

Influences of manufacturing processes on offshore support structures

Project: RAVE - GIGAWIND alpha ventus
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Gefördert auf Grund eines Beschlusses
des Deutschen Bundestages

Projektträger

Koordination



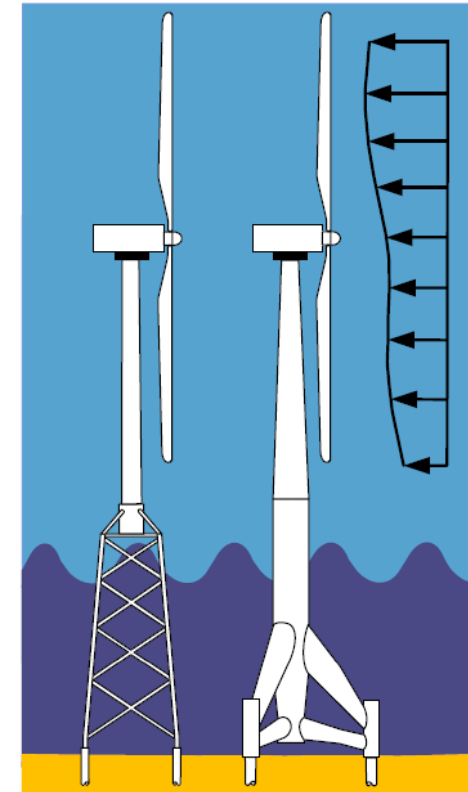
Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit



Holistic design concept for OEWC support structures on the base of measurements at the offshore test field "alpha ventus"

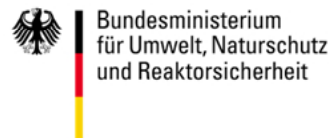
Project consortium:

Industrial partners:



Associated project in:

Funded by:



GIGAWIND alpha ventus



GIGAWINDav

The working packages

TP 1 - Load modelling for wind and waves and its correlation effects

TP 2 - Influence of manufacturing aspects on fatigue resistance

TP 3 - Corrosion protection for offshore steel structures

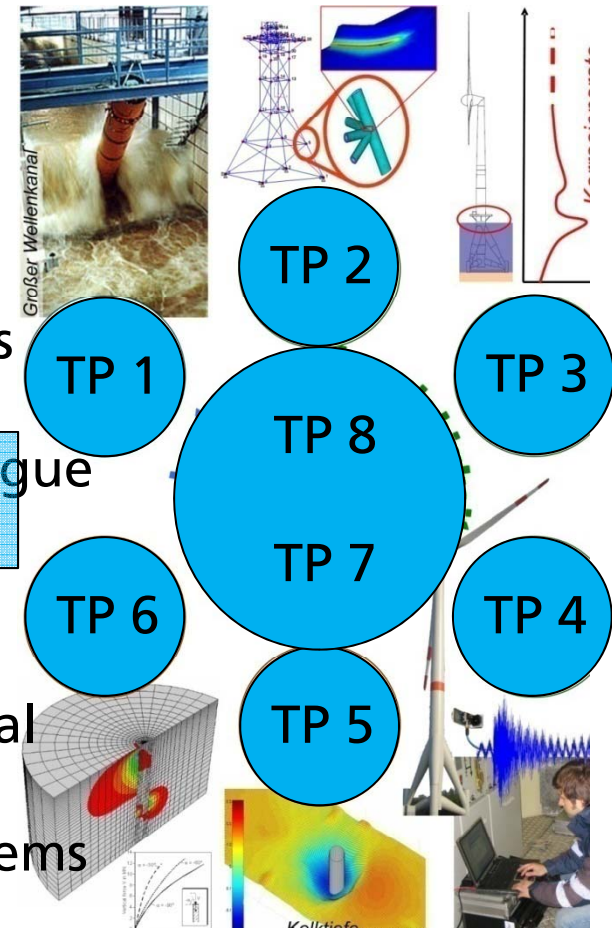
TP 4 - Reliable load monitoring at global and local parts of the structure

TP 5 - Development of new scour protection systems and local scour monitoring,

TP 6 - Modelling of the load-carrying behaviour for driven offshore piles

TP 7 - Automated Validation of general structural models

TP 8 - Holistic design concept for OWECS support structures

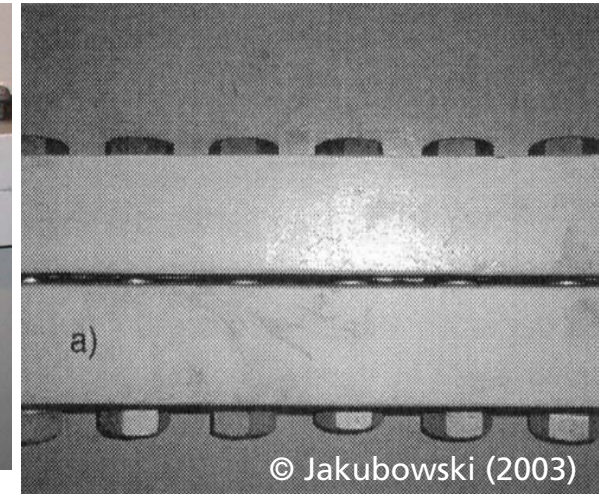
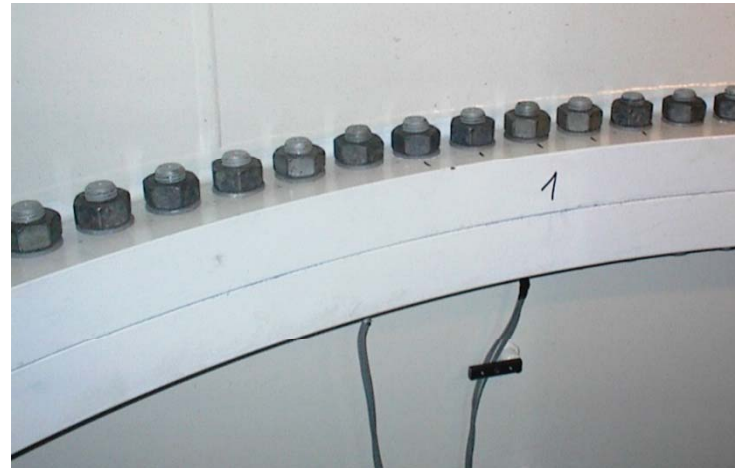


