



**European Network on New Sensing Technologies for Air Pollution  
Control and Environmental Sustainability - *EuNetAir*  
COST Action TD1105**

**INTERNATIONAL WG1-WG4 MEETING on**

***New Sensing Technologies and Modelling for Air-Pollution Monitoring***

**Institute for Environment and Development - IDAD**

**Aveiro, Portugal, 14 - 15 October 2014**

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 3: 2014-15 (*Ongoing Action*)

**TOWARDS ULTRA-LOW-POWER ENVIRONMENTAL AIR  
MONITORING WITH POWER HEMTS**



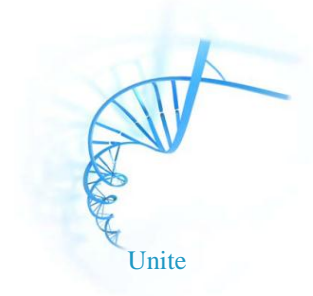
**Peter Offermans**

**Function in the Action: WG2 Member**

**IMEC Holst-Centre / The Netherlands**

# Background: Holst Centre

- **Independent, with reputed parents**
  - Founded by **imec** (1300 fte, Belgium) and **TNO** (4500 fte, The Netherlands)
  - Operational since 2006
- **Critical mass to create impact**
  - Staff of **180 researchers**; >28 nationalities
  - Involving groups of mother organisations
  - 70 industrial and academic residents
- **Focus on relevant topics**
  - Ultra-low-power and flexible electronics
  - Lighting, Solar, Displays, Healthcare
- **Supported by strong eco-system**
  - Global industrial and academic partners
  - Embedded in high-tech region
- **Co-funded by local and Dutch government**
  - Fastest growing R&D consortium in the Netherlands

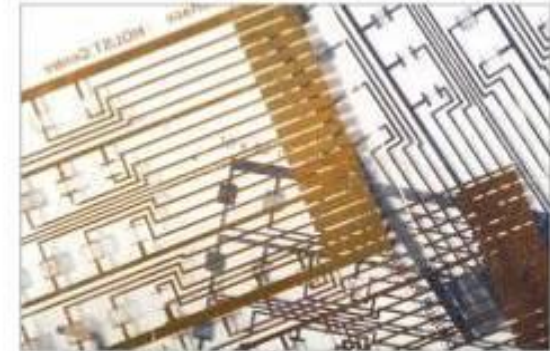
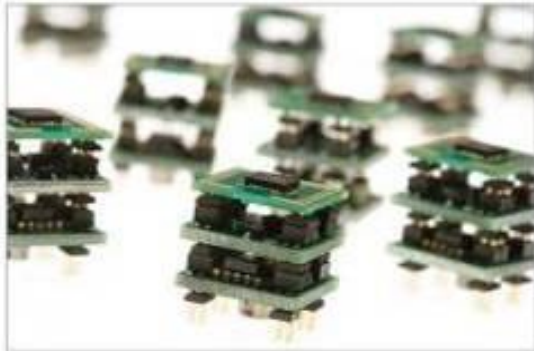


