Guide to the use of FAST GC

What is FAST-GC /FASTGC

Fast GC is a GC technique with one of the highest potentials, and already widely demonstrated in practice, and is rapidly becoming mor popular in these recent years. As the name itself indicates, FASTGC is fast gas chromatography, which enables the reduction in analysis times by 10 times compared to the amount of time in conventional capillary of packed column GC analysis. With FASTGC you can get analysis only in only 5 to 12 minutes by maintaining 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, whilst using cheaper columns and not wasting valuable lab and Your time!

Theoretical aspects of Fast GC

The parameter that indicates 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 peak height

The smaller the internal diameter, the longer a column, the more theoretical plates it will have and the greater its separative power will be. Also for same column lengths with a narrower internal diameter these will also have a greater separative power as the number of theoretical plates will increase by decreasing the internal diameter.
To make it clear, a traditional column with an internal diameter equal to 0.25mm and a 25 meter length has 100,000 theoretical plates; as it is shown in table1, a FASTGC column with a narrower internal diameter (100um), needs to have only 10 meters to have the same number of theoretical plates as more traditional GC.
This means you can keep the same separative power even though the column is shorter and whilst allowing a reduction in analysis time.
Columns for FASTGC have very small internal diameters (50, 100um usually), which means that even though they are short, they require a high pressure on the injector in order to obtain practical flow rates.
Usually the optimal flows that have to be used in FASTGC (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 it is less viscous that Helium, so there will be the need for a lower pressure to reach the same flow in the column.
Hydrogen carrier gas allows work at higher speeds without losing in any significant way column efficiency, allowing then to shorten up once more the analysis time.
For these two reasons it is best to use Hydrogen as carrier gas in FASTGC, even though the use of Helium as the carrier gas results in comparable column efficiency.

What is needed to accomplish FAST-GC.

To accomplish FAST GC you will only need:
●A short column with a smaller internal diameter (called “narrow bore” columns). Typically a column of 10 m with an internal diameter of 0.10 mm is used.
●A gas chromatographer 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.

Internal Diam	Length	Film Thickness	Theoretical Plates(N)
50um	2.5m	0.05um	50,000
		0.10um	
	5m	0.05um	100,000
		0.10um	
100um	5m	0.1um	50,000
		0.20um	
	10m	0.10um	100,000

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 theoretical plates (N) calculated with the formula written on the previous page (1).
We advise not to use 100micron i.d. columns longer than 10 m and 5 m for 50 microns i.d. columns because the pressure needed will be too high on for todays instrumentation!

Effect of the data acquisition frequency on the shape of the peak and on the integration effectiveness.

