

ESTECO  
**USERS' MEETING**  
**NORTH AMERICA**

**Switching from simulation-driven to data-driven design  
by exploiting the synergy of VOLTA and romBOX**

**um**  
**2023**

Haysam TELIB  
Co-Founder & CTO  
OPTIMAD





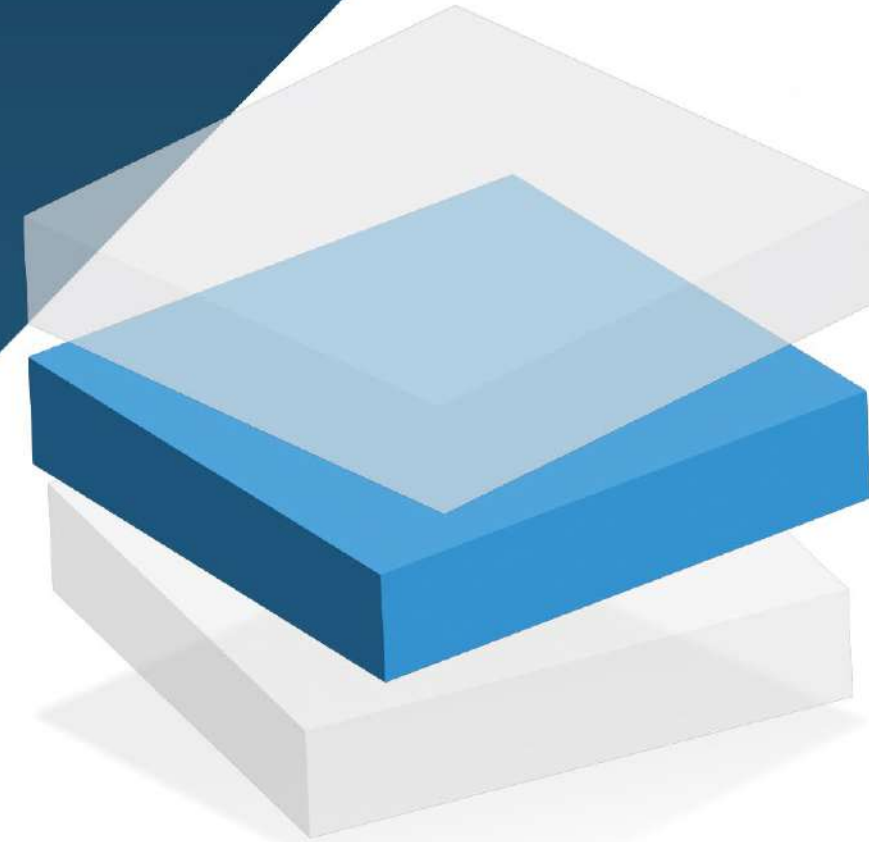
## About OPTIMAD

## Simulation-Driven vs Data-Driven

## Synergy between romBOX & VOLTA

What is romBOX  
Ensuring scalability and maintainability through VOLTA

## Conclusions



# ABOUT OPTIMAD

# People and competencies

## Strong scientific background

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

## Industrial proficiency

- computational fluid dynamics
- its integration in product development.

**28** employees

**52%** hold a PhD

**31** average age

**7** countries



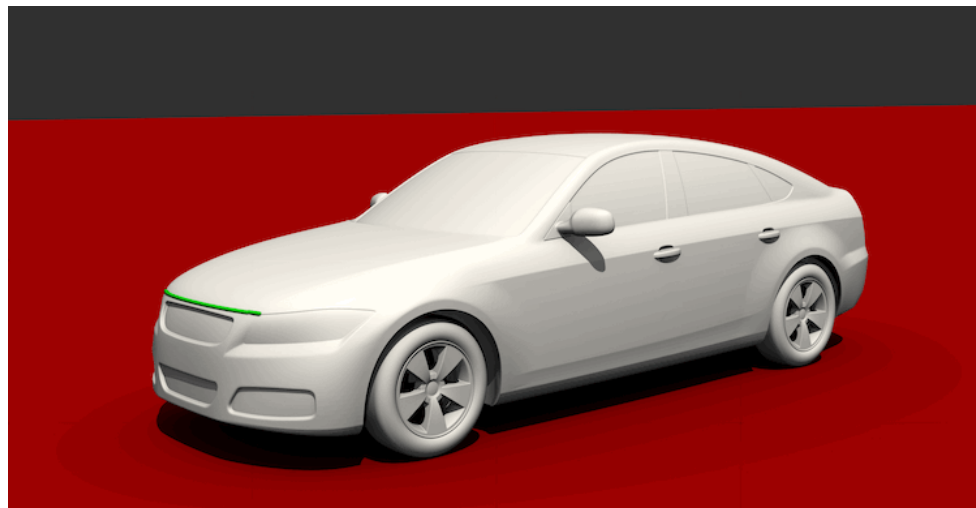


# Our products

Enabling the digital transformation of product development cycles and design processes

