Guide to the use of FAST-GC

What is FAST-GC?

FAST-GC is one of the highest potential techniques, already widely demonstrated in practice, that is spreading out especially in these years. How the name itself indicates, FAST-GC is a fast gascromatography, which is able to ten times reduce analysis time compared to the amount of time in conventional GC analysis. With FAST-GC you can get analysis only in 1-2 minutes by keeping a sufficient resolution for the separation of medium or medium-high complexity mixtures. In this way it is possible to increase the number of analysis made in a day, decreasing analytical costs, using cheaper columns and not wasting time!

Theorical notices.

The parameter that shows the separative power of a capillary column in the best way is the number of theoretical plates (N) of a column.

$$N = 5.54 \cdot \left(\frac{tr}{w50} \right)^2 ; where: tr = retention\ time, w50 = Peak\ width\ calculated\ at\ mid\ height \quad (1).$$

At equal credit of the internal diameter, the more a column is long, the more theoretical plates it will have and the greater its separative power will be. At equal merit of lenght the columns with a shorter internal diameter will have a greater separative power since the number of theoretical plates will increase by decreasing the internal diameter. Just to make it clear, a traditional column with an internal diameter equal to 0.25mm and a 25 meter lenght has 100000 theoretical plates; as it is shown in table 1, a FAST-GC column with a narrower internal diameter (100µm), is only 10 meters long and it has the same number of theoretical plates as traditional GC. This allows to keep the same separative power even though the column is shorter and allows to reduce analysis time.
Columns for FAST-GC have very short internal diameters (50, 100µm usually), which means that even though they are short, they require a high pressure on the injector in order to obtain functional flows. Usually optimal flows that have to be used in FAST-GC (at normal conditions) are 0.5mL/min about (60cm/s @ 50°C (starting temperature of the GC's oven)) of gas in a column (see the table below on recommended flows). If hydrogen is used as carrier gas, there will be an advantage because, for it being less viscous that Helium, there will be the need of a lower pressure to reach the same flow in column. Hydrogen carrier gas allows to work with higher speeds without losing in a significant way efficiency terms of the column, allowing then to shorten up once more the analysis time. For these two reasons it is best to use Hydrogen as carrier gas in FAST-GC, even though the correct use of Helium as carrier gas brings to the same conclusions in efficiency terms.

What is needed to accomplish FAST-GC.

To accomplish FAST-GC you will only need:

- A short column with a short internal diameter (called "narrow-bore" columns). Typically a column of 10 m with an internal diameter of 0.10 mm is used.
- A gascromatographer able to carry out fast temperature rate, of 25°C/min and up, with a high frequency acquisition system (See Fig.1 on the effect of acquisition frequency on the peak shape) and able to manage relatively high pressures on the head of the column.

Dimensions of the FAST-GC columns.

Internl Diameter	Lenght	Film Thickness	Theorical Plates (N)
50 µm	2.5 m	0.05 µm	50000
		0.10 µm	
	5 m	0.05 µm	100000
		0.10 µm	
100 µm	5 m	0.10 µm	50000
		0.20 µm	
	10 m	0.10 µm	100000

Table 1. These are the dimensions of the columns that can be found in the catalogue. For each column it is reported the number of theorical plates (N) calculated wih the formula written on the previous page (1). We advise not to use 100 micron i.d. columns longer than 10 m and 50 microns i.d. columns because the pressure needed it will be too high on the today strumentation!

Effect of the acquisition frequency on the shape of the peak and on the goodnes of integration

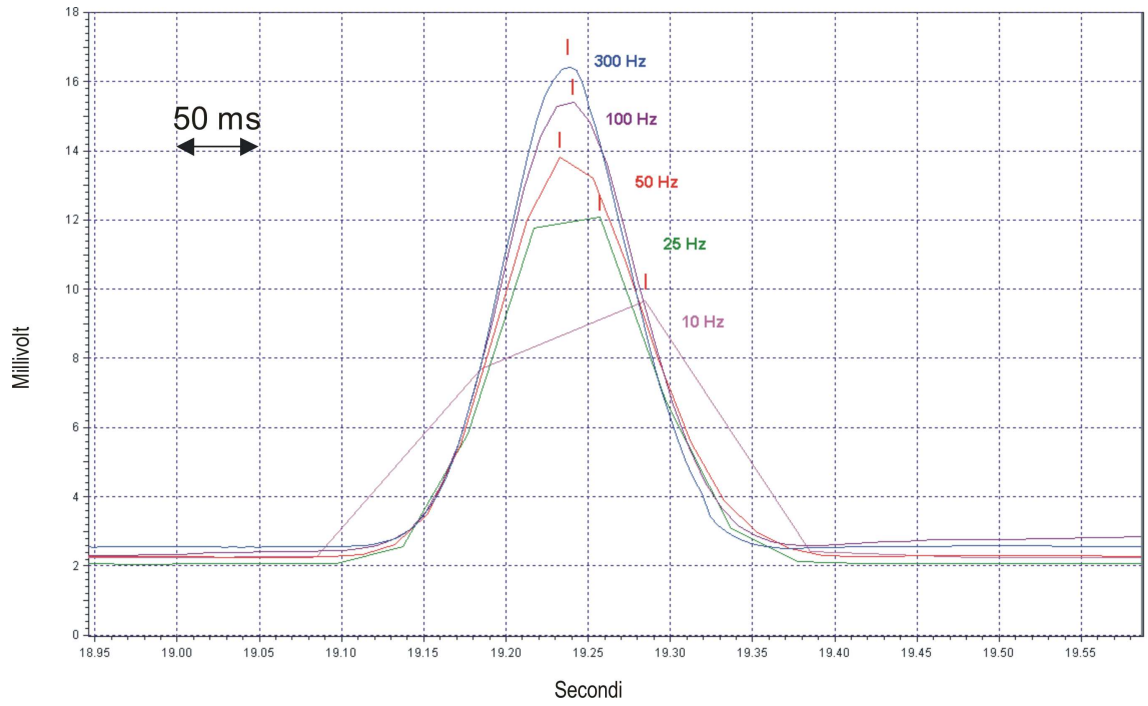


Figure 1. Effect of the acquisition frequency on the peak's shape. With these kinds of narrow peaks like the ones of FAST-GC (from 0.5 to 2 s) it is necessary to acquire the signal with high frequencies in order to have a correct peak shape and to be able to be adequately integrated. Achievement frequencies of 50 Hz are acceptable, frequencies of 100 Hz are optimal for most cases.

Guidelines for the Use of FAST-GC

Conventional GC	**FAST-GC**
Column: *usually columns with internal diameters of 0.25/0.32 mm with lenghts of 25, 30, 50m.*	**Column:** **column with internal diameters of 0.05/0.10mm and lenghts of 5, 10m.**
Temperature Rates: *1 – 20 °C/min*	**Temperature Rates:** **20 – 60 °C/min**
Injection: *with normal injection techniques it is possible to inject modest quantities, for example 1µl of a diluted solution with a split ratio of 1:20, 1:50.*	**Injection:** **the injected quantity has to be at least 10 times less than traditional GC. Usually the split ratio that are used are greater than 1:100 with solutions that are strongly diluted (< 100 ppm). (A new injector is in process of developement to allow direct injections on narrow-bore columns of a sample as liquid in quantity of the order of nanoliters!)** **Go to www.mega.mi.it to see the news of this revolutionary injector.**
Carrier Gas: *the gas flows in column (with Helium and Hydrogen) vary on the dimensions and the characteristics of the column.* *There are flows not less than 0.8 ml/min.* *Download in the section "Support-Download" of the site www.mega.mi.it the table of the flows and of pressures for the columns.*	**Carrier Gas:** **optimal flows for FAST-GC are around 0.5 ml/min for the columns of 10m 0.10mm. (See fig. n. 3,4 below).** ***Download in the section "Support-Download" of the site www.mega.mi.it the table of the flows and of pressures for the columns.***
Peak Width: *2 – 5 s*	**Peak Width:** **0.5 – 2 s**
Detector: *any type of detector can be used.*	**Detector:** **any type of detector can be used. It is necessary that the acquisition frequency of the detector is a bit high, seen the reduced width of the peak.** **Values > 50 Hz (achievement frequency of the detector) are recommended. (See fig.1).**
Analysis Time: *20 – 60 min*	**Analysis Time:** **1 – 10 min**

Table 2. The table shows the foundamental analysis parameters Conventional GC VS FAST-GC.