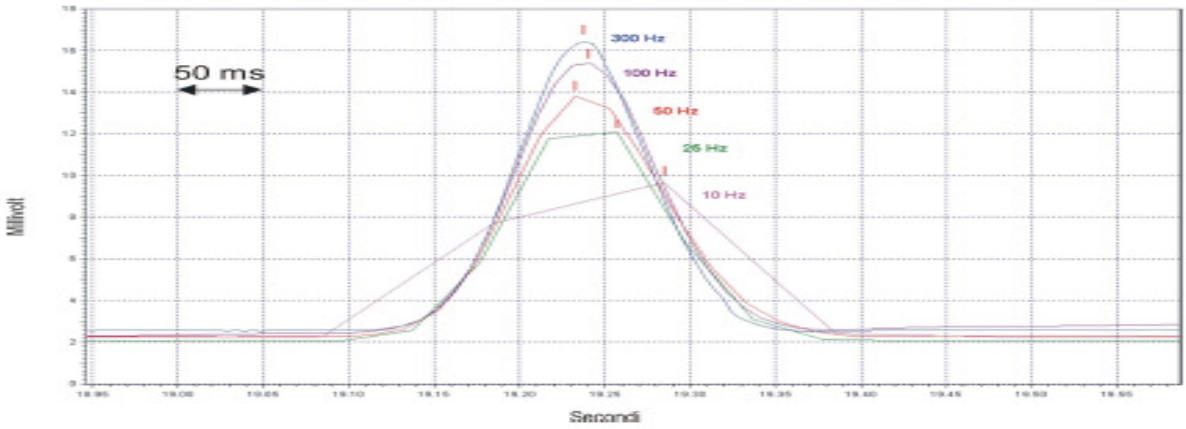

Figure 1 Effect of the acquisition frequency on the peaks shape. With these kinds of narrow peaks like the ones in Fast GC (from 0.5 to 2 secs) it is necessary to acquire the signal with high frequencies in order to have the correct peak shape and to be able adequate integration . Frequencies of 50Hz are acceptable but frequencies of 100Hz are optimal for most cases.
UltraFast GC may suffer resolution and inaccuracy unless higher A/D speed are available.
Note : A/D speeds are part of the story but low speed OpAmp (if used) can be detrimental and electrometer speeds
Column efficiency should always be checked at start on each GC with a new column and test chromatogram comparison should be used to evaluate instrument effect may also effect performance
250Hz is preferred (peaks of 100ms to 1 second are common)
Data System overall performance can be marginalised by the efficiency of the s'ware coding itself; a true comparison

Guidelines for the Use of FAST-GC	
Conventional GC	FAST-GC
Column: usually columns with internal diameters of0.25/0.32 mm with lengths of 25, 30, 50m.	**Column:** with internal diameters of0.05/0.10mm and lengths of 5, 10m.
Temperature Rates: 1 – 20 °C/min	Temperature Rates: 20 – 60 °C/min (ultraFast GC: 300Deg/min or higher)
Injection: with normal injection techniques it is possible to inject modest quantities, for example 1ul of a diluted solution with a split ratio of 1:20, 1:50. *The higher pressure drop of narrow bore columns actually helps flow control of both the column and achieve the higher split flows required.*	**Injection:** the injected quantity has to be at least 10times less than traditional GC. Usually the split ratio that are used are greater than1:100 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 ofthis revolutionary injector.
Carrier Gas: the gas flows in column (with Helium and Hydrogen) vary on the dimensions and the characteristics of the column. Generally these flows are not less than 0.8 ml/min. Download in the section "SupportDownload" of the site www.mega.mi.it the table the flows and of pressures for the columns.	**Carrier Gas:** optimal flows for FAST-GC are around 0.5ml/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 various columns.
Peak Width: 2 to 5 s	Peak Width: 0.5 to 2 s
Detector: any type of detector can be used — except older style of TCD which tend to have excessive dead volume causing severe peak spread	Detector:microTCD (NOT conventional TCD) and most low dead volume Ionisation Detectyors (FID; HID; MS etc) but high A?D Data Systems are required (>100Hz) seefig. 1
Analysis Time:20 – 60 min	1 – 10 min

Table 2. The table shows the fundamental analysis parameters Conventional GC VS FASTGC.

Guidelines for the Use of FAST-GC

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Analysis Time:20 – 60 min	1 – 10 min

Table 2. The table shows the fundamental analysis parameters Conventional GC VS FASTGC.

Recommended Pressures and Flows		
HYDROGEN Carrier Gas (40 – 80 cm/s)		
L / ID	50um	100um
5 m	300-630kPa 43-91psi 3-6.3 bar 0.15-0.4ml/min	58-140kPa 9.9-20.2ps 0.68-1.4bar 0.25-0.6ml/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 / ID	50 µm	100 µm
5 m	500 – 760 kPa 72.2 – 110 psi 16.1 – 24.5 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 FASTGC 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 "SupportDownload" section, to download the complete table for PressureFlows

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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 fact,where the shortening of analysis time may produces a loss in resolution terms, the selectivity of the stationary phase can intervene to separate critical peak pairs.
This is the reason why MEGA has the widest choice of FASTGC 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% Cyanopropil Polysiloxano (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	Copolymer Polyethyleneglycol (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 – SE30 FAST	100% Methyl Polysiloxane (Apolar)	
MEGA – SE54 FAST	T5% Phenyl, 1% Vinyl, 94% Methyl Polysiloxane (Low Polarity)	
MEGA – WAX FAST	Polyethylenglycol (PEG) (High Polarity)	Available for High Temperatures (300°C!).