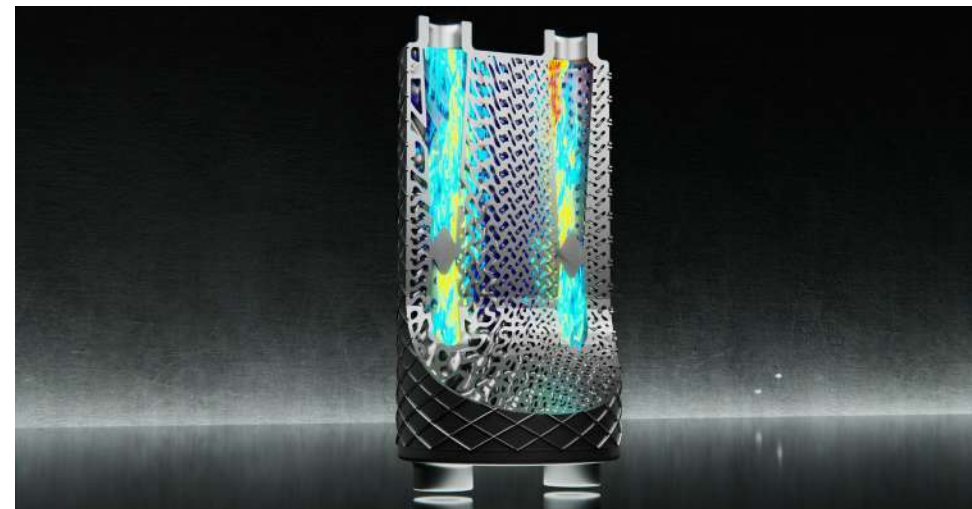
## mimic

shape parameterization, mesh manipulation & morphing



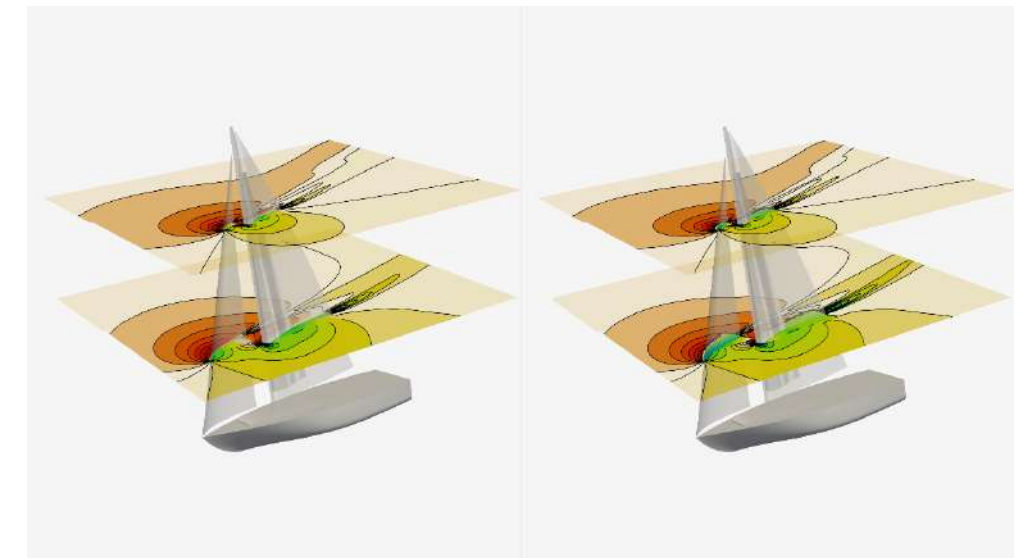
## immerFLOW

high-productivity CFD solver



## romBOX

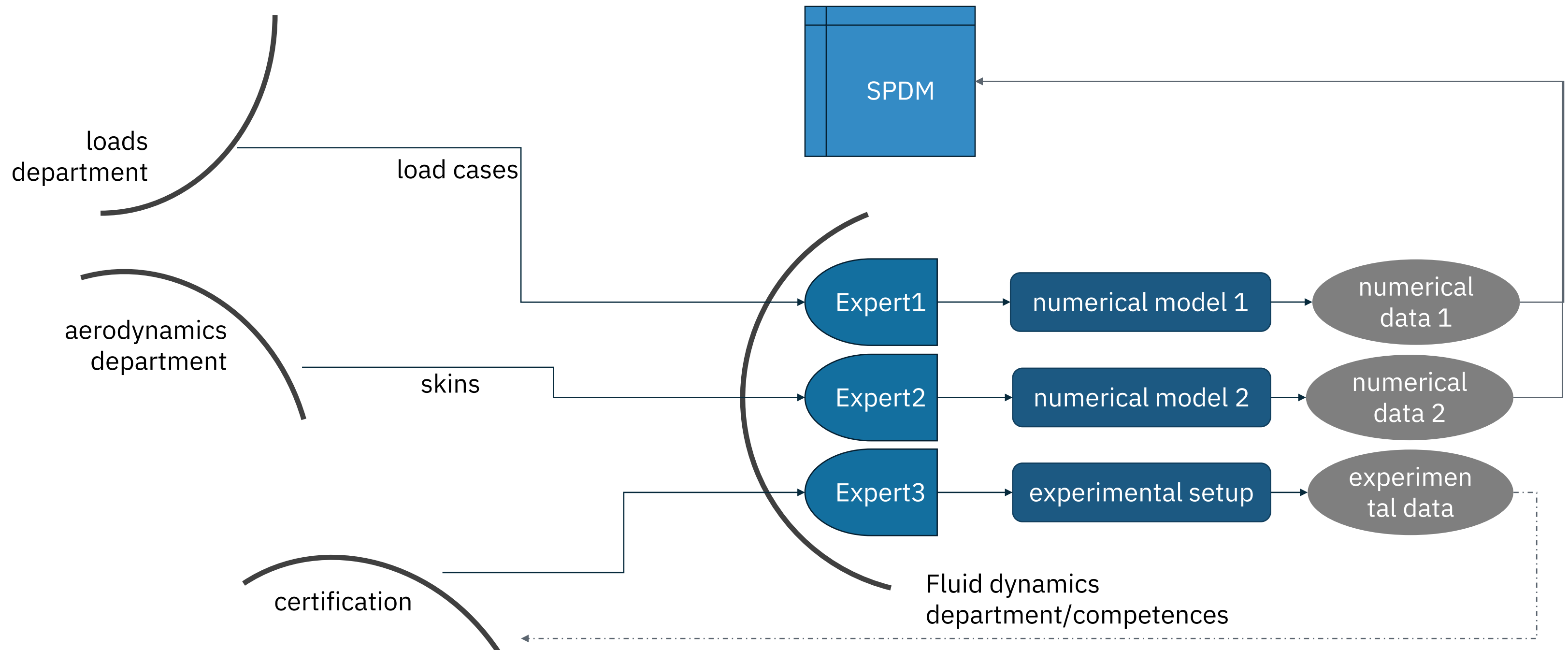
reduced order models & machine learning for simulation data exploitation



