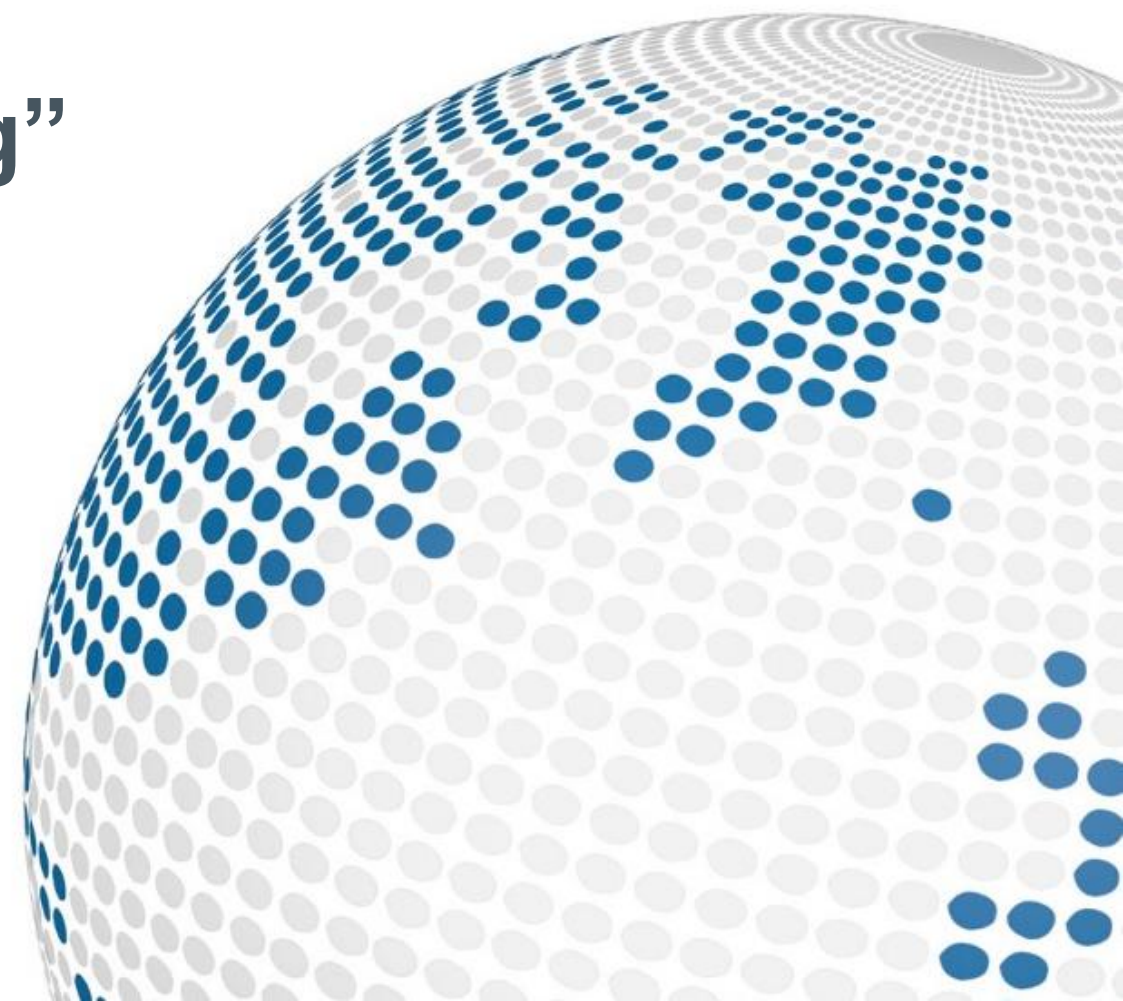


# Photonics 4 well being – “Mobile Fine Dust Monitoring”

Shaping the world with sensor solutions



G. Fasching  
May 2021



# Photonics 4 Sustainable Environment

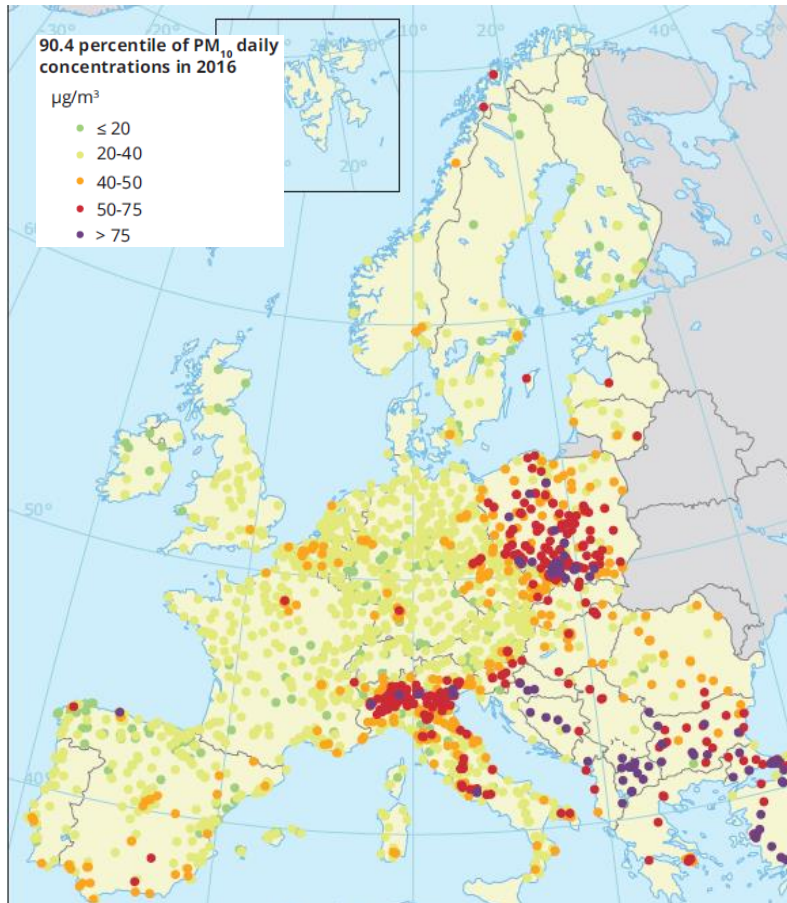


- ❖ Photonics is a tool to drive innovation
- ❖ Photonics 4 raising societal awareness
- ❖ Addressing “issues” to be solved 4 sust. environment
- ❖ Right measures at the right time and place

# Personal air quality monitoring: Improve people's health and well-being

## World Health