

A RESEARCH-INDUSTRY COLLABORATIVE APPROACH TO STANDARDIZED ELECTRONIC NOSE CLASSIFICATION

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Problem definition & objectives

Odour pollution is an increasingly critical environmental issue, particularly in industrial and waste treatment contexts. Regulatory frameworks rely on **dynamic olfactometry (EN 13725)**, which is discontinuous, costly, and affected by human variability.

Electronic noses (IOMS) offer continuous monitoring capabilities, but their adoption is limited by the **lack of standardized, reproducible, and fully instrumental evaluation procedures**.

Objectives

- Develop a standardized classification framework for electronic noses
- Validate a fully instrumental calibration approach (no sensory panels)
- Apply and test the IEEE SA P2520.1 methodology
- Enable transfer from laboratory validation to operational deployment
- Support the development of data-driven odour monitoring infrastructures

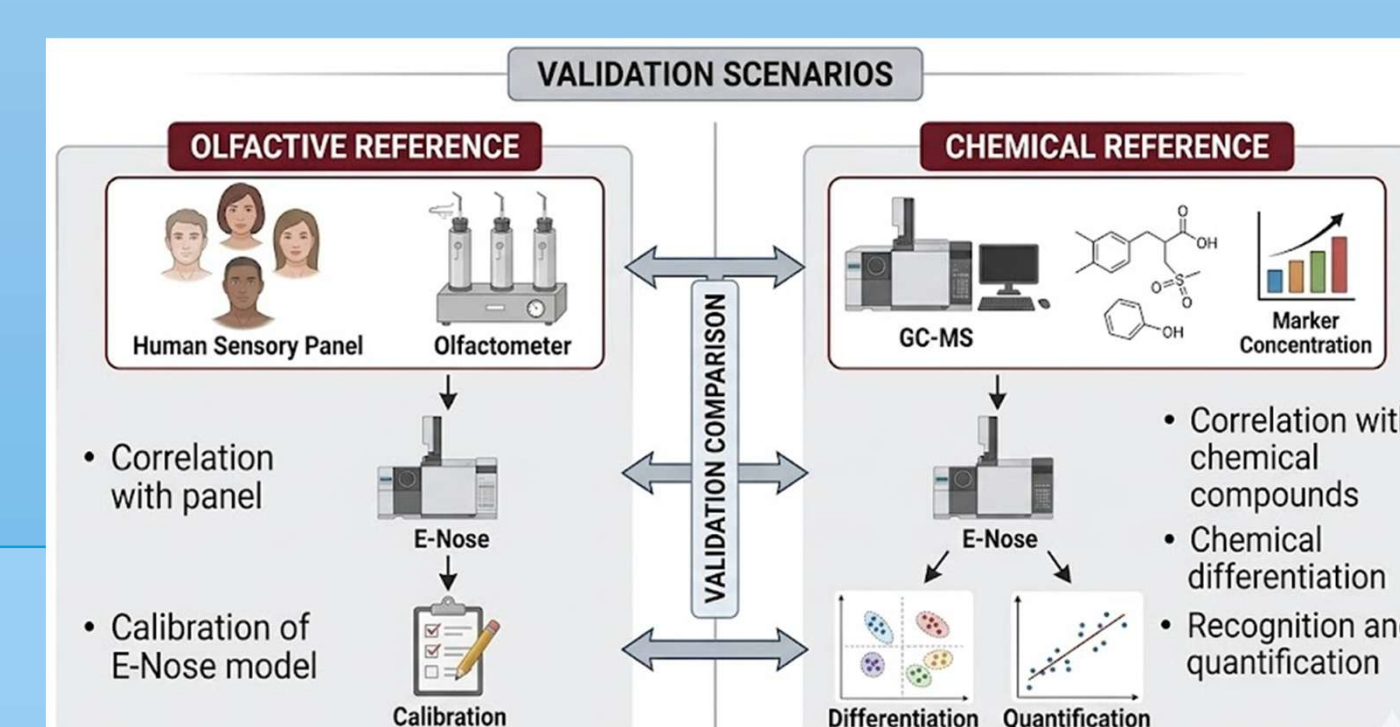
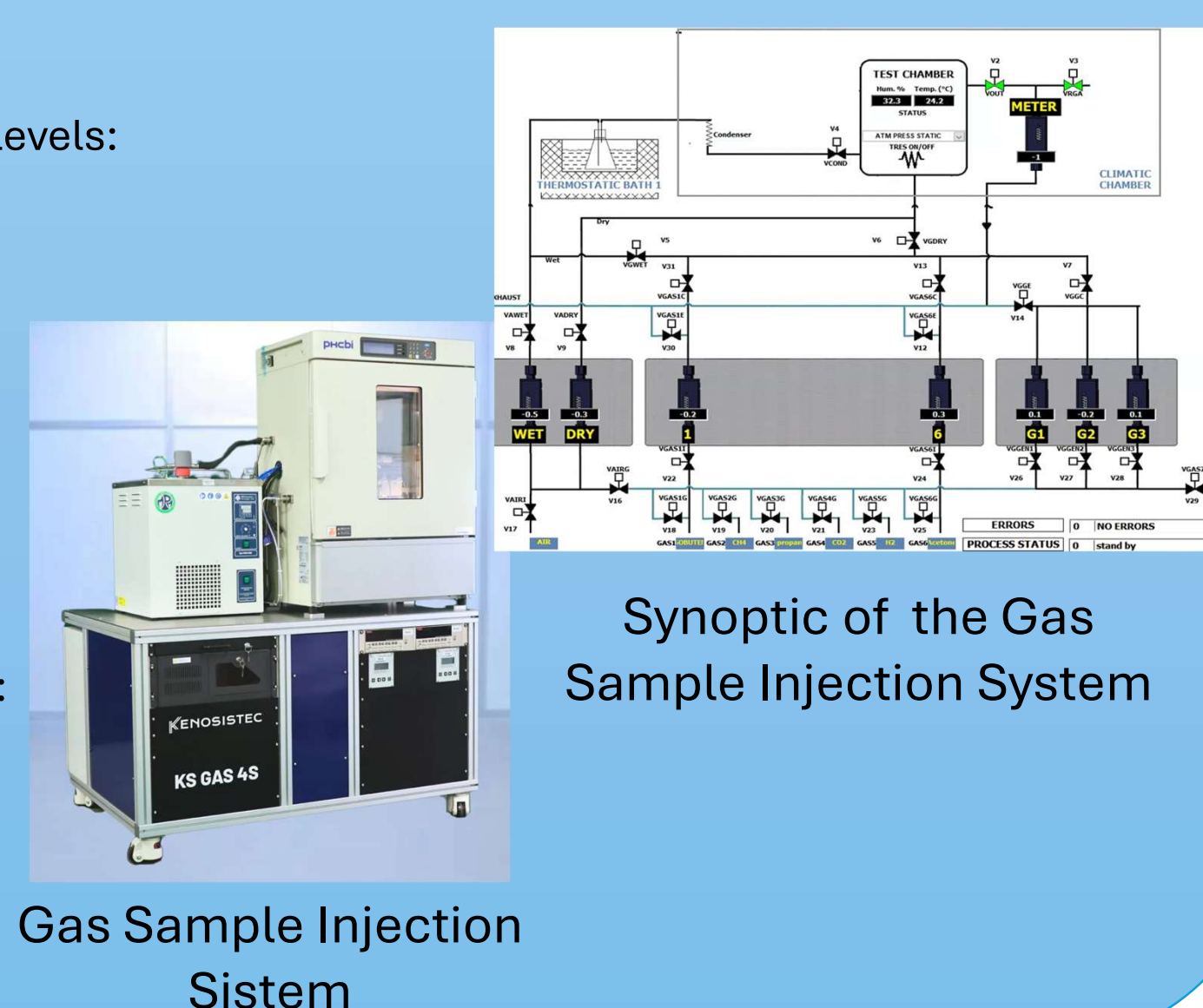
Strategy, methods, theory

