

ESTECO  
**USERS' MEETING**  
**INDIA**

**Leveraging scalable ROM, ML and AI  
through the synergy of  
VOLTA and romBOX**

**um**  
**2023**

Haysam TELIB  
Co-Founder & CTO  
OPTIMAD





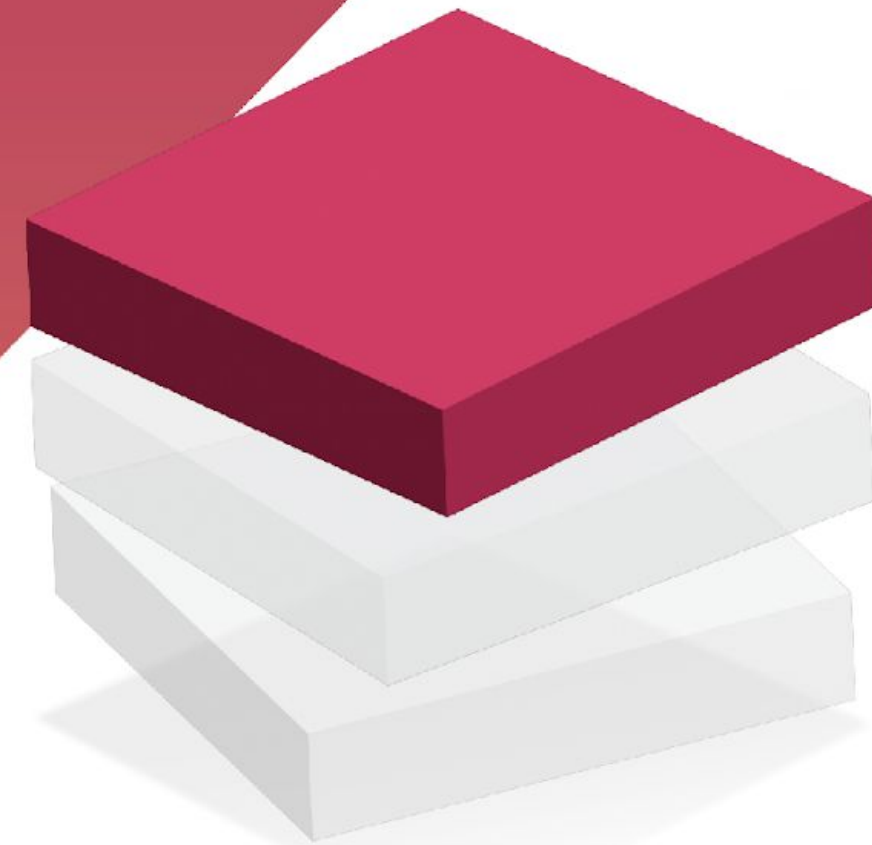
## About OPTIMAD

## Simulation-Driven vs Data-Driven

## romBOX & VOLTA

What is romBOX  
Synergy between romBOX and VOLTA

## Conclusions



# ABOUT OPTIMAD

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We use **mathematical modelling and numerical simulation** to describe products and processes and **blend them with Machine Learning and Artificial Intelligence** to value historical data and accelerate development times.

Our team is **talented, multi-disciplinary, and experienced**. They combine deep engineering knowledge and imagination to deliver innovation. We **cultivate competencies** and we **learn together** with our customers.

# People

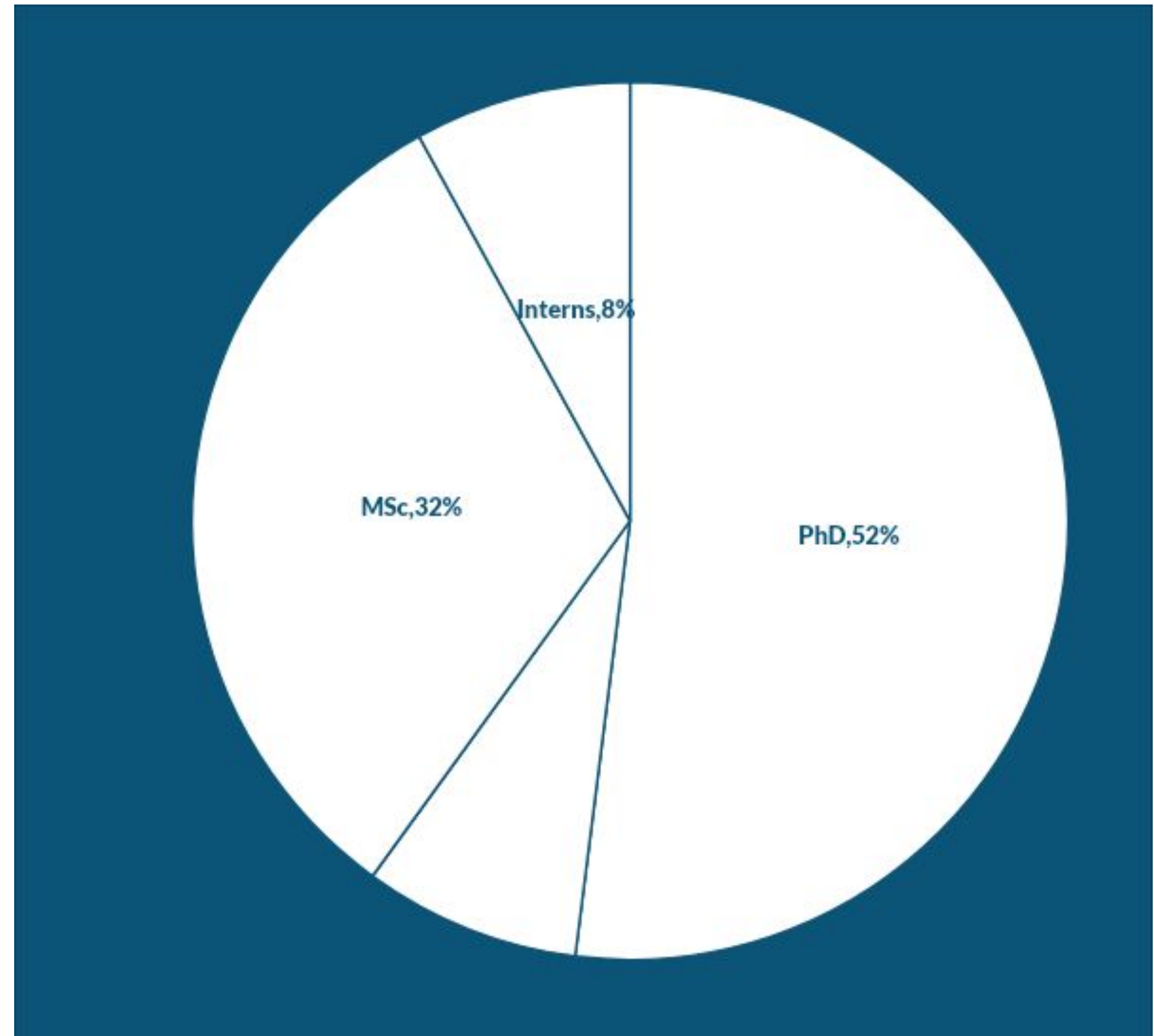
Headcount (q4/22) 27

## Strong scientific background

- computational geometry;
- numerical methods, scientific computing;
- data intelligence (reduced order models, ML, AI).

