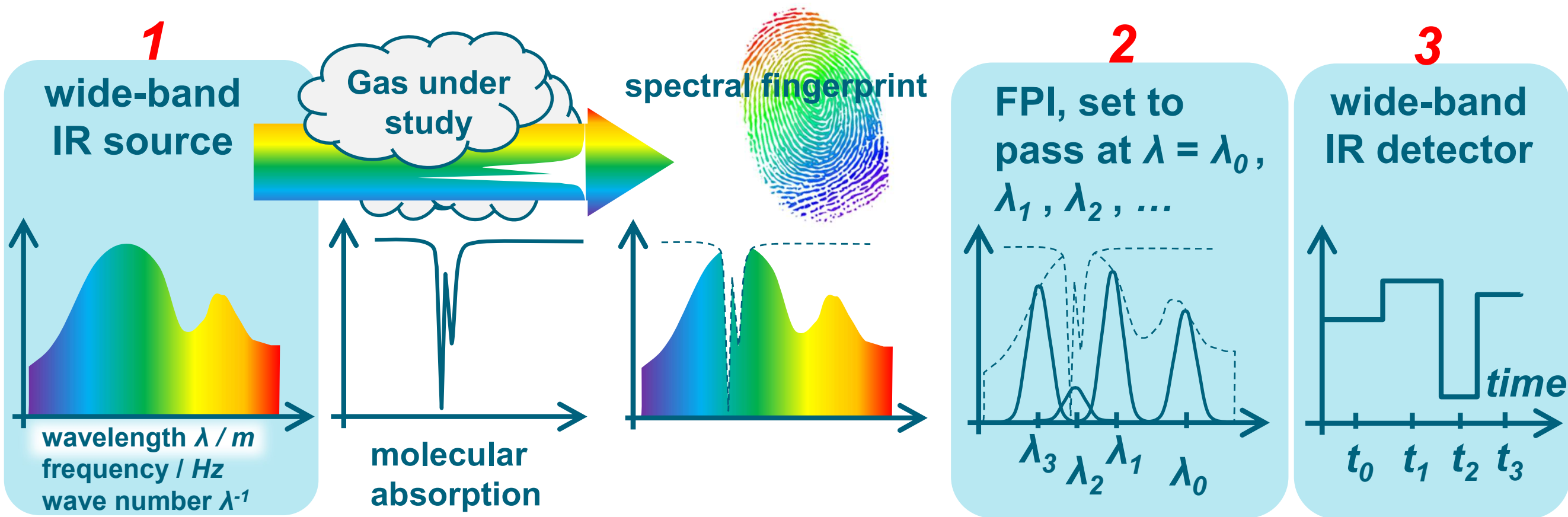


Contents

- MOEMS for gas spectroscopy
 - 3** IR detector
 - 1** IR emitter
 - 2** IR filter
 - Applications
- Vaisala
- People in Vaisala

