

Tips and Tricks of Faster GC Analysis

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Application Engineer
E-seminar
October 1, 2009

Questions to Ask

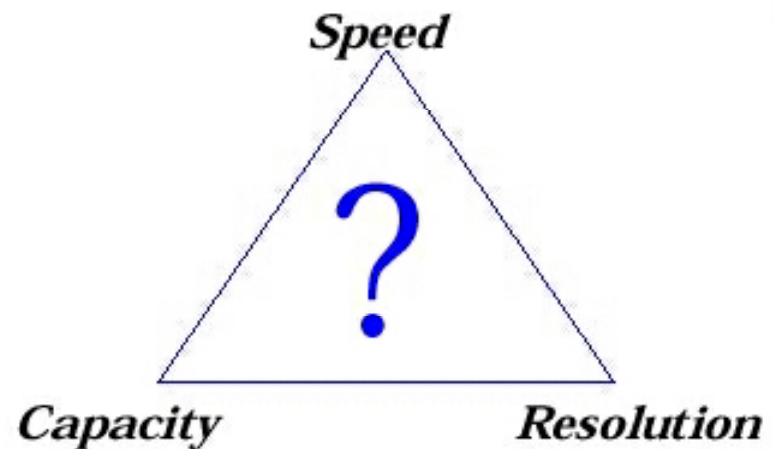
What information do you need from your analysis?

Do you have more baseline than you need between your peaks?

Do you need to resolve all of the components?

Variables for Shortening Run Times

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

Resolution

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

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$$N = f(\text{gas}, L, r_c)$$

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

Stationary Phase - Common Types

Siloxane polymers

Poly(ethylene) glycols

Porous polymers

Selectivity

Relative spacing of the chromatographic peaks

The result of all non-polar, polarizable and polar interactions that cause a stationary phase to be more or less retentive to one analyte than another

Optimizing Selectivity

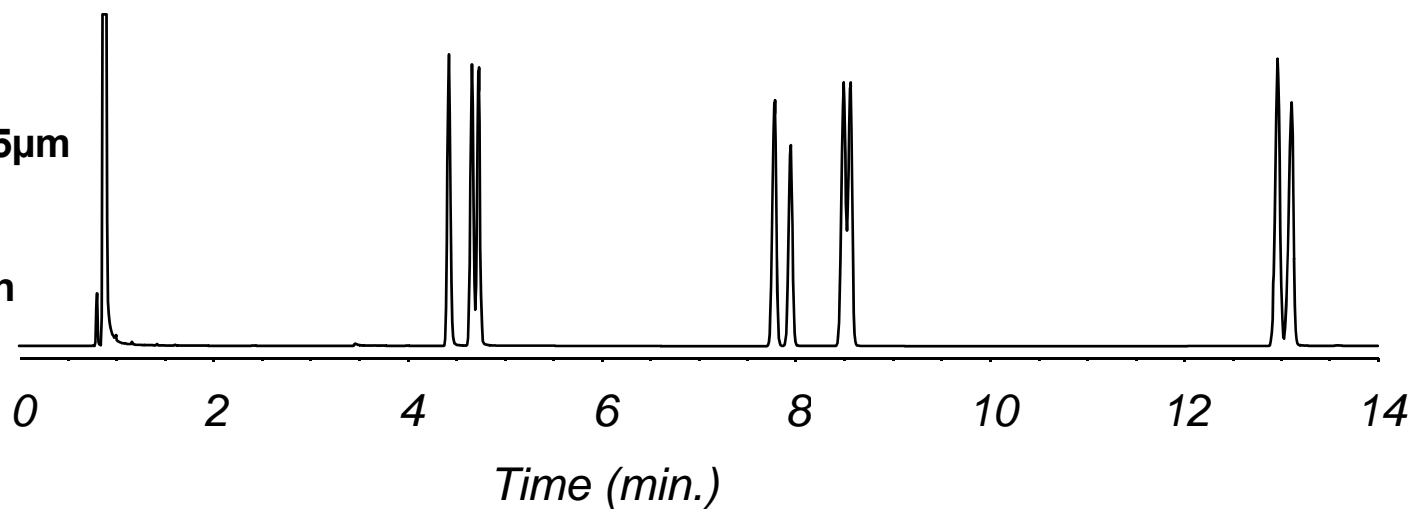
Match analyte polarity to stationary phase polarity

-like dissolves like(oil and water don't mix)

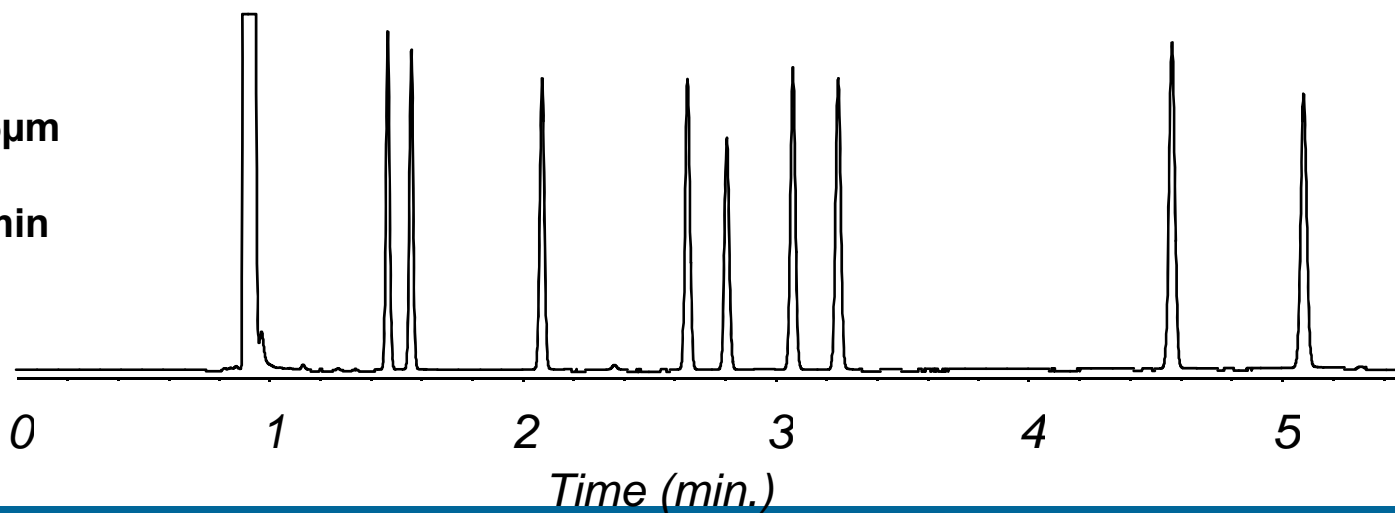
Take advantage of unique interactions between analyte and stationary phase functional groups

Start with the Right Phase

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



DB-Wax
15m, 0.32mm, 0.25 μ 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	$N = f$ (gas, L, r_c)	L = Length
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Selectivity	$\alpha = f$ (T, 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

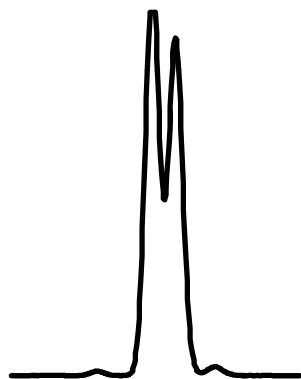
$$R \propto \sqrt{n} \propto \sqrt{L}$$

Length X 4 = Resolution X 2

$$t \propto L$$

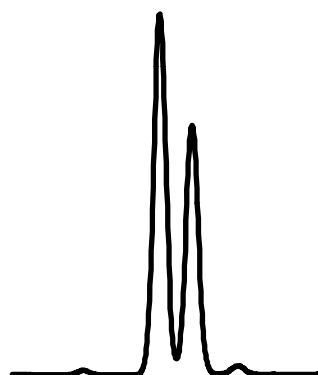
Column Length VS Resolution and Retention: Isothermal

R=0.84
2.29 min



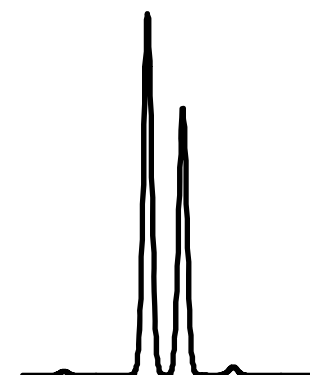
15 m

R=1.16
4.82 min



30 m

R=1.68
8.73 min

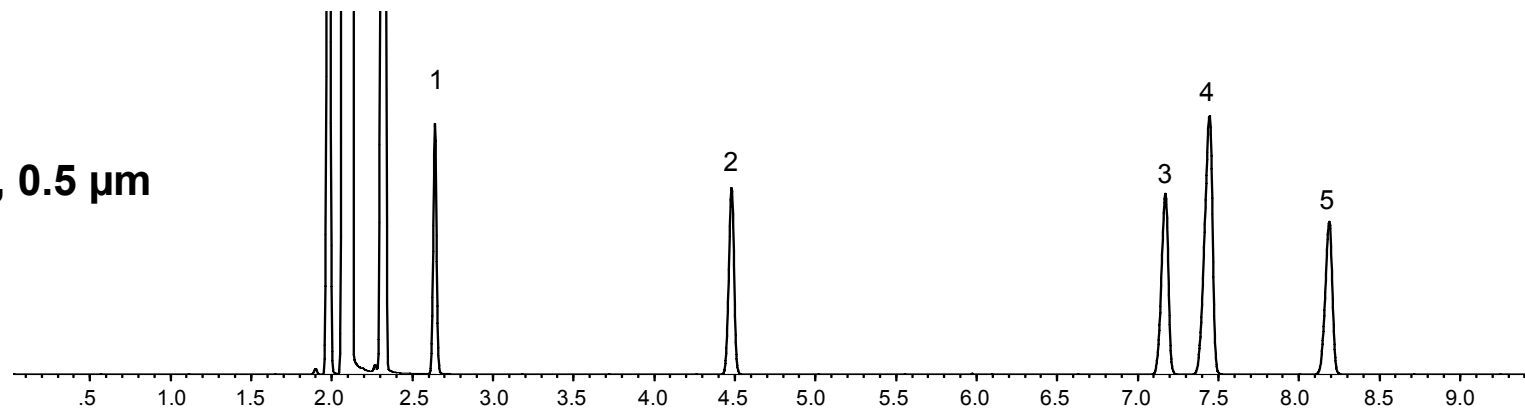


60 m

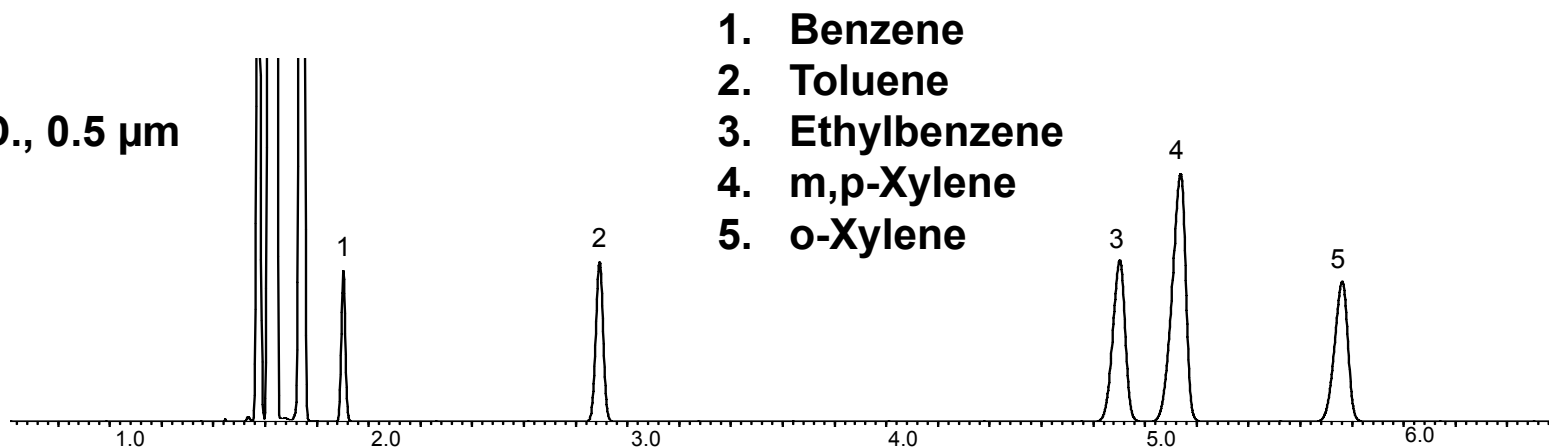
Double the plates, double the time
but not double the the resolution

