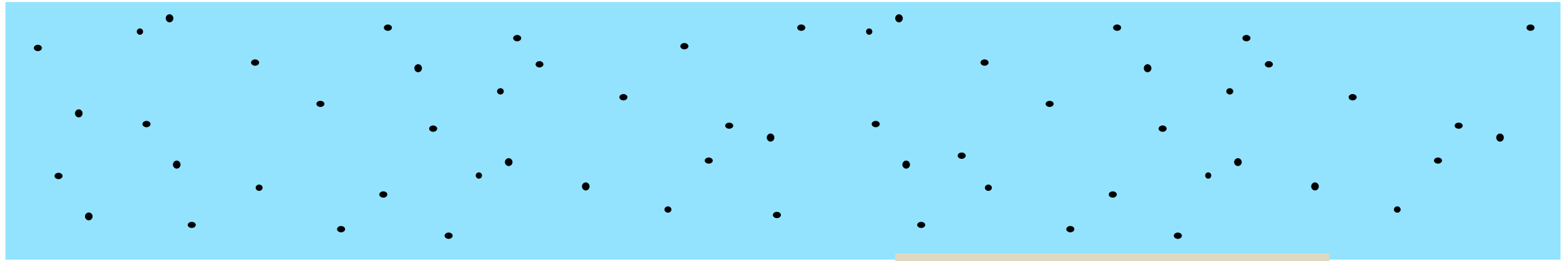


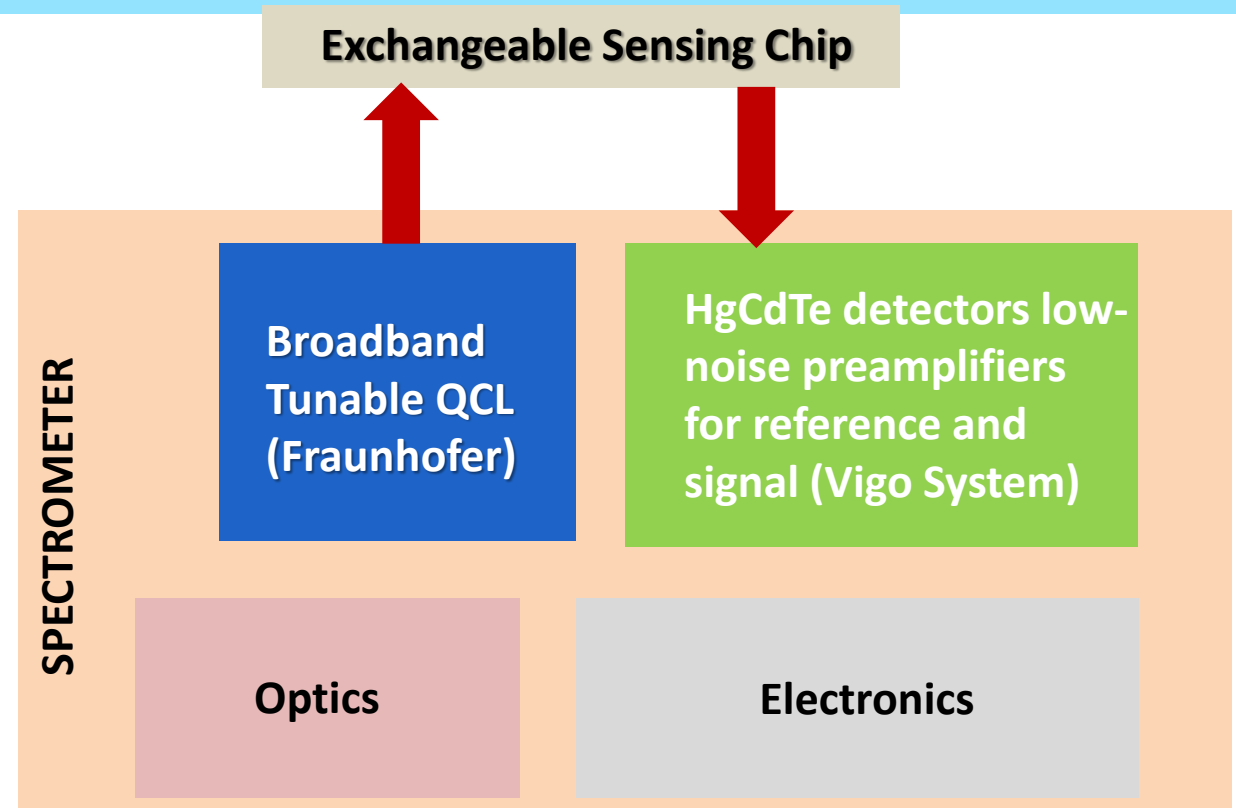
BROADBAND INTEGRATED MID-IR WAVEGUIDE SENSOR FOR TRACE ANALYSIS OF CONTAMINANTS IN WATER

