FAMOS 4 Wind

Lebensdauerbewertung von WEA Türmen auf Basis realer Lasten

Steffen Bergholz, Nadim Moussallam; Rainer Ziegler
Framatome GmbH
steffen.bergholz@framatome.com
Tel.+49 9131 900 96170

Spreewindtage 2019
Potsdam, 06. November 2019

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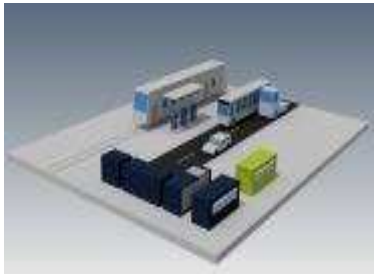
Covalion* als Spin-Off der Framatome GmbH

Covalion ist Systemintegrator für Wasserstoff- und Batteriespeicherlösungen

- Projektentwicklung – Engineering – Systeme – Komponenten – Realisierung – Service – Betrieb
- Jahrzehntelange internationale Projekterfahrung – bewährte, industrielle Infrastruktur
- Frische Ideen von und mit hochqualifizierten Experten



z.B. H_2-Tankstellen

z.B. H_2-Speicher-technologien

z.B. H_2-Erzeugungs-technologien

z.B. Batteriespeicherlösungen

*Marke

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Content

- LTO – Key for “Energiewende”?
- FAMOSi – Fatigue Monitoring System
- FAMOS 4 WIND
- Summary

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LTO
Key for success of Energiewende ?

Project “German Energiewende”

➔ **is an highly ambitious project, followed by increasing energy costs**

➔ **about 10,000 additional 3MW wind turbines are necessary in order to replace the existing NPP’s up to 2022**

➔ **amortize wind turbines**
shall run as long as possible to limit or reduce the energy costs

