

# European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

## WGs and MC Meeting at ISTANBUL, 3-5 December 2014

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Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

## Smart Calibration for Successful European Gas Sensor Production



Ingrid Bryntse  
WG4 Leader,  
SenseAir AB / Sweden

 **cost**  
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY





# New calibration system for sub-ppm sensors

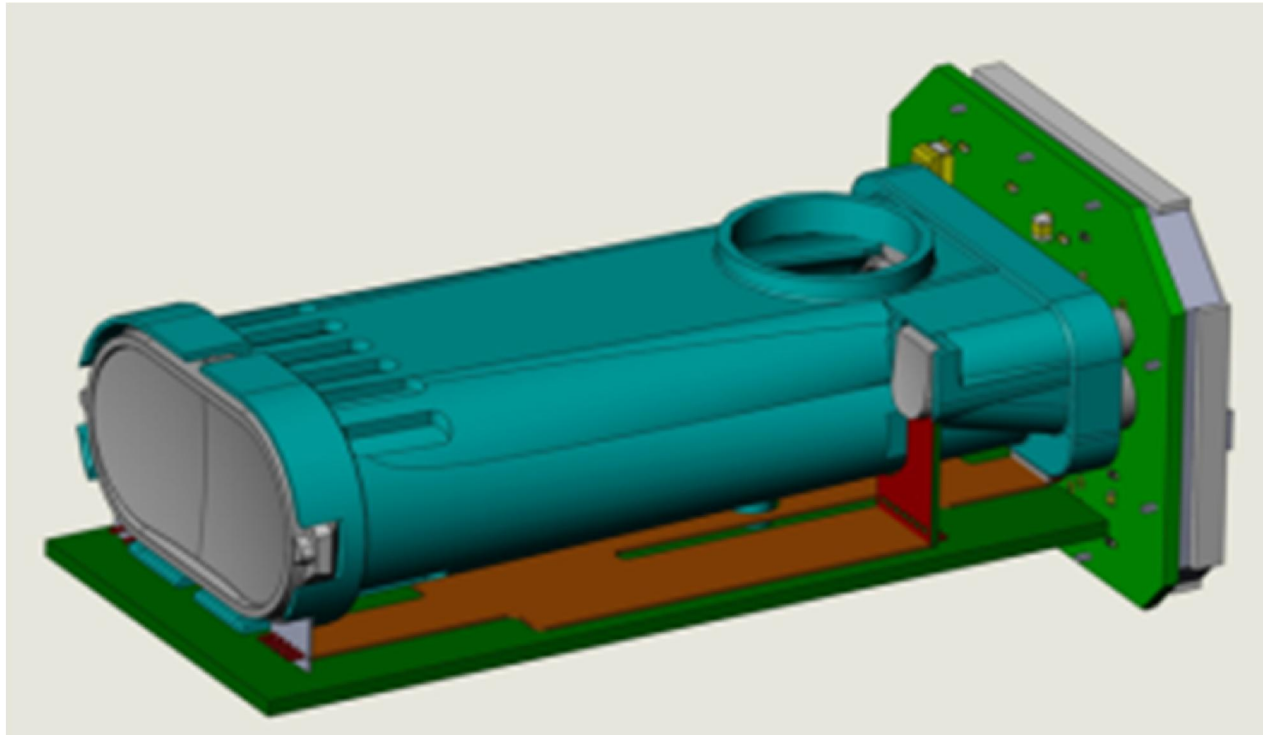
- Three Swedish companies **Autoliv**, **SenseAir**, and **Hök Instrument** have designed a new NDIR platform for **ethanol** and **CO<sub>2</sub>** measurements, aiming at a future Alcolock for traffic safety
- The new sensor platform and calibration system is also suitable for **greenhouse** or **hazardous gases**: **NH<sub>3</sub>**, **N<sub>2</sub>O**, **H<sub>2</sub>O<sub>2</sub>**, **O<sub>3</sub>**, **CH<sub>4</sub>**, **hydrocarbons**, **freons...**
- A corresponding novel Alcolock **Prototype Calibration System** was built at SenseAir supported by our partners and Vinnova (Sweden's Innovation Agency)

# Long Path Length NDIR platform



# The Long Path Length “LPL” Platform has shrunk


New cuvette length ~ 1 m





# Novel Alcolock prototype

- >50 % smaller
- More robust materials
- Improved mirror coating
- Temperature stable gas cuvette
- Optimised PCB design
- Carefully chosen key components
- Two perpendicular channels



# An improved sensor requires a perfect calibration system!

- The **total accuracy of any calibration system must be >3x “better”** than the sensor requirements
- It demands **full parameter control**: temperature, pressure, chamber gas concentration, measurement period, statistics, reference gas quality, system leakage, gas / vapor generation system, carrier gas / compressed air

# Calibration system improvements

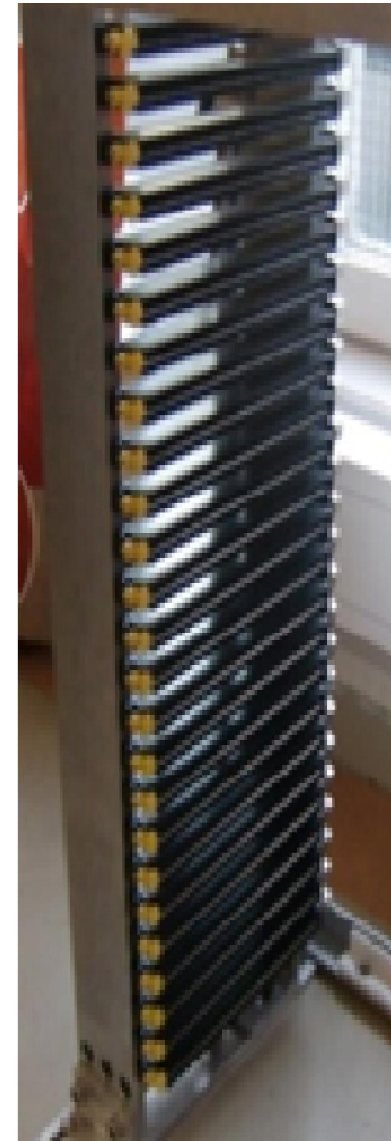
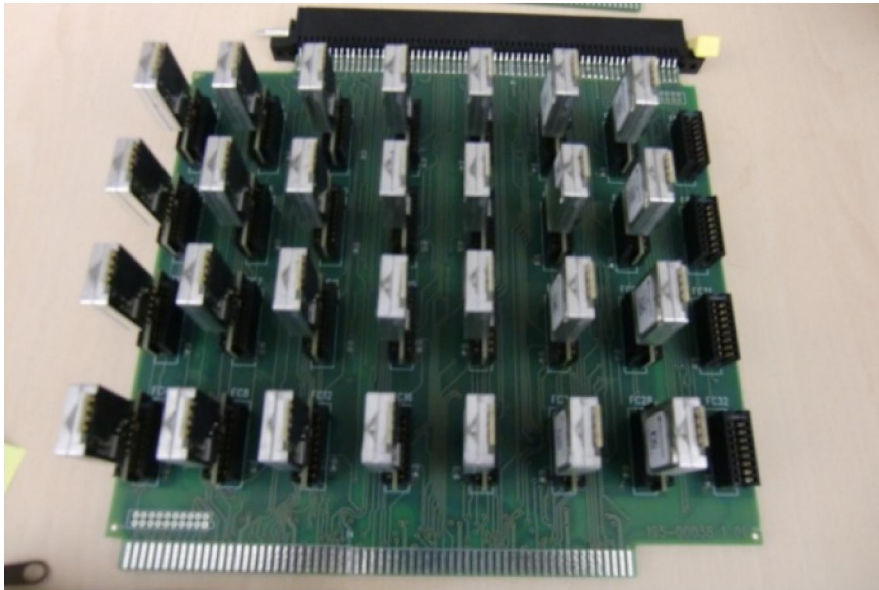
- Flexible, universal
- Future compatible = scaleable
- Modular
- Minimized nr of interruptions
- 100% traceable
- Internal size and air flow optimized for pallets
- Temp range +5 to +95°C
- CO<sub>2</sub> range 0 to 50 000 ppm (5%)
- EtOH range 0 to 500 ppm
- Separate calibration of CO<sub>2</sub> and EtOH in first demonstrator

## Calibration System initial goals

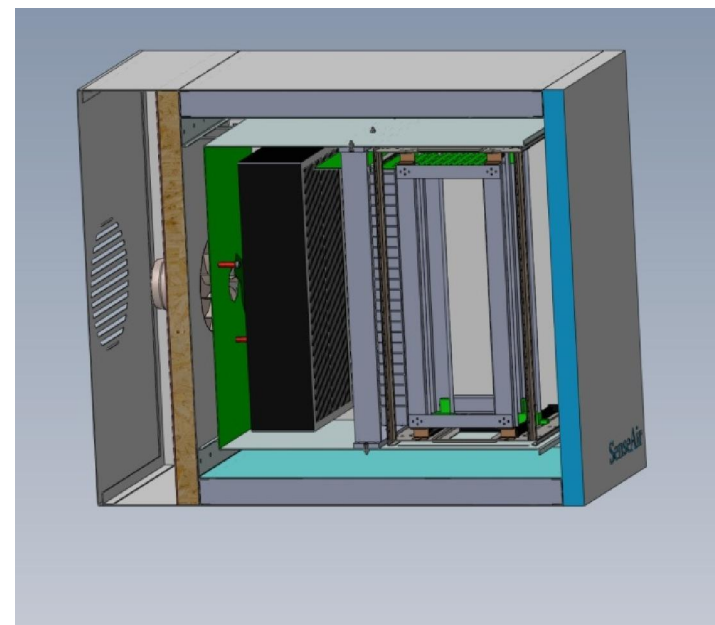
<b>Humidity</b>	Zero humidity in gas containing parts (pipes, KK, ref sensor cabinet)
<b>Temperature stability</b>	Temperature accuracy $\pm 1^{\circ}\text{C}$ or better at a particular temp / long time studies
<b>Temperature points</b>	25, 50 and $80^{\circ}\text{C}$
<b>EtOH concentrations</b>	$0\pm 5$ , $200\pm 6$ , $500\pm 15$ ppm
<b>CO<sub>2</sub> concentrations</b>	$0\pm 20$ , $15\ 000\pm 450$ , $30\ 000\pm 900$ ppm
<b>Process time</b>	Full calibration time including verification $< 4$ h



