nanoSAFE '18
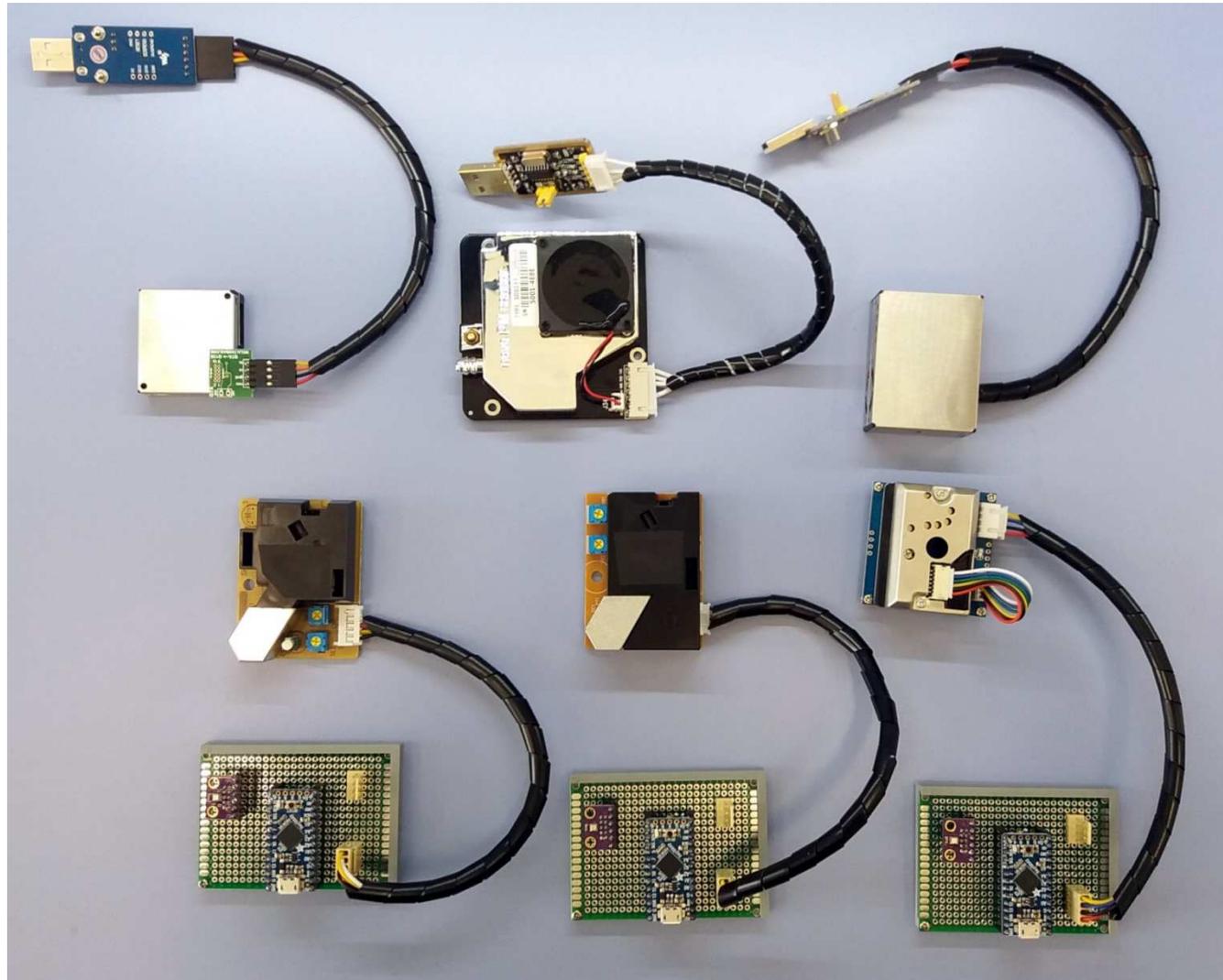
Detection of nanoaerosols using ionized air

