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CO_2 Sensors in Smart Phones

- THE ULISSES PROJECT

Live Webinar, Wednesday January 27th, 2021
Presenters: Henrik Rödjegård and Kristinn Gylfason

WEBINAR AGENDA

AIR SENSORS FOR EVERYONE, EVERYWHERE

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This webinar is a co-production hosted by:

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ULISSES AIR SENSORS FOR EVERYONE, EVERYWHERE

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MEET ULISSES

Ultra

Integrated optical

Environmental

ULISSES

Multichannel
Gas Sensing

Low-power

Sensor Systems for networked

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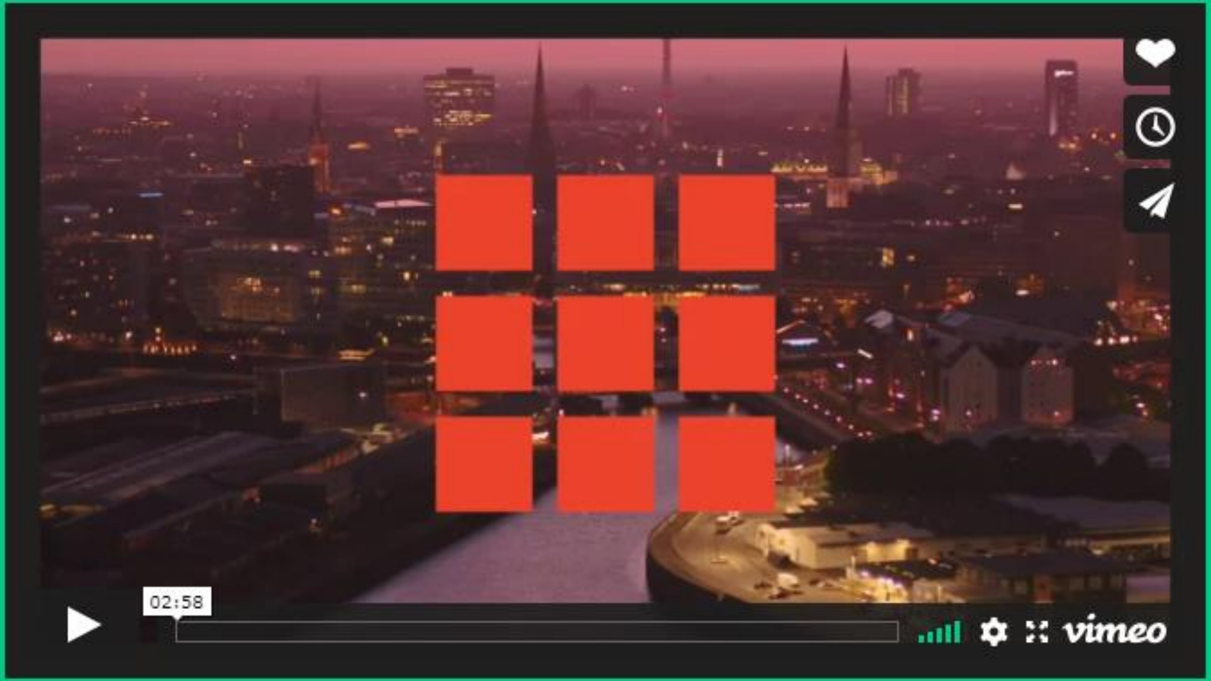
THE PROJECT



Why do we want air sensors everywhere and accessible to everyone?

Discover the story behind ULISSES.

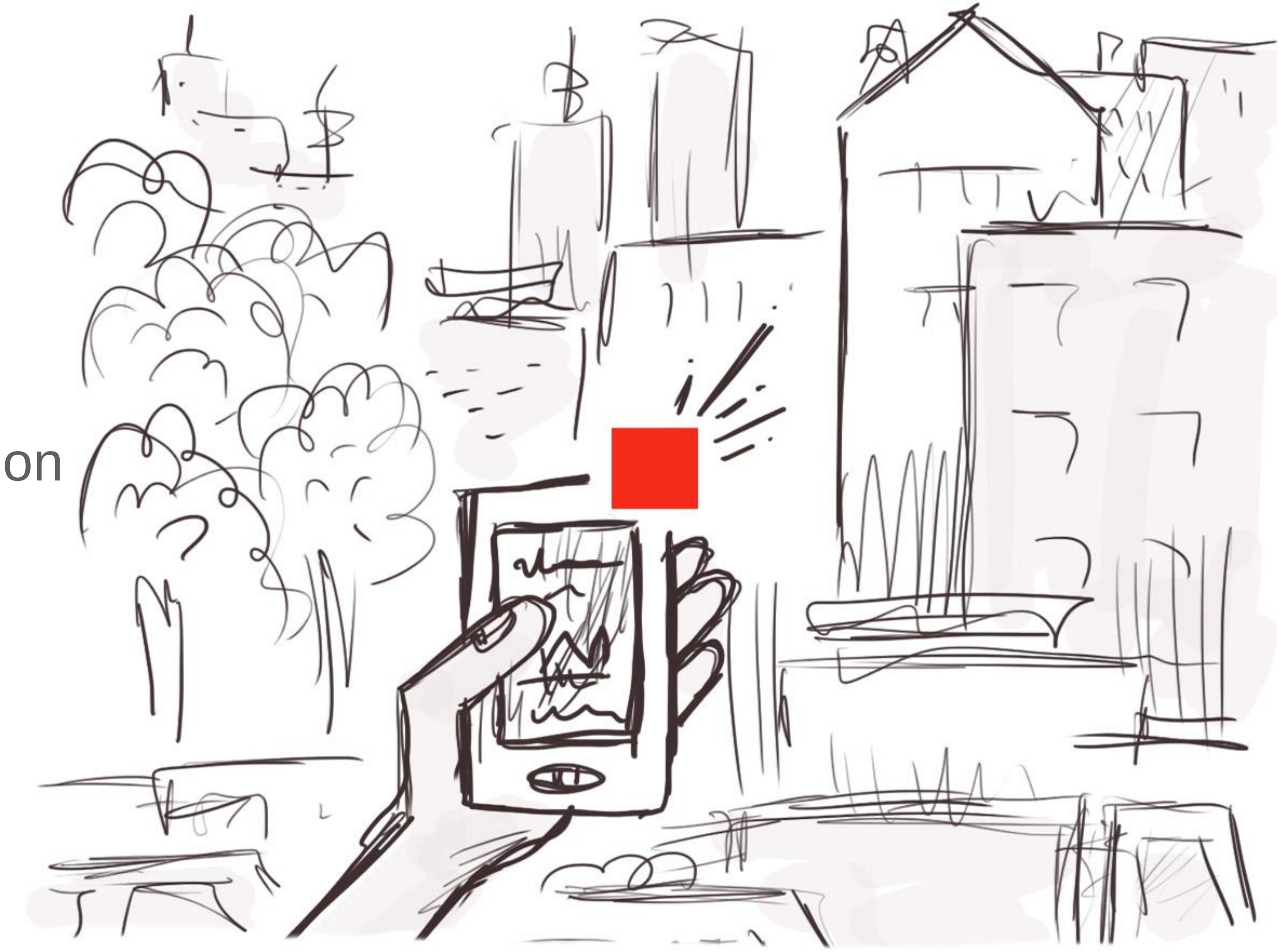
https://www.ulisses-project.eu/

THE VISION

Develop:

- Technology
- Infra structure

for future mass implementation of sensors for air quality measurement



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FOR EVERYONE,
EVERYWHERE

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MARYNA RAZAKHATSKAYA

https://www.creativetechnologist.london/mohair

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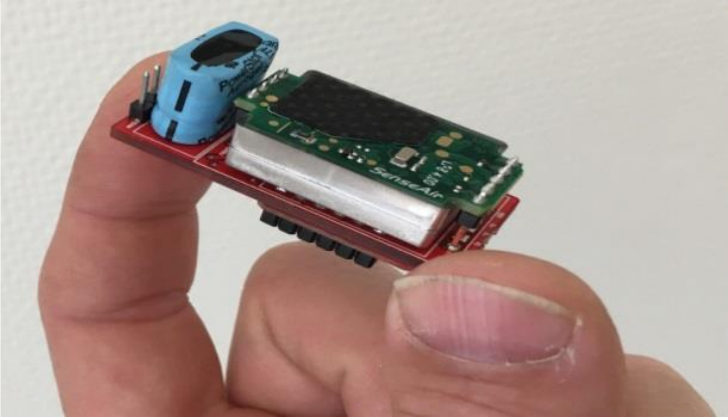

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WHY WE MEASURE CO_2

- Many of the air pollutants can't be seen, smelled or sensed by humans.
- Poor Indoor Air Quality (IAQ) effects wellbeing, health and productivity.
- Perfect parameter for ventilation control.
- Fresh air is 400 ppm and indoors up to 800 or 1000 ppm is considered OK.