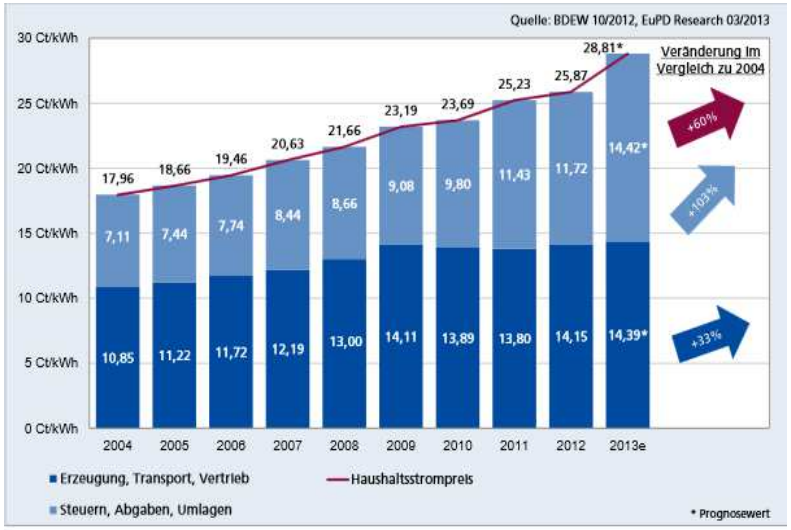

Abbildung 56: Entwicklung der Haushaltsstrompreise in Deutschland

➔ **strategies for LTO on renewable energy market shall be items on the agenda**

» **reuse of existing industrial approaches can support LTO of wind turbines**

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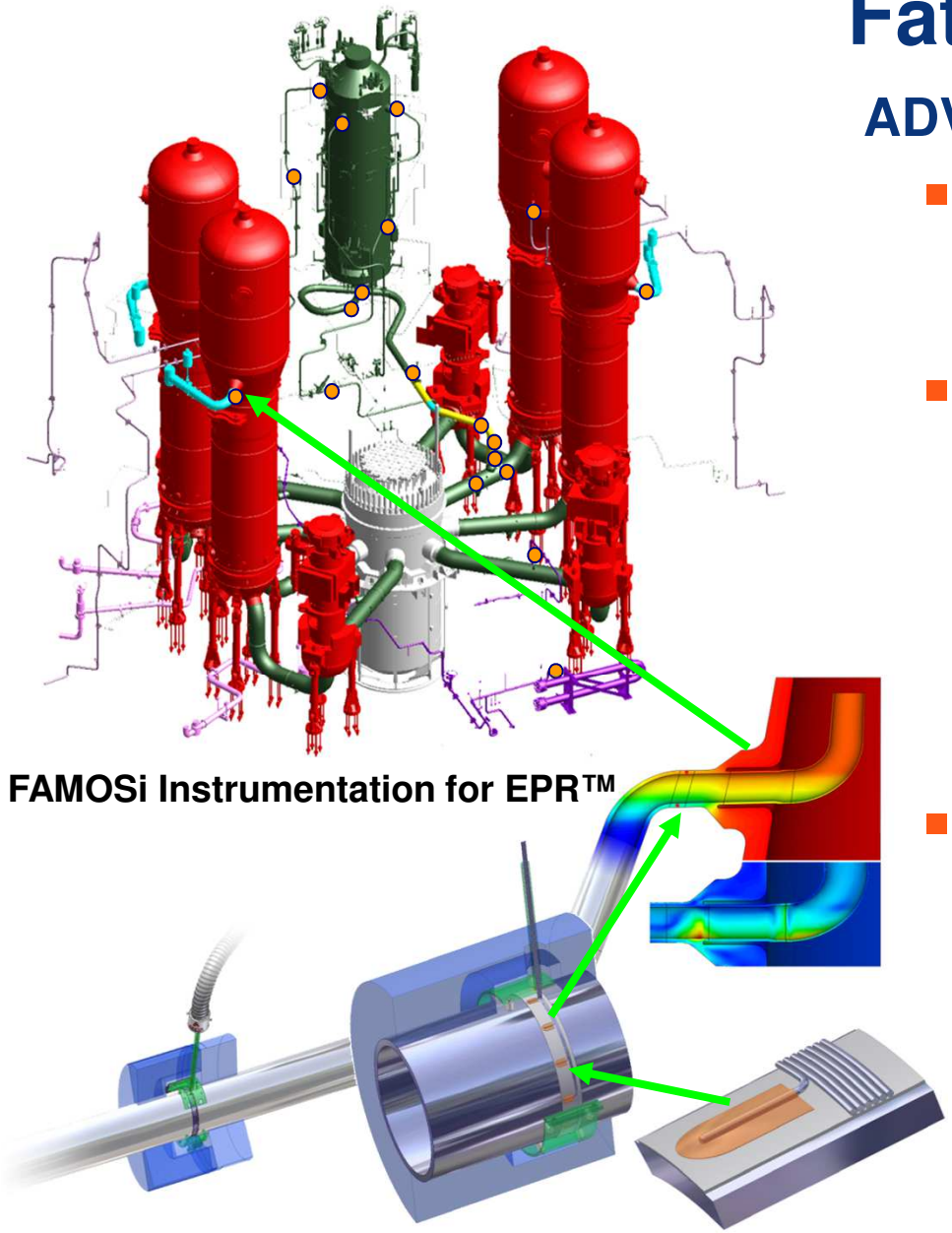
Fatigue Monitoring based on

ADVANCE FATIGUE SOLUTION (AFS)



FAMOSi Instrumentation for EPR™

- **Load monitoring**
  - The component loading data acquisition is based on appropriate measurement systems (FAMOSi)
- **Automatic fatigue analysis e.g. based on the Fast Fatigue Evaluation (FFE) module**
  - The measured temperature is transformed to a stress-time-history at the relevant component positions by means of the elementary transients approach and the cumulative usage factor is calculated
- **Efficient fatigue software**
  - Efficient data processing is based on a modern signal processing software with fast and flexible data viewer and SQL data base structures
  - Data can be centrally stored and evaluated

