




# The UPSCALE project

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Tuesday, 24<sup>rd</sup> May 2022

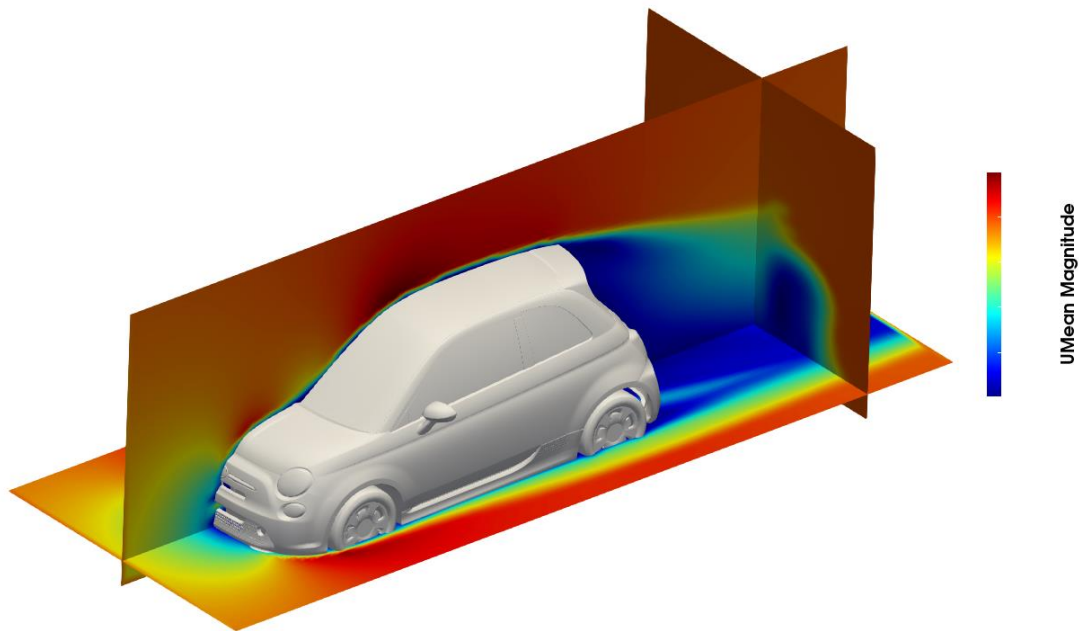
 PUBLIC

- UPSCALE is the first EU-project that has the specific goal to integrate artificial intelligence (AI) methods directly into traditional physics-based Computer Aided Engineering (CAE)-software and methods.
- ROM models for battery cells shortcut prediction
- “real time” aerodynamic computation



## Challenge

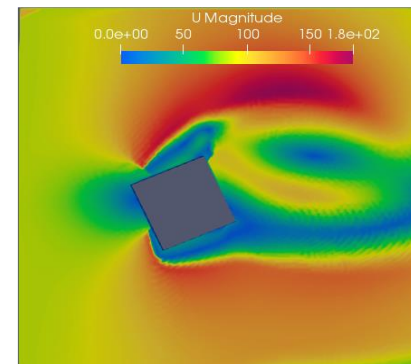
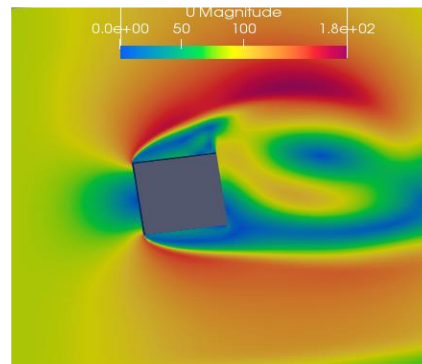
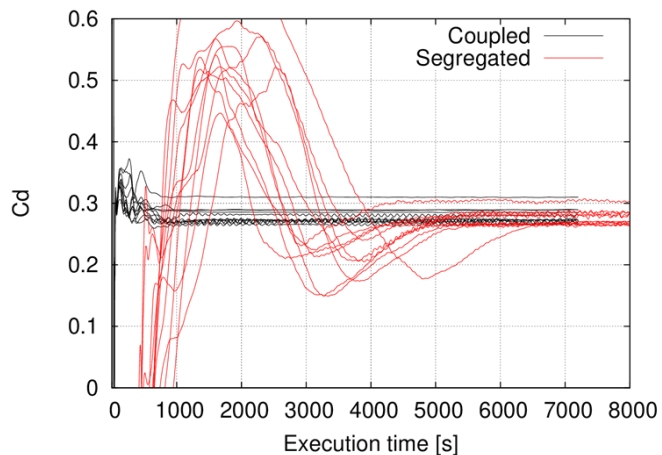
- Interactive aerodynamics assessment for designers based on STL inputs
- Aerodynamic force
- Airflow



