Monitoring beacon for early or hidden fungal development detection dedicated to heritage conservation

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Fungi in indoor environments
Dwellings and cultural heritage

North Europe, 23-80 % of contaminated dwellings
(Pirhonen, 1996. Koskinen, 1999)

France, 10-37 % of contaminated dwellings
National Campaign on dwellings' Indoor Air quality (Moularat *et al.*, 2008)

Canada and USA, 14-38 % of contaminated dwellings
(Dales et al., 1991; Tsongas, 1994; Escamilla-Garcia, 1997)

In France, a quarter of historical monuments and about half of national collections are infested

(Survey by Ecole du Louvre, 2015)

Health effects

Damages

-Nosocomial Invasive
Aspergillosis
-Toxi-Infections
-Allergies

-Buildings
-Works
-Books

Fungal Detection through Volatil Organic Compounds (VOCs)
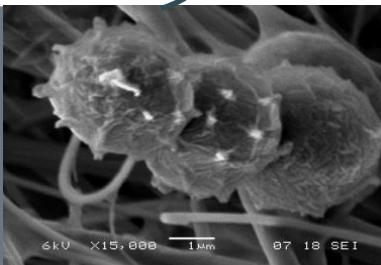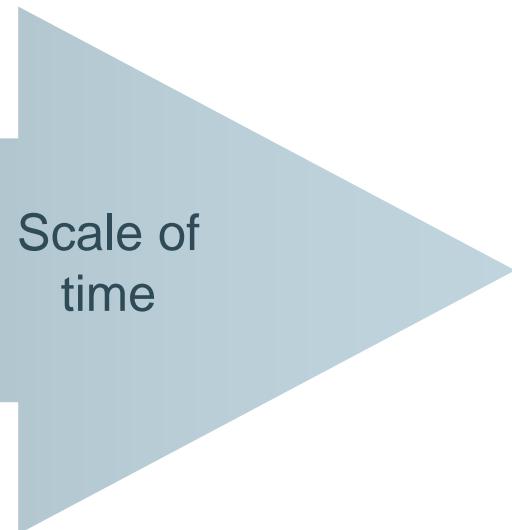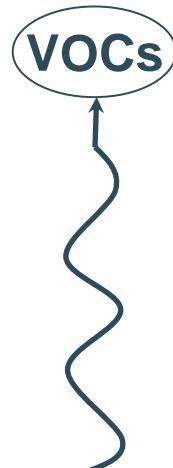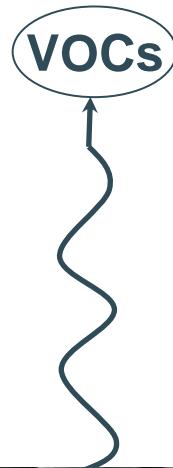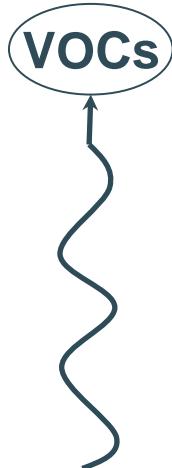
Emissions during growth phases

Fungal Detection through Volatil Organic Compounds (VOCs)

Identification of tracers

Origin (metabolism, biodegradation…)

Specificity (other sources?)
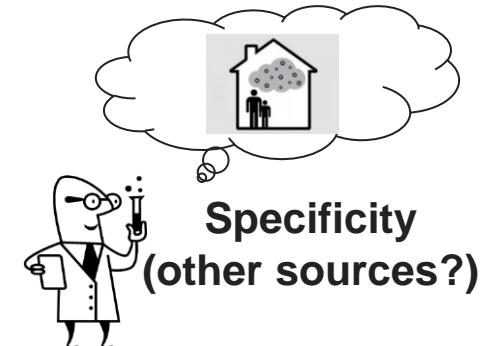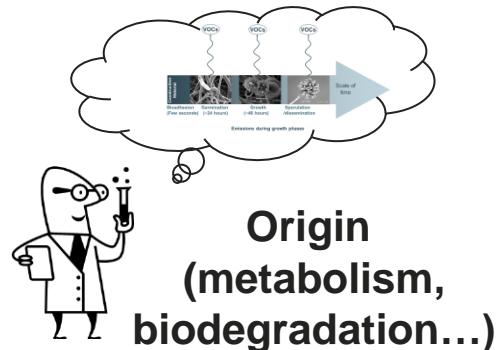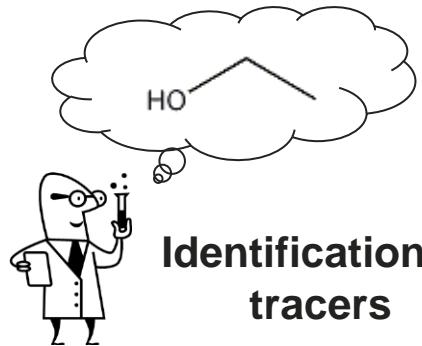
Construction of an index
Incrementation as a function of the presence or absence of each target

- Detection of hidden contaminations (diffusion of VOC)
- Detection of recent contaminations (emission from the beginning of development)

