Model Sizes in Implicit and Explicit Calculations

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Tecosim GmbH, Germany

TECOSIM

best partner for simulation

Element Sizes in implicit and explicit calculation

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Agenda

- Tecosim-best partner for simulation
- Introduction
- Different Mesh sizes in complex structures
- Analysis of Results/ Conclusion
- Outlook

The Company

- Company founded in 1992
- Strategic CAE Partner of Major OEM‘s and Suppliers
- Core Competence in CAE
- Turnover € 8,5 Mio in 2005
- Currently more than 150 Employees at 5 European Locations (nearly all with university engineering degree, 10 PhD’s)
- State-of-the-Art IT Infrastructure
- Co-operation with Leading Engineering and Service Supplier
- Comprehensive liability insurance
- Quality Management System according to ISO 9001, UM 14001 and Customer Specific Requirements (FORD Q1 Award)

Locations & References

Rüsselsheim

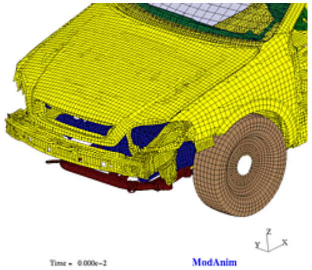
Köln

Leonberg Basildon (UK) Coventry (UK)

- **Audi AG**
- **Adam OPEL AG**
- **Daimler Chrysler**
- **Daihatsu**
- **Fiat**
- **FORD**
- **General Motors**
- **HONDA**
- **Hyundai**
- **ISUZU**
- **KIA**
- **John Deere**
- **Jaguar**
- **Landrover**
- **Nissan**
- **PORSCHE AG**
- **Toyota**

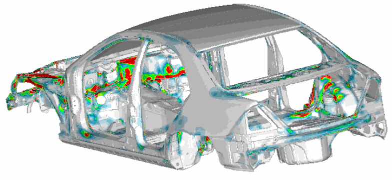
- **AMG**
- **Autoliv**
- **Bayer AG**
- **Bentler**
- **Bertone**
- **Bosch / Blaupunkt**
- **Degussa-Hüls AG**
- **Dynamit Nobel**
- **EADS**
- **Faurecia**
- **Getrag**
- **Hella KG**
- **Johnson Controls**
- **Karmann**
- **Lear**
- **Magna**
- **Thyssenkrupp**
- **TRW Automotive**
- **Mahle**
- **MAN**
- **Mannesmann / Sachs**
- **Siemens VDO**
- **Wagon Automotive**

CAE Portfolio

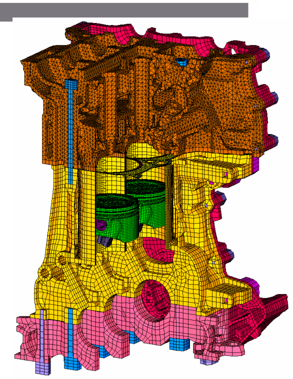


CRASH

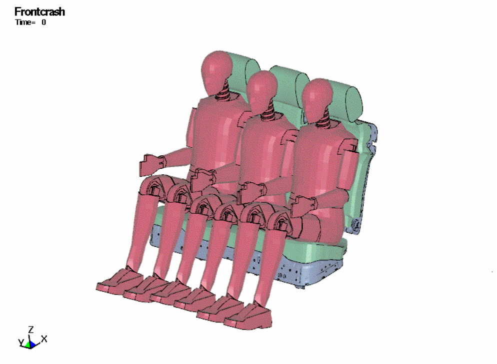
Safety



NVH / Durability

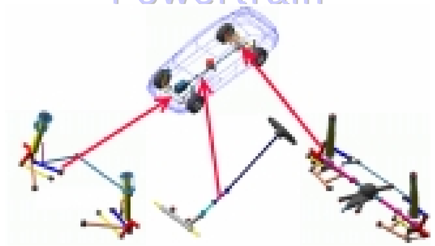


Powertrain

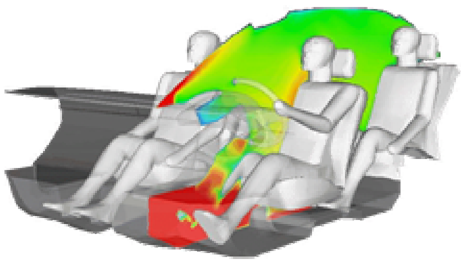


Seats

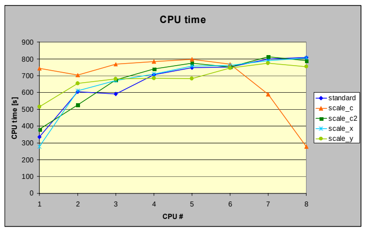
CAE Portfolio



Multi Body Systems (MBS)