Recommended Pressures and Flows

HYDROGEN Carrier Gas (40 – 80 cm/s)

L \ d.i.	50 µm		100 µm
5 m	300 – 630 kPa *43 – 91 psi* 3 – 6.3 bar *0.15 – 0.4 ml/min*		68 – 140 kPa *9.9 – 20.2 psi* 0.68 – 1.4 bar *0.25 – 0.6 ml/min*
10 m			140 – 296 kPa *20.2 – 43 psi* 1.4 – 2.95 bar *0.3 – 0.9 ml/min*

HELIUM Carrier Gas (32 – 45 cm/s)

L \ d.i.	50 µm		100 µm
5 m	500 – 760 kPa *72.2 – 110 psi* 5 – 7.6 bar *0.15 – 0.3 ml/min*		115 – 170 kPa *16.1 – 24.5 psi* 1.15 – 1.7 bar *0.25 – 0.4 ml/min*
10 m			258 – 339 kPa *37.3 – 49.1 psi* 2.6 – 3.4 bar *0.35 – 0.6 ml/min*

Tables 3,4. These two tables illustrate some optimal flow and pressure indications that can be used for the treatment of FAST-GC columns of the illustrated dimensions. These conditions have been calculated with a temperature of 50°C (typical starting temperature) and at P outlet atmospheric conditions (if treated with a mass spectrometer, the indications can be held as a good starting point especially for the flows to use).

Visit www.mega.mi.it Support-Download section, to download the complete table for Pressure-Flows!

MEGA stationary phases available in FAST-GC.

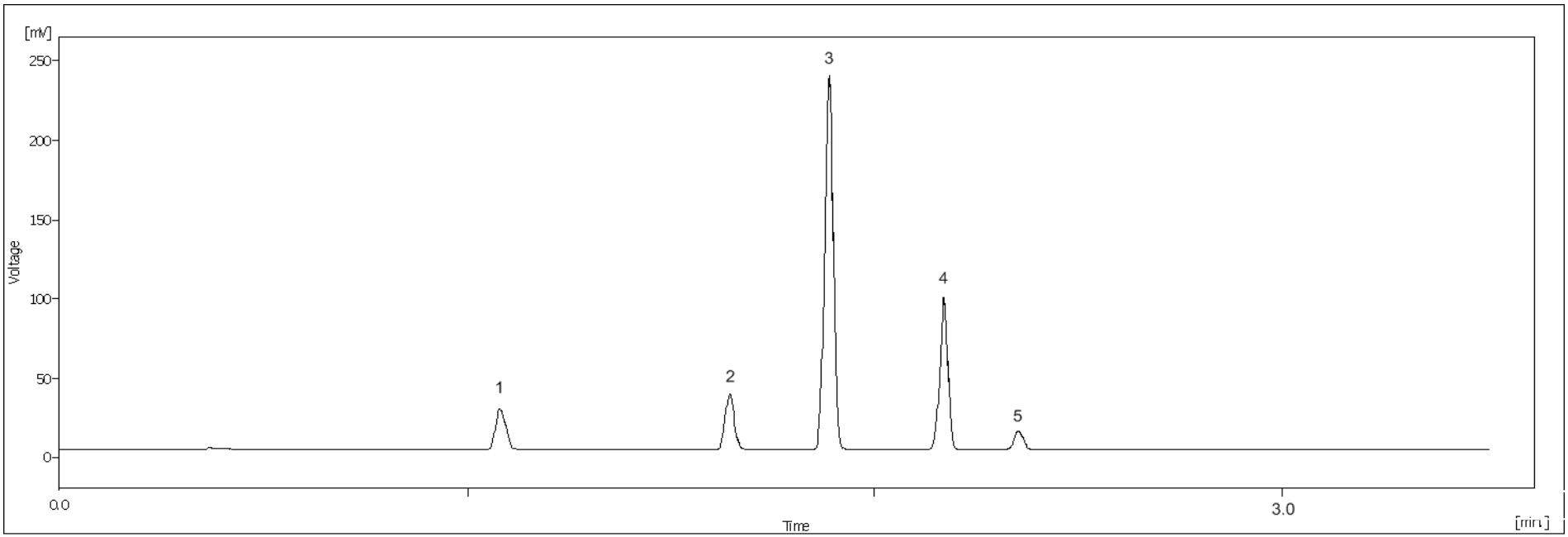
In FAST-GC, the choice of the stationary phase is even more important than in traditional GC. In facts, where the shortening of analysis time produces a loss in resolution terms, the selectivity of the stationary phase can intervene to separate critical couples! This is the reason why MEGA has the widest choice of FAST-GC columns with phases that don't have any competition equivalent on the market!

Stationary Phase	*Composition*	*Notes*
MEGA – 1 FAST	100% Methyl Polysiloxane (Apolar)	
MEGA – 10 FAST	100% Cianopropil Polisilossano (High Polarity)	
MEGA – 101 FAST	100% Methyl Polysiloxane (Apolar)	
MEGA – 13 FAST	13% Phenyl, 87% Methyl Polysiloxane (Intermediate Polarity)	
MEGA – 17 FAST	50% Phenyl, 50% Methyl Polysiloxane (Mid to High Polarity)	
MEGA – 1701 FAST	7% Cyanopropyl, 7% Phenyl, 86% Methyl Polysiloxane (Intermediate Polarity)	
MEGA – 20 FAST	20% Phenyl, 80% Methyl Polysiloxane (Intermediate Polarity)	
MEGA – 200 FAST	Trifluoropropyl Methyl Polysiloxane (High Polarity)	
MEGA – 225 FAST	25% Cyanopropyl, 25% Phenyl, 50% Methyl Polysiloxane (Mid to High Polarity)	
MEGA – 5 FAST	5% Phenyl, 95% Methyl Polysiloxane (Low Polarity)	
MEGA – 50 FAST	50% Cyanopropyl, 50% Methyl Polysiloxane (Mid to High Polarity)	
MEGA – 624 FAST	3.5% Cyanopropyl, 3.5% Phenyl, 93% Methyl Polysiloxane (Intermediate)	
MEGA – ACID FAST	Polyethylenglycol (PEG) Acid (High Polarity)	
MEGA – PLUS FAST	Copolimer Polyethylenglycol (PEG) + Methyl Polysiloxane (Mid to High Polarity)	No Equivalents
MEGA – JXR FAST	100% Methyl Polysiloxane (Apolar)	
MEGA – PS255 FAST	1% Vinyl, 99% Methyl Polysiloxane (Apolar)	
MEGA – PS264 FAST	5.8% Phenyl, 0.2% Vinyl, 94% Methyl Polysiloxane (Medium-Low Polarity)	
MEGA – SE30 FAST	100% Methyl Polysiloxane (Apolar)	
MEGA – SE54 FAST	5% Phenyl, 1% Vinyl, 94% Methyl Polysiloxane (Low Polarity)	
MEGA – WAX FAST	Polyethylenglycol (PEG) (High Polarity)	Available for High Temeperatures (300°C!).

Visit www.mega.mi.it to discover online our complet catalog, new products and all the news from MEGA. You can require completely custom products for specific analytical problems!

MEGA allows you to send us your sample to try, completely free, the performances of FAST-GC directly on your separation! This service has not any add-costs also on the column price eventually purchased!

Residual Solvents – Head Space – USP 467 OVIs



Column

Phase	MEGA-624 FAST
I.D.	0.10 mm
Film Thickness	0.45 µm
Length	10 m

Chromatographic Conditions

Inlet	Split	250℃
Split Ratio	1:100	
Injected Volume	0.5 mL	
HS	45 min	80℃
Oven	T start	35℃
	Rate	15℃/min
	T end	100℃
Detector	FID	250℃
Carrier Gas	Hydrogen	0.4 mL/min

