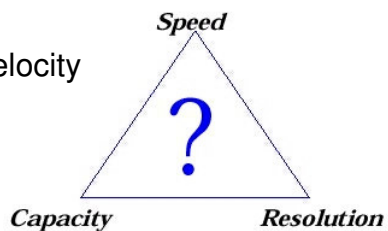


## Practical Faster GC Applications with High-Efficiency GC Columns and Method Translation Software

### Variables for Shortening Run Times

- Stationary Phase
- Shorten Column Length
- Decrease Internal Diameter
- Temperature Programming
- Carrier Gas: type and linear velocity



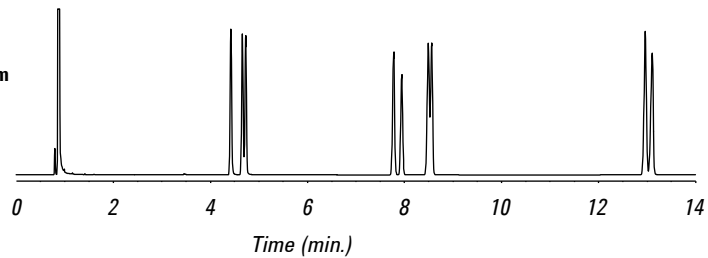
## Resolution

$$R_s = \frac{\sqrt{N}}{4} \left( \frac{k}{k+1} \right) \left( \frac{\alpha-1}{\alpha} \right)$$

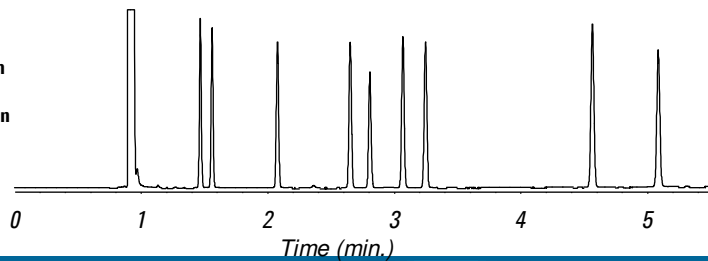
Efficiency	$N = f$ (gas, L, $r_c$ )	L = Length
Retention	$k = f$ (T, $d_f$ , $r_c$ )	$r_c$ = column radius $d_f$ = film thickness
Selectivity	$\alpha = f$ (T, phase)	T = temperature

## Start with the Right Phase

**DB-1**  
15m x 0.32mm, 0.25 $\mu$ m  
Oven:  
40°C for 2 min  
40-120°C at 5°C/min



**DB-Wax**  
15m, 0.32mm, 0.25 $\mu$ m  
Oven:  
80-190°C at 20°C/min



## Resolution

$$R_s = \frac{\sqrt{N}}{4} \left( \frac{k}{k+1} \right) \left( \frac{\alpha-1}{\alpha} \right)$$

Efficiency	$N = f (L, r_c)$	L = Length
Retention	$k = f (T, d_f, r_c)$	$r_c$ = column radius $d_f$ = film thickness
Selectivity	$\alpha = f (T, \text{phase})$	T = temperature

## Column Length and Efficiency (Theoretical Plates)

Length (m)	n
15	69,450
30	138,900
60	277,800

0.25 mm ID  
 $n/m = 4630$  (for  $k = 5$ )

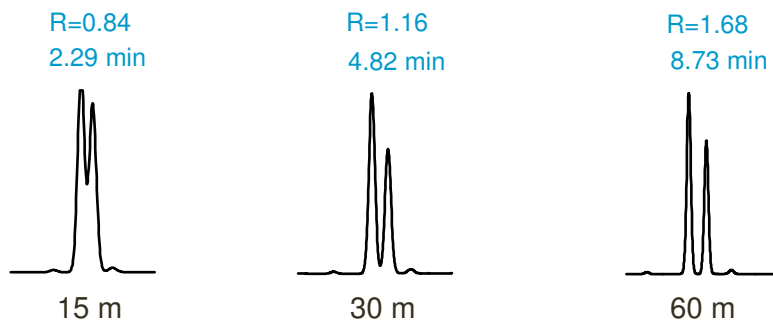
## Column Length and Resolution

$$R \propto \sqrt{n} \propto \sqrt{L}$$

Length X 4 = Resolution X 2

$$t \propto L$$

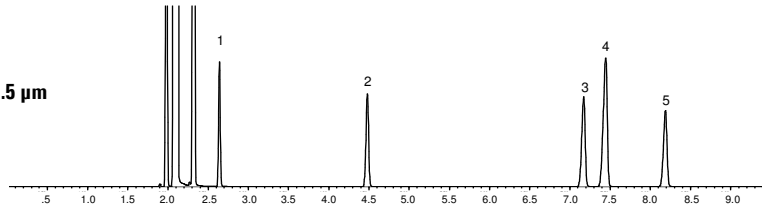
## Column Length VS Resolution and Retention: Isothermal



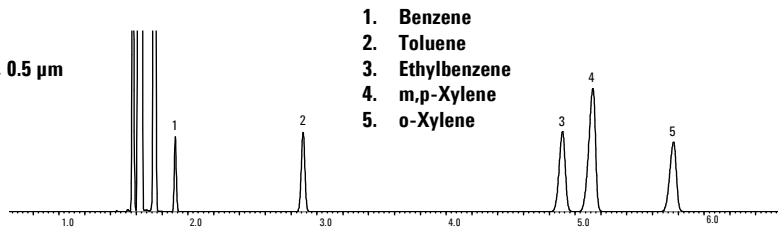
Double the plates, double the time  
but not double the resolution

## DECREASE THE LENGTH

DB-5  
30 m  
0.53 mm I.D., 0.5 µm



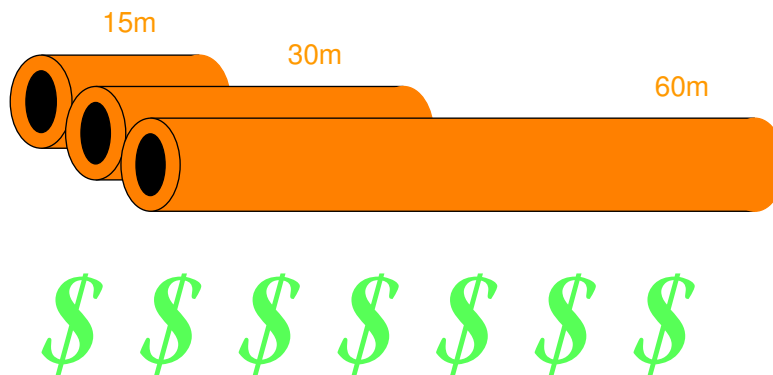
DB-5  
15 m  
0.53 mm I.D., 0.5 µm



1. Benzene
2. Toluene
3. Ethylbenzene
4. m,p-Xylene
5. o-Xylene

BTEX  
Carrier: Helium, 36 cm/sec at 40°C  
Oven : 40°C for 3 min, 5°/min to 100°C

## Column Length and Cost



## Length Summary

### If you Decrease Length:



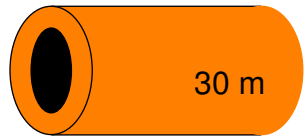
Efficiency	Decrease
Resolution	Decrease
Analysis Time	Decrease
Pressure	Decrease
Cost	Decrease

## Resolution

$$R_s = \frac{\sqrt{N}}{4} \left( \frac{k}{k+1} \right) \left( \frac{\alpha-1}{\alpha} \right)$$

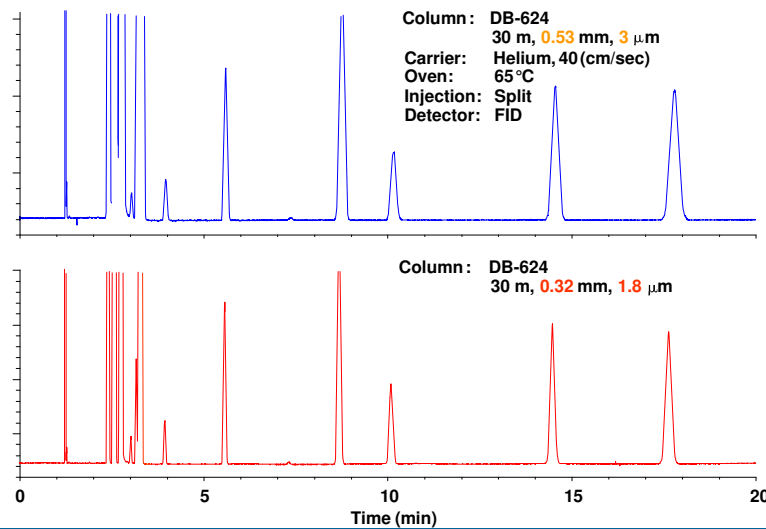
Efficiency	$N = f(\text{gas}, L, r_c)$	L = Length
Retention	$k = f(T, d_f, r_c)$	$r_c$ = column radius $d_f$ = film thickness
Selectivity	$\alpha = f(T, \text{phase})$	T = temperature

