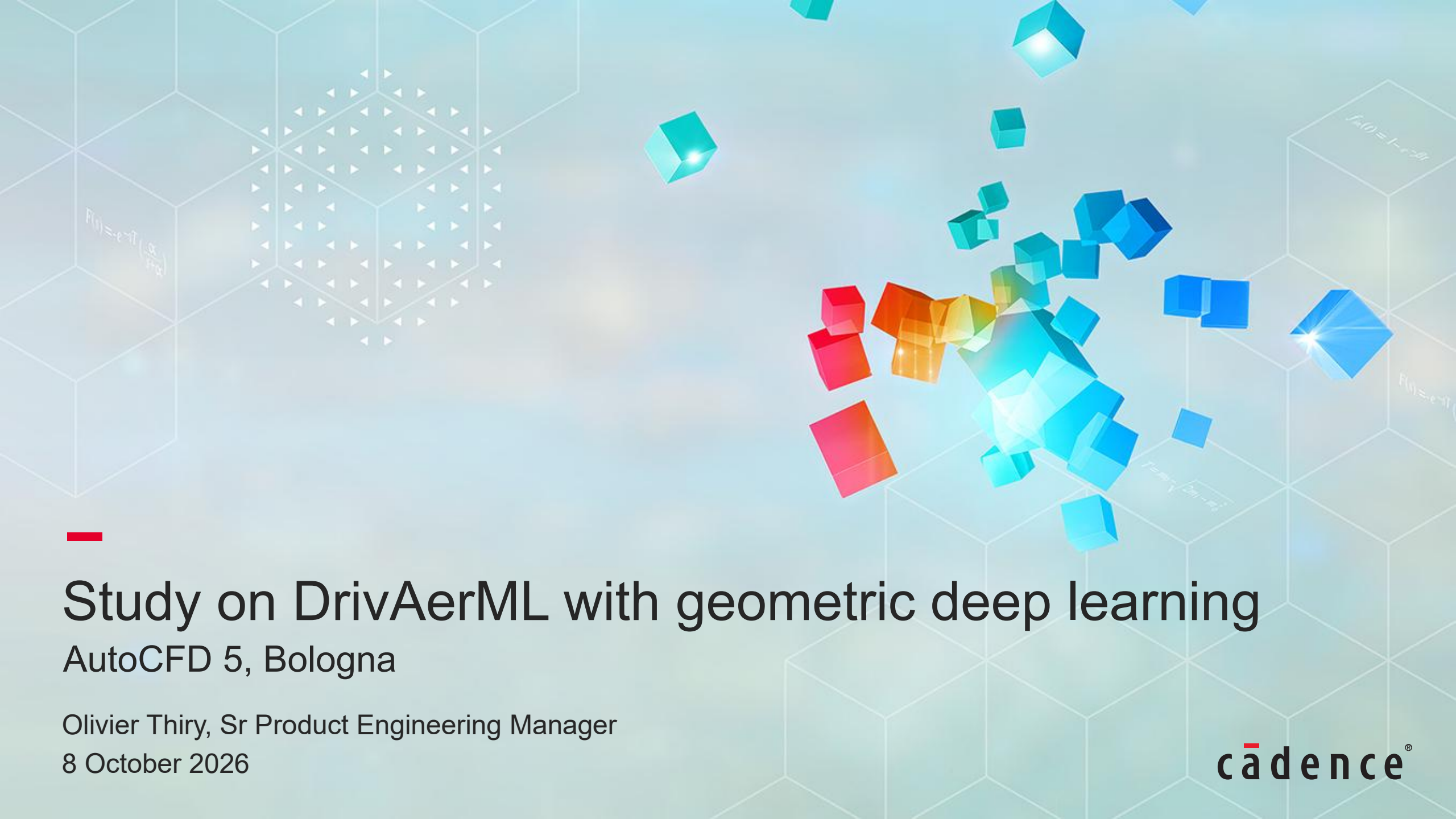


Study on DrivAerML with geometric deep learning

AutoCFD 5, Bologna

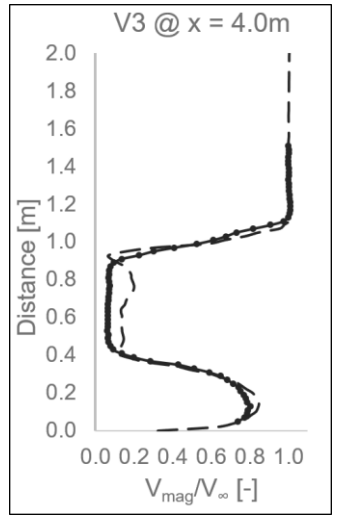
Olivier Thiry, Sr Product Engineering Manager

