

# SankhyaSutra Labs Ltd.

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## The 2nd Automotive CFD Prediction Workshop

# Introducing SankhyaSutra Labs Ltd.



To become a global leader for providing tools and solutions for engineering and scientific simulations across industry and academia



Aerospace, Automotive, Biomedical, Petrochemical, Semiconductors  
North America, Europe, India and Japan

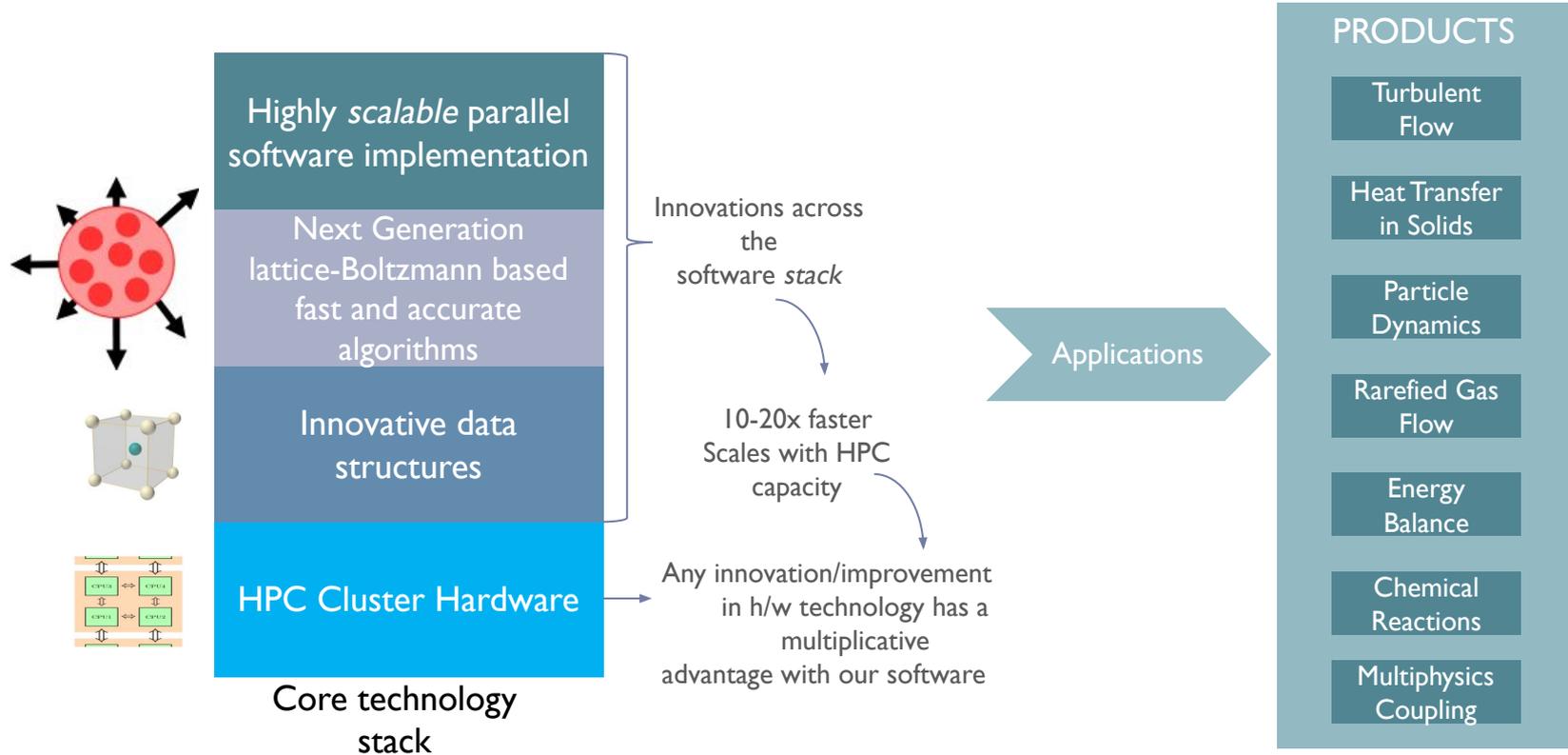
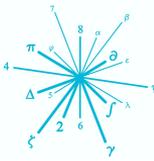


2015: Incubated in JNCASR  
2019: Investment by Reliance



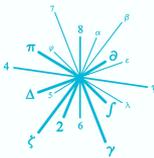
40 Engineers and Scientists  
Leadership team with strong industry and research experience

