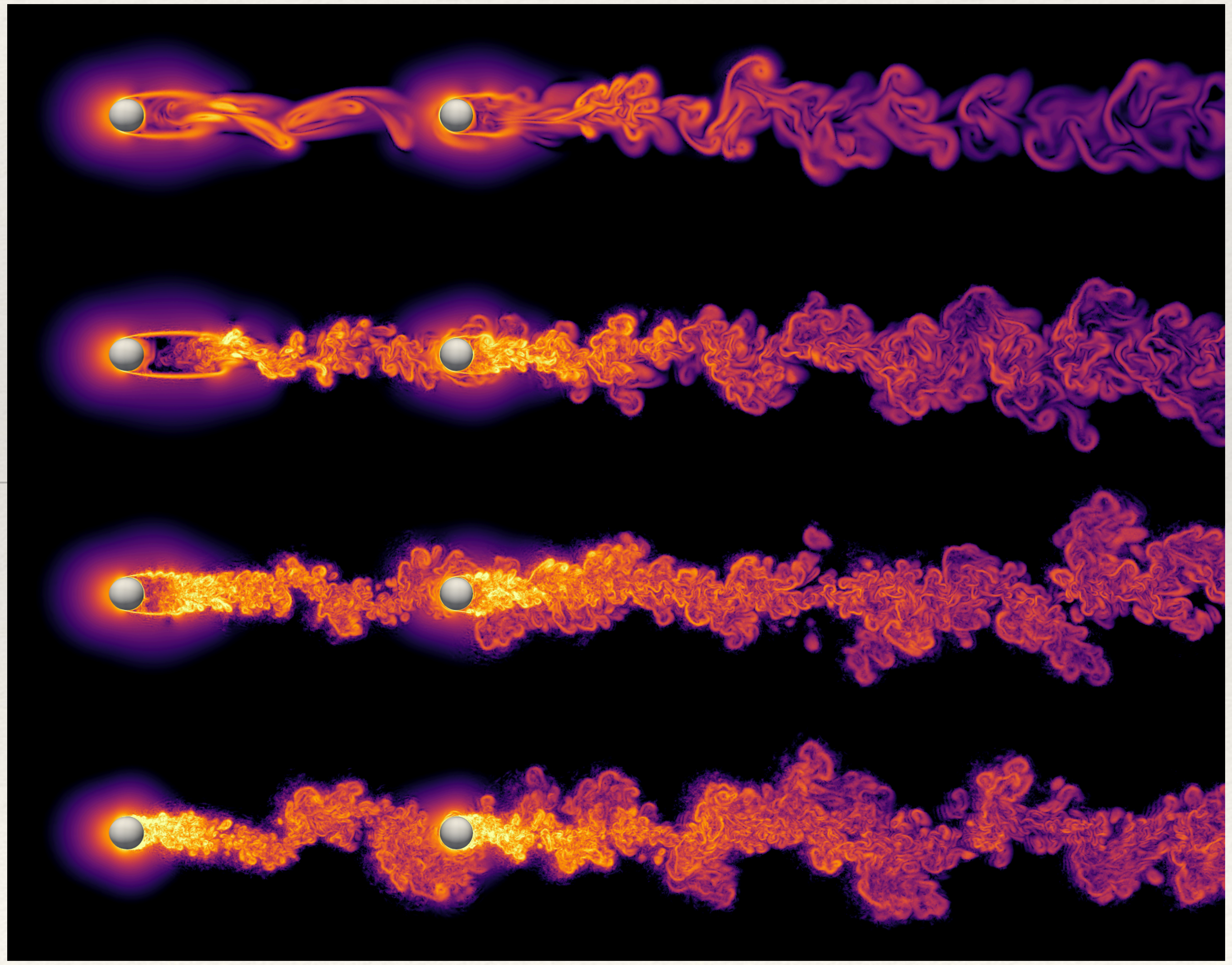
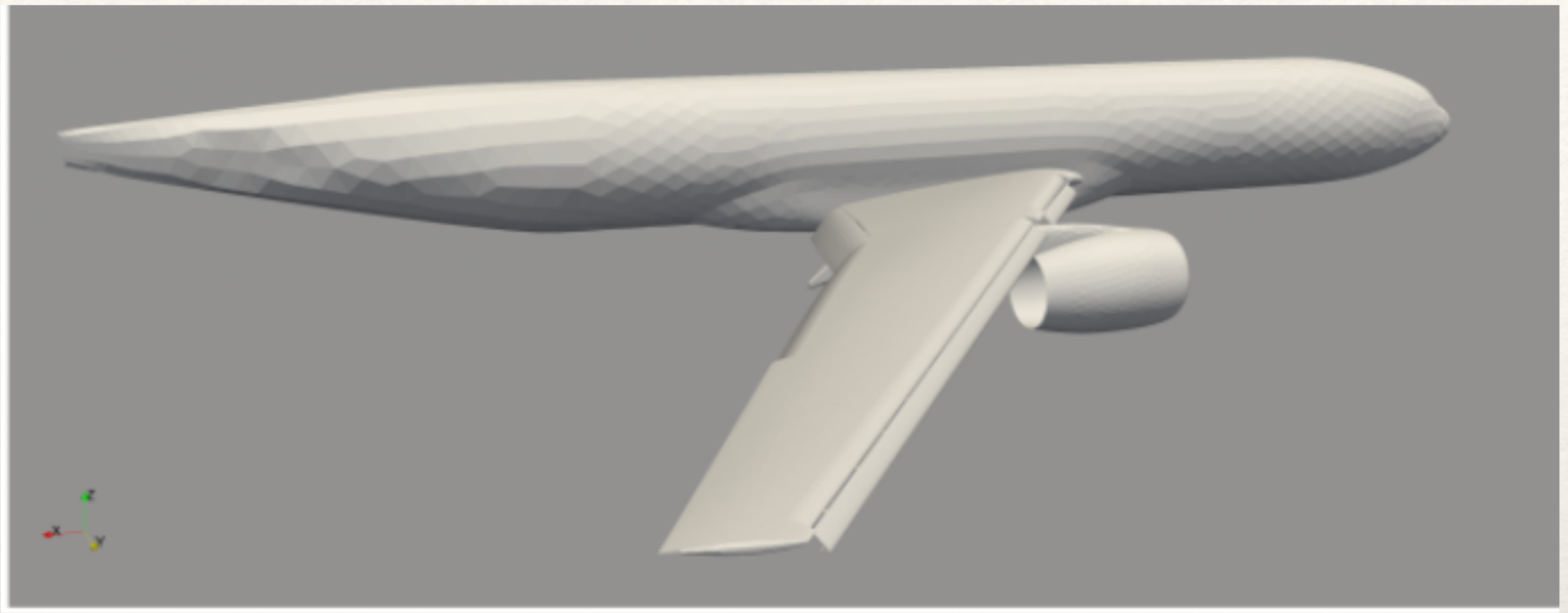
Luigi Martinelli