# Simulation-driven vs Data-driven

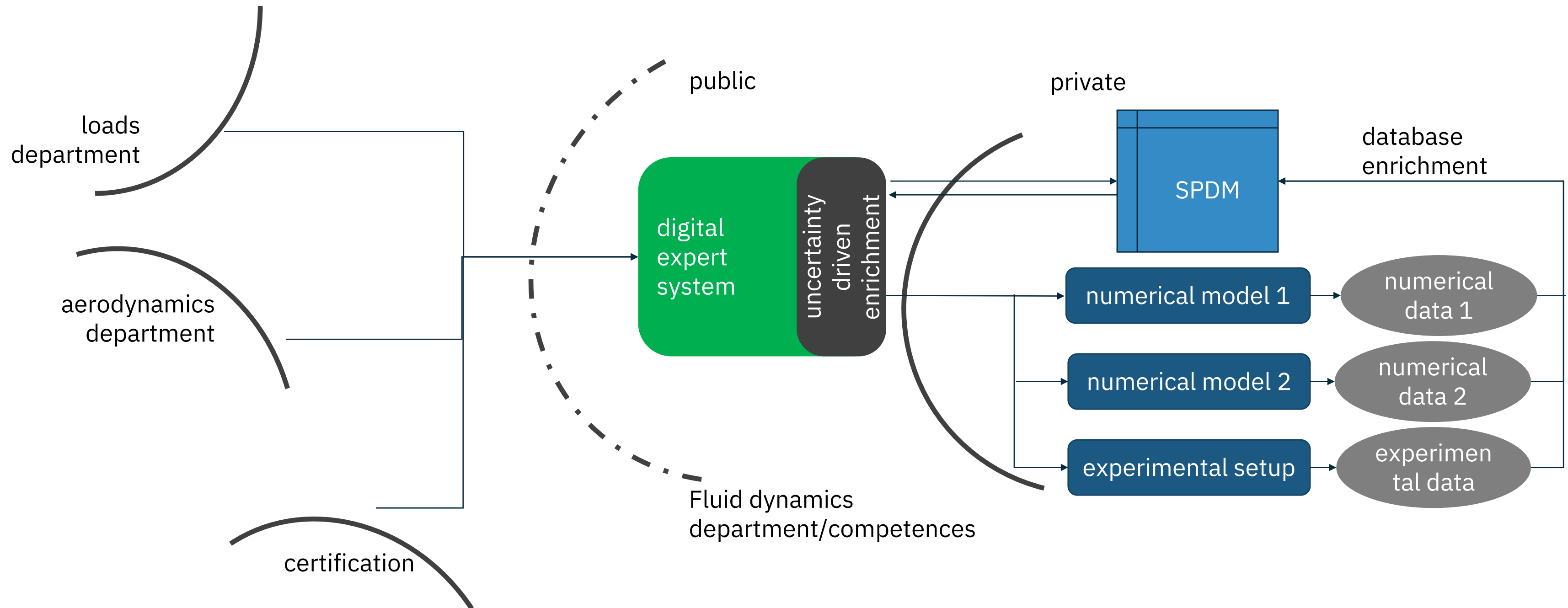
# Simulation-driven design

State-of-the-art



# Data-driven design

Our vision – leveraging consolidated technology





# Data lifecycle

## Simulation Driven

- created to accomplish a **task**
- used for the duration of a **task**

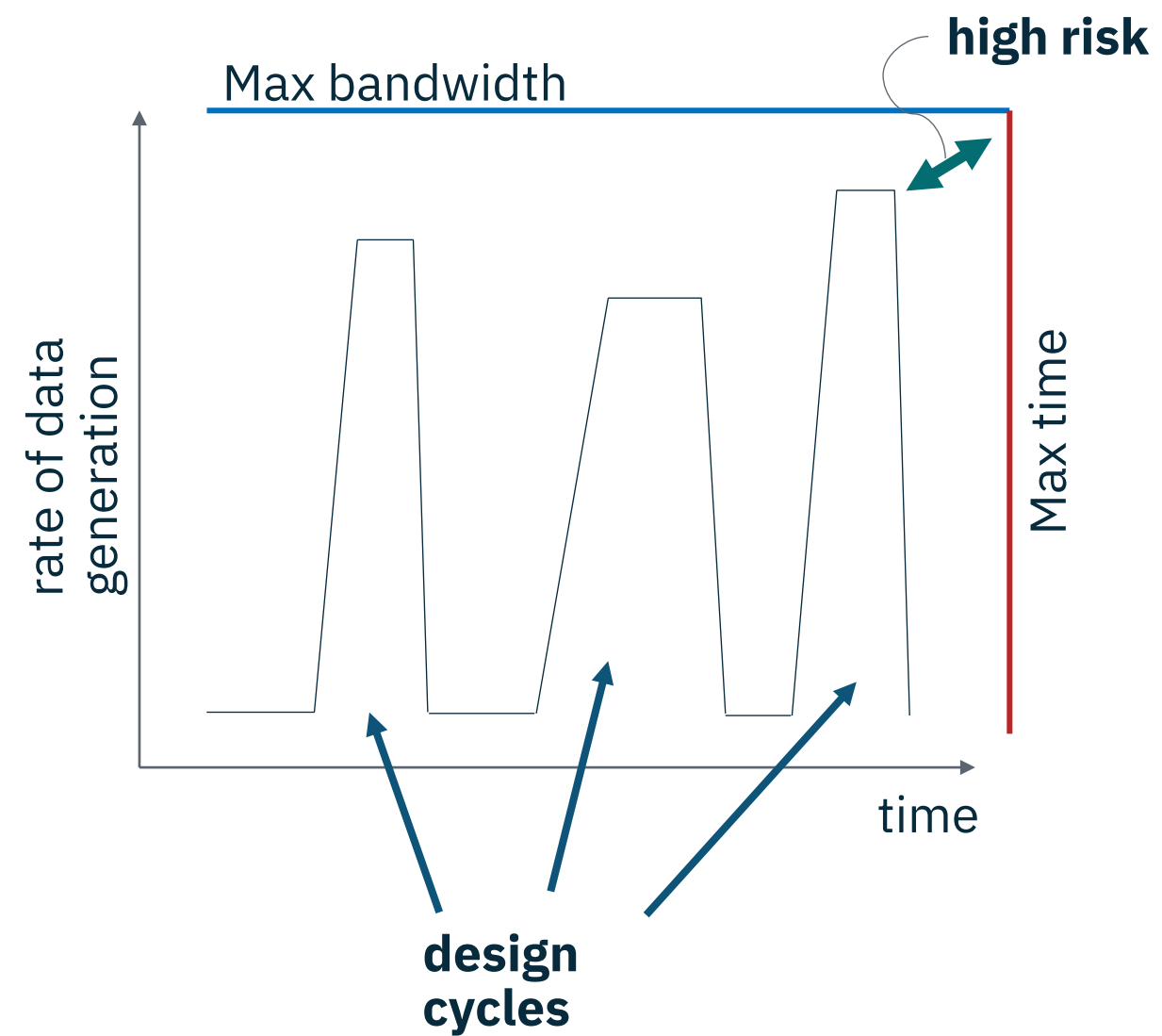
## Data Driven

- created to accomplish a **task**
- intensively exploited during the **product lifecycle**

