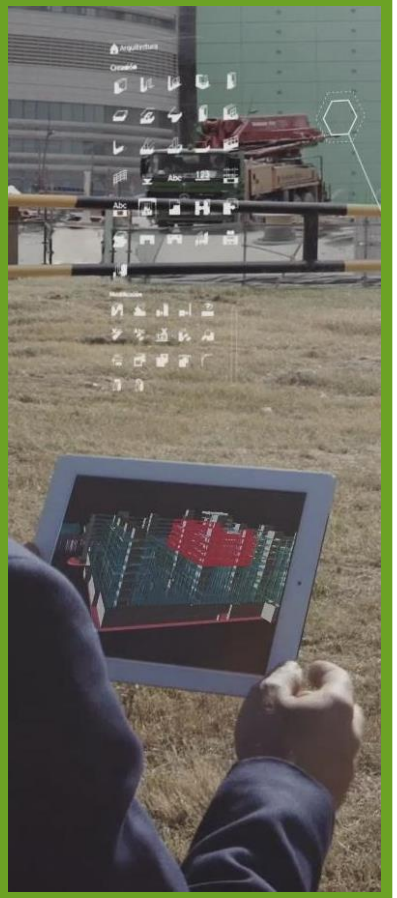

BUILT2SPEC

Tools for the 21st Century Construction Worksite

A new portable indoor air quality self-inspection technique

www.built2spec-project.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 637221. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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Tools for the 21st Century Construction Worksite

Objective

Reduce the performance gap between
a building's designed and as-built performance.

Self-Inspection, 3D Modelling,
Management and Quality-Check Tools
for the Construction Worksite

Portable and easy to use!

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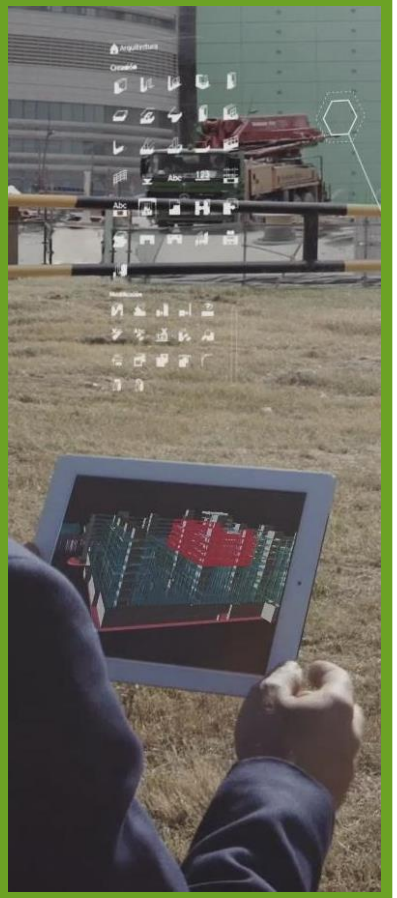
Tools for the 21st Century Construction Worksite



Funded by the European Union's Horizon 2020 research and innovation program

Coordinator: Nobatek

Start: January 2015

Duration: 4 years

5 Universities
4 RTO
1 SHO
2 LE
8 SME

20 European partners:
Universities, research institutions and technological centers, industrials and SMEs from France, Germany, Spain, Ireland, Netherlands, Italy, Switzerland and Great Britain

Nobatek · OHL · NUI Galway OÉ Gaillimh · OP ORAN PRE-CAST LTD · ecofix · VRM TECHNOLOGY · The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA · TNO innovation for life · eurecat · R2M SOLUTION

Passive House Institute · nantes ensa architecture · LogiRep · blue · Lakehouse · ETH zürich · BSRIA · université de BORDEAUX · laSalle Ramon Llull University · DE5 DE CINQUE

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We have some answers… new tools + IDDS

- Help the constructors and workers
- Control and Improve the quality of construction
- Establish a strong link between the value chain of actors (architects, building owners, engineers, workers)
- Impact the final energy performance of the building
- Impact the final environmental performance of the building

