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INDIA

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

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OPTIMAD

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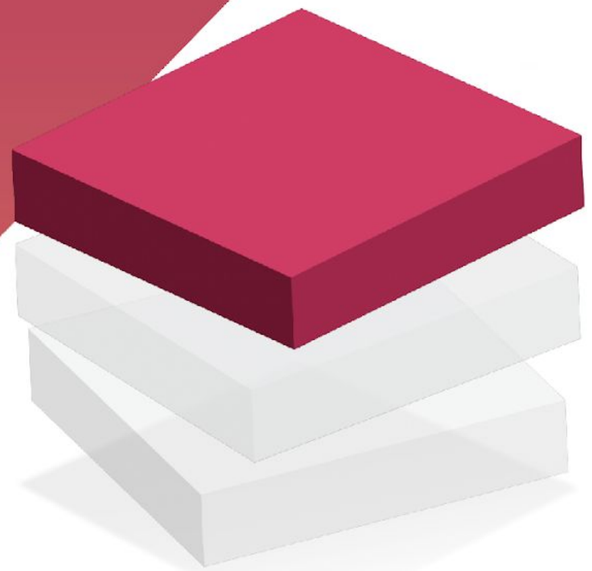
About OPTIMAD

Simulation-Driven vs Data-Driven

romBOX & VOLTA

What is romBOX
Synergy between romBOX and VOLTA

Conclusions



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ABOUT OPTIMAD

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We use **mathematical modelling and numerical simulatio**n 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

