



Olivier RAMALHO, Stéphane MOULARAT, François LOUBET,
Joachim GOSCHNICK, Daniel HÄRINGER and Birgit MÜLLER

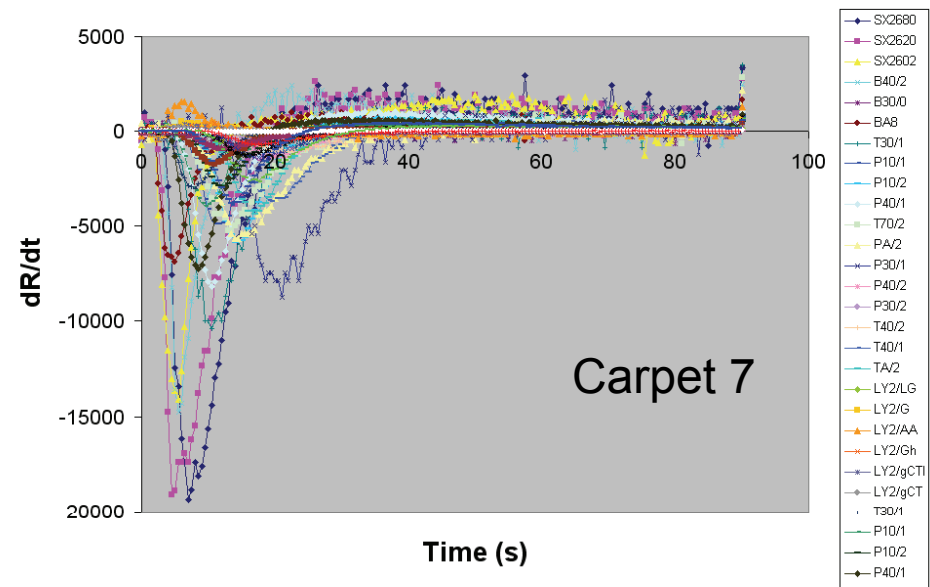
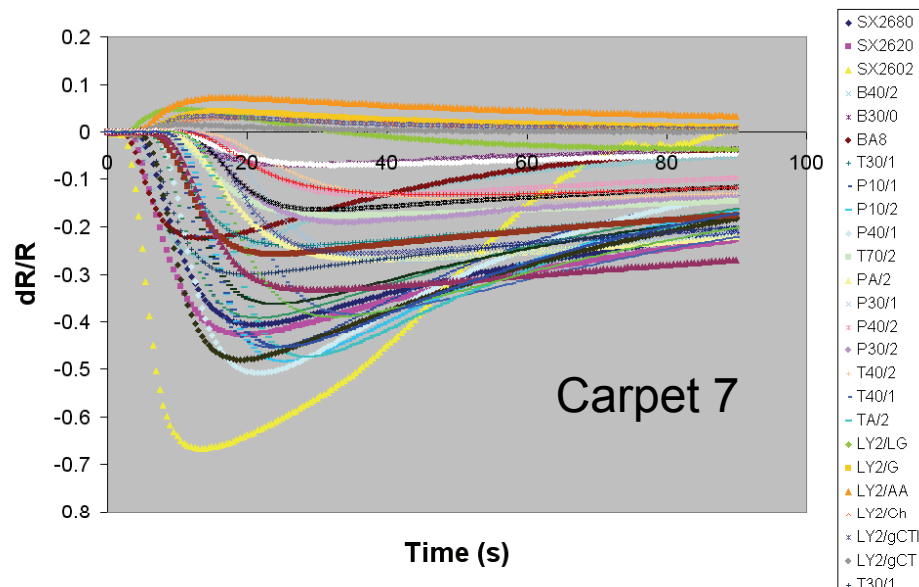
Discrimination of gas-phase emissions from building material samples by combining two gas-sensor arrays

Objective

- Objective: assessment of the *a priori* discrimination power of a merged system integrating 2 different gas sensor arrays to emissions of 20 building materials
- Part of the European project SysPAQ
(Müller et al., 2008, presented at Indoor Air 2008, paper id 530)
- Experiments were performed by AlphaMOS using 24 individual metal oxide sensors and FZK-IMT using the Kamina chip of 38 sensor segments
(details presented in Goschnick et al., Indoor Air 2008, paper id 259)
- Building material samples were provided by DTU and SBi from Denmark.