Visit www.mega.mi.it to discover online our complete catalog, new products and all the news fromMEGA. 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 FASTGC directly on your separation! This service has not any added costs also on the column price eventually purchased!

ALLERGENES

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

Column

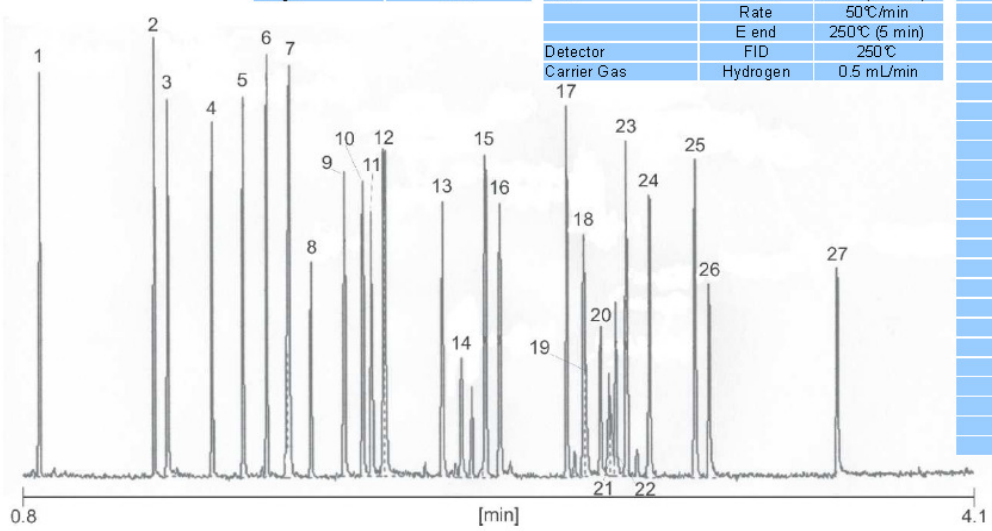
Phase	MEGA-1701 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

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

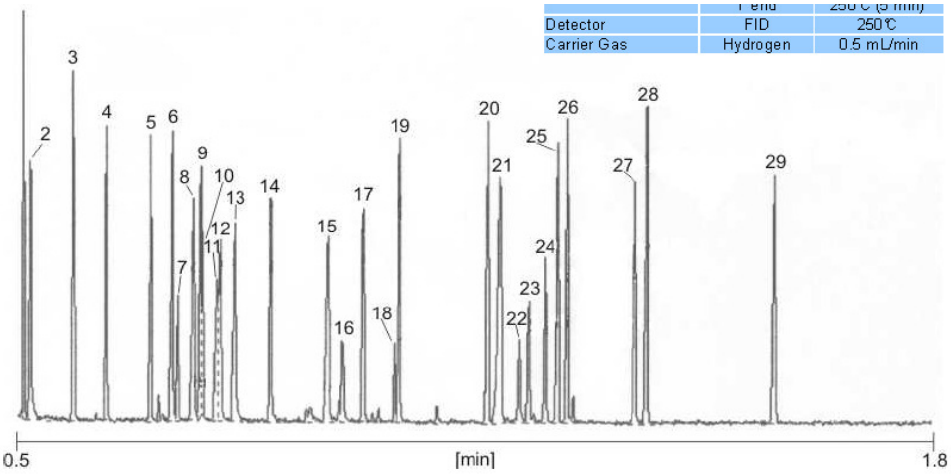
Peak Identification

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



Detector	FID	250°C
Carrier Gas	Hydrogen	0.5 mL/min

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



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FAST-GC Gas Chromatography Made in Italy

