

ECCOMAS YIC 2025

TOWARDS DIGITAL CONTINUITY IN VIRTUAL PRODUCT DEVELOPMENT OF COMPOSITE AEROSPACE STRUCTURES BY MEANS OF A DOMAIN-SPECIFIC LANGUAGE FOR COMPUTATIONAL STRUCTURAL MECHANICS AND ITS SOFTWARE ECO-SYSTEM

Martin Rädcl, Andreas Schuster, Felix Schoenitz, Jean Lefèvre

DLR, Institute of Lightweight Systems, Department Structural Mechanics & VPH

17.09.2025, Pescara, Italy

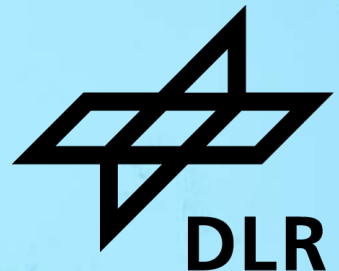
Gefördert durch:



Bundesministerium
für Wirtschaft
und Klimaschutz

aufgrund eines Beschlusses
des Deutschen Bundestages

 **PredictECO**

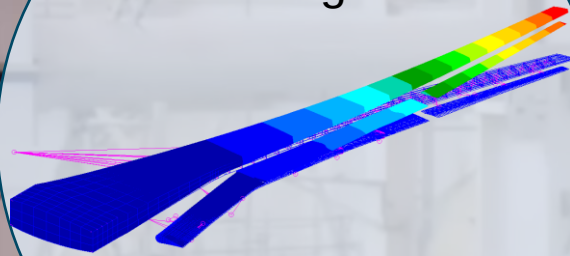


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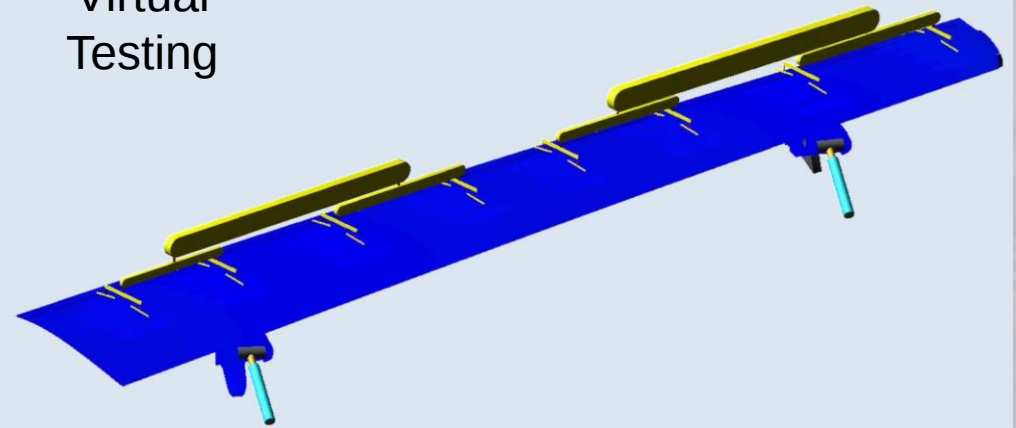
Imagine...