Peak Identification

1	Dichloromethane
2	Chloroform
3	Benzene
4	Trichloroethylen
5	1,4 Dioxane

HS in Water

Carried out on DANI MASTER GC

ALLERGENES

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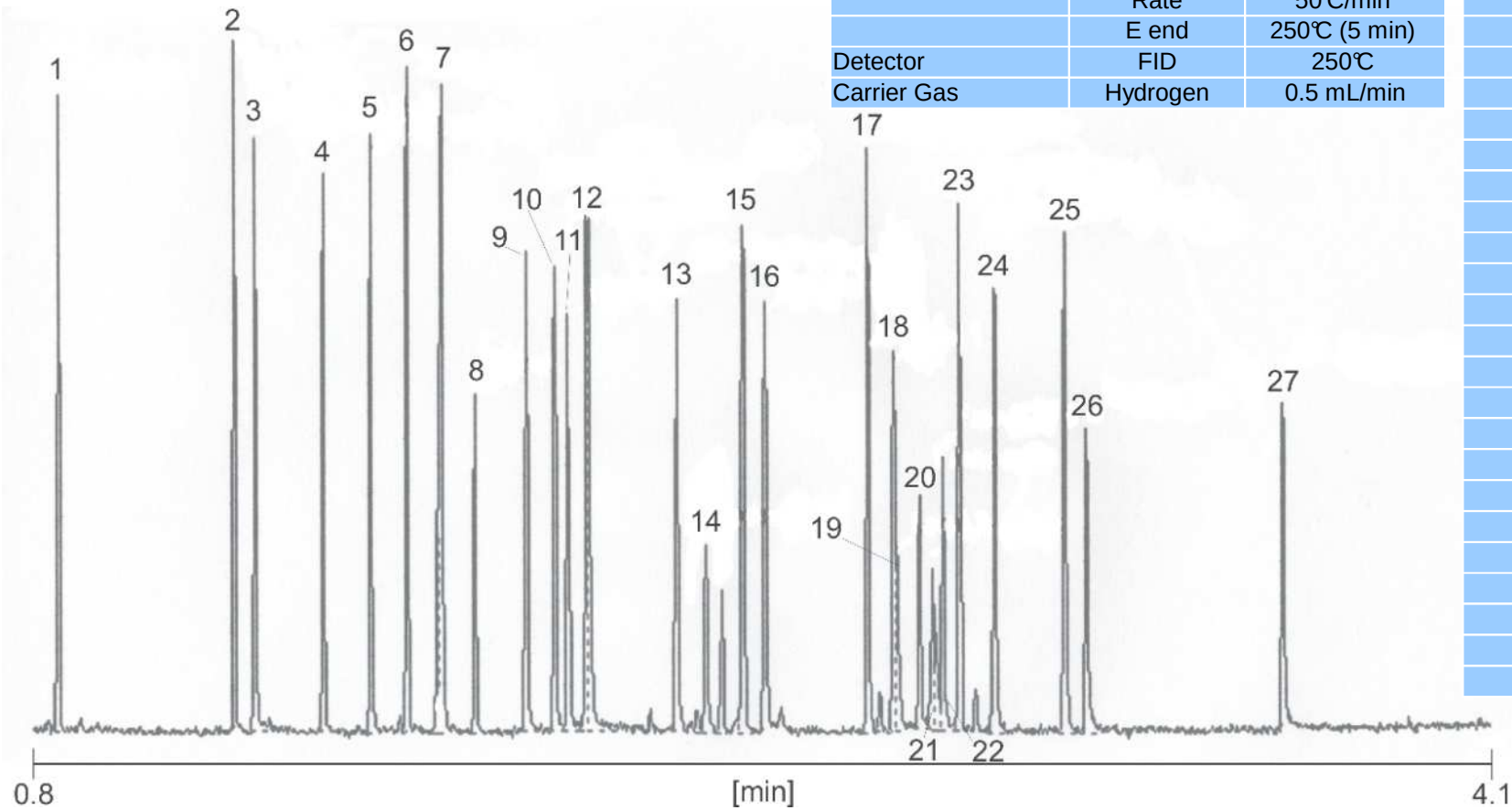
Column

Phase	MEGA-1701 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injection	Split	230℃
Injection volume	1.0 µL	
Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	50℃/min
	E end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min



Peak Identification

1	Limonene
2	Linalol
3	Benzyl Alcohol
4	Veratrol
5	Me-Octynoate
6	Citronellol
7	/
8	Neral
9	Geranial
10	OH-Citronellal
11	Eugenol
12	Anisol + Cinnamol
13	α iso Me-Ionone
14	Isoeugenol
15	Lilial
16	Coumarine
17	Amyl Cynnamal
18	Lyral 1
19	Lyral 2
20	Farnesol 1
21	Farnesol 2
22	Farnesol 3
23	Amyl Cynnamol
24	Hexyl Cynnamal
25	Cynnamal
26	Bz. Salycilate
27	Bz. Cynnamate

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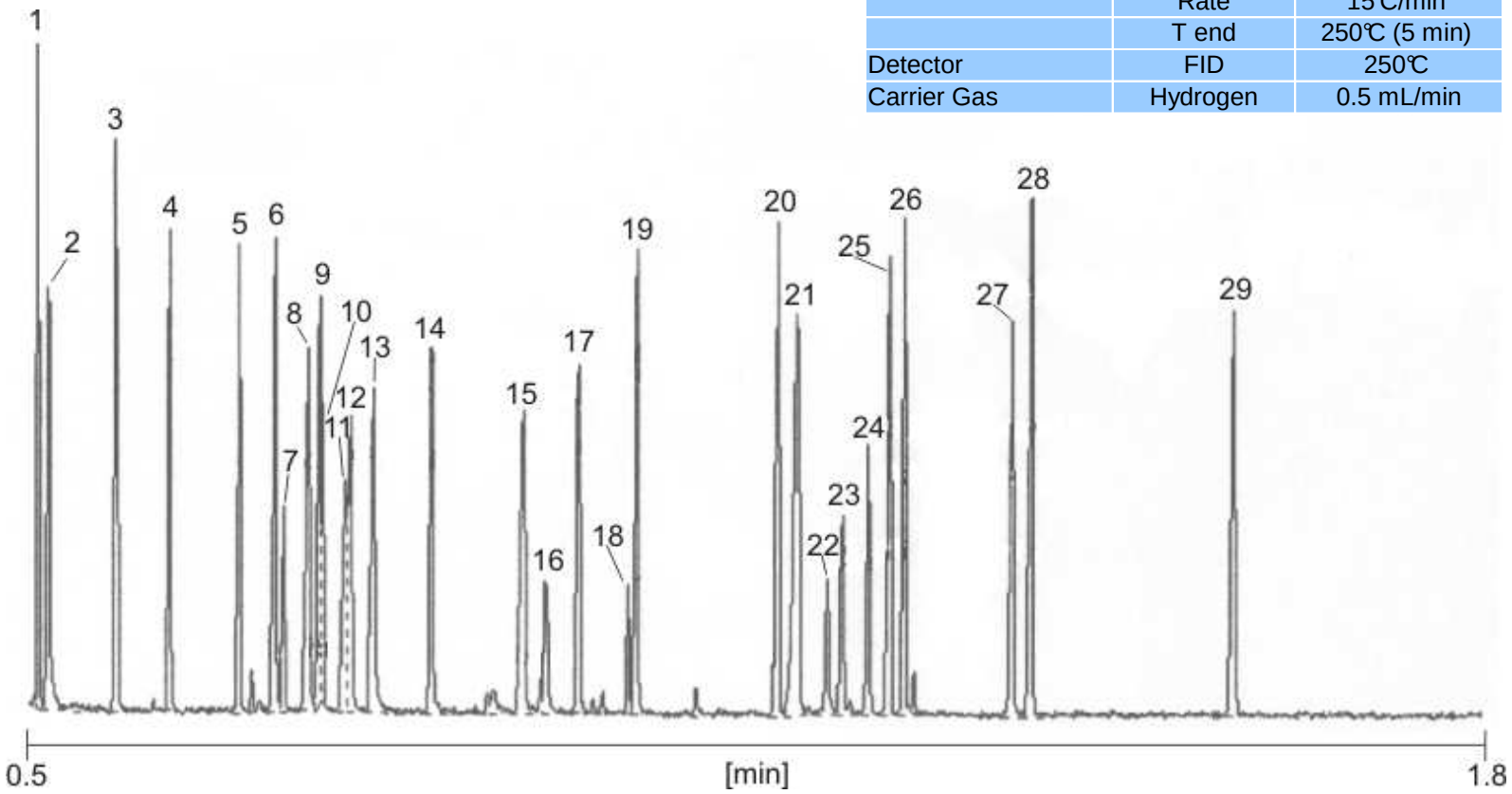
Column

Phase	MEGA-SE54 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injection	Split	230℃
Injection volume	1.0 µL	
Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	15℃/min
	T end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min



Peak Identification

1	Benzyl Alcohol
2	Limonene
3	Linalol
4	Veratrol
5	Me-Octynoate
6	Citronellol
7	Citral 1
8	Geraniol
9	Cynnamic Ald.
10	Citral 2
11	Anysic Alcohol
12	OH-Citronellal
13	Cynnamic Alcohol
14	Eugenol
15	Coumarine
16	Isoeugenol
17	α iso Me-Ionone
18	α Me-Ionone
19	Lilial
20	Farnesol 1
21	Lyral 1 + Lyral 2
22	Farnesol 1
23	Farnesol 2
24	Farnesol 3
25	Amyl Cynnamal
26	Hexyl Cynnamal
	Bz. Salycilate
27	1-Ph-Decanone
28	1-Ph-Decanone
29	Bz. Cynnamate

