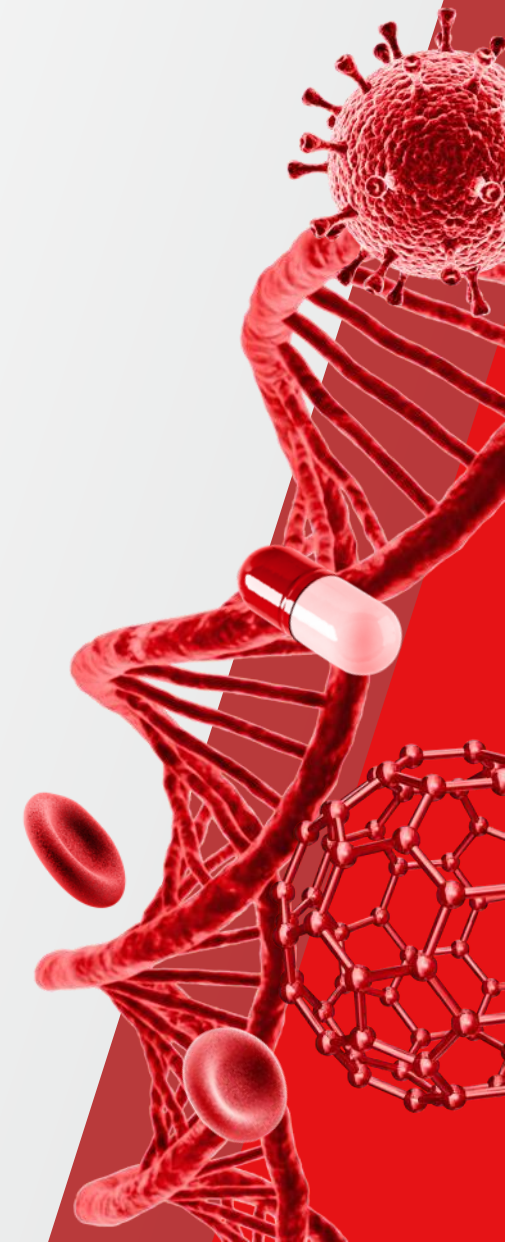




Mastering the Balance of ICP-MS: Sensitivity and Matrix Robustness Without Trade-offs

Christoph Wehe, Tim Elseberg, Hans-Jürgen Schlüter, Norbert Quaas, Benno Straßer, Georgina Thyssen, Lothar Rottmann

 The world leader in serving science



Thermo Scientific™ iCAP™ MX Series ICP-MS

Thermo Scientific™ iCAP™ MSX ICP-MS Thermo Scientific™ iCAP™ MTX ICP-MS



Single quadrupole



Triple quadrupole



Thermo Scientific™ iCAP™ MX Series ICP-MS

- Around 25% of all parts have changed
- Redesigned sample introduction system and interface
 - All new electronics
- IP claims filed for innovative technology



Instruments have lost about 10% weight

iCAP MX Series ICP-MS in a nutshell

- Enhanced sensitivity
- Enhanced matrix robustness
- Ease of use



- How to combine higher sensitivity with higher matrix robustness?!?

