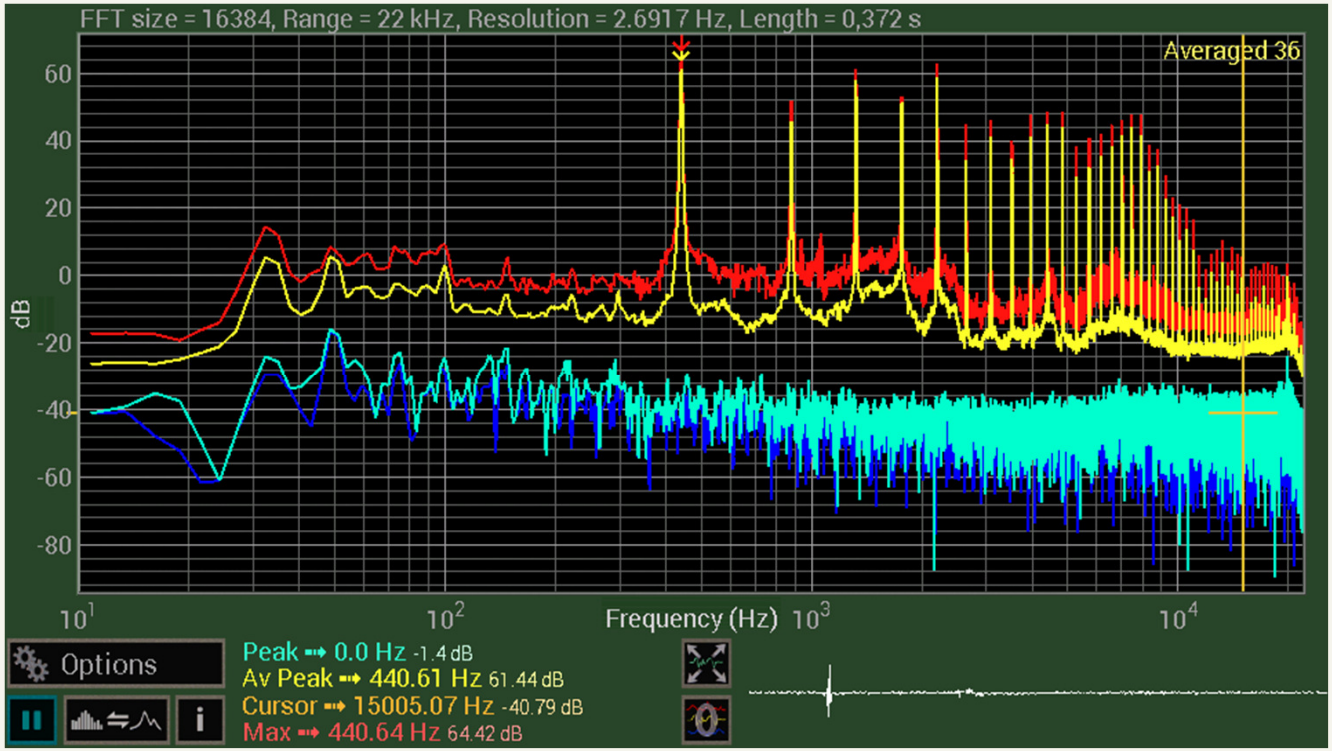
university of groningen / faculty of science and engineering

