AI ET SIMULATION INDUSTRIELLE: VERS UN DEVELOPPEMENT PLUS RAPIDE ET EFFICACE

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in behalf of: Dr Juan Pedro Berro | Technical Director France, Spain and Italy

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Altair's Vision

Computational intelligence will drive innovation for a more connected, safe, and sustainable future

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ALTAIR HYPERWORKS
Platform for Simulation Driven Innovation

ALTAIR RAPIDMINER
Platform for AI Driven Innovation

ALTAIR HPCWORKS
Platform for Compute-Driven Innovation

3rd party solvers

Turnkey
Physical Appliances

Turnkey
Virtual Appliances

ALTAIR ONE
Our Vision of the Convergence

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Altair is Leading AI-Powered Engineering

Paradigm Shift

Computer-Aided Design

Computer-Aided Engineering

Computer-Aided Manufacturing

AI-Powered Design

AI-Powered Engineering

AI-Powered Manufacturing

Augmenting Engineers

Increasing productivity

Capturing knowledge

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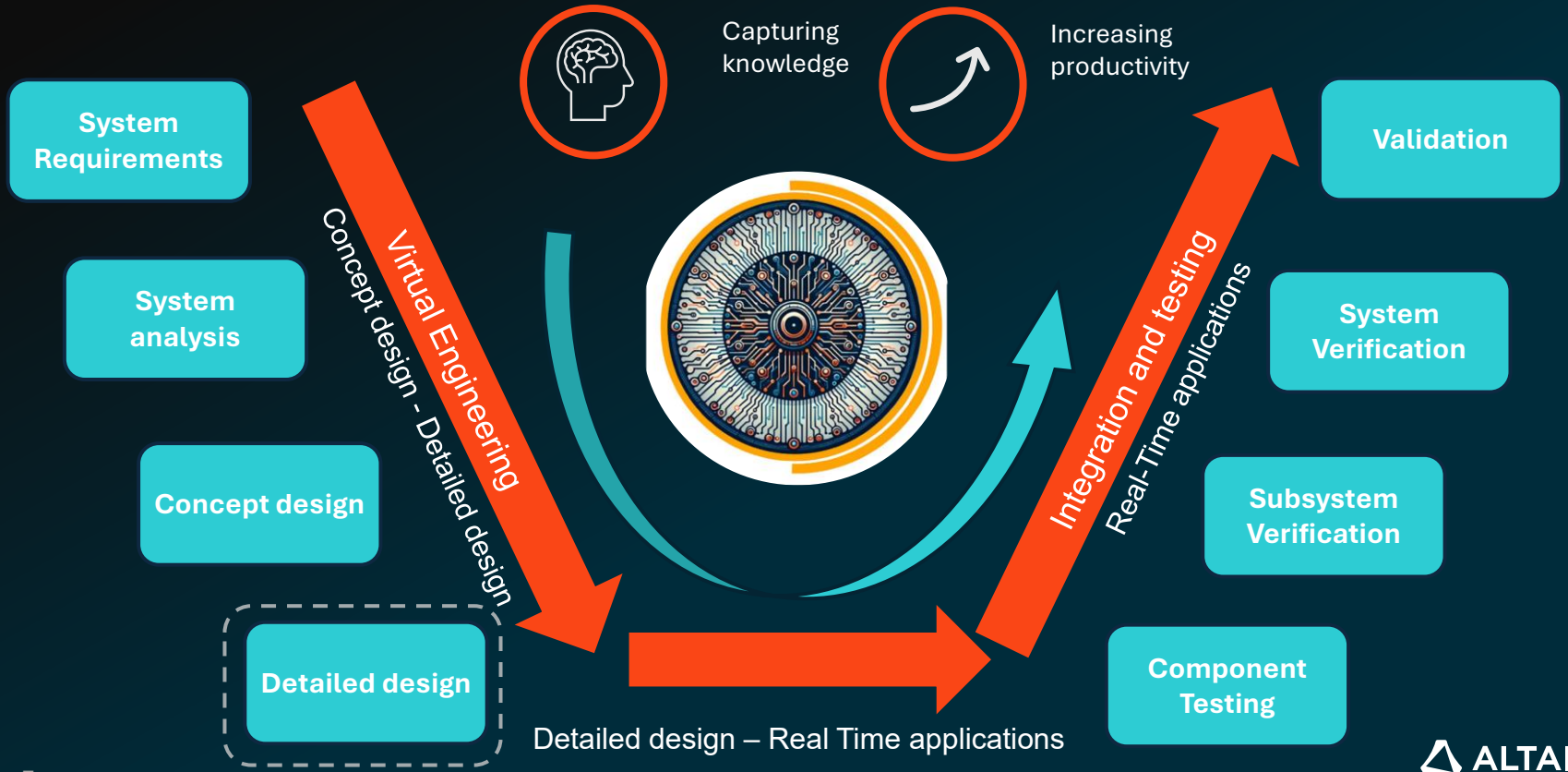
AI and Product Development