## Accelerated RANS solver (x6 acceleration)

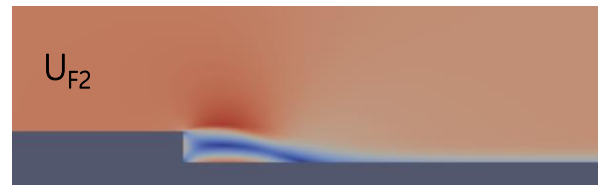
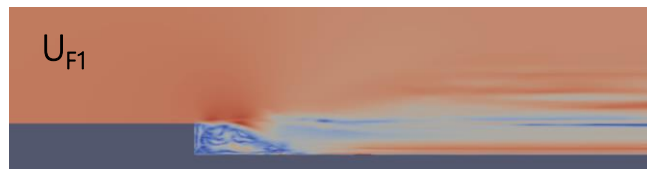
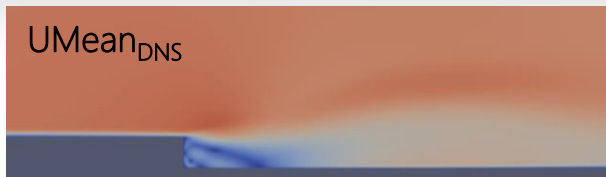
- Smart mapping initialization
- Block based coupled solver
- VDB based meshing

	No initialisation	Potential Flow	Coordinate-based mapping	Distance-based mapping	Smart mapp
Case 125	520	518	436	180	164
Case 62	274	509	137	88	85
Case 375	113	461	145	195	255
Case 948	148	439	451	402	173
Case 521	382	458	105	114	92
Average	287.4	477	254.8	195.8	153.8
Speedup	1	0.6	1.13	1.47	1.87