# Our Core Technology

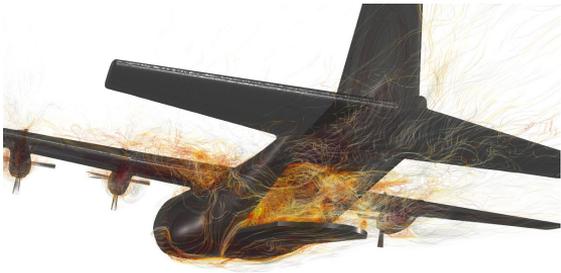




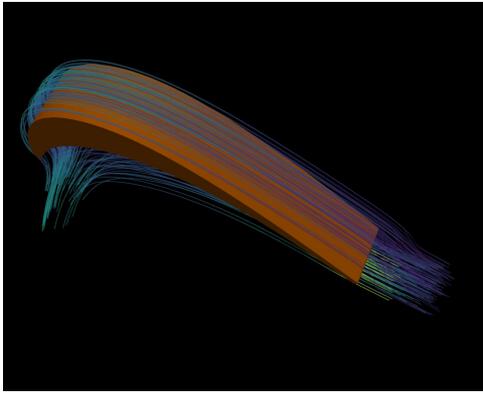
# Applications



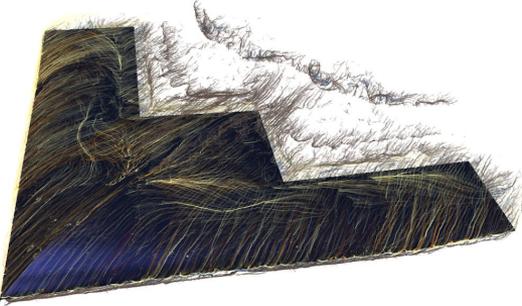
**IC Engines**



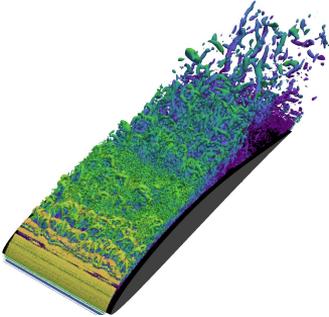
**C130 Aircraft**



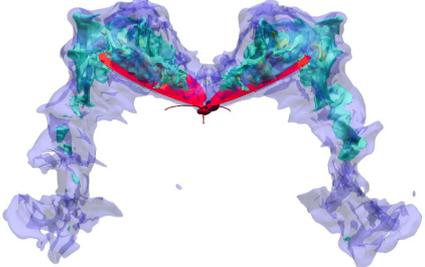
**T106A Low-Pressure Turbine (LPT) cascade**



**Sacson**

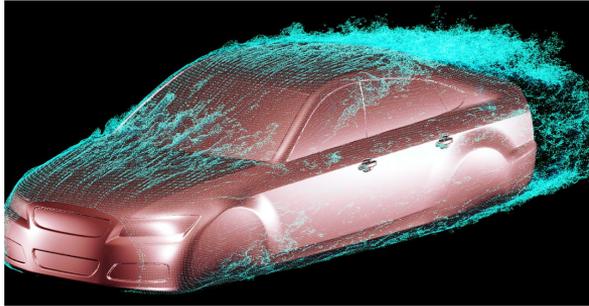
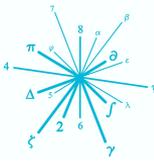


**E387 Airfoil**

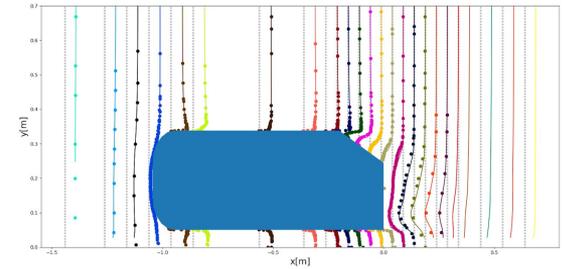
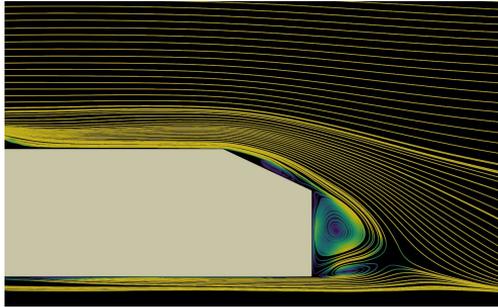
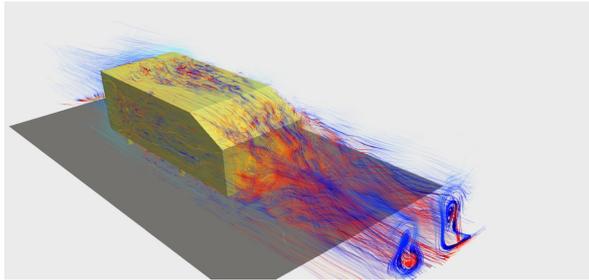
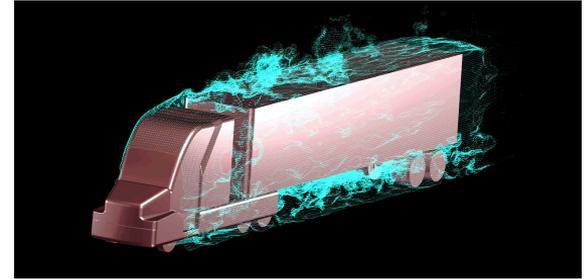


**Glasswing Butterfly**

# Ground-Based Vehicle Simulations

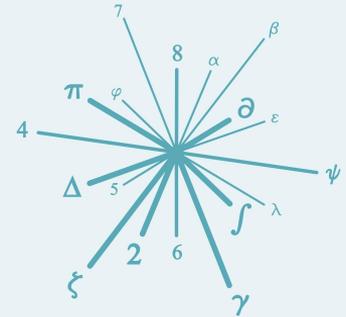
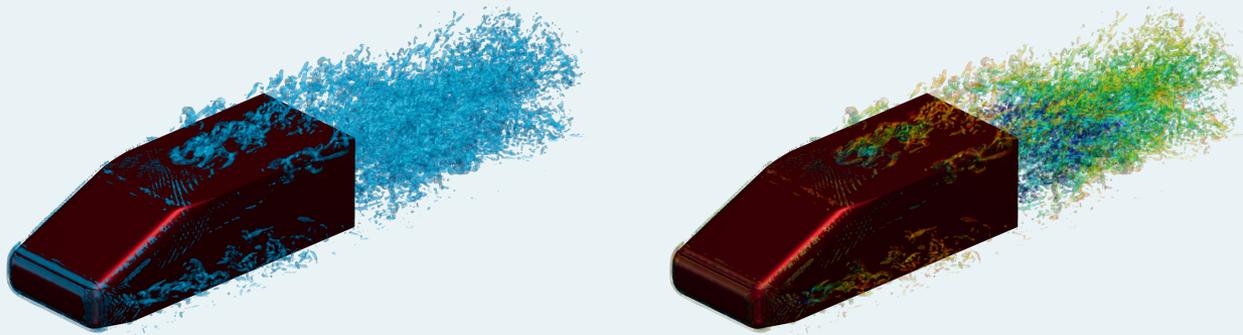


