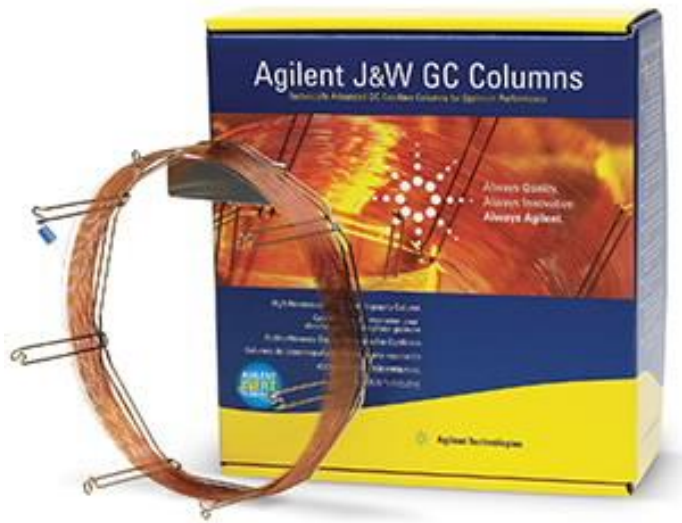
# An overview of GC columns and new technologies for the analysis of FAMEs

Gustavo Serrano Izaguirre, Ph.D.
Global Product Manager – GC Columns

Saurabh Patel, Ph.D.
Applications support Engineer




# What Are We Testing?

Fat profiles:

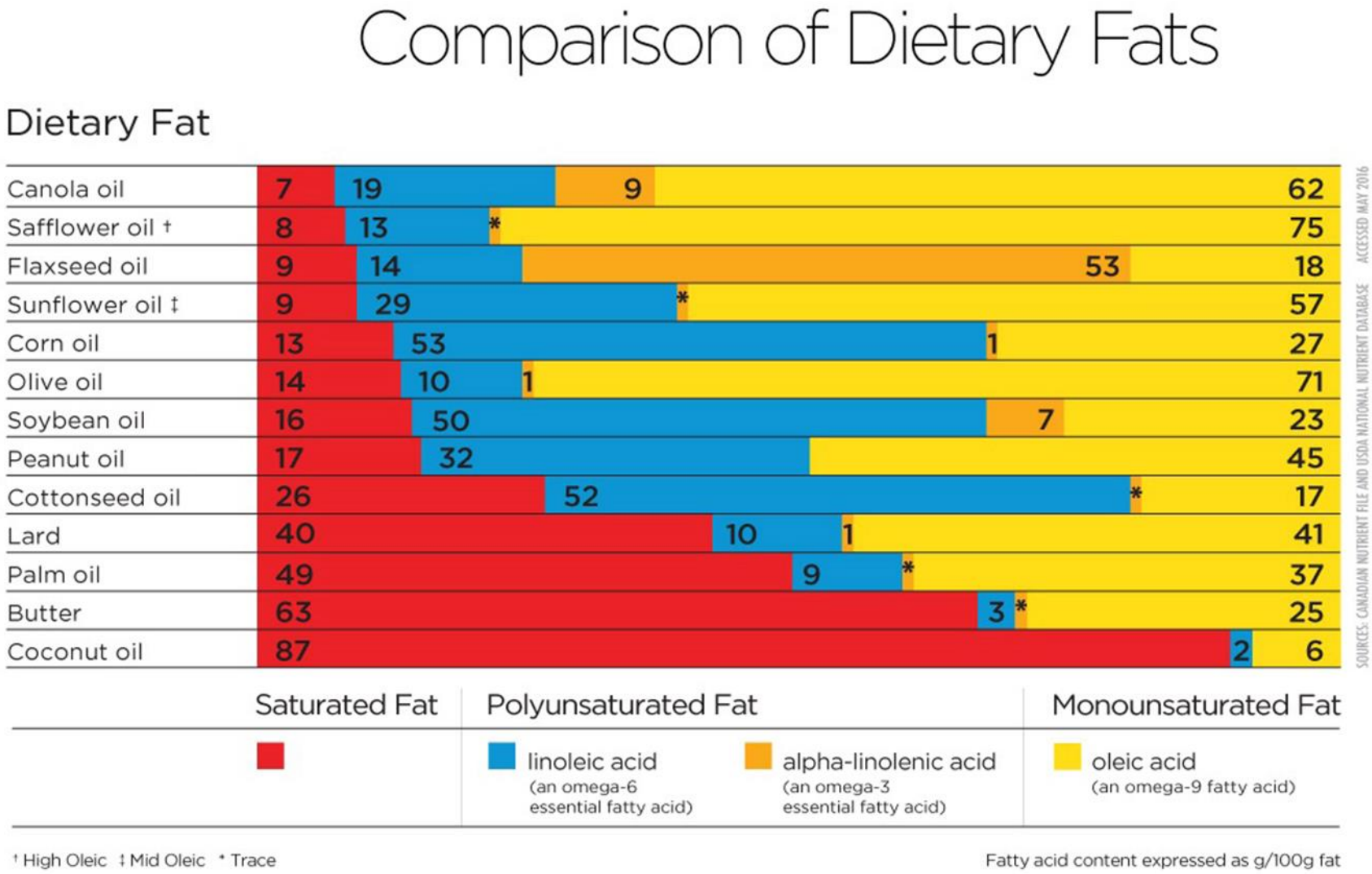
- Total Fat
- Saturated Fat
- Monosaturated Fat
- Trans Fat

Free fatty acids

Triglycerides

Omega 3 and 6 fatty acids

# What Are We Testing?




CanolaInfo. Far Chart & Nutritional Analysis, https://www.canolainfo.org

# Markets Where FAMEs in Food are Analyzed

## Food/beverage testing labs

- Nutritional label testing/authenticity
- QA/QC analysis, Regulatory methods
  - AOCS
  - AOAC


## Food processing/Mfg

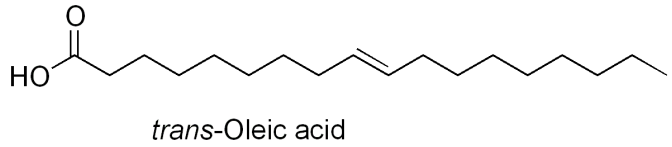
- Edible oils/dairy
- R&D, QA/QC, production


## Fats and oil producers

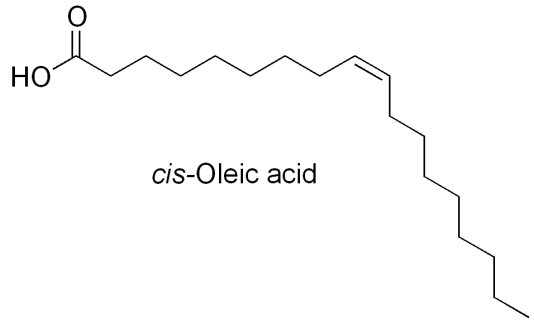
- Omega 3 and 6 supplements
- QA/QC, process control

# Terminology

## Fats, oils, FAMEs, triglycerides, fatty acids



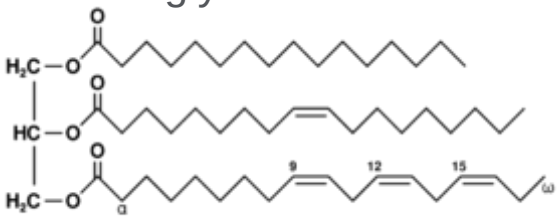

*trans*-Oleic acid



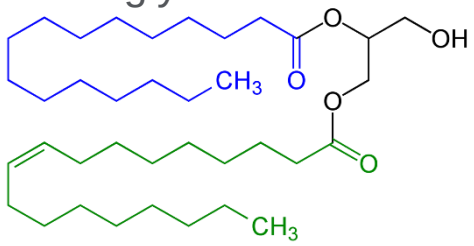

*cis*-Oleic acid

- Fatty acids: carboxylic acid with long aliphatic chain (C4 – C28)
- Vegetable oils: triglycerides from plants (seeds and nuts)
  mono and diglycerides in minor amounts

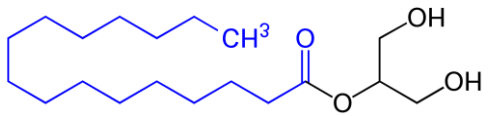
Triglycerides



Diglycerides




Monoglycerides




Fats = Triglycerides (animal or plant origin)

FAMEs: **fatty acid methyl esters** derived by transesterification of fats with methanol (in presence base)
FAEEs: fatty acid ethyl esters, naturally occurring in alcoholic beverages

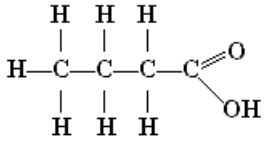
**Structures of fats and oils**
A triglyceride is called a fat if it is a solid at 25 °C; it is called an oil if it is a liquid at that temperature. These differences in melting points reflect differences in the degree of unsaturation and number of carbon atoms in the constituent fatty acids.

# What Type of Fatty Acids are There?

Fatty acids are long-chain hydrocarbons that can be separated into three categories: saturated, monounsaturated (MUFA), and polyunsaturated (PUFAs).

**Saturated fatty acids (SFAs):**

Have all the hydrogen that the carbon atoms can hold
and, therefore, have no double bonds between carbon atoms.



or CH3-CH2-CH2-COOH or CH3-(CH2)2- COOH
Butyric acid

**Monounsaturated fatty acids (MUFAs):** Have only one double bond

**Polyunsaturated fatty acids (PUFAs):** Have more than one double bond

CH3CH2CH2CH2CH2CH=CHCH2CH=CHCH2CH2CH2CH2CH2CH2CH2COOH
9,12-octadecadienoic acid (Linoleic acid) (C18:2)

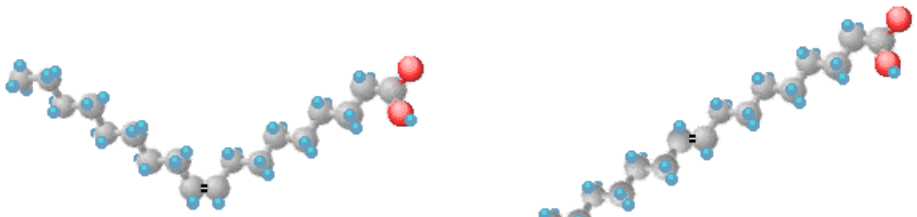
Which would be abbreviated as:
CH3(CH2)4CH=CHCH2CH=CH(CH2)7COOH

# Fatty Acid Configurations

**Fatty Acid Configurations**

**What are *Trans* Fats?**

Double bonds bind carbon atoms tightly and prevent rotation of the carbon atoms along the bond axis. This gives rise to *configurational isomers* which are arrangements of atoms that can only be changed by breaking the bonds.



***Cis*-9-octadecenoic acid (Oleic acid)**



***Trans*-9-octadecenoic acid (Elaidic acid)**

These three-dimensional molecular projections show the *Cis* and *Trans* configurational isomers of 9-octadecenoic acid with the hydrogen atoms shown in blue. The Latin prefixes *Cis* and *Trans* describe the orientation of the hydrogen atoms with respect to the double bond. *Cis* means "on the same side" and *Trans* means "across" or "on the other side". Naturally occurring fatty acids generally have the *Cis* configuration. The natural form of 9-octadecenoic acid (oleic acid) found in olive oil has a "V" shape due to the *Cis* configuration at position 9. The *Trans* configuration (elaidic acid) looks more like a straight line.

*Cis* Configuration *Trans* Configuration

Fatty acids: Positional isomers – which position in the chain are the double bonds in
Geometrical isomers – what is the configuration of the bond (cis or trans)

**Trans fats**

Most trans fats are manufactured through a process called hydrogenation, which is the artificial addition of hydrogen atoms to unsaturated oils. Hydrogenation converts liquid vegetable oils to solid or semisolid fats that remain stable at room temperature. These fats can then be incorporated into certain food products (for example, cookies, chips) to increase shelf life.