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Evaluation of low cost air quality sensors

for PM10 and PM2.5 measurements

< 35 EUR

< 15 EUR

Advantages and applications of low cost PM sensors

Advantages over laboratory grade devices:
- Cheap enough to risk it's damage or loosing
- Exchange data quality for number of measurement points
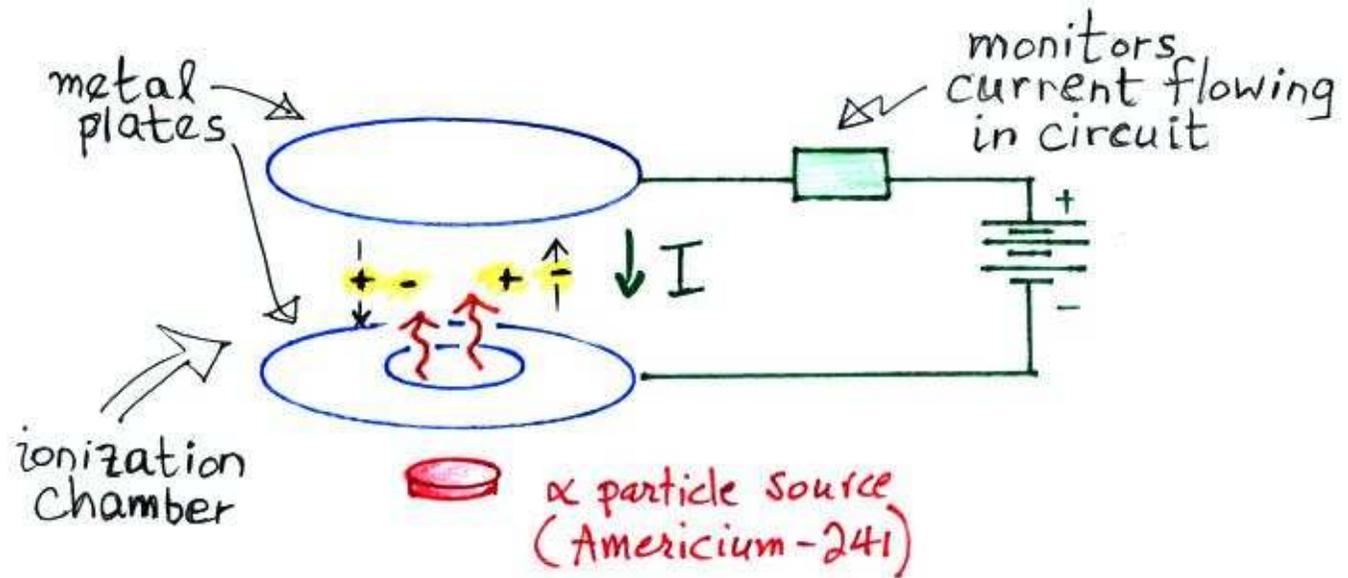- Easy to use in both operation and data interpretation

Typical applications:
- Control of air purifing devices
- Indoor air quality monitoring
- Distributed sensor networks
- Mobile sensors
- Citizen science initiatives

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Is it possible to build low cost nanoparticles detector?

Ionization - type Smoke Detector

metal plates

monitors current flowing in circuit

ionization Chamber

α particle Source (Americium-241)

- low cost
- can work on batteries for years
- simple in construction and operation
- quick response to small particles

source: http://www.atmo.arizona.edu

Verification of the idea

- Charles D. Litton et al. *Combined optical and ionization measurement techniques for inexpensive characterization of micrometer and submicrometer aerosols*, Aerosol Science and Technology 38, 2004

- Rufus Edwards *An inexpensive dual-chamber particle monitor: laboratory characterization*, J. Air & Waste Manage. Assoc. 56, 2006

- Andreas Dahl et al. *A low cost nanoparticle monitor for screening measurements in indoor environments*, Indoor Air 2008

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Goal: low cost, low power nanoparticles detector

Design assumptions:
- Total cost of components below 250 EUR
- Ability to operate on batteries for long time periods
- Able to quantify numerical, volume or mass concentration of nanoaerosol

Planned applications:
- Sensor networks for testing of nanoaerosols propagation
- Real time, long-term exposure monitoring
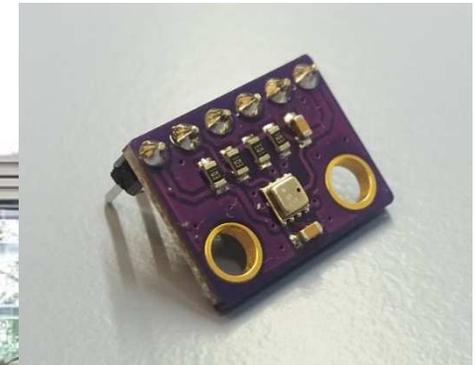- Detection of failures and unforeseen situations in industry