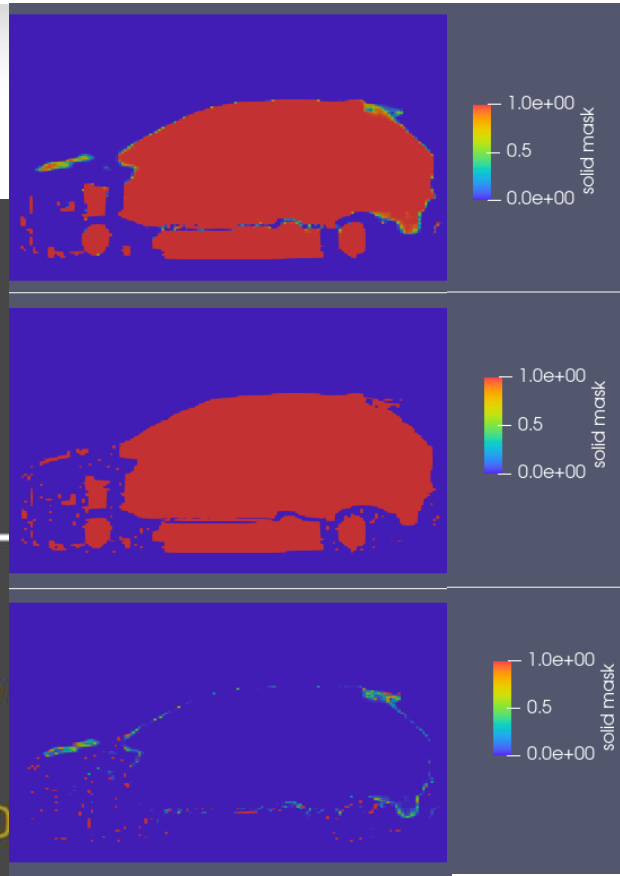
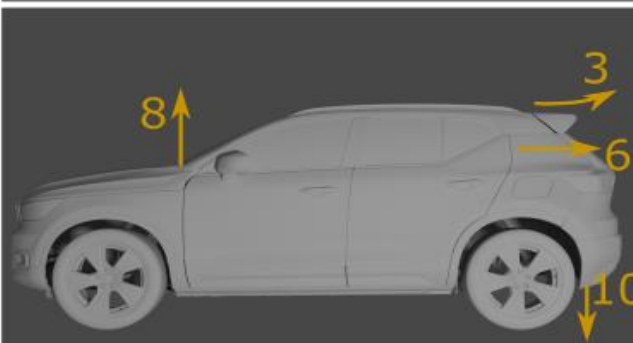
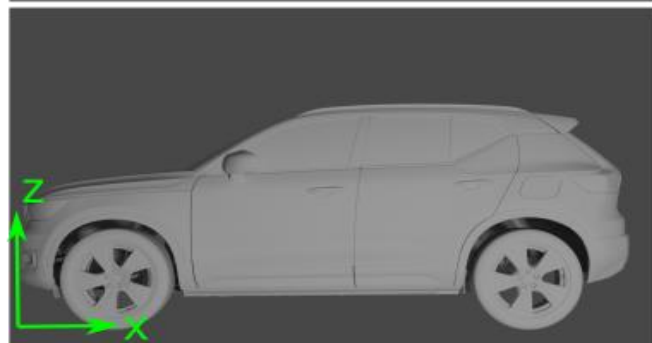
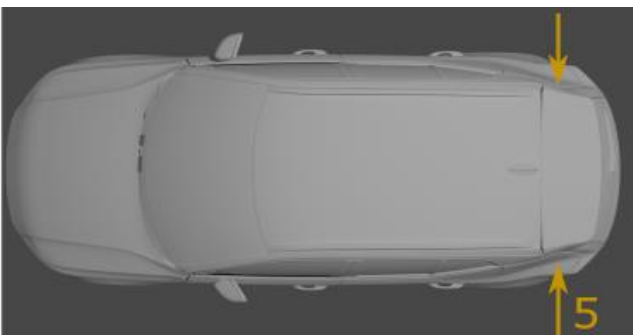
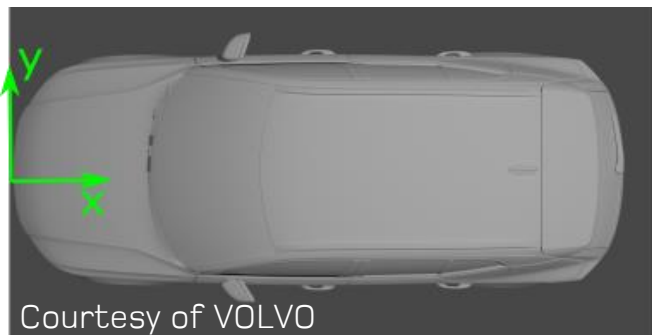
## PIML turbulence modelling

- “Re stress” pattern from high fidelity solutions
- Framework 1: Re stress correction
- Framework 2: Re stress computation & coupling with RANS equations
- RANS OpenFOAM looping with ML Re stresses



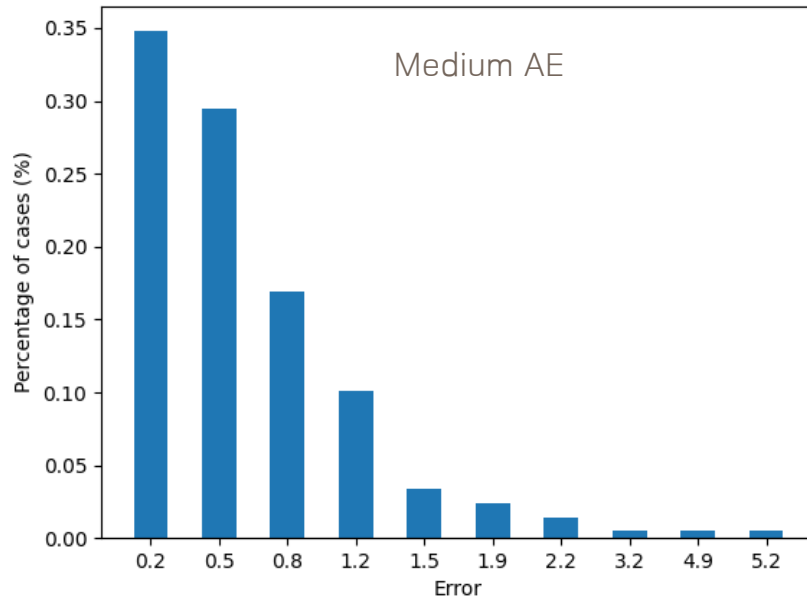
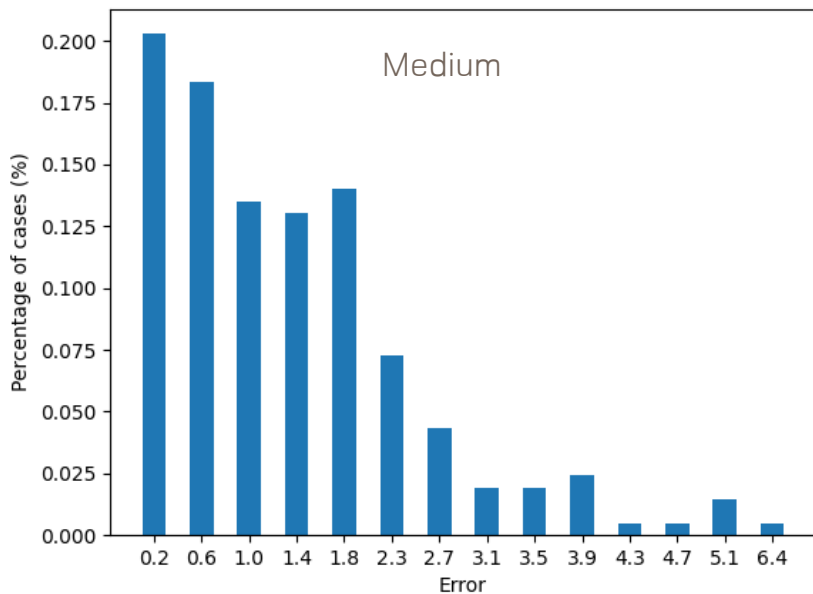
## Universal geometry parametrization

