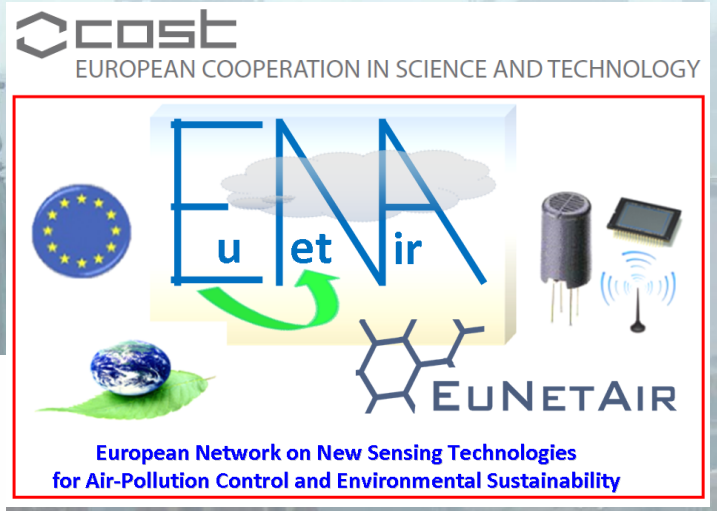
Sub-Working Group 4.3
Benchmarking of New Products and Market of Commercial AQC Sensors



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Current and Future Urban Air Quality Monitoring Workshop
COST Action TD 1105 4-6 March, 2013 Duisburg

We will discuss-

- Types of sensors
- Testing protocols

- Laboratory and field test methodologies

- Commercial needs

Types of sensors

Gases

- **Amperometric electrochemical**
- Chemresistor, FET (**Metal oxide**, CNT/ graphene, polymer, nanowire)
- Optical
  - **Absorption (NDIR)**
  - TDLS
  - Spectroscopy (FTIR, Raman)
  - Fluorescence (polymer, orgaometallic)
  - Evanescent wave (SPR, optical fibers)
  - IR Gas cameras (FLIR)
- Physical chemistry (enthalpy, speed of sound, thermal conductivity)

VOCs

- Ionisation (**PID**, IMS, FAIMS)
- **Diffusion tubes** (Drager, Kittegawa)
- Sorption/ desorption (Tenax, polymer fibre, etc)

Particulates, aerosols

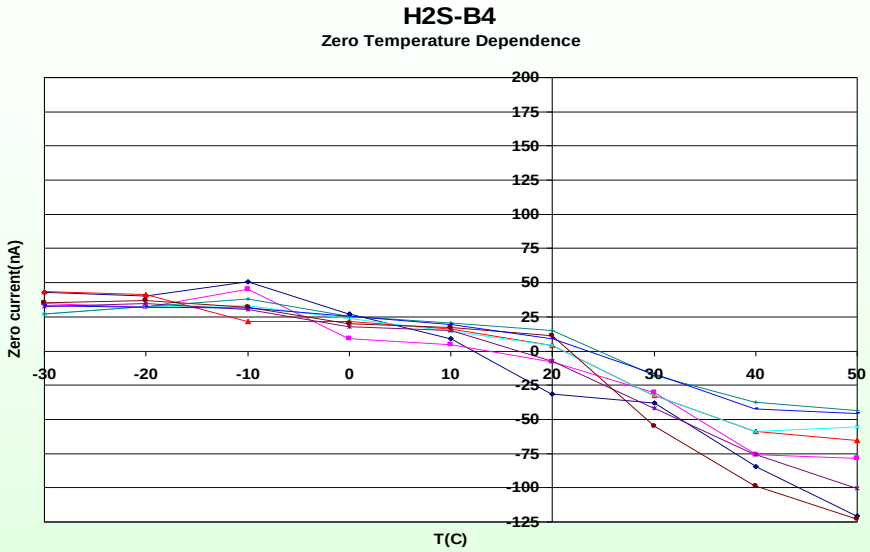
- Impact/ weight
- TEOM
- Laser scattering
- DMA