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Column

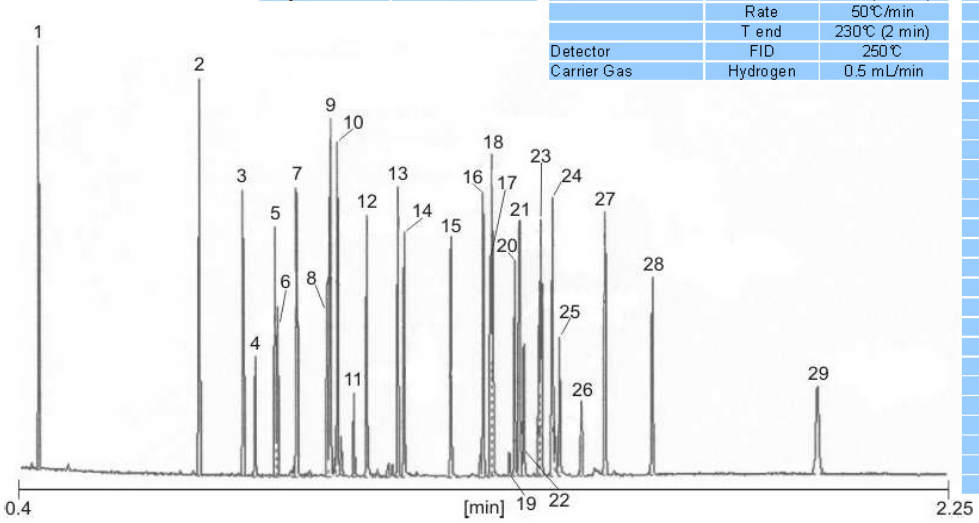
Phase	MEGA-WAX FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injection	Split	230°C
Injection volume	1.0 µL	
Dilution	1:200	in Cyclohexane
Oven	T start	50°C (0.1 min)
	Rate	50°C/min
	T end	230°C (2 min)
Detector	FID	250°C
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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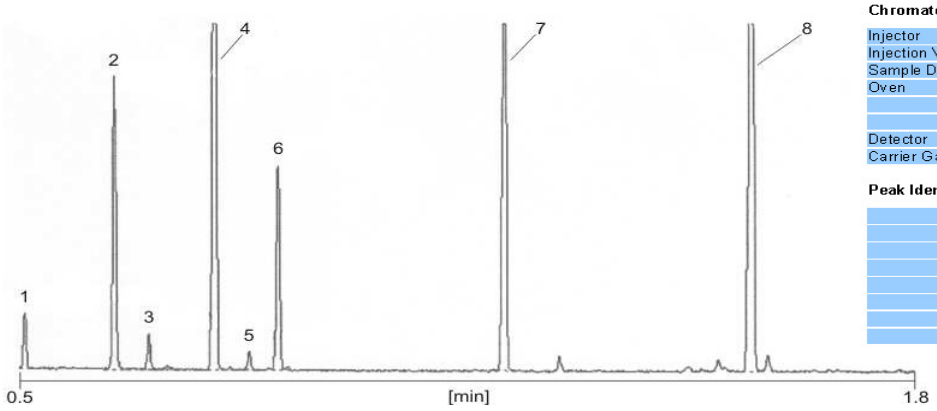