Smartphone apps in Physics practicals

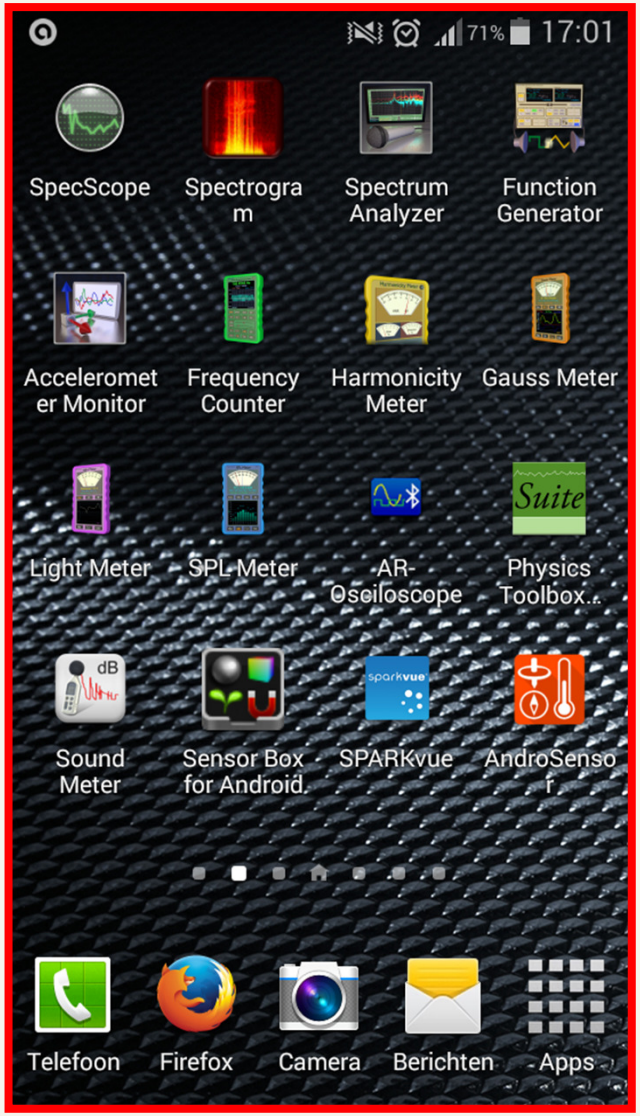


Robert Klein-Douwel

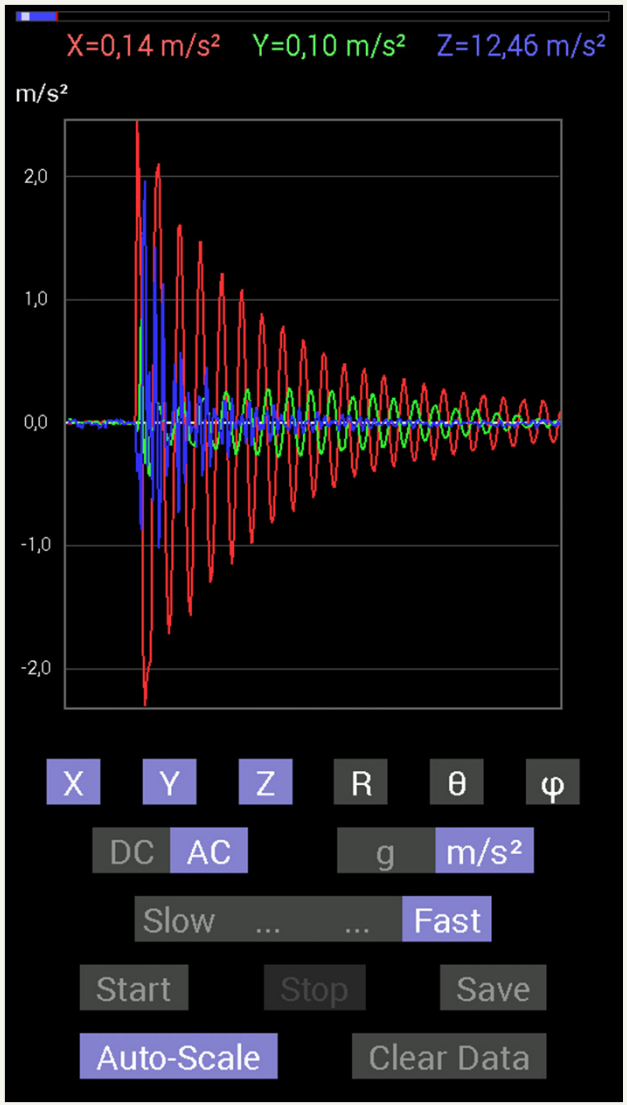
Landelijke Natuurkundepracticumdag 24-01-2020 (all data by author)

Smartphone

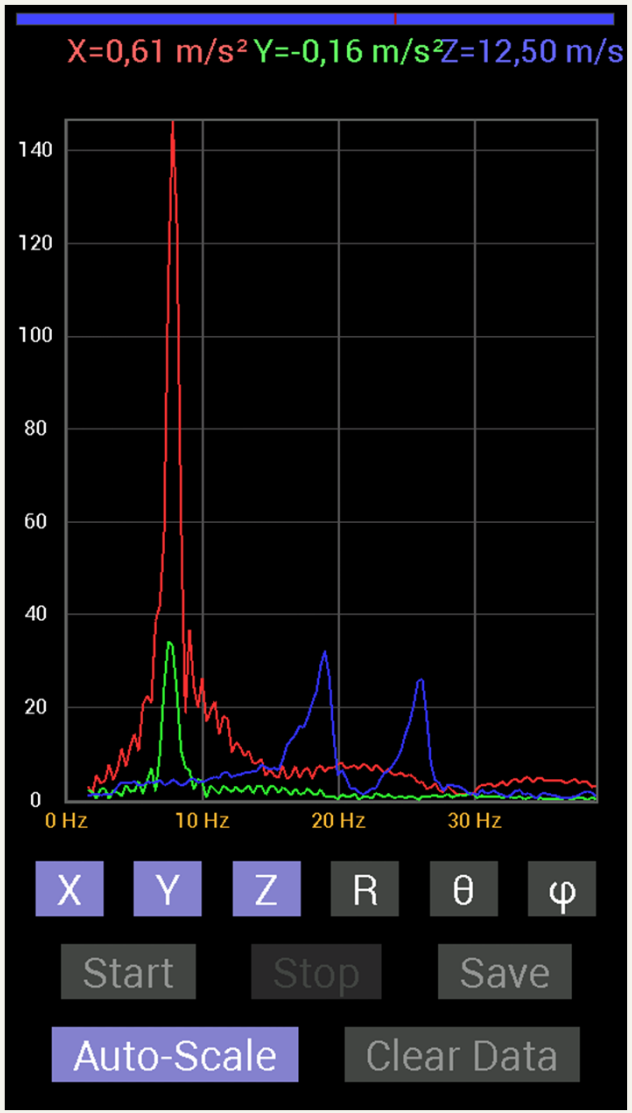
- At least 1 sensor, often many
- Almost ubiquitous
- Everyone has mobile detectors



