

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

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Application Engineer
July 28, 2010



Questions to Ask

What information do you need from your analysis?

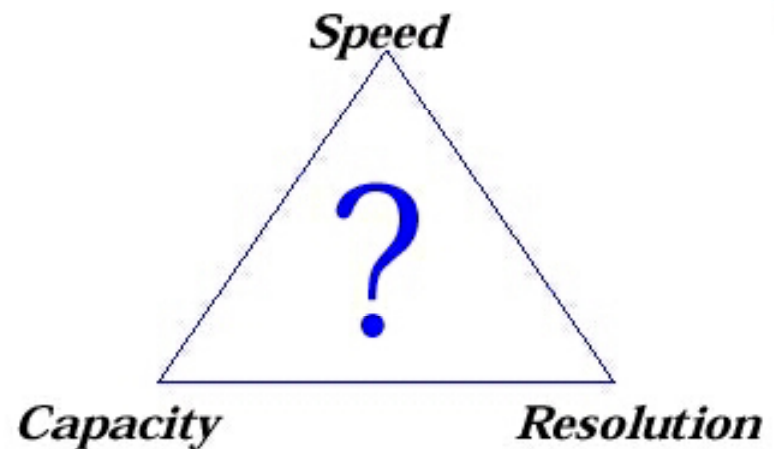
Do you have more baseline than you need between your peaks?

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

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

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

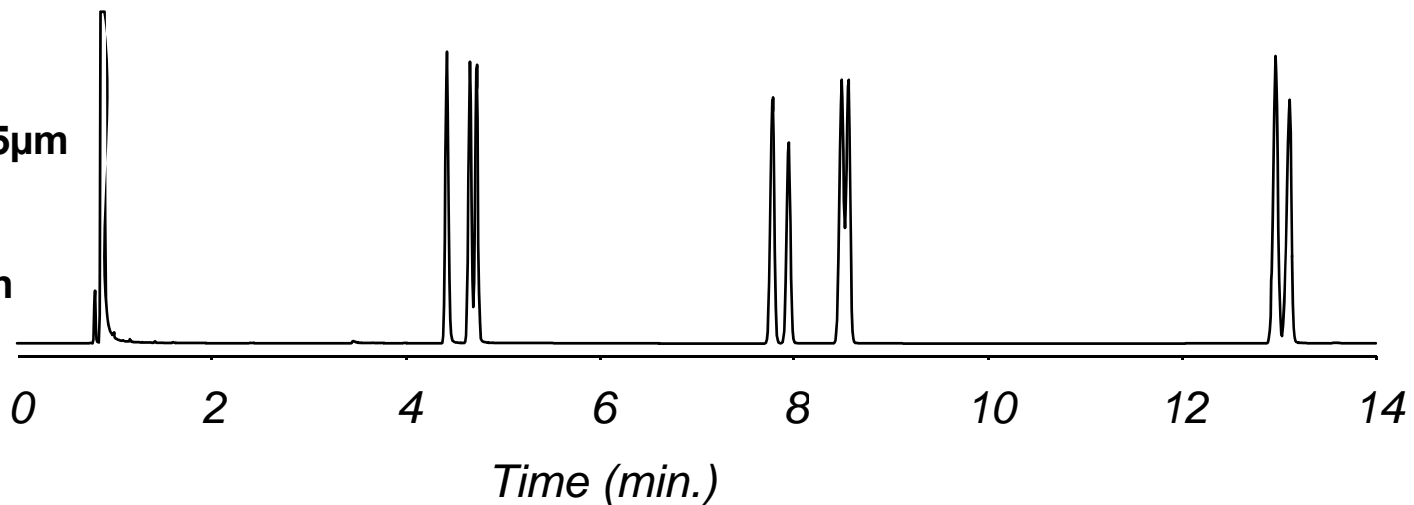
Match analyte polarity to stationary phase polarity

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

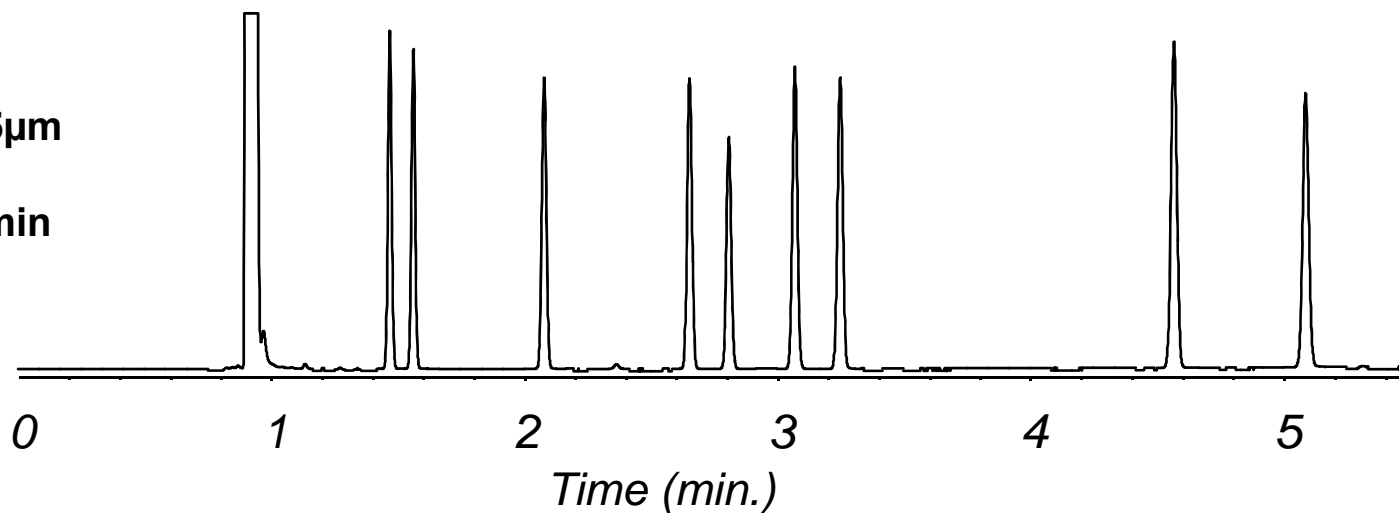
Take advantage of unique interactions between analyte and stationary phase functional groups

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
Retention	$k = f$ (T, d_f , r_c)	r_c = column radius d_f = film thickness
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

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

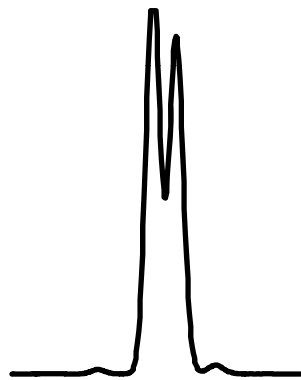
Length X 4 = Resolution X 2

$$t \propto L$$



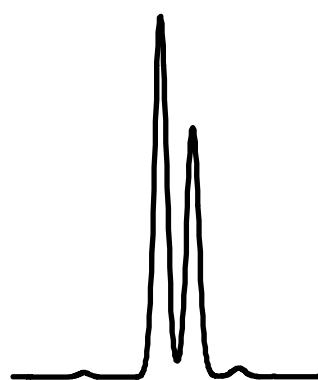
Column Length VS Resolution and Retention: Isothermal

R=0.84
2.29 min



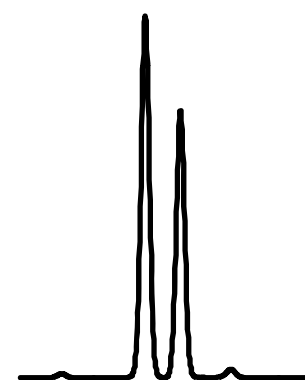
15 m

R=1.16
4.82 min



30 m

R=1.68
8.73 min

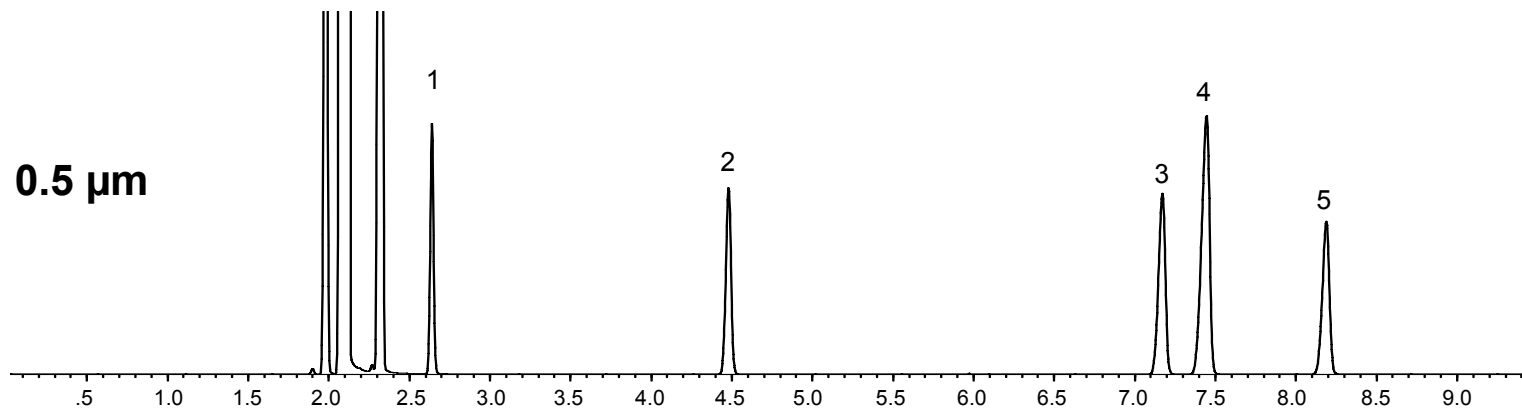


60 m

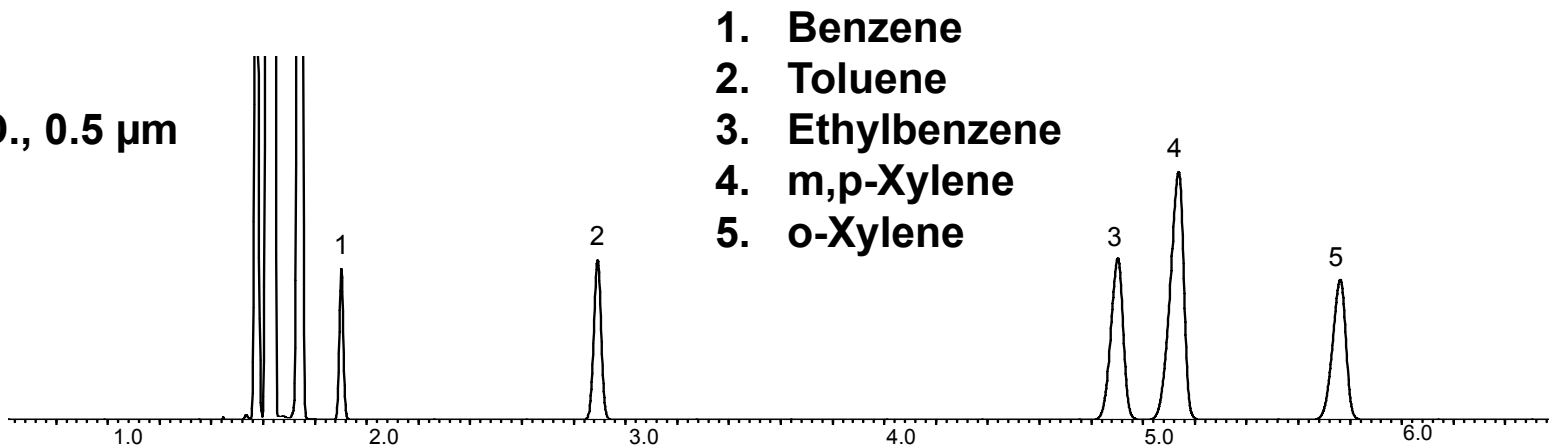
Double the plates, double the time
but not double the the resolution

