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Simulation Process & Data Management

Efficient fatigue assessment of welded structures using unstructured continuum element meshes

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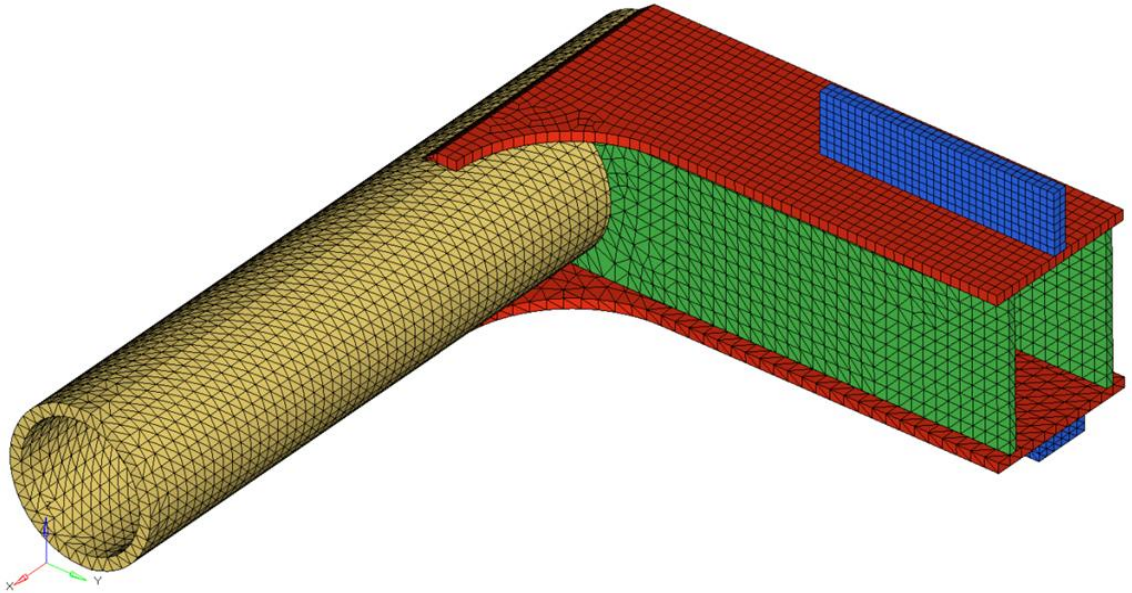


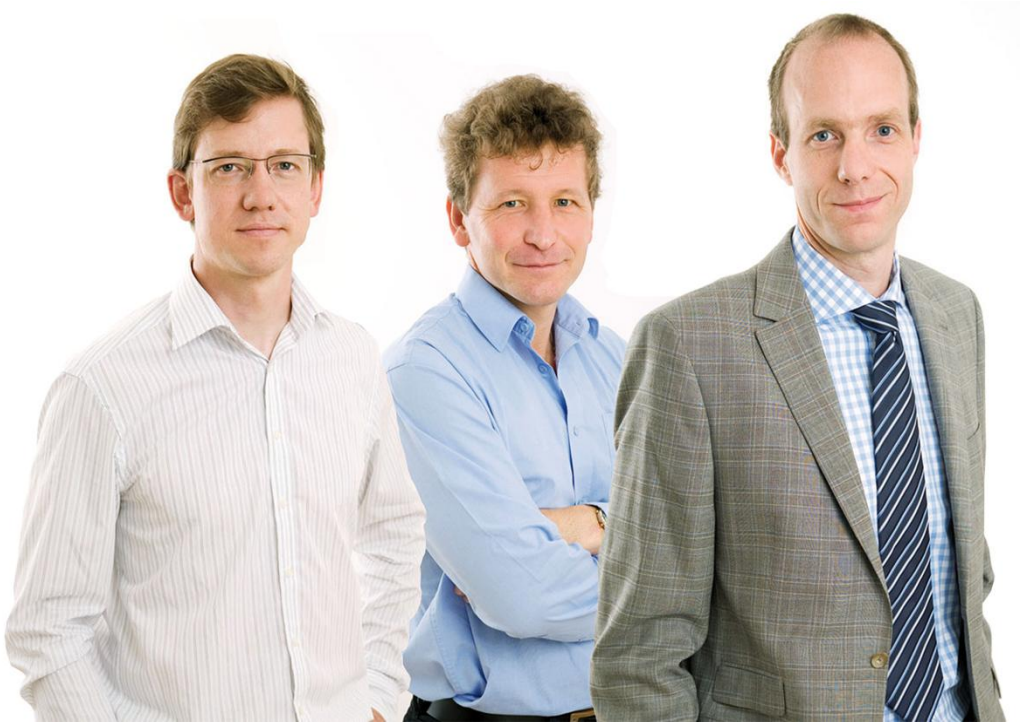
Efficient and conforming-to-standard fatigue assessment of welded structures using unstructured continuum element meshes

W. Vonach, N. Friedl, P. Löffler

Company Profile

Who we are:

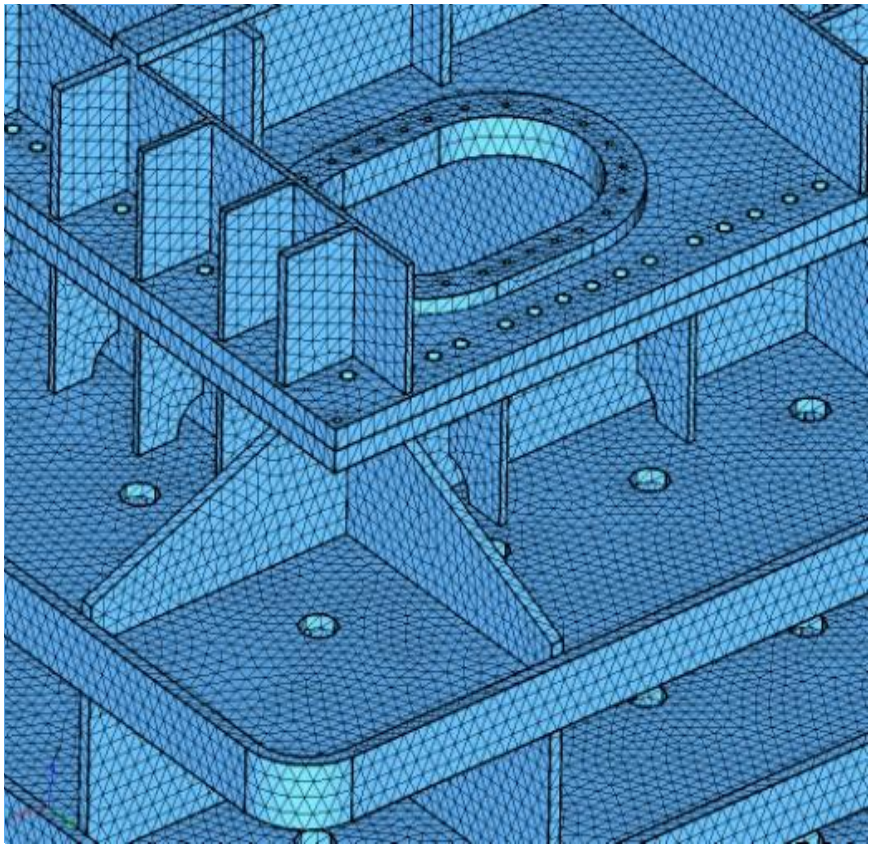
- Engineering service provider
  - FEM, CFD and client specific software development focused on:
    - complex and non-linear problems
    - fatigue assessment
  - Based in Vienna
- Internal R&D
  - Internal research projects
  - Software development