Outline



- Objectives
- Laser measurements
- Total station + ultrasonic
- Parameter studies
- Surface modelling
- Summary

Objectives

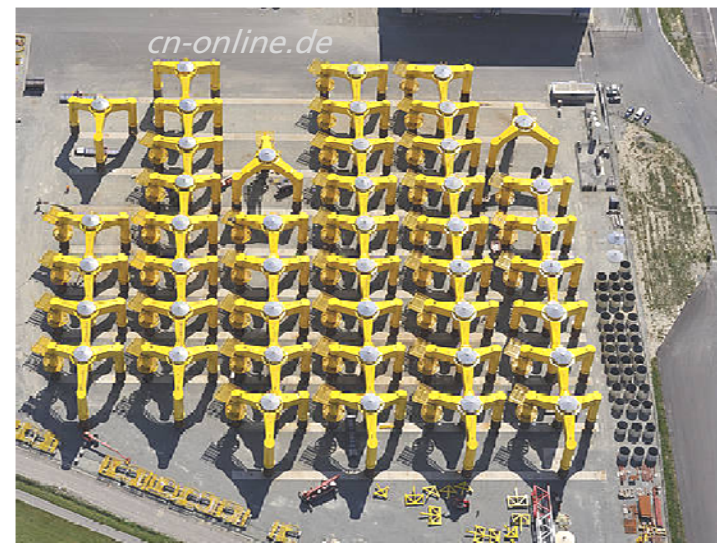


Objectives



Piece production

Serial production

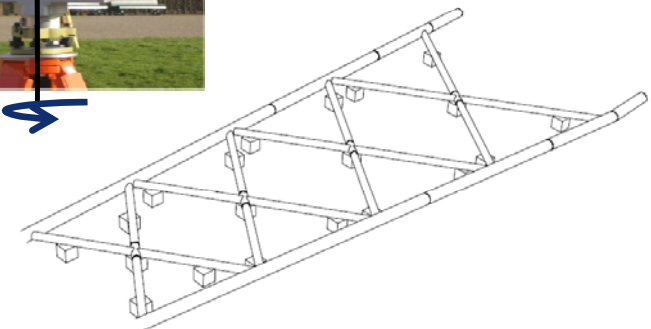
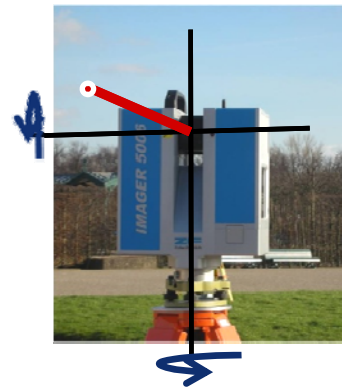
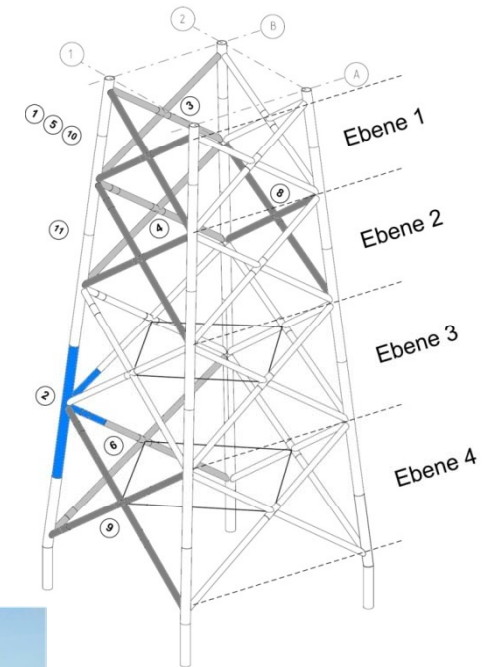


Laser measurements (1)

- Measurement system: laser scanner
- Object: jacket R4



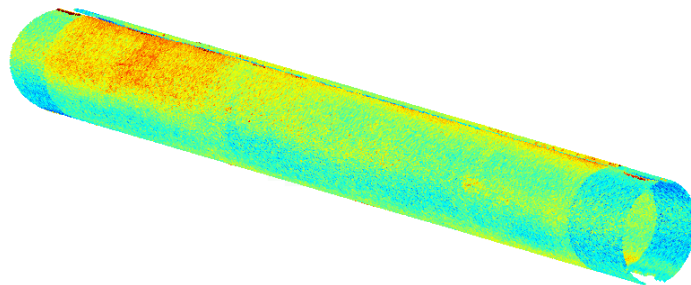
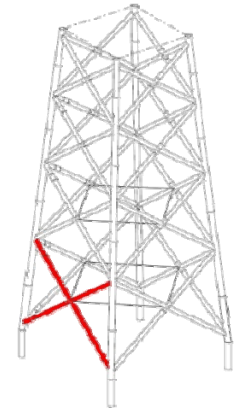
Manufacturing of a frame



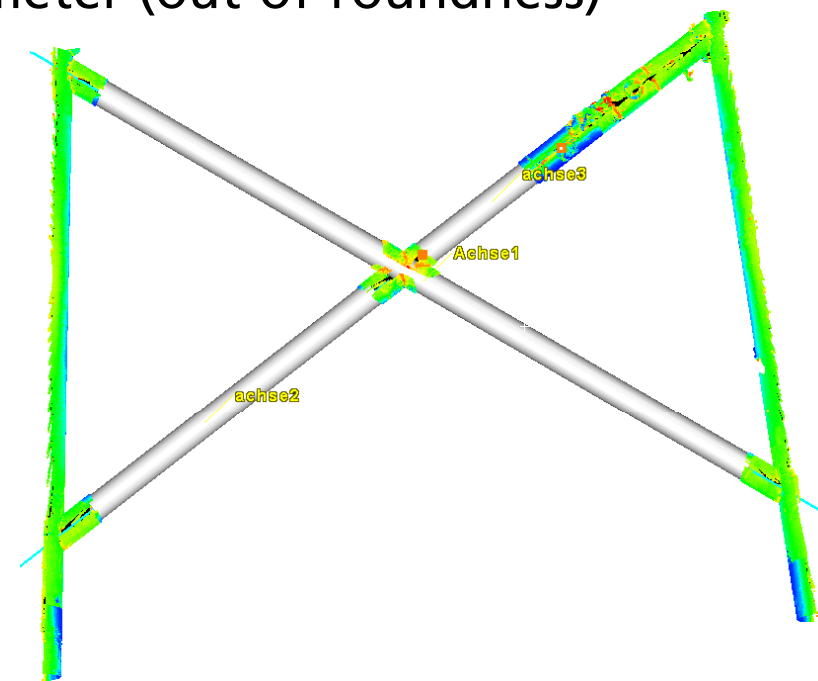
Laser measurements (2)