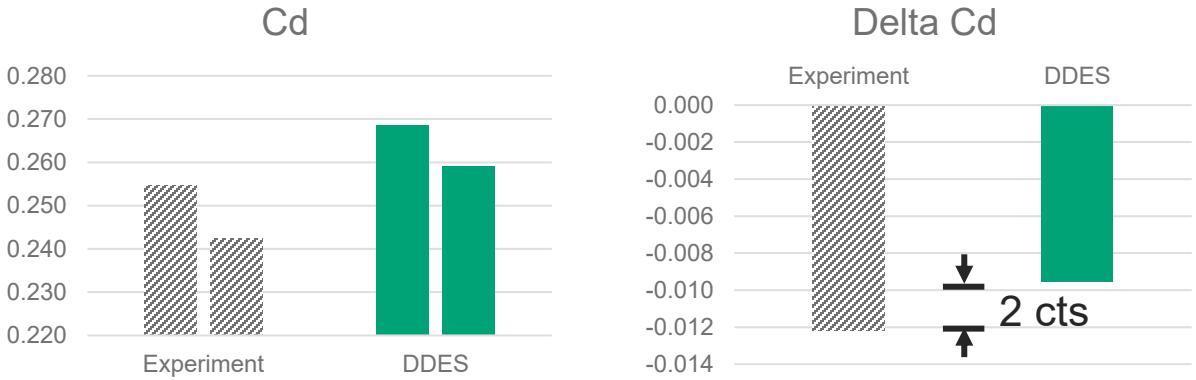
8 October 2026

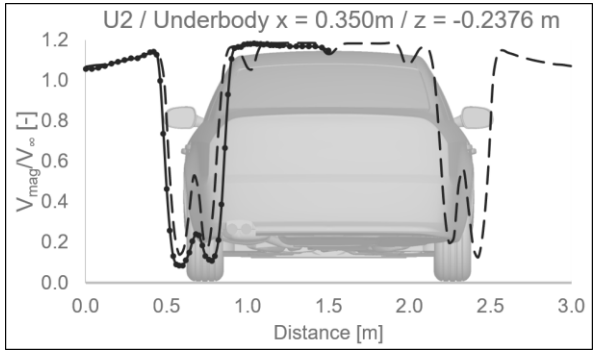
cadence®

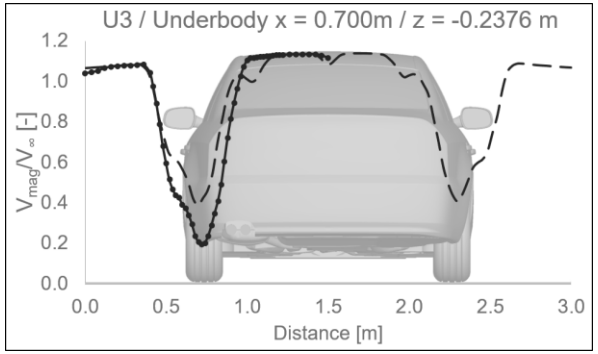
CFD simulation results

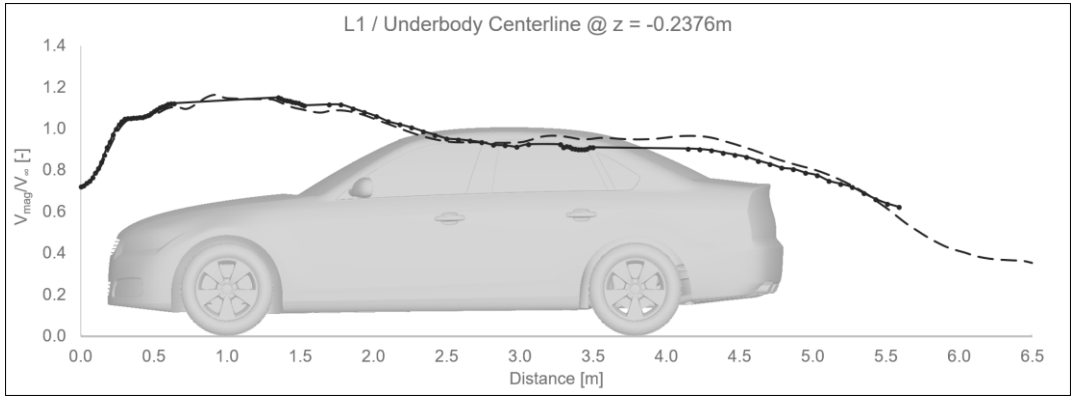
- DDES results submitted to the dashboard
- Shows good comparison to experimental results
- Simulation cost: 55 GPU.h for 5s of physical time on Nvidia RTX Pro 6000 GPUs

