Effects of Scan Mode on Peak Size with Varian 240/4000 Ion Trap GCMS

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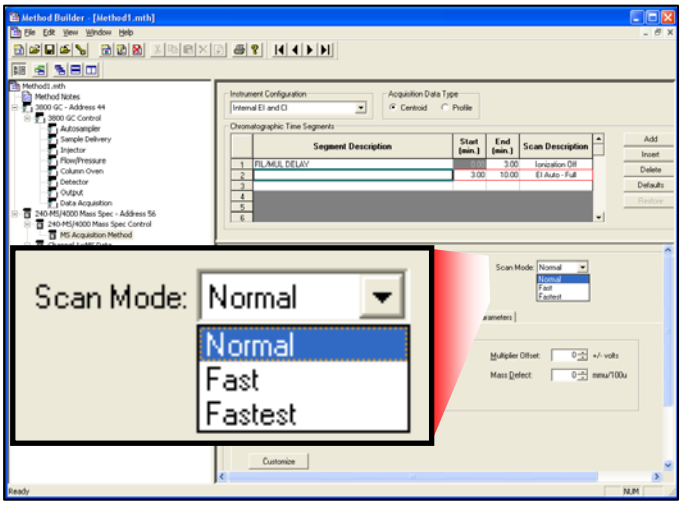
The ionization processes in the Varian 240/4000 GCMS generate ions that are stored and stabilized in the ion trap cavity by an RF field applied to the ring electrode of the trap. To keep the trap from exceeding its maximum storage capacity, when peak resolution and spectral quality would degrade, the Automatic Gain Control (AGC) performs a quick assessment – a Prescan - of the ion load just prior to every µScan. Ionization time is subsequently adjusted to maintain the number of ions at an optimum level. Then the RF voltage is ramped at a constant rate to eject specific ions to the detector to generate the mass spectrum.

This scan rate is selected by the Scan Mode parameter in the MS Workstation method. **Normal** sets the scan rate at 5,000 µ/sec, and **Fast** is 10,000 µ/sec. Both use a prescan to set the ionization time.



For **Fastest**, the ionization time is set by assessing the number of ions from the previous µScan, instead of performing a prescan. This process eliminates several steps in the scan function and permits a faster effective scan rate than with the other modes.

Data rates for Varian Ion Traps are dependent on specific conditions used for the mass spectrometer. Typical conditions for measuring toxic compounds by EPA Methods 524.3, 624B, 8260 and Method TO-15 are employed for the data rate listings below:

Mass Range	35-300 m/z
Steps in Scan Segments	4

Data Rates[4] for Varian 240/4000 GCMS

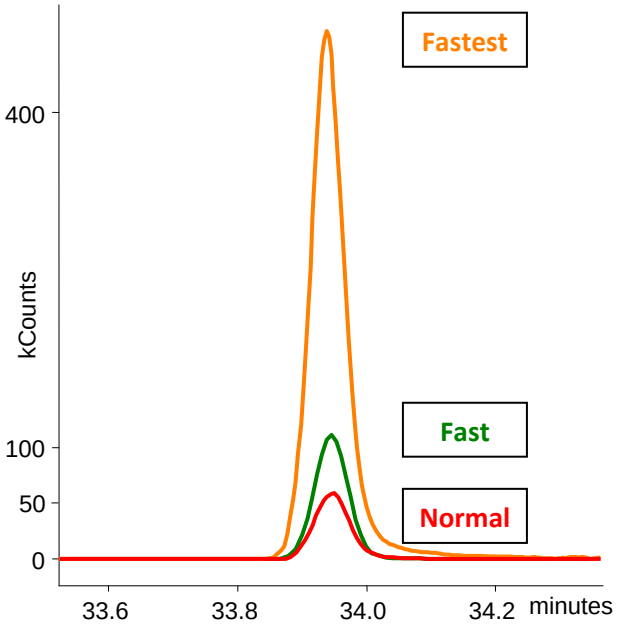
Scan Mode -	Normal		Fast		Fastest	
µScans Averaged	**Scan Time (sec/scan)**	**Data Rate (Hz)**	**Scan Time (sec/scan)**	**Data Rate (Hz)**	**Scan Time (sec/scan)**	**Data Rate (Hz)**
1	0.34	2.94	0.31	3.23	0.08	12.50
2	0.67	1.49	0.62	1.61	0.16	6.25
4	1.34	0.75	1.24	0.81	0.32	3.13
8	2.68	0.37	2.47	0.40	0.63	1.59
16	5.36	0.19	4.94	0.20	1.25	0.80
32	10.71	0.09	9.88	0.10	2.49	0.40
64	21.42	0.05	19.75	0.05	4.98	0.20
89	29.79[1]	0.03	-	-	-	-
97	-	-	29.93[5]	0.03	-	-
99	-	-	-	-	7.70[5]	0.13

[1] These µScans Averaged settings are the maximum allowed values.

When scanning at 10,000 µ/sec with **Fast** mode, the electrometer for the detector measures voltages that are twice the size of **Normal** at 5,000 µ/sec, since voltage is a measure of ejected ions per unit time, and **Fast** is twice the rate of **Normal**. Thus, peak sizes generated with **Fast** will be about twice the size of those generated with **Normal**. MS Workstation does not adjust responses for this enhancement.

Even more dramatic is amplification realized with **Fastest** scan mode. Here, when areas for the same sample are compared, peak sizes increase by nearly a factor of eight, for all choices of µScan Averaging.

Faster data rates do increase noise since less data averaging is taking place. To compensate for this boost in noise, the number of µScans Averaged can be altered, and data points can be smoothed with Mean or Saviksky-Golay functions. Results from the three Scan Modes are compared with a 10 ppbV Benzene peak by choosing these parameters to make the noise level equivalent for all three test cases. **Fast** yields an enhancement near the theoretical factor of 2. **Fastest** shows an improvement in size by a factor of 7.3.



	Scan Modes		
	Normal	**Fast**	**Fastest**
µScans Averaged	2	3	5
Data Rate	1.49 Hz	1.08 Hz	2.56 Hz
S-G Smoothing	5 pts	5 pts	11 pts
Peak Height	60,641	111,552	472,418
Noise	13	14	15
S/N	4,665	8,252	31,495
Peak Area	249,668	419,224	1,834,163
Area Enhancement Factor	--	**1.7**	**7.3**

Comparisons of Scan Modes are made by evaluating results from 10 ppbV Benzene (m/z 78) run under the different modes. Data rates and smoothing are adjusted to give the same noise levels.

Using **Fastest** scan mode, with appropriate µScan averaging and smoothing, will improve operations by either allowing a reduction of emission current (for longer filament life), reduced sample on-column injection loadings, or improved detection limits with the larger peaks.

The trade-off occurs when huge peaks can saturate the detector and its associated analog-to-digital converter (ADC) more frequently with **Fast** and **Fastest** modes, than with **Normal**. Large peaks that show up correctly with **Normal** may have their upper reaches flattened from overload with **Fast** and **Fastest** scan modes, and could give inaccurate responses as a result.

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