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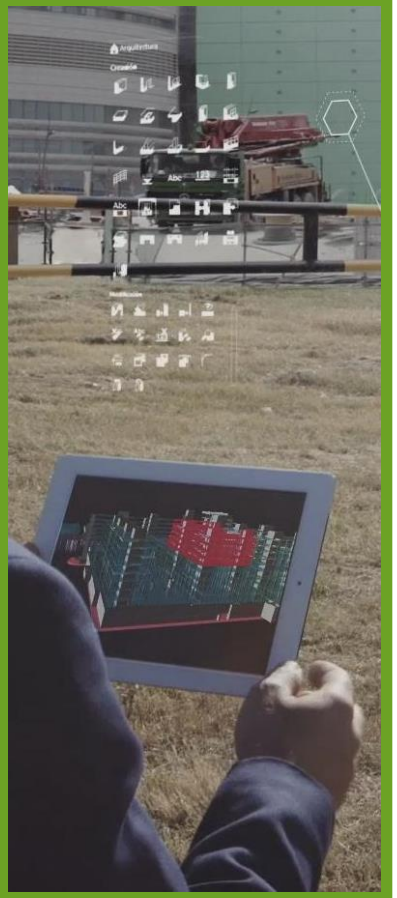

What is the B2S project concept ?

Level 1	Level 2	Level 3	Level 4
Assemble excellent science **technologies** and **techniques**	Create **new knowledge** for inspection, check processes and determine how to **automate it**	Integrate levels 1 & 2 into an **IDDS framework** and provide them as **resource** at the worksite	Create **synergies** and **new functionalities** through this integration

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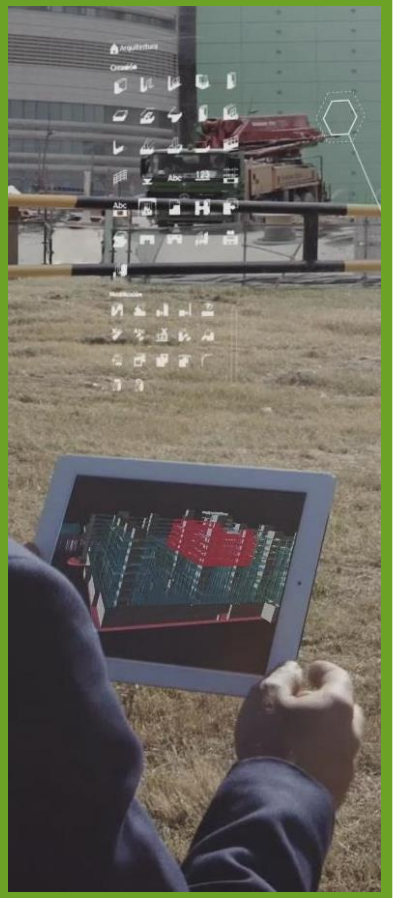
How can we operate in real case?



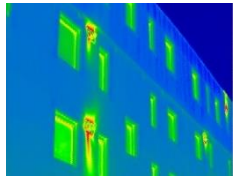
- Energy efficiency quality checks
- Indoor air quality tools
- 3D and imagery tools
- Smart building components
- Building Information Modelling
- Acoustic tools
- Airtightness test tools
- Thermal imaging tools

Virtual Construction Management Platform







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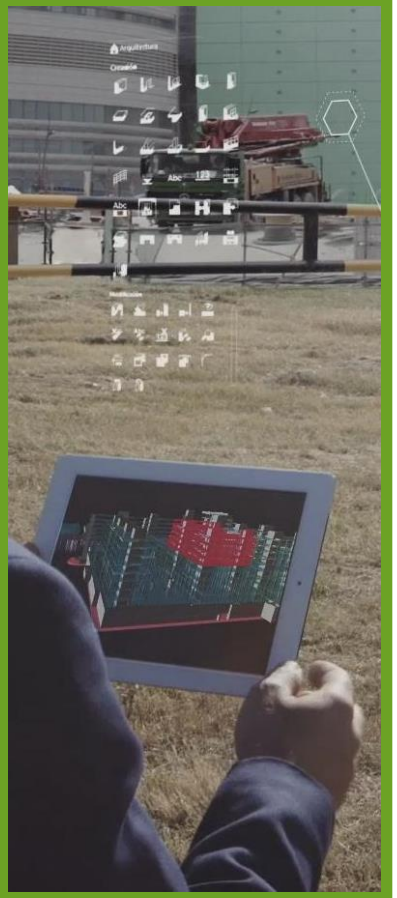
Tools for the 21st Century Construction Worksite

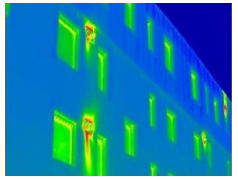


Indoor air quality tools –

identify pollution and track its source!