**DrivAer Fastback**  
**Ahmed Body**  
**GCM Truck**



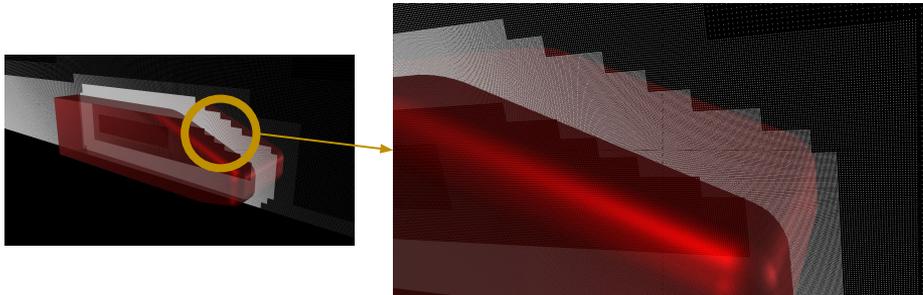
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# LES/DNS of flow past the Windsor Geometry using a higher-order LB model (CASE NW1B)

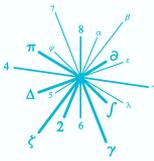
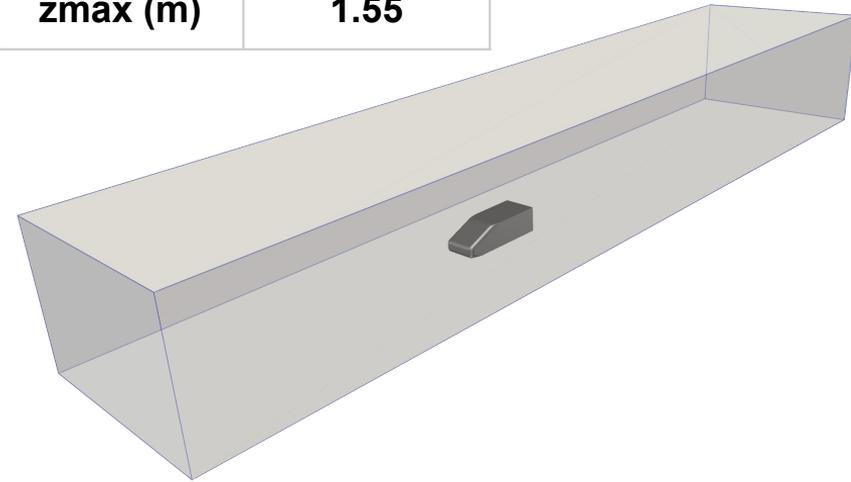


# Case nW1B Setup

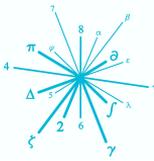
- The **domain dimensions** have been given as **specified** in the workshop document
- **Meshing Design**
  - Custom multiresolution **LBM grid** specified as close to committee grid as possible
  - **Finest resolution on the body = 0.00045m**
  - Automatic load balancing
  - Automated **body-fitted mesh** based on **local curvature**
  - Final mesh ~ 1.12B elements
- **Re = 2.9e06** based on the vehicle length



<b>xmin (m)</b>	<b>-5.00</b>
<b>xmax (m)</b>	<b>6.28</b>
<b>ymin (m)</b>	<b>-1.17</b>
<b>ymax (m)</b>	<b>1.17</b>
<b>zmin (m)</b>	<b>0.00</b>
<b>zmax (m)</b>	<b>1.55</b>