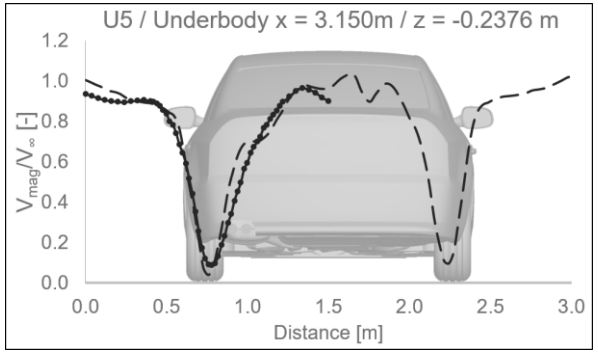


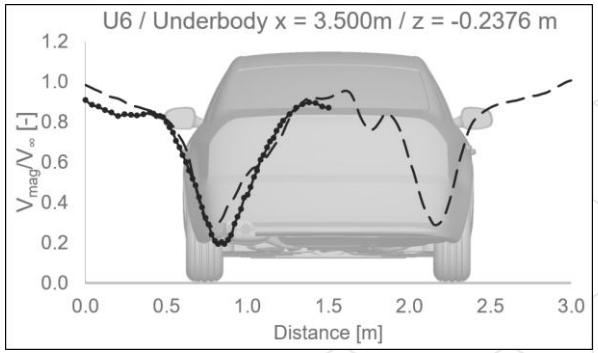












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Geometric deep learning model

Key ideas and model workflow

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A guided path from your existing CFD data to a trained model

Your CFD data

Geometry + CFD already in a data model or **easily imported from 3rd party solutions**

Guided setup

You choose the model's inputs and outputs

Automated train

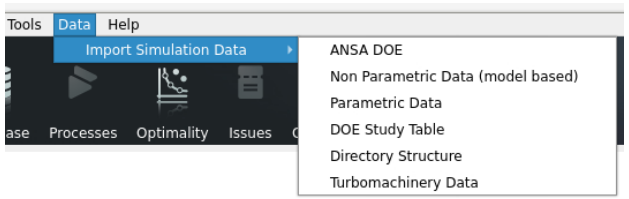
Sanity checks;

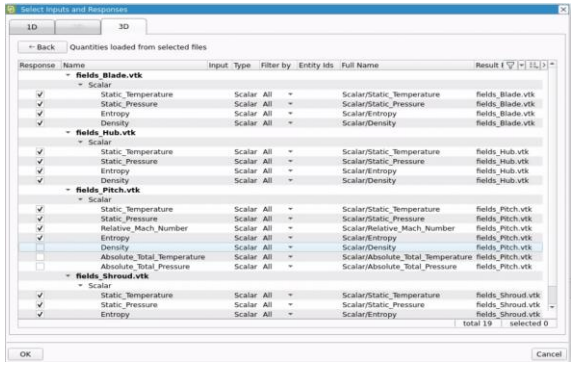
very few hyperparameters;