# Fatty Acid Composition of Palm Oil

The major fatty acids in palm oil are oleic acid, palmitic acid, and linoleic acid.

| Composition | Content (mg/g)[a] | Composition | Content (mg/g) | Composition | Content (mg/g) |
|---|---|---|---|---|---|
| **C12:0** | 2.06 ± 0.03 | **cis C18:1** | 336.98 ± 9.34 | **11c C20:1** | 0.33 ± 0.01 |
| **C14:0** | 9.97 ± 0.24 | **9c 12t C18:2** | 0.92 ± 0.07 | **9c12c15cC18:3** | 1.63 ± 0.05 |
| **C15:0** | 0.43 ± 0.02 | **9t 12c C18:2** | 0.79 ± 0.07 | **trans C18:1[d]** | ND[b] |
| **C16:0** | 465.49 ±11.08 | **9c12c C18:2** | 68.85 ± 2.66 | **trans C18:2[e]** | 1.71± 0.02 |
| **9cC16:1** | 1.12 ± 0.01 | **C20:0** | 1.65 ± 0.04 | **trans C18:3[f]** | ND |
| **C17:0** | 0.80 ± 0.01 | **ctt/cct C18:3[c]** | ND | **C18:2/C16:0** | 0.1479 |
| **C18:0** | 37.86 ± 0.76 | **9t 12c15c C18:3** | ND | **C18:3/C16:0** | 0.0035 |

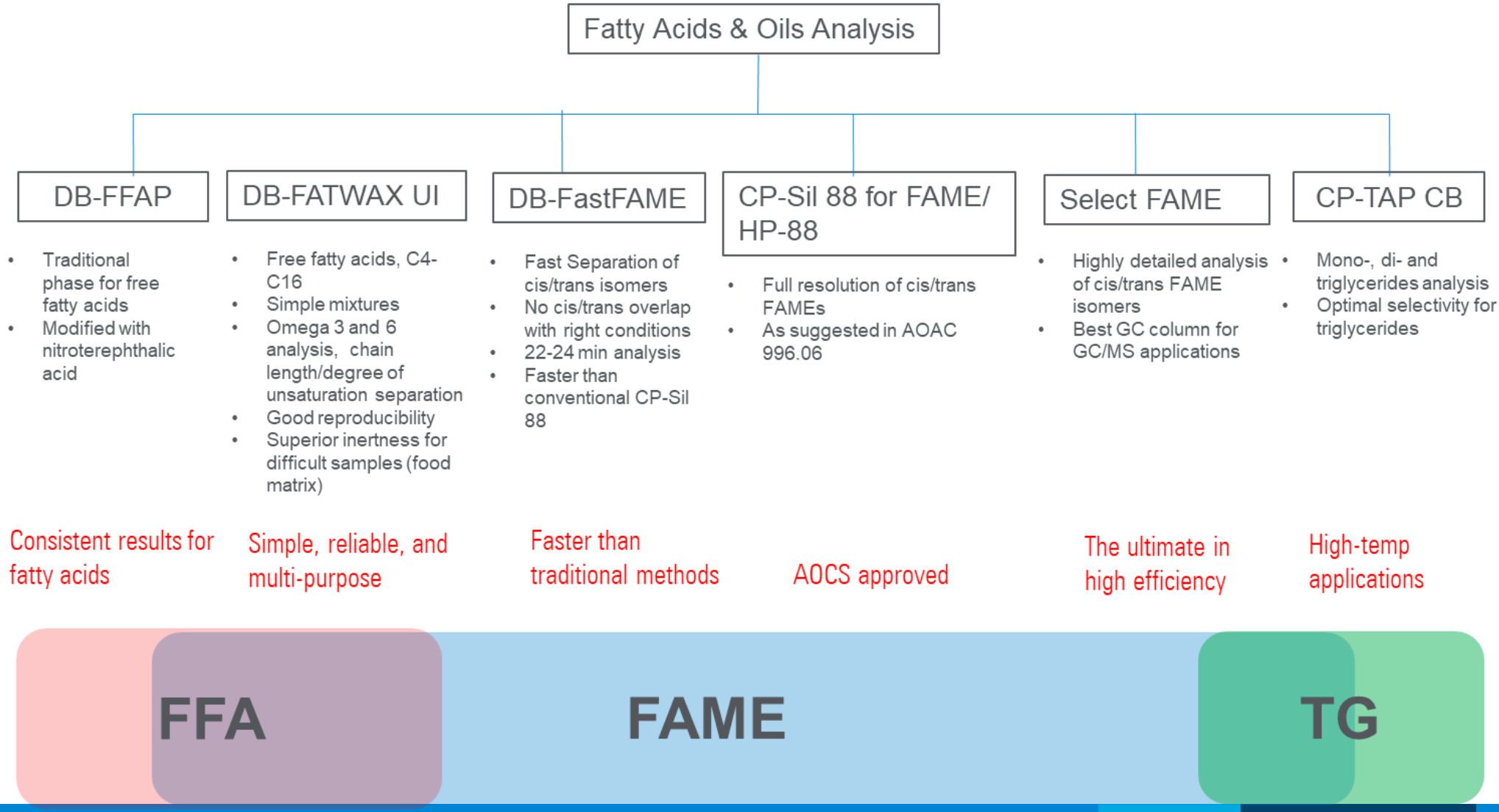
[a] Means of duplicate analyses ± standard deviation
[b] ND: not detected
[c] Total contents of *9c 12t 15t* C18:3 and *9c12c 15t* C18:3
[d] Total contents of *9t* C18:1 and *11t* C18:1
[e] Total contents of *9c 12t* C18:2 and *9t 12c* C18:2
[f] Total contents of *9c 12t 15t* C18:3, *9c12c 15t* C18:3 and *9t 12c15c* C18:3

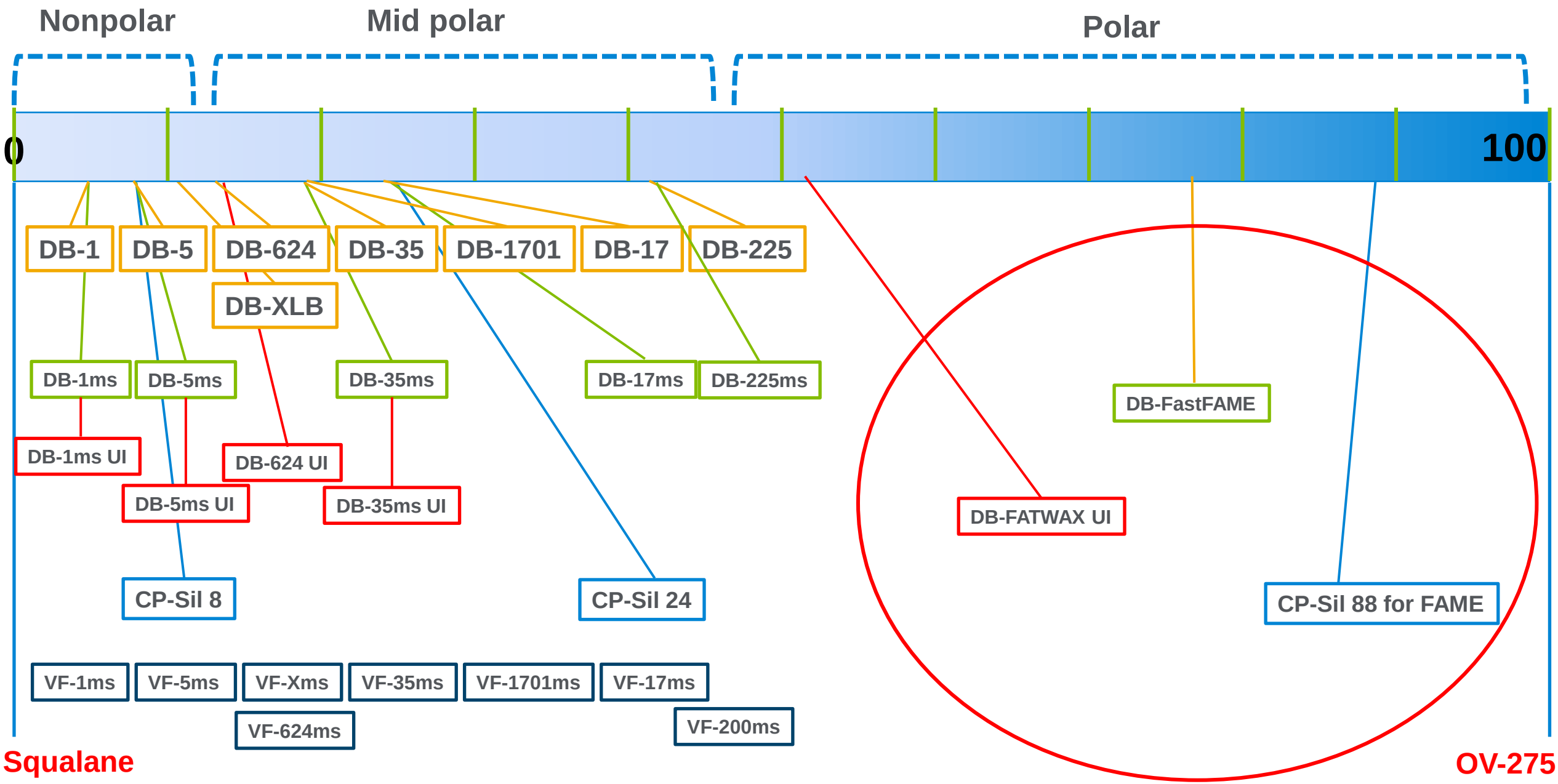
# Why Do We Analyze FAMEs?


Because of the highly polar and acidic end of free fatty acids, compounds often create tailing and the columns used have limited lifetime. A lengthy transesterification process taking 4 to 6 hours may be required.

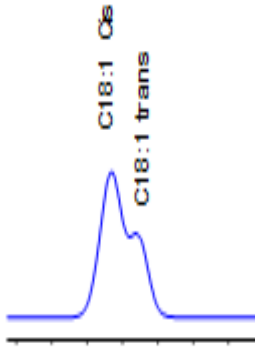
Free fatty acids can be an analytical challenge

# Comprehensive Portfolio for Fatty Acids, FAME, and Oils Analysis



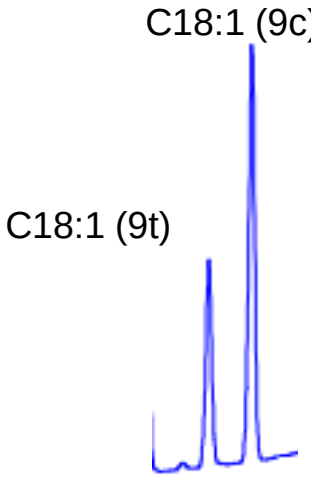

Nonpolar
Mid polar
Polar
0
100
DB-1
DB-5
DB-624
DB-35
DB-1701
DB-17
DB-225
DB-XLB
DB-1ms
DB-5ms
DB-35ms
DB-17ms
DB-225ms
DB-1ms UI
DB-624 UI
DB-5ms UI
DB-35ms UI
CP-Sil 8
CP-Sil 24
DB-FastFAME
DB-FATWAX UI
CP-Sil 88 for FAME
VF-1ms
VF-5ms
VF-Xms
VF-35ms
VF-1701ms
VF-17ms
VF-624ms
VF-200ms
Squalane
OV-275

# Column Polarity/Interaction Effects – FAMEs

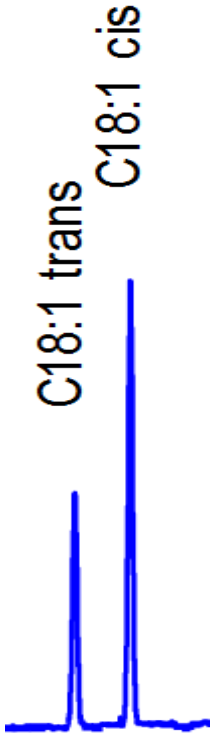



DB-FATWAX UI


DB-FastFAME, 30 m




DB-FastFAME, 90 m




CP-Sil 88 FAME

# Traditional GC Columns

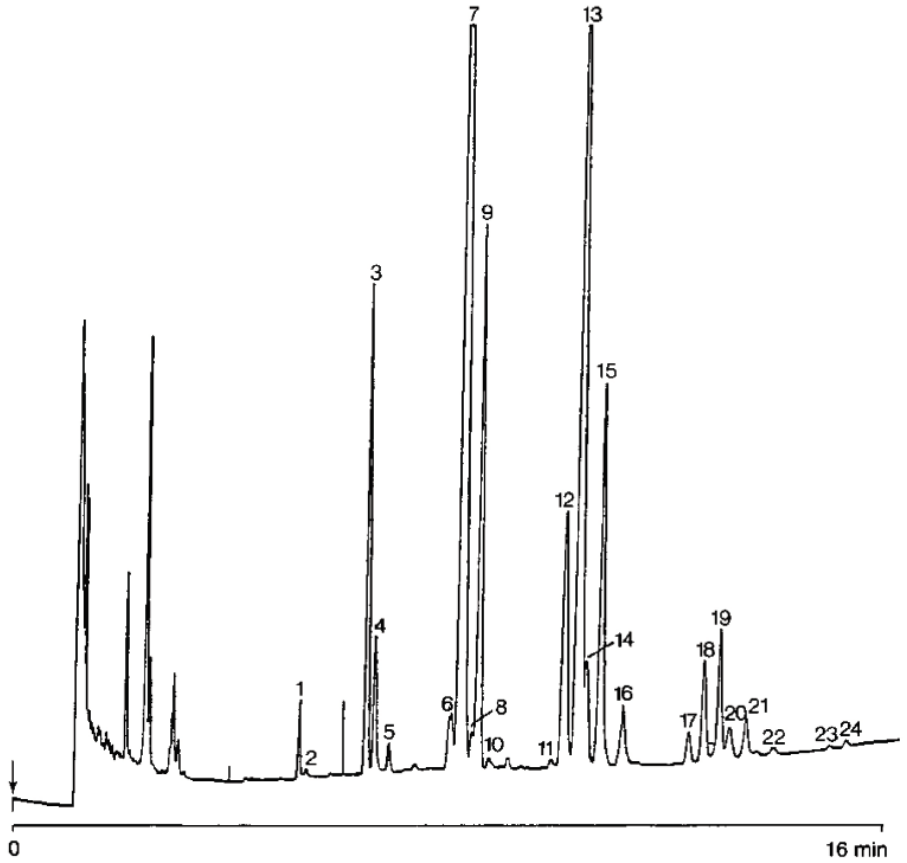
## For fatty acids, FAMEs and triglycerides

