Quality control of fresh agro products with gas sensing technologies

QCAP

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www.nweurope.eu/projects/project-search/real-time-interactive-storage-quality-control-in-fresh-agro-products-qcap

Need for gas sensing

Environmental

Breath analysis

Combustion

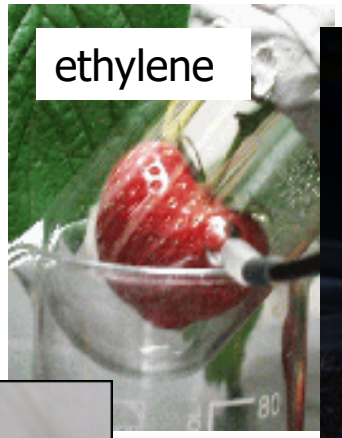
Fresh fruit storage

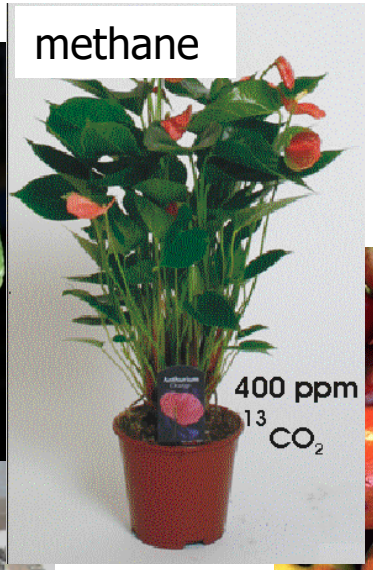
Transport products

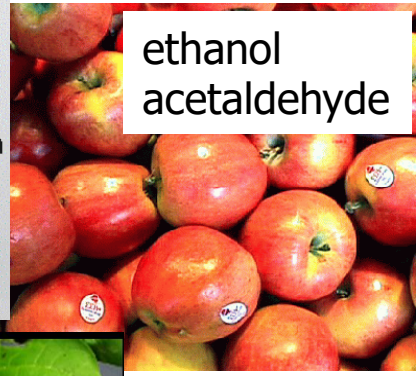
Green houses

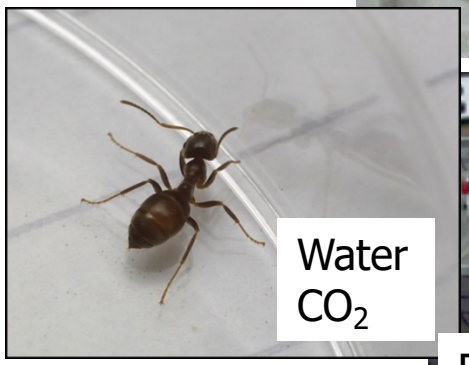
Purity gases

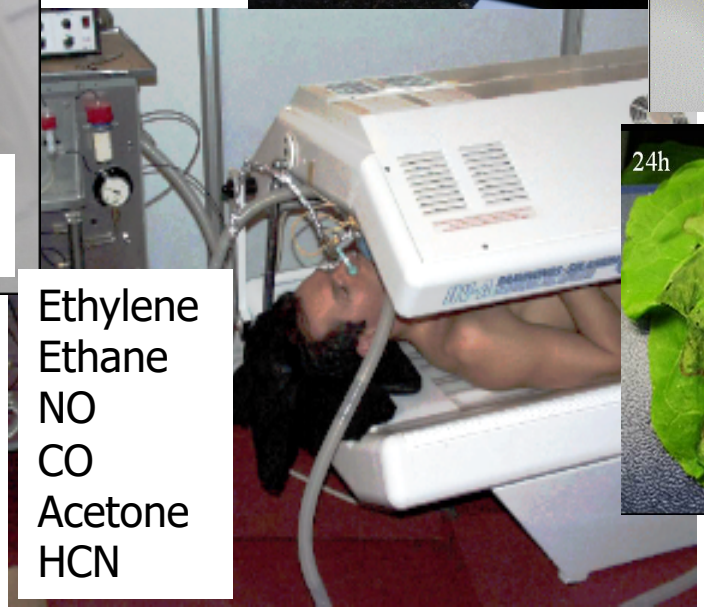
Research examples

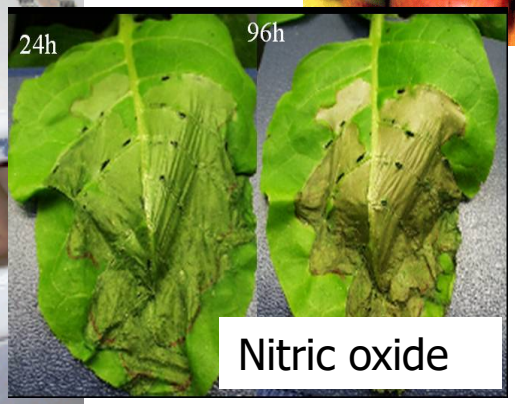












Trace gas experiments in the part per billion range ($1:10^9$ molecules)
using state-of-the art laser-based detectors,
allowing on-line experiments, under dynamical changing conditions

Need for gas sensing

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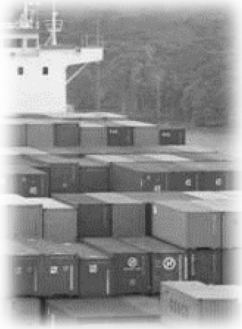

Green houses

Purity gases

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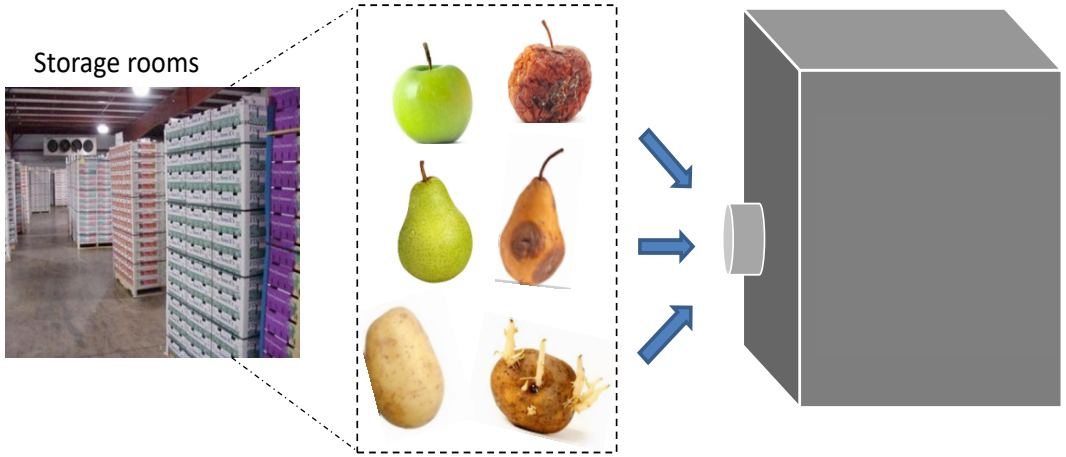
Main Goal/ Focus

An prototype for an interactive storage system

- validated in real life, commercial conditions
- for apples, blueberries, potatoes and pears
- able to reduce storage losses by 50%



Anticipation ⇨ Actions to avoid food wastage

Motivation

Apple/pear/blueberry

- Stored at low O_2 (0-1%)
  high CO_2 level (1-5-25%)
- Wrong levels damages product
- Besides rotting, sprouting, fungi, etc.