DECREASE THE LENGTH

DB-5
30 m
0.53 mm I.D., 0.5 μ m

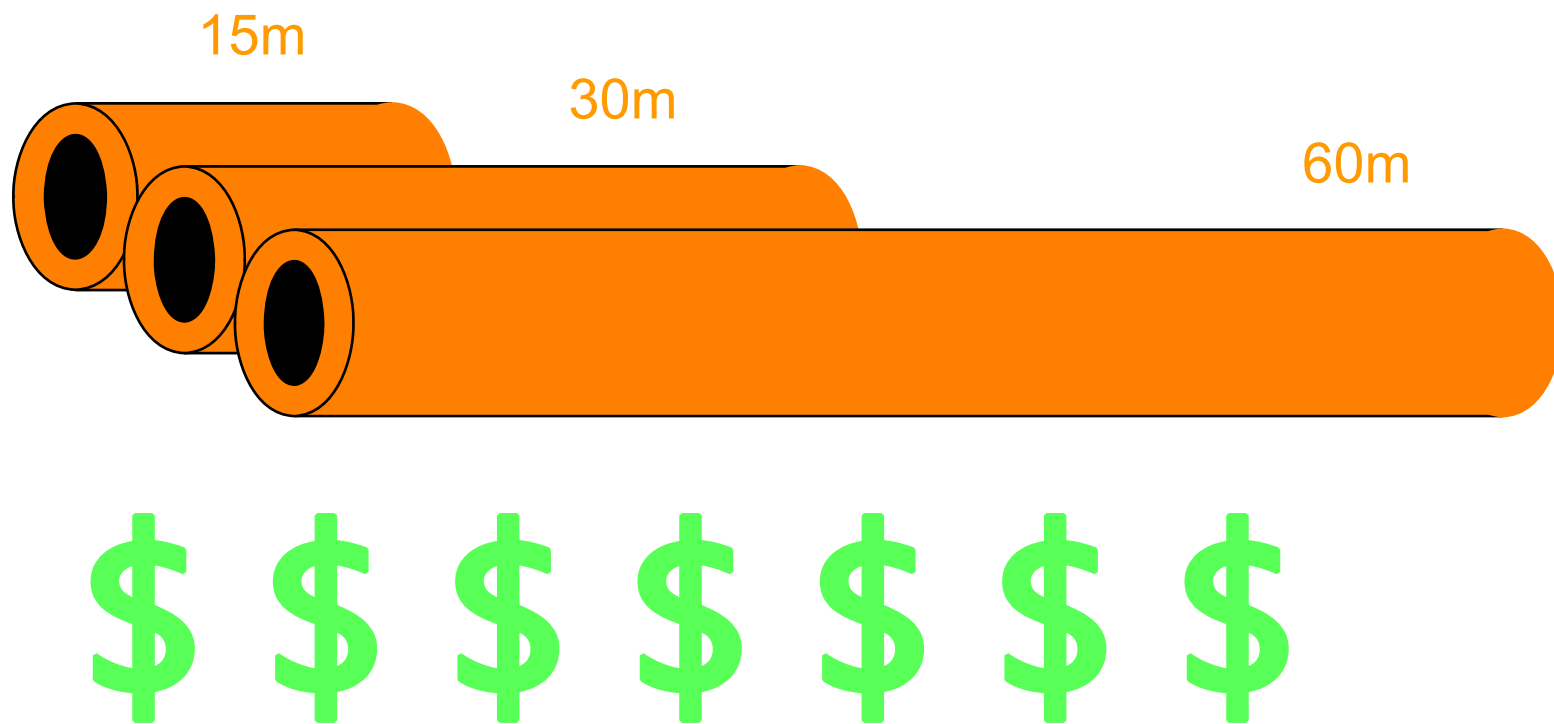


DB-5
15 m
0.53 mm I.D., 0.5 μ m



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




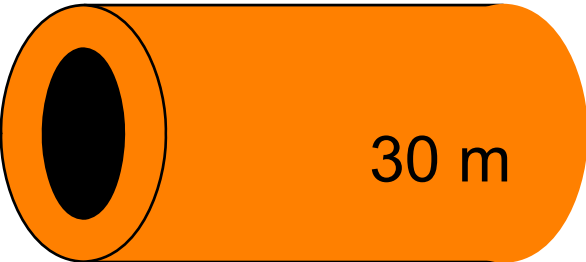
d_f = film thickness

Selectivity

$$\alpha = f(T, \text{phase})$$

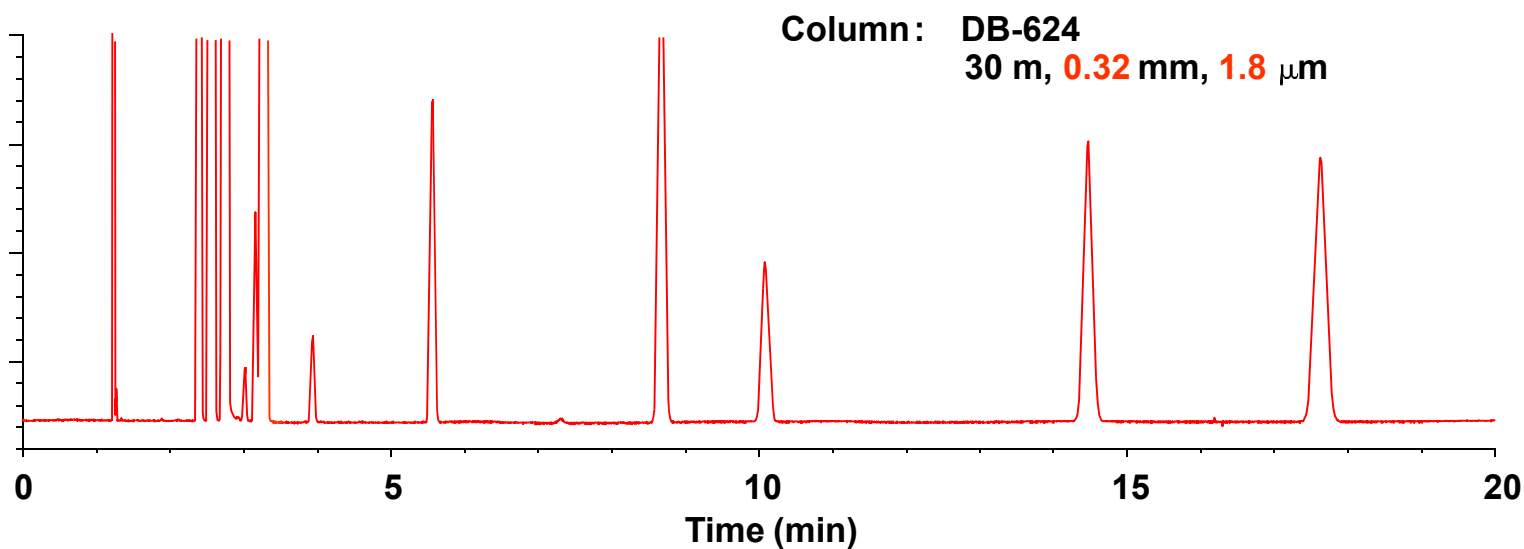
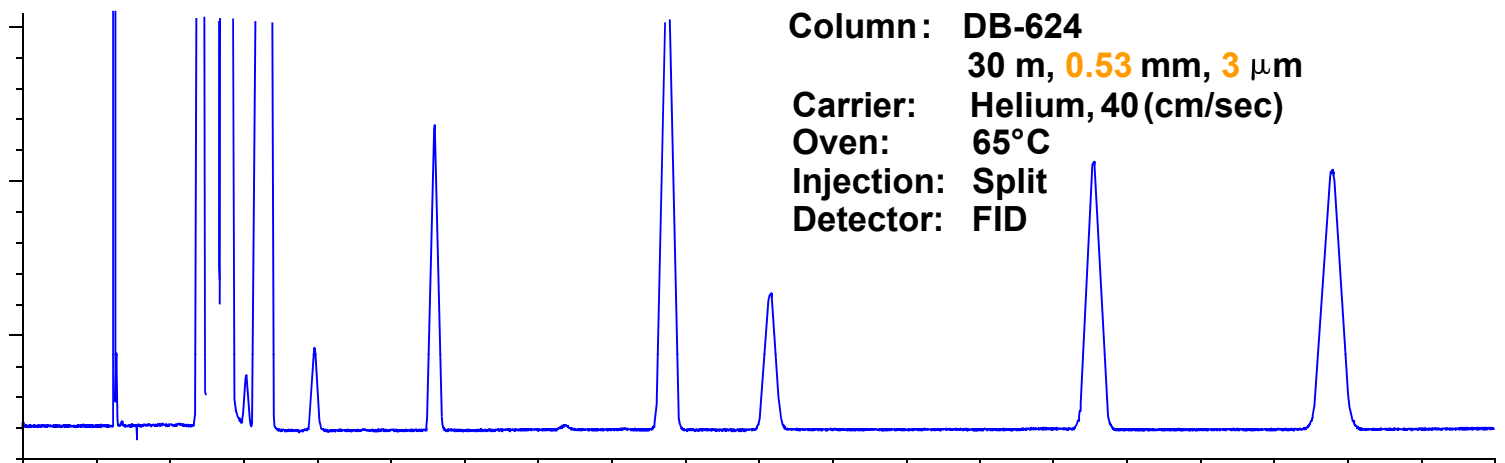
T = temperature

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
		0.18	6,660
 20 m	N ~ 112,000	0.20	5830
		0.25	4630
 30 m	N ~ 112,000	0.32	3660
		0.45	2840
		0.53	2060

k = 5

Different Column I. D. Equal Phase Ratios



PHASE RATIO (β)

Film Thickness

Column Dimensions

30 m x .53 mm x 3.0 μm

30 m x .32 mm x 1.8 μm

Phase Ratio β

44

44

$$K_C = k \beta$$

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

Column Diameter and Capacity

I.D. (mm)	Capacity (ng)
0.05	1-2
0.10	6-13
<hr/>	
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 μm film thickness

Column Diameter - Inlet Head Pressures (Helium)

I.D (mm)	Pressure (psig)
0.05	275-400
0.10	90-130
0.18	30-45
0.20	25-40
0.25	15-25
0.32	10-20
0.45	3-7
0.53	2-4

30 meters
Hydrogen pressures x 1/2

Column Diameter and Carrier Gas Flow

Lower flow rates: Smaller diameter columns

Higher flow rates: Larger diameter columns

Low flow rates : GC/MS

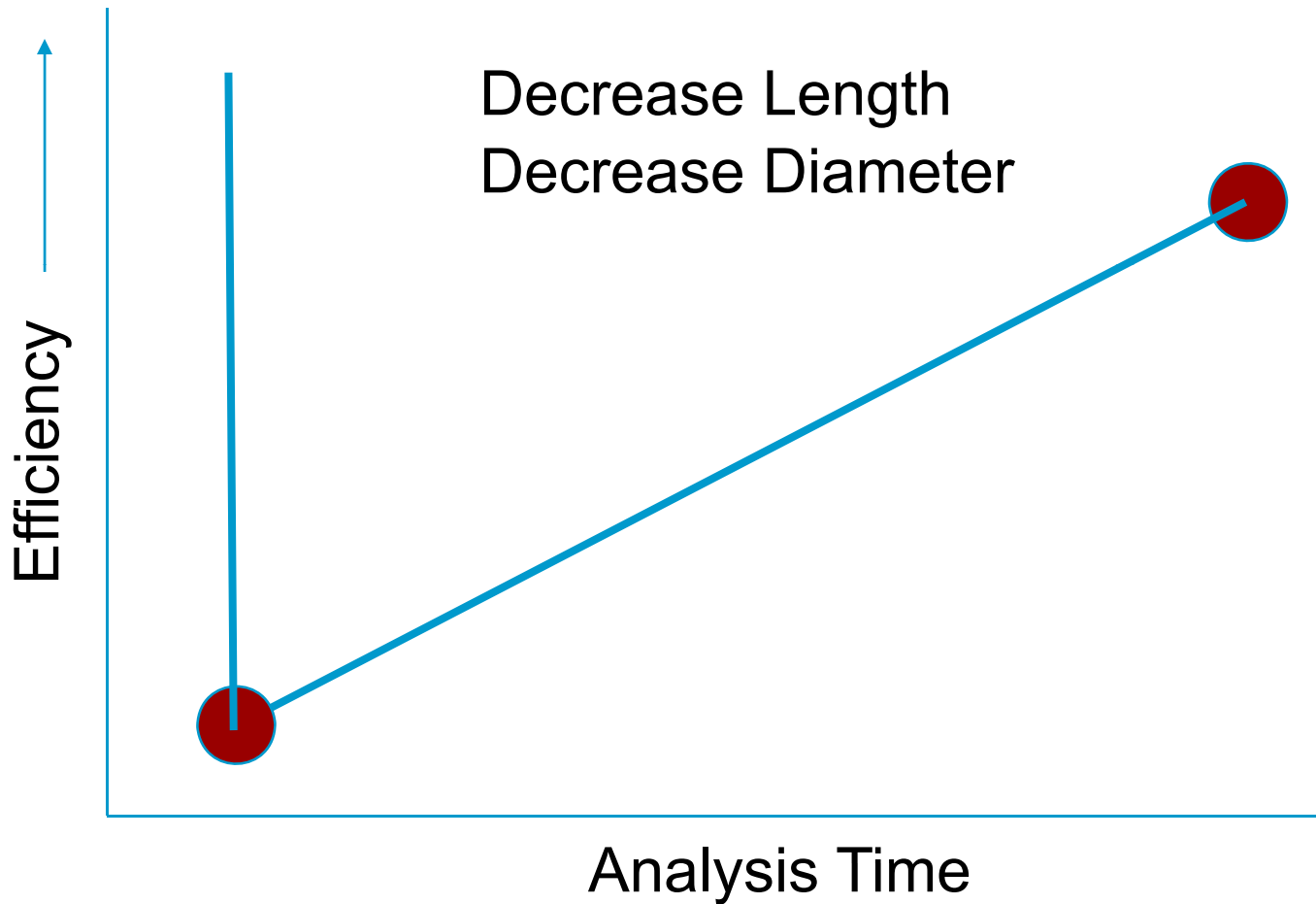
High flow rates: Headspace, purge & trap

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



Carrier Gas Considerations

Best velocity?

