

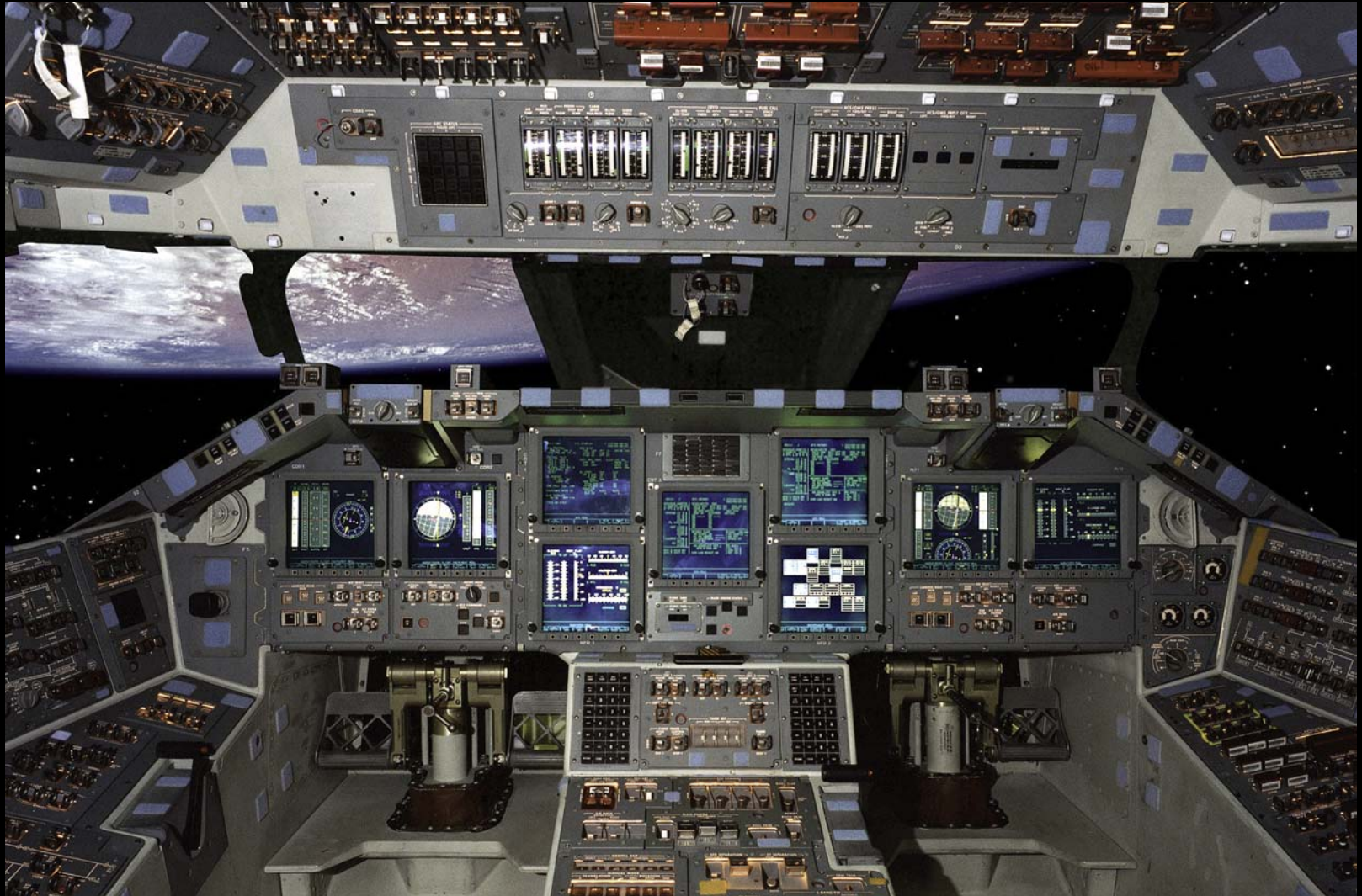
# DETECTION OF PRE-IGNITION SIGNATURES FROM ELECTRICAL COMPONENTS BY GAS CHROMATOGRAPHY MASS SPECTROMETRY AND DIFFERENTIAL MOBILITY SPECTROMETRY

