Jornada Técnica *on-line*

AGUASRESIDUALES.INFO

Innovaciones en la Gestión de Olores: E-noses, o Sistemas Instrumentales de Vigilancia del Olor (SIVO)

09 MAYO

16:30
Hora España

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ellona

AMBIENTE ET ODORA S.L.

IBEC
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ELLONA

Hablemos de SIVOS:

- Cómo se integra in SIVO en la nueva gestión integral y digital
- Qué debe tener un SIVO para hacerte la vida más fácil
- Qué tipos de información de olor puedes extraer de un SIVO
- Cómo se entrenan los modelos cyberfísicos de olor
- Cuáles son los casos de uso más habituales

Tendencias en gestión y operación

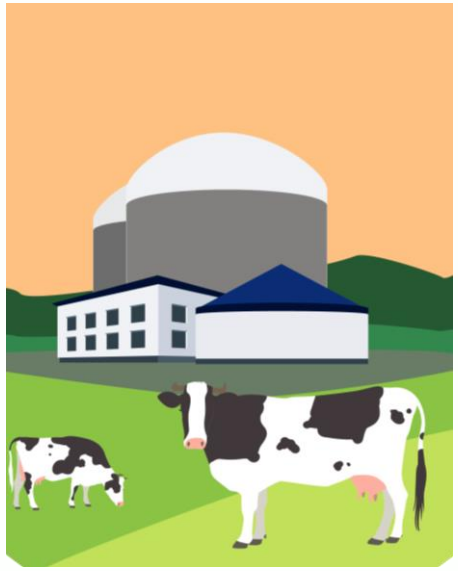
Infraestructuras sostenibles

Crisis energética & Sequía

Enfoque en la Circularidad

Inversión en Biogas y Biometano

Auge de Citizen Science



Infraestructuras reguladas

Directiva de Emisiones Industriales

BAT (Best Available Technologies)

- Olfactometry
- Field Inspection
- Odour surveys
- Electronic sensor systems

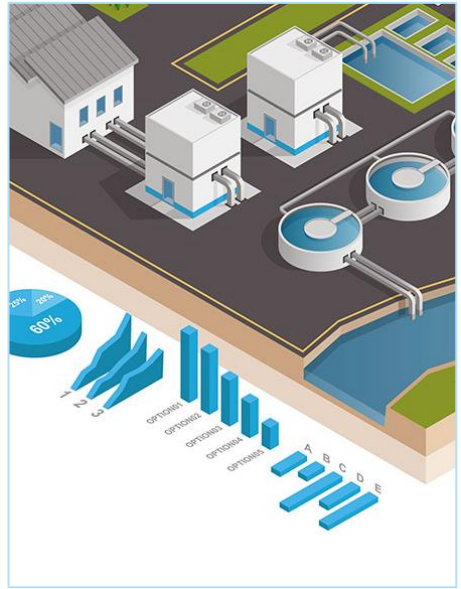
Digital Water

Digital Twins

IA & Nowcasting, toma de decisiones

Monitorización continua

“Rubish in rubish out”



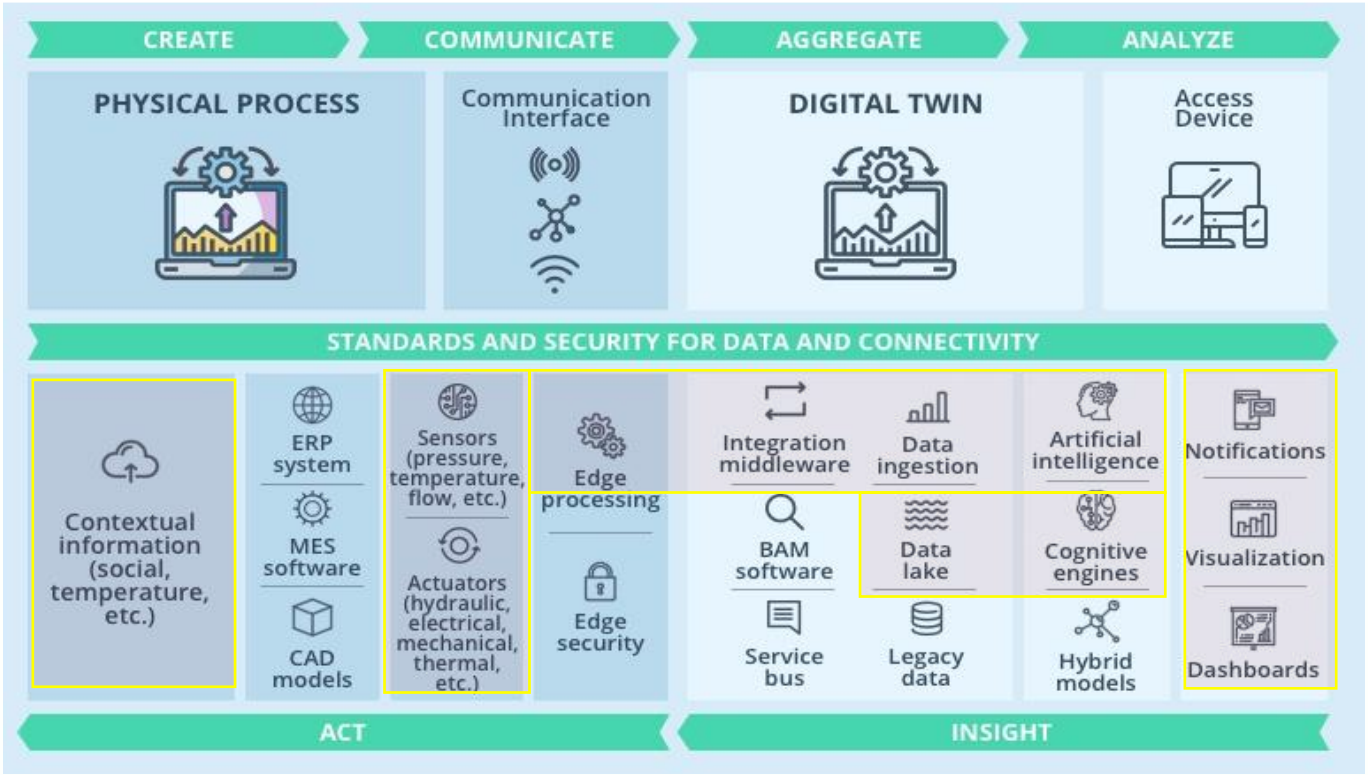
La utopía digital y sostenible

ODOUR IMPACT ASSESSMENT

	Measurements		Mathematical Methods
	Sensorial	Instrumental	
Emisión / Sources 	• Dynamic Olfactometry (EN13725:2003) • GC-Olfactometry	• Chemical Analysis • Electronic nose (IOMS)(SIVO)	• Odour emisión factor (OEF) • Emission Inventory
Inmisión / Receptor 	• Field inspection (EN16841:2016) • Field olfactometry • Citizen Science (PNE77270)	• Chemical Analysis • Electronic nose (IOMS)(SIVO)	• Dispersion Models • Back-trajectories

Source: Laura Capelli

SUSTAINABLE & DIGITAL INFRASTRUCTURE



ODOUR CONSULTING & MANAGEMENT

Diseño de Proyecto	PGO (Planes de Gestión)	Integración de Sistemas

ODOUR CONTROL TECHNOLOGIES

Biological Methods	Chemical Methods	Physical methods	Adsorption	Ozone	Thermal	Photocatalytic

☑ Reduce OPEX ☑ Improve ESG Performance ☑ Reduce Risks

II.

Cuál es la mejor tecnología disponible de SIVOS?

SIVO = SISTEMA ...

Sensores

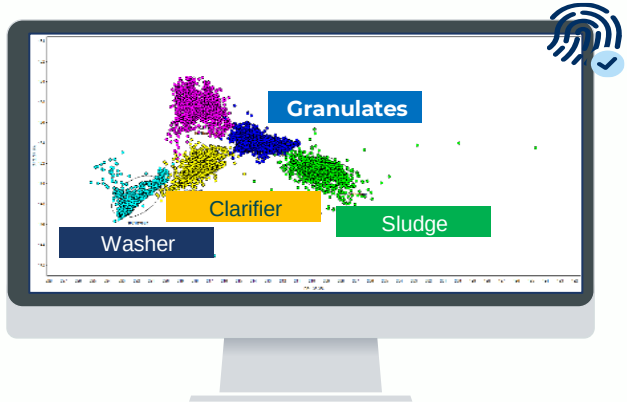
- Olores
- Calidad del Aire
- Gases
- Partículas
- Ruido
- Temperatura
- Humedad
- Vibración
- Presión
- Luz

Recolección de Datos

WiFi
LoRa
LTE-M
Ethernet

Procesamiento Avanzado de datos

✓-Plataforma avanzada de tratamiento de datos



✓- Identificación de huella de olor

De los datos a la acción

- ✓Monitorización continua y en tiempo real
- ✓Visualización de datos complejos
- ✓Integración de datos meteorológicos
- ✓Notificaciones de alerta personalizadas y automáticas
- ✓Acceso a alertas en tiempo real
- ✓Exportación de datos e informes avanzados
- ✓Integración vía API

ORTELIUM
nasapp
SUEZ
ODOUR COLLECT
ellona

Una gama de accesorios

Panel solar

Muestreo Automático

Cámara de muestreo

Tejado protector

Dryer

Sensores de agua y tierra

Estación Meteo

- Wind speed and direction
- Pluviometry
- Temperature and relative humidity
- Atmospheric pressure
- Solar irradiance
- Autonomous wireless communication

