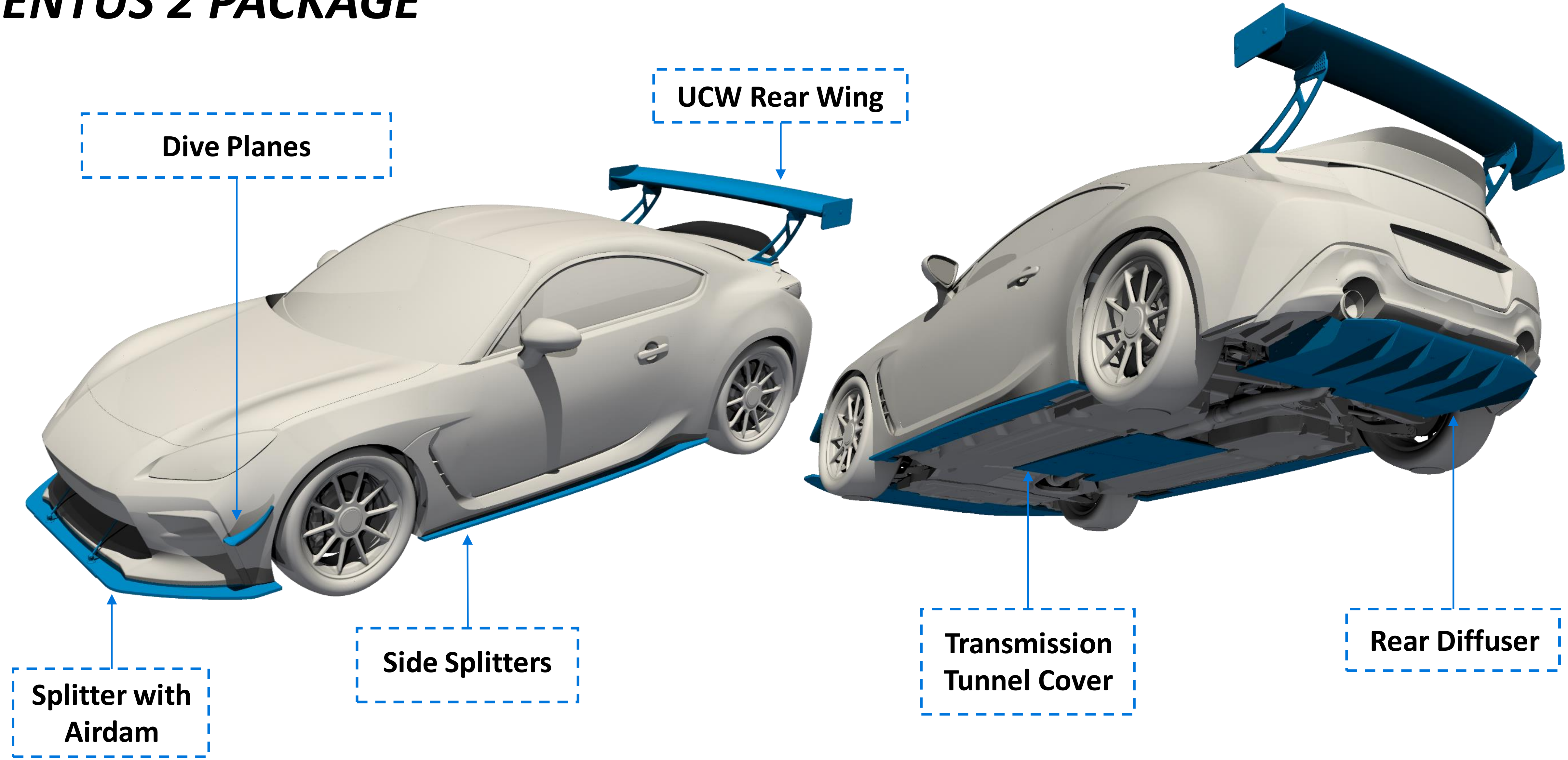
The individual components do not need to be installed as a package, but that will give the best performance for decreasing track times.



