Real Time Systems – SS2016

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Computer Science and Engineering

Sensoring

Sensors

A Sensor converts a physical oder chemical measure
into electrical signals.

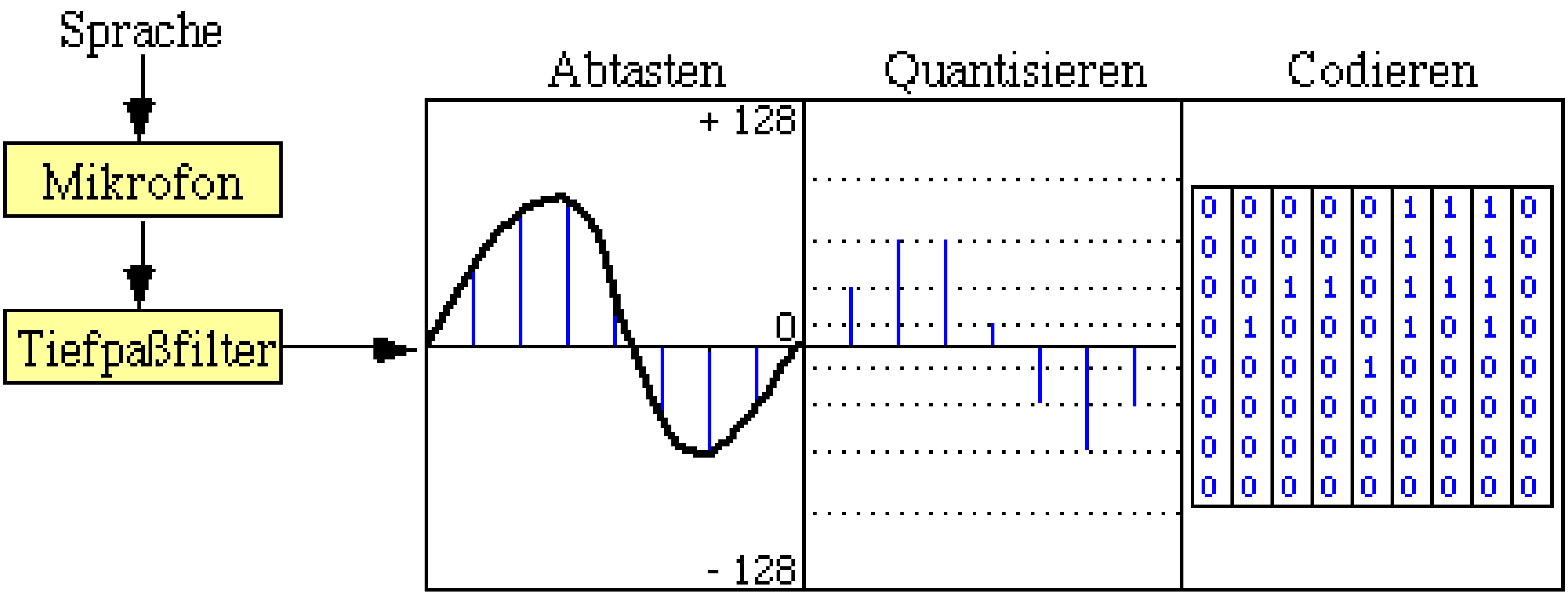
Example:

A microphone converts an alternatic air pressure
into elektrical alternating voltage.

An analog/digital-converter (ADC) digitizes the alternating voltage
to digitale Data.