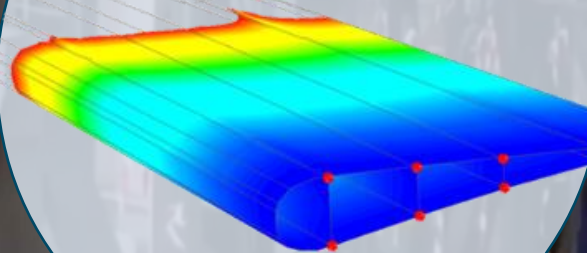
Digital
Design



Virtual
Testing

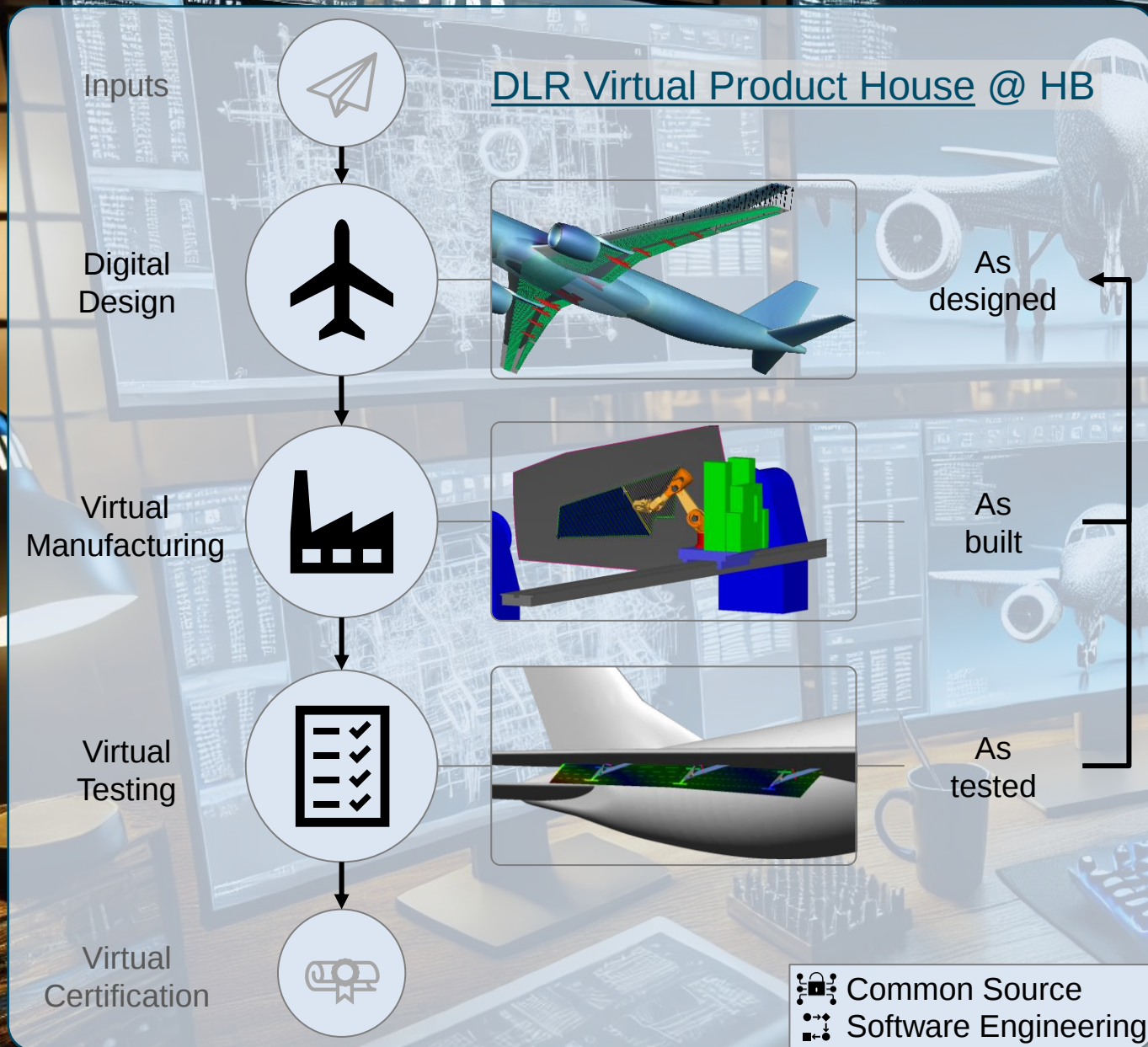


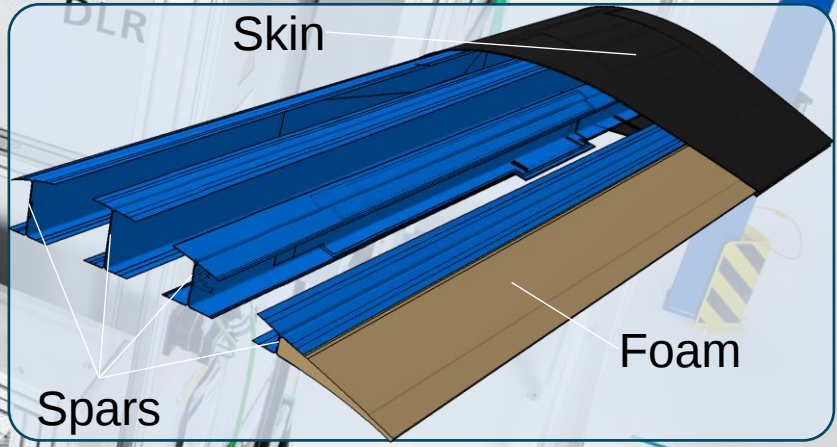
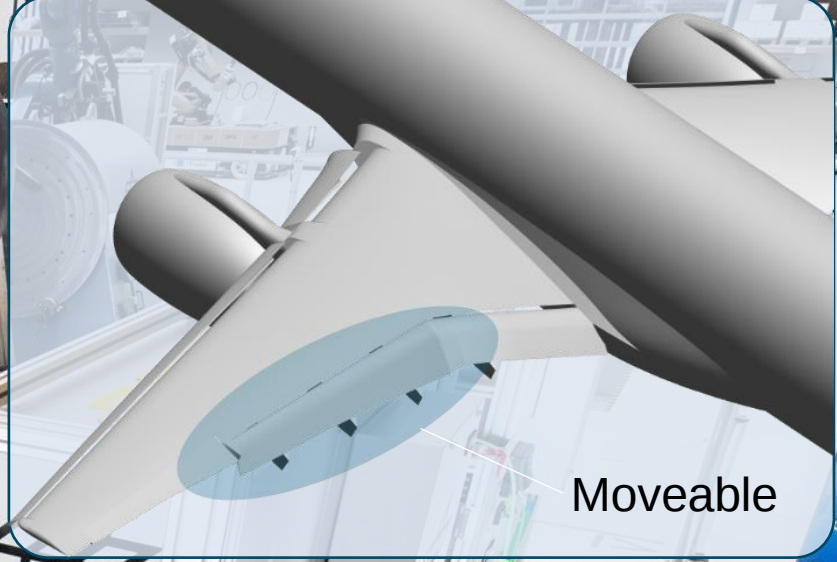
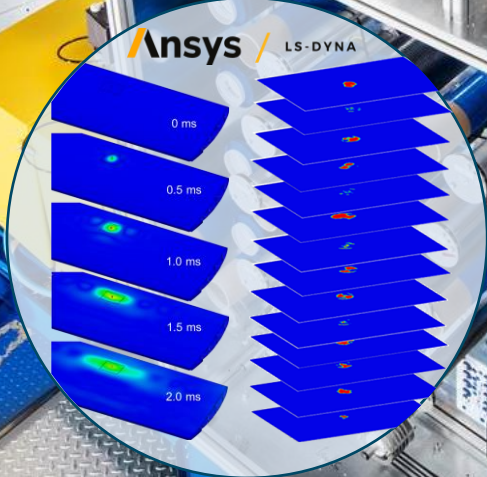
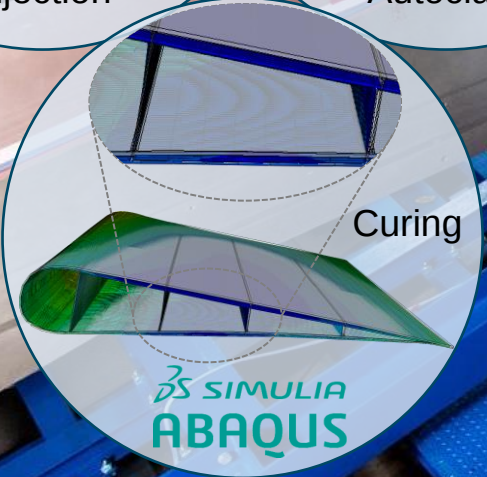
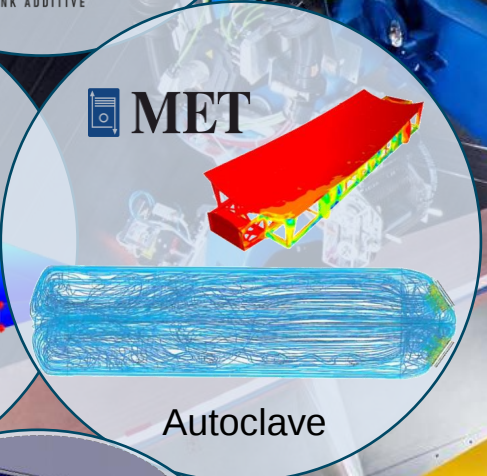
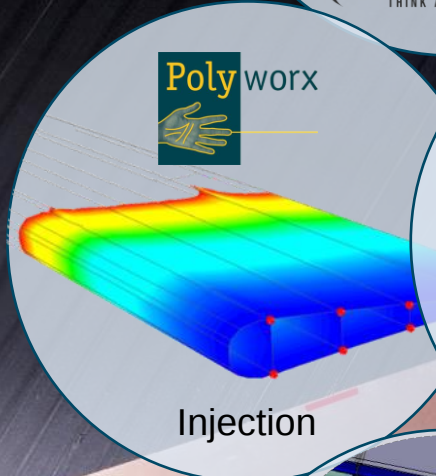
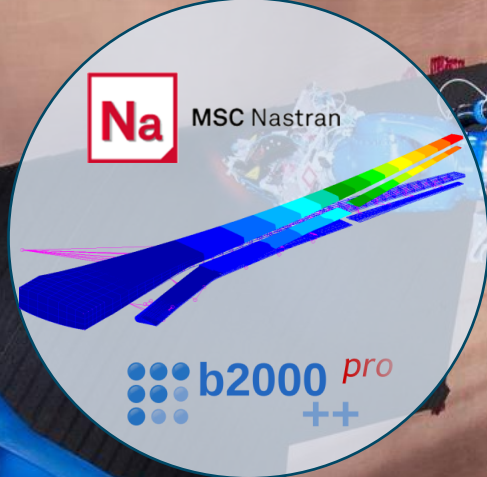
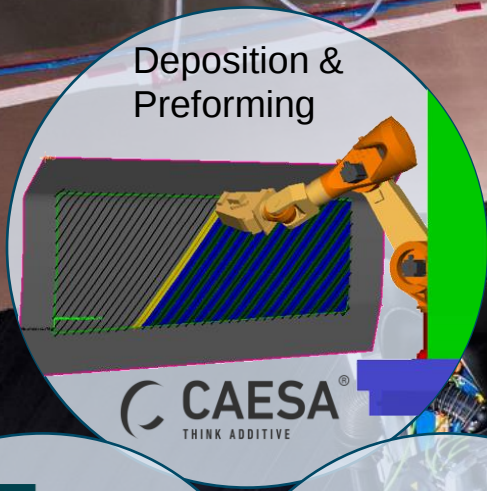
Virtual
Manufacturing



Applications:

- Virtual product development
- Eco-efficiency assessment



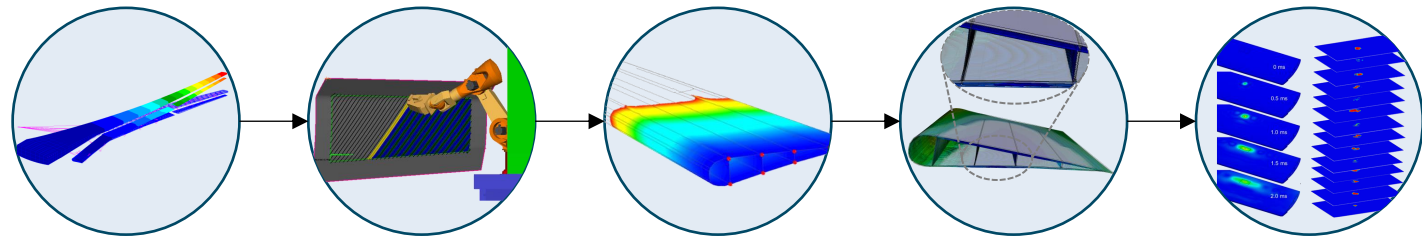


Manufacturing

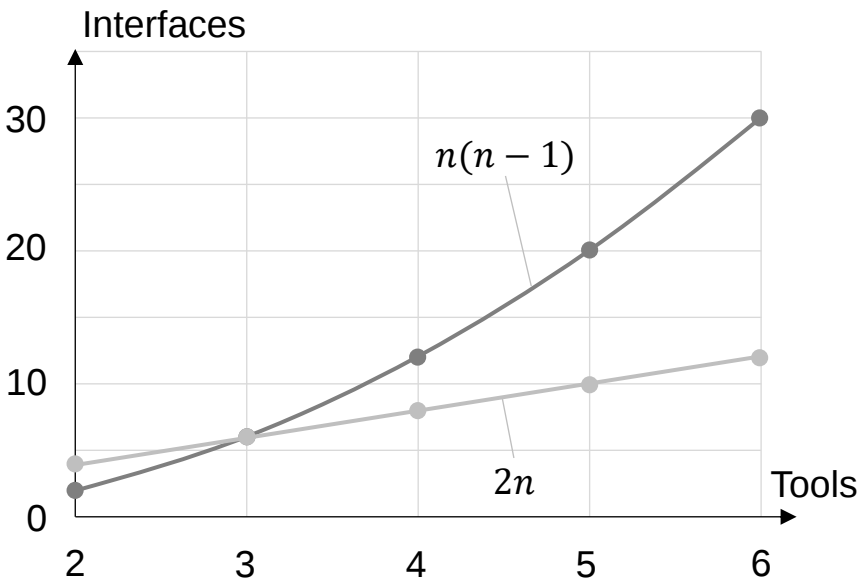
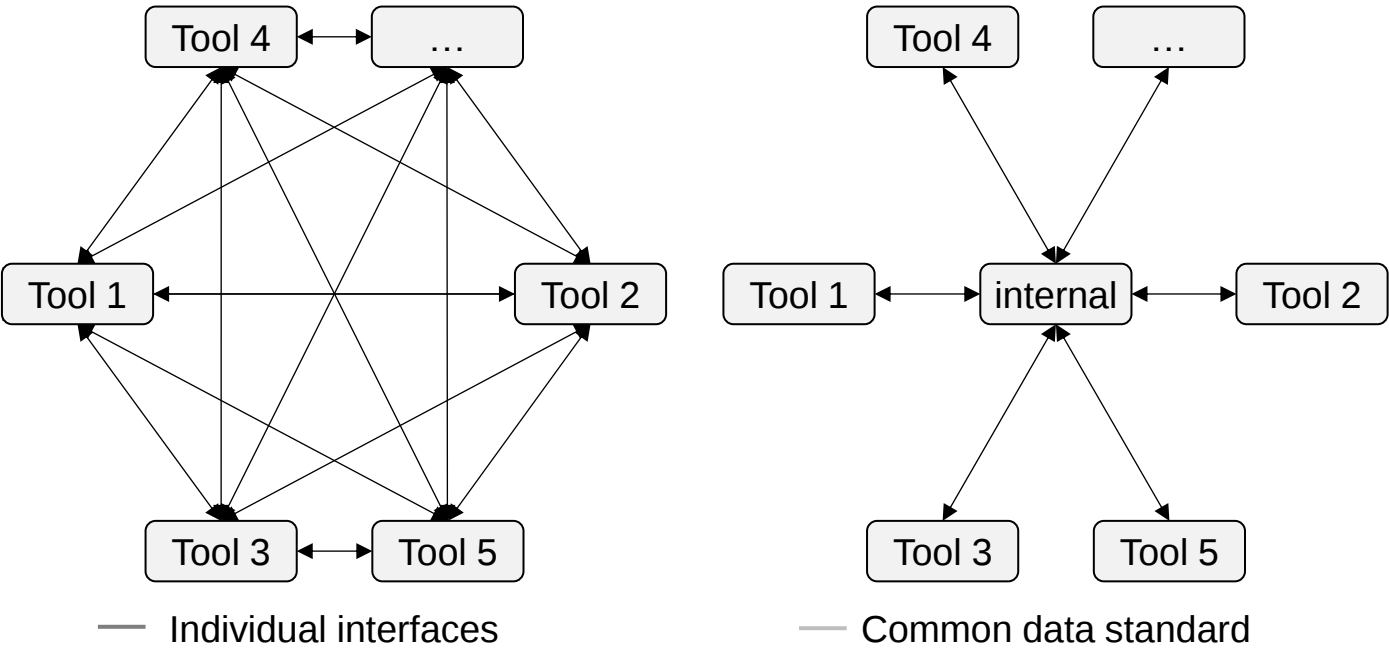
Testing

Digital continuity

Idea



- End-to-end enabler: common language



Digital continuity

Internal language

Define DTOs

DSL software packages

- Nodes
- Elements
- ...
- Results
- Sections
- Loads & BC
- ...
- Solution
- Materials
- Composites
- Crosssections
- ...

File representation

Heavy data



References

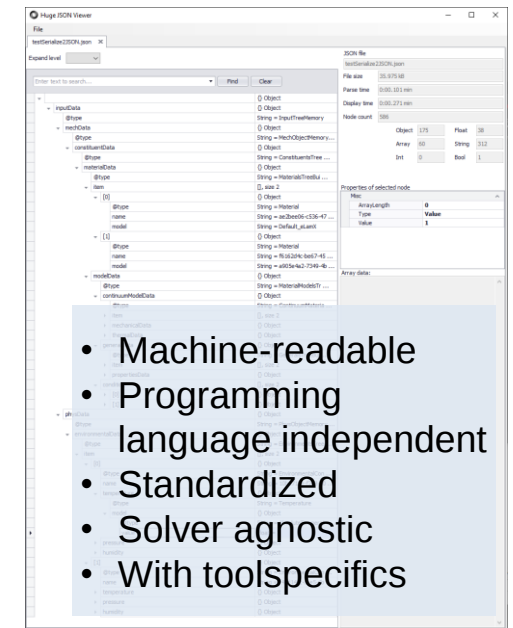
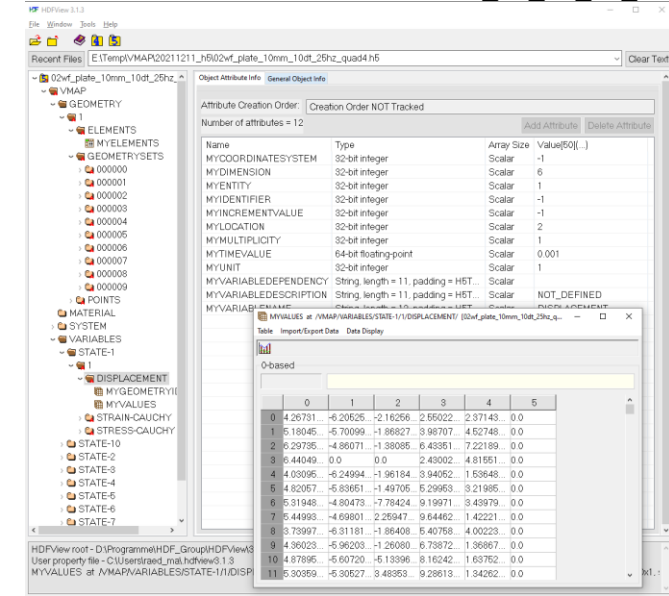
Light data