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Standard Product Design workflow

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Standard Product Design workflow

Detailed Design

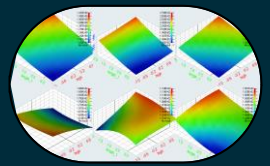
Computationally expensive

Needs field expertise

Lot of iterations

Parametric Optimization

Metamodel based Optimization

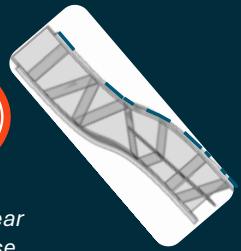


Physics Performance assessment

Highly Nonlinear Field Expertise

Manufacturing assessment

Highly Nonlinear Mfg Expertise



physicsAI

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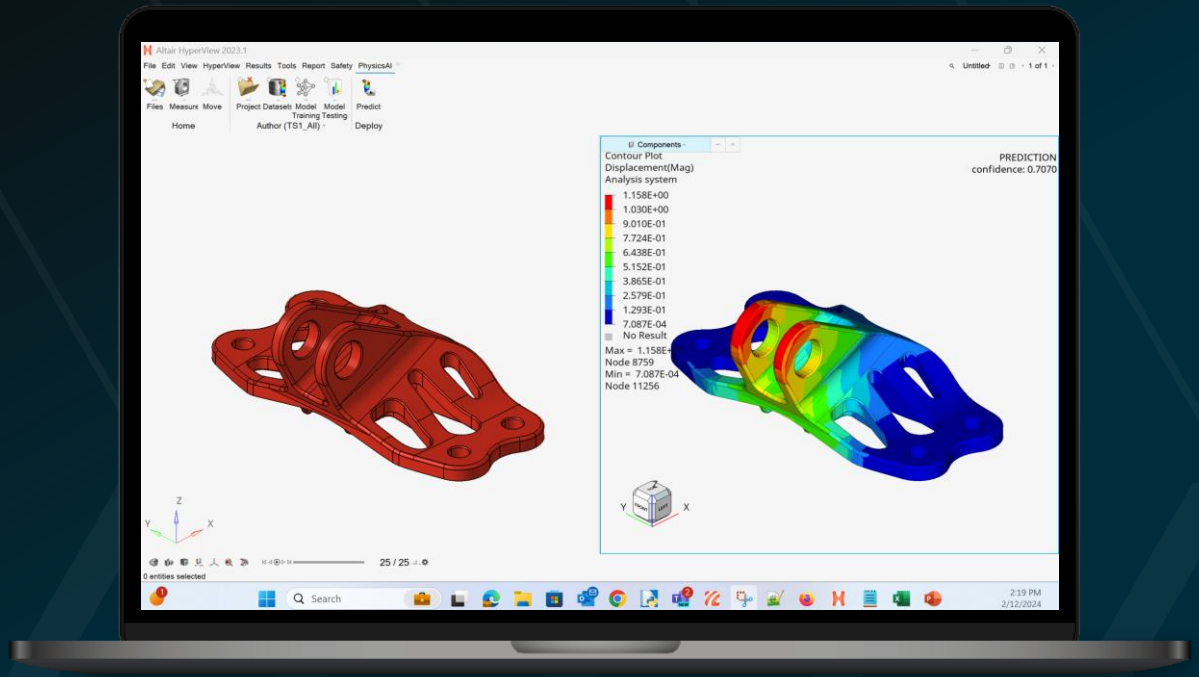
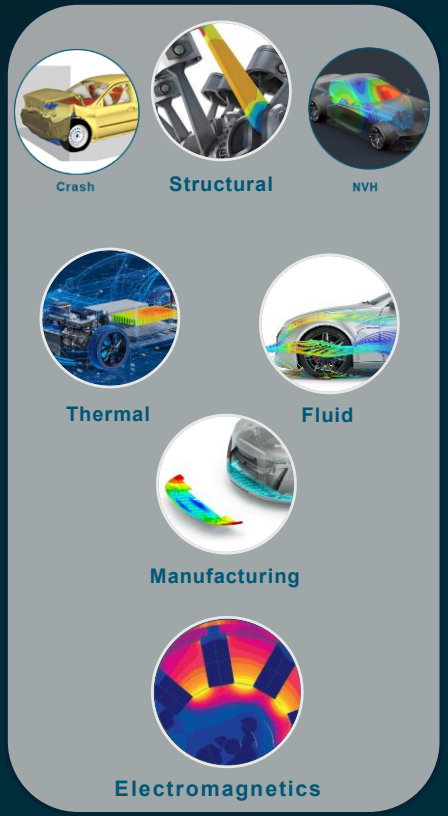
physicsAI: Expanding design exploration through Real-time Predictions