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WHY WE MEASURE CO_2

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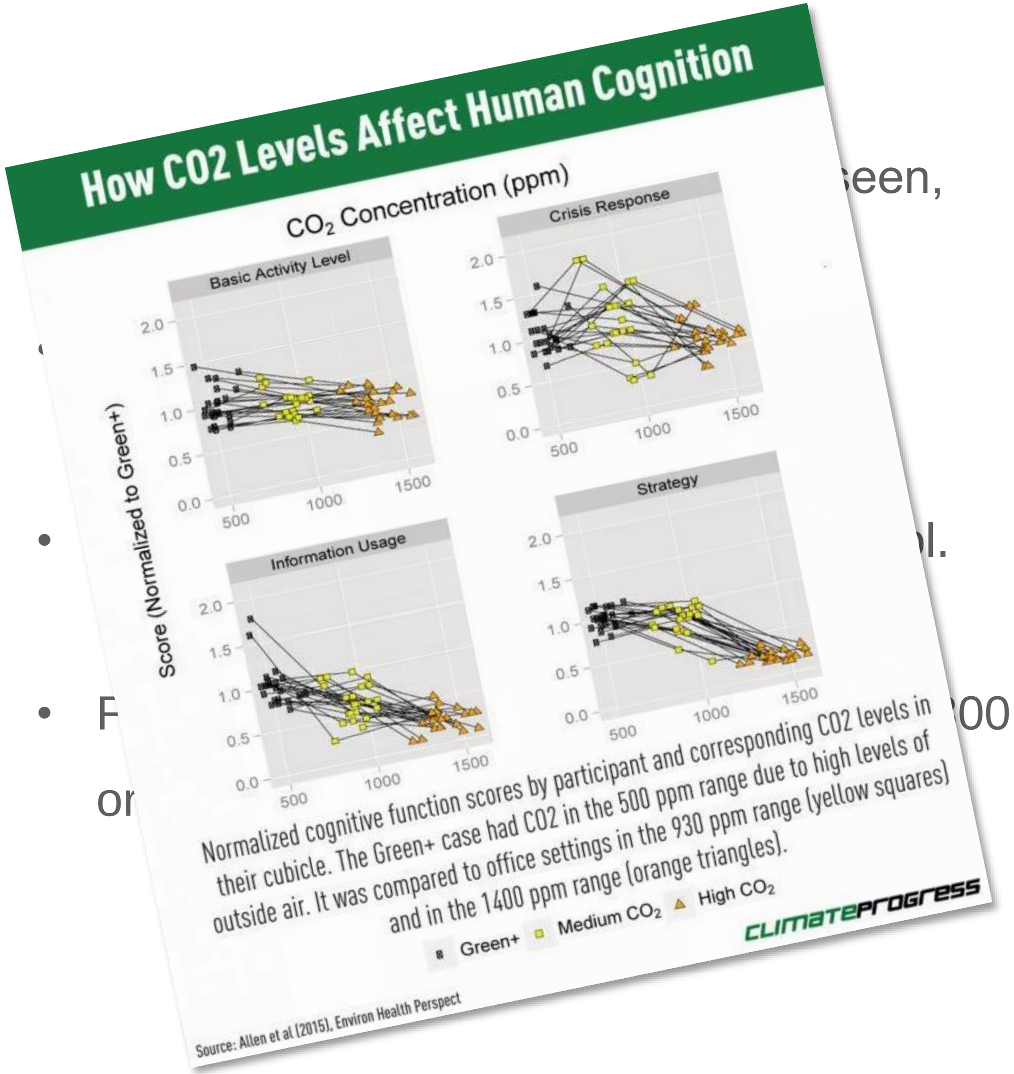

WHY WE MEASURE CO_2

Journal of Exposure Science & Environmental Epidemiology
https://doi.org/10.1038/s41370-018-0055-8

ARTICLE

Airplane pilot flight performance on 21 maneuvers in a flight simulator under varying carbon dioxide concentrations

Joseph G. Allen[1] · Piers MacNaughton[1] · Jose Guillermo Cedeno-Laurent[1] · Xiaodong Cao[1] · Skye Flanigan[1] · Jose Vallarino[1] · Francisco Rueda[2] · Deborah Donnelly-McLay[1] · John D. Spengler[1]

Received: 31 October 2017 / Revised: 14 May 2018 / Accepted: 15 June 2018

Abstract

Background Recent studies suggest that carbon dioxide has an impact on cognitive function performance of office workers at concentrations previously thought to be benign (1000–2500 ppm). The only available data for CO_2 on the flight deck indicate that the average CO_2 concentrations are typically <1000 ppm, but the 95th percentile concentration can be as high as 1400 ppm, depending on airplane type.

Methods We recruited 30 active commercial airline pilots to fly three 3-h flight segments in an FAA-approved flight simulator with each segment at a different CO_2 concentration on the flight deck (700, 1500, 2500 ppm). CO_2 concentrations were modified by introducing ultra-pure CO_2 into the simulator; ventilation rates remained the same for each segment. The pilots performed a range of predefined maneuvers of varying difficulty without the aid of autopilot, and were assessed by a FAA Designated Pilot Examiner according to FAA Practical Test Standards. Pilots and the Examiner were blinded to test conditions and the order of exposures was randomized.

Results Compared to segments at a CO_2 concentration of 2500 ppm, the odds of passing a maneuver as rated by the Examiner in the simulator were 1.52 (95% CI: 1.02–2.25) times higher when pilots were exposed to 1500 ppm and 1.69 (95% CI: 1.11–2.55) times higher when exposed to 700 ppm, controlling for maneuver difficulty, Examiner and order of maneuvers.