cosmo

Numerical implementation data

Connecting data

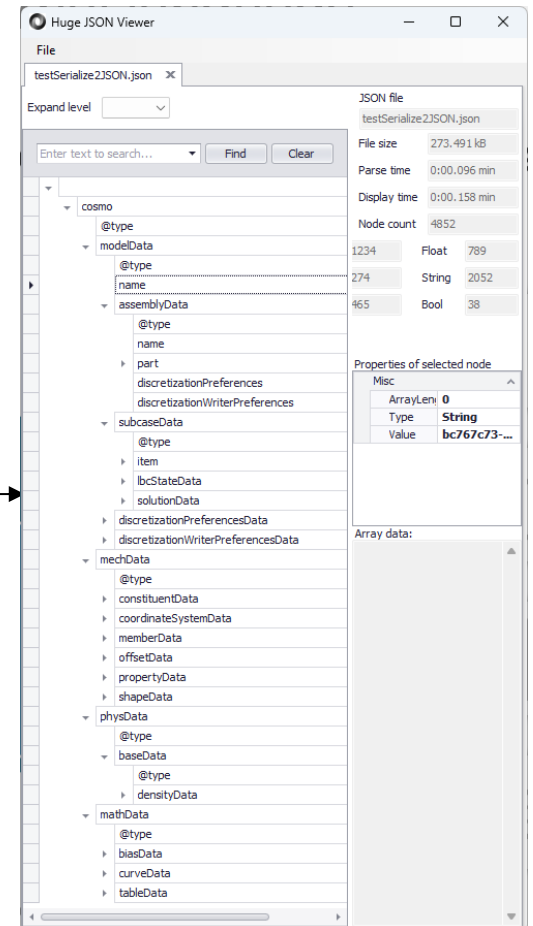
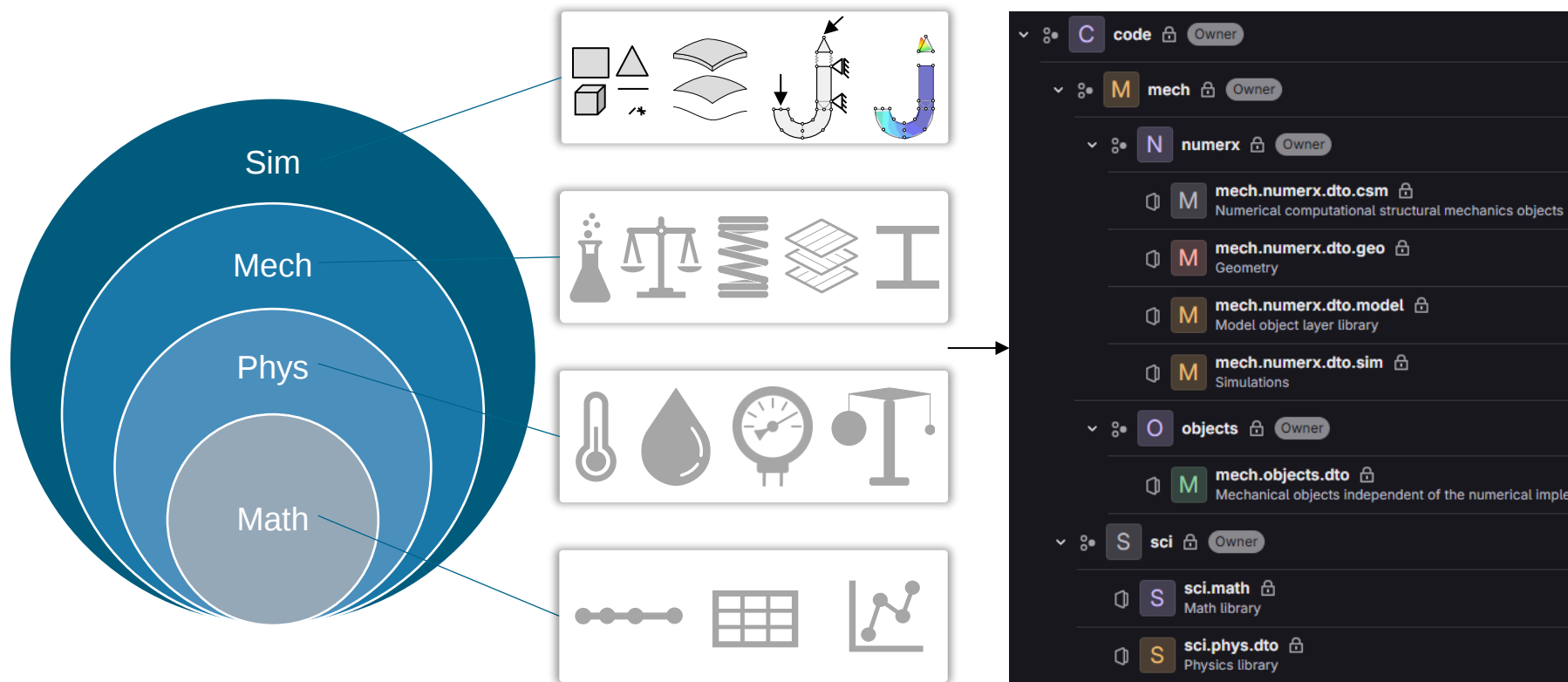
Math, physics & mech. idealization data



- Machine-readable
- Programming language independent
- Standardized
- Solver agnostic
- With toolspecifics

