Vibrationanalysis with High Speed Image Correlation

Partners for progress

Content

1. Overview Dantec Dynamics
2. Technology
3. High Speed Applications
4. Conclusion

Dantec Dynamics

- **Founded in 1947 by DISA as a dedicated business unit**
- **Private Limited company since 1992, by LD Equity, Vitesse A/S, management and employees**
- **Share capital: 15 m DKK**
- **Export sales: 99% of turnover**
- **ISO 9001:2000 certified**

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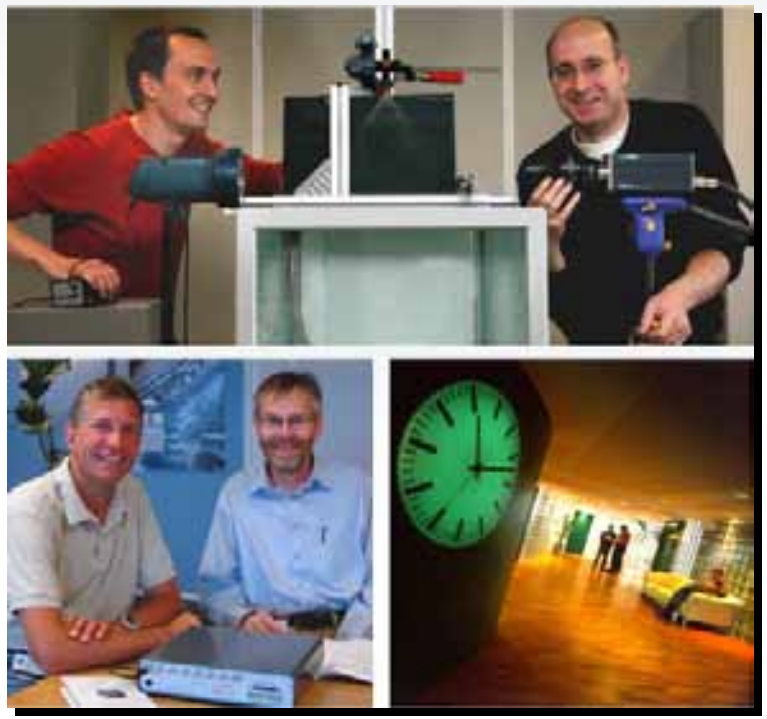
Offices and employees

- **Headquartered in Copenhagen, Denmark**
- **Sales subsidiaries in 5 countries**
- **120+ employees worldwide, the majority with MSc, PhD and other postgraduate degrees**
- **Average time of service for employees is 13 years**



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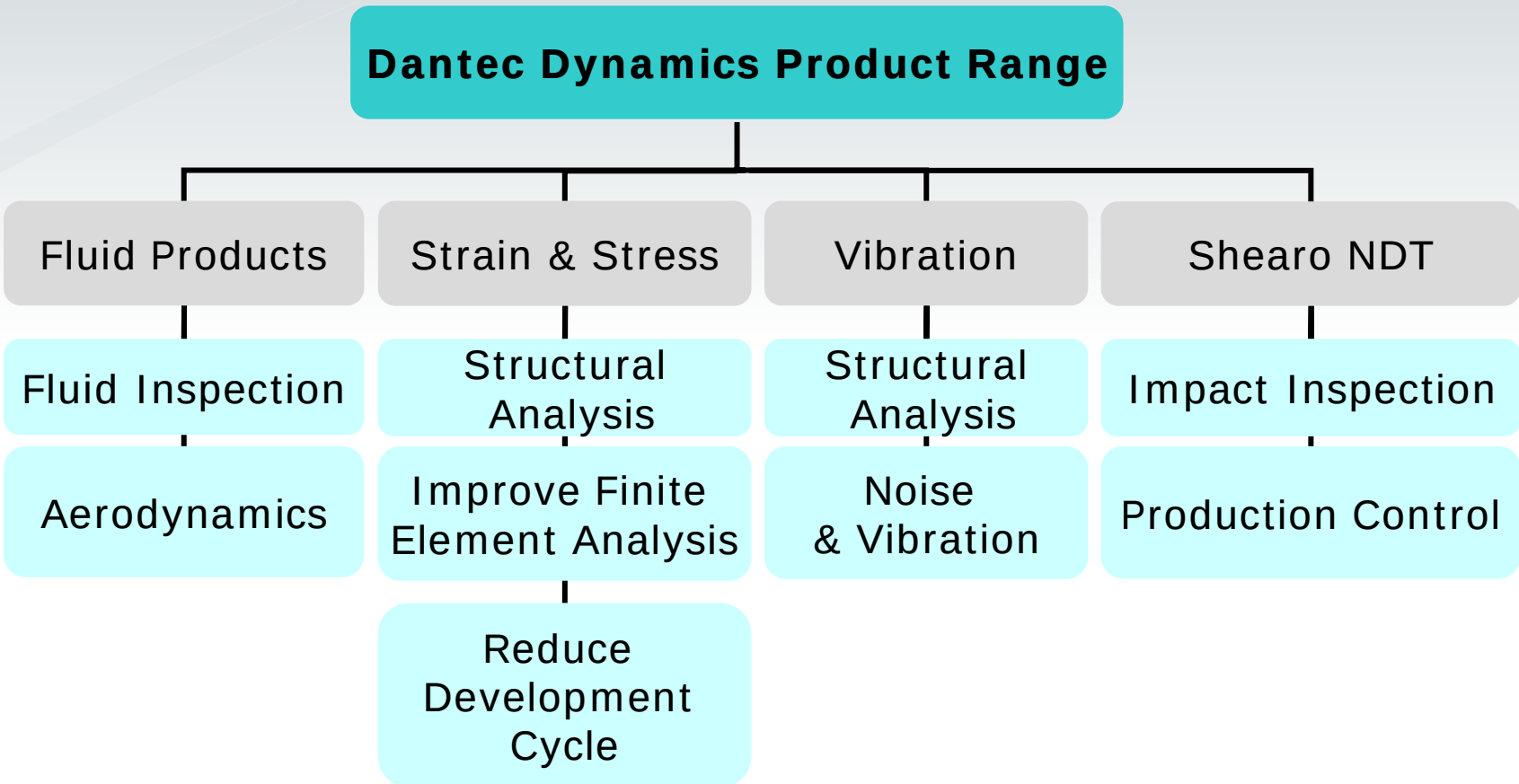
Dantec Product Range



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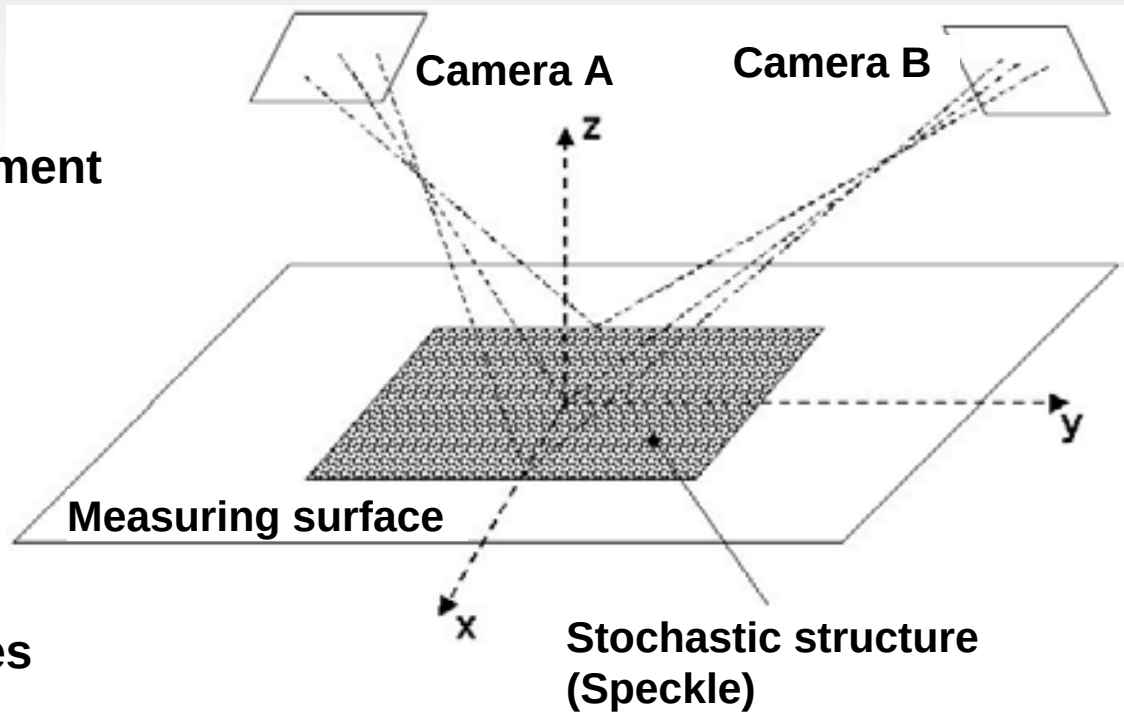
Digital Image Correlation

- 3D- displacement and contour information
- Strain information
- Full field measurement
- Non contact measurement
- High strain rates

Digital Image Correlation

- **Principle**
  - **Stereoscopic camera system**
  - **Surface preparation with stochastic pattern**
  - **For 3D contour and displacement measurement optimized correlation algorithm, based on affine transformation, identifies homologous points**
  - **With known optical parameters the surface positions can be reconstructed from two camera images**



Digital Image Correlation (Q-4xx Systems)

- **Calibration:**
  - **On-line Calibration (typically 8 images)**
  - **Real-Time detection of calibration marker and Quality feed back**
  - **Calculation of Calibration Parameter and their std. Deviation**
- **Measurement:**
  - **1st Step: Recognition of the Shape**
  - **2nd Step: Recognition of Displacement**
  - **Result: Geometry, 3D-Displacement and Strain**
- **Visualization and Analyzing:**
  - **3D model with mapped data (e.g. Contour, Displacement, Strain)**
  - **Multiple virtual Gauge Elements (Points, Lines, Areas)**
  - **Quick visualization of results(Reports, Spatial and Temporal Plots)**
  - **Multiple Coordinate Systems (eg. Sensor-, Object-, User- Coordinate systems)**
  - **Easy export using Clipboard and Open data format (HDF5)**