Best-fit analysis

- Approximation of point cloud by ideal cylinders
 - Average diameter
 - Deviation from average diameter (out-of-roundness)
- Identification of cylinder axes
 - Angular misalignment
 - Misalignment of axes



Out-of-roundness of a tube



Point cloud (green) and best-fit cylinder

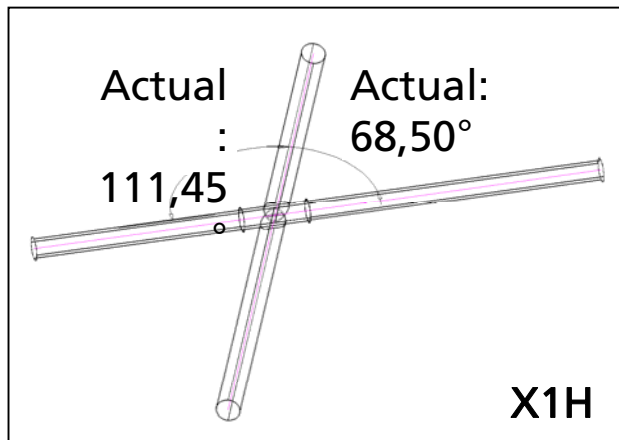
Laser measurements (3)

Angular misalignment

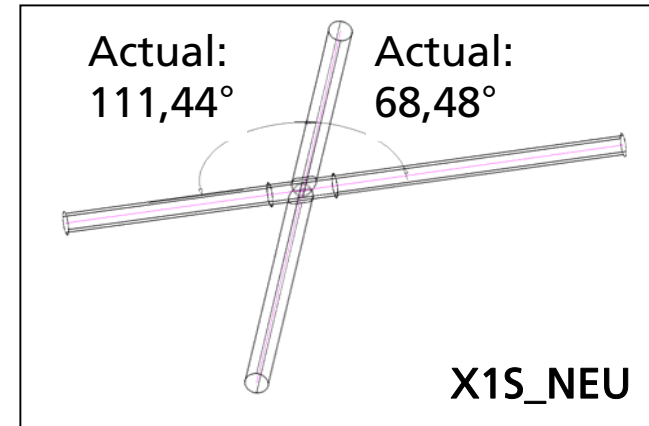
- Check of production accuracy
- Discrepancy in magnitude of measurement spreads

Set: 111,55°

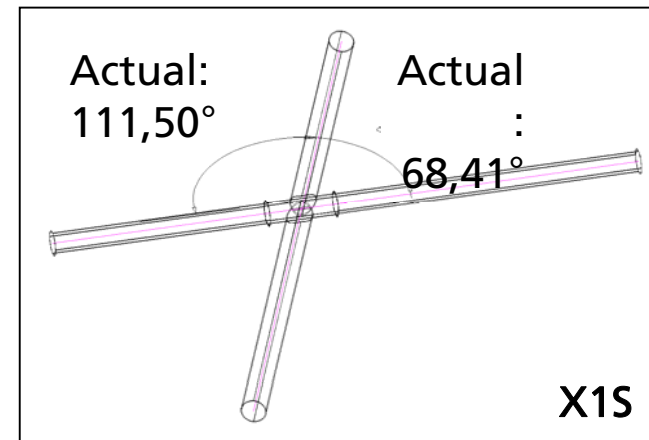
Set: 68,45°



X-node 1, tack welded



*X-node 1, welded,
Check measurement*



X-node 1, welded

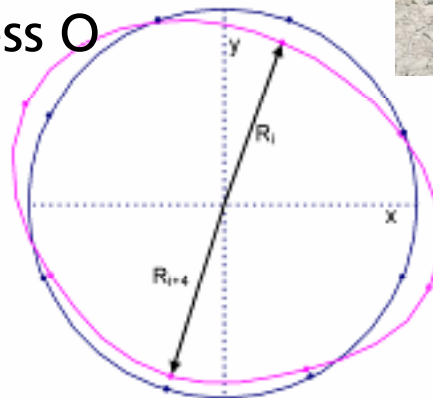
Total station + ultrasonic (1)

10 tubes:

- Measuring devices:
Total station,
calliper ultrasonic thickness gage
measuring tape

Parameters:

- Circumference U (diameter D)
- Wall thickness t
- Out-of-roundness O



→ Agreement with common codes / regulations (DIN EN 10219-2, GL Wind IV-2)

Total station + ultrasonic (2)

Measurement: Jacket

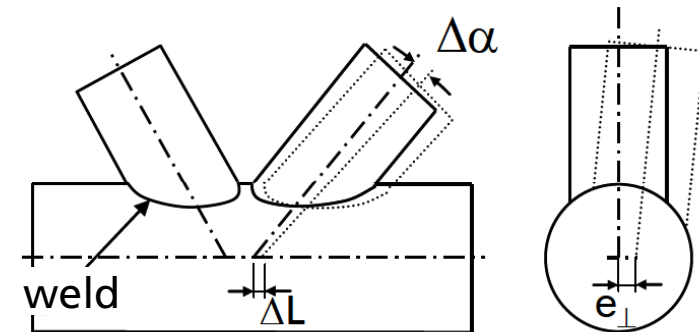
Evaluation of measurements:

- Determination of centerline from surface points

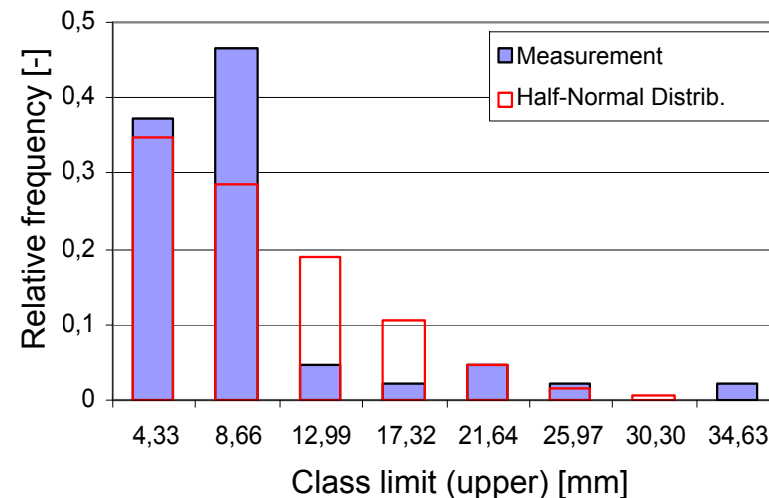
Statistical evaluation of inaccuracies:

- Expected value $\mu=0$ known for $\Delta\alpha$, e_{\perp} und ΔL
- Use of absolute values and classification
- χ^2 -Test for normal distribution not successful

→ More data needed, in order to determine statistically assured distribution



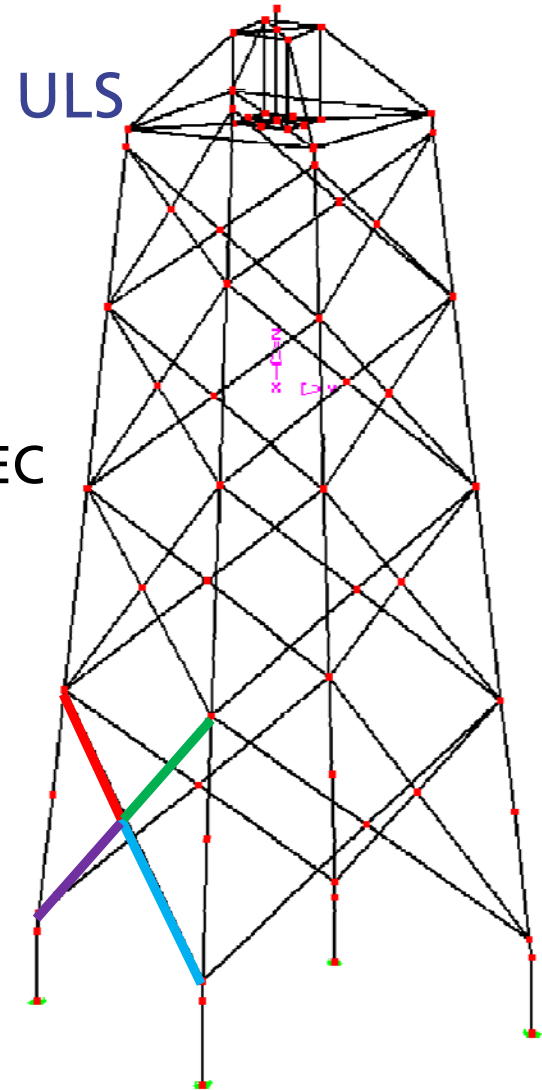
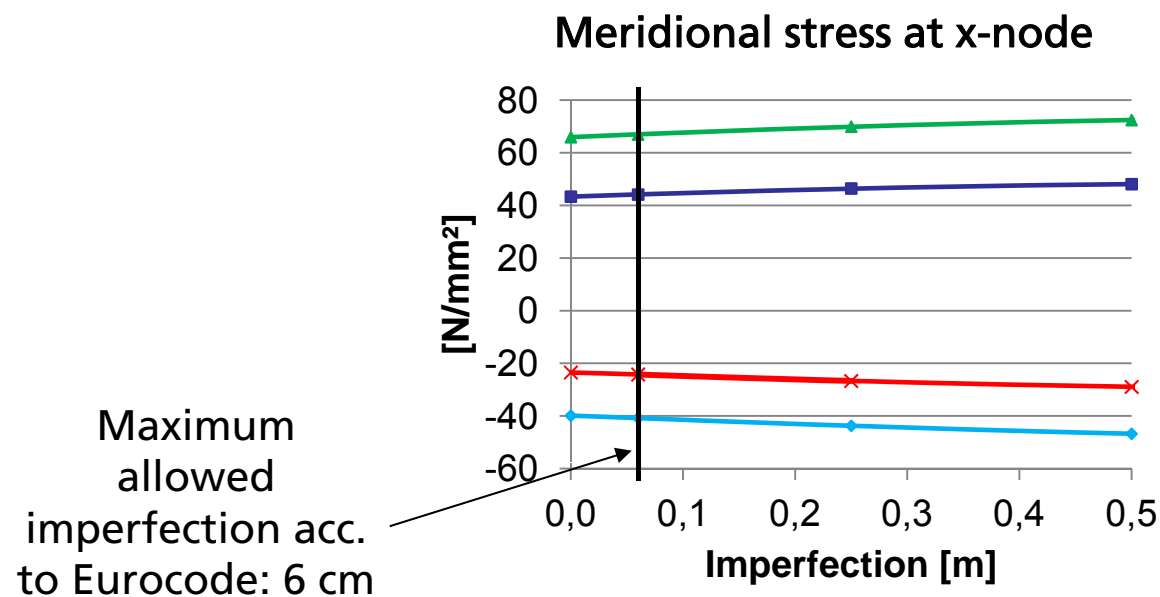
Histogram $|e_{\perp}|$ - (n=43)



Parameter studies (1)