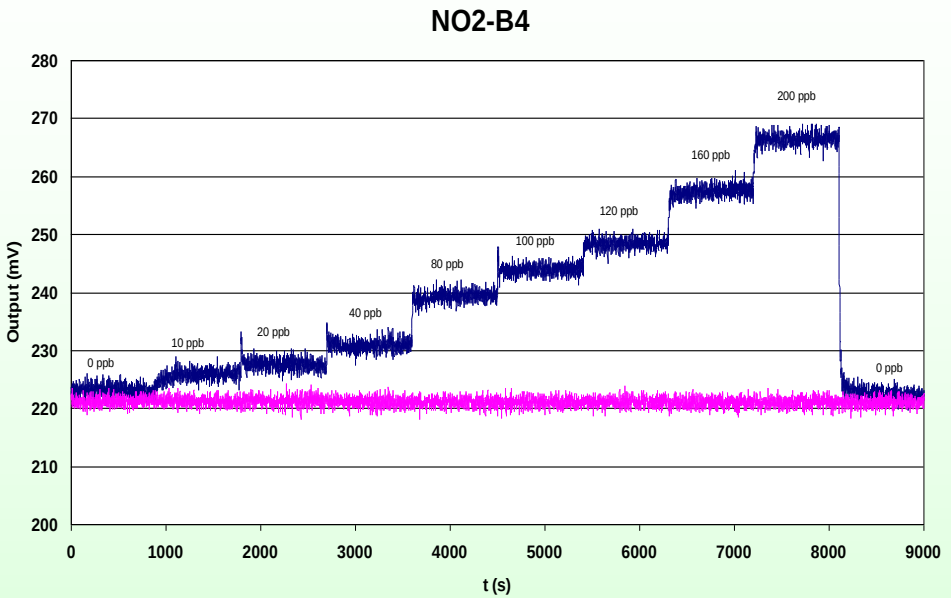
Testing protocols

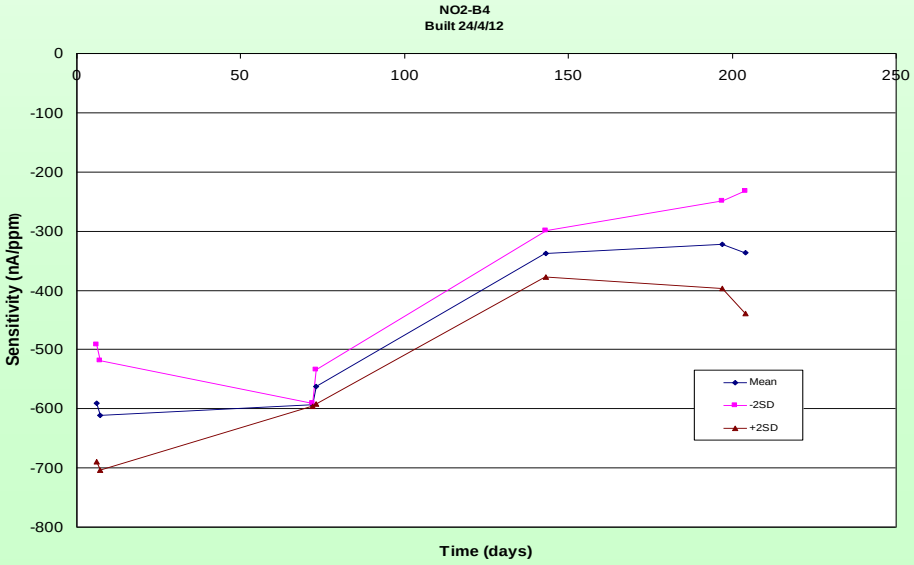
- Sensitivity/ limit of detection
- Range, linearity, hysteresis, t_{90}, baseline
- Temperature, humidity (pressure?) dependence
- Short term, long term stability (baseline and sensitivity)
- Interferents