Acceleration

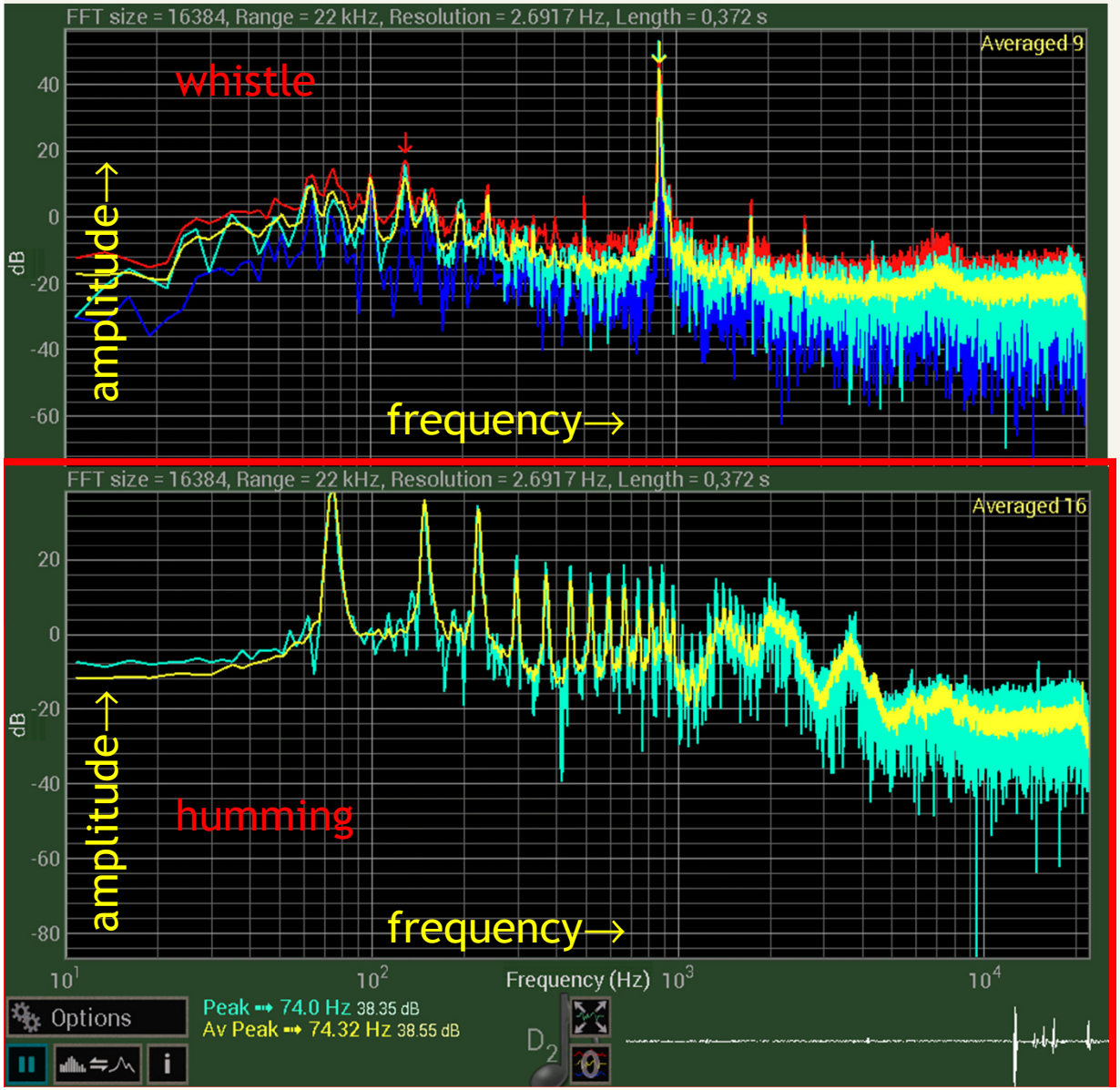


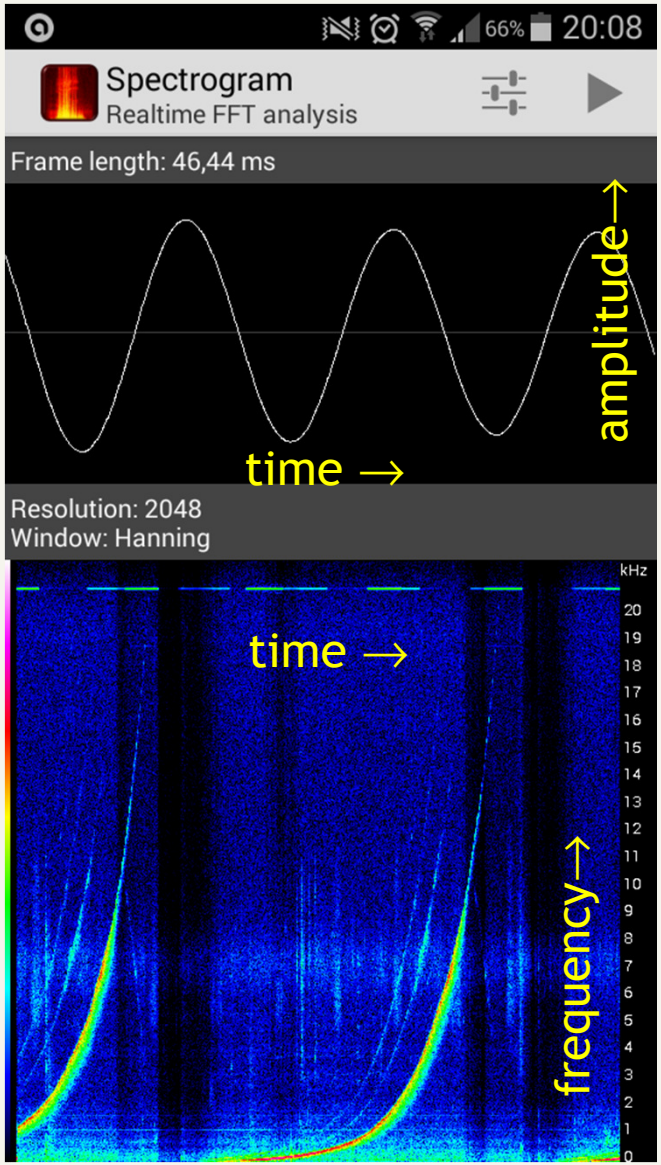
Oscillating table



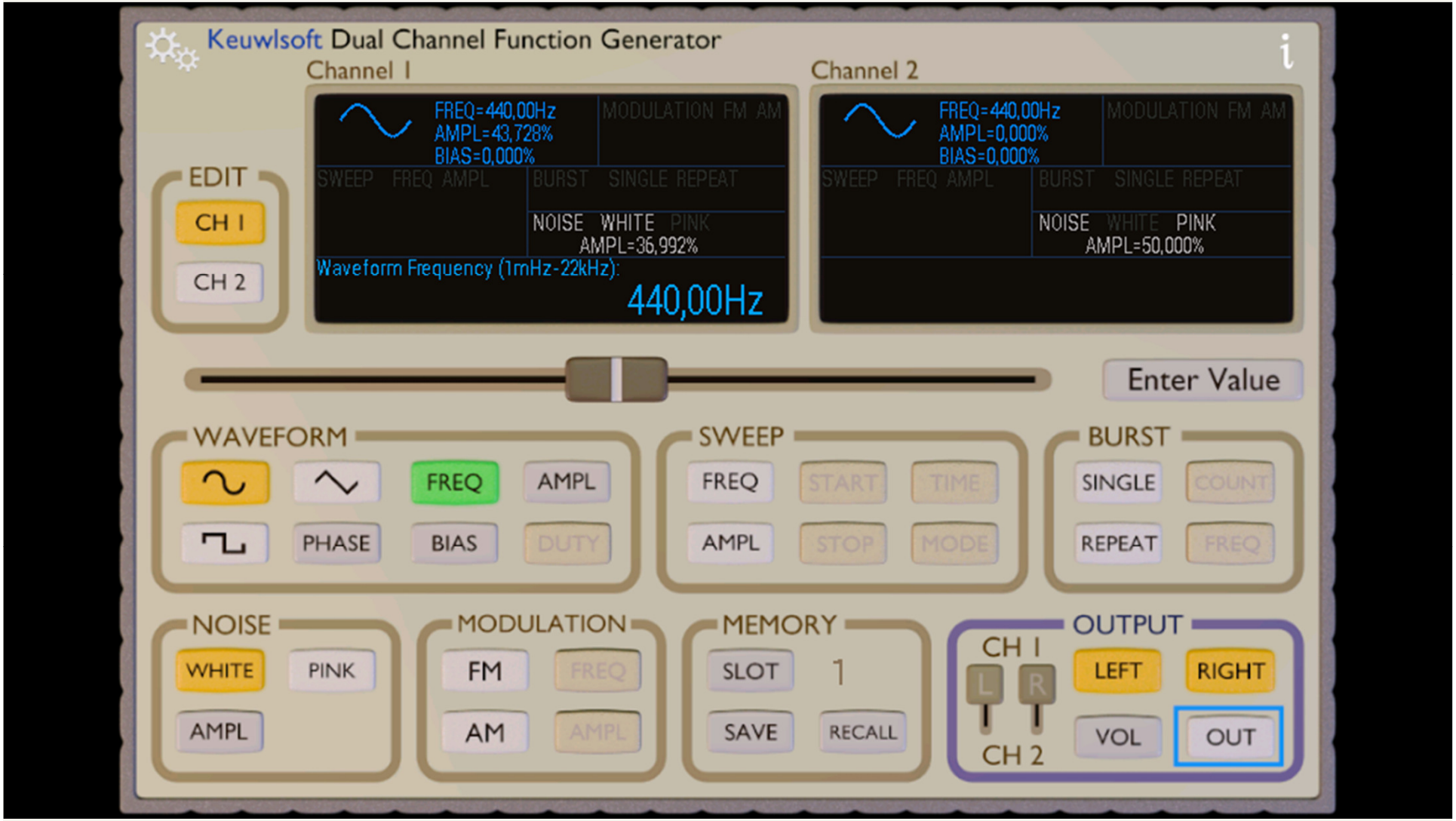
Fourier transform

Microphone


FFT size = 16384, Range = 22 