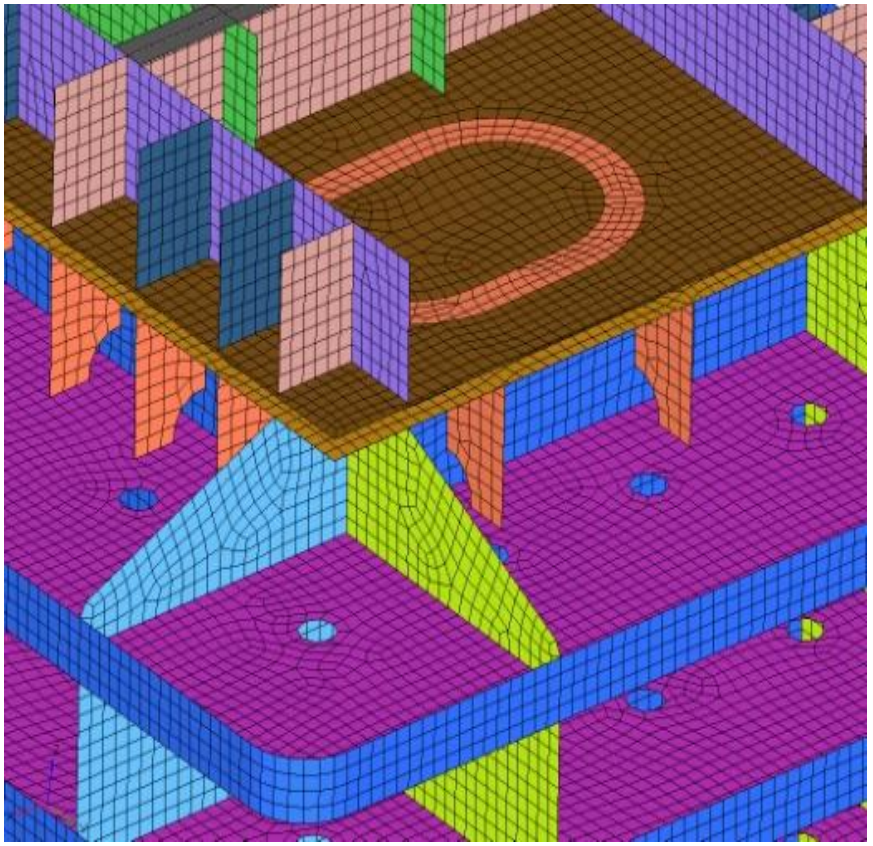
LIMIT stress evaluation

Motivation

- Solid models: quick and easy mesh generation



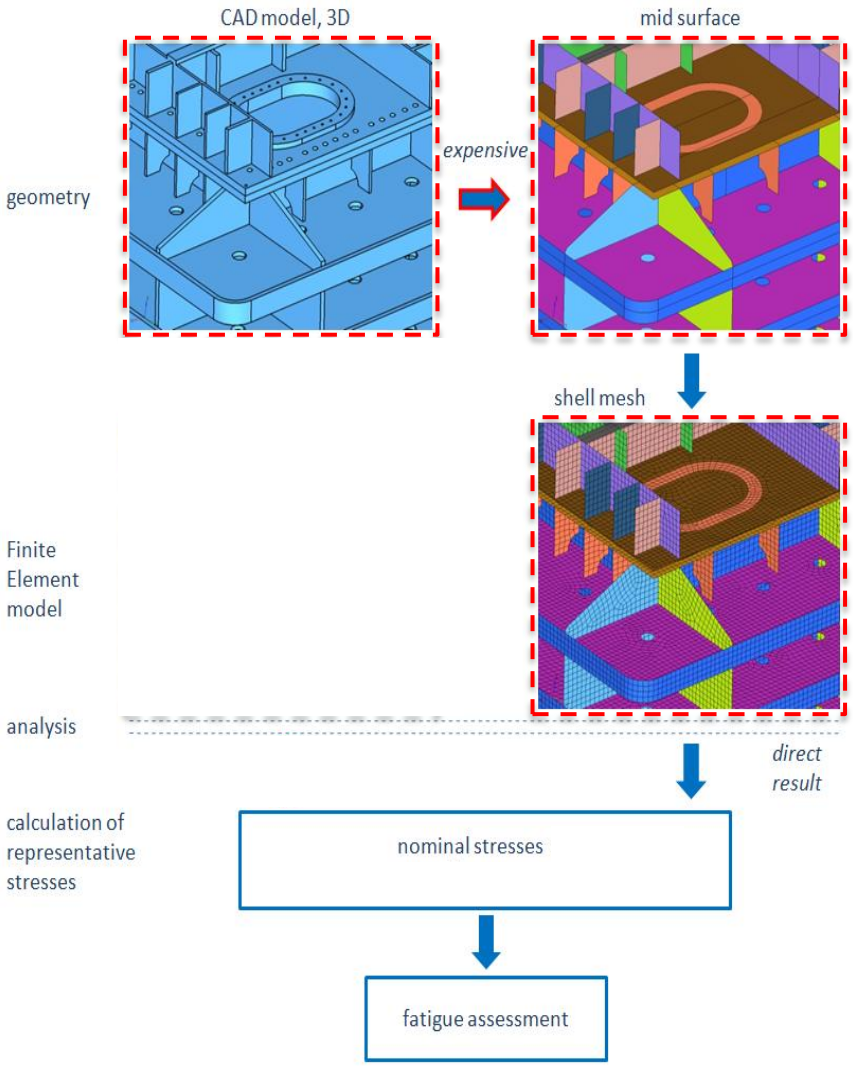
- Shell models: most of work



Concept

LIMIT stress evaluation

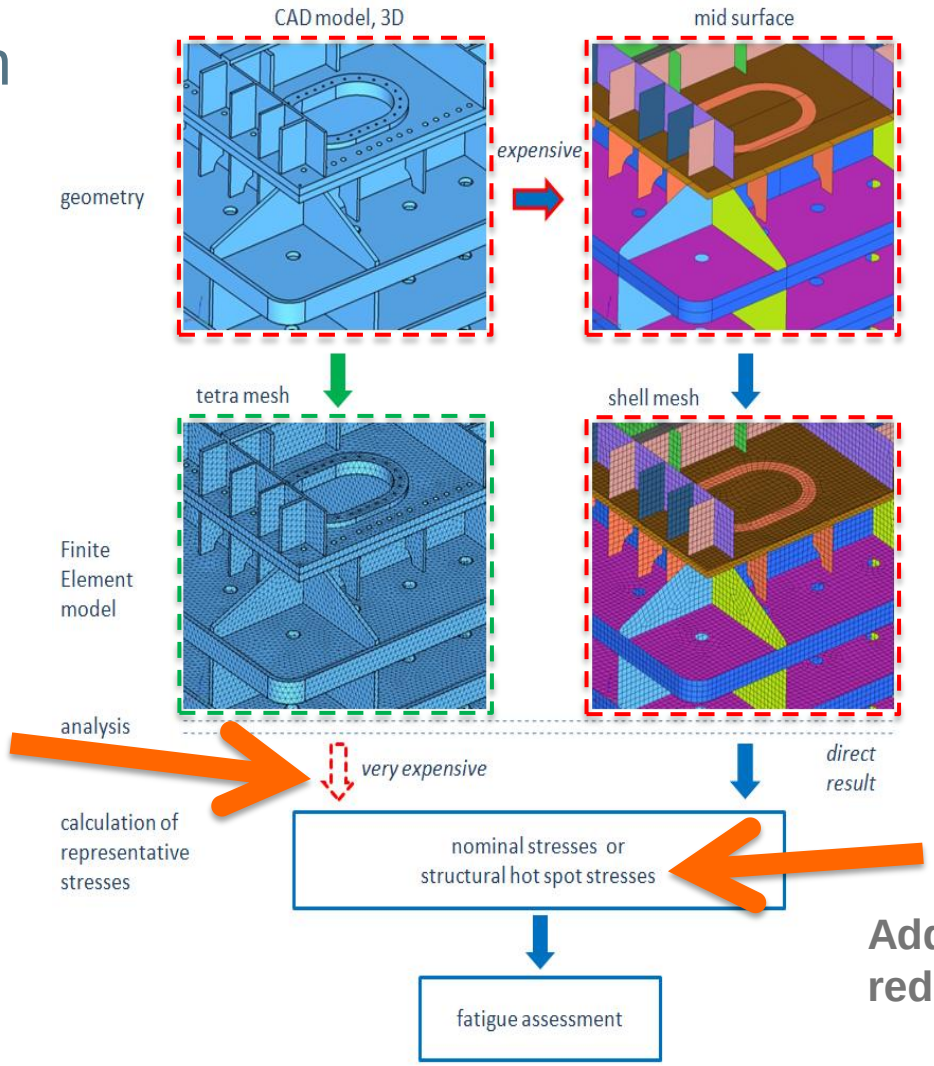
Motivation



Concept

LIMIT stress evaluation

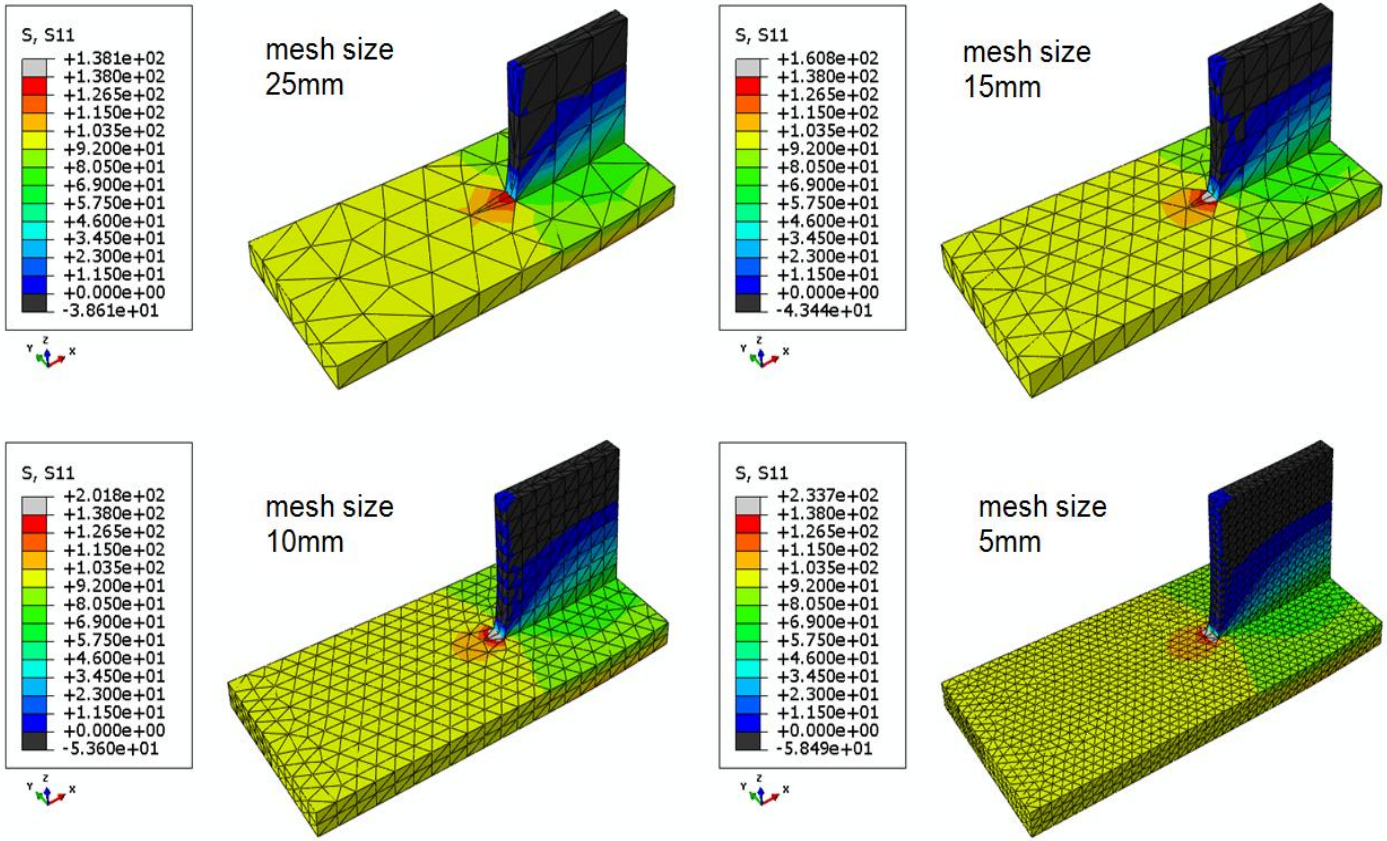
Motivation



Additional aim:
reduce mesh dependency

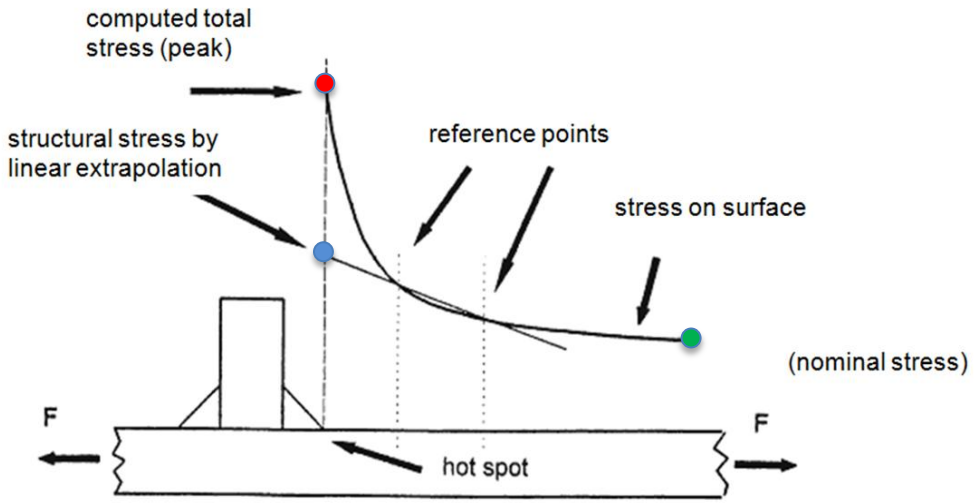