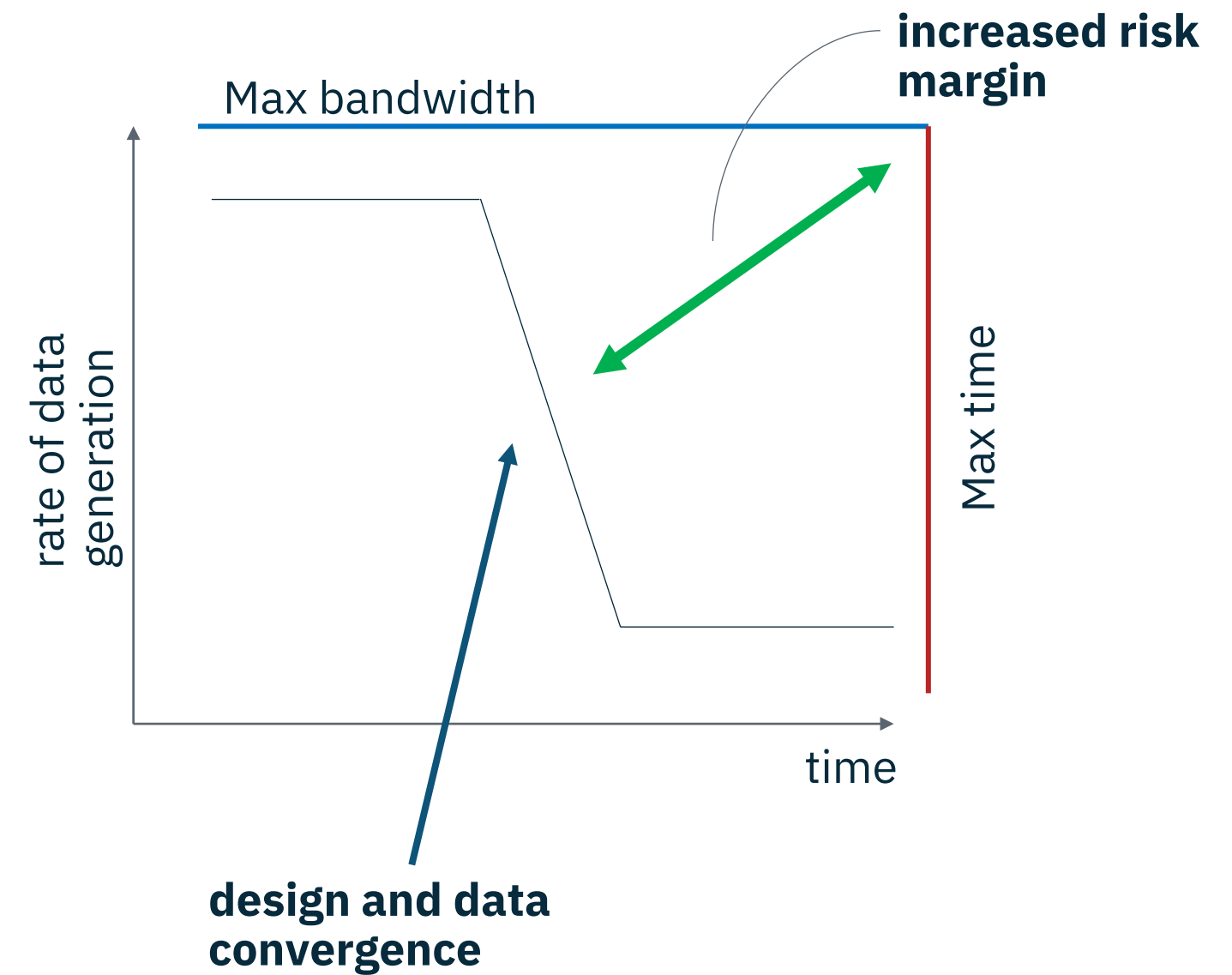


# Usage of resources

## Simulation Driven

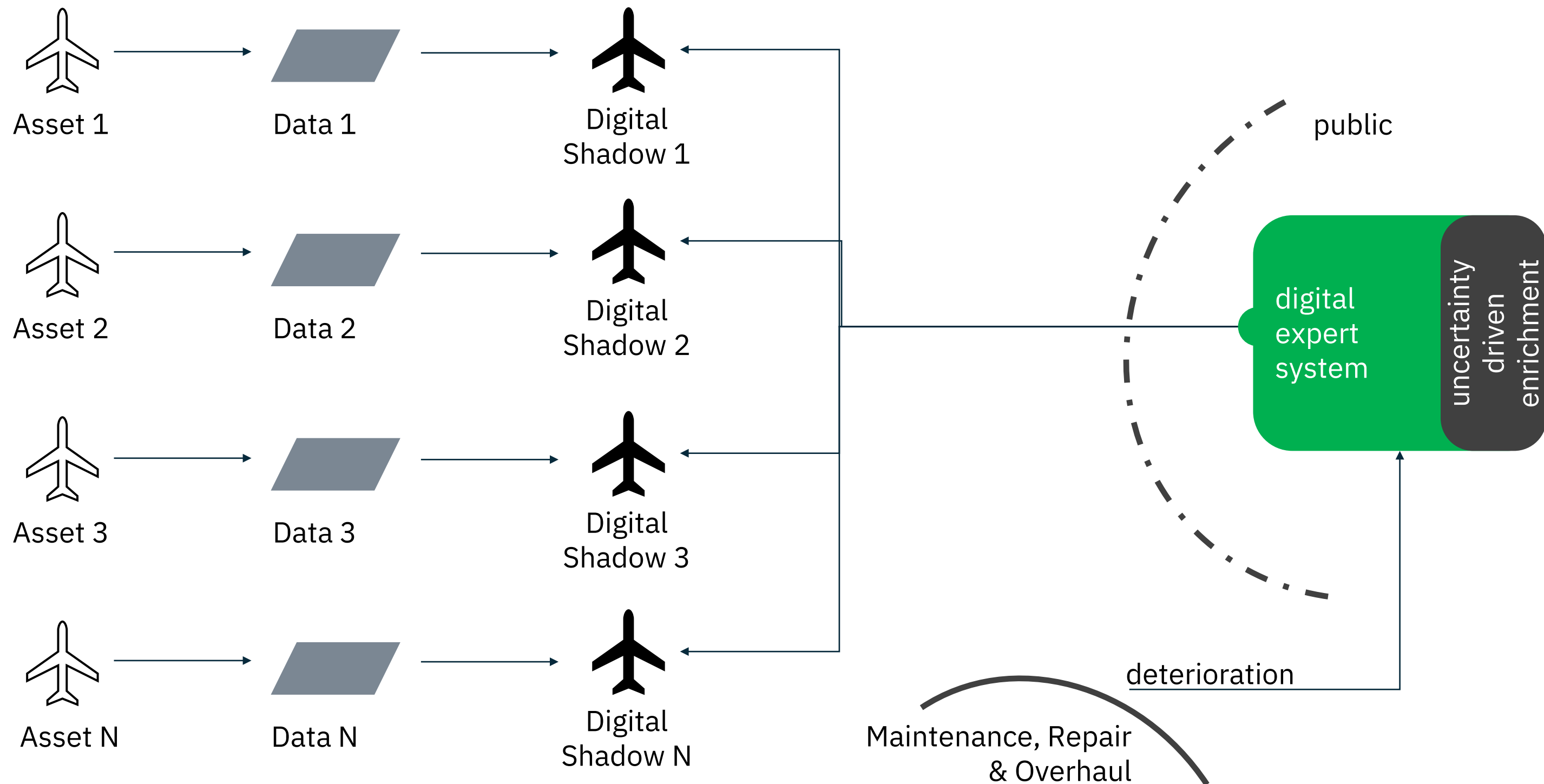


## Data Driven



# Beyond design

## Towards digital shadows and twins



# Syngergy between romBOX & VOLTA

What is romBOX?



