



Analysis of the Eternaus Explorer Hydrogen Airship: Analytical and CFD Investigation at Sea-Level Conditions

Hans G. Kraus

Innovair Creation, Development & Operation of Special Aircraft

Felipe J. da Costa

BRENG Engineering and Technology

AVIATION, 8-12 June 2026

Copyright © by Hans G. Kraus/*Innovair Creation, Development & Operation of Special Aircraft*.
Published by the American Institute of Aeronautics and Astronautics, Inc., with permission.

The fourth generation of airships — the Super Rigid Airships.

GREETINGS

Good morning, distinguished colleagues, professors, researchers, engineers, students, and industry leaders.

We are here today to talk about something that does not belong to the past... and does not yet belong to the present.

My name is Hans Georg Kraus, and for more than two decades I have dedicated my life to reviving — and reinventing — a technology that should never have been abandoned.

1st airplane worked together with LTA N. 14 (14-BIS) -1906



The fourth generation of airships — the Super Rigid Airships.

Today, I want to open your eyes to a new aerospace architecture: the fourth generation of airships — the Super Rigid Airships.

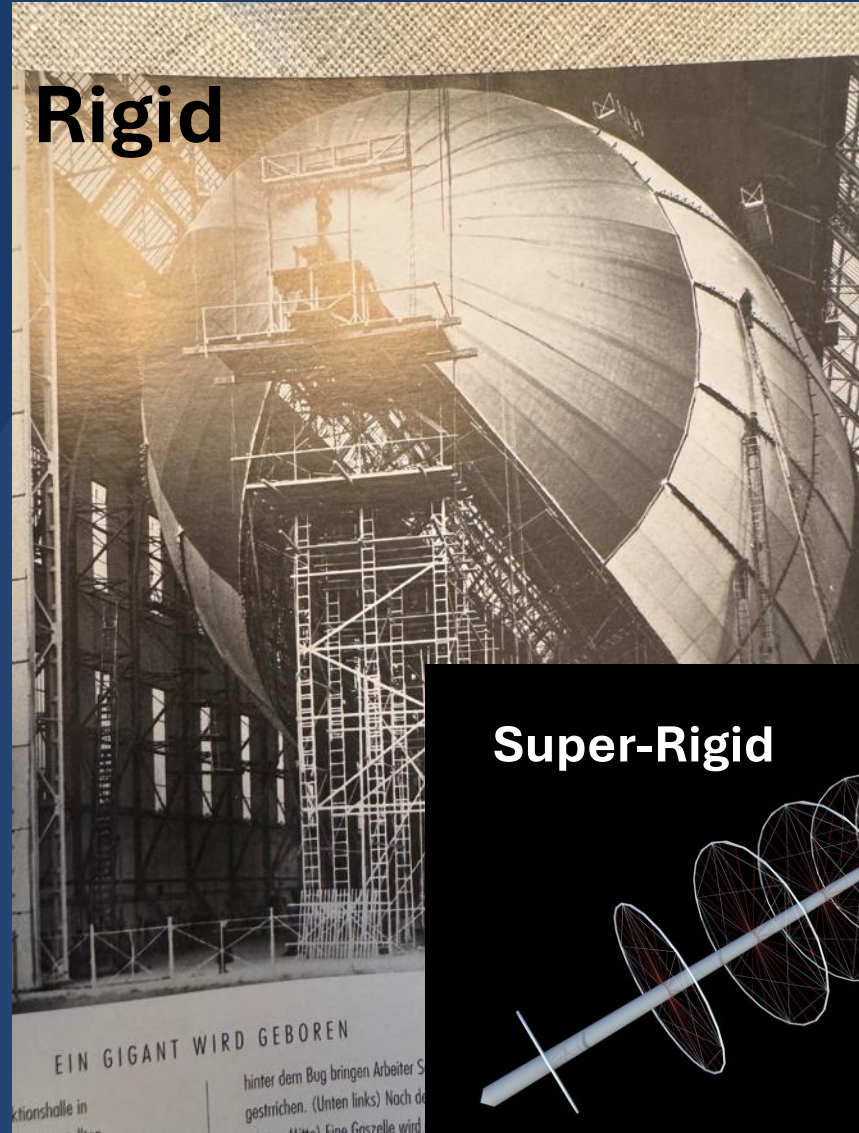
For many, the story of the dirigibles ended in 1937. But I ask you: should the Hindenburg incident have eliminated an entire class of aircraft?

Our atmosphere is an immense navigable ocean... and we simply stopped exploring it.

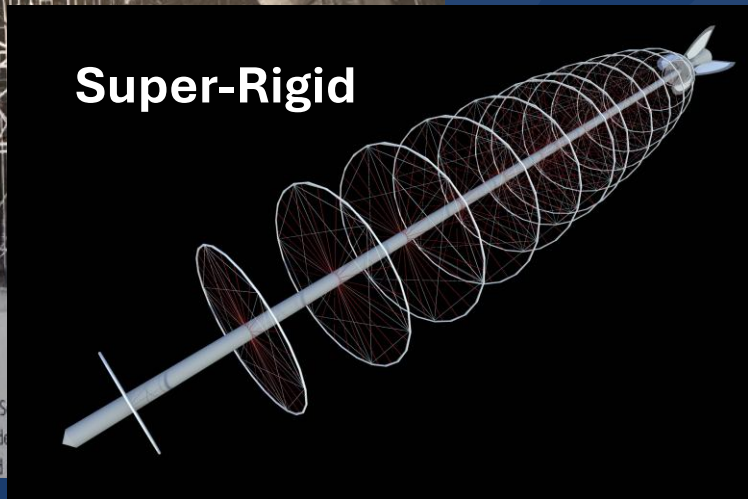
Why do we accept that only rockets and hypersonic aircraft represent the future... while a colossal potential floats above us, ignored?

What I bring to you today is not a blimp... not a semirigid... not a hybrid... and not a balloon.

Rigid



Super-Rigid



The fourth generation of airships — the Super Rigid Airships.

It is a symbiosis — a fusion of airplanes, helicopters, drones, and airships. A new category of aircraft that combines the best of each world.

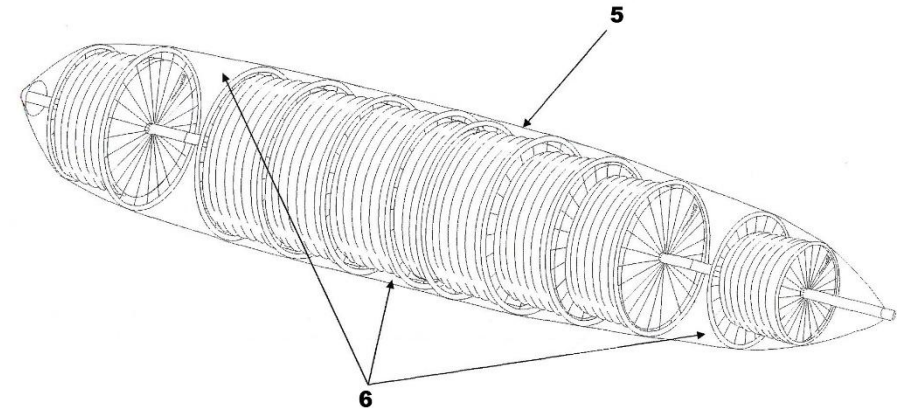
The result is the most secure, most versatile, most economical, and most environmentally efficient flying machine ever conceived.

The foundation of this new architecture is the principle of **Bidirectional Prestressing**. Here, pressure is not just lift — **pressure becomes structure**.

This creates an aircraft that does not bend... does not deform... does not collapse... does not fatigue... even under extreme weather conditions.

It is the evolution from rigid... to **super-rigid**.

FIGURA 4

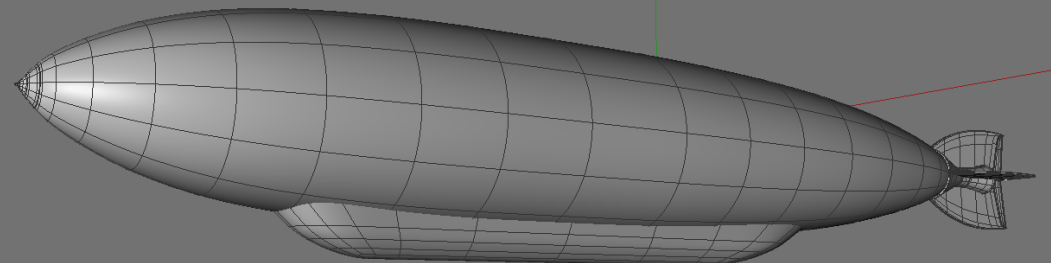


5 - Aussenhülle- (Aluminium + CFK)

Kann bei einem internen Überdruck von 420 mmWS, 420 kg/m²

Aussen Last ohne Deformationen Aushalten, dass heisst eine Windgeschwindigkeit bis 294 km/St.

6- Eine Mischung von Helium und Halon in den Zwischenräumen sorgt für die Sicherheit und Unbrennbarkeit der Wasserstoff Balonen (Ca 5-10 % vom gesamt Volumen des Luftschiffes)



The fourth generation of airships — the Super Rigid Airships.

Eternaus is Years ahead of any current LTA

The project is being conducted with aerospace rigor

This project was not born in isolation.

In 1999, I visited Dr. Klaus Hagenlocher, the engineer behind the Zeppelin NT60. He provided me with valuable technical insights and original information about the Hindenburg — data that became the foundation of my development.



The fourth generation of airships — the Super Rigid Airships.

Years later, in 2006, when I presented the completed concept, he told me it was the best airship project he had ever seen.

The Eternaus architecture therefore carries the technological lineage of the largest and most impressive transport vehicle ever built and operated: **the Hindenburg.**

Yet, for decades, universities and aerospace institutions have treated LTA technology as something from the past. But the Super-Rigid architecture demands to be studied, taught, and developed.

When we unite modern aeronautical engineering with aerostatic potential, we create something far greater than either field alone.

It is time for academia — and industry — to revisit this domain with scientific rigor and open minds.



The fourth generation of airships — the Super Rigid Airships.

The Explorer 16.9/100 H₂ — The First Demonstrator

And so, today, I present to you the Eternaus Super-Rigid Aerostatic Architecture — and its first demonstrator: **the Explorer 16.9/100 H₂**.

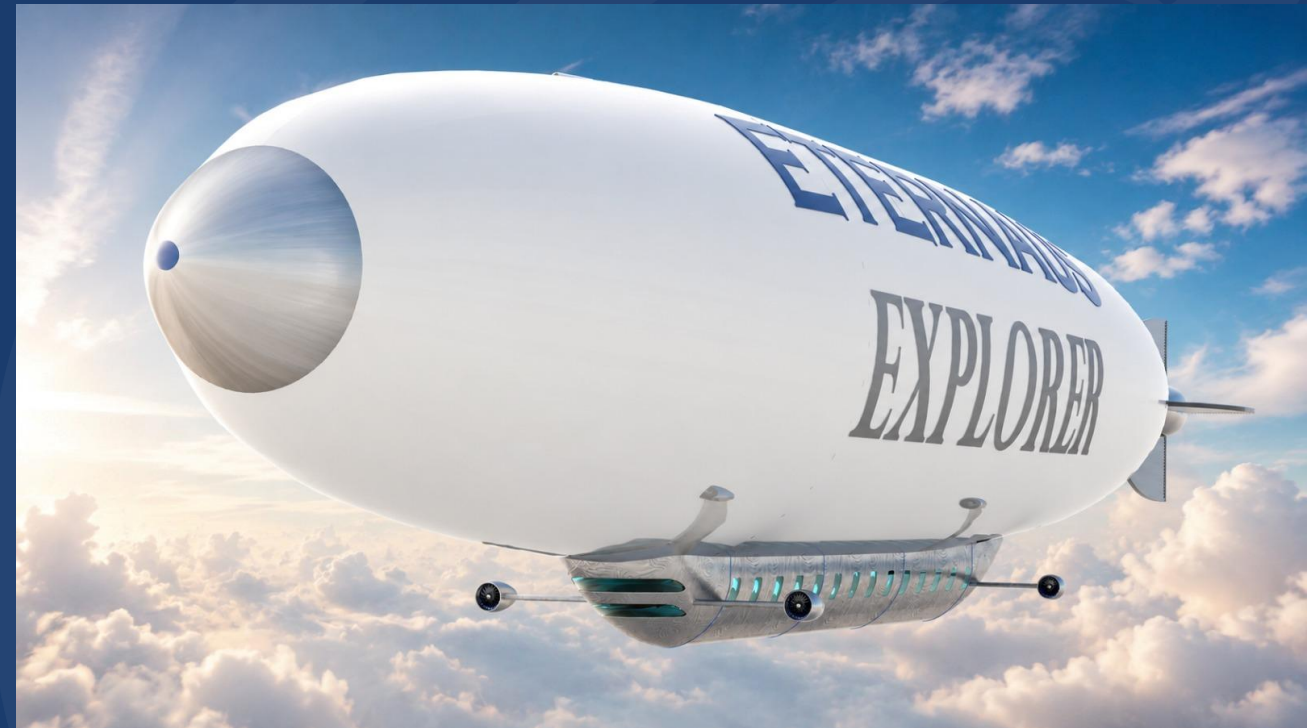
The Explorer introduces a new chapter in atmospheric mobility: *a 100-meter flying yacht that merges the elegance of a superyacht, the autonomy of a long-range aircraft, and the sustainability of next-generation clean aviation.*

100 meters long

16.9 meters in diameter

15,567 m³ of displacement

But numbers alone do not define it.