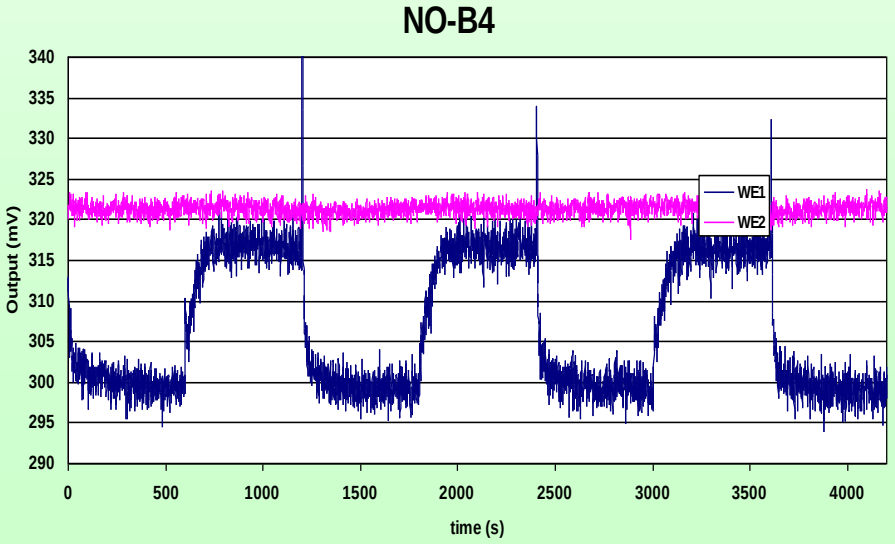
Laboratory and field test methodologies

Laboratory test procedures have been proposed



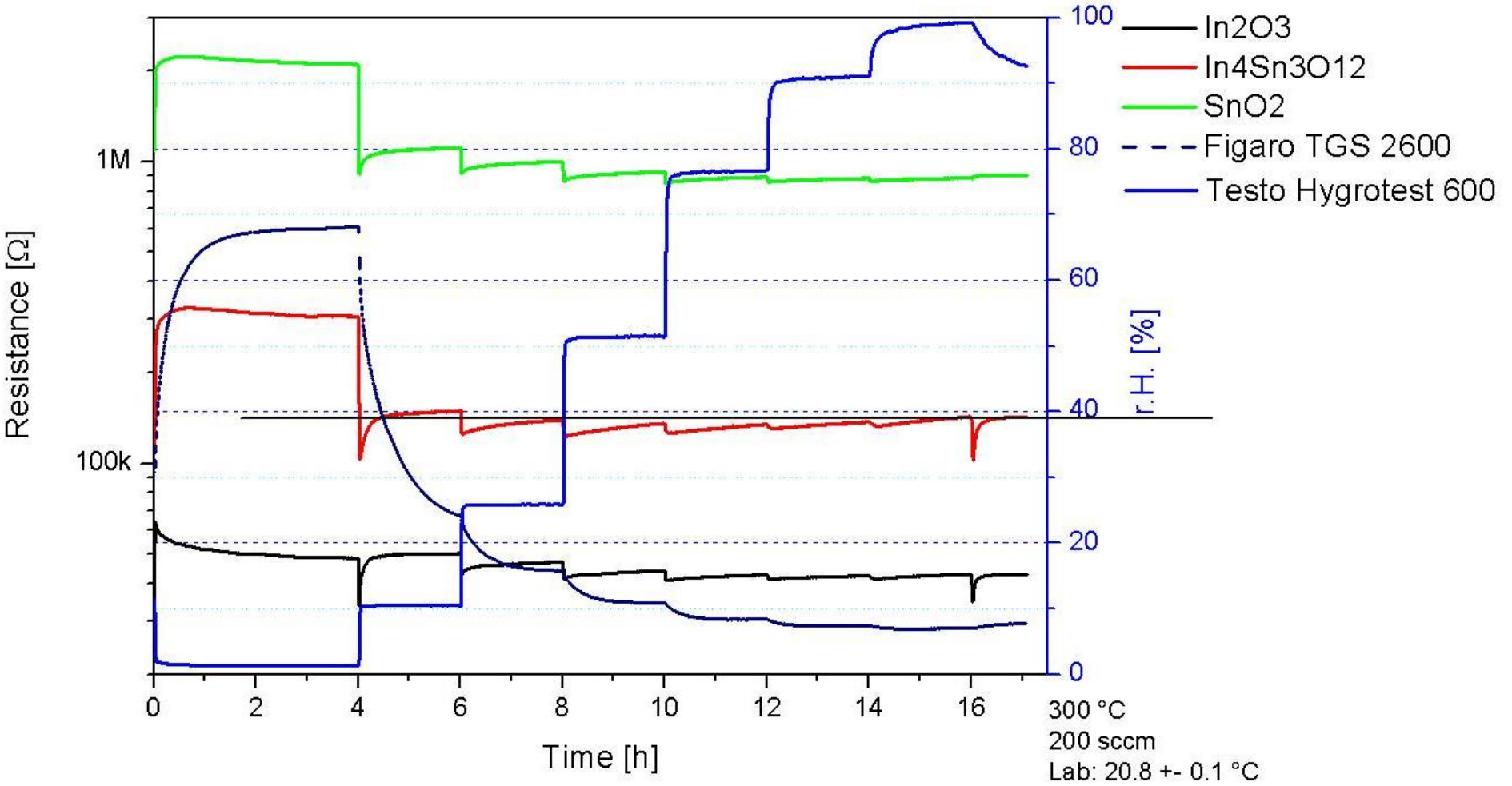






Each sensor type requires different test methods

below: Metal oxide chemresistor