digitale data of sensors is called raw-data

The digital microphone

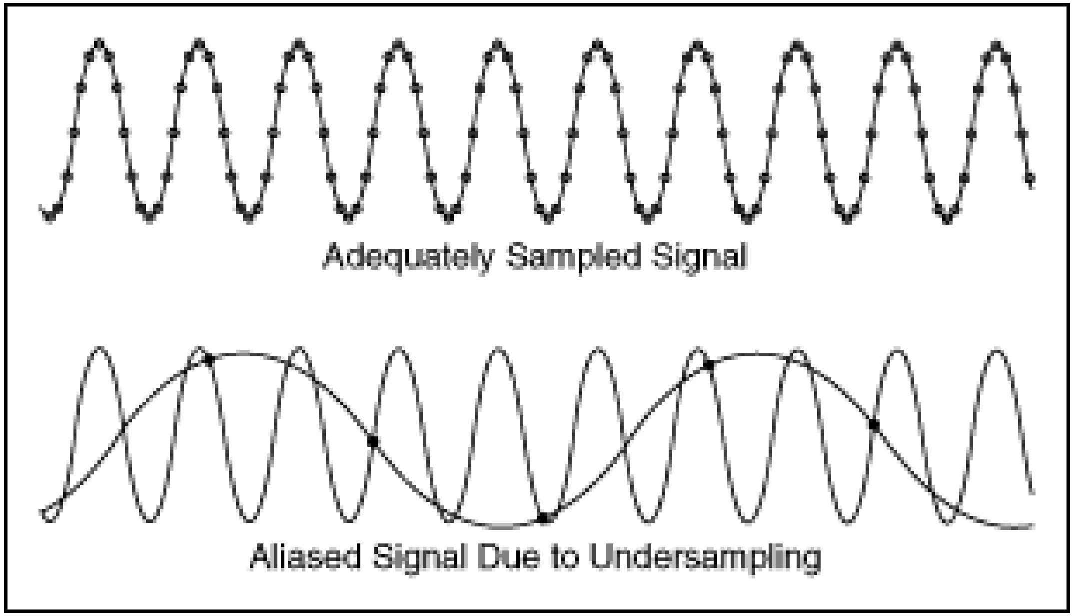


Import for DAC:

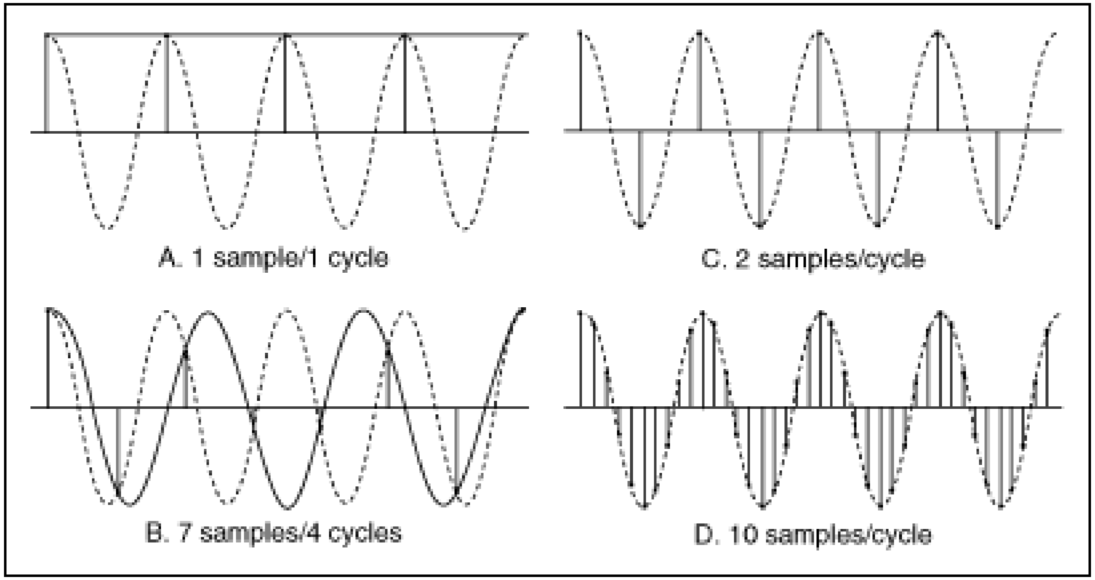
How many bits needs to be used to hit the mimimal error?

Sampling frequence: needs to be at least twice the maximum of the recorded signal (Nyquist Theorem) therefore we need a low pass filter

Nyquist Theorem

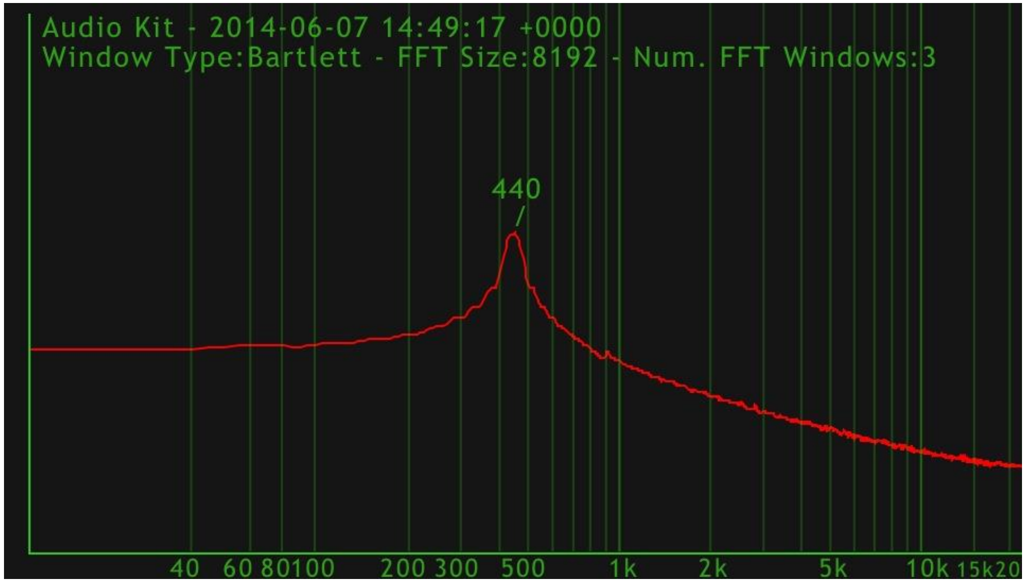


An aliased signal provides a poor representation of the analog signal. Aliasing causes a false lower frequency component to appear in the sampled data of a signal. The following illustration shows an adequately sampled signal and an inadequately sampled signal. In this illustration, the inadequately sampled signal appears to have a lower frequency than the actual signal—two cycles instead of ten cycles.

