

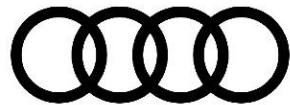
From Simulation to Real-Time Prediction: How Machine Learning Will Impact Digital Prototyping

22.09.2022

Dr. Jakob Lohse

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- Founded in 2014
- Some of our customers



AIRBUS



AI accelerated engineering



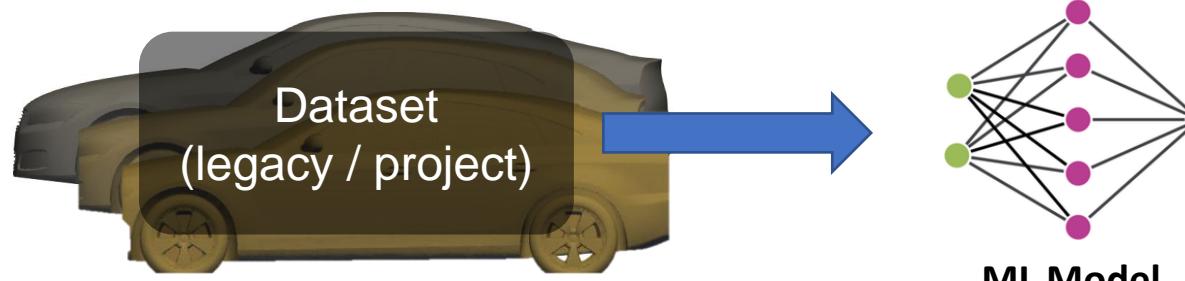
Re tool engineering.
imagine products.
think business.
altime CFD.

Motivation for Real-Time Simulation

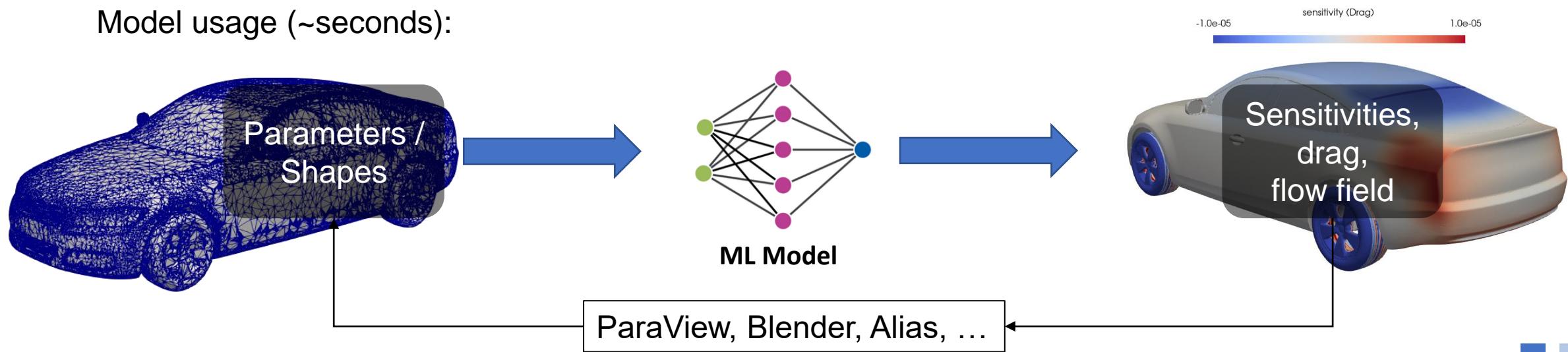


Workflow

Model preparation (~days):



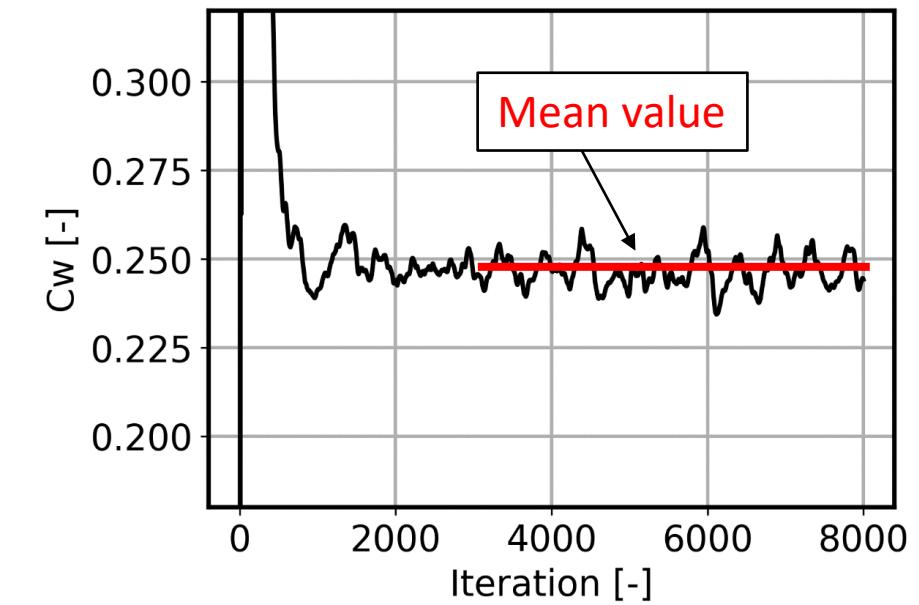
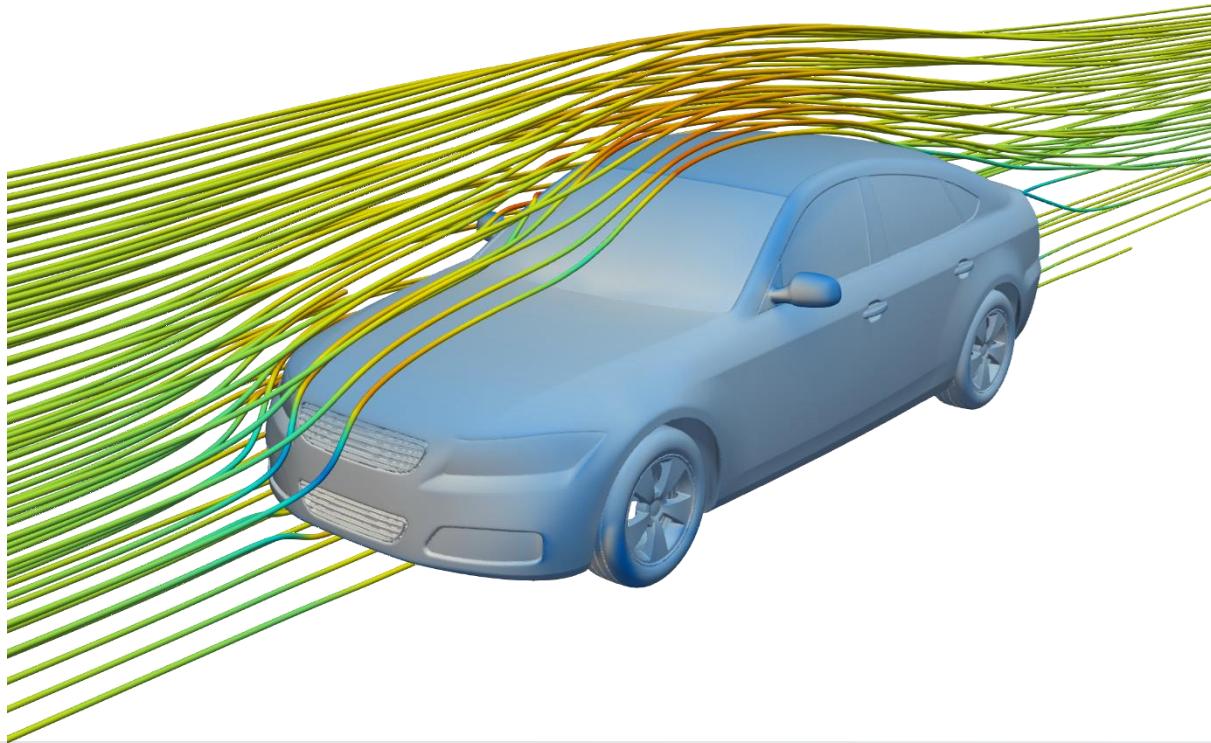
Model usage (~seconds):