VENTUS 1 PACKAGE



VENTUS 2 PACKAGE



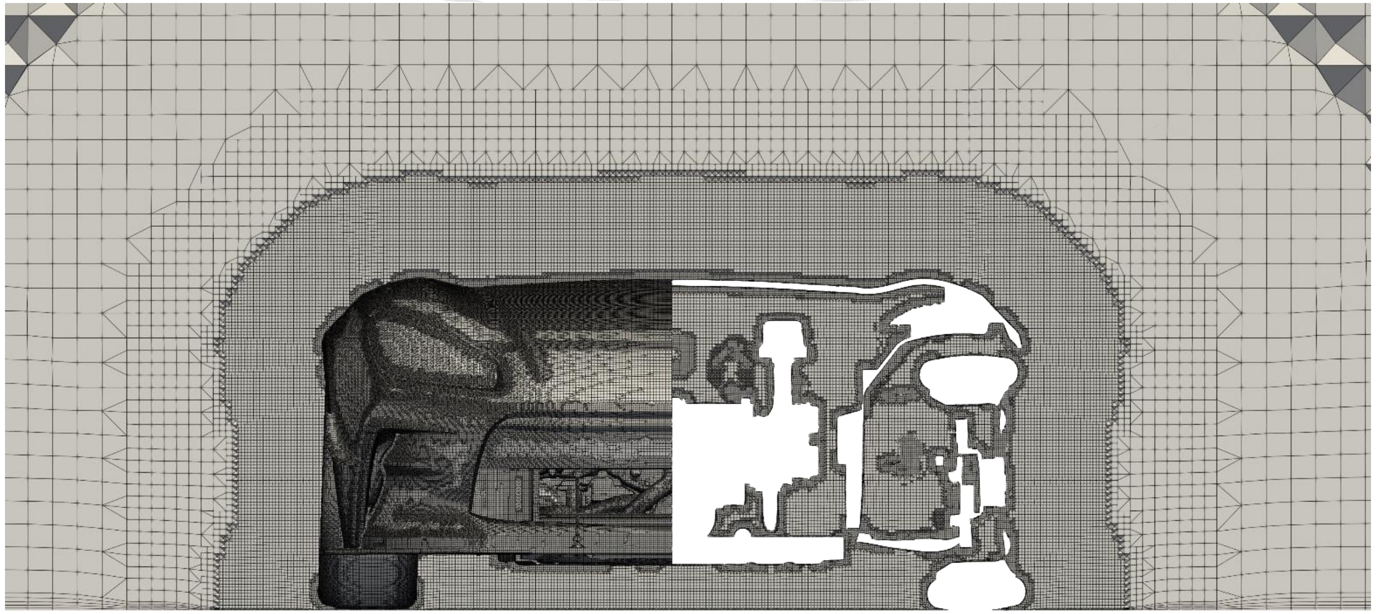
DEFINITIONS

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).

QUALITY OF CAD MODEL

It is common knowledge with any simulation that if you have bad information/data as the input, that bad results occur. This means the simulation is only as good as the geometry and settings used. The CAD model is a crucial aspect of the accuracy. The Toyota GR86 was scanned in-house and a CAD model was created. The image to the right shows the overlay of the CAD model to the scan. The scan is blue and the CAD of the body is in grey. As you can, the model is very accurate with the majority of the surfaces being less than 1mm off from actual. The heights deviation is 3.0mm and that is only in a few areas of simplification.

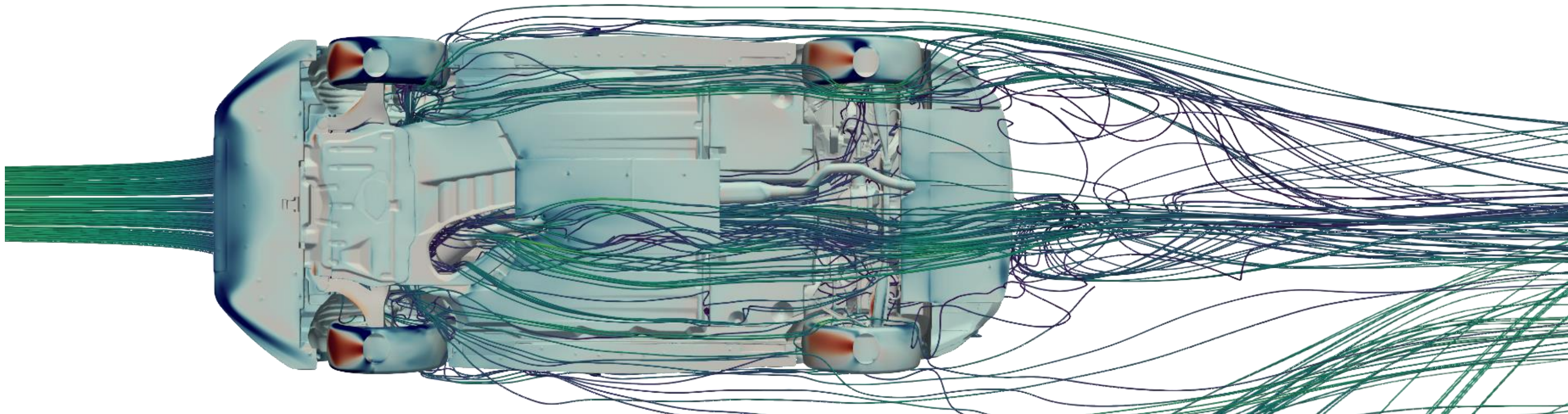
The engine bay was simplified but includes the main parts of the engine and rest of the drivetrain.