Fluid Mechanics and Locomotion



Fluids are usually opposing the motion (Drag)

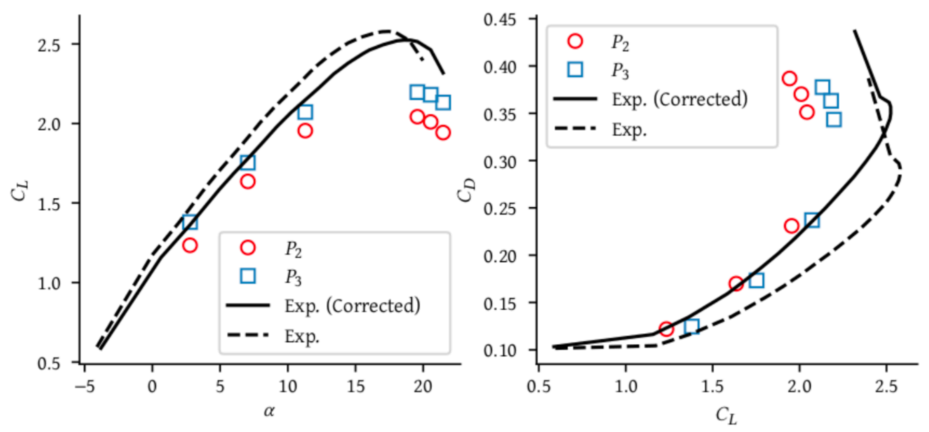
Lift - (Side-force too)



4th AIAA high-lift prediction workshop

We were one of two groups willing and able to run high order solvers on this problem, with 50+ groups running more conventional solvers.

- $Ma = 0.3$, $Re = 5.5 \times 10^6$ configuration with extensive wind tunnel data.
- Stability issues encountered at full Re; ran at $Re = 5.5 \times 10^5$.
- Good results at lower α, underpredicts lift at higher α (as expected by the lower Re.)
- Meshes were designed for the nominal $\alpha = 7°$ test with $3M$ cells. Highly underresolved for this geometry - better resolution should aid stability issues.



