



## BROOKS AUTOMATION, INC.

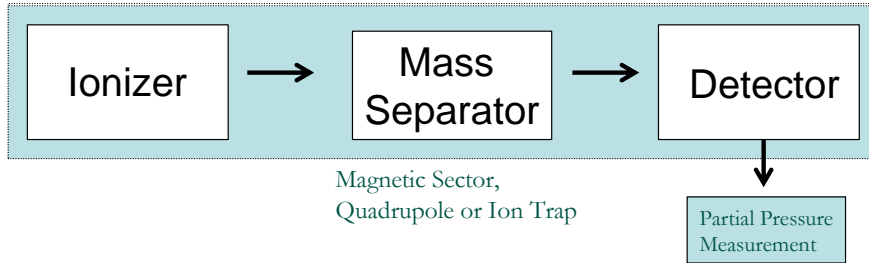
# Autoresonant Ion Trap Mass Spectrometer The RGA Alternative

**GRANVILLE-PHILLIPS®**  
A DIVISION OF BROOKS AUTOMATION  
Advanced Vacuum Measurement Solutions

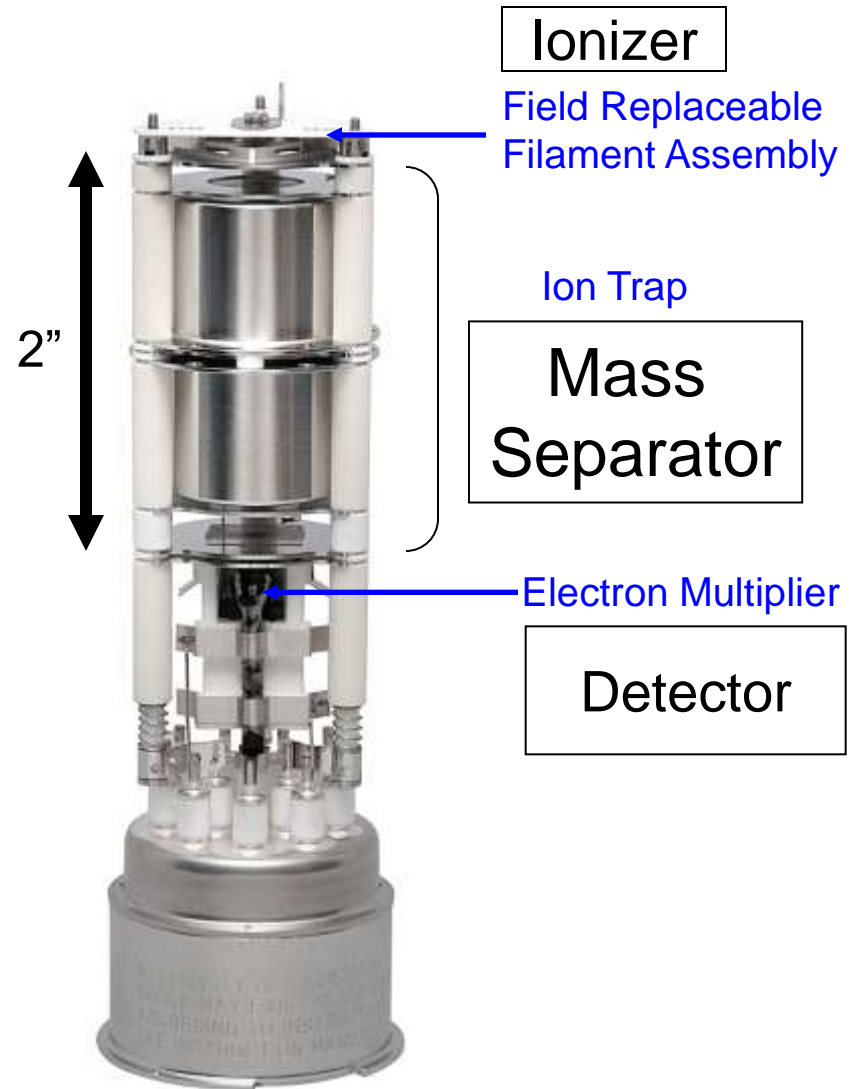


# What is a Mass Spectrometer?

## Mass Spectrometer



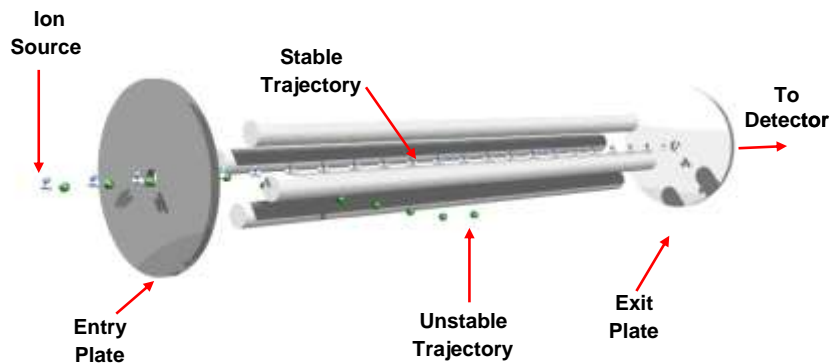
- Gas molecules are ionized (+ ions), and the resulting ions are separated, detected and measured according to their mass-to-charge ratios ( $m/z$ ).