Field predictions by physicsAI: Geometric Deep Learning



- CAE std format
- Predict Scalars | Curves | 2D/3D fields
- Domain Agnostic
- Custom features enabled
- No mesh needed
- Fully integrated in CAE environment

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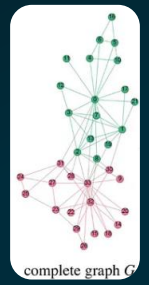
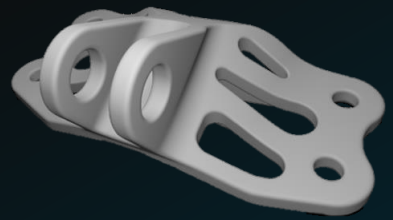
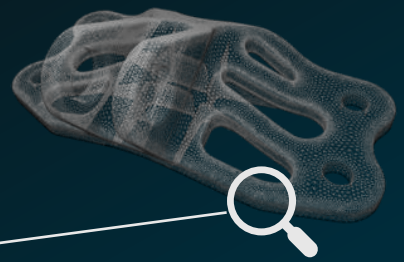
How does physicsAI Process Geometries?

GDL: Geometric Deep Learning



https://medium.com/@shekhawatsamvardhan/types-of-neural-networks-graph-neural-networks-a82ae13638ac

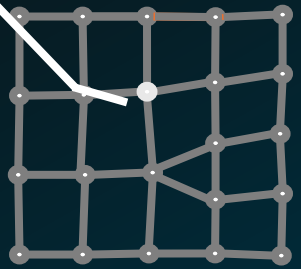




node features

node labels

- X, Y, Z
- Mesh-Connectivity
- Part Label
- Global Parameters
- Nodal Parameters