Measuring indoor air quality from the worksite to the exploitation of the building with a **portable and fast analyzer**!

Built2Spec will develop a portable version of BLUE analyzers, designed for field operation by a construction technician.



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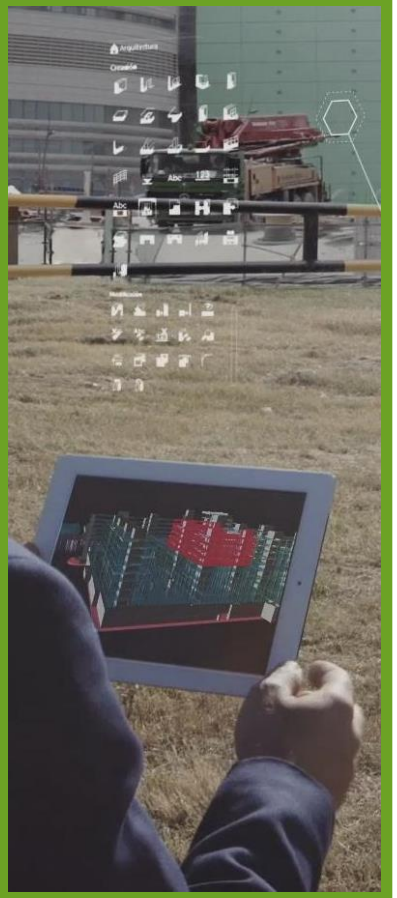


An atypical technology
Blue Industry and Science

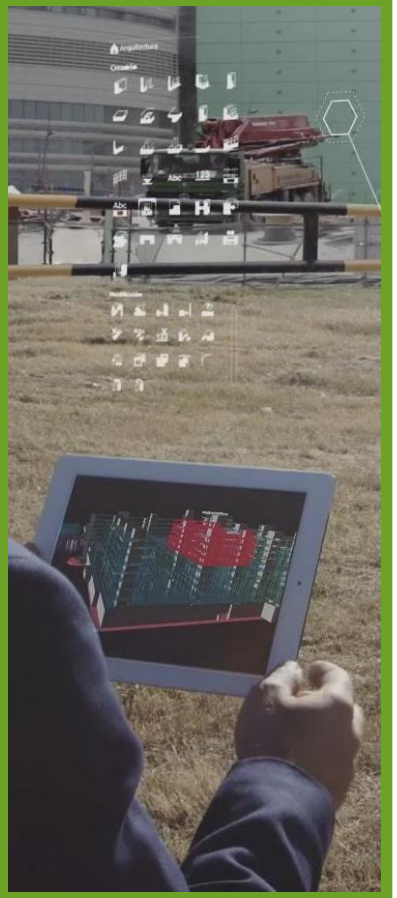
Blue X-FLR8 analyzer

Main objective:
Develop a tool able to measure on-site and in a real time the concentrations of several air pollutants of the indoor air