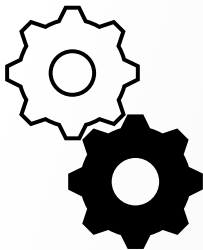
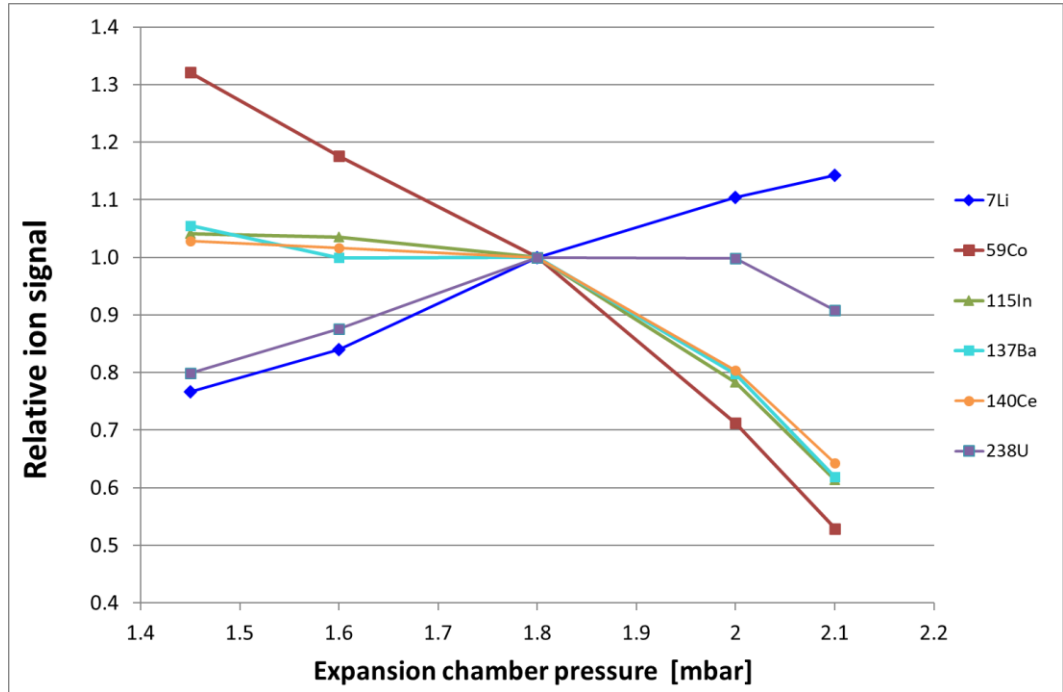
SENSITIVITY  MATRIX EFFECTS 

- Reduce matrix load to the system
- Adapt the system to handle difference matrices

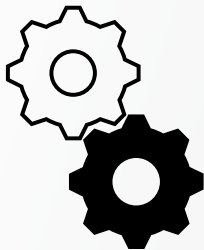
- Areas of improvement
 - Interface between plasma and mass spectrometer
 - Tuning of ion optics
 - Sample introduction and online dilution system

Interface – keeping the pressure?

- **Static vs. adjusted interface pressure**
 - Vacuum inside the interface region of the instrument can be controlled via the pump speed of the fore vacuum pump
 - Strong effect on sensitivity



fixed speed



controllable speed

- Additional benefit - less power consumption

Instrument	Average Energy Usage (kWh) / day	
iCAP MSX	24.7	72%
iCAP MTX	25.6	75%
RQ plus	34.1	100%



Skimmer cone design

One interface for all applications

- **Insert free skimmer cone** – offers flexibility with increased instrument up-time by eliminating need of insert changes
- Variable voltages can be applied to skimmer cone, mimicking the different skimmer inserts
- One interface hardware for all sample types – no manual intervention, minimum inventory
- Automatic and easy switch-over between various applications: Matrix or Sensitivity