Optimal range of velocities

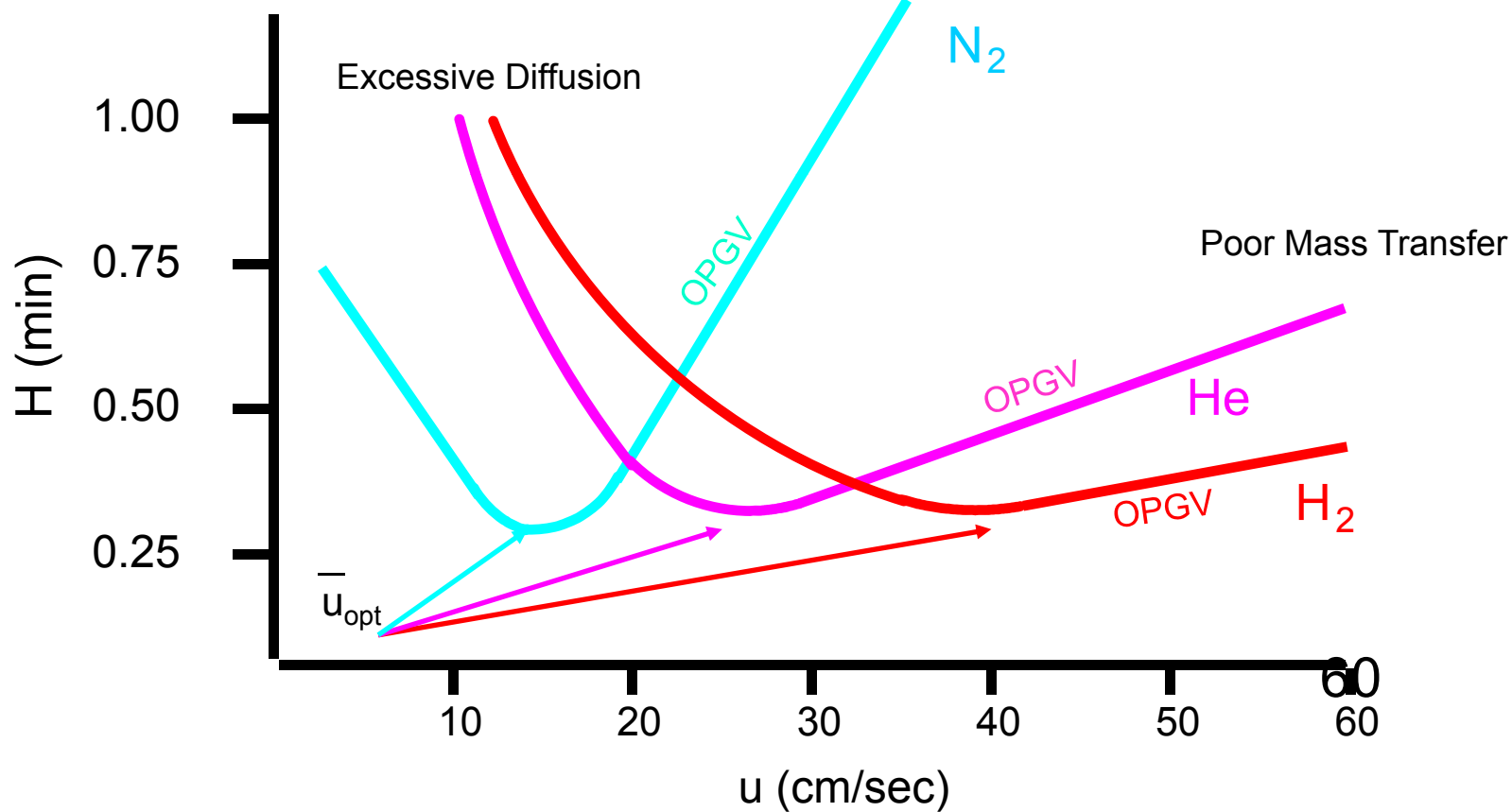
Too low or high results in loss of resolution

Balance resolution and analysis time

BUT... there is no LAW against going FASTER

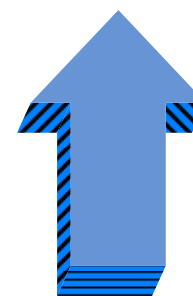
Carrier Gas Considerations

Van Deemter Curve



Carrier Gas 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

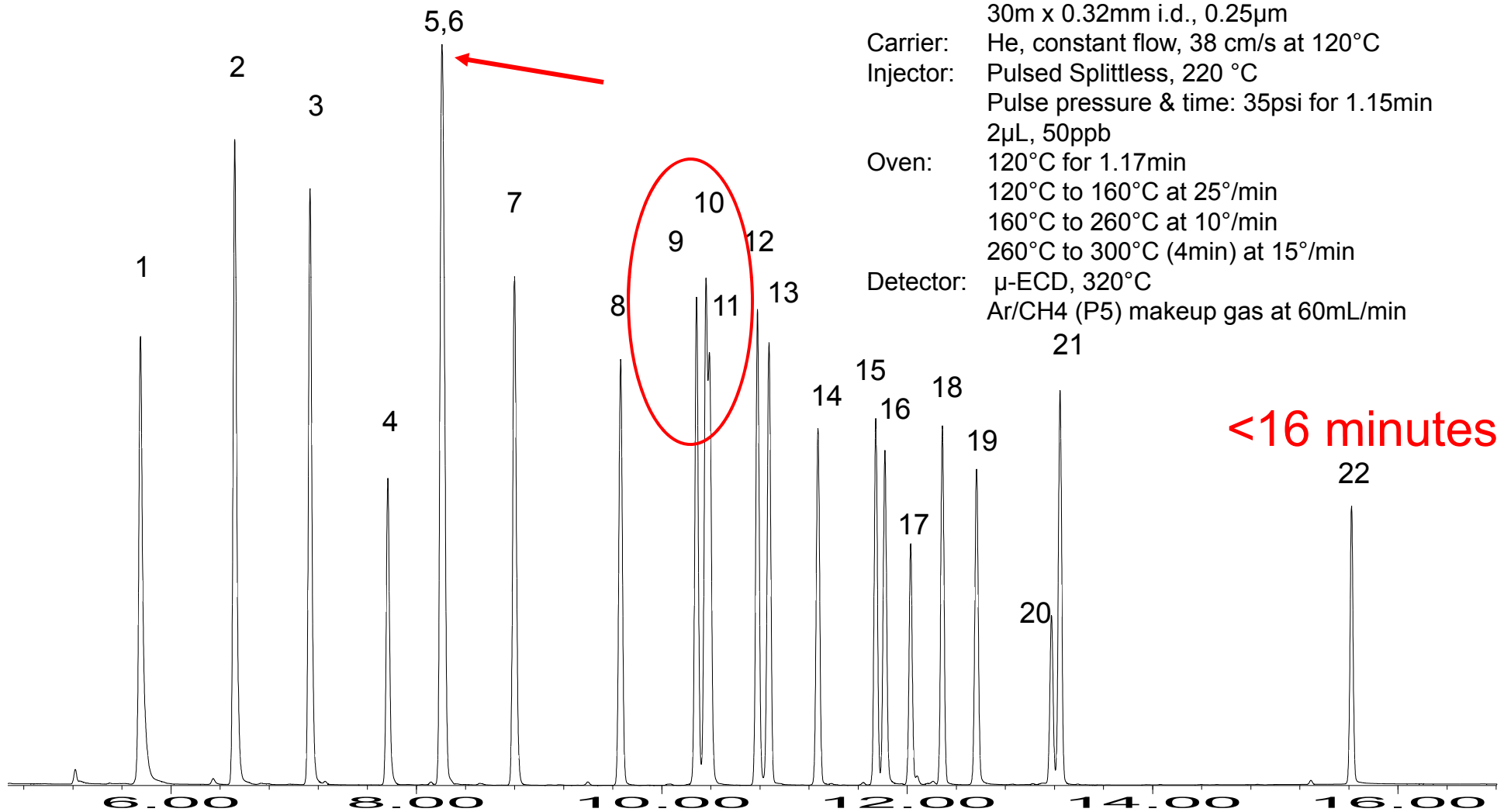
Switch He to H₂ Carrier Gas and Try Faster Velocities

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



Column: DB-XLB
30m x 0.32mm i.d., 0.25 μ m
Carrier: He, constant flow, 38 cm/s at 120 $^{\circ}$ C
Injector: Pulsed Splitless, 220 $^{\circ}$ C
Pulse pressure & time: 35psi for 1.15min
2 μ L, 50ppb
Oven: 120 $^{\circ}$ C for 1.17min
120 $^{\circ}$ C to 160 $^{\circ}$ C at 25 $^{\circ}$ /min
160 $^{\circ}$ C to 260 $^{\circ}$ C at 10 $^{\circ}$ /min
260 $^{\circ}$ C to 300 $^{\circ}$ C (4min) at 15 $^{\circ}$ /min
Detector: μ -ECD, 320 $^{\circ}$ C
Ar/CH4 (P5) makeup gas at 60mL/min

<16 minutes

Input Original Method Parameters

GC Method Translation - EPACLP.MXD

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

Original Method

Column
 Length, m
 Internal Diameter, μm
 Film
 Thickness, μm
 Phase Ratio

Carrier Gas
 Enter one Setpoint
 Head Pressure, psi
 Flow Rate, mLn/min
 Outlet Velocity, cm/sec
 Average Velocity, cm/sec
 Hold-up Time, min

Outlet Pressure (absolute), psi
 Ambient Pressure (absolute), psi

Oven Temperature 3-ramp Program

Ramp	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

Translated Method

30
 320
 Unlock
 0.25
 320.0

Helium
 15.126
 2.5600
 70.17
 44.61
 1.12070

14.696
 14.696

Ramp Rate Final Temp. Final Time
 $^{\circ}\text{C}/\text{min}$ $^{\circ}\text{C}$ min

		120	0.997
29.352	160	0.000	
11.741	260	0.000	
17.611	300	3.407	

Sample Information None

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																																										
Film																																												
Thickness, μm	0.25	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.25 <input type="radio"/> 320.0																																										
Phase Ratio	320.0																																											
Carrier Gas	Helium	<input type="checkbox"/> 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																																										
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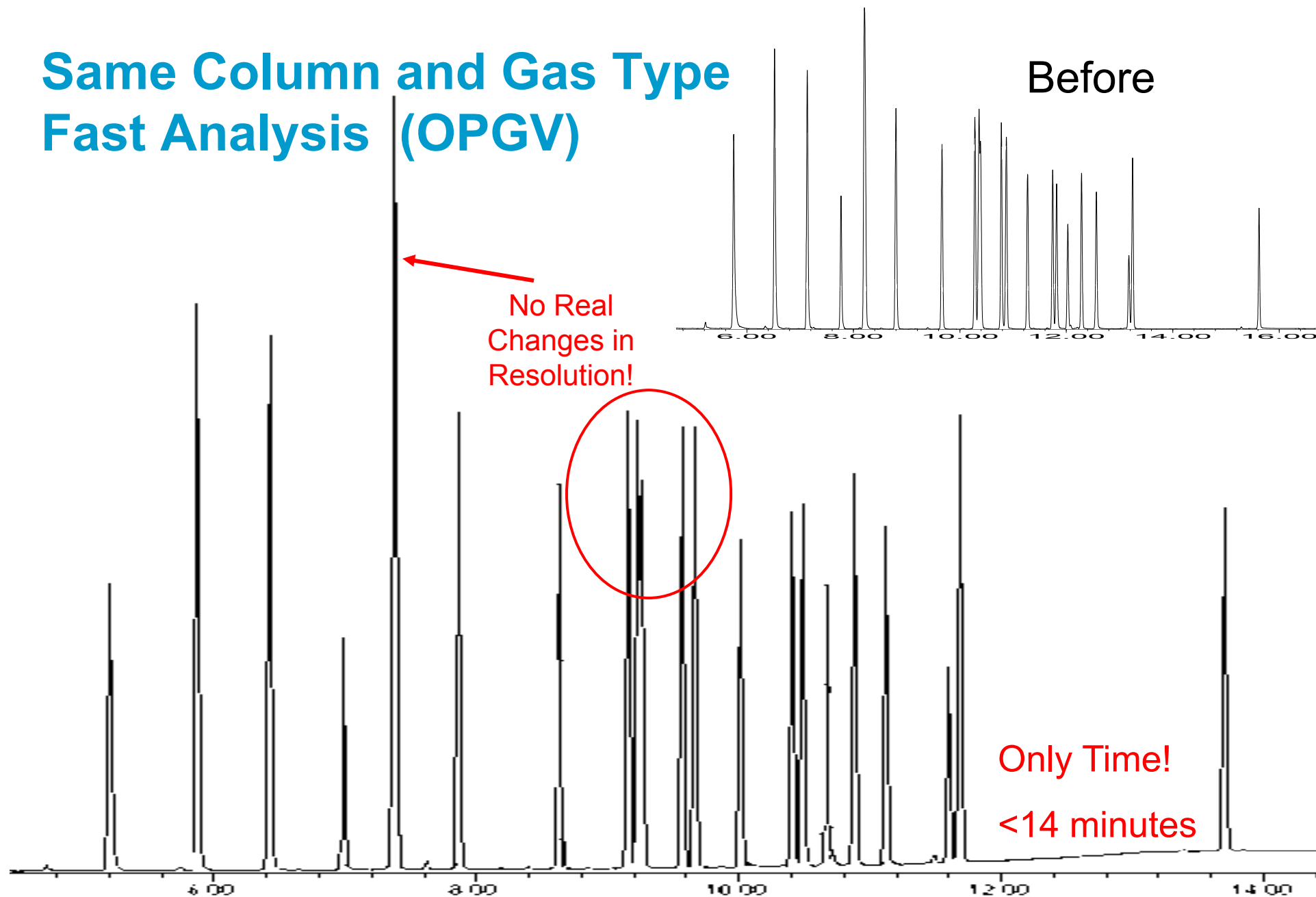
Transfer same dimensions