THE SCIENCE

The development was done using OpenFOAM v2106 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. Most of the cases simulated used a 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. Other ride heights and yaw rates were also used to simulate cornering.

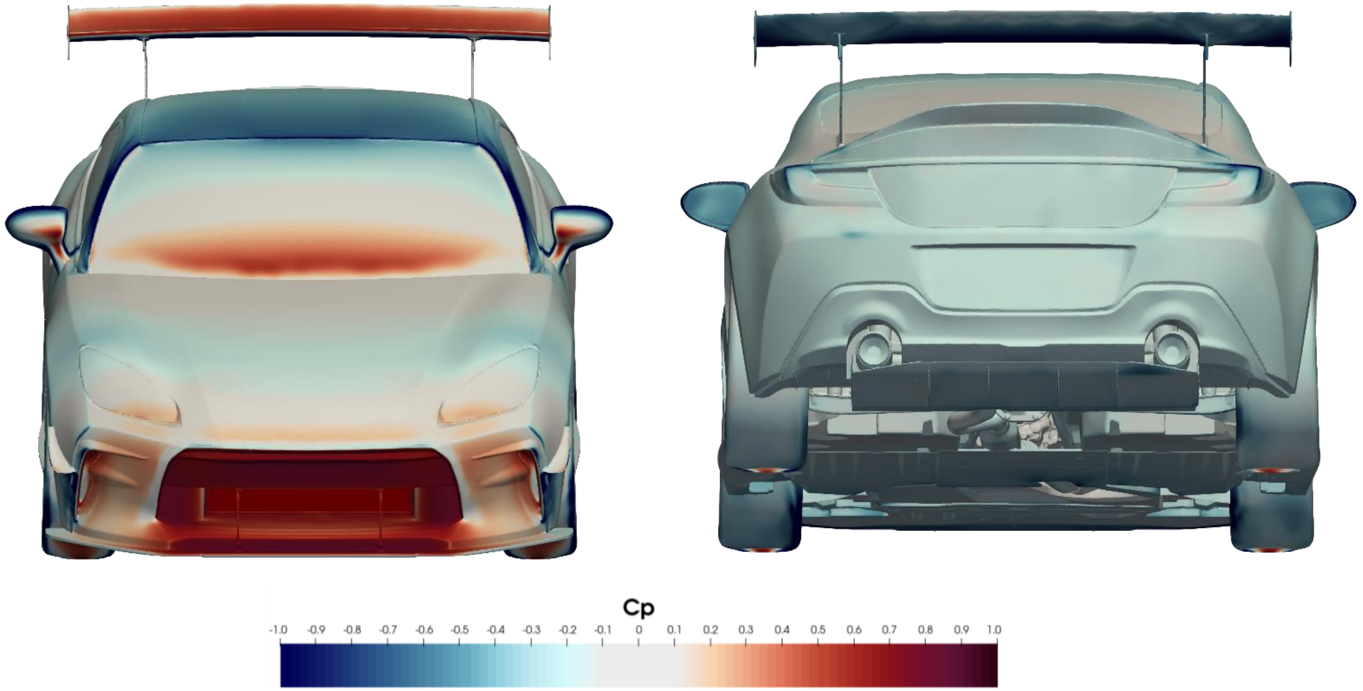
The use of porous flow was used for the front cooling stacks on the car. The darcy-forchheimer values used were based on past work of similar radiators/heat exchangers. The flow past the radiator went into a simplified engine bay.