DECREASE THE LENGTH

DB-5
30 m
0.53 mm I.D., 0.5 µm



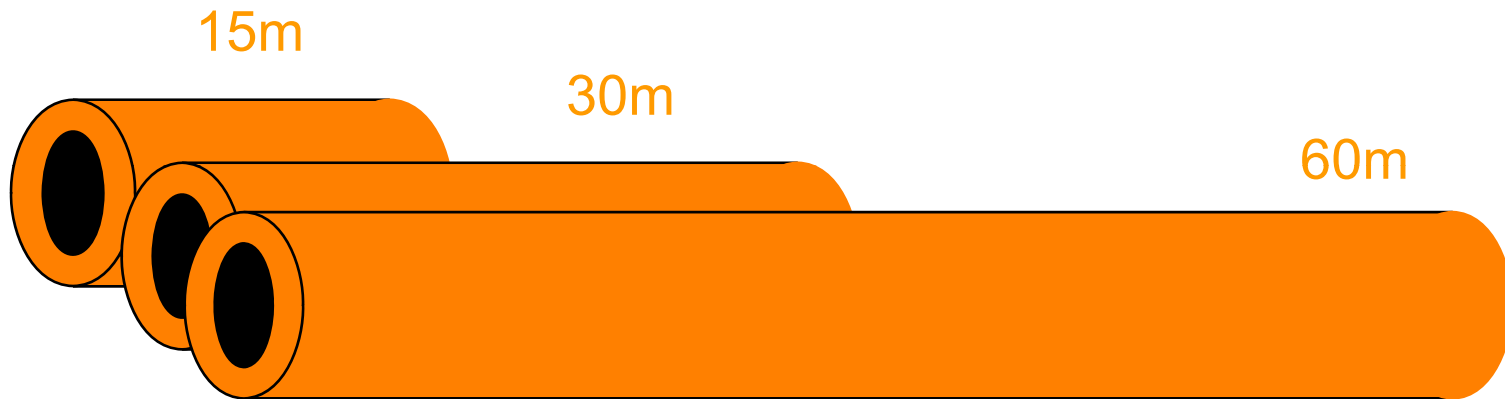
DB-5
15 m
0.53 mm I.D., 0.5 µm



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:




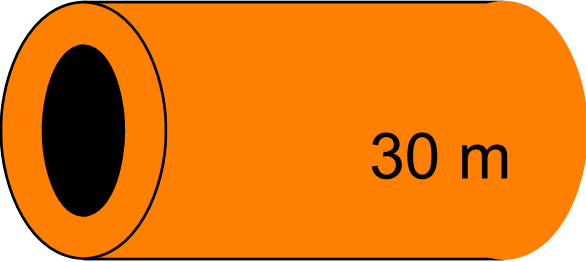
Efficiency	Decrease
Resolution	Decrease
Analysis Time	Decrease
Pressure	Decrease
Cost	Decrease

Resolution

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

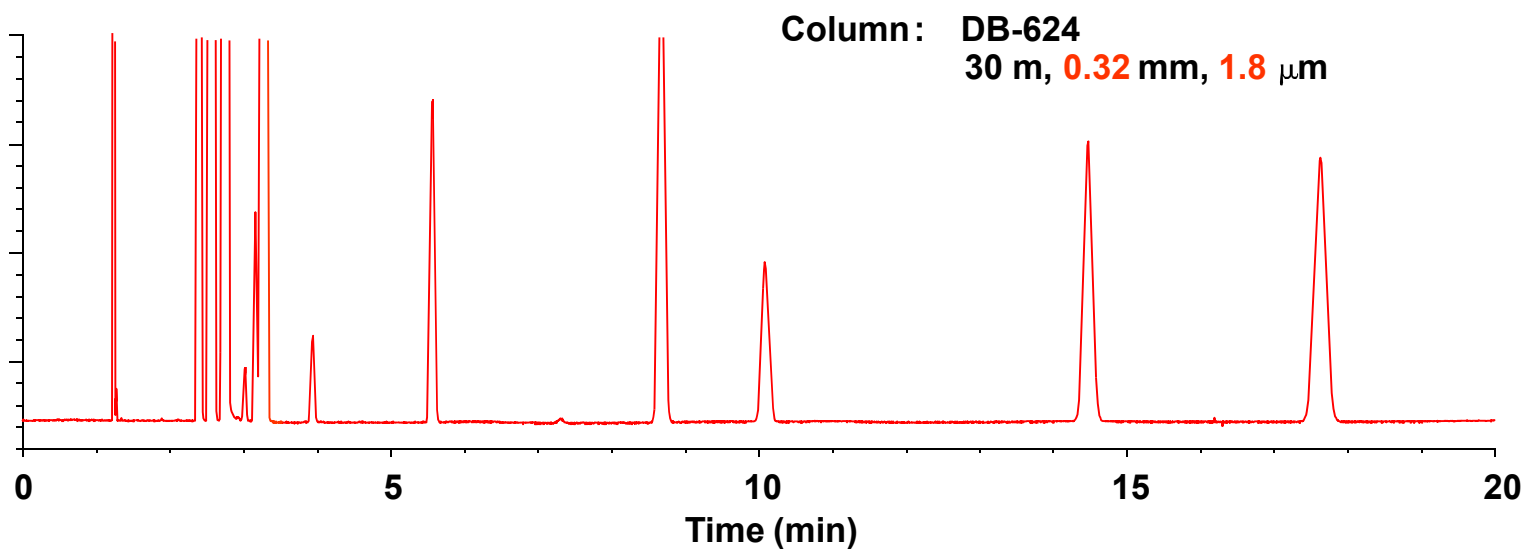
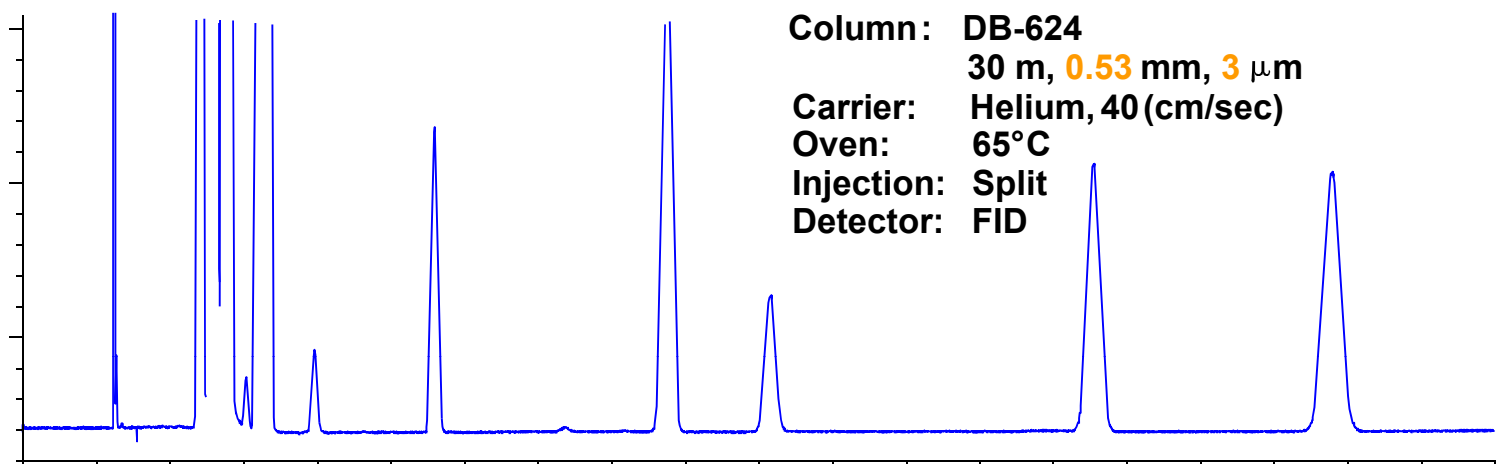
Efficiency	$N = f(\text{gas}, L, r_c)$	L = Length
Retention	$k = f(T, d_f, r_c)$	r_c = column radius d_f = film thickness
Selectivity	$\alpha = f(T, \text{phase})$	T = temperature