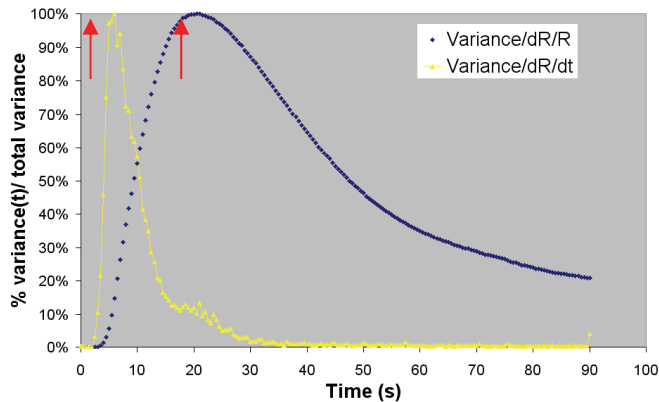
Signal feature extraction from sensor array response

→ Selection of signal feature: 3 different features tested, **relative change in resistance $\Delta R/R$** , **resistance change rate dR/dt** and **time to reach maximum signal change t_{max}** to improve discrimination

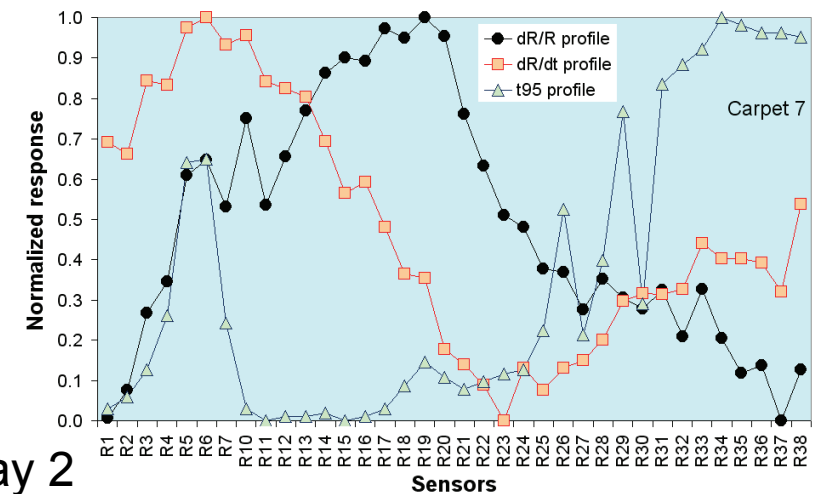
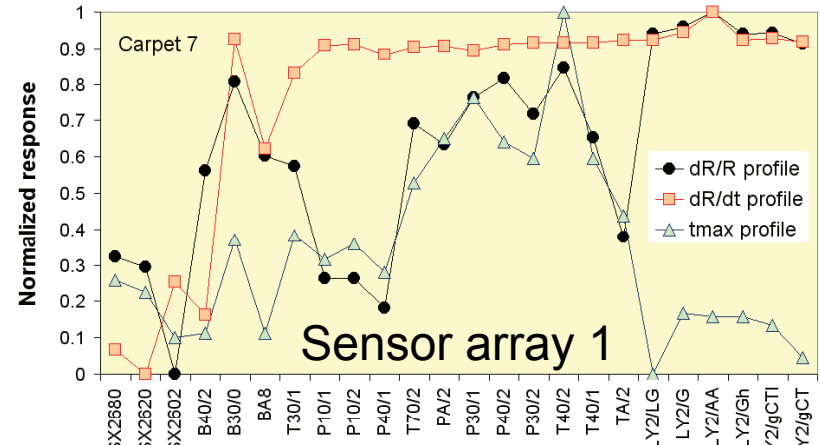


Selection of optimal profile

→ Selection of optimal profile → time at maximum inter-sensor variance



Construction of several data matrixes using the signal features for the 2 sensor arrays and the merged system



