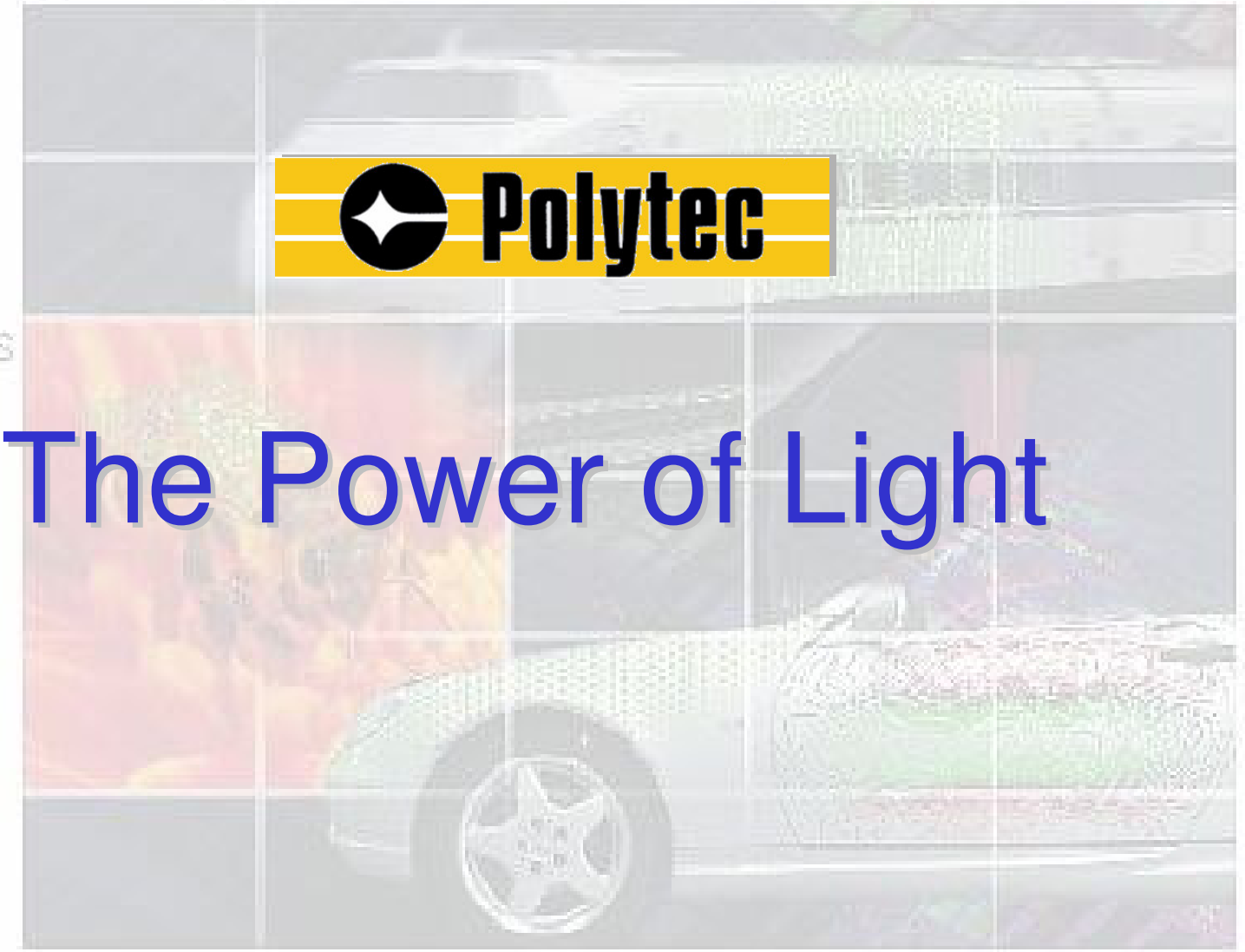
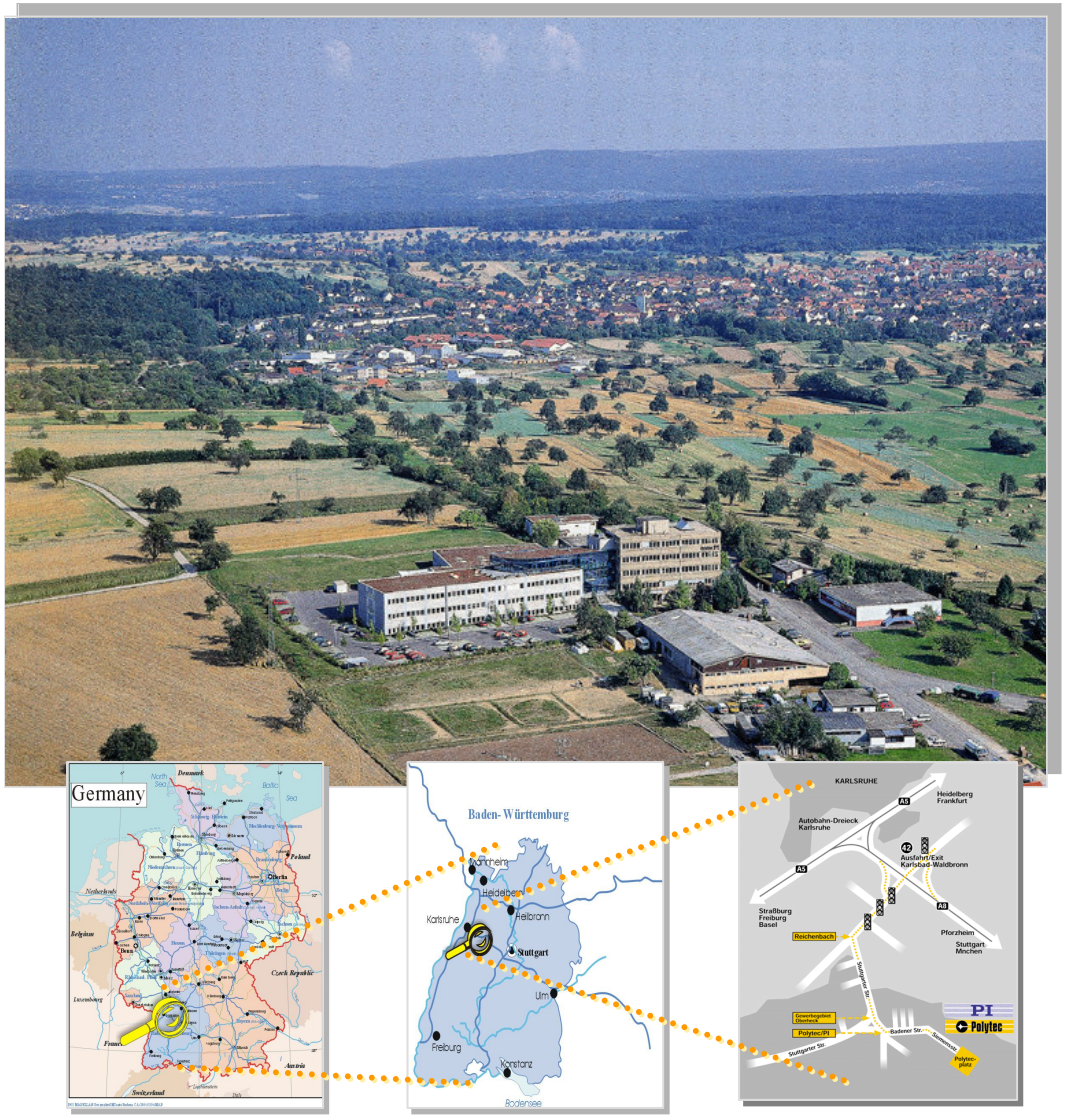
Schwingungen sehen!