Mesh influence

Tet mesh / mesh size influence



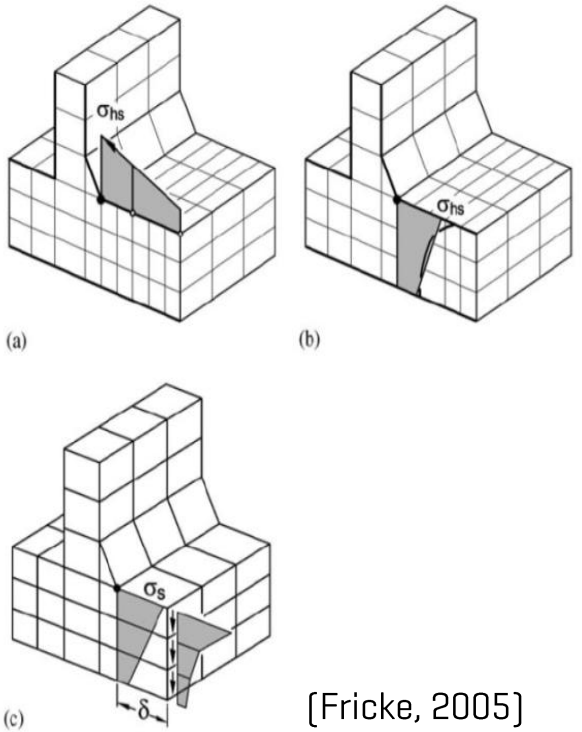
Concept

Assessment concepts



[Hobbacher, 2007]

Structural stress for solids

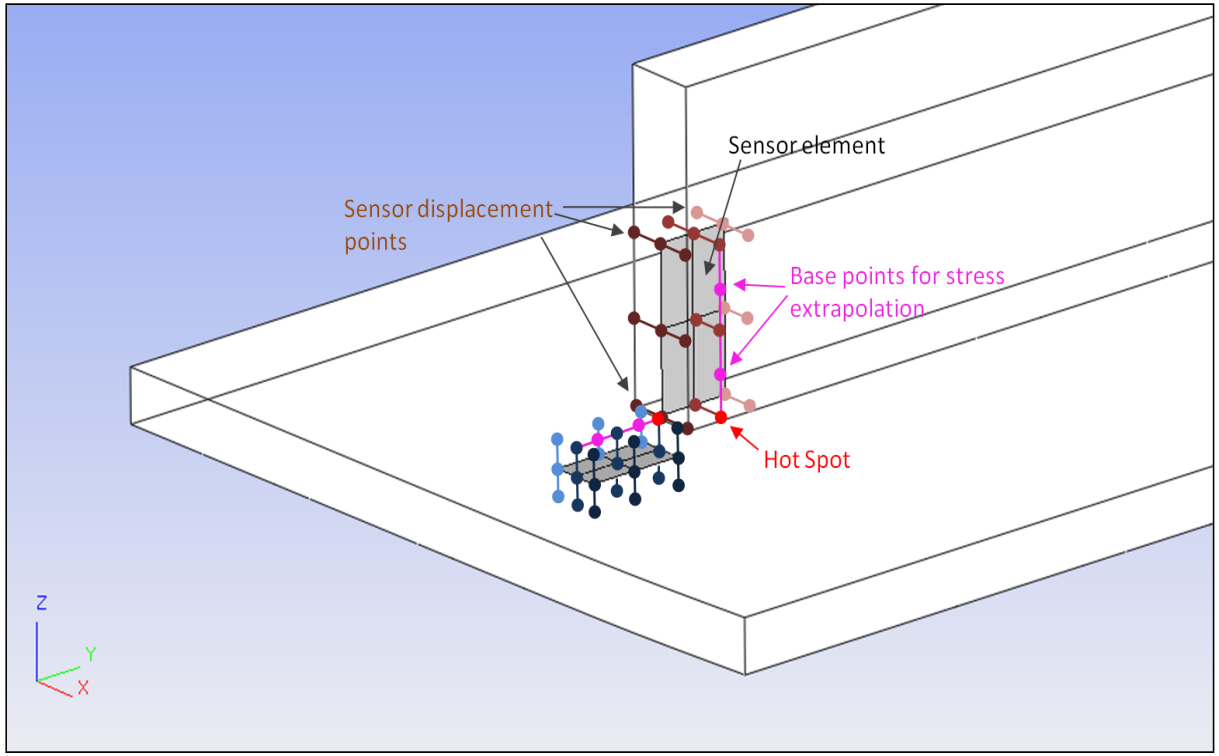


[Fricke, 2005]

Sensor elements

Sensor Elements

- Generated and embedded within post-processing
- Uses deformation field of solid model
- Stresses gained:
  - Structural stress
  - Averaged stress ("nominal")

