2008 ISMA
International Conference on Noise and Vibration Engineering

Roland Kruse, Tiedo Meyer:

Vibration platform for the calibration of optical sensors

CARL VON OSSIETZKY universität OLDENBURG
acoustics GROUP

Overview

The project KOLOS
Vibration sensor
  Measurement principle
Vibration platform I
  Concept
  Characteristics / Performance
Vibration platform II
  Characteristics / Performance
Summary

The project KOLOS

(Cost-Effective Laser Sensor for Optical Vibration Measurements)

- Low cost, contactless sensor for measuring the amplitude of in-plane vibrations
- Based on the evaluation of the speckle pattern of the surface

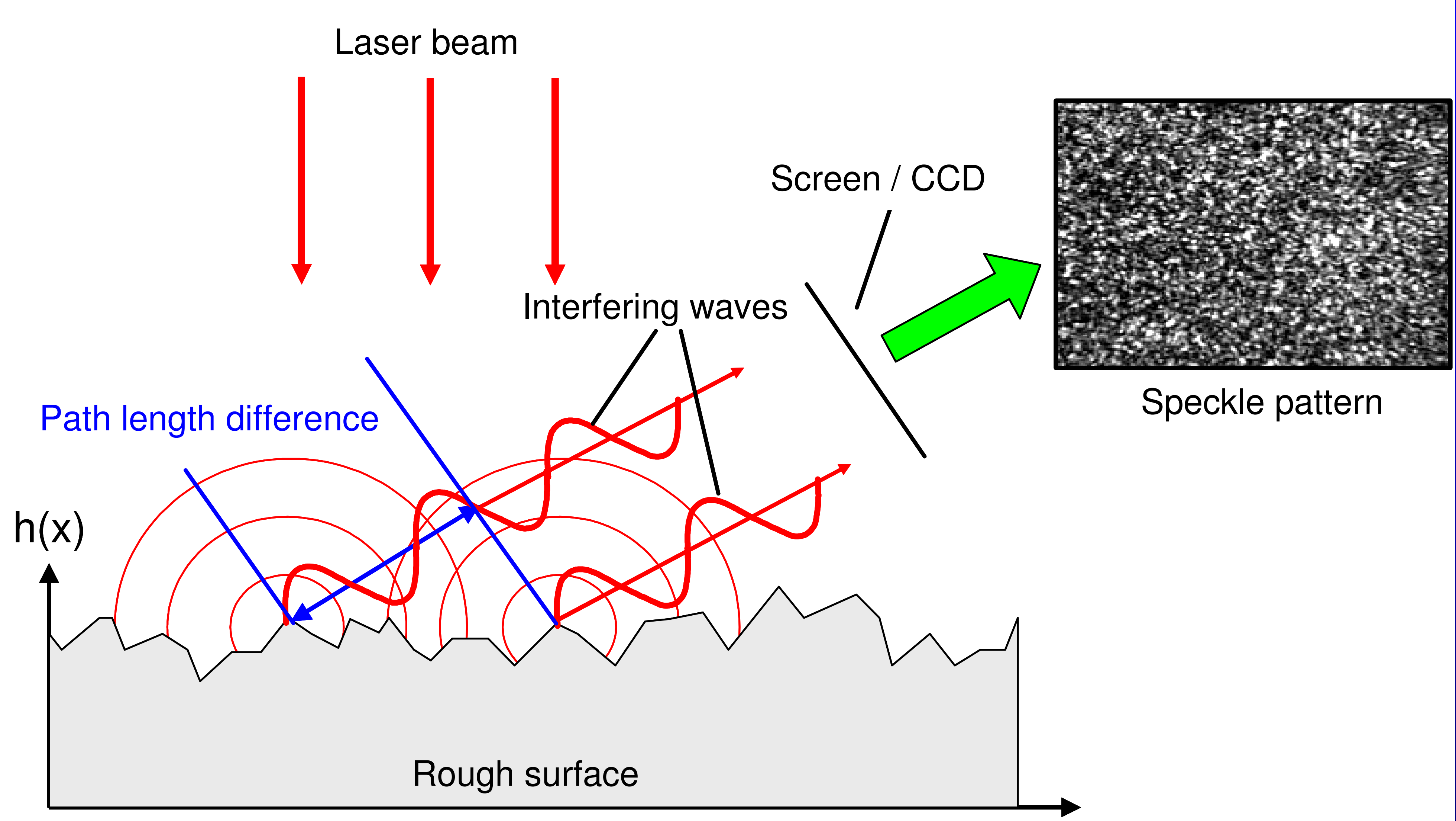
- Alternative to laser vibrometers (large, expensive but **contactless**) and accelerometers (low cost, triaxial measurement, high precision but has to be **bond to surface**)

Device required for

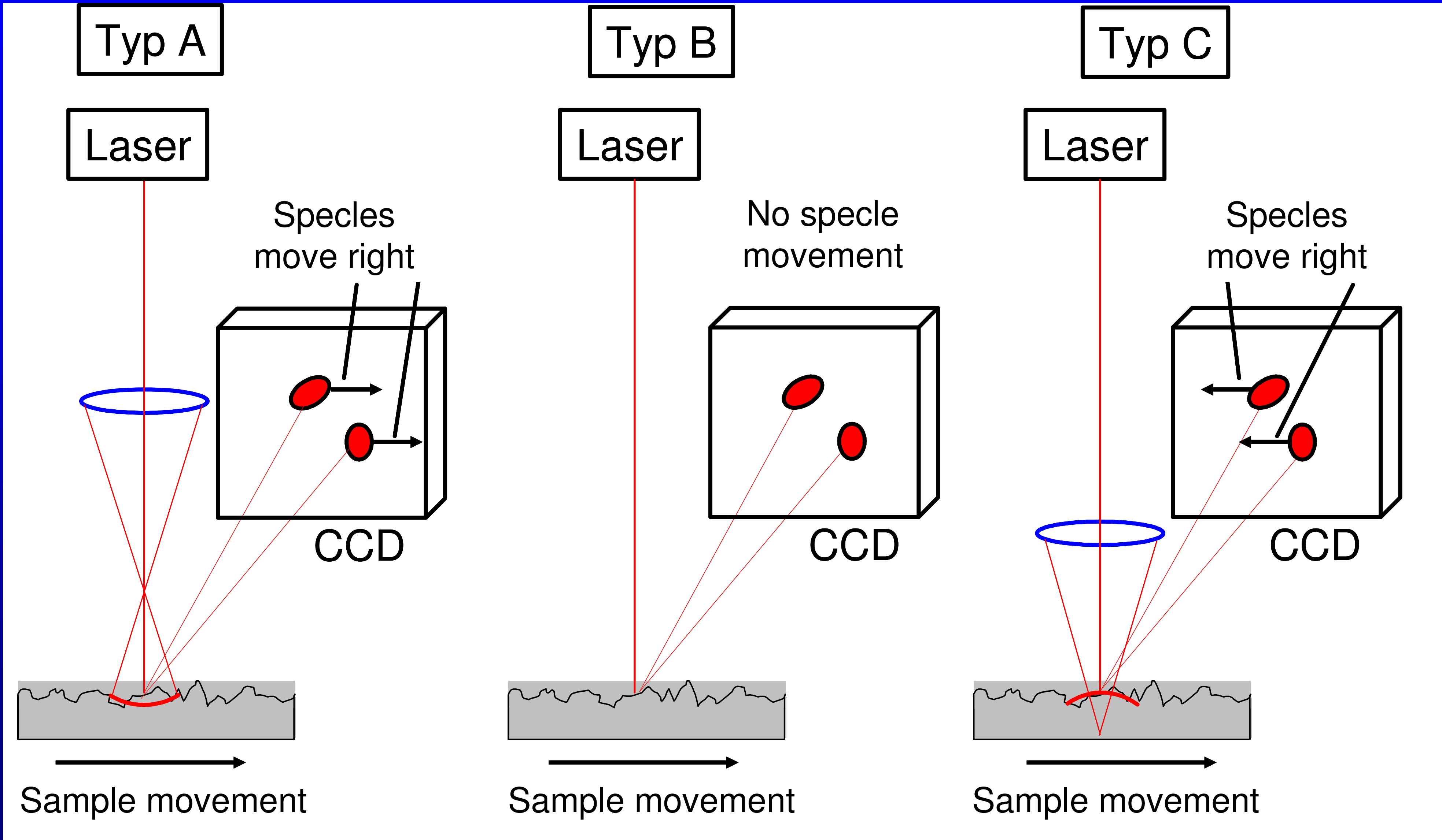
- Calibration of the new sensor
- Check it's performance (amplitude and frequency range)
- Check the effect of surface - normal vibrations
  (Can the sensor surely distinguish vibrations in different directions ?)