# a reduced order modelling & machine learning toolbox

## Data-driven models

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

## Physics-driven models

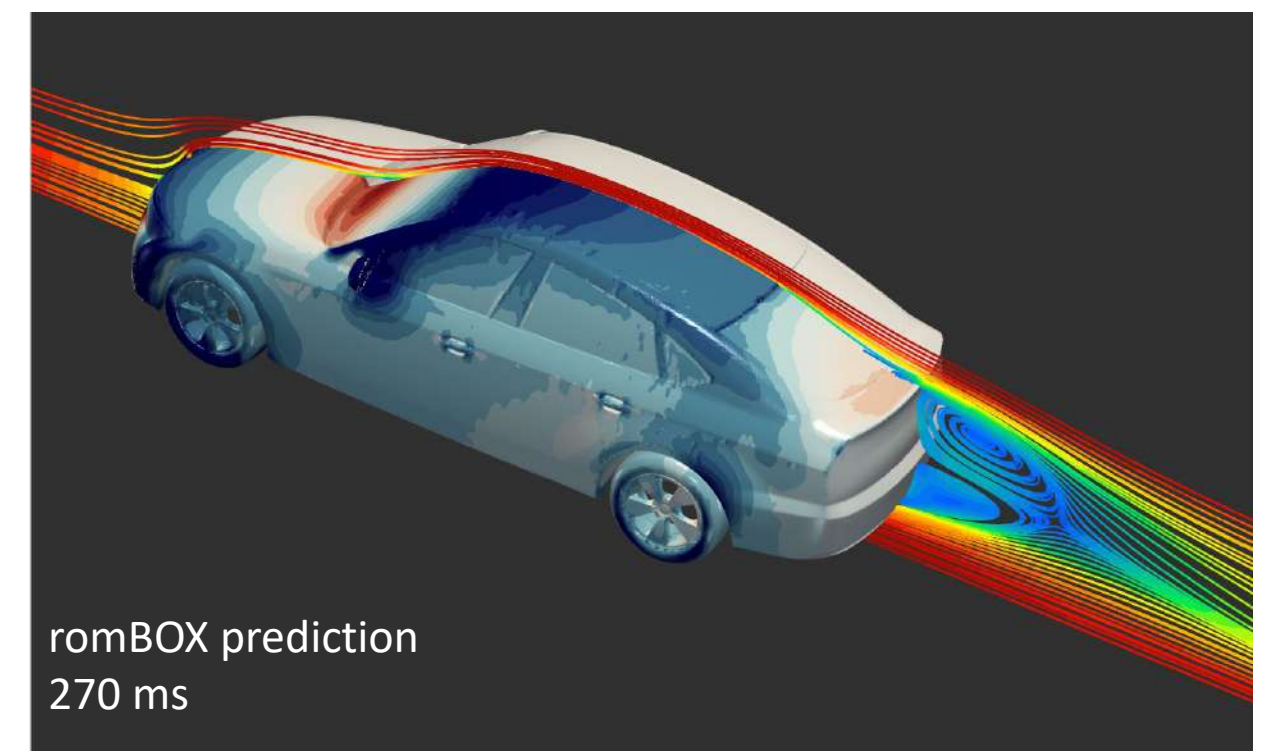
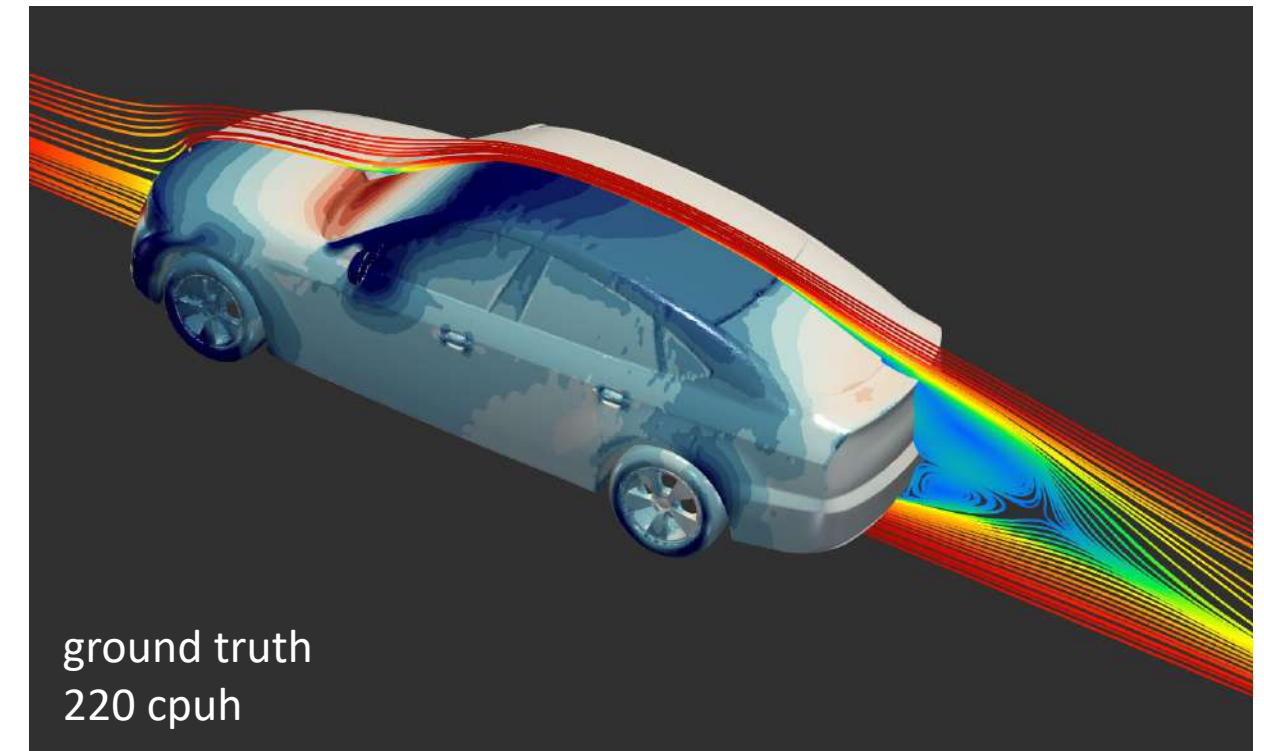
- by coupling solver