# Triglycerides Analysis of Palm Oil

CP-TAP CB for triglycerides

| | |
|---|---|
| Column | **CP-TAP CB**, 25 m, 0.25 mm, 0.10 µm (p/n CP7483) |
| Inlet | Oncolumn |
| Carrier | Hydrogen, 100 kPa (1 bar, 15 psi) |
| Oven | 340 ºC (1 min) to 355 ºC at 1 ºC/min |
| Detector | FID |
| Injection | 0.2 µL |
| Sample | 0.05% palm oil in hexan |

| | | Carbon No. |
|---|---|---|
| 1. | MPP | 46 |
| 2. | MOM | 46 |
| 3. | PPP | 48 |
| 4. | MOP | 48 |
| 5. | MLP | 48 |
| 6. | PPS | 50 |
| 7. | POP | 50 |
| 8. | MOO | 50 |
| 9. | PLP | 50 |
| 10. | MLO | 50 |
| 11. | PSS | 52 |
| 12. | POS | 52 |
| 13. | POO | 52 |
| 14. | PLS | 52 |
| 15. | PLO | 52 |
| 16. | PLL | 52 |
| 17. | SOS | 54 |
| 18. | SOO | 54 |
| 19. | OOO | 54 |
| 20. | SLO | 54 |
| 21. | OLO | 54 |
| 22. | OLL | 54 |
| 23. | SOA | 56 |
| 24. | AOO | 56 |




| | |
|---|---|
| M: Myristic acid (tetradecanoic acid) | C14:0 |
| P: Palmitic acid, (hexadecanoic acid) | C16:0 |
| S: Stearic acid (octadecanoic acid) | C18:0 |
| O: Oleic acid (cis-9-octadecenoic acid) | C18:1 |
| L: Linoleic acid (cis,cis-9,12,octadecadienoic acid) | C18:2 |
| A: Arachidic acid (eicosanoic acid) | C20:0 |

Application note: A00195

# Analysis of Free Fatty Acids

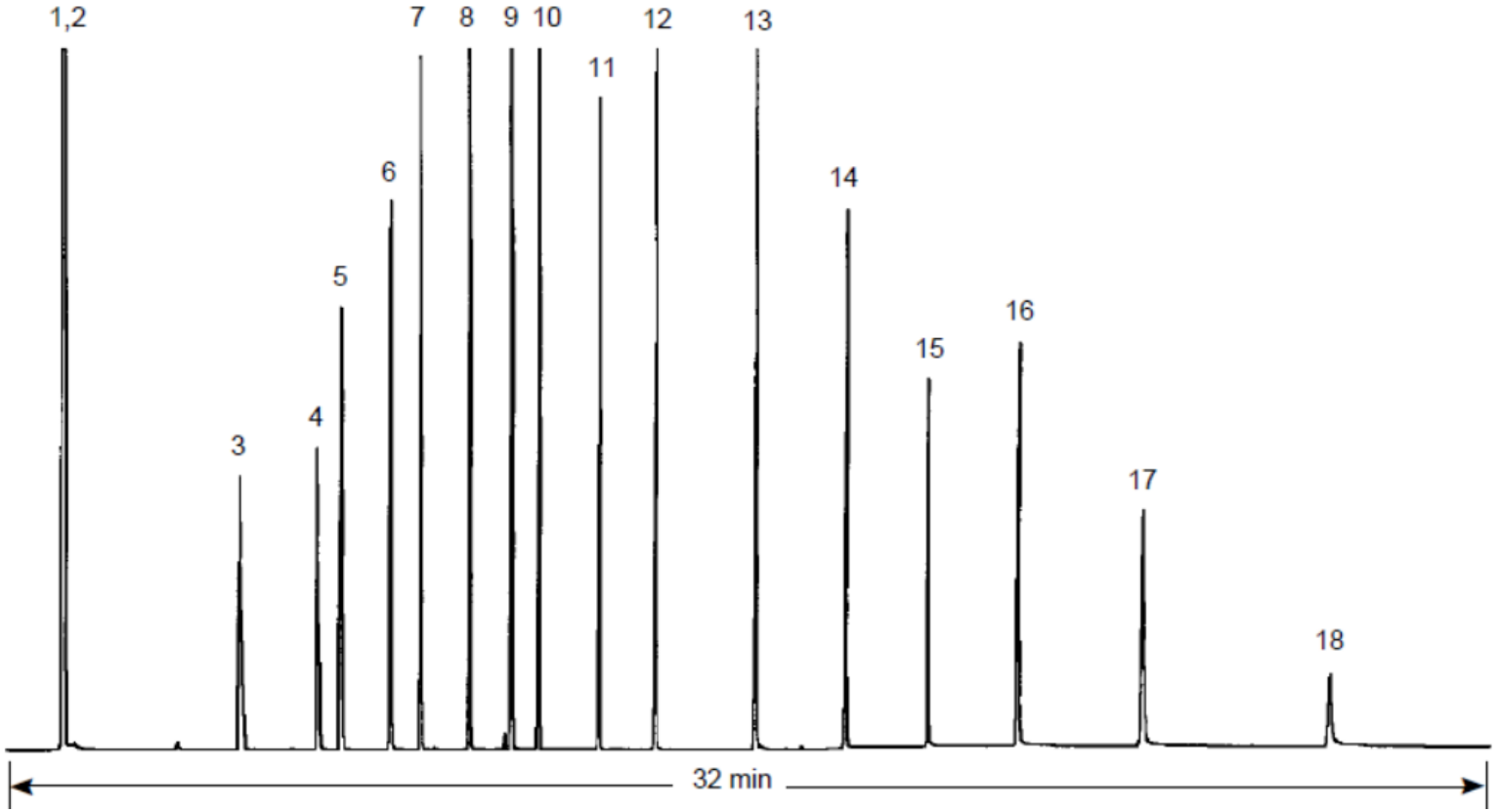
Acid-based WAX: DB-FFAP

| | |
|---|---|
| Column | **DB-FFAP**, 30 m, 0.25 mm, 0.25 µm (p/n 122-3232) |
| Carrier | Helium at 40 cm/s, measured at 100 °C |
| Oven | 100 ºC (5 min) to 250 ºC (12 min) at 10 ºC/min |
| Detector | FID, 300 °C |
| | Nitrogen makeup gas at 30 mL/min |
| Injector | Split 1:50, 250 °C |

Chromatogram C077

Peak Number

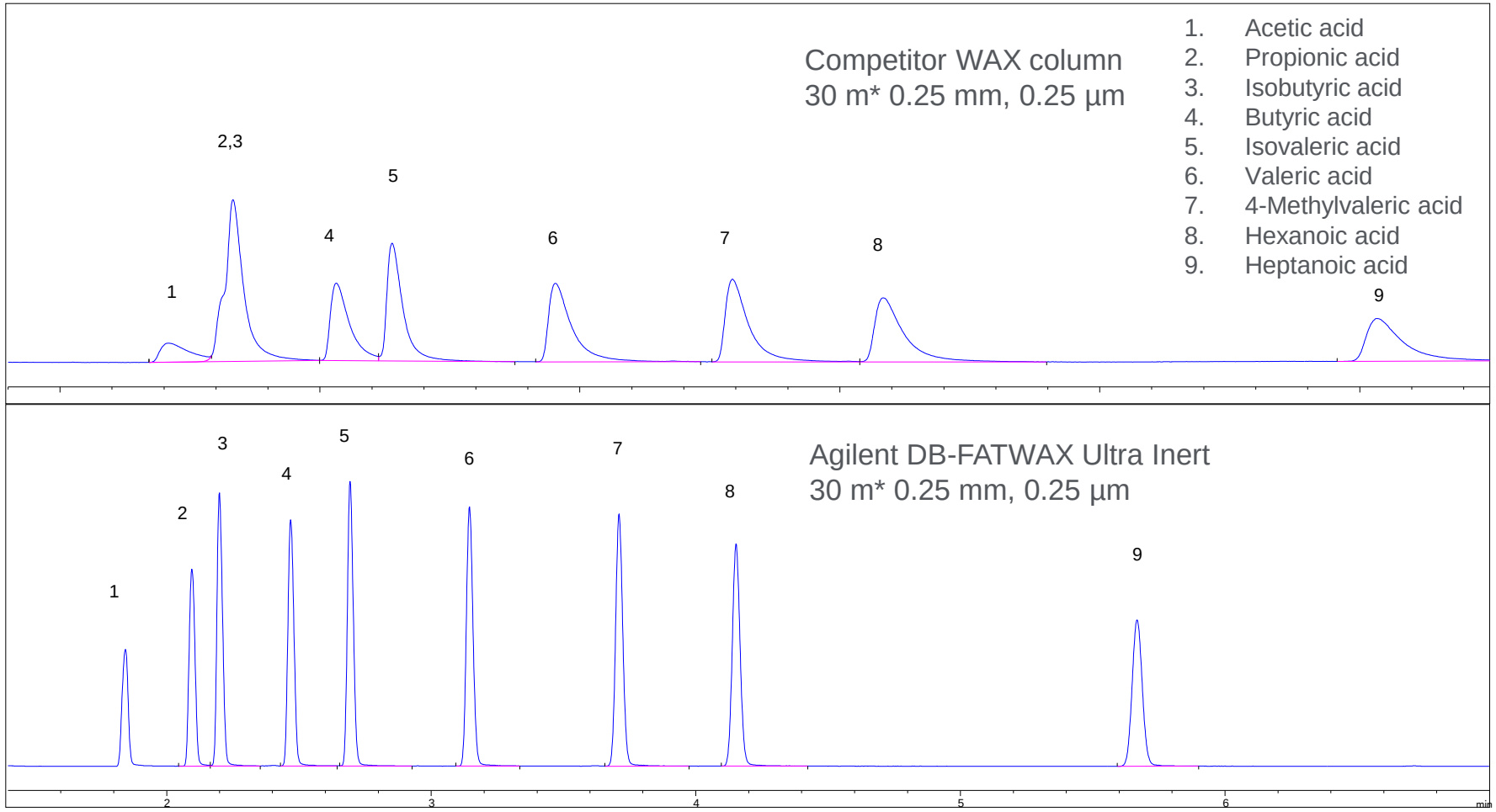
1. Acetone
2. Formic acid
3. Acetic acid
4. Propionic acid
5. Isobutyric acid
6. Butyric acid
7. Isovaleric acid
8. Valeric acid
9. Isocaproic acid
10. Caproic acid
11. Heptanoic acid
12. Octanoic acid
13. Decanoic acid
14. Dodecanoic acid
15. Tetradecanoic acid
16. Hexadecanoic acid
17. Octadecanoic acid
18. Arachidic acid