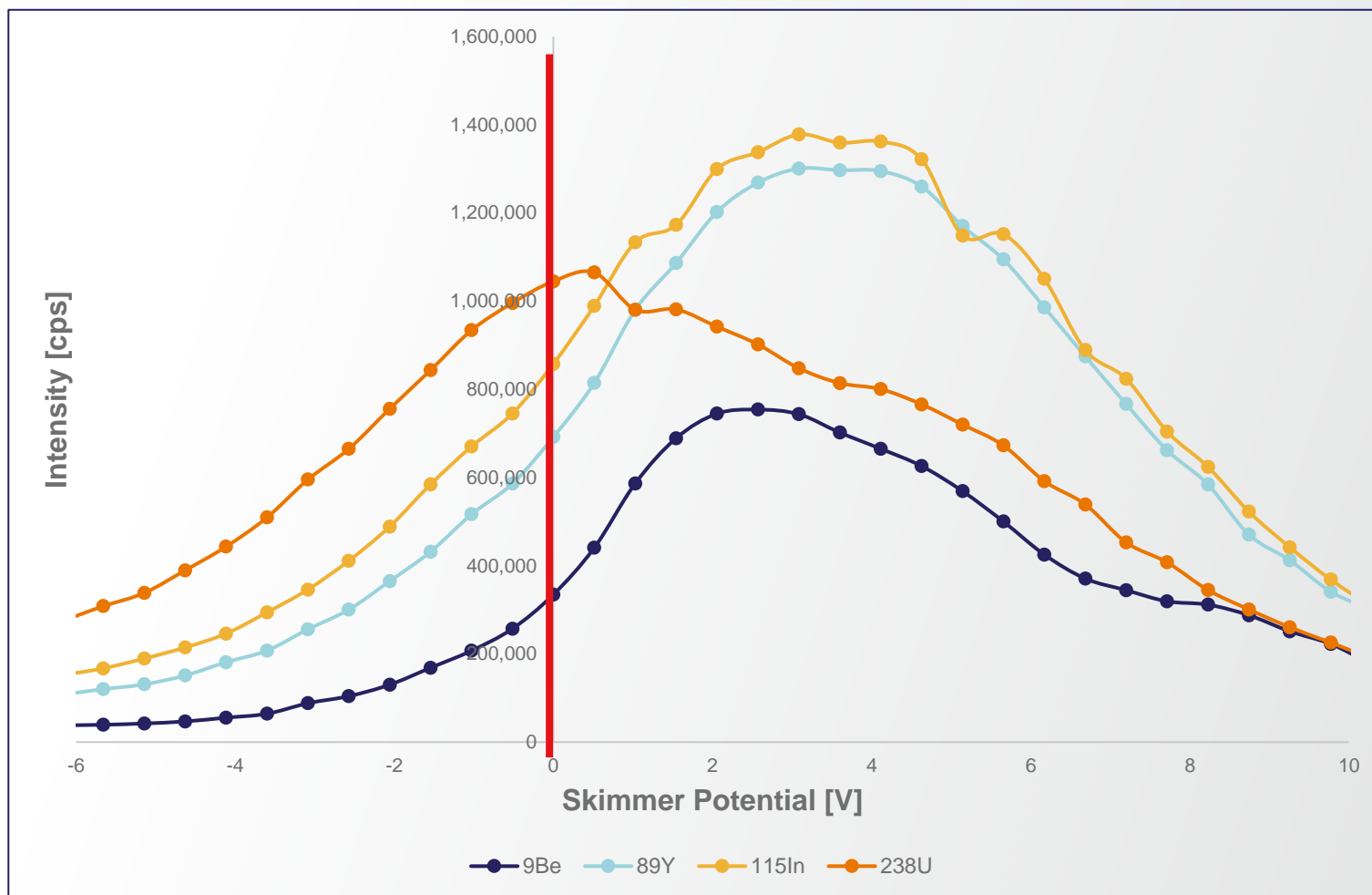


Insert free
skimmer cone

Tailored performance without hardware modifications

Optimized settings for boosting sensitivity

- Rapid pressure drop downstream of the skimmer orifice
- Increased mean free path due to fewer particle collisions
- Higher electron mobility leads to faster diffusion out of the beam than ions
- Net positive charge results in ion beam expansion inside the skimmer (space charge effect)
- Positive skimmer potential induces a radial force directing ions toward the beam axis
- This force counteracts beam expansion caused by the space charge effect