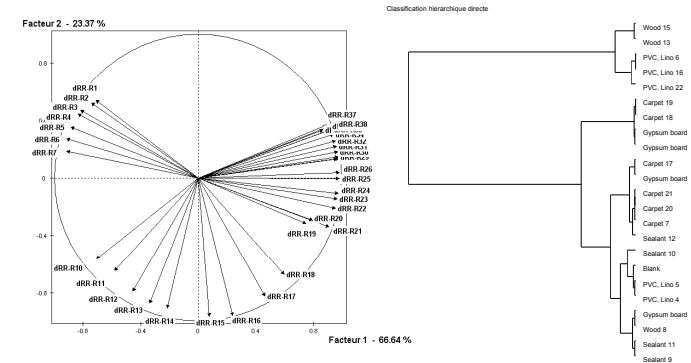
Sensor array 2

Multivariate statistical analysis

For each data matrix, we perform the following:

→ Principal component analysis

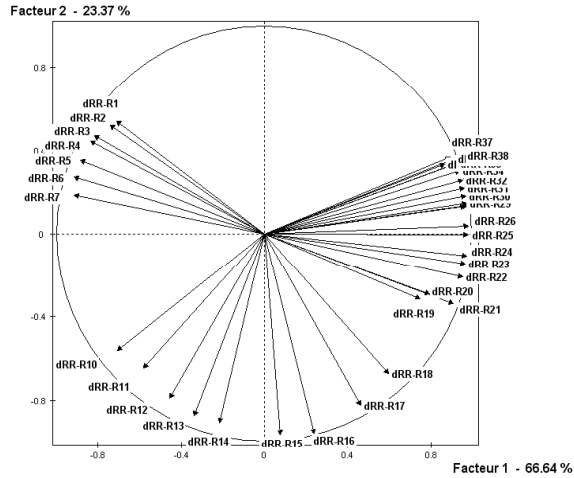
→ Hierarchical classification on all dimensions



→ Automatic selection of the 3 best partitions.

→ **Best discrimination is achieved for**

$$\frac{Inertia_{inter-classes}}{\max(Inertia_{intra-classes})} \quad \text{maximum}$$

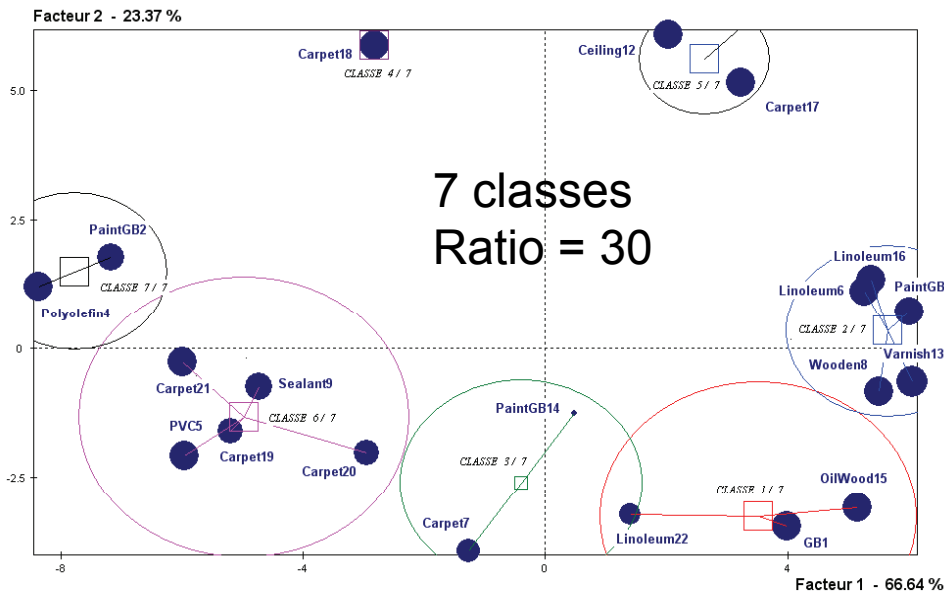
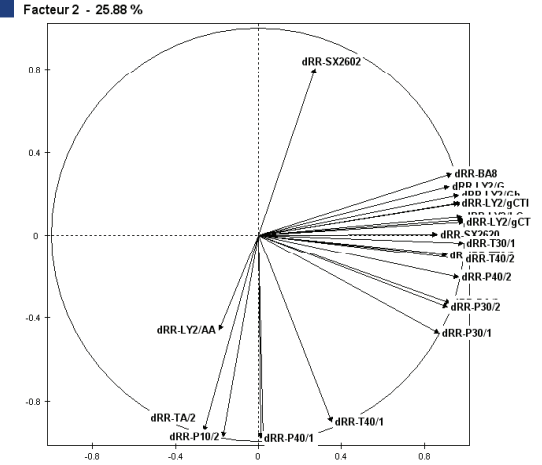