# The two worlds of Holst Centre

Wireless  
Autonomous  
Transducer  
Solutions

Technology  
Integration  
Programs

Systems  
in  
Foil







# ... AT LOW POWER & LOW COST!

Smart environment: **Sensors integrated in every device**

## Technologies



## Applications



Health & Wellbeing



Smart homes  
& buildings



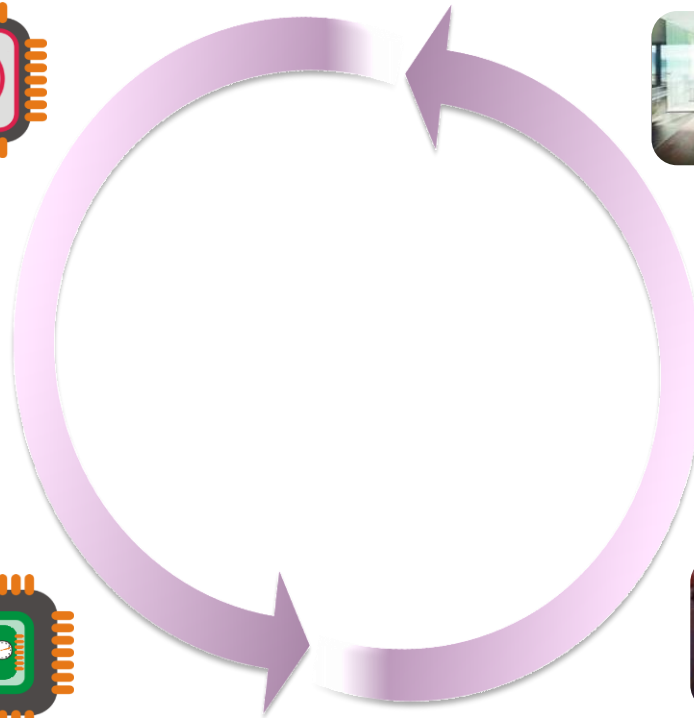
Industrial



Automotive



Consumer

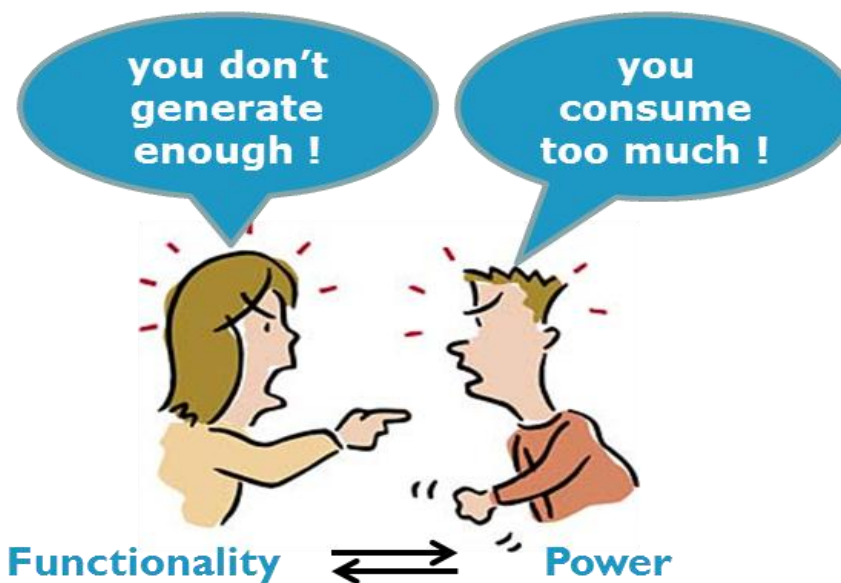




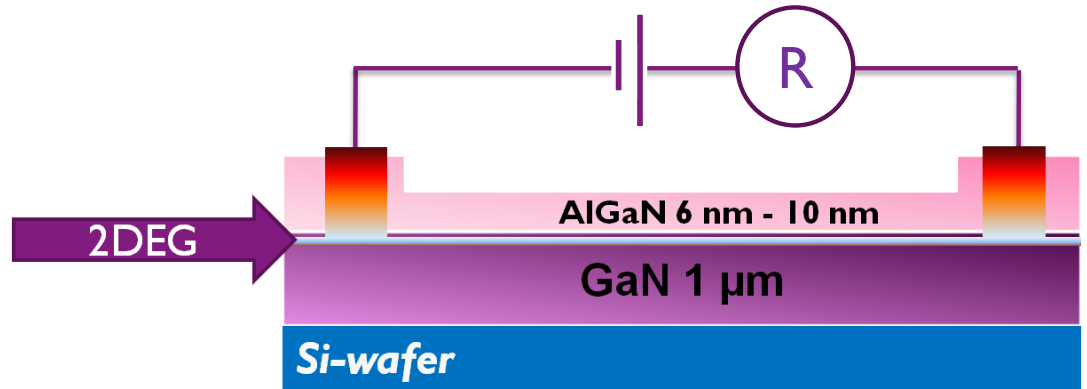
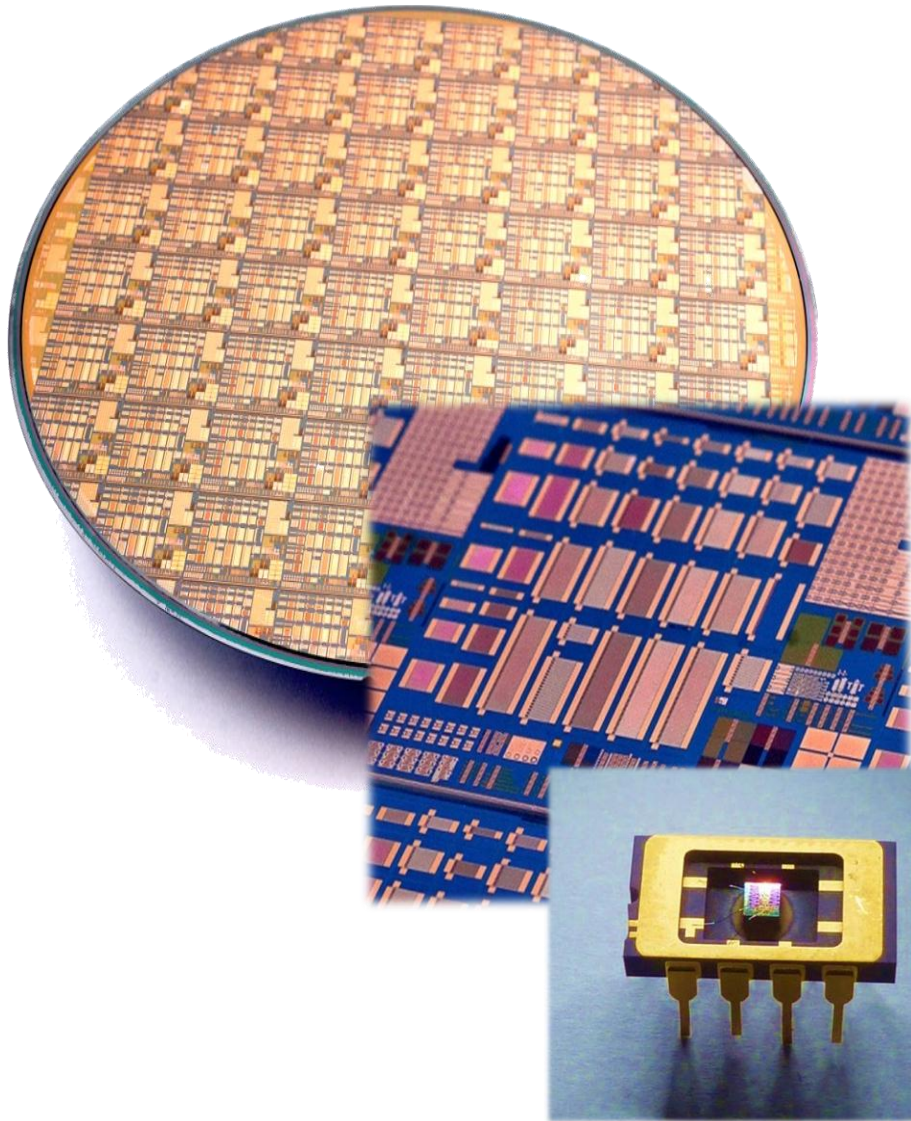
# Scientific context and objectives

- **Brief reminder of objectives: WG2**
- Sensors, devices and sensor-systems for AQC
  - The development of nanosensors and nanotransducers for portable gas sensor systems, miniaturised systems and microsystems

**How to miniaturize sensors without sacrificing sensitivity, achieve low-cost fabrication and low power?**



# Current activity: AlGaIn/GaN 2DEG based sensors



- Sensor based on GaN power HEMT
- 8" GaN-on-Si substrate → lower costs
- CMOS-compatible processing
- Spontaneous formation of a highly mobile, buried 2DEG at interface
- Low noise electrical readout
- Size-compatible with mobile applications
- Highly sensitive to NO<sub>2</sub>

# Current activities

- **Further development of GaN-based air quality sensor**

*Reduction of power consumption*

*Field testing*

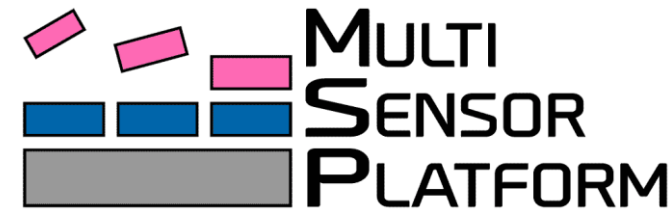
*Platform extension towards other gases*



- **MSP (Multi Sensor Platform) EU project**

*3D-integration of sophisticated components and sensors on multi sensor platform*