- ML auto-encoder method based on CNN



## ROM for aero forces

Database	$C_D$ (error %)	$\text{std}(C_{D,\text{error}})$	$\text{max } C_{D,\text{error}}$	GPU hrs
medium	1.39	1.14	6.15	22.91
mediumAE	0.65	0.65	5.05	20.87

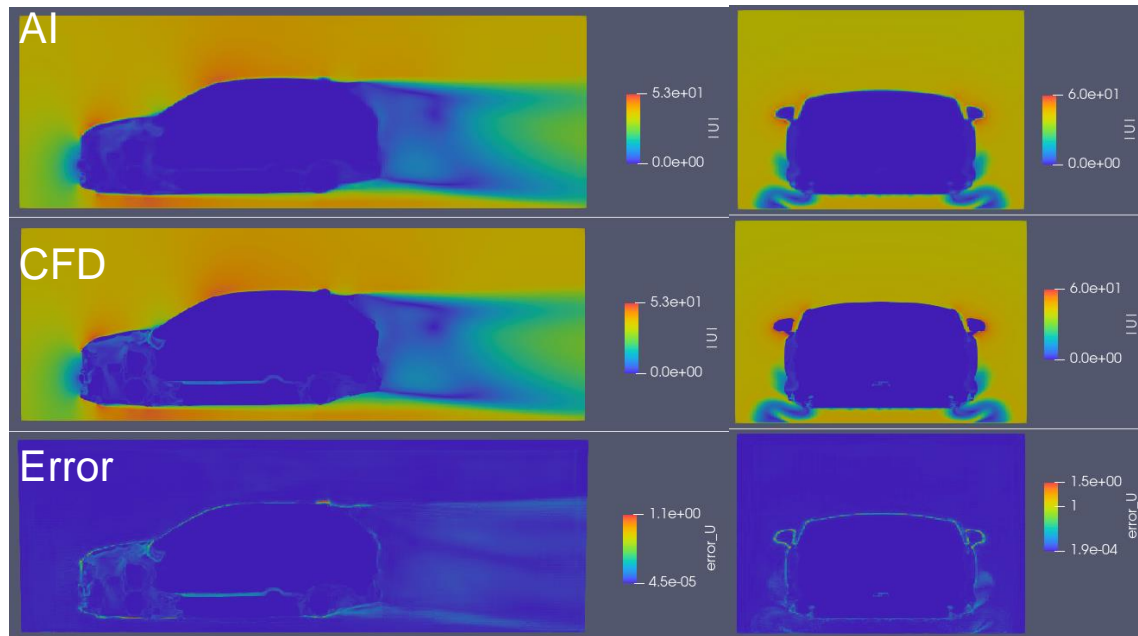




## ROM for aero forces &amp; flow maps prediction

p (error %)	U (error %)	std(p <sub>error</sub> )	std(U <sub>error</sub> )	GPU hrs
0.52	1.48	0.11	0.26	130.45