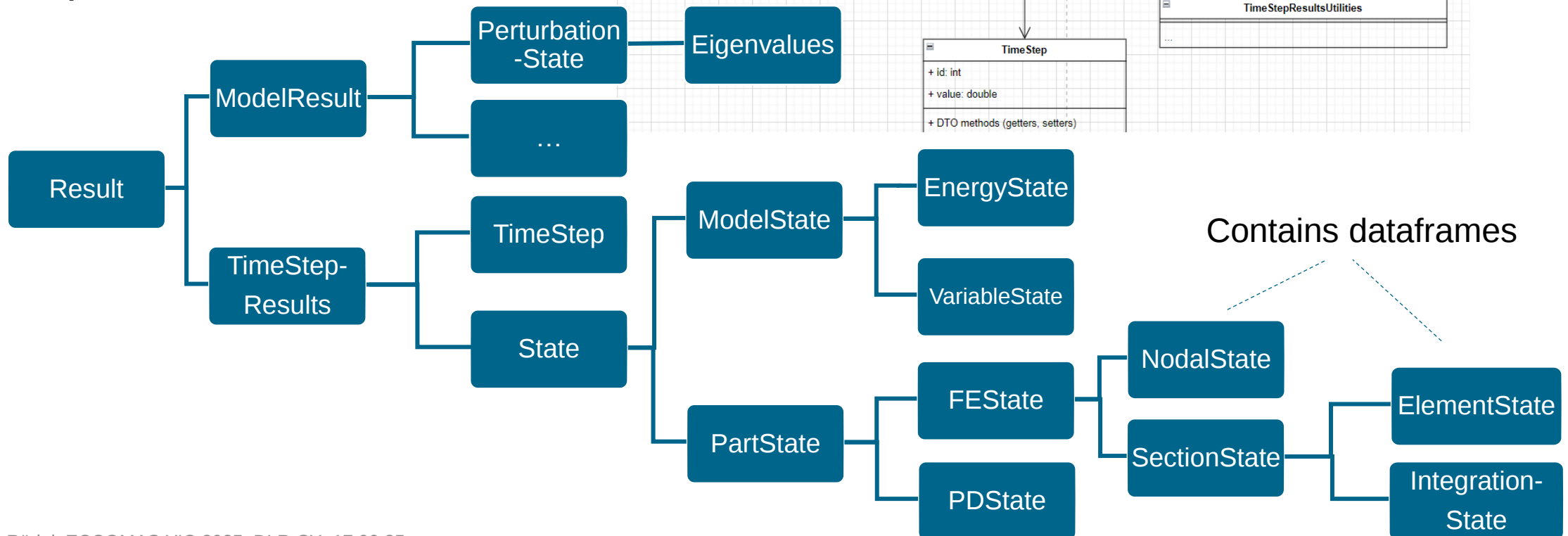
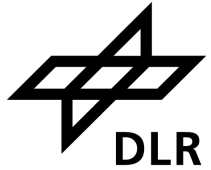
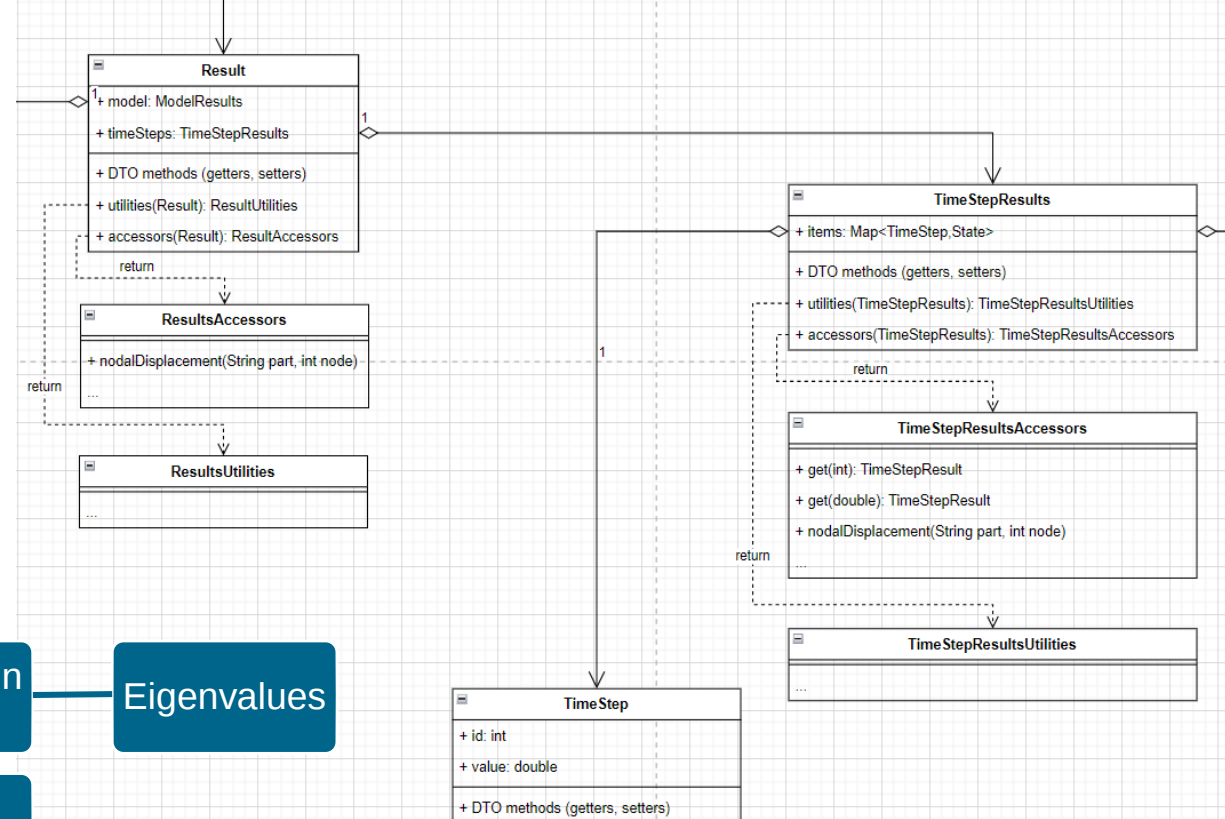
Digital continuity DSL

- Modular language vocabulary → based on level of assumptions & theories
- Reuse between levels