New Velocity

New Temp. Program

Same Column and Gas Type Fast Analysis (OPGV)

Before



Same Column and Gas type

None mode, Try higher velocities

GC Method Translation - EPACL.P.MXD

Criterion: Translate Only Best Efficiency Fast Analysis None

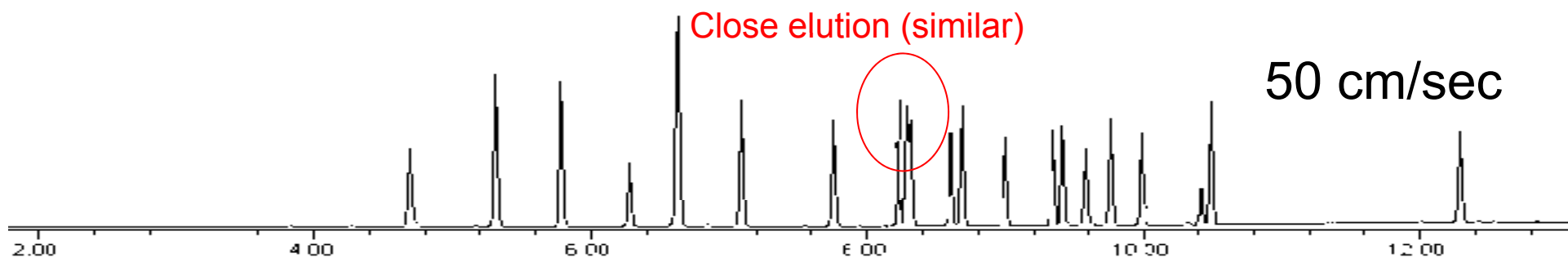
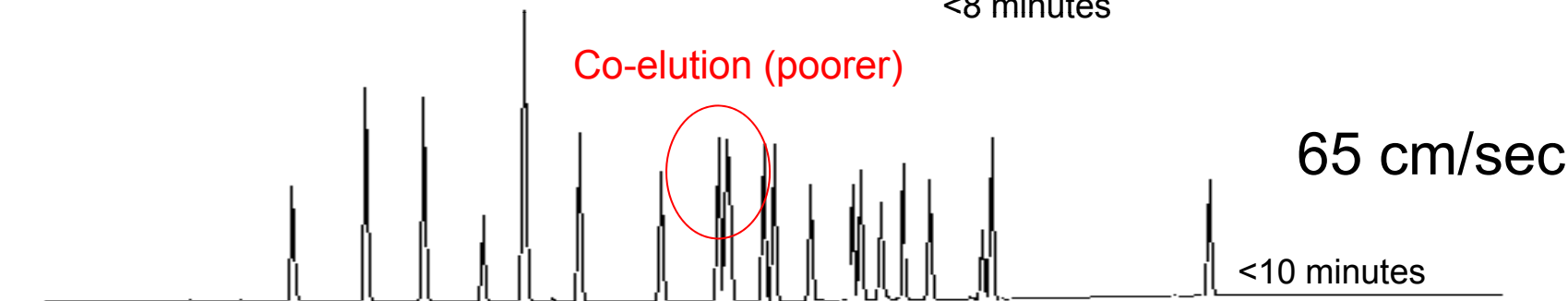
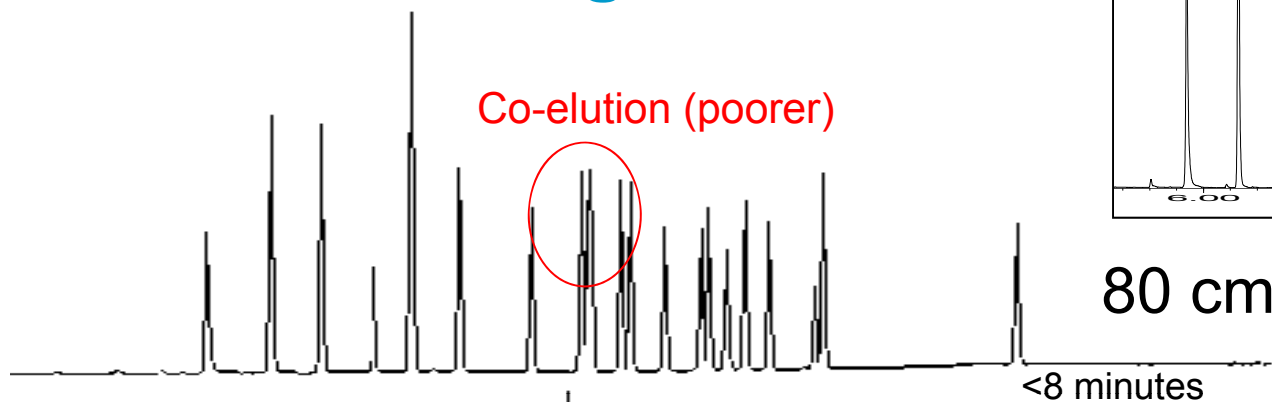
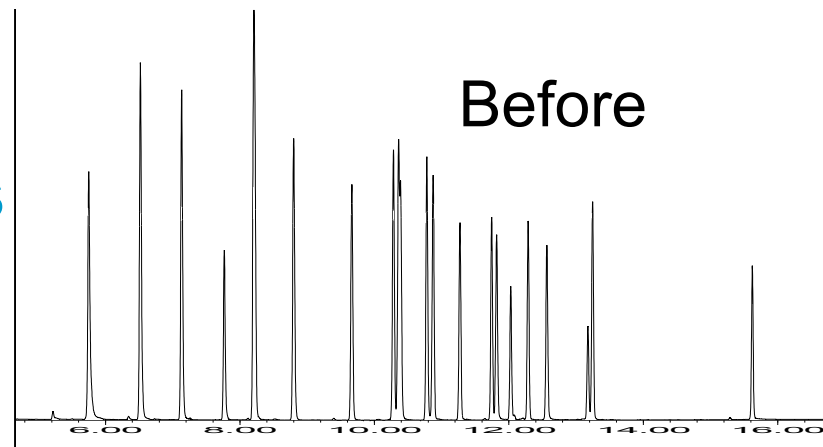
Speed gain: 1.31579

Speed gain: 1.71053

Speed gain: 2.10526

Original Method	Translated Method	Translated Method	Translated Method																																				
Column Length, m: 30 Internal Diameter, μm : 320 Film Thickness, μm : 0.25 Phase Ratio: 320.0	<input checked="" type="checkbox"/> 30 <input checked="" type="checkbox"/> 320 <input type="radio"/> Unlock <input checked="" type="radio"/> 0.25 <input type="radio"/> 320.0	<input checked="" type="checkbox"/> 30 <input checked="" type="checkbox"/> 320 <input type="radio"/> Unlock <input checked="" type="radio"/> 0.25 <input type="radio"/> 320.0	<input checked="" type="checkbox"/> 30 <input checked="" type="checkbox"/> 320 <input type="radio"/> Unlock <input checked="" type="radio"/> 0.25 <input type="radio"/> 320.0																																				
Carrier Gas Helium Head Pressure, psi: 12.786 Flow Rate, mLn/min: 2.0502 Outlet Velocity, cm/sec: 56.20 Average Velocity, cm\sec: 38 Hold-up Time, min: 1.31579 Outlet Pressure (absolute), psi: 14.696 Ambient Pressure (absolute), psi: 14.696	<input type="checkbox"/> Helium <input checked="" type="radio"/> Unlock <input type="radio"/> 17.057 <input type="radio"/> 3.0121 <input type="radio"/> 82.57 <input checked="" type="radio"/> 50 <input type="radio"/> 1.00000 <input type="checkbox"/> 14.696 <input type="checkbox"/> 14.696	<input type="checkbox"/> Helium <input checked="" type="radio"/> Unlock <input type="radio"/> 22.554 <input type="radio"/> 4.4541 <input type="radio"/> 122.10 <input checked="" type="radio"/> 65 <input type="radio"/> 0.769231 <input type="checkbox"/> 14.696 <input type="checkbox"/> 14.696	<input type="checkbox"/> Helium <input checked="" type="radio"/> Unlock <input type="radio"/> 28.205 <input type="radio"/> 6.1761 <input type="radio"/> 169.30 <input checked="" type="radio"/> 80 <input type="radio"/> 0.625000 <input type="checkbox"/> 14.696 <input type="checkbox"/> 14.696																																				
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Sample Information: None																																							

Same Column and Gas type None mode, Higher velocities



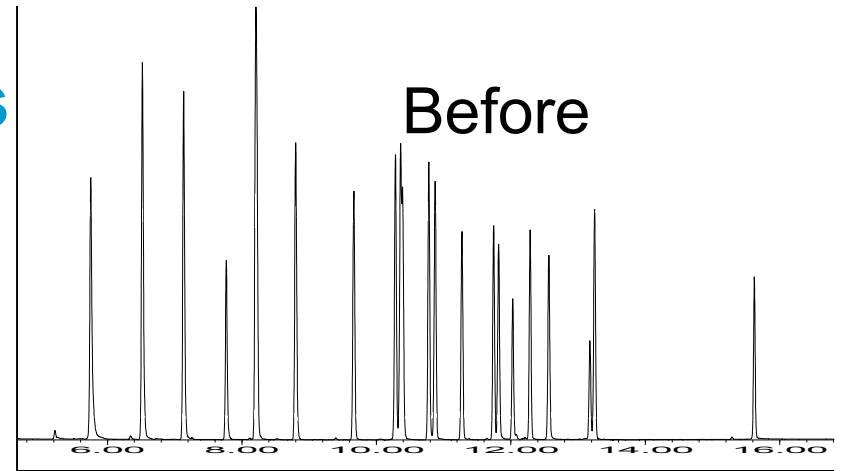
Same Column, **Hydrogen** Carrier Gas Translate Only

GC Method Translation - EPACLP.MXD

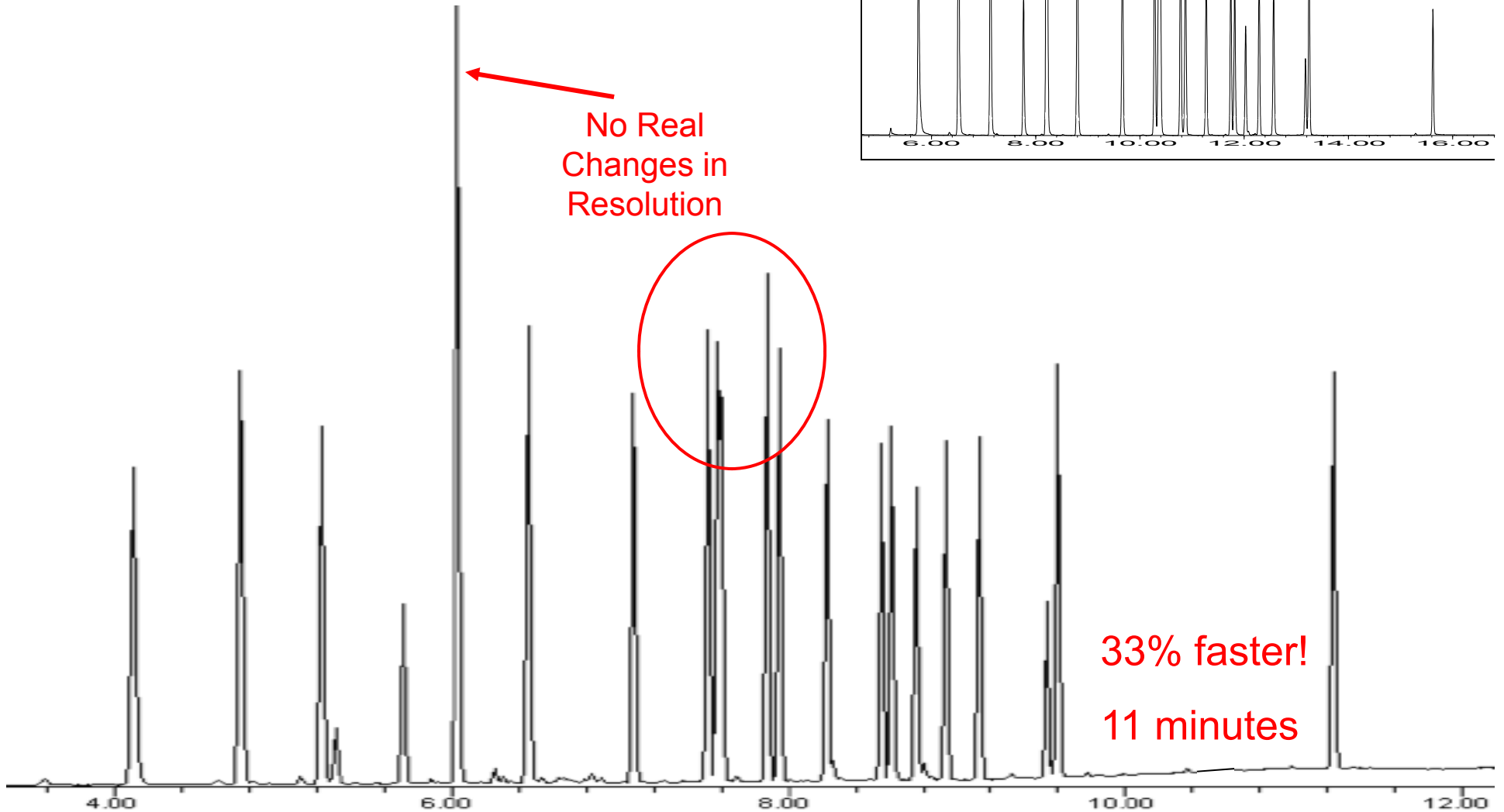
Criterion: Translate Only Best Efficiency Fast Analysis None **Speed gain: 1.42668**