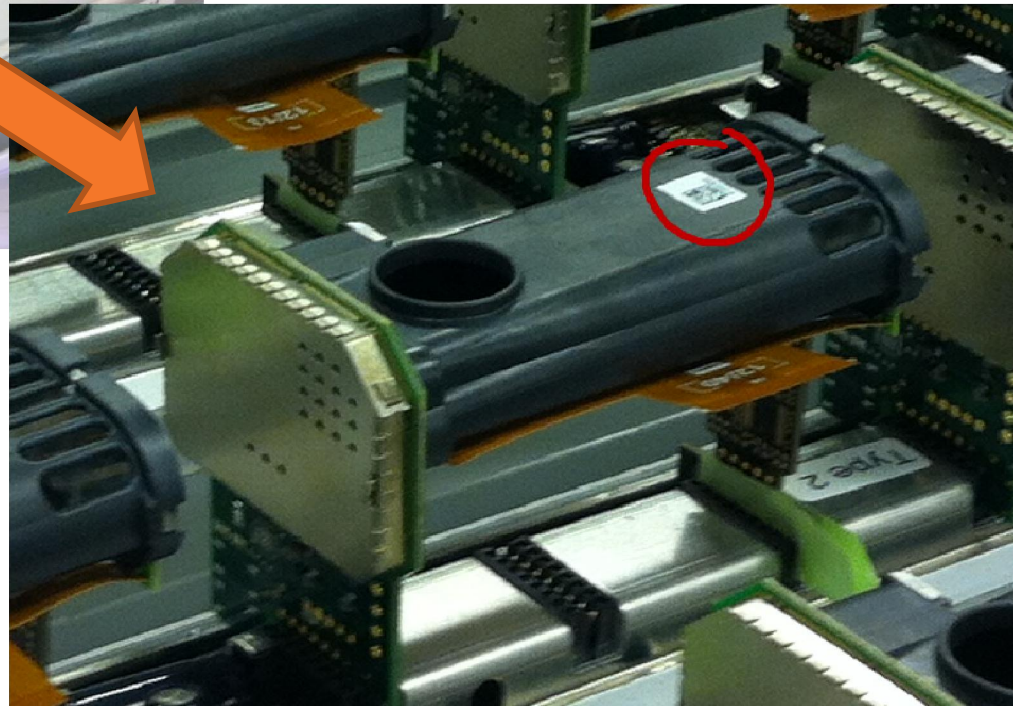
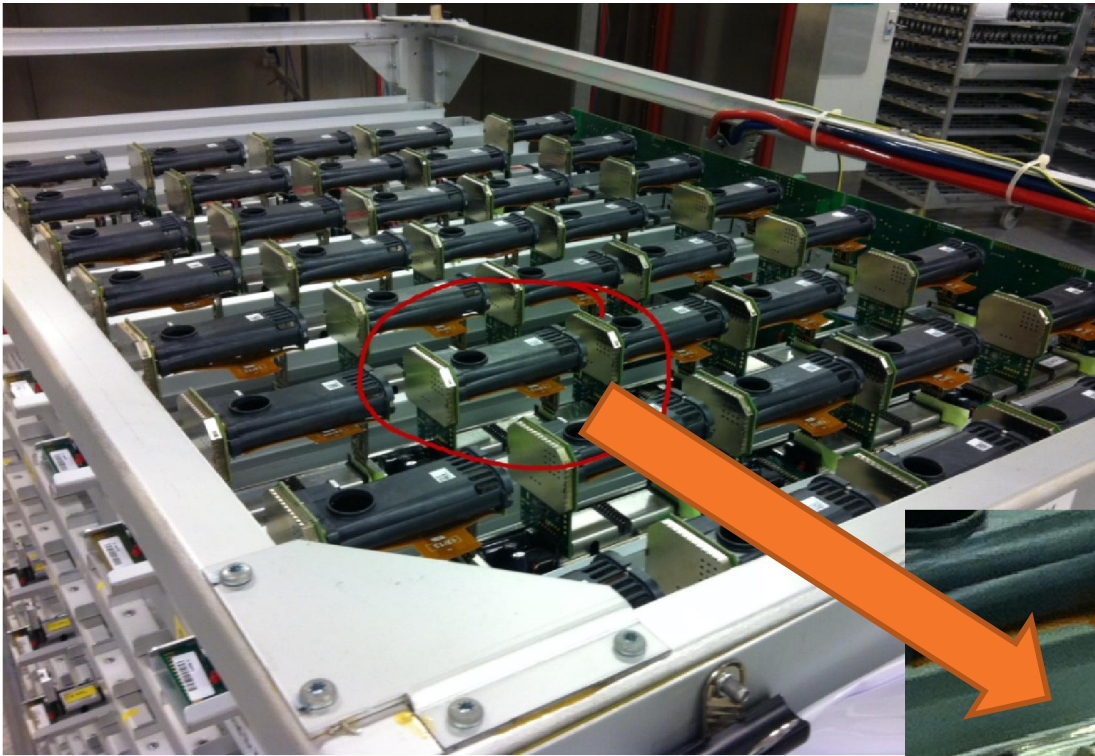
# HW design of pallet, controlling and communicating sensor carrier



# Calibration EtOH & CO<sub>2</sub>



# Full traceability



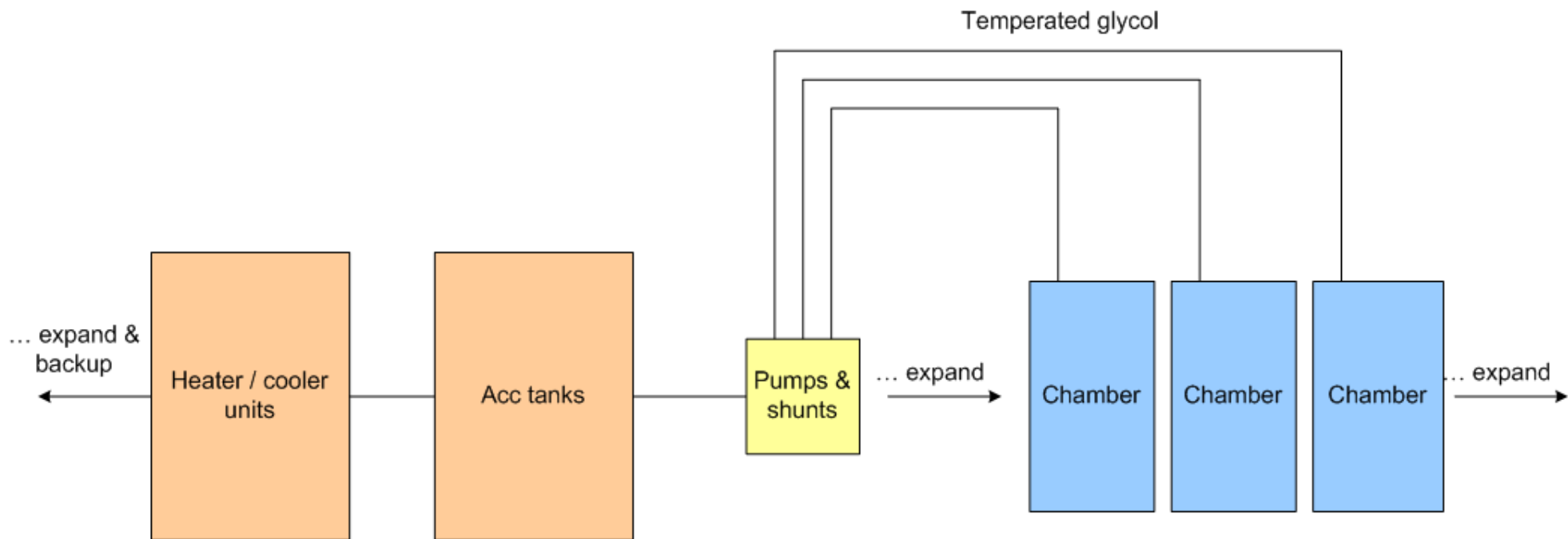
Individual serial number with complete traceability and history of batch & calibration data