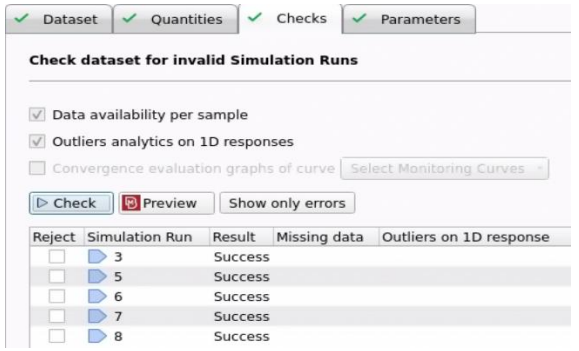
Multi-GPU training

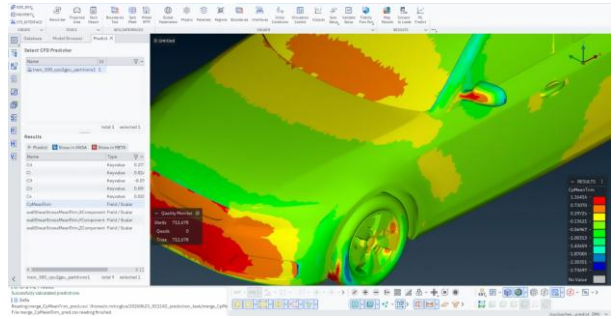
Inference where you work

Run the trained model in Komvos or inside ANSA









Guided and automated end-to-end – minimal tuning, and the model runs in the tools you already use (ANSA, Komvos)

Physics keeps the final word – AI accelerates the workflow; CFD still confirms the design

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Use An Output Hierarchy That Improves Force Accuracy

Predict the decision quantities first. Add **flow context with engineering value** to guide learning and explain trends.

PRIMARY

Forces

Train for Cd, Clf, Clr, and Cs predictions

RECOMMENDED

Surface pressure

Add boundary Cp outputs to improve force prediction and show where trends come from

OPTIONAL

Selected fields

Add slice planes or curves when they answer a specific engineering question

QUALITY CHECK

Convergence curves

Screen simulation quality before training

No need to provide volume mesh or volume data.
Add outputs only when they strengthen decisions or model quality.

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Separate The Source Of Truth From The Model Input

Fine CFD representation

TRAINING TRUTH

- Resolves the flow physics
- Produces forces and boundary results
- Supports high fidelity validation

