Update on Q-ACSM Performance and Operation from Aerodyne

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Topics

• Variability of RIE SO4 value observed between different ACSM instruments (as well as AMS systems).
• Non-linear amplifier behavior observed at lowest gain stages.
• Decay of Faraday detector collection efficiency over time.
• Prisma connection stability.
SO4 RIE

- Care should be taken in applying the standard RIE SO4 = 1.2
- Different ACSM are reporting different RIE values for SO4, likely due to “tight” ion extraction geometry associated with the smaller quadrupole system.
- Calibration of SO4 RIE is recommended.
- SO4 calibration procedure will soon be integrated into software.
- RIE SO4 can be estimated from existing data by forcing the NH4 measured-predicted plot to have a slope of unity (using RIE NH4 determined from NO3NH4 calibration). This estimate assumes SO4 is fully neutralized.
One Approach to Measuring SO4 RIE in ACSM

- Measure NH₄NO₃ response factor for RIE_{NH4/NO3}
- Measure DMA size-selected/CPC counted (NH₄)_2SO₄ in MID mode at m/z 15, 16, 17, 48, 64, 80, 81, 98 at a series of concentrations
- Apply RIT correction
- Apply FragTable analysis
- Fit SO₄ signal vs SO₄ mass and NH₄ signal vs NH₄ Mass – take ratio of slopes to calculate RIE_{NH4/SO4}
- RIE_{SO4/NO3} = RIE_{NH4/NO3} / RIE_{NH4/SO4}
- As a bonus: Using this data the CE can also be calculated as (IE_{SO4\_apparent}/IE_{NO3\_apparent})/(RIE_{SO4/NO3}/RIE_{NO3/NO3}) assumes 100% CE for NH₄NO₃
SO$_4$ RIE Measurement

$\text{NH}_4\text{NO}_3$

$\text{RIE}_{\text{NH}_4/\text{NO}_3} = 4.97$

$\text{RIE}_{\text{NH}_4/\text{SO}_4} = 3.78$

$\text{RIE}_{\text{SO}_4/\text{NO}_3} = 1.32$

Have also seen results as low as 0.75 on a different system – need to determine what controls this
Non-linear amplifier behavior

A non-linear behavior in the NO₃ diagnostic plot has been observed.

This is due to the auto ranging amplifier extending into the lower (and not needed) range settings.

This behavior is not limited to NO₃ only.

Can be eliminated by preventing the amplifier from using the lowest ranges via software settings.

The non-linear effect is important but not significant since only the smallest signals are effected. The effect is to under report ion signal intensities.
The Auto-down amplifier setting avoids non-linear behavior

- Same behavior observed for $^{28}\text{N}_2^+/^{29}\text{N}_2^+$
  - Finally convinced ourselves and Pfeiffer this was really just about the amplifier
- Tests have showed that ranges of $10^{-10}$ amp and larger is ok.
- Newest DAQ software has appropriate settings by default.
Faraday signal decay

- We are seeing that the efficiency of ion collection by the Faraday detector decreases with age, likely due to contamination.
- As a result referencing the SEM signal to Faraday signal for multiplier gain determination is not an optimal method.
- An alternate approach is to set the SEM voltage to achieve a fixed N\textsubscript{2} reference signal level of 10^{-7} amps.
Automatic voltage determination for a reference N2 signal

(1x10^-7 amps recommended)

New panel in DAQ software

A quick tune of Heater Bias voltage with automatic determination of signal maximum can also be performed here.
Important Acquisition Software Updates

• Amplifier is automatically configured to not use the lowest (non-linear) gain stages.

• Inactive filter valve switching maybe resolved by introducing a short delay between scans. Prisma connection stability still remains un-resolved.

• New procedure for setting SEM voltage based on maintaining a fixed N2 signal level, no longer based on Faraday signal.
Latest ACSM DAQ software is Version 1.4.3.8

Recommend updating since it addresses most of the issues presented.

Download program and application note AN-004a describing installation from ACSM support site

https://sites.google.com/site/ariacsm/
END
Automatic determination of SEM Voltage and Heater Bias setting

New panel can be accessed from either Scan Parameters form or the Vaporizer and Ionizer form.
Quick tune of Heater Bias voltage with automatic determination of signal maximum