Implementation of Ethera's indoor air quality monitoring solution in Grenoble city' schools

Hugues FRADET, Grenoble City

Romain FRANÇOIS, Ethera

June 19 & 20 2018, Paris, France

Monitoring IAQ in schools

The city of Grenoble has been engaged for several years to improve IAQ in schools.

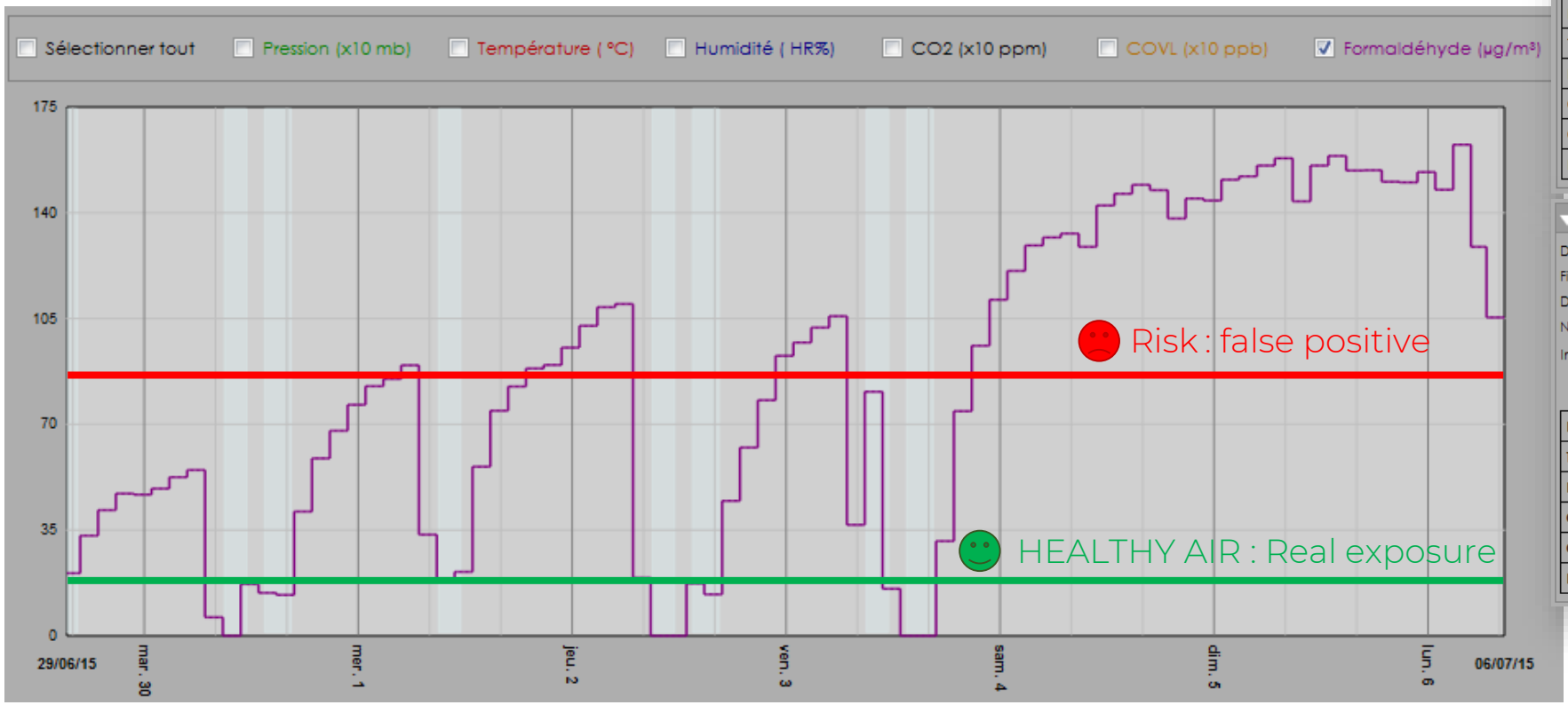
This program focuses on the following points:

- **Improve the construction of new schools** (with less emissive materials and high-speed ventilation systems)
- **Set health prescriptions into its public markets** (paints, schools supplies, cleaning products, …)
- **Monitor IAQ permanently in schools and kindergartens** (with specific static or continuous measurements – French regulation on IAQ)
- **Set up IAQ training for teachers and school's staff**

Why IAQ continuous measurements ?

French regulation : Possibility to use continuous measurement if the sensor get :

- A high specificity
- A low quantification limit
- The ability to perform measurements during 4,5 days minimum



Mesures

Début	29/6/15 15:19:18
Fin	6/7/15 08:44:18
Durée totale	6 jours 17 h 25 min 0 s
Nb mesures unitaires	1938
Indice de confinement	0 Confinement nul

	Min.	Max.	Moy.
Pression	987 mb	996 mb	992 mb
Température	25.5 °C	29.0 °C	27.5 °C
Humidité	43 HR%	63 HR%	55 HR%
CO2	342 ppm	1639 ppm	530 ppm
COVL	40 ppb	265 ppb	139 ppb
Formaldéhyde	--	162.6 µg/m³	85.0 µg/m³

Mesures

Début	29/6/15 15:19:18
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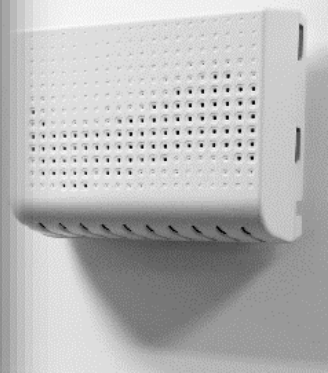
	Min.	Max.	Moy.
Pression	989 mb	996 mb	993 mb
Température	26.5 °C	29.0 °C	27.7 °C
Humidité	45 HR%	63 HR%	53 HR%
CO2	472 ppm	1639 ppm	785 ppm
COVL	40 ppb	226 ppb	83 ppb
Formaldéhyde	--	80.8 µg/m³	16.8 µg/m³



Innovation in the air

Why IAQ continuous measurements ?

To get the real children's exposure

To understand the dynamics of indoor air pollution.

To put in place good practices

And what else?

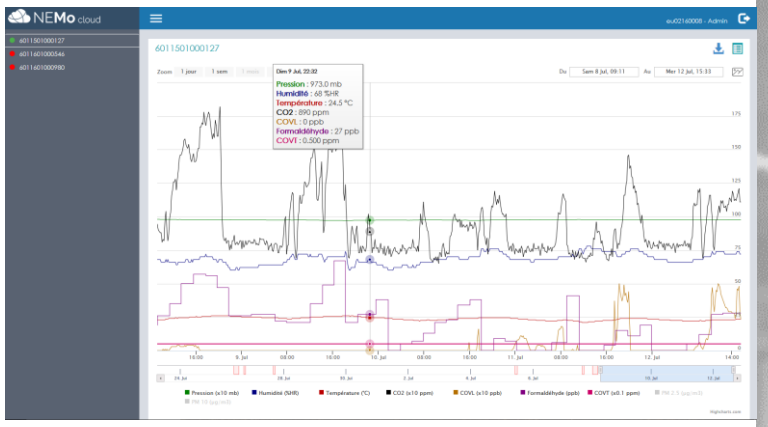
French regulatory : Only four chemical pollutants (carbon dioxide, formaldehyde, benzene and perchloroethylene).

More data on IAQ (Particulate matter, light VOCs, Total VOCs, …) can be useful, and we want them continuously .