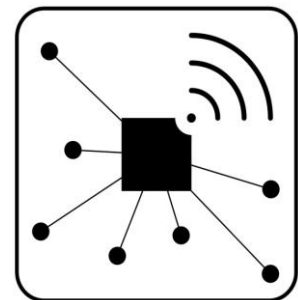
*→ Wrist band based AQM demonstrator*



- **ESEE (Environmental sensors for energy efficiency)**

*Sensor networks for energy efficient ventilation systems in building and air craft cabins*

*→ Integration of NO<sub>2</sub> sensor in plasma air purifier*



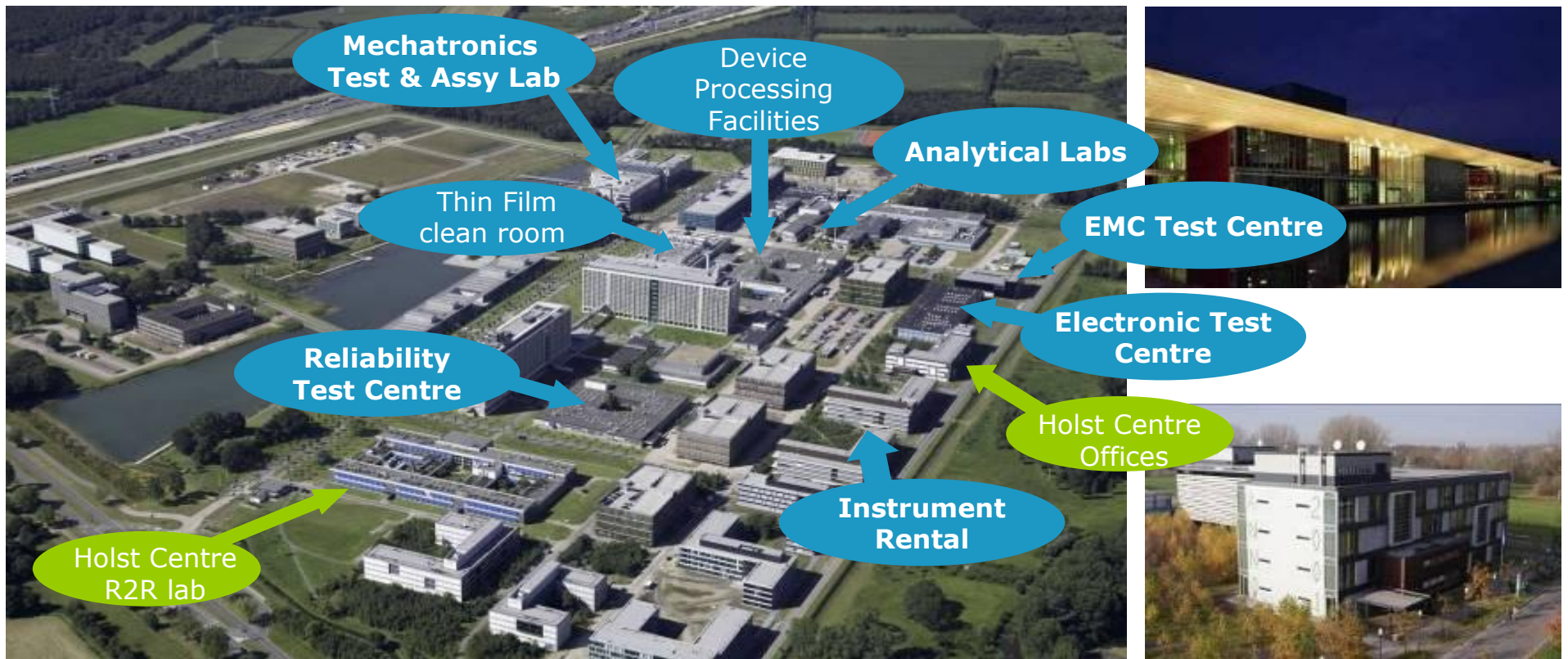


# Facilities available to Holst Centre

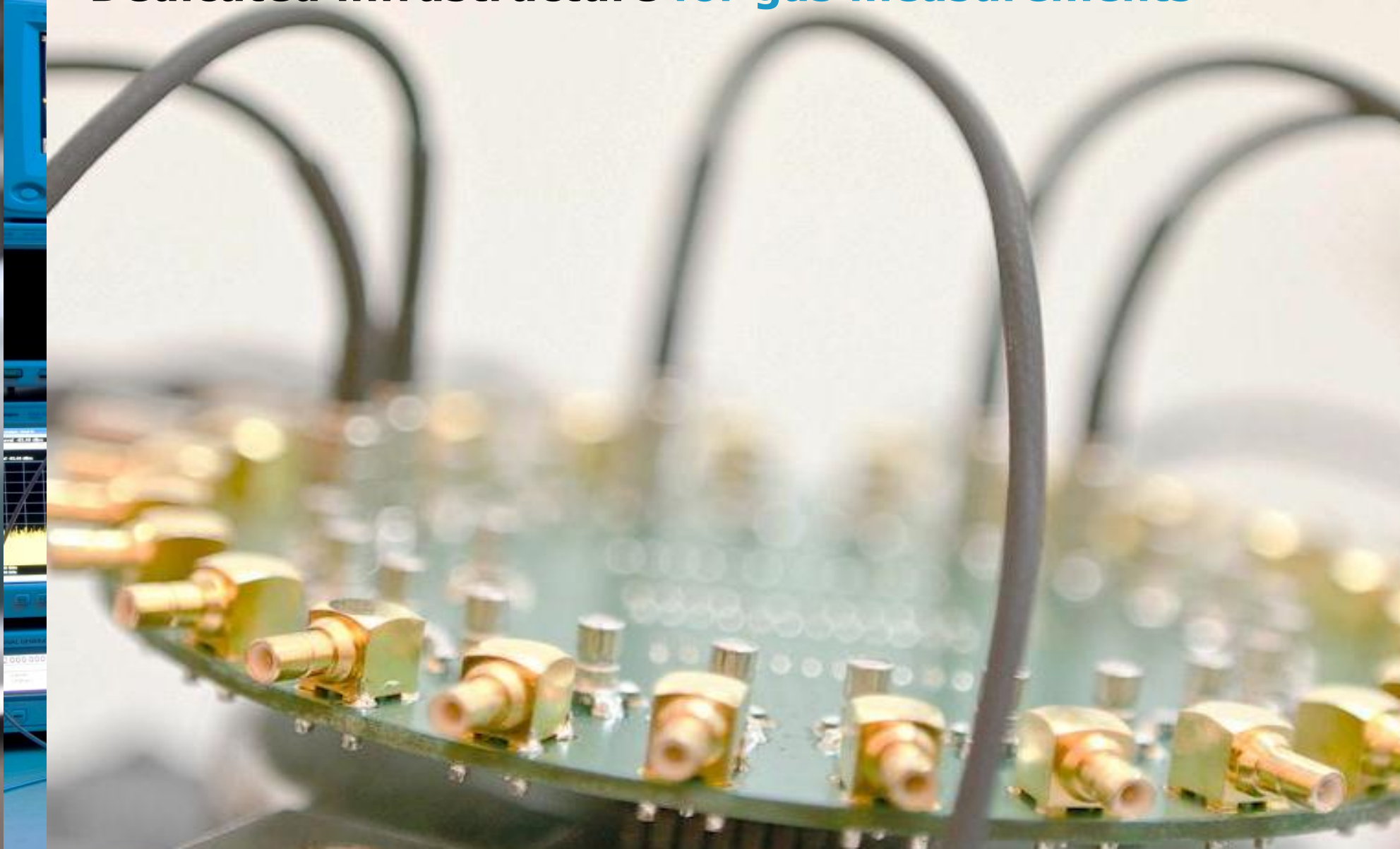
## MiPlaza facilities at High Tech Campus



High Tech Campus Eindhoven

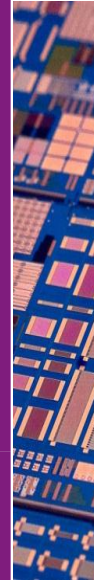
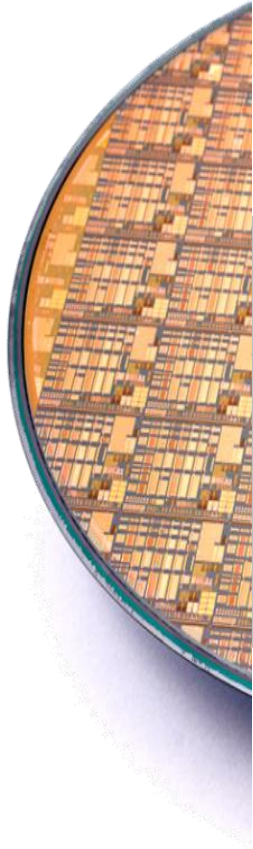