Nuria Teigell Beneitez

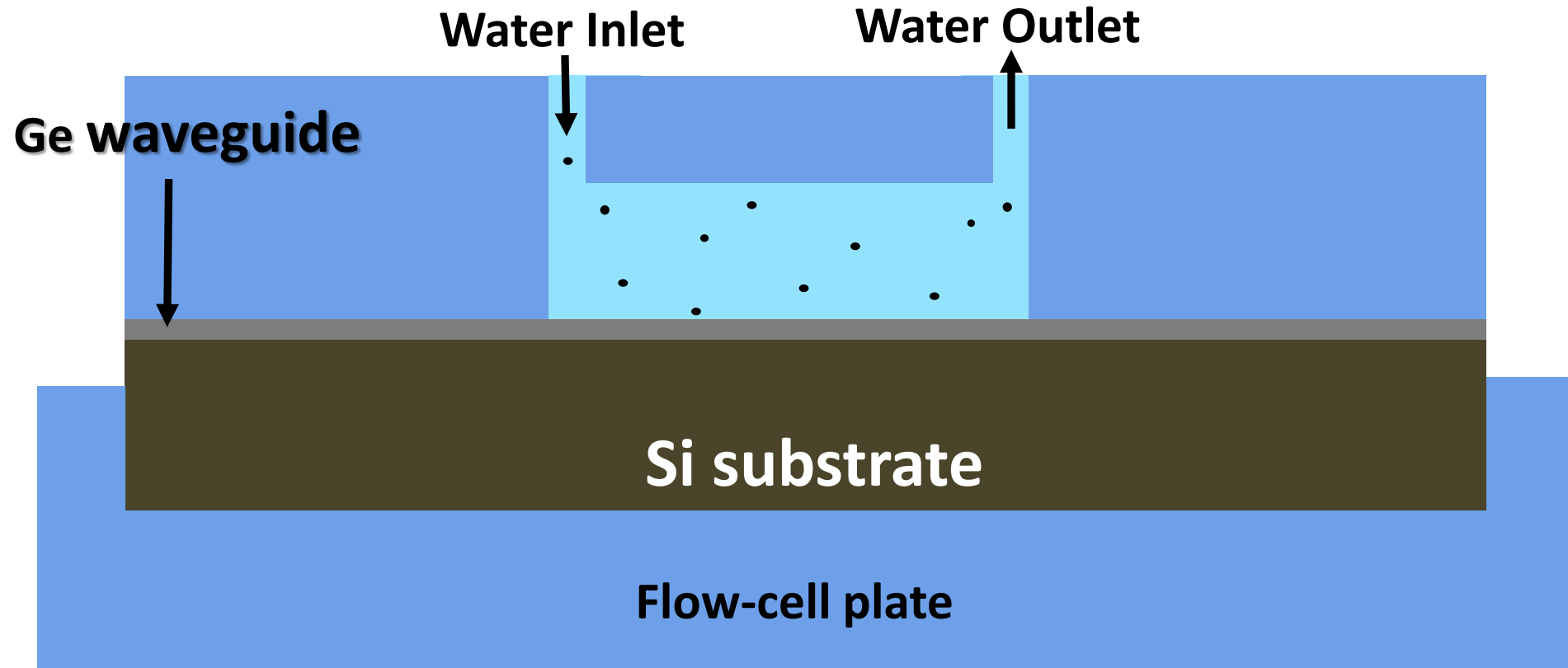
SENSING CONCEPT (H2020 AQUARIUS)



- Continuous monitoring of hydrocarbons in water
- LOD: ppm's for industrial applications and sub-ppm for drinking water.
- One of the proposed systems is an in-line sensor