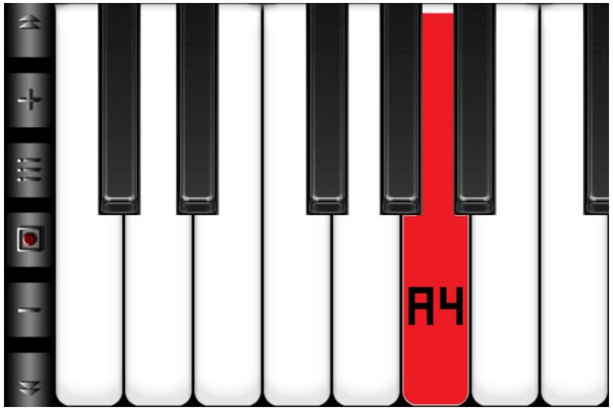


In **case A** of this illustration, the sampling frequency f_s equals the frequency f of the sine wave. f_s is measured in samples/second. f is measured in cycles/second. Therefore, in case A, one sample per cycle is acquired. The reconstructed waveform appears as an alias at DC.
In **case B** of the previous illustration, $f_s = 7/4f$, or 7 samples/4 cycles. In case B, increasing the sampling rate increases the frequency of the waveform. However, the signal aliases to a frequency less than the original signal—three cycles instead of four.
In **case C** of the previous illustration, increasing the sampling rate to $f_s = 2f$ results in the digitized waveform having the correct frequency or the same number of cycles as the original signal. In case C, the reconstructed waveform more accurately represents the original sinusoidal wave than case A or case B. By increasing the sampling rate to well above f, for example, $f_s = 10f$ = 10 samples/cycle, you can accurately reproduce the waveform.
Case D of the previous illustration shows the result of increasing the sampling rate to $f_s = 10f$.

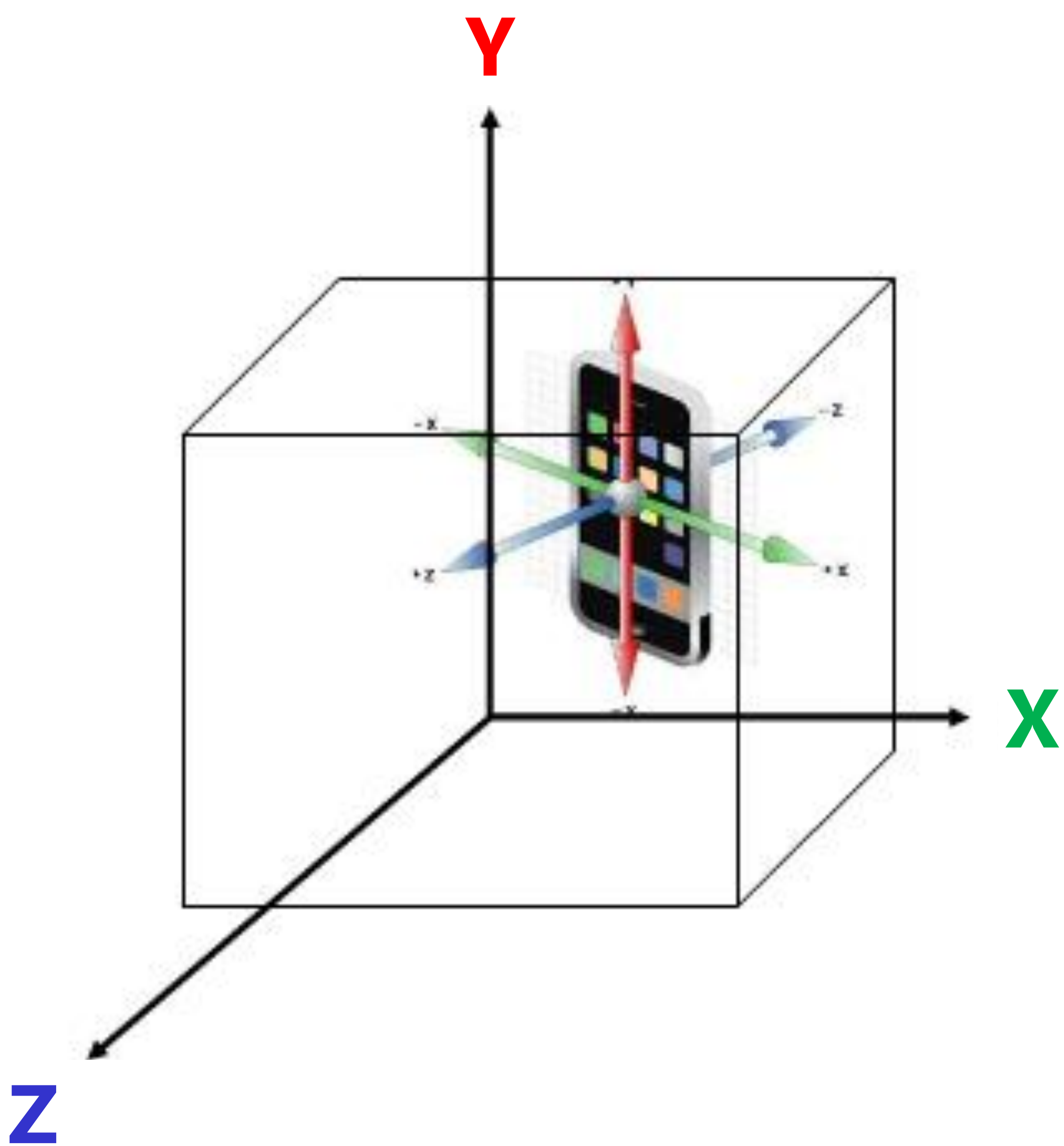
Tuning fork (Stimmgabel)