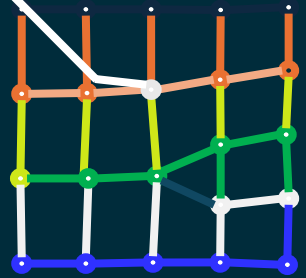


physicsAI

GNS

TNS

- Width
- Depth
- Sections
- Attention



- Scalars
- Curves

Models source: MIT DSL, http://digitalstructures.mit.edu/

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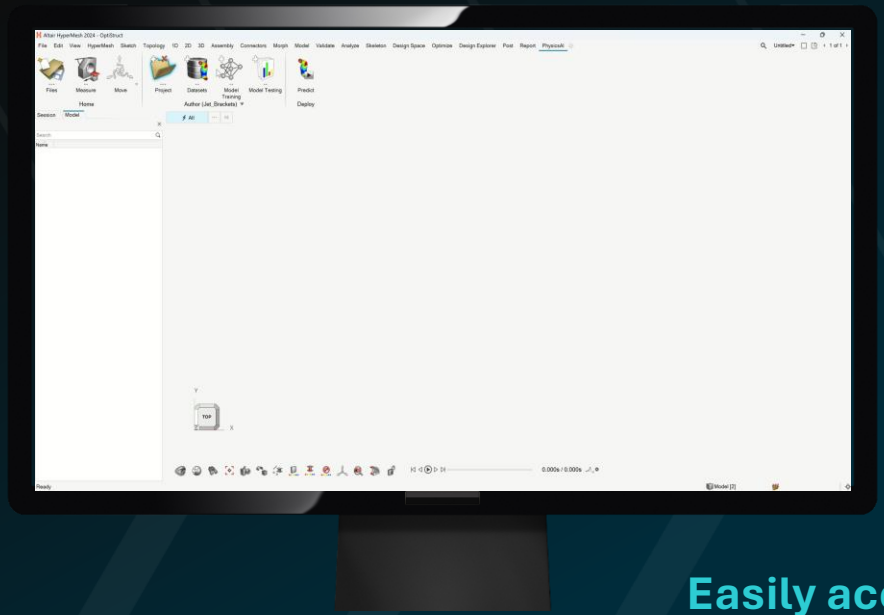
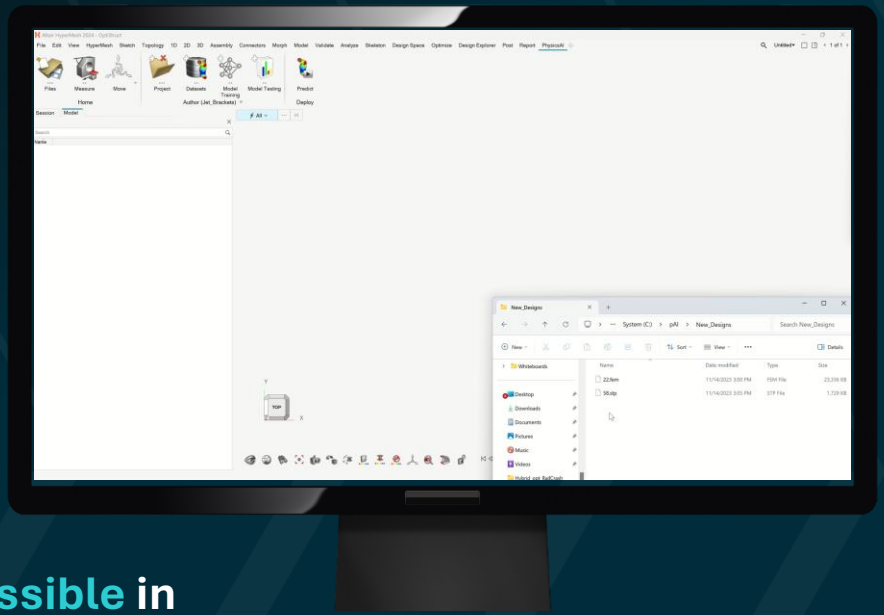
physicsAI: Embedded AI Fields predictions

physicsAI training



physicsAI prediction



Easily accessible in HyperMesh

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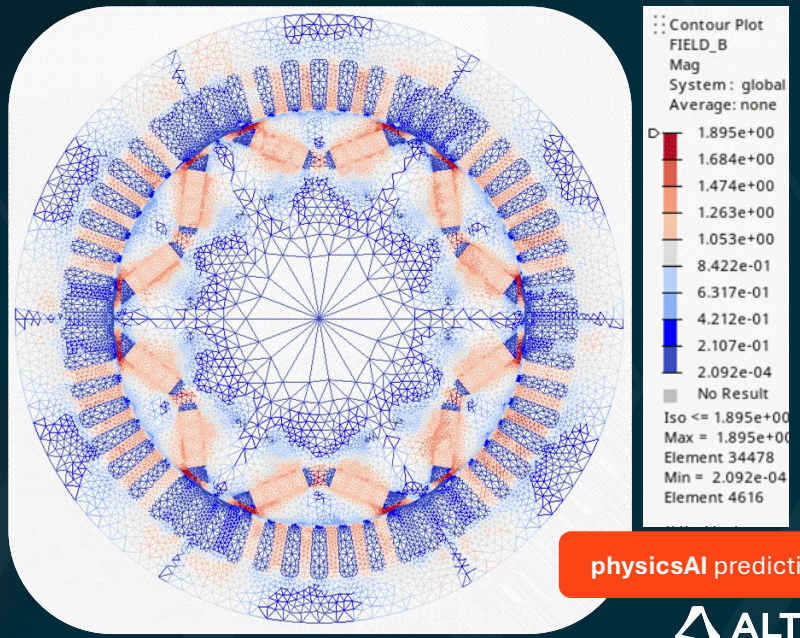
PhysicsAI-Based Electromagnetic Result Prediction

Introduction

AI-driven simulation of electric motors

Field prediction (magnetic flux density B / T)



