Advanced modelling in Implicit simulations with **Simcenter Optistruct**

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ADVANCED ENGINEERING TechDay 2026 (online)
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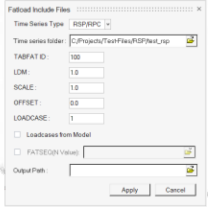
BIW Durability : Simcenter Optistruct Workflow

- ## One Model One Solver

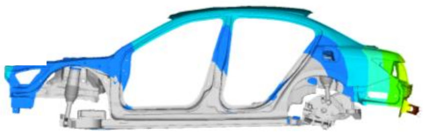
X-loading is from speed bump
Z-loading is from Pothole
Y-loading is due to extra turning
Braking loading with turning will be bending load
Pothole loading is also torsional loading

MBD Load data after corelated with Test, and then applied as FEA load.

MBD to OptiStruct via RSP File

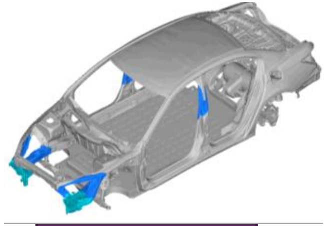


MBD Road Simulation to FE-Load



Linear Vibration
Optistruct

Brake Load, Speed Bump ,Pothole
NL Static
Optistruct



Modal Transient
Optistruct

PSD Fatigue
Optistruct

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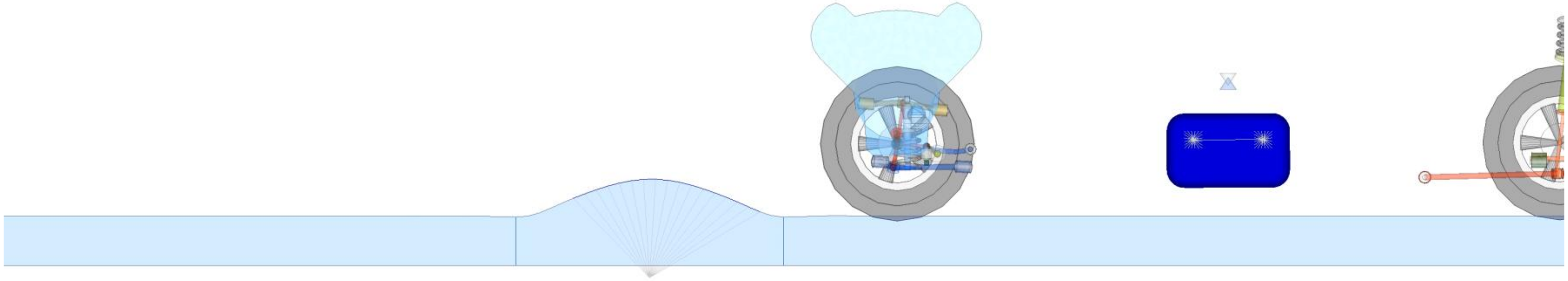
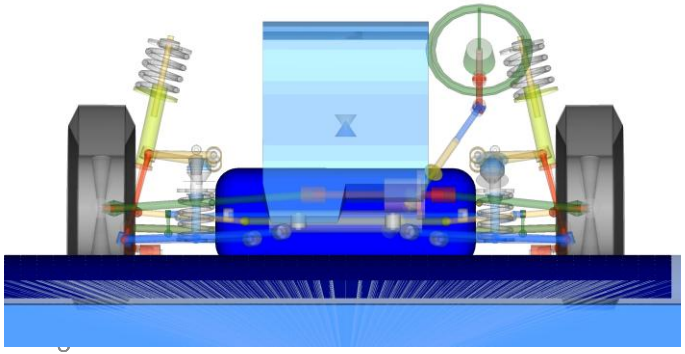
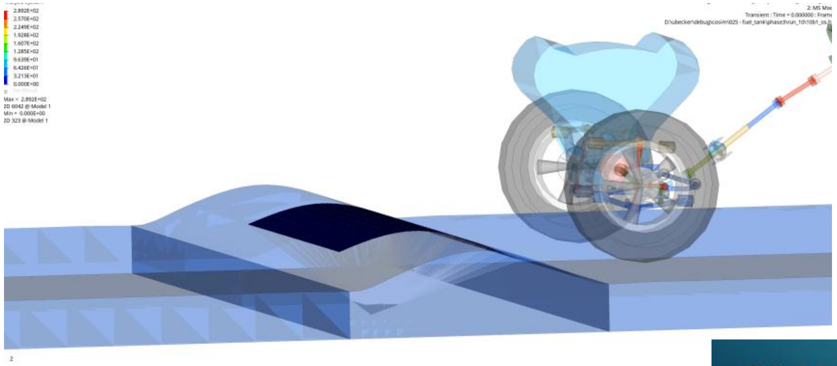
Early Phase Design : Simcenter Optistruct – Motion : Multiphysics

- Ground Impact Analysis (e.g. battery casing)

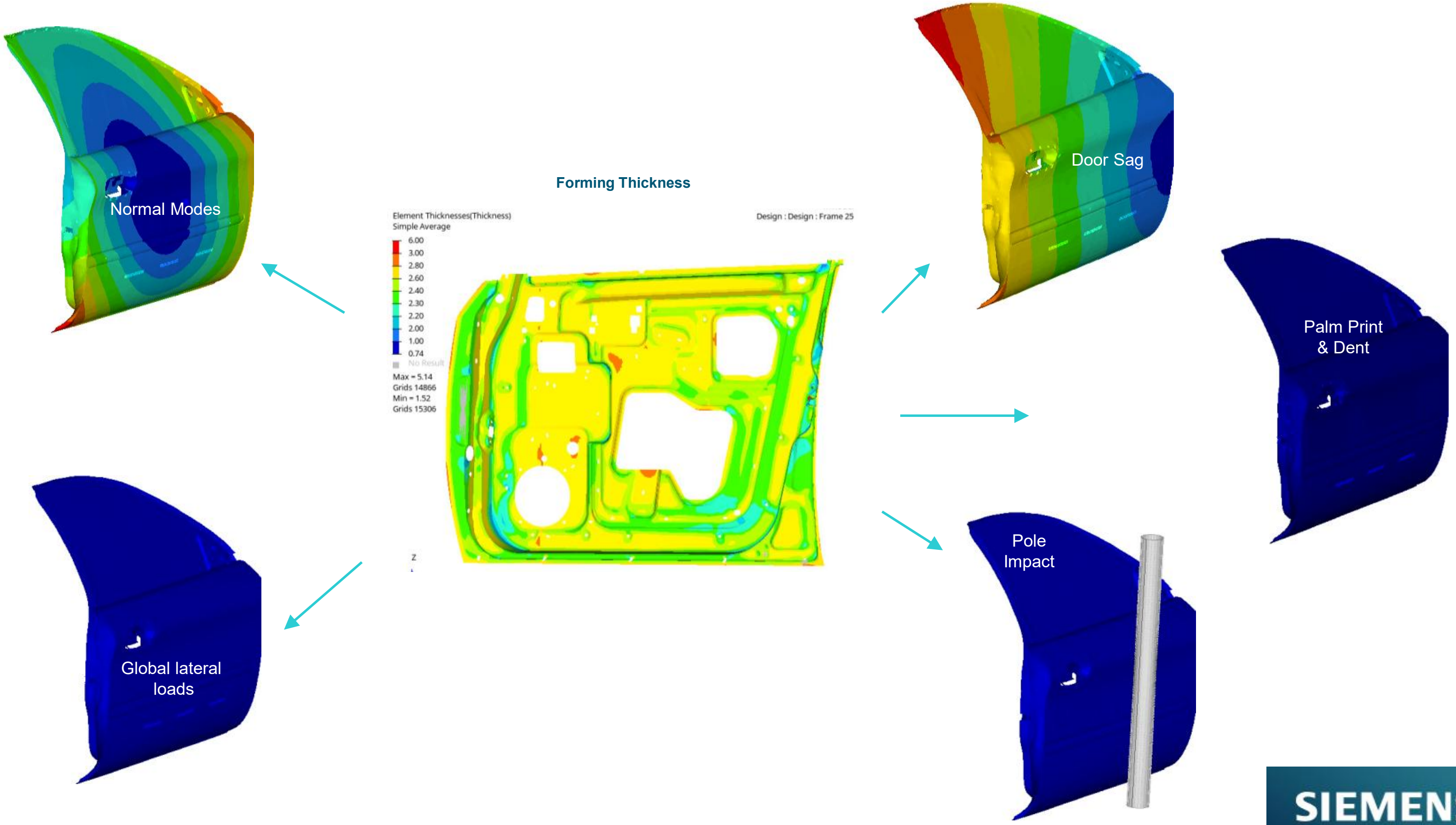






Manufacturing Solutions

Sheet Metal Stamping (state of the art) – Thickness/Stress/Strain Mapping



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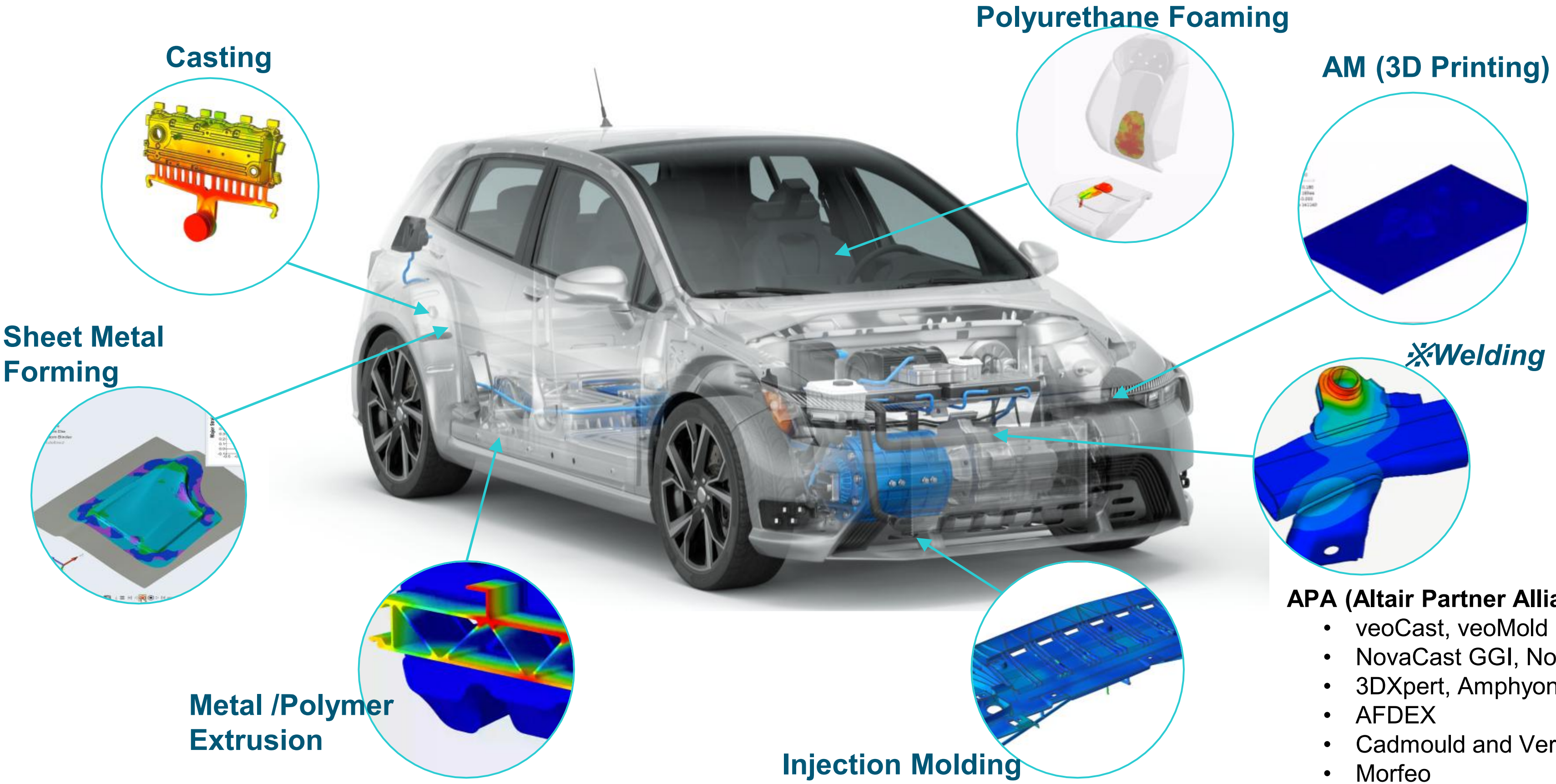
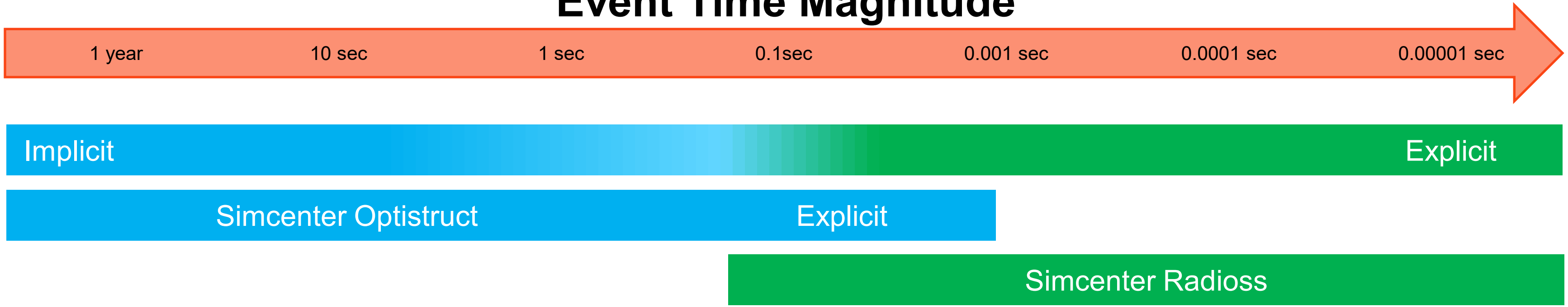
Manufacturing Solutions



