Electronic Supplementary Material (ESI) for Lab on a Chip

Supplementary Information:

Smart multi-channel two-dimensional micro-gas chromatography for rapid workplace hazardous volatile organic compounds measurement

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Higher hierarchy of multi-channel multi-dimensional μGC

The illustration of 1x3 channel 2-D μGC and 1x2x4 channel 3-D μGC is shown in Fig. S1.

Control/operation algorithm

The control/operation algorithm included two major modules: peak identification module and system control module.

The peak identification module was implemented by using a Schmitt trigger coded in LabView™ to analyze the signal from the detector. Each detector in the smart 2-D μGC (1st Detector, 2nd Detector A and B) had one Schmitt trigger attached. Two thresholds were set to the Schmitt trigger (see Fig. S2): a high threshold to identify the elution peak from noise and a low threshold to judge whether the peak has passed through the detector. When the vapor sensing signal from the detector exceeded the high threshold, the operation algorithm registered one elution peak to its respective detector and waited for the vapor sensing signal to fall below the low threshold. Once a pair of such vapor sensing signals was received, a "peak passed" signal was sent to the system control module.

The system control module controlled the operation of Three-port valve A and B, Thermal injector A and B, and temperature ramping of 1st Column. It was implemented by both software and hardware (see Fig. S3). The software control received the "peak passed" signals from all detectors to decide which and when the trigger signal(s) to be sent out. Each component listed above had one specific trigger signal to activate its corresponding hardware control. The activation of hardware by the trigger signal was controlled through a relay, which toggled the connection between this component and its power supply. When the trigger signal stayed at a

low voltage (0 V), the relay disconnected the component from the power supply. When the trigger signal sent a high voltage (5 V), the relay connected the component to the power supply.

Calculation of the 1st and 2nd retention time

The 1st and 2nd retention time was calculated by the following equations:

1st retention time=Elution time recorded by 1st Detector–Total prior suspension time in the 1st column.

2nd retention time=Elution time recorded by 2nd Detector–The time when the separation at the corresponding 2nd Column started (*i.e.*, when the thermal injector started to fire).

All the parameters in the above equations can be obtained directly from the real-time chromatograms from 1st and 2nd Detectors. We use the separation shown in Fig. S4 as an example, which is an enlarged part of Fig. 4(A). The solid (dashed) boxes represent the separation duration at the 1st (2nd) column, while the spaces outside the solid (dashed) boxes represent the duration when the separation at the 1st (2nd) column was suspended. The separation at the 1st column was suspended twice from 64 seconds to 71 seconds and from 143 seconds to 159 seconds, respectively. Consequently, the 1st retention time of Analyte #15 = 210 s (elution time recorded by 1st Detector) – 23 s (total prior suspension time in the 1st column) = 187 s. The 2nd retention time of Analyte #15 = 240 s (elution time recorded by 2nd Detector A) – 231 s (the time when the separation at 2nd Column A started) = 9 s.