WT1 + Dryer: Una solución para fuentes canalizadas

1 **Muestreo: Linea de trasmisión calefactada**

2 **Secado**

3 **Análisis: WT-1**

4 **Entrada adicional**

Un sistema de captura de feedback de operación

Real-time user feedback

Mapeo Ciencia Ciudadana (PNE77270)

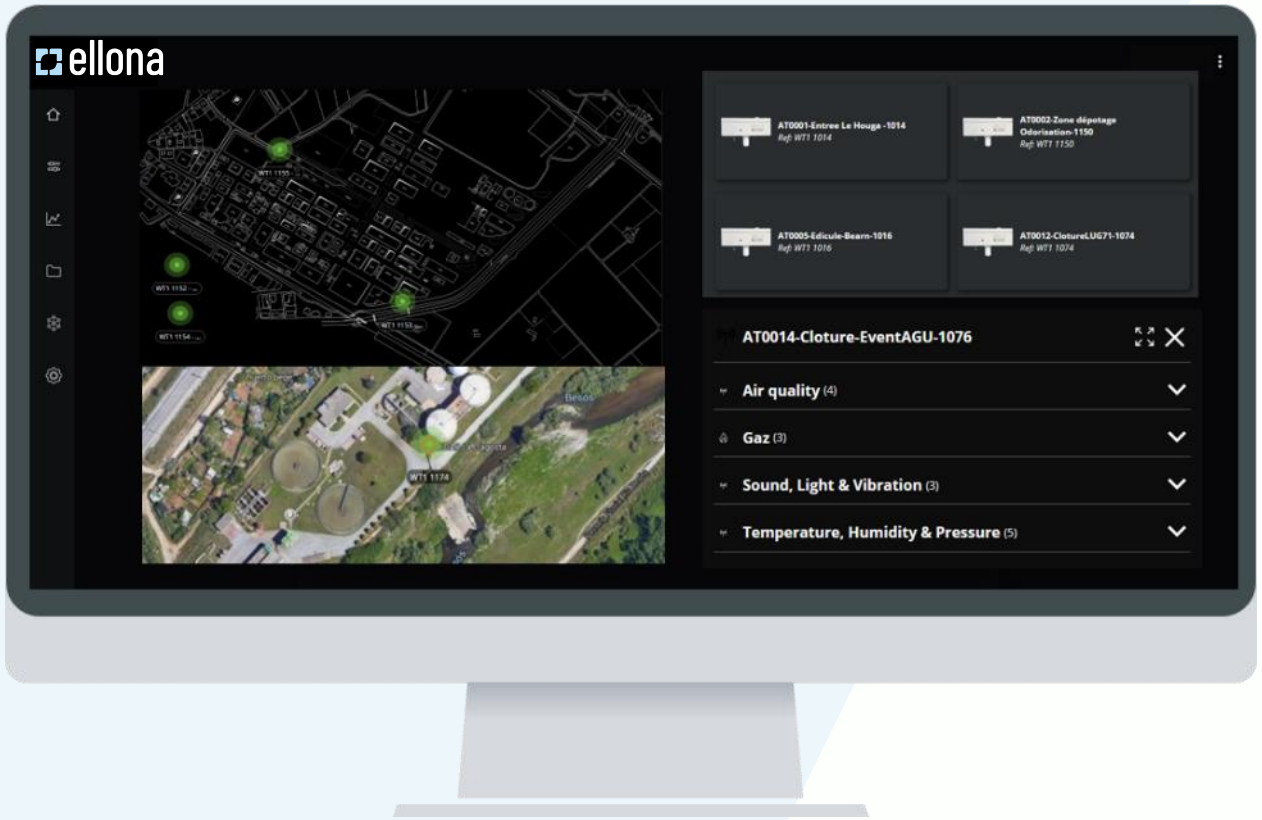
- **Individual & subjective assessment of wellbeing via QR code**
- **Personalized surveys**

Una plataforma IoT abierta

Ellonasoft platform

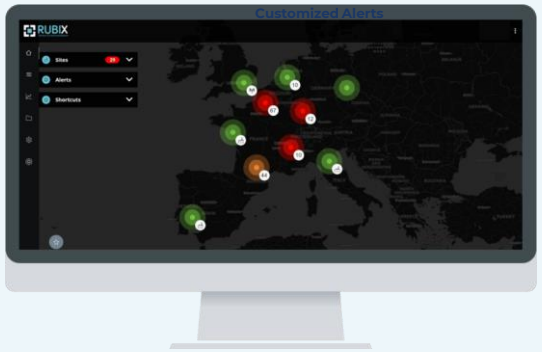
Environmental Intelligence Platform

- ✓ Easy-to-use real-time & continuous monitoring & data visualization
- ✓ Identification of signatures/nuisances
- ✓ Weather data integration
- ✓ Customized & automatic alert notifications
- ✓ Multilingual & responsive access
- ✓ Data export
- ✓ Advanced reports
- ✓ API integration

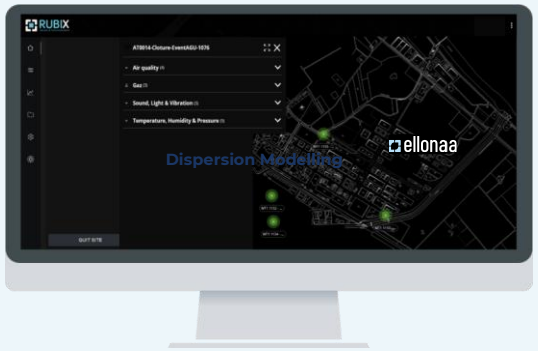


Ellonasoft IoT

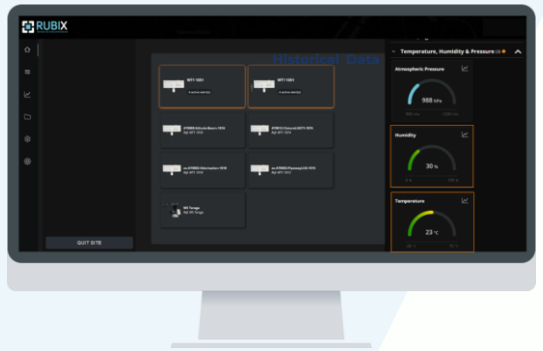
Device Localization



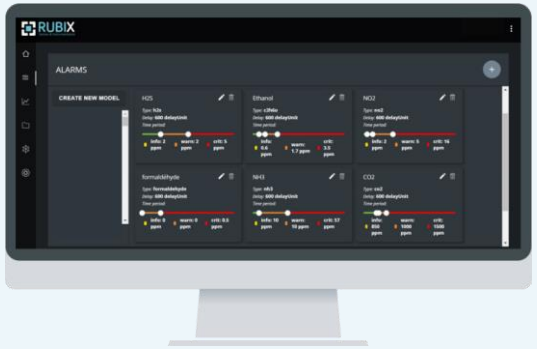
Site Management



Asset Management

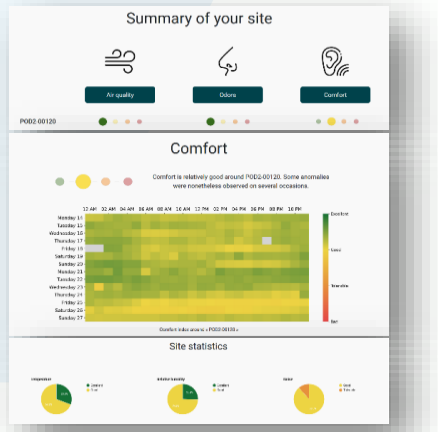


Alerts Management



Diffusion Plume

Advanced Reporting



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III.

Los modelos digitales de olor

Hablemos de algoritmos y modelos cyber-físicos de olor

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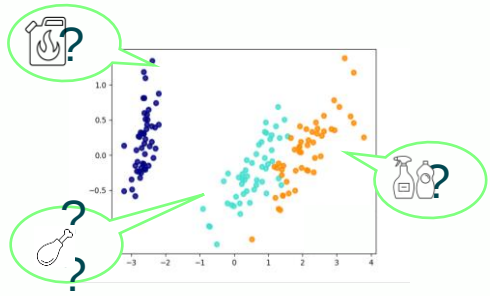
Datos de sensores

PCA or Principal Component Analysis

Find composite axes that maximize the variance of the data

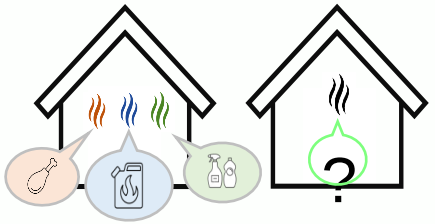
Data exploration & visualization

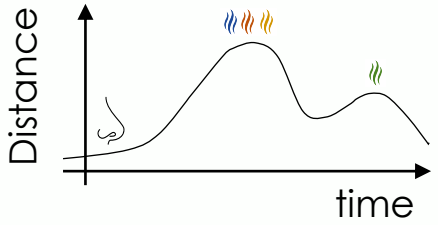


LDA or Linear Discriminant Analysis

Find component axes that maximizes class-separation. Linear classifier.