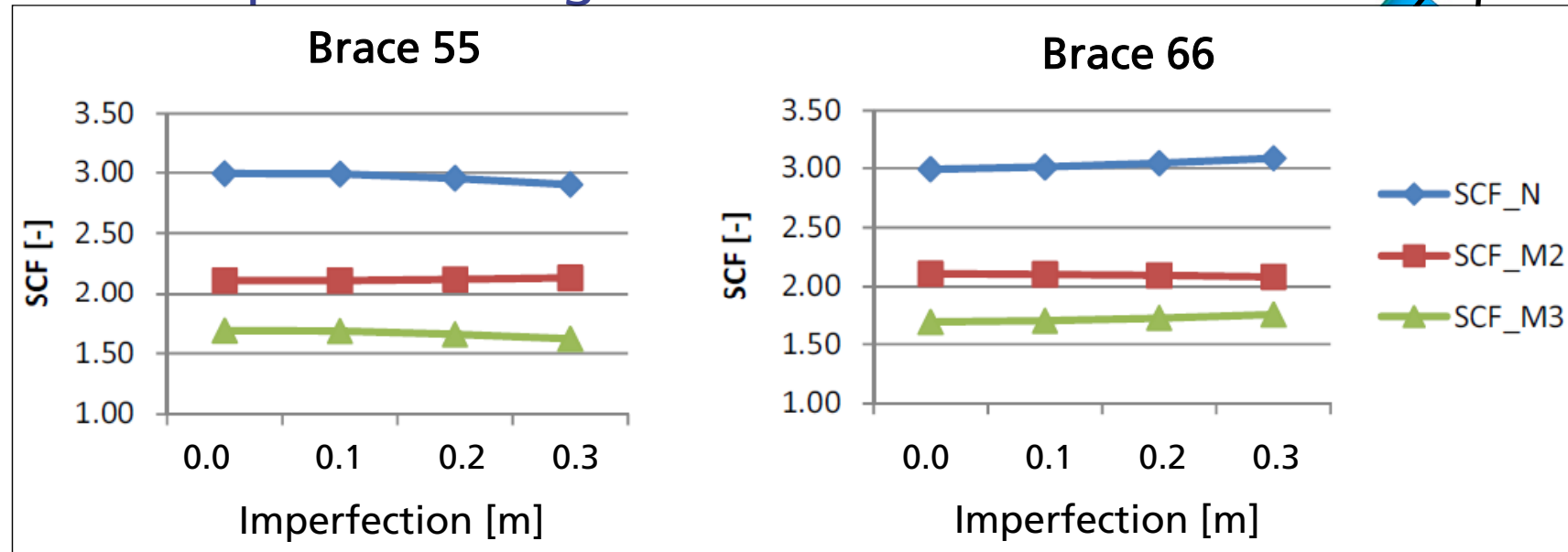
Influence of out of plane eccentricities on ULS

- Calculation on 3D framework
- Imperfection: translation of single nodes
- In detail: out-of-plane translation of X-node
 - $\Delta\sigma \approx 3,3\%$ under max. imperfection acc. to EC

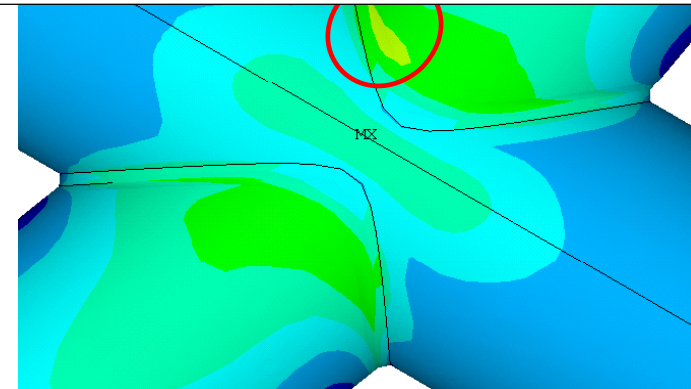


Parameter studies (2)

Lokal impact on fatigue stress



- Small influences on SCF

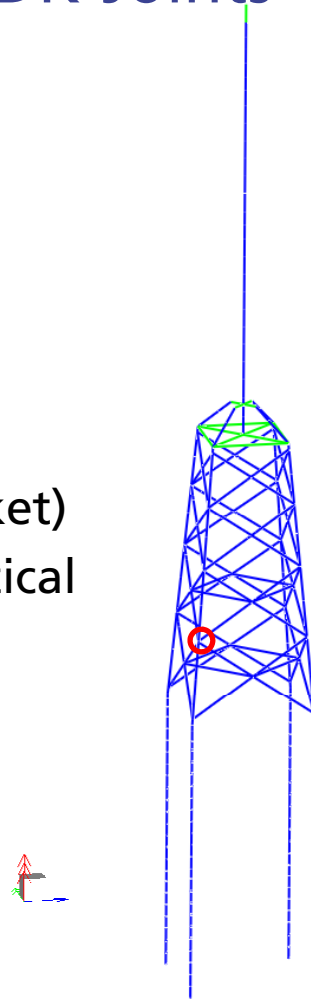


Parameter studies (4)

Investigations on DK-Joints – Global Model

Model AV 4:

- Sea state
JONSWAP-spectrum:
 $H_s = 3 \text{ m}$
 $T_p = 8 \text{ s}$
- 2 directions:
 0° und 90° (rel. Jacket)
- 10 min, „seed“ identical
- ANSYS/ASAS