Organization<sup>1</sup>

- ❖ Air pollution is a major **environmental risk to health** (heart disease, lung cancer, and respiratory diseases incl. asthma)
- ❖ PM is a common proxy indicator for air pollution. It affects more people than any other pollutant.

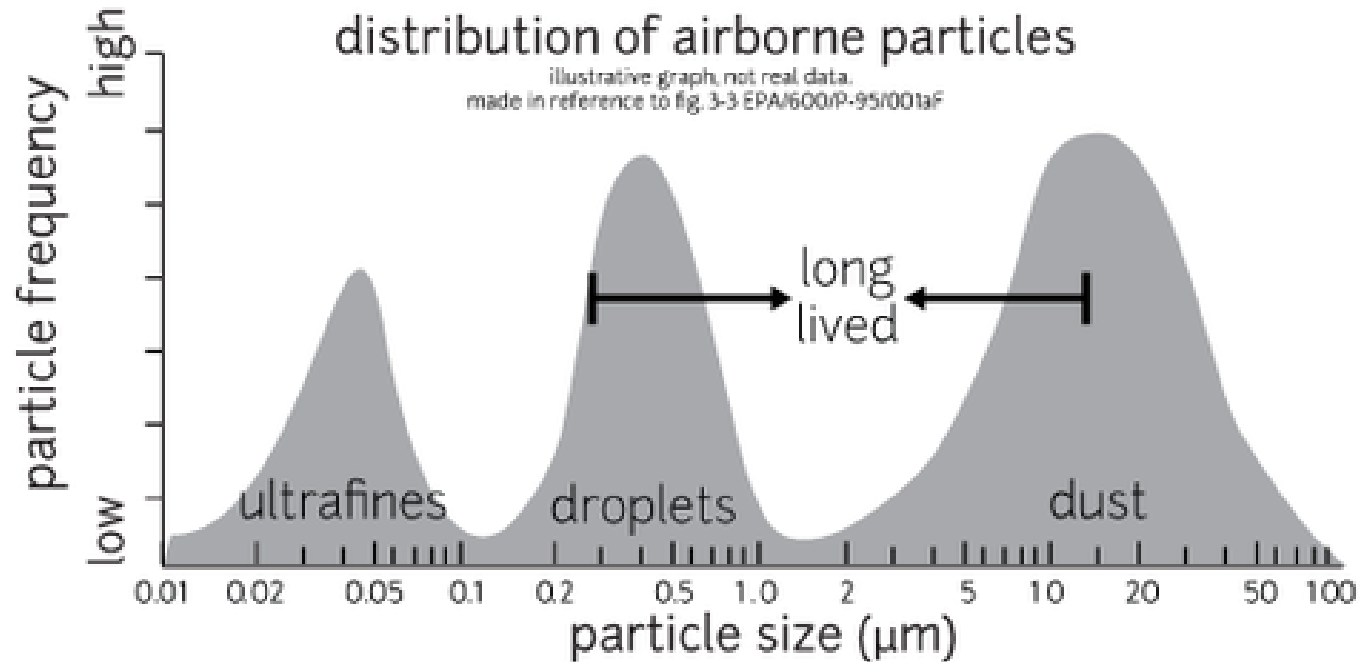


- ❖ Official air quality monitoring stations provide only averaged outdoor but no indoor air data.  
-> We spend 90% of our life in buildings
- ❖ A portable air quality measuring device in our smartphones or wearables – could solve this problem.