## Industrial proficiency

- Computational fluid dynamics
- its integration in product development.



## Our products

### **mimic**

shape parameterization, mesh manipulation & morphing

### **immerFLOW**

high-productivity CFD solver

### **romBOX**

reduced order models & machine learning for simulation data intelligence

Enabling the  
digital transformation of  
product development cycles  
and design processes

# References

## Transportation Industry

- Aerospace & Defence
- Automotive
- Naval
- Rail

## Industrial Equipment

## Additive Manufacturing

## Food & Beverage

## Chemical Engineering

## Biomedical



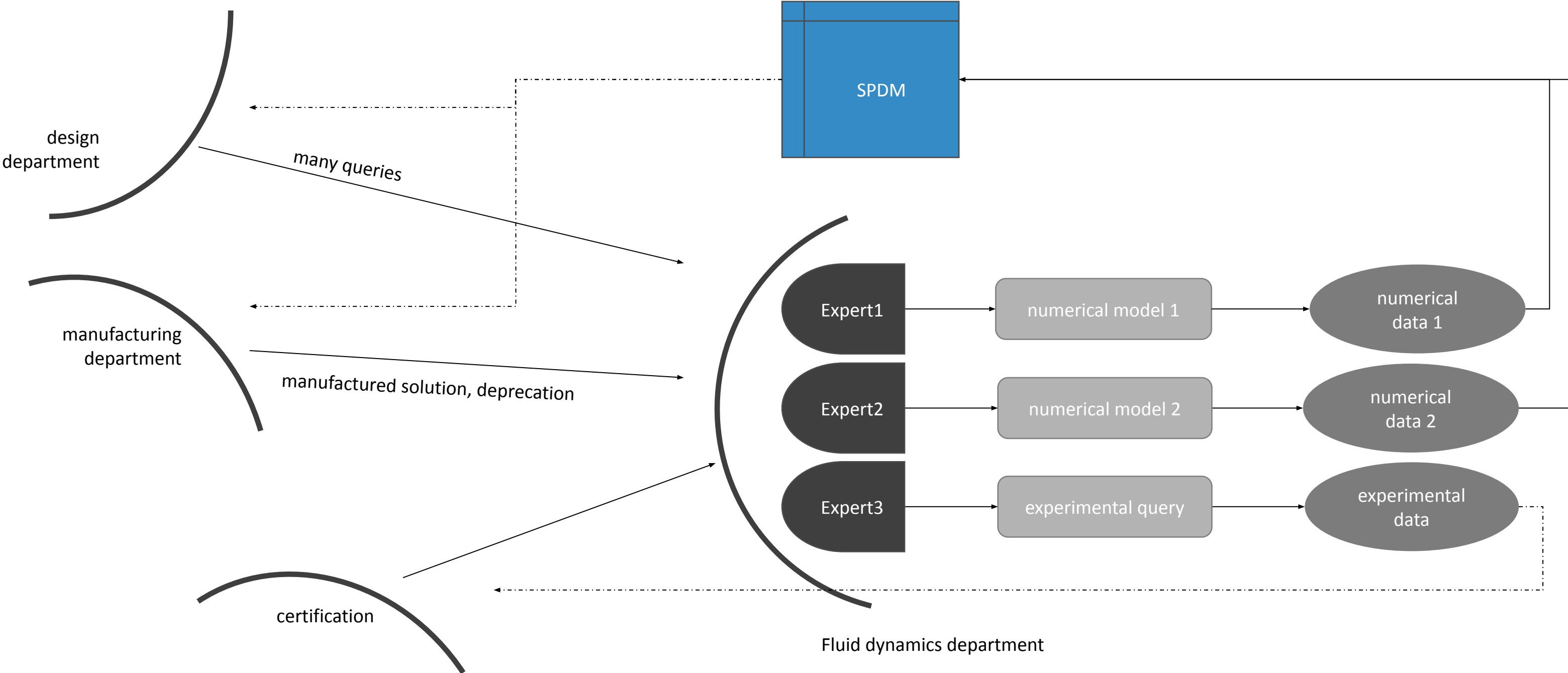
# Simulation-driven vs Data-driven

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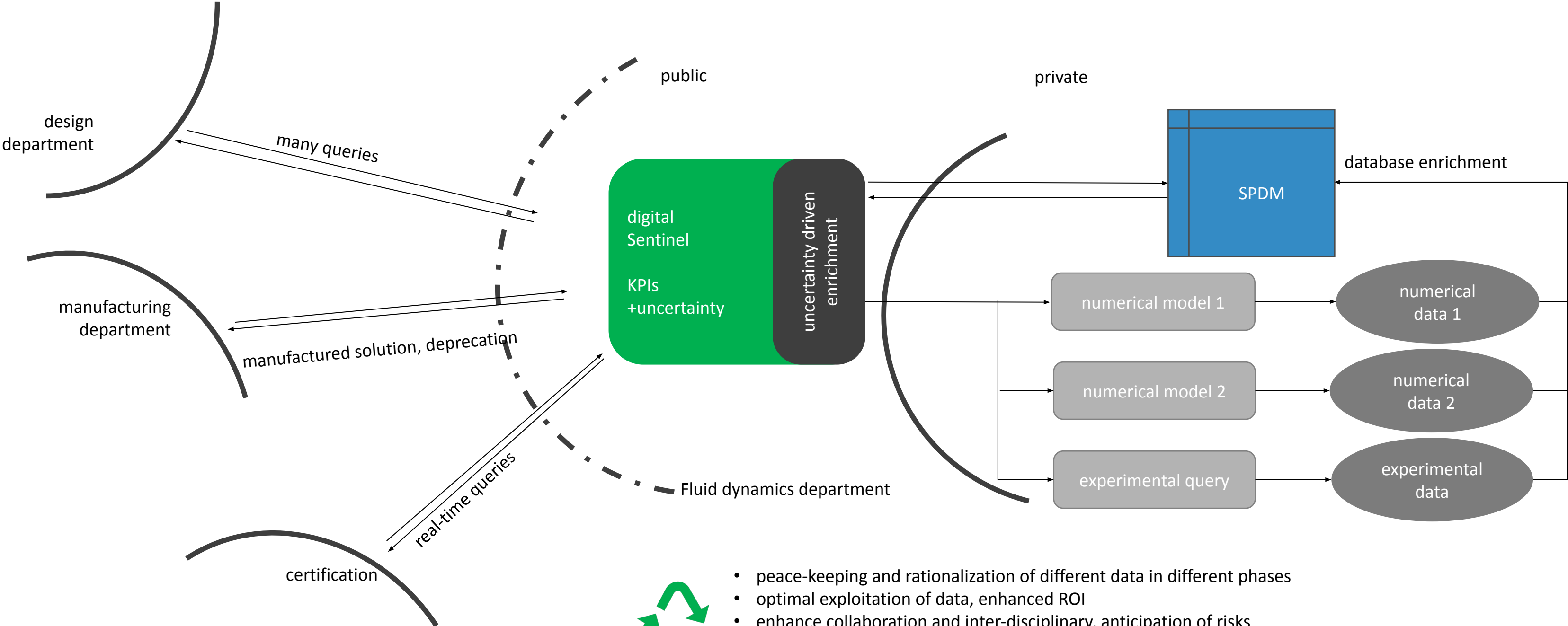
# Simulation-driven product definition