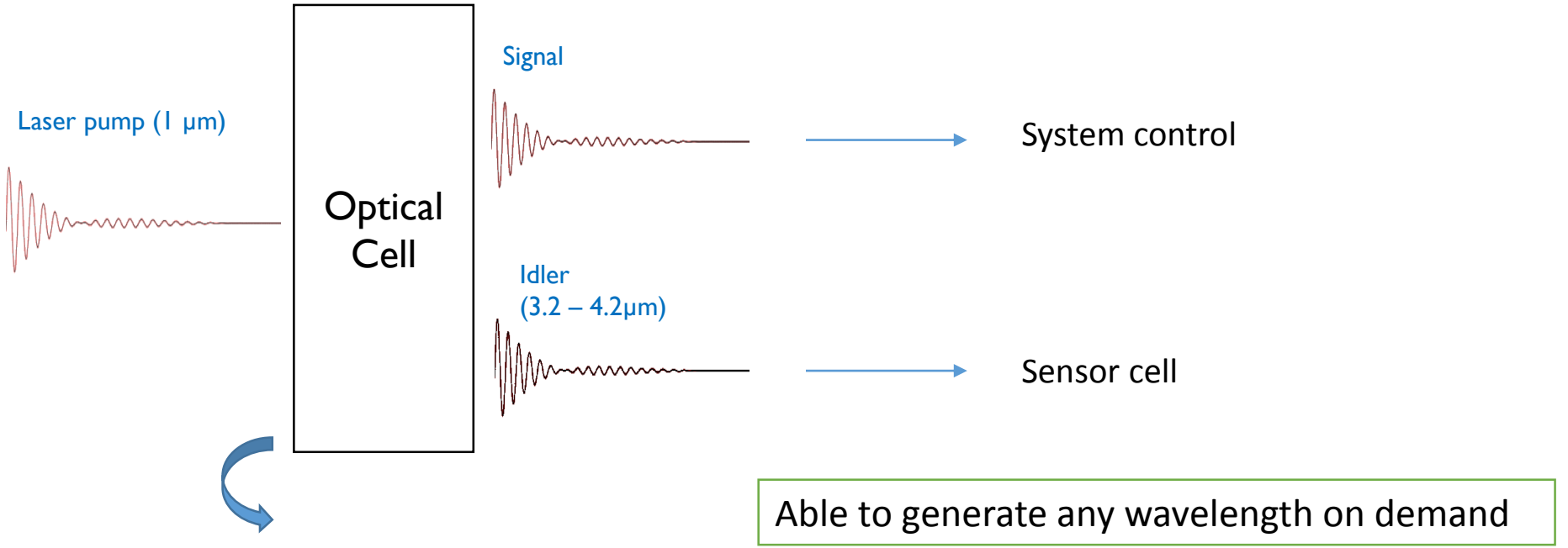
High level technology:
Tunable laser source, ONERA licence (The French Aerospace Lab)

- Laser spectroscopy: real time, robust, portable
- Widely tunable: multi-gas, interference management

ONERA
THE FRENCH AEROSPACE LAB



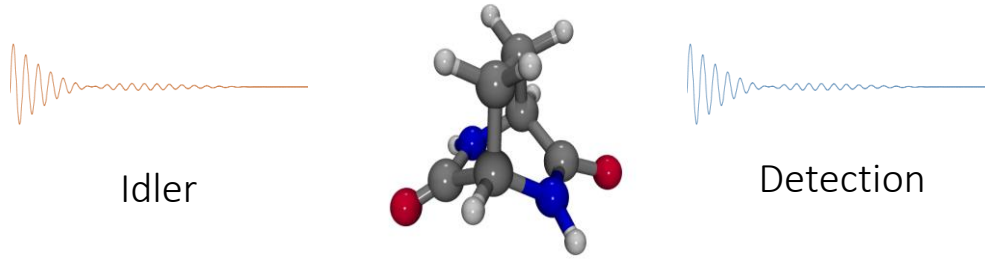
An atypical technology



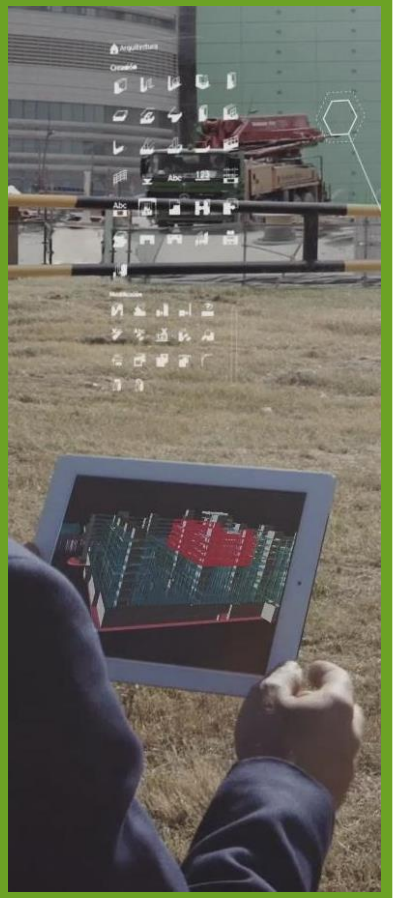
Able to generate any wavelength on demand