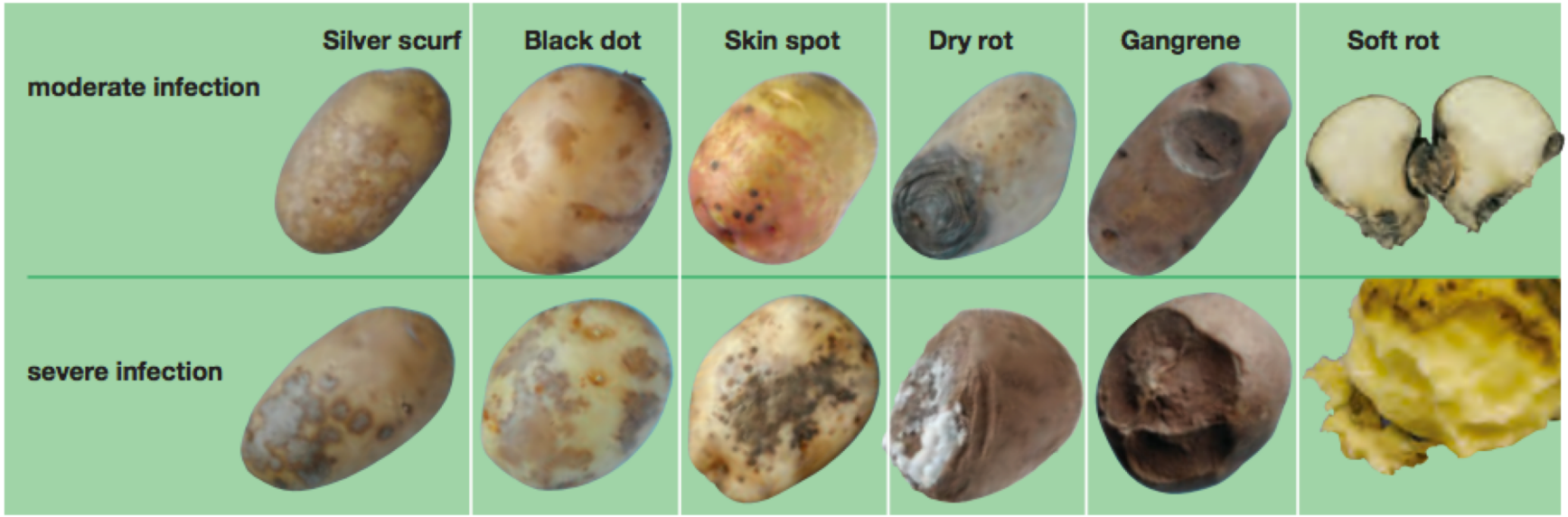
North-West Europe estimated production:

- apple 3.4 M tons
- pear 0.9 M tons
- blueberry 18.000 tons
- potato 28 M tons

Estimated loss: 3-5%;

QCAP aims to reduce losses equivalent
to a value of 60.000 Euro/farmer per year

Fungal and bacterial rots in potato



Helminthosporium solani

Colletotrichum coccodes

Polyscytalum pustulans

Fusarium species

Boeremia foveata

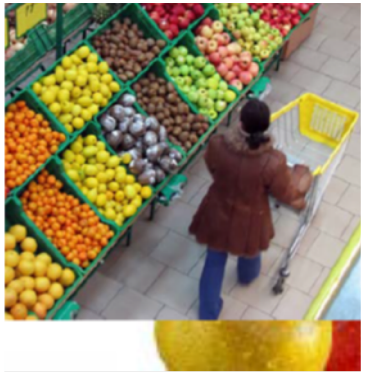
Pectobacterium atrosepticum
P. carotovorum

Nowadays, indicators for the best apple quality

- Minimum decrease of firmness
- Preventing internal and external defects
- Maintain good color of background/blush
- Long shelf life with good quality
- Perfect taste

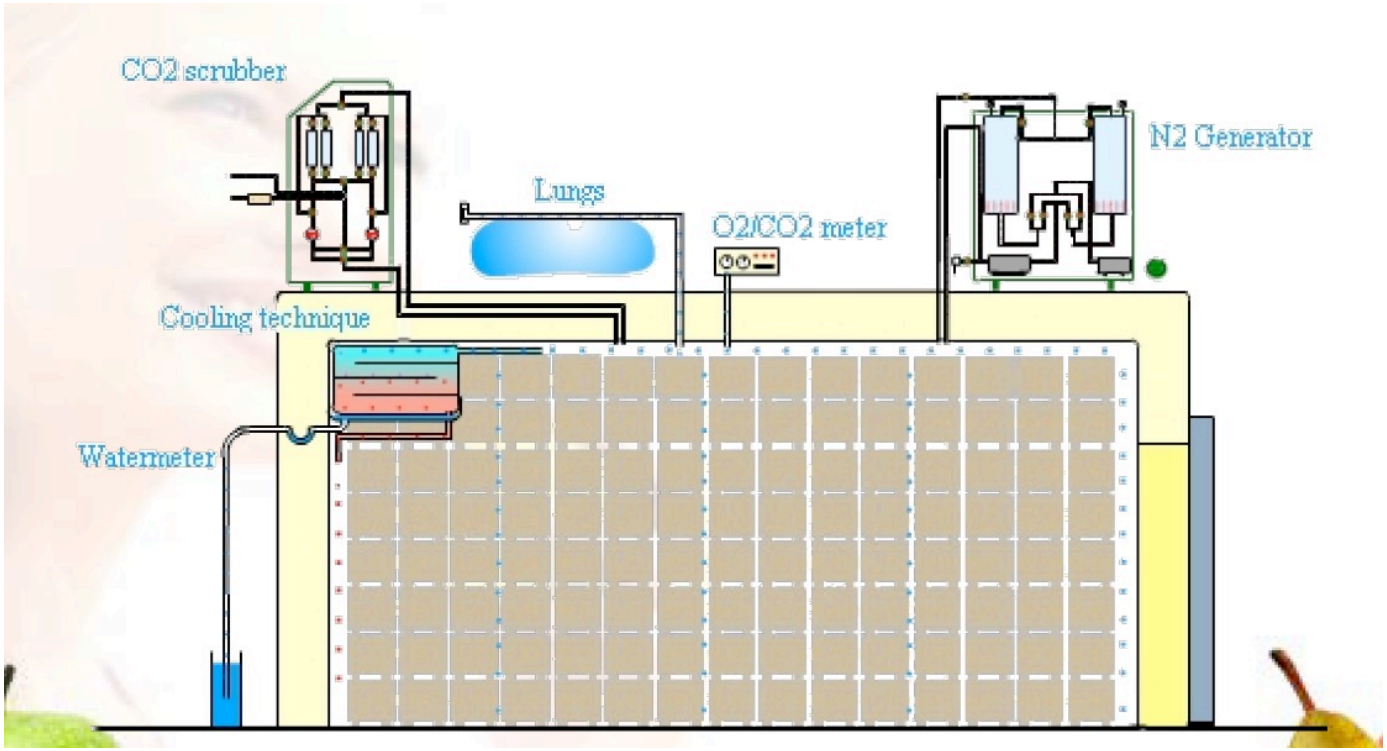
Done with:

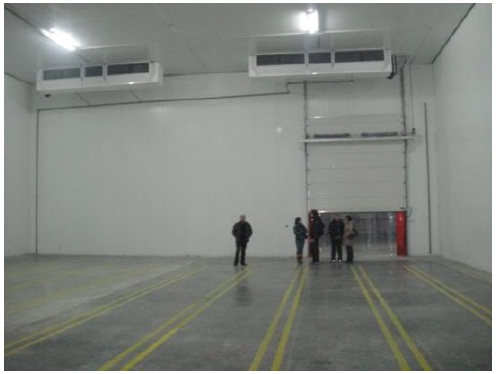
- Control temperature, O_2, CO_2, humidity, ethylene, ethanol