kHz, Resolution = 2.6917 Hz, Length = 0,372 s
Averaged 9
whistle
amplitude→
frequency→
FFT size = 16384, Range = 22 kHz, Resolution = 2.6917 Hz, Length = 0,372 s
Averaged 16
humming
amplitude→
frequency→
Frequency (Hz)
Options
Peak ➟ 74.0 Hz 38.35 dB
Av Peak ➟ 74.32 Hz 38.55 dB

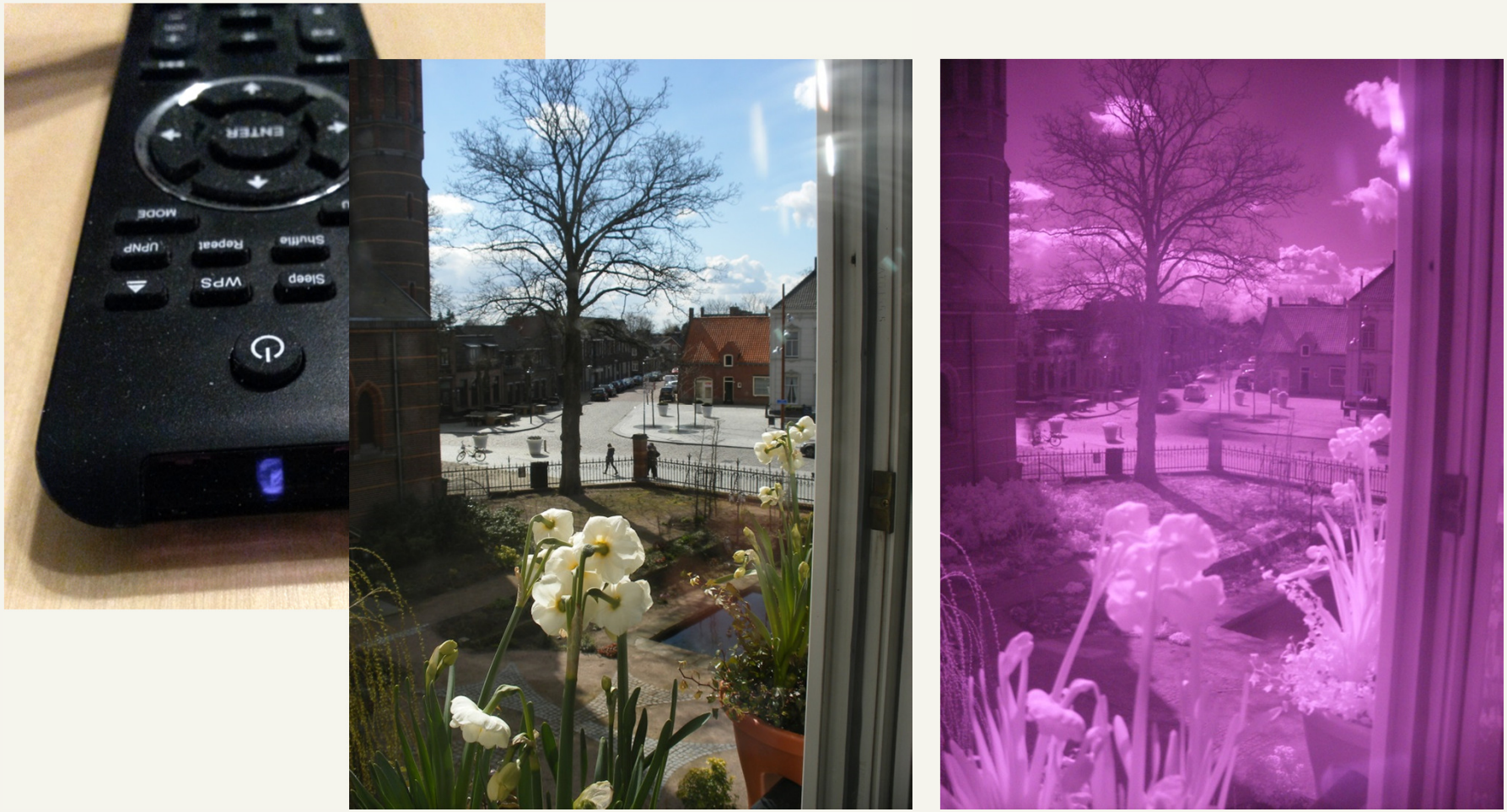

66% 20:08
Spectrogram
Realtime FFT analysis
Frame length: 46,44 ms
amplitude→
time →
Resolution: 2048
Window: Hanning
time →
frequency→
kHz