## Dedicated infrastructure for gas measurements



# Achieved results and future activities

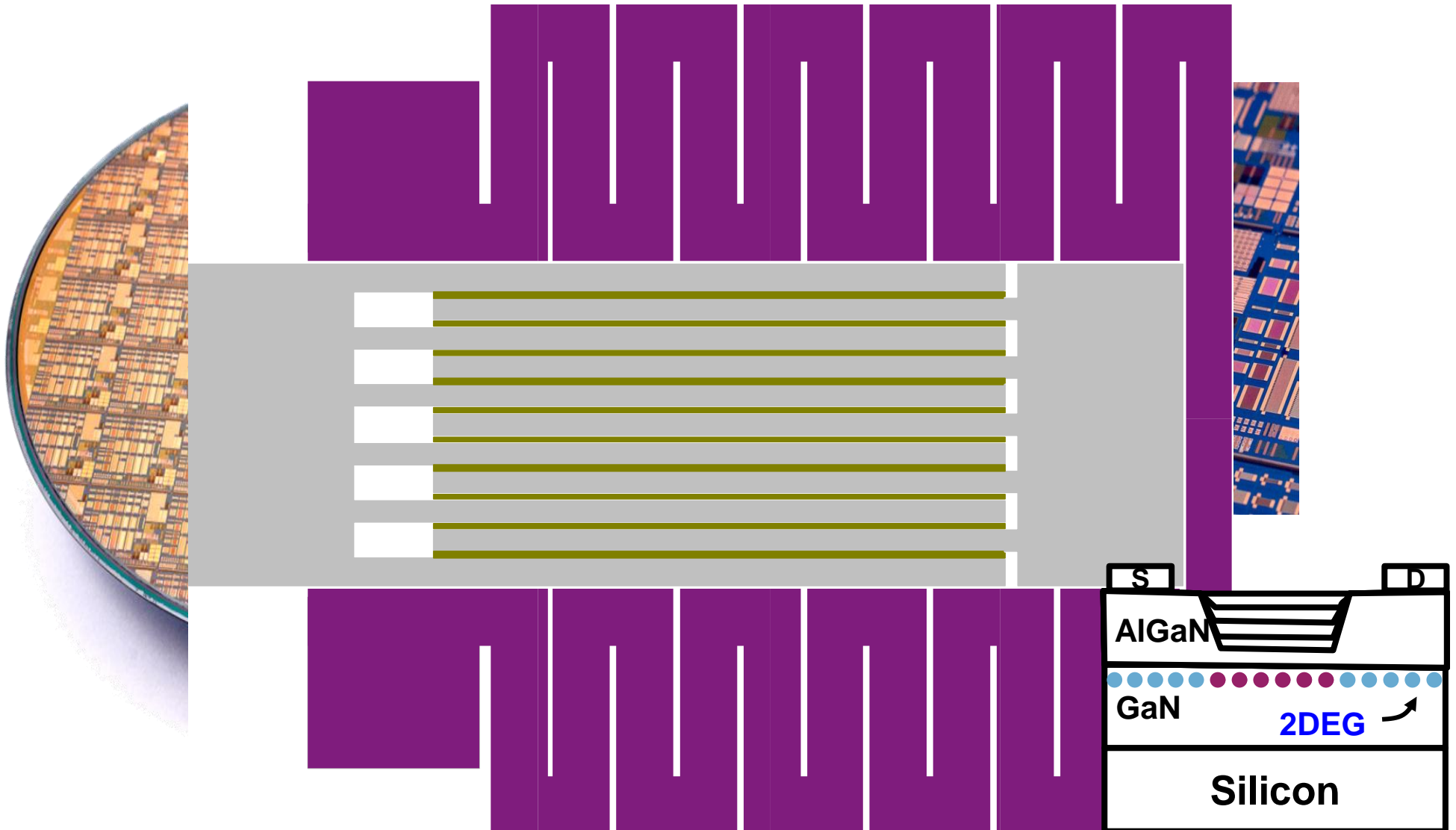
## SENSING WITH POWER HEMTs





# Achieved