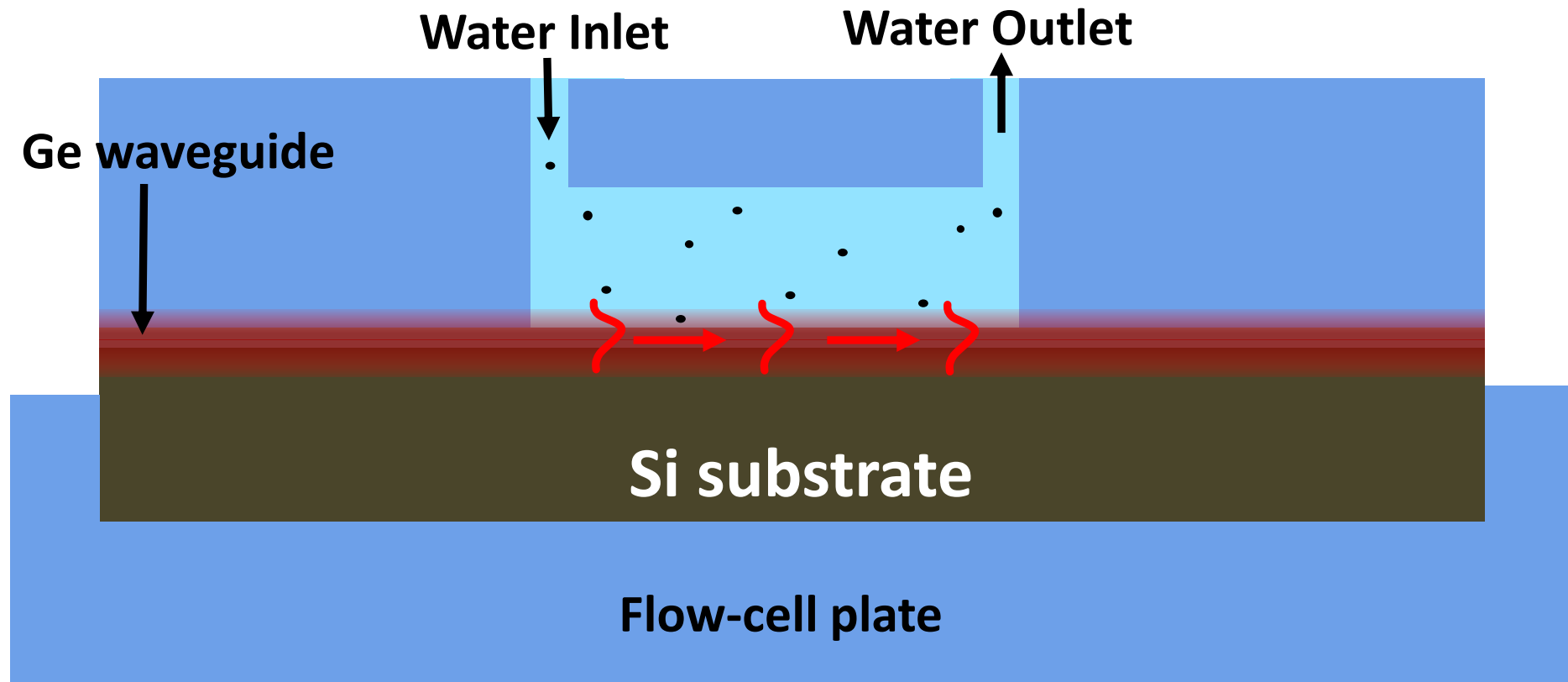
EXCHANGEABLE SENSING CHIP




• • •
Analyte

- Broadband sensing platform operating in the fingerprint mid-IR spectral region
- Aqueous environments
- Allowing easy and fast chip exchange within the read-on unit.