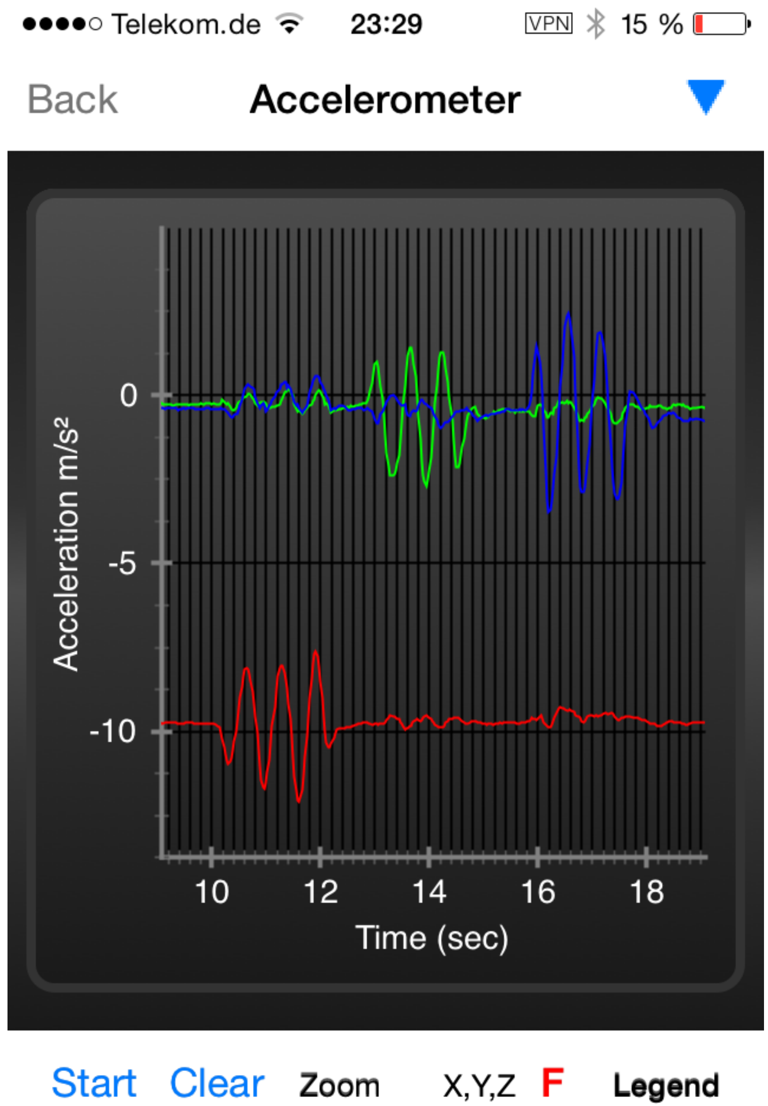


Die Schallwellen der Stimmgabel werden durch das Mikrofon in elektrische Wechselspannung umgewandelt (siehe oben). Durch Fast-Fourier-Transformation (FFT) ergibt sich das Frequenzspektrum mit einem Maximum bei 440Hz.
By semantic annotation this results in „A4“ on the piano.