The fourth generation of airships — the Super Rigid Airships.

What defines it is this:

“More than an aircraft, the Explorer is a stabilized airborne environment — capable of hovering at 70 meters and lowering occupants or cargo through elevators or dynamically stabilized capsules.”

This is not aviation. This is **atmospheric infrastructure independence.**

Aviation has always sought the sky. Eternaus seeks the entire planet.

The Explorer is the world's first pressurized super rigid airship with modern numerical validation

To explore the full architecture, the technical foundations, and the future applications, I invite you to visit: www.eternaus.com



The fourth generation of airships — the Super Rigid Airships.

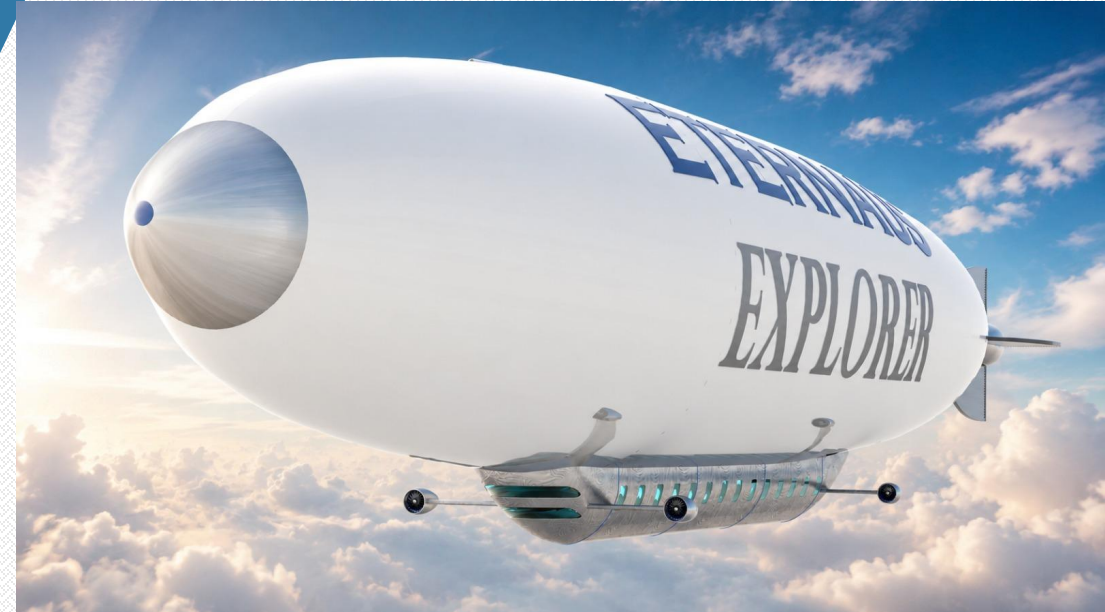
“And now, to present the scientific validation of this architecture — the results of the 2D and 3D CFD studies conducted in ANSYS Fluent 2025 R2 — I would like to invite Engineer Dr. Felipe. He will show, in a clear and technical way, how the Explorer behaves aerodynamically and why we can state that this is a numerically validated project.”

(Felipe presents.)

“Thank you, Felipe. With this scientific validation presented, we can now look at the real-world impact of this architecture. I will now display the Explorer’s applications panel — where it becomes clear how this technology can transform logistics, tourism, humanitarian operations, offshore activities, environmental monitoring, scientific research, and remote access. This is the moment where engineering meets practical utility.”



CFD Analysis

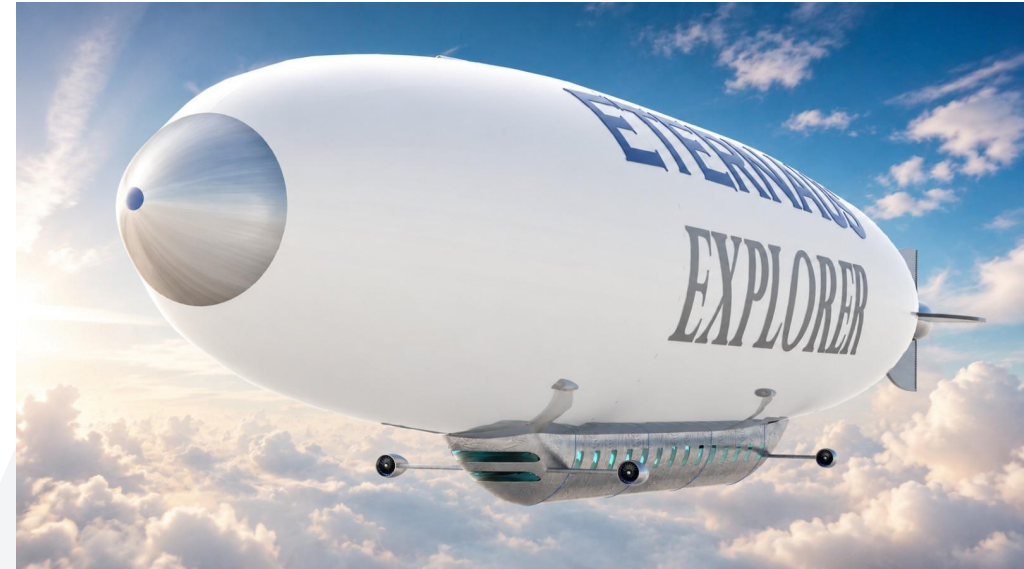


Eternaus Explorer



Explorer Parameters

Parameter	Symbol	Value
Total length	L	100 m
Max diameter	D	16.9 m
Surface area	S	4,330 m ²
Hull material	—	Al-2090-T83 sheet
Skin thickness	e	0.4 mm
Operational speed	V	58 m/s ($\approx$ 210 km/h max) / 39 m/s ($\approx$ 140 km/h max)
Gas	—	Hydrogen (internal), Air (external flow)
Pressure differential	Po	420 mmH ₂ O
Altitude	h	0 m (sea level)



Eternaus Explorer



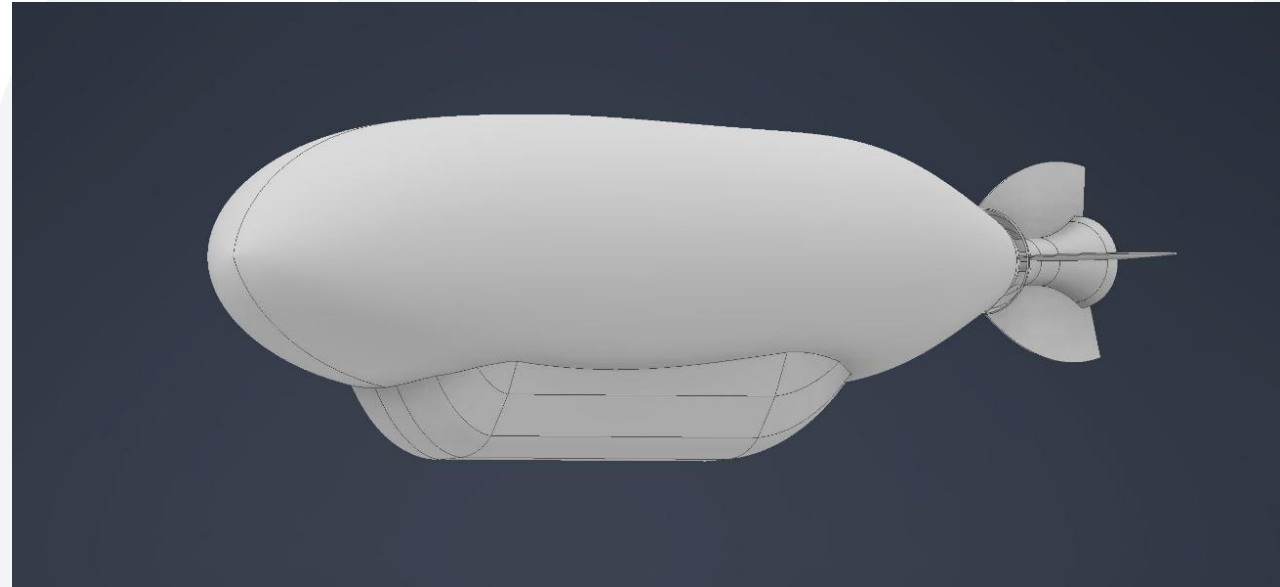
Description of the Geometric Model

The geometric model analyzed corresponds to the Explorer airship, whose main dimensions are:

Total length: **100 m**

Maximum diameter: **16.9 m**

Maximum frontal area (reference area): **224.3 m²**



Numerical Methodology (ANSYS Fluent 2025 R2)

Computational Setup

The simulations were carried out using ANSYS Fluent 2025R2, considering the following assumptions:

Three-dimensional (3D) simulation;
Steady-state regime;
Atmospheric conditions at sea level;
Zero angle of attack.

The inlet velocity was set to **58 m/s and 39 m/s**, with an air density of **1.225 kg/m³**.

A 3D axisymmetric transient simulation was carried out using the ANSYS Fluent 2025 R2 solver.

Numerical Methodology (ANSYS Fluent 2025 R2)

Computational Settings

Setting	Option
Solver type	Pressure-based, transient
Coupling scheme	Coupled
Discretization	2nd-order upwind (momentum, turbulence, energy)
Temporal scheme	2nd-order implicit
Turbulence model	k- ω SST (with near-wall correlation)
Compressibility	Ideal gas model, low-Mach correction
Time step	1×10^{-3} s, 10,000 iterations
Domain	Axisymmetric
Inlet velocity	58 m/s / 39 m/s
Turbulence intensity	5%
Turbulent viscosity ratio	10
Outlet	Pressure outlet (101325 Pa)
Wall condition	No-slip, adiabatic

Numerical Methodology (ANSYS Fluent 2025 R2)

Computational Domain

The computational mesh was generated using unstructured tetrahedral elements, totaling approximately:

- 2.3 million nodes
- 6.5 million elements

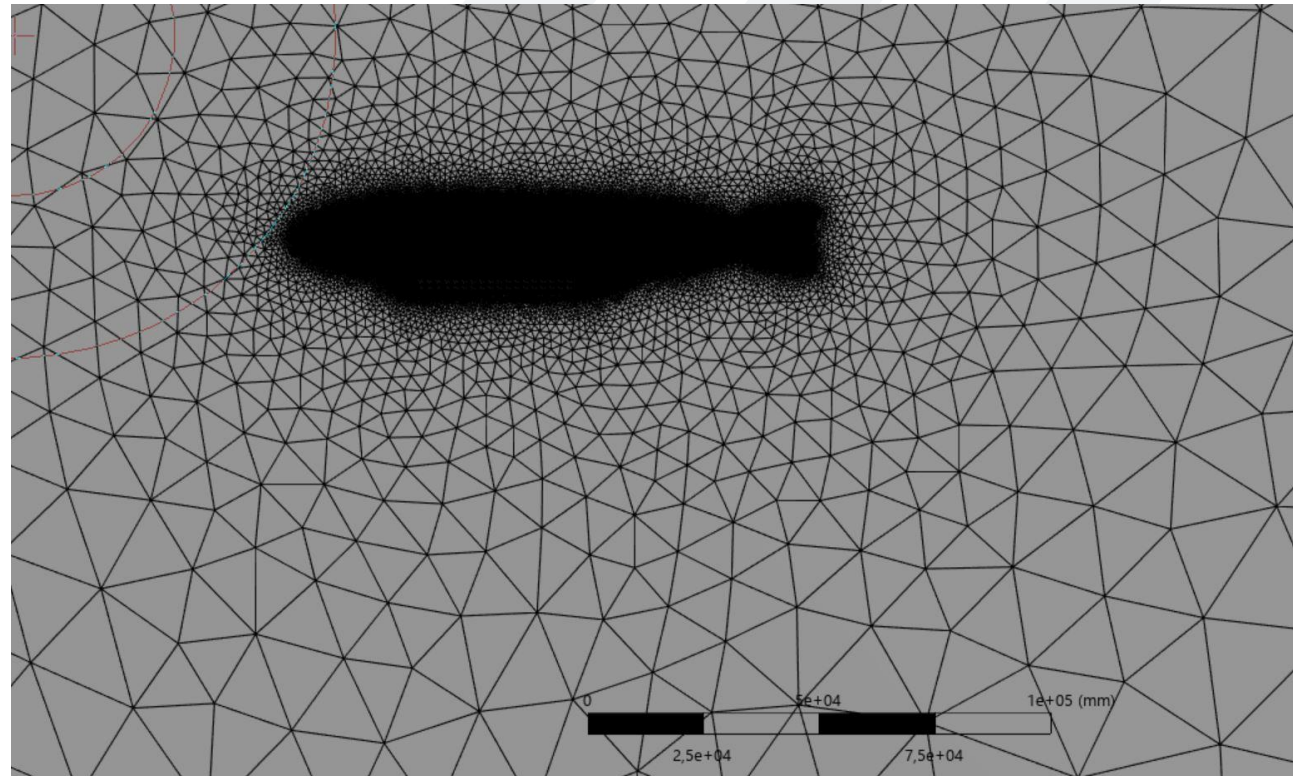
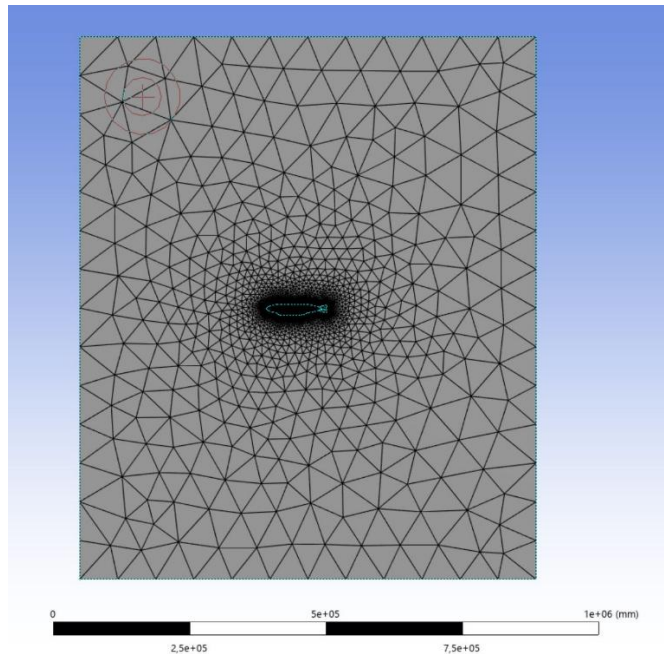
Mesh refinements were applied along the airship surface (inflation), enabling proper resolution of the boundary layer and viscous effects. The mesh refinement was concentrated in the following regions:

- Airship nose (stagnation region);
- External surface of the body;
- Aft region and rear appendages;
- Downstream wake region.

Numerical Methodology (ANSYS Fluent 2025 R2)

Computational Domain

The numerical model considered a rectangular computational domain with approximate dimensions of **1000 m × 1500 m × 1500 m**, as shown in Figure.

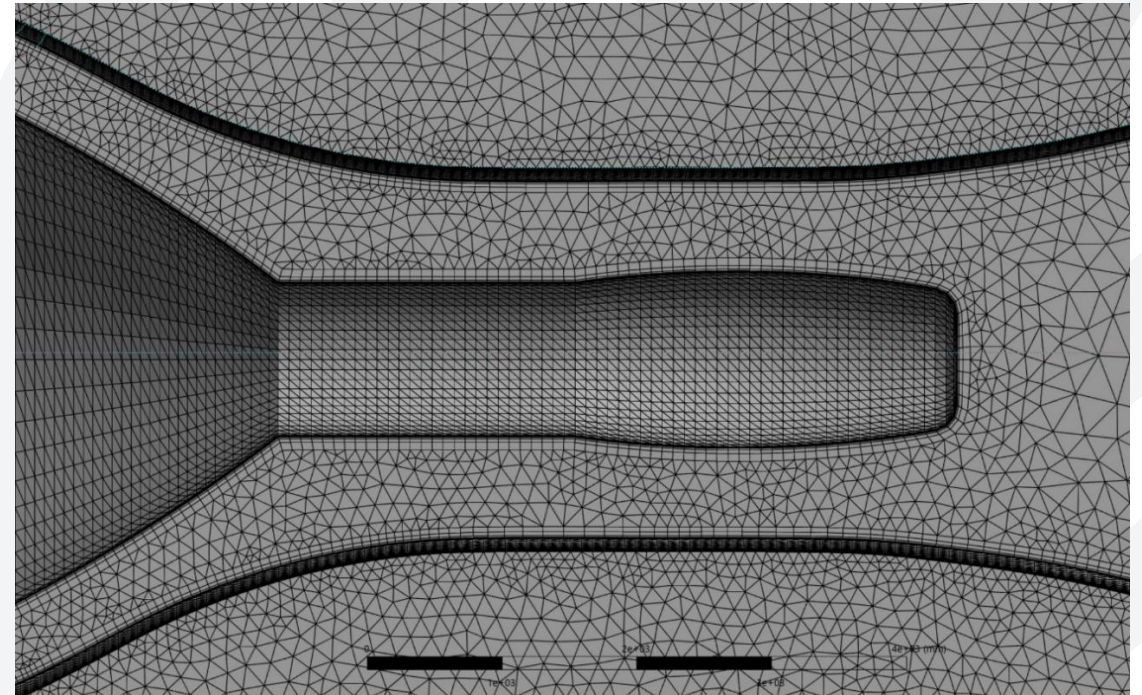


Numerical Methodology (ANSYS Fluent 2025 R2)

Mesh and Near-Wall Resolution

The mesh consisted of $\sim 7.7 \times 10^5$ quadrilateral elements, generated using the Quad Dominant and Sweep methods. Refinement layers were applied along the hull with a growth rate ≤ 1.2 and first cell height ensuring $y^+ < 1$.

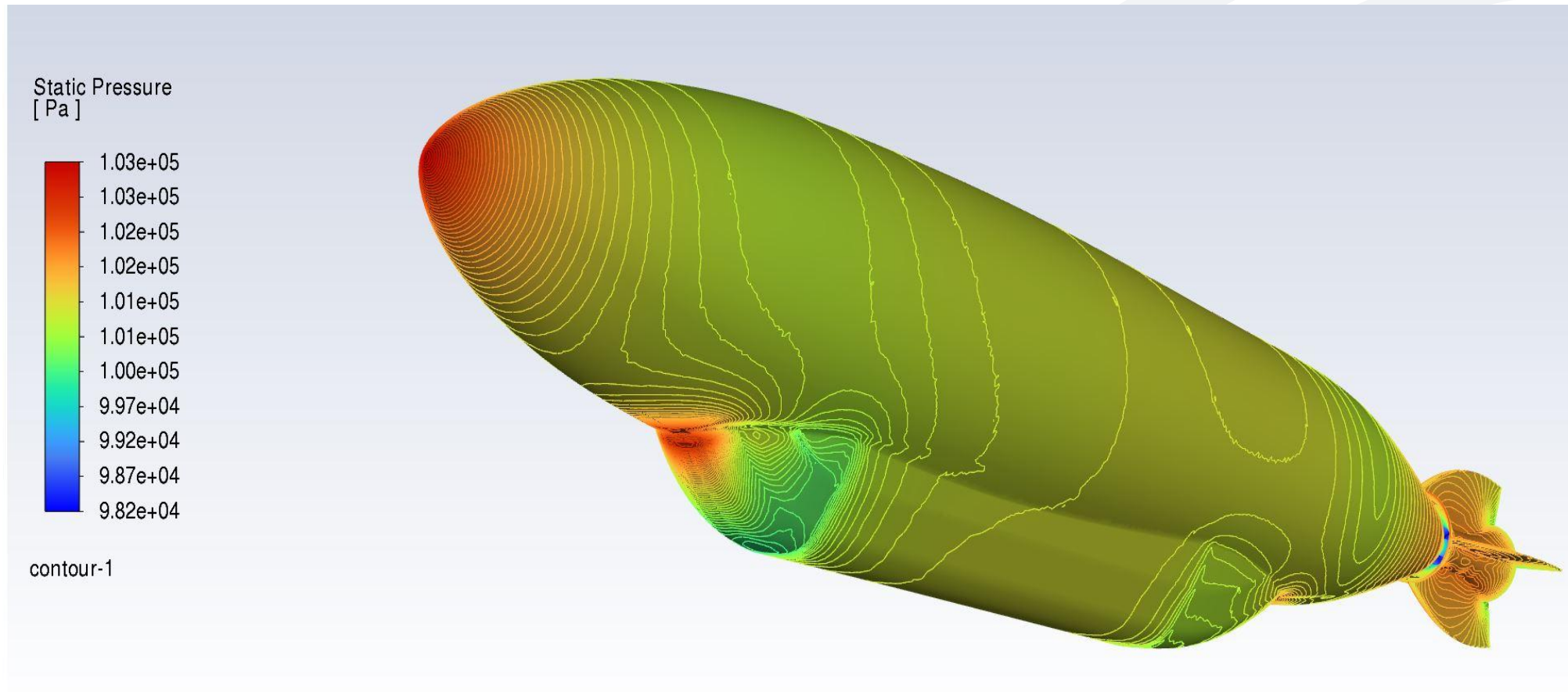
Parameter	Value
Nodes	772,290
Elements	767,171
y^+ (average)	0.7
Growth rate	1.18
Farfield extent	20D upstream, 30D downstream



Results and Discussions



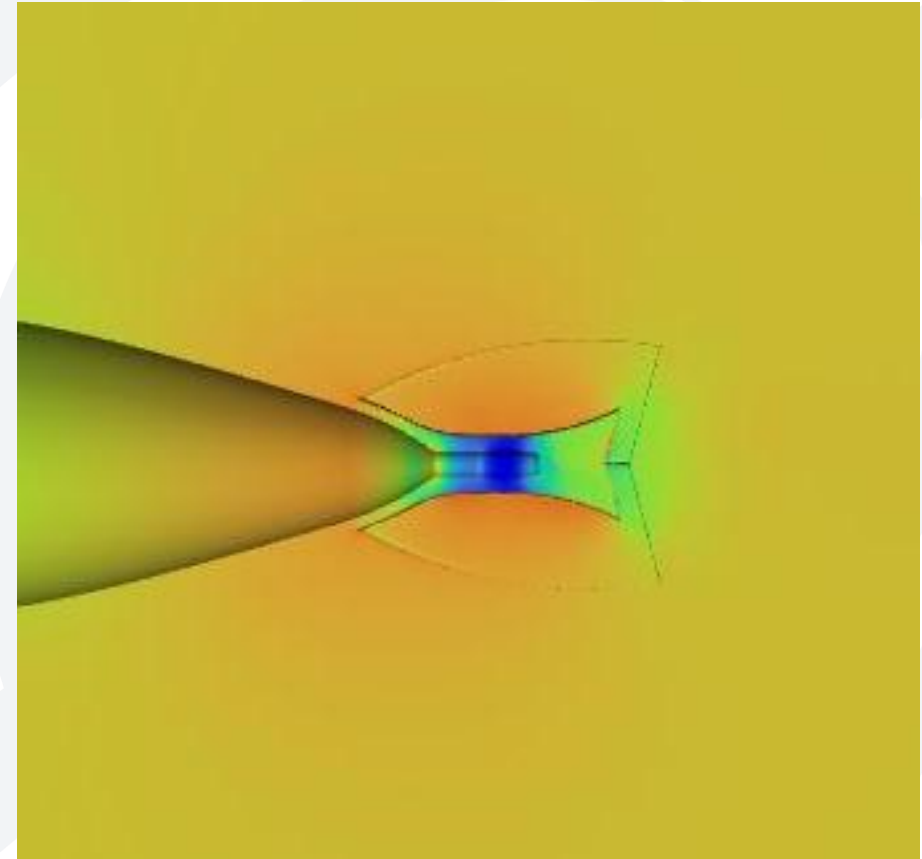
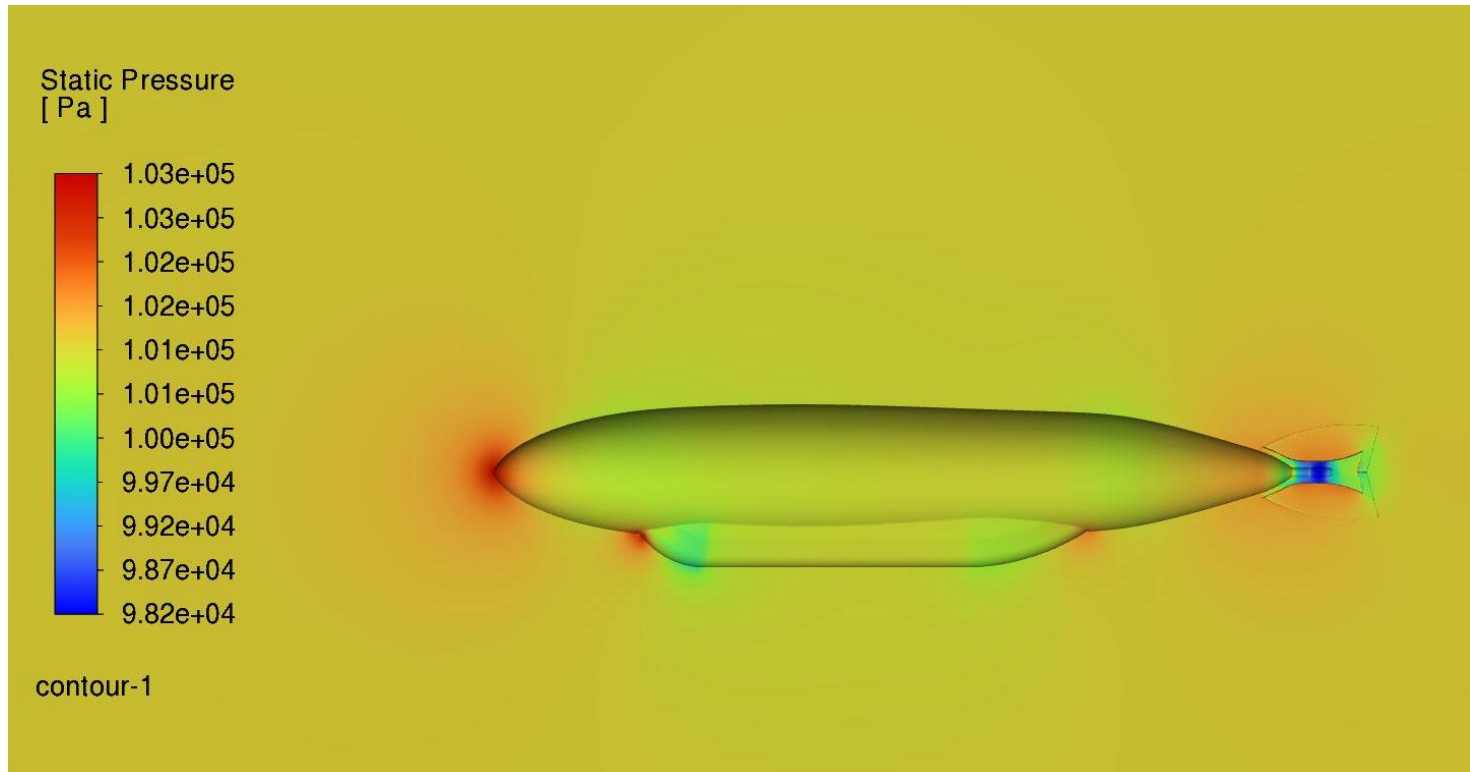
Pressure Distribution for 58 m/s