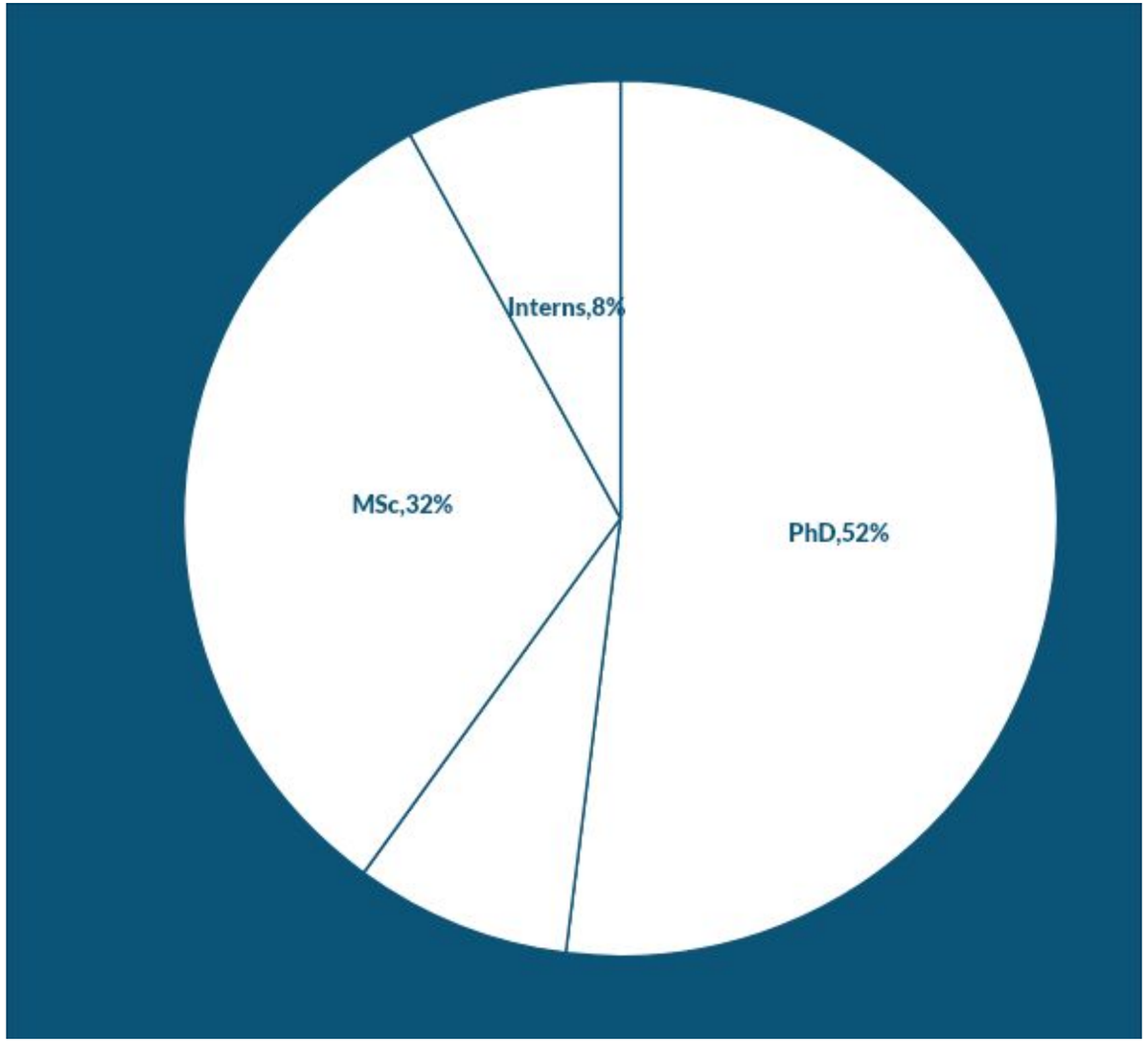
Headcount (q4/22) 27

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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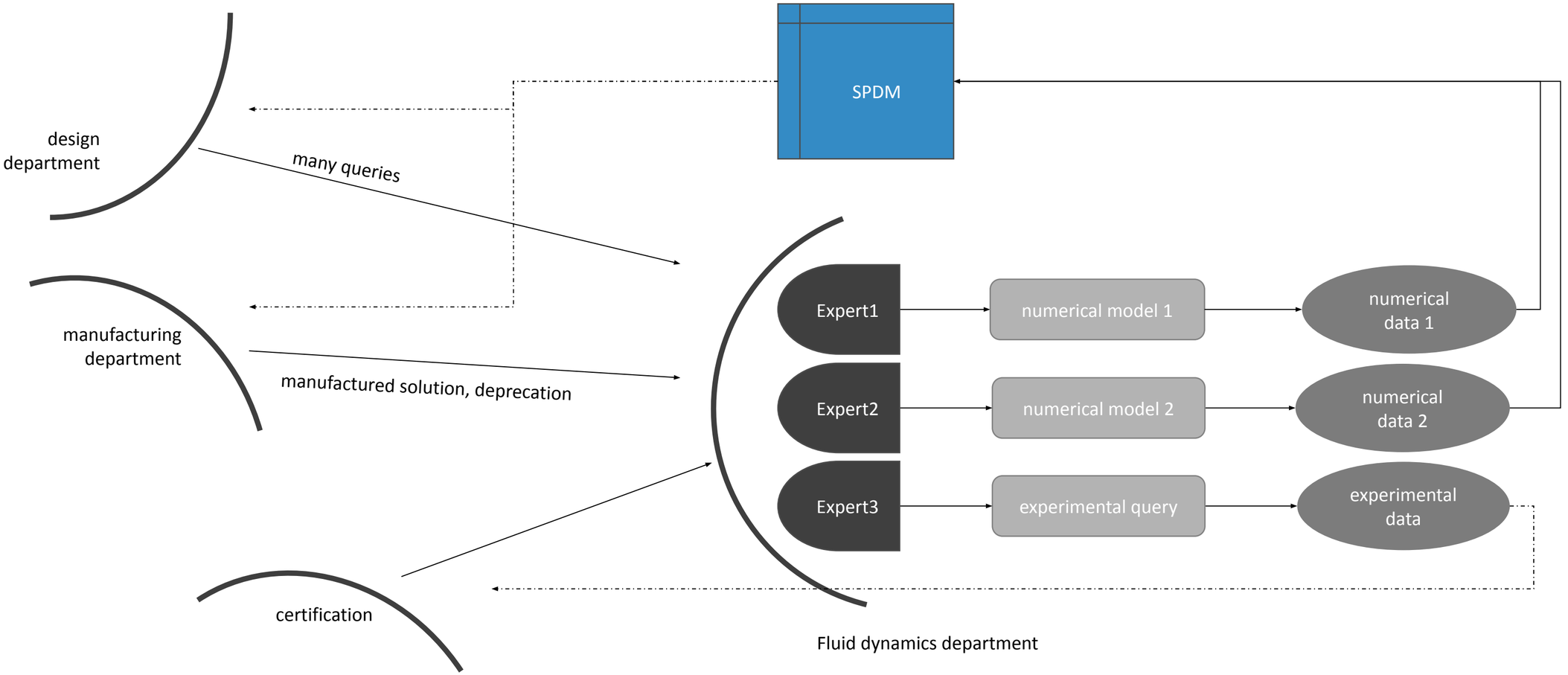
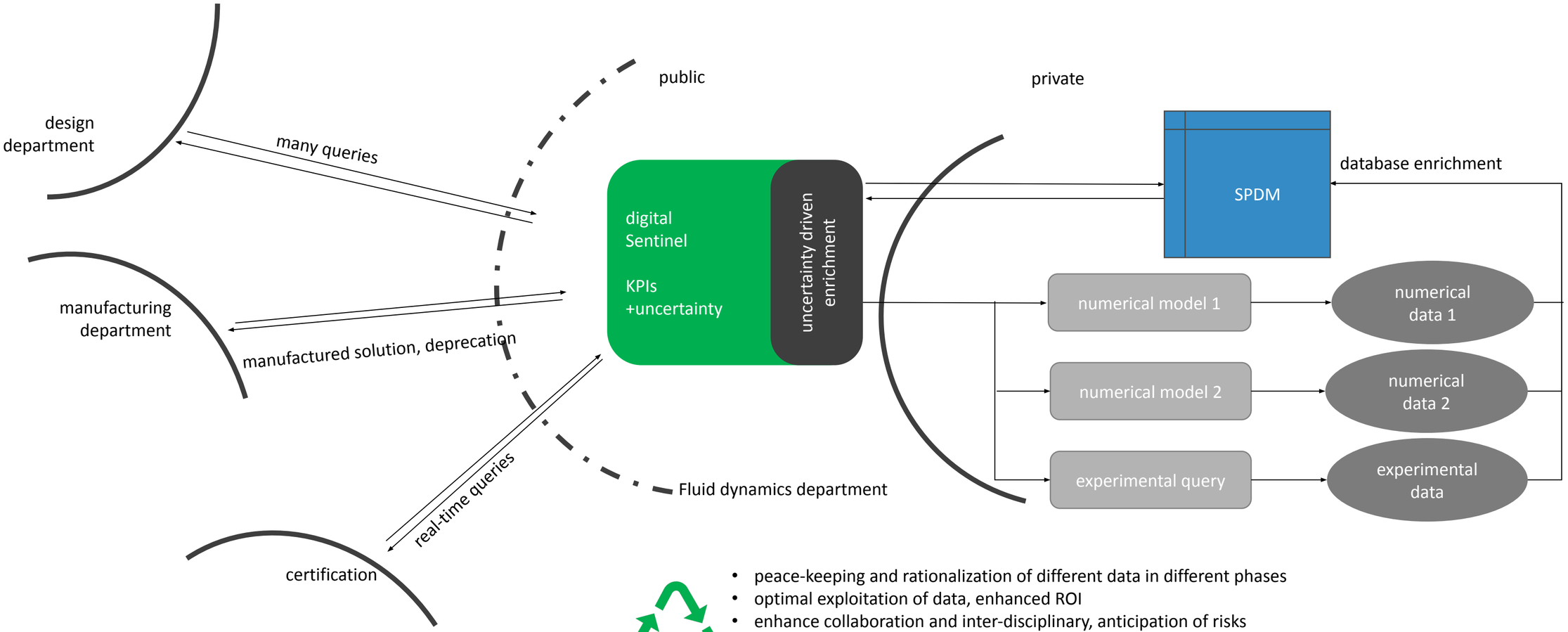
Simulation-driven product definition