APA (Altair Partner Alliance)

- veoCast, veoMold
- NovaCast GGI, NovaFlow
- 3DXpert, Amphyon by Oqton
- AFDEX
- Cadmould and Verimos
- Morfeo

Event Time Magnitude



Creep	**Static / Dynamics**	**Quasi static**	**Drop / Impact/Durability/ Structural Integrity**	**Crash**	**FSI/ALE/CEL/SPH**	**Detonations & Blast / Ballistics**	**Hypervelocity Impact**

Simcenter Optistruct **Simcenter Radioss**

EXAMPLES

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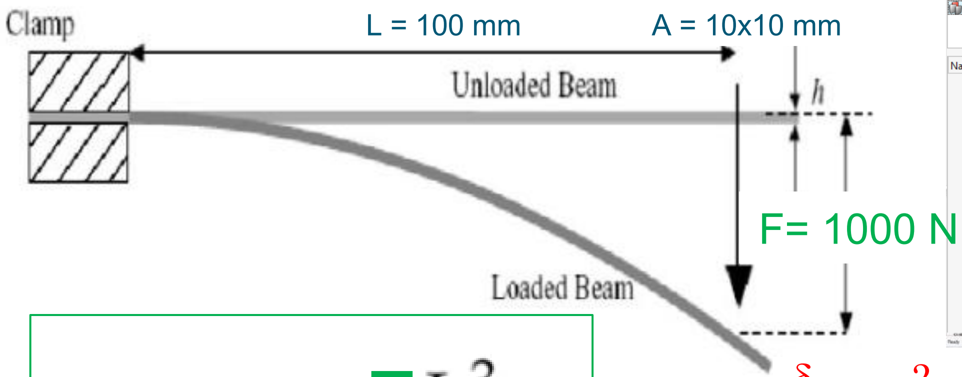
Little bit of Theory…Validation #1

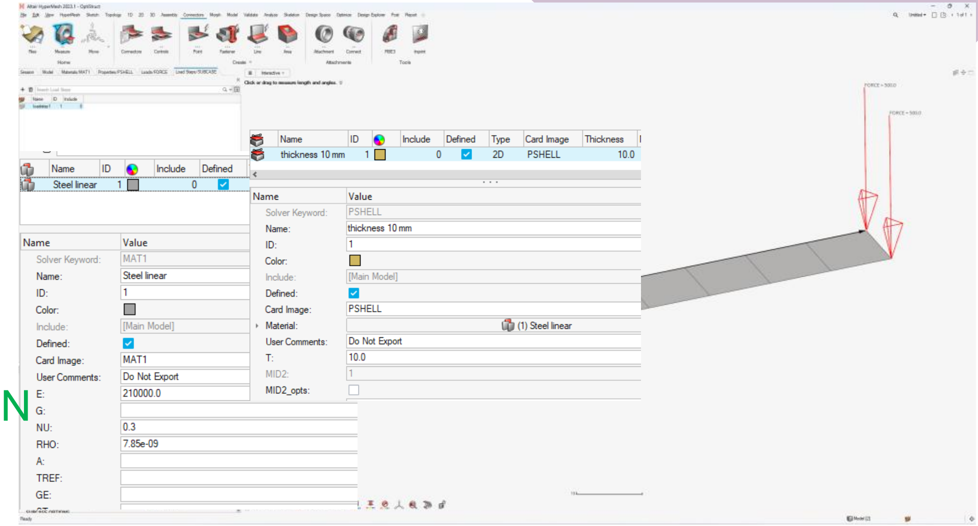


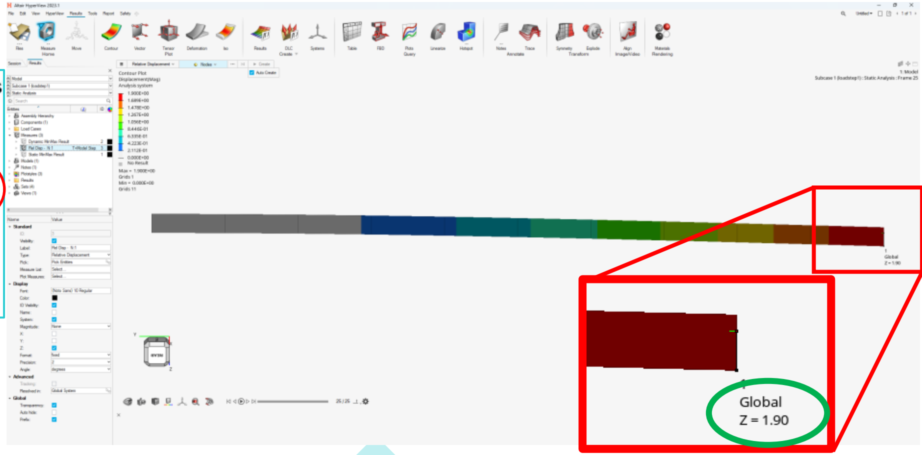
$$\delta_{max} = \frac{FL^3}{3EI}$$

Sectional areas moment calculated thus

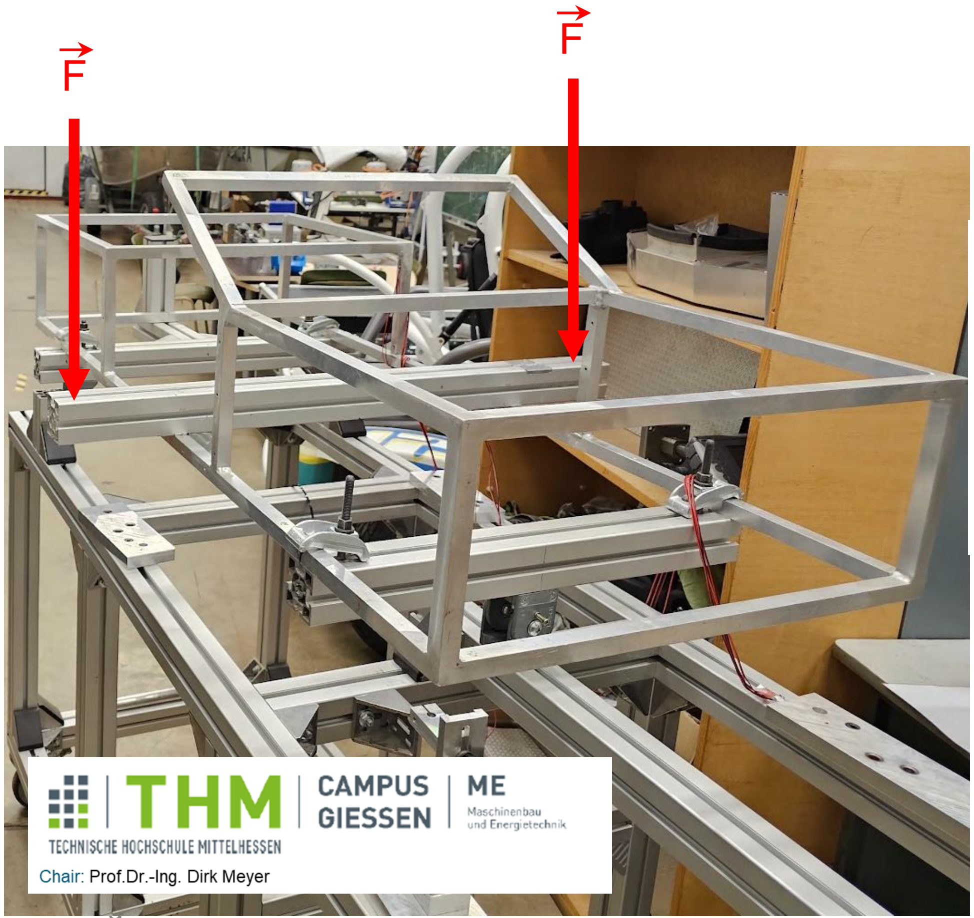
1. Square: $I_{xx} = I_{yy} = \frac{b^4}{12}$
2. Rectangular: $I_{xx} = \frac{bh^3}{12}$ and; $I_{yy} = \frac{hb^3}{12}$
3. Triangular: $I_{xx} = \frac{bh^3}{36}$
4. Circular: $I_{xx} = I_{yy} = \frac{1}{4}\pi r^4 = \frac{1}{64}\pi d^4$

	A	B	C	D	E
1					
2		F	1000	N	
3		L	100	mm	
4		E	210000	N/mm^2	
5		A (10x10mm)	100	mm^2	
6					
7		I	833,333333	mm4	
8					
9		delta =	1,90	mm	
10					
11					



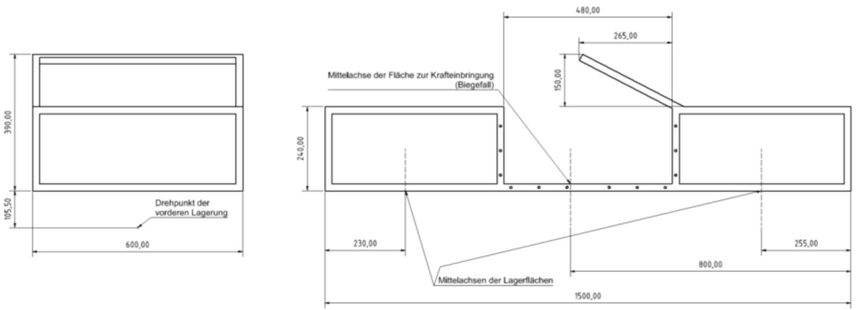


Little bit of Theory…Validation #2



Chair: Prof.Dr.-Ing. Dirk Meyer

Automotive frame - **Steel** [Source: My Photo, 22.02.2024]