Ionization sensor used for evaluation

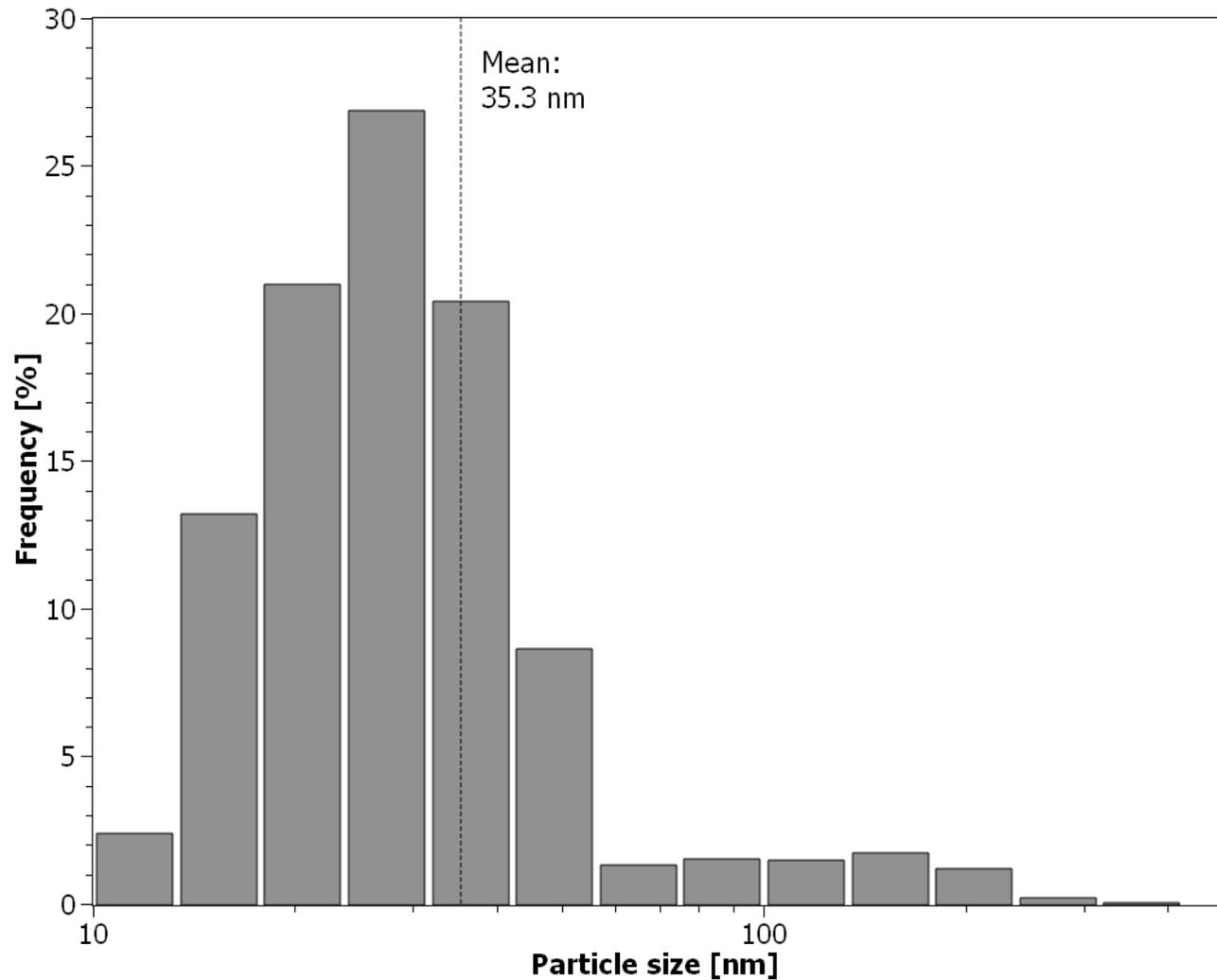modified by exposing voltage signals, costs 35 EUR