# Mass Separator – Modern Trends

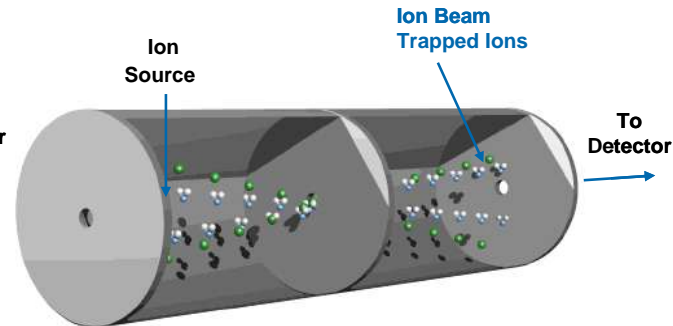
- Magnetic Sector and Quadrupoles are prevalent technologies
- The Electrostatic Ion Trap is the next generation of low mass separation technology

## Quadrupole MS



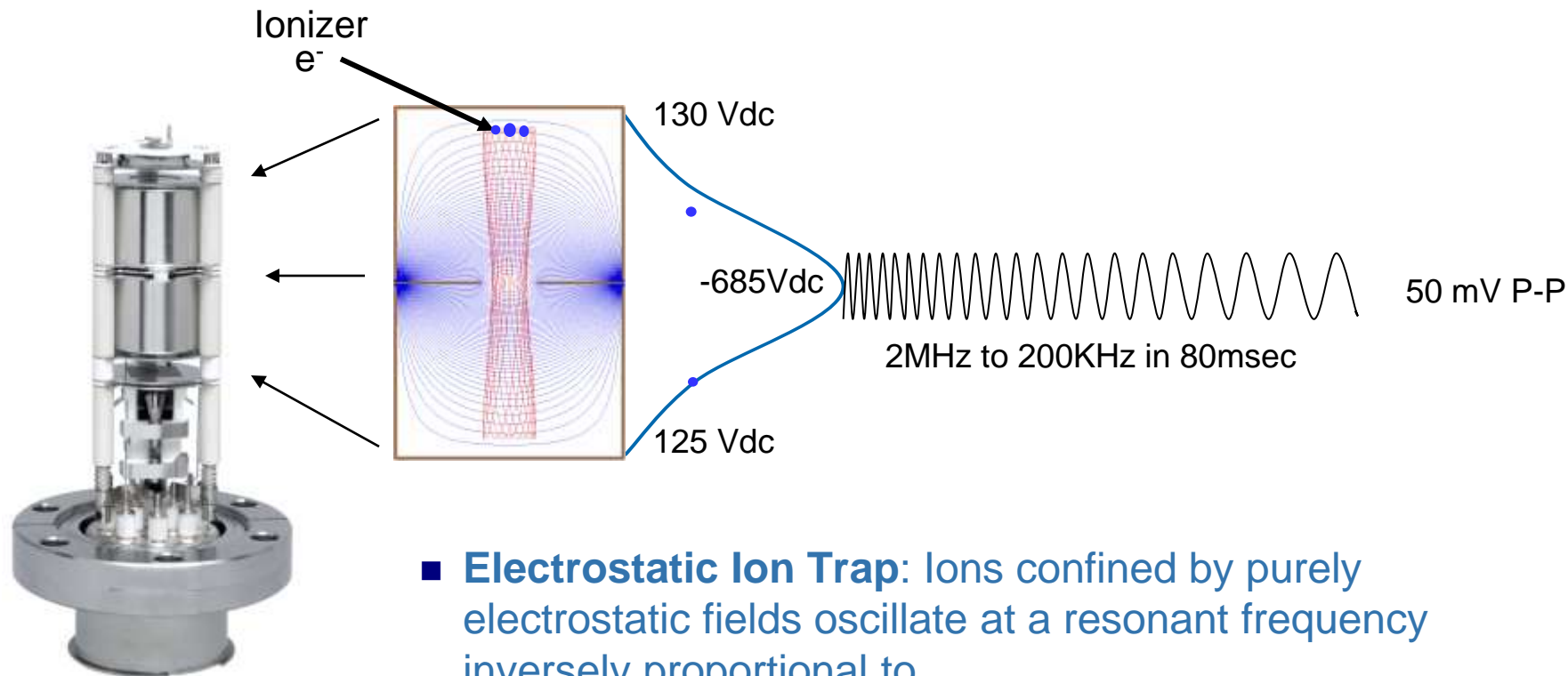
- Ionization is outside the mass separator
- Mass filter - one  $m/z$  at a time
- Poles get dirty
- Slow scanning