Source: Projectwork by Maximilian Tropp und Leon Schnörch. 26.03.2024]

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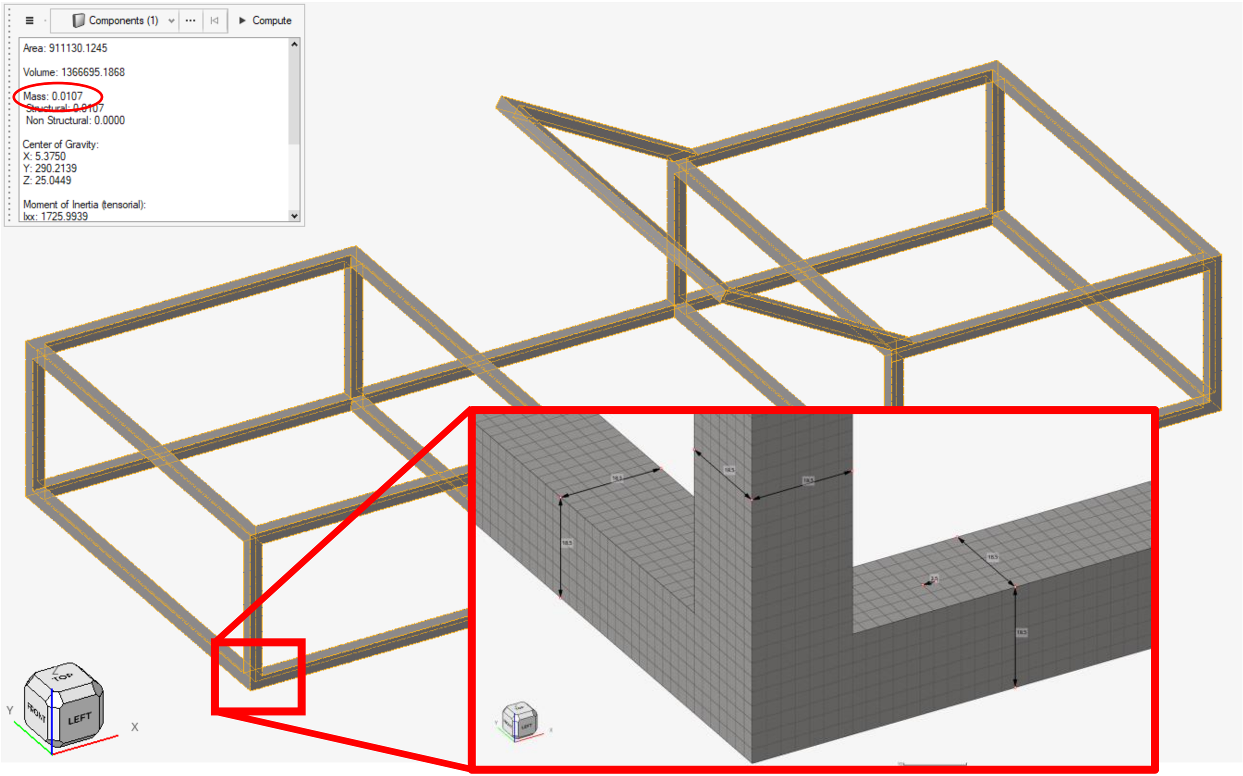
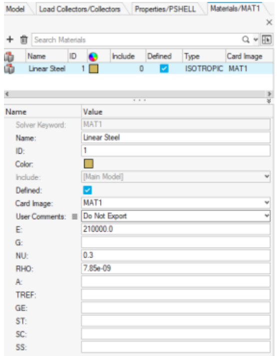
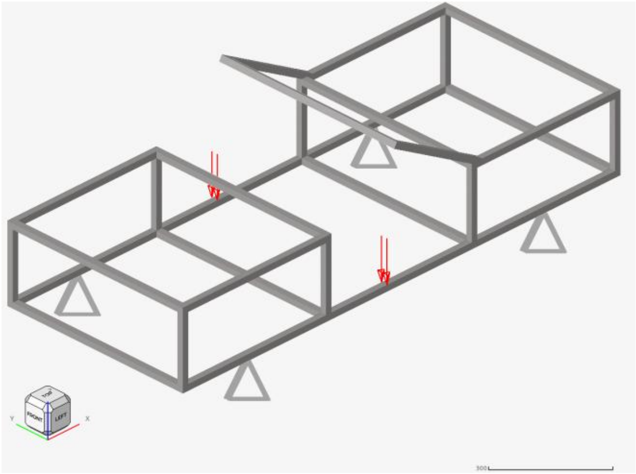
Little bit of Theory…Validation #2







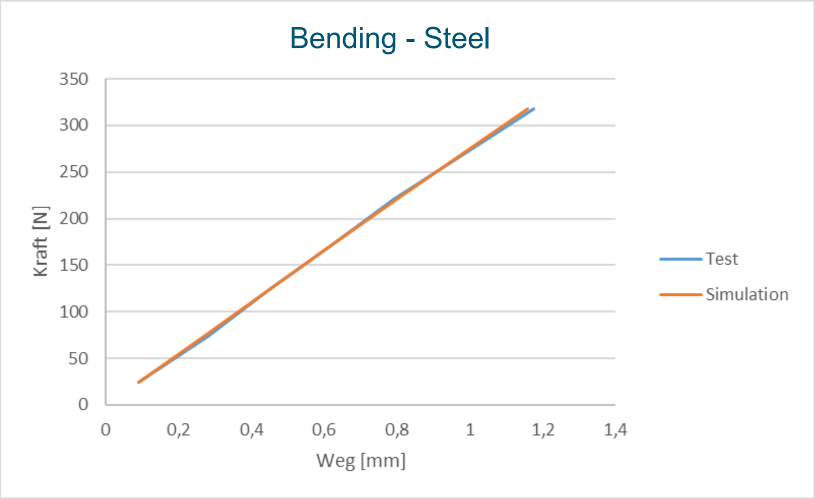
OptiStruct FEM model:Steel [HyperMesh 2023.1]: Material and mass

➔ **Overall mass:** (20x20x1.5 mm) **Steel** Profiles : **m = 10,7 [kg]**.

Little bit of Theory…Validation #2

Additional mass [kg]	Overall mass [kg]	Force [N]	Measured deflection (mean) [mm]	Result Simulation [mm]	Difference [%]
0	2,4567	24,10	0,09	0,09	0,0
5	7,4567	73,15	0,28	0,27	3,6
10	12,4567	122,20	0,445	0,445	0,0
15	17,4567	171,25	0,62	0,62	0,0
20	22,4567	220,30	0,79	0,80	1,3
25	27,4567	269,35	0,985	0,981	0,4
30	32,4567	318,40	1,175	1,159	1,4

➔ ~0,6%



➔ **Perfect match for the loadcase Bending: Test vs. Simulation. (Simcenter Optistruct)**

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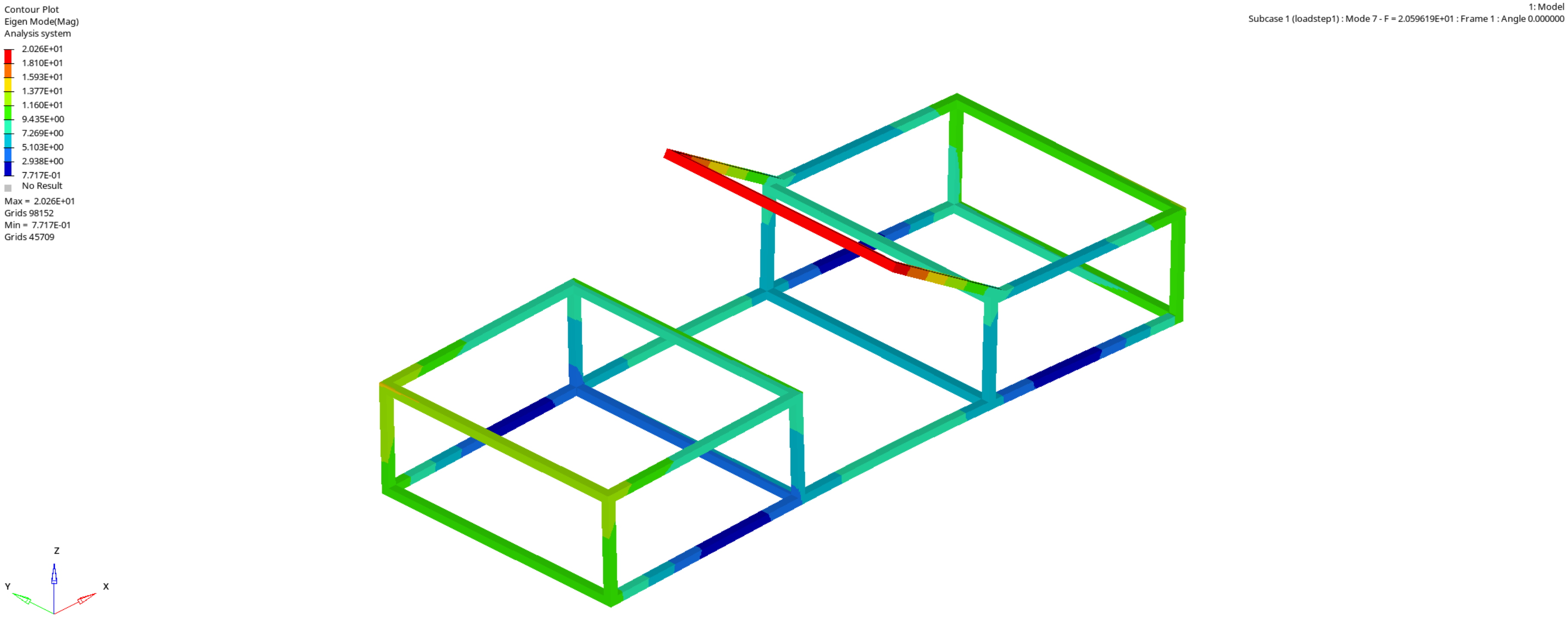
Analyse: Steelframe - Eigen-Modes

1. Eigen-Mode at **20,6 Hz** → Bending



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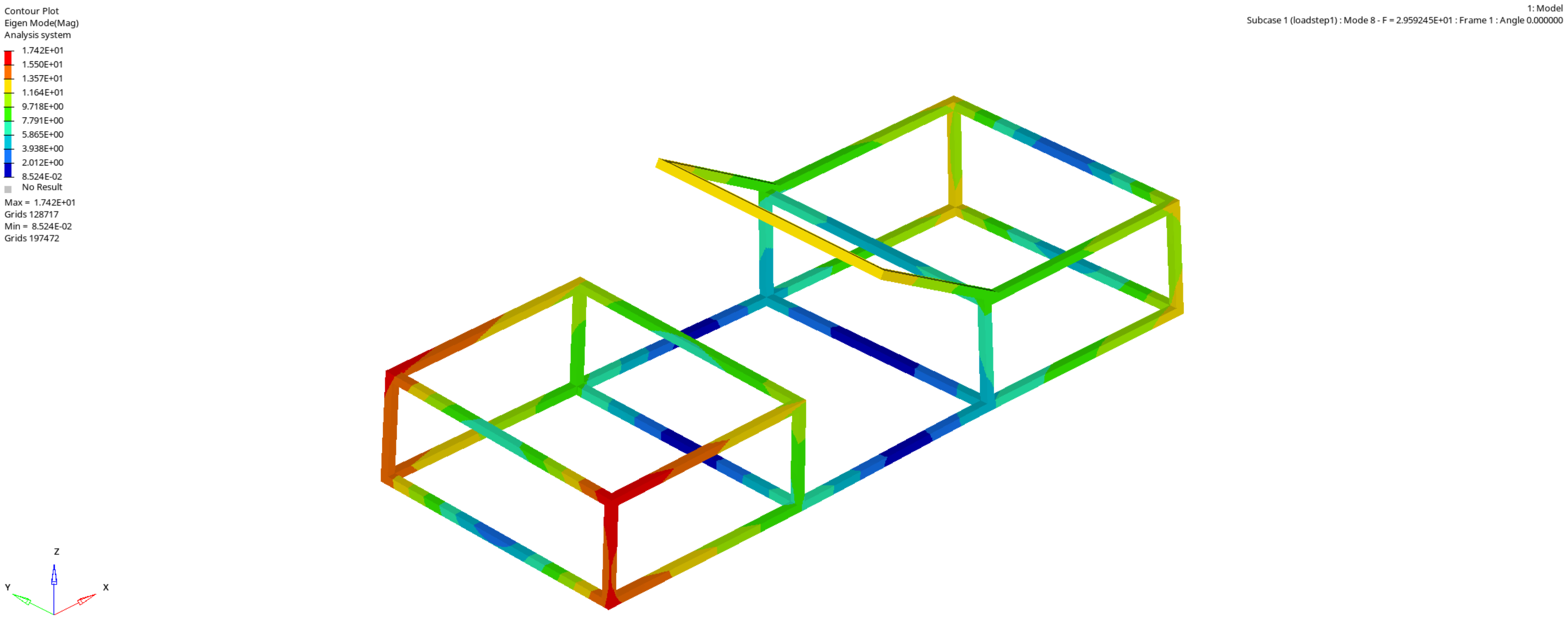
Analyse: Steelframe - Eigen-Modes