Example 1: parametric

- DrivAer Body

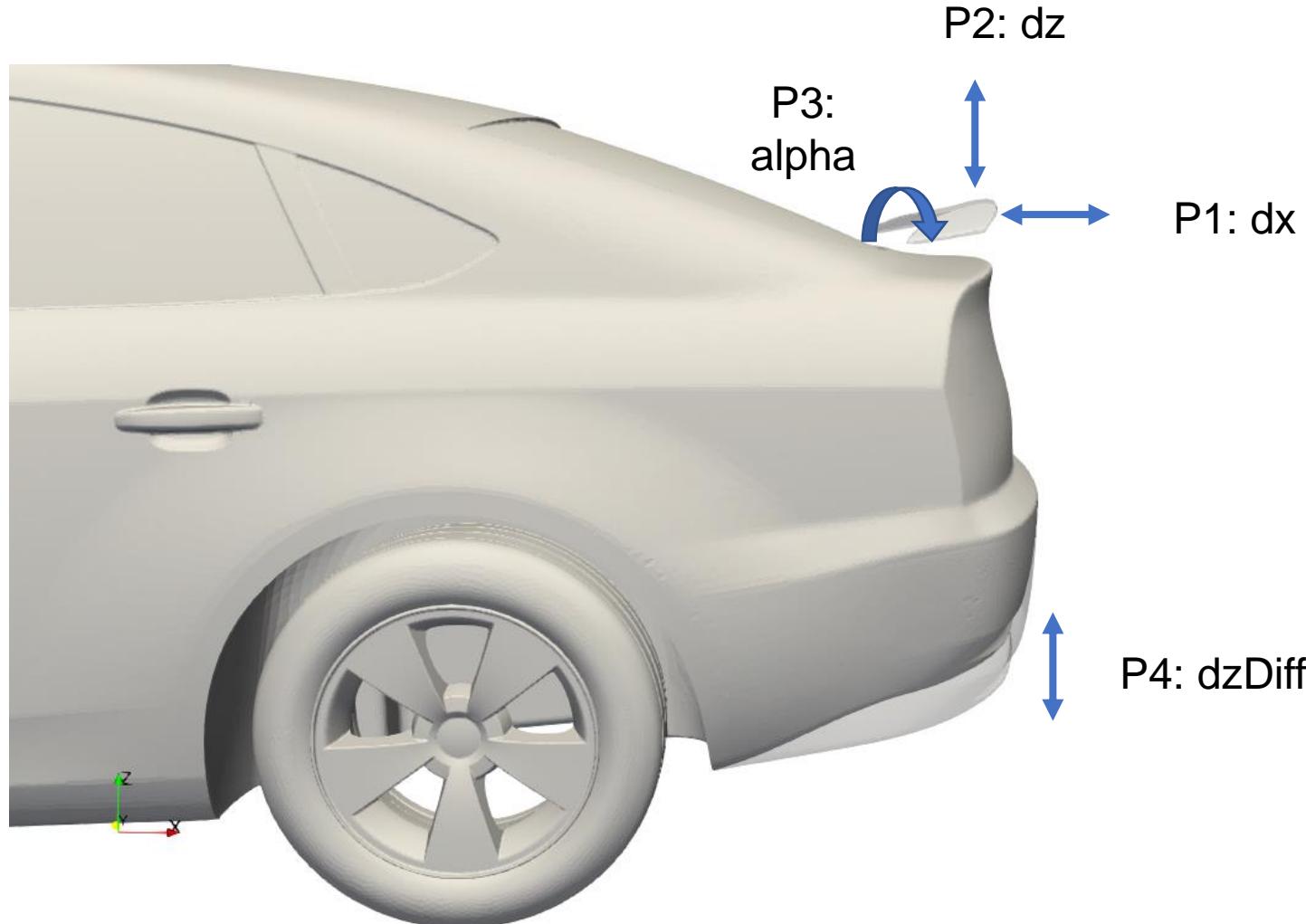
- Generic car model
- FS-wM-wW-woL + Extendable rear spoiler
- simpleFoam solver with k-Omega-SST
- 26,7 Mio. cells



	C_w
NAVASTO RANS	0,247
Experiment Audi	0,251
Experiment TUM ASME	0,247
Experiment TUM SAE	0,243

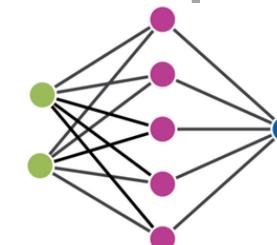
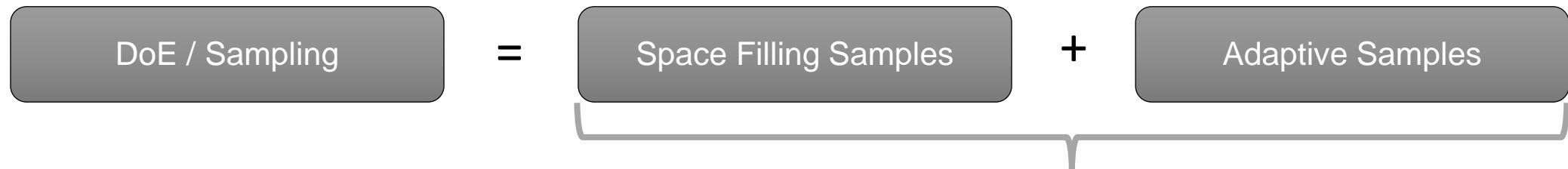
Example 1: parametric