NEMo XT: IAQ monitoring solution

Parameters

- Formaldehyde
- CO_2
- LVOCs
- TVOCs (PID)
- PM 2,5 / 10
- Temperature
- Hygrometry
- Pressure
- Radon
- Other parameters



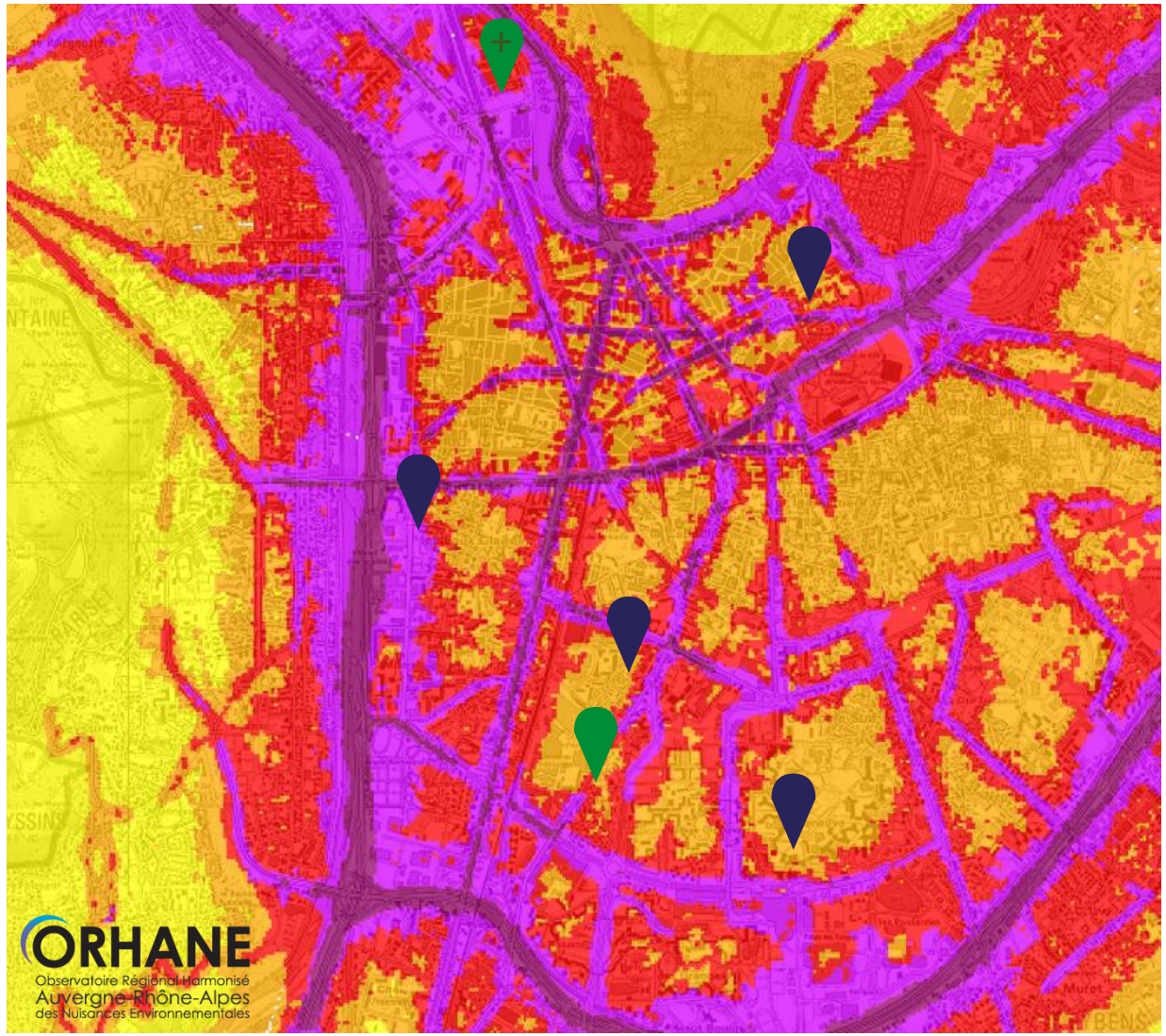
Advantages

- Continuous measurement (formaldehyde, CO_2...)
- Measurement of real exposure to pollutants
- Identification of pollution peaks
- Flexible and evolutionary configuration

Used for :

- Schools Indoor Air Quality monitoring
- Industry (with PID)
- Formol user (anatomical laboratory....)

Campaign description



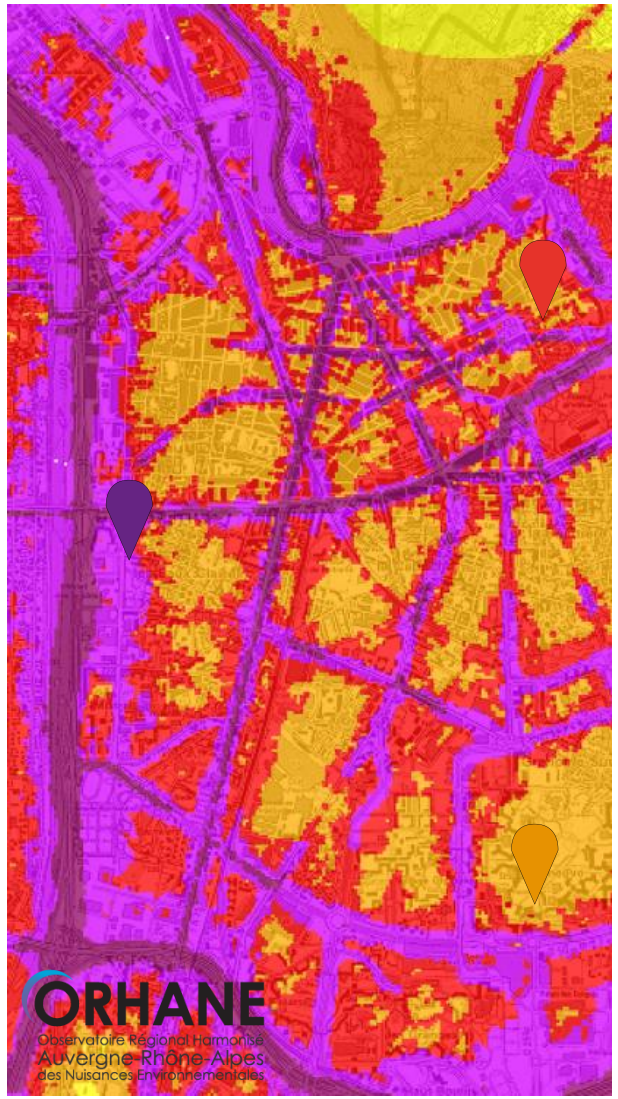
4 months (feb – may)

1 pollution peak

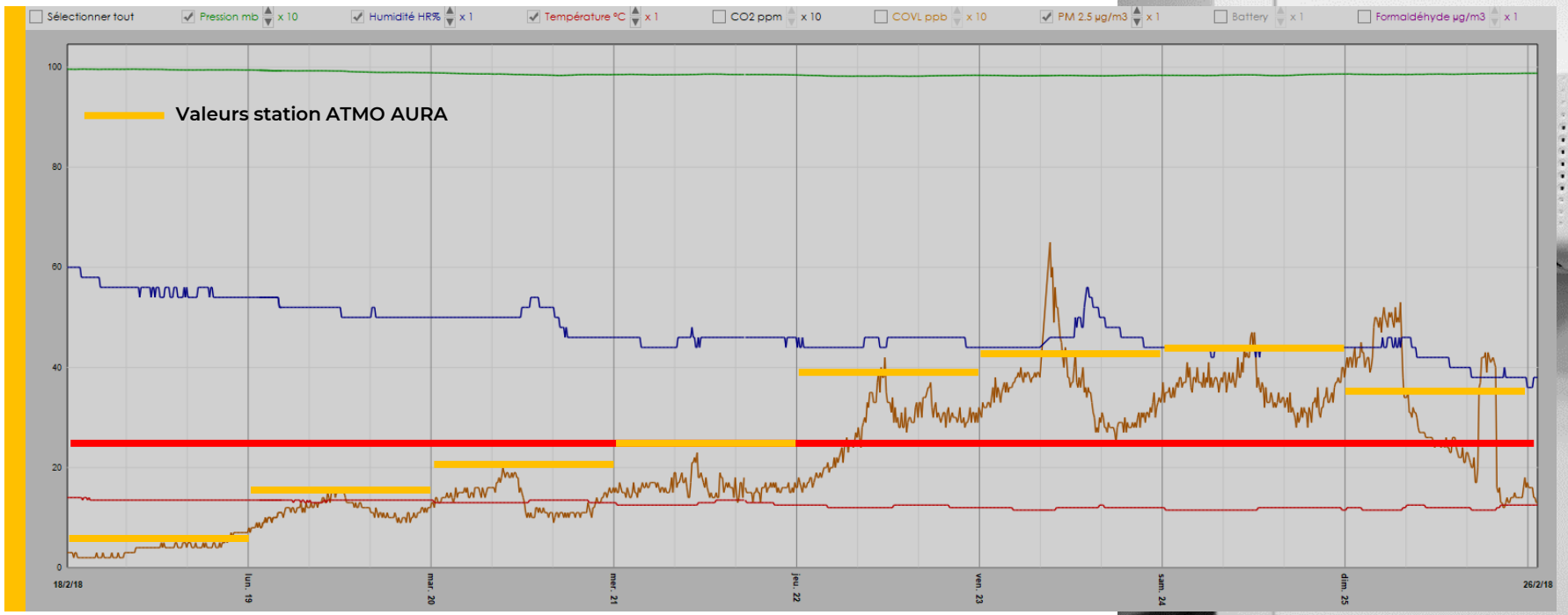
6 schools

- 4 “old” schools
- 1 “new” school with a 15 m^3/h/occupant air flow
- 1 “new” school with a 25 m^3/h/occupant air flow