2. Eigen-Mode at **29,6 Hz** → Torsion



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Substitution of material: Steel ➔ Aluminium

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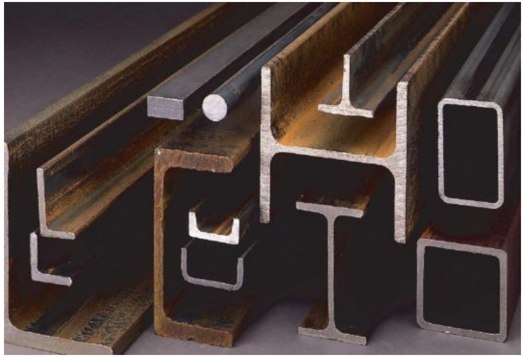
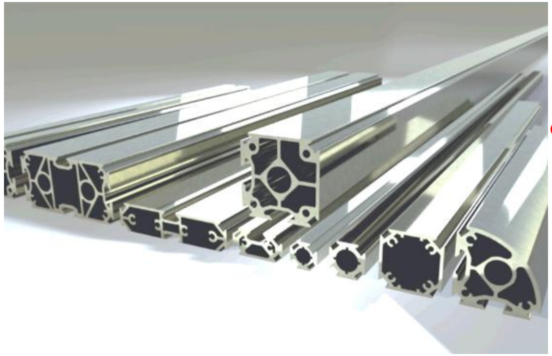
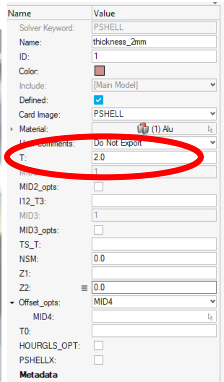
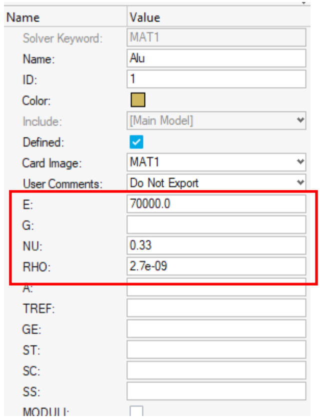
Chair: Prof.Dr.-Ing. Dirk Meyer

Substitution: Steel ➔ Aluminum





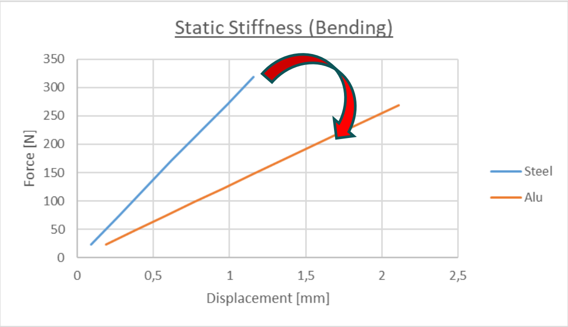


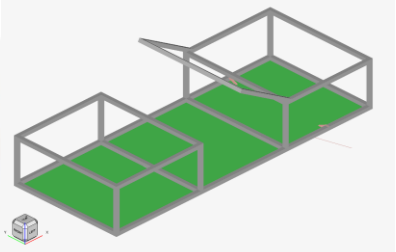


Weight: Steel ➔ Aluminum

10.7 kg ➔ 4.9 kg

Stiffness:





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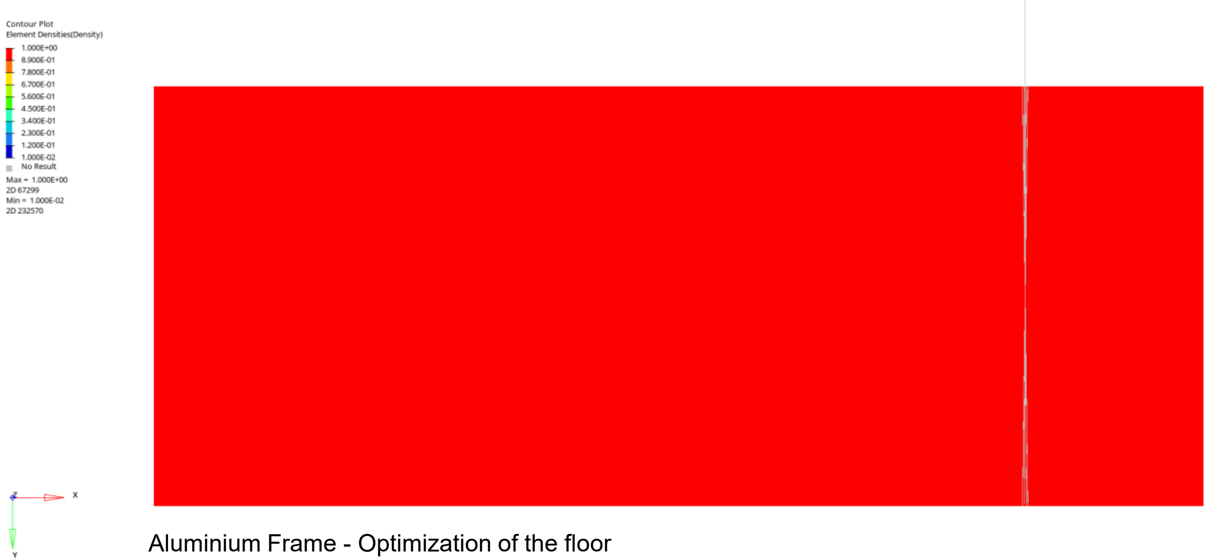
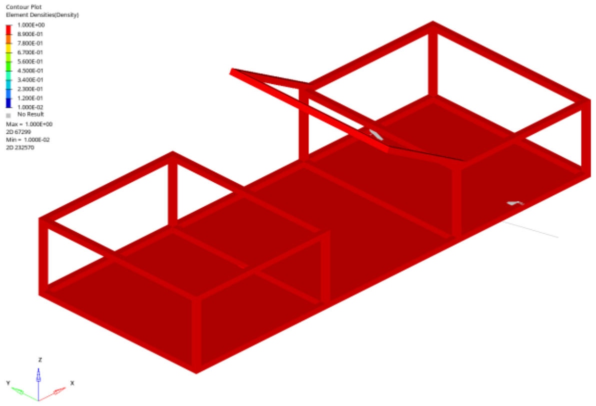
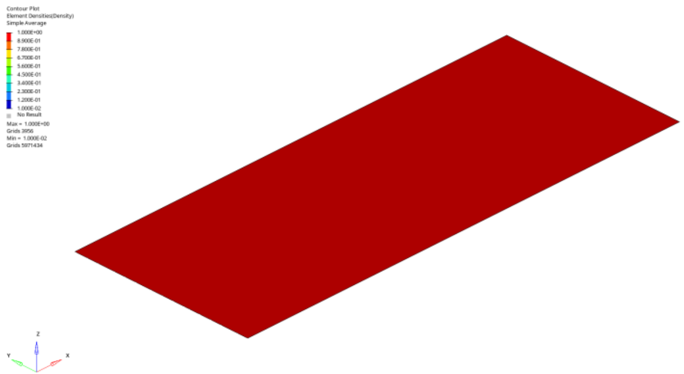
Optimization: Aluminium Floor - Load-case: Torsion



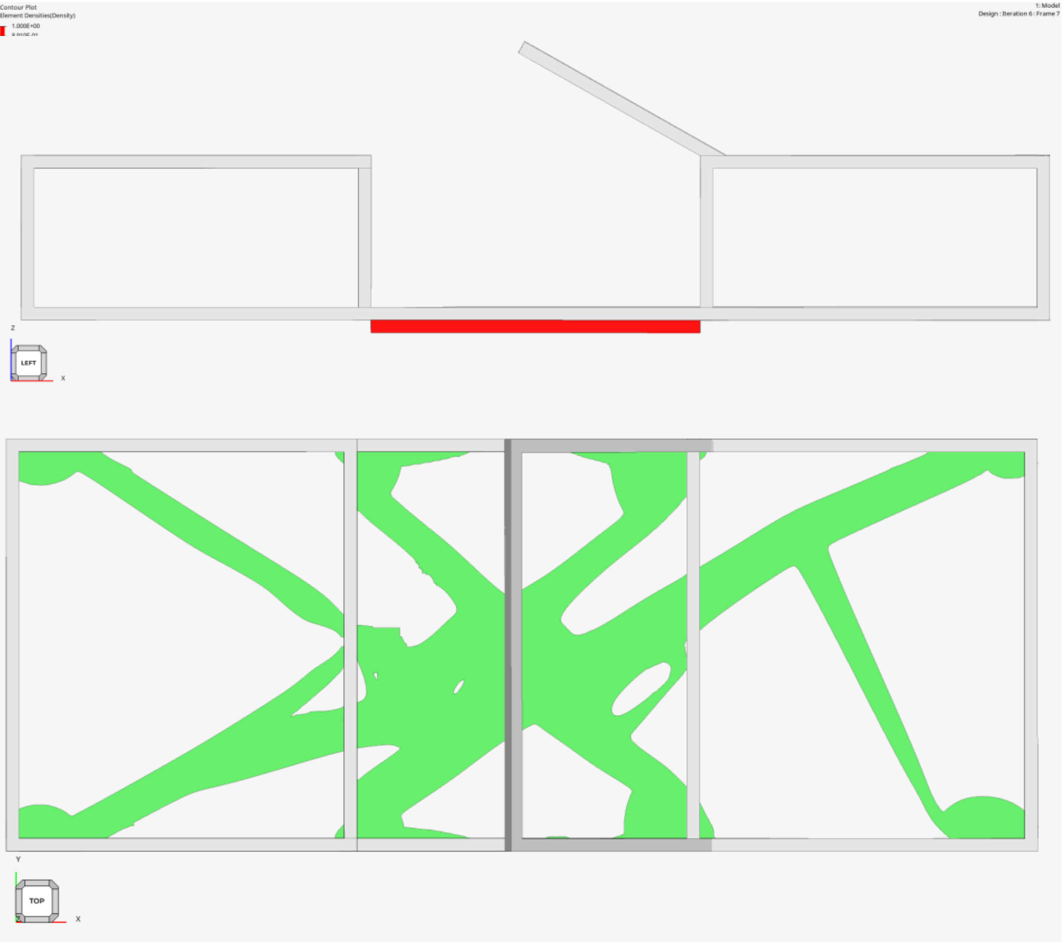
Aluminium Frame - Optimization of the floor