- Design space is described by 4 geometric parameters



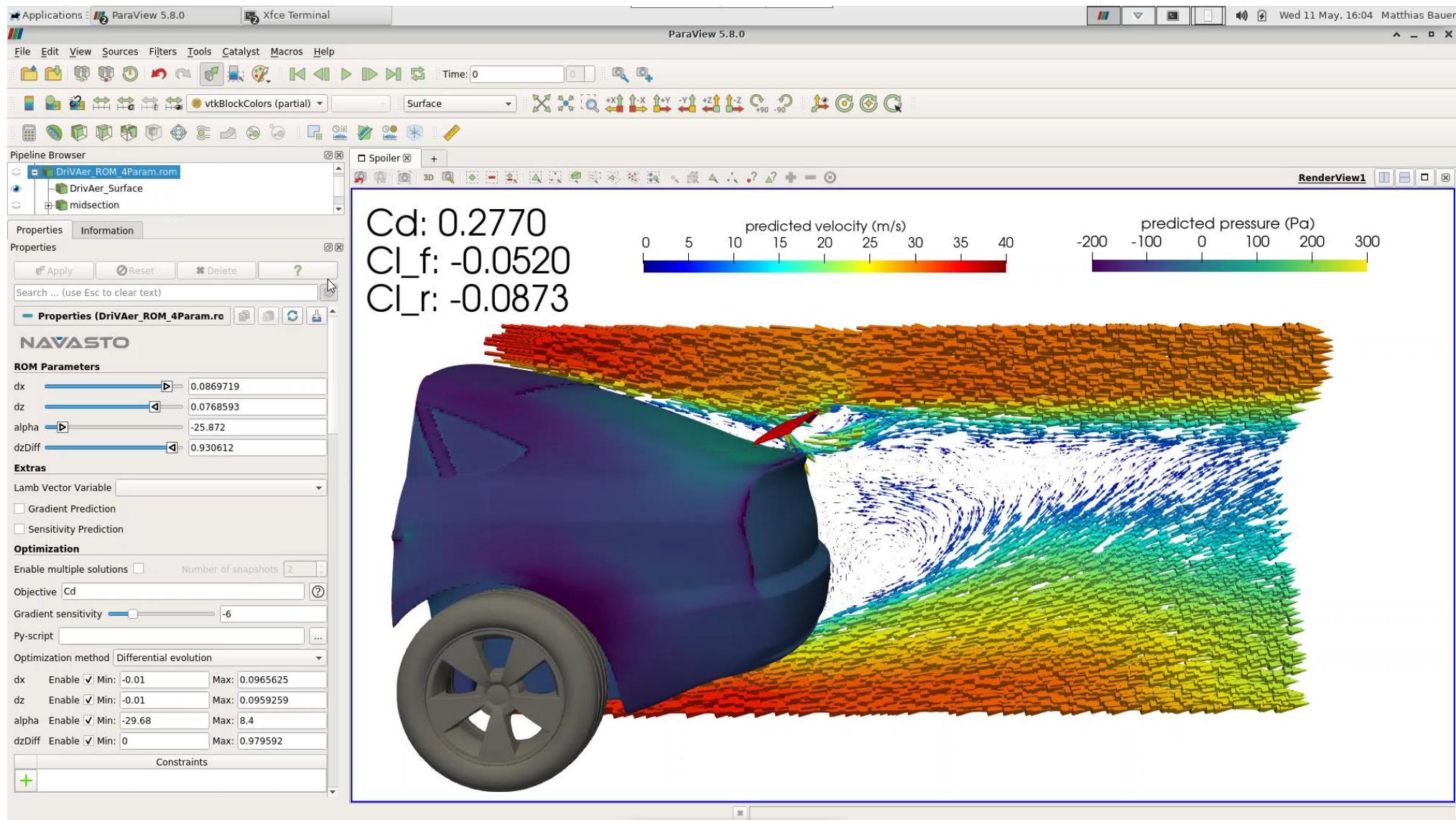
Example 1: parametric

- Design space is described by 4 geometric parameters



ML Model on the parameters

Example 1: parametric



Example 2: **SAILGP™** F50 foiling catamaran (8 parameters)

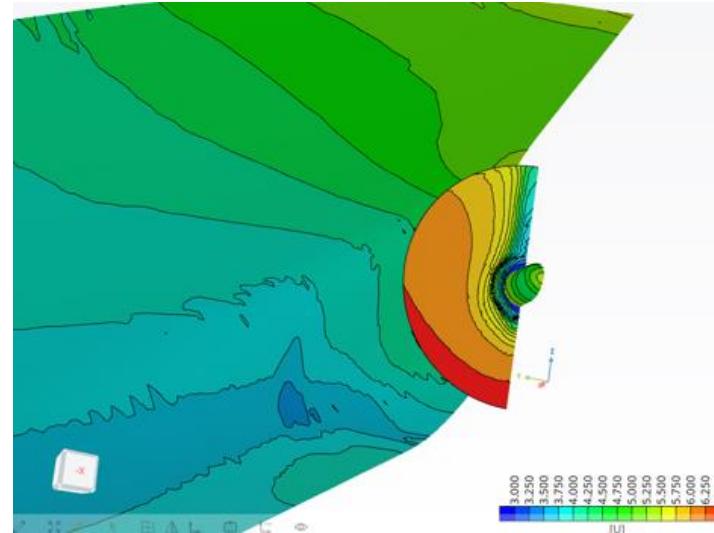


NAVASTO



Example 3: CAESES Testcase

- “DeffProForm” - designing efficient ship propellers with unconventional form
- Realistic wake field prediction in the early design stages for better propeller simulation assessment