General Strategy

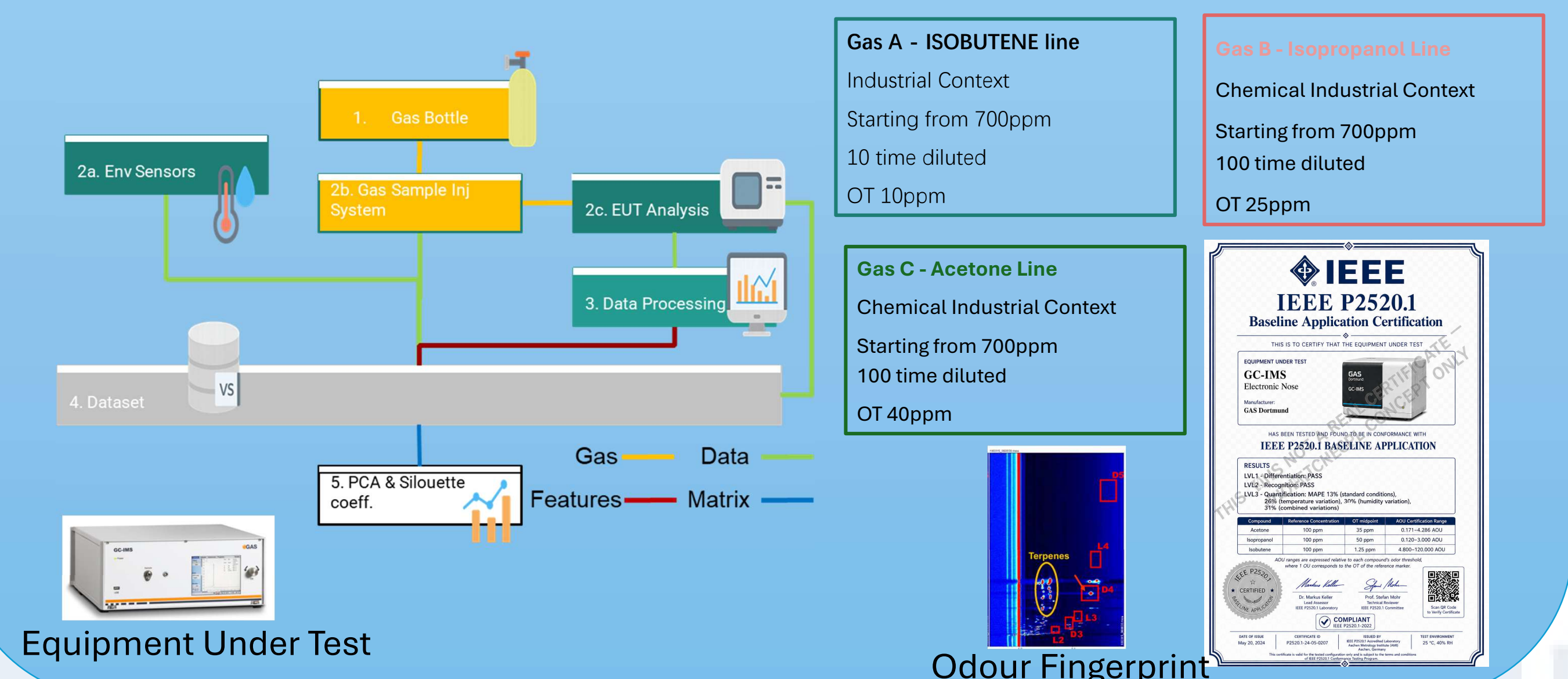
A research-industry collaboration (ENEA + Neotes) aimed at **bridging laboratory standardization, field validation, and operational deployment**.

