

Detection of the Respiratory Droplets in Ambient Air

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Problem

- The COVID-19 pandemic has underscored the critical importance of detecting respiratory droplets, which can carry viruses and spread diseases.
- Spreading of diseases via infected respiratory droplets presents a significant risk for public health, in particular during pandemics.
- In Europe, 4 million patients are affected by healthcare-associated respiratory infections every year. These infections impose an additional burden on the healthcare system.
- Monitoring of air quality is performed by measuring particulate matter (PM), ultrafine particles, and CO₂.
- Currently, there is no instrument on market, which would selectively detect respiratory droplets in air.

Air quality monitoring

Condensation Particles Counters



- Heavy (> 40 kg)
- Expensive (> 150 000 EUR)
- Trained operator
- Regular calibrations

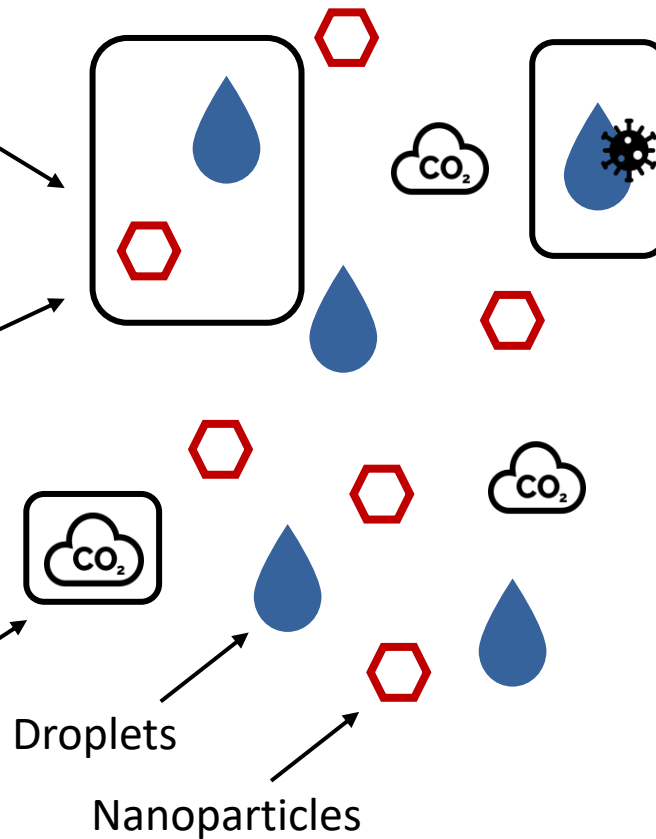
Low-cost detectors



- Cannot count single droplets
- Depend on chemical composition, shape,...

CO₂ detectors

- Cannot count either droplets or particles



Our solution

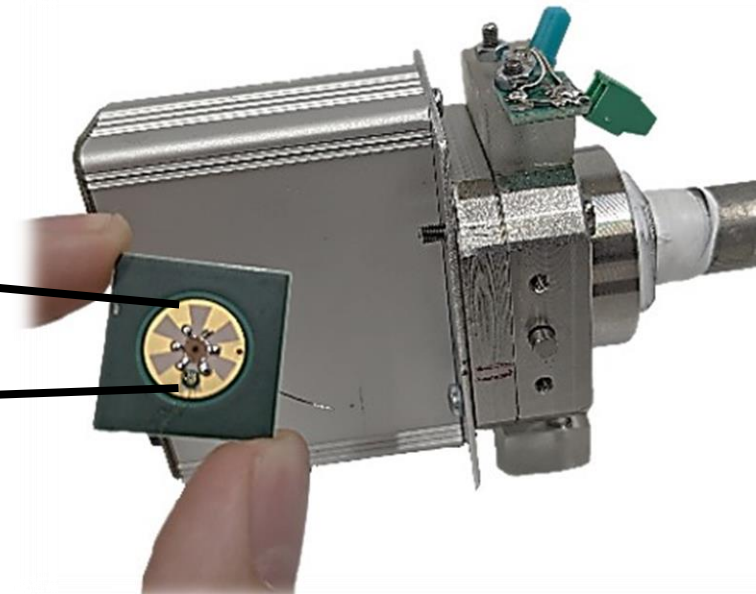
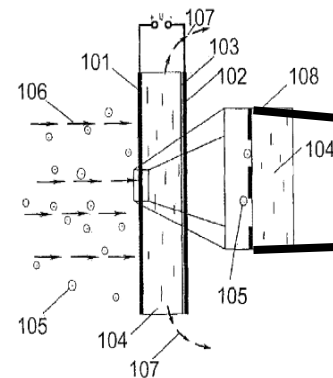
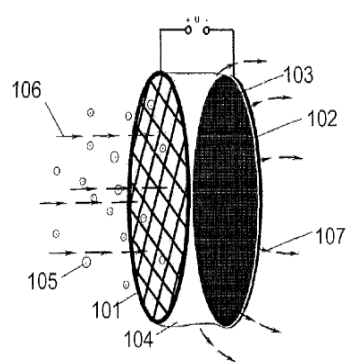