1) [https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)

2) <https://www.who.int/data/gho/data/themes/air-pollution/ambient-air-pollution>

# Particulate Matter: Dust, droplets, ultrafines



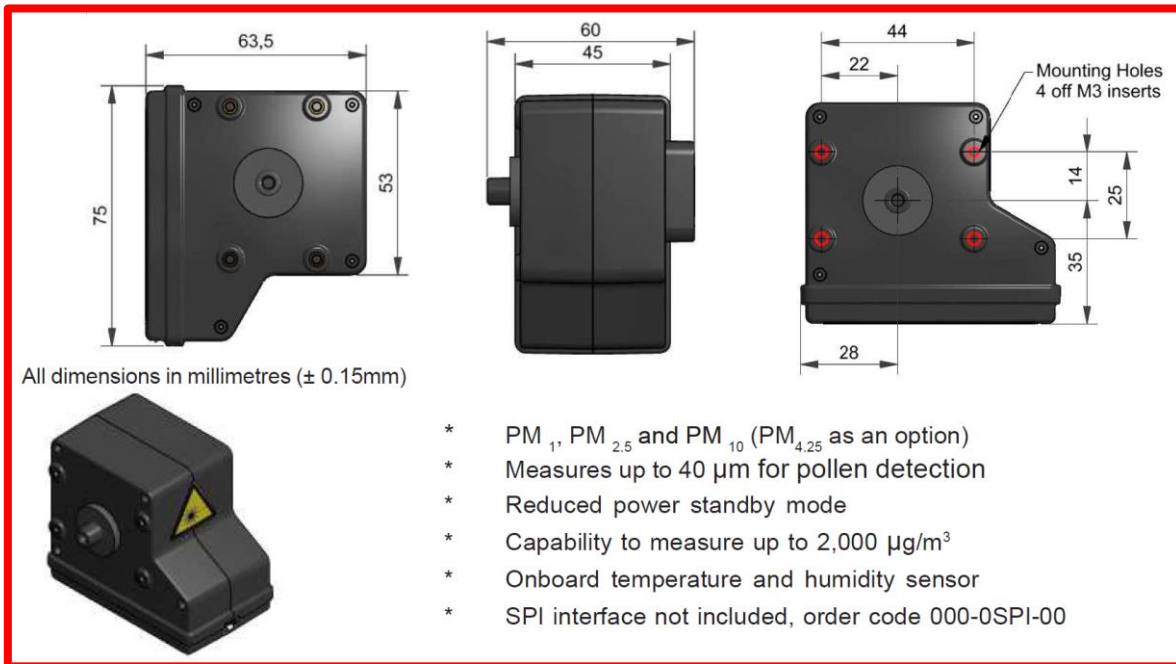
Dust: Short lived Solid particles broken from larger solids (settle-out)

Droplets: Liquid particles which grow as they condense gases out of the air).

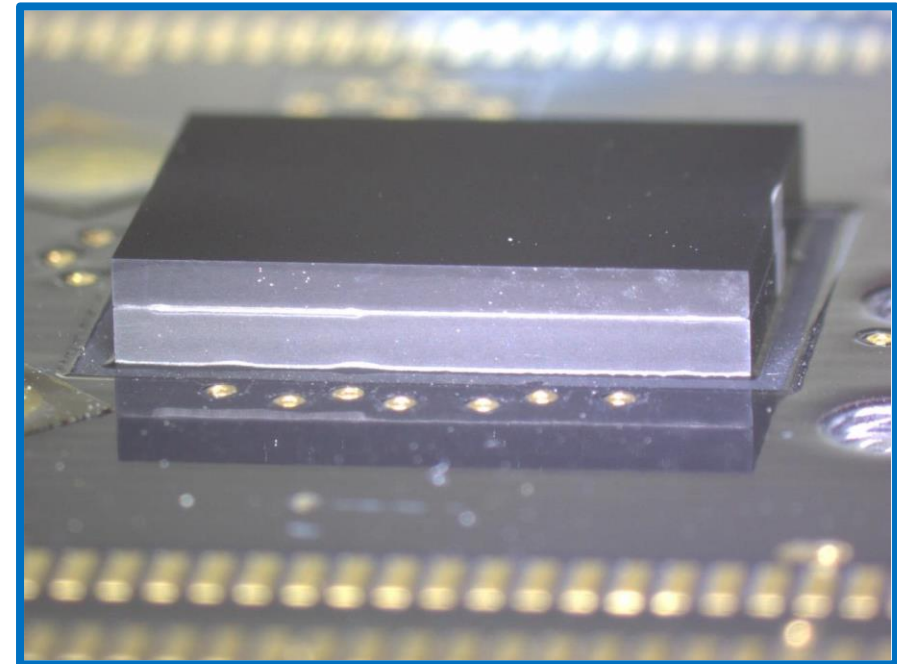
Ultrafines: Short-lived emissions from combustion (nucleation centers).