Odor classification, source identification

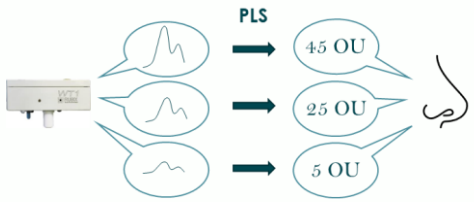




SQC or Statistical Quality Control

A distance that assesses the similarity of the data with a reference

Trigger an alarm when unusual events occur



PLS or Partial Least Squares regression

A regression technique often used in the case where the number of variables is significantly larger than the number of data points

Get odor intensity (following EN13725 standard) from a set of sensors values

Data Models

	AIR QUALITY STATION	IOMS / SIVO / e-nose	ENV. INTELLIGENCE
	Monovariants / Odorants	Multivariants / Odours	Data Fusion
Type			
Application			
Generic Principle			
Odour Principle			
Meauring Unit / Virtual Sensor			
Signal Sensor			
ML / AI Algorythm			
Does the model training require: Samples?			
Does the model training require: Inputs?			
Limitations & Roadmap			
Data Usage			

Entrenamiento con muestras de Fuente y olfactometría

Collection

1. step

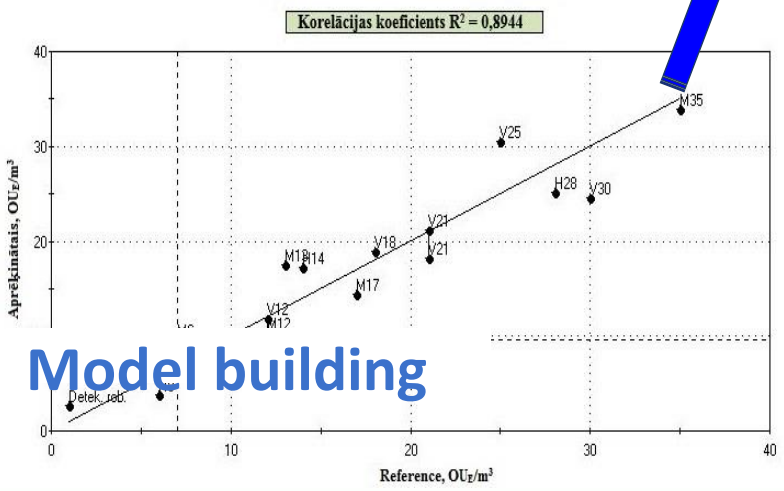
Feeding

2. step

4. step

3. step

Sniffing



Model building

Assessment
& Cross validation

5. step

Sistema de identificación de olores en línea en tiempo real (intensidad y fuente)

Fuente del cliente

Otra fuente (tercero)

Alertas y Notificaciones

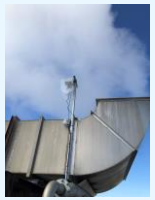
- Sí/No
- Intensidad relativa
- Duración
- Fuente conocida Sí/No
- Recurrencia

Mitigación, Remediación o prevención

IV.

Casos de Uso

Odor monitoring



Pulp & Paper plant

- Request from city council to reduce number of odor emissions (to avoid the need to relocate the plant)

Objectives:

- Identify emitting sources
- Control odor emissions from the plant and identify signature
- **Reduce complaints** from neighbourhood
- **Optimize the operations** online
- Differentiate plant activities from nearby off-site source emissions.

Challenges

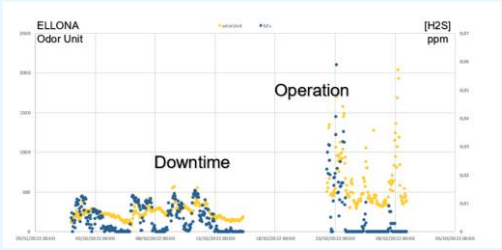
- Dynamic air pollution sources : site nearby elevated railroad, highways, dense group of own and external channeled sources generating pollution
- Continuous monitoring of odors and gases
- Qualification of nuisances
- **Deadline** to implement all key features : one month for 2 sources

Solutions

- Ellona WTI (MOX)
- Anomaly detection and correlation with **process activities** and gas emissions
- Odor characterization : survey from local operators around the plant (**3 sources :Pungent, Rotten Egg and Wet Paper odors**)

Benefits

- Identification of main sources
- Odor levels automatic identification (real-time)
- Characterization of perceived odors thanks to **event signature**
- **Triggering of alerts** for remediation purposes
- Odor correlation analysis with operational activities
- **Cost saving** (energy, use of additive for biofilters)



Detección de fuentes en incineradora Waste-to-Energy Plant, Saint-Ouen, Paris.

syctom
l'agence métropolitaine des déchets ménagers

Objetivos

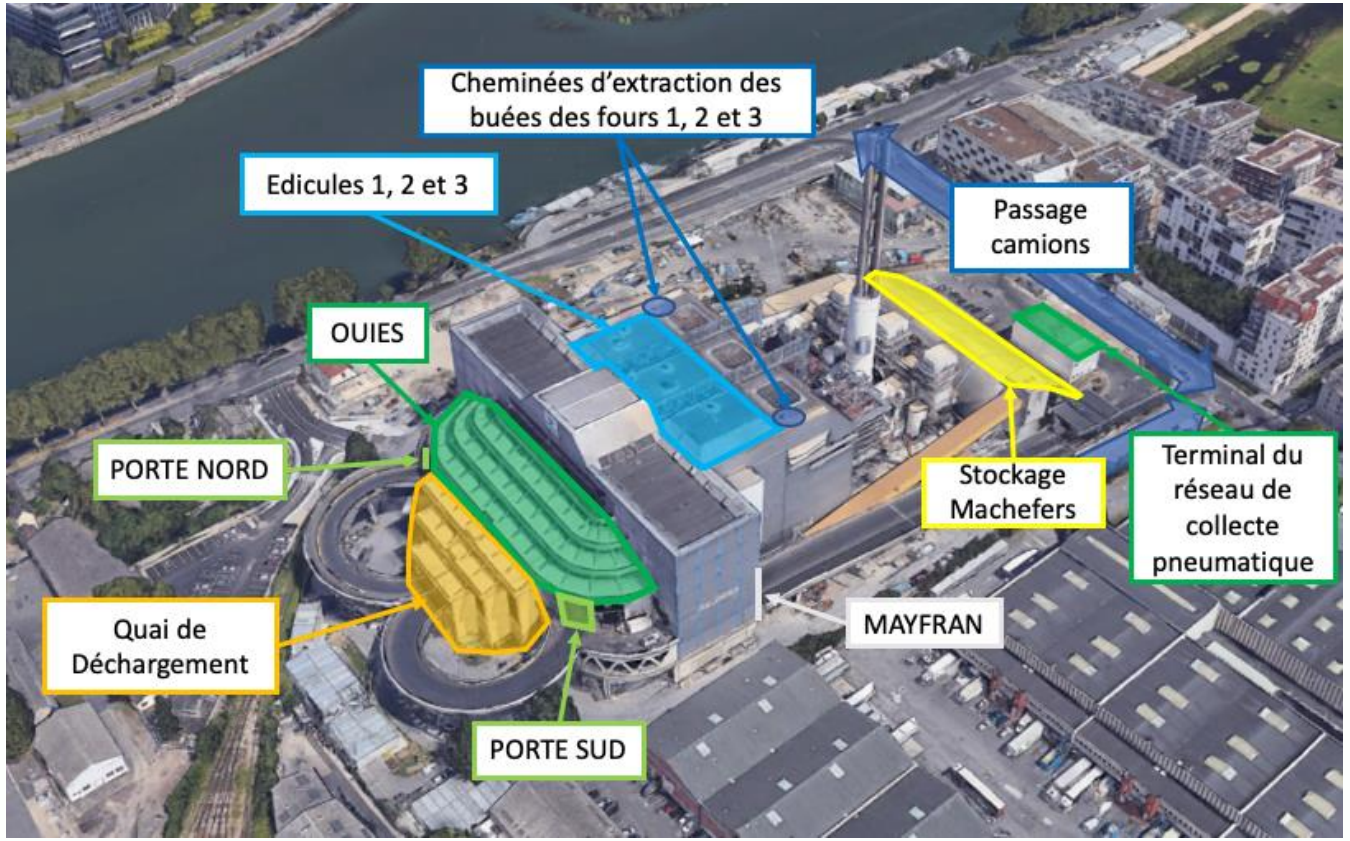
Identificación de fuentes de emisión de olores en el recinto y en el medio ambiente.

Solución

- Despliegue de red de 21 e-noses (MOX, NH3, H2S, PID, PM2.5, PM10)
- Entrenamiento con muestras de las fuentes

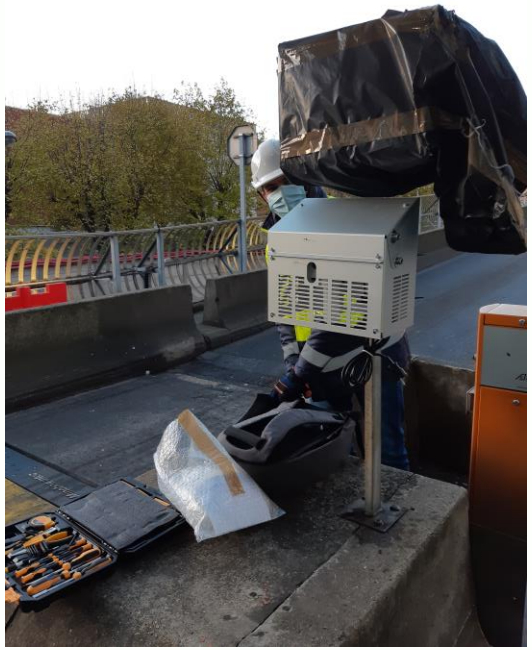
Logros

- Identificación de fuentes
- Reporte de correlación con quejas
- Renovación contrato +2 años