NEIL PAZ

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY



# SPACECRAFT CONTAIN HIGH DENSITY OF ELECTRONICS FOR NAVIGATION AND OTHER PURPOSES



# GOAL OF STUDIES: DETECT AN APPROACHING FIRE USING VAPORS FROM OVERHEATED ELECTRONIC CIRCUIT BOARDS

**BOARDS  
BECOME  
HOT...no fire  
just hot**

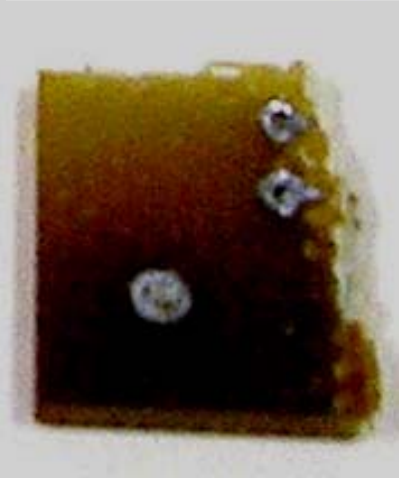
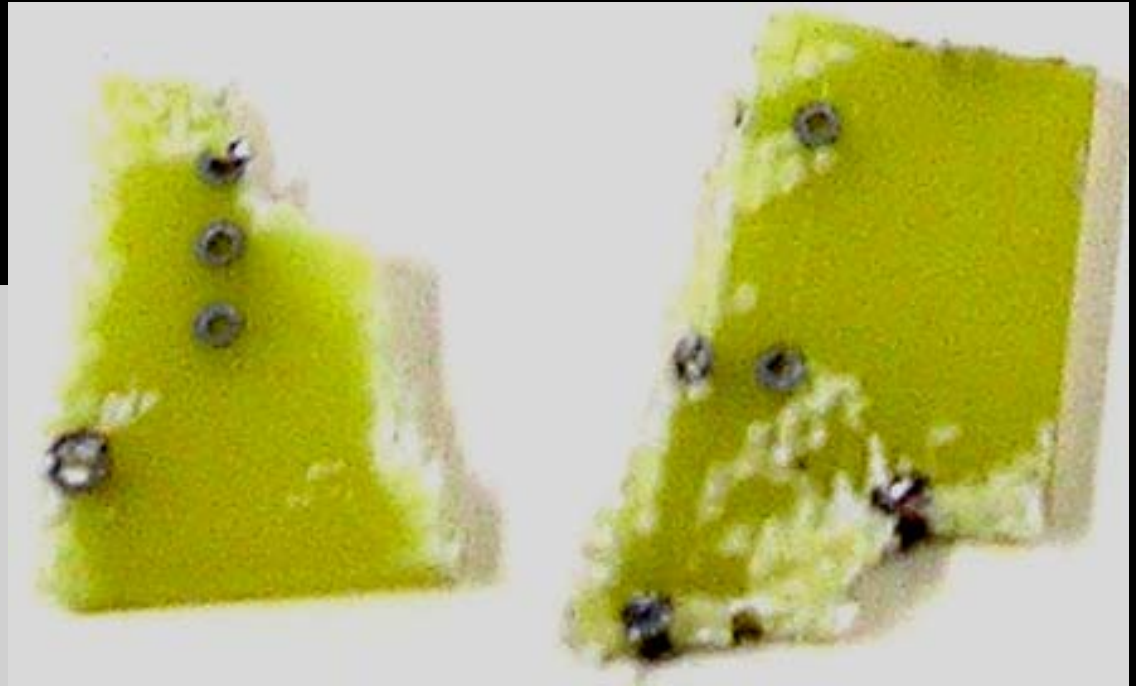
**POST CLEANUP**  
How long do  
contaminants stay  
in a recirculated  
atmosphere?