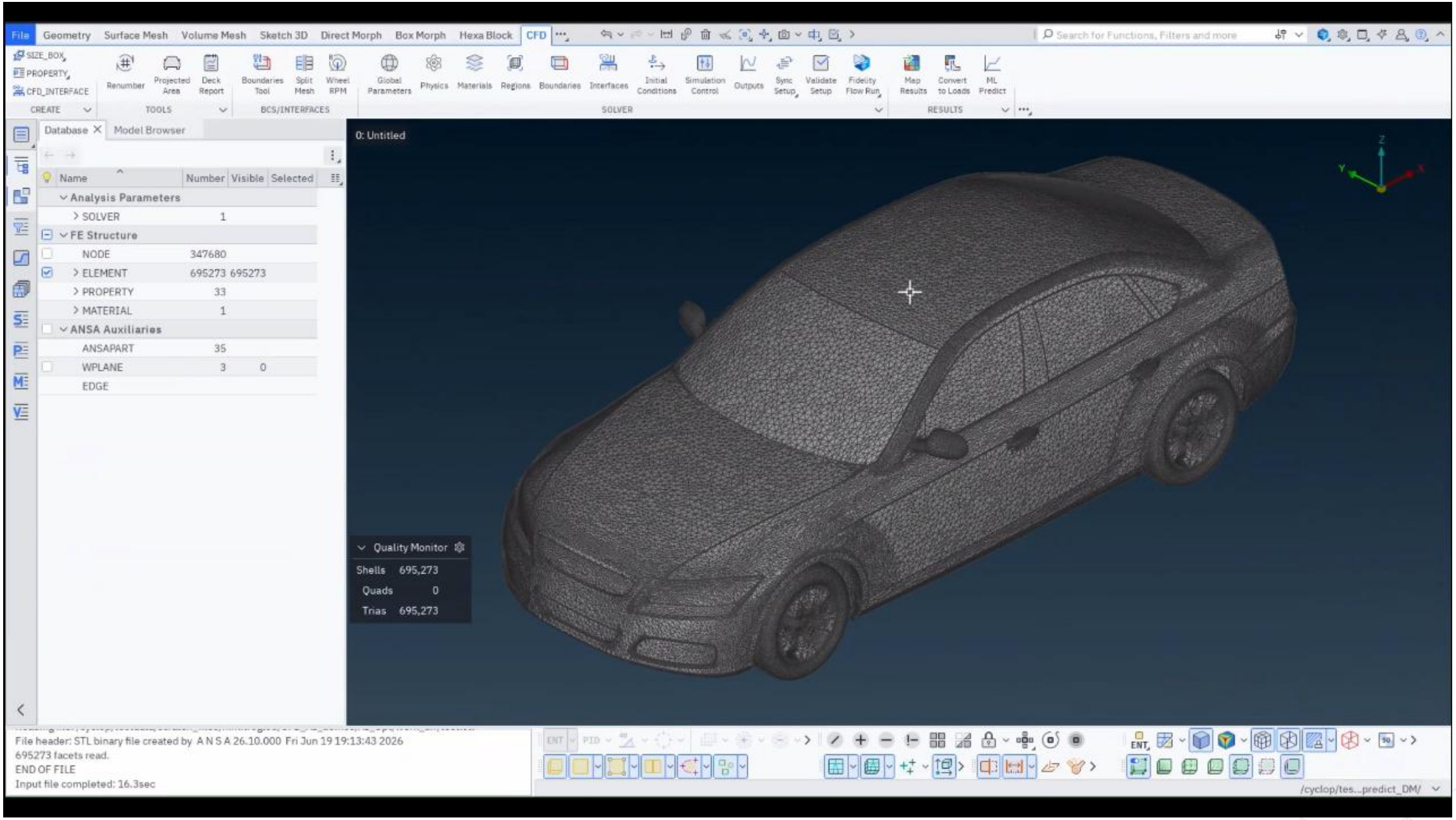
Coarse geometry tessellation

LEARNING INPUT

- **Represents the design shape**
- **Remains independent of the CFD mesh**
- **Feeds training and inference directly**

Use CFD to create the answers. Use geometry to teach the model.

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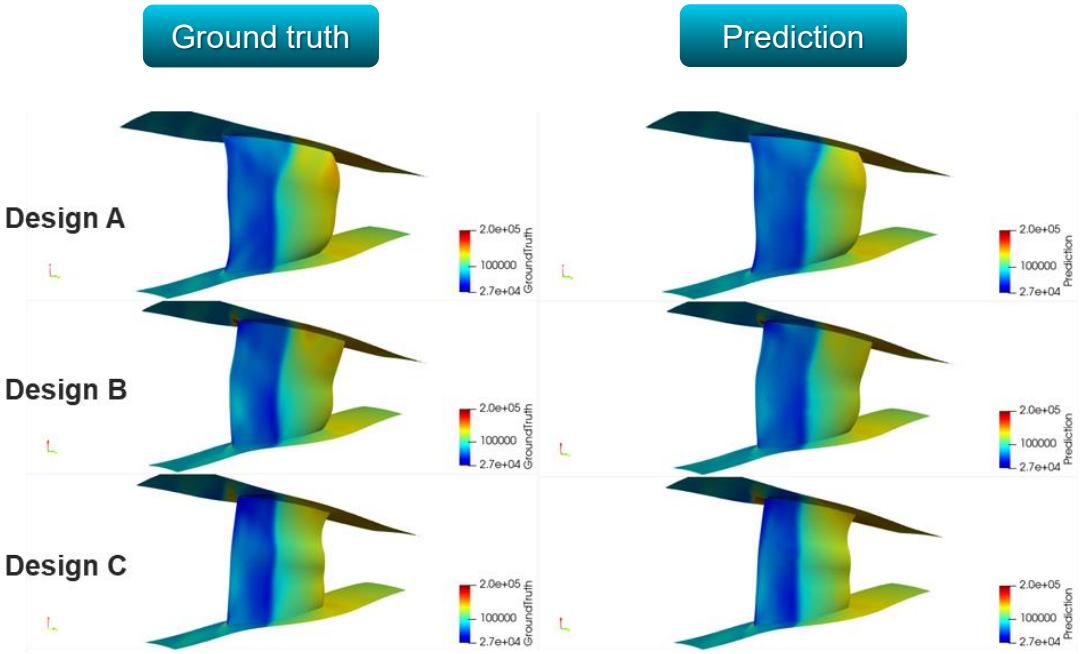
Turbomachinery example