## Geometry handling

- User-given parameterization
- Empiric parametrization
- Autoencoders

## Any data

- Surface data
- Volume data
- QoI
- Sensitivities



# Example: real-time aerodynamic predictions

## Setup

### Geometry

- DrivAer baseline
- Mimic
- 8 design parameters

### Aerodynamic evaluation

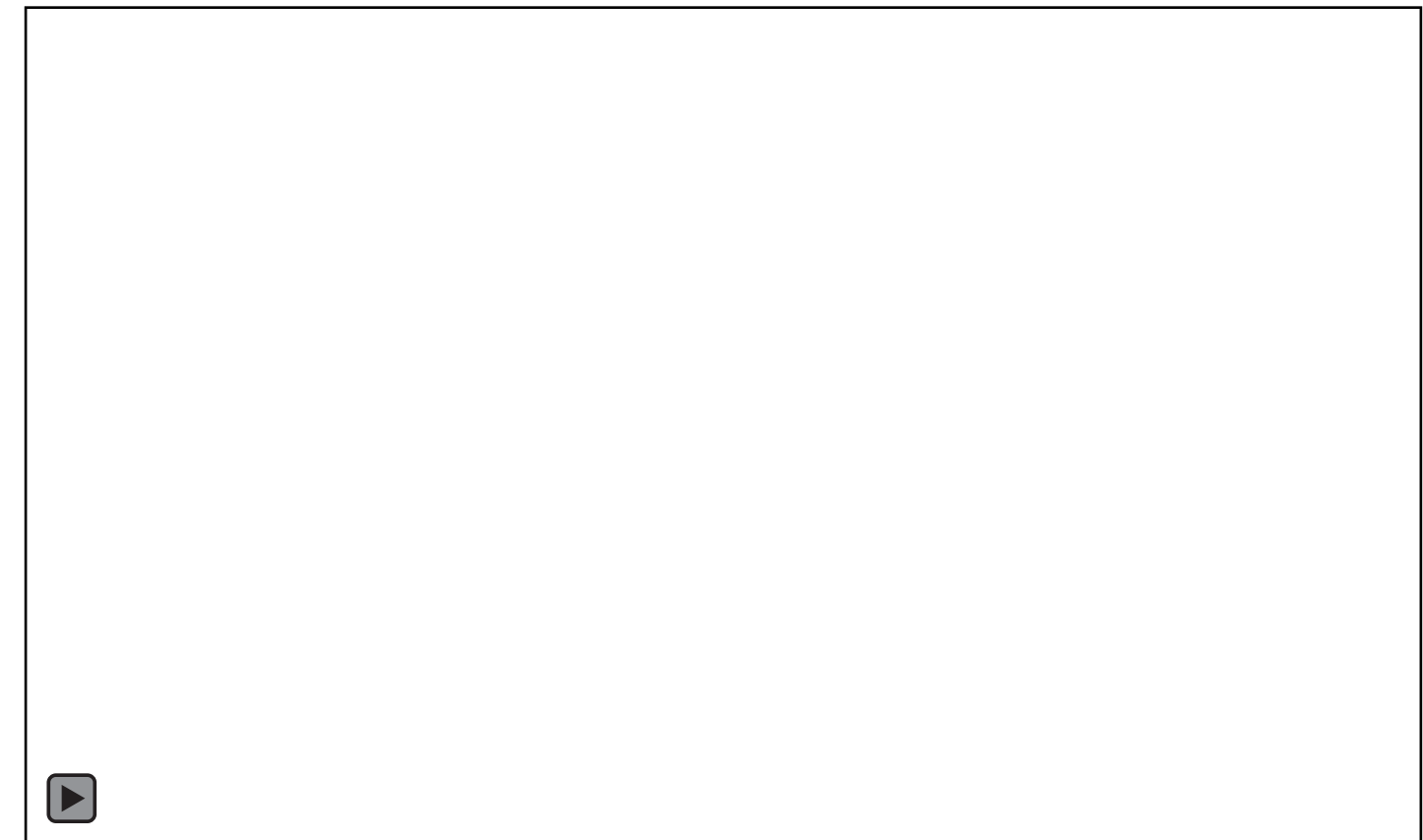
- OpenFOAM
- 15M, simpleFOAM

### ROM

- romBOX geometrical & data encoder
- NN regression model

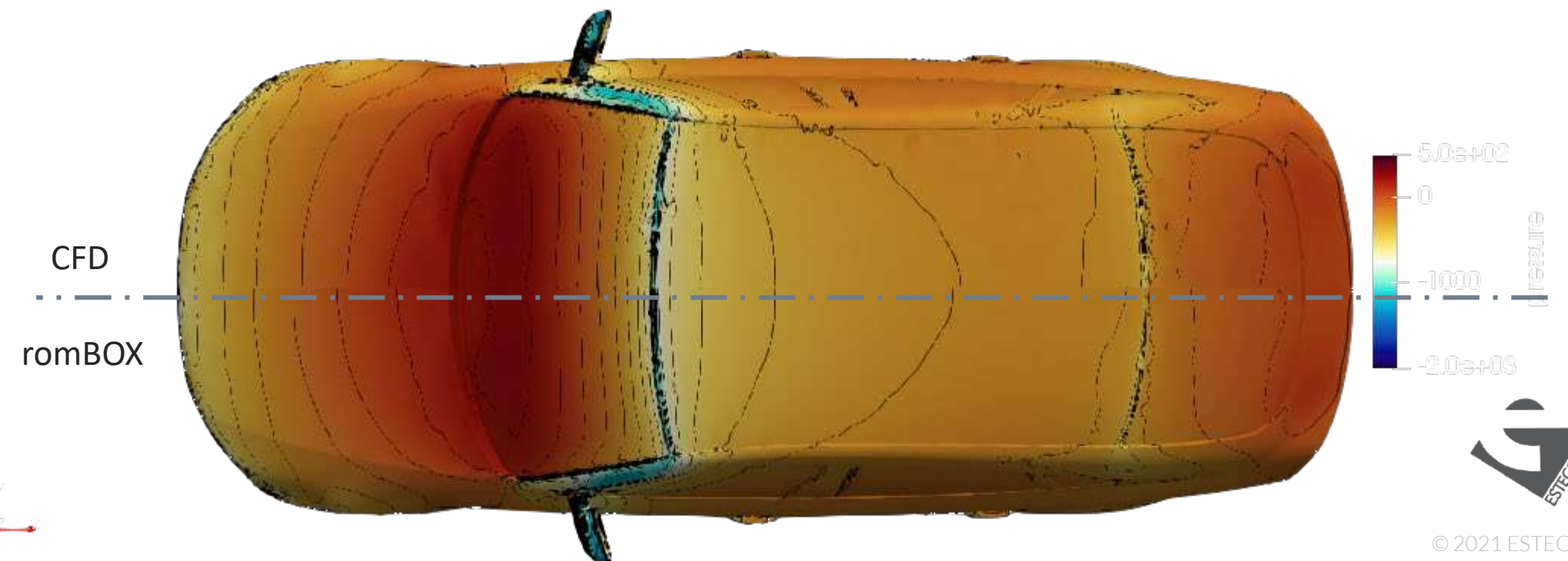
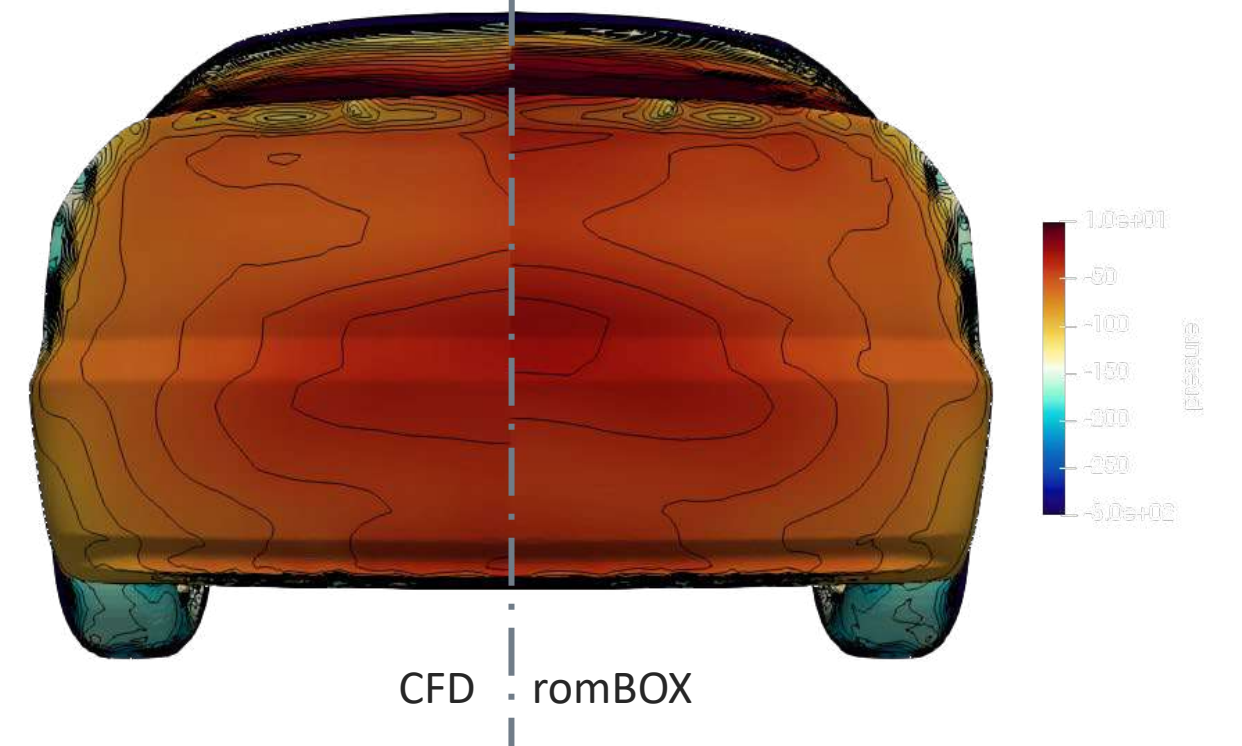
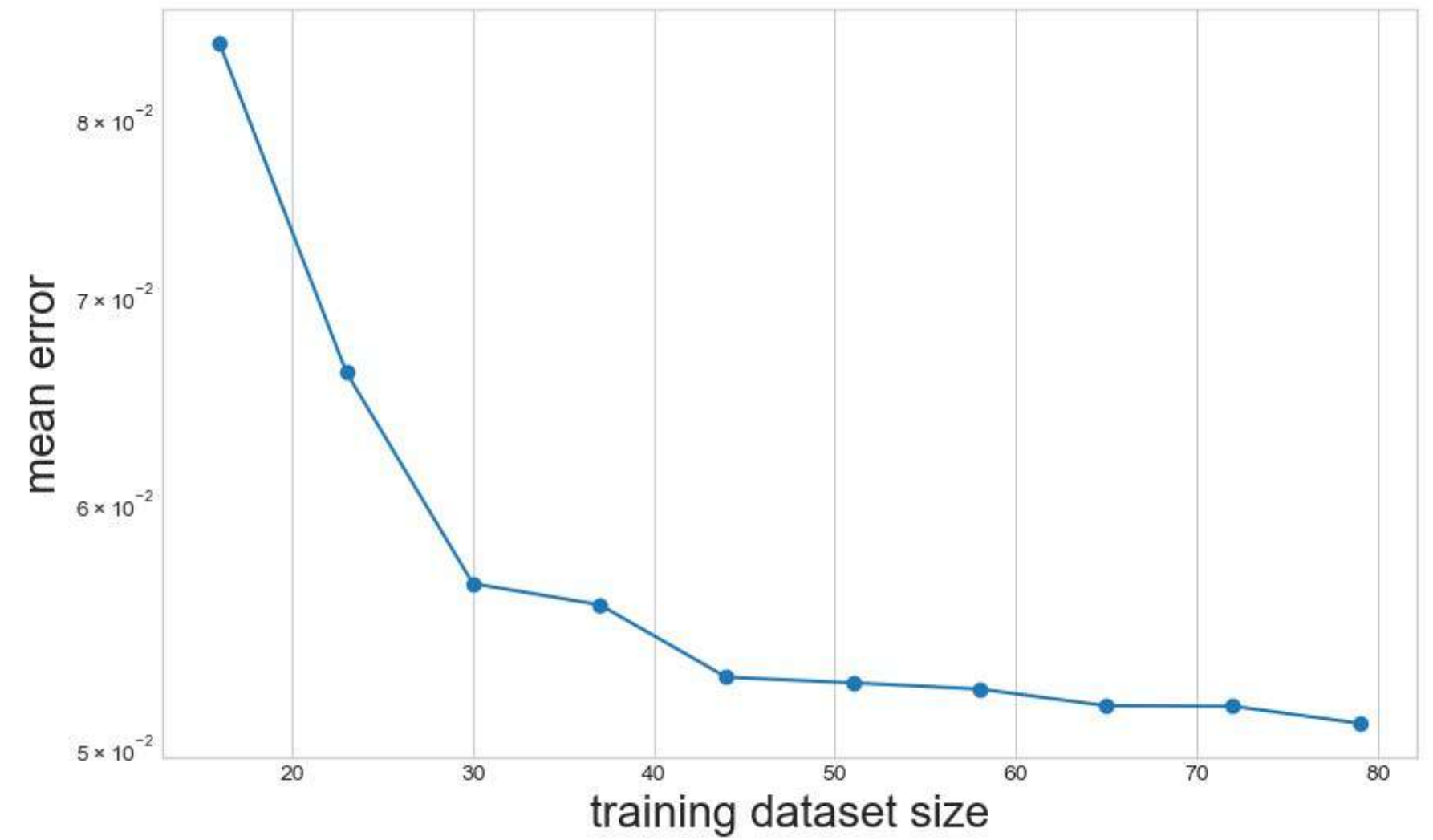
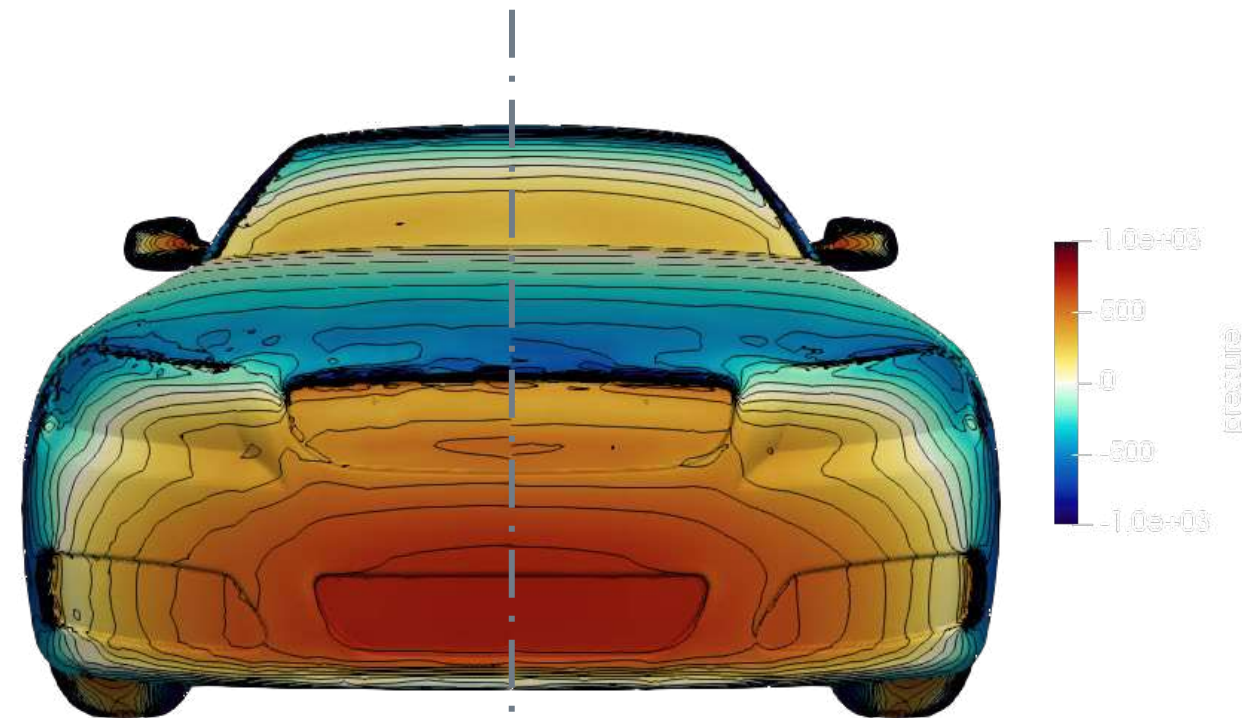
### Validation