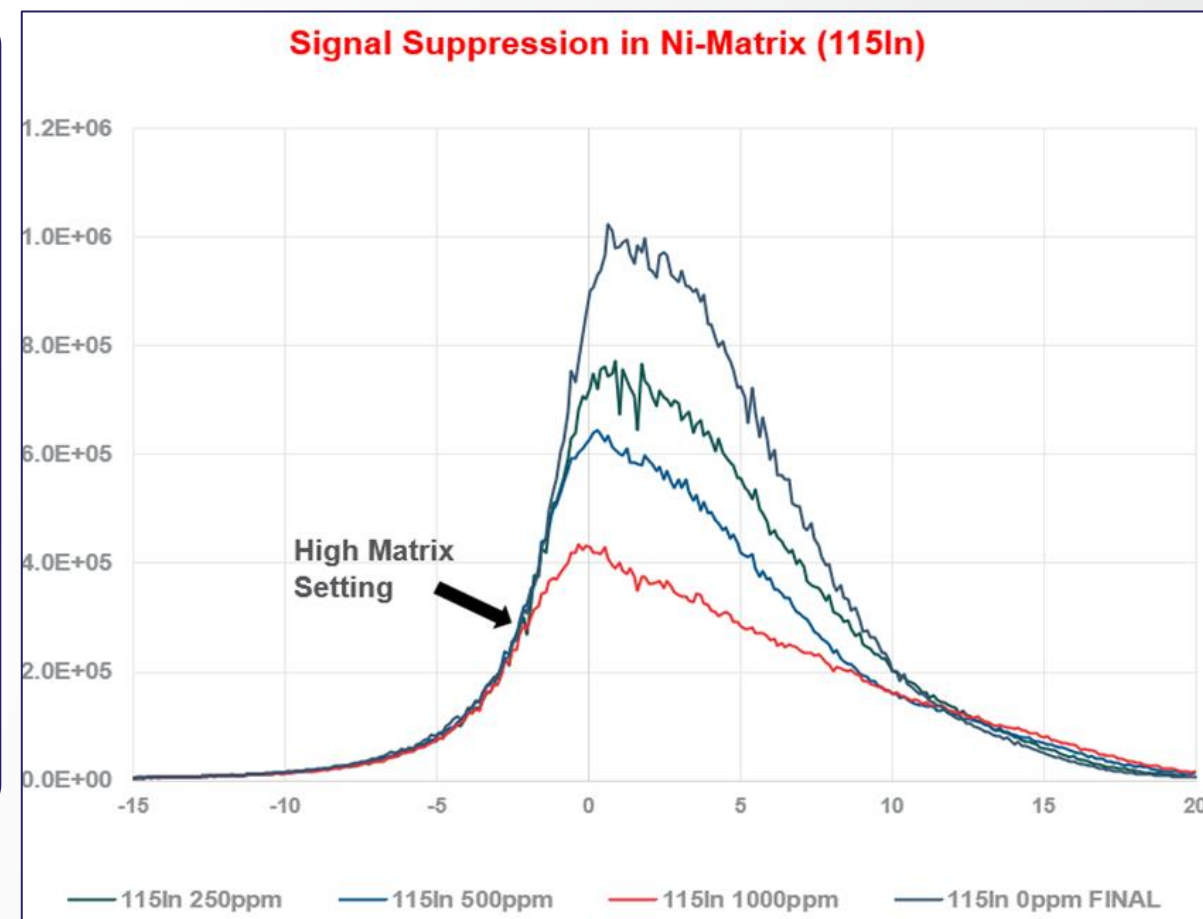


Positive Skimmer potential improves sensitivity

Optimized settings for optimized matrix handling

- Additional matrix ions increase beam expansion due to space charge, leading to higher analyte ion loss (matrix suppression)
- This effect is reduced if the initial ion beam (without matrix) has a larger diameter and is less concentrated on the beam axis
- A negative skimmer potential can achieve this for matrix measurements
- Negative skimmer potential induces a radial force directing ions away from the beam axis → defocusing
- Reduced matrix suppression in case of additional matrix ions (better matrix recovery)