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**

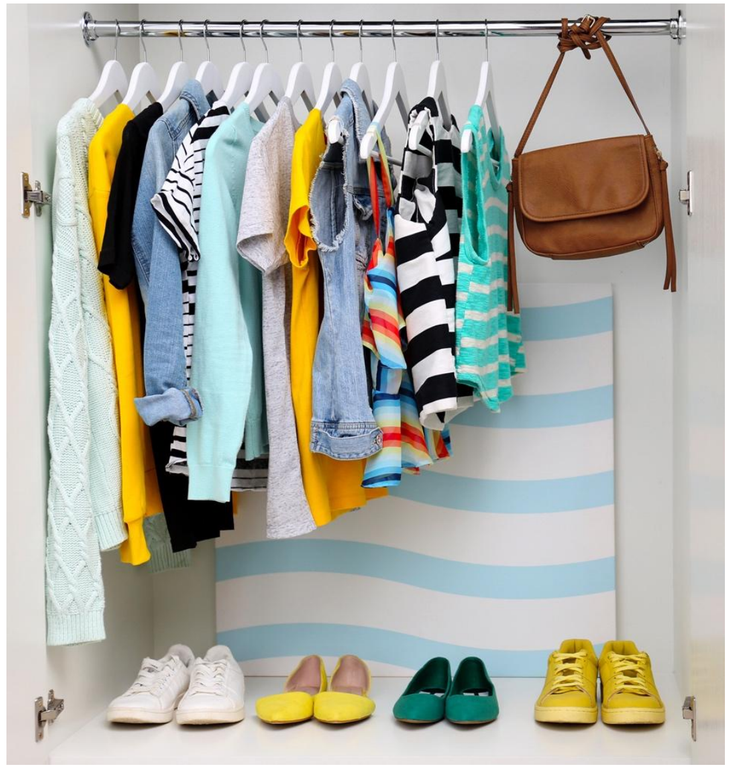
Let’s have a look at the data

Amount of data

Simulation Driven without SPDM

Simulation Driven with SPDM

Data Driven



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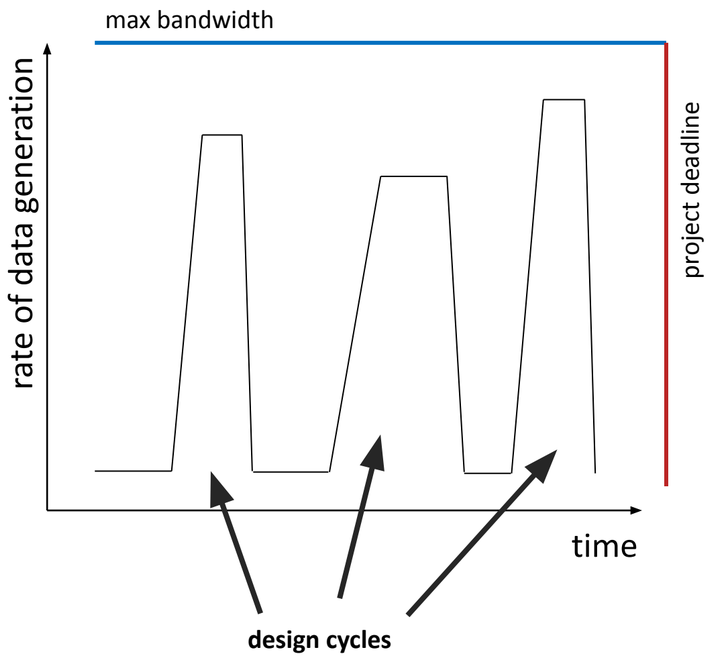
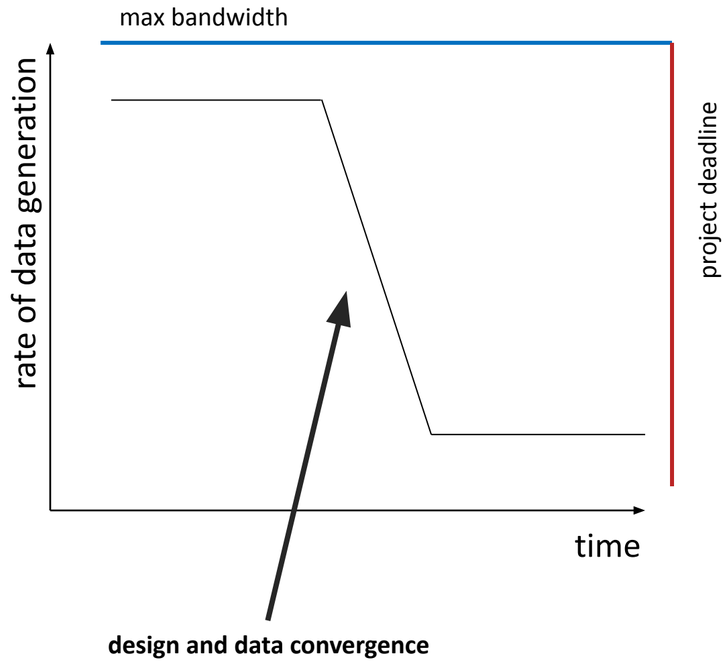
Let’s have a look at the data