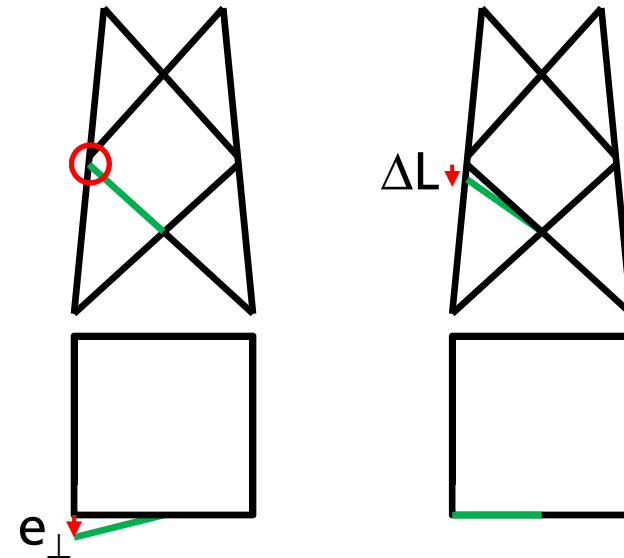


3 Configurations:

0: undeformed

1: $e_{\perp} = 100 \text{ mm}$

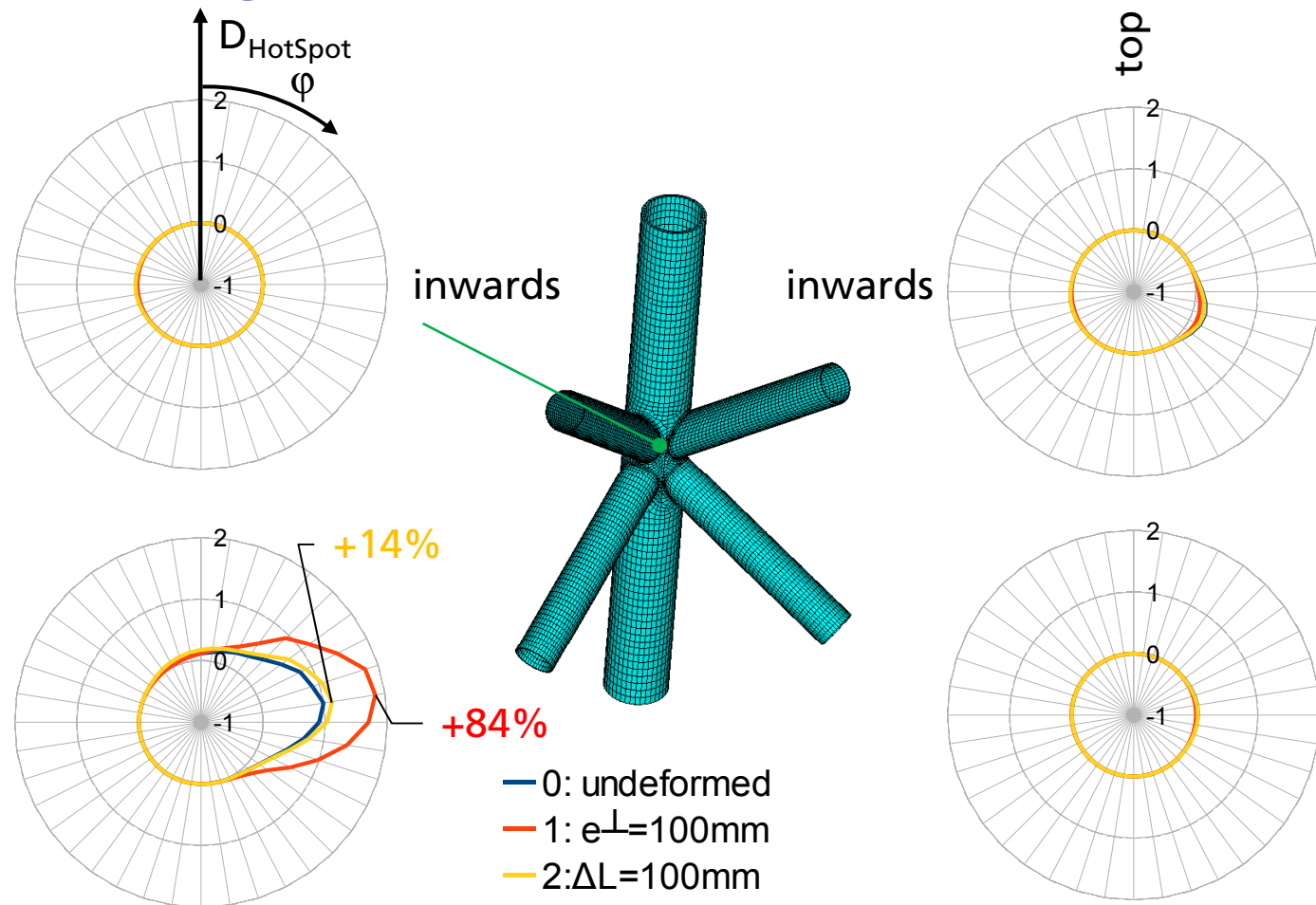
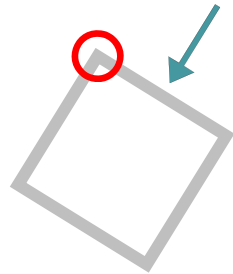
2: $\Delta L = 100 \text{ mm}$



Parameter studies (5)

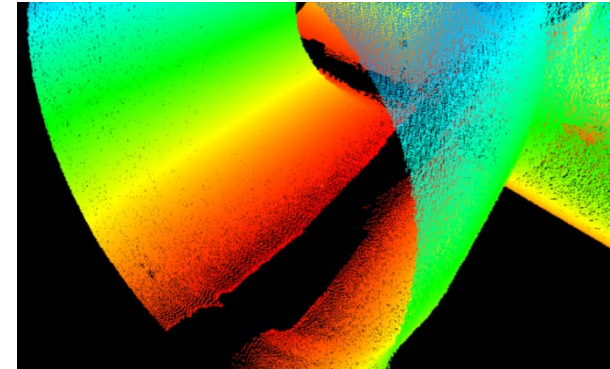
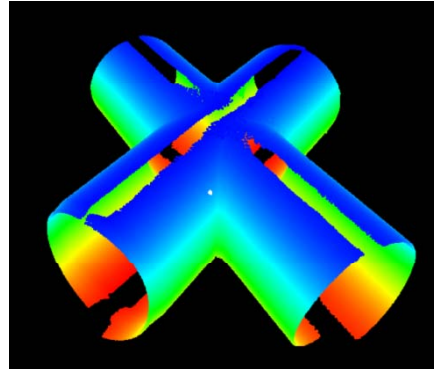
Accumulated Damage Weld – See state 0°-Direction

Chord:
 $m=5$
(norm.)