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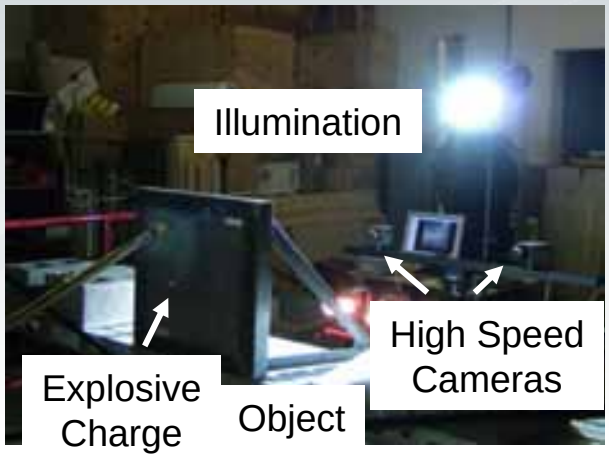
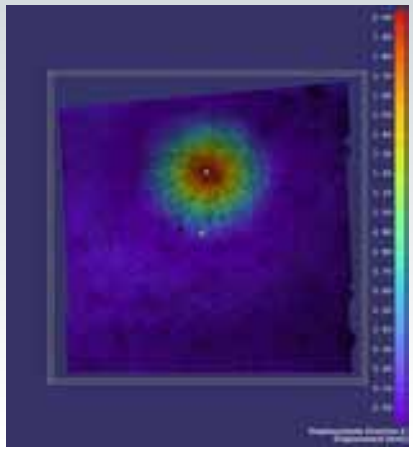
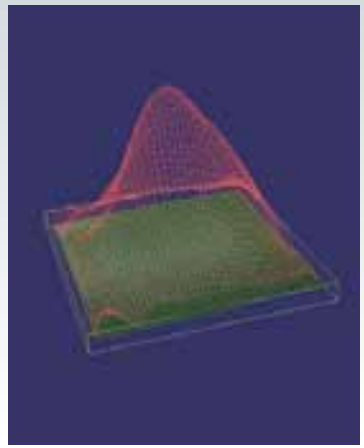
Recent High Speed Applications

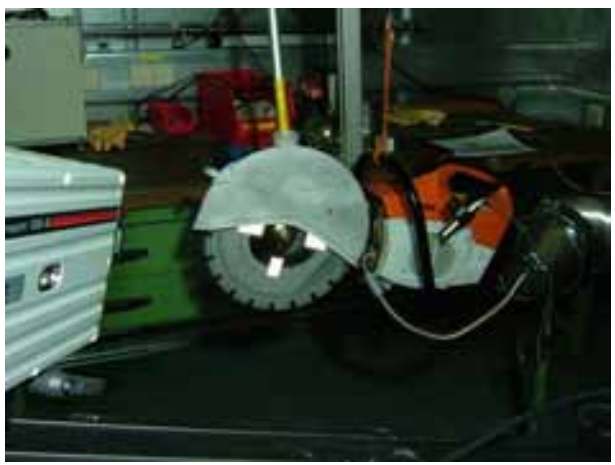


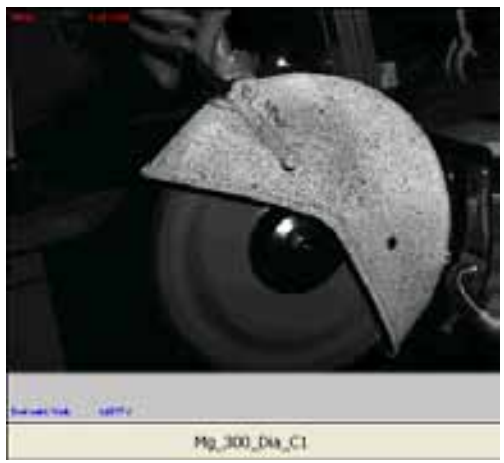




Shock Excitation

(ms resolution)





Vibration meas. on manually operated tool (friction saw)

(large rigid body movement)

Harmonic Excitation

- Measurement of a vibration membrane
  - -Object: Bass Loudspeaker with rubber membrane
  - -Frequency: 59,93 Hz
  - -Frame Rate: 1000 Hz
  - -Out- of plane deformation starting from the excitation

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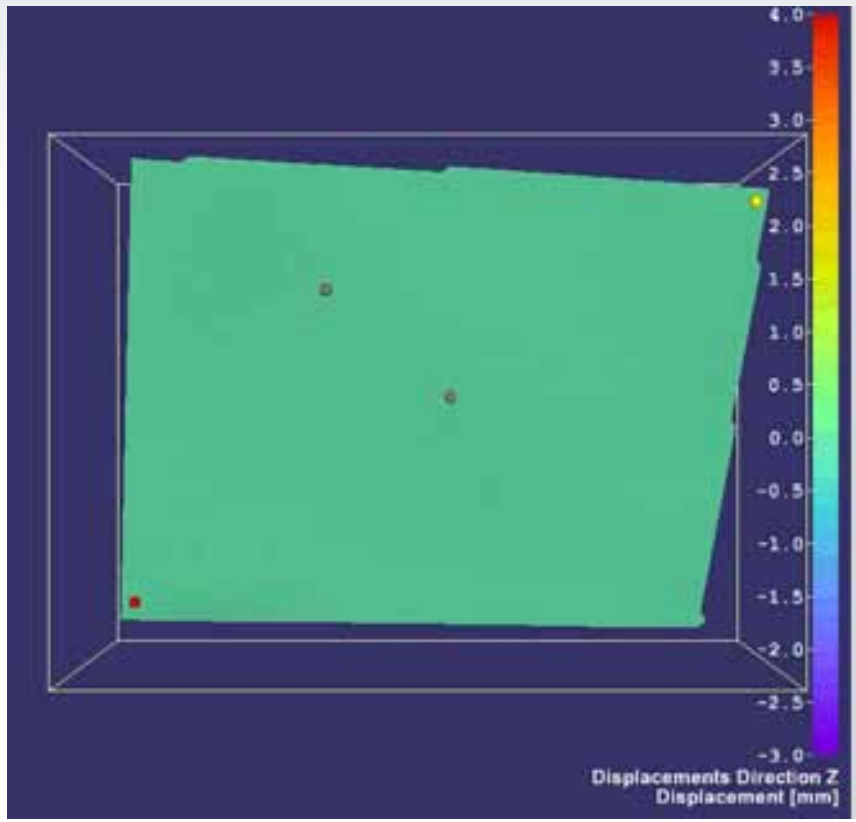
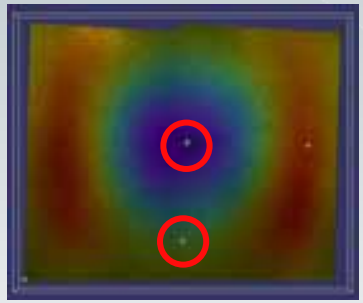
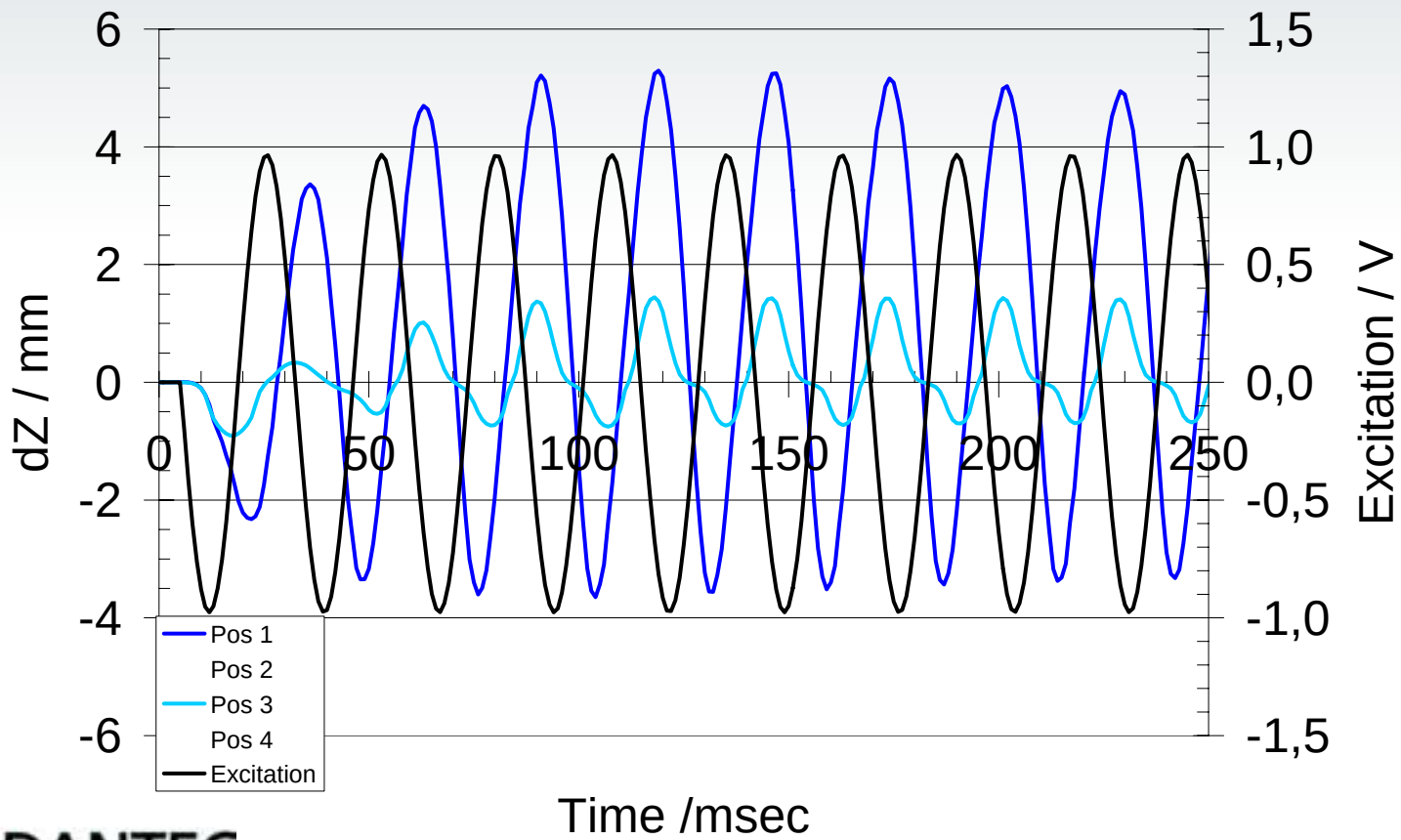


