Introduction

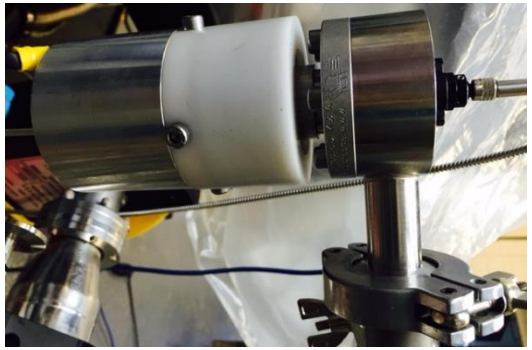
2022

www.gencoa.com/optix

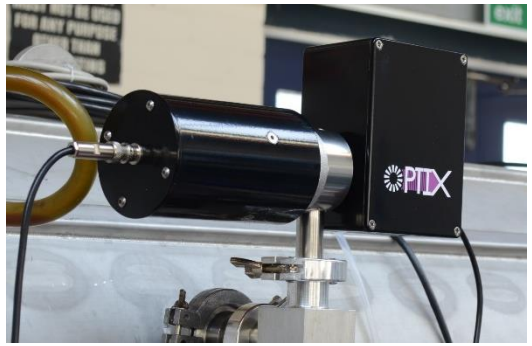
Optix history

- Introduction to the market in Feb 2017
- Had to trailblaze as there were no serious similar products
- Over 200 global sales to date (US, Europe, China, Japan, Korea)
- Customers including Apple, CERN, GKN, Guardian Glass, PPG, Lawrence Livermore National Laboratory

Development (2015 – 2017)



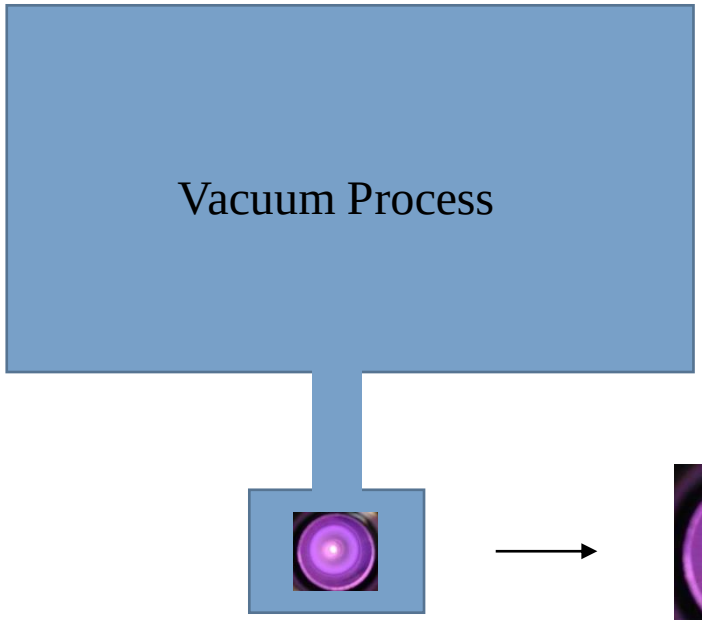
Market introduction (2017)



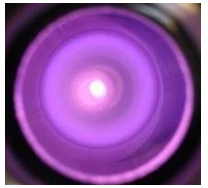
“Version 2.0” (2020)

2015 **2017** **2020**

RPEM principal



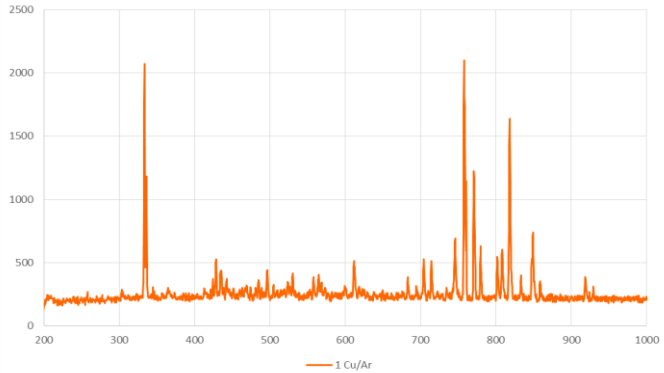
Remote plasma generator



Plasma

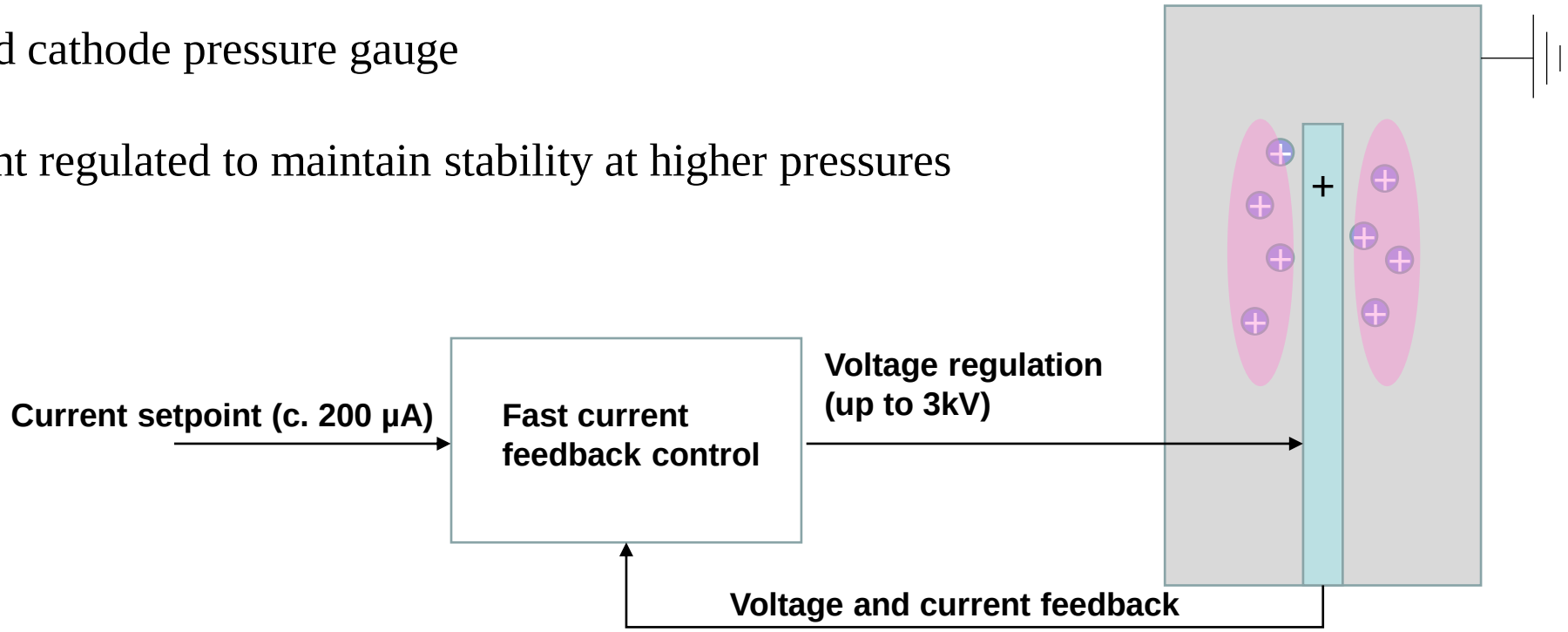
Miniature spectrometer

Spectrum analysis gives species composition and concentration



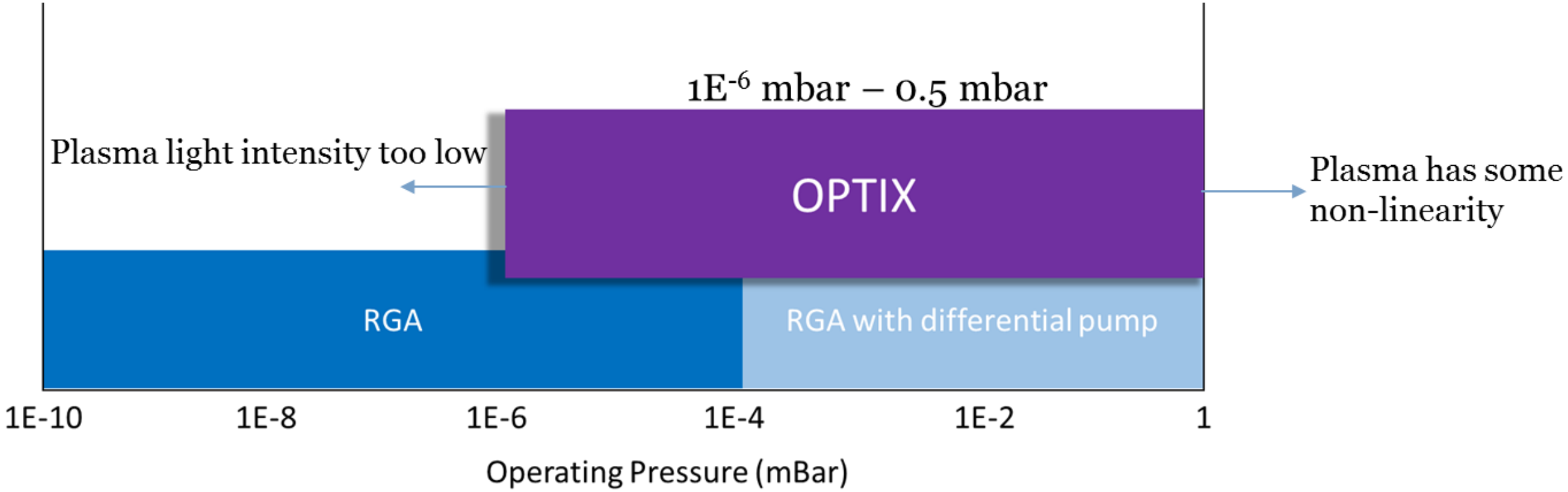
Optix plasma generation

- Inverted magnetron plasma generator
- Similar to a cold cathode pressure gauge
- Plasma is current regulated to maintain stability at higher pressures