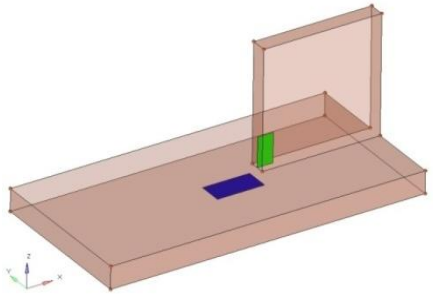


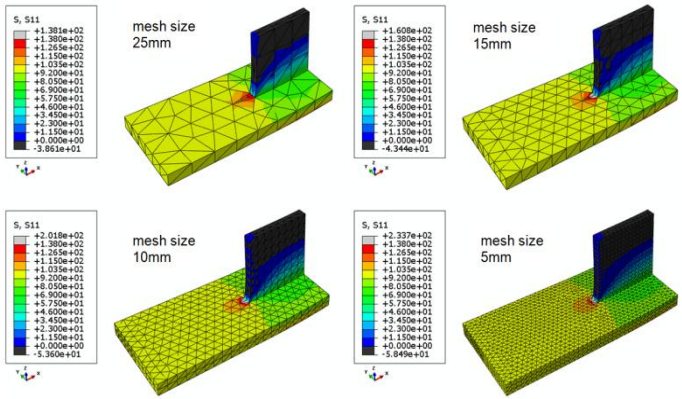
Comparison of results

LIMIT stress evaluation

Results for different stress deriving methods

- tet mesh, sensor concept (IIW) with different mesh sizes: (a, b, c, d)
- shell mesh: direct stress result: (e), IIW extrapolation (f ,g)
- structured fine hex mesh, Dong, FE-Safe (h)
- tet mesh, surface stress extrapolation (i, j)
- flange thickness: 15mm, gusset: 10mm