physicsAI prediction results

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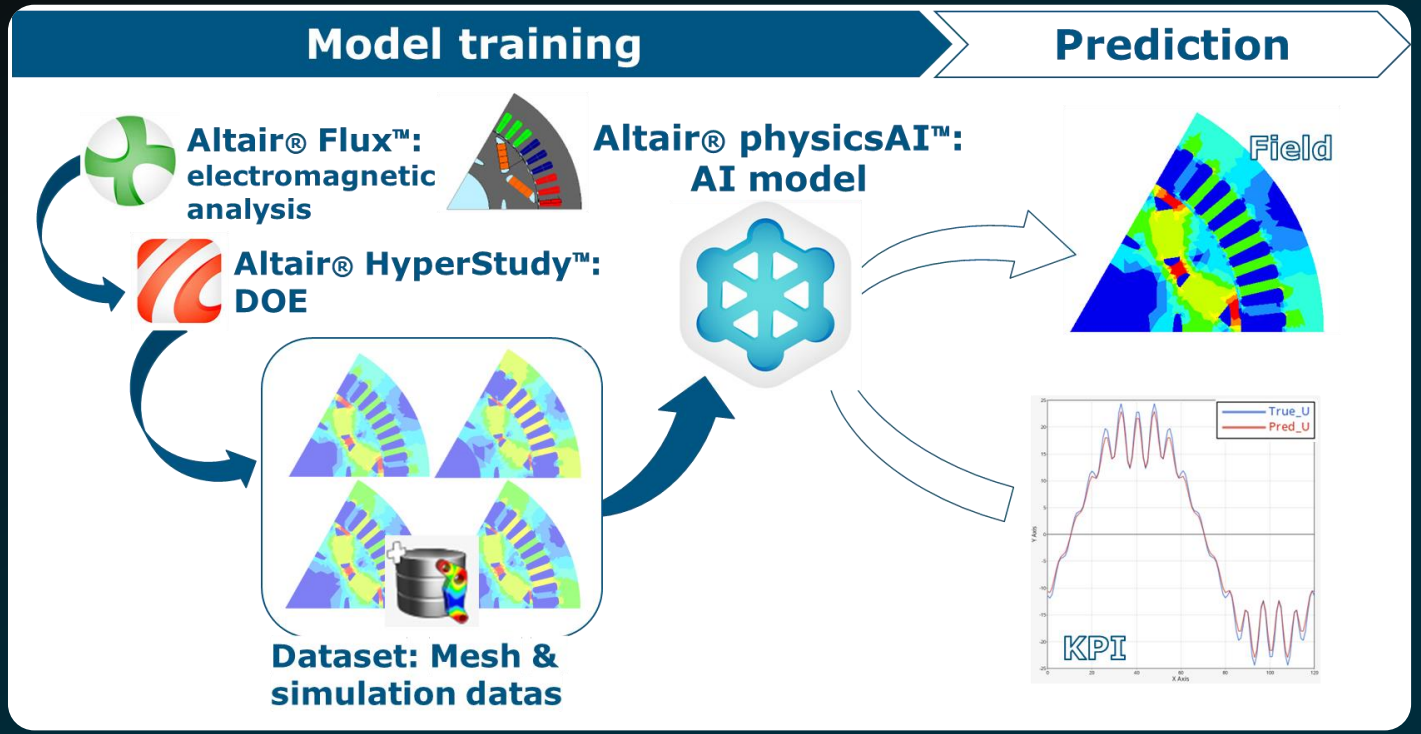
PhysicsAI-Based Electromagnetic Result Prediction

Analysis Workflow

- PhysicsAI-driven electromagnetic analysis: **implementation workflow**



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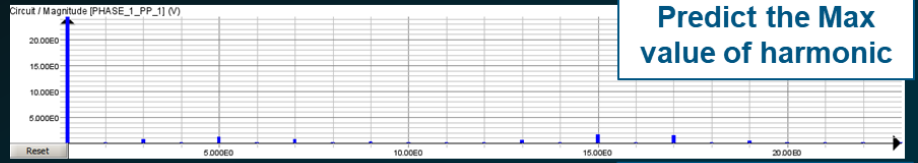
PhysicsAI-Based Electromagnetic Result Prediction

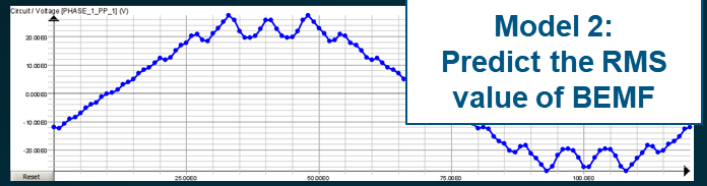
E-Motor Application Example

Objectives

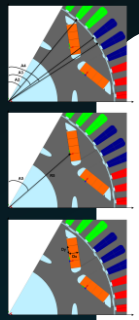
- Minimize harmonic distortion;
- Minimize magnet size;
- Sustain the original magnetic flux.



