GENCOA

SVC TechCon 2019

Long Beach, CA

In-situ gas monitoring as an industrial tool for rapid troubleshooting

Joe Brindley, Tommaso Sgrilli, Benoit Daniel, Victor Bellido-Gonzalez, Dermot Monaghan

Gencoa Ltd, UK

Presentation outline

- Why in-situ gas monitoring – current state of the industry
- Description of Remote Plasma Emission Monitoring technique
- Qualitative identification of process problems
  - Air leaks
  - Water leaks
  - Contaminated process gas
- Using RPEM as a quantitative monitoring tool

The current state of process monitoring

Some form of pressure monitoring > Almost everyone

Pressure monitoring in each zone > Most users

Access to a He leak detector > Most users

Immediate access to a He leak detector > Some users

Access to a QMS (RGA) > Some users

RGA permanently on the tool > **Very few users**

In-situ gas monitoring
Why and why not?

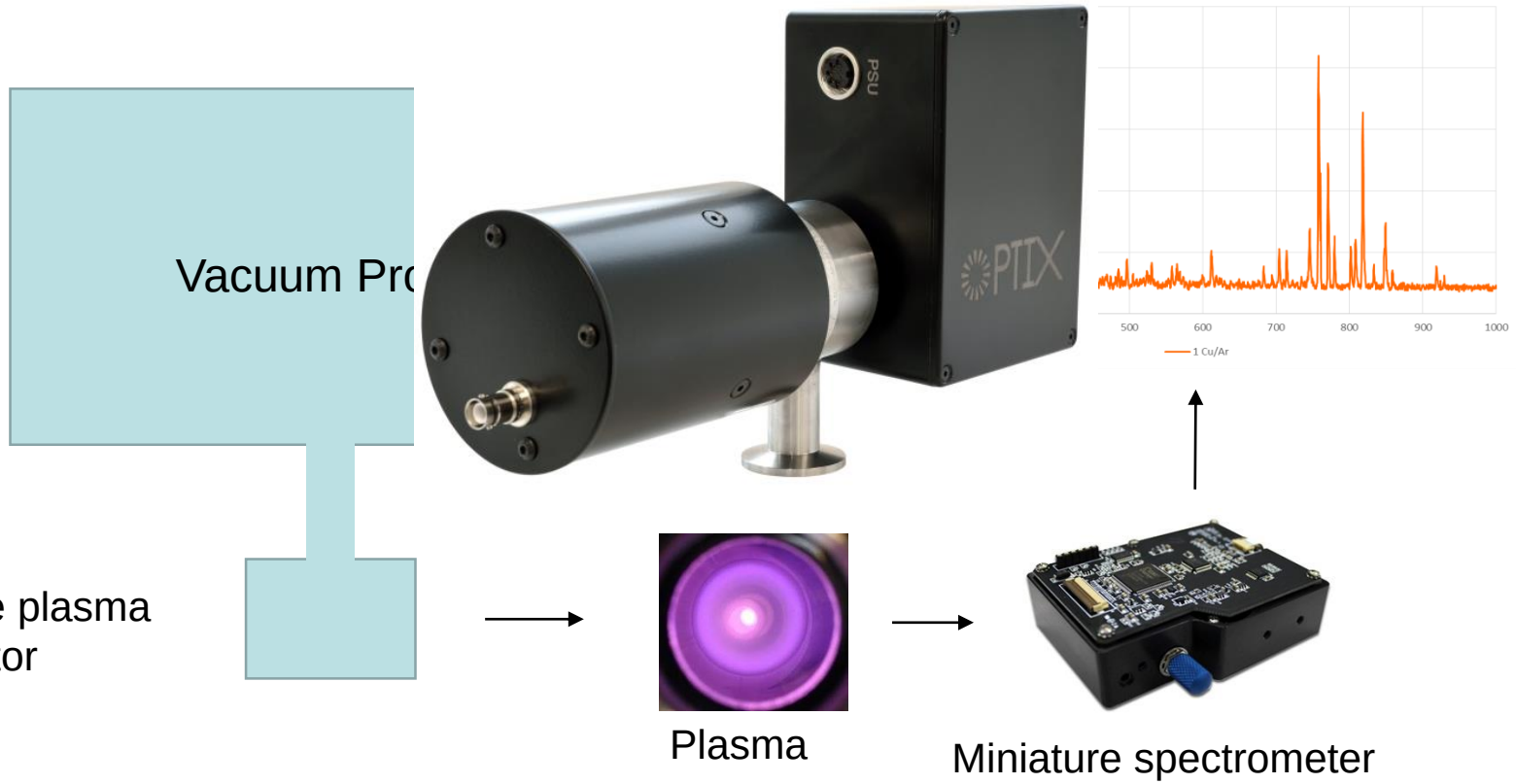
- Take pre-emptive action – **proactive not reactive!**
- Identify problems early before they affect the substrate
- Predict if a problem is likely to occur
- Schedule maintenance just in time

Expensive **Easy to break** **Complex operation**

Remote Plasma Emission Spectroscopy (RPEM)

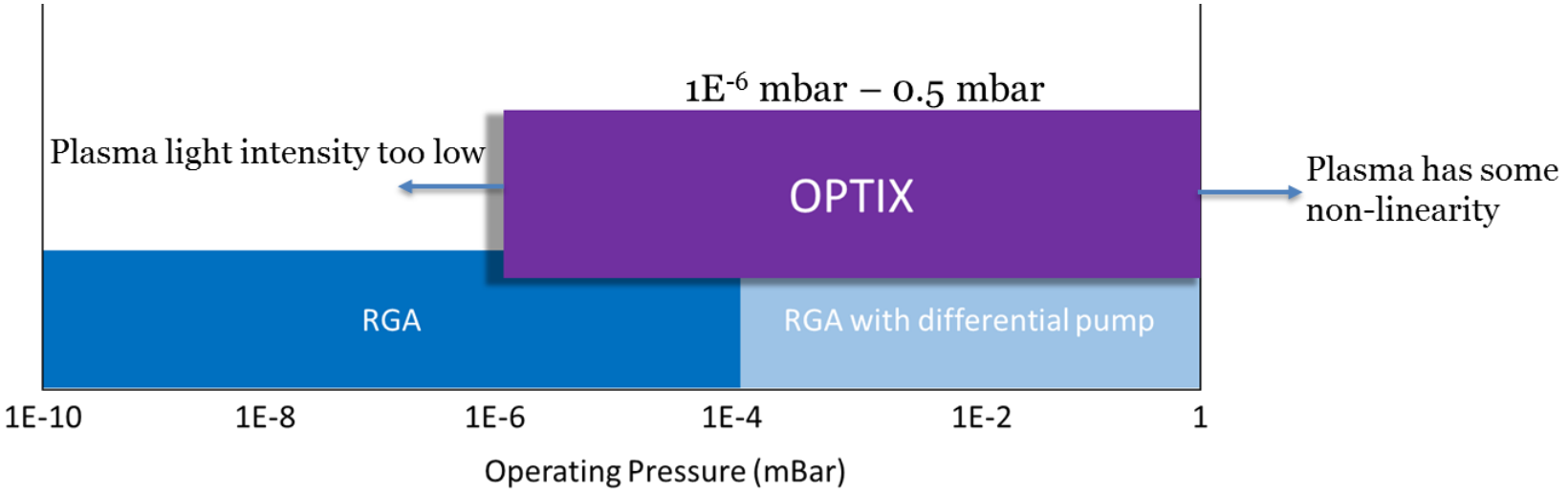
- Original concept used by Mann in 1981 leak detection

Spectrum analysis
gives species composition



Remote Plasma Emission Spectroscopy

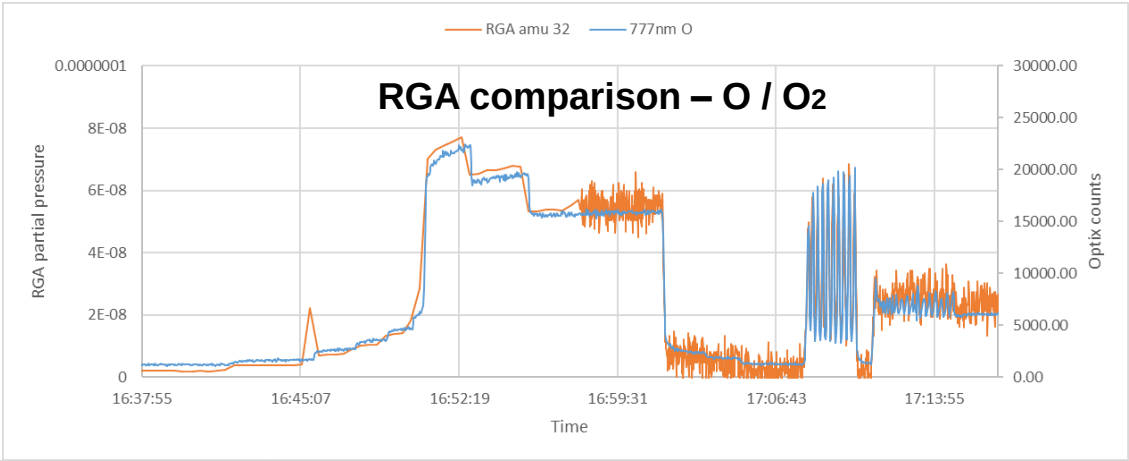
- Fast feedback control of the current allows for a stable plasma to be generated from **1E^{-6} mbar to 0.5 mbar**