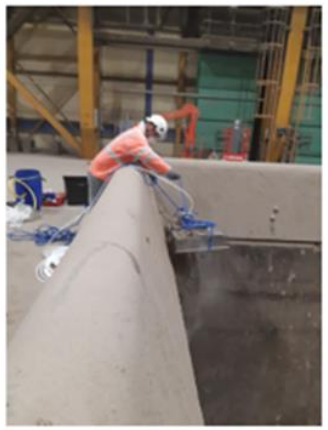


Capacidad: 630.000 ton/año

Deployment of devices - on site

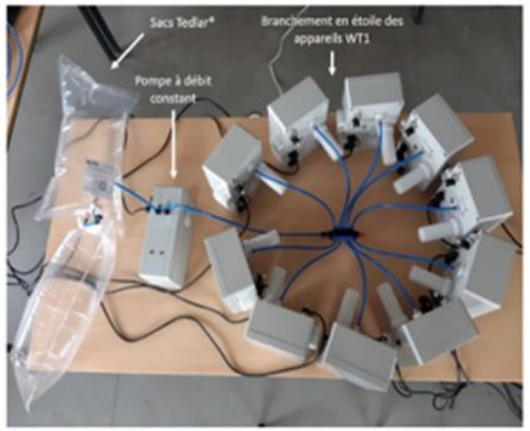


Odor learning on site



Etape 1

Collecte des échantillons



Etape 2

Apprentissage des sacs de prélèvement

Etape 3

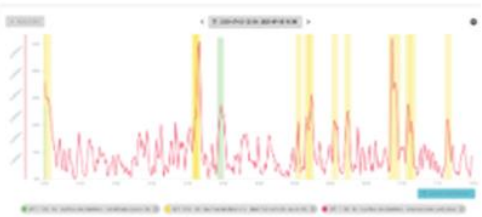
Détermination des unités d'odeur

Etape 4

Implémentation du modèle

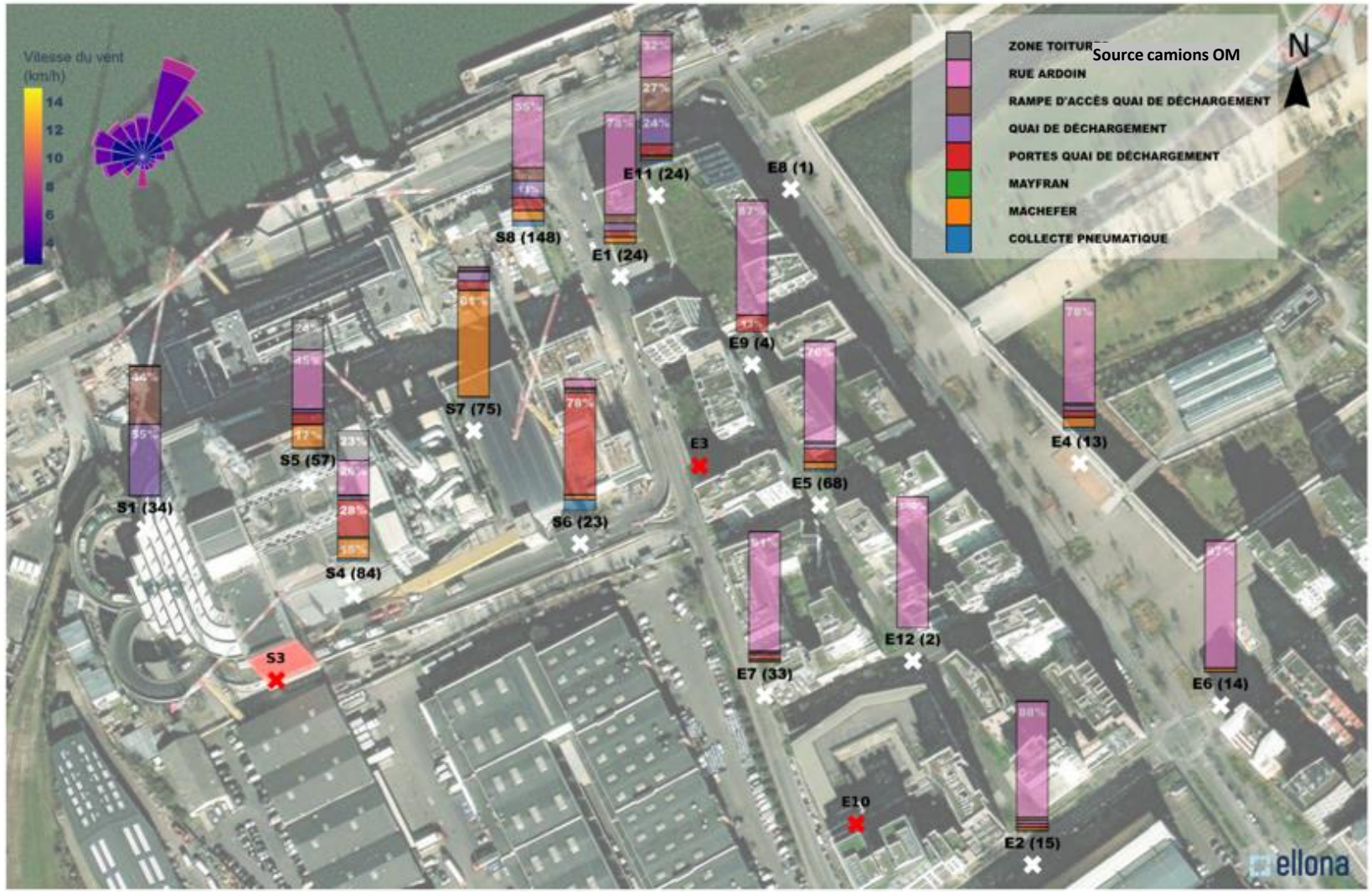
Etape 5

Evaluation



Estudio de contribución de fuentes

Eventos de olores (número y aportes de las fuentes conocidas de Syctom de un mes específico)



Medición de OU en fuente canalizada en tiempo real. EDAR, Seine Aval, Paris.

Objetivos

Cuantificación de olores post tratamiento

Solución

2 WT1 + Dryer con modelo de OU:

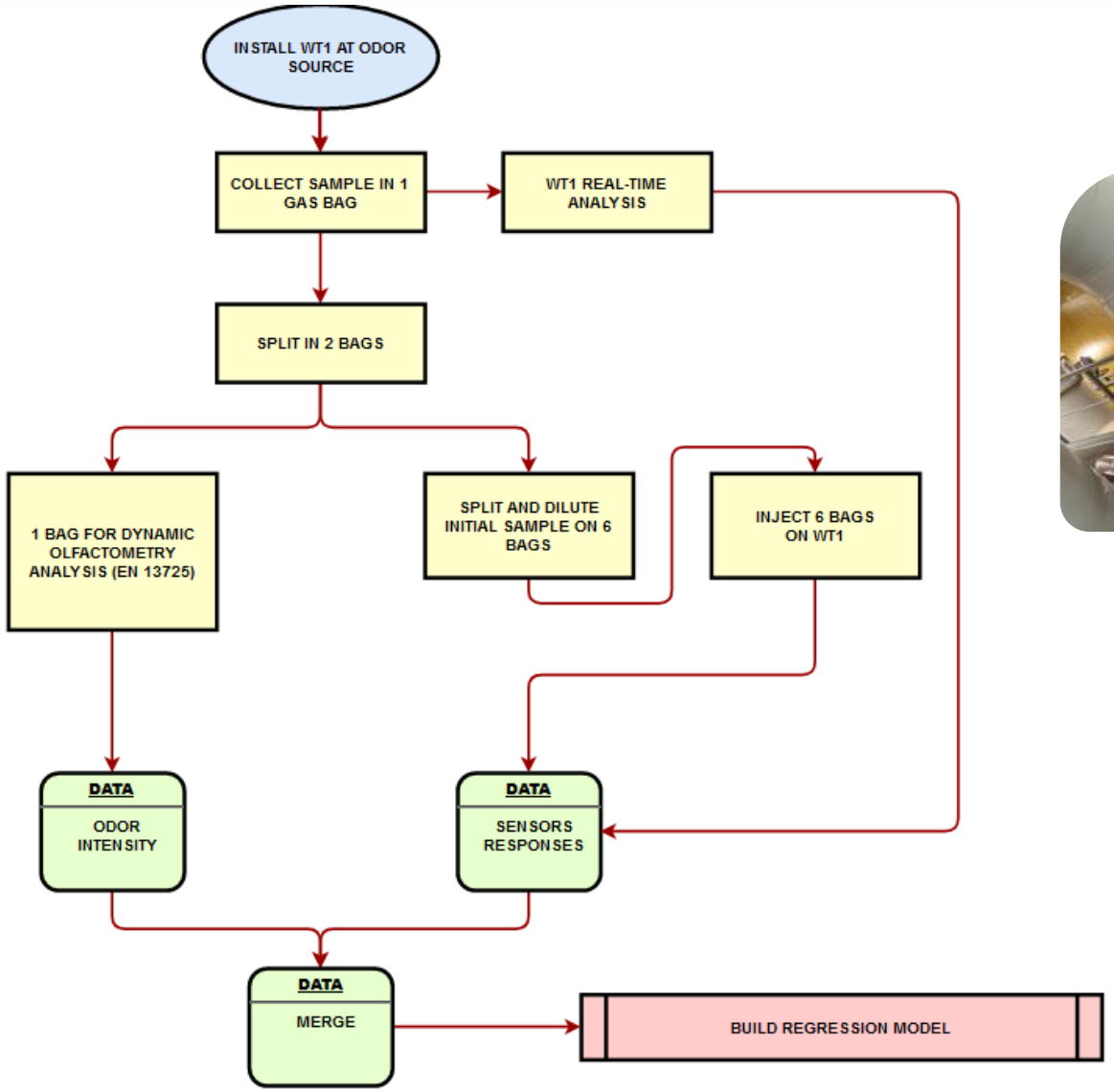
- **En el sector de tratamiento de aguas (UPEI)**, en la salida de desodorización del proceso de nitrificación-desnitrificación
- **En el sector de tratamiento de lodos (UPBD),** a la salida del proceso de desodorización físico-químico