Column

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

Chromatographic Conditions

Injector	Split	230°C
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50°C (0.1 min)
	Rate	50°C/min
	T end	250°C (5 min)
Detector	FID	250°C
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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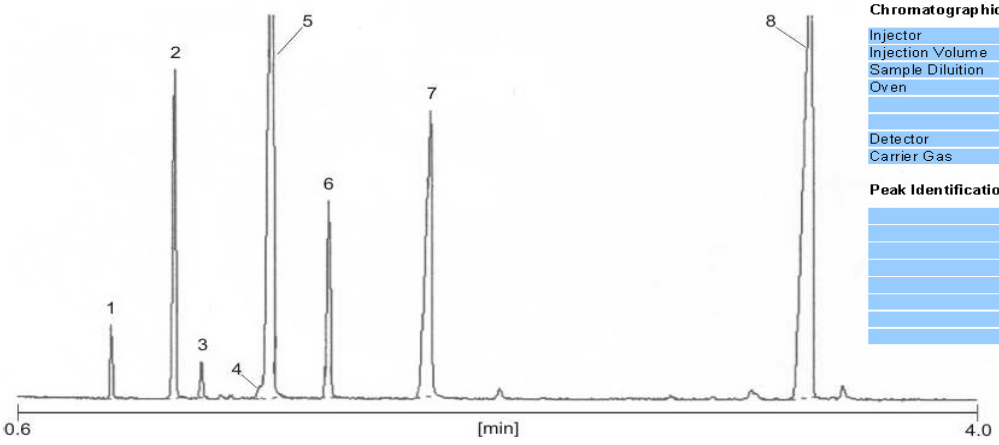

Column

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

Chromatographic Conditions

Injector	Split	230°C
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50°C (0.1 min)
	Rate	15°C/min
	T end	250°C (5 min)
Detector	FID	250°C
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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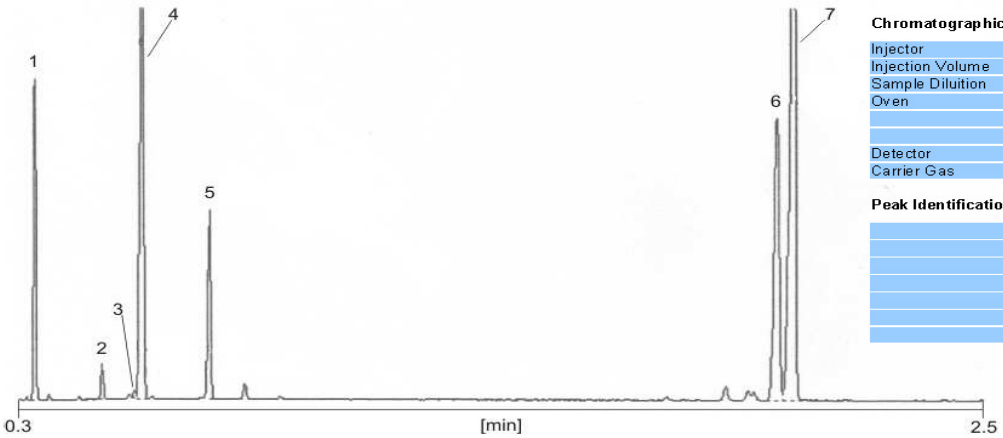

Column

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

Chromatographic Conditions

Injector	Split	230°C
Injection Volume	1.0 µL	
Sample Diluition	1:200	in Cyclohexane
Oven	T start	50°C (0.1 min)
	Rate	30°C/min
	T end	250°C (5 min)
Detector	FID	250°C
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

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CHAMOMILE – Convenzional GC vs FAST-GC

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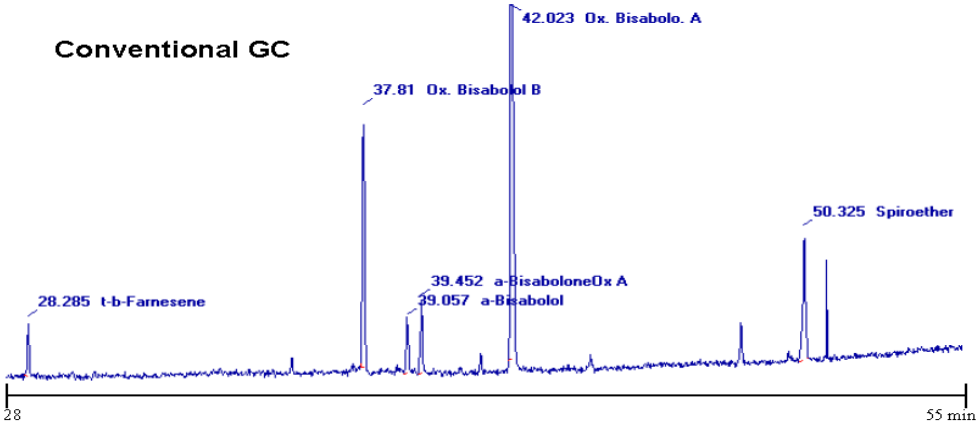
Column