STOREX
CONTROLLED ATMOSPHERE

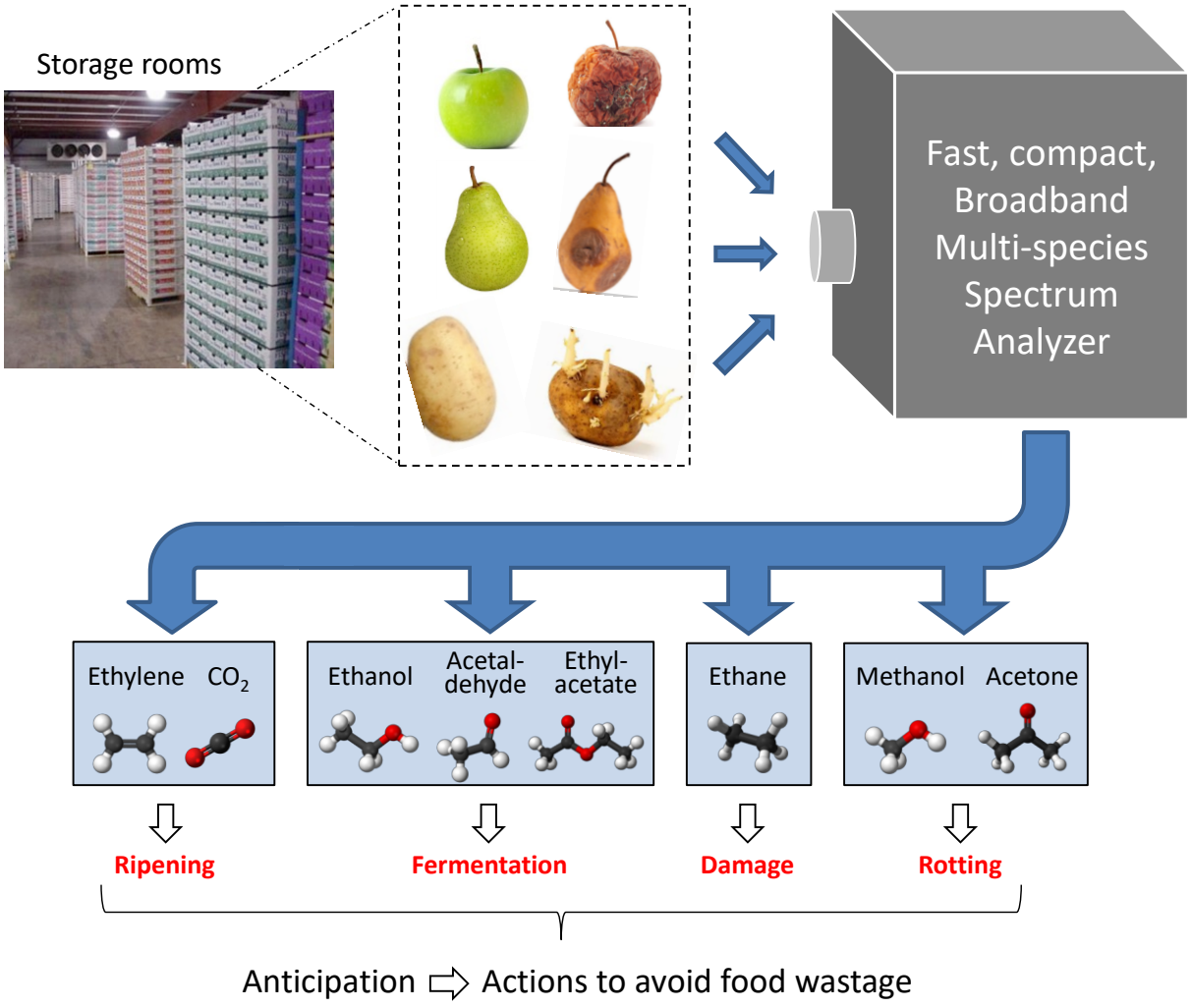
Overview
Controlled Atmosphere storage room





Storage capacity
125.000 Tons
(24 rooms)

Concept QCAP

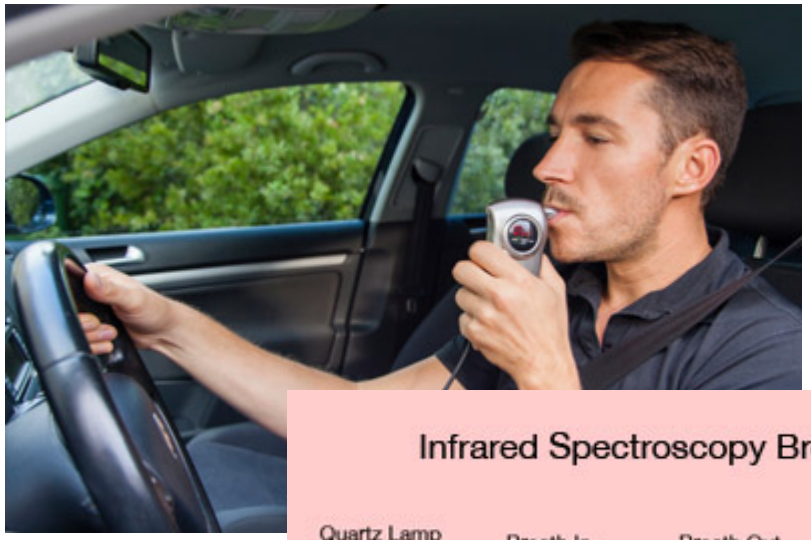


Sensitive multi-species trace gas sensor.

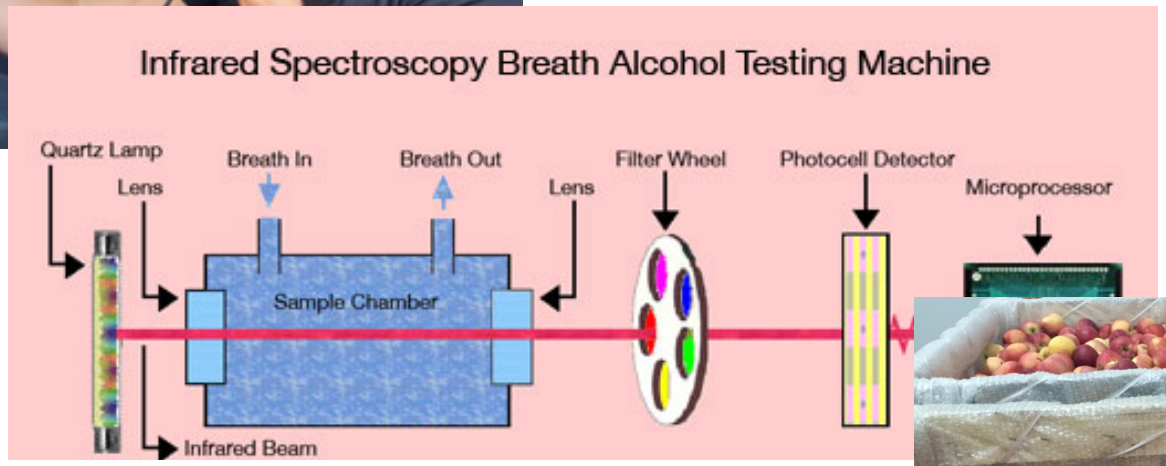
Trace gases represent ripening, fermentation, damage and rotting

The sensor will give an early warning to growers and retailers,

Thereby avoiding undesirable quality loss/downgrading of stored produce.

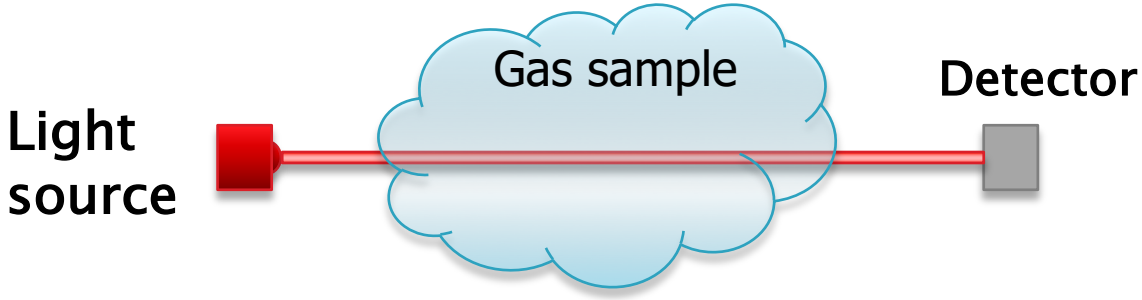


The alcohol breath test for driving

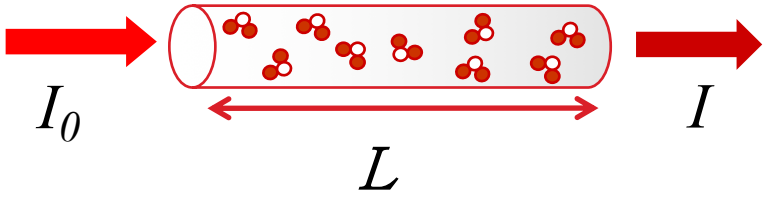


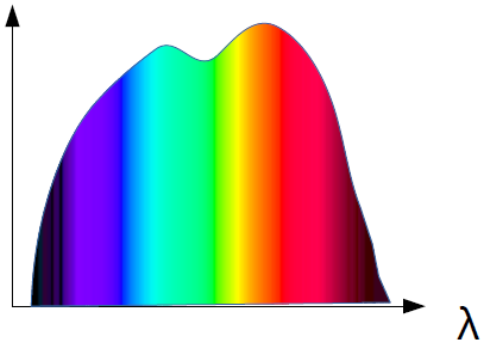
The ethanol test for storage

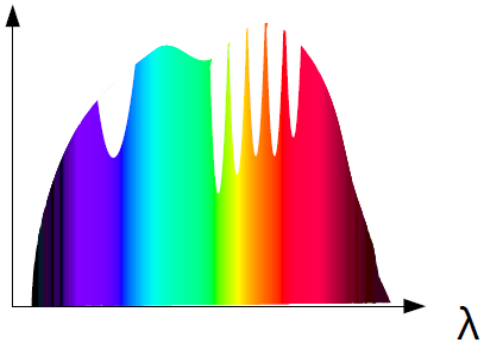
Gas sensing via infrared absorption spectroscopy