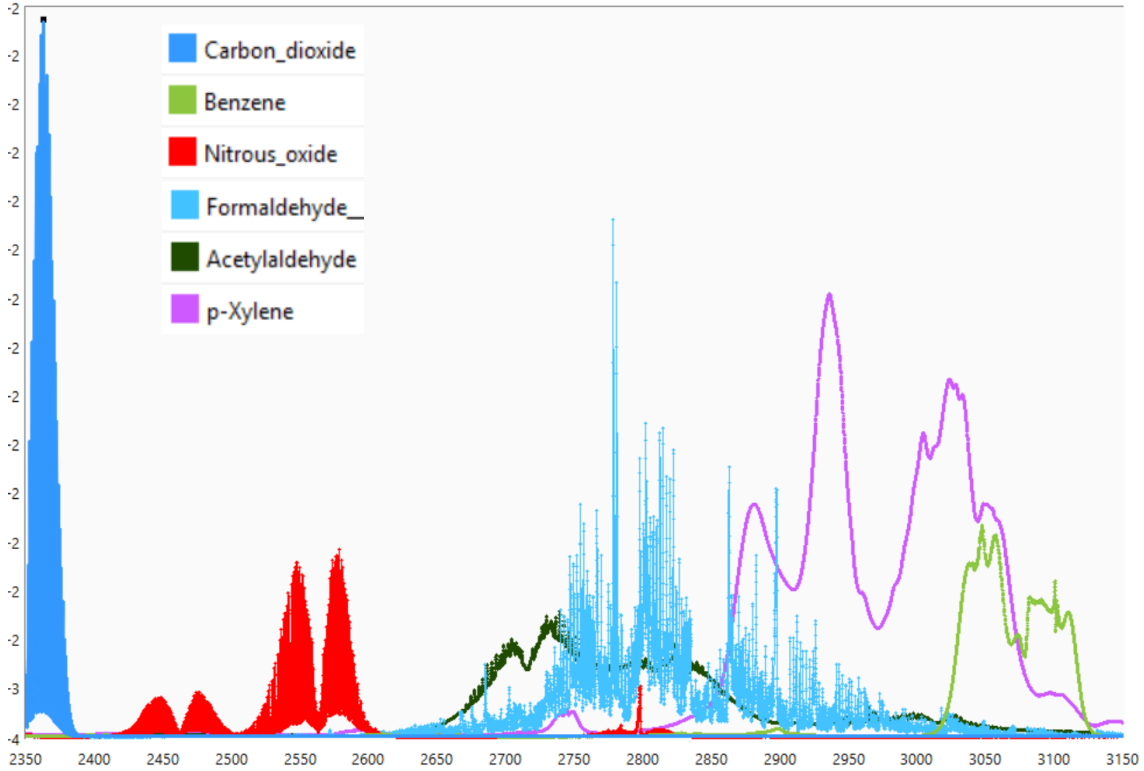
Methods for the generation of the wavelength

- Cell geometry
- Thermal conditions control



An atypical technology





- Several hundreds of pollutants concentrations quantification
- Down to the ppb
- Real time (at point of sampling)
  - Dynamic measurements
  - Fast diagnosis