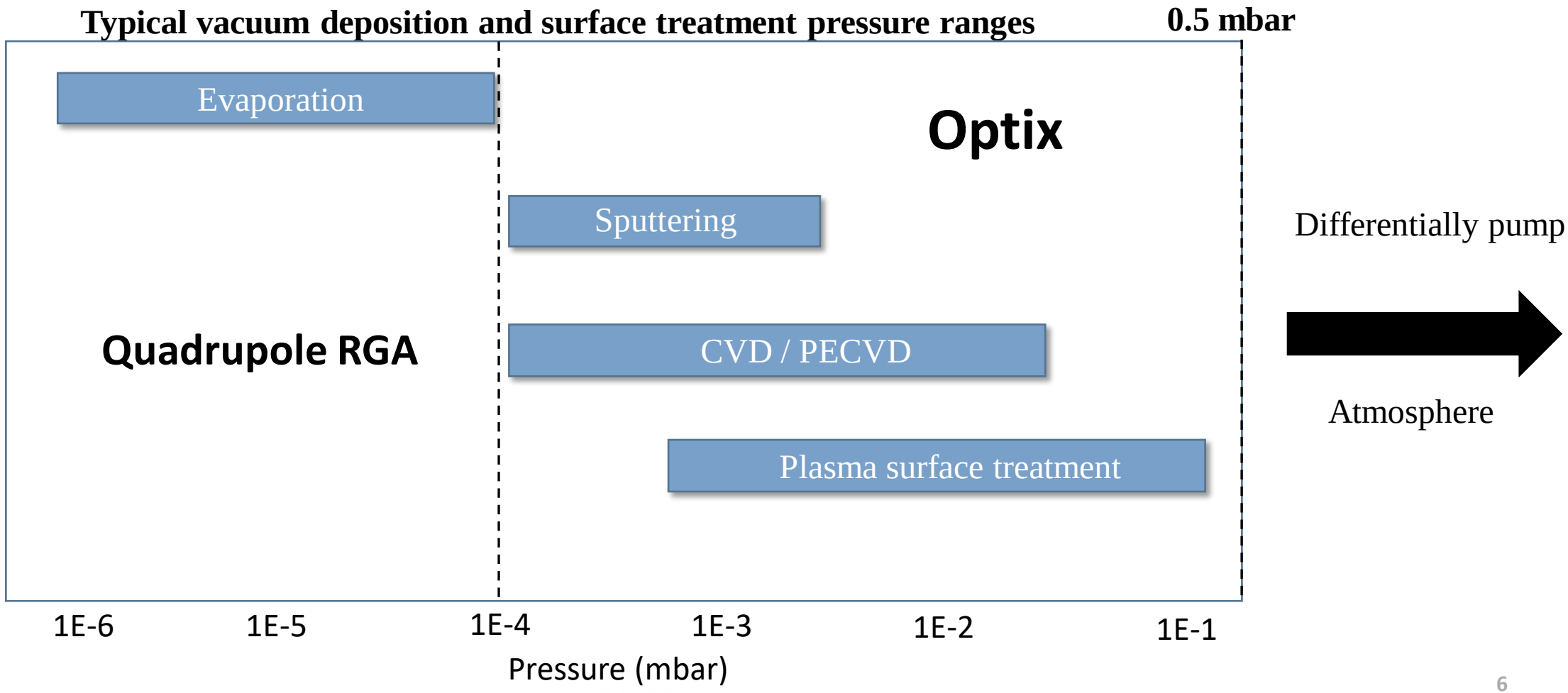


Optix pressure range

Pressure range



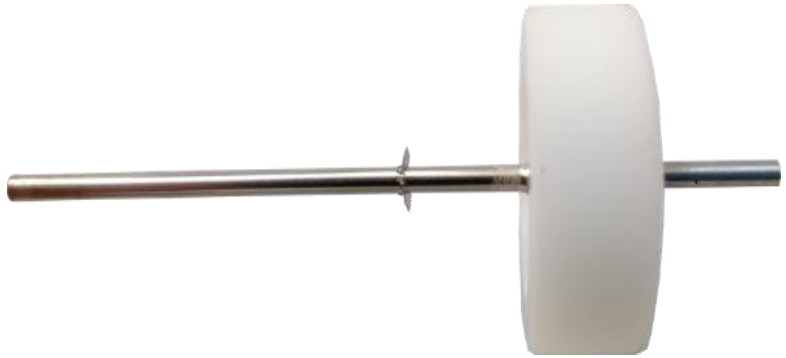
Optix pressure range



Maintenance of the plasma generator

Robustness

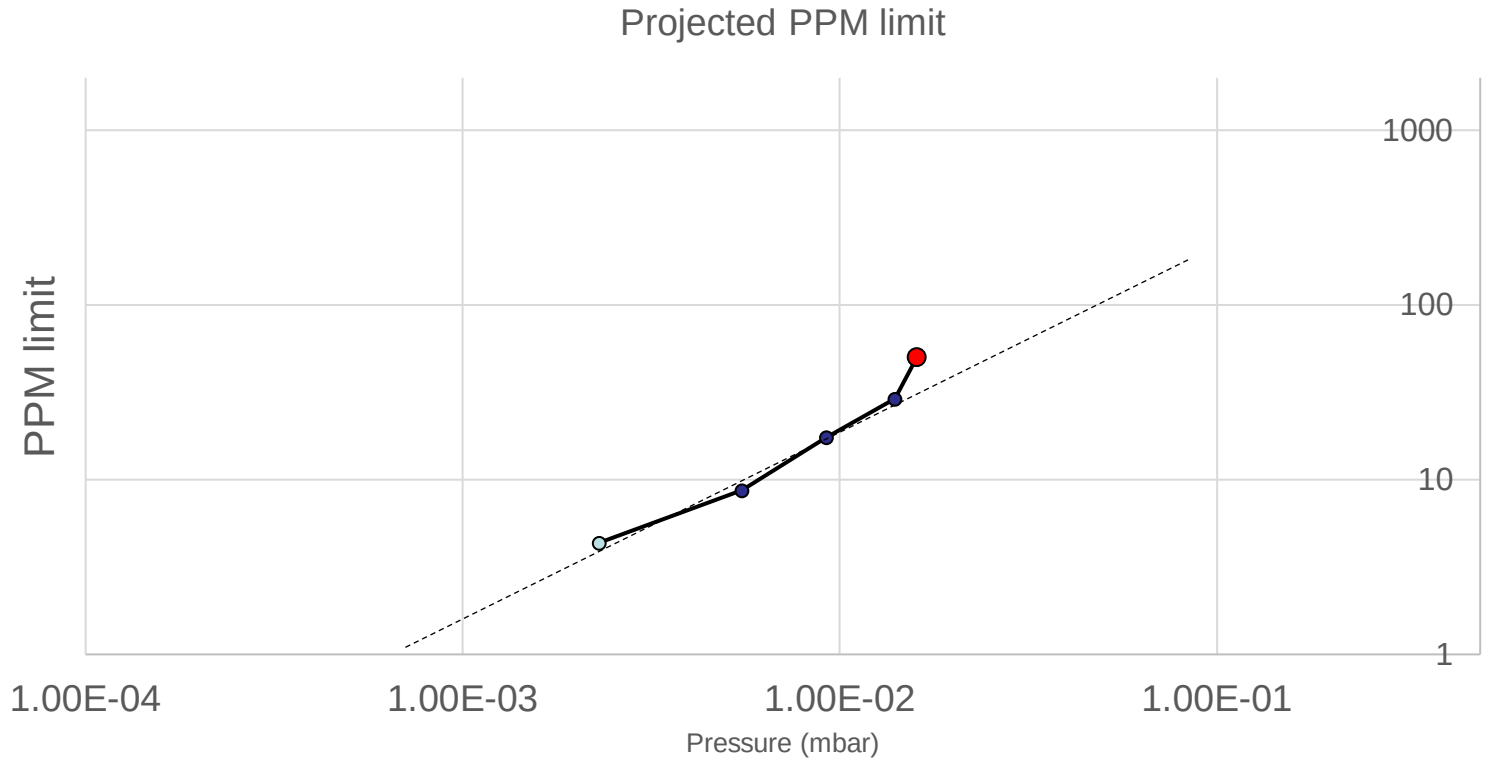
- **No filament**
- **Interlocked via internal pressure gauge**
- **Easily cleanable and replaceable electrodes**



Common questions from RGA users

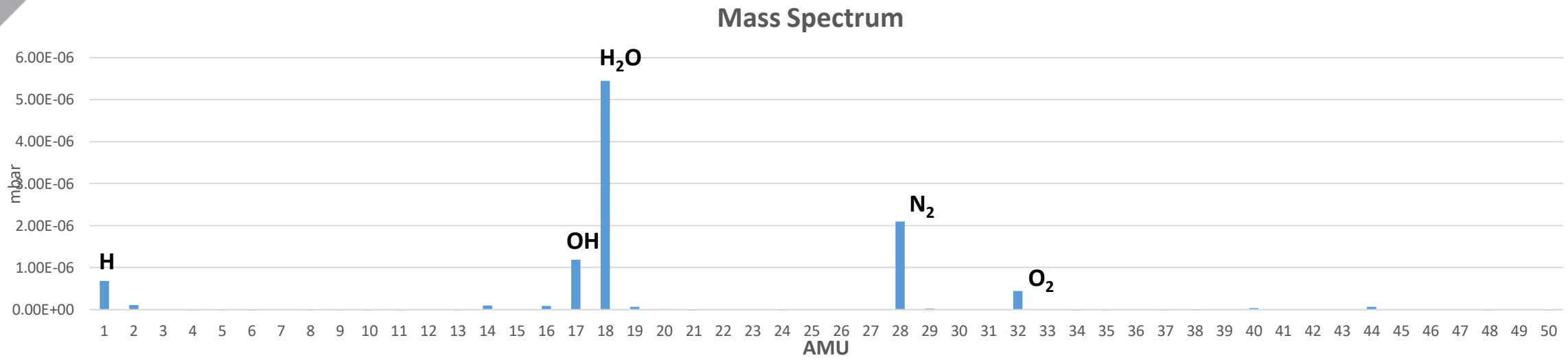
How sensitive is it?