	Original Method	Translated Method																																										
Column																																												
Length, m	30	<input checked="" type="checkbox"/> 30																																										
Internal Diameter, μm	320	<input checked="" type="checkbox"/> 320																																										
Film																																												
Thickness, μm	0.25	<input type="radio"/> Unlock																																										
Phase Ratio	320.0	<input checked="" type="radio"/> 0.25																																										
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Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696																																										
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	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th>$^{\circ}\text{C}/\text{min}$</th> <th>$^{\circ}\text{C}$</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</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>$^{\circ}\text{C}/\text{min}$</th> <th>$^{\circ}\text{C}$</th> <th>min</th> </tr> </thead> <tbody> <tr> <td>Initial</td> <td>120</td> <td>0.820</td> </tr> <tr> <td>Ramp 1</td> <td>35.667</td> <td>160</td> <td>0.000</td> </tr> <tr> <td>Ramp 2</td> <td>14.267</td> <td>260</td> <td>0.000</td> </tr> <tr> <td>Ramp 3</td> <td>21.400</td> <td>300</td> <td>2.804</td> </tr> </tbody> </table>	Ramp Rate	Final Temp.	Final Time	$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min	Initial	120	0.820	Ramp 1	35.667	160	0.000	Ramp 2	14.267	260	0.000	Ramp 3	21.400	300	2.804
Ramp Rate	Final Temp.	Final Time																																										
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Sample Information	None																																											

Same Column, H_2 Carrier Gas Translate Only



No Real Changes in Resolution



Same Column, H2 Carrier Gas, Higher Velocities

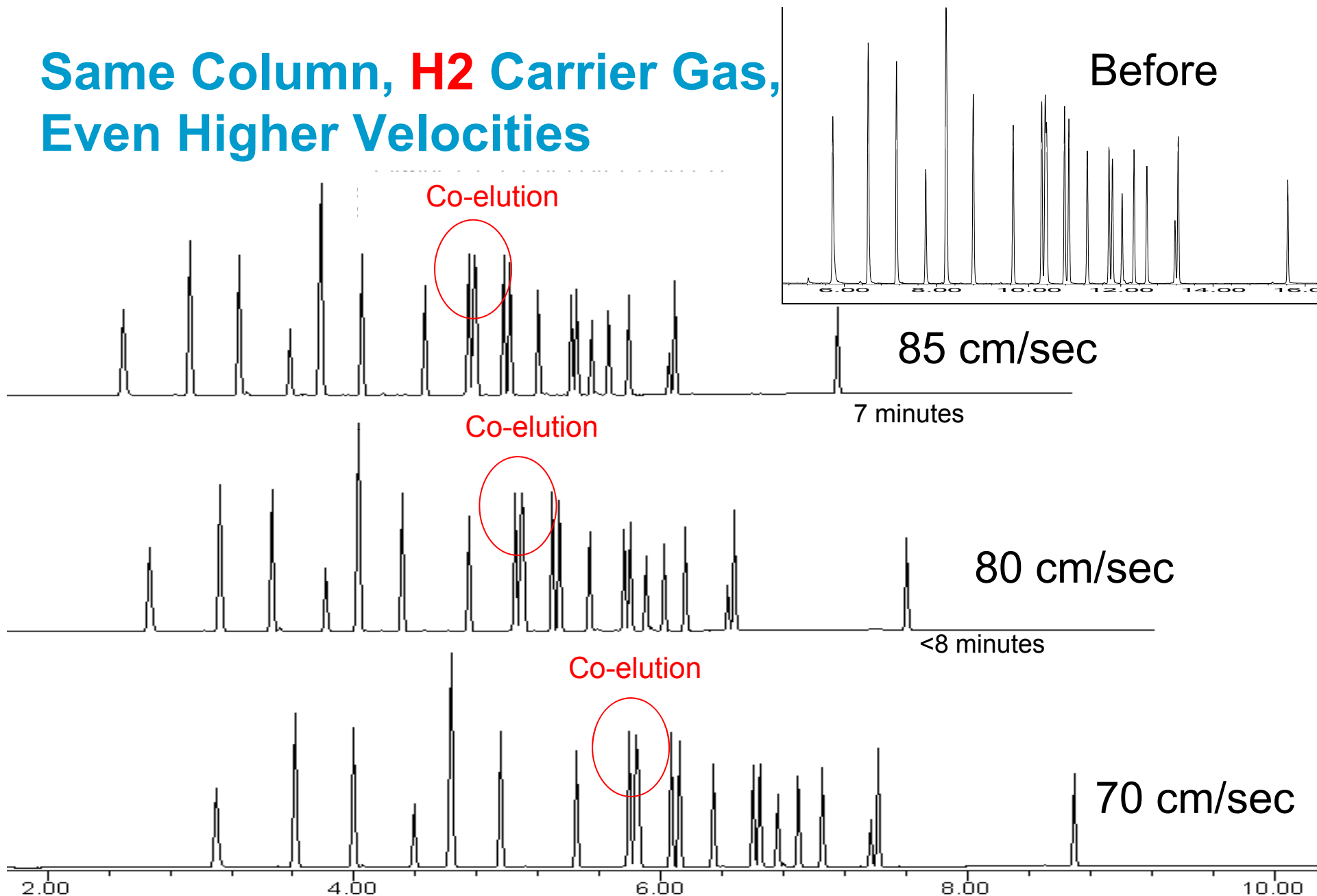
GC Method Translation - EPACLP.MXD

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																																																																																				
Column																																																																																								
Length, m	30.00	<input checked="" type="checkbox"/> 30.00	<input checked="" type="checkbox"/> 30.00	<input checked="" type="checkbox"/> 30.00																																																																																				
Internal Diameter, μm	320.0	<input checked="" type="checkbox"/> 320.0	<input checked="" type="checkbox"/> 320.0	<input checked="" type="checkbox"/> 320.0																																																																																				
Film																																																																																								
Thickness, μm	0.250	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.250 <input type="radio"/> 320.0	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.250 <input type="radio"/> 320.0	<input type="radio"/> Unlock <input checked="" type="radio"/> 0.250 <input type="radio"/> 320.0																																																																																				
Phase Ratio	320.0	<input type="radio"/> 320.0	<input type="radio"/> 320.0	<input type="radio"/> 320.0																																																																																				
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Carrier Gas	Helium	<input type="checkbox"/> Hydrogen	<input type="checkbox"/> Hydrogen	<input type="checkbox"/> 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"/> 10.550	<input type="radio"/> 12.118	<input type="radio"/> 12.908																																																																																				
Flow Rate, mLn/min	2.0502	<input type="radio"/> 3.5509	<input type="radio"/> 4.2388	<input type="radio"/> 4.6012																																																																																				
Outlet Velocity, cm/sec	56.20	<input type="radio"/> 97.34	<input type="radio"/> 116.19	<input type="radio"/> 126.13																																																																																				
Average Velocity, cm/sec	38.00	<input type="radio"/> 70	<input type="radio"/> 80	<input type="radio"/> 85																																																																																				
Hold-up Time, min	1.31579	<input type="radio"/> 0.714286	<input type="radio"/> 0.625000	<input type="radio"/> 0.588235																																																																																				
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696																																																																																				
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Sample Information	None																																																																																							

Same Column, H₂ Carrier Gas, Even Higher Velocities



New Column Dimensions, H₂ Gas, Translate Only

GC Method Translation

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

	Original Method	Translated Method																																				
Column																																						
Length, m	30	<input type="checkbox"/> 20																																				
Internal Diameter, μm	316	<input type="checkbox"/> 177																																				
Film																																						
Thickness, μm	0.25	<input checked="" type="radio"/> Unlock																																				
Phase Ratio	316.0	<input type="radio"/> 0.18																																				
		<input type="radio"/> 245.8																																				
Carrier Gas	Helium	<input type="checkbox"/> Hydrogen																																				
Enter one Setpoint																																						
Head Pressure, psi	13.126	22.883																																				
Flow Rate, mLn/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	<input type="checkbox"/> 14.696																																				
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696																																				
Oven Temperature 3-ramp Program																																						
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Ramp Rate	Final Temp.	Final Time																																				
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Sample Information None																																						

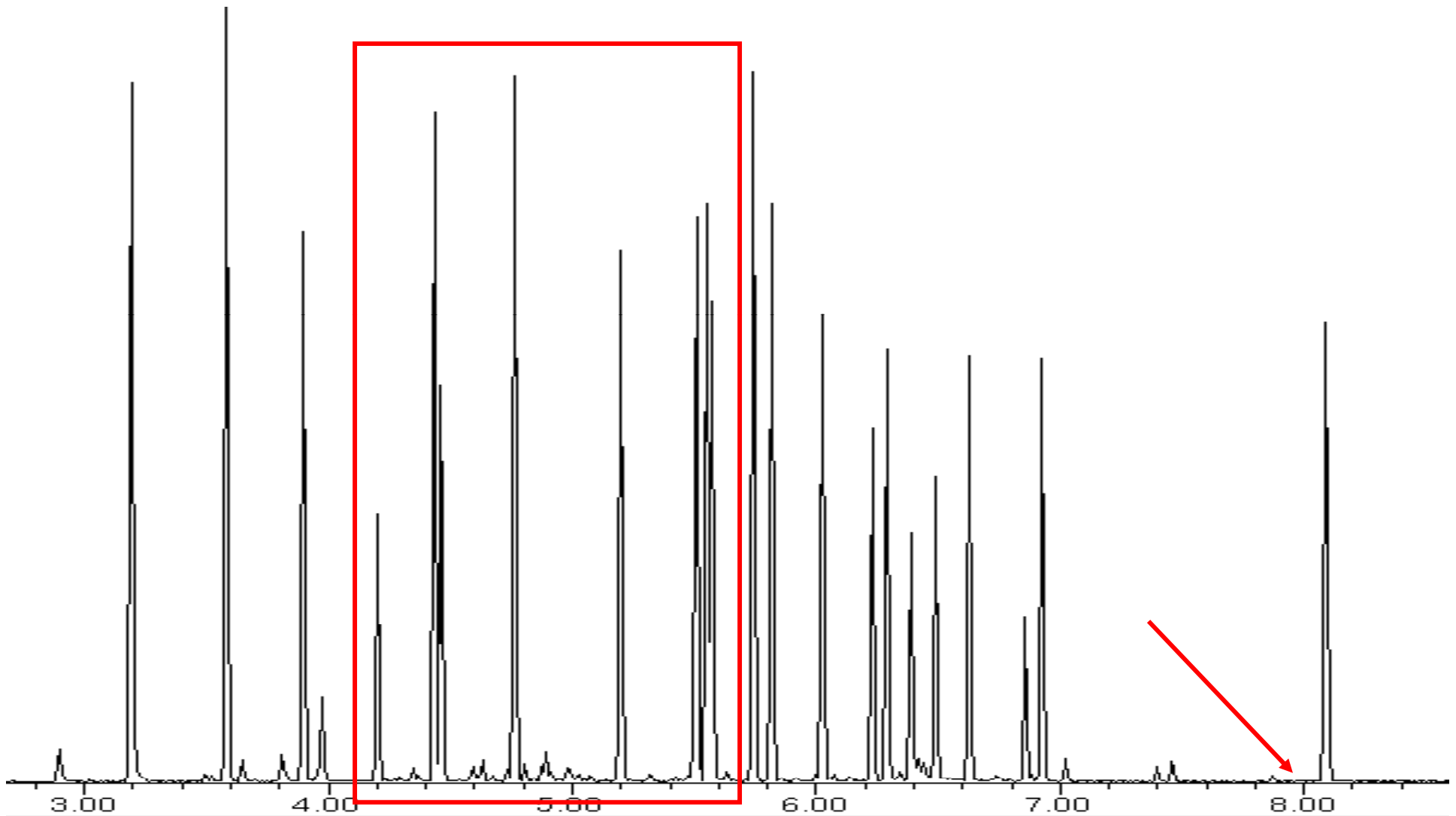
Input NEW dimensions

Close enough (got lucky)