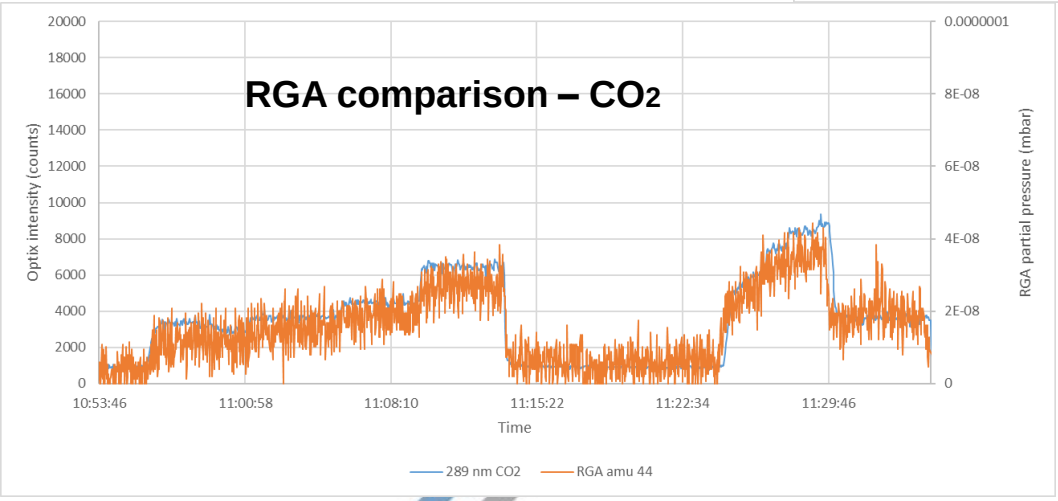


RPEM / RGA Comparison

- Good agreement between QMS results and RPEM for many gases

Optix installed on a PVT coating machine



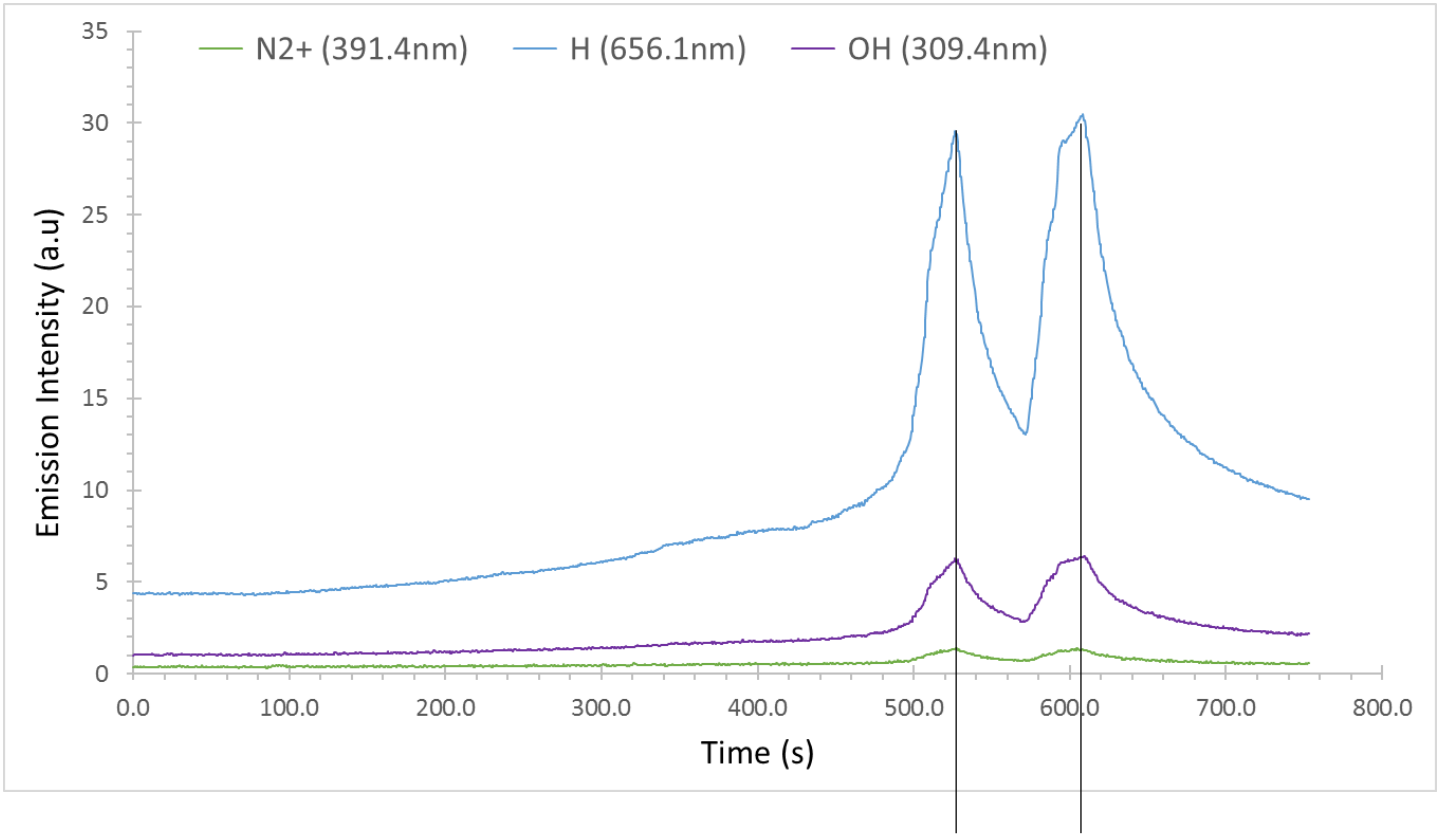


QMS RGA

RPEM (Optix)

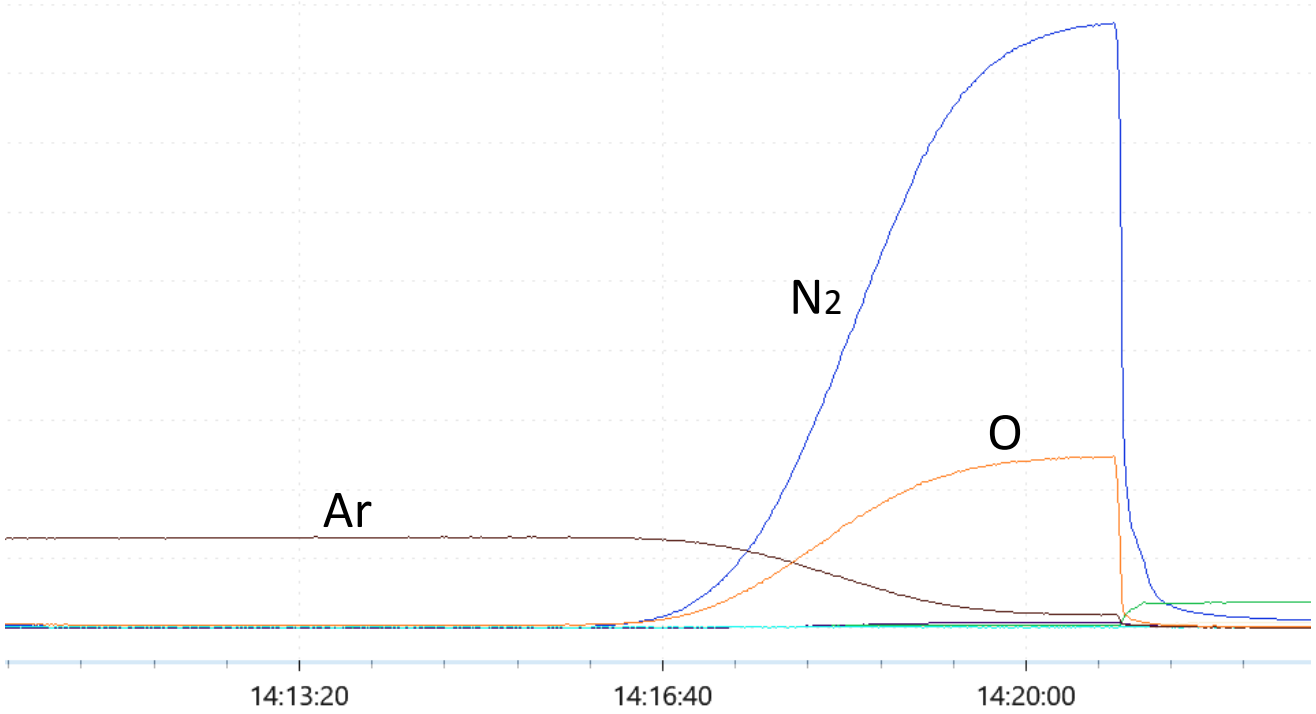
Detection of water leaks

- OH and H emissions indicate water vapor
- Clear increase seen when dynamic seal is moving



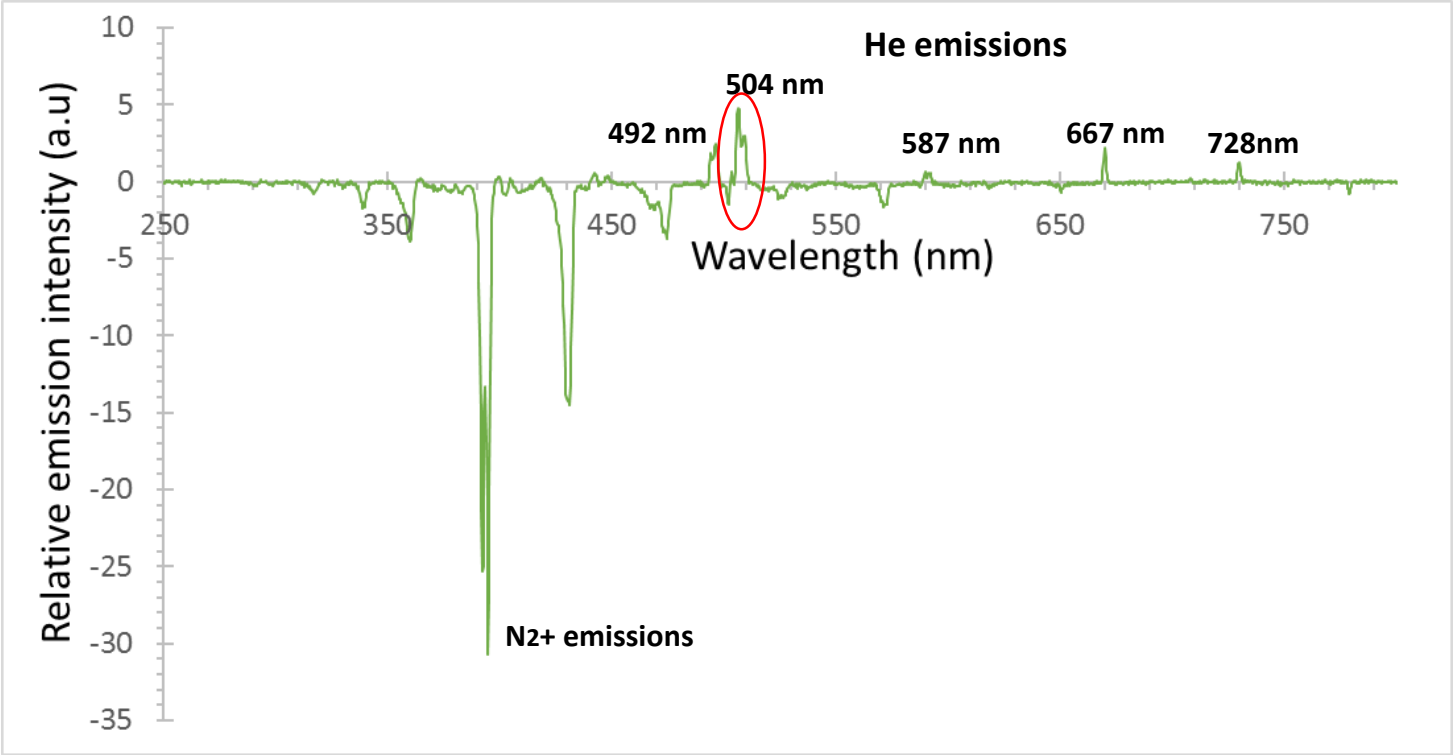
Detecting process gas contamination

- Ar process gas line contaminated with air
- MFC feedback would have shown no problem
- No system leak to detect – in situ gas monitoring only way to see this