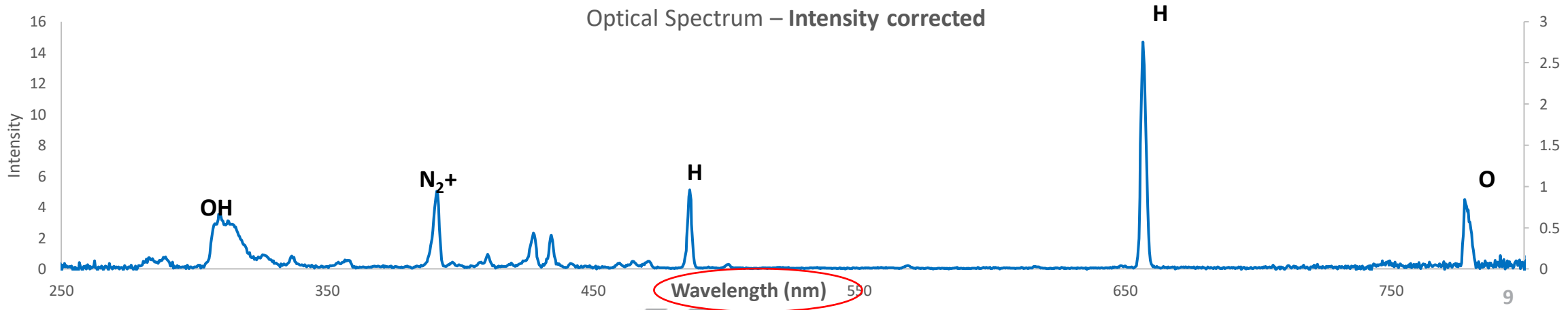
- The sensitivity of Optix is reduced as pressure increases above 1E-4mbar
- Gas dependent – smaller molecules are generally less sensitive



Common questions from RGA users

Mass vs Optical spectrum



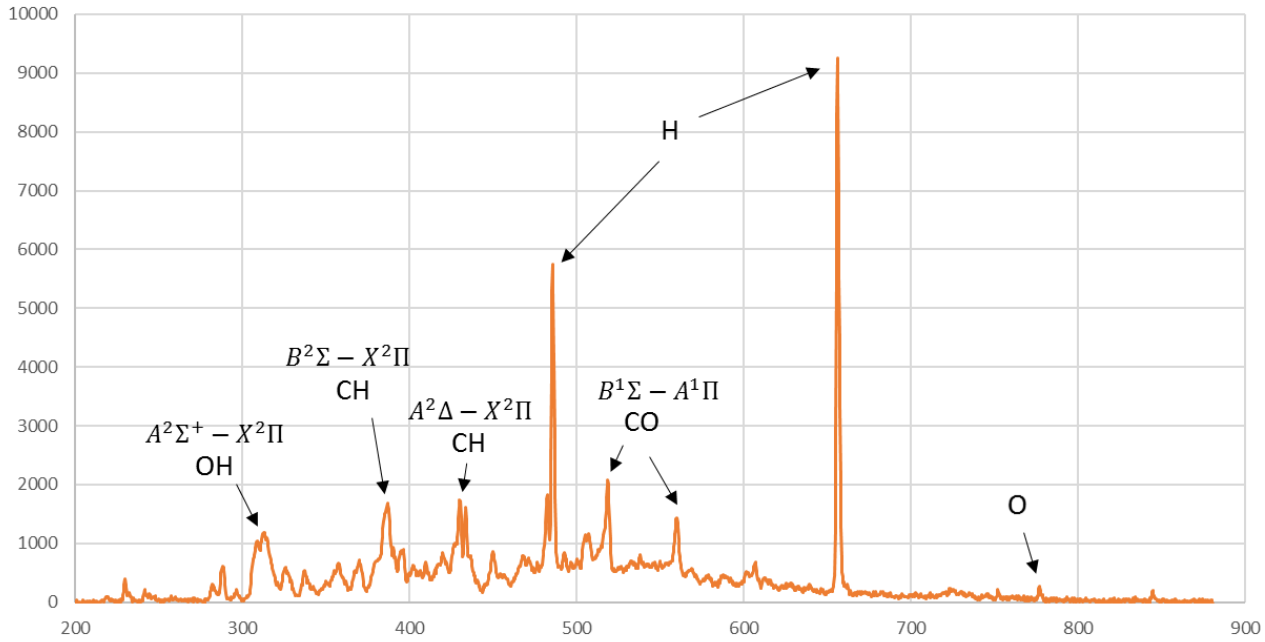


Common questions from RGA users

Equivalent AMU range

- The plasma inside the Optix will break larger molecules into smaller components
- Prominent, defined peaks from component species

Isopropanol ($CH_3CHOHCH_3$)



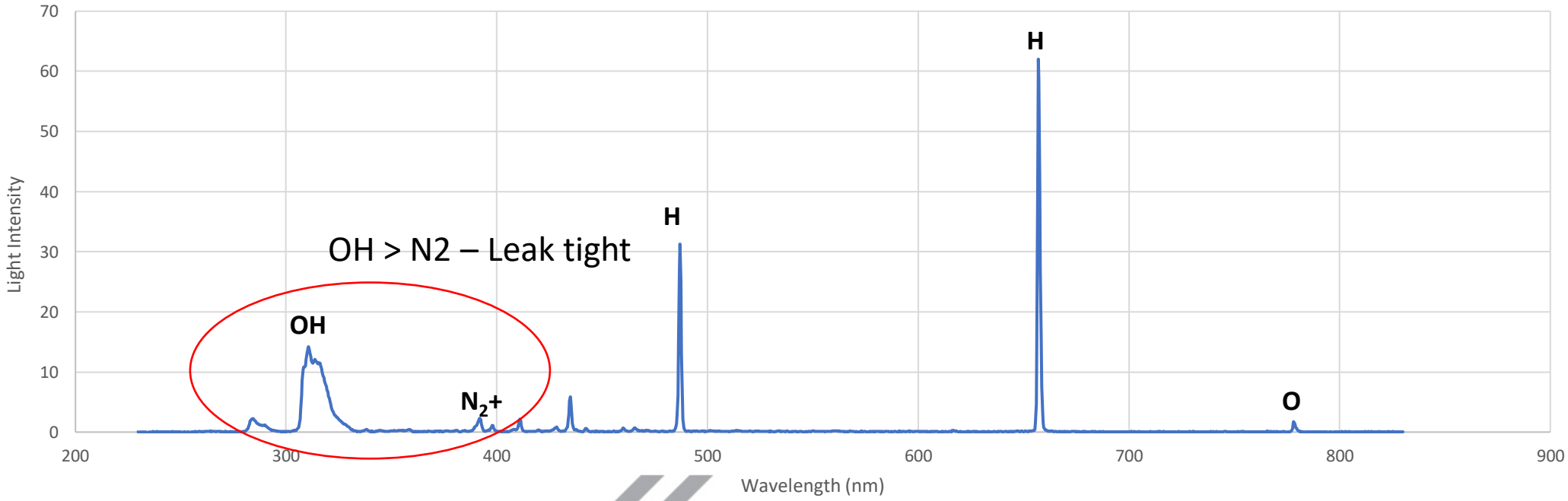
- **Can directly observe up to tri-atomic molecules**
  - **c. 50 AMU**
- **Can indirectly observe very large molecules via fragmentation**
  - **c. 100s AMU**

Optix vs RGA summary

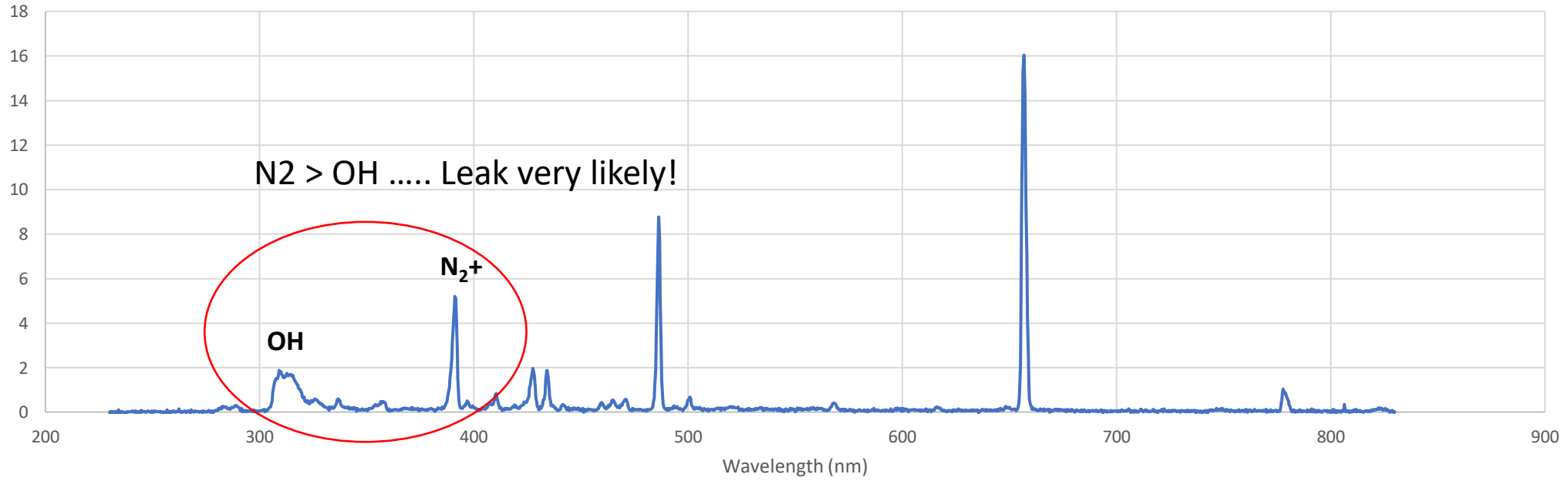
OPTIX – remote plasma gas analysis (RPGA) Optical method	Quadrupole Residual Gas Analyzers (RGAs)
Robust– detector separated from chemicals by optical window	Detector in contact with chemicals – easy to contaminate, hard to clean
No filaments –simple electrode geometry	Filaments and ionizers are consumables
Operates 0.5 to 10^{-6} mbar	Only operates reliably down to 10^{-4} mbar
Direct chamber monitoring – no need for differential pumping unless atmospheric sampling	Higher than 10^{-4} mbar pressure needs differential pumping – loss of sensitivity
FAST – 'speed of light', 10-50 msec response	Typically 0.5 to several seconds range
Tolerates volatiles in the vacuum – hydrocarbons, solvents, long chain polymers	Only small amounts of contamination before sensor failure
Wide range of useful software applications available – gas tracking, leak detection, pump-down monitoring, water tracker, end-point detection, multi-mode process tracking	Typically gas tracking & leak detection
Sensor degassing mode – avoid false reading	Yes, but degas can affect filament lifetime

Application examples – Water and Air

- Example of “Clean” vacuum system
- Mainly water vapour – OH and H emissions
- Small amount of N_2 in relation to water vapour
- General rule that < 1E-2 mbar a leak tight system should not have significant N2 present