- Schnell
- Zuverlässig
- Berührungslos



The Power of Light

Polytec,Waldbronn



Polytec Staff

- Polytec 230
- including PI 440
- worldwide ca. 600

Subsidiaries:

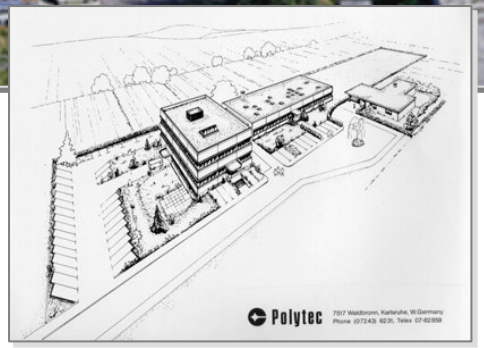
- Berlin
- France
- England
- Japan
- USA West- und East

Consolidated turnover of Polytec– PI group:

120 Mio. €

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Polytec,Waldbronn



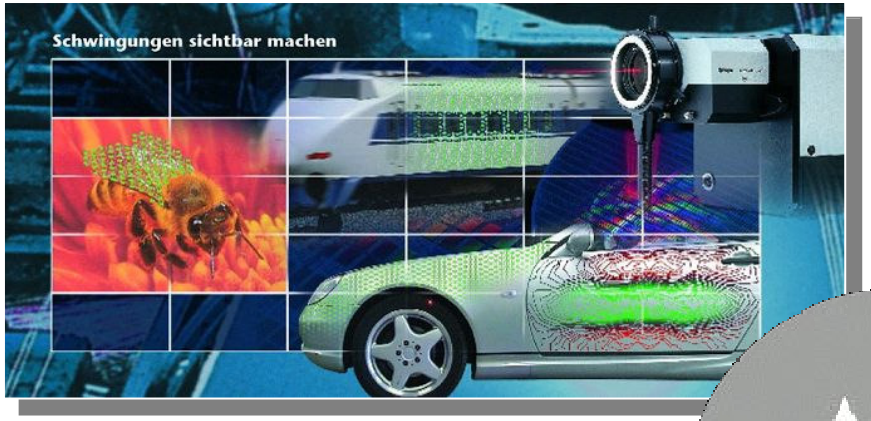
1967 Formation of Polytec
1972 1. Stage of expansion: Waldbronn
1983 2. Stage of expansion