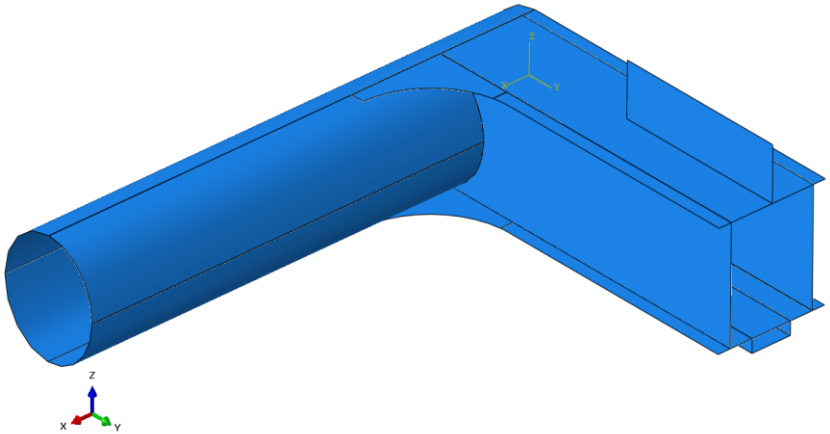


Comparison shell and solid assessment concept

LIMIT stress evaluation

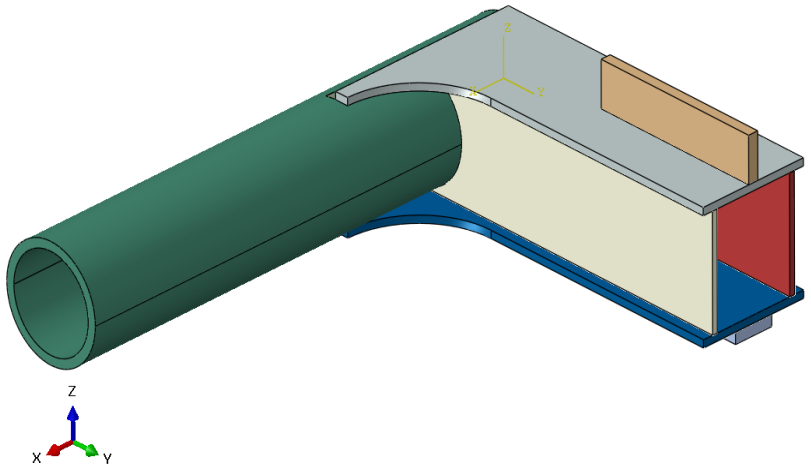
Shell model

- has to be derived from 3D geometry
- mid surface generation
- joining of midsurfaces
- thickness definitions
- effort needed!



Solid model

- only geometry import needed

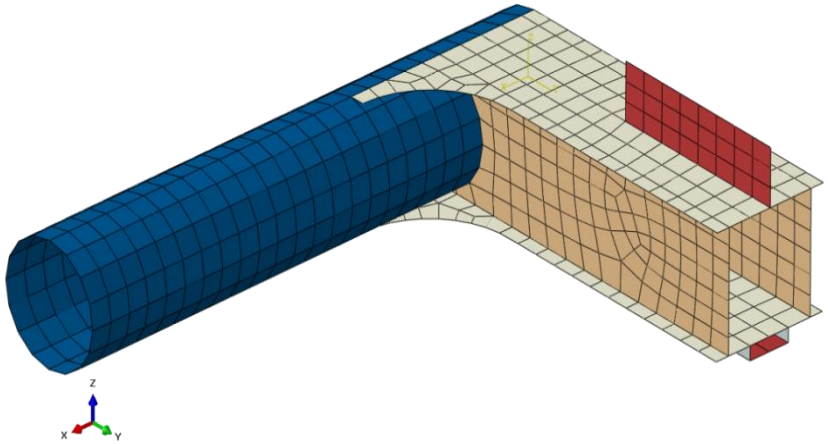


Comparison shell and solid assessment concept

LIMIT stress evaluation

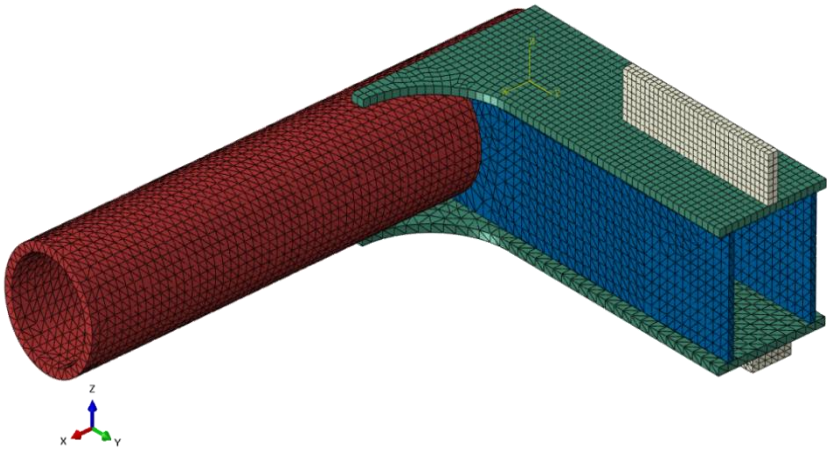
Shell model

- Element size 2 to 3 times shell thickness
  - for deriving „nominal“ stress



Solid model

- Quick non-conformal meshes of bodies
- Automatic tie generation
- Quick „tet and tie“ mesh
- 2nd order Elements
- Element size 0.5 to 2 times plate thickness
- Higher computing time