## Column Diameter - Theoretical Efficiency

	Total Plates	I.D. (mm)	n/m
 5 m	N ~ 112,000	0.05	23,160
 10 m	N ~ 112,000	0.10	11,580
<hr style="border-top: 1px dashed #ff0000;"/>			
 20 m	N ~ 112,000	0.20	5830
 30 m	N ~ 112,000	0.25	4630
		0.32	3660
		0.45	2840
		0.53	2060

k = 5

## Different Column I. D. Equal Phase Ratios



## PHASE RATIO ( $\beta$ )

### Film Thickness

<u>Column Dimensions</u>	<u>Phase Ratio <math>\beta</math></u>
30 m x .53 mm x 3.0 $\mu$ m	44
30 m x .32 mm x 1.8 $\mu$ m	44

$$K_C = k \beta$$

$$\beta = \frac{r}{2d_f}$$

## Column Diameter and Capacity

<u>I.D. (mm)</u>	<u>Capacity (ng)</u>
0.05	1-2
0.10	6-13
<hr style="border-top: 1px dashed #ff0000;"/>	
0.18	25-55
0.20	35-70
0.25	80-160
0.32	110-220
0.45	600-800
0.53	1000-2000

Like Polarity  
Phase/Solute  
0.25  $\mu$ m film thickness

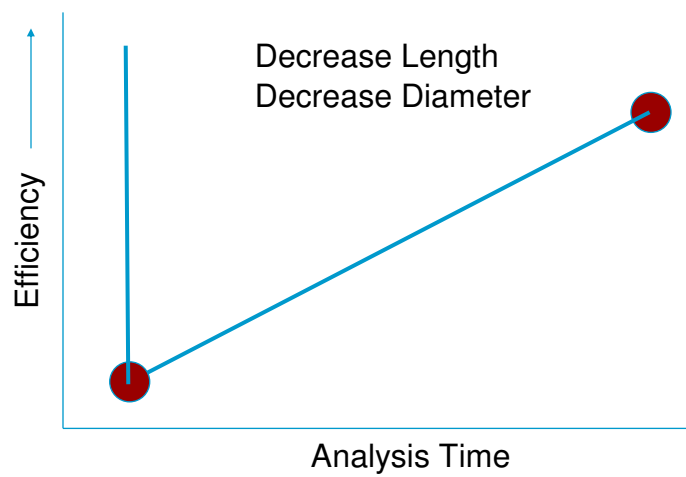


## Diameter Summary

If you decrease the inside diameter:

Efficiency	Increase
Resolution	Increase
Pressure	Increase
Capacity	Decrease
Flow rate	Decrease

## Combining a change in Length with a change in Diameter



## Resolution

$$R_s = \frac{\sqrt{N}}{4} \left( \frac{k}{k+1} \right) \left( \frac{\alpha-1}{\alpha} \right)$$

Efficiency	$N = f$ (gas, L, $r_c$ )	L = Length
Retention	$k = f$ (T, $d_f$ , $r_c$ )	$r_c$ = column radius $d_f$ = film thickness
Selectivity	$\alpha = f$ (T, phase)	T = temperature

## Carrier Gas Considerations Best velocity?

Optimal range of velocities

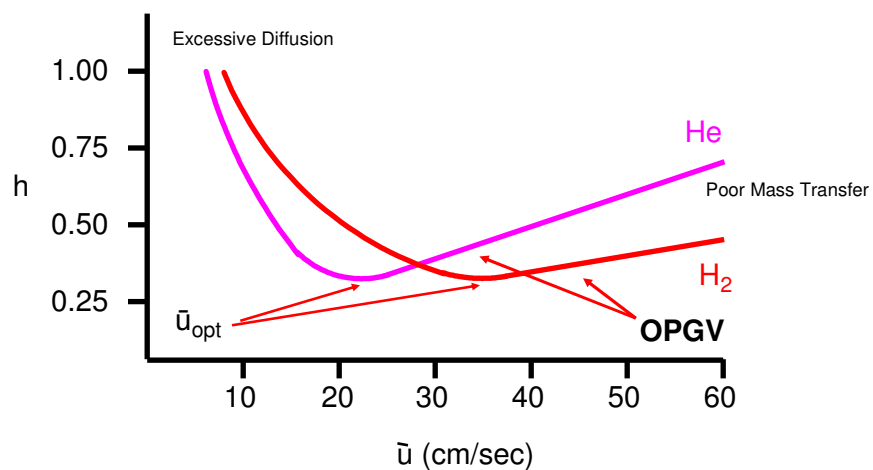
Too low or high results in loss of resolution

Balance resolution and analysis time

**BUT... there is no LAW against going FASTER**

## Carrier Gas Considerations

### Van Deemter Curve



## Carrier Gas - Hydrogen Comments

Hydrogen is extremely diffusive in air

Difficult to reach explosive level of ~4 %

Most GC's flow regulated with safety shutdown

Spring loaded/Explosion proof doors

## Carrier Gas Considerations Utilizing Computer Controlled Flow Ramping (EPC)

Lonely Late Eluters? = P



Decrease retention and overall run time by  
**increasing pressure** (speed up the gas!)

## Easy Options with Method Translation Software

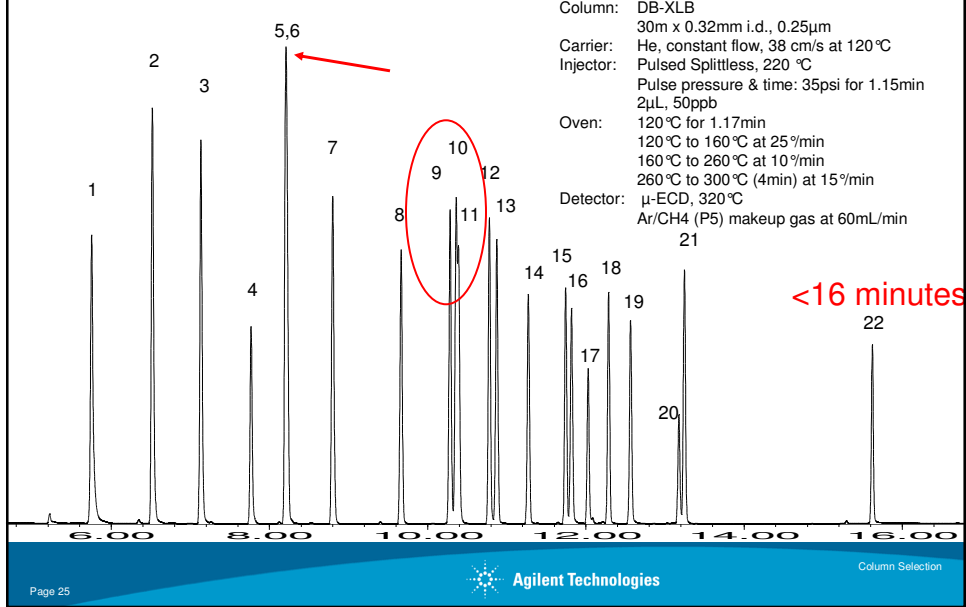
Different Column Dimensions

Switch He to H<sub>2</sub> Carrier Gas and Try Faster Velocities

Same Column & Gas Type but Faster Velocities

Combination of all of the above

## CLP-Pesticides - Original "Improved" Method 0.32mm I.D., Helium Carrier Gas



## Input Original Method Parameters

GC Method Translation - EPACLP.MXD

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None [Speed gain: 1.17407]

Parameter	Original Method	Translated Method																																				
Column Length, Internal Diameter	30 m, 320 $\mu$ m	<input checked="" type="checkbox"/> 30 m, <input checked="" type="checkbox"/> 320 $\mu$ m																																				
Film Thickness, Phase Ratio	0.25 $\mu$ m, 320.0	<input checked="" type="checkbox"/> 0.25 $\mu$ m, <input checked="" type="checkbox"/> 320.0																																				
Carrier Gas	Helium	<input type="checkbox"/> Helium																																				
Head Pressure	12.786 psi	15.126 psi																																				
Flow Rate	2.0502 mLn/min	2.5600 mLn/min																																				
Outlet Velocity	56.20 cm/sec	70.17 cm/sec																																				
Average Velocity	38 cm/sec	44.61 cm/sec																																				
Hold-up Time	1.31579 min	1.12070 min																																				
Outlet Pressure (absolute)	14.696 psi	<input type="checkbox"/> 14.696 psi																																				
Ambient Pressure (absolute)	14.696 psi	<input type="checkbox"/> 14.696 psi																																				
Oven Temperature	3-ramp Program																																					
	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th><math>^{\circ}</math>C/min</th> <th><math>^{\circ}</math>C</th> <th>min</th> </tr> </thead> <tbody> <tr> <td>Initial</td> <td>120</td> <td>1.17</td> </tr> <tr> <td>Ramp 1</td> <td>25</td> <td>160 0</td> </tr> <tr> <td>Ramp 2</td> <td>10</td> <td>260 0</td> </tr> <tr> <td>Ramp 3</td> <td>15</td> <td>300 4</td> </tr> </tbody> </table>	Ramp Rate	Final Temp.	Final Time	$^{\circ}$ C/min	$^{\circ}$ C	min	Initial	120	1.17	Ramp 1	25	160 0	Ramp 2	10	260 0	Ramp 3	15	300 4	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th><math>^{\circ}</math>C/min</th> <th><math>^{\circ}</math>C</th> <th>min</th> </tr> </thead> <tbody> <tr> <td></td> <td>120</td> <td>0.997</td> </tr> <tr> <td></td> <td>29.352</td> <td>160 0.000</td> </tr> <tr> <td></td> <td>11.741</td> <td>260 0.000</td> </tr> <tr> <td></td> <td>17.611</td> <td>300 3.407</td> </tr> </tbody> </table>	Ramp Rate	Final Temp.	Final Time	$^{\circ}$ C/min	$^{\circ}$ C	min		120	0.997		29.352	160 0.000		11.741	260 0.000		17.611	300 3.407
Ramp Rate	Final Temp.	Final Time																																				
$^{\circ}$ C/min	$^{\circ}$ C	min																																				
Initial	120	1.17																																				
Ramp 1	25	160 0																																				
Ramp 2	10	260 0																																				
Ramp 3	15	300 4																																				
Ramp Rate	Final Temp.	Final Time																																				
$^{\circ}$ C/min	$^{\circ}$ C	min																																				
	120	0.997																																				
	29.352	160 0.000																																				
	11.741	260 0.000																																				
	17.611	300 3.407																																				
Sample Information	None																																					