![CIOP PIB logo]
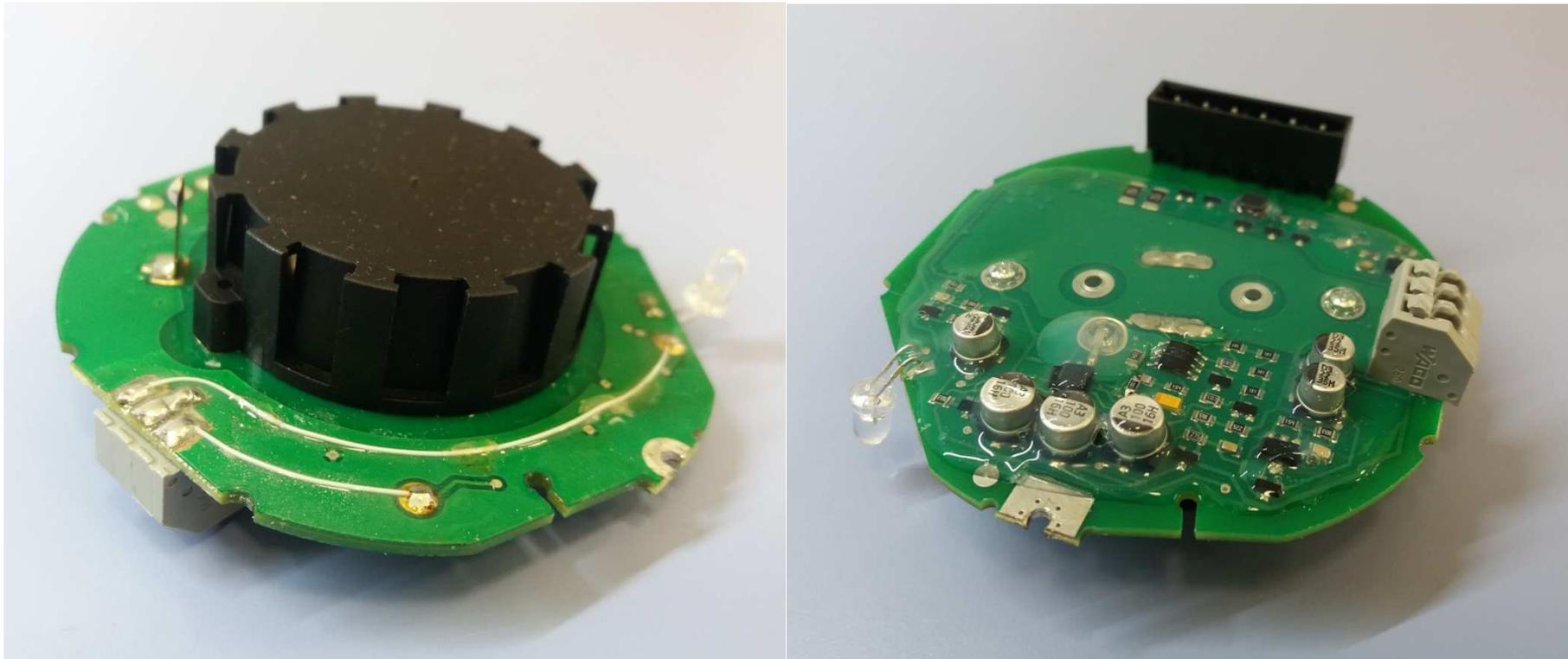
Experimental setup

- Air speed – orifice with pressure transducer
- Temperature, relative humidity and air pressure – Bosch BME280
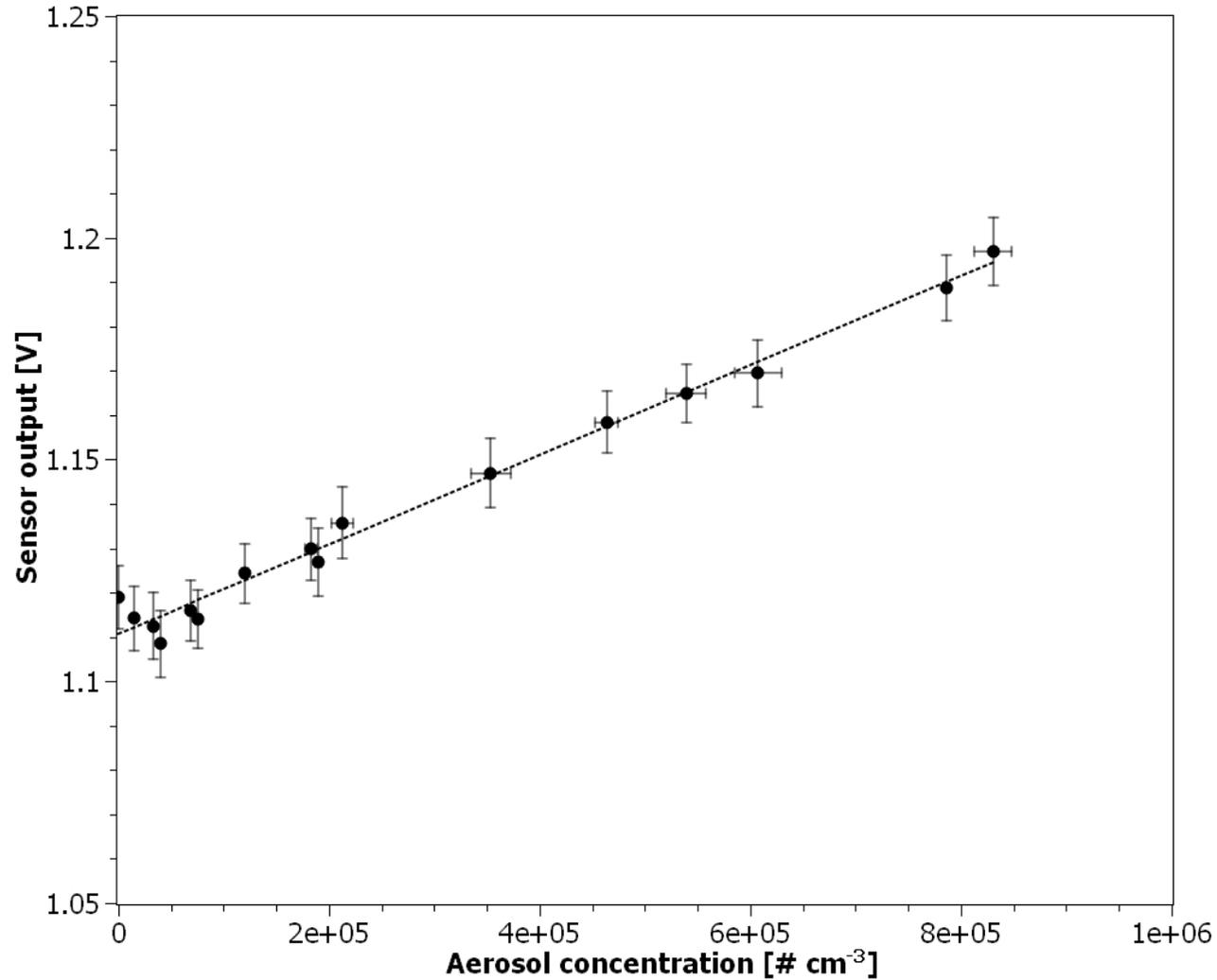- Particles concentration – TSI NanoScan 3910