1987 3. Stage
1996 4. Stage
2001 5. stage

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

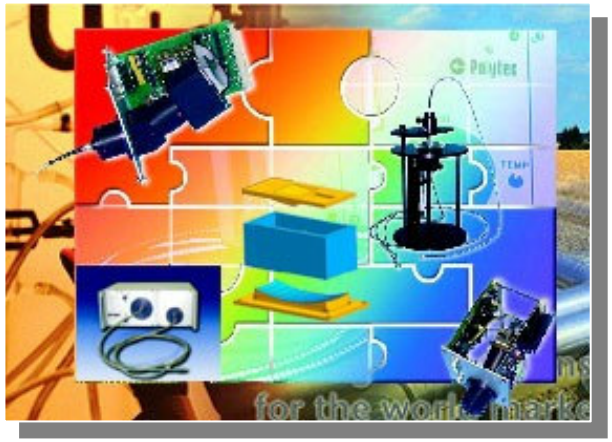
Business Units

Laser Measurement Systems



Photonics

Spectral Technologies



Synergy is what happens working together

Polymer Technologies

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Laser Measurement Systems

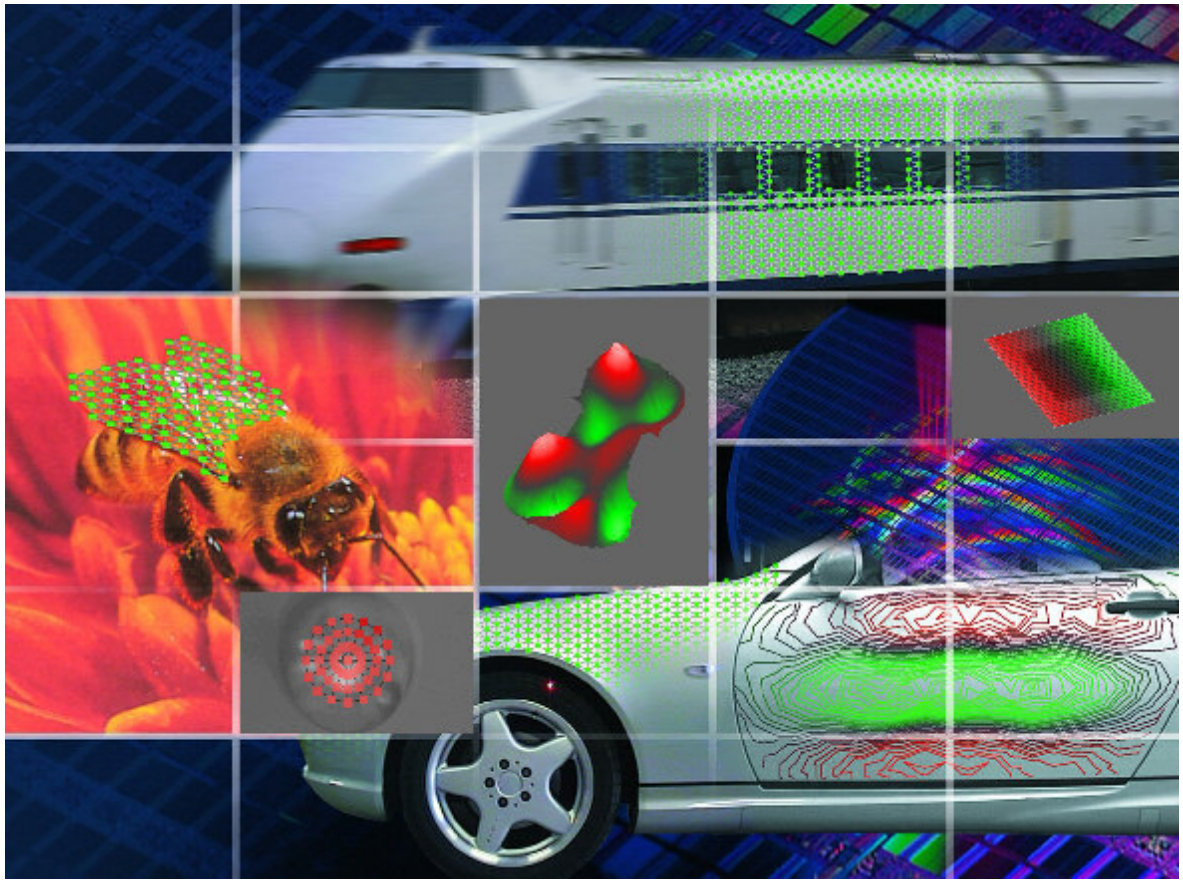
Laser Doppler Vibrometer
for non-contact vibration measurement

Laser Surface Velocimeter
for non-contact length & speed measurement

PNA Solutions for noise analysis and acoustic quality control

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Laser Measurement Systems



Vibration Analysis

- Single-point or full-field
- 1- or 3-dimensional
- on tiny or large objects
- in R&D or production environments

Applications in

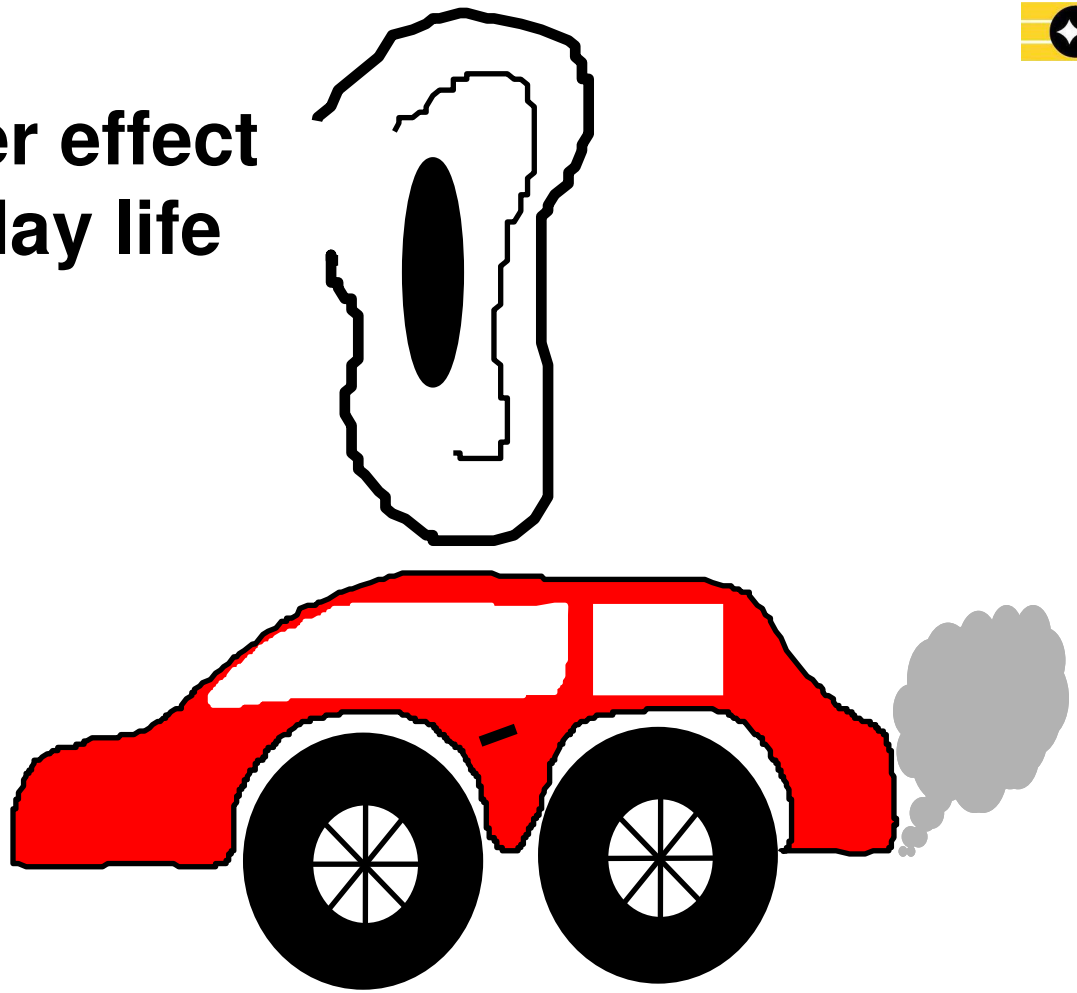
- Automotive industries
- Aerospace industries
- Data Storage
- Microstructures
- Transportation
- Audio and Acoustics
- Mechanical Engineering
- Biology and Medicine
- And in your business!