ALLERGENES

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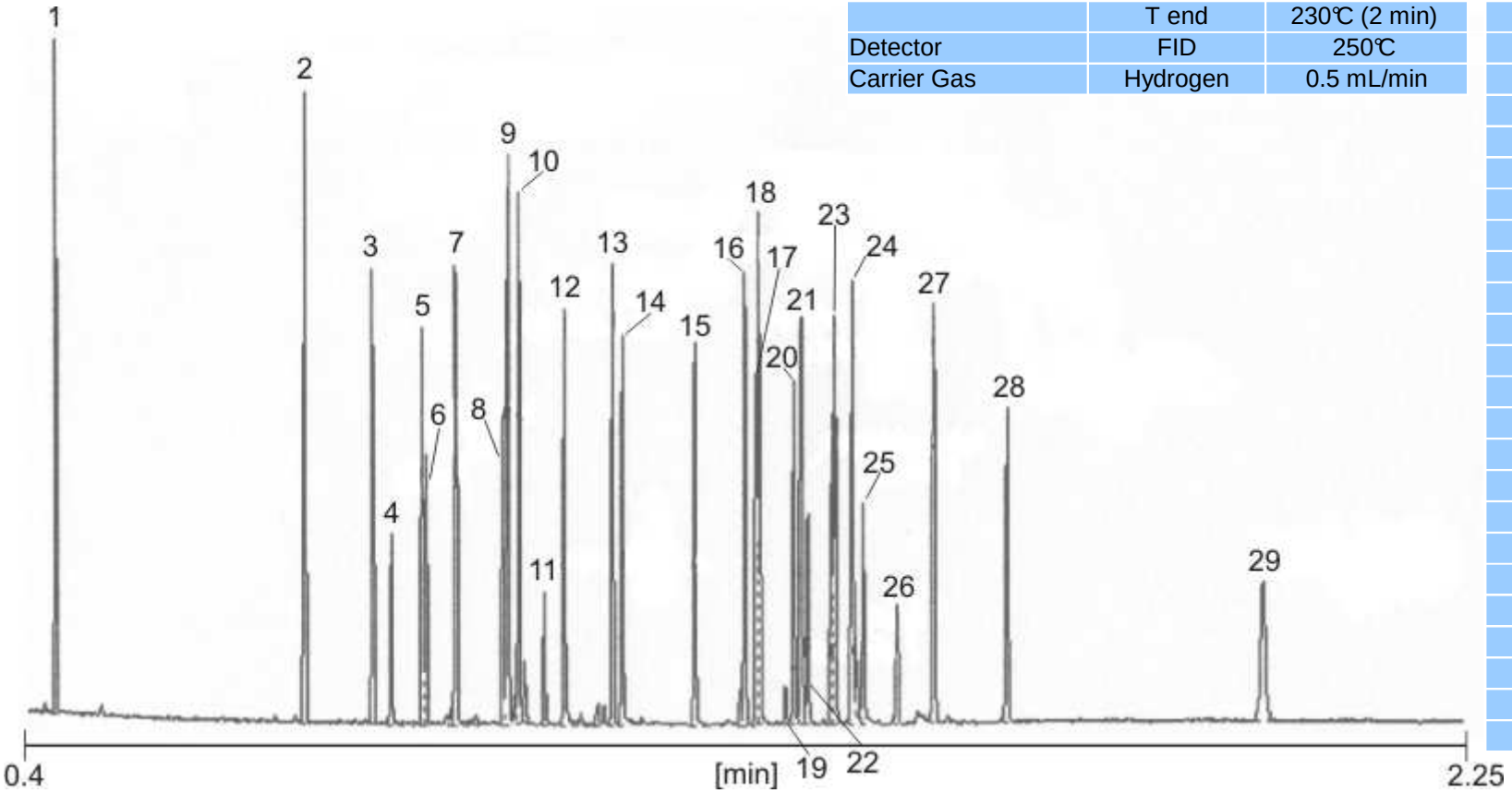
Column

Phase	MEGA-WAX FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injection	Split	230℃
Injection volume	1.0 µL	
Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	50℃/min
	T end	230℃ (2 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min



Peak Identification

1	Limonene
2	Linalol
3	Me-Octynoate
4	Neral
5	Veratrol
6	Geranial
7	/
8	α iso Me-Ionone
9	Geraniol
10	Alc. Benzyl
11	α Me-Ionone
12	OH-Citronellal
13	Cynnamal
14	Citronellal
15	Eugenol
16	Amyl Cynnamal
17	Anysol
18	Cynnamol
19	Farnesol 1
20	Isoeugenol
21	Hexyl Cynnamal
22	Amyl Cynnamol
23	1-Ph-10
24	Coumarine
25	Lyral 2
26	/
27	Bz. Benzoate
28	Bz. Salycilate
29	Bz. Cynnamate

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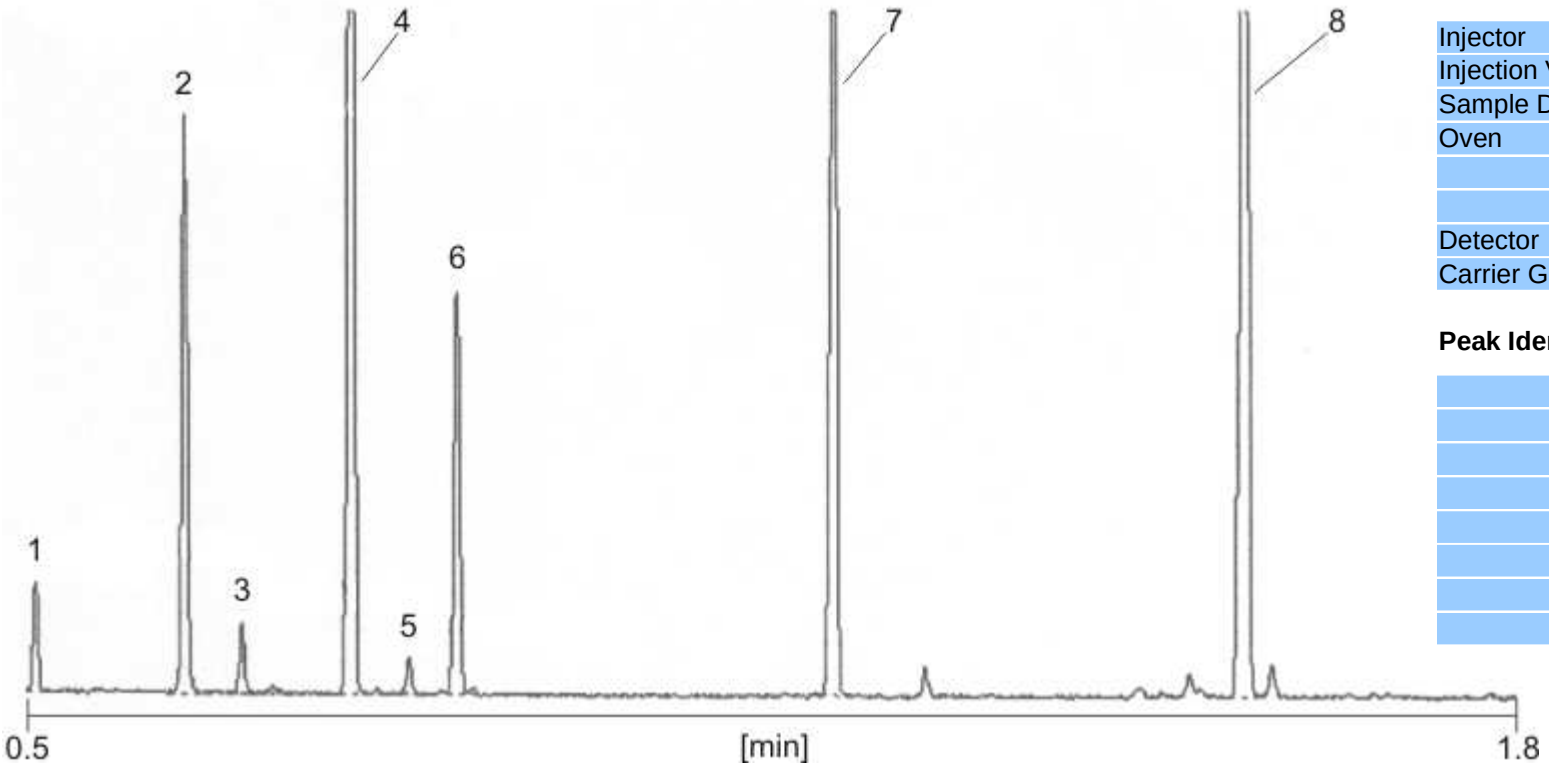

Column

Phase	MEGA-1701 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injector	Split	230℃
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	50℃/min
	T end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min

Peak Identification

1	α-Pinene
2	β-Pinene
3	Myrcene
4	Limonene
5	p-Cimene
6	γ-Terpinene
7	Linalool
8	Linalyl Acetate