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

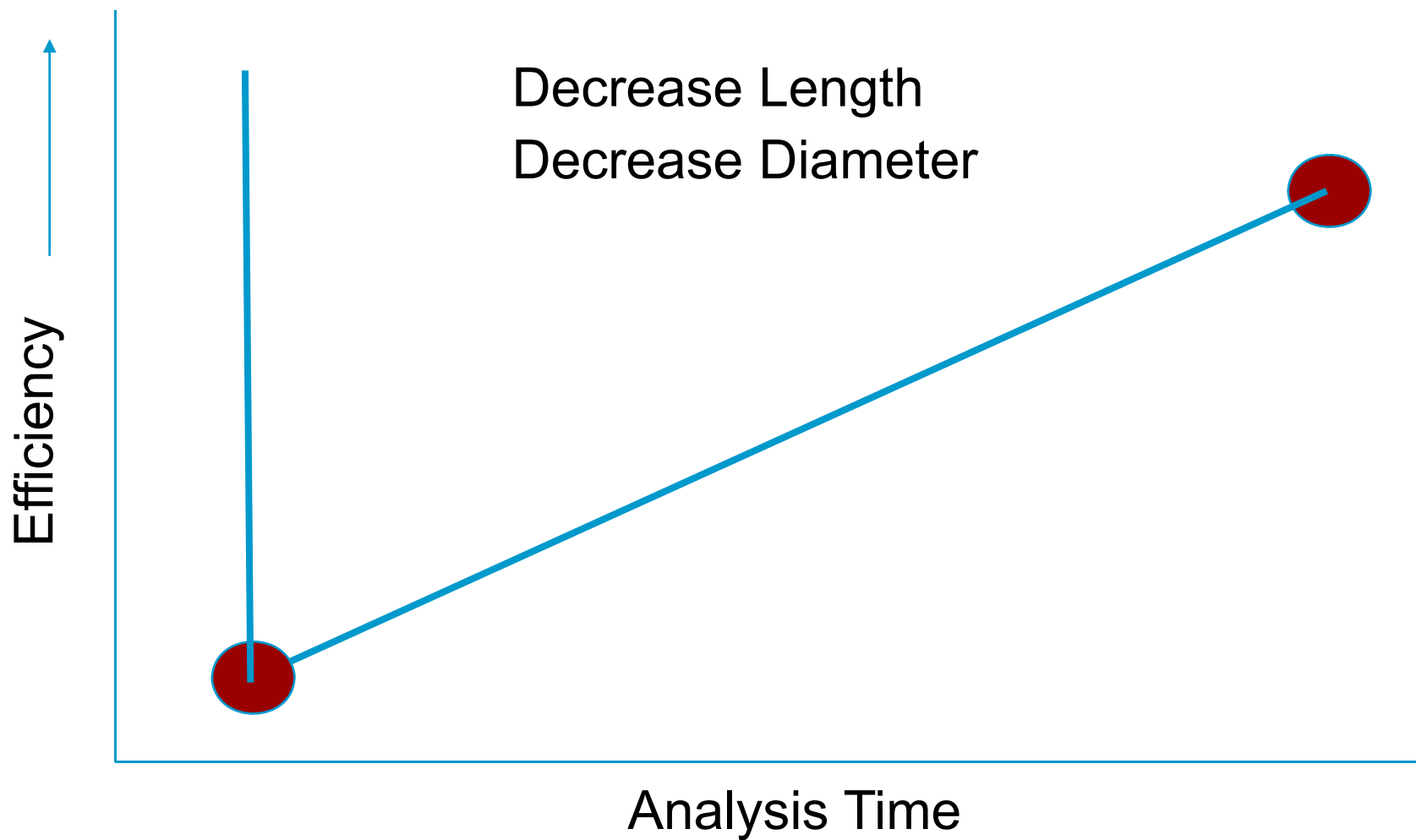


Diameter Summary

If you decrease the inside diameter:

Efficiency	Increases
Resolution	Increases
Pressure	Increases
Capacity	Decreases
Flow rate	Decreases

Combining a Change in Length With a Change in Diameter



Carrier Gas Considerations

Best velocity?

Optimal range of velocities

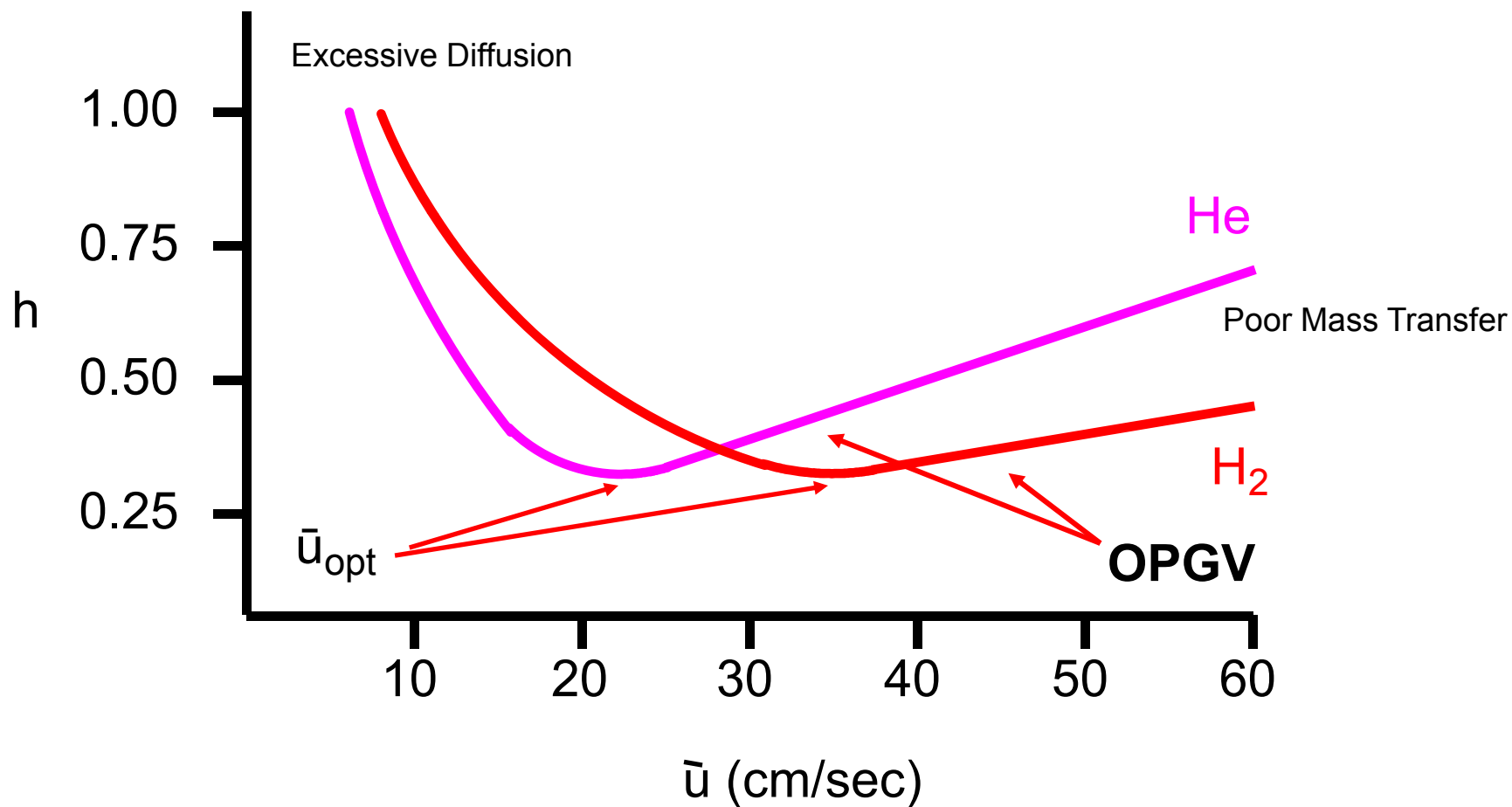
Too low or high results in loss of resolution

Balance resolution and analysis time

BUT... there is no LAW against going FASTER

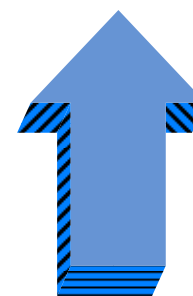
Carrier Gas Considerations

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

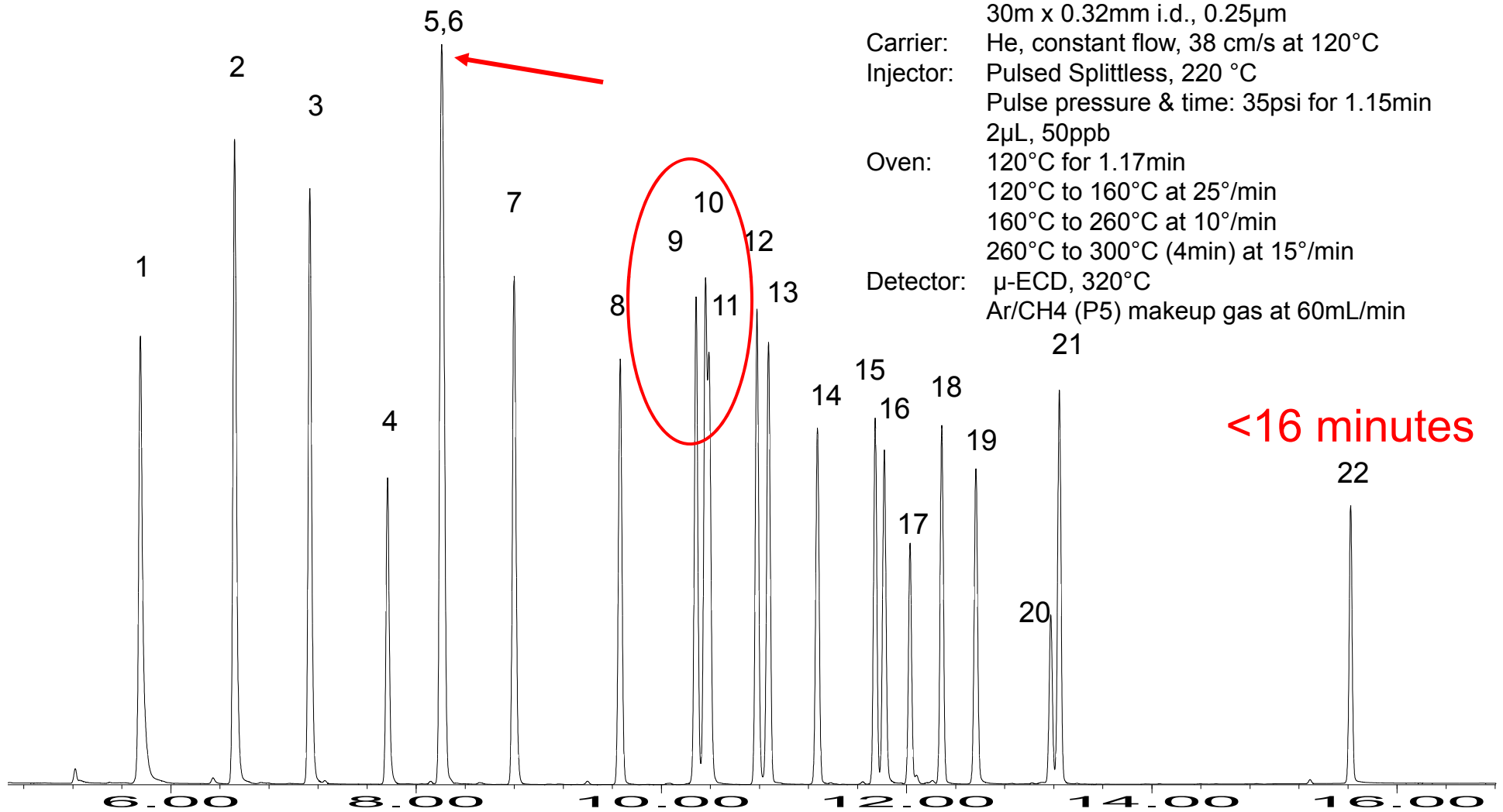
Switch He to H₂ Carrier Gas and Try Faster Velocities