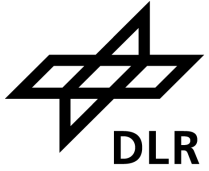
Digital continuity DSL

- Simplified from UML
- Based on user stories
- Expandable

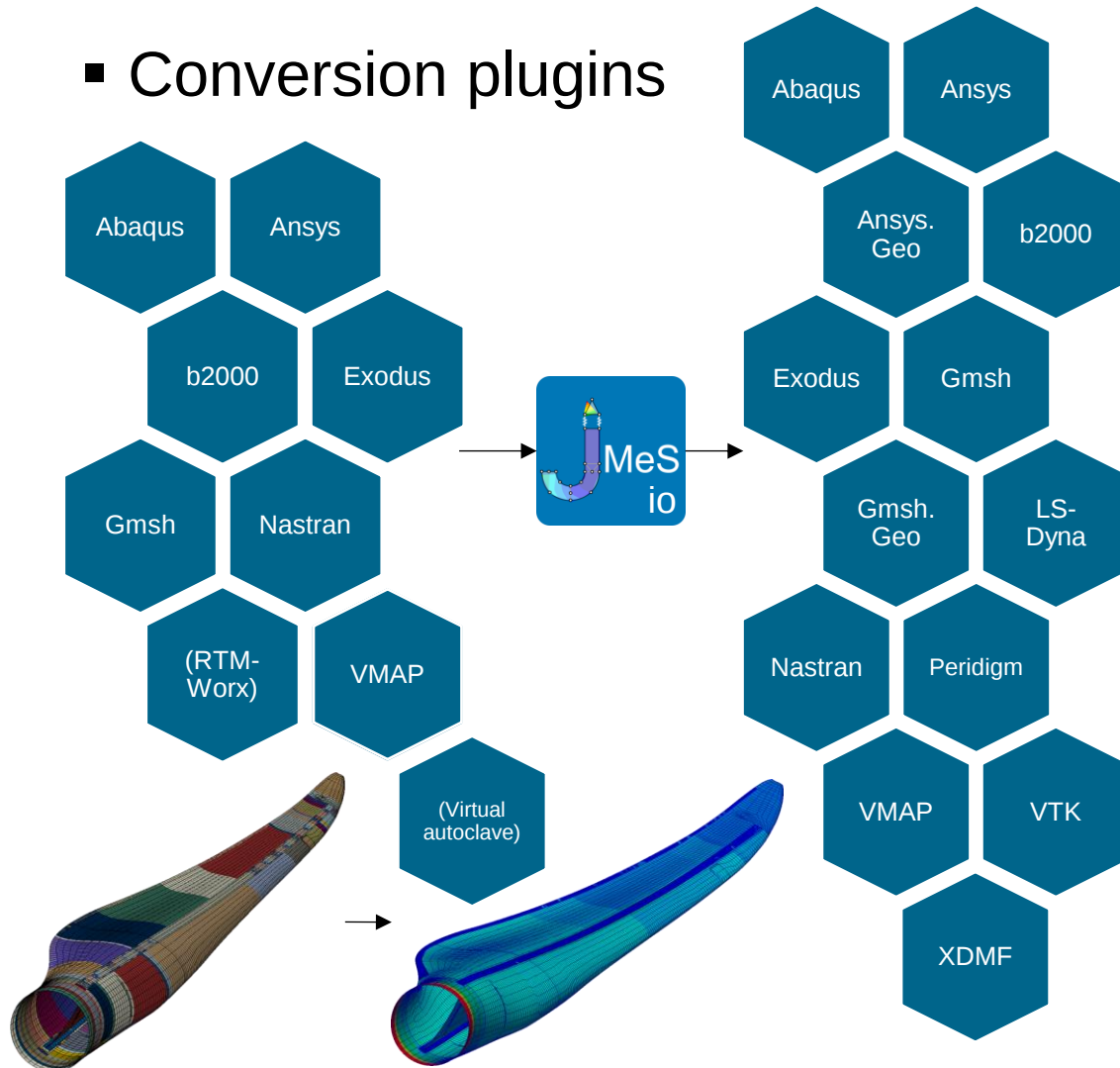


Digital continuity

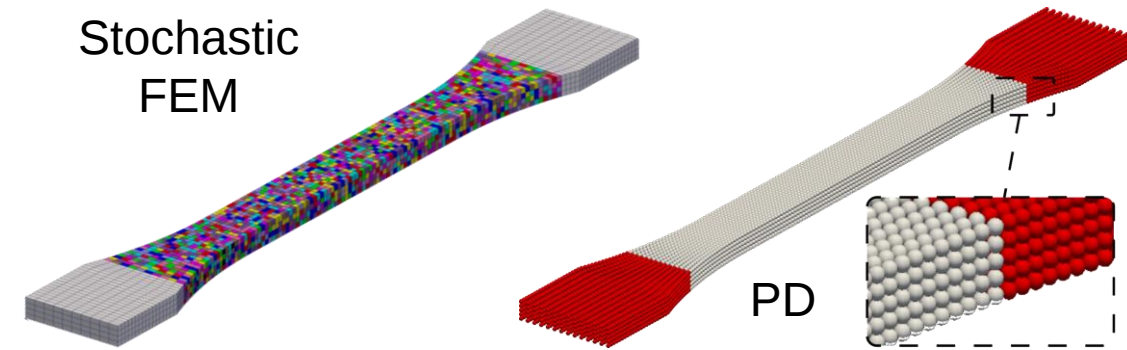
Eco-system: Modeling & preprocessing



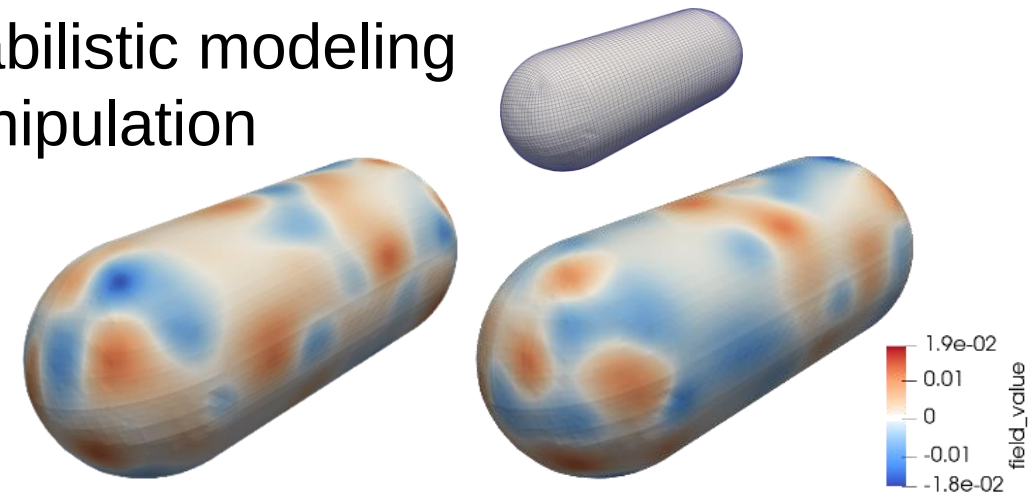
■ Conversion plugins



■ Idealization & theory-independent model generation



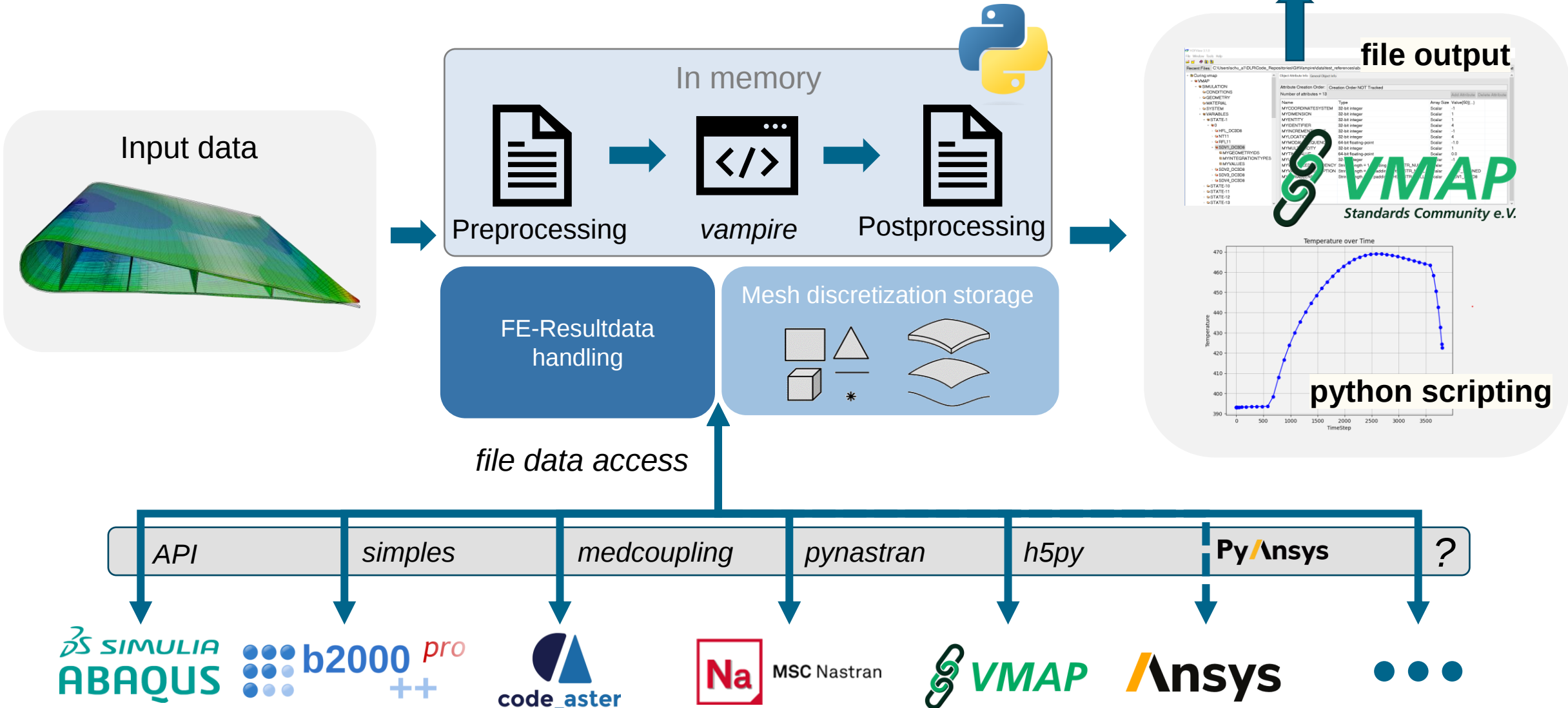
■ Probabilistic modeling & manipulation



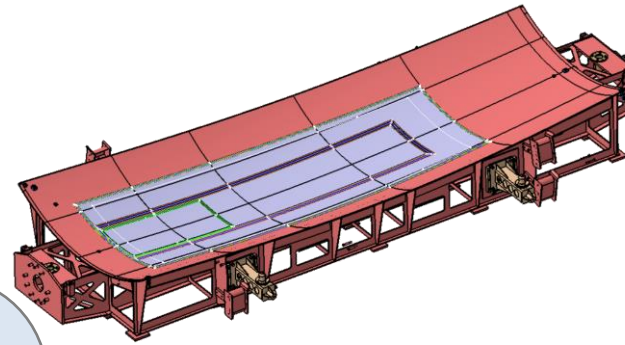
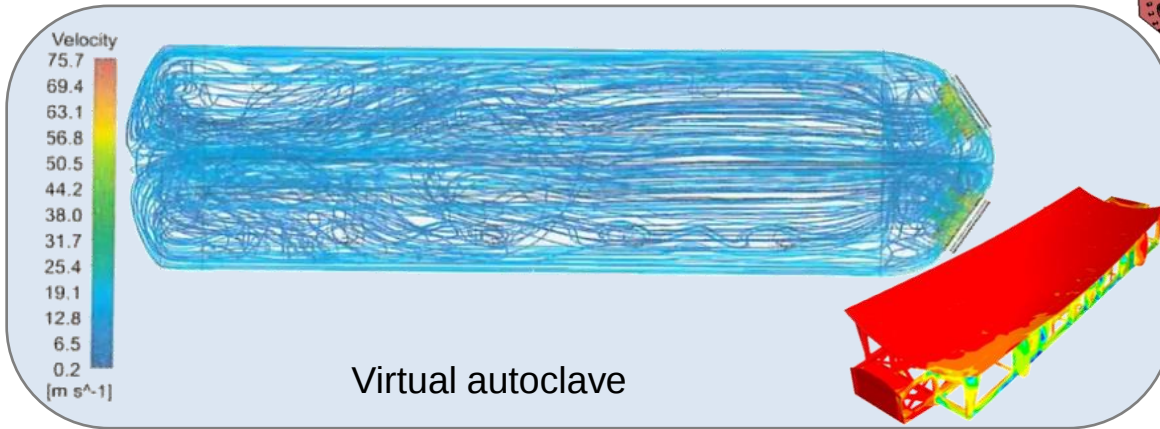