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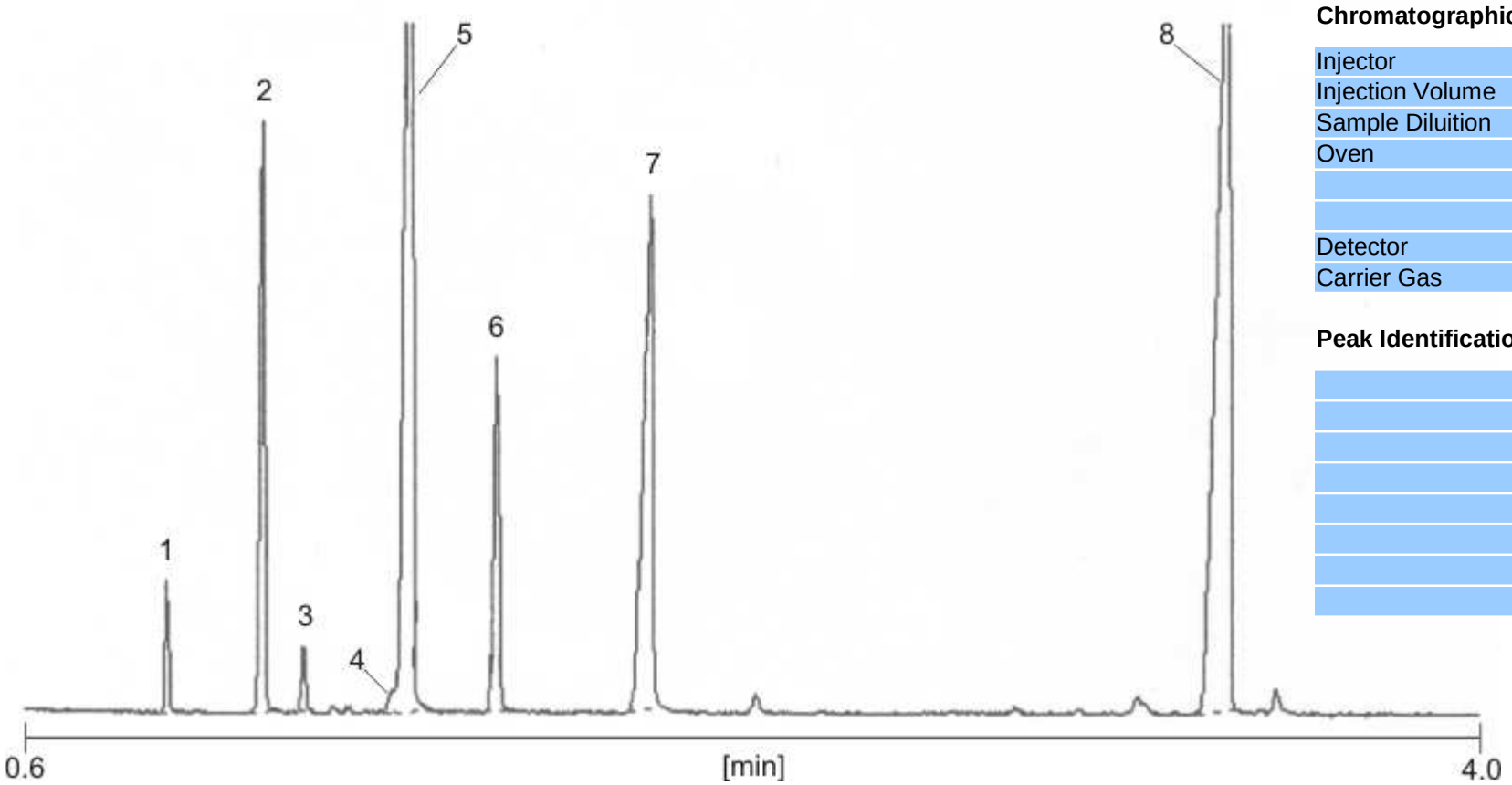

Column

Phase	MEGA-SE54 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injector	Split	230℃
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	15℃/min
	T end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min

Peak Identification

1	α-Pinene
2	β-Pinene
3	Myrcene
4	p-Cimene
5	Limonene
6	γ-Terpinene
7	Linalol
8	Linalyl Acetate

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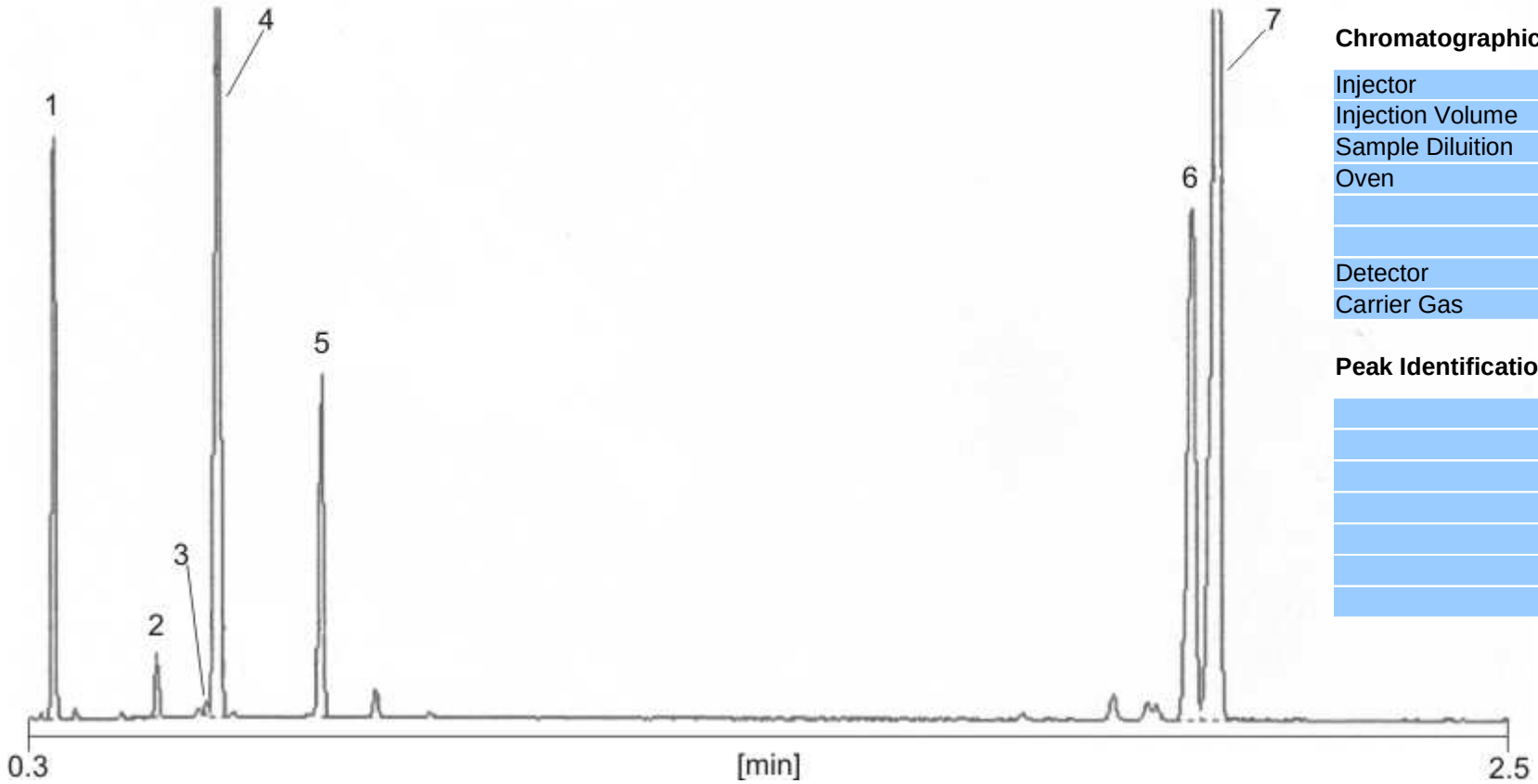

Column

Phase	MEGA-WAX FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injector	Split	230℃
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	30℃/min
	T end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min

Peak Identification

1	β-Pinene
2	Myrcene
3	p-Cimene
4	Limonene
5	γ-Terpinene
6	Linalool
7	Linalyl Acetate

