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Computational Fluid Dynamics

Simulation around a hummingbird

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Overview

- Introduction
- Geometry
- Computational mesh
- Models
- Computational results
- Analysis
- Summary

Introduction

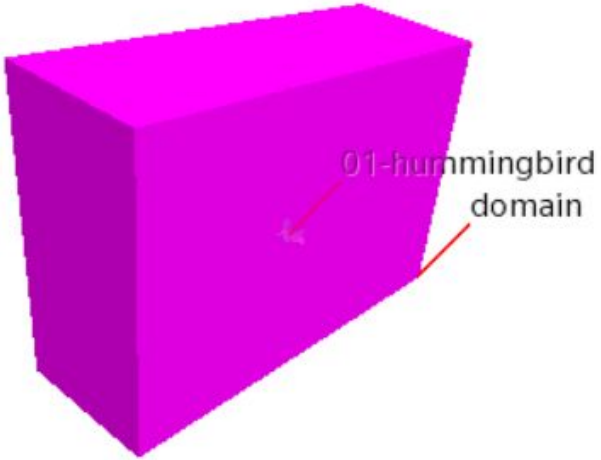
- Study the flow behaviour around a hummingbird
- Characteristics:
  - Flow velocity
  - Pressure
  - Drag
  - Lift
- Nature is the best engineer