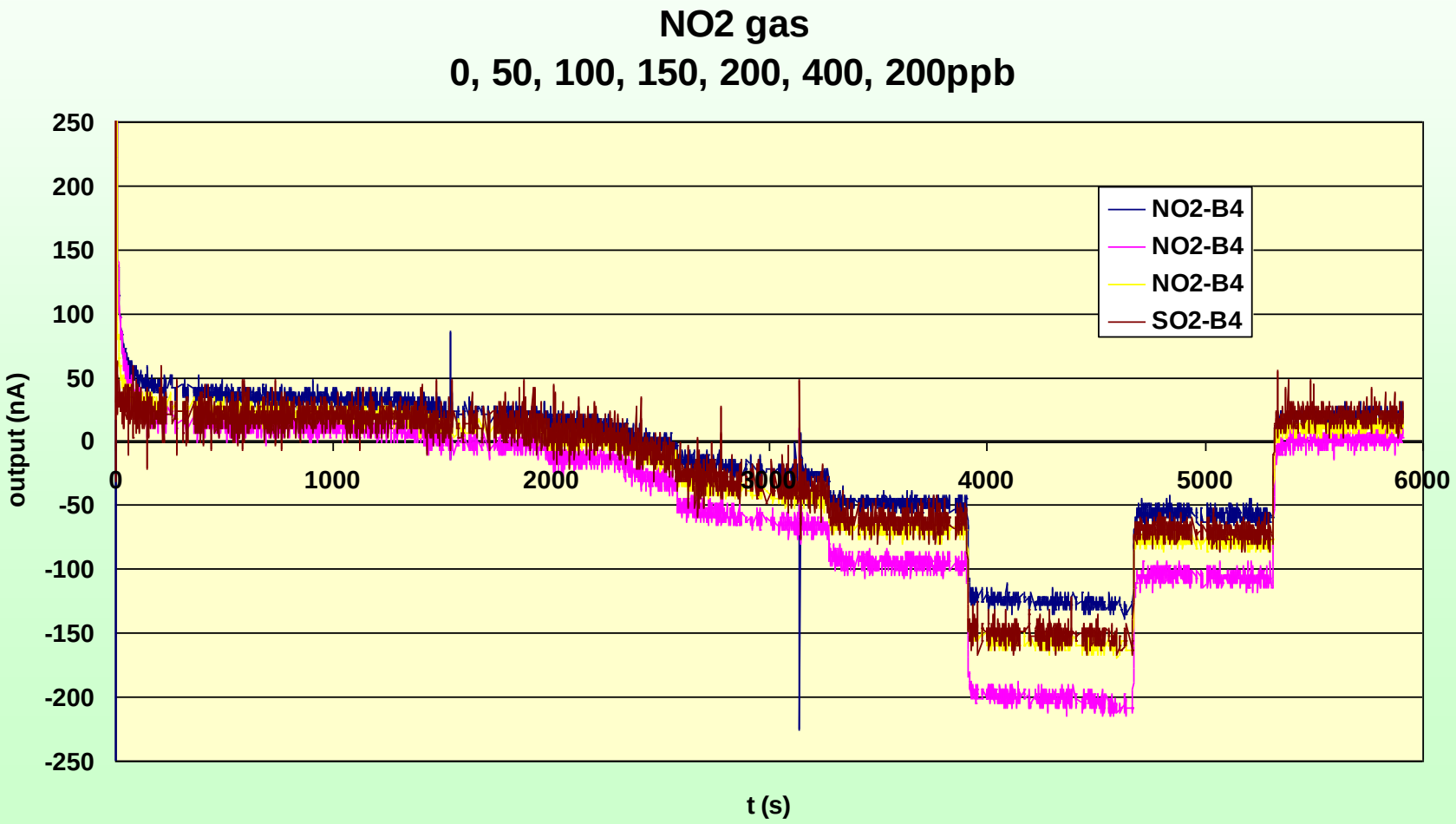
Test capability is important: good lab facilities, good electronics

Gases: DMFC blending of calibrated gas bottles with zero air & rh control

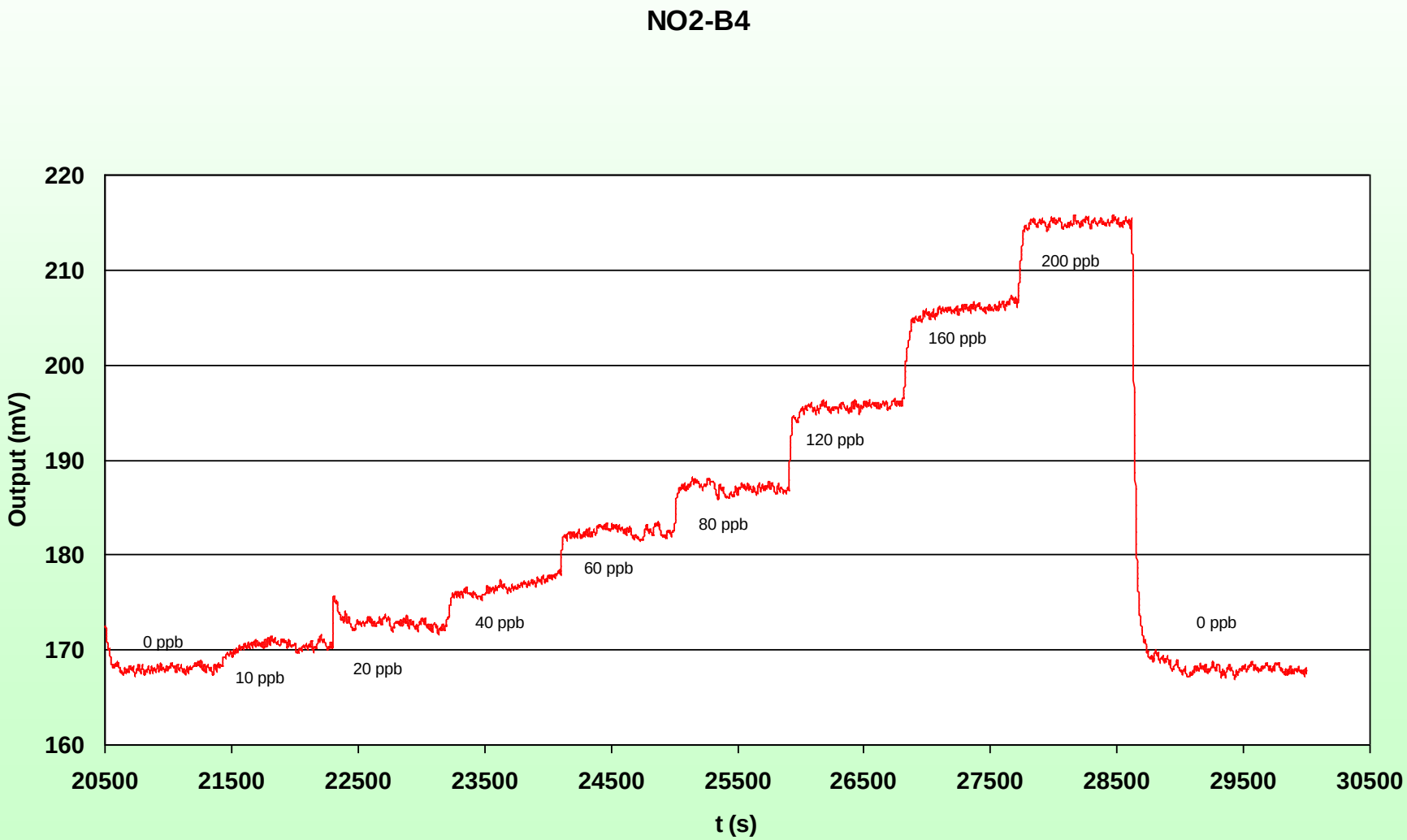
VOCs: permeation tubes with zero air/ rh control