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

Physics-driven models

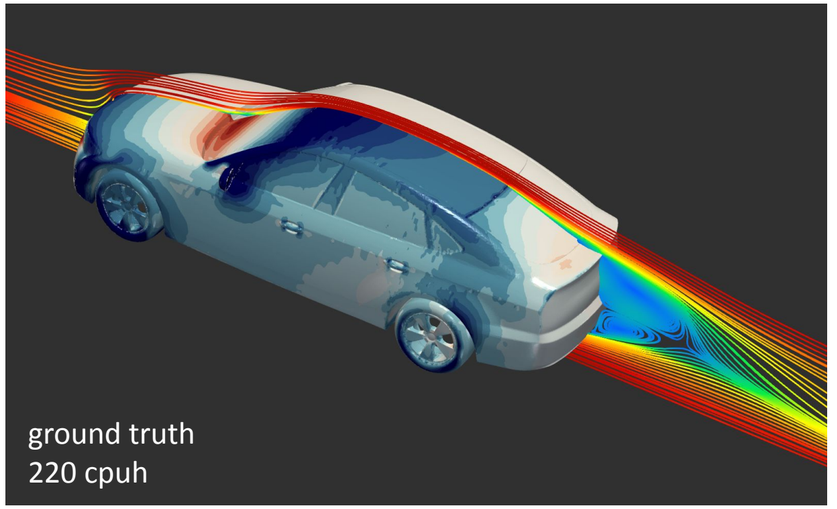
- by coupling solver

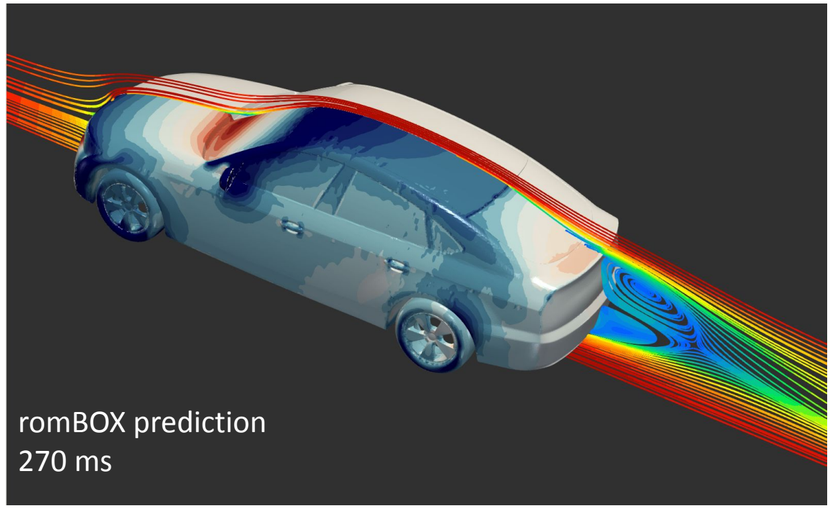
Geometry driven

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

Any data

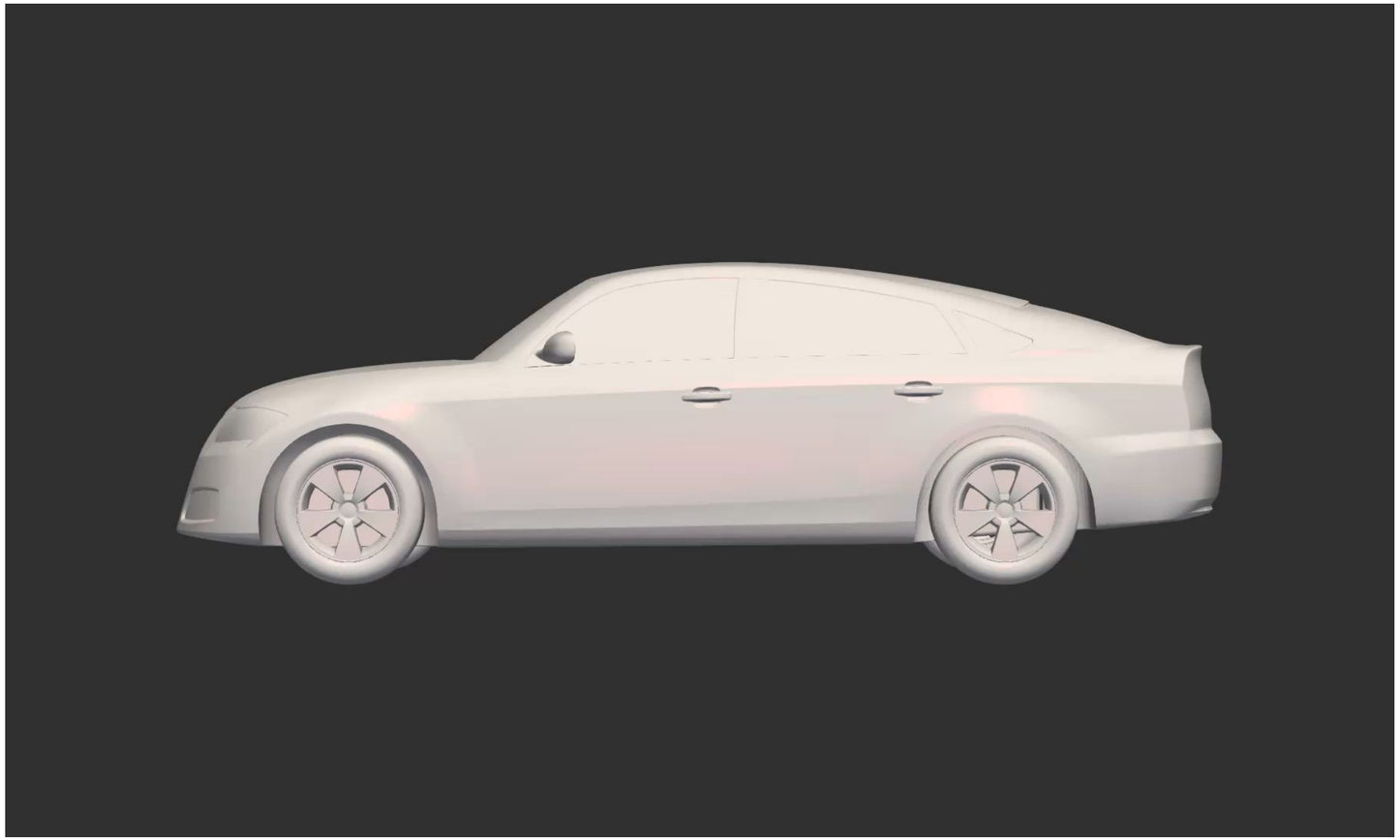
- Surface data
- Volume data
- QoI
- Sensitivities