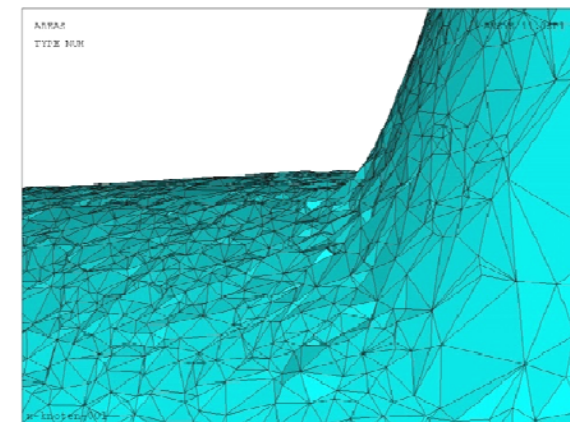
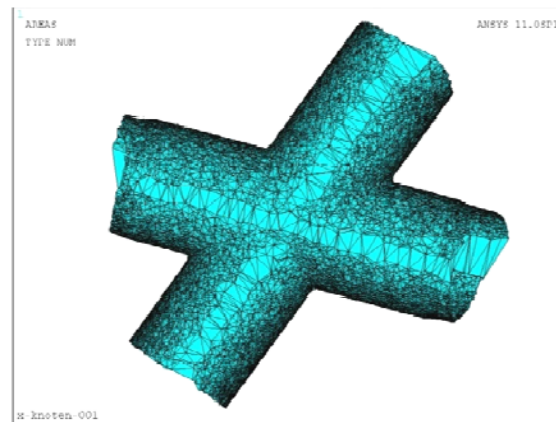
Surface modelling (1)

- Cleaning of point cloud



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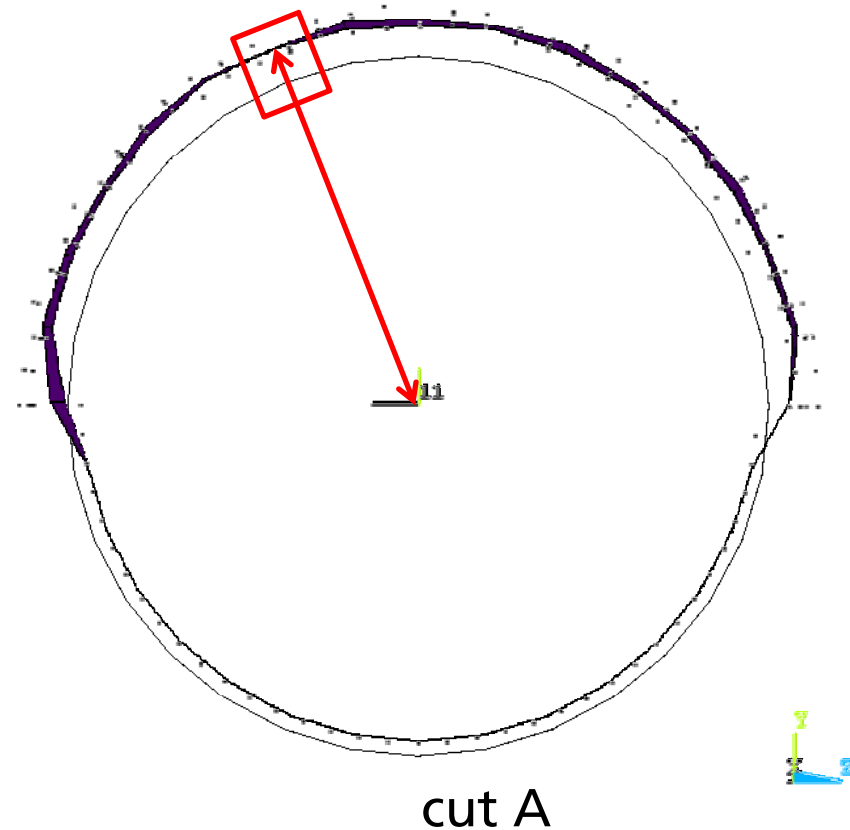
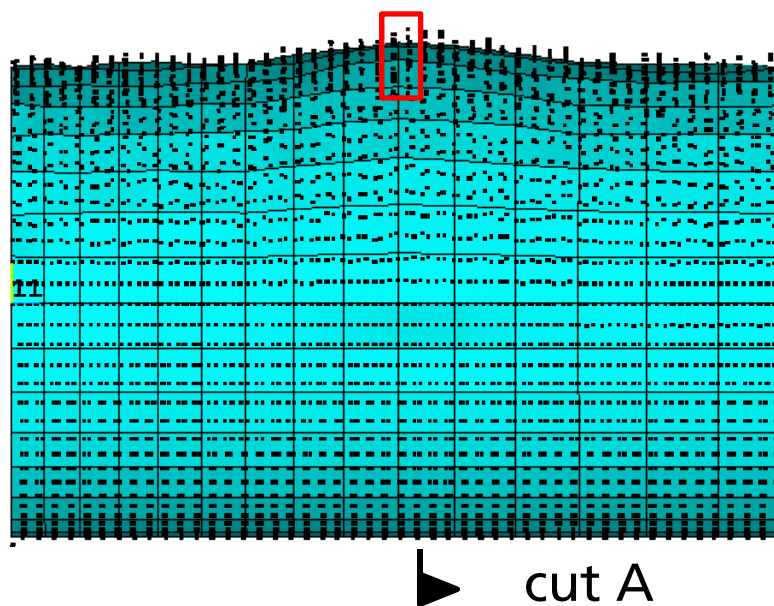
- Measurement point based meshing with triangular elements



Surface modelling (2)