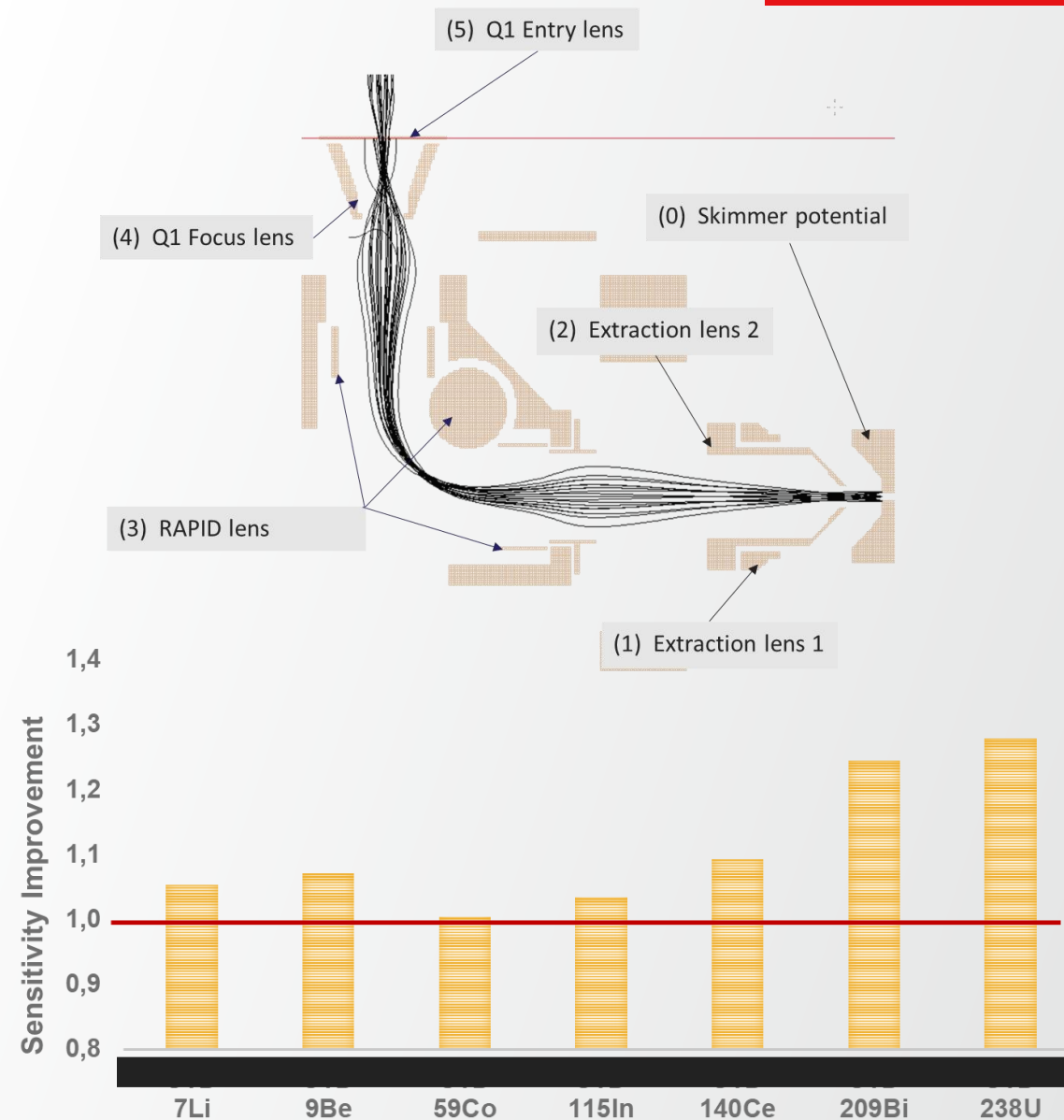
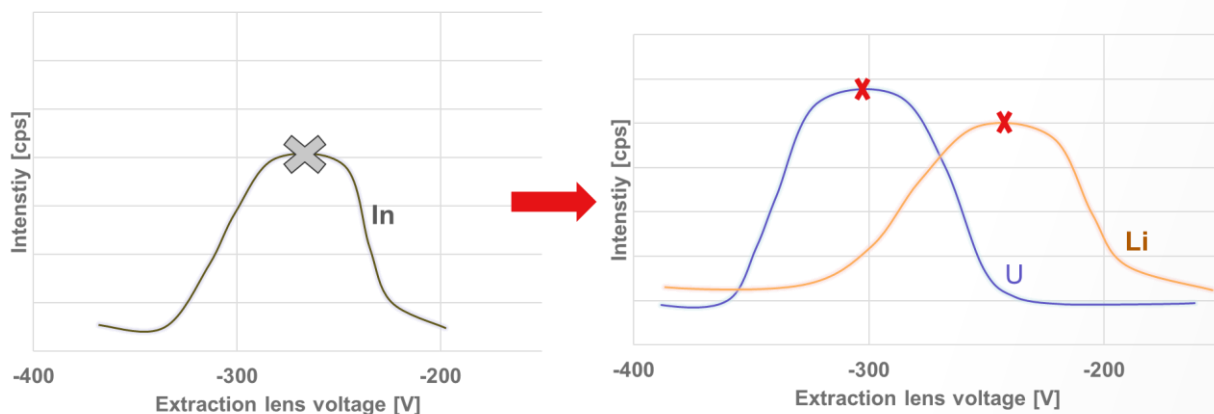
	59Co	38Ar	Ratio
"S-plus"			
1.65 mbar	1127000	3.47E+07	3.3 %
2.0 V			
"M-minus"			
2.17 mbar	109450	1.02E+06	10.7 %
-3.0 V			