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

Chromatographic Conditions

Inlet	Split	230°C	Oven	T start	50°C (0.1 min)
Injected Volume	1.0 µL			Rate	3°C/min
Sample Diluition	1:200	in Ciclohexane		T end	250°C (5 min)
Carrier Gas	Hydrogen	1.5 mL/min	Detector	FID	250°C



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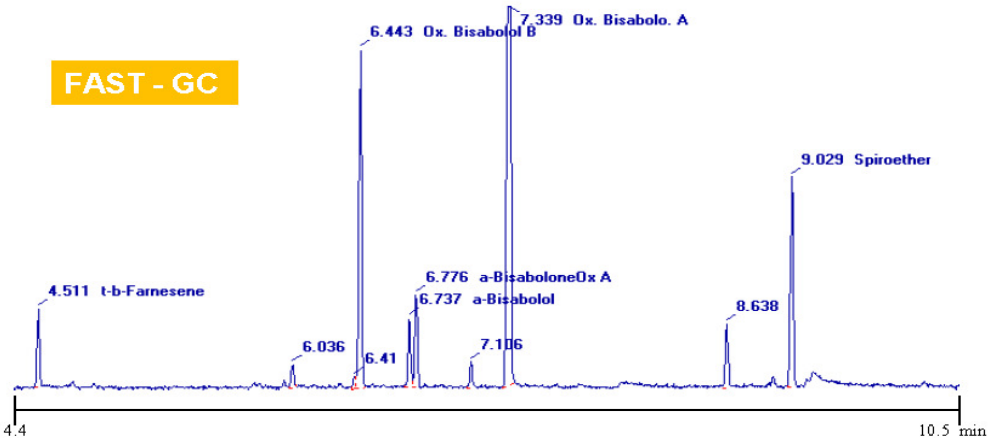
Column

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

Condizioni

Inlet	Split	230°C	Oven	T start	50°C (0.1 min)
Injected Volume	1.0 µL			Rate	50°C/min
Sample Diluition	1:200	in Ciclohexane		T end	250°C (5 min)
Carrier Gas	Hydrogen	0.5 mL/min	Detector	FID	250°C



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CHAMOMILE

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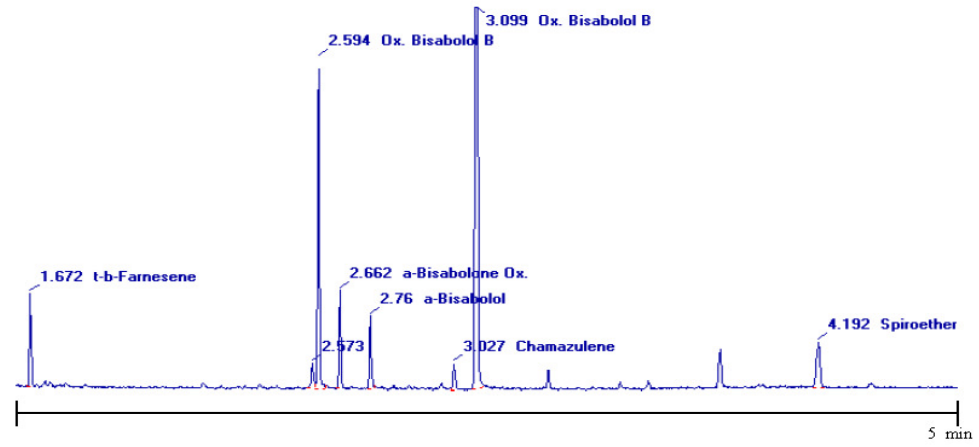
Column

