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AI Accelerated Engineering

AI/ML for Marine Applications: Data Driven Approaches for Complex Engineering Challenges

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01

AI in engineering

Real-time collaboration

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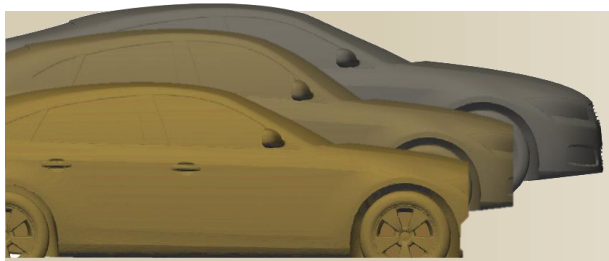
Development paced at the speed of engineering ingenuity –
– enabled by interactive design and intelligent recommendation systems.

AI-models: Real-time capable 3D surrogates for simulation

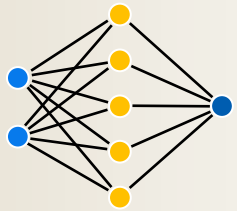
Offline and Online Phases

Train
offline



Geometries and/or Parameters

AI MODEL

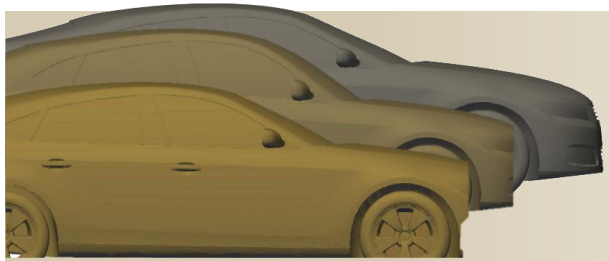


Simulation/Experiment data is collected und used to train a machine/deep learning model.