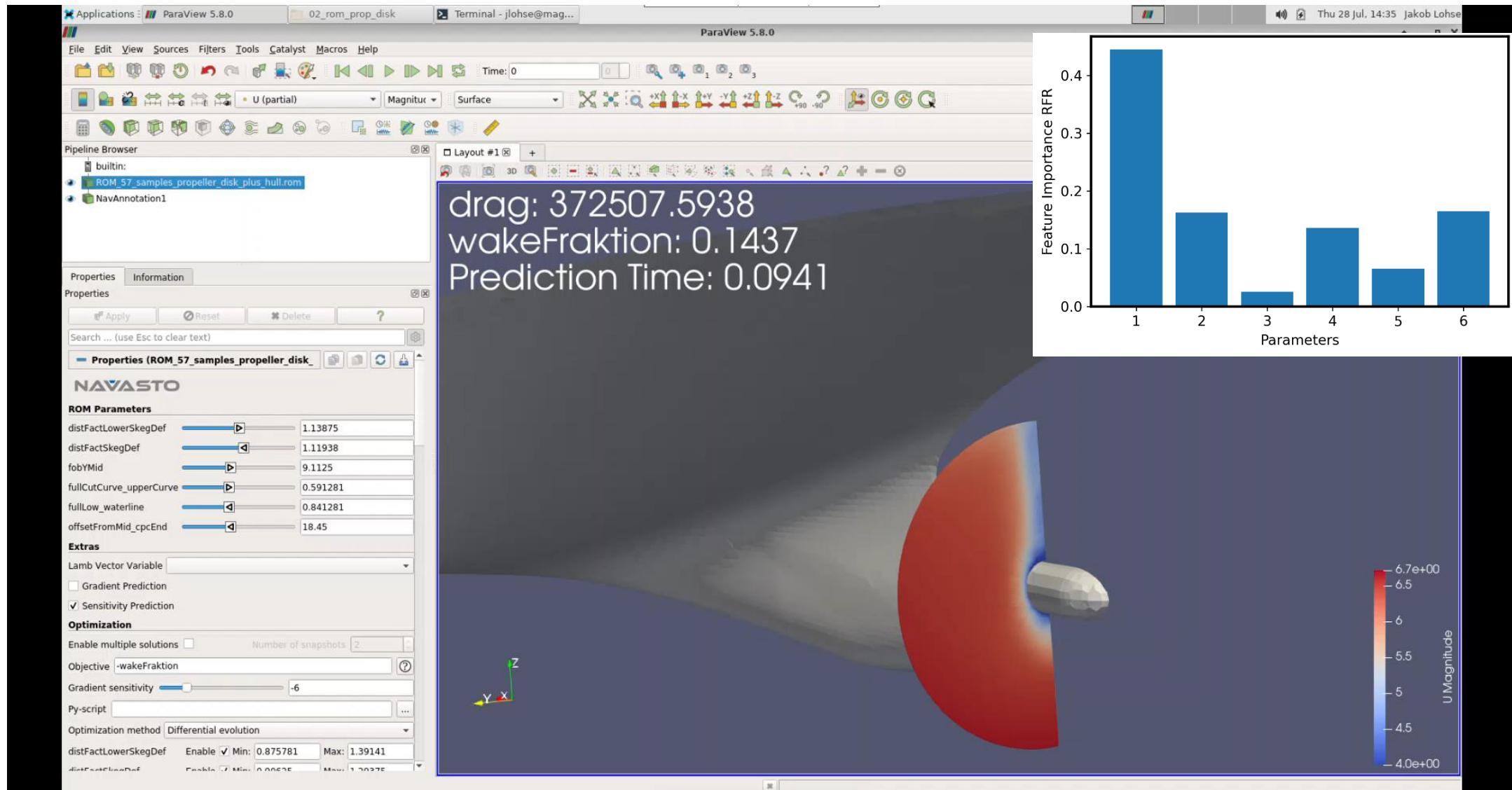
6 Parameter
Setup in
CAESES

Sobol
Sequence
(57 DoE
Samples)

Simulations

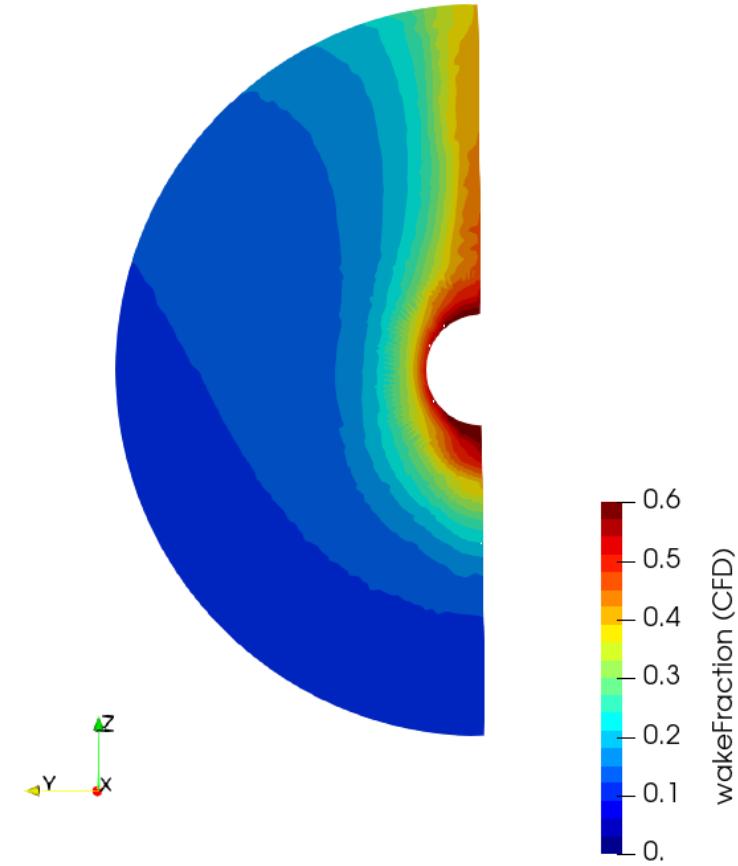
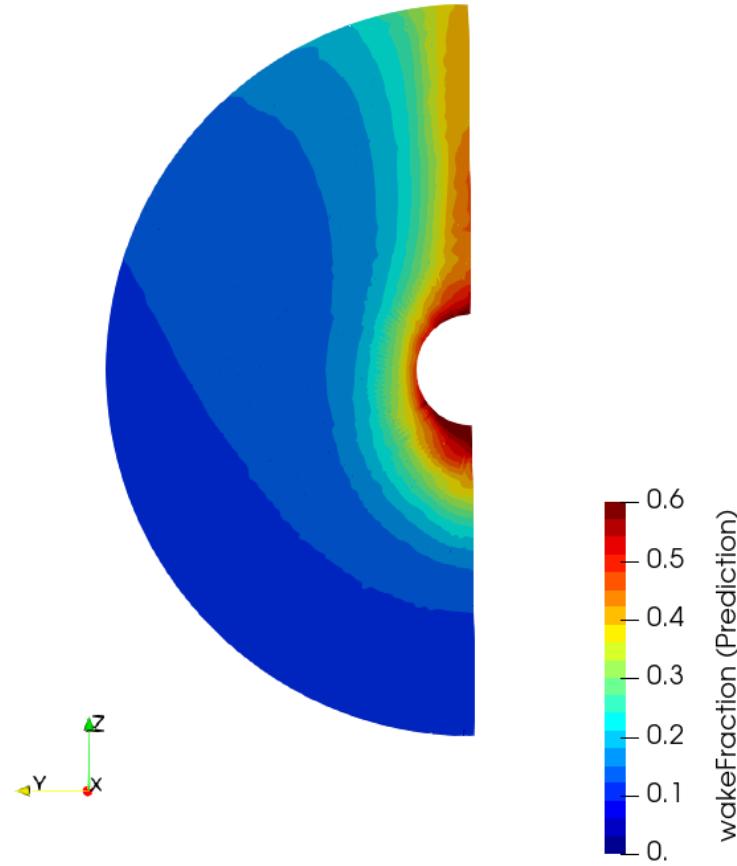