Aerosol particles

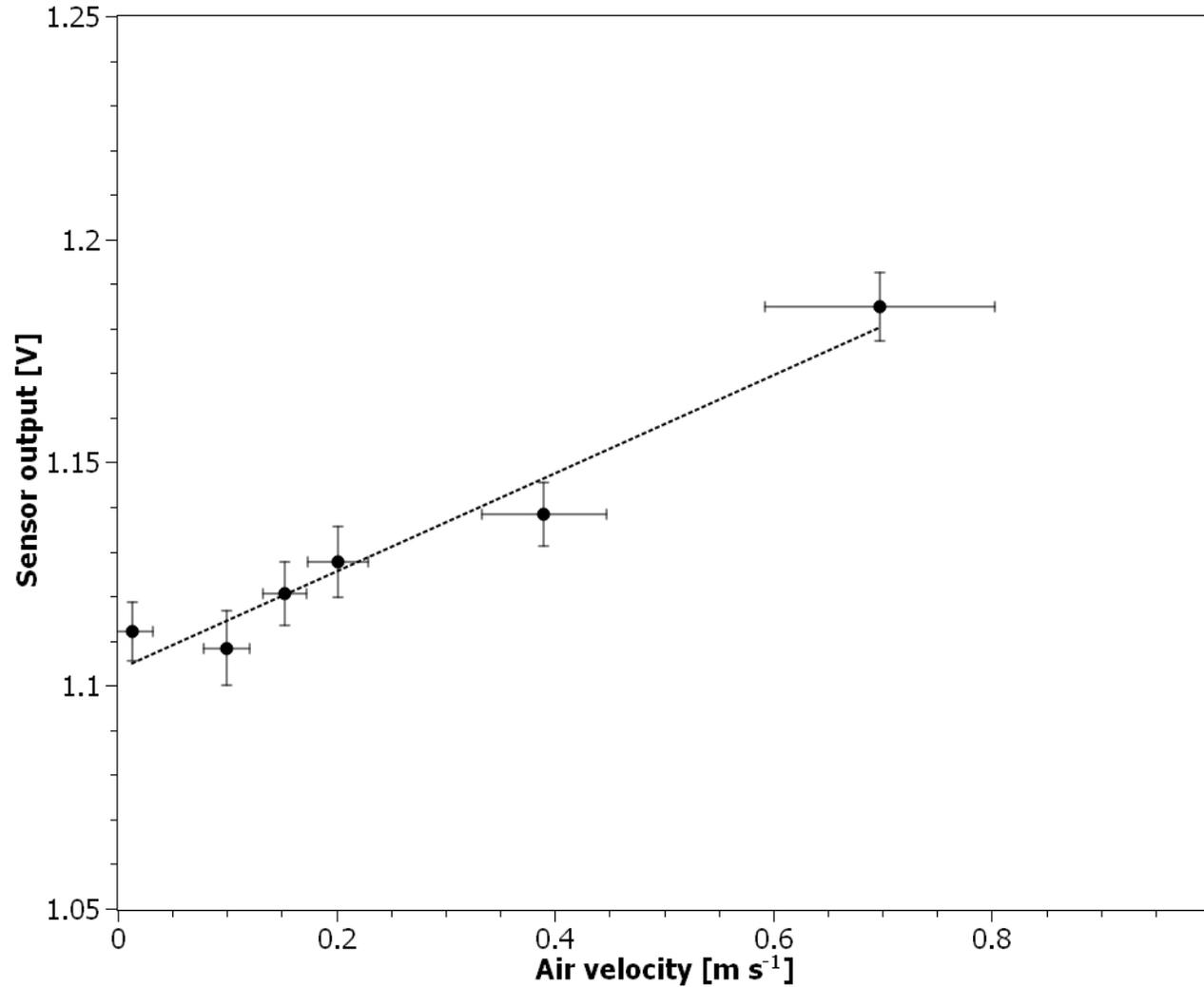## generated using Palas GFG 1000 with graphite electrodes