Results and Discussions



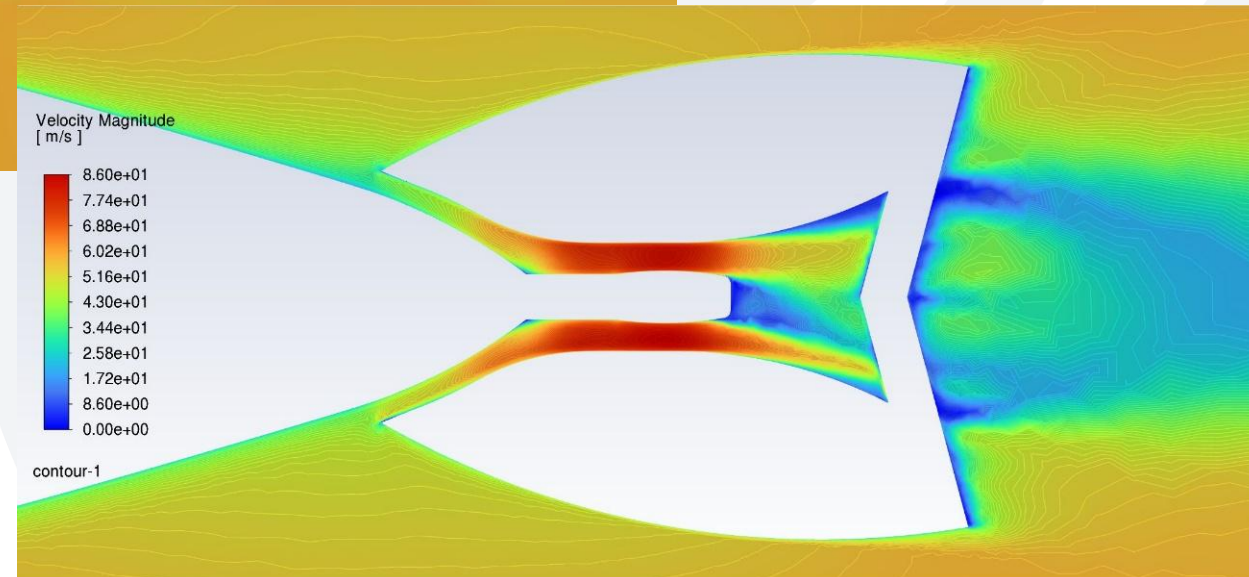
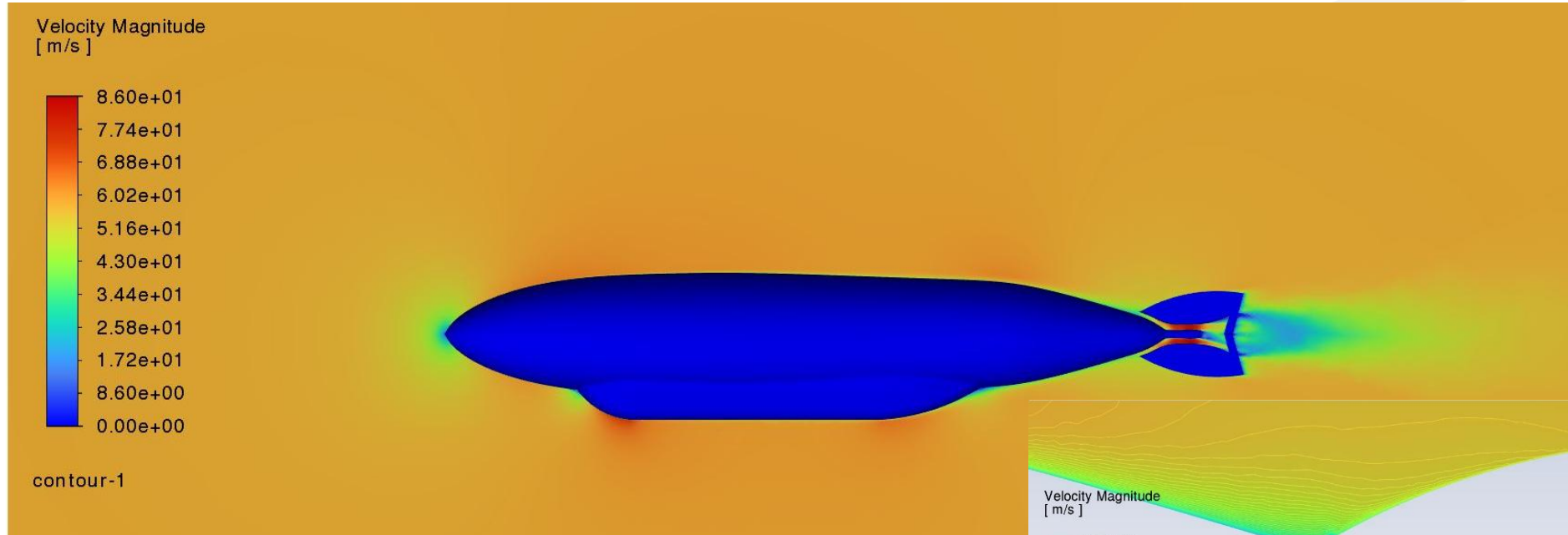
Pressure Distribution for 58 m/s