We present here the first instrument, **AeroDrops**, for the selective detection of respiratory droplets in indoor air.



AeroDrops

- Basic principle: Change of the capacitance
- Selective detection of respiratory droplets
- TRL 6, integration of all components into a single self-contained unit
- US Patent 9,151,724B2
- User-friendly, standalone, portable (0,5 kg), low power (~1,5 W)
- Large series production cost: 1000 EUR



Market in EU

- **Locations where respiratory diseases spread:**

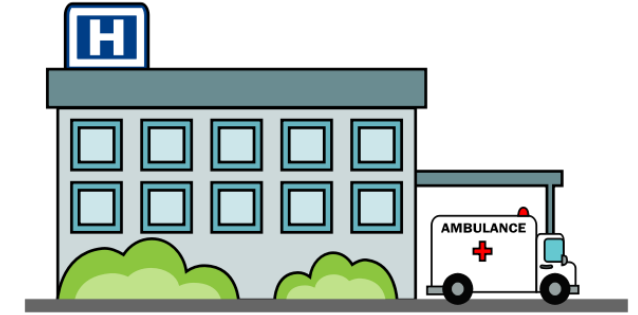
- schools,
- kindergartens,
- inner playgrounds,
- hospitals,
- elderly care homes,
- sports facilities,
- transport,
- concert halls,...

- **Additional applications:**

- inhaler testing,
- spray mist analysis,
- cloud droplet analysis,
- air pollution monitoring,...