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 Splittless, 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

21

<16 minutes

22

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: 30
 Internal Diameter, μm : 320
 Film
 Thickness, μm : 0.25
 Phase Ratio: 320.0

Carrier Gas: Helium

Enter one Setpoint
 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

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
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

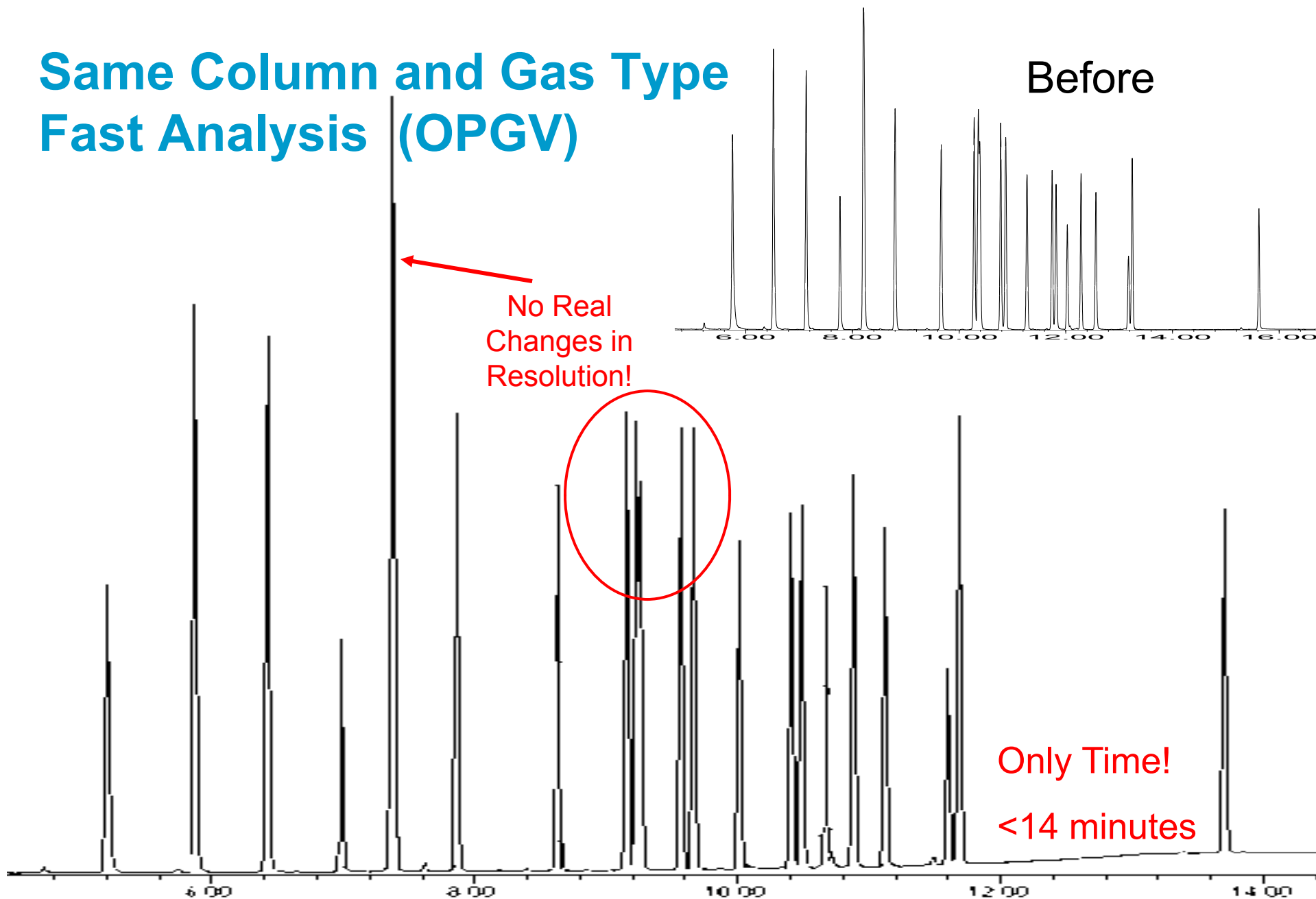
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Oven Temperature 3-ramp Program																																												
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Sample Information	None																																											

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

Criterion: Translate Only Best Efficiency Fast Analysis None

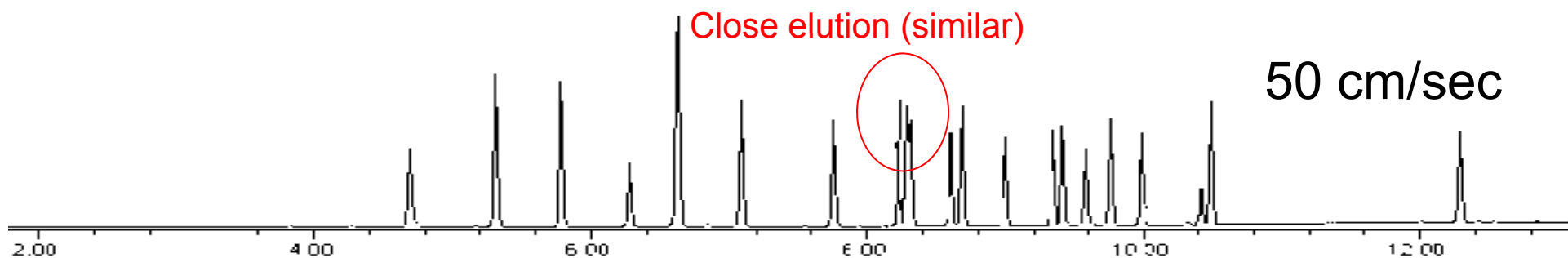
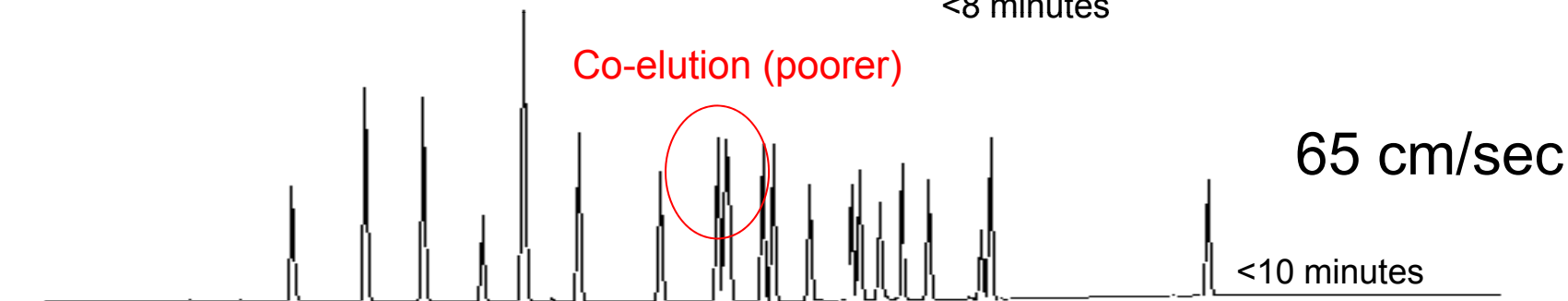
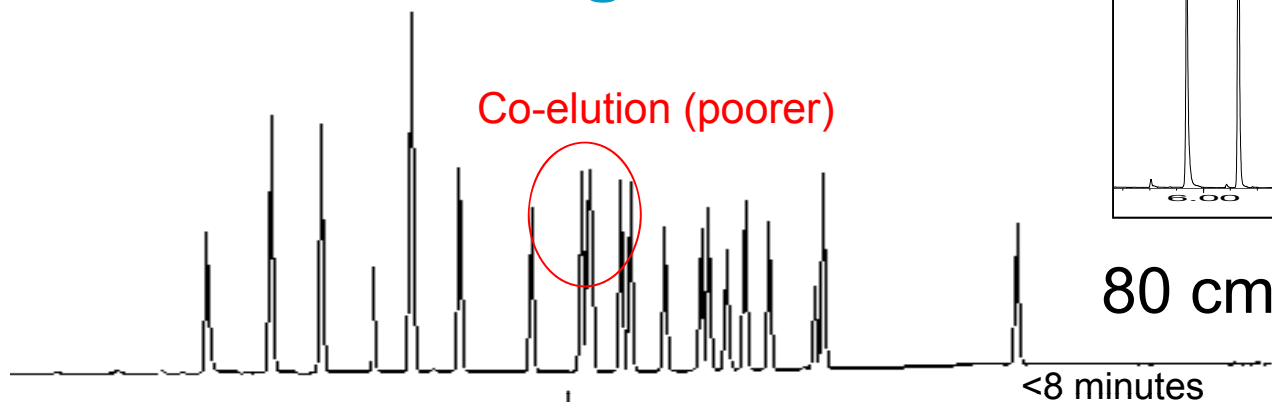
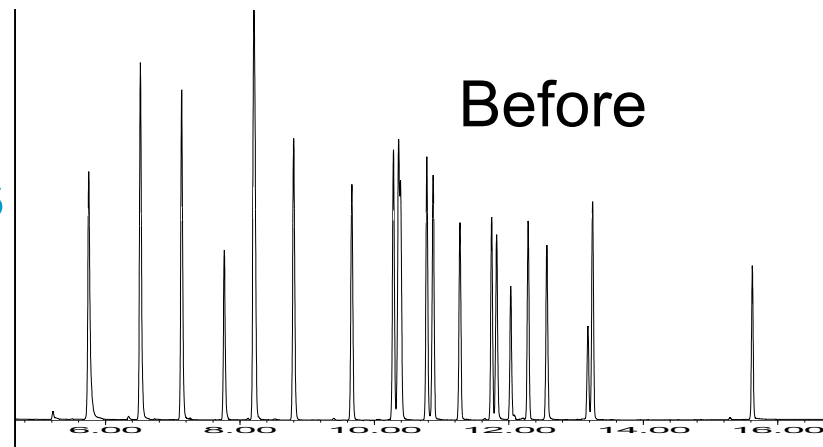
Speed gain: 1.31579 | Speed gain: 1.71053 | Speed gain: 2.10526