# Separation of Short-Chain Volatile Organic Acids in Water

## Using a traditional WAX column and DB-FATWAX Ultra Inert

Standard WAX columns don't have the inertness to separate most organic acids



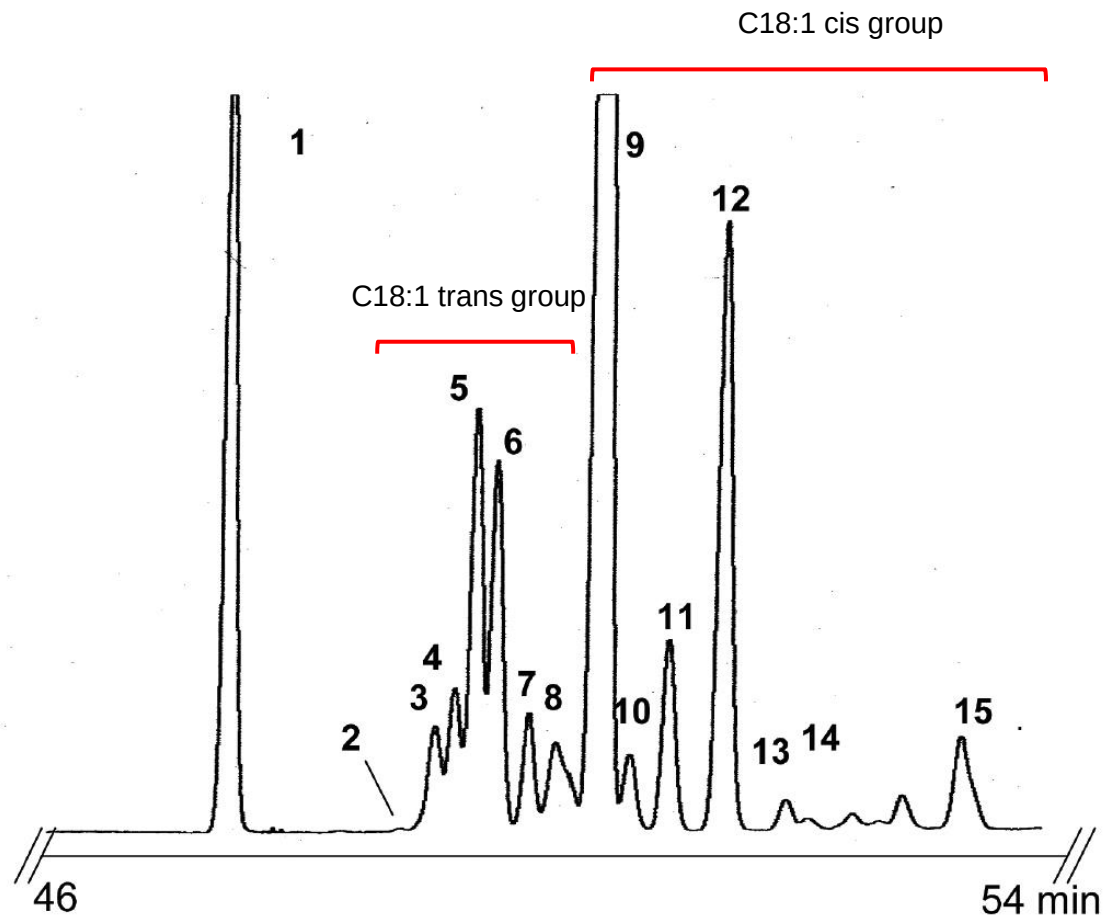
# Detailed Analysis of Cis/Trans FAMEs C18:1 Positional Isomers

| | |
|---|---|
| Column | **Select FAME,** 200 m, 0.25 mm id (p/n CP7421) |
| Inlet | 250 °C, split mode, split ratio 1:20 |
| Carrier | Helium, 520 kPa |
| Oven | 185 °C |
| FID | 250 °C |
| Injection | 0.5 µL |

Select-FAME

Peak Number

1. C18:0
2. C18:1 7 trans
3. C18:1 8 trans
4. C18:1 9 trans
5. C18:1 10 trans
6. C18:1 11 trans
7. C18:1 12 trans
8. C18:1 trans + ?
9. C18:1 9 cis
10. C18:1 10 cis
11. C18:1 11 cis
12. C18:1 12 cis
13. C18:1 13 cis
14. C18:1 14 cis
15. C18:1 15 cis



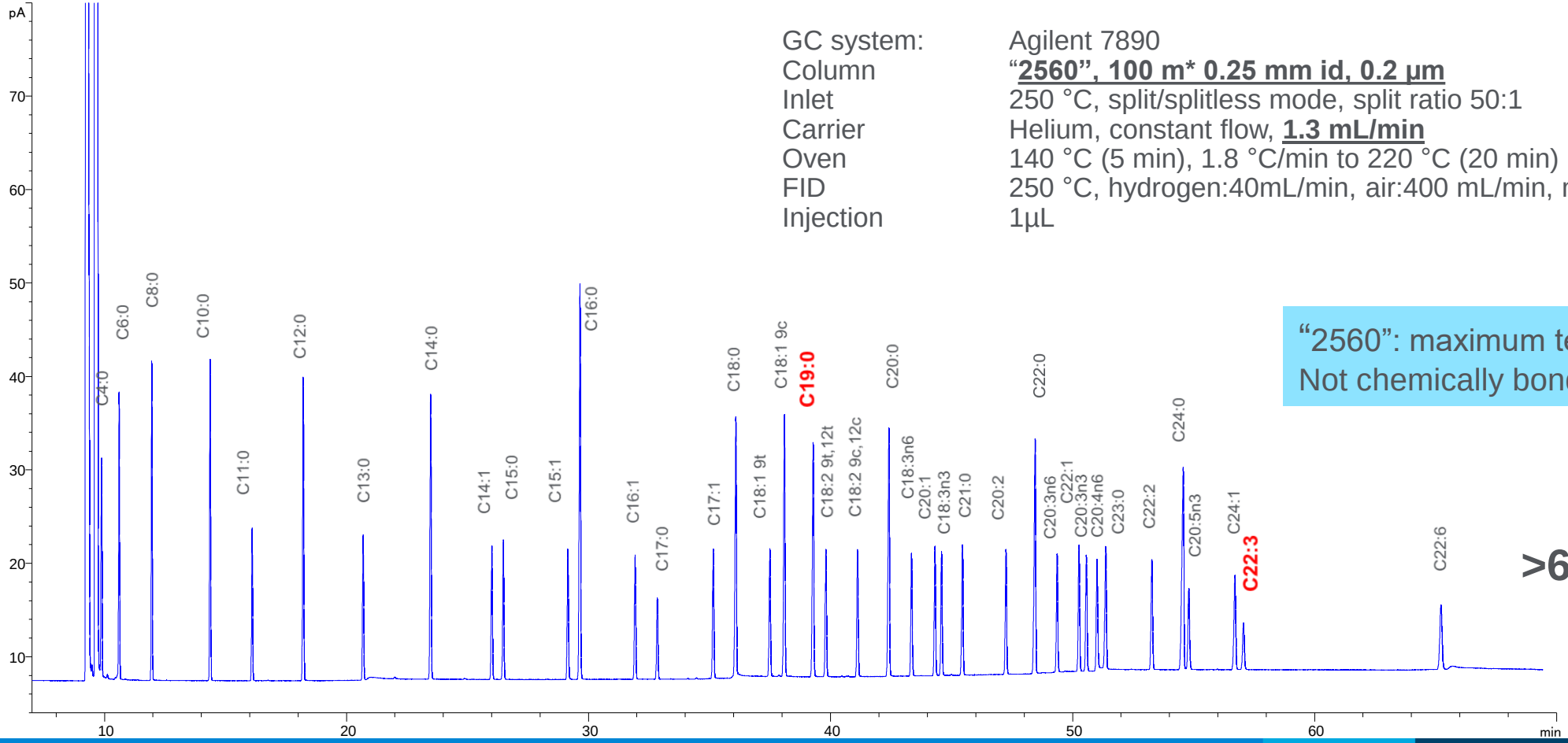
# Introducing High-Resolution DB-FastFAME

- Fast separation of cis/trans isomers
- No cis/trans overlap with right conditions
- 22 to 24 minute analysis (<37 FAMES)

# Traditional FAME Analysis on “2560” Column

- 37-FAME mix plus C19:0 and C22:3
- Analysis time is typically in the 65 to 76 min range, following AOAC 996.02 method
- Cyanopropyl column (100 m) is the ‘go-to’ column for positional cis/trans isomers

| | |
|---|---|
| GC system: | Agilent 7890 |
| Column | “**2560”, 100 m* 0.25 mm id, 0.2 µm** |
| Inlet | 250 °C, split/splitless mode, split ratio 50:1 |
| Carrier | Helium, constant flow, **1.3 mL/min** |
| Oven | 140 °C (5 min), 1.8 °C/min to 220 °C (20 min) |
| FID | 250 °C, hydrogen:40mL/min, air:400 mL/min, makeup gas: 25mL/min |
| Injection | 1µL |

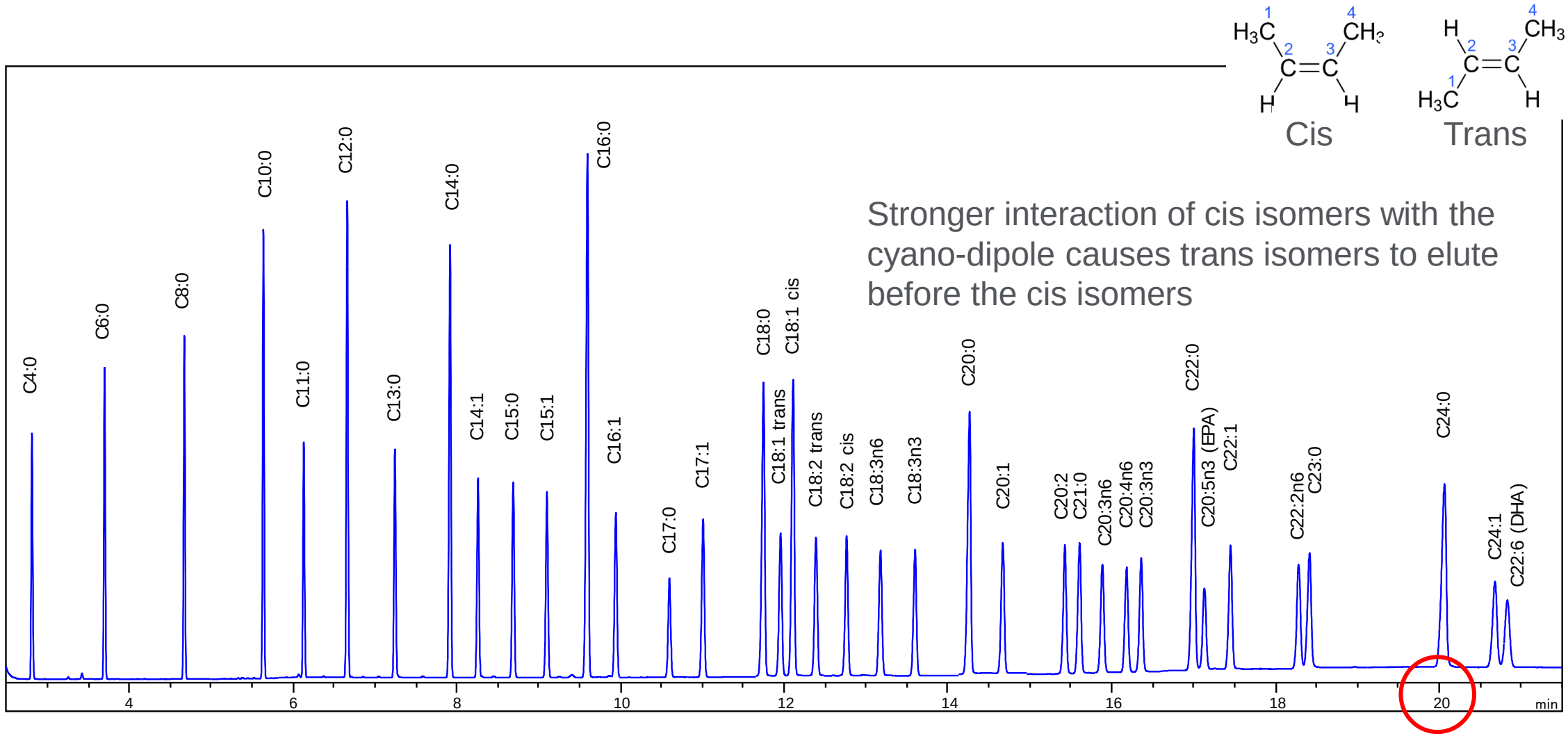



“2560”: maximum temperature is 250 °C
Not chemically bonded

**>65 min**

# DB-FastFAME (30 m x 0.25 mm x 0.25 µm)

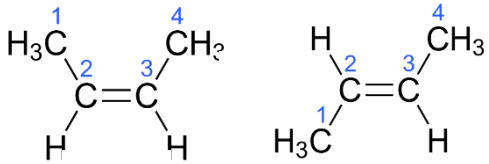
## Technical note 5991-8706EN



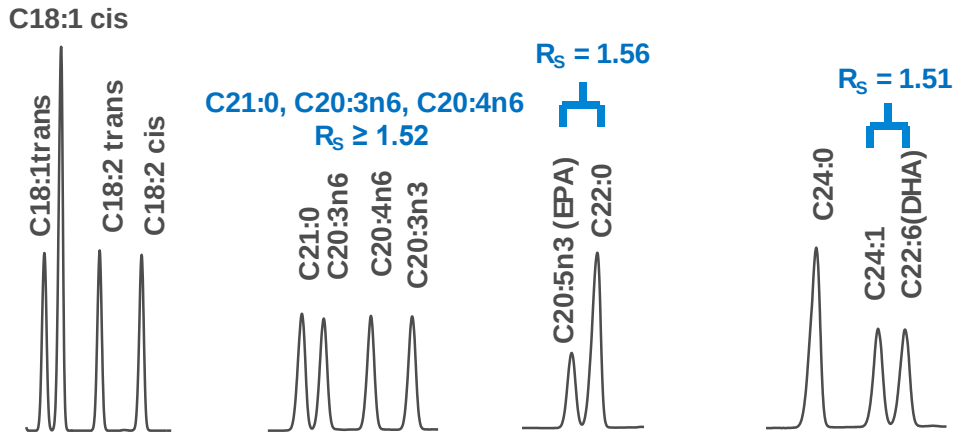
# DB-FastFAME
## 20 m x 0.18 mm x 0.20 µm