<u>Needed: Device for reproduction of vibrations in 3D</u>

The vibration sensor I

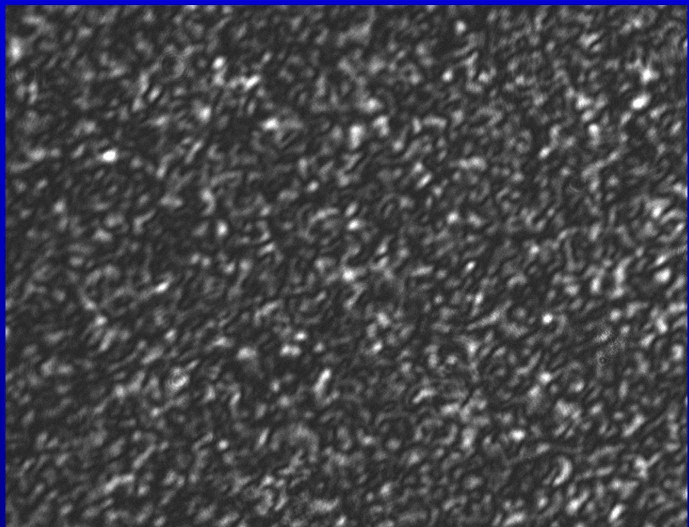


The vibration sensor II



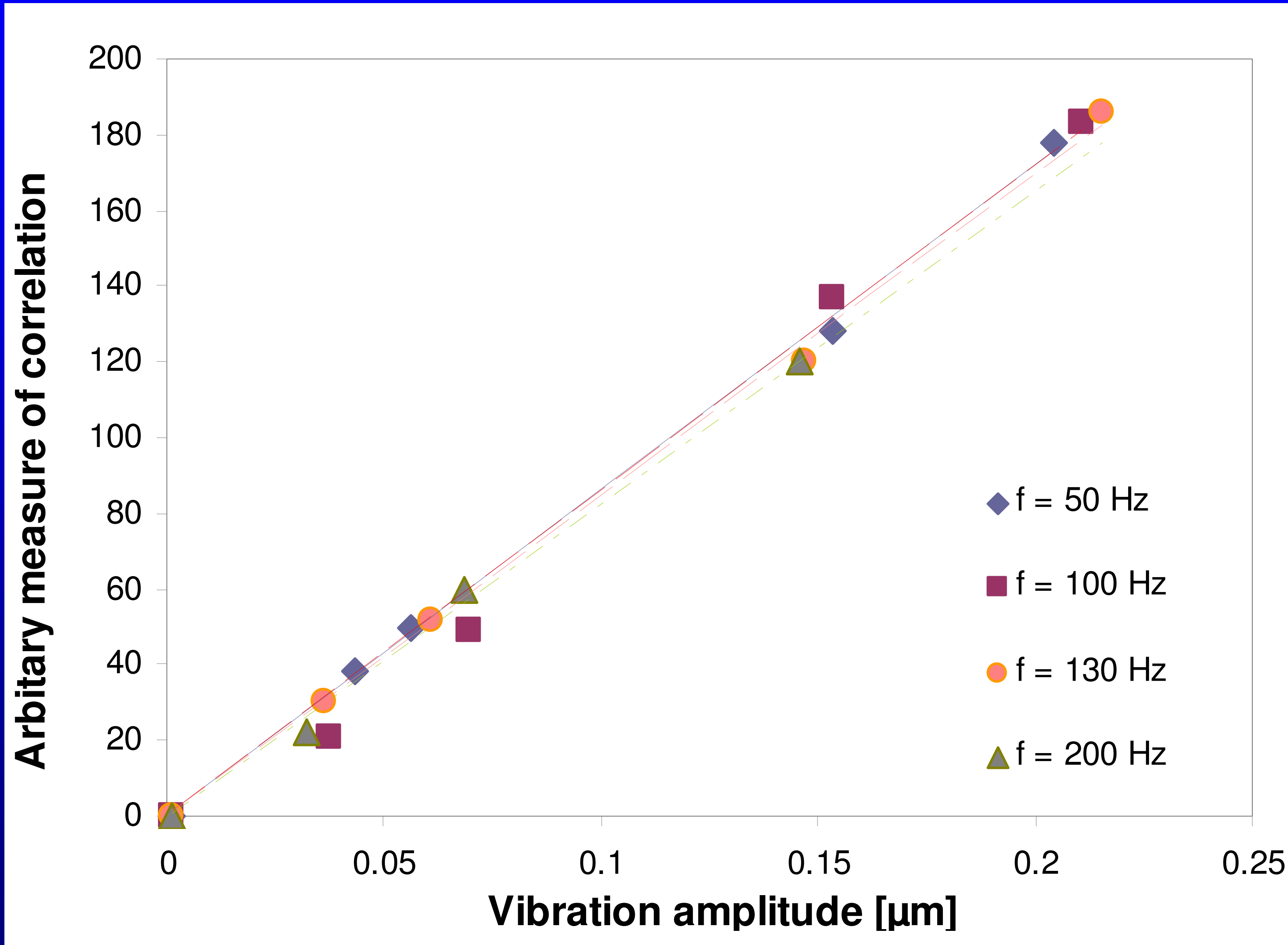
The vibration sensor III

No motion

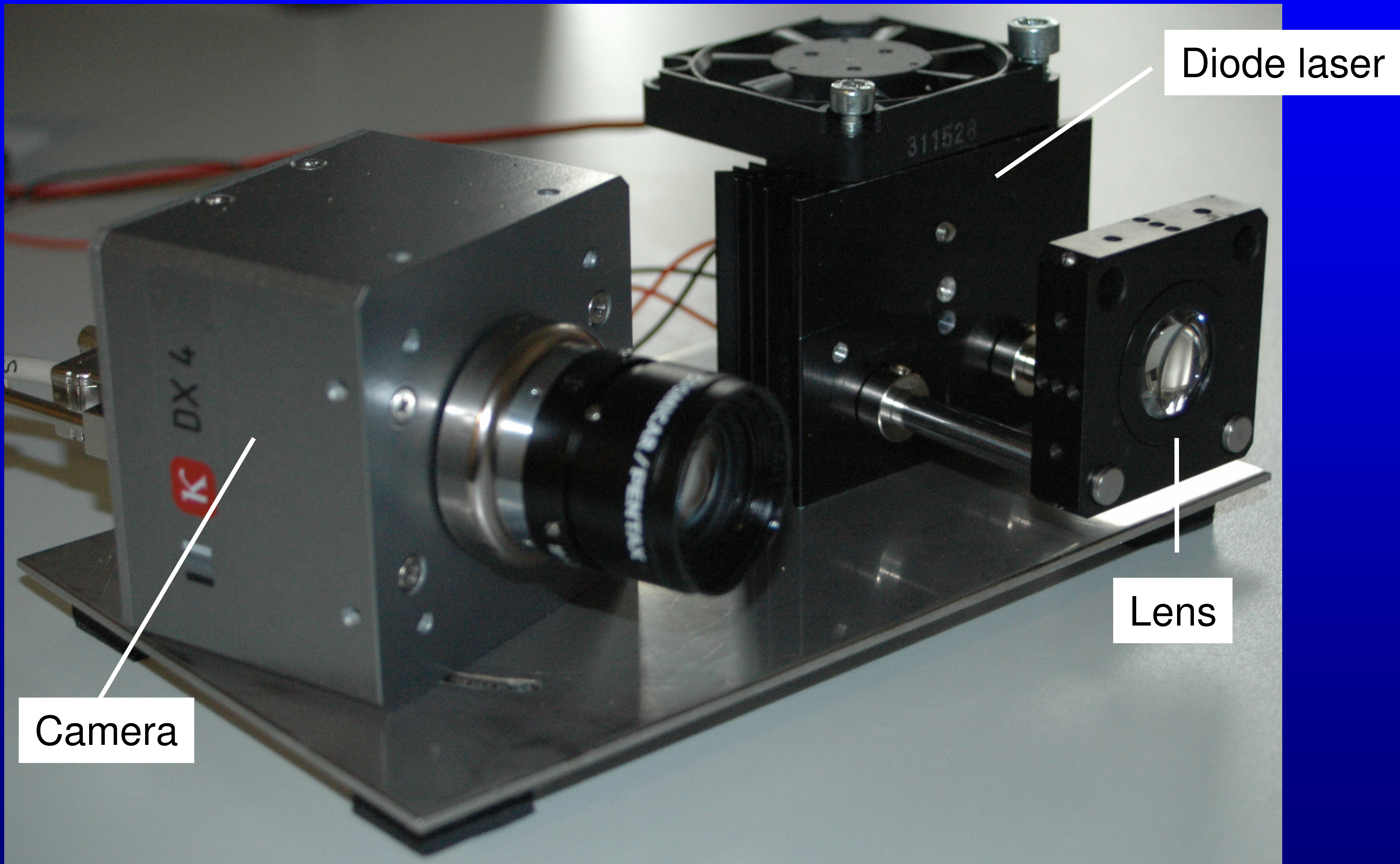


With linear motion

The vibration sensor IV



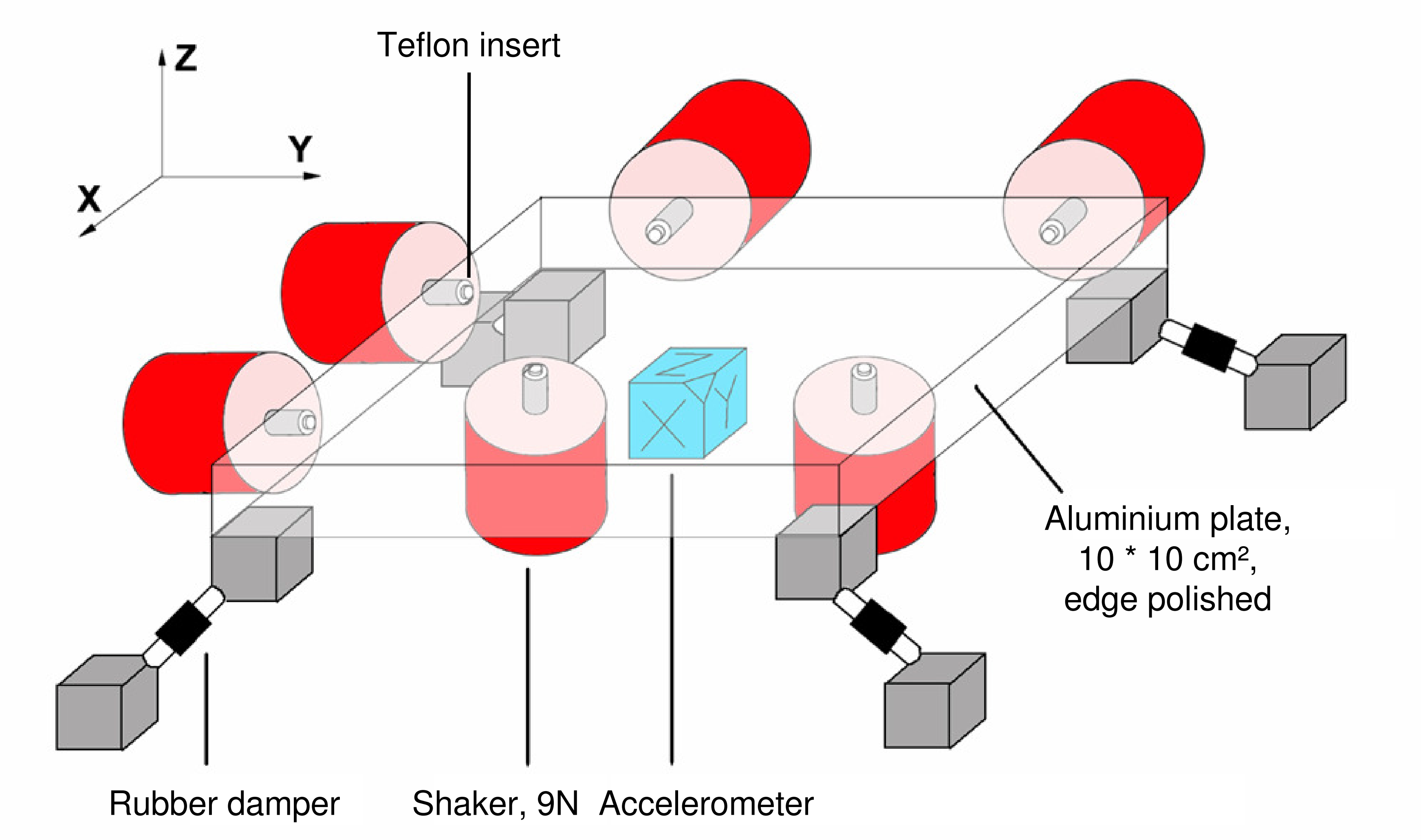
The vibration sensor V