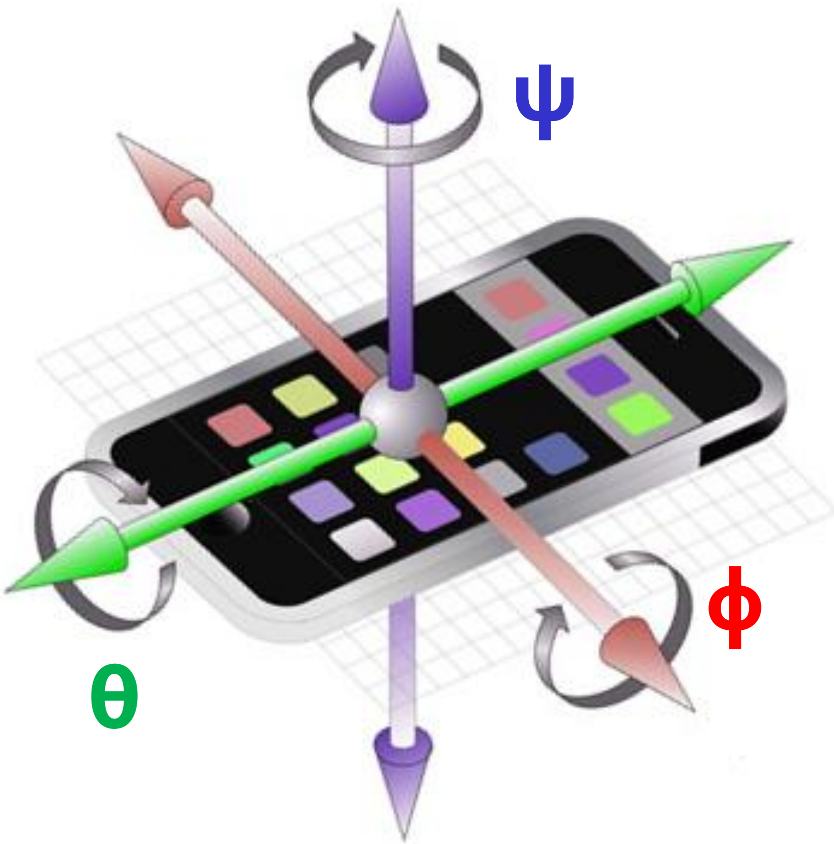


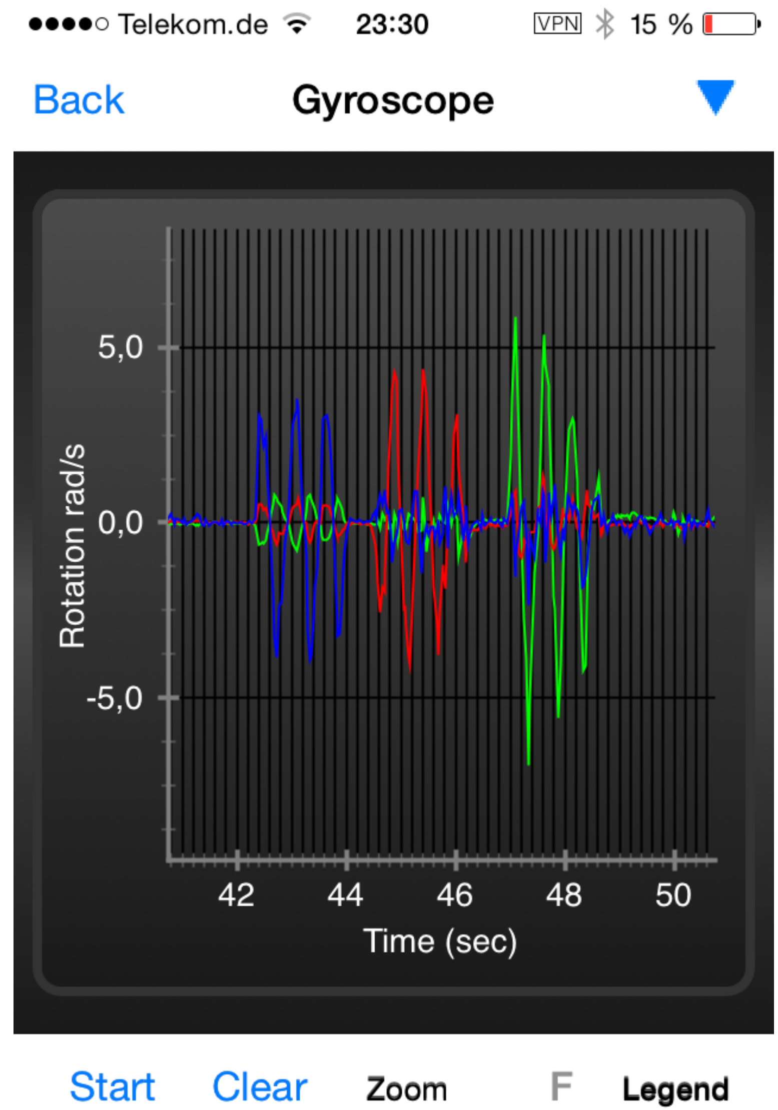
1.2.2 Der Beschleunigungssensor/Accelerometer