Outdoor air impact on indoor air



1 pollution peak – February : sat 23 & sun 24



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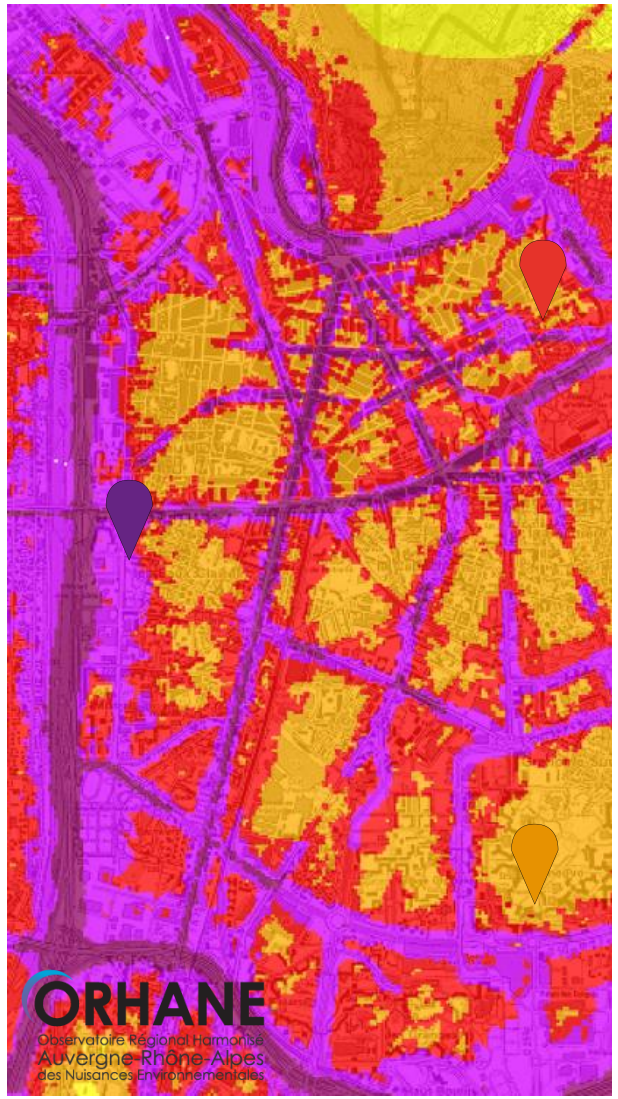

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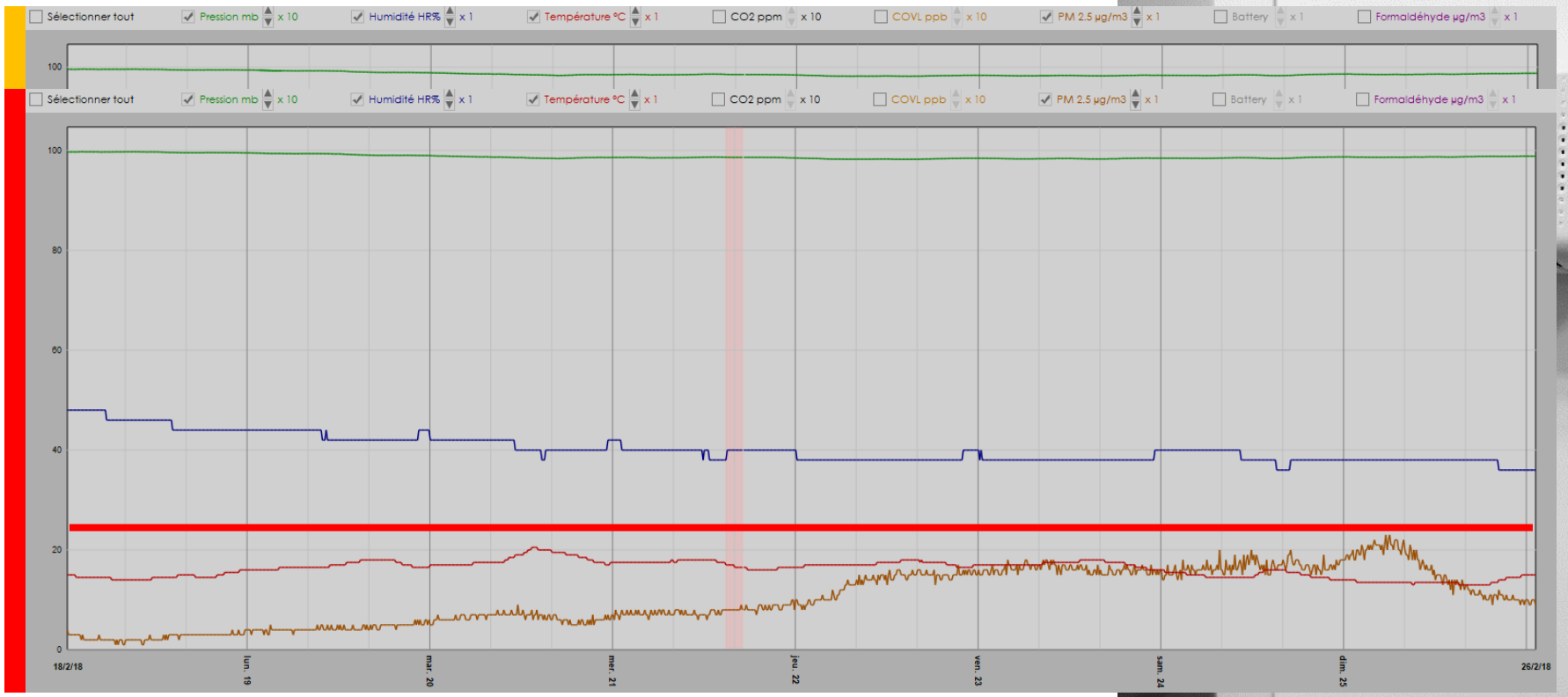
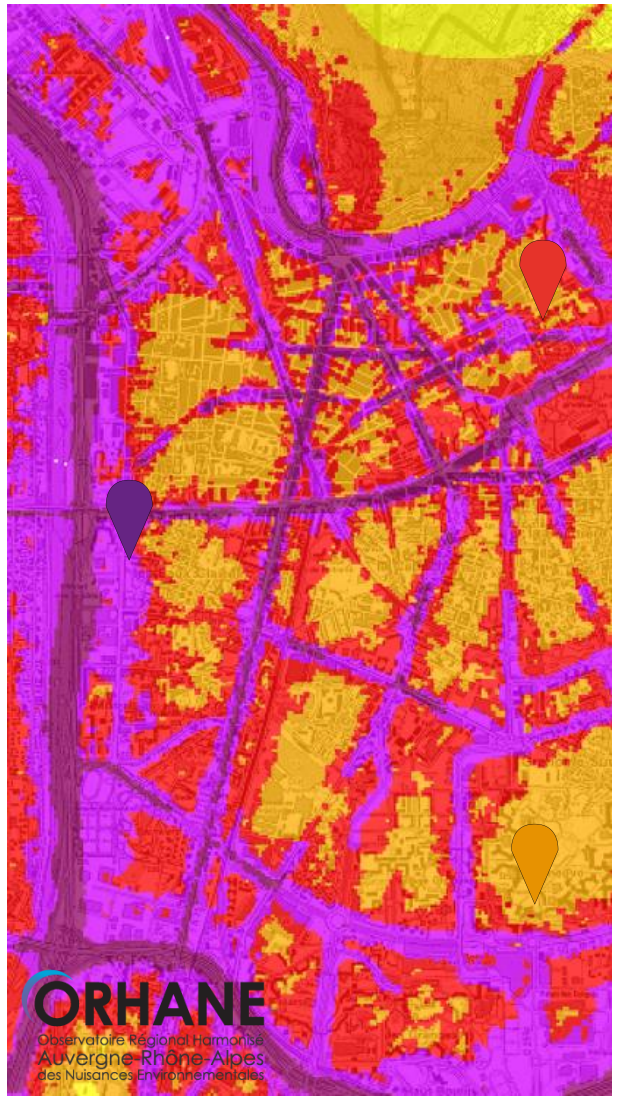