Turbomachinery Rotor37

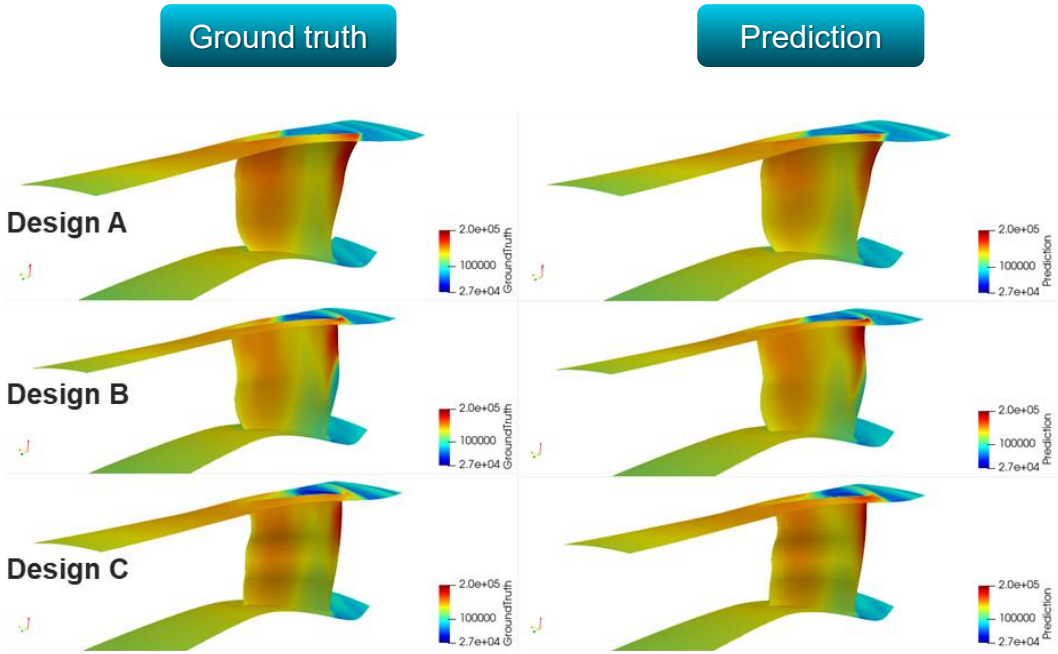
- Showing 3 out of 300 design variants
- Average relative error <1% across all quantities

Test set MAE	0.0023

Isentropic efficiency error (AI vs. CFD)



Suction side of rotor 37



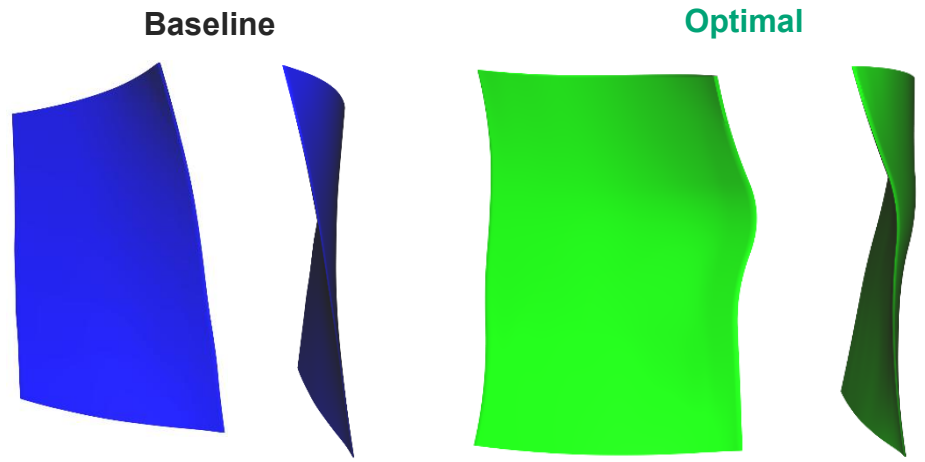
Pressure side of rotor 37

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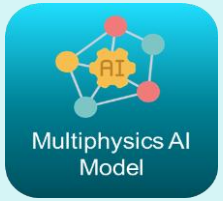
Design optimization in an hour – not days

Turbomachinery Rotor37

Optimized design	CFD	AI	Relative L1 error
Isentropic efficiency	**0.86940**	**0.86950**	**0.01 %**
Mass flow	20.422	20.399	0.11%
Total pressure ratio	2.0471	2.0477	0.03 %