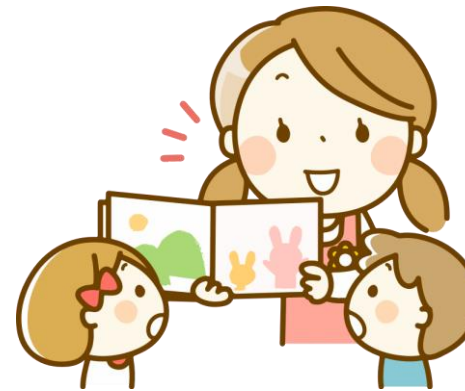


3.5+ million beds



2.3+ million beds

3 million devices

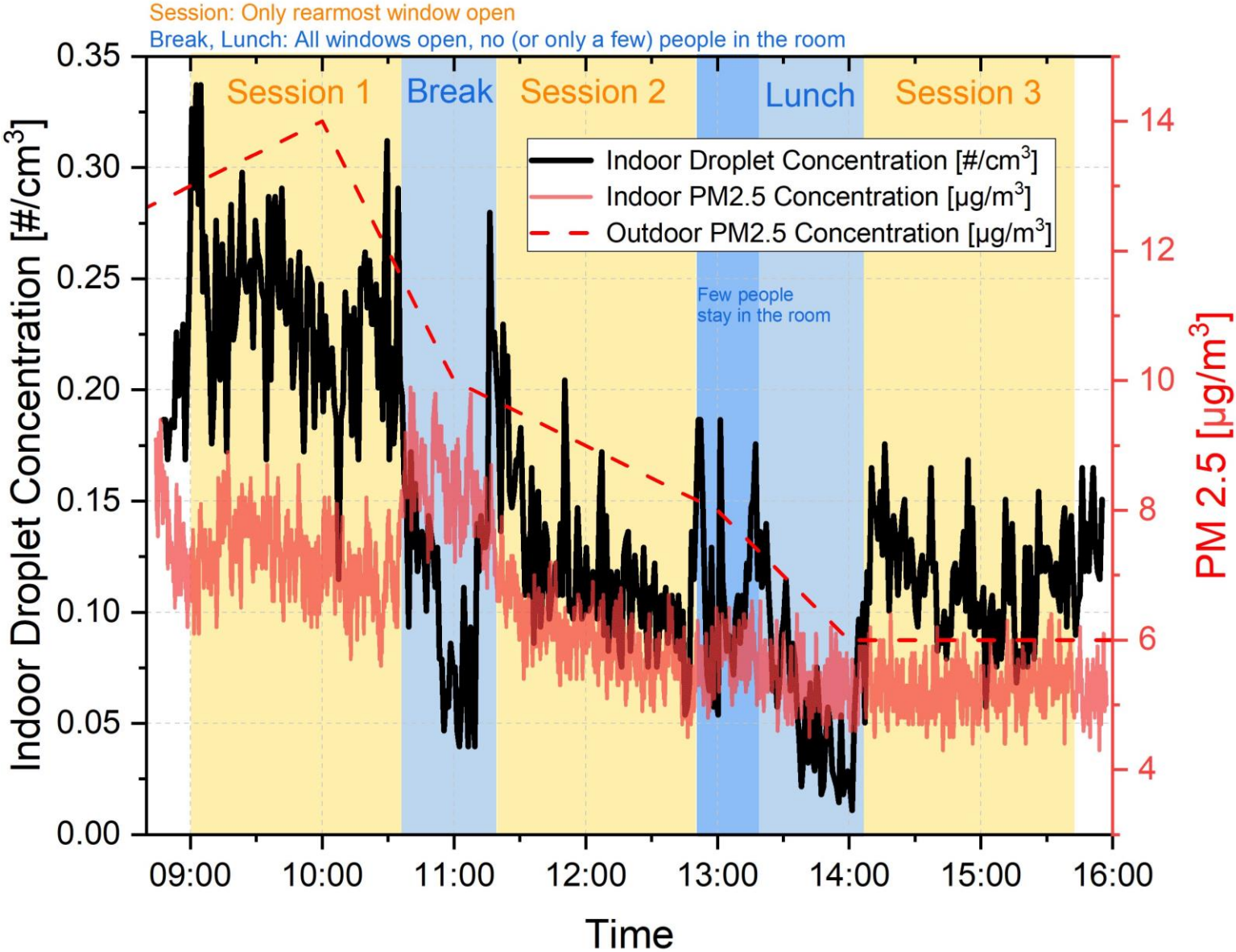


1+ million kindergarten groups and 1+ million school classes



Comparative monitoring of respiratory droplets and PM2.5

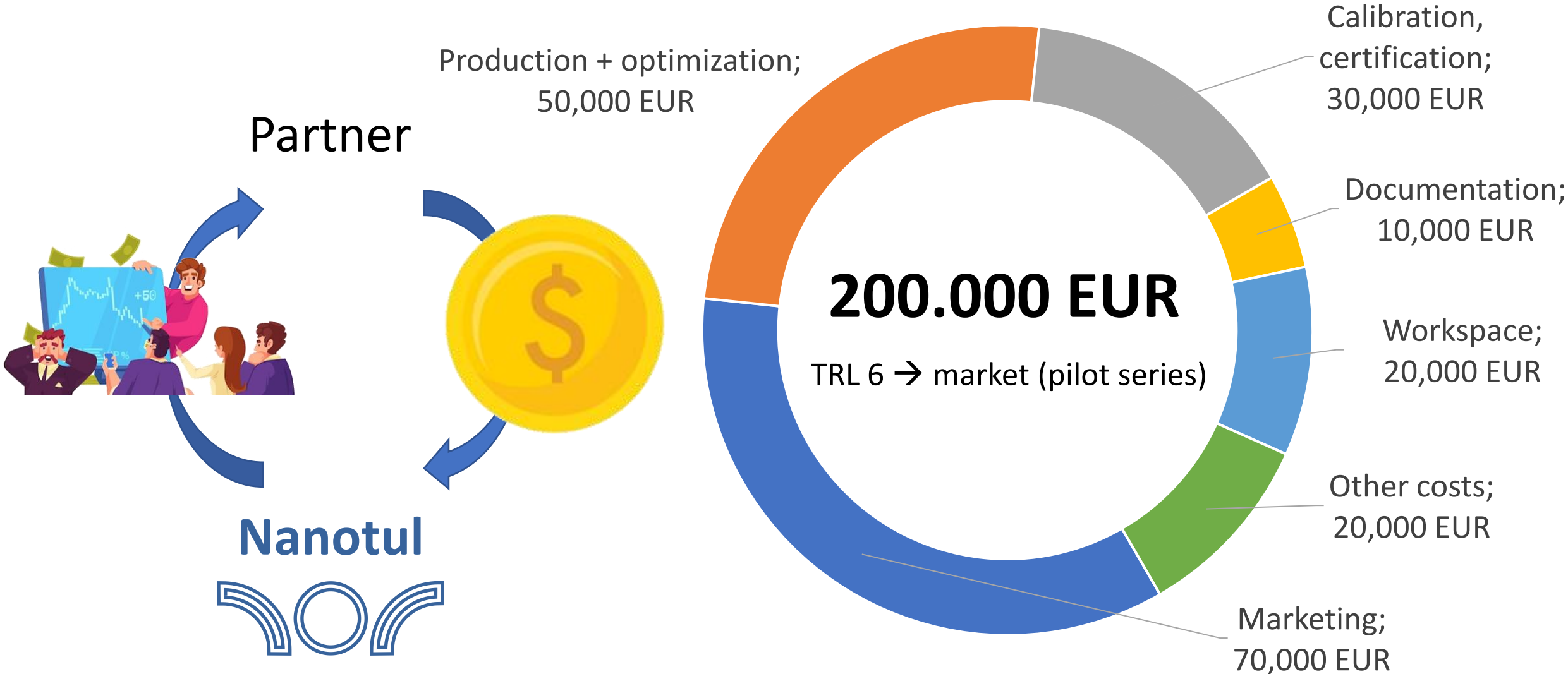
Concentration of respiratory droplets decreased by ventilation, while concentration of PM increased.



Opportunities for Collaboration

- ❖ Partnering with private companies for pilot production.
- ❖ Licensing of the technology.
- ❖ Partnering with academics and research institutions for further development of:
 - In-situ characterization of potentially infected respiratory droplets.
 - Upgrade of AeroDrops for nanoparticles detection.