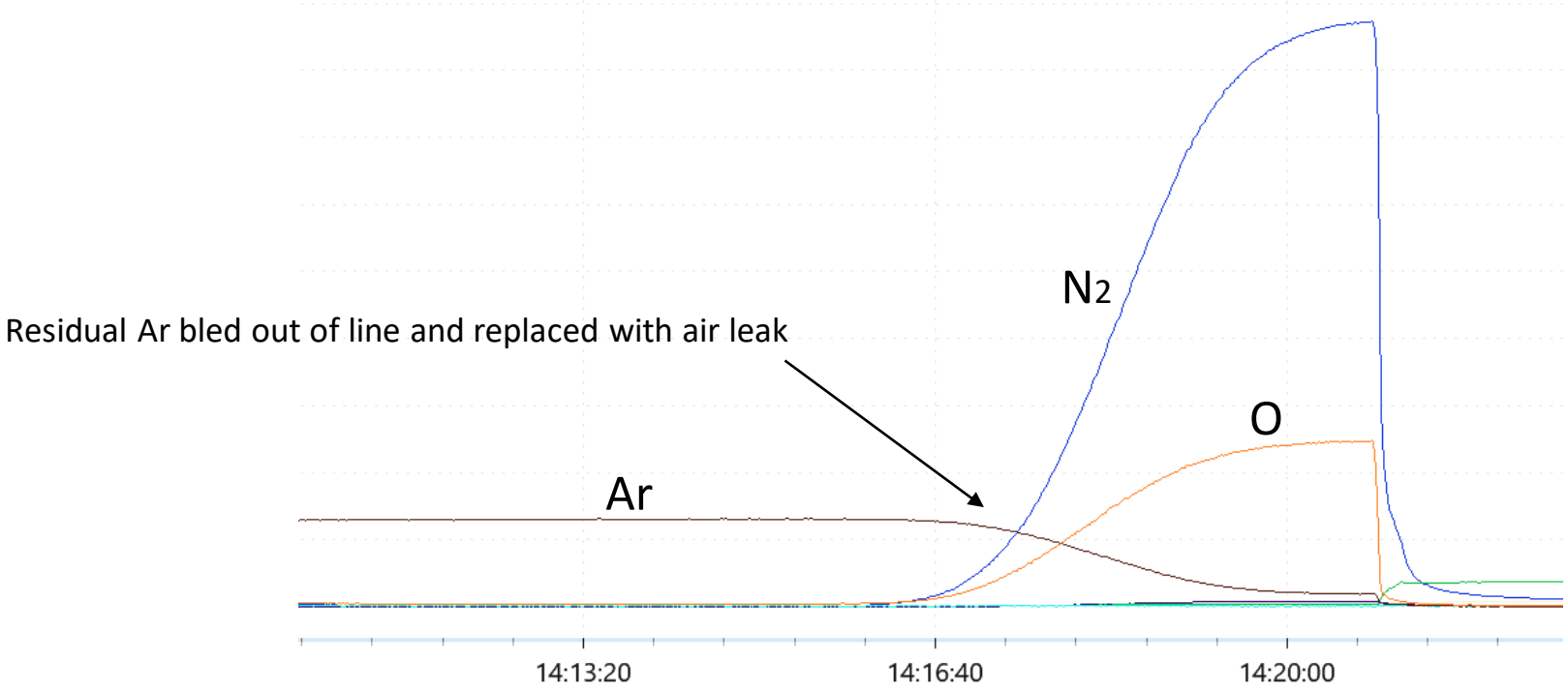


Application examples – Water and Air



Application examples – Gas line check

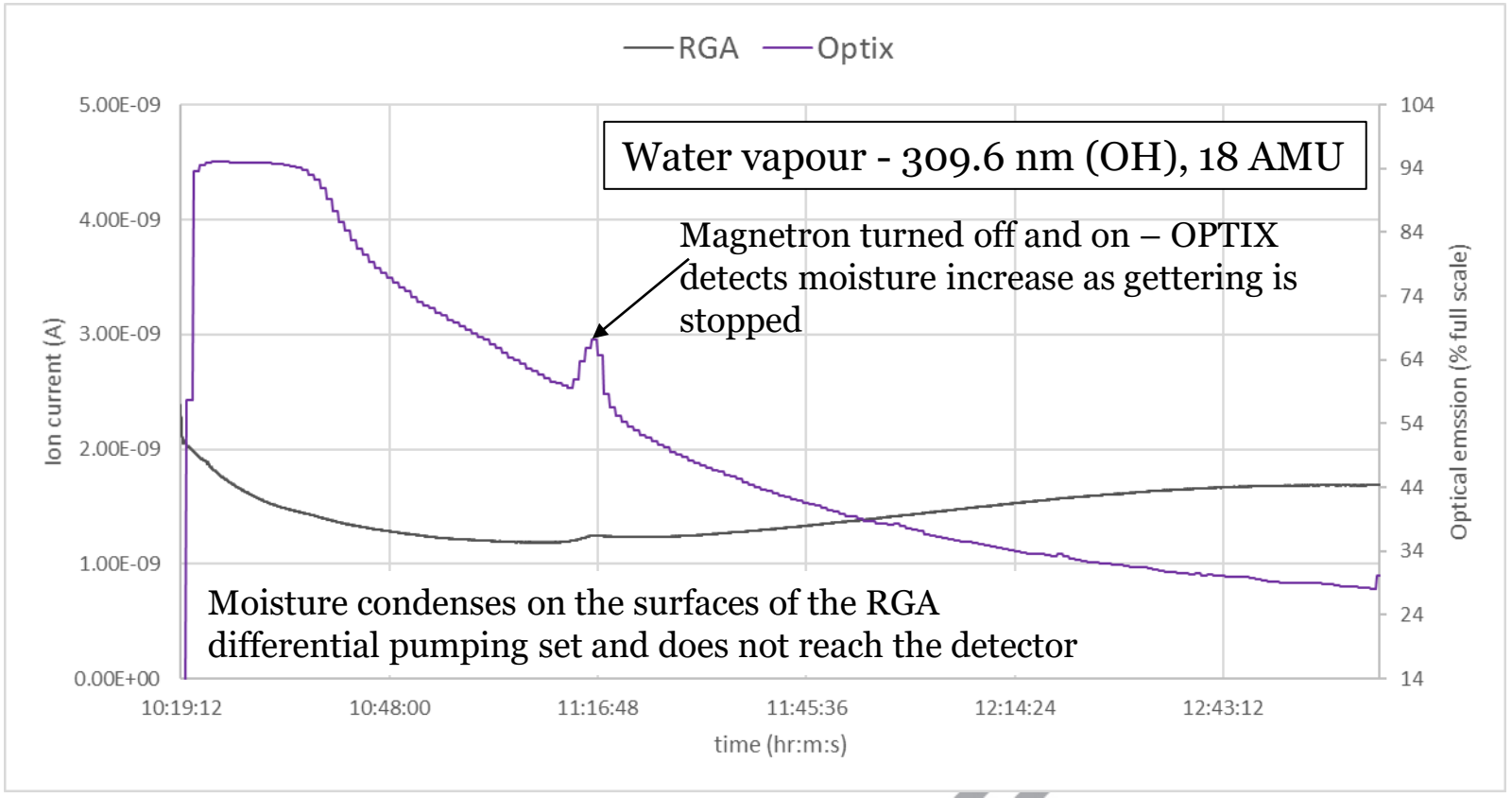
- Ar process gas line contaminated with air
- MFC feedback would have shown no problem, Pressure gauges would also not detect the problem
- **No system leak to detect** – in situ gas monitoring only way to see this



Application examples – Water

Direct sensing

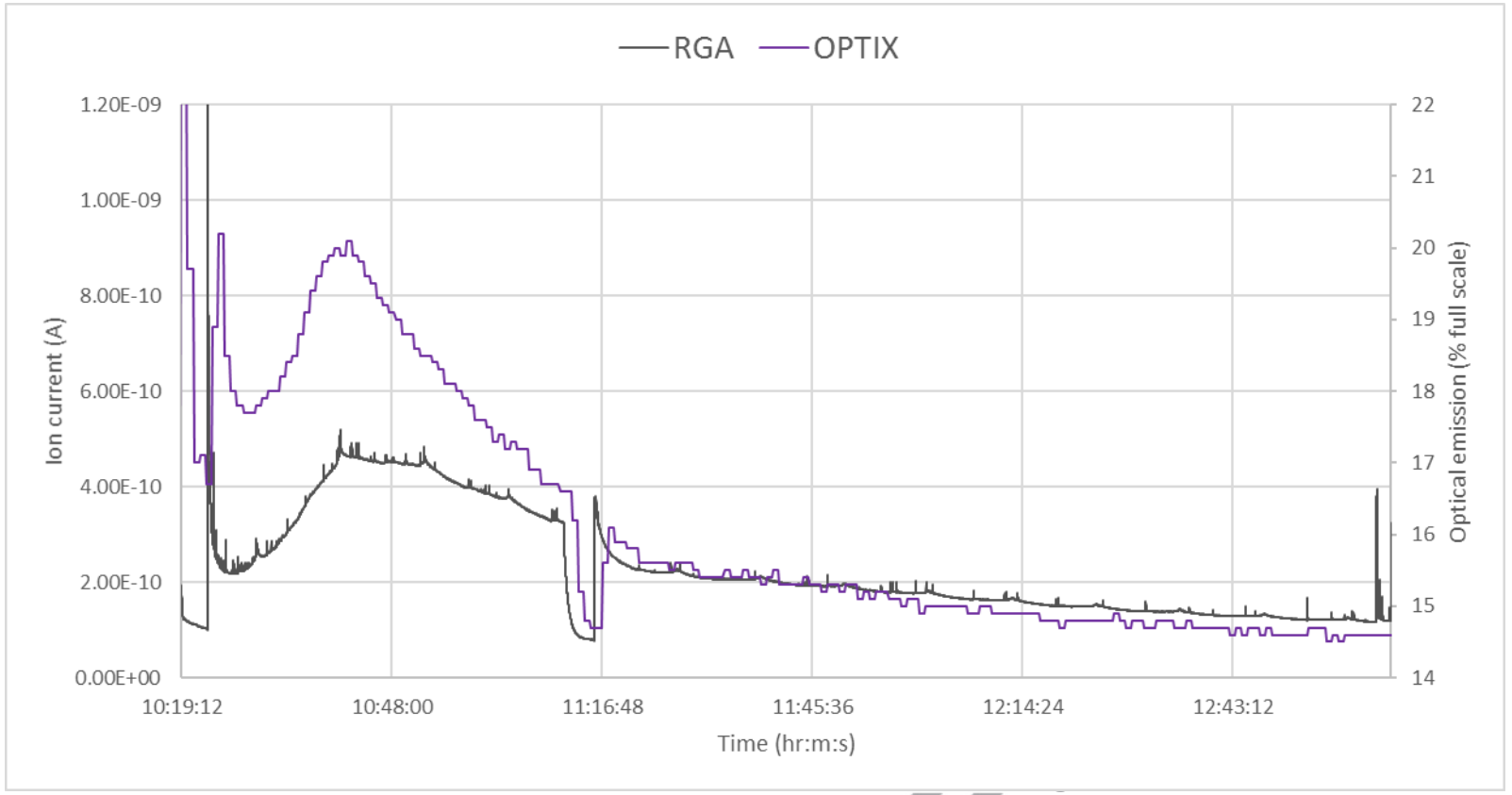
- Optix can directly sense the vacuum: **Pressure 0.1 mbar**
- **Enhanced sensitivity for condensable species**