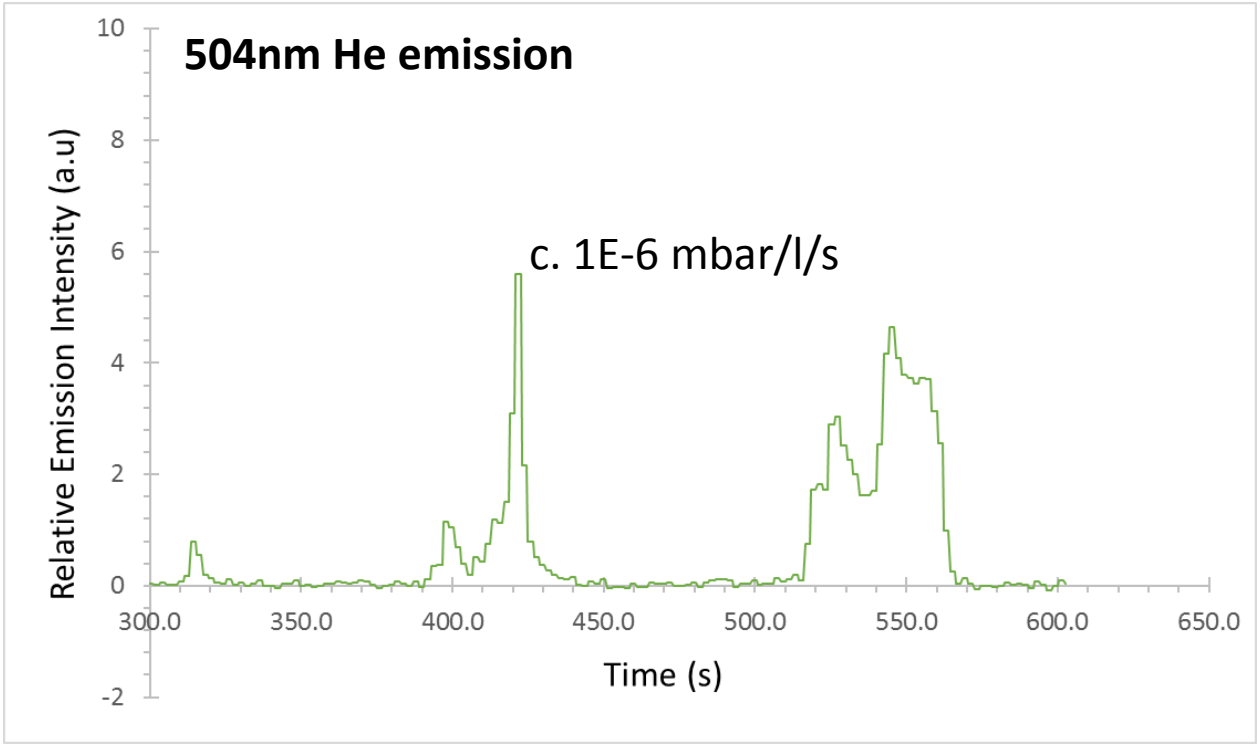
He leak detection with RPEM

- Differential spectrum produced when spraying He around an air leak



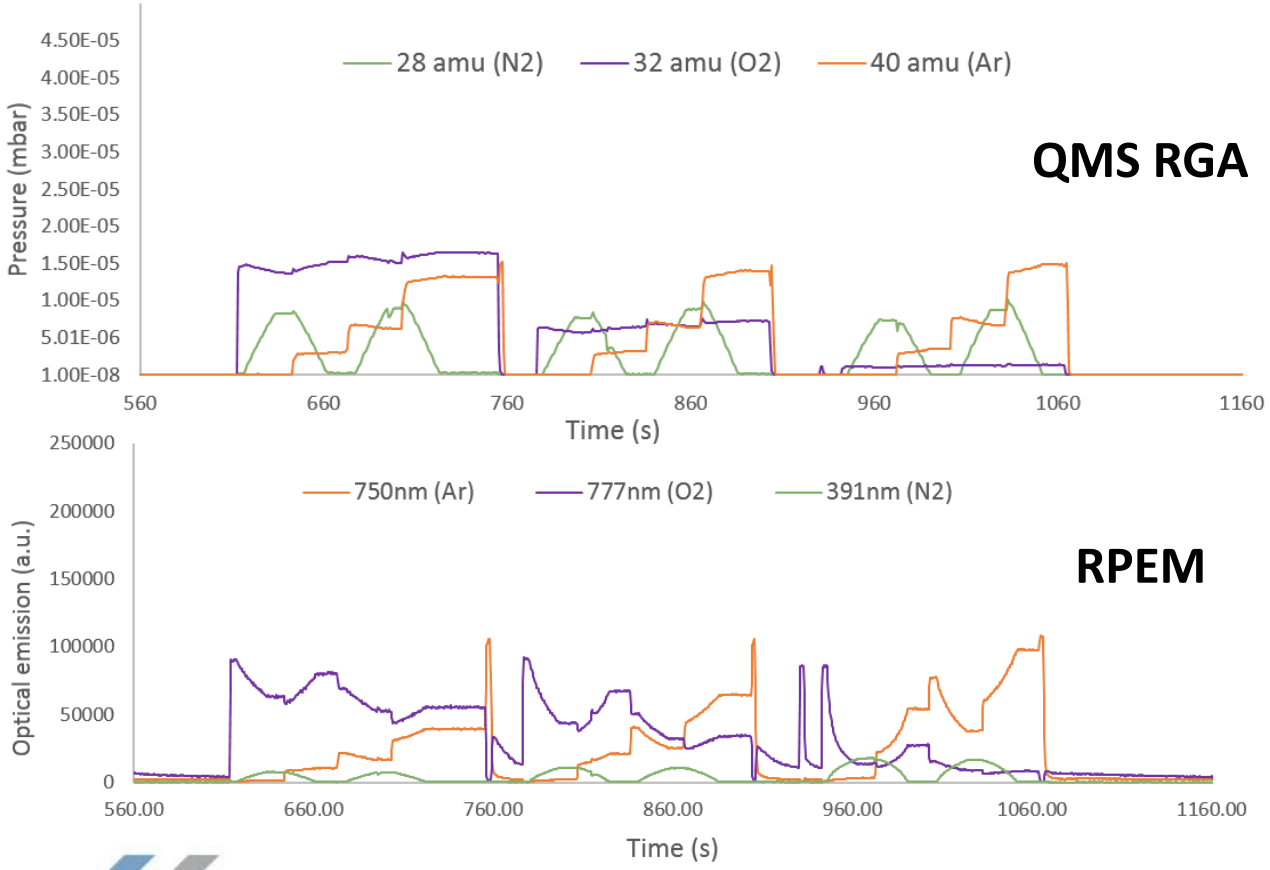
He leak detection with RPEM

- Possible to localise air leaks by monitoring He emission
- Not a complete replacement for a dedicated He leak detector
- Leak rates are not directly quantifiable



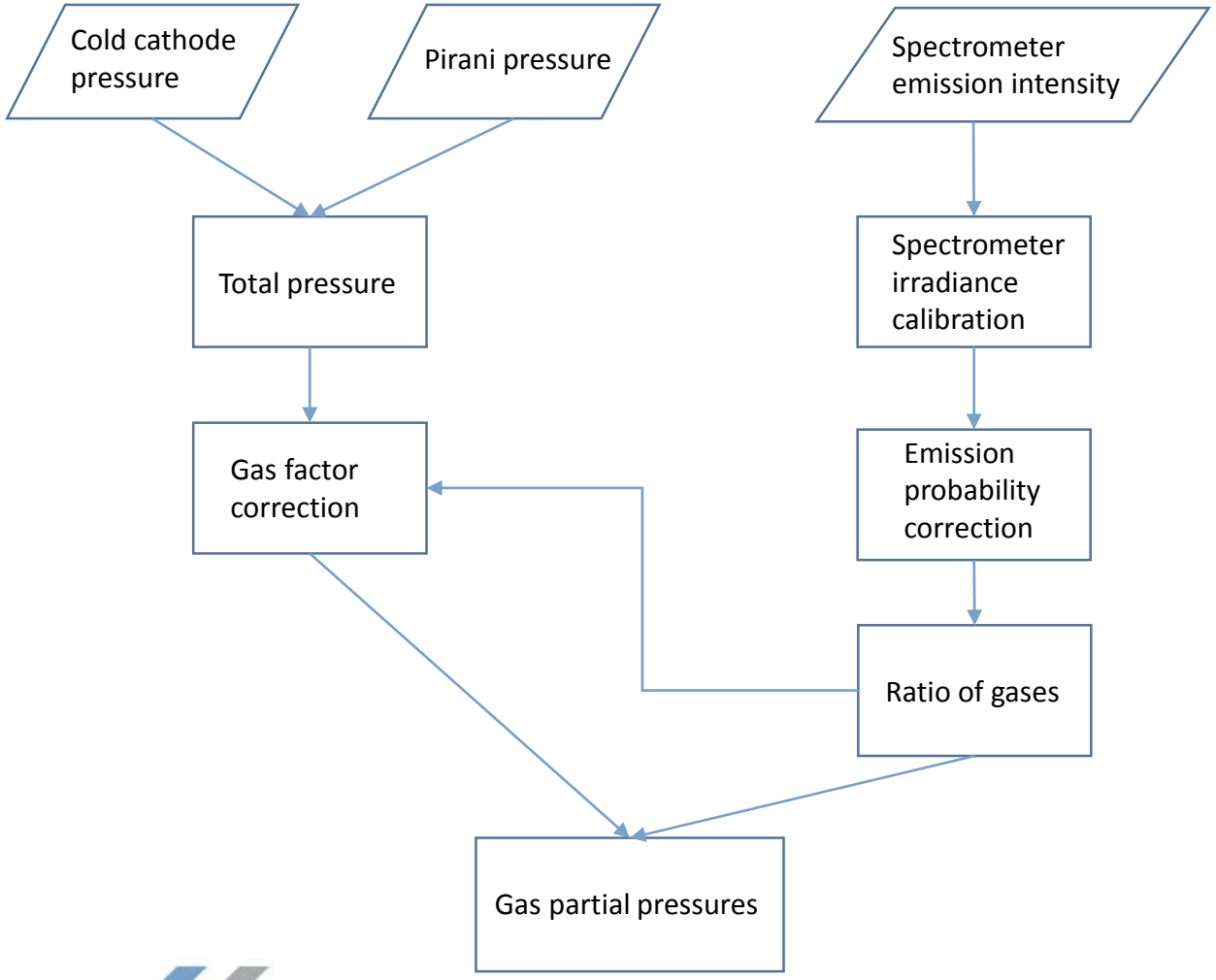
The RPEM quantification problem

- Gas readings are interactive (relative to each other)
- Results are more like **ratios** of gases

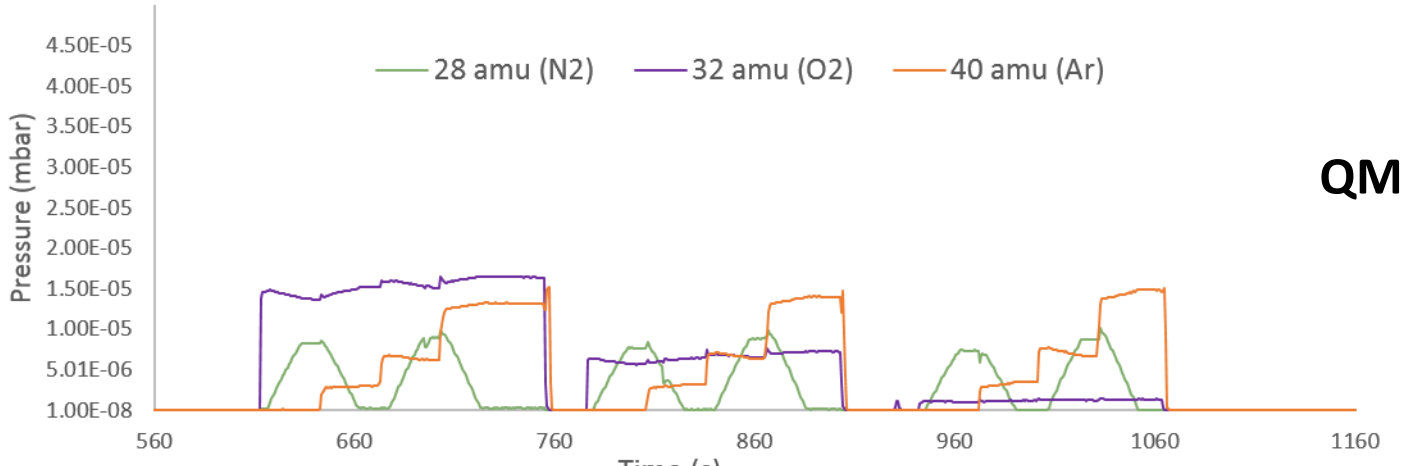


The RPEM quantification problem (and solution)

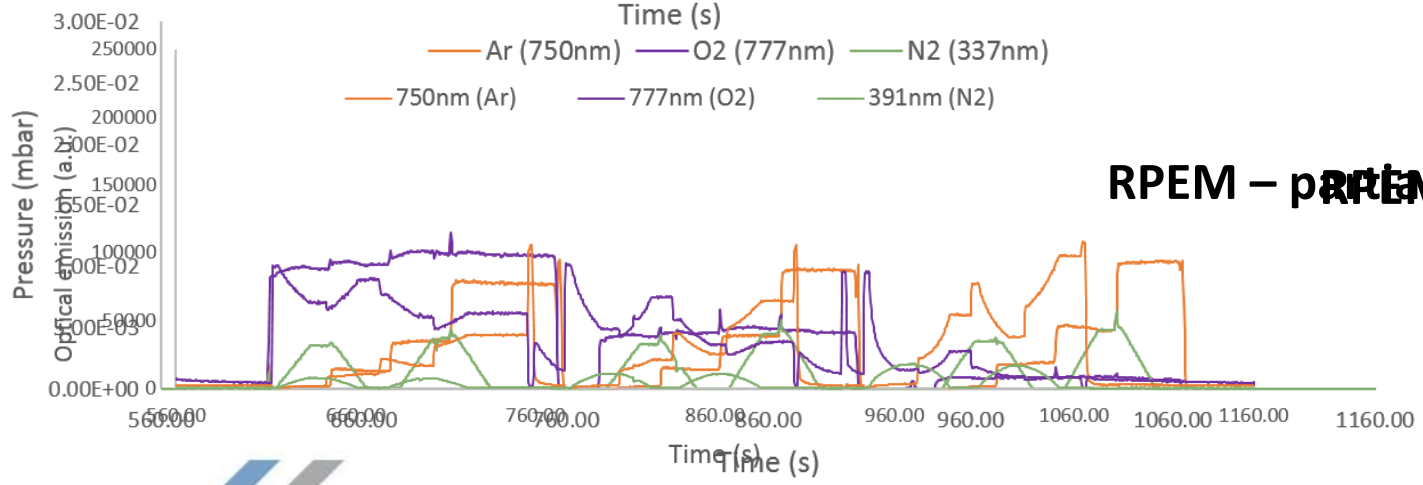
PCT/GB2019/050484



The RPEM quantification problem (and solution)