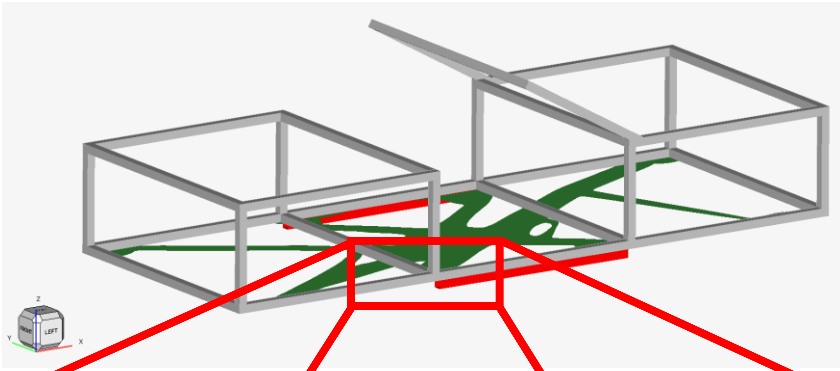


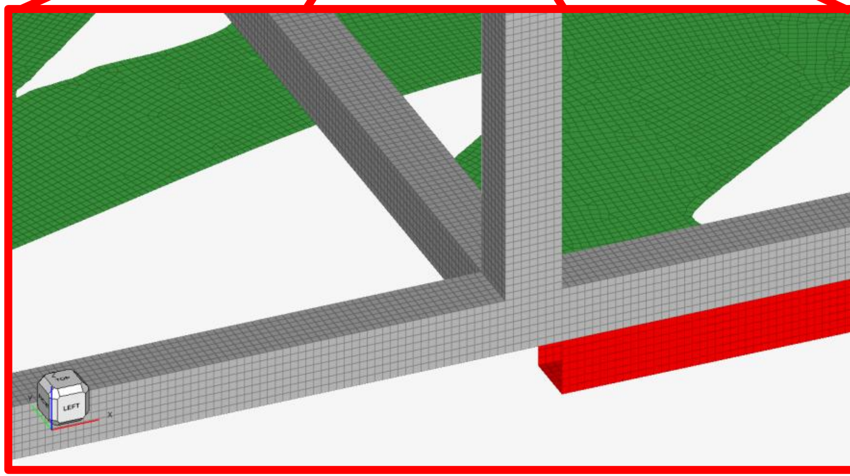


➔ TopologieOptimization.

Optimization: Aluminium Floor - Loadcase: Bending



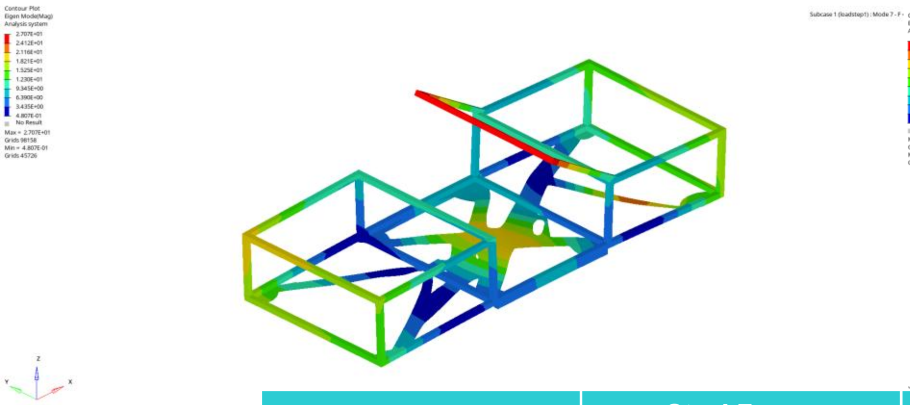


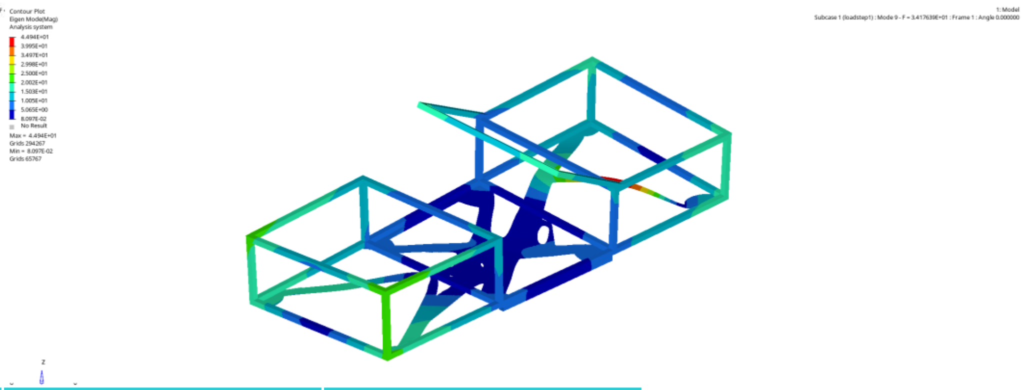


Results: Optimized Aluminium Frame - Eigen-Modes

1. Eigen-Mode bei 29,3 Hz → Bending

3. Eigen-Mode at 34,2 Hz → Torsion





Eigenmodes	Steel Frame [Hz]	Aluminium Frame [Hz]	Optimized Aluminium Frame [Hz]
1	20,6	20,3	29,3
2	29,6	29,0	33,3
3	48,1	47,3	34,2
4	59,5	58,5	41,2

Tabelle 7: Results - Eigenmodes (Source: Simulationen in May 2024 with OptiStruct 2023.1)

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Analyse: Optimierter Aluminium Rahmen - Torsion

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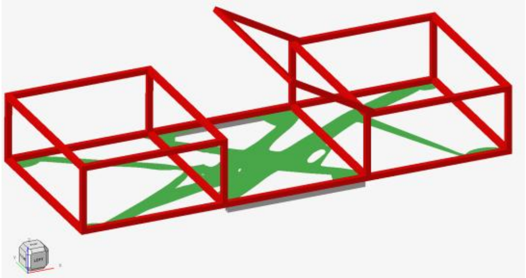

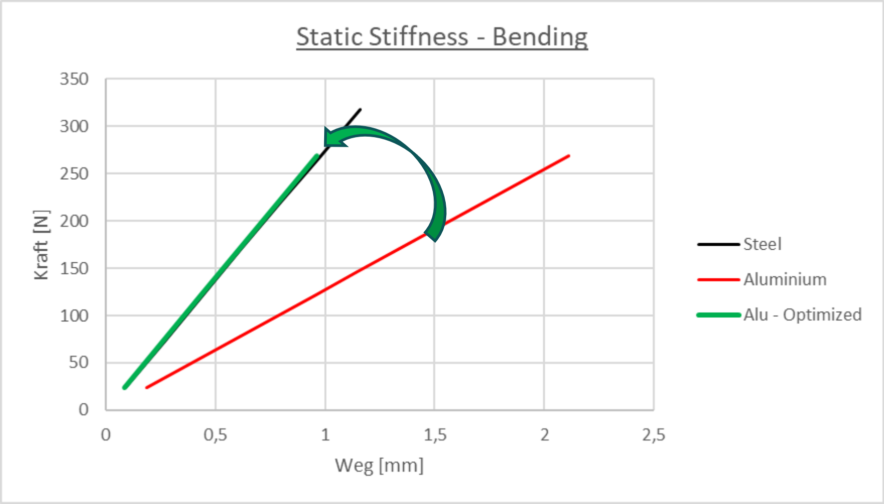

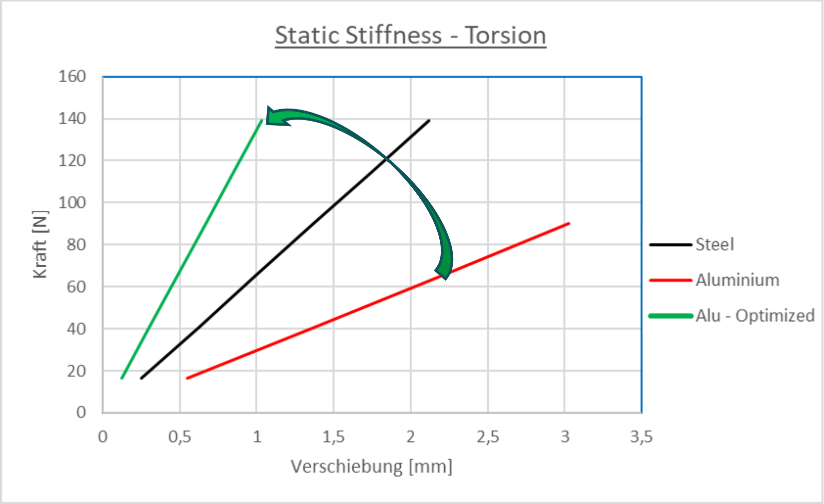

➔ **Increased the stiffness (static and dynamic) in optimized Aluminium structure**

➔ **Totoal mass = 6,98 [kg] ➔ Mass Reduktion of 35% vs. Steel frame !**

(Initial steel m = 10,7 [kg])

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NEW FEATURE – MESH REFINEMENT

Auto-Mesh Refinement in Topology Optimization

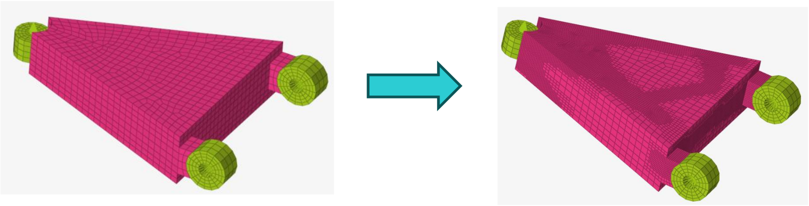
Motivation and Capabilities

Why?

- To get more detailed results
- To reduce solution time

How?

- Use coarse meshes but internally and automatically refine them iteratively based on topology optimization results



Initial Mesh *Automatically Refined Mesh*

Auto-Mesh Refinements Capabilities

- User can select which topology regions to refine
- User can optionally select conditions to trigger refinements (higher density levels)
- User can select number of refinements (e.g. 1, 2, etc.)
- Available for CHEXA and CTETRA elements
- Optional configuration files to customize model parameters for challenging problems (e.g. bounds of constraints can be set to different values for different refinements levels)

ALTAIR

Added parameters to control the process

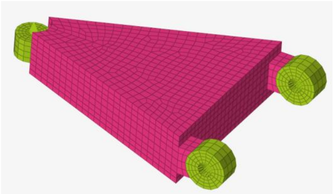
New continuation line in DTPL: REFMESH

Format

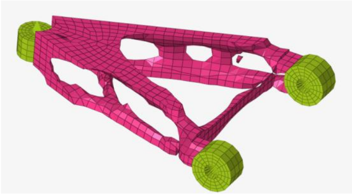
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
DTPL	ID	PTYPE	PID1	PID2	…				
+	**REFMESH**	**REFTYPE**	**LB**	**UB**					

Field	Name	Value	Description
2	REFMESH	REFMESH	Indicates that refined mesh parameter will follow
3	REFTYPE	1	Refined mesh will contain refined and original element and will use same PID. Default
		2	Refined mesh will contain refined and original element and will use different PID referencing a soft material
		3	Refined mesh will contain only refined elements
4	LB	Real or Blank	Splitable elements which densities are equal or larger than LB will be split & lower or equal than UB will be split. LB Default = 0.3
5	UB	Real or Blank	Splitable elements which densities are equal or larger than LB will be split & lower or equal than UB will be split. UB Default = 1.0