Speaker



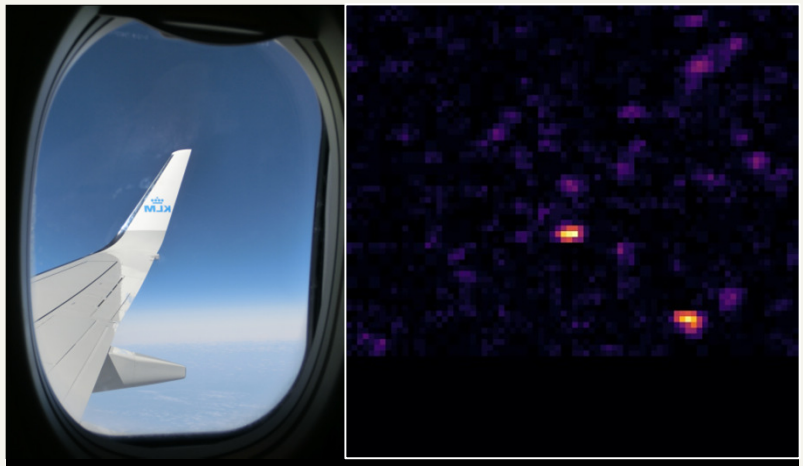
Function generator

Camera - IR



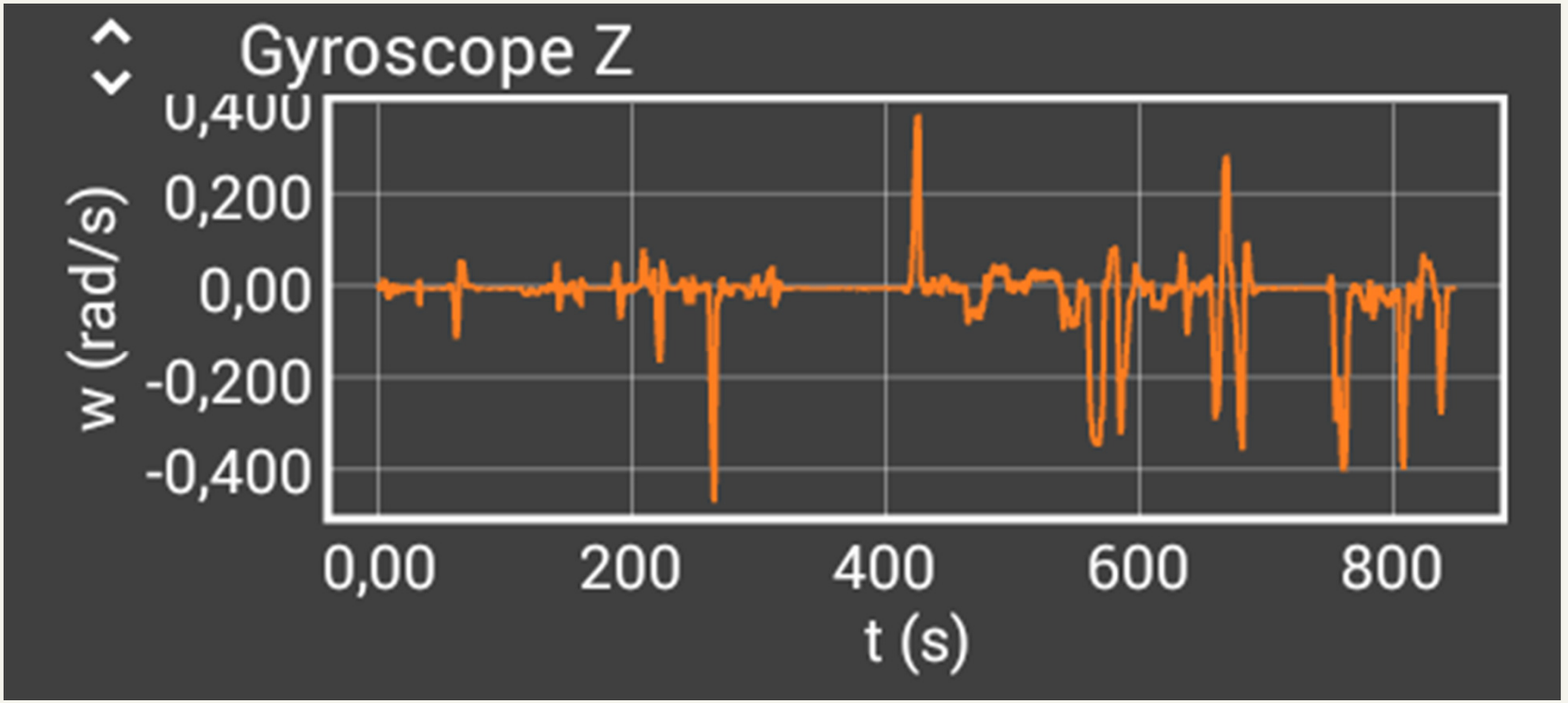
(RG780 filter)