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Laser Doppler Interferometry

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

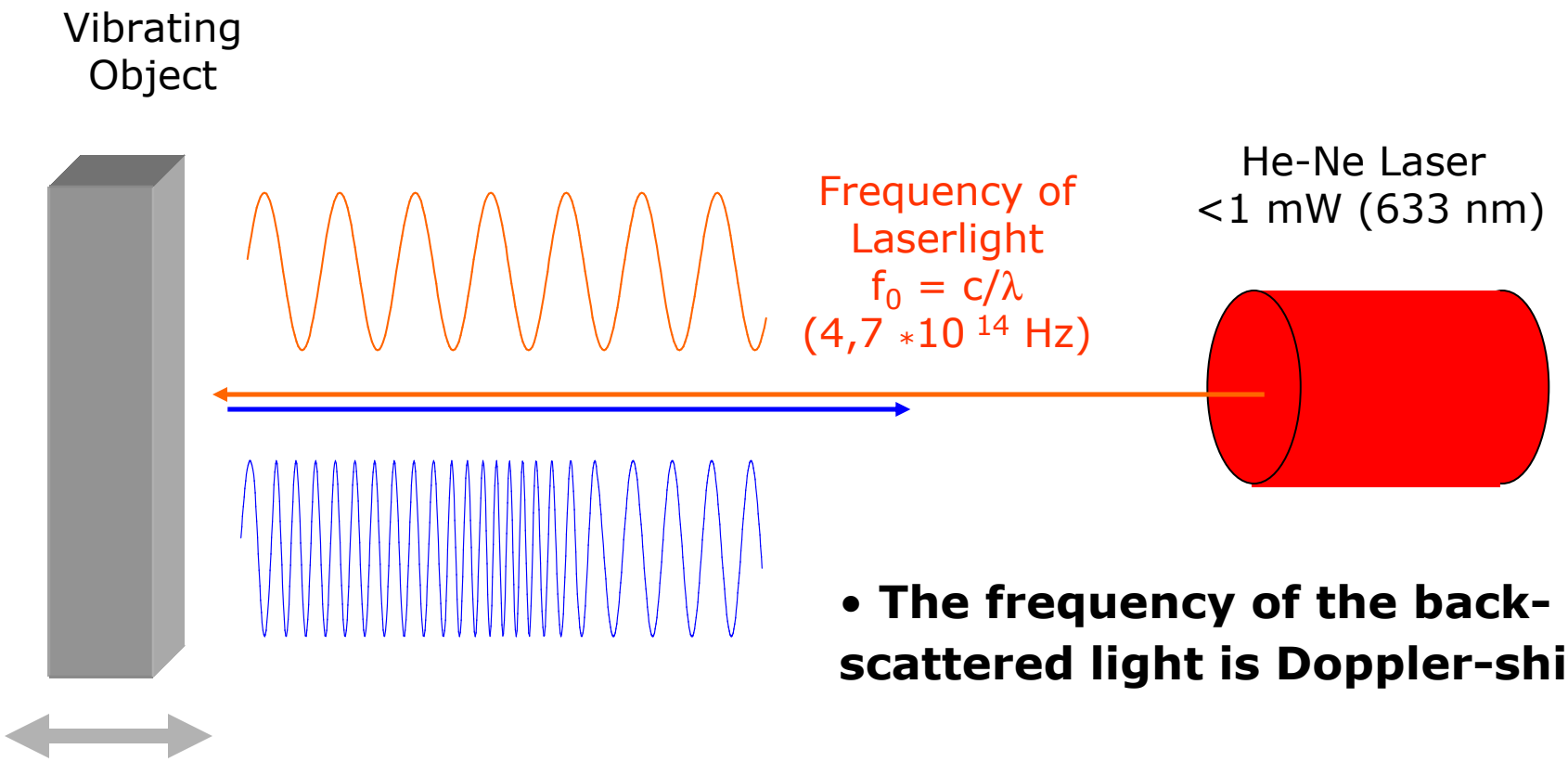
The Doppler effect in every day life



Frequency shift can be heared directly

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

2 Ways of looking at it: Doppler shift



- **The frequency of the back-scattered light is Doppler-shifted**

- **Doppler-Shift is proportional to object velocity**
- **1 m/s = 3,16 MHz**

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

The Doppler effect follows the equation:

$$f_D = 2 \cdot \frac{v}{\lambda}$$

The Doppler frequency is:

$$f_D = 3.16 \cdot 10^{6} \cdot v$$

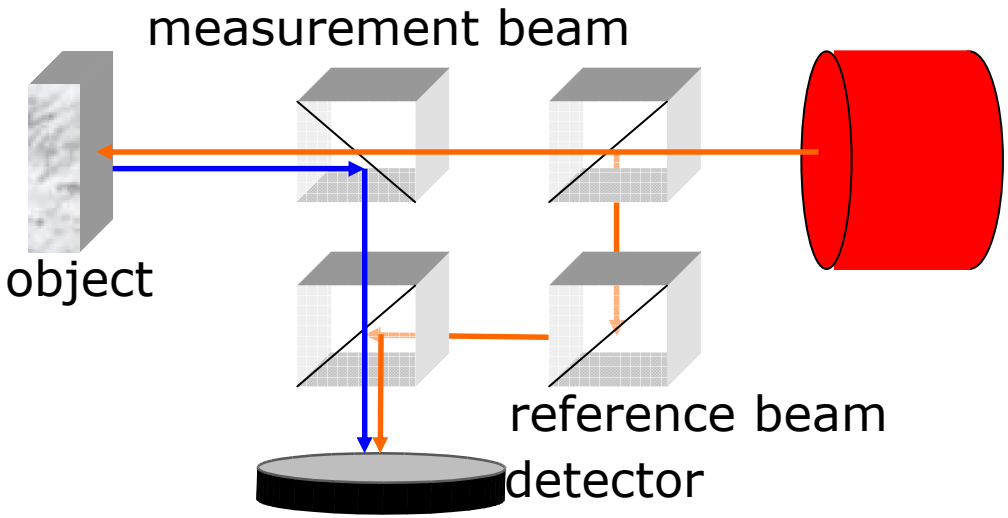
V in m/s

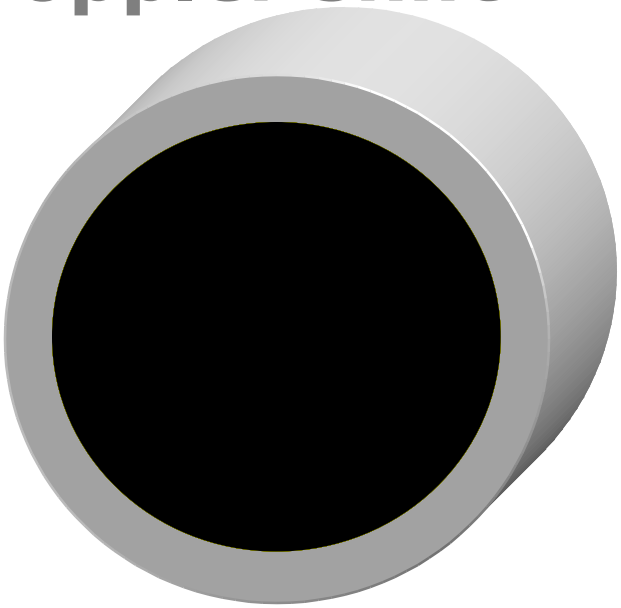
f_D in Hz

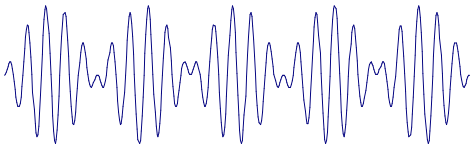
λ= 632,8 nm

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

2 ways of looking at it: Doppler shift







Interference of measurement and reference beam:
Intensity modulation with exactly the Doppler frequency

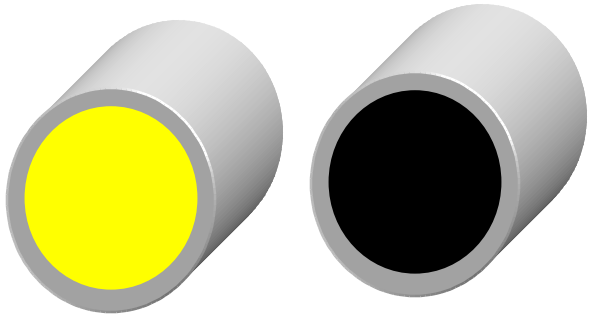
Displacement and velocity

2 Ways of measuring (the same vibration...) :

1. Count light and dark fringes on detector:

Displacement

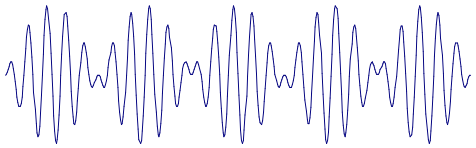
(linked to phase of Doppler signal)



2. Determine frequency of this intensity modulation

Velocity

(linked to frequency of Doppler signal)



Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Bragg cell

Doppler frequency shift depends on the absolute value of the object velocity, it is not possible to detect the direction of the object movement (as no negative frequency can be measured):