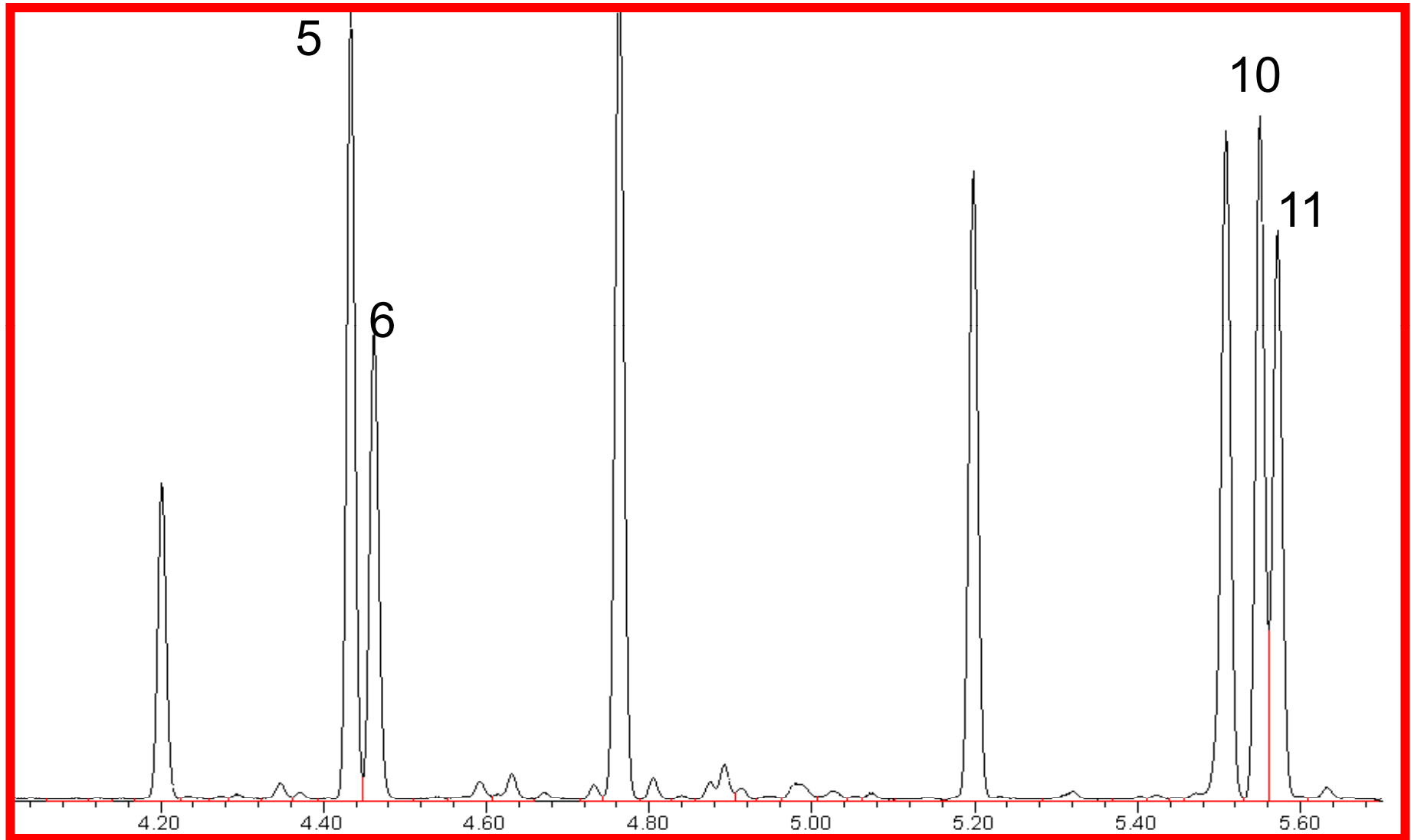
New Velocity

New Temp. Program

New Column Dimensions, H₂ Gas, Translate Only



New Column Dimensions, **H2** Gas, Translate Only



New Column Dimensions, H2 Gas, Fast Analysis

GC Method Translation - EPACLP.MXD

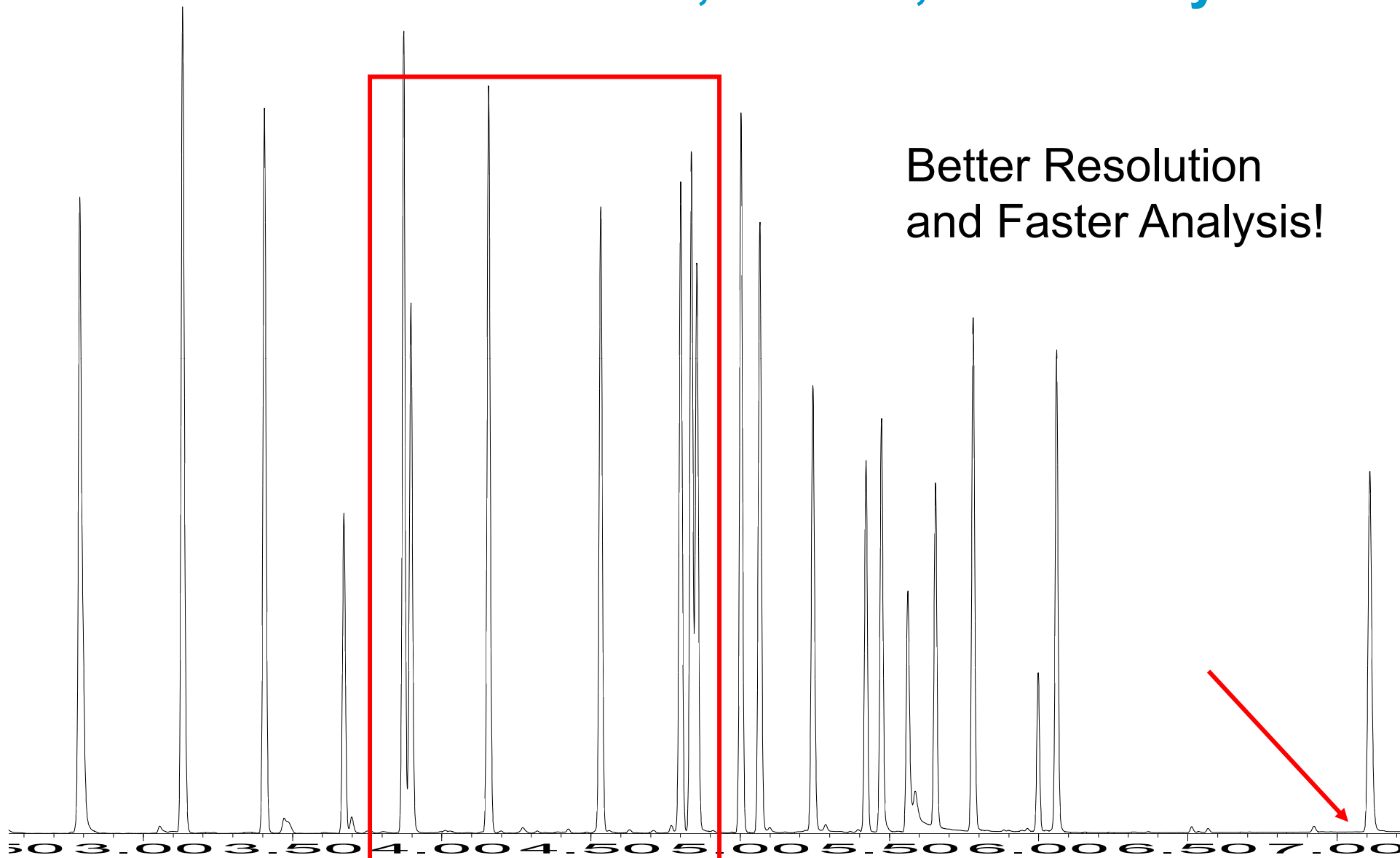
Criterion: Translate Only Best Efficiency Fast Analysis None **Speed gain: 2.34453**

	Original Method	Translated Method																																				
Column																																						
Length, m	30	<input type="checkbox"/> 20																																				
Internal Diameter, μm	320	<input type="checkbox"/> 177																																				
Film		<input checked="" type="radio"/> Unlock																																				
Thickness, μm	0.25	<input type="radio"/> 0.18																																				
Phase Ratio	320.0	<input type="radio"/> 245.8																																				
Carrier Gas	Helium	<input type="checkbox"/> Hydrogen																																				
Enter one Setpoint																																						
Head Pressure, psi	12.786	26.714																																				
Flow Rate, mLn/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	<input type="checkbox"/> 14.696																																				
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696																																				
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>$^{\circ}\text{C}/\text{min}$</th> <th>$^{\circ}\text{C}$</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</td> </tr> <tr> <td>Ramp 2</td> <td>10</td> <td>260</td> </tr> <tr> <td>Ramp 3</td> <td>15</td> <td>300</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	Ramp 2	10	260	Ramp 3	15	300	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th>$^{\circ}\text{C}/\text{min}$</th> <th>$^{\circ}\text{C}$</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> </tr> <tr> <td>Ramp 2</td> <td>23.445</td> <td>260</td> </tr> <tr> <td>Ramp 3</td> <td>35.168</td> <td>300</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	Ramp 2	23.445	260	Ramp 3	35.168	300
Ramp Rate	Final Temp.	Final Time																																				
$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min																																				
Initial	120	1.17																																				
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Sample Information None																																						

New Velocity

New Temp. Program

New Column Dimensions, H₂ Gas, Fast Analysis



Better Resolution
and Faster Analysis!

New Column Dimensions, H2 Gas, Higher Velocities

GC Method Translation - EPACLP.MXD

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

Original Method vs **Translated Method**

Column
 Length, m: 30 → 20
 Internal Diameter, µm: 320 → 177
 Film Thickness, µm: 0.25 → 0.18
 Phase Ratio: 320.0 → 245.8

Carrier Gas
 Helium → Hydrogen
 Head Pressure, psi: 12.786 → 29.598
 Flow Rate, mLn/min: 2.0502 → 2.0619
 Outlet Velocity, cm/sec: 56.20 → 184.91
 Average Velocity, cm/sec: 38 → 85
 Hold-up Time, min: 1.31579 → 0.392157
 Outlet Pressure (absolute), psi: 14.696
 Ambient Pressure (absolute), psi: 14.696

Oven Temperature 3-ramp Program

	Ramp Rate °C/min	Final Temp. °C	Final Time min
Initial		120	1.17
Ramp 1	25	160	0
Ramp 2	10	260	0
Ramp 3	15	300	4

Translated Method (Speed gain: 2.88086)

Hydrogen
 Head Pressure, psi: 33.397
 Flow Rate, mLn/min: 2.4764
 Outlet Velocity, cm/sec: 222.08
 Average Velocity, cm/sec: 95
 Hold-up Time, min: 0.350877
 Outlet Pressure (absolute), psi: 14.696
 Ambient Pressure (absolute), psi: 14.696

	Ramp Rate °C/min	Final Temp. °C	Final Time min
Initial		120	0.406
Ramp 1	64.440	160	0.000
Ramp 2	25.776	260	0.000
Ramp 3	38.664	300	1.552

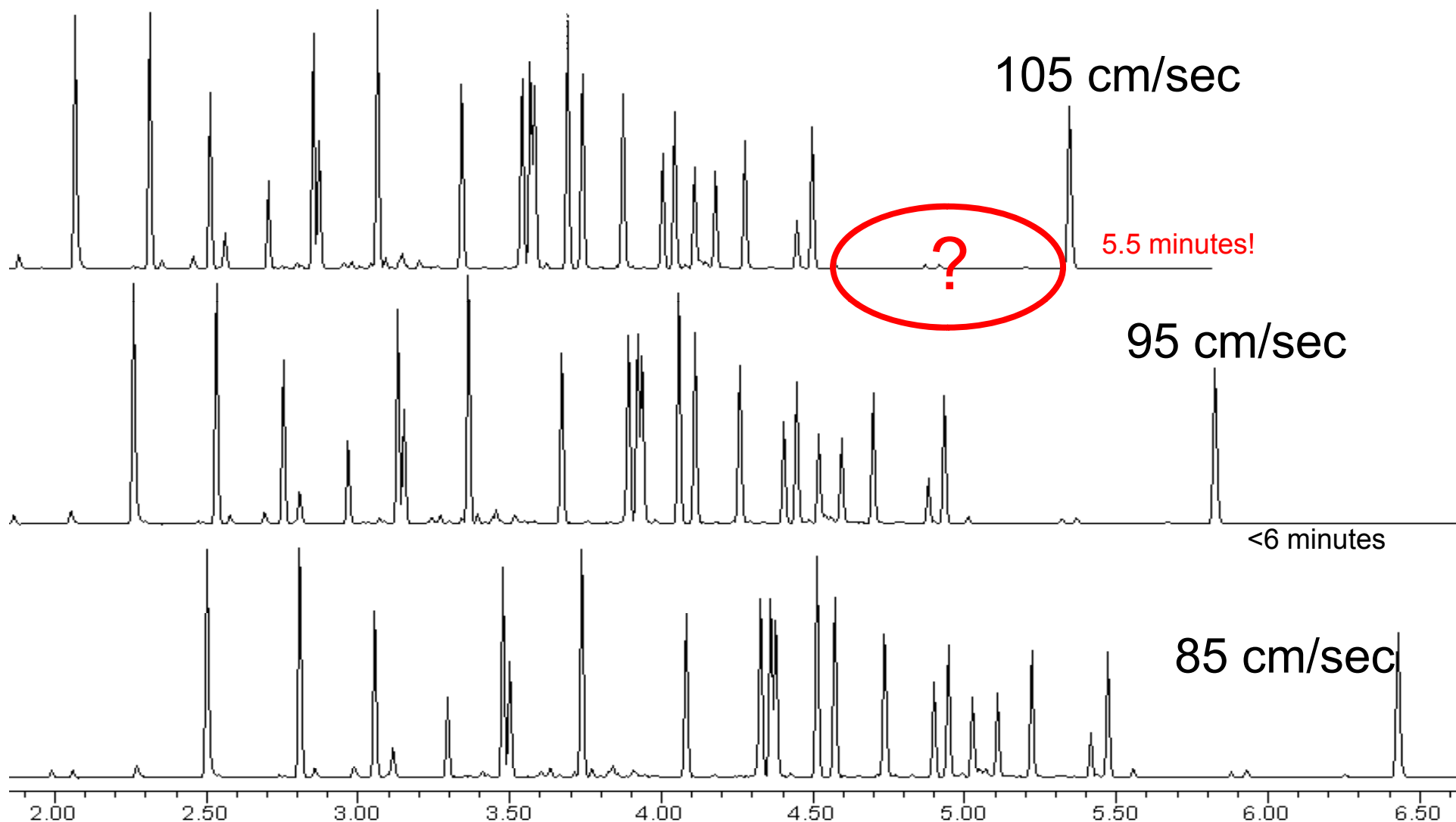
Translated Method (Speed gain: 3.18411)