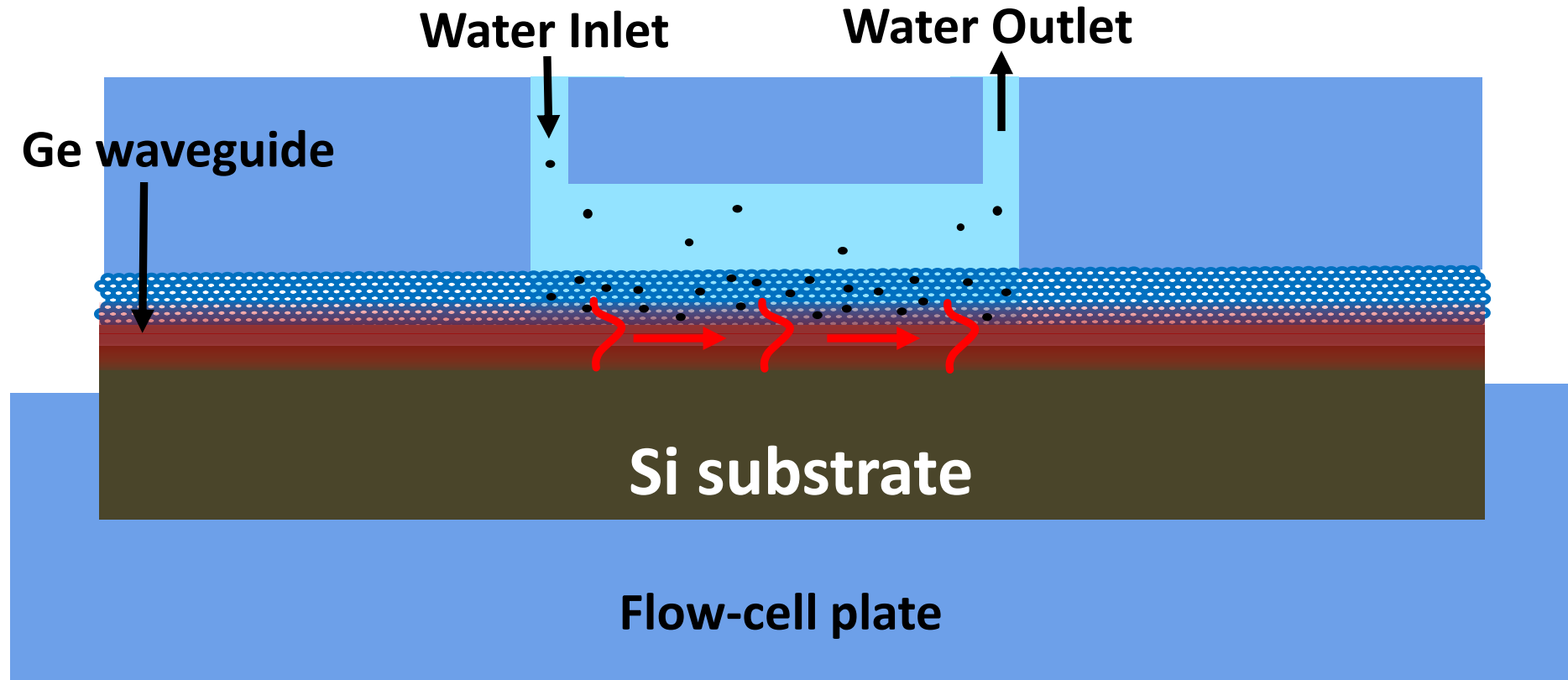
STRONG WATER ABSORPTION



• • •
Analyte


Propagating
mode

MESOPOROUS ENRICHMENT COATING



Mesoporous silica coating:

- Hydrophobic
- Apolar analyte enrichment



**Selective
coating**

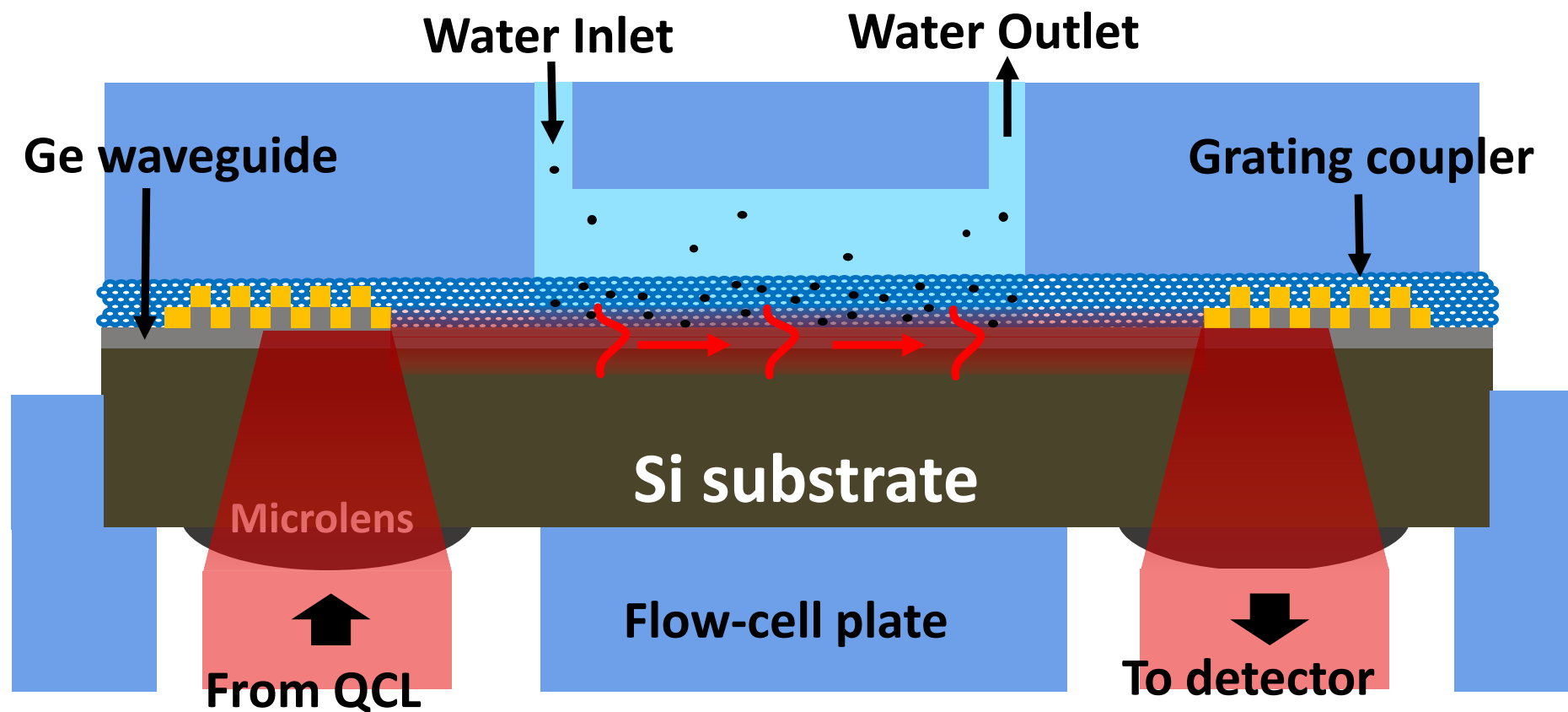


Analyte




**Propagating
mode**

MICRO-LENSES INTEGRATED IN THE SUBSTRATE




Microlenses:

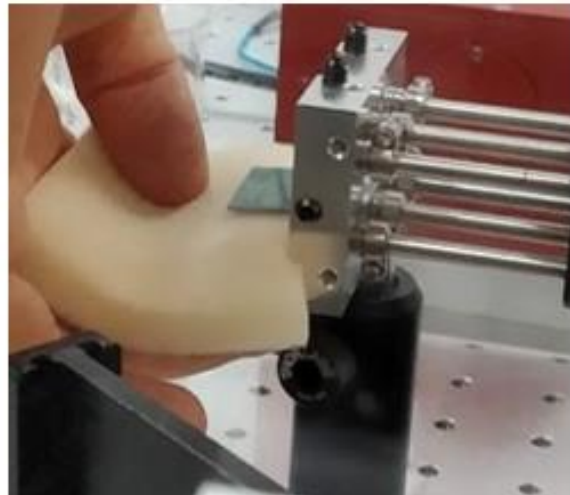
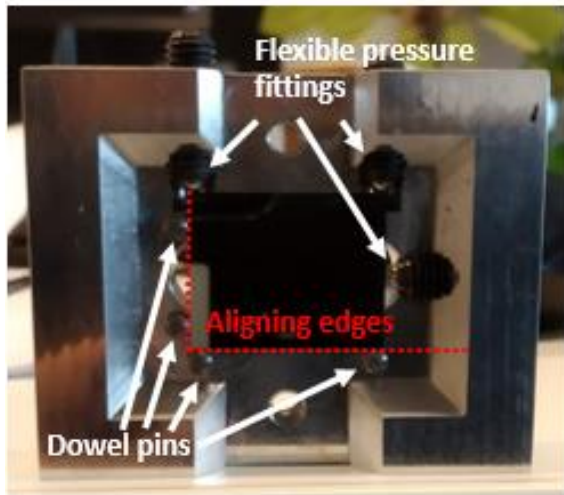
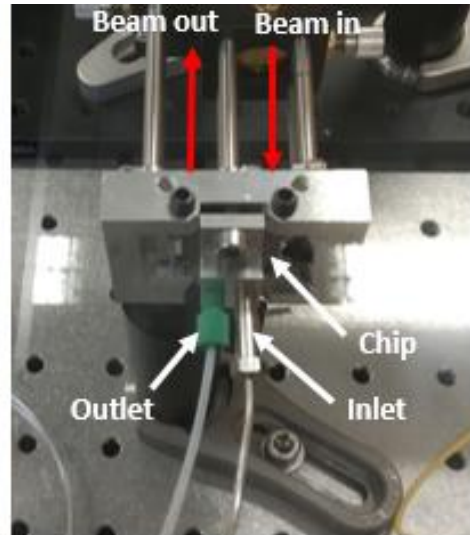
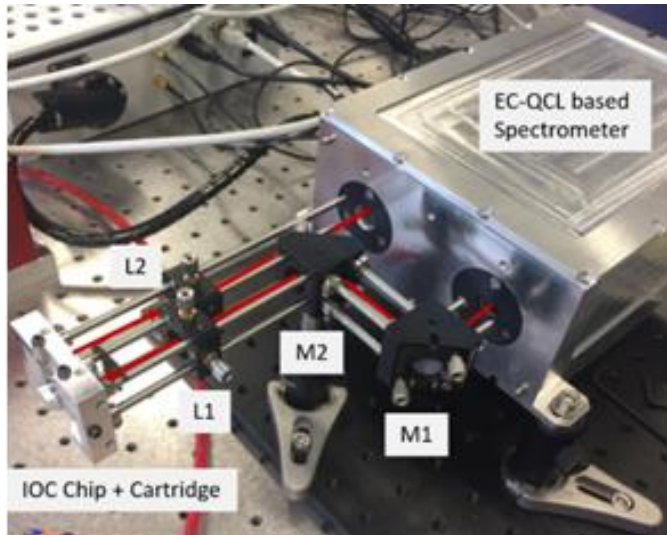
- Focusing and collimation
- Increases lateral tolerances