Harmonic Excitation



- 36.5 Hz



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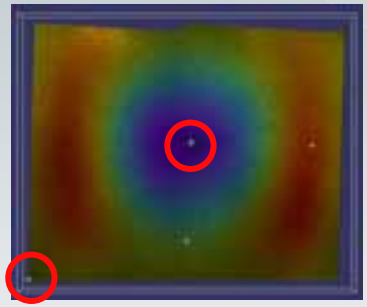
Harmonic Excitation



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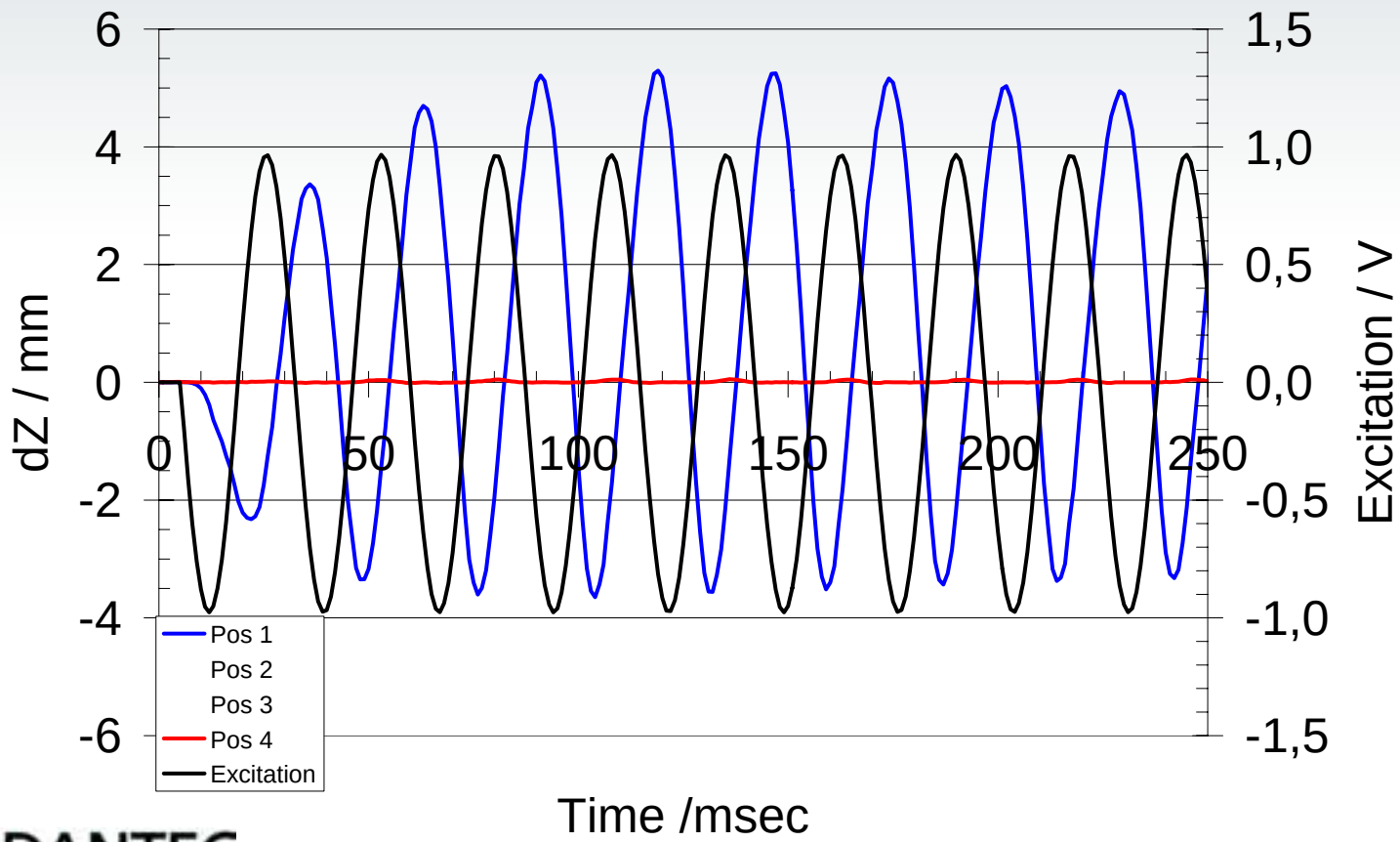

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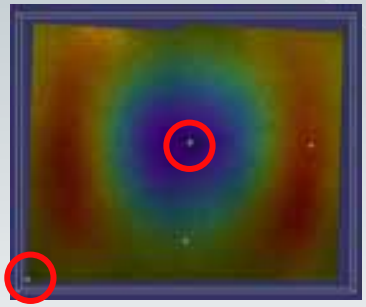
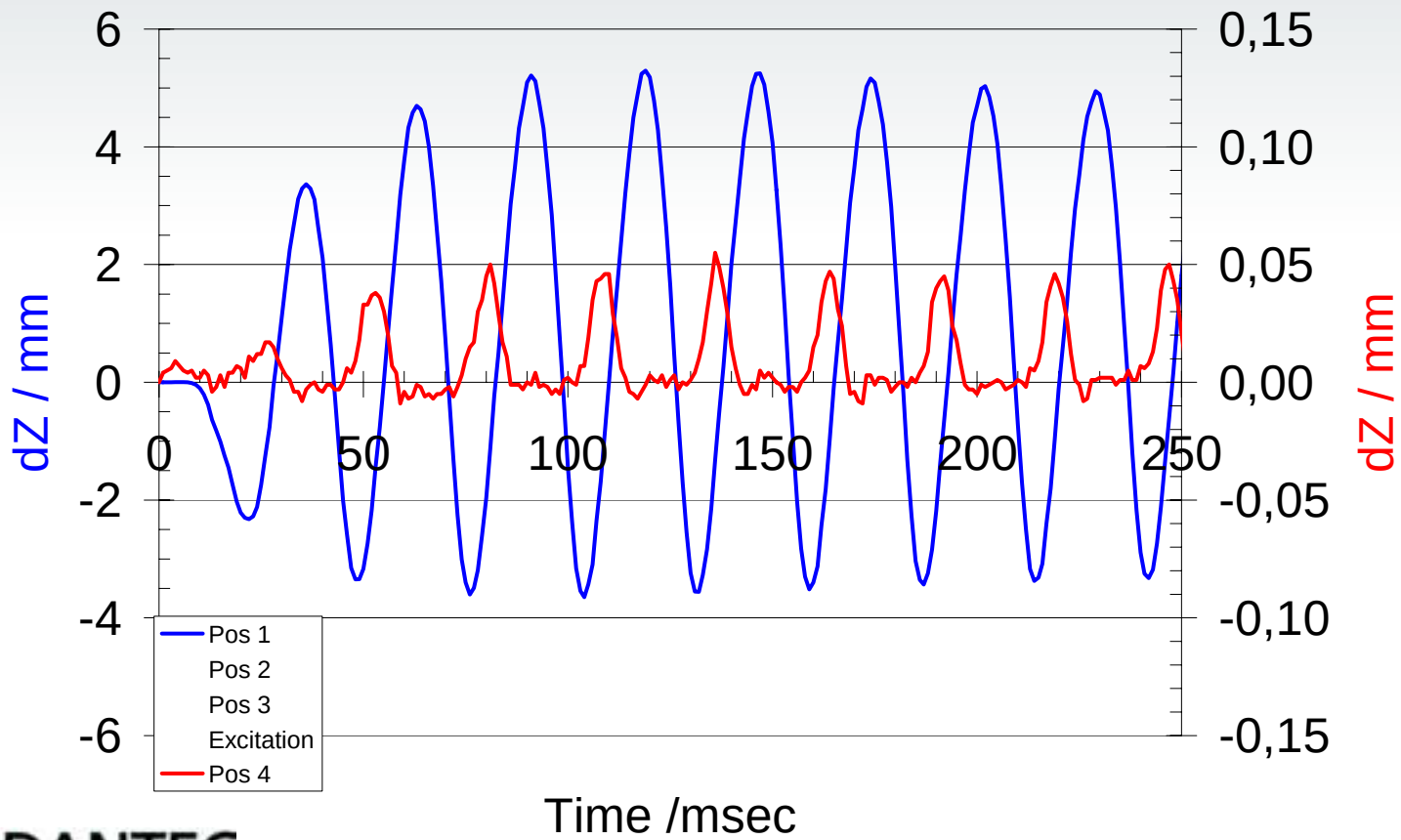
Harmonic Excitation



- 36.5 Hz

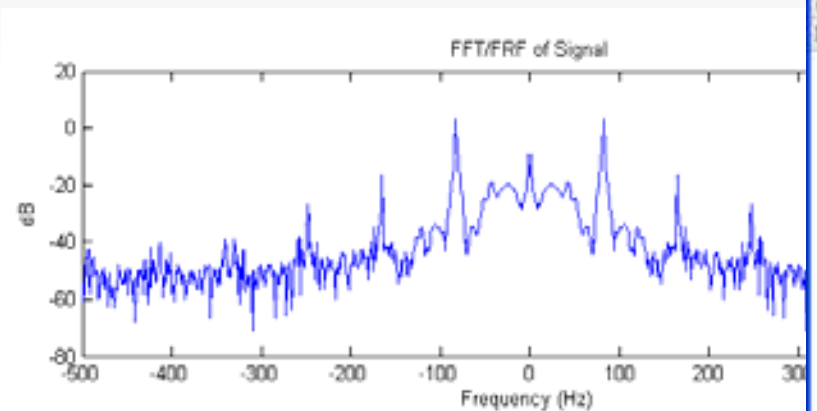
High Dynamic Range !