results and future activities

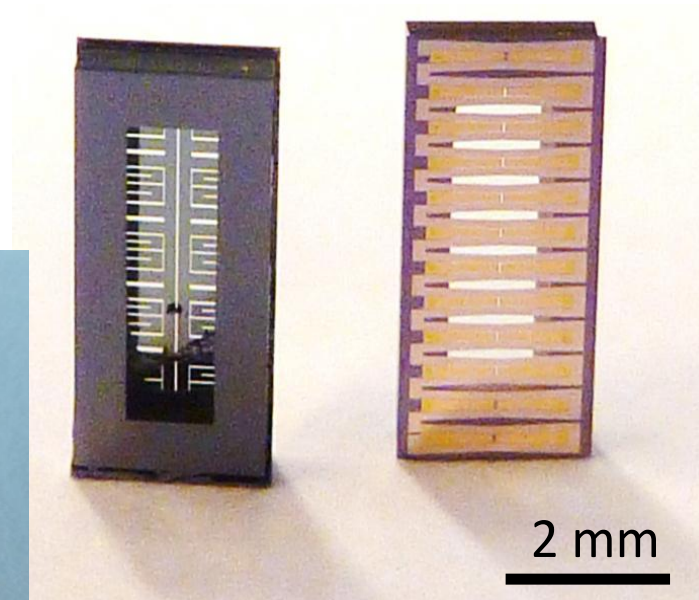
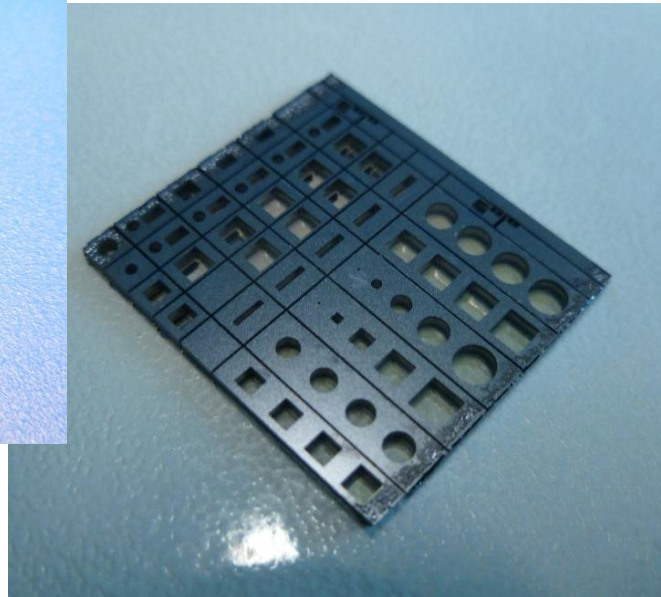
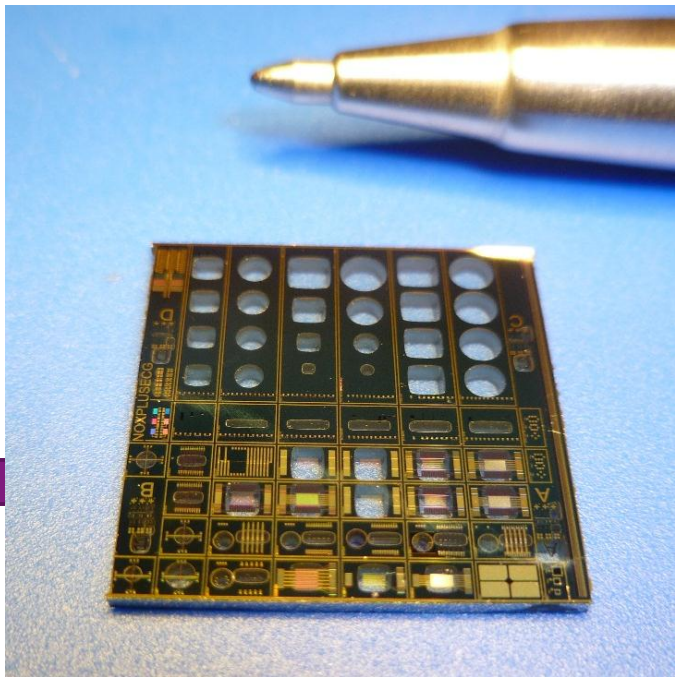
## SENSING WITH POWER HEMTs