**Selective
coating**

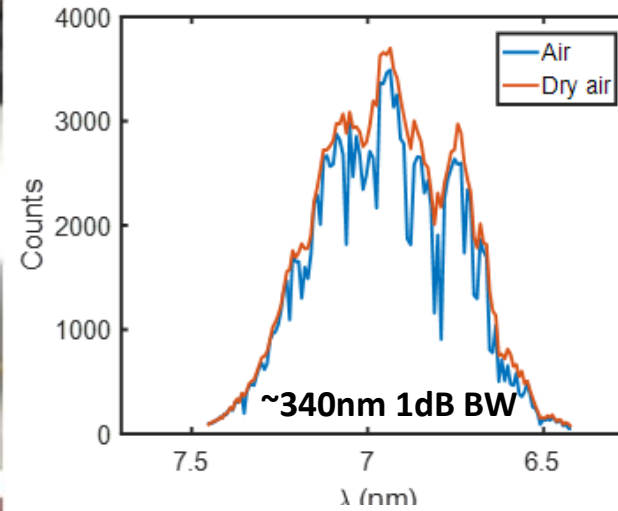

Analyte


**Propagating
mode**

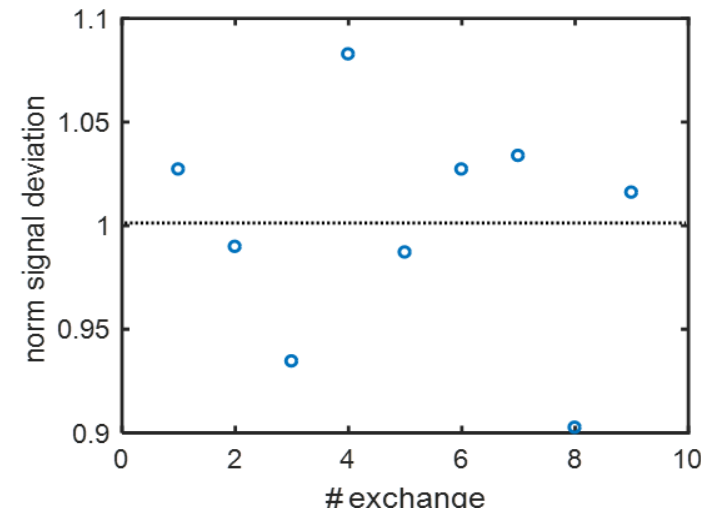
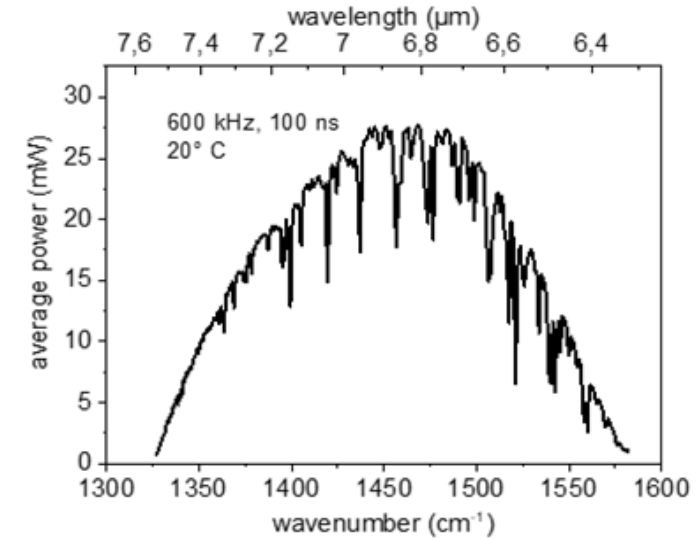
PASSIVE CHIP EXCHANGE