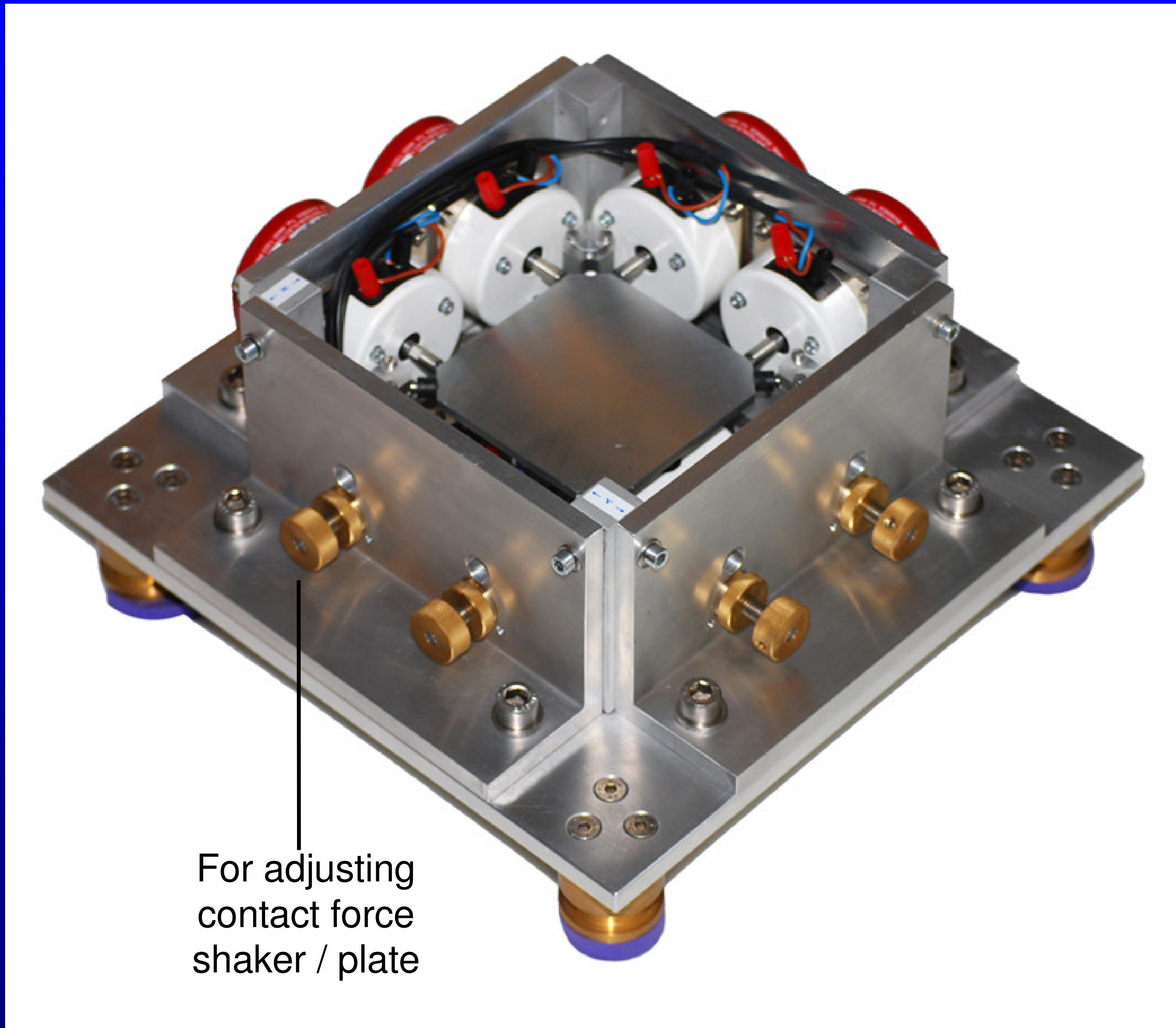
Vibration platform: Concept

- Aluminium plate (≥ 5 * 5 cm²) driven by electro-dynamical shakers
- Elastic suspension
- 3D accelerometer for vibration monitoring
- PC (Matlab) providing GUI and vibration control, including crosstalk compensation
- Amplitude limited by nominal shaker force, frequency by first eigenmode of plate
- Requirement: 10 µm amplitude up to 500 Hz (~ 10 g)