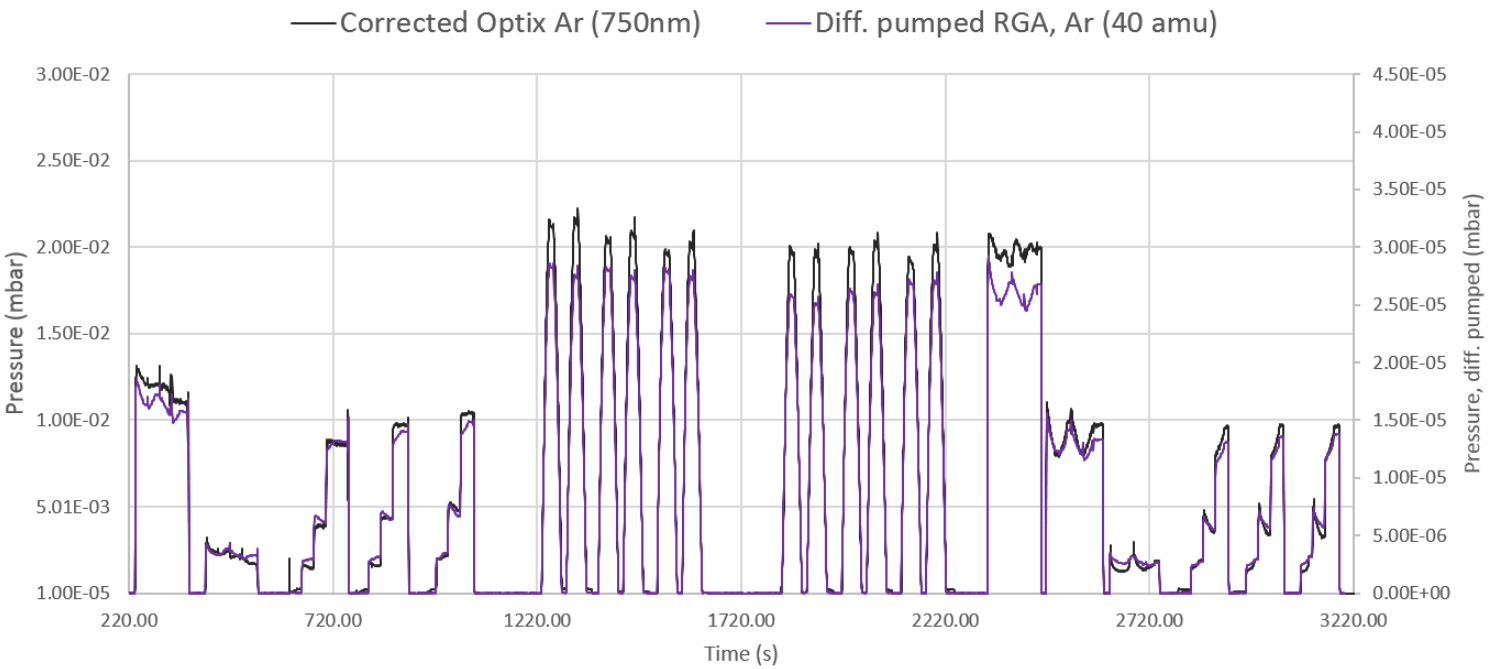
QMS RGA



RPEM – partial pressures

The RPEM quantification problem (and solution)

- Quantifiable gas partial pressure readings are possible using RPEM
- Data can be produced that is a close match with a QMS RGA

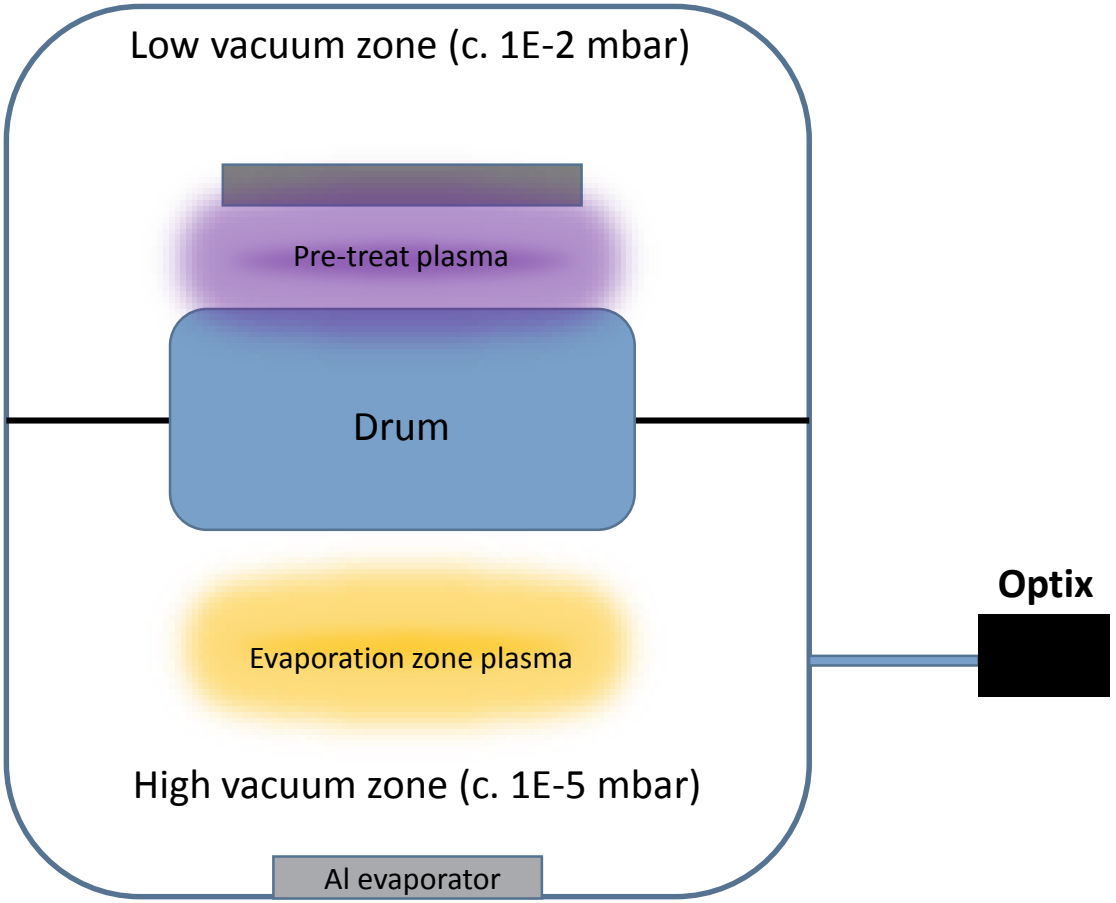


Case study – R2R process mapping

- AlOx evaportation onto 12µm PET
- Webwidth: 2450mm
- Bobst K5000 R&D metalizer

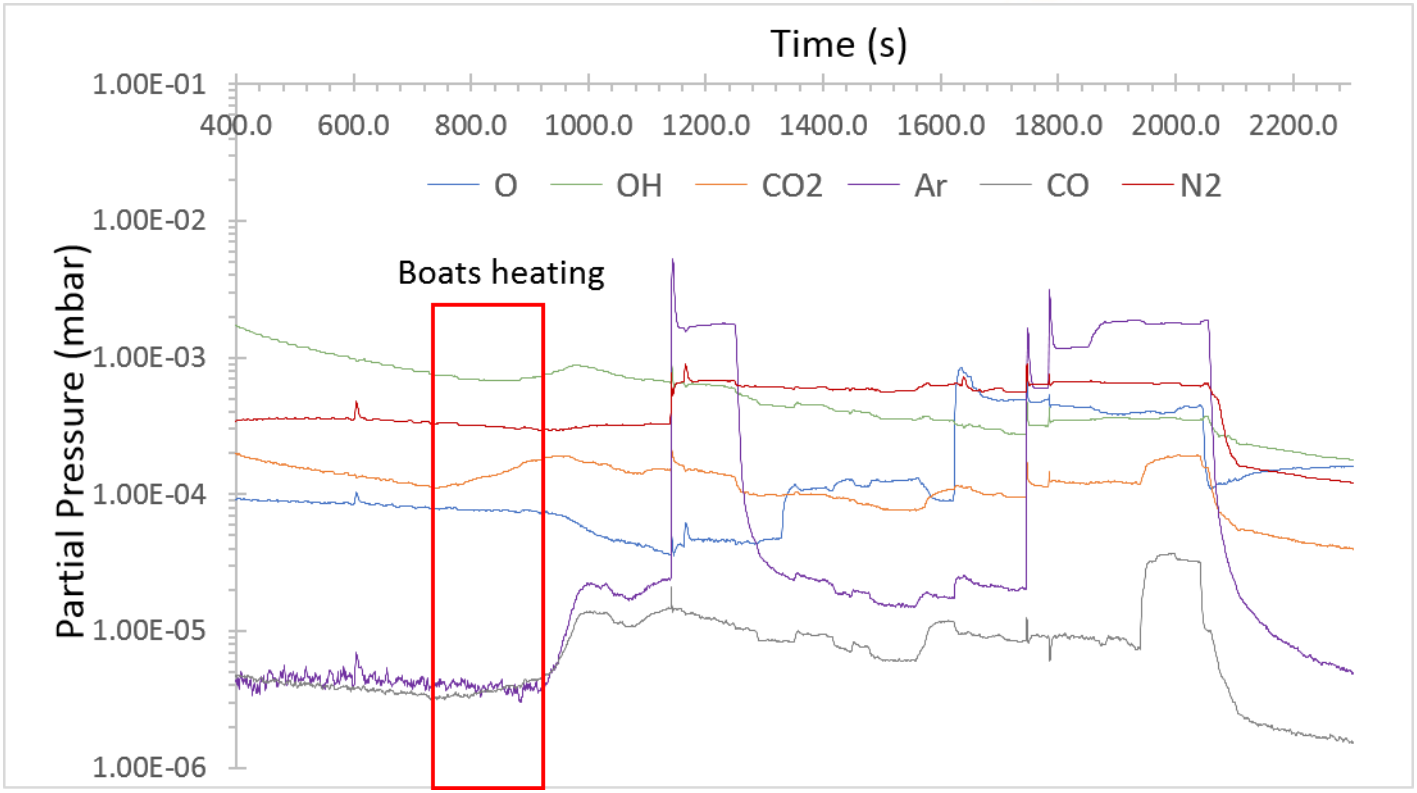
Case study – R2R process mapping

- Two process zones
- Plasma pre-treatment
- Al evaporation
- Evaporation zone plasma



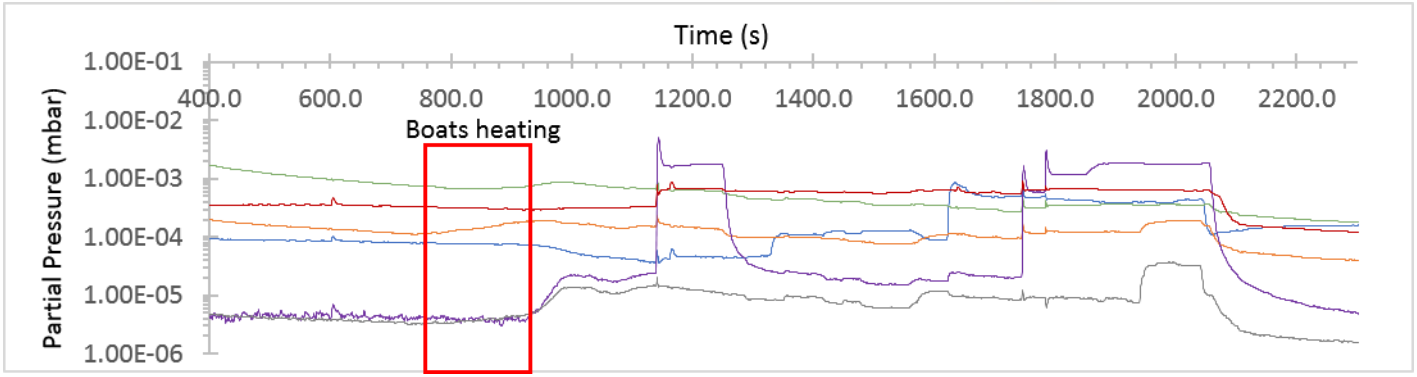
Case study – R2R process mapping

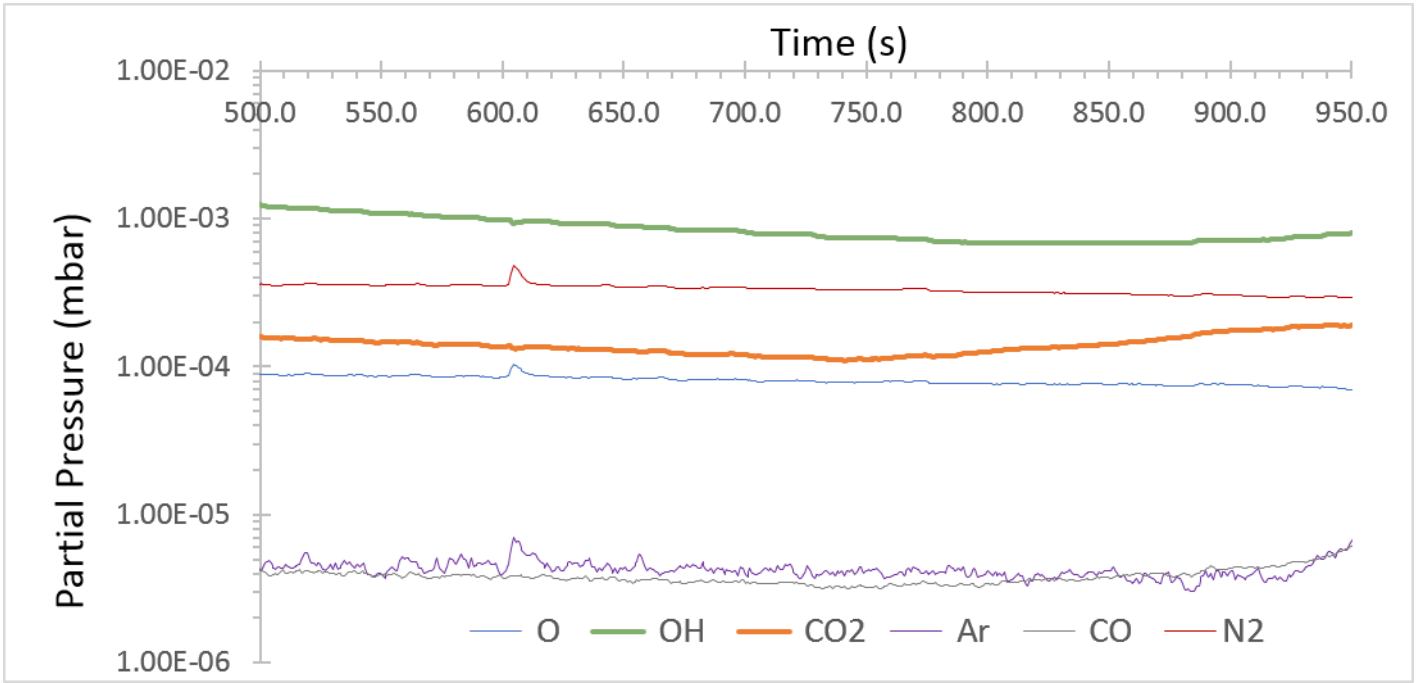
- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited

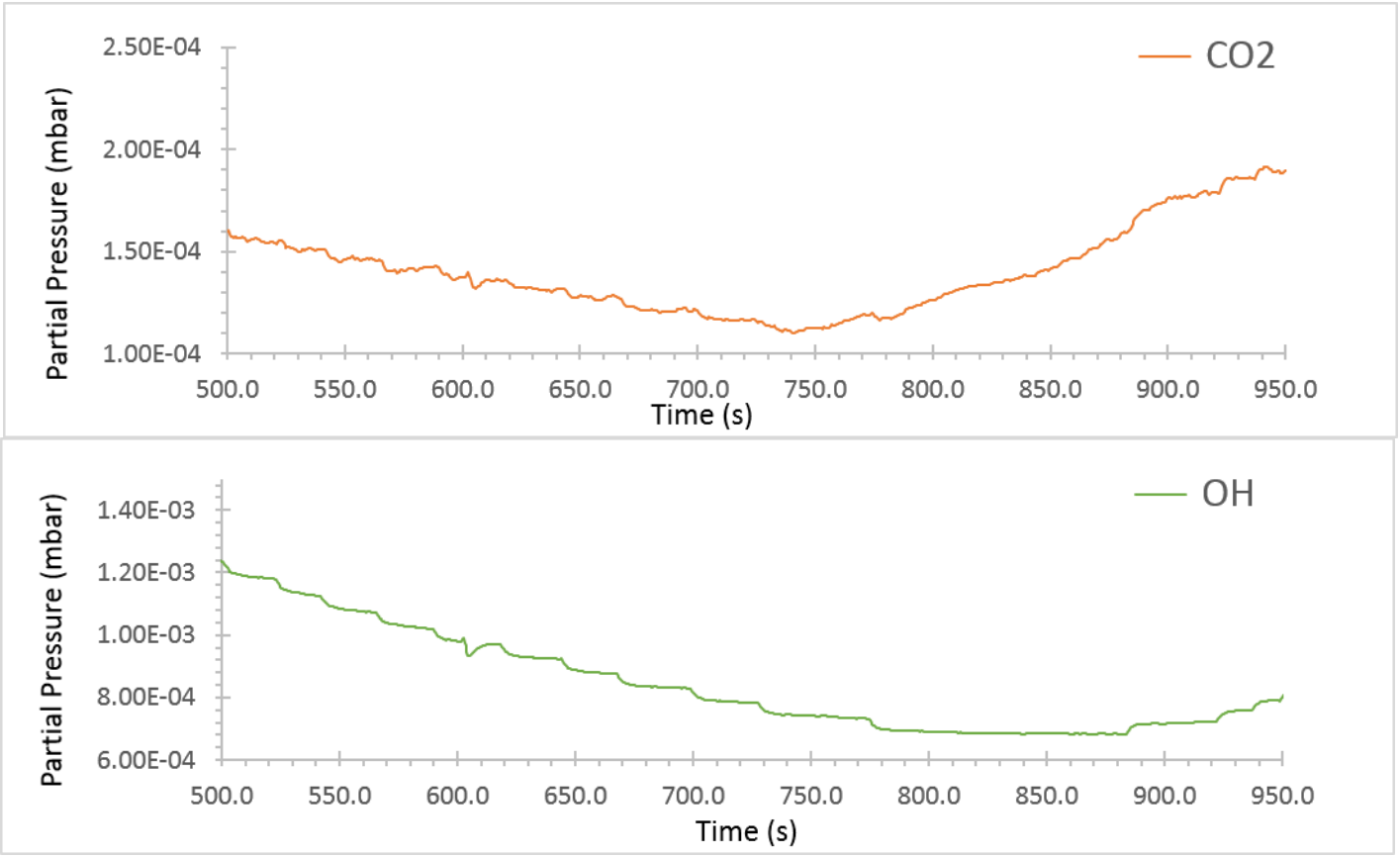




Case study – R2R process mapping

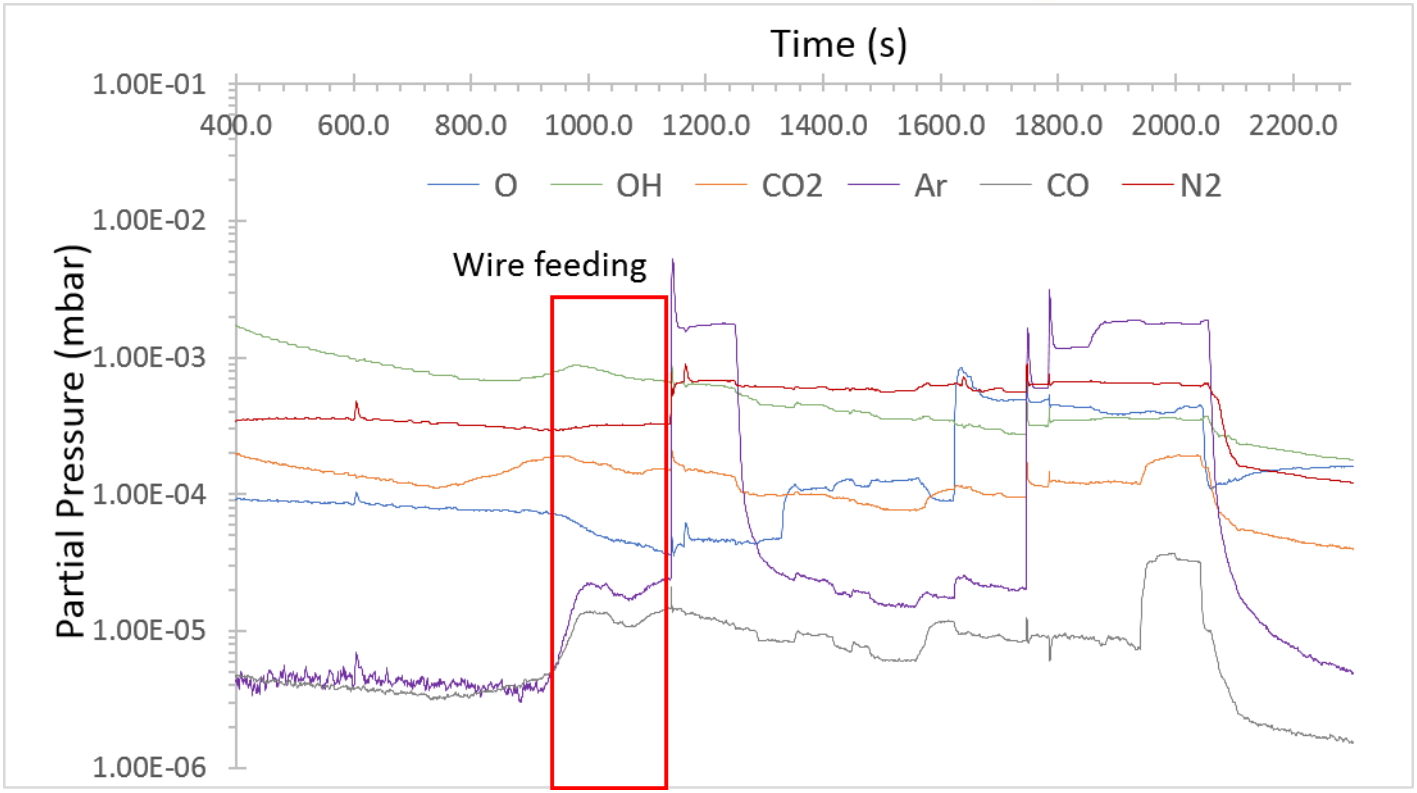
- CO_2 outgassing from the evaporation boats
- Small increase in water vapor due to heating