Measured input-output signal

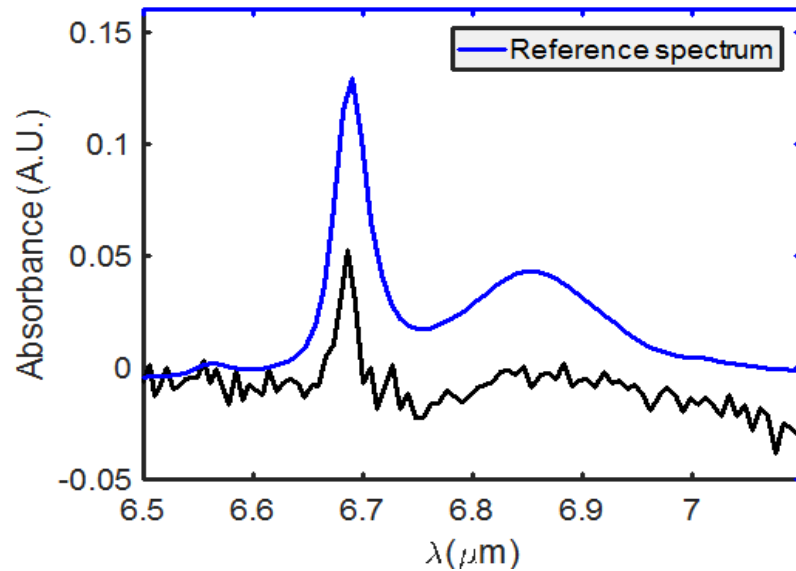


EC-QCL spectra

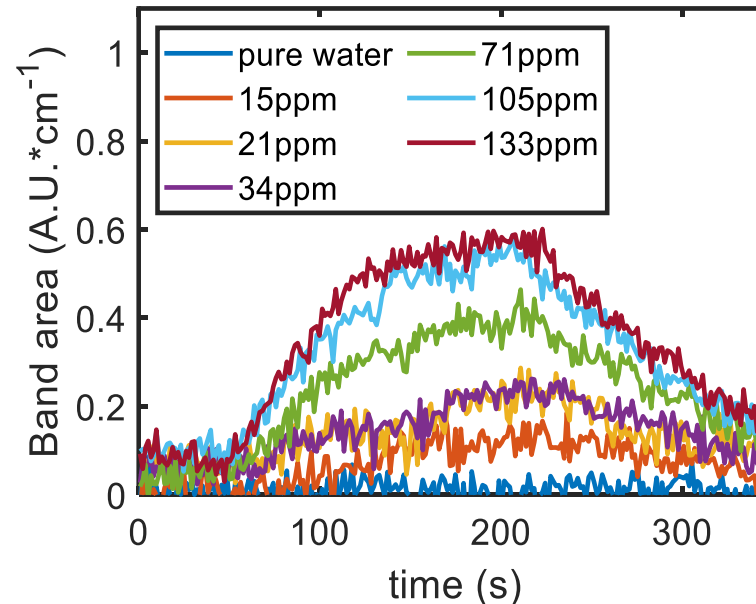


Measured variation of the total insertion loss is within 1 dB for 10 chips exchanges

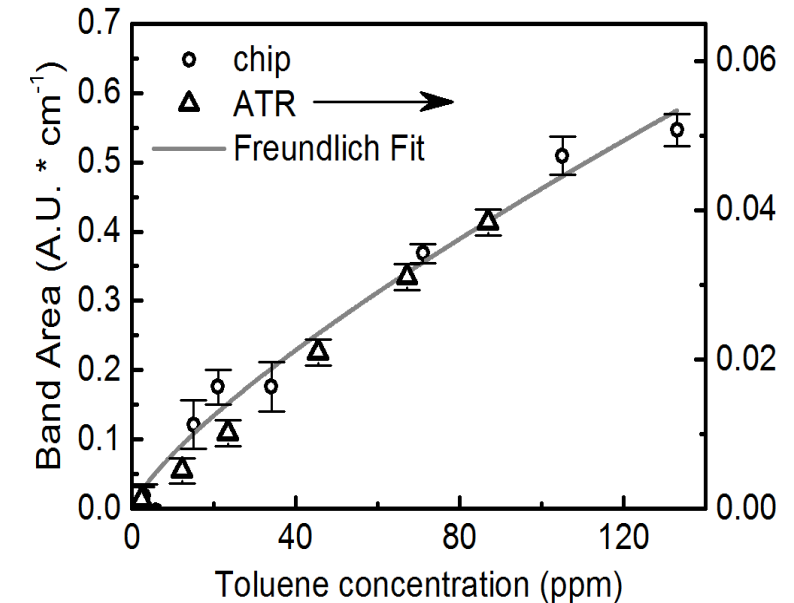
SENSING PERFORMANCE



Recorded spectra for 133ppm of Toluene in water



Time response profiles



Noise floor = 0.02 A.U.