Results and Discussions



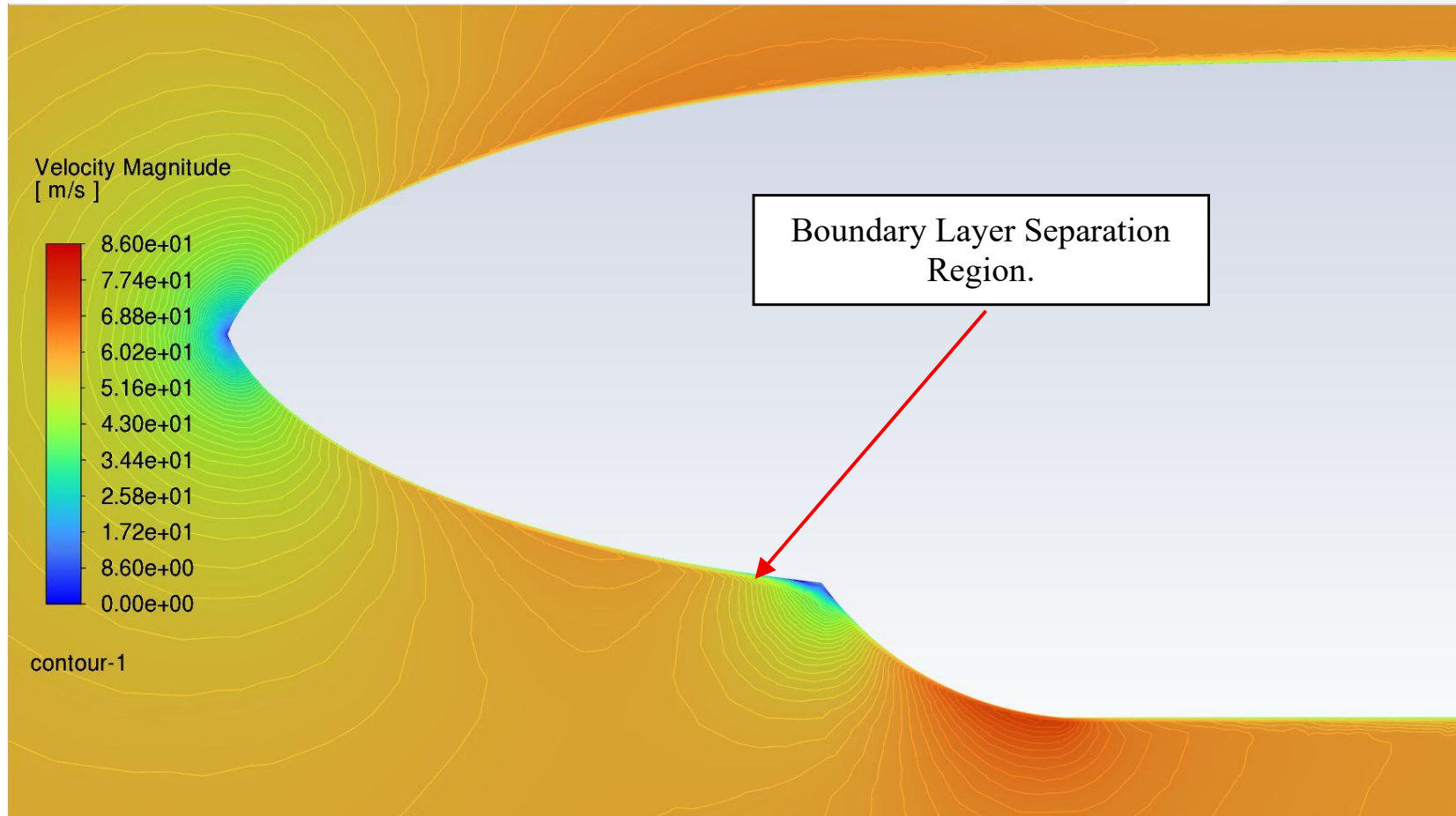
Flow Field Velocity



Results and Discussions



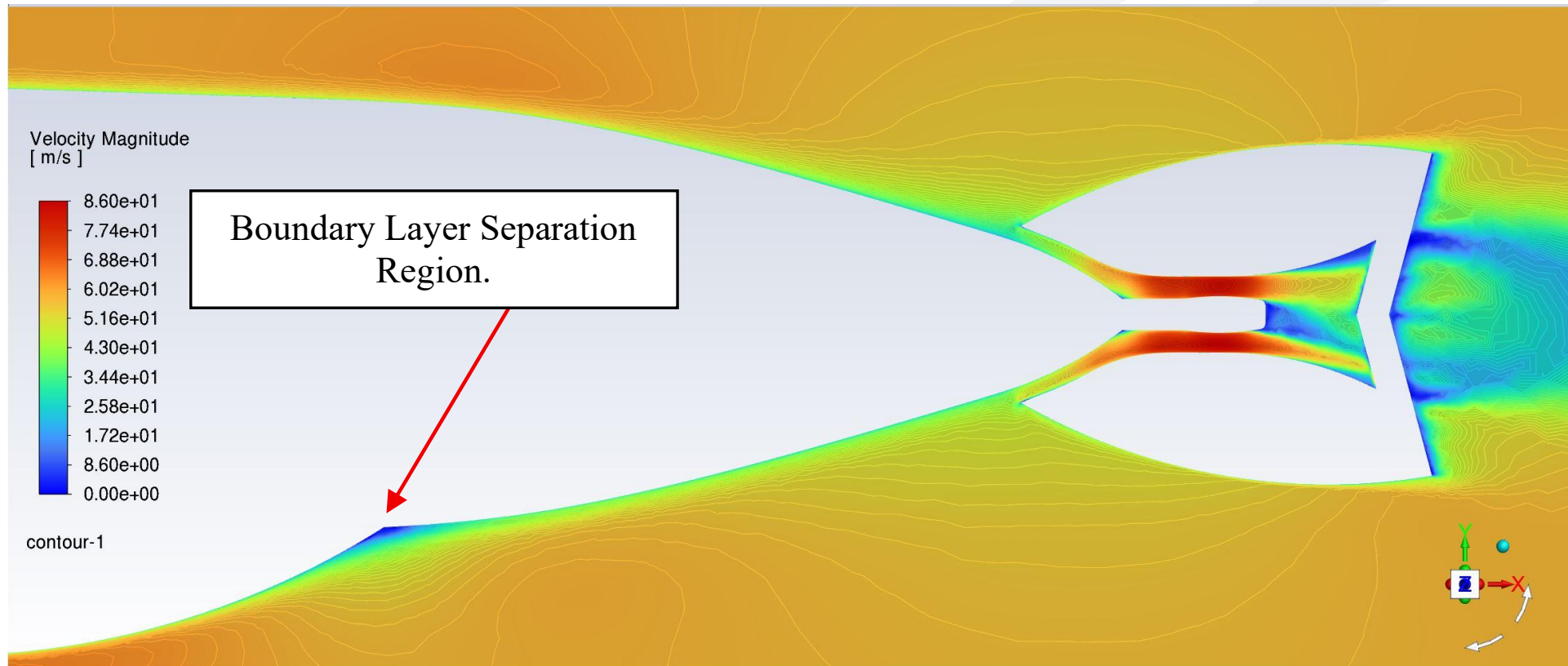
Flow Field Velocity



Results and Discussions



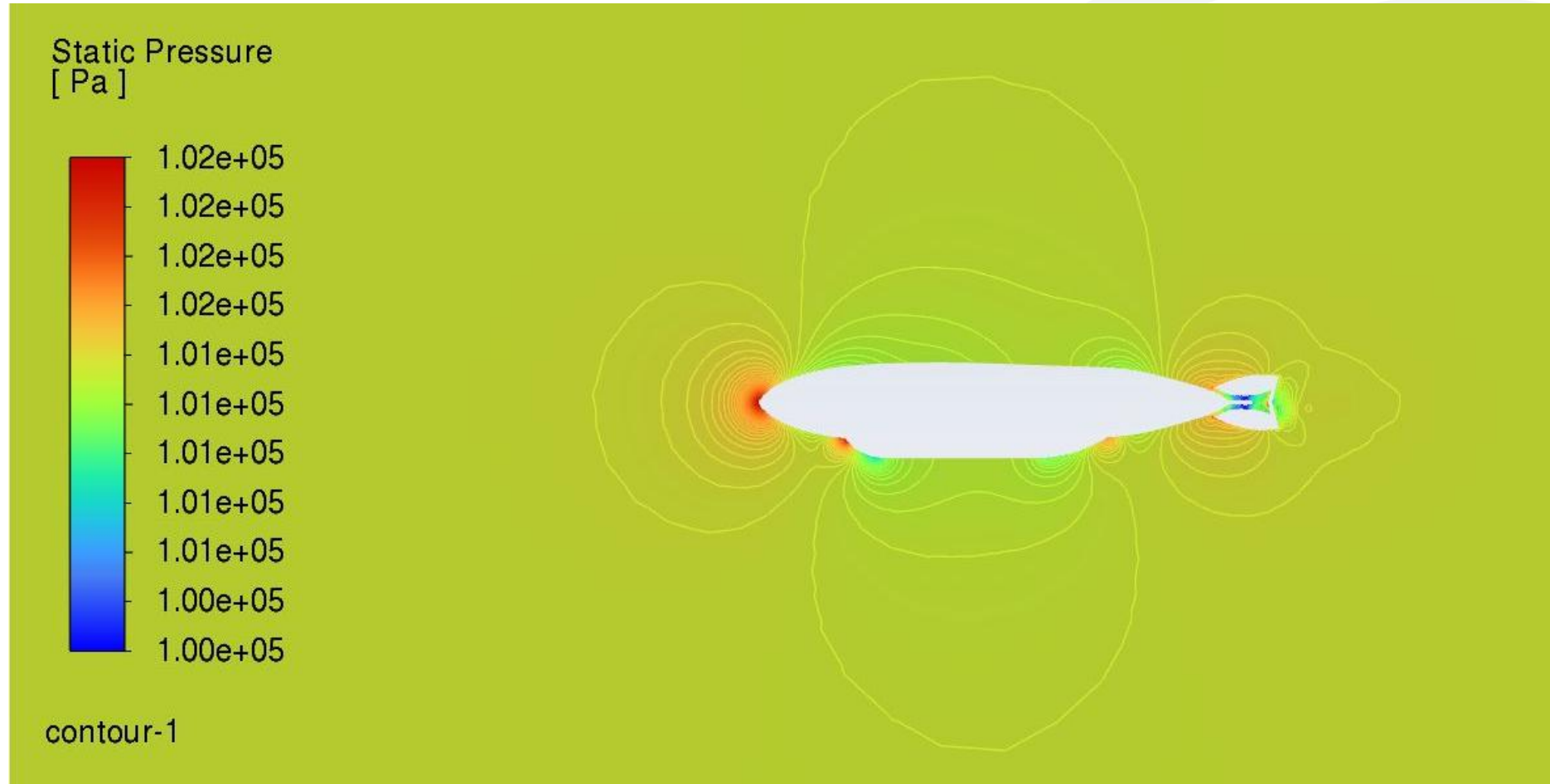
Flow Field Velocity



Results and Discussions



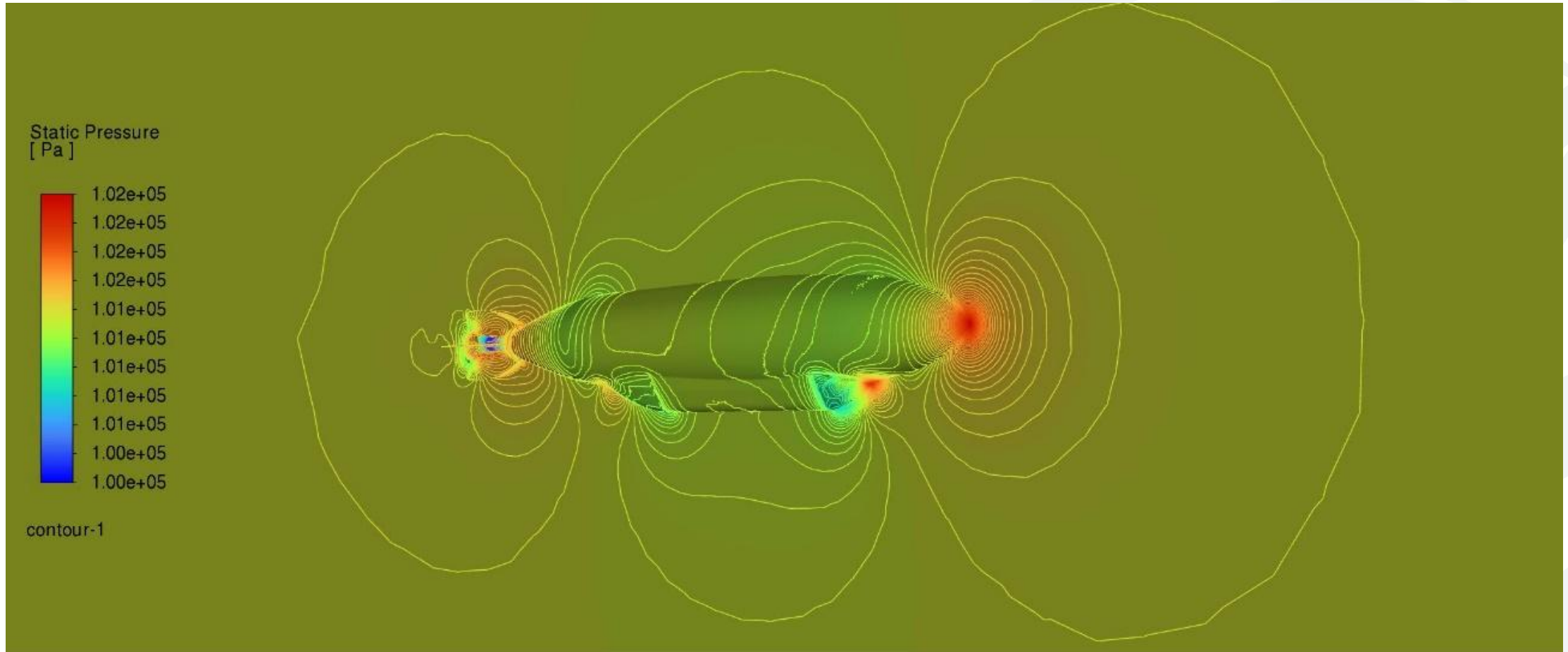
Pressure Distribution for 39 m/s



Results and Discussions



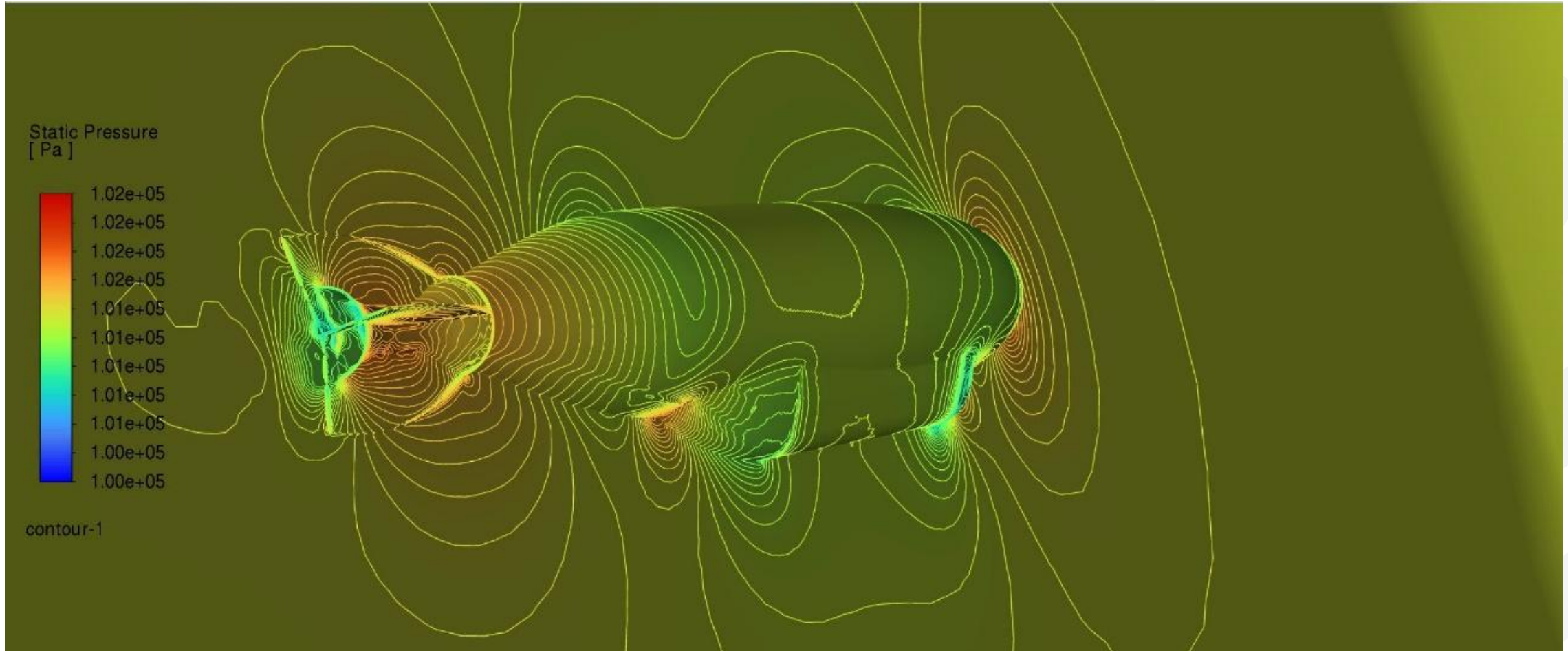
Pressure Distribution for 39 m/s



Results and Discussions



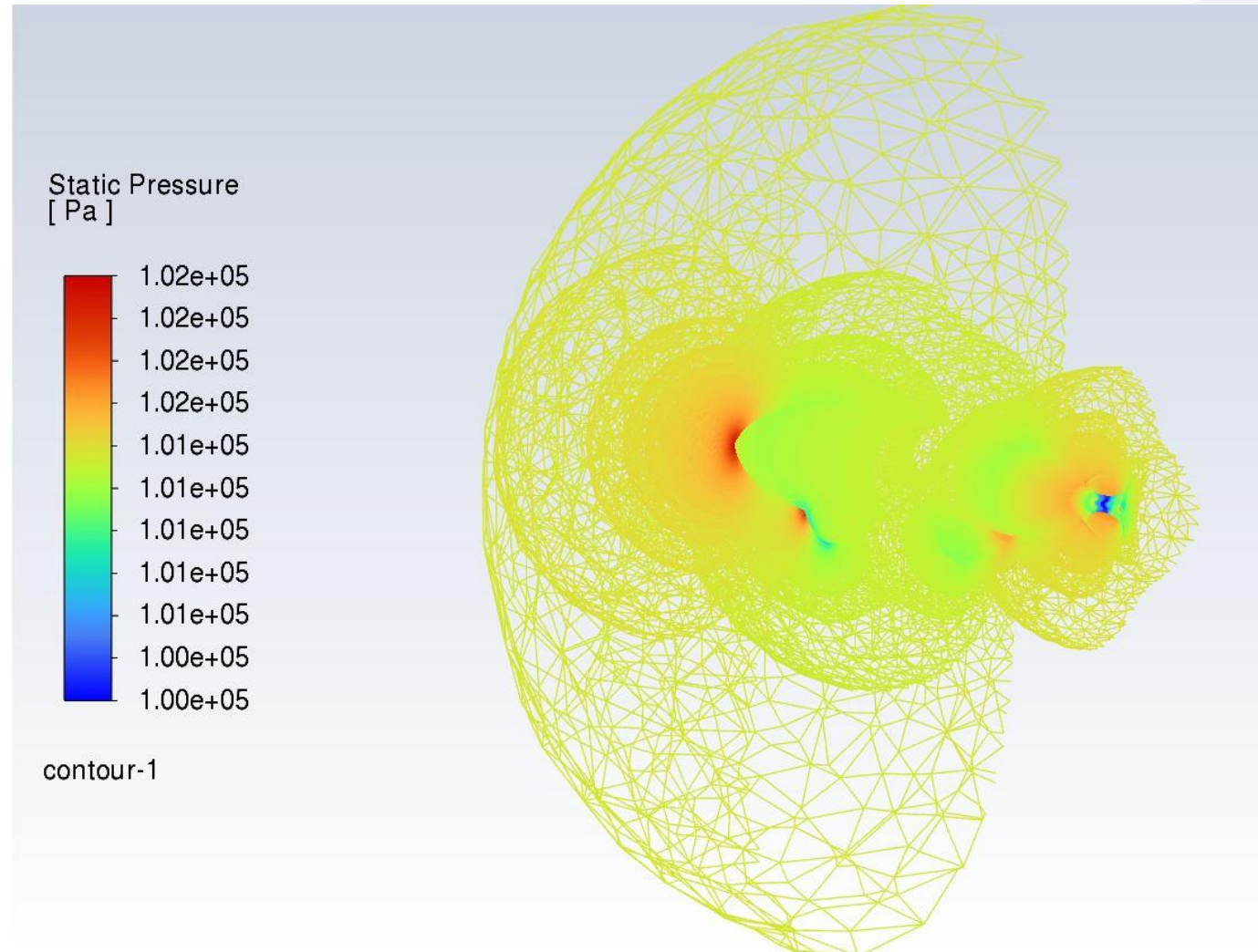
Pressure Distribution for 39 m/s



Results and Discussions



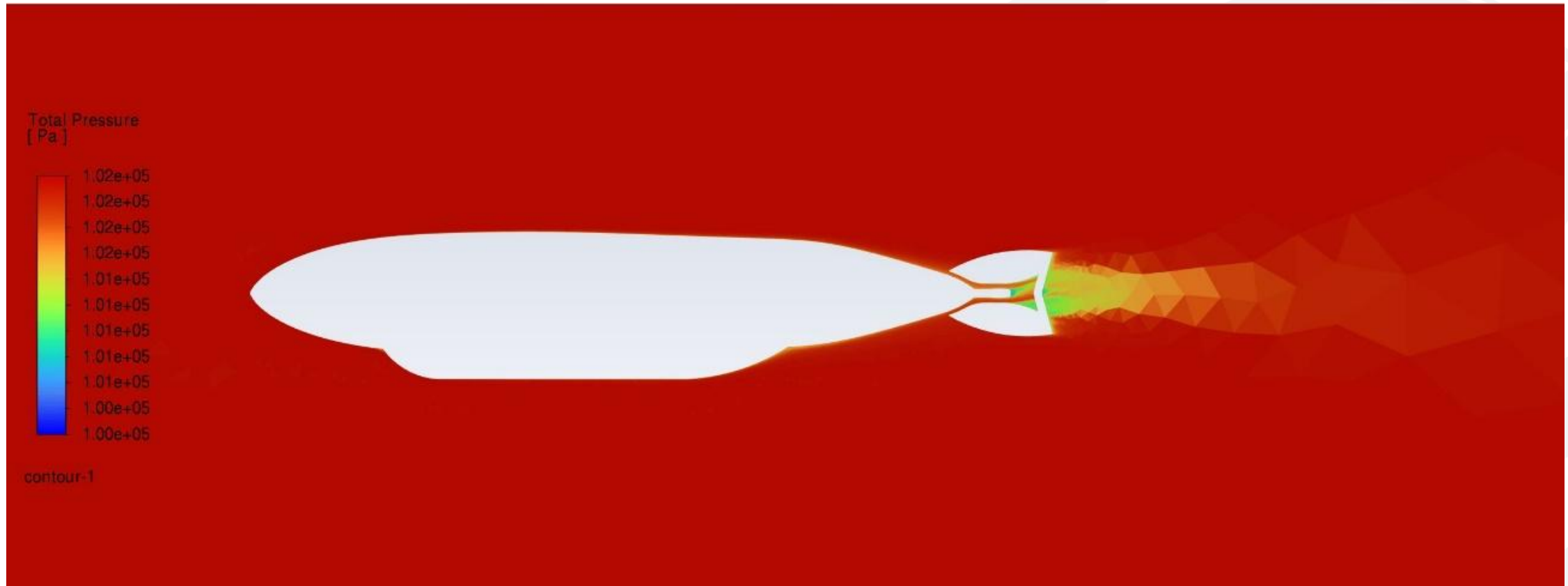
Pressure Distribution for 39 m/s



Results and Discussions



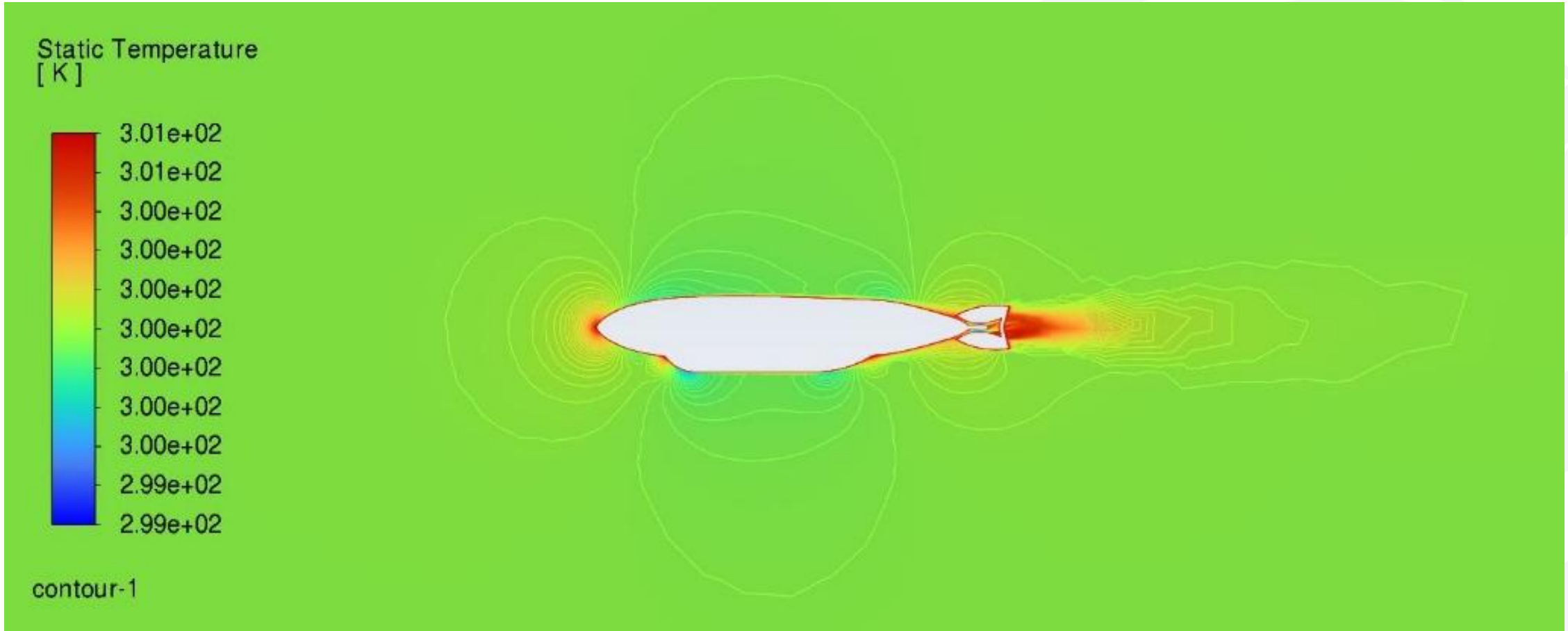
Total Pressure Distribution for 39 m/s



Results and Discussions



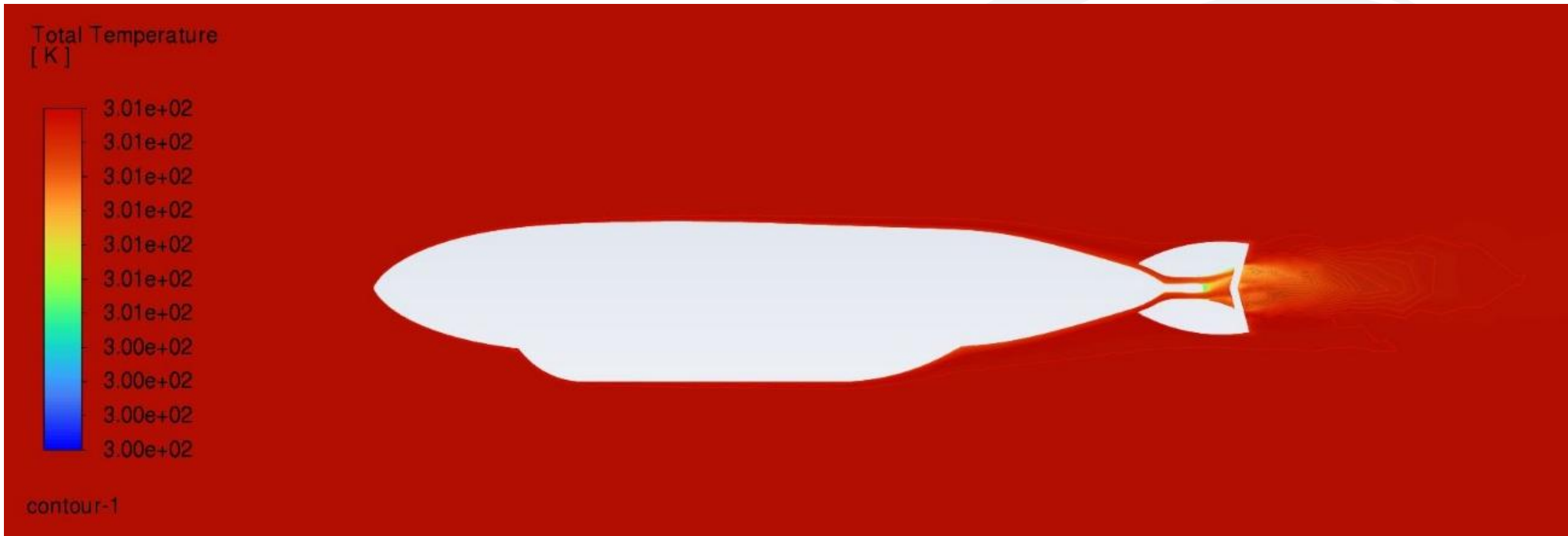
Static and Total Temperature Fields



Results and Discussions



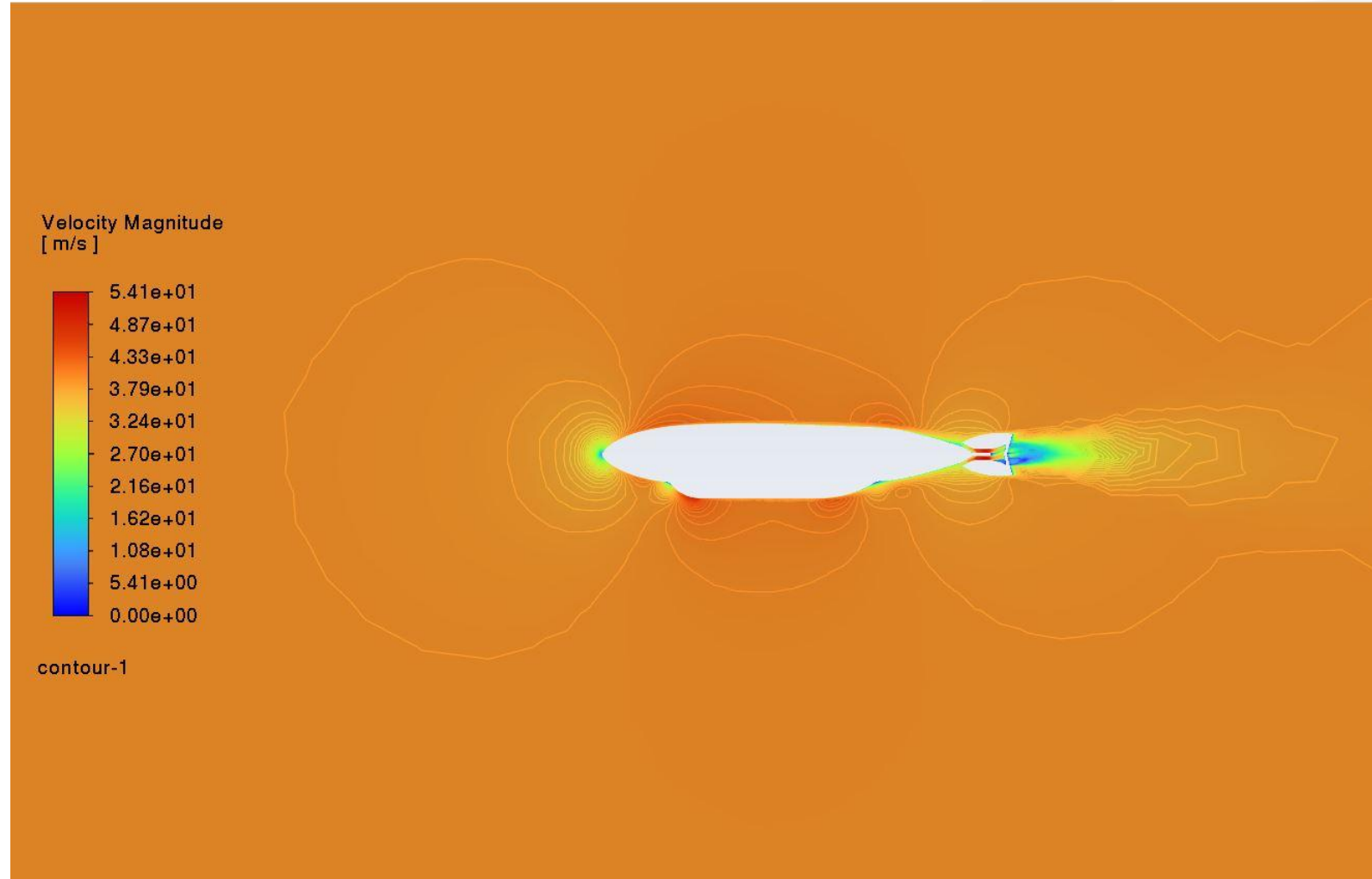
Static and Total Temperature Fields



Results and Discussions



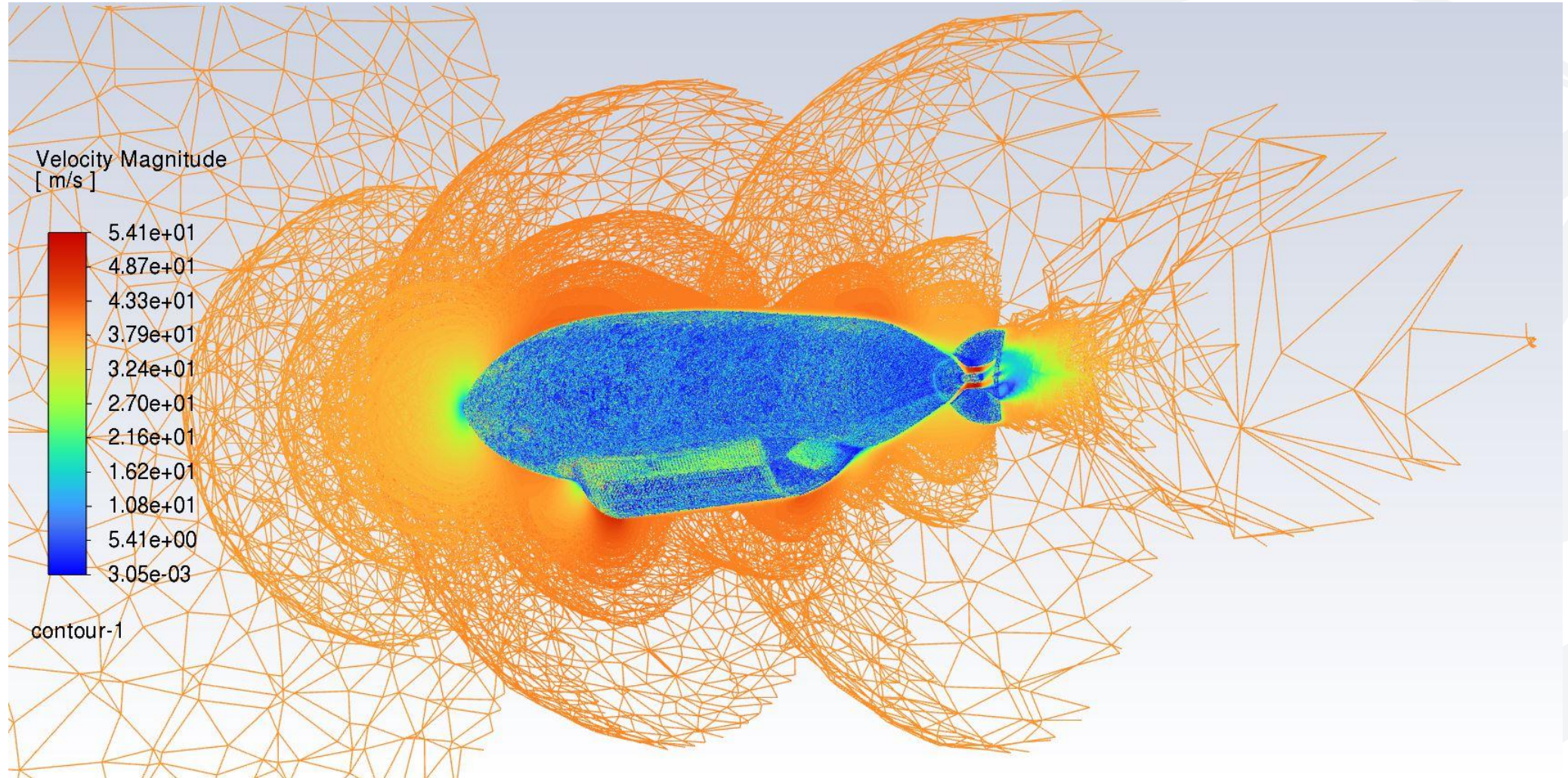