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



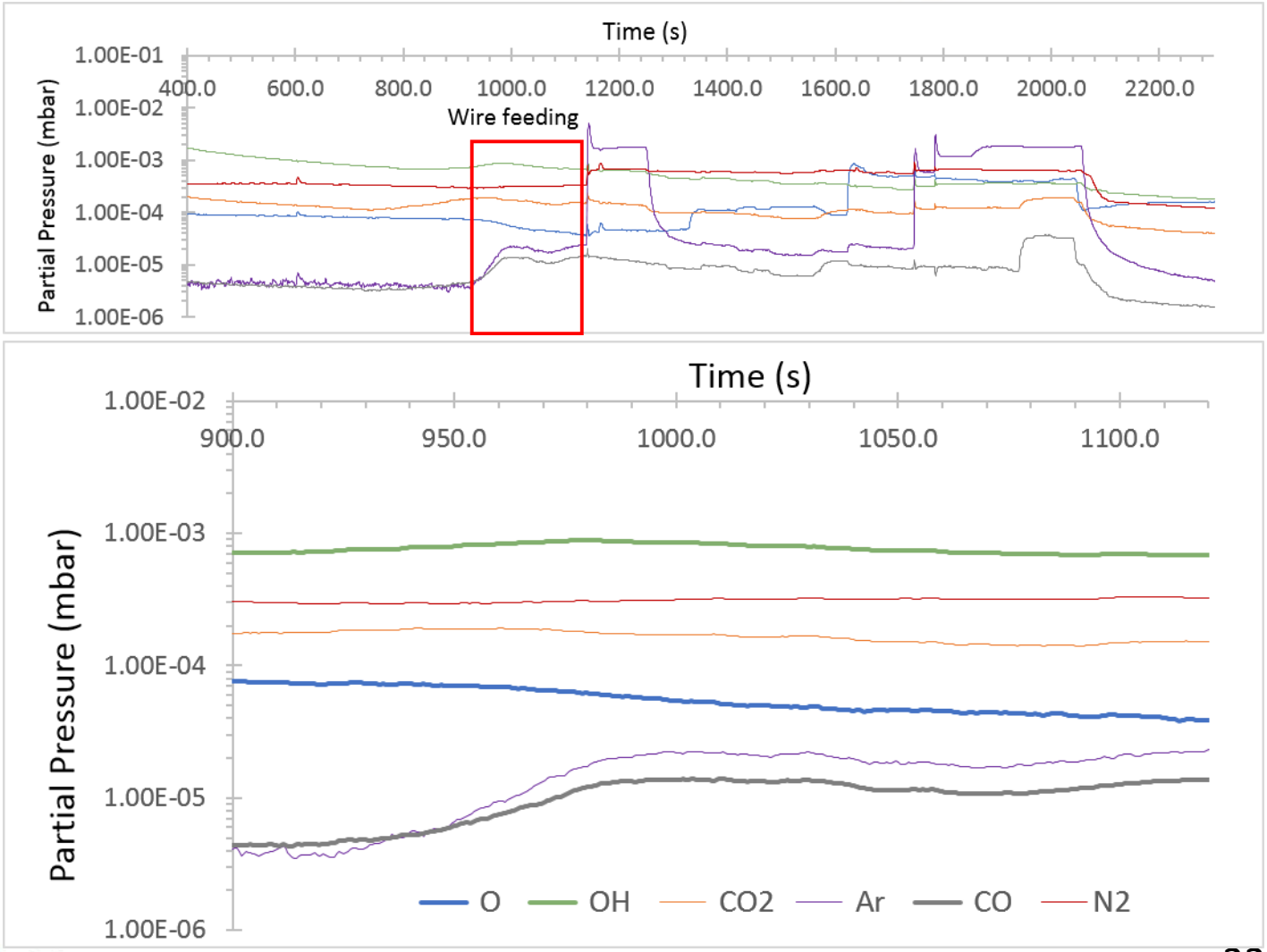
Case study – R2R process mapping

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

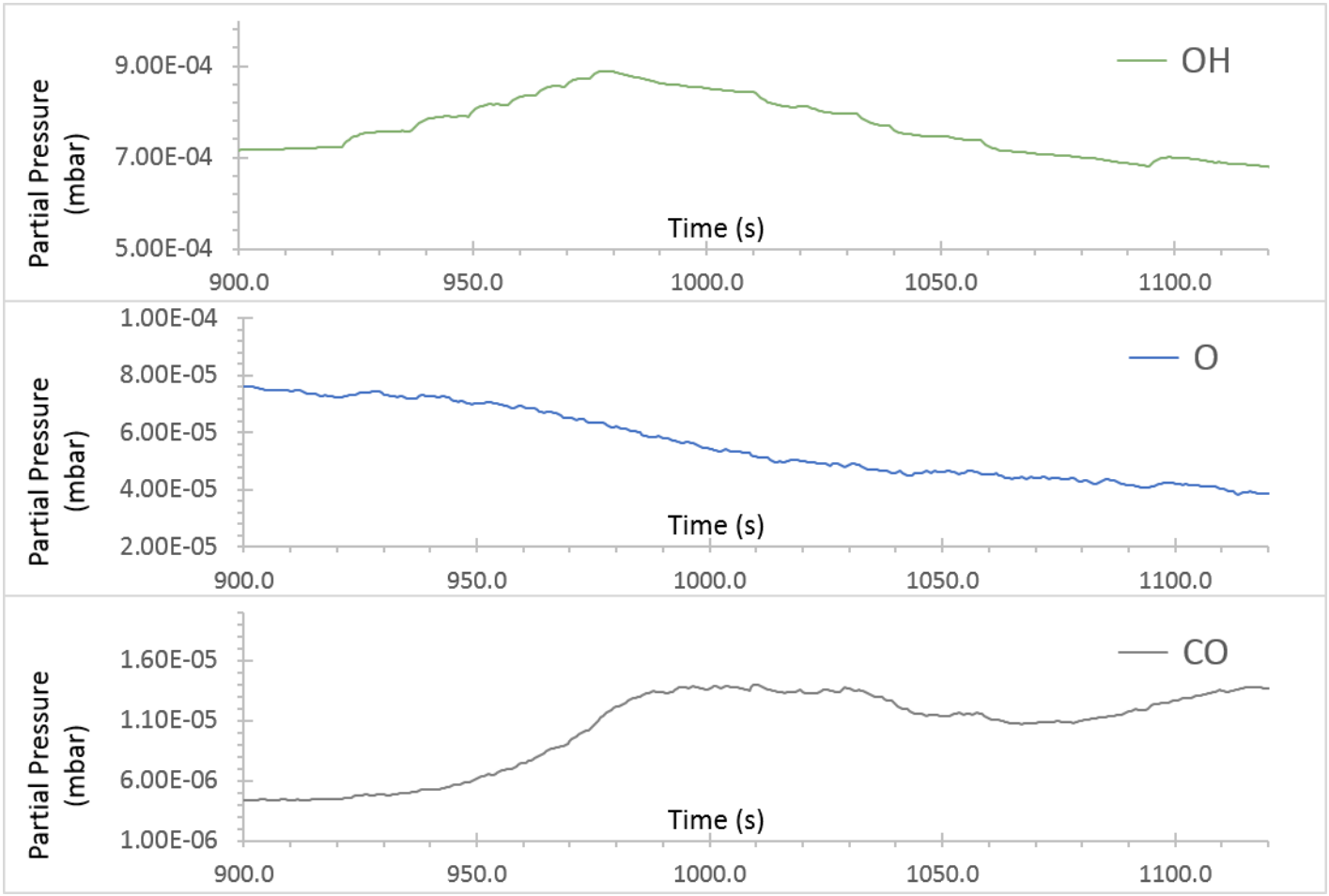
- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

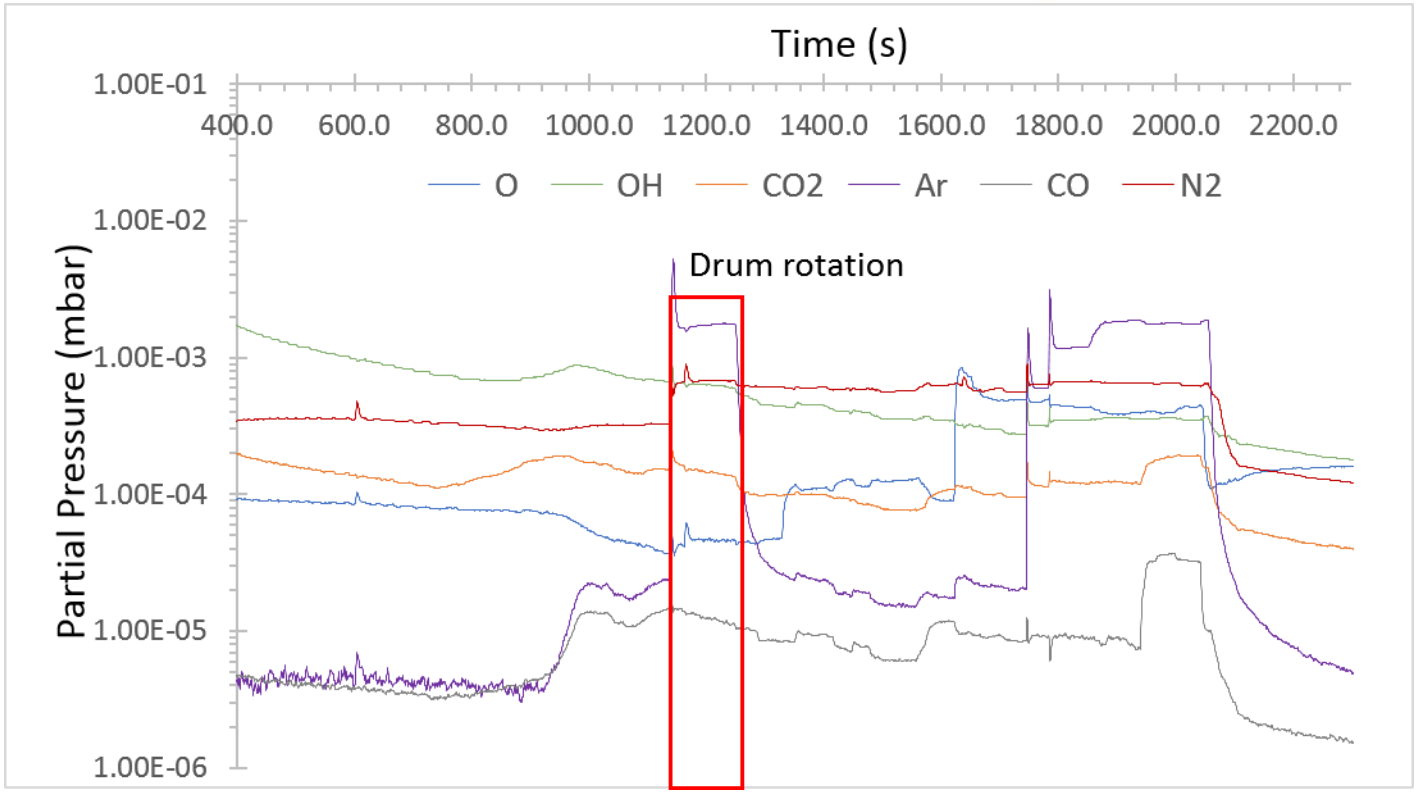
- Gettering of OH and O from evaporated Al
- Outgassing of CO – organic contamination on wire?

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



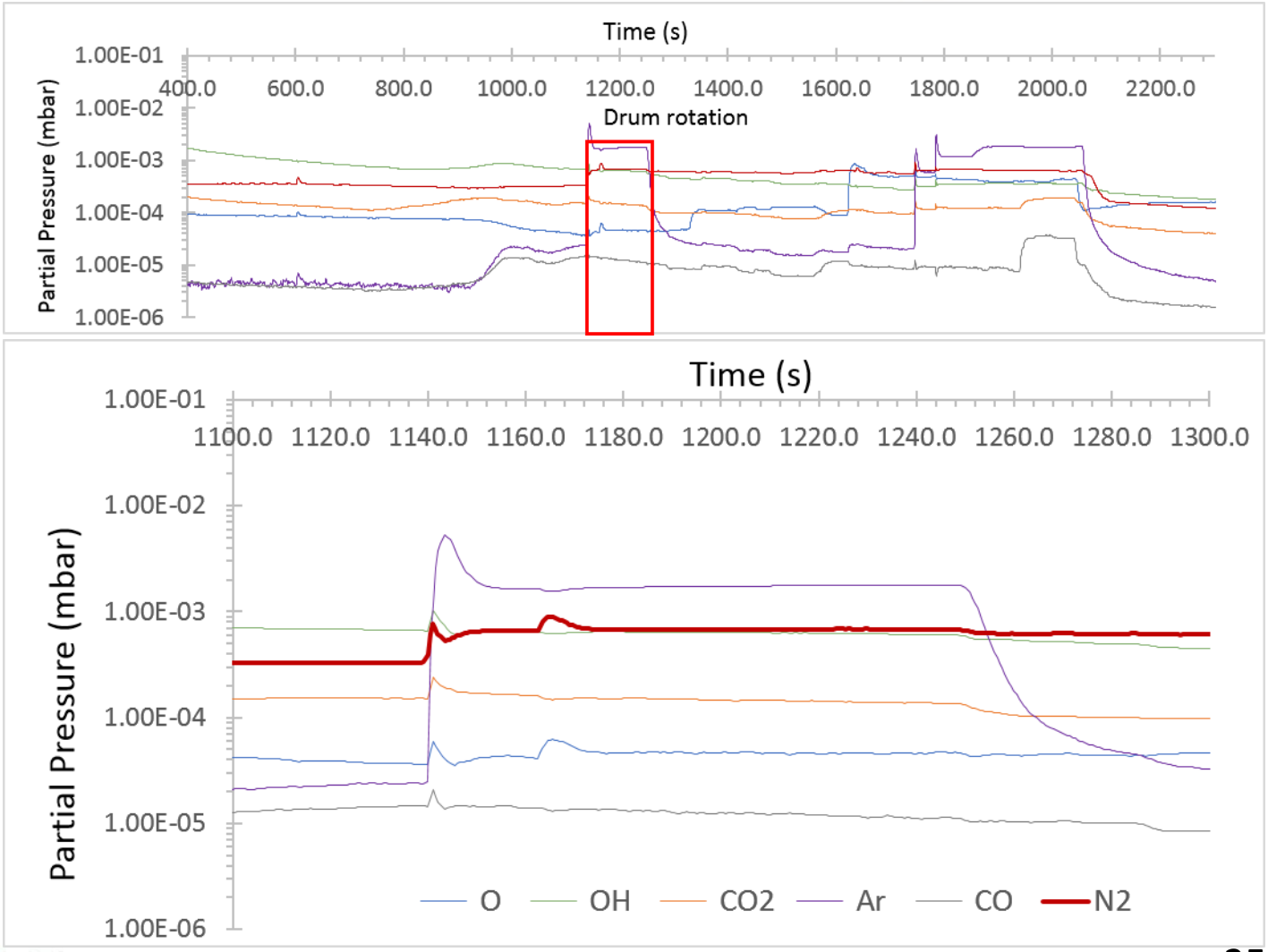
Case study – R2R process mapping

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

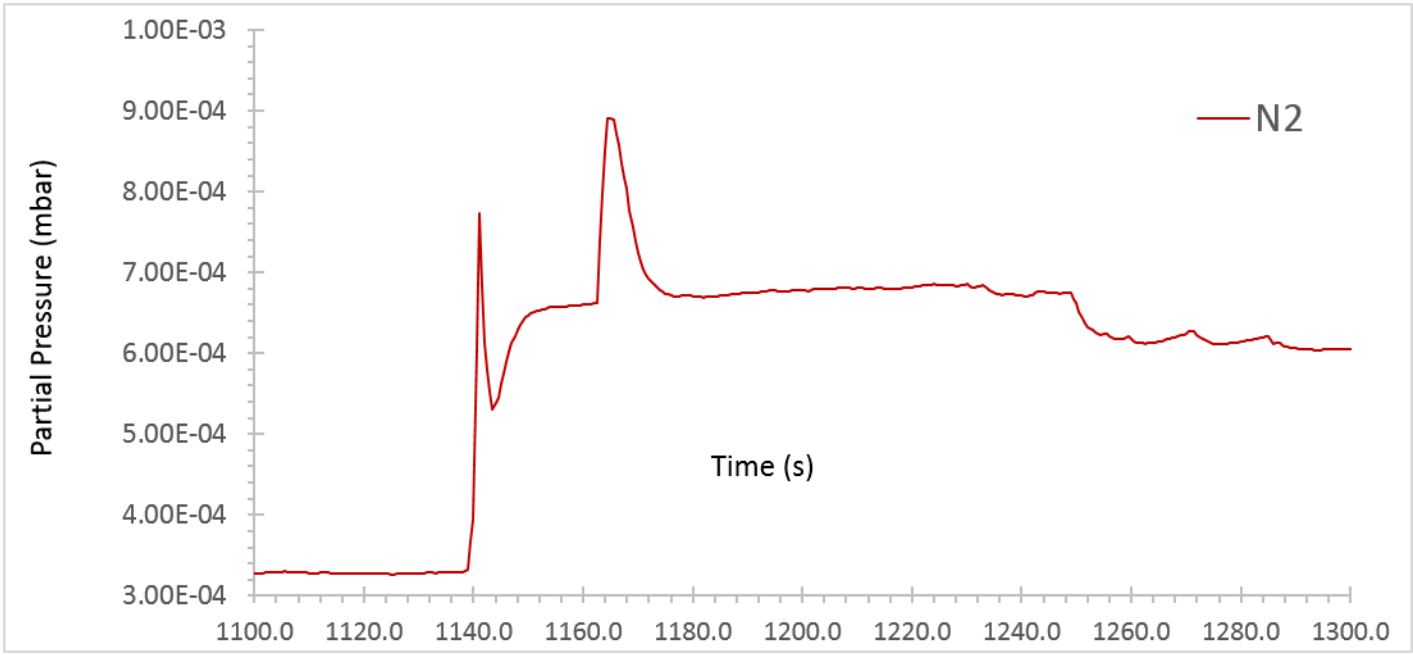
- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