$$f_{\text{mod}} = f_D = 2\frac{|v|}{\lambda}$$

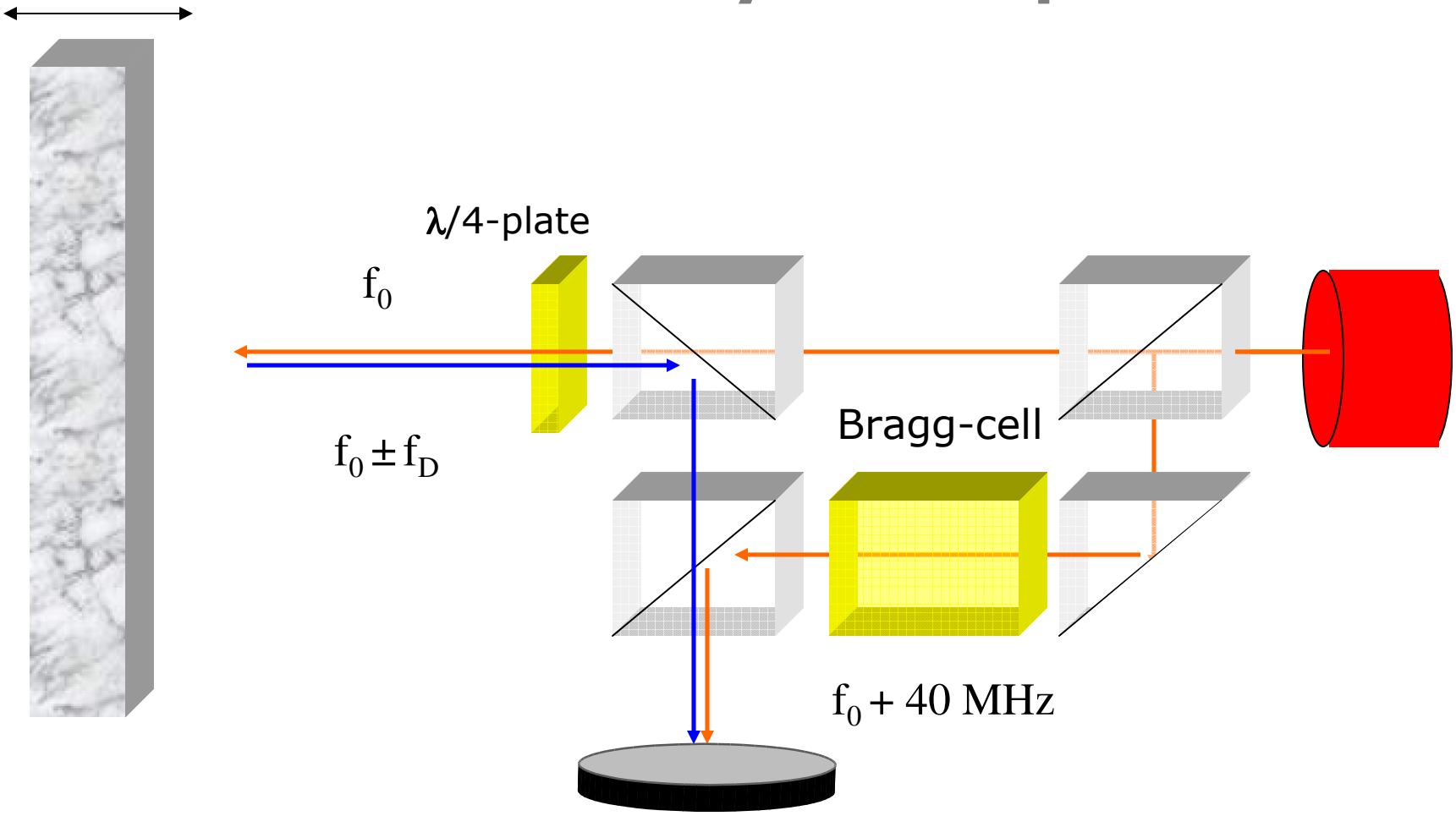
Introduce offset by a "Bragg cell"

Which offsets by f_B (e.g. 40 MHz)

$$f_{\text{mod}} = f_B + 2\frac{v}{\lambda}$$

This also enables precise measurementof small velocities (small Doppler frequencies)