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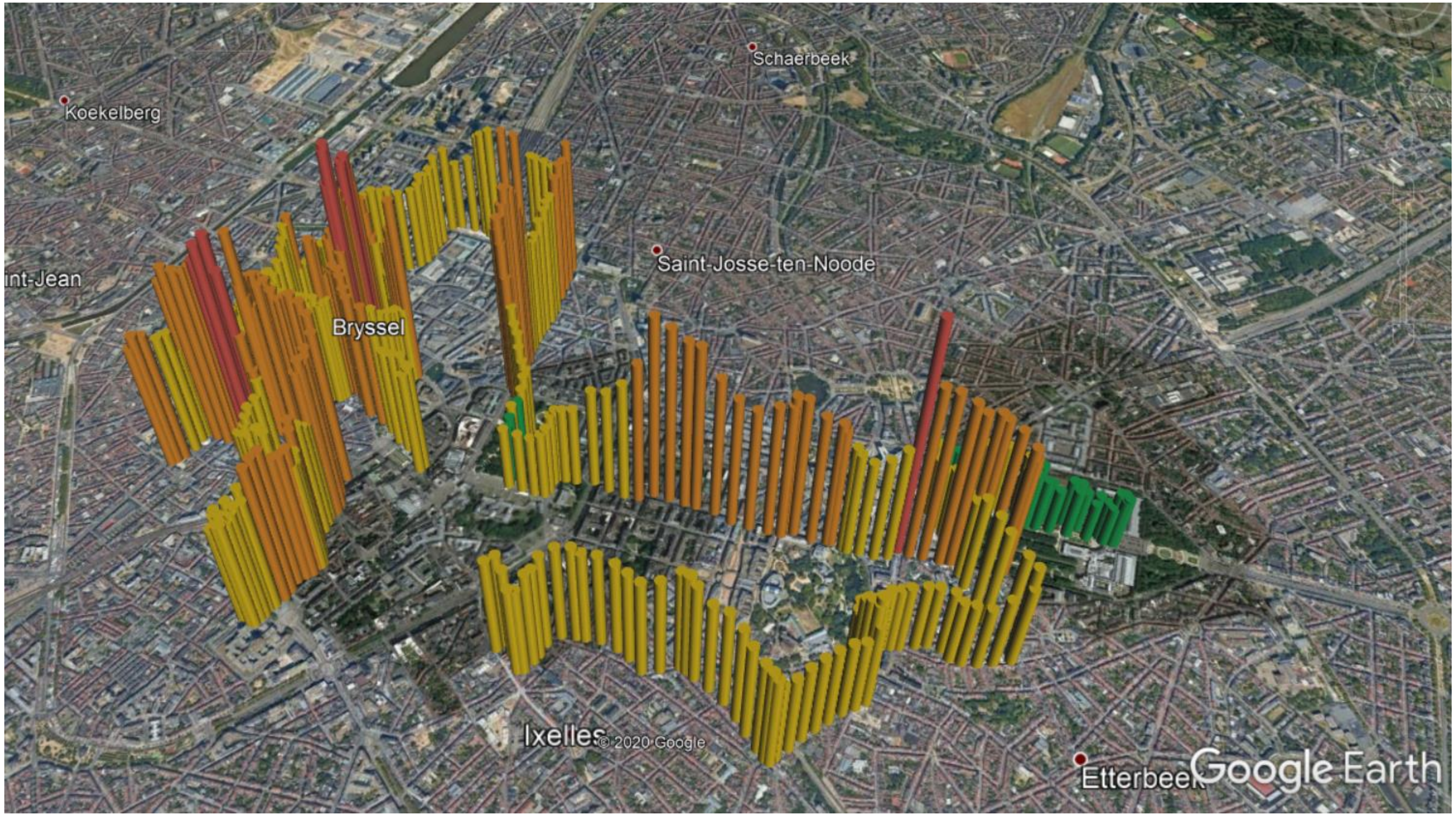
WHY WE MEASURE CO_2

BACK TO MARYNAs INVENTION

When you place outdoor CO_2-data on a map you get information with pollution from combustion engines.



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REAL-TIME AIR QUALITY MONITORING

What if you could monitor AQ and make real-time decisions based on facts?

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REAL-TIME AIR QUALITY MONITORING

What if you could monitor AQ and make real-time decisions based on facts?

What ideas do you have?

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REAL-TIME AIR QUALITY MONITORING

SCIPROM Science, Management & Communication

Scientific communication and management

KTH VETENSKAP OCH KONST

Smart sensor research
MOEMS research

OXFORD INSTRUMENTS

Fabrication equipment business

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Develop gas sensor technology and business

Universität der Bundeswehr München

Material research

ICN2 Institut Català de Nanociència i Nanotecnologia EXCELENCIA SEVERO OCHOA

Physics modelling research

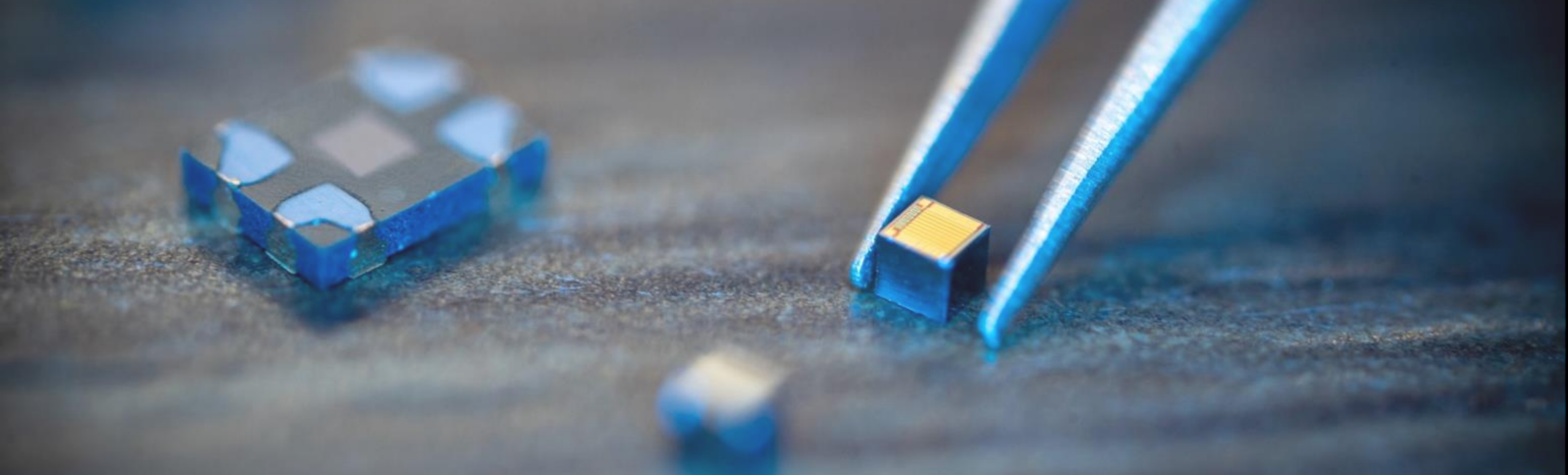
Graphenea

Graphene fabrication business

AMO

Opto-electrical device research

NETWORKED SENSORS – Research in…



- Fabrication and development of 2-D materials
- Micro structure integration
- Component development
- Sensor production and calibration techniques
- Utilization of big data in the cloud

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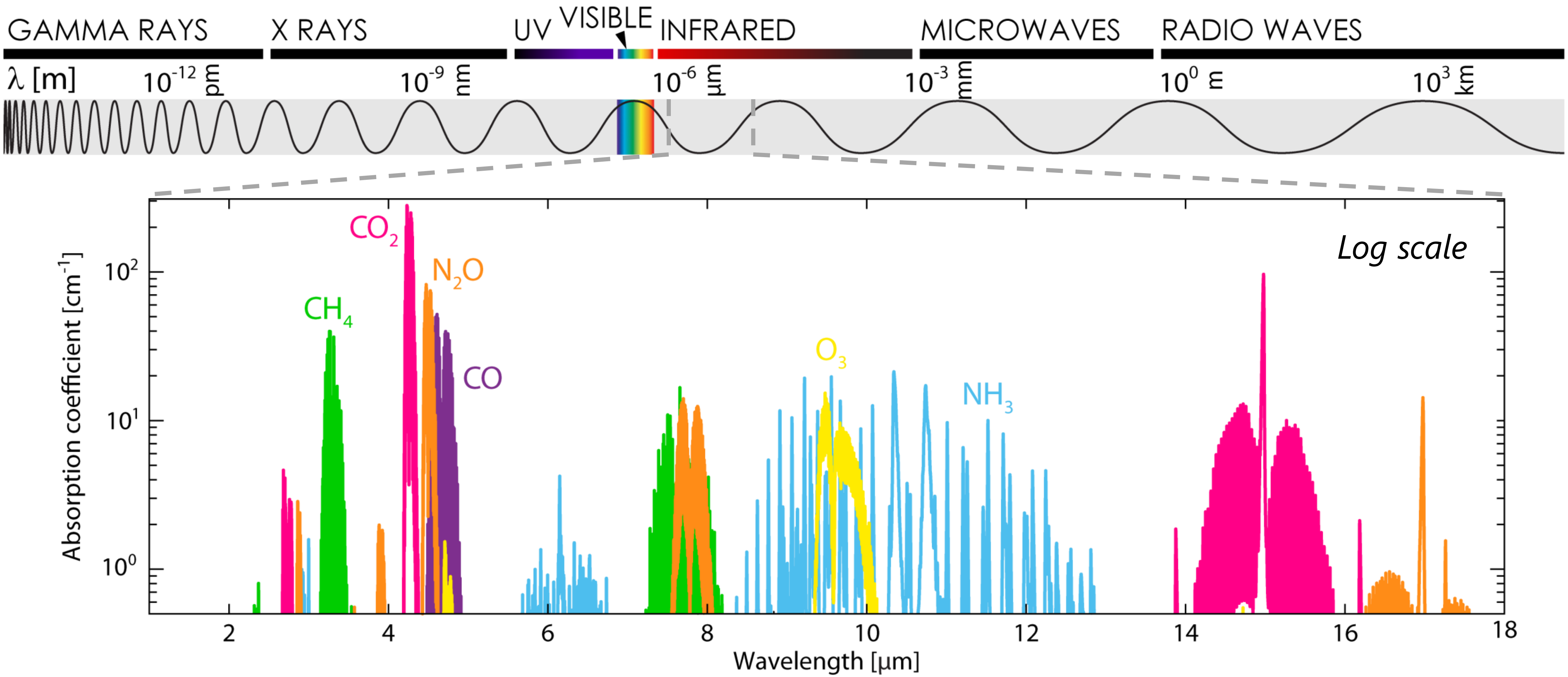
ABSORPTION SPECTRA: the mid-IR wavelength region