**VAPOR  
EMISSIONS IN  
AIR  
(aka smells)**

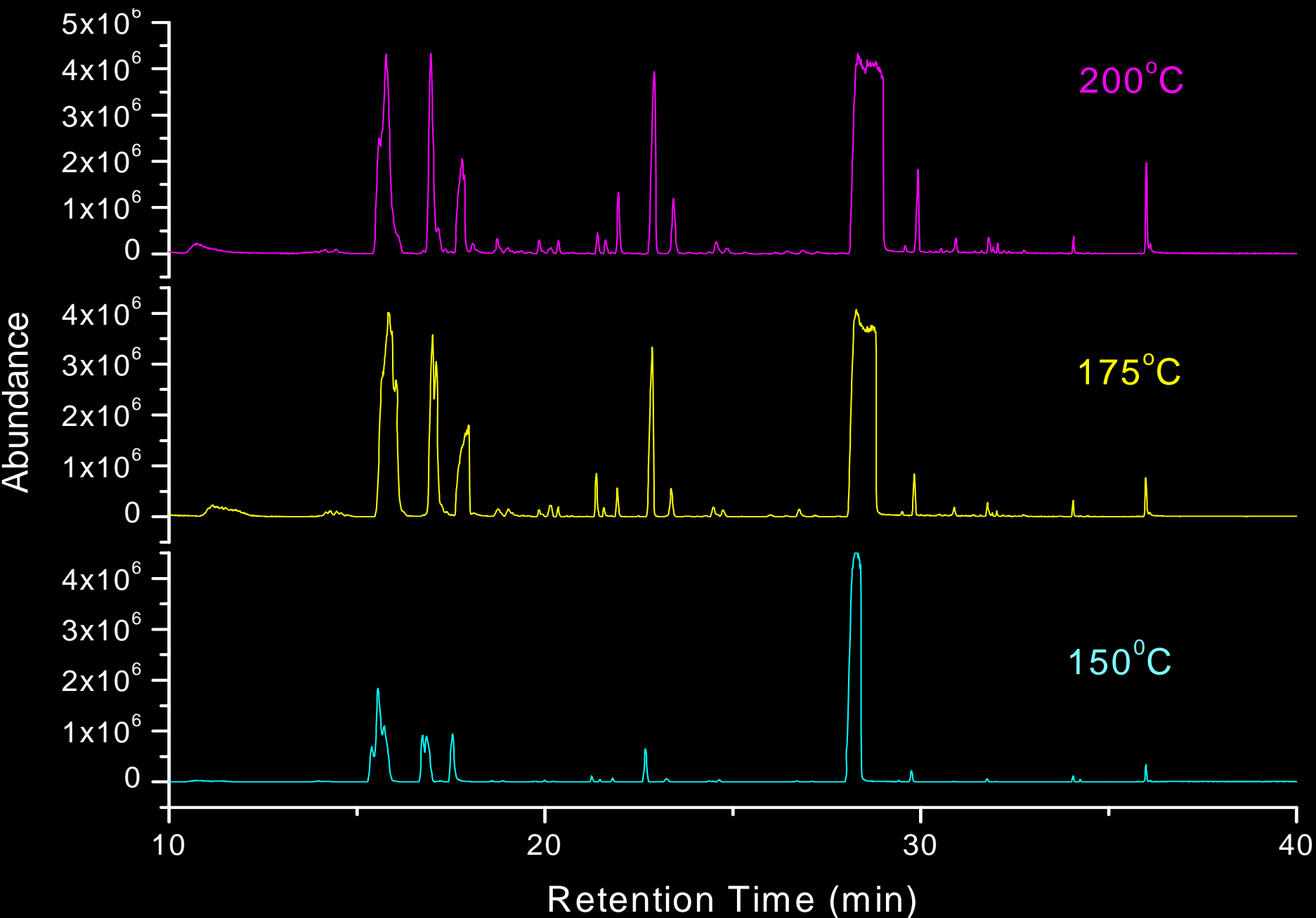
**DETECT  
VAPORS USING  
FAST  
SELECTIVE AND  
SENSITIVE  
SENSORS**

**FIRE**

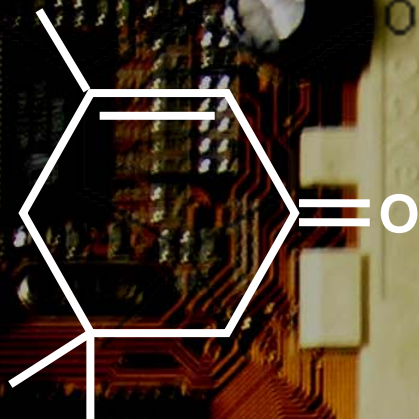
# EXAMPLES OF CHANGES IN ELECTRONIC CIRCUIT BOARD WITH HEAT



# VAPORS FROM RESISTOR (1 WATT)



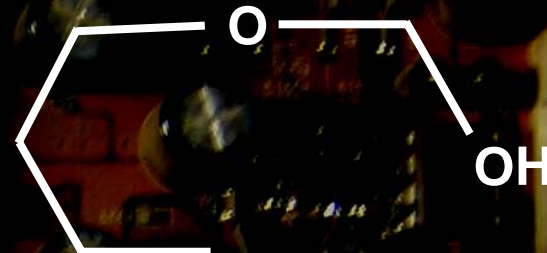
# IDENTITIES OF VAPORS FROM A RESISTOR (1 WATT)