VILLE DE GRENOBLE

ethera
Innovation in the air

Outdoor air impact on indoor air



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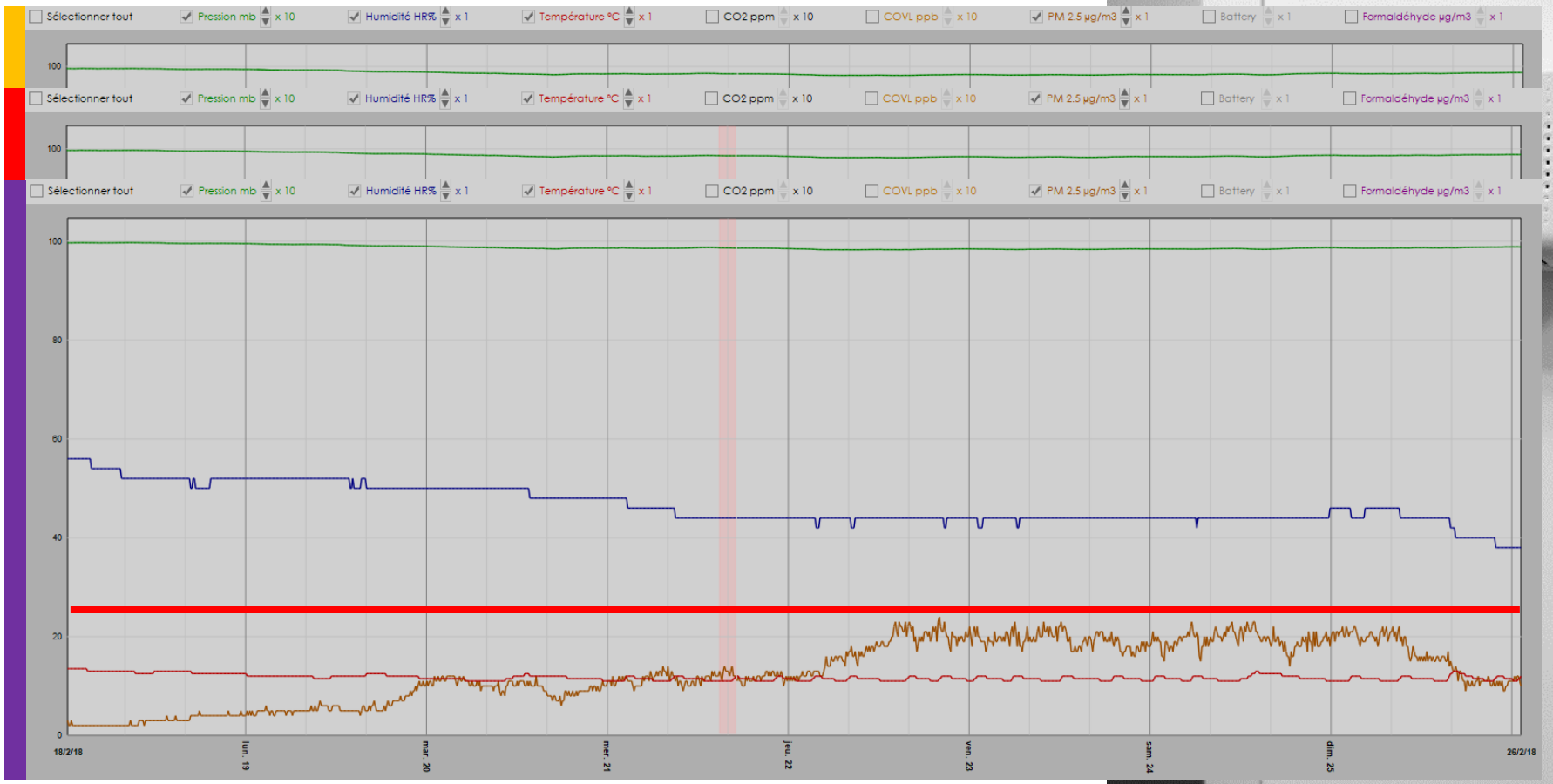

VILLE DE GRENOBLE

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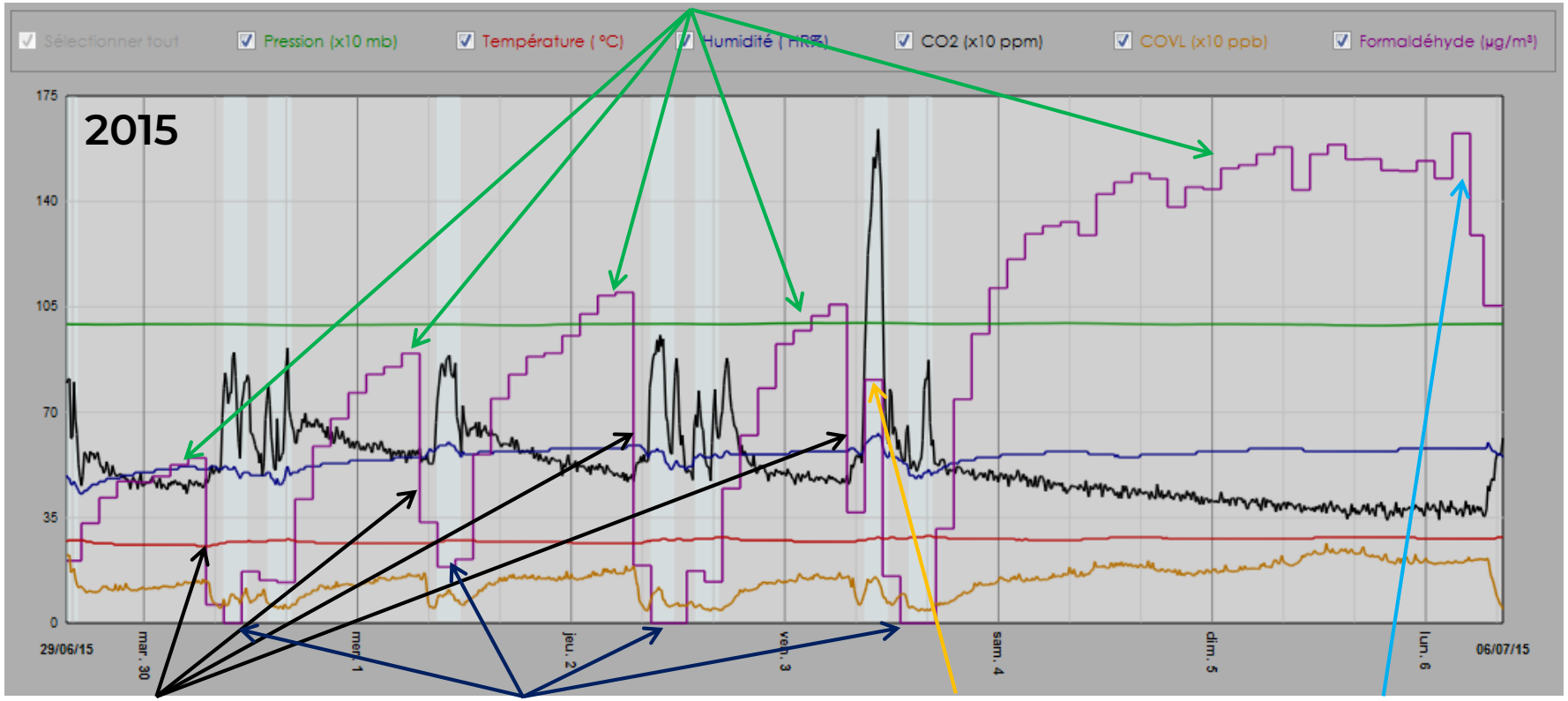
Innovation in the air