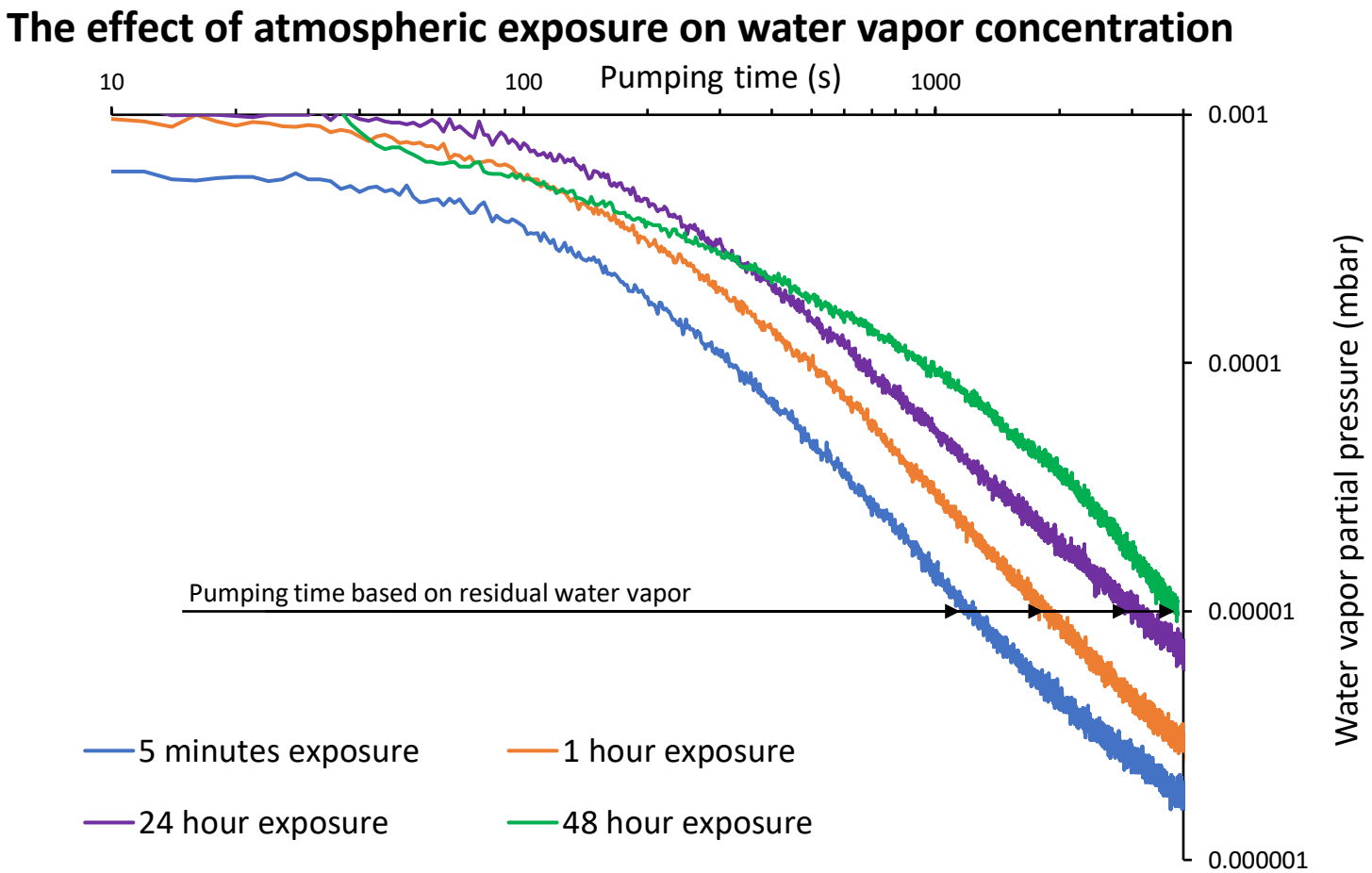
Application examples – Water

Direct sensing

Hydrogen - 656 nm, 2 AMU

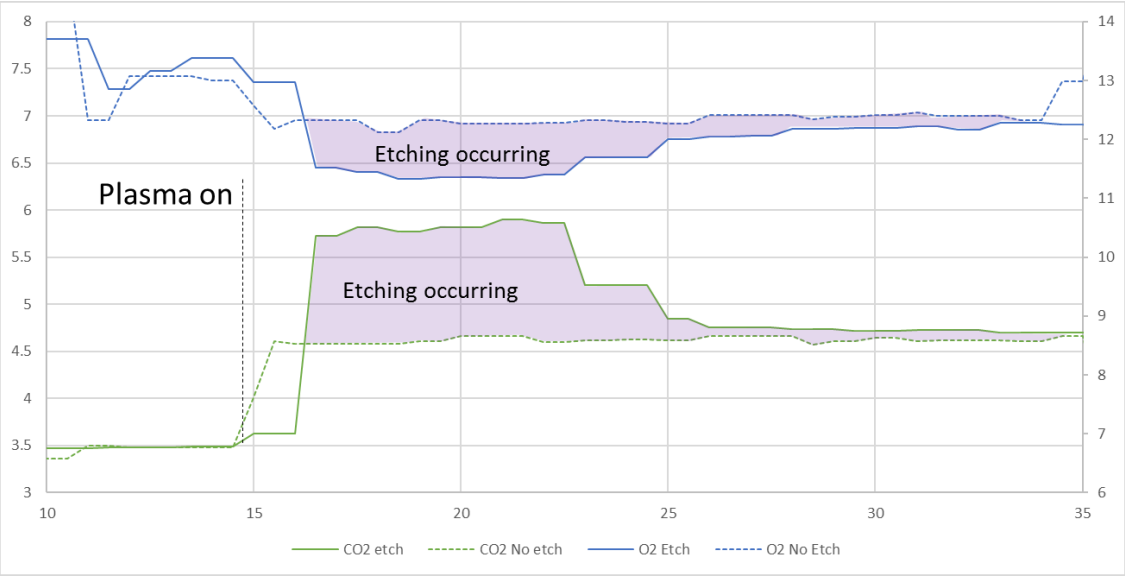


Direct sensing



Ar / O2 dry etch monitoring

- **Process pressure: 5E-2 mbar**
- Oxygen consummation and CO2 production during photoresist etching
- Comparison between wafer with photoresist applied and without



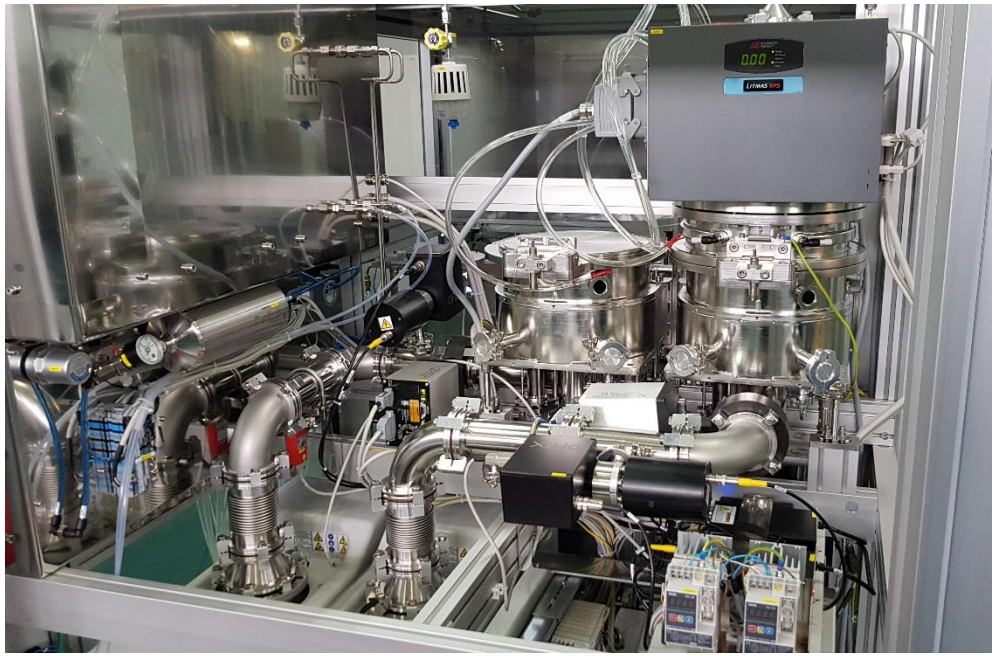
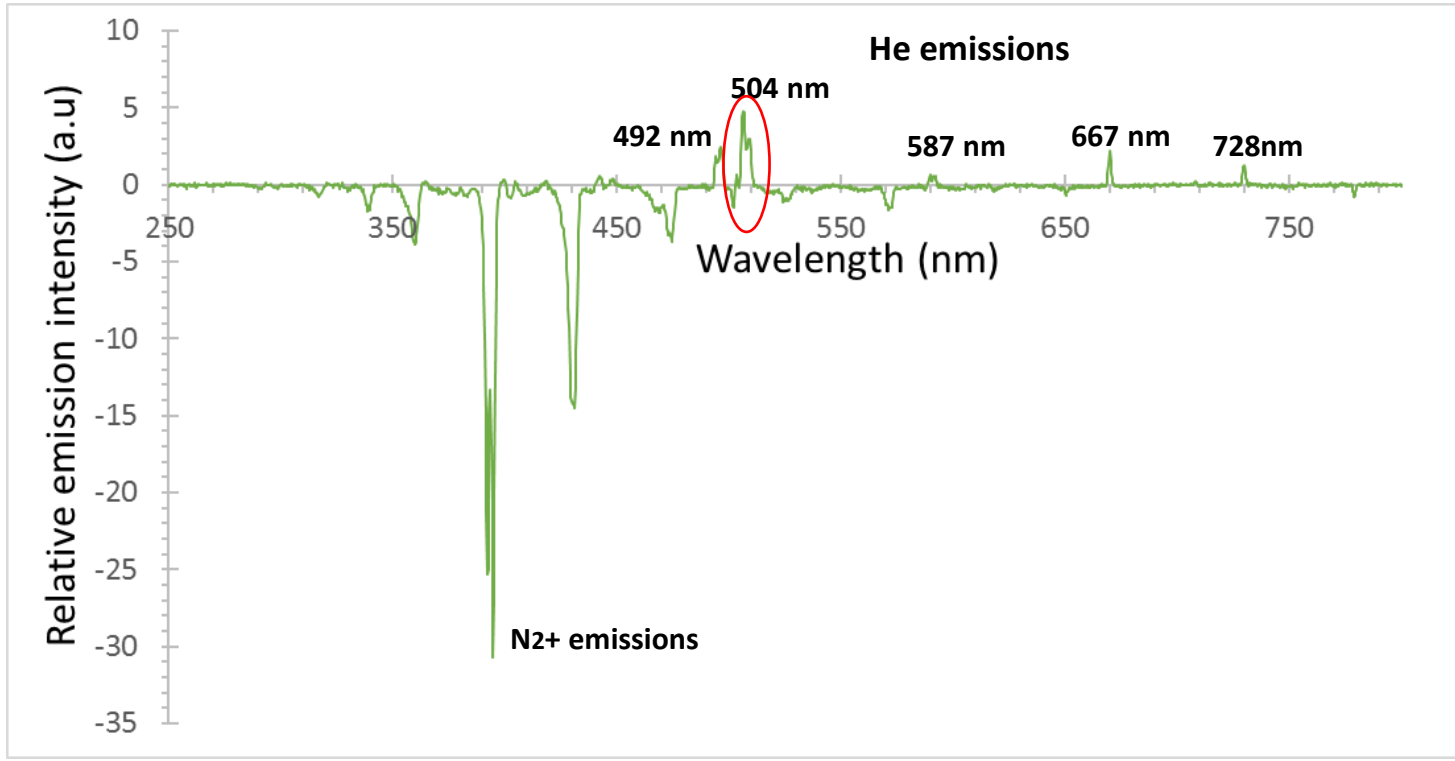