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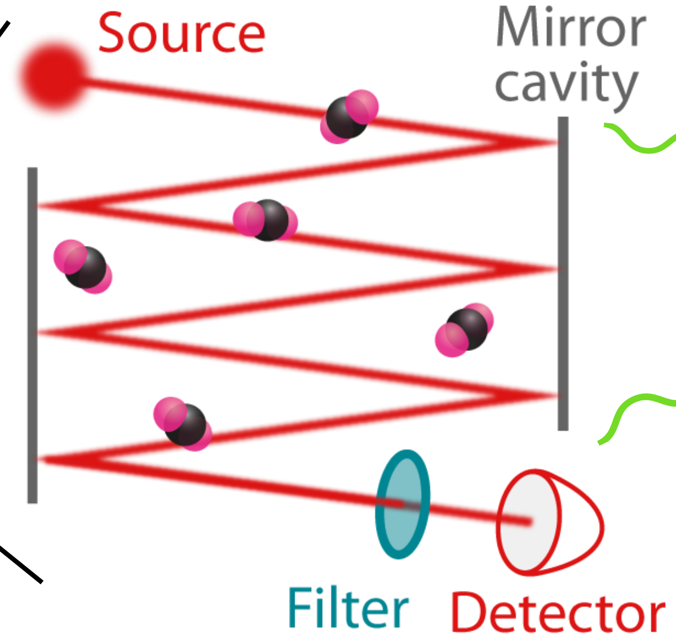
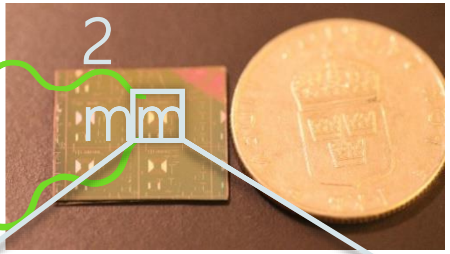
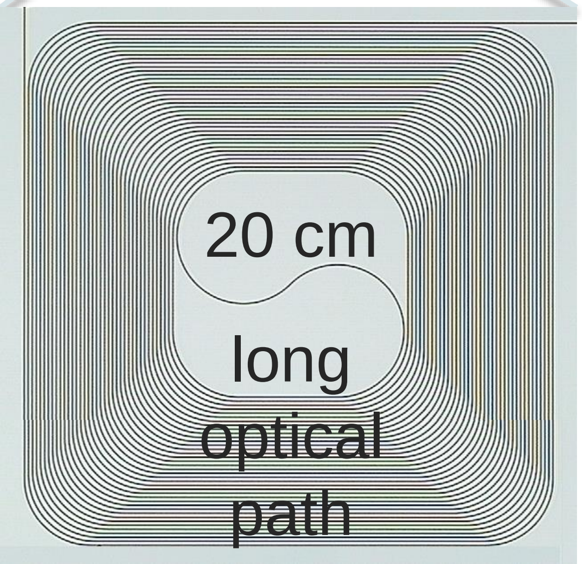
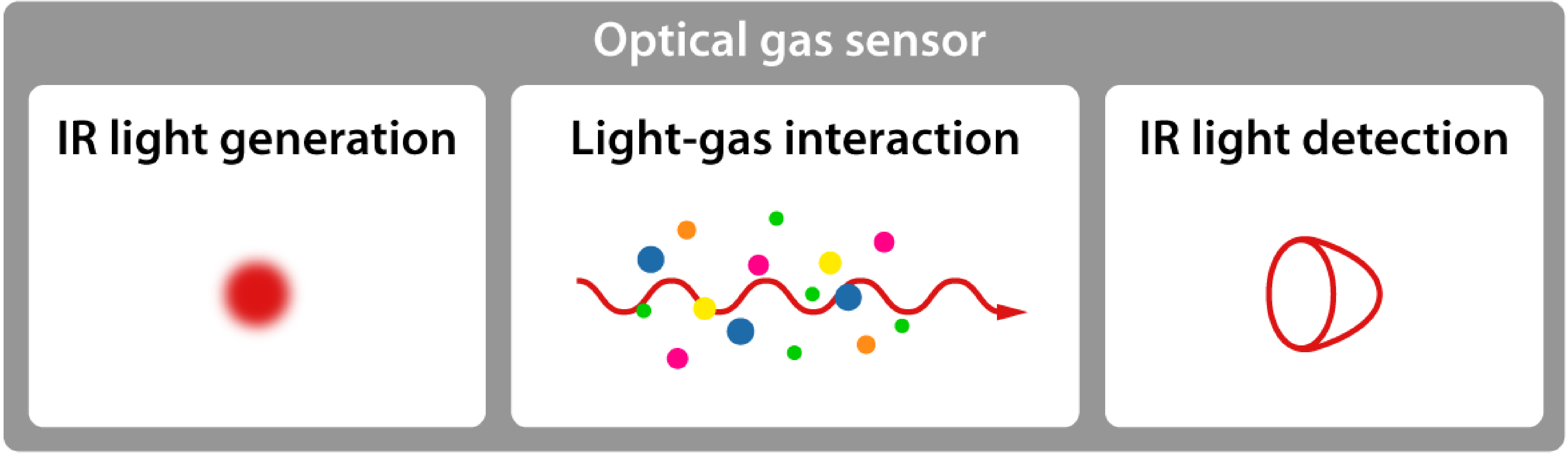






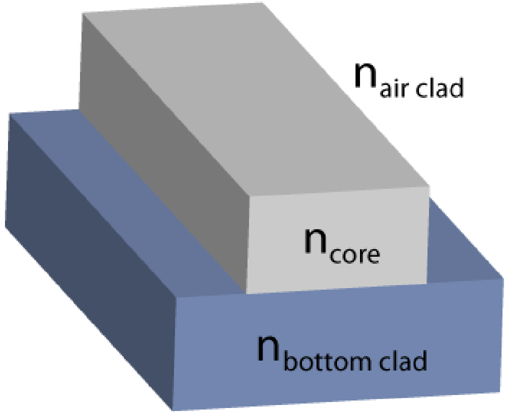
Photonic waveguides

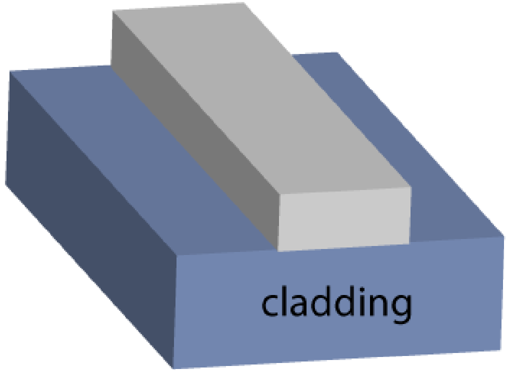
mid-IR TECHNOLOGIES: for miniaturized optical gas sensors