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## Same Column and Gas Type Fast Analysis (OPGV)

GC Method Translation - EPACLP.MXD

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None Speed gain: 1.17407

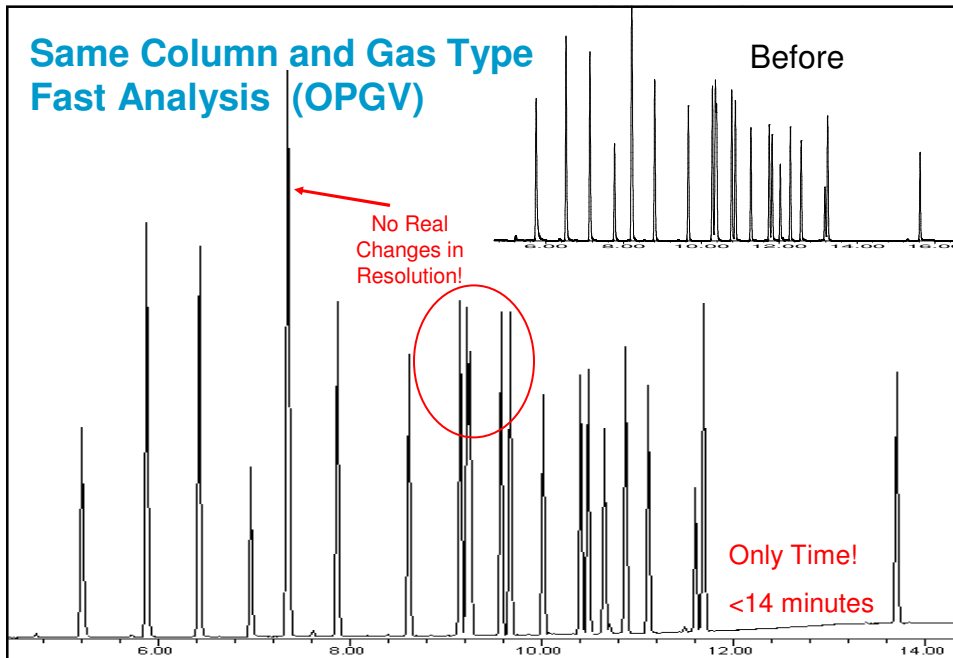
		Original Method	Translated Method				
Column Length,	m	30	<input checked="" type="checkbox"/> 30				
Internal Diameter,	µm	320	<input checked="" type="checkbox"/> 320				
Column Film Thickness,	µm	0.25	<input type="radio"/> Unlock				
Phase Ratio		320.0	<input checked="" type="radio"/> 0.25				
Carrier Gas		Helium	Helium				
Enter one Setpoint							
Head Pressure,	psi	12.786	15.126				
Flow Rate,	mL/min	2.0502	2.5600				
Outlet Velocity,	cm/sec	56.20	70.17				
Average Velocity,	cm/sec	38	44.61				
Hold-up Time,	min	1.31579	1.12070				
Outlet Pressure (absolute),	psi	14.696	<input type="checkbox"/> 14.696				
Ambient Pressure (absolute),	psi	14.696	<input type="checkbox"/> 14.696				
Oven Temperature 3-ramp Program							
		Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
		°C/min	°C	min	°C/min	°C	min
Initial			120	1.17		120	0.997
Ramp 1		25	160	0	29.352	160	0.000
Ramp 2		10	260	0	11.741	260	0.000
Ramp 3		15	300	4	17.611	300	3.407
Sample Information		None					

Transfer same dimensions

New Velocity

New Temp. Program

## Same Column and Gas Type Fast Analysis (OPGV)



## Same Column and Gas type None mode, Try higher velocities

GC Method Translation - EPAQLP.MXD

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None | Speed gain: 1.31579 | Speed gain: 1.71053 | Speed gain: 2.10526

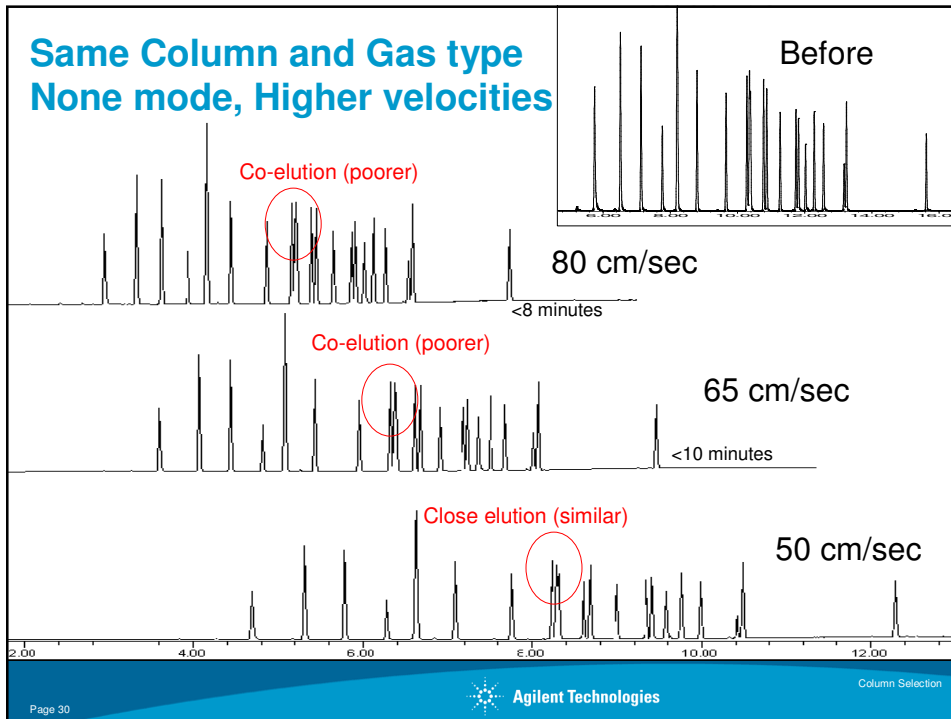
	Original Method	Translated Method	Translated Method	Translated Method
Column Length, m	30	<input checked="" type="checkbox"/> 30	<input checked="" type="checkbox"/> 30	<input checked="" type="checkbox"/> 30
Internal Diameter, $\mu\text{m}$	320	<input checked="" type="checkbox"/> 320	<input checked="" type="checkbox"/> 320	<input checked="" type="checkbox"/> 320
Film Thickness, $\mu\text{m}$	0.25	<input type="radio"/> Unlock <input type="radio"/> 0.25	<input type="radio"/> Unlock <input type="radio"/> 0.25	<input type="radio"/> Unlock <input type="radio"/> 0.25
Phase Ratio	320.0	<input type="radio"/> 320.0	<input type="radio"/> 320.0	<input type="radio"/> 320.0
Carrier Gas	Helium	<input type="checkbox"/> Helium <input type="radio"/> Unlock	<input type="checkbox"/> Helium <input type="radio"/> Unlock	<input type="checkbox"/> Helium <input type="radio"/> Unlock
Enter one Setpoint Head Pressure, psi	12.786	<input type="radio"/> 17.057	<input type="radio"/> 22.554	<input type="radio"/> 28.205
Flow Rate, mL/min	2.0502	<input type="radio"/> 3.0121 <input type="radio"/> 82.57	<input type="radio"/> 4.4541 <input type="radio"/> 122.10	<input type="radio"/> 6.1761 <input type="radio"/> 169.30
Outlet Velocity, cm/sec	56.20	<input type="radio"/> 50 <input type="radio"/> 1.00000	<input type="radio"/> 65 <input type="radio"/> 0.769231	<input type="radio"/> 80 <input type="radio"/> 0.625000
Average Velocity, cm/sec	38			
Hold-up Time, min	1.31579			
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696
Oven Temperature   3-ramp Program				
	Ramp Rate	Final Temp.	Final Time	
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	
Initial	120	1.17		
Ramp 1	25	160	0	32.895 160 0.000
Ramp 2	10	260	0	13.158 260 0.000
Ramp 3	15	300	4	19.737 300 3.040
				42.763 160 0.000
				17.105 260 0.000
				25.658 300 2.338
				52.632 160 0.000
				21.053 260 0.000
				31.579 300 1.900