Standardization Framework

- IEEE SA P2520.1 → e-nose structured performance levels:
 - Differentiation
 - Recognition
 - Quantification
- Experimental Approach
 - GC-IMS system tested in controlled conditions
 - Certified gas mixtures:
 - Isobutene
 - Isopropanol
 - Acetone
 - Environmental parameters controlled variation:
 - Temperature
 - Humidity
 - Time

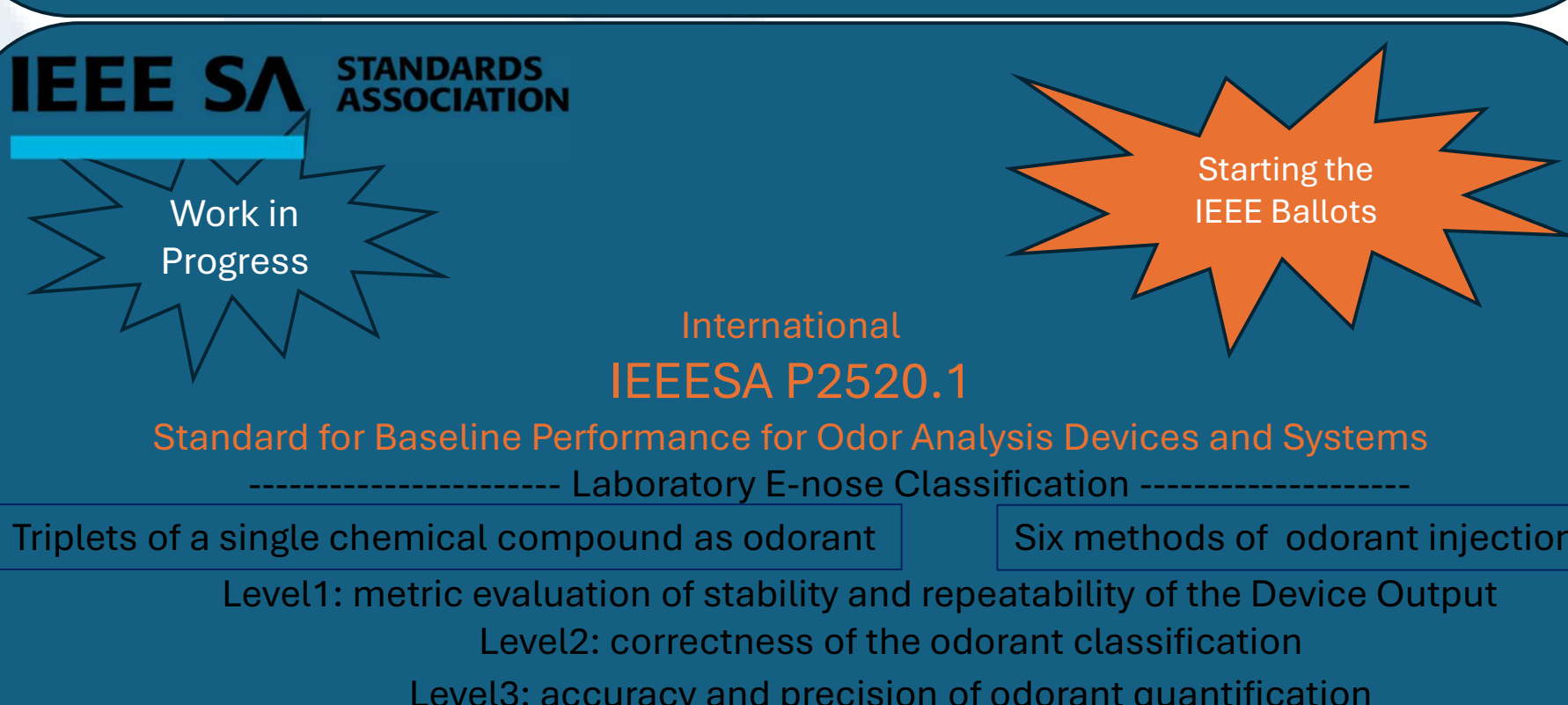
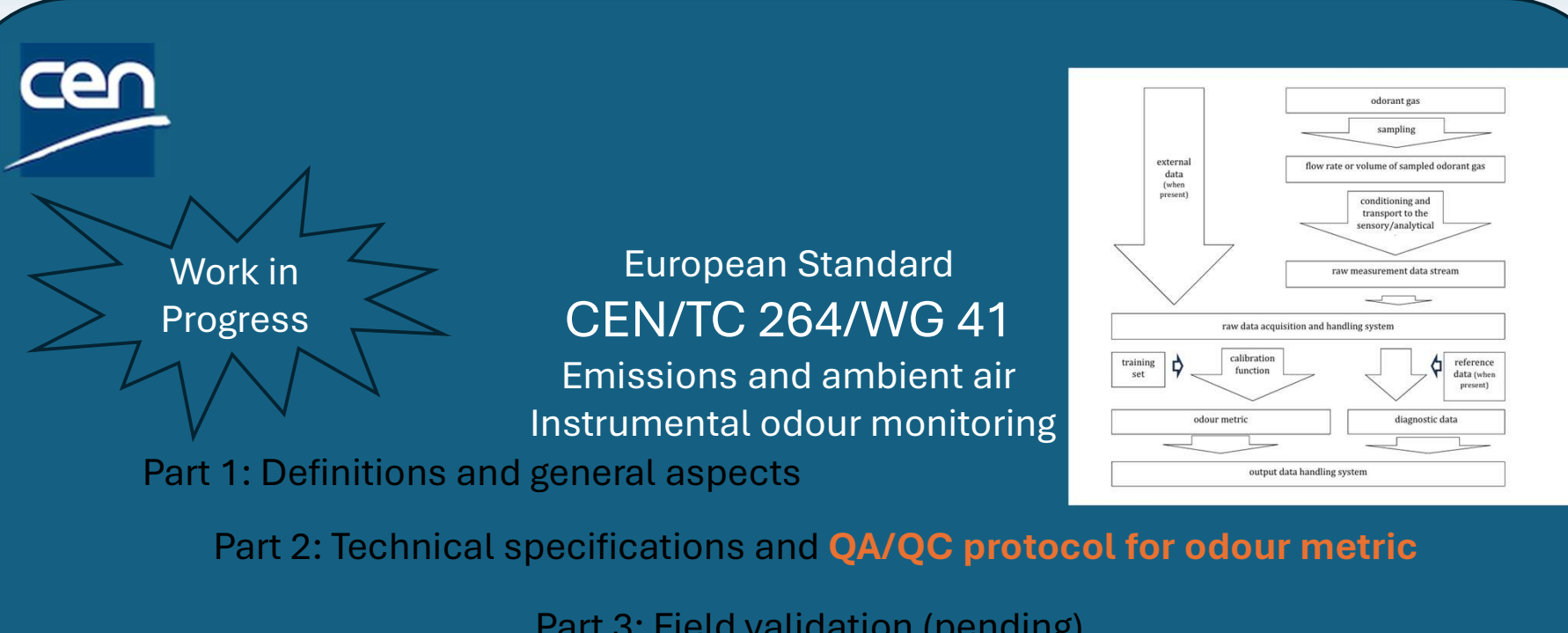
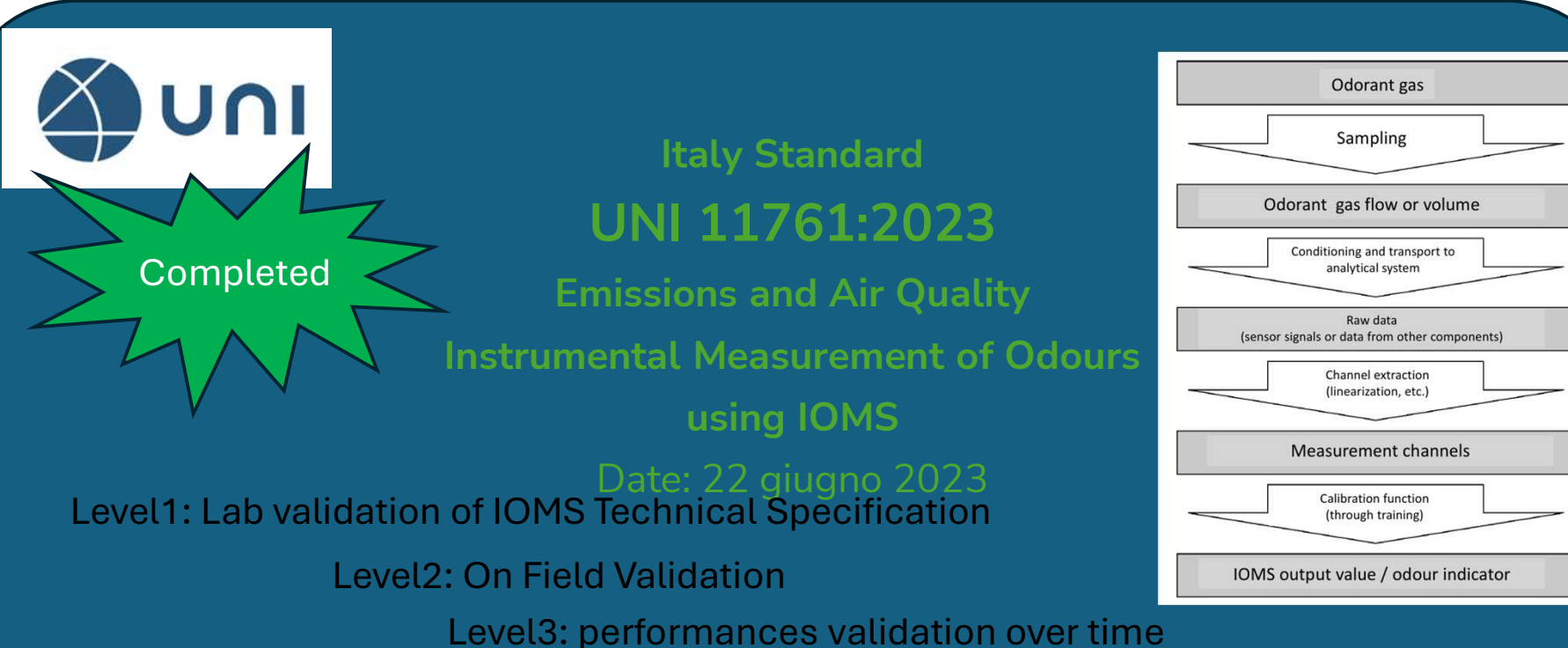