PM: Lab comparison with transfer standard (U. Manchester)

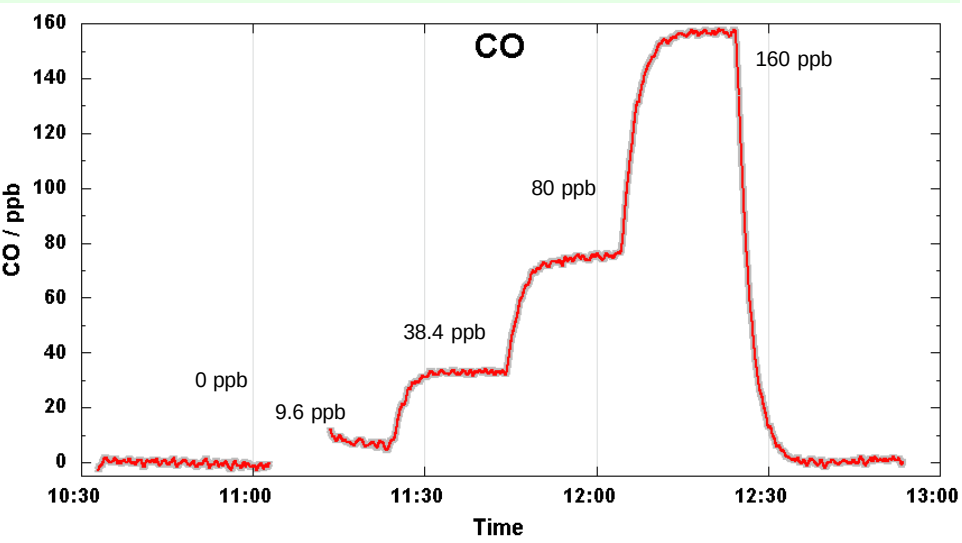
With normal electronics, we can detect 50 ppb NO_2