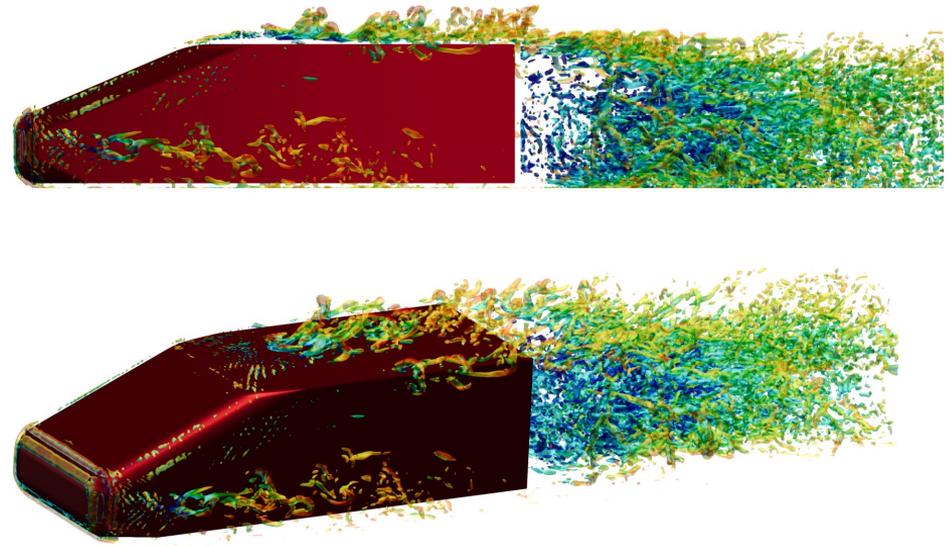
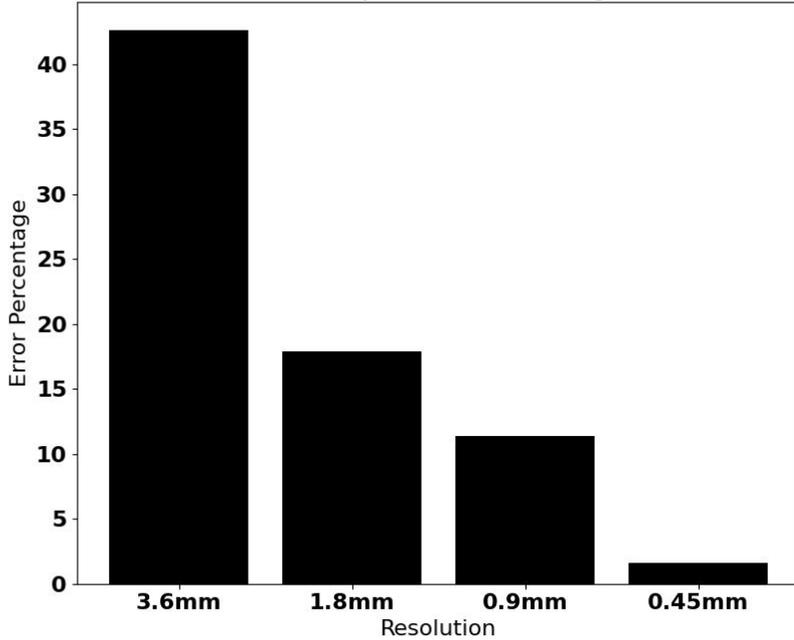
# Results (Drag)



Reference Drag: 0.3070  
SSLabs : 0.3105

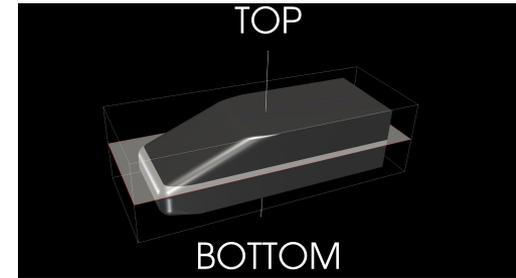
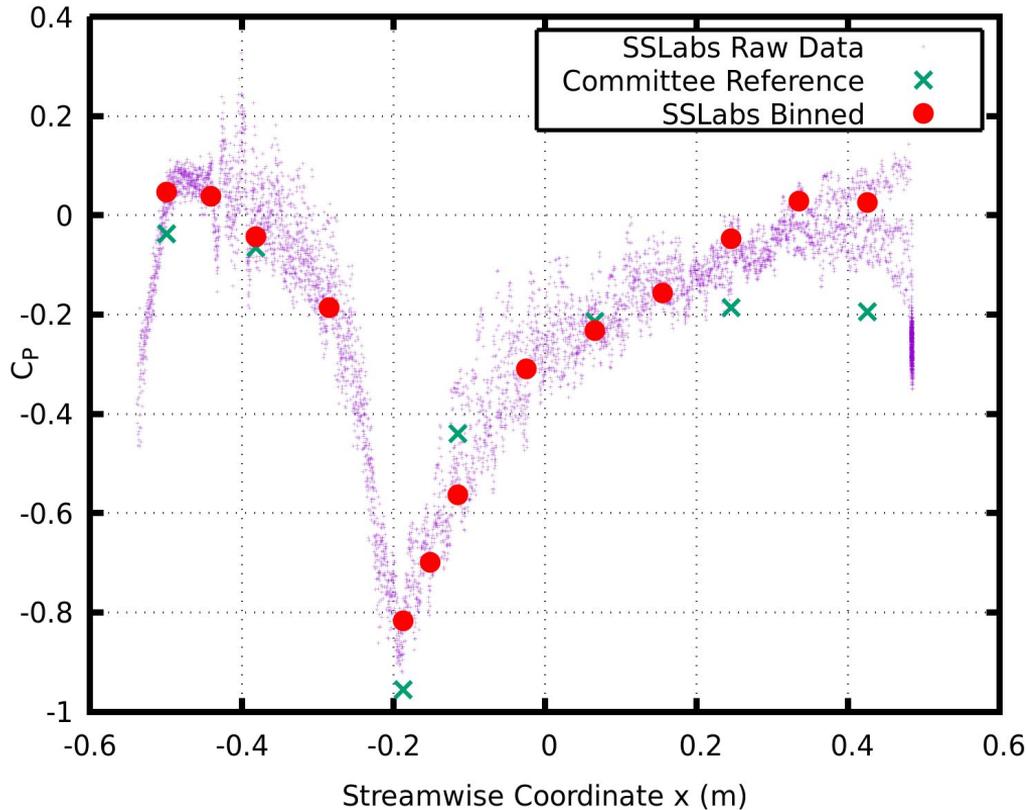
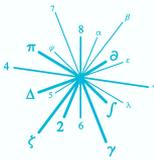
Percentage Error: 1.14%  
(at finest res)

Error and Near-Body Resolution (Drag Coefficient)