## State-of-the-art



# Data-driven product definition

## Our vision



- peace-keeping and rationalization of different data in different phases
- optimal exploitation of data, enhanced ROI
- enhance collaboration and inter-disciplinary, anticipation of risks
- asynchronous parallel engineering
- **cost and time reduction through data re-usage**

# Let's have a look at the data

## Amount of data

Simulation Driven without SPDM



Simulation Driven with SPDM



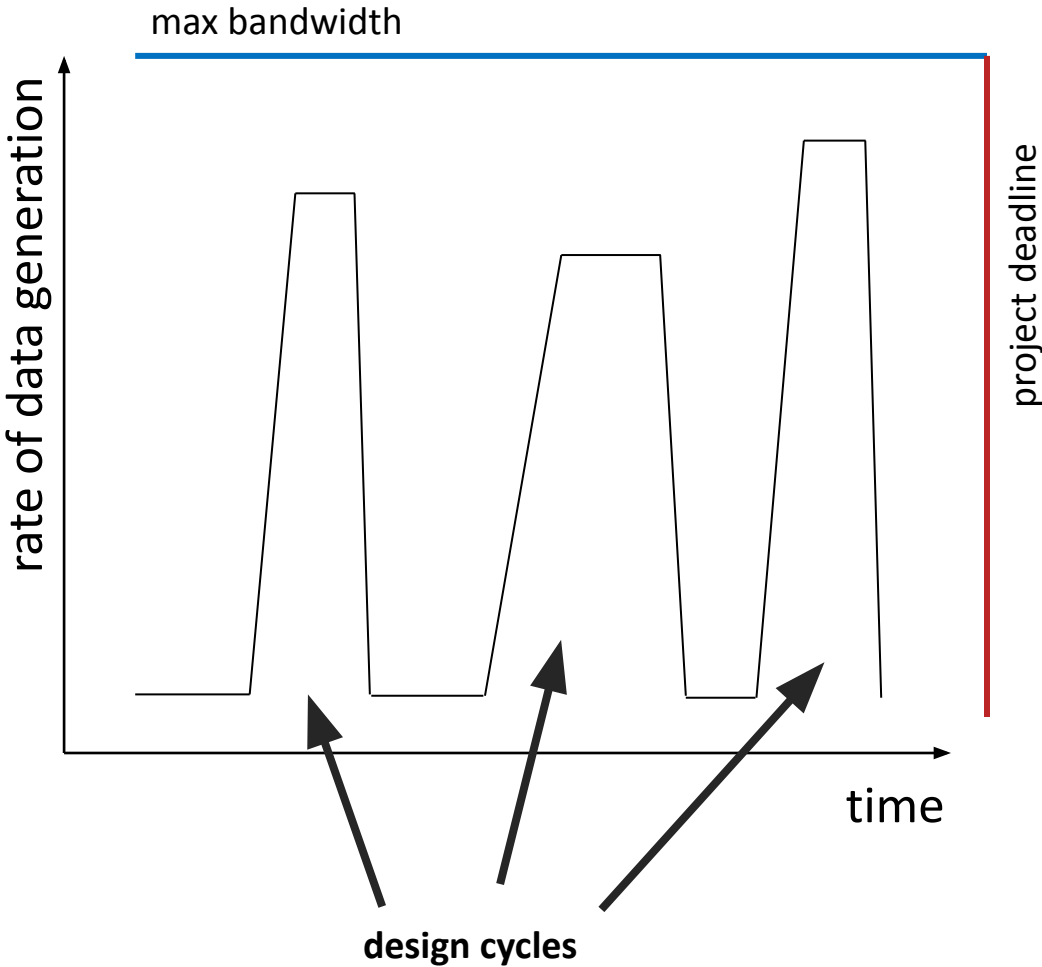
Data Driven



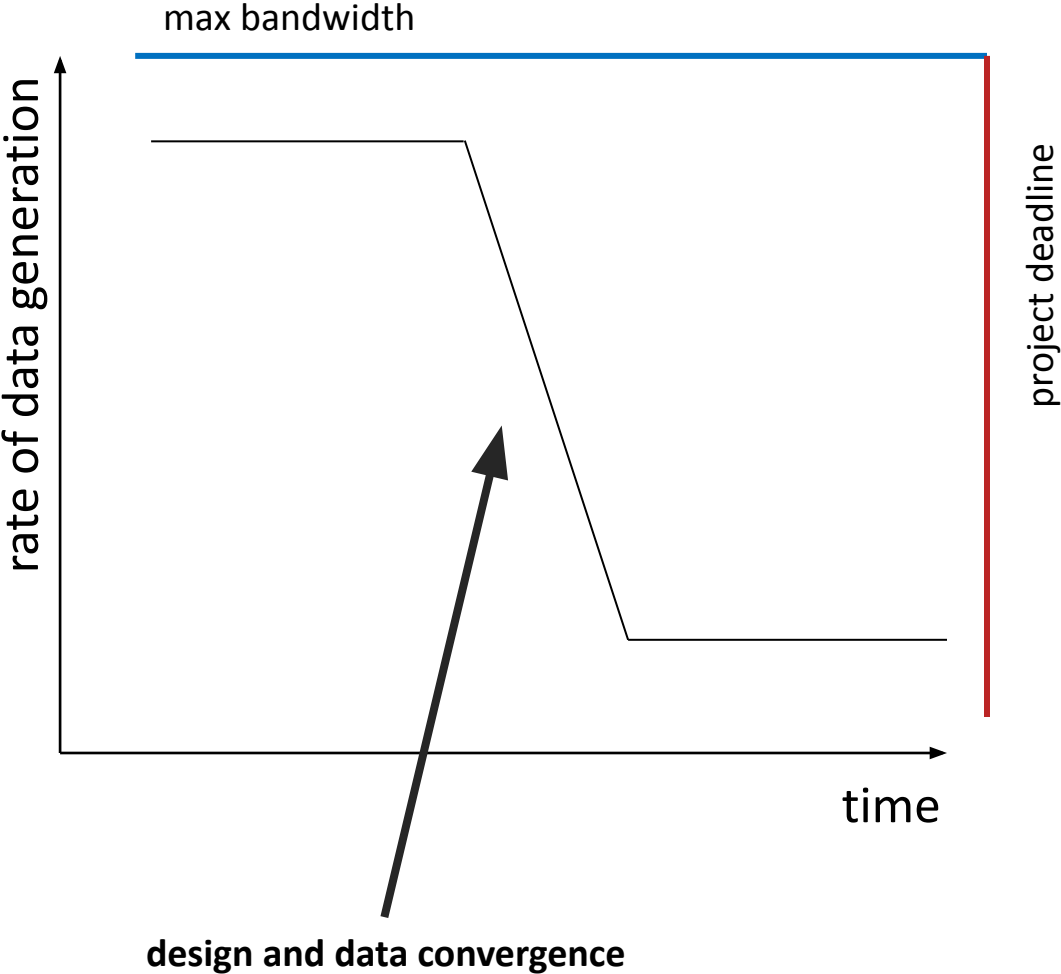
# Let's have a look at the data

## Data generation over time

Simulation Driven



Data Driven



# Let's have a look at the data

## Lifetime of data

### Simulation Driven

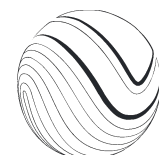
- created and used for the duration of a **task**
- conserved for process traceability and coherence