Turnaround time – design optimization on <u>1 operating point</u>



~1h on any workstation or laptop

Standard CFD-based workflow **14h on 16 CPU**

The **fully AI driven design optimization** leads to efficiency increase of 1.81% → **confirmed by CFD**

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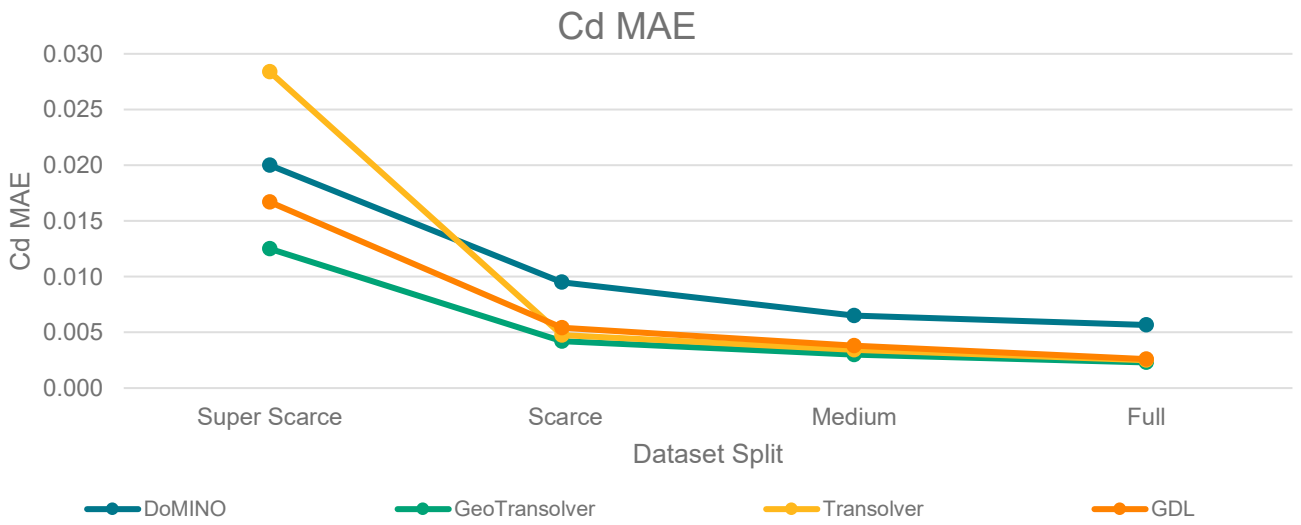
Geometric deep learning model

Exploration on DrivAerML dataset

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Influence of the data split

- Results on super scarce dataset split show that not enough data is present to cover the design space.
- From the scarce dataset, continuous improvements are seen until the full dataset split.
- The GDL model inside KOMVOS yields very similar accuracy to models available in PhysicsNEMO, evaluated at the same stl resolution.