isophorone



1, 3 dimethyl-  
benzene



2-n-butoxy-1-  
ethanol



benzaldehyde



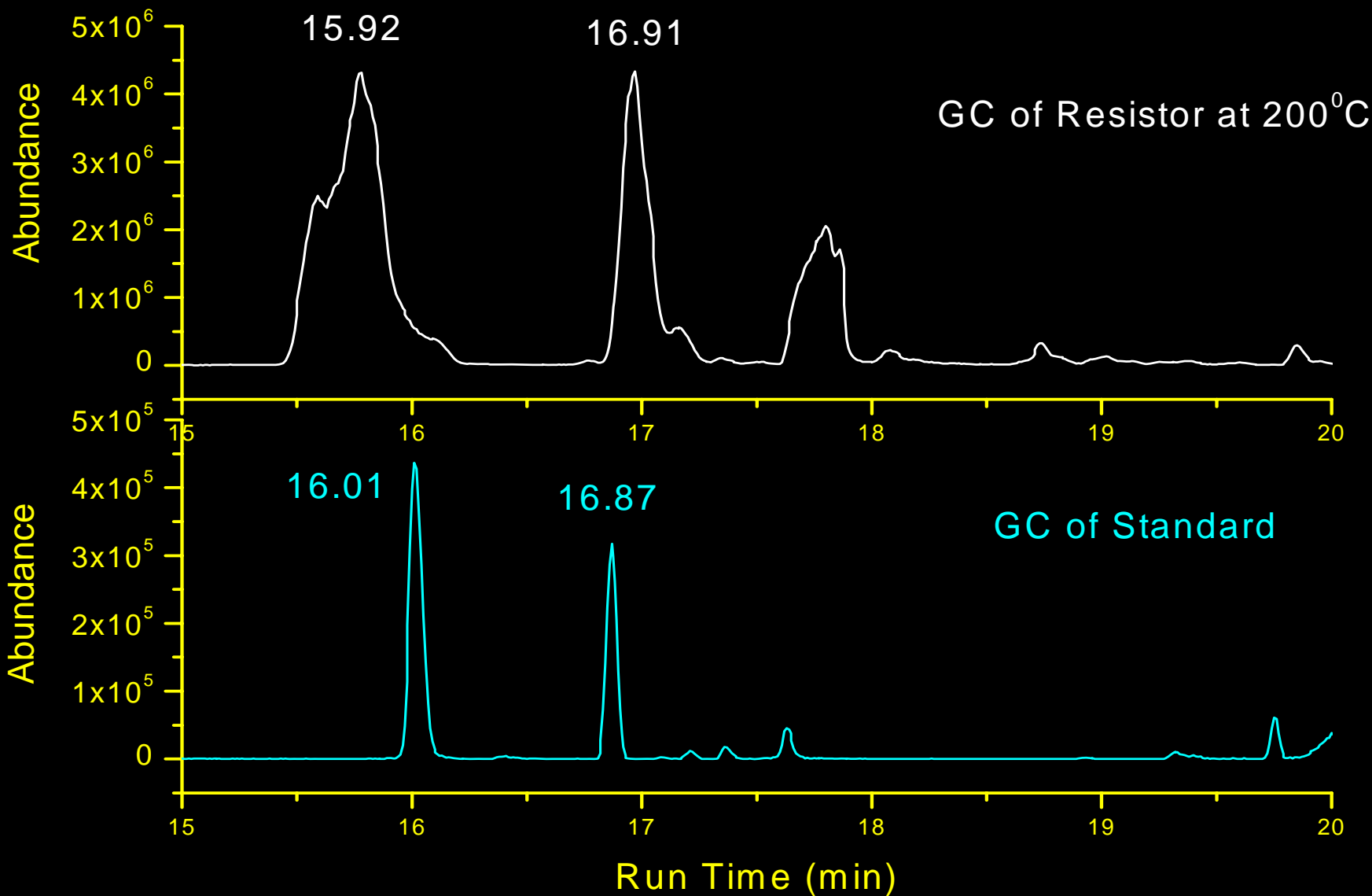
cetoisophorone



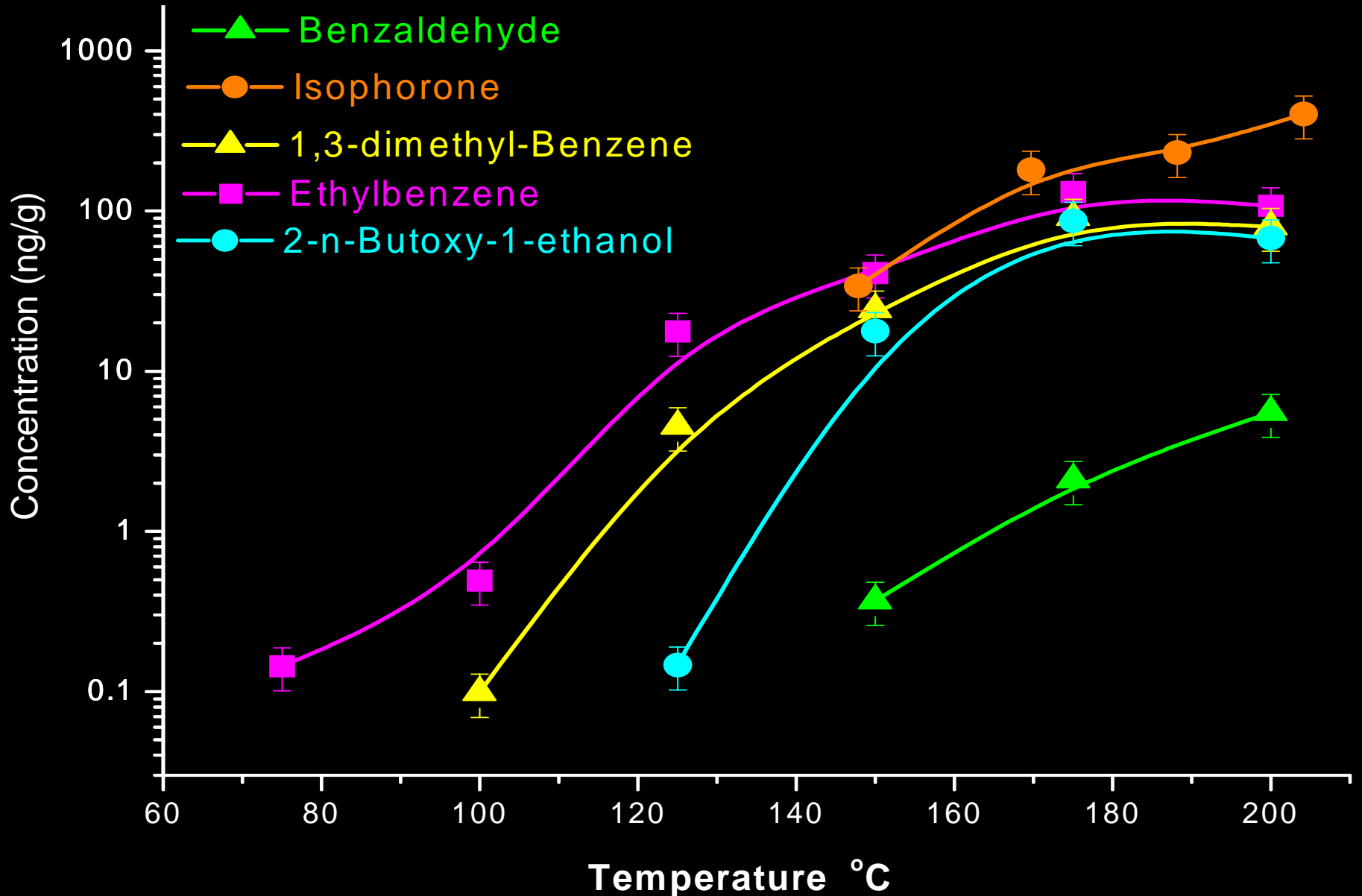
ethylbenzene

# CONFIRMATION OF VAPOR IDENTITIES WITH CHEMICAL STANDARDS

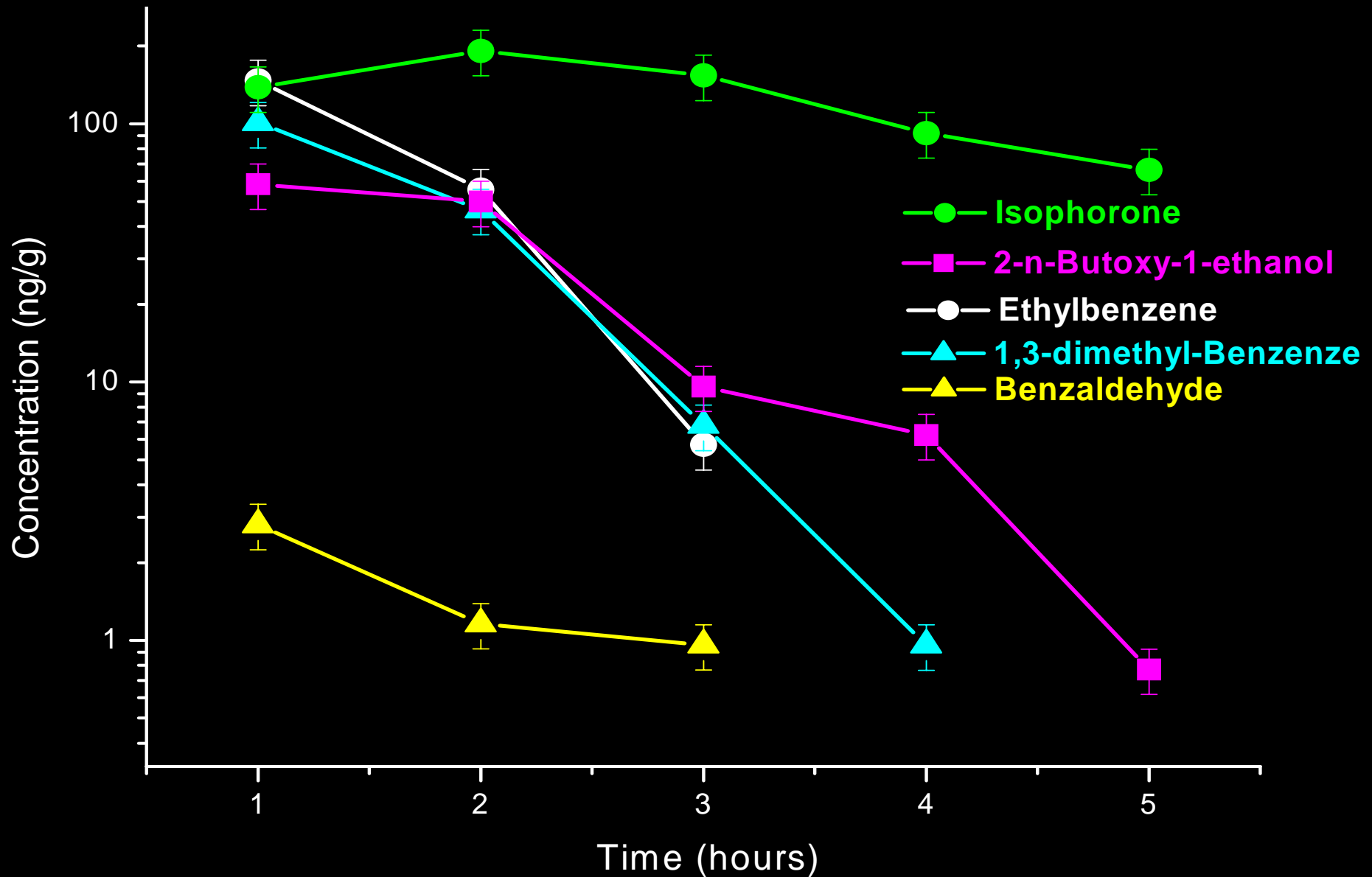
Ethylbenzene 1,3 dimethyl-Benzene



# HOW MUCH CONTAMINANT IS RELEASED INTO AIR FROM RESISTOR?



# HOW LONG DO CONTAMINANTS RELEASED INTO AIR FROM RESISTOR?

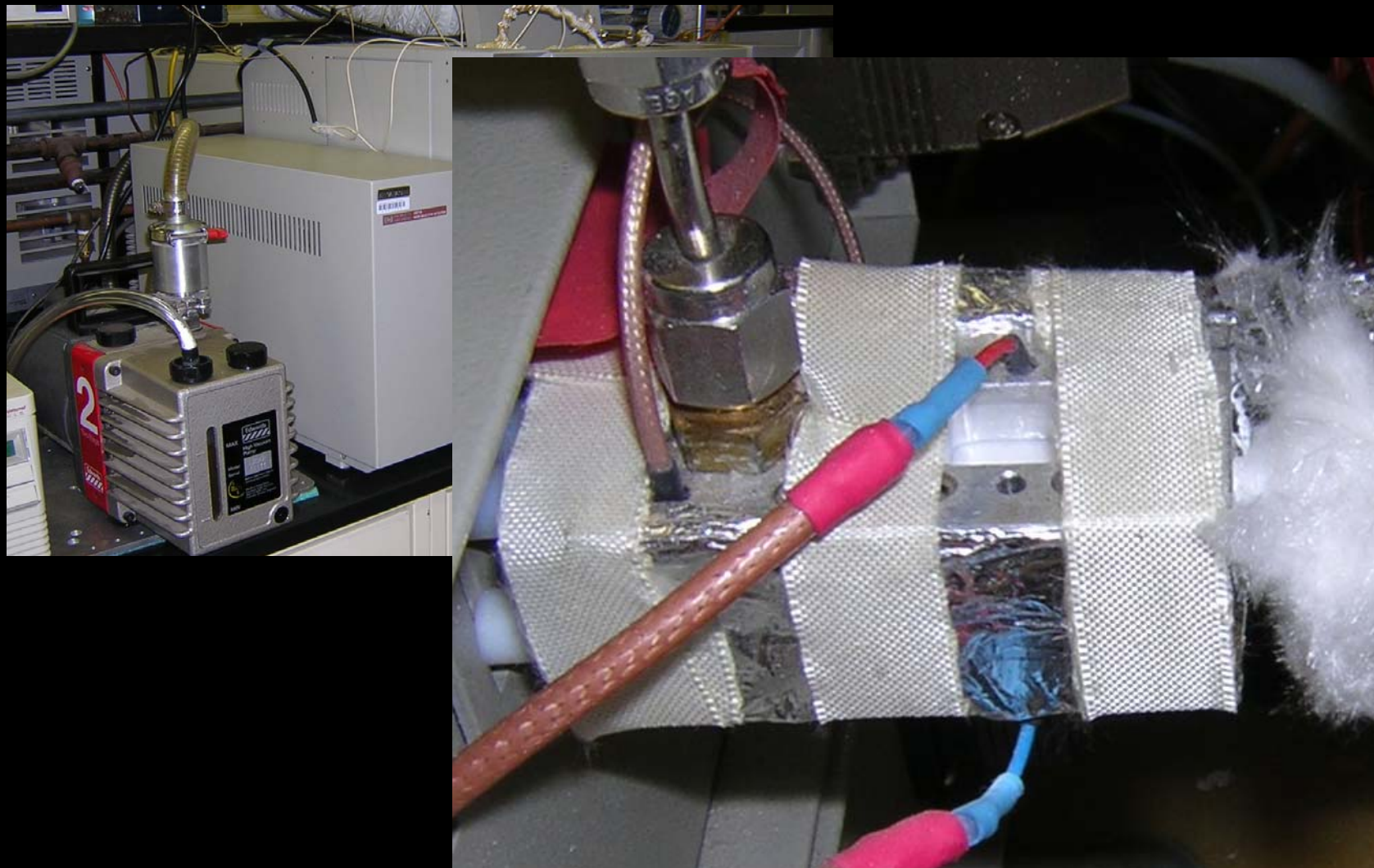