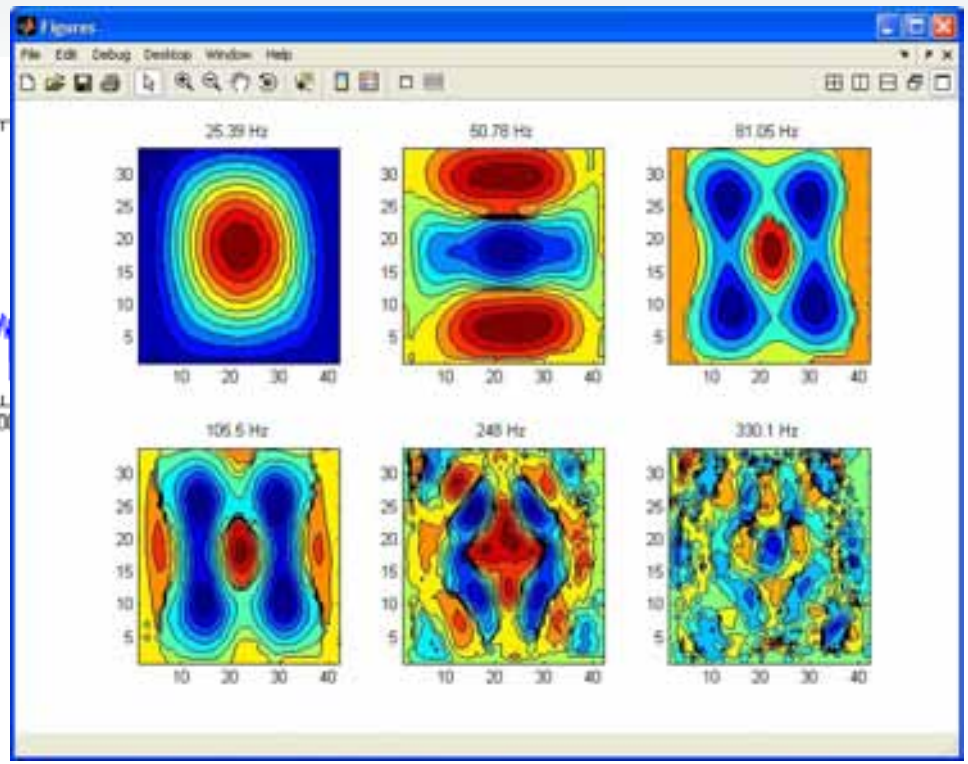
5 mm to 0.050 mm



Mode Shape Analysis

- MatLab Interface for further analysis (modal shape)
- Data are not filtered
- Extraction of different mode shapes





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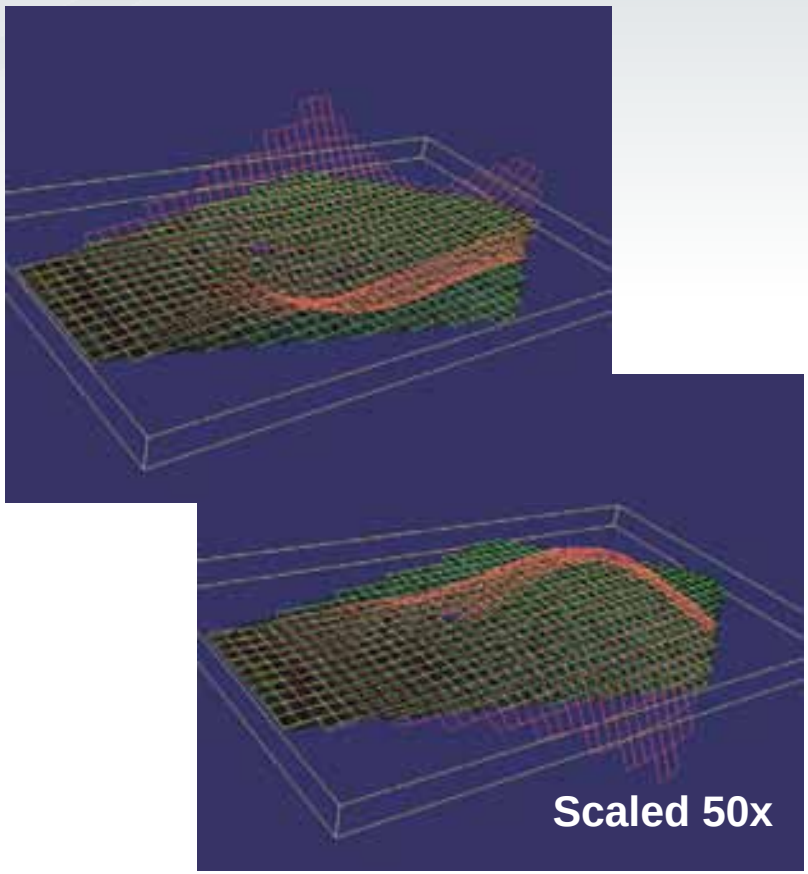
Q-450 Glass fiber sample

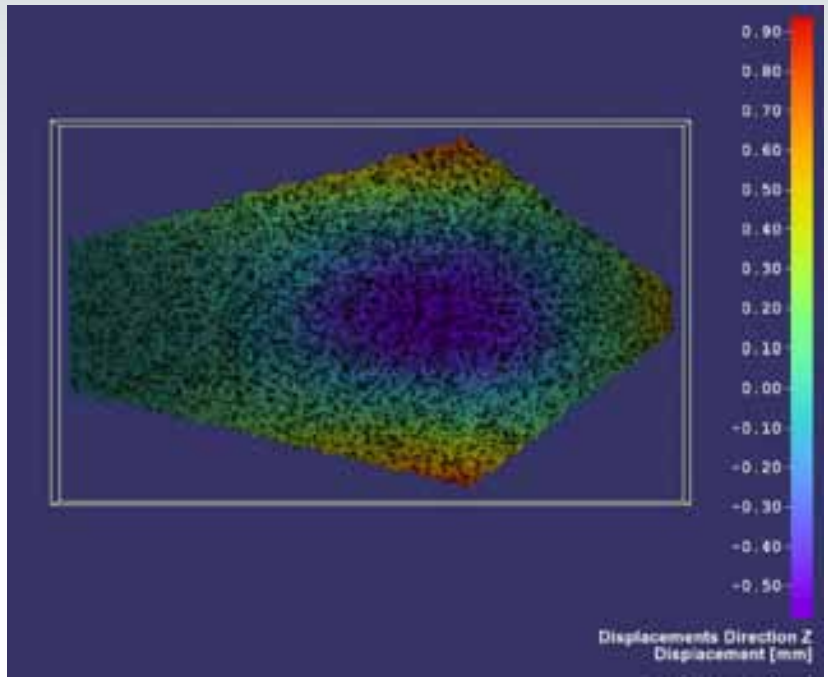
- Q-450 with MK III
- Shaker
  - -5 to 3000 Hz
  - -Max. acc. 1000 m/s^2
  - -Max. ampl. ±12.7 mm
- Beam
  - -3x40x150 mm (HxWxL)