Time impact on indoor air

"new" School, Comparison **2015 vs 2018**
15 m^3/h/occupant air flow from 6 am to 6 pm
0 m^3/h/occupant air flow from 6 pm to 6 am

Air flow reduction during nights & WE



Airing

Ventilation

VOCs Emission

Ventilation start

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Time impact on indoor air

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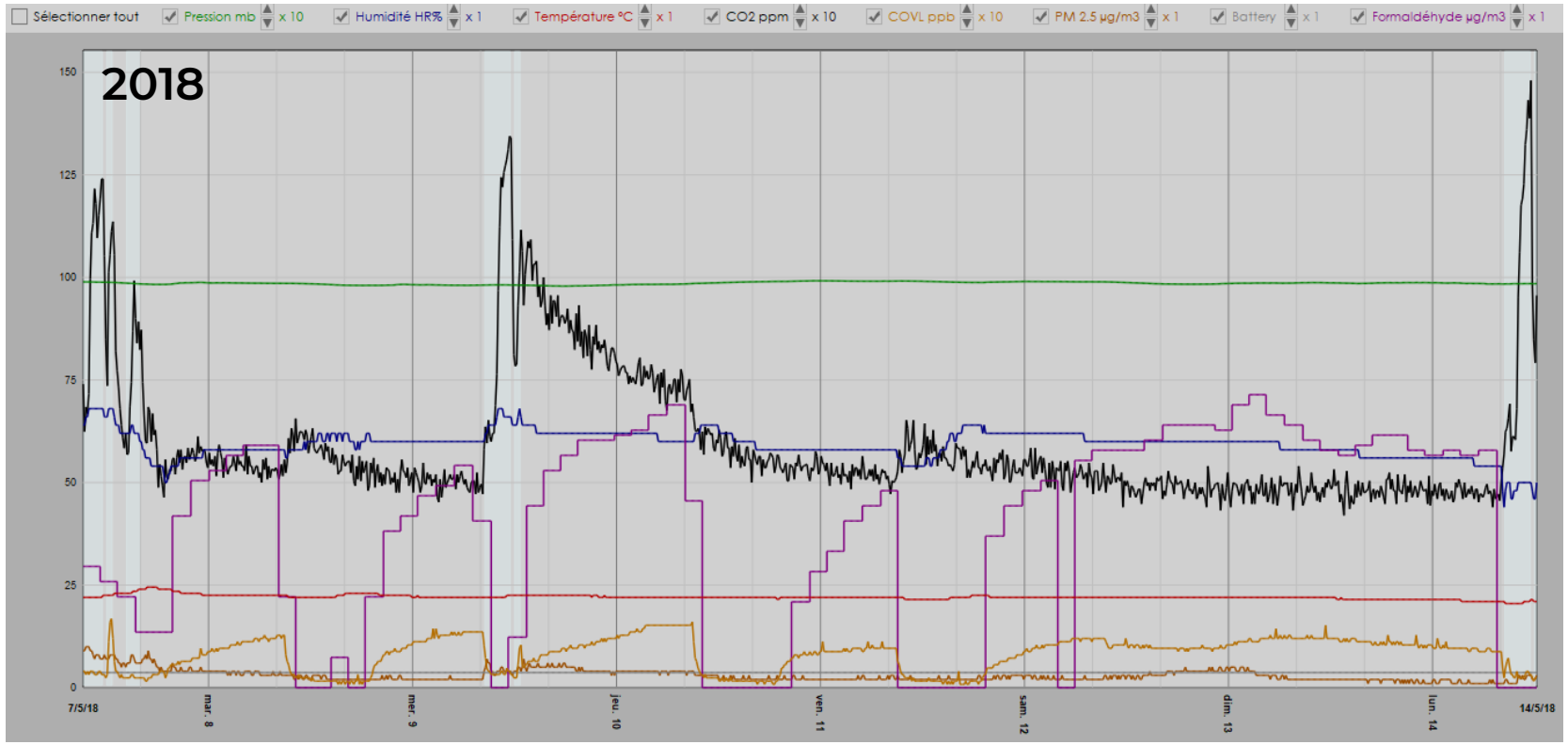

Mesures

Du 7/5/18 09:15:21 au 14/5/18 12:15:05
Durée totale 7 jours 2 h 59 min 44 s
Nb mesures unitaires 1027
Indice de confinement 1
Semaine type 5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	981 mb	989 mb	985 mb
Humidité	46 HR%	68 HR%	61 HR%
Température	20.5 °C	24.0 °C	21.9 °C
CO2	568 ppm	1432 ppm	920 ppm
COVL	24 ppb	168 ppb	40 ppb
PM 2.5	1 µg/m3	10 µg/m3	5 µg/m3
Battery	3.6875	3.6875	3.6875
Formaldéhyde	0 µg/m3	40.6 µg/m3	13.9 µg/m3

Innovation in the air

Time impact on indoor air

"new" School, Comparison **2015 vs 2018**
15 m^3/h/occupant air flow from 6 am to 6 pm
0 m^3/h/occupant air flow from 6 pm to 6 am

Mesures **2015**

Début	29/6/15 15:19:18
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Durée totale	6 jours 17 h 25 min 0 s
Nb mesures unitaires	1938
Indice de confinement	0 Confinement nul

	Min.	Max.	Moy.
Pression	989 mb	996 mb	993 mb
Température	26.5 °C	29.0 °C	27.7 °C
Humidité	45 HR%	63 HR%	53 HR%
CO2	472 ppm	1639 ppm	785 ppm
COVL	40 ppb	226 ppb	83 ppb
Formaldéhyde	--	80.8 µg/m³	16.8 µg/m³