Camera - β, γ radiation



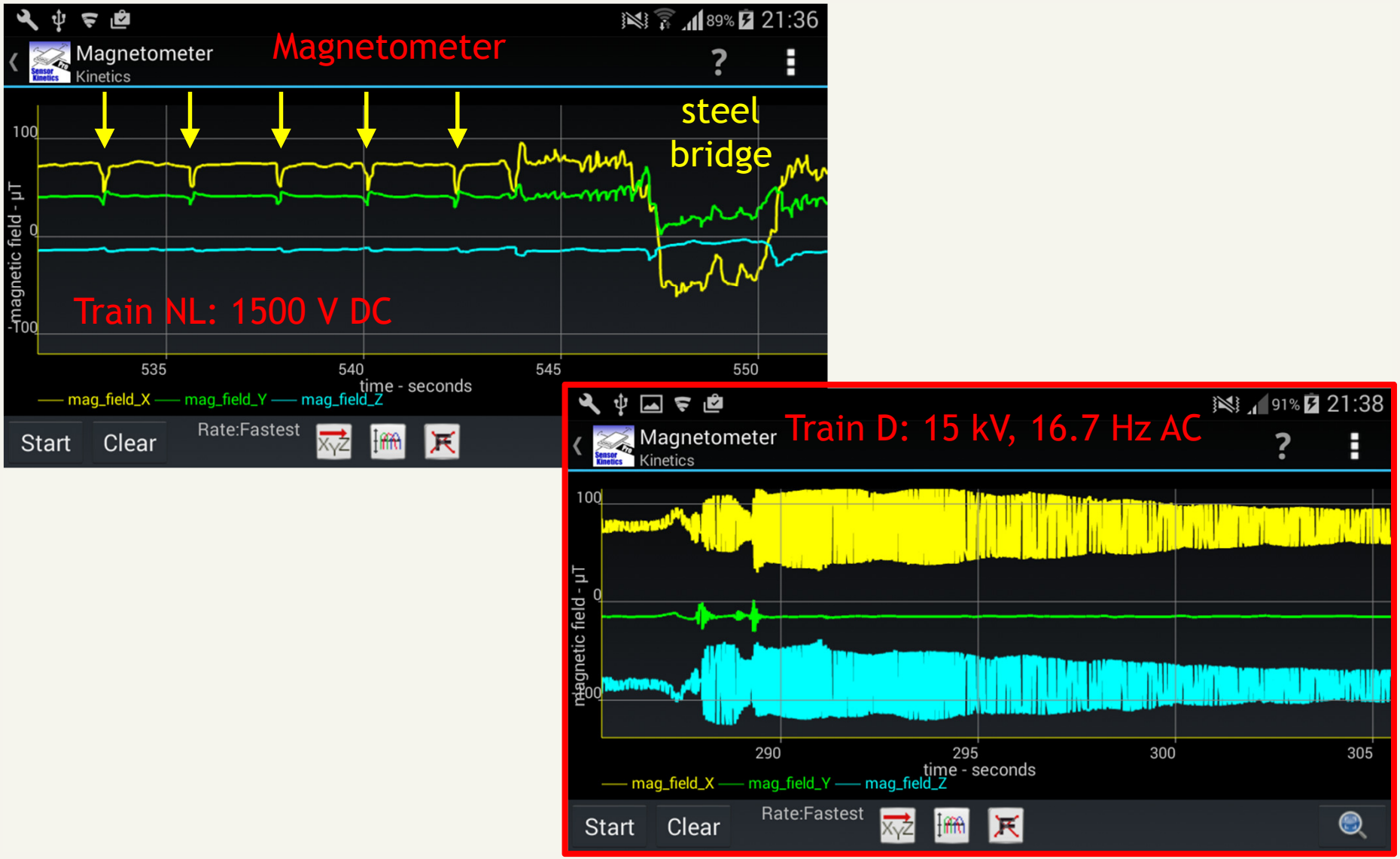
Amsterdam – Kiev
Cosmic radiation
(radiation camera app)

Gyroscope



Curvy train ride

Magnetometer



Other sensors

- Light
- Proximity
- GPS
- Pressure
- Temperature (internal)
- Humidity

Fun or useful?

- Increases curiosity and awareness
- Both fun and useful

Using Smartphones as Experimental Tools—Effects on Interest, Curiosity, and Learning in Physics Education

Katrin Hochberg [1] · Jochen Kuhn [1] · Andreas Müller [2]

Published online: 6 April 2018

Abstract
Smartphones as experimental tools (SETs) offer inspiring possibilities for science education, as their built-in sensors allow many different measurements, but until now, there has been little research that studies this approach. Due to current interest in their development, it seems necessary to provide empirical evidence about potential effects of SETs by a well-controlled study. For the present investigation, experiments were developed that use the smartphones' acceleration sensors to investigate an important

Journal of Science Education and Technology (2018) 27:385–403
https://doi.org/10.1007/s10956-018-9731-7

(many references for apps as well)