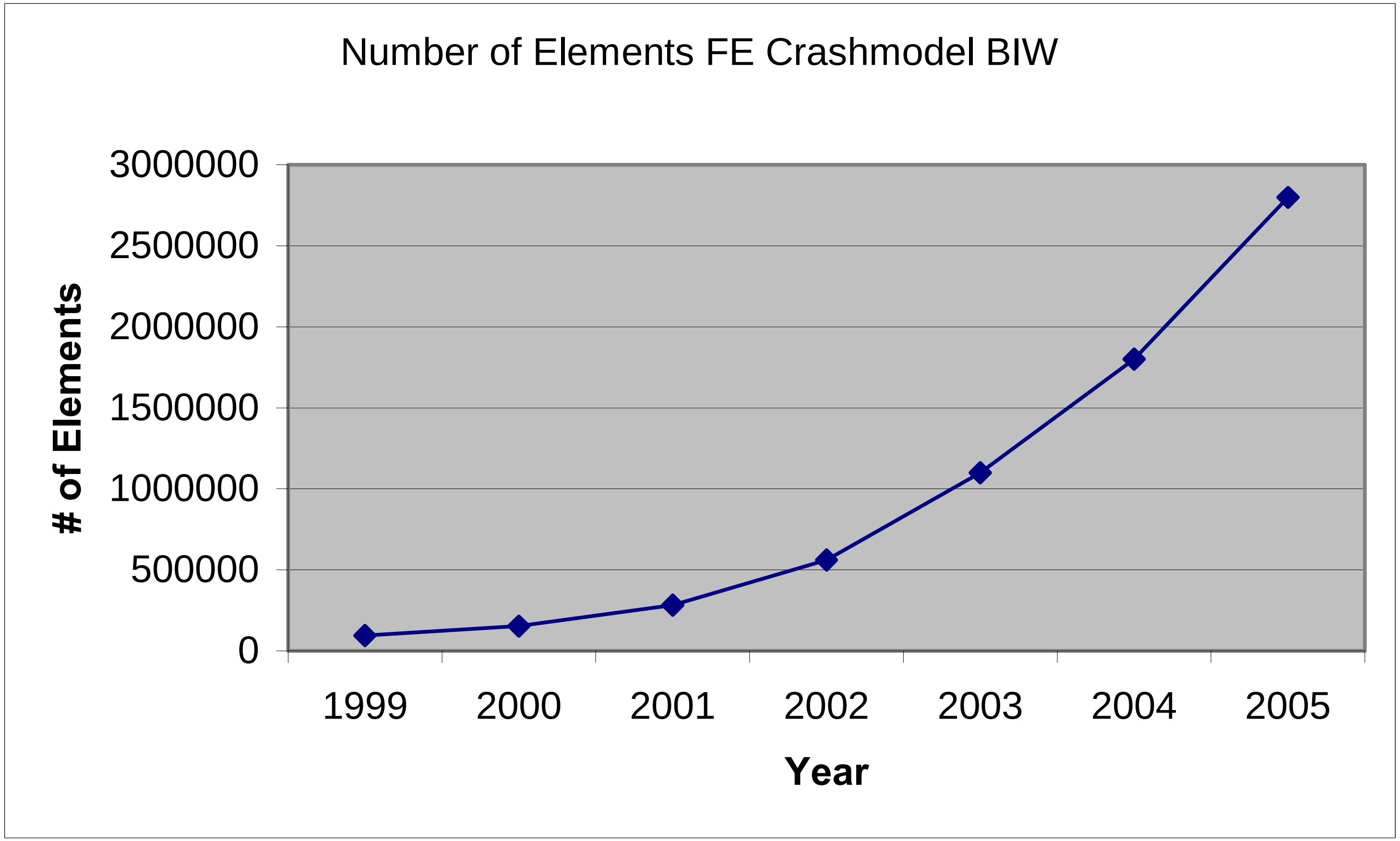
CFD



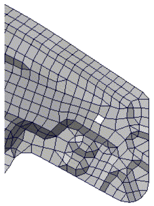
Optimization

TECODM
best software for simulation
TECPROM
best process for simulation
TECBENCH
best benchmarking for simulation

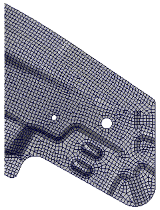
CAE Products


Number of Elements FE Crashmodel BIW
# of Elements
3000000
2500000
2000000
1500000
1000000
500000
0
1999
2000
2001
2002
2003
2004
2005
Year

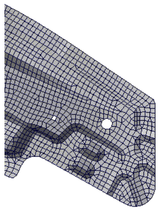
- How should a mesh look like?



TEC|ODM Mesh Element size 12 mm



TEC|ODM Mesh Element size 4 mm



TEC|ODM Mesh Element size 6 mm

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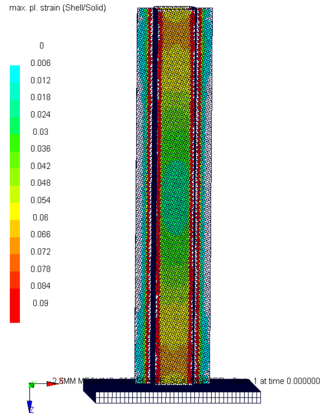
Simple box crash experiment:

Box section 50 mm x 80 x 500mm, t= 1.0mm, mild steel



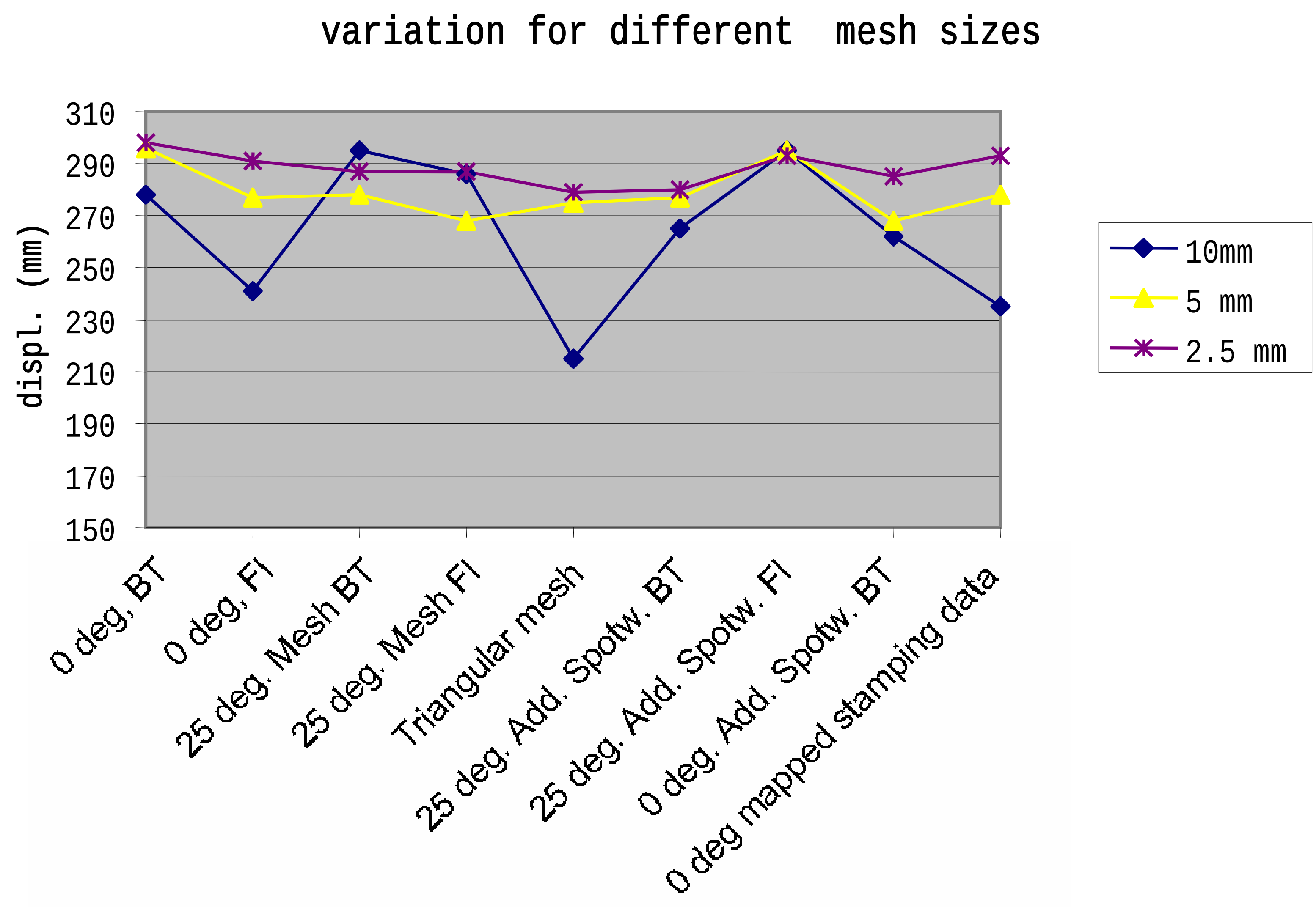
Varied parameters:

- average edge length 15/10/5/2,5mm
- mesh orientation 0deg/ 25deg
- different mesh/ integration method: Belytschko-Tsay/ Fully Integration
- Varied number of spotwelds
- With and without mapping or stamping data
- Renumbering and move in space

Objective:

- Is the result depending on the element length?
- Is the result depending on the element orientation?
- How does mapping influence/stabalise the results?
- How do small changes in the input influence the results?