» **Realistic fatigue monitoring**

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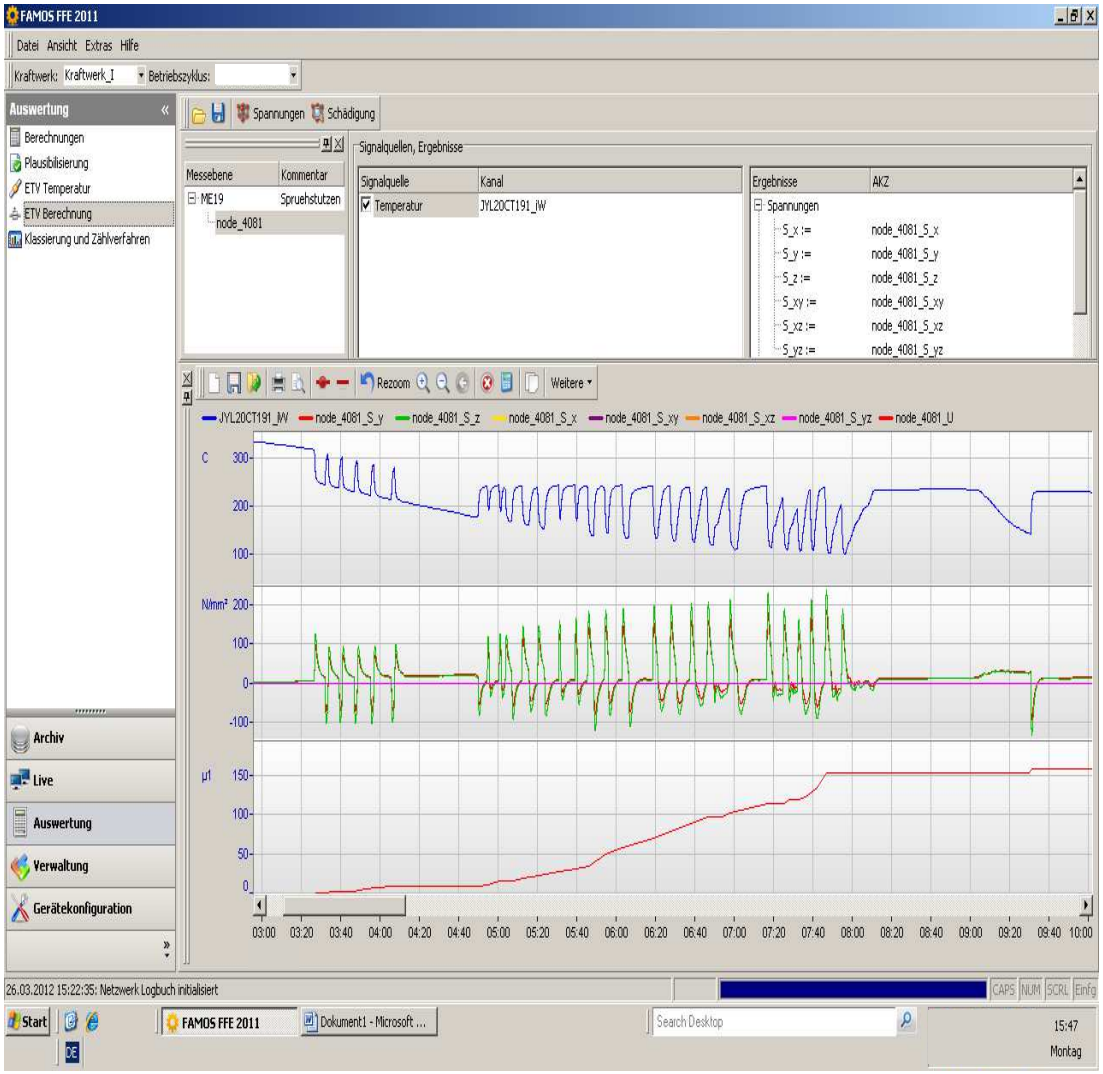
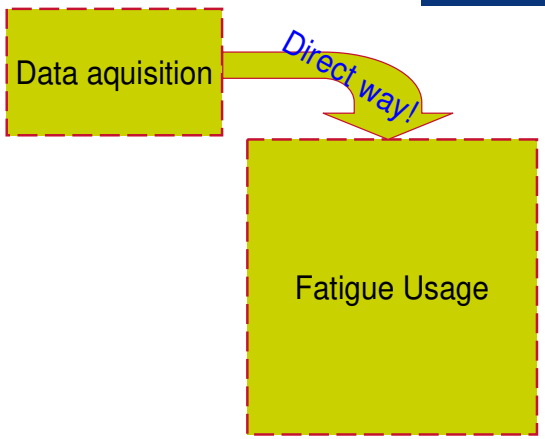
Direct Fatigue Assessment Methods





Temperature

Stress

Real fatigue usage

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CMS for wind turbines

Condition based

Load based

Monitoring of changes in the state of the wind turbines

Lifetime analyses based on realistic dynamic loads

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Advance Fatigue Solution (AFS)
Synergy to wind turbines

Synergies	Thermal power plant	Wind Turbines
Load	Cyclic change of Pressure Temperature	Stochastic change of wind and wave loads
Load data acquisition	Measurement of pressure and temperature	Strain gauges; measurement of rotation number, force, acceleration and distance
Automatic stress analysis	Elementary transients approach applicable	Elementary stress response approach applicable
Efficient software	FAMOSi is available	FAMOSi is available, can be adapted to other kinds of load data acquisition
Advantages	Realistic stress and ageing analysis by way of direct assessment of measured data ➔ optimized maintenance	No application of load collective data required by way of direct assessment of measured data and very realistic stress analysis ➔ optimized maintenance ➔ Basis fot lifetime extension