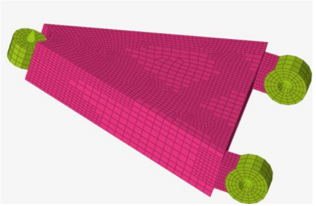
Auto-Mesh Refinement Example



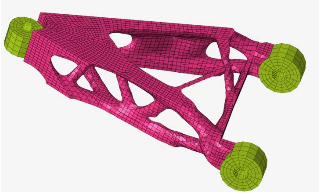
Element size 12 mm



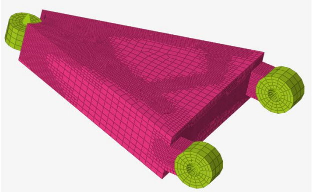
Topology 0



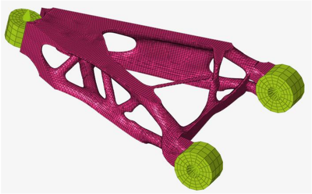
Element size 6-12 mm



Topology Refinement 1

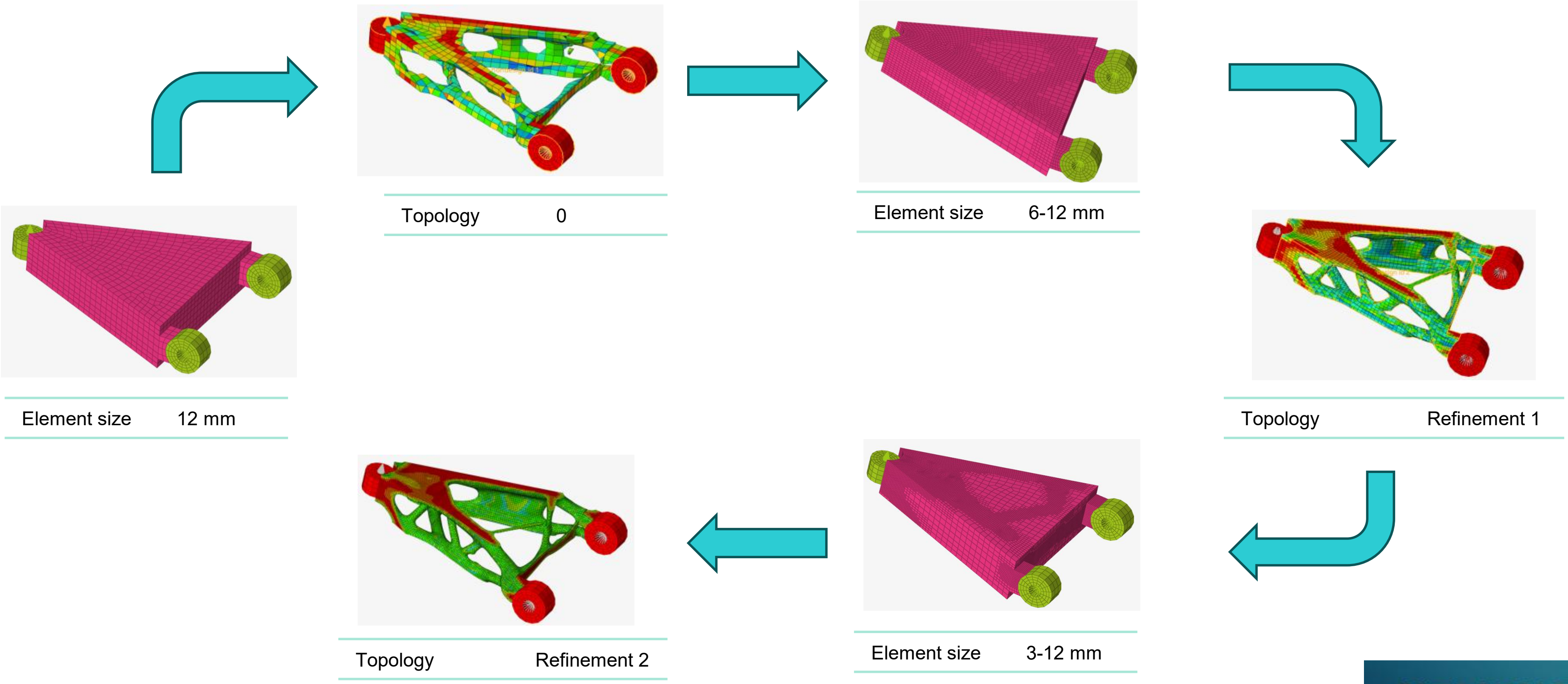


Element size 3-12 mm



Topology Refinement 2

Auto-Mesh Refinement Example



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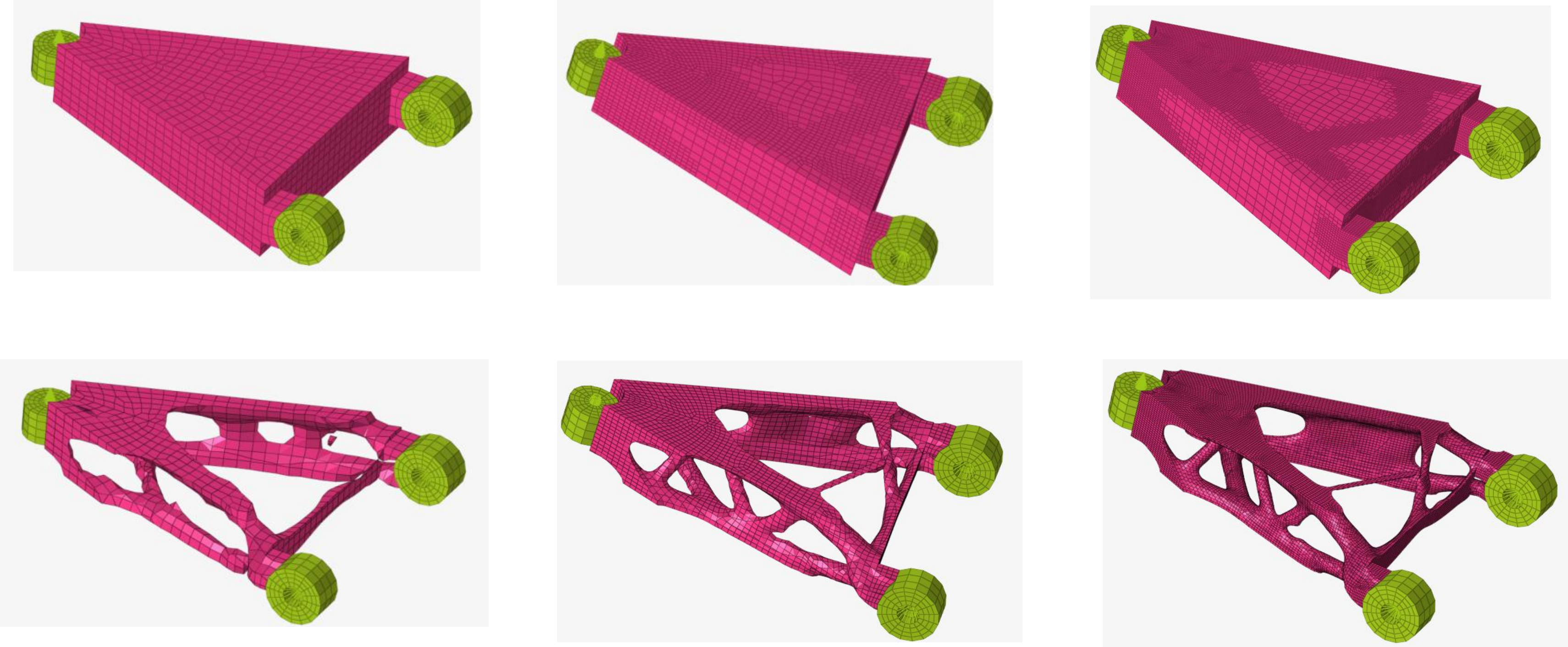
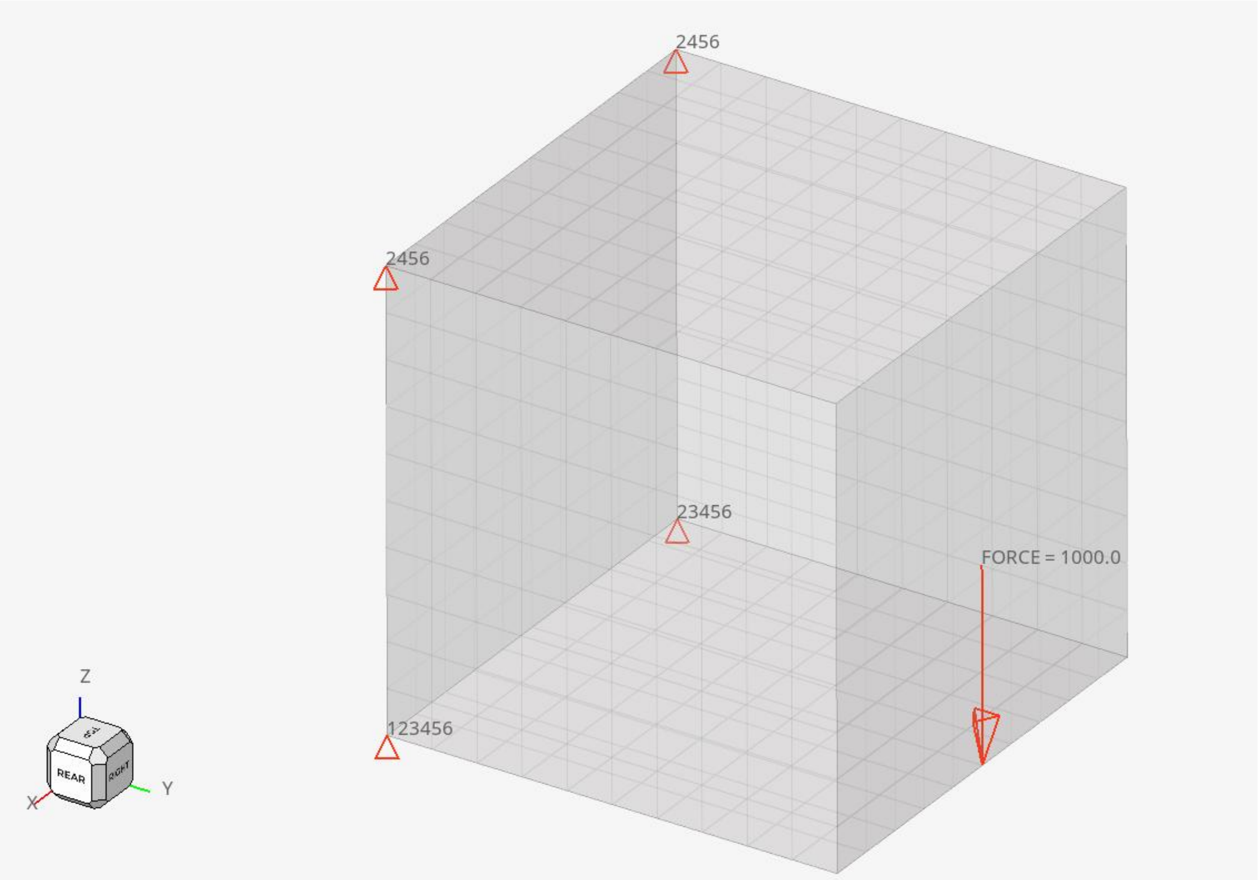
Auto-Mesh Refinement Example