romBOX

example, real-time aerodynamic predictions



geomtery

- DrivAer baseline
- mimic
- 8 design parameters

aerodynamic drag evalutation

- OpemFOAM
- 15M, simpleFOAM

ROM

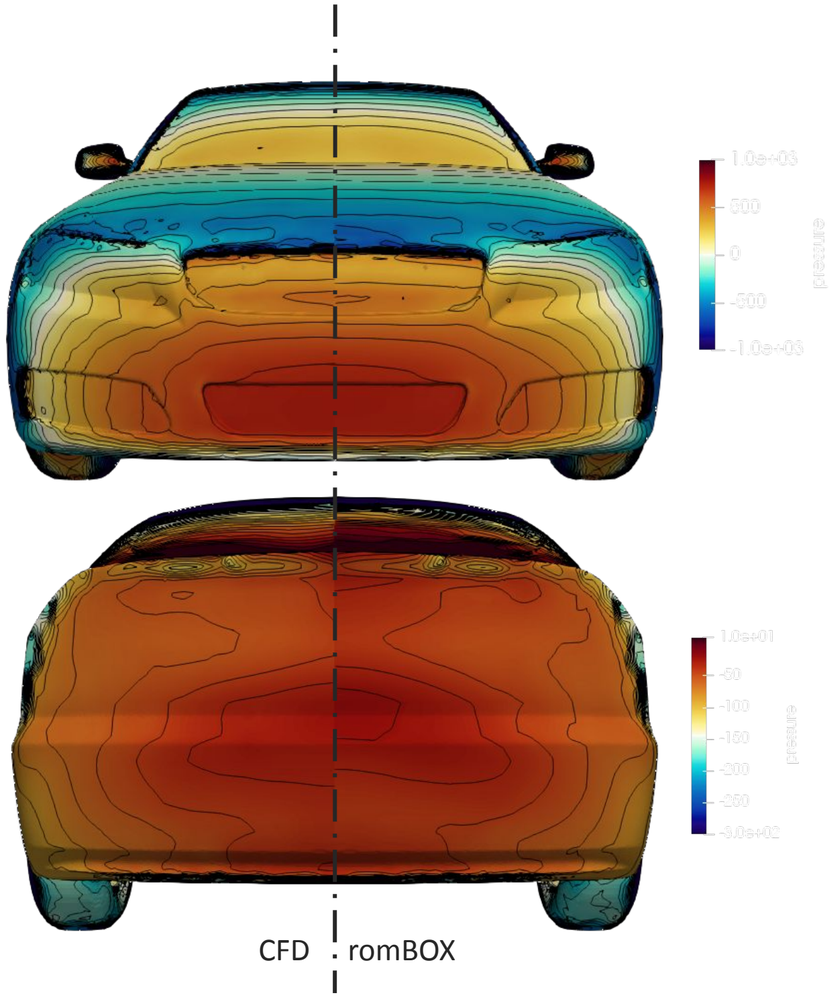
- romBOX geometrical & data encoder
- RBF-NN regression model