CHAMOMILE – Convenzional GC vs FAST-GC

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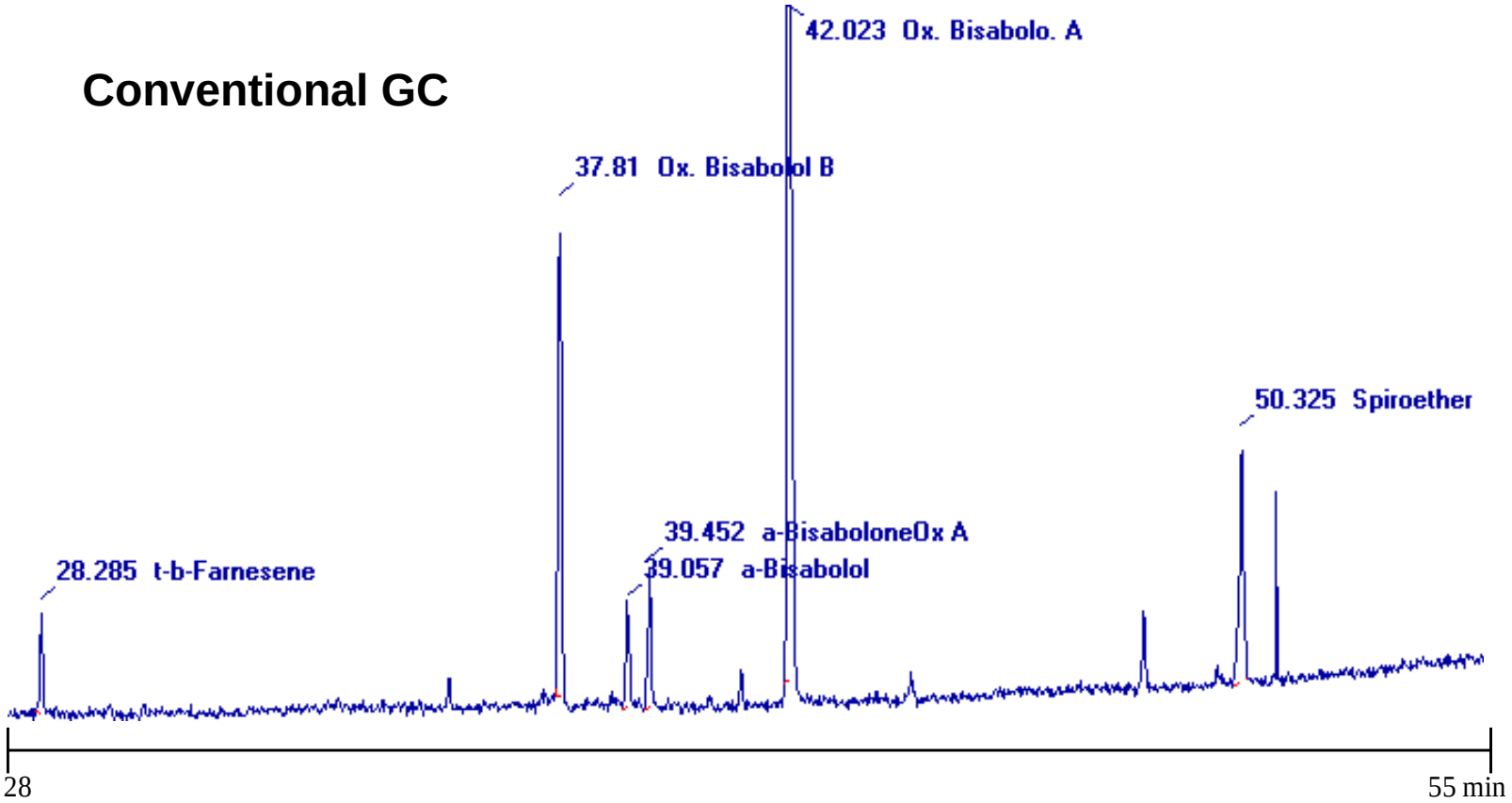
Column

Phase	MEGA-1701
I.D.	0.25 mm
Film Thickness	0.3 µm
Length	25 m

Chromatographic Conditions

Inlet	Split	230℃
Injected Volume	1.0 µL	
Sample Dilution	1:200	in Ciclohexane
Carrier Gas	Hydrogen	1.5 mL/min

Oven	T start	50℃ (0.1 min)
	Rate	3℃/min
	T end	250℃ (5 min)
Detector	FID	250℃



CHAMOMILE – Convenzional vs FAST-GC

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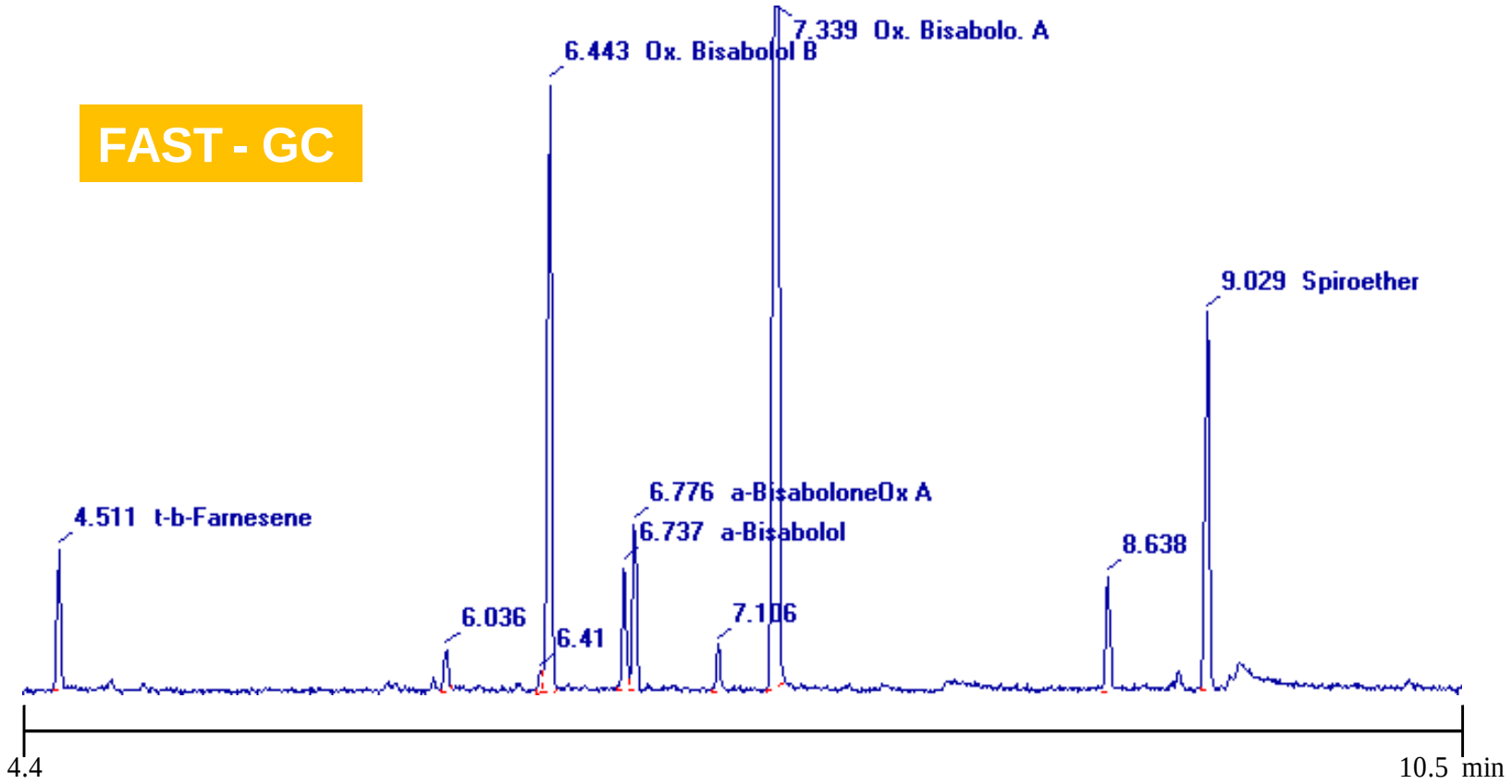
Column

Phase	MEGA-1701 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Condizioni

Inlet	Split	230℃
Injected Volume	1.0 µL	
Sample Diluition	1:200	in Ciclohexane
Carrier Gas	Hydrogen	0.5 mL/min