REAR WING : UCW

The Verus Engineering rear wing for the Toyota GR86 in the Ventus 2 package is our UCW. The profile was developed in CFD and refined in the wind tunnel. This allowed it to produce efficient downforce as a 3D profile on multiple chassis platforms.

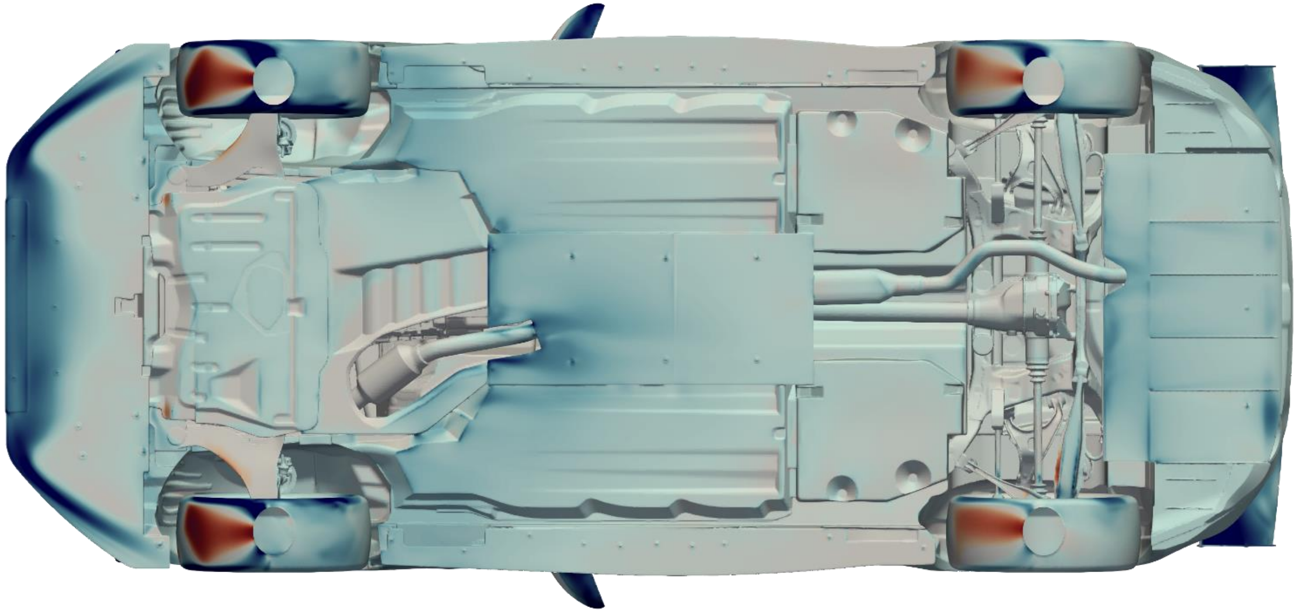
- The bottom surface is where most of the work is done for making downforce. The bottom surface is the surface with the low pressure that helps pull the car downward
- The top surface also creates downforce, just less than the bottom surface which is standard. The Cp on the top does not go above 0.7 while the bottom surface goes below -1. In other words, the bottom surface is working harder than the top.