AI-models: Real-time capable 3D surrogates for simulation

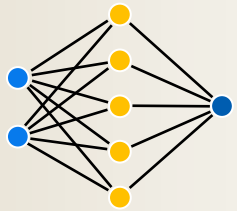
Offline and Online Phases

Train
offline



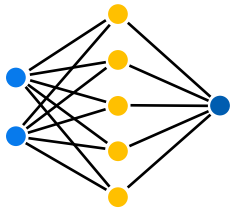
Geometries and/or Parameters

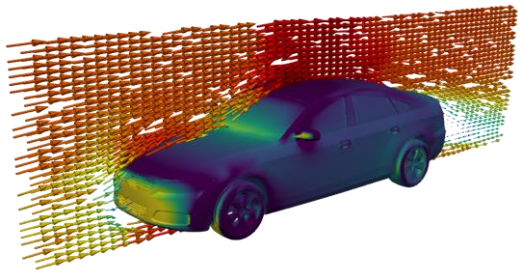
AI MODEL



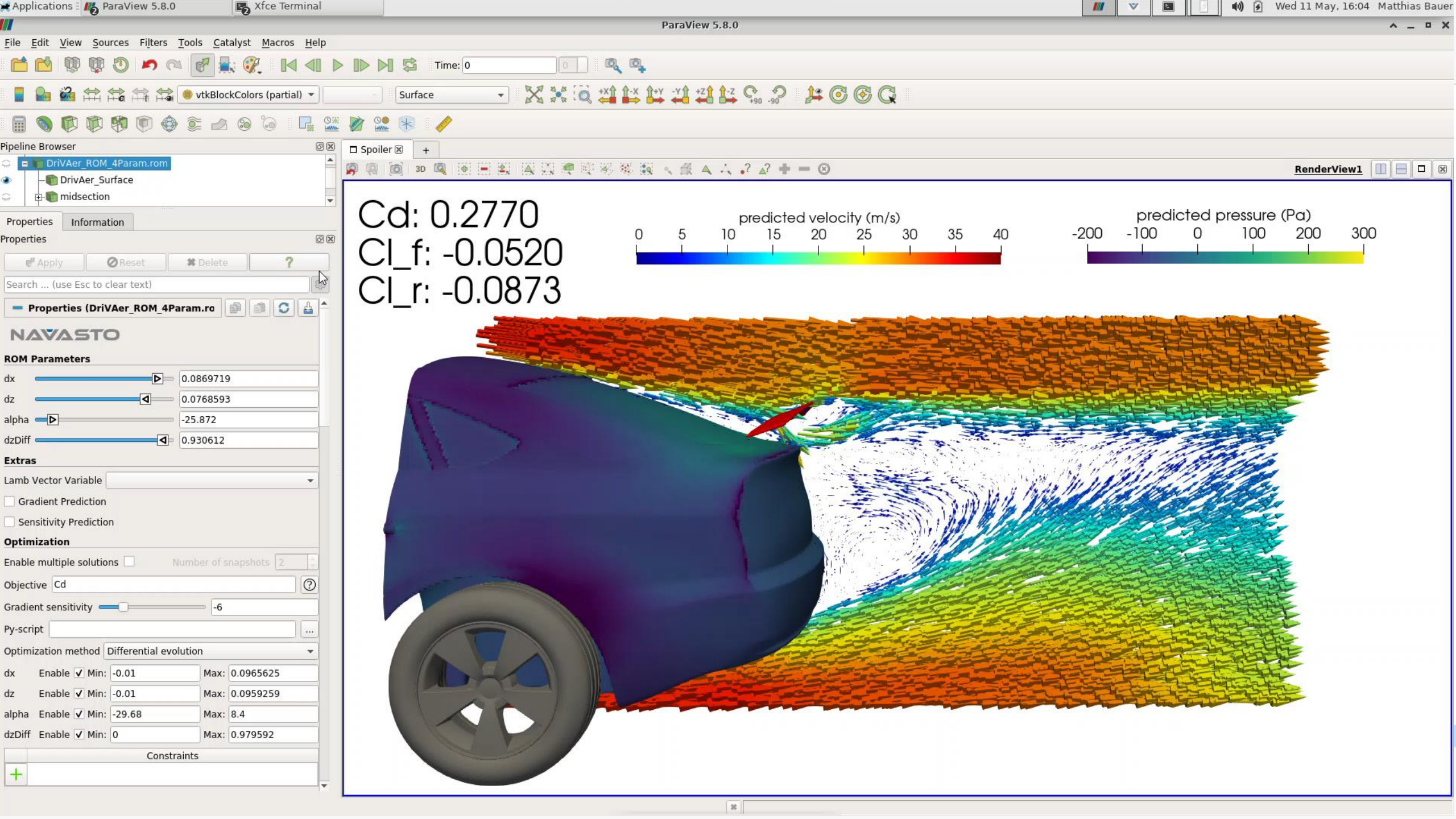
Use
Online

NEW DESIGN





The trained model can be queried with new design ideas and will predict the result of a simulation within milliseconds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Xfce Terminal
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dz 0.0768593
alpha -25.872
dzDiff 0.930612
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Gradient Prediction
Sensitivity Prediction
Optimization
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Number of snapshots 2
Objective Cd
Gradient sensitivity -6
Py-script
Optimization method Differential evolution
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dz Enable Min: -0.01 Max: 0.0959259
alpha Enable Min: -29.68 Max: 8.4
dzDiff Enable Min: 0 Max: 0.979592
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Spoiler
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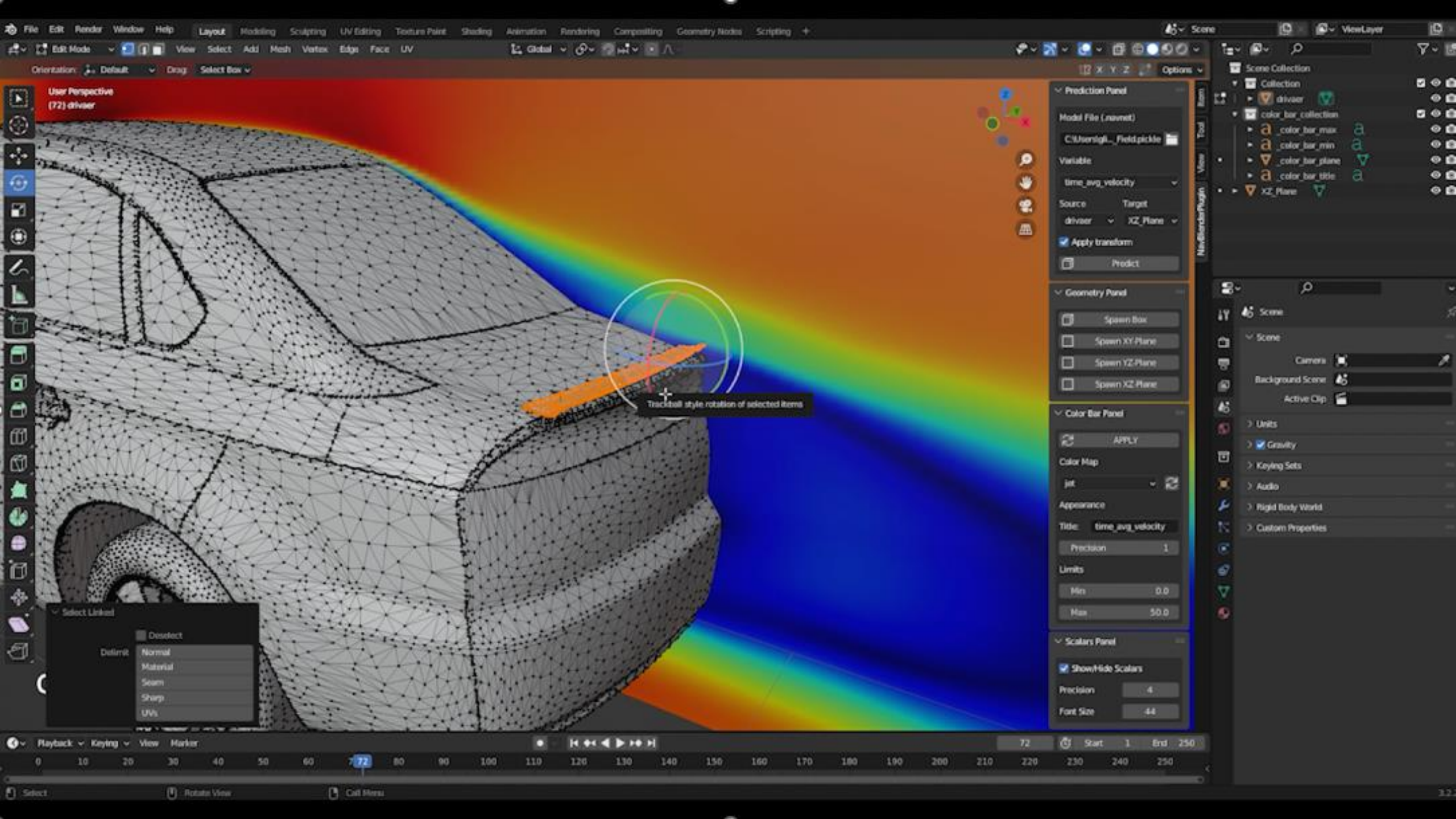
predicted pressure (Pa)
-200 -100 0 100 200 300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Background Scene
Active Clip
Units
Gravity
Keying Sets
Audio
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0 10 20 30 40 50 60 72 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Select
Rotate View
Call Menu

02

Marine Results

Planing boat

R&D project **AutoPlan** (http://auto-plan.net)
MarTERA project
Financed by the Federal Ministry for
Economic Affairs and Climate Action, Germany
Administrated by Projektträger Jülich

FRIENDSHIP SYSTEMS

Bundesministerium
für Wirtschaft
und Klimaschutz

Projektträger Jülich
Forschungszentrum Jülich

Parametric Model → Numerical Setup → DoE Simulations → ML Model → Interactive Design