# Large temperature control system



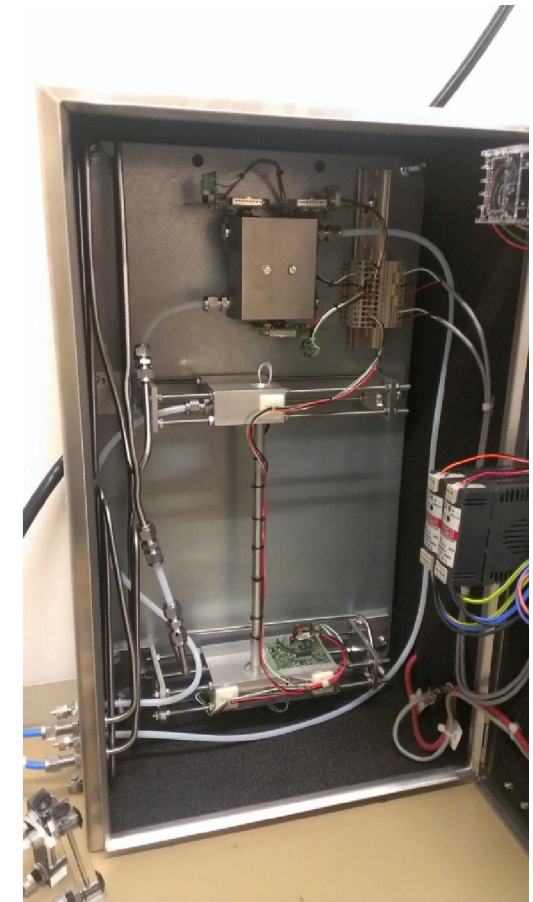
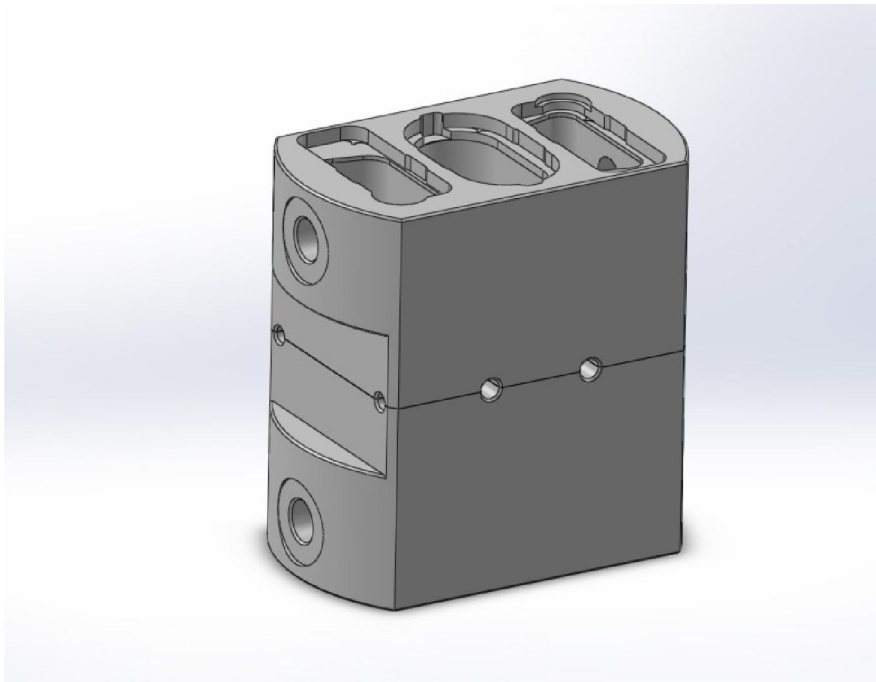
# Large temperature control system

- **Temperature stability** in chamber  $<0.5^\circ$
- **Temperature control** from large external equipment

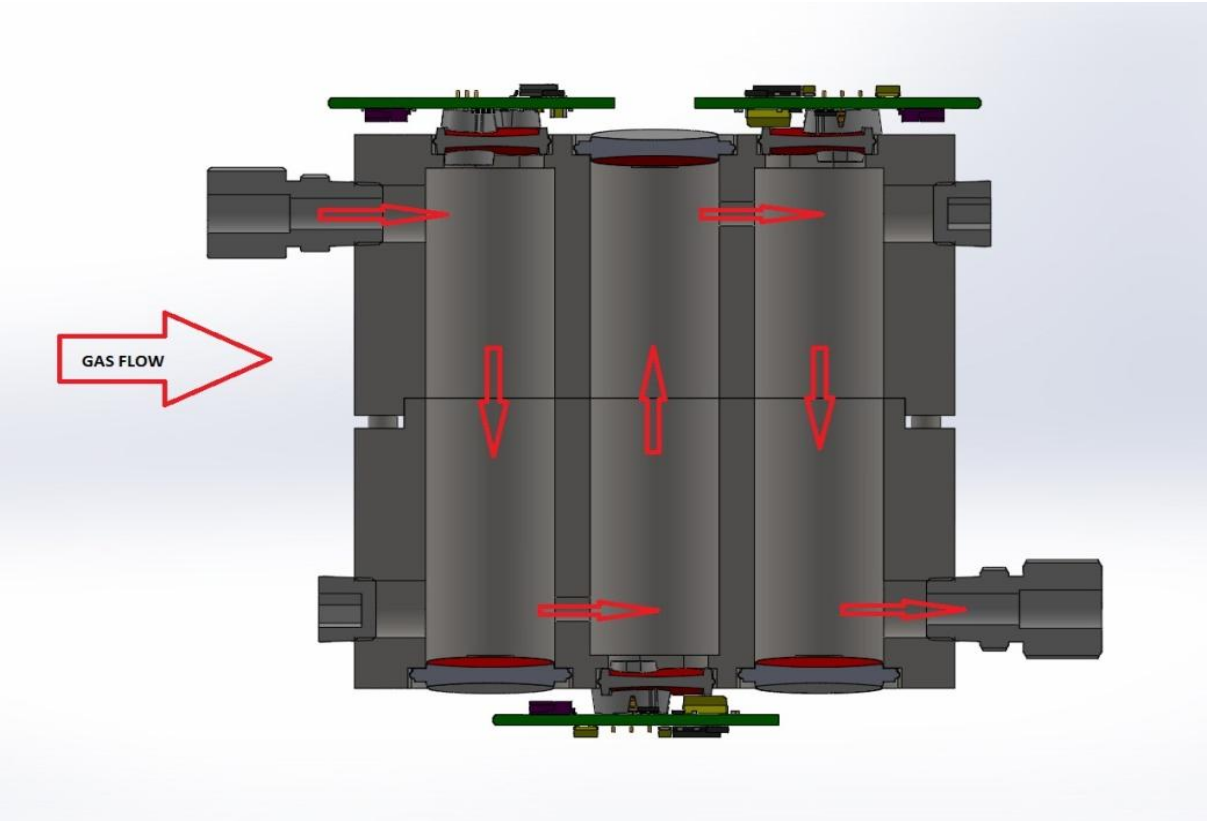


# Improved reference sensors for gas control

- Extremely **stable** materials
- Well hidden in **temp stabilized closet**
- **Three parallel sensors** for each gas

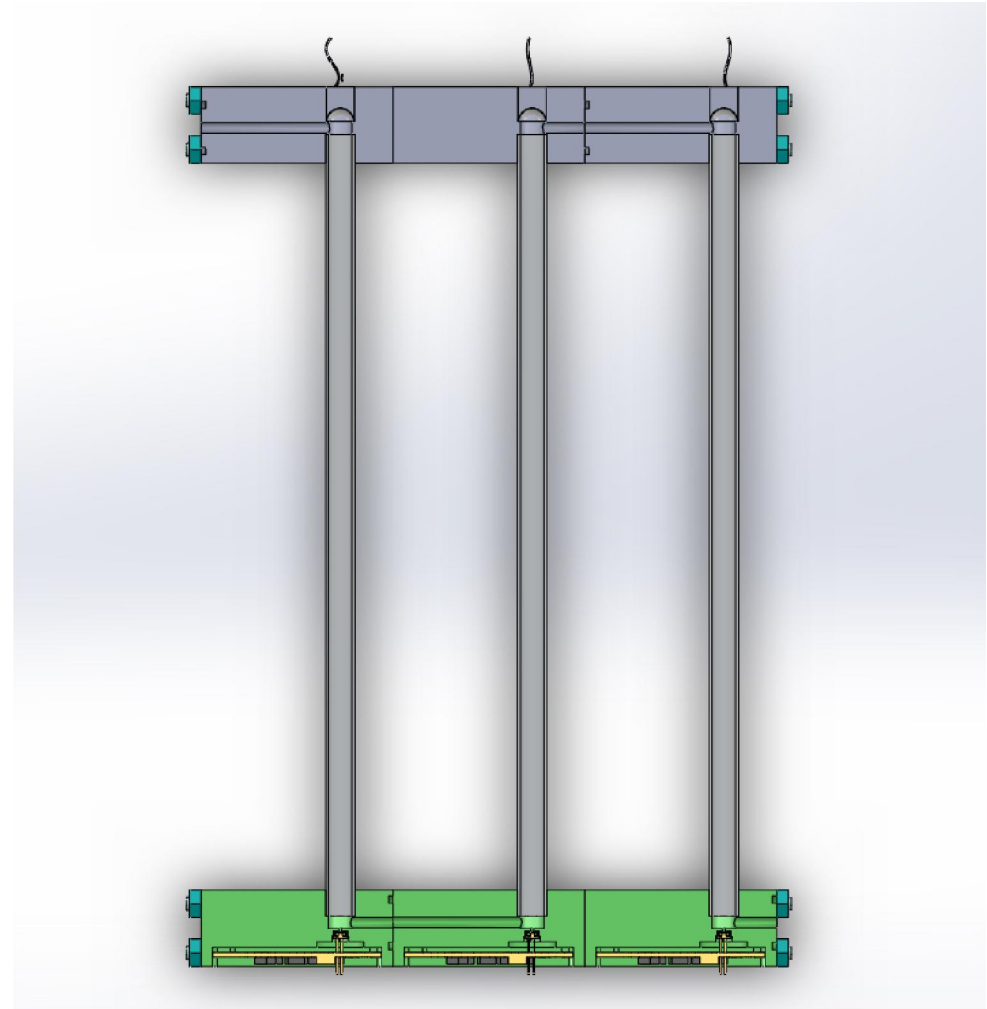
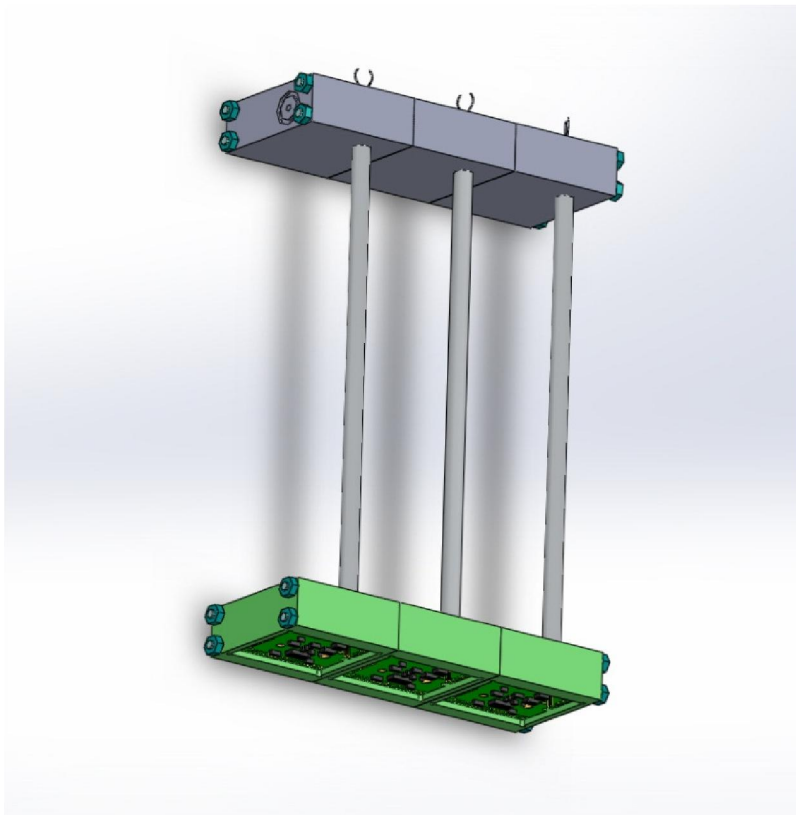