Image courtesy of SNT

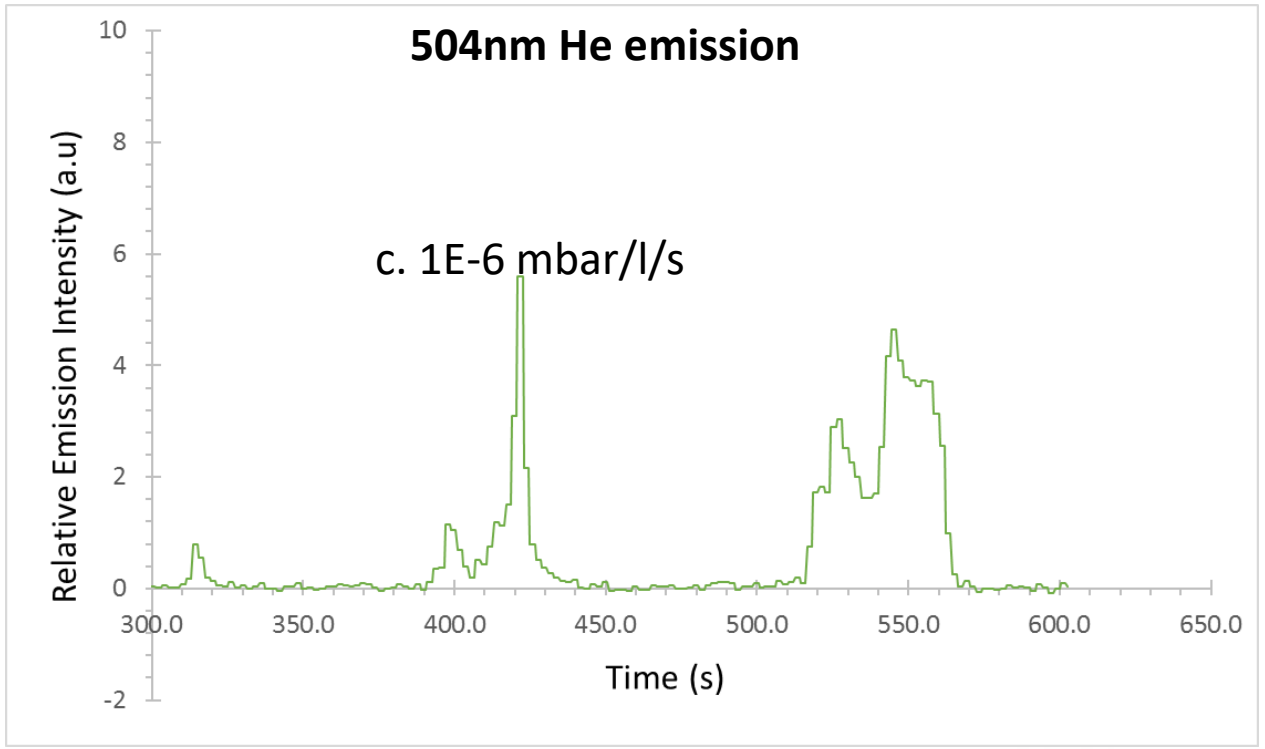
Application examples – He leak detection

- Differential spectrum produced when spraying He around an air leak

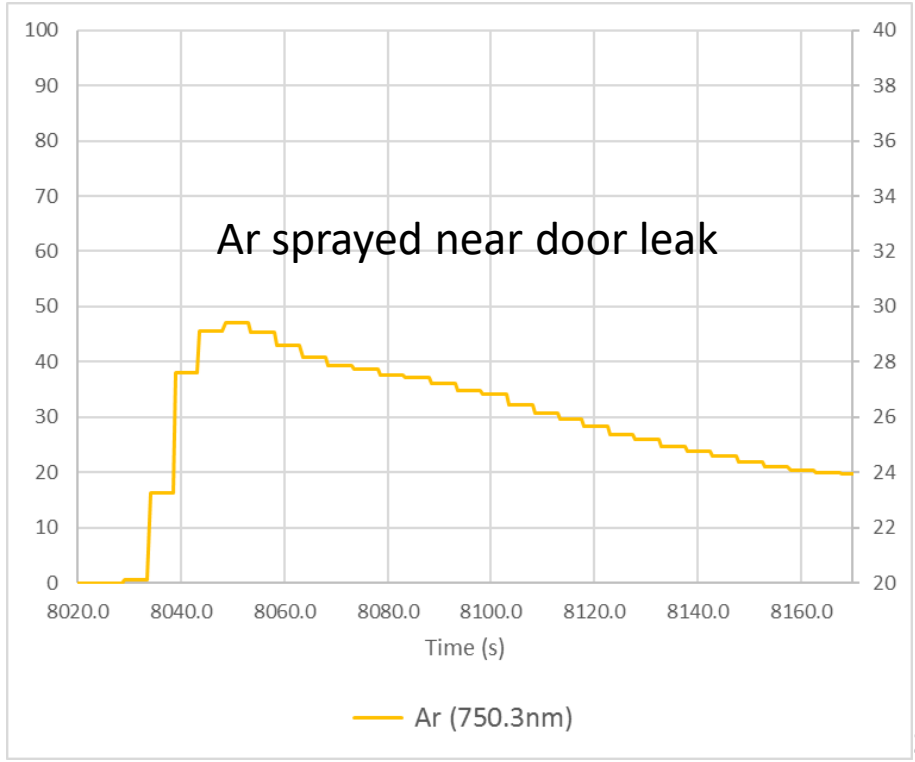


Application examples – He leak detection

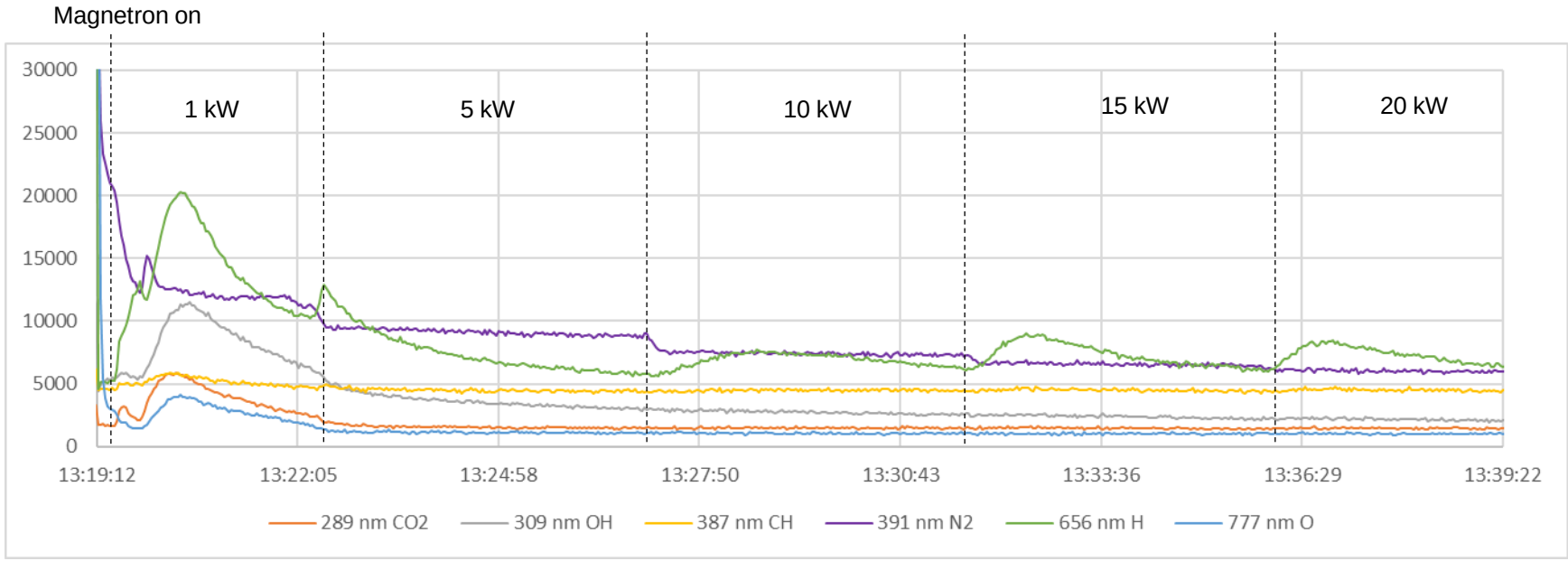
- Possible to localise air leaks by monitoring He emission
- Not a complete replacement for a dedicated He leak detector
- Leak rates are not directly quantifiable



Why not use Argon?



