

Optimising Scan Rate in MASsoft or QGA Professional Software

Scan rate can be an important part of experimental set up and can be crucial to improve accuracy or display dynamic changes in gas composition. MASsoft Professional and QGA Professional software, used in default mode, will give data with optimised signal to noise ratio but scan rate can be slower than required. In most circumstances, increases in scan rate will also increase signal to noise ratio but it is possible to improve scan rate without significantly compromising signal to noise.

The scan rate is affected by a number of factors:

1) Settle and Dwell Time

Settle – The time in between a change in mass, to allow electronics to stabilise.

Dwell – The time allowed for a mass to be scanned.

The scan will apply settle first, then dwell.

In MASsoft, settle and dwell can be entered in ms or %. If 'Auto-range' is selected then as the signal increases or decreases across partial pressure ranges, the settle and

dwell will change, to maintain the same level of accuracy. Amplifiers also change to improve accuracy. Tables showing the real values of 100% settle and dwell, depending on the range are detailed below*.

Faraday

Range	High	Low	Settle (ms)	Dwell (ms)
-6	1e-5	1e-6	5	16
-7	1e-6	1e-8	150	10
-8	1e-7	1e-9	250	160
-9	1e-8	1e-9	300	640
-10	1e-9	1e-10	400	2750

SEM

Range	High	Low	Settle (ms)	Dwell (ms)
-7	1e-6	1e-8	5	10
-8	1e-7	1e-9	5	25
-9	1e-8	1e-10	5	64
-10	1e-9	1e-11	150	160
-11	1e-9	1e-11	250	1600
-12	1e-11	1e-12	300	1600
-13	1e-11	1e-13	400	2750

*For systems with 7.15 Firmware

To avoid slow scan rates at low partial pressure the range can be either be set, by deselecting Auto-range, or limited using the range limits. This may give noise at lower signal levels but maintains scan rate. The 'Highest' range must be high enough to cover the highest partial pressure.

If noise is less important, then settle and dwell can be reduced by setting the % values to less than 100%.

In QGA software, although the range amplifiers will change, the settle and dwell times are set. The selection of 'slow', 'normal' or 'fast' for settle and dwell should always be set based on the lowest range at which accurate data is required.

2) Auto Zero

Auto Zero is an option in MASsoft but is always used in QGA software. Auto Zero ensures the signal reaches zero before starting the next scan. It is recommended that it is also used in MASsoft.

Auto-zero takes the length of settle + dwell. The software will attempt Auto Zero and if this fails will try again. It normally takes 2 auto-zero's for zero to be found so for each mass, scan time is (settle + dwell) x 3. The scan applies Auto Zero first, then settle and dwell.

3) The Range and Detector

Certain changes in range or detector introduce a further delay between scans. A table showing the range / detector delay is shown below.

Time for range change across amplifiers and detectors:

From	to	Time (ms)
F6	F7-10	3000
F6	S7-9	363
F6	S10-13	9363
F7-10	F6	500
F7-10	S7-9	863
F7-10	S10-13	6363
S7-9	F6	400
S7-9	F7-10	9400
S7-9	S10-13	3000
S10-13	F6	900
S10-13	F7-10	6400
S10-13	S7-9	500