Flow Field Velocity



Results and Discussions



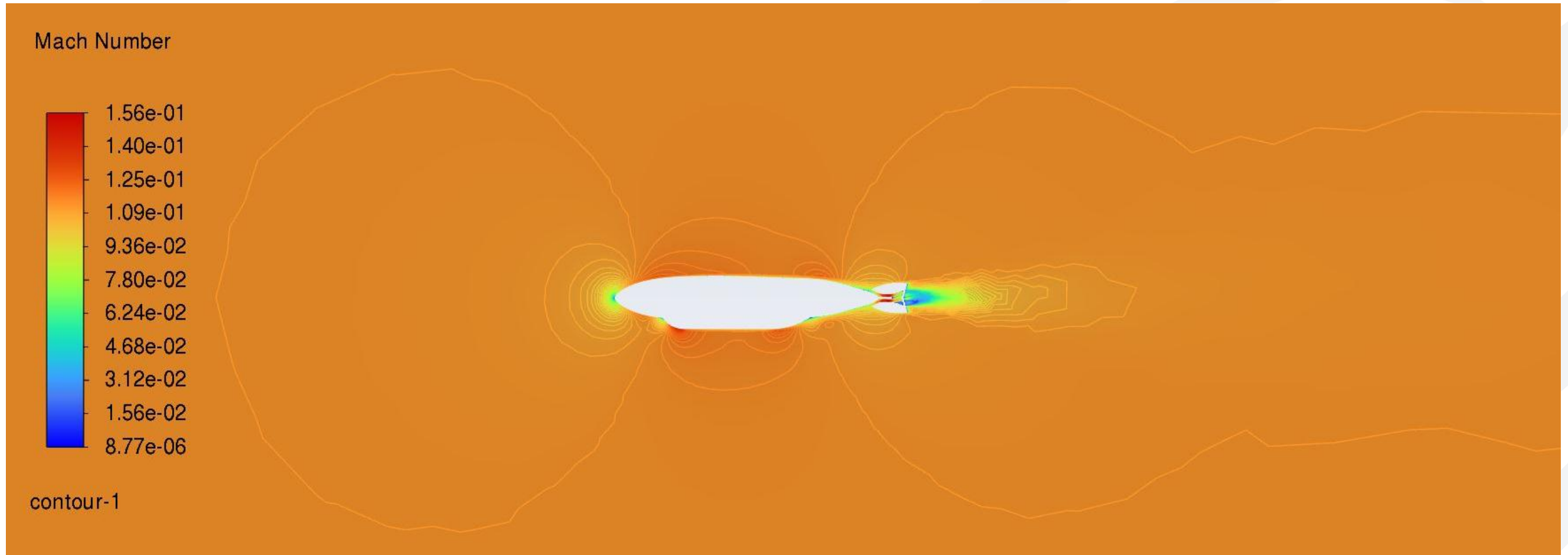
Flow Field Velocity



Results and Discussions



Mach Number



Results and Discussions



Drag Force and Drag Coefficient

The total aerodynamic drag force, adjusted to represent the complete vehicle, was:

$$D = 40,408 \text{ N (58 m/s) and } 18,345 \text{ N (39 m/s)}$$

The global drag coefficient was calculated using the expression:

$$C_D = \frac{D}{\frac{1}{2}\rho V^2 A}$$

where:

$$\rho = 1,225 \text{ kg/m}^3$$

$$V = 58 \text{ m/s and } 39 \text{ m/s}$$

$$A = 224,3 \text{ m}^2$$

Resulting in:

$$C_D \approx 0.21 \text{ (58 m/s) and } 0.0778 \text{ (39 m/s)}$$

Results and Discussions



Comparative Analysis of Operating Conditions

Parameter	58 m/s	39 m/s	Expected Variation	Observation
Velocity (m/s)	58	39	—	Problem input
Mach Number	~0.17	~0.11	Linear with V	Subsonic regime
Dynamic Pressure (Pa)	~2060	~930	$\propto V^2$	Increase of ~2.2×
Total Drag (N)	~40,408	~18,345	$\propto V^2$	Consistent
Pressure Drag (N)	↑	~10,473	$\propto V^2$	Dominant
Viscous Drag (N)	↑	~7,871	$\propto V^2$ (approx.)	Boundary layer influence
Wake Structure	More intense	Moderate	↑ with V	Greater dissipation
Pressure Gradients	Higher	Moderate	↑ with V^2	Higher aerodynamic loading
Compressibility	Negligible	Negligible	—	Mach < 0.3
Temperature	~300 K	~300 K	—	No relevant thermal effects
Required Power	2.34 MW (≈ 3,182 hp)	0.71 MW (≈ 965 hp)	$\propto V^3$	Strong dependence on velocity
Installed Power (+30%)	3.05 MW (≈ 4,136 hp)	0.92 MW (≈ 1,255 hp)	$\propto V^3$	Includes operational margin

Conclusions



Based on the Computational Fluid Dynamics (CFD) simulations performed, it is concluded that the Explorer airship exhibits aerodynamic behavior compatible with its intended operational envelope, demonstrating stable flow characteristics and pressure distributions consistent with large-volume configurations. The estimated drag coefficient, on the order of 0.21, is in agreement with values reported in the technical literature for airships of similar scale, indicating aerodynamic efficiency suitable for the proposed mission profile.