Oven	T start	50℃ (0.1 min)
	Rate	50℃/min
	T end	250℃ (5 min)
Detector	FID	250℃



CHAMOMILE

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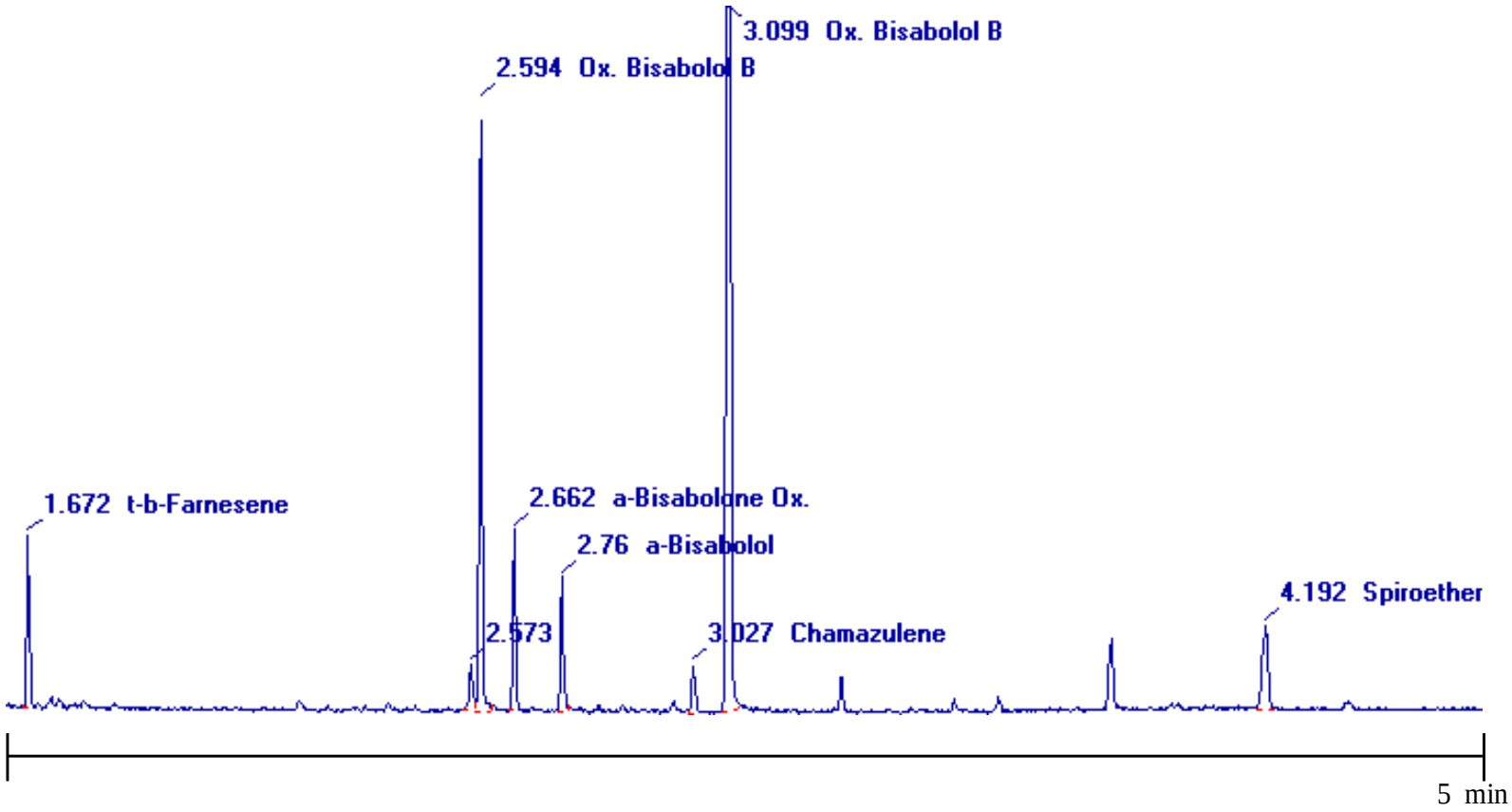
Column

Phase	MEGA-WAX FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Condition

Inlet	Split	230°C
Injected Volume	1.0 µL	
Sample Diluition	1:200	in Ciclohexane
Carrier Gas	Hydrogen	0.5 mL/min

Oven	T start	50°C (0.1 min)
	Rate	3°C/min
	T end	250°C
Detector	FID	250°C



PESTICIDES

Courtesy of Prof. C. Bicchi, C. Brunelli – Università di Torino, Dipartimento Scienza e Tecnologia del Farmaco – Via P.Giuria, 9 – Torino

Column

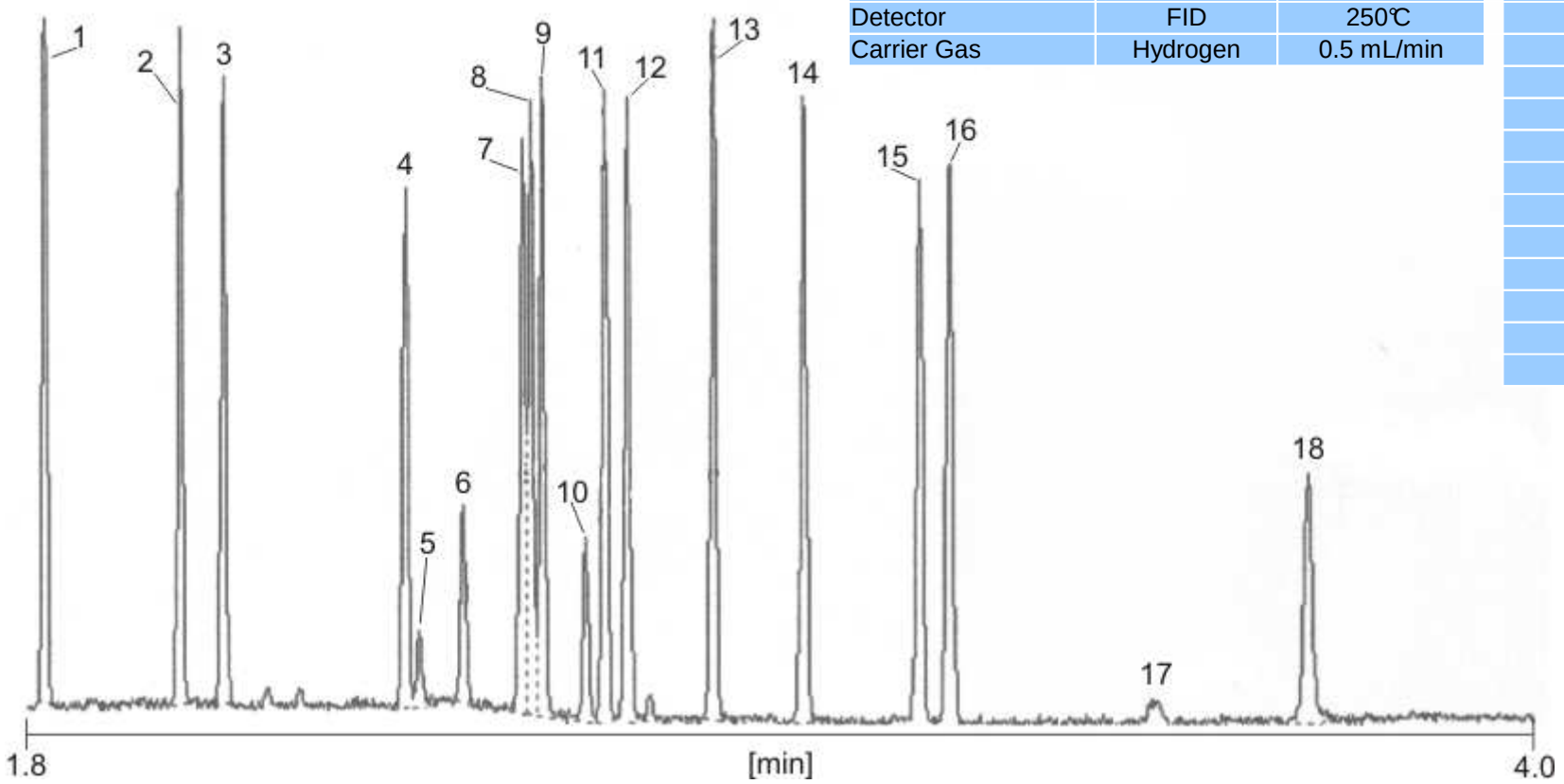
Phase	MEGA-1701 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injector	Split	230℃
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	50℃/min
	T end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min

Peak Identification

1	α-HCH
2	γ-HCH
3	Heptachlor
4	Chlorotalonil
5	/
6	Parathion-Me
7	Malathion
8	Fenotrothion
9	Parathion-Et
10	/
11	Fenitrothion
12	Chlordane-Cis + Trans
13	Dieldrin
14	o,p'-DDT
15	β-Endosulfan
16	p,p'-DDT
17	/
18	Tetradifon