# Air flow in new ethanol reference sensor



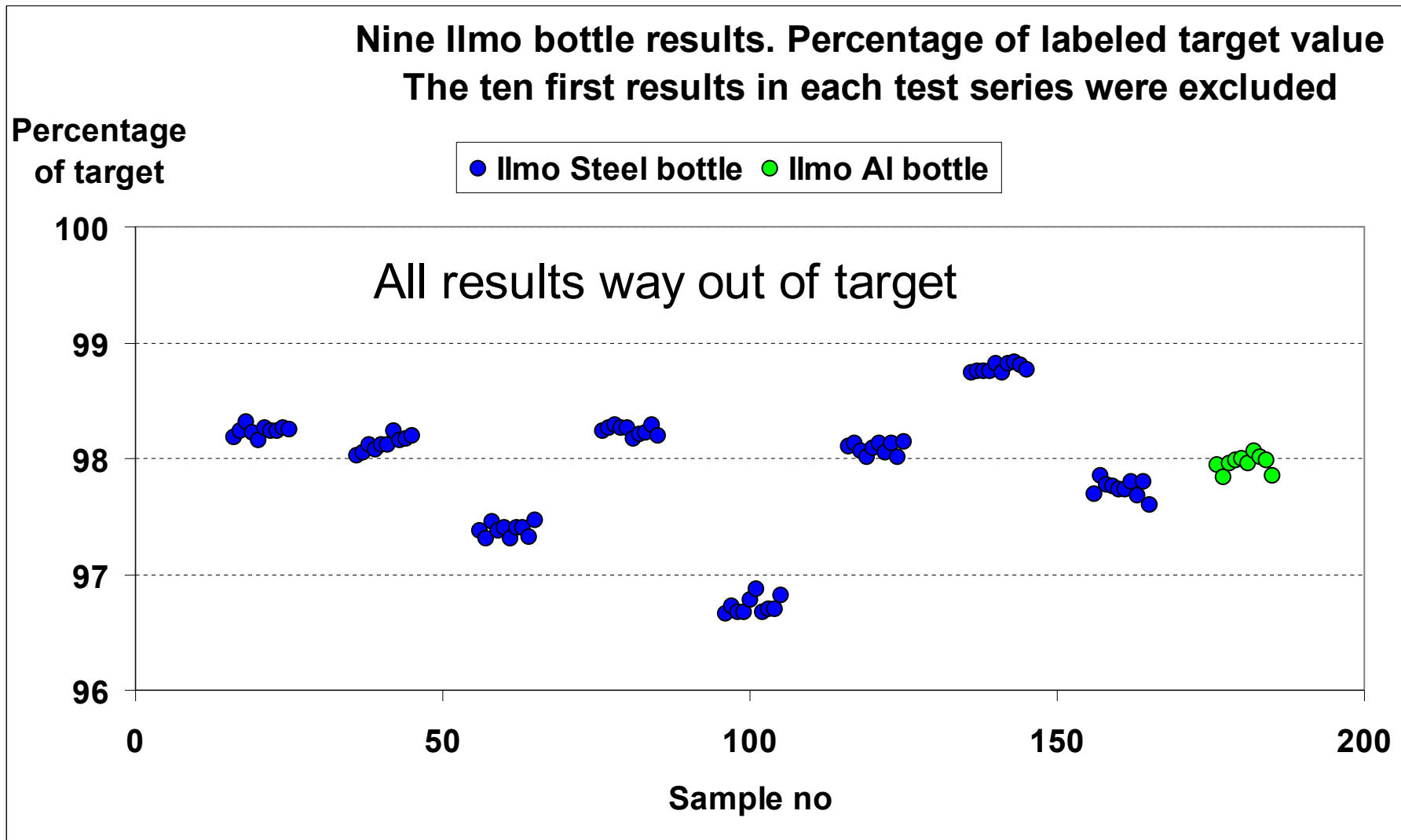
# CO<sub>2</sub> reference meter for low concentrations (0-2000 ppm)