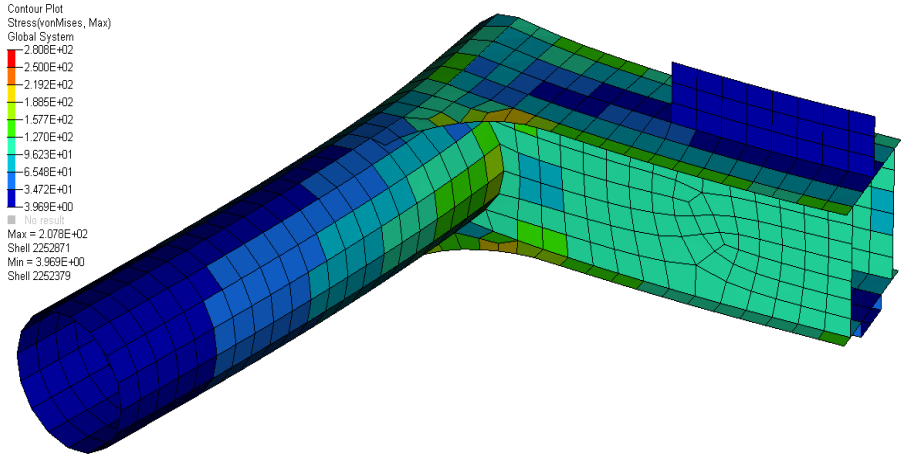


Comparison shell and solid assessment concept

LIMIT stress evaluation

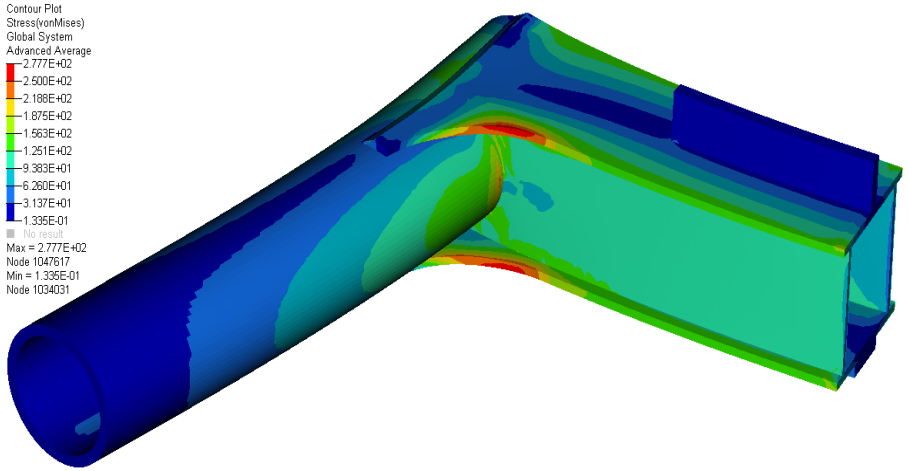
Shell model

- global deformation
- „nominal“ stresses
  - direct from FEM (eg S4R) for weld assessment
  - local stress and deformation not captured
  - inappropriate for base material assessment

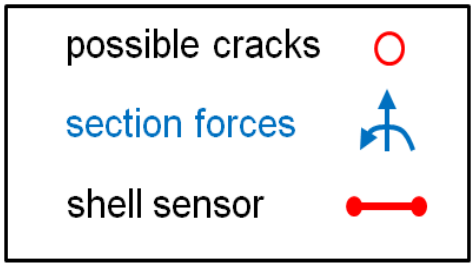


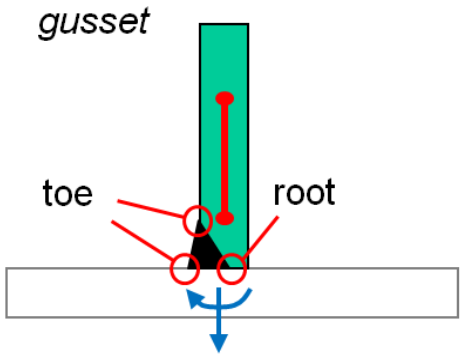
Solid model

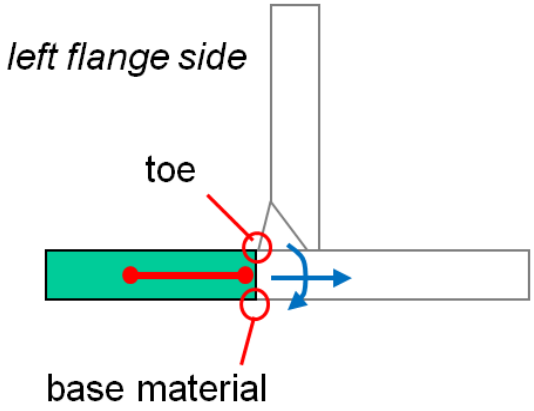
- global deformation
- local deformation
- local stress peaks
  - for base material assessment
  - structural and „nominal“ stresses via sensor concept
- More Information