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



# Example: real-time aerodynamic predictions

Validation





# Synergy between romBOX and VOLTA

Ensuring scalability and maintainability through VOLTA



# Data and user management

Mastering logistics to assure quality, scalability and maintenance

## Data management & traceability

### 1<sup>st</sup> level Annotation

Raw data has been generated with which simulation model

### Versioning

ROM has been trained with which data

### 2<sup>nd</sup> level Annotation

Results have been generated by which ROM

## User management & roles

- simulation experts are responsible for generating high-value (automatic) workflows
- domain experts train and publish ROMs
- stakeholders can query the ES



# Deployment

## 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, allowing the user to set specific input values for a model run. The 'Single run' window includes a table of parameters and a detailed view of the 'spoiler\_displ' parameter.

**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

## Inspect results

run\_PODI\_multi-fidelity

Overview Results Dependencies Events

### Results

Open in VOLTA advisor

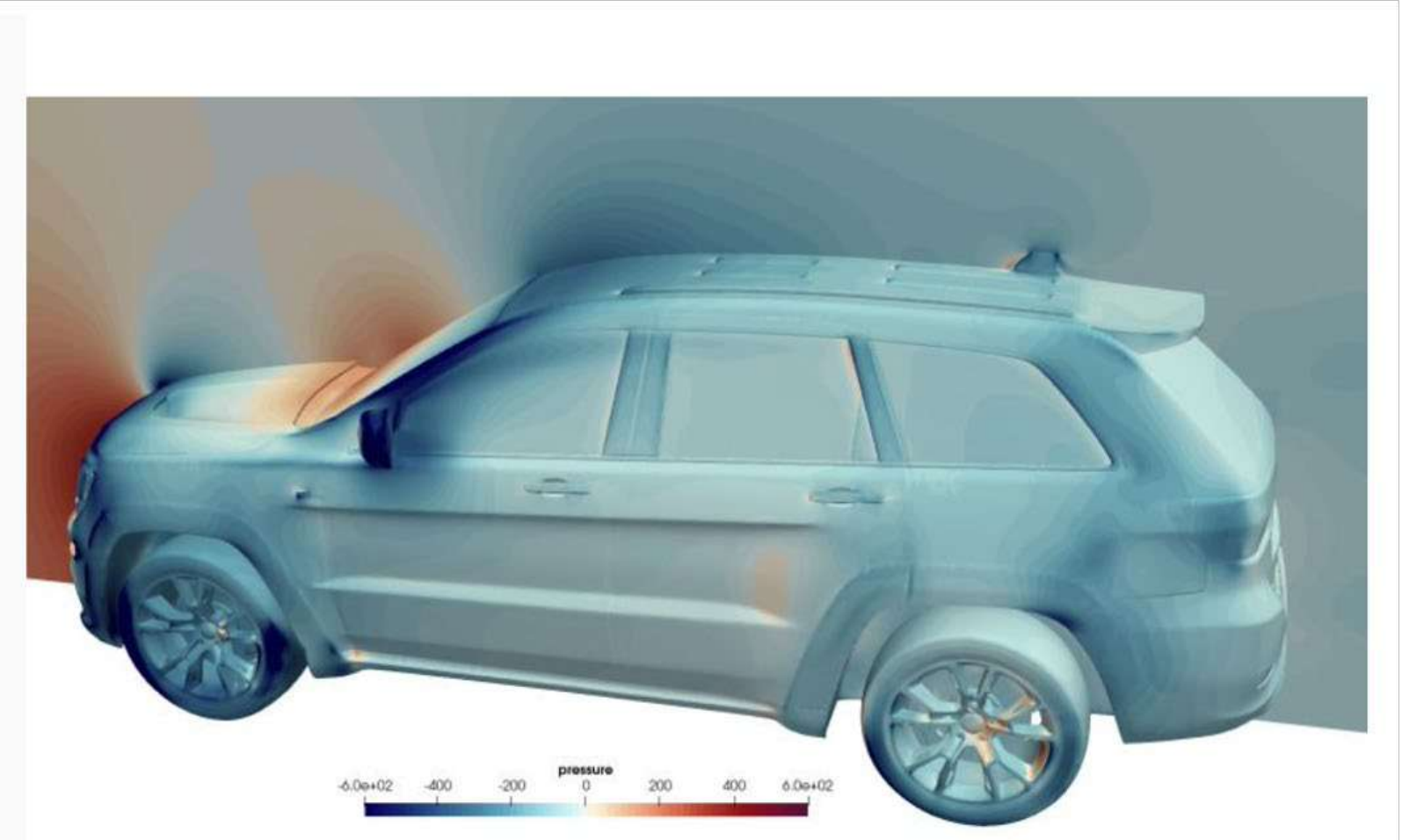
100%

Total	Feasible	Unfeasible	Error	Rerun
1	1	0	0	0

### 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	<a href="#">field.png</a>

# Conclusions





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# Thank you!

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