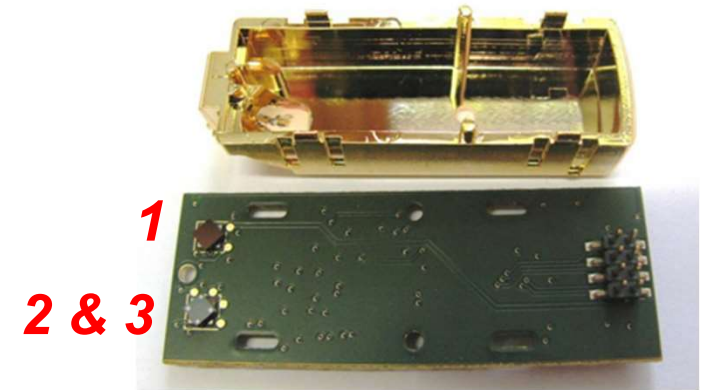
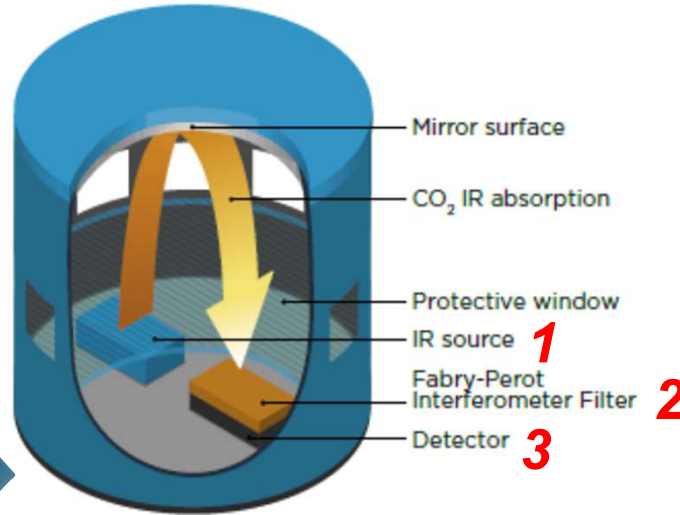
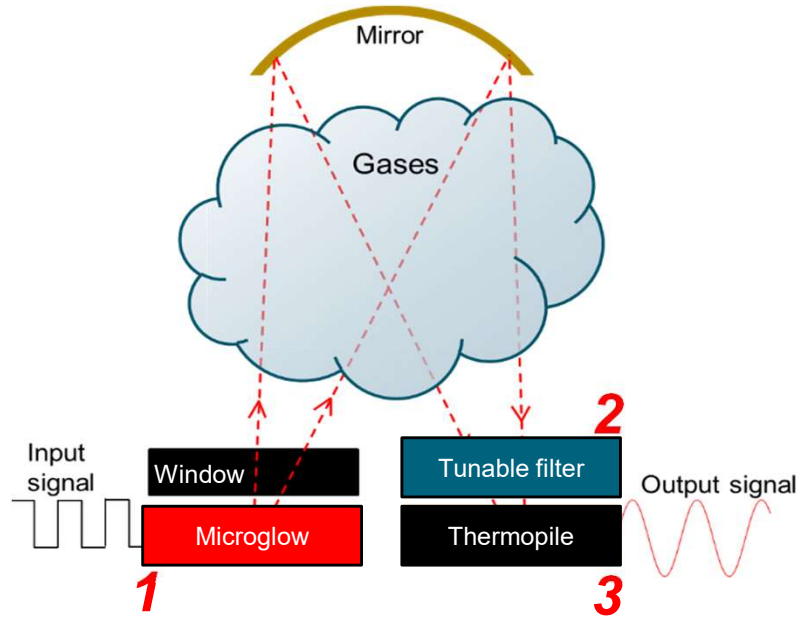
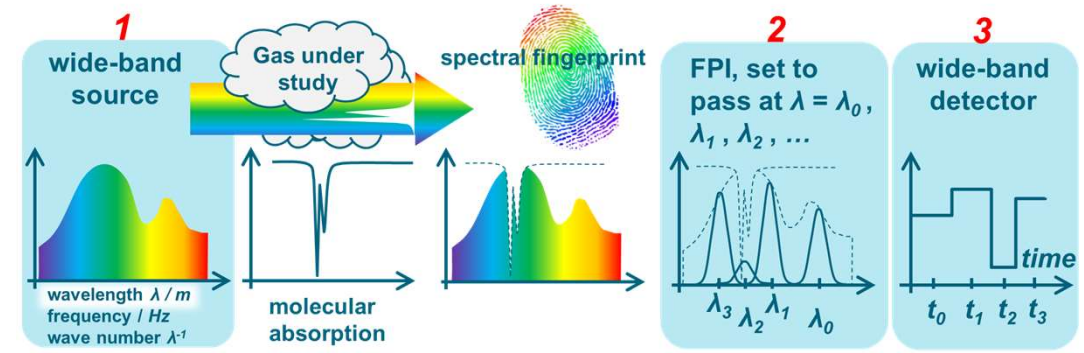
3 x IR MOEMS