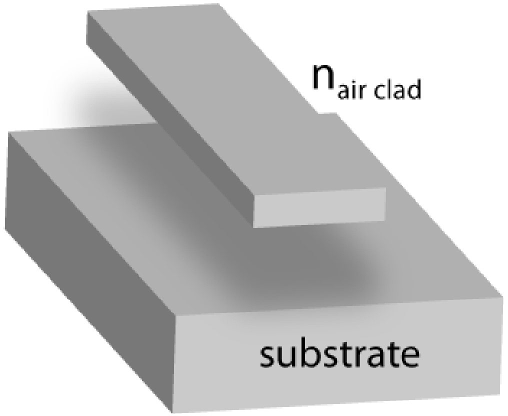


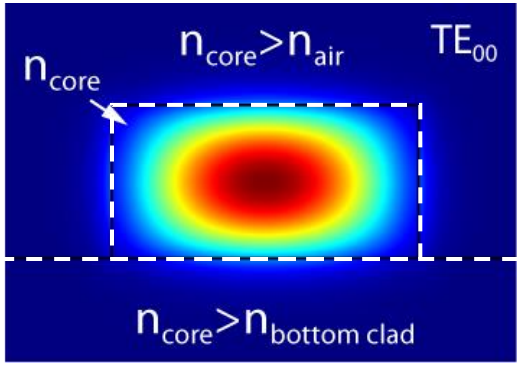
PHOTONIC WAVEGUIDES

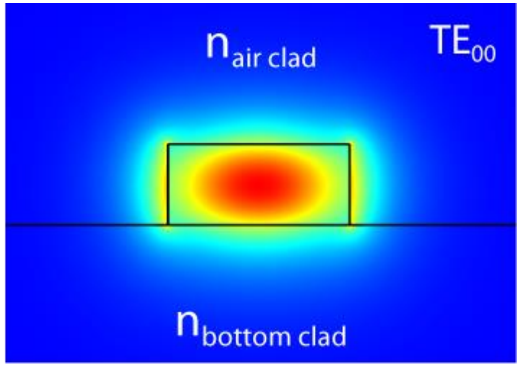
Strip waveguide	Strip waveguide	Suspended strip waveguide
High confinement	Low confinement	Low confinement

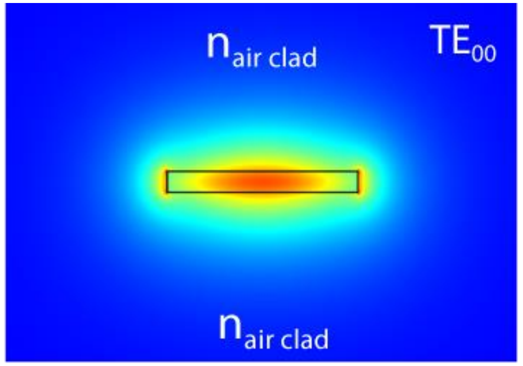












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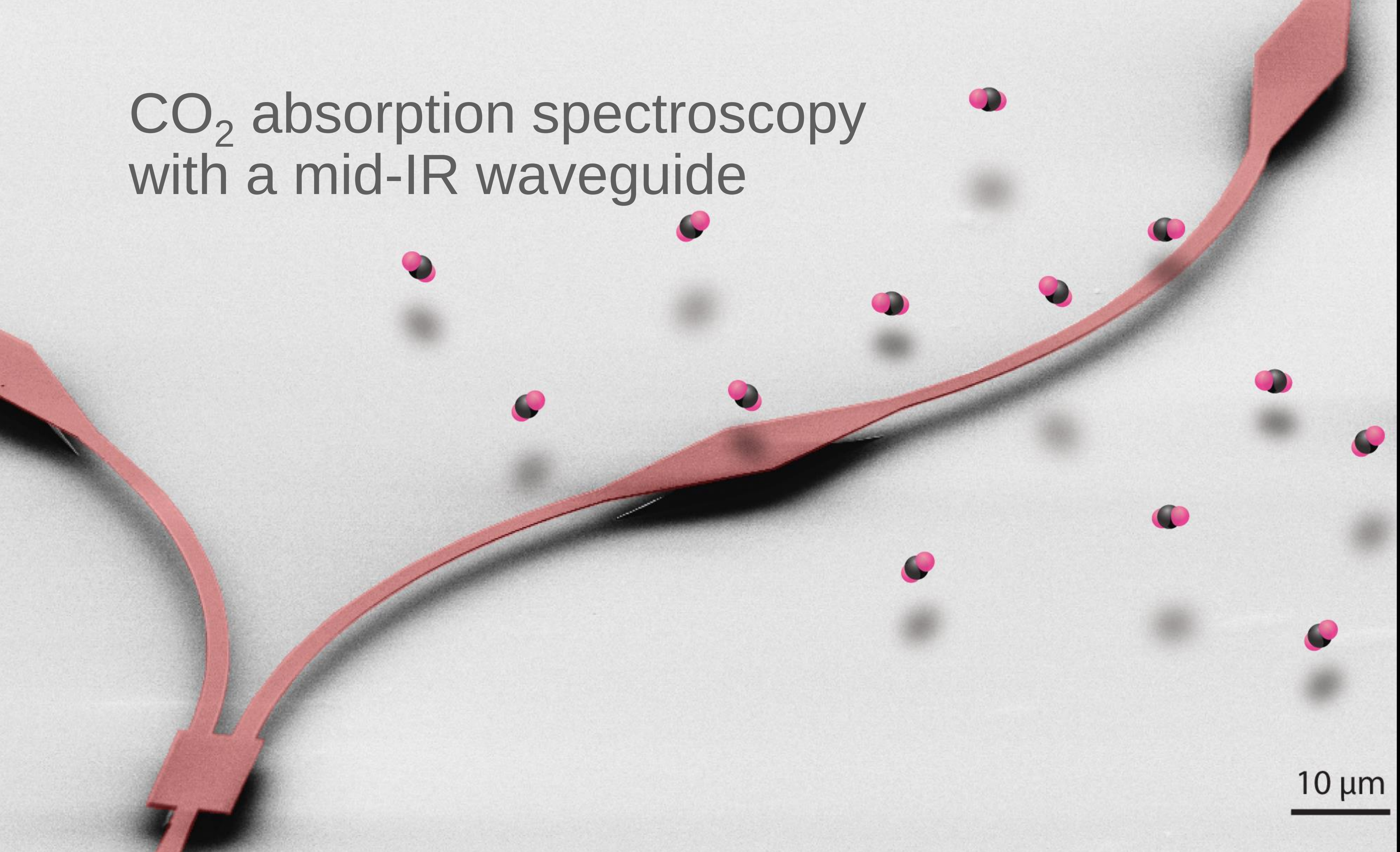
CO_2 absorption spectroscopy with a mid-IR waveguide