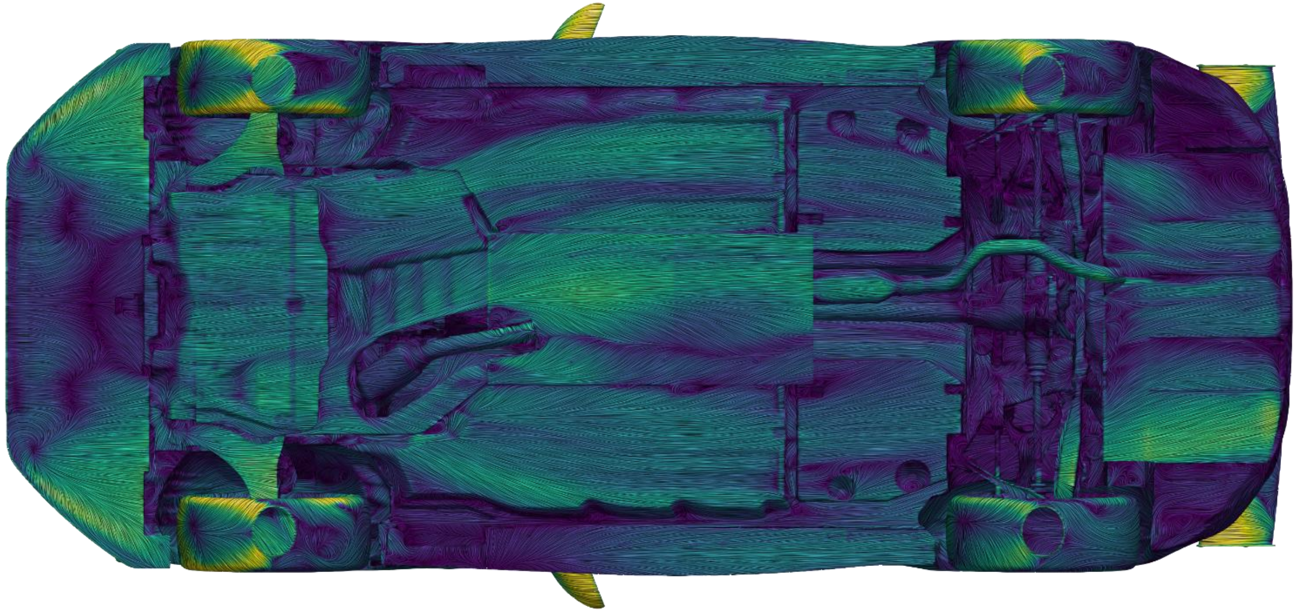


SPLITTER

The Verus Engineering Front Splitter is ideal for increasing front-end downforce. While the splitter is a flat component, it makes significant front downforce since it is using ground effects. The full splitter assembly is simulated. The full splitter assembly has an efficiency [L/D] of 17. Splitters are a very efficient downforce creating component for vehicles.

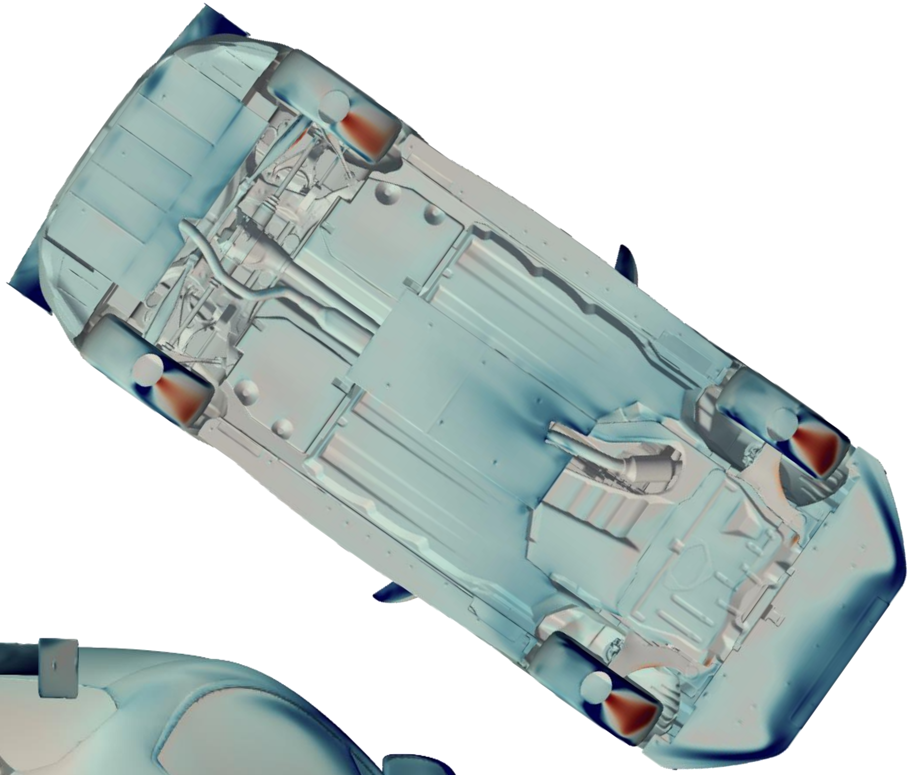
- High pressure on the top side is similar to a wing. It makes downforce, but not like the bottom side.
- The bottom is designed to make most of the downforce and help feed to the rest of the floor which is pretty flat.