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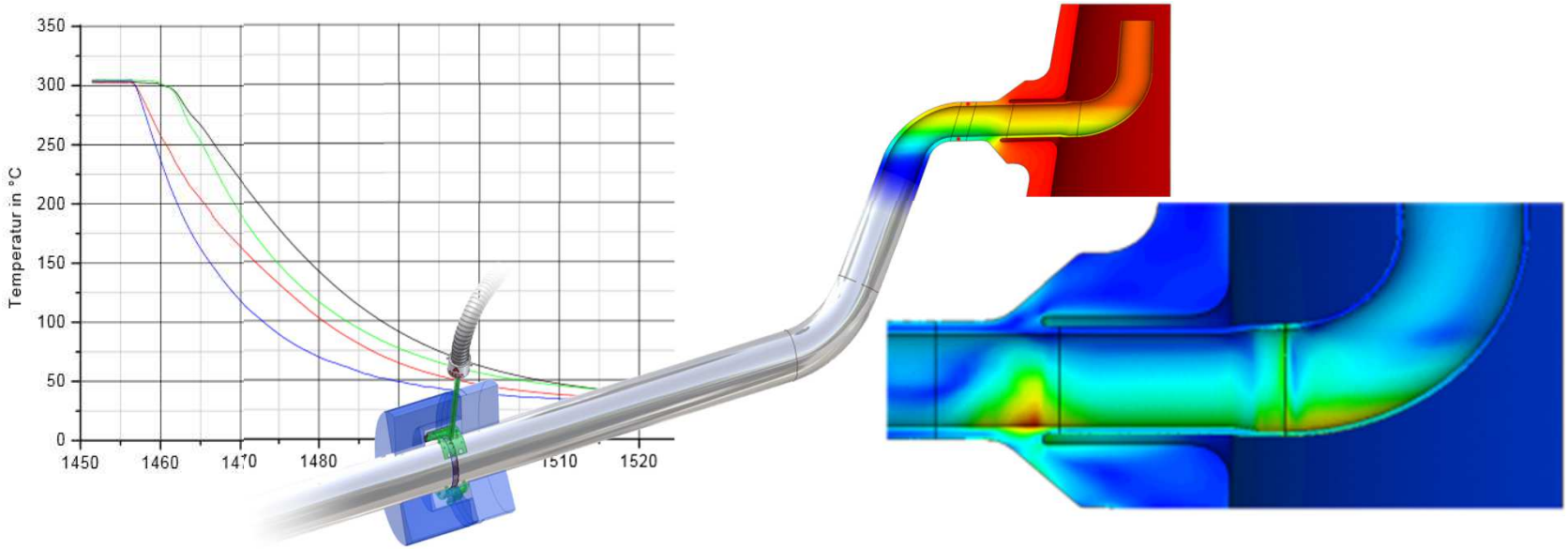
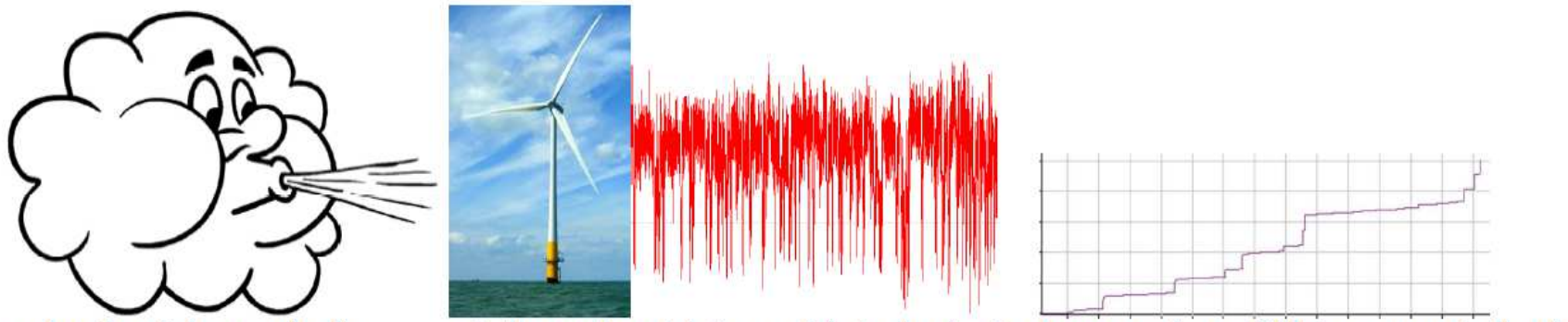
Load ➔ Damage Correlation





outer load (e.g. wind) ➔ inner load (stress histories) ➔ damage (e.g. CUF accumulation)

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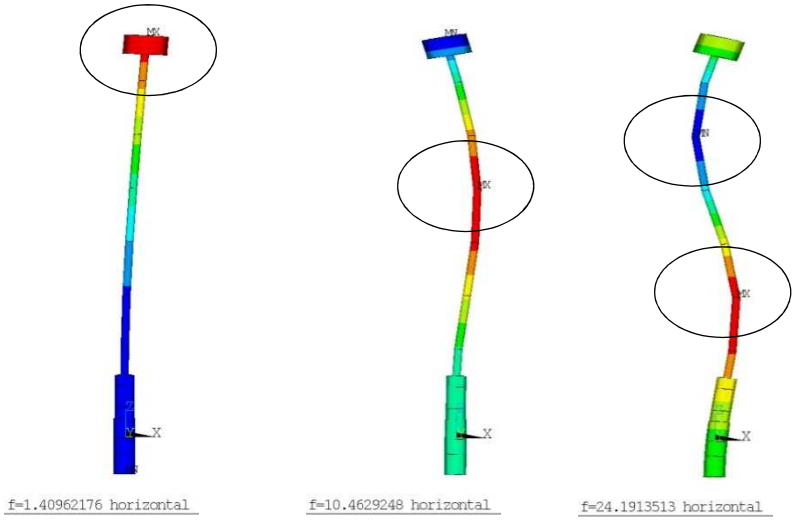
Stress determination based on real time acquisition

For dynamic problems:

Determination of measurement locations dependent on the dynamic behavior of the structure.
That‘s why important:

- **Determination of the Eigenvalue behavior**
- **Direction of stresses (e.g. for the selection of bending and torsion)**
- **Simple calculation model: Reduction of the structure to master degrees of freedom**