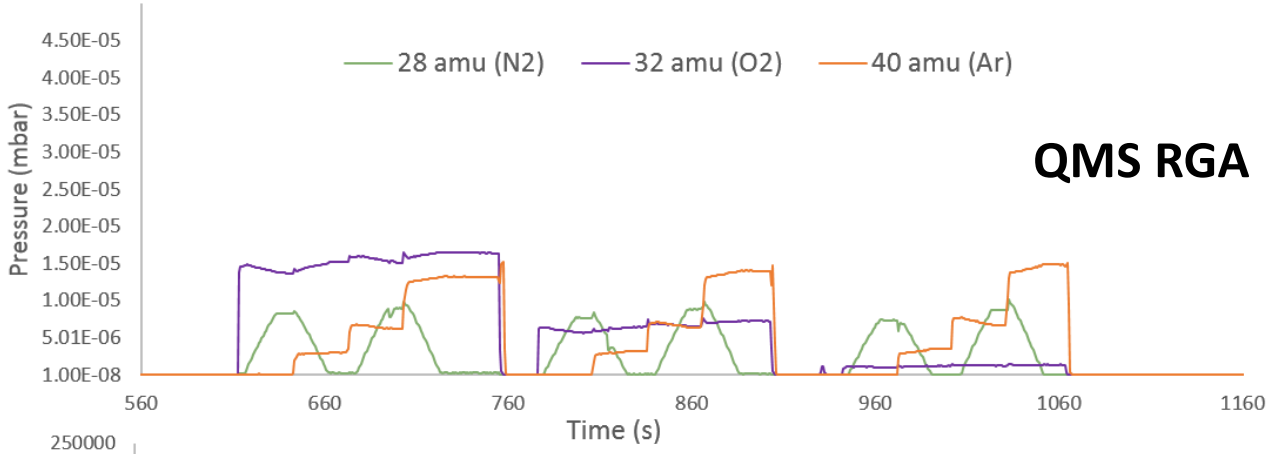
Application examples – Target cleaning



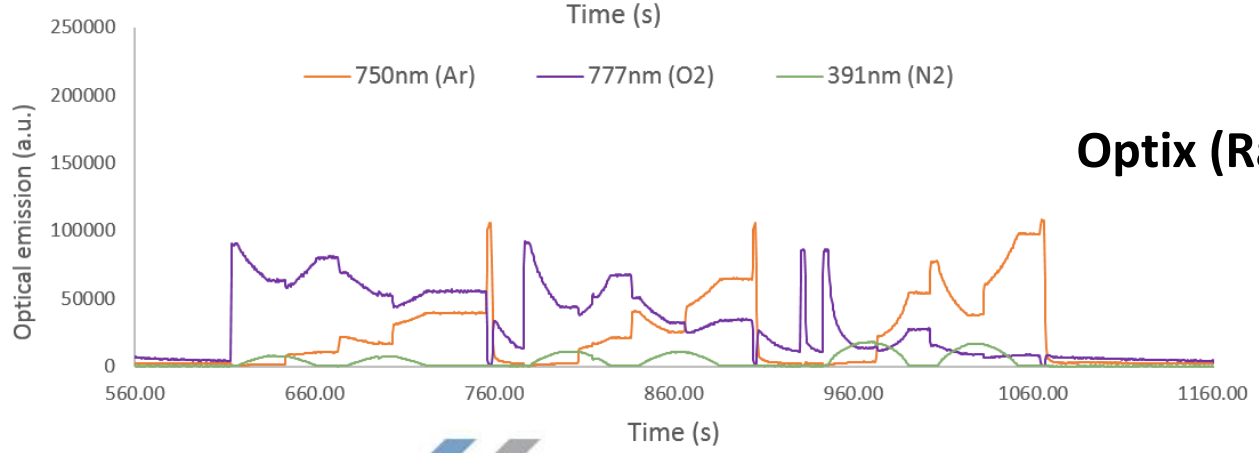
- Very large H outgassing – taking significant time to reach steady state
- Other species also observed initially outgassing – OH, CO2, O
- Subsequent power increases cause increased H outgassing and additional settling time
- Consumption of N2 also observed – small chamber leak

Partial pressure feature

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



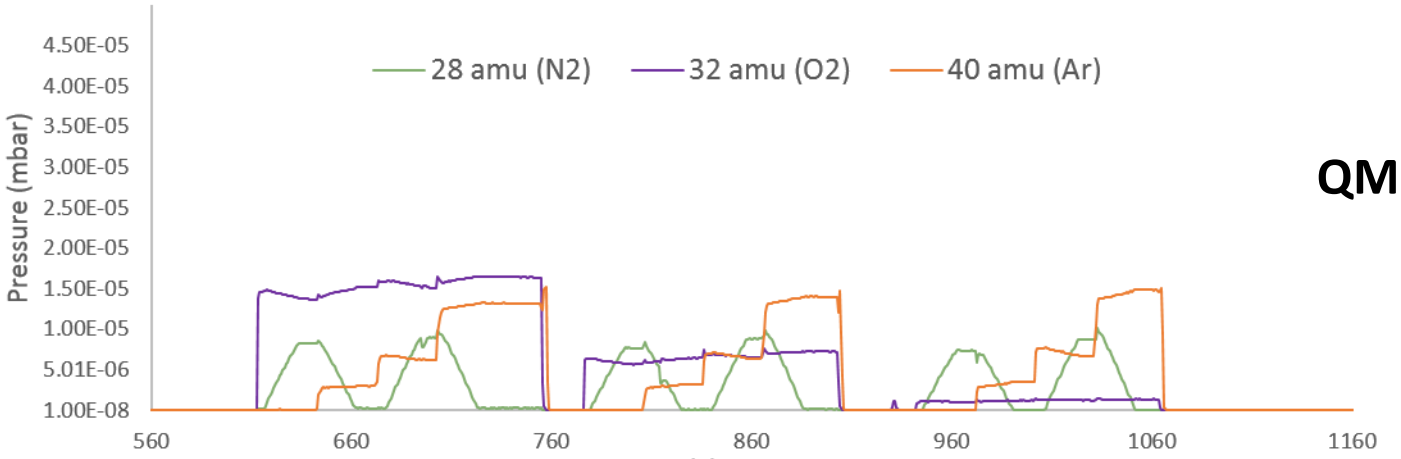
QMS RGA



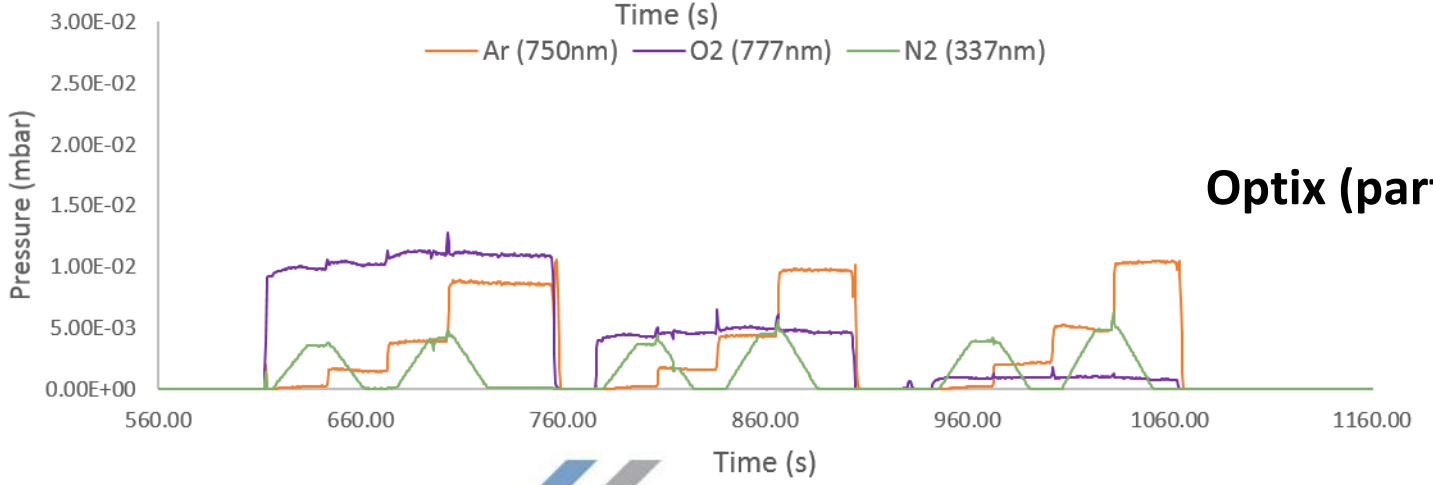
Optix (Raw data)

Partial pressure feature

- Optix has a patented algorithm that transforms the readings into **partial pressures**