Applying the IEEE SA P2520.1 - Experimental Setup



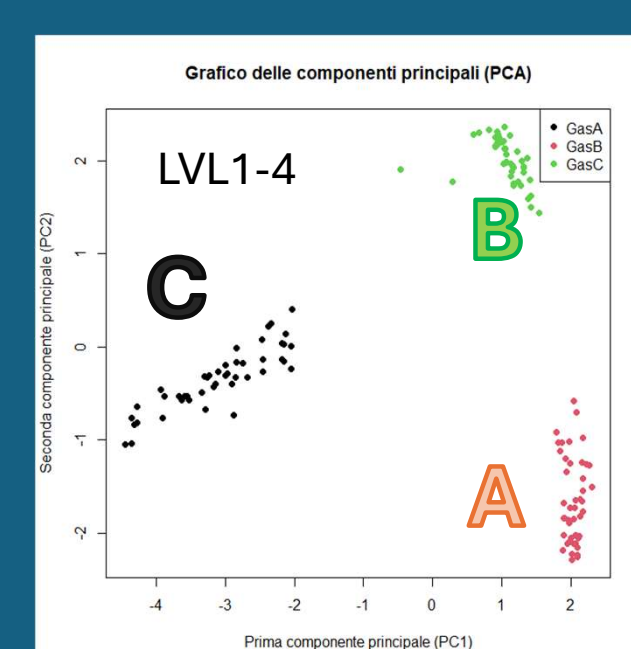
Results

Standardization and experimental applications of procedures for the use and classification of IOMS