Mode 1 **Mode 2** **Mode 3**



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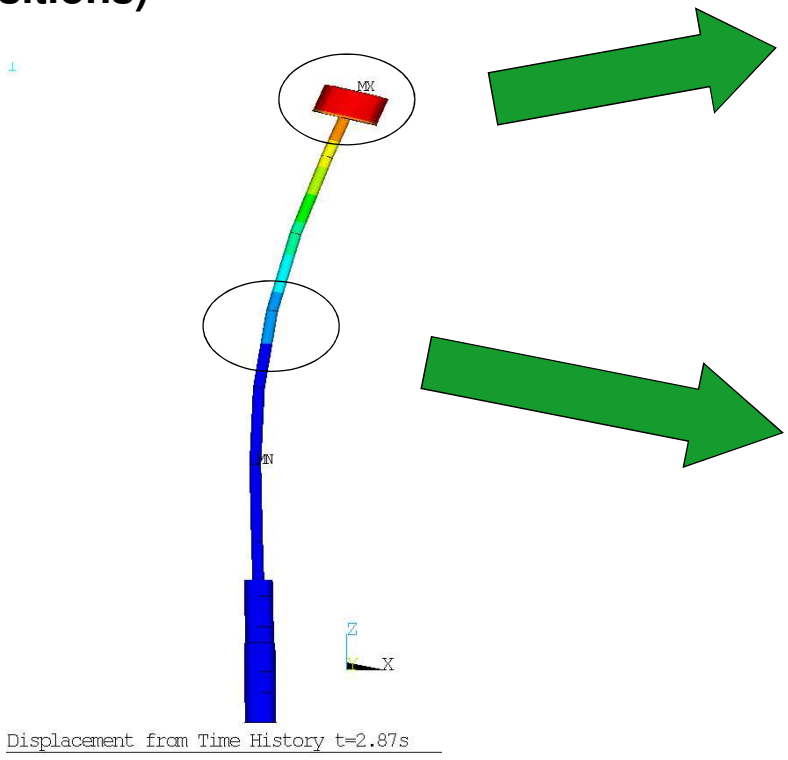
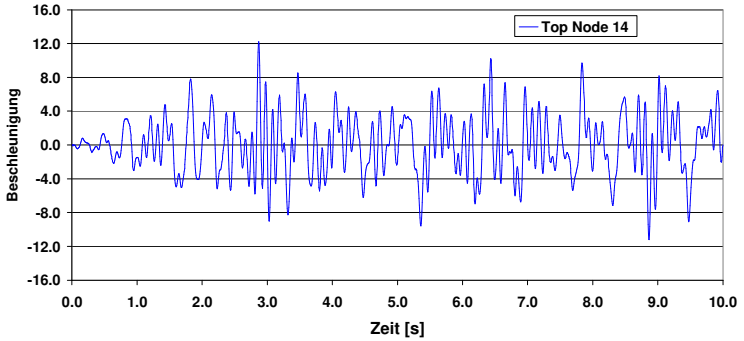
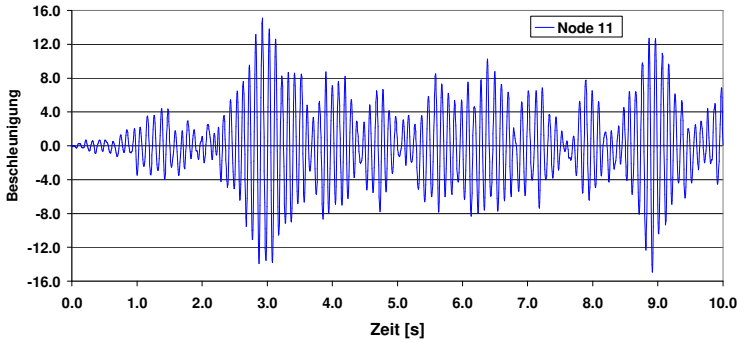
Stress determination based on real time acquisition

Measured acceleration

(shown e.g. for two selected positions)







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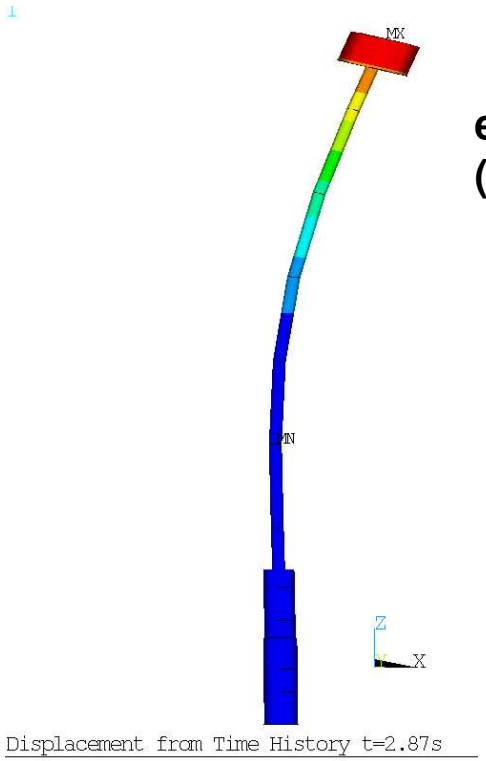
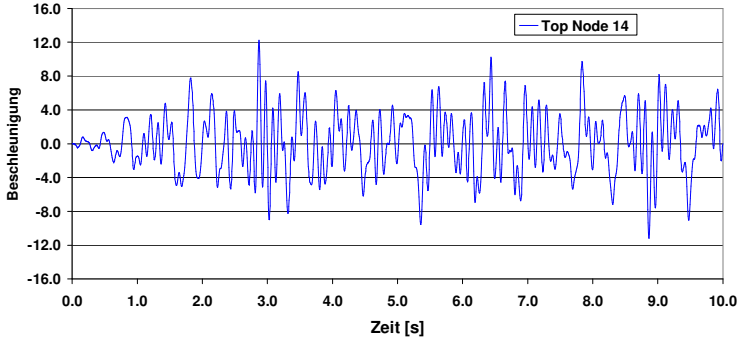
Stress determination based on real time acquisition