Heterodyne setup

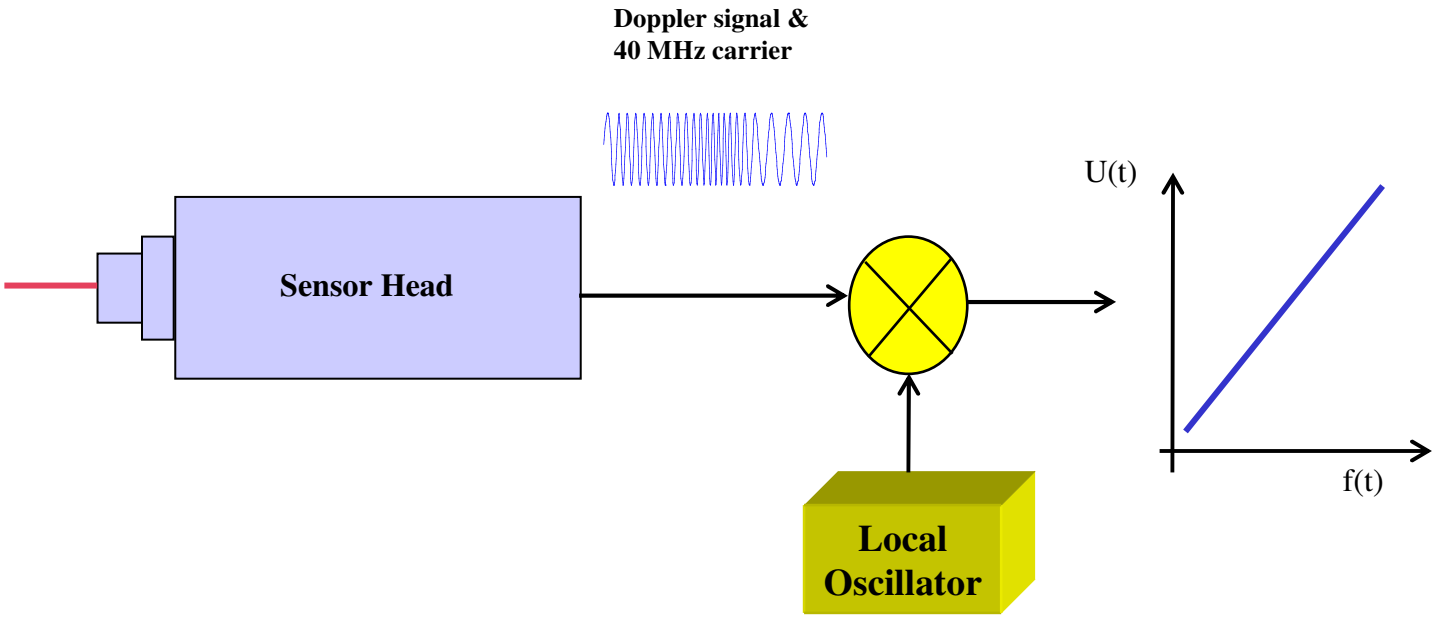


$$I_{\text{detector}} \propto \cos(40\text{MHz} \pm f_D)$$

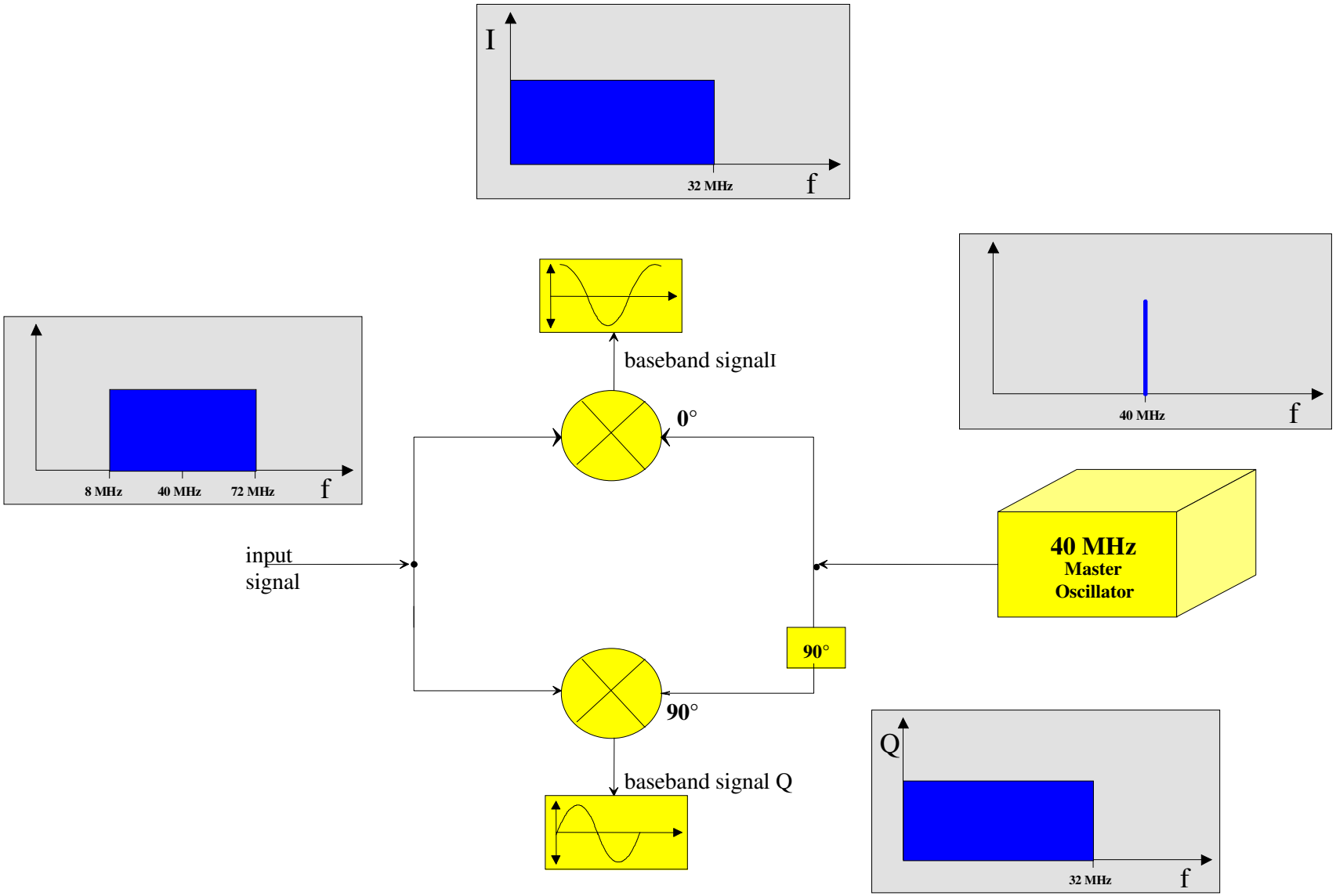
Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Analog velocity demodulation

Surface motion will introduce a doppler shift to the optical frequency of the beam. Velocity is electronically derived by measuring the amount of doppler shift. This is done by mixing the detector signal with a variable local-oscillator frequency and subsequent FM demodulation. The output signal of a demodulator U(t) is linked to the input frequency f(t) via an in principle linear characteristic : *U(t) = const. f(t)*



Quadrature demodulator



Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Displacement demodulation using Phase Decoding

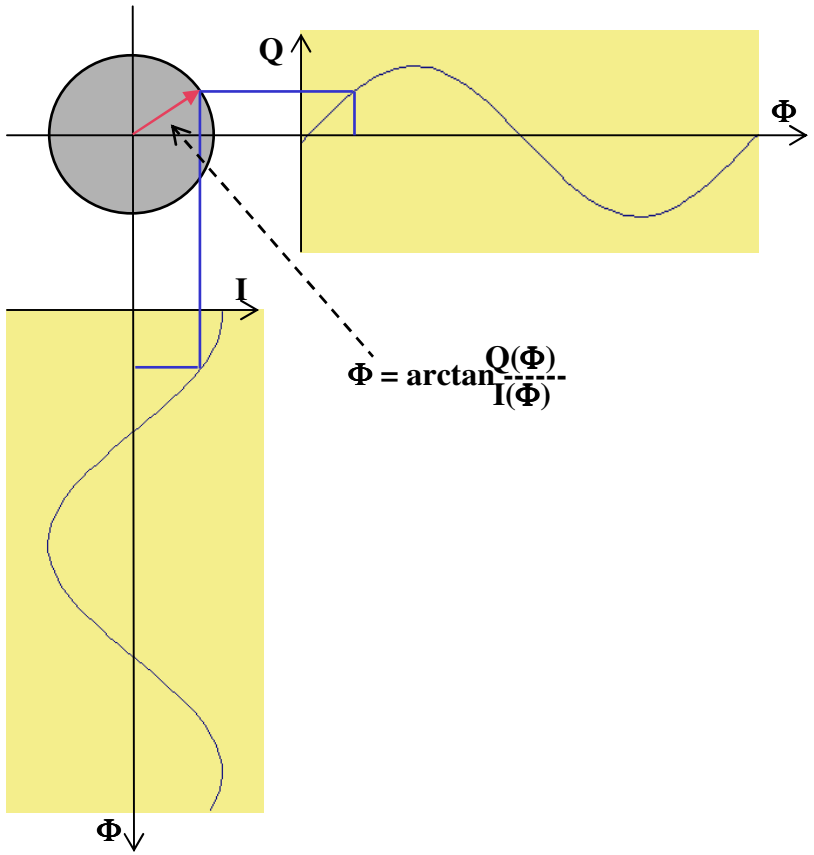
Phase relations:

$$\Phi(\Delta x) = \frac{4\,\Pi}{\lambda}\,\Delta x$$

$\Phi(\Delta x)$ = Interferometric phase

Δx = Object displacement

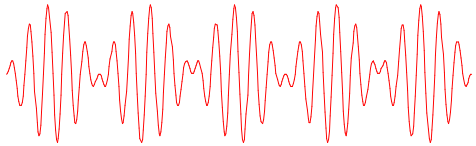
λ = Laser wavelength



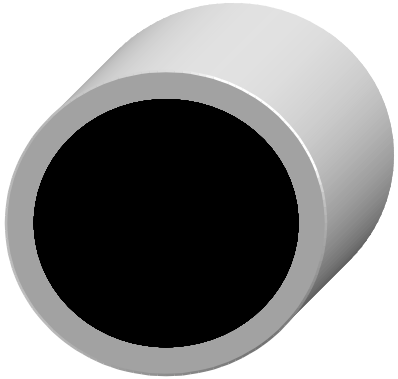
The I & Q signals can be represented by a vector in the I-Q diagram as shown above. This vector should describe a perfect circle. The circle can be distorted by amplitude variations, offset or phase variations (≠ 90°) which are numerically compensated.

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Demodulating the signal



Optical interference signal



Electrical signal

Decoder

Voltage ~ Velocity

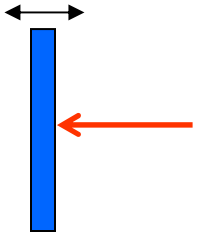
Voltage ~ Displace-ment

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

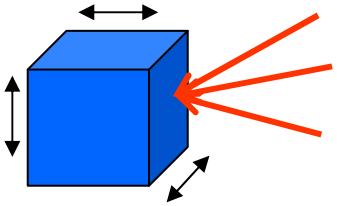
Laser-Doppler Vibrometer Typology

Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

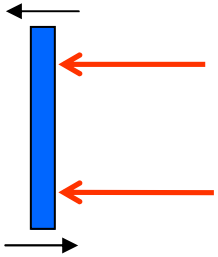
Laser-Doppler Vibrometer



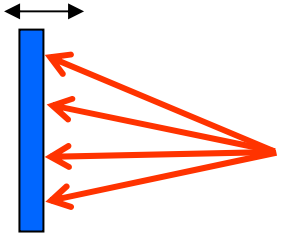
Single point,
out-of-plane vibrometers



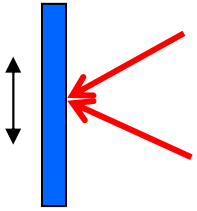
3D vibrometer



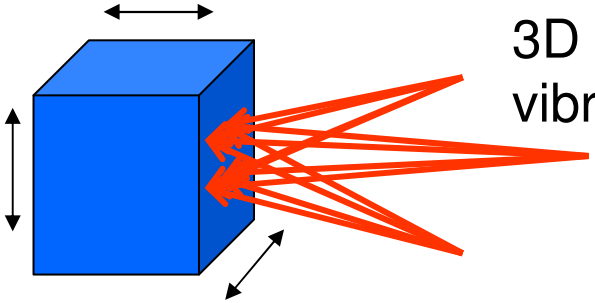
Differential
out-of plane vibrometer



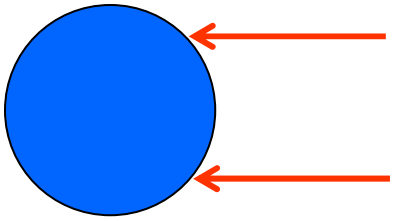
Scanning vibrometers



In-plane vibrometers



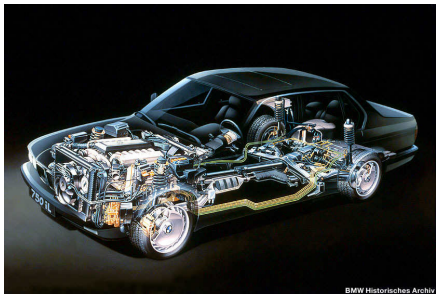
3D scanning
vibrometer



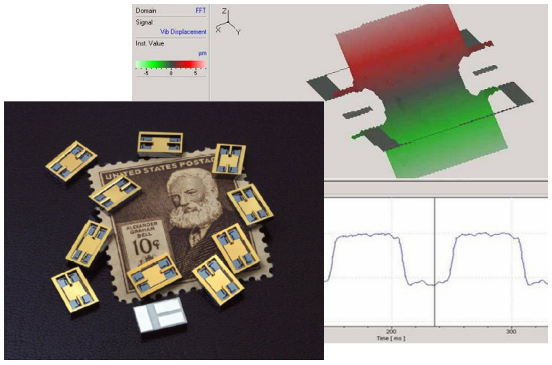
Rotational vibrometer

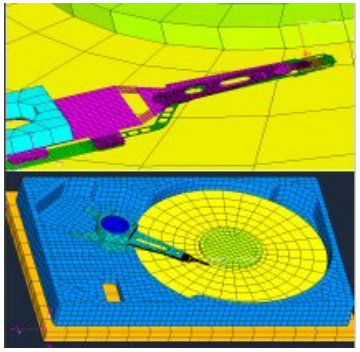
Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944

Where are the application?



… and in your business !





Polytec GmbH • Polytec-Platz 1-7 • 76337 Waldbronn • Germany
Fon +49 (0) 7243 604 0 • Fax +49 (0) 7243 69944