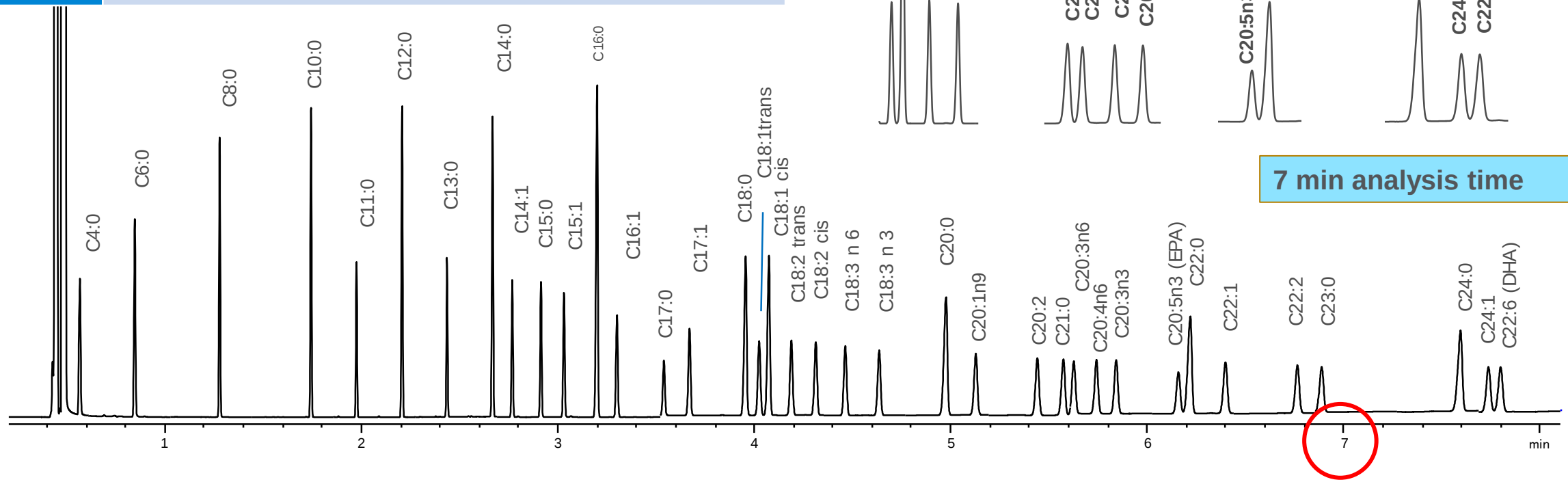
| Column | Agilent J&W DB-FastFAME, 20 m x 0.18 mm, 0.20 µm |
|---|---|
| Gas | **Hydrogen**, 28 psi, constant pressure mode |
| Inlet | Split/splitless, 250 °C, split ratio 50:1 |
| Oven | 80 °C (0.5 min), **65 °C/min** to 175 °C, 10 °C/min to 185 °C (0.5 min), 7 °C/min to 230 °C |
| FID | 280 °C, hydrogen: 40 mL/min; air: 400 mL/min; makeup gas: 25 mL/min. |
| Injection | 1 µL |

Strong interaction between cis isomers and the dipoles of the cyanopropyl ligands. This allows the trans to elute after the cis isomers.




$R_S \geq 1.95$ for cis/trans isomers

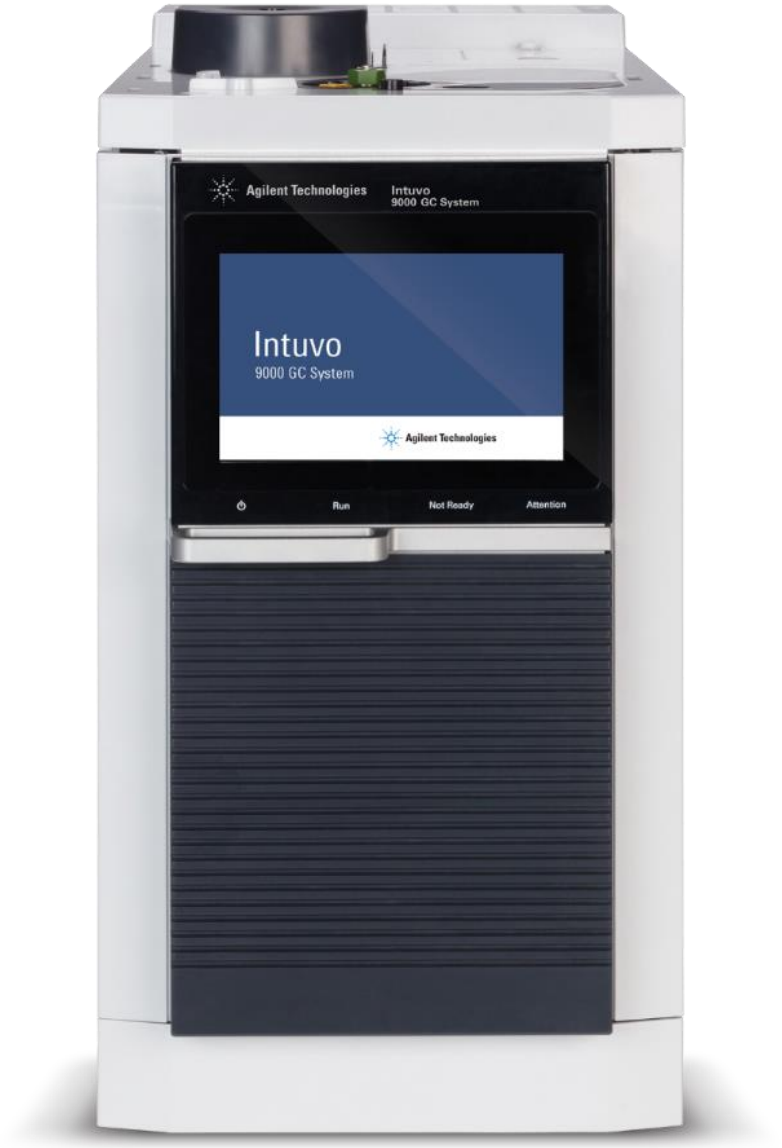



**7 min analysis time**

# Agilent Intuvo 9000

- New design
- New column connection
- Guard chip
- New column heating
- Application to FAME analysis




Intelligent, intuitive, innovative. Intuvo.