F6 = Faraday -6, S7-10 = SEM -7 to -10

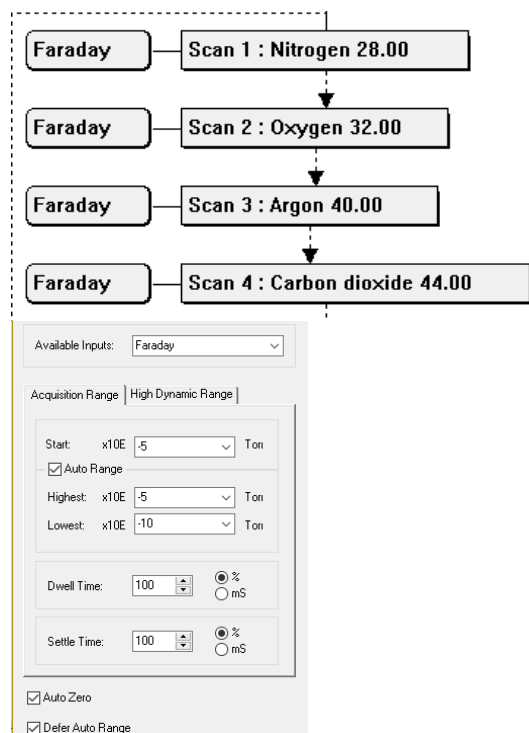
Detectors and ranges should be grouped together to reduce the number of changes within a scan. A delay is still present when moving from the last mass in the scan tree back to the first.

If possible, the same detector should be used. To allow only a single detector to be used during a scan, change partial pressure by changing emission, measuring fragments or using the bypass valve.

By setting the range or range limits it is possible to reduce the number of range changes in the scan. The high range must always be high enough for your highest signal for the particular mass. The low range should not be so low that it introduces a large range change delay. Settle and dwell should be set to ensure the required accuracy at the lowest partial pressure.

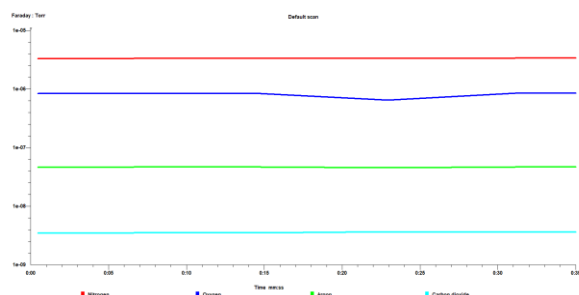
MASsoft Worked Example

- 1) Use default settings to measure air gases.

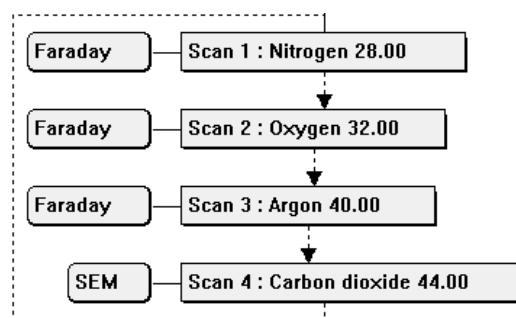


Gives a scan rate of **8.1 seconds/cycle**.

MID Trace of Default Scan: CO₂ Injection at 15s, not measured

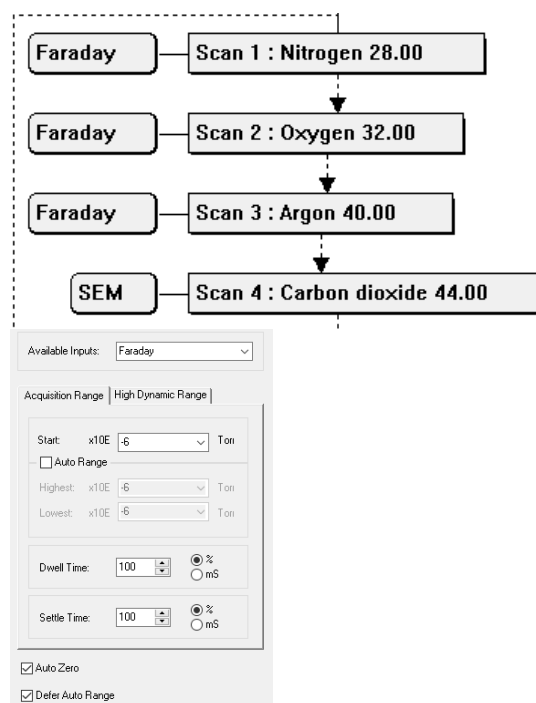


- 2) Carbon Dioxide (1×10^{-9} pp) can be measured using the SEM.