Vibration platform I: Model



Vibration platform I: Photo



Vibration Platform I: Characteristics

Frequency response

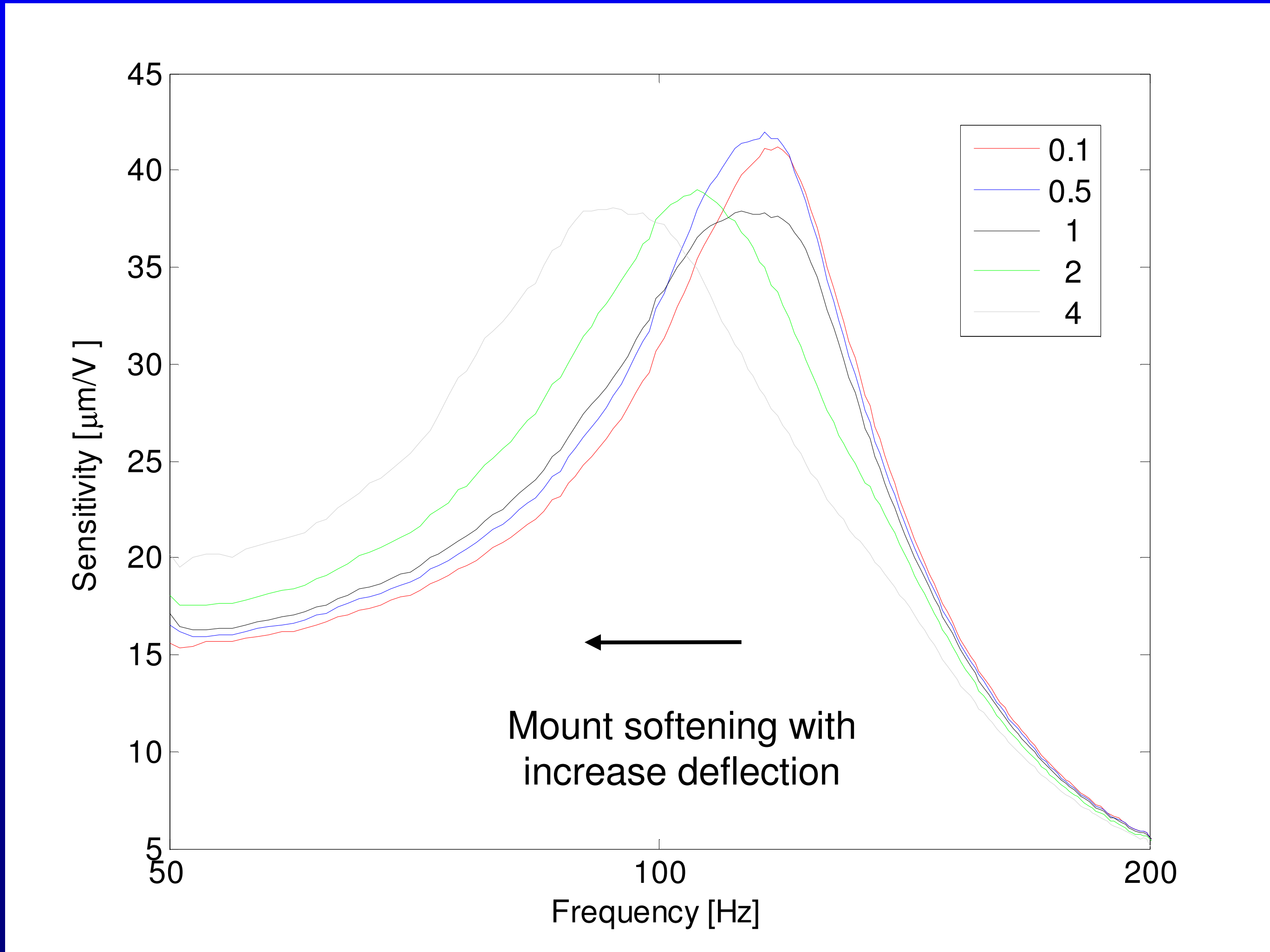
Amplitude range

Crosstalk

Motion pattern

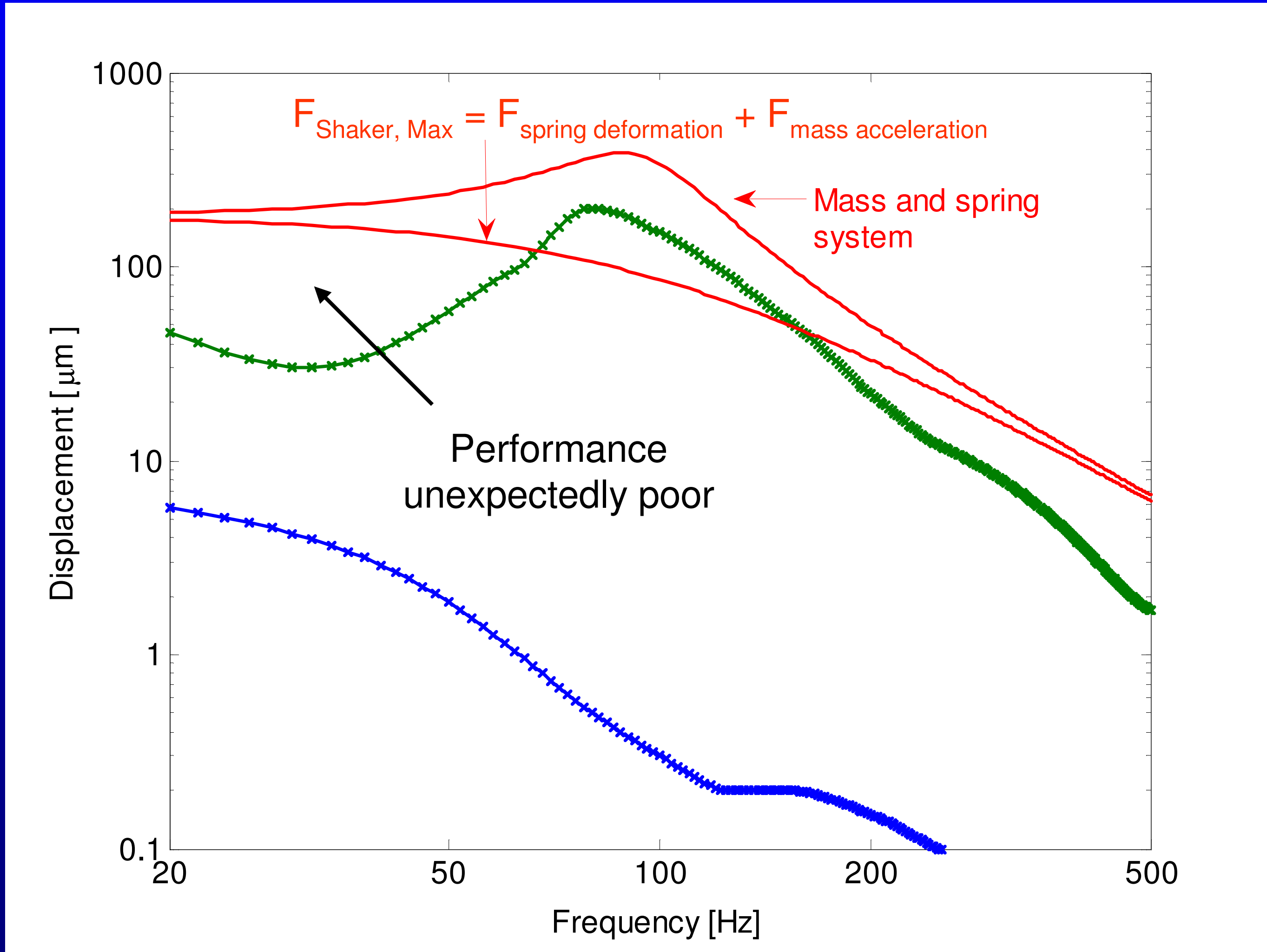
Vibration platform I: Frequency response

Non - linearity: Dependence of frequency response on driving voltage



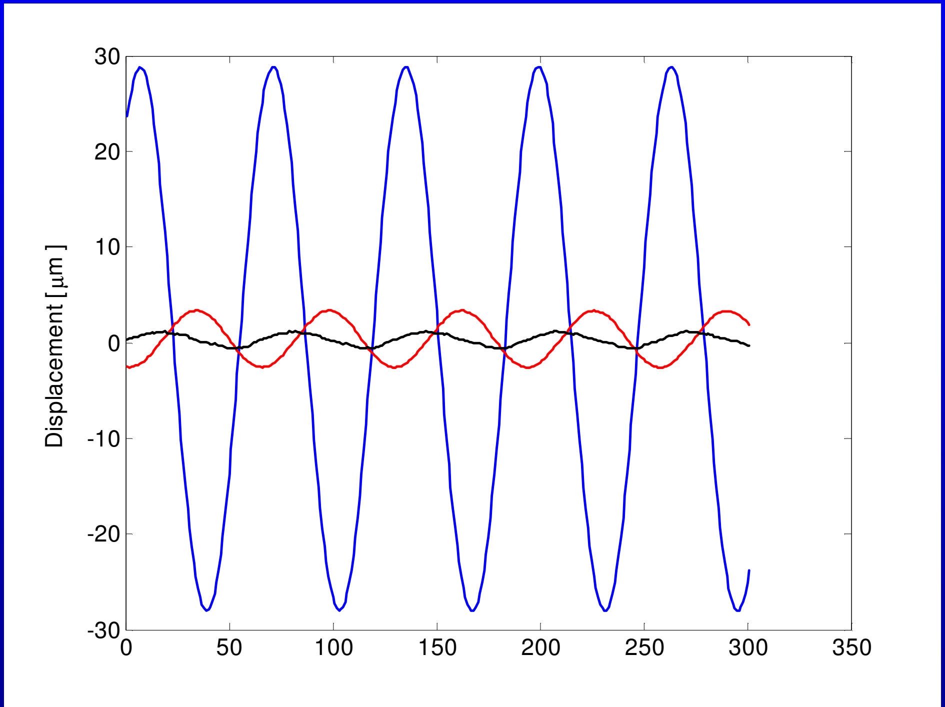
Vibration platform I: Amplitude range

X - direction: Amplitude range for THD+N < 1%



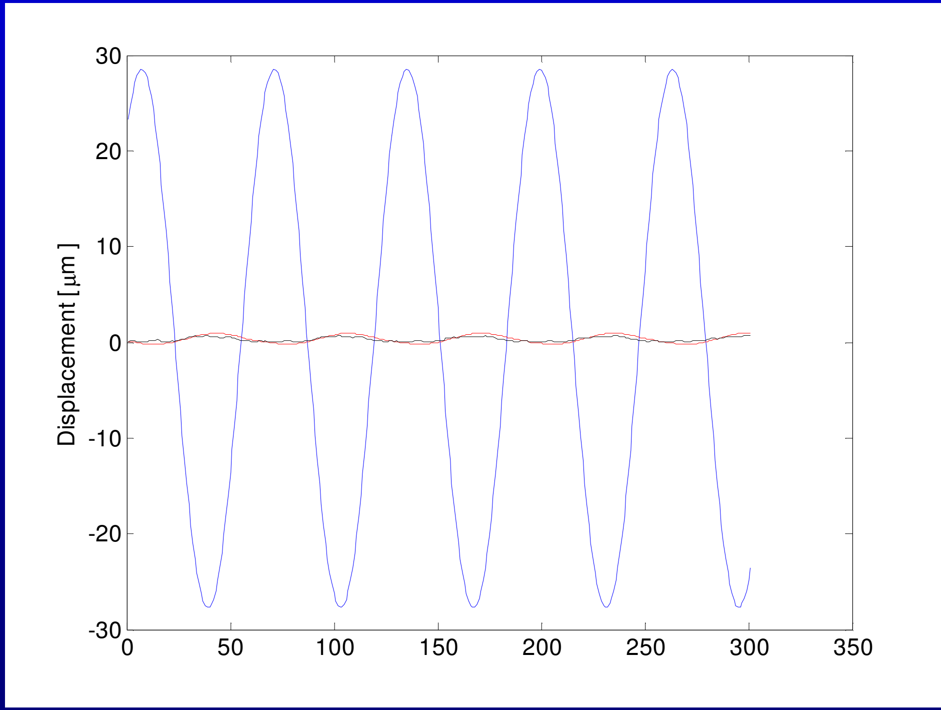
Vibration platform I: Crosstalk compensation