# Photonics & integration is enabler for personal air quality monitoring

## PM reference device

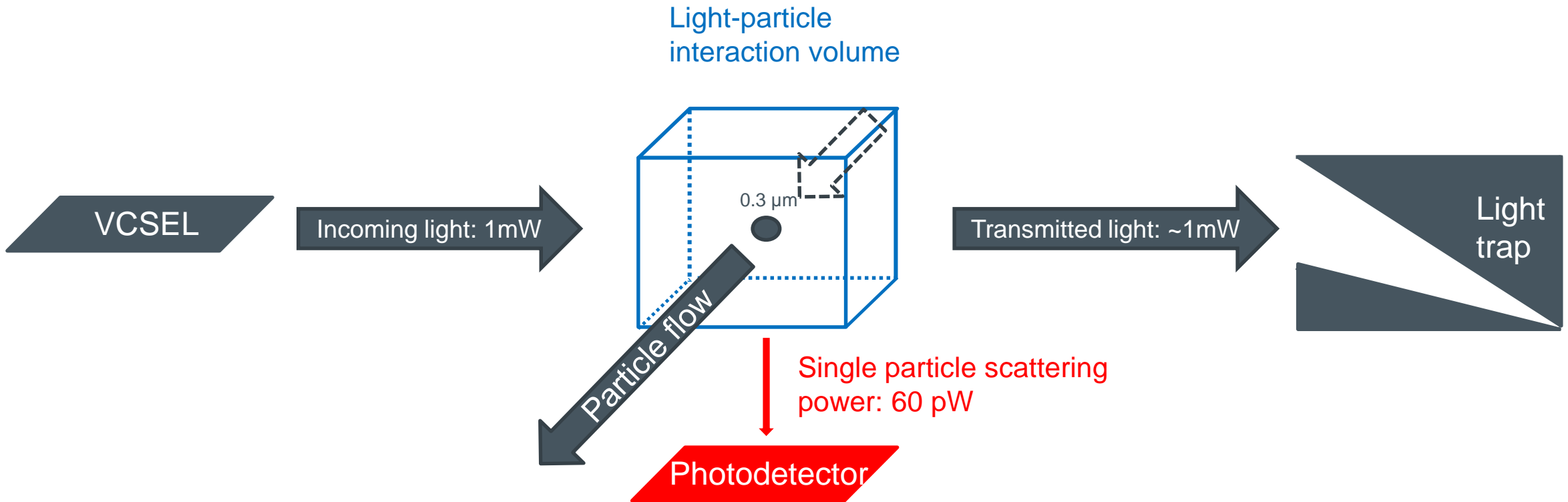


## Mobile PM sensor 9\*11\*2,2 mm<sup>3</sup>



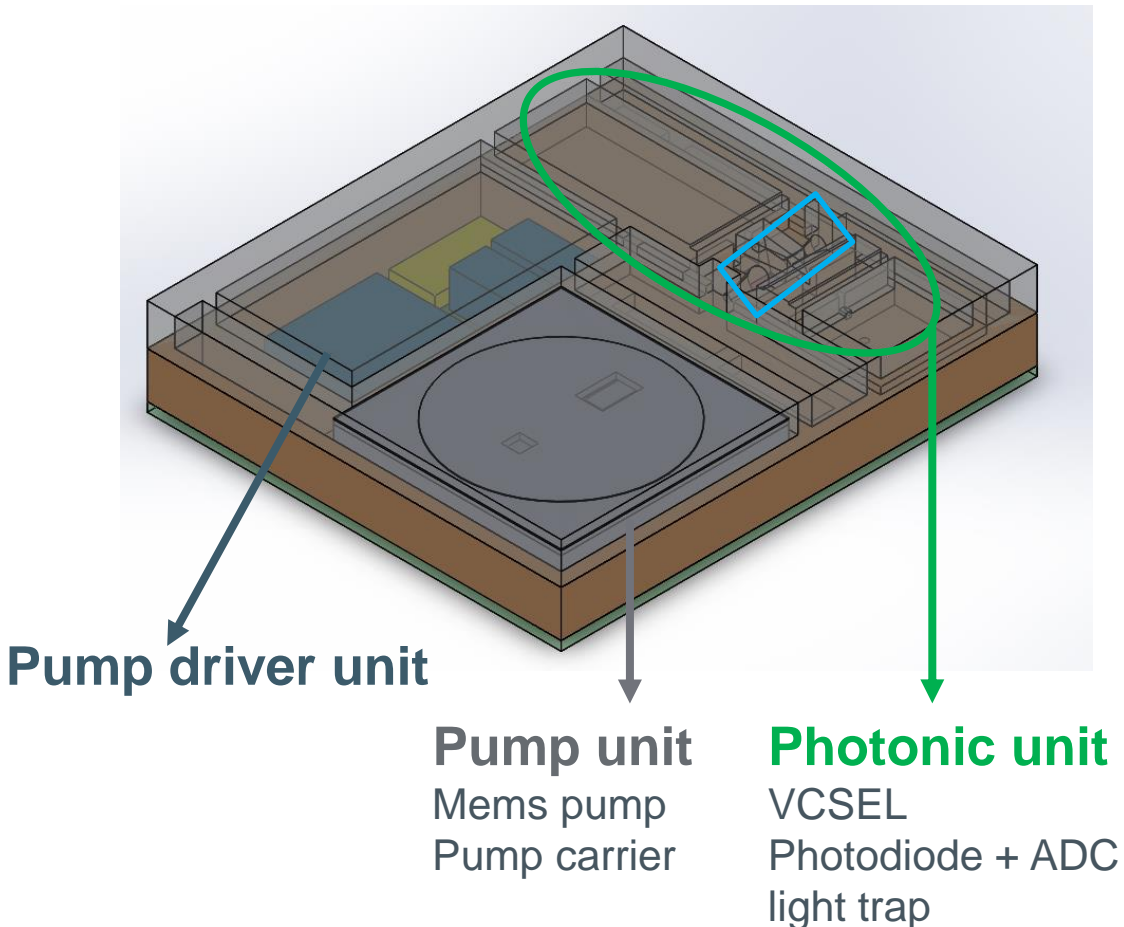