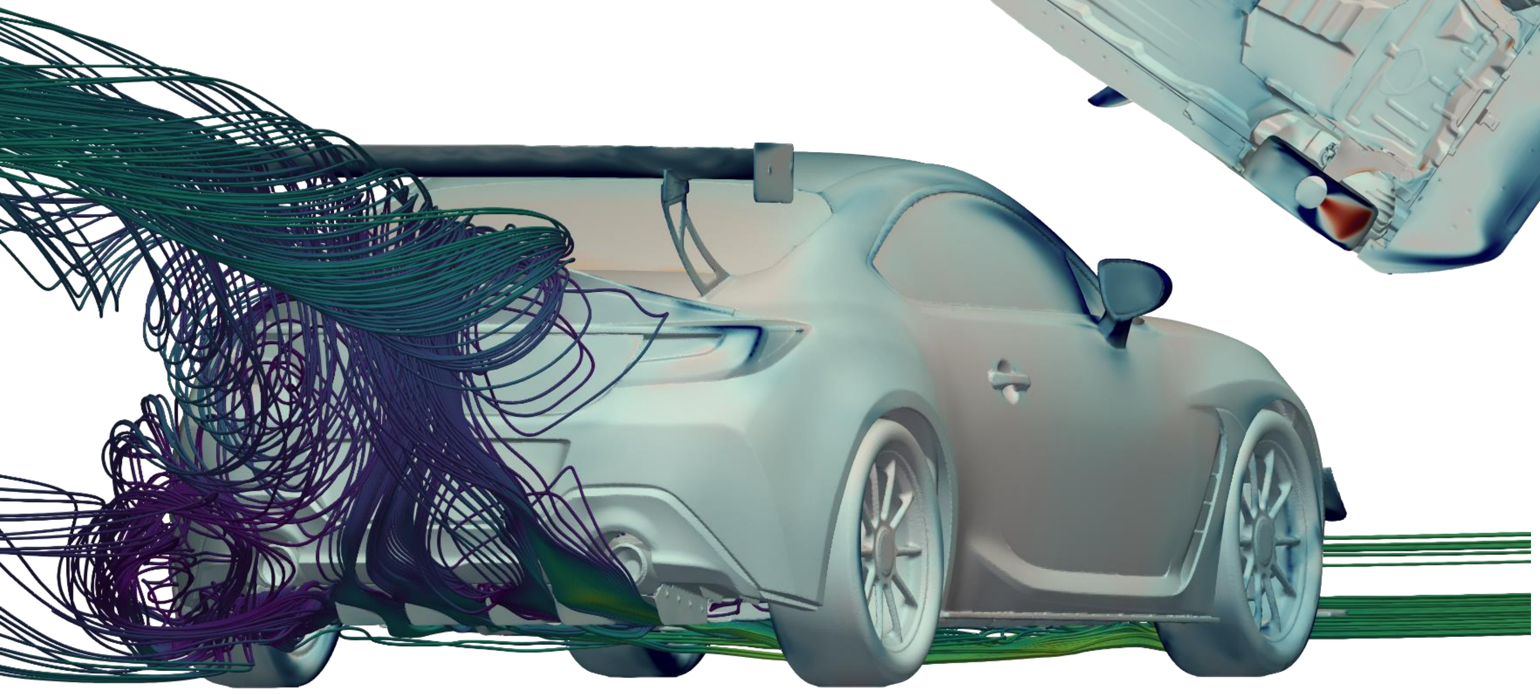




REAR DIFFUSER

The Verus Engineering Rear Diffuser is a key component in creating efficient downforce. Adding a rear diffuser is perfect for a street car since it will add downforce (stability) and reduce overall car drag when designed properly.