Sample Information: None

**New calculated temp. program**

Agilent Technologies | Column Selection

## Same Column and Gas type None mode, Higher velocities



## Same Column, Hydrogen Carrier Gas Translate Only

GC Method Translation - EPACLP.MXD

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None Speed gain: 1.42668

	Original Method	Translated Method				
Column Length, m	30	<input checked="" type="checkbox"/> 30				
Internal Diameter, $\mu\text{m}$	320	<input checked="" type="checkbox"/> 320				
Film Thickness, $\mu\text{m}$	0.25	<input type="checkbox"/> Unlock				
Phase Ratio	320.0	<input type="checkbox"/> 0.25				
		<input type="checkbox"/> 320.0				
Carrier Gas	Helium	<b>Hydrogen</b>				
Enter one Setpoint						
Head Pressure, psi	12.786	8.110				
Flow Rate, mL/min	2.0502	2.5628				
Outlet Velocity, cm/sec	56.20	70.25				
Average Velocity, cm/sec	38	<b>54.21</b>				
Hold-up Time, min	1.31579	0.922272				
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696				
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696				
Oven Temperature 3-ramp Program						
	Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min
Initial		120	1.17		120	0.820
Ramp 1	25	160	0	35.667	160	0.000
Ramp 2	10	260	0	14.267	260	0.000
Ramp 3	15	300	4	21.400	300	2.804

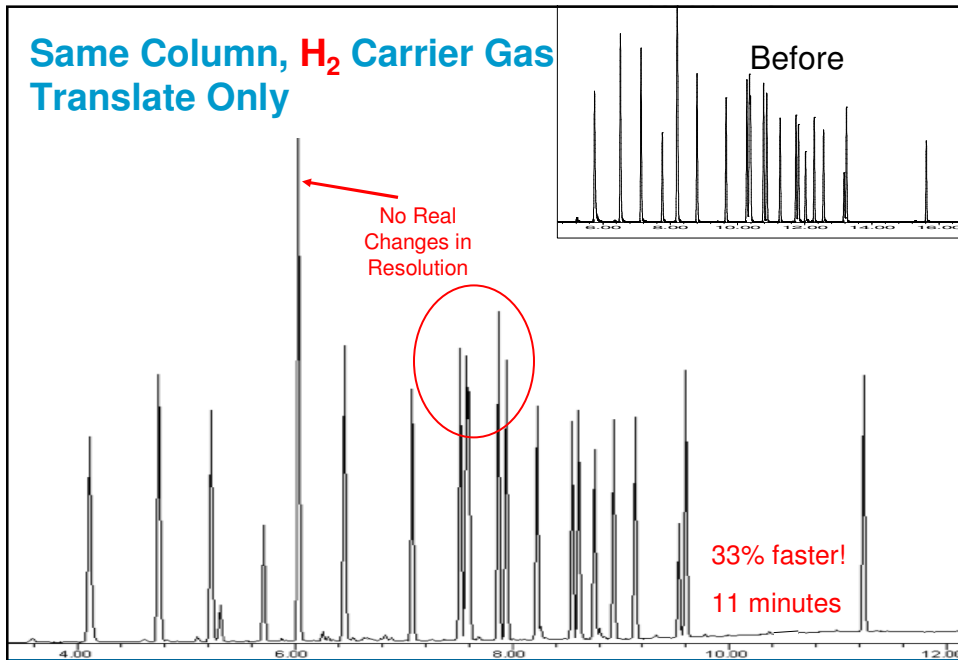
Sample Information None

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Column Selection

## Same Column, H<sub>2</sub> Carrier Gas Translate Only



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Column Selection



## Same Column, H<sub>2</sub> Carrier Gas, Higher Velocities

GC Method Translation - EPACLP.MXD

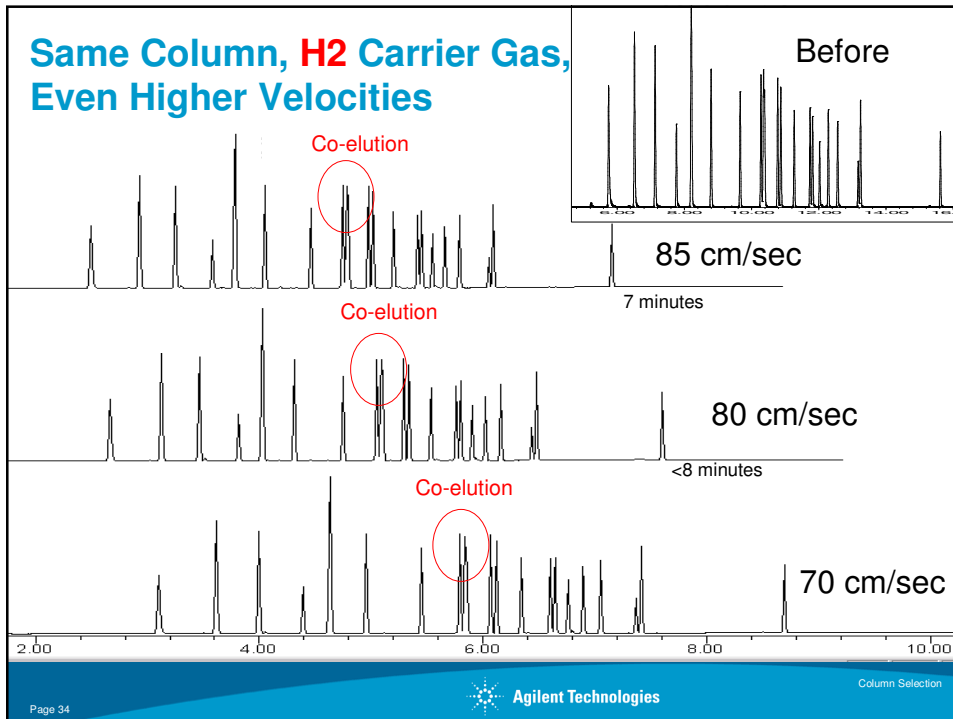
Criterion:  Translate Only  Best Efficiency  Fast Analysis  None

Speed gain: 1.84211 | Speed gain: 2.10526 | Speed gain: 2.23684

	Original Method	Translated Method	Translated Method	Translated Method
<b>Column</b>				
Length, m	30.00	<input checked="" type="checkbox"/> 30.00	<input checked="" type="checkbox"/> 30.00	<input checked="" type="checkbox"/> 30.00
Internal Diameter, $\mu\text{m}$	320.0	<input checked="" type="checkbox"/> 320.0	<input checked="" type="checkbox"/> 320.0	<input checked="" type="checkbox"/> 320.0
Film Thickness, $\mu\text{m}$	0.250	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.250	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.250	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.250
Phase Ratio	320.0	<input type="radio"/> 0.250 <input checked="" type="radio"/> 320.0	<input type="radio"/> 0.250 <input checked="" type="radio"/> 320.0	<input type="radio"/> 0.250 <input checked="" type="radio"/> 320.0
<b>Carrier Gas</b>				
Enter one Setpoint		<input type="checkbox"/> Helium <input checked="" type="checkbox"/> Hydrogen	<input type="checkbox"/> Helium <input checked="" type="checkbox"/> Hydrogen	<input type="checkbox"/> Helium <input checked="" type="checkbox"/> Hydrogen
Head Pressure, psi	12.786	<input type="radio"/> 10.550 <input checked="" type="radio"/> 12.786	<input type="radio"/> 10.550 <input checked="" type="radio"/> 12.118	<input type="radio"/> 10.550 <input checked="" type="radio"/> 12.908
Flow Rate, mL/min	2.0502	<input type="radio"/> 3.5509 <input checked="" type="radio"/> 2.0502	<input type="radio"/> 3.5509 <input checked="" type="radio"/> 4.2388	<input type="radio"/> 3.5509 <input checked="" type="radio"/> 4.6012
Outlet Velocity, cm/sec	56.20	<input type="radio"/> 97.34 <input checked="" type="radio"/> 56.20	<input type="radio"/> 97.34 <input checked="" type="radio"/> 116.19	<input type="radio"/> 97.34 <input checked="" type="radio"/> 126.13
Average Velocity, cm/sec	38.00	<input type="radio"/> 0.714286 <input checked="" type="radio"/> 38.00	<input type="radio"/> 0.714286 <input checked="" type="radio"/> 80	<input type="radio"/> 0.714286 <input checked="" type="radio"/> 85
Hold-up Time, min	1.31579	<input type="radio"/> 0.714286 <input checked="" type="radio"/> 1.31579	<input type="radio"/> 0.625000 <input checked="" type="radio"/> 1.31579	<input type="radio"/> 0.588235 <input checked="" type="radio"/> 1.31579
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696 <input checked="" type="checkbox"/> 14.696	<input type="checkbox"/> 14.696 <input checked="" type="checkbox"/> 14.696	<input type="checkbox"/> 14.696 <input checked="" type="checkbox"/> 14.696
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696 <input checked="" type="checkbox"/> 14.696	<input type="checkbox"/> 14.696 <input checked="" type="checkbox"/> 14.696	<input type="checkbox"/> 14.696 <input checked="" type="checkbox"/> 14.696
<b>Oven Temperature</b> 3-ramp Program				
	Ramp Rate	Final Temp.	Final Time	Ramp Rate
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	$^{\circ}\text{C}/\text{min}$
Initial	120.00	1.170		120.00
Ramp 1	25.000	160.00	0.000	52.632
Ramp 2	10.000	260.00	0.000	21.053
Ramp 3	15.000	300.00	4.000	31.579
				0.635
				0.556
				0.000
				0.000
				1.900
				1.788
Sample Information	None			