### Data Driven

- created during a **task**
- used for the duration of the **project for several tasks**
- conserved for process traceability and coherence
  
- Can data be exploited **among projects?**

# What is romBOX?

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# a reduced order modelling & machine learning toolbox

## Data-driven models

- Reduced Order Models
- ML, AI
- Multi-fidelity
- Data morphing

## Geometry driven

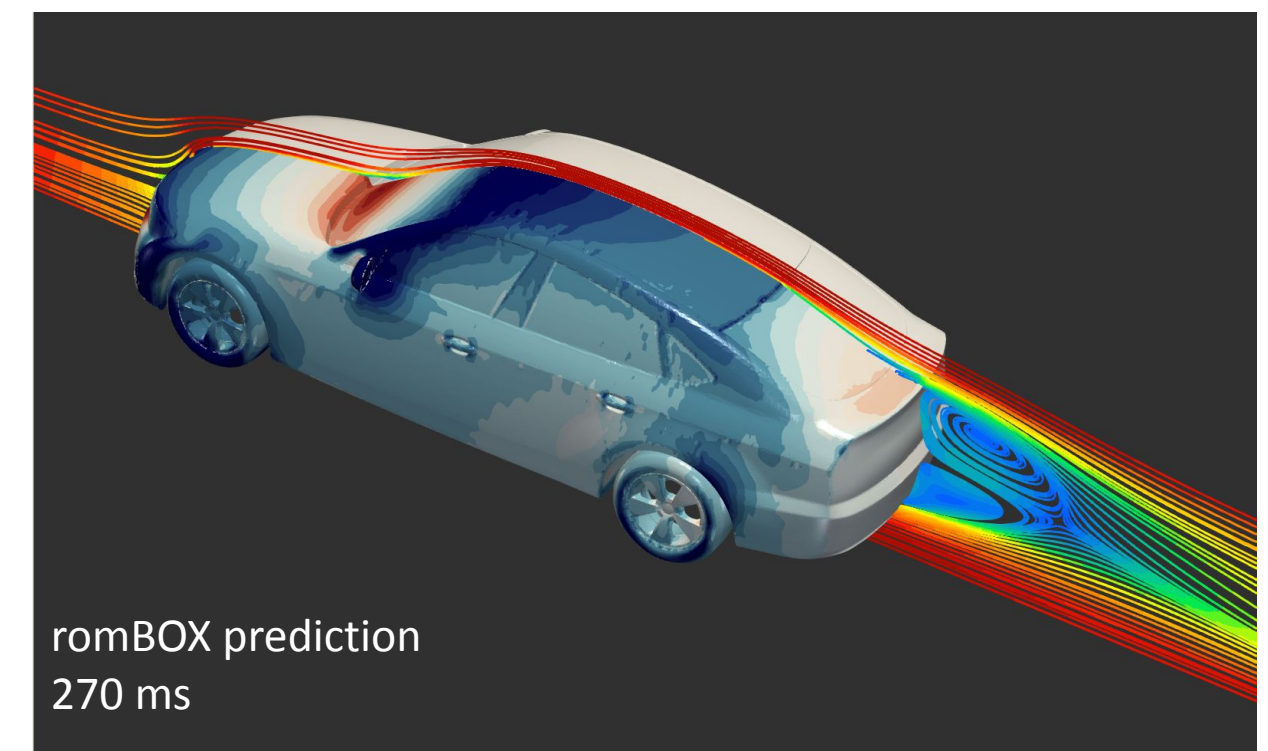
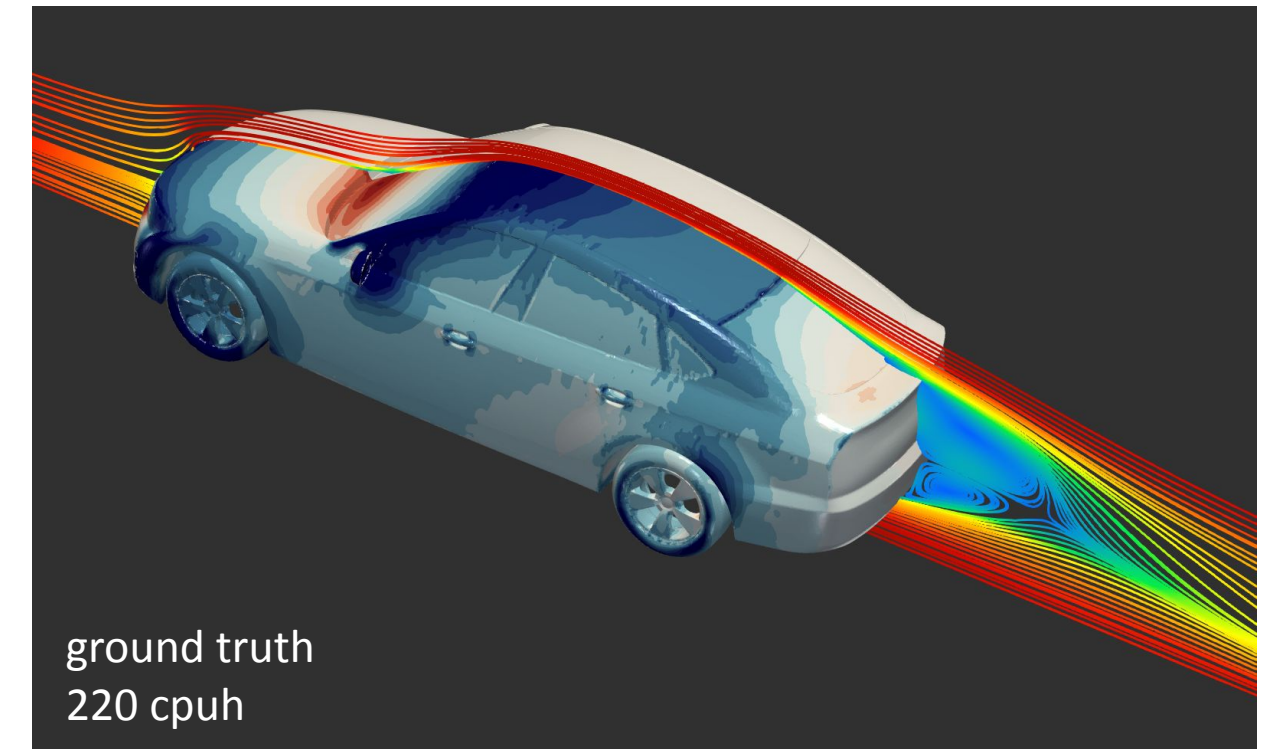
- **User-given parameterization**
- **Empiric parametrization**
- Autoencoders