Analysis: comparison max displacement variation



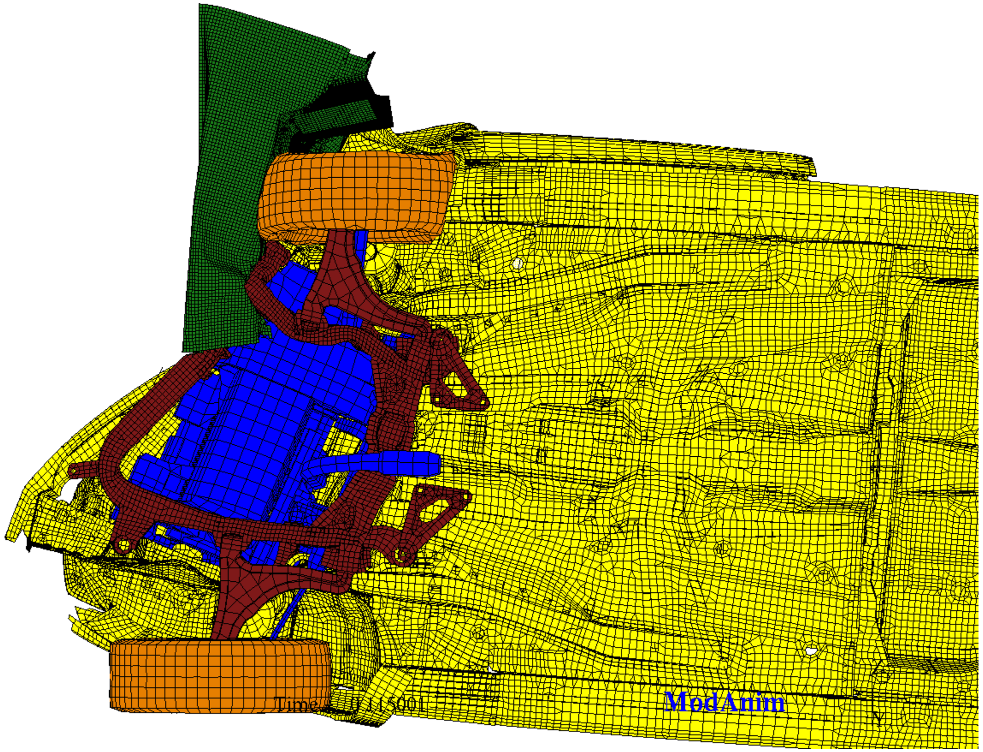
Conclusion

- If you know the collapse mode of a part you can use a coarse mesh which should be orthogonal in the collapse direction (so you can achieve “superconvergence”)
- If you doesn't know the collapse mode of a part; Please use finer meshes
- No one knows the exact collapse mode of all the parts in a vehicle!
- Meshing rules for orthogonal /Mapping/Integration schemes meshes are important for coarser meshes but not important for finer meshes.

- *Creation of finer meshes can be automated by* **TEC|ODM***!*

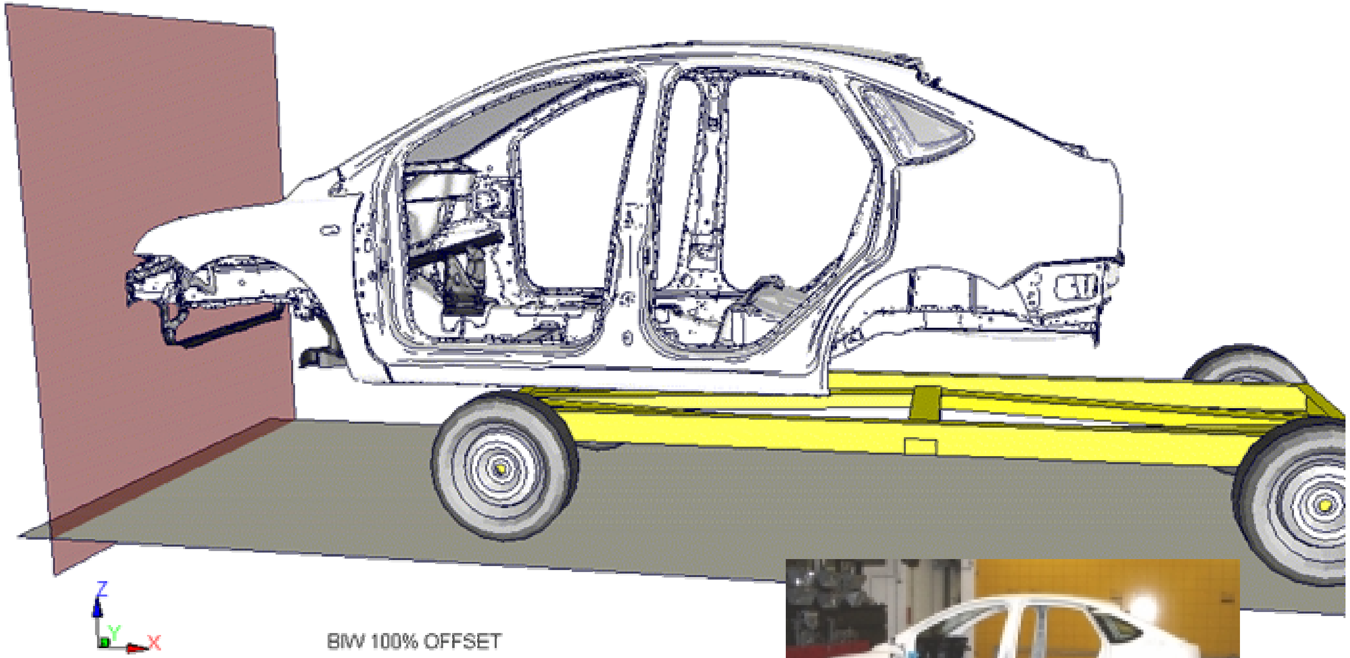
Outlook

The crashbox sample will be applied to a complete vehicle to find out about the time saving potential and the influence on the results.