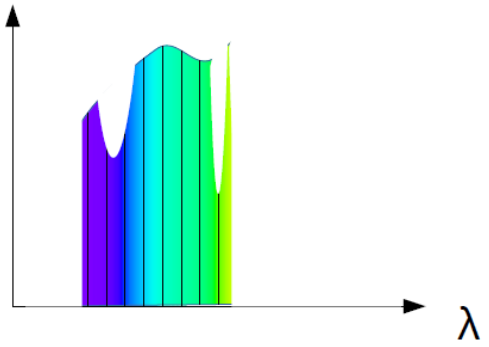


Beer-Lambert law:









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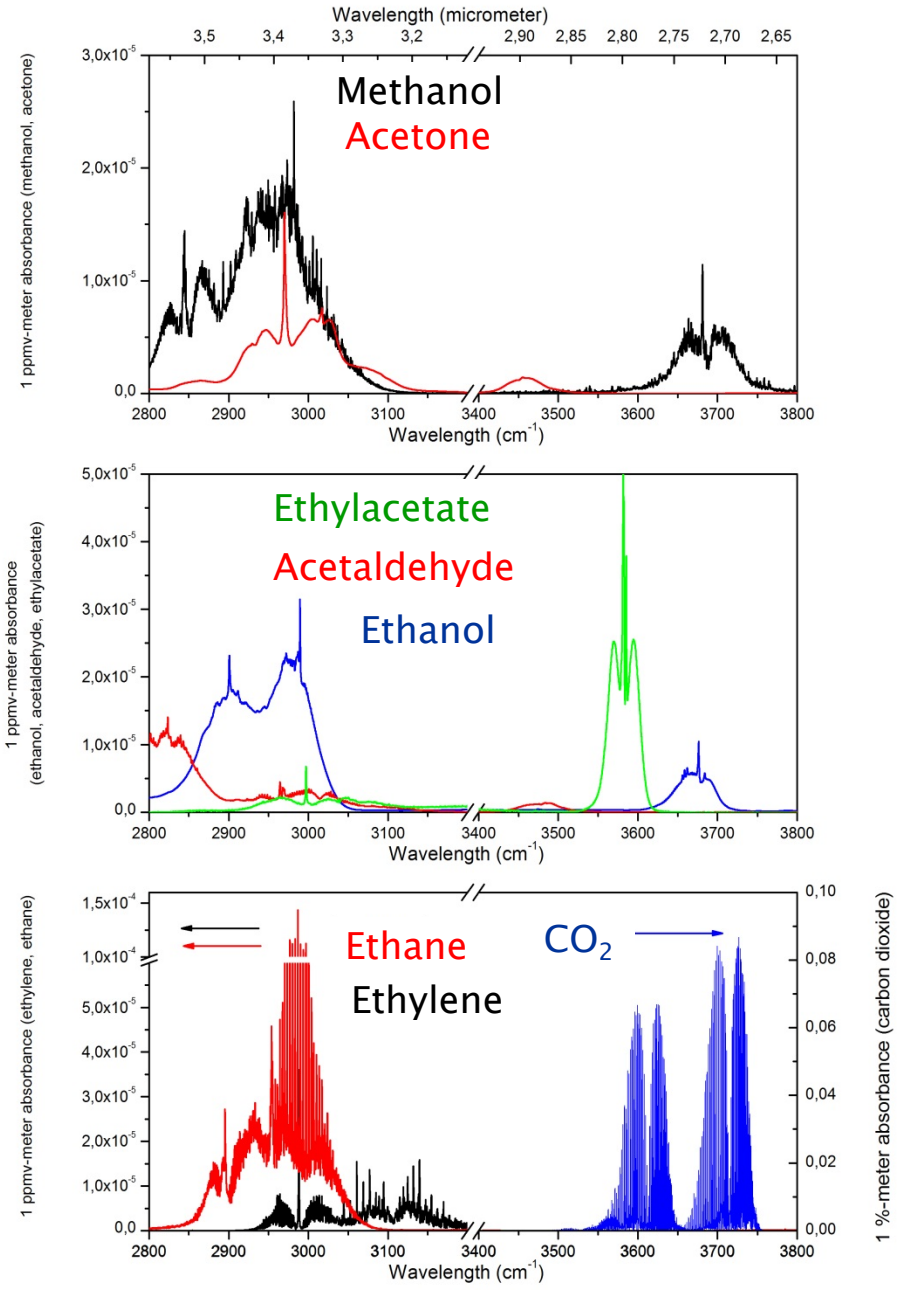
For fruit storage: selectivity/sensitivity

Sensitivity

Species	Concentration in storage room	Required accuracy
Ethanol	1-100 ppbv	10 -100 ppbv
Acetaldehyde	1-100 ppbv	1 -10 ppbv
Ethylacetate	1-100 ppbv	10 -100 ppbv
Methanol	1-100 ppbv	1 -10 ppbv
Acetone	1-100 ppbv	1 -10 ppbv
Ethylene	1-50 ppmv	10 -100 ppbv
Ethane	1-100 ppbv	1 -10 ppbv

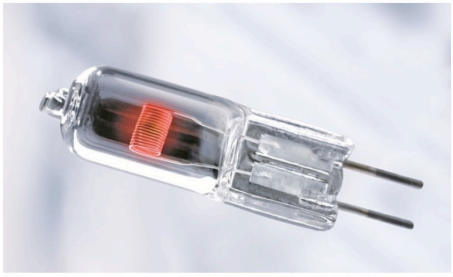
1 ppbv= 1 part per billion volume= 1: 10^9

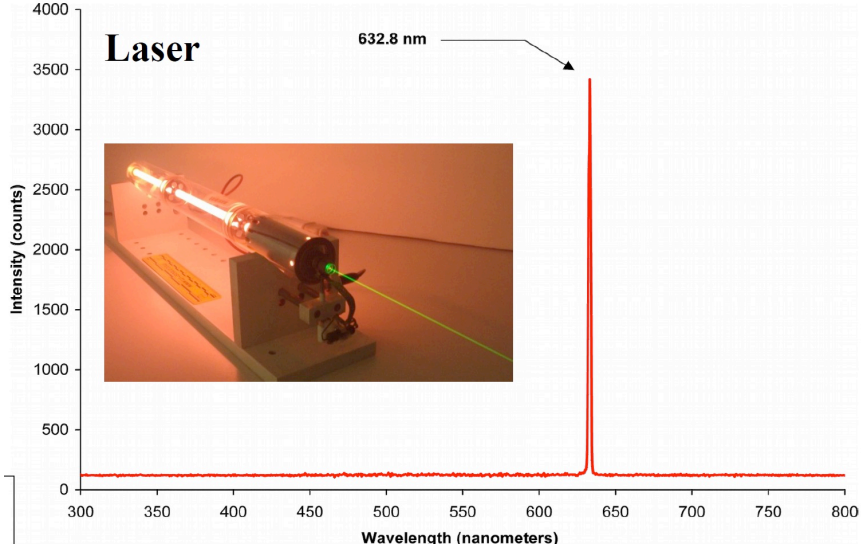
Selectivity

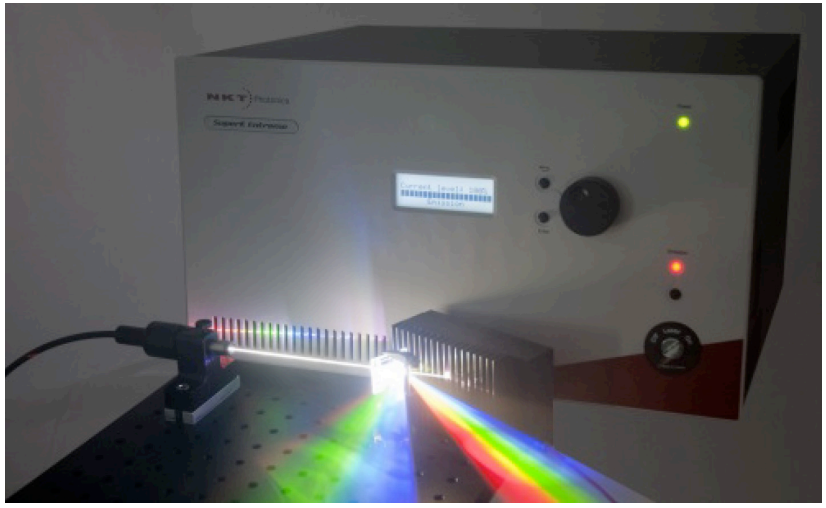


White light laser source

White light







White laser:

- Spectrum, broad as a lamp,
- directionality of a laser

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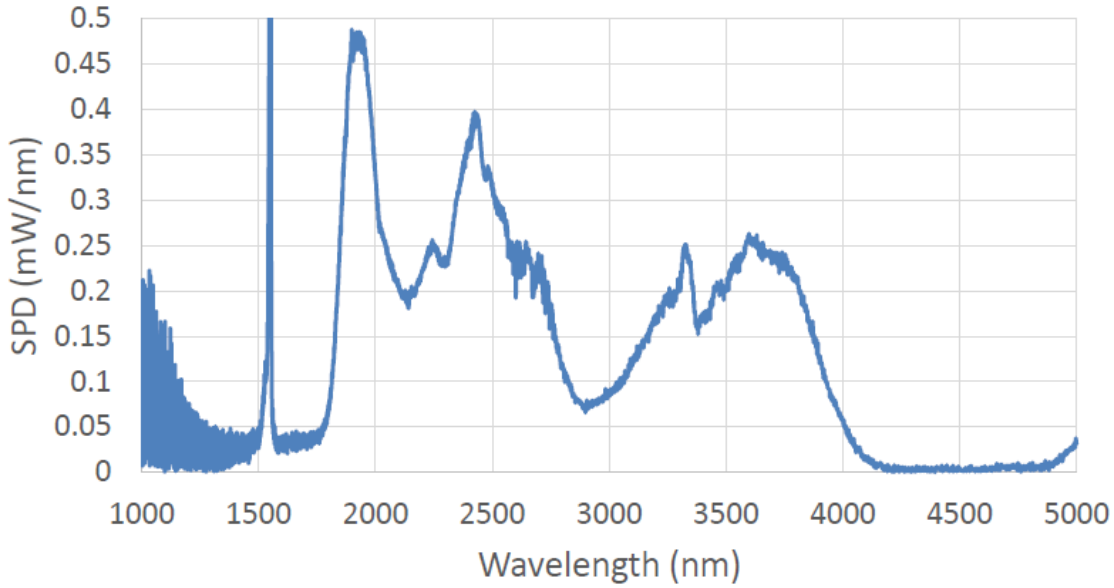
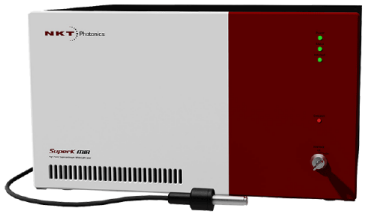
Mid-infrared, fiber-based, supercontinuum laser

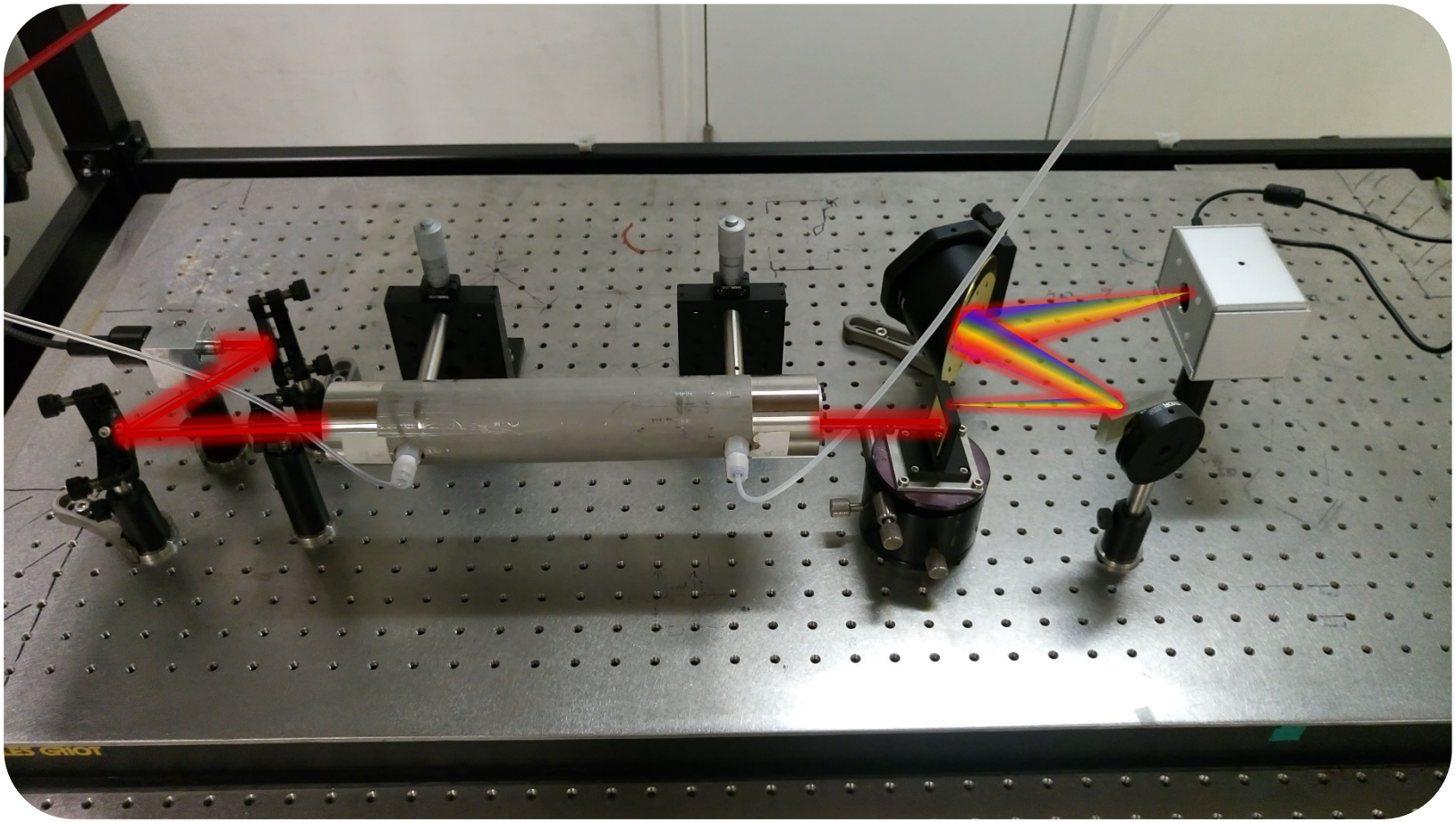




Power: 525 mW
Rep. Freq.: 2 MHz
Coverage: 1.5-4.1µm

spectral coverage of a lamp
directionality of a laser

Principle gas sensing system



Real-time quality control in fresh agro produce

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Sensor design

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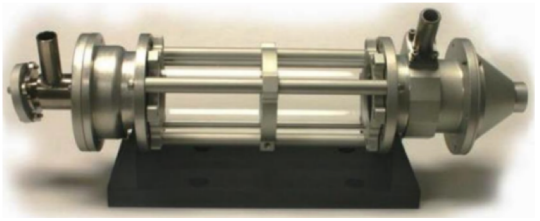
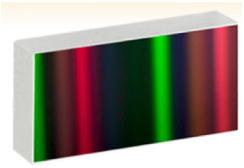
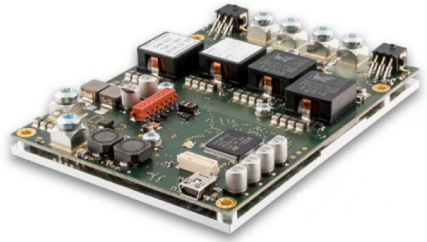
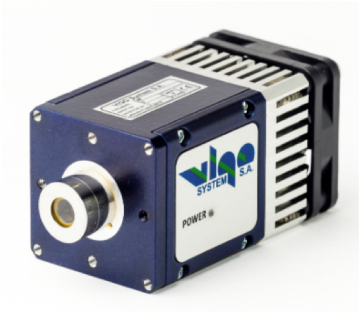
System integration