PESTICIDES

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Column

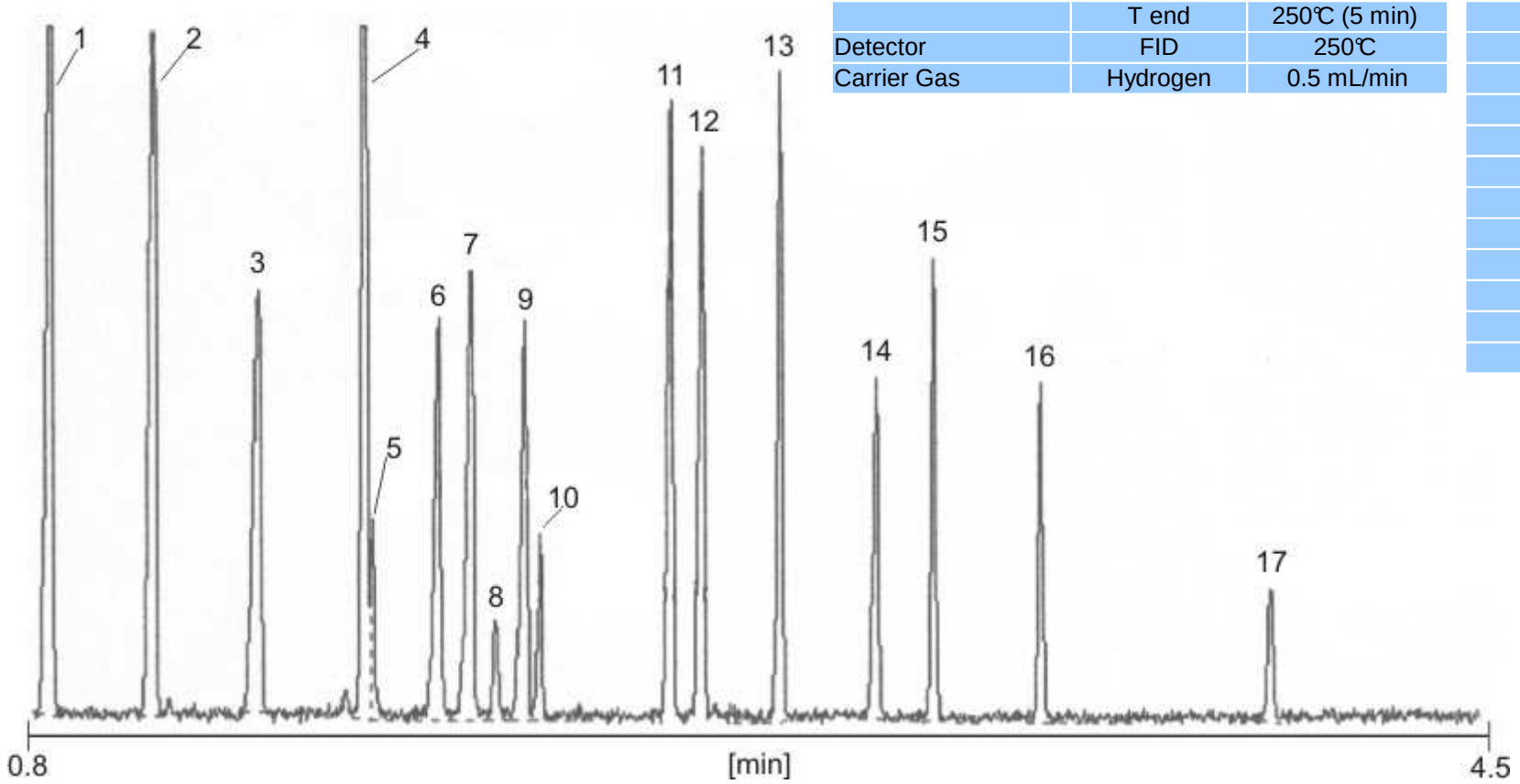
Phase	MEGA-SE54 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injector	Split	230℃
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50℃ (0.1 min)
	Rate	15℃/min
	T end	250℃ (5 min)
Detector	FID	250℃
Carrier Gas	Hydrogen	0.5 mL/min

Peak Identification

1	α-HCH
2	γ-HCH
3	Chlorotalonil
4	Heptachlor
5	Parathion-Me
6	Paraoxon-E
7	Malathion
8	Fenitrothion
9	Parathion-Et
10	/
11	Chlordane-Trans
12	Chlordane-Cis + α-End.
13	Dieldrin
14	β-Endosulfan
15	o,p'-DDT
16	p,p'-DDT
17	Tetradifon



CHAMOMILE – Conventional GC vs FAST-GC

Courtesy of Prof. C. Bicchi, C. Brunelli – Università di Torino, Dipartimento Scienza e Tecnologia del Farmaco – Via P.Giuria, 9 – Torino

Column

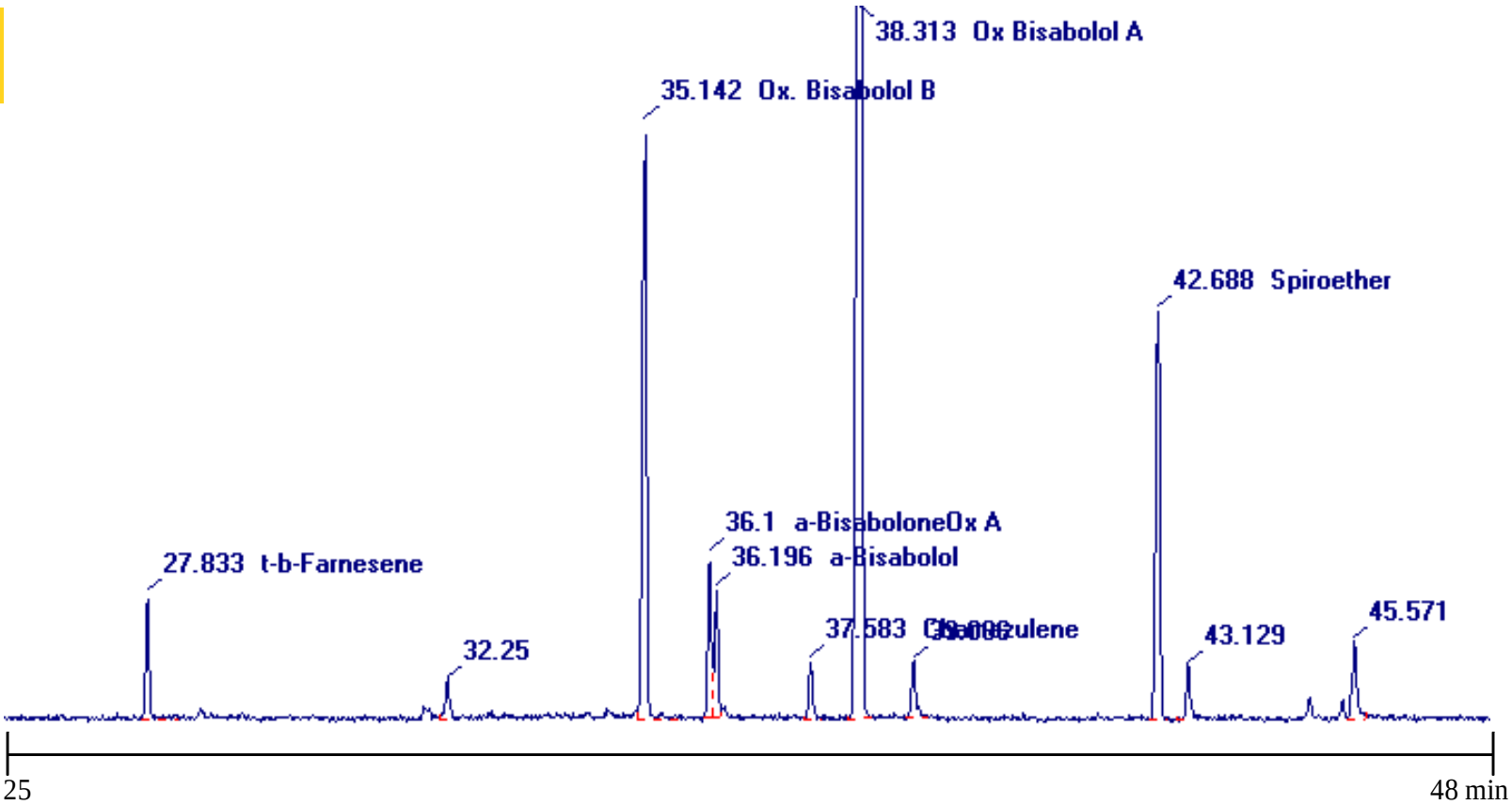
Phase	MEGA-SE54
I.D.	0.25 mm
Film Thickness	0.3 µm
Length	25 m

Chromatographic Conditions

Inlet	Split	230℃
Injected Volume	1.0 µL	
Sample Dilution	1:200	in Ciclohexane
Carrier Gas	Hydrogen	1.5 mL/min

Oven	T start	50℃ (0.1 min)
	Rate	3℃/min
	T end	250℃ (5 min)
Detector	FID	250℃

Conventional GC



CHAMOMILE – Conventional GC vs FAST-GC

Courtesy of Prof. C. Bicchi, C. Brunelli – Università di Torino, Dipartimento Scienza e Tecnologia del Farmaco – Via P.Giuria, 9 – Torino

Column

Phase	MEGA-SE54 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Inlet	Split	230℃
Injected Volume	1.0 µL	
Sample Diluition	1:200	in Ciclohexane
Carrier Gas	Hydrogen	0.5 mL/min

Oven	T start	50℃ (0.1 min)
	Rate	50℃/min
	T end	250℃ (5 min)
Detector	FID	250℃

FAST-GC