Hydrogen
 Head Pressure, psi: 37.244
 Flow Rate, mLn/min: 2.9308
 Outlet Velocity, cm/sec: 262.84
 Average Velocity, cm/sec: 105
 Hold-up Time, min: 0.317460
 Outlet Pressure (absolute), psi: 14.696
 Ambient Pressure (absolute), psi: 14.696

	Ramp Rate °C/min	Final Temp. °C	Final Time min
Initial		120	0.367
Ramp 1	79.603	160	0.000
Ramp 2	31.841	260	0.000
Ramp 3	47.762	300	1.256

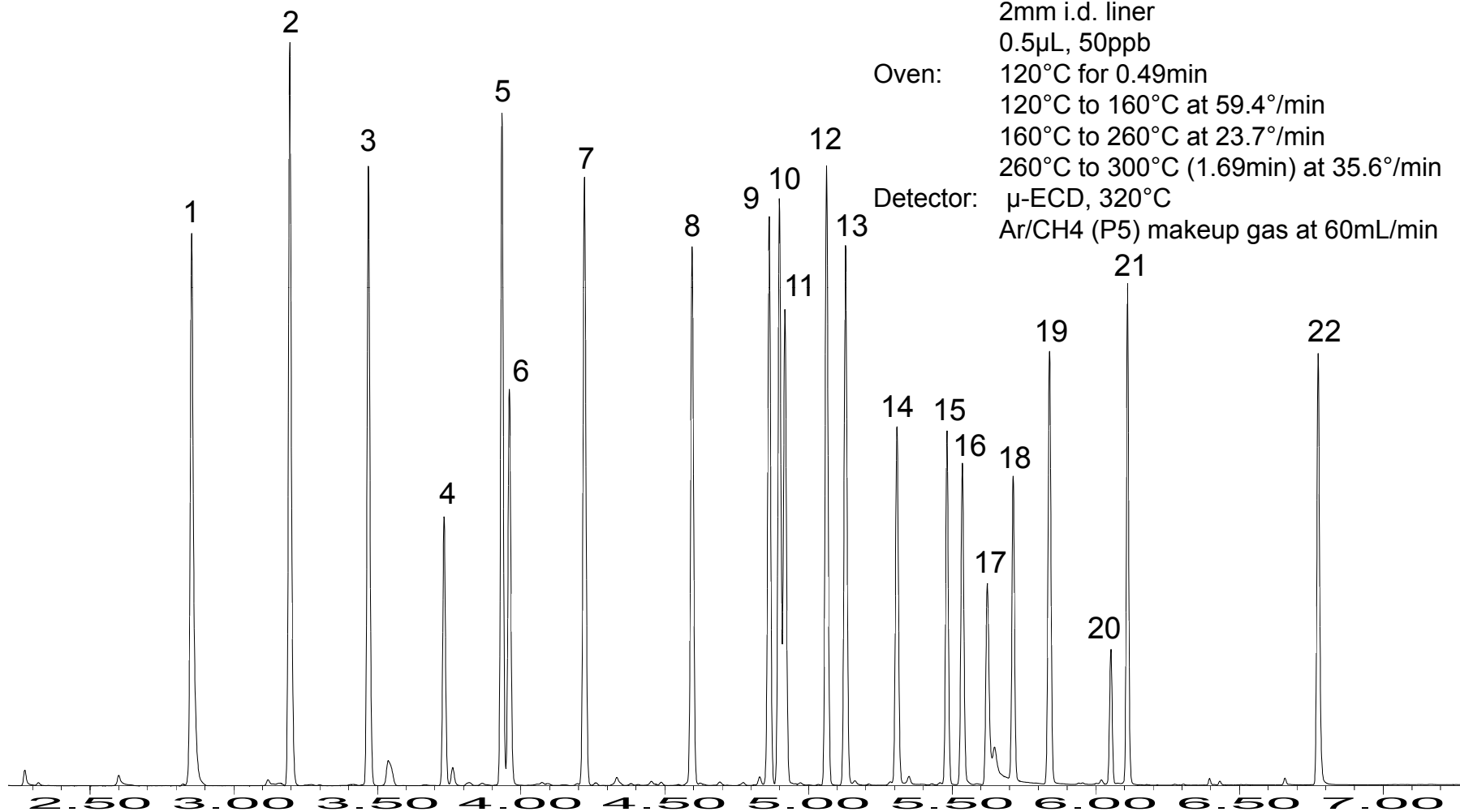
Sample Information: None

New Column Dimensions, H₂ Gas, Higher Velocities

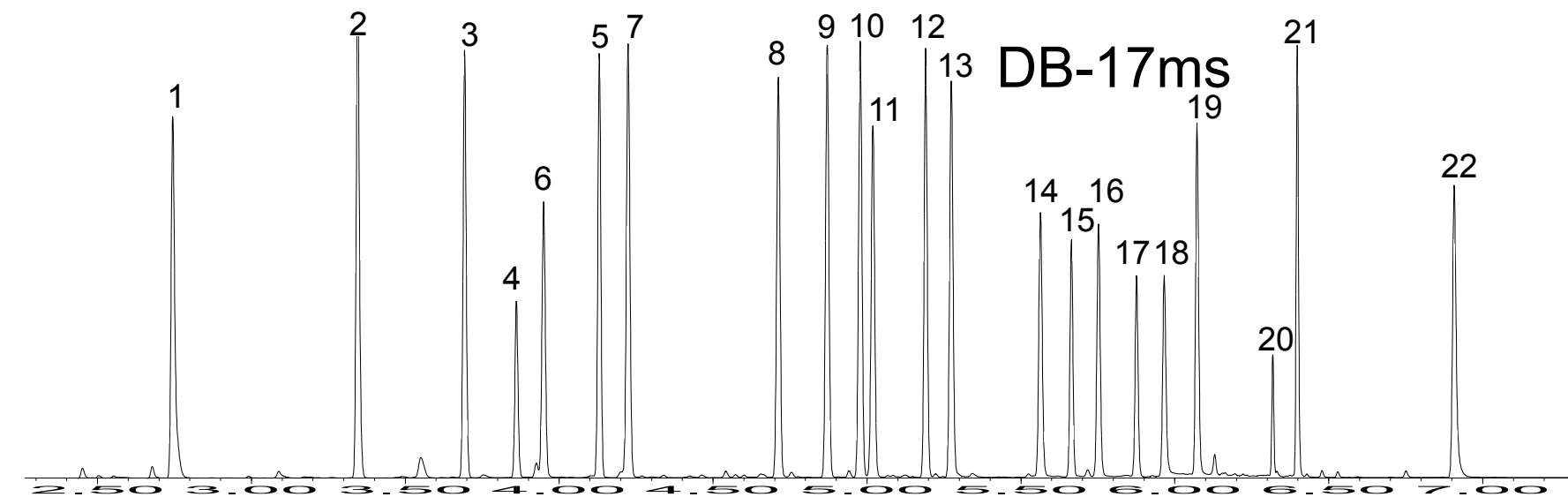
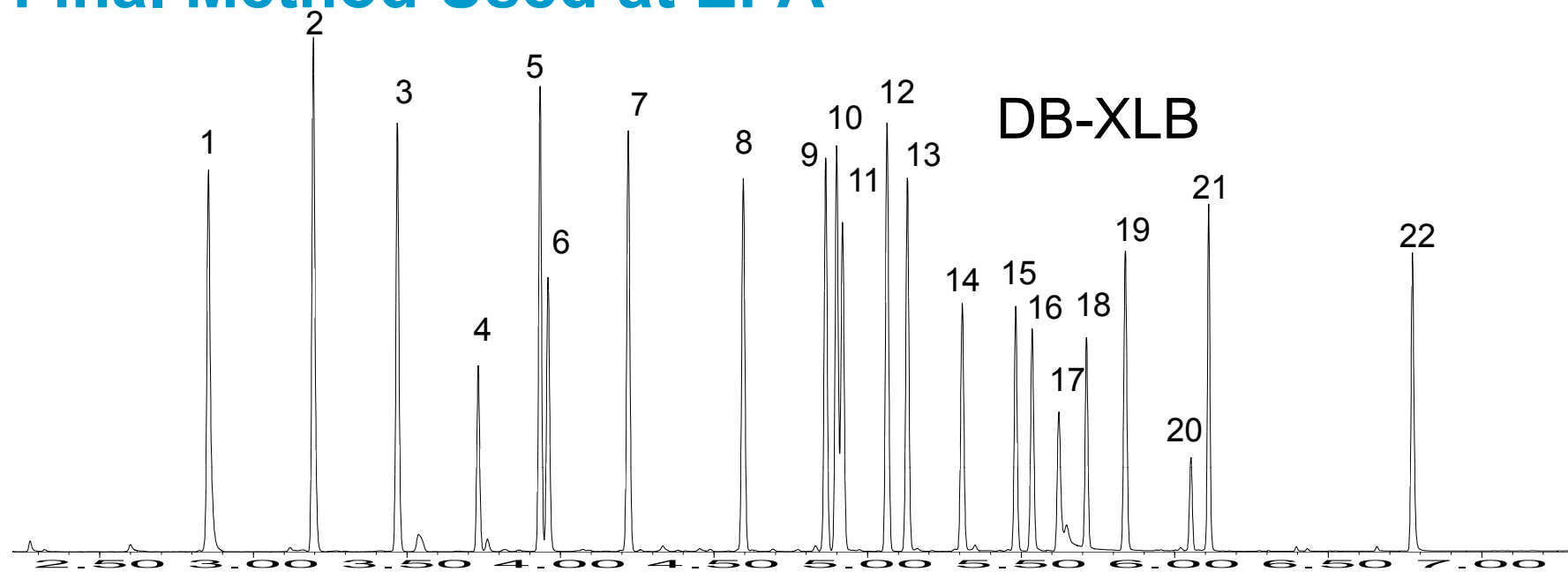


Final Method Used at EPA

Column: DB-XLB
20m x 0.18mm i.d., 0.18 μ m
Carrier: H₂, constant flow, 77.3cm/s at 120°C
Injector: Pulsed Splitless, 220 °C
Pulse pressure & time: 35psi for 0.5min
Flow ramp at 6.25min of 99mL/min² to 3mL/min
2mm i.d. liner
0.5 μ L, 50ppb
Oven: 120°C for 0.49min
120°C to 160°C at 59.4°/min
160°C to 260°C at 23.7°/min
260°C to 300°C (1.69min) at 35.6°/min
Detector: μ -ECD, 320°C
Ar/CH₄ (P5) makeup gas at 60mL/min



Final Method Used at EPA



Food/Fragrance – Method translation

GC Method Translation

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

	Original Method	Translated Method																								
Column																										
Length, m	30	<input type="checkbox"/> 20																								
Internal Diameter, μm	250.0	<input type="checkbox"/> 180																								
Film																										
Thickness, μm	0.250	<input type="radio"/> Unlock																								
Phase Ratio	250.0	<input type="radio"/> 0.180																								
		<input checked="" type="radio"/> 250.0																								
Carrier Gas	Helium	<input type="checkbox"/> Helium																								
Enter one Setpoint																										
Head Pressure, psi	0.563	5.698																								
Flow Rate, mLn/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																								
Oven Temperature 1-ramp Program																										
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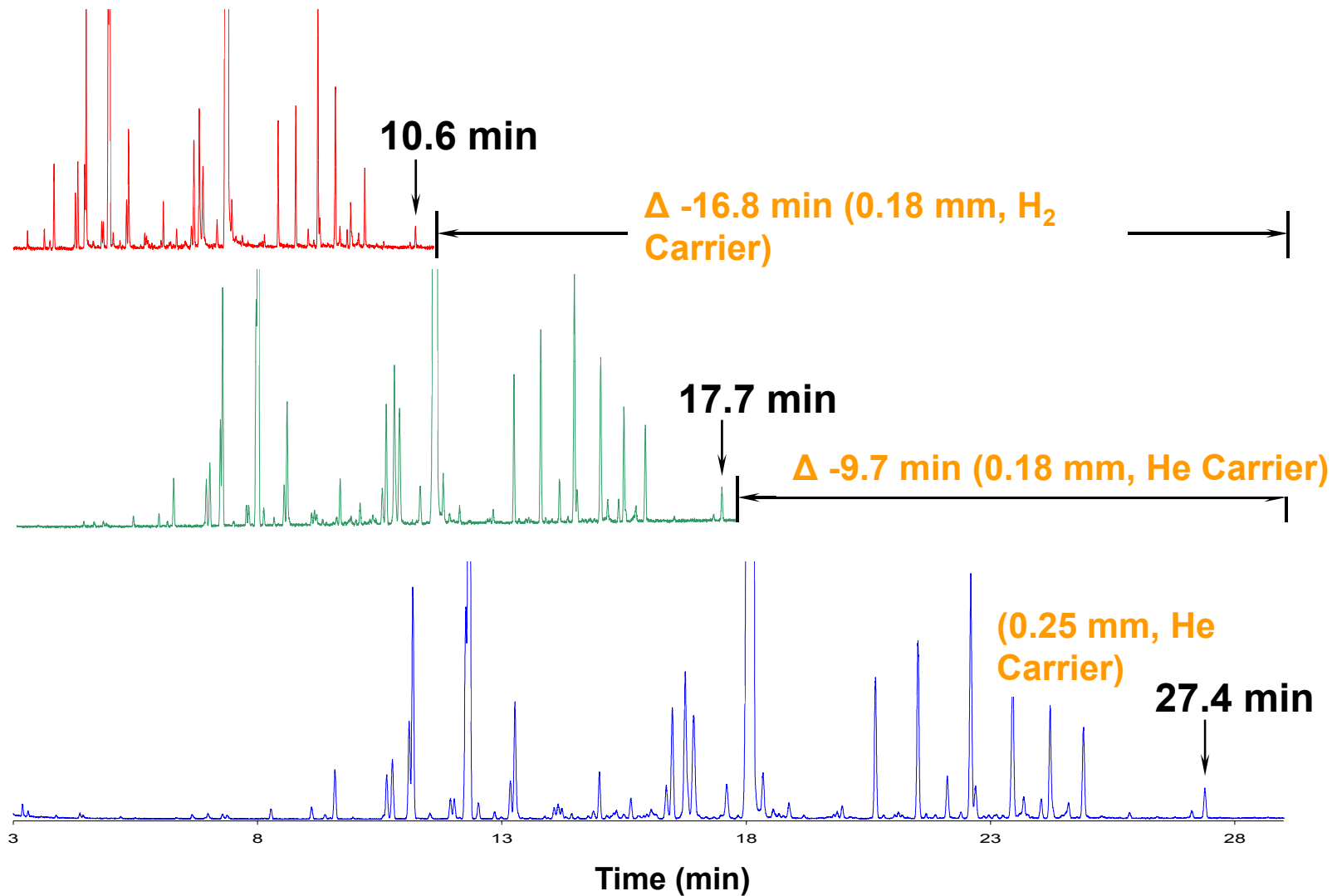
Food/Fragrance – Method translation