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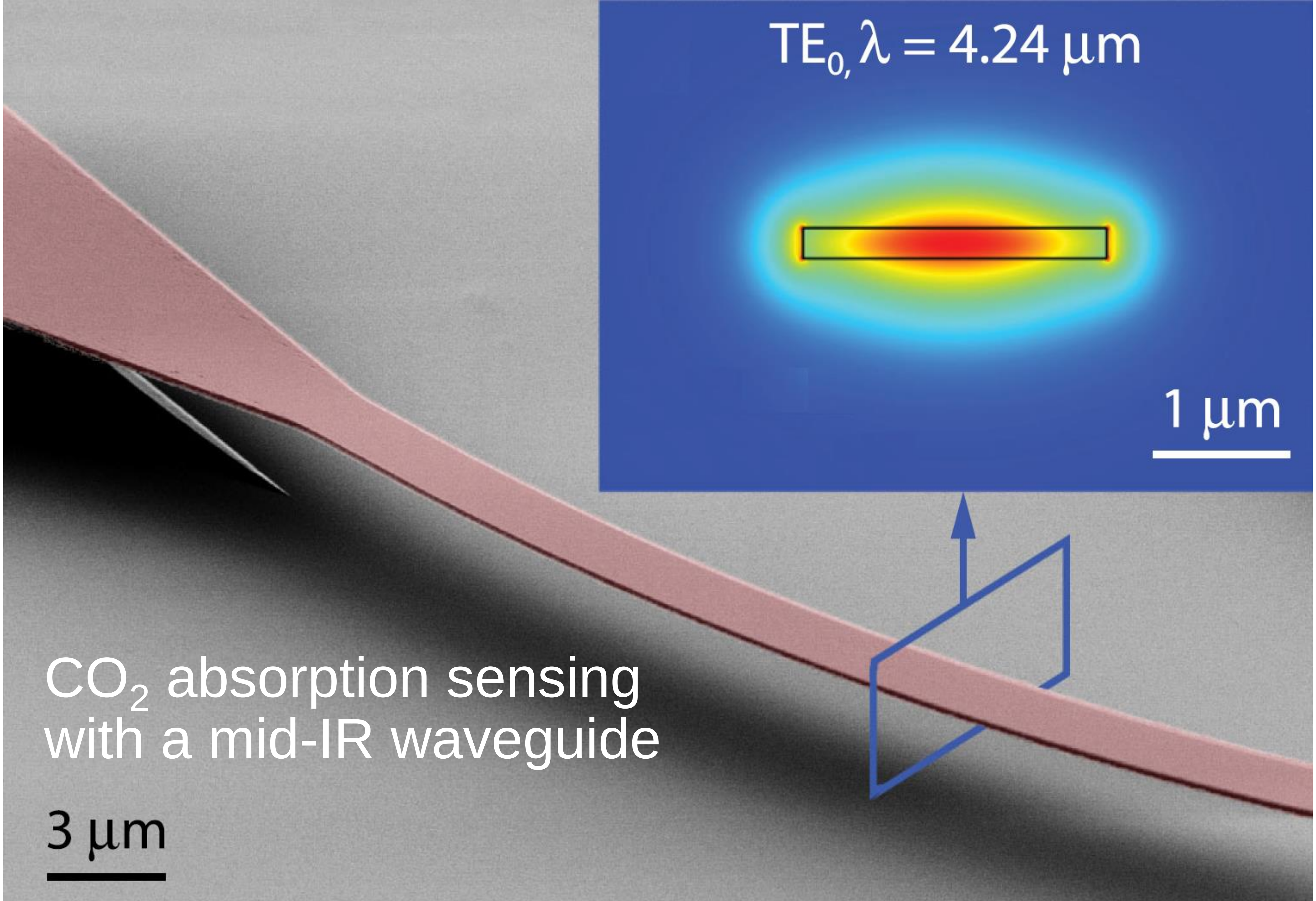
CO_2 absorption sensing with a mid-IR waveguide



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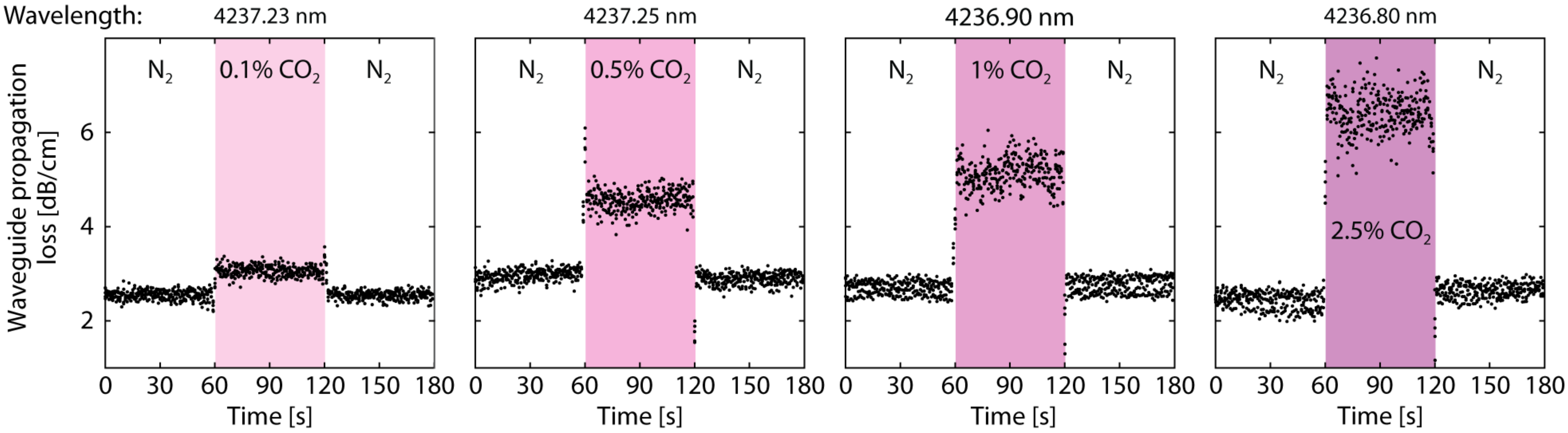
CO_2 MEASUREMENTS



Waveguide CO_2 absorption loss

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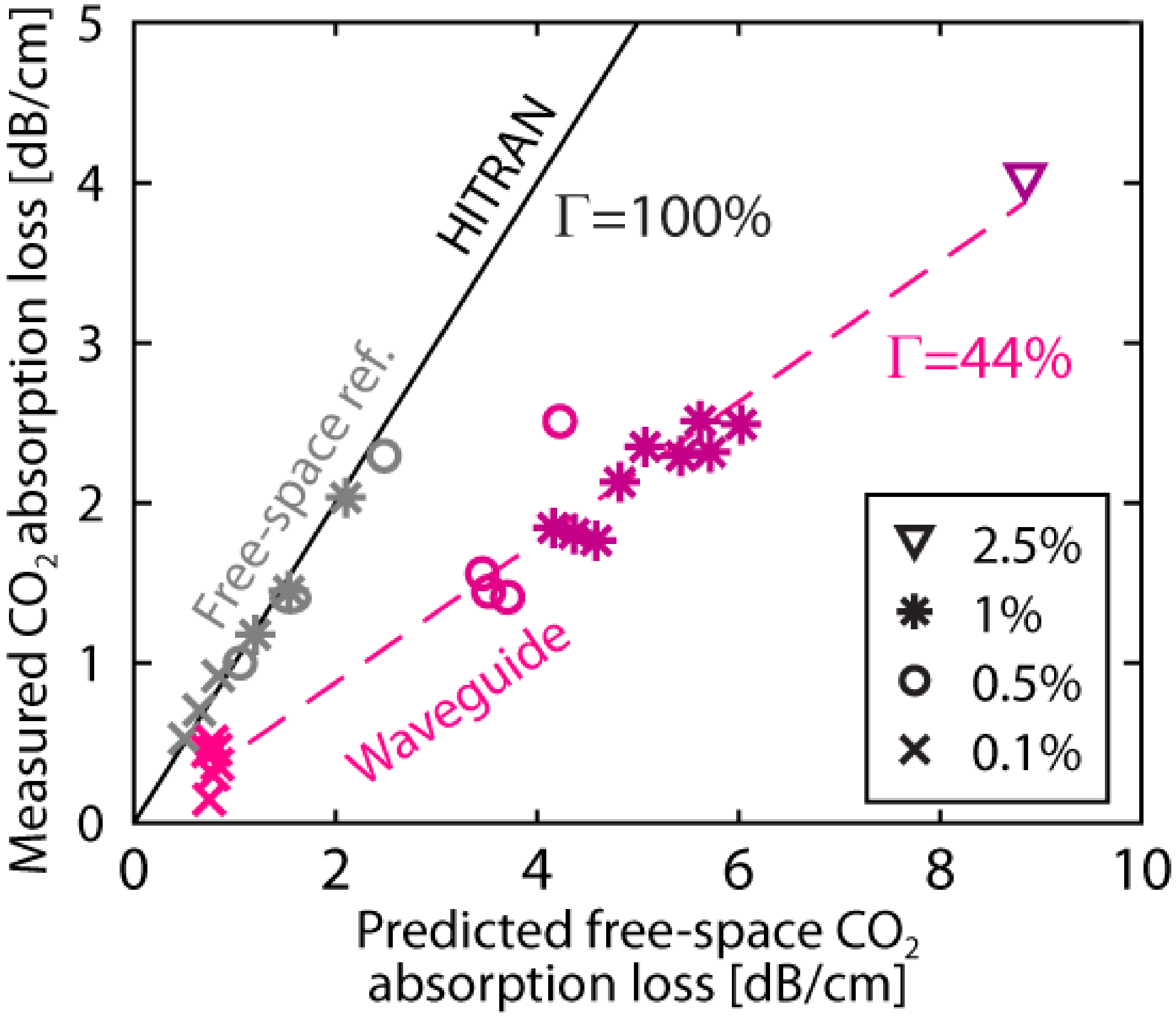
SENSING PERFORMANCE