Friendship Systems — NAVASTO

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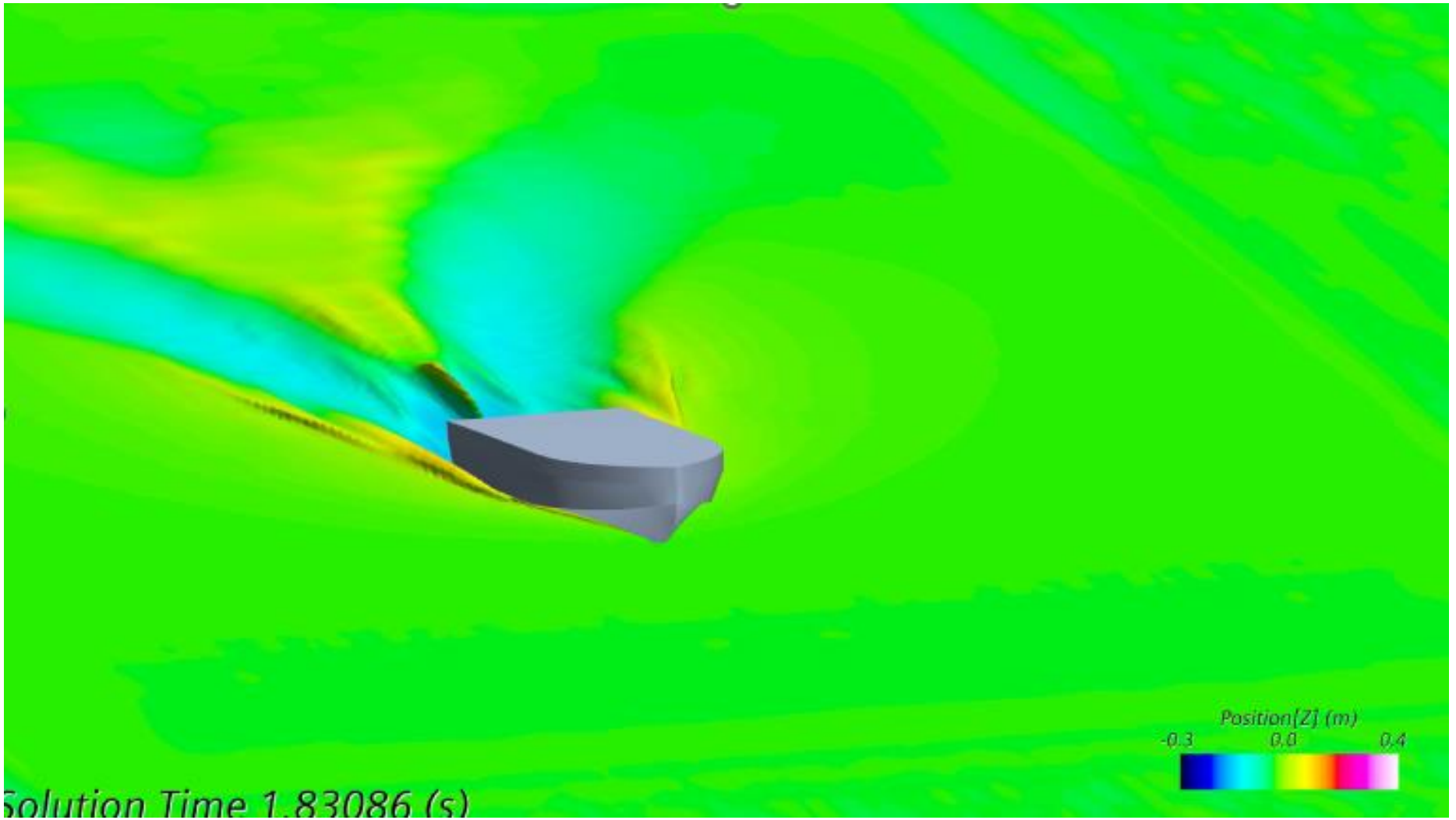
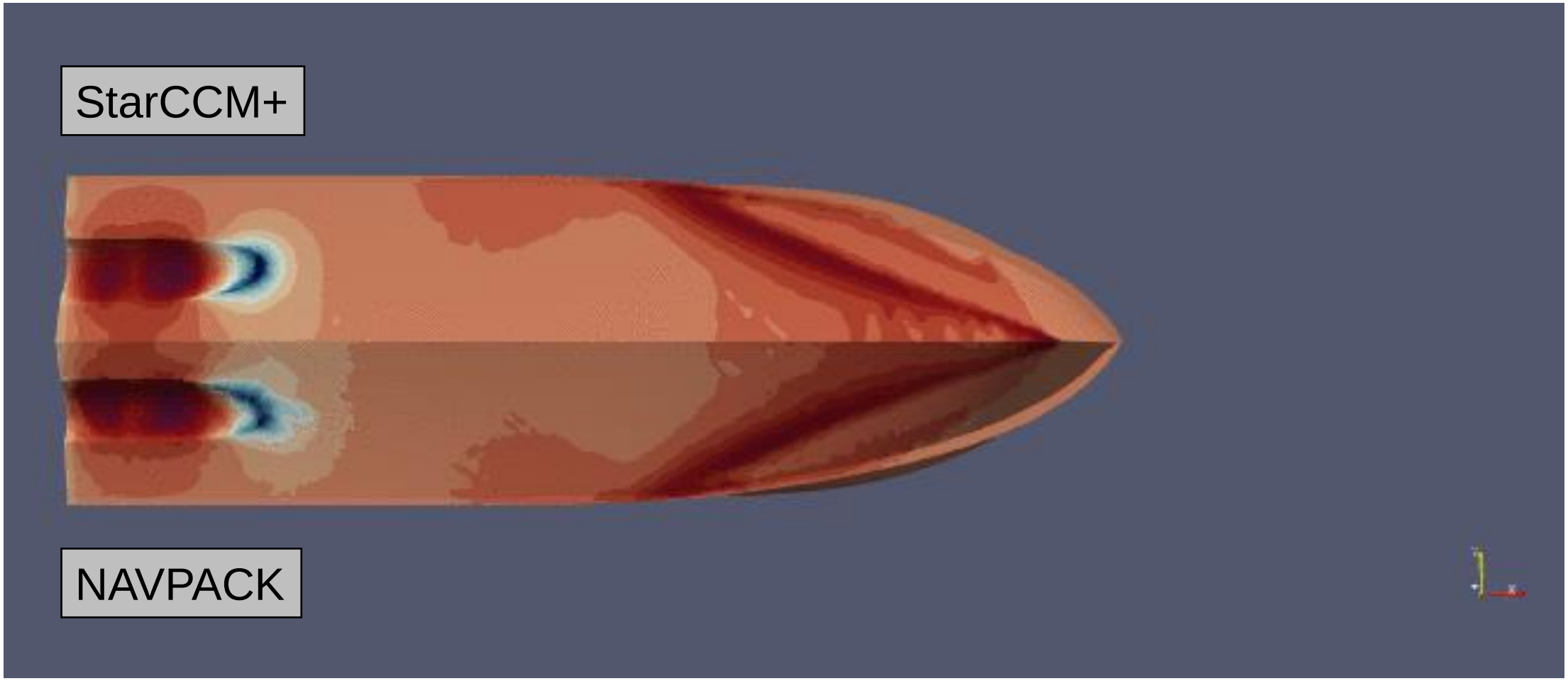
Simulations – Planing Hull Case