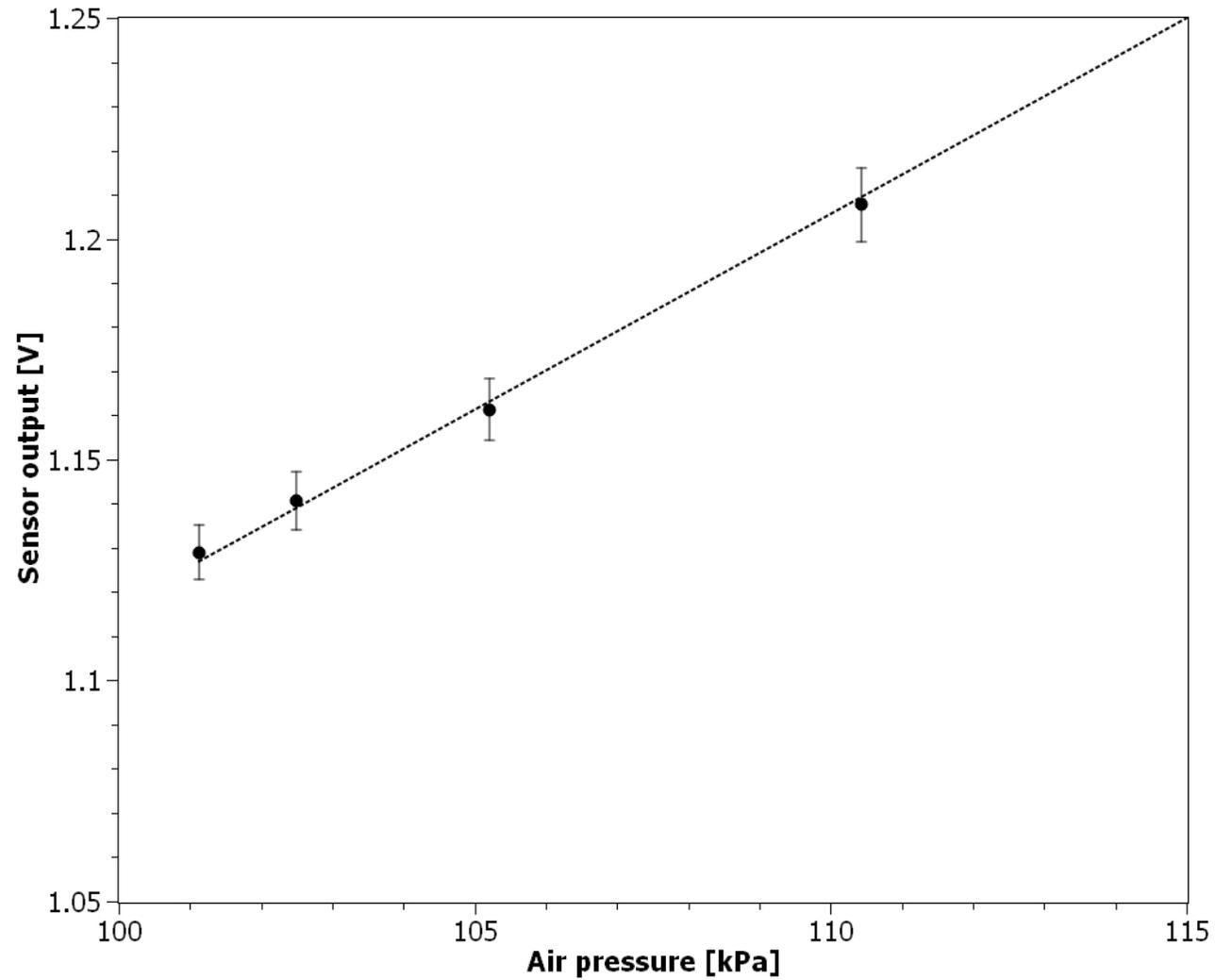
Sensor response for aerosol concentration change