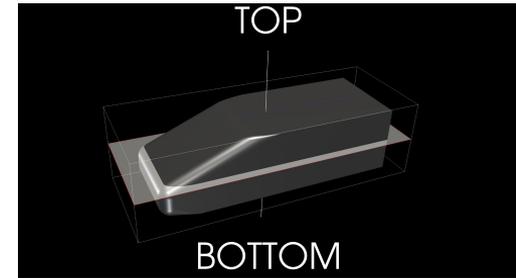
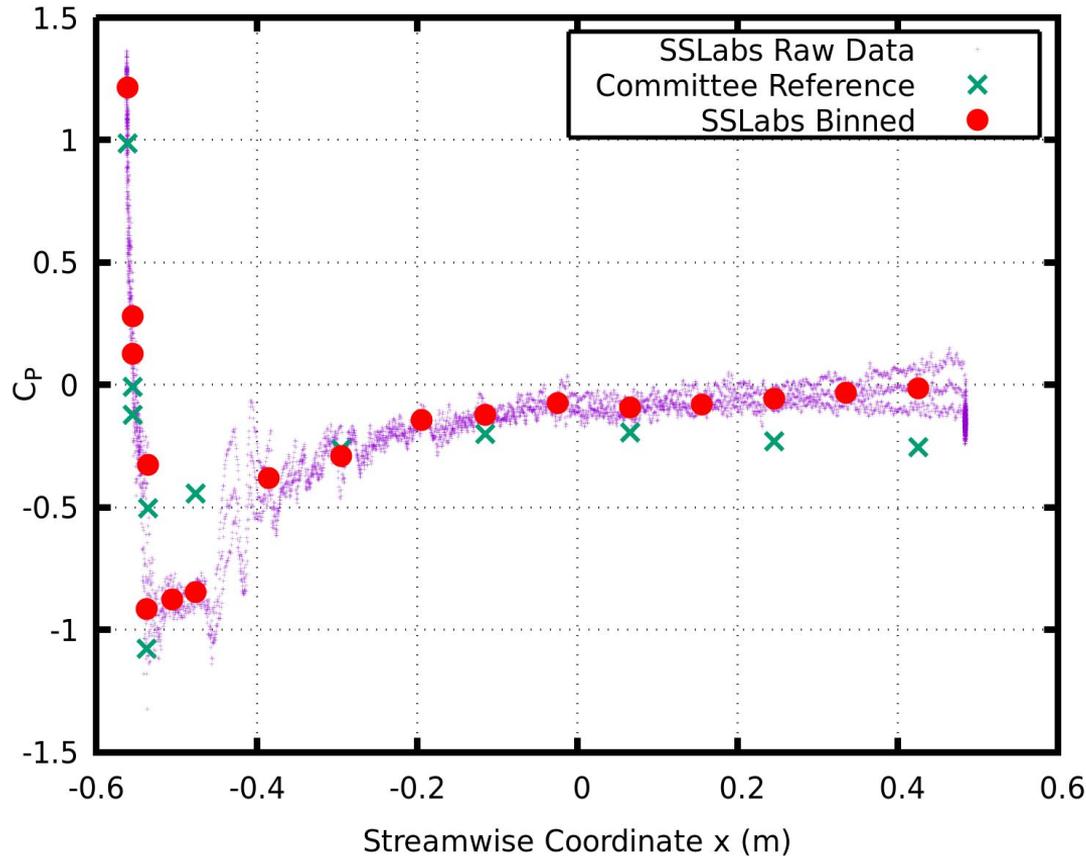
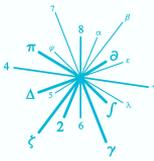
Visualizing Q-Criterion Contours (Q = 350)  
(with velocity colouring)

# Results (Pressure Data - Top Surface)

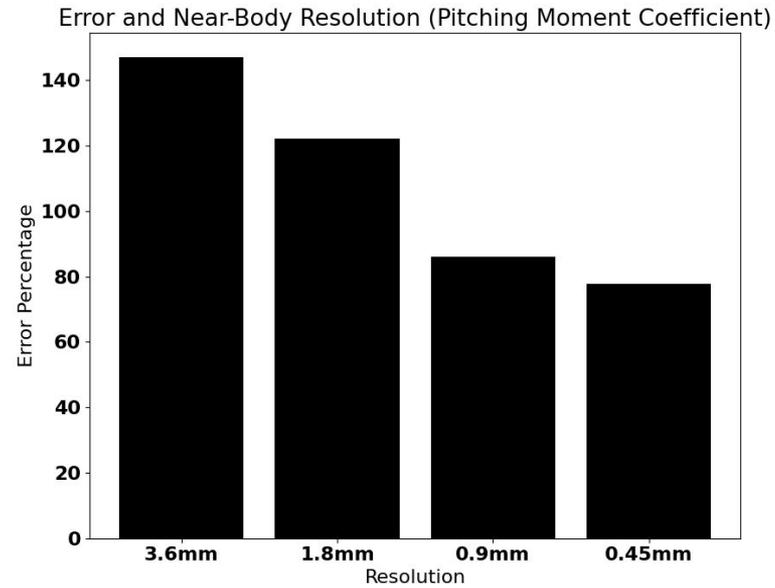
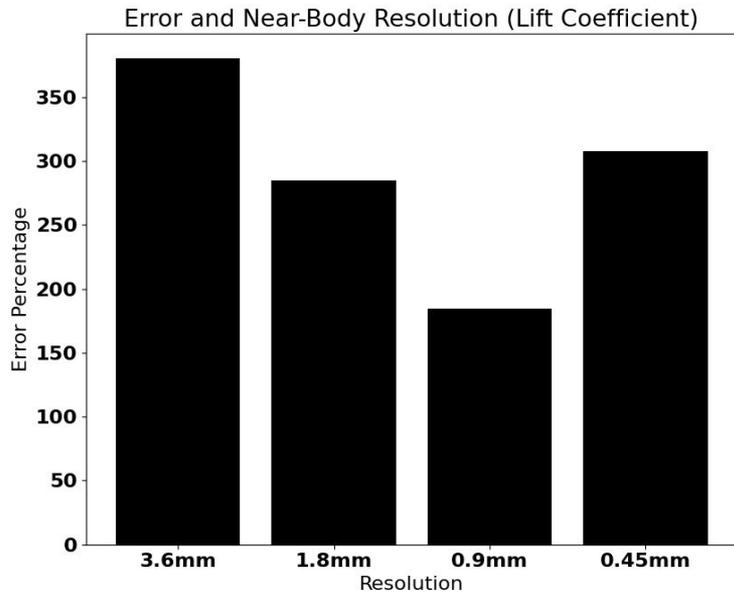
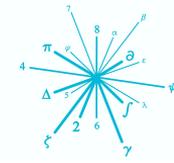