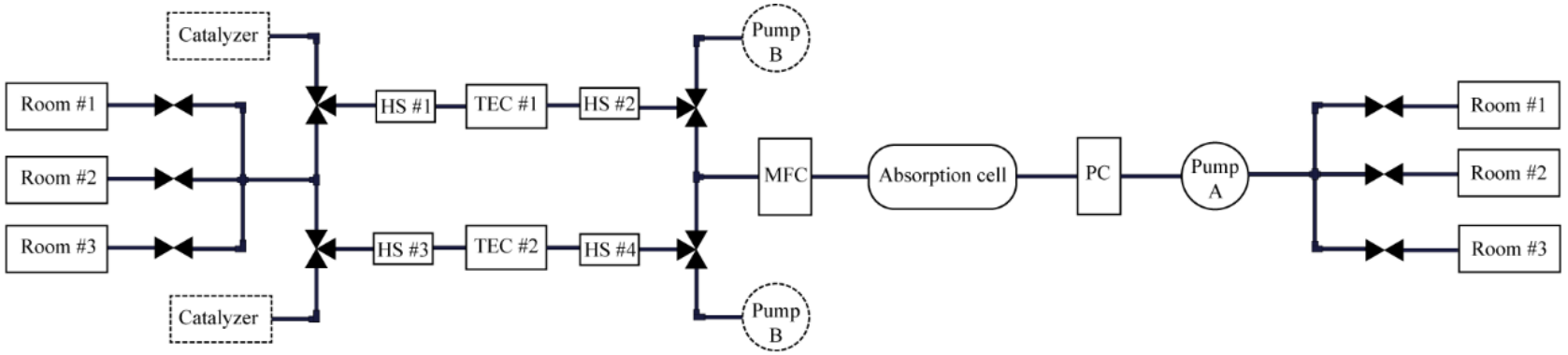


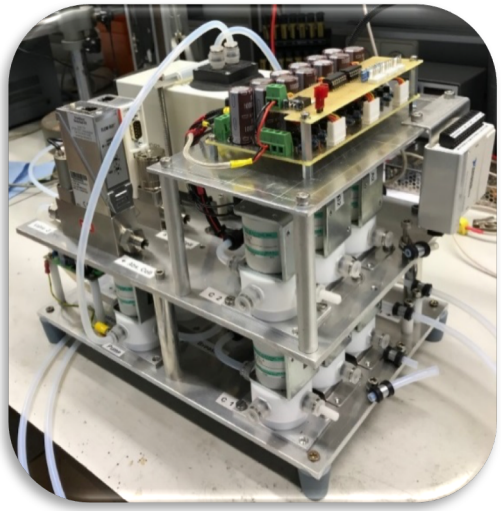




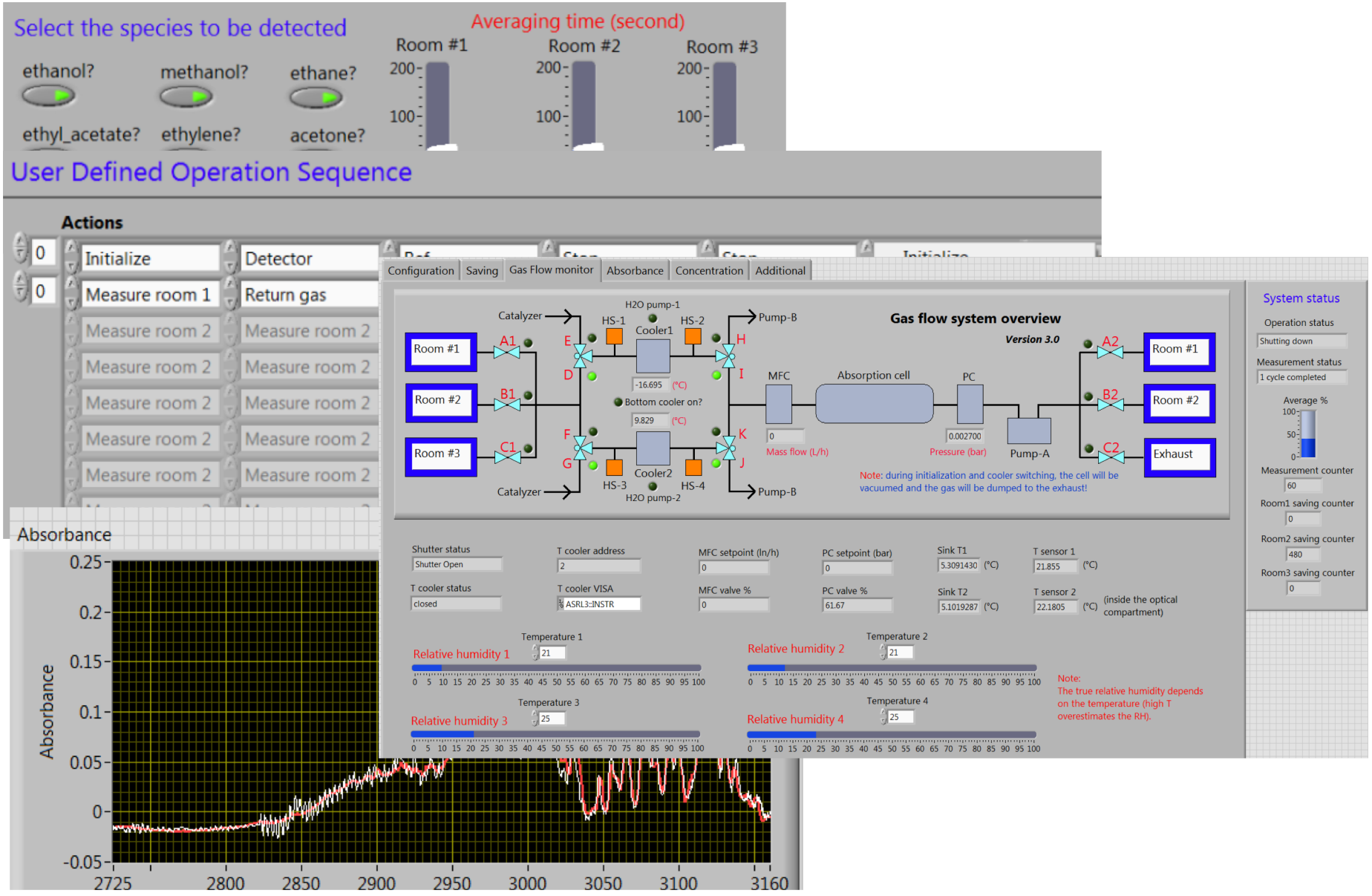


Gas handling system





Software integration for automated control



Transportable gas sensing system

Optical Sensing

Opto-electronic support

Gas handling support

Real-time quality control in fresh agro produce

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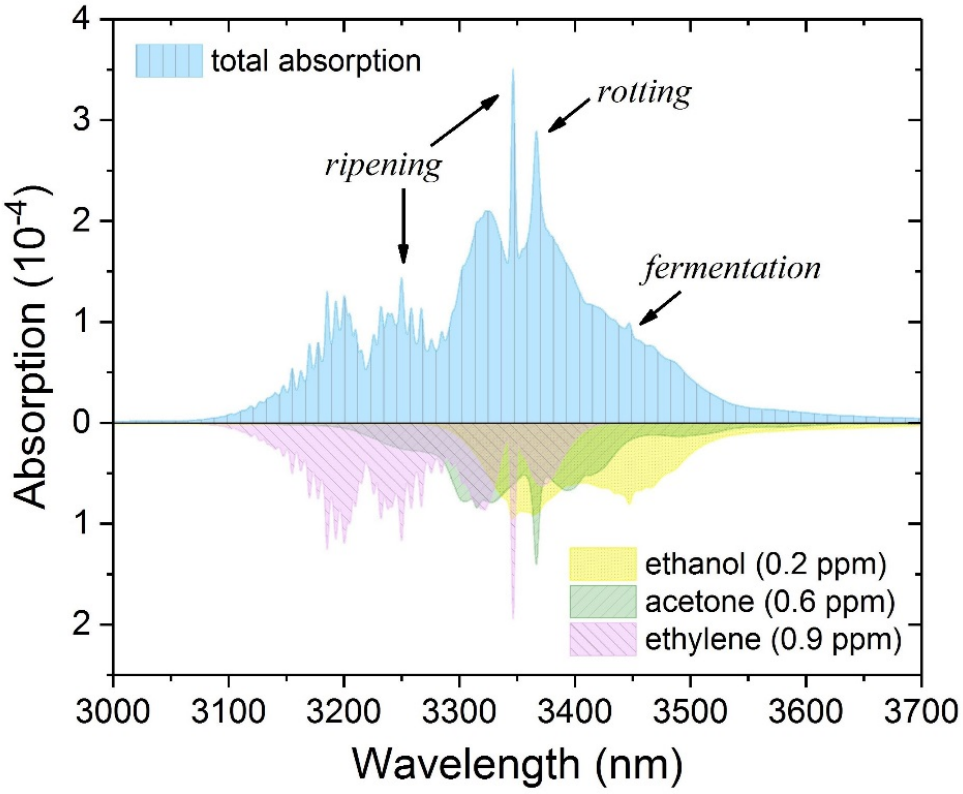
Operational principles