Before compensation



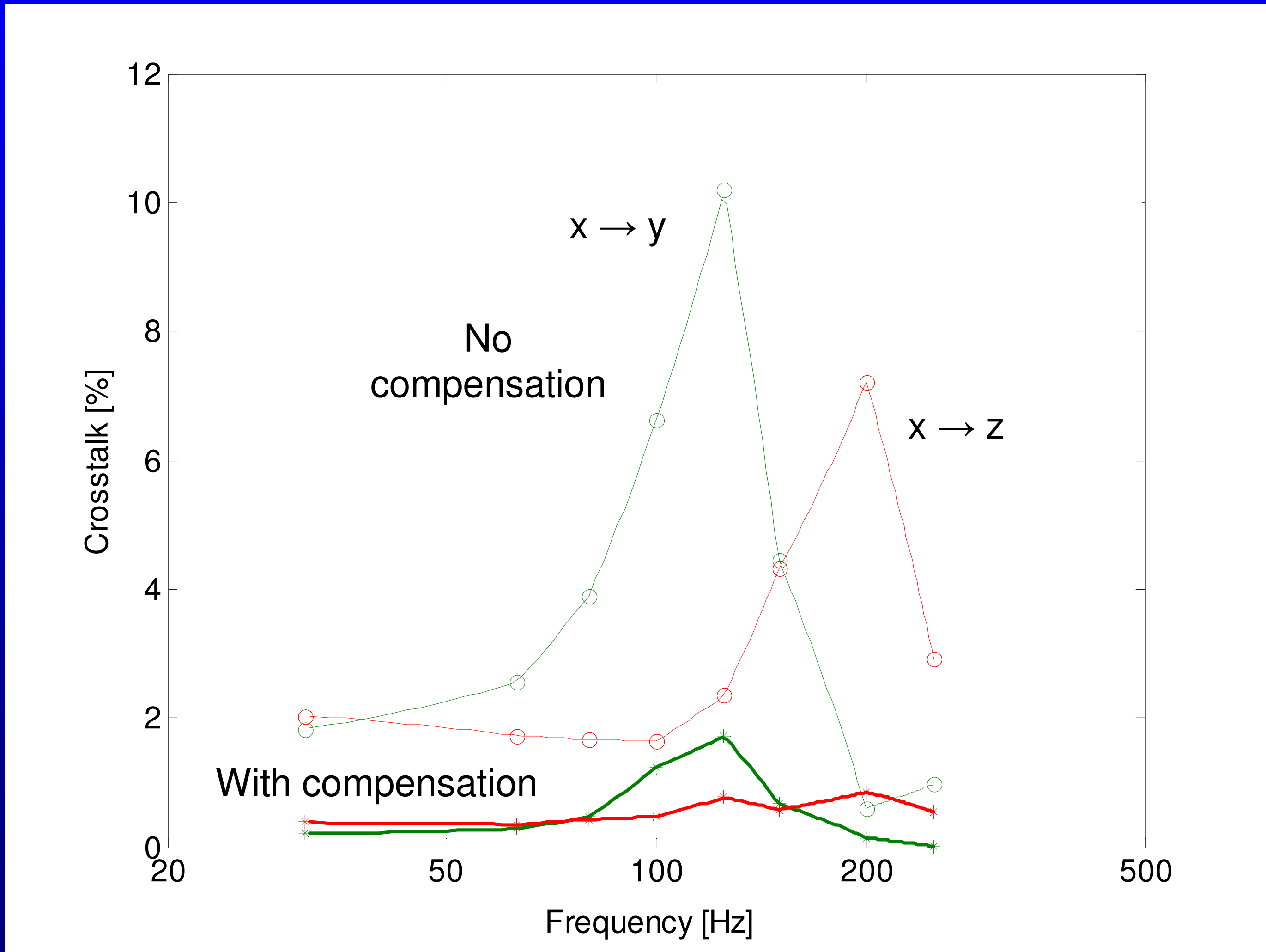
After compensation,

inversely phased signal output

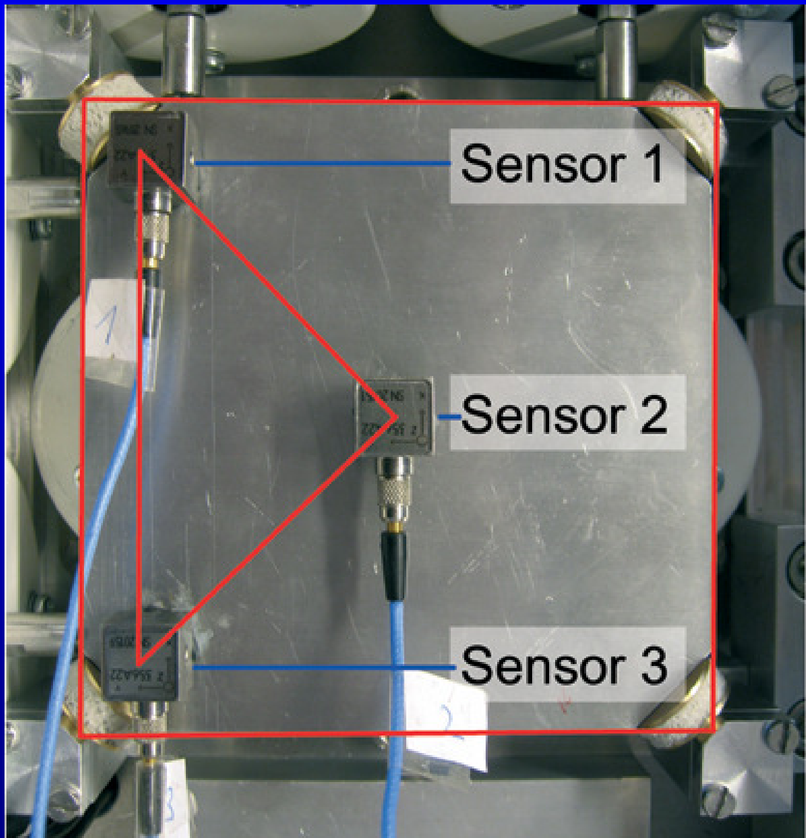


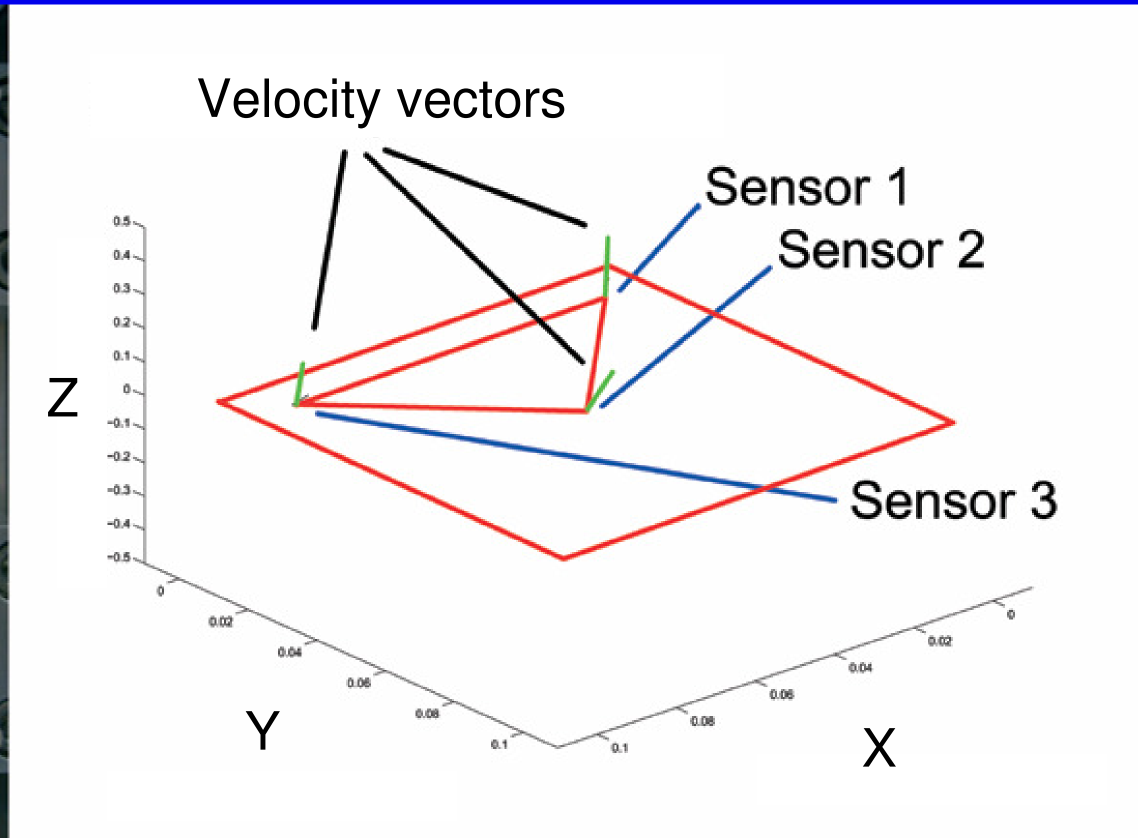
Vibration platform I: Crosstalk compensation