The numerical methodology adopted, including the computational domain modeling, mesh criteria, and solution approach, proved to be appropriate for preliminary aerodynamic performance assessments, providing consistent and technically well-founded results. Additionally, the obtained data establish a solid basis for the continuation of the studies, enabling the progressive refinement of the design and its scaling within the context of the Eternaus Program.

As a natural continuation of this stage, it is recommended that complementary analyses be carried out, including investigations under crosswind conditions, transient wake studies for the characterization of vortical structures and potential instabilities, as well as evaluations of geometric modifications aimed at drag reduction and the overall optimization of aerodynamic performance.

Conclusions



Based on the obtained results and the analyses performed, it can be concluded that the aerodynamic drag increase follows, with high accuracy, the quadratic dependence on velocity: $D \propto V^2$ as predicted by theory for incompressible flows. The agreement between the theoretical values and the numerical results indicates that the computational model exhibits a high level of physical consistency, with no evidence of modeling errors, numerical instabilities, or non-physical behavior in the obtained results.

It is also observed that increasing the velocity leads to a more energetic and spatially extended wake, with greater intensity of vortical structures and increased total pressure losses, reflecting higher energy dissipation within the flow. In addition, the contribution of pressure drag becomes more significant, reinforcing the influence of geometry on drag generation. As a consequence, the overall aerodynamic loading increases considerably, directly impacting thrust and power requirements.

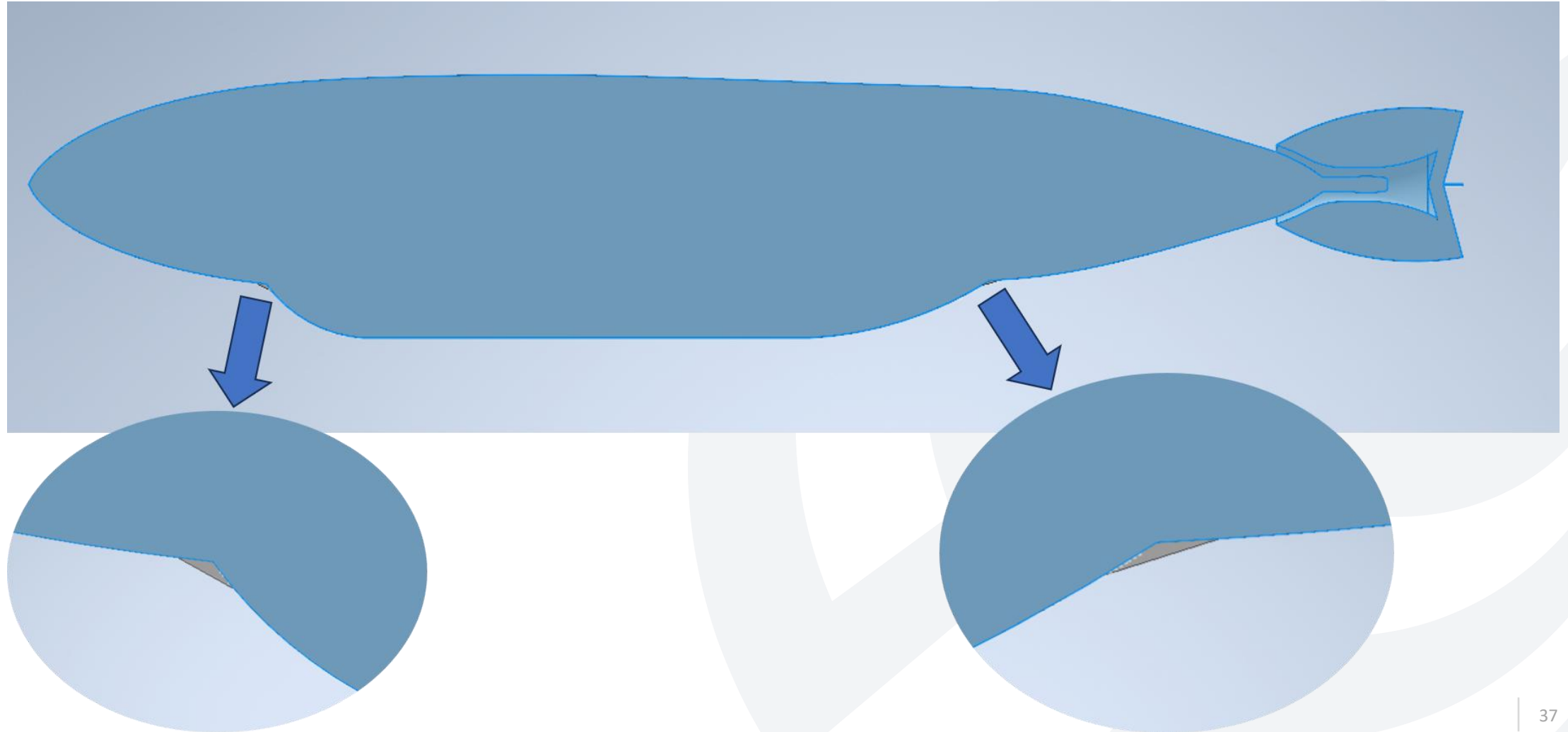
From a design perspective, the airship performance demonstrates high sensitivity to operating velocity, particularly in the cruise regime. Small variations in velocity result in significant increases in drag and required power due to the relationships: $D \propto V^2$ and $P \propto V^3$.

Therefore, geometric optimization, especially in the aft region and at the interface with the empennage, proves to be critical for reducing pressure drag and improving the overall aerodynamic efficiency of the vehicle.

Next Steps

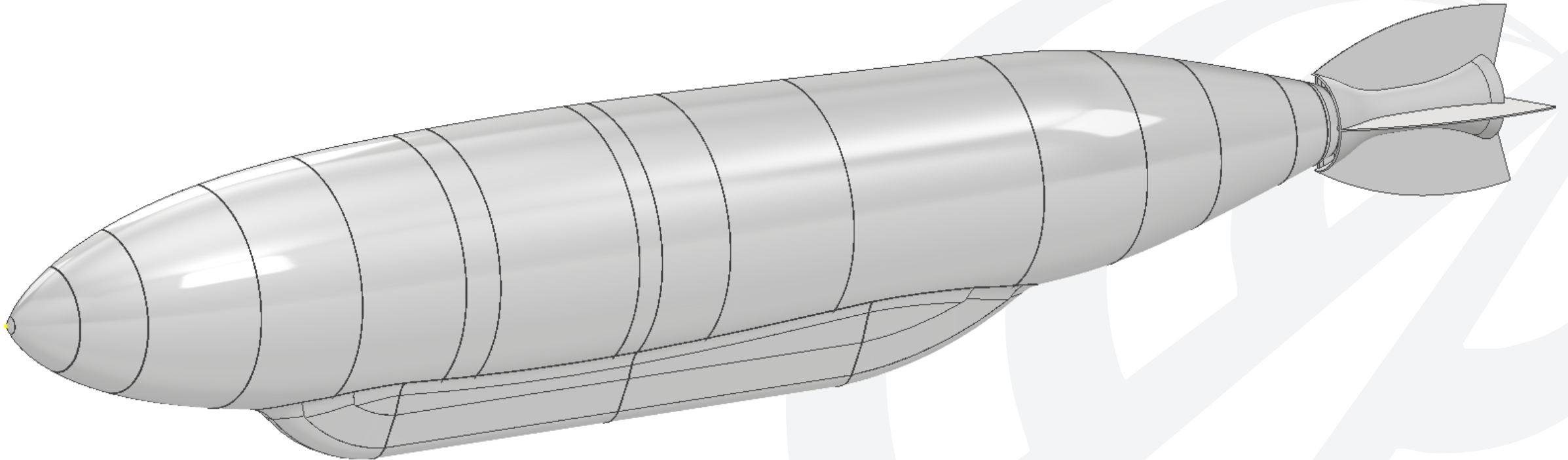


Geometry improvement and Structural Analysis



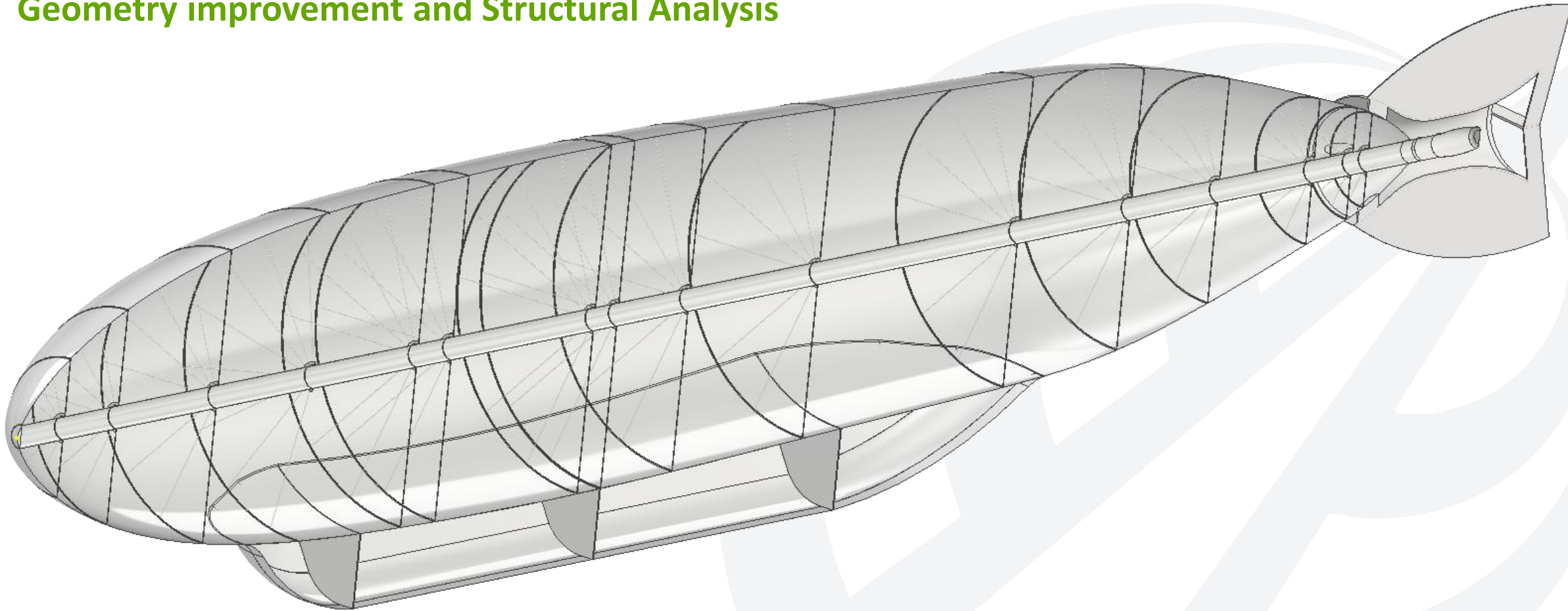
Next Steps

Geometry improvement and Structural Analysis



Next Steps

Geometry improvement and Structural Analysis



Acknowledgments



The authors gratefully acknowledge the Eternaus Aerospace Systems Research Division for supporting this investigation and providing computational resources. Special thanks to the ESSS and ANSYS company for their assistance with the ANSYS Fluent 2025 R2 setup and to the structural analysis group for integrating prestressed geometry data into the aerodynamic model.

The fourth generation of airships — the Super Rigid Airships.

“Thank you, Felipe. With this scientific validation presented, we can now look at the real-world impact of this architecture. I will now display the Explorer’s applications panel — where it becomes clear how this technology can transform logistics, tourism, humanitarian operations, offshore activities, environmental monitoring, scientific research, and remote access. This is the moment where engineering meets practical utility.”







Questions?





Eng. Hans G. Kraus

hangkraus@eternaus.com

Dr. Felipe J. da Costa

felipejean@brengtrein.com.br

Thank You

www.eternaus.com