FRIENDSHIP SYSTEMS

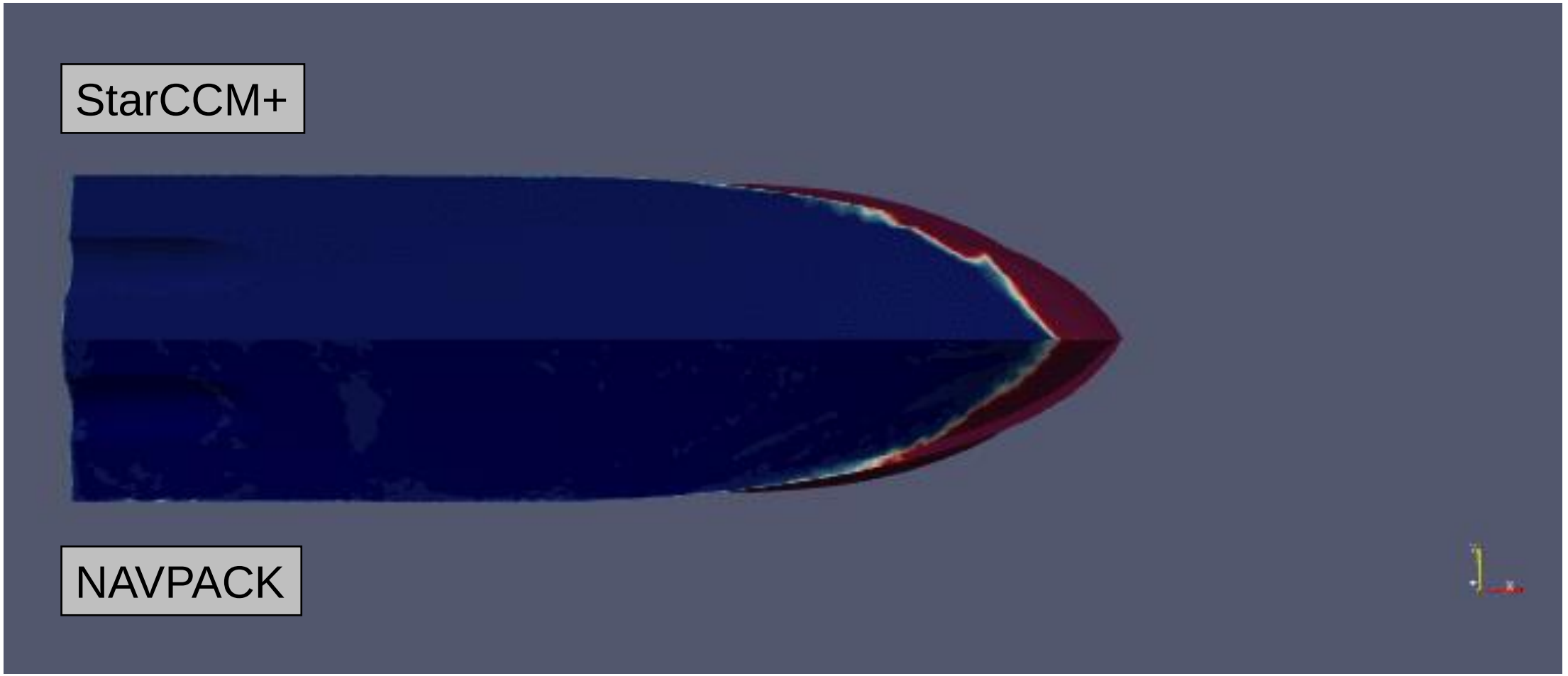
Predictions – Planing Hull Case

Dynamic pressure



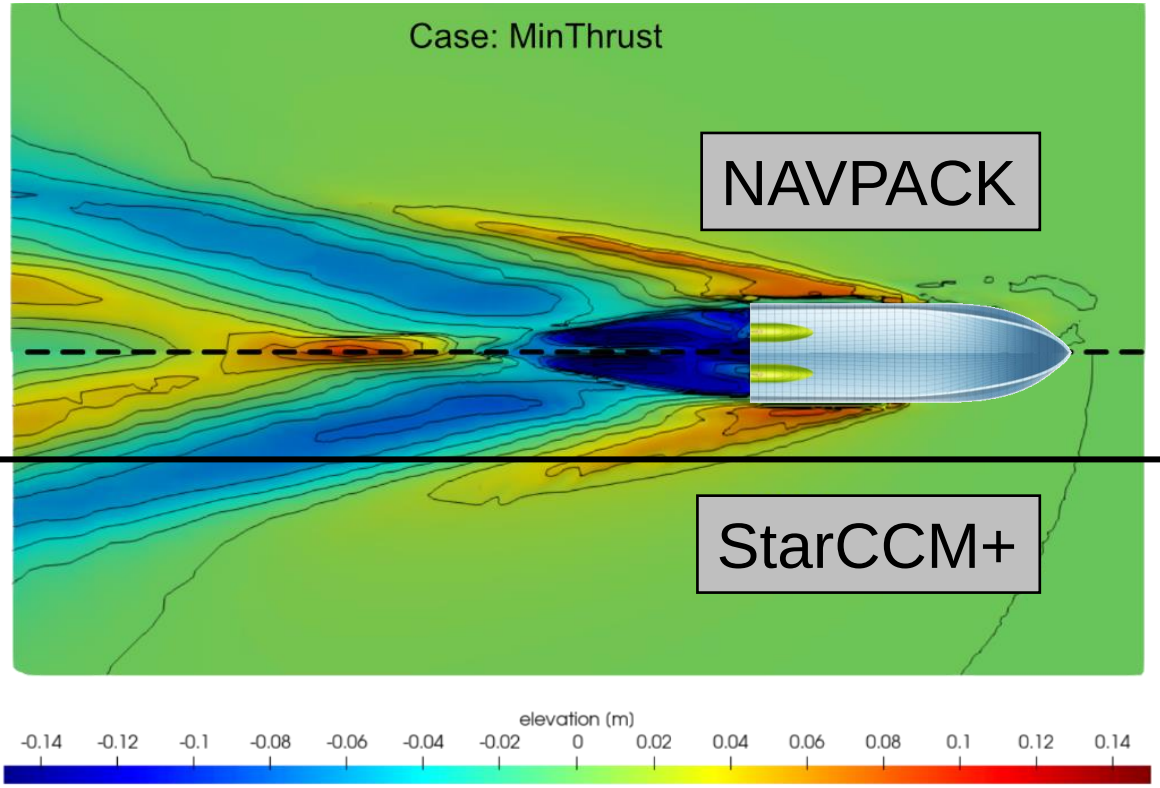
Predictions – Planing Hull Case

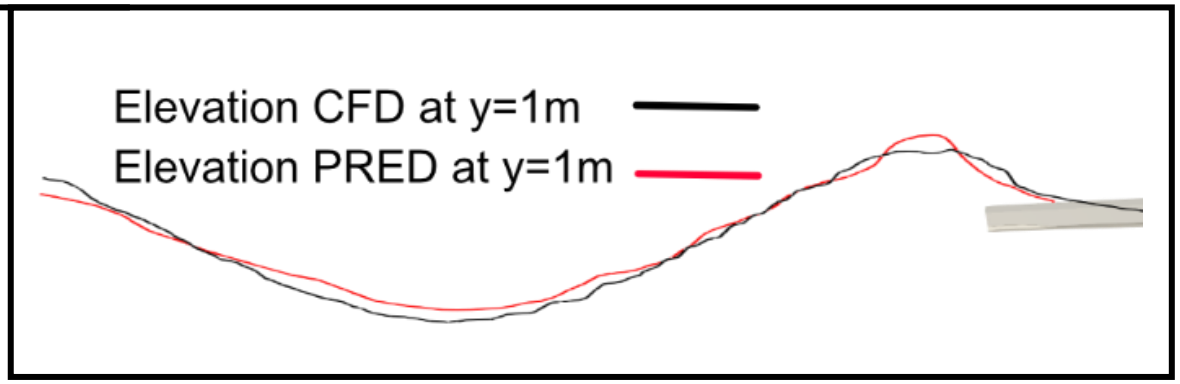
Phase fraction



Predictions – Planing Hull Case

Wave elevation





Interactive Design

- 6 Use- / Testcases

Objective	Thrust (CFD)	Thrust (Prediction)	Deviation for thrust	Heave (CFD)	Heave (Prediction)	Pitch (CFD)	Pitch (Prediction)
Min. thrust	393.4	399.8	1.63%	0.104	0.116	-4.5	-4.5
Max. thrust	525.2	526.4	0.23%	0.064	0.049	-2.3	-2.2
Min. thrust at moderate pitch (max. 3°)	422.0	427.0	1.18%	0.083	0.094	-3.4	-3.5
Max. heave	441.8	418.8	-5.21%	0.111	0.129	-4.8	-4.6
Min. wave cut	514.2	501.0	-2.57%	0.065	0.063	-2.4	-2.6
Opt. design	390.4	388.8	-0.41%	0.102	0.107	-4.2	-4.5

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Surface Sensitivities

Real-time sensitivities wrt. thrust

Blue regions: push inward to lower required thrust
Red regions: pull outward for lower thrust

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03

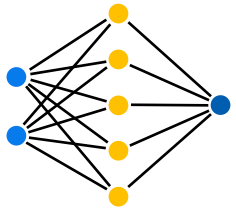
Uncertainty + Transfer Learning

Dataset

Jib1

Jib2

AI MODEL



INPUTS:

Geometry

- Main Twist
- Main Car
- Jib Twist
- Jib Car

BC

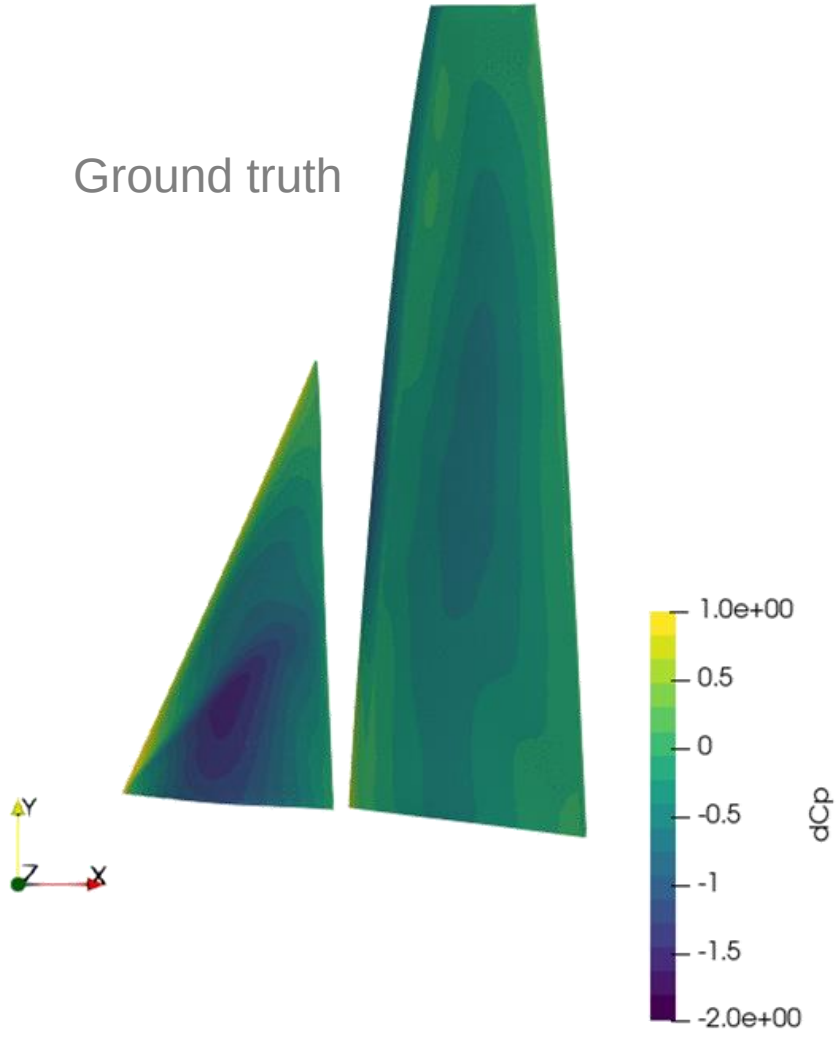
- TWA
- TWS
- Speed
- Leeway
- Heel
- Sink
- Trim