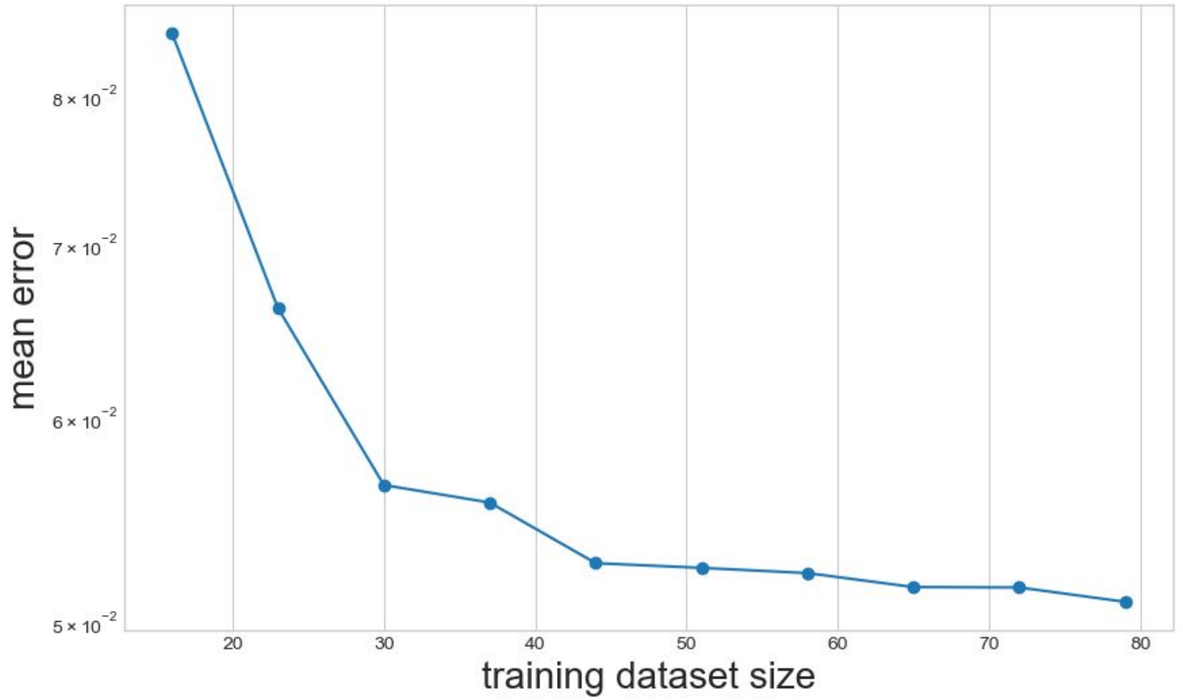
Validation

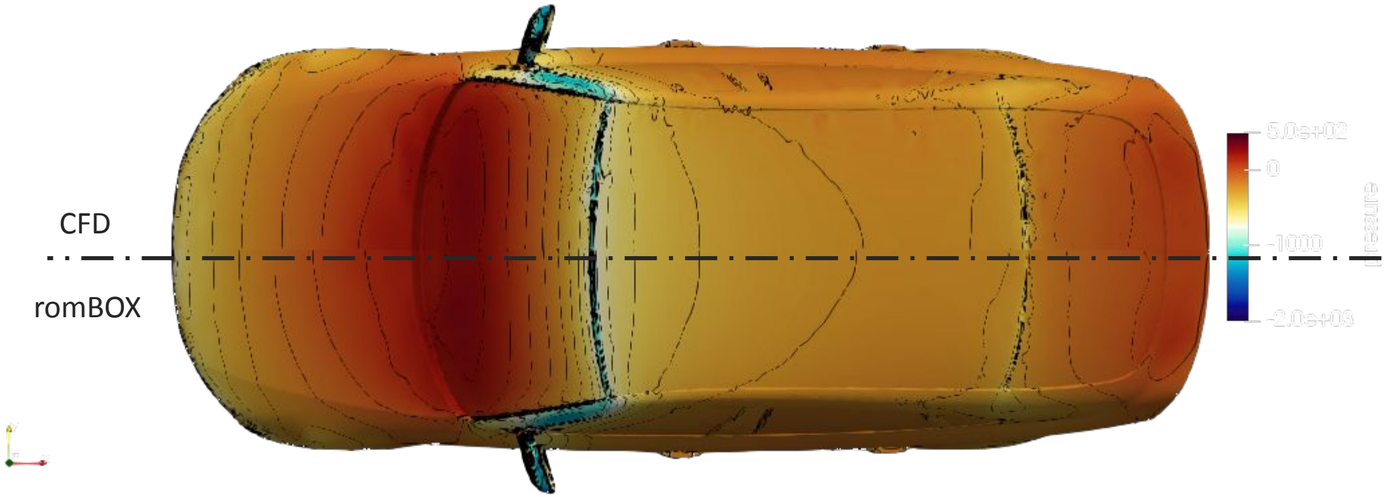
- 20 unseen random configurations
- average L2 error on pressure distribution

romBOX

example, real-time aerodynamic predictions







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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 stackholders