Crosstalk for 10 µm vibration in X - direction

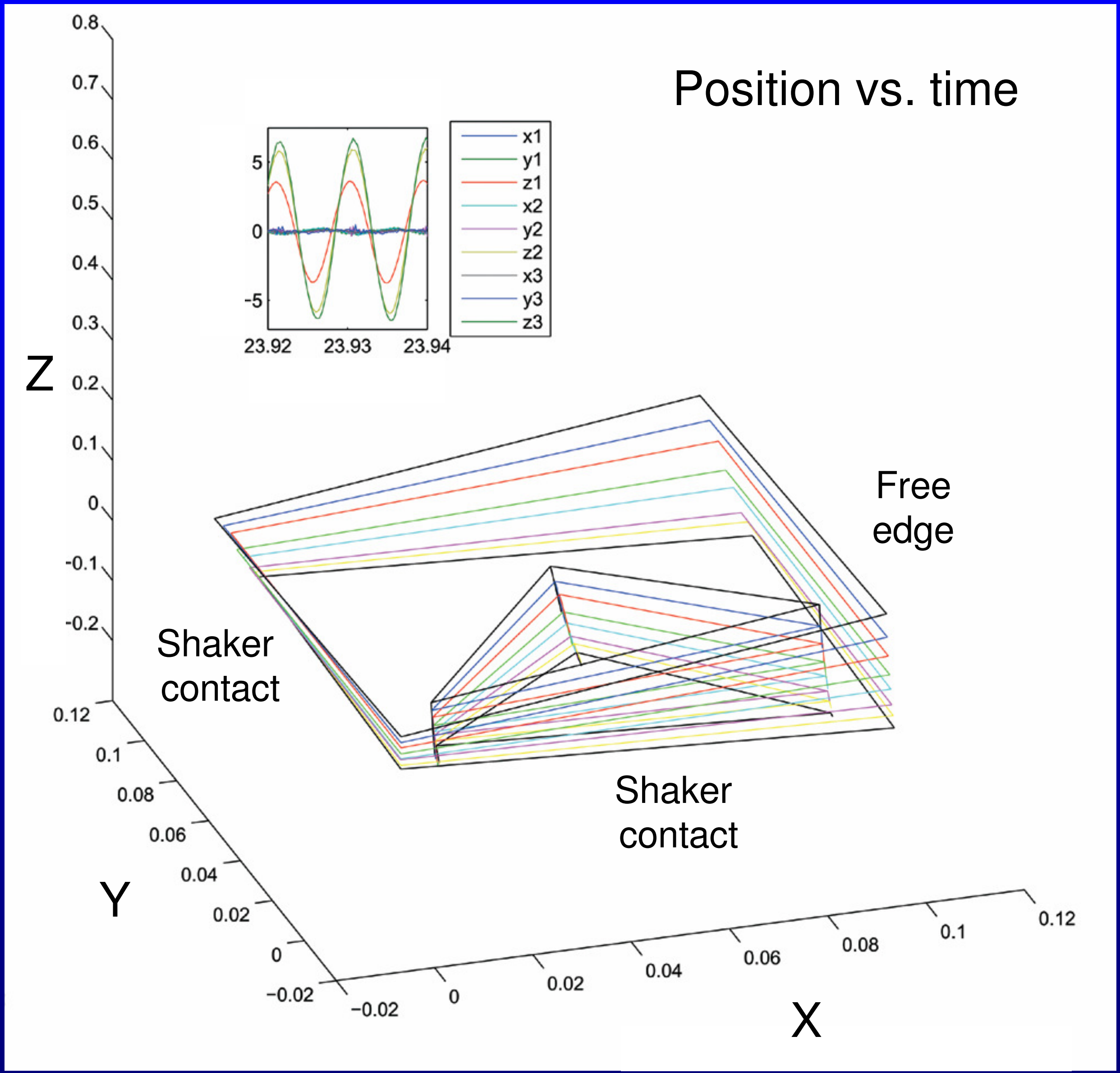


Vibration platform I: Motion pattern





Vibration platform I: Motion pattern (Z)



Vibration platform I: Summary

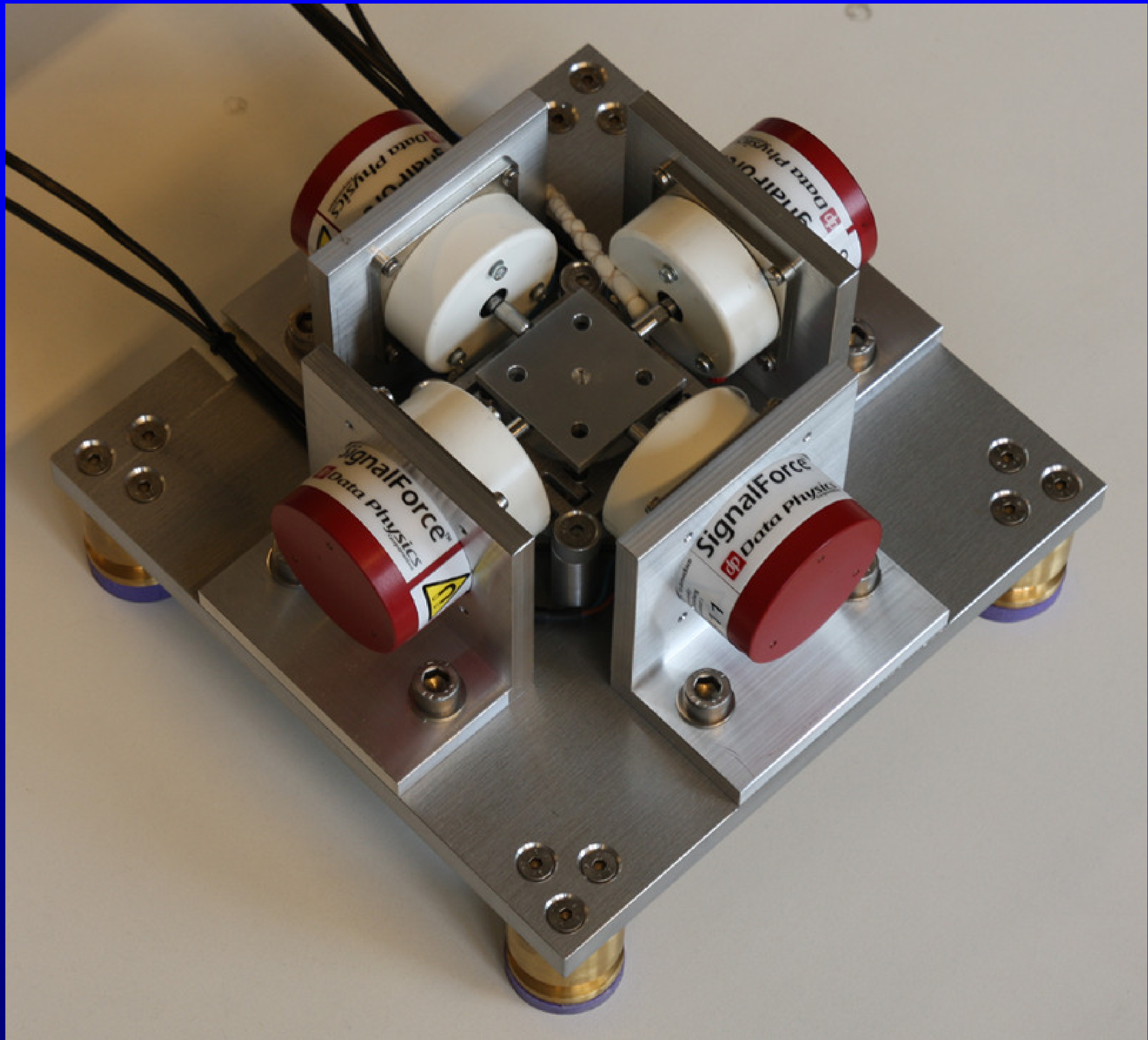
- Design generally adequate
- Crosstalk cancellation working

- Non – linear behavior means control system required (Proportional controller)

- Vibration amplitude above 300 Hz too low
- Z – vibration not uniform on the surface