## Ion Trap MS



- Ionization is inside the trap
- Trap - all ions stored together
- Clean
- Fast spectral output

# Autoresonant Ion Trap Mass Separator



- **Electrostatic Ion Trap:** Ions confined by purely electrostatic fields oscillate at a resonant frequency inversely proportional to

$$\sqrt{m/z}$$

Where, m is mass, z is the total charge of the ion

- **Autoresonance:** RF scan pushes ions when scan frequency matches ion's resonant frequency

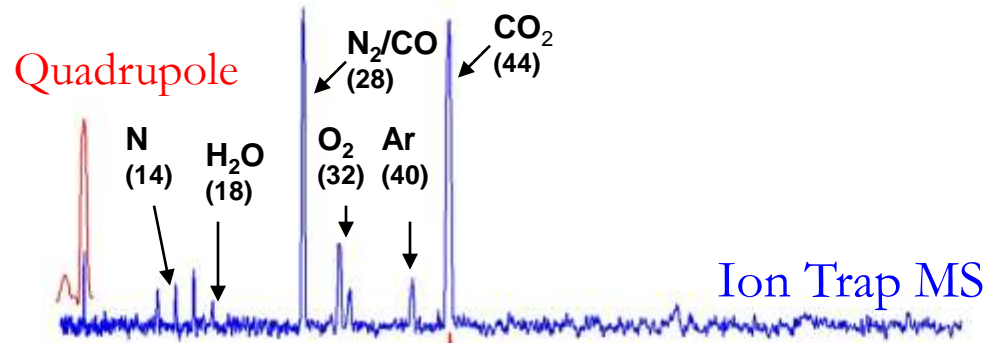
**Electrostatic confinement = Ultra-low power requirements**