Mesures **2018**

Du 7/5/18 09:15:21 au 14/5/18 12:15:05	
Durée totale	7 jours 2 h 59 min 44 s
Nb mesures unitaires	1027
Indice de confinement	1
Semaine type	5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	981 mb	989 mb	985 mb
Humidité	46 HR%	68 HR%	61 HR%
Température	20.5 °C	24.0 °C	21.9 °C
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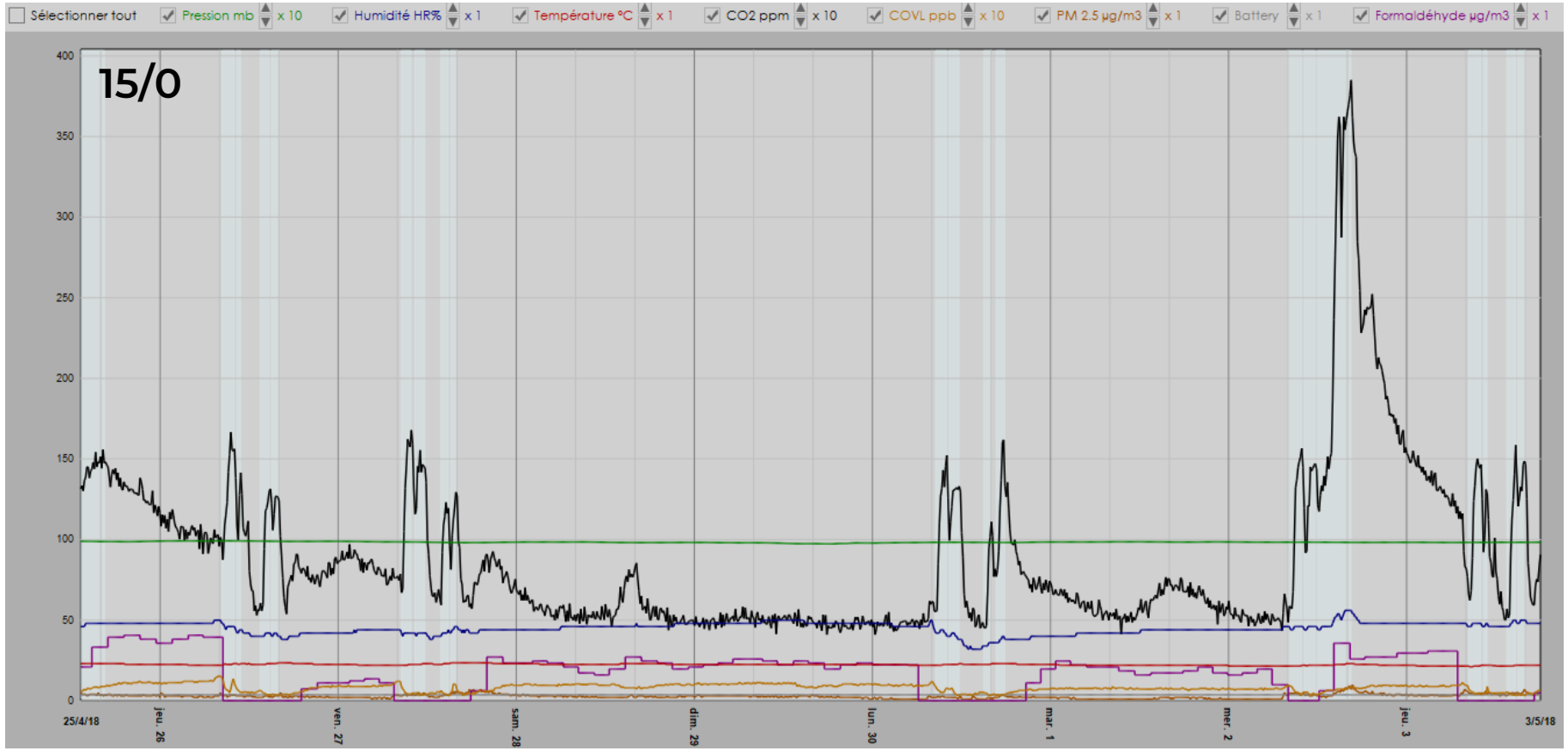
Formaldéhyde	0 µg/m3	40.6 µg/m3	13.9 µg/m3

HCAV system impact on indoor air

"new" School, Comparison **15 m³/h/occupant vs 25m³/h/occupant**
15 / 25 m³/h/occupant air flow from 6 am to 6 pm
0 / 10 m³/h/occupant air flow from 6 pm to 6 am



Mesures

Du 25/4/18 13:18:08 au 3/5/18 18:01:52
Durée totale 8 jours 4 h 43 min 44 s
Nb mesures unitaires 1181
Indice de confinement 2
Semaine type 5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	981 mb	992 mb	985 mb
Humidité	34 HR%	56 HR%	45 HR%
Température	21.0 °C	23.5 °C	22.4 °C
CO2	450 ppm	3758 ppm	1365 ppm
COVL	32 ppb	136 ppb	57 ppb
PM 2.5	1 µg/m3	9 µg/m3	4 µg/m3
Battery	3.6875	3.6875	3.6875
Formaldéhyde	0 µg/m3	39.3 µg/m3	6.4 µg/m3

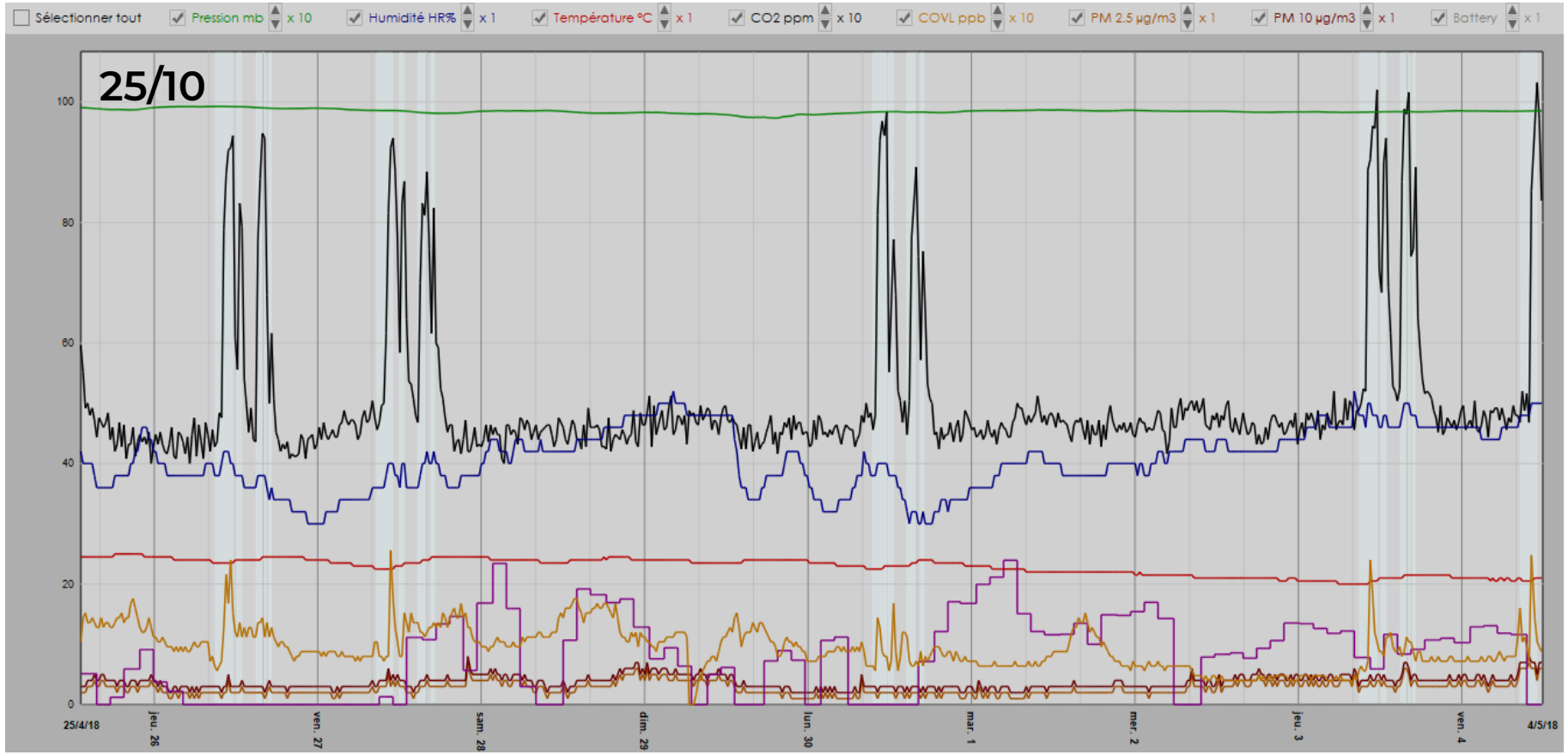
Innovation in the air

HCAV system impact on indoor air

"new" School, Comparison **15 m³/h/occupant vs 25m³/h/occupant**

15 / 25 m³/h/occupant air flow from 6 am to 6 pm

0 / 10 m³/h/occupant air flow from 6 pm to 6 am



Mesures

Du 25/4/18 13:13:14 au 4/5/18 11:52:54

Durée totale 8 jours 22 h 39 min 40 s

Nb mesures unitaires 1284

Indice de confinement 0

Semaine type 5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	981 mb	993 mb	986 mb
Humidité	30 HR%	52 HR%	41 HR%
Température	20.0 °C	24.5 °C	22.5 °C
CO2	436 ppm	1060 ppm	732 ppm
COVL	48 ppb	288 ppb	110 ppb
PM 2.5	1 µg/m3	8 µg/m3	3 µg/m3
PM 10	2 µg/m3	9 µg/m3	4 µg/m3
Battery	0.0000	0.0000	0.0000
Formaldéhyde	0 µg/m3	11.6 µg/m3	3.4 µg/m3

HCAV system impact on indoor air

"new" School, Comparison **15 m³/h/occupant vs 25m³/h/occupant**
15 / 25 m³/h/occupant air flow from 6 am to 6 pm
0 / 10 m³/h/occupant air flow from 6 pm to 6 am