Transfer learning

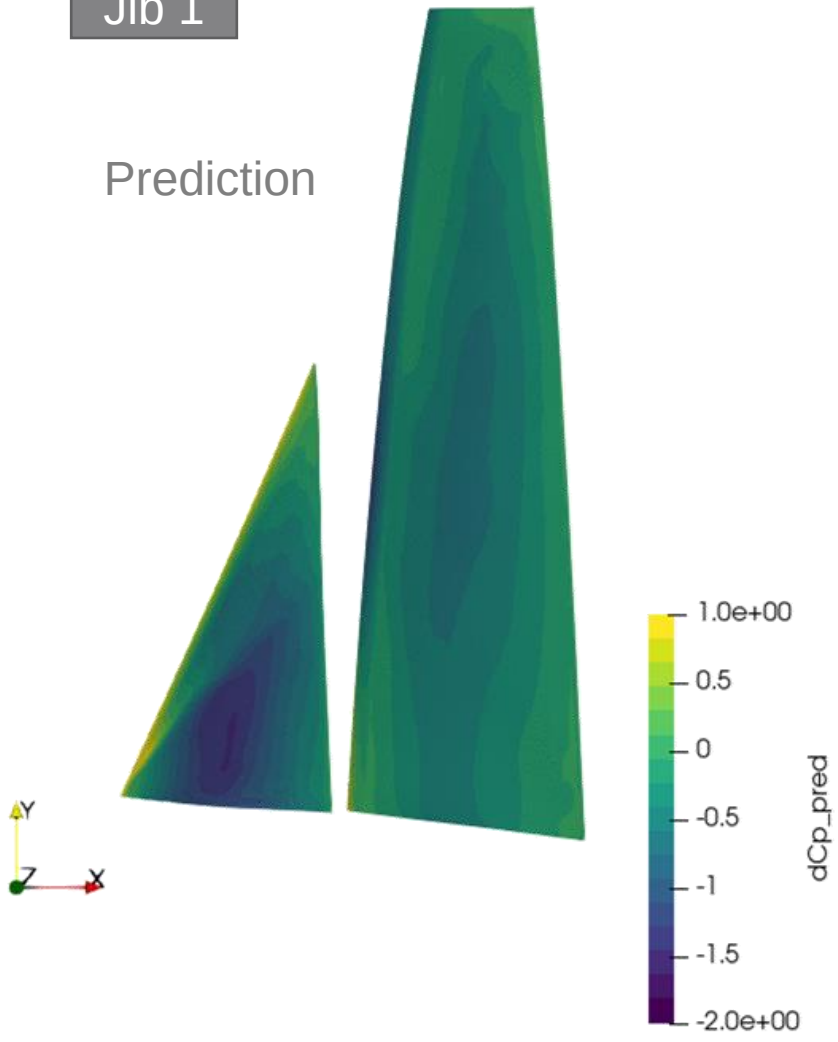
Train model on jib 1 → predict on jib 1

Jib 1

Ground truth

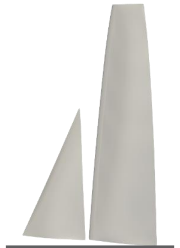


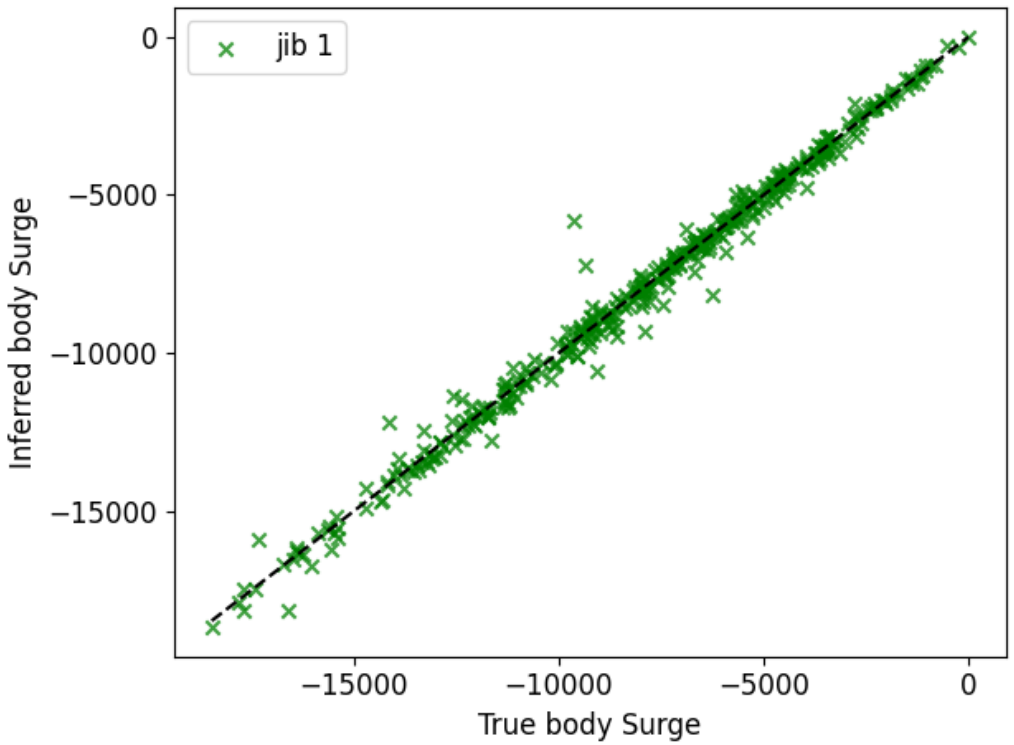
Prediction

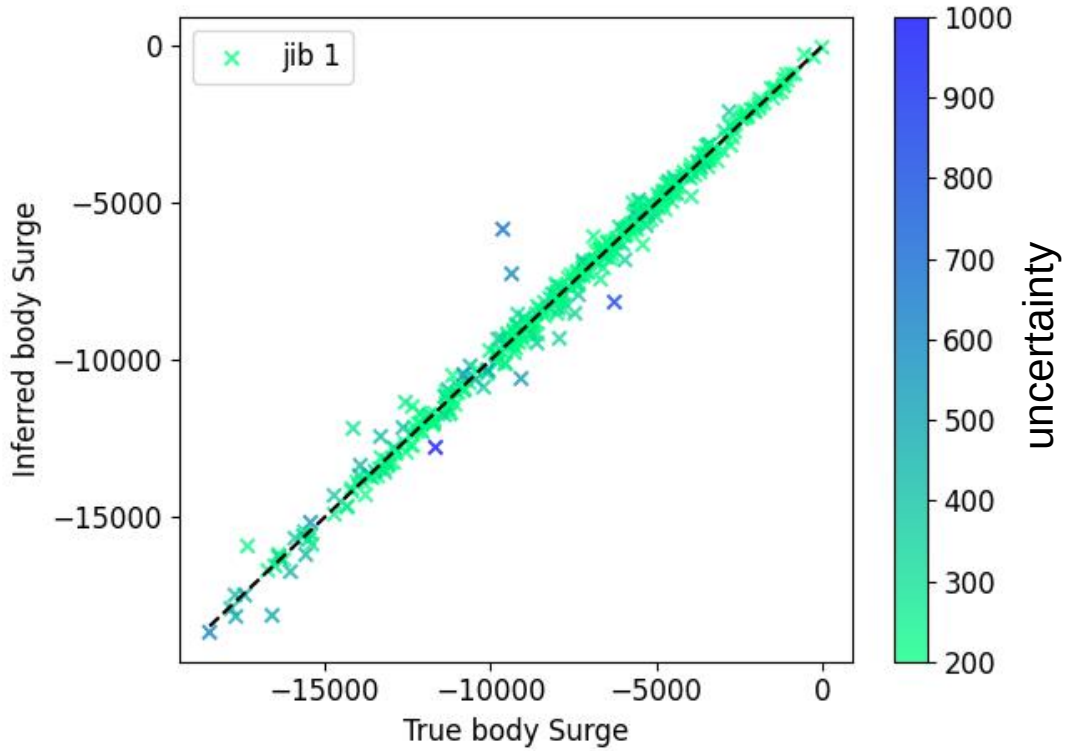


Transfer learning

Train model on jib 1 → predict on jib 1

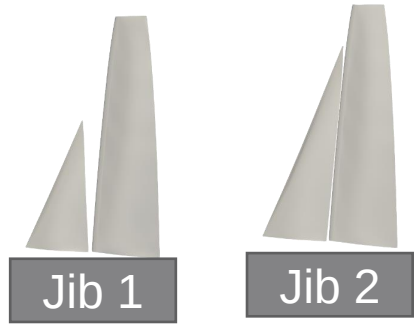


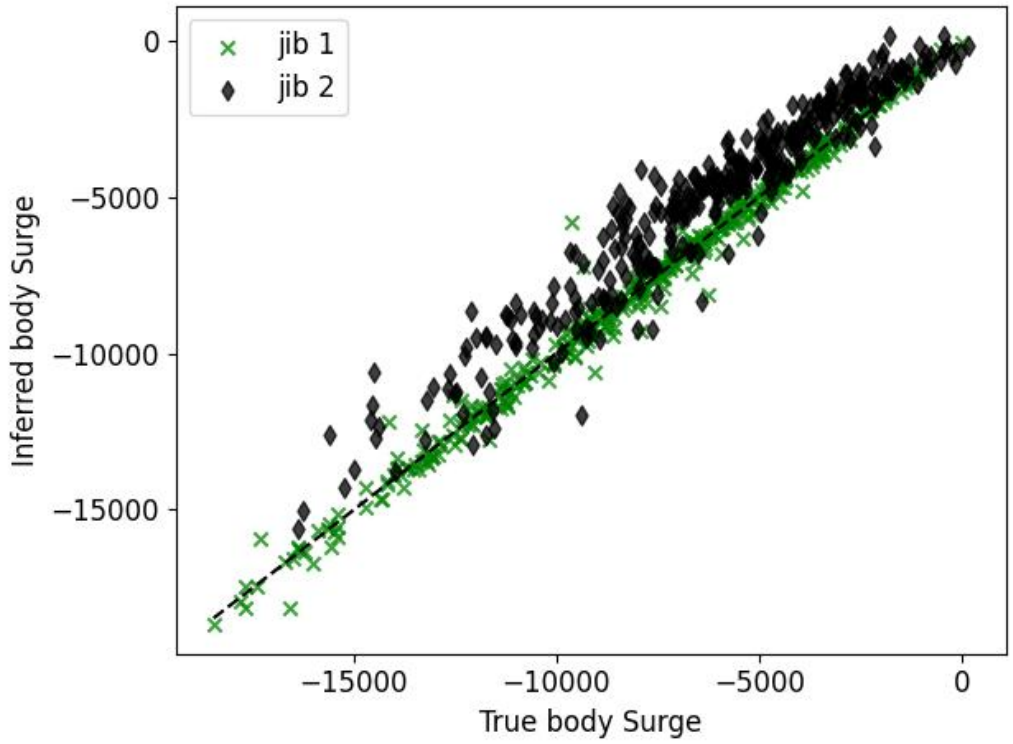