Front end experiment:

Complete car frontend in crash test condition:
7,8m/s, 1710 kg vs rigid wall

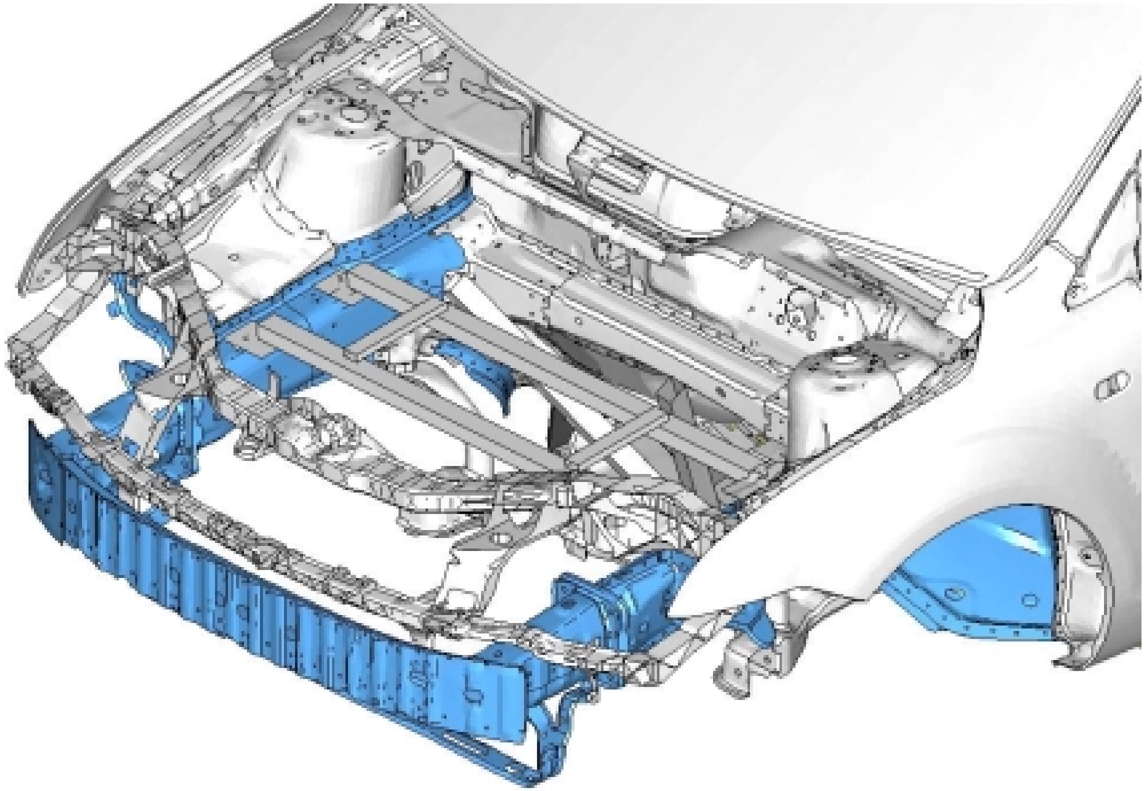


Objective:

- Is the result depending on the element length?
- How do small changes in the input influence the results?

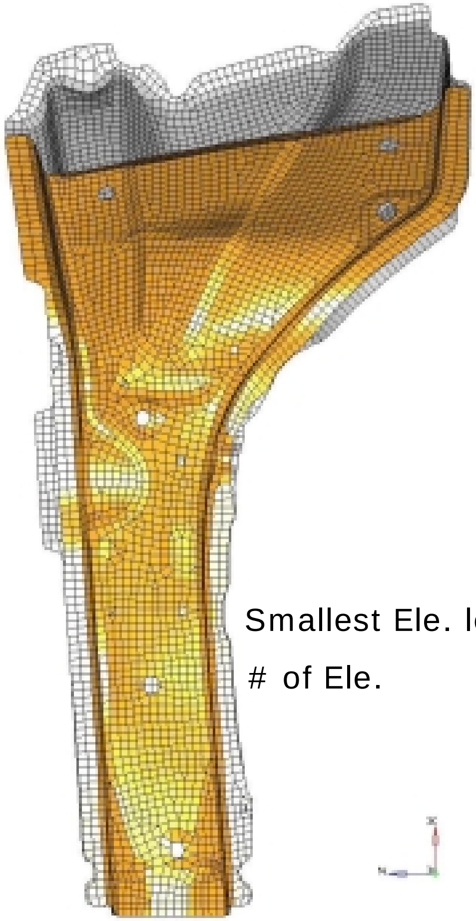
modified TEC|BENCH™ model

- Refinement of Bumper, Crashbox, side member, etc



TECOSIM

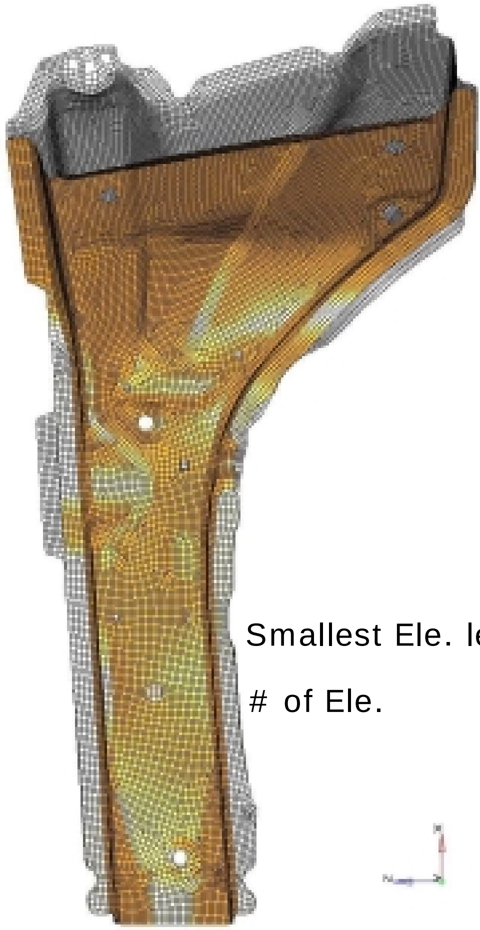
Example of refinement of TEC|BENCH™ model