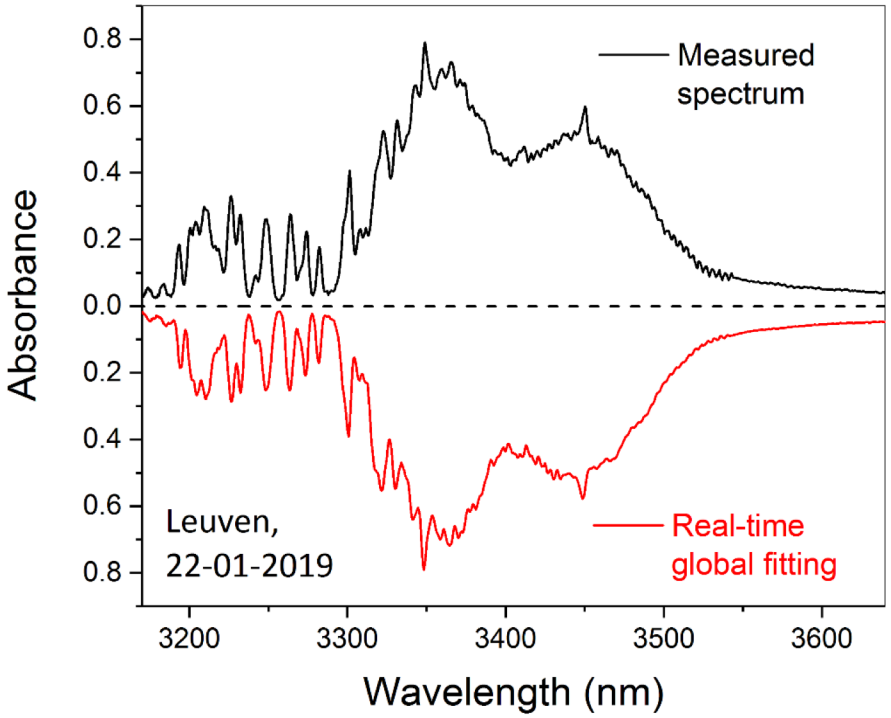
- Continuous monitoring
- Smart processing
- Interpretation
- Feedbacks
- Actions

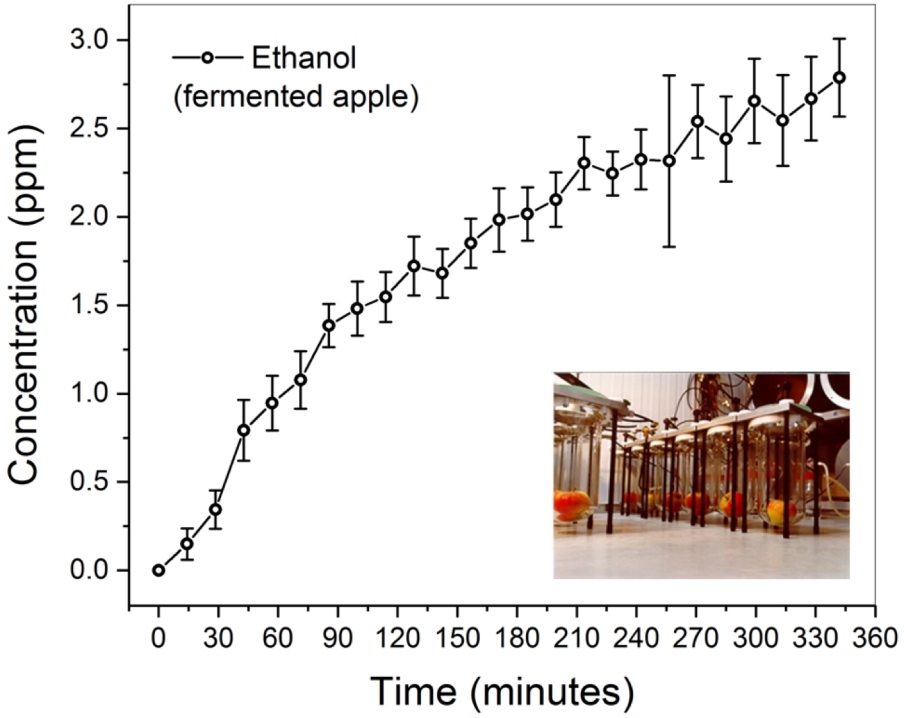
First field trial

Flemish Center for Storage Technology
Leuven, Belgium

21-01-2019

First field results





Real-time quality control in fresh agro produce

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Sampling storage rooms with pears

Feb 2019

Same field and picking date

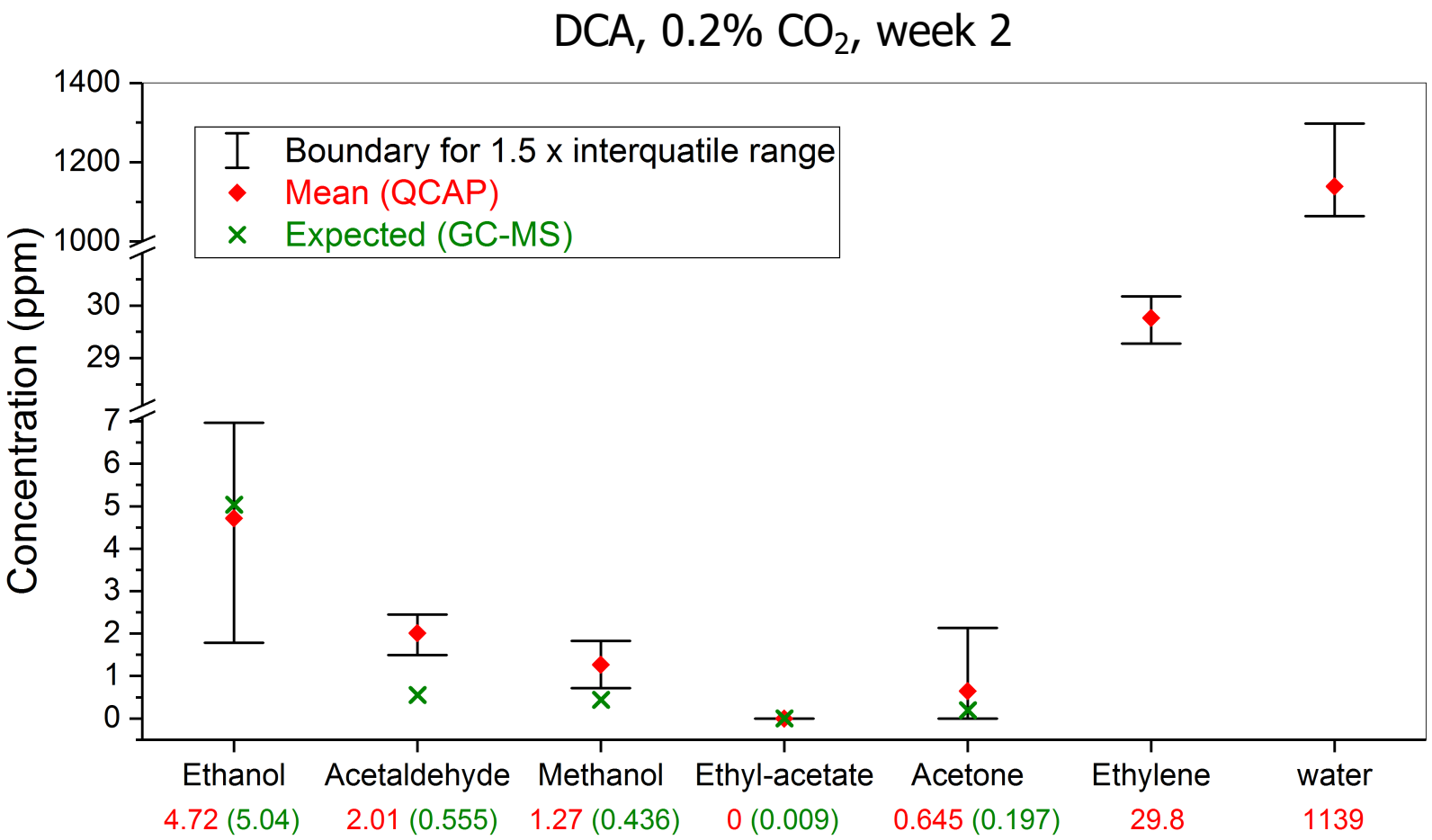
4 storage conditions (300 L, -1 ℃)