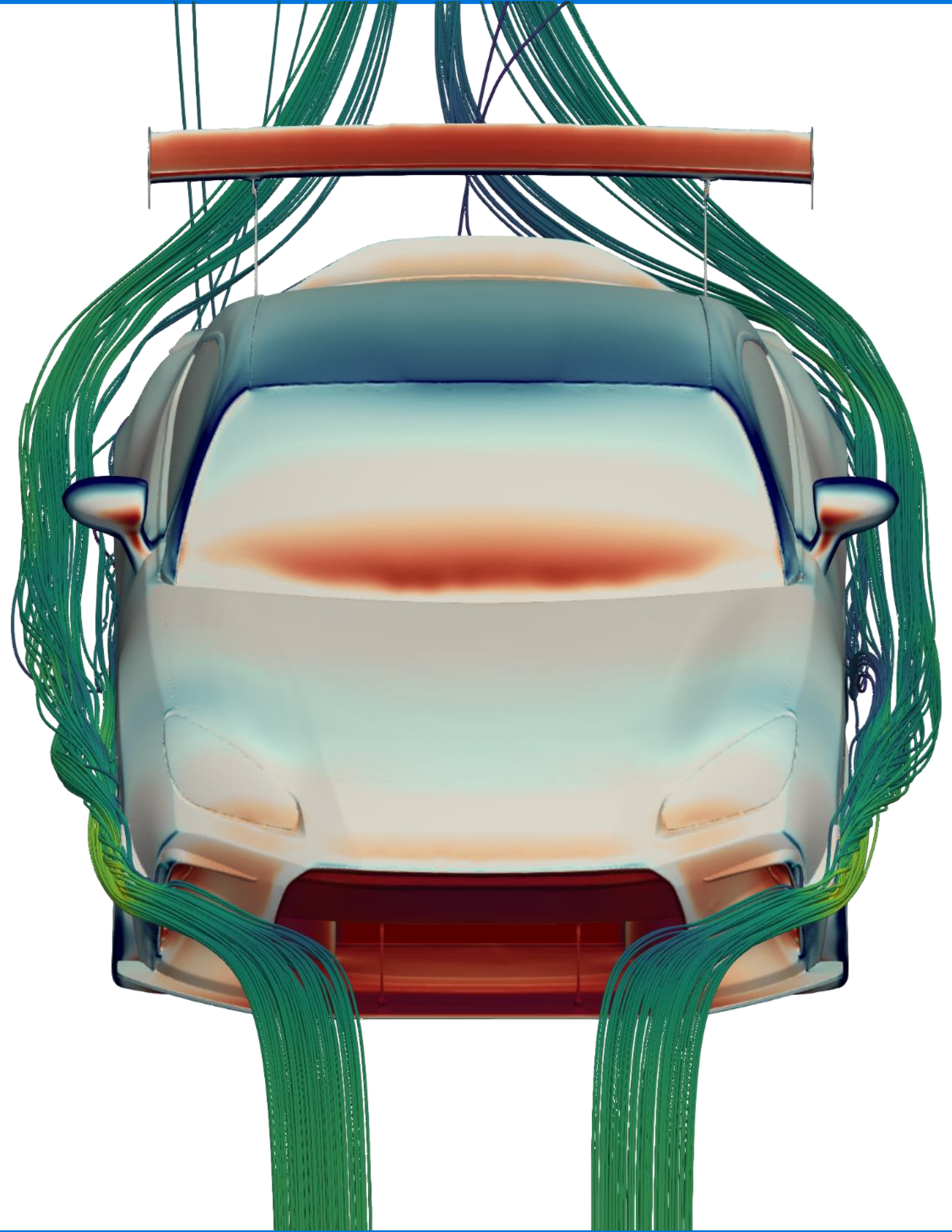
A large portion of the drag on a normal road vehicle, like the GR86 Platform, is from pressure drag. Pressure drag is caused by the low pressure region behind the vehicle which wants to pull the car rearward. This low pressure region behind the vehicle is called the wake region.

Knowing this information and with proper R&D we can increase downforce and reduce drag with the rear diffuser. The Verus Engineering Rear Diffuser specifically targets the wake region and helps fill this region with air from under the vehicle. Filling this wake region reduces overall drag on the car.