Model 1: Predict the Max value of harmonic



Model 2: Predict the RMS value of BEMF



DOE
540 runs
(30 cores):
2h40min

AI Model Prediction

Model 1

Model 2

Model training:
4h
(2 models at the same time without GPUs[1])

Optimization

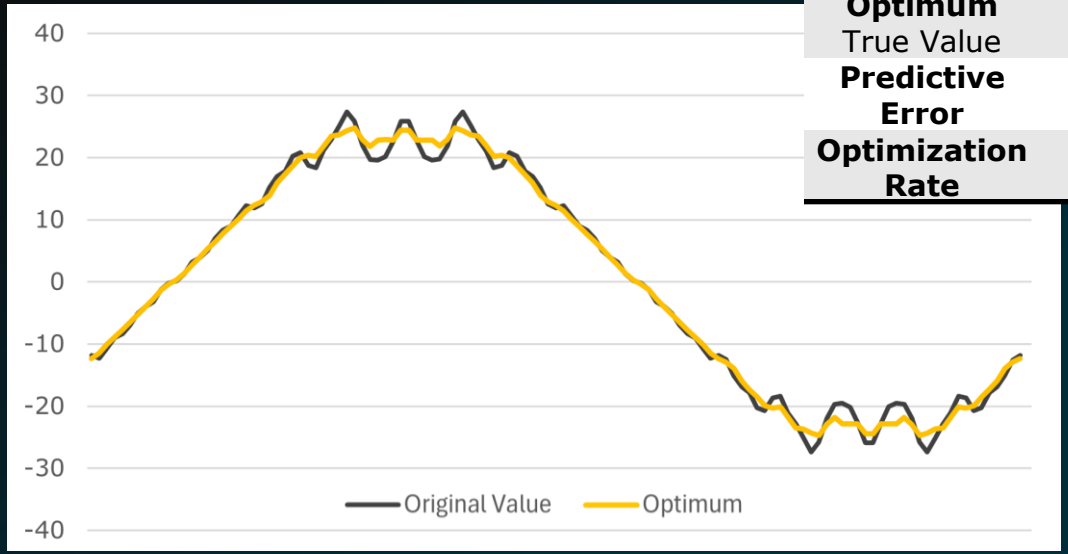
Label	Varname	Expression	Value	Goals
U_rms	U_rms	mean(U)	17.269583	>= 17.320000
Harmonic_max	Harmonic_max	max(Harmonic)	1.6707573	Minimize
Magnet Size	Magnet Size	IM_DY*IM_DX	38.160000	Minimize

Optimization:
2h30min

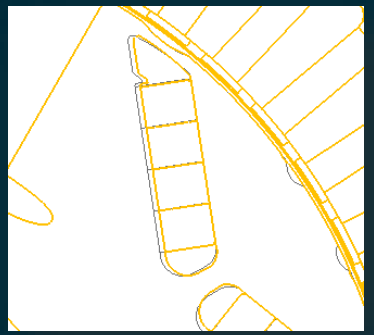
PhysicsAI-Based Electromagnetic Result Prediction

E-Motor Application Example

- AI-based optimization results
  - Back EMF curve



	U rms	Harmonic max	Magnet size
Original	17.32	1.73	38.16
Optimum Prediction	17.54	0.94	34.02
Optimum True Value	17.37	0.99	34.02
Predictive Error	1%	5%	0
Optimization Rate	≈	43%	11%