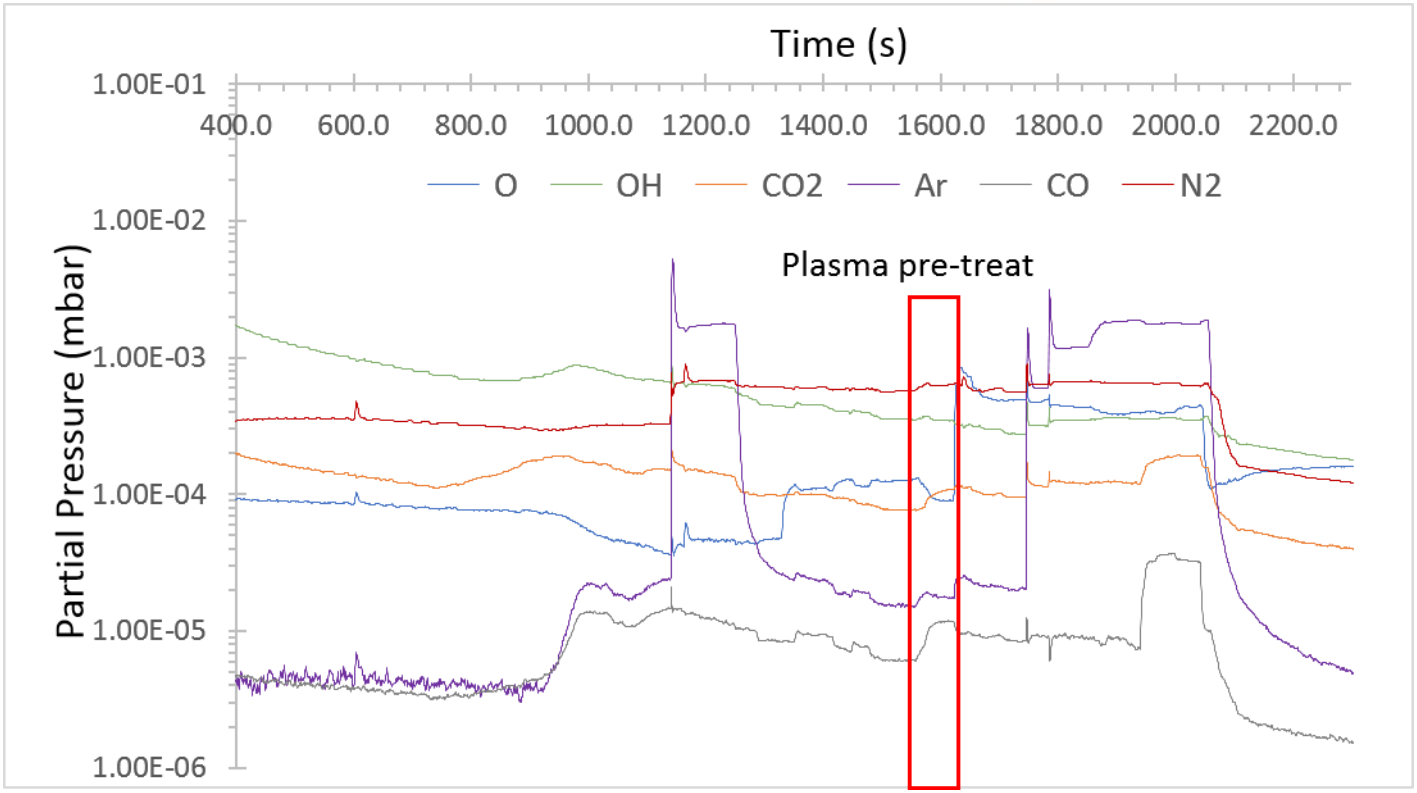
- N_2 is being “dragged” in from the low vacuum zone of the system

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



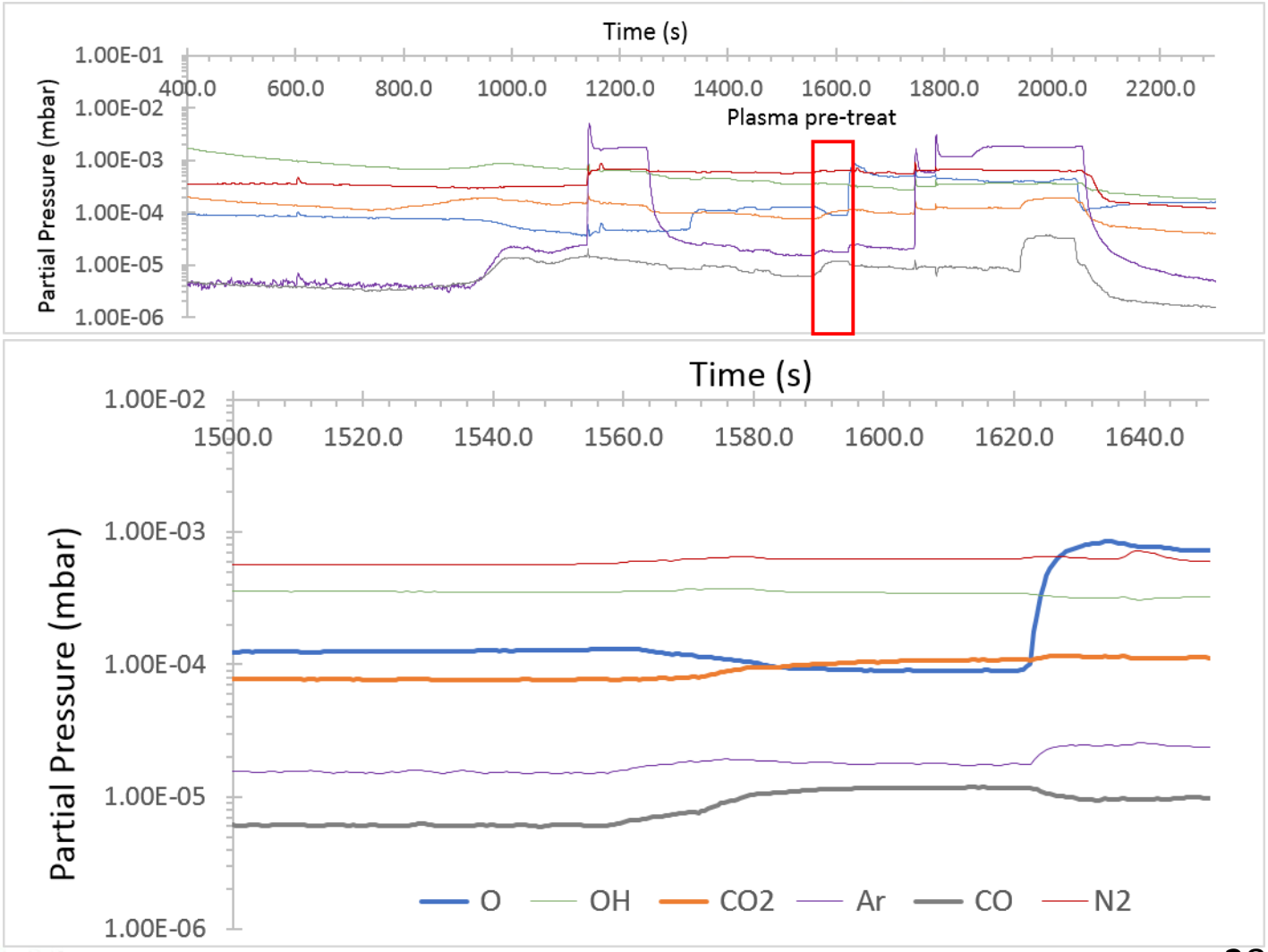
Case study – R2R process mapping

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

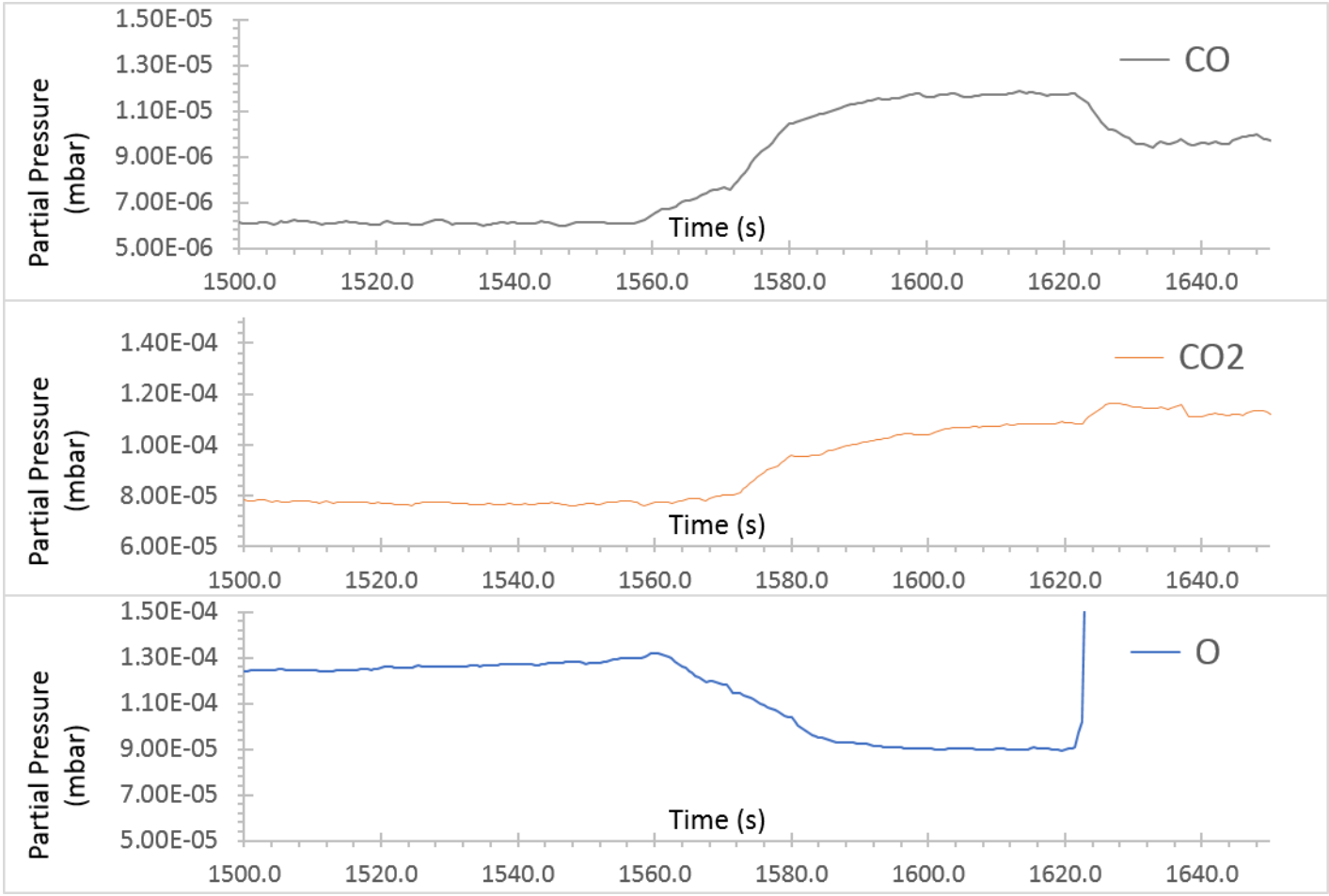
- Boats heating
- Wire feeding
- Drum rotation
- **Plasma pre-treat ignited**
- Evaporation plasma ignited