Example 3: CAESES Testcase



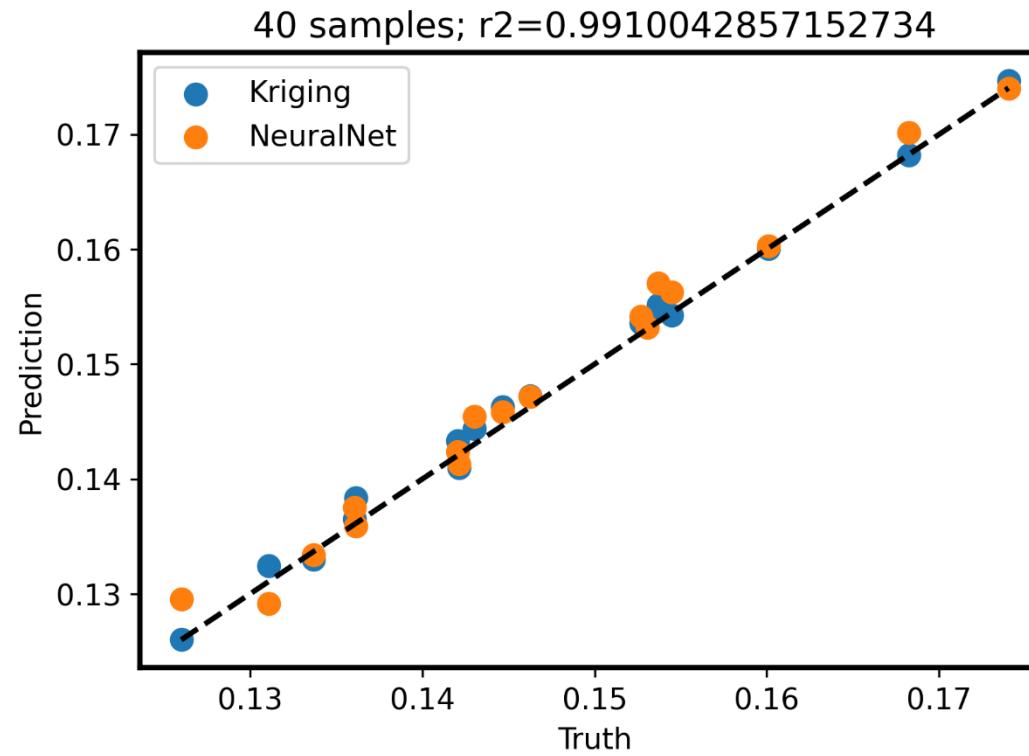
Example 3: CAESES Testcase

- Model quality of the flow field on the disk via “Leave-One-Out Cross-Validation”
- Sample 20



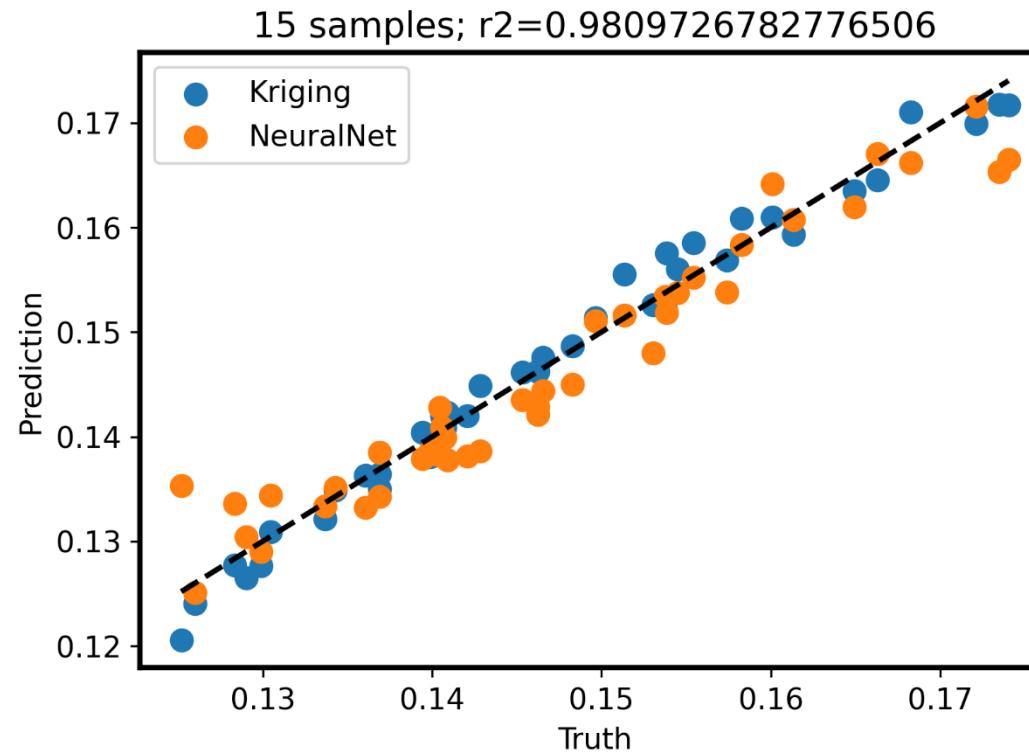
Example 3: CAESES Testcase

- Model quality of the scalar values via train-test-split
- Surrogate auf variable “wakeFraction”: 40 Training samples + 17 Test samples



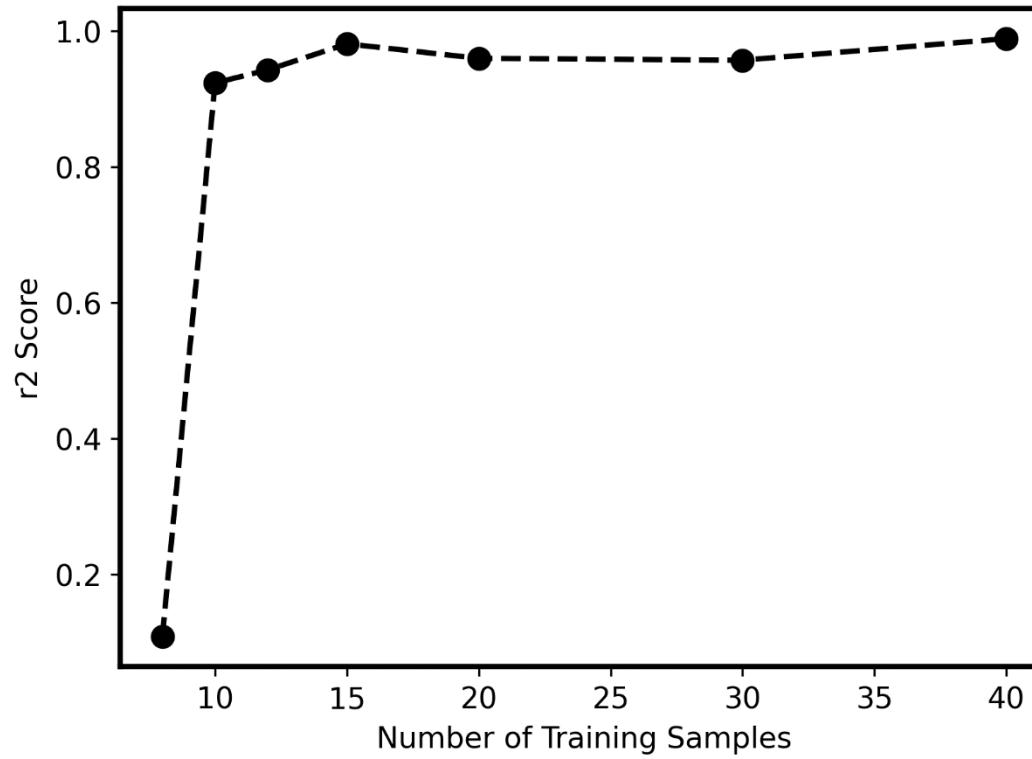
Example 3: CAESES Testcase

- Model quality of the scalar values via train-test-split
- Surrogate auf variable “wakeFraction”: **15** Training samples + **42** Test samples