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

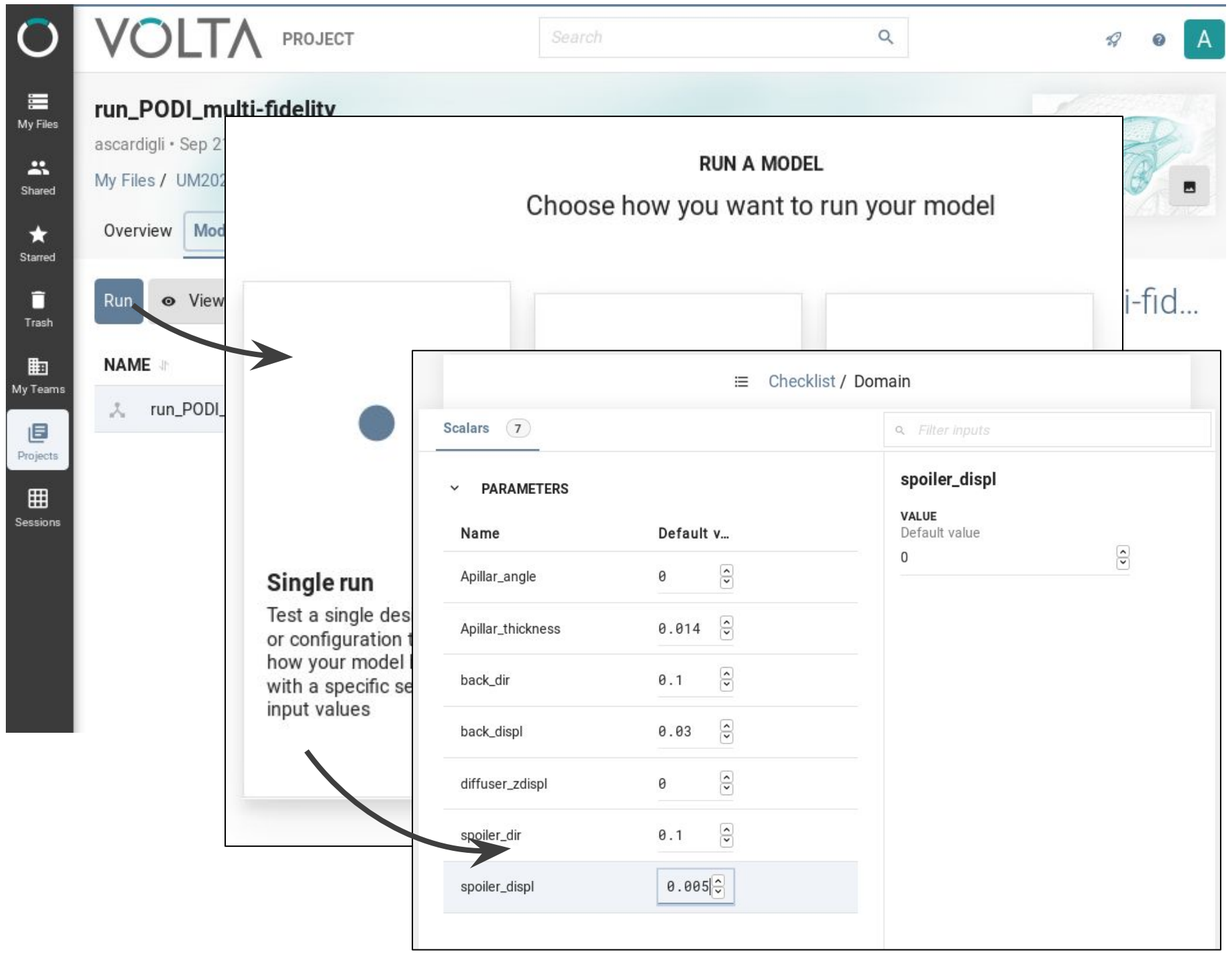
- single run
- DoE
- Optimization

+ data insight through VOLTA Advisor

- **scalable system**

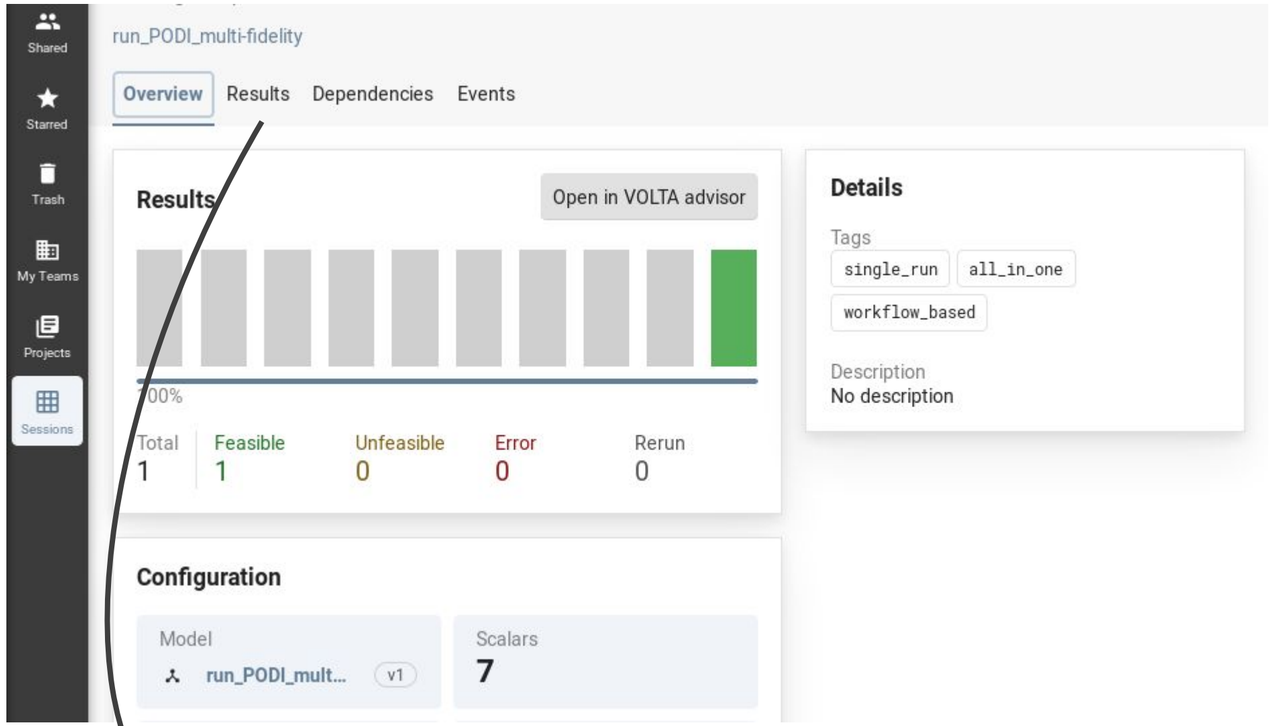
Deployment

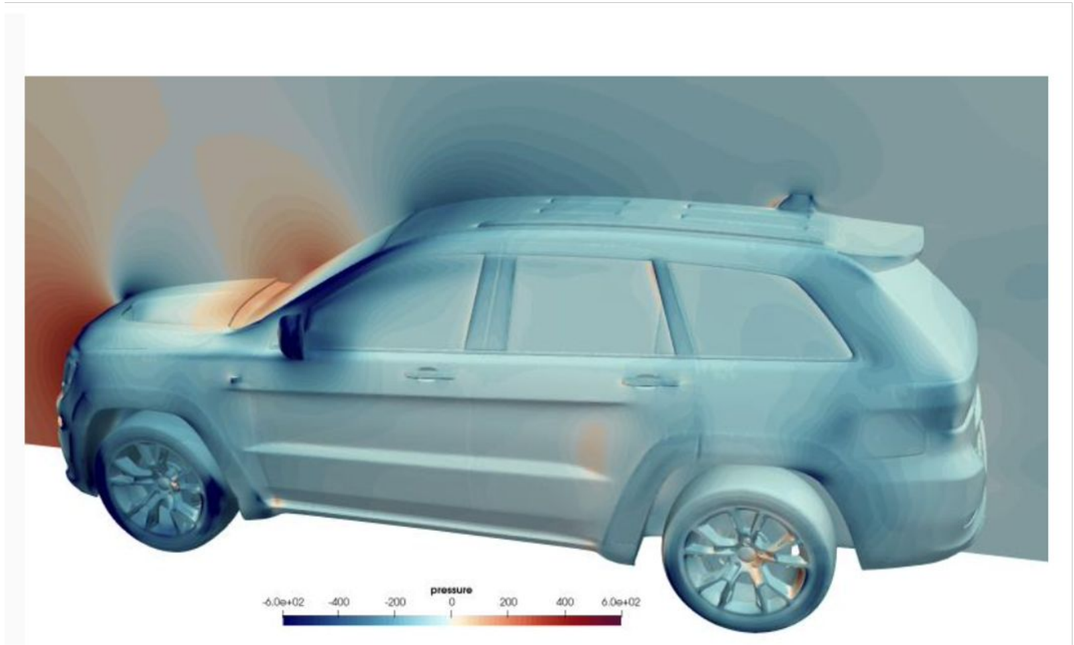
example: run an error-constrained model



Deployment