- 1 Source : thermal, "micro-glow", μG
- 2 Filter : tunable interferometer, Fabry-Perot, **FPI**
- 3 Detector : thermo-pile, **TP**



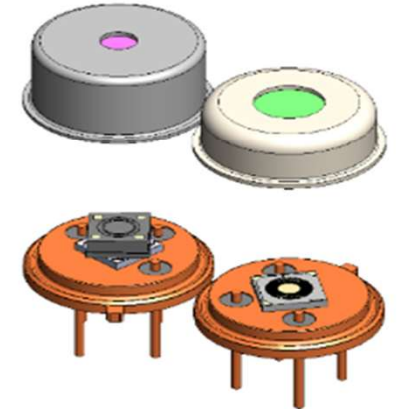
Devices arrangement

- 1** Source : "micro-glow", μG
- 2** Filter : tunable interferometer, **FPI**
- 3** Detector : thermo-pile, **TP**



Chips on PCB if gas contact OK.

TO-can with IR window, if hermetic isolation from gas is needed.



VAISALA

Refractive index and absorption coefficient

- Reflectivity (Reflectance) = reflected power / incident power
- Transmittivity (Transmittance) = transmitted power / incident power

Speed of light: $v = c/n$
 $n = n(\omega)$

Refractive index is frequency dependent!