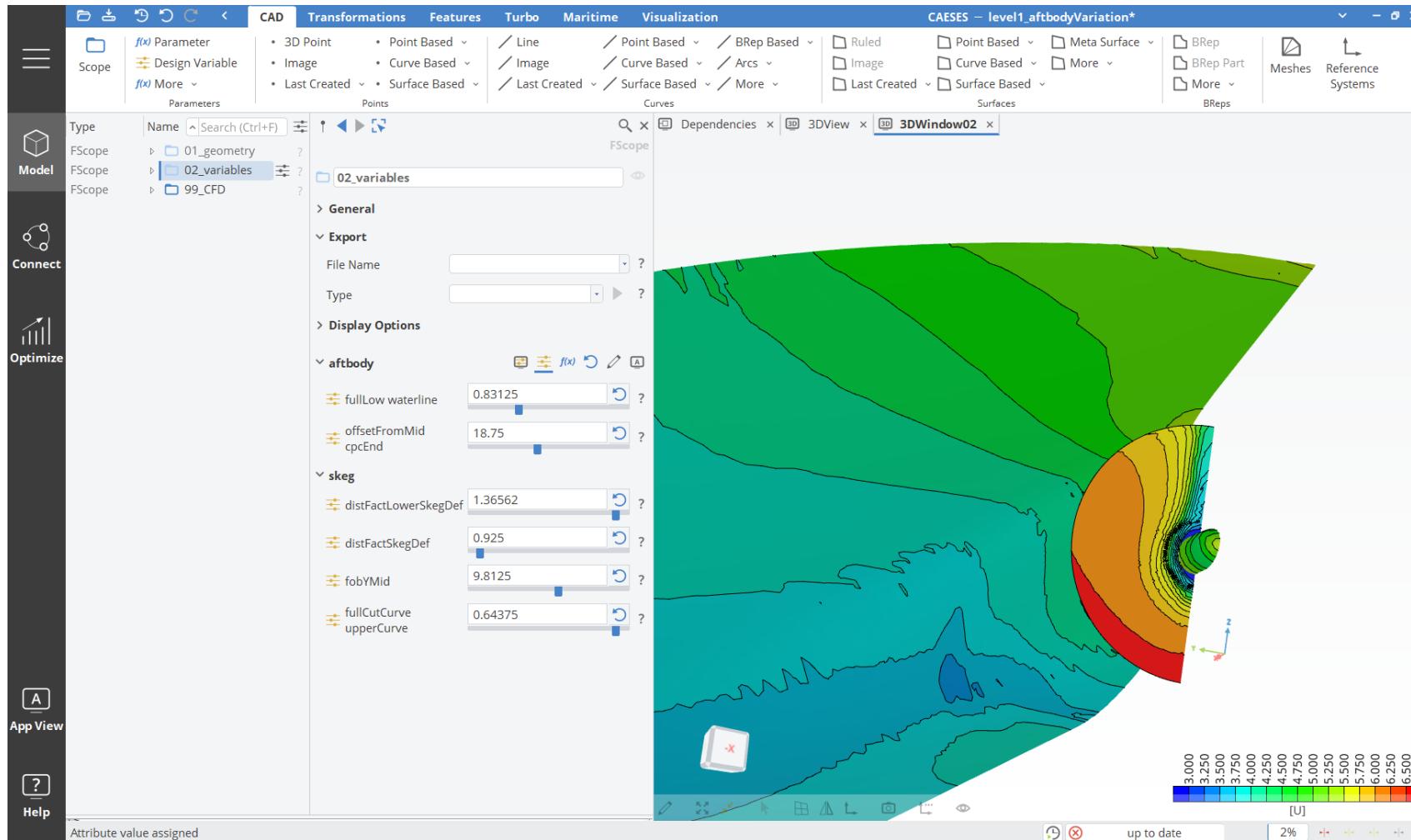
Example 3: CAESES Testcase

- How many samples do I really need?



Future Project

- Work together on the use of ML models in CAESES

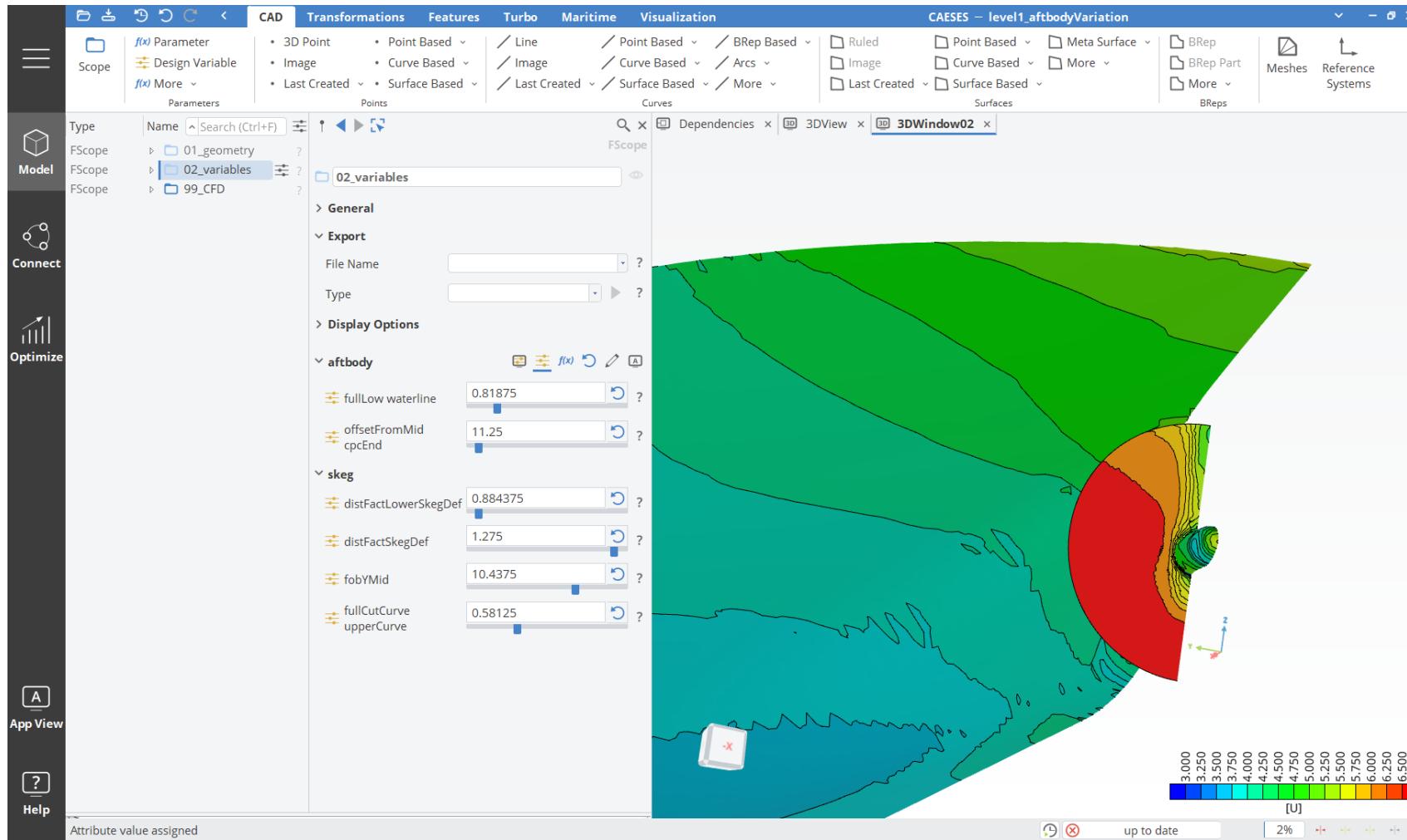


Realtime
Prediction of
Simulation
Results

Sensitivity
Analysis

Future Project

- Work together on the use of ML models in CAESES



Realtime
Prediction of
Simulation
Results

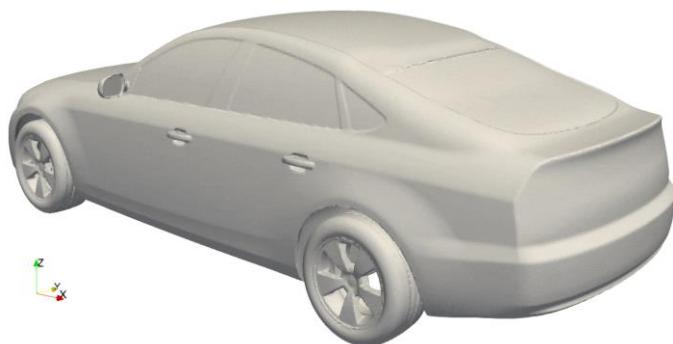
Sensitivity
Analysis

Example 4: Shape Centric (Use your Legacy Data)