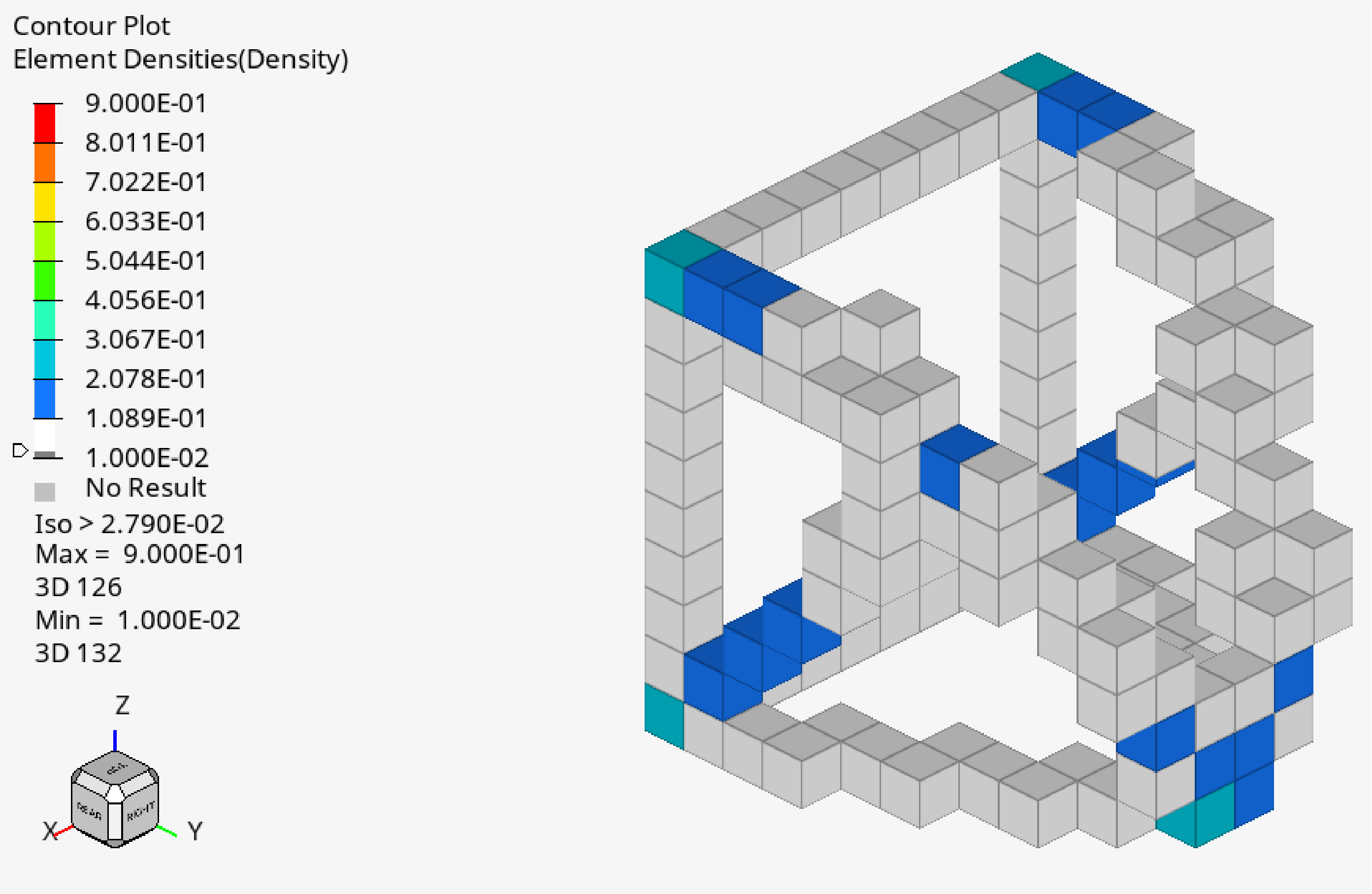
Topology	0	Topology	Refinement 1	Topology	Refinement 2

Topology optimization – Simple 3D Cube



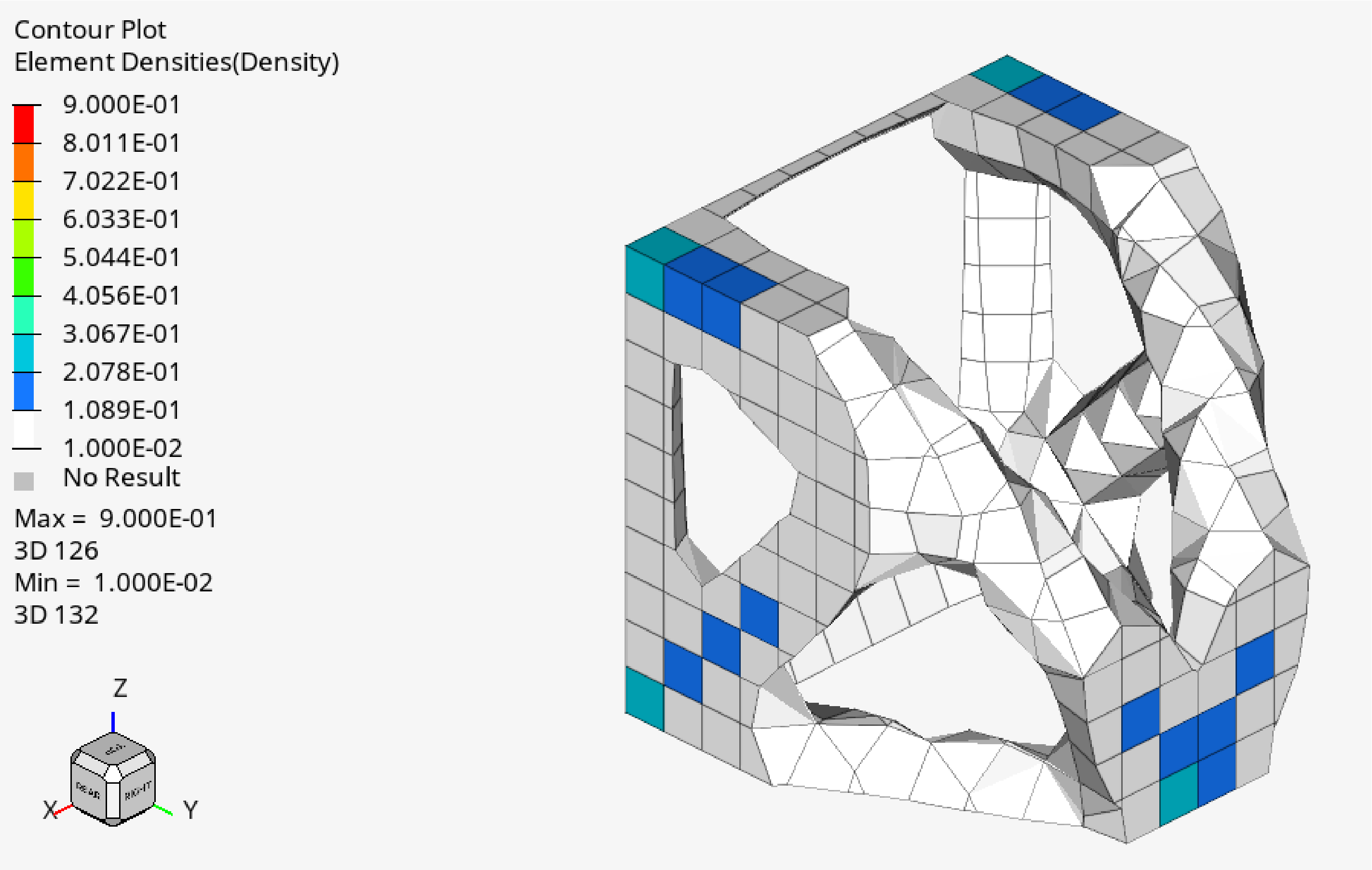
Objective is to reduce the mass !

Topology optimization



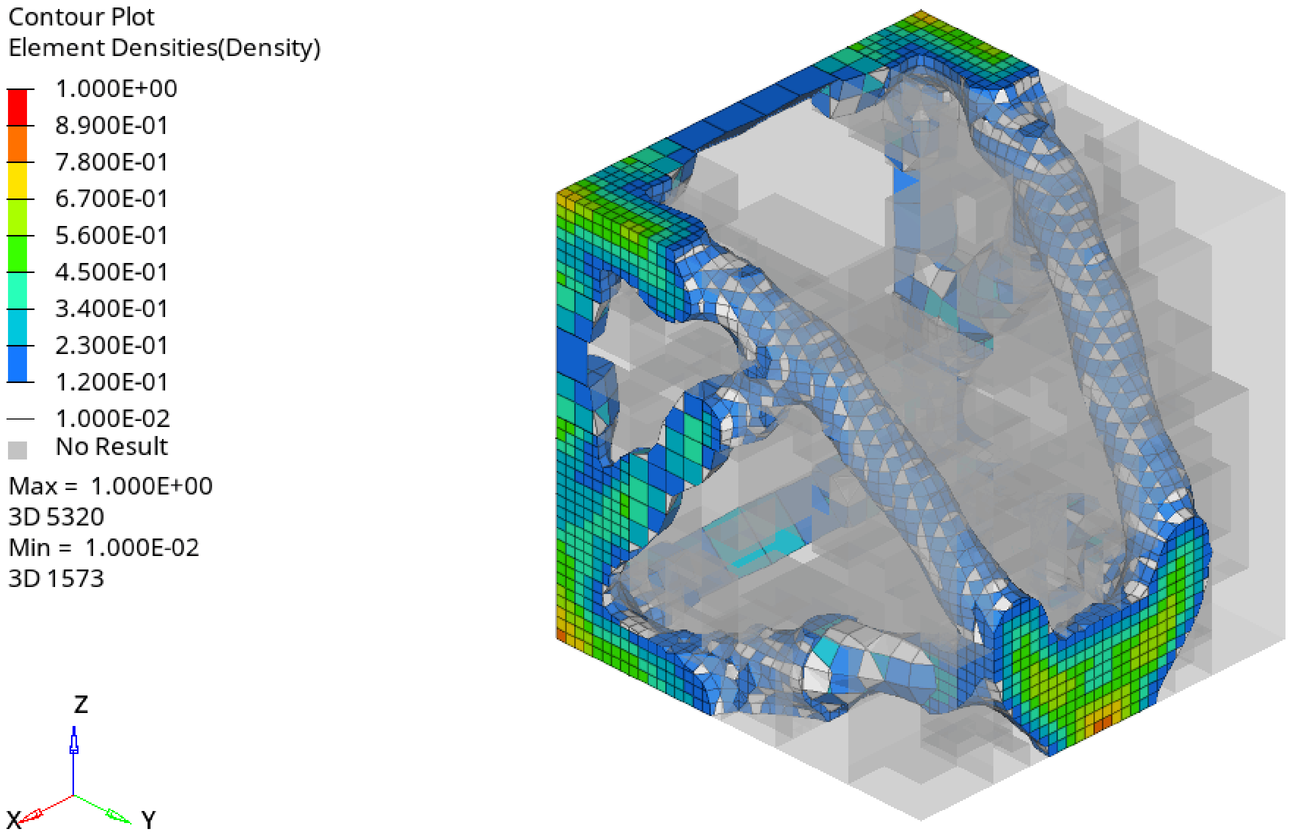
Results with coarse mesh!