**VOCs Analysis :
3 main steps**

Aim : Development of a microsystem for fungal contamination detection

1. Sampling

Travelling to site

Sample transport

2. Analysis

3. Interpretation
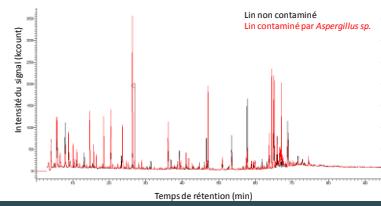
Analysis by a specialist

Low cost

Rapidity
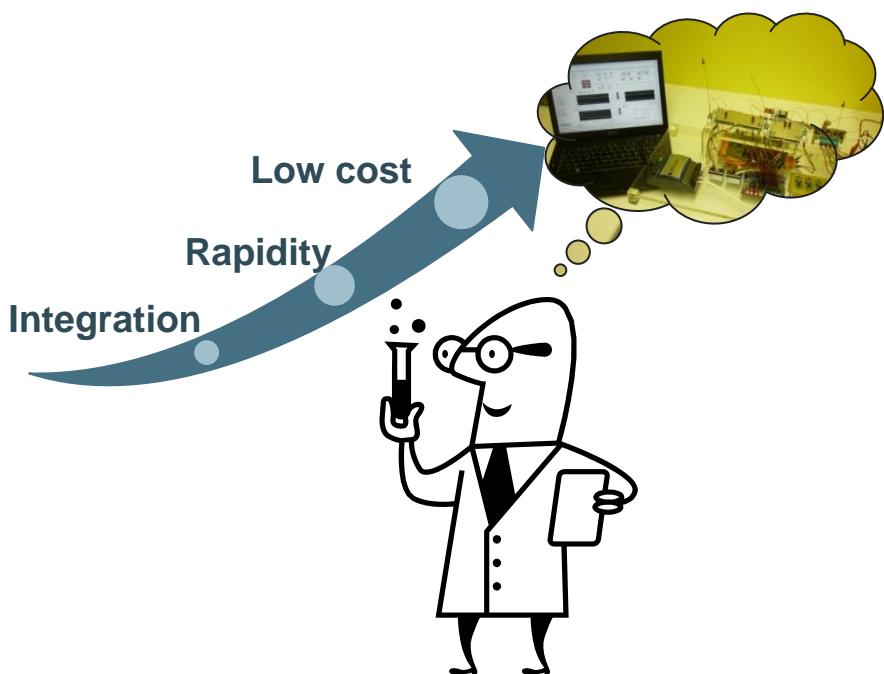
Integration

✓ **Integration of the 3 steps**
✓ **Analysis on site**
✓ **Automated interpretation**
✓ **Cost reduction**

(Patent (2010) FR2967692 (A1); Wo2012069752 (A1); (2011) B52433FR)

Monitoring solution

Building monitored with the beacon

Contamination management

Center of Expertise

Remote
Information
Networking
Remote control

Early warning if contamination

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Chemosphere 143 (2016) 41–49

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

A new approach to detect early or hidden fungal development in indoor environments

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Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Airborne fungal volatile organic compounds in rural and urban dwellings
Detection of mould contamination in 94 homes determined by visual inspection and airborne fungal volatile organic compounds method

Stéphane Moularat, Marion Hulin, Enric Robine, Isabella Annesi-Maesano, Denis Caillaud

International Journal of Hygiene and Environmental Health

journal homepage: www.elsevier.com/locate/ijheh

Positive associations between respiratory outcomes and fungal index in rural inhabitants of a representative sample of French dwellings

M. Hulin, S. Moularat, S. Kirchner, E. Robine, C. Mandin, I. Annesi-Maesano

Contents lists available at ScienceDirect

International Biodeterioration & Biodegradation

journal homepage: www.elsevier.com/locate/ibiod

Detection of moulds by volatile organic compounds: Application to heritage conservation

Yaël Joblin, Stéphane Moularat, Rukshala Anton, Faisl Bousta, Geneviève Orial, Enric Robine, Odile Picon, Tarik Bourouina

ScienceDirect CHEMOSPHERE
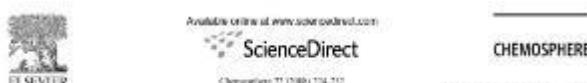
Detection of fungal development in closed spaces through the determination of specific chemical targets

Stéphane Moularat, Enric Robine, Olivier Ramalho, Mehmet A. Oturan

Moisissures dans les environnements intérieurs : état des connaissances et détermination de la contamination fongique des logements français par un indice chimique

POLLUTION ATMOSPHÉRIQUE N° 197 - JANVIER-MARS 2008

Stéphane MOULARAT, Enric ROBINE, Marjorie DRAGHI, Mickael DERBEZ, Séverine KIRCHNER, Olivier RAMALHO

ScienceDirect

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Detection of fungal development in a closed environment through the identification of specific VOC: Demonstration of a specific VOC fingerprint for fungal development

Stéphane Moularat, Enric Robine, Olivier Ramalho, Mehmet A. Oturan

DECAGRAPH : détection précoce des contaminants des collections graphiques

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Technology Readiness Level of the microsystem

1. Principle

Patent
(2007)
WO2008125770

2. Concept

Patent
(2010)
FR2985314, CA2800085,
CN103215183,
JP2013140154,
US2013171687, EP2610617

3. Conception of
elementary modules

Patent
(2011)
Wo2012069752

4. Validation of
modules

5. Validation of
prototype in
laboratory

6. Validation of
prototype withe
environments

7. *In situ*
demonstration of
prototype