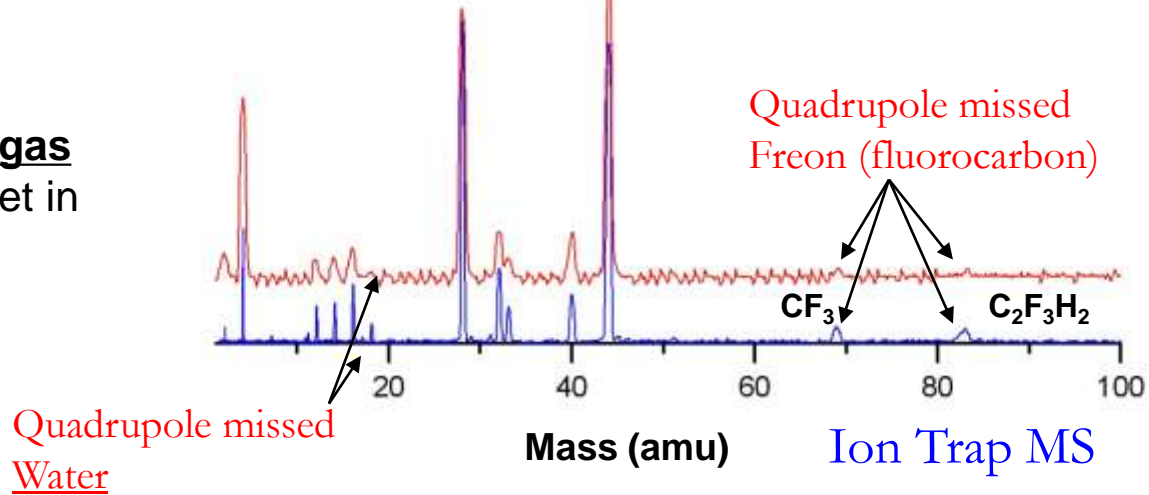
# ART MS vs. Quadrupole RGA

Quad RGA = 1.5 sec, Ion Trap MS = 70 msec – 1-100 amu scan

How much **information** you get in a 70 msec scan



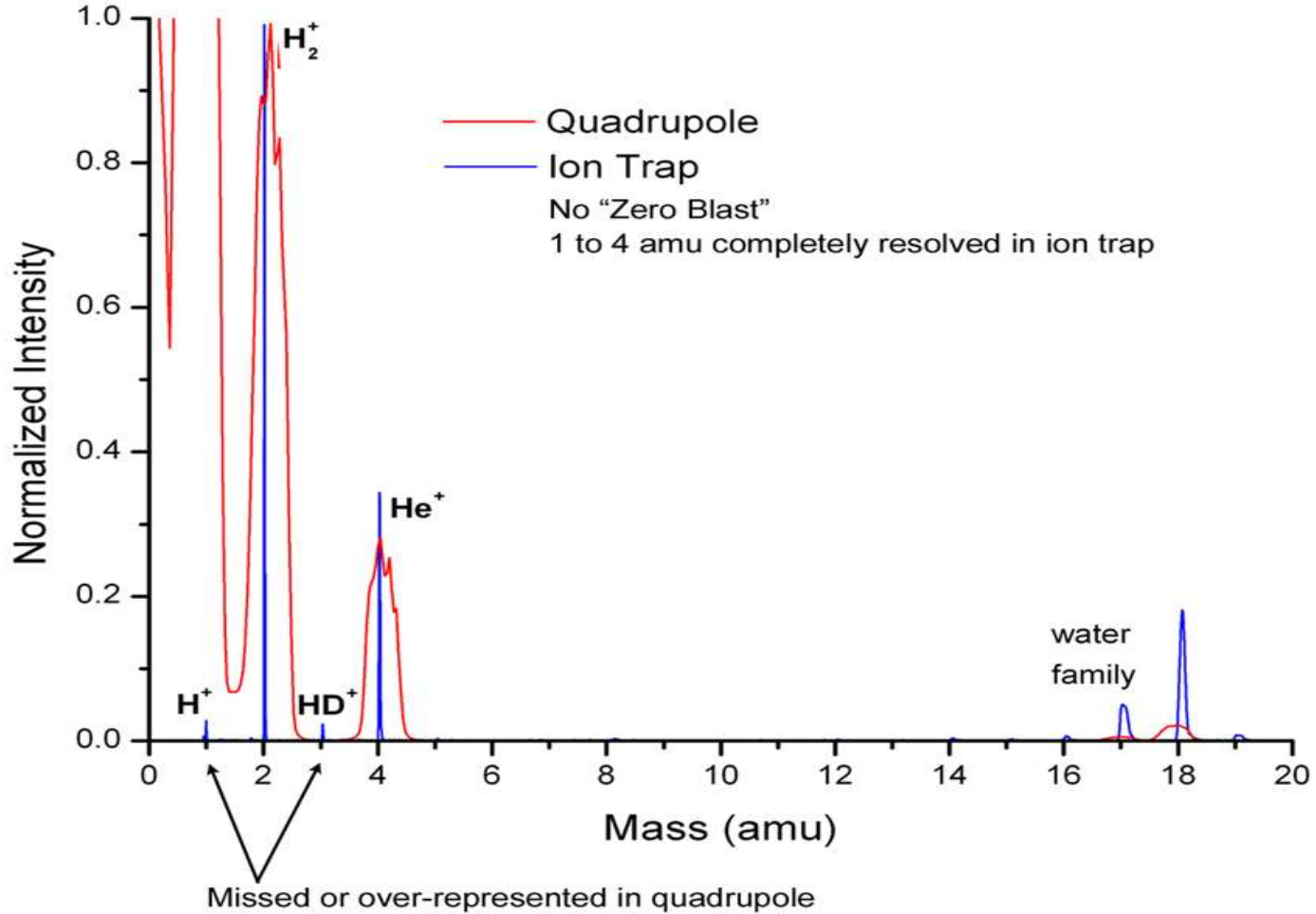
How much **resolution and gas detection** you get in 1.5 seconds