Parameter	Original Method	Translated Method (1.31579)	Translated Method (1.71053)	Translated Method (2.10526)
Column Length (m)	30	30	30	30
Column Internal Diameter (µm)	320	320	320	320
Film Thickness (µm)	0.25	0.25	0.25	0.25
Phase Ratio	320.0	320.0	320.0	320.0
Carrier Gas	Helium	Helium	Helium	Helium
Head Pressure (psi)	12.786	17.057	22.554	28.205
Flow Rate (mLn/min)	2.0502	3.0121	4.4541	6.1761
Outlet Velocity (cm/sec)	56.20	82.57	122.10	169.30
Average Velocity (cm/sec)	38	50	65	80
Hold-up Time (min)	1.31579	1.00000	0.769231	0.625000
Outlet Pressure (absolute) (psi)	14.696	14.696	14.696	14.696
Ambient Pressure (absolute) (psi)	14.696	14.696	14.696	14.696

Oven Temperature Program			
Ramp	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

New calculated temp. program			
Ramp	Ramp Rate (°C/min)	Final Temp. (°C)	Final Time (min)
Initial		120	0.889
Ramp 1	32.895	160	0.000
Ramp 2	13.158	260	0.000
Ramp 3	19.737	300	3.040

Same Column and Gas type None mode, Higher velocities



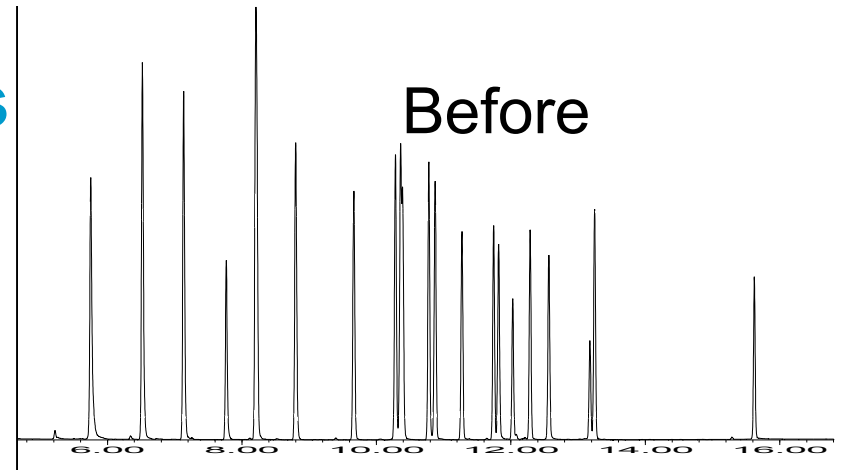
Same Column, Hydrogen Carrier Gas Translate Only

GC Method Translation - EPACLP.MXD

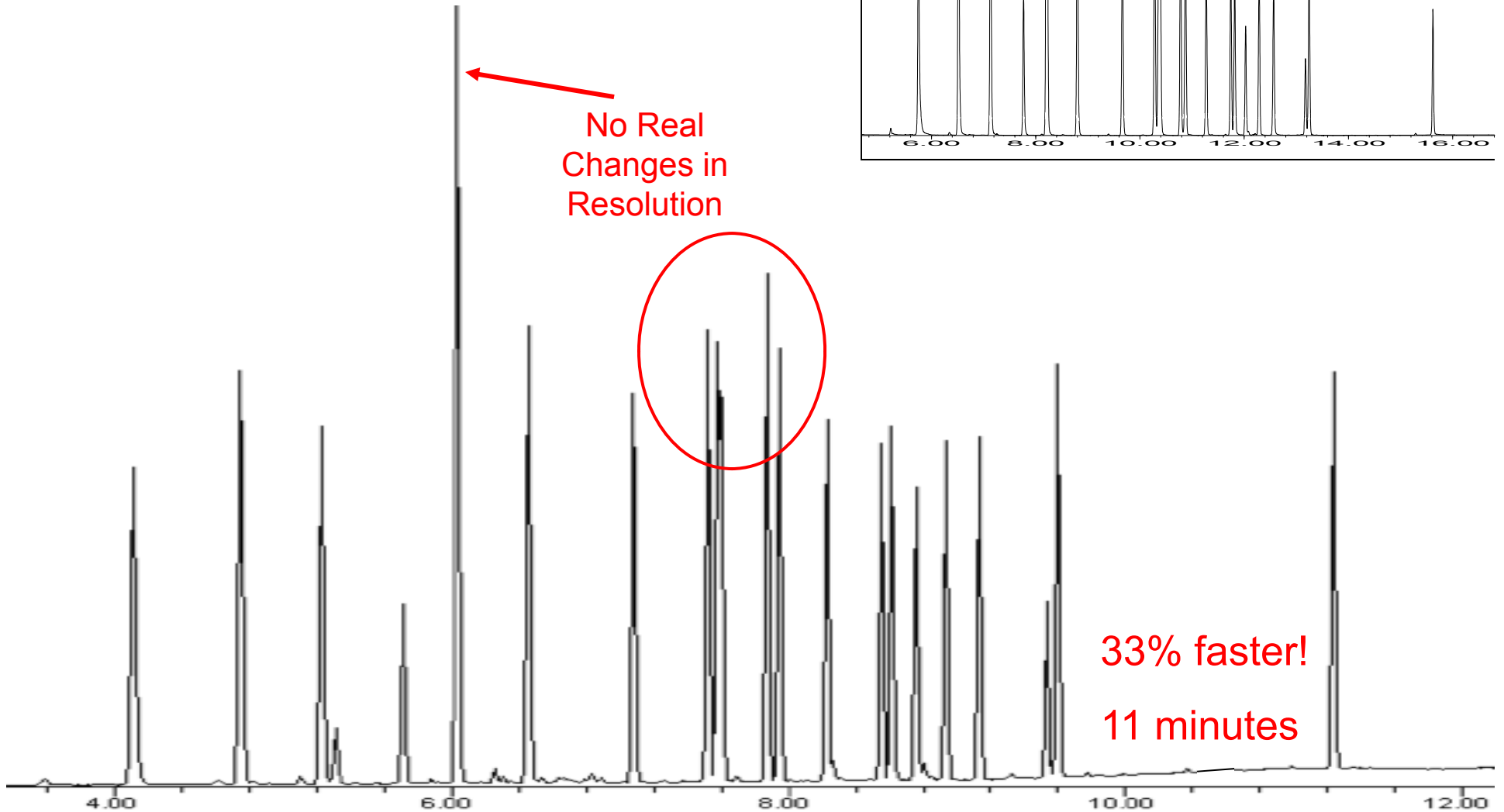
Criterion: Translate Only Best Efficiency Fast Analysis None Speed gain: 1.42668

	Original Method	Translated Method																																										
Column																																												
Length, m	30	<input checked="" type="checkbox"/> 30																																										
Internal Diameter, μm	320	<input checked="" type="checkbox"/> 320																																										
Film		<input type="checkbox"/> Unlock																																										
Thickness, μm	0.25	<input checked="" type="radio"/> 0.25																																										
Phase Ratio	320.0	<input type="radio"/> 320.0																																										
Carrier Gas	Helium	<input type="checkbox"/> Hydrogen																																										
Enter one Setpoint																																												
Head Pressure, psi	12.786	8.110																																										
Flow Rate, mLn/min	2.0502	2.5628																																										
Outlet Velocity, cm/sec	56.20	70.25																																										
Average Velocity, cm/sec	38	54.21																																										
Hold-up Time, min	1.31579	0.922272																																										
Outlet Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696																																										
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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