QMS RGA

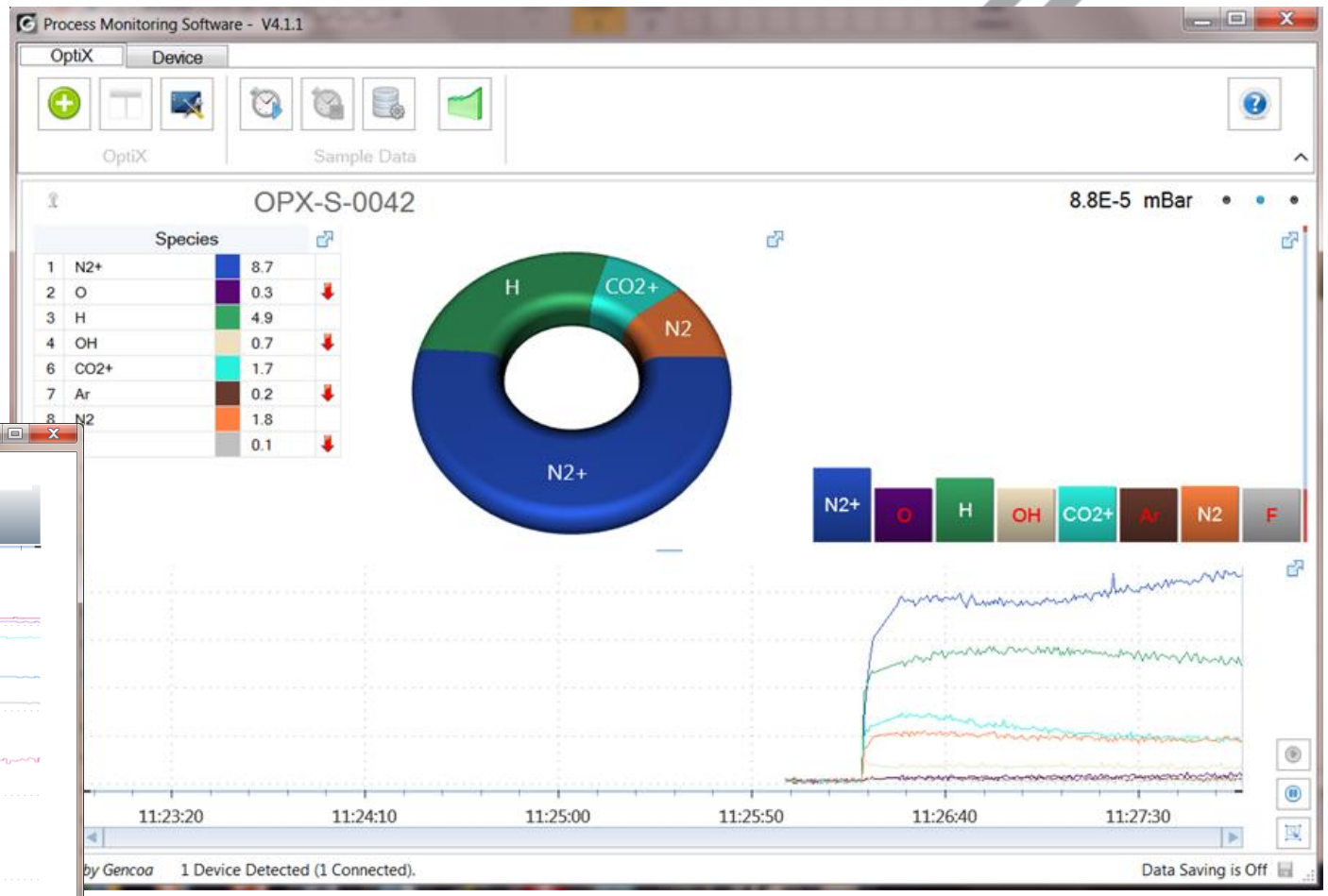


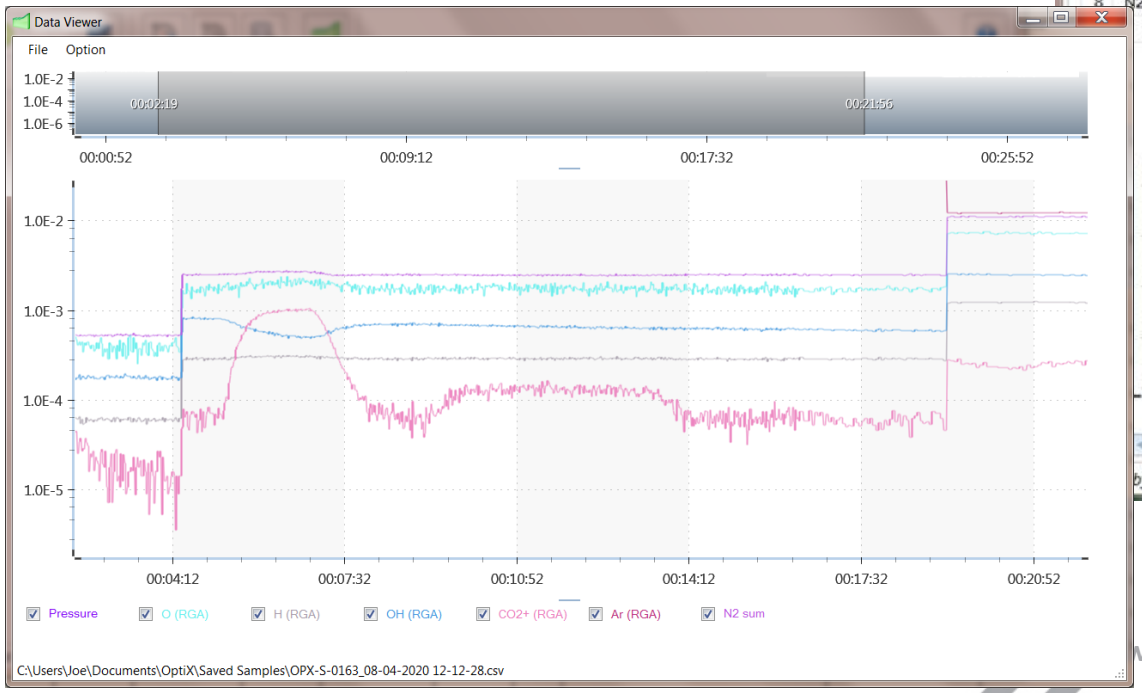
Optix (partial pressure algorithm)

Included software

Ease of use

- Optix software is simple and easy to use
- Powerful analysis options (spectrum auto ID)
- Flexible options for integrating with PLCs

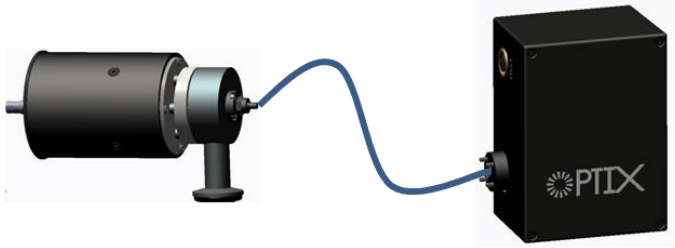




Alternative configurations

Versatility

Standard OPTIX package, plasma generator with power supply (DC as standard, pulsed DC as an option) with Spectrometer head and OPTIX software package / cables



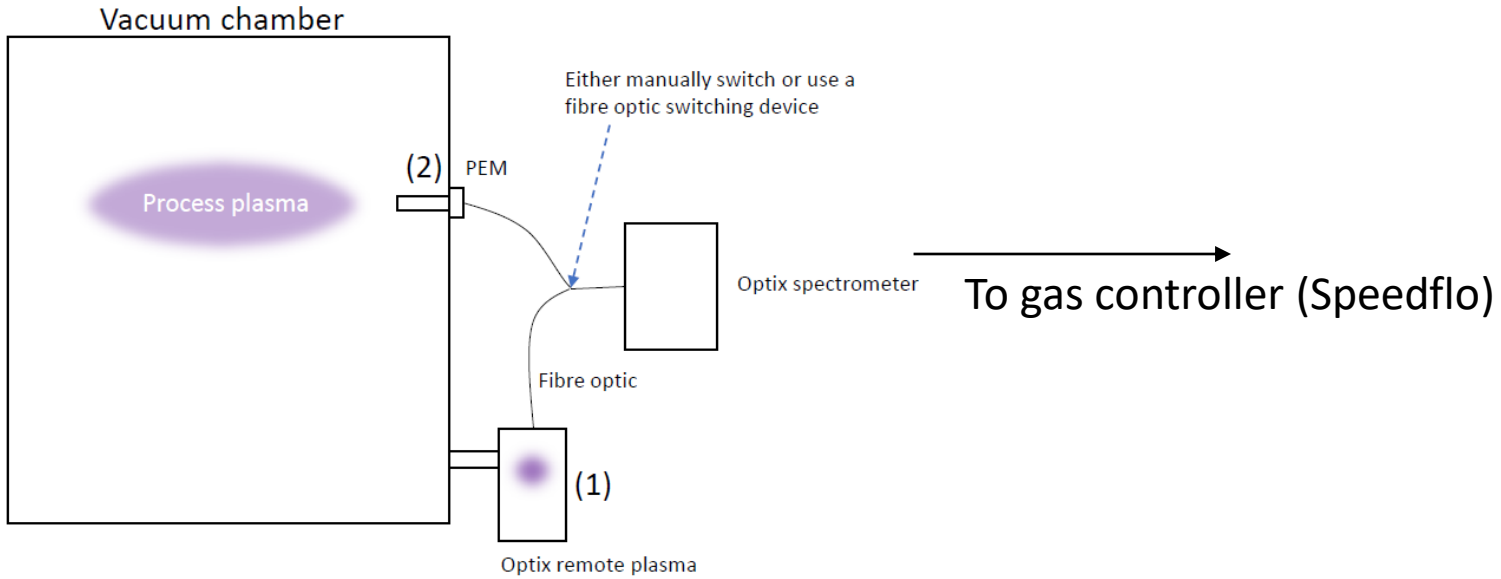
Standard OPTIX package, with optional optical fiber link between sensor and spectrometer – increases flexibility of the package – use items separately

Plasma generator with power supply (DC as standard, pulsed DC as an option) and cables – generates an intense plasma over a wide pressure range – can link to Speedflo or other control platforms

Spectrometer head with OPTIX software package – take advantage of the OPTIX software suite to manage your plasma monitoring and take advantage of the communication and trigger facilities

Alternative configurations

Optix can also be configured to analyse and monitor the process plasma (i.e deposition source plasma)



Mode (1) "RGA mode". The Optix functions like a QMS RGA, monitoring the gaseous species in the vacuum environment. No process plasma is required. Can be used to monitor the pump down, analyse outgassing, leak detection etc...

Mode (2) Monitoring the process plasma. Can be used to analyse ionisation, gas composition of the plasma, substrate interaction etc. If no direct line of sight is available to the process plasma then in-vacuum fibre optics can be used.

Optix Summary

- Highly robust and easy to use – no filaments to replace & easy to use software
- OPTIX can work at all process pressures – no need to differentially pump unless atmospheric sensing
- Highly mobile – can be carried in a small bag for on-site trouble shooting
- OPTIX is less sensitive to contamination than RGA's, can be used for 'dirty' hydrocarbon environments as well as etch, CVD and ALD type processes
- This sensing technique offers a lower cost and lower complexity solution than alternative methods
- Can link directly to Speedflo reactive gas controller or PLC for feedback control