temperature 25.5 °C, relative humidity = 0 %, pressure 100.7 kPa, velocity 0.15 m/s
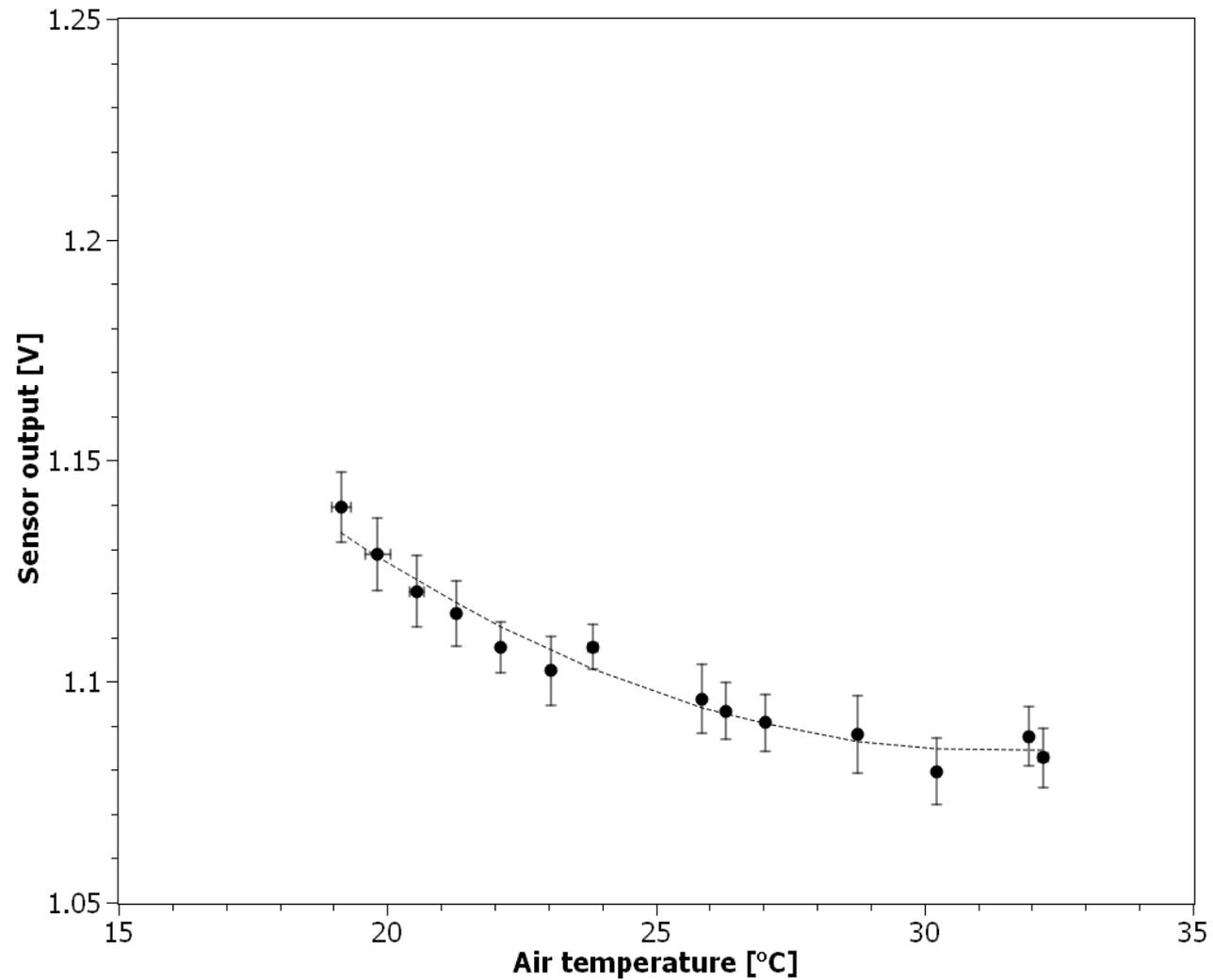
Sensor response for air velocity change