# Detection scheme based on Mie scattering to count matter particles between 0.3 to 2.5 $\mu\text{m}$ diameter



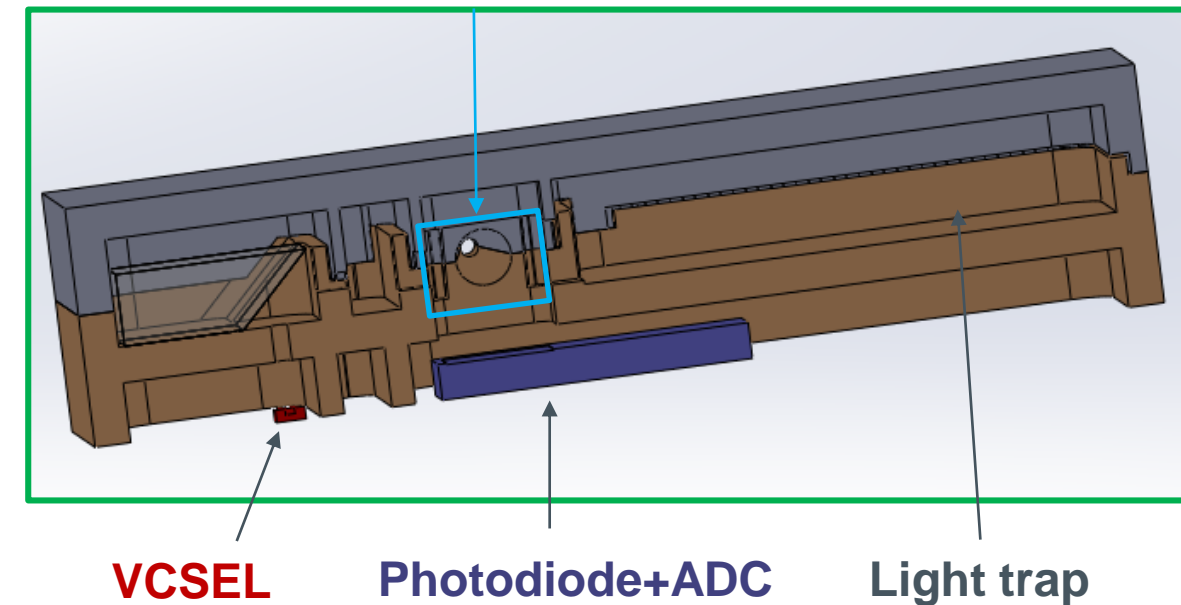
# Main components of PM2.5 sensor system