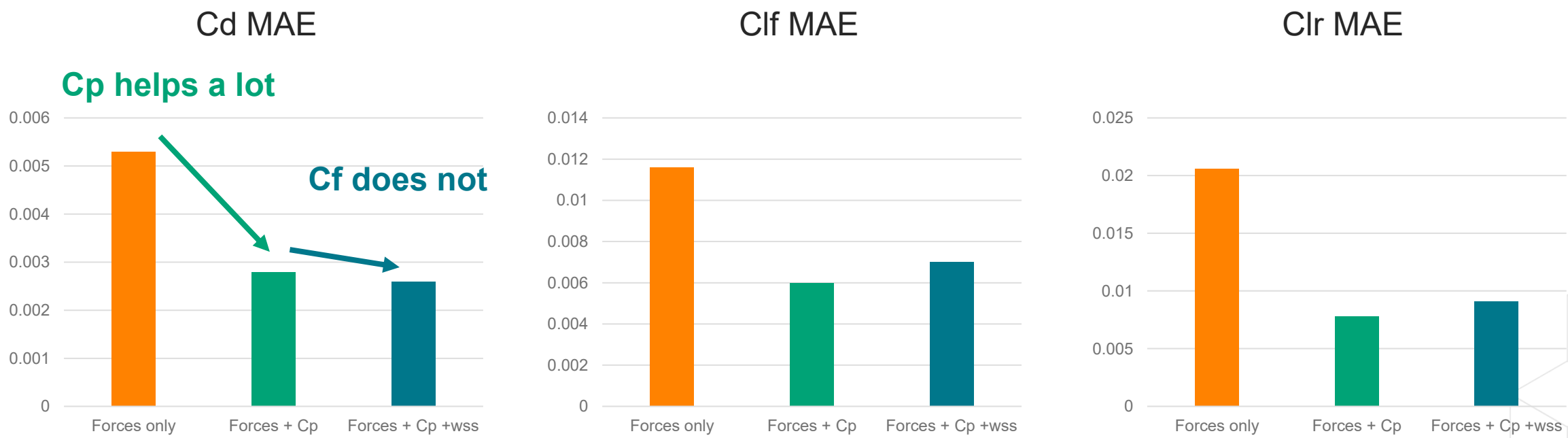


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Including surface fields improves force predictions

- Adding Cp on the car surface improves the drag predictions
- Adding wall shear stress does not bring further improvements on the prediction of forces

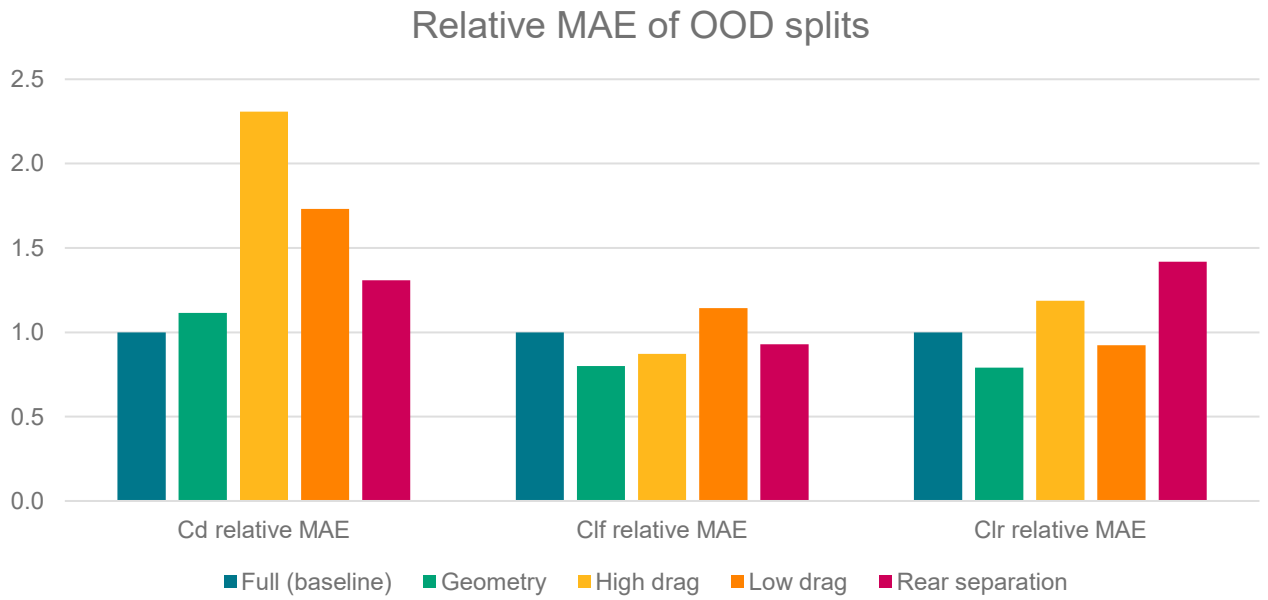
Full split



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Out-of-distribution splits

- The geometry split does not degrade the accuracy of the predictions, showing that sufficient coverage of the design space is achieved.
- High and low drag splits show less accurate drag predictions, but no significant change in lift prediction
- Rear separation split has a small impact on drag predictions, and a more pronounced impact on rear lift predictions



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A Force Predictor With Flow Context

Replace full volume CFD

NOT THE GOAL

- No promise of complete volume reconstruction
- Not a substitute for final high-fidelity validation
- Do not add outputs without engineering value

Accelerate design decisions

THE GOAL

- **Fast Cd, Clf, Clr, and Cs predictions**
- **Boundary Cp and selected-plane output**
- **Direct access in design and optimization tools**

Surface pressure output guides the force model and gives engineers a readable explanation of the trend.

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