## Physics-driven models

- by coupling solver

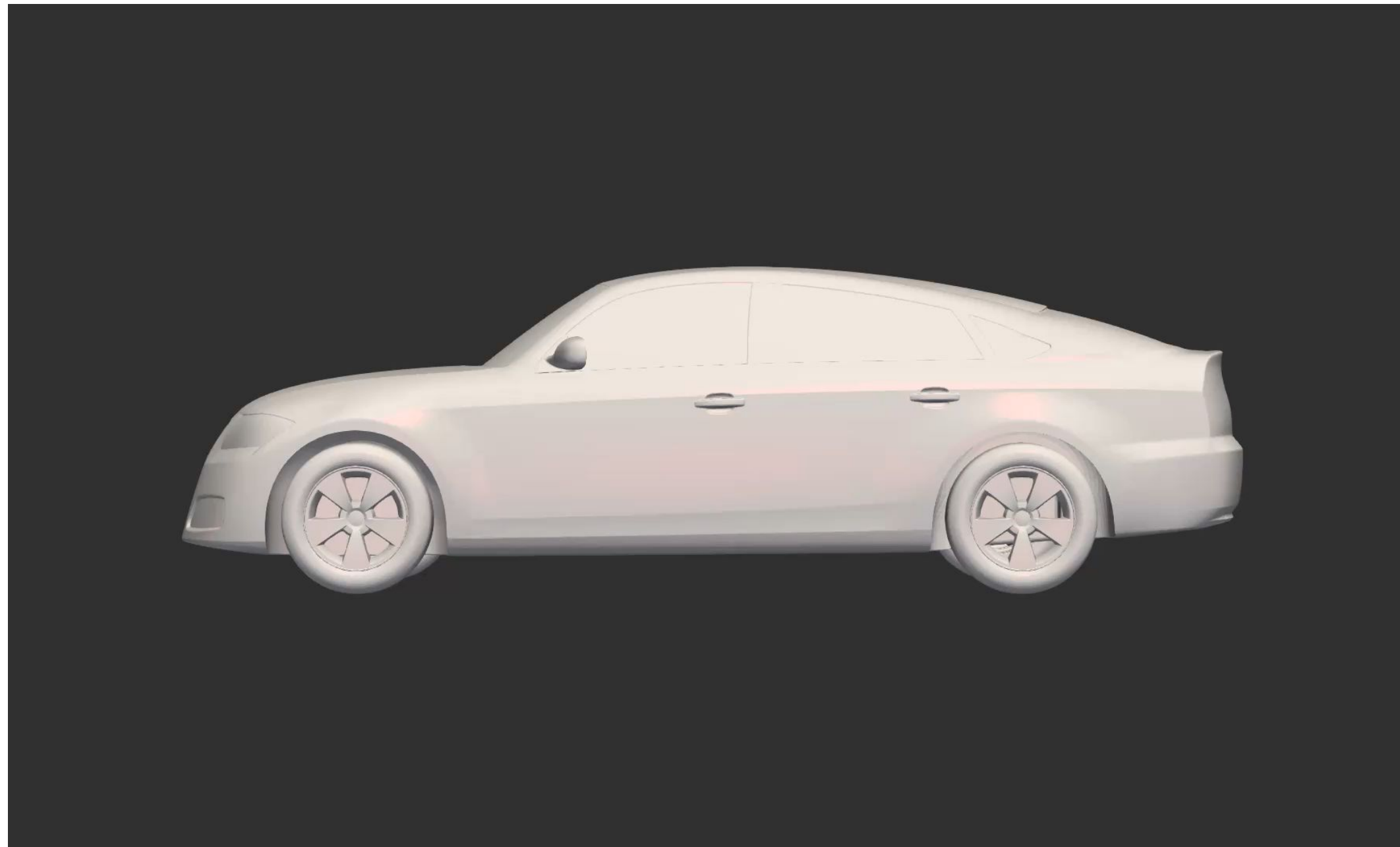
## Any data

- Surface data
- Volume data
- QoI
- Sensitivities



# romBOX

example, real-time aerodynamic predictions



## geomtery

- DrivAer baseline
- mimic
- 8 design parameters