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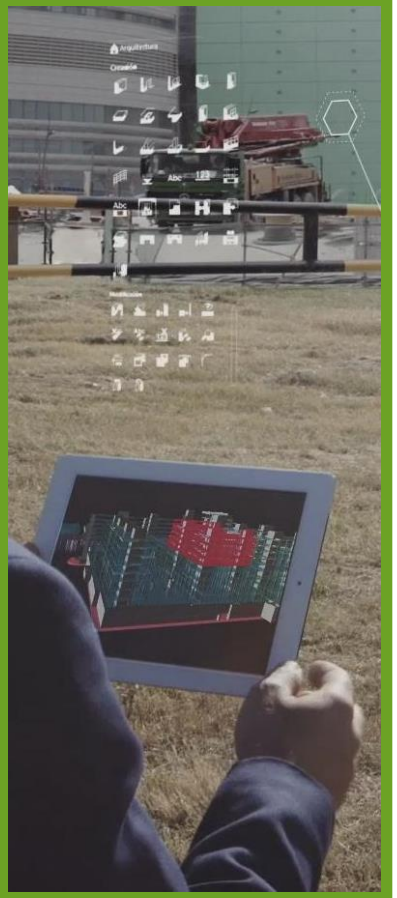
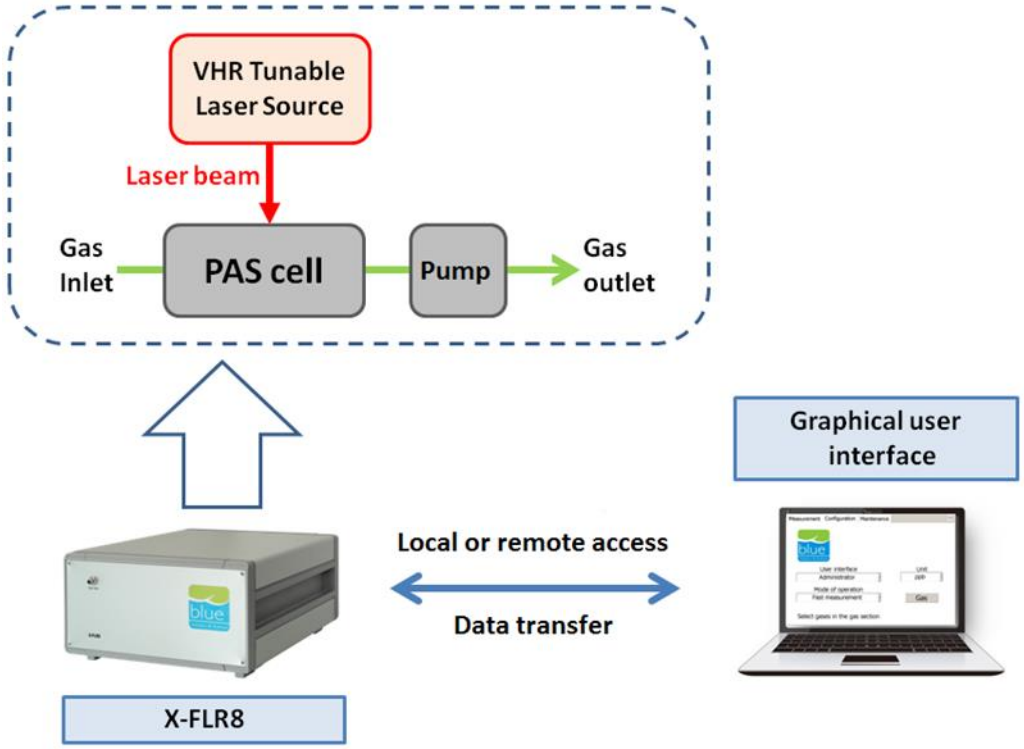
An on-site measurement technology



- ❑ Portable
- ❑ Direct sampling (integrated pump)
- ❑ Real time analysis in few seconds

- ❑ Non standard method
- ❑ Continuous sampling
- ❑ Pollution sources identification



Results

European ETV Certification from LNE / France official metrology body

- Parameters: repeatability, reproducibility, accuracy, robustness (T, RH)
- Pollutants: benzene, formaldehyde, 1,3 butadiène, éthane (multi-gas or monogas)

ETV — LNE

Déclaration de vérification

Environmental Technology Verification

Technologie	Blue X-FLR8
Numéro d'enregistrement	LNE040002-0
Numéro d'identification LNE	30525-0
Date d'émission	30/11/2015