Smallest Ele. length 6,21 mm

# of Ele. 8.588

Base model

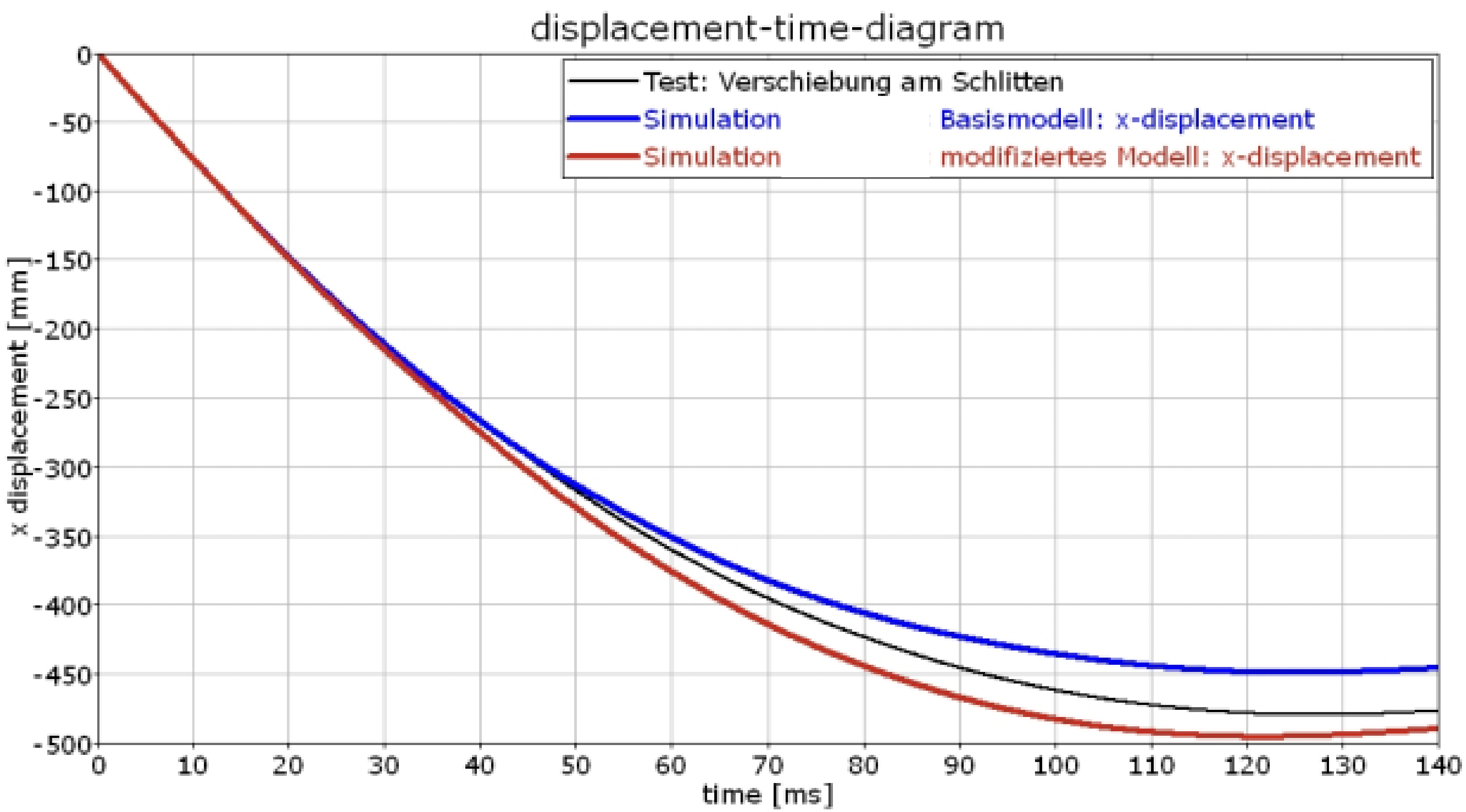


Smallest Ele. length 3,11 mm

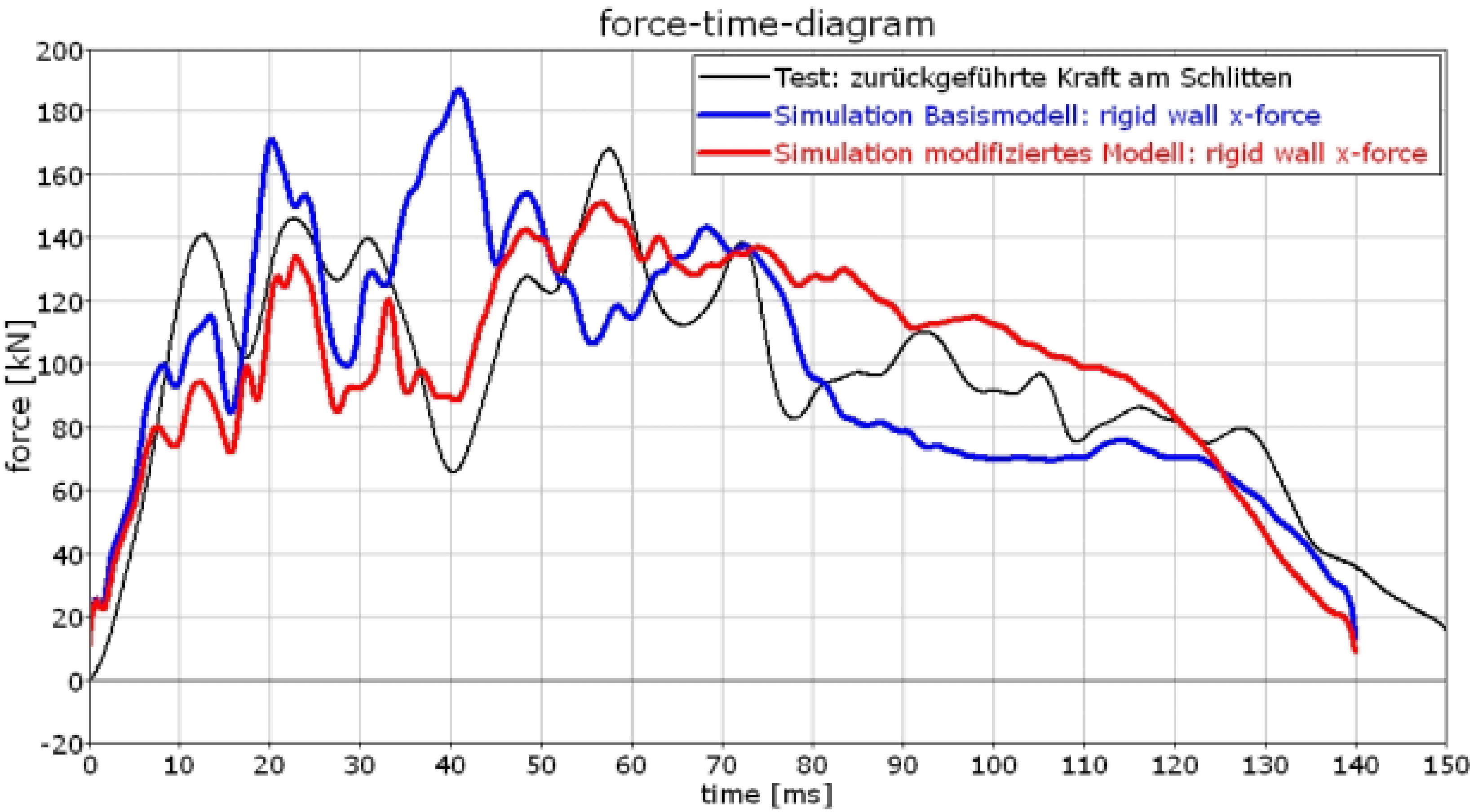
# of Ele. 34.119

modified model