temperature 26.2 °C, relative humidity = 4 %, pressure 100.8 kPa
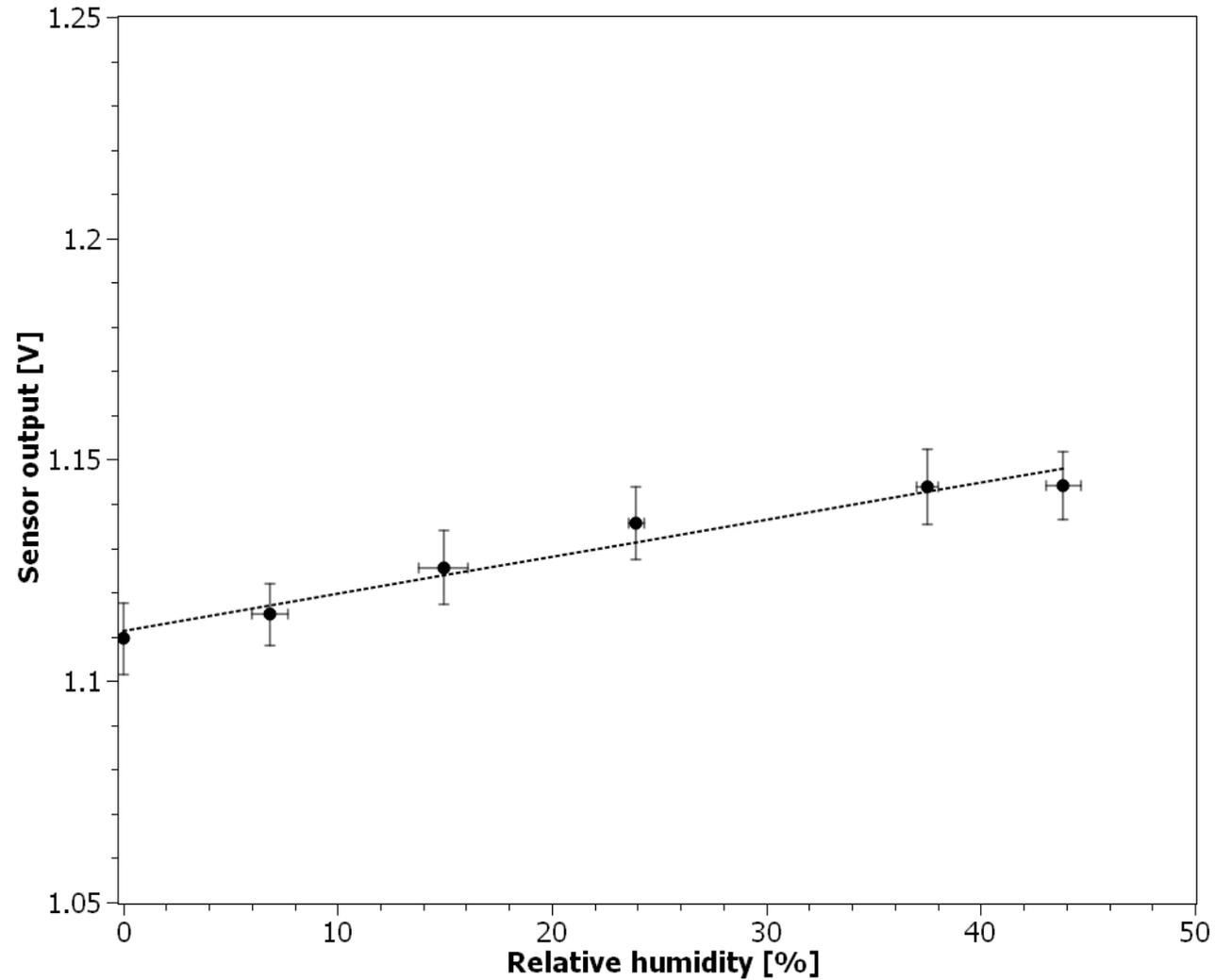
Sensor response for air pressure change

temperature 22.7 °C, relative humidity = 4 %, velocity 0 m/s

Sensor response for air temperature change

relative humidity = 0 %, pressure 102.2 kPa, velocity 0.15 m/s

Sensor response for relative humidity change

temperature 27.2 °C, pressure 101.5 kPa, velocity 0.15 m/s

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What is needed to meet design assumptions

- Design an inlet impactor to cut off bigger particles
- Air speed control system
- Aerosol preheater
  - may be necessary in humid conditions
- Power supply system
  - device should be mains or battery operated
- 3D printed enclosure
- Calibration for different types of nanoparticles
  - influence of surface charge
  - surface morphology
- Data analysis
  - choose optimal output units
  - response time for aerosol concentration change

Thank you for your attention

Any comments or suggestions? Feel free to ask.

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