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## Same Column, H<sub>2</sub> Carrier Gas, Even Higher Velocities



## New Column Dimensions, H<sub>2</sub> Gas, Translate Only

GC Method Translation

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None **Speed gain: 2.05607**

	Original Method	Translated Method				
<b>Column</b>						
Length, m	30	20				
Internal Diameter, $\mu\text{m}$	316	177				
Film Thickness, $\mu\text{m}$	0.25	0.18				
Phase Ratio	316.0	245.8				
<b>Carrier Gas</b>	Helium	Hydrogen				
Enter one Setpoint						
Head Pressure, psi	13.126	22.883				
Flow Rate, mL/min	2.0176	1.4126				
Outlet Velocity, cm/sec	56.72	126.69				
Average Velocity, cm/sec	38	66.95				
Hold-up Time, min	1.31579	0.497855				
Outlet Pressure (absolute), psi	14.696	14.696				
Ambient Pressure (absolute), psi	14.696	14.696				
<b>Oven Temperature</b> 3-ramp Program						
	Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min
Initial		120.00	1.17	120.00	0.553	
Ramp 1	25	160	0	51.402	160	0.000
Ramp 2	10	260	0	20.561	260	0.000
Ramp 3	15	300	4	30.841	300	1.945

Sample Information None

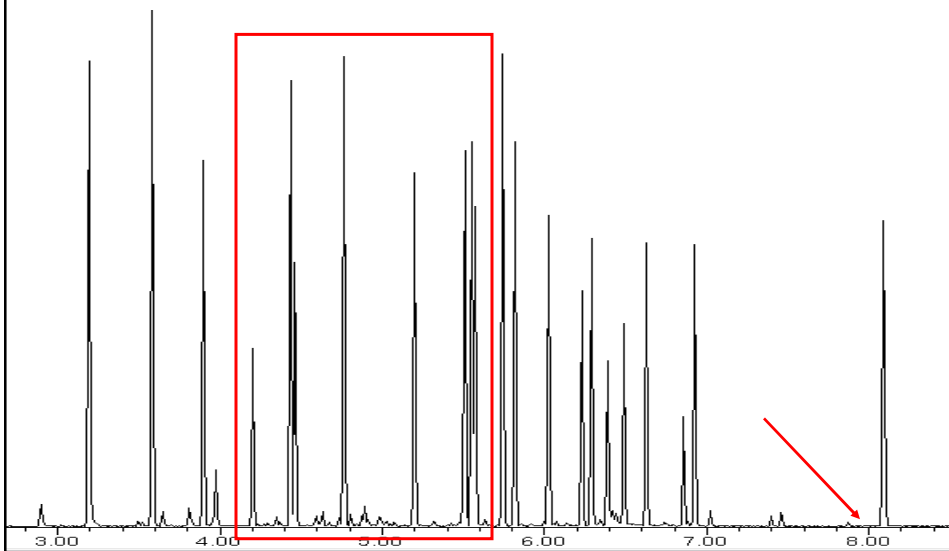
Input NEW dimensions

Close enough (got lucky)

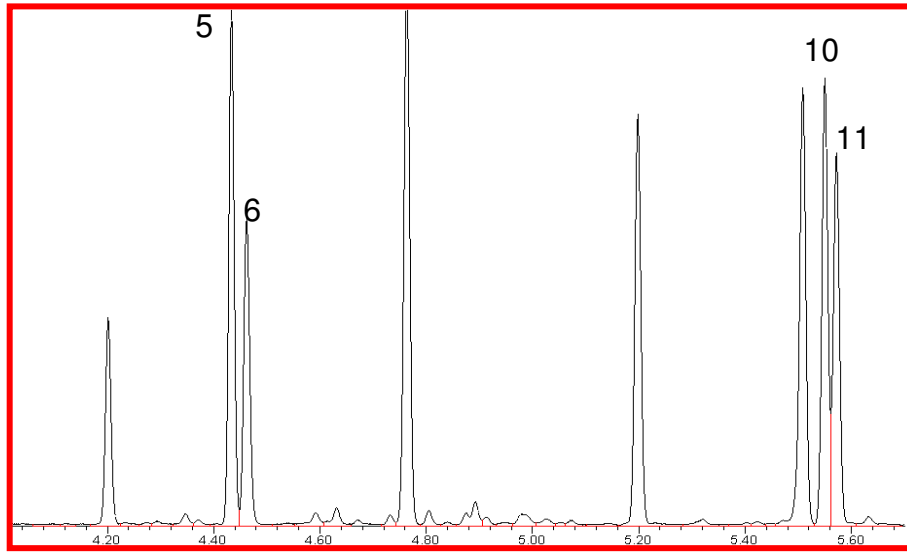
New Velocity

New Temp. Program

## New Column Dimensions, H<sub>2</sub> Gas, Translate Only



## New Column Dimensions, H2 Gas, Translate Only



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Agilent Technologies

Column Selection

## New Column Dimensions, H2 Gas, Fast Analysis

GC Method Translation - EPACLP.MXD

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None Speed gain: 2.34453

	Original Method	Translated Method																																										
Column Length, m	30	20																																										
Internal Diameter, $\mu\text{m}$	320	177																																										
Film Thickness, $\mu\text{m}$	0.25	<input checked="" type="radio"/> Unlock																																										
Phase Ratio	320.0	<input type="radio"/> 0.18 <input type="radio"/> 245.8																																										
Carrier Gas	Helium	Hydrogen																																										
Enter one Setpoint Head Pressure, psi	12.786	26.714																																										
Flow Rate, mL/min	2.0502	1.7700																																										
Outlet Velocity, cm/sec	56.20	158.74																																										
Average Velocity, cm/sec	38	77.31																																										
Hold-up Time, min	1.31579	0.431144																																										
Outlet Pressure (absolute), psi	14.696	14.696																																										
Ambient Pressure (absolute), psi	14.696	14.696																																										
Oven Temperature Program	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th><math>^{\circ}\text{C}/\text{min}</math></th> <th><math>^{\circ}\text{C}</math></th> <th>min</th> </tr> </thead> <tbody> <tr> <td>Initial</td> <td>120</td> <td>1.17</td> </tr> <tr> <td>Ramp 1</td> <td>25</td> <td>160</td> <td>0</td> </tr> <tr> <td>Ramp 2</td> <td>10</td> <td>260</td> <td>0</td> </tr> <tr> <td>Ramp 3</td> <td>15</td> <td>300</td> <td>4</td> </tr> </tbody> </table>	Ramp Rate	Final Temp.	Final Time	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	Initial	120	1.17	Ramp 1	25	160	0	Ramp 2	10	260	0	Ramp 3	15	300	4	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th><math>^{\circ}\text{C}/\text{min}</math></th> <th><math>^{\circ}\text{C}</math></th> <th>min</th> </tr> </thead> <tbody> <tr> <td>Initial</td> <td>120</td> <td>0.499</td> </tr> <tr> <td>Ramp 1</td> <td>58.613</td> <td>160</td> <td>0.000</td> </tr> <tr> <td>Ramp 2</td> <td>23.445</td> <td>260</td> <td>0.000</td> </tr> <tr> <td>Ramp 3</td> <td>35.168</td> <td>300</td> <td>1.706</td> </tr> </tbody> </table>	Ramp Rate	Final Temp.	Final Time	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	Initial	120	0.499	Ramp 1	58.613	160	0.000	Ramp 2	23.445	260	0.000	Ramp 3	35.168	300	1.706
Ramp Rate	Final Temp.	Final Time																																										
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Sample Information	None																																											