## aerodynamic drag evalutation

- OpenFOAM
- 15M, simpleFOAM

## ROM

- romBOX geometrical & data encoder
- RBF-NN regression model

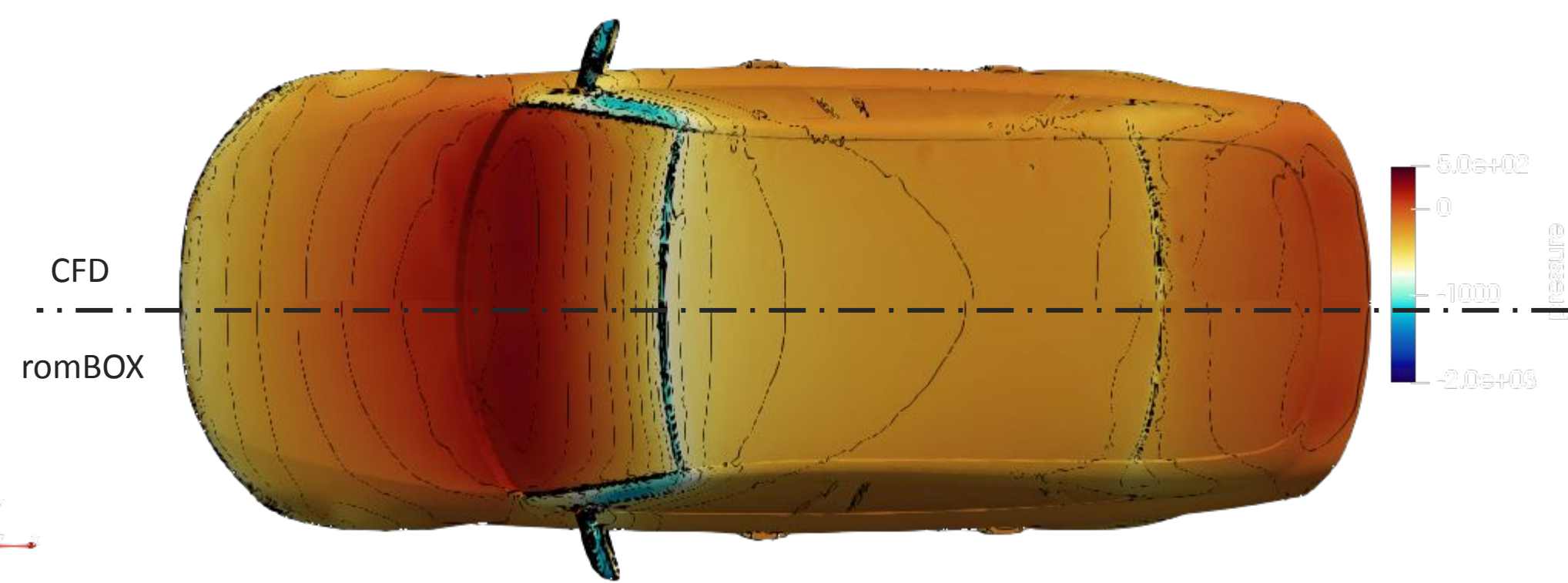
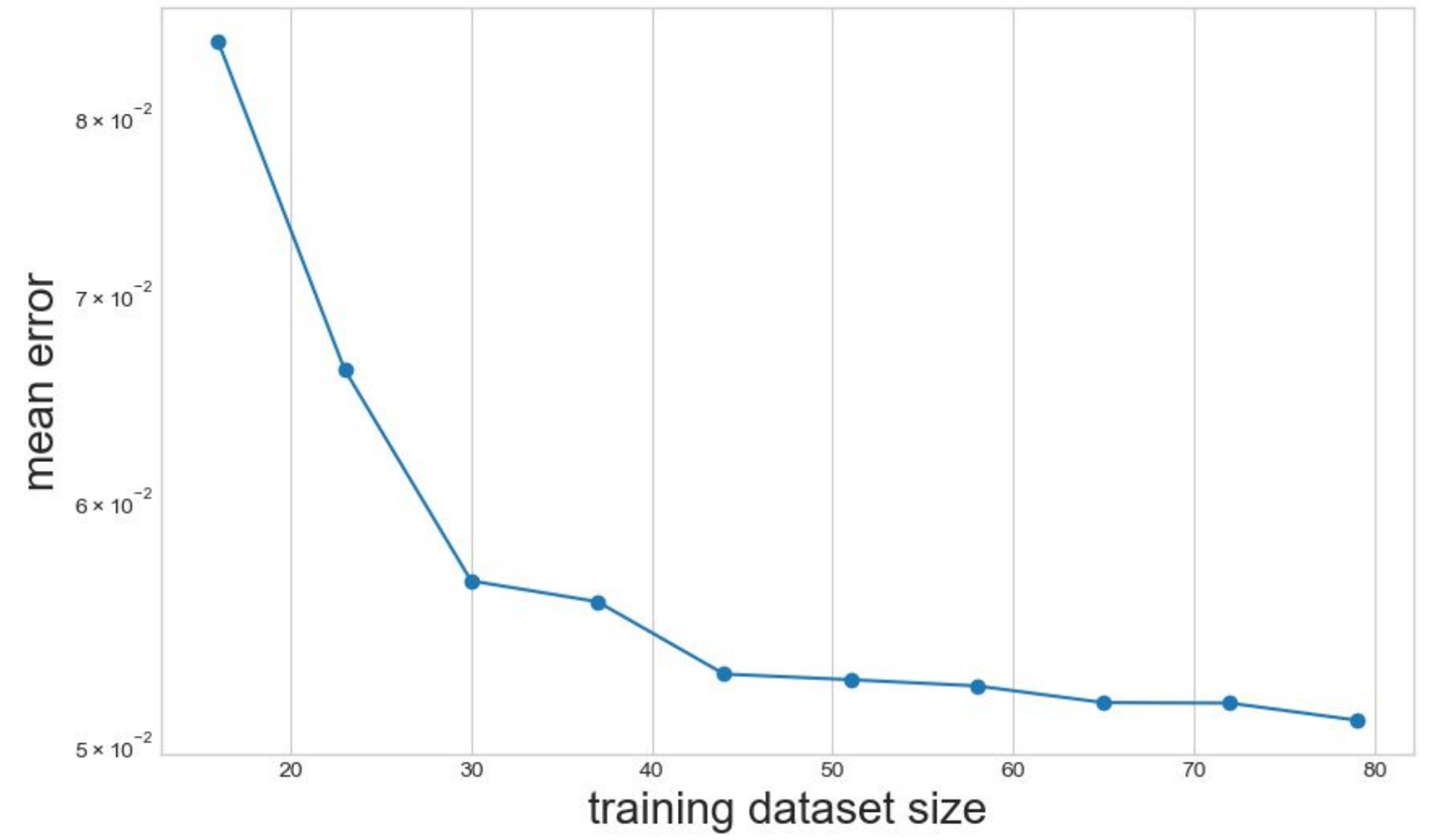
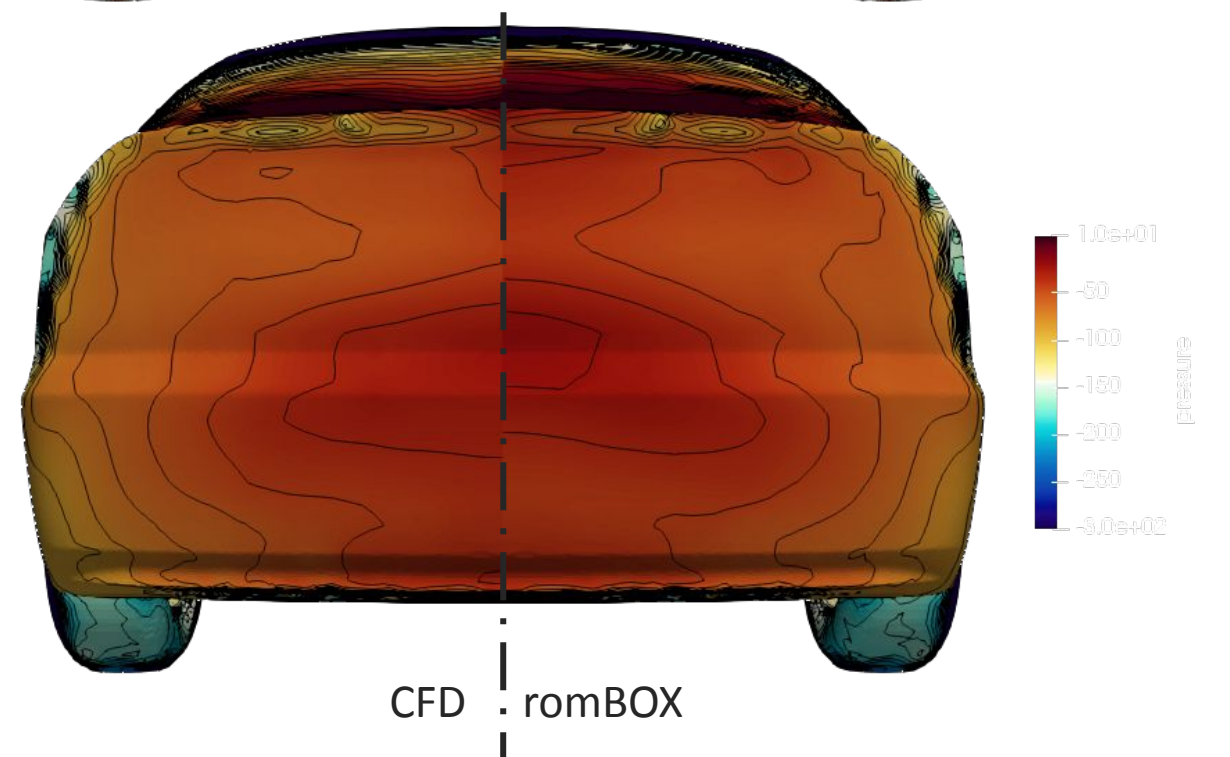
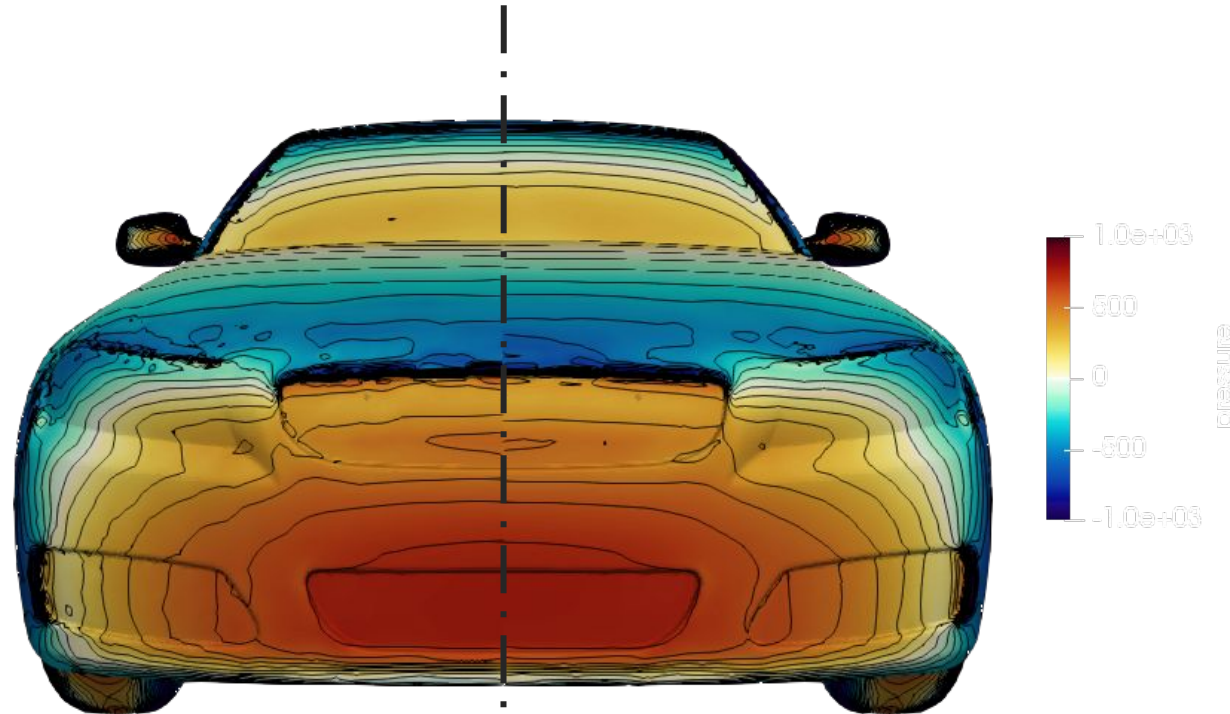
## Validation