example: retrieve results





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Deployment

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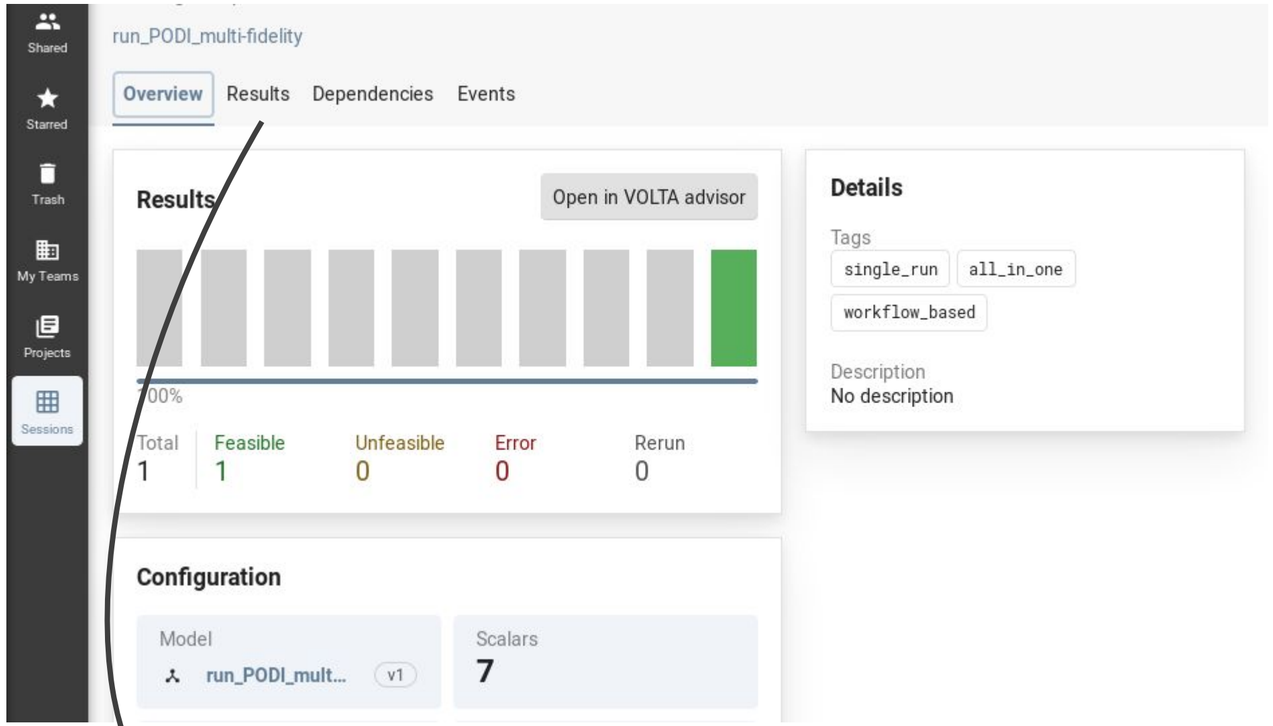

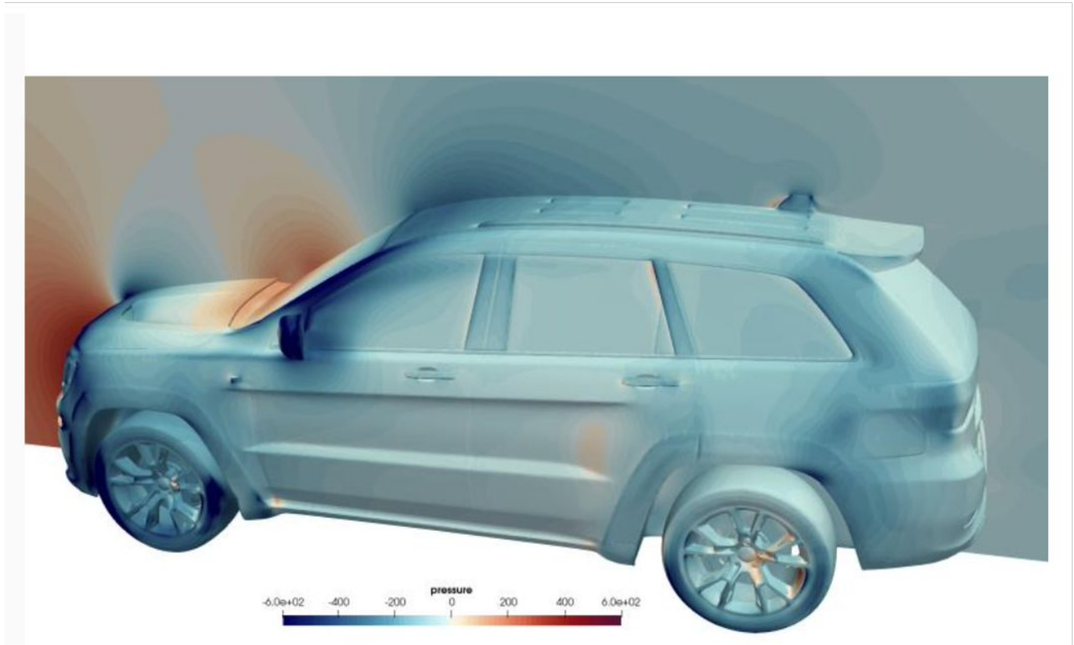

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Conclusions

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