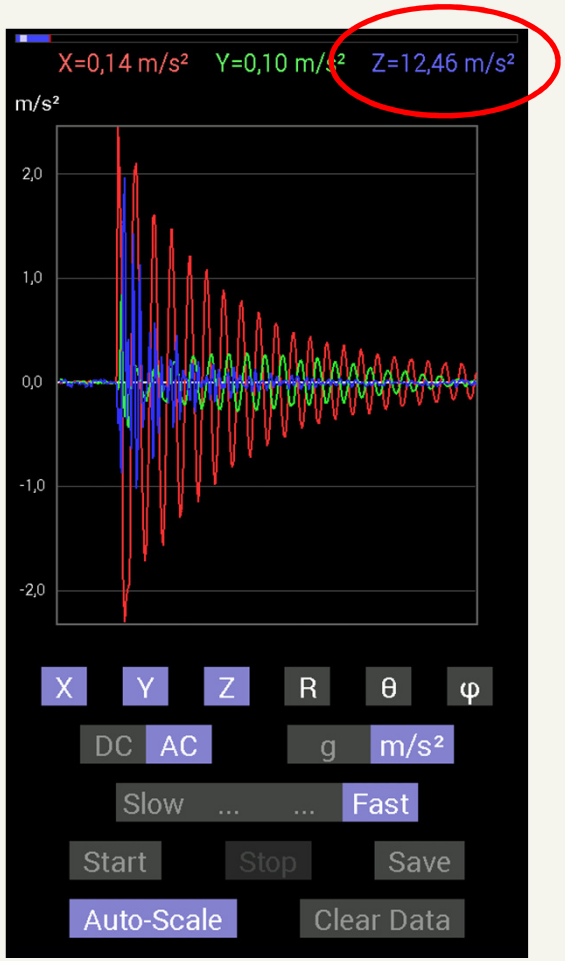
phyphox

- Specifically developed for education (RWTH Aachen)
- http://phyphox.org/
- Android and iOS
- Many standard options, others programmable
- Several sensors simultaneously
- Remote control
- On-phone analysis
- Data storage

- demo

Sensor calibration

- Calibration (sound, gravity)
- Spontaneous recalibration magnetometer sensor (> 100 µT)
- Be aware!



Electricity & Magnetism course

- 3 practicals in addition to course (year 1)
- 3rd practical: Smartphone magnetometer

- *Go measure a magnetic object or phenomenon!*
- Anywhere but in the Physics Practical Laboratory

Practical assignment:

1. Find out how sensor works and why it is in your phone
2. Describe object/phenomenon, provide theory if possible
3. Describe experiments performed
4. Analyse results, compare to theory
5. Give conclusions

Resources


Apps, journals, software – ...
NANP2-10 Physics Laboratory 2
https://nestor.rug.nl/bbc
Search
university of groningen
faculty of science and engineering
NANP2-10 Physics Laboratory 2: some apps, journals, software & miscellanea
Send comments or suggestions to Robert Klein-Douwel.
This list is subject to change without notice.
Status: 01-03-2017
* Disclaimer When exposing your smartphone or tablet to magnetic or electric fields or when subjecting it to acceleration, rotation or other conditions, you do so entirely at your own risk. Take care not to exceed the limitations of the smartphone/tablet or its sensors. Responsibility for any damage (direct, consequential or otherwise) cannot be accepted.
Android & iOS apps ⚠*
Phyphox [Physical Phone Experiments] (mobile lab: many sensors, ideas & experiments, remote control, storage)
Sensor Kinetics (many sensors) - Sensor Kinetics Pro (many sensors simultaneously, storage) (€)
Physics Toolbox (many sensors and ideas; tone generator, stroboscope)
Weather station
Temperature (battery)
Runtastic (fitness)
Vernier (pc, iOS, Android)
Pasco SPARKvue (Science)
Smartphone magnetometers (info British Geological Survey)
Android apps ⚠*
KeuwlSOFT (> 20 apps: accelerometer, magnetometer, FFT spectrum analyser, sonar, 2 channel tone generator, ... [storage])

Magnetic objects

- Single loop
- Home made coil
- Permanent magnet, refrigerator magnet
- Electric toothbrush
- Microwave

- Pocket calculator
- Laptop doing heavy processing

Student appreciation

- Strongly **love it**
- - allows creativity, lots of freedom
- - very interesting
- - adds to course

- Strongly **hate it**
- - assignment unclear
- - don’t know what to do to pass this practical

- (nothing in between)

- Earth’s magnetic field often forgotten!

- Stopped after 2 years by lecturer (did not add significantly to course)

Physics Laboratory 2

- (Physics Project Practical)

- *“Do you have [very expensive] microphone?”*
- *“Do you have very accurate, large Fourier transform machine?”*
- *“How can I measure oscillations?”*

- Perhaps you could use an app for that?

- *“It’s not accurate enough”*

- Well, try and see what you can do with it

- Few groups use an app (but satisfied when they do)

Physics Laboratory 1

- Analysis of series of data points

- Get students to measure *g* and enter value in online data file
- Calculate average and standard deviation

- Very low response rate
- No great stimulus to actually do this
- Next year: ??

Your experiences

- Your information and thoughts
- What works well for you and your students …
- … and what does not?