New Velocity

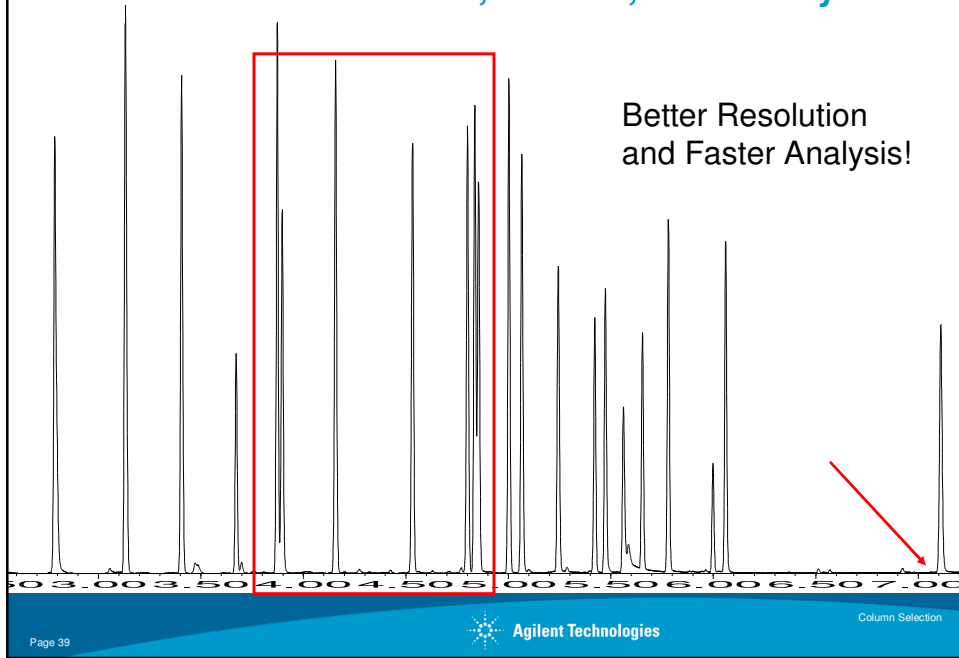
New Temp. Program

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Agilent Technologies

Column Selection

## New Column Dimensions, H<sub>2</sub> Gas, Fast Analysis



## New Column Dimensions, H<sub>2</sub> Gas, Higher Velocities

GC Method Translation - EPACLP.MXD

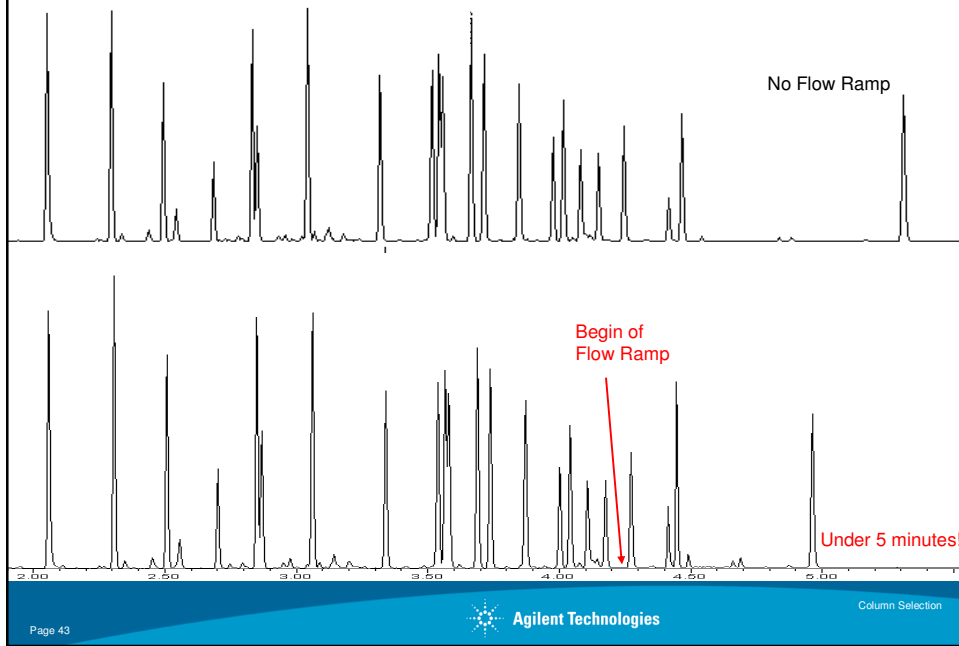
Criterion:  Translate Only  Best Efficiency  Fast Analysis  None **Speed gain: 2.57761** **Speed gain: 2.88086** **Speed gain: 3.18411**

	Original Method	Translated Method	Translated Method	Translated Method
<b>Column</b>				
Length, m	30	<input type="checkbox"/> 20	<input type="checkbox"/> 20	<input type="checkbox"/> 20
Internal Diameter, $\mu\text{m}$	320	<input type="checkbox"/> 177	<input type="checkbox"/> 177	<input type="checkbox"/> 177
Film Thickness, $\mu\text{m}$	0.25	<input type="radio"/> Unlock	<input checked="" type="radio"/> Unlock	<input checked="" type="radio"/> Unlock
Phase Ratio	320.0	<input type="radio"/> 0.18	<input type="radio"/> 0.18	<input type="radio"/> 0.18
		<input type="radio"/> 245.8	<input type="radio"/> 245.8	<input type="radio"/> 245.8
<b>Carrier Gas</b>	Helium	Hydrogen	Hydrogen	Hydrogen
Enter one Setpoint		<input checked="" type="radio"/> Unlock	<input checked="" type="radio"/> Unlock	<input checked="" type="radio"/> Unlock
Head Pressure, psi	12.786	<input type="radio"/> 29.598	<input type="radio"/> 33.397	<input type="radio"/> 37.244
Flow Rate, mL/min	2.0502	<input type="radio"/> 2.0619	<input type="radio"/> 2.4764	<input type="radio"/> 2.9308
Outlet Velocity, cm/sec	56.20	<input type="radio"/> 184.91	<input type="radio"/> 222.08	<input type="radio"/> 262.84
Average Velocity, cm/sec	38	<input type="radio"/> 85	<input type="radio"/> 95	<input type="radio"/> 105
Hold-up Time, min	1.31579	<input type="radio"/> 0.392157	<input type="radio"/> 0.350877	<input type="radio"/> 0.317460
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696
<b>Oven Temperature</b> 3-ramp Program				
	Ramp Rate	Final Temp.	Final Time	Ramp Rate
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	$^{\circ}\text{C}/\text{min}$
Initial	120	1.17		120
Ramp 1	25	160	0	72.021
Ramp 2	10	260	0	28.809
Ramp 3	15	300	4	43.213
				Final Temp.
				$^{\circ}\text{C}$
				Final Time
				min
				0.454
				0.000
				0.000
				1.552
				0.406
				0.000
				0.000
				1.388
				0.367
				0.000
				0.000
				1.256
Sample Information	None			

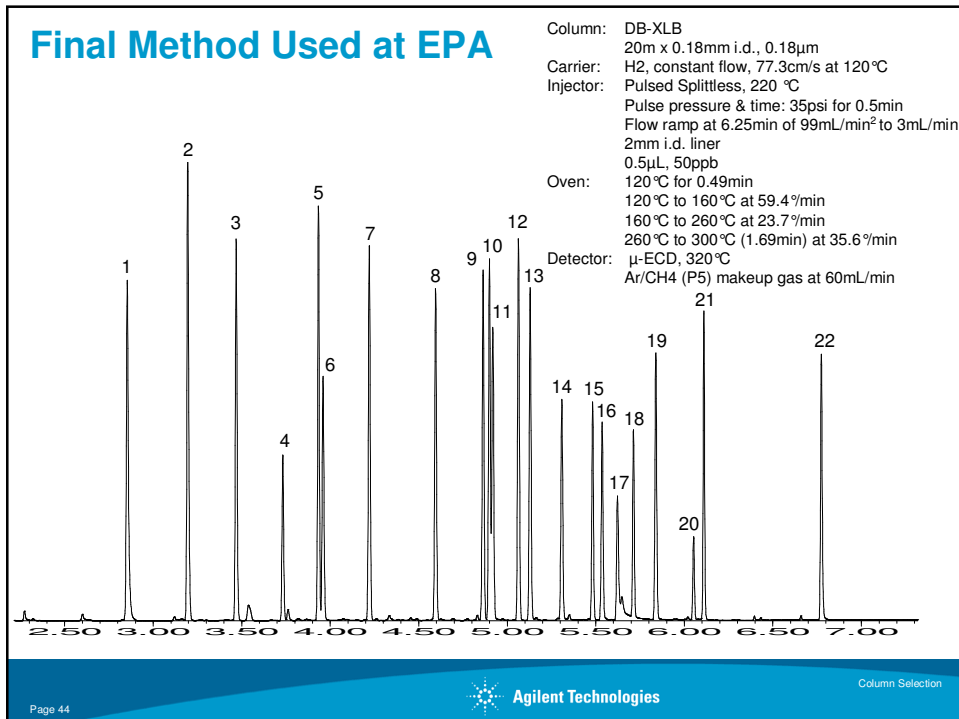
Page 40 Agilent Technologies Column Selection



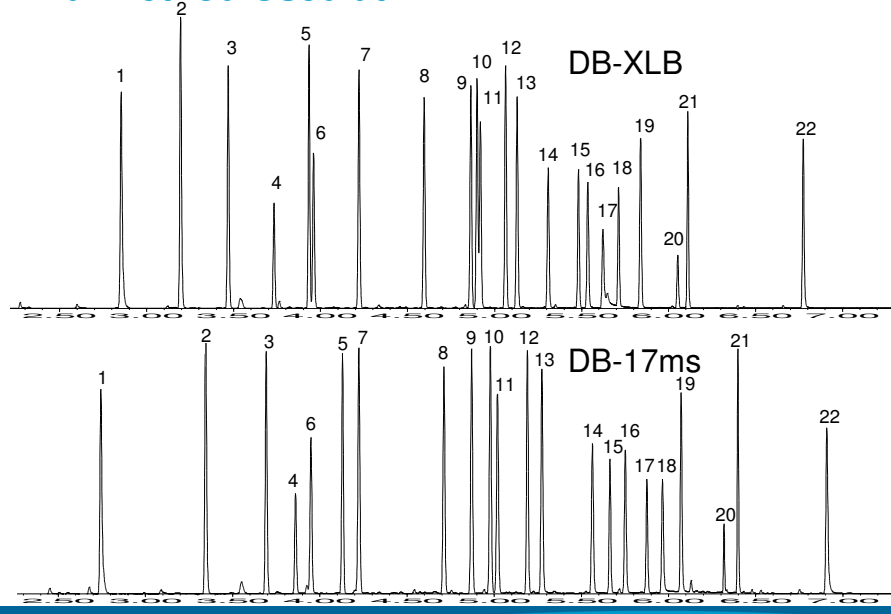
## Flow Ramp



## Final Method Used at EPA



## Final Method Used at EPA



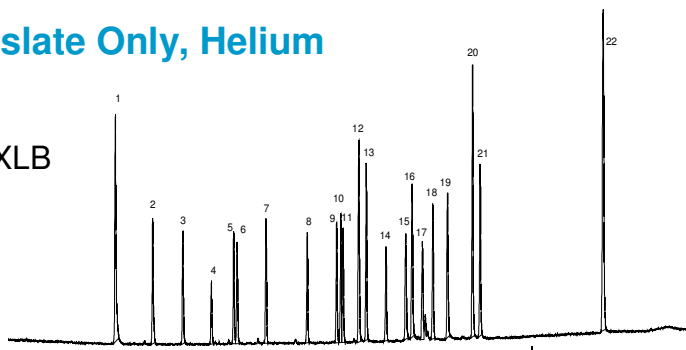
## Further Work (App. Note 5989-7818EN)