- 20 unseen random configurations
- average L2 error on pressure distribution



# romBOX

example, real-time aerodynamic predictions



# Synergy between romBOX and VOLTA

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# Process, user and data management

criticalities

## Correct data management

- Automatic annotation of data in the database
- Full control on data included in training

## Traceability

- of activity, i.e. who, what, when
- of results, models and data
  - data has been generated with which simulation model (annotation)
  - ROM model has been trained with which data (version tracking)
  - data has been generated when by who, with which method

## User management & roles

- simulation experts are responsible for generating high-value (automatic) workflows
- application engineer exploit the simulation workflows to generate product relevant data
- domain experts train and publish ROMs to be exploited by other stakeholders

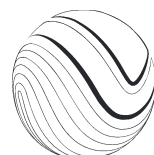
# Deployment for a streamlined user experience

## Offline & online workflow as a project on VOLTA

- web technology on private or public cloud
- connect from anywhere
- handling of resources, distributed computing
- intuitive interface
- collaborative
  
- **allows experts to train a reliable ROM**
- **allows non-expert users to exploit ROM autonomously**

## Tasks

- single run
  - DoE
  - Optimization
- + data insight through VOLTA Advisor
- 
- **scalable system**



# Deployment

example: run an error-constrained model

The screenshot shows the VOLTA PROJECT interface. A 'RUN A MODEL' dialog box is open, prompting the user to 'Choose how you want to run your model'. Below this, a 'Single run' configuration window is displayed, showing a list of parameters and their default values. The 'spoiler\_displ' parameter is highlighted, and its value is set to 0.005. The interface also includes a sidebar with navigation options like 'My Files', 'Shared', 'Starred', 'Trash', 'My Teams', 'Projects', and 'Sessions'. The main content area shows a project named 'run\_PODI\_multi-fidelity' with a 'Run' button and a 'View' button. A search bar is visible at the top right.

**RUN A MODEL**  
Choose how you want to run your model

**Single run**  
Test a single design or configuration to see how your model behaves with a specific set of input values

Name	Default v...
Apillar_angle	0
Apillar_thickness	0.014
back_dir	0.1
back_displ	0.03
diffuser_zdispl	0
spoiler_dir	0.1
spoiler_displ	0.005