Measurements performed at
Rolls Royce, Derby, UK

Q-450 Glass fiber sample

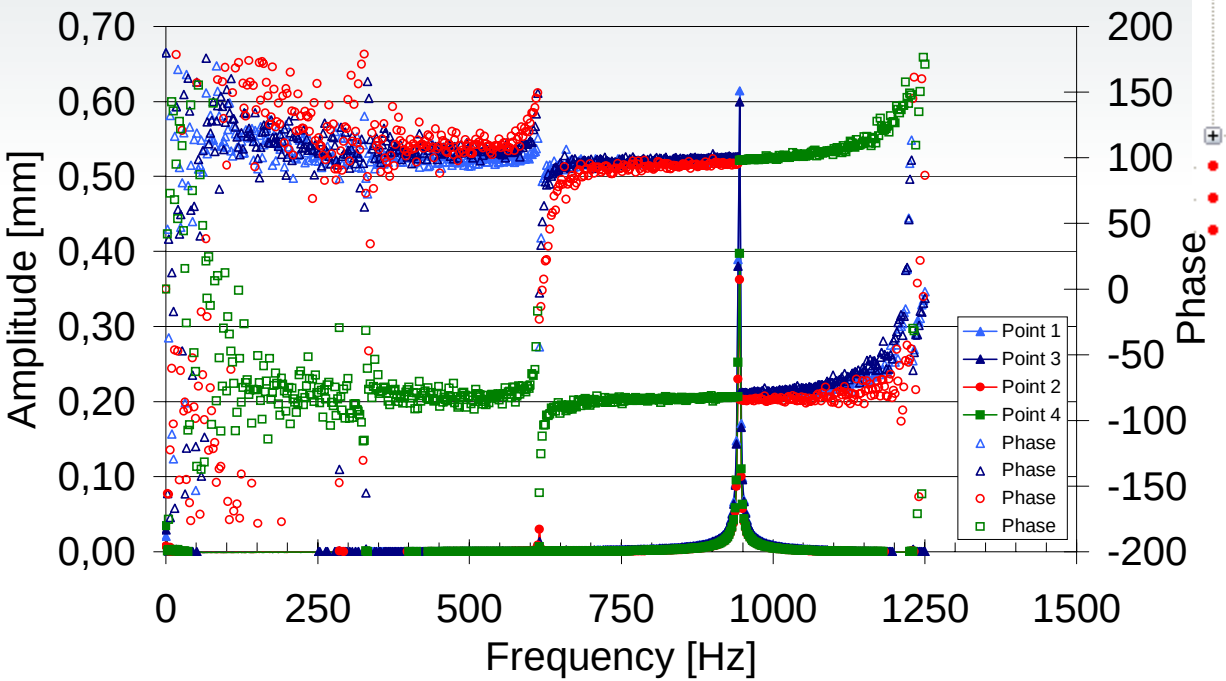
- Out of plane displacement

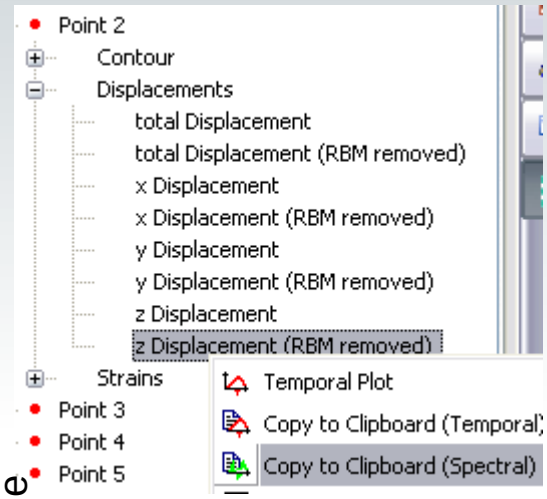




Q-450 Glass fiber sample

- Spectral analyses of temporal signal
- Amplitude in mm and Phase





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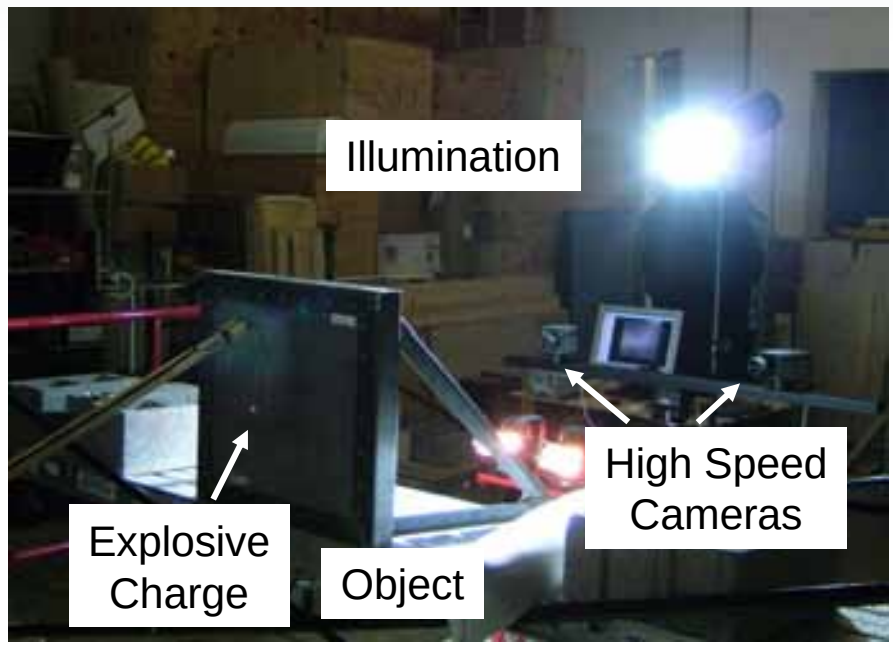
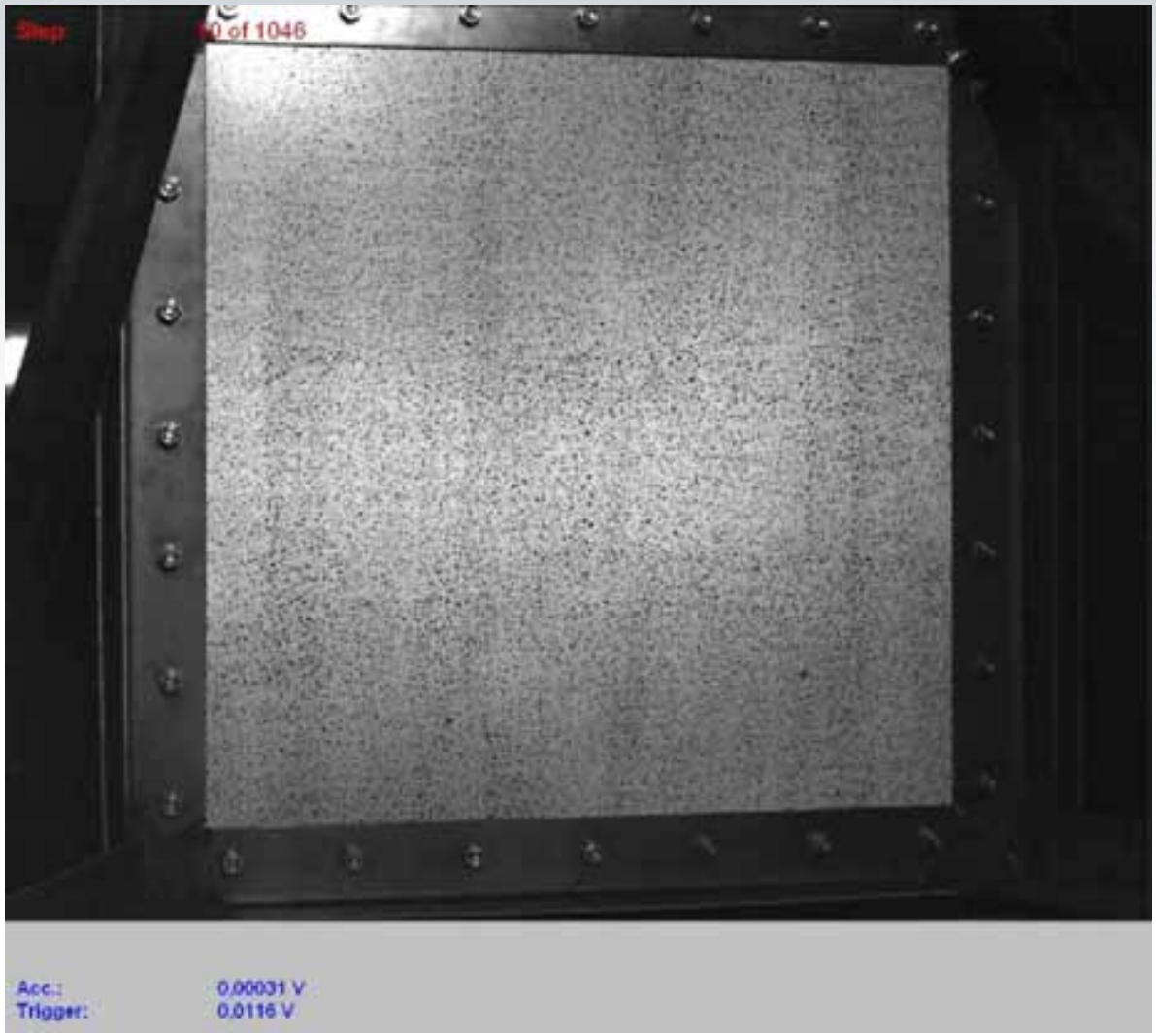
Shock Excitation

- Measurements on an Aluminum Plate with explosive charge excitation
  - -Object: Aluminum plate, 700 x 700 mm
  - -Load: Explosive Charge
  - -Trigger: Automatic Triggering on an Accelerator Signal
  - -Frame Rate: 1 kHz / 5 kHz
  - -Acquisition time: 3.2 s / 0.6 s
  - -Evaluated: 350 msec



Shock Excitation

- Camera image
  - -1 kHz
  - -0.1 sec



Recorded
AD Channels

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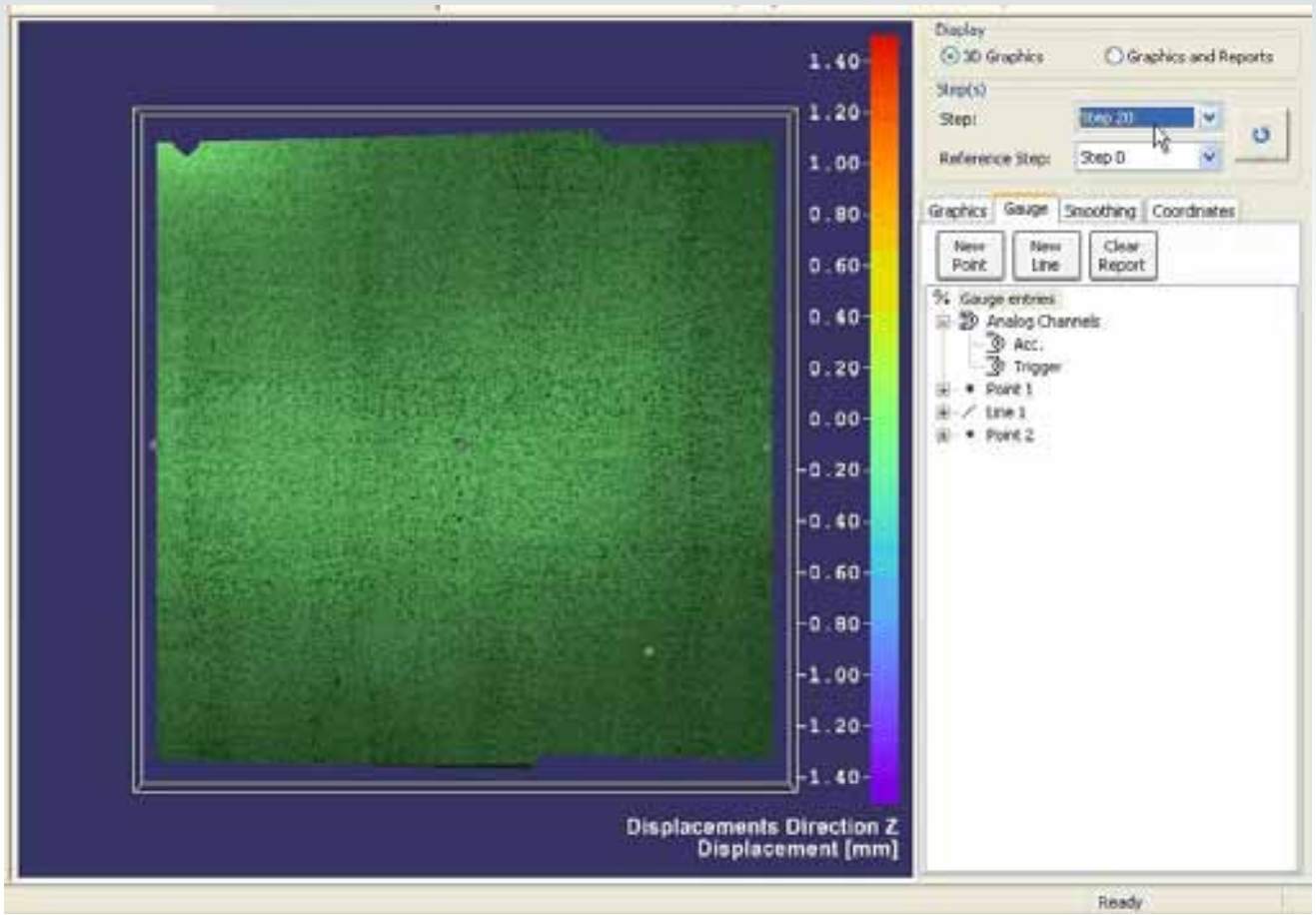
Shock Excitation