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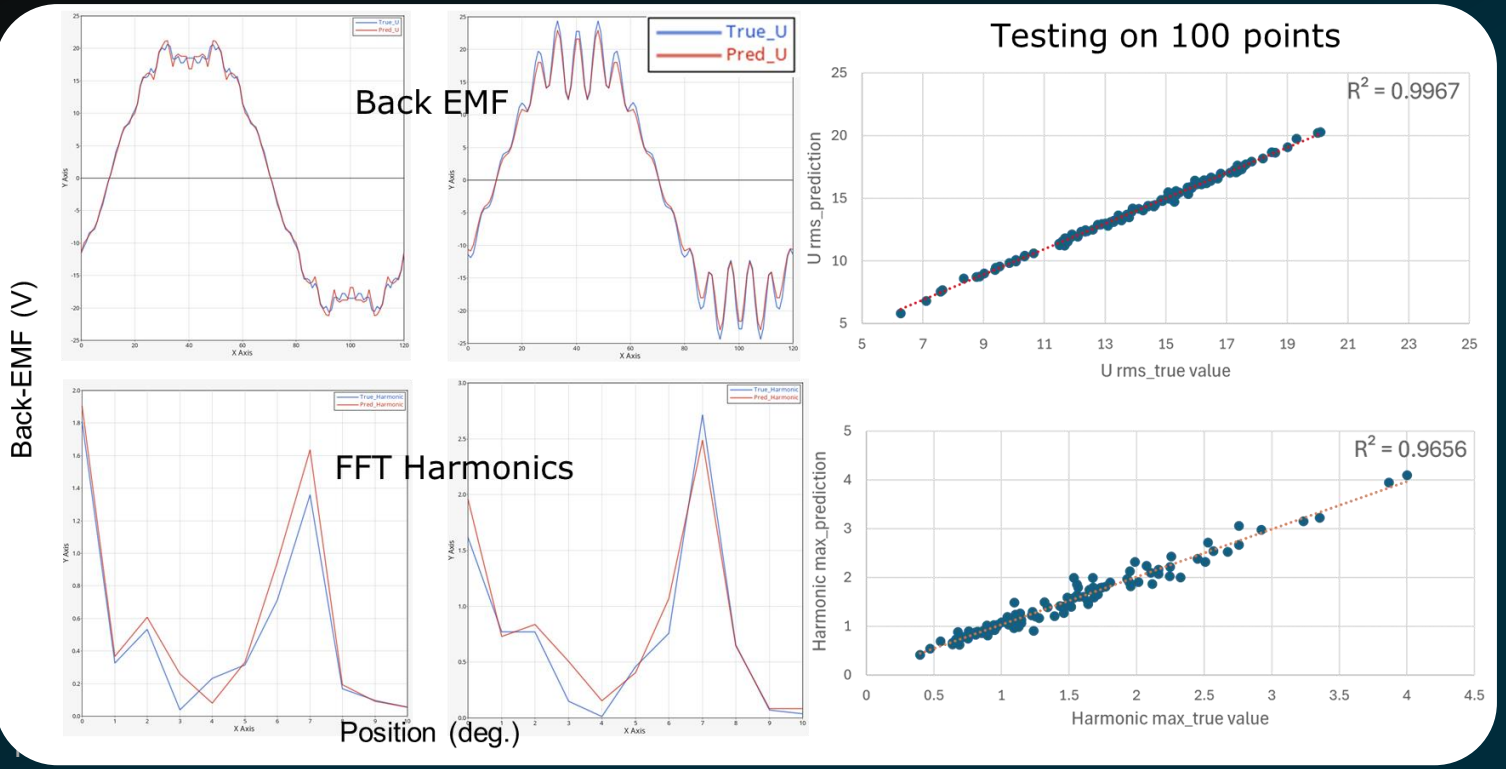
PhysicsAI-Based Electromagnetic Result Prediction

E-Motor Application Example

- Accuracy of physicsAI prediction results (KPI)



PhysicsAI summary

No need for handcrafted parametrization:

- Parametrization can be difficult and handcrafted set may not be optimal leading to loss for improvement

Richer learning:

- No need for parametric or same topology datasets

Better design direction:

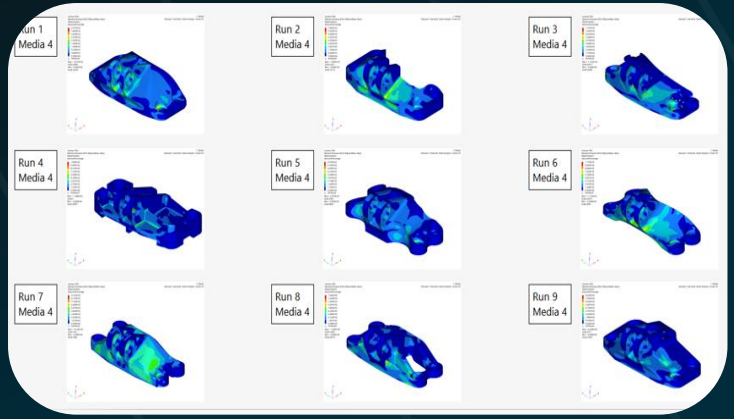
- Much faster than a solver, enables design exploration

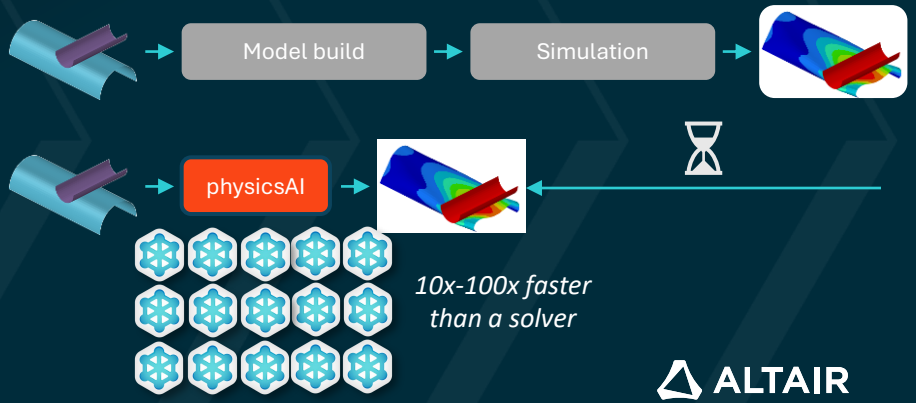
Predicts on CAD:

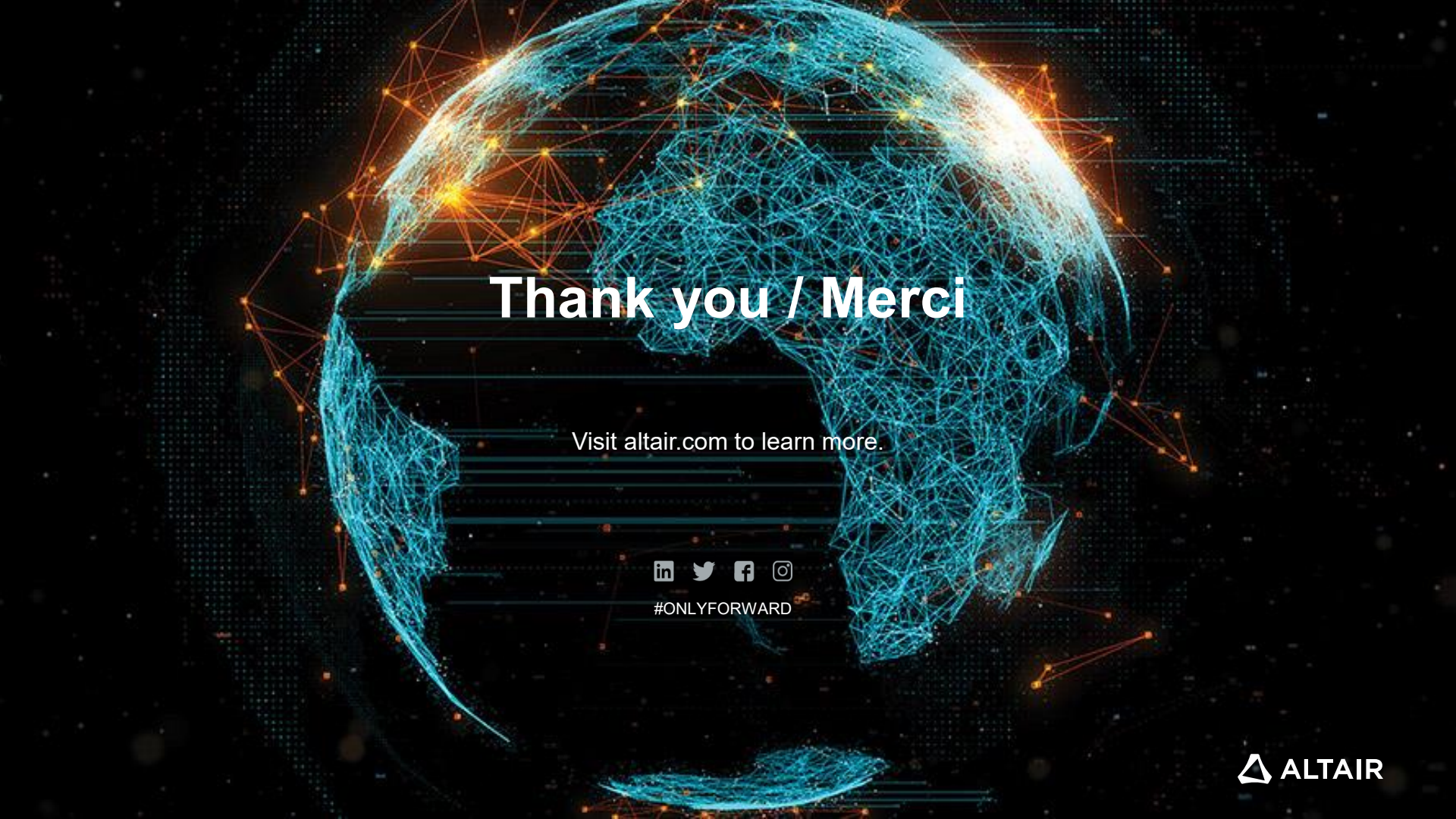
- Reduce or eliminate model build time

Embedded in CAE engineer environment:

- Easy access and utilization



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