<b>Good</b>	<b>Bad</b>
<b>Front/Mid-Region</b>	<b>Mid to Rear Region</b>

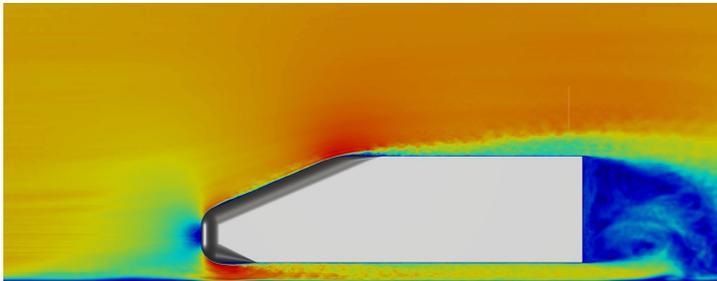
# Results (Pressure Data - Bottom Surface)



Pressure mismatch manifesting in lift mismatch



20mm  60mm

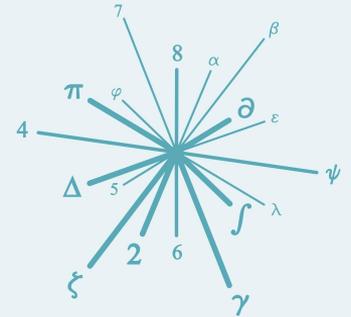
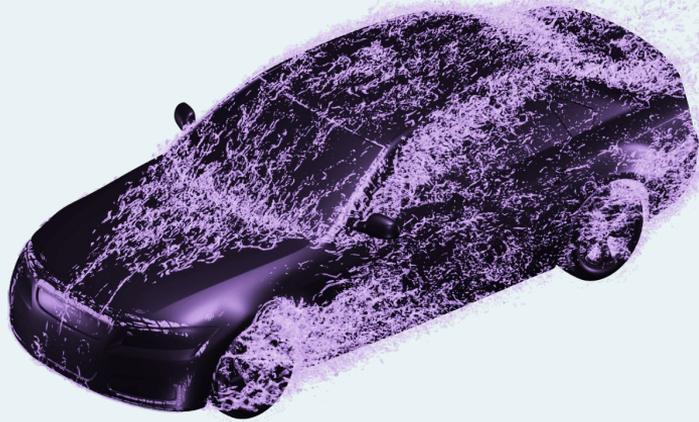


BL is clearly **laminar!**

- BCs not treated for BL thickness
- Affects underbody flow
- Mismatch in lift and pitching moment
- No observable trend towards convergence

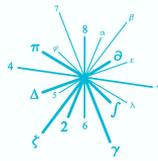
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# LES/DNS of flow past the DrivAer Notchback Geometry using a higher-order LB model

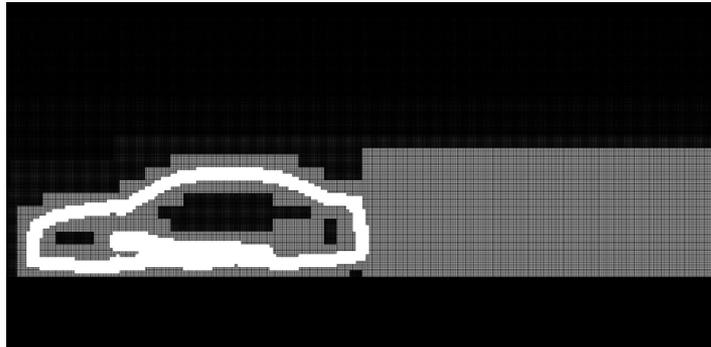


# Case 2 Setup

- The **domain dimensions** have been given as specified in the workshop document
- **Meshing Design**
  - **Finest resolution on the body = 0.00221m (full-scale model used)**
  - Two grids - coarse and fine
  - Final meshes have an approximate of 2.83B elements
  - **Challenges in marking the geometry** due to complex underbody components
- **Re = 4.87e06** based on the length of the vehicle



<b>xmin (m)</b>	<b>-40.00</b>
<b>xmax (m)</b>	<b>81</b>
<b>ymin (m)</b>	<b>-21</b>
<b>ymax (m)</b>	<b>21</b>
<b>zmin (m)</b>	<b>0.00</b>
<b>zmax (m)</b>	<b>19.8</b>