Whole sensor system  $\sim 9 \times 11 \times 2.2 \text{ mm}^3$



## X-section of photonic unit

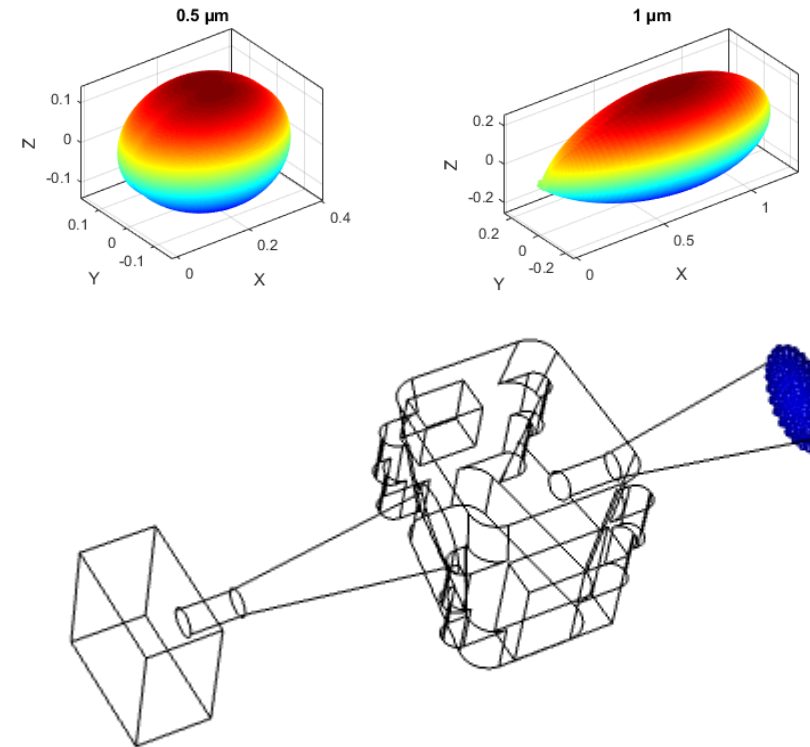
Light-particle  
interaction volume



# Concept & design requires extensive simulations **ams** Sensing is life.

## Photonic Unit

- ❖ VCSEL light source emission characteristics
- ❖ Light guiding & cavity dump raytracing
- ❖ Light-particle interaction (Mie scattering)
- ❖ Photodetector response

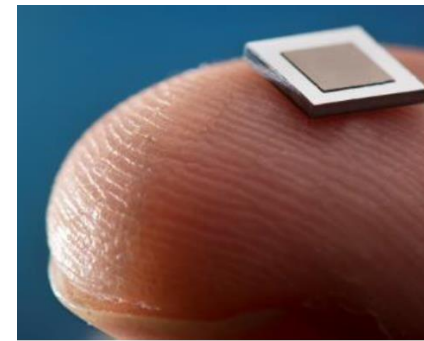


## Pump unit

- ❖ MEMS micropump design
- ❖ CFD particle flow simulation

## Driver unit

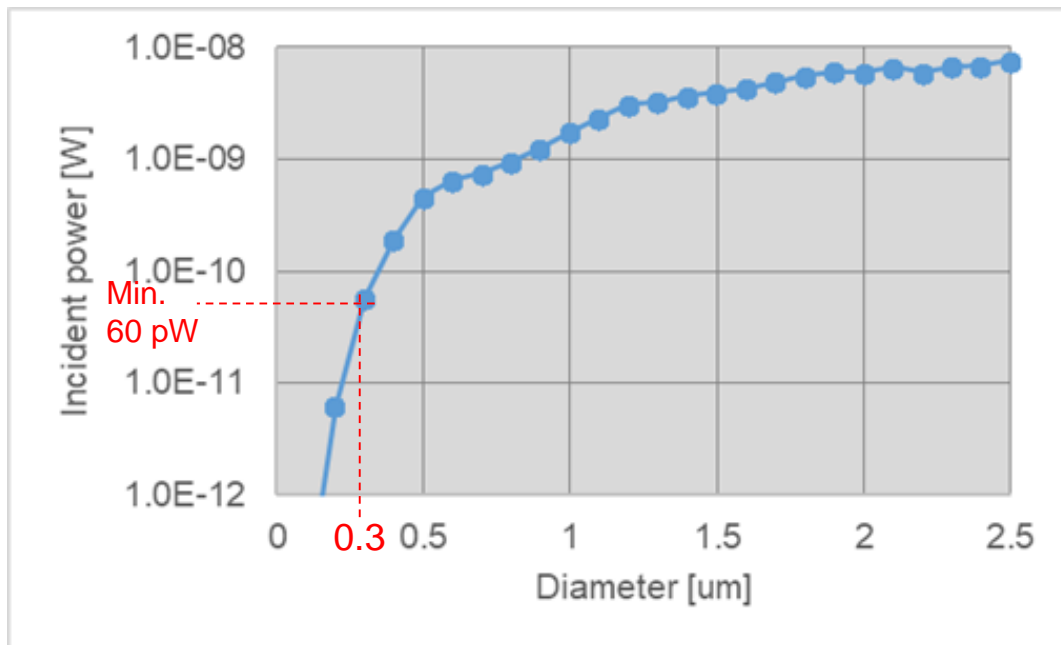
- ❖ IC design (data collection)
- ❖ Power unit