# Innovating a New Path to GC Productivity

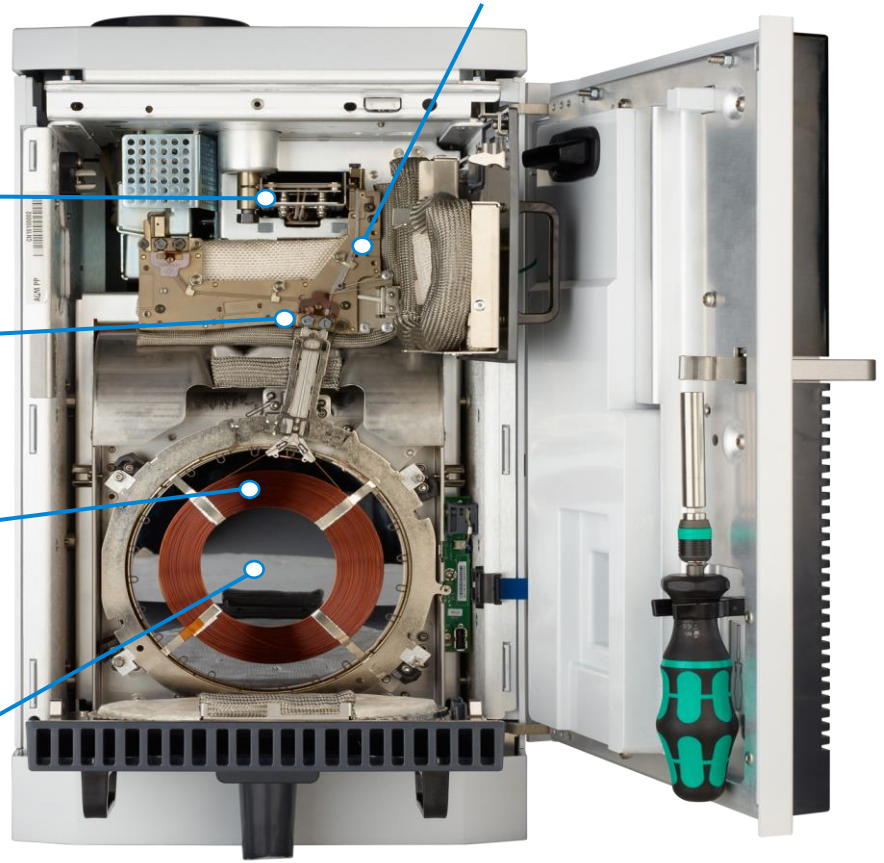
Disposable Guard chip

Ferrule-free click-and-run connections


No-trim column

Direct heating

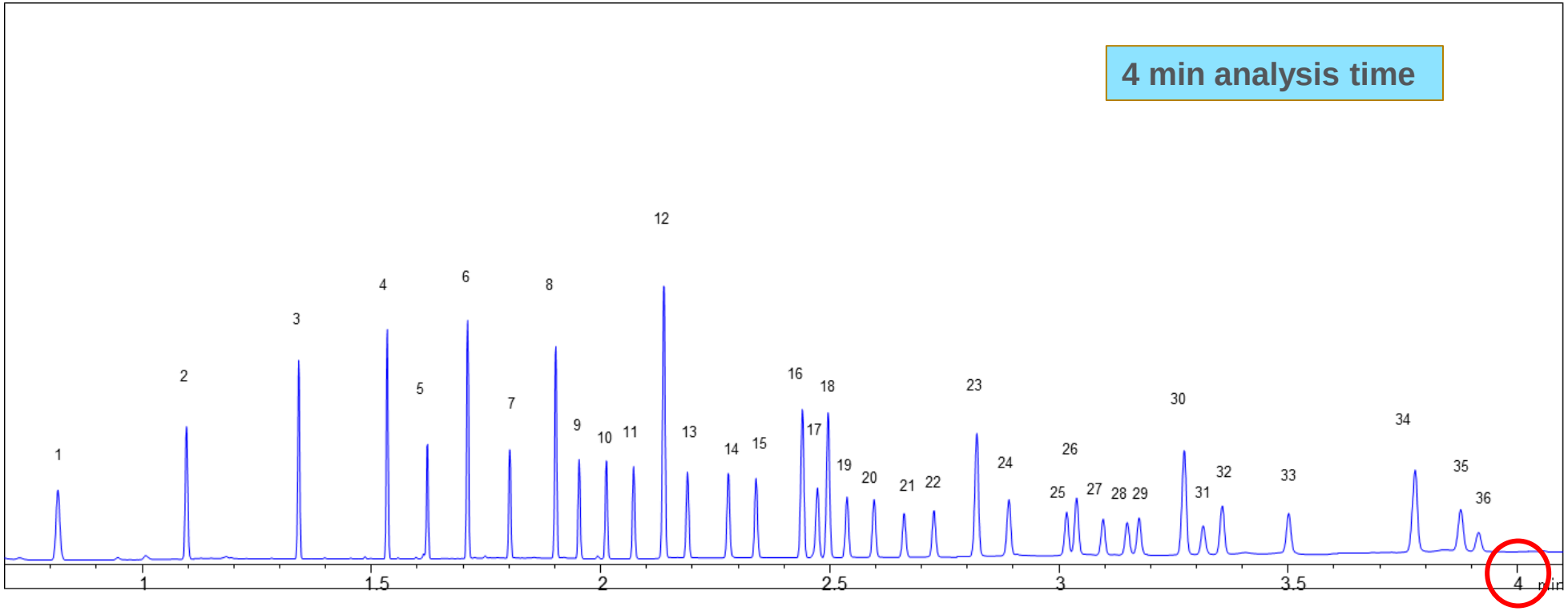
Modular
Intuvo flow chips



# Fast Analysis of a 36-FAME Mix (AOAC 2012.13)

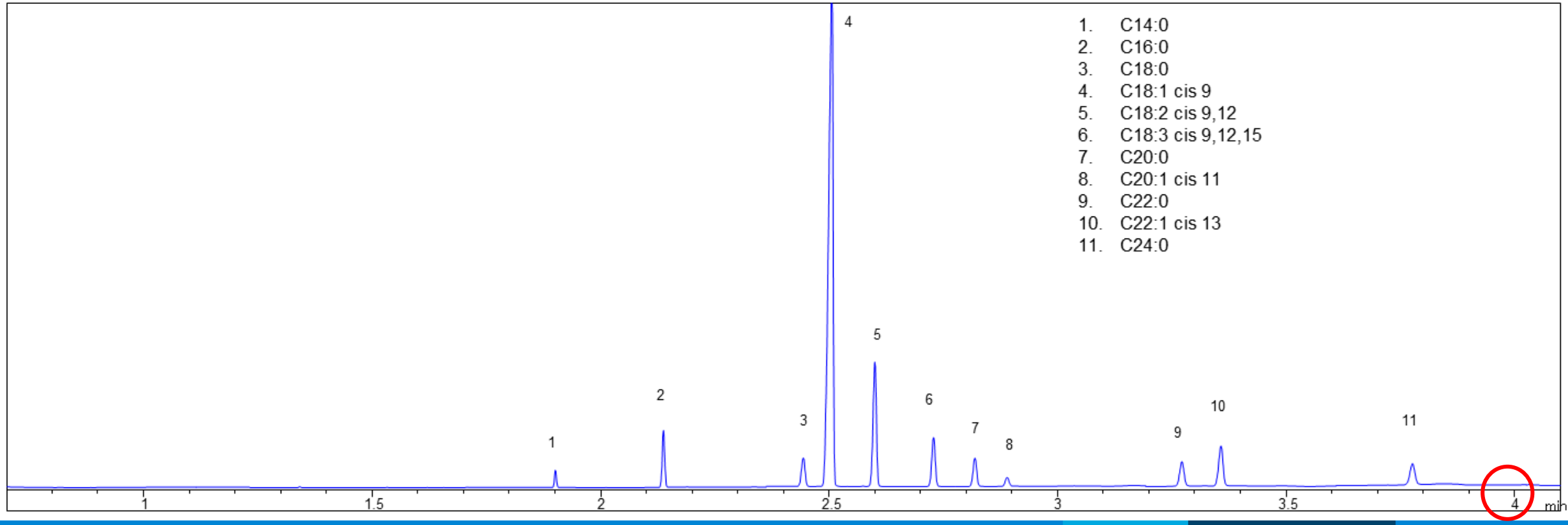
## With the Intuvo 20-m DB-FastFAME


| | |
|---|---|
| GC system: | Agilent Intuvo 9000 GC system |
| Column | DB-FastFAME, 20 m* 0.18 mm id, 0.20 µm, Intuvo module |
| Inlet | 250 °C, split/splitless mode, split ratio 100:1 |
| Intuvo Guard chip | 200 °C |
| Carrier | **Hydrogen**, constant pressure, 28 psi |
| Oven | 50 °C (0.3 min), 200 °C/min to 200 °C (0.4 min), 20 °C/min to 240 °C (1 min) |
| FID | 260 °C, hydrogen:40 mL/min, air: 400 mL/min, makeup gas: 25 mL/min |
| Injection | 1 µL |



# Fast analysis of rapeseed oil
# With the Intuvo 20-m DB-FastFAME


| | |
|---|---|
| GC System: | Agilent Intuvo 9000 GC system |
| Column | DB-FastFAME, 20m*0.18mm I.D, 0.20um, Intuvo module |
| Inlet | 250°C, split/splitless mode, split ratio 100:1 |
| Intuvo Guard chip | 200°C |
| Carrier | **Hydrogen**, constant pressure, 28psi |
| Oven | 50°C(0.3min), 200°C/min to 200°C(0.4min), 20°C/min to 240°C(1min) |
| FID | 260°C, Hydrogen:40mL/min, Air:400mL/min, make-up gas:25mL/min |
| Injection | 1uL |



# How About More Complex FAME Samples like PHVO?

# Agilent J&W High-Resolution DB-FastFAME GC columns

## Highlights

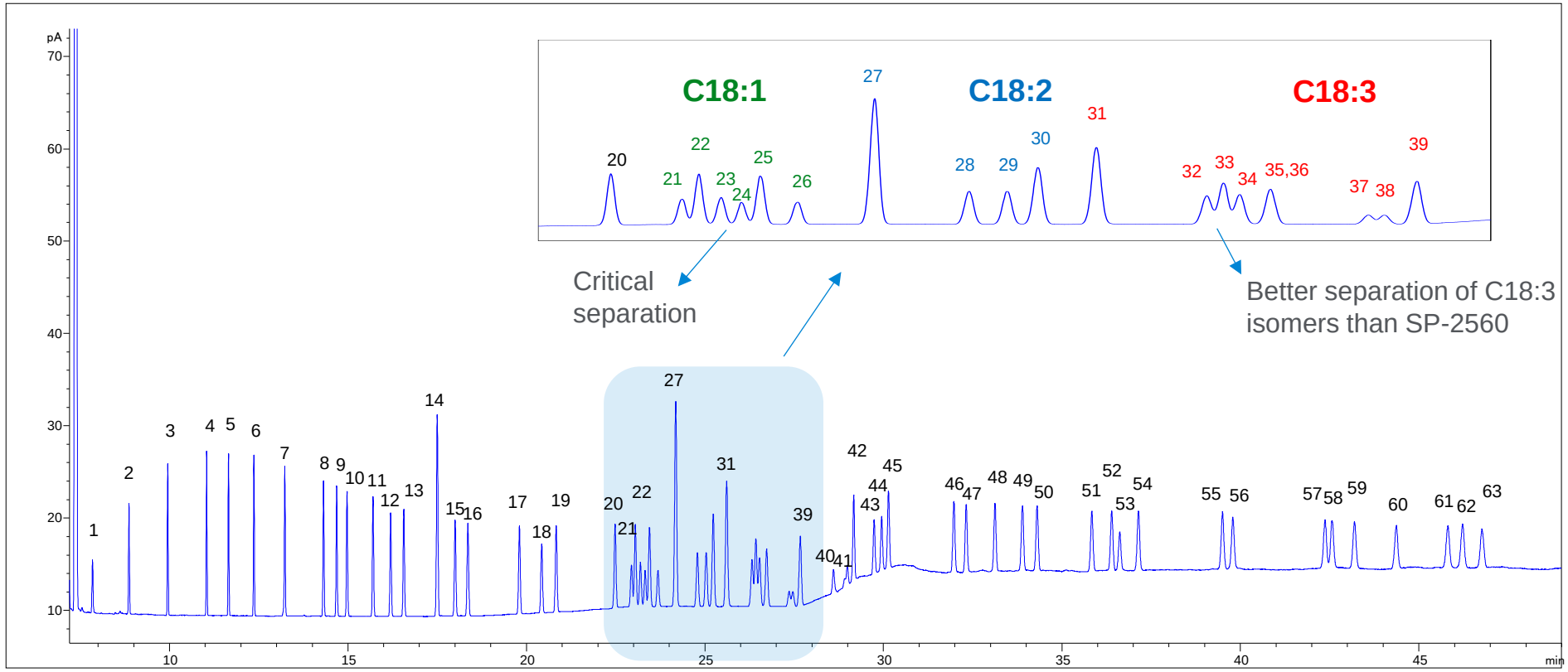
- The 90-meter DB-FastFAME separates complex positional cis/trans FAME isomers with similar or better resolution than SP-2560, in <48 minutes
- A 60-meter DB-FastFAME is available for less demanding separations, and Intuvo applications
- Resolves critical fatty acids in food samples, making it easy to comply with labeling requirements
- Provides increased thermal stability and extend column lifetime over nonbonded cyano phases
- Same micro-union developed for Intuvo is used to assemble the 90-meter DB-FastFAME

# 63-Component FAME Mixture Analysis

## In <48min using a 90m x 0.25mm DB-fastFAME column

| | |
|---|---|
| GC system: | Agilent 8890 |
| Column | DB-FastFAME, 90 m* 0.25 mm id, 0.25 µm (p/n G3903-63013Z,s/n T009721Z) |
| Inlet | 260 °C, split/splitless mode, split ratio 30:1 |
| Carrier | Helium, constant pressure 44 psi |
| Oven | 75 °C (1 min), 35 °C/min to 200 °C (14 min), 2.5 °C/min to 210 °C ( 5 min), 12 °C/min to 230 °C (20 min) |
| FID | 260 °C, hydrogen: 30 mL/min, air: 300 mL/min, makeup gas: 25 mL/min |
| Injection | 1 µL |

- Separation of critical C18:1 isomers
- $R_S$ of C18:1 (11t)/c18:1(6c) >1.40 (baseline resolution)
- Separation of C18:2 isomers
- Separation of C18:3 isomers except for one pair (same as SP-2560)
- Analysis time <48min