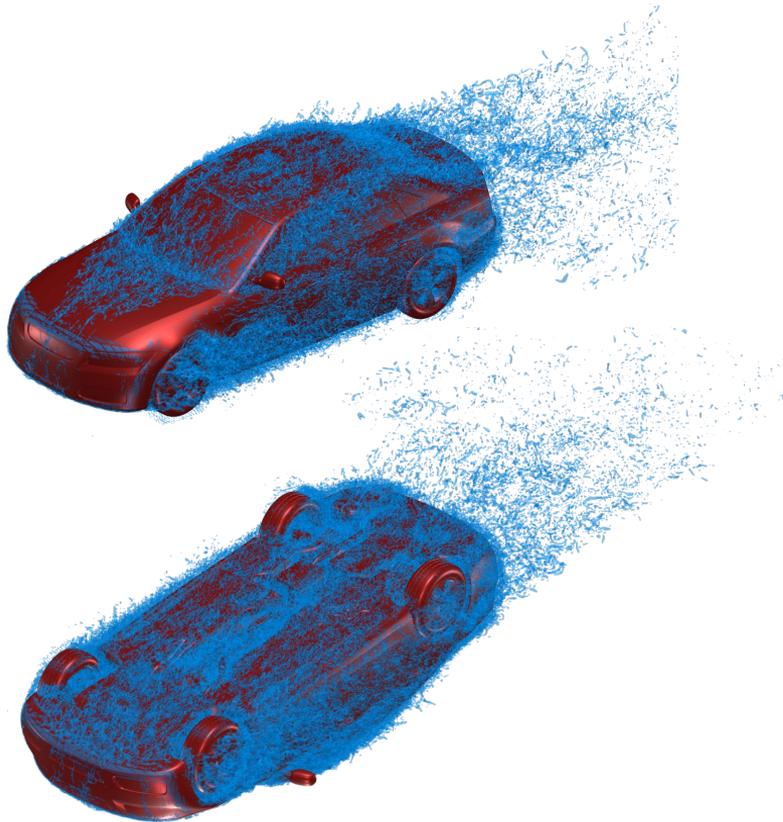
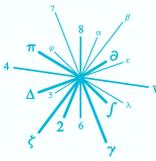
Case 2: **Finer Mesh**



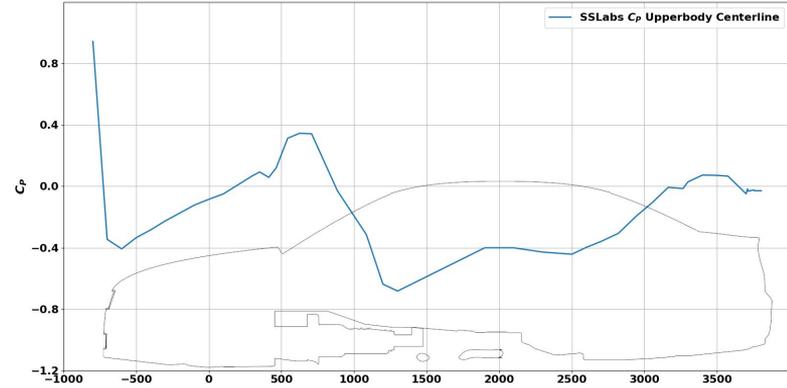
Case 2: **CFD Domain**



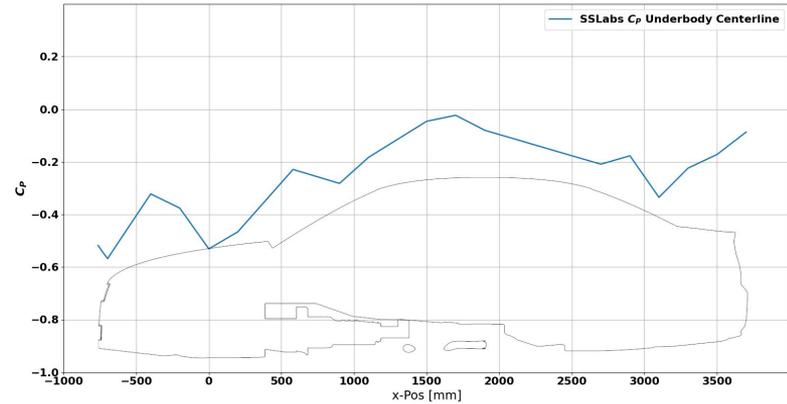
# Results (Pressure)



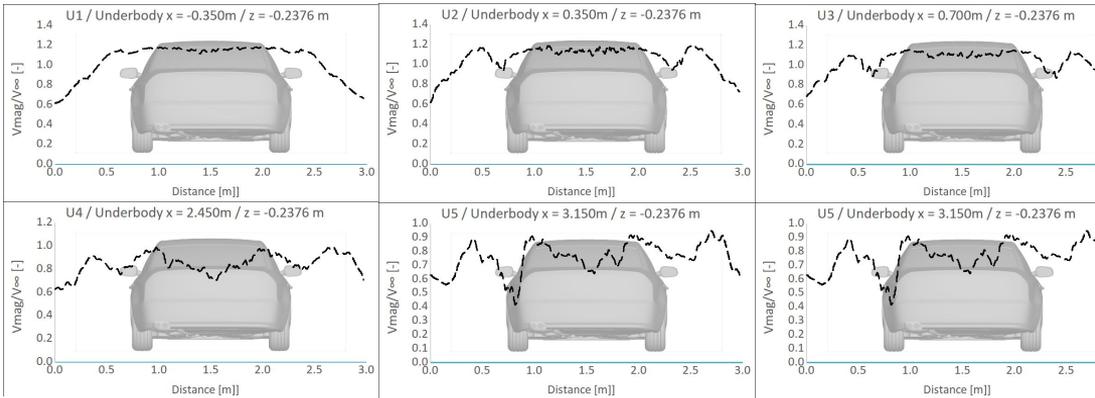
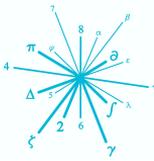
TOP