Topology optimization



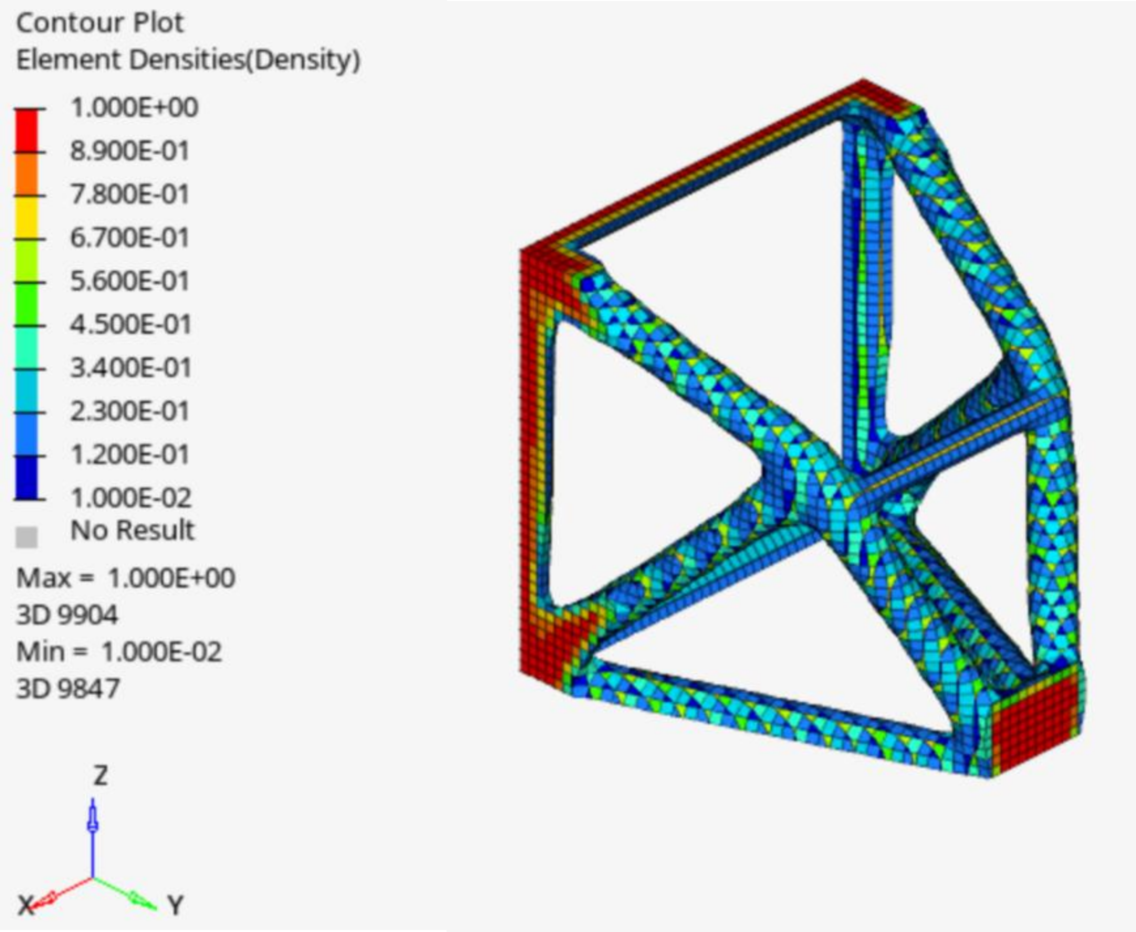
Smoothed results with coarse mesh!

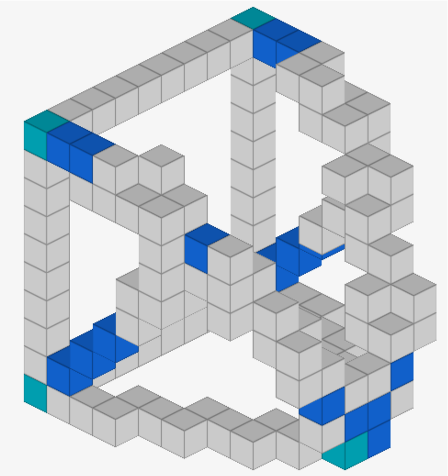
Topology optimization

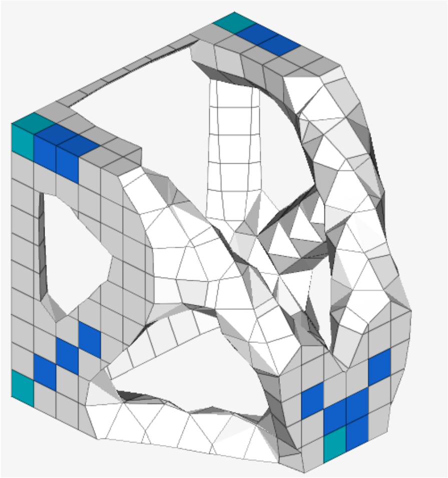


Mesh refinement with coarse mesh!

Topology optimization







Result of mesh refined model, starting with the coarse mesh!

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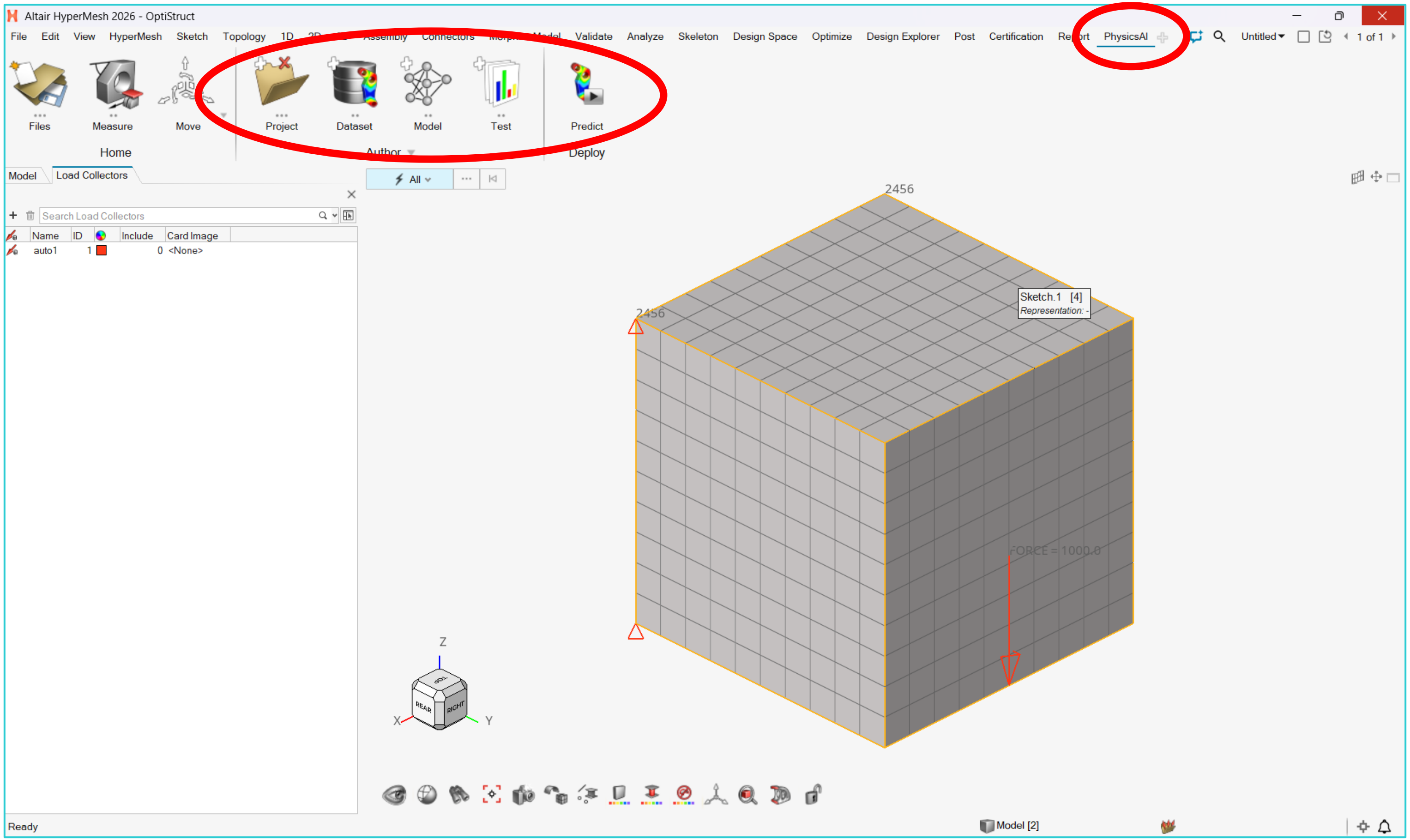
NEW FEATURE – OPTISTRUCT+AI

Topology optimization



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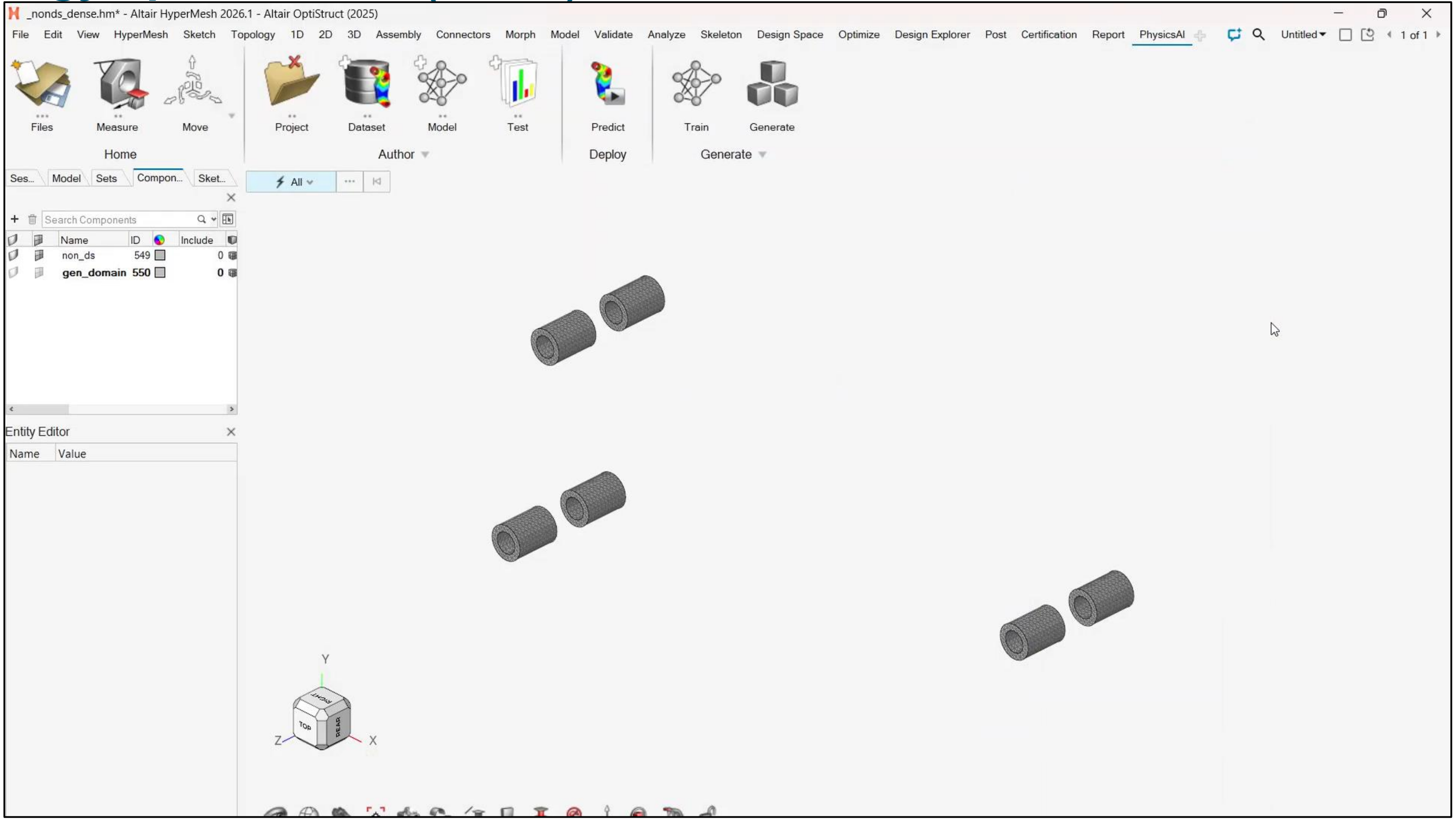
Topology optimization (Video)



Usage in real-time

Conclusion

Today's presentation has shown advanced the power of simulation and validation compared to reality with **Simcenter Optistruct**

These capabilities are helping engineers to dramatically reduce the development time and costs by using CAE

With latest developments of Simcenter Optistruct, the engineers are getting results of much higher quality, which enables them to increase the results fidelity.

AI/ML (PhysicsAI) helps the engineers to drastically reduce the development time !

Thank You

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Open for discussion

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