Application Note: 5994-1862EN

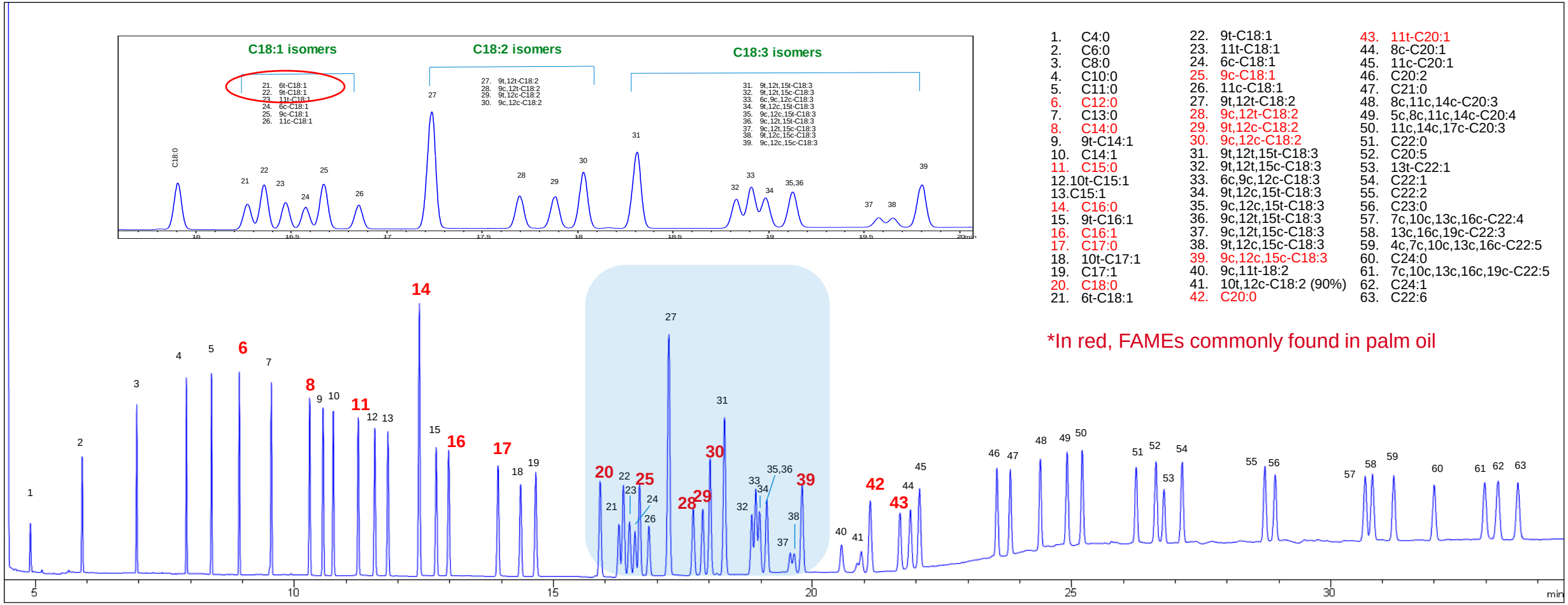
| | | | |
|---|---|---|---|
| 1. | C4:0 | 33. | C18:3 (6c,9c,12c) |
| 2. | C6:0 | 34. | C18:3 (9t,12c,15t) |
| 3. | C8:0 | 35. | C18:3 (9c,12c,15t) |
| 4. | C10:0 | 36. | C18:3 (9c,12t,15t) |
| 5. | C11:0 | 37. | C18:3 (9c,12t,15c) |
| 6. | C12:0 | 38. | C18:3 (9t,12c,15c) |
| 7. | C13:0 | 39. | C18:3 (9c,12c,15c) |
| 8. | C14:0 | 40. | C18:2 (t9,c11) |
| 9. | C14:1(9t) | 41. | C18:2 (t10,c12) (90%) |
| 10. | C14:1 | 42. | C20:0 |
| 11. | C15:0 | 43. | C20:1(11t ) |
| 12. | C15:1 | 44. | C20:1(8c) |
| 13. | C15:1 (10t) | 45. | C20:1(11c) |
| 14. | C16:0 | 46. | C20:2 |
| 15. | C16:1 (9t) | 47. | C21:0 |
| 16. | C16:1 | 48. | C20:3 (8c,11c,14c) |
| 17. | C17:0 | 49. | C20:4 (5c,8c,11c,14c) |
| 18. | C17:1(10t) | 50. | C20:3(11c,14c,17c) |
| 19. | C17:1 | 51. | C22:0 |
| 20. | C18:0 | 52. | C20:5(4c,7c,10c,13c,16c) |
| 21. | C18:1(6t) | 53. | C22:1 (13t) |
| 22. | C18:1 (9t) | 54. | C22:1 (13c) |
| 23. | C18:1 (11t) | 55. | C22:2(13c,16c) |
| 24. | C18:1 (6C) | 56. | C23:0 |
| 25. | C18:1 (9C) | 57. | C22:4(7c,10c,13c,16c) |
| 26. | C18:1 (11C) | 58. | C22:3(13c,16c,19c) |
| 27. | C18:2 (9t,12t) | 59. | C22:5 (4c,7c,10c,13c,16c) |
| 28. | C18:2(9c,12t) | 60. | C24:0 |
| 29. | C18:2 (9t,12c) | 61. | C22:5 (7c,10c,13c,16c,19c) |
| 30. | C18:2(9c,12c) | 62. | C24:1 |
| 31. | C18:3 (9t,12t,15t) | 63. | C22:6(4c,7c,10c,13c,16c,19c) |
| 32. | C18:3 (9t,12t,15c) | | |

# GC/FID Chromatogram of 63-Component FAMEs Standard Mixture

## On an Agilent J&W DB-FastFAME column using **hydrogen** as carrier gas

**<40 min**

Application note: 5994-1862EN

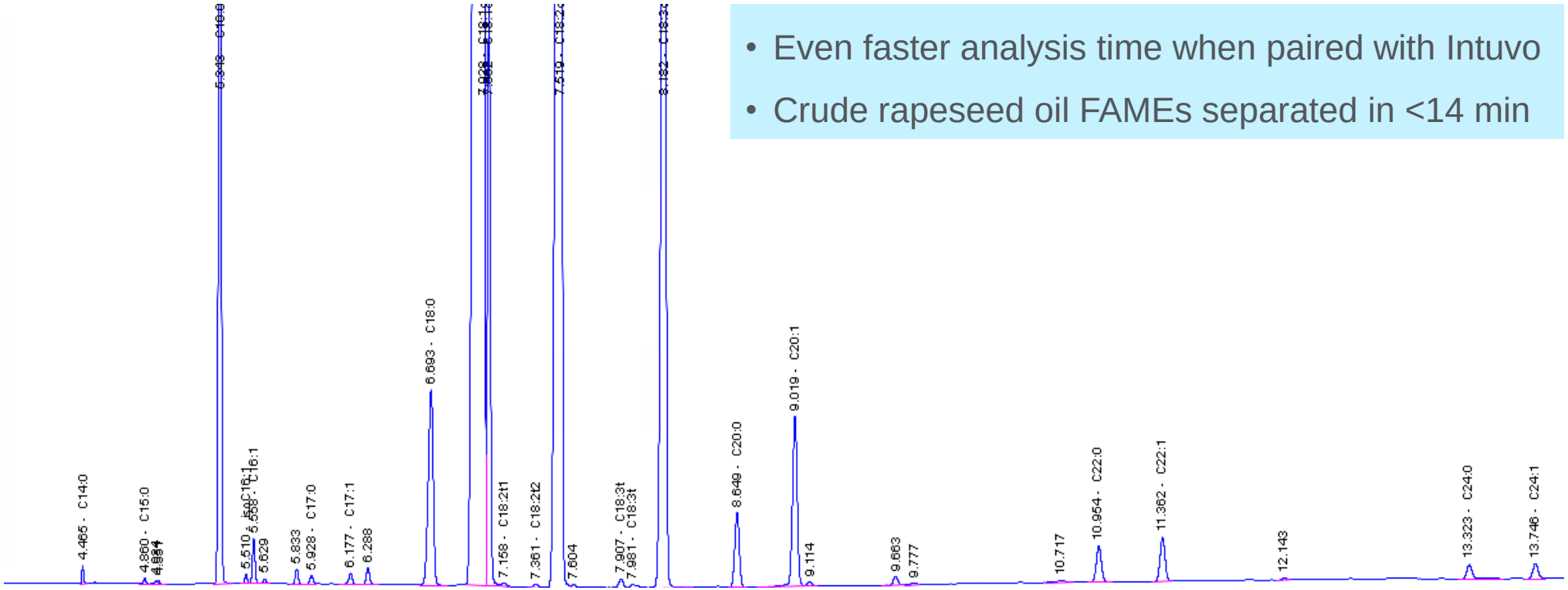



1. C4:0
2. C6:0
3. C8:0
4. C10:0
5. C11:0
6. C12:0
7. C13:0
8. C14:0
9. 9t-C14:1
10. C14:1
11. C15:0
12. 10t-C15:1
13. C15:1
14. C16:0
15. 9t-C16:1
16. C16:1
17. C17:0
18. 10t-C17:1
19. C17:1
20. C18:0
21. 6t-C18:1
22. 9t-C18:1
23. 11t-C18:1
24. 6c-C18:1
25. 9c-C18:1
26. 11c-C18:1
27. 9t,12t-C18:2
28. 9c,12t-C18:2
29. 9t,12c-C18:2
30. 9c,12c-C18:2
31. 9t,12t,15t-C18:3
32. 9t,12t,15c-C18:3
33. 6c,9c,12c-C18:3
34. 9t,12c,15t-C18:3
35. 9c,12c,15t-C18:3
36. 9c,12t,15t-C18:3
37. 9c,12t,15c-C18:3
38. 9t,12c,15c-C18:3
39. 9c,12c,15c-C18:3
40. 9c,11t-18:2
41. 10t,12c-C18:2 (90%)
42. C20:0
43. 11t-C20:1
44. 8c-C20:1
45. 11c-C20:1
46. C20:2
47. C21:0
48. 8c,11c,14c-C20:3
49. 5c,8c,11c,14c-C20:4
50. 11c,14c,17c-C20:3
51. C22:0
52. C20:5
53. 13t-C22:1
54. C22:1
55. C22:2
56. C23:0
57. 7c,10c,13c,16c-C22:4
58. 13c,16c,19c-C22:3
59. 4c,7c,10c,13c,16c-C22:5
60. C24:0
61. 7c,10c,13c,16c,19c-C22:5
62. C24:1
63. C22:6

*In red, FAMEs commonly found in palm oil

# Crude Rapeseed Oil FAMEs with Intuvo 60 m DB-FastFAME GC column

| | |
|---|---|
| Column | DB-FastFame, 60 m* 0.25 mm id, 0.25 µm (p/n G3909-63007) |
| Inlet | 250 °C, split mode, split ratio 100:1 |
| Guard Chip | SSL guard chip in track oven mode |
| Carrier | Hydrogen, constant flow mode,50 cm/s avg linear velocity |
| Oven | 120 °C (1 min), 100 °C/min to 200 °C (5 min), 5 °C/min to 240 °C |
| FID | 250 °C, hydrogen: 40 mL/min, air: 400 mL/min, makeup gas: 25 mL/min |
| Injection | 1 µL |




- Even faster analysis time when paired with Intuvo
- Crude rapeseed oil FAMEs separated in <14 min

# The High-Resolution Columns are a DB-FastFAME Product Line Extension

| DB-FastFAME Product Line | Features and Benefits | Applications |
|---|---|---|
| 20 m x 0.18 mm x 0.20 µm, 7 in cage and Intuvo | Faster separation of FAMEs than any other column on the market | Simpler FAME mixture (<37 FAMEs) in 8 minutes (for example, vegetable and extra virgin oils) |
| 30 m x 0.25 mm x 0.25 µm, 7 in cage and Intuvo | Good balance between speed and capacity | Simpler FAME mixture (<37 FAMEs) in 25 minutes (for example, vegetable and extra virgin oils) |
| 60 m x 0.25 mm x 0.25 µm, 7 in cage and Intuvo | Ideal for specific FAME applications (CLAs, C18:1 groups, C18:3 groups), and Intuvo applications | Intuvo applications<br>CLA isomers per new GB method<br>55 FAMEs <38 minutes |
| 90 m x 0.25 mm x 0.25 µm, 7 in cage only | High detail analysis of positional cis/trans isomers with 30-35% faster analysis time than SP-2560 | All purpose FAME column (milk fat, cooking oil, trans fats)<br>63 FAMEs <48 minutes |

# Introducing a novel detector for FAME analysis by GC

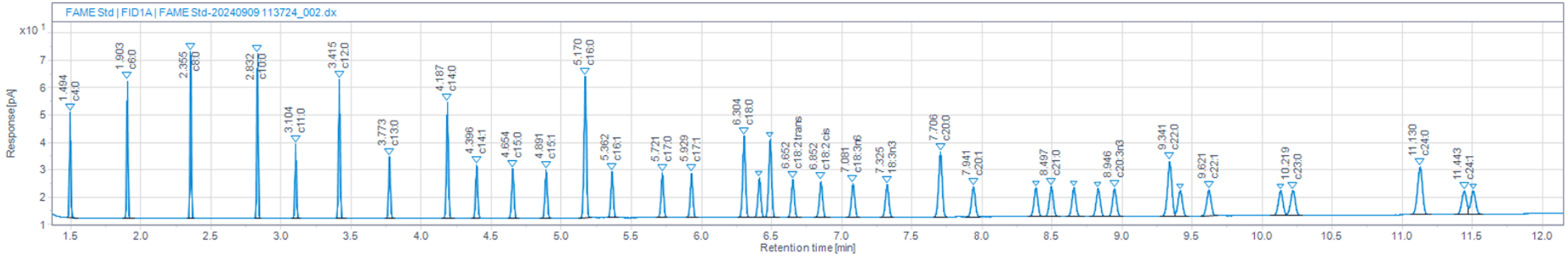
LUMA multi-channel vacuum ultraviolet (VUV)

# Some features of the LUMA detector

- Uses vacuum ultraviolet light for highly sensitive and selective detection of organic compounds (118-1050 nm over 12 channels)
- Capable of detecting a wide array of substances, including challenging compounds that are often difficult to identify with other detectors
- Excellent for complex matrices, offering clear, interpretable results by effectively ignoring common interferences
- Delivers detection down to parts per billion (ppb), making it ideal for trace-level analysis