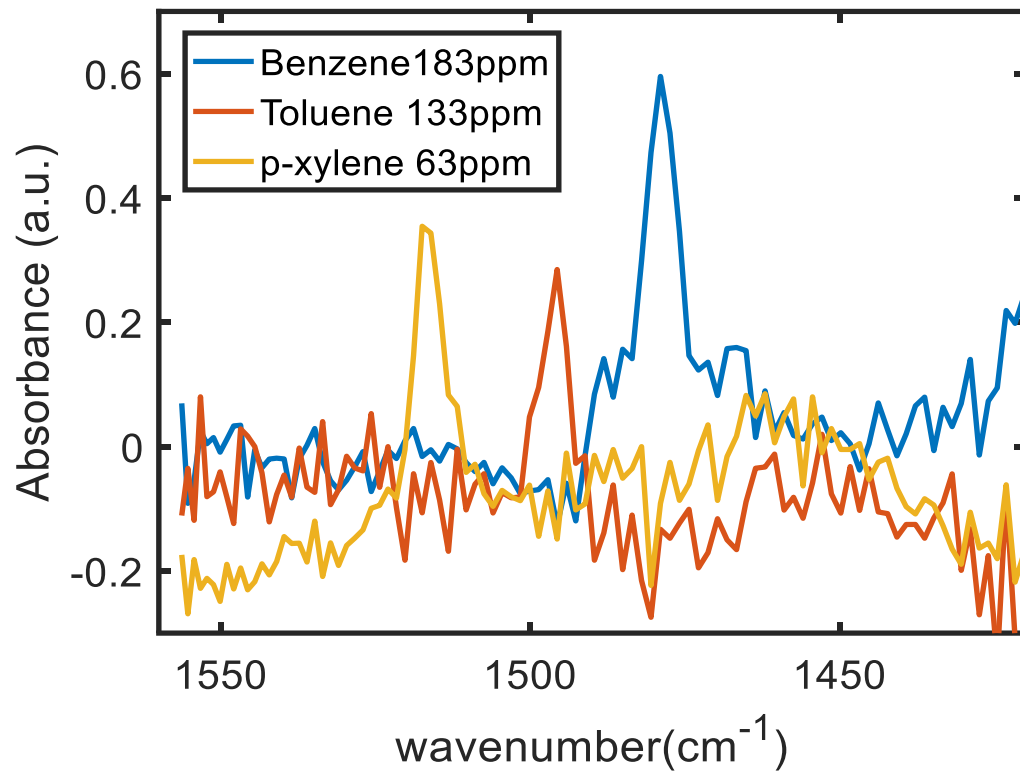
LOD ($3 \cdot \text{Noise}$) = 7ppm

Enrichment factors for 70 ppm toluene:

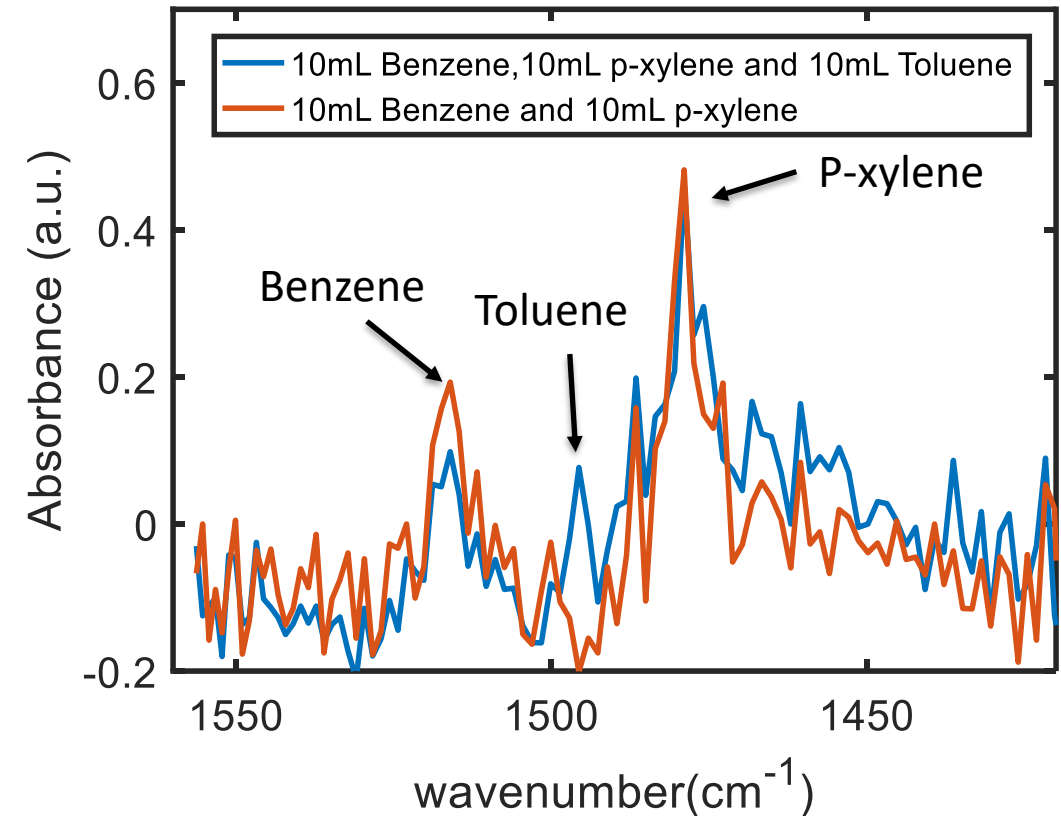
- 870 on ATR crystal with $\sim 500\text{nm}$ thick layer
- 760 for 'AQUARIUS' Chip (1% confinement factor in coating)

SENSING PERFORMANCE

Multiple analytes



Plots of 3 experiments overlapped



Spectra of samples with a mix of analytes



<https://aquarius-project.eu/>

- ❑ A sensing platform enabling in-line water sensing in the fingerprint mid-IR range
- ❑ Broadband, through-substrate and position tolerant optical interfacing demonstrated (enabling fast and easy chip exchange)
- ❑ LOD for BTX's in water <10ppm with a noise floor of 10's of mA.U (paving-the-way to achieve LOD in the ppb range)
- ❑ Achieved time responses pave-the-way for continuous monitoring
- ❑ The sensing platform can be adapted to different applications
- ❑ Developed chips are also suitable for gas sensing



System validation



System validation



OiW analyser



Coordination/
Technology Projection