GC Method Translation - □ ×

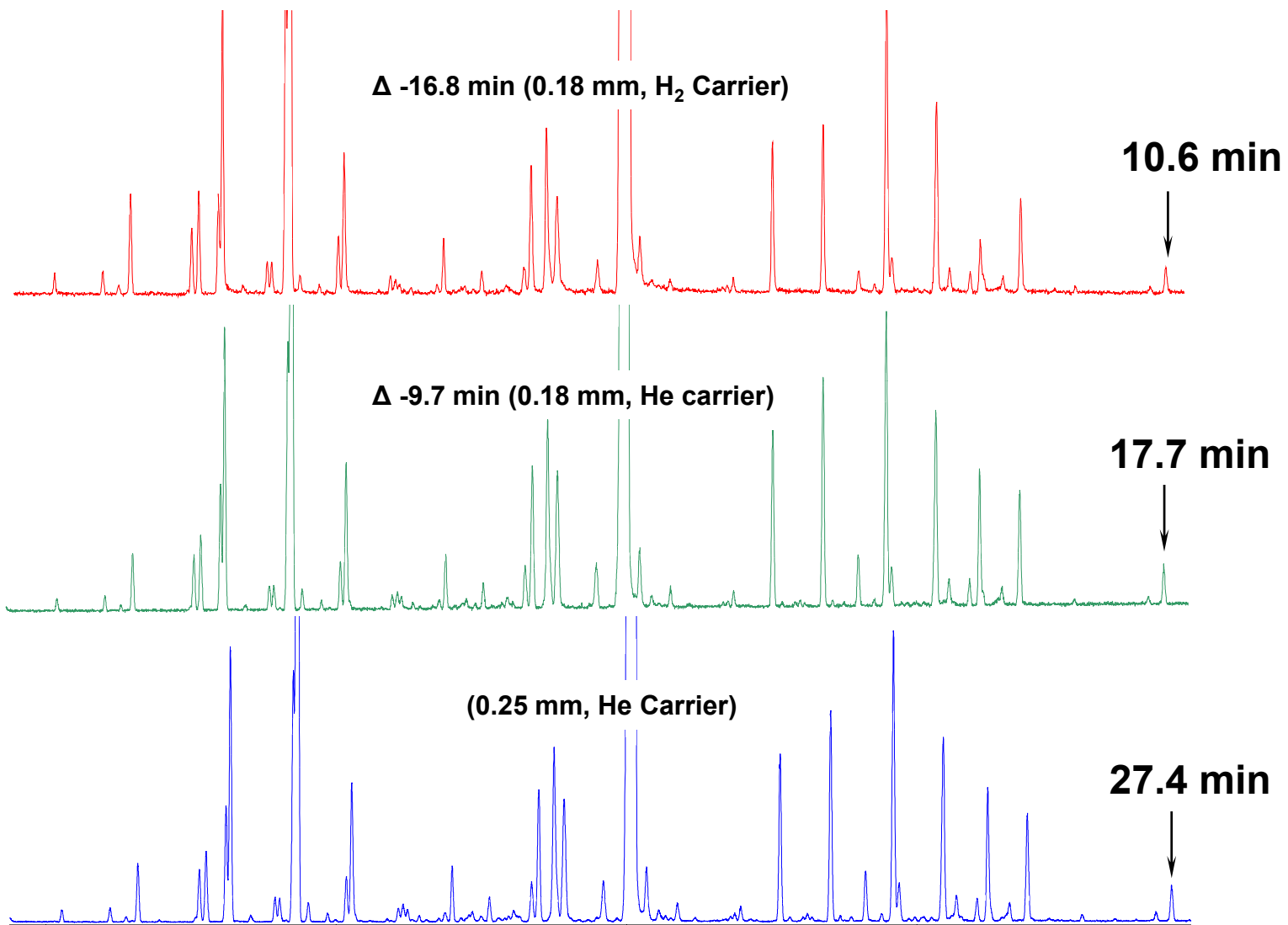
Criterion: Translate Only Best Efficiency Fast Analysis None Speed gain: 2.59618

	Original Method	Translated Method																								
Column																										
Length, m	30	<input type="checkbox"/> 20																								
Internal Diameter, μm	250.0	<input type="checkbox"/> 180																								
Film																										
Thickness, μm	0.250	<input type="radio"/> Unlock																								
Phase Ratio	250.0	<input type="radio"/> 0.180																								
		<input checked="" type="radio"/> 250.0																								
Carrier Gas	Helium	<input type="checkbox"/> Hydrogen																								
Enter one Setpoint																										
Head Pressure, psi	0.563	0.610																								
Flow Rate, mLn/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																								
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Sample Information	None																									

Spearmint Oil



Spearmint Oil – Resolution Check



Resolution Maintained

Compound Resolution			
Compound	0.25 mm	0.18 mm	0.18 mm
s	Helium	Helium	Hydrogen
Sabinene	1.52	1.59	1.56
β -Pinene			
α -Terpinene	1.61	1.73	1.86
p-Cymene			
Speed Gain	N/A	35%	61%

CONCLUSIONS

Stationary Phases – Chosen for optimized selectivity

Diameter – Smaller allows shorter length but has less capacity

Make Small Changes – Again think capacity

Carrier Gas – Hydrogen, high velocity, but can still go fast with He

Temperature Program – Scale properly to preserve elution pattern

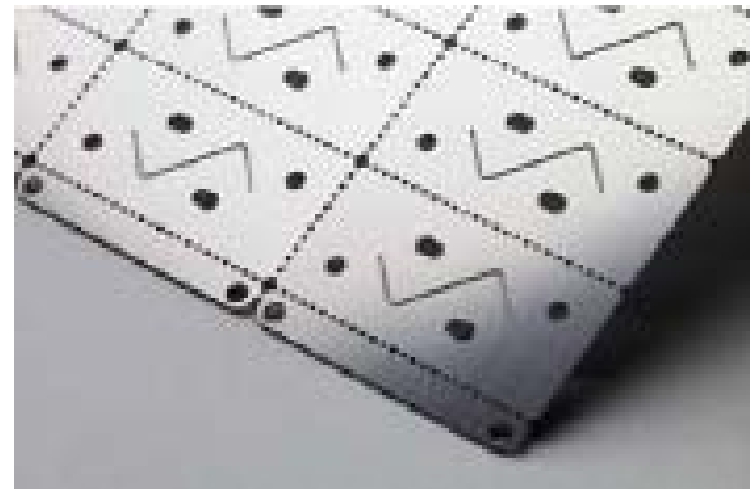
Method Translation Software – FREE, reliable

Flow Ramp – Increase at end of run for late eluters (if necessary)

New Devices & Instrument Improvements Provide Even Faster Analytical Cycle Times



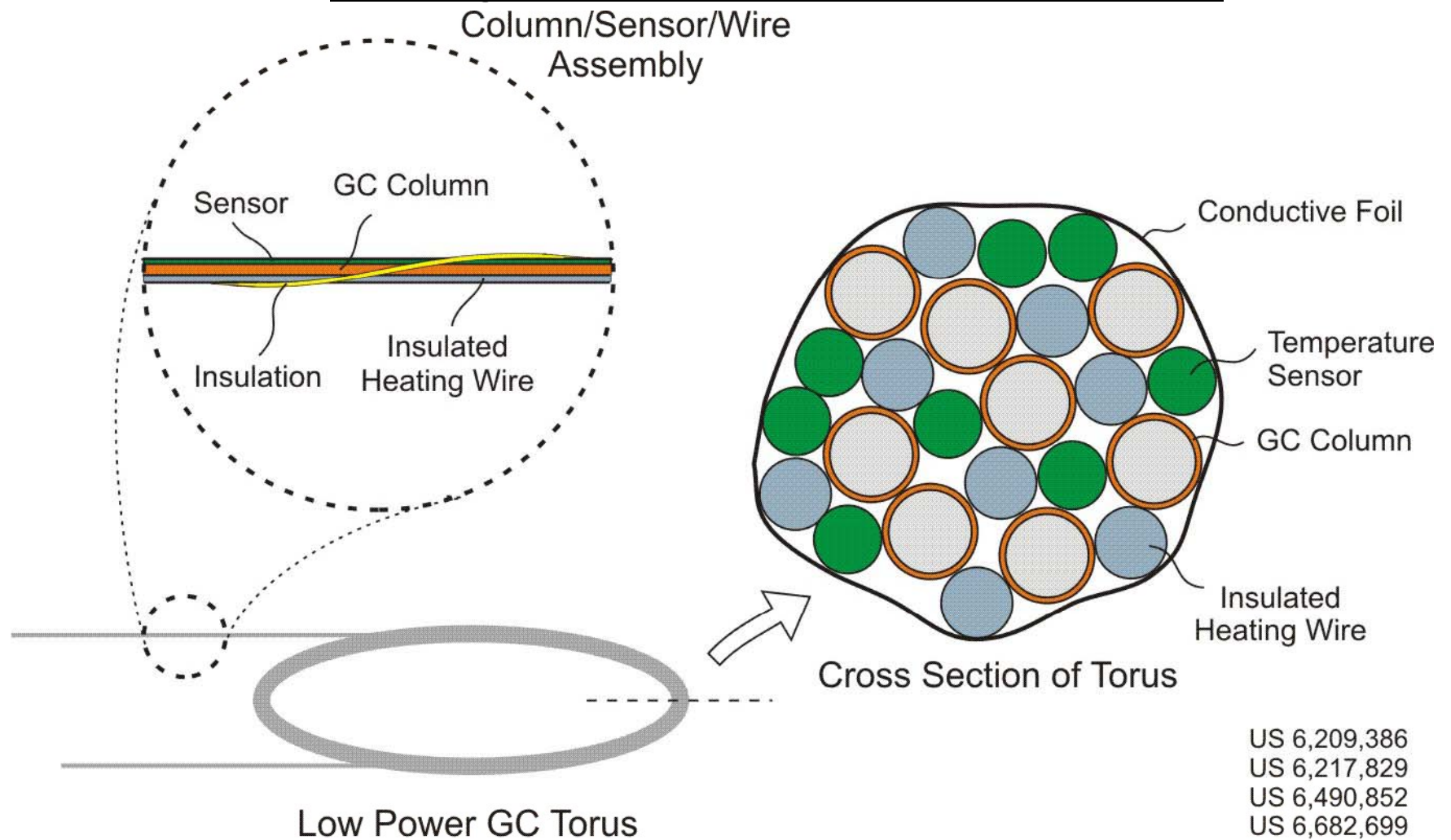
Low Thermal Mass Technology



Capillary Flow Technology

“LTM” (Low Thermal Mass) Technology (Patented)

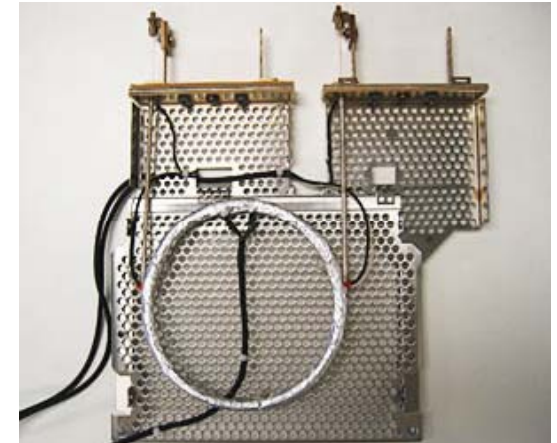
Directly heat/cool fused silica GC columns



A Closer Look



LTM Retrofit Door



LTM Column



LTM Column Module

TECHNICAL SUPPORT

1-800-227-9770, #3, #3, #1

866-422-5571 (FAX)

E-mail:

gc-column-support@agilent.com