Logros

- Cuantificación de OU con un 90% de muestras dentro de los rangos de error de EN 13725:2003
- Extensión del contrato

Capacidad: 1.500.000 m3/día

Training method

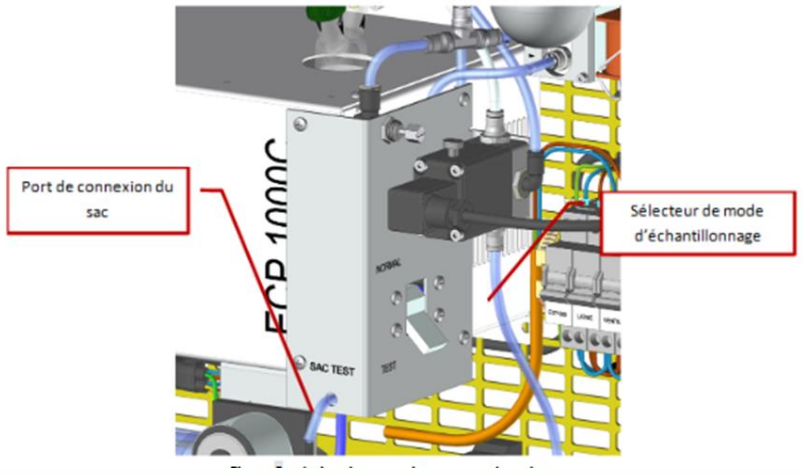


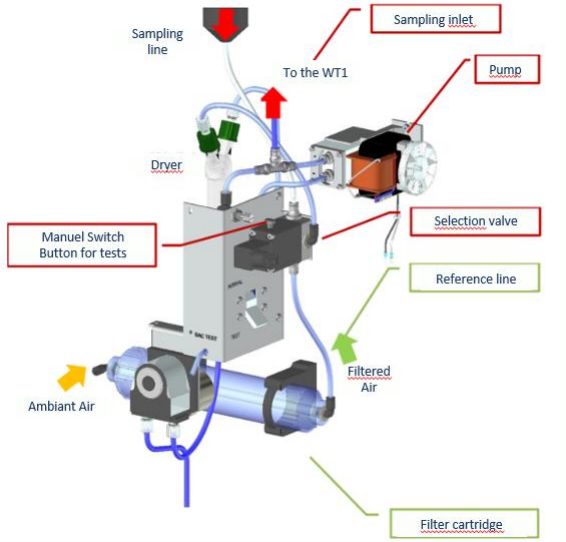
Collection

Injection

Analysis

Calibration stage : injection in WT1





Criterios de Adjudicación de contrato: Validación: Predicción ciega de OUE/m3

Validation results

Blind test

Sample ID	Real concentration	Low limit	High limit	Model prediction	Validation
Device 1					
1	981	491	1471	1215	OK
2	733	367	1099	987	OK
3	1278	639	1917	1369	OK
4	972	486	1458	1000	OK
5	1547	774	2320	1191	OK
Device 2					
1	175	88	262	191	OK
2	230	115	345	269	OK
3	153	77	229	332	NOK
4	322	161	483	281	OK
5	272	136	408	327	OK

> 80% = Extensión del contrato

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DIAPOS RESERVA

Process monitoring

SIAAP
Service public de l'assainissement francilien

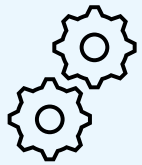
WWT Plant context

- **Quantify odor and gas emissions** from deodorization process in 2 sites
- Unstable environmental conditions (**channeled sources**)
- Toxic gases: hydrogen sulfide , ammonia
- **Compliance to regular monitoring audits by local authorities** (dynamic olfactometry)
- Training of the electronic noses over a period of 3 months including 5 sampling campaigns, validation and blind samples assessment
- Key contact : **Environmental manager**

Installation
- 2 dryer units
- 1 day

Challenges

- Continuous monitoring of odor unit using **dynamic olfactometry** (EN13725:2003)
- Real-time analysis for **quantification of odors**
- Prevent local complaints of odors with survey of deodorization processes
- Blind prediction of odor unit should **reach 80% of success** with olfactometry scores
- **self-contained and easy to maintain solution** (**sampling, sensor stability**, model robustness)



Sampling campains
- 5 days (over a period of 3 months)
- Creation of models (2 days)

Solutions

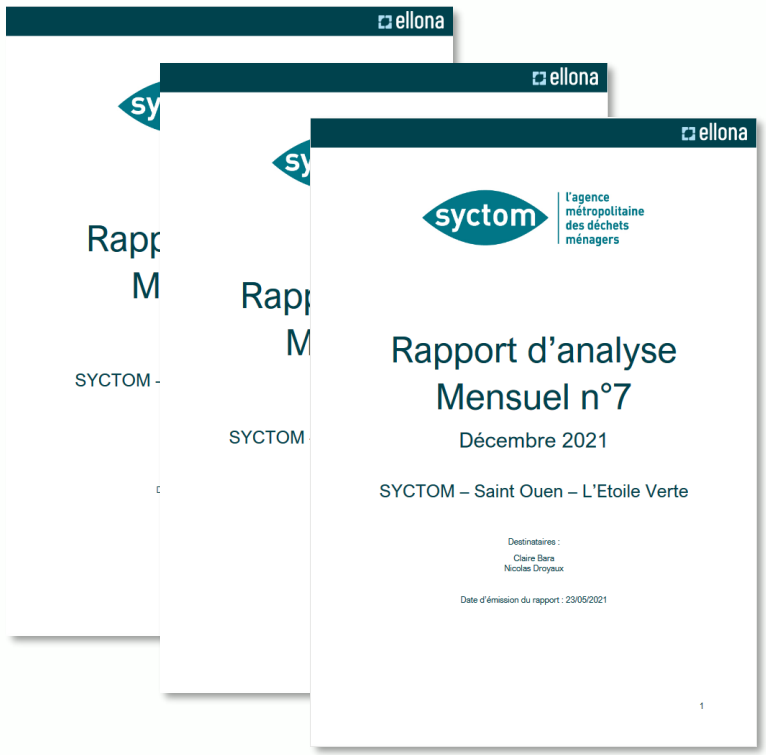
- ellona dryer and software
- Configuration of dashboard and **alarms** for target parameters
- ellonasoft algorithm (pls) for odor unit correlation and display
- **Solution has been proven with 90% of success**

Blind results
- 90% of success for OU
- 4 new dryers ordered

Benefits

- **Operations follow up**: upstream and downstream installation can be controlled. **Improve maintenance f**or optimal deodorization process
- **Online control of gas & odor** emissions with real time alerts
- **Limit periodic checks** and save cost on olfactometry campains
- New dryers to be deployed in critical environnement for **emissions monitoring in new site**

Expert report



- Spatial and temporal characterization of olfactory pollution events.
- Semi-quantitative analysis of the contribution of known sources.
- Qualitative analysis of the contribution of all sources (including unknown sources).
- Correlation between potentially odorous events and complaints from residents

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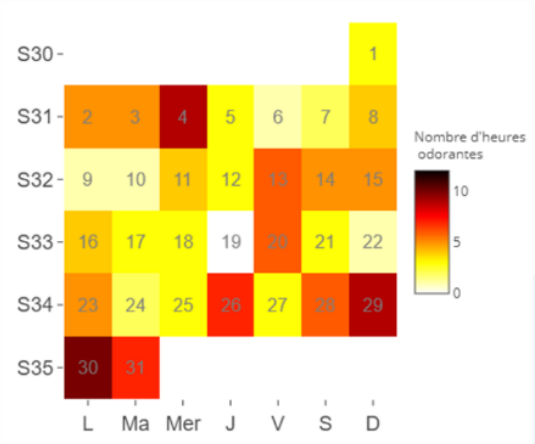
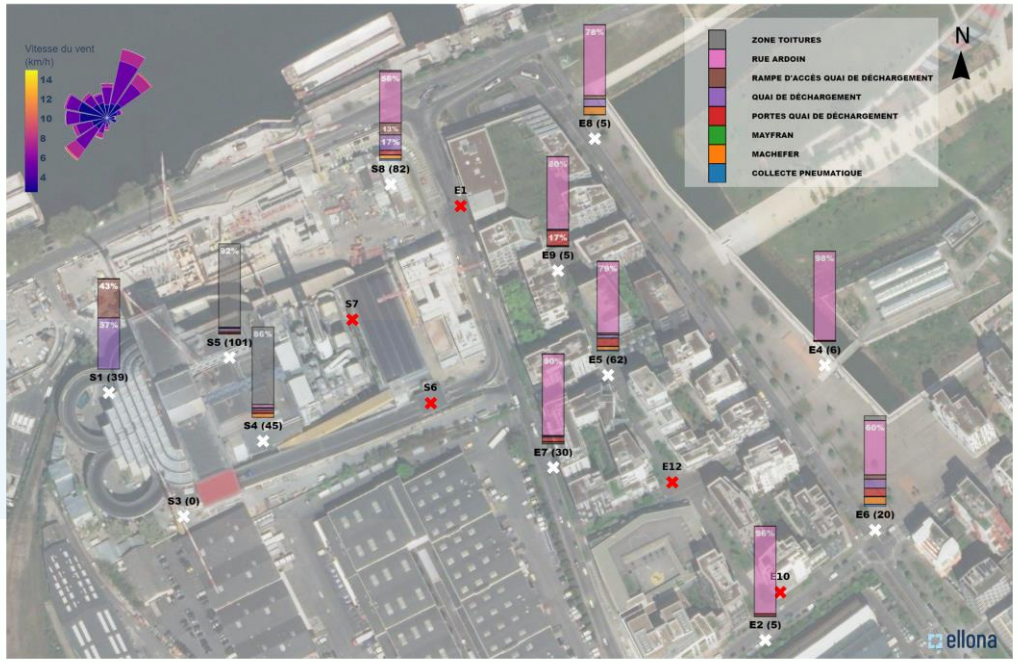
Contributions from Syctom's known sources

Association of each hour to an average weather condition.