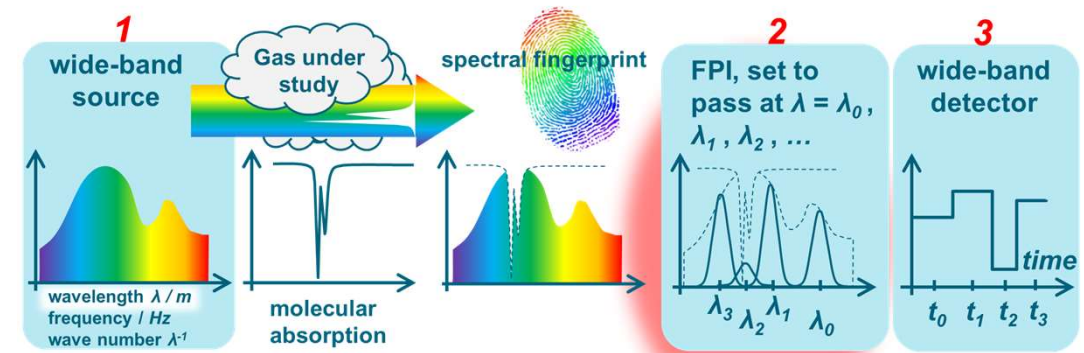
$z+dz$ $(z+dz)$

Complex refractive index

Complex refractive index: $\tilde{n} = n + ik$

Refractive index \nearrow Attenuation (damping) factor \nwarrow

Fabry-Perot Interferometer : the tunable IR filter

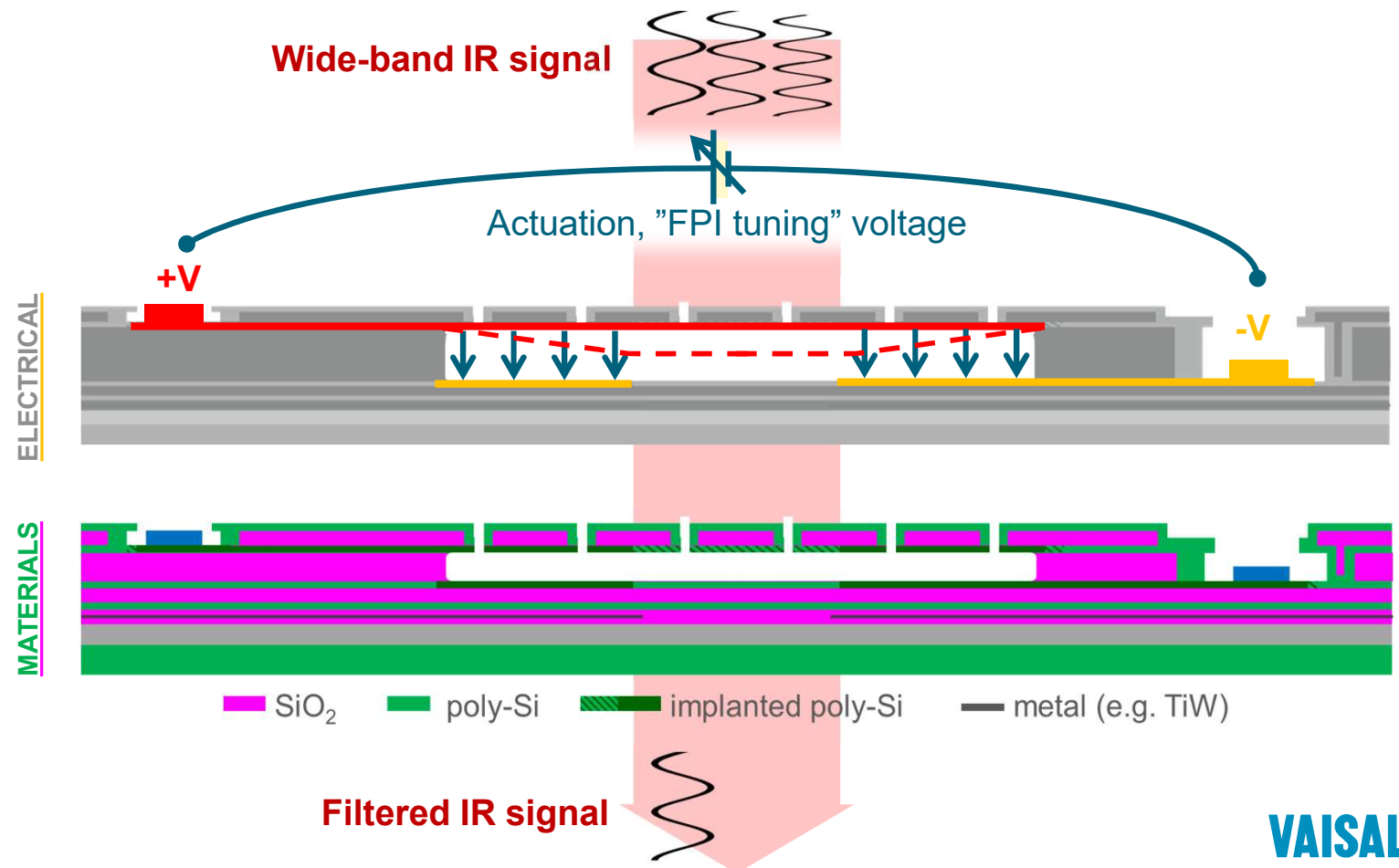


Low-loss dielectrics thin-film stack for IR mirrors

- High & low refractive indices, e.g. Si & SiO₂

Electrostatic actuator for wavelength tuning

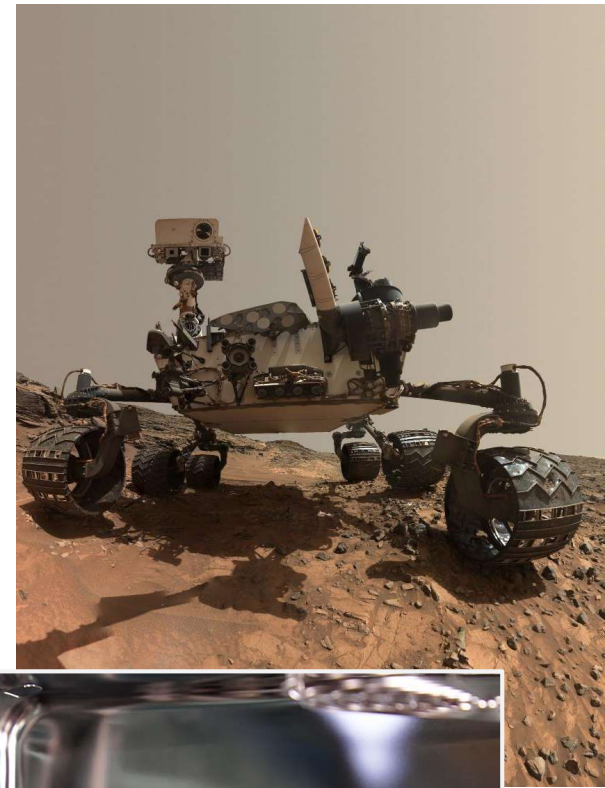
- Charge-carrier doping of Si by ion implantation