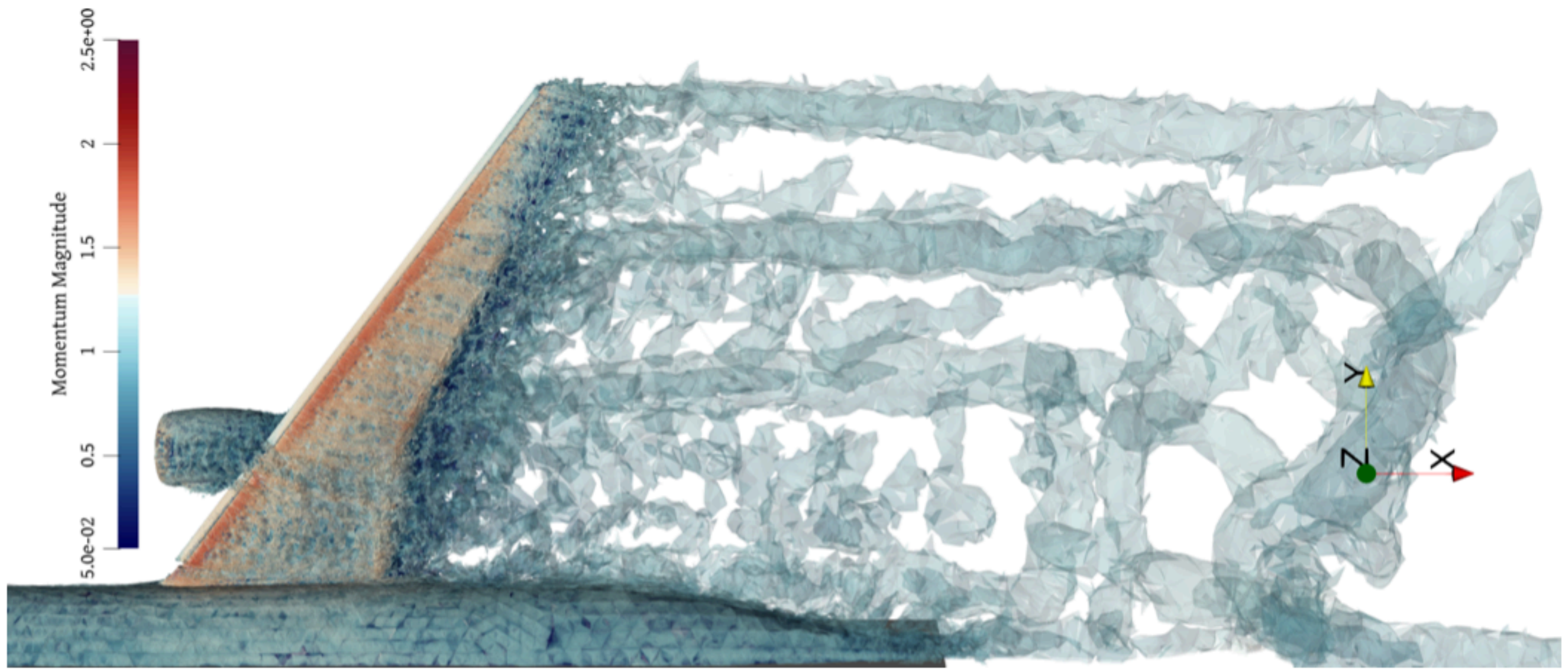


Figure: Q-criterion, $\alpha = 7.05°$ planform view

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Integrated Resistance - Propulsion - Co

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Aerodynamics Forces

$$C_L = \frac{L}{\frac{1}{2}\rho V^2 S}$$