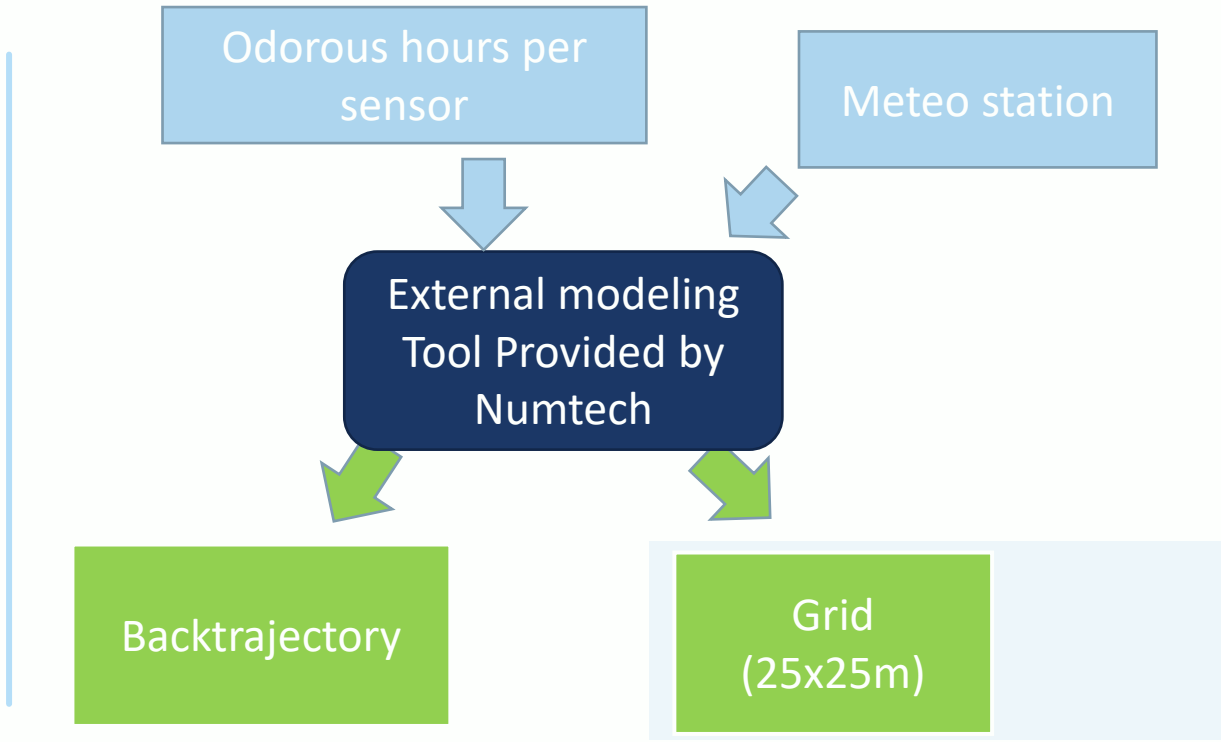
Factorisation with the basis of atmospheric transfer coefficients (ATC).



Maximum number of odorous hours measured per day on all devices



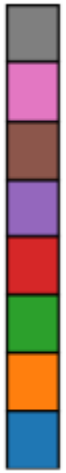
Backtrajectory analysis



Ellona modeling map

Example

complaint from 6 allée de Paris (dated July 26 at 2:30)



ZONE TOITURES

Source camions OM

RAMPE D'ACCÈS QUAI DE DÉCHARGEMENT

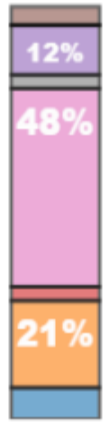
QUAI DE DÉCHARGEMENT

PORTES QUAI DE DÉCHARGEMENT

MAYFRAN

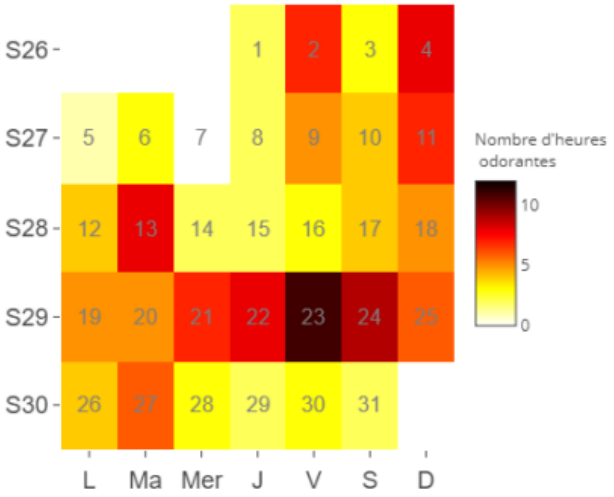
MACHEFER

COLLECTE PNEUMATIQUE

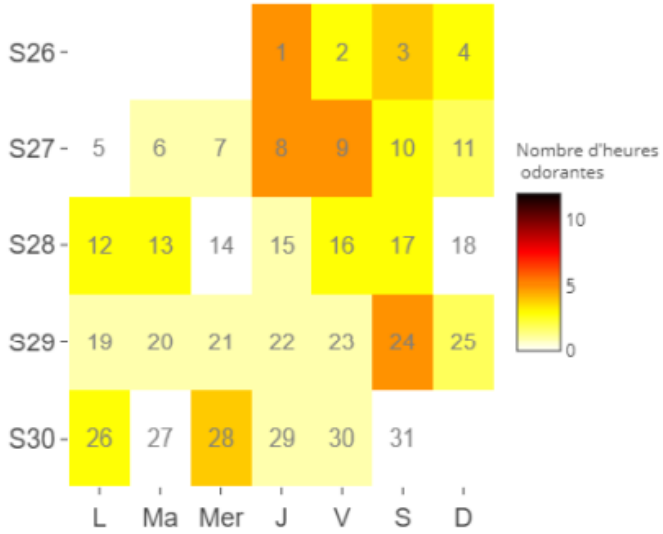


2021 02h_6 Allée de Paris, Saint-Ou

Site



E5



Zoom

ellona

- Evidencias de buen funcionamiento

CATEGORY	DOCUMENT	CONFERENCE / EVENT	CITATION / RELATED TO	PERMALINK
Research Article	Realisation of a multi-sensor system for real-time monitoring of odour emissions at a waste treatment plant	Nose, Taormina 2022		https://www.aidic.it/nose2022/programma/35Panzitta.docx
Research Article	Electronic Nose for real-time monitoring of odour emissions at a Wastewater Treatment Plant	Nose, Taormina 2022		https://www.aidic.it/nose2022/programma/44Prudenza.docx
Research Article	Real-time monitoring of odour concentration at a landfill fenceline: performance verification in the field	Nose, Taormina 2022	Bax C., Lotesoriere B.J., Capelli L., 2021, Real-time Monitoring of Odour Concentration at a Landfill Fenceline: Performance Verification in the Field, Chemical Engineering Transactions, 85, 19-24.	https://www.aidic.it/cet/21/85/004.pdf
Research Article	Hydrogen gas in circular depressions in South Gironde, France: Flux, stock, or artefact?	n.a.	Paul Halas, Alain Dupuy, Michel Franceschi, Vincent Bordmann, Jean-Marc Fleury, Dominique Duclerc, Hydrogen gas in circular depressions in South Gironde, France: Flux, stock, or artefact?, Applied Geochemistry, Volume 127, 2021, 104928, ISSN 0883-2927	https://doi.org/10.1016/j.apgeochem.2021.104928
Research Article	APPLICATION AND PERFORMANCE VERIFICATION OF ELECTRONIC NOSES FOR LANDFILL ODOUR MONITORING	Sardinia Symposium 2019: The 17th International Waste Management and Landfill Symposium	Bax, C.; Li Voti, M.; Sironi, S.; Capelli, L., 2019, Application and performance verification of electronic noses for landfill odour monitoring, Proceedings Sardinia 2019 17Th International Waste Management And Landfill Symposium	https://re.public.polimi.it/retrieve/e0c31c0f-2888-4599-e053-1705fe0aef77/s19_BAX_FullPaper_rev06_senza-intestazione.pdf
Video Presentation	On line monitoring of odor unit (OU) emissions and odor sources identification, by using a new generation of agas and odors analyzers.	ASIC 2022, Pasadena	RIGA PORT USE CASE https://www.ellona.io/real-time-quantification-and-identification-of-odors-in-the-port-and-city-of-ventspils/	https://youtu.be/A5vezEOwnOo
Video Presentation	Benefits of online environmental monitoring for mining: before, during and after operations	BAUMA 2022, Munich		https://www.ellona.io/benefits-of-online-environmental-monitoring-for-mining/
Video Presentation	IOMS PROVEN EFFECTIVE TO MONITOR ACCURATELY THE ODOUR CONCENTRATION	9th IWA Odours & VOC/Air Emission Conference, Bilbao, Spain,		https://www.ellona.io/ioms-proven-effective-to-monitor-accurately-the-odour-concentration-2/
Video Presentation	BLIND PREDICTION TEST FOR ODOR CONCENTRATION WITH AN ELECTRONIC NOSE A REAL CASE OF STUDY	Digital Olfaction Society 7th Conference 2022, Tokyo	PAPER COMPANY USE CASE https://www.ellona.io/real-time-identification-and-quantification-of-odors-for-operational-and-compliance-objectives/	https://youtu.be/gVq4AaO9AWY