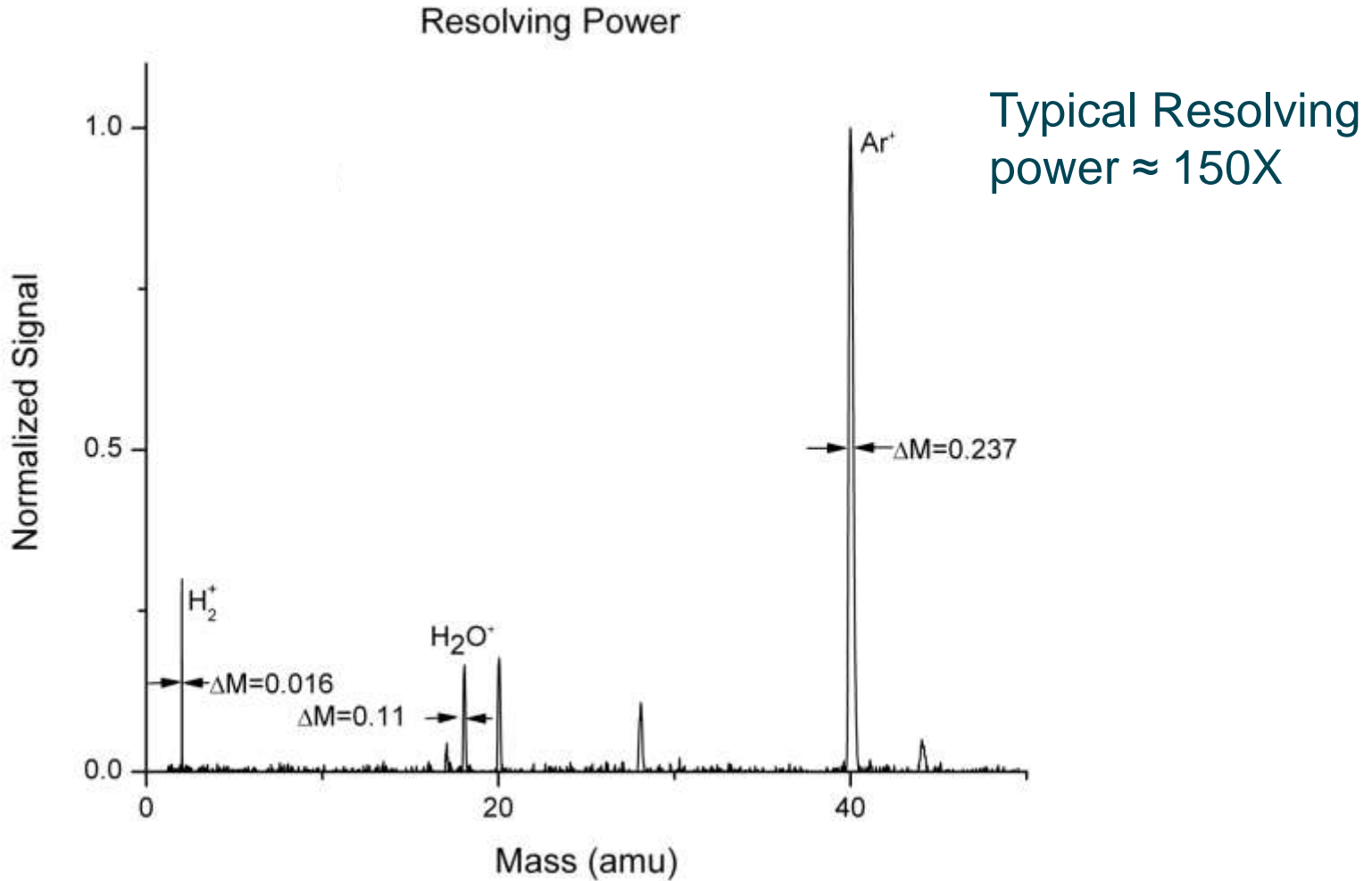
# Low Mass Comparison

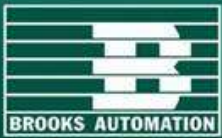
## Low Mass Range Capability 830 VQM compared to Quadrupole