- 30 cm optical path length
- Mechanically improved design

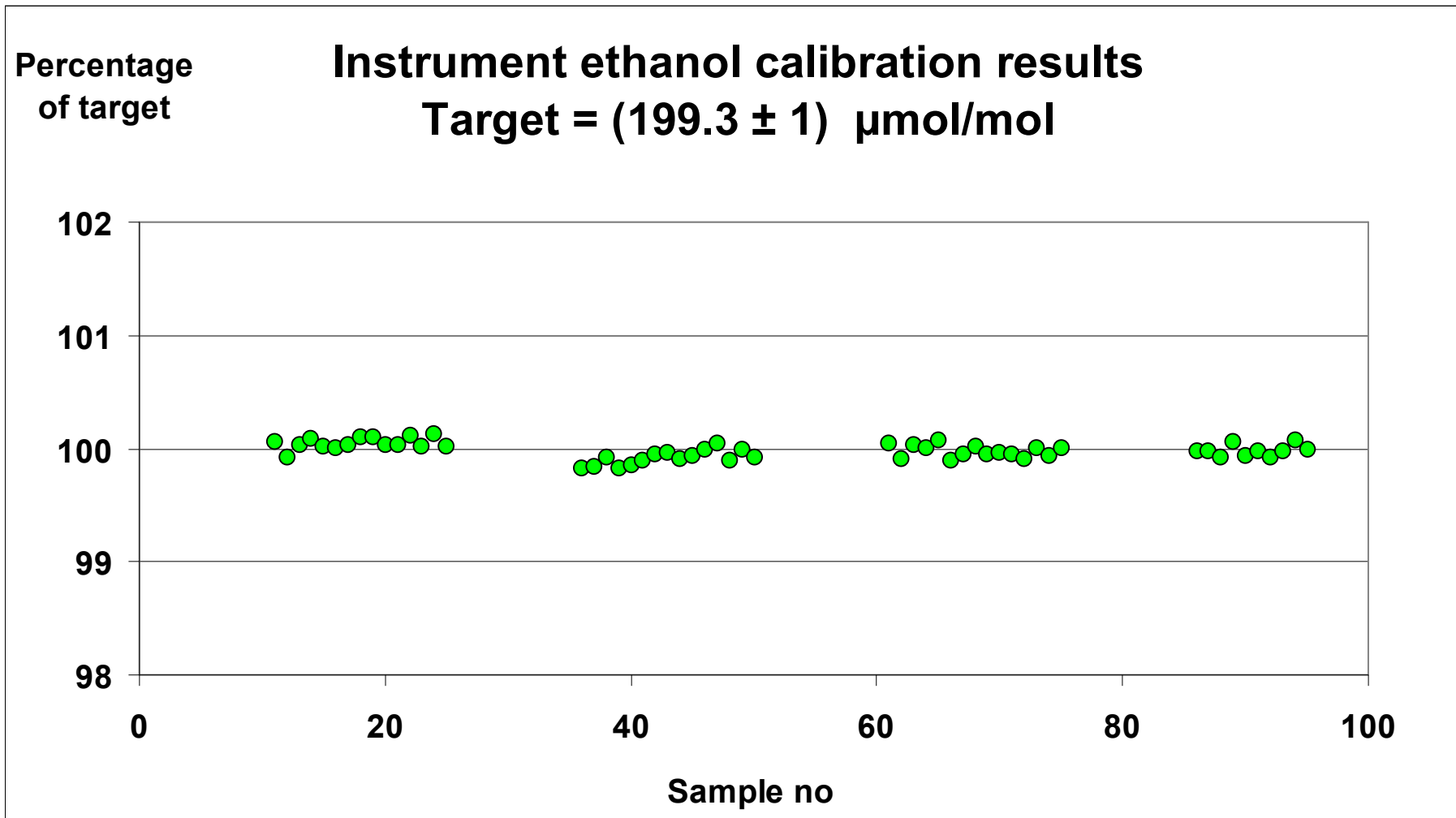




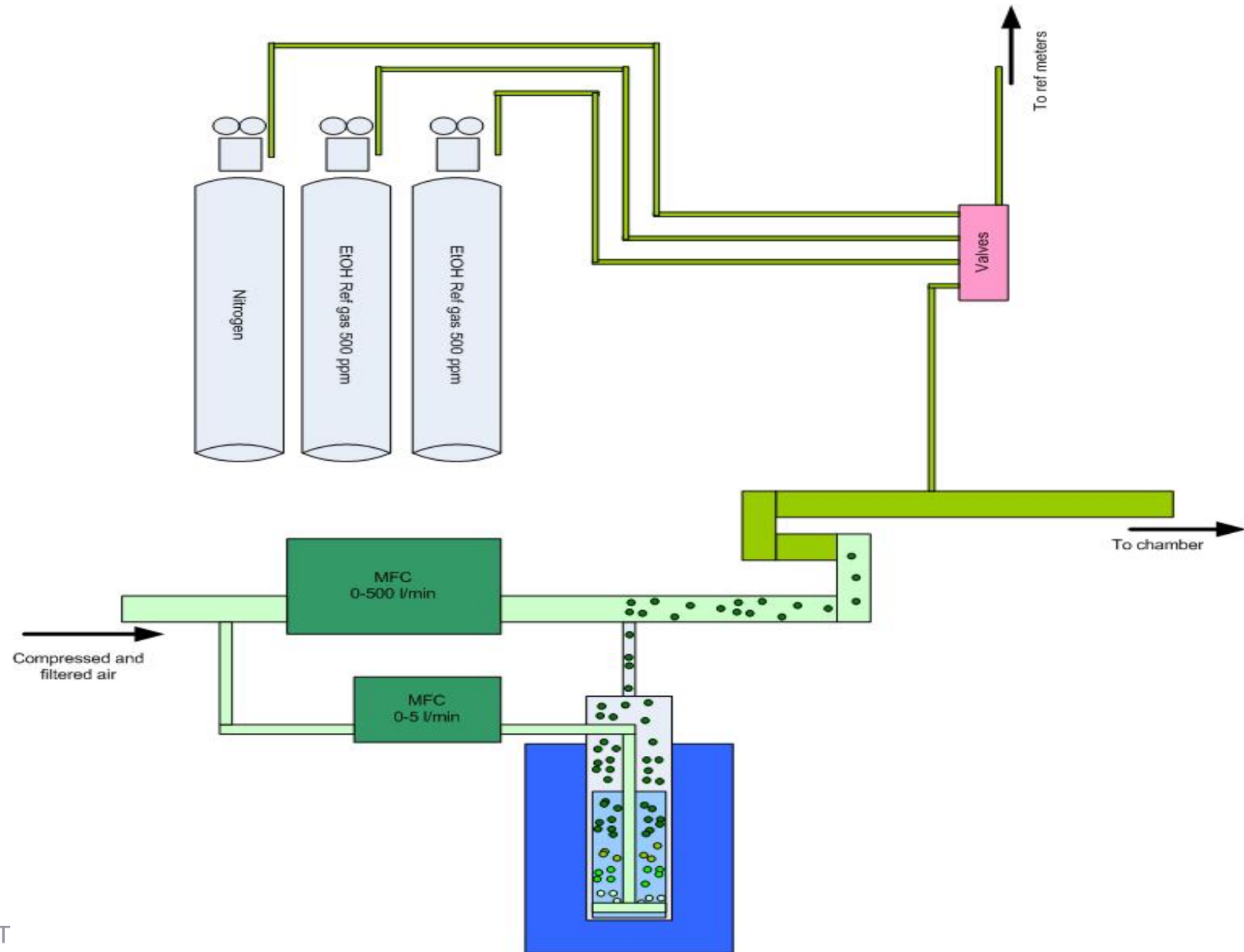
# Analysis of reference gas; Non-approved