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

Chromatographic Condition

Inlet	Split	230°C	Oven	T start	50°C (0.1 min)
Injected Volume	1.0 µL			Rate	3°C/min
Sample Diluition	1:200	in Ciclohexane		T end	250°C
Carrier Gas	Hydrogen	0.5 mL/min	Detector	FID	250°C



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Column

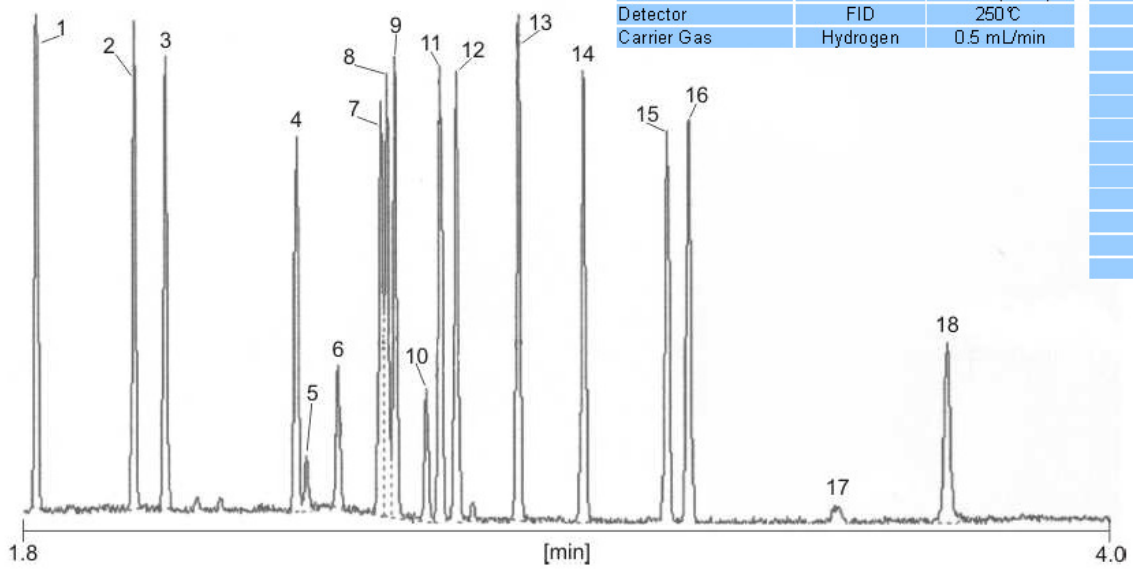
Phase	MEGA-1701 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

Injector	Split	230°C
Injection Volume	1.0 µL	
Sample Dilution	1:200	in Cyclohexane
Oven	T start	50°C (0.1 min)
	Rate	50°C/min
	T end	250°C (5 min)
Detector	FID	250°C
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