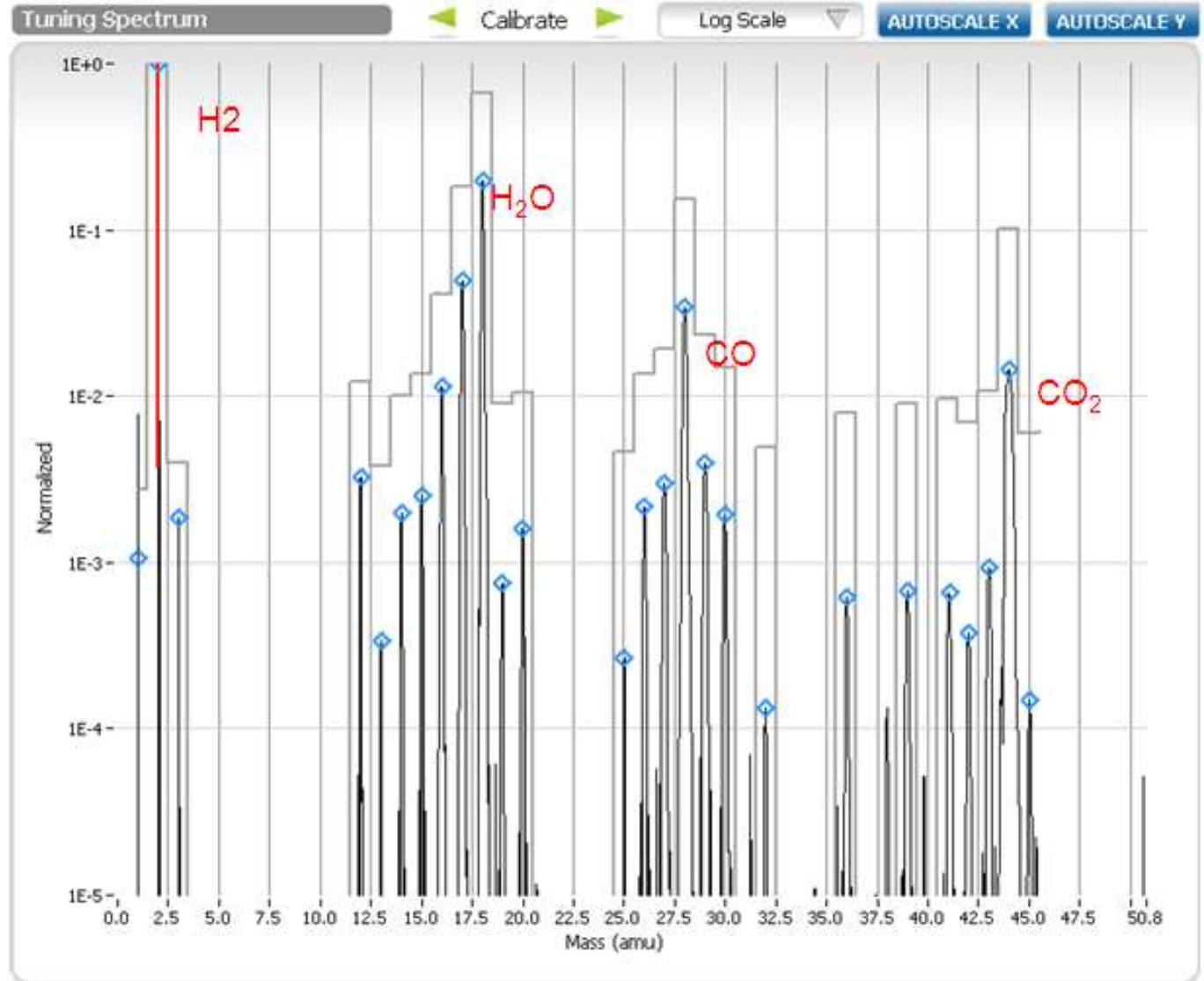
# VQM Resolution

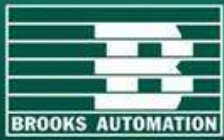




# VQM Sensitivity / Dynamic Range

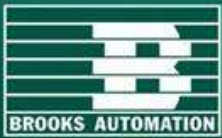
- Min detectable partial pressure is 2-3 decades below the max peak partial pressure
- 3 decades requires averaging
- Over 3 at UHV