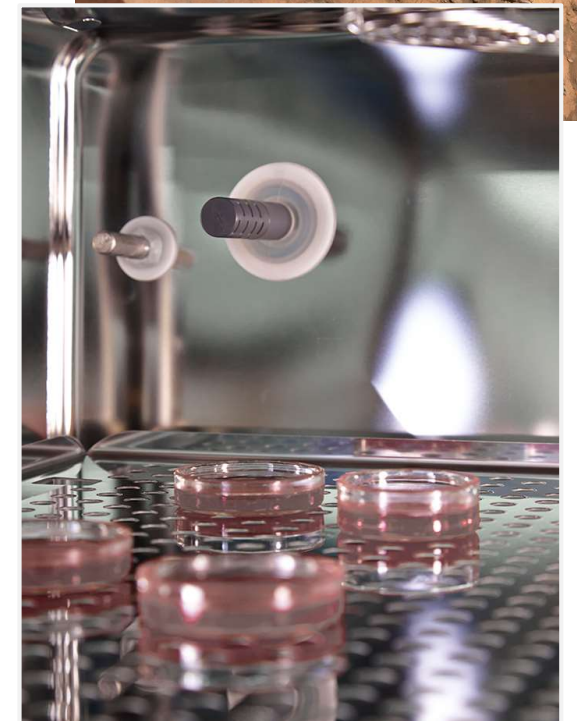
High-end humidity

- Humidity measurements when performance matters.
- Gas measurements for indoor environments (CO_2 , RH%, T).



High-end carbon dioxide

- Harsh environments where stable and accurate performance is required.
- Greenhouses, agriculture, data centers, refrigeration and other demanding HVAC applications.





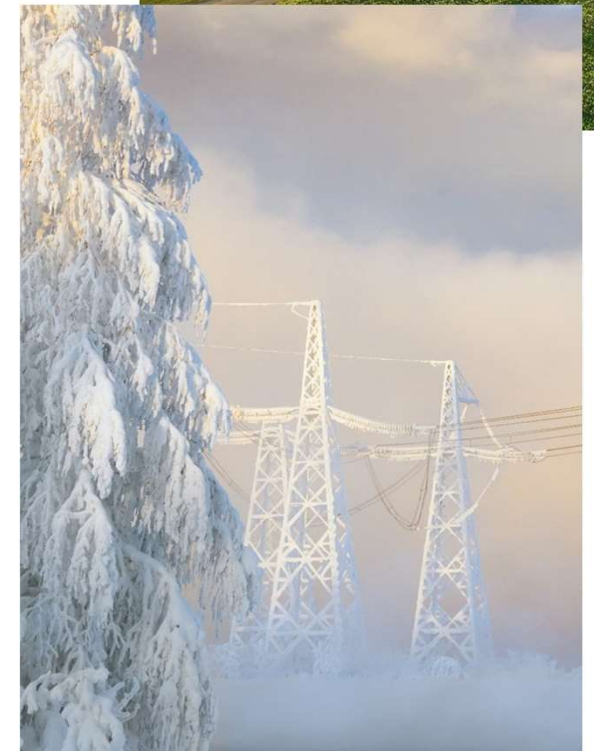
Biogas

- World's first 3-in-1 (CH_4 , CO_2 , H_2O) measurement of biogas quality.
- Value from waste: Improve methane and minimize water through continuous in-line measurement.



Power industry

- High voltage transformer continuous online monitoring for early indication of faults.
- Measuring multiple gases and moisture in transformer oil.





In **1936**, Vilho Väisälä founded Vaisala and sold the first radiosondes to MIT.