Fácil Mantenimiento

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Material

- **Sensor chamber kit** with original configuration (ref. 500-0022)
- Ellona **Calibration box** & software
- Reference device (colocation) or laboratory bench (if no calbox)
- WT1 user manual to be updated in next release

All maintenance operations and pricing are managed directly with local support and end-customer

Preventive Level 1

no odor model

- Scheduled
- Systematic action : **replace sensor chamber with new kit**

Preventive Level 1

odor model

- Use **Calbox** for sensor calibration
- If one gas sensor failed, partner orders the sensor, replace defective one and recalibrate it with calbox

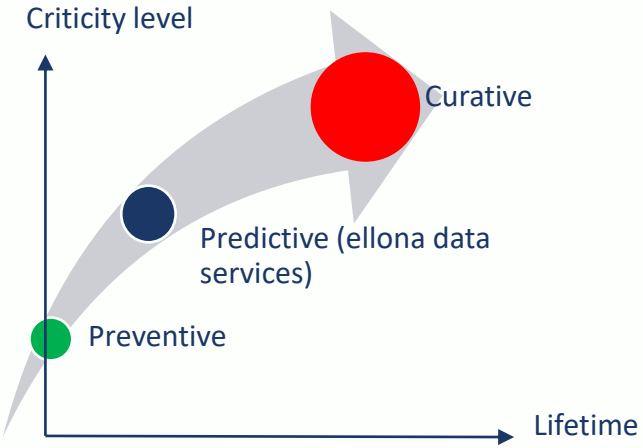
Corrective

Hardware Failure

- Diagnostic of root cause
- MK2: upgrade in MK3
- MK3 : use a back up device during repair
- Order of Parts & ellona service package if device return to ellona

Level 2

- Conditionnal maintenance
- Sensor adjustment (recalibration) with colocated device



On field intervention by trained operator

Maintenance	Action	Periodicity	duration (minutes)
no calbox	sensors chamber replacement	12 to 18 months	15
calbox	calibration check by sensor	6 to 12 months*	20

*depending of environmental conditions

Part 7.
Wrap Up and Next Step

Case of study: Wastewater Plant

Context

- Control emissions from deodorization process in 2 sites
- Unstable environmental conditions (channeled sources)
- Emissive pollution, particularly odors and gases
- Toxic gases: Hydrogen Sulfide , Ammonia
- Compliance to regular monitoring audits by local authorities
- Training of the electronic noses took place over a period of 4 months including 5 training campaigns, validation and blind samples assessment

Case of study: Wastewater Plant

Challenge

- Continuous monitoring of odor unit vs. dynamic olfactometry (EN13725:2003)
- Real-time analysis for quantification of odors and gases to comply with authorities requests
- Prevent local complaints of odors with survey of deodorization processes
- Blind prediction of odor unit should reach 80% of success with olfactometry scores

Material and method

Ellona Dryer solution

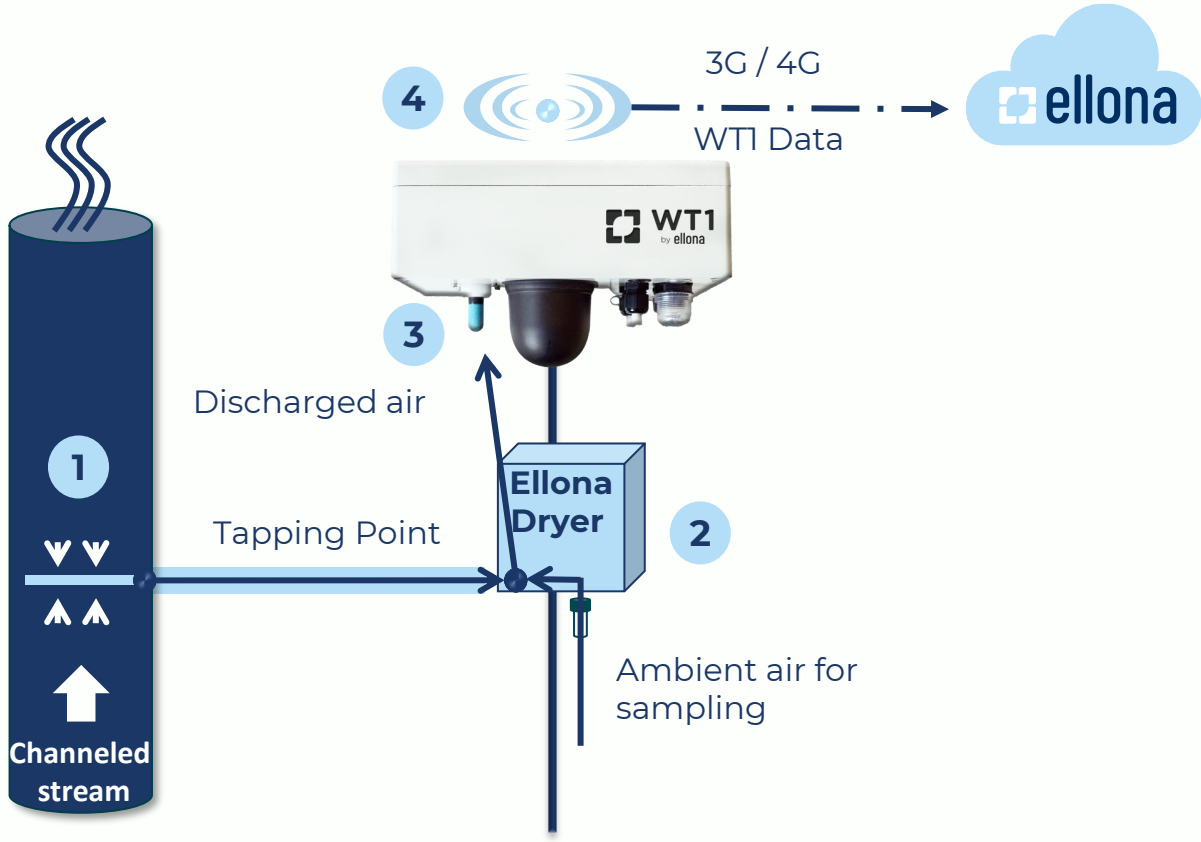
For diffusive source monitoring

1 **Air Sampling**

2 **Air drying**

3 **Air Analysis**

4 **Data communication**



WATCH TOWER 1 (WT1)

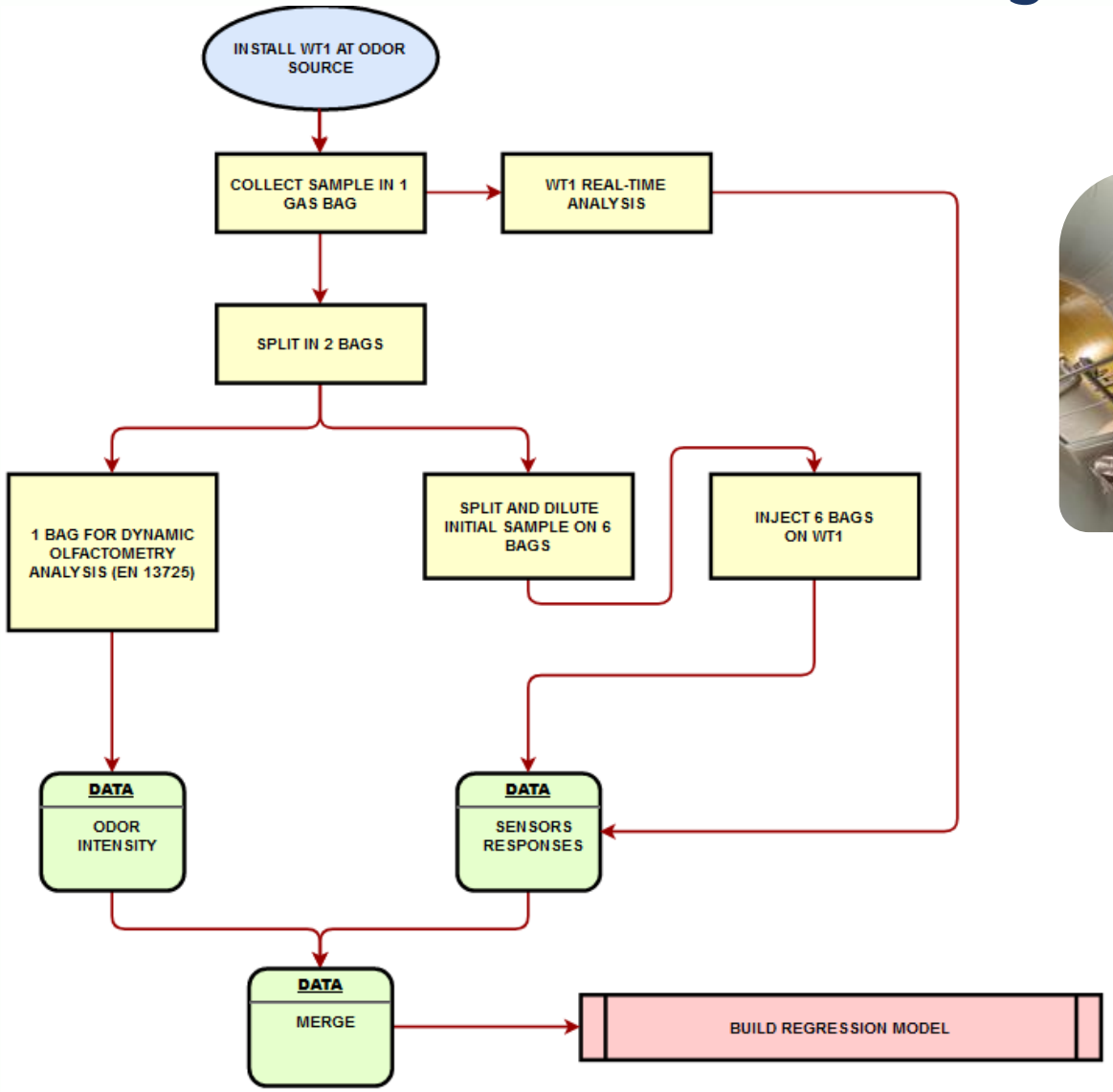
Size: 26 x 16 x 16 cm

Weight: 3 kg

Monitoring & Recognition of outdoor environment

- **VOC**
- **Gas** (up to 8 gases)
- **Particulate Matters** (PM1, 2.5, 10)
- **Odors** (recognition)
- **Noise** (intensity, recognition)
- **Temperature**
- **Humidity**
- **Atmospheric pressure**