Analyte/Interference ratio improves in attenuated beam

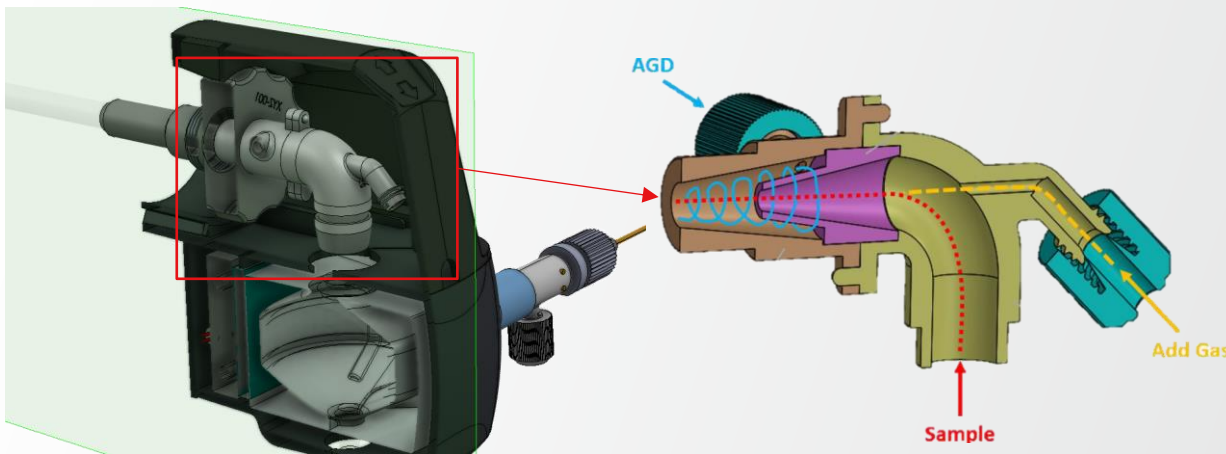
Revisiting ion optics tuning

- Ion optical lens voltages are changed according to desired m/z ratio for optimal transmission of certain mass ranges
 - Tuning across entire mass range setting multiple points across the full range, instead of the typical approach of using one mass and single optimized value
 - Tuned values from 4 to 6 points/masses will be used to calculate polynomial function for the entire mass range

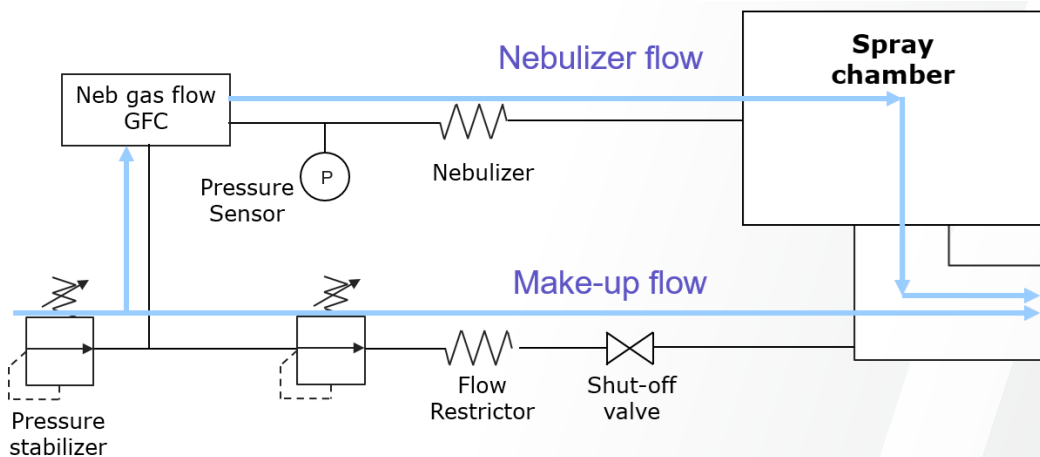


Argon Gas Dilution

- Enables introduction of high matrix samples
- Dilute samples with Argon Gas Dilution
 - No manual dilution necessary, less solvent needed
 - No hardware change required



- AGD introduced via integrated nozzle ensuring tangential argon flow
- Pre-defined gas dilution allows analysis direct analysis of samples with up to 35% total dissolved solids (TDS)

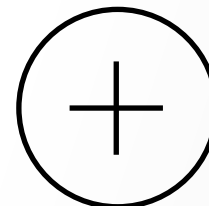


Argon gas dilution

Controlled Interface Vacuum

Skimmer on Potential

Scanning Lenses



- Short dwell times of down to 5 μ s
- Higher linear dynamic range of up to 11 orders of magnitude
- Longer cleaning intervals

- Enhanced sensitivity
- Enhanced matrix robustness
- Ease of Use



Thank you

Come visit our booth for in-depth discussions!