**spoiler\_displ**  
VALUE  
Default value  
0

# Deployment

example: retrieve results

run\_PODI\_multi-fidelity

Overview Results Dependencies Events

**Results** Open in VOLTA advisor

100%

Total	Feasible	Unfeasible	Error	Rerun
1	1	0	0	0

**Details**

Tags

single\_run all\_in\_one

workflow\_based

Description  
No description

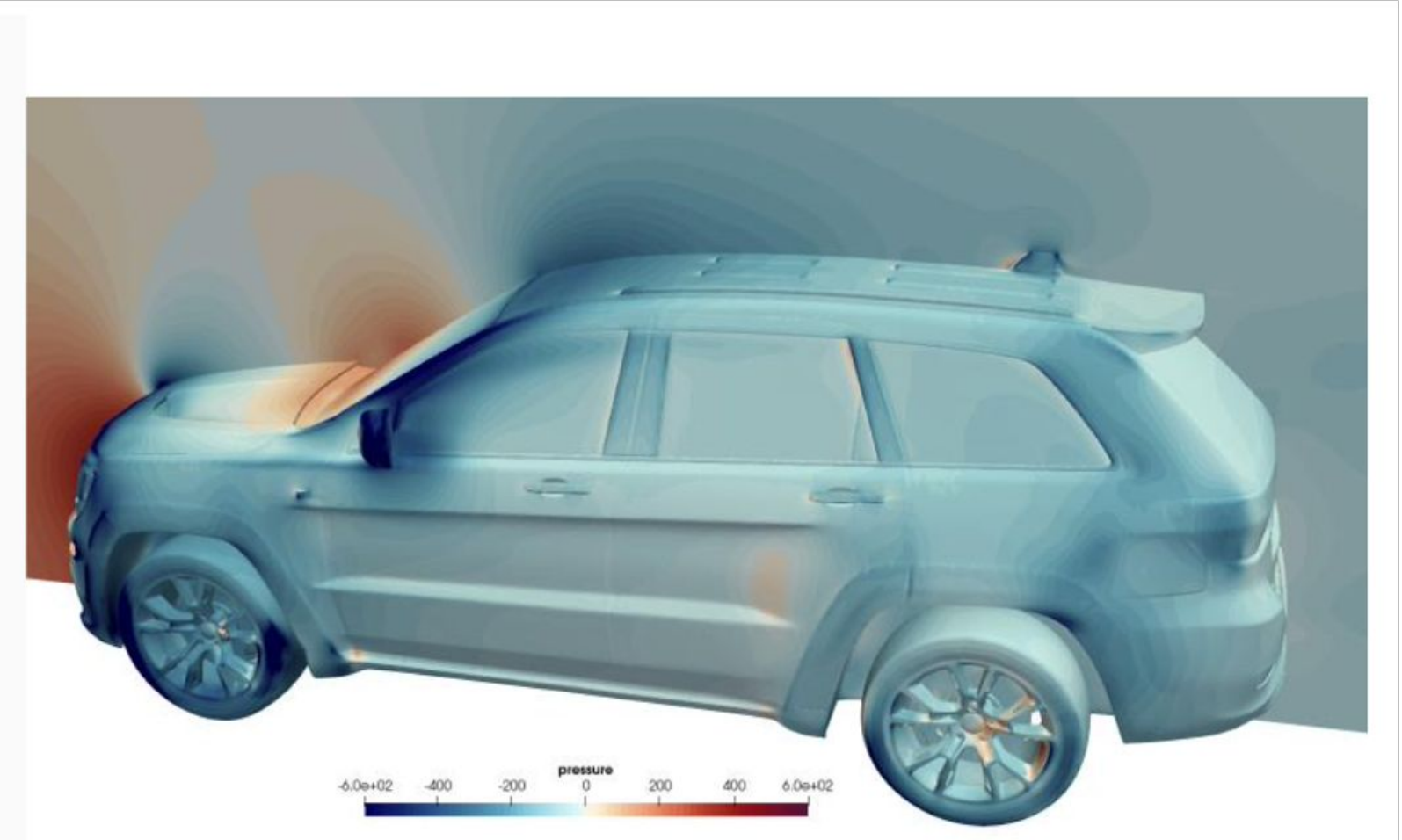
**Configuration**

Model

run\_PODI\_mult... v1

Scalars

7



Overview Results Dependencies Events

Open in VOLTA advisor Export as xlsx Create RSM model

Feasible 1 Best 0 Unfeasible 0 Error

ID	Apillar_angle	Apillar_thickness	back_dir	back_displ	diffuser_zdispl	spoiler_dir	spoiler_displ	Cd	Cl	Cl_front	Cl_rear	field_pic
0	0.0000E0	1.4000E-2	1.0000E-1	3.0000E-2	0.0000E0	1.0000E-1	5.0000E-3	2.2184E-1	-6.4574E-3	-1.1965E-1	1.1320E-1	field.png

# Deployment

example: retrieve results

run\_PODI\_multi-fidelity

Overview Results Dependencies Events

**Results** Open in VOLTA advisor

100%

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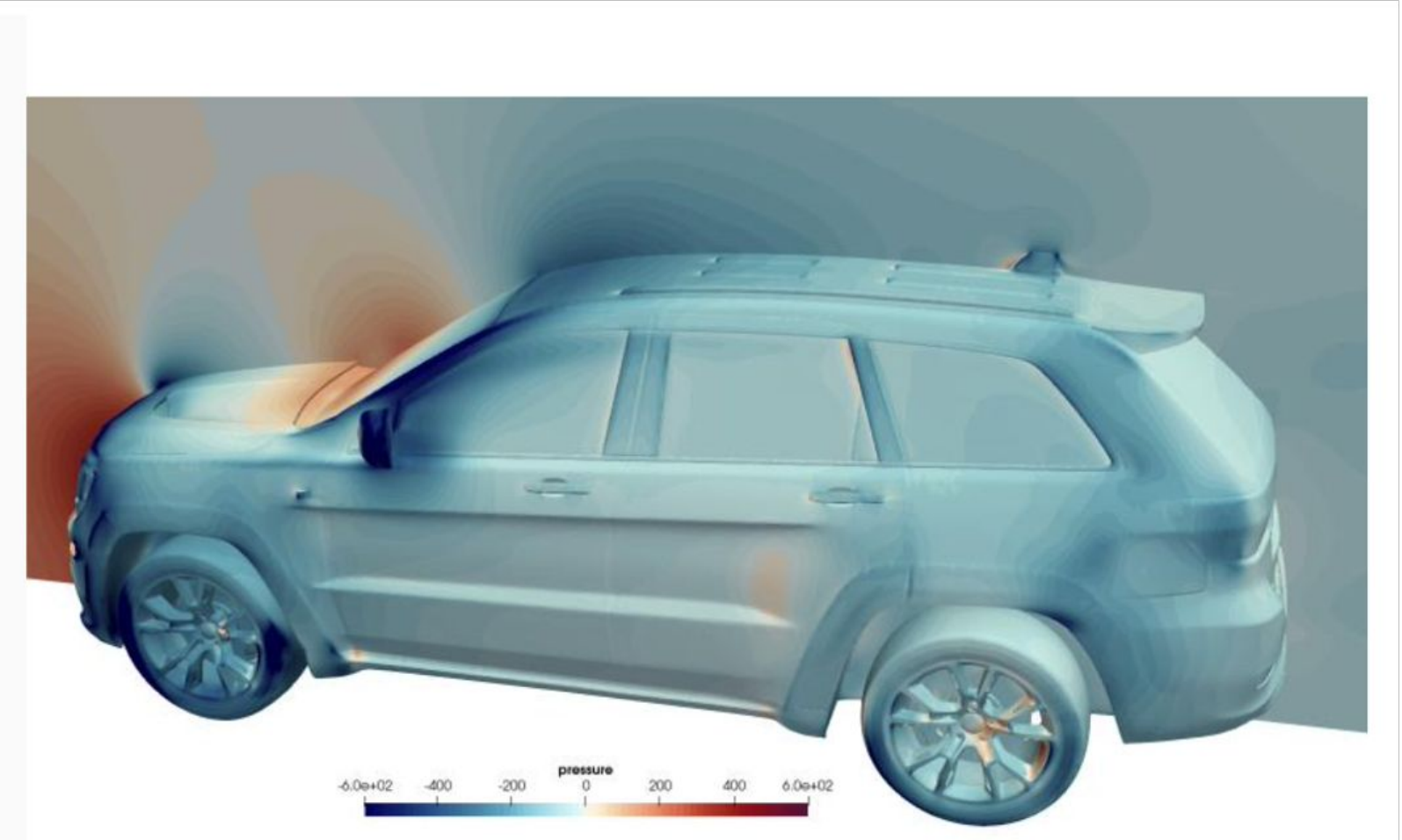
**Configuration**

Model

run\_PODI\_mult... v1

Scalars

7



Overview Results Dependencies Events

Open in VOLTA advisor Export as xlsx Create RSM model

Feasible 1 Best 0 Unfeasible 0 Error

ID	Apillar_angle	Apillar_thickness	back_dir	back_displ	diffuser_zdispl	spoiler_dir	spoiler_displ	Cd	Cl	Cl_front	Cl_rear	field_pic
0	0.0000E0	1.4000E-2	1.0000E-1	3.0000E-2	0.0000E0	1.0000E-1	5.0000E-3	2.2184E-1	-6.4574E-3	-1.1965E-1	1.1320E-1	field.png

# Conclusions

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# Thank you!

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