# Achieved results and future activities

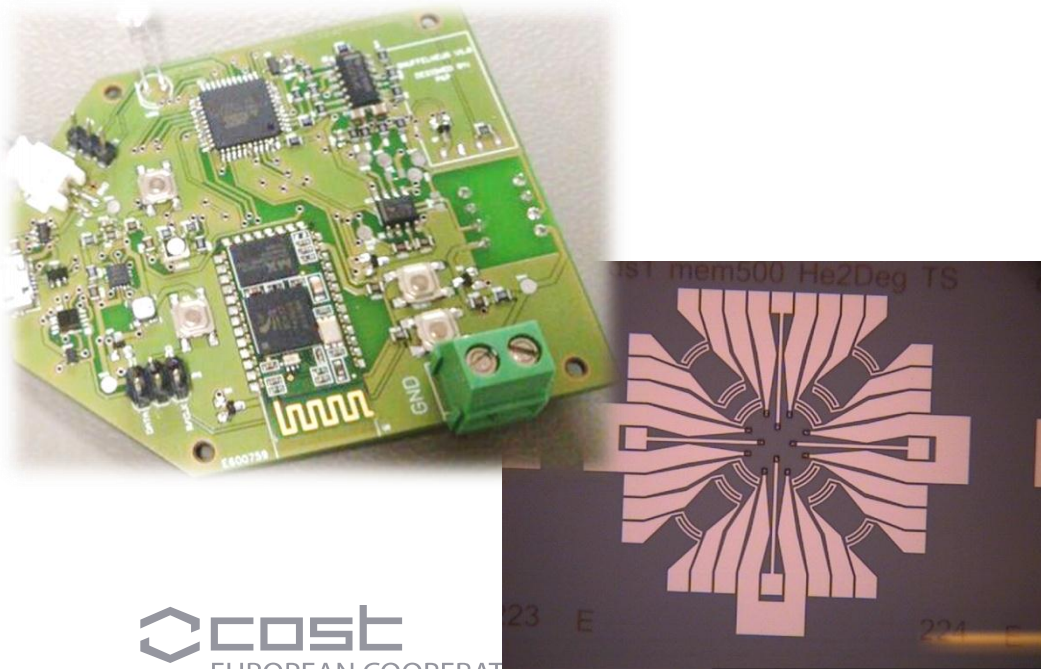
Minimize power consumption by use of freestanding GaN membranes

→ microhotplate design → mW range

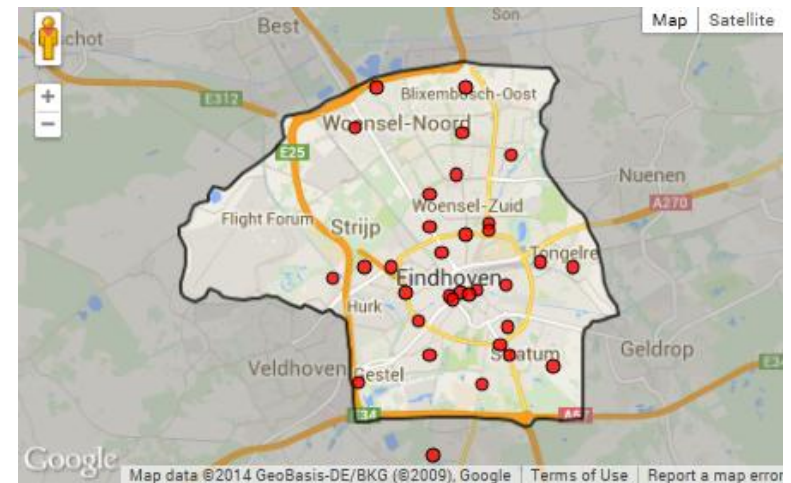


# Future planned activities

- Field testing; lab testing shows high selectivity towards  $\text{NO}_x$  already tested humidity,  $\text{NH}_3$ ,  $\text{C}_2\text{H}_2$ , toluene,  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{H}_2\text{CO}$
- Sensor integration in (portable) devices, i.e. MSP, ESEE
- Optimization of microhotplate design, duty cycled operation
- Packaging



# AAREAS





# Conclusions

- Small but sensitive sensor for NO<sub>2</sub> developed based on power HEMT technology
- Low cost when produced in large numbers
- Low power consumption will be achieved using microhotplate design
- Working on sensor integration in networks and portable devices
- Field testing is essential for further development!