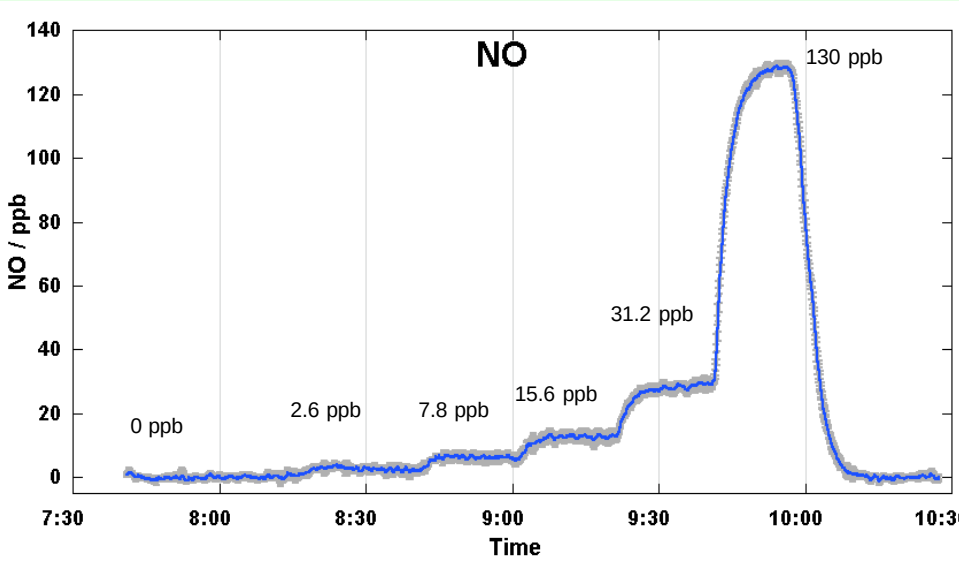


With good electronics, we can detect 10 ppb NO_2



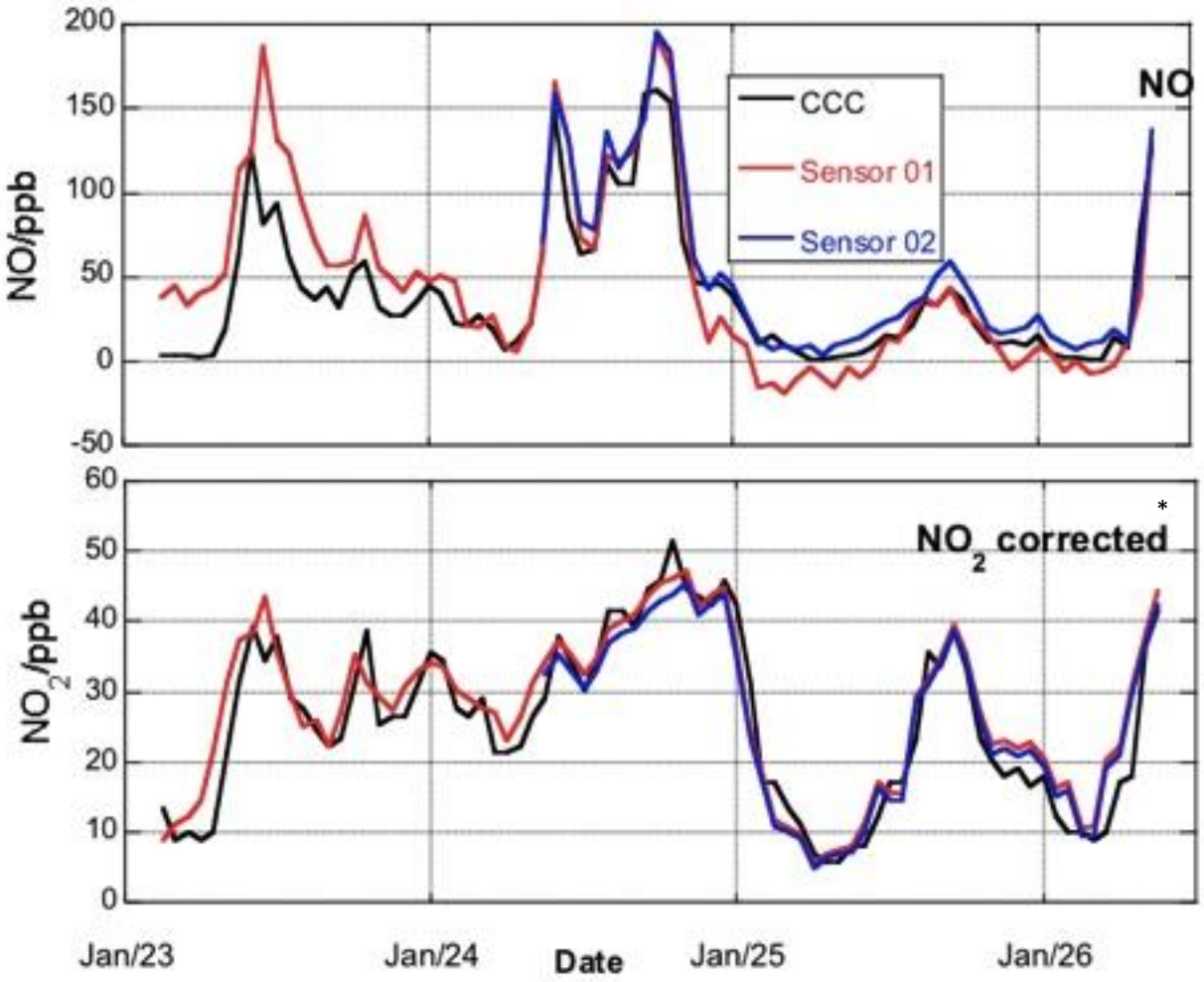
With smoothing algorithms we can resolve 2-3 ppb NO_2.

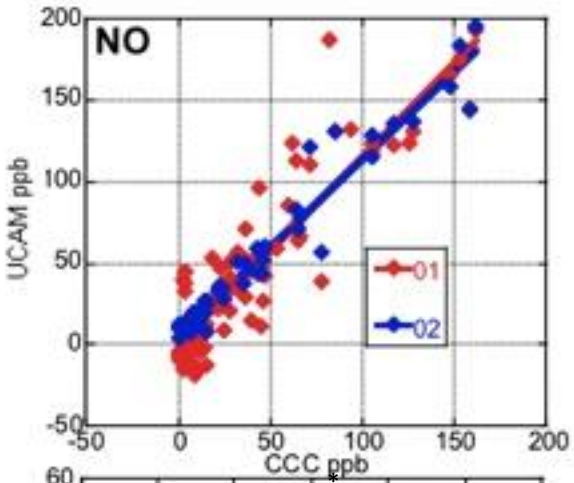


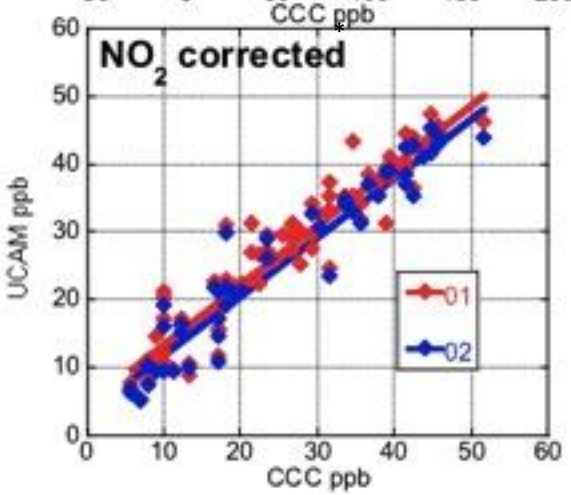


Field testing: sensores are referenced to AQMs

‘Real world’ comparison of NO_2 and NO with ratified AURN site







Performance replicated in the field….