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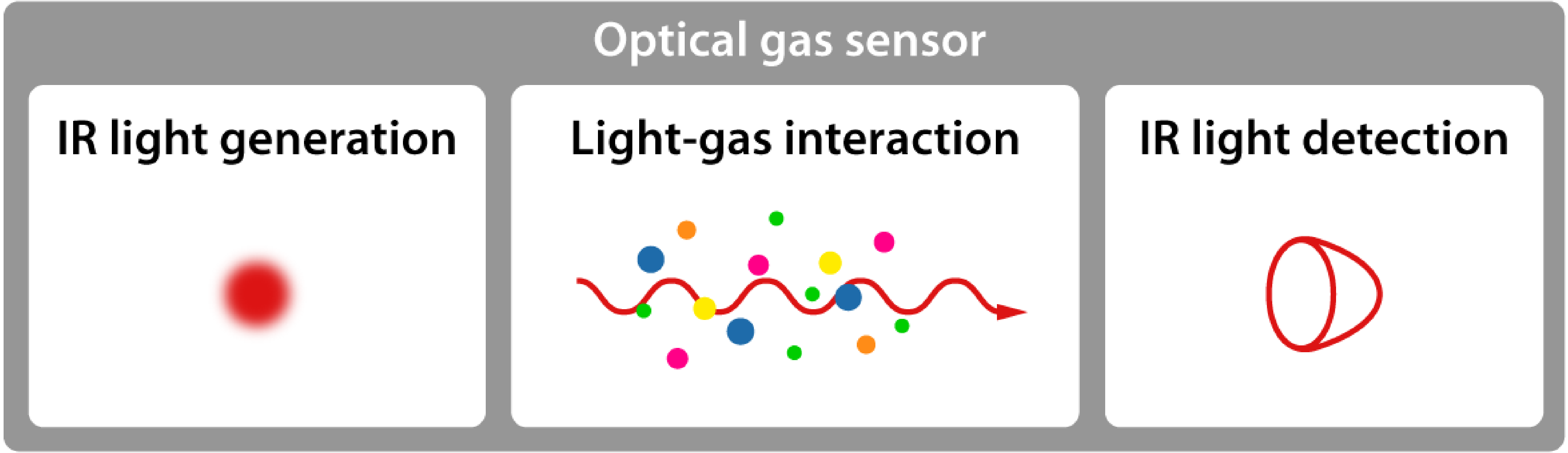
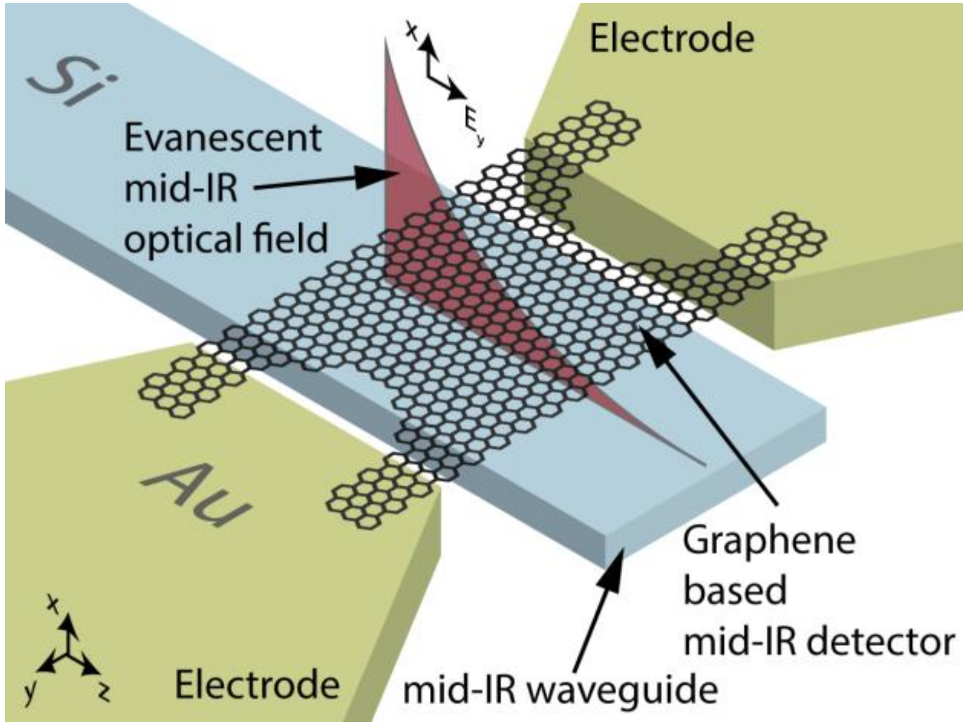
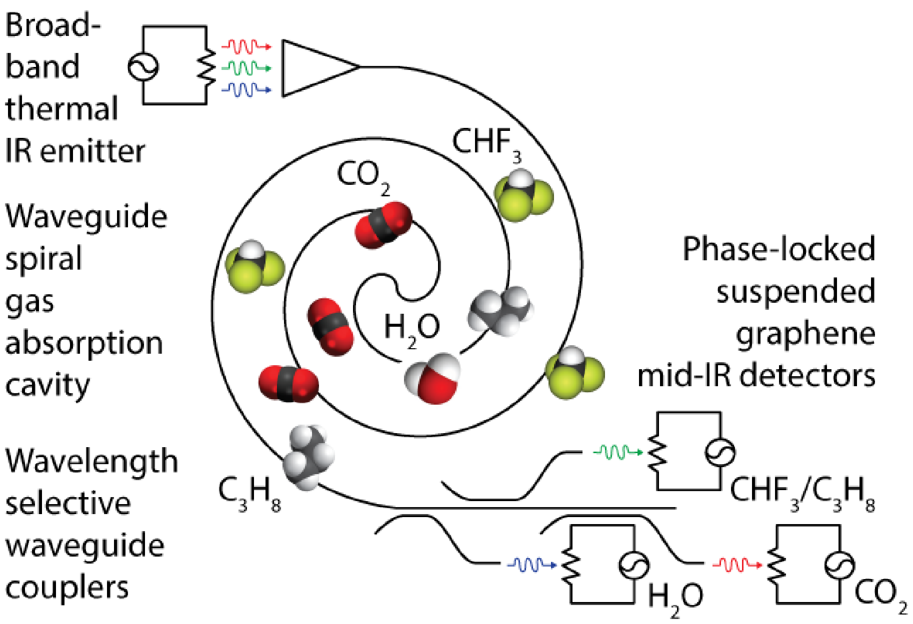
mid-IR TECHNOLOGIES: for miniaturized optical gas sensors



Graphene as waveguide integrated mid-IR detector





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SENSOR FUSION AND SELF-CALIBRATION

SENSOR FUSION AND SELF-CALIBRATION

- Use machine learning based on data uploaded to the cloud.
- Each sensor can learn from its history and self-estimate its reliability.
- The reported measurement is not just a single ppm-value, but a self-estimated belief function with a probability distribution over a range of ppm-values.
- Geometrical methods can be used to achieve more accurate data from several sensor in the same area. This is used for calibration, and improves the self-belief!