# AMOUNTS OF CONTAMINANT (ng/g) RELEASED INTO AIR FROM RESISTOR W/ TEMPERATURE

	TEMPERATURE °C					
	75	100	125	150	175	200
Ethylbenzene	0.14	0.49	17.69	40.84	131.56	107.46
1, 3-dimethyl-benzene	-	0.10	4.54	24.27	91.03	79.92
2-n-Butoxy-1-ethanol	-	-	0.15	17.83	86.88	67.67
Benzaldehyde	-	-	-	0.37	2.10	5.52
Isophorone	-	-	33.99	181.13	231.35	402.54

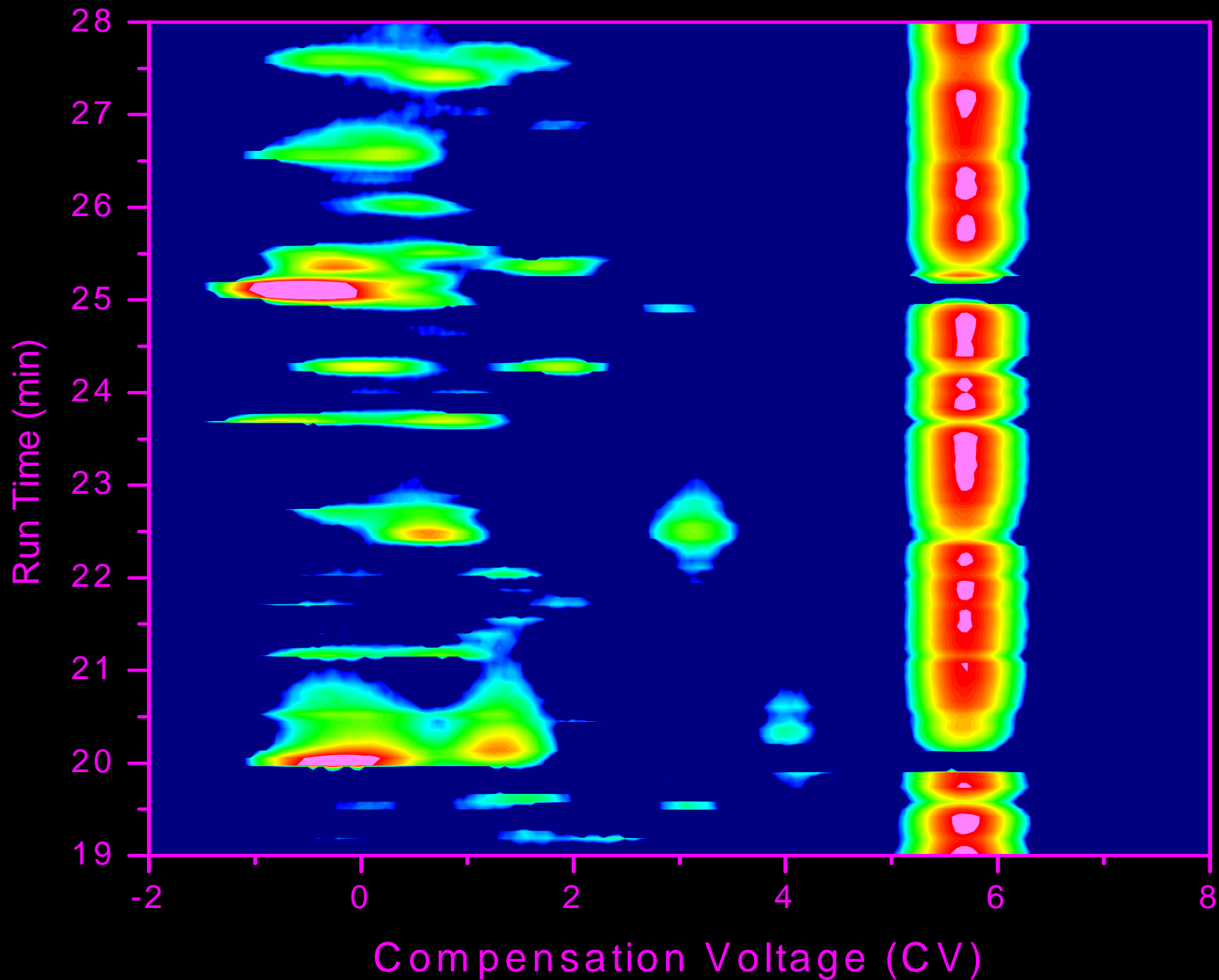
Chemical	Component	TEMPERATURES °C					