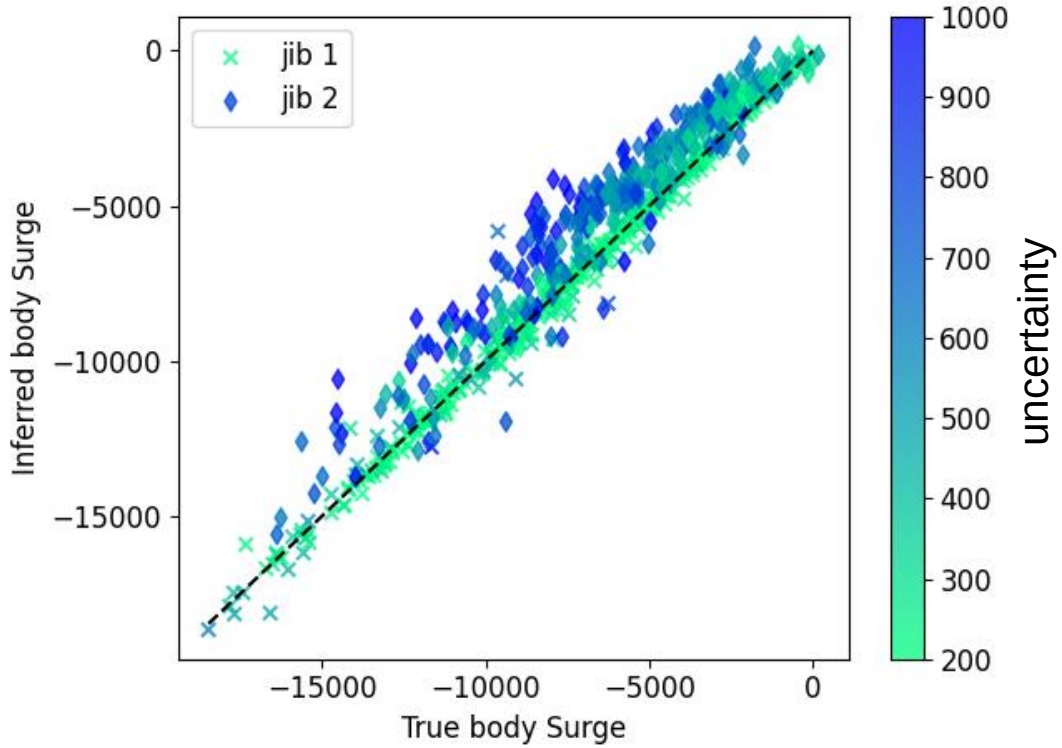


Transfer learning

Train model on jib 1 → predict on jib 1 + jib 2

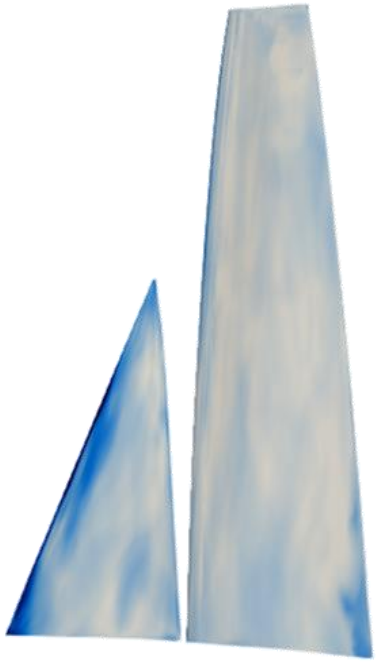




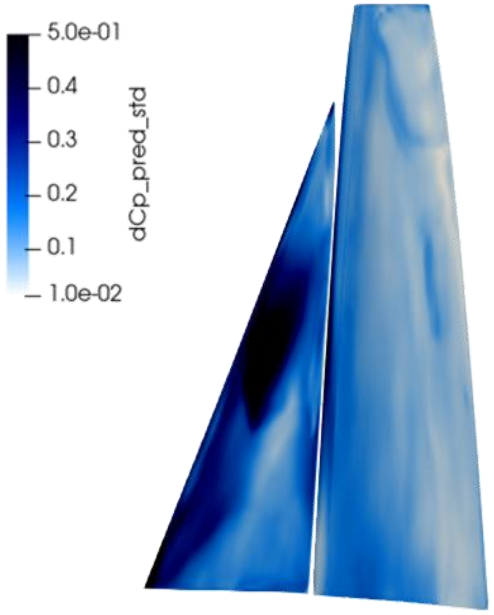


Transfer learning

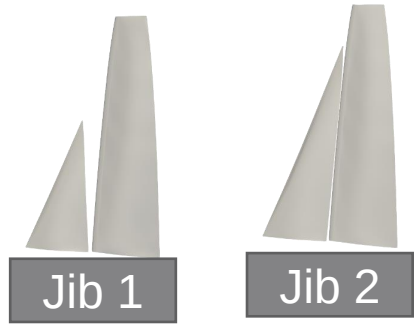
Train model on jib 1 → predict on jib 1 + jib 2

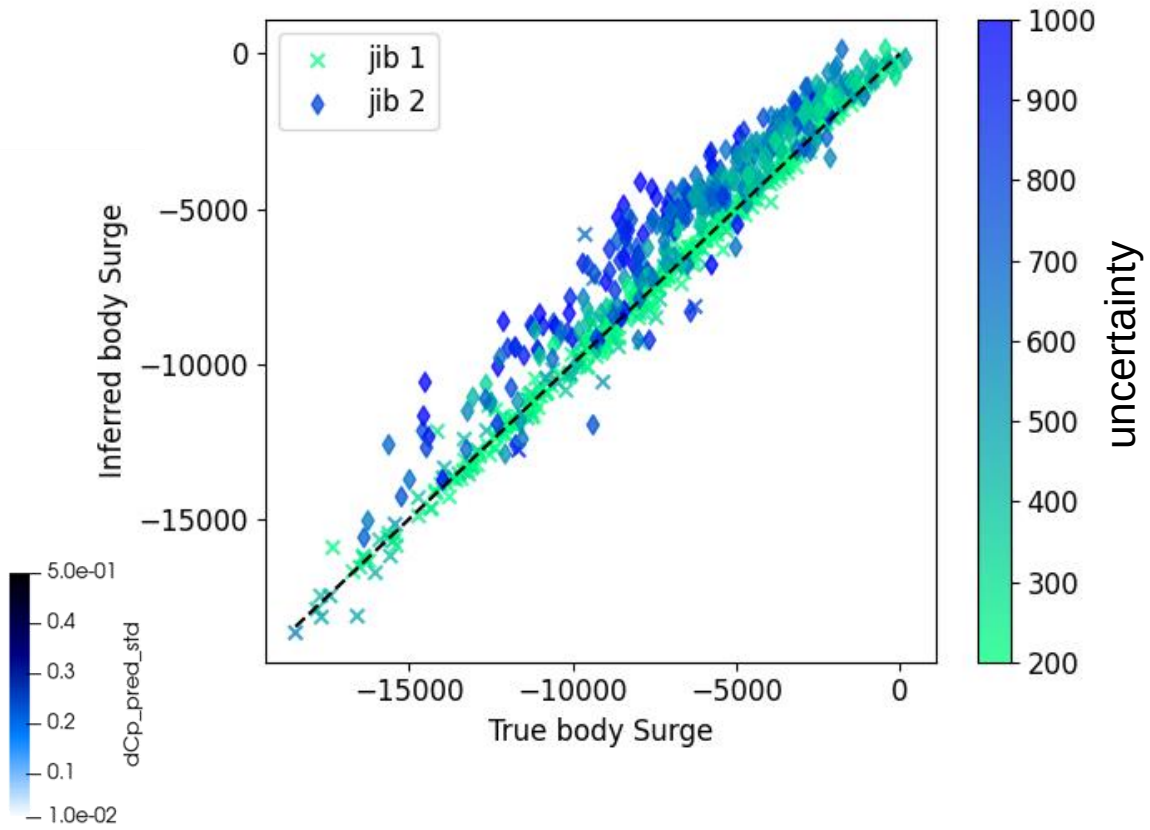


„Seen“ sample (Jib1)



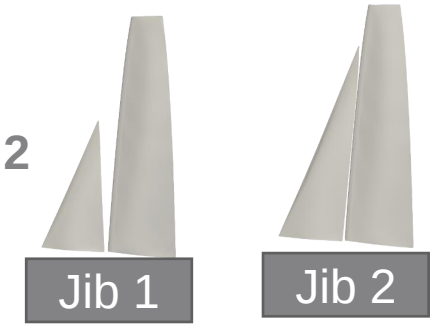
Unseen sample (Jib2)