Dataset resolution (512x256x256)



Courtesy of VOLVO

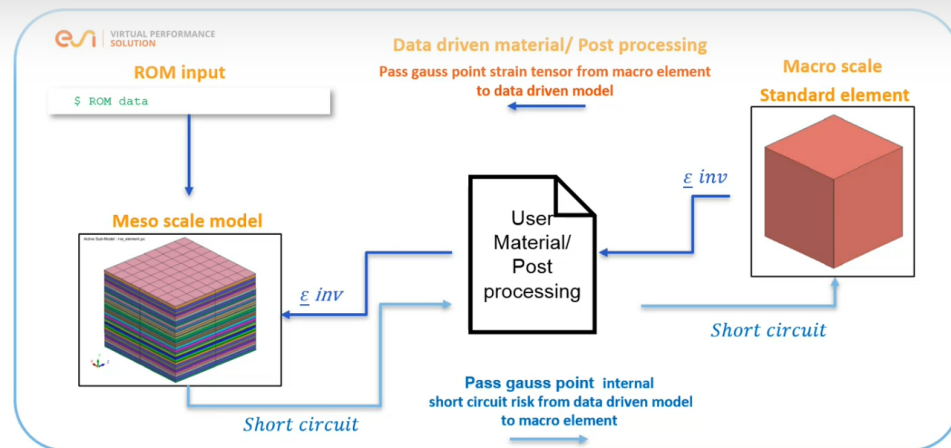


## Challenge

- Unfeasible cell modelling with standard procedures

## Solution 1

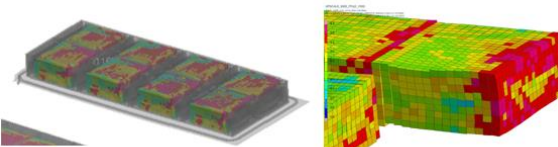
- ROM for shortcut with homogenous material



Courtesy of ESI

- Homogenized Cell with AI short risk
  - Risk model from AI training
  - 200K-1M solids dep. on mesh gauge
  - 4-8.5 hours on 72 CPUs for pole impact
  - Standard post-processing/ DMP

Courtesy of VW



## Challenge

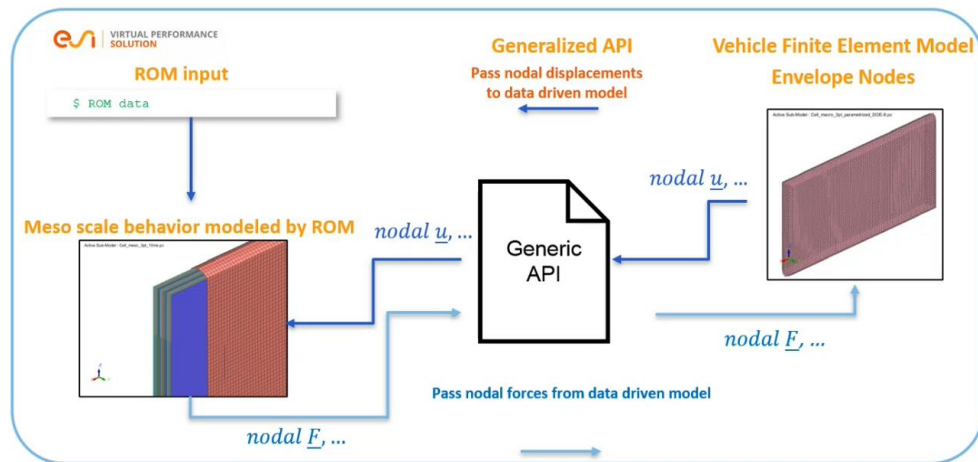
- Unfeasible cell modelling with standard procedures

## Solution 2

- ROM for stiffness + shortcut

## Main project outcome

- ROM generation process for shortcut & stiffness
- Framework for ROM usage within VPS



Courtesy of ESI

## Aerodynamics ROM

- Successful usage of aero-ROM for variants of a defined model
- Training cost trade-off
- Universal predictor by continuous learning ???

## Battery shortcut ROM

- FEM surrogated parts by means of **tailored material cards** for stiffness modelling
- Shortcut probability computation by means of **tailored material cards**



Notes





T H A N K   Y O U  
F O R   Y O U R   K I N D   A T T E N T I O N



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