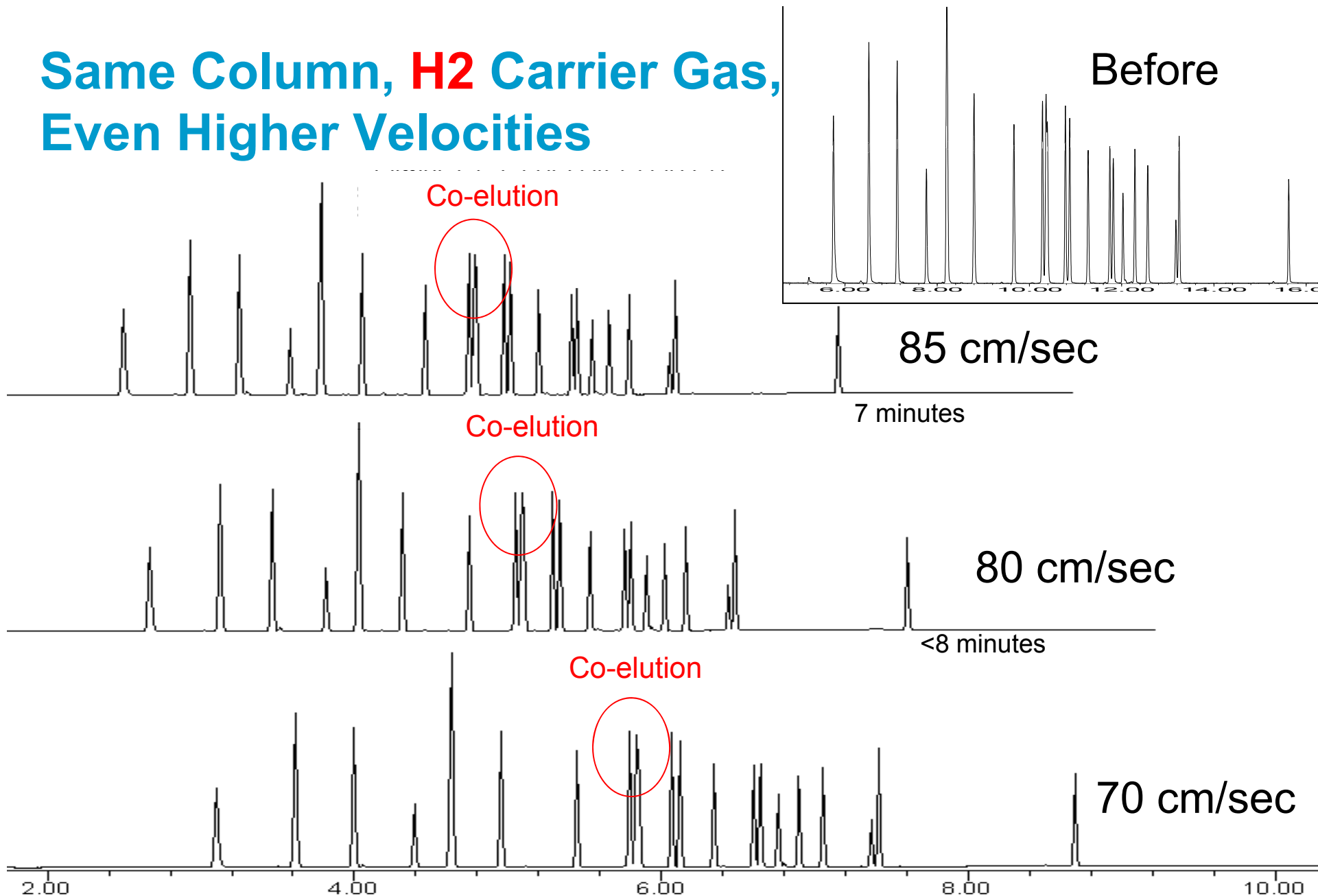
GC Method Translation - EPACLP.MXD

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																																																																																				
Carrier Gas																																																																																								
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																																																																																				
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696	<input type="checkbox"/> 14.696																																																																																				
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Ramp Rate	Final Temp.	Final Time																																																																																						
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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		<input checked="" type="radio"/> Unlock																																				
Thickness, μm	0.25	<input type="radio"/> 0.18																																				
Phase Ratio	316.0	<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																																						
	<table border="1"> <thead> <tr> <th>Ramp Rate</th> <th>Final Temp.</th> <th>Final Time</th> </tr> <tr> <th>°C/min</th> <th>°C</th> <th>min</th> </tr> </thead> <tbody> <tr> <td></td> <td>120.00</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	°C/min	°C	min		120.00	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>°C/min</th> <th>°C</th> <th>min</th> </tr> </thead> <tbody> <tr> <td></td> <td>120.00</td> <td>0.569</td> </tr> <tr> <td></td> <td>160</td> <td>0.000</td> </tr> <tr> <td></td> <td>260</td> <td>0.000</td> </tr> <tr> <td></td> <td>300</td> <td>1.945</td> </tr> </tbody> </table>	Ramp Rate	Final Temp.	Final Time	°C/min	°C	min		120.00	0.569		160	0.000		260	0.000		300	1.945
Ramp Rate	Final Temp.	Final Time																																				
°C/min	°C	min																																				
	120.00	1.17																																				
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Sample Information None																																						

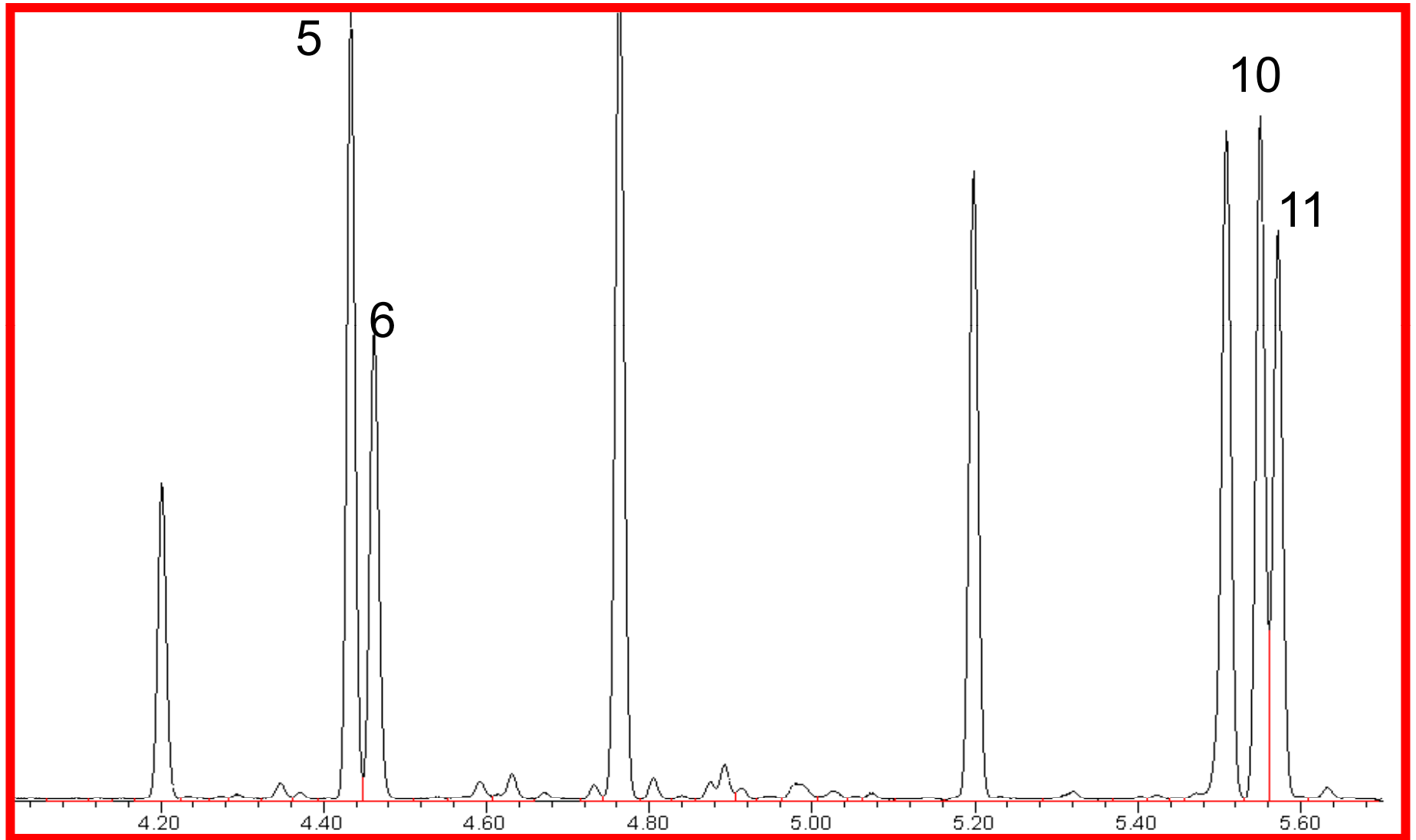
Input NEW dimensions

Close enough (got lucky)

New Velocity

New Temp. Program

New Column Dimensions, H2 Gas, Translate Only



New Column Dimensions, H2 Gas, Fast Analysis

GC Method Translation - EPACLP.MXD

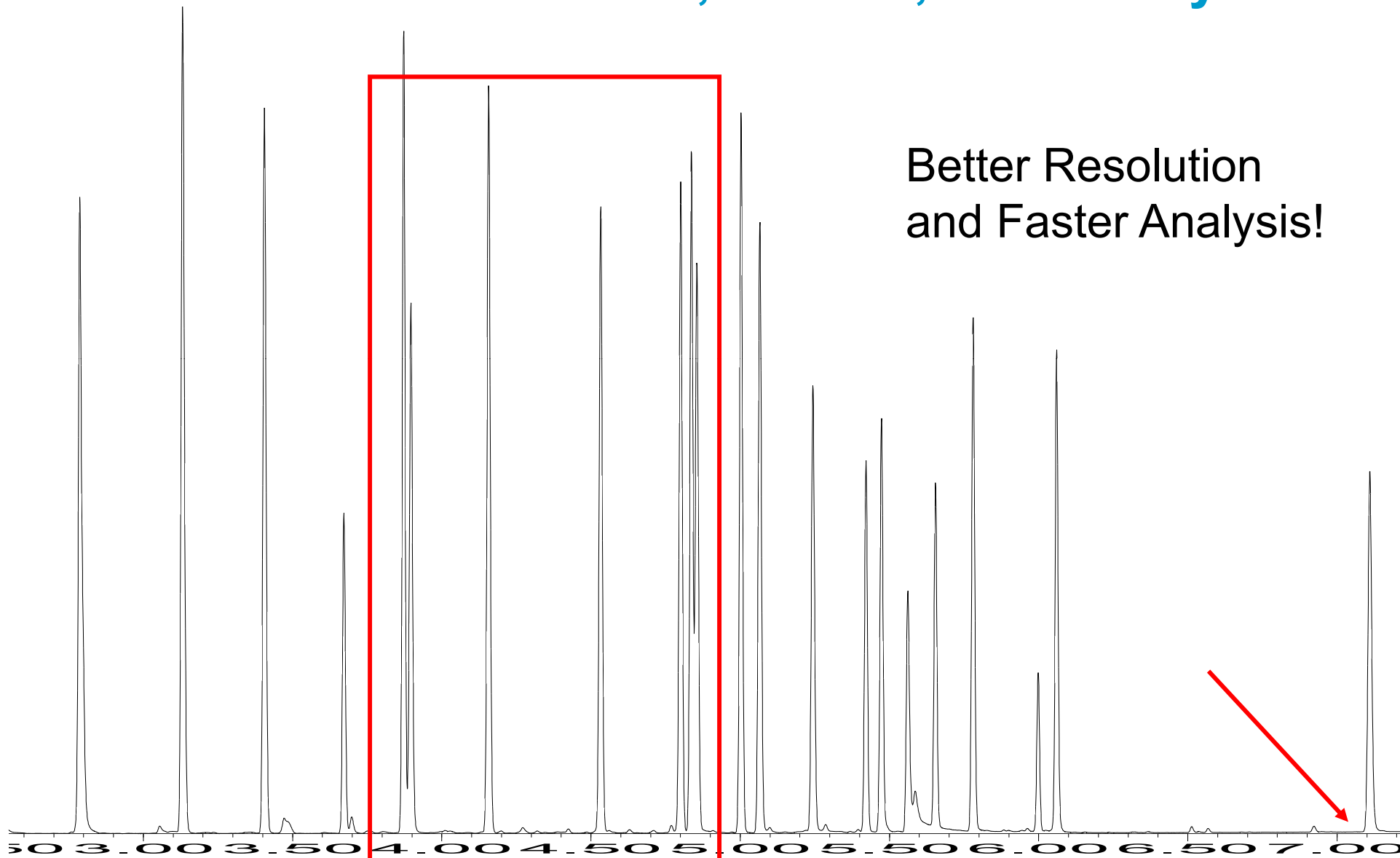
Criterion: Translate Only Best Efficiency Fast Analysis None **Speed gain: 2.34453**

	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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Ramp 2	10	260																																				
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Ramp 3	35.168	300																																				
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 | **Translated Method** | **Translated Method** | **Translated Method**

Speed gain: 2.88086 | **Speed gain: 3.18411**

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

Enter one Setpoint

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 | 14.696

Ambient Pressure (absolute), psi: 14.696 | 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