# Analysis of reference gas; Approved



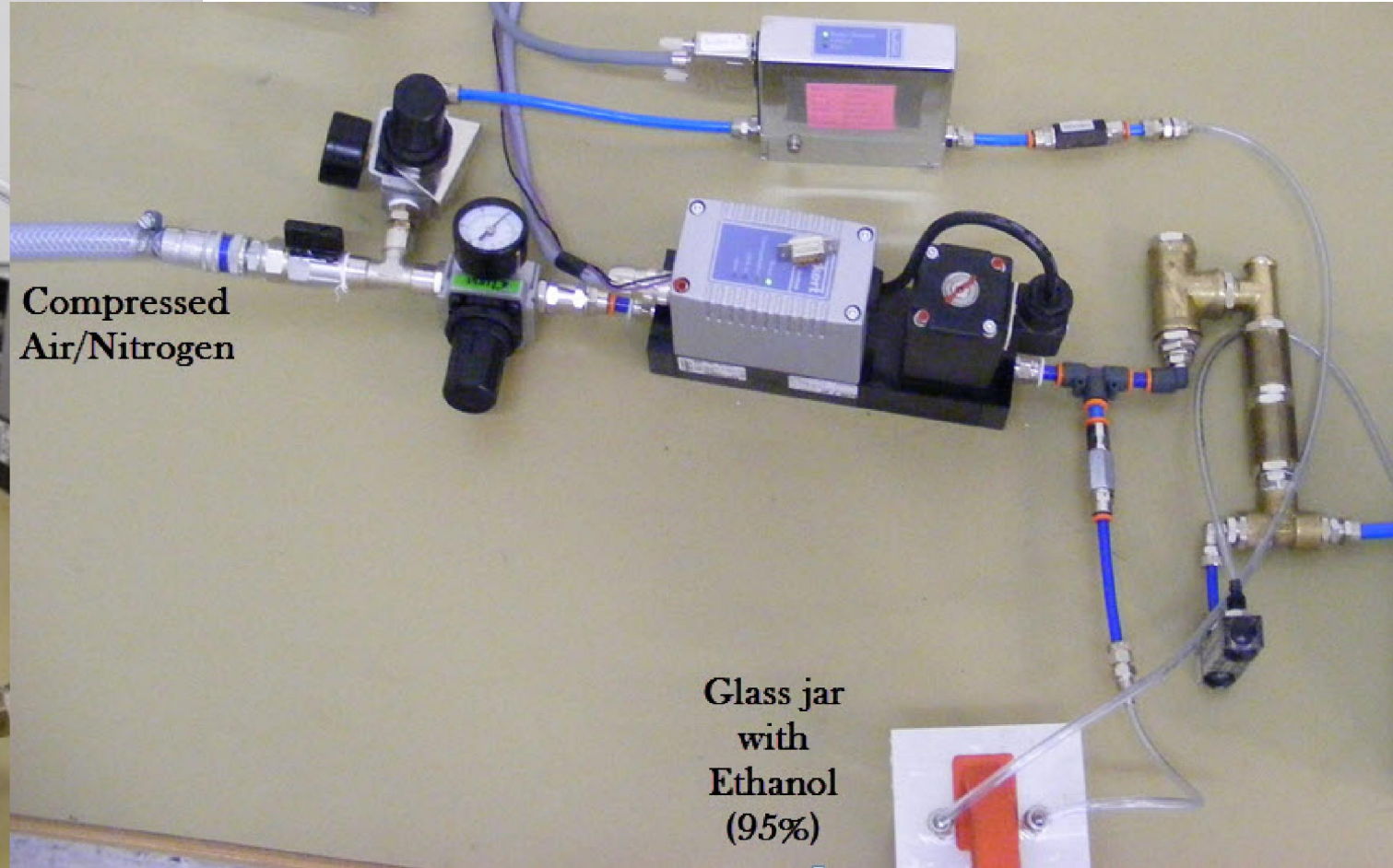
# Vapor generation 1, bubbling module



# Vapor generation 1, bubbling module

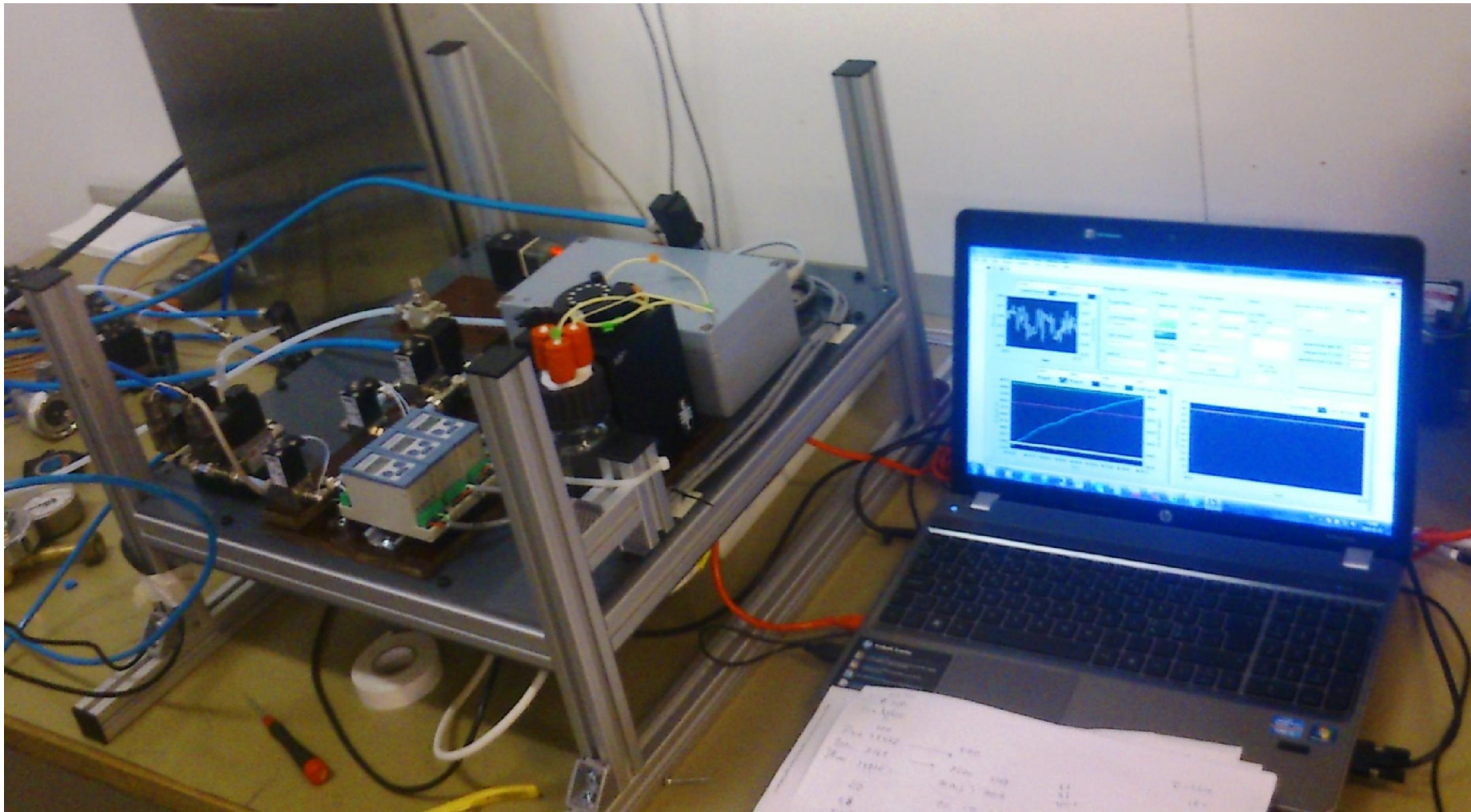


Compressed  
Air/Nitrogen



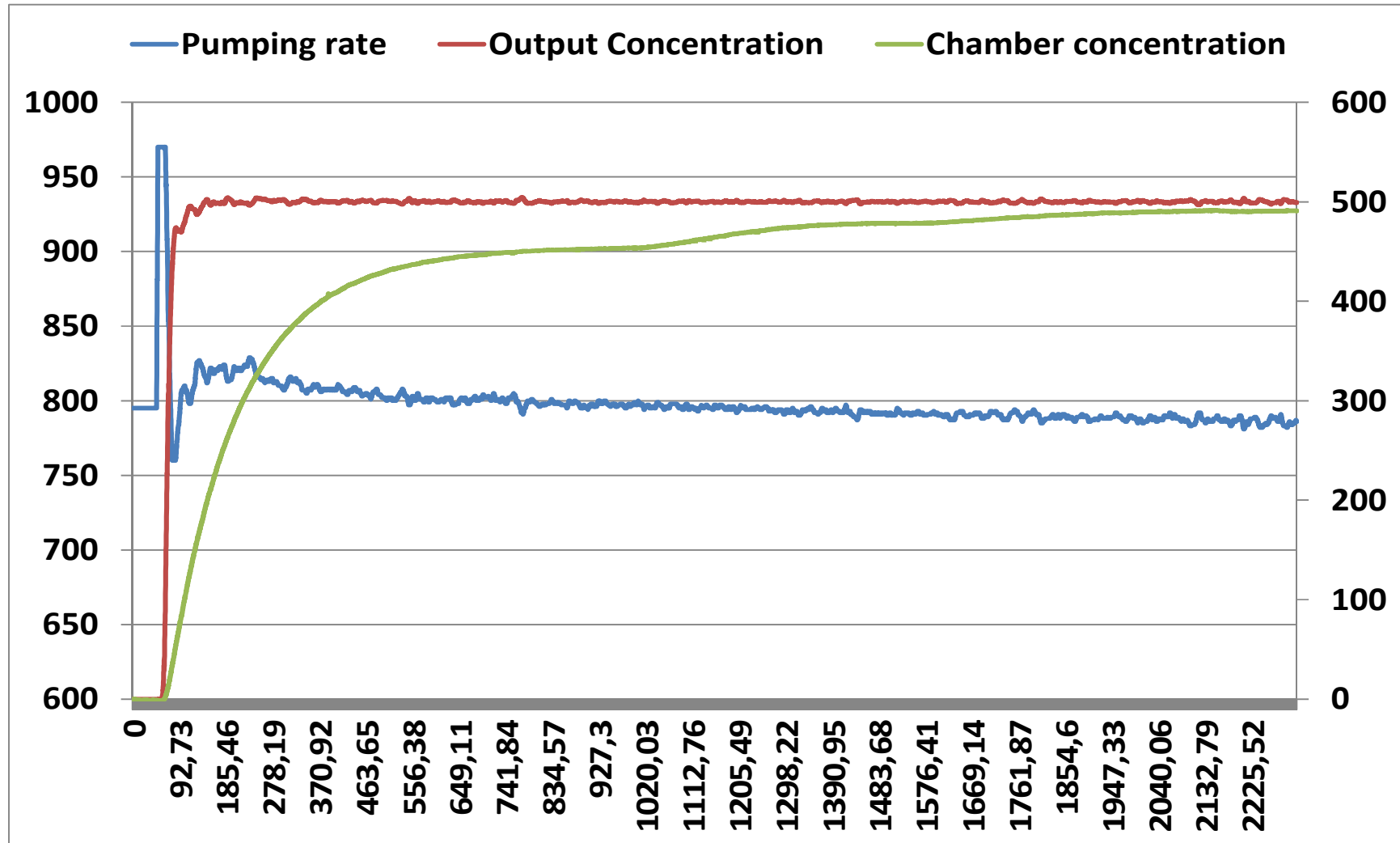
Glass jar  
with  
Ethanol  
(95%)