Mesures **15/0**

Du 25/4/18 13:18:08 au 3/5/18 18:01:52
Durée totale 8 jours 4 h 43 min 44 s
Nb mesures unitaires 1181
Indice de confinement 2
Semaine type 5 jours, 28 H modifié

	Min.	Max.	Moy.
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PM 2.5	1 µg/m3	9 µg/m3	4 µg/m3
Battery	3.6875	3.6875	3.6875
Formaldéhyde	0 µg/m3	39.3 µg/m3	6.4 µg/m3

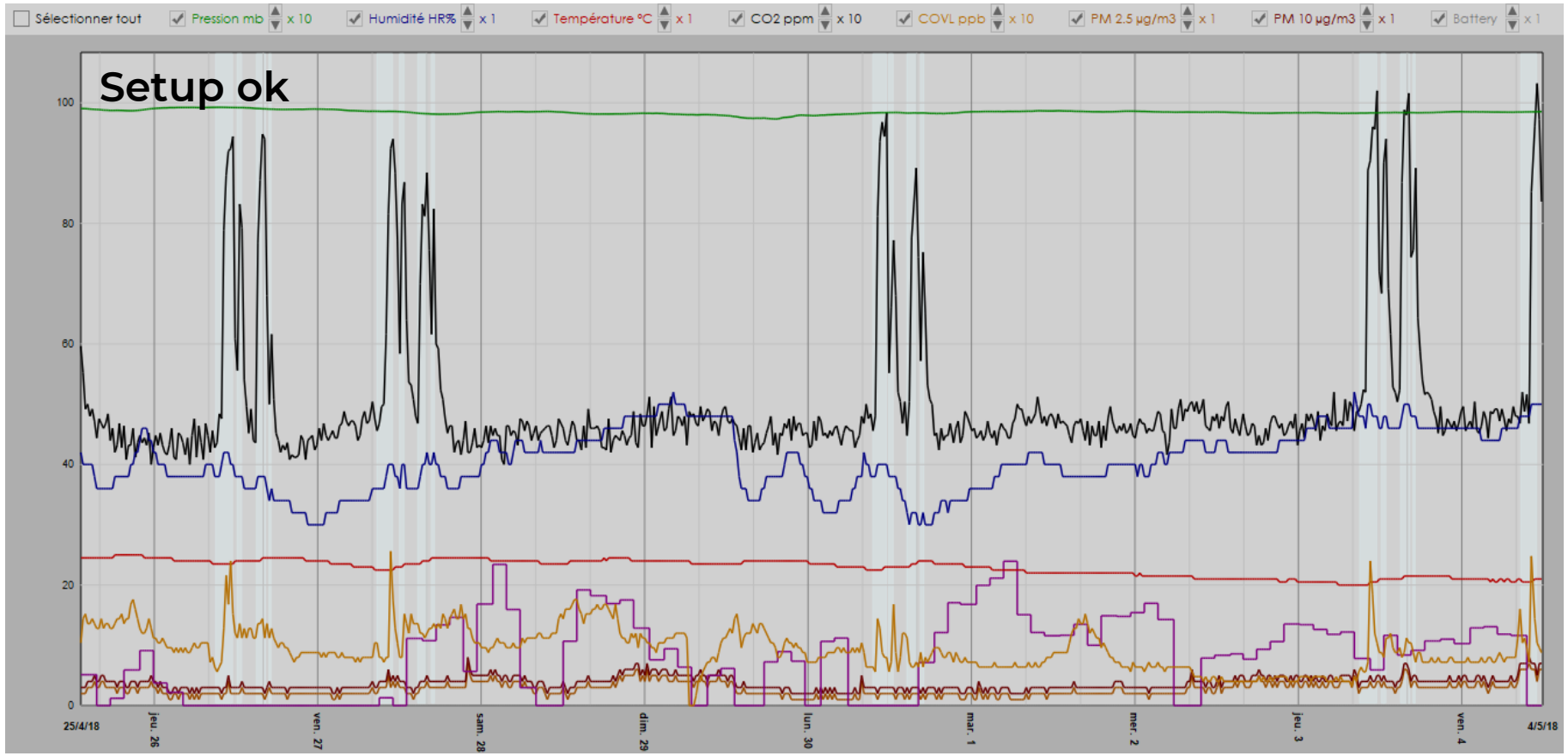
Mesures **25/10**

Du 25/4/18 13:13:14 au 4/5/18 11:52:54
Durée totale 8 jours 22 h 39 min 40 s
Nb mesures unitaires 1284
Indice de confinement 0
Semaine type 5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	981 mb	993 mb	986 mb
Humidité	30 HR%	52 HR%	41 HR%
Température	20.0 °C	24.5 °C	22.5 °C
CO2	436 ppm	1060 ppm	732 ppm
COVL	48 ppb	288 ppb	110 ppb
PM 2.5	1 µg/m3	8 µg/m3	3 µg/m3
PM 10	2 µg/m3	9 µg/m3	4 µg/m3
Battery	0.0000	0.0000	0.0000
Formaldéhyde	0 µg/m3	11.6 µg/m3	3.4 µg/m3

HVAC system setup impact on indoor air

"new" School, Comparison **25m³/h/occupant**
25 m³/h/occupant air flow from 6 am to 6 pm
10 m³/h/occupant air flow from 6 pm to 6 am



Mesures

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Durée totale 8 jours 22 h 39 min 40 s
Nb mesures unitaires 1284
Indice de confinement 0
Semaine type 5 jours, 28 H modifié

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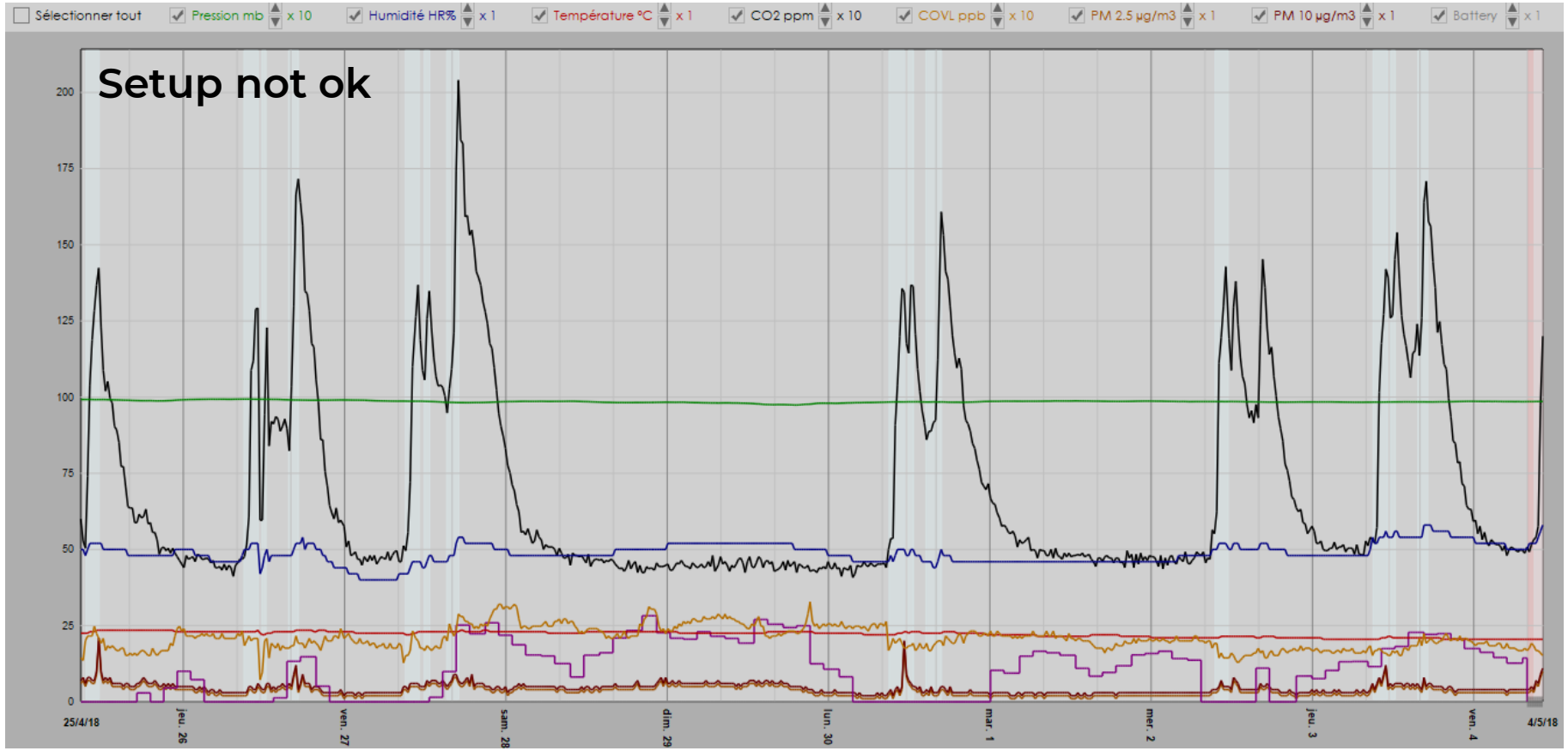
PM 2.5	1 µg/m3	8 µg/m3	3 µg/m3
PM 10	2 µg/m3	9 µg/m3	4 µg/m3
Battery	0.0000	0.0000	0.0000
Formaldéhyde	0 µg/m3	11.6 µg/m3	3.4 µg/m3