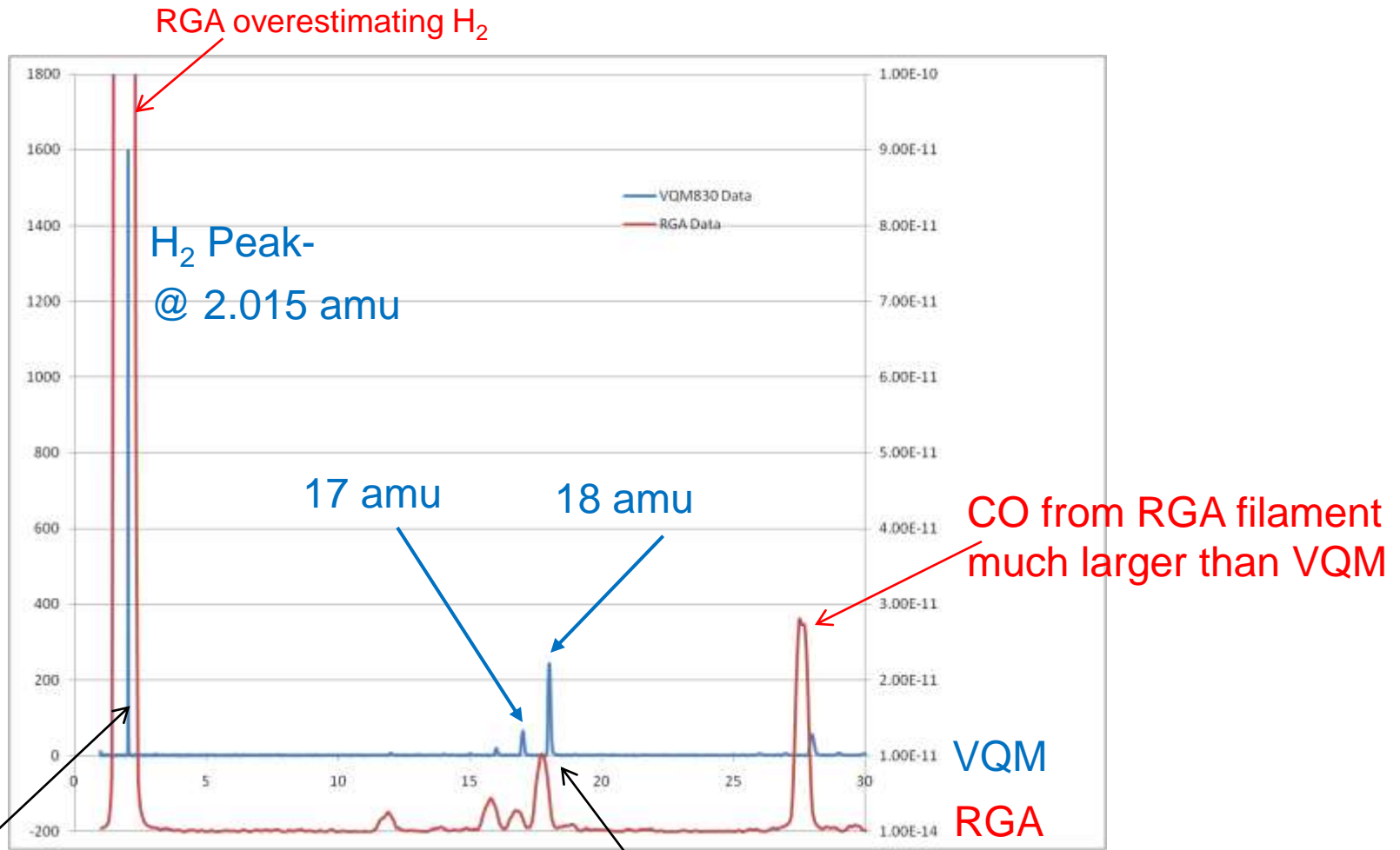


# VQM Advantages at UHV

- Capable of running at extreme vacuum levels
  - Experiments run as low as  $3\text{E-}13$  Torr
  - Can fill the trap at any pressure so performance does not degrade
- Does not over represent  $\text{H}_2$
- Low CO and  $\text{CO}_2$  outgassing
- No  $\text{O}_2$  outgassing
- Can get up to 4 decades dynamic range
- Catches fast transients