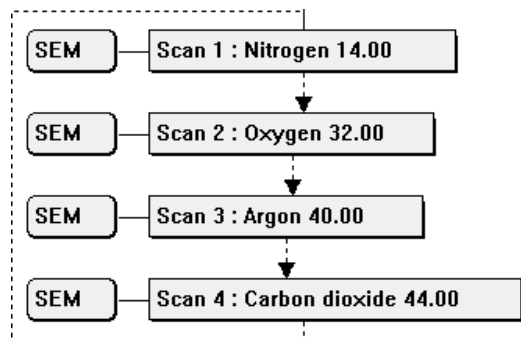
This improves scan rate to **6.3 s/cycle**.

- 3) Nitrogen, Oxygen and Argon can be set to use -6 range, avoiding range change delay.



Improves scan rate to **1.1 s/cycle**.

- 4) Reduce emission and use mass 14 Nitrogen fragment to allow all gases to be measured using the SEM.



Increases scan rate to **4.8 s/cycle**.

- 5) Set range limit for Carbon dioxide to -9, avoiding range change delay.

Available Inputs: SEM

Acquisition Range: High Dynamic Range

Start: x10E -7 Ton

☒ Auto Range

Highest: x10E -7 Ton

Lowest: x10E -9 Ton

Dwell Time: 100 ☒ % ☐ mS

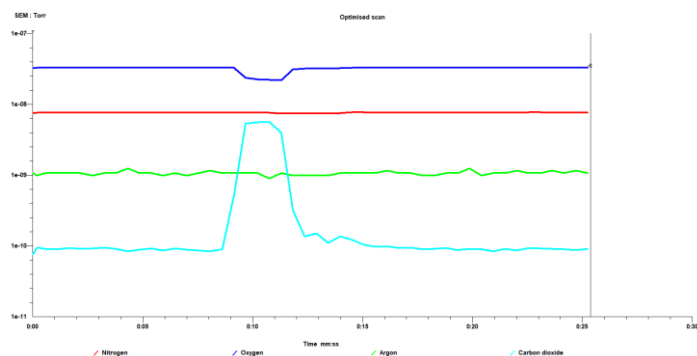
Settle Time: 100 ☒ % ☐ mS

☒ Auto Zero

☒ Defer Auto Range

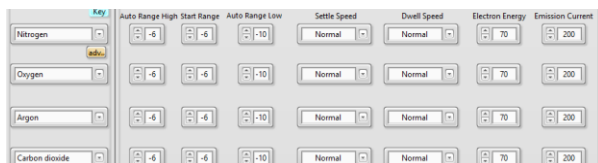
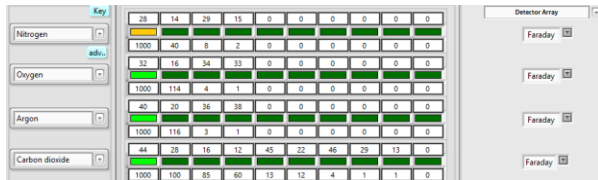
Improves scan rate to **0.5 s/cycle**.

MID trace of Optimised Scan: CO₂ injection at 8s, dynamically measured



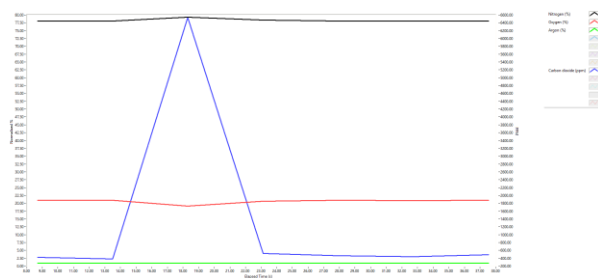
QGA Worked Example

- 1) Use default settings to measure Air gases.

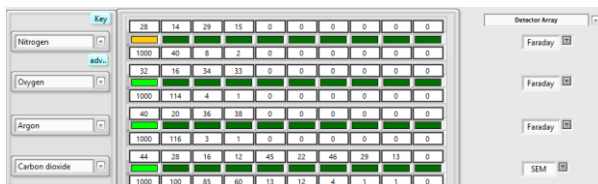


Gives scan rate of 4.8 s/cycle.