- Camera image
  - -1 kHz
  - -0.1 sec



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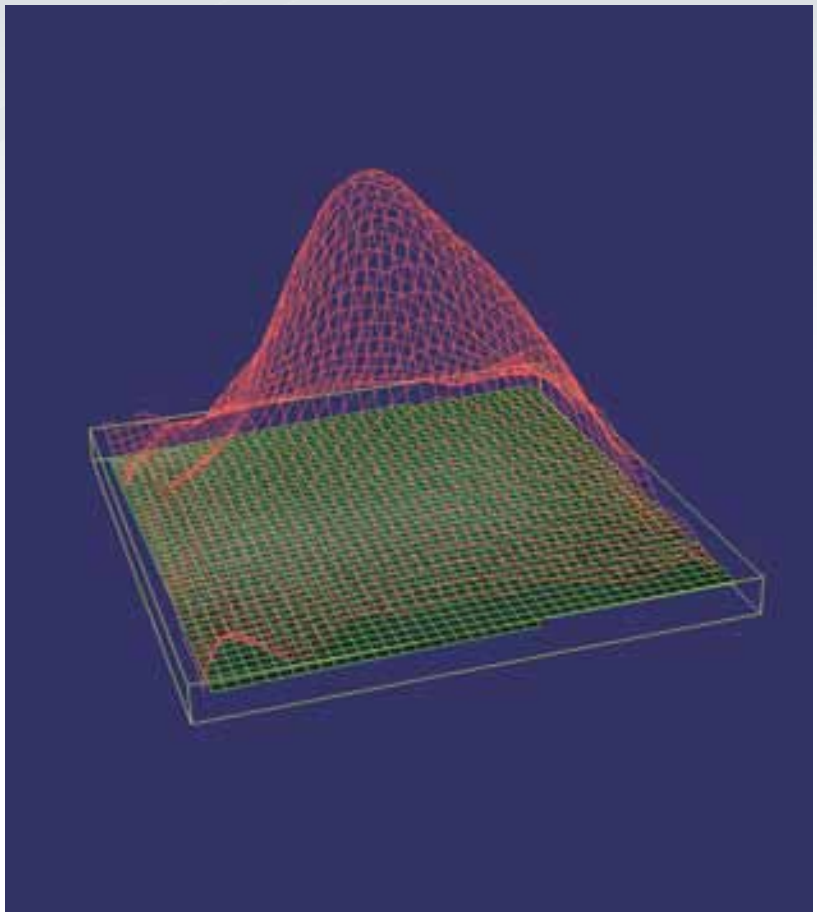
Partners for progress

Shock Excitation



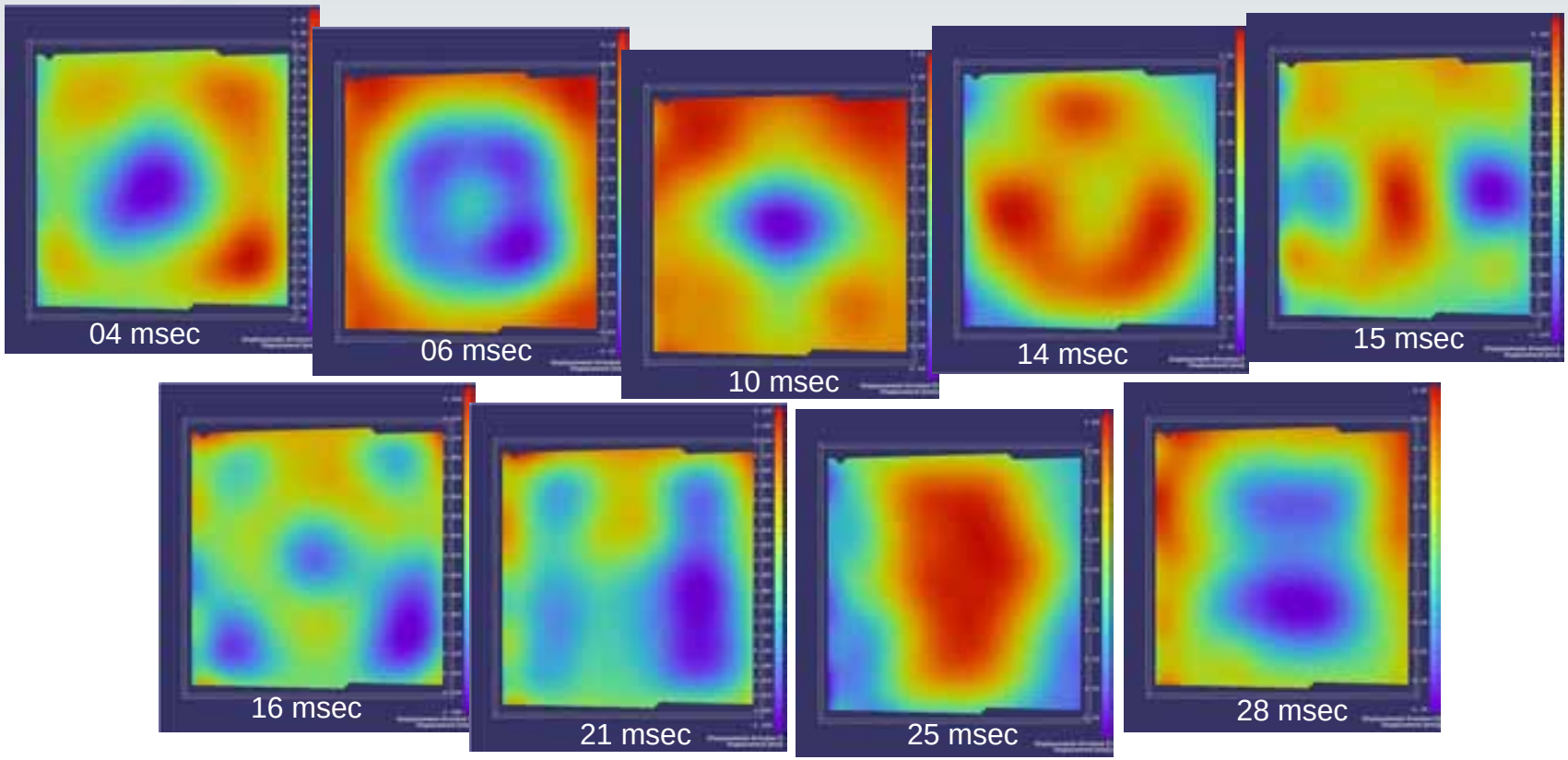
- Fullfield Deformation

12 msec

Deformation Scaled x 300

Shock Excitation

- Vibration modes



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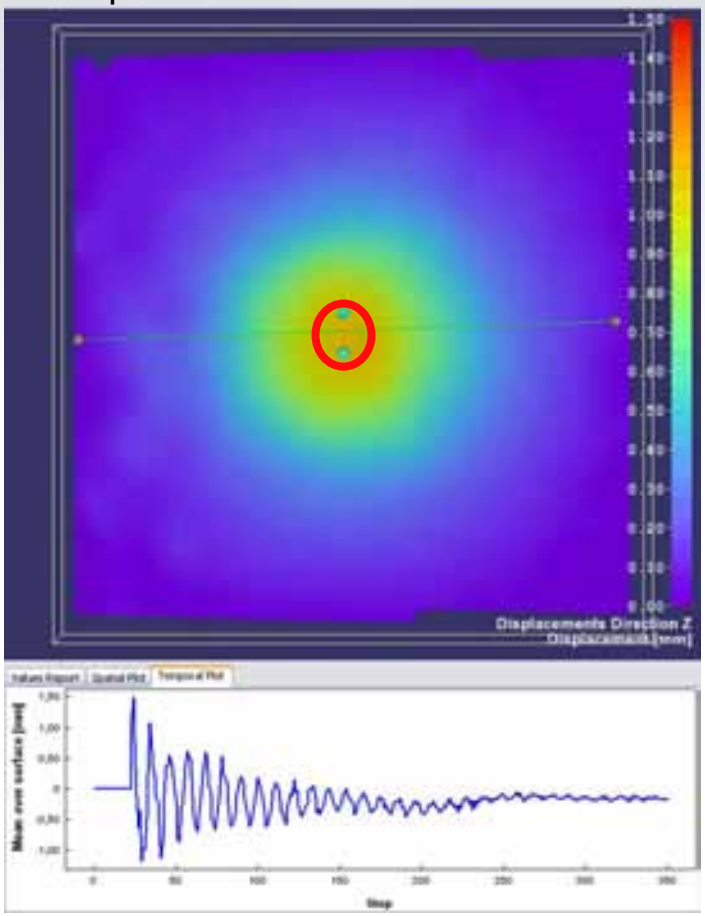
Shock Excitation