1.2.3 Gyroskop-Sensor/Gyroscope





θ: roll/Rollwinkel

ϕ: nick/Nickwinkel

ψ: yaw/Gierwinkel

1.2.4 Magnetometer/Kompass, GPS

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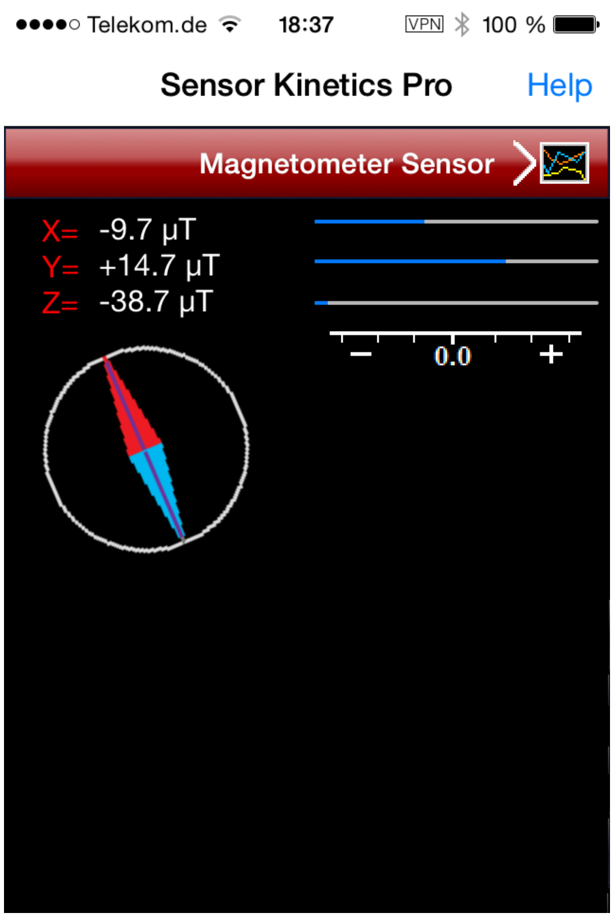
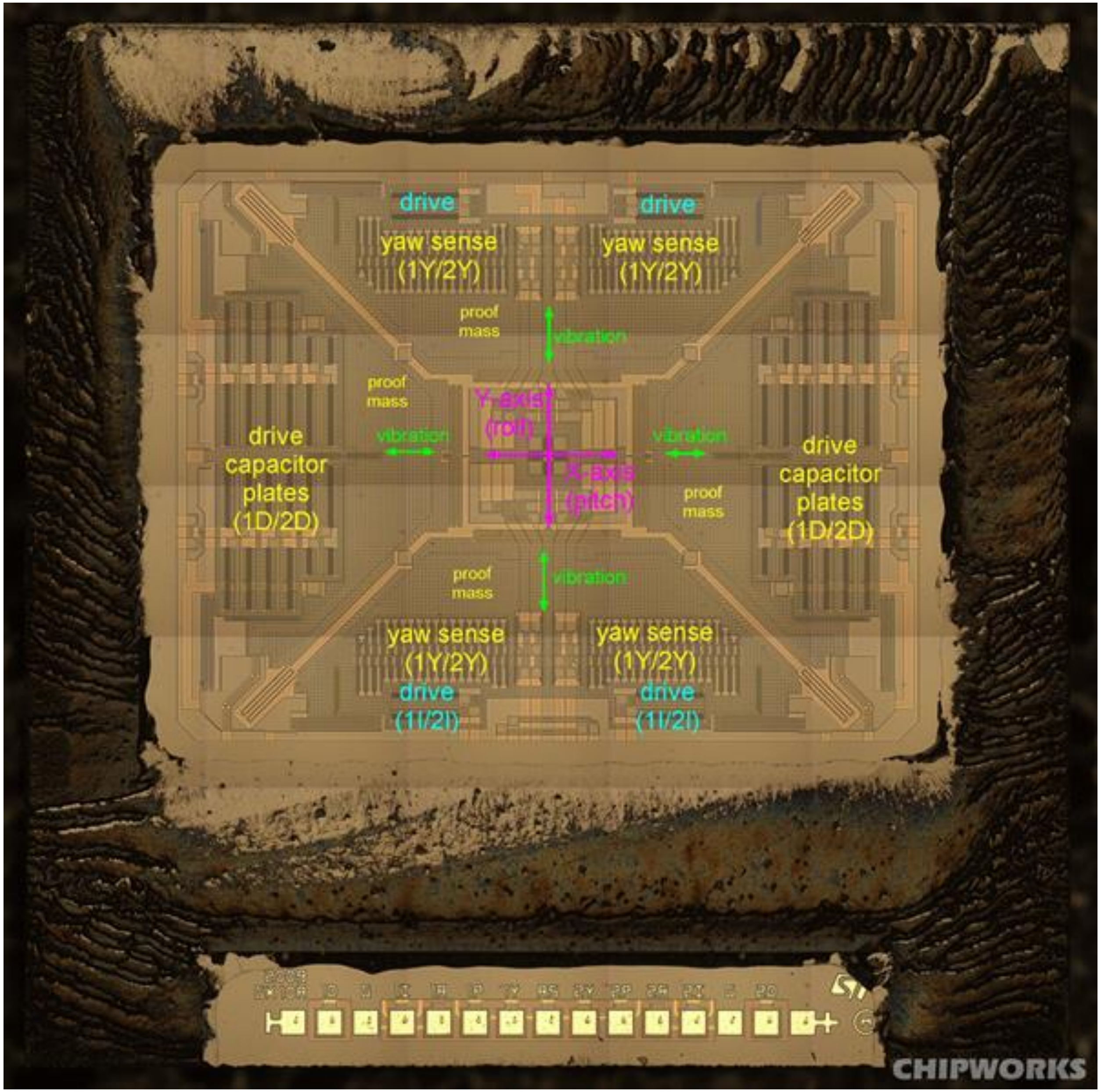