Parameter set A



Parameter set B



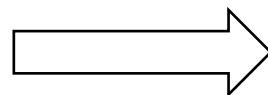
Different project



Spoiler: Translation +
Rotation

Body shape: height, rear top,
boattailing, diffusor, wheel width

Different shape



No consistent parametrization across (legacy) data

Example 4: Shape Centric (Use your Legacy Data)

Parameter set A



+

Parameter set B



+

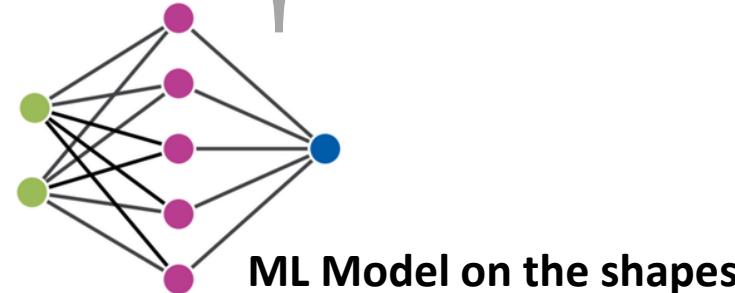
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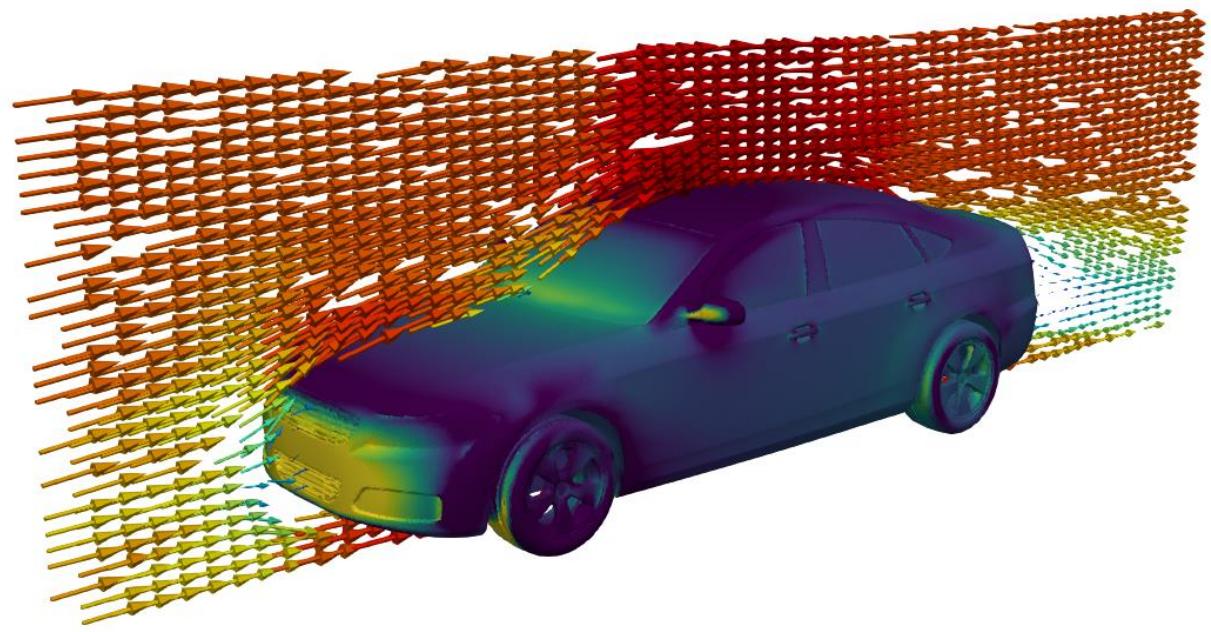
Example 4: Shape Centric

Input: STL, STEP

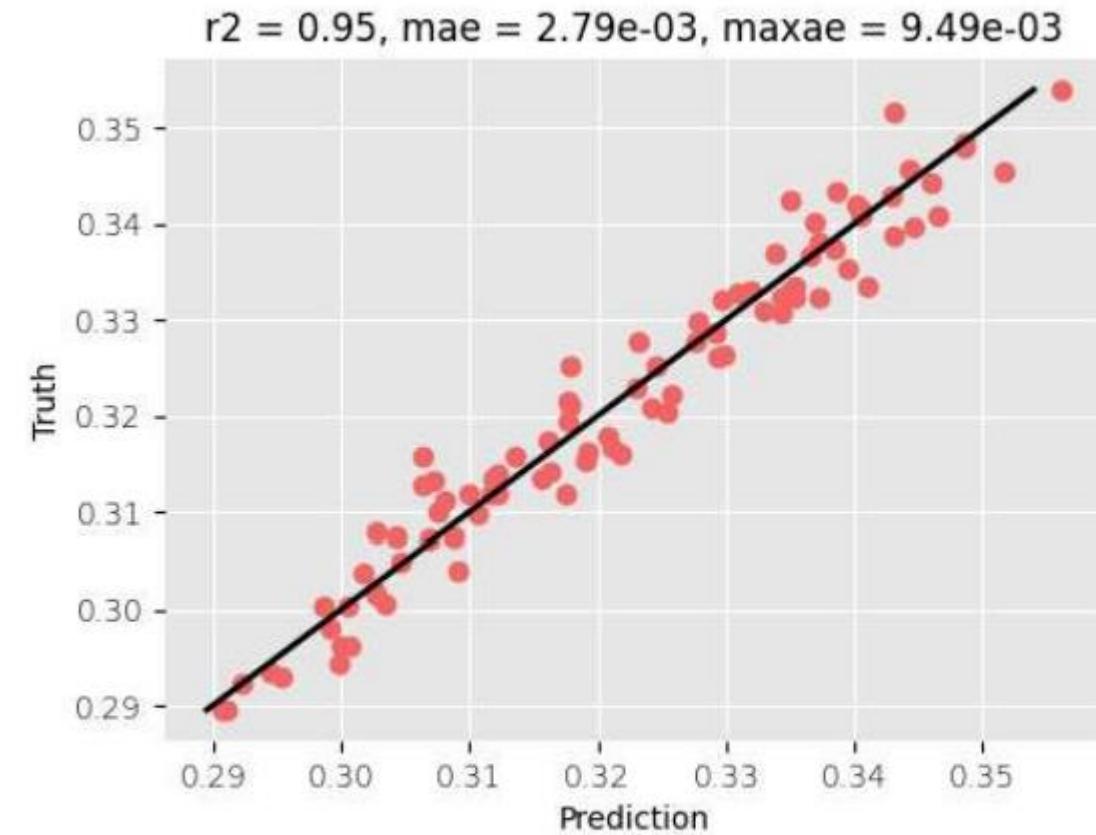
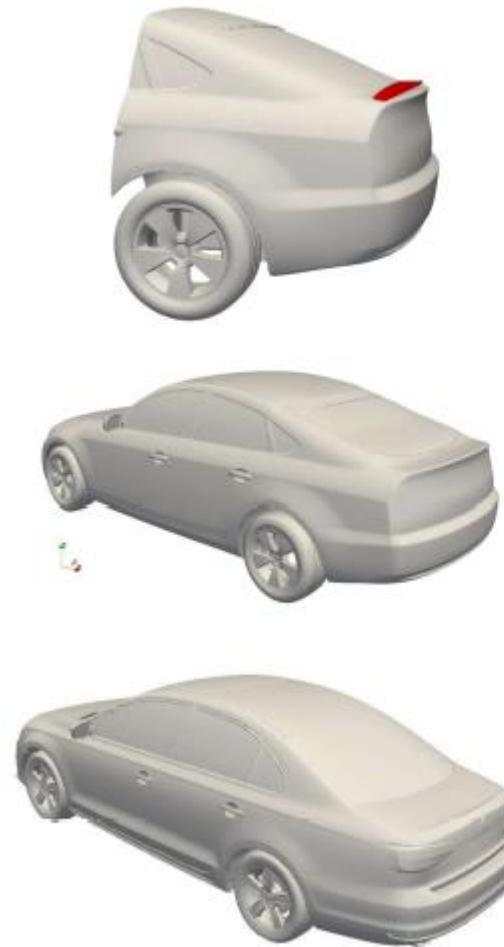