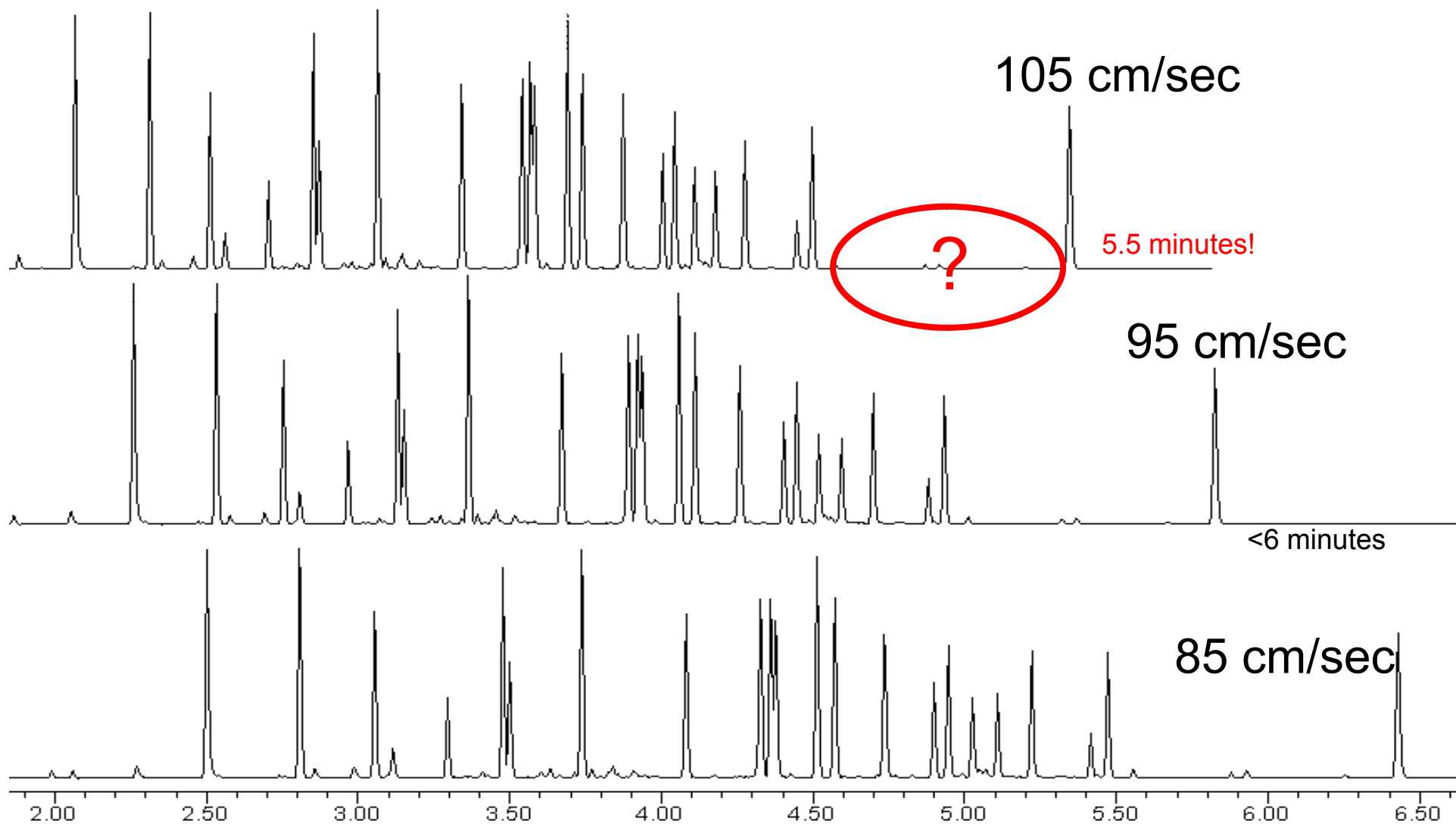
	Ramp Rate °C/min	Final Temp. °C	Final Time min
Initial		120	0.454
Ramp 1	64.440	160	0.000
Ramp 2	25.776	260	0.000
Ramp 3	38.664	300	1.552

	Ramp Rate °C/min	Final Temp. °C	Final Time min
Initial		120	0.406
Ramp 1	72.021	160	0.000
Ramp 2	28.809	260	0.000
Ramp 3	43.213	300	1.388

	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

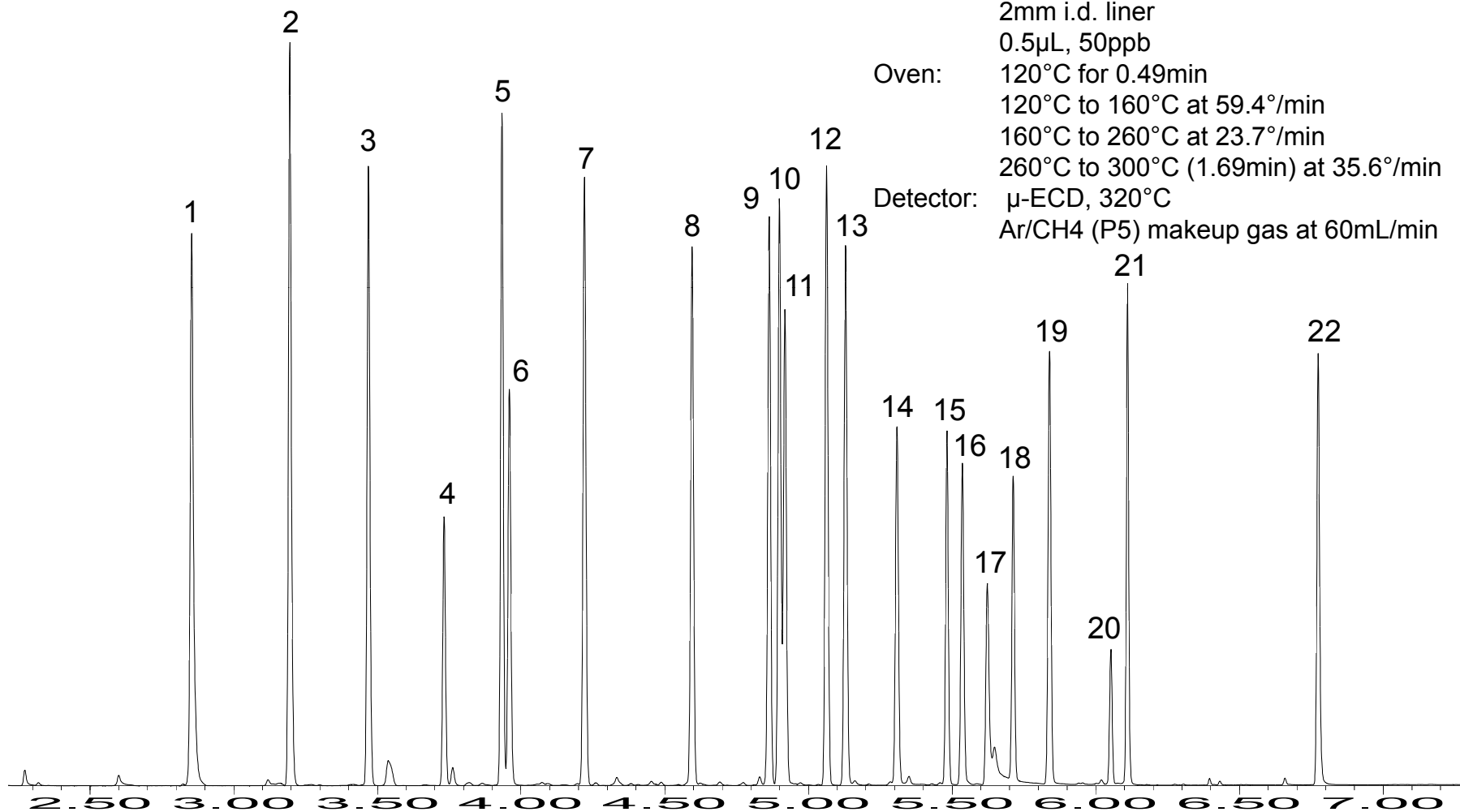
Sample Information None

New Column Dimensions, H2 Gas, Higher Velocities

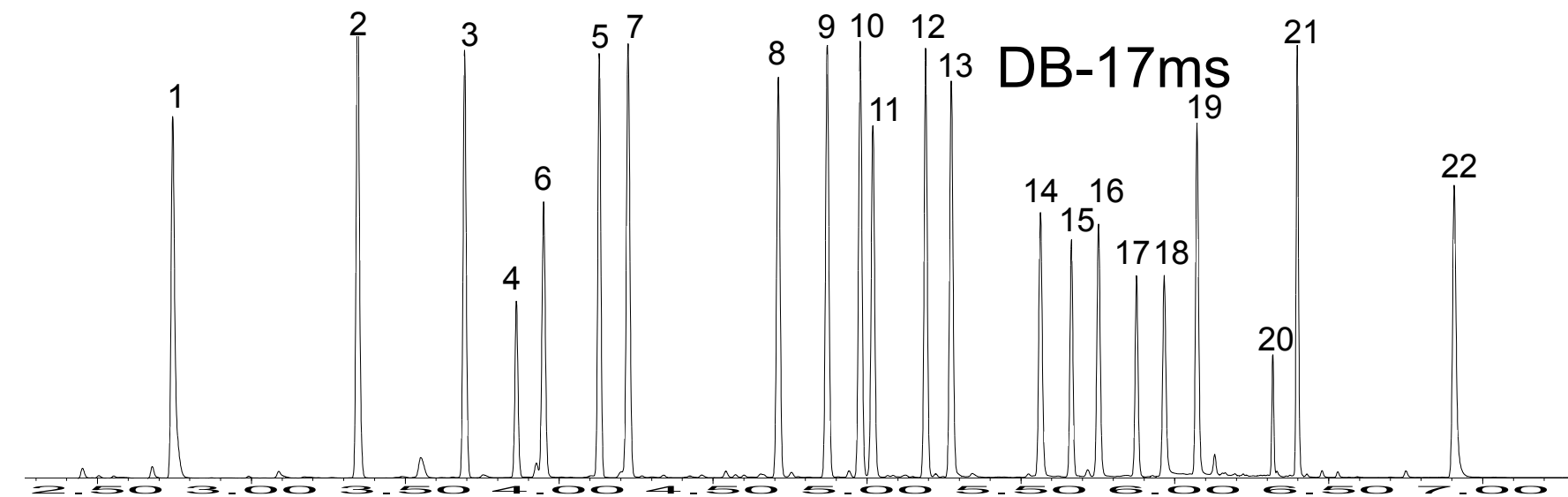
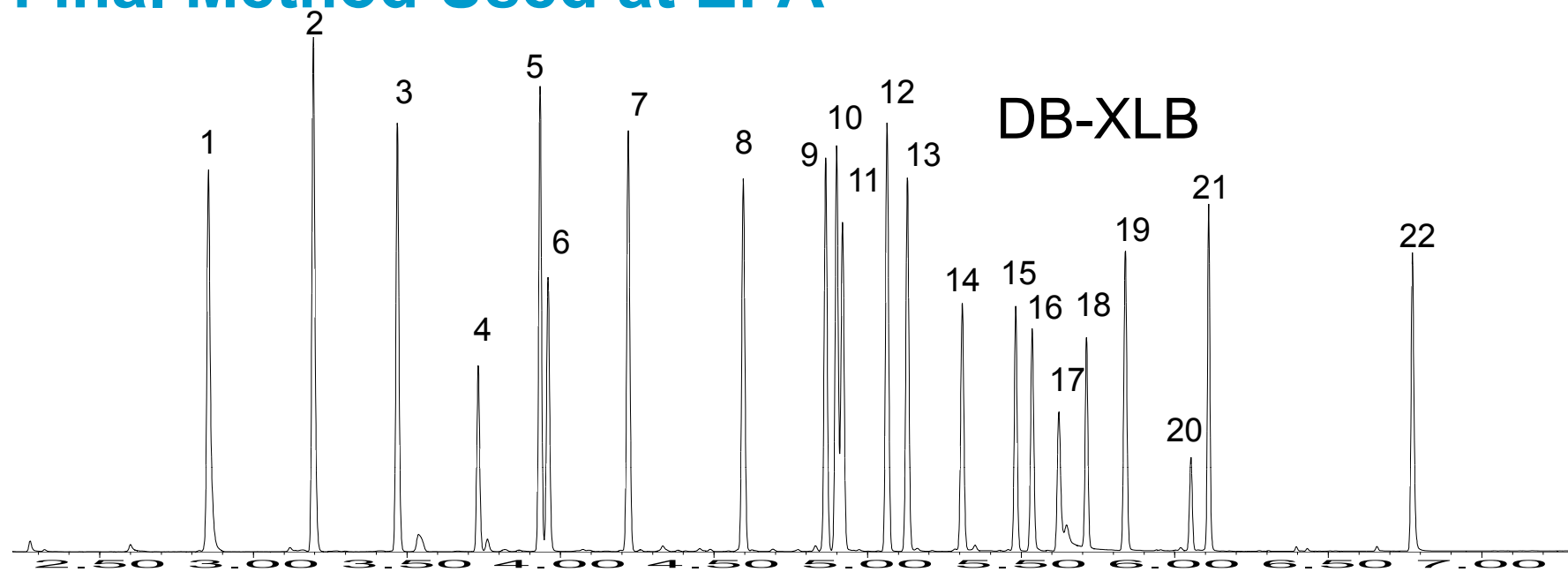