		75	100	125	150	175	200
	<b>Capacitor</b>						
?-Methylstyrene		0.47	2.32	6.85	21.46	69.71	82.72
Benzaldehyde		0.27	0.64	1.22	3.71	16.98	19.51
Acetophenone		0.25	1.12	2.43	4.43	24.36	22.88
2-ethyl-1-Hexanol		4.29	35.63	39.20	44.23	64.26	63.00
Isophorone			12.05	12.65	14.01	13.16	< 2.00
	<b>Resistor</b>						
Ethylbenzene		0.14	0.49	17.69	40.84	131.56	107.46
1, 3-dimethyl-Benzene (m-xylene)			0.10	4.54	24.27	91.03	79.92
2-n-Butoxy-1-ethanol				0.15	17.83	86.88	67.67
Benzaldehyde					0.37	2.10	5.52
Isophorone				33.99	181.13	231.35	402.54
	<b>Transformer</b>						
3-methyl-Phenol (m-Cresol)						2.76	43.42
2,4-dimethyl-Phenol						3.47	46.54
3-Ethylphenol						8.79	96.42
Decanal		0.08	0.35	1.18	< 1.00		
Nonanal		0.01	0.04	1.15	0.66		
Tetradecane		1.38	5.46	10.96	0.45		
	<b>Diode</b>						
Benzaldehyde							1.62
Decanal							0.32
Dodecanal							0.16
Nonanal							0.03
	<b>Transistor</b>						
Benzaldehyde						3.95	7.81