* Corrected for O_3 interference

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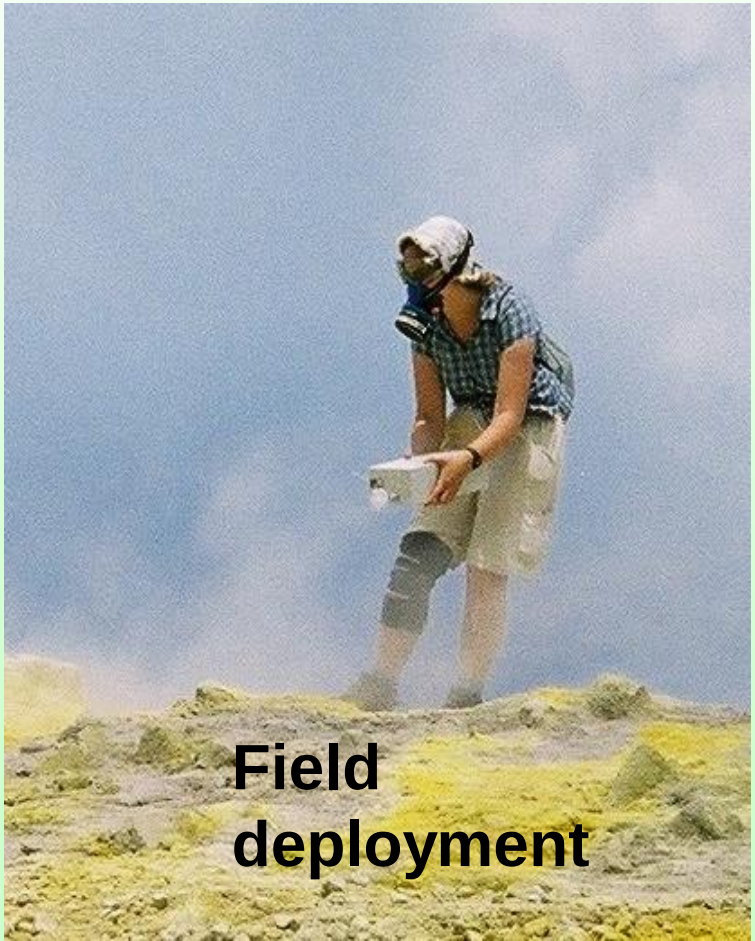
PIC.

Extreme field testing: volcanoes!

Typical PPE: face-mask (gas filters), hard hat, goggles, high-visibility vest, hiking boots, gloves, sunscreen, sunhat

In-field repairs



Field deployment

Commercial needs

Low cost (<€100/ sensor)

Low power (<30mW)

ppb limit of detection (5 to 20 ppb LoD)

Long term zero and sensitivity stability

Stable selectivity to other gases (MUST be predictable and stable)

Conclusions

- We are ready for lab testing of gas/ VOC sensors/ sensor systems
- PM testing is progressing
- Field testing has been undertaken but is not fully defined
- Commercial opportunities will develop during the project

Acknowledgements

- Wah On Ho, Mark Giles, Ronan Baron — Alphasense Ltd.
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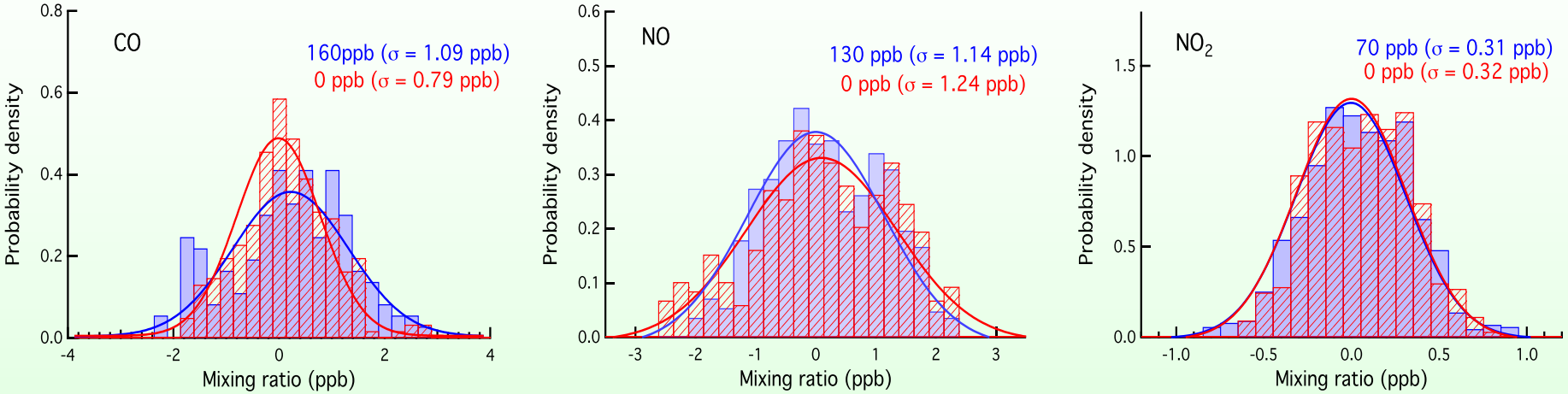
- Paul Kaye — University of Hertfordshire
- Paul Williams — University of Manchester

Thank you.