Training method



Collection

Injection

Analysis

Calibration: olfactometry

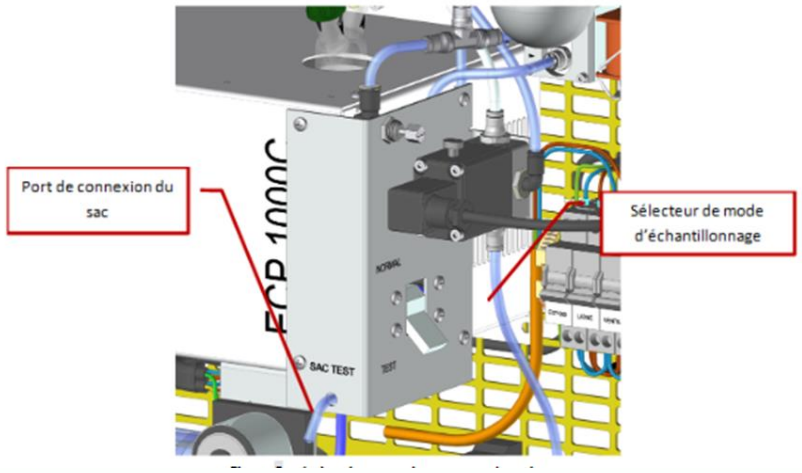
- Period of sampling considering source variation: 4 months
- 5 training campaigns to build and validate the prediction of odor intensity model

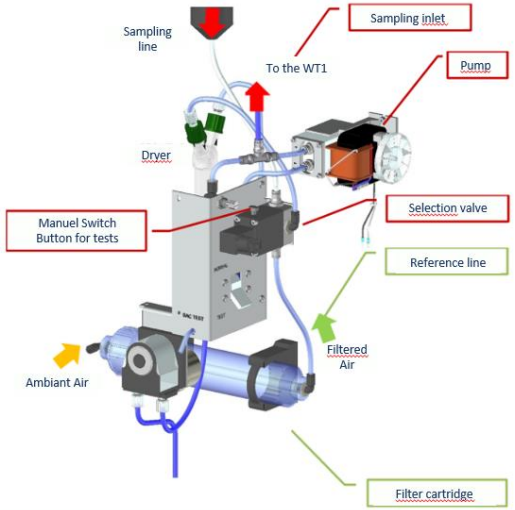
Material

- Nalophan bags from 60 L to 130 L
- Sampling ‘lung’ for training bags dedicated to olfactometry (EN13725) and dilution for WT1

Lab analysis

Calibration stage : injection in WT1



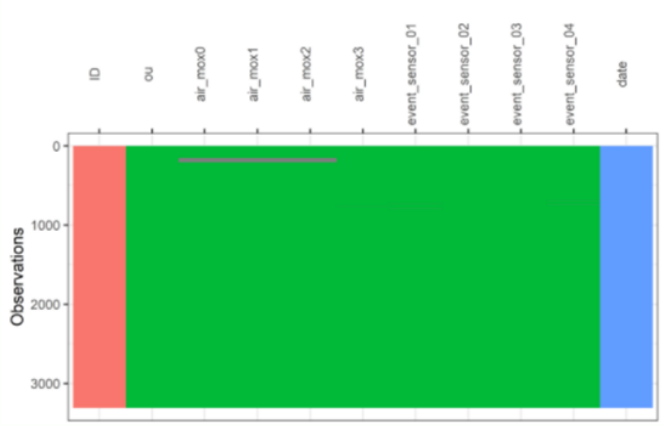


Data pipeline

Sensors' responses

Label (OU/m^3)


Lab analysis



Matrix of 3308 samples for 2 sites

Partial Least Squares (PLS) regression

Principle: regression technique

Application: Get odor intensity (following EN13725 standard) from a set of sensors values

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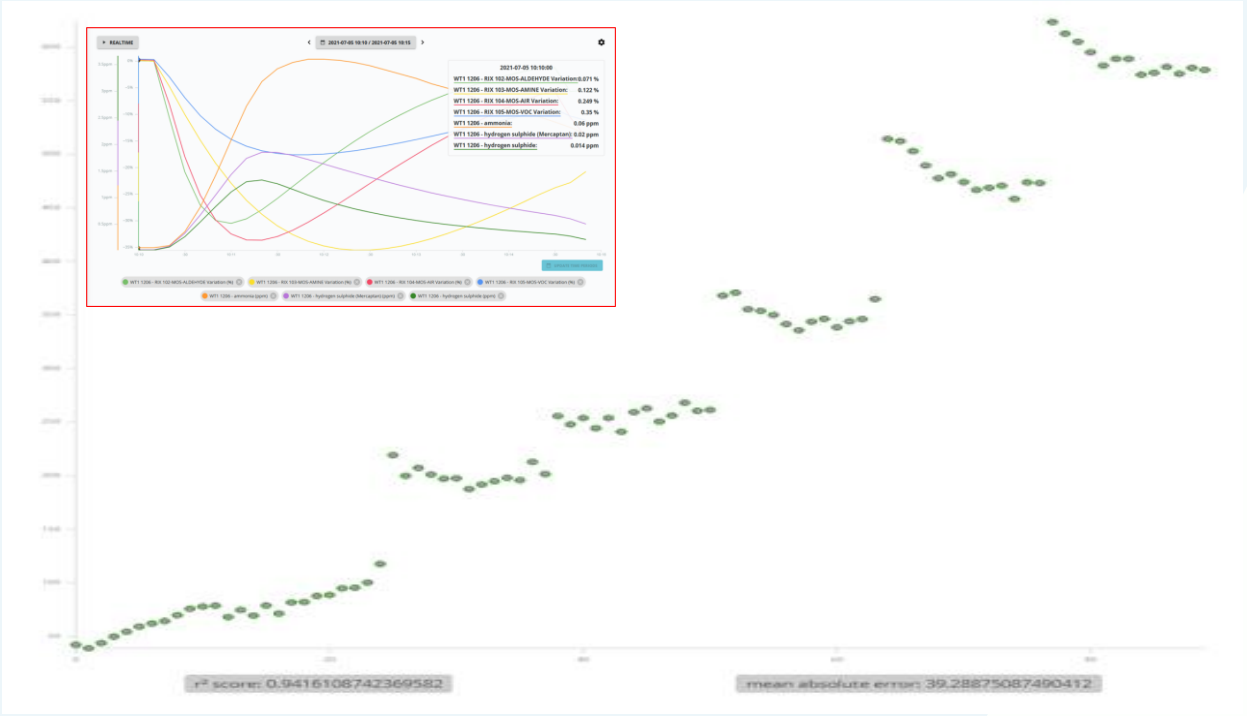
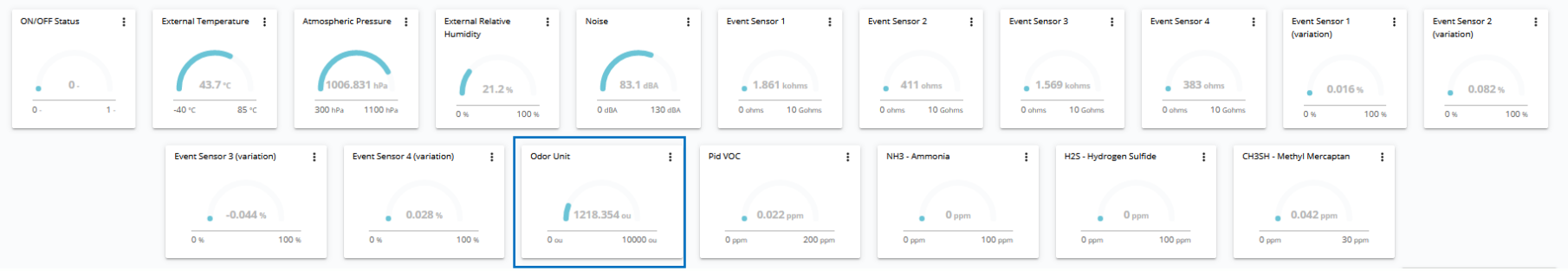
Regression model

1. Data collected during the olfactometry study is used to calculate the model which «translates» sensor data into odour units suited to each site

2. Model is then integrated into the analyser control software as an additional sensor : OU/m³ value can be followed in real time





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Blind prediction: score

Odor concentration forecasting lead to successful prediction with 90% of correct identification

Blind analysis Odor concentration UO_E/m^3

Validation results

Blind test

Sample ID	Real concentration	Low limit	High limit	Model prediction	Validation
Device 1					
1	981	491	1471	1215	OK
2	733	367	1099	987	OK
3	1278	639	1917	1369	OK
4	972	486	1458	1000	OK
5	1547	774	2320	1191	OK
Device 2					
1	175	88	262	191	OK
2	230	115	345	269	OK
3	153	77	229	332	NOK
4	322	161	483	281	OK
5	272	136	408	327	OK

Online measurements

Example of Odour concentration with alarm level limits (low , medium, critical)

Thank you