← GPS-Daten: geographische Breite u. Länge

Aus der Magnetfeldstärke (x,y,z)=(-9,7µT, +14,7µT, -38,7µT) ergibt sich durch Projektion und Korrektur ein Winkel von 36° gegenüber geographisch Nord.
Aus den 36° ergibt sich dann durch semantische Annotation die Richtung Nord-Ost (NO).

1.2.5 MEMS: Micro Electronic Mechanical Systems



MEMS: Accelerometer iphone4

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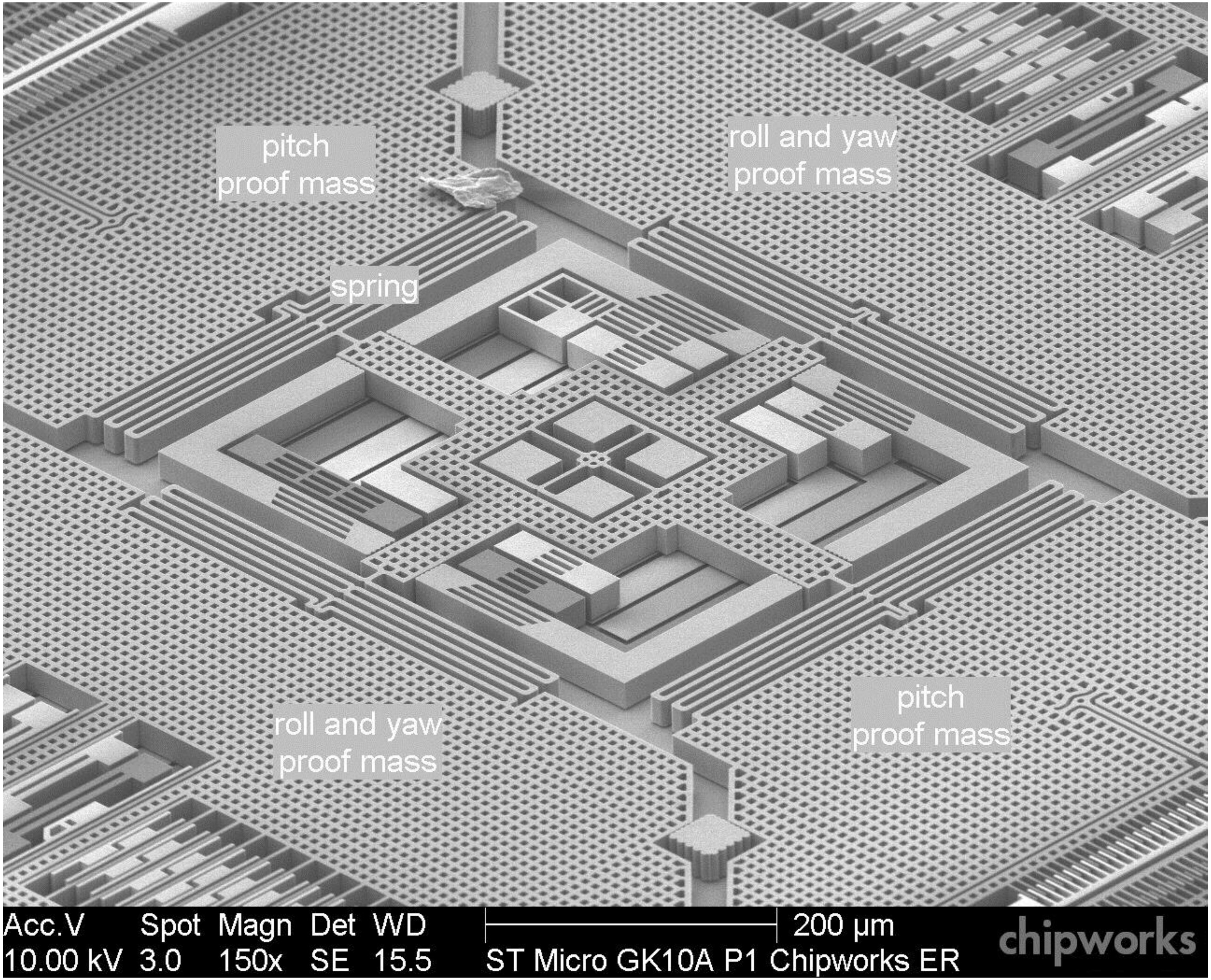
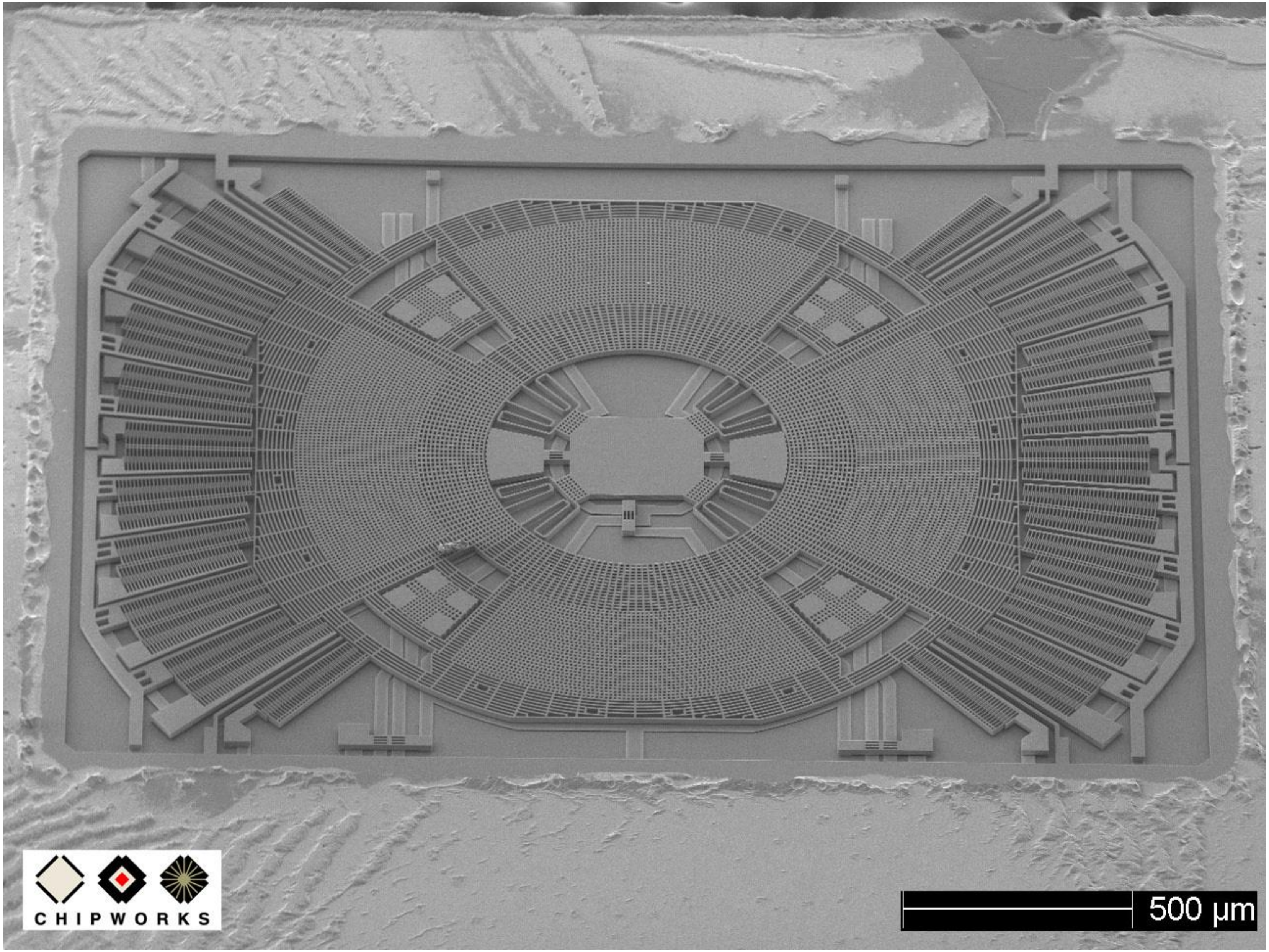


1.2.6 MEMS: Gyroscope



1.2.6 MEMS: Accelerometer

Charles Stark Draper Laboratory: Tuning Fork