MID Trace of Default Scan: CO₂ Injection at 13s, measured as spike

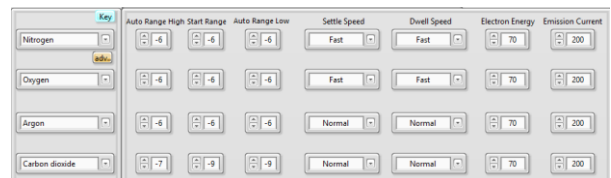


- 2) Carbon Dioxide can be measured using the SEM and range limited to -9.



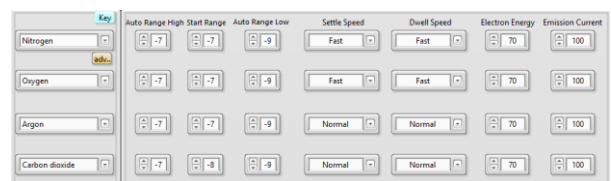
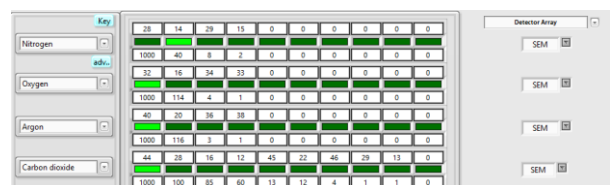
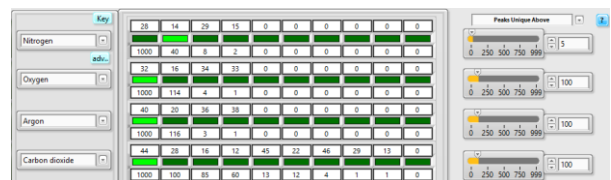
Increases scan rate to 15 s/cycle

- 3) Nitrogen, Oxygen and Argon can be set to use -6 range avoiding range change delay. Settle and Dwell set to 'Fast' for Oxygen and Nitrogen.



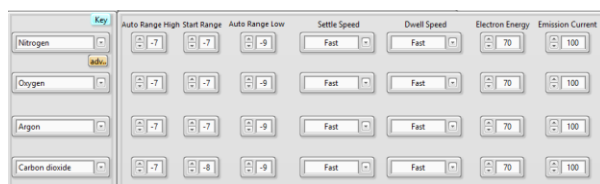
Scan rate improved to 3.2 s/cycle.

- 4) Reduce emission and use mass 14 Nitrogen fragment to allow all gases to be measured using the SEM. Set range limit to -9.



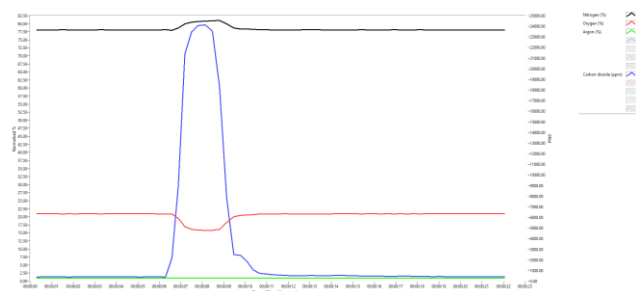
Scan rate improved to 2.5 s/cycle.

5) Set Settle and Dwell to 'Fast' for Argon and Carbon Dioxide.



Scan rate improved to 0.3 s/cycle.

MID trace of Optimised Scan: CO₂ injection at 13s, dynamically measured



Summary

- Select appropriate detector for predicted partial pressure and required accuracy
- Select appropriate range for predicted partial pressure and required accuracy
- Group same detectors and ranges together
- Avoid detector or amplifier range changes
- Use Settle and Dwell to give faster scan rates
- Increase or decrease partial pressures to allow use of the same detectors or limited ranges