MEGA® CAPILLARY COLUMNS LABORATORY
FAST-GC Gas Chromatography Made in Italy

PESTICIDES

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

Column

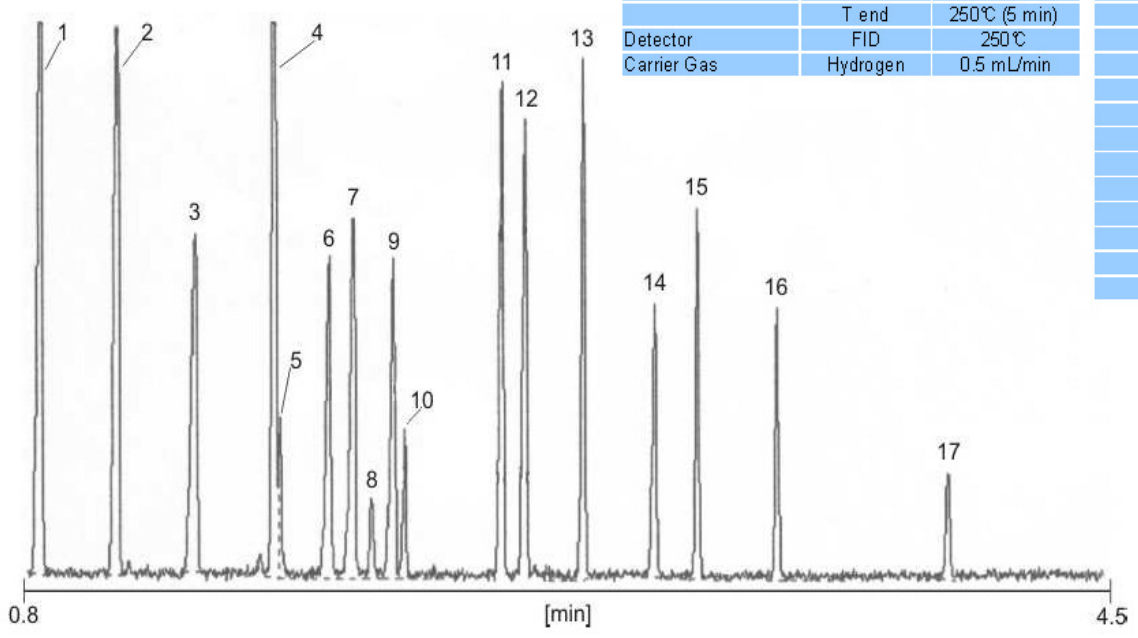
Phase	MEGA-SE54 FAST
I.D.	0.1 mm
Film Thickness	0.1 µm
Length	5 m

Chromatographic Conditions

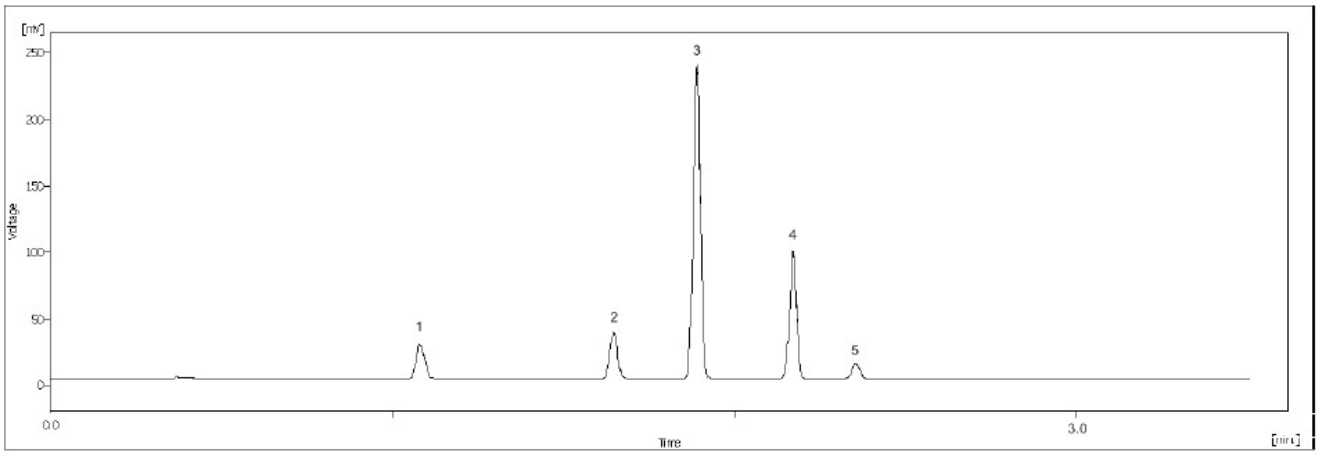
Injector	Split	230°C
Injection Volume	1.0 µL	
Sample Dilution	1:200	in Cyclohexane
Oven	T start	50°C (0.1 min)
	Rate	15°C/min
	T end	250°C (5 min)
Detector	FID	250°C
Carrier Gas	Hydrogen	0.5 mL/min

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



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°C
Split Ratio	1:100	
Injected Volume	0.5 mL	
HS	45 min	80°C
Oven	T start	35°C
	Rate	15°C/min
	T end	100°C
Detector	FID	250°C
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