- Reduce mass of vibrating parts
- Make design more symmetric

Vibration platform II: Photo



Vibration Platform II: Characteristics

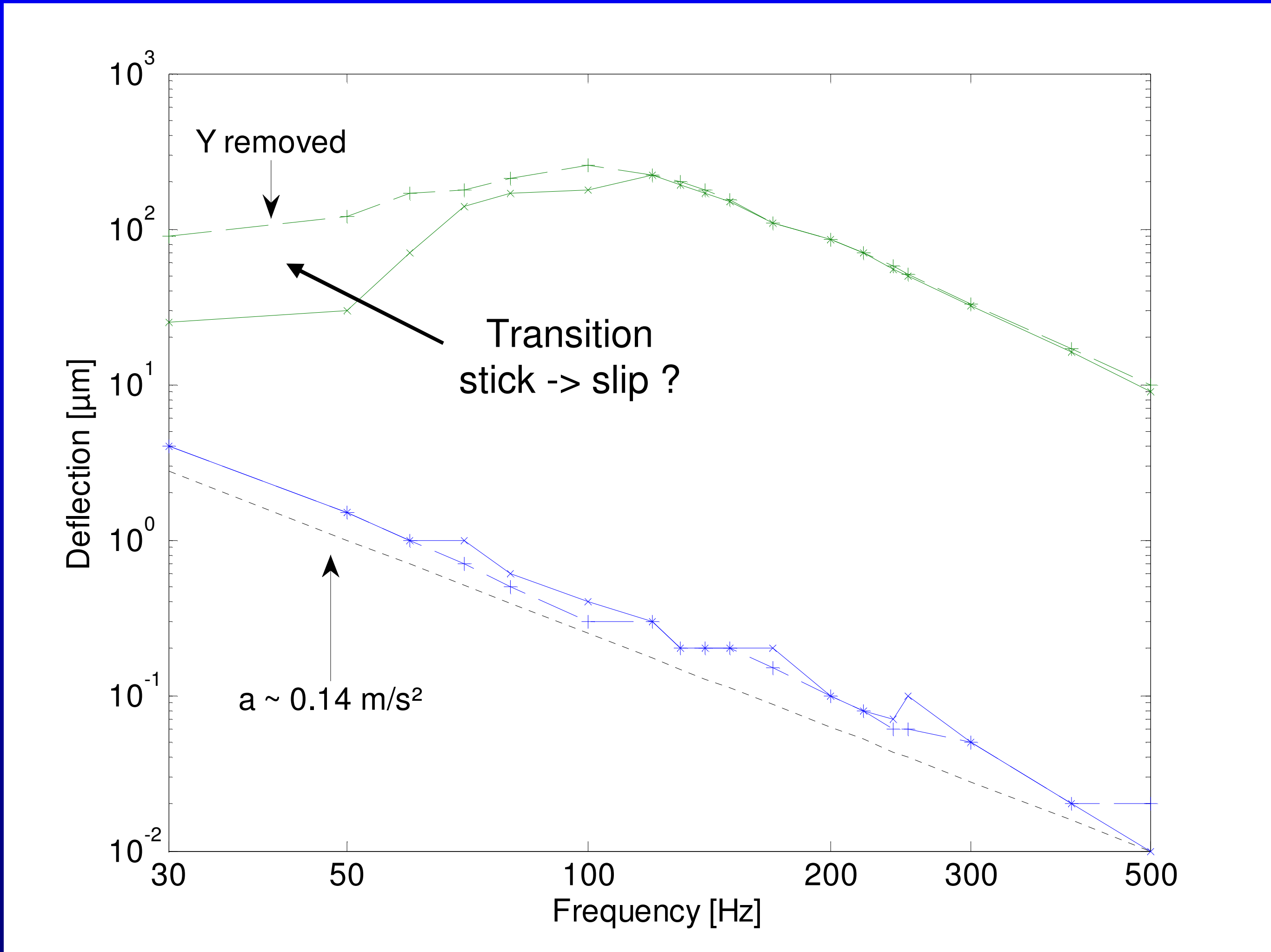
Amplitude range

Crosstalk

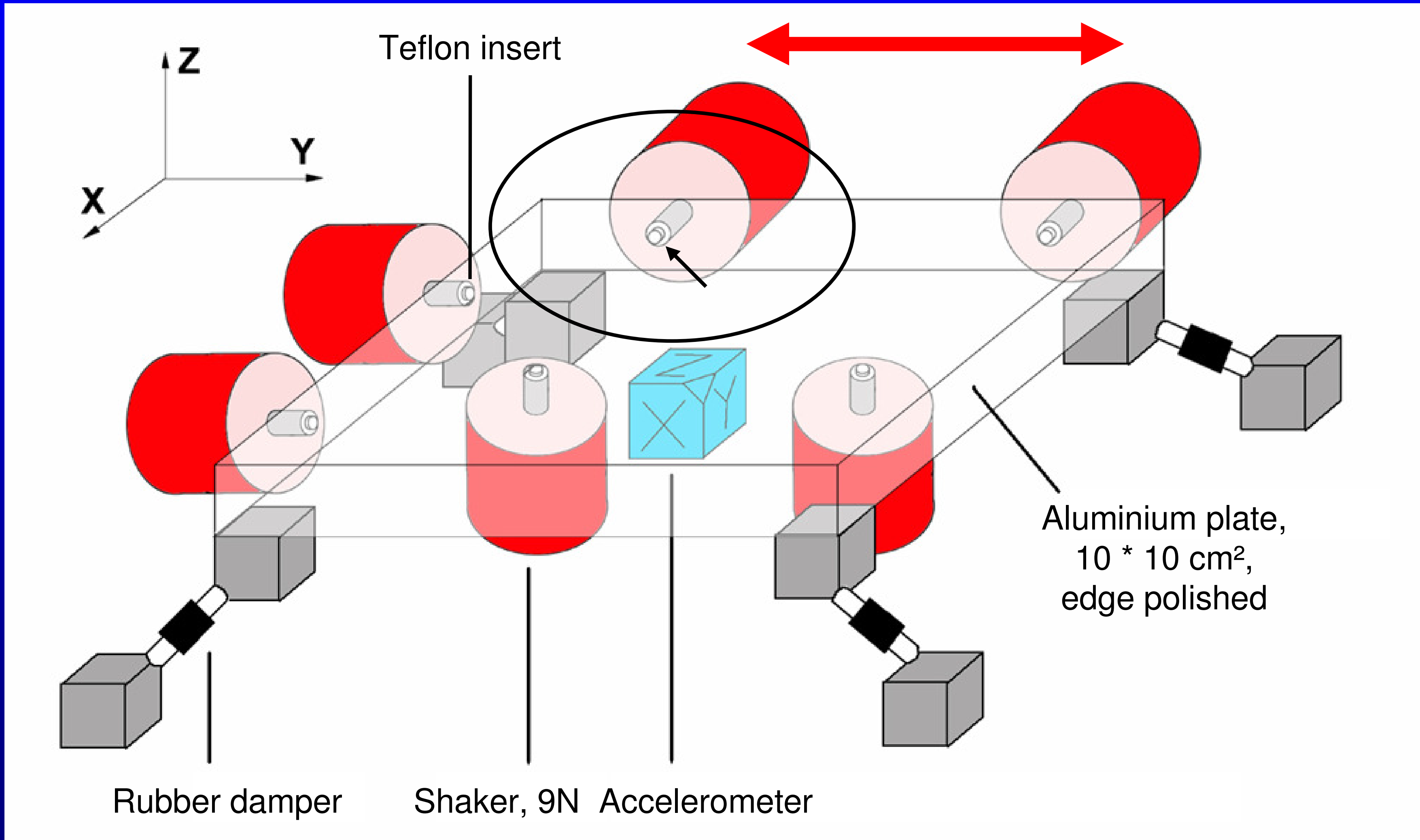
Uniformity of vibration

Vibration platform II: Amplitude range X

X - direction: Amplitude range for THD+N < 1%

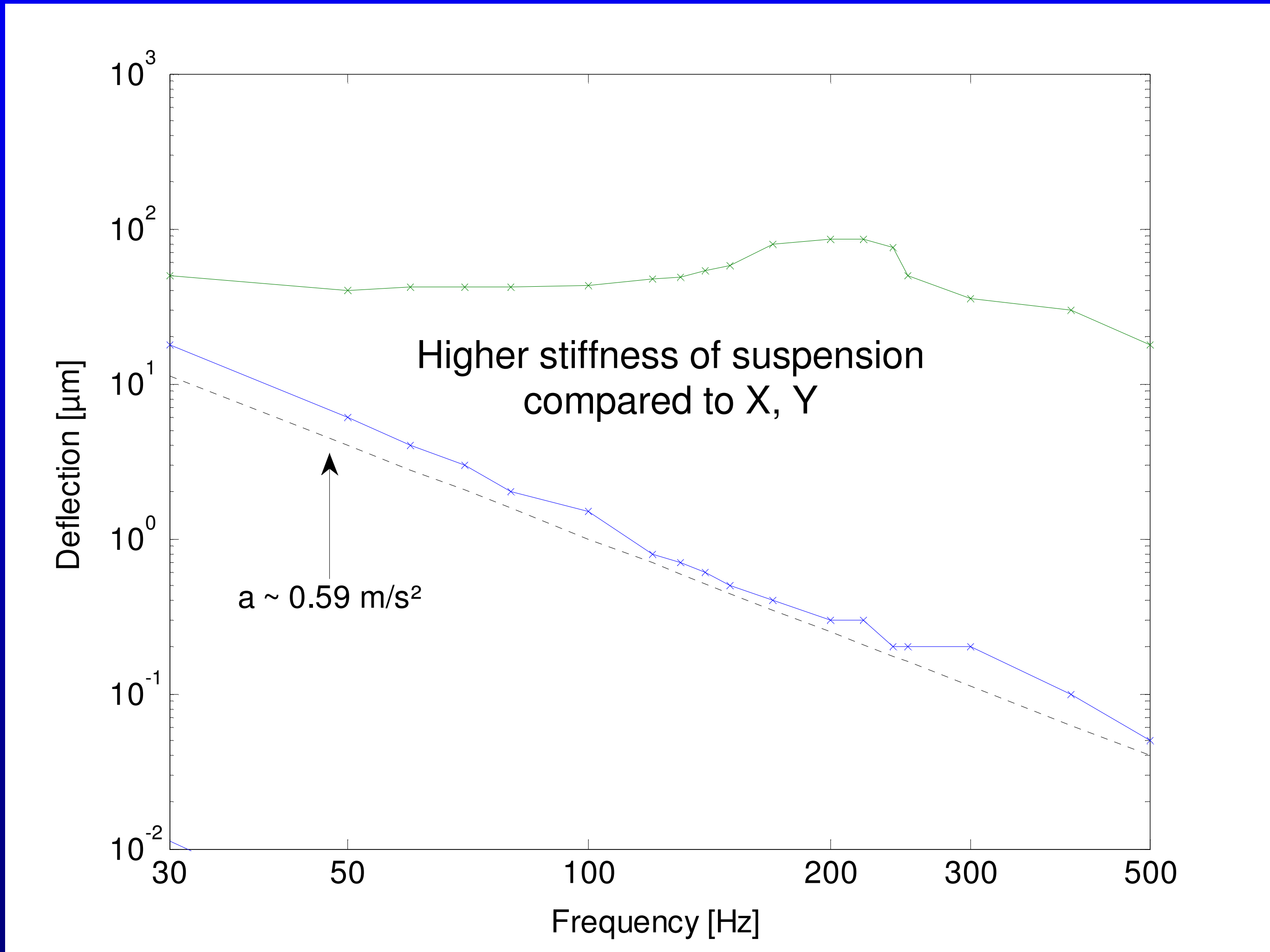


Vibration platform: Model



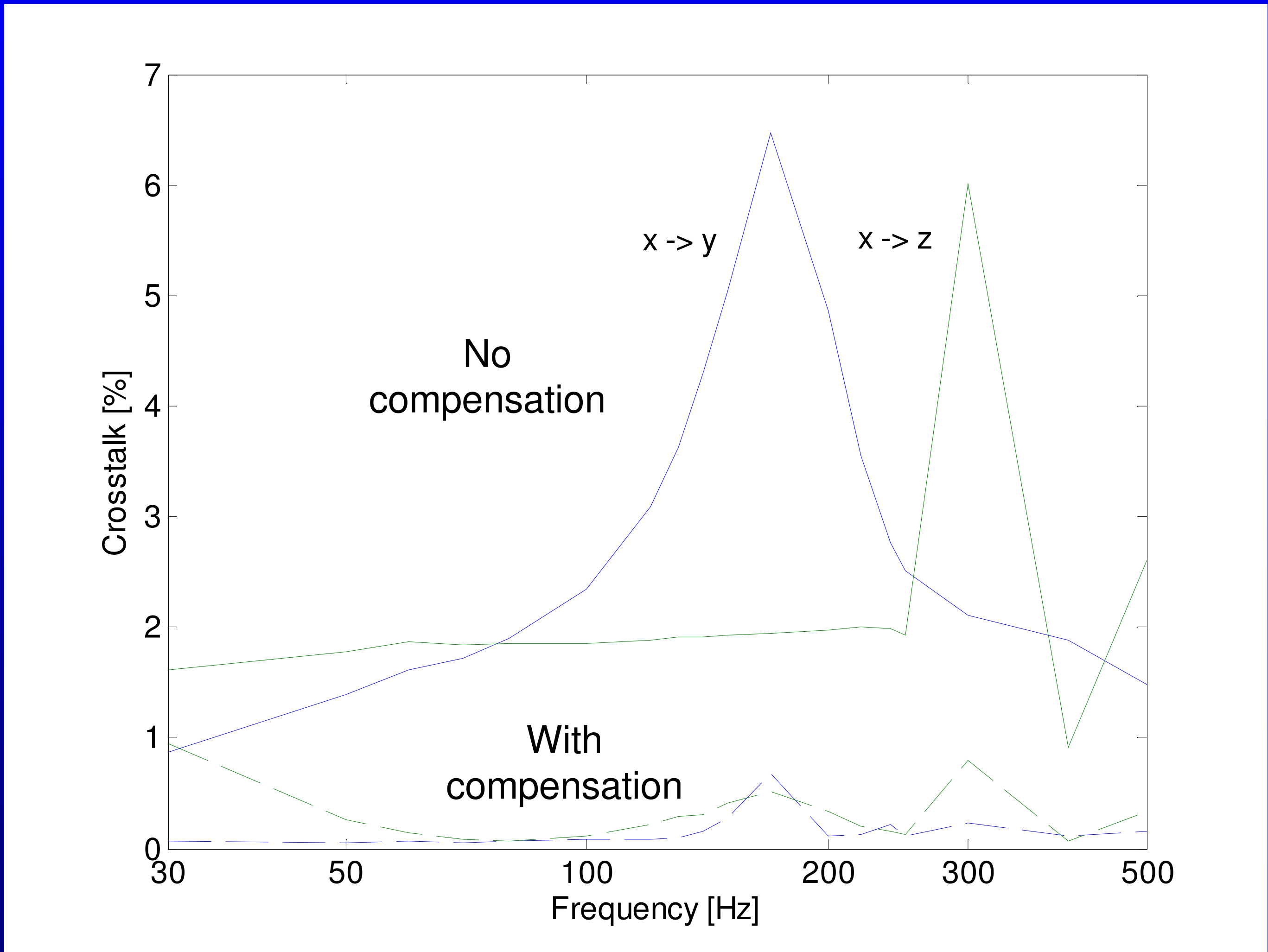
Vibration platform II: Amplitude range Z

Z - direction: Amplitude range for THD+N < 1%



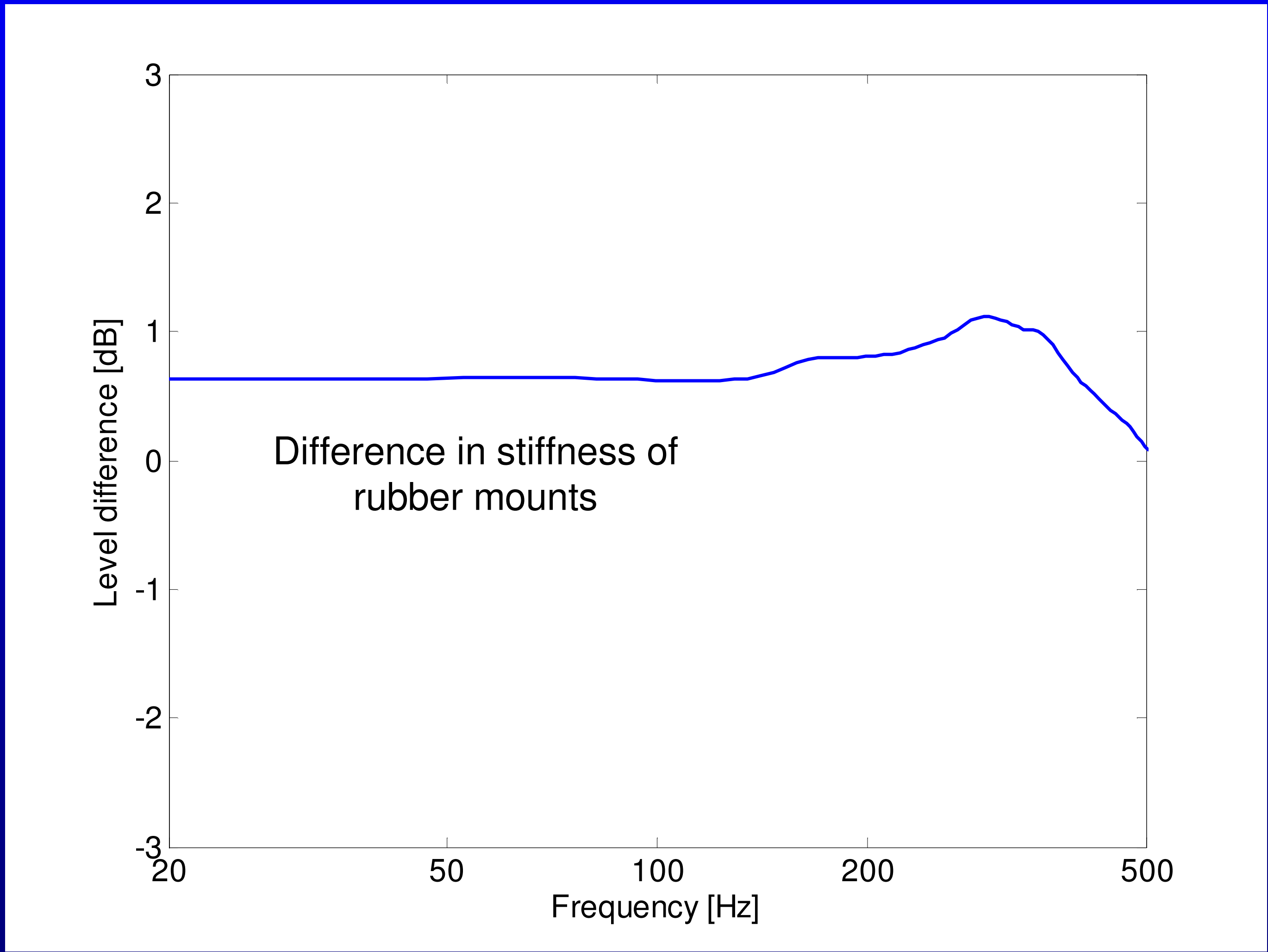
Vibration platform II: Crosstalk

Crosstalk for 10 µm vibration in X - direction



Vibration platform II: Z - vibration

Difference in vibration amplitude between two positions (edges) on the surface



Summary

- Platform for reproduction of 3D vibrations has been constructed
- Useful for testing and calibration of (optical) vibration sensors if 1D calibration is not sufficient

- Frequency range of 20 – 500 Hz with an amplitude ≥ 10 µm (maximum 200 µm)
- Simple and effective crosstalk compensation
- Reasonable uniform vibration amplitude on the surface

Thank you for your attention !