Final Method Used at EPA

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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Ramp Rate	Final Temp.	Final Time																								
$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min																								
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$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min																								
	40	0.642																								
7.794	290	0.000																								
Sample Information None																										

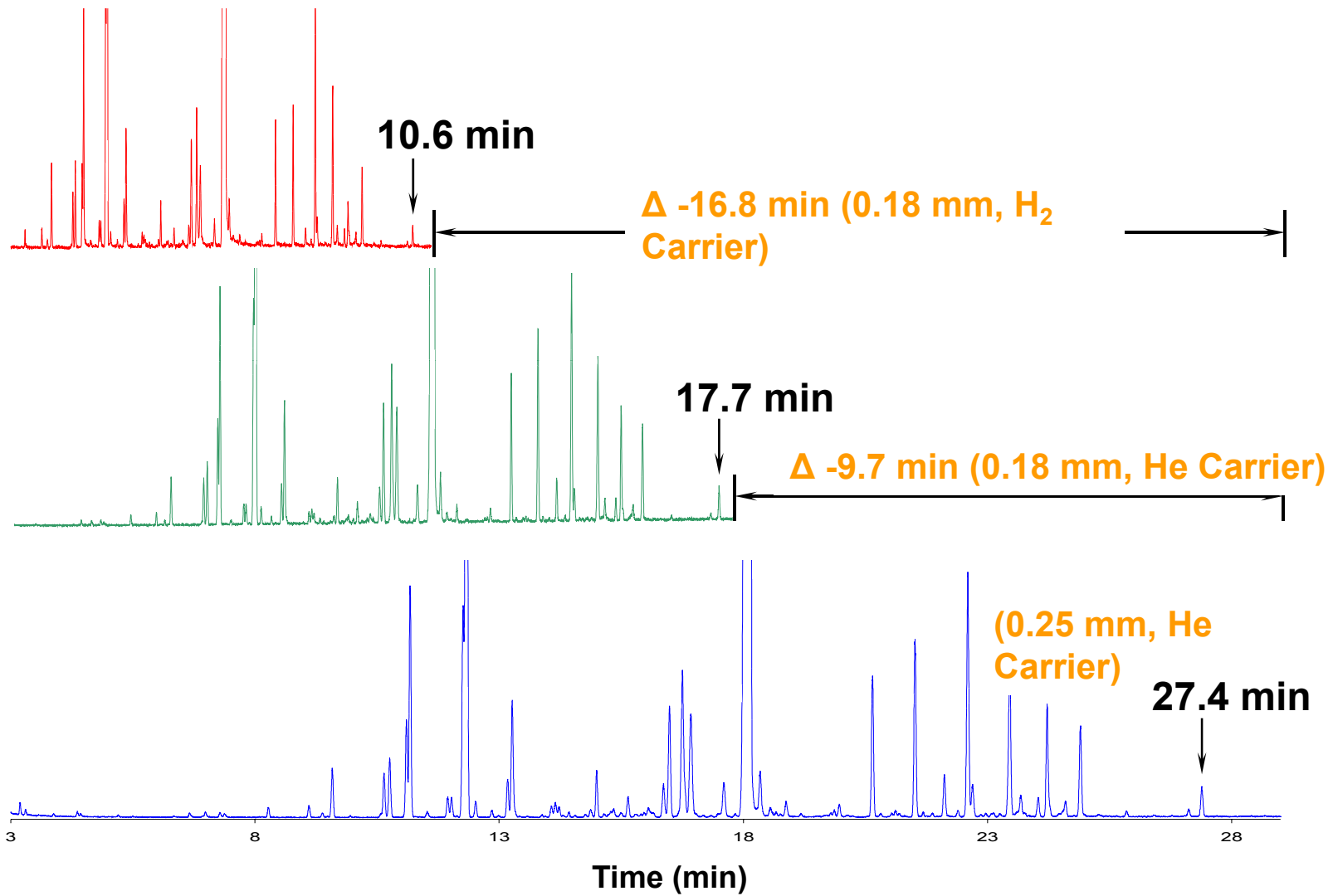
Food/Fragrance – Method translation

GC Method Translation

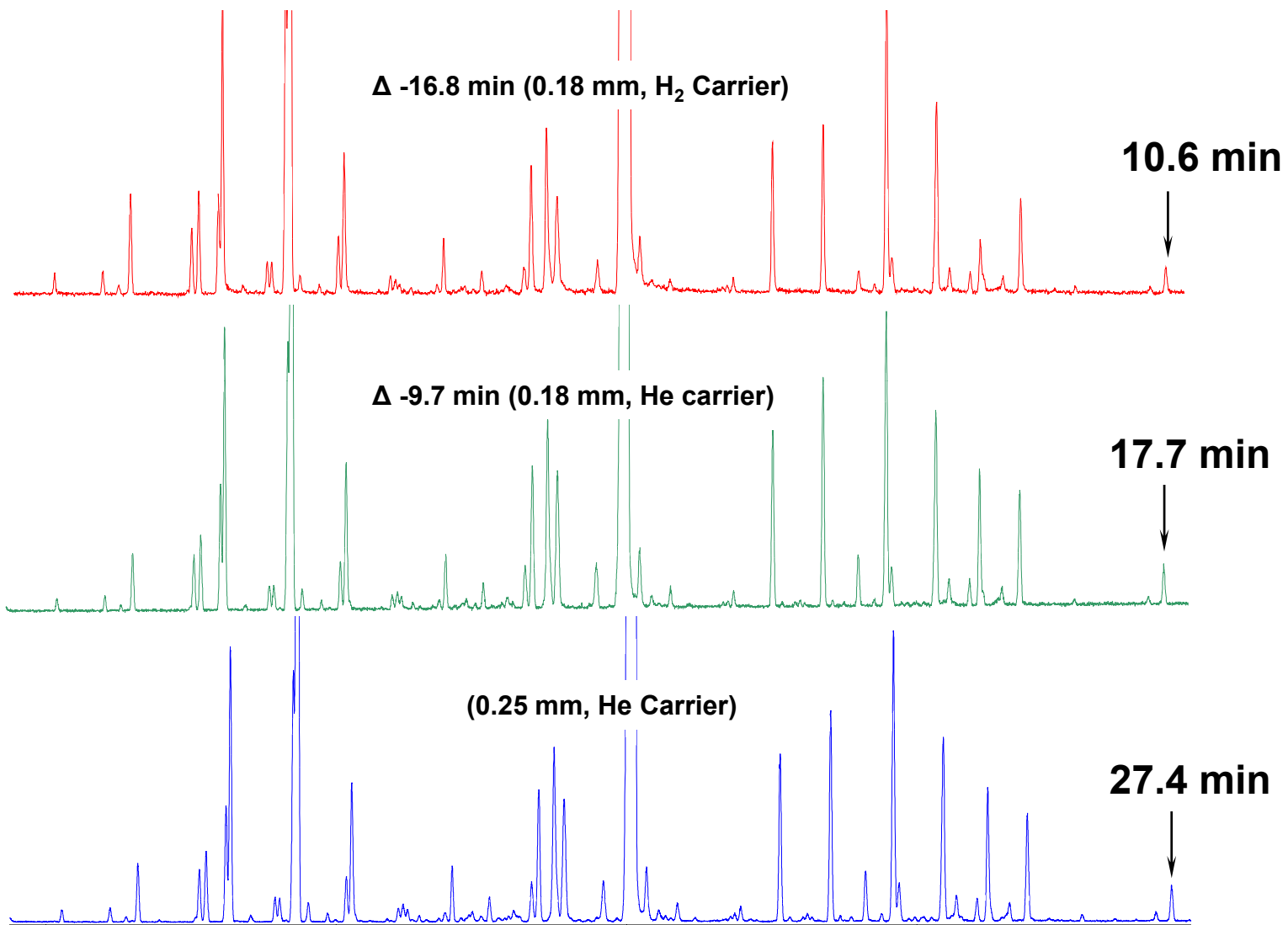
Criterion: Translate Only Best Efficiency Fast Analysis None **Speed gain: 2.59618**

	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																								
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696																								
Oven Temperature 1-ramp Program																										
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Ramp Rate	Final Temp.	Final Time																								
$^{\circ}\text{C}/\text{min}$	$^{\circ}\text{C}$	min																								
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5	290	0																								
Ramp Rate	Final Temp.	Final Time																								
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12.981	290	0.000																								
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)