Any questions?

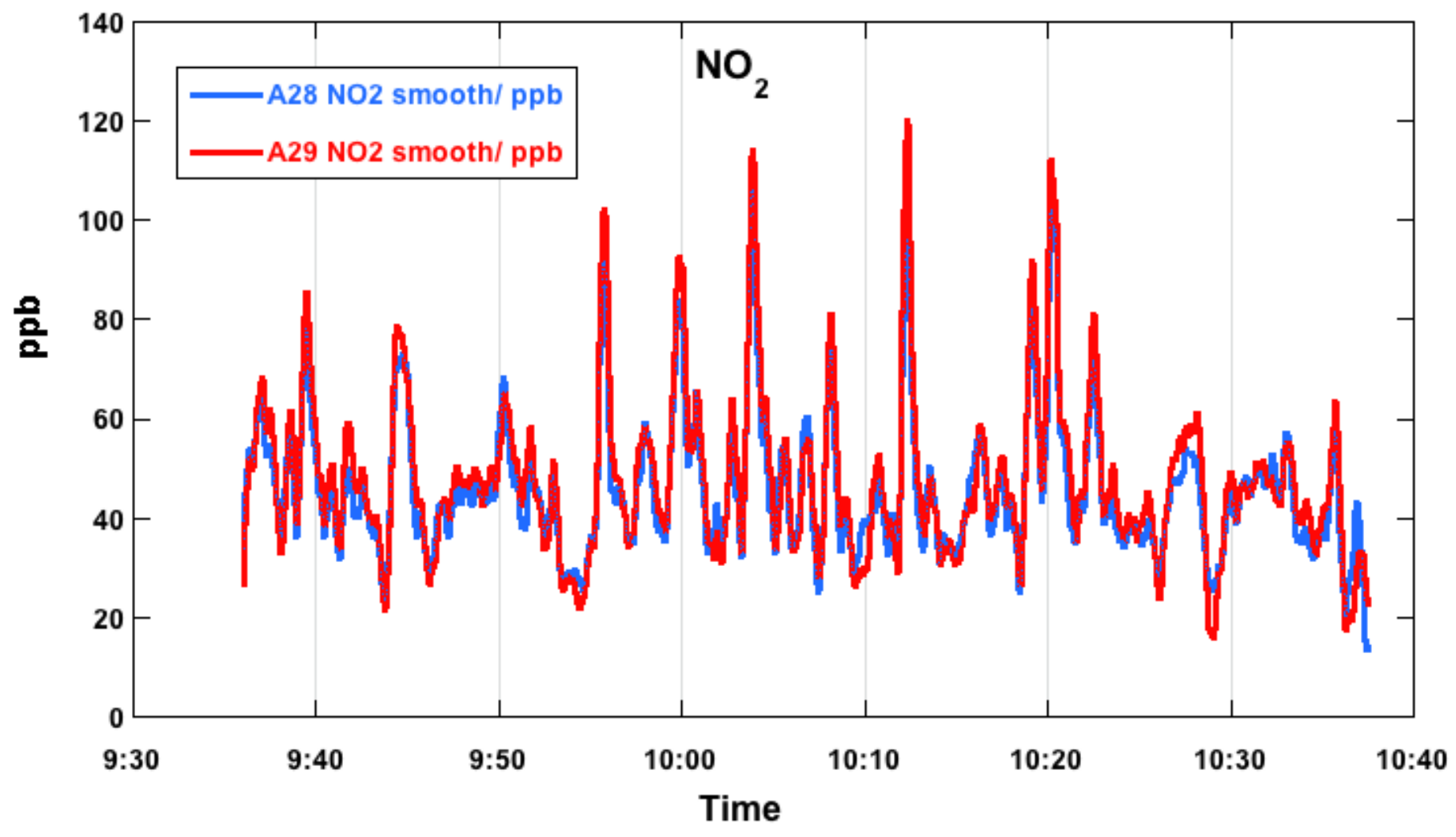
Cambridge laboratory measurements define noise at 1-2 ppb.

Noise characteristics:



- Typical sensor sensitivities/LoD are < 5ppb (< 7μg/m^3) for CO, 1-2 ppb (~2-4 μg/m^3) for NO and NO_2.
- SO_2, O_3 have comparable performance to NO_x.
- Typical sensor t_{90} ~ 10-20s (determined by diffusion)
- Very low power consumption (μW)

Co-located sensors (NO_2) – real structure can be seen. **Repeatability** is very good.



(Uncorrected for O_3)

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