Organisme de vérification		Proposant	
Nom	Laboratoire national de métrologie et d'essais	Nom	Blue Industry and Science
Contact	M. Emmanuel Rebuffat	Contact	M. Julien Roquette
Adresse	1 rue Gaston Boissier 75015 Paris	Adresse	361 avenue du Président Wilson 93211 SAINT DENIS LA PLAINE
Téléphone	01 40 43 37 40	Téléphone	+33 1 78 76 71 48
Courriel	etv@lne.fr	Courriel	info@blueindustryandscience.com
Internet	http://www.lne.fr	Internet	http://www.blueindustryandscience.com/

Le Directeur Général du LNE

Original signé

Le Directeur Général de la société Blue Industry and Science

Original signé

	Formaldehyde
Linearity	0,9986
Accuracy	Under-estimation of 3%
LOD/ LOQ (nmol/mol)	9/18
Accuracy in presence of water	Deviation between -0,5% and +6%

Results

Field study: day-care center

Pollutants	Room 1	Room 2	Room 3	Room 4
Acetaldehyde	168 µg/m^3	331 µg/m^3	331 µg/m^3	272 µg/m^3
Formaldehyde	< 9 µg/m^3	13 µg/m^3	15 µg/m^3	< 9 µg/m^3
TEX tot	< 300 µg/m^3	< 300 µg/m^3	< 300 µg/m^3	< 300 µg/m^3
Temperature	19 °C	16 °C	20 °C	17 °C
Relative Humidity	37%	43%	36%	46%

- ❑ Formaldehyde concentration below the guide value of 30 µg/m^3
- ❑ Acetaldehyde concentration well above the guide value of 160 µg/m^3

-> Attributed to a cleaning product containing d-limonene

H. Buee, J. Delahaye, C. Levy, J. Georges Des Aulnois, « Low-cost indoor air quality diagnoses for a fast characterization and localization of chemical pollutants in school buildings", Indoor Air, 2016

Beyond the tool

Identification of the list of targeted pollutants (21 targeted)

Formaldehyde	**Ethylbenzene**
Benzene	2-butoxyethanol
Naphtalene	Acrolein
Trichloroethylene	α-pinene
Tetrachloroethylene	Limonene
Acetaldehyde	TVOC
Toluene	NO_2
Xylene	CO
Styrene	PM 2.5
1,2,4-trimethylbenzene	PM10
1,4-dichlorobenzene	

Beyond the tool

Work in progress

- **Definition of use cases**
  -> When? Which measurement? (improvement of the quality of the construction)

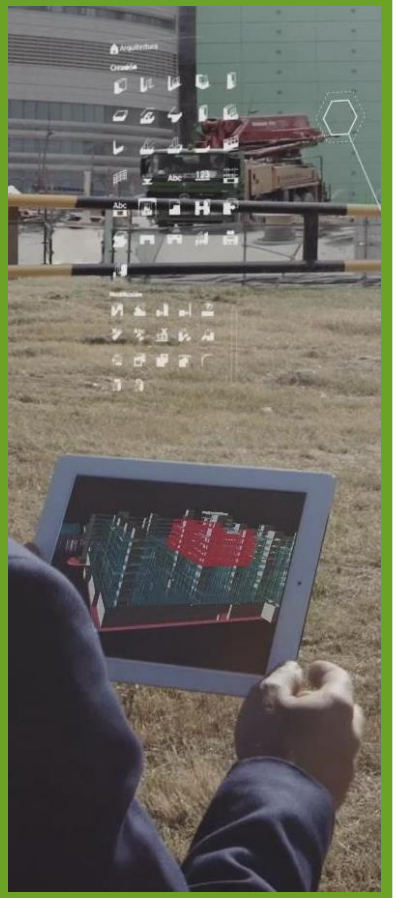
- **Definition of indicators**
  -> Which values for the different use cases?

- **Interface development**
  -> Which information will be visible?
  What design?
  How it will communicate with the platform (link between the actors of the value chain)?

Work in progress

- ❑ Measurement methodology development and validation
- ❑ Integration of the sensors in a portable field analyzer
- ❑ Data workflow integration with the VCMP
- ❑ Field tests

First field tests for the IAQ analyzer are planned in 2017 across various European countries. These tests will continue in 2018.



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Boosting construction practices through a new set of technologies

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