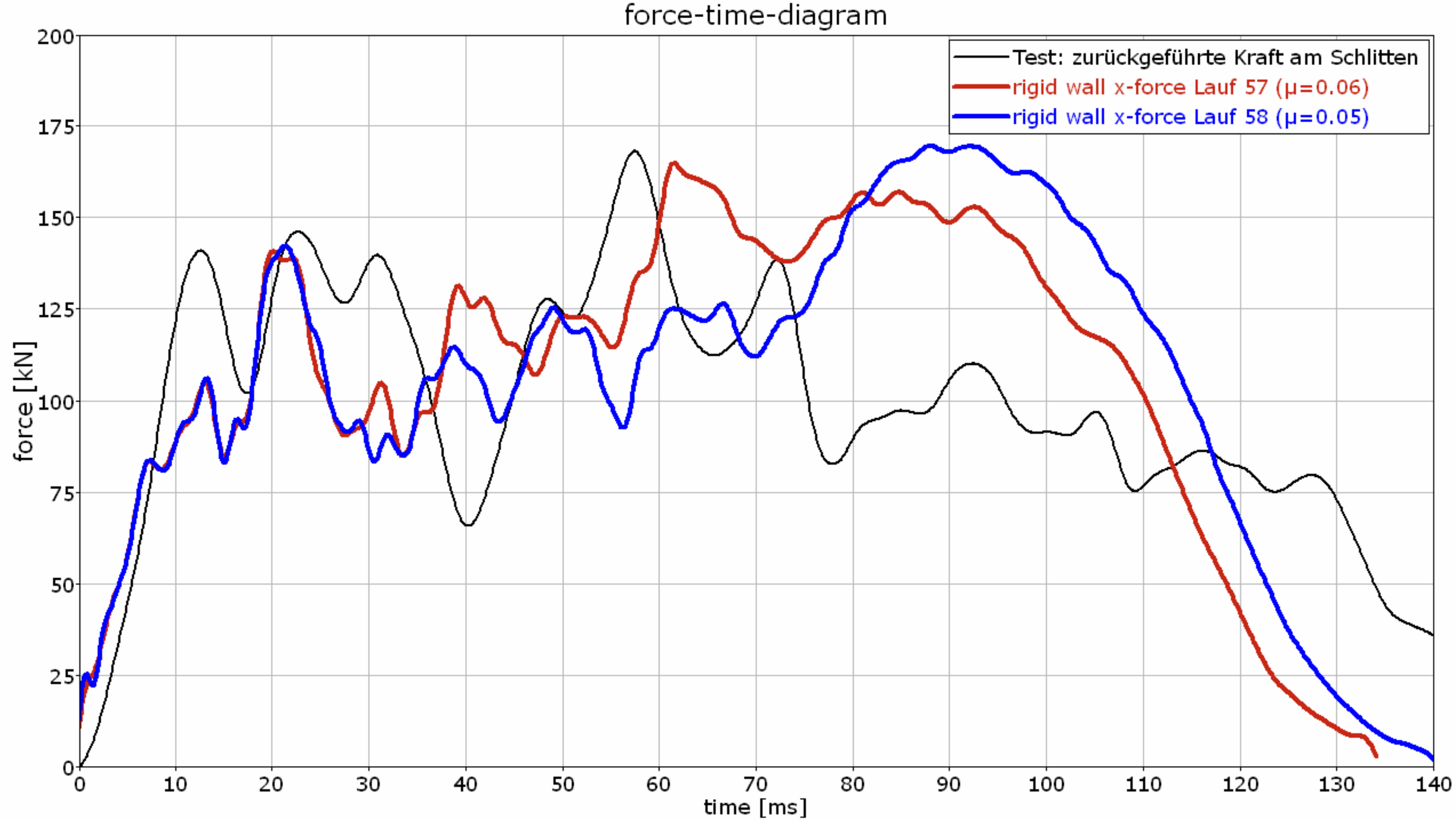
Comparison Test / rough model / fine model



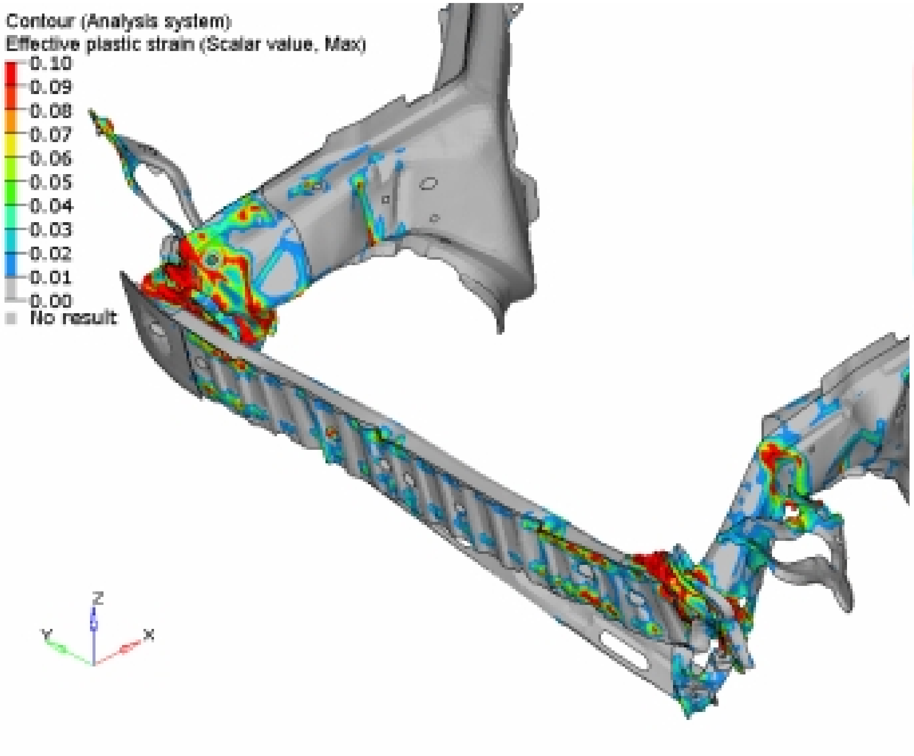
Comparison Test / rough model / fine model