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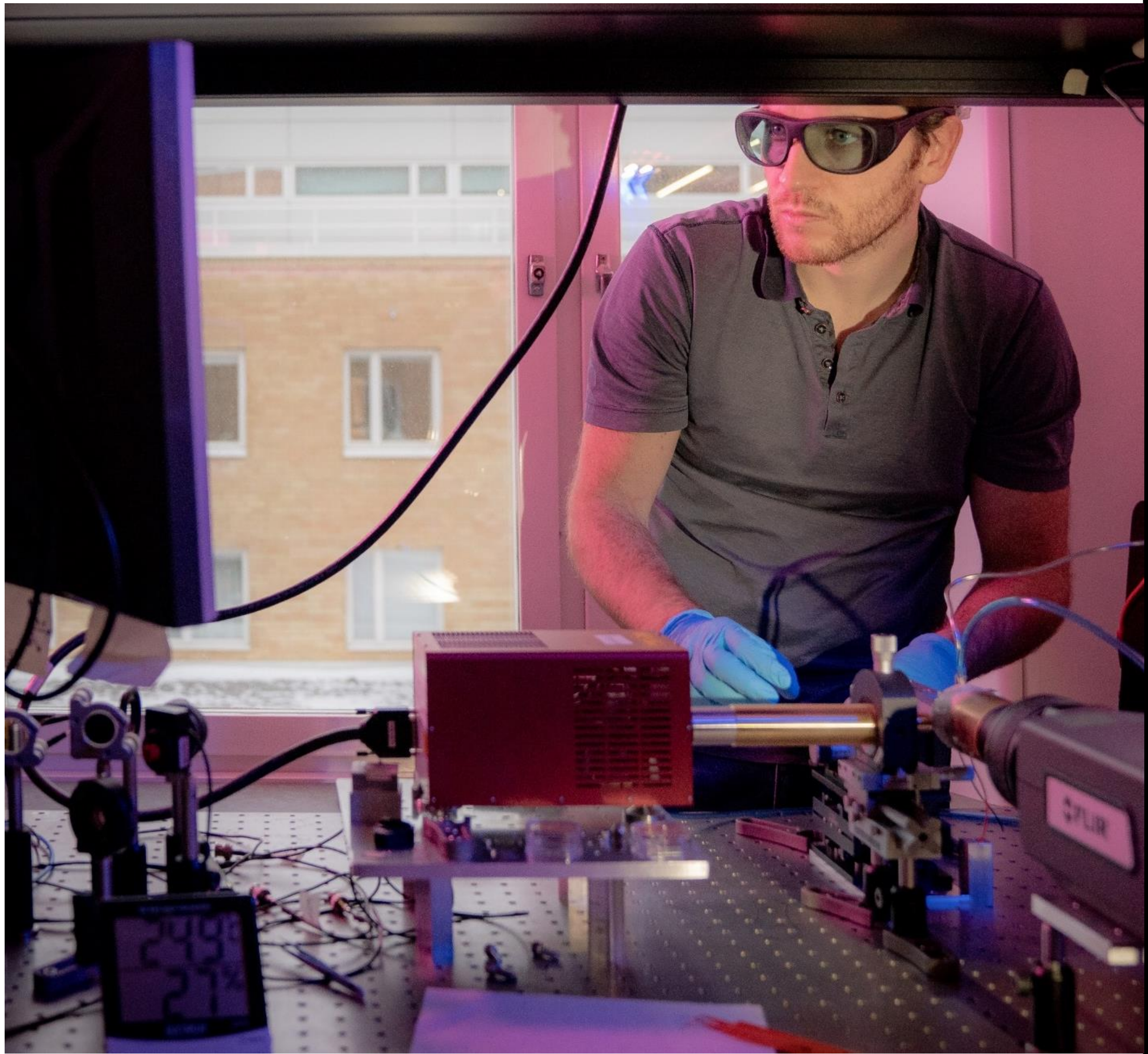
TECHNICAL CHALLENGES

- MOEMS chip integration
- 2D material fabrication
- Obtain proper signal-to-noise ratio
- Managing sensor drift and non-ideal behavior.



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CURRENT ACHIEVEMENTS

- Machine learning has been proven on large sets of real data.
- Chip based waveguide gas sensing has been proven to work in lab.
- A MOEMS architecture including 2D-materials has been proposed and the sub-components have been fabricated.
- A first test fleet with IoT sensors reporting to a cloud data is up and running 24-7.

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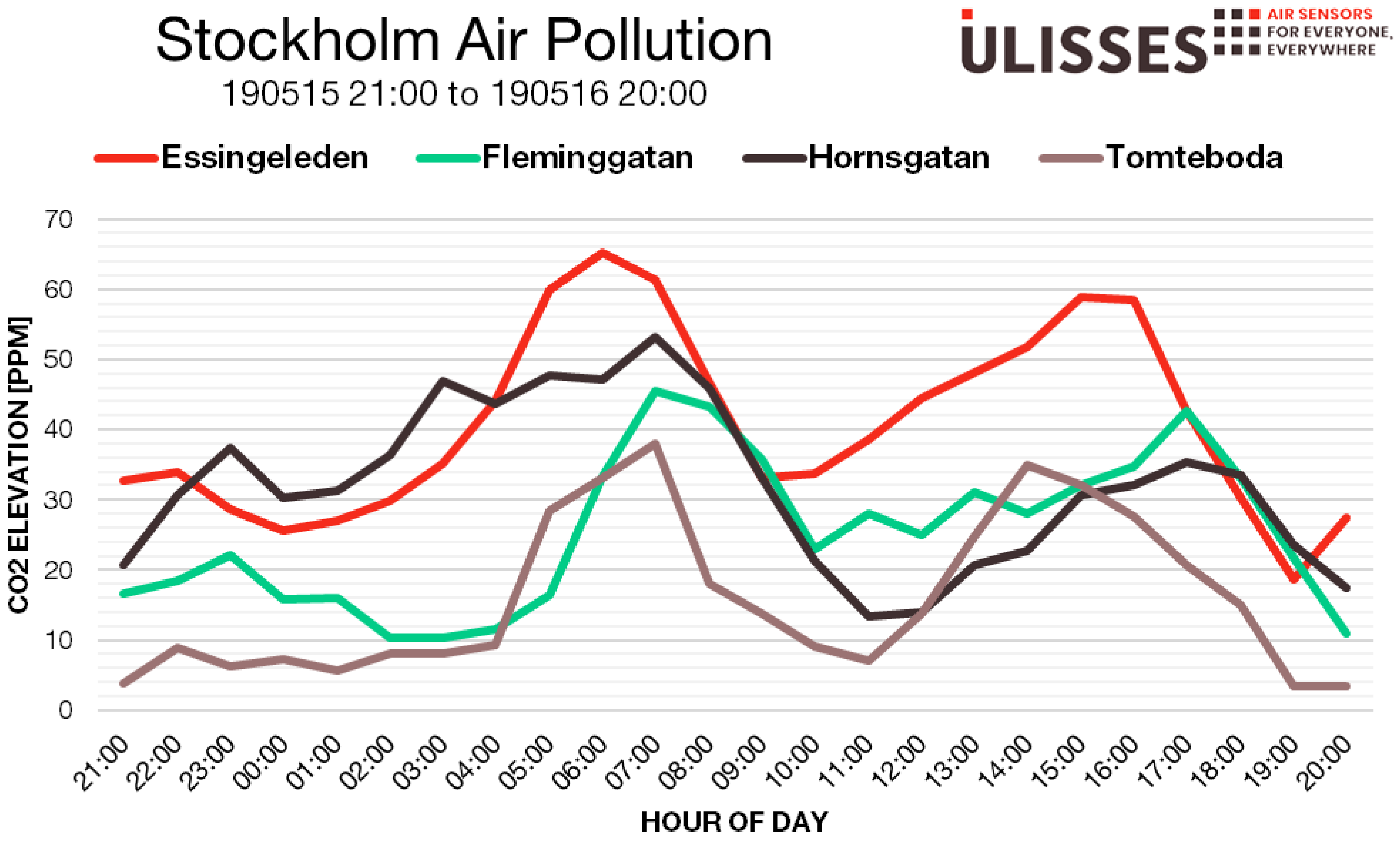
CURRENT ACHIEVEMENTS



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REAL-TIME AIR QUALITY MONITORING

What if you could monitor AQ and make real-time decisions based on facts?

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THANK YOU!

Please stay for the Q&A session

ANY QUESTIONS?

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NEXT WEBINAR

The FLAIR Project

Thursday February 18th

4pm – 5pm CET

The flying dog that can sniff and tell what gases there are in a specific place.

Learn more about the webinar at: www.senseair.com

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