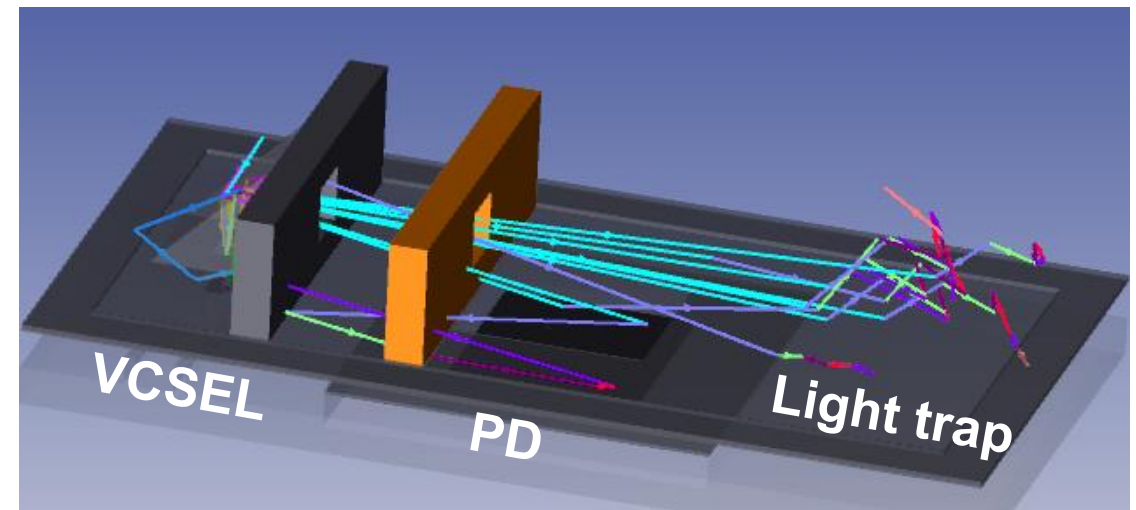
# Expected optical signal and stray light level

## Scattered light from particles



- ❖ Mie scattering from smallest single particles results in  $\sim 60$  pW incident power onto photodetector