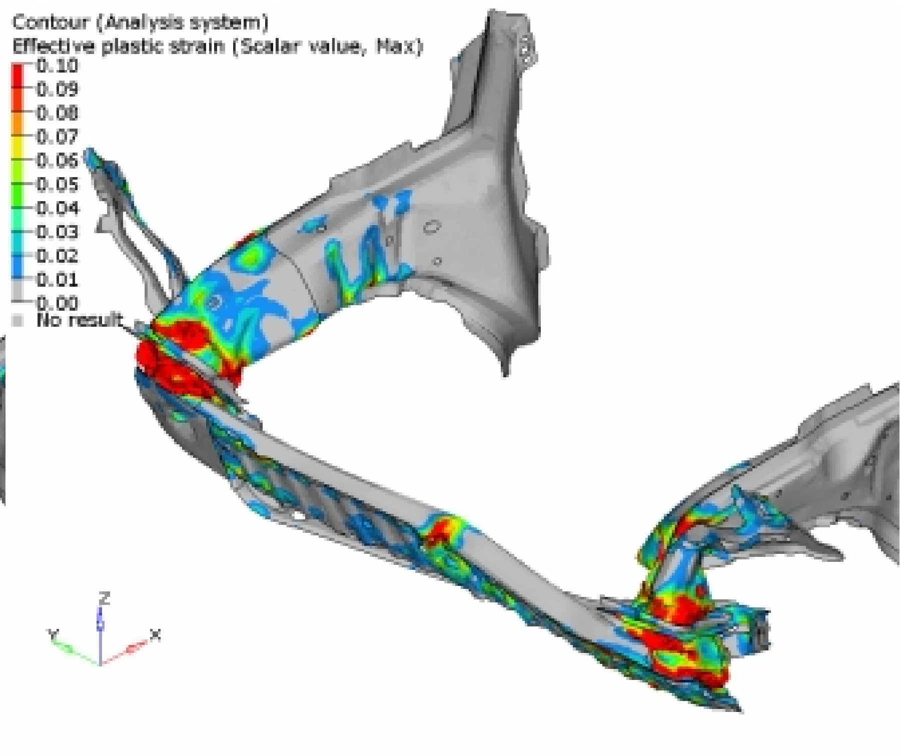
Sensitivity check: Test / rough model with changed rigid wall friction (μ =0,05 + μ =0,06)