# Vapor generation 2, nanopump system

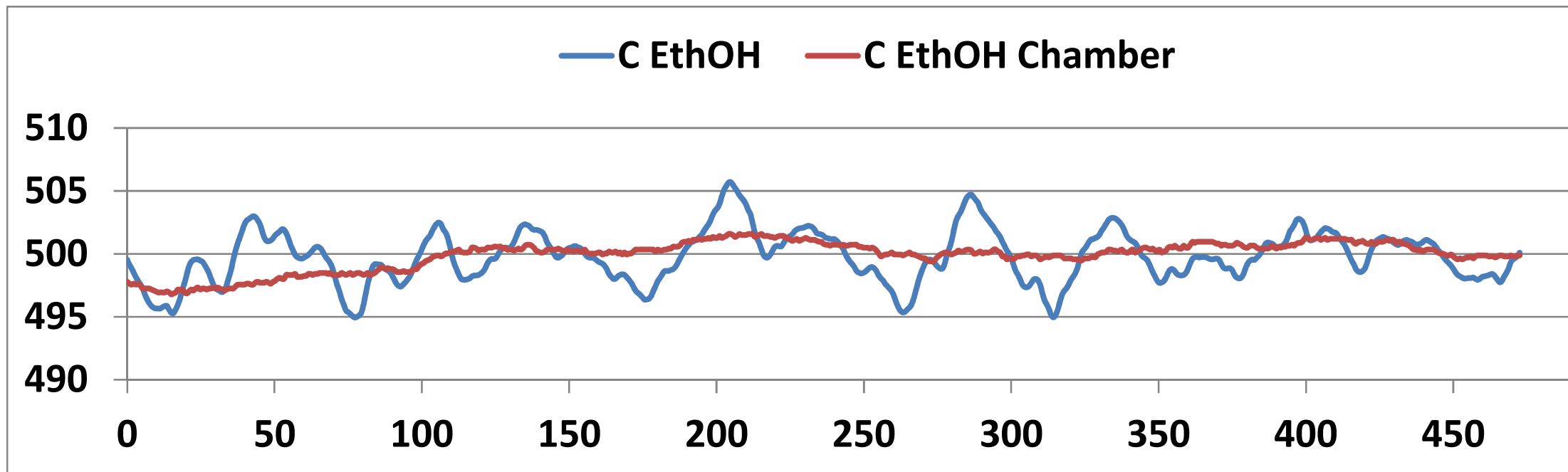


# Tests

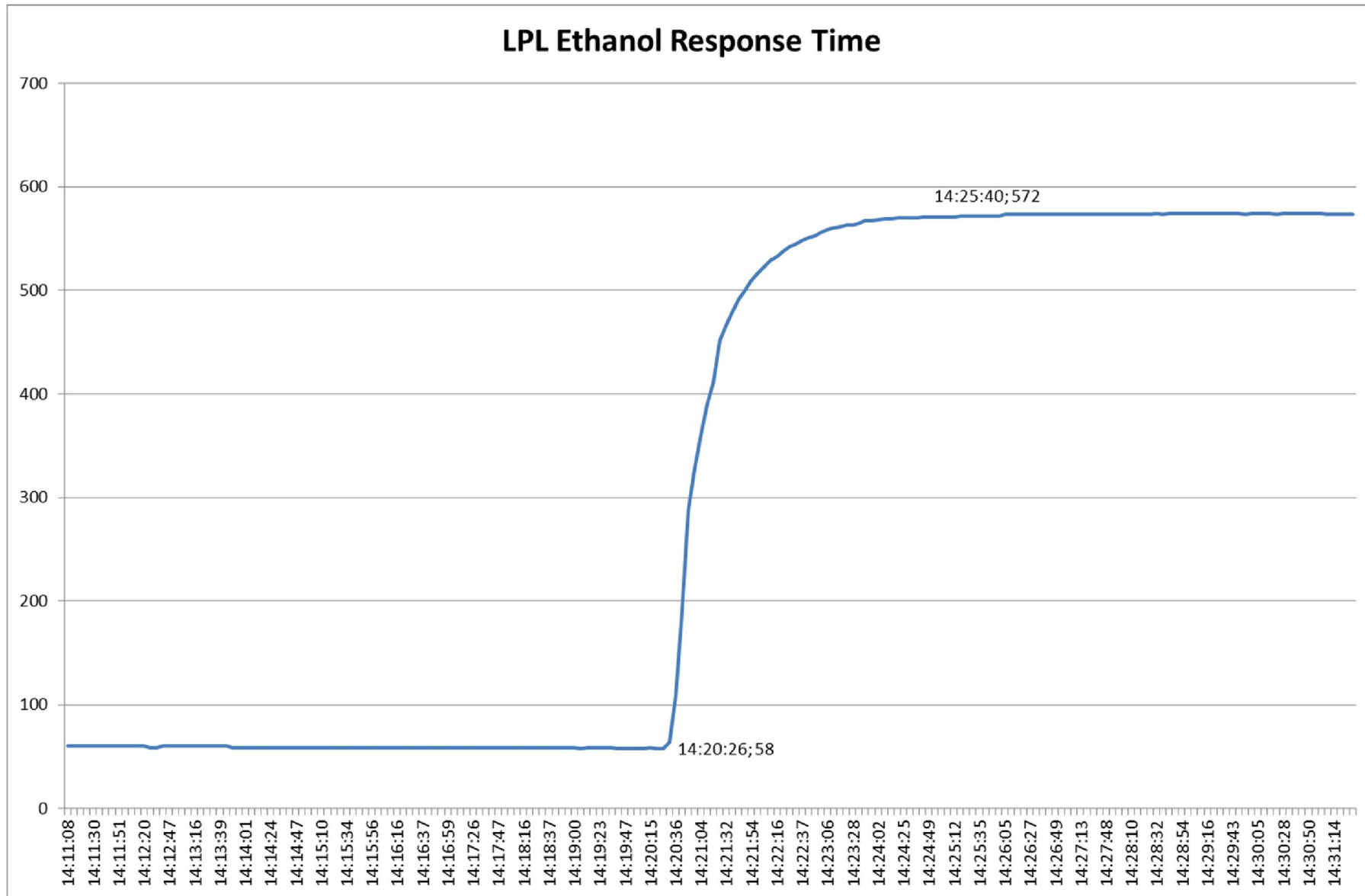
## Standard pumping mode



# Concentration variation near gas generator system and in chamber volume

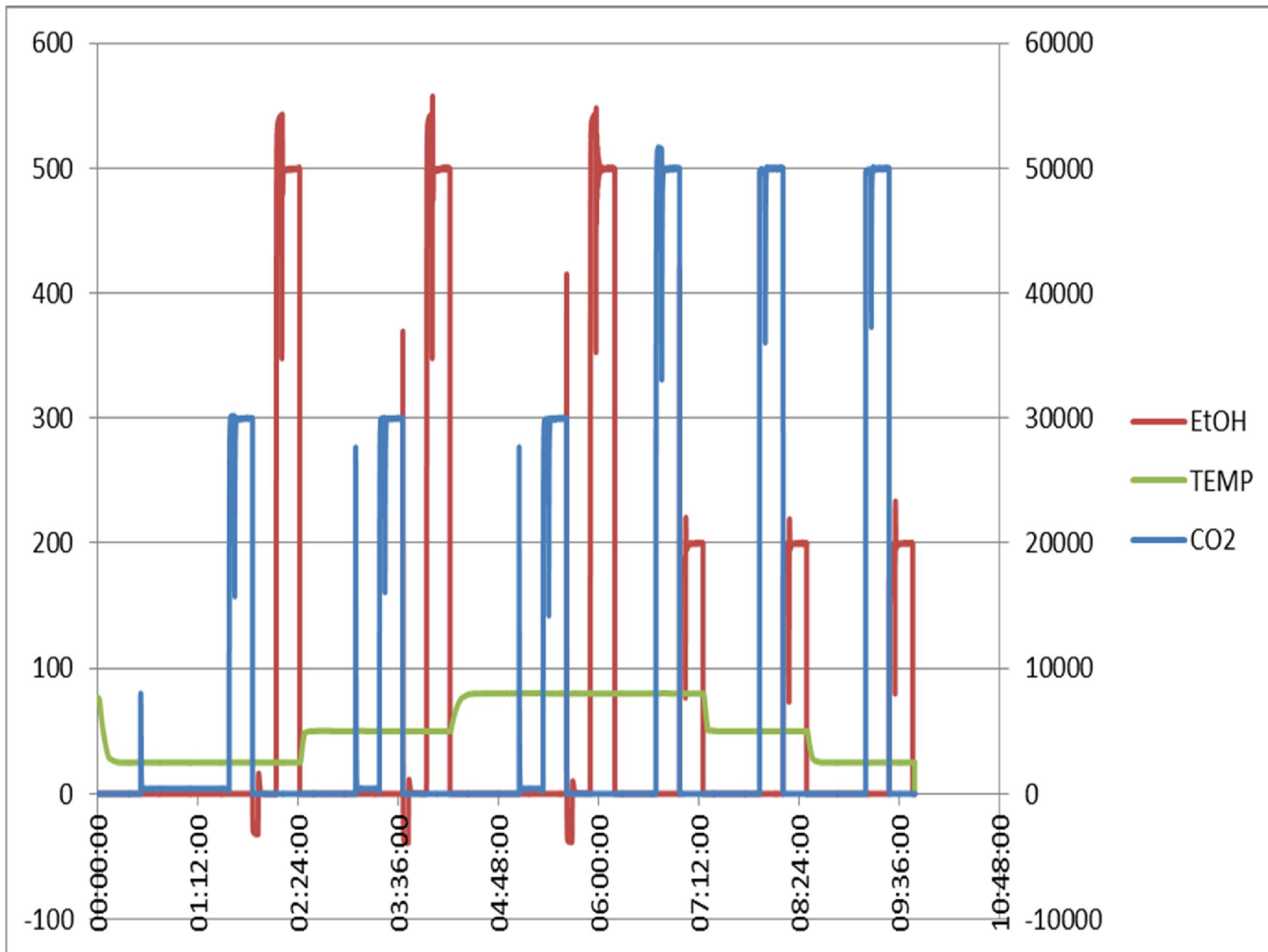


# Response time for system

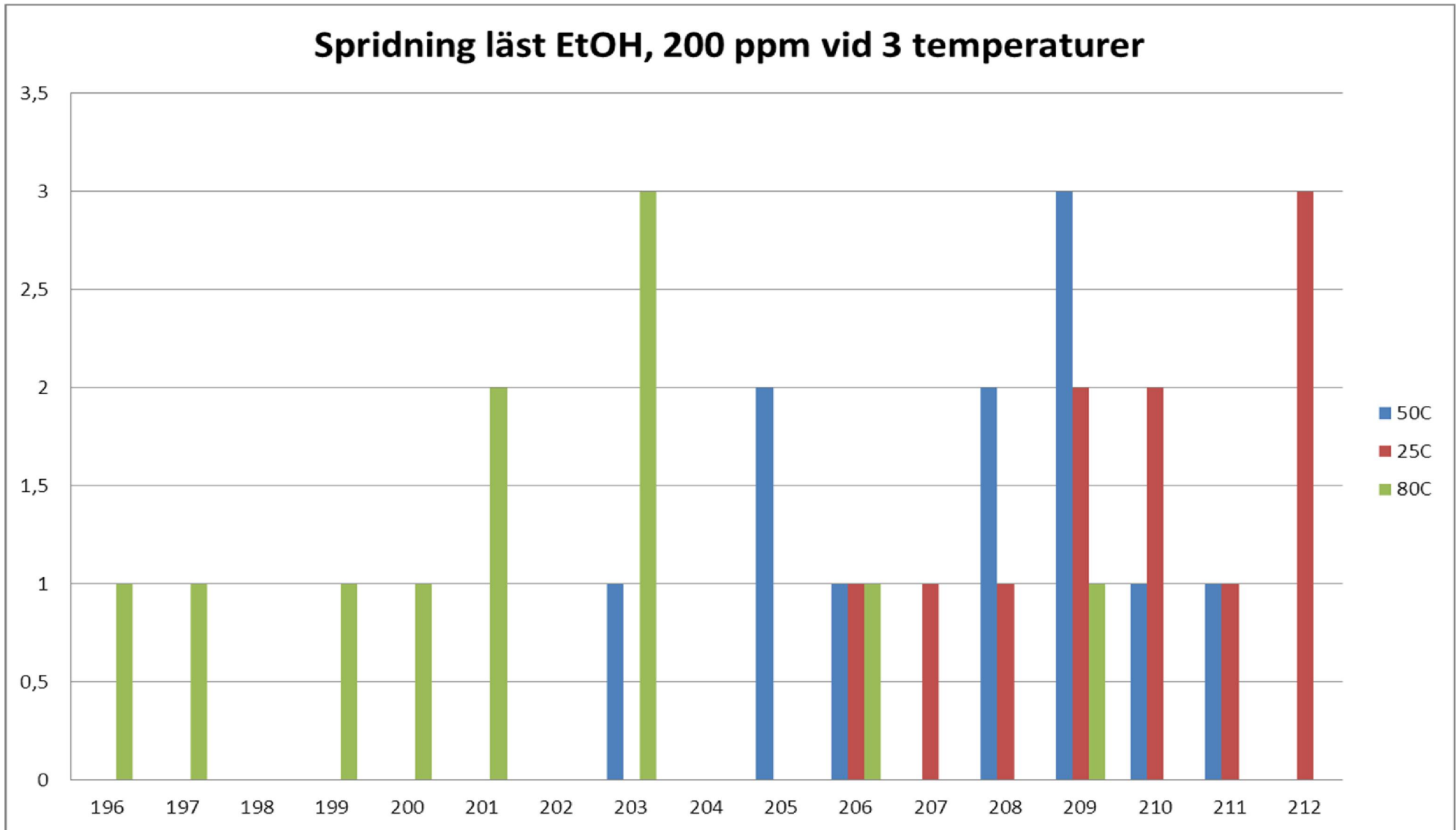




# Complete production run



# Spread in EtOH values after calibration





# Other gases suitable for this platform

Other greenhouse or hazardous gases:

- $\text{NH}_3$
- $\text{N}_2\text{O}$
- $\text{H}_2\text{O}_2$
- $\text{O}_3$
- $\text{CH}_4$
- hydrocarbons
- freons
- ...