20m x 0.18mm ID, Fast Even in Helium

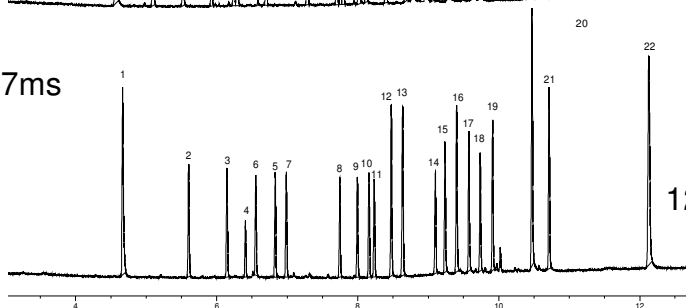
GC Method Translation - XLB-TA.MXD			
Criterion: <input checked="" type="radio"/> Translate Only <input type="radio"/> Best Efficiency <input type="radio"/> Fast Analysis <input type="radio"/> None <b>Speed gain: 0.63934</b>			
	Original Method	Translated Method	
<b>Column</b>			
Length, m	20.00	<input type="checkbox"/>	20.00
Internal Diameter, $\mu\text{m}$	180.0	<input type="checkbox"/>	180.0
Film Thickness, $\mu\text{m}$	0.180	<input type="checkbox"/> Unlock	0.180
Phase Ratio	250.0	<input checked="" type="radio"/>	250.0
<b>Carrier Gas</b>	Hydrogen	<input type="checkbox"/>	Helium
Enter one Setpoint			
Head Pressure, psi	25.756	37.597	
Flow Rate, mL/min	1.7943	1.4354	
Outlet Velocity, cm/sec	155.58	124.47	
Average Velocity, cm/sec	77.30	49.42	
Hold-up Time, min	0.431220	0.674472	
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	
<b>Oven Temperature</b> 3-ramp Program			
	Ramp Rate	Final Temp.	Final Time
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min
Initial		120.00	0.490
Ramp 1	59.400	160.00	0.000
Ramp 2	23.700	260.00	0.000
Ramp 3	35.600	300.00	1.690
		120.00	0.766
	37.977	160.00	0.000
	15.152	260.00	0.000
	22.761	300.00	2.643
Sample Information	None		

## Translate Only, Helium

DB-XLB



DB-17ms



12 minutes

## Food/Fragrance – Method translation

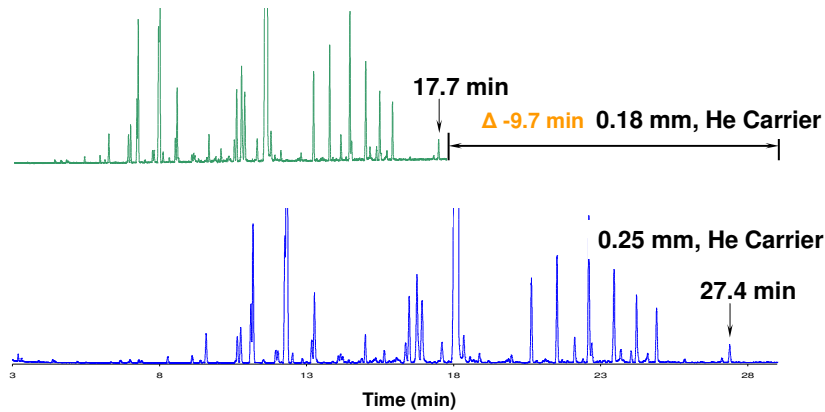
GC Method Translation

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None **Speed gain: 1.55885**

	Original Method	Translated Method				
<b>Column</b>						
Length, m	30	20				
Internal Diameter, $\mu\text{m}$	250.0	180				
<b>Film</b>						
Thickness, $\mu\text{m}$	0.250	<input type="checkbox"/> 0.180				
Phase Ratio	250.0	<input checked="" type="radio"/> 250.0				
<b>Carrier Gas</b>	Helium	Helium				
<b>Enter one Setpoint</b>						
Head Pressure, psi	0.563	5.698				
Flow Rate, mL/min	0.4833	0.3480				
Outlet Velocity, cm/sec	Very large	Very large				
Average Velocity, cm/sec	25.00	25.98				
Hold-up Time, min	2.00000	1.28300				
Outlet Pressure (absolute), psi	0	<input checked="" type="checkbox"/> 0				
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696				
<b>Oven Temperature</b>   1-ramp Program						
	Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min
Initial	40	1		40	0.642	
Ramp 1	5	290	0	7.794	290	0.000
Sample Information	None					



## Spearmint Oil on DB-1



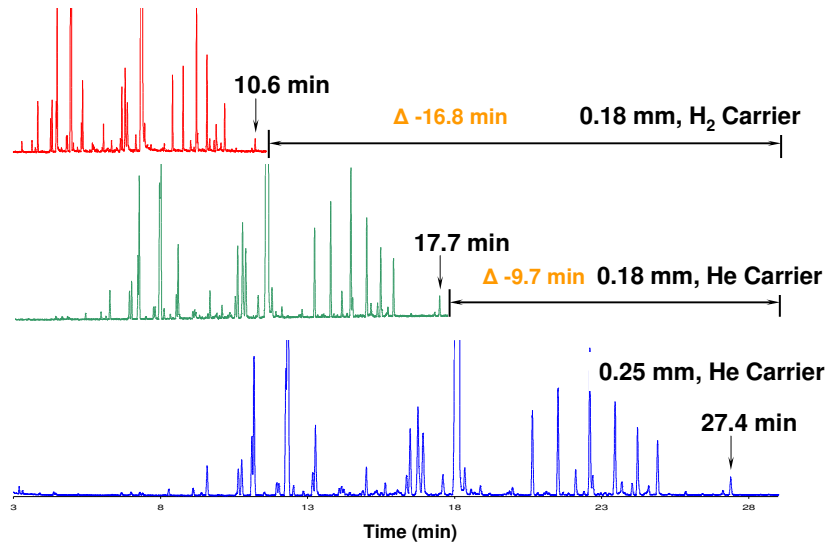
## Food/Fragrance – Method translation, Hydrogen

GC Method Translation

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None **Speed gain: 2.59618**

	Original Method	Translated Method				
<b>Column</b>						
Length, m	30	20				
Internal Diameter, $\mu\text{m}$	250.0	180				
<b>Film</b>		<input type="checkbox"/> Unlock				
Thickness, $\mu\text{m}$	0.250	<input type="radio"/> 0.180				
Phase Ratio	250.0	<input checked="" type="radio"/> 250.0				
<b>Carrier Gas</b>	Helium	Hydrogen				
<b>Enter one Setpoint</b>						
Head Pressure, psi	0.563	0.610				
Flow Rate, mL/min	0.4833	0.4350				
Outlet Velocity, cm/sec	Very large	Very large				
Average Velocity, cm/sec	25.00	43.27				
Hold-up Time, min	2.00000	0.770362				
Outlet Pressure (absolute), psi	0	<input checked="" type="checkbox"/> 0				
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696				
<b>Oven Temperature</b> 1-ramp Program						
	Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min
Initial	40	1		40	0.385	
Ramp 1	5	290	0	12.981	290	0.000
Sample Information	None					

## Spearmint Oil on DB-1, (App. Note 5989-7509EN)

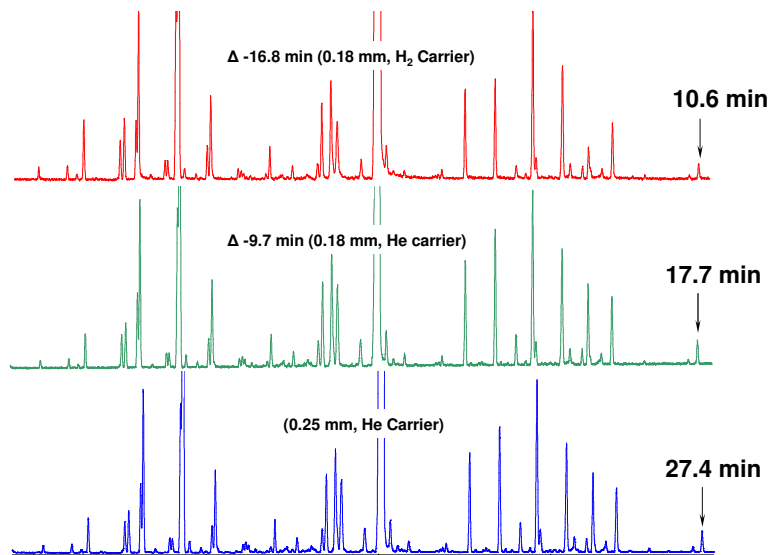


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Column Selection

## Spearmint Oil on DB-1 – Resolution Check



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Column Selection

## Resolution Maintained

Compound Resolution			
Compounds	0.25 mm	0.18 mm	0.18 mm
	Helium	Helium	Hydrogen
Sabinene	1.52	1.59	1.56
$\beta$ -Pinene			
$\alpha$ -Terpinene	1.61	1.73	1.86
p-Cymene			
<b>Speed Gain</b>	<b>N/A</b>	<b>35%</b>	<b>61%</b>