■ Mapping

Digital continuity

Eco-system: Postprocessing

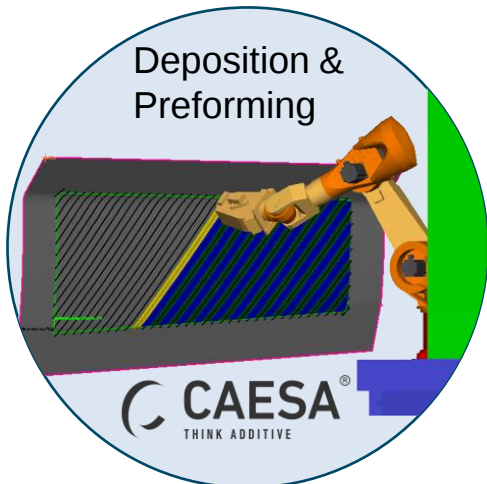
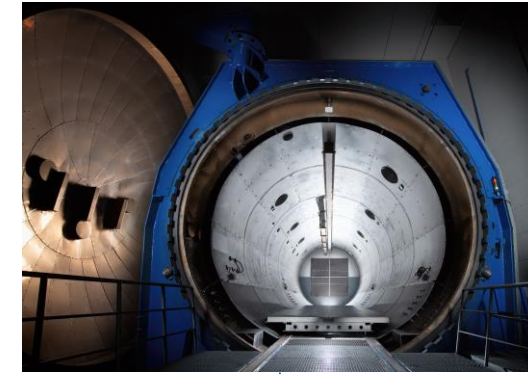


Applications

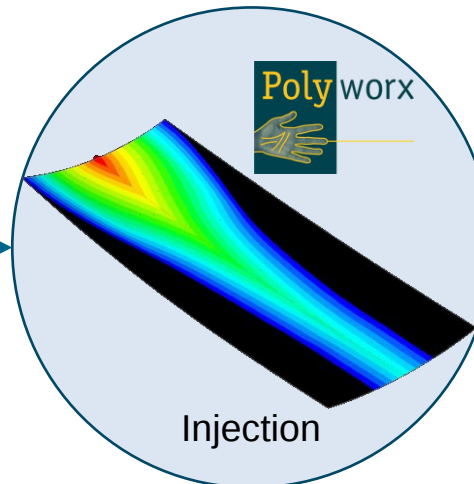


On specimen surface $f(\text{time})$:

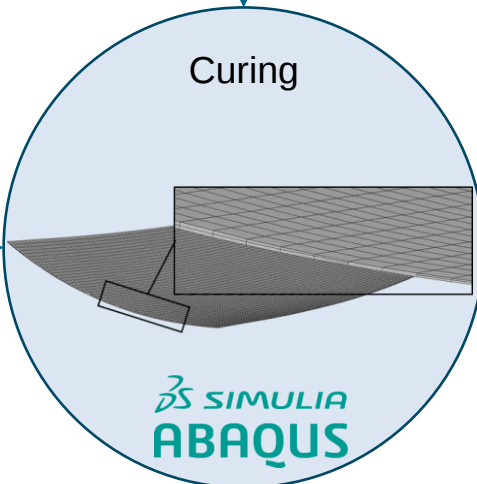
Temperature
Heat transfer



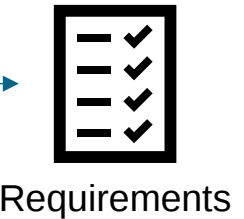
@ final state:
Gaps & overlaps



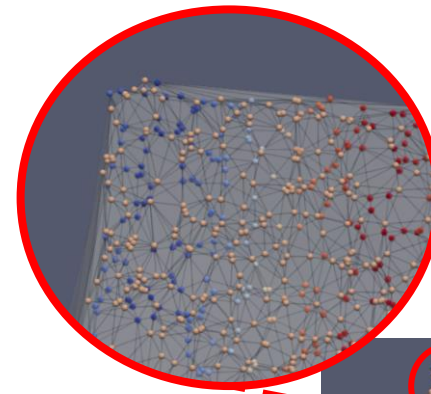
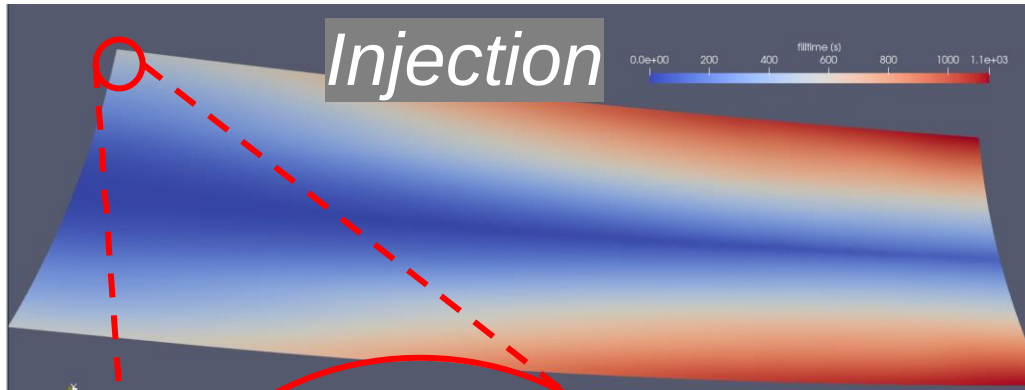
@ final state:
Fibre volume content
Degree of cure