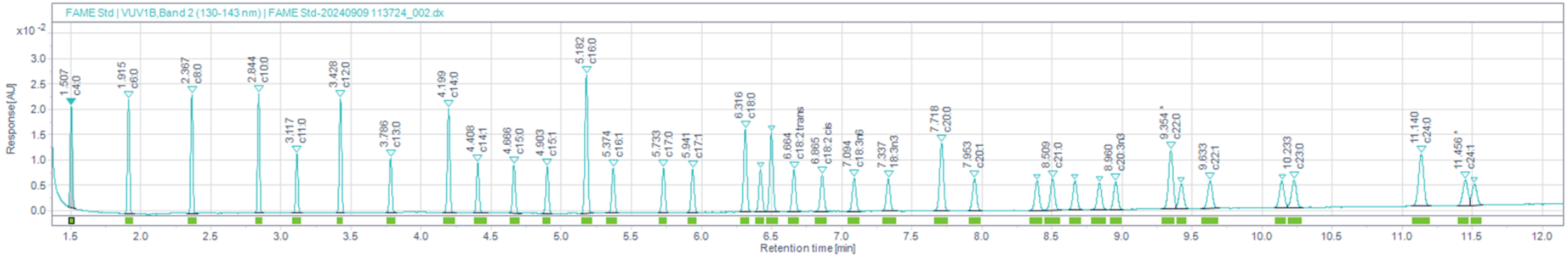
# A 37-FAME mix analyzed simultaneously on an FID and LUMA VUV

**FID**



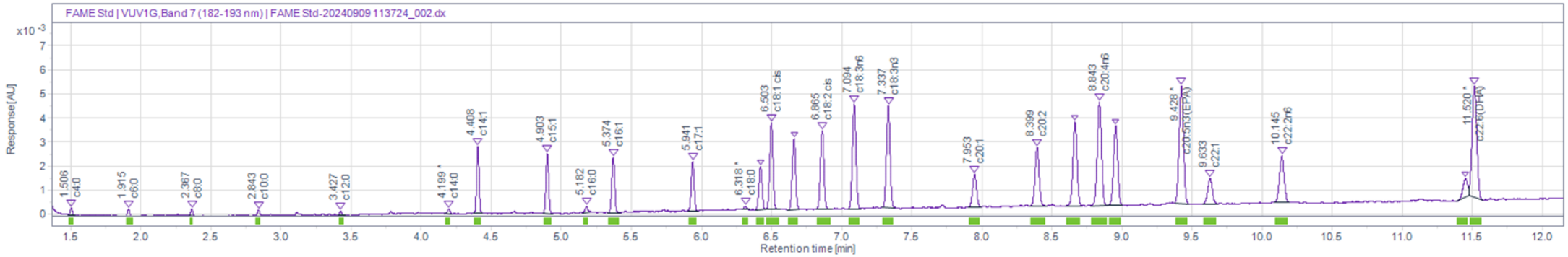

**LUMA Band 2**

**(130 to 143 nm)**




**LUMA Band 7**

**(186 to 198 nm)**




**This band shows stronger absorbance for unsaturated fats**

# Zoomed-in chromatograms of the C17:1 to C18:3n6 FAMEs

- The low absorbance of C18:0 is more evident

**FID**

**Band 2**

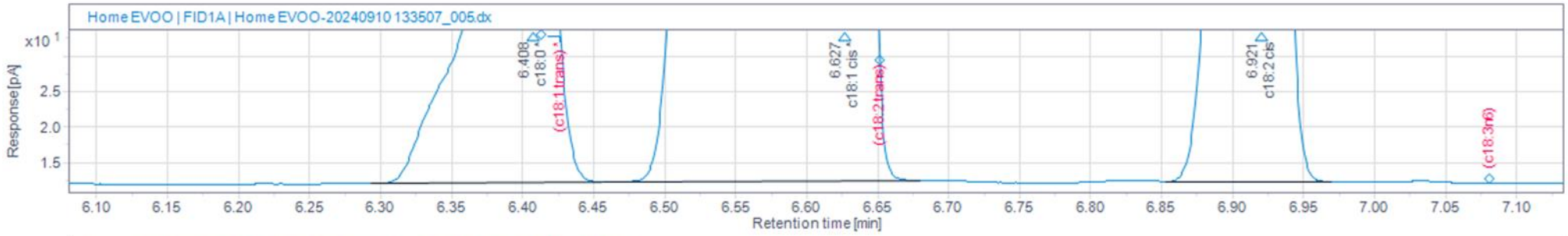
**Band 7**

# The benefits of the LUMA detector in real samples

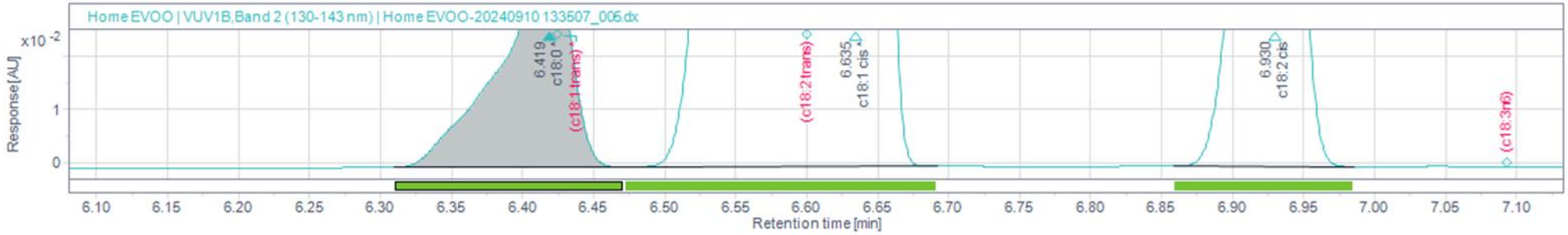
## EVOO sample as analyzed on the FID and LUMA bands 2 and 7

- The sample shows a potential co-elution between C18:0 and C18:1t when using GC/FID

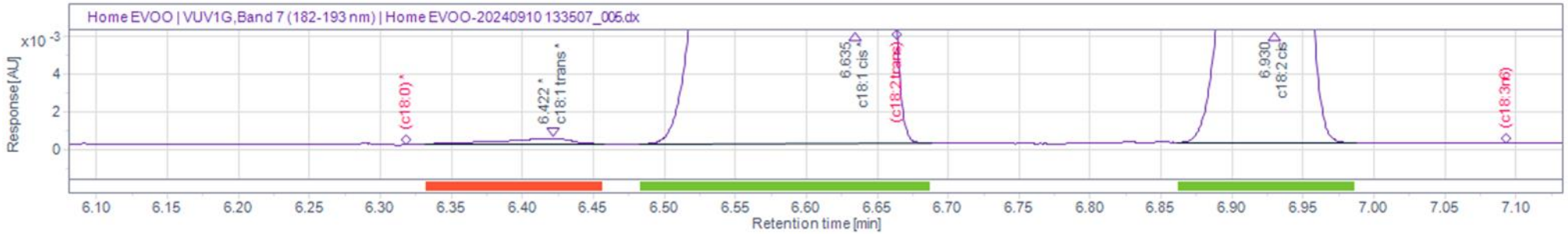
**FID**




**Band 2**

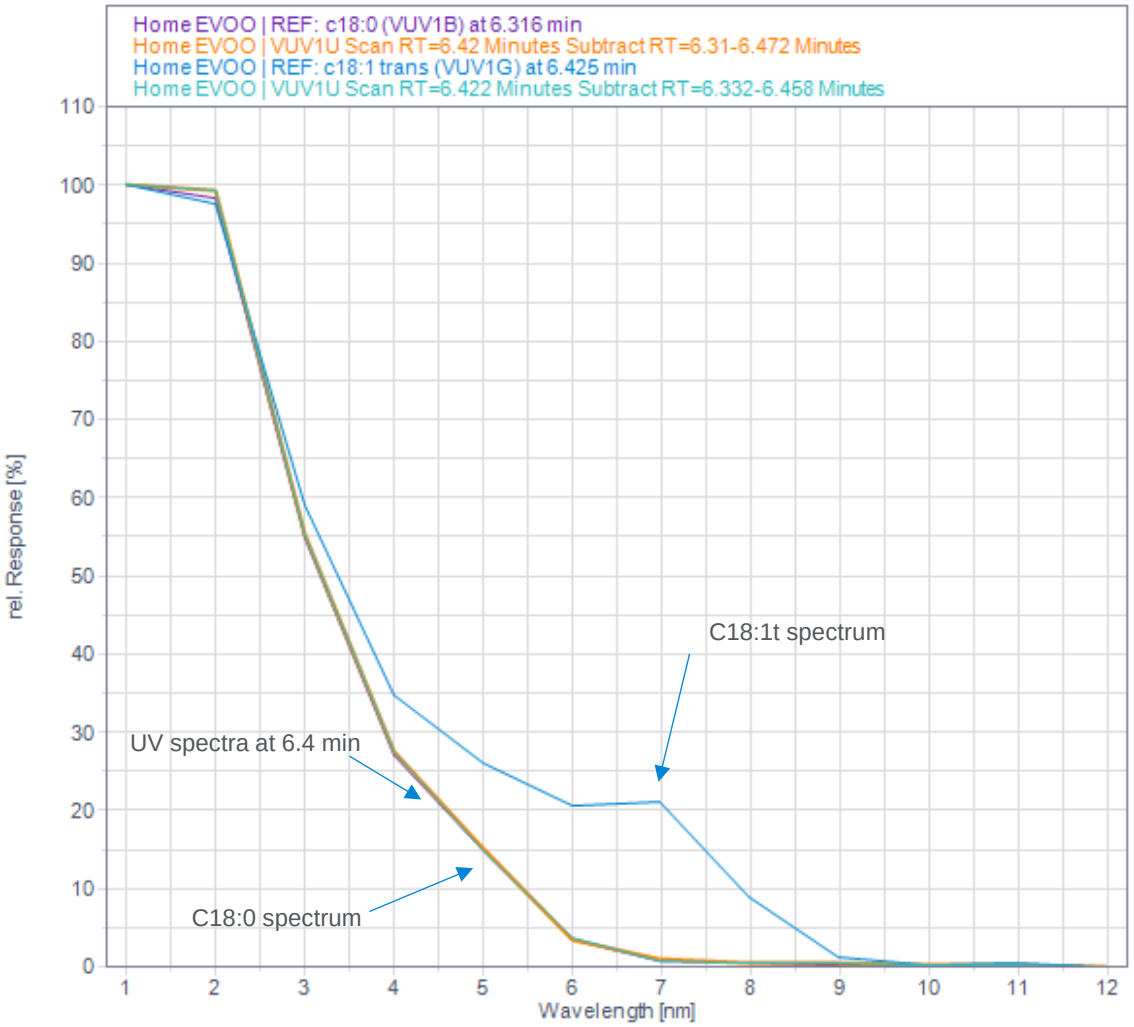



**Band 7**



# The benefits of the LUMA detector in real samples

- We can use UV purity criteria for each compound using standards
- This is then match from the UV spectra from the sample at a specific time and compared
- Purity criteria matching is a power tool for peak deconvolution and can be used to confirm the presence of co-elution in the samples.



# Collateral

| LITERATURE | LINK/PUBLICATION NUMBER | |
|---|---|---|
| Improving the Analysis of 37 Fatty Acid Methyl Esters: Using Three Types of Capillary Columns | 5991-8706EN | Application note |
| Analysis of Omega 3 and Omega 6 FAMEs in Fish Oil and Animal Fat Using an Agilent J&W DB-FATWAX Ultra Inert GC Column | 5991-8744EN | Application note |
| A comparison study of the analysis of volatile organic acids and fatty acids: Using DB-FATWAX Ultra Inert and other WAX GC columns | 5991-9223EN | Application note |
| Comprehensive Analysis of FAMEs, Fatty Acids and Triglycerides | 5991-8763EN | 20-page brochure |
| Rapid Separation of Fatty Acid Methyl Esters using DB-FastFAME Intuvo GC columns | 5994-0116EN | Application note |
| Analysis of 37 Fatty Acid Methyl Esters on the Agilent 8890 GC using FID and LUMA detectors | 5994-7849EN | Application brief |

# Contact Agilent Chemistries and Supplies Technical Support

1-800-227-9770 Option 3, Option 3:

Option 1 for GC and GC/MS columns and supplies

Option 2 for LC and LC/MS columns and supplies

Option 3 for sample preparation, filtration, and QuEChERS

Option 4 for spectroscopy supplies

Option 5 for chemical standards

Available in the USA and Canada 8–5, all time zones

gc-column-support@agilent.com

lc-column-support@agilent.com

spp-support@agilent.com

spectro-supplies-support@agilent.com

chem-standards-support@agilent.com

# Thanks for your attention

## Any questions?