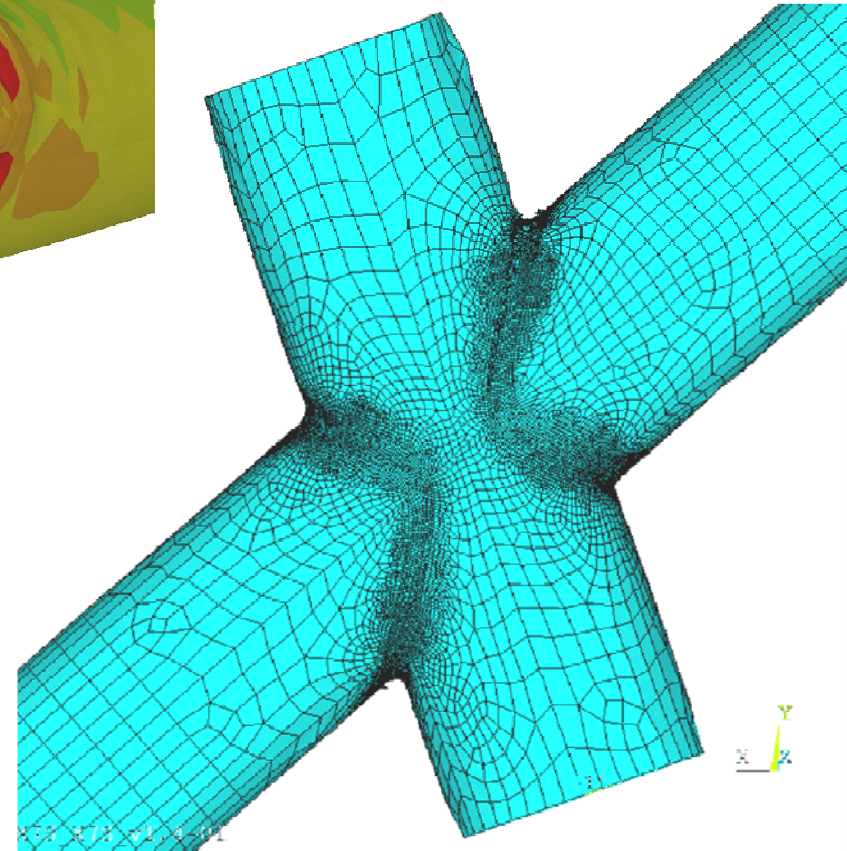
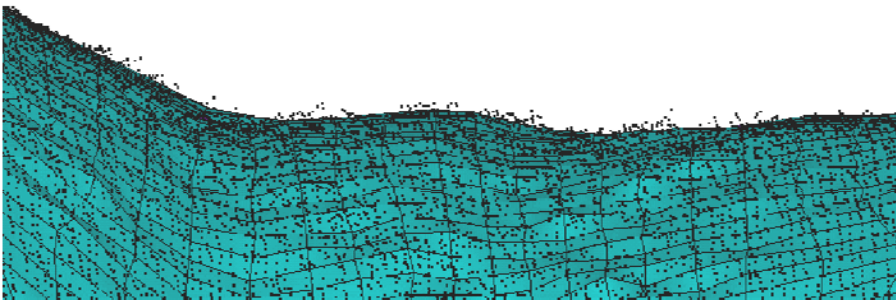
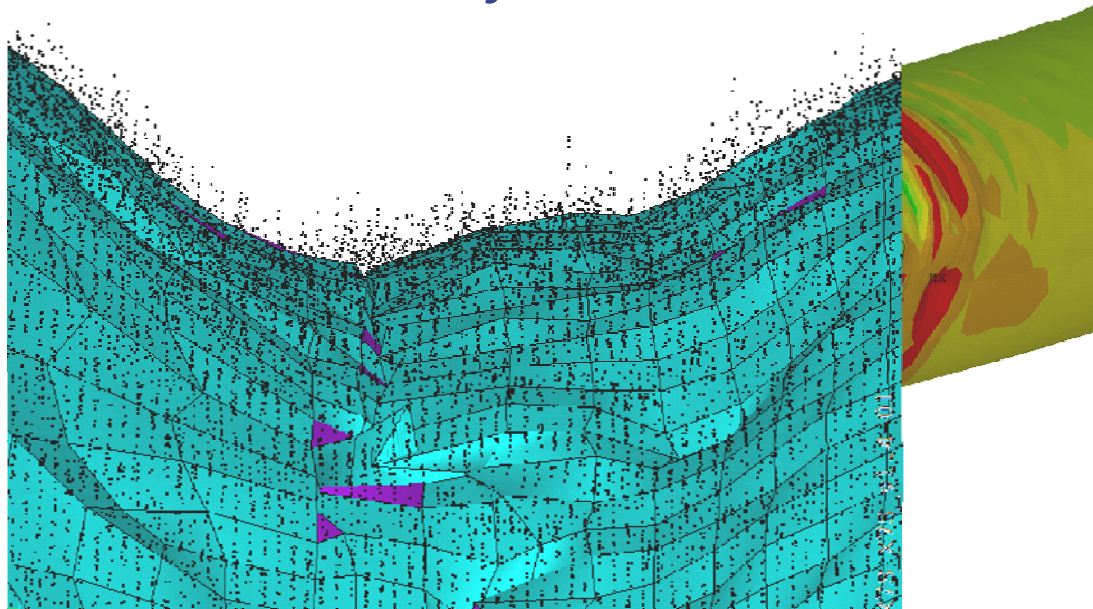
Alternative meshing algorithm

- Impressing of real surface on ideal structure
- Loading of point cloud
- Calculation of new radii
- Translation of nodes



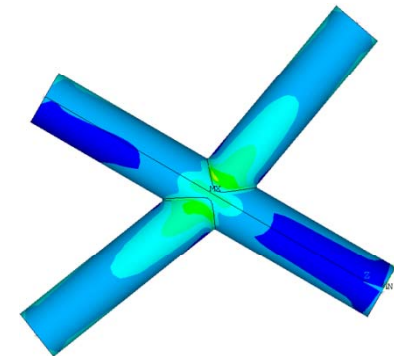
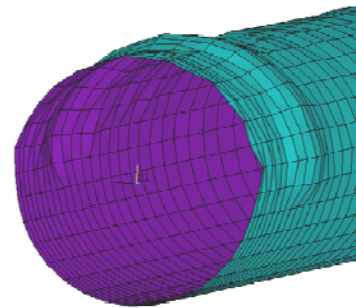
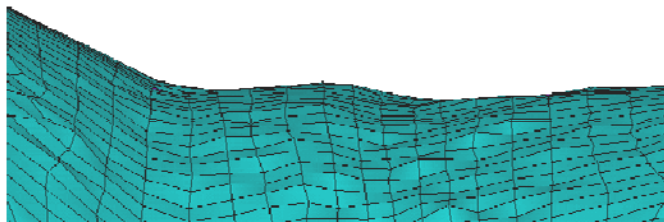
Surface modelling (3)

Structural analysis



Summary

- Applicability of different measuring techniques
- Geometric deviations in tolerance limits
- Optional reduction of substitute design imperfections
- Development of numerical tools for evaluation and reverse engineering (-> FEM)



Thank You very much for your attention!