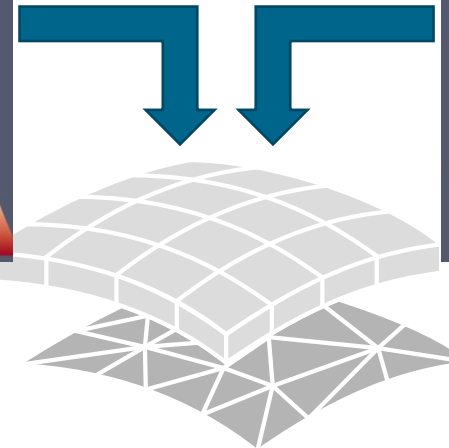
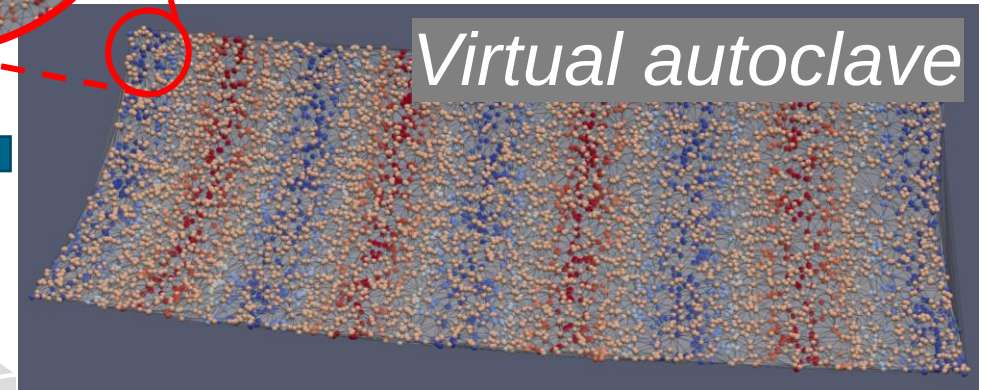
SCHOLZ
Maschinenbau
SPSS



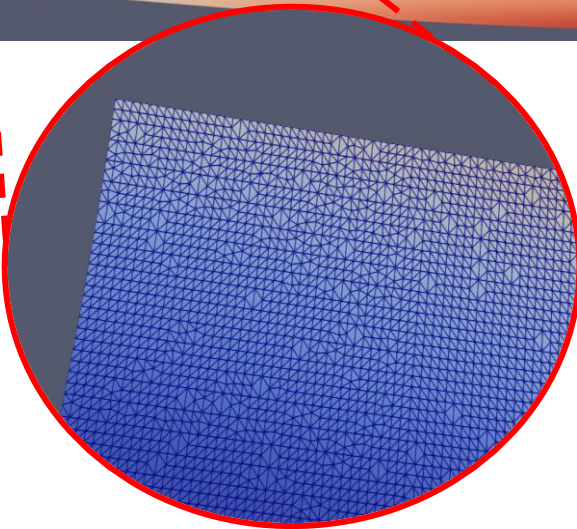
Applications Results



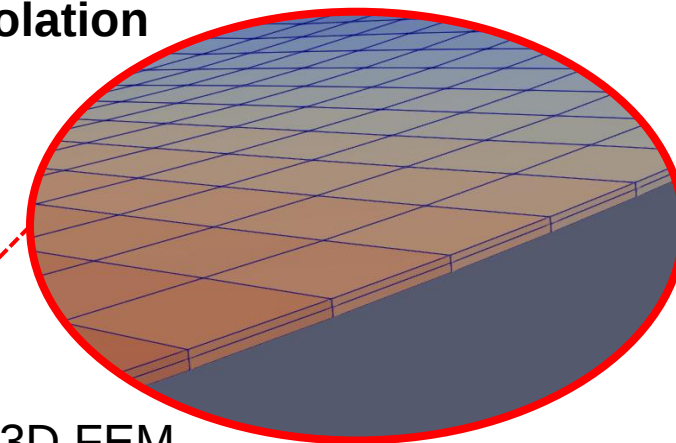
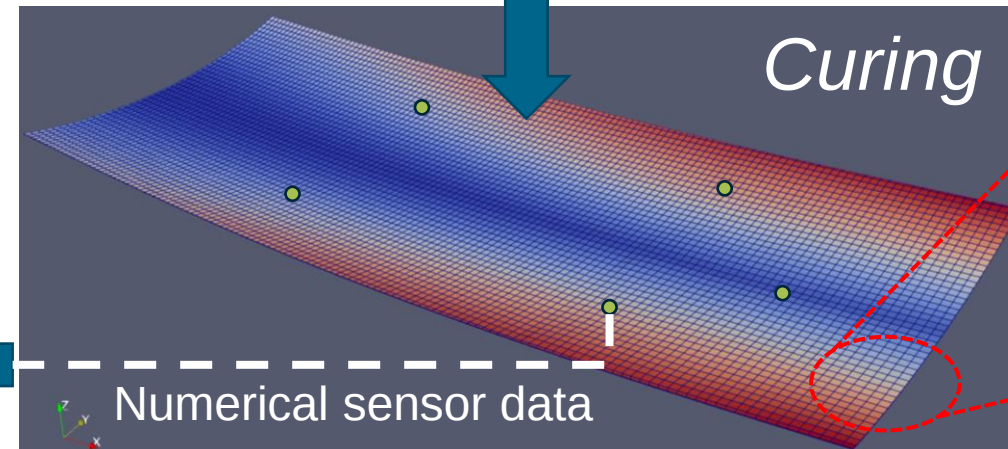
Point cloud data
Triangulation, Tetrahedralization



Mesh Interpolation



2.5D FEM/FVM



3D FEM

With proper through-
thickness mapping



A large white commercial airliner is shown from a low angle, flying upwards against a blue sky with light clouds. The aircraft is overlaid with a complex, semi-transparent blue wireframe mesh representing a computational fluid dynamics (CFD) simulation. Red and yellow streamlines are visible trailing behind the wings and tail, indicating flow patterns. The DLR logo is visible on the tail fin and the side of the fuselage.

THANK YOU FOR YOUR ATTENTION

Contact

Martin Rädel et al.

German Aerospace Center
Institute of Lightweight Systems
Department of Structural Mechanics

Lilienthalplatz 7
38108 Braunschweig

 +49 (0)531 295-2048

 +49 (0)531 295-2232

 martin.raedel@dlr.de

 www.dlr.de/sy



PredictECO

Virtual Product House

Cornelius-Edzard-Straße 15
28199 Bremen



www.dlr.de/vph

Gefördert durch:



Bundesministerium
für Wirtschaft
und Klimaschutz

aufgrund eines Beschlusses
des Deutschen Bundestages



Acknowledgement

Funding



- “PredictECO” - Produktentwicklung unter Berücksichtigung der simulationsgestützten Nachhaltigkeitsbewertung (grant number 01MN23014B) (06/2023 – 05/2026)

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des Deutschen Bundestages

Topic: **Towards Digital Continuity in Virtual Product Development of Composite Aerospace Structures by means of a Domain-Specific Language for Computational Structural Mechanics and its Software Eco-system**
ECCOMAS YIC 2025

Date: 2025-09-17

Author: Martin Rädcl, Andreas Schuster, Felix Schoenitz, Jean Lefèvre

Institute: DLR-SY

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