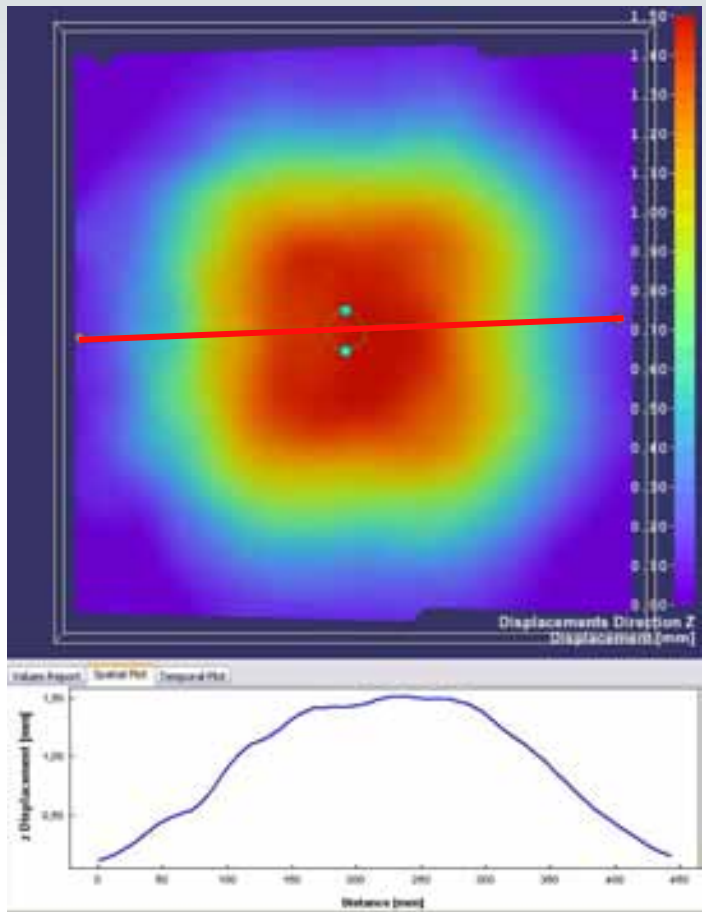
- Out-of plane Deformation

1 msec



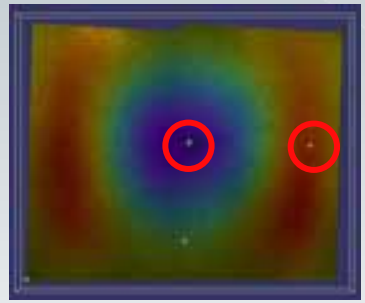
Temporal deformation of central point

2 msec

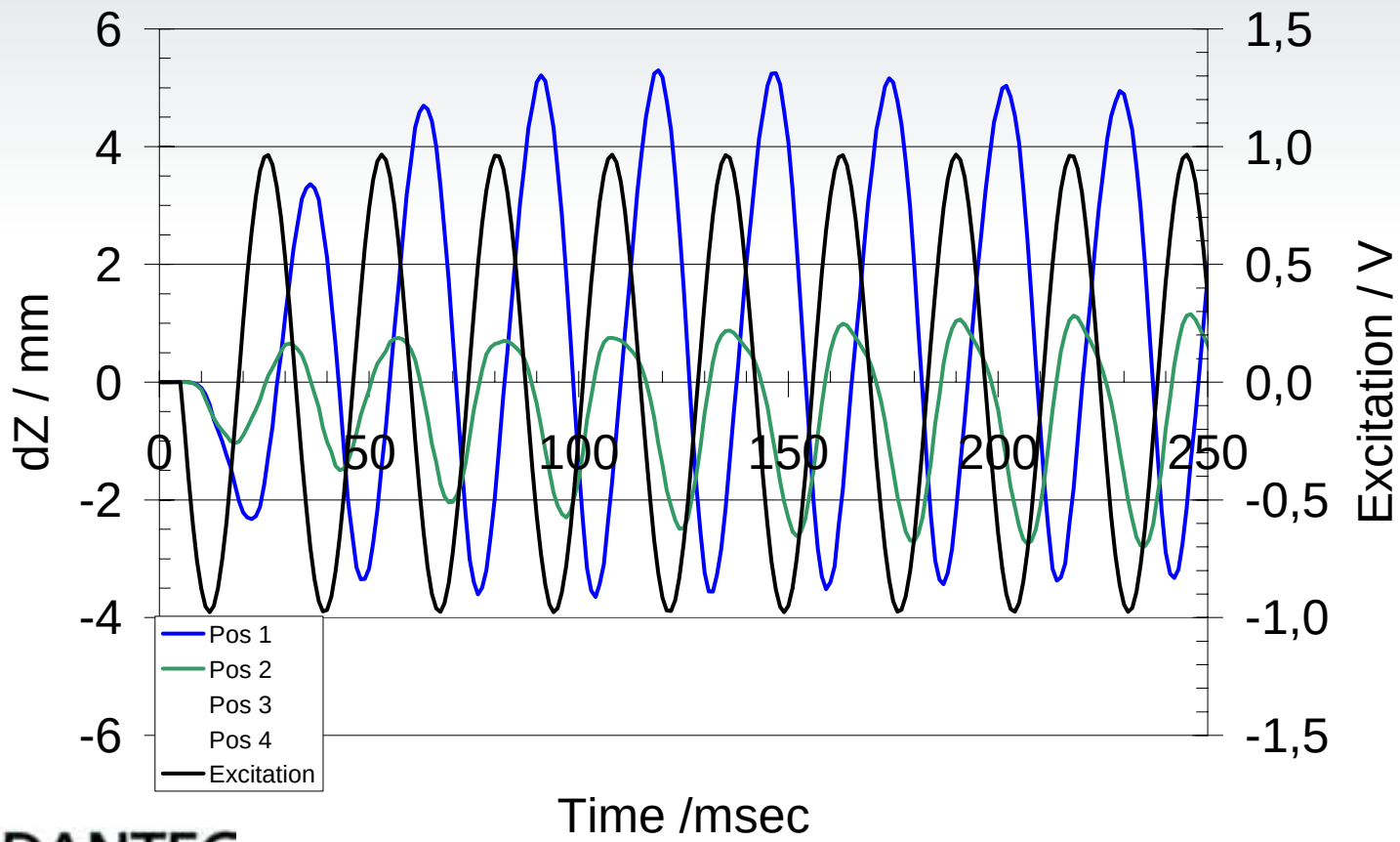


Spatial deformation of central line

Harmonic Excitation



- 36.5 Hz



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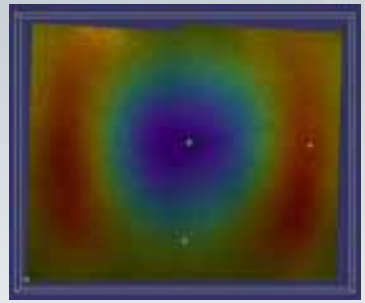