Comparison rough model/fine model

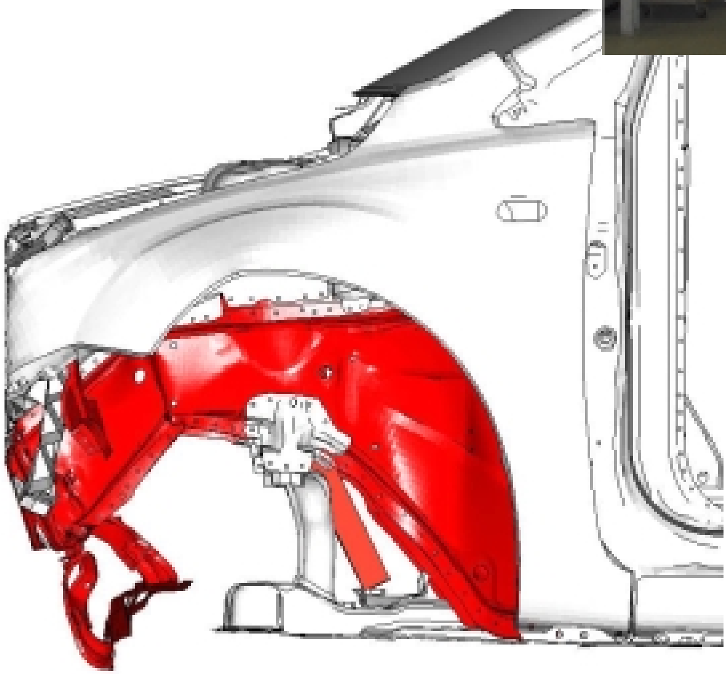


Base model

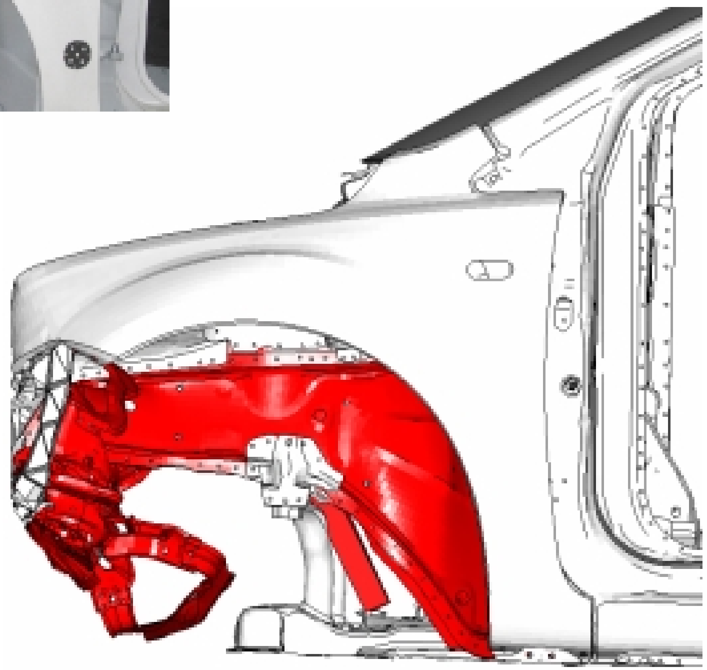


modified model

Comparison Test / rough model / fine model

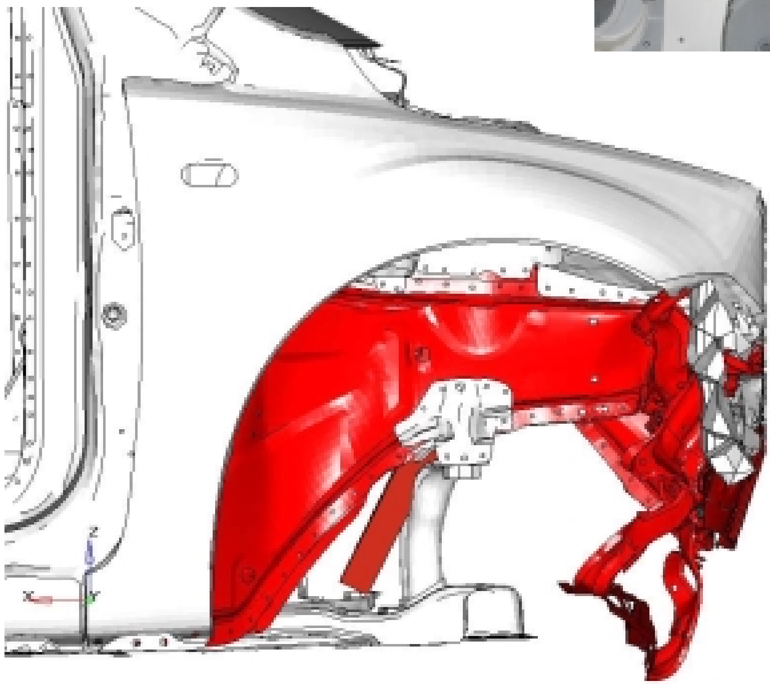


Base model

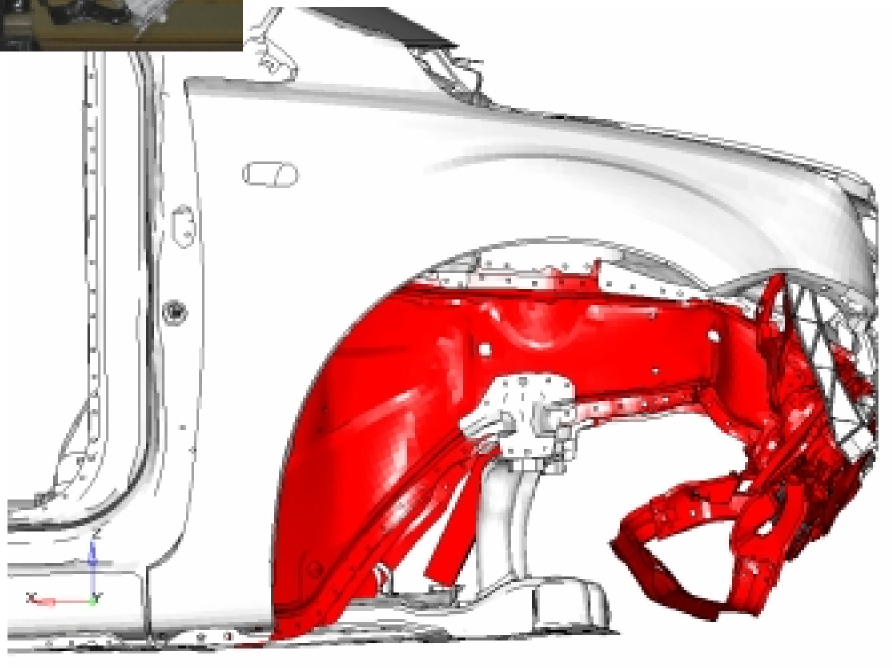


modified model

Comparison Test / rough model / fine model



Base model



modified model

Influence in NVH global modes and frequencies

						coarse model		fine model	
mode test	**frequency [Hz]**	**description**	**mode sim.**	**frequency [Hz]**	**modal weight [kg]**	**MAC**	**rel. frequency**	**MAC**	**rel. frequency**
1	35,61	global torsion	1	34,28	64,00	97%	96%	97%	97%
2	37,78	normal upper window mode	3	38,77	5,68	91%	103%	91%	102%
3	42,28	lateral bending	2	36,62	38,30	85%	87%	87%	86%
4	46,03	vertical bending	4	43,60	0,49	88%	95%	83%	93%
5	48,55	Oscillating body mode	5	45,16	1,60	63%	93%	62%	91%
6	52,22	2nd torsion / lateral bending	6	47,64	8,94	45%	91%	48%	90%
7	54,65	vertical pumping rear end	8	54,83	2,28	74%	100%	68%	99%
8	56,59	MFE and front end mode	8	54,83	2,28	38%	97%	42%	96%
9	57,00								
10	60,85	normal lower window mode	10	57,87	3,04	57%	95%	50%	94%
11	62,74	oscillating window mode	12	61,35	1,92	45%	98%	59%	96%
12	64,40	oscillating MFE mode	14	64,93	0,61	42%	101%	33%	96%
13	67,60	3rd lateral bending with MFE and roof parts	13	62,84	0,45	49%	93%	45%	92%
14	70,58	front end torsion mode	14	64,93	0,61	46%	92%	22%	95%

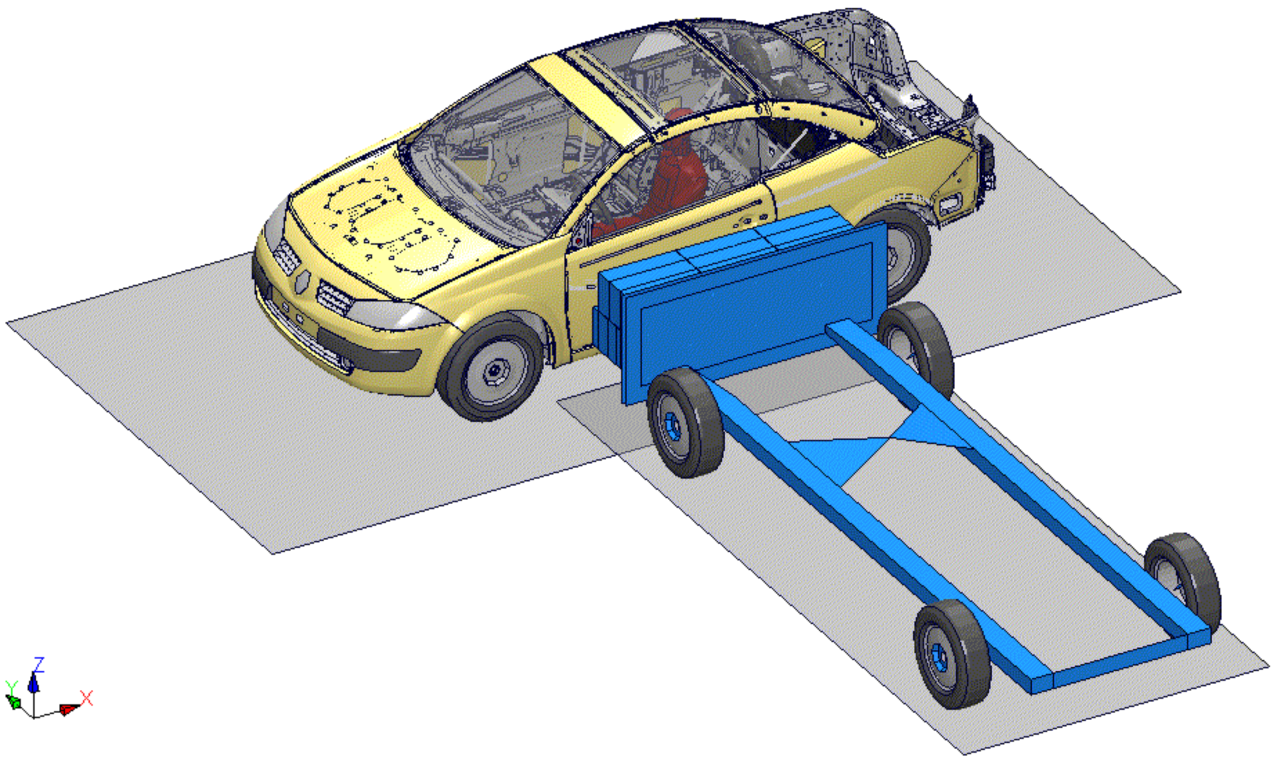
Conclusion

- Finer mesh results had a better starting point for the validation
- Global NVH modes can be analysed with refined meshes
- NVH Results seems to have small impact on mesh refinements
- Element resolution has an effect on the results
- Different element orientation give different results for coarser meshes
- Finer mesh is not so sensitive for different element orientation and changed boundary conditions (i.e. Rigid wall force)

- *Creation of finer meshes can be automated by* **TEC|ODM***!*

Outlook

- Findings will be validated with more crash runs and NVH local modes
- Simulation results will be extended to further TEC|BENCH models (Renault Megane CC, Golf 5, etc.)



Thank you for your attention!
Please ask some questions