# REPLACE LARGE, POWER-CONSUMING MASS SEPECTROMETER WITH SMALL ANALYZER

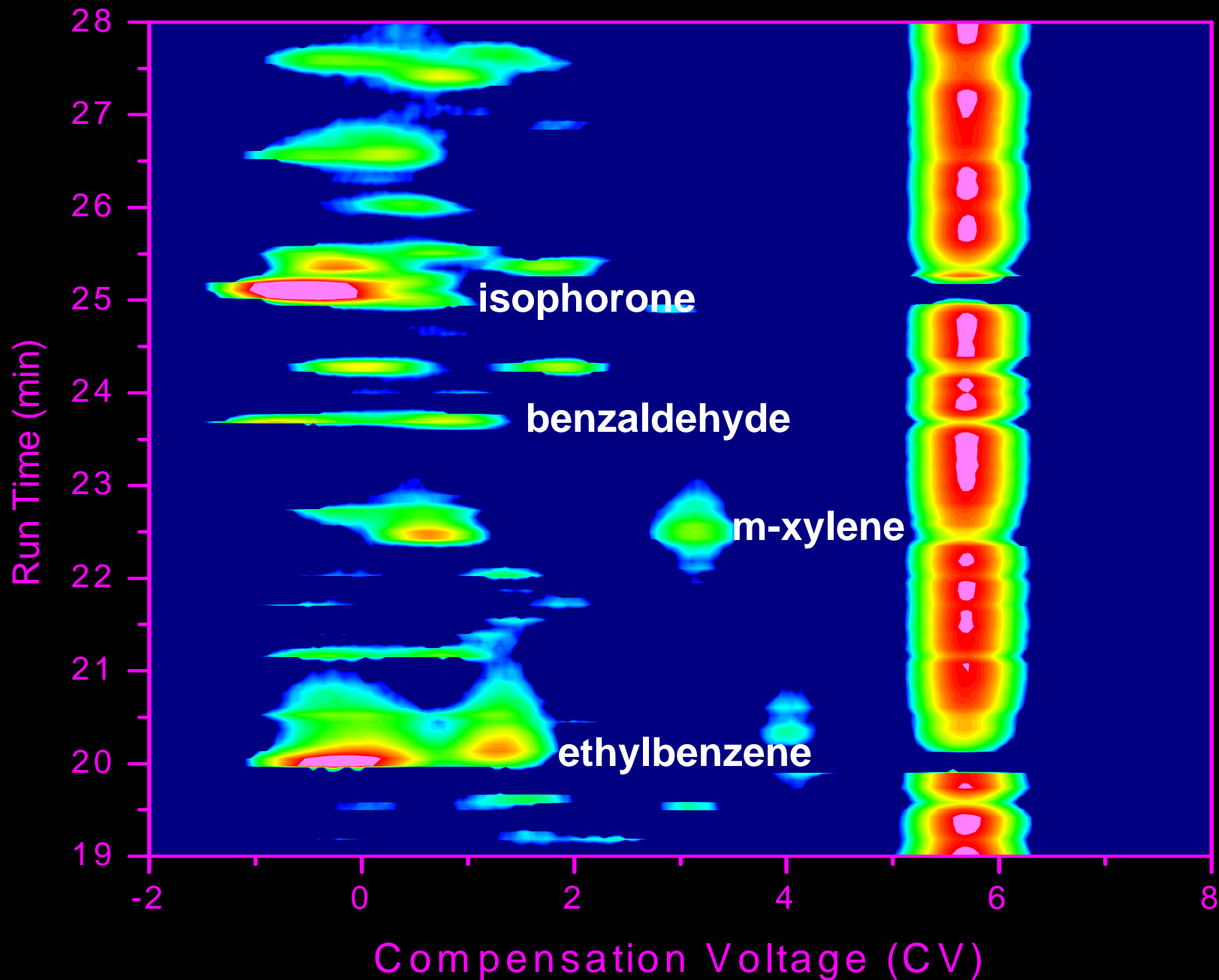


**Micro-fabricated differential mobility spectrometer**

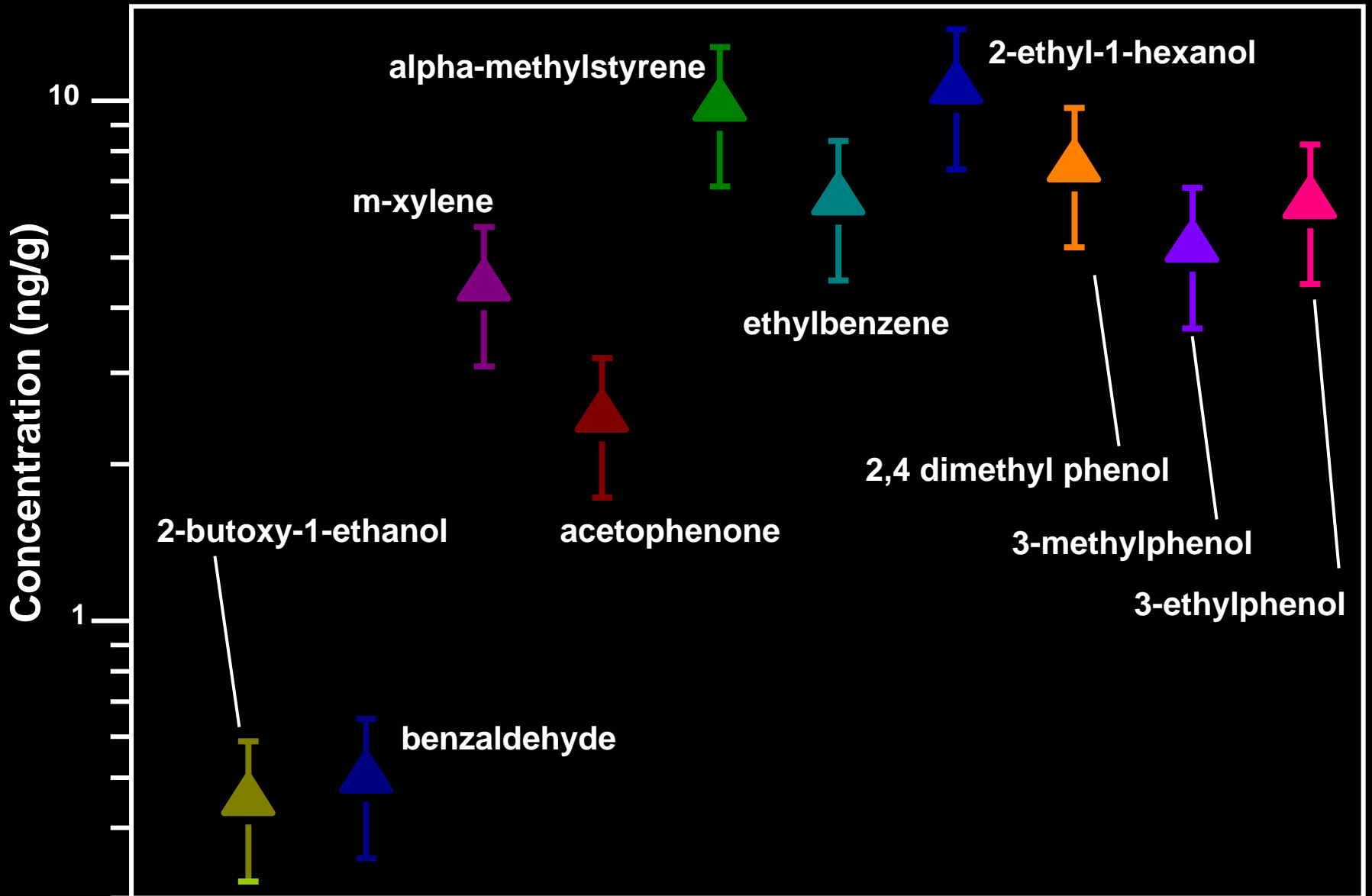
# VAPORS FROM RESISTOR BY GC/DMS



# VAPORS FROM RESISTOR BY GC/DMS



# DETECTION LIMITS FOR VAPORS USING GC DMS



# CHROMATOGRAPHY = “ME TIME” HOW TO DO FAST MEASUREMENTS?



**HAND HELD MOBILITY SPECTROMETRY**

# REDUCED SIZE MOBILITY SPECTROMETER



# DIFFERENTIAL MOBILITY SPECTROMETRY

# CONCLUSIONS

- a. Substances released from electronic circuit boards, component by component, identified**
  
- b. Quantitative levels in 10 to 500+ ng/g and affected by temperature and exposure time**
  
- c. Technology of hand held mobility analyzers suitable for continuous monitoring of vapors**
  
- d. Soon ready for practical trials including matrix interference studies**

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# Questions ?