Vaisala in numbers

“October 14, 2022: Vaisala estimates 2022 net sales will be 500–520 million €”

Net sales in 2021

438
MEUR

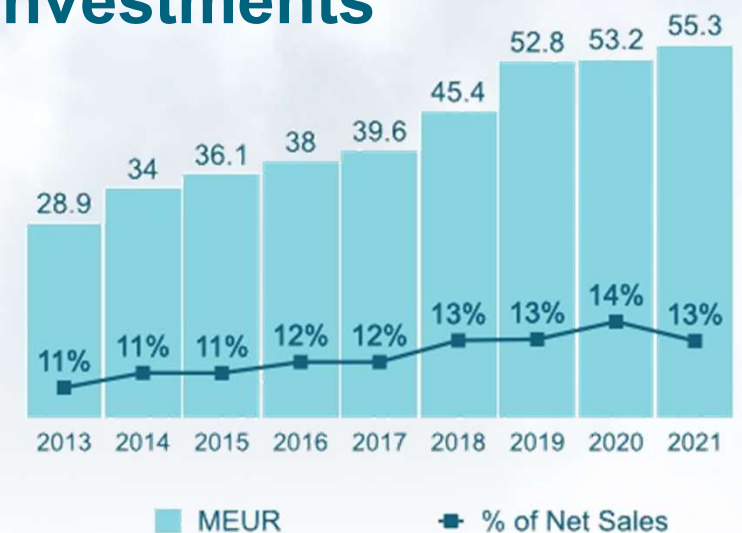
13%
of net sales
invested
into R&D

2,000+
employees
worldwide

25+
offices in
16
countries

- 29% of employees working in R & D
- State-of-the-art in-house cleanroom
- New R&D and innovation center 2021