Time dependent determination of the deformation state at all principal degrees of freedom

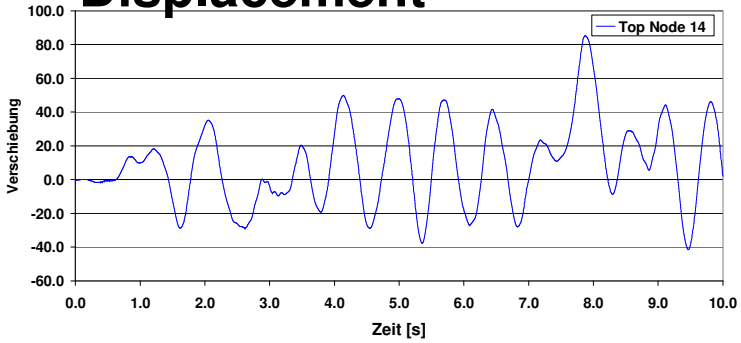


e.g. at node 14 (above)

Acceleration



Displacement



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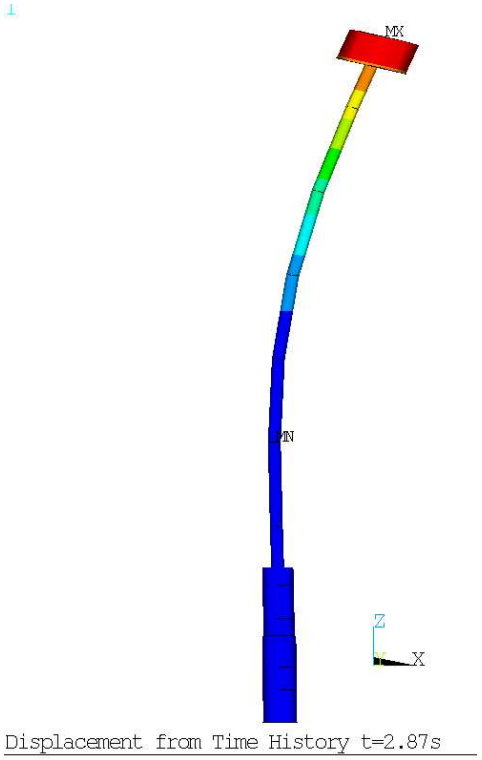
Stress determination based on real time acquisition

Time dependent determination of the section forces:

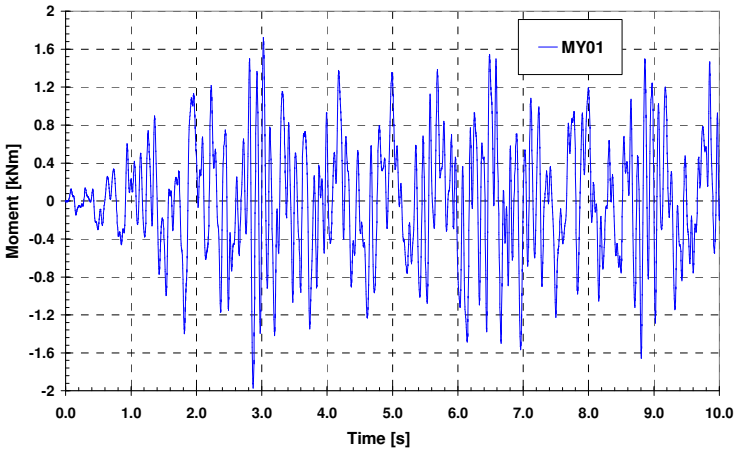
Application of reduced stiffness matrices of the structure

$$[K] u = F$$



At node 1 (below)

e.g. bending moment



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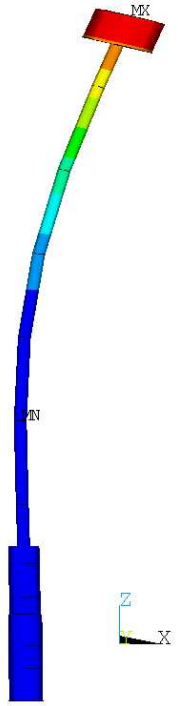
Stress determination based on real time acquisition