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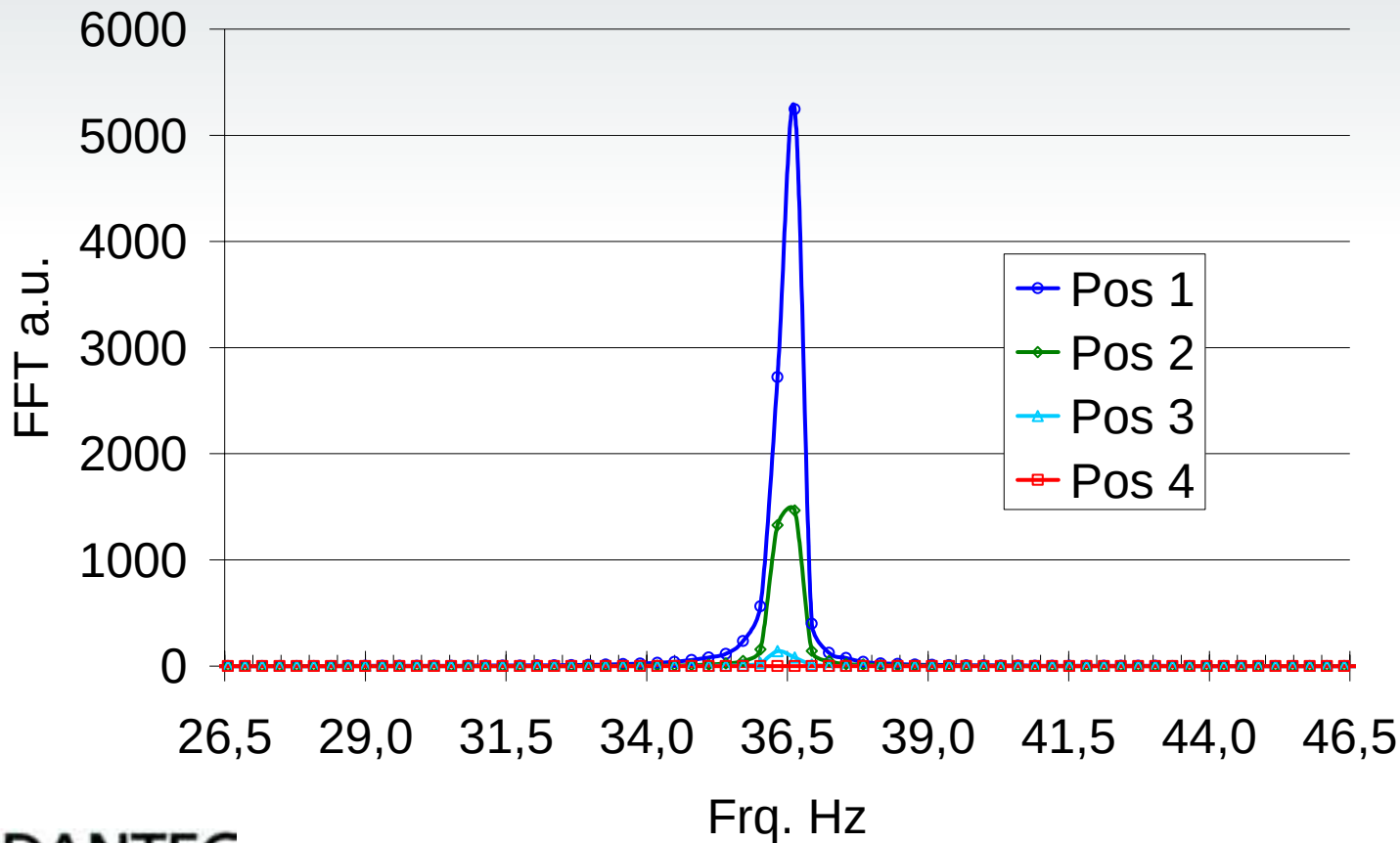
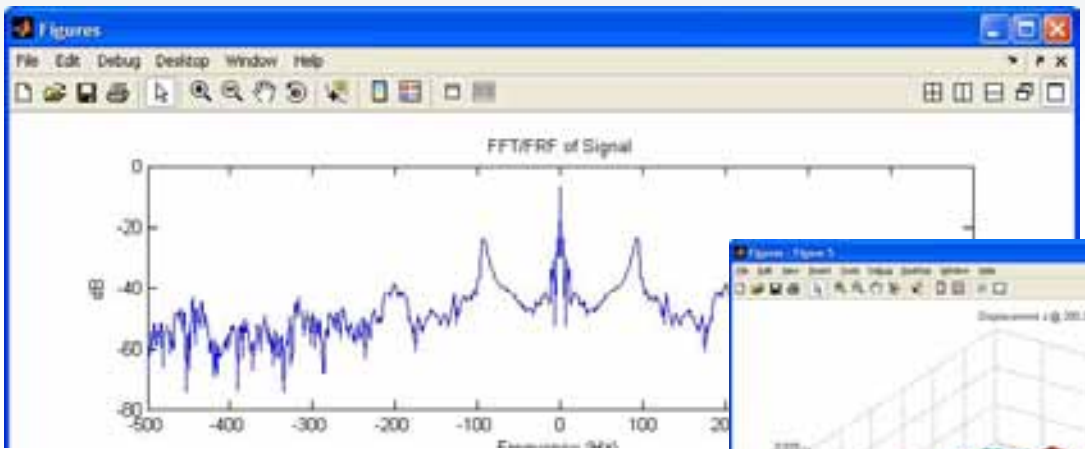
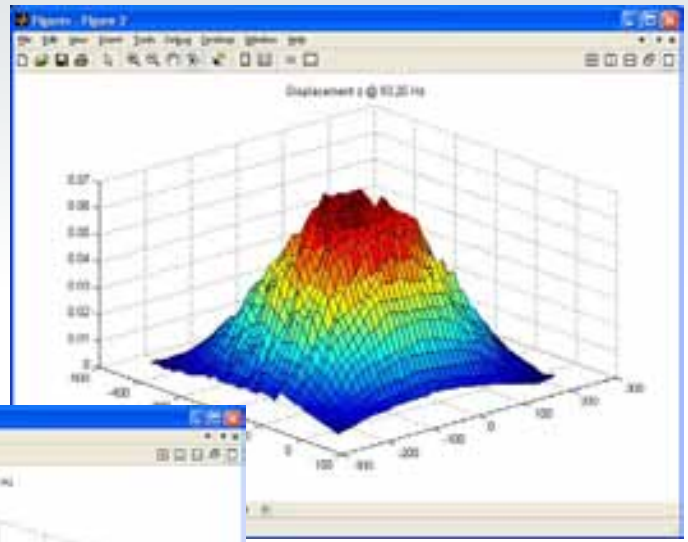
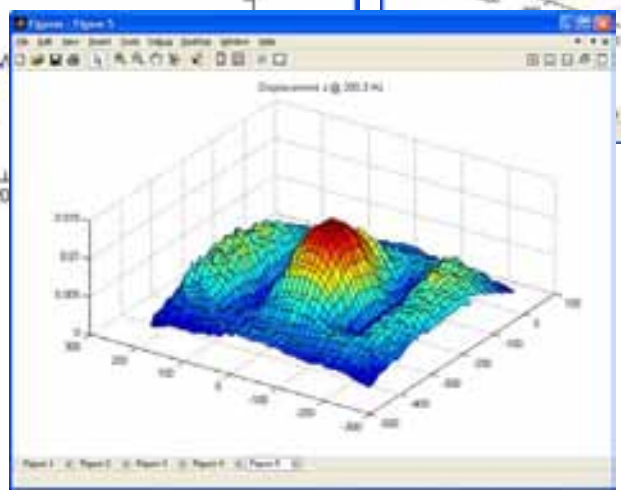


Mode Shape Analysis

- Use of temporal information for further analysis





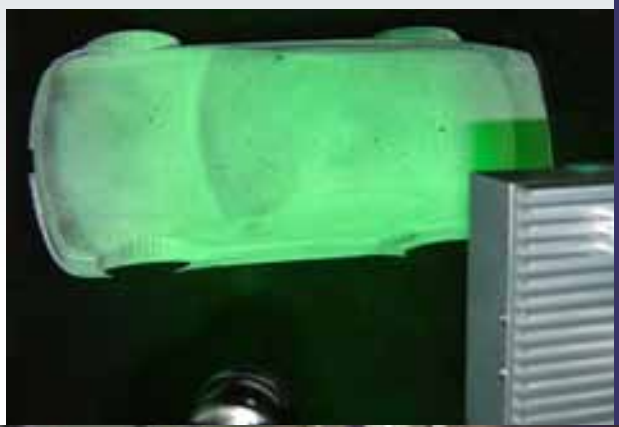


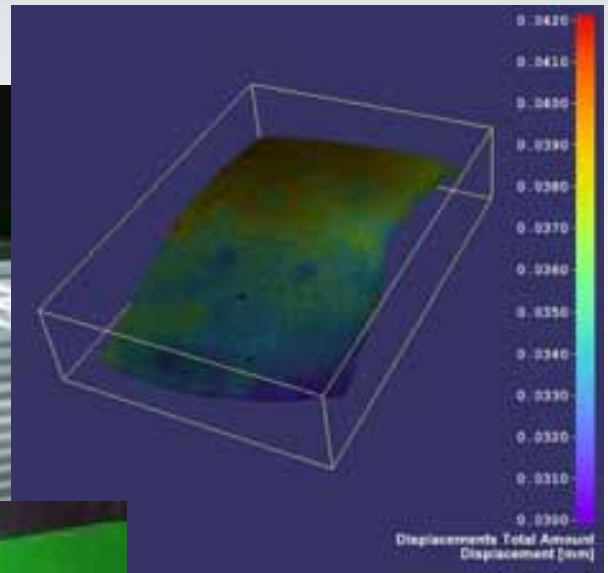
Peaks at 93 and 200 Hz

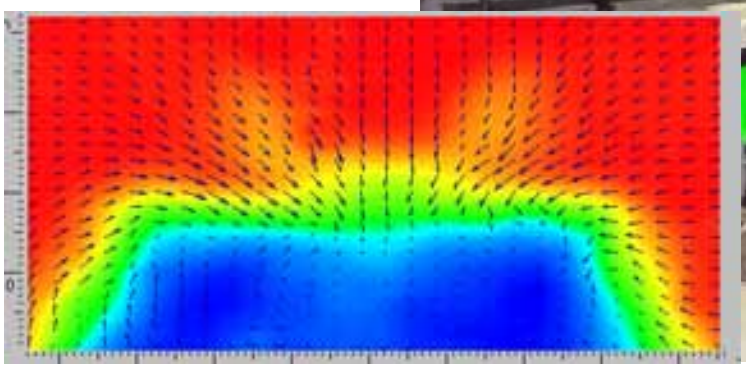
Partners for progress

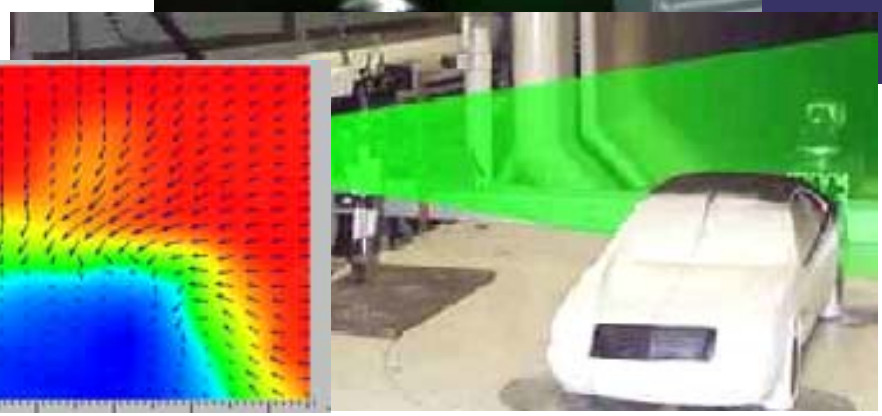
Combination of different techniques

- Solid – Fluid Interaction (PIV and DIC)
  - Combination of two full field techniques
  - Measurement in parallel or orthogonal planes





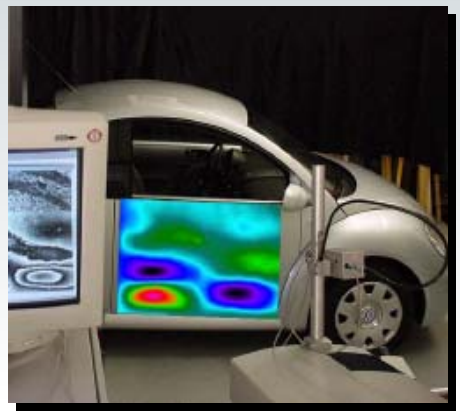




Fields of Application

- Aerospace
- Automotive
- Space
- Green Energy
- Home Appliances
- Electronics
- Machinery
- Yacht Industry

and many more



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Conclusion

- The optical full field techniques do not substitute existing technology, they are complementary technologies which provide other and more information
- Development in hardware (Cameras, Computers) makes the systems more user friendly and opens additional fields of applications (e.g. hybrid systems, high speed)
- High Potential for future Developments:
  - Projects in progress for standardisation of optical full field techniques (e.g. SPOTS)
  - DIC can provide value information of strain and displacement maps for each data point very fast
  - This results in a higher acceptance of optical full field techniques

Thank you very much for your attention!

For more information please see us at

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