R&D investments



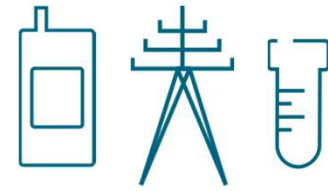
Serving customers all over the world

66 % of personnel in Finland





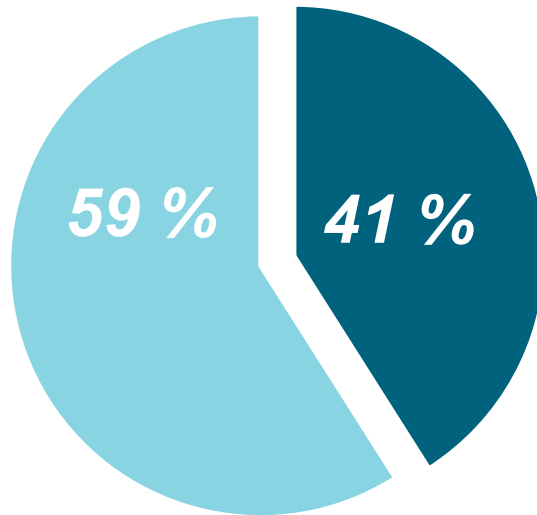
Weather and Environment



Industrial Measurements



NET SALES



End-user products



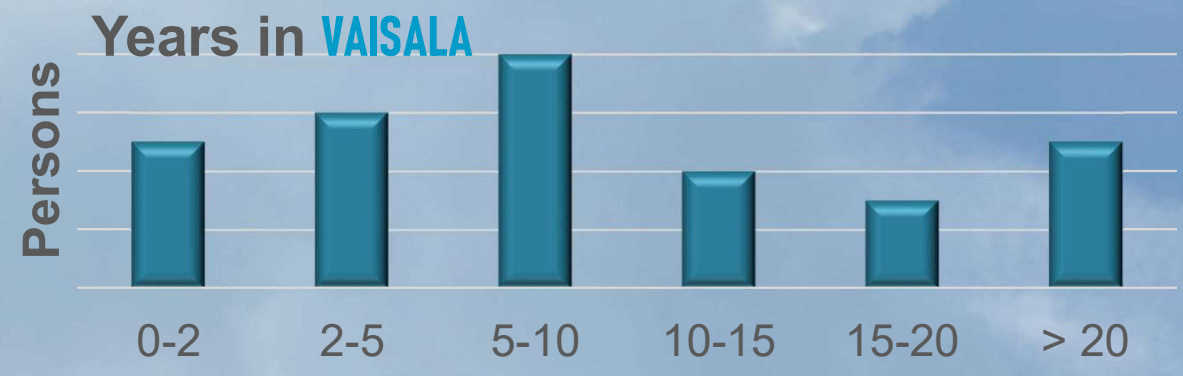
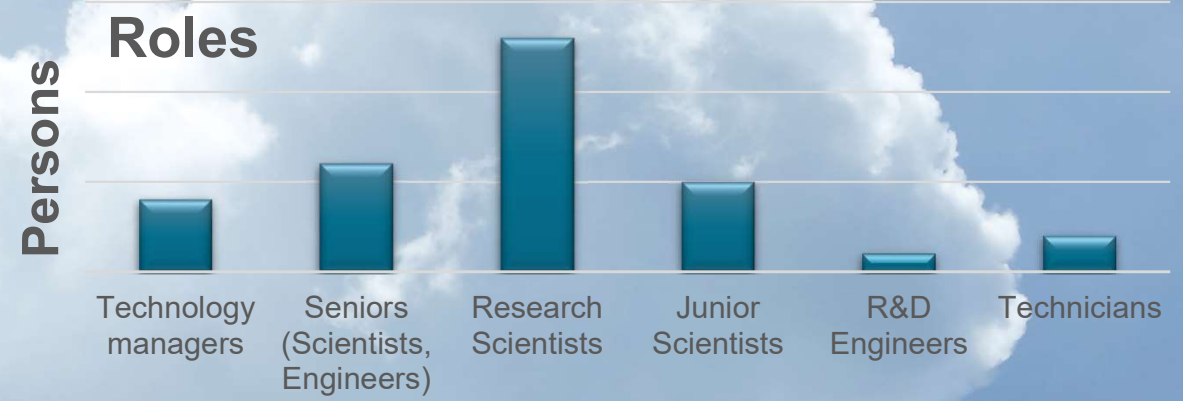
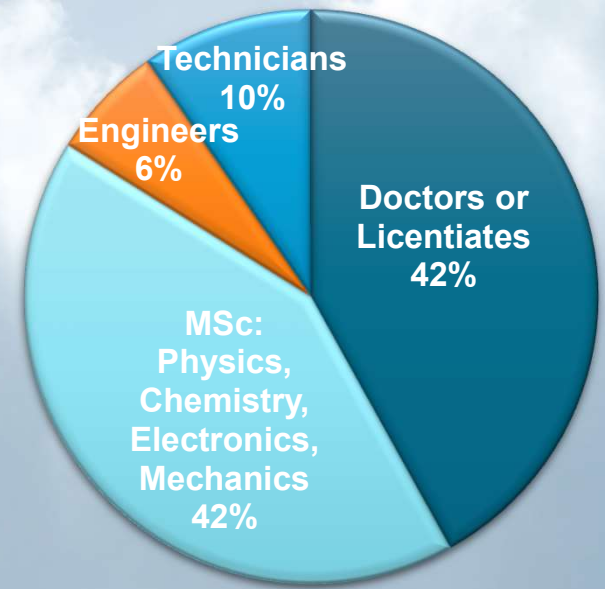
Mikko Tuohiniemi, Dr.Sci (Eng.), Senior Scientist, Optical Sensors, Vaisala Oyj



Micro-Sensor Technology R'n'D teams

~50 people in four teams:

- Micro-Sensor Technologies
- Thin-Film Sensors
- Optical Sensors
- New Measurement Technologies



An aerial photograph of the Mars Science Laboratory rover tracks on the red planet surface. The tracks are arranged in a way that spells out the word "WARRIOR" in large, bold letters. The rover is visible in the distance, at the end of the tracks. The background shows the vast, reddish-brown landscape of Mars.

Thank You

Our technology on Mars