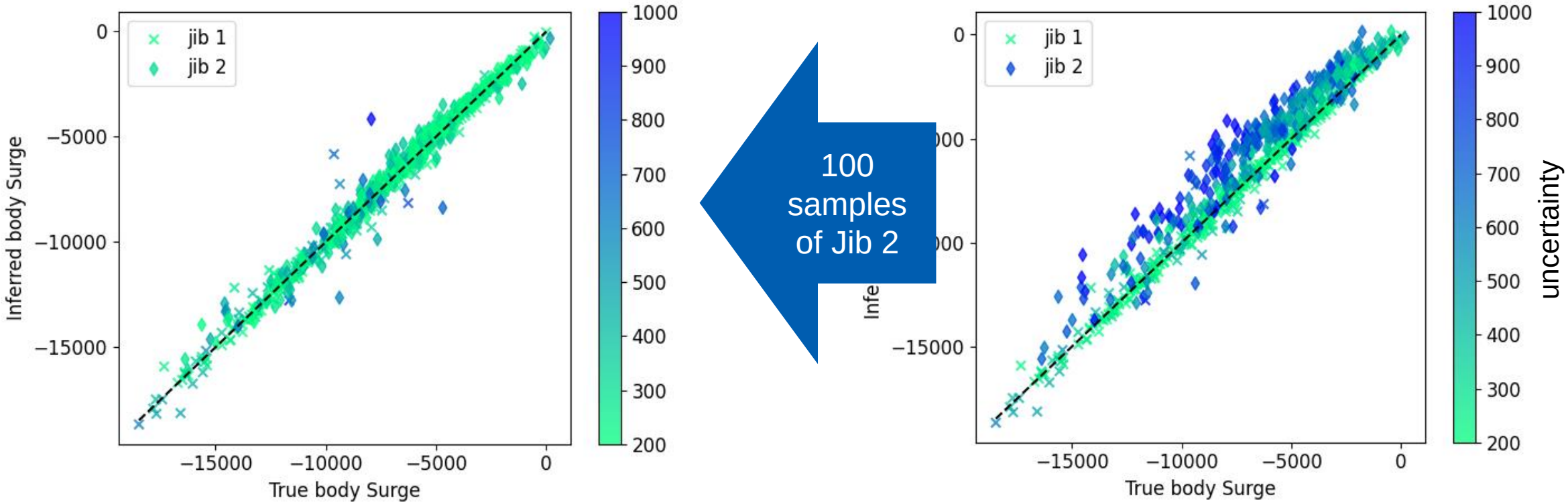




Transfer learning

Update existing models with 100x jib 2→ predict on jib 1 + jib 2

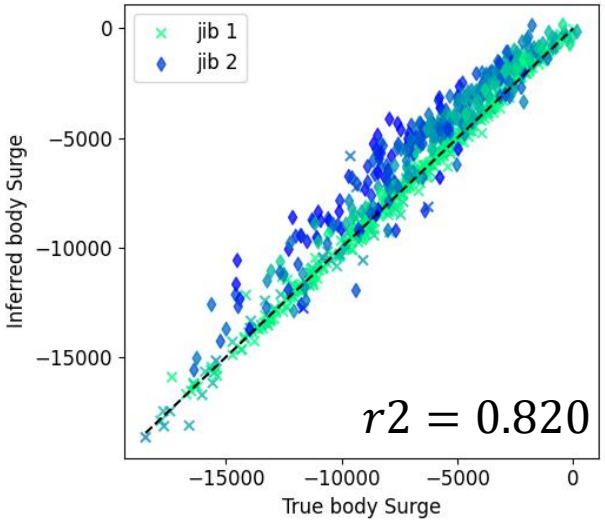




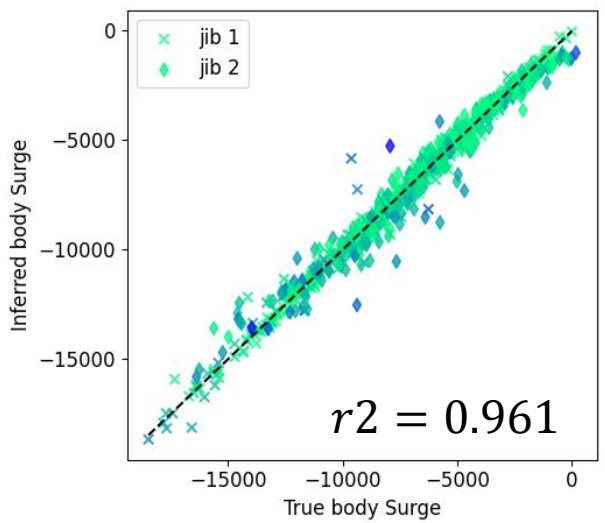
Transfer learning

Model improvement utilizing continual training

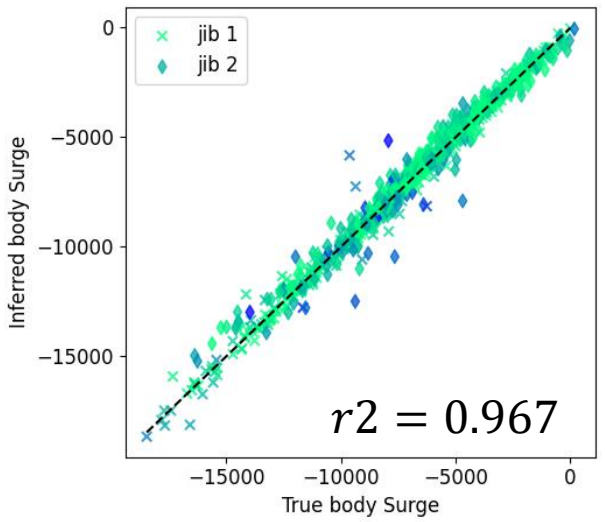
Jib 1



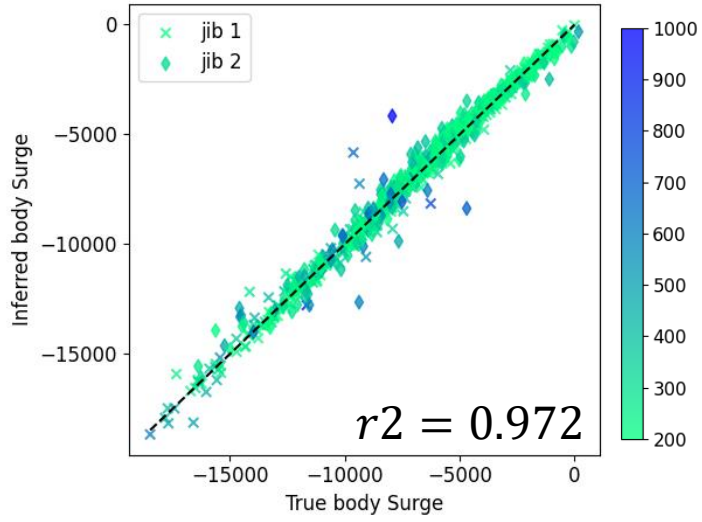
Jib 1 + 25 jib 2



Jib 1 + 50 jib 2



Jib 1 + 100 jib 2



- jib 1 model (1000 epochs)
- Continue training for 200 epochs
- Deep Ensemble GNN Regression

Thank you

Contact information

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