HVAC system setup impact on indoor air

"new" School, Comparison **25m³/h/occupant**

25 m³/h/occupant air flow from 6 am to 6 pm

10 m³/h/occupant air flow from 6 pm to 6 am



Mesures

Du 25/4/18 08:45:33 au 4/5/18 10:15:48

Durée totale 9 jours 1 h 30 min 15 s

Nb mesures unitaires 1297

Indice de confinement 2

Semaine type 5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	982 mb	994 mb	987 mb
Humidité	42 HR%	58 HR%	50 HR%
Température	20.5 °C	23.5 °C	22.2 °C
CO2	476 ppm	2040 ppm	1091 ppm
COVL	96 ppb	288 ppb	190 ppb
PM 2.5	1 µg/m3	20 µg/m3	5 µg/m3
PM 10	2 µg/m3	21 µg/m3	6 µg/m3
Battery	0.0000	0.0000	0.0000
Formaldéhyde	0 µg/m3	25.1 µg/m3	5.1 µg/m3

HVAC system setup impact on indoor air

"new" School, Comparison **25m³/h/occupant**
25 m³/h/occupant air flow from 6 am to 6 pm
10 m³/h/occupant air flow from 6 pm to 6 am

Mesures **Setup ok**

Du 25/4/18 13:13:14 au 4/5/18 11:52:54

Durée totale	8 jours 22 h 39 min 40 s
Nb mesures unitaires	1284
Indice de confinement	0
Semaine type	5 jours, 28 H modifié

	Min.	Max.	Moy.
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PM 10	2 µg/m3	9 µg/m3	4 µg/m3
Battery	0.0000	0.0000	0.0000
Formaldéhyde	0 µg/m3	11.6 µg/m3	3.4 µg/m3

Mesures **Setup not ok**

Du 25/4/18 08:45:33 au 4/5/18 10:15:48

Durée totale	9 jours 1 h 30 min 15 s
Nb mesures unitaires	1297
Indice de confinement	2
Semaine type	5 jours, 28 H modifié

	Min.	Max.	Moy.
Pression	982 mb	994 mb	987 mb
Humidité	42 HR%	58 HR%	50 HR%
Température	20.5 °C	23.5 °C	22.2 °C
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Battery	0.0000	0.0000	0.0000
Formaldéhyde	0 µg/m3	25.1 µg/m3	5.1 µg/m3

Conclusion

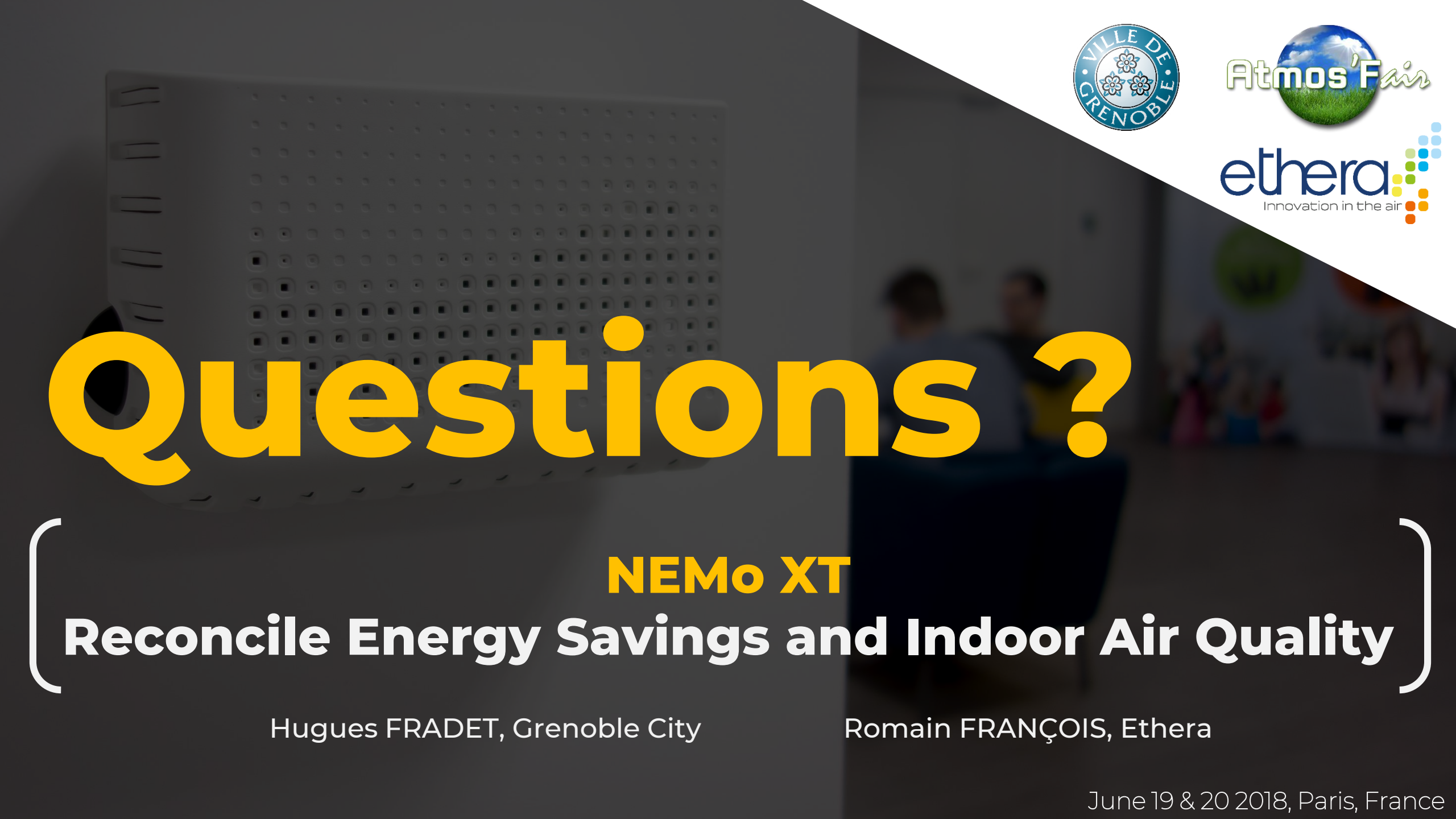
Indoor air pollution is complex due to the mix of indoor and outdoor sources

Measuring outdoor air pollutants in indoor air helps to identify schools that can be affected by outdoor pollution

Formaldehyde 2023 IAGV can be respected with HVAC system's legal airflow (15 m3/h/occupant).

- If materials' emission are low
- If HVAC system is well setup
- Monitoring IAQ permanently can help to optimize/control HVAC system to ensure a good IAQ

Continuous measurement is necessary to study Indoor Air Quality



Questions ?

NEMo XT

Reconcile Energy Savings and Indoor Air Quality

Hugues FRADET, Grenoble City

Romain FRANÇOIS, Ethera

June 19 & 20 2018, Paris, France