Output:

Drag: 0.2908
LiftFront: -0.2671
LiftRear: 0.3493

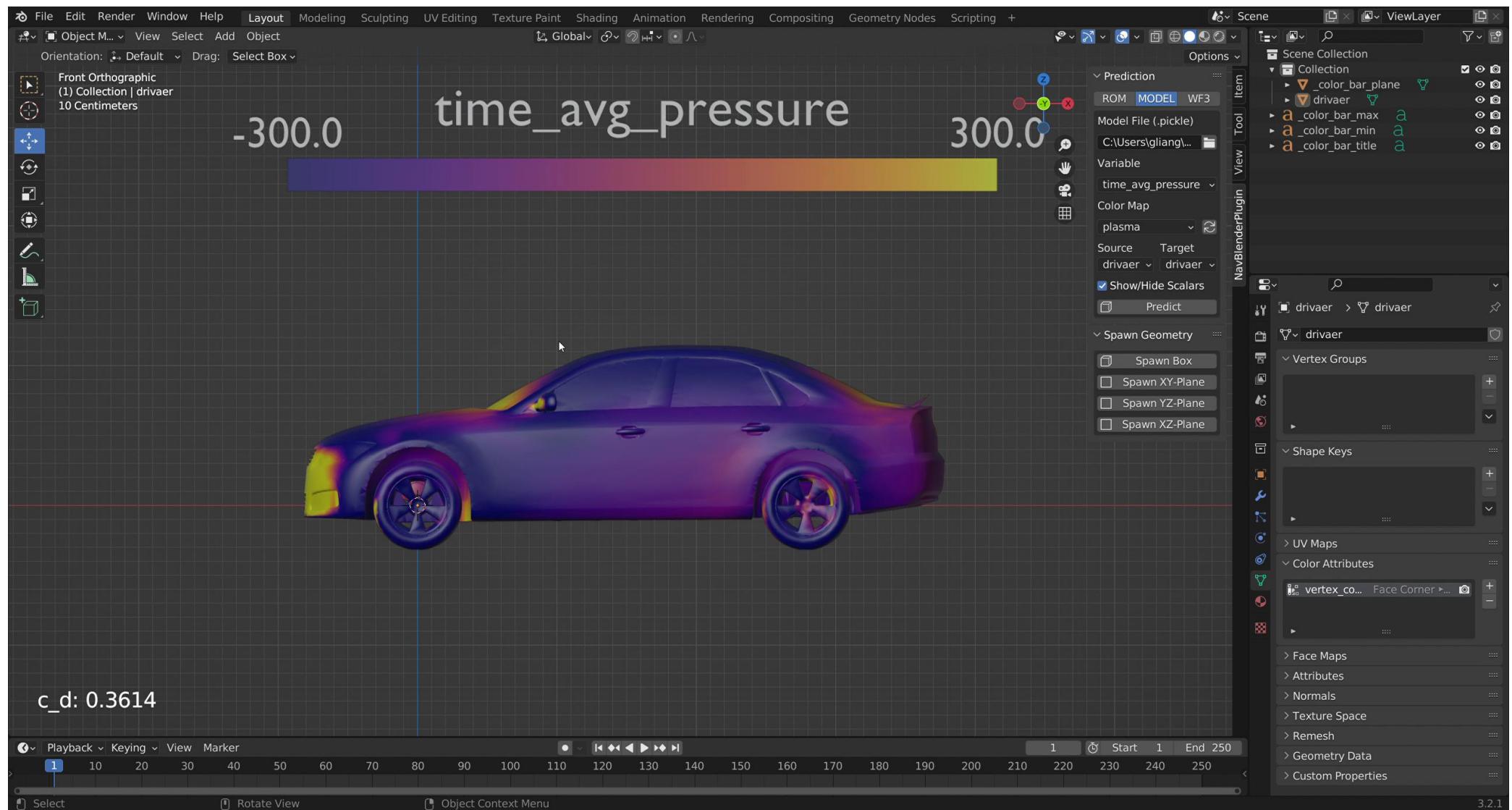


Example 4: Shape Centric



→ Excellent correlation on unseen data

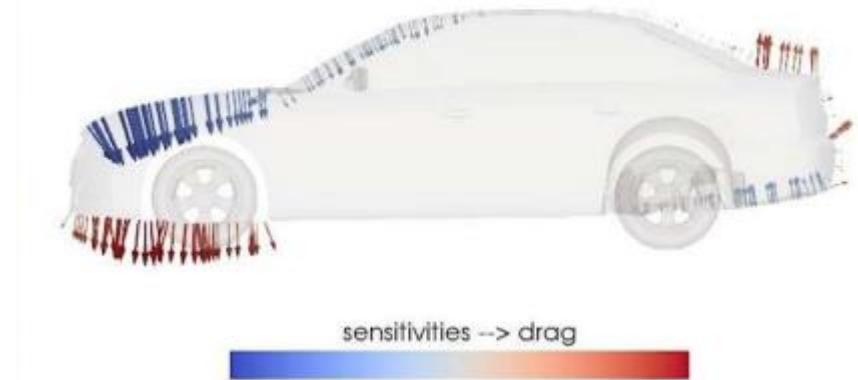
Example 4: Shape Centric



Summary

- Use existing simulation data for interactive design with ML models
 - With parameters
 - Without parameters
 - Project data
 - Legacy data
- Evaluate the ML model for unlimited iterations
- Use real-time sensitivities on the surfaces

C_d: 0.319 +/- 0.012
C_{lr}: 0.045 +/- 0.034



Thank you!