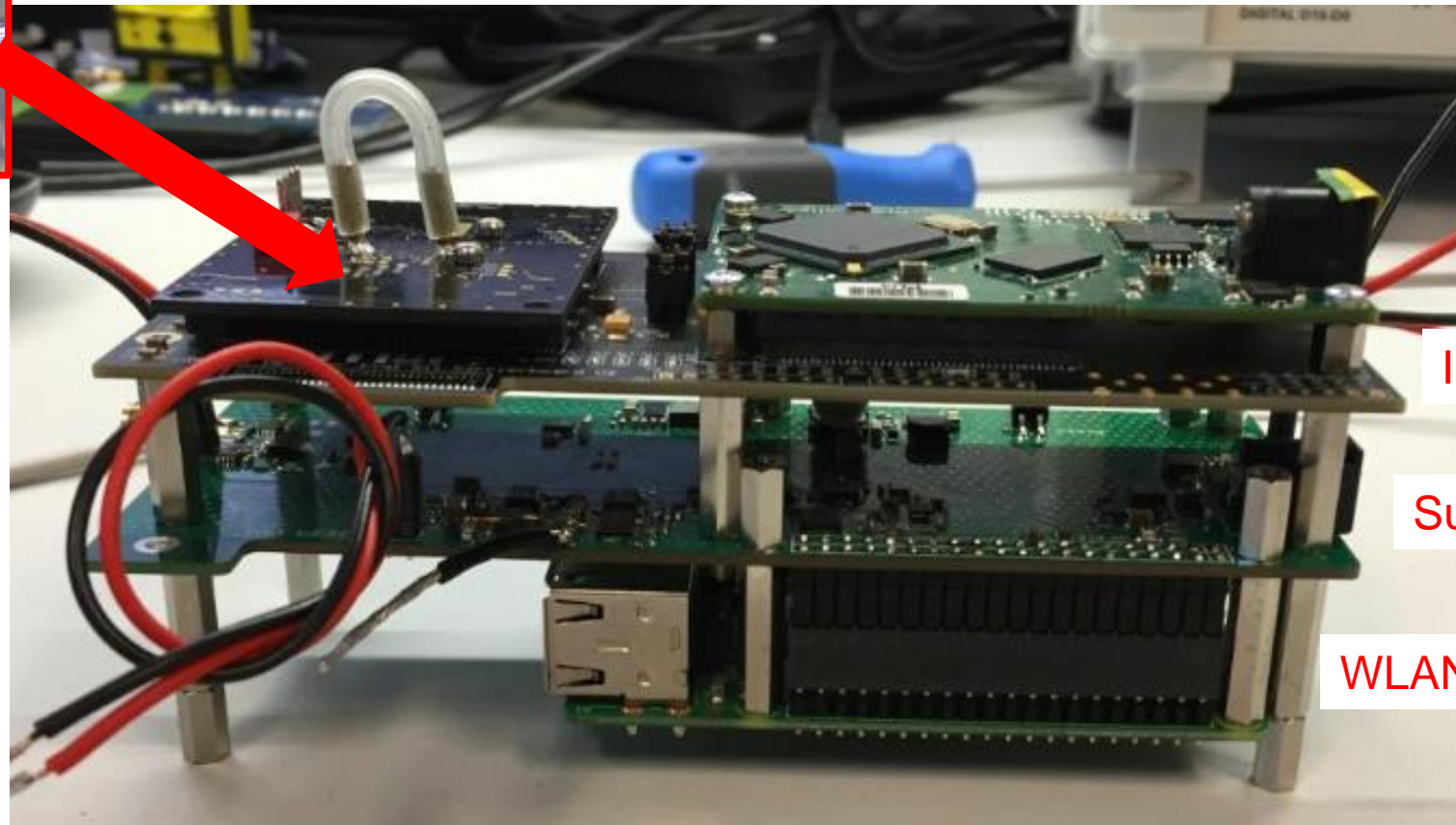
## Ray tracing to minimize stray light



- ❖ Beam ( $\sim 1$  mW) entering light trap experience min 4 bounces before it might reach the PD:  
 $1\text{mW} \cdot 0.01^4 \sim 10$  pW stray light

# WLAN based PM2.5 sensor demonstrator

## Lab demonstrator



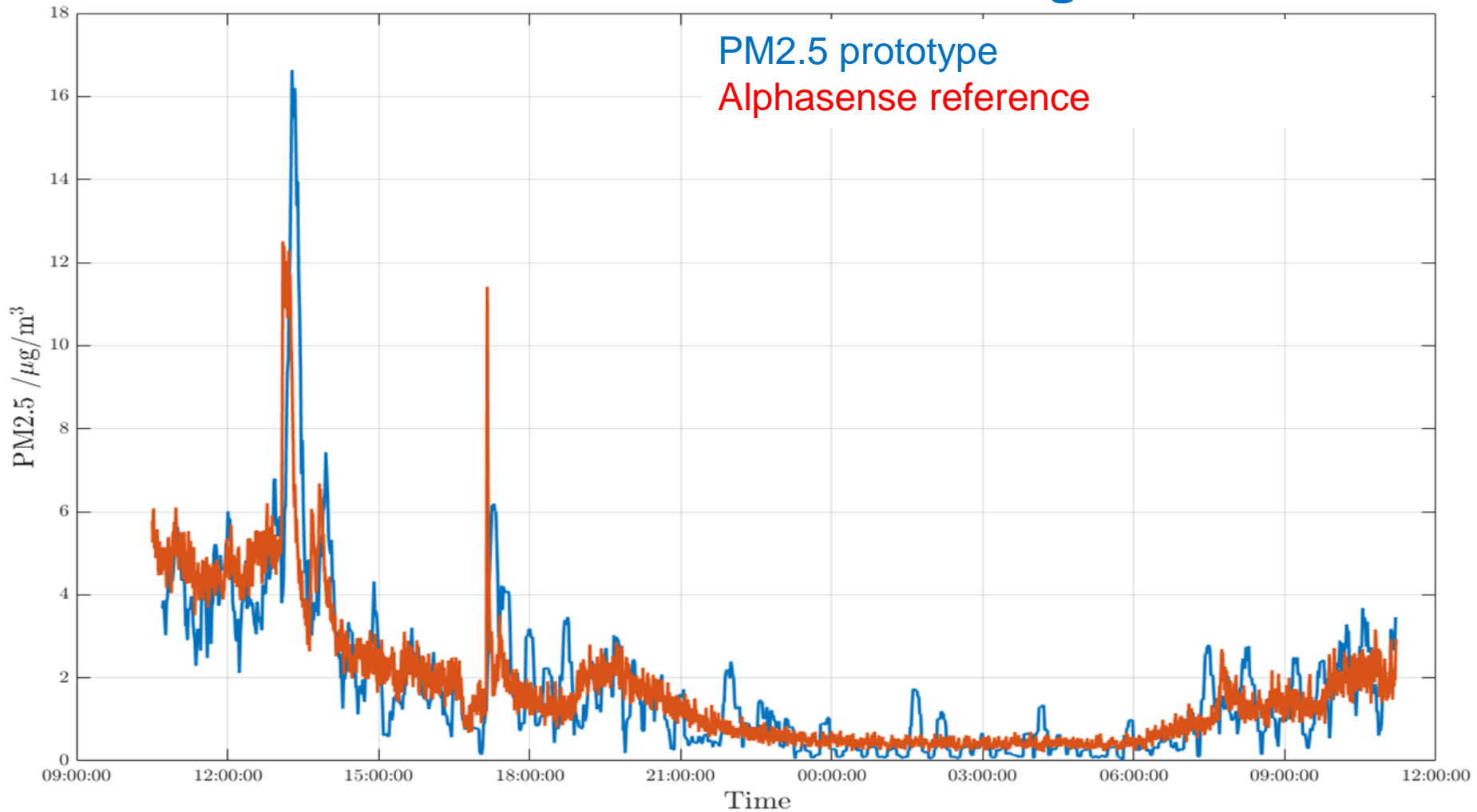
Interface (FPGA)

Supply board

WLAN server

# Mobile sensor delivers high accuracy

## 24 hrs ambient air monitoring





# Thank you!

Please visit our website  
[www.ams.com](http://www.ams.com)