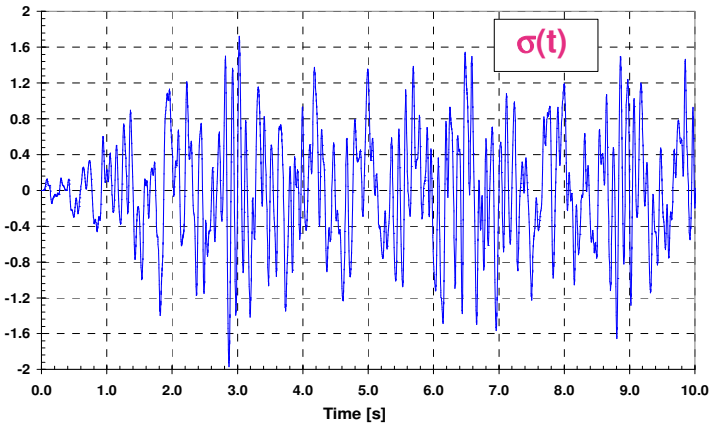
Time dependent determination of the stresses:



The stress-time-history is calculated based on the stored stress responses σ_0 for the elementary loads:

e.g. for moment $\sigma(t) = \sigma_0 \cdot M(t)/M_0$

e.g. at node 1



Basis for realistic fatigue assessment

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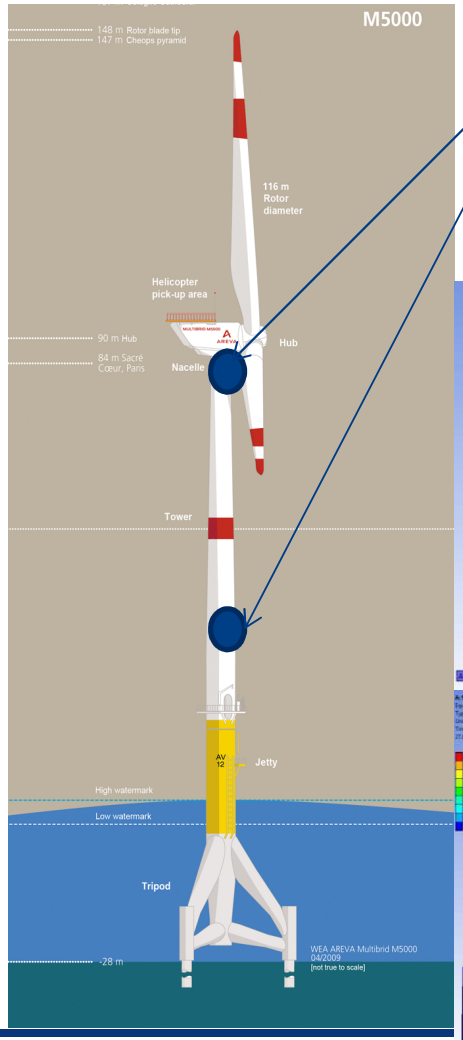
Possible application on M5000 example



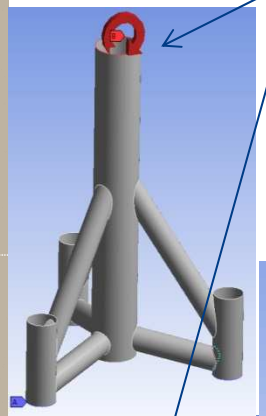
Acceleration measurement

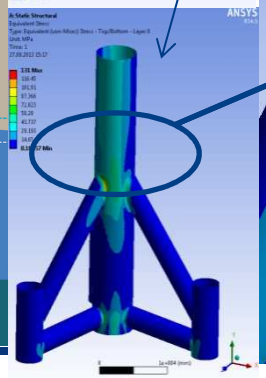
Calculation of inner loads

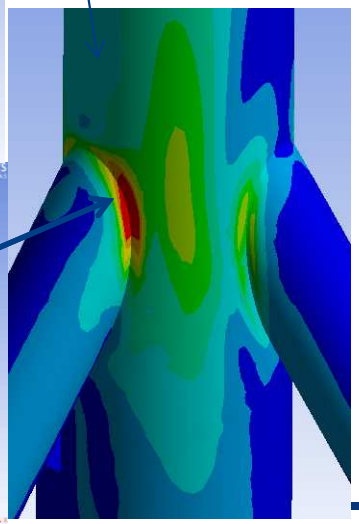
Scaling of the component elementary stress responses