Array 1
38 sensor
Segments

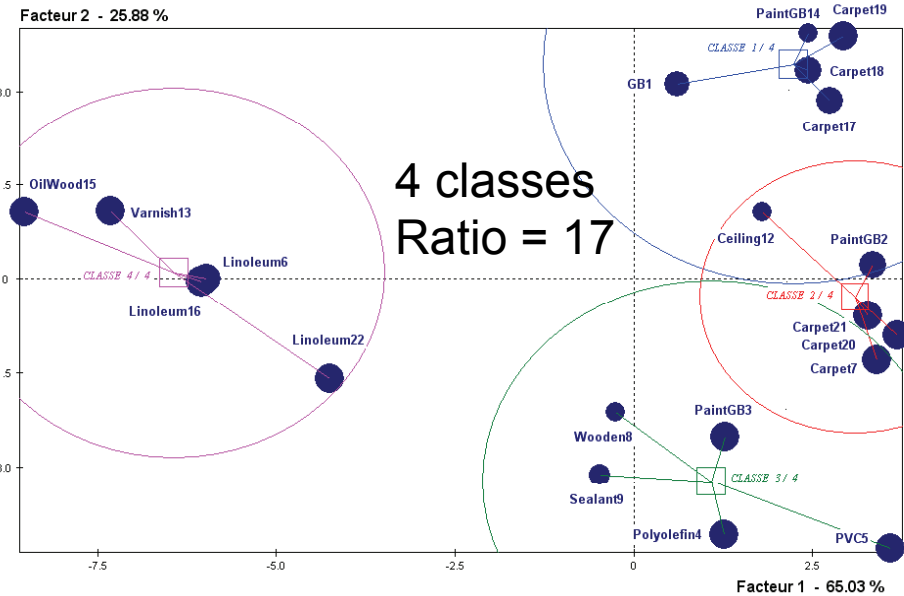
$$\Delta R/R$$

Array 2
24 individual
sensors

$$\Delta R/R$$



7 classes
Ratio = 30

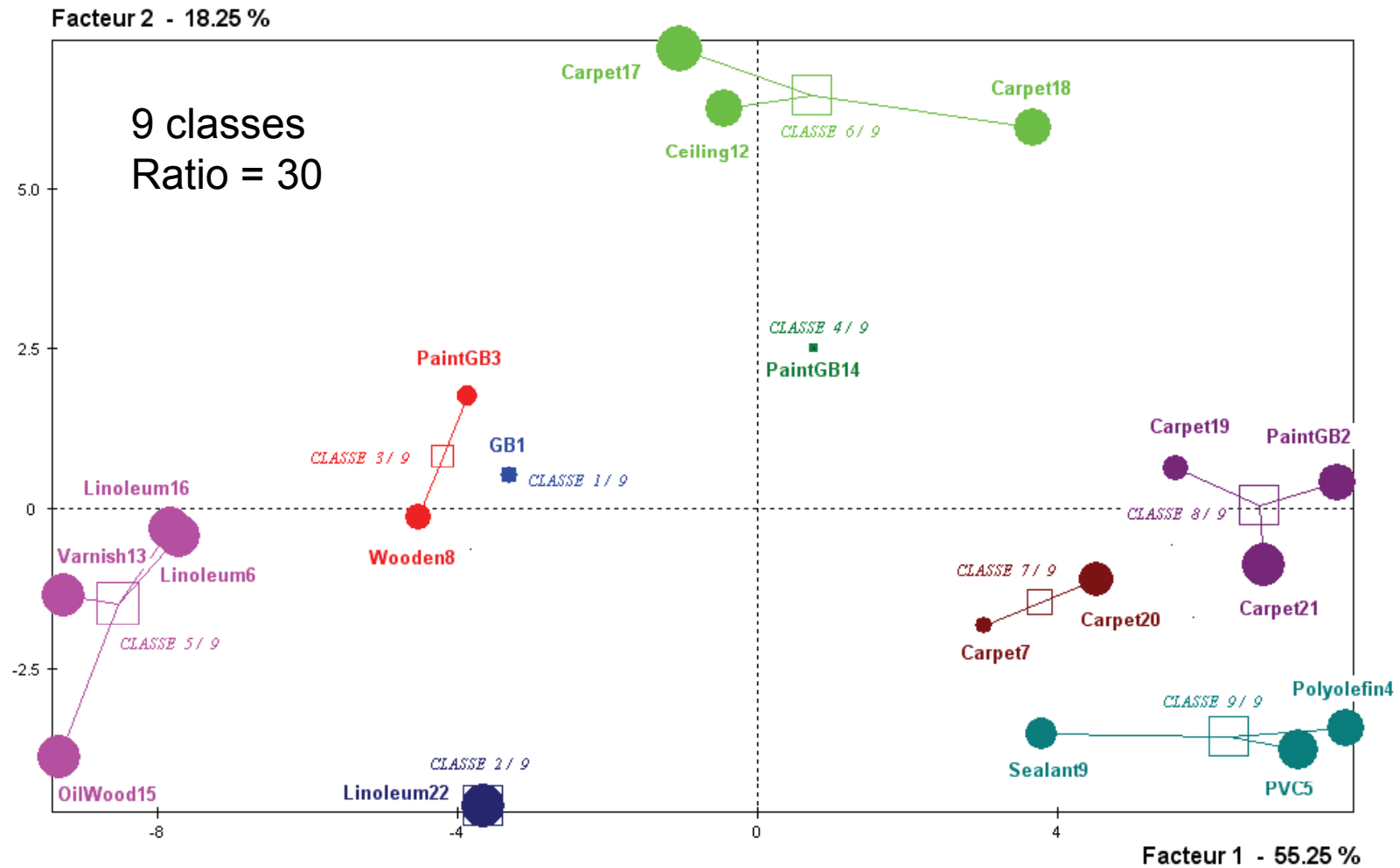


4 classes
Ratio = 17

Sensor array 1	Sensor array 2	Number of classes	I inter-classes / I total	I total	Max I intraclass	I inter / I intra ratio
24 individual MOS	38 sensor chip					
$\Delta R/R_0$ (max var)	$\Delta R/R_0$ (max var)	9	0.88	60	1.78	30
	$\Delta R/R_0$ (max var)	7	0.92	36	1.09	30
$\Delta R/R_0$ (max var)		4	0.84	24	1.17	17
	$\Delta R/R_0 + dR/dt + t_{95}$	10	0.84	108	6.33	14
	t_{95}	7	0.83	36	2.19	14
$\Delta R/R_0 + dR/dt + t_{max}$		5	0.78	71	4.96	11
dR/dt (max var)		5	0.83	23	2.21	9
t_{max}		4	0.73	24	2.24	8
	dR/dt (max var)	5	0.73	36	4.23	6
$\Delta R/R_0 + dR/dt + t_{max}$	$\Delta R/R_0 + dR/dt + t_{95}$	5	0.56	179	25.50	4

→ Best discrimination is achieved when merging relative change in resistances from the two sensor arrays.

Best discrimination



Conclusion

- According to the extracted feature, different *a priori* classifications of building materials can be achieved by sensor arrays.
- Data merging does not automatically improve discrimination
- This study presents a method to optimize discrimination and get homogeneous classes. Classes gather materials that share a common feature in the response of sensors.
- But in order to relate it to perceived air quality, the olfactory differences between samples need first to be assessed, e.g. *a priori* classification of building material based on reliable olfactory information.