Case study – R2R process mapping

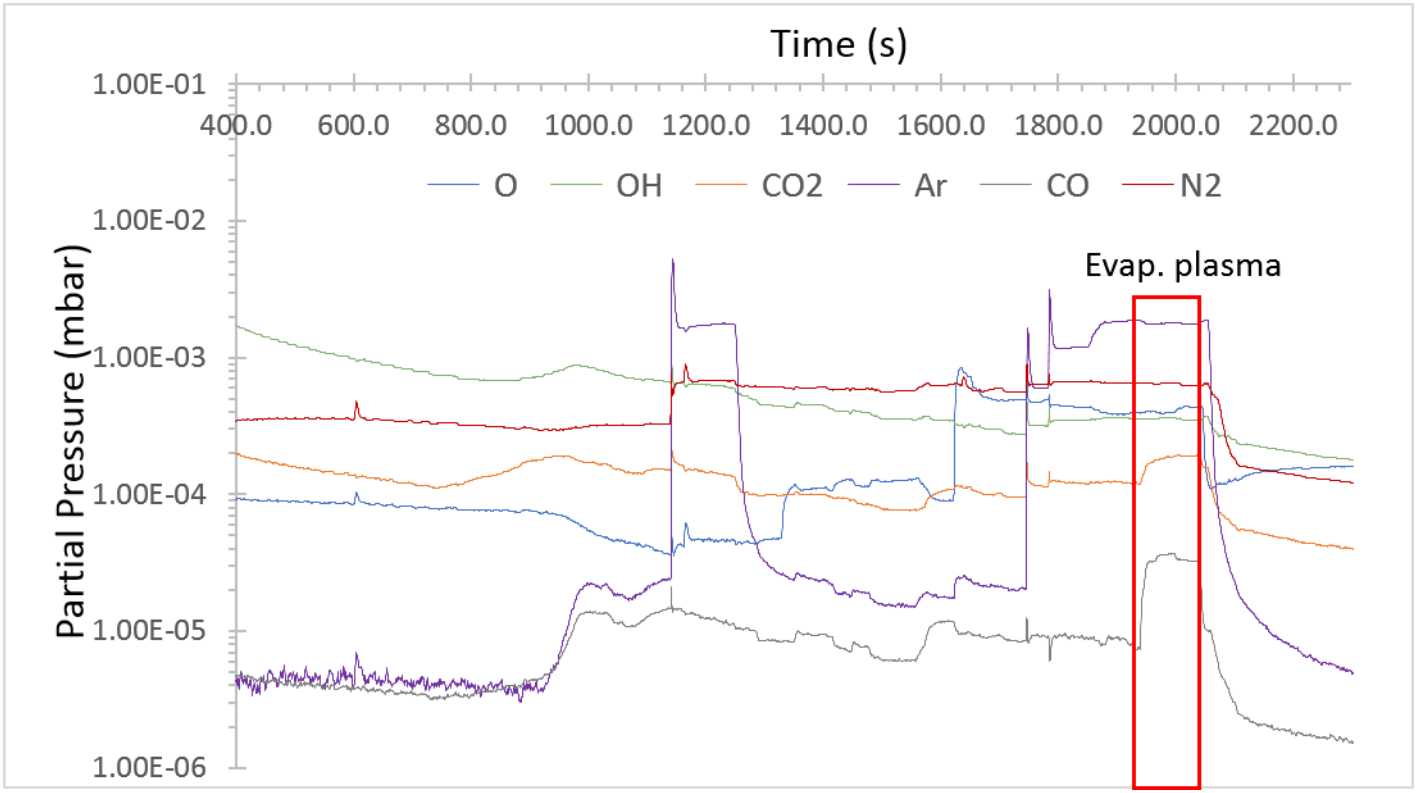
- Effect of the pre-treat plasma in the low vac. zone
- Reaction of web ligands with O – forming CO / CO_2

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



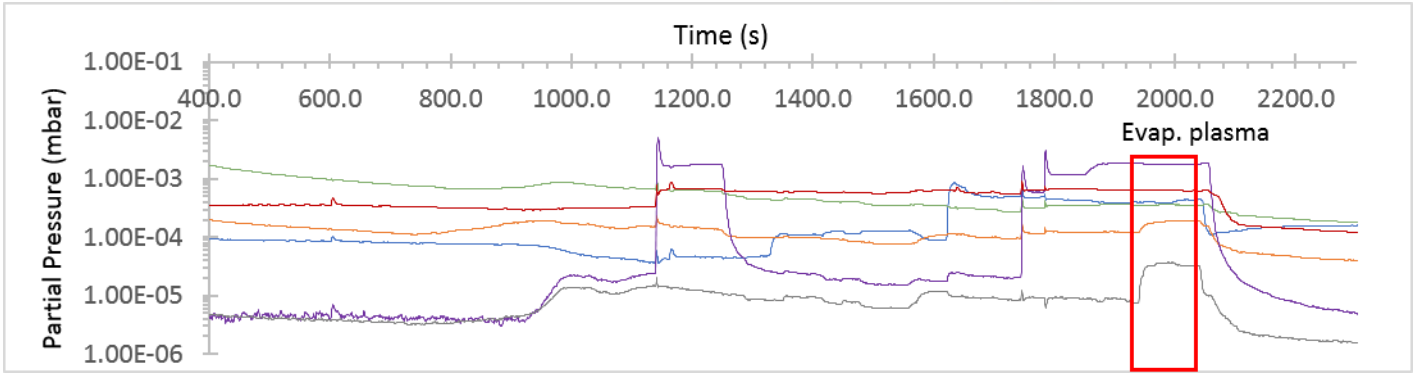
Case study – R2R process mapping

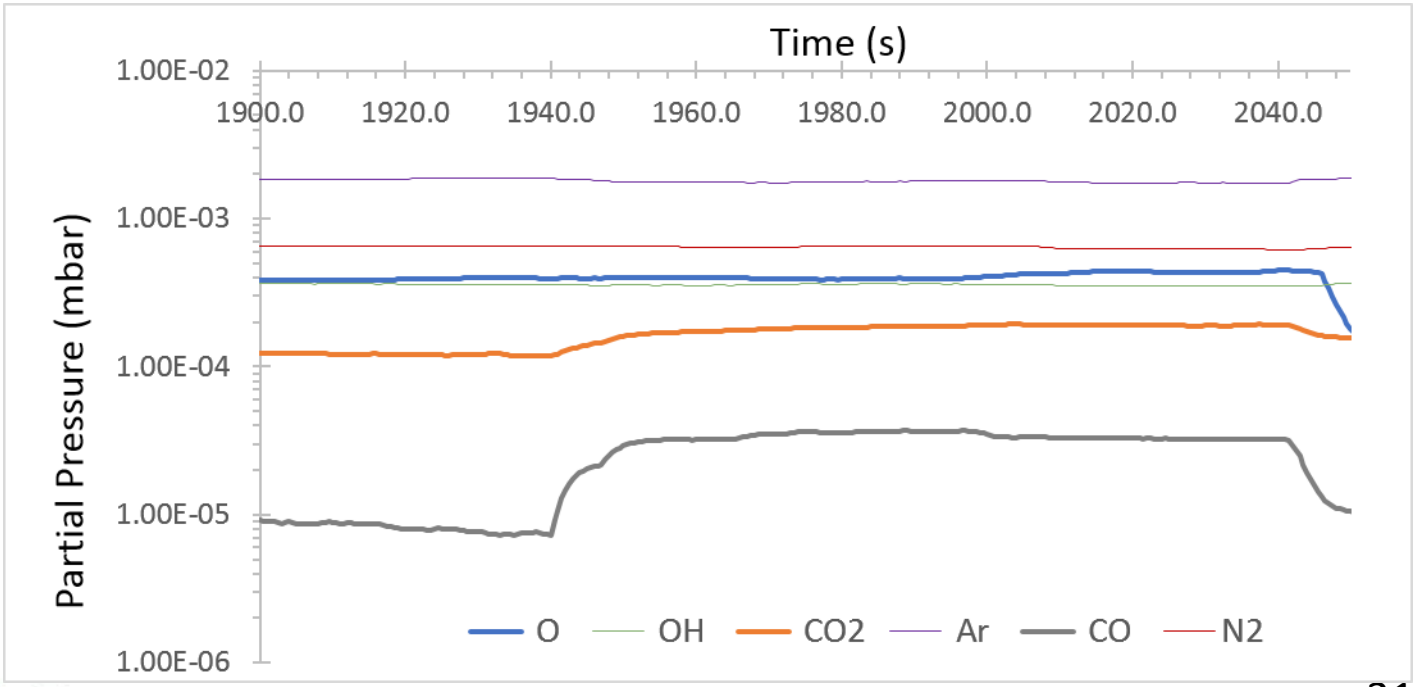
- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Case study – R2R process mapping

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited

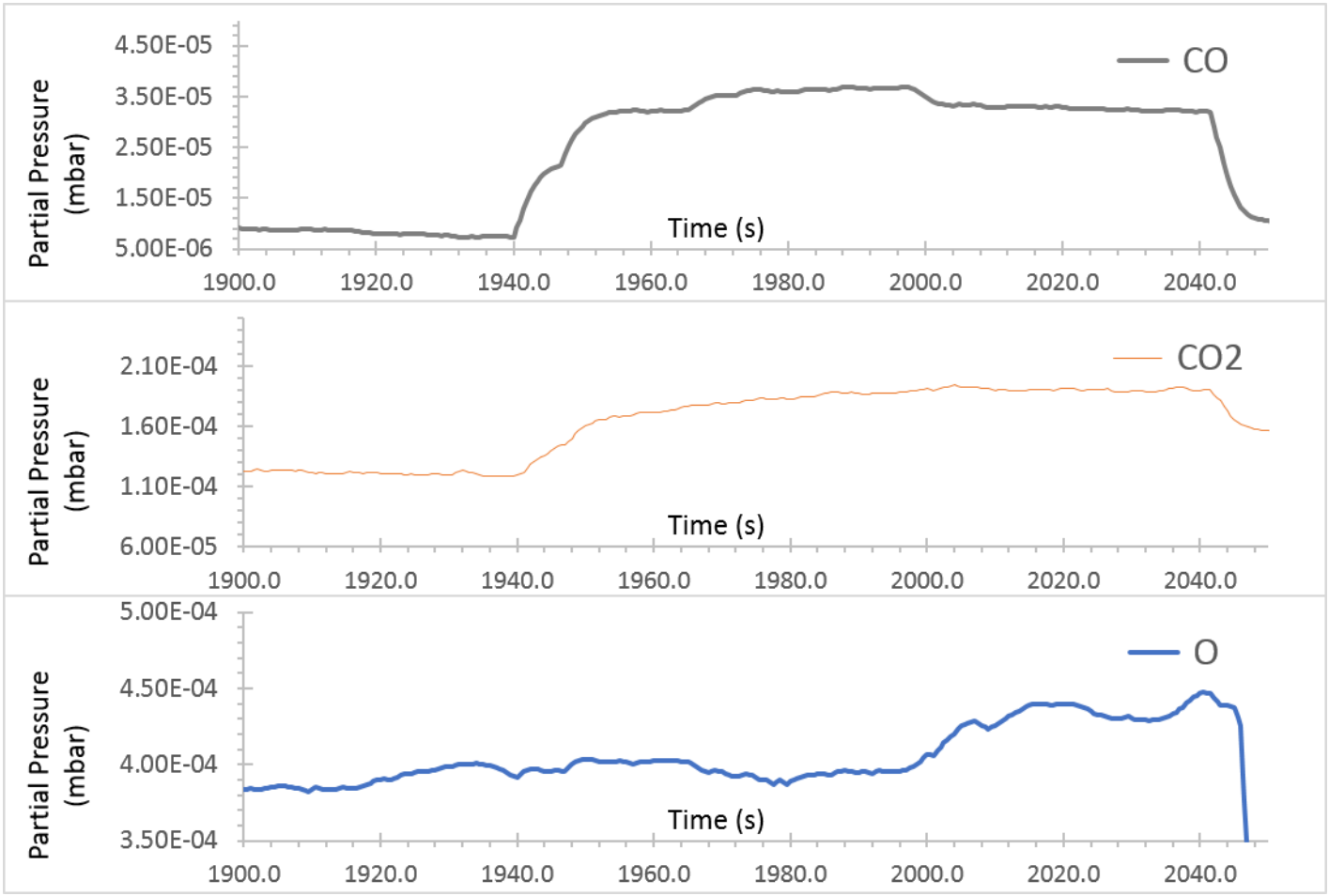




Case study – R2R process mapping

- Formation of CO and CO_2
- Effect of the evap. plasma on the web can be monitored

- Boats heating
- Wire feeding
- Drum rotation
- Plasma pre-treat ignited
- Evaporation plasma ignited



Summary

- Common industrial vacuum processing problems can be identified early, before the consequences escalate.
- Examples include water leaks, air leaks, outgassing, gas contaminants
- Gas concentrations can be quantified when using RPEM
- Processes can be “fingerprinted” – for proactive problem solving

GENCOA

Thank you for your attention!

Please visit us at Booth 720