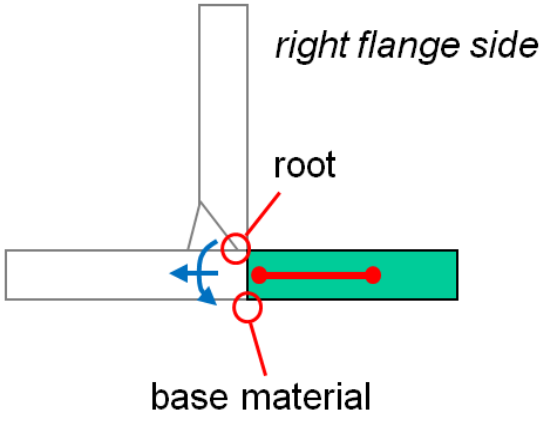


Example: T-connection







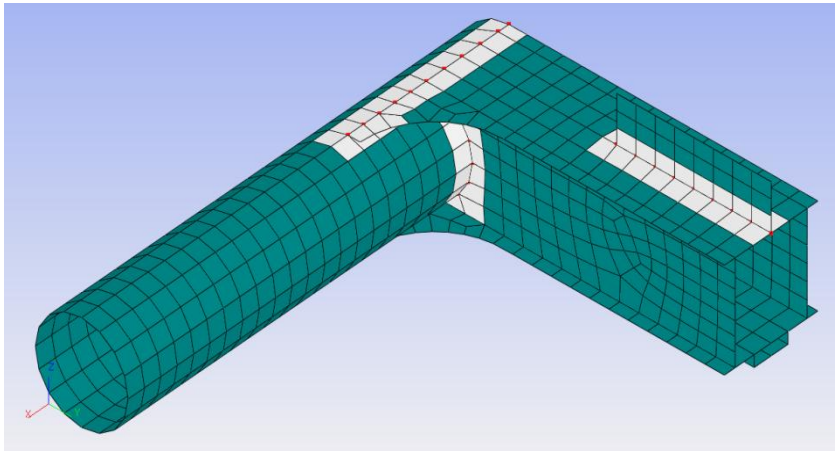


Comparison shell and solid assessment concept

LIMIT stress evaluation

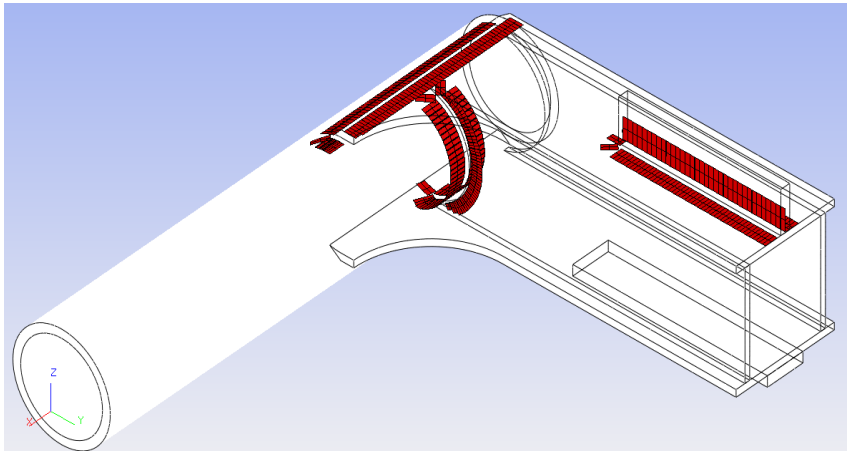
Shell model

- weld definition in LIMIT -GUI



Solid model

- sensor generation and weld definition in LIMIT -GUI

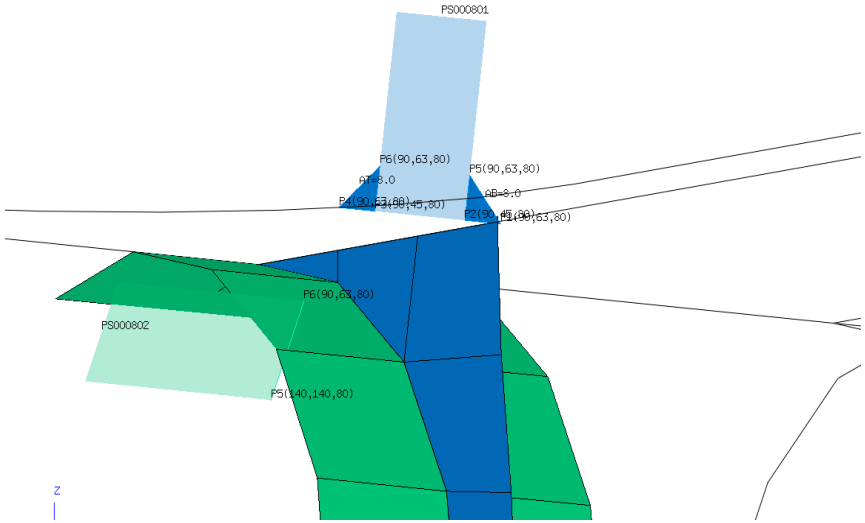


Comparison shell and solid assessment concept

LIMIT stress evaluation

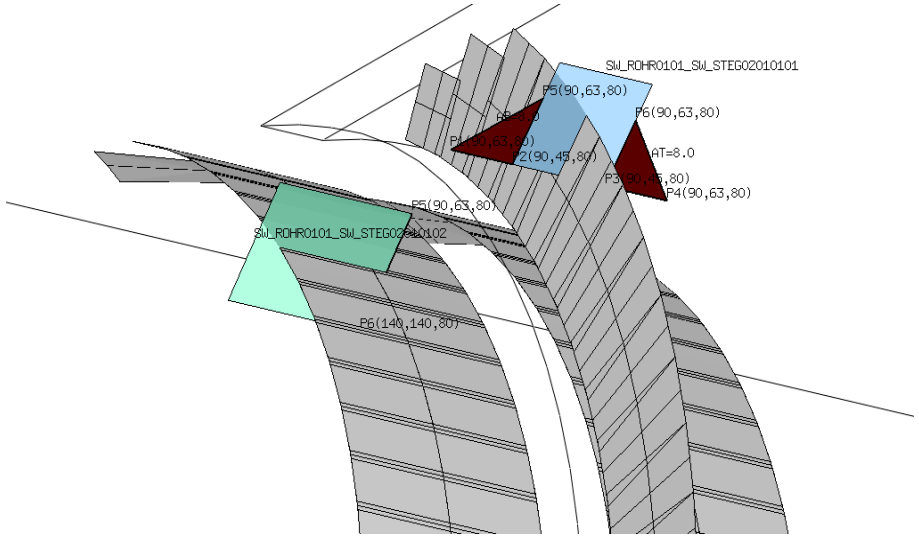
Shell model

- weld definition
  - weld position, weld size a, FAT values
  - weld element definition
- stress taken directly from element
  - only „nominal“ available (element centroid)
  - mesh dependent



Solid model

- weld definition
  - weld position, weld size a, FAT values
  - sensor placement
- stress evaluation method
  - „nominal“ stress (linearised and averaged)
  - structural stress (linearised and extrapolated)

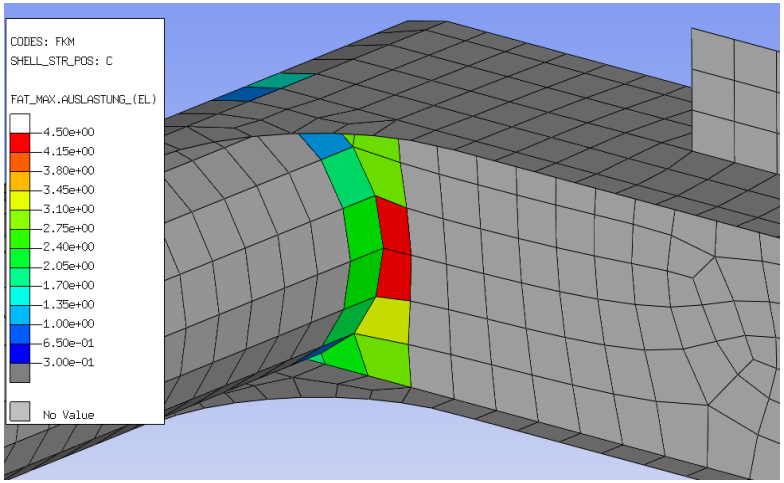


Comparison shell and solid assessment concept

LIMIT stress evaluation

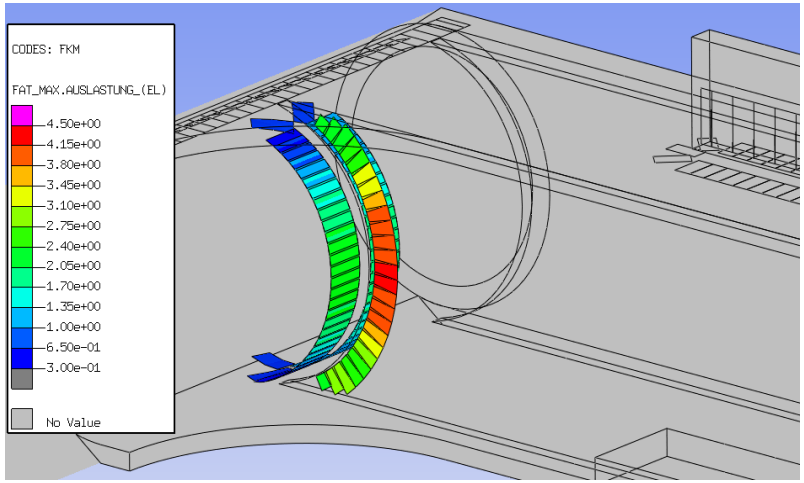
Shell model

- utilization ratio for each element
- discontinuous result
- good correlation to sensor results