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

$$C_L = F(Re, Ma, \alpha)$$

$$C_D = G(Re, Ma, \alpha, \beta)$$

$$Re = \frac{\rho V L}{\mu}$$

$$Ma = \frac{V}{a}$$

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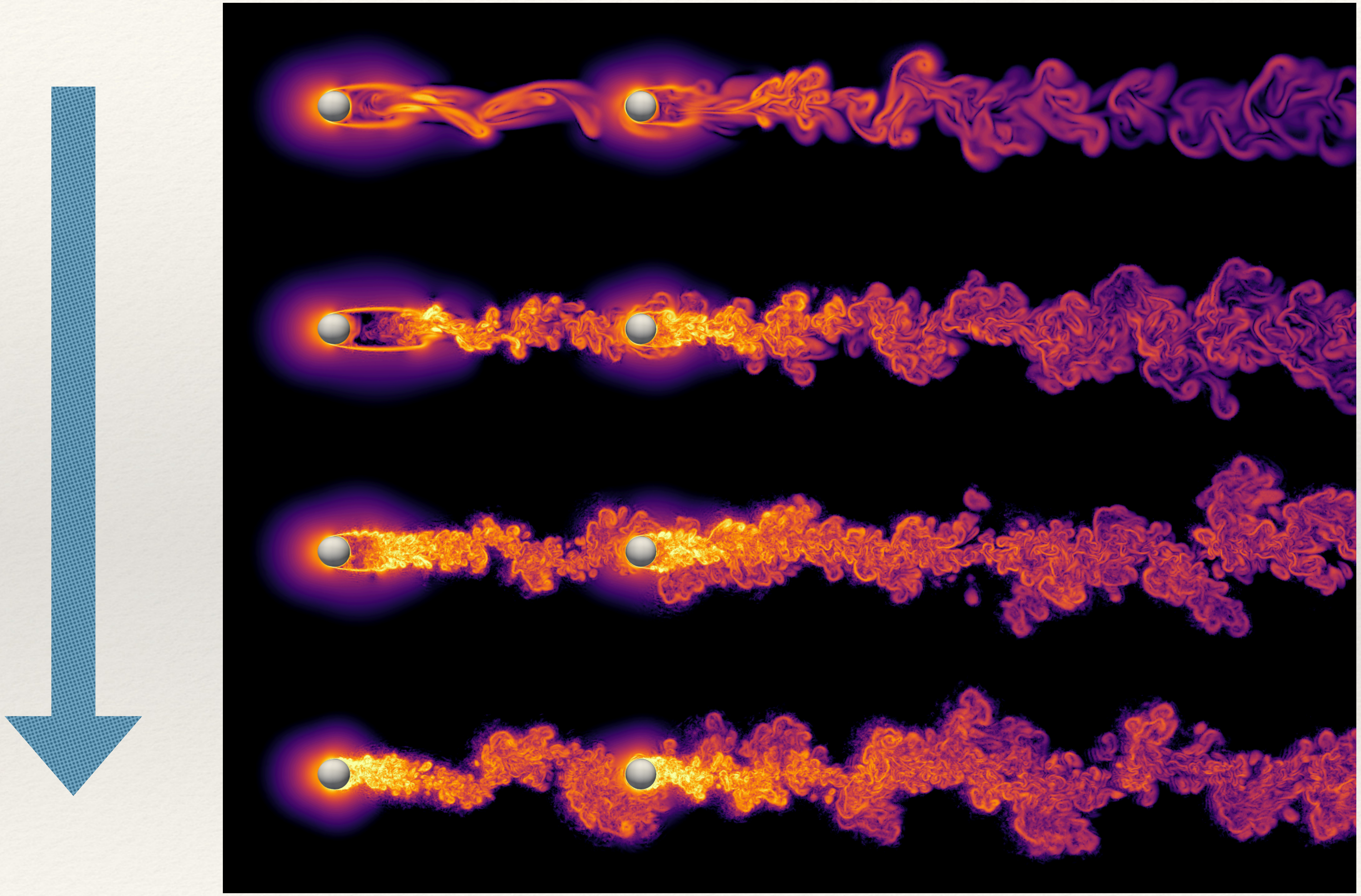
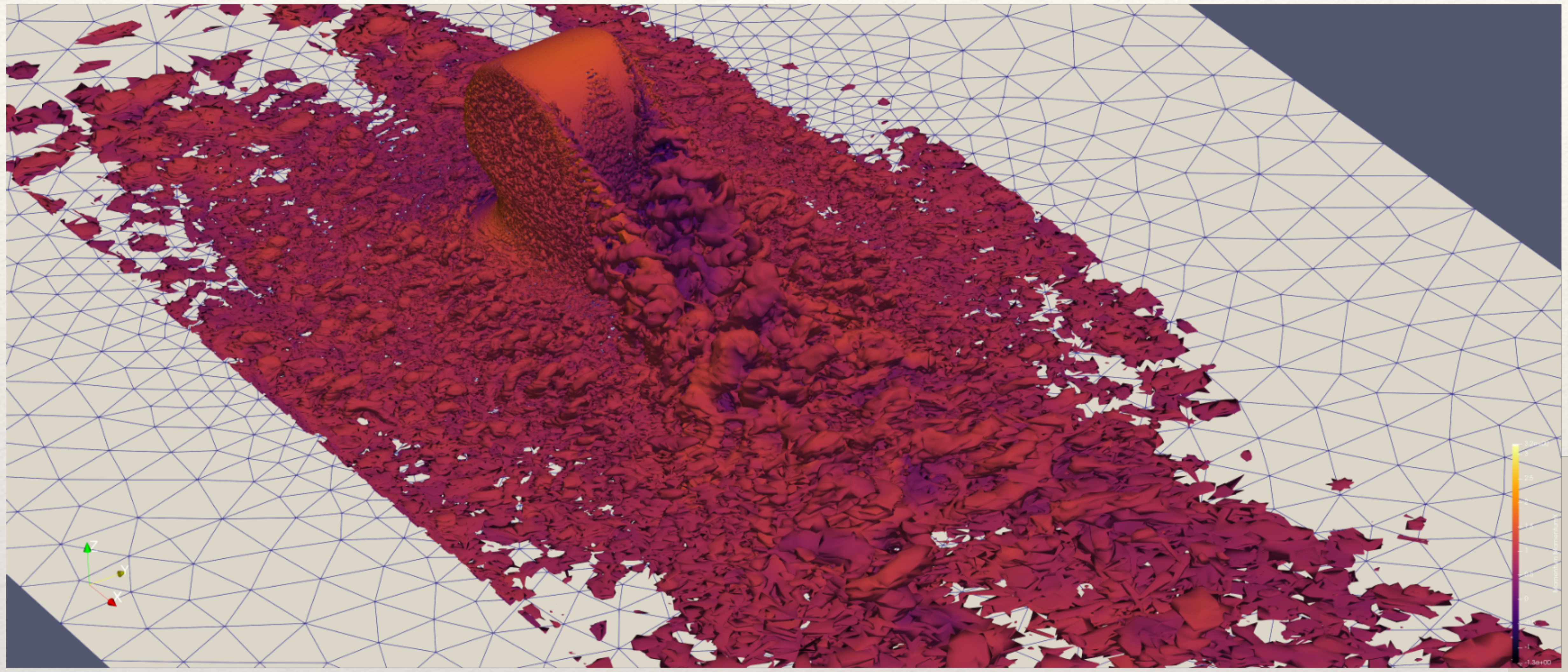
Reynolds Number Effect

$$Re = \frac{\rho V L}{\mu}$$

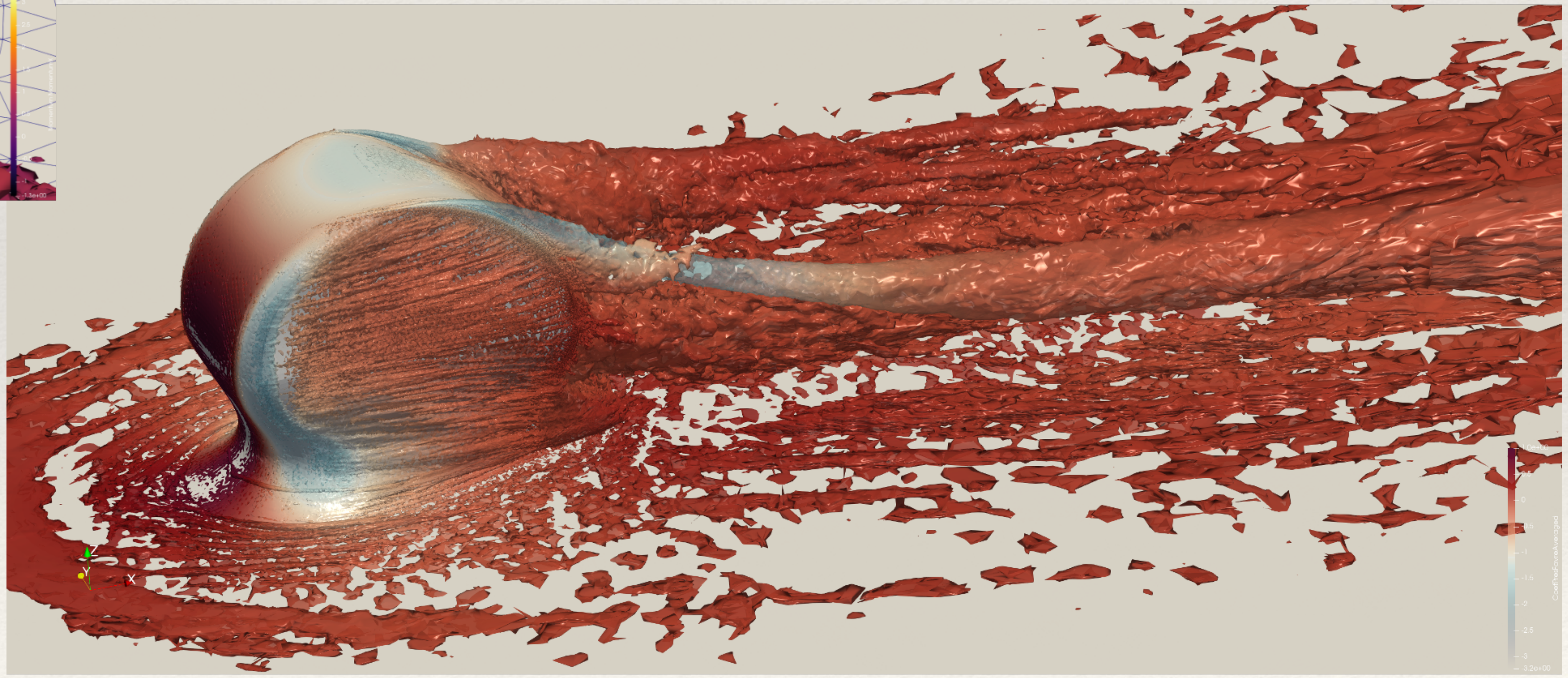


What a Turbulent Flow Looks Like



Instantaneous

Averaged



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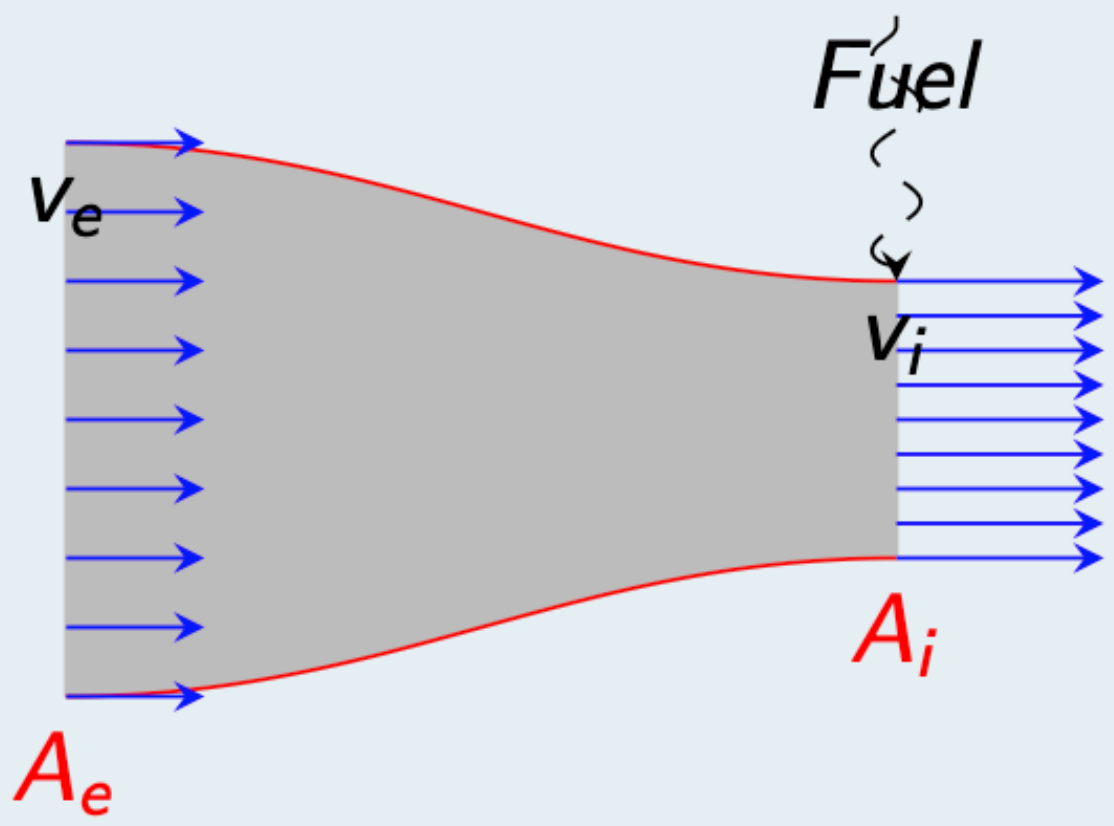
Overview

- Fluid dynamics of carburation. Otto cycle engines used for the propulsion motorcycle - either two-stroke or four-stroke - they require a premixed air-fuel mixture (commercial gasoline, special gasolines for certain competitive uses or, in some rare cases , methyl alcohol and/or ethyl) that can be ignited by the spark produced by a spark plug .
- Engine Cooling: require heat exchange between the engine and the outside air (either direct or via a radiator).
- Overview of Aerodynamic forces on ground vehicles. On a streighaway these are drag (opposing the motion), downforce.

Venturi Effect

Venturi effect

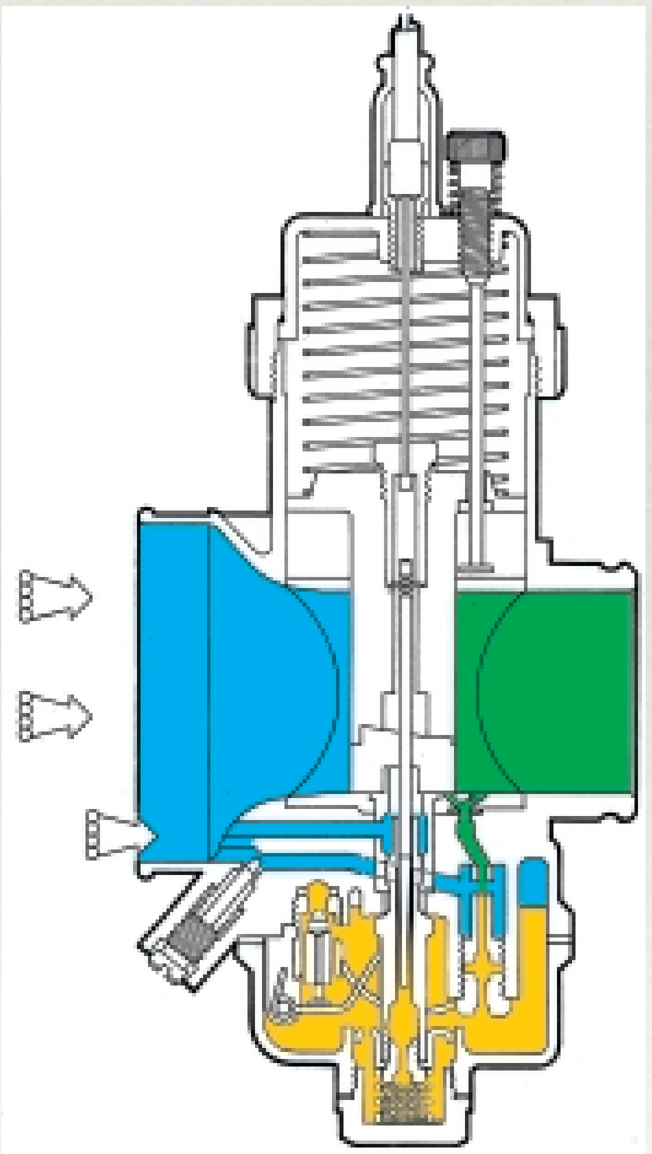
For an incompressible flow, a reduction of area causes an increase in local flow velocity and a consequent decrease in pressure



$$\frac{1}{2}\rho_e v_e^2 + p_e = \frac{1}{2}\rho_i v_i^2 + p_i$$

Carburator Main Functions

1. Control the engine power by adjusting the air intake flow according to the rider's control
2. Meter the fuel flow in the air flow aspirated maintaining the ratio air/fuel to optimal values throughout the engine operating range
3. Homogenize the mixture of air and fuel to enable the subsequent combustion



Engine Cooling

A. The temperature of the hot gases inside the cylinder can be as high as 2000 C (3630 F) .

B. The cylinder head is held at a much lower temperature, the recommended maximum temperature measured at the spark plug base being about 230 to 260 C (446 to 500 F).

C. Thus, the temperature difference between the outside of the cylinder head wall (at the base of the fins) and the cooling air is several times smaller than that from the combustion gas to the wall.

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Convective Heat-transfer

A. Steady State

B. Thin Fin

C. Fourier Heat conduction law

$$\dot{q} = Ah(T_b - T_\infty)$$

Energy Balance

$\theta = (T - T_\infty)$

$$\theta(0) = \theta_b, \begin{cases} \theta(L) = 0 \\ \text{or} \quad \dot{q}(L) = 0 \\ \text{or} \quad \dot{q}(L) = \dot{q}_{cv} \end{cases}$$

Length

$$\frac{d^2\theta}{dx^2} - \frac{hp}{kA_{cs}}\theta = 0.$$

Perimeter

coefficient of conduction

cross sectional area

It is possible to obtained optimal thicknesses, spacing of the fins by mathematical computations

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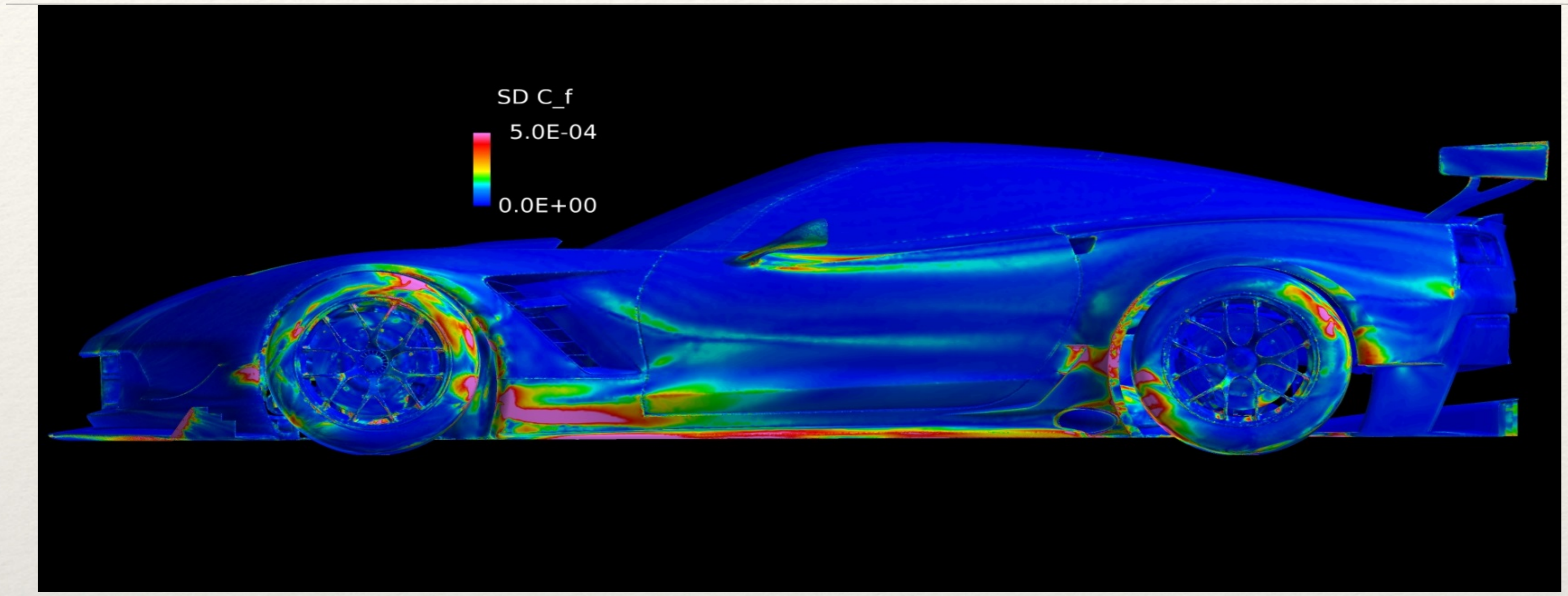
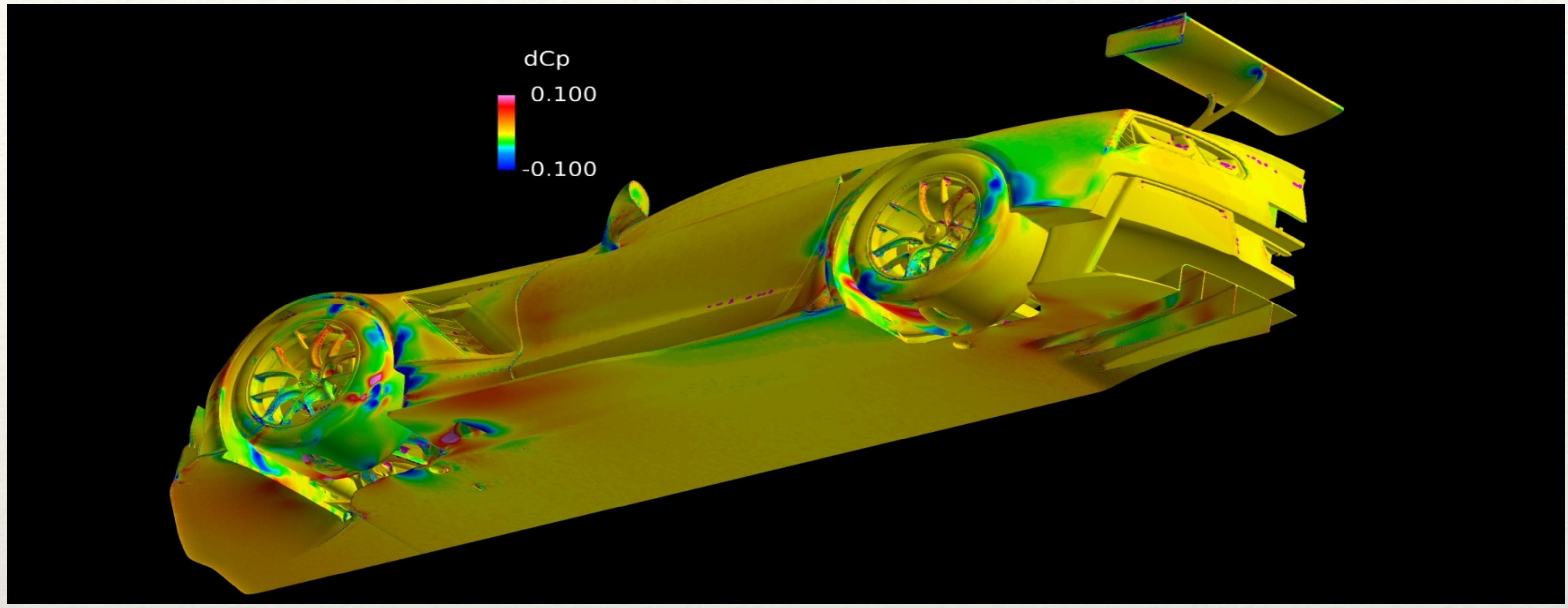