Pilot production



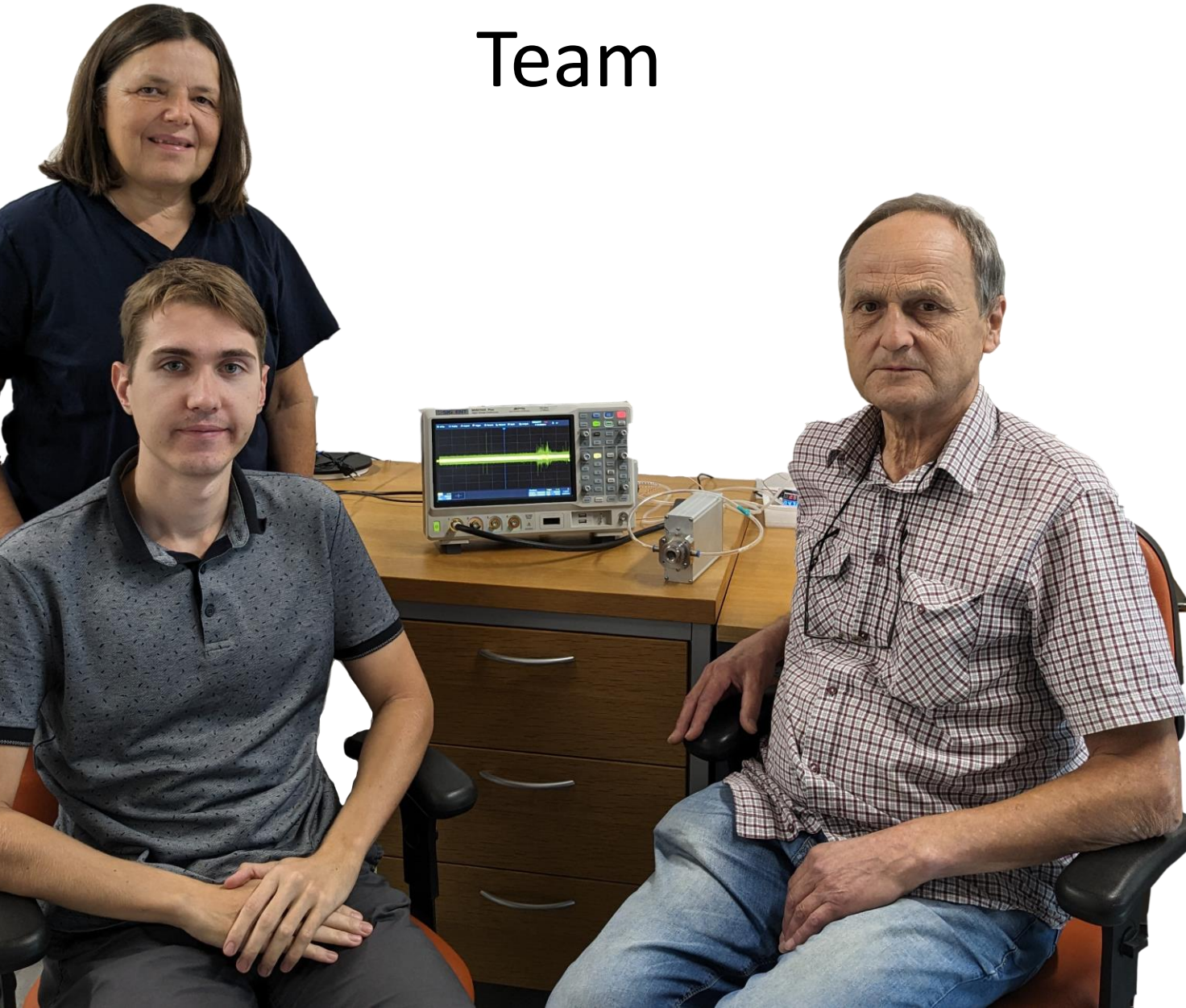
For the commercialization of the instrument, spin-off company Nanotul Ltd. has been established. Company holds exclusive right for the commercialization.

Further Developments

- ❖ Identification of infection in detected droplets
 - Collect the detected droplets during the detection process.
 - Conduct in-situ and/or off-line analysis on the collected droplets to identify potential infectious agents within them.

- ❖ Detection of nanoparticles
 - The device will be upgraded to detect nanoparticles.
 - Our instrument can replace optical detection in nanoparticles counters.
 - It can address limitations of optical counters:
 - limited particle size range,
 - sensitivity to particle composition, density and scattering properties,
 - susceptibility to interference by ambient factors.

Team



- Prof. Maja Remškar
 - PhD Physics; inventor, project lead, basic science; owner of **Nanotul**
- Matjaž Malok
 - MSc Mechatronics; technology development
- Darko Kavšek
 - Electrical engineer; technology development
- External experts
 - Gregor Filipič, PhD, basic science, IJS
 - Ivan Iskra, PhD, business development, inventor, AethLab

Additional Literature

- M. Malok, D. Kavsek, G. Filipic, I. Iskra, M. Remskar, "Capacitive sensor for counting and measuring nanodroplets," European Aerosol Conference, Malaga, Spain, Sep. 03-08, 2023.
- I. Iskra et al., "Capacitive-type counter of nanoparticles in air," Appl. Phys. Lett., vol. 96, no. 9, Mar. 01, 2010, doi: 10.1063/1.3352554.
- D. Križaj, I. Iskra, and M. Remškar, "(Quasi 3D) numerical simulation of operation of a capacitive type nanoparticle counter," J. Electrostatics, vol. 69, no. 6, pp. 533-539, Dec. 2011, doi: 10.1016/j.elstat.2011.07.003.
- M. Remskar et al., "Method and capacitive sensor for counting aerosol nanoparticles," U.S. Patent 9,151,724 B2, 2015.

Conclusion

- **AeroDrops:** The first instrument for detection of respiratory droplets in indoor air.
- **Collaborations:** Diverse partnerships, such as joint research, pilot production, licensing of technology, and technological enhancements,...



<https://tinyurl.com/AeroDrops>



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