EXPERIMENTAL RESULTS ON THE IEEE SA P2520.1 APPLICATION

Test Level 1 – EUT'S odors differentiation

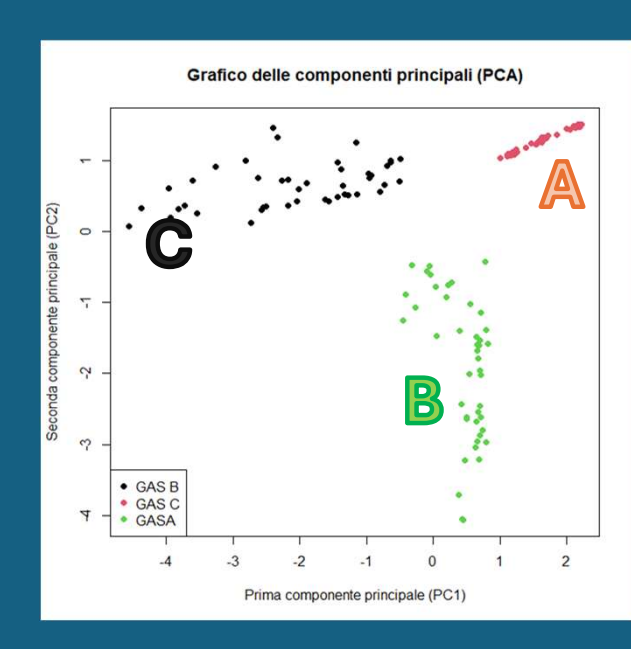


Gas concentration in air set to 100ppm;
EUT setup different between Gas A and Gas B, C;

9 measure for 1 MPS;
Gas sequence: A100/B100/C100 – B100/C100/A100 – C100/A100/B100
Two days for one MSS composed by 5 MPS:
Day 1 standard condition – LVL1-1
Day 1 change humidity – LVL1-2
Day 2 change Temp – LVL1-3
Repeat three times the MSS – LVL1-4

SC LVL1-1=0.90 SC LVL1-3=0.89
SC LVL1-2=0.86 SC LVL1-4=0.84

Test Level 2 – EUT's G1 odors recognize



25%, 50% and 100% of the standard Gas concentration;

9 measure for 1 CPS;
Gas Sequence: A25/B50/C100 – B25/C50/A100 – C25/A50/B100
Two days for one MSS composed by 5 MPS:
Day 1 standard condition – LVL2-1
Day 1 change humidity – LVL2-2
Day 2 change Temp – LVL2-3
Repeat three times the MSS – LVL2-4

SC LVL2-1 > 0 SC LVL2-3 > 0
SC LVL2-2 > 0 SC LVL2-4 > 0

Test Level 3 – Quantification Accuracy

Table with 10 columns: Odor, Condition, MAPE, etc.

LVL3-2 - MAPE 13% - standard conditions
LVL3-3 - MAPE 26% - change in temperature
LVL3-4 - MAPE 30% - change in humidity
LVL3-5 - MAPE 31% - all together

FUTURE PERSPECTIVES

The ongoing research-industry collaboration is currently extending toward real-world validation through a field experimentation at the Mechanical Biological Treatment (MBT/STIR) plant in Battipaglia. This activity represents a feasibility study aimed at demonstrating the potential of an integrated telematic infrastructure based on multivariate analysis of electronic nose data.

Key objectives of the field deployment

- Assess electronic nose performance under **real environmental conditions**
- Develop a **data-driven system** for odour impact monitoring and management
- Enable **continuous and automated interpretation** of sensor signals
- Support operational decision-making and environmental control strategies

Expected impact

- Strengthening collaboration between **ENEA, Neotes, and the waste treatment facility**
- Supporting compliance with **A.I.A. environmental monitoring requirements**
- Facilitating the adoption of **continuous instrumental odour monitoring systems**

Standardization evolution and strategic positioning

In parallel with the experimental activity, the IEEE P2520.2.2 technical working group on "Landfill Odor Monitoring Devices and Systems" has been initiated. This new framework will extend the IEEE SA P2520.1 approach toward **application-oriented scenarios**, specifically addressing landfill and waste treatment contexts.

The experimental results obtained within the P2520.1 framework are expected to be **directly relevant** for this new standardization effort, positioning this collaboration at the **forefront of methodological and technological development**.

Outlook

- This combined research, field validation, and standardization activity may enable:
- Deployment of **networked electronic nose infrastructures**
- Development of **early-warning systems** for odour events
- Contribution to **next-generation international standards** for environmental odour monitoring