## Aromatic Solvents on HP-INNOWax

GC Method Translation

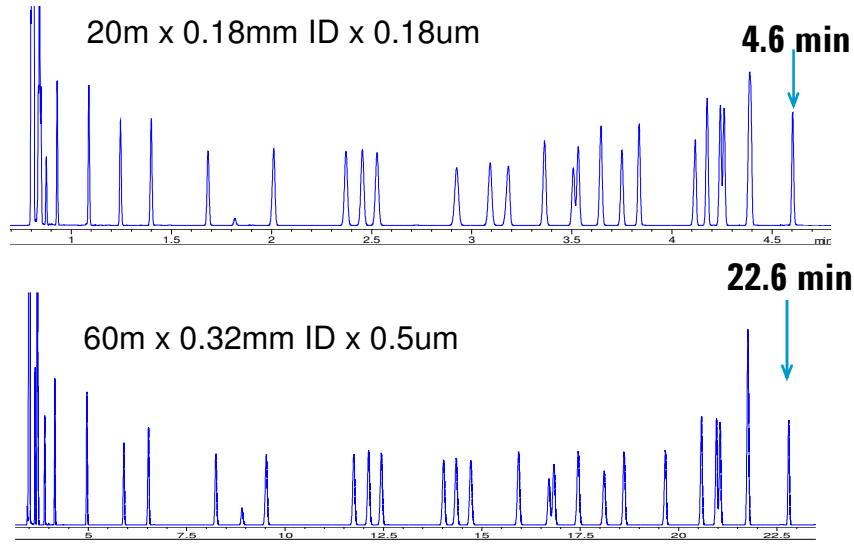
Criterion:  Translate Only  Best Efficiency  Fast Analysis  None Speed gain: 7.09637

Translated Method

Criterion:  Translate Only  Best Efficiency  Fast Analysis  None Speed gain: 6.63497

	Original Method	Translated Method
Column Length, m	60	20
Internal Diameter, $\mu\text{m}$	320	180
Film Thickness, $\mu\text{m}$	0.5	0.18
Phase Ratio	160.0	250.0
Carrier Gas	Helium	Helium
Head Pressure, psi	20	30.666
Flow Rate, mL/min	2.2911	1.2887
Outlet Velocity, cm/sec	55.79	98.96
Average Velocity, cm/sec	31.48	44.56
Hold-up Time, min	3.17677	0.748112
Outlet Pressure (absolute), psi	14.696	14.696
Ambient Pressure (absolute), psi	14.696	14.696
Oven Temperature		
Ramp Rate	75 $^{\circ}\text{C}/\text{min}$	75 $^{\circ}\text{C}/\text{min}$
Final Temp.	10 $^{\circ}\text{C}$	1.507 $^{\circ}\text{C}$
Final Time	10 min	0.000 min
Ramp 1	3 $^{\circ}\text{C}/\text{min}$	19.905 $^{\circ}\text{C}/\text{min}$
Ramp 2	10 $^{\circ}\text{C}/\text{min}$	66.350 $^{\circ}\text{C}/\text{min}$
Final Temp.	100 $^{\circ}\text{C}$	100 $^{\circ}\text{C}$
Final Time	0 min	0.000 min
Ramp Rate	70.964 $^{\circ}\text{C}/\text{min}$	75 $^{\circ}\text{C}/\text{min}$
Final Temp.	145 $^{\circ}\text{C}$	145 $^{\circ}\text{C}$
Final Time	0.000 min	1.409 min

## Aromatic Solvents on HP-INNOWax



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Agilent Technologies

Column Selection

## Aromatic Solvents on HP-INNOWax

Modified Temp then converted to Hydrogen

GC Method Translation

Criterion: Translate Only Best Efficiency Fast Analysis None Speed gain: 1.54952

Original Method			Translated Method		
60	20		20		
320	180		180		
0.5	0.18		0.18		
160.0	250.0		250.0		
Helium	Helium		Helium		Hydrogen
20	32.990		32.990		
2.2911	1.4400		1.4400		
55.79	110.57		110.57		
31.48	47.66		47.66		
3.17677	0.699470		0.699470		
14.696	14.696		14.696		14.696
14.696	14.696		14.696		14.696
Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
°C/min	°C	min	°C/min	°C	min
3	75	10	3	75	1.409
10	100	0	21.289	100	0.000
	145	0	70.964	145	0.000

Original Method			Translated Method		
Column Length, m	20		20		
Internal Diameter, µm	180		180		
Film Thickness, µm	0.18		0.18		
Phase Ratio	250.0		250.0		
Carrier Gas	Helium		Helium		Hydrogen
Enter one Setpoint					
Head Pressure, psi	33		22.403		
Flow Rate, mL/min	1.4763		1.8454		
Outlet Velocity, cm/sec	111.73		139.67		
Average Velocity, cm/sec	48.15		74.60		
Hold-up Time, min	0.692343		0.446811		
Outlet Pressure (absolute), psi	14.696		14.696		14.696
Ambient Pressure (absolute), psi	14.696		14.696		14.696
Oven Temperature	1-ramp Program				
	Initial				
	Ramp 1				
Ramp Rate	Final Temp.	Final Time	Ramp Rate	Final Temp.	Final Time
°C/min	°C	min	°C/min	°C	min
45	70	3	45	70	1.936
	145	0.5	69.728	145	0.323

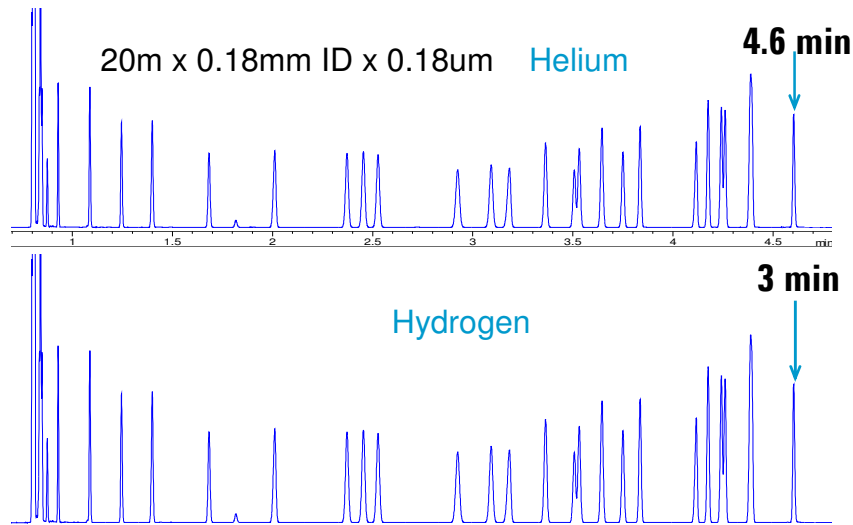
Sample Information None

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Column Selection

## Aromatic Solvents on HP-INNOWax (App. Note 5989-7623EN)



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Column Selection

## CONCLUSIONS

**Stationary Phase** – Chosen for optimized selectivity

**Length** – Shorter might be possible without losing a lot of R

**Carrier Gas** – Helium can still go fast but Hydrogen has the most advantage at high velocities

**Flow Ramp** – Increase at end of run for lonely late eluters

**Temperature Program** – Use MTS to scale temps properly

**Method Translation Software** – FREE, reliable

**Diameter** – Smaller allows shorter length but has less capacity

**Small Change in ID Easier to Translate** – Again think capacity

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Agilent Technologies

Column Selection

## TECHNICAL SUPPORT

**1-800-227-9770, #4, #1**

**E-mail: [gc\\_column\\_support@Agilent.com](mailto:gc_column_support@Agilent.com)**

**1-972-699-6423 (Daron)**

**1-866-912-6701 (toll free)**



**E-mail:  
[Daron\\_Decker@Agilent.com](mailto:Daron_Decker@Agilent.com)**

## For More Detailed Information

“Fast Analysis of Aromatic Solvent with 0.18 mm ID GC Column”  
(5989-7623EN)

“Analysis of Semivolatiles Using High Efficiency Capillary GC  
Columns” (5989-7500EN)

Rapid Analysis of Food and Fragrances Using High-Efficiency  
Capillary GC Columns” (5989-7509EN)

Agilent J&W High-Efficiency Capillary columns: Productivity-  
Enhancing Tools for Fast GC Applications” (5989-7499EN)

[www.agilent.com/chem/HEColumns](http://www.agilent.com/chem/HEColumns)