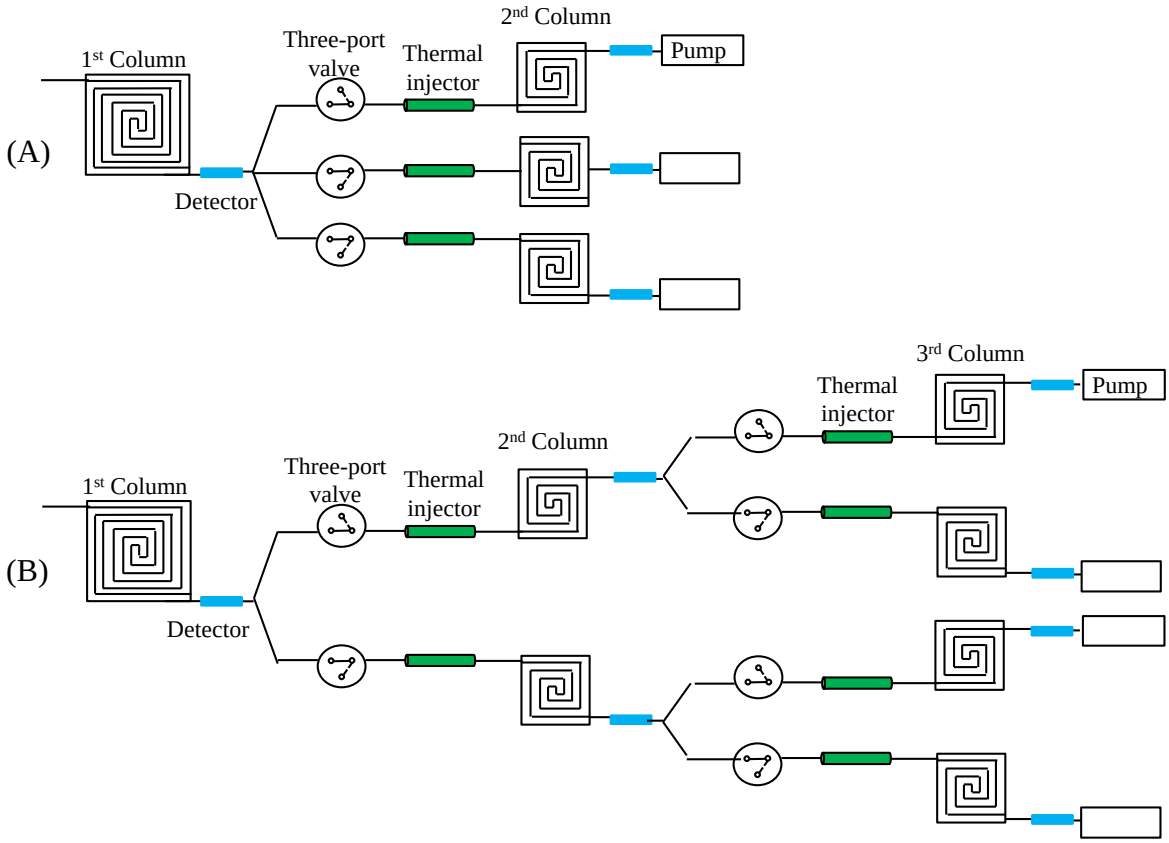

Figure S1. Conceptual illustration of (A) 1x3 channel 2-D μGC and (B) 1x2x4 channel 3-D μGC.

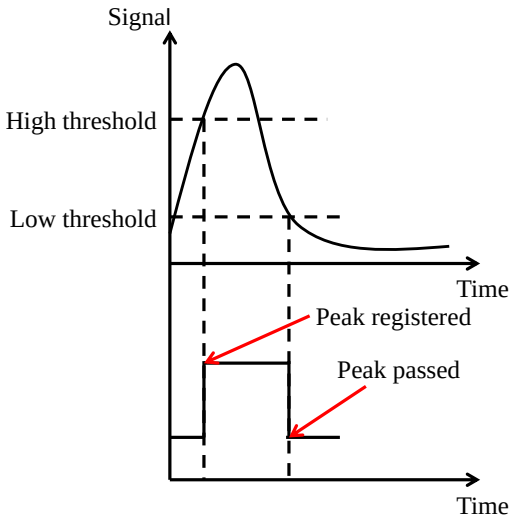

Figure S2. Illustration of a Schmidt trigger.

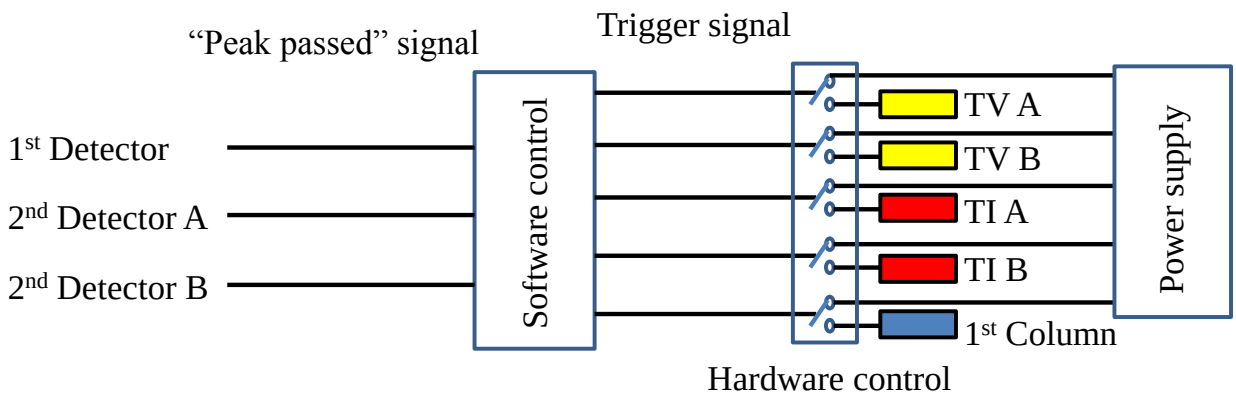

Figure S3. Schematic of the control/operation algorithm. TV: three-port valve; TI: thermal injector.

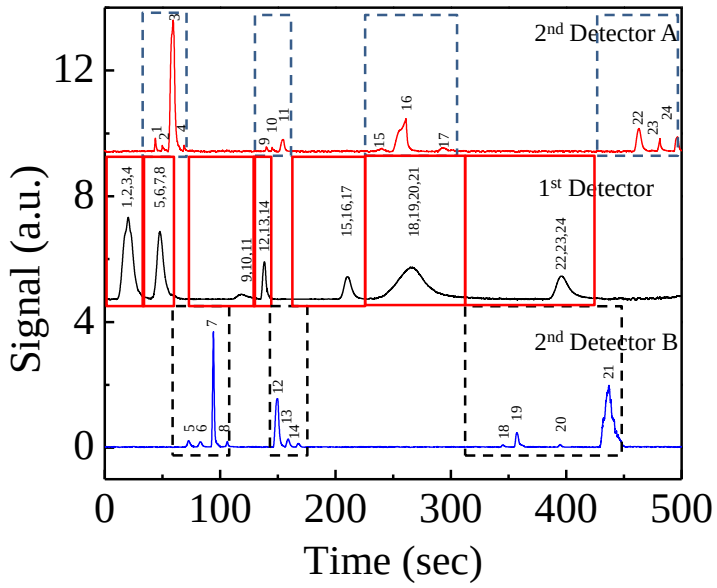

Figure S4. An enlarged part of Fig. 4(A). Solid (dashed) boxes represent the separation duration at the 1st (2nd) column, while spaces outside the solid (dashed) boxes represent the duration when the separation at the 1st (2nd) column was suspended. Note that for better illustration, the entire real-time chromatograms for 1st Detector and 2nd Detector A are vertically rearranged in comparison with the original Fig. 4(A).