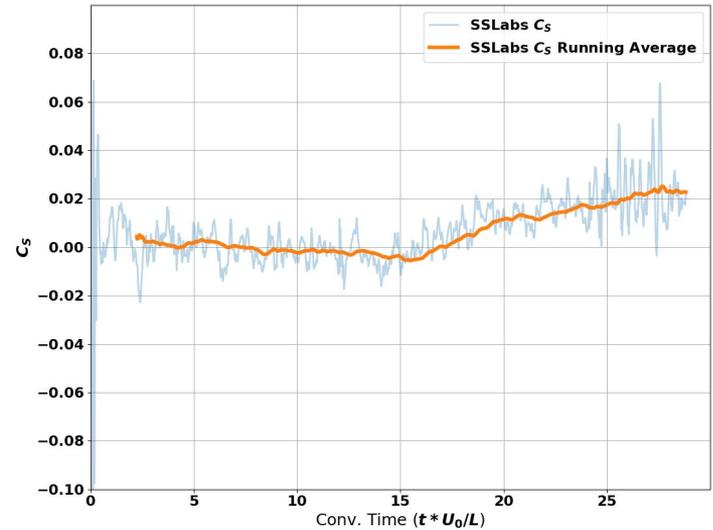
BOTTOM



# Results (Velocity Plots - Underbody, Side Force Coefficient)

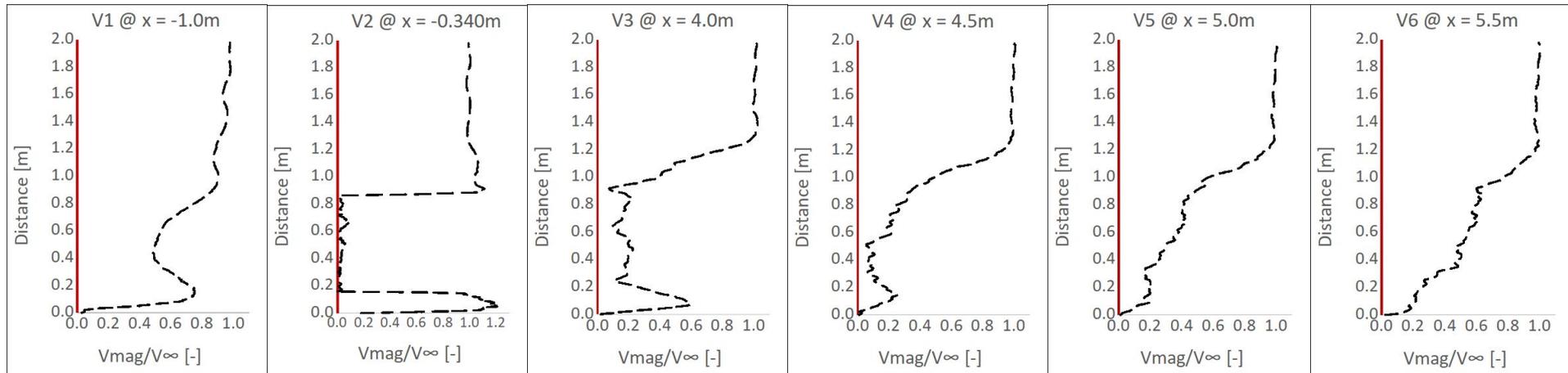
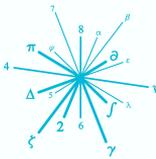


**Lack of symmetry, have to run/average for more CTUs**

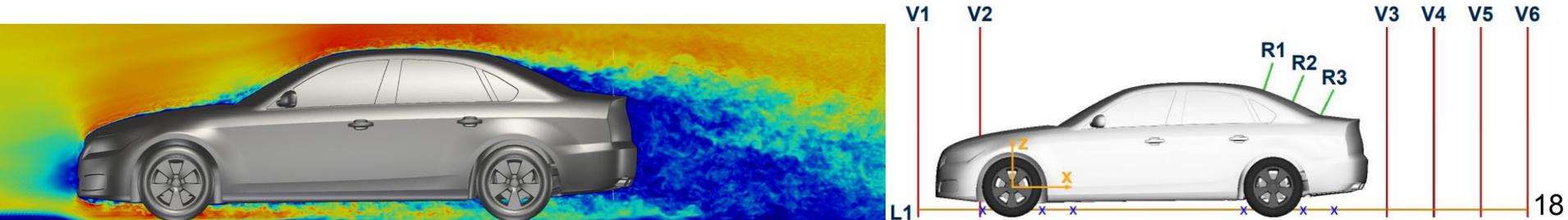


**Side Force Coefficient Value: 0.017**

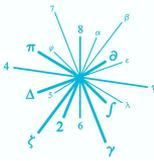
# Results (Velocity Plots - Wake)



Recirculation leads to most of the **drag**

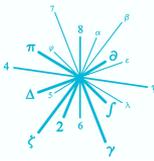


# Conclusions/Remarks



- Case nW1B and Case 2 simulations were conducted with Taral with multiple grids, with the near body resolution kept to be as close to the committee grids as possible
- Case nW1B displayed **convergence in drag** but **mismatch in lift** is apparent:
  - **BL treatment** has to be done more carefully, BL is purely laminar
  - Simulations need to be conducted at **higher resolutions** to establish convergence
- Among **Case 2**'s force coefficient values, the **drag coefficient did not change much** from the coarser to the finer grid
- However, the **lift coefficient seems to have changed** but the simulation has not been run for long enough to establish convergence
- In Case 2, the **side force coefficient is also not zero**, perhaps due to the **asymmetry in the underbody region** of the vehicle

# Contact



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*Thank you!*