DIVE PLANES / CANARDS

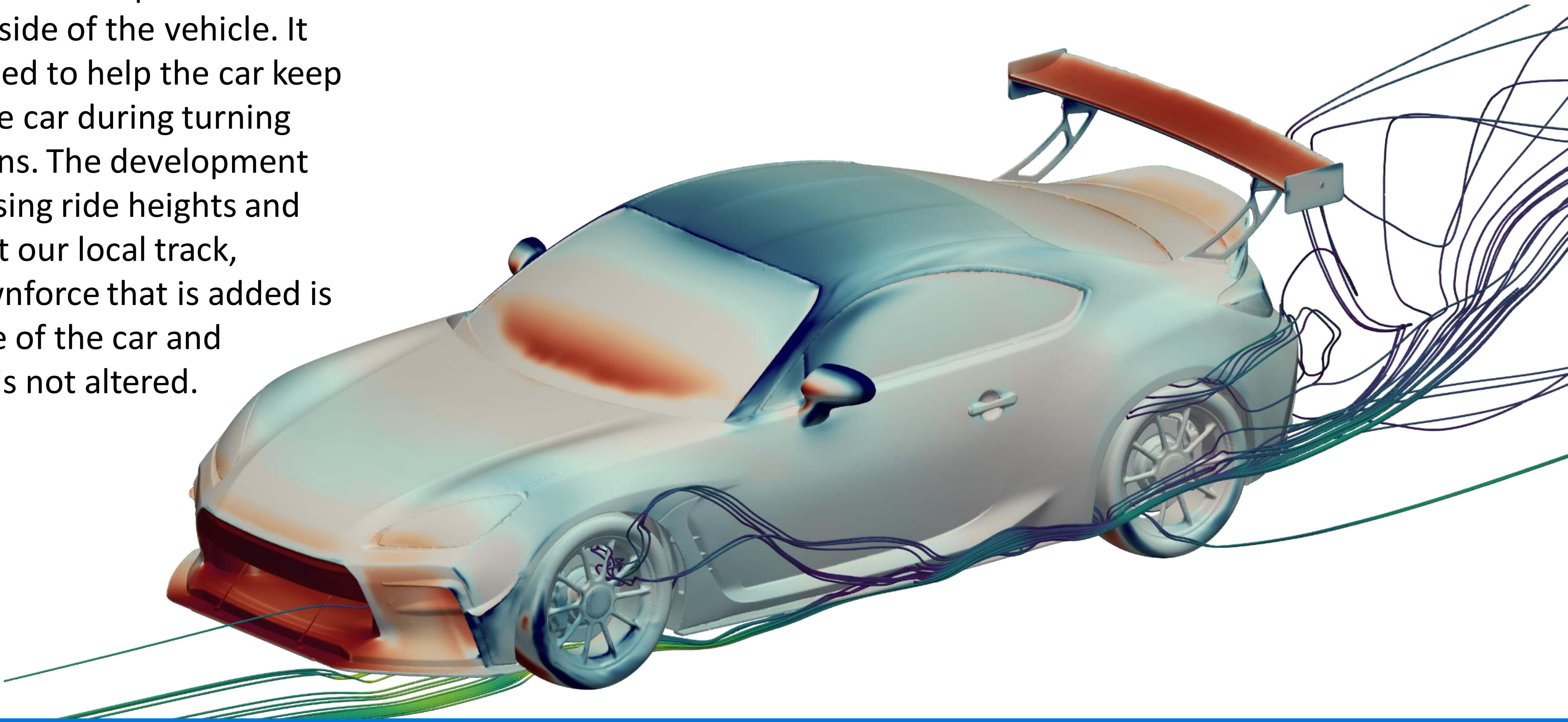
Dive planes can serve a variety of purposes. While most people believe dive planes produce downforce by the airflow on the units themselves; Verus Engineering does significantly more with the development of the dive planes to increase the effectiveness.

- 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. However, this is not the full story.
- The main way downforce is created with dive planes 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.



SIDE SPLITTERS

The Verus Engineering Side Splitters reduce the amount of flow from the top side of the vehicle to the bottom side of the vehicle. It was specifically designed to help the car keep clean airflow under the car during turning and high yaw conditions. The development on these were done using ride heights and steering angles used at our local track, Putnam Park. The downforce that is added is centered in the middle of the car and aerodynamic balance is not altered.



TRANSMISSION COVER

The Verus Engineering Transmission Tunnel Cover reduces the vehicle's drag. The 2 panels reduce drag by decreasing the dirty air under the car and closing up large openings. These underbody panels reduce the vehicle's coefficient of drag (Cd) by 8 points. The panels also increase downforce by utilizing air coming from the engine bay and feeding out and over the panels. These panels also help clean up the air from the engine bay as it makes its way to the rear diffuser.