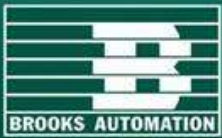


# Waveform Comparison

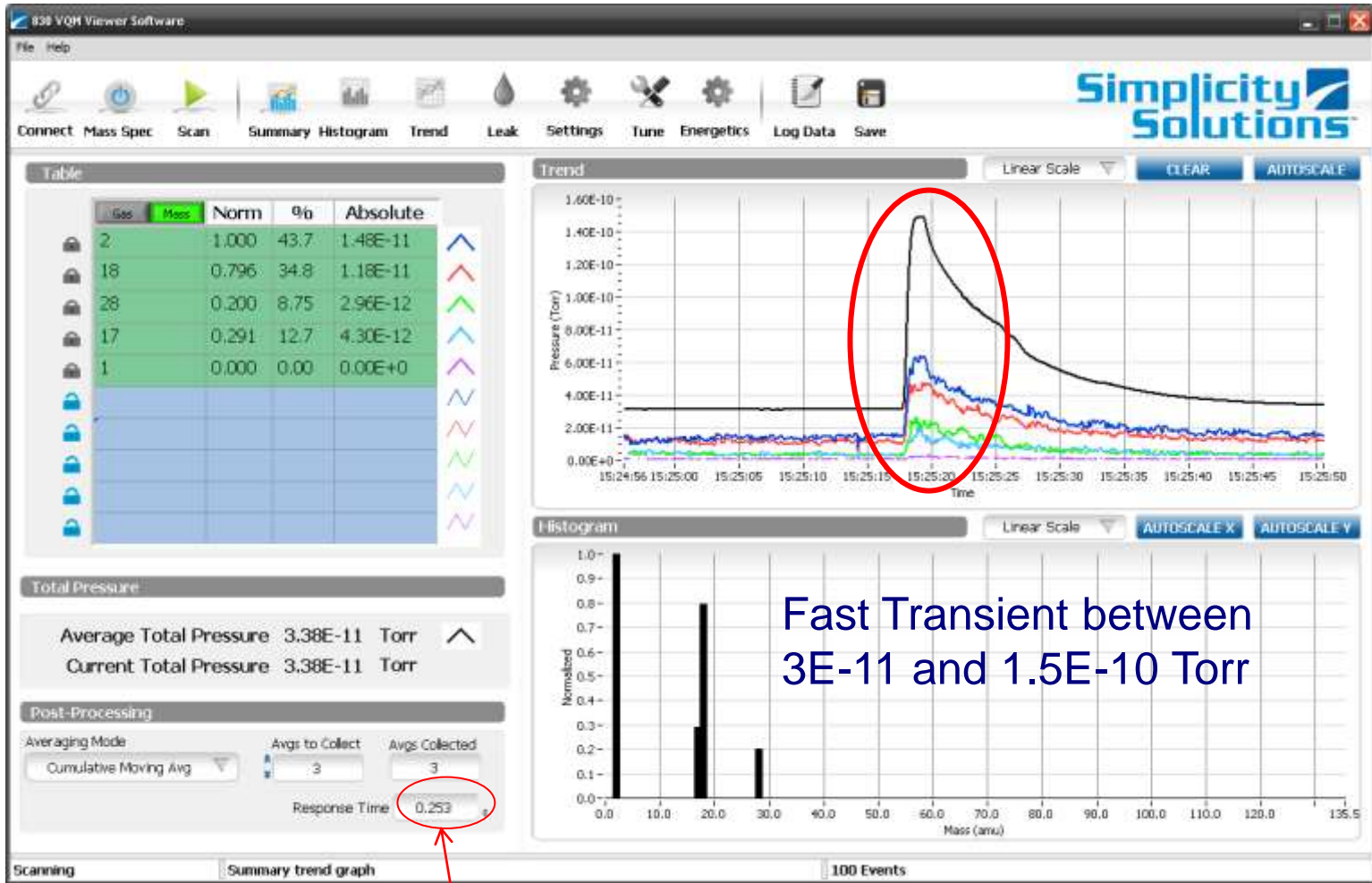


VQM resolution is much better

Waveforms are normalized to water peak

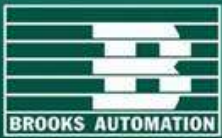


# VQM Sees Fast Transients

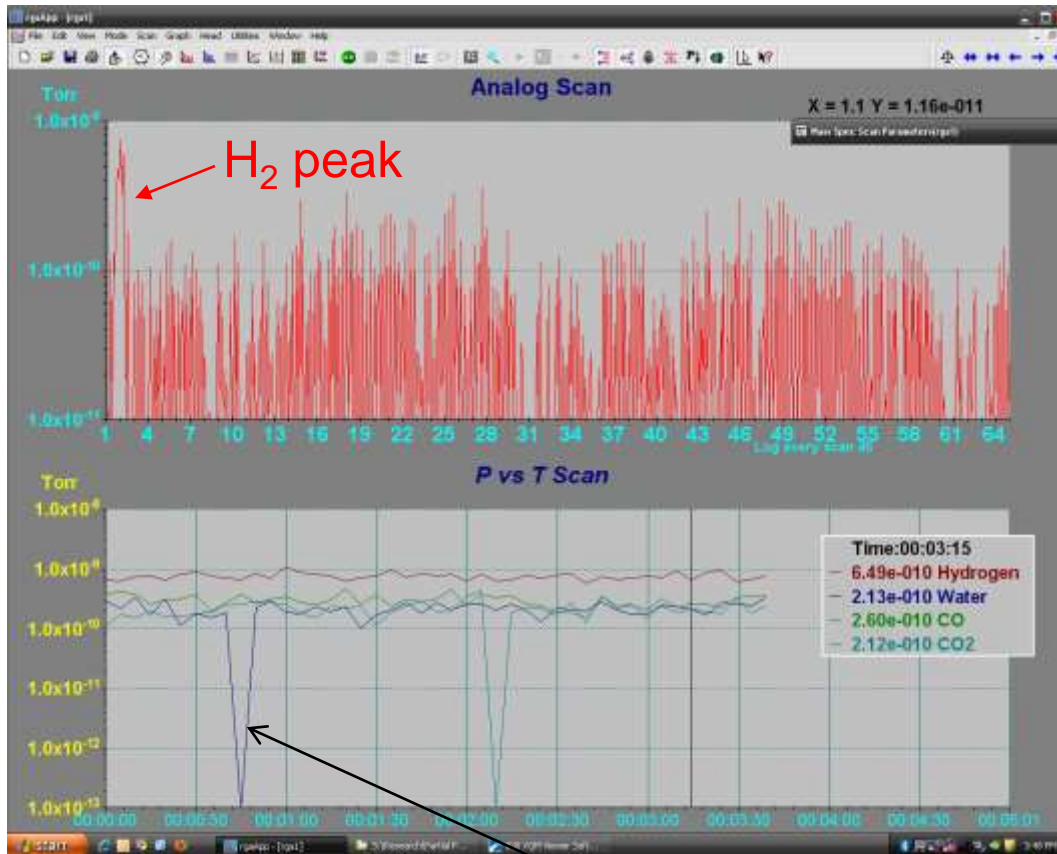


253 msec response time

Transient generated by turning Extractor Gauge filament on



# RGA Misses Fast Transients



■ Transient is below noise level.

■ RGA not fast enough to see transient

SRS RGA:

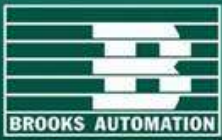
- SS=7
- 4 second scan (135 amu range)
- EM on; Gain:1000X

This is not the transient  
➤ it's a dropout in the water waveform



# Mass Spec Comparison

830	RGA	Feature	Comments
✓		Speed	Scan speed 85 ms vs. 1-3 seconds (for 1-135 amu)
✓		Power	15W vs. 60-70W Max
✓		Calibration	Single gas – very simple calibration
✓		Zero Blast	RGAs have don't filter accurately below 4 amu
✓		Match Controller to Gauge	Any controller can drive any gauge
✓		UHV Performance	VQM has better dynamic range and low outgassing
✓		Cleanliness	RGAs filter ions to poles; 830 clean after a year of use
	✓	Higher Pressures	RGAs with Faraday Cup detectors go up to $10^{-4}$ Torr
	✓	Dynamic Range	Can get 4-8 decades?



# Introducing the 830 Vacuum Quality Monitoring System



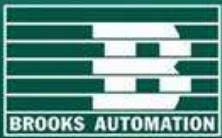
830 VQM Viewer

830 VQM Controller  
830 VQM Gauge



Total Pressure Kit





# 830 VQM Features Summary

## *Highly Differentiated!*

- Fast (Scan time 85ms)
- Full 1-135 amu measurement range
- Large Pressure Range UHV to  $10^{-5}$  Torr
- Unprecedented low power requirements (8W)
- Single point mass axis calibration
- Comprehensive, easy to use viewer
- Small size
- Electronics remote from sensor
- Electronics not paired to the sensor