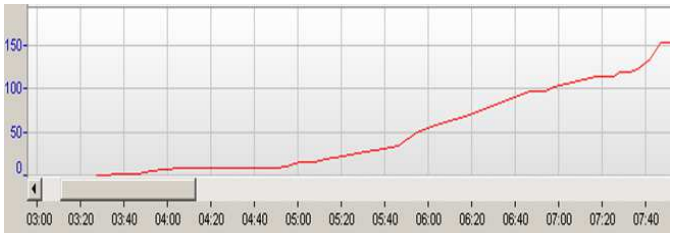
Local stress-time-histories

Fatigue damage accumulation









Fatigue assessment of all relevant positions of the tower possible

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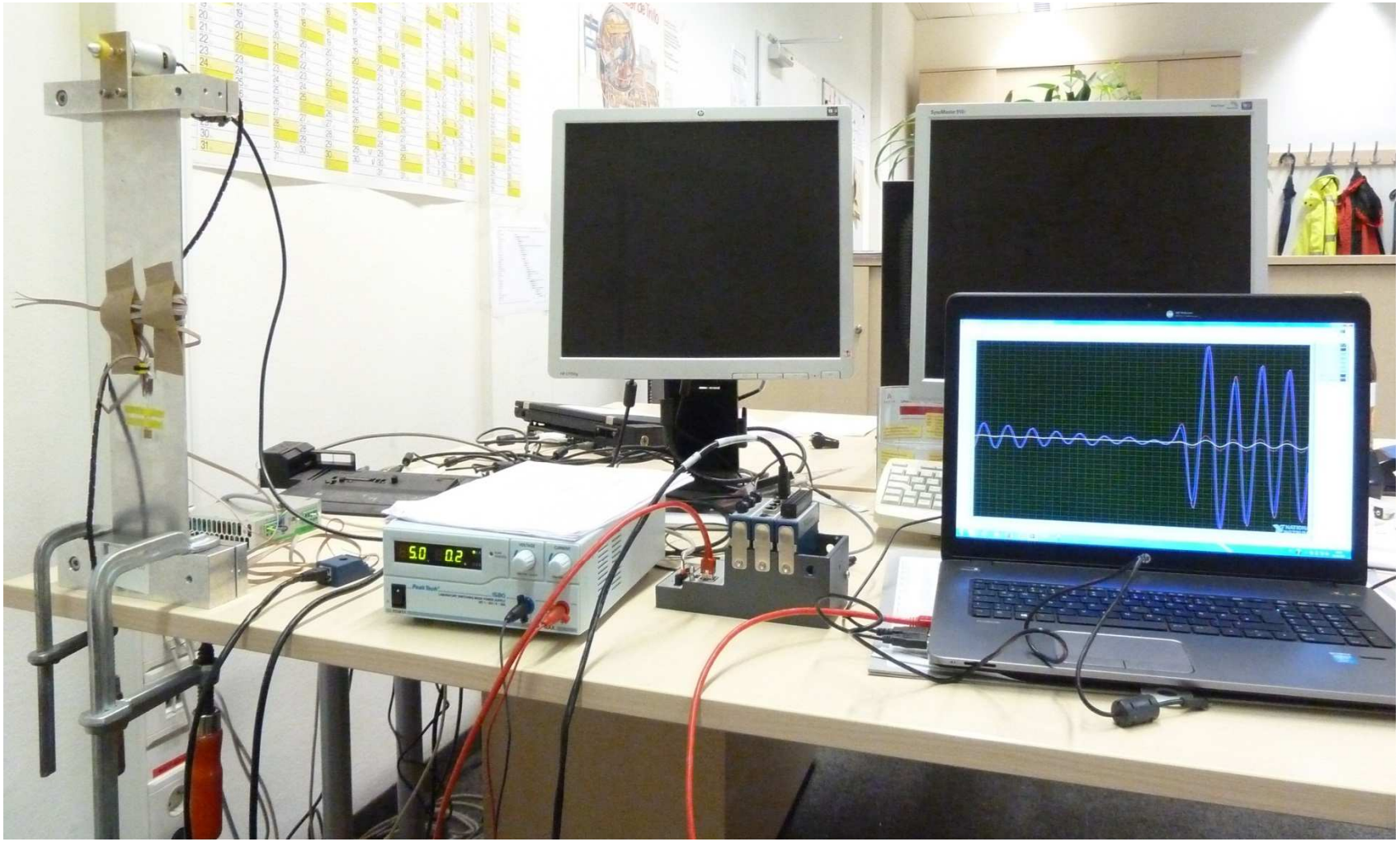
Verification on test equipment



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FAMOS 4 Wind
Summary

- Experiences in Fatigue Monitoring on **Thermal Power Plants** available
- Reuse for **Wind Energy** possible

- **Advantages of FAMO4Wind:**
  - **Basis for LTO (Weiterbetrieb)**
    ➔ reducing the energy cost
  - **NDT is plannable based on real condition**
    ➔ cost saving
  - **Knowledge of damage status can be the basis for load ranking within a wind park**
  - **Investors value will be increased**

Using automated SHM solutions

Load ➔ Damage Correlation

can support "German Energywende"

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Vielen Dank

für Ihre Aufmerksamkeit !

FAMOS 4 Wind

Steffen Bergholz
Framatome GmbH
steffen.bergholz@framatome.com
Tel.+49 9131 900 96170

Spreewindtage 2019
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