- Conventional ULO: 2.5% O_2, 0.7% CO_2
- ULO with low CO_2: 2.5% O_2, 0.2% CO_2
- DCA with 0.7% CO_2 (2 containers)
- DCA with met 0.2% CO_2

ULO: Ultra Low Oxygen
DCA: Dynamic Controlled Atmosphere

Comparison with golden standard

(Gas Chromatograph–Mass Spectrometer)



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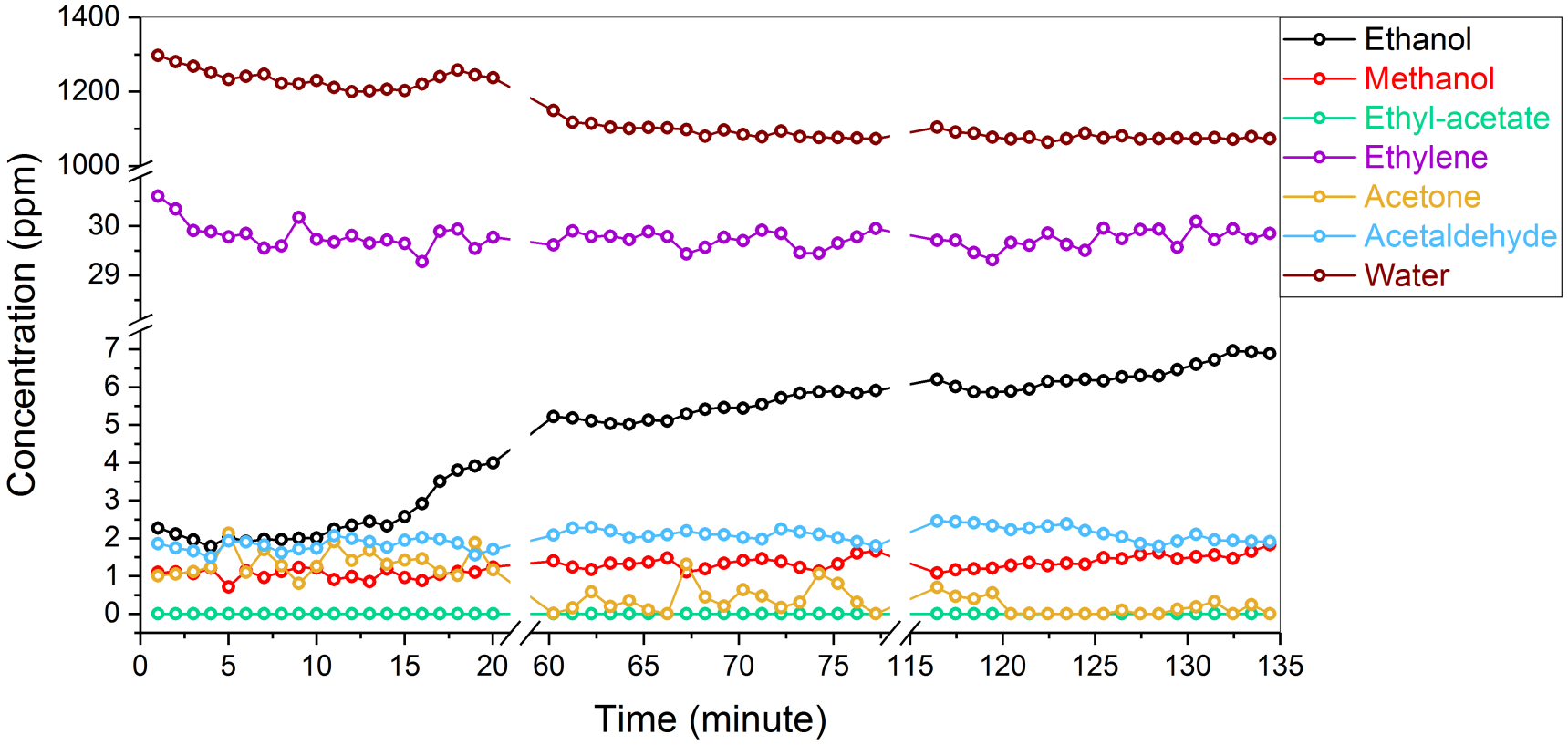
Real-time sensing, pear emision



Conclusions/outlook

- Supercontinuum sources are promising for infrared-spectroscopic-related field applications
- Huge potential in agro-food sector

- Project extension towards onions and carrots
- Follow up project for commercialization via Fast track to Innovation (H2020)

Acknowledgements

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Paul Assman

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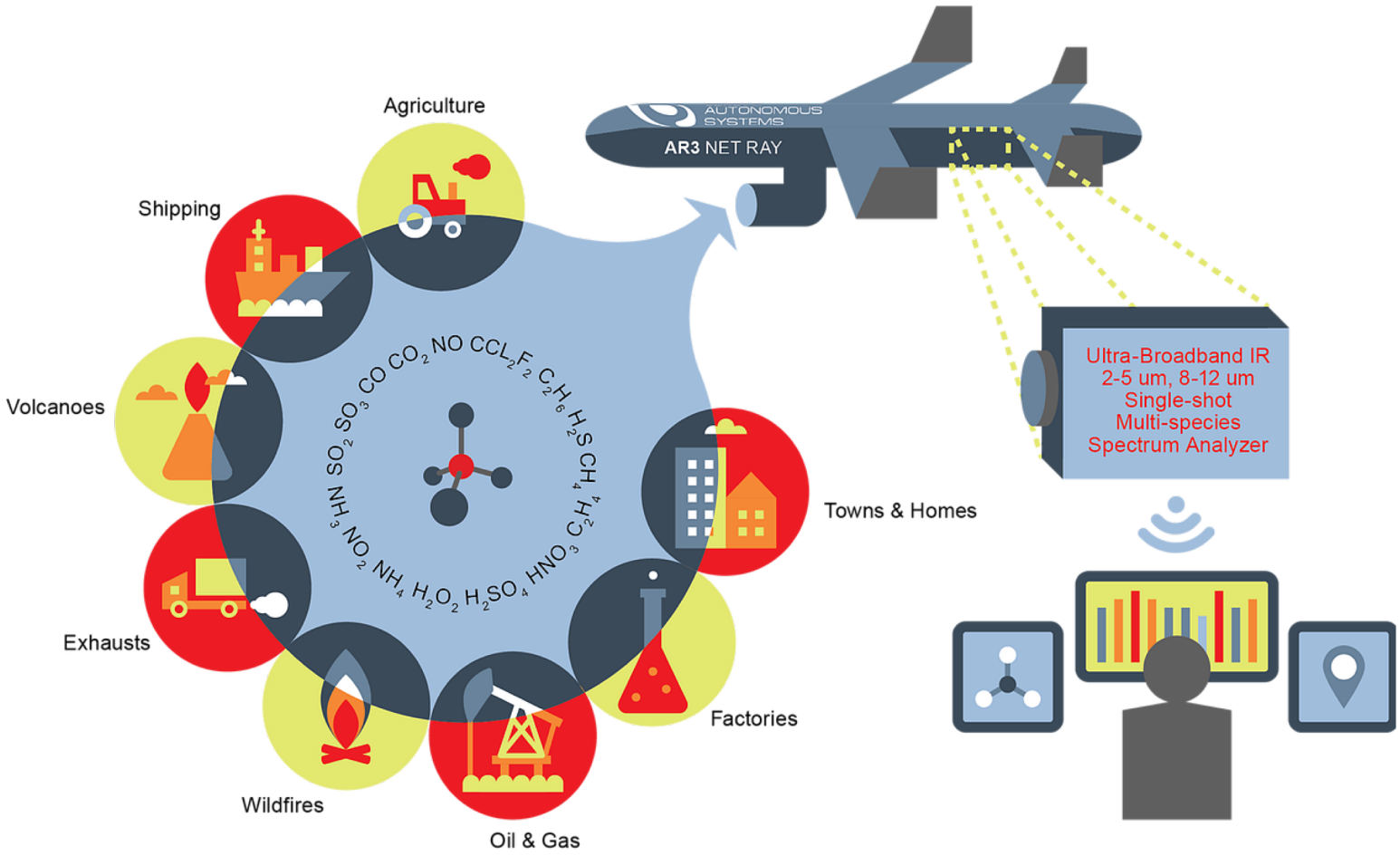
Flying an Ultra broadband Infrared Sensor



EU-H2020 FLAIR project

Using fiber based supercontinuum lasers