Solid model

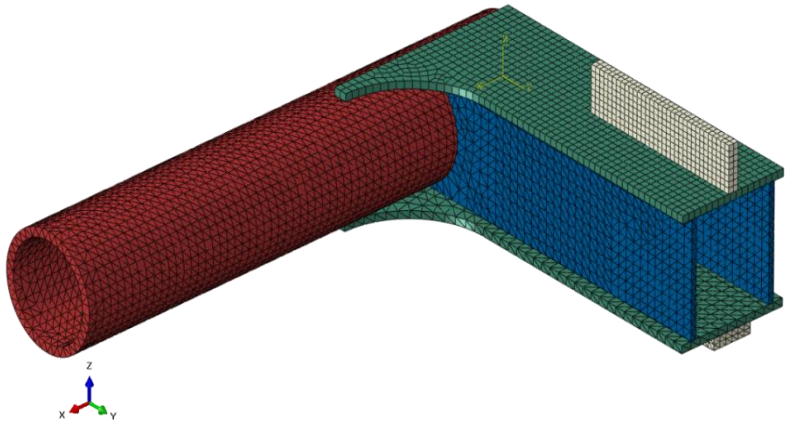
- utilization ratio for all sensors
- continuous result
- good correlation to shell model
  - if shell model is appropriate

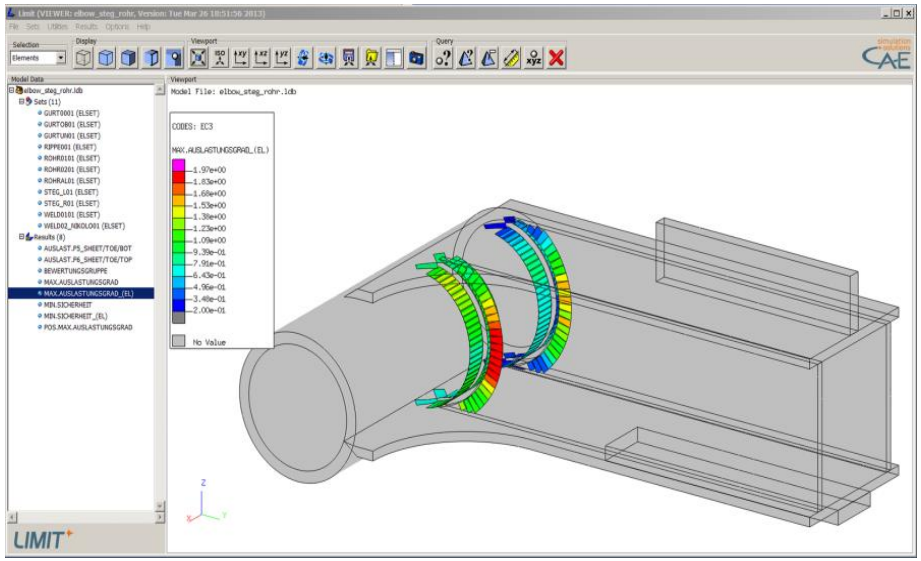


Conclusion

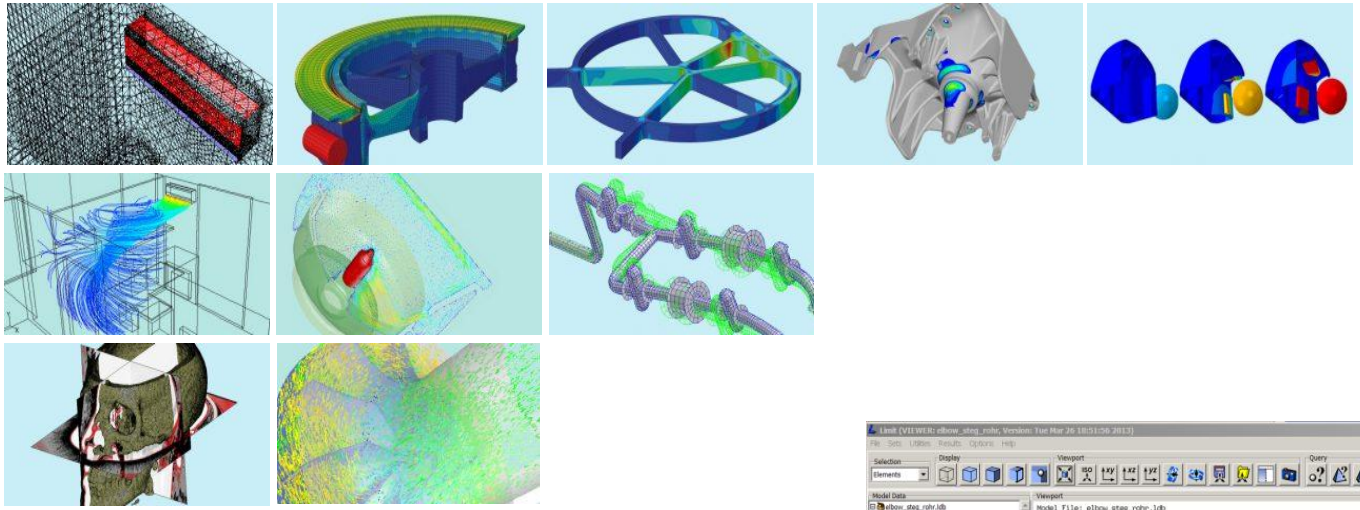
Advantages of sensor technology in *LIMIT*

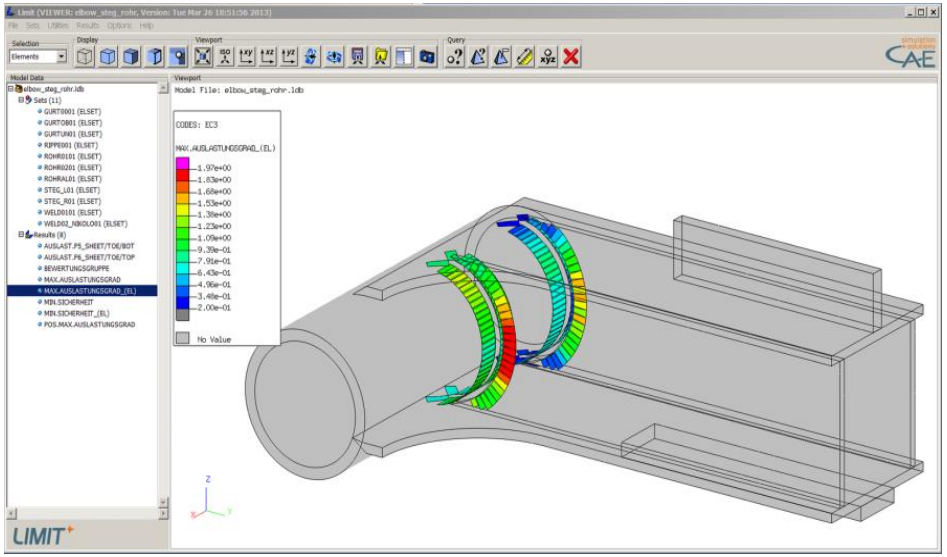
- less modelling time
- strongly reduced mesh influence
- structural and „nominal“ stress available
  - different assessments of hot spots without remeshing
- improved accuracy
- closer to reality





Thank you for your attention





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