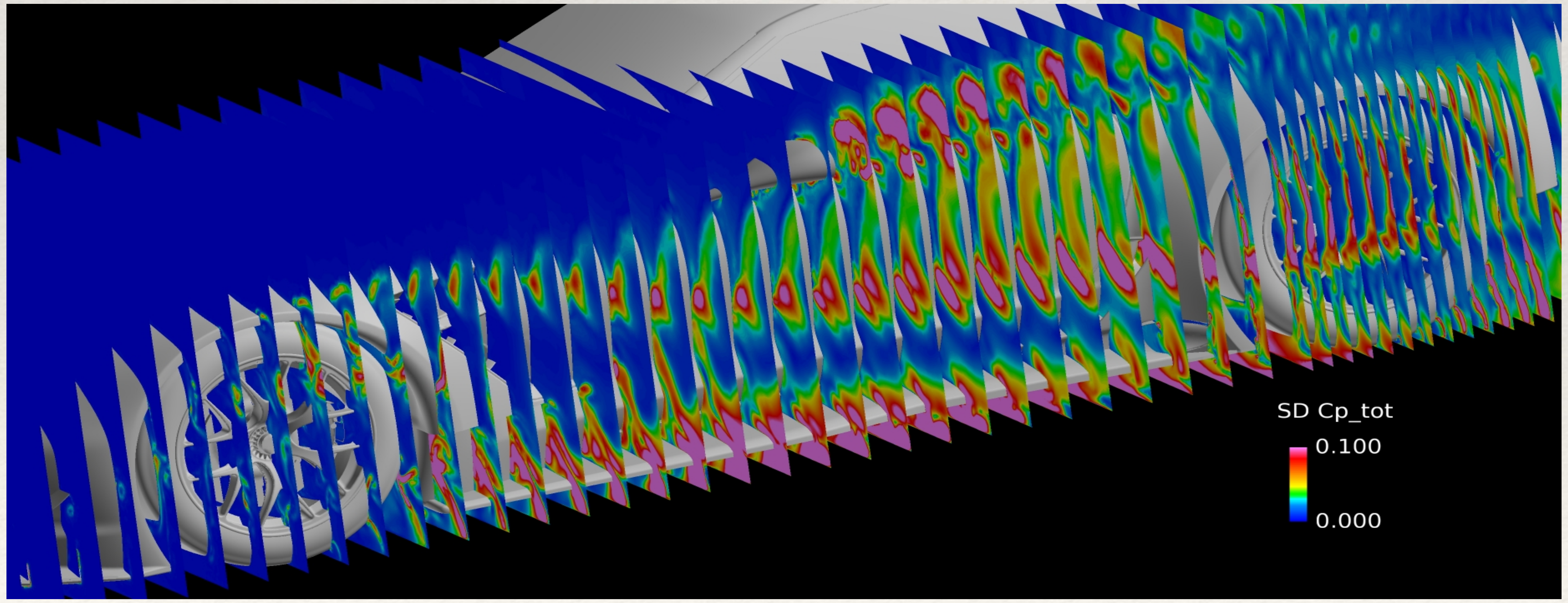
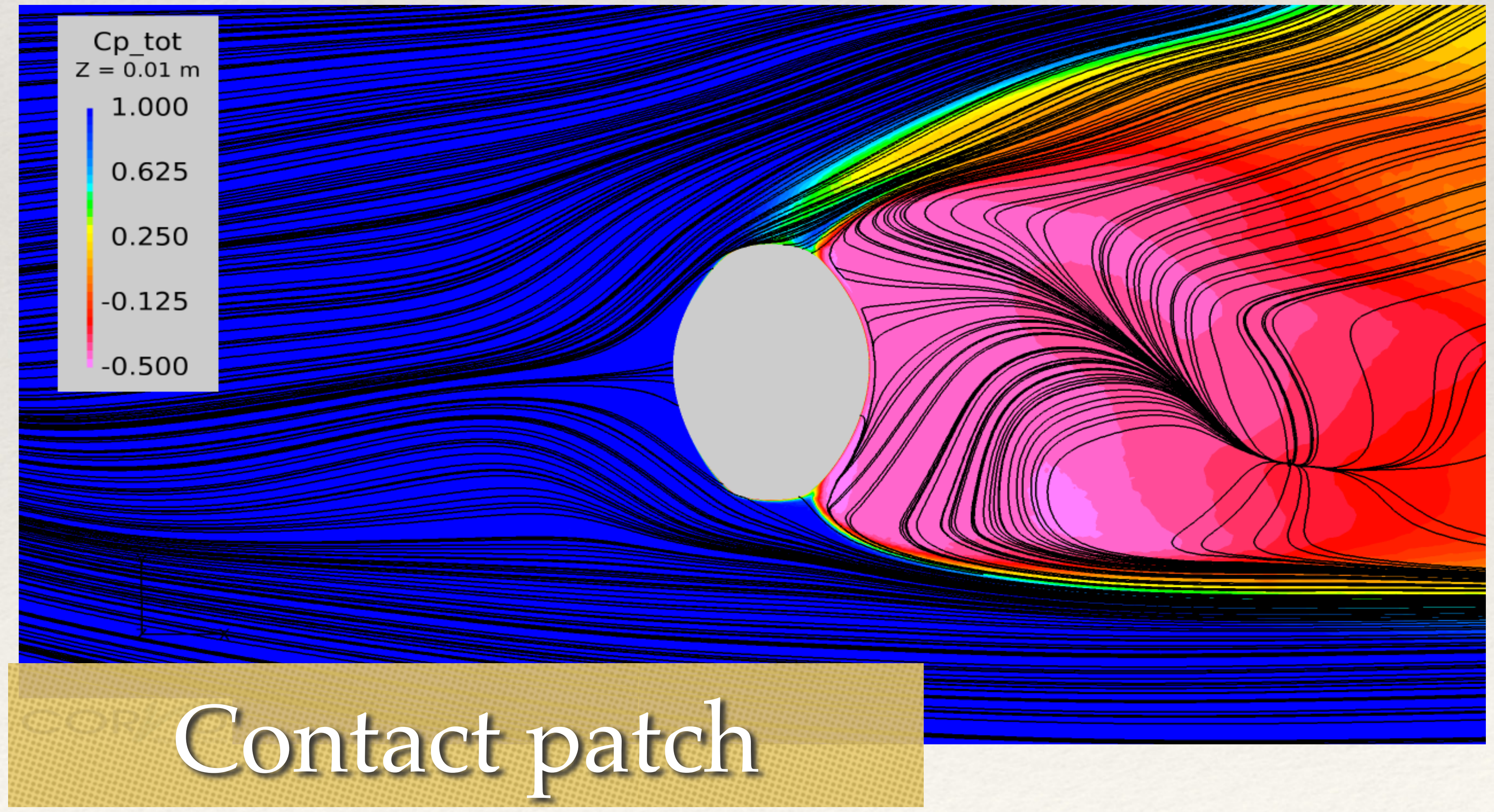
External Aerodynamics









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