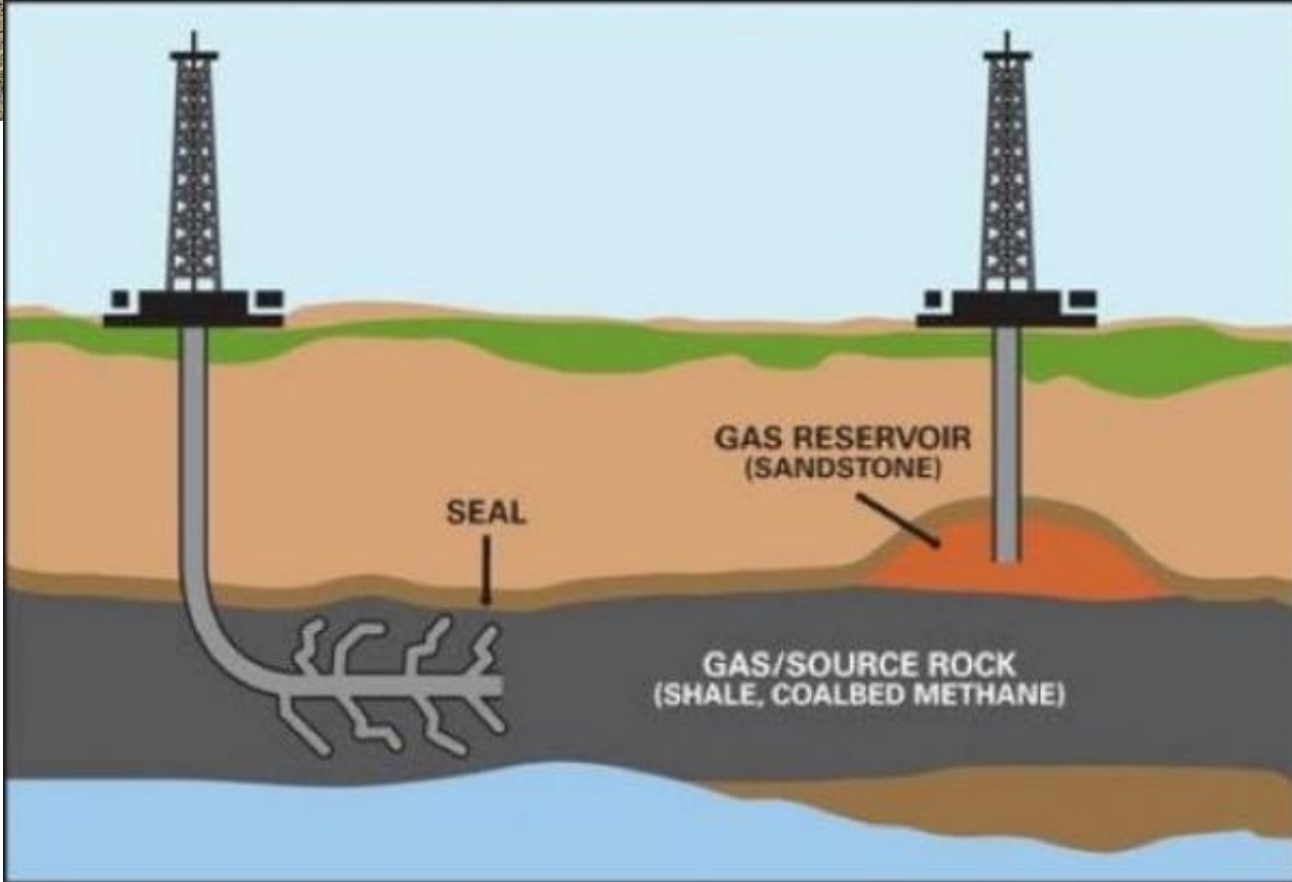


# Methane Detectors Challenge for EDF

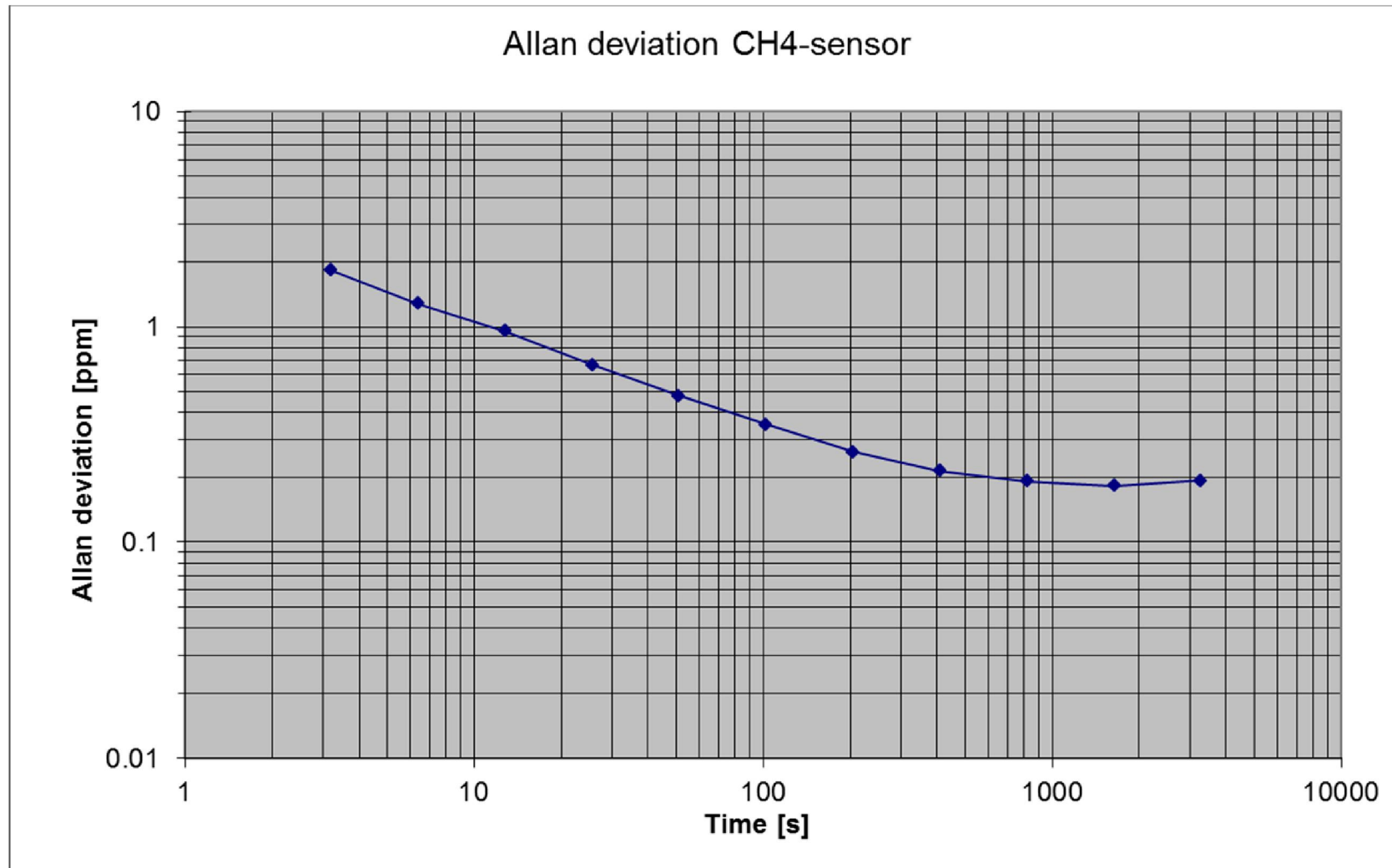
[http://www.edf.org/sites/default/files/mdc\\_selection\\_factsheet\\_final.pdf](http://www.edf.org/sites/default/files/mdc_selection_factsheet_final.pdf)

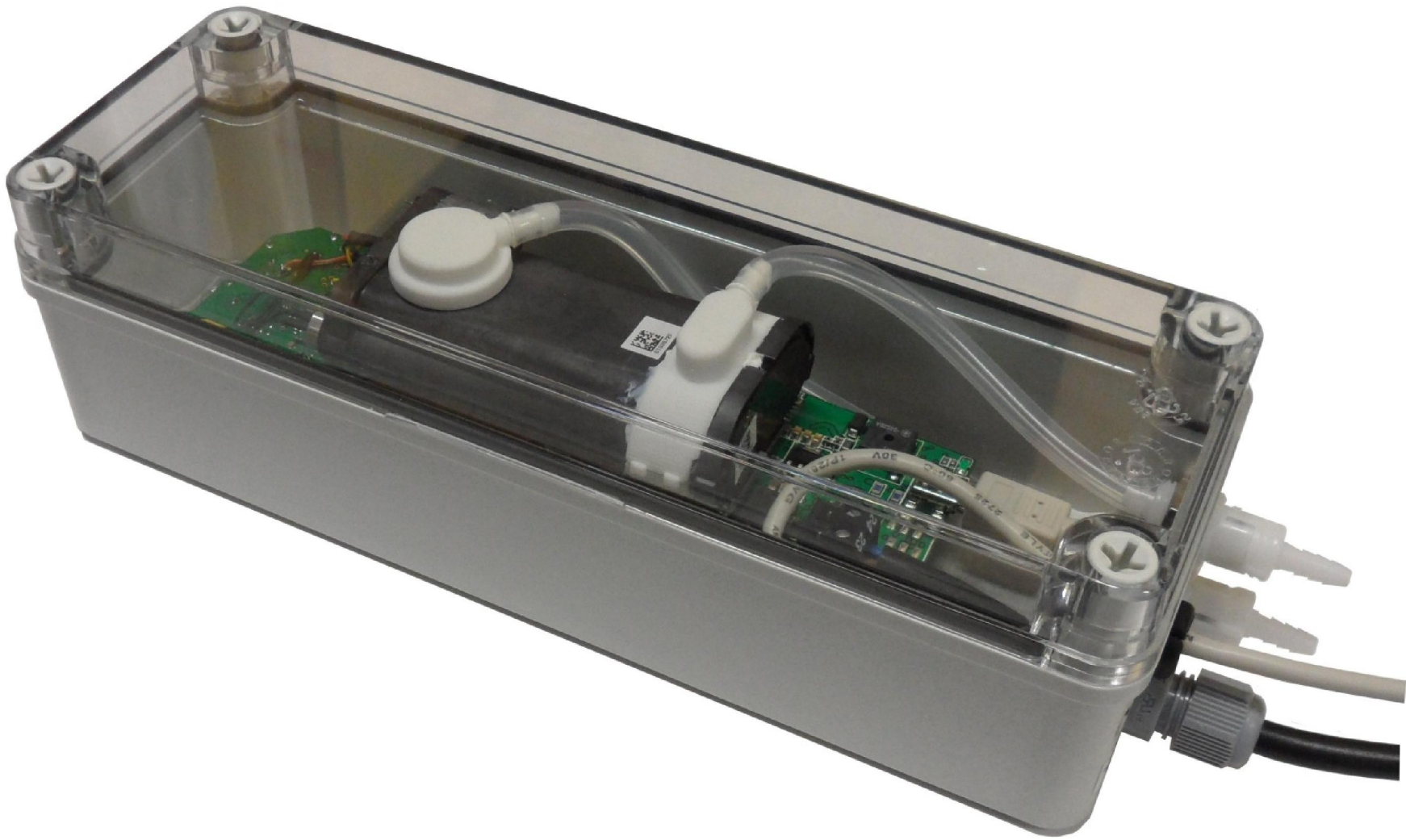
PPM-Level Leak Detection for Methane: Two firms adept in gas sensor development, Honeywell and the company's RAE Systems gas detection product division, and SenseAir AB, are adapting a handheld alcohol sensor and integrated continuous sampling system for low parts-per-million (PPM) methane and hydrocarbon detection.

This joint effort by Honeywell, a Fortune 100 company based in Morristown, New Jersey, and SenseAir, a firm from Delsbo, Sweden, with 25 years of gas-sensing experience and more than 20 U.S. and European patents in the field, provides an integrated systems approach matched with low costs and good leak detection performance.



# Methane analysis for fracking industry in USA







# Conclusions

- A prototype research park for testing calibration models was built
- The first experiments show that the initial goals were met
- A modular production system opens up for all new gases that are suitable for the improved LPL design