Geometry

Model dimension: 20 cm

Hummingbirds range from 5 cm - 23 cm

Computational Domain

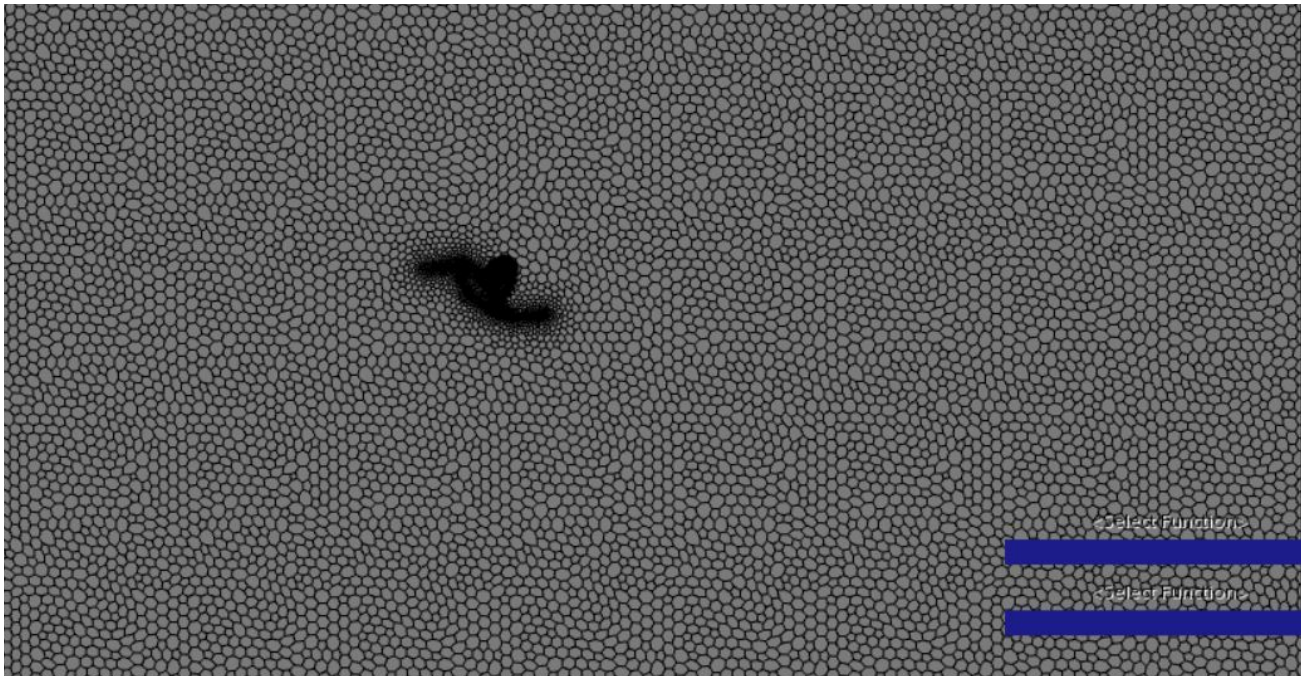


Computational mesh

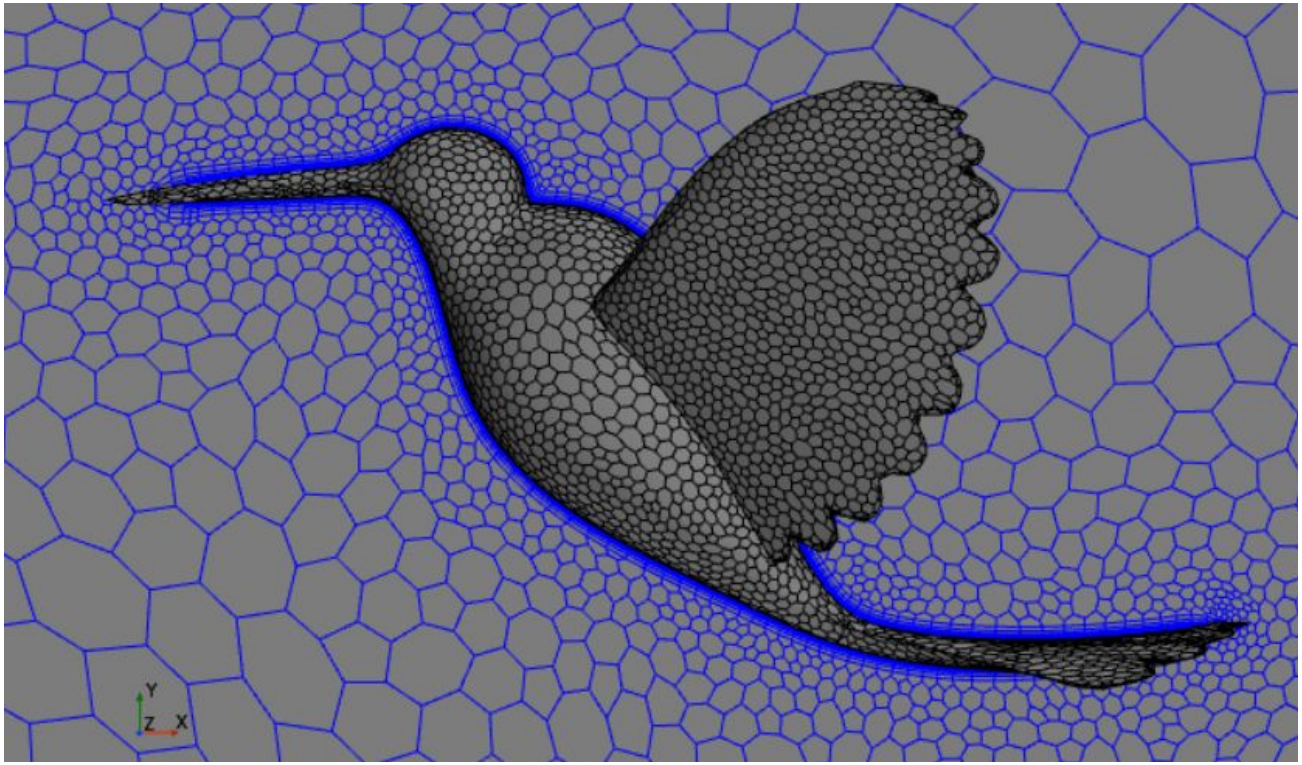
Polyhedral cells
Prism cells

Base size - 20 mm
No.of Prism layers - 9

No of cells : 2,80,700



Computational mesh

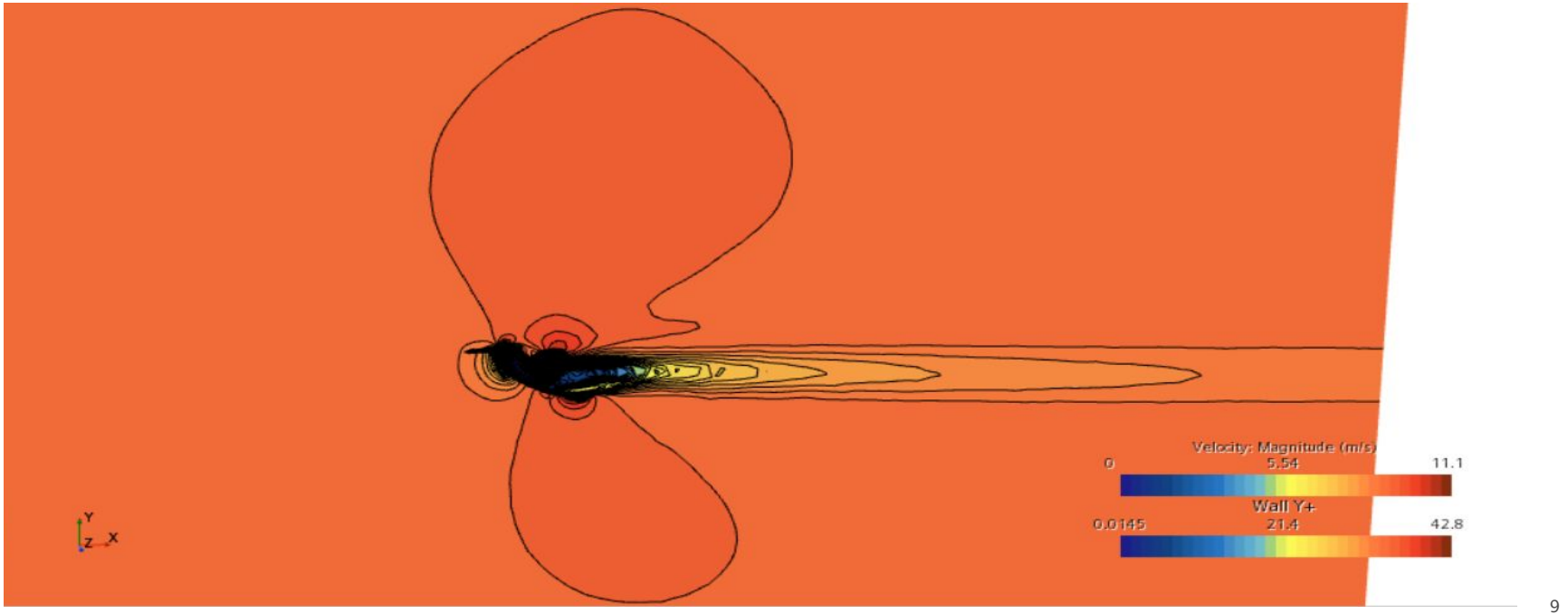


Models

- Two-Layer All y+ Wall Treatment
- Wall Distance
- Realizable K-Epsilon Two-Layer
- K-Epsilon Turbulence
- Reynolds-Averaged Navier-Stokes
- Turbulent
- Constant Density
- Gradients
- Segregated Flow
- Steady
- Gas
- Three Dimensional

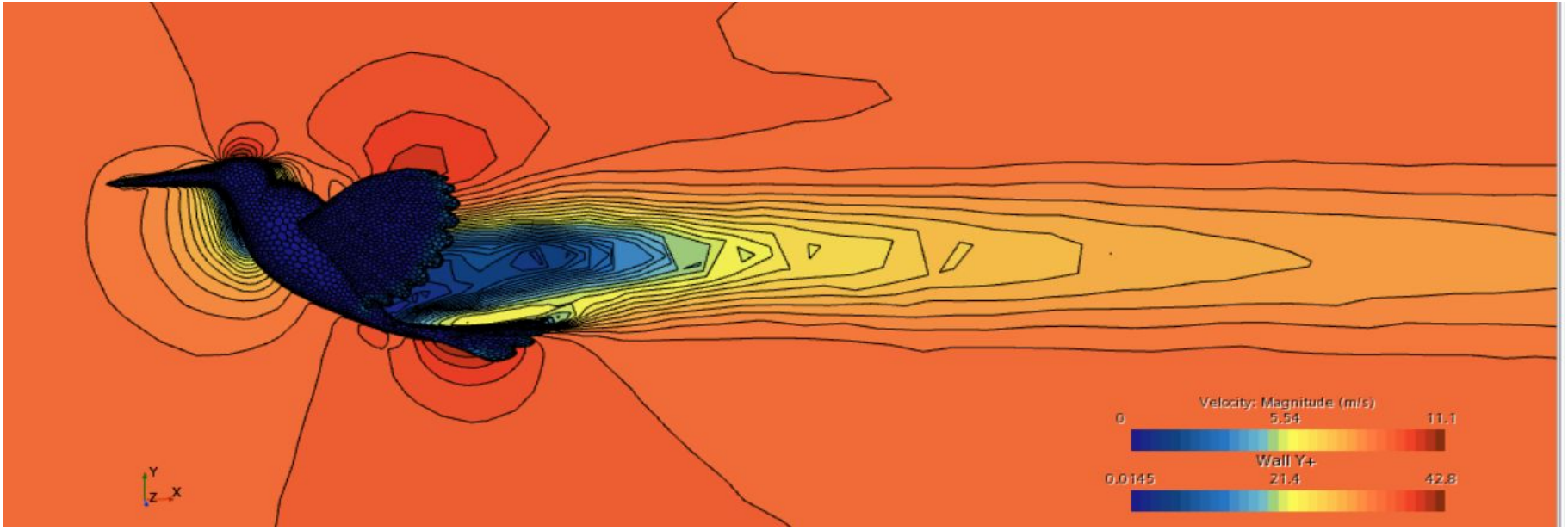
Computational Results

Velocity profile for 9 m/s inflow profile



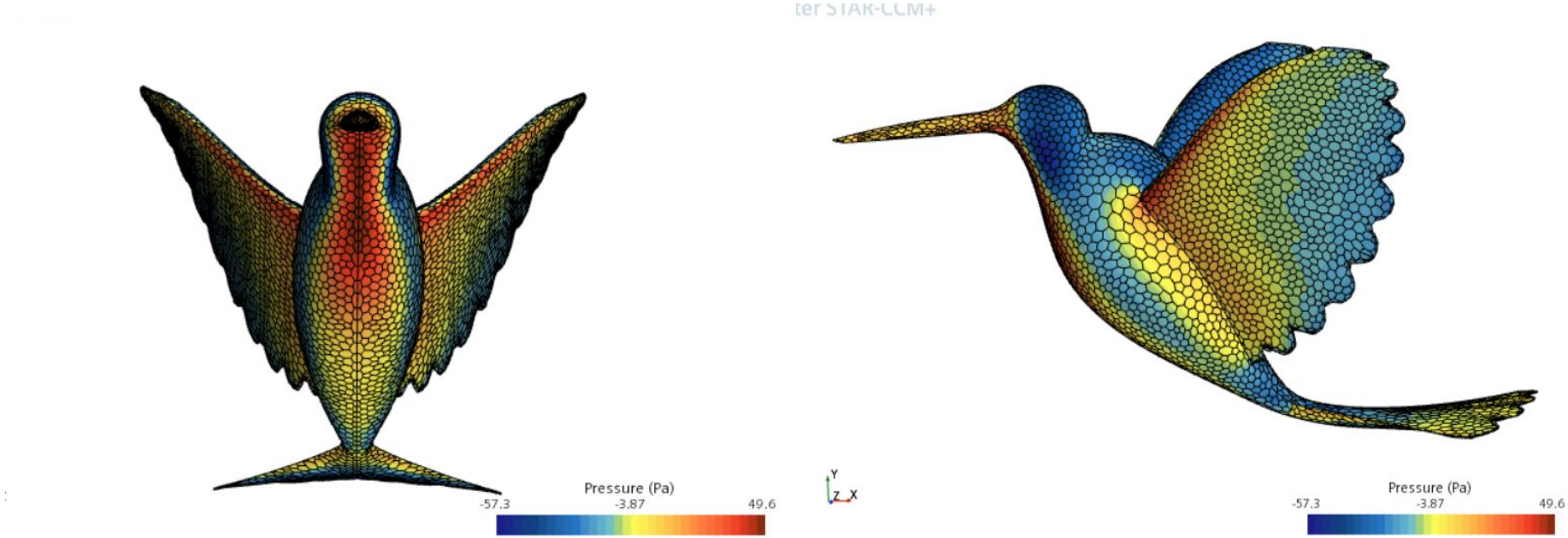
Computational Results

Velocity profile for inflow velocity of 9 m/s



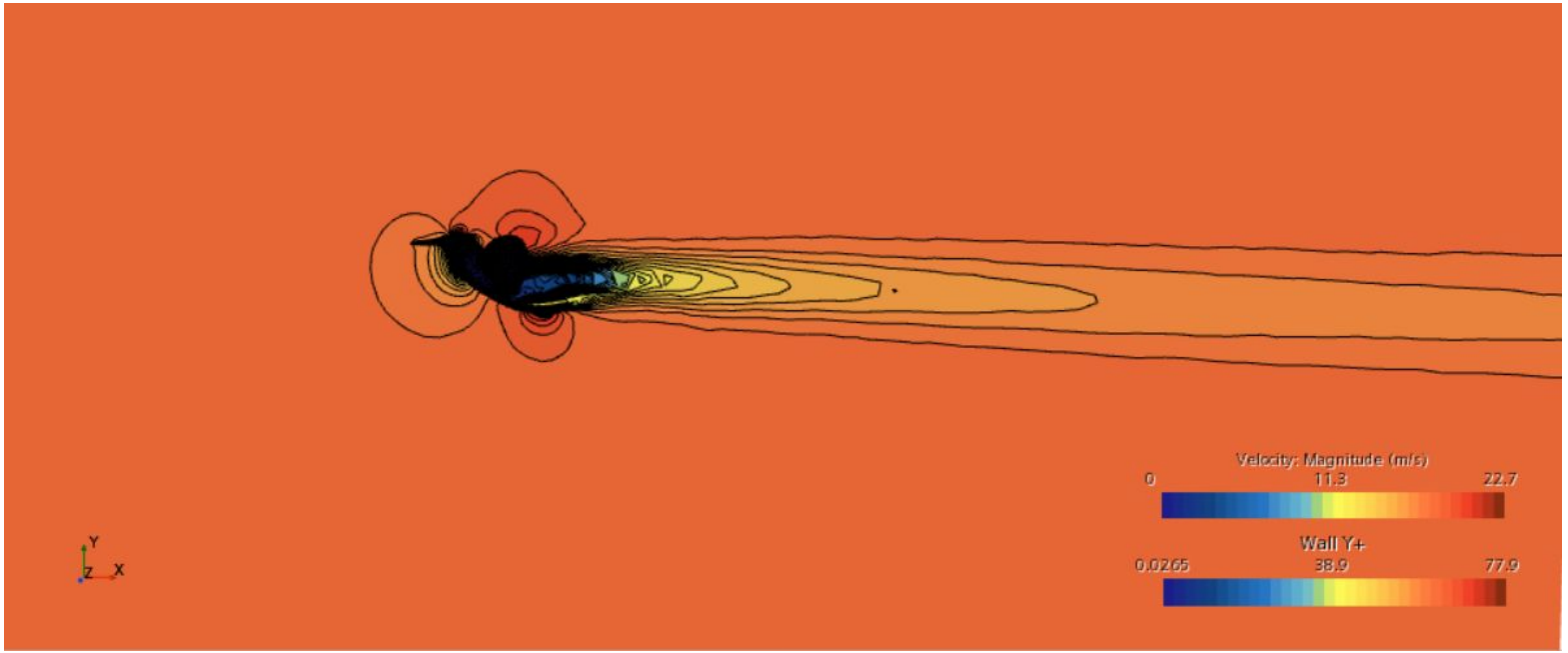
Computational Results

Pressure distribution for inflow velocity of 9 m/s



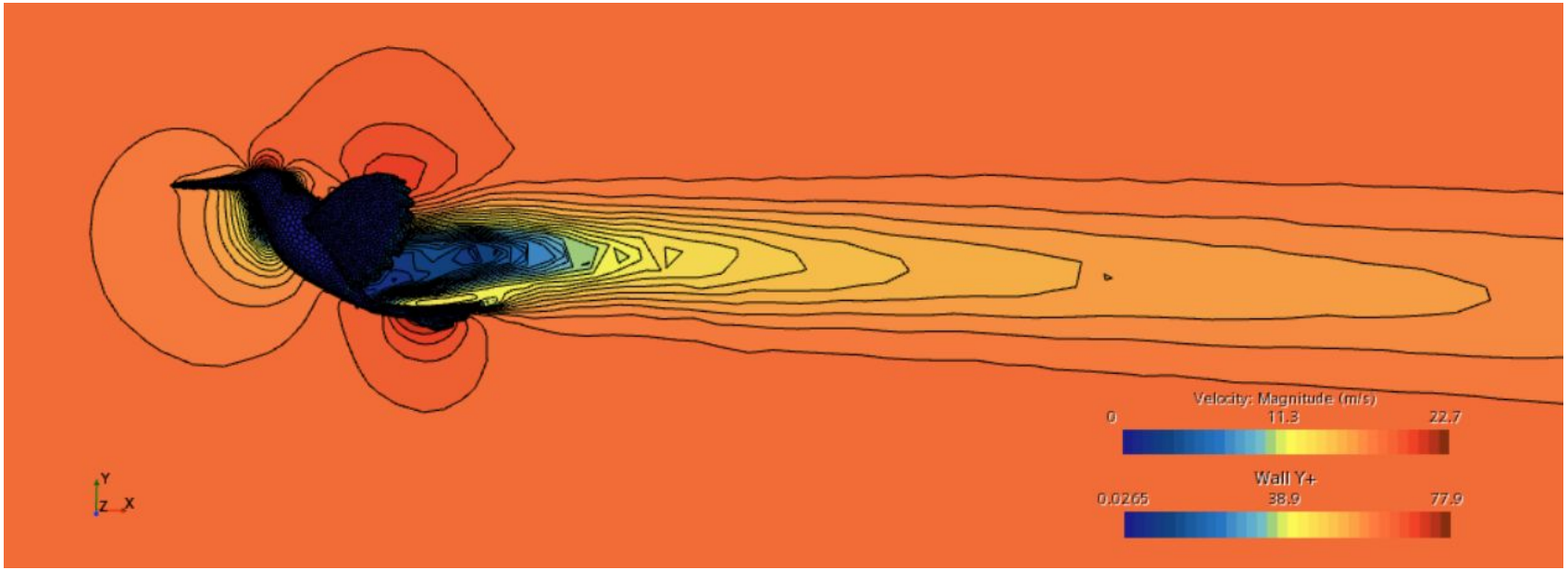
Computational Results

Velocity profile for inflow velocity of 18 m/s



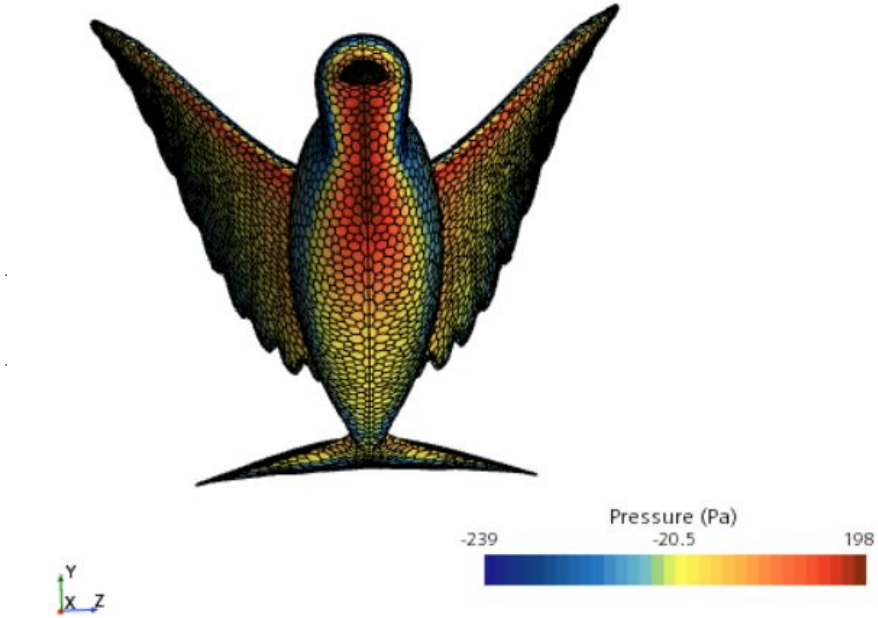
Computational Results

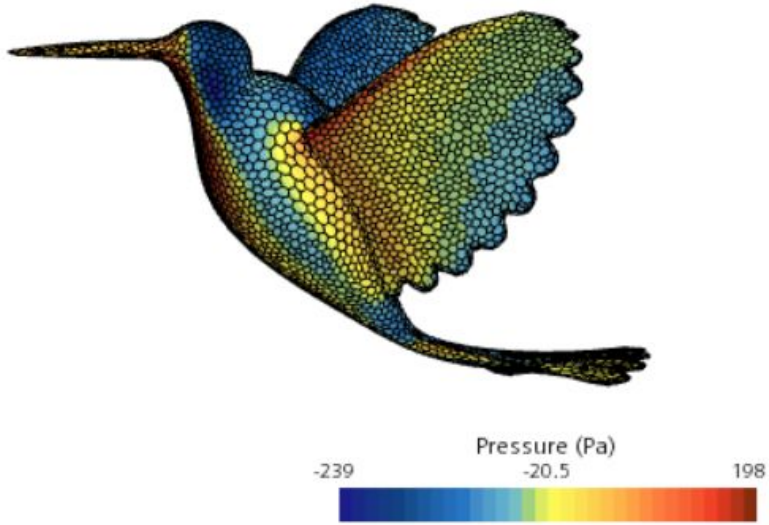
Velocity profile for inflow velocity of 18 m/s



Computational Results

Pressure distribution for inflow velocity of 18 m/s





Analysis

Inflow velocity	Frontal Area	Drag Coefficient	Drag force	Lift Coefficient	Lift force
9 m/s	0.002152 m²	0.538	0.06 N	0.328	0.028 N
18 m/s		0.529	0.238 N	0.327	0.114 N

Summary

- Change in velocity not affecting the coefficients much
- Forces increase